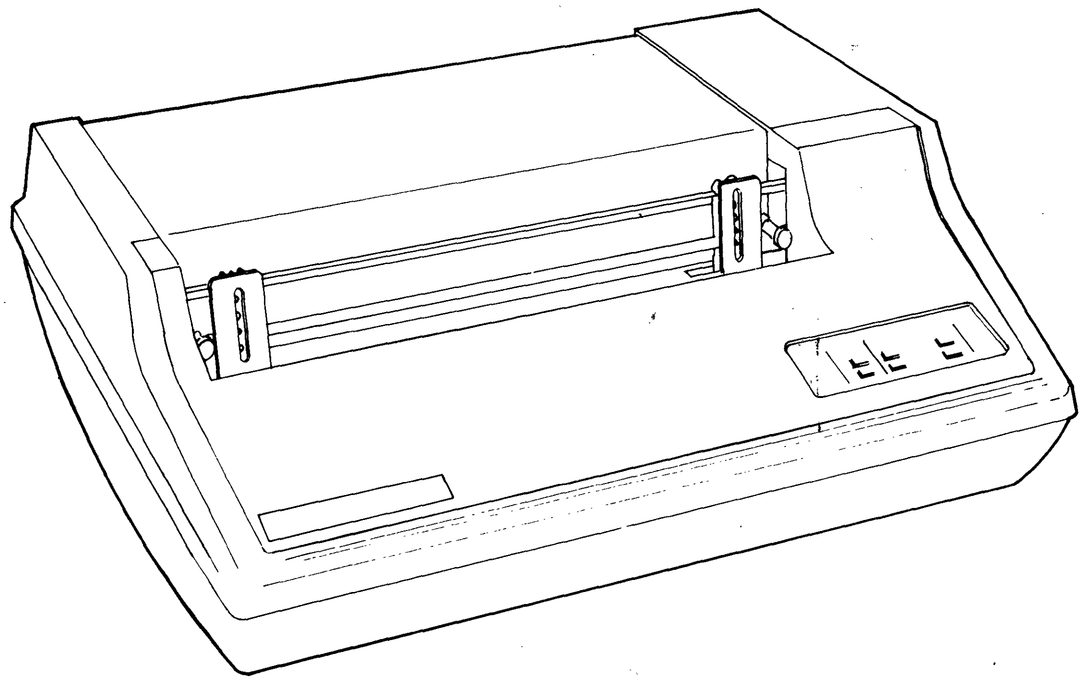
OMNI 800
electronic data terminals



MAINTENANCE MANUAL FOR MODEL 810 PRINTER

MANUAL NO. 994386-9701 Rev. B
Revised 1 June 1978

TEXAS INSTRUMENTS
INCORPORATED

INSERT LATEST CHANGED PAGES.DESTROY SUPERSEDED PAGES

LIST OF EFFECTIVE PAGES

Note: The portion of the text affected by the changes is indicated by a vertical bar in the outer margins of the page.

Maintenance Manual for Model 810 Printer
Manual No. 994386-9701
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Total number of pages in this publication is 342 consisting of the following:

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CHANGE NOTICES

Revision Letter	Date	ECN Number	ECN Level	Description
A	3/15/78	432918	D	Update drawings, add preventive maintenance information
B	6/1/78	432332	D	Correct errors; add Line Buffer Option Drawings and Installation Instructions.

PREFACE

This manual provides operation, installation, and maintenance information for the Model 810 Printer manufactured by Texas Instruments Incorporated. The manual is organized into the following sections:

Section I — describes the standard features of the Model 810 and lists specifications and available options and accessories.

Section II — presents installation instructions, including unpacking, interface cabling, and initial preparation and testing.

Section III — provides descriptions of the control panels and indicators, operating instructions, self-help procedures, interface information, and software commands.

Section IV — explains principles and theory of operation of the mechanism and electronics.

Section V — describes maintenance, including troubleshooting, assembly removal and replacement, and preventive maintenance.

Section VI — contains assembly drawings and associated parts lists.

Section VII — presents logic diagrams and electrical schematics.

Various options available for the Model 810 Printer are identified throughout this manual by a three-letter configuration code. The options installed in your printer can be determined from the configuration label on the underside of the access door. We suggest you copy this information onto the figure for ready reference to the user of this manual. The code is defined in the table below.

CONFIGURATION

PRINTER	INTERFACE OPTION	CHARACTER SET	
BSC ____	EIA ____	FUL ____	UKF ____
FLC ____	TTY ____	UKL ____	DNF ____
VFC ____	PLT ____	DNL ____	SWF ____
FCO ____	LBE ____	SWL ____	GRF ____
VCO ____	BRO ____	GRL ____	KAT ____
	DSC ____	EXP ____	KTS ____
PROCESSOR	IRC ____		
OPTIONS	DNB ____		
NDE ____	GDS ____	NOTES:	
DNB ____	GED ____		
IRC ____	LBP ____		
LB ____	DSC ____		
BRO ____	GDS ____		
	LBT ____		
	HDP ____		
	BRO ____		
	DSC ____		
	GDS ____		

DEFINITIONS OF PRINTER CONFIGURATION CODE

BRO – Baud Rate Option
BSC – Basic
DNB – Data Terminal Not Busy
DNF – Denmark/Norway Full ASCII
DNL – Denmark/Norway Limited ASCII
DSC – Decode Carriage Return
EIA – Serial Data
EXP – Expanded Domestic U.S.
FCO – Forms Length & Compressed Print
FLC – Forms Length Control
FUL – Full ASCII Domestic U.S.
GDS – Gated Data Strobe
GED – Gated EIA Data
GRF – Germany Full ASCII
GRL – Germany Limited ASCII
HDP – Half Duplex Operation
IRC – Inverted/Reverse Channel
KAT – Katakana & Full US ASCII
KTS – Katakana plus Six Special Characters, Full US ASCII
LB – Line Buffer
LBE – Line Buffer bd, EIA I/F
LBP – Line Buffer bd, Par I/F
LBT – Line Buffer bd, TTY I/F
NDE – Non-Delete Recognition
PLT – Par Input TI-compatible
SWF – Sweden/Finland Full ASCII
SWL – Sweden/Finland Ltd. ASCII
TTY – 20 mA Current Loop
UKF – United Kingdom Full ASCII
UKL – United Kingdom Ltd. ASCII
VCO – Vertical Format Control and Compressed Print
VFC – Vertical Format Control

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SECTION I

GENERAL DESCRIPTION

1.1 INTRODUCTION.

This section of the manual contains a general description of the Texas Instruments Model 810 Printer shown in Figure 1-1. Specifications and features are listed in Table 1-1.

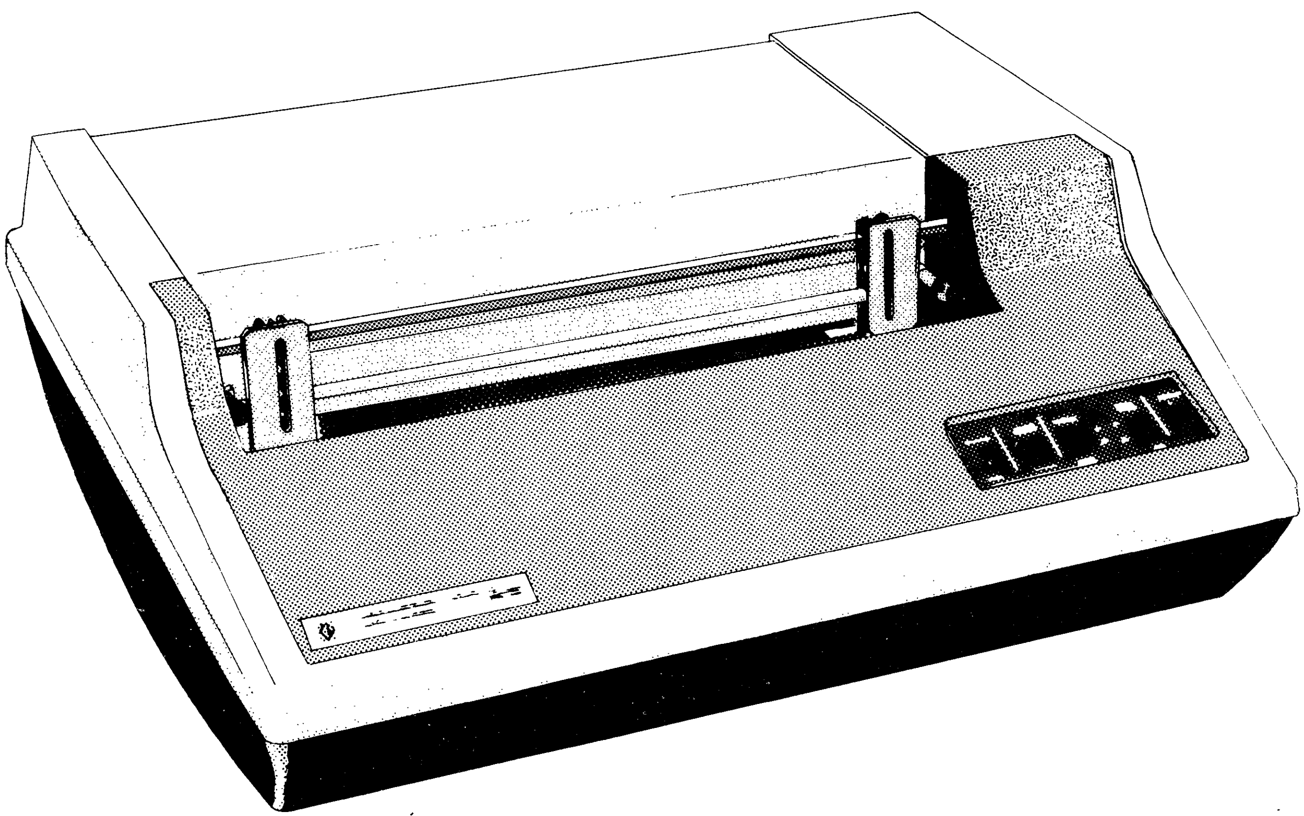

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Figure 1-1. Model 810 Printer

Table 1-1. Standard Features and Specifications

CHARACTERISTICS	SPECIFICATION
PRINTING	
Technique	Wire matrix impact
Character matrix	9 x 7 (9 wide, 7 high) dot matrix
Character set	64-character ASCII
Characters per inch	10
Characters per line	132 maximum
Lines per inch	6 or 8 (operator or software selectable)
THROUGHPUT	
Print speed	150 characters per second
Lines per minute	64 at 132 characters per line, and up to 450 at 10 characters per line
Line feed	33 milliseconds
Paper slew	17.7 cm per second (7 inches per second)
PAPER HANDLING	
Paper width	Adjustable from 7.6 to 38.1 cm (3 to 15 inches)
Paper loading	Rear or bottom feed
Number of copies	One original and five copies
CONTROL SYSTEM	
Electronics	TMS 8080 microprocessor system
Printing method	Bidirectional
Buffer (FIFO) capacity	256 characters
Horizontal tabs	Software programmable
Vertical format control	Software and operator programmable
Self-test	Prints ASCII characters in a rotating pattern (barber pole)
Bell	Pulsing audible tone
COMMUNICATIONS	
Interface	Serial (EIA RS-232-C)
Baud rates	110, 150, 300, 1200, 2400, 4800, 9600
Parity	Odd, even, or ignore
INPUT POWER	
AC voltage	100, 120, 220, or 240 Vac (+10% to −15%)
Frequency	47 to 63 hertz
Power consumption	200 watts maximum
Power fuse	100 or 120 Vac range requires 5 amp., 250 V fuse 220 or 240 Vac range requires 2.5 amp., 250 V fuse
ENVIRONMENT	
Mounting	Table top
Operating temperature	+5°C (+37°F) to +40°C (+104°F)
Storage temperature	−30°C (−22°F) to +70°C (+158°F)
Operating humidity	5% to 90% (no condensation)
Storage humidity	5% to 95% (no condensation)
PHYSICAL	
Weight	25 kilograms (55 pounds)
Height	20.3 cm (8 inches)
Width	65.4 cm (25-3/4 inches)
Depth	50.8 cm (20 inches)

1.2 DESCRIPTION.

The Model 810 Printer is a receive-only, forms programmable, impact printer. The printer features a microprocessor system which controls all character recognition, printing, and paper movement. Basic operating, data processing, and self-test routines for the microprocessor system are resident in read-only memory (ROM). Random-access memory (RAM) stores vertical format control routines which are locally programmable by the operator or remotely programmable through the communications line.

A single printhead produces a seven-dot column which forms the 9 x 7 dot matrix used for character generation (see Appendix A). The ASCII 64-character set is standard; a complete ASCII 95-character set (see Appendix B) and other character sets are available as options. Printing is bidirectional at the rate of 150 characters per second. A full 132-character line is printed in less than 1 second.

Standard print format is ten characters per inch horizontally and six or eight lines per inch vertically. An option is available to add 16.5 characters per inch (compressed print) capability. The printer produces one original and up to five copies using sprocket-fed paper in widths from 7.62 to 38.1 centimeters (3 to 15 inches).

In addition to the standard serial interface, a parallel interface or a TTY current loop interface is also available as an option.

1.3 CONFIGURATION.

The Model 810 Printer is available in five different versions:

PART NUMBER	CODE	TYPE
994292-0001	BSC	Basic
994292-0002	FLC	Forms Length Control
994292-0003	VFC	Vertical Format Control
994293-0001	FCO	Forms Length, Compressed Print
994293-0002	VCO	Vertical Format Control, Compressed Print

Complete identification of the options (see paragraph 1.5) installed in each printer is provided on the underside of the access door using three-letter configuration codes.

1.4 MODIFICATION FEATURES.

The following standard modification features are available in all printers:

- Ability to enable or disable the NDE option (recognition of DELETE characters) on processor board . To enable install Berg connector between terminals E2 and E3. To disable (NDE printer option) install Berg connector between terminals E1 and E2.

- Ability to modify the DNB option (busy or not busy on DTR line). Install Berg connector between terminals E4 and E5 on processor board for DTR = ON LINE only and secondary request to send (SCA) signal not busy. Install Berg connector between terminals E5 and E6 for DTR = ON LINE and NOT BUSY (DNB printer option).

- Ability to modify the IRC option (reverse channel signal). Connect Berg connector between terminals E8 and E9 (on processor board -0002 only) for asserted signal HIGH (standard). Connect Berg connector between terminals E7 and E8 for asserted signal LOW (IRC printer).
- Bell option. Disconnect R99 connection on Power Supply board to disable bell.

1.5 OPTIONAL FEATURES.

The following features (identified by configuration code in parentheses) are offered as options:

Full ASCII 95-character set (FUL)

European (DNF, DNL, SWF, SWL, UKF, or UKL) and other character sets

Texas Instruments-compatible (PLT)

TTY 20-mA neutral current loop (TTY)

Selectable forms lengths (FCO or FLC)

Vertical Format Control, non-volatile eight-channel memory (VCO or VFC)

Compressed print 16.5 characters per inch (FCO or VCO)

Elapsed Time Indicator

Line Buffer Option Kit (See Appendix F for installation instructions).

1.6 ACCESSORIES.

The following items are available as accessories:

Paper Basket

Floor Mounting Stand

Interface Cable (See cabling information in Section II for selection of cables.)

SECTION II

INSTALLATION

2.1 INTRODUCTION.

This section provides information for selecting the installation site, unpacking and setting up the printer, and ensuring that the printer is operating properly.

2.2 SPACE REQUIREMENTS.

The printer occupies a flat surface area 65.4 centimeters (25.75 inches) wide by 58.4 centimeters (23 inches) deep including cable clearance of 7.6 centimeters (3 inches) . See Figure 2-1 for printer outline dimensions. Space must be provided for adequate ventilation. Particular care must be taken to prevent blocking the cooling fan intake and exhaust louvers (on either side of the printer). An unobstructed paper feed path must be provided behind or below the printer for the paper supply. A method of holding the printed output must also be provided if the optional paper basket accessory is not used. The printer should be so located as to allow easy access to the operator controls. The printer should not be placed in an environment where humidity, temperature, or other specifications listed in Section I may be exceeded. A sturdy table capable of adequately supporting 25 kilograms (55 pounds) is suitable if the optional floor mounting stands are not used. Regardless of the mounting selected, care must be taken to ensure that the paper chute underneath the printer does not bear any weight of the printer and is not subjected to any pressure which could deform it.

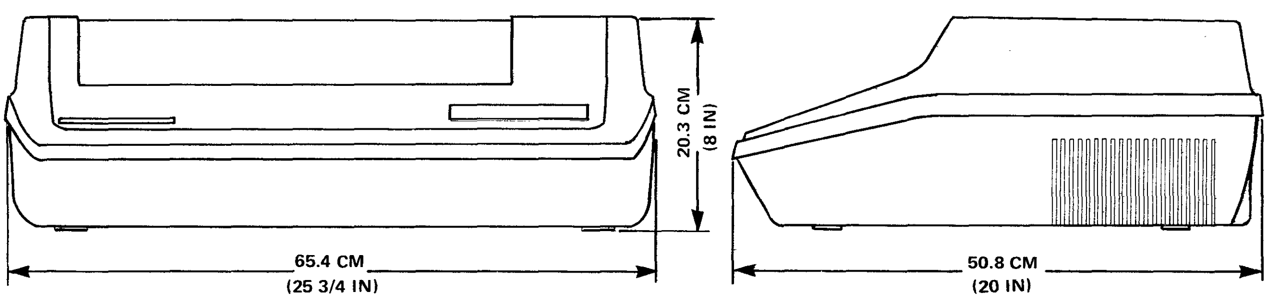

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Figure 2-1. Printer Dimensions

2.3 UNPACKING AND SETTING UP.

To remove the printer from its shipping carton and place the printer in its normal operating location, perform the following procedure.

1. Examine shipping carton for apparent damage. If any damage is observed, note nature of damage and follow local procedure for handling damaged shipments.

2. Place shipping carton on floor and open top of shipping carton.

3. Remove loose items from shipping carton.

4. Using an assistant, grip printer close to styrofoam end caps (at either end of printer), lift printer from shipping carton, and place printer on table or optional floor mounting stand.

5. Remove styrofoam end caps.

6. Remove two mechanism shipping snubbers and related hardware underneath printer.

7. Open access door, remove styrofoam block covering printhead, and remove rubber band wrapped around printhead.

8. Slide printhead from stop to stop and check that printhead and attached wire rope move freely and that wire rope is not unstrung.

9. Close access door.

10. (If applicable) Install optional paper basket.

2.4 CABLING AND GROUNDING INFORMATION.

The communications interface connector (or connectors) is located at the right rear of the printer (Figure 2-2). All printers have an EIA Standard RS-232-C interface connector for serial input. A parallel or a TTY interface connector is available as an option. The logic (signal) ground is connected to the safety (chassis) ground by a jumper from E6 to E7 on the motherboard (Figure 2-3). The logic ground can be isolated from the safety ground by cutting this jumper. To gain access to ground jumpers remove the top cover, electronics cover, and the printed circuit boards (refer to Section V). Cables for various input devices are available as options. Refer to Figure 2-4 for cabling requirements to the indicated input devices.

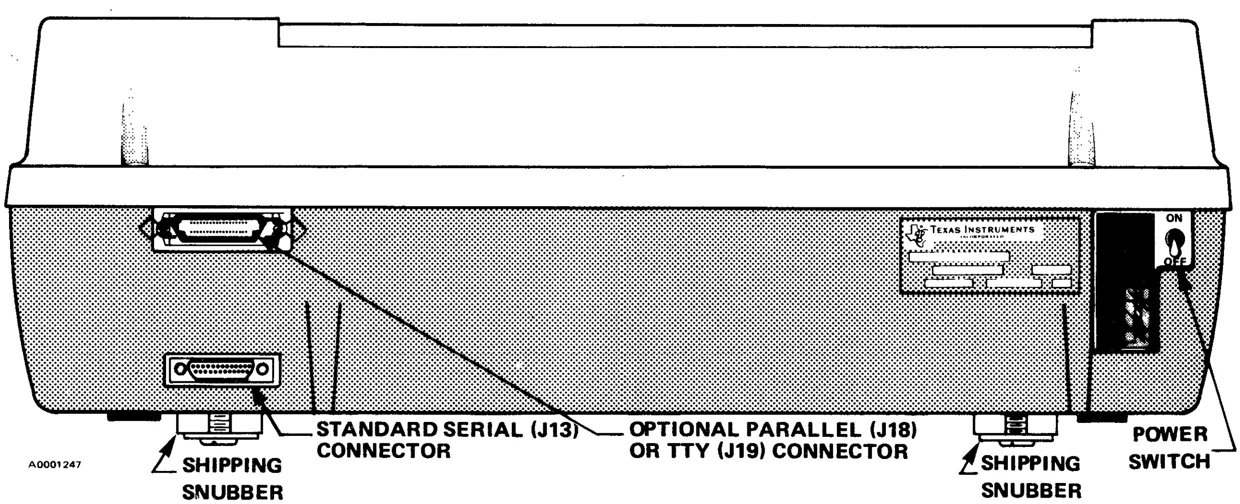


Figure 2-2. Rear View of Printer

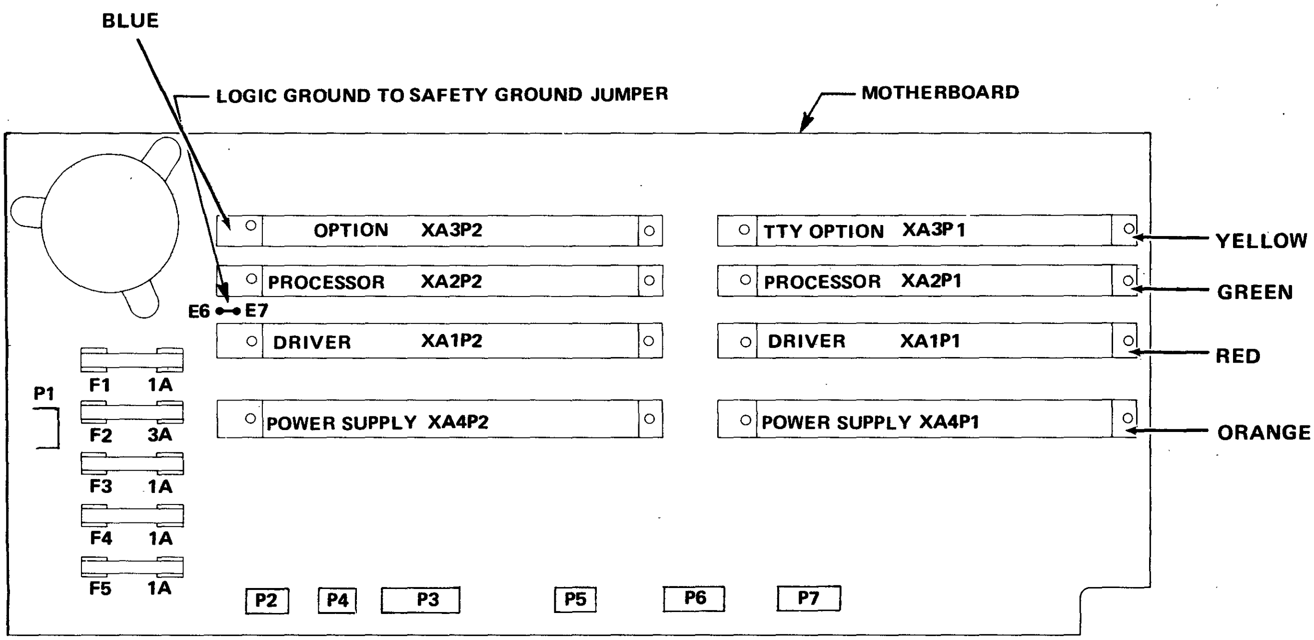
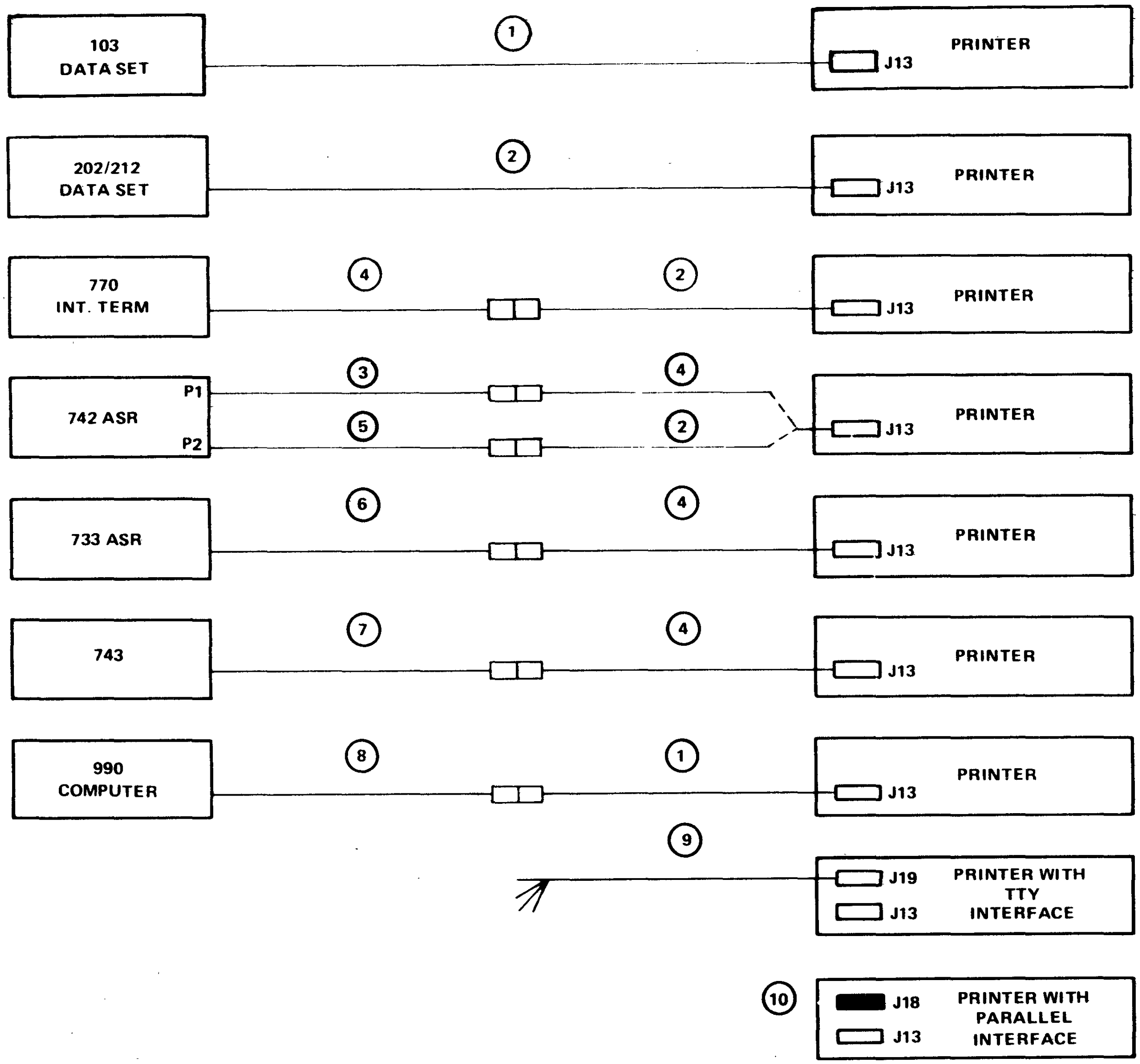


Figure 2-3. Ground Jumper And PC Board Locations

2.4.1 SERIAL INTERFACE CABLE (EIA). The printer serial interface connector J13 requires a 25-pin connector (AMP 205208-1 or equivalent) with signal lines connected as follows:

PIN	SIGNAL NAME	EIA (CCITT) DESIGNATION
1	Protective Ground	AA (101)
2	Transmitted data	BA (103)
3	Received data	BB (104)
4	Request to send	CA (105)
5	Clear to send	CB (106)
6	Data set ready	CC (107)
7	Signal ground	AB (102)
8	Received line signal detector (carrier detect)	CF (109)
9	+12 volts	NA
10	−12 volts	NA
11	Secondary request to send (reverse channel)	SCA (120)
20	Data terminal ready	CD (108.2)

Recommended maximum length is 6 meters (20 feet).



ITEM NUMBER	PART NUMBER	DESCRIPTION	LENGTH METERS	(FEET)
1	993204-0001	103 DATA SET CABLE	1.8	(6)
2	993205-0001	202/212 DATA SET CABLE	1.8	(6)
3	969626-0001	742 TERMINAL CABLE	1.8	(6)
4	993210-0001	DATA TERMINAL CABLE	1.8	(6)
5	973265-0001	742 AUXILIARY EIA INTERFACE CABLE	3.6	(12)
6	959372-0002	ASR TERMINAL CABLE (1200 BAUD)	1.8	(6)
7	983848-0001	743 TERMINAL CABLE	1.8	(6)
8	975056-0010	990 COMPUTER CABLE	3	(10)
8	975056-0020	990 COMPUTER CABLE	6	(20)
9	994403-0001	CURRENT LOOP INPUT CABLE (INCLUDED IN TTY OPTION)	1.8	(6)
10	414127-0001	CONNECTOR ONLY (INCLUDED IN PARALLEL OPTION)	--	–
ALSO AVAILABLE	993211-0001	EIA EXTENSION CABLE (25 WIRES)	1.8	(6)

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Figure 2-4. Cable Options

2.4.2 PARALLEL INTERFACE CABLE. The optional parallel interface connector J18 is located above the serial interface connector. The parallel interface connector requires a 36-pin connector (Amphenol 57-30360 or equivalent) with signal lines connected as follows:

SIGNAL PIN	RETURN PIN*	SIGNAL NAME
1	19	Data Strobe
2	20	Data 1
3	21	Data 2
4	22	Data 3
5	23	Data 4
6	24	Data 5
7	25	Data 6
8	26	Data 7
9	27	Data 8
10	28	Acknowledge
11	29	Busy
12	–	PE (Paper Out)
13	–	SLCT (On Line)
15	33	OSCXT (External Clock)
16	–	Logic Ground
17	–	Chassis Ground
18	–	+5 VDC
31	30	REMRST
32	14	Fault
34	35	Line Count

Signals which list a return pin require twisted pair lines with the return to logic ground. Recommended maximum length is 9 meters (30 feet).

2.4.3 TTY INTERFACE CABLE. The TTY interface connector J19 requires a nine-pin connector (Cannon DEC-9P or equivalent) with signal lines connected as follows:

PIN*	SIGNAL NAME
1	TTY Transmit Data
2	TTY Transmit Data Return
3	Ground
4	TTY Receive Data Return
5	TTY Receive Data

*Pins 1 and 2 are for one twisted pair and pins 4 and 5 are for the other twisted pair. Recommended maximum length is 300 meters (1000 feet).

2.5 INITIAL PREPARATION.

In addition to the unpacking and setting up instructions, the procedures in the following paragraphs are required to ensure that the printer is ready for normal operation.

2.5.1 LINE VOLTAGE SELECTION. The printer operates on any one of four line voltages: 100, 120, 220, or 240 Vac. To adapt the printer to another line voltage, refer to Figure 2-5 and proceed as follows:

CAUTION

To prevent possible damage to the printer, do not apply power until the proper line voltage selection has been made.

1. Check the line voltage at the ac wall receptacle.
2. At left rear of printer, disconnect power cord and slide clear plastic cover up to gain access to fuse compartment.
3. Remove line fuse by pulling out and upward on FUSE PULL lever.
4. Rotate FUSE PULL lever fully upward and use a ball point pen or similar device to remove PC board.

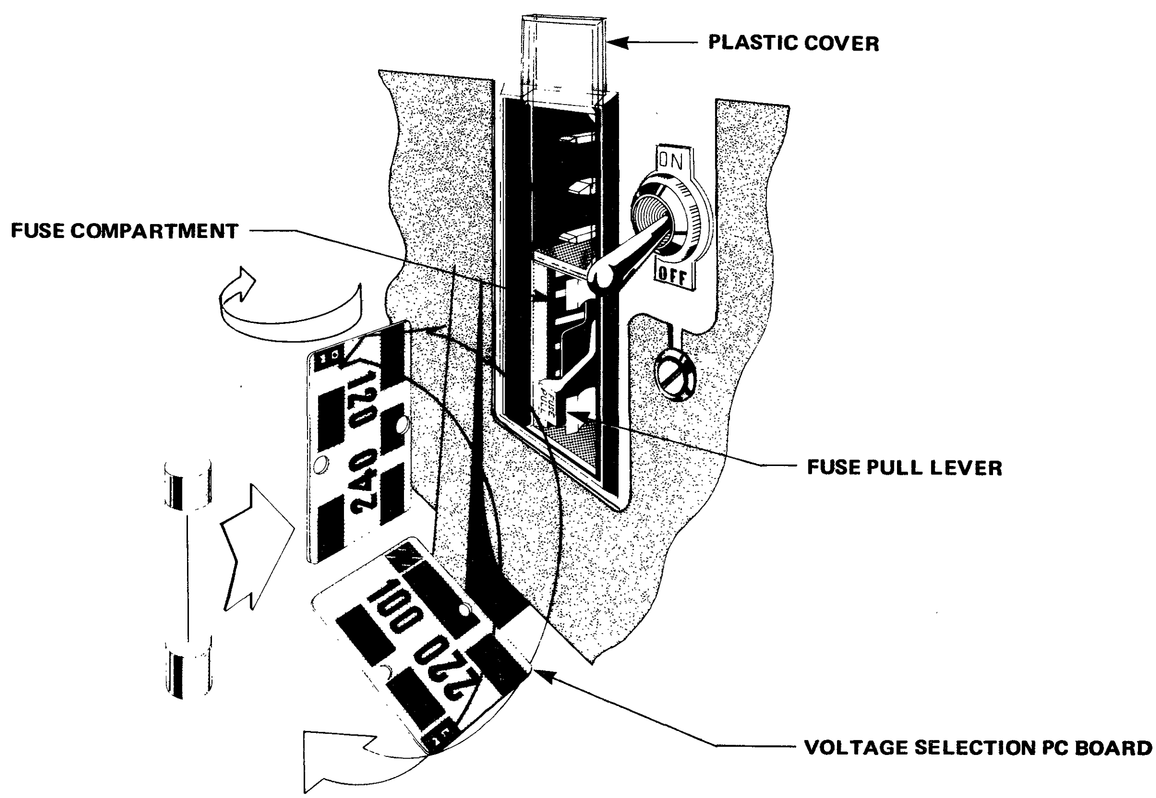


Figure 2-5. Line Voltage Selection PC Board and Fuse Compartment

5. Select operating voltage. (Line voltage must be within +10% to -15% of voltage selected.)

6. Orient PC board so that selected voltage marking is at top and faces fuse area.

7. Push PC board firmly into slot. (Only selected voltage marking should be visible after the PC board is installed.)

CAUTION

To prevent possible damage to the printer, be sure to use proper fuse value for the voltage selected.

8. Push FUSE PULL lever down, select proper fuse, and place fuse in fuse holder.

VOLTAGE SELECTED	FUSE TYPE	TI PART NUMBER
100 or 120 volts	5.0 ampere, 250 V	416434-0503
220 or 240 volts	2.5 ampere, 250 V	416434-0004

9. Slide clear plastic cover down.

10. Check that ON/OFF switch is in OFF position.

11. Connect power cord to receptacle and to power source.

2.5.2 SUPPLIES INSTALLATION. To install the supplies, perform the ribbon installation and paper loading procedures in Section III.

2.5.3 OPERATIONAL CHECKOUT. To provide an operational checkout of the printer, perform the following procedures in Section III.

Procedure	Paragraph
Turn On Procedure	3.4.3
Self-Test Diagnostic	3.4.6
(If applicable) Programming Form Length	3.4.16
(If applicable) Programming Vertical Format Control	3.4.17 and 3.4.18
Turn Off Procedure	3.4.19

SECTION III

OPERATION AND INTERFACE INFORMATION

3.1 INTRODUCTION.

This section contains detailed information on the printer controls and indicators, and signal interface information for the standard serial interface as well as for the optional parallel and TTY interfaces. General operating and programming information is also provided. All operator available controls and indicators are located on the control panel and the auxiliary control panel (located under the access door) except for the power ON/OFF switch and the printhead adjust lever. See Figure 3-1 for operator control locations. The power ON/OFF switch is located on the back left corner of the printer, and the printhead adjust lever is located under the right side of the access door. These controls and indicators which are most often used in normal operation are located on the control panel.

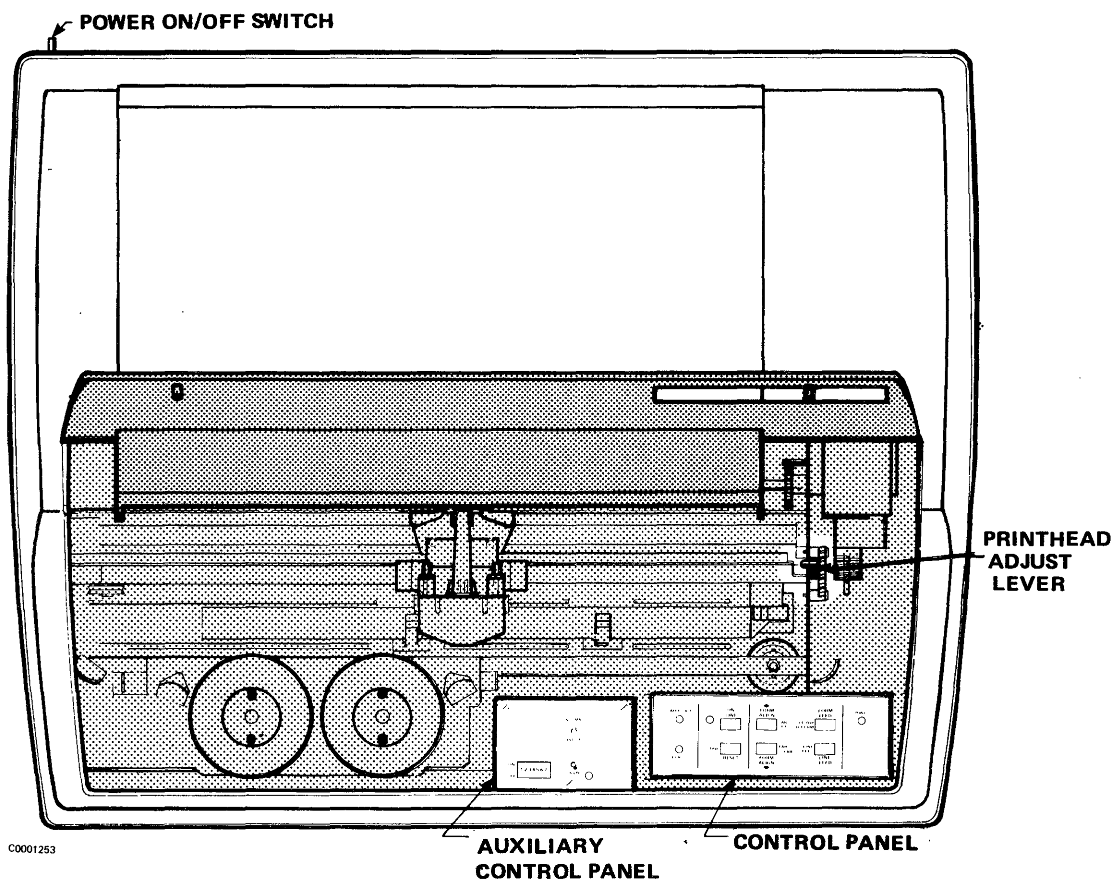


Figure 3-1. Control Locations

3.2 CONTROL PANEL CONTROLS AND INDICATORS.

The following paragraphs describe the control and indicator functions available at the control panel. There are five switches on the control panel which have an alternate function (marked in red) in the vertical format programming mode. These alternate functions are active only when the auxiliary control panel NORMAL/TEST/VFC switch is set to the TEST/VFC position. See Figure 3-2 for the layout of the control panel.

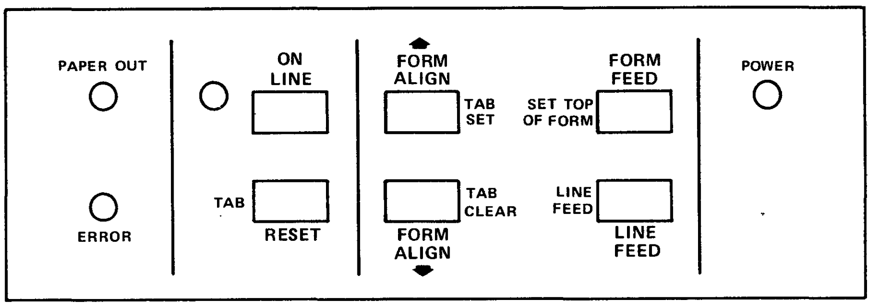


Figure 3-2. Control Panel

3.2.1 PAPER OUT INDICATOR. Indicator lights when paper out switch is activated. The audible tone (bell) beeps five times. This indicator is extinguished when paper is loaded and the RESET switch is pressed.

3.2.2 ERROR INDICATOR. The ERROR indicator has two functions:

1. The ERROR indicator lights steady when a parity error is detected. (A special parity error symbol " ◆ " will be printed.)

2. For a printhead carriage fault, indicator blinks if the printhead carriage runs into an obstacle or if the microprocessor loses encoder pulses for any reason. Power to the printhead carriage motor is turned off. The audible tone (bell) beeps five times.

The RESET switch is used to clear these error indications.

3.2.3 ON LINE SWITCH AND INDICATOR. Pressing this switch places the printer in the ON LINE condition. Pressing this pushbutton switch a second time places the printer in the OFF LINE condition. The indicator lights to indicate ON LINE condition. The ON LINE condition allows the printer to receive data from an external source (EIA, TTY, or parallel interface). The printer also goes ON LINE upon receipt of a remote ASCII DC1 control code and OFF LINE upon receipt of an ASCII DC3 control code (printhead initializes to the left margin). The OFF LINE condition causes the interface to go busy; partial data lines remain in the buffer.

3.2.4 RESET/TAB SWITCH. The normal RESET function of this pushbutton switch clears the paper out condition or either of the two error conditions. The printhead moves to the left margin after clearing a carriage fault condition. The alternate TAB function of this switch is active only in the vertical format control mode. When active, pressing the switch advances the paper to the next vertical tab which has been set.

3.2.5 FORM ALIGN ▲ /TAB SET SWITCH. The normal FORM ALIGN ▲ function of this pushbutton switch causes the paper to move up 0.014 inches (refer to paragraph 4.2.5). If the switch is held down, three small steps will be taken and then full line feeds will be executed to accelerate paper movement. This switch is active both off line and on line. The alternate TAB SET function of this switch is active only in the vertical format control mode. When active, pressing this pushbutton switch sets a vertical tab at the present line.

3.2.6 FORM ALIGN ▼ /TAB CLEAR SWITCH. The normal FORM ALIGN ▼ function of this pushbutton switch causes the paper to move 0.014 inches down. If the switch is held down, paper will continue to move in 0.014 inch increments. This switch is active both off line and on line. The alternate TAB CLEAR function of this switch is active only in the vertical format control mode. When active, pressing this pushbutton switch clears the vertical tab at the present line.

3.2.7 FORM FEED/SET TOP OF FORM SWITCH. The normal FORM FEED function of this pushbutton switch causes the paper to move to the top of the next form. Contents of the line buffer are printed before paper motion occurs. This switch is active both off line and on line. The alternate SET TOP OF FORM function of this switch is active only in the vertical format control mode. When active, pressing this pushbutton switch sets the top of form or causes the microprocessor to read the FORM LENGTH switch setting.

3.2.8 LINE FEED/LINE FEED SWITCH. Each time this pushbutton switch is pressed, the paper moved up one line (twelve steps for six lines per inch and nine steps for eight lines per inch). If the line buffer is not empty, its contents will be printed before paper motion occurs. This switch is active only off line. The normal and alternate functions of this switch are the same.

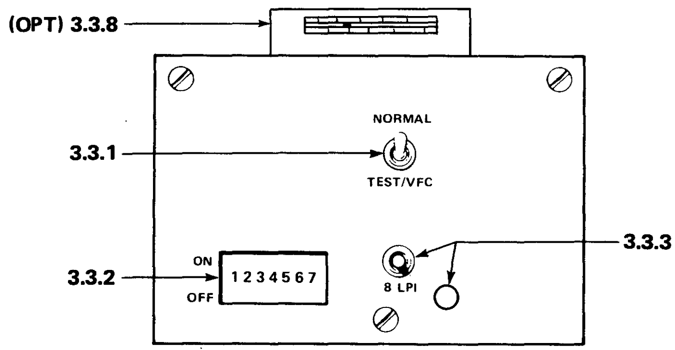
3.2.9 POWER INDICATOR. The POWER indicator lights when the 5 volt supply comes up.

3.3 AUXILIARY CONTROL PANEL CONTROLS AND INDICATORS.

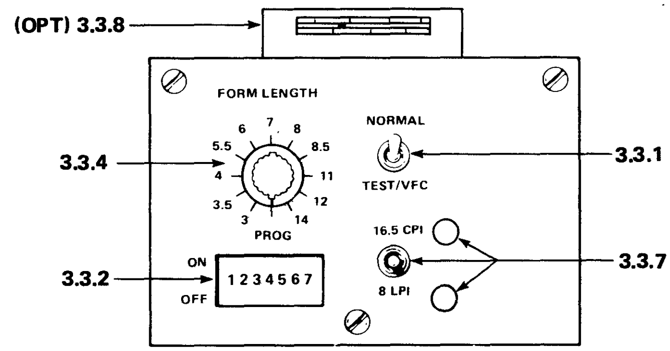
There are five versions of the auxiliary control panel:

Panel Type	Configuration Code
Basic	BSC
Forms Length Control	FLC
Vertical Format Control	VFC
Forms Length and Compressed Print	FCO
Vertical Format Control and Compressed Print	VCO

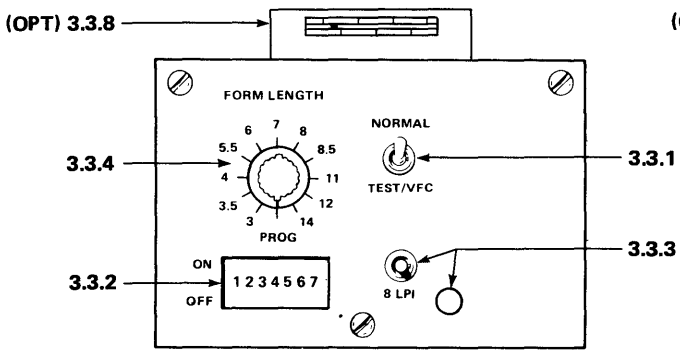
These are illustrated and identified in Figure 3-3. The following paragraphs describe the control and indicator functions. The letters in parentheses after the name of the control or indicator refer to the configuration code of the control panels shown in Figure 3-3.



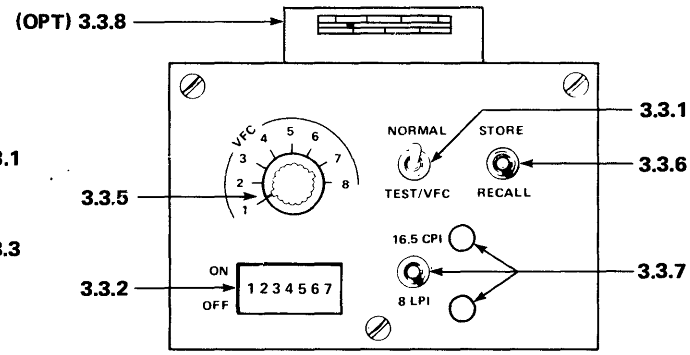
BASIC (994292–0001) BSC



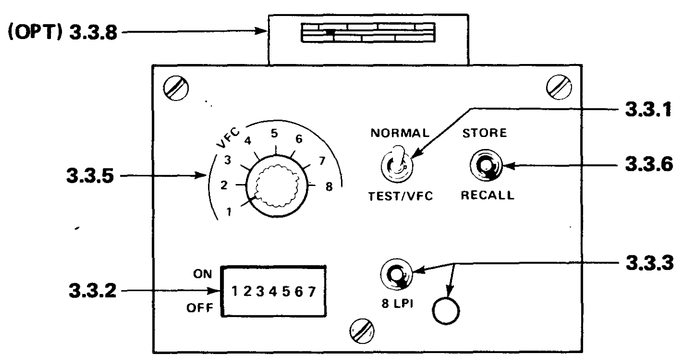
FORMS LENGTH AND COMPRESSED PRINT
(994293–0001) FCO



FORMS LENGTH (994292–0002) FLC



VERTICAL FORMAT CONTROL AND
COMPRESSED PRINT (994293–0002) VCO



VERTICAL FORMAT CONTROL
(994292–0003) VFC

NOTE:

1. AUXILIARY CONTROL PANELS ARE IDENTIFIED BY TYPE OF OPTION, PRINTER PART NUMBER AND CONFIGURATION CODE.
2. REFER TO PARAGRAPHS CALLED OUT BY PARAGRAPH NUMBER FOR CONTROL FUNCTION EXPLANATION.

A0001255

Figure 3-3. Auxiliary Control Panels

3.3.1 NORMAL/TEST/VFC SWITCH (BSC, FLC, VFC, FCO, VCO). In NORMAL position, this switch enables normal operation of the printer. With this switch in TEST/VFC position and serial I/F mode selected, pressing the ON LINE switch will initiate a rotating character test pattern (barber pole). With this switch in the TEST/VFC position (and the printer is OFF LINE), the alternate function switches TAB, TAB SET, TAB CLEAR, SET TOP OF FORM and LINE FEED are enabled for vertical format control programming.

3.3.2 PENCIL SWITCHES (BSC, FLC, VFC, FCO, VCO). All auxiliary control panels have seven pencil switches. Switches 1, 2, and 3 are used to select baud rates of 110, 150, 300, 1200, 2400, 4800, or 9600 baud or parallel input. Switches 4 and 5 are used to select odd, even, or ignore parity. Switch 6 activates the automatic line feed. Switch 7 activates the top of form automatic perforation skip. The automatic perforation skip causes the printer to skip three lines before printing the first line of the next form. Changes in pencil switch settings take effect while the printer is off line.

3.3.3 8 LPI SWITCH AND INDICATOR (BSC, FLC, VFC). In the 8 LPI position, this momentary three-position, center-off switch selects the eight lines per inch mode. This mode is also software programmable through the communications interface. This indicator lights when the printer is in the eight lines per inch mode. Reactivating this switch returns the printer to the six lines per inch mode.

3.3.4 FORM LENGTH ROTARY SWITCH (FLC, FCO). The 12-position FORM LENGTH rotary switch allows the operator to select any one of the following 11 fixed form lengths: 3, 3.5, 4, 5.5, 6, 7, 8, 8.5, 11, 12, and 14 inches. In the PROG position, this switch allows the operator to program form lengths from the front panel from 4 to 112 lines.

3.3.5 VFC SWITCH (VFC, VCO). The eight-position vertical format control channel rotary switch selects one of eight non-volatile vertical format programs. These eight channels are also software programmable through the communications interface.

3.3.6 STORE/RECALL SWITCH (VFC, VCO). In the STORE position this momentary, three-position, center-off switch stores manually programmed vertical tabs, form length and lines per inch spacing in the selected VFC channel. In the RECALL position, the format program stored in the selected VFC channel is recalled into working memory. STORE and RECALL are active only in the vertical format control mode and both are software programmable through the communications interface.

3.3.7 16.5 CPI/8 LPI SWITCH AND INDICATORS (FCO, VCO). In the 16.5 CPI position, this momentary three-position, center-off switch selects the 16.5 characters per inch compressed print mode. This mode is also software programmable through the communications interface. The 16.5 CPI indicator lights when the printer is in the compressed print mode. Setting this switch to the 16.5 CPI position a second time returns the printer to the standard 10 characters per inch print mode. The printhead initializes to the left margin each time a change is made between 10 and 16.5 characters per inch. In the 8 LPI position, this switch selects the eight lines per inch mode. The 8 LPI indicator lights when the printer is in the eight lines per inch mode. This mode is also software programmable through the communications interface. Setting this switch to the 8 LPI position a second time returns the printer to the six lines per inch mode.

3.3.8 ELAPSED TIME INDICATOR (OPTIONAL). The optional elapsed time indicator shows accumulated ribbon motion time to 2000 hours.

3.3.9 BAUD RATE OPTION (BRO). This option gives you an additional baud rate family. See Paragraph 3.4.9.

3.4 OPERATING PROCEDURES.

Before the printer can be placed in service, the operator must determine the following:

1. Printer configuration: BSC, FLC, VFC, FCO, or VCO. (See the configuration label on the underside of the access door, or identify the printer from Figure 3-3 by the type of auxiliary control panel installed.)

2. Baud rate of the received serial data, or whether parallel data (optional on PLC or PLT printers only) is to be received.

3. Parity selection: odd, even, or ignore.

Perform those procedures in the following paragraphs which apply to your printer configuration and your printing requirements. The title of each paragraph identifies the printer configuration (in parentheses) to which it applies. If the printer does not perform as indicated in the following procedures; or if the ERROR indicator lights; or if the audible tone (bell) is heard, consult the self-help procedures in paragraph 3-5.

3.4.1 RIBBON INSTALLATION (ALL PRINTERS). The printer uses a 1/2-inch wide nylon ribbon (TI Part No. 996241-0001 or equivalent) mounted on two 3 1/4-inch spools. To install the ribbon, refer to Figure 3-4 and proceed as follows:

1. Check that the power switch (at left rear of printer) is set to OFF (down).

2. Open access door.

3. Check that ribbon is attached to both spools.

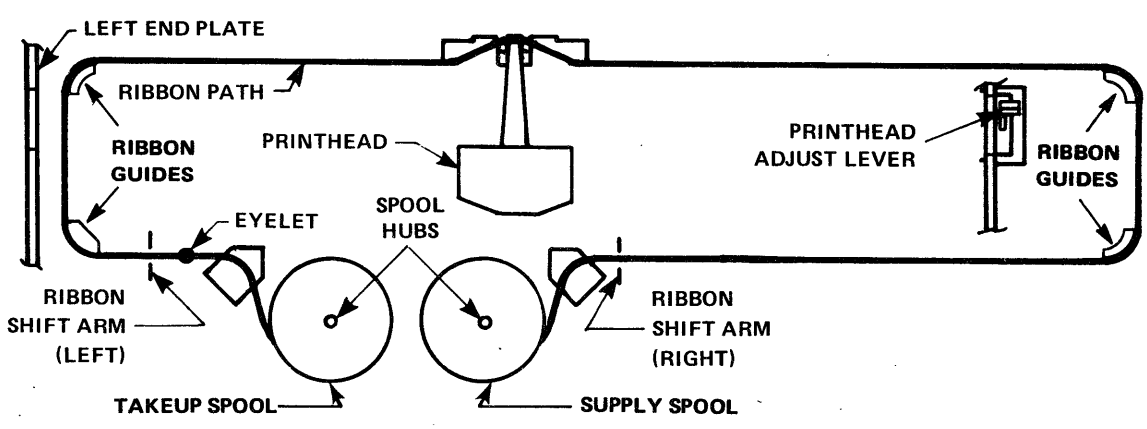


Figure 3-4. Ribbon Installation

4. (If original printhead clearance is to be maintained, note position of printhead adjust lever.) Move printhead adjust lever slightly to right and fully toward front of printer (to move printhead away from platen).

5. Place empty takeup spool on left spool hub with feed-out side of spool toward front of printer, and feed ribbon out along ribbon path as shown in Figure 3-4.

CAUTION

Check that ribbon reversing eyelet is located between the left ribbon shift arm and the left spool hub (otherwise, the ribbon will not reverse). Also check that the ribbon is inside the left end plate (to prevent drag on the ribbon).

6. Place full supply spool on right spool hub and rotate spool hubs as necessary to remove slack from ribbon.

7. Check that ribbon is centered in slot on right ribbon shift arm. If ribbon is not centered, refer to Section V for adjustment.

8. If original printhead clearance is desired, reset printhead adjust lever to position noted in step 3, otherwise perform printhead adjustment procedure (paragraph 3.4.5).

3.4.2 PAPER LOADING (ALL PRINTERS). The printer uses continuous form paper with standard feed perforations on each edge. Paper widths from 7.62 to 38.1 centimeters (3 to 15 inches) can be accommodated. Using either the rear chute or bottom chute (see Figure 3-5), multiple part forms, one original and up to five copies can be printed on paper with the following weight specifications:

Single Part Forms:	15 to 20 pound
Multiple Part Forms:	Original: 12 to 15 pound
	Copies: 9 to 12 pound, last copy 15 pound
Carbon Paper:	7-1/2 pound with medium hardness

Card stock up to 0.1778 millimeter (0.007 inch) thick can be used as single part or last copy only when using the bottom chute. In any case, total form thickness should not exceed 0.533 millimeter (0.021 inch). To load paper in the printer, refer to Figure 3-5 and proceed as follows:

NOTE

It is not necessary to turn the power off when loading paper.

1. Open access door.

2. If left paper feed tractor is not locked in desired position (normally at extreme left margin), loosen lock knob, adjust left paper feed tractor to desired position, and tighten lock knob.

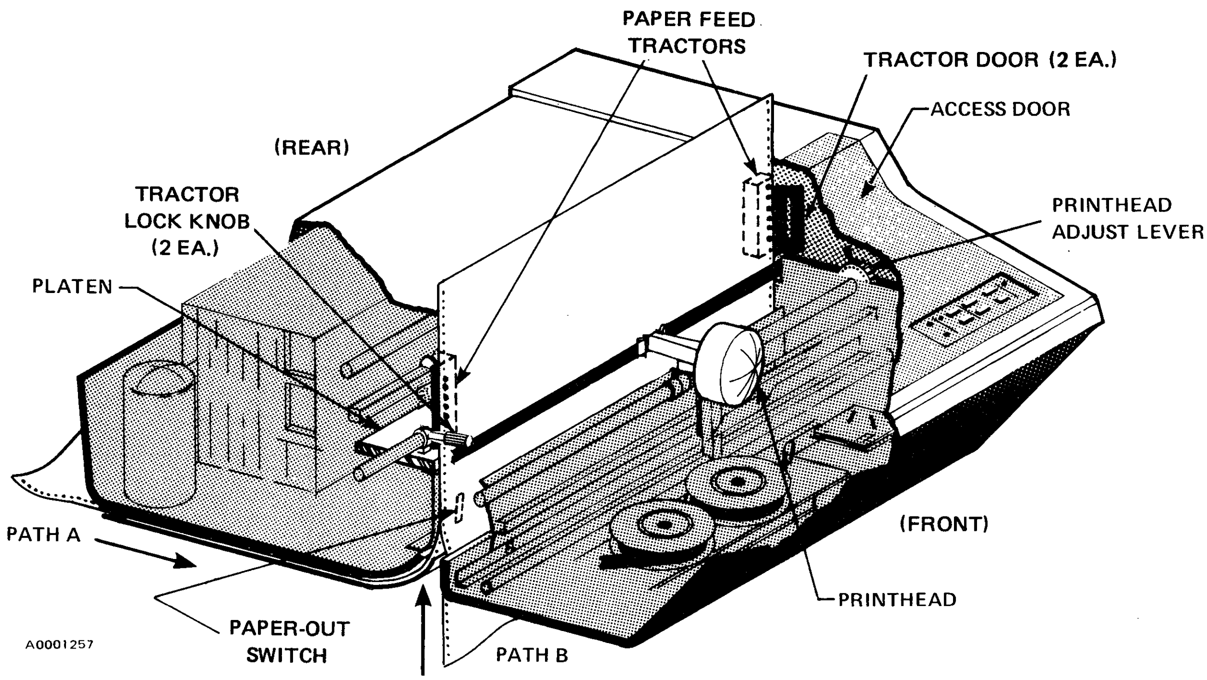


Figure 3-5. Paper Loading

3. Open doors on both paper feed tractors.

4. Using printhead adjust lever, move printhead away from platen.

5. **Rear Chute:** Load paper through rear chute as follows (or proceed to Step 6 for bottom loading):

   a. Place paper supply behind printer.

   NOTE

   If the printer is mounted on a table and the paper supply is placed on the floor, be sure the rear edge of the printer is located slightly over the edge of the table top to prevent the paper from catching on the edge of the table.

   b. Feed paper (path A, printing side down) into paper chute at bottom rear of printer until paper appears at platen.

   c. Proceed to step 7.

6. **Bottom Chute:** Load paper through bottom chute as follows:

   a. Align printer bottom chute with slot in table or stand.

b. Place paper supply under table and align paper path to prevent paper edges from rubbing against table slot or ends of bottom chute.

c. Feed paper (Path B, printing side forward) into bottom chute of printer until paper appears at platen.

7. Loosen lock knob on right tractor and adjust tractor as necessary to accommodate paper width.

8. Place top of paper in both tractors and check that holes in paper edge perforations are engaged in corresponding tractor pins.

9. Close tractor doors. Adjust right tractor as necessary to remove slack in paper and tighten lock knob.

10. Check that paper supply is aligned with paper chute (paper must not rub sides of chute) and that paper out switch is actuated.

11. Readjust printhead adjust lever and close access door.

3.4.3 TURN-ON PROCEDURE (ALL PRINTERS). To turn the printer on, proceed as follows:

CAUTION

To prevent possible damage to the printhead, do not print without a ribbon or with paper too narrow for the printed line width. If the full 132-column line is used, the paper must be at least 27.8 cm (14-7/8 inches) wide for the standard 10 characters per inch spacing and at least 21.6 cm (8-1/2 inches) wide for the optional (FCO and VCO printers only) 16.5 characters per inch compressed print spacing.

1. Check that ribbon and paper are properly installed. (See paragraph 3.4.1 for ribbon installation and paragraph 3.4.2 for paper loading.)

2. Set power ON/OFF switch (at left rear of printer) to ON (up) position.

3. Observe that control panel ON LINE indicator is off and that printhead is at left margin.

At this point, the printer is operating under the following initial conditions:

- The printer is off line

- The form length is 27.9 cm (11 inches) for the BSC printer (and also for the FCO and FLC printers if the auxiliary control panel FORM LENGTH switch is in the PROG position).

The FCO and FLC printers are set to the form length selected on the FORM LENGTH switch. The VCO and VFC printers are set to the form length of the last vertical format stored or recalled.

- The line spacing is 16.66 mm (six lines per inch) for the BSC, FCO, and FLC printers. The VCO and VFC printers are set to the line spacing of the last vertical format stored or recalled.

- The character spacing is 2.54 mm (10 characters per inch) center to center.

- All horizontal tabs are cleared from the working memory. (Horizontal tabs can be set only by software.)

- All vertical tabs are cleared from the working memory of the BSC, FCO, and FLC printers. The VCO and VFC printers retain the vertical tab settings of the last vertical format stored or recalled.

- The line counter is set to zero, causing the present line location to be the first line of the form.

- The line buffer is empty. (All previous printable characters have been cleared.)

This completes the turn-on procedure if:

- From previous operation, the forms (paper) are aligned as desired and the printhead adjust lever is properly set.

- No changes to the above initial conditions are desired.

- The pencil switches on the auxiliary control panel for the baud rate, parity, automatic line feed override, and automatic perforation skip override have been previously set as desired.

To change the printer from its initial condition status, perform the procedures in paragraphs 3.4.4 through 3.4.9, as applicable. After all applicable procedures have been completed, the printer is ready to receive data when placed on line by the operator or a DC1 (select) ASCII code character is received via the communications line. All the software commands (described in paragraph 3.9.1) can now be performed by the sending device (to the degree permitted by the printer options).

3.4.4 TOP OF FORM ADJUSTMENT (ALL PRINTERS). With the power on (paragraph 3.4.3), set the top of form as follows:

CAUTION

To prevent possible damage to the printhead, do not print without a ribbon and do not print on paper too narrow for the printed line width. If the full 132-column line is used, the paper must be at least 37.8 cm (14-7/8 inches) wide for the standard 10 characters per inch spacing and at least 21.6 cm (8-1/2 inches) wide for the optional (FCO and VCO printers only) 16.5 characters per inch compressed print spacing.

1. Press the FORM FEED switch.

2. Press the FORM ALIGN ▲ switch or the FORM ALIGN ▼ switch until the printhead is at the approximate point where the first line of the form is to be printed.

NOTE

A finer top of form adjustment can be made during the self-test procedure (paragraph 3.4.6), or while data is being received, simply by pressing the FORM ALIGN ▲ or FORM ALIGN ▼ switch until the next line printed is exactly aligned on the form.

3.4.5 PRINTHEAD ADJUSTMENT (ALL PRINTERS). The printhead adjust lever controls the clearance between the platen and the face of the printhead. This clearance must be adjusted in accordance with the thickness of the forms used. With the power on (paragraph 3.4.3), adjust the printhead for optimum print quality as follows:

CAUTION

To prevent possible damage to the printhead, do not print without a ribbon or on paper too narrow for the printed line width. If the full 132-column line is used, the paper must be at least 37.8 cm (14-7/8 inches) wide for the standard 10 characters per inch spacing and at least 21.6 cm (8-1/2 inches) wide for the optional (FCO and VCO printers only) 16.5 characters per inch compressed print spacing.

1. Open the access door.

2. Move printhead adjust lever slightly to right and completely toward front of printer.

3. Check that ribbon and paper are installed.

NOTE

The printhead adjustment can be made while the printer is on line and data is being printed, or while the self-test rotating character pattern (barber pole) is being printed.

4. (If barber pole method is used) Set auxiliary control panel NORMAL/TEST/VFC switch to TEST/VFC.

5. Press control panel ON LINE switch to start printing.

6. Move printhead adjust lever toward rear of printer until print quality is satisfactory.

7. If smudging occurs, printhead is too close and must be backed off.

8. Move printhead adjust lever until nearest detent is engaged.

9. (If barber pole method has been used) Set auxiliary control panel NORMAL/TEST/VFC switch to NORMAL.

10. Close access door.

3.4.6 SELF-TEST DIAGNOSTIC (ALL PRINTERS). This test will *not* function if parallel option is selected. With the power on (paragraph 3.4.3), perform the self-test as follows:

CAUTION

To prevent possible damage to the printhead, do not print without a ribbon or on paper too narrow for the printed line width. If the full 132-column line is used, the paper must be at least 37.8 cm (14-7/8 inches) wide for the standard 10 characters per inch spacing and at least 21.6 cm (8-1/2 inches) wide for the optional (FCO and VCO printers only) 16.5 characters per inch compressed print spacing.

1. Open access door.

2. Ensure pencil switches are *not* set for parallel operation.

3. Set auxiliary control panel NORMAL/TEST/VFC switch to TEST/VFC.

4. Press control panel ON LINE switch and observe that the rotating character pattern (barber pole) starts.

5. Check that the entire 64-character (or optional 95-character) character set is printed for each line, and that each line is shifted one column position from adjacent lines.

6. After several lines have been printed and checked, set auxiliary control panel NORMAL/TEST/VFC switch to NORMAL and observe that printing halts.

3.4.7 LINES PER INCH SPACING (ALL PRINTERS). With the power on (paragraph 3.4.3) and if the eight lines per inch spacing is desired, proceed as follows:

1. Open access door.

2. Momentarily set auxiliary control panel 8 LPI (or 16.5 CPI/8 LPI) switch to 8 LPI.

3. Observe that 8 LPI indicator lights.

4. Close access door.

To return to the six lines per inch spacing (initial conditions), repeat the above procedure except observe that the 8 LPI indicator goes out.

3.4.8 CHARACTERS PER INCH SPACING (FCO, VCO). With the power on (paragraph 3.4.3) and if the optional 16.5 characters per inch spacing (compressed print) is desired, proceed as follows:

1. Open access door.

2. Momentarily set auxiliary control panel 16.5 CPI/8 LPI switch to 16.5 CPI.

3. Observe that 16.5 CPI indicator lights before next line is printed.

4. Close access door.

To return to the 10 characters per inch spacing (initial conditions), repeat the above procedure except observe that the 16.5 CPI indicator goes out before the next line is printed.

3.4.9 BAUD RATE/PARALLEL INPUT SELECTION. To select the baud rate (or parallel input for PLT printers), proceed as follows:

1. Open the access door.

2. Using a ball point pen or similar device, set the auxiliary control panel "pencil" switches 1, 2, or 3 to the baud rate of the serial data to be received, or to the optional parallel input as follows:

Baud Rate		Pencil Switches		
Standard	**BRO***	1	2	3
110	110	OFF	OFF	OFF
150	200	ON	OFF	OFF
300	300	OFF	ON	OFF
1200	1200	ON	ON	OFF
2400	2400	OFF	OFF	ON
4800	600	ON	OFF	ON
9600	9600	OFF	ON	ON
parallel		ON	ON	ON

*BRO = Baud Rate Option

3. Close the access door.

3.4.10 PARITY SELECTION (ALL PRINTERS). Select parity as follows:

1. Open the access door.

2. Set the auxiliary control panel pencil switches 4 and 5 as follows (refer to paragraph 3.3.2):

Selection	Pencil Switches	
	4	5
Ignore Parity	OFF	OFF
Odd Parity	ON	ON
Even Parity	ON	OFF

3. Close the access door.

3.4.11 AUTOMATIC LINE FEED OVERRIDE (ALL PRINTERS). Open the access door and set auxiliary control panel switch 6 to ON for automatic line feed *override* or to OFF *for* automatic line feed. Close the access door.

3.4.12 AUTOMATIC PERFORATION SKIP OVERRIDE (ALL PRINTERS). Open the access door and set auxiliary control panel switch 7 to ON for automatic (three-line) perforation skip *override*, or to OFF *for* automatic (three-line) perforation skip. Close the access door.

3.4.13 VERTICAL TAB SETTING (ALL PRINTERS). All printers have a working memory in which vertical tabs can be set and retained as long as the power is on. With the power on (paragraph 3.4.3), set vertical tabs as follows:

1. If form is not aligned as desired, perform top of form adjustment (paragraph 3.4.4).

2. Open access door.

3. Set auxiliary control panel NORMAL/TEST/VFC switch to TEST/VFC.

4. Press control panel LINE FEED switch until line to be tab-set is opposite printhead.

5. Press control panel TAB SET switch.

6. Repeat steps 4 and 5 as necessary to set all desired tabs.

7. Set auxiliary control panel NORMAL/TEST/VFC switch to NORMAL.

8. Press control panel FORM FEED switch.

9. Verify tab settings as follows:

    a. Set auxiliary control panel NORMAL/TEST/VFC switch to TEST/VFC.

b. Press control panel TAB switch and observe that desired (tab-set) line is opposite printhead. If desired (tab-set) line is not opposite printhead, press control panel TAB CLEAR switch (this clears unwanted tabs from working memory).

c. Repeat step b. as necessary to verify that only desired tabs are set.

d. After final desired tab is verified, press control panel TAB switch and observe that next form is aligned as desired in step 1.

e. Repeat step b. as necessary to clear unwanted tabs from working memory.

f. Set auxiliary control panel NORMAL/TEST/VFC switch to NORMAL.

10. Close access door.

3.4.14 VERTICAL TAB CLEARING (ALL PRINTERS). All printers have a working memory in which vertical tabs can be set (paragraph 3.4.13) and retained as long as the power is on. With the power on (paragraph 3.4.3), these tabs can be cleared as follows:

1. Press FORM FEED switch.
2. Open access door.
3. Set auxiliary control panel NORMAL/TEST/VFC switch to TEST/VFC.
4. Press control panel TAB switch.
5. If tab at this line location is to be cleared, press control panel TAB CLEAR switch; if not, press control panel TAB switch.
6. Repeat step 5 as necessary to clear all unwanted tabs.
7. When top of the next form is reached, set auxiliary control panel NORMAL/TEST/VFC switch to NORMAL.
8. Close access door.

For the BSC, FCO, and FLC printers, all vertical tabs can be simultaneously cleared by turning the power off (paragraph 3.4.19). This returns these printers to the initial conditions listed in paragraph 3.4.3 when the power is again turned on.

3.4.15 FIXED FORM LENGTH SELECTION (FCO, FLC). On the FCO and FLC printers the operator can select any one of 11 fixed form lengths. Selecting a fixed form length clears any previous form length (whether set by the operator or by software) from the working memory. With power on (paragraph 3.4.3), select a fixed form length as follows:

1. If the form is not aligned as desired, perform top of form adjustment (paragraph 3.4.4).

2. Open access door.

3. Set auxiliary control panel NORMAL/TEST/VFC switch to TEST/VFC.

4. Set auxiliary control panel FORM LENGTH rotary switch to desired fixed form length position.

5. Press control panel SET TOP OF FORM switch.

6. Set auxiliary control panel NORMAL/TEST/VFC switch to NORMAL.

7. Close access door.

3.4.16 PROGRAMMING FORM LENGTH (FCO, FLC). On the FCO and FLC printers, the operator can program any form length from 4 to 112 lines. Programming the form length clears any previous form length (whether set by the operator or by software) from the working memory. With the power on (paragraph 3.4.3), program the form length as follows:

1. If form is not aligned as desired, perform top of form adjustment (paragraph 3.4.4).

2. Open access door.

3. Set auxiliary control panel NORMAL/TEST/VFC switch to TEST/VFC.

4. Set auxiliary control panel FORM LENGTH rotary switch to PROG.

5. Press control panel SET TOP OF FORM switch. (This sets the line counter to zero).

6. Press control panel LINE FEED switch until next form is aligned as desired.

7. Press control panel SET TOP OF FORM switch.

8. Set auxiliary control panel NORMAL/TEST/VFC switch to NORMAL. (This sets the form length.)

9. Close access door.

3.4.17 STORING VERTICAL FORMAT (VFC, VCO). The VFC and VCO printers have a special vertical format control which can store a different vertical format in each channel of an eight-channel memory. Vertical formats can be stored by the operator or by software. The vertical format information which can be stored consists of the form length, the vertical tab locations, and the lines per inch spacing. The stored vertical formats are retained even with the printer power off. With the power on (paragraph 3.4.3), a vertical format is first entered into working memory and then stored as follows:

1. If form is not aligned as desired, perform top of form adjustment (paragraph 3.4.4).
2. Open access door.
3. Set auxiliary control panel VFC rotary switch to desired channel position.
4. Set auxiliary control panel NORMAL/TEST/VFC switch to TEST/VFC.
5. If eight lines per inch spacing is desired, momentarily set auxiliary control panel 8 LPI (or 16.5 CPI/8 LPI) switch to 8 LPI and observe that 8 LPI indicator lights.
6. Press control panel SET TOP OF FORM switch. (This sets the line counter to zero.)
7. Press control panel LINE FEED switch until line to be tab-set is opposite printhead.
8. Press control panel TAB SET switch.
9. Repeat steps 7 and 8 as necessary to set all desired tabs.
10. Press control panel LINE FEED switch until next form is aligned as desired (or paper perforation is at reference mark).
11. Press control panel SET TOP OF FORM switch.
12. Set auxiliary control panel switch to NORMAL and then back to TEST/VFC.
13. Verify vertical format as follows:
    a. Press control panel TAB switch and observe that desired (tab-set) line is opposite printhead. If desired (tab-set) line is not at printhead, press control panel TAB CLEAR switch. (This clears unwanted tabs from memory.)
    b. Repeat step a. as necessary to verify that only desired tabs are set.
    c. After final desired tab has been verified, again press control panel TAB switch and observe that perforation of next form is aligned as desired. If not, press control panel TAB CLEAR.
    d. Repeat step c. as necessary to clear unwanted tabs from memory.
14. Momentarily set auxiliary control panel STORE/RECALL switch to STORE.
15. Set auxiliary control panel NORMAL/TEST/VFC switch to NORMAL.
16. Close access door.

3.4.18 RECALLING VERTICAL FORMAT (VFC, VCO). The VFC and FCO printers have a special vertical format control which allows previously stored vertical formats to be recalled into the working memory by the operator or by software. With the power on (paragraph 3.4.3), a vertical format in any one of the eight channels of memory can be recalled into the working memory by the operator as follows:

1. Open access door.
2. Set auxiliary control panel VFC rotary switch to desired channel.
3. Set auxiliary control panel NORMAL/TEST/VFC switch to TEST/VFC.
4. Momentarily set auxiliary control panel STORE/RECALL switch to RECALL.
5. Set auxiliary control panel NORMAL/TEST/VFC switch to NORMAL.
6. Perform the top of form adjustment (paragraph 3.4.4).
7. Close access door.

3.4.19 TURN-OFF PROCEDURE (ALL PRINTERS). To turn off the printer requires only that the power ON/OFF switch (at the left rear of the printer) be set to OFF. It should be remembered that when power is again applied to the printer, it will return to certain initial conditions according to the configuration of the printer. If conditions other than these are to be retained, they must be noted and re-entered in the printer when power is again applied. For more complete information on the initial conditions of each printer configuration, refer to the turn-on procedure (paragraph 3.4.3).

3.5 SELF-HELP PROCEDURES.

The self-help procedures in Table 3-1 are designed to aid the operator in correcting minor problems in the operation of the printer. If these procedures do not correct the problem, refer to Section V.

Table 3-1. Self-Help Procedures

Problem	Probable Cause	Corrective Action
PAPER OUT indicator lights and bell beeps five times (printer stops printing)	The printer is out of paper.	When the PAPER OUT indicator is on, a line will be printed each time the RESET switch is pressed. Press the RESET switch as often as required to complete the form, then load new forms in the printer. (Refer to the Paper Loading procedure in Section IV or to the instruction label on the underside of the access door.) After the new forms have been loaded, press the RESET switch to resume printing.
ERROR indicator blinks and bell beeps five times (printer stops printing).	Printhead movement blocked by paper jam or other obstruction.	Remove the paper jam or other obstruction. Press the RESET switch to resume printing.
ERROR indicator lights steady and special parity error symbols are printed.	Parity error. The bit count of the character was wrong.	Press the RESET switch to turn the ERROR indicator off. Correct the portions of the data which contain the parity error symbols. If parity errors occur frequently, have the communications line checked for excessive electrical noise. If parity errors occur continuously, check that correct printer parity is selected.

The Model 810 Printer is available in two versions of serial interface (which are selectable at time of purchase). These are the standard EIA RS-232-C serial interface and a modified EIA serial interface. The modified version ignores the reverse channel signal when used with TI computers and certain customer applications. The signals at connector J13 are defined as follows:

J13 Connector Pin No.	Signal Name	EIA AND (CCITT) Designation	Source	Function
1	Protective Ground	AA(101)	None	Chassis ground
2	Transmitted Data	BA(103)	Printer	This signal is at the negative EIA level in the normal mode, and at the positive EIA level in the test mode.
3	Received Data	BB(104)	Input Device	Received serial data.
4	Request to Send	CA(105)	Printer	This signal is held at the negative EIA level.
5	Clear to Send	CB(106)	Input Device	(Not used)
6	Data Set Ready	CC(107)	Input Device	This signal must be at the positive EIA level for the printer to receive data.
7	Signal Ground	AB(102)	None	Return path for data and control signals.
8	Carrier Detect	CF(109)	Input Device	This signal must be at the positive EIA level for the printer to receive data.
9	+12 Volts	—	Printer	May be used as bias voltage for inputs to printer. **(50 mA maximum).**
10	−12 Volts	—	Printer	May be used as bias voltage for **inputs to printer (50 mA maximum).**
11	Reverse Channel	SCA(120)	Printer	This signal is at the negative EIA level when the standard printer is busy, and at the positive EIA level when the standard printer is not busy. These levels are inverted in the IRC* printer.
20	Data Terminal Ready	CD(108.2)	Printer	This signal is at the positive EIA level when the standard printer is on line or when the DNB* printer is on line and not busy; and at the negative EIA level when the standard printer is off line, or when the DNB* printer is off line or busy.

*These versions are described in Appendix C.

3.6.1 BAUD RATE. The selectable data transmission rates are 110, 150, 300, 1200, 2400, 4800, or 9600 baud. The baud rate is selected by the first three of the seven pencil switches on the auxiliary control panel. See paragraph 3.4.9 for pencil switch settings.

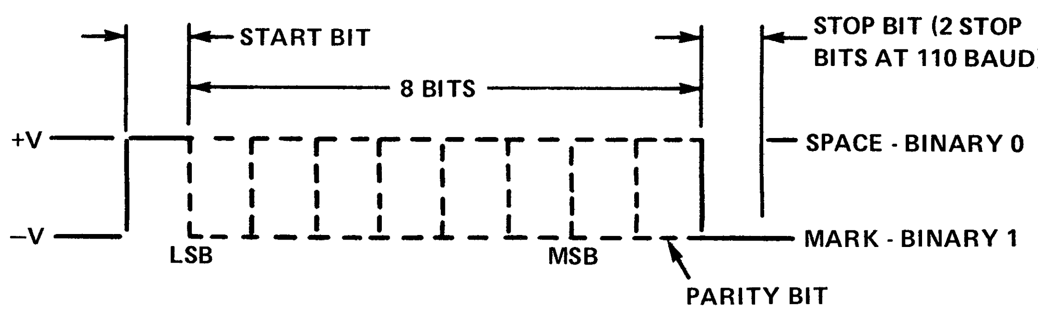
3.6.2 SIGNAL LEVELS AND TERMINATIONS. Serial interface signal levels are defined by EIA Standard RS-232-C as follows:

	–25 to –3 Vdc	–3 to +3 Vdc	+3 to +25 Vdc
Data Signal	Marking	Not Defined	Space
Timing or Control Function	Off	Not Defined	On

The terminator load impedance is a non-inductive 3,000 to 7,000 ohm dc resistance. Any open circuit driver voltage will not exceed 25 Vdc.

3.6.3 ASYNCHRONOUS DATA FORMAT. Each character sent to the printer on the received data line consists of one start bit, seven data bits, one parity bit, and one or two stop bits as shown in Figure 3-6.

3.6.3.1 Timing. The printer accepts data when the input device has raised the Data Set Ready and the Carrier Detect line to the positive level. The standard printer holds the Data Terminal Ready line at the positive level when the standard printer is on line (or when the DNB printer is on line and not busy), or at the negative level when the standard printer is off line (or when the DNB printer is off line or busy). Refer to paragraph 1.4 for a definition of DNB. The Reverse Channel line is used to transmit printer busy status to the input device. In the standard printer, the Reverse Channel line is held at the positive level when the printer is free to accept data; when the printer becomes busy, it will set the Reverse Channel line to the negative level. In the IRC printer these signal levels are inverted (ready equals a negative level, busy equals a positive level). The printer will accept the character which causes the busy condition and up to three more characters but will ignore any subsequent characters until the busy condition is cleared.



A0001251

Figure 3-6. Asynchronous Data Format

3.6.3.2 Parity. The bit immediately preceding the stop bit in the asynchronous data format is the parity bit (see Figure 3-6). Characters received with incorrect parity are printed as " ◆ " signs and the control panel ERROR indicator lights. A parity error in a format statement (see paragraph 3.9) will terminate the statement.

3.7 PARALLEL INTERFACE (OPTIONAL)

The optional parallel interface includes the Parallel TI compatible (PLT) interface. The parallel interface signals at connector J18 are defined as follows:

NOTE

Logic ground is internally connected to chassis ground for all interfaces. To isolate logic ground from chassis ground, remove jumper wire shown in Figure 2-3.

Connector Signal	Connector Return	Signal	Source	Description
1	19	$\overline{\text{Data Strobe}}$	Input Device	A 0.5 microsecond pulse (minimum) used to clock data from the input device to the printer logic.
2	20	Data 1	Input Device	Input data levels. A high represents a binary one, a low represents a binary zero. All printable characters (i.e., codes having a one in Data 6 or Data 7) are stored in the print buffer. Control characters (i.e., codes having a zero in both Data 6 and Data 7) are used to define control functions.
3	21	Data 2	Input Device	
4	22	Data 3	Input Device	
5	23	Data 4	Input Device	
6	24	Data 5	Input Device	
7	25	Data 6	Input Device	
8	26	Data 7	Input Device	
9	27	Data 8	Input Device	
10	28	$\overline{\text{Acknowledge}}$	Printer	A pulse low indicates that a character has been received and that the printer is ready to accept another character.
11	29	Busy	Printer	A signal high indicates that the printer cannot receive data.
12	–	PE (Paper Out)	Printer	A signal high indicates that the printer is out of paper.
13	–	SLCT (On Line)	Printer	A signal high indicates that the printer is selected.
16	–	Logic Ground	Printer	Logic ground
17	–	Chassis Ground	Printer	Chassis ground (protective).
18	–	+5 VDC	Printer	For test purposes.
31	30	REMRST	Input Device	A signal low terminates a form feed or vertical tab motion.
32	14	$\overline{\text{Fault}}$	Printer	A signal low indicates a fault condition.

Other connector pins are used. Signal pins with return pins indicate twisted pairs.

3.7.1 SIGNAL LEVELS AND TERMINATIONS. For a high input signal to the printer, the input device must be able to source 0.320 milliamperes at +2.4 Vdc. For a low input signal, the input device must be able to sink 14 milliamperes. For a high output from the printer, the printer is able to provide up to 0.320 milliamperes at +2.4 Vdc. For a low output, the printer is able to sink up to 14 milliamperes. Data lines are terminated in the printer by 1,000 ohms to +5 Vdc.

3.7.2 TIMING. The basic parallel interface timing is as shown in Figure 3-7 (for PLT version).

3.8 TTY CURRENT LOOP INTERFACE (OPTIONAL).

The TTY current loop option uses a four-wire, receive only, neutral current loop and is passive. The TTY current loop interface does not interface with the standard EIA serial interface. Data can be received from either interface provided the other interface is in a spacing condition or its connector is unplugged. The TTY current loop interface is passive. The TTY current loop interface signals at optional connector J19 are defined as follows:

NOTE

Logic ground is internally connected to chassis ground for all interfaces. To isolate logic ground from chassis ground, remove jumper wire shown in Figure 2-3.

Pin	Signal Name	Function
1	TTY Transmitted Data	Low impedance (marking) between pins 1 and 2 when the TTY printer is ready to accept data; high impedance (spacing) when the TTY printer is busy.
2	TTY Transmitted Data Return	
3	Ground	Provides chassis ground.
4	TTY Received Data Return	Senses changes in current (data) through pins 4 and 5. High current for marking; low current for spacing.
5	TTY Received Data	

3.8.1 SIGNAL LEVELS AND TERMINATIONS. The TTY current loop receiver senses current levels from the sending device and converts them to the corresponding EIA voltage levels. The voltage drop across the receive inputs is 3 volts maximum at 20 mA loop current. The marking/spacing decision threshold is nominally 12 ±3.5 mA. The TTY current loop transmitter switches the current supplied by the sending device. The input to the transmitter is the EIA Reverse Channel signal (SCA) representing the printer ready or busy status. The voltge drop across the transmitter terminals is less than 1.5 volts at 20 mA loop current. The maximum spacing leakage current is 0.5 mA at 50 Vdc. The transmitter output is on or marking (low impedance) when the TTY printer is ready to accept data, and off or spacing (high impedance) when the TTY printer is busy.

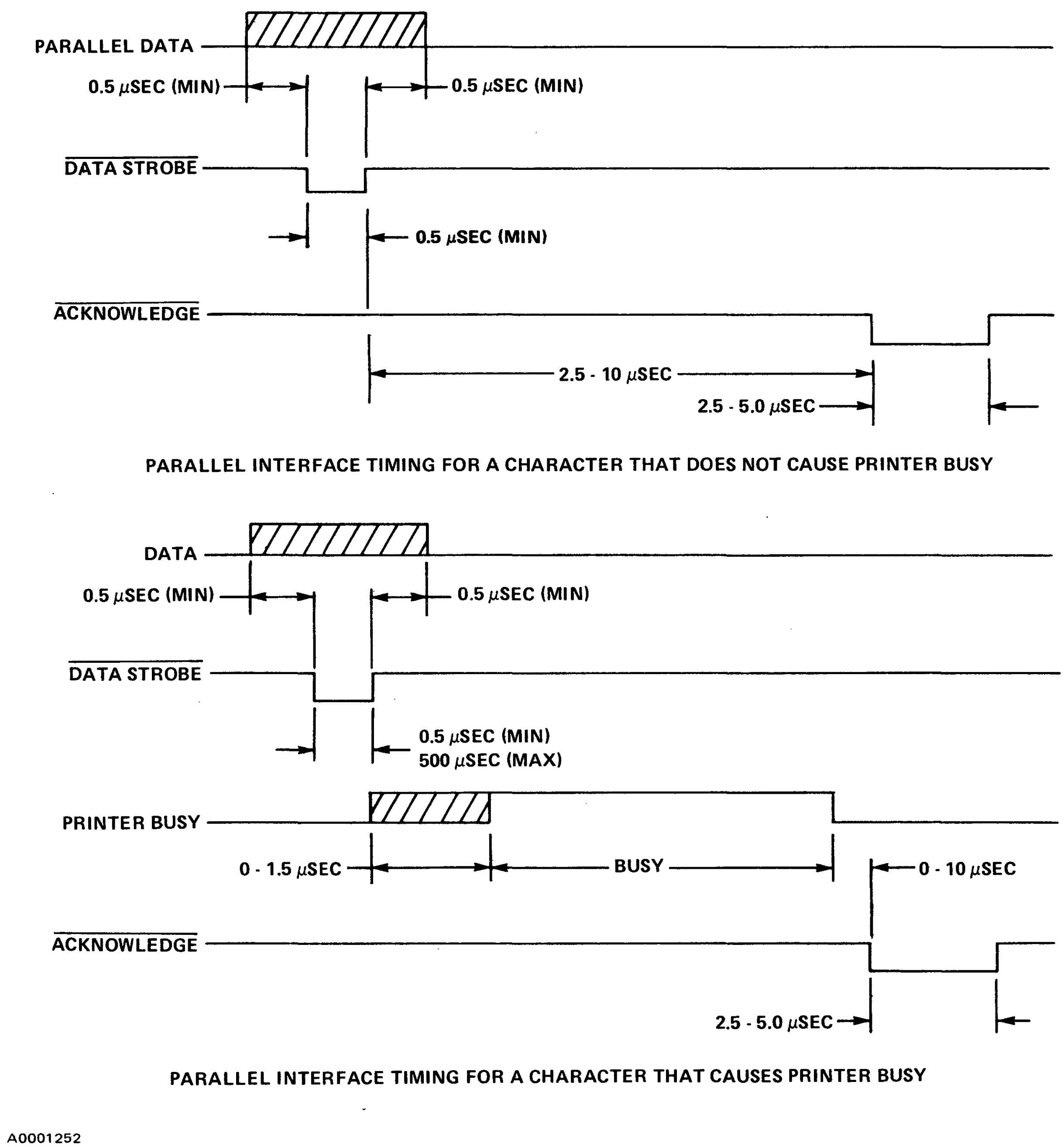


Figure 3-7. Parallel Interface Character Timing

3.8.2 TIMING. The asynchronous data format shown in Figure 3-6 is applicable to the TTY current loop.

3.9 SOFTWARE (REMOTE) CONTROL.

The following paragraphs contain information and procedures required to control the printer through the communications interface. All printer functions which can be controlled by the sending device are described in tabular form. The more complex functions requiring a sequence of control codes are further described in step-by-step procedures.

3.9.1 SOFTWARE COMMANDS. Table 3-2 describes the action taken by the printer in response to the various received control characters. In the second column of Table 3-2, the actual ASCII code characters which are to be sent to the printer are underlined, while the letters "N" and "n" represent numbers which are to be sent as noted. The plus (+) sign indicates that the character which follows is to be sent next in the command sequence. All characters received by the printer are stored in a first-in first-out (FIFO) buffer. When the printing mechanism is not busy, data characters are transferred from the FIFO to the line buffer. The contents of the line buffer are printed when any of the following occur:

1. A carriage return (CR) character or any of the paper movement characters, line feed (LF), vertical tab (VT), form feed (FF), or tab to line (DC2), is received.
2. A total of 133 printable characters (one character over a full line) is received.
3. A deselect (DC3) character is received.
4. The operator presses the printer ON LINE switch (setting the printer off line), and then presses the printer LINE FEED switch.
5. The operator presses the printer FORM FEED switch.

3.9.2 SOFTWARE FORM LENGTH SETTING. The following sequence, when received by the printer, causes the form length to be set at the line number represented by "n". Any form length from four lines up to the maximum 112 lines may be set. If a parity is selected on the printer, a parity bit must be added to the seven-bit "n" as the most significant (eighth) bit.

1. <u>ESC</u>
2. <u>2</u>
3. The binary equivalent of the number "n" of lines in the desired form length.

NOTE

Use Table 3-3 to select the ASCII code character which produces the required binary equivalent.

Example: <u>ESC</u> + <u>2</u> + <u>@</u> sets the form length at 64 lines. The ASCII code character "@" produces a binary 100 0000 (decimal 64).

Table 3-2. Software Commands

NOTE: Underlined characters represent ASCII code.

Command	ASCII Code Characters Received	Printer Action Taken
Carriage Return	CR	This command causes data, if any, in the line buffer to be printed. Because of the bidirectional printing capability of the printer, a carriage return is not executed. Instead, the carriage stops upon completion of printing a line. When the next line is received, the carriage is positioned to print forward or backward, whichever requires the least carriage movement.
Delete	DEL	This command clears the line buffer. If the NDE (no delete) option is installed, this command will be ignored.
Deselect	DC3	This command deselects the printer, causing it to ignore all incoming data and control characters except DC1 (select) after printing out the contents of the line buffer.
Form Feed	FF	This command causes data, if any, in the line buffer to be printed and advances the paper to the top of the next form.
Form Length Set	ESC + 2 + n (See Note 1.)	This command sets the form length used by the Form Feed (FF) command to n lines (from 4 to 112 lines). See paragraph 3.9.2 for form length setting procedure.
Horizontal Tab	HT	This command causes spaces to be entered in the line buffer up to the next horizontal tab location, where printing will begin.
Horizontal Tab Set	ESC + 3 + n_1 + n_2... + n_k + NUL (See Note 1.)	This command clears all existing horizontal tabs and sets new tabs at columns n_1, n_2,..., and n_k (columns 1 through 126). See paragraph 3.9.3 for horizontal tab setting procedure.
Line Feed	LF	This command causes data, if any, in the line buffer to be printed and advances the paper one line space.
Line Width Set	ESC + : + n (See Note 1.)	This command causes the printer to print lines n columns wide (from 2 to 126 columns). (Line width is automatically set to 132 columns at power-up.) See paragraph 3.9.4 for line width setting procedure.
Line Width 132	ESC + ;	This command causes the printer to print lines 132 columns wide. (Line width is automatically set to 132 columns at power-up).
Null	NUL	This command terminates the tab setting sequence for both horizontal and vertical tabs, otherwise it is ignored.

Table 3-2. Software Commands (Concluded)

NOTE: Underlined characters represent ASCII code.

Command	ASCII Code Characters Received	Printer Action Taken
Recall	ESC + 9 + N	This command recalls the stored vertical format information in the optional VFC channel N memory to the working memory. If the VFC option is not installed, this command is ignored. See Paragraph 3.9.5 for the recall procedure. (See note 3).
Select	DC1	When power is applied to the printer, this command selects the printer, enabling it to receive data.
Store	ESC + 8 + N (See Note 2.)	This command stores vertical format information from the working memory in the optional VFC channel N memory. If the VFC option is not installed, this command is ignored. See Paragraph 3.9.6 for the store procedure (See note 3).
Tab To Address	DC4 + n (See Note 1.)	This command causes spaces to be entered in the line buffer from the present column up to column n; (n must be greater than the present column and no greater than column 126). If n is less than the present column, this command will be ignored.
Tab To Line	DC2 + n (See Note 1.)	This command causes the paper drive system to slew to the line specified by n (line 4 through 112) after printing contents of the line buffer (n must be greater than the present line). If n is less than the present line, this command will be ignored.
Vertical Tab	VT	This command causes data, if any, in the line buffer to be printed and advances the paper to the next vertical tab location or top of form, whichever occurs first. If no vertical tabs are set, this command causes the paper to be advanced to top of form.
Vertical Tab Set	ESC + 1 + n_1 + n_2 +...+ n_k +NUL	This command clears all existing vertical tabs and sets tabs at lines n_1, n_2,..., and n_k (where n is less than or equal to line 112). See paragraph 3.9.7 for the vertical tab setting procedure.
6 LPI	ESC + 4	This command sets the paper drive system to 6 lines per inch. (The paper drive system is automatically set to 6 lines per inch at power-up.)
8 LPI	ESC + 5	This command sets the paper drive system to 8 lines per inch.
10 CPI	ESC + 6	This command sets the carriage system to 10 characters per inch. (The carriage system is set to 10 characters per inch at power-up.)
16.5 CPI	ESC + 7	This command sets the carriage system to 16.5 characters per inch.

NOTE 1: The number "n" as used in the DC2, DC4, ESC+1, and ESC+2, ESC+3, and ESC+: commands represents a seven-bit binary number. See Table 3-3 for the ASCII character code which will transmit the desired binary number.

NOTE 2: The number "N" as used in the ESC+8 and ESC+9 commands represents the ASCII coded numbers from one through eight, which correspond to the selected VFC channel.

NOTE 3: Vertical format information includes: number of lines per inch, form length, and tabs.

Table 3-3. Column Or Line "n" Number Conversion

For Column Or Line Number	Send ASCII Code Character	For Column Or Line Number	Send ASCII Code Character	For Column Or Line Number	Send ASCII Code Character	For Column Or Line Number	Send ASCII Code Character
1	SOH	33	!	65	A	97	a
2	STX	34	"	66	B	98	b
3	ETX	35	#	67	C	99	c
4	EOT	36	$	68	D	100	d
5	ENQ	37	%	69	E	101	e
6	ACK	38	&	70	F	102	f
7	BEL	39	/	71	G	103	g
8	BS	40	(	72	H	104	h
9	HT	41	)	73	I	105	i
10	LF	42	*'	74	J	106	j
11	VT	43	+	75	K	107	k
12	FF	44	,	76	L	108	l
13	CR	45	—	77	M	109	m
14	SO	46	.	78	N	110	n
15	SI	47		79	O	111	o
16	DLE	48	0	80	P	112	p
17	DC1	49	1	81	Q	113	q
18	DC2	50	2	82	R	114	r
19	DC3	51	3	83	S	115	s
20	DC4	52	4	84	T	116	t
21	NAK	53	5	85	U	117	u
22	SYN	54	6	86	V	118	v
23	ETB	55	7	87	W	119	w
24	CAN	56	8	88	X	120	x
25	EM	57	9	89	Y	121	y
26	SUB	58	:	90	Z	122	z
27	ESC	59	;	91	[	123	{
28	FS	60	<	92	\	124	¦
29	GS	61	=	93	]	125	}
30	RS	62	>	94	Λ	126	~
31	US	63	?	95	–	127	DEL
32	SPACE	64	@	96	'		

3.9.3 SOFTWARE HORIZONTAL TAB SETTING. The following sequence, when received by the printer, causes all previous horizontal tabs to be cleared and new horizontal tabs to be set at the column represented by "n" (where "n1" is the first tabbed column and "nk" is the last tabbed column). Horizontal tabs may be set at any column up to and including the 127th column. If a parity is selected on the printer, a parity bit must be added to the character code (seven-bit character or binary number "n") as the most significant (eighth) bit.

1. ESC
2. 3
3. The binary equivalents of the columns "n1" through "nk" where the horizontal tabs are to be set.

NOTE

Use Table 3-3 to select the ASCII code character which produces the required binary equivalent.

4. NUL

Example: ESC + 3 + DLE + 4 + T + t + NUL sets horizontal tabs at columns 16, 52, 84, and 116. The ASCII code characters "DLE", "4", "T", and "t" produce the binary numbers 0001 0000 (decimal 16), 011 0100 (decimal 52), 101 0100 (decimal 84), and 111 0100 (decimal 116) respectively.

3.9.4 SOFTWARE LINE WIDTH SETTING. The following sequence, when received by the printer, causes the line width to be set at the number of columns represented by "n". Any line width up to the maximum 127 columns may be set. If parity is selected on the printer, a parity bit must be added to the seven-bit number "n" as the most significant (eighth) bit.

1. ESC
2. :
3. The binary equivalent of the number "n" of columns in the desired line width.

NOTE

Table 3-2 defines ESC commands for setting line width to 132 columns wide. Use Table 3-3 to select the ASCII code character which produces the required binary equivalent.

Example: ESC + : + P sets the line width at 80 columns. The ASCII code character "P" produces a binary 101 0000 (decimal 80).

3.9.5 SOFTWARE VERTICAL FORMAT RECALL. The following sequence recalls the stored vertical format information in the optional VFC channel memory (channels 1 through 8) to the working memory after clearing the previous vertical format information from the working memory. The form length of the channel takes effect following the first form feed operation. If the VFC option is not installed, this command will be ignored.

1. ESC
2. 9
3. The ASCII code character for the channel selected.

Example: ESC + 9 + 7 + FF recalls the vertical format stored in VFC channel 7 to the working memory. The form feed recalls the form length of channel 7.

3.9.6 SOFTWARE VERTICAL FORMAT STORE. The following sequence stores the vertical format information in the working memory into the selected optional VFC channel memory (channels 1 through 8) after clearing the previous vertical format information from the selected channel. The vertical format information in the working memory is not cleared. If the VFC option is not installed, this command will be ignored.

1. ESC
2. 8
3. The ASCII code character for the VFC channel in which the vertical format information from the working memory is to be stored.
4. Form Feed

Example: ESC + 8 + 3 + Form Feed stores the vertical format information in the working memory into VFC channel 3.

3.9.7 SOFTWARE VERTICAL TAB SETTING. The following sequence, when received by the printer, causes vertical tabs to be set at the lines represented by "n" (where "n1" is the first tabbed line and "nk" is the last tabbed line). Vertical tabs may be set at any line up to an including 112th line. If parity is selected on the printer, a parity bit must be added to the seven-bit number "n" as the most significant (eighth) bit. Commands to set tabs at lines beyond the 112th line will be ignored.

1. ESC
2. 1
3. The binary equivalents of the lines "n1" through "nk" where the vertical tabs are to be set

NOTE

Use Table 3-3 to select the ASCII code character which produces the required binary equivalent.

4. NUL

Example: ESC + 1 + DLE + 4 + T + t + NUL sets vertical tab at lines 16, 52, and 84. The ASCII code characters "DEL", "4", "T", and "t" produce the binary numbers 001 0000 (decimal 16), 011 0100 (decimal 52), 101 0000 (decimal 84), and 111 0100 (decimal 116), respectively. The binary number 111 0100 (decimal 116) will be ignored since it is beyond the 112 line maximum.

SECTION IV

THEORY OF OPERATION

4.1 GENERAL.

This section contains principles and theory of operation. Principles of operation include a system block diagram, a discussion of dot matrix printing, as used by the Model 810, and an overview of the major printer subsystems. Theory of operation describes the printer at a printed circuit board level.

4.2 PRINCIPLES OF OPERATION.

This paragraph is intended to introduce the key electromechanical and electronic subsystems of the Model 810 Printer (refer to Figure 4-1). These subsystems include:

- Electronic Control Subsystem
- Printhead Carriage Subsystem
- Paper Feed Subsystem
- Power Supply

The Electronic Control Subsystem includes a TMS 8080A Microprocessor which contains firmware programs that define operation of the printer as commanded by the control panel switches and/or by incoming signals from the sending device. When the printer is on line, the Electronic Control Subsystem interprets incoming data, control panel signals, and feedback signals from the Printhead Carriage Subsystem; and generates all necessary timing and control signals which are fed to the Printhead Carriage and Paper Feed Subsystems.

The Printhead Carriage Subsystem produces carriage motion, produces drive signals to generate printable characters via the dot matrix printhead (based on commands from the microprocessor), and feeds carriage position encoder pulses back to the microprocessor. The Paper Feed Subsystem controls paper motion. The power supply provides all ac, dc, and regulated dc voltages necessary to operate the printer.

The following subparagraph introduces the Dot Matrix Printing Mechanism. Subsequent subparagraphs provide a more detailed description of the subsystems introduced above.

4.2.1 DOT MATRIX PRINTING MECHANISM. The Model 810 Printer features a dot matrix printing mechanism which prints characters in a 9 x 7 dot matrix pattern on paper through an inked ribbon. The Model 810 is a smart, bidirectional, impact-type printer, capable of printing multiple copies (one original and up to five copies). The printhead is in continuous horizontal motion as the characters are being formed.

The printing mechanism physically consists of a printhead assembly, carriage drive, paper drive, and ribbon drive (refer to Section VI for physical location of these items).

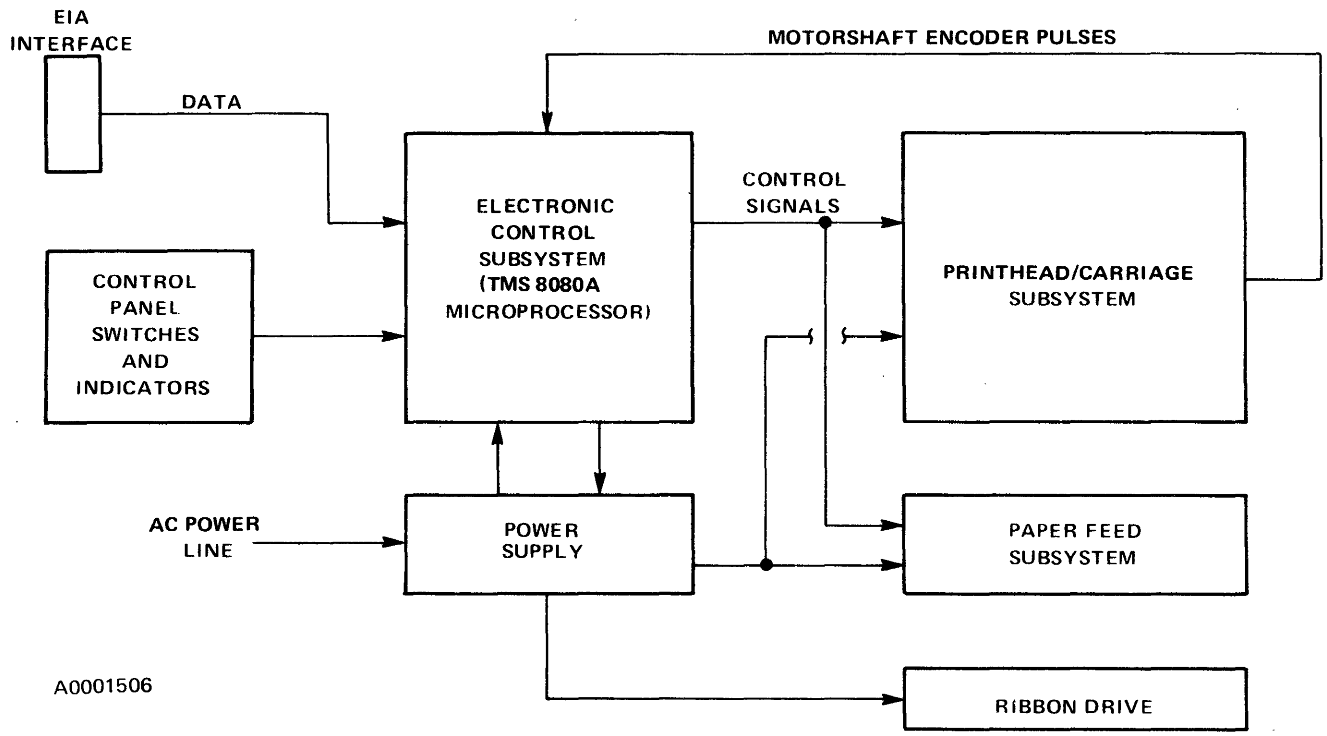


Figure 4-1. Model 810 Printer Simplified Block Diagram

4.2.1.1 **Printhead Assembly.** The printhead consists of a frame and seven solenoids arranged radially around the printhead (refer to Figure 4-2). Each solenoid has a tungsten print wire attached. The free end of the print wires pass through a synthetic ruby wire guide at the front of the printhead. This guide spaces the wires to form a vertical 1 x 7 column.

In operation, the solenoids drive the wires with sufficient force to print an impression on an original plus five carbon copies (standard 12-pound bond paper with 7 1/2-pound carbons). The printhead operates at 900 Hz, producing a 150 characters per second print rate. Continuous operations of this device is possible without forced air cooling.

4.2.1.2 **Carriage Drive.** The carriage drive is a closed-loop electromechanical assembly which allows proper positioning of the printhead as it prints each line of characters. The carriage itself supports the printhead assembly, and is guided by guide rods attached to the printer frame (refer to Section VI for location). The guide rods maintain proper spacing between the printhead and platen as the printhead is moved across the page.

Bidirectional printing is used to eliminate the need for a carriage return after each line. The Electronic Control Subsystem has a two-line buffer so that (upon completion of printing a line) the next line is examined to determine which direction should be used to print the next line in order to achieve minimum carriage positioning time (hence the term "smart printer").

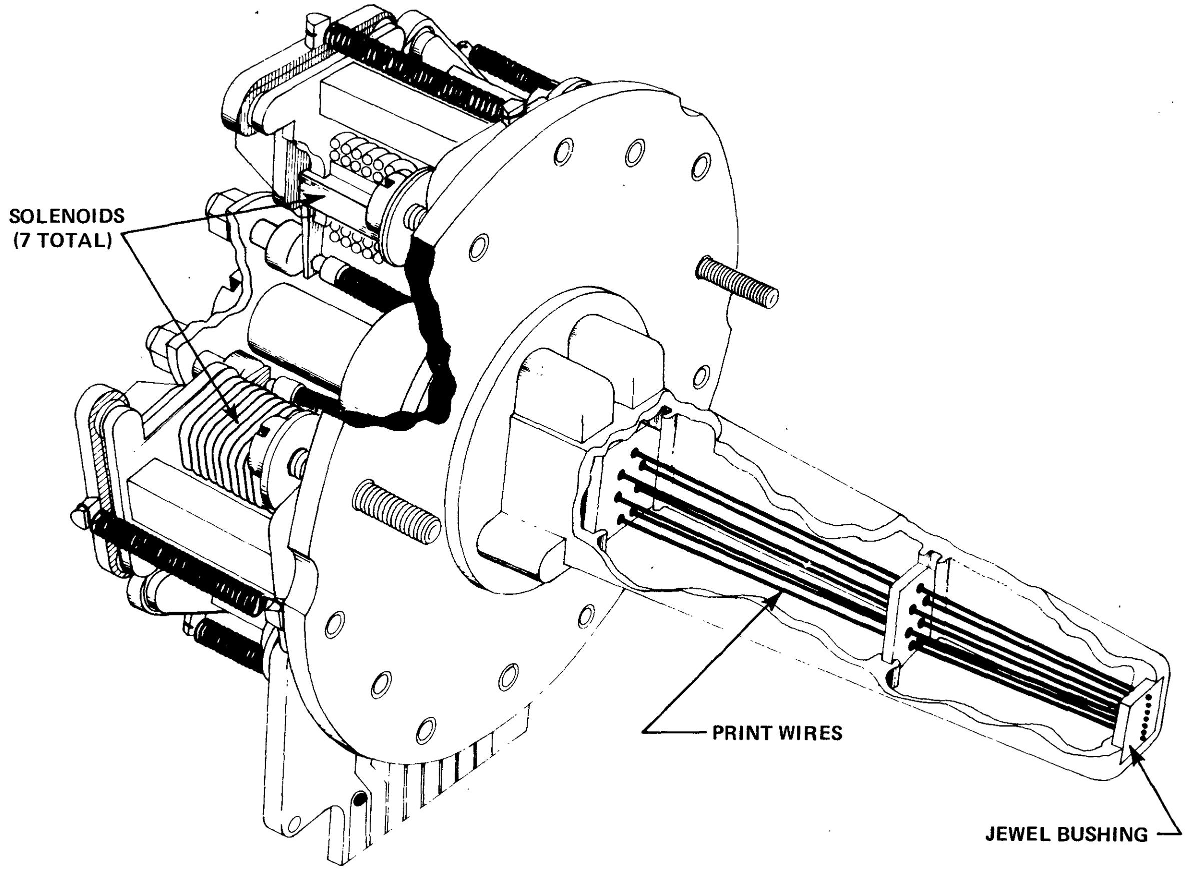


Figure 4-2. Model 810 Printer Printhead Assembly

Maximum carriage travel is 34.5 cm (13.6 inches) with velocity control over the full range of travel. The carriage drive operates at character throughput rates up to 150 characters per second (CPS). A dc servo motor controlled by the microprocessor is used to position the carriage. An optical encoder mounted on the motor shaft provides signals from which velocity, position, and direction of carriage movement are obtained.

4.2.1.3 Paper Drive. The paper drive mechanism allows the paper form to be advanced through the printer in 0.014 inch increments. The paper drive consists of a stepper motor geared to the paper tractor feed shaft which drives two pin-feed type paper tractors. The paper drive is mounted on the printer frame (refer to Section VI for location).

The operator loads paper either through a path entering horizontally along the bottom rear of the printer, or through a path entering vertically beneath the platen print surface. Two control panel switches (FORM ALIGN ▲ and FORM ALIGN ▼) allow the operator to align the form vertically with the printhead. The paper is driven by the two pin feed paper tractors that pull and guide the forms through the printer. The tractors are continuously adjustable between widths of 3 to 15 inches and allow horizontal registration of the paper. Under control of the microprocessor, the paper drive advances the form through the printer in six lines per inch (1/6-inch steps) or eight lines per inch (1/8-inch steps).

The form thickness capacity is 0.053 mm (0.021 inch) maximum (sufficient for one original, five carbons, and five copies using standard 12-pound bond with 7-1/2 pound carbons). A paper out sensor indicates to the microprocessor that the paper supply has been exhausted. When the paper out condition is sensed, the microprocessor allows printing to continue until the end of the line is reached, then the control panel PAPER OUT lamp lights and a busy signal is sent to the input device. Paper can be loaded and the printer ready to print in less than 30 seconds. Power does not have to be turned off during paper loading, thus vertical format and horizontal tab information stored in the Electronic Control Subsystem memory is not lost.

4.2.1.4 Ribbon Drive. The Ribbon Drive uses two standard spools (IBM type 1443 or equivalent) with the ribbon material and ink specified to be compatible with wire matrix printing (refer to Section VI for location). The ribbon has a minimum print capacity of 7 million characters. The ribbon spools are located underneath the access door. The ribbon path is set at a slight diagonal to the printhead path in order to print over as much ribbon surface as possible and obtain the maximum life from the ribbon. The ribbon spools are driven by a dedicated motor which moves the ribbon spools through a swinging gear. The ribbon is reversed by reversing the direction of motor rotation when one of the eyelets (at either end of the ribbon) actuates a switch. The ribbon drive is turned off when printing ceases for 1 second.

4.2.1.5 Dot Matrix Printing Mechanics. This paragraph briefly describes how the printing mechanism prints a character. As previously mentioned, the printhead prints characters in a 9 x 7 dot matrix (9 horizontally and 7 vertically) on a paper form through inked ribbon. The printhead carriage position and velocity are controlled by the microprocessor which maintains a record of the printhead carriage position. The microprocessor determines carriage position by incrementing or decrementing a counter (depending on direction of carriage motion) for each output pulse from the encoder mounted on the shaft of the carriage drive servo motor.

Each character space is divided into twelve equal increments on the horizontal axis (8.33 mils wide). The character uses nine spaces with three spaces between characters. Figure 4-3 illustrates how the letter "E" is formed on the dot matrix. Note that there are seven horizontal grid lines (corresponding to the seven print wires) and five vertical columns. The five vertical columns are subdivided into half columns, providing a total of nine vertical columns. The letter "E" begins in column 2 by firing all seven solenoids. The first, fourth and seventh solenoids are fired on columns 4, 6, and 8; and the first and seventh solenoids are fired on column 10 (thus forming the letter "E". The next three half-columns are empty and the letter "W" starts on half-column 2. The printhead is in continous horizontal motion when the solenoids are fired. The carriage generates an encoder pulse as each of the 12 space increments is passed. There are 12 encoder pulses per character (e.g., there is an encoder pulse associated with each vertical column in Figure 4-3). Each pulse provides an interrupt to the 8080A microprocessor and causes it to fetch a byte from a read-only memory (which contains the dot pattern for that column). This pattern is then sent to the seven printhead drive circuits, which fire the solenoids required to form the desired character dot pattern. Due to recovery time, a solenoid cannot be fired on consecutive encoder pulses; it is limited to firing on every other encoder pulse.

For maximum efficiency a carriage return, as such, is not used. Instead, the microprocessor examines the next line of data in the line buffer and calculates the distance from the present carriage position to

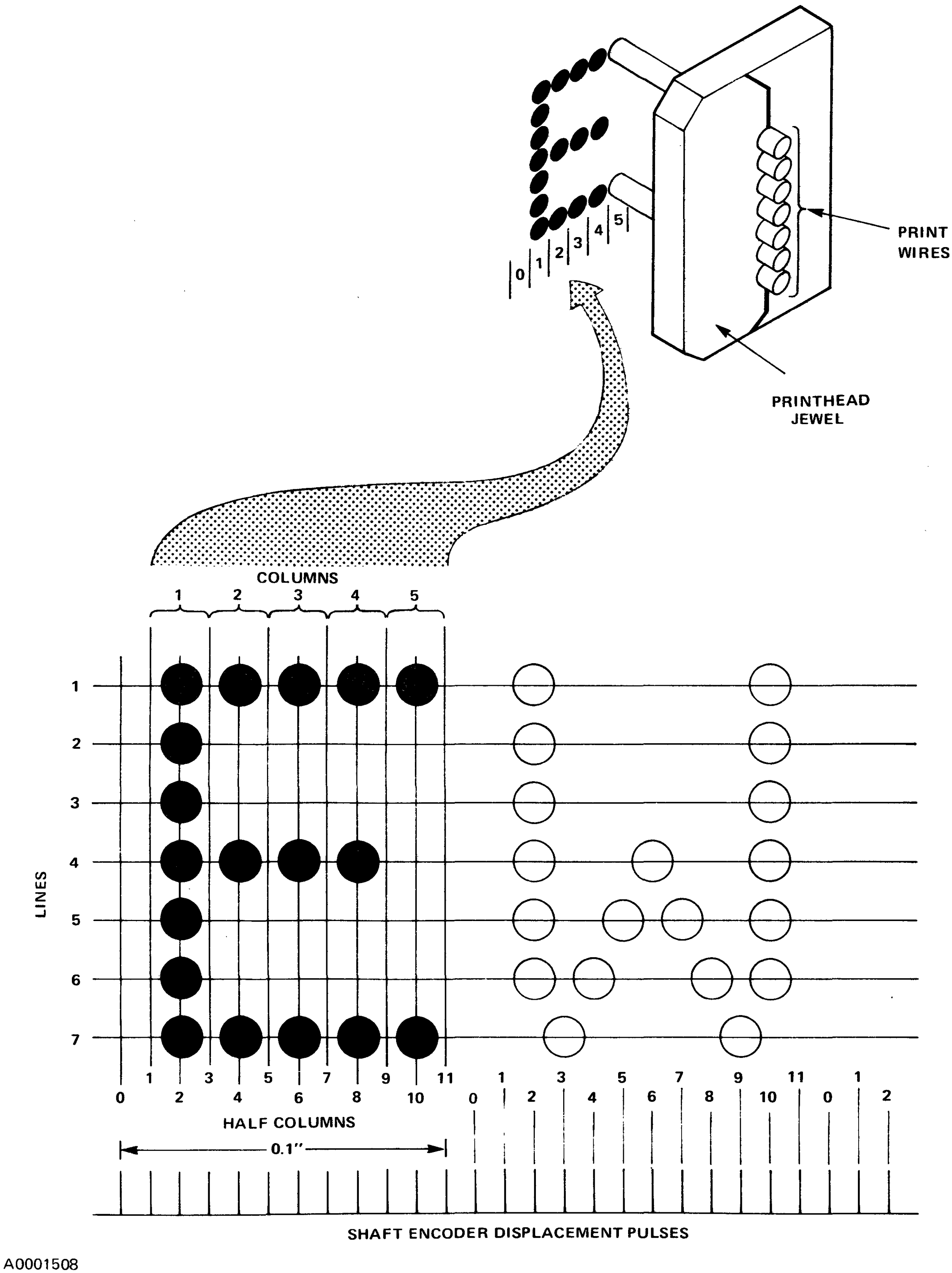


Figure 4-3. Printing the Letter "E"

either end of the next line. The microprocessor then commands the drive electronics to move the printhead carriage to the position of the first or last character in the next line (whichever is closer), and prints this line left to right or right to left depending on the end selected.

4.2.2 ELECTRONIC CONTROL SUBSYSTEM. The Electronic Control Subsystem is located on the processor board, part number 994244. This subsystem consists of a TMS 8080A microprocessor system; serial and parallel communications interfaces; control panel and device board interface; and speed counter, printhead timing and carriage encoder logic. (Refer to Figure 4-4.)

The microprocessor system consists of a Texas Instruments TMS 8080A microprocessor, 256 bytes of random-access memory (RAM), two 2K bytes of read-only memory (ROM), 1K byte of optional programmable read-only memory (PROM), a special purpose TMS 5501 I/O device, and a 256 character first-in first-out (FIFO) buffer. The RAM provides a 256-byte workspace for the microprocessor. It holds one line of 132 characters to be printed, saves the microprocessor register contents during interrupt cycles (i.e., pushdown stack), and provides temporary storage for the microprocessor flag registers. The ROM contains the dot patterns for the printable characters as well as firmware programs and routines required to perform the various printer functions. Portions of firmware programs that are customer application dependent, are stored in optional PROMs. The 256-byte FIFO buffer stores input characters received by the Model 810 Printer during the period while the printer is busy printing.

The TMS 8080A communicates with all other components of the microprocessing system through a 16-bit parallel address bus, and an 8-bit parallel data bus. (Refer to Appendix D for detailed information.) After power-up, the microprocessor system scans the control panel and auxiliary control panel switches to determine the control functions (such as on line, form feed, normal or test mode, etc.) required by the switch settings. Incoming data from the sending device is fed into the printer through the EIA interface or optional TTY or parallel interfaces. All serial data comes in through the TMS 5501 I/O and timing device (refer to Appendix E for detailed information), and is then fed to the FIFO buffer via the 8-bit data bus. Data is stored in the FIFO buffer until print time. Parallel data is fed through a multiplexer latch circuit and loaded directly into the FIFO buffer.

At print time, the microprocessor analyzes the characters stored in the FIFO buffer one-by-one to determine if they are printable characters (alphabet, numerals, and punctuation marks), control characters (such as line feed, carriage return, horizontal tab, etc.) or four special characters (DC2, DC4, ESC, or NUL) which alter the operating characteristics of the printer. The print characters are then fed back over the 8-bit data bus through the TMS 5501 to the print buffer which is a 132 character space in RAM. The microprocessor reads the ASCII characters in the print buffer one at a time to determine the address in ROM which contains the dot pattern required to form the desired character. Each 1 x 7 vertical column of the 9 x 7 matrix (required to form the character) is read from ROM (one at a time), and fed through the I/O and timing device, the inverters, and into I/O latches which control the printhead drivers. The microprocessor then commands the printhead drivers (a part of the Printer/Carriage Subsystems) to drive the printhead and print the character one vertical column at a time. During this process, the microprocessor is also controlling carriage and paper motion.

In summary, the Electronic Control Subsystem accepts incoming data, and produces signals to the Print/Carriage Subsystem driver board to control the printhead solenoids, printhead carriage, and paper motion.

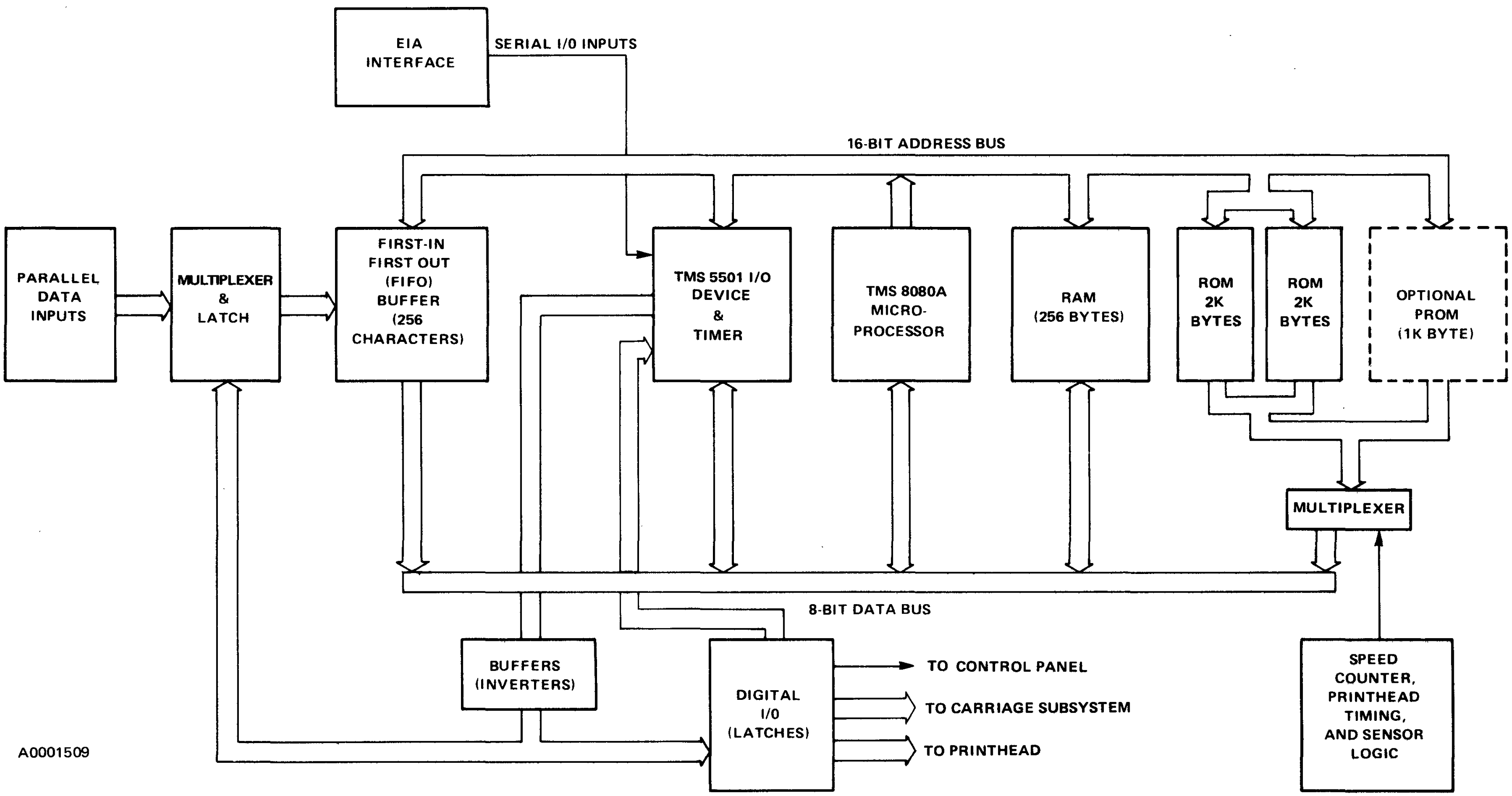


Figure 4-4. Electronic Control Subsystem Block Diagram

4.2.3 FIRMWARE PROGRAM OVERVIEW. The Model 810 software programs, referred to as firmware, are stored in ROM. Application-dependent software programs are stored in optional PROMs. At power-up, the microprocessor is reset to hexadecimal address 0000 and begins executing instructions to perform the following tasks:

- Clear RAM
- Initialize flags, states, constants, and variables
- Clear TMS 5501 and unmask interrupts
- Initialize control latches
- Start fail-safe timer
- Align stepper motor to phase A
- Align carriage to left bumper
- Initialize printer options.

The microprocessor system then moves into the NORMAL or TEST mode, depending on the control panel switch setting. The microprocessor then begins to loop through the background software programs without halt (in NORMAL mode) until an interrupt is received. The major subroutines in this loop initiate tasks such as paper motion, carriage motion, and printing. These tasks are then completed by interrupt driven software with the microprocessor system returning to the background loop during its spare time. The sending device communicates to the software in the form of commands. The complete set of software commands are given in Table 3-2. The software commands are used to control all physical movements of the printing mechanism. Refer to General Software Structure under Theory of Operation for more detailed information on the Model 810 software and subroutines.

4.2.4 PRINTHEAD CARRIAGE SUBSYSTEM. The function of the printhead carriage subsystem is to move the printhead at a controlled velocity across the width of the printed line and provide drive current to drive the seven printhead solenoids. The elements of the carriage subsystem are:

- Printhead and printhead carriage
- DC servo motor with shaft encoder
- Power drive circuits for dc servo motor and printhead solenoids
- Capstan, wire rope and tensioning mechanisms
- Printhead-to-platen positioning mechanism.

Refer to drawing number 994183 in Section VI for a mechanical relationship of these components. The power drive circuits for the dc servo motor are a part of the driver printed circuit board (refer to Figure 4-5).

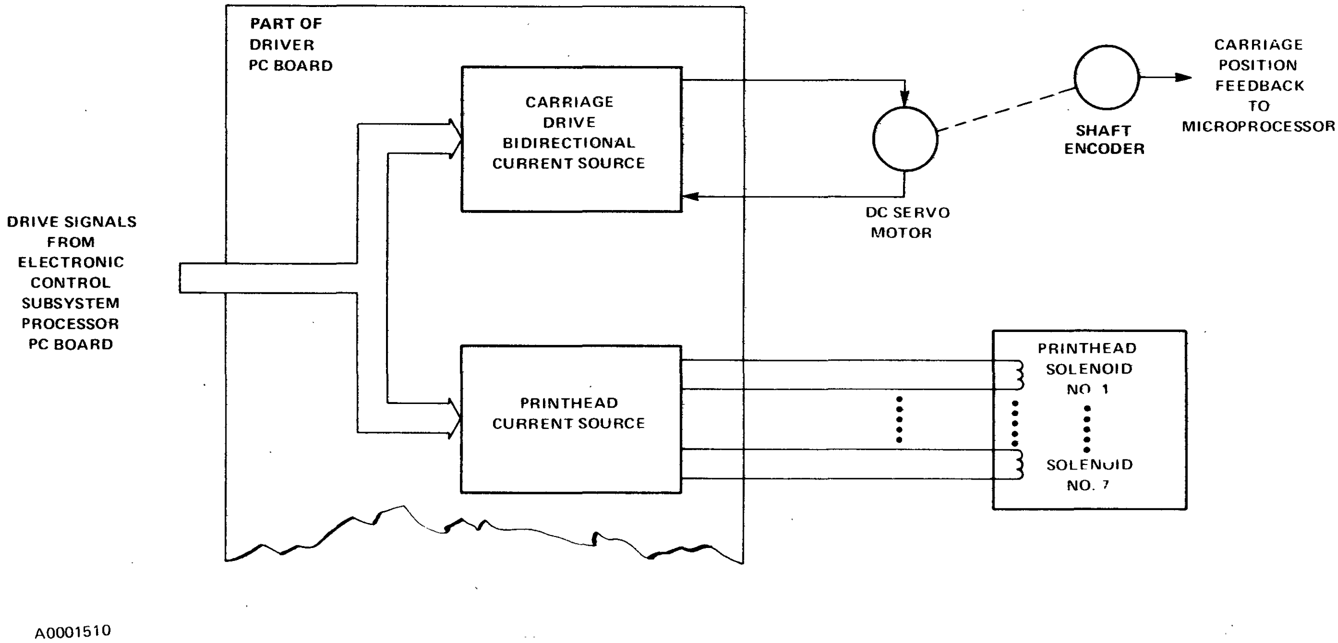


Figure 4-5. Printer/Carriage Subsystem, Block Diagram

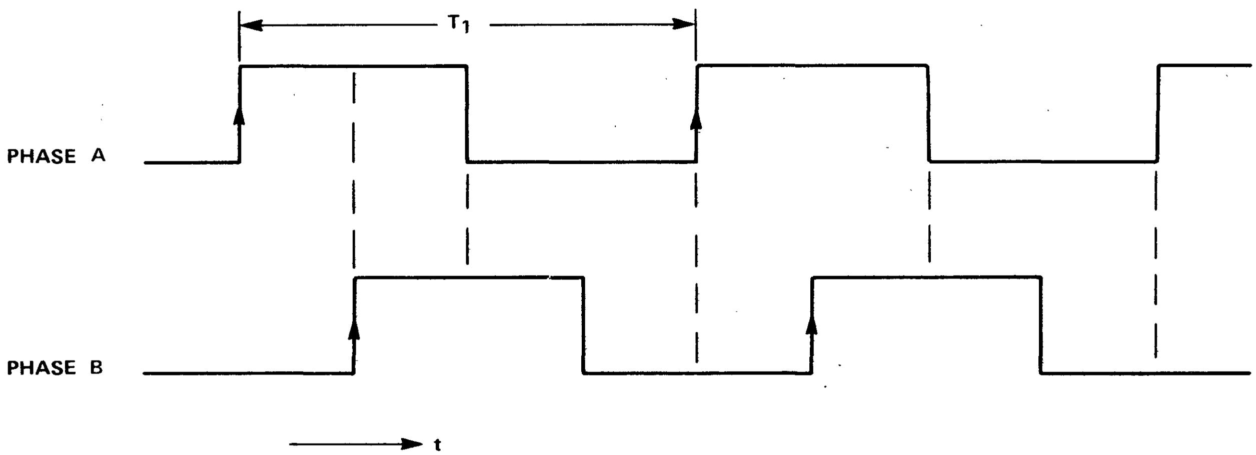
4.2.4.1 Printhead Drive. The printhead driver circuits provide drive current for the seven printhead solenoids. Drive signals from the Electronics Control Subsystem are fed to the printhead current sources. The printhead current sources provide current pulses to the printhead solenoids upon command from the microprocessor. The sequence and duration of current pulses to the printhead solenoids is controlled by the microprocessor system. Refer to Theory of Operation for a more detailed description of the printhead drive circuits.

4.2.4.2 Carriage Drive. The dc servo motor is the drive source for mechanically positioning the carriage for printing. The shaft encoder attached to the rear shaft of the dc servo motor generates a pulse train which is used by the processor to determine the location of the printhead on the paper. The pulse train is also used to determine carriage velocity and direction of travel.

Operating modes of the carriage subsystem are:

- Initializing
- Forward or reverse printing
- Forward or reverse slewing.

a. Initializing Mode. The initializing mode is used during a power-up sequence or when changing from normal to compressed print modes. In this mode the carriage is slowly moved to the left until the carriage strikes a rubber bumper. The processor detects the stalled motor condition through the loss of encoder pulses. This known physical location is stored by the processor and becomes the basis for determining carriage location by incrementing or decrementing position counters when encoder pulses are received. Direction is determined by using two outputs from the encoder that are in phase quadrature. These outputs are shown in Figure 4-6. The phase relationship between these two signals is used to determine the direction of rotation. The time between encoder pulses (T1) is inversely proportional to the carriage velocity. This time can therefore be used by the processor to determine when to turn the motor on or off to regulate carriage velocity.



NOTES

1. In normal print mode the encoder produces 288 pulses per revolution which produces a 1.8 kHz pulse train at normal print velocity of 15 inches per second.
2. In compressed print mode the encoder produces 475 pulses per revolution which produces a 1.8 kHz pulse train at compressed print velocity of 9.1 inches per second.

A0001511

Figure 4-6. Carriage Motor Shaft Encoder Phase Relationship for Left-to Right Carriage Motion

b. Forward or Reverse Printing Mode. In the forward or reverse printing mode, the carriage is accelerated to 38.1 cm (15 inches) per second for normal printing or 23.1 cm (9.1 inches) per second for compressed printing. A velocity profile of this mode is shown in Figure 4-7.

During the time interval T1 (Figure 4-7) the motor is driven from a constant current, 3A source to produce a linear carriage acceleration of 2540 cm (1000 inches) per second^2 (nominal). At time T1 the motor drive current is reduced to 1.5A to change the acceleration rate to 1270 cm (5 inches) per second^2 (nominal). At time T2, the processor determines the carriage velocity is greater than required and turns off the drive current source. The motor will coast down to the regulating point, where the processor will again turn on the 1.5A constant current source. In this manner, the velocity will be regulated at print speed during time interval T3.

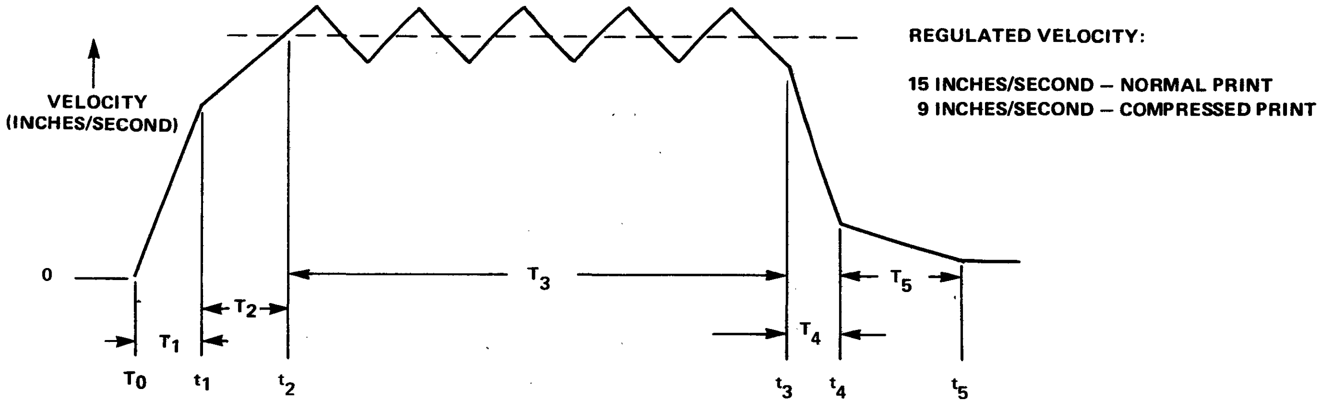


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Figure 4-7. Carriage Velocity Profile in Print Mode

A stop command at t3 will reverse the current flow in the motor to decelerate the motor until t4. At t4 the motor is turned off and the carriage friction stops the carriage. Forward or reverse carriage velocity regulation cycles are identical except for direction of current flow in the motor.

c. Forward or Reverse Slewing Mode. The last carriage motion operating mode is the slew mode. This mode is used to rapidly move over distances greater than 2 inches long from the present carriage position to the next print position.

The higher carriage velocities in the slew mode are achieved by setting higher reference velocities in the processor program. Motor currents and acceleration rates are identical as described for the normal print mode. Since the acceleration rates are the same, the time required to reach slew velocity is 35 milliseconds.

4.2.5 PAPER FEED SUBSYSTEM. The function of the Paper Feed Subsystem is to control the paper motion in the Model 810 Printer. Paper advance is performed with a 15° variable reluctance stepper motor geared to the paper feed tractor shaft. Each 15° step of the paper advance motor moves the paper 0.36 mm (0.014 inch). Twelve steps of the motor are used to achieve a full line advance in the 6 lines per inch mode. Nine steps moves the paper a full line in the 8 lines per inch mode.

Paper feed rate is 7.0 inches per second in the slew mode. A line feed in the 8 lines per inch mode requires 33 msec. The 6 lines per inch mode requires 25 msec.

Limited reverse paper feed is possible via the unique electronic paper alignment system used on the Model 810. Reverse paper feeds are limited to one motor step (0.014" paper travel) each time the operator presses the FORM ALIGN ⬇ key.

The microprocessor directly controls the paper advance mechanism through the logic signals indicated in Figure 4-8. Proper sequencing and timing of the control signals Phase A (PϕA), Phase B (PϕB), and Phase C (PϕC) control the direction and rate of rotation. PSTEP and PFAST signals

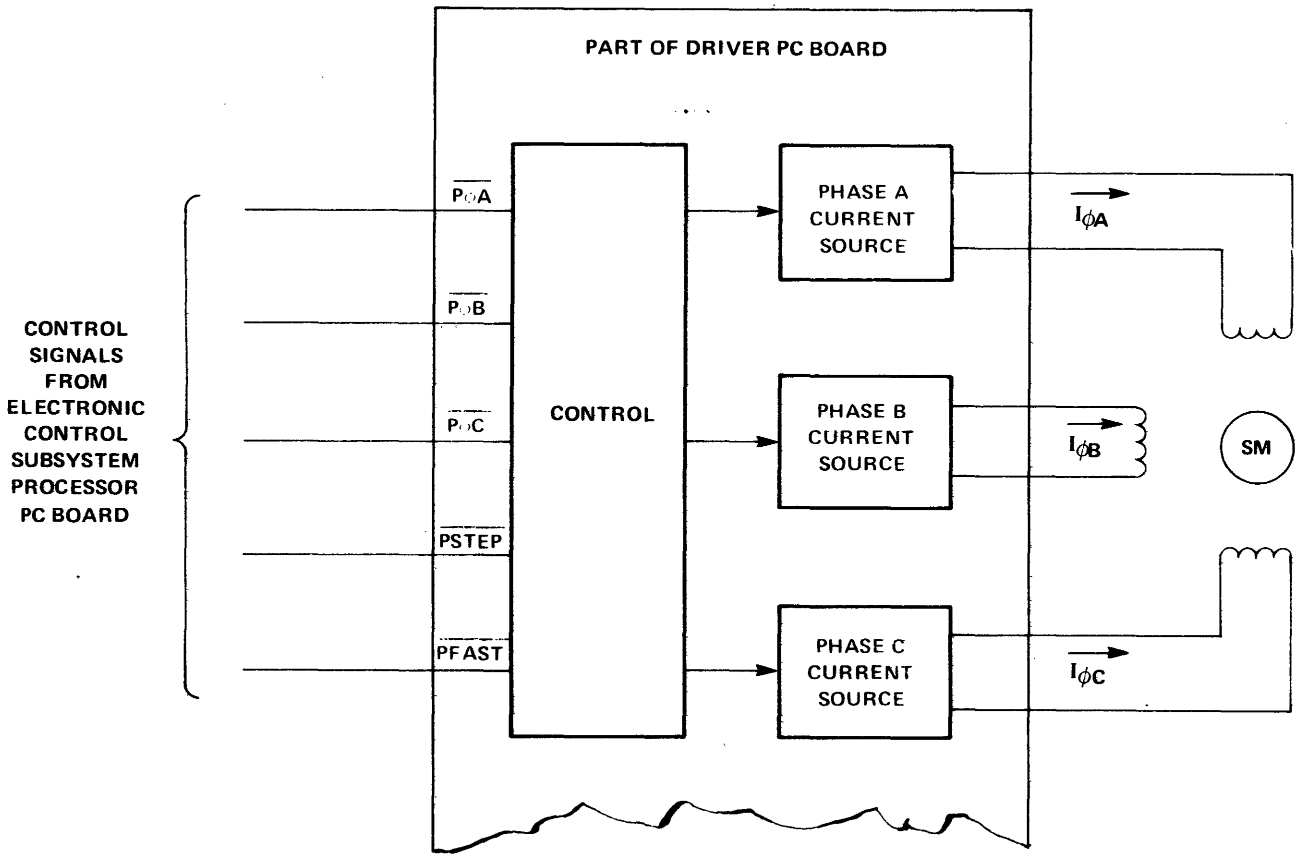

Figure 4-8. Paper Feed Subsystem Block Diagram

determine the magnitude of the constant current source and decay characteristics of the current wave forms. Paper slewing at 17.8 cm (7.0 inches) per second requires sequencing the phases at 500 pulses per second. Refer to Theory of Operation for a detailed circuit description.

4.2.6 POWER SUPPLY. The function of the power supply is to provide the necessary regulated and unregulated voltage requirements for all Model 810 Printer subsystems. It also generates power good and reset signals for initializing the microprocessor system when power is turned on. The power supply is physically distributed over the AC Module, motherboard, and power supply printed circuit board assembly (refer to Figure 4-9).

The AC Module (Figure 4-9) converts the ac line voltage to lower ac voltages required by the power supply board and fan. It also converts ac voltage to unfiltered dc voltage which is used by other subsystems within the printer. The lower ac voltages are fed into the motherboard and power supply board where they are converted to various ac and dc voltages required to operate the printer. The following voltages are distributed to the printer subsystems through the motherboard:

28 Vac, 1A	8 SW
+30 Vdc, 3A	−5 Vdc regulated, 10 mA
−75 Vdc, 0.5 A	+12 Vdc regulated, 350 mA
+5 Vdc regulated, 4A	−12 Vdc regulated, 350 mA
	Power Good/Reset

Refer to Theory of Operation for detailed information on operation of the power supply circuits and power supply board.

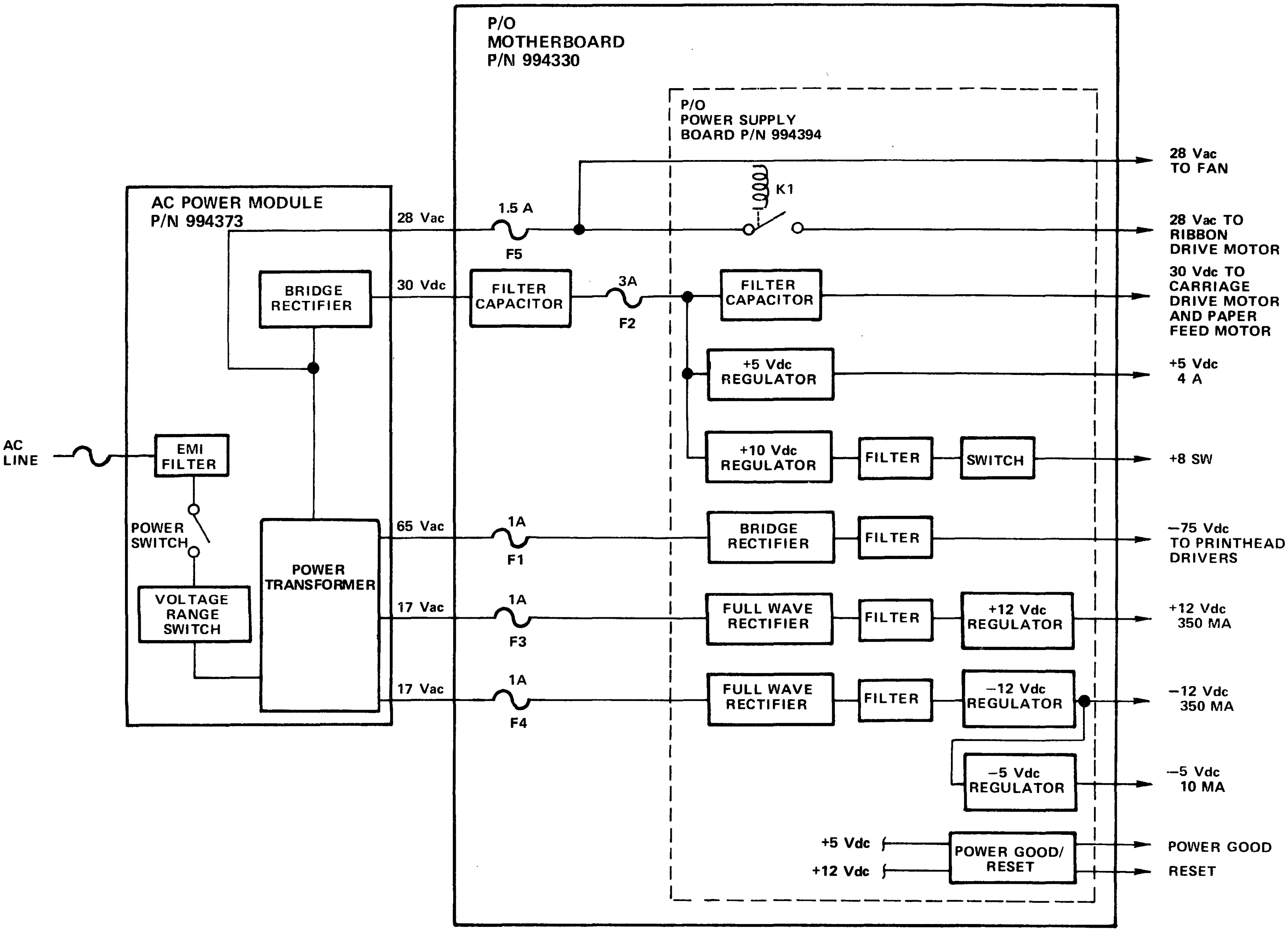

Figure 4-9. Model 810 Printer Power Supply Block Diagram

4.2.7 FUSES. The ac line is fused with either a 2.5 A or 5.0 A fuse, depending upon line voltage selection. Refer to paragraph 2.5.1 for information on line voltage selection.

The secondary side of the power transformer is fused with five fuses located on the motherboard. Refer to drawing number 994392, sheet 1, in Section VII for location of these fuses in the power supply circuits, or see Figure 2-3.

4.3 THEORY OF OPERATION.

The following subsections provide detailed theory of operation of the Model 810 Printer electronics circuits. The theory begins with a block-diagram-level discussion and then leads into circuit descriptions at the printed circuit board level. For an overall subsystem level description of the printer, refer to Principles of Operation, paragraph 4.2.

4.3.1 OVERVIEW. The Model 810 Printer electronic subassemblies are contained on three printed circuit boards that plug into the motherboard, the motherboard itself, and on the ac power module. The three printed circuit boards include the processor board, the power supply board, and the driver board. Refer to Section VI for physical location of these components. The functional relationship between these components is illustrated in Figure 4-10.

NOTE

> The major functional blocks at the subsystem level include the Electronic Control Subsystem, Printhead Carriage Subsystem, Paper Feed Subsystem, and Power Supply. These functional blocks are described in paragraph 4.2, Principles of Operation. Operation of control panel switches and indicators are described in Section III of this manual.

The Processor Board (Figure 4-10) contains the microprocessor system which consists of a TMS 8080A Microprocessor, a TMS 5501 I/O and timing device, RAM and ROM and optional PROM memories. It also contains interface logic circuitry necessary to interface with the control panels and driver board. The microprocessor and associated software or firmware programs control operation of the printer as commanded by the control panel switch settings and/or incoming signals from the sending device. When the printer is on line, the processor board interprets incoming data, control panel signals, pulse feedback from the encoder and generates control and timing signals which are required by the driver board.

The driver board contains the printhead, carriage motor, and paper feed motor driver circuits. These drive circuits receive control signals from the processor board, and generate drive currents to drive the printhead, carriage motor, and paper feed motor.

The power supply provides all ac (regulated and unregulated) and dc voltages necessary to operate the printer. Power is distributed to the printer through the motherboard. The ac module provides 40 Vac center-tapped, 65 Vac and unfiltered +30 Vdc to the power supply board as well as 28 Vac to operate the cooling fan and the ribbon drive. The power supply board supplies regulated +5 Vdc and +12 Vdc for operation of both the processor board and the driver board. It also supplies +8 SW dc voltage, unregulated +30 Vdc and unregulated −75 Vdc to the driver board. The power supply

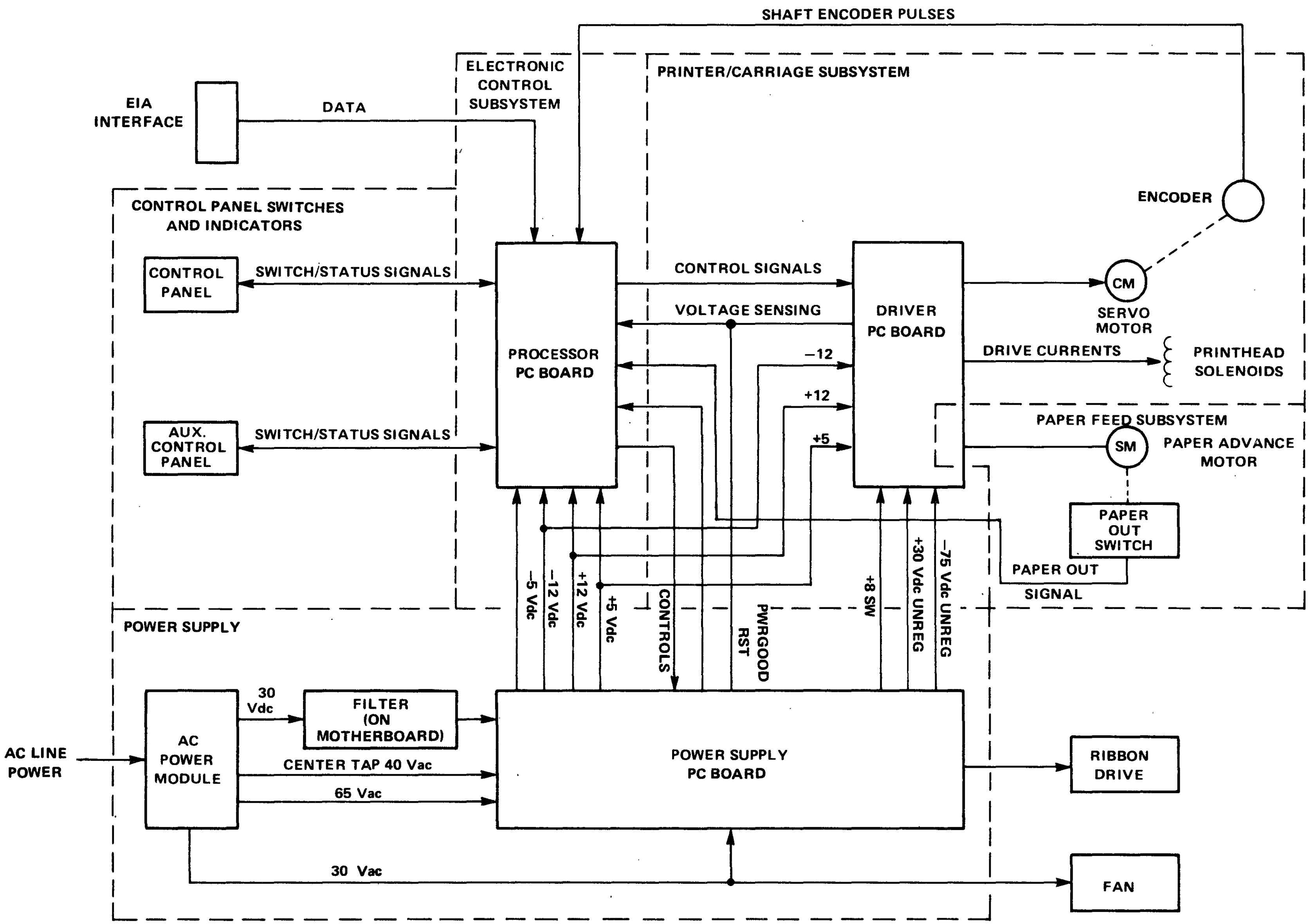

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Figure 4-10. Model 810 Printer Simplified Electronics Block Diagram

board also generates Powergood (PWRGOOD) and Reset (RST) signals which indicate to the processor board that the regulated +5 and +12 volt supplies are above the minimum required levels. PWRGOOD also controls the +8 SW power to the driver board. Thus if PWRGOOD goes false (indicating an out of tolerance power supply), all of the power stages on the driver board will be disabled. This prevents application of power to the motors and printhead during power up or a power fault.

The bell and power control circuits for the ribbon drive motor are also located on the power supply board. Logic level signals from the processor board control the bell and ribbon drive.

4.3.2 PROCESSOR BOARD. The processor board, part number 994244, consists of a TMS 8080A microprocessing system; serial and parallel communications interfaces; operator and driver board interfaces; and a carriage speed counter, printhead, timing, and sensor logic. Figure 4-11 provides a detailed block diagram of the processor board. The sheet numbers on the diagram refer to logic diagram 994242 sheet numbers located in Section VII of this manual. Refer to Section VII for detailed logic diagrams of the processor board.

The processor board monitors all printer inputs and generates all necessary timing and control signals to effect data transfers, control carriage and paper motion, and generate printable characters through the wire (dot) matrix printhead. The following subsections provide a detailed description of the processor board.

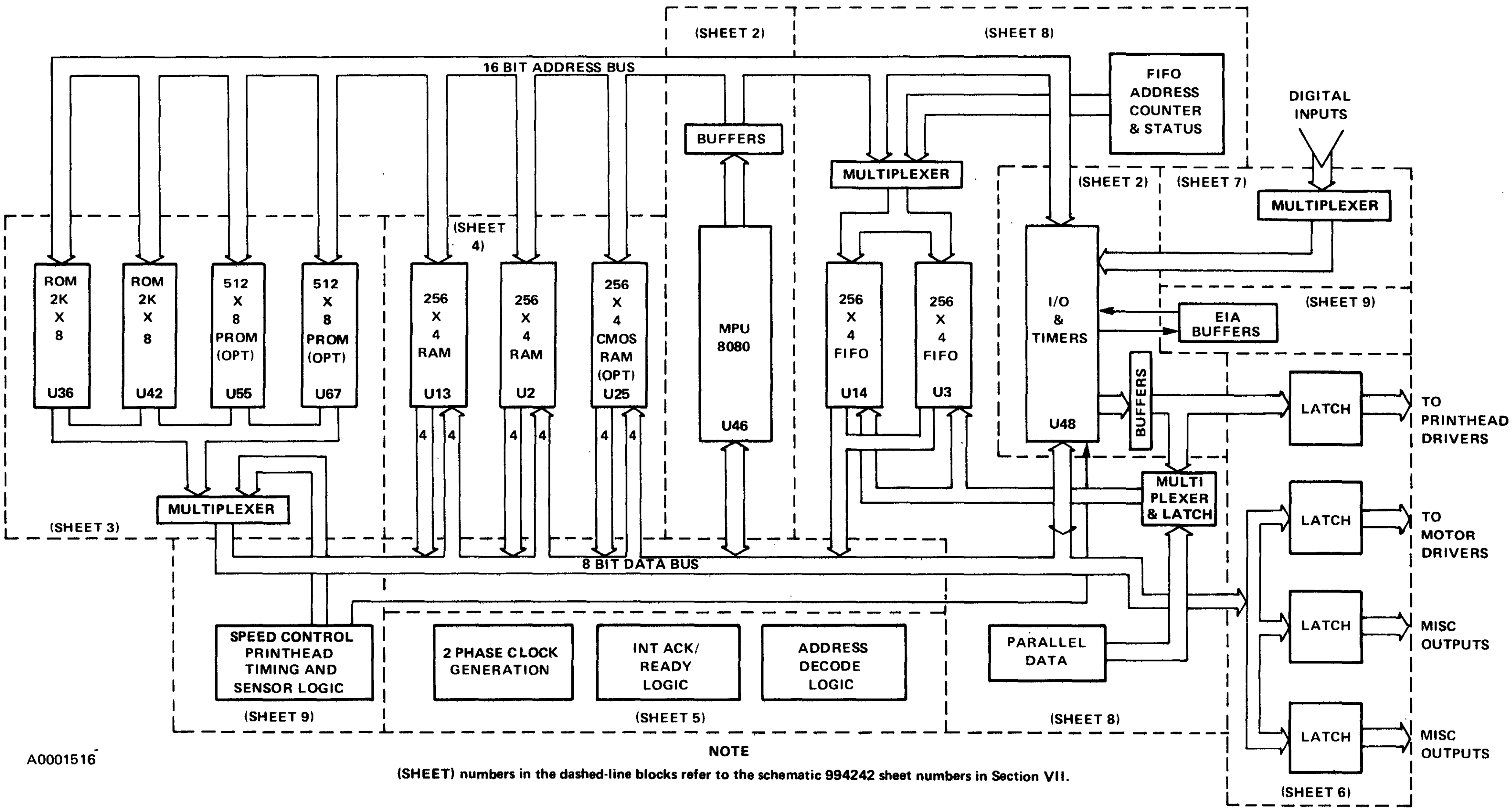
4.3.2.1 Microprocessor System. The microprocessor system consists of a Texas Instruments TMS 8080A microprocessor (Appendix D), 256 bytes of random-access memory (RAM), 4K bytes of read-only memory (ROM), 1K byte of optional programmable read-only memory (PROM), a special purpose TMS 5501 I/O and timing device (Appendix E), and a 256 character first-in/first-out (FIFO) buffer.

The RAM provides a 256 byte memory workspace for the TMS 8080A microprocessor. The RAM holds one line of 132 characters to be printed, provides up to 40 byte space for storing microprocessor register contents during interrupt cycles, and provides temporary storage for microprocessor flag registers. During an interrupt cycle, the microprocessor register contents are stored into a space (up to 40 bytes) in RAM (referred to as "pushdown stack") which allows the microprocessor to use the internal registers while servicing the interrupt. When the microprocessor returns to normal operation, the pushdown stack is written back into the microprocessor register from RAM.

The ROM contains the dot patterns for printable characters as well as software programs and routines (referred to as "firmware") required to perform the various printer functions (e.g., generating the rotating character barber pole pattern during self-test mode).

Optional programmable read-only memories (PROM's) are used for various language applications (refer to Appendix C). The PROM's contain additional firmware which works with ROM resident firmware to perform tasks required for other specific customer applications.

The TMS 5501 I/O and timing device receives all incoming serial data and converts it to parallel form. The TMS 8080A firmware writes the data into the 256 byte FIFO buffer. The FIFO buffer stores the



NOTE

(SHEET) numbers in the dashed-line blocks refer to the schematic 994242 sheet numbers in Section VII.

Figure 4-11. Processor PC Board, Detailed Block Diagram

input characters during the period while the printer is busy printing. Refer to Appendix E for a detailed description of the TMS 5501 Multifunction Input/Output Controller.

The TMS 8080A communicates with all other components of the microprocessing system through a 16-bit parallel address bus, and an 8-bit parallel data bus. When power is turned on, the microprocessor is initialized by the Reset signal from the power supply. The microprocessor then begins executing instructions starting at hexadecimal address 0000 (located in ROM). Refer to paragraph 4.3.2.5 for a description of the software. Refer to Appendix D for a detailed description of the TMS 8080A microprocessor.

4.3.2.2 Communications Interfaces. The processor board monitors received data from the serial EIA and the parallel data interfaces. Asynchronous serial data is received in accordance with ANSI Standard X3.16 x 1966 for character structure and parity sense, and ANSI Standard X 3.15—1967 for bit sequence. Baud rate and serial/parallel operation are selected by the operator as described in Section II of this manual. Serial data is routed through the TMS 5501 device which converts it to parallel form. The TMS 8080A program then writes the received character into the FIFO buffer memory. Parallel data is written directly into the FIFO buffer.

4.3.2.3 FIFO Buffer. The FIFO memory is implemented in hardware logic. It consists of an input register with selection of processor or parallel data (U5 and U16 on drawing 994242, sheet 8), a 256 byte RAM memory (U3 and U14 on sheet 8), a counter to indicate the next available memory cell (U15 on sheet 8), up/down counters (U52 and U64) and decoding circuits to remember the number of characters in the FIFO and also provide empty and full status signals. A write cycle is initiated by the parallel data strobe ($\overline{\text{DSTRB}}$) or the serial FIFO write strobe ($\overline{\text{SFWR}}$) clocking flip-flop U73 (sheet 5). Refer to the FIFO memory write cycle timing diagram, Figure 4-12. Storing of data in the FIFO is synchronized to occur during the microprocessor M1 or instruction fetch cycle in order to assure that the FIFO is not being accessed by the TMS 8080A Microprocessor.

4.3.2.4 Printhead Carriage Control. The processor board generates signals for speed control of the printhead carriage, for vertical positioning of the paper, and for printing of the printable characters.

a. Carriage Positioning and Control. The microprocessor generates a carriage direction command ($\overline{\text{CMFWD}}$), a motor on/off command ($\overline{\text{SCON}}$) and an acceleration level control signal (ACC). These signals are active when low. A low level on all three will cause the carriage to move forward (left to right) at high acceleration. The microprocessor tracks the position of the carriage by counting sensor interrupts produced by the encoder coupled to the carriage motor. A "zero" or reference position is established by initializing the carriage against a mechanical stop at the left margin.

Carriage Feedback Sensor System. As the carriage moves, the carriage motor encoder produces a pair of pulsed signals with a 90° phase difference. These signals, TϕA and TϕB, are synchronized with clock signal CLK01A, and fed to a four-state controller to produce the count interrupt signal, SENSOR, and a direction indicator signal (FWT). (Refer to drawing number 994242, sheet 9, zones 4, 5 and 6). Figure 4-13 provides a encoder pulse state diagram. For normal printing the pulses occur at a rate of 120 per inch. With the compressed print option, a second pair of pulses at a rate of 198 per inch is also produced. The selection between these two is made by the signal COCHO and and/or invert gates U23 (sheet 9, zone 7 and 8).

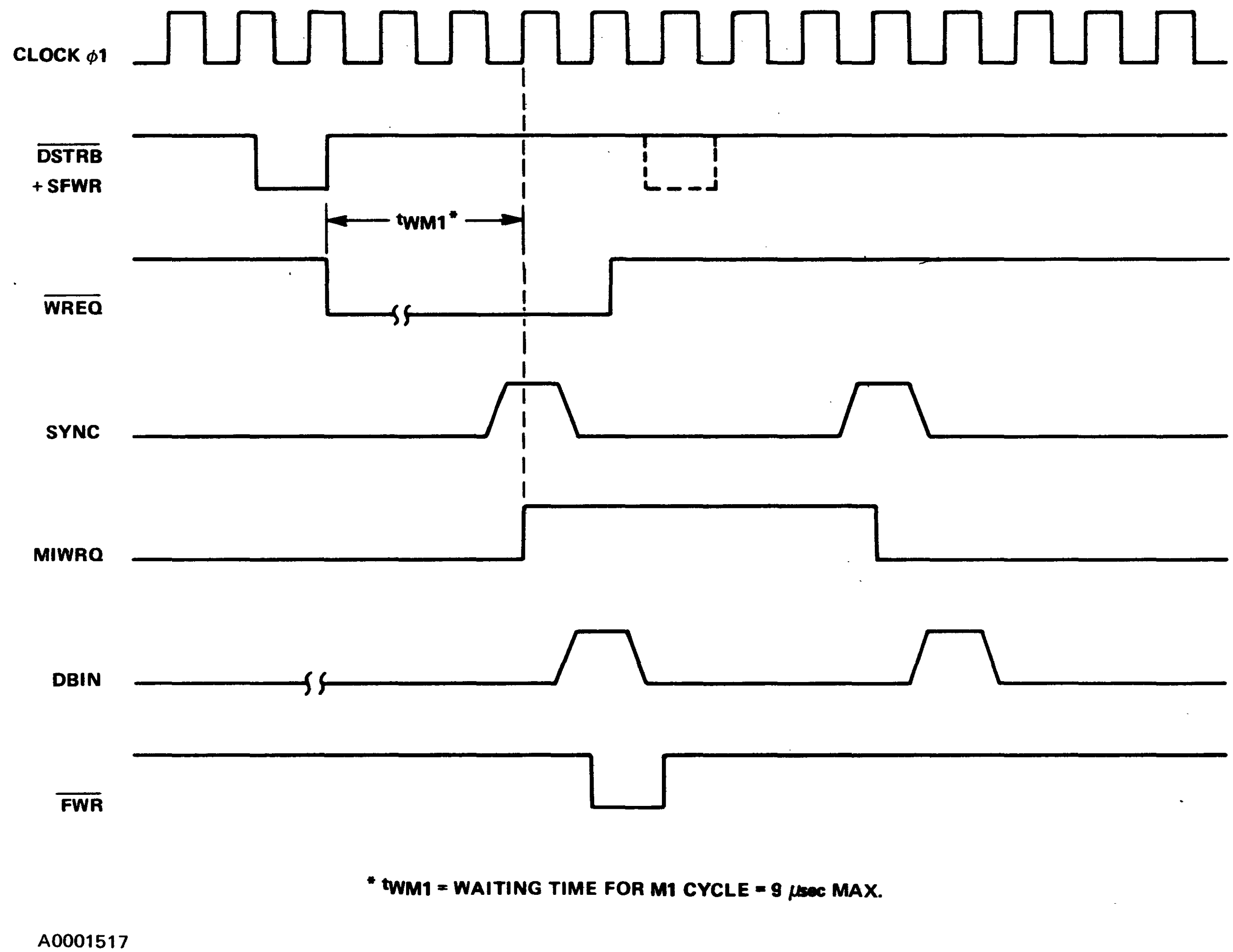


Figure 4-12. FIFO Memory Write Cycle Timing Diagram

Carriage Speed Control. The microprocessor sets the control signal ($\overline{SCON}$) by comparing the actual speed which is measured by a reference counter (U44 on sheet 9) to a desired value. If the speed is too low, $\overline{SCON}$ is turned on (low). If the speed is too high, $\overline{SCON}$ is turned off. Counter U44, when enabled, counts at 8 microsecond resolution. When a maximum count of 252 is reached or a sensor interrupt occurs, the counter is stopped by making CTEN low. The value stored in the counter is read by the microprocessor as part of the sensor interrupt routine, generating signal $\overline{RDCTR}$. This signal produces a counter reset (CLRCTR) pulse which enables the counter again on the next clock (CLK01). Since the sensor interrupt to read counter time is constant, the value of the reference counter is proportional to the time between sensor interrupts. Refer to the speed counter timing diagram in Figure 4-14.

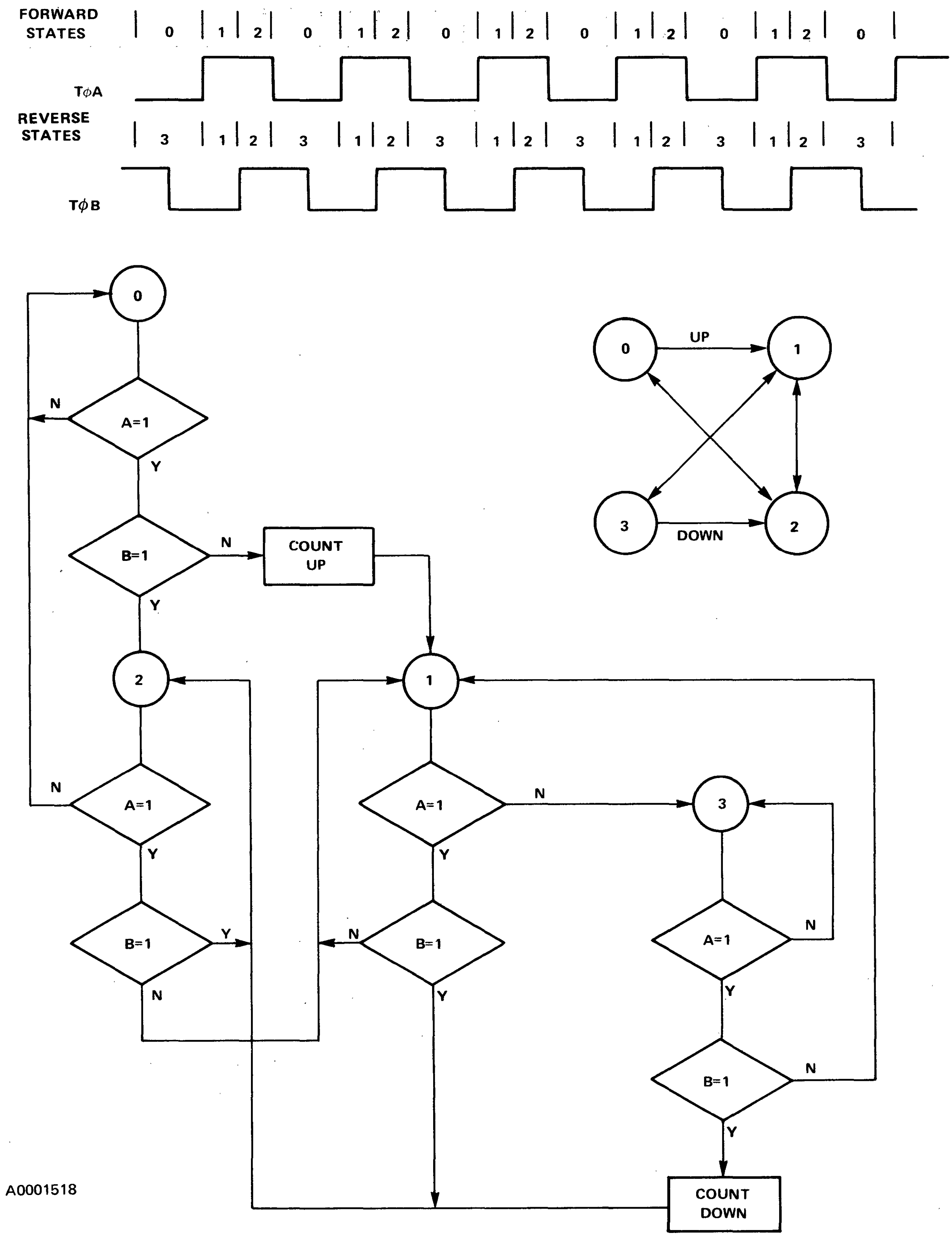


Figure 4-13. Carriage Motor Shaft Encoder State Diagram

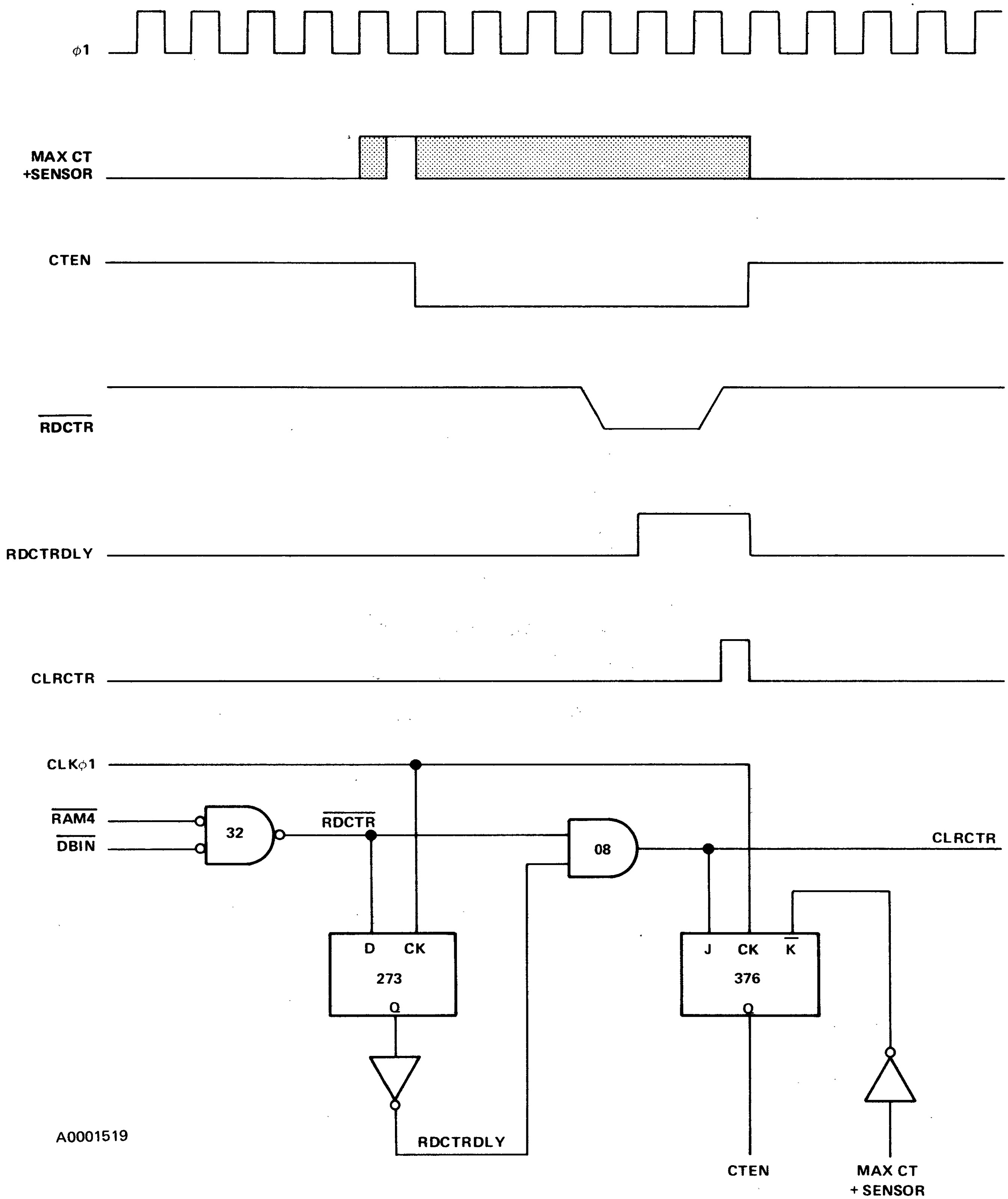


Figure 4-14. Carriage Speed Control Counter Timing Diagram

b. Character Printing. The space allotted for printing each character is divided into twelve equal increments (see Figure 4-15). Three of the increments are the space between characters when no commands are issued to the printhead solenoid drivers. Following the remaining nine sensor interrupts, the microprocessor transfers the appropriate dot pattern from the ROM to the printhead control latch (U28 on sheet 6Z) via signal $\overline{\text{CNTLI}}$. This signal also clocks flip-flop U73 on sheet 5 producing a low on the printhead control signal, $\overline{\text{PHCTL}}$, enabling the outputs of the printhead control latch. $\overline{\text{PHCTL}}$ returns to a high level when the reference counter reaches a count of 56 or 448 microseconds after the microprocessor reads the reference counter. Since the $\overline{\text{CNTLI}}$ signal occurs about 45 microseconds after $\overline{\text{RDCTR}}$, the resulting printhead solenoid control pulses are approximately 400 microseconds in duration. Formation of the character "W" is illustrated in Figure 4-15. A complete timing diagram of one solenoid for both forward and reverse carriage motion is shown in Figure 4-16.

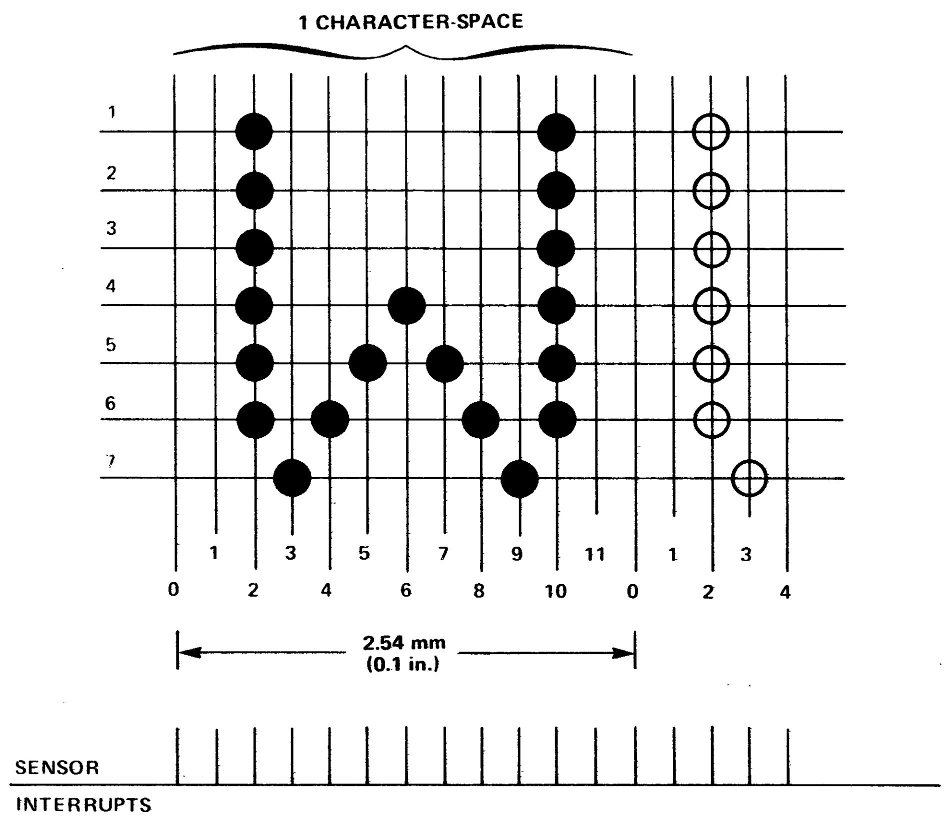


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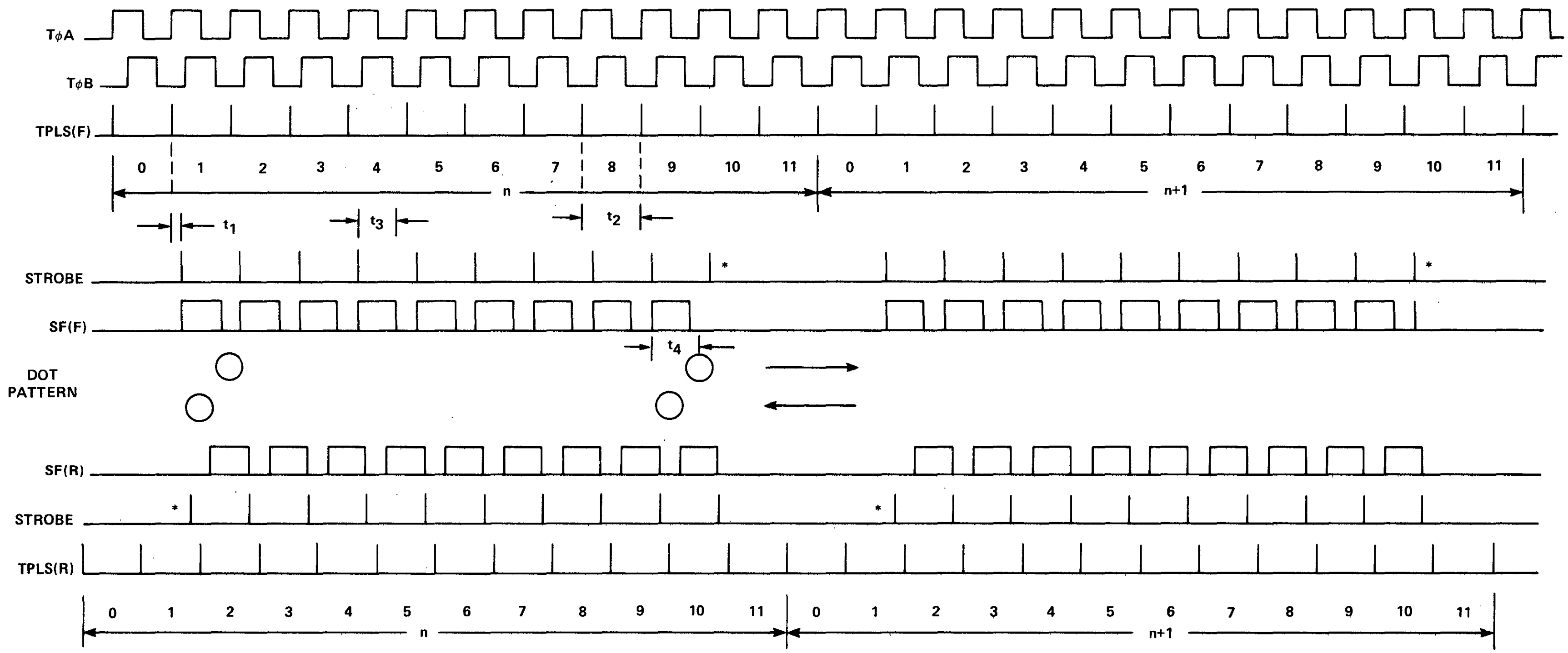
Figure 4-15. Forming the Character "W"

4.3.2.5 Software. When power is applied to the printer, the TMS 8080A is reset to hexadecimal address 0000 by the Reset signal from the power supply. The microprocessor then begins executing instructions stored in ROM to perform the following tasks:

1. Clear RAM
2. Initialize flags, states, constants, variables
3. Clear TMS 5501 device, unmask interrupts



NOTES

*10th STROBE IS REQUIRED TO CLEAR SOLENOID DATA LATCH
t_1 = DELAY FROM TACH PULSE TO STROBE
t_2 = ENCODER PULSE INTERVAL (555 μSEC @ 15 IPS)
t_3 = SOLENOID PULSE WIDTH (400 μSEC)
t_4 = PRINT WIRE IMPACT DELAY
(F)=FORWARD
(R)=REVERSE

Figure 4-16. Printhead Solenoid Timing Diagram

4. Initialize control latches, turn of ERROR, PAPER OUT and BUSY lights

5. Start the 24 msec fail-safe timer

6. Align stepper motor to phase-A

7. Align carriage to left bumper

8. Initialize printer options.

The CPU then moves to the NORMAL or TEST mode, depending on the position of the auxiliary control panel mode switch.

a. Background Loop and Major Subroutines (NORMAL Mode). In NORMAL mode the microprocessor continues to loop through the background software waiting for an interrupt. The major subroutines in this loop initiate tasks such as paper motion, carriage motion, and printing. These tasks are then completed by interrupt driven software with the microprocessor returning to the background loop during spare time. (Refer to normal mode flowchart, Figure 4-17.) The following is a brief description of the major subroutines.

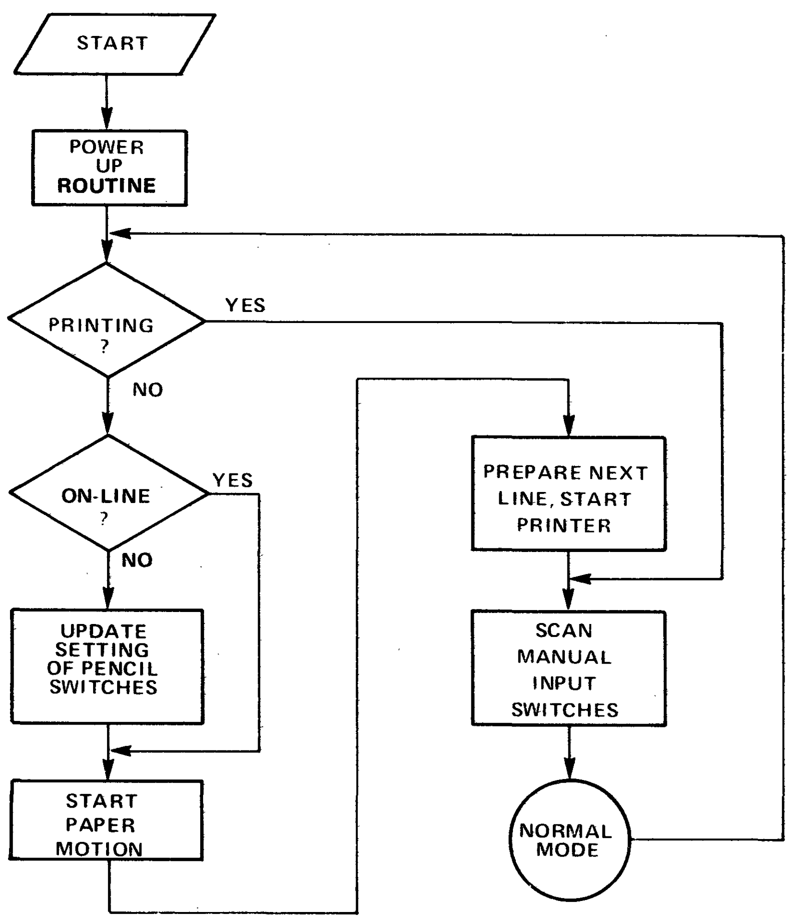


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Figure 4-17. Normal Print Mode Flowchart

SCAN and IMPLEM. The SCAN subroutine reads the control panel switch and stores any inputs for implementation (IMPLEM subroutine) later when printing of the current line is completed or immediately if the printer is not busy.

DOPMC. The DOPMC subroutine initiates any paper motion indicated by a character received over the line (LF, CR, VT, FF, DC3). The actual paper motion is an interrupt driven sequence handled by Timer 3 software.

E100. During the time required to complete paper motion, the E100 subroutine is called to prepare the next line for printing. E100 handles all characters with a series of accept states which select characters as printable, control, or as characters which alter the operating characteristics of the printer. Table 4-1 lists the accept states and the sequence of characters required to reach them. Figure 4-18 illustrates a state diagram of the accept states. E100 also arranges characters in the print buffer for the next line to be printed, computes the best direction and speeds for the carriage to reach the printing start point, and initiates carriage motion when paper motion is completed. Carriage motion and printing are then handled by interrupt driven software (Sensor-Trap 2).

Table 4-1. Printhead Subroutine E100 Accept States

State	Function	Sequence
ACPTS1	Normal state, handles control and printable characters	
ACPTS3	Escape Handler	ESC
ACPTS3	Substates: Go to 6 lines per inch Go to 8 lines per inch Go to 10 characters per inch Go to 16.5 characters per inch	 ESC, 4 ESC, 5 ESC, 6 ESC, 7
ACPTS4	Horizontal tab to address	DC4, CHR
ACPTS5	Set vertical tabs	ESC, 1, CHR, ... CHR, NUL
ACPTS6	Set form length	ESC, 2, CHR
ACPTS7	Set horizontal tab	ESC, 3, CHR, ... CHR, NUL
ACPTS8	Vertical tab to address	DC2, CHR
ACPTS9	Change column count	ESC, :, CHR
ACPS10	Store VFU channel	ESC, 8, CHR
ACPS11	Recall VFU channel	ESC, 9, CHR

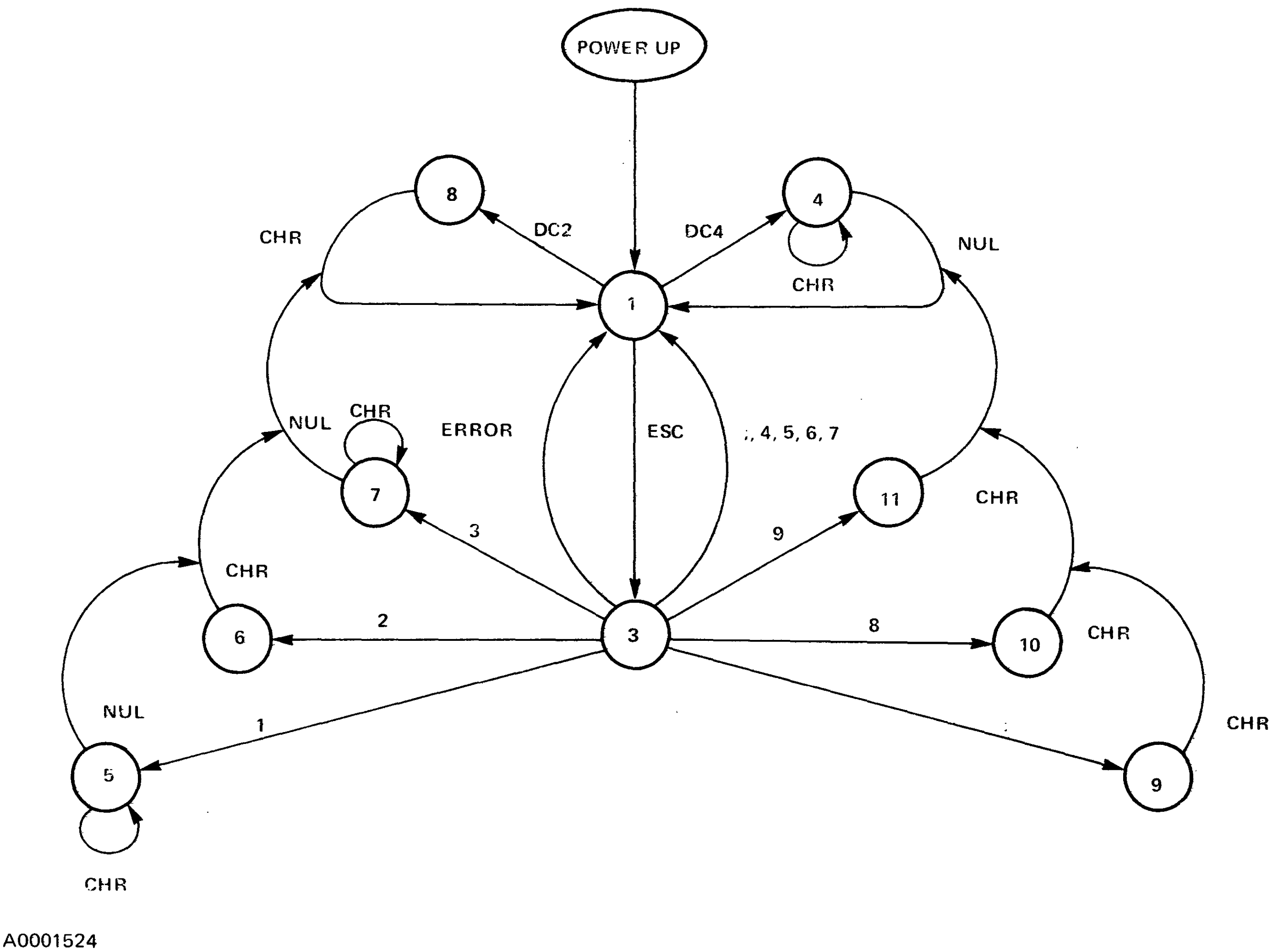

Figure 4-18. Printer Subroutine E100 Accept States State Diagram

BAUDFX. If the printer is offline in the normal mode, the microprocessor will loop through the BAUDFX subroutine to update the pencil switch inputs on the auxiliary panel.

b. Test Loop (TEST Mode). In the TEST mode the microprocessor handles manual format inputs off line. The form length and vertical tabs may be altered by an appropriate sequence of inputs. The manual SAVE and RECALL switches for the VFU option are also active in this loop. On line in the TEST mode, the microprocessor uses the SCAN, IMPLEM, DOPMC, and E100 subroutines to print a rotating barber pole test pattern and also handle manual inputs. (Refer to the test mode flowchart, Figure 4-19.)

c. Interrupt Driven Software (Sensor-Trap 2). The sensor interrupt software controls all carriage motion, speed regulation and printing. Table 4-2 lists the function of each of the 12 carriage states and lists their maximum execution time. Table 4-3 lists the carriage motion reference speeds. A carriage state diagram is shown in Figure 4-20.

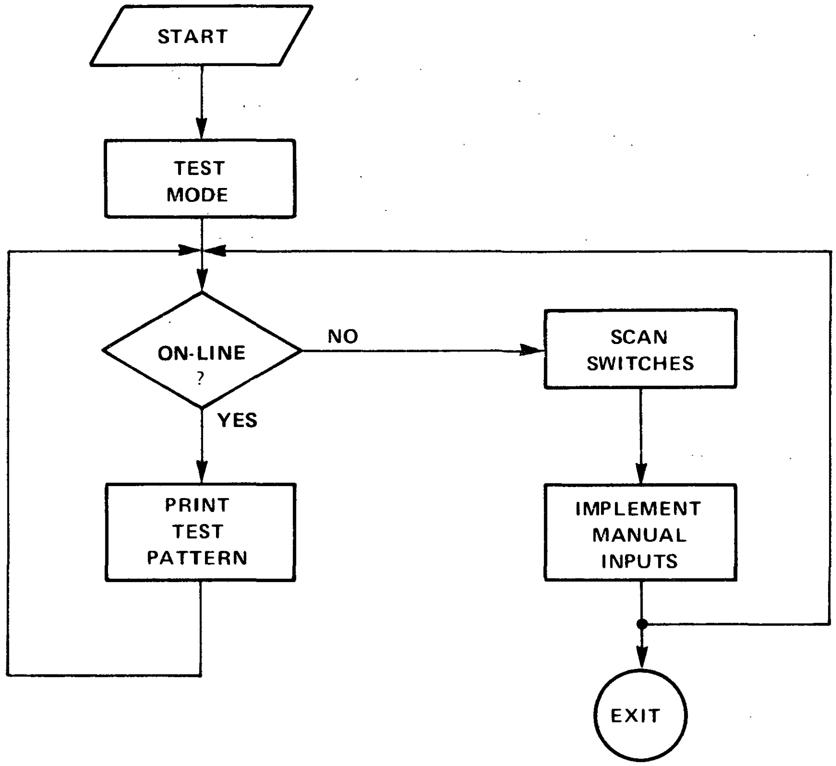

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Figure 4-19. Test Mode Flowchart

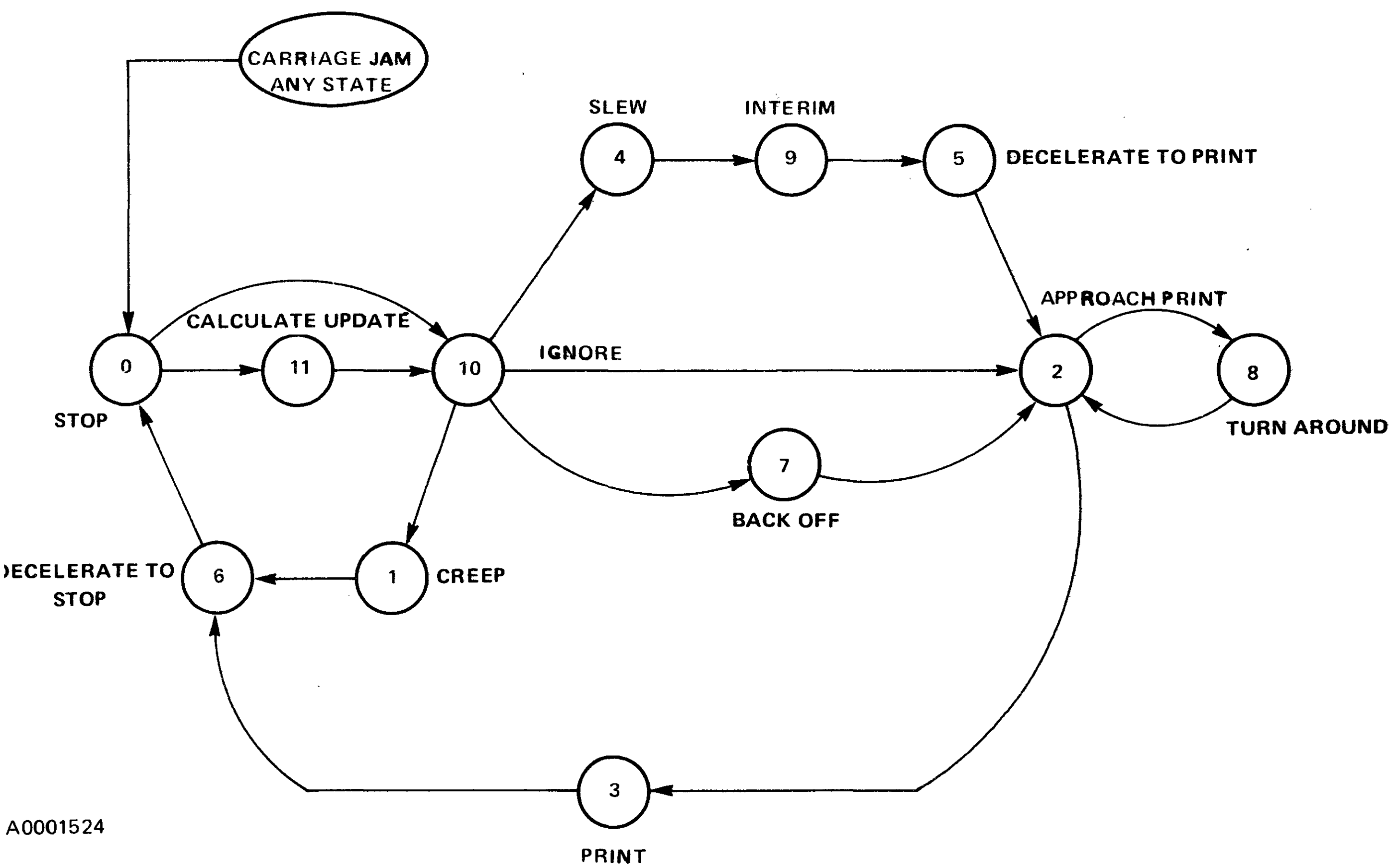

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Figure 4-20. Printhead Carriage State Diagram

Table 4-2. Carriage State Maximum Software Execution Times (Microseconds)

State		Standard Option	Full-ASCII Option	Katakana Option
CARST0 –	STOP	148.5		
CARST1 –	CREEP	217		
CARST2 –	APPROACH START OF PRINTING	424	487	507.5
CARST3 –	PRINT	392	455	475
CARST4 –	SLEW	152		
CARST5 –	DECELERATE TO PRINT SPEED	187		
CARST6 –	DECELERATE TO STOP	240		
CARST7 –	BACK OFF	246.5		
CARST8 –	DECELERATE AND REVERSE DIRECTION	218		
CARST9 –	INTERIM	158		
CARS10 –	IGNORE	192		
CARS11 –	UPDATE CALCULATIONS	111.5		

Table 4-3. Carriage Motion Reference Speeds

Reference	State	Speed (Inches/Second)
PRINT	CARST 2, 3	13.1
PRINT2	CARST 2, 3	14.5
SLEWS	CARST 4	39.2
SLPRIN	CARST 5	16.9
BAKCRP	CARST 1, 7	5.5
STOPRF	CARST 6	9.4

Timer 3 — Trap 3.
The Timer 3 interrupt software controls the stepper motor, all paper motion except vertical alignment, and long and short time delays. Four Timer 3 modes handle the following functions:

MODE 0 — Last 10 msec step of any paper movement

MODE 1 — All paper movement except last step

MODE 2 — Time delays less than 16 msec

MODE 3 — Time delays greater than 16 msec.

Serial Data Input — Trap 4
Serial data arriving in the receive buffer of the TMS 5501 is removed and stored in the FIFO.

Fail-Safe Timer or Timer 4 — Trap 6
The fail-safe timer is used to shut off the carriage motor if an obstruction prevents sensor interrupts from occurring for longer than 24 msec during printing. Timer 4 also controls the error bell and blinking light during a carriage jam and in normal operation shuts off the ribbon drive if no printing occurs for 1 second.

4.3.3 DRIVER BOARD. The driver board, part number 994322, contains power circuits for driving the printhead, the carriage motor, and the paper feed stepper motor (refer to Figure 4-21). All drivers are constant current switching regulators. Power for the carriage driver motor and paper feed motor is derived from the +30 Vdc supply. Power for the printhead solenoids is derived from the —75 Vdc supply.

4.3.3.1 Printhead Driver Circuits. The function of the printhead driver circuits is to provide a current pulse of proper magnitude for the excitation of the seven print wire solenoids. The sequence and duration of the current pulses are defined by the microprocessor, which provides the active low logic level input signals $\overline{SF1}$ through $\overline{SF7}$ to the printhead driver circuitry (Figure 4-21).

Each of the seven solenoid drivers can be described as a free running 1.5 A current mode switching regulator. Processor board outputs $\overline{SF1}$ through $\overline{SF7}$ are NOR'ed with the current sensing comparator circuit output, which enables the regulator power circuit to generate the current pulse profile illustrated in Figure 4-22. Current flow in the power circuit (relative to the current profile of Figure 4-22) is illustrated in Figure 4-23, which illustrates one of the seven printhead driver circuits (all seven circuits are identical). Refer to Logic Driver diagram number 994320 in Section VII for detailed circuit information. The rising portions of the current profile (section 1, Figure 4-22) occur while Q2 is on (Figure 4-23). The solenoid current path is from ground through R11 (A1—A7), the printhead solenoid, through Q2 (A1—A7) and CR2, CR3, CR4 (stage A8) to the -75 Vdc supply. When the voltage across R11 is more negative than VREF (-0.3 V), the comparator (U1) turns Q2 off and the current decays through R11, CR2 (A1—A7) and Q1 (stage A8), (section 2, Figure 4-22). The hysteresis of the comparator (U1) then allows current to fall approximately 0.25A before the comparator turns Q2 on again. The circuit oscillates in this mode for the duration of the input pulse. The oscillation frequency is variable over the 24—100 kHz range. When the input pulse returns high, Q2 (A1—A7) and Q1 (A8) turn off, leaving the solenoid clamped to +30 Vdc through supply CR1.

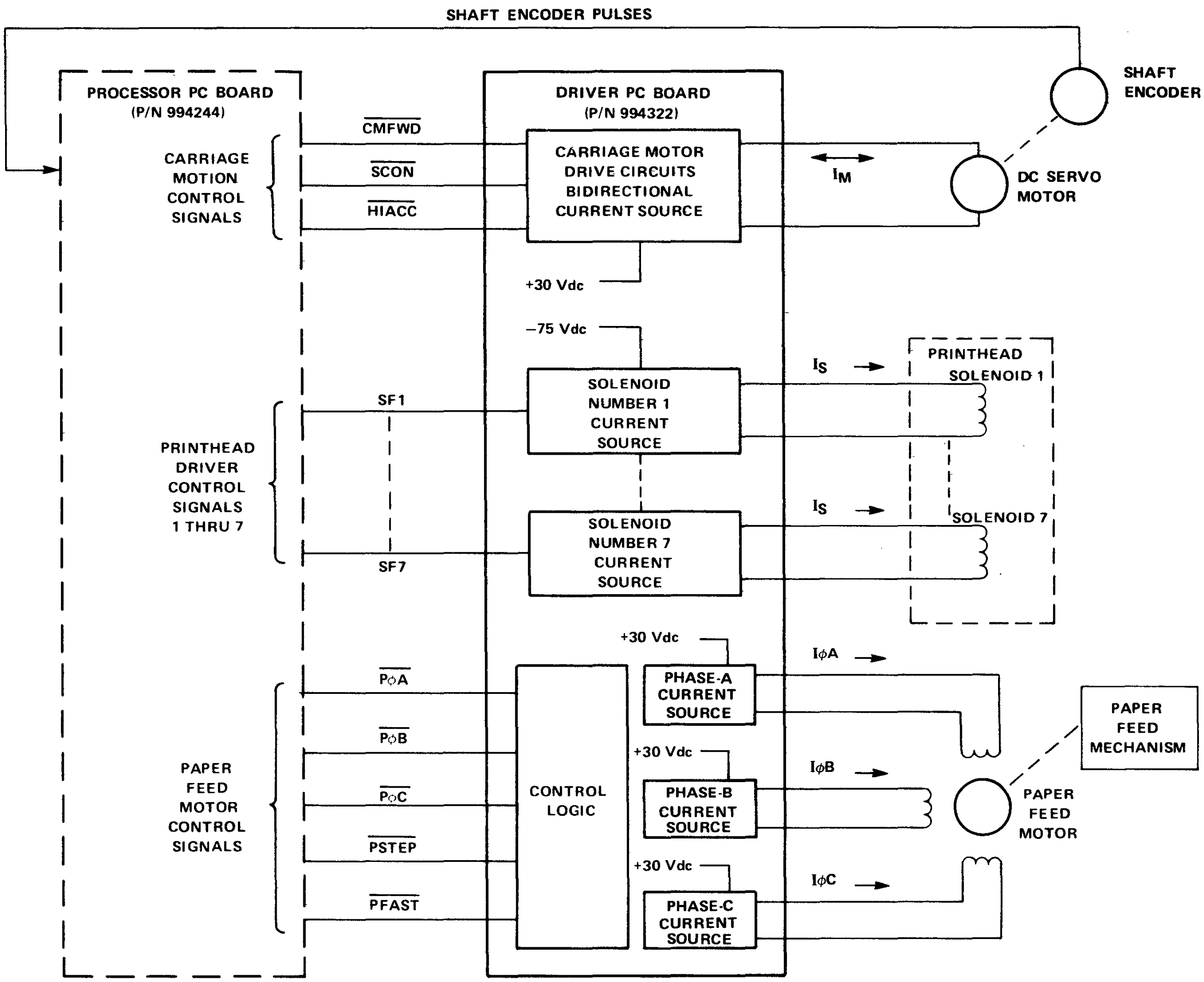

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Figure 4-21. Driver PC Board Block Diagram

This causes the solenoid current to decay rapidly (section 3, Figure 4-22) and returns the energy stored in the solenoid to the 30 Vdc supply for greater system efficiency.

The 8 SW line is used to derive the base drive from Q2 (stage A1-A7) allowing the power circuit to be enabled or disabled remotely by the PWRGOOD signal. (Enabling of the 8 SW is described in paragraph 4.3.4.4.) CR2, CR3, and CR4 are used to develop the necessary negative bias for turning off Q2 and are common to all seven drivers. CR5 is used to derive the -0.3 V reference for all seven comparators. The printhead driver circuits are logically disabled when either S1 (A8) (located in the upper left area of the driver board) is in the off position, and/or when the printhead is disconnected.

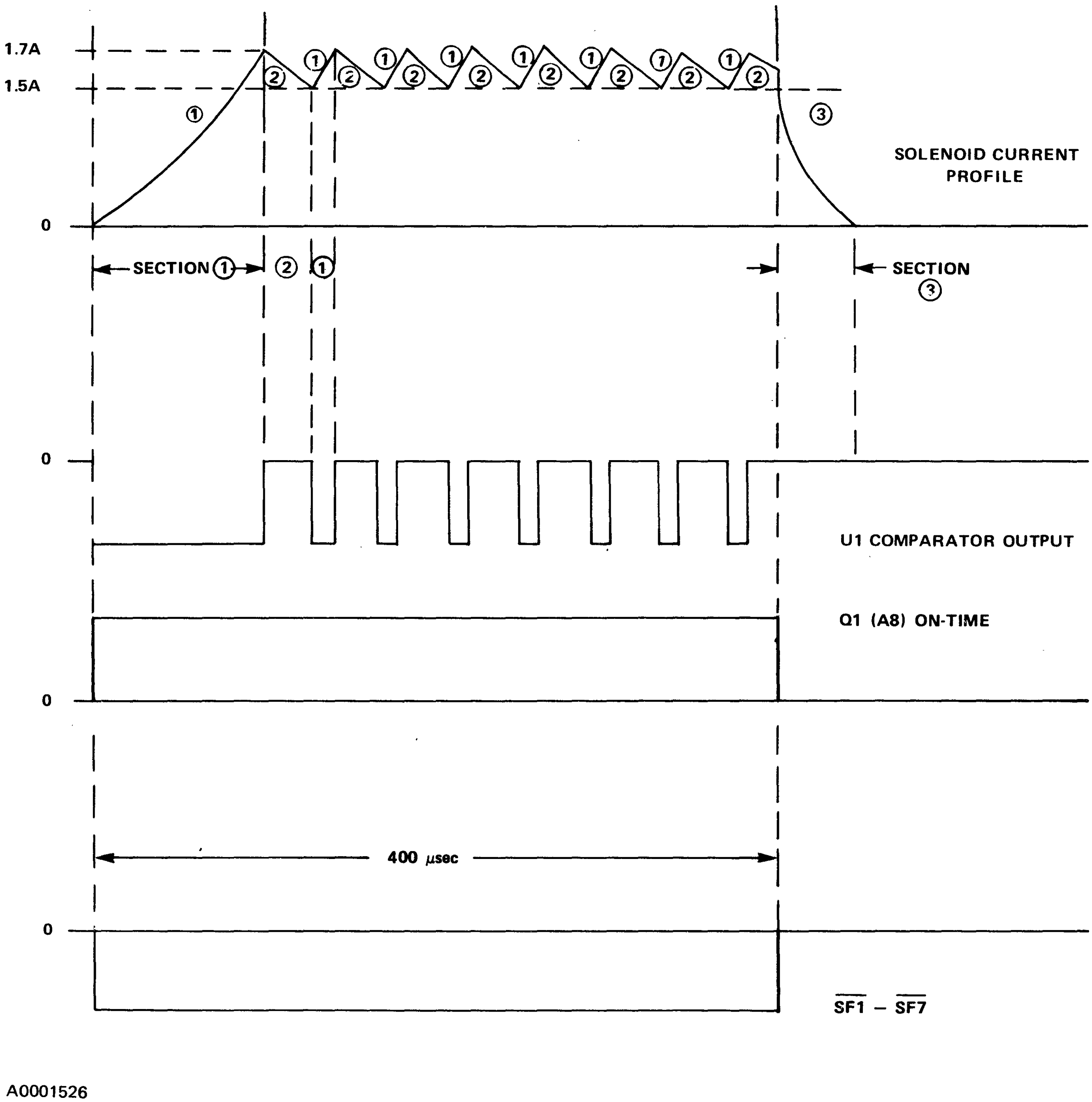

Figure 4-22. Printhead Solenoid Current Pulse Profile

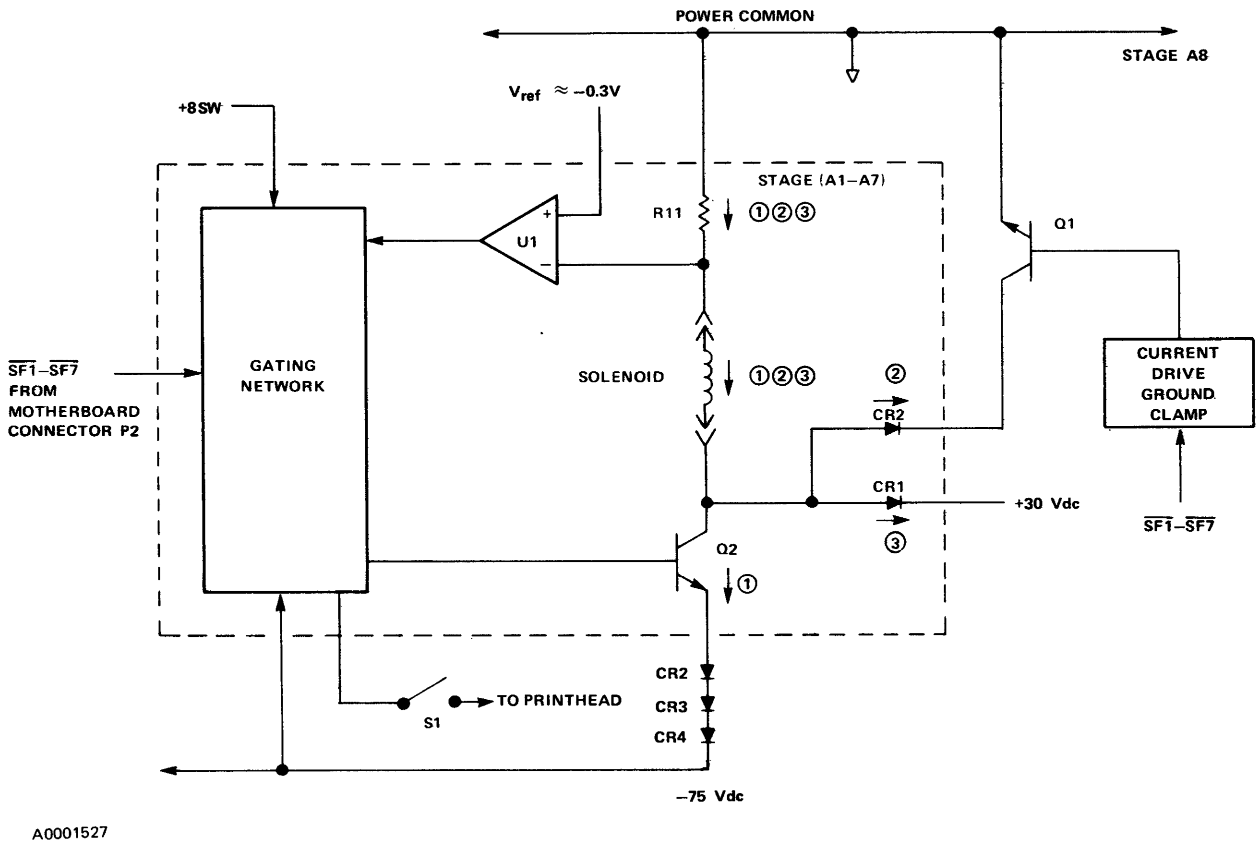

Figure 4-23. Printhead Power Driver Simplified Schematic

4.3.3.2 Carriage Motor Driver Circuit. The carriage motor driver circuit is a bidirectional, two level, regulated current source. "Bidirectional" describes the ability to reverse the direction of the motor current so as to drive the carriage in either direction. The high-level current setting is used during periods in which high acceleration or deceleration rates are required: these include starting from rest, accelerating from print speed to slew speed, decelerating from slew to print speeds, or stopping from print speeds. The low current setting is used during the print speed or slew speed regulating mode to minimize velocity variations during these phases of operation. With constant current motor drive, carriage acceleration is constant.

Nominal acceleration values for the two levels of current are

Level	Motor Current Amperes	Acceleration In./Sec^2	Deceleration In./Sec^2
Hi (ACC = 1)	2.85 ± 5%	1000	1500
Lo (ACC = 0)	1.43 ± 5%	500	1000

These acceleration values allow the carriage to reach print speed (15 inches per second) in 15 milliseconds, or slew speed in 35 milliseconds.

The carriage motor drive control signals from the processor board (Figure 4-21) are

$\overline{\text{CMFWD}}$ An active low on this line sets direction of current flow in the carriage motor to produce forward carriage motion (left to right).

$\overline{\text{SCON}}$ An active low on this line turns on the motor current.

$\overline{\text{ACC}}$ An active low on this line sets the motor current to the high acceleration value (2.85A nominal).

The basic circuit of the carriage motor driver is a switching mode current regulator which operates from the unregulated +30 Vdc bus. The main components of this circuit are illustrated in simplified form in Figure 4-24. The four power transistors, Q1 through Q4, operate in pairs (Q1, Q4 and Q2, Q3) to establish current flow through the motor in the + to — or — to + direction, respectively. Motor current always flows through the sense resistor R9 in the same direction.

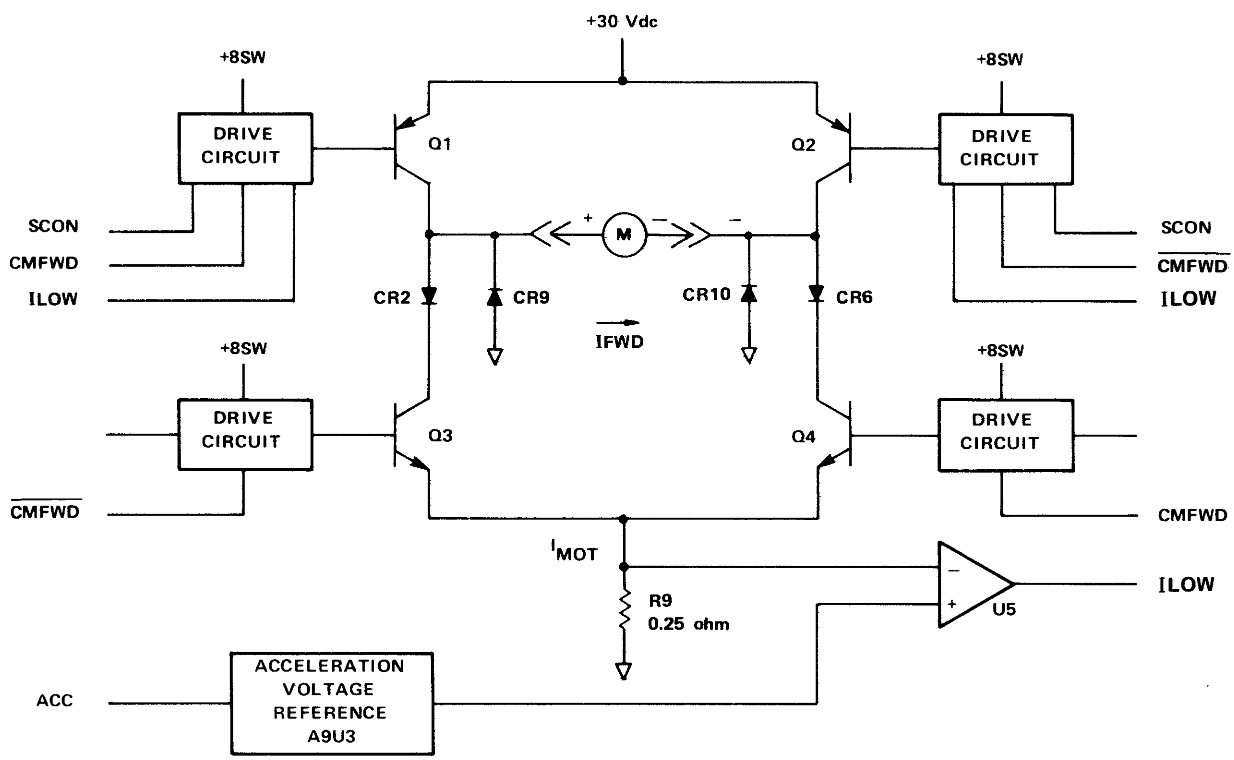

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Figure 4-24. Printhead Carriage Driver Simplified Schematic

Figure 4-25 illustrates current flow for a forward command from the processor board. The CMFWD signal is applied through the driver circuits to turn on Q4. Q4 will remain on as long as the processor is commanding forward motion. $\overline{\text{CMFWD}}$ will prevent Q3, Q2 from conducting. (Refer to Figure 4-24.) The operation of the carriage motor circuit can be analyzed using the conduction paths illustrated in Figure 4-25 for forward motion. Conduction in transistor Q1 is controlled by three signals: CMFWD, SCON, and ILOW. CMFWD and SCON are generated by the processor board and are assumed to be true for this part of the circuit analysis. ILOW is a logic level signal generated on the driver board by comparator U5, which compares a voltage drop across R9 to one of two dc reference voltages. The voltage drop across R9 is proportional to the motor current. The dc reference voltage is selected by an FET switch (A9U3) by the ACC command from the processor board. The output of comparator U5 is at a logic one level if the voltage drop across R9 is less than the selected dc reference voltage. Thus, ILOW will be high if the motor current is below the reference selected, or low when the motor current is greater than the reference. Assuming the processor has selected forward motion by setting CMFWD

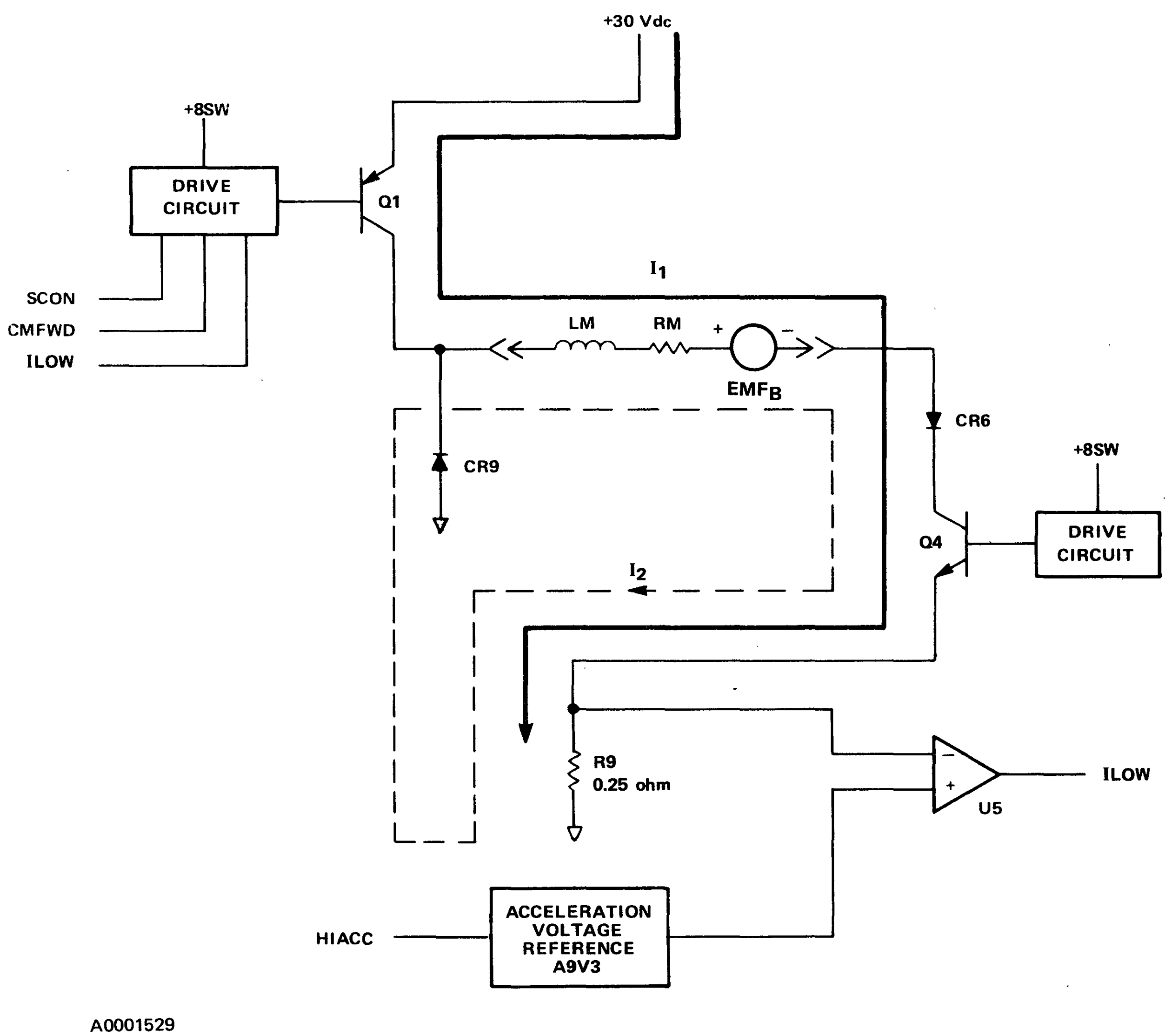


Figure 4-25. Printhead Carriage Driver Circuit Forward Command

and SCON true, ILOW will determine if Q1 is conducting. When Q1 is turned on, current I1 (Figure 4-25) will exponentially increase towards a target value set by the unregulated supply voltage, the back emf generated by the motor, and the circuit resistance.The time constant of this exponential rise is set by the motor inductance and the circuit resistance. Figure 4-26 illustrates a typical motor current waveform from turn-on through the first few regulating cycles. When the motor current reaches the comparator upper trip point, ILOW will go low, turning Q1 off. The current path shown as I1, therefore, is interrupted. Motor current cannot change instantaneously, however, due to the motor inductance. The collapsing magnetic field in the motor will try to maintain the motor current. Figure 4-25 illustrates this current path (I2).

Figure 4-26 illustrates the exponential decay of motor current I2. The motor inductance and circuit resistance determine the time constant or decay rate for the motor current.

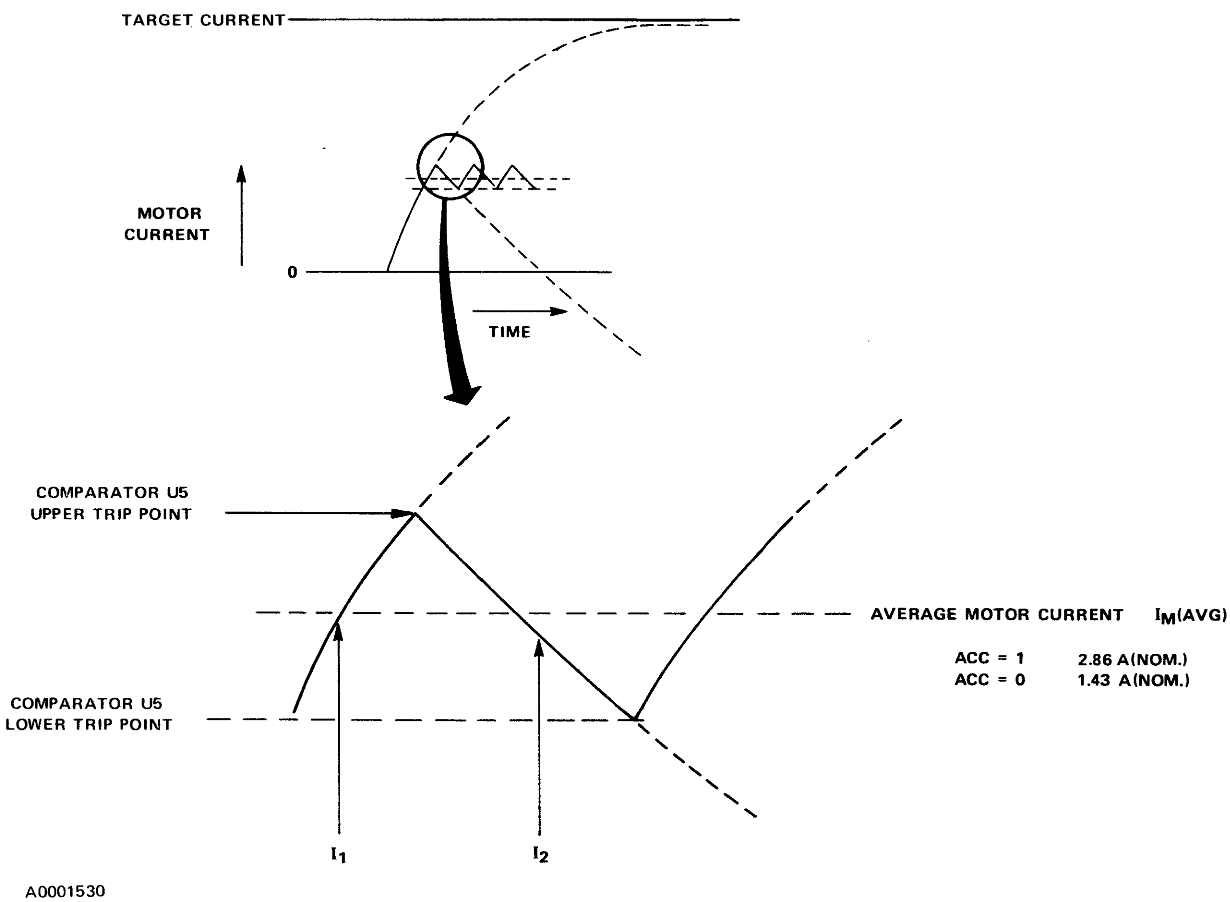


Figure 4-26. Printhead Carriage Motor Current Waveforms

The comparator circuit has a designed-in hysteresis which causes the lower trip point to be approximately 150 mA lower than the upper trip point. When I2 decays to this lower trip point, ILOW will go high again (Figure 4-25). This action turns Q1 on again and current will again be established along current path I1. Q1 will be turned on and off at a frequency determined by the current rise (I1) and fall times (I2) and the amount of comparator hysteresis. The nominal frequency is 10 kHz, although this value can vary widely with variations in motors and the +30 Vdc unregulated supply voltage. As long as SCON and CMFWD remain true, this switching action will continue and produce a constant average current in the motor windings. This average motor current will be between the upper and lower comparator trip points as shown in Figure 4-26.Average motor current is also determined by the dc reference voltage applied to the comparator positive input terminal. When ACC is true, the average motor current is 2.86A (nominal). When ACC is false, the average motor current is 1.43A (nominal).

Bidirectional printhead drive capability is achieved by reversing the current flow in the motor. The processor changes the circuit configuration by changing CMFWD from true to false (refer to Figure 4-24). In the reverse direction, Q1 and Q4 are turned off, Q2 and Q3 are turned on. Current regulation in the reverse direction is similar to the forward current cycle except that the current flows through Q2, Q3, CR2, R9 and CR10.

Refer to Logic Driver diagram (994320, sheet 2) located in Section VII for a detailed schematic of the carriage motor power circuits. The basic circuit components are Q1 through Q4, CR9, CR10, and U5. Transistors Q5, Q6 and U1 form the drive circuit and logic functions for Q1. Transistors Q7, Q8 and section 2 of U1 form the drive and logic functions for Q2.

Q3 and Q4 are high gain Darlington power transistors requiring minimal base drive current through R16 and R32, respectively. Diodes CR2 and CR6 prevent inverted mode operation of Q3 and Q4 during the motor current decay phase (I2, Figure 4-26).

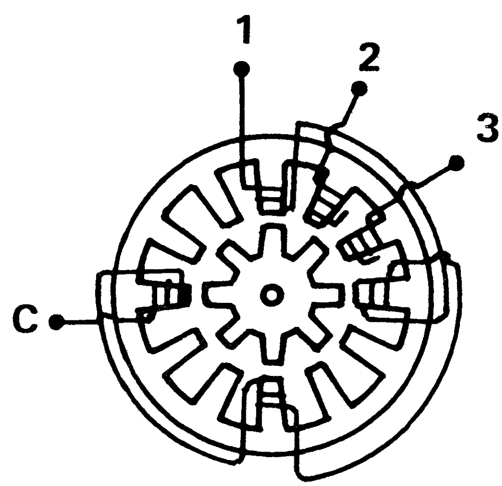
CR1 is a 1 percent, 5.1 V zener reference which is used to set the 2.86A current level for high acceleration. This same 5.1 V reference source is divided down by R22 and R23 to set the 1.43A reference for U5. U3 is a quad FET switch used to select the required reference. The reference voltage set by CR1 is also used by the paper feed motor drive circuit.

U5 is an inverting comparator with the hysteresis level set by the 425 k ohm feedback resistor R12. Resistor R40 and CR5 bias the output stage of U5 to 0.6 V below ground to provide additional noise margins when coupling to TTL circuits grounded on the motherboard.

The +8 SW supply voltage controls base drive to Q3 and Q4 directly and to Q1 and Q2 indirectly. Thus, the +8 SW supply forms a positive motor drive inhibit function independent of logic supplies. This prevents application of power to the carriage motor during power-up sequences or marginal power conditions since the +8SW is only turned on when PWRGOOD is true. (See paragraph 4.3.4.8 for a PWRGOOD circuit description.)

4.3.3.3 **Paper Feed Motor Driver Circuits.** The stepper motor driver circuit provides driving current to the three-phase variable reluctance (VR) stepper motor, based on commands from the microprocessor. Logic signals from the microprocessor control the sequence, direction, and magnitude of current through each of the three windings in the stepper motor as needed to start, brake, and reverse the motion of the paper (forms). Paper direction is controlled by pulsing the stepper motor A, B, and C windings in the proper order (A, B, C; A, B, C . . . etc. for forward; or C, B, A; C, B, A, . . . etc. for reverse).

The VR stepper motor starter consists of various wire wound poles (Figure 4-27). The rotor consists of a cylindrical, toothed member. The number of teeth determines the step angle required (15° for the Model 810 Printer). When current flows through the selected set of motor windings, a torque is developed to rotate the rotor to a position of minimum path reluctance.



15° VR Stepper (3-phase), complete winding shown for one phase only.

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Figure 4-27. Variable Reluctance, Paper Feed Stepper Motor

This position is statically stable; i.e., external torque is required to move the rotor from its present position. This position is not an "absolute" position since there are many stable positions of the motor.

When a different set of windings is energized, the minimum reluctance occurs at a different set of poles and rotor teeth, causing the rotor to move to a new position. These stable positions can be made to rotate smoothly around the stator poles by energizing selected sets of windings. This action produces rotational speed and torque which is coupled to the paper drive tractors through a 7.5-to-1 gear set. When the phase rotation sequence stops, the rotor position becomes fixed. The rotor has a "detent" torque due to the holding current which locks the tractors and paper into position for printing.

When the energizing sequence is stopped, the rotor will continue to move because of motor and load inertias. The motor will overshoot until sufficient reverse torque is developed to pull the rotor back to the detent position. Special timing is used in the stepper motor drive sequence to minimize overshoot when the motor is stopped.

The stepper motor drive circuits form a switching mode, constant current regulator, which operates from the unregulated +30 Vdc bus. Figure 4-28 illustrates the major component parts of the switching regulator drive current for all three motor phases. The switching action (which regulates the current in a selected phase) can be analyzed using the simplified single phase schematic illustrated in Figure 4-29.

The PNP transistor labeled Q2/Q3 is a quasi-PNP circuit formed from an NPN output stage and a PNP driver. Q2/Q3 is turned on by a combination of signal PϕA from the processor board and the output of comparator U3.

The stepper motor is operated in two modes: Hold and Stepping. In the Hold mode the stepper is not moving but is providing a detenting torque to prevent paper movement while printing. In the Stepping mode, the motor moves the paper 0.014 inch for each 15° step the motor is advanced.

The power circuits are controlled by the processor board through the following logic signals:

$\overline{P\phi A}$, $\overline{P\phi B}$, $\overline{P\phi C}$	An active low on one of these signal lines determines which of the three motor phases will be energized. One phase is energized at all times (the signals are exclusive).
$\overline{PSTEP}$	An active low on this line will set the motor phase current to 3.0 amperes nominal. A high level sets the motor phase current to 1.0A.
$\overline{PFAST}$	An active low on this line will change the time constant of the current decay circuits from slow to fast.

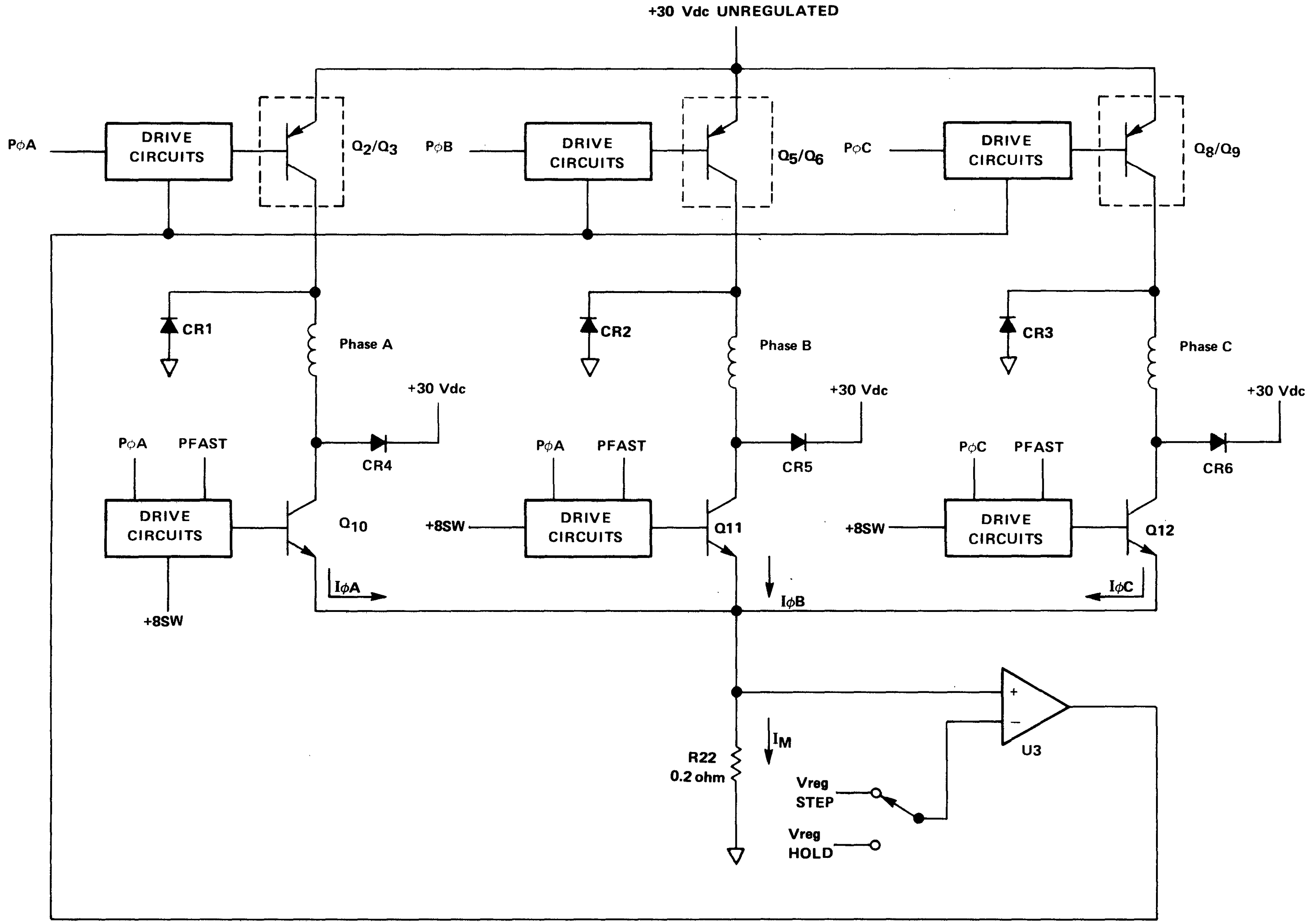

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Figure 4-28. Stepper Motor Drive Circuit, Simplified Diagram

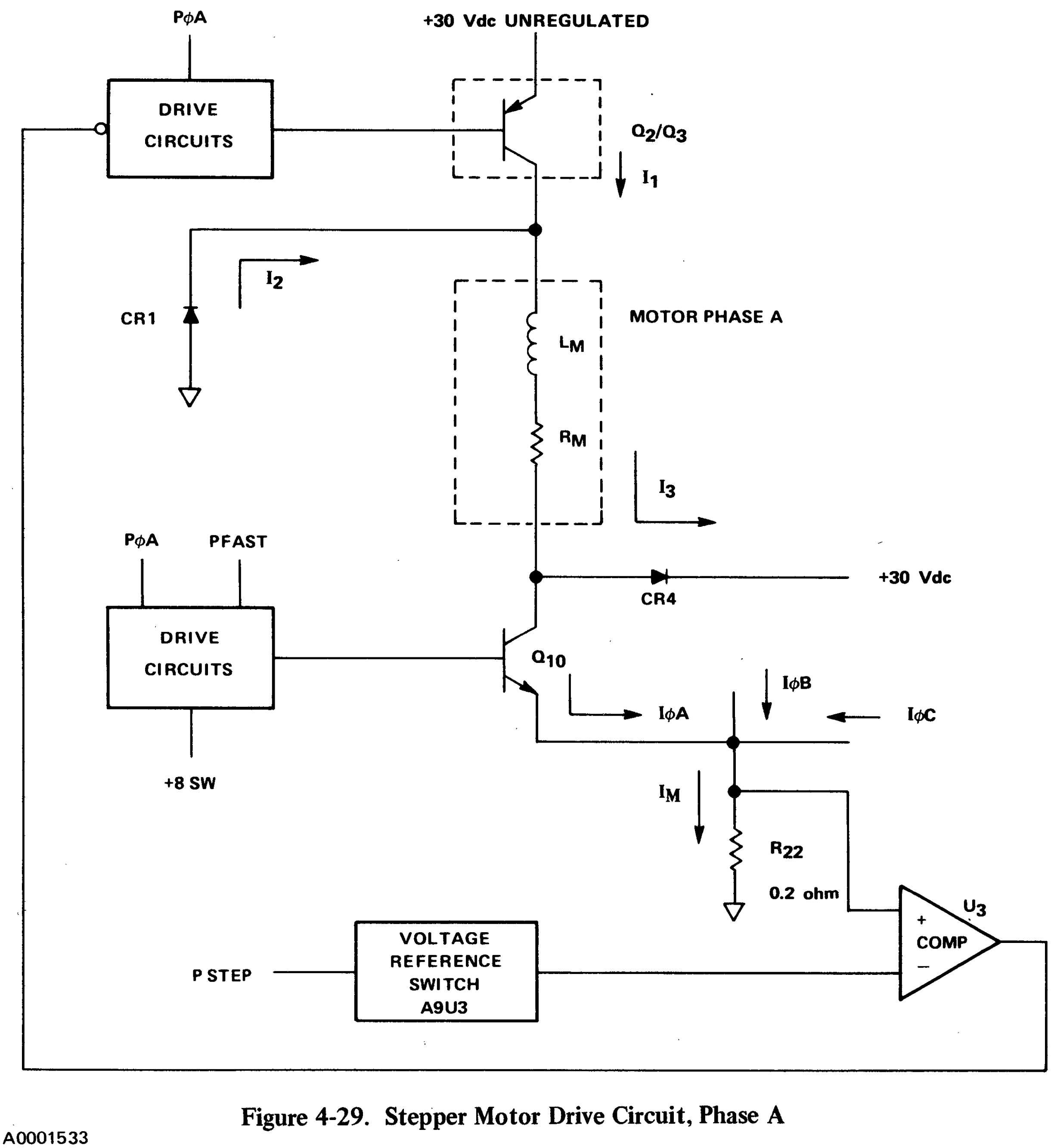

Figure 4-29. Stepper Motor Drive Circuit, Phase A

a. Hold Mode Operation. The hold mode energizes the selected phase of the stepper motor with a low level (1.0A) constant current which is used to provide a detent or holding torque. Since the hold mode involves only one phase, it is the most straightforward mode to analyze. In the hold mode the processor board will select the hold mode voltage reference and apply it to the inverting terminal of U3 (refer to Figure 4-29). The comparator U3 output will be at a logic low for motor current (I_M) less than the reference current. The PFAST command from the processor board changes the time constant of the motor current decay circuit. In the normal regulating mode, this command will be false. Starting with zero motor current and PφA true, transistor switches Q2/Q3 and Q10 will be turned on. Motor current I1 will start to rise at a rate set by the supply voltage and the circuit time constant determined by the motor inductance and resistance. At this instant I1, I A, and I_M (see Figure 4-29) represent the motor phase current. The motor current will continue to increase towards a target value set by the supply voltage and circuit resistance. Figure 4-30 illustrates the switching waveforms. When the current reaches the upper comparator limit, the voltage drops across R22 will equal the hold current reference voltage and comparator U3 will switch to a high state. This, in turn, will switch off transistor Q2/Q3.

Since the motor is inductive, motor current cannot change instantly (refer to Figure 4-29). The path for the decay current is through A10 (I A), R22 (I_M) and CR1 (I2). The time constant for this decay path is determined by the motor and circuit resistances and is relatively long. The current will continue to decay until the lower current limit is reached. The lower limit is set by the hold current reference voltage and the comparator (U3) hysteresis. At the lower limit, Q2/Q3 are again turned on and the switching cycle is repeated. The holding current is the average of the switched current waveform.

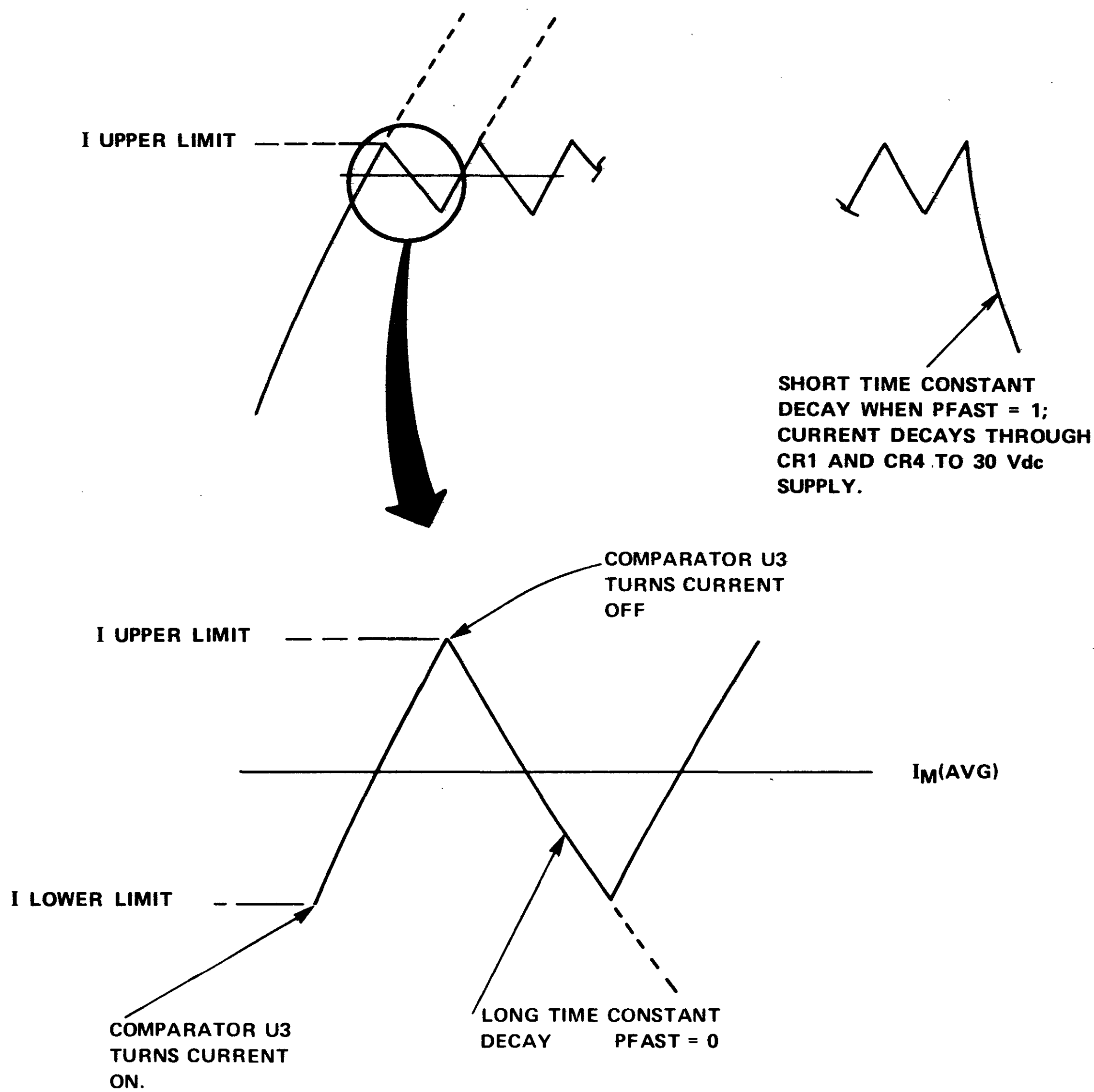

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Figure 4-30. Stepper Motor Circuit Waveforms *b. Stepping Mode Operation.* The regulation action of the stepper motor driver circuit is similar to the analysis presented for the hold current mode. However, there are exceptions:

• Magnitude:	The average current level is maintained at a 3.0 A (nominal) level by the PSTEP command.
• End-of-step time delay:	When switching current from one phase to another during the stepping mode, a decrease in the time constant is required for the current decay in the phase being turned off. This is accomplished by turning off Q10 with the PFAST signal from the processor. The decay current then flows through diode CR4 and CR1 as shown by I3 and I2 in Figure 4-29. The energy stored in the magnetic field of the motor windings is returned to the +30 volt supply, and the current decays very rapidly as illustrated in Figure 4-30.

b. Motor Braking Mode. Referring again to Figure 4-28, note that the three phase currents $I\phi A$, $I\phi B$, and $I\phi C$ are summed to form the total motor current Im. Therefore, when viewed as a complete driver circuit, the total regulated current is 3A in the stepping mode. This summing effect is important during the overlap time between the decay current in the preceding phase and the buildup of current in the phase being turned on.

Figure 4-31 illustrates the current distribution in the stepper motor when making a transition to the last or detent phase. Normal stepping time, or the time each phase is energized in the stepping mode, is 2 milliseconds. At the end of each step the time constant is changed to fast (PFAST = 1), which causes a rapid decay of phase current. At T12 (Figure 4-31) the normal sequence is changed to leave the decay time constant in the slow mode (PFAST = 0). The phase signals are advanced as in a normal step. The slowly decaying current (Note 1, Figure 4-31) retards the normally fast current buildup of the next phase (Note 2, Figure 4-31). This is necessary since the sum of the phase currents must be equal to the programmed motor current.

The mechanical position of the rotor at time T12 is leading the energized winding. The slow decay of current, therefore, becomes a retarding force. In addition slow buildup of current in the detent windings provides only a relatively weak accelerating force on the rotor. The net effect is to slow the rotor just prior to detenting to the final position. This action minimizes the overshoot of the rotor and brings the paper advance mechanism to a smooth stop.

d. Line Feed Cycle. Figure 4-32 illustrates the current waveforms in the phase A, B, and C windings of the motor for a complete 12 step line feed. The diagram assumes the motor is in the hold mode with phase C energized at the start of the sequence.

4.3.4 POWER SUPPLY. The power supply consists of the ac power module and the power supply board (which plugs into the motherboard). The power supply provides the necessary voltage and current requirements for all Model 810 Printer operations. It also generates Power Good (PWRGOOD) and Reset (RST) signals for initializing the microprocessor system when power is turned on. Figure 4-33 provides a detailed block diagram of the power supply. (The sheet numbers listed on Figure 4-33 refer to schematic 994392 sheet numbers located in Section VII of this manual.) The following subsections provide a detailed description of the power supply.

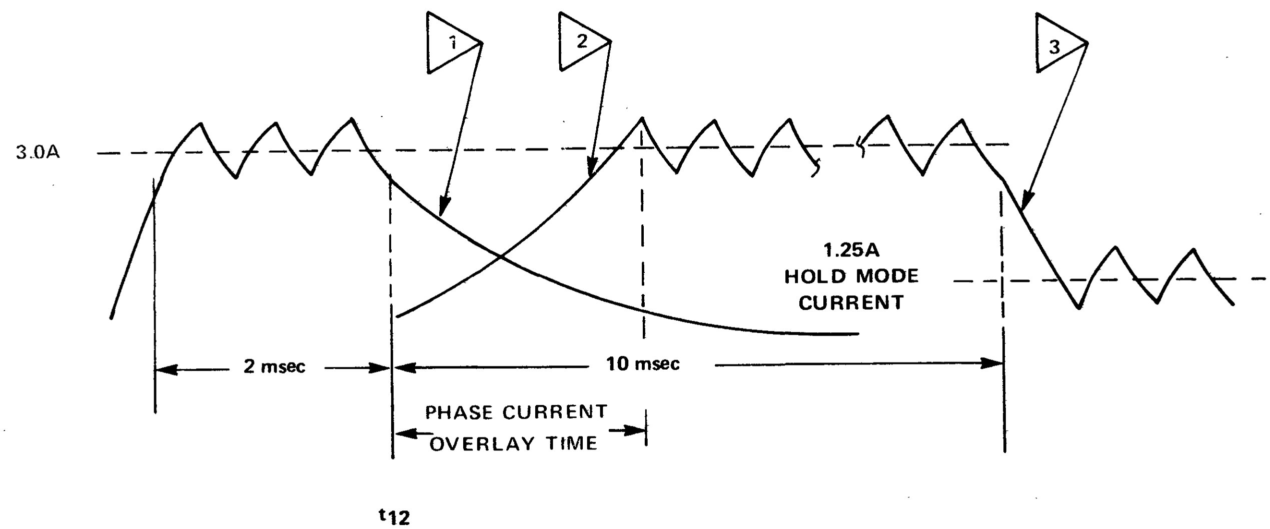

Figure 4-31. Paper Feed Stepper Motor Currents

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4.3.4.1 AC Power Module. As shown in Figure 4-33, the ac power module (part number 994384) consists of an EMI filter, an on/off power switch, line fuse, power transformer, a bridge rectifier, and a power input selection mechanism which allows selection of four primary line voltages: 100, 120, 220, or 240 Vac. The power supply module produces 75 Vac, 40 Vac (center tapped to produce two 20-Vac lines), 30 Vdc unfiltered and 28 Vac to operate the inked ribbon drive and the cooling fan.

Line voltage selection (described in Section II, paragraph 2.5.1) is accomplished by changing the orientation of a small printed circuit board at the rear of the printer which rearranges the power transformer primary taps. The primary taps arrangements are illustrated in Figure 4-34. Refer to diagram number 994384 in Section VII for a detailed schematic of the ac power module.

The EMI filter prevents printer switching regulator noise from being conducted into the ac power line. The ac line (primary side of power transformer) is fused with either a 2.5A or 5.0A fuse depending upon line voltage selection (refer to paragraph 2.5.1 for line voltage selection). A 5.0A fuse is required for 100 or 120 Vac selection (Figure 4-33), and a 2.5A fuse is required for 220 or 240 Vac selection. The secondary side of the power transformer is fused with five fuses located on the motherboard. Refer to diagram 994392, sheet 1, in Section VII for location of these fuses in the power supply circuits, or see Figure 2-3.

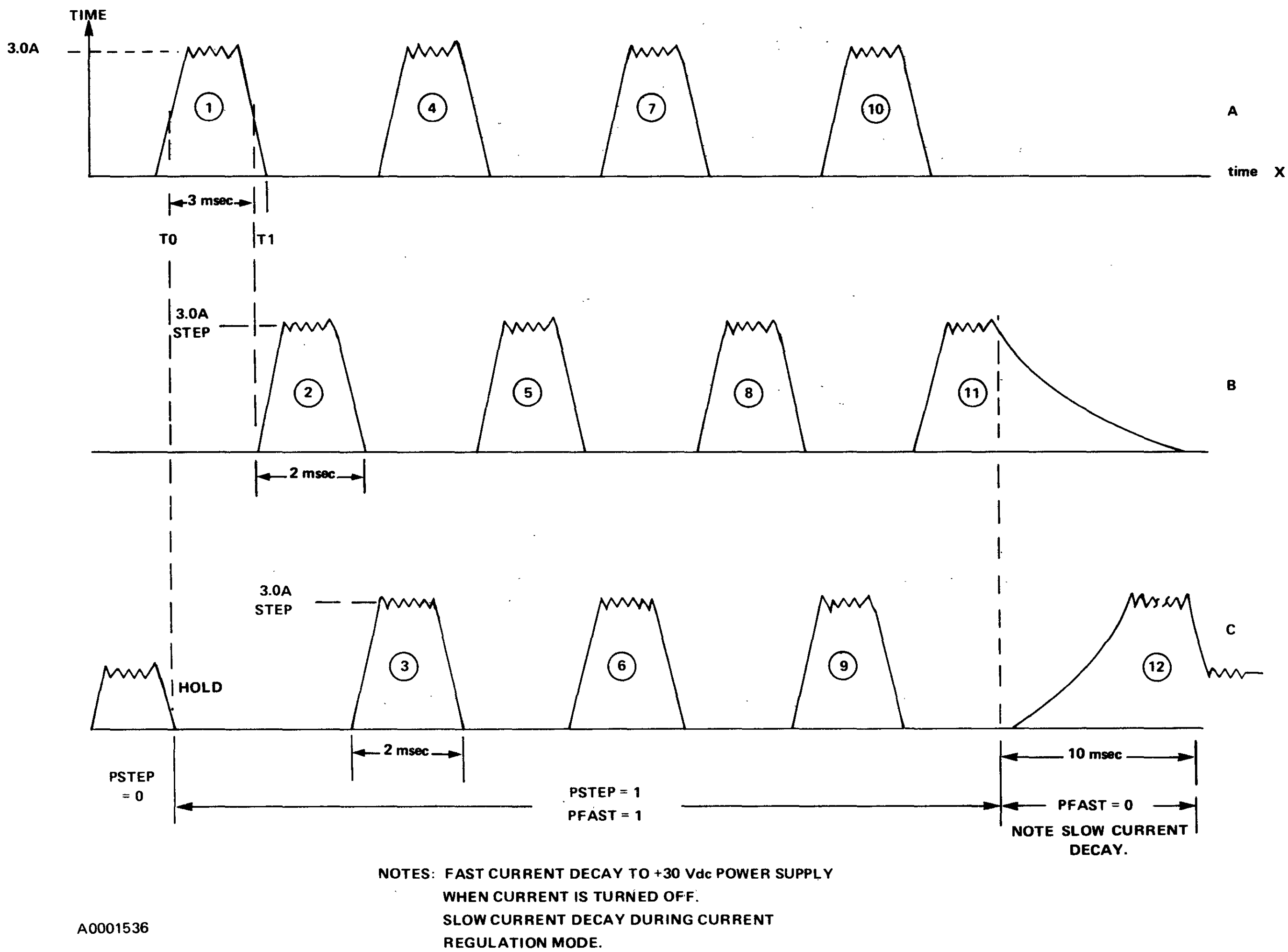

Figure 4-32. Stepper Motor Line Feed Cycle

4.3.4.2 +30 Vdc Supply. The +30 Vdc supply consists of a transformer, bridge rectifier, and filter capacitor configuration as illustrated in Figure 4-35.

The transformer and bridge rectifier are contained in the ac module. Filter capacitor C1 is located on the motherboard and filter capacitor C2 is located on the power supply board. C1 is a low frequency electrolytic capacitor which filters the raw dc voltage from the ac module; and C2 is a high frequency electrolytic capacitor used to decouple the high frequency load imposed by the numerous switching regulators in the printer.

The +30 V line supplies power for the carriage motor, paper feed motor, +4 Vdc regulator, and the +8 SW regulator (Figure 4-33).

4.3.4.3 +5 Vdc Regulator. The +5 Vdc regulator, located on the power supply board (Figure 4-22), supplies power for all processor, driver board, and option board circuits. The +5 V regulator can be defined as a constant ΔI voltage switching regulator. The basic configuration of the circuit is illustrated in Figure 4-36. The +30 Vdc supply provides input power for the +5 Vdc regulator.

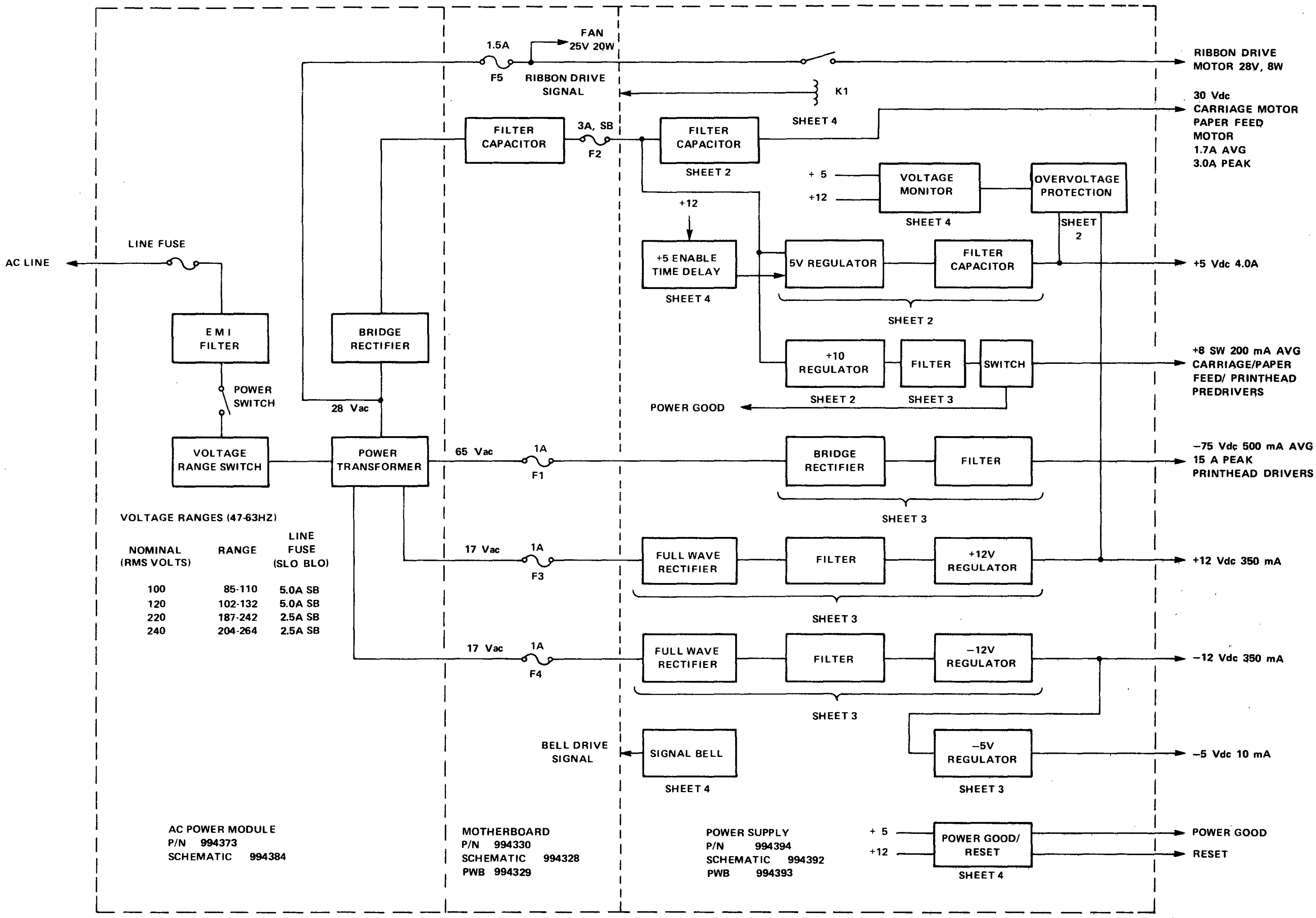

Figure 4-33. Power Supply Functional Block Diagram

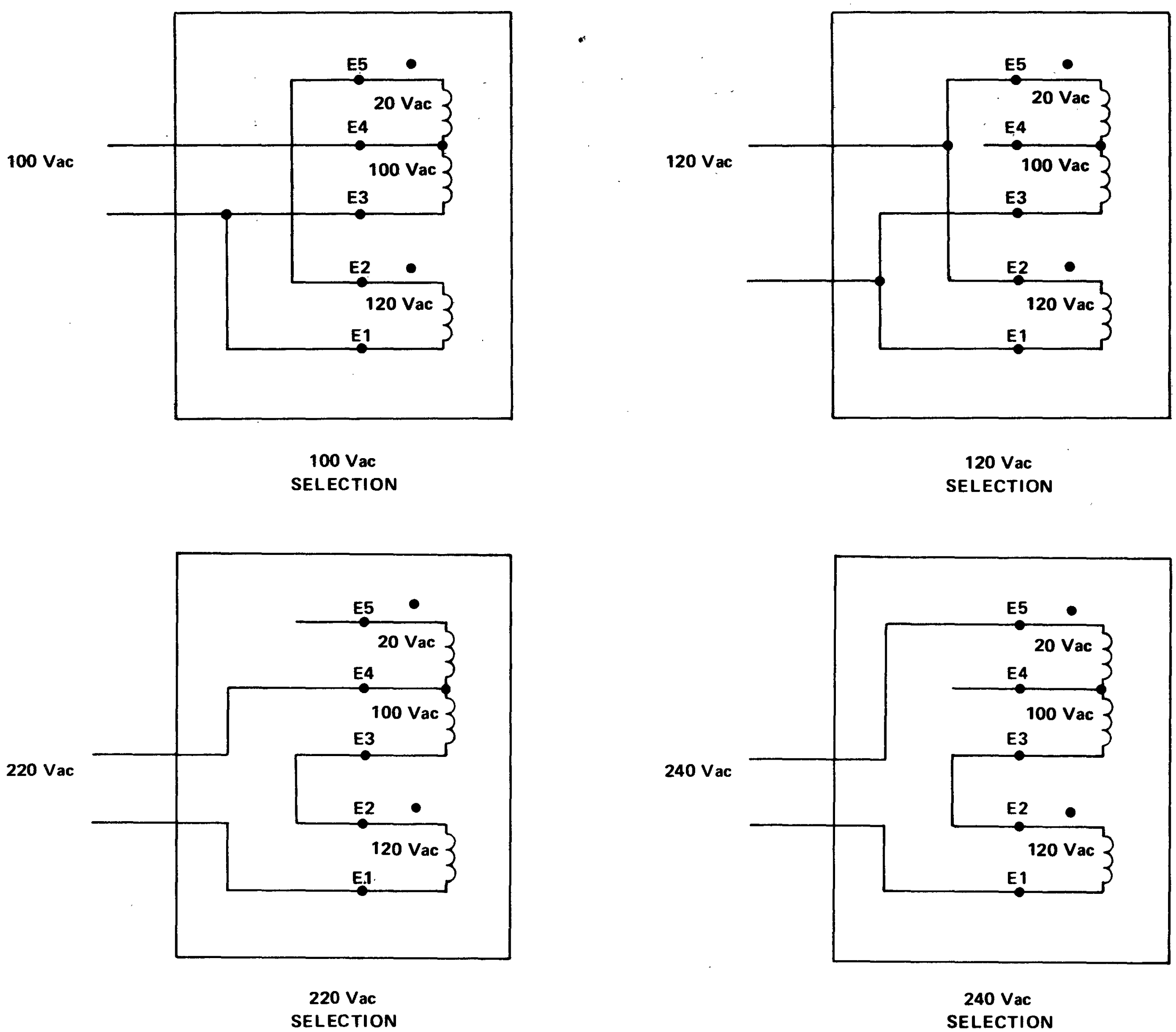

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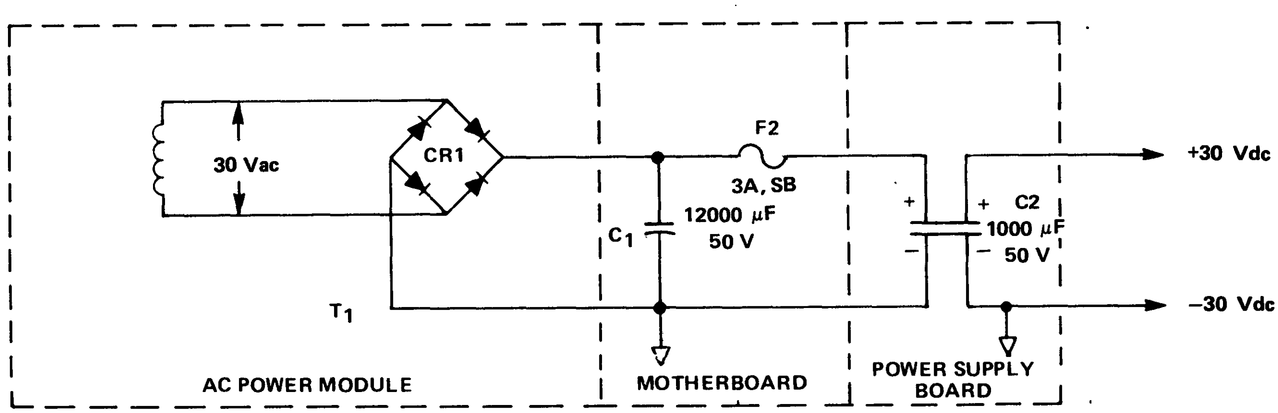
Figure 4-34. Power Transformer Primary Tap Arrangements



A0001540

Figure 4-35. 30 Vdc Supply

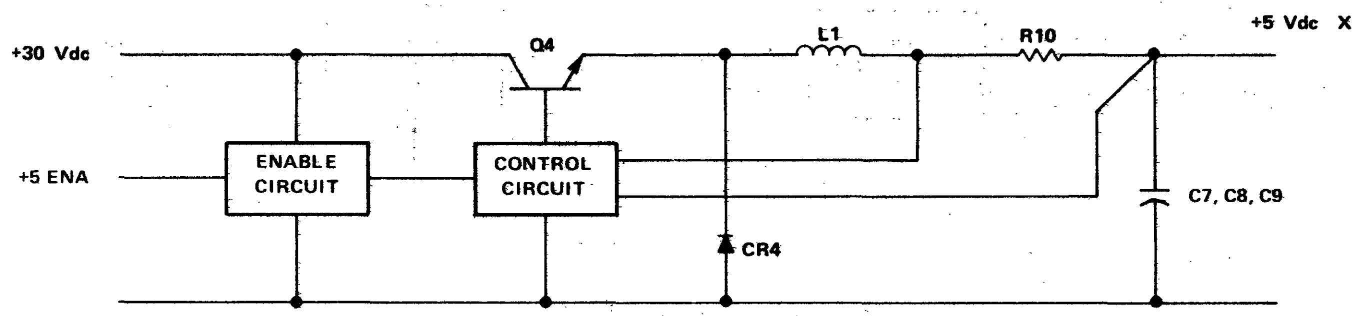


Figure 4-36. +5 Vdc Regulator

The +5 Vdc regulator output is maintained at +5 ± 0.10 Vdc with a load current from 0.5 to 4.0A. The output is regulated by the power switch Q4 duty cycle and the control circuitry (which monitors the ac and dc voltage cross R10 and the 5 Vdc output voltage). L1, C7, C8, and C9 are the energy storage elements of the regulator. CR4 serves as a commutating diode during the off time of Q4. The enable circuit provides a means of enabling or disabling the entire regulator (i.e., when +5 ENA is high, the regulator is turned on).

Refer to drawing number 994392, sheet 2, in Section VII for the following discussion of the +5 Vdc regulator operation.

Transistors Q3 and Q4 form a power switch which is turned on or off by the circuit which controls transistor Q2. Q2 acts as a voltage isolating element to prevent the +30 Vdc on the base of Q3 from increasing the driving point (pin 2 of AR1) more than 0.6 V above the AR1 supply voltage (derived from CR39). Transistor Q1 enables the 24 mA constant current source which supplies current to CR39 and AR1. A voltage proportional to the ripple current in R10 is fed back to AR1 through C4 and C6. This voltage defines the filter capacitor ripple current and, thereby, the ripple voltage at the output. The dc output voltage is remotely sensed as indicated, and the voltage at pin 2 or R13 is compared to an internal reference in AR1 to produce the desired output. Adjustment of R13 will vary the output dc level from 4.2 Vdc to 5.5 Vdc. If the regulator output is overloaded, Q6 senses an overvoltage across R10 and increases the offtime of Q4 to current limit the regulator at 5 amps. This lowers the frequency of operation from 25 kHz to 8 kHz which produces an audible indication that the regulator is overloaded or shorted.

4.3.4.4 +8 SW. Refer to Figure 4-33. The +8 SW line is required to enable the power circuitry on the driver board after the +12 V and +5 V regulators in the power supply exceed their respective minimum values for proper machine operation (refer to Power Good/Reset circuit description, paragraph 4.3.4.8). This prevents carriage and paper motion and/or printing to occur during the power-up and power-down sequence of the machine. Basic implementation of the circuit is illustrated in Figure 4-37. The +8 Vdc output is derived from the +30 Vdc line. The reference voltage for the regulator is derived from the +12 monitor line. This regulated voltage is then communicated to the load through power switch 1 which is turned on or off by the PWRGOOD signal.

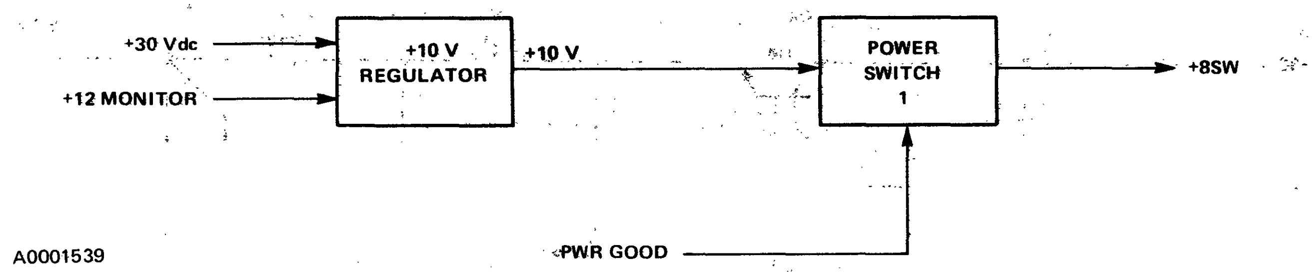


Figure 4-37. +8 SW Line

Refer to drawing number 994392, sheets 2 and 3 in Section VII for the following detailed discussion of the +8 SW circuit.

Diode CR7 is a programmable shunt regulator which provides a constant emitter voltage (10.45 V) on transistor Q9 (Darlington), thereby producing the regulated output voltage. Transistor Q10 is used as a current limiter by sensing the voltage across R28. As the voltage across R28 exceeds ≈ .6V, Q10 turns on and sinks a portion of the base drive for Q9, causing it to turn off limiting the output current to ≈ .3A. This regulated voltage is connected to the load through the power switch comprised of transistor Q8 (Darlington) and its driver transistor Q7. Q7 is turned on when the power good line goes high. CR41 and CR42 ensure that Q7 is off when power good is low. The collector-emitter drop across Q8 lowers the output to approximately +8 Vdc.

4.3.4.5 ±12 Vdc and -5 Vdc Regulators. The ±12 Vdc regulators are two 3-terminal regulators. The -5 Vdc output is regulated by zener diode CR16 from the -12 Vdc bus. Figure 4-28 illustrates ±12 Vdc and -5 Vdc regulator configuration. The input to the ±12 Vdc regulators is from a conventional center-tapped transformer, bridge rectifier, and capacitor configuration.

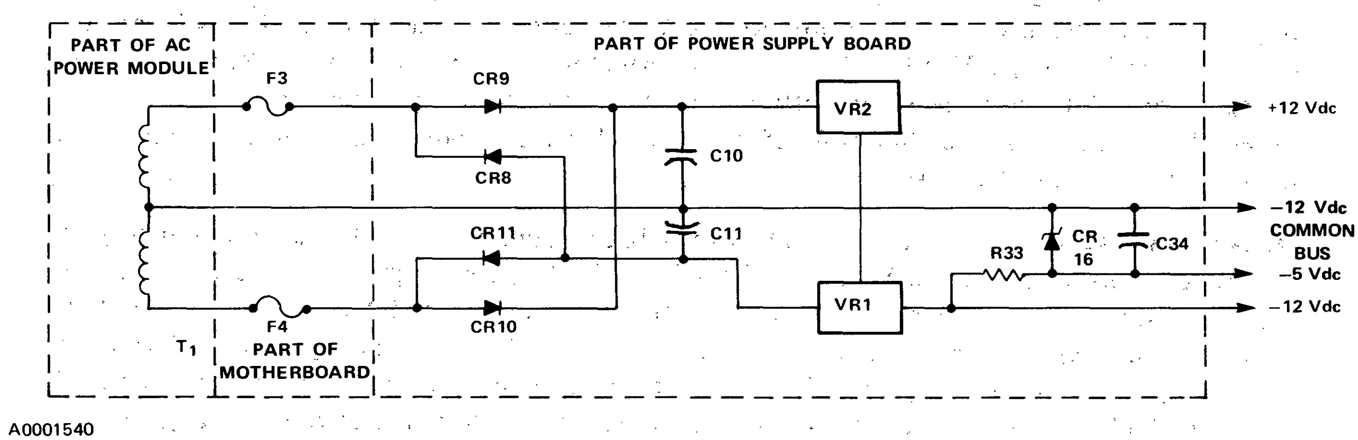


Figure 4-38. ±12 Vdc and −5 Vdc Regulators

The +12 Vdc output supplies the MOS device on the processor board and the various comparators on the driver board. The —12 Vdc line supplies comparators on the driver board and MOS circuit devices on the processor board. The -5 Vdc line is used as a substrate bias for the TMS 8080A Microprocessor.

4.3.4.6 —75 Vdc Supply. The —75 Vdc source is derived from a conventional transformer, bridge rectifier, and capacitor configuration as illustrated in Figure 4-39.

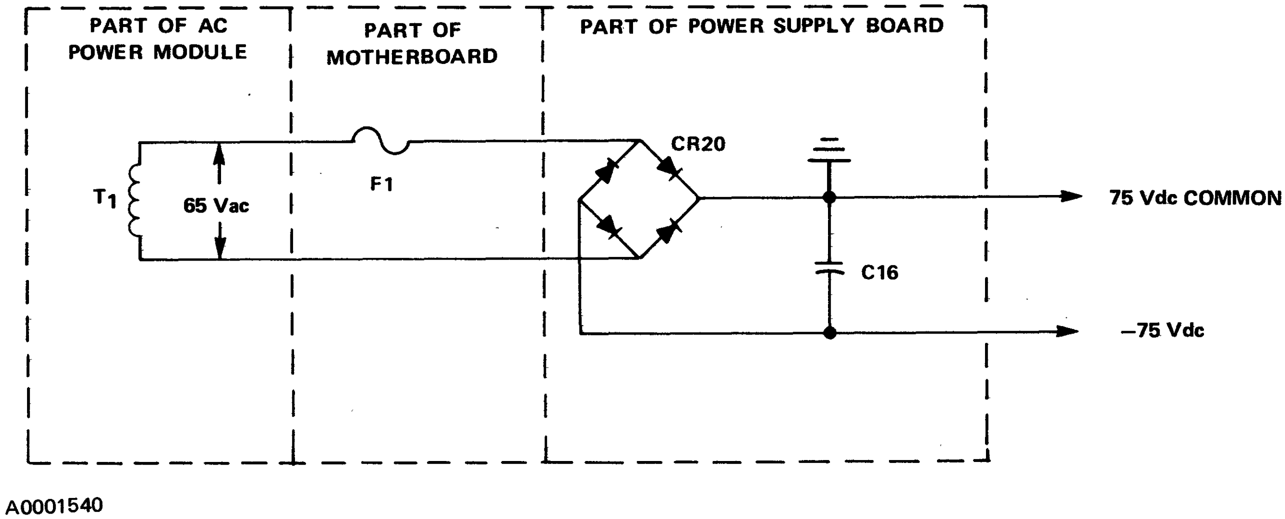


Figure 4-39. —75 Vdc Supply

The —75 Vdc supply is used only for supplying power to the printhead driver circuits. This high potential is necessary to produce fast rising current pulses in the printhead solenoids.

4.3.4.7 Overvoltage Protection Circuit. The overvoltage protection (OVP) circuit is used to disable the printer under a condition of overvoltage on the +5 Vdc or +12 Vdc line. The circuit operates in two modes, destructive and nondestructive. In the destructive mode, the OVP should fire as a result of an actual power supply malfunction when the +5 Vdc and/or +12 Vdc regulator exceed their preset upper voltage limit. In this mode, the +30 Vdc and/or the +20 Vdc fuses will blow and disable the printer. In the nondestructive mode, the OVP will fire under conditions of overvoltage on the +5 Vdc or +12 Vdc as a result of other malfunctions not associated with the power supply. In this mode the +12 Vdc and +5 Vdc power supply outputs are grounded through SCR1. Both the +12 Vdc and +5 Vdc supplies immediately go into current limit. With the +12 Vdc output at ground, the +5 Vdc regulator is disabled by the power good circuit. The printer remains in this state, with the +12 Vdc regulator operating in dissipation limit until power is recycled.

Refer to drawing number 994392 (sheets 2 and 4) in Section VII; sheet 4 illustrates the SCR trigger pulse generator. The output is derived from +5 and +12 Vdc monitors. Sheet 2 illustrates the SCR and the manner in which it grounds the +5 Vdc and +12 Vdc outputs. The +5 Vdc and +12 Vdc trigger pulse generators are essentially the same. The voltage detection devices include diodes CR32 and CR34 (which are TL430 programmable shunt regulators).

Since the +5 Vdc and +12 Vdc detection circuits are similar, only the +5 Vdc circuit is described. When the voltage at the emitter of transmitter Q19 rises above the programmed voltage of CR32 (which is set by voltage divider R83 and R84), CR32 begins to sink current from the base of Q19. This action turns Q19 on, sourcing current through CR33 and into the gate of Q5(SCR). This causes Q5 to fire, grounding the +5 Vdc output and the +12 Vdc output. Q5 remains on until ac power is recycled. Figure 4-40 provides a block diagram of the overvoltage protection circuit.

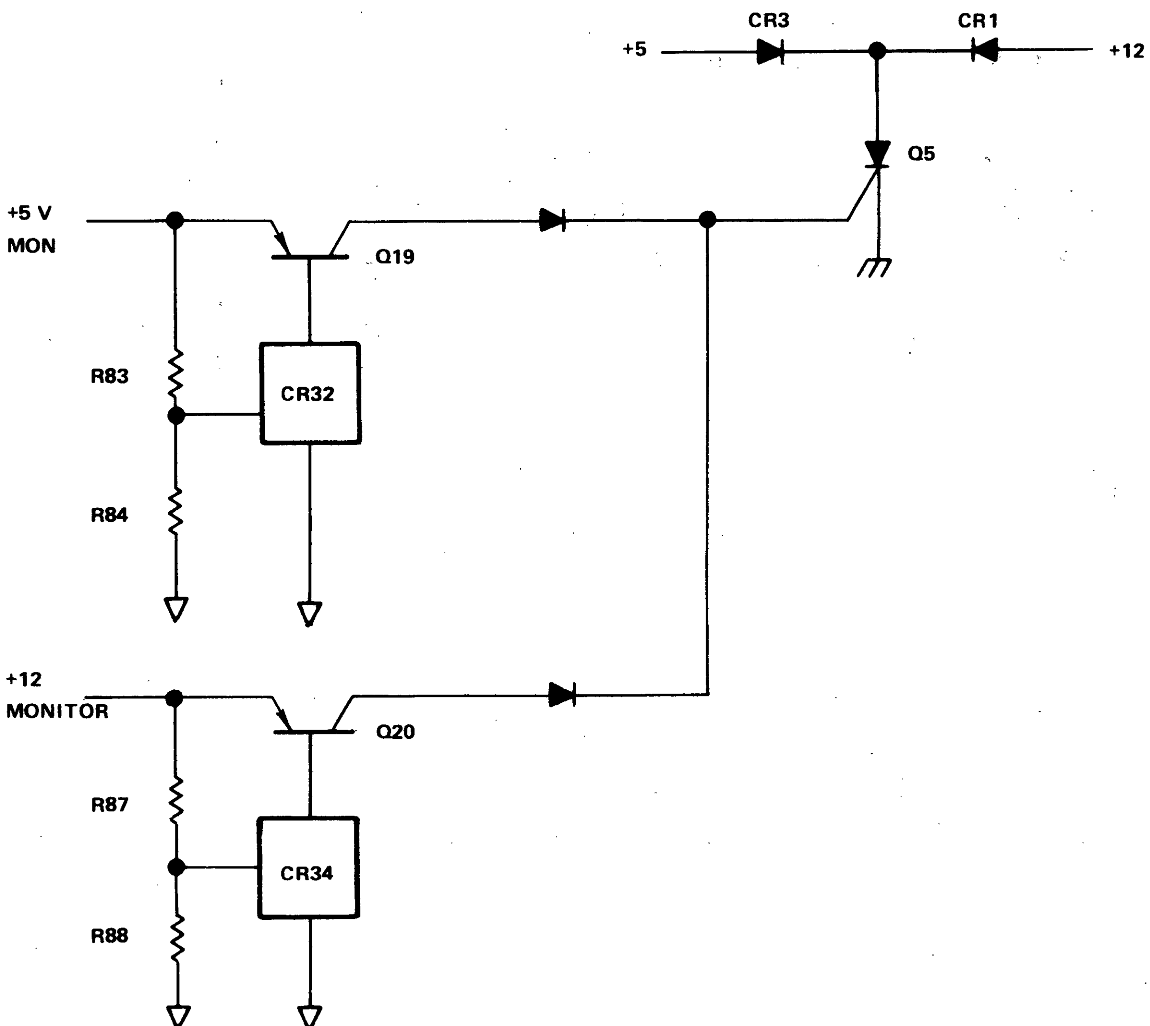


Figure 4-40. Overvoltage Protection Circuit

4.3.4.8 Power Good/Reset. The purpose of the power good/reset circuit is to provide signals to the processor board which indicate that the +5 Vdc and +12 Vdc supplies are above the minimum required levels for proper circuit operation. The power good signal also controls the +8 SW power to the driver board. Figure 4-41 illustrates the power good and reset signal profiles during power-up and power-down. The low to high transition of the power good line indicates that the +5 Vdc line and the +12 Vdc line exceed their respective minimum values for proper printer operation. These signals are used to reset the TMS 8080A Microprocessor, as an enable for the 8 SW circuit (which remotely enables the power circuits on the driver board), and to clear the control latches on the processor board. A functional block diagram of the power good/reset circuit is illustrated in Figure 4-42.

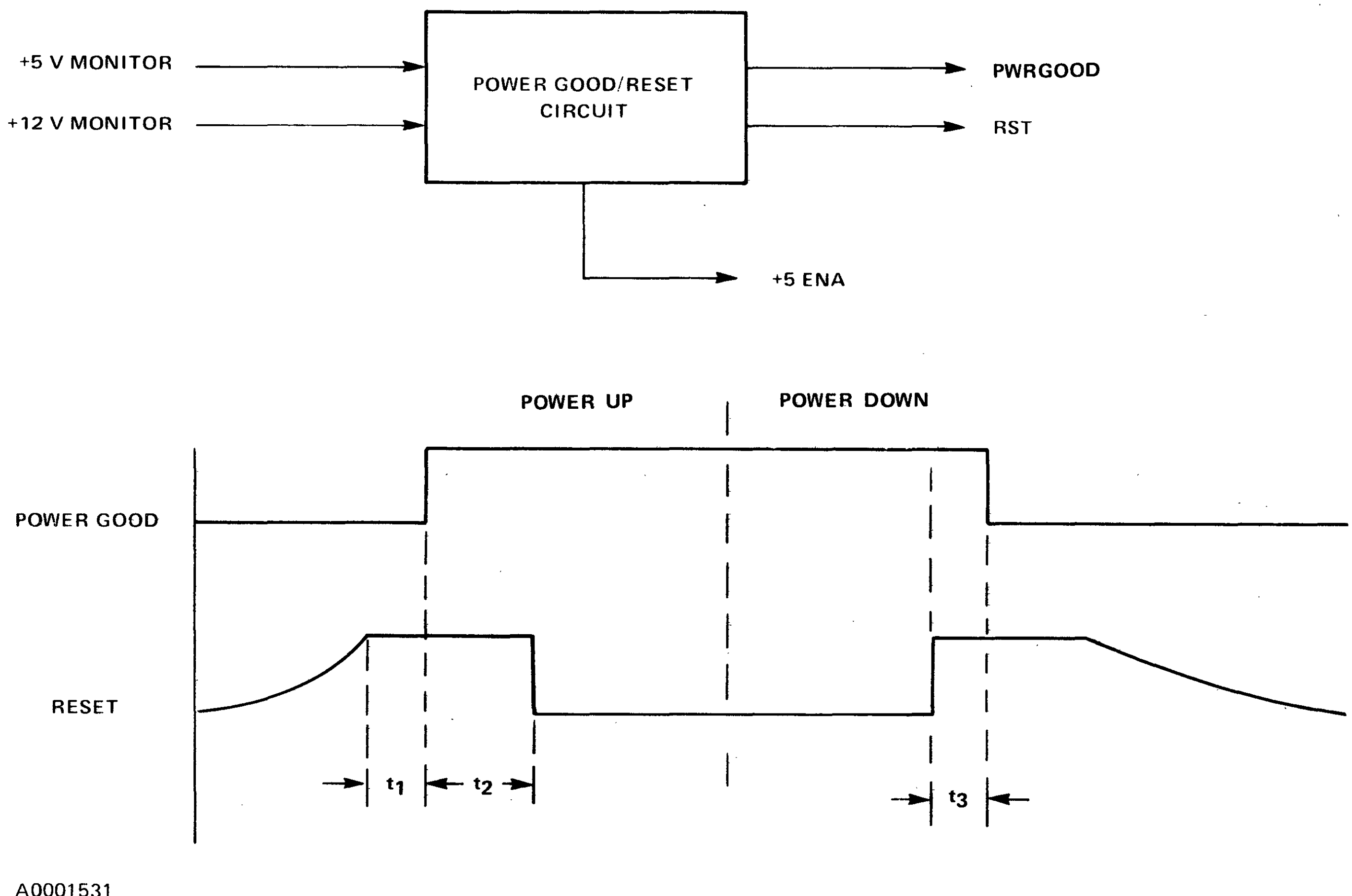


Figure 4-41. Powergood/Reset Signal Profiles

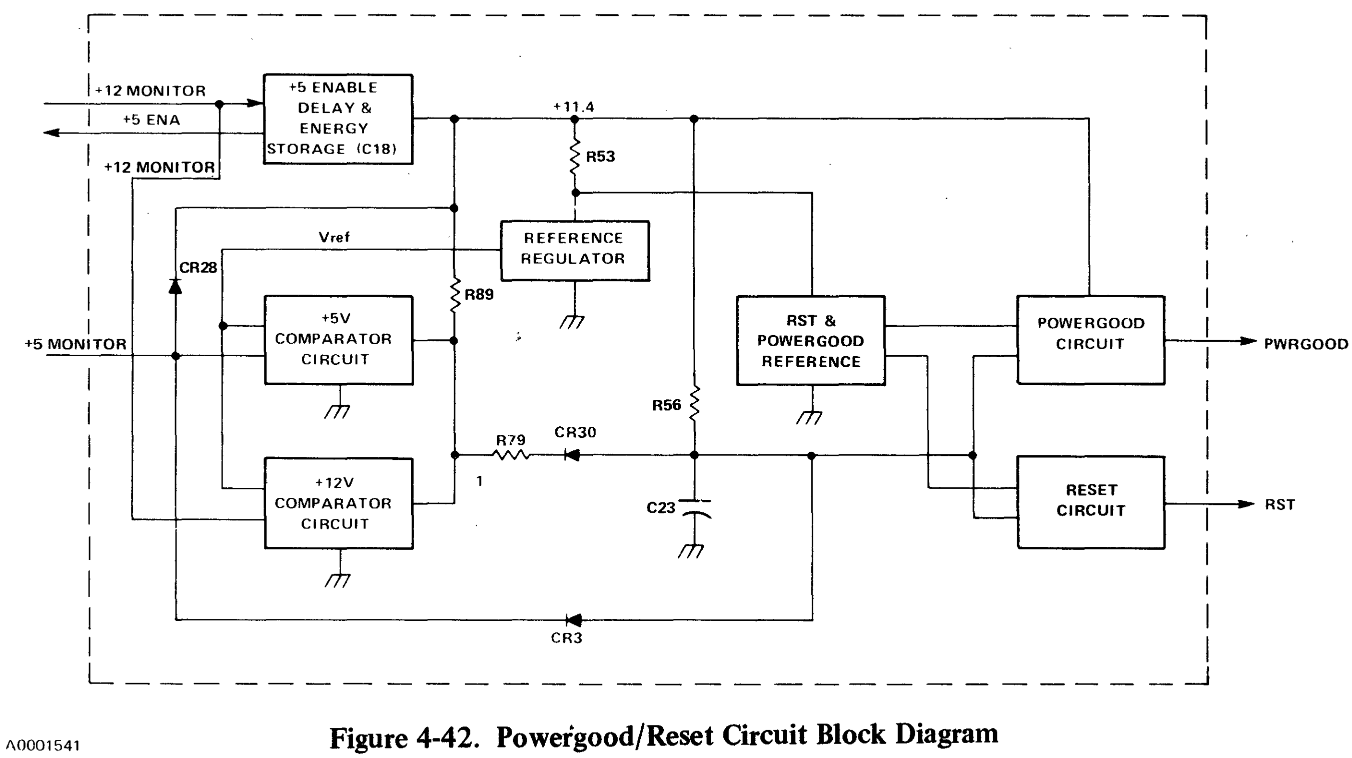


Figure 4-42. Powergood/Reset Circuit Block Diagram

The 5 Vdc enable (ENA) provides a timed delay which allows the +12 Vdc regulator to be at least in coarse regulation before the +5 Vdc line is allowed to come up. This ensures that the power good/reset circuit itself has adequate power for its own operation. The storage element in this block (C18) provides enough energy for this circuit to remain in operation during power-down or circuit malfunction (for an orderly power-down sequence). The +5 Vdc and +12 Vdc comparator circuits compare the +12 Vdc monitor and the +5 Vdc monitor lines to a voltage generated by the reference regulator block. The outputs of these comparator circuits are wire-ANDed such that when the +5 Vdc and +12 Vdc regulators are both within limits, and both detection circuit outputs are high, C23 begins charging through R56. The voltage ramp developed across C23 is compared to a low level reference in the power good circuit comparator and a higher level reference in the reset circuit comparator. If either of the detector comparators goes low because either the +5 Vdc or the +12 Vdc line falls below its reference values, C23 discharges through R79, generating a power down sequence. For a detailed circuit diagram of the power good/reset circuit, refer to schematic number 994392, sheet 4 (Section VII).

The storage for the power good/reset circuit is provided by C18. CR26 prevents C18 from being discharged by the grounding or crowbar of the +12 Vdc monitor line. Q14 or Q15 act as an inverted Schmitt trigger. Q15 remains saturated during power up while C19 is charging. This keeps the base of Q15 below the base of Q14 for approximately 200 msec, which provides enough time for the +12 Vdc regulator to come into regulation under normal conditions. If the +12 Vdc supply does not come up, the +5 ENA signal remains low, and the +5 Vdc regulator is not enabled. If the +11.4 Vdc line is grounded, C19 is discharged through CR27 and the +5 ENA line immediately goes low, disabling the +5 Vdc regulator.

CR29 and R53 provide the constant reference voltage for use by all of the comparator circuits of the printer. This ramp is applied to the inputs of the power good and reset comparator circuits, which are also configured as voltage comparators with hysteresis. The output of the power good comparator (AR2/2) is buffered by Q17 and Q18 to provide the necessary current sink capability. The output of the reset comparator goes directly to the microprocessor. CR31 provides immediate discharge of C23 in the event of a system overvoltage.

4.3.5 CURRENT LOOP OPTION BOARD. The current loop option board (part number 994305-0001) enables the Model 810 Printer to receive data from a teletypewriter (TTY) data source. This capability requires installation of the TTY Current Loop Interface Kit (part number 994401) if the Printer was not purchased with this option installed. The current loop option board includes a receiver circuit, and a transmitter circuit.

4.3.5.1 Receiver Circuit. The current loop (TTY) receiver (refer to schematic number 994303, sheet 2, in Section VII) consists of the necessary circuitry to sense current from an external source, and to convert the current levels to the appropriate EIA-level logic values required by the serial input of the processor board. The voltage drop across receiver inputs TTYRCVD and TTYRCVD/R is 3 Vdc (maximum) at 20 mA loop current into TTYRCVD. The MARK/SPACE threshold decision current is nominally 12 ±3.5 mA. The receiver circuit utilizes an optically coupled isolator to isolate the current loop from the printer circuitry.

A current level at the receiver circuit input above the MARK/SPACE threshold will forward-bias the U4 energizing the phototransistor. With the phototransistor energized, a logic ZERO is applied to pin 1 of U5 and the RCVD output of U6 is negative (less than —3 volts).

With a current level at the receiver input below the MARK/SPACE threshold, the emitter and phototransistor of U4 are off and a logic ONE is applied to pin 1 of U5. With the EIA interface disconnected, circuit BB is open and a logic ONE also appears at pin 2 of U5 and, hence, circuit RCVD will be positive (greater than +3 volts).

Circuits CDET and DSR are held positive by the action of U6.

4.3.5.2 Transmitter Circuit. The current loop (TTY) transmitter (refer to schematic number 994303, sheet 2, in Section VII) consists of the circuitry necessary to switch the current in the transmit loop (supplied from an external source). The input to the transmitter is the EIA-level status signal, REVCH, from the processor board. When positive, this signal indicates that the printer is ON-LINE and ready to receive data. The voltage drop across the transmitter output terminals is less than 1.5 Vdc at 20 mA loop current. The maximum SPACING leakage current is 0.5 mA at 50 Vdc.

A positive voltage level (greater than +3 volts) at pin 1 of U11 will energize Q1. With Q1 on, the emitter and phototransistor of U10 are energized. With base drive supplied to Q2, the output transistor remains on, allowing current flow in the transmit loop.

A negative voltage level (less than —3 volts dc) at pin 1 of U11 will switch off Q1. With Q1 off, the emitter and phototransistor of U10 are off. With no base current drive, output transistor Q2 is off and the transmitter is open (i.e., no current).

4.3.5.3 Auxiliary Parallel Interface. This PC board (part number 994305-0002) provides two auxiliary interface signals for the parallel interface (refer to schematic number 994303, sheet 2, in Section VII). The processor board, 2-MHz clock signal (CLK01 is divided by U12 to produce a 125-kHz clock signal OSCXT at connector pin P2-66. An isolated contact closure is provided between signals LINE COUNT and LINE COUNT RET. This contact closes momentarily for each line feed.