

LQ-500 L-1000

TECHNICAL MANUAL

EPSON

FCC COMPLIANCE STATEMENT FOR AMERICAN USERS

This equipment uses and generates radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with limits for a Class B computing device in accordance with Sub-part J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- reorient the receiving antenna
- relocate the computer with respect to the receiver
- move the computer away from the receiver
- plug the computer into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet, prepared by the Federal Communications Commission, helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, D.C., 20402, Stock No. 004-000-00345-4.

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REVISION SHEET

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PRECAUTIONS

Precautionary notations throughout the text are categorized relative to 1) personal injury, and 2) damage to equipment:

DANGER Signals a precaution which, if ignored, could result in serious or fatal personal injury. Great caution should be exercised in performing procedures preceded by a DANGER heading.

WARNING Signals a precaution which, if ignored, could result in damage to equipment.

The precautionary measures itemized below always should be observed when performing repair/maintenance procedures.

DANGER

1. *ALWAYS DISCONNECT THE PRODUCT FROM BOTH THE POWER SOURCE AND PERIPHERAL DEVICES BEFORE PERFORMING ANY MAINTENANCE OR REPAIR PROCEDURE.*
 2. *NO WORK SHOULD BE PERFORMED ON THE UNIT BY PERSONS UNFAMILIAR WITH BASIC SAFETY MEASURES AS DICTATED FOR ALL ELECTRONICS TECHNICIANS IN THEIR LINE OF WORK.*
 3. *WHEN PERFORMING TESTING AS DICTATED WITHIN THIS MANUAL, DO NOT CONNECT THE UNIT TO A POWER SOURCE UNTIL INSTRUCTED TO DO SO. WHEN THE POWER SUPPLY CABLE MUST BE CONNECTED, USE EXTREME CAUTION IN WORKING ON POWER SUPPLY AND OTHER ELECTRONIC COMPONENTS.*
-

WARNING

1. *Repairs on Epson products should be performed only by an Epson-certified repair technician.*
2. *Make certain that the source voltage is the same as the rated voltage, listed on the serial number/rating plate. If the Epson product has a primary AC rating different from the available power source, do not connect it to the power source.*
3. *Always verify that the Epson product has been disconnected from the power source before removing or replacing printed circuit boards and/or individual chips.*
4. *In order to protect sensitive microprocessors and circuitry, use static discharge equipment, such as anti-static wrist straps, when accessing internal components.*
5. *Replace malfunctioning components only with those components recommended by the manufacturer. Introduction of second-source ICs or other nonapproved components may damage the product and void any applicable Epson warranty.*

PREFACE

This manual describes functions, theory of electrical and mechanical operations, maintenance, and repair of the LQ-500 and the L-1000. Throughout this manual both printers are discussed. When an item is unique to one printer, special notation is made. Common items are treated in a general format.

The instructions and procedures included here are intended for the experienced repair technician, who should pay attention to the precautions on the preceding page. The chapters are organized as follows:

- Chapter 1 - Provides a general product overview, lists specifications, and illustrates the main components of the printer.
- Chapter 2 - Describes the theory of printer operation
- Chapter 3 - Discusses the options.
- Chapter 4 - Includes a step-by-step guide for product disassembly, assembly, and adjustment.
- Chapter 5 - Provides Epson-approved techniques for troubleshooting.
- Chapter 6 - Describes preventive maintenance techniques and lists lubricants and adhesives required to service the equipment.

* The contents of this manual are subject to change without notice.

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1.1 FEATURES

The LQ-500/L-1000 are small, light-weight, low-cost printers compatible with the LQ-800. The two printers differ in the housing design. All other features are the same. The main features are as follows:

1. Expanded ESC/P-code printing, implemented as a standard feature
2. Printing speeds: 180 CPS (alphanumeric Draft 12 CPI)
150 CPS (alphanumeric Draft 10 CPI)
60 CPS (alphanumeric LQ 12 CPI)
50 CPS (alphanumeric LQ 10 CPI)
3. Optional 8100 series interface
4. Clear, easy-to-read printing with a standard EPSON font
5. Two built-in LQ fonts (Roman and Sans Serif)
6. Optional Font Module to provide a wide variety of fonts
7. Front panel switch selection of Draft, Roman, Sans Serif, or slot (Optional Font Module) font
8. Automatic paper-loading function
9. Easy handling of cut sheets with the optional cut-sheet feeder (CSF)

The LQ-500/L-1000 is equipped with the standard EPSON 8-bit parallel interface. Various interface options enable users to print data from a wide variety of computers. Table I-I lists the interface options, Table I-2 lists the optional units available for the LQ-500/L-1000, and Figure I-I shows an exterior view of the LQ-500 / L-1000.

Table I-I. Interface Options

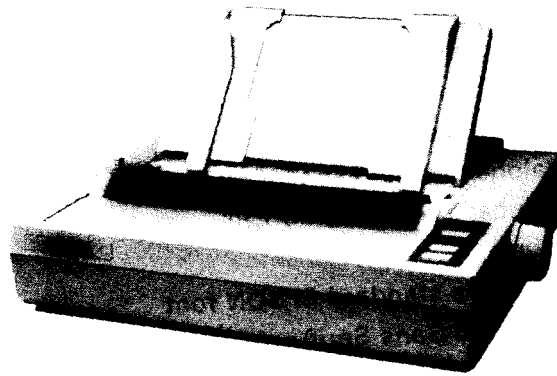
Model	Description
8143	New serial interface board
8145	RS-232C/Current loop interface type II
8148	Intelligent serial interface board
8149	Intelligent serial interface board type II
8149M	Intelligent serial interface board type III
8161	IEEE-488 interface board
8165	Intelligent IEEE-488 interface board
8172	32K buffer parallel interface board
8172M	128K buffer parallel interface board

NOTE: Refer to the "Optional Interface Technical Manual" for details.

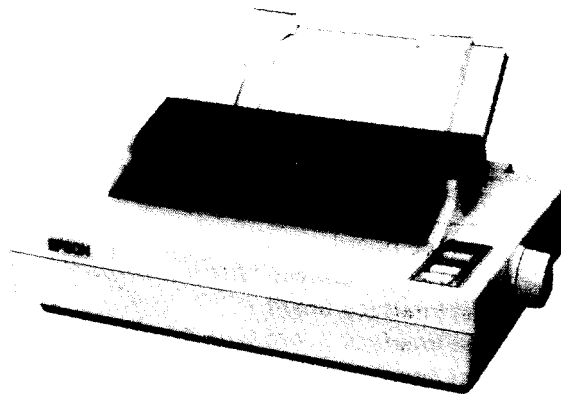
Table 1-2. Optional Units

Model	Description
7341	Cut-sheet feeder (CSF)
7400	Font module Courier
7401	Font module Prestige
7402	Font module Script
7403	Font module OCR-B

GENERAL DESCRIPTION



(Printer Cover A)



(Printer Cover B)

Figure 1-I. Exterior View of the LQ-500/L-1000

1.2 SPECIFICATIONS

This section describes the specifications for the LQ-500/L-1000 printer.

1.2.1 Hardware Specifications

Printing Method Serial, impact, dot matrix
Pin Configuration 24 wires (12 x 2 staggered, diameter 0.2 mm)

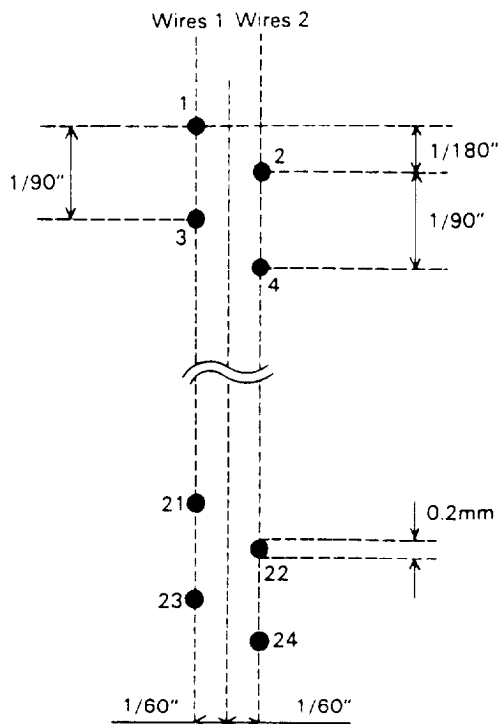


Figure 1-2. Pin Configuration

Feeding Method Friction feed, tractor feed (pull tractor)
Line Spacing 1/6 inch, or programmable in units of 1/180 inch
Paper Insertion From rear
Paper-Feed Speed 100 ms/line (at 1/6-inch feed)
 2.2 inches per second (continuous feed)
Paper Specifications See Tables 1-3 and 1-4

Table 1-3. Cut-Sheet Specifications

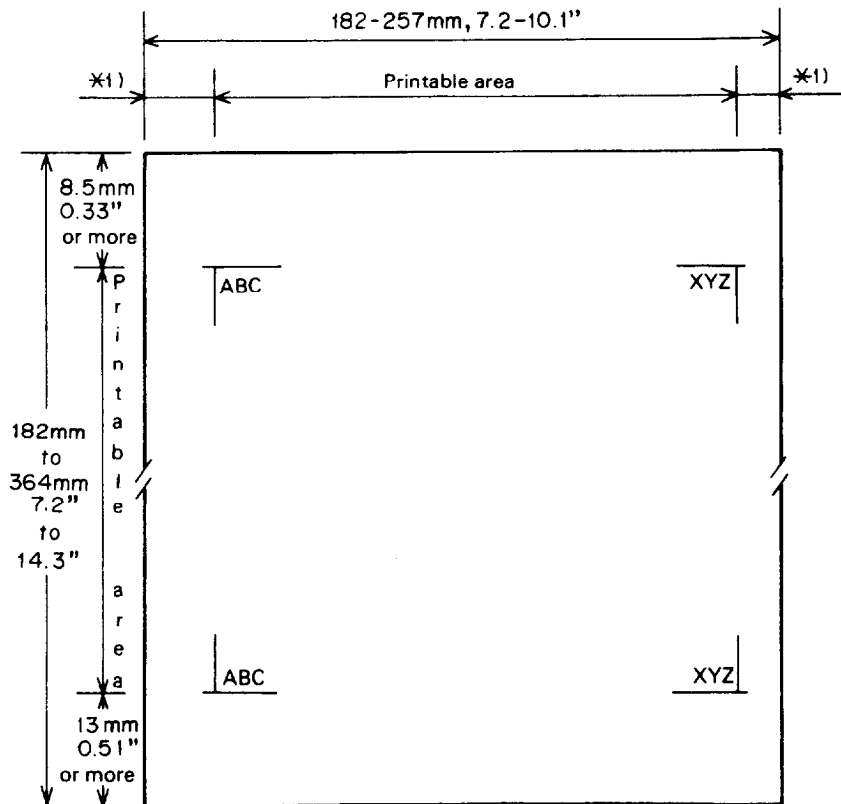
Width	182 mm to 257 mm (7.2 in. to 10.1 in.)
Length	182 mm to 364 mm (7.2 in. to 14.3 in.)
Thickness	0.065 mm to 0.1 mm (0.0025 in. to 0.004 in.)
Weight	52 g/m ² to 82 g/m ²
Quality	Copier paper or bond
Copies	Not available

Table 1-4. Continuous (Sprocket) Paper Specifications

Width	101 mm to 254 mm (4.0 in. to 10.0 in.)
Copies	3 sheets, maximum (1 original and 2 copies)
Quality	Computer paper or other continuous-form paper
Total Thickness	0.065 mm to 0.25 mm (0.0025 in. to 0.01 in.)
Weight	1 sheet - 52 g/m ² to 82 g/m ² 2 sheets - 40 g/m ² to 58 g/m ² X 2 3 sheets - 40 g/m ² to 58 g/m ² X 3

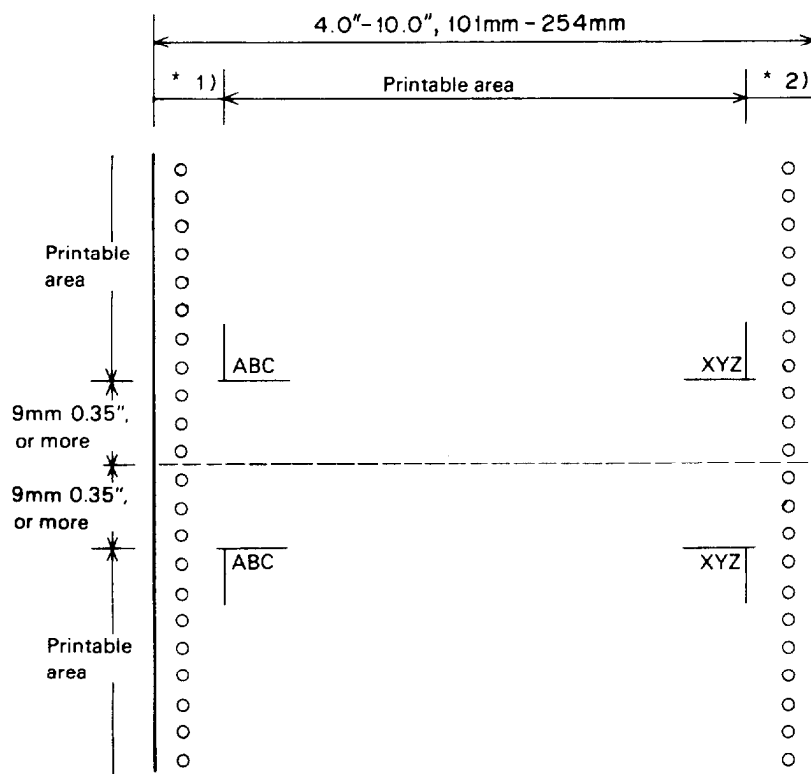
Printable Area

The figure below illustrates the printable area for cut sheets.



*1) 3 mm or more using 182 mm to 229 mm (7.2 in. to 9 in.) width paper.
27 mm or more using 257 mm (10.1 in.) width paper.

Figure 1-3. Cut-Sheet Printable Area



- *1) 13 mm or more using 101 mm to 242 mm (4 in. to 9.5 in.) width paper.
 26 mm or more using 254 mm (10 in.) width paper.
- 2) 13 mm or more using 101 mm to 242 mm (4 in. to 9.5 in.) width paper.
 24 mm or more using 254 mm (10 in.) width paper.

Figure 1-4. Printable Area for Continuous (Sprocket) -Feed Paper

Ink Ribbon

Type	Exclusive ribbon cartridge
Color	Black
Reliability	2 million characters at 48 dots/character
Dimensions of Ribbon Cartridge	293 mm (width) x 34 mm (height) x 72 mm (depth)

Reliability

Mean Cycles Between Failures (MCBF)	3 million lines (excluding printhead)
Mean Time Between Failures (MTBF)	4000 POH (25% duty)

Life of Printhead

200 million strokes

Safety Approvals

Safety Standards	UL478 (U.S. version) CSA22.2#154 VDE0806 (TUV) (European version)
Radio Frequency Interference (RFI)	FCC class B (U.S. version) VDE0871 (Self-certification) (European version)

Electrical Specifications

Power Conditions	120 VAC \pm 10% (120 V version) 220 VAC \pm 10% (220 V version) 240 VAC \pm 10% (240 V version)
Frequency Range	49.5 to 50.5 Hz (50 Hz version) 59.5 to 60.5 Hz (60 Hz version)
Rating Current	1.8A (120 V version) 0.9A (220 V version) 0.9A (240 V version)
Insulation Resistance	10 Megohms min. (Between AC Line and Chassis)
Dielectric Strength (Between AC Line and Chassis)	1250 VAC (rms), 1 minute (120 V version) 3750 VAC (rms), 1 minute (220/240 V version)

Environmental Conditions

Temperature	5 to 35 degrees C -operating -30 to 60 degrees C -in shipment container
Humidity	10 to 80 % RH -operating 5 to 85 % RH -storage
Resistance to Shock	1 G, within 1 ms -operating 2 G, within 1 ms -storage
Resistance to Vibration	0.25 G, 55 Hz max. -operating 0.50 G, 55 Hz max. -storage

Physical Specifications

Weight	7 Kg
Dimensions	390 mm (width) x 320 (depth) x 139 mm (height), excluding knobs and paper guides

1.2.2 Firmware Specifications (ESC/P)

Control Code	ESC/P™ level ESC/P-83 (EPSON Standard Code for Printers)
Printing Direction	Bidirectional (text) Bidirectional (bit-image) (when SW 2-6 is ON) Unidirectional (bit-image) (when SW 2-6 is OFF)
Input Data Buffer	8K bytes (when SW 2-5 is ON)* 1K byte (when SW 2-5 is OFF) *When DIP SW 2-5 is set on ON, downloading will be ignored.
Character Code	8 bits
Character Set	96 ASCII and 13 international character sets
Family	EPSON Roman (Family number: 0) EPSON Sans Serif (Family number: 1)
Fonts	EPSON Roman 10, EPSON Roman 12, EPSON Roman 15, EPSON Roman Proportional; EPSON Sans Serif 10, EPSON Sans Serif 12, EPSON Sans Serif 15, EPSON Sans Serif Proportional; EPSON Draft 10, EPSON Draft 12, EPSON Draft 15.
Printing Mode	Selection and mixture of the following modes are allowed, except 15 CPI Condensed Mode <ul style="list-style-type: none"> ● Printing quality (draft/letter quality) ● Character pitch (10, 12, 15, or proportional) ● Condensed ● Double-width <ul style="list-style-type: none"> ● Double-height ● Emphasized ● Double-strike ● Italic <ul style="list-style-type: none"> ● Underlined ● Outline ● Shadow
Printing Speed	See Table 1-5.
Printing Columns	See Table 1-5.
Character Matrix	See Table 1-6.
Character Size	See Table 1-6.

Table 1-5. Printing Mode

Print pitch	Condensed	Emphasized	Double width		Printable columns	Character pitch (cpi)	Printing speed (cps)	
							Draft	LQ
10	0	0	0		80	10	150	50
	0	0	1		40	5	75	25
	0	1	0		80	10	75	50
	0	1	1		40	5	37.5	25
	1	x	0		137	17.1	128.6	85.7
	1	x	1		58	8.5	64.3	42.9
12	0	0	0		96	12	180	60
	0	0	1		48	6	90	30
	0	1	0		96	12	90	60
	0	1	1		48	6	45	30
	1	x	0		160	20	150	100
	1	x	1		80	10	75	50
15	0	0	0		120	15	225	75
	0	0	1		120	15	112.5	37.5
	0	1	0		60	7.5	112.5	37.5
	0	1	1		60	7.5	112.5	75
	1	x	x		Cannot be condensed			
Proportional	0	x	0	max.	68	8.6	—	42.9
				min.	160	20	—	100
	0	x	1	max.	34	4.3	—	21.4
				min.	80	10	—	50
	1	x	0	max.	137	17.1	—	85.7
				min.	320	40	—	200
	1	x	1	max.	68	8.6	—	42.9
				min.	160	20	—	100
Proportional Super/ Subscript	0	x	0	max.	102	12.8	—	64.3
				min.	240	30	—	150
	0	x	1	max.	51	6.4	—	32.1
				min.	120	15	—	75
	1	x	0	max.	204	25.7	—	128.6
				min.	480	60	—	300
	1	x	1	max.	102	12.8	—	64.3
				min.	240	30	—	150

NOTES:

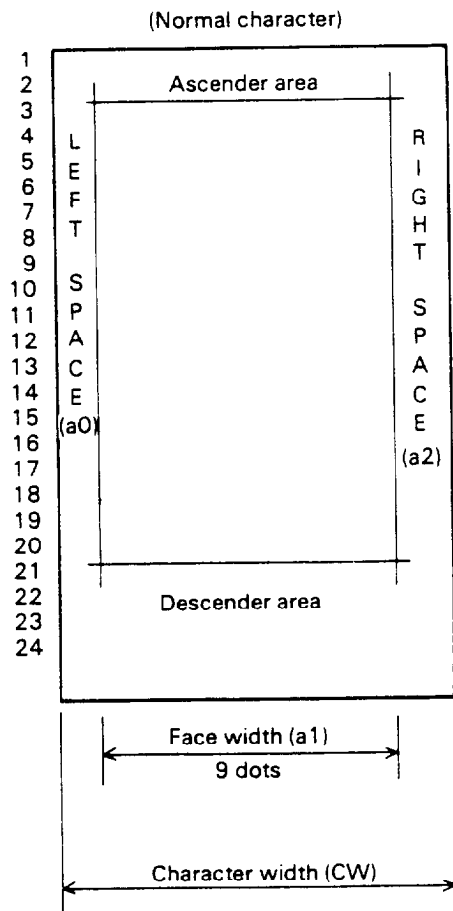
1. "Max." means the value when characters of the maximum width were printed.
2. "Min." means the value when characters of the minimum width were printed.
3. "-" means that "LQ" character set is automatically selected when proportional pitch is specified.

Table 1-6. Character Matrix and Character Size

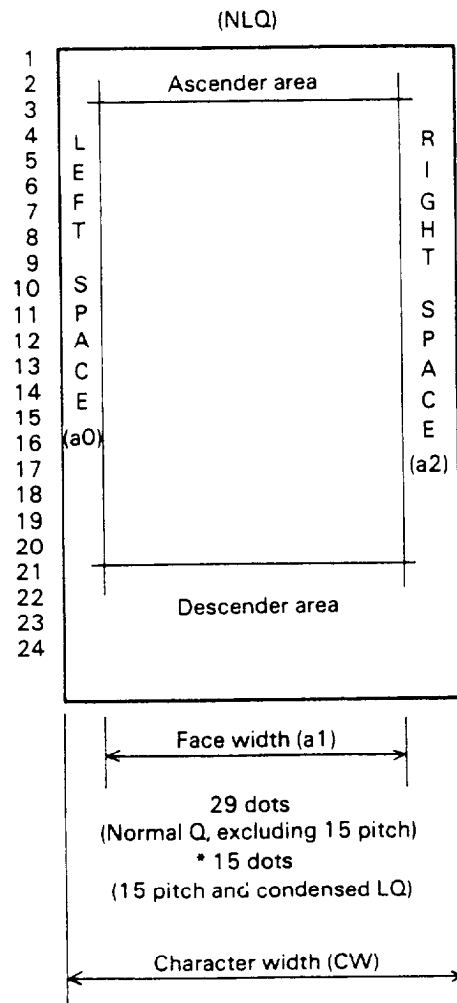
Printing mode	Face matrix	HDD	Character size H. × V. (mm)	Unit ESC sp
DARFT, 10 pitch	9 × 23	120	1.9 × 3.2	120
DRAFT, 12 pitch	9 × 23	120	1.9 × 3.2	120
DARFT, 15 pitch	9 × 16	120	1.0 × 2.3	120
DRAFT, 10 pitch, condensed	———	240	———	120
DRAFT, 12 pitch, condensed	———	240	———	120
LQ, 10 pitch	29 × 23	360	2.0 × 3.2	180
LQ, 12 pitch	29 × 23	360	2.0 × 3.2	180
LQ, 15 pitch	15 × 16	360	1.0 × 2.3	180
LQ, 10 pitch, condensed	———	360	———	180
LQ, 12 pitch, condensed	———	360	———	180
LQ, proportional	max. 39 × 23	360	2.6 × 3.2	180
	min. 18 × 23	360	1.0 × 3.2	
LQ, proportional, condensed	———	360	———	180
	———	360	———	
LQ, proportional, super/subscript	max. 28 × 16	360	1.8 × 2.3	180
	min. 12 × 16	360	0.7 × 2.3	
LQ, proportional, super/subscript, condensed	———	360	———	180
	———	360	———	

NOTES:

1. HDD is horizontal dot density in dots per inch.
2. Face matrix and character size indicate the size of the maximum character, and this value will be changed by differences in paper, ribbon, etc.
3. Unit ESC sp (which also can be sent as the unit followed by the character string CHR\$ (&h20)) indicates the minimum length to be added to the right of the character that can be specified with the ESC sp control code.
4. " " indicates that character matrix is reshaped by printer firmware. Character width becomes half of noncondensed character width.



12 dots (10 pitch) 120 DPI†
 15 dots (12 pitch) 180 DPI
 16 dots (15 pitch) 240 DPI
 14 dots (condensed 10 pitch) 240 DPI
 12 dots (condensed 12 pitch) 240 DPI



36 dots (10 pitch) 360 DPI
 30 dots (12 pitch) 360 DPI
 24 dots (15 pitch) 360 DPI
 21 dots (condensed 10 pitch) 360 DPI
 18 dots (condensed 12 pitch) 360 DPI

* 15 dots are made from 29 dots by printer firmware.

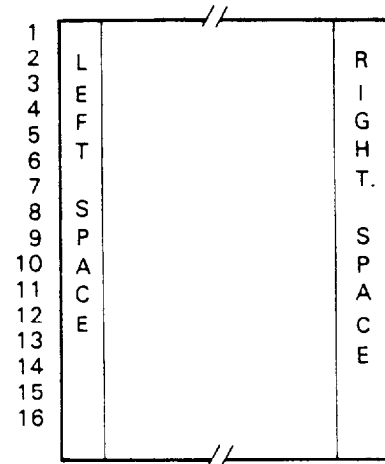
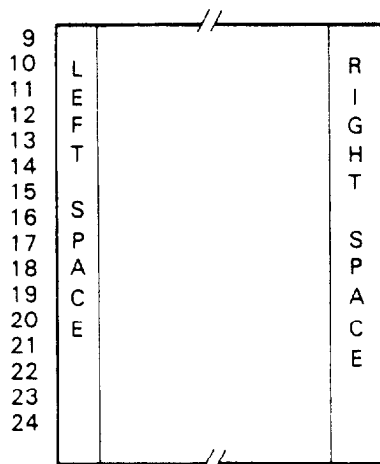


Figure 1-5. Character Matrix

1.3 INTERFACE OVERVIEW

The 8-bit parallel interface, provided standard with this printer, has the following specifications:

Data Format	8-bit parallel
Synchronization	By <u>STROBE</u> pulse
Handshaking	By <u>BUSY</u> and <u>ACKNLG</u> signal
Signal Level	TTL-compatible
Adaptable Connector	57-30360 (Amphenol) or equivalent
Data Transmission Timing	See Figure 1-6

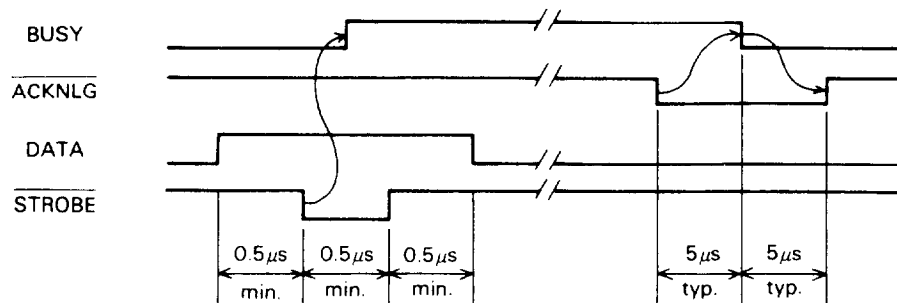


Figure 1-6. Data Transmission Timing

Table 1-7 shows the connector pin assignments and signal functions of the 8-bit parallel interface.

Table 1-7. Connector Pin Assignments and Signal Functions

Pin No.	Signal Name	Return Pin No.	Dir.	Functional Description
1	STROBE	19	In	Strobe pulse to read the input data. Pulse width must be more than 0.5 μ s. Input data is latched after falling edge of this signal.
2	DATA 1	20	In	Parallel input data to the printer. HIGH level means 1. LOW level means 0.
3	DATA 2	21	In	
4	DATA 3	22	In	
5	DATA 4	23	In	
6	DATA 5	24	In	
7	DATA 6	25	In	
8	DATA 7	26	In	
9	DATA 8	27	In	
10	ACKNLG	28	Out	This pulse indicates data has been received and the printer is ready to accept more data. Pulse width is approximately 11 μ s.
11	BUSY	29	Out	HIGH indicates printer cannot accept more data.

Table 1-7. Connector Pin Assignments and Signal Functions (Cont.)

Pin No.	Signal Name	Return Pin No.	Dir.	Functional Description
12	PE	30	Out	HIGH indicates paper-out. This signal is effective only when <u>ERROR</u> signal is LOW.
13	SLCT	—	Out	Always HIGH output. (Pulled up to +5 V through 3.3 k Ω register.)
14	AUTOFEED-XT	—	In	If the signal is LOW when the printer is initialized, a line feed is automatically performed upon receipt of CR code (Auto LF).
15	—	—	—	Not used.
16	GND	—	—	Ground for twisted-pair grounding.
17	Chassis GND	—	—	Chassis ground level of printer.
18	—	—	—	Not used.
19 to 30	GND	—	—	Ground for twisted-pair grounding.
31	INIT	16	In	Pulse (Width: 50 μ s min., active LOW) input for printer initialization.
32	ERROR		Out	LOW indicates that some error has occurred in the printer.
33	GND	—	—	Ground for twisted-pair grounding.
34	—	—	—	Not used.
35	—	—	Out	Always HIGH. (Pulled up to +5 V through a 3.3 k Ω register.)
36	SLCT-IN	—	In	If the signal is LOW when printer is initialized, the DC1/DC3 control is disabled.

NOTES:

1. "Dir." refers to the direction of the signal flow as viewed from the printer.
2. "Return" denotes a twisted-pair return line.
3. The cable used must be shielded to prevent noise.
4. All interface conditions are based on TTL levels. Both the rise and fall times of all signals must be less than 0.2 μ s.
5. The AUTO FEED-XT signal can be set at LOW by DIP switch 2-4.
6. The SELECT-IN signal can be set at LOW by jumper 6.
7. Printing tests, including those of the interface circuits, can be performed without using external equipment by setting DATA 1-8 of the interface connector to certain codes and connecting the ACKNLG signal to the STROBE signal.

Table 1-8 shows the printer select/deselect (DC1 /DC3) control, including relations among ON-LINE, SELECT-IN input, DC1 /DC3, and interface signals.

Table 1-8. Printer Select/Deselect Control

ON-LINE SW	SLCT-IN	DC1/DC3	ERROR	BUSY	ACKNLG	DATA ENTRY
OFF-LINE	HIGH/LOW	DC1/DC3	LOW	HIGH	No pulse	Disable
ON-LINE	HIGH	DC1	HIGH	LOW/HIGH (During data entry)	Pulse output after entry	Enable (Normal Process)
		DC3	HIGH	LOW/HIGH (During data entry)	Pulse output after entry	Enable (Waits DC1. See Note 2)
	LOW	DC1	HIGH	LOW/HIGH (During data entry)	Pulse output after entry	Enable (Normal Process)
		DC3	HIGH	LOW/HIGH (During data entry)	Pulse output after entry	

NOTES:

1. In Table 1-8, it is assumed that no ERROR status exists other than that attributable to OFF-LINE mode.
2. Once the printer is deselected by the DC3 code, the printer will not revert to the selected state unless the DC1 code is input again. (In the deselected state, the printer ignores input data until the DC1 code is received.)
3. The DC1 and DC3 codes are enabled only when the SLCT-IN signal (Input Connector 36 for the parallel interface unit) is HIGH and printer power is initialized.
4. If the SLCT-IN signal is LOW when the printer is initialized, DC1 /DC3 printer select/deselect control is invalidated, and these control codes are ignored.
5. If the SLCT-IN signal is HIGH and is not set to LOW by jumper 6 when printer initialized, the printer starts from the selected (DC1) state.

1.4 DIP SWITCHES AND JUMPER SETTING

This section describes the DIP switch selections and the jumper setting for the LQ-500/L-1000 printer.

1.4.1 DIP Switch Settings

The two **DIP** switches for the printer are located inside the ROM cartridge slot cover and function **as** shown in Tables 1-9 through 1-13. (Note that the status of the DIP switches is read only at power on or upon receipt of the INIT signal.)

Table 1-9. Settings for DIP Switch 1 (SW1)

No.	Description	ON	OFF
1 2 3	International character set selection	See Table 1-11 below.	
4 5	Font selection	See Table 1-12 below.	
6 7 8	Condensed printing Code table selection Cut-sheet feeder (CSF) mode	On Graphic On	Off Italic Off

Table 1-10. Settings for DIP Switch 2 (SW2)

No.	Description	ON	OFF
1 2	Page length CSF page length	12 in. 65 lines (A4)	11 in. 61 lines (letter)
3 4	1-inch skip Auto LF	On On	Off Off
5 6	Input data buffer Print direction of graphics	8 KB Bidirect.*	1 KB Unidirect.
7 8	Character pitch selection	See Table 1-13 below.	

* Unidirectional printing is selected by default, however input of ESC U O can be used to set the print direction to Bidirectional.

Table 1-11. International Character Set Selection

1-1	1-2	1-3	Country	1-1	1-2	1-3	Country
On	On	On	U.S.	Off	On	On	Denmark 1
On	On	Off	France	Off	On	Off	Sweden
On	Off	On	Germany	Off	Off	On	Italy
On	Off	Off	U.K.	Off	Off	Off	Spain 1

Table 1-12. Font Selection

1-4	1-5	Font
Off	Off	Roman
On	Off	Sans Serif
Off	On	Slot
On	On	Draft

Table 1-13. Character Pitch Selection

2-7	2-8	Character Pitch
Off	Off	10 CPI
On	Off	12 CPI
Off	On	15 CPI
On	On	Proportional

1.4.2 Jumper Setting

Jumper 6, which is user-selectable, is located inside the ROM cartridge slot cover. If the jumper is connected, the SLCT-IN signal is fixed to LOW, and DC1 /DC3 printer select control is ignored.

1.5 SELECTYPE FUNCTION

Selectype allows the user to choose fonts easily while the printer is ON-LINE. This function provides for selection of Draft, Roman, Sans Serif, or the slot (ROM cartridge) font. SelecType is effective only when the printer is ON-LINE and is not printing. Font selection is performed by pressing the FORM-FEED switch with the printer ON-LINE and not printing. The printer's control panel indicates which font has been specified.

1.6 OPERATING INSTRUCTIONS

This section describes the self-test and hexadecimal dump functions and also includes the error states, printer initialization, and the buzzer operation.

1.6.1 Self-Test

To begin printing the self-test using Draft mode, turn the printer ON while pressing the LINE-FEED button. To begin printing the self-test using the Letter Quality (LQ) mode, turn the printer power ON while pressing FORM-FEED.

Self-test printing can be stopped or started by pressing ON-LINE (ON-LINE indicator is not lit). To finish the self-test, stop the printing by pressing the ON-LINE switch and turn OFF the printer power.

The firmware revision number is printed as the first line of the self-test, and subsequently, current DIP switch settings are printed.

xxxxxx

Country	SW1-1	1-2	1-3	Page length	SW2-1
USA	on	on	on	11"	off
France	on	on	off	12"	on
Germany	on	off	on	CSF page length	SW2-2
U.K.	on	off	off	61 Lines	off
Denmark	off	on	on	65 Lines	on
Sweden	off	on	off	1"Skip	SW2-3
Italy	off	off	on	Invalid	off
Spain	off	off	off	Valid	on
Font	SW1-4	1-5		Auto LF	SW2-4
Roman	off	off		Invalid	off
Sans serif	on	off		Valid	on
Slot	off	on		Receive buffer	SW2-5
Draft	on	on		1kbytes	off
Condensed	SW1-6			8kbytes	on
Invalid	off			Graphics print	SW2-6
Valid	on			Uni-d	off
CG table	SW1-7			Bi-d	on
Italic	off			Pitch	SW2-7 2-8
Graphic	on			10 pitch	off off
CSF mode	SW1-8			12 pitch	on off
Invalid	off			15 pitch	off on
Valid	on			Proportional	on on

Roman 10

```
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`'abc
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`'abcd
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`'abcde
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`'abcdef
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`'abcdefg
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`'abcdefgh
```

Figure 1-7. Self-Test Printout

1.6.2 Hexadecimal Dump Function

The printer enters HEX-DUMP mode when it is powered on while the LINE-FEED and FORM-FEED buttons are pressed down. In HEX-DUMP mode, the hexadecimal representation of the input data is printed out, along with corresponding ASCII characters. This function is valuable for checking the data the printer has received from the host. If input data is a control code rather than a character code, a period (.) is printed in the ASCII column.

Data Dump Mode

0D 43 41 50 54 45 52 20 31 0D 0A 47 45 4E 45 52	.CAPTER 1..GENER
41 4C 20 44 45 53 43 52 49 50 54 49 4F 4E 0D 0A	AL DESCRIPTION..
0D 0A 31 2E 31 20 46 45 41 54 55 52 45 0D 0A 31	..1.1 FEATURE..1
2E 32 20 53 50 45 43 49 46 49 43 41 54 49 4F 4E	.2 SPECIFICATION
53 0D 0A 20 20 20 20 31 2E 32 2E 31 20 48 61 72	S.. 1.2.1 Har
64 77 61 72 65 20 53 70 65 63 69 66 69 63 61 74	dware Specificat
69 6F 6E 73 0D 0A 20 20 20 20 31 2E 32 2E 32 20	ions.. 1.2.2
46 69 72 6D 77 61 72 65 20 53 70 65 63 69 66 69	Firmware Specifi
63 61 74 69 6F 6E 73 20 28 45 53 43 2F 50 29 0D	cations (ESC/P).
0A 31 2E 33 20 49 4E 54 45 52 46 41 43 45 20 4F	.1.3 INTERFACE O
56 45 52 56 49 45 57 0D 0A 31 2E 34 20 44 49 50	VERVIEW..1.4 DIP
20 53 57 49 54 43 48 45 53 20 41 4E 44 20 4A 55	SWITCHES AND JU
4D 50 45 52 20 53 45 54 54 49 4E 47 0D 0A 20 20	MPER SETTING..
20 20 31 2E 34 2E 31 20 44 49 50 20 53 77 69 74	1.4.1 DIP Swit
63 68 20 53 65 74 74 69 6E 67 73 0D 0A 20 20 20	ch Settings..
20 31 2E 34 2E 32 20 4A 75 6D 70 65 72 20 53 65	1.4.2 Jumper Se
74 74 69 6E 67 0D 0A 31 2E 35 20 53 45 4C 45 43	tting..1.5 SELEC
54 59 50 45 20 46 55 4E 43 54 49 4F 4E 0D 0A 31	TYPE FUNCTION..1
2E 36 20 4F 50 45 52 41 54 49 4E 47 20 49 4E 53	.6 OPERATING INS
54 52 55 43 54 49 4F 4E 53 0D 0A 20 20 20 20 31	TRUCTIONS.. 1
2E 36 2E 31 20 53 65 6C 66 2D 54 65 73 74 20 0D	.6.1 Self-Test .
0A 20 20 20 20 31 2E 36 2E 32 20 48 65 78 61 64	. 1.6.2 Hexad
65 63 69 6D 61 6C 20 44 75 6D 70 20 46 75 6E 63	ecimal Dump Func
74 69 6F 6E 0D 0A 20 20 20 20 31 2E 36 2E 33 20	tion.. 1.6.3
42 69 74 2D 49 6D 61 67 65 20 50 72 69 6E 74 69	Bit-Image Printi
6E 67 0D 0A 20 20 20 20 31 2E 36 2E 34 20 45 72	ng.. 1.6.4 Er
72 6F 72 20 43 6F 6E 64 69 74 69 6F 6E 73 0D 0A	ror Conditions..
20 20 20 20 31 2E 36 2E 35 20 42 75 7A 7A 65 72	1.6.5 Buzzer
20 4F 70 65 72 61 74 69 6F 6E 0D 0A 20 20 20 20	Operation..
31 2E 36 2E 36 20 50 72 69 6E 74 65 72 20 49 6E	1.6.6 Printer In
69 74 69 61 6C 69 7A 61 74 69 6F 6E 0D 0A 20 20	itialization..
20 20 31 2E 36 2E 37 20 44 65 66 61 75 6C 74 20	1.6.7 Default
56 61 6C 75 65 73 0D 0A 20 20 20 20 31 2E 36 2E	Values.. 1.6.
38 20 41 64 6A 75 73 74 20 4C 65 76 65 72 20 4F	8 Adjust Lever O
70 65 72 61 74 69 6F 6E 0D 0A 20 20 20 20 31 2E	peration.. 1.
36 2E 39 20 50 72 69 6E 74 65 72 20 50 72 6F 74	6.9 Printer Prot
65 63 74 69 6F 6E 20 66 6F 72 20 48 65 61 76 79	ection for Heavy
2D 44 75 74 79 20 50 72 69 6E 74 69 6E 67 0D 0A	-Duty Printing..
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42 4D 41 20 42 6F 61 72 64 0D 0A 20 20 20 20 31	BMA Board.. 1
2E 37 2E 32 20 50 45 42 50 4E 4C 20 42 6F 61 72	.7.2 PE8PNL Boar
64 0D 0A 20 20 20 20 31 2E 37 2E 33 20 50 45 42	d.. 1.7.3 PCB
46 49 4C 20 42 6F 61 72 64 0D 0A 20 20 20 20 31	FIL Board.. 1
2E 37 2E 34 20 54 72 61 6E 73 66 6F 72 6D 65 72	.7.4 Transformer
0D 0A 20 20 20 20 31 2E 37 2E 35 20 50 72 69 6E	.. 1.7.5 Prin
74 65 72 20 4D 65 63 68 61 6E 69 73 6D 20 28 4D	ter Mechanism (M
2D 35 34 31 30 29 0D 0A 20 20 20 20 31 2E 37 2E	-5410).. 1.7.
36 20 48 6F 75 73 69 6E 67 0D 0A 0D 0A 0D 0A 31	6 Housing.....1
2E 31 20 46 45 41 54 55 52 45 53 0D 0A 0D 0A 54	.1 FEATURES....T
68 65 20 50 65 62 62 6C 65 73 20 20 69 73 20 61	he Pebbles is a
20 73 6D 61 6C 6C 2C 20 6C 69 67 68 74 2D 77 65	small, light-we

Figure 1-8. Hexadecimal Dump Function

1.6.3 Bit-Image Printing

This printer has four standard print densities, listed below in dots per inch (dpi):

- 120 dpi (including half dots): Triple speed
- 180 dpi (including half dots): Double speed
- 240 dpi (including half dots): 1.5 speed
- 360 dpi (including half dots): Normal speed

The firmware, however, implements the print densities as shown in Table 1-14

Table 1-14. Print Density

Pins	m	Bit-image printing mode	Dot density (dpi)	Adjacent dot printing	$256 \times n2 + n1$	Print speed (ips)
8	0	Single-density	60	yes	480	15
8	1	Dual-density	120	yes	960	7.5
8	2	Double-speed, dual-density	120	no	960	15
8	3	Quadruple-density	240	no	1920	7.5
8	4	CRT graphics	80	yes	640	7.5
8	6	CRT graphics II	90	yes	720	10
24	32	Single-density	60	yes	480	15
24	33	Dual-density	120	yes	960	7.5
24	38	CRT graphics II	90	yes	720	10
24	39	Triple-density	180	yes	1440	5
24	40	Hex-density	360	no	2880	5

NOTES: ESC* m n1 n2 [DATA] n2 x 256 + n1

dpi = dots per inch

ips = inches per second

The firmware handles the print densities as shown in Table 1-15.

Table 1-15. Bit-Image Printing

Dot Density	Printing Method
80 dpi	Prints at 240 dpi by expanding bit image by nine: $80 \times 3 = 240$

1.6.4 Error Conditions

If any of the following error conditions is detected, the printer automatically enters OFF-LINE mode.

- Home position is not detected at printer mechanism initialization.
- Home position is detected during printing.
- ON-LINE is pressed, and the printer enters OFF-LINE.
- A paper-out signal is detected and forms-override is finished.
- Paper out is detected after the printer performs a paper-loading operation with the cut-sheet feeder enabled.

The following interface signals are output to indicate the error and to halt data transmission:

BUSY signal becomes HIGH.

ERROR becomes LOW.

No ACKNLG pulse is sent.

1.6.5 Buzzer Operation

The buzzer sounds under the following circumstances:

- When the BEL code is sent to the printer (0.5-second ring).
- When a paper-out error is detected, the buzzer sounds 3 times (rings for 0.1 second with a 0.1-second interval).
- When abnormal carriage movement is detected, the buzzer sounds 5 times (rings for 0.5 second, with a 0.5-second interval).
- When a panel setting is accepted (0.1-second ring).

1.6.6 Printer Initialization

There are two initialization methods: hardware initialization and software initialization.

Hardware Initialization

This type of initialization takes place when the printer power switch is turned ON (and the AC power cord is plugged in) or when the INIT signal is received over the parallel interface line.

When the printer is initialized, it performs the following actions:

- (a) Initializes printer mechanism.
- (b) Clears input data buffer.
- (c) Clears downloaded character set.
- (d) Clears the print buffer.
- (e) Returns printer settings to their default values.

Software Initialization

This type of initialization takes place when the printer receives the software initialize code. Upon receipt of this code, the printer does not perform the functions listed above under (a), (b), and (c). The settings changed by the last SelectType operation are reset.

1.6.7 Default Values

When the printer is initialized, the following default values or functions are set:

Page Position	Current paper position becomes top-of-form position
Left and Right Margins	Released
Line Spacing	116 inch
Vertical Tabs	Cleared
Horizontal Tabs	Every 8 characters (relative)
VFH Channel	Channel 0
Category of Type Style	SelecType - Software initialization DIP switch - Hardware initialization
Downloaded Characters	Deselected - Software initialization Cleared - Hardware initialization
Justification	Left justification
Character Spacing	10 CPI
Bit-Image Mode Assignment	ESC K = ESC + 0, ESC L = ESC * 1 ESC Y = ESC * 2, ESC Z = ESC * 3
Printing Effects	Cleared

1.6.8 Adjust Lever Operation

The head adjust lever must be set to the proper position according to the paper thickness. See Table 1-16 and Figure 1-9.

Table 1-16. Lever Position Operation

Paper Type	Lever Position
Ordinary (single sheets or continuous)	2
Thin paper	2 or 1
Multi-part paper	
2 sheets	3
3 sheets	4

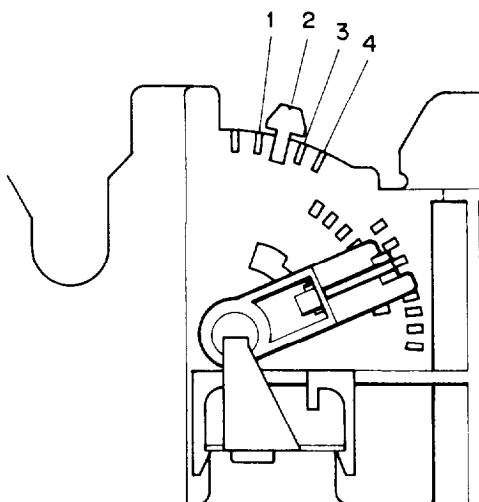


Figure 1-9. Lever Position

1.6.9 Printer Protection for Heavy-Duty Printing

This printer has “printhead protection” to safeguard the printhead from overheating or from voltage dropping to the head driver.

If head temperature exceeds upper limit value, then printing is automatically stopped until head temperature has dropped to a certain value to resume printing.

If heavy-duty printing causes the voltage supplied to the head drive circuit to drop to the lower limit, then printing is interrupted immediately, and thereafter, if power supply voltage is recovered to a certain value, then the remaining print line will be printed. This protection will occur when half or more of the wires are activated simultaneously and continuously.

1.7 MAIN COMPONENTS

The main components of the LQ-500/L-1000 printer are designed for easy removal and replacement to maintain/repair the printer. The main components are:

- 1) **PBMA board:** The main control board; the CPU on this board controls all main functions
- 2) **PEBPNL board:** The control panel board.
- 3) **PEBFIL board:** The filter circuit board.
- 4) **Transformer**
- 5) **M-5410:** The printer mechanism.

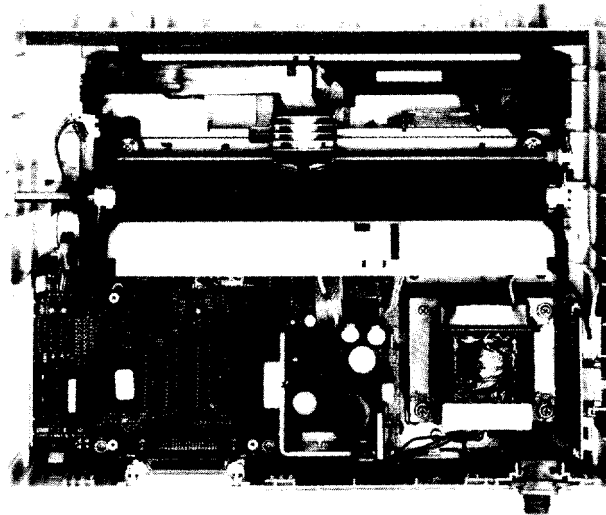


Figure 1-10. LQ-500/L-1000 Component Layout

1.7.1 PBMA Board

The use of the μ PD7810HG CPU makes the main control board simple in its circuit design.

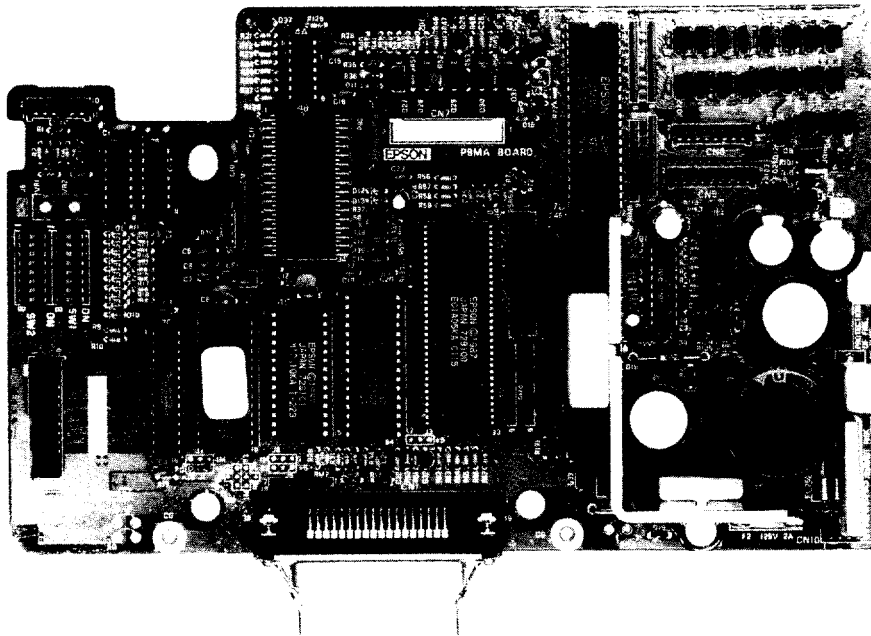


Figure 1-11. PBMA Main Control Board

1.7.2 PEBPNL Board

The PEBPNL board is the LQ-500/L-1000 control panel, which contains the indicator LEDs, switches, and buzzer.

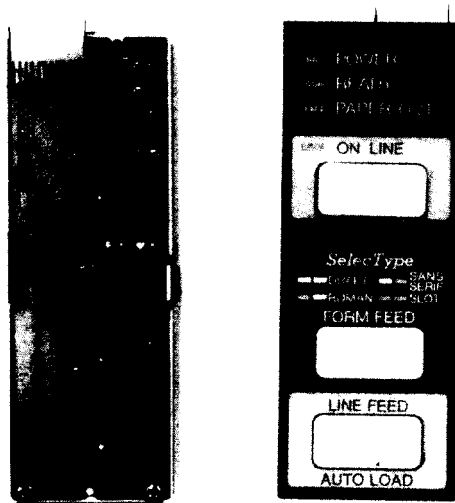
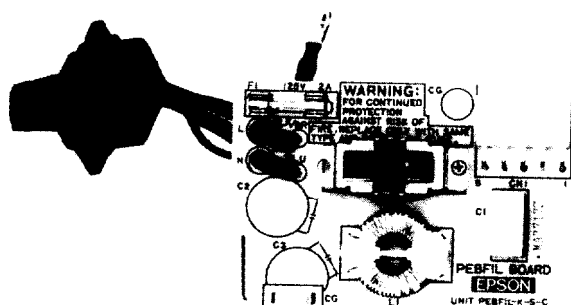


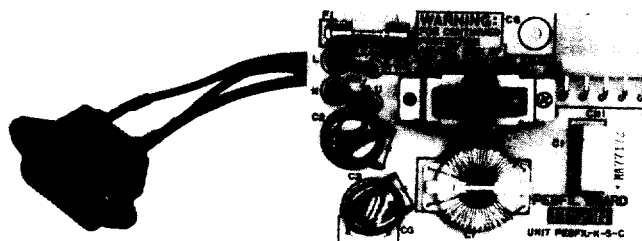
Figure 1-12. PEBPNL Control Panel Board

1.7.3 PEBFIL Board

The PEBFIL board eliminates noise from the AC line to the printer and from the printer to the outer line. The fuse used on this board prevents overheating.



(120 V Version)



(220/240 V Version)

Figure 1-13. PEBFIL Filter Board

1.7.4 Transformer

This transformer changes the input AC from the filter circuit into 26 VAC and 12 VAC in order to supply the necessary voltages to the control circuit board.

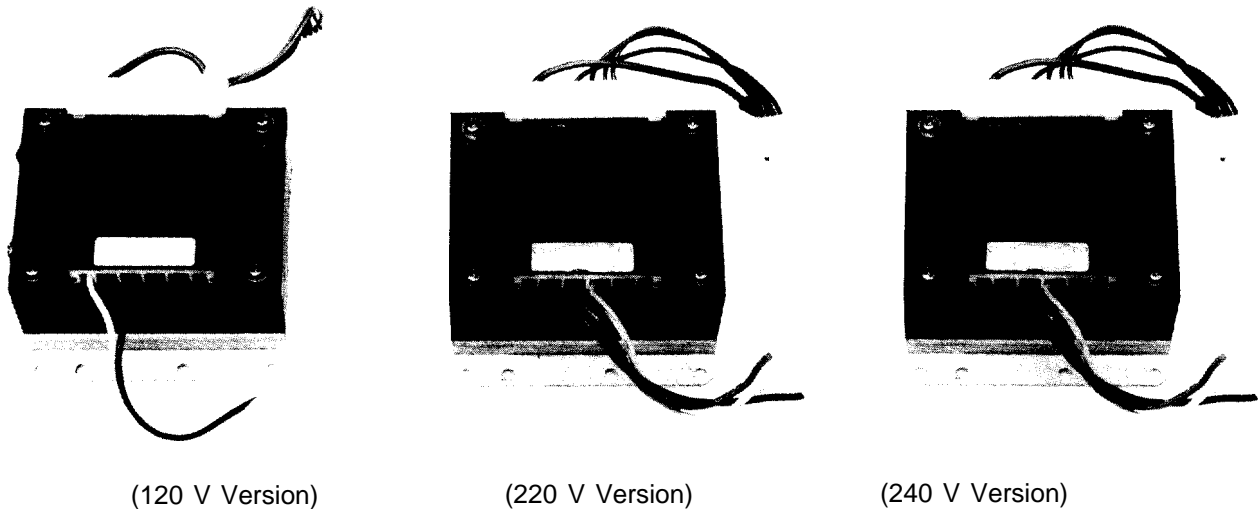


Figure 1-14. Transformer

1.7.5 Printer Mechanism (M-5410)

The M-5410 printer mechanism was developed expressly for use with LQ-500/L-1000 printer: the components include a carriage motor, carriage mechanism, paper-feed motor, paper-feed mechanism, ribbon-feed mechanism, printhead, and sensors.

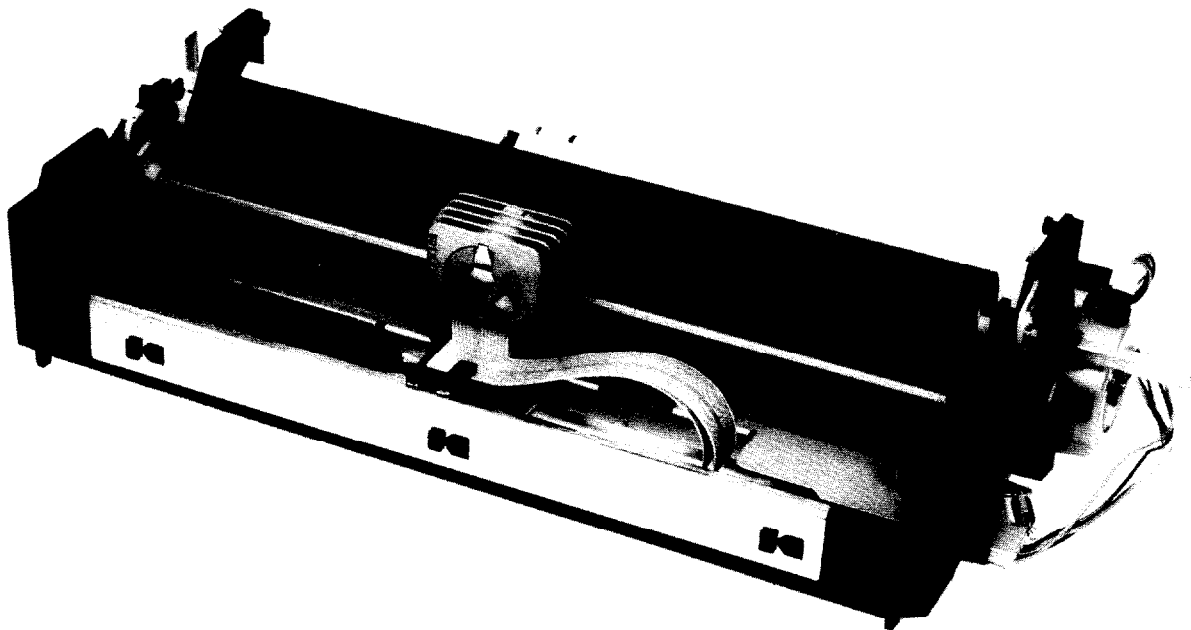


Figure 1-15. Model 5410 Printer Mechanism

1.7.6 Housing

LQ-500/L-1000 housing consists of the upper and lower cases. The upper case houses the control panel. The lower case contains the printer mechanism and the main control board. The printer cartridge is easily removable and can be replaced simply by lifting the upper case.

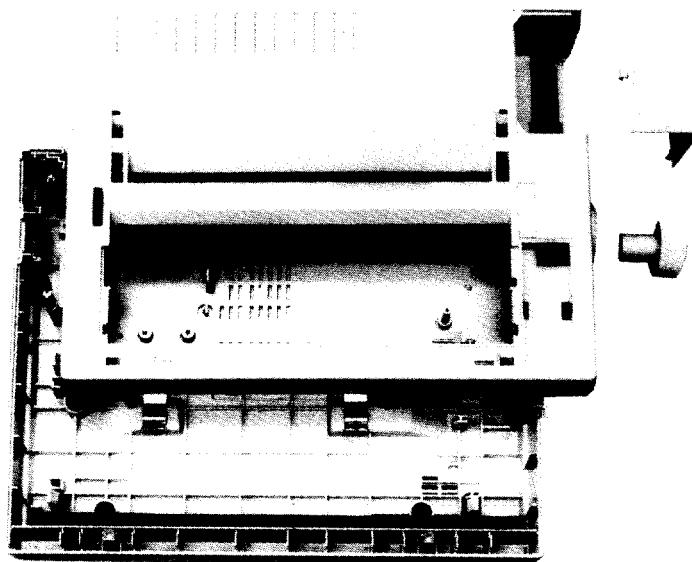


Figure 1-16. Housing

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2.1 OVERVIEW

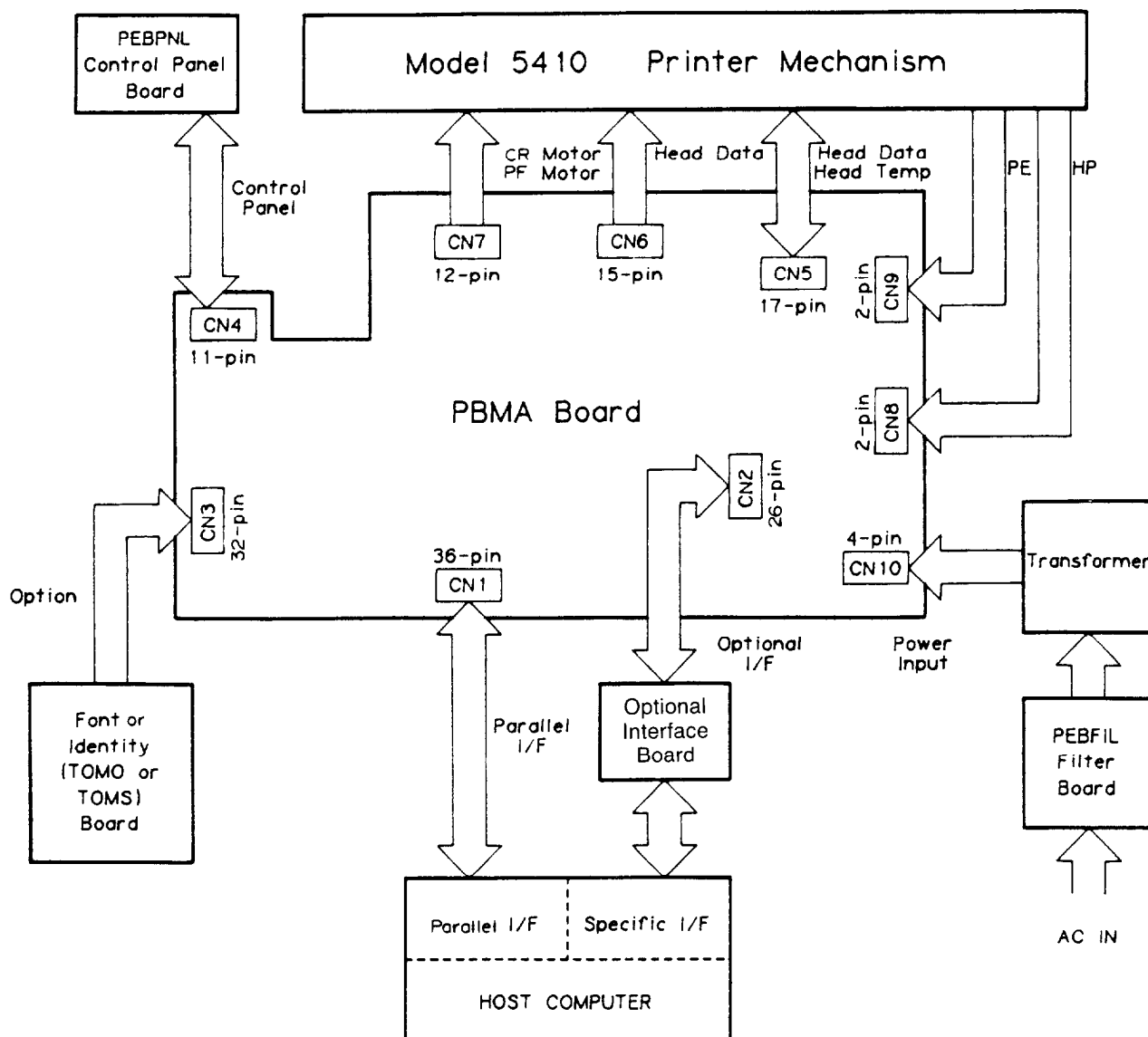
This chapter describes the signals at the various connectors that link the primary Components of the LQ-500/L-1000, including the printer mechanism, power supply circuits, and control circuits. The chapter also describes the operation of the printer's circuitry and printer mechanism.

2.1.1 Summary of Connectors

The interconnection of the primary components is shown in Figure 2-1. Table 2-1 summarizes the function, size, and type of the connectors designated in the figure.

Table 2-1. Board Connector Summary

Board	Connector	Function	Pins	Reference Table
PBMA Board	CN1	Host I/F (Parallel)	36	1 – 7
	CN2	Optional I/F Board	26	A – 8
	CN3	Font Module or Identity Module	32	A – 9
	CN4	Control Panel	11	A – 10
	CN5	Head 1	17	A – 11
	CN6	Head 2	15	A – 12
	CN7	CR Motor and PF Motor	12	A – 13
	CN8	HP Signal	2	A – 14
	CN9	PE Signal	2	A – 15
	CN10	AC Power Input	4	A – 16
PEBFIL Board	CN1	AC Power Output	2 or 3	—
PEBPNL Board	CN1	Control Panel	11	A – 10
TOMS Board	CN1	Font Module	32	A – 9
TOMO Board	CN1	Identity Module	32	A – 9

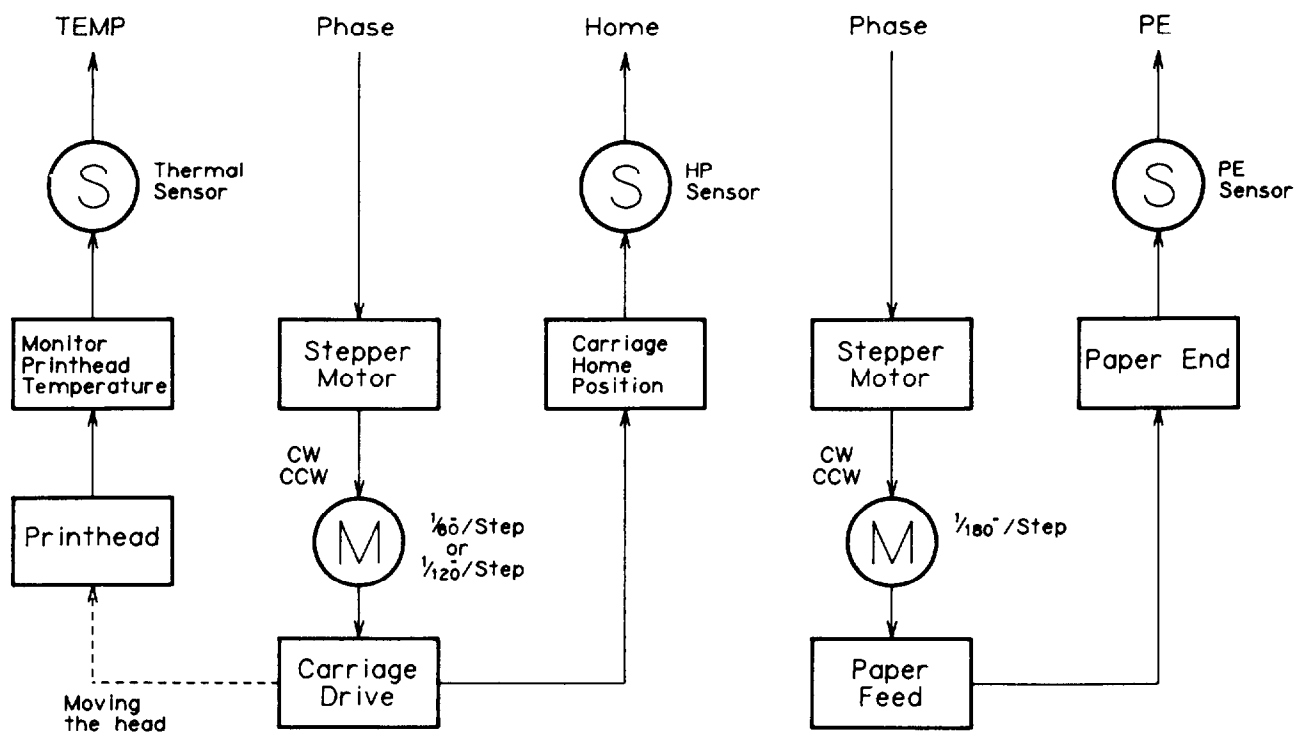


NOTE: CR = carriage.
 PF = paper feed.
 HP = home position.

Figure 2-1. Cable Connections

2.1.2 Overview of Printer Mechanism Operation

The Model 5410 printer mechanism is a serial, impact, dot-matrix printer that prints at 180 dots per inch (DPI) in both the horizontal and vertical directions. Figure 2-2 shows a block diagram of the Model 5410 printer mechanism.



NOTE: CW = clockwise; CCW = counterclockwise.

HP = home position.

PE = paper end.

Figure 2-2. Printer Mechanism Block Diagram

2.1.2.1 Sensors

The printer mechanism is equipped with the following sensors:

- Paper-End (PE) Sensor
- Home-Position (HP) Sensor
- Thermal Sensor (Printhead Temperature)

Paper-End Sensor (PE Sensor)

Figure 2-3 shows the paper-end sensor. This sensor switch is ON when paper runs out.

Paper-out state → ON → LOW level

Paper present → OFF → HIGH level

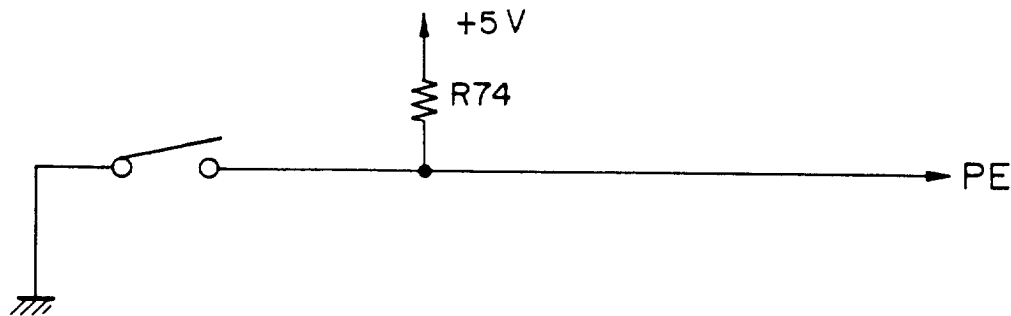


Figure 2-3. Paper-End Sensor

Home-Position Sensor (HP Sensor)

Figure 2-4 shows the home-position sensor. This sensor switch is ON when the carriage is at the home position.

Home position → ON → LOW level

Other position → OFF → HIGH level

The reference position for the carriage driver is determined by this sensor.

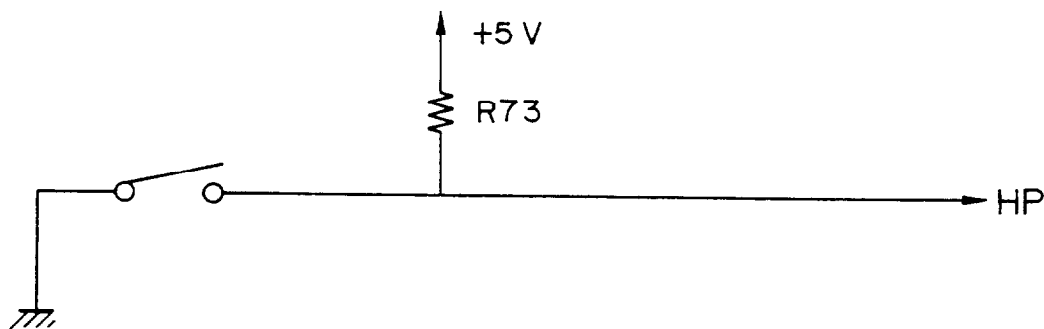


Figure 2-4. Home-Position Sensor

Thermal Sensor (Printhead Temperature Detection)

The thermal sensor in the printhead monitors printhead temperature. If head temperature exceeds the upper limit value, then printing is automatically stopped until head temperature drops to a certain value before resuming printing.

Figure 2-5 below illustrates the printer's thermal-sensor circuit.

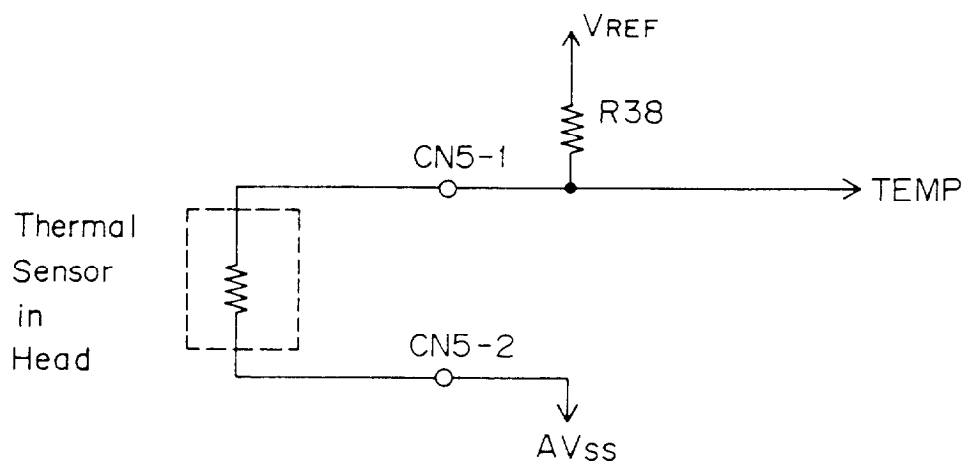


Figure 2-5. Thermal Sensor (Printhead Temperature Detection)

2.1.2.2 Motors

This printer has the following motors:

- Carriage motor (stepper motor)
- Paper-feed motor (stepper motor)

Carriage Motor

The carriage motor is used to move the carriage right and left along the platen. This unit employs a 4-phase, 48-step motor using either 1-2 or 2-2 phase excitation and is controlled by an open-loop system.

Paper-Feed Motor

Paper feeding is carried out by a 4-phase, 48-step motor. This unit is designed to advance the paper 1/180 inch for each step (phase switch), using 2-2 phase excitation. The motor is controlled by the CPU in an open-loop configuration.

2.1.2.3 Printhead

Figure 2-6 shows the dot-wire operation. The head-driving coil is energized, so that the dot wire is pushed out. The dot wire strikes the ribbon against the paper, printing a dot.

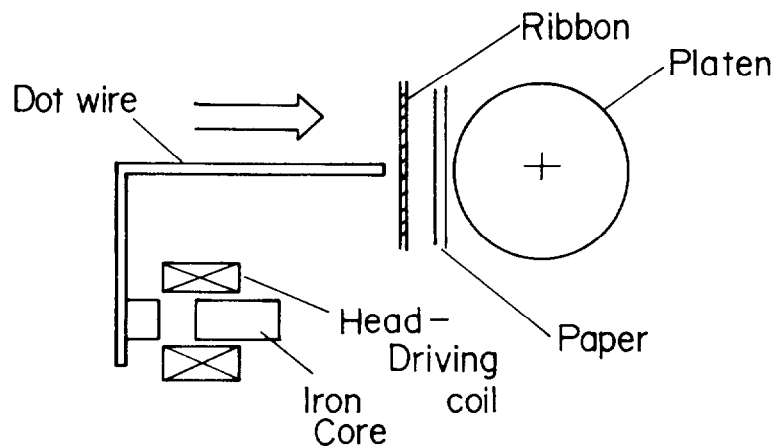
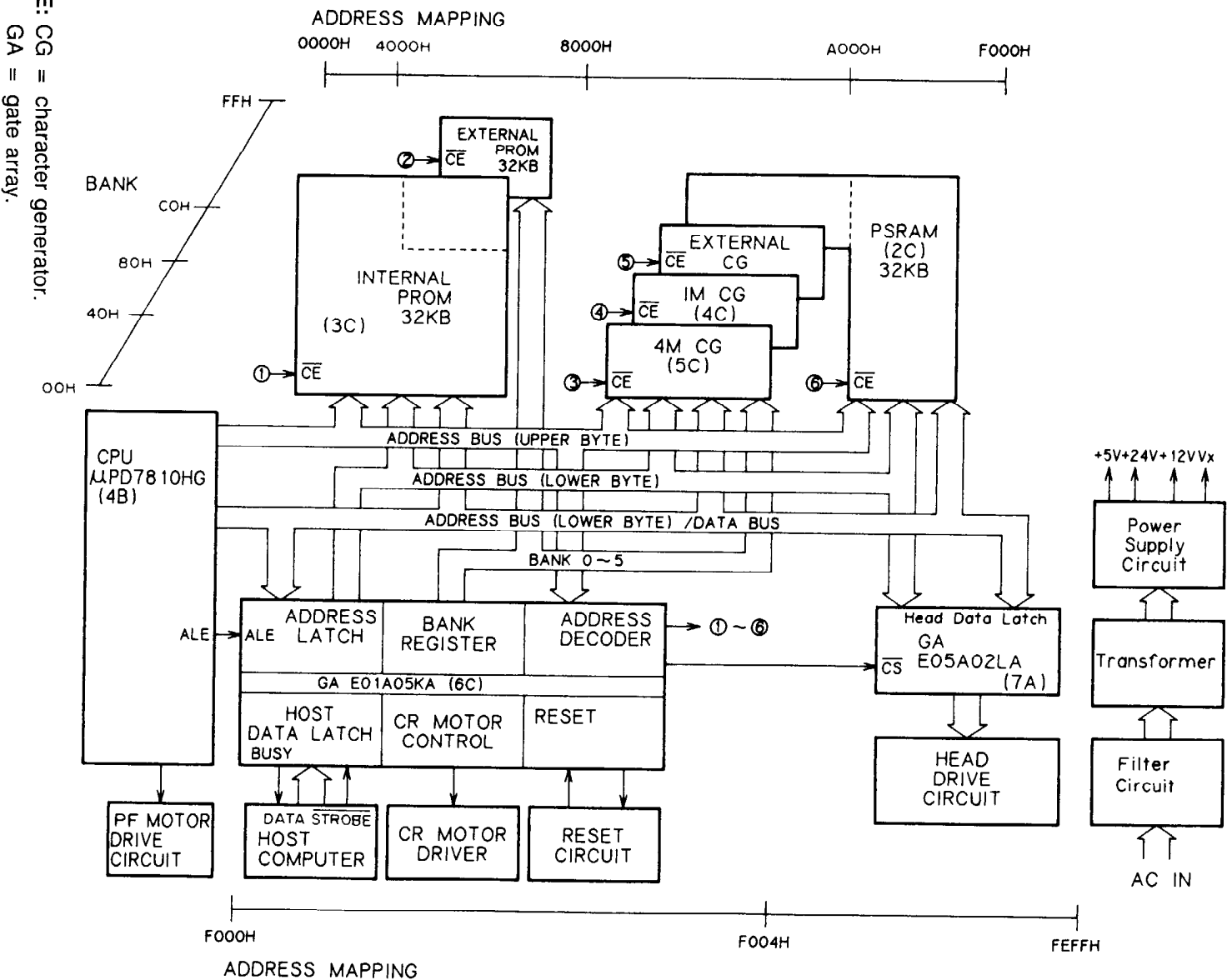


Figure 2-6. Printhead

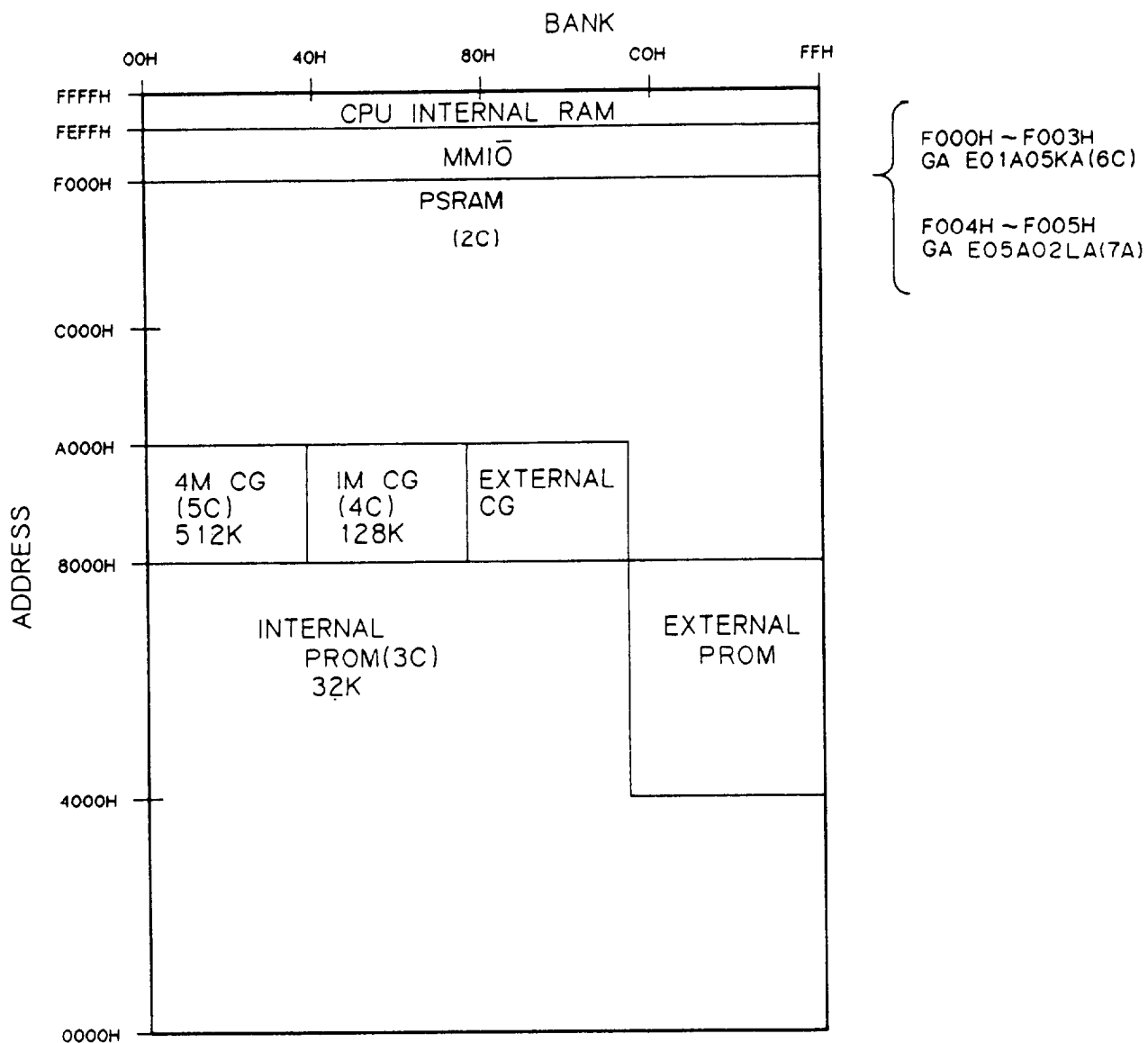
2.1.3 Overview of Circuitry

Figure 2-7 shows a block diagram of the circuitry.



2.1.4 Firmware Overview

This printer has a μ PD7810HG **CPU** with 64K bytes of address space. Figure 2-8 shows a memory map of this address space.



NOTE: **CG** = character generator.
GA = gate array.

Figure 2-8. Memory Map (64K Bytes)

2.2 PRINCIPLES OF OPERATION

This section describes the operation of each component.

2.2.1 Power Supply Circuit

The paragraphs below provide details of power supply circuit operations.

2.2.1.1 Power Supply Circuit Block Diagram

120/220/240 VAC are applied to the step-down transformer via the filter circuit to create 26 VAC and 12 VAC, which are then input to the power supply circuit on the main board. The 26 VAC are converted into about 36 VDC via the full-wave rectifier and smoothing circuit, and input to the regulator circuits for + 24 VDC and + 5 VDC to be supplied to the control circuit. The + 24 VDC and + 5 VDC are also supplied to the Vx voltage circuit and, while generating the Vx voltage, transferred to the control circuit.

The 12 VAC supplies a nonstabilized + 12 V to the control circuit via the positive terminal of the half-wave rectifier and smoothing circuit.

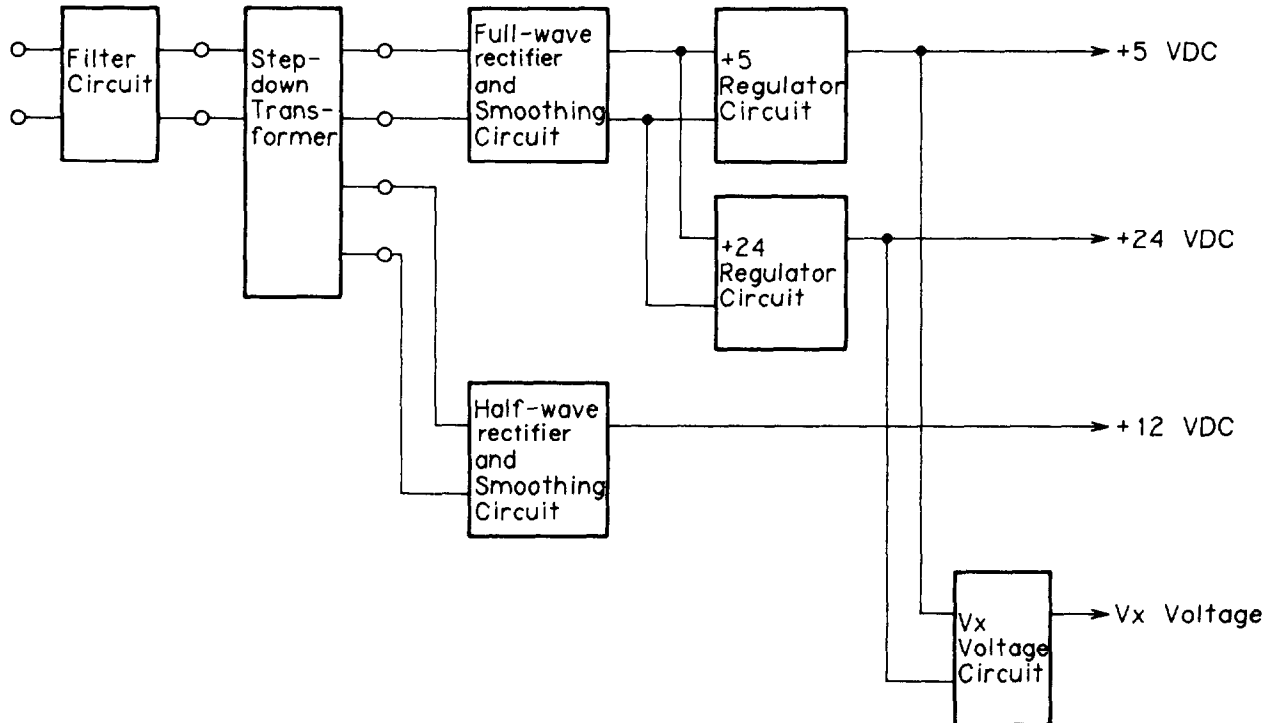


Figure 2-9. Power Supply Circuit Block Diagram

Table 2-2. Power Supply Applications

Voltage	Application
+5 V	Logic circuit, etc.
+24 V	Carriage motor drive voltage Paper-feed motor drive voltage Printhead drive voltage
+12 V	Optional I/F voltage
Vx	Reset circuit Printhead data signal pull-up voltage Paper-feed motor phase data signal pull-up voltage

2.2.1.2 Chopper-Type Switching Regulator Circuit

A chopper-type switching regulator is employed in the power supply circuit. Operation of the step-down circuit is as follows:

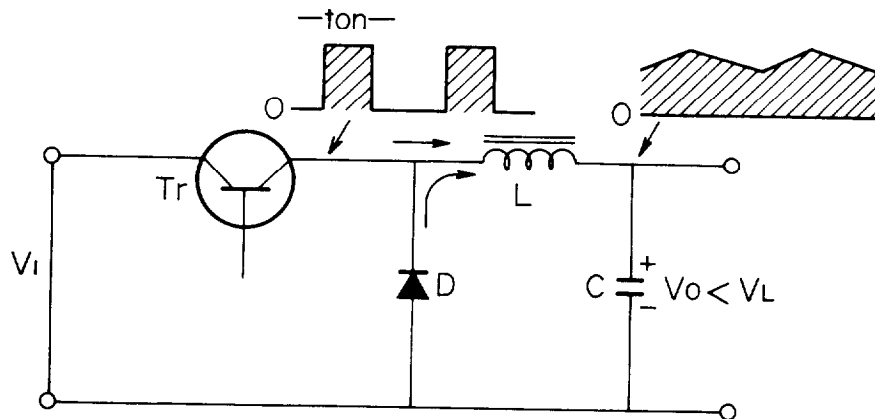


Figure 2-10. Step-Down Circuit

Figure 2-10 shows the chopper-type, step-down switching regulator circuit. When the transistor is ON, voltage V_i is applied to coil L and capacitor C , and load current I_L flows. At this time, electromagnetic energy w_L is accumulated in choke coil L . When the transistor turns off, energy w_L is applied to the load via flywheel diode D so that output voltage V_o becomes the average value:

$$V_o = \frac{V_i \times T_{on}}{T} \text{ where, } T = T_{on} + T_{off} \text{ (T is constant)}$$

Therefore, V_o can be held constant by controlling T_{on} . Figure 2-11 shows the step-down timings.

Voltage between the collector and the emitter of T_r

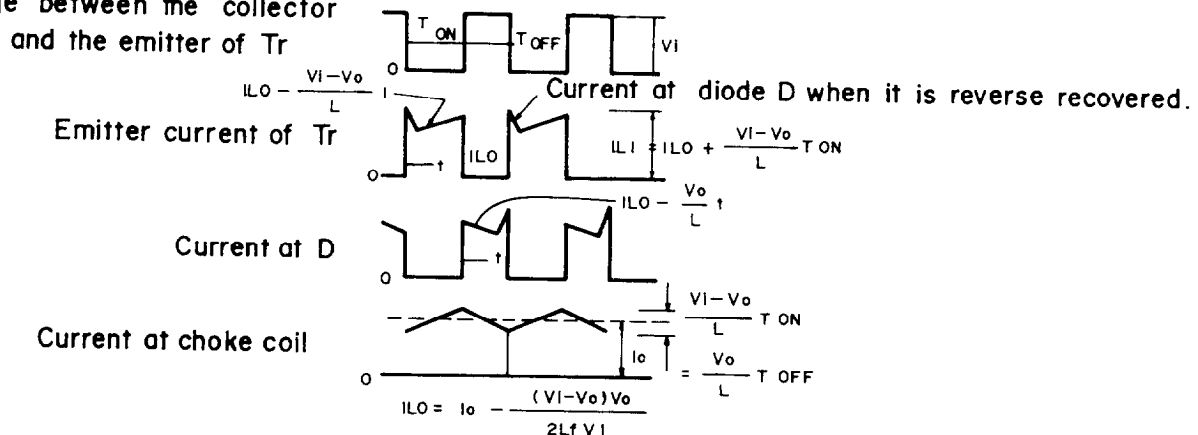


Figure 2-11. Step-Down Timings

2.2.1.3 Filter Circuit

The AC line voltage passes through the power switch, then is input to the filter circuit. A fuse, F1, is used on the PEBFIL board. The filter circuit attenuates external noise and inhibits noise generated in the printer from going out via the AC line. Either C1 or C2 drains leakage current between the primary coil and the case. Figure 2-12 shows the filter circuit.

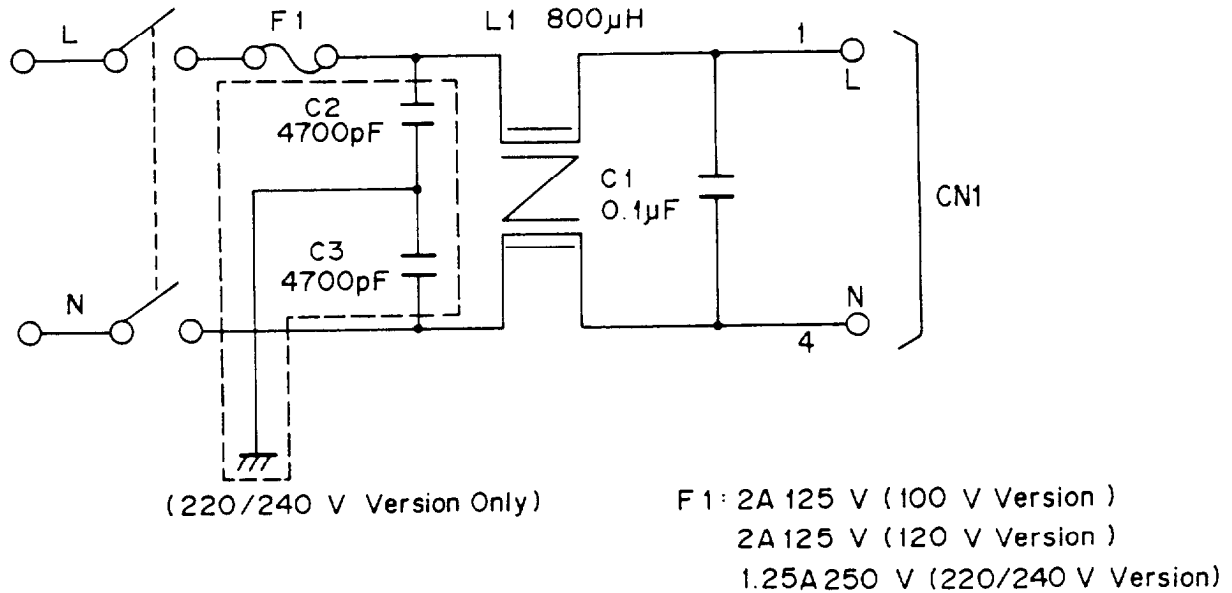


Figure 2-12. PEBFIL Filter Circuit Board

2.2.1.4 Transformer

AC voltages (120 VAC, 220 VAC, 240 VAC) that pass through the filter circuit are divided into 26 VAC and 12 VAC and supplied to the PBMA circuit. Figure 2-13 shows a schematic drawing of the power transformer.

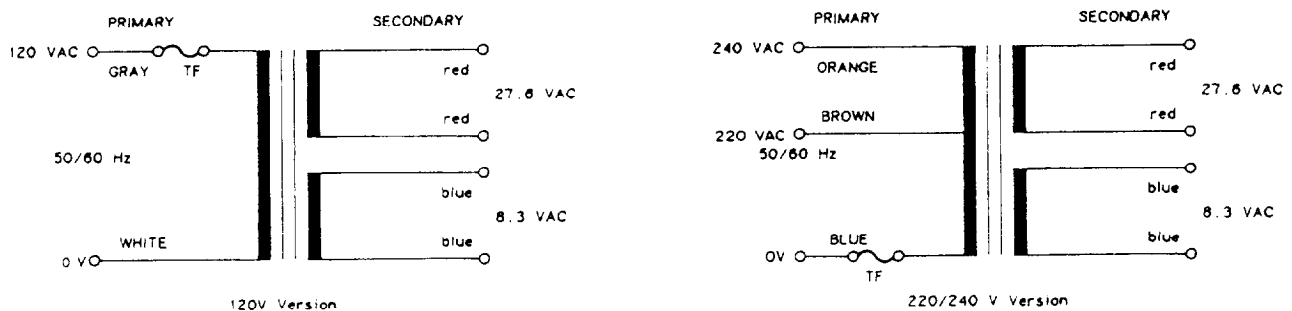


Figure 2-13. Transformer Circuit

2.2.1.5 Rectifier and Smoothing Circuit

The 26 VAC from the secondary coil of the transformer are full-wave rectified by diode bridge DB1, and converted to approximately 36 VDC by smoothing capacitor C40. The + 24 VDC and + 5 VDC voltages are converted from this DC voltage, which is used as the power supply voltage for the switching regulator IC at the next stage.

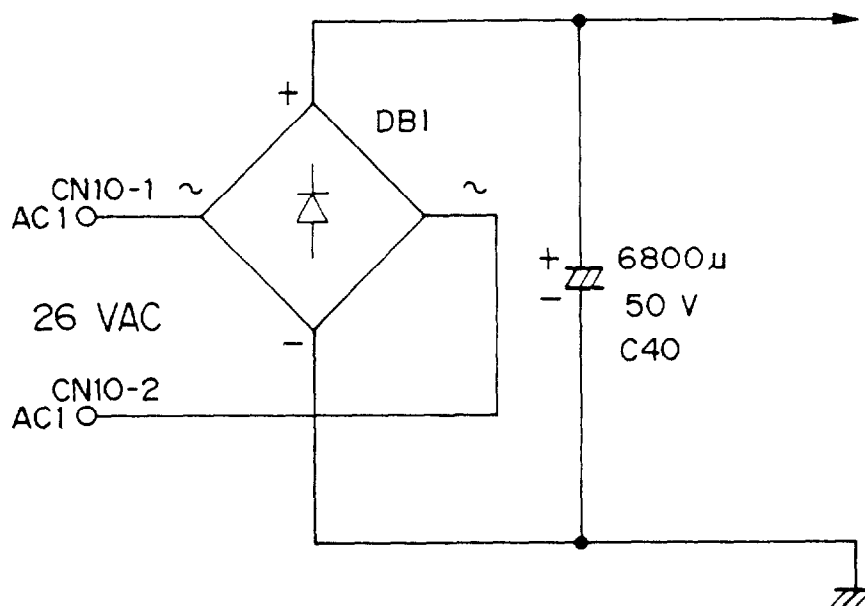


Figure 2-14. Rectifier and Smoothing Circuit

2.2.1.6 + 5 V Regulator Circuit

Figure 2-15 shows the +5 VDC regulator circuit. An NJM2355 switching regulator IC is used for constant-frequency pulse-width modulation. The circuit shown above employs an NJM2355 configured as a chopper-style switching regulator circuit.

This IC has a built-in oscillator. The oscillation frequency is determined by external components connected to pins 2 and 3. Therefore, R105 and C34 cause the circuit to oscillate at about 30 KHz. The oscillator waveform is shown in Figure 2-16.

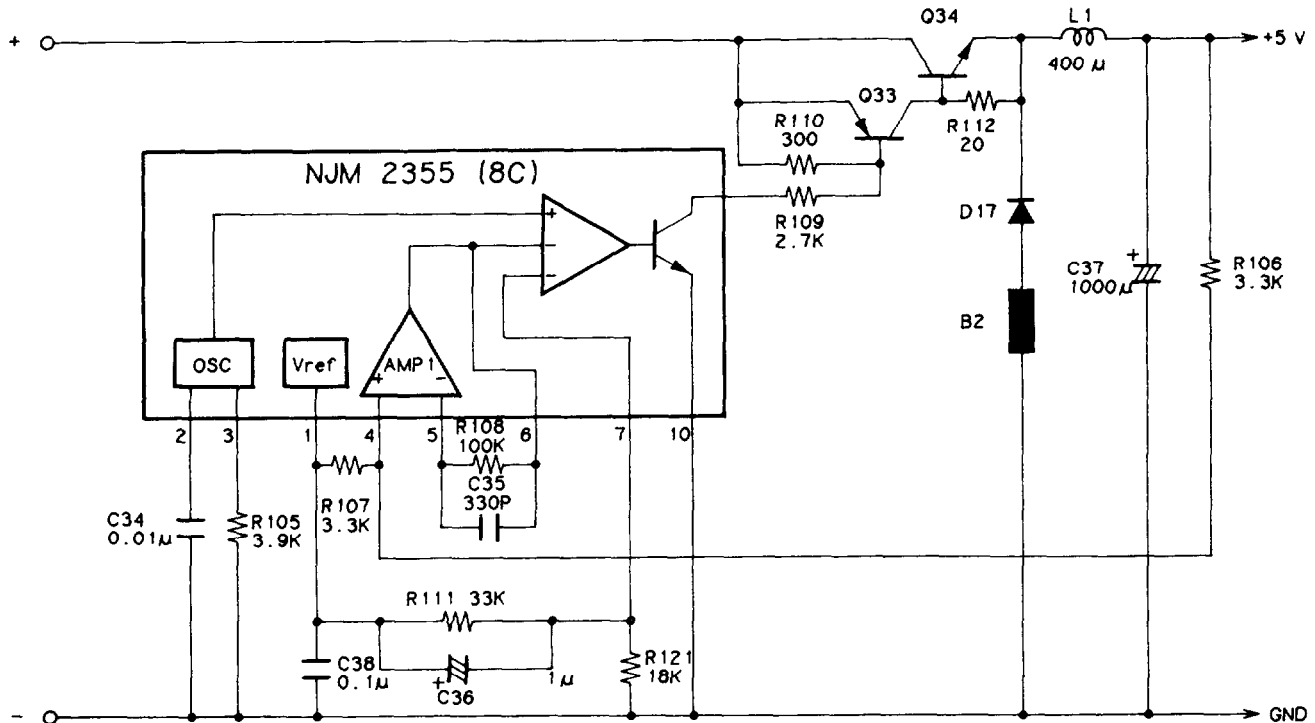


Figure 2-15. + 5 V Regulator Circuit

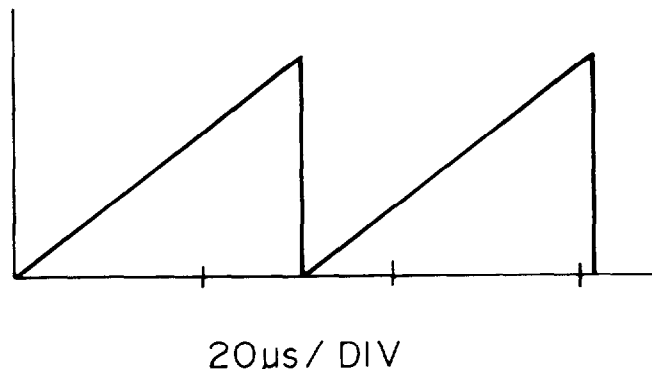


Figure 2-16. Oscillator Waveform

AMP 1 in the IC is an error amplifier used to monitor the output voltage. Figure 2-17 shows the constant-voltage control circuit. Pin 1 of the IC provides a 5 V reference output (Vref), which is applied to the negative terminal of **AMP 1**. The error amplifier adjusts its output according to the voltages applied to the positive and negative input terminals. This has the effect of maintaining the voltage at the positive terminal at 5 V.

Figure 2-18 shows the output from AMP 1. When the voltage at pin 4 becomes higher than that at pin 5 (over voltage), AMP 1 outputs current modulated by pulse-width modulation (PWM) to reduce the output voltage of the circuit. PWM is described below.

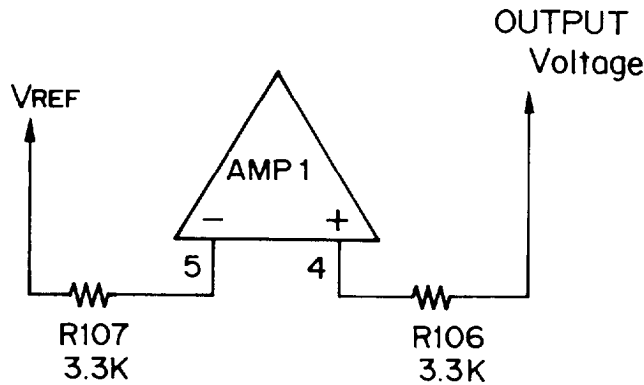


Figure 2-17. Constant Voltage Control (+ 5 VDC)

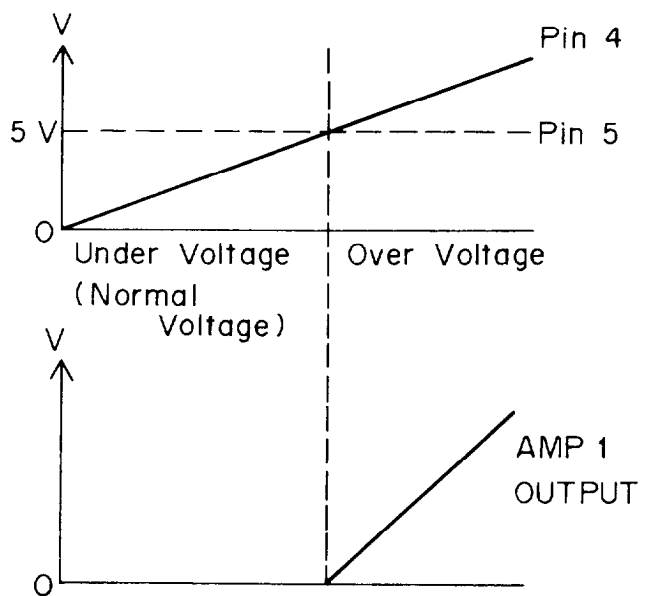


Figure 2-18. AMP 1 Output

R108 and C35 compensate for phase lag in the error amplifier to prevent abnormal oscillation.

2.2.1.7 Pulse-Width Modulation (PWM) Circuit

Figure 2-19 shows the internal circuit of the NJM2355 IC. The PWM comparator operates as follows:

In circuit 1 the output from AMP 1 flows into the negative terminal of comparator 1, and the outputs from AMP 2 and AMP 3 in circuit 2 flow into the negative terminal of PWM comparator 2 without wired OR. Dead-time control voltage is also input to additional negative terminals of both PWM comparators 1 and 2.

A sawtooth waveform from the oscillator is input to the positive terminals. The sawtooth waveform from the oscillator causes the comparators to generate pulses as shown in Figure 2-20.

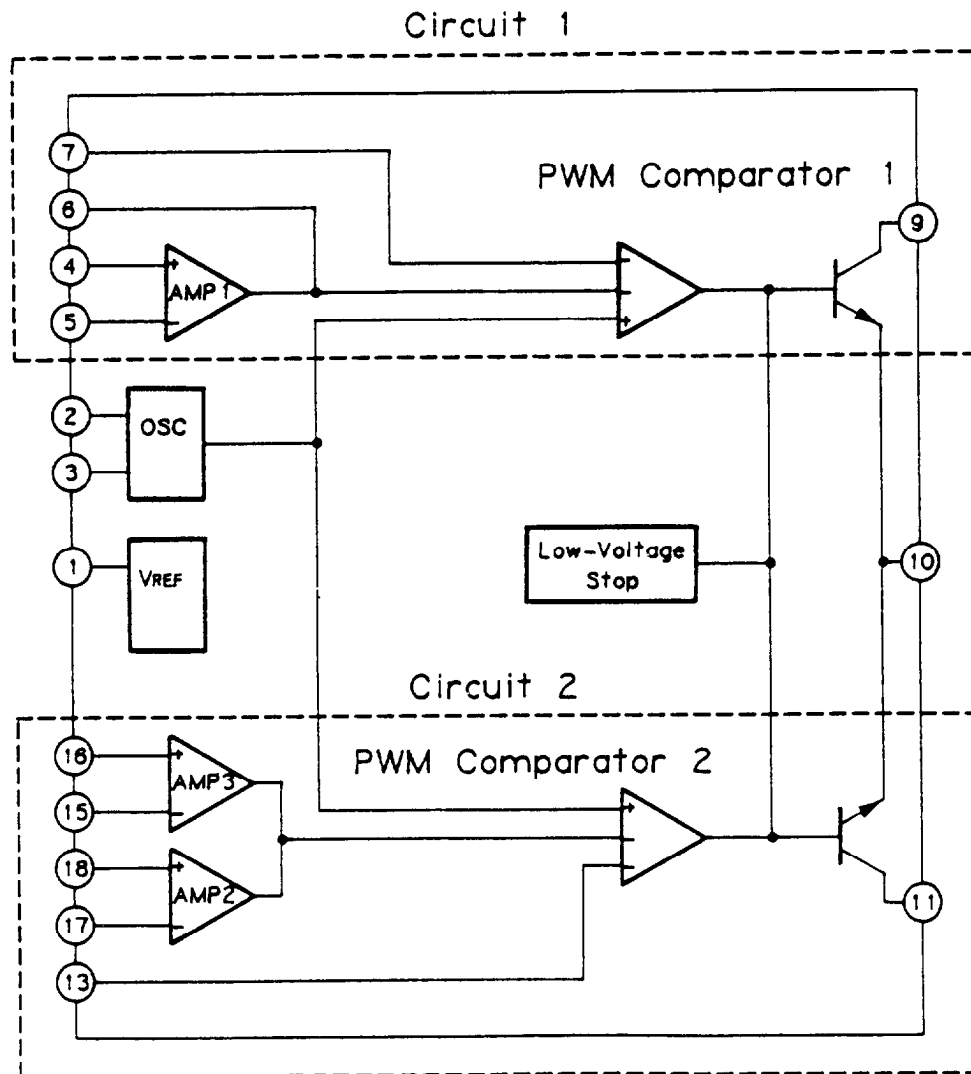


Figure 2-19. NJM2355 Internal Circuit

As shown in Figure 2-20, when the potential at the NJM2355 is lower than the preset voltage or current value, it is controlled by the dead-time control voltage. When it exceeds the preset value, it is controlled by the error amplifier to keep it lower than the preset value.

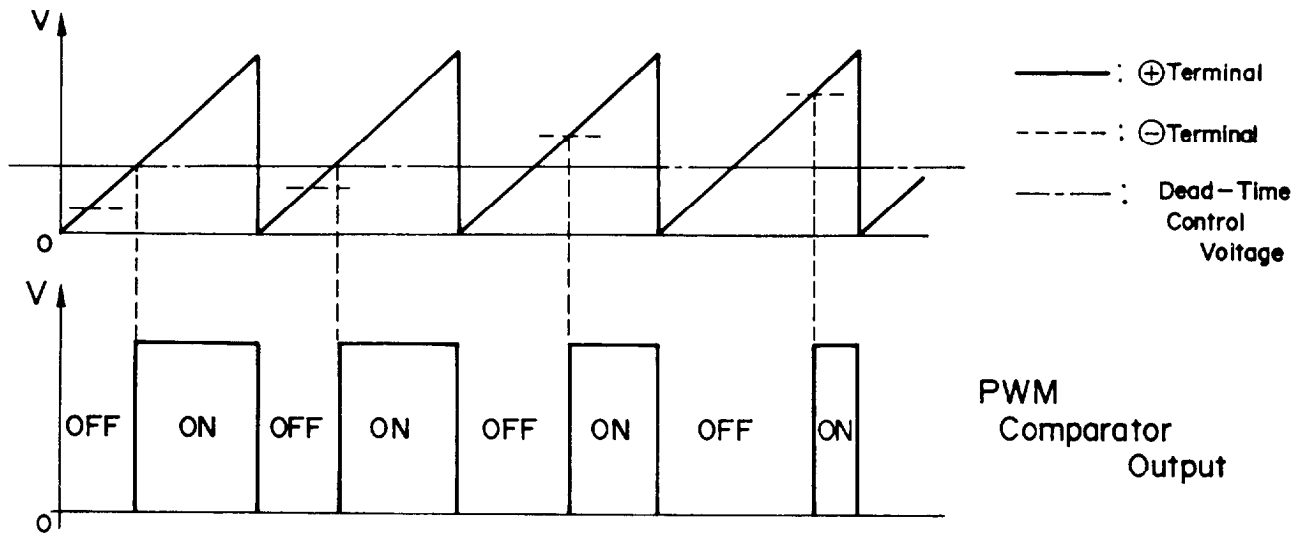


Figure 2-20. Output Transistor Drive Waveform

2.2.1.8 + 24 VDC Regulator Circuit

Figure 2-21 shows the + 24 V regulator circuit. The + 24 VDC regulator circuit has almost the same function and employs the same oscillation circuit as the +5 VDC regulator circuit. Here, the error amplifier AMP 2 is used for over-current control, and AMP 3 for constant-voltage control. The operation of the error amplifier AMP 3 IS AS FOLLOWS.

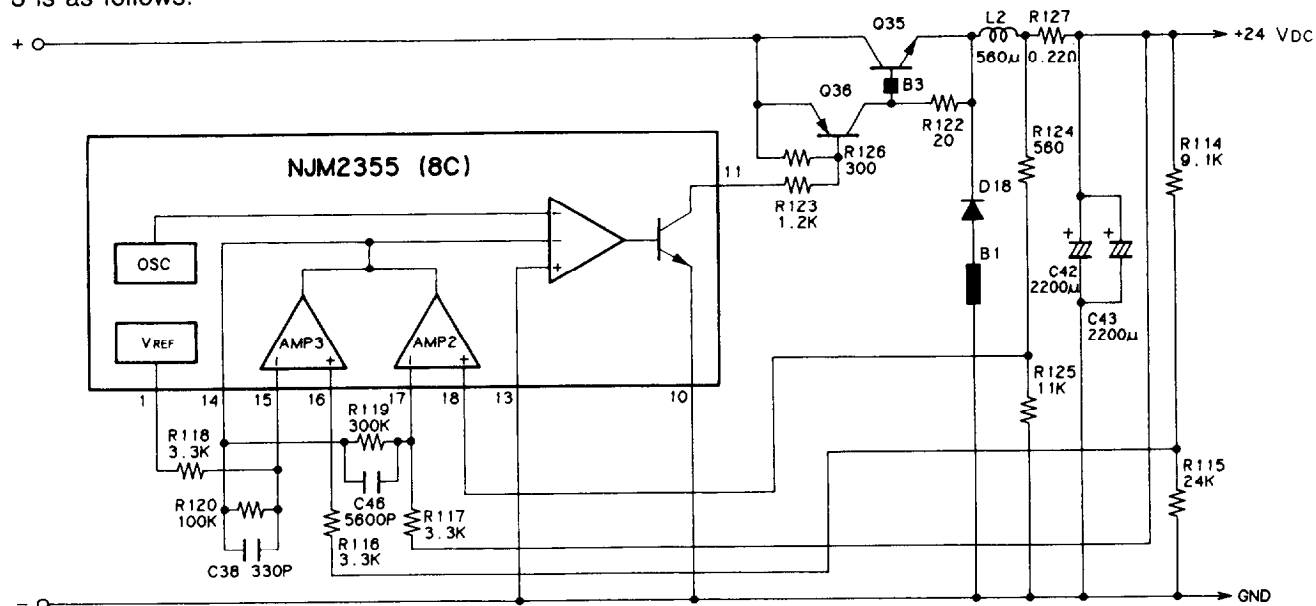


Figure 2-21. +24 V Regulator Circuit

The negative terminal of **AMP 3** receives V_{REF} (5 V). Consequently, the voltage applied to the positive terminal is adjusted to 5 V. Therefore, based on Figure 2-22, the output voltage is set to the following value:

$$\frac{V_{REF}}{R_{115}} (R_{114} + R_{115}) = \frac{5 \text{ V}}{2.4 \text{ K ohms}} (9.1 \text{ K ohms} + 2.4 \text{ K ohms})$$

$$= 23.96 \text{ V}$$

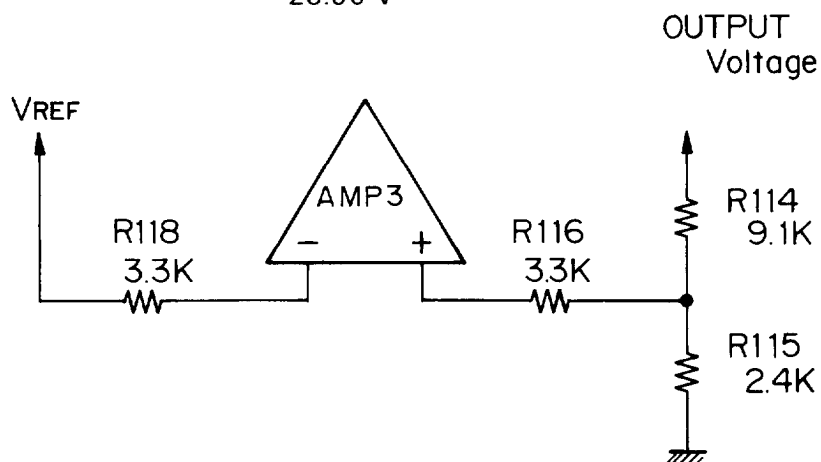


Figure 2-22. Constant-Voltage Control (+ 24 VDC)

AMP 2 operates as follows for over-current control: + 24 V is applied to the negative terminal, and the positive terminal will receive an equal voltage when, based on Figure 2-23, a negative current of the following value flows.

$$\frac{\text{Output Voltage}}{R_{125}} R_{124}/R_{127} = \frac{24 \text{ V}}{11 \text{ K ohms}} \cdot \frac{560 \text{ ohms}}{0.22 \text{ ohms}}$$

$$= 5.55 \text{ [A]}$$

the current exceeds this value, over-current protection is turned on to reduce the output voltage.

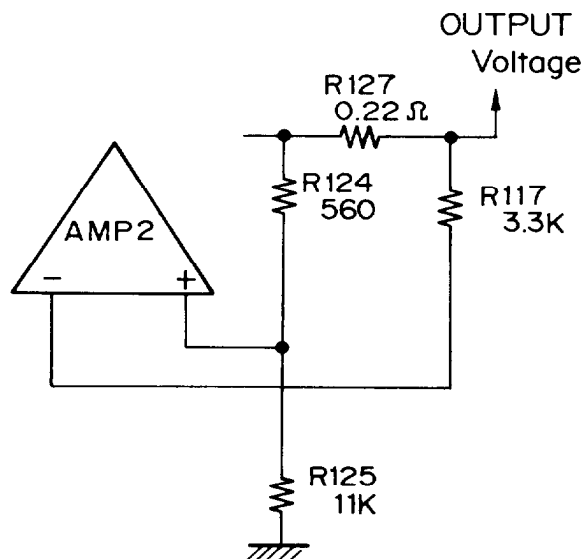


Figure 2-23. Over-Current Protection (OCP)

Dead-time control has no bearing in this case, because pin 3 of IC1 is grounded.

2.2.1.9 + 12 VDC Supply Circuit

The 12 VAC from the transformer is half-wave rectified by diode D19 and is converted to + 12 VDC. As shown by Figure 2-24, the half-wave rectified voltages pass through the capacitor smoothing circuit so that the ripple is small, and the average DC voltage rises when no load current flows and drops as load current increases.

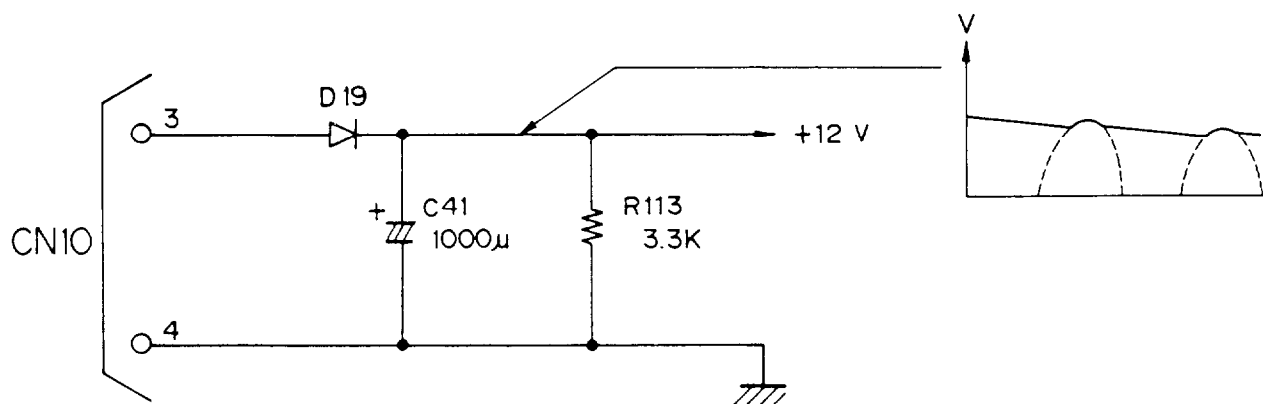


Figure 2-24. + 12 VDC Circuit

2.2.1.10 Vx Voltage Supply Circuit

When the +24 V power supply line reaches 18.6 V ($18\text{ V} + 0.6\text{ V}$), transistors Q25 and Q26 turn on and Vx (+ 5 V) is output. On the other hand, if the + 24 V power supply line drops to 18.6 V or less, Q25 and Q26 turn off and the Vx voltage is shut off.

The Vx voltage is used to prevent abnormal operation of the printer when the power is switched on or off.

- Reset Circuit Power Supply

When the power is switched on or off, the circuit is reset so that it will not drive the printer until the power supply becomes stable.

- Pull-ups for the Printhead Signal Lines

These prevent printhead malfunctions when power is switched on or off.

- Pull-ups for the Paper-Feed Motor Signal Lines

These prevent paper-feed motor malfunctions when power is switched on or off.

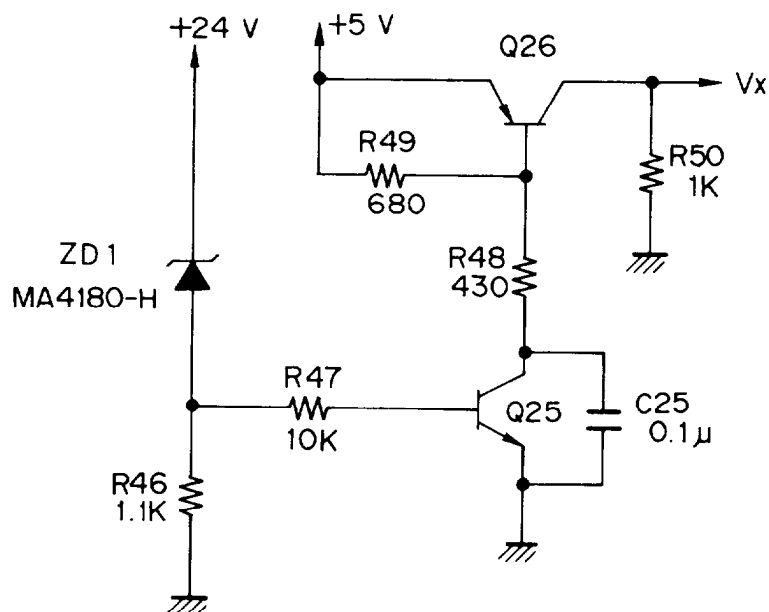


Figure 2-25. Vx Voltage Circuit

2.2.2 Reset Circuit

Figure 2-26 shows the reset circuit. The $\overline{\text{RESET}}$ signal generated here is sent to the RESET terminal of CPU $\mu\text{PD781 OHG}$ (46) and to connector CN2-13 (optional interface) as a hardware initialization signal. The RESET signal is output from the circuit when any of the following occurs:

- Power is turned on or off.
- The INIT signal is input from either the host interface or an optional interface.
- A module (font or identity) is mounted or removed.

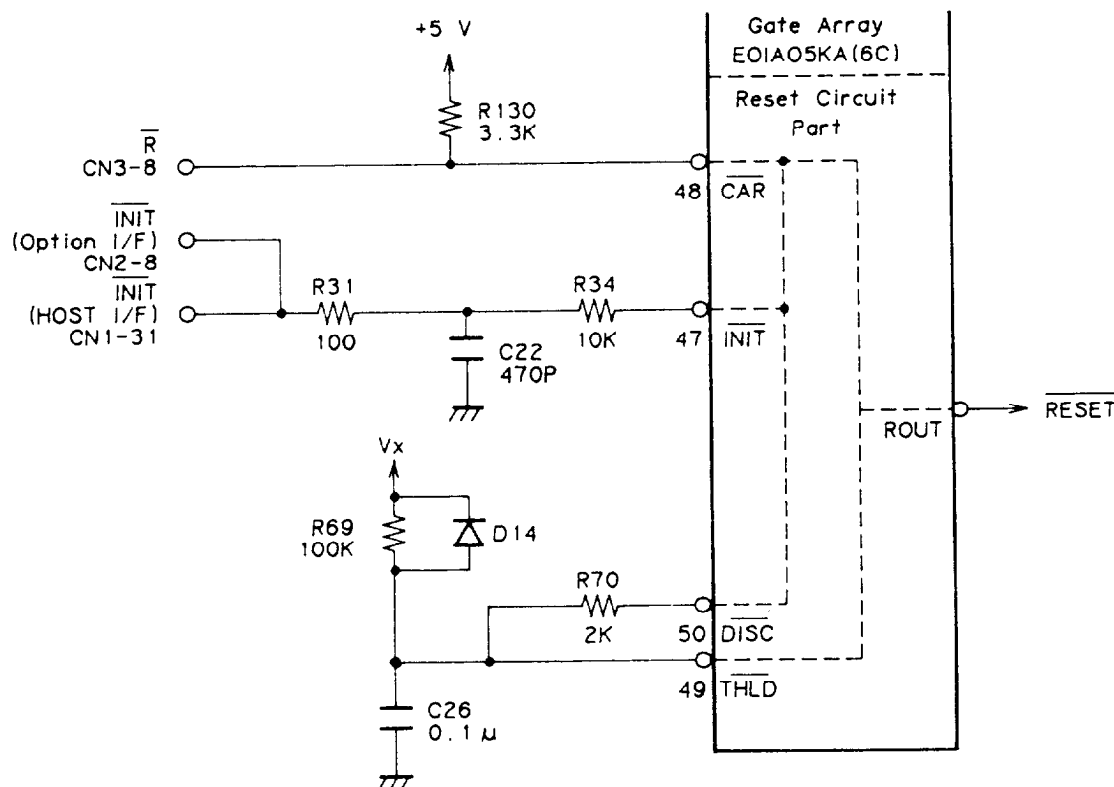


Figure 2-26. Reset Circuit

Power On or Off

D14, R69, and C26 in Figure 2-26 comprise an ON/OFF reset circuit. The purpose of this circuit is to make the CPU start from address 0000 hex. when power is applied and prevent CPU malfunctions when the power is switched off.

The rising edge of the Vx voltage cancels the RESET signal after a delay of time constant $\tau = R69 \times C26$ produced by the integration circuit of resistor R69 and capacitor C26. The falling edge of the Vx voltage activates a RESET signal by discharging capacitor C26 via diode D14.

The gate array (pins 49 to 51) is used for waveform shaping.

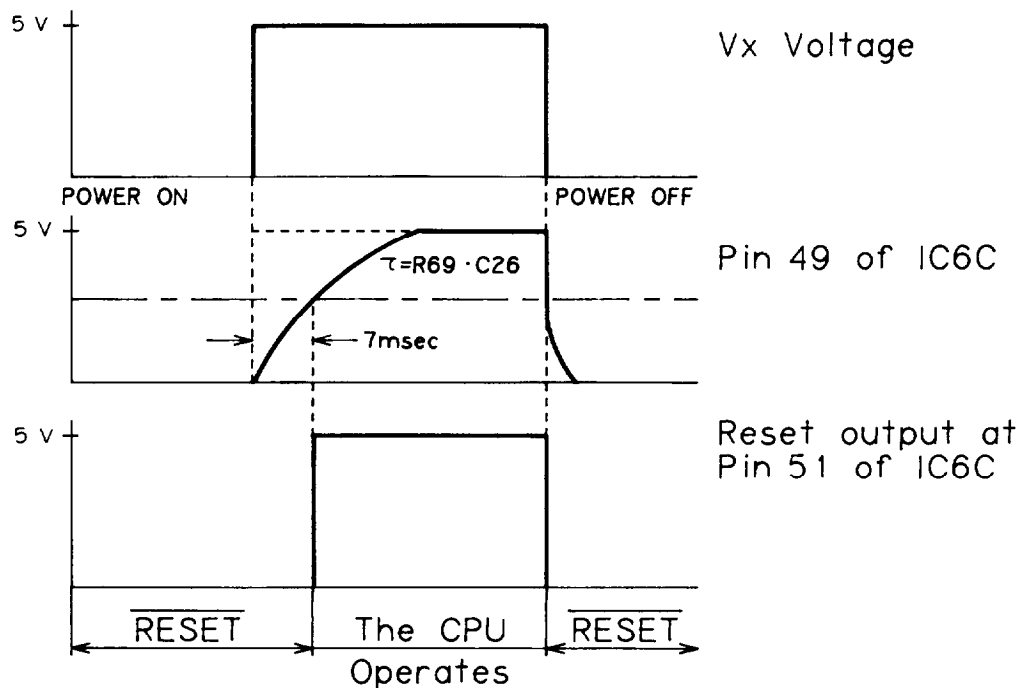


Figure 2-27. $\overline{\text{RESET}}$ Output

INIT Signal Input (from CN1 or CN2)

The external INIT signal (50 μsec or less) is passed through the low-pass filter of R31 and C22, and waveform-shaped in the gate array (pin 47 of IC6C) to set the DISC terminal LOW, discharge capacitor C26, and set the gate array THLD terminal LOW. Following this, the ROUT terminal outputs the $\overline{\text{RESET}}$ signal.

Module Installation or Removal

Figure 2-28 shows the $\overline{\text{RESET}}$ pulse generation process that occurs when a ROM cartridge is mounted. Numbers in parentheses below correspond to circled numbers in the figure. After the ROM cartridge is mounted, the LOW signal flows into the CAR terminal of the gate array (6C), and a LOW signal is correspondingly output from the DISC terminal and $\overline{\text{RESET}}$ is output from the ROUT terminal.

As the DISC terminal goes LOW, capacitor C26 is discharged with a time constant $= R70 \times C26$. When the discharge of C26 reduces the potential at the THLD terminal to threshold voltage V_{th} , the RESET signal is canceled, and the DISC terminal goes HIGH. After the DISC terminal goes HIGH, V_x voltage discharges C31 at time constant $= R69 \times C26$ again.

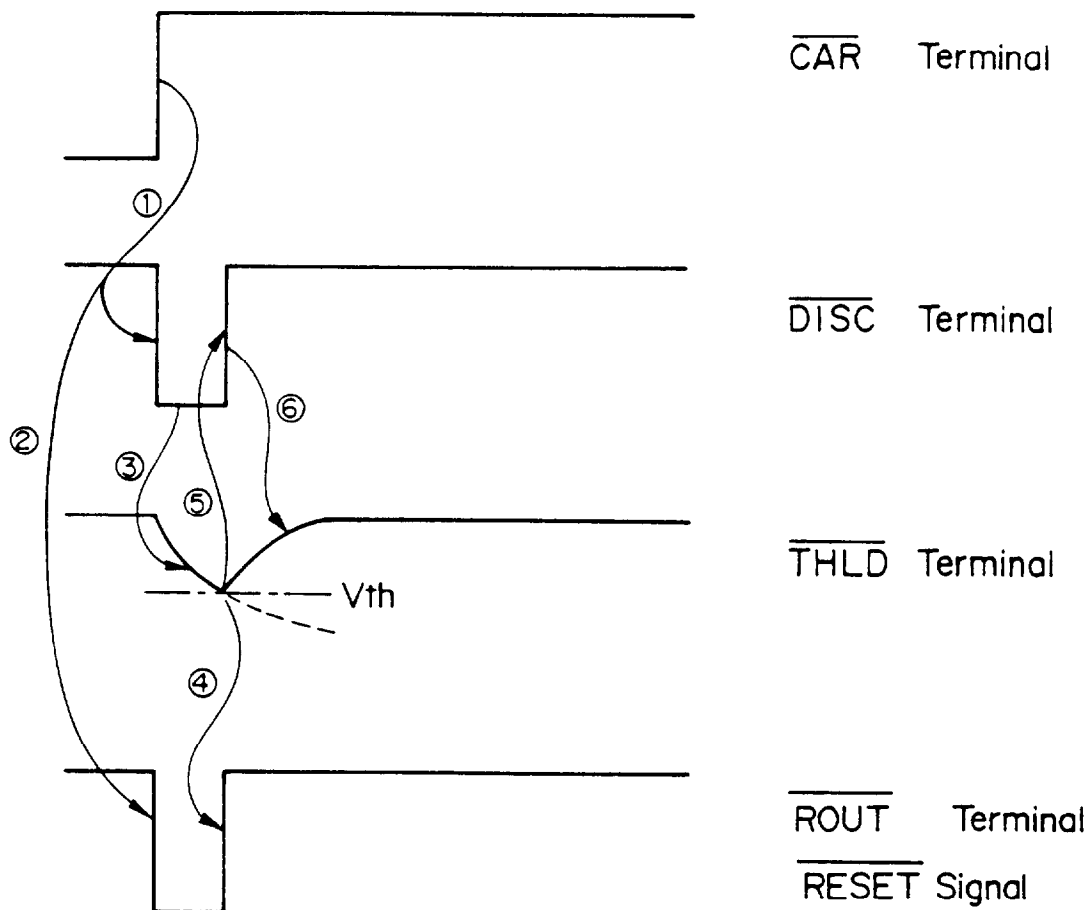


Figure 2-28. $\overline{\text{RESET}}$ Pulse Oscillation Process (Module Mounted)

When the ROM cartridge is removed (see Figure 2-29), the CAR terminal of the gate array (6C) receives a HIGH signal. Then the DISC terminal outputs a LOW signal, and the $\overline{\text{ROUT}}$ terminal outputs a $\overline{\text{RESET}}$ signal. The remainder of the sequence is similar to that when a ROM cartridge is mounted, so please refer to the preceding page.

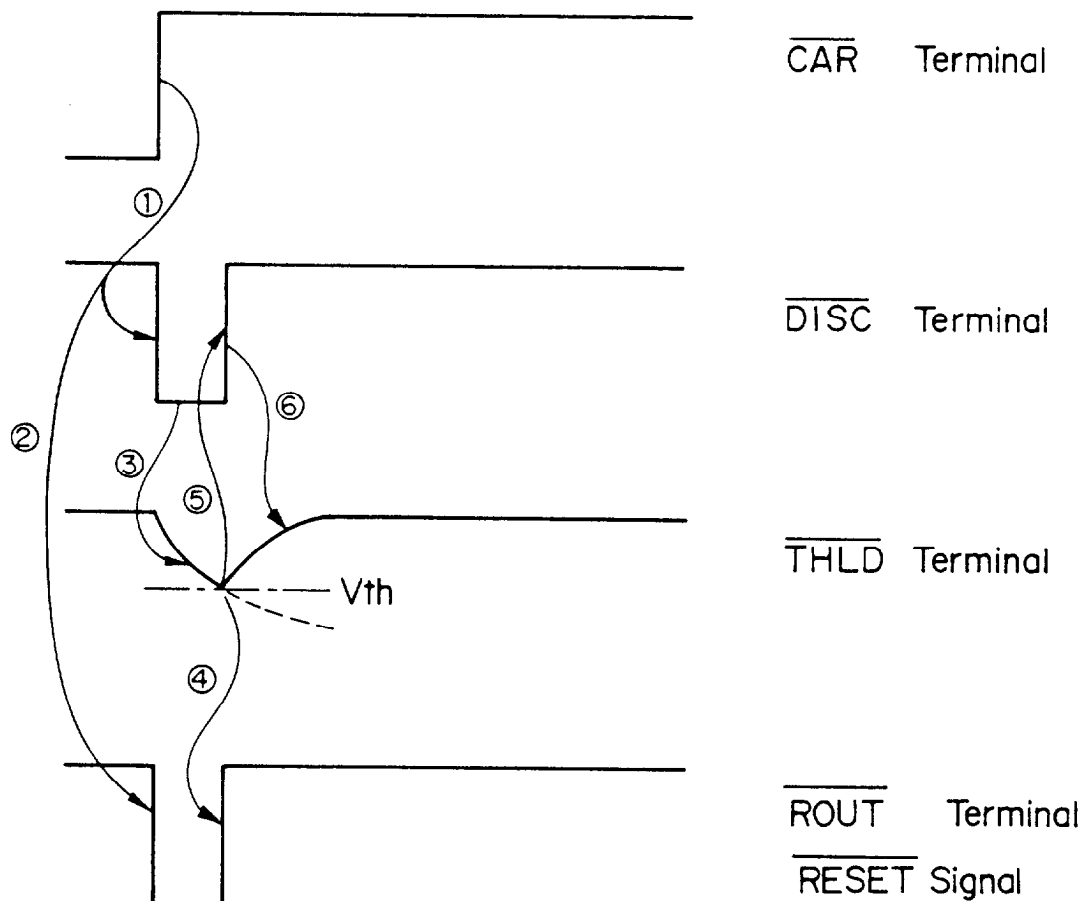


Figure 2-29. $\overline{\text{RESET}}$ Pulse Oscillation Process (Module Removed)

2.2.3 Firmware Operation at Reset

After being reset, the CPU executes the initialization program from address 0000 hex. When this program has completed normally, the CPU enters the standby state and waits for data. Figure 2-30 shows the initialization program flowchart.

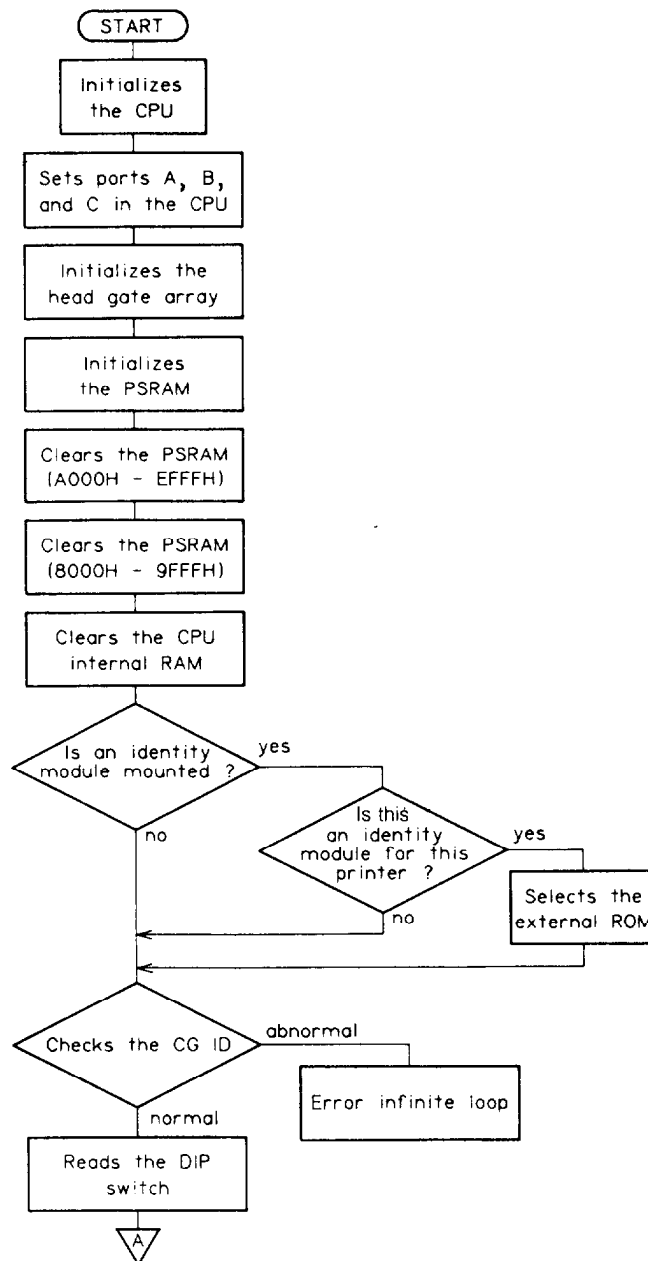


Figure 2-30. Initialization Program Flowchart

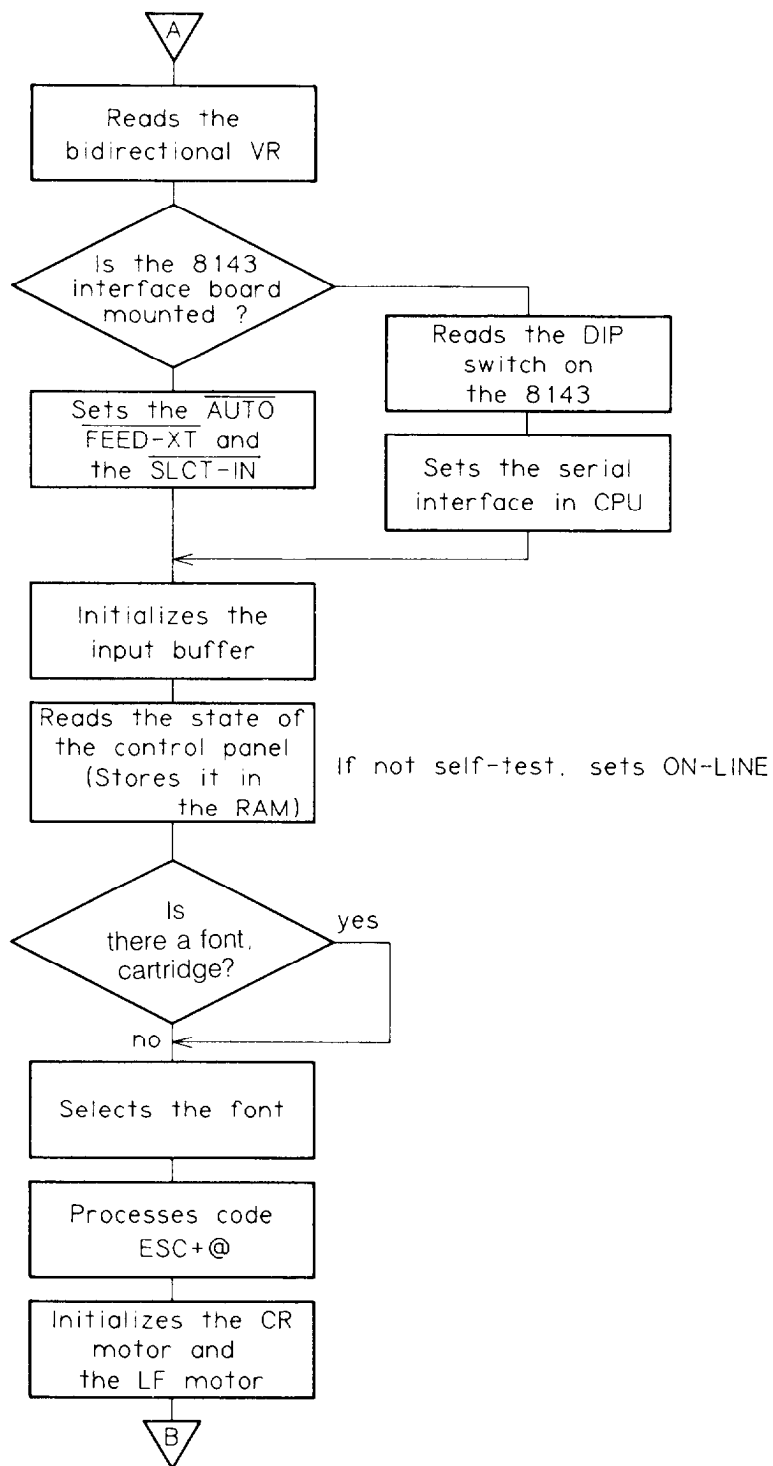


Figure 2-30. Initialization Program Flowchart (Cont.)

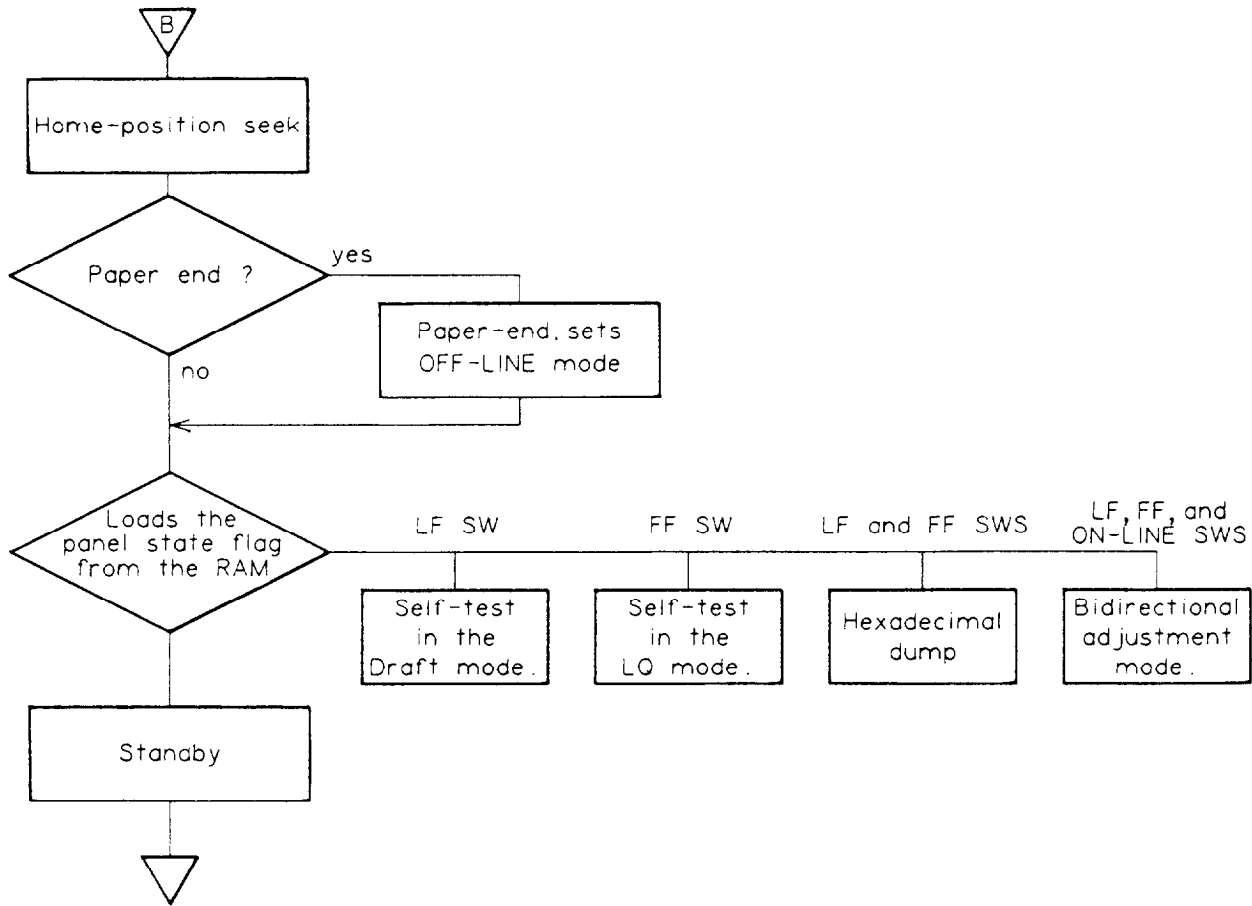


Figure 2-30. Initialization Program Flowchart (Cont.)

2.2.4 Address Decoder and Bank Register

This section describes the address decoder and bank register.

Address Decoder

This unit includes an address decoder in gate array E01A05KA (6C). The address decoder outputs a chip-select signal to the internal PROM (3C), external PROM, 4MCG (5C), 1 MCG (2C), external CG, RAM (2C), HEAD gate array (7A) via address lines AB12 through AB15 and bank lines 7 and 6 (in the gate array). However, the chip select for the CS is generated in conjunction with the RD signal, and that of the RAM is generated in conjunction with the ALE signal.

Software control of firmware can check whether an external PROM is mounted or not, and if the correct PROM is mounted, the memory map shown in Figure 2-31 is obtained by writing bit 7 LOW at address FO01 hex.

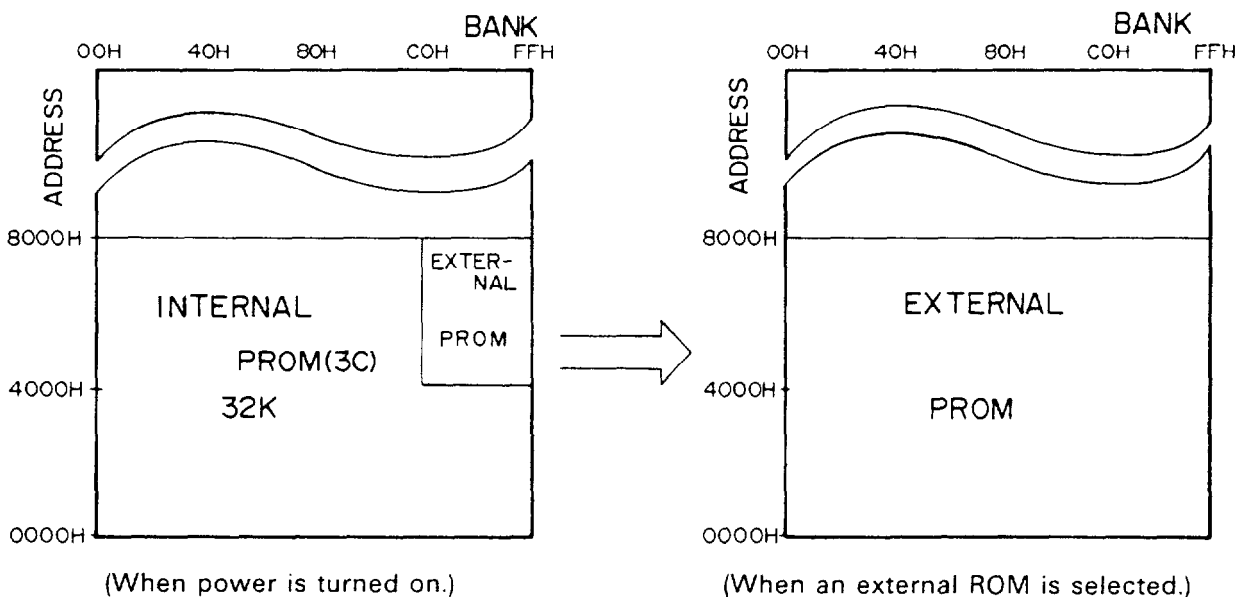


Figure 2-31. Memory Map

Bank Register

This unit has a bank register in gate array EOIA05KA (6C). The bank lines are set by writing to address F002 hex., and they can be checked by reading the same address. Table 2-3 shows the relationship between data bits and bank lines.

Table 2-3. Control Commands

WORK NAME		WR F002H	Sets the BANK line
BIT	Function		When power is turned on
7	BANK 7		0
6	6		0
5	5		0
4	4		0
3	3		0
2	2		0
1	1		0
0	0		0

WORK NAME		RD F002H	Reads the BANK line
BIT	Function		
7	BANK 7		
6	6		
5	5		
4	4		
3	3		
2	2		
1	1		
0	0		

2.2.5 Carriage Operation

This section describes the carriage.

2.2.5.1 Carriage Mechanism

The carriage mechanism includes the printhead, the carriage, the timing belt, the carriage motor, and the platen. Figure 2-32 shows the carriage mechanism.

The timing belt is connected into the bottom of the carriage. This belt is driven by the carriage motor and moved via the belt-driven pulley. The printhead is mounted on the carriage, and the entire unit is moved right and left along the carriage guide shaft and plate.

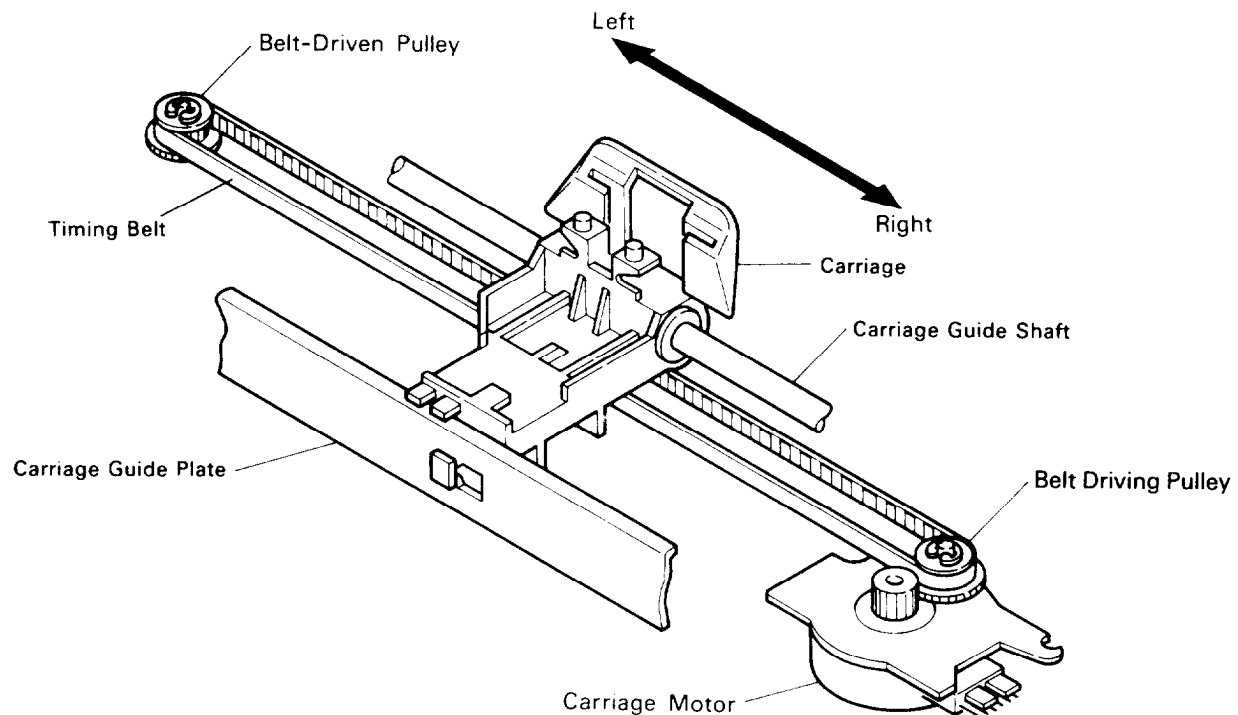


Figure 2-32. Carriage Mechanism

2.2.5.2 Carriage Motor Specifications

Carriage motor specifications are as follows:

Type	4-phase, 48-pole stepper motor
Drive Voltage	24 V \pm 10%
Coil Resistance	21 ohms \pm 7% at 25 degrees C
Current	Maximum 0.34 A (rush current)
	Driving: 0.3 A (typical) (triple speed, 24 V)
	0.23 A (typical) (double speed, 1.5 speed, normal speed, 24 V)
	Holding: 0.17 A \pm 20%

2.2.5.3 Carriage Drive Circuit Block Diagram

Figure 2-33 shows a block diagram of the carriage motor drive circuit. In this circuit, the phase switching for the carriage motor is not directly executed by the CPU, but by the gate array (6C) using pulses from the CPU. STK-6981 B is employed to drive the carriage motor using a stabilized current.

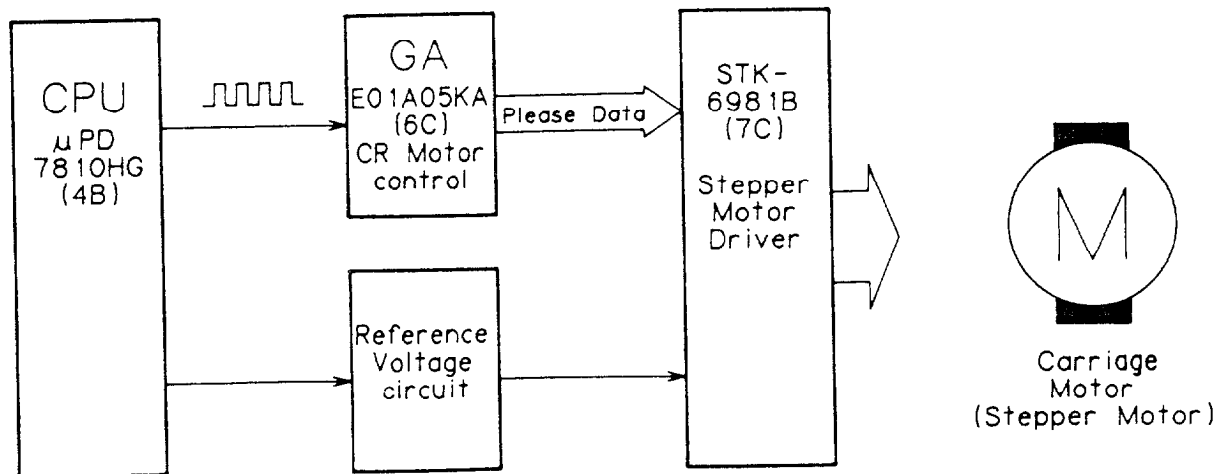


Figure 2-33. Carriage Drive Circuit Block Diagram

2.2.5.4 Gate Array EOIA05KA Operation in Carriage Motor Drive Circuit

The phase switching for the carriage motor (stepper motor) is performed by gate array EOIA05KA (6C). This gate array first sets the excitation system (2-2 phase or 1-2 phase) and rotation direction (clockwise Or counterclockwise). Then, after the CPU outputs a pulse to the TM terminal of the gate array, executes auto phase switching to drive the stepper motor. Figure 2-34 shows this process.

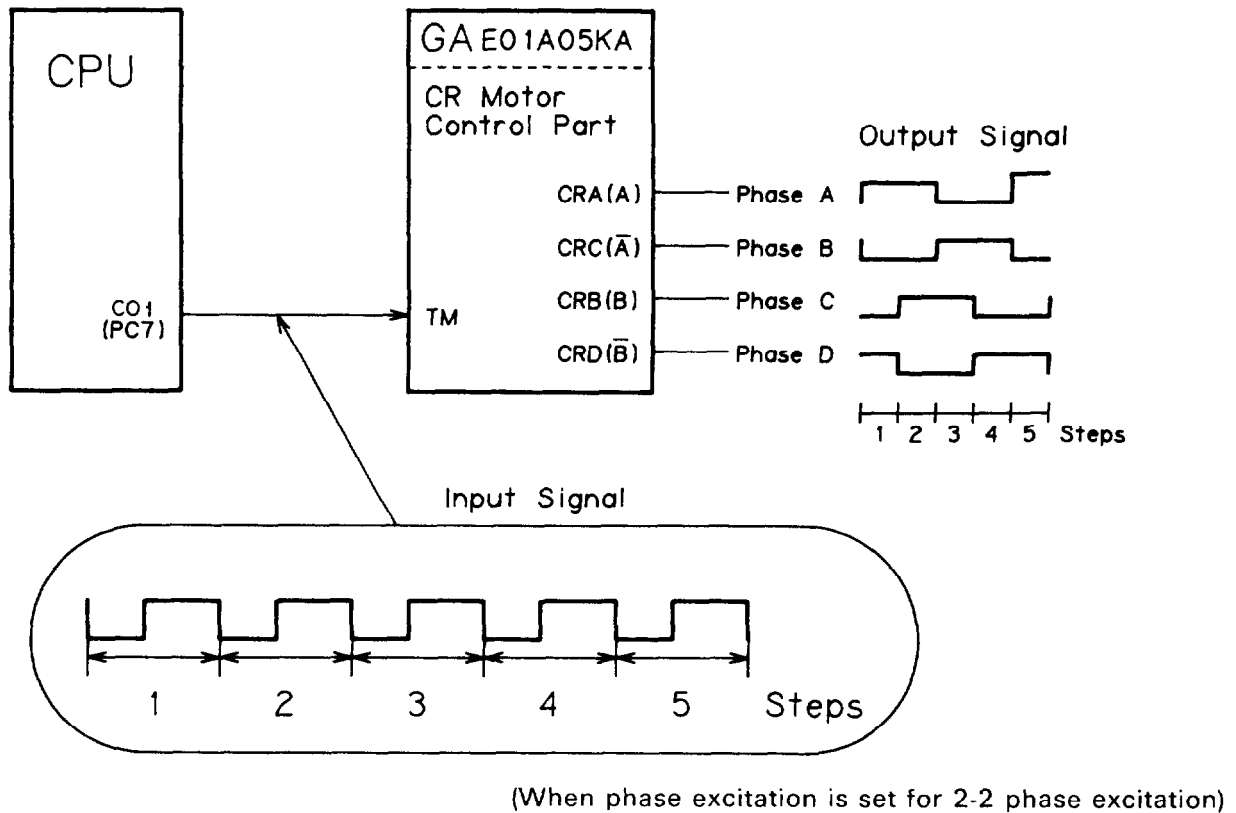


Figure 2-34. Gate Array Operation

The carriage motor control port of the gate array is assigned to address FO03 hex. Control commands for the carriage motor (via the gate array) are listed in Table 2-4.

Table 2-4. Control Commands

When power is turned on

WORK NAME		WR F002H	CR motor control
BIT	Function		When Power is turned on
7	_____		_____
6	_____		_____
5	_____		_____
4	_____		_____
3	CR motor control circuit enable		disable
2	Phase data active HIGH/LOW		HIGH
1	CW/CCW		CW
0	2-2 phase/1-2 phase		2-2 phase

(CW = clockwise; CCW = counterclockwise)

2.2.5.5 Carriage Motor Drive Circuit

The LQ-500 employs the STK-69816, which is a hybrid IC used to drive stepper motors. STK-6981B (IC8C) drives the stepper motor with a constant current. The value of the current is determined by an external voltage level. The IC operation can be separated into phases AB and CD, which are completely equivalent. Phase CD is described here as a model. Figure 2-35 shows the carriage motor drive circuit. Figure 2-36 shows the STK-6981 B circuit diagram

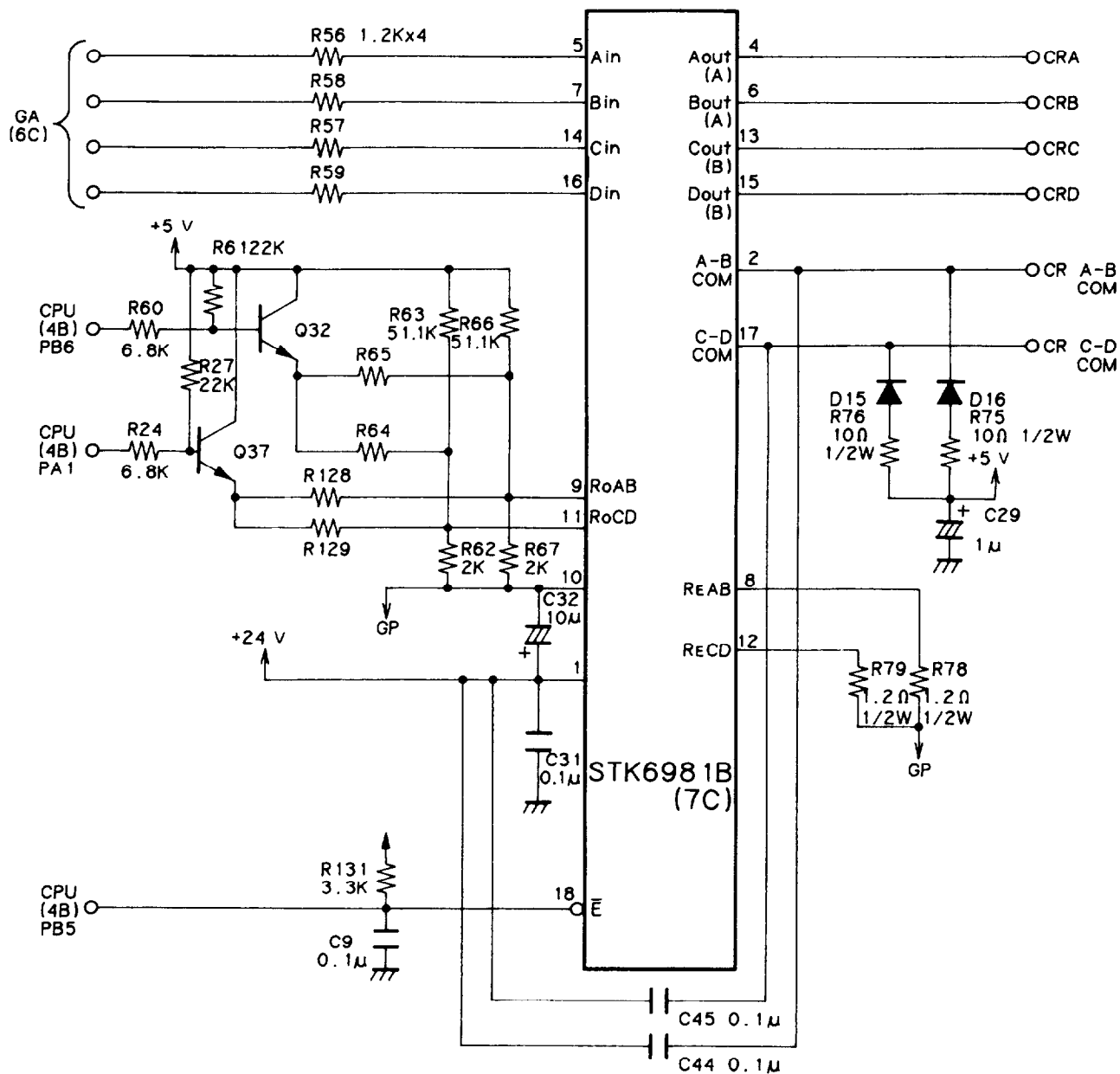
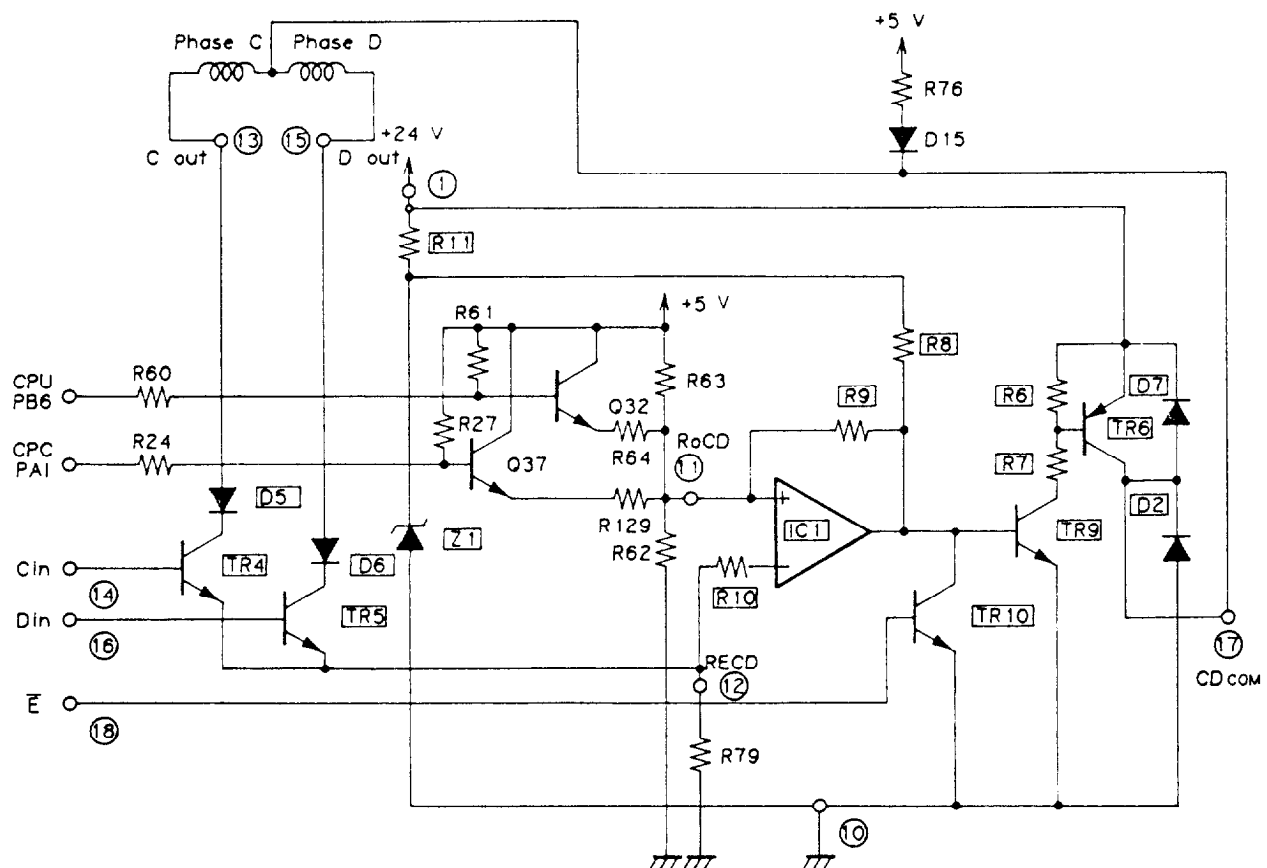


Figure 2-35. Carriage Motor Drive Circuit



NOTE: Phase AB is equivalent to the above.

Figure 2-36. STK-6981 B Circuit Diagram

Reference Voltage Generation Circuit

Figure 2-37 shows the reference voltage generation circuit and Table 2-5 shows the reference voltage.

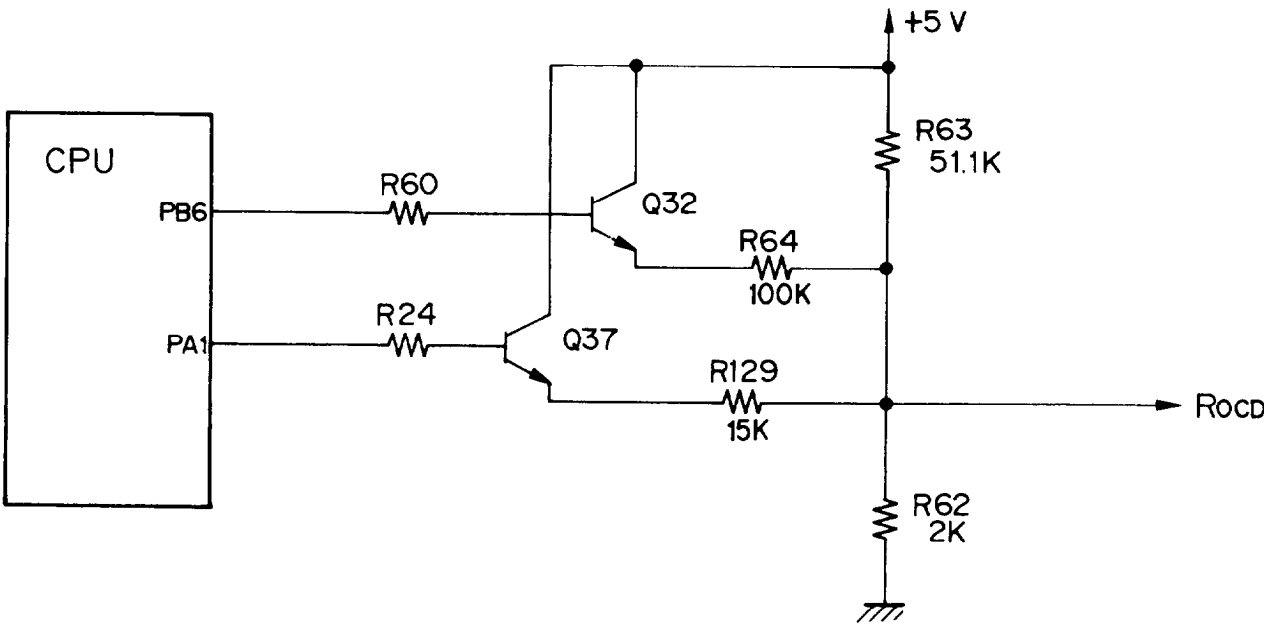


Figure 2-37. Reference Voltage Generation Circuit

Table 2-5. Reference Voltage

PB6 SPDM	PB1 SPDH	Reference Voltage VrCD
H	H	0.807 V
L	H	0.736 V
H	L	0.279 V
L	L	0.188 V

Constant Current Drive Circuit

The carriage motor-drive current is given by the following equation:

$$I = V_{rCD}/R_{79} = V_{rCD}/1.2 \text{ ohms}$$

When the carriage stops, port PB5 of the CPU is set HIGH, the input to the chopping circuit becomes 0 V, and current is applied from the + 5 V line to the motor via resistor R1 and diode D1. This current is given by:

$$I = \frac{(5 \text{ V} - V_{D15} - V_{D5})}{R_{76} - 21 \text{ ohms/phase} + R_{79}}$$

Figure 2-38 shows the constant current circuit; Table 2-6 lists the current values for reference voltages.

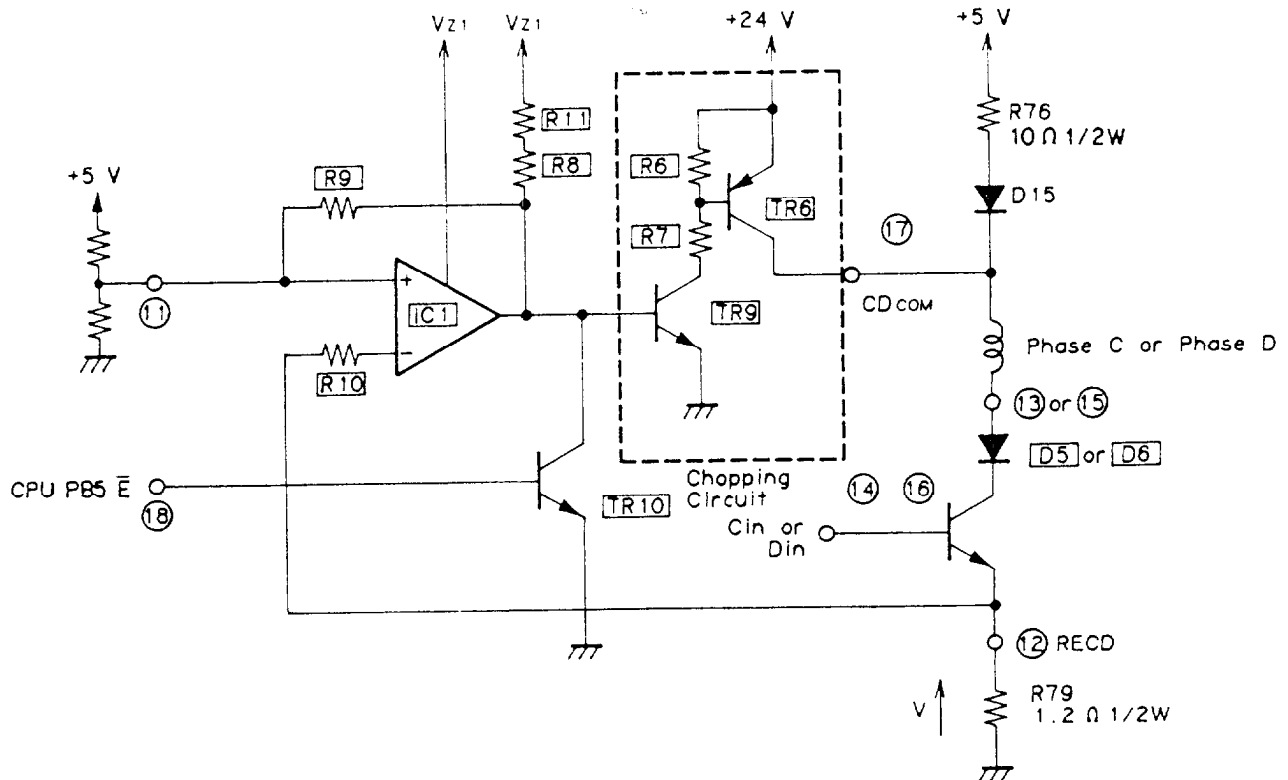


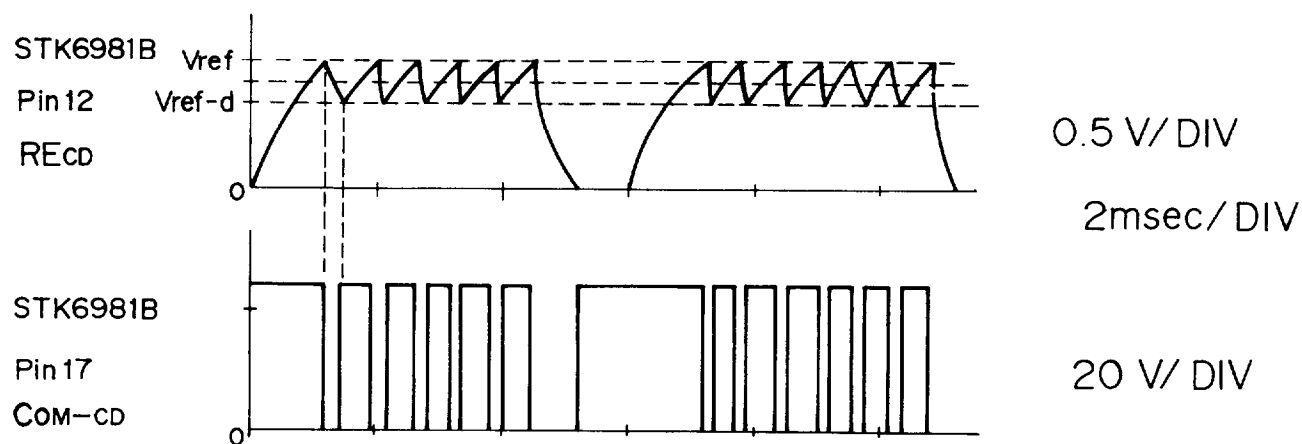
Figure 2-38. Constant Current Control Circuit

Table 2-6. Current Values for Reference Voltages

PB5 E	PB6 SPDM	PB1 SPDH	Current Value
L	H	H	0.67A
L	L	H	0.61A
L	H	L	0.23A
L	L	L	0.16A
H (Hold)	—	—	0.12A

With positive feedback through R9, a hysteresis, whose upper bound is the reference voltage, is generated in the comparator of IC1. The comparator works as a Schmitt trigger, which senses a difference only when the feedback (inverse terminal) is slightly larger or smaller than the hysteresis level. Reference voltage-a and the feedback voltage are compared by the comparator in IC1. If reference voltage-a is HIGH, TR6 turns on, applying approximately 25 VDC to the coil. The current rises linearly due to inductance, and TR6 turns off when the feedback voltage reaches reference voltage. In this manner an almost constant current can be applied to the coil.

Figure 2-39 shows the drive current waveform (pin 12) of the carriage motor and the chopping waveform (pin 17) of the drive voltage (+ 25 V), at 900 PPS. Figure 2-39 shows the Schmitt trigger circuit.

**Figure 2-39. Chopping Waveforms**

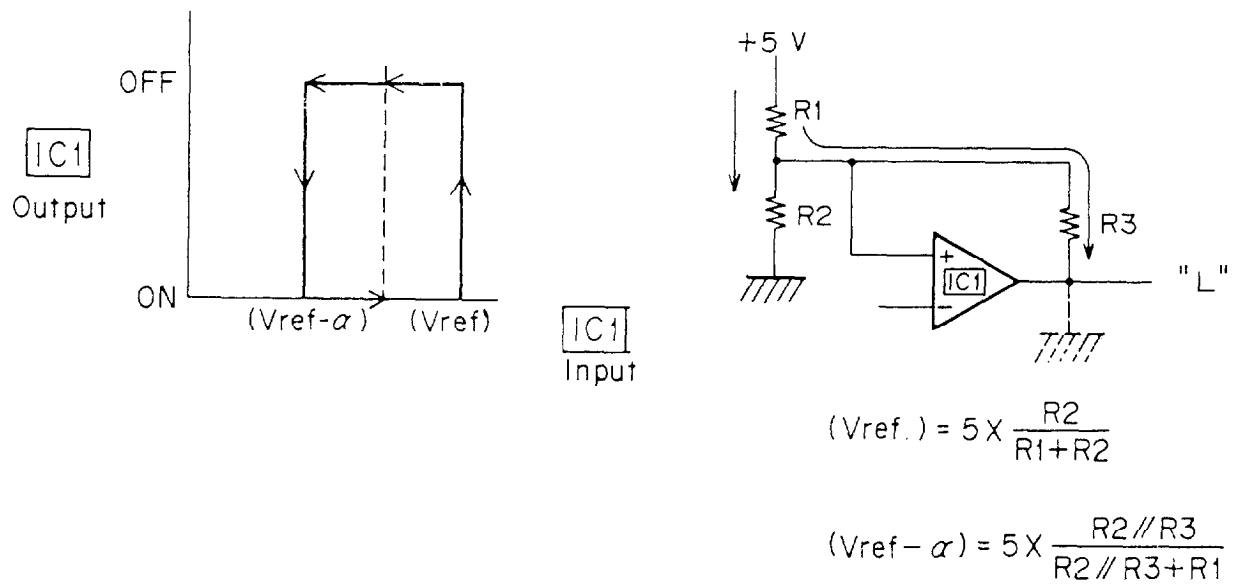


Figure 2-40. Schmitt Trigger Circuit

2.2.5.6 Carriage Motor Software Control

This section describes the carriage motor software control.

Excitation System

The excitation system is determined by the firmware and is executed in accordance with the carriage speed, as shown in Table 2-7. The motor drive sequence for each excitation system is shown in Tables 2-8 and 2-9.

Table 2-7. Phase-Excitation Method

Carriage Speed		Phase-Excitation Method
× 3	900 PPS	2-2 Phase
× 2	600 PPS	2-2 Phase
× 1.5	900 PPS	1-2 Phase
× 1	600 PPS	1-2 Phase

Table 2-8. Drive Sequence (2-2 Excitation)

CR DIRECTION	Left → Right				Right → Left			
Step No.	Phase A	Phase B	Phase C	Phase D	Phase A	Phase B	Phase C	Phase D
1	ON	OFF	ON	OFF	ON	OFF	OFF	ON
2	ON	OFF	OFF	ON	ON	OFF	ON	OFF
3	OFF	ON	OFF	ON	OFF	ON	ON	OFF
4	OFF	ON	ON	OFF	OFF	ON	OFF	ON

Table 2-9. Drive Sequence (1-2 Excitation)

CR DIRECTION	Left → Right				Right → Left			
	Phase A	Phase B	Phase C	Phase D	Phase A	Phase B	Phase C	Phase D
1	ON	OFF	OFF	ON	ON	OFF	ON	OFF
2	ON	OFF	OFF	OFF	ON	OFF	OFF	OFF
3	ON	OFF	ON	OFF	ON	OFF	OFF	ON
4	OFF	OFF	ON	OFF	OFF	OFF	OFF	ON
5	OFF	ON	ON	OFF	OFF	ON	OFF	ON
6	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF
7	OFF	ON	OFF	ON	OFF	ON	ON	OFF
8	OFF	OFF	OFF	ON	OFF	OFF	ON	OFF

Since a stepper motor is used for the carriage motor, it is possible to hold at any position and switch printing direction. The carriage motor control system is an open-loop system which switches the phases in accordance with set speeds.

The drive chopping current is switched at the drive frequency for the carriage motor. The relationship between drive speed and switching current value is shown in Figure 2-41, and values for the drive chopping current are listed in Table 2-10.

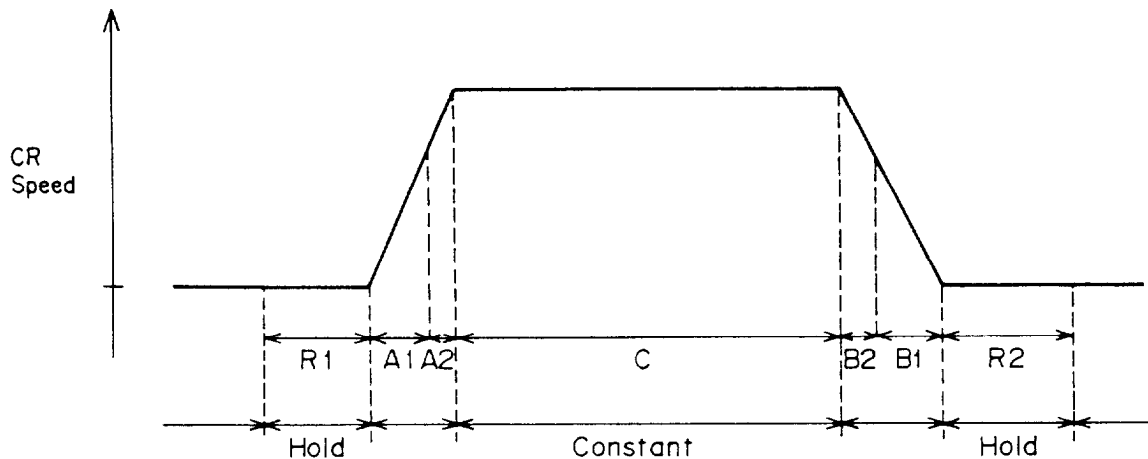
**Figure 2-41. Chopping Current and Drive Speed**

Table 2-10. Chopping Current

CR Speed	Drive Frequency (PPS)	Current (mA)						
		R1	A1	A2	C	B2	B1	R2
× 3	900	300	640	640	300	300	300	300
× 2	600	300	640	300	230	230	300	300
× 1.5	900	300	640	300	230	230	300	300
× 1	600	300	640	300	230	230	300	300

The times for constant speed, acceleration control, and deceleration control are shown below. The a marks in the acceleration and deceleration columns control items in the tables and indicate switching times from A1 to A2 or B2 to B1.

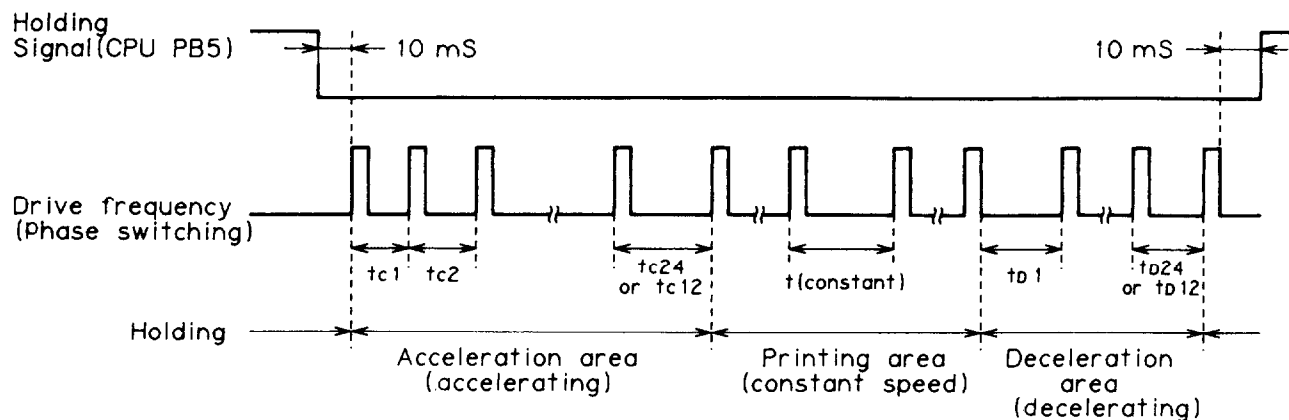


Figure 2-42. Carriage Motor Control

Table 2-11. Time Constants for Speeds

	× 3 900 PPS	× 2 600 PPS	× 1.5 900 PPS	× 1 600 PPS
Constant Speed (ms)	1.11	1.66	1.11	1.66

Accuracy +50 μ s
-0 μ

Table 2-12. Acceleration Time Data (2-2 Excitation)

	× 3 900 PPS	× 2 600 PPS
tc 1	4.00 ms	3.56 ms
tc 2	2.80 ms	3.22 ms
tc 3	2.00 ms	2.20 ms
tc 4	1.62 ms	2.00 ms
tc 5	1.50 ms	↑
tc 6	1.40 ms	1.95 ms
tc 7	↑	- ↑
tc 8	1.30 ms ◁	1.85 ms ◁
tc 9	↑	↑
tc 10	1.22 ms	↑
tc 11	↑	1.75 ms
tc 12	1.15 ms	↑
tc 13	1.11 ms	1.66 ms
tc 14	↑	↑
Constant Speed	1.11 ms	1.66 ms

Table 2-13. Deceleration Time Data (2-2 Excitation)

	× 3 900 PPS	× 2 600 PPS
td 1	1.11 ms	1.66 ms
td 2	↑	↑
td 3	↑	↑
td 4	1.15 ms	↑
td 5	1.20 ms	1.75 ms
td 6	↑	↑
td 7	1.35 ms ◁	1.85 ms ◁
td 8	↑	1.92 ms
td 9	1.60 ms	2.16 ms
td 10	↑	↑
td 11	↑	↑
td 12	2.00 ms	2.44 ms
td 13	2.30 ms	2.76 ms
td 14	3.00 ms	3.48 ms

Table 2-14. Acceleration Time Data (1-2 Excitation)

	× 1.5 900 PPS	× 1 600 PPS
tc 1	3.30 ms	3.30 ms
tc 2	2.60 ms	2.60 ms
tc 3	2.31 ms	2.22 ms
tc 4	2.00 ms	2.00 ms
tc 5	1.72 ms	1.92 ms
tc 6	1.51 ms	1.85 ms
tc 7	1.46 ms	↑
tc 8	↑	↑
tc 9	1.34 ms	1.75 ms
tc 10	↑	↑
tc 11	↑	1.66 ms
tc 12	1.22 ms	↑
tc 13	↑	↑
tc 14	1.16 ms	↑
tc 15	↑	↑
tc 16	1.11 ms	↑
tc 17	↑	↑
tc 18	↑	↑
tc 19	↑	↑
tc 20	↑	↑
tc 21	↑	↑
tc 22	↑	↑
tc 23	↑	↑
tc 24	↑	↑
tc 25	↑	↑
tc 26	↑	↑
tc 27	↑	↑
tc 28	↑	↑
Constant Speed	1.11 ms	1.66 ms

Accuracy +50μs

0...

Table 2-15. Deceleration Time Data (1-2 Excitation)

	× 1.5 900 PPS	× 1 600 PPS
td 1	1.11 ms	1.66 ms
td 2	↑	↑
td 3	↑	↑
td 4	↑	↑
td 5	↑	↑
td 6	↑	↑
td 7	↑	↑
td 8	↑	↑
td 9	↑	↑
td 10	↑	↑
td 11	↑	↑
td 12	↑	↑
td 13	↑	↑
td 14	↑	↑
td 15	1.22 ms	↑
td 16	↑	↑
td 17	↑	1.75 ms
td 18	↑	↑
td 19	↑	1.85 ms
td 20	1.35 ms	↑
td 21	↑	1.92 ms
td 22	1.46 ms	↑
td 23	↑	2.05 ms
td 24	1.66 ms	↑
td 25	↑	2.18 ms
td 26	1.92 ms	↑
td 27	2.29 ms	2.44 ms
td 28	2.91 ms	3.06 ms

Accuracy +50 μ s
 -0 μ s

Home-Position Seek

The control that causes the carriage to move to the home position when the power is turned on is called home-position seek. Figure 2-43 shows the home-position seek operation. After power is applied, the printer executes 2-2 phase excitation for 20 or 30 ms and checks the HOME signal, regardless of the phase switching timing. The result of this check determines whether the starting position should be 1 or 2. The carriage enters the home position only once during the initialization.

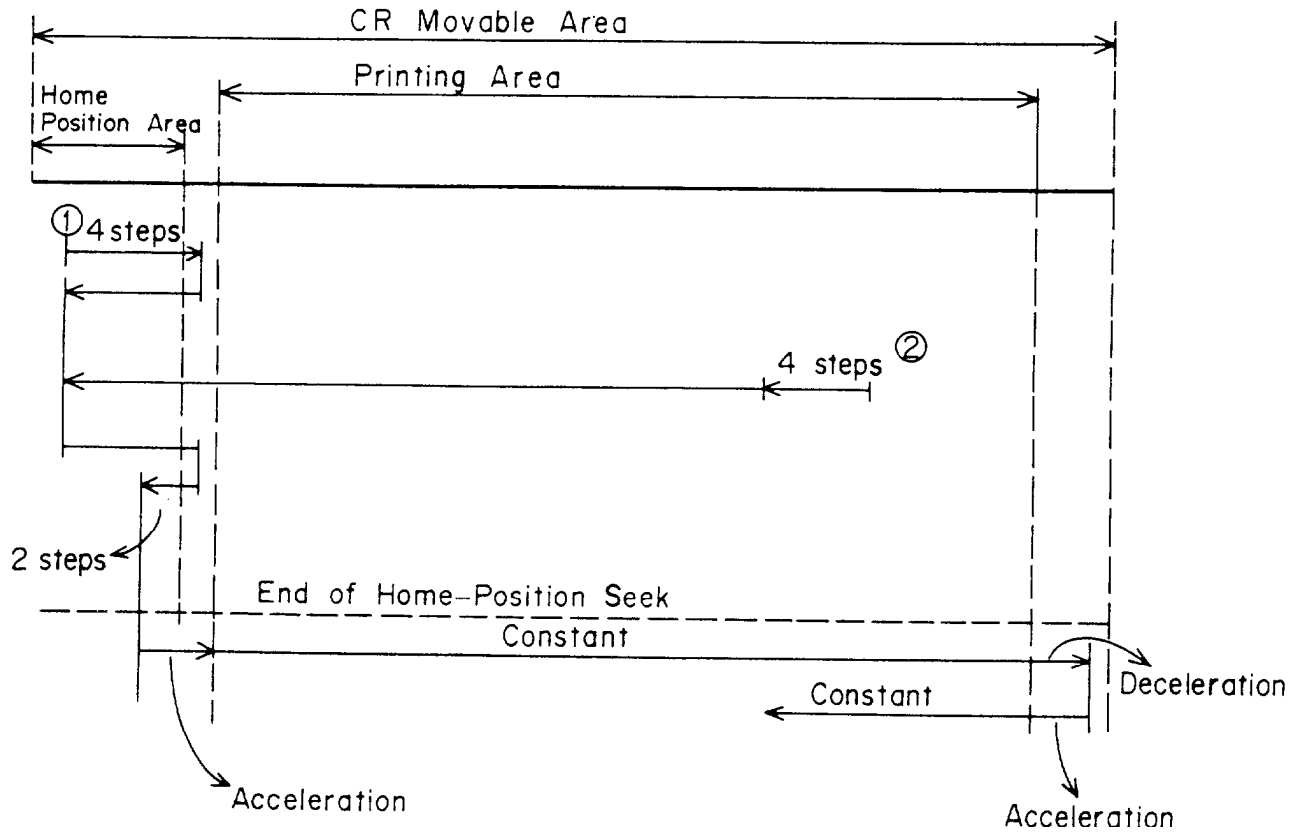


Figure 2-43. Home-Position Seek

Printing Area

The printing area is defined as starting 22 phase switching times after the home position.

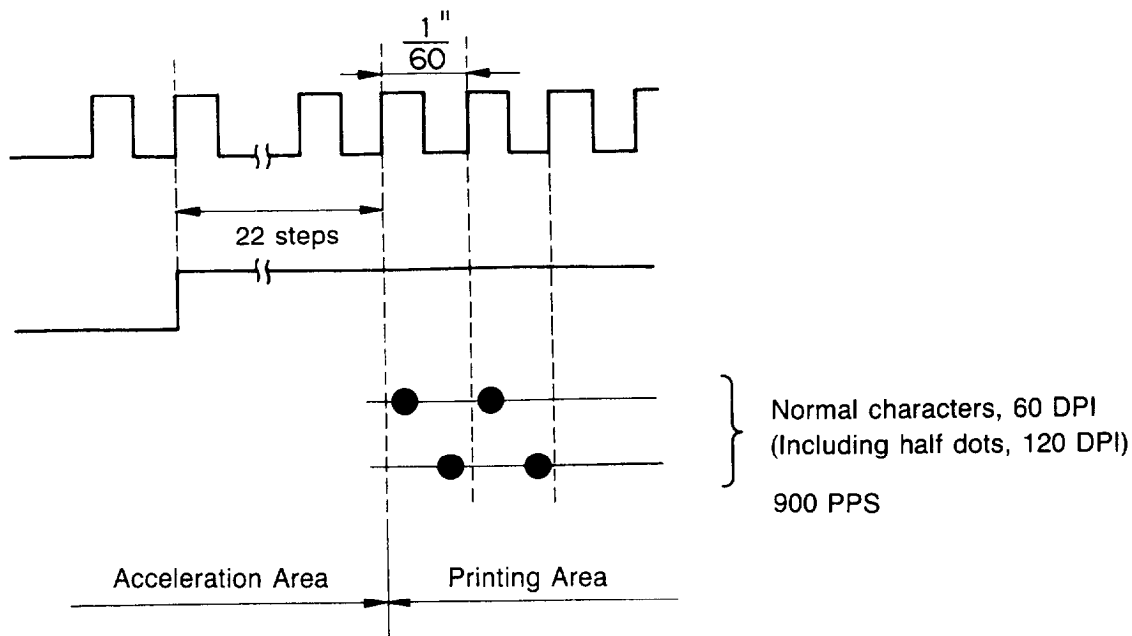


Figure 2-44. Printing Area and Printing Timing

Abnormal Carriage Operation

This unit does not employ a print timing signal (PTS) sensor and cannot detect abnormal carriage operation. Therefore, no error occurs even if carriage movement is prevented by external forces. An error will only occur if the HOME signal is received in the printing area, in which case the carriage will stop.

2.2.6 Paper Feed

This section describes the paper-feed operation.

2.2.6.1 Paper-Feed Mechanism Operation

The paper-feed mechanism operates by friction feed for cut sheets and by the sprocket-feed method for fanfold paper.

Friction-Feed Operation

The paper is held against the platen by two paper-feed rollers and by the printer cover. At this time, the paper-feed motor is driven to rotate the platen gear, via the paper-feed reduction gear, in the direction shown in Figure 2-45. The rotation of the platen gear feeds the paper in the direction of the arrow, due to friction from the paper-feed rollers and platen. Because the paper is held against the platen by the spring force of the paper-feed rollers, the paper can be released by shifting the paper-release lever forward.

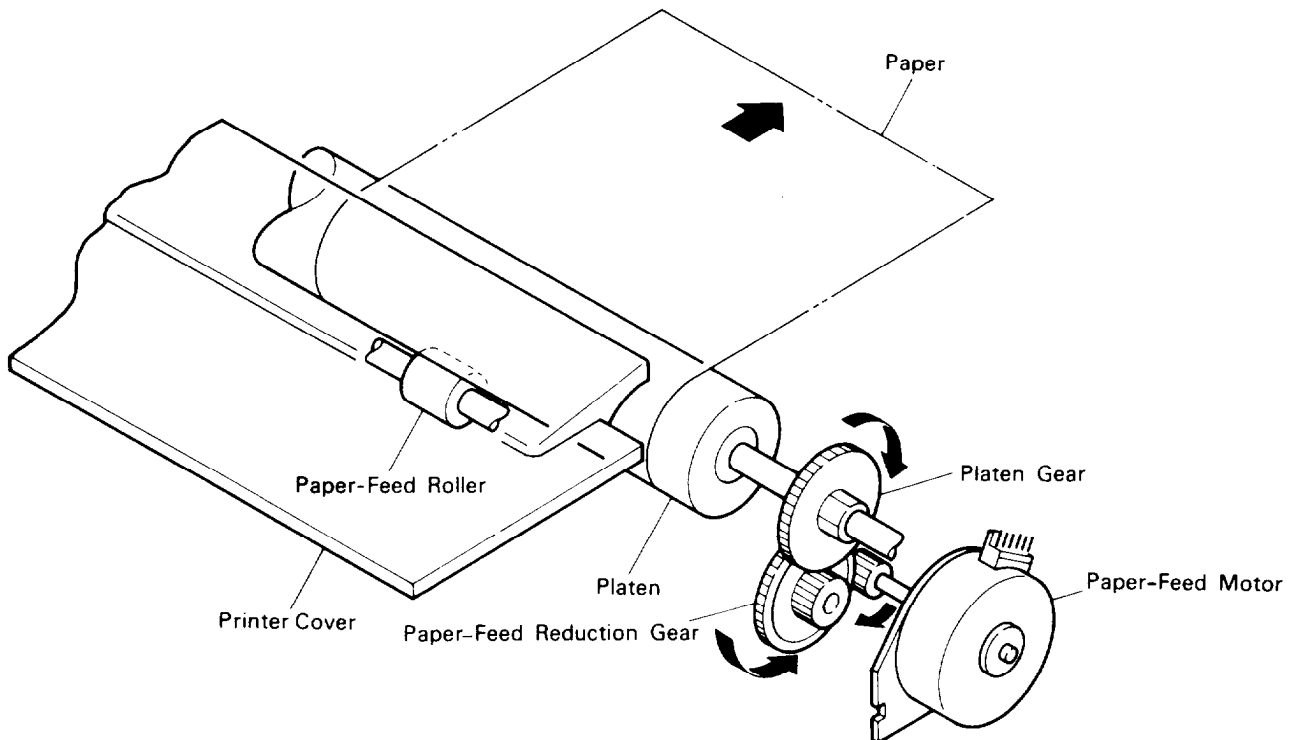


Figure 2-45. Friction-Feed Operation

Sprocket-Feed Operation

When using the sprocket-feed method, set the holes in the paper over the sprocket pins along the sprocket wheel. The paper-feed motor is driven to rotate the gears, via the pinion on the shaft of the motor, in the direction shown in Figure 2-46. Rotating the gears rotates the sprocket wheels, which advances the paper in the direction shown by the arrow.

For the sprocket-feed method, the pressure of the paper-feed rollers against the platen is released by shifting the release lever forward.

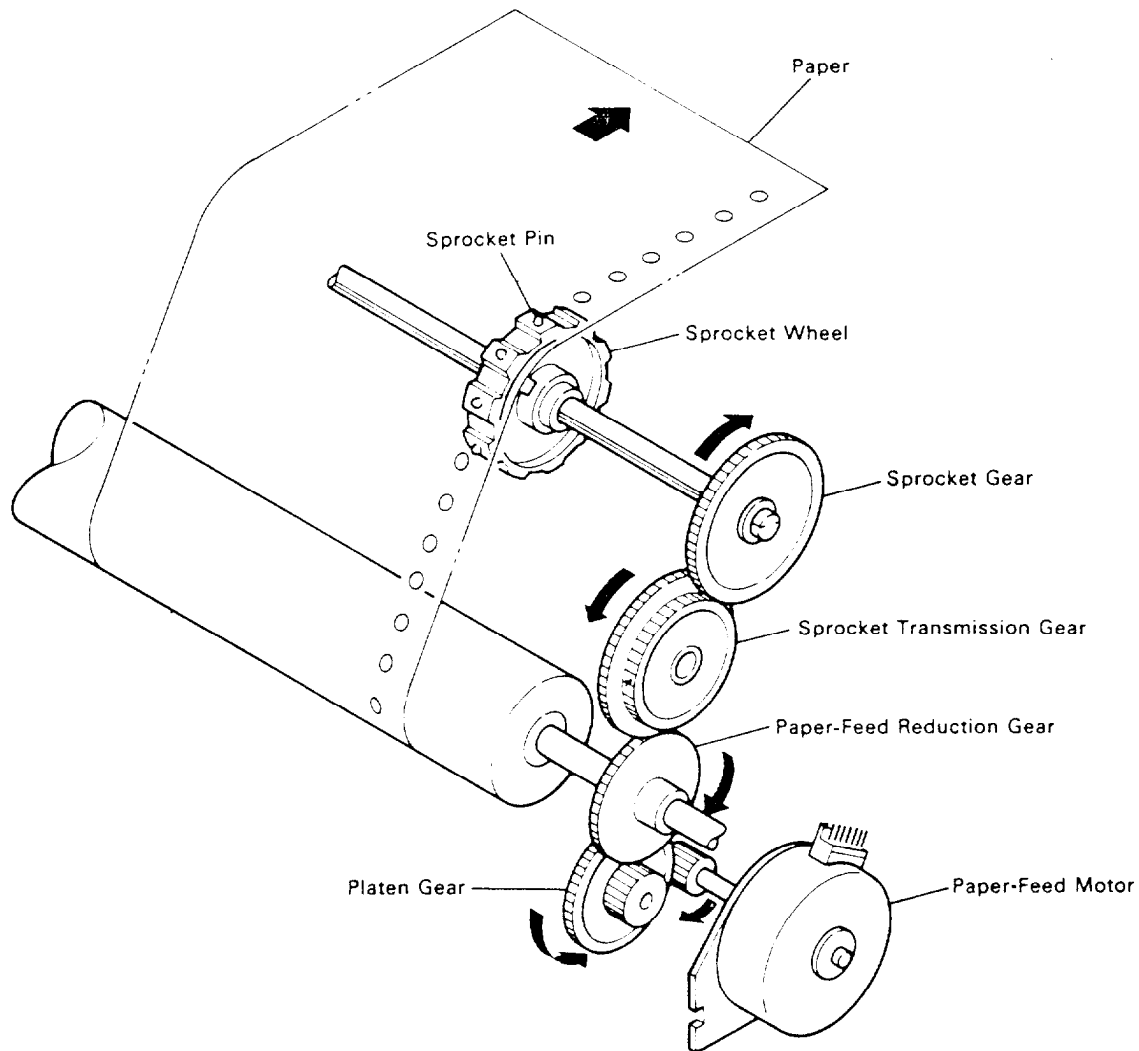


Figure 2-46. Sprocket-Feed Operation

2.2.6.2 Paper-Feed Motor Specifications

Paper-feed motor specifications are as follows:

Type	4-phase, 48-pole stepper motor
Drive Voltage	24 VDC \pm 10%
Coil Resistance	58 ohms \pm 7% at 25 degrees C
Phase Excitation	2-2 phase excitation
Current	Maximum, 1.1 A (Rush Current) Driving: 0.30 A (typical) Holding: 0.06 A \pm 20 mA
Driving Frequency	400 PPS

2.2.6.3 Paper-Feed Motor Drive Circuit

The paper-feed motor drive circuit is shown in Figure 2-47. A stepper motor is used as the paper-feed motor, and the 2-2 phase excitation system is employed. When the paper-feed signal PB2 is set to LOW, Q27 is turned on, and +24 V is supplied to the motor. When the paper-feed motor is not being driven, +5 V is supplied to the motor via resistor R36 and diode D11 to hold the motor.

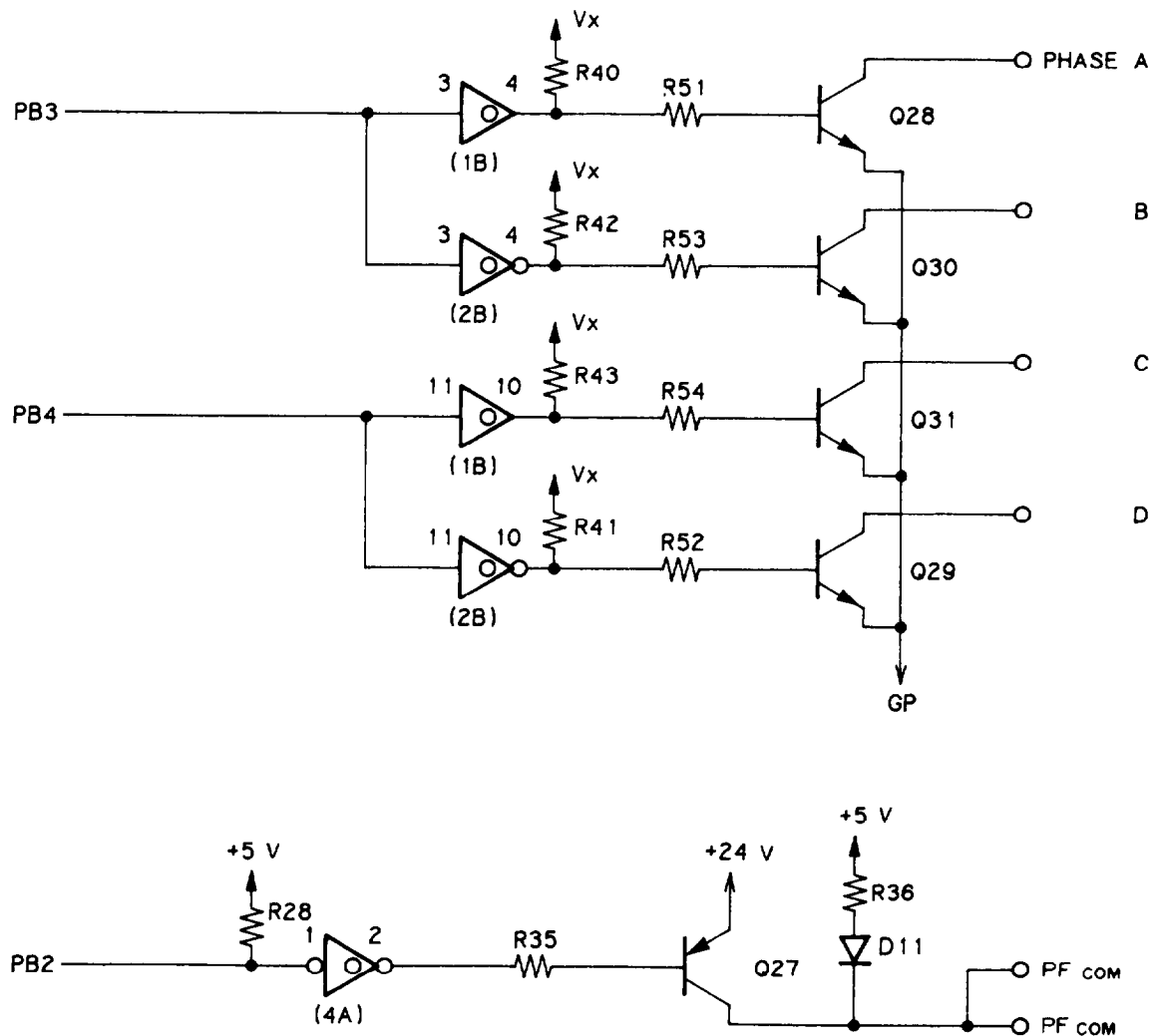


Figure 2-47. Paper-Feed Motor Drive Circuit

2.2.6.4 Paper-Feed Motor Software Control

The paper-feed motor is a 48-pole stepper motor and is open-loop controlled. Paper is fed 1/180th inch for each step when the paper-feed motor is driven by the 2-2 phase excitation system. Table 2-16 shows the paper-feed motor excitation system.

Table 2-16. Excitation Sequence (Clockwise: Paper Feeds Forward)

Step No.	PB3	PB4	A Phase	B Phase/ (\bar{A} Phase)	C Phase	D Phase/ (\bar{C} Phase)
0	H	H	ON	OFF	ON	OFF
1	H	L	ON	OFF	OFF	ON
2	L	L	OFF	ON	OFF	ON
3	L	H	OFF	ON	ON	OFF

NOTE: If the paper-feed motor is driven counterclockwise, paper is fed in reverse.

Figure 2-48 and Table 2-17 show the timing chart and the counter values for the acceleration and deceleration control, respectively.

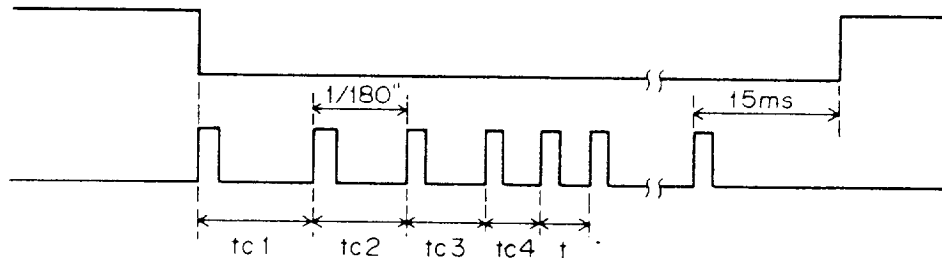


Figure 2-48. Paper-Feed Motor Drive Timing Chart

Table 2-17. Setting Time

Acceleration		Deceleration	
	Set Time (ms)		Set Time (ms)
tc 1	3.33	t	2.50
tc 2	2.87	td 1	2.53
tc 3	2.65	td 2	2.65
tc 4	2.53	td 3	2.87
t	2.50	td 4	3.33

Time Accuracy + 200 μ s, - 50 μ s

NOTE: If steps are less than 10, the speed is neither accelerating nor decelerating

2.2.7 Printhead

This section describes printhead operation.

2.2.7.1 Printhead Printing Operation

The dot-wire operation during printing is as follows: when the head-driving coil for a dot wire is energized, the actuating plate engaged with the dot wire at one end is attracted to the iron core and drives the dot wire toward the platen. The dot wire strikes the ribbon and the paper against the platen to print a dot in the paper.

When the head-driving coil is deenergized, the actuating plate returns to the initial position as a result of action of the actuating plate spring. After striking the platen, the dot wire also returns to its initial position as a result of impact energy and from the wire-resetting spring, and the dot wire is held in engagement with the actuating plate until it is driven again. Figure 2-49 shows the printhead printing operation.

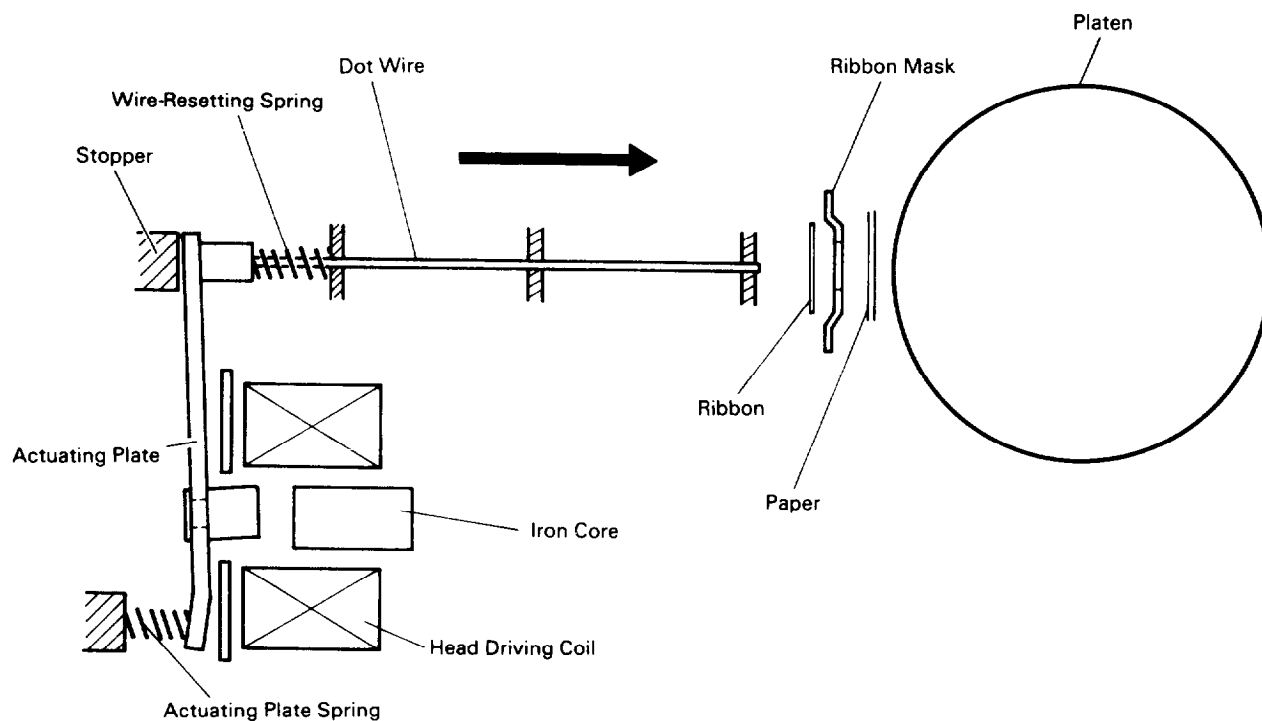


Figure 2-49. Printhead Printing Operation

2.2.7.2 Printhead Specifications

Printhead specifications are as follows:

Solenoids	24 solenoids
Wire Diameter	0.02 mm
Pin Arrangement	12 x 2, staggered
Drive Voltage	24 VDC \pm 10%
Coil Resistance	16 \pm 10% at 25 degrees C
Driving Pulse Width	415 μ s to 435 μ s
Solenoid Drive Frequency	1 .111 msec (900 Hz) \pm 5%
Current	0.12 A (typical)

2.2.7.3 Printhead Drive Circuit Block Diagram

Gate array E05A02LA is used as an 8-bit x 3 data latch. The CPU determines the pulse width for the head-wire drive pulses from gate array E05A02LA by monitoring the printhead drive power (+ 24 V line). The CPU also monitors the printhead temperature and stops printing if it gets too high.

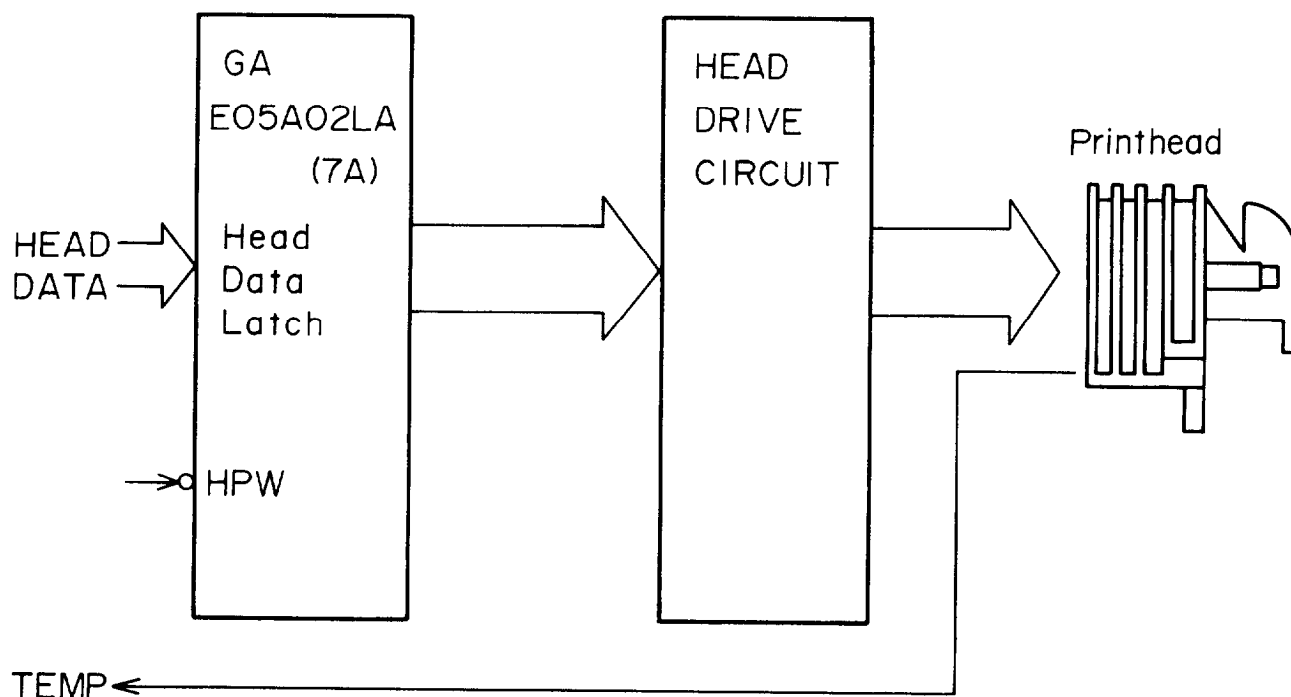


Figure 2-50. Printhead Drive Circuit Block Diagram

2.2.7.4 Gate Array E05A02LA Operation in Printhead Drive Circuit

The E05A02LA gate array includes circuitry to interface the CPU and the printhead. This general-purpose gate array has special commands that lighten the load on the CPU when outputting printhead data. Figure 2-51 is a block diagram of the E05A02LA gate array. The gate array mainly consists of data latches: 8 bits x 3 = 24 bits. The gate array has functions (commands) for writing data to all 24 bits of the data latches efficiently.

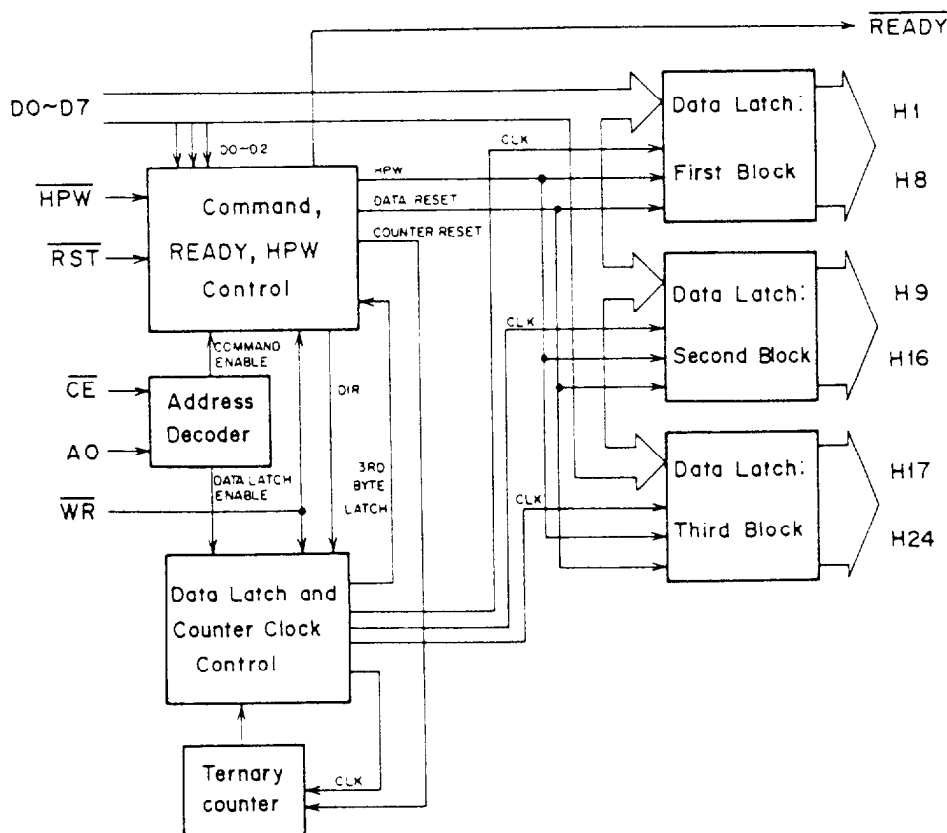


Figure 2-51. E05A02LA Block Diagram

Because the CS terminal of this gate array is activated by accessing addresses F004 hex. and F005 hex., the command output address and data output address are determined as shown in Table 2-18.

Table 2-18. E05A02LA Gate Array Functions

Address	Function
F004 hex.	Outputs a command: Bit 7: Data latch writing-sequence set up 0: Ascending order 1: Descending order Bit 6: $\overline{\text{HPW}}$ valid/invalid setting Bit 5: Counter resetting Bit 4 to Bit 0: Optional
F005 hex.	Latches data and increases the counter: When latching data, the data is NANDed with the contents of the current latch and is protected against double writes (the same data cannot be output twice in succession). Latching data into all the data latches is completed by latching three bytes, one at a time. When $\overline{\text{HPW}}$ is valid as a command, the latched head data is inverted, then is output while $\overline{\text{HPW}}$ is LOW.

NOTE: When HPW setting is invalid, the HPW output will be in the open-drain ON state independent of the HPW input. The drive pulse is input to the HPW terminal.

2.2.7.5 Printhead Drive Circuit

The drive pulse width is adjusted using CPU port PC6. The V_x voltage is used to pull up the output signals from the gate array in order to prevent printhead malfunctions.

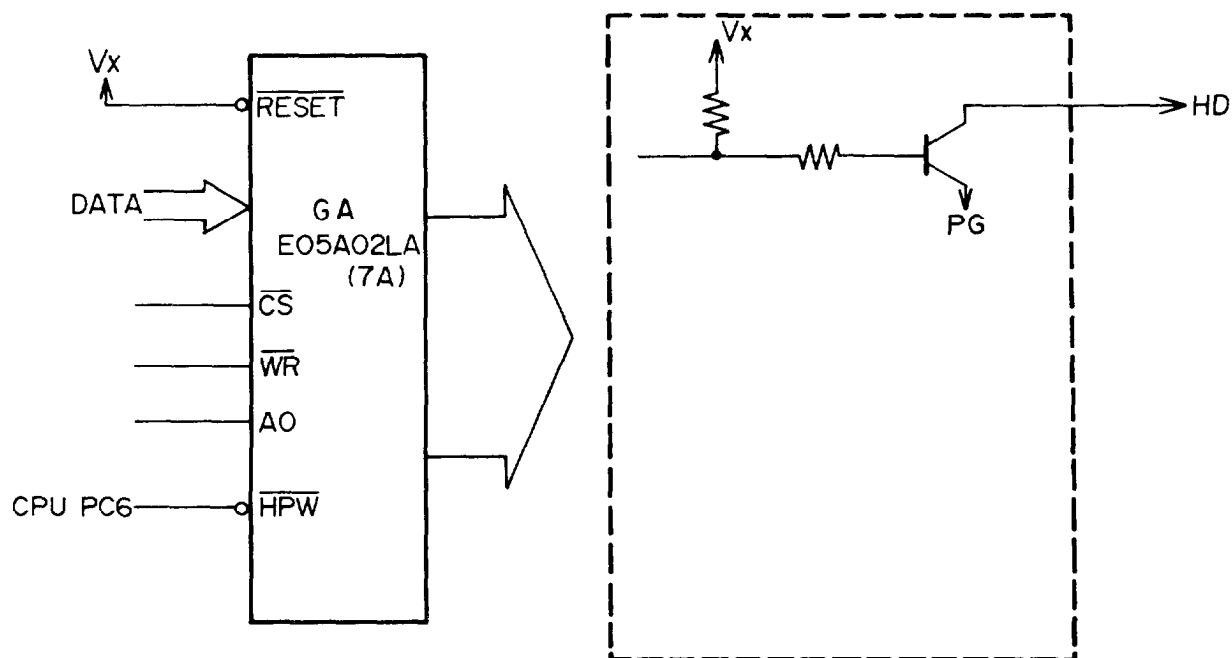


Figure 2-52. Printhead Drive Circuit

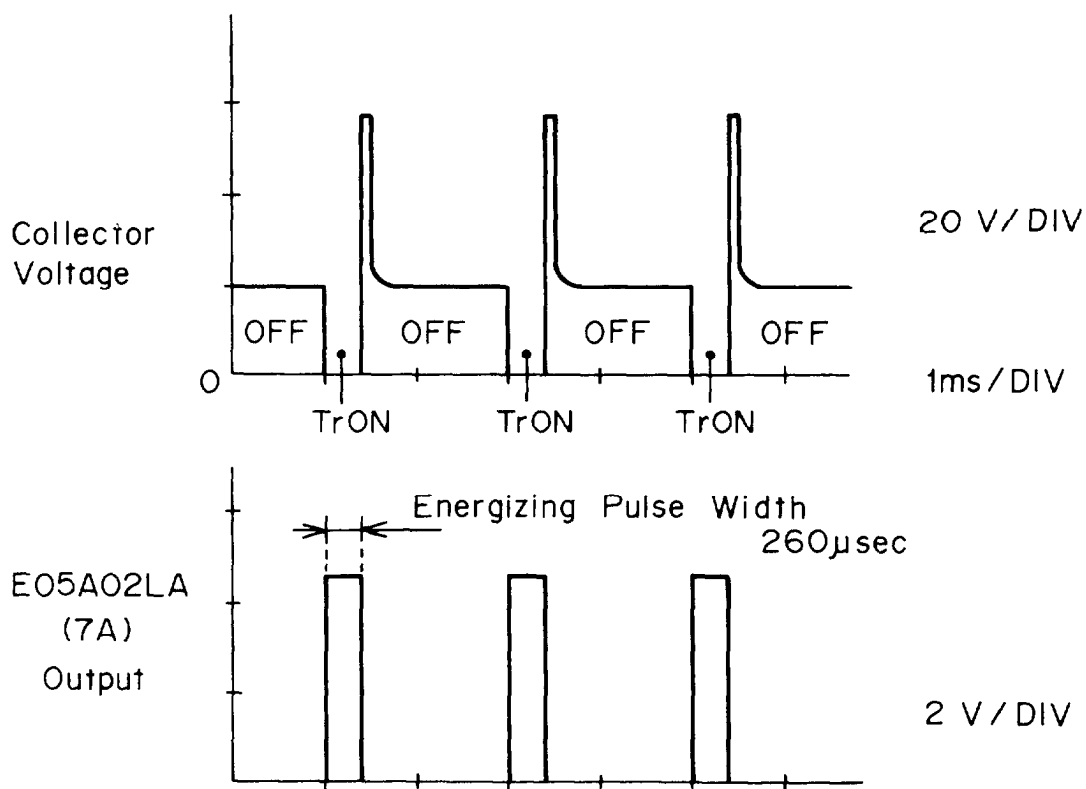


Figure 2-53. Printhead Driving Waveforms

2.2.7.6 Printhead Software Control

During operation at 900 PPS, one print cycle is performed at each phase switching step to meet the specifications of the printhead (solenoid drive frequency: 900 Hz).

The drive pulse width is adjusted by using an A/D converter to detect the drive voltage, and is kept within the area shown by the oblique lines in Figure 2-55.

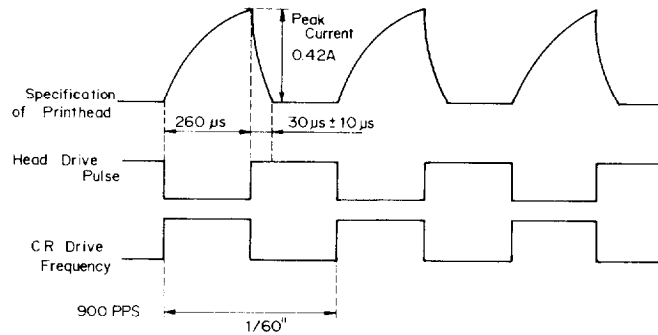


Figure 2-54. Print Timing

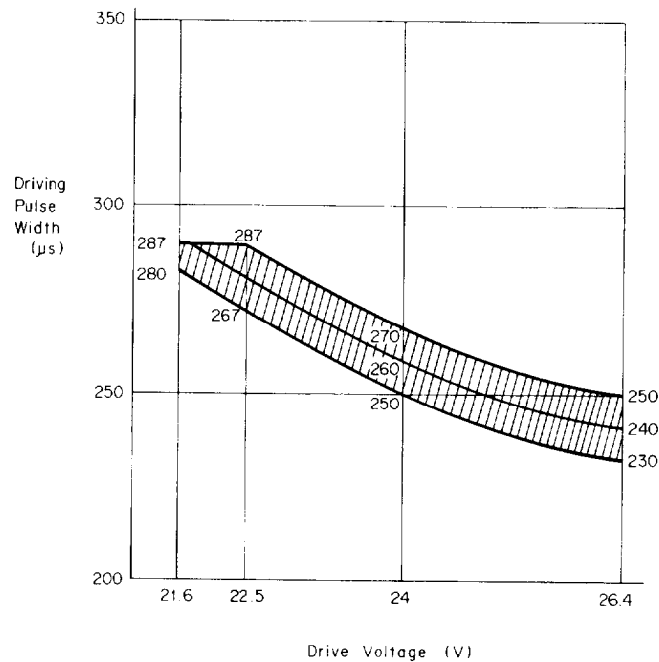


Figure 2-55. Relationship between Head Driver Voltage and Print Driving Pulse Width

2.2.8 A/D Converter Circuit

Figure 2-56 shows the A/D converter circuit. The functions of this converter are as follows:

- Monitors the +24 V line to determine the drive pulse width for the printhead.
- Monitors the temperature (the resistance value) of the printhead.
- Reads the initial DIP switch settings.
- Reads the set value of the bidirectional adjustment.

Using shunt regulator TL431CLPB, R37, and R55, reference voltage V_{REF} in this circuit is set as follows:

$$V_{REF} = \frac{2.5 \text{ V}}{R_{55}} (R_{55} + R_{37}) = 4.5$$

NOTE: 2.5 V is the shunt regulator reference voltage.

Using this value as a reference, the + 24 V line is monitored by AN0, the head temperature is monitored by AN1, and DIP switches and bidirectional adjustment are read using AN2 through AN7.

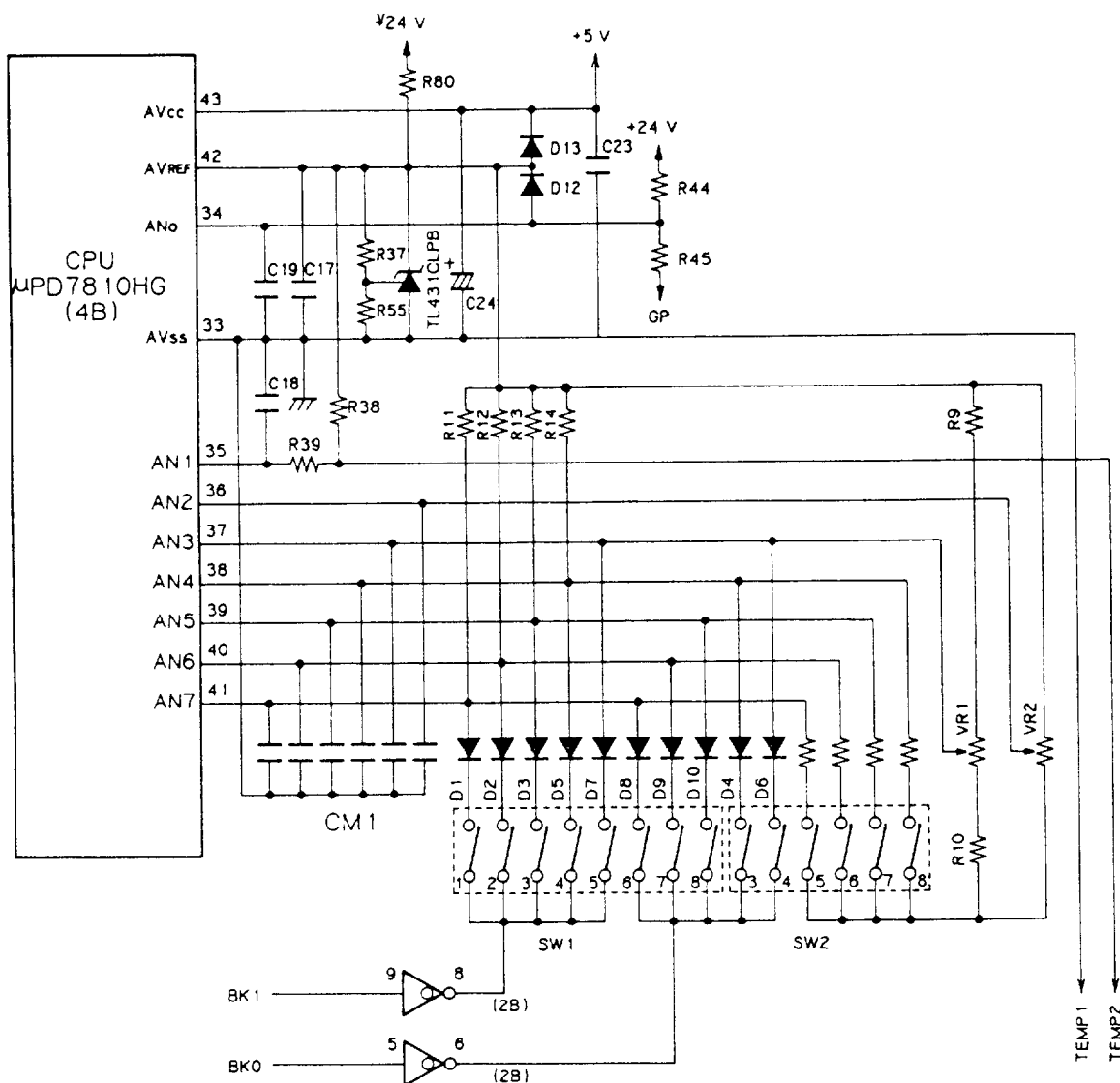


Figure 2-56. A/D Converter Circuit

Table 2-19 shows the relationship between the scan lines and DIP switches.

Table 2-19. Scan Lines and DIP Switches

DIP Switch	Scan Line	
	BK 0	BK 1
SW-1 1-5	L	H
SW-1 6-8 SW-2 3-4	H	L
SW-2 5-8	H	H

2.2.9 Host Interface

The host interface circuit is shown in Figure 2-57. STROBE pulses from the host computer pass through the low-pass filter, consisting of R32 and C21, and flow into the STRB terminal. These pulses latch the parallel data and set the BUSY signal HIGH, so that subsequent data transfer is inhibited. The gate array PINT terminal is automatically output by the STRB signal to request a CPU interrupt. When the CPU receives this interrupt request, it reads the data latched in the gate array. Table 2-20 shows the commands associated with the gate array E01A05KA (6C) host interface.

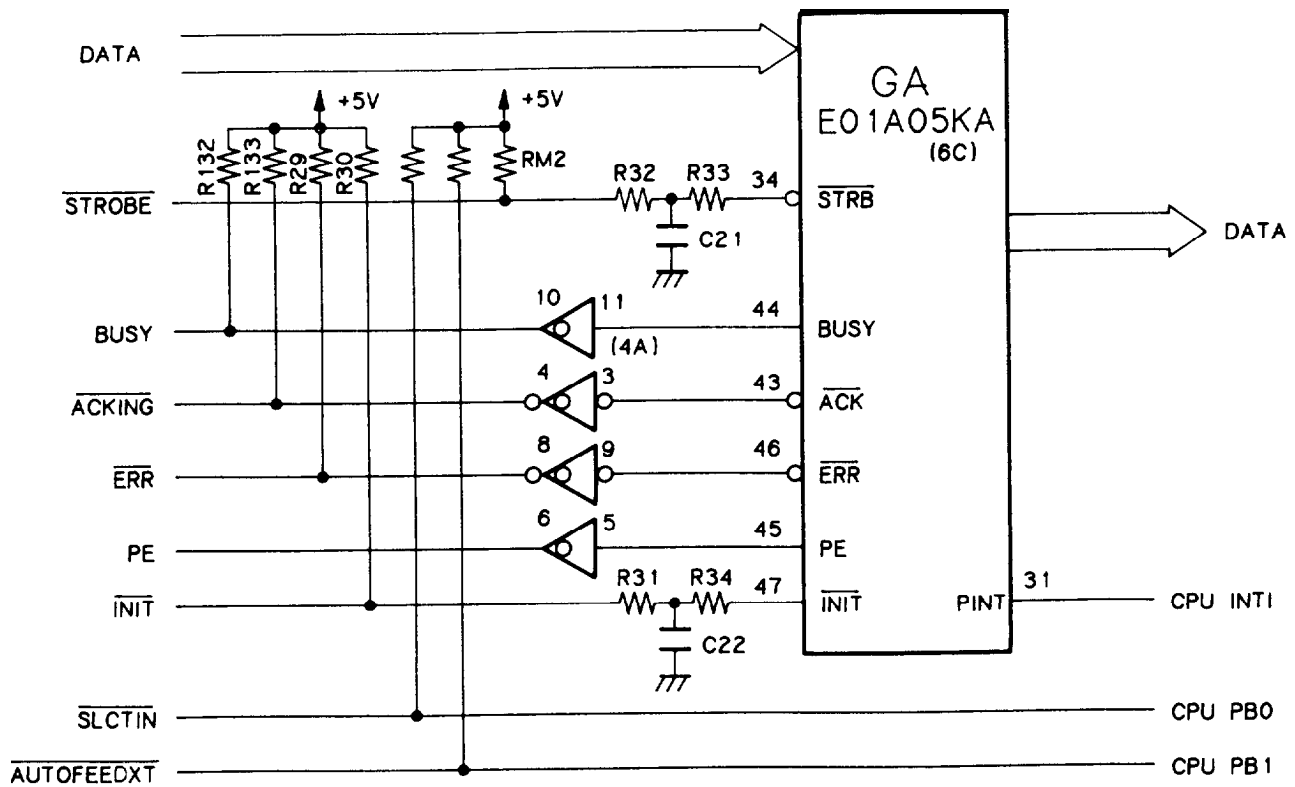


Figure 2-57. Host Interface

Table 2-20. Control Commands

WORK NAME		RD F000H	Reads the PARALLEL I/F Data (* 1) (Automatically Resets the Hardware Reset)
BIT	Function		
7	DIN 7		
6	6		
5	5		
4	4		
3	3		
2	2		
1	1		
0	0		

WORK NAME		RD F001H	Reads the PARALLEL I/F Signal
BIT	Function		
7	Internal ROM / External ROM		
6	_____		
5	STRB Signal: Negative Edge/Positive Edge (*2)		
4	Hardware BUSY (*3)		
3	Software BUSY		
2	ACK		
1	ERR		
0	PE		

Table 2-20. Control Commands (Cont.)

WORK NAME		WR F001H	Sets the PARALLEL I/F Signal
BIT	Function		When power is turned on.
7	External ROM Selected		External ROM
6	_____		_____
5	STRB Signal: Negative Edge/Positive Edge		Positive Edge
4	Hardware BUSY		LOW
3	Software BUSY		HIGH
2	ACK		HIGH
1	ERR		HIGH
0	PE		LOW

WORK NAME		RD F003H	Read the PARALLEL I/F DATA
BIT	Function		
7	DIN 7		
6	6		
5	5		
4	4		
3	3		
2	2		
1	1		
0	0		

- NOTES:**
1. Hardware BUSY is automatically reset by reading address F000 hex.
 2. This bit determines whether hardware BUSY is activated by the rising or falling edge of STRB.
 3. Hardware BUSY is activated by the rising or falling edge of the STRB signal. The final output of the BUSY signal **is** the conjunction of the hardware BUSY and software BUSY.

2.2.10 Buffer and Data Flow

This section describes the buffer and data flow.

2.2.10.1 Buffer

There are 5 kinds of buffers: input, line, image, queue, and download. The structure of each buffer is described as follows:

Input Buffer

Figure 2-58 shows the input buffer structure. This buffer is a 1K-byte or 8K-byte ring buffer, where data and commands from the host computer are stored. Data and commands are input by the INIT signal or by the INTSR interruption signal generated from the CPU.

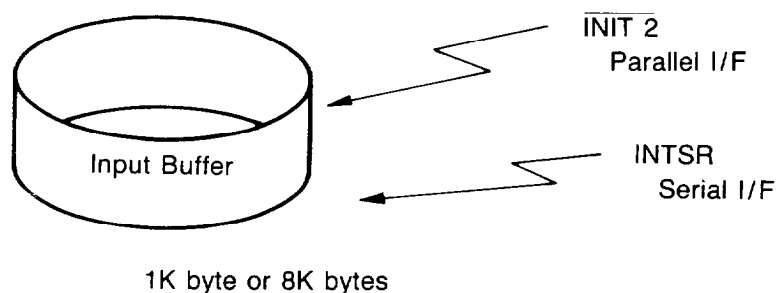


Figure 2-58. Input Buffer Structure

Line Buffer

Figure 2-59 shows the line buffer. Flags indicate the character type and enhancements, and the data up to the printing command (data for one line) is edited.

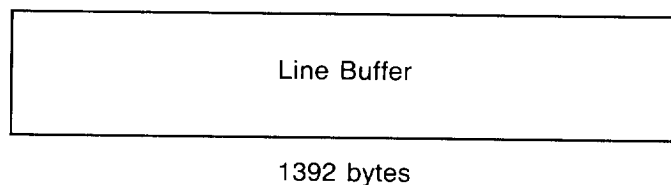


Figure 2-59. Line Buffer Structure

Image Buffer

The image buffer has two lines at 360 DPI (including half dots). One line is used for data output, and the other is used for developing the image data. The image data is output when an interruption is made by the SOFTI. Figure 2-60 shows the image buffer structure.

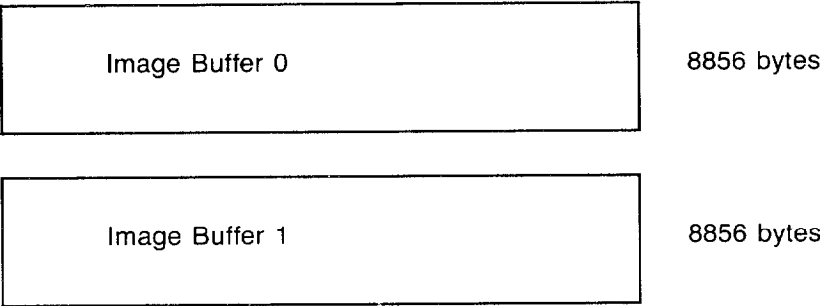


Figure 2-60. Image Buffer Structure

Queue Buffer

The queue buffer is used for controlling the paper-feed operation. With the INTEO interruption, paper is fed automatically according to the contents of the queue buffer. Figure 2-61 shows the queue buffer structure.

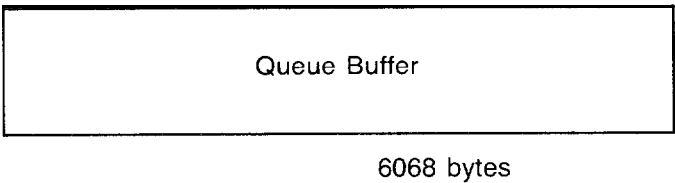


Figure 2-61. Queue Buffer Structure

Download Buffer

The download buffer has a capacity of 6K bytes. Figure 2-62 shows the download buffer structure.

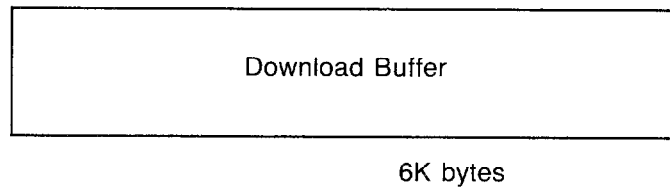


Figure 2-62. Download Buffer Structure

2.2.10.2 Data Flow

Data flow is shown in the main routine (Figure 2-63) and the printing routine (Figure 2-64). The main routine analyzes commands, develops data into image data, and controls interruption (prohibition, permission, operation). Interruption includes data input from the host computer, paper-feed operation, printing output, and the refresh operation.

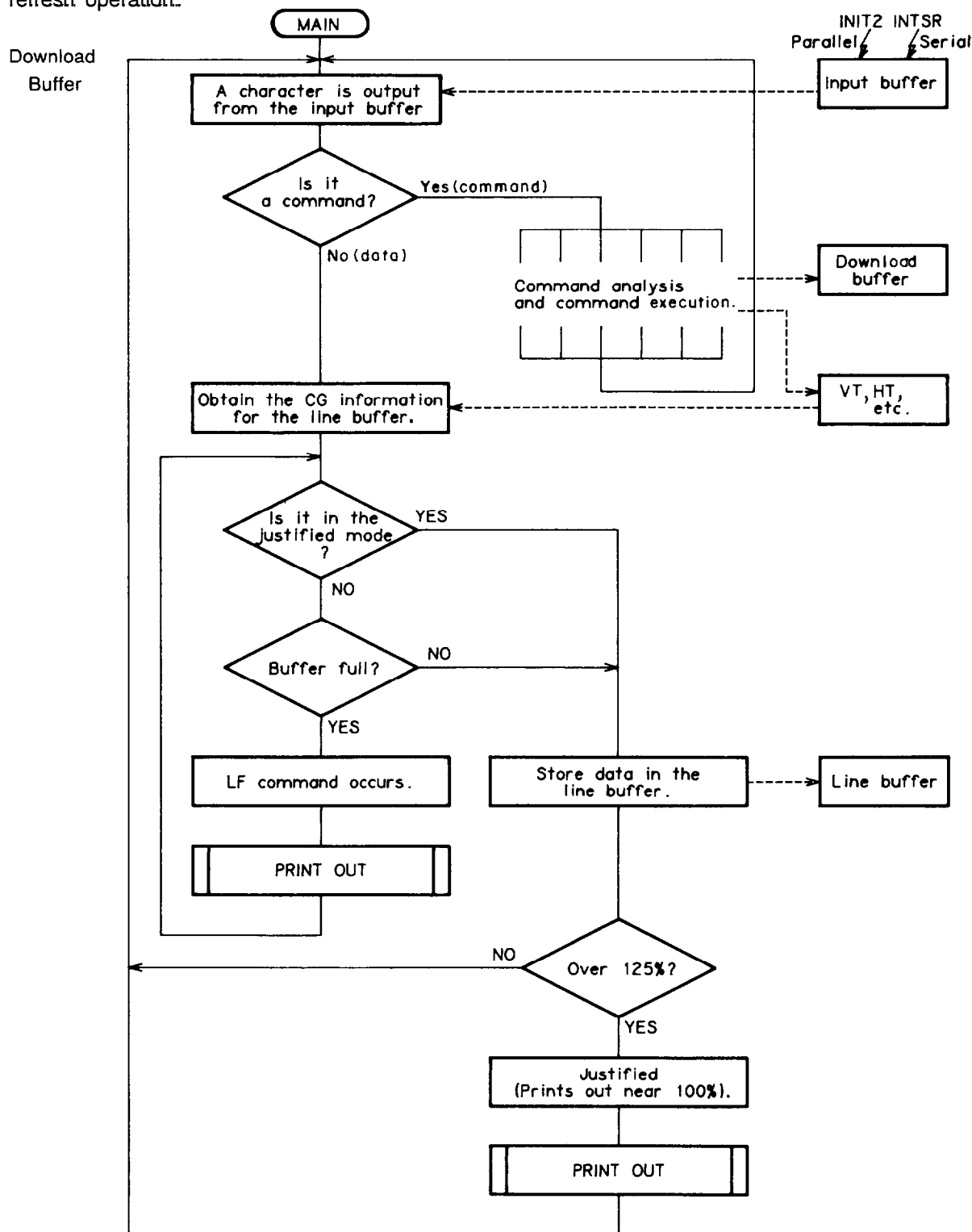


Figure 2-63. Main Routine

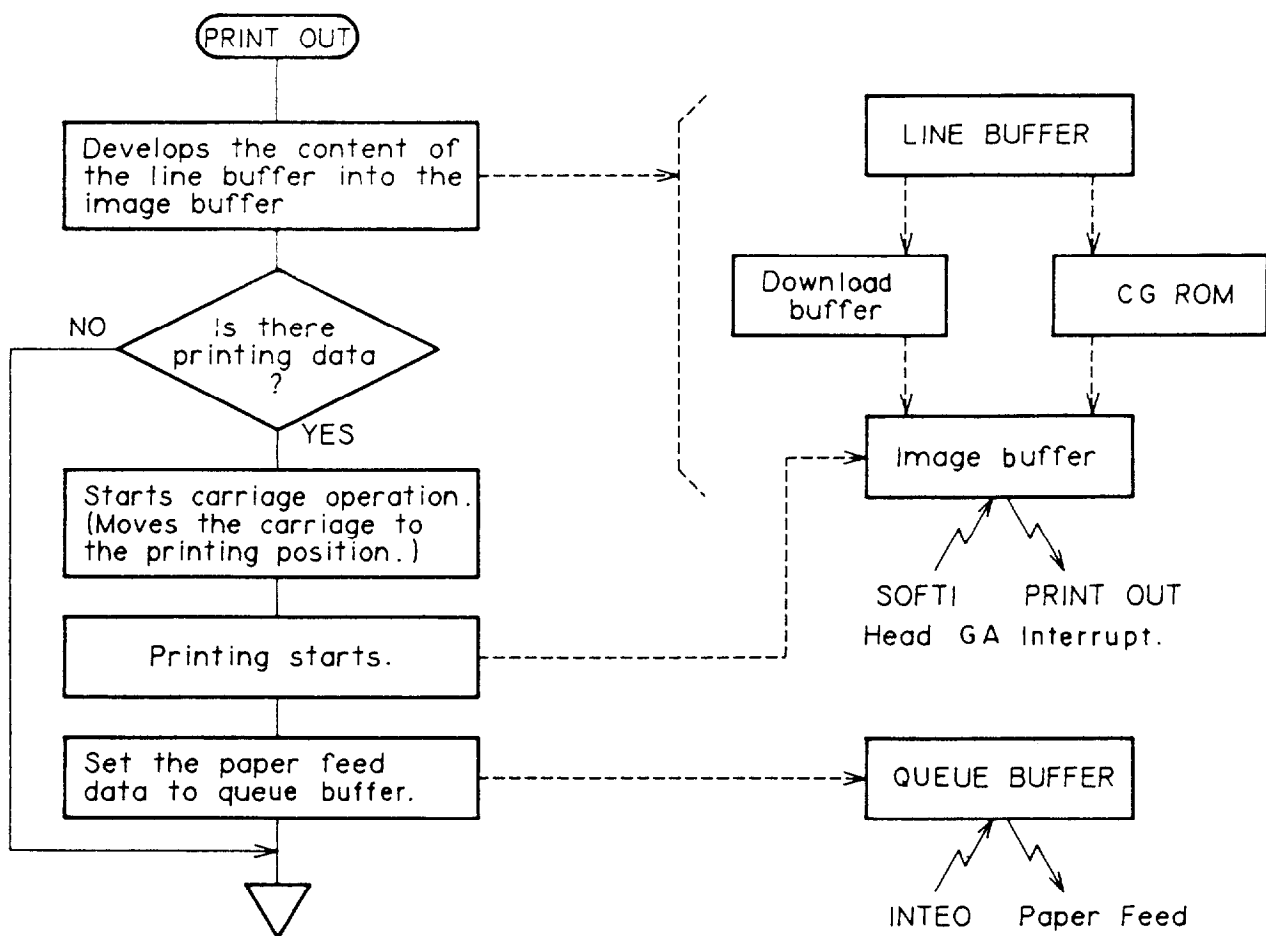


Figure 2-64. Printing Routine

2.2.11 Ribbon-Feed Mechanism

The ribbon-feed mechanism consists of the ribbon cartridge and the ribbon-feed section. The ribbon-driving gear always turns counterclockwise, via the gear trains shown in Table 2-21, irrespective of the direction of the timing belt.

Table 2-21. Ribbon-Feed Gear Train

Direction of Movement of Carriage	Gear Train
Left to right (arrow ➡)	Belt-driven pulley → Platen gear (1) → Platen gear (2) → Ribbon-driving gear
Right to left (arrow ⇐)	Belt-driven pulley → Platen gear (1) → Platen gear (3) → Platen gear (4) Ribbon-driving gear

Figure 2-65 shows the ribbon-feed mechanism. The inked ribbon is inside the cartridge case in an endless state, held between the ribbon-feed and ribbon-pressure roller mounted on the ribbon-driving gear. The rollers are driven by the movement of the gear and the inked ribbon is fed.

A ribbon-braking spring is attached at the exit of the cartridge case to prevent the ribbon from slacking. A ribbon mask is installed for preventing the ribbon from staining the paper.

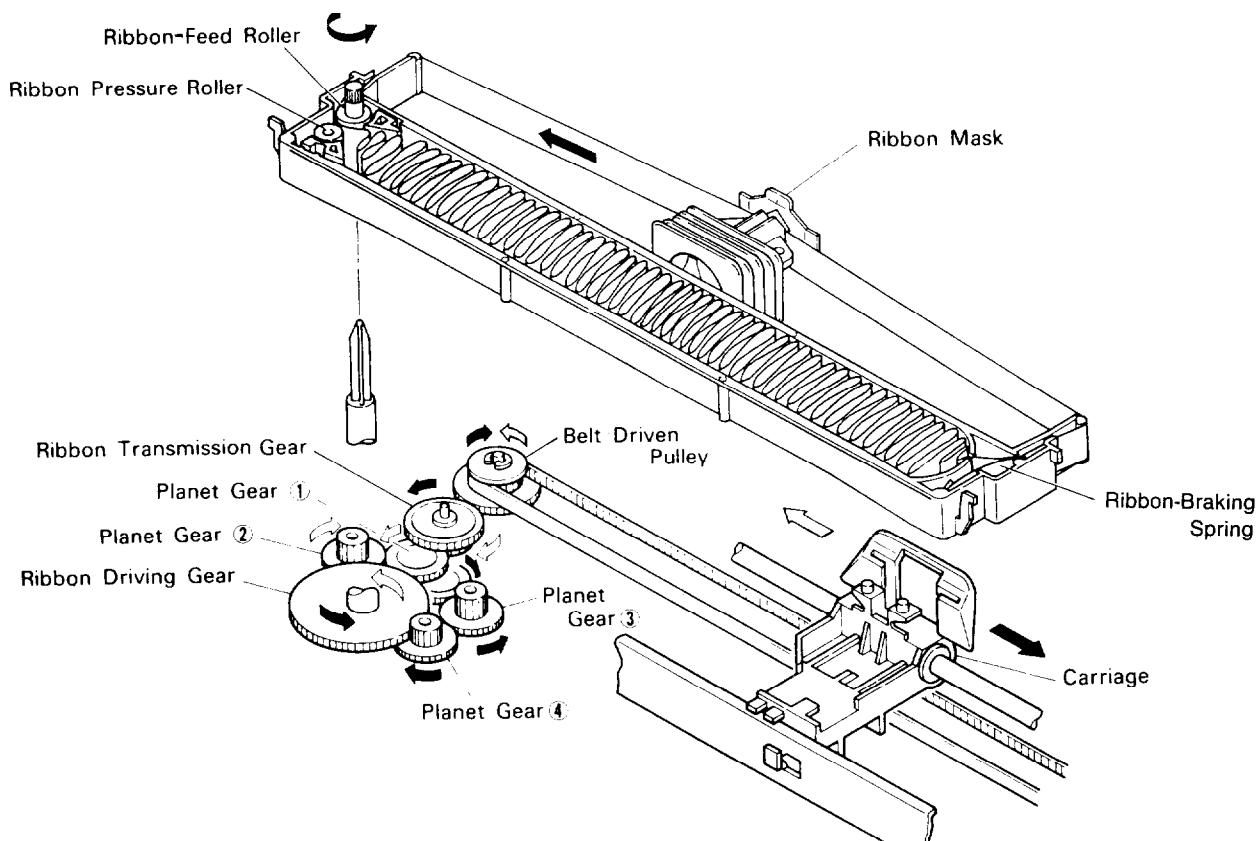


Figure 2-65. Ribbon-Feed Mechanism

CHAPTER 3

OPTIONAL EQUIPMENT

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3.1 OPTIONS AVAILABLE FOR THE LQ-500/L-1000

This chapter describes the options available for the LQ-500/L-1000.

3.2 INTERFACE OPTIONS

The LQ-500/L-1000 can use the Model 8100 series optional interface. The main interfaces are listed in Table 3-1.

Table 3-1. Optional Interfaces

	Cat. No.	Description			
		Buffer Size	Function		
Standard Parallel Interfaces					
	8172	2K	2K-byte buffer parallel interface (First Release)		
	8172	32K	32K-byte buffer parallel interface (Second Release)		
	8172M	128K	128K-byte buffer parallel interface		
RS-232C Current Loop		Buffer Size	Flag Control	X-ON/OFF Control	Max. Bit Rates (BPS)
	8143	None	—	—	—
	8145	2K	o	x	9600
	8148	2K/8K	o	o	19200
	8149	32K	o	o	19200
	8149M	128K	o	o	19200
IEEE-488 (GP-IB)		Buffer Size	Function	Listen Only Operation	Adress Operation
	8161	None	L	x/o	o
	8165	2K/8K	AH, L, DC	o	o

NOTE: Refer to the "Optional Interfaces Technical Manual" for details.

3.2.1 Model 8143 Serial Interface Operation

This printer has the capability to support the Model 8143 serial interface board as an option under RS232C and 20mA neutral current loop.

Specifications

Synchronization	Asynchronous
Bit rate	75 to 19200 BPS*
Word length	
Start bit	1 bit
Data bits	7 or 8 bits*
Parity bit	Odd, even, or no parity*
Stop bit	1 bit or more
Signal level	
RS-232C	Mark = logical "1" (-3 to -27 V) Space = logical "0" (+ 3 to + 27 V)
Current loop	Mark = logical "1" (current ON) Space = logical "0" (current OFF)
Handshaking	By REV signal or X-ON/OFF code (Signal polarity can be inverted by jumper setting.)

* Indicates that settings can be changed by DIP switch setting.

NOTE: Disconnect the parallel interface cable, if connected, before using 8143 board, because parallel interface input is used to read jumper setting and DIP switch status.

Jumper Settings

Table 3-2. Jumper Settings

Jumper	Function				
J1	ON: "TTY TXD" is pulled up to +12 V through 470 ohm resistor.				
J2	ON: "TTY TXD RET" is connected to signal ground.				
J3	ON: "TTY TXD" is pulled up to +12 V through 470 ohm resistor.				
J4	ON: "TTY TXD RET" is connected to signal ground.				
J5	ON: "TDR and DCD" are pulled up to +12 V through 4.7K ohm resistor.				
JRC	Select input signal level	ON	RS-232C level	ON	Current loop level
JC		OFF		OFF	
JNOR	Select polarity to disable data entry	ON	MARK (RS-232C)	OFF	MARK (RS-232C)
JREV		OFF	SPACE (Current loop)	ON	SPACE (Current loop)
JF	Select TTY TXD function	ON	Output REV flag	OFF	Output X-ON/X-OFF signal
JX		OFF		ON	

Table 3-3. DIP Switch Settings

DIP SW No.	Function	ON	OFF
1-1 (JB3)	Bit rate selection	See Table 3-4	
1-2 (J8/7)	Data length selection	7 bits	8 bits
1-3 (JB1)	Bit rate selection	See Table 3-4	
1-4 (JB2)	Bit rate selection	See Table 3-4	
1-5 (JO/E)	Parity selection	Even	Odd
1-6 (JPDS)	Parity selection	Enabled	Disabled
1-7 (JB4)	Bit rate selection	See Table 3-4	
1-8 (P/S)	8143 selection	Enabled	Disabled

Table 3-4. Bit Rate Settings

Bit Rate (BPS)	SW1-7 (JB4)	SW1-1 (JB3)	SW1-4 (JB2)	SW1-3 (JB1)	Bit Rate (BPS)	SW1-7 (JB4)	SW1-1 (JB3)	SW1-4 (JB2)	SW1-3 (JB1)
75	ON	ON	ON	ON	1800	OFF	ON	ON	ON
110	ON	ON	ON	OFF	2400	OFF	ON	ON	OFF
134.5	ON	ON	OFF	ON	4800	OFF	ON	OFF	ON
150	ON	ON	OFF	OFF	9600	OFF	ON	OFF	OFF
200	ON	OFF	ON	ON	19200	OFF	OFF	ON	ON
300	ON	OFF	ON	OFF	19200	OFF	OFF	ON	OFF
600	ON	OFF	OFF	ON	19200	OFF	OFF	OFF	ON
1200	ON	OFF	OFF	OFF	19200	OFF	OFF	OFF	OFF

NOTE: In current loop operation, normal data transfer cannot be guaranteed at a bit rate greater than 1200 BPS.

Handshaking Timing

This printer outputs the X-OFF code and/or REV signal (polarity can be selected by jumper setting) to indicate “not ready to receive data” when the amount of vacant input data buffer space becomes 256 bytes. Additionally, the printer outputs the X-ON code and/or changes REV signal to indicate “ready to receive data” when the amount of vacant input data buffer space becomes 528 bytes.

Error Handling

The asterisk (*) character is printed when a parity error is detected. Other errors, such as “overrun error” and “framing error,” will be ignored.

3.3 FONT MODULE (TOMS BOARD)

The font module provides a wide range of optional fonts. Font modules for LQ-800/1000 printer can be used with this printer also. Table 3-5 shows the list of optional font modules.

Table 3-5. Optional Font Module List

Cat. No.	Name
7400	Courier
7401	Prestige
7402	Script
7403	OCR-B

CHAPTER 4

DISASSEMBLY, ASSEMBLY, AND ADJUSTMENT

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4.1 GENERAL REPAIR INFORMATION

This chapter describes the disassembly, assembly, and adjustment procedures for replacing any of the main components of the LQ-500/L-1000.

DANGER

- Prior to beginning the disassembly, assembly, and adjustment procedures, be sure to disconnect the AC power cord.
- When assembling, disassembling, and adjusting the printer, wear gloves to protect your hands from being cut by the printer mechanism or an edge of a plate, such as the ground plate.

WARNING

- The printer mechanism, the various boards, and other parts are sometimes held without screws by plastic clips. When removing these units be careful not to damage the plastic clips.

The tools and measuring instruments listed in Tables 4-1 and 4-2 are recommended for use when disassembling and repairing the printers.

Table 4-1. Repair Tools

Description	Type	Part No.
Brush no. 1	O	B741400200
Brush no. 2	O	B741400100
Cleaning brush	O	B741600100
Round-nose pliers	O	B740400100
Diagonal cutting nippers	O	B740500100
Tweezers	O	B641000100
Soldering iron	O	B740200100
E-ring holder #2.5*	O	B740800400
E-ring holder #5	O	B740800700
Phillips screwdriver no. 2	O	B743800200
Screwdriver no. 0	O	B743800300
Thickness gauge (0.45 mm)	⊕	B776700001

- NOTES:**
1. The tool marked * is used when attaching the E-ring (2.3 mm).
 2. O = Commercially available tool.
 3. ⊕ = EPSON-exclusive tool.

Table 4-2. Measuring Instruments

Description	Specifications	Class
Oscilloscope	50 MHz	A
Tester		A
Slide calipers		A
Multimeter		B
Logic Analyzer		B

NOTE: A = Mandatory, B = Recommended

After printer disassembly, assembly, and adjustment, be sure to perform lubrication, adhesive application, cleaning, and maintenance, as indicated in Chapter 6, to maintain optimal printer performance.


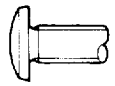

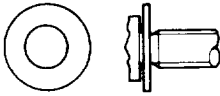

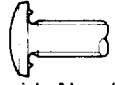

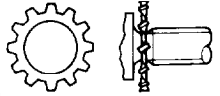
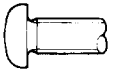

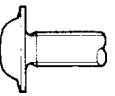

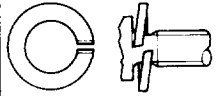

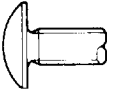

All small parts are described using the following abbreviations.

Table 4-3. List of Abbreviations for Small Parts

Abbreviation	Part Name
CTBB	Cross-recessed head Tapping B-tight screw (Bind)
CBO	Cross-recessed head Bind Outside toothed lock washer
CTPS (O)	CTP (S-tight) screw with Outside toothed lock washer

Table 4-4 describes the relationship between the form of the screw and its abbreviated part name.

Table 4-4. Form and Abbreviated Part Name of Screw

Head		Body	Washer (assembled)
1. <u>C</u> ross-recessed head	1. <u>B</u> ind	1. <u>N</u> ormal	1. <u>P</u> lain washer
			
2. <u>S</u> lotted head	(with <u>N</u> otch)	2. <u>T</u> ap tight <u>S</u> tight	2. <u>O</u> utside toothed lock washer
			
	2. <u>P</u> an	<u>B</u> tight	
			
	3. <u>C</u> up	3. <u>T</u> apping	3. <u>S</u> pring washer
			
	4. <u>T</u> russ		
			

4.2 DISASSEMBLY AND ASSEMBLY

This chapter describes the disassembly of the LQ-500/L-1000. Assembly can be performed simply by reversing the order of disassembly. Special notes for assembly are given as "ASSEMBLY POINTS." For assembly and disassembly procedures which require adjustment, the necessary adjustment is indicated as "ADJUSTMENT REQUIRED." After assembly and disassembly, perform the necessary adjustment as indicated.

WARNING

- Read Section 4.1, *GENERAL REPAIR INFORMATION*, before disassembly.
- Remove paper and the ribbon cartridge before disassembly.

The disassembly sequence of this section is given in five parts: (1) removal of printhead, (2) removal of cases, (3) removal of the circuit boards, (4) removal of printer mechanism unit, and (5) disassembly of printer mechanism. Refer to Figures A-25 through A-27, the exploded diagrams for the LQ-500/L-1000 and its printer mechanism.

4.2.1 Removal of Printhead

Refer to Figure 4-1 below for an illustration of this removal procedure.

1. Remove the printer cover, and confirm that the paper and the ribbon cartridge have been removed.
2. Unlock the two levers securing the printhead to the carriage by pulling them down, and lift the printhead to remove it.

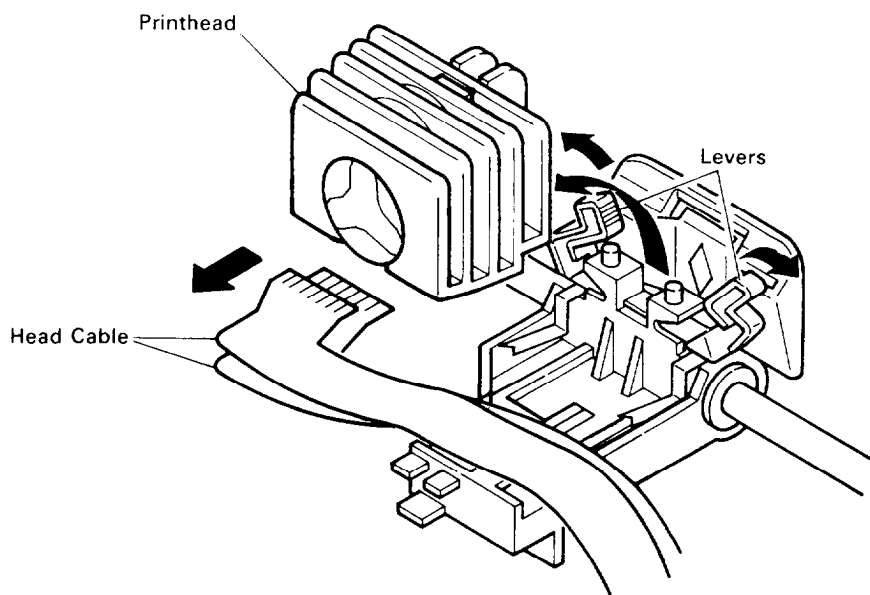


Figure 4-1. Printhead Removal

3. Disconnect the head cable from the connector on the printhead.

4.2.2 Removal of Cases

This section describes upper case and control panel (PEBPNL) removal.

4.2.2.1 Upper Case Removal

1. Remove the sheet guide unit, printer cover, ROM cartridge slot cover, and paper guide.
2. Insert a standard screwdriver into the two holes at the front of the lower case, unlock the notches, then lift the upper case.

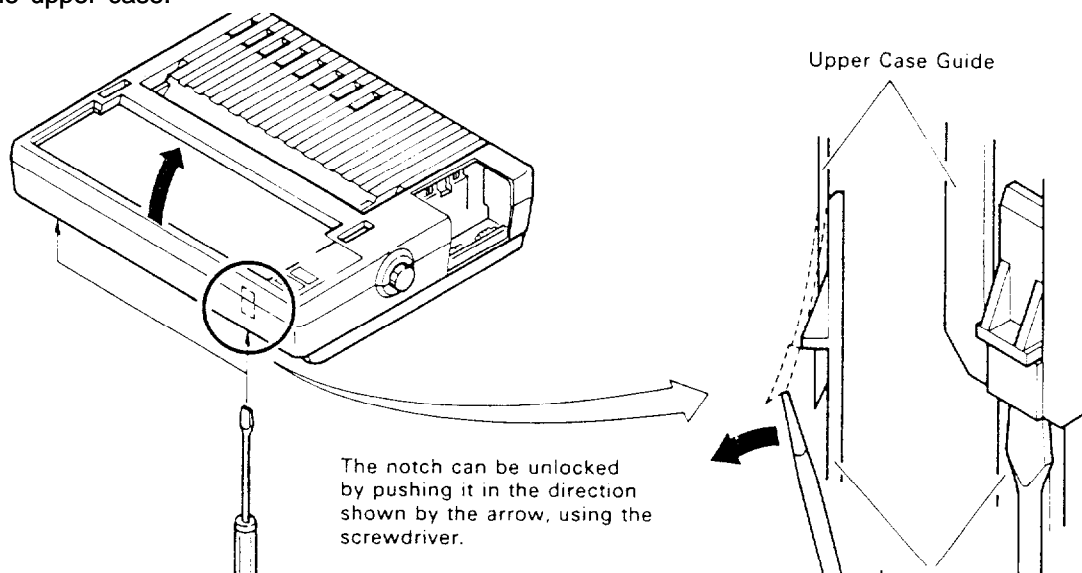


Figure 4-2. Upper Case Removal 1

3. While lifting the upper case, disconnect the flexible printed cable (FPC) of the control panel (PEBPNL) from connector CN4 on the PBMA board, and remove the upper case.

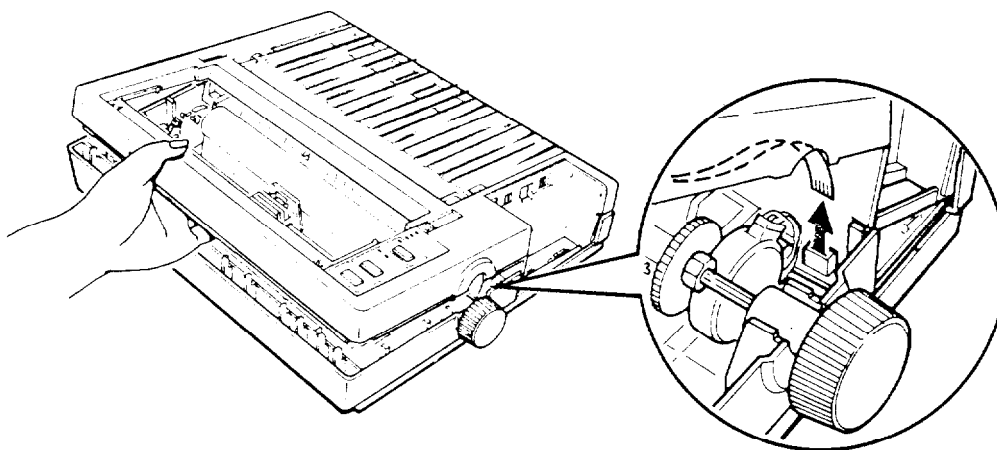


Figure 4-3. Upper Case Removal 2

4.2.2.2 Control Panel (PEBPNL Board) Removal

1. Remove the upper case (refer to Section 4.2.2.1).
2. Turn the upper case over, push in the two notches securing the control panel to the upper case, and remove the control panel from the upper case.

WARNING

When mounting and removing the control panel, be careful not to damage the FPC of the control panel with the FPC guide of the upper case.

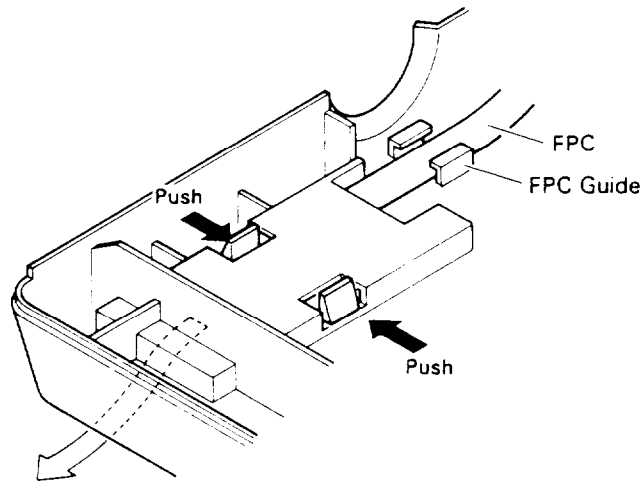


Figure 4-4. Control Panel Removal

4.2.3 Removal of Circuit Boards

This section describes removal of the PBMA board, PEBFIL board, and transformer.

4.2.3.1 PBMA Board Removal

1. Remove the upper case (refer to Section 4.2.2.1).
2. Disconnect connectors CN5, CN6, CN7, CN8, CN9, and CN10 on the PBMA board, which connect each component to the PBMA board.

WARNING

When disconnecting the connectors, pull them out slowly while holding the board. The board could be damaged if the connectors are pulled out roughly.

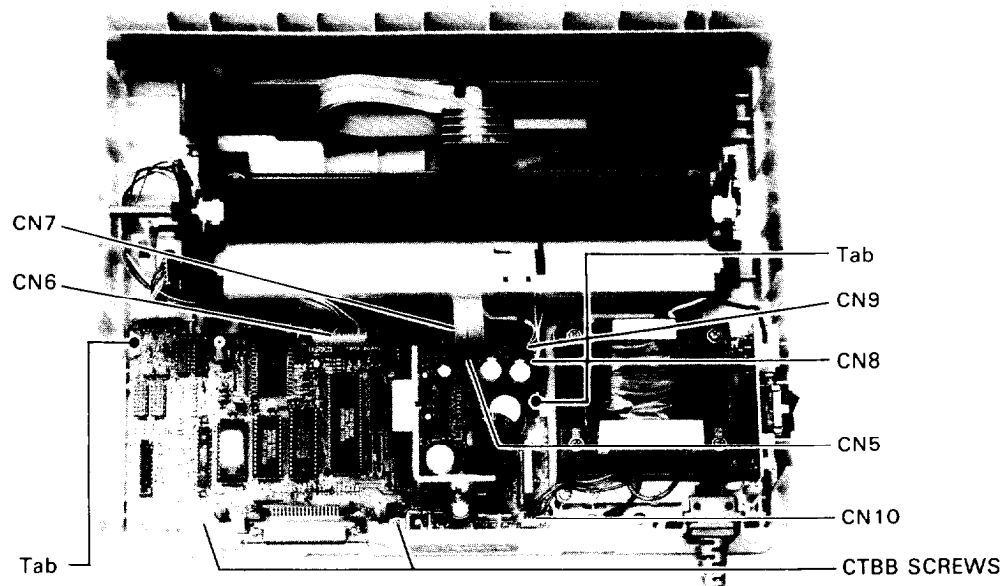


Figure 4-5. PBMA Board Removal

3. Remove the two CTBB screws (M3 x 5) securing the PBMA board to the base plate.
4. Using a screwdriver, loosen the six bent tabs for the lower case, which secure the PBMA board to the lower case and remove the PBMA board.

WARNING

When removing the PBMA board from the lower case, do not bend the tabs too far. Be careful when pushing the tabs not to break them or damage the components on the PBMA board.

4.2.3.2 PEBFIL Board Removal

1. Remove the upper case (refer to Section 4.2.2.1).
2. Disconnect connector CN1 on the PEBFIL board, which connects the transformer to the PEBFIL board.
3. Remove the CBO (M4 x 8) screw securing the ground terminal of the PEBFIL board.
4. Remove the CTPS(0) (M3 x 6) screw securing the PEBFIL board to the base plate.
5. Remove the PEBFIL board and the power cord.

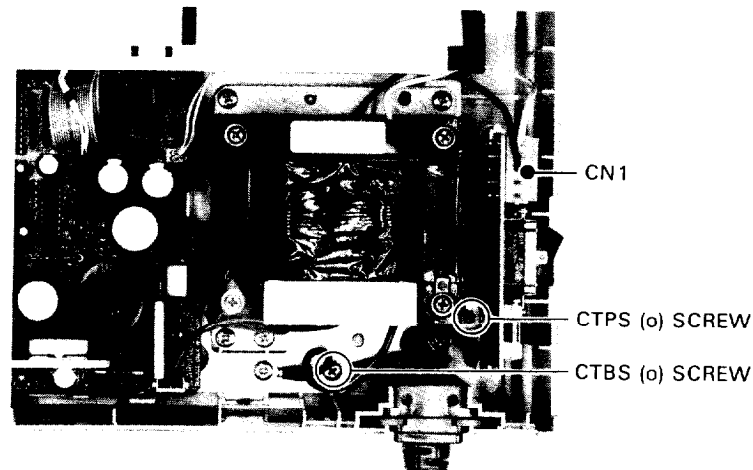


Figure 4-6. PEBFIL Board Removal

4.2.3.3 Transformer Removal

1. Remove the upper case (refer to Section 4.2.2.1).
2. Disconnect connector CN10 on the PEBFIL board, which connects the transformer to the PEBFIL board.
3. Disconnect connector CN10 on the PBMA board, which connects the transformer to the PBMA board.
4. Remove the CBO (M4 x 8) screw securing the transformer ground terminal.
5. Remove the four CTBB (M4 x 12) screws and the CBO (M4 x 8) screw securing the power transformer, and remove the transformer.

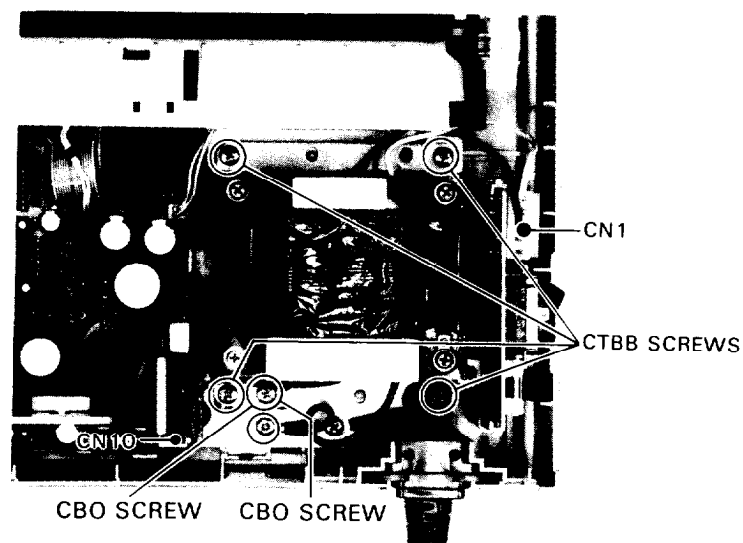


Figure 4-7. Transformer Removal

4.2.4 Removal of Printer Mechanism

This section describes the removal of the platen unit, paper guide, and printer mechanism. Before removing the printer mechanism, take off the platen unit and the paper guide so that the printer mechanism can be removed quickly and easily.

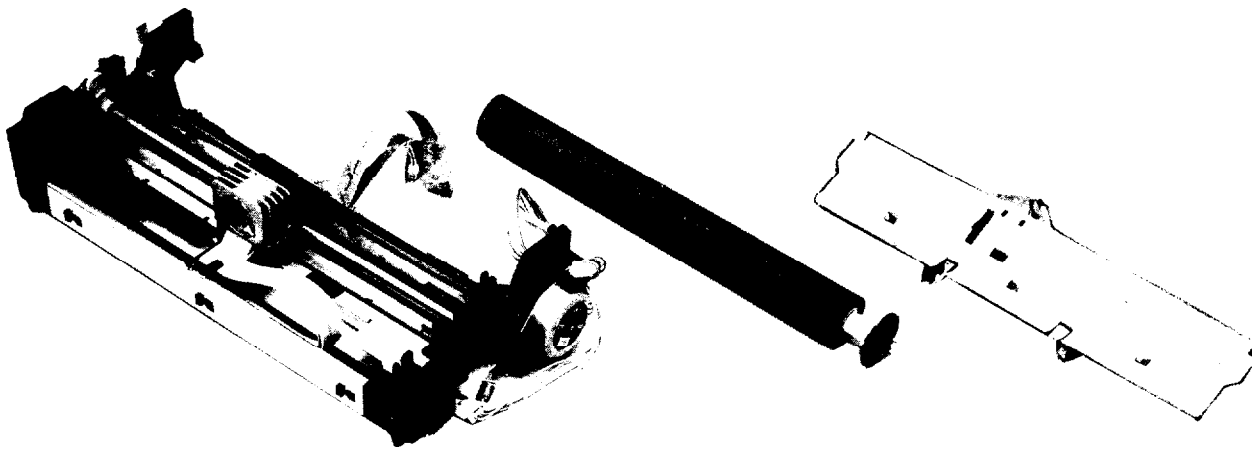


Figure 4-8. Printer Mechanism Removal

4.2.4.1 Removal of Platen Unit and Paper Guide

1. Remove the upper case (refer to Section 4.2.1.1).
2. Turn the shaft holders at the left and right sides of the platen unit as shown in Figure 4-9, and lift the platen unit to remove it.
 - a. Push the shaft holder outward using a screwdriver.
 - b. Turn the shaft holder counterclockwise.

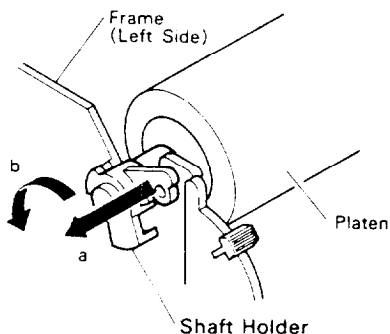


Figure 4-9. Platen Unit Removal

3. Disconnect the cable from connector CN9 on the PBMA board.
4. Unlock the two notches of the paper guide by pushing them toward the front from the back of the printer mechanism, and remove the paper guide.

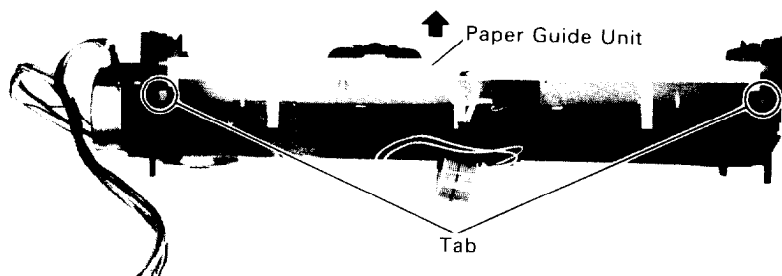


Figure 4-10. Printer Mechanism Rear View

ADJUSTMENT REQUIRED

If any problems occur (such as nonuniform print density) after removing and installing the platen unit or replacing the platen unit with a new one, perform the Platen Gap Adjustment (see Section 4.3.1).

4.2.4.2 Removal of Printer Mechanism

1. Remove the platen unit and the paper guide (refer to Section 4.2.4.1).
2. Disconnect the cables from connectors CN5, CN6, CN7, and CN8 on the PBMA board (refer to Figure 4-5).
3. Loosen the six tabs for the lower case, which secure the printer mechanism to the lower case, by pushing them with a screwdriver. The printer mechanism can be removed easily using the following procedure:

WARNING

When loosening the tabs, push them gently so as not to damage the lower case or printer mechanism.

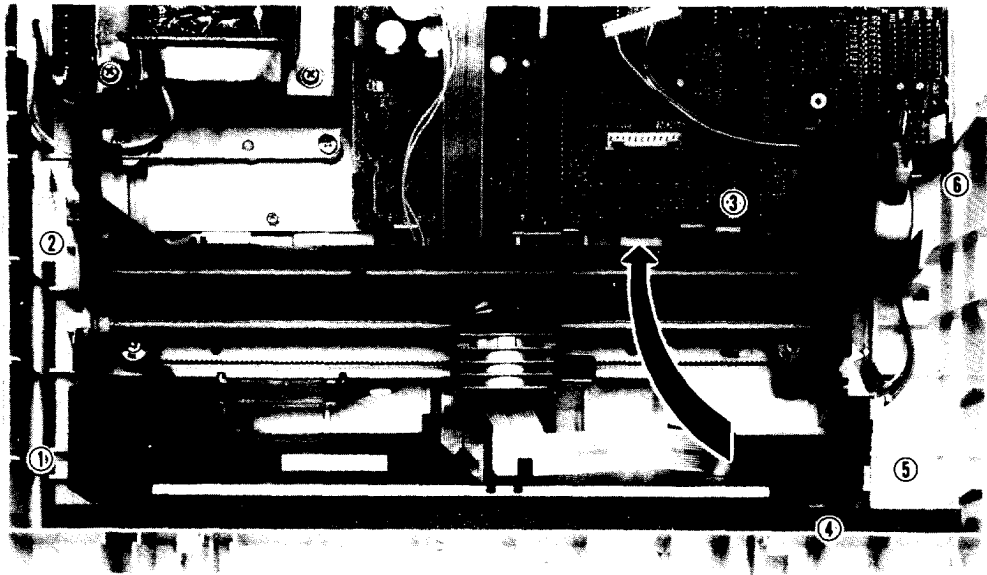


Figure 4-11. Printer Mechanism Removal

- a. Loosen tabs 1 and 2, and lift the left side of the frame 1 cm from the lower **case**.
- b. Loosen tab 3, and lift the left side of the frame 5 more cm from the lower **case**.
- c. Slide the printer mechanism in the direction shown by the arrow in Figure 4-11 to remove it from tabs 4 and 5. Use tab 6 as a fulcrum.

4.2.5 Disassembly of Printer Mechanism

This section describes the removal of each component from the printer mechanism. Refer to Figure A-26, *Printer Mechanism Exploded Diagram*, and Table A-10, *Component Name List*.

4.2.5.1 Paper-Feed Mechanism Removal

1. Remove the printer mechanism (refer to Section 4.2.4).
2. Push the notch of the paper-guide-plate release lever, and pull the paper-guide release lever and the paper-guide release shaft to remove them.

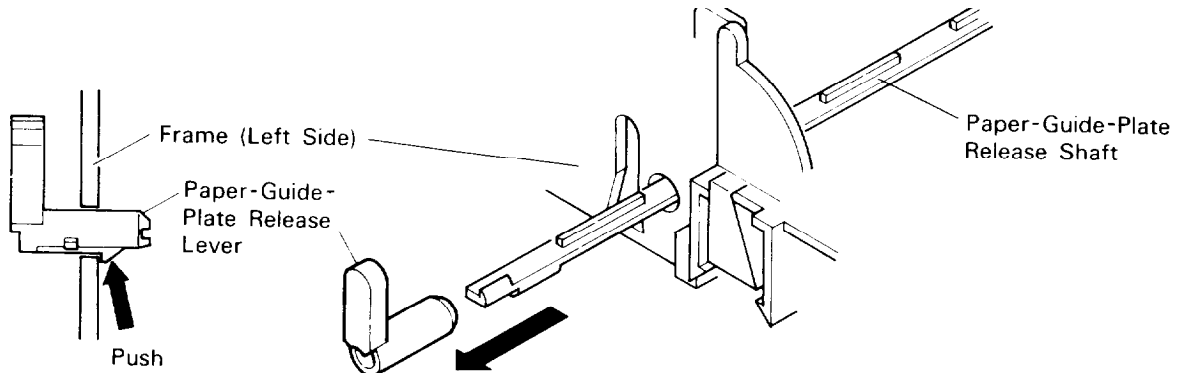


Figure 4-12. Removal of Paper-Guide-Plate Release Lever

3. Push the notch of the paper-guide-plate release lever from the inside of the frame, and remove the release lever.

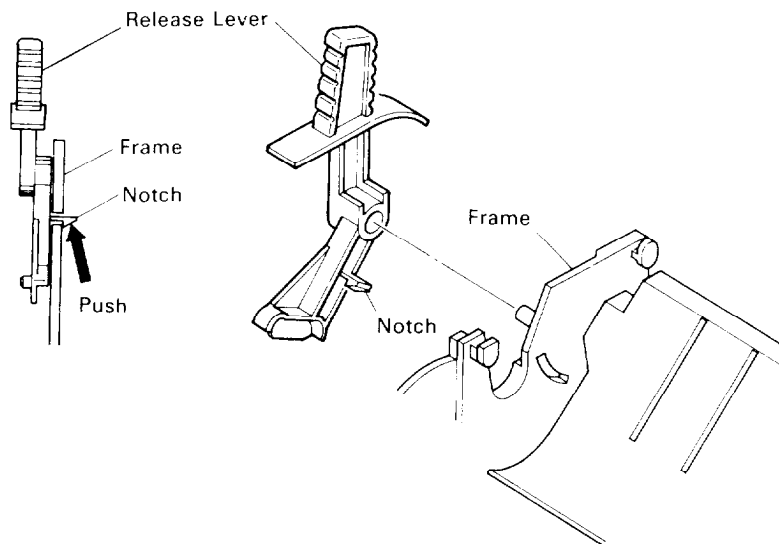


Figure 4-13. Removal of Release Lever

4. Push the paper-feed roller shaft down, slide it approximately 2 cm to the left, and lift it to remove it.

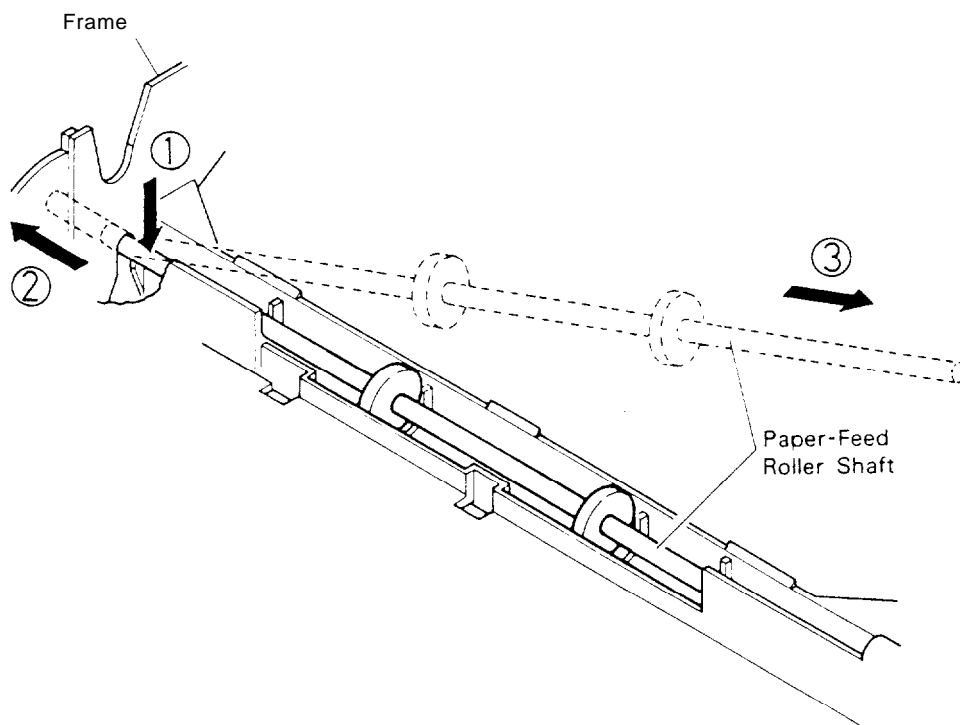


Figure 4-14. Removal of Paper-Feed Roller Shaft

5. Loosen the four tabs securing the paper-guide plate and the paper-guide-plate spacer to the frame, using a screwdriver, and lift them to remove them. (Push the tabs out from the frame.)

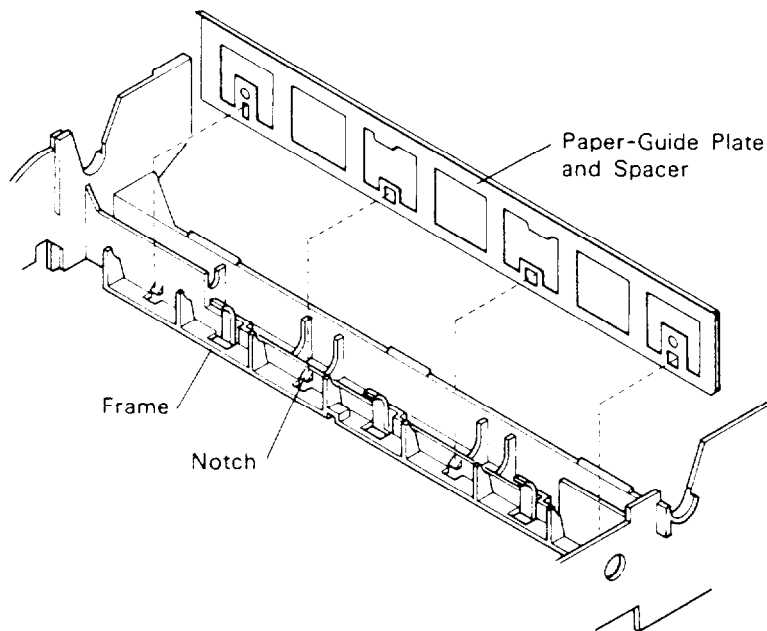
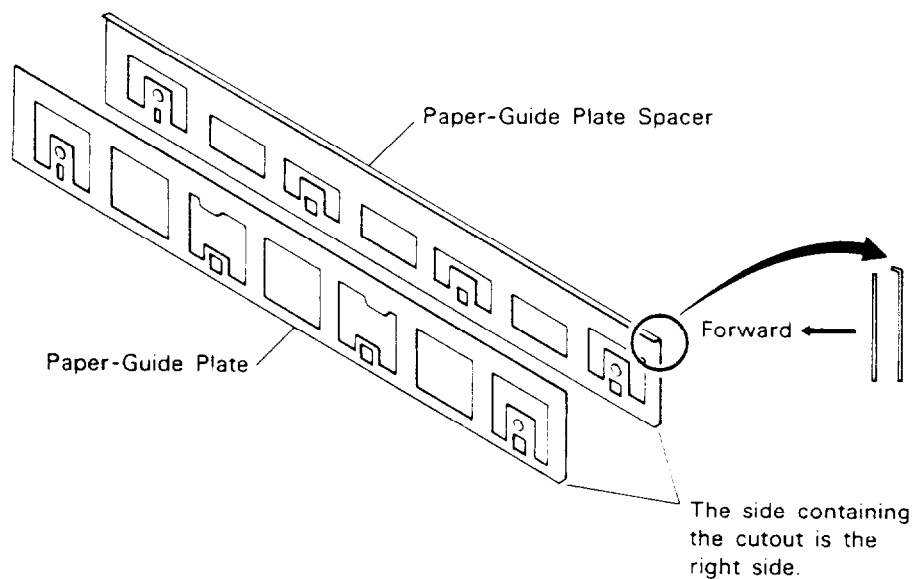


Figure 4-15. Removal of Paper-Guide-Plate and Spacer

Assembly Points

1. When reassembling the paper-guide plate and the paper-guide spacer, refer to Figure 4-16 for the mounting direction.



(Viewed from front of printer mechanism)

Figure 4-16. Paper-Guide-Plate and Spacer Assembly Points

2. When installing the paper-release lever and the paper-guide-plate release lever, carefully observe the mounting positions shown in Figure 4-17.

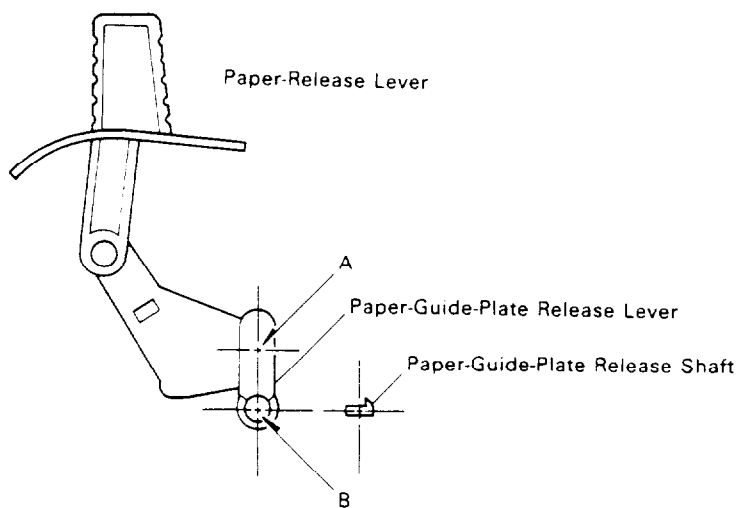


Figure 4-17. Paper-Release Lever and Paper-Guide-Plate Release Lever Assembly Point

- The paper-release lever and the paper-guide-plate release lever must be joined at point A, and the paper-guide-plate release shaft and a section of the paper-guide-plate release shaft must be joined at point B, as shown in the figure above.

4.2.5.2 Removal of Paper-Feed Motor

1. Remove the printer mechanism (refer to Section 4.2.4).
2. Disconnect the motor cable from the paper-feed motor.
3. Loosen the tab on the frame, which secures the paper-feed motor to the frame, by pushing it, using a screwdriver. Remove the paper-feed motor by turning it in the direction shown by the arrow below, using point A as a fulcrum.

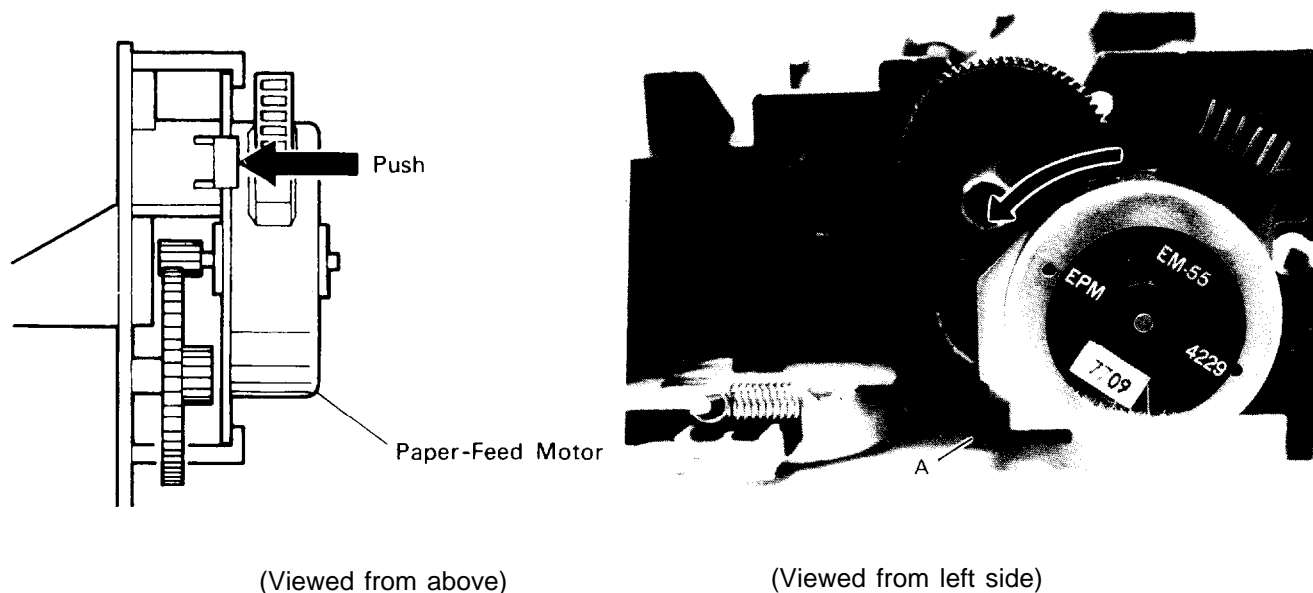


Figure 4-18. Removal of Paper-Feed Motor

4.2.5.3 Removal of Paper-End Sensor

1. Remove the platen unit and paper guide (refer to Section 4.2.4.1).
2. Loosen the tab securing the paper-end sensor to the paper guide, remove the paper-end sensor by turning it in the direction shown by the arrow below, using point A as a fulcrum.

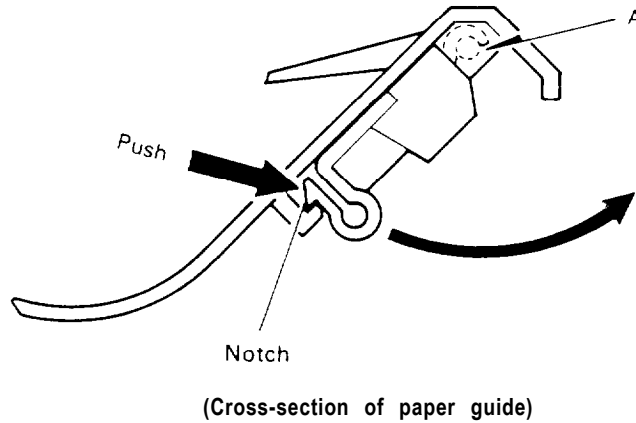


Figure 4-19. Removal of Paper-End Sensor

4.2.5.4 Disassembly of Platen Unit

1. Remove the platen unit (refer to Section 4.2.4.1).
2. Remove the left shaft holder and the paper-feed knob from the platen unit.
3. Pull out the platen gear at the right side of the platen unit.
4. Remove the E-ring from the platen, and pull out the right shaft holder and the flat spring.

Assembly Point

When reassembling the platen unit, refer to Figure 4-20 to install the flat spring and the shaft holder correctly, and insure that the gap between the platen and the platen gear is adequate.

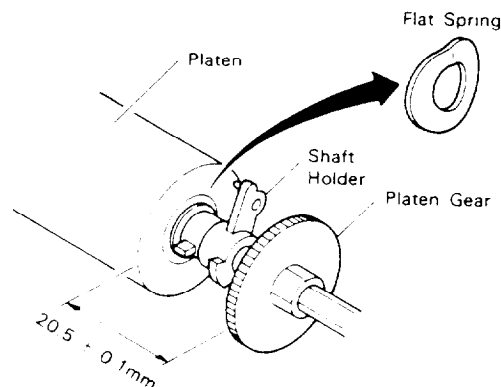


Figure 4-20. Platen Unit Assembly Point

4.2.5.5 Removal of Carriage Unit

1. Remove the printer mechanism (refer to Section 4.2.4).
2. Remove the printhead and disconnect the head cable.
3. Turn the printer mechanism over, and manually move the carriage unit to the cutout in the carriage motor frame. (Move the carriage unit so that the joint of the carriage unit and the timing belt can be seen through the cutout.)

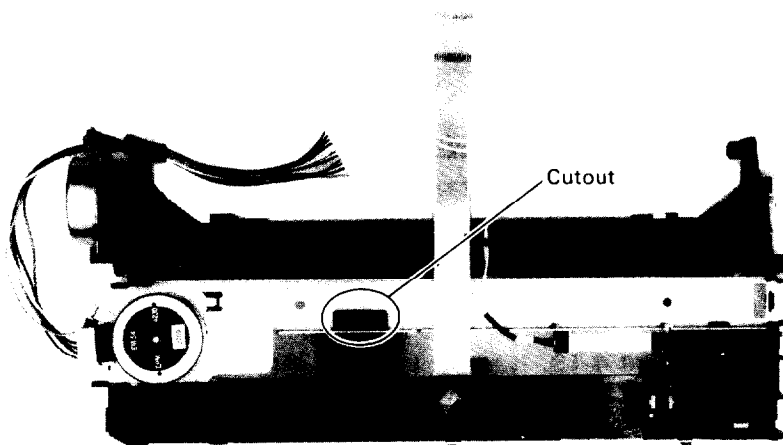


Figure 4-21. Printer Mechanism Bottom View

4. Detach the timing belt from the carriage unit using round-nose pliers. Be careful not to damage it.
5. Lift portion A of the carriage guide shaft ground plate to remove it from the notch in the carriage motor frame, and slide the plate so that it can be removed from the frame (through the cutout at portion B of the plate).

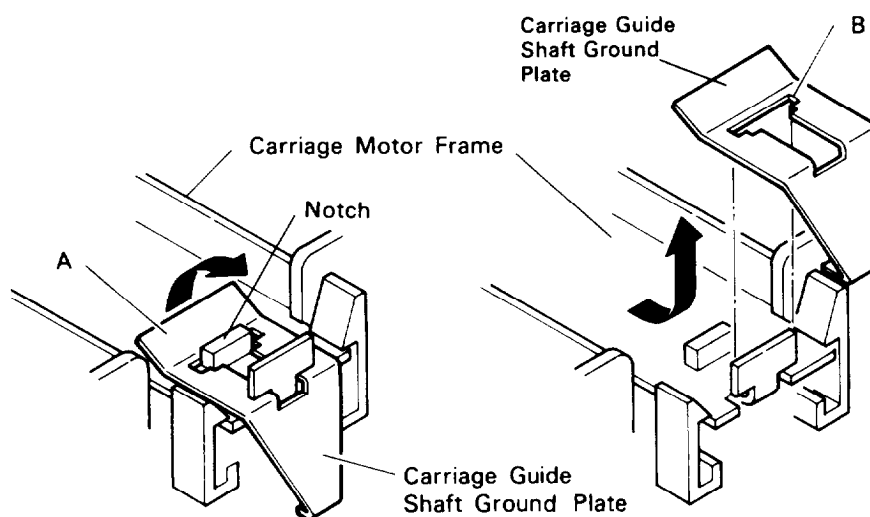


Figure 4-22. Removal of Carriage-Guide-Shaft Ground Plate

6. Place the printer mechanism face up. Turn the left carriage guide shaft lever fully counterclockwise and pull it out through cutout A. Then turn the right carriage guide shaft lever fully clockwise, and pull it out the same way as the left lever.

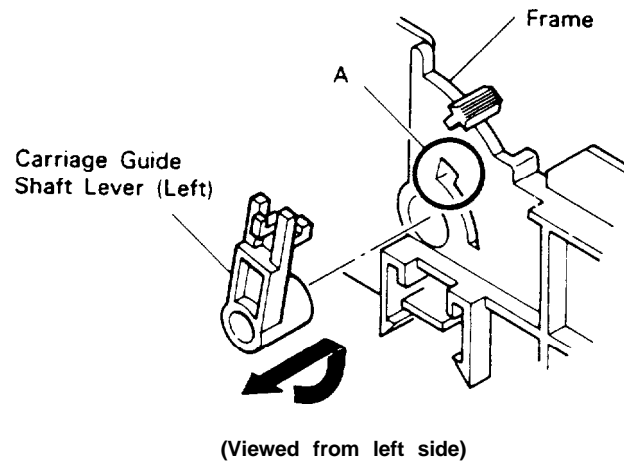


Figure 4-23. Removal of Carriage Guide Shaft

7. Push the notch of the frame, which secures the carriage guide plate to the frame, and slide the carriage guide plate to the left to remove it.

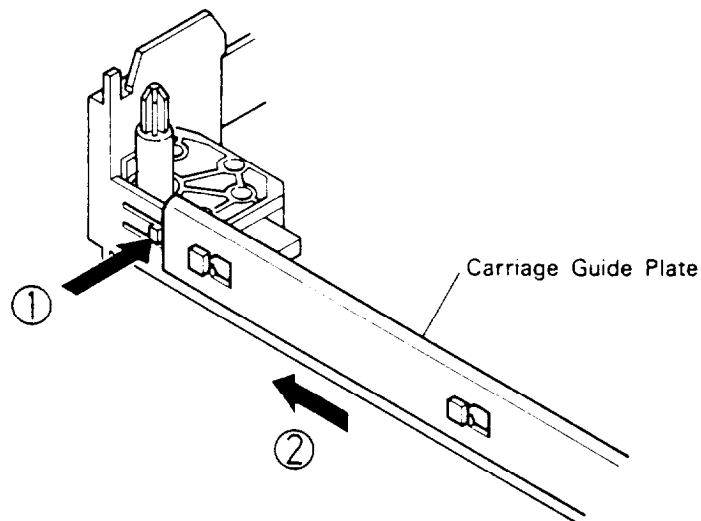


Figure 4-24. Removal of Carriage Guide Plate

8. Lift the carriage unit, carriage guide shaft, and head adjust lever to remove them.

Assembly Points

1. Before installing the carriage guide shaft and the head adjust lever, position them as shown in Figure 4-25.

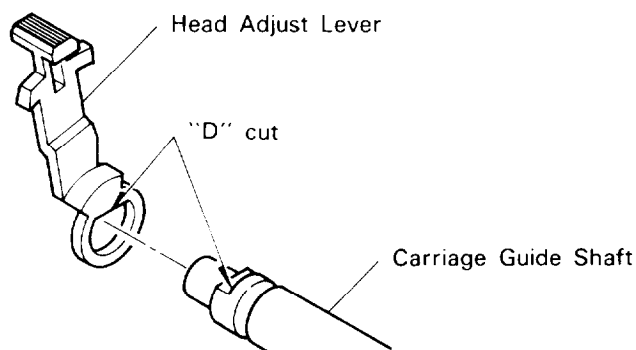


Figure 4-25. Carriage Guide Shaft and Head Adjust Lever

2. The colors of the left and right carriage guide shaft lever are gray and black, respectively. The hole in each lever must slide onto the corresponding end of the shaft.
3. When connecting the head cable, pass it correctly through the PFC guide at the frame.

ADJUSTMENT REQUIRED

When the carriage unit is reassembled, perform the Platen Gap Adjustment (see Section 4.3.1).

4.2.5.6 Removal of Carriage Motor

1. Perform steps 1 to 5 of Section 4.2.5.5.
2. Disconnect the motor cable from the carriage motor. Disconnect the lead wire of the home-position sensor from the molded clip at the bottom of the frame. (Refer to Figure 4-26.)
3. Using a screwdriver, loosen the four tabs securing the carriage motor frame to the chassis frame, and remove the carriage motor frame.

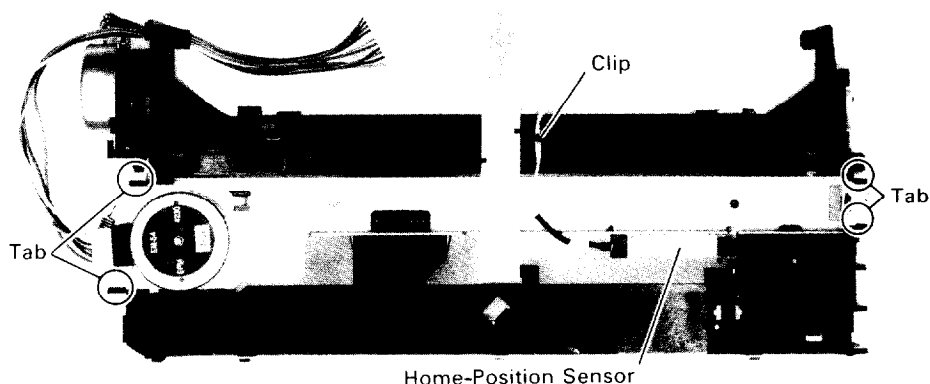


Figure 4-26. Carriage Motor Frame Removal

4. Remove the belt tension spring from the carriage motor frame. Remove the E-type (3.2) retaining ring on the carriage motor side, then remove the plain washer, belt pulley flange, belt pulley shaft holder, belt pulley, and timing belt.

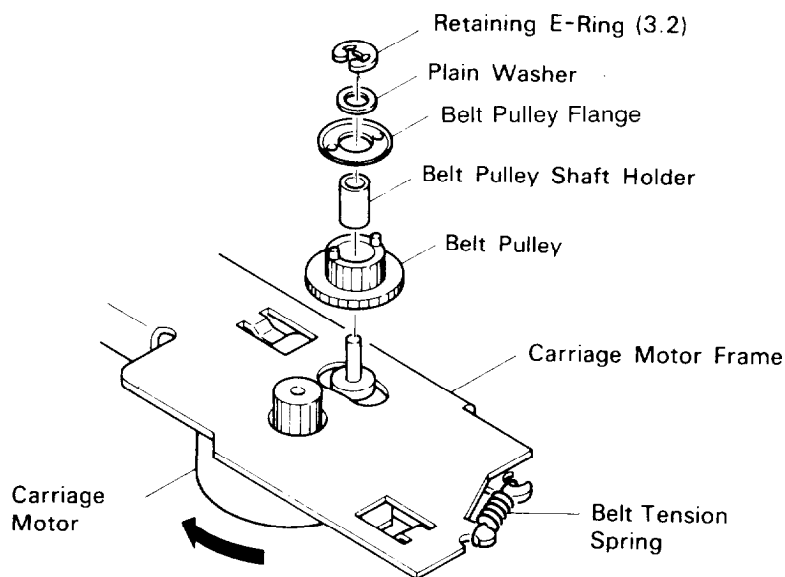


Figure 4-27. Removal of Carriage Motor

5. Move the carriage motor in the direction shown by the arrow to remove it.

Assembly Point

Attach the E-rings as follows:

- When attaching a ring to the left pulley shaft, set it so that its opening faces left.
- When attaching a ring to the right pulley shaft, set it so that its opening faces right.

Using the tweezers, confirm that the attached retaining rings do not move.

4.2.5.7 Removal of Home-Position Sensor

1. Perform steps 1 to 3 of Section 4.2.5.6 to remove the carriage motor frame.
2. Push in the notch of the home-position sensor, and remove the home-position sensor from the carriage motor frame.

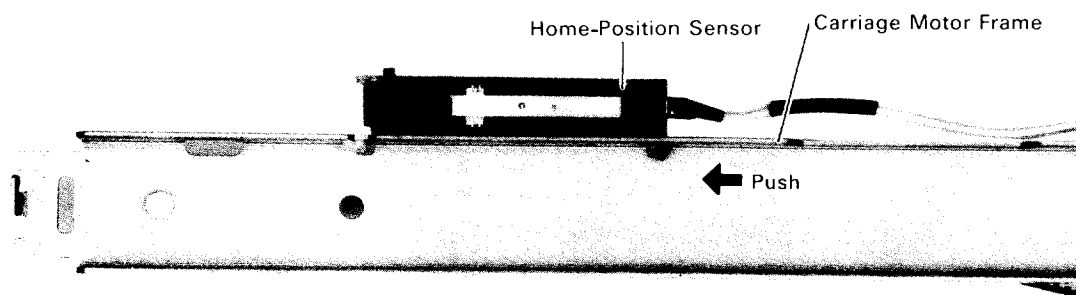
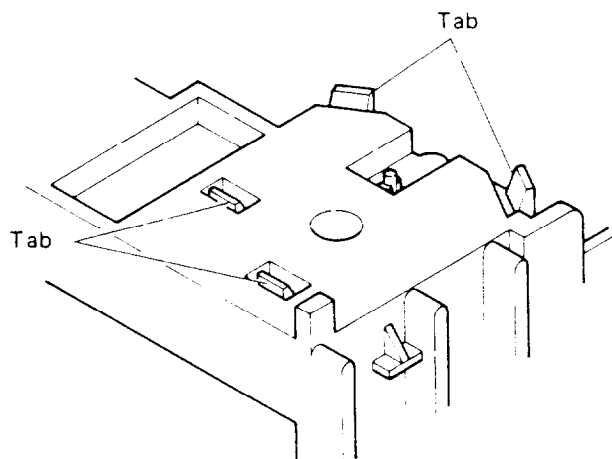


Figure 4-28. Removal of Home-Position Sensor

4.2.5.8 Disassembly of Ribbon-Feed Mechanism

1. Remove the printer mechanism (refer to Section 4.2.4).
2. Turn the printer mechanism over, and loosen the four bent tabs for the ribbon gear cover using a screwdriver. (At this time, just loosen the tabs slightly but do not remove the ribbon gear cover. If it is removed before the printer mechanism is turned over, the gears will be scattered.)



(Bottom view of the printer mechanism)

Figure 4-29. Ribbon Gear Cover Removal

3. Place the printer mechanism face up, and lift the ribbon gear cover to remove it.

4.2.5.9 Disassembly of Tractor Unit

1. Loosen the three tabs on the sprocket mounting plate using a screwdriver and remove the side cover. (Both the left and right side covers can be removed at the same time.)

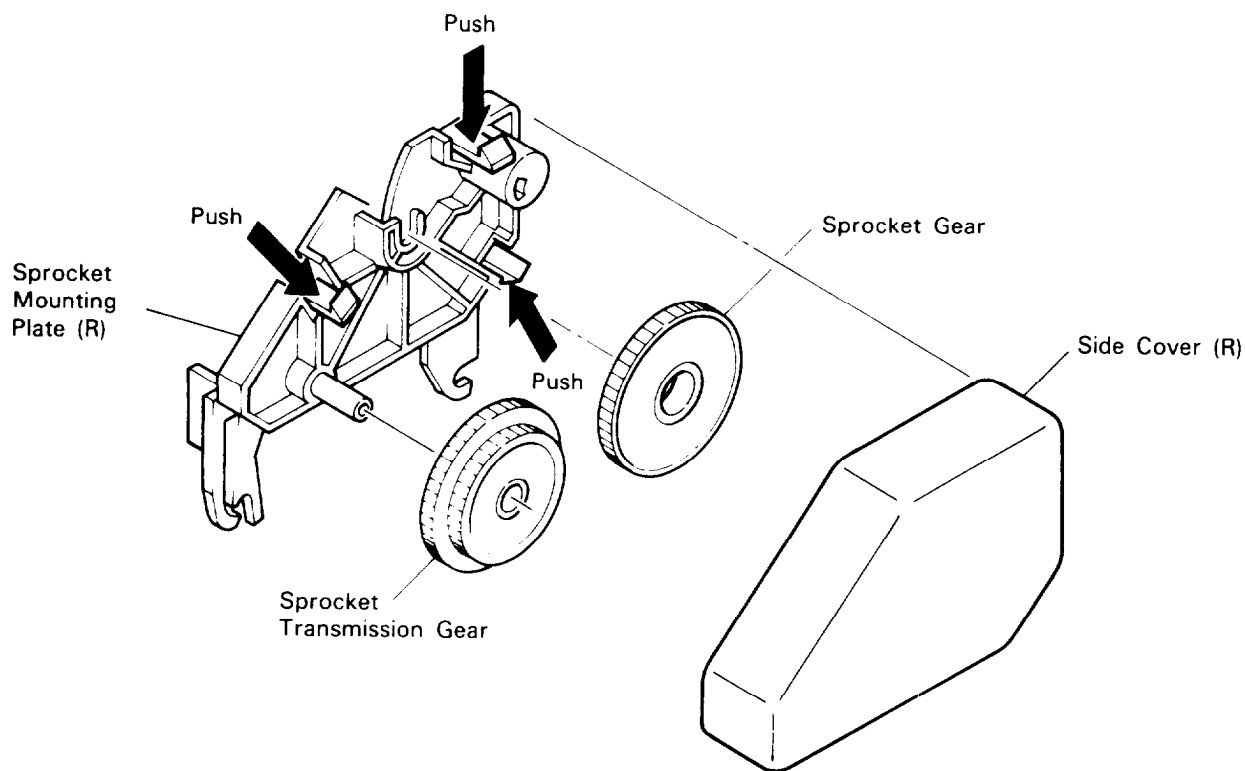


Figure 4-30. Removal of Side Cover

2. Remove the sprocket gear and the sprocket transmission gear.
3. Remove the shaft holder and remove the sprocket shaft from the sprocket mounting plate.
4. Loosen the sprocket mounting plate tab using a screwdriver, and pull out the sprocket guide shaft.

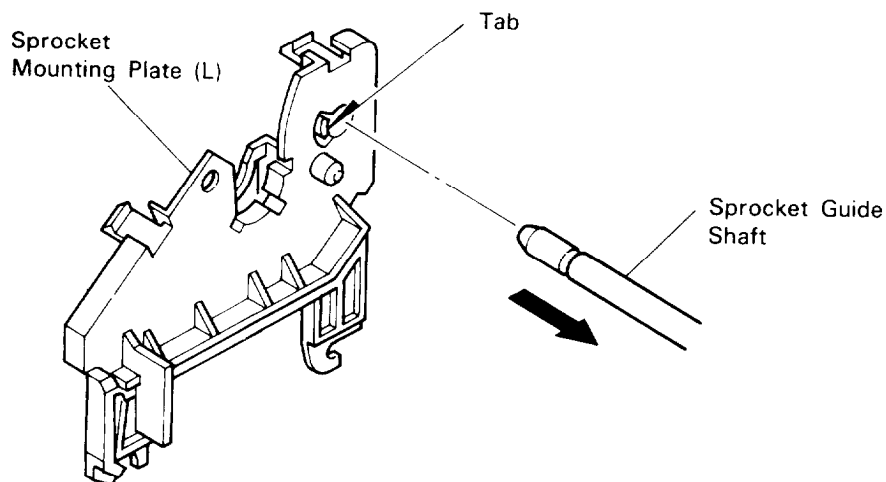


Figure 4-31. Removal of Sprocket Guide Shaft

5. Pull out the sprocket assembly and the paper-guide roller from the sprocket shaft and the sprocket guide shaft. When pulling out the paper-guide roller, move it along the sprocket shaft toward the side with the T-shaped notch. (When assembling the paper-guide roller, insert the sprocket shaft from the side with the T-shaped notch.)

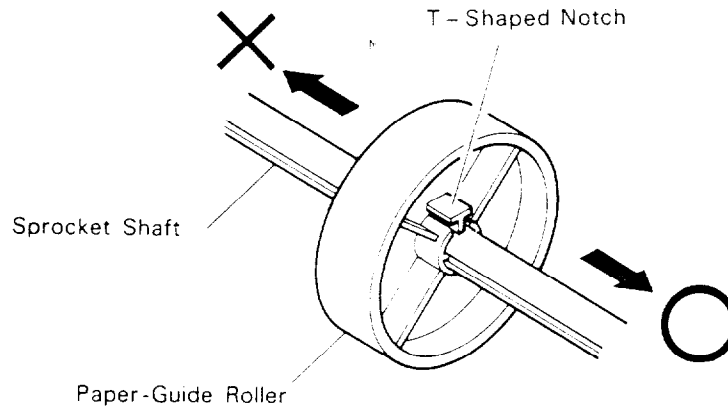


Figure 4-32. Paper-Guide Roller Removal and Attachment

Assembly Points

1. When attaching the paper-guide roller to the sprocket shaft, attach it from the direction indicated in Figure 4-32.
2. When attaching the sprocket wheel to the sprocket shaft, attach it so that the sprocket wheel marks are on the left side, and so that the marks on the two wheels line up.

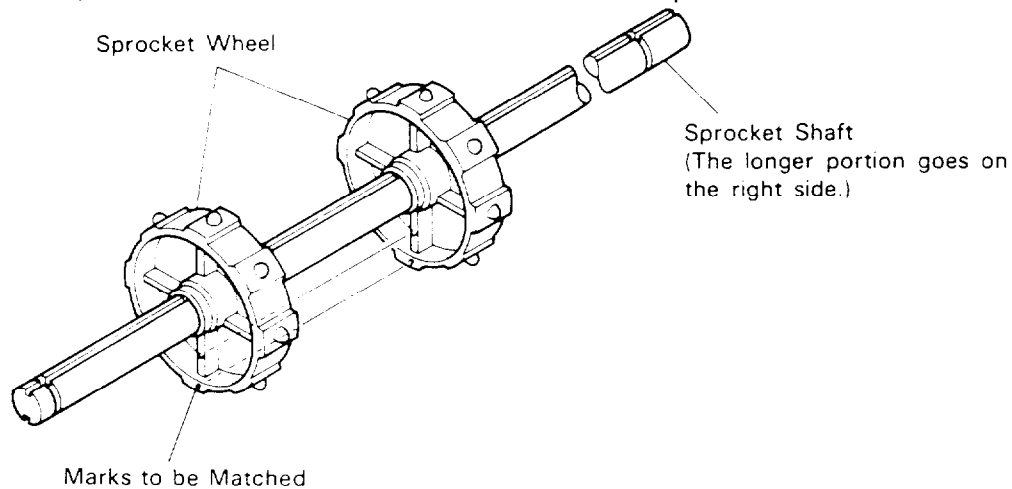


Figure 4-33. Sprocket Wheel Attachment

4.3 ADJUSTMENT

This section describes the adjustment procedures required for assembling the LQ-500/L-1000 printer. When disassembly or replacement is performed during maintenance or repair of the parts described in this section, perform the following adjustments to ensure proper operation.

4.3.1 Platen Gap Adjustment

Adjust the gap between the platen and the printhead when the carriage guide shaft or carriage guide shaft levers are rotated or removed, or the printing is abnormal.

1. Remove the printer mechanism (refer to Section 4.2.4).
2. Install the paper guide and the platen unit on the printer mechanism.
3. Remove the printhead, then remove the ribbon mask using tweezers. When removing the ribbon mask, pull it frontward slightly, then lift it.

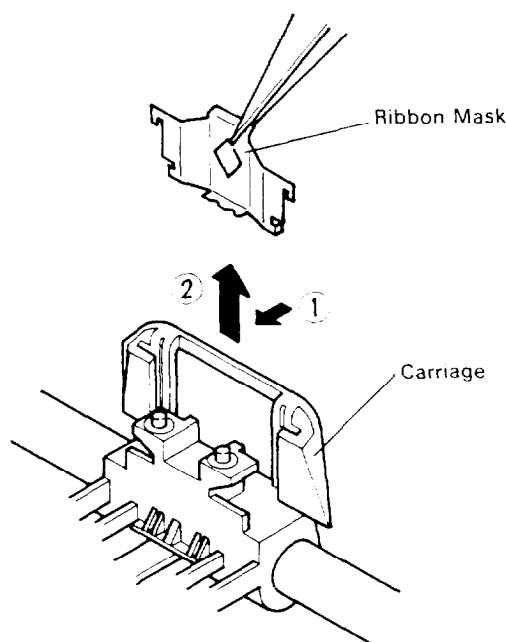


Figure 4-34. Removal of Ribbon Mask

4. Reinstall the printhead.
5. Set the head adjust lever at the position nearest the platen.
6. Manually move the carriage to column 10.
7. Insert a thickness gauge (0.45 mm) between the platen and the printhead, and adjust the left and right carriage guide shaft levers so that the gap becomes 0.44 m 0.47 mm. When the weight of the thickness gauge causes it to slip down, the gap adjustment is adequate.

When setting the position of the carriage guide shaft lever, be sure that both tabs A and B do not enter the notch at the same time. It is designed so that tab B may not enter when tab A is inside, and that tab A may not enter when tab B is inside.

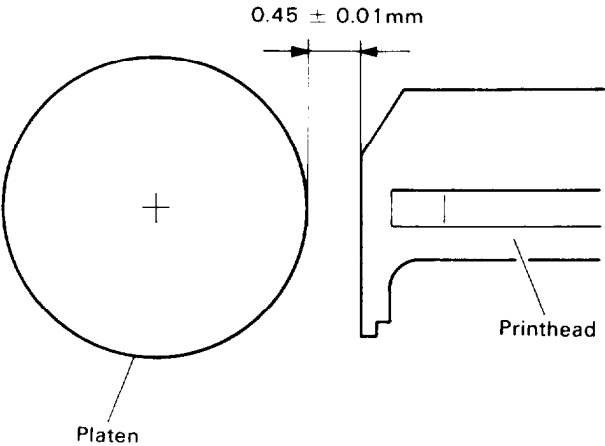


Figure 4-35. Platen Gap

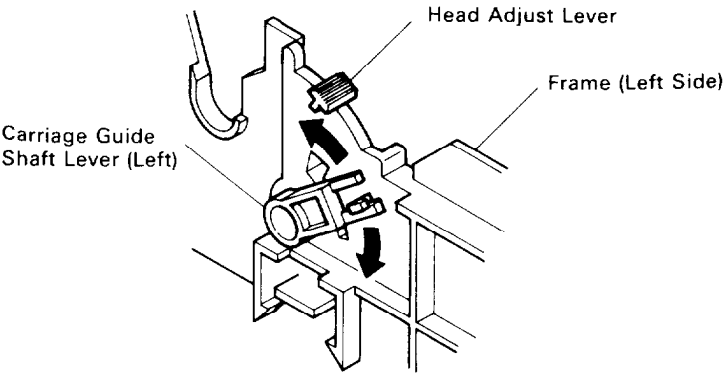


Figure 4-36. Carriage Guide Shaft Lever Movement

- | | |
|-------------------------------|---|
| Carriage guide shaft (left) | Turned clockwise - The platen gap widens. |
| | Turned counterclockwise - The platen gap narrows. |
| Carriage guide shaft (right): | Turned clockwise - The platen gap narrows. |
| | Turned counterclockwise - The platen gap widens. |

Perform the above adjustment at the 10th and 70th column positions, and at the middle of the platen. When the gaps at all three positions match, the adjustment is complete. ==

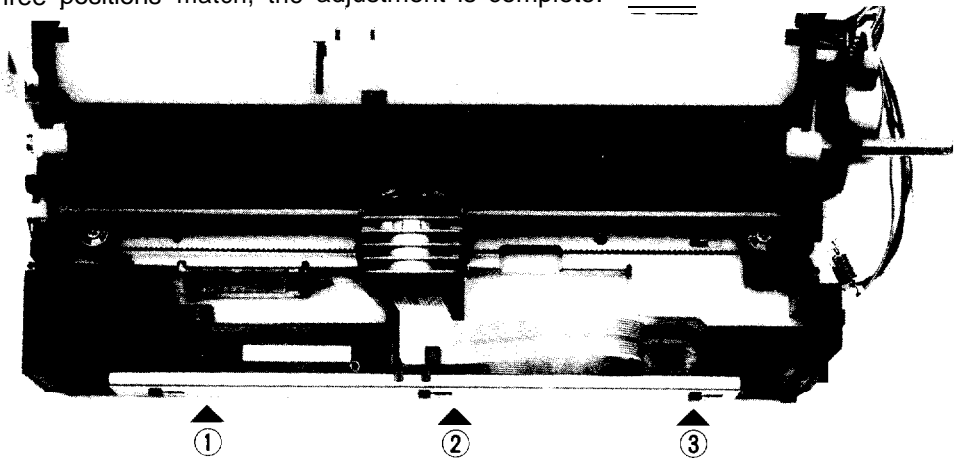


Figure 4-37. Platen Gap Adjustment Positions

4.3.2 Bidirectional Printing Alignment Adjustment

This adjustment is required when the lines or characters are misaligned in bidirectional printing, and also when the PBMA board or the printer mechanism is replaced.

4.3.2.1 Specifications of VR1 and VR2

Bidirectional printing alignment is adjusted by using VR1 and VR2 on the PBMA board. VR1 is used in draft mode and VR2 is used in LQ mode. The specifications of VR1 and VR2 are shown in Tables 4-4 and 4-5. The misalignment usually occurs when the carriage moves from right to left.

Table 4-4. VR1 Specifications


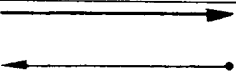
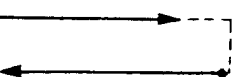
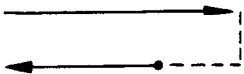


VR1	Shifting Direction and Value	
-7 -6 -5 -4 -3 -2 -1	7/240 inch 6/240 inch 5/240 inch 4/240 inch 3/240 inch 2/240 inch 1/240 inch	 <p>Printing starts $n/240''$ to the left of the reference position.</p>
0	Normal Position	 <p>Printing starts here. (Reference position)</p>
1 2 3 4 5 6 7	1/240 inch 2/240 inch 3/240 inch 4/240 inch 5/240 inch 6/240 inch 7/240 inch	 <p>Printing starts $n/240''$ to the right of the reference position.</p>

Table 4-5. VR2 Specifications

VR2	Shifting Direction and Value	
-11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1	11/720 inch 10/720 inch 9/720 inch 8/720 inch 7/720 inch 6/720 inch 5/720 inch 4/720 inch 3/720 inch 2/720 inch 1/720 inch	 <p>Printing starts $n/720''$ to the left of the reference position.</p>
0	Normal Position	 <p>Printing starts here. (Reference position)</p>
1 2 3 4 5 6 7 8 9 10 11	1/720 inch 2/720 inch 3/720 inch 4/720 inch 5/720 inch 6/720 inch 7/720 inch 8/720 inch 9/720 inch 10/720 inch 11/720 inch	 <p>Printing starts $n/720''$ to the right of the reference position.</p>

4.3.2.2 Adjustment Procedures

VR1 and VR2 have each standard value to make adjustment easy. The standard value is set where VR1 (or VR2) stops when rotating it counterclockwise. When you adjust the bidirectional printing alignment, utilize the standard value initially.

This section describes the adjustment procedures without using the standard value.

Draft Mode Adjustment

1. Turn the power on while depressing the ON LINE, FORM FEED (FF), and LINE FEED (LF) switches.
2. Depress the LF switch, so that the test pattern is printed. The test pattern prints four patterns, and the value of the position where VR1 is becomes the center. (Refer to Figure 4-38.)

Example: VR1 = 2 (Pattern 3)

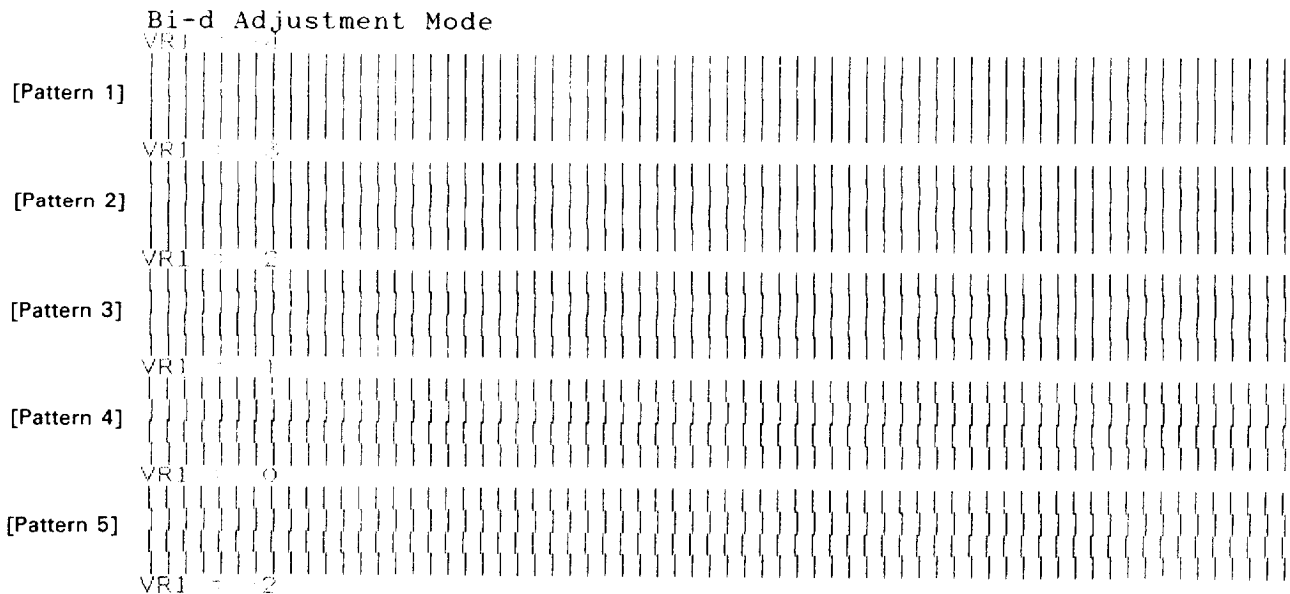


Figure 4-38. Test Pattern Printing (Draft Mode)

3. Check and select the most aligned pattern.
 - If the selected pattern is above the center, depress the FF switch an applicable number of times (once or twice). (Refer to Table 4-6.)
 - If the selected pattern is lower than the center, depress the LF switch an applicable number of times (once or twice). (Refer to Table 4-6.)

Table 4-6. Relationship Between Pattern and Switch

Pattern Selected	Switch Depressed	Number of Times
1	FF	Twice
2	FF	Once
3 (Center)	—	—
4	LF	Once
5	LF	Twice

Example: The most aligned pattern is VR1 = -3 (Pattern 2). So, depress the FF switch one time.

4. Depress the ON LINE switch, so that only the new selected pattern is printed again.
5. Confirm the printed pattern. If it is not OK, return to STEP 3.

Example: [Present] VR1 = -3 (Pattern 2)

↓ Depress the LF switch two times.

VR2 = - 1 (Pattern 4)

6. Rotate VR1 until the buzzer sounds.
7. Turn the power off.

LQ Mode Adjustment

LQ mode adjustment is similar to the one for draft mode.

1. Turn the power on while depressing the ON LINE, FORM FEED (FF), and LINE FEED (LF) switches.
2. Depress the FF switch, so that the test pattern is printed. The test pattern prints four patterns, and the value of the position where VR2 is becomes the center. (Refer to Figure 4-39.)

Example: VR2 = +9 (Pattern 3)

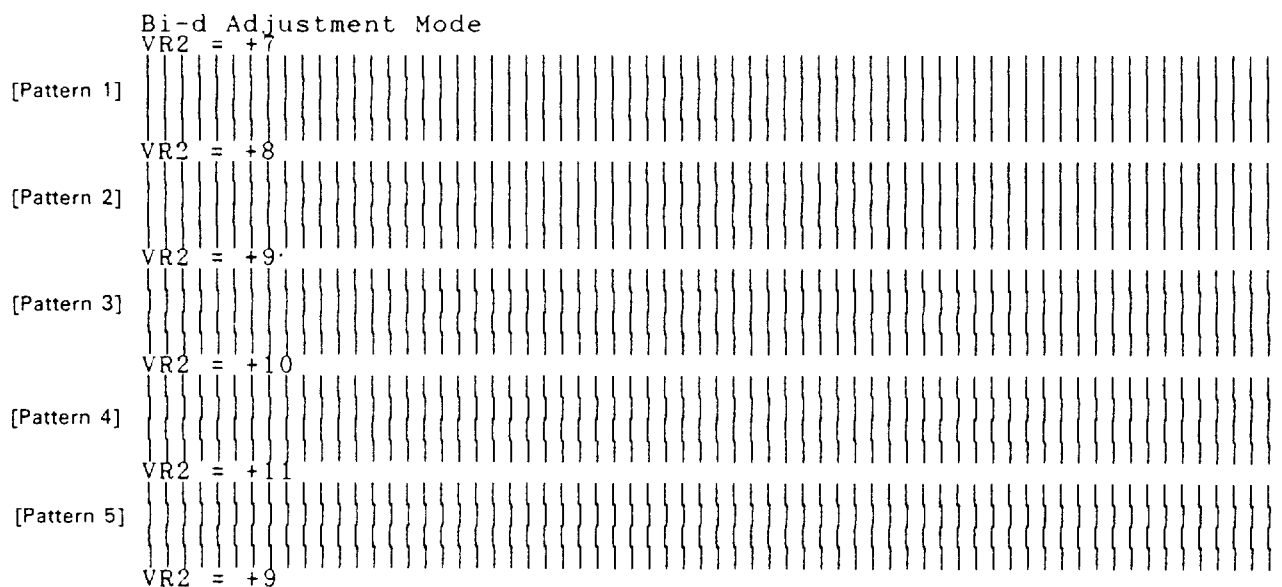


Figure 4-39. Test Pattern Printing (LQ Mode)

3. Check and select the most aligned pattern.
 - If the selected pattern is above the center, depress the FF switch an applicable number of times (once or twice). (Refer to Table 4-6.)
 - If the selected pattern is lower than the center, depress the LF switch an applicable number of times (once or twice). (Refer to Table 4-6.)

Example: The most aligned pattern is VR2 = + 7 (Pattern 1). So, depress the FF switch two times.

4. Depress the ON LINE switch, so that only the new selected pattern is printed again.
5. Confirm the printed pattern. If it is not OK, return to STEP 3.

Example: [Present] VR2 = +7 (Pattern 1)

4 Depress the FF switch one time.

VR2 = +6

6. Rotate VR2 until the buzzer sounds. (Position VR2 to the value of the new selected pattern.)
7. Turn the power off.

CHAPTER 5

TROUBLESHOOTING

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5.1 GENERAL TROUBLESHOOTING TECHNIQUES

Because various types of problems can occur, troubleshooting can be complicated. Here is a simple procedure provided to perform troubleshooting.

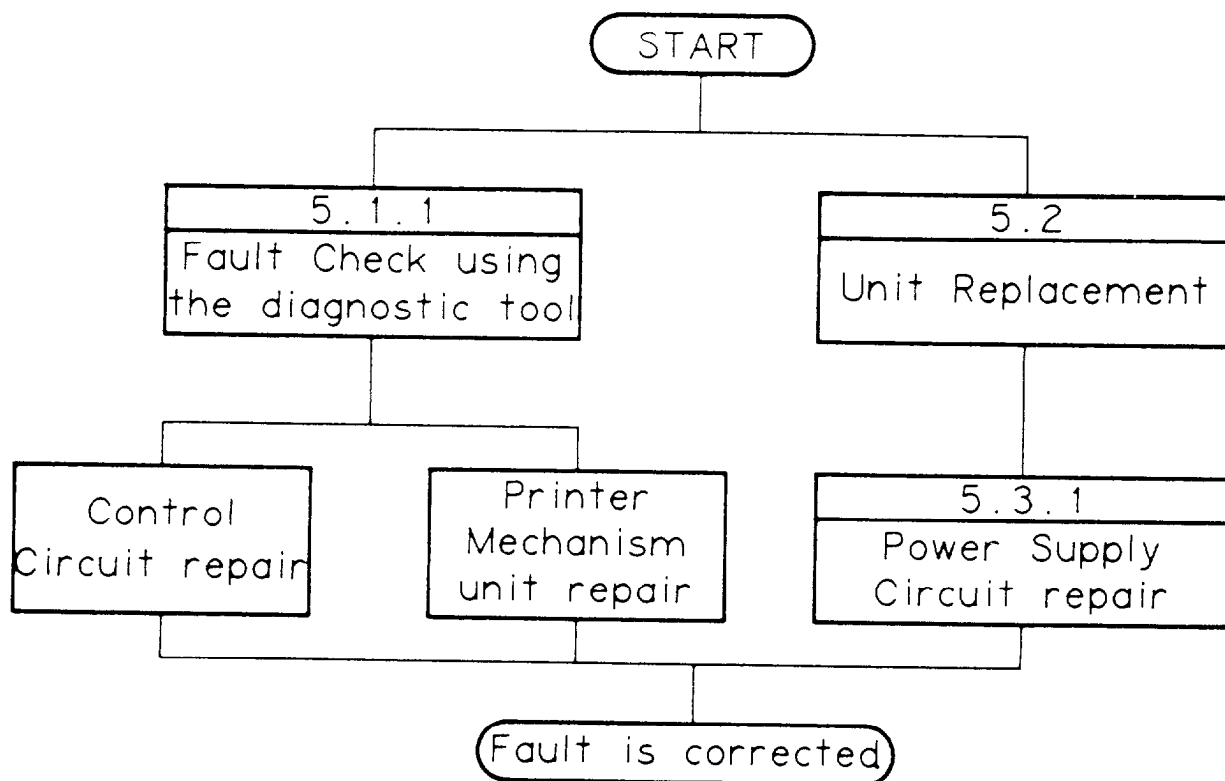


Figure 5-1. Troubleshooting Procedures

Table 5-1 lists the troubleshooting tools contained in the printer.

Table 5-1. Troubleshooting Tools

Tool No.	Item	Description	Part No.
E643	Diagnostic Tool	Use with Epson PC (Equity) series	B765109401
E938	Cable (26-pin)	Between PBMA board (CN2) and optional interface board	Y422320000

5.1.1 Diagnostic Tools

The diagnostic tools enable anyone to troubleshoot the components, regardless of their experience.

5.1.1.1 Diagnostic System Outline

Connect this system to an MS-DOS-based computer (Epson PC (Equity), etc.) using an RS-232C cable, E934 cable, and 8143 optional interface board.

First, install the diagnostic cartridge in the printer and run the diagnostic program with the computer. The host computer sends the test programs to the printer, which then executes them. The host computer receives the test program results back from the printer and determines the status of the printer. Figure 5-2 and Table 5-2 show this diagnostic system.

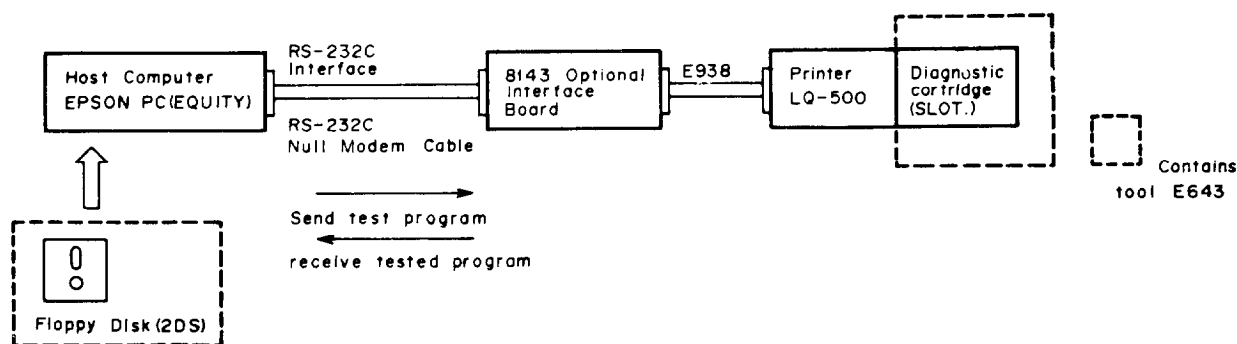


Figure 5-2. Printer Diagnostic System

Table 5-2. Printer Diagnostic System

Printer	LQ-500/L-1000
Computer	Epson PC (Equity)
Diagnostic Tool	E643
Interface Cable	RS-232C Null Modem Cable
Interface Board	8143 Optional Interface Board
Extension Cable	E938

This system has the following features:

- Provides anyone with a way to troubleshoot, regardless of technical or electronic expertise.
- A choice of programs offers various methods for repair, analysis, and testing of the printer.
- The defective unit can be identified easily.

5.2 UNIT REPLACEMENT

The unit replacement is based on system analysis. According to the particular symptom found by the multimeter, the units listed in Table 5-3 need to be replaced.

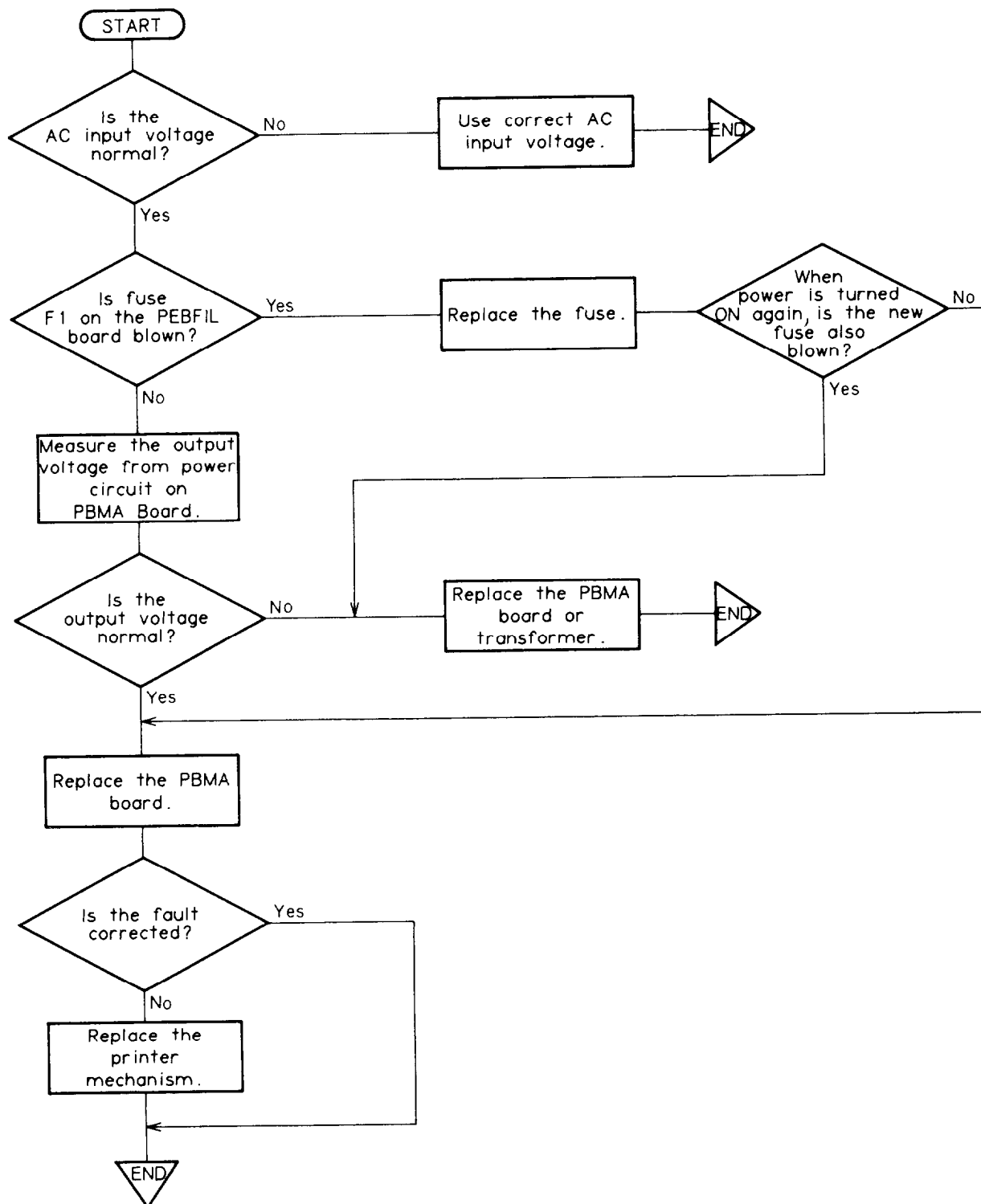
Table 5-3. Unit Replacement Numbers

Unit Name	Description	Unit No.
Fuse (F1)	2 A, 125 V (120 V Version)	X502061011
	1.25 A, 250 V (220/240 V Version)	X502063040
PEBFIL BOARD	120 V Version	Y566202100
	220/240 V Version	Y566202200
PBMA BOARD	Main Board	Y566201100
Model 5410	Printer Mechanism	Y566590100
Printhead	24-pin Dot Head	F417100000

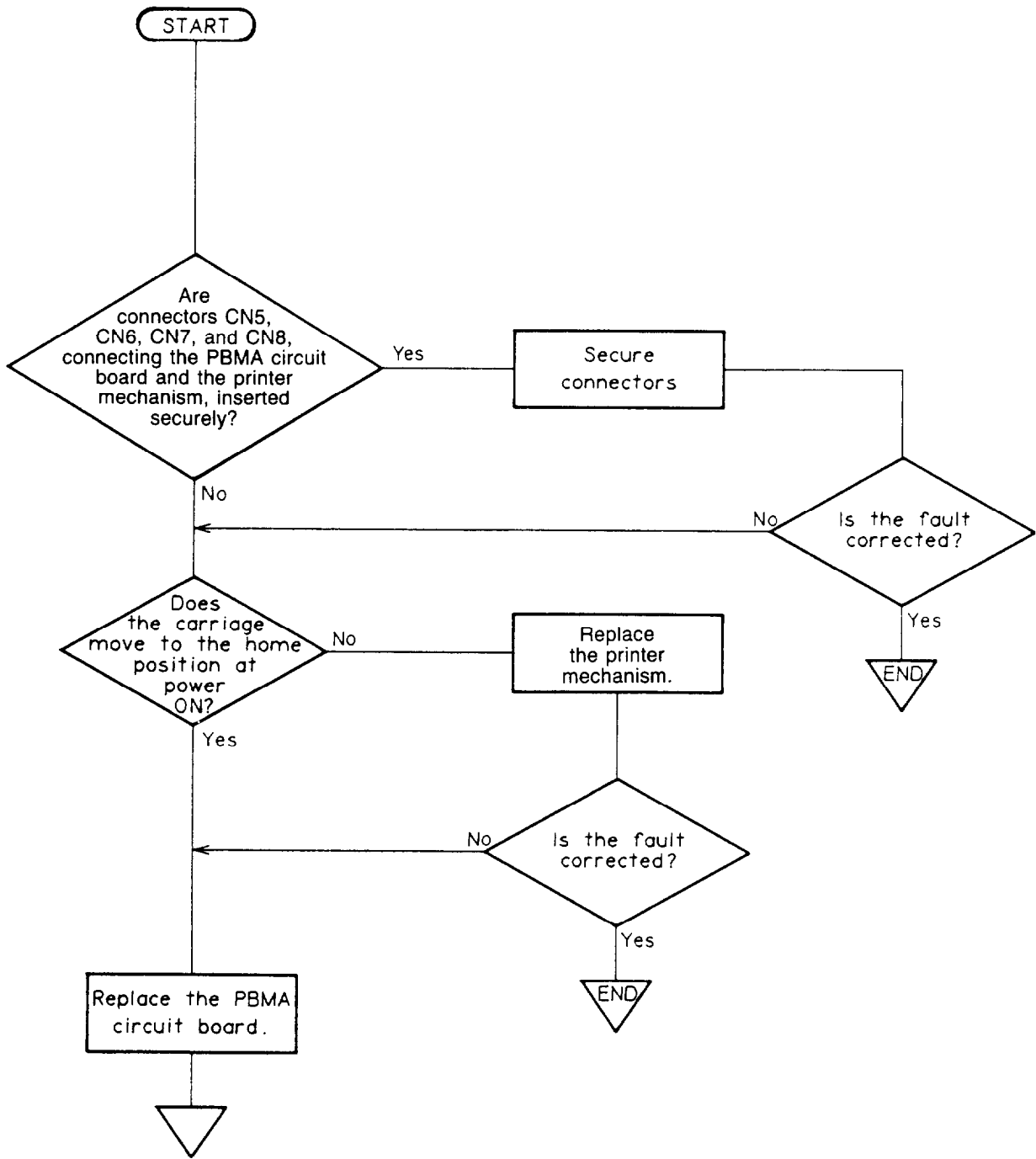
Table 5-4. Symptom and Reference Pages

Symptom	Problem	Reference Page
Printer does not operate with power switch ON	<ul style="list-style-type: none"> ● Carriage does not move. ● None of the indicators on the control panel light. 	5-4
Abnormal carriage operation	<ul style="list-style-type: none"> ● Carriage moves away from home position at power ON. ● Although the carriage returns to the home position, the printer does not enter READY mode. 	5-5
Incorrect printing (in self-test) with normal carriage operation	<ul style="list-style-type: none"> ● No printing is executed. ● Some dots do not appear. 	5-6
Abnormal paper feed	<ul style="list-style-type: none"> ● No paper is fed. ● Space between lines varies as a result of irregular paper feed. 	5-8
Abnormal operation of control panel	<ul style="list-style-type: none"> ● No paper is fed when the LF or FF switch is in OFF-LINE mode. ● Mode of operation mode cannot be set from the control panel. ● ON-LINE or OFF-LINE mode cannot be entered. 	5-9
Incorrect printing ON-LINE mode	<ul style="list-style-type: none"> ● Carriage operates normally at power ON, and the result of the self-test is correct. However, the print data from the computer is not output normally. 	5-10

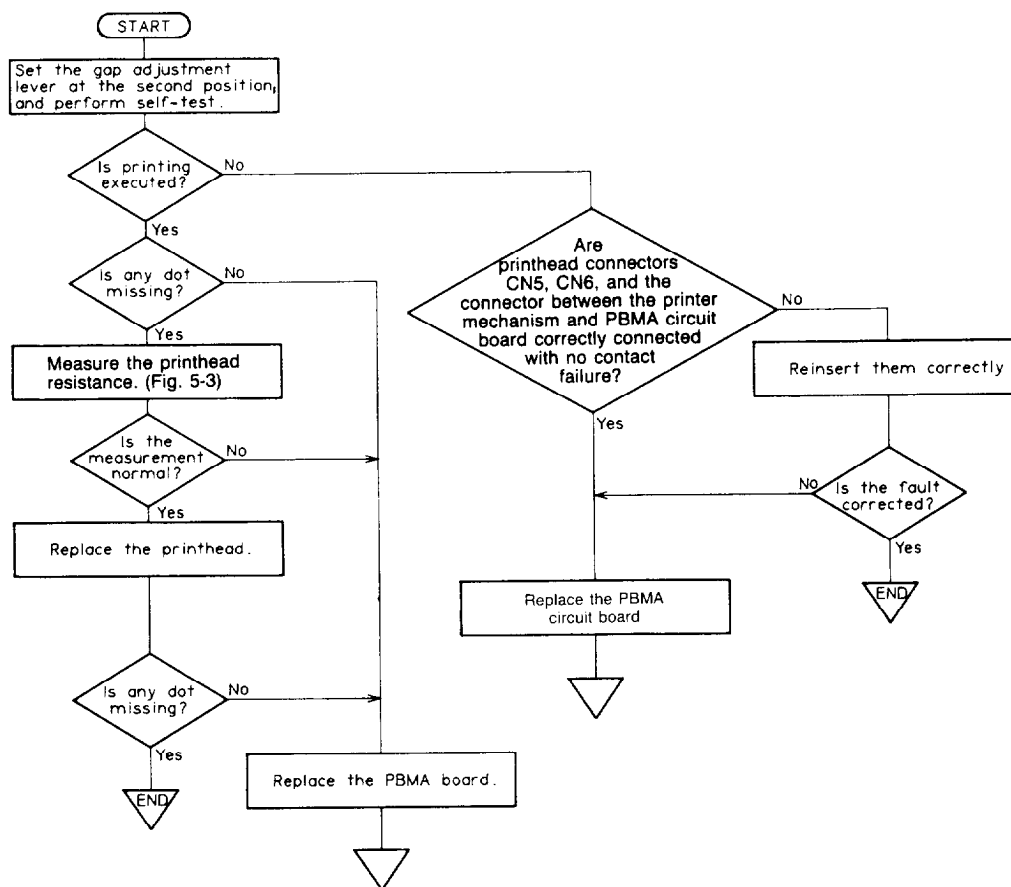
(1) Printer Does Not Operate with Power Switch ON



(2) Abnormal Operation of Carriage



(3) Incorrect Printing (in Self-Test) with Normal Carriage Operation



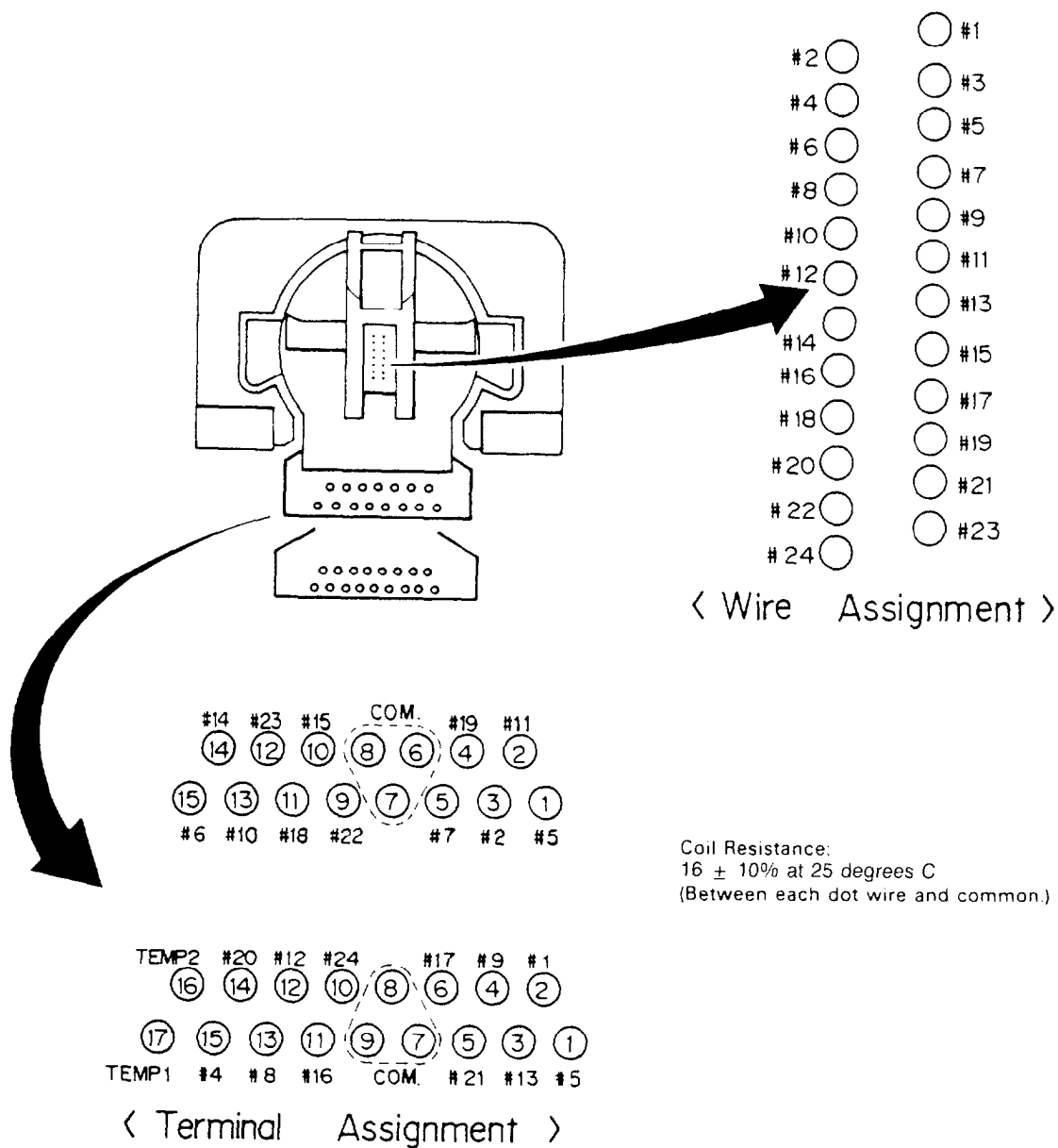
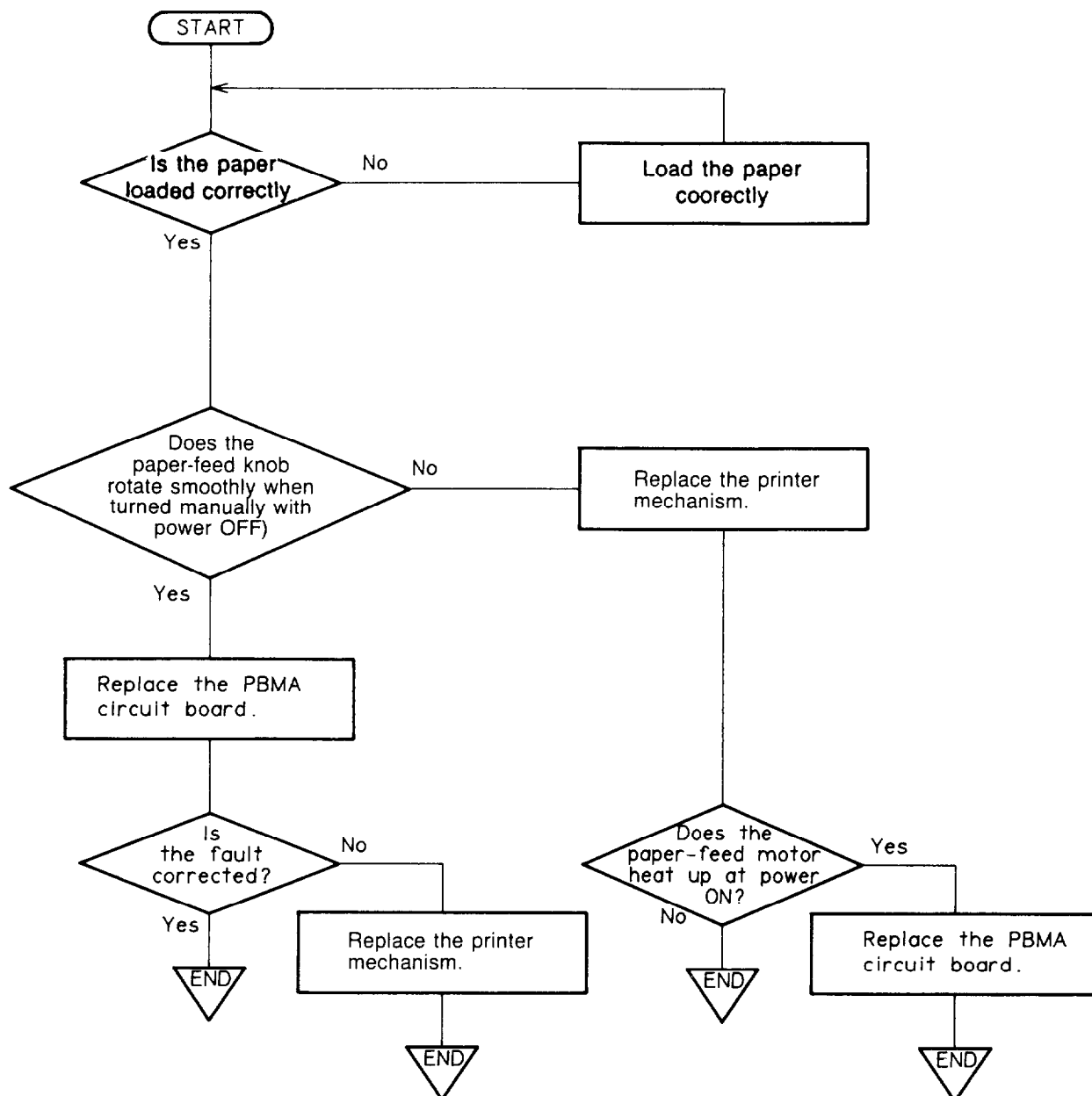
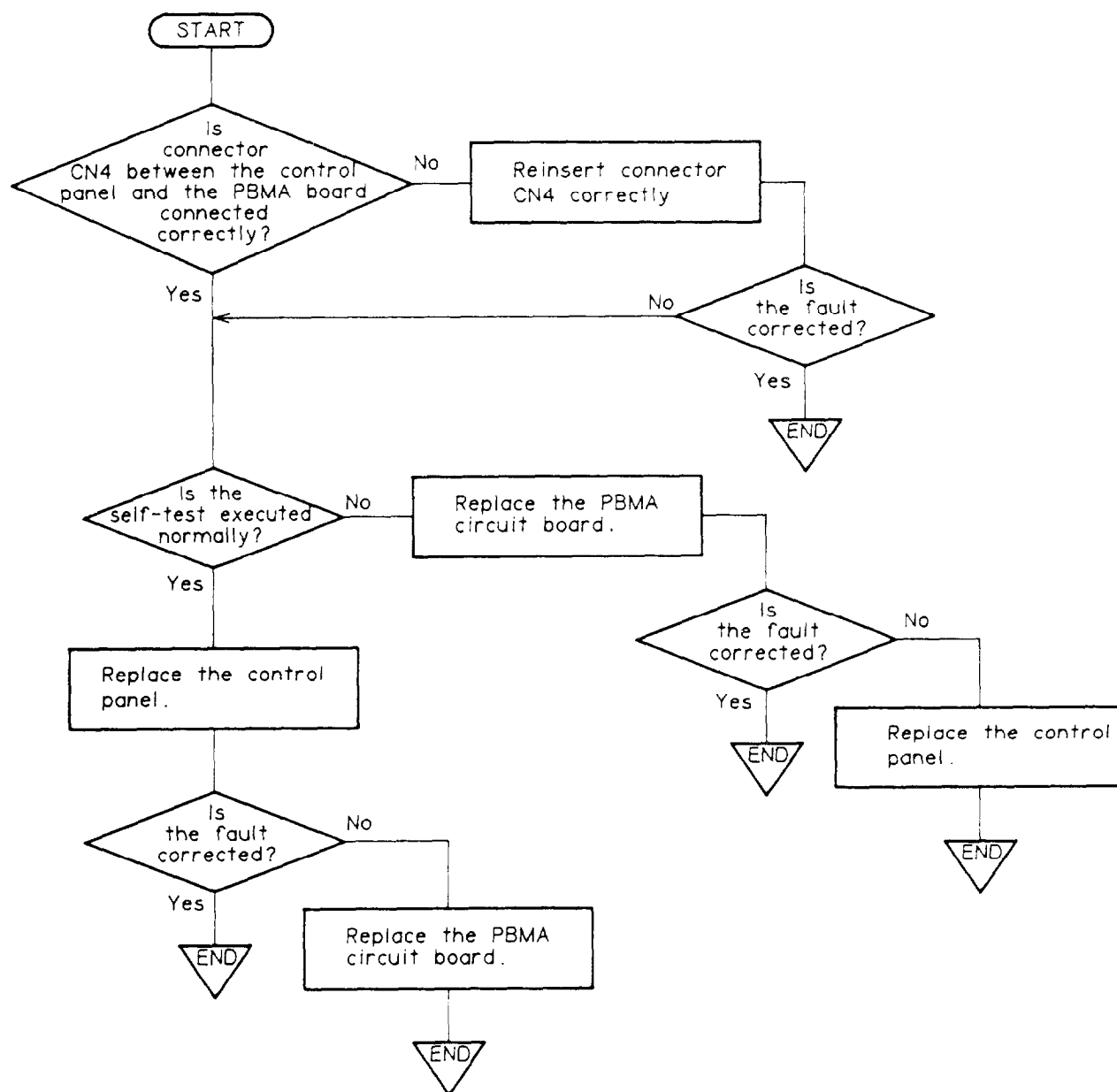


Figure 5-3. Printhead Resistance

(4) Abnormal Paper Feed (with normal printing)

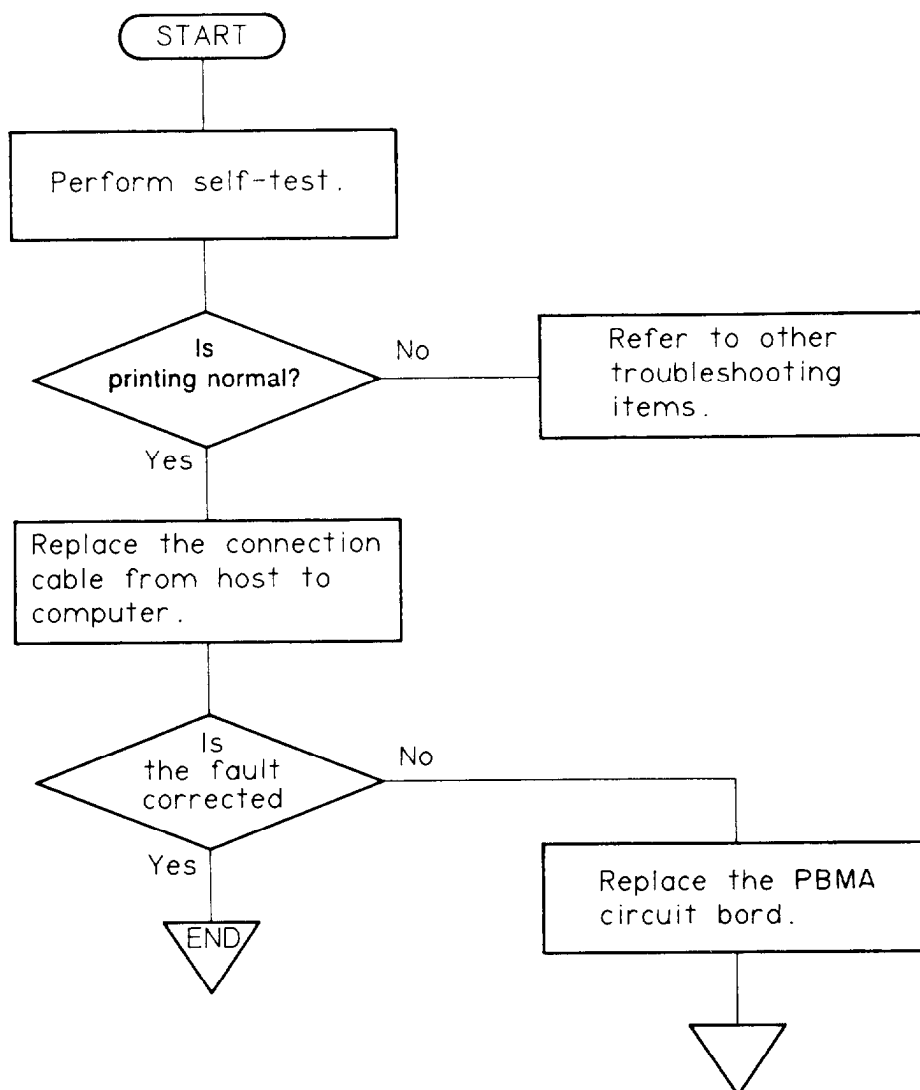


(5) Abnormal Operation of Control Panel



(6) Incorrect Printing in ON-LINE Mode

NOTE: It is assumed that the host computer operates normally.



5.3 UNIT REPAIR

Unit repair is comprised of three parts: (1) repair of the power supply circuit; (2) repair of the control circuit; (3) repair of the printer mechanism.

This section describes (1) power supply circuit unit repair. If (2) control circuit, or (3) printer mechanism need repair, use the diagnostic tool introduced in Section 5.1.1.

5.3.1 Power Supply Circuit

This section indicates possible causes and check points for differences in the power supply circuit. The checkpoints include waveforms for normal operation. By referring to the checkpoints, determine the defective component and perform the proper repair. Table 5-6 has the following four columns:

- Symptom: Check symptoms against those given in this column.
- Cause: Check problems against the causes listed in this column.
- Check Point: Use the instructions given in this column for troubleshooting.
- Solution: Make repairs according to the instructions given in this column.

Table 5-5. Power Supply Circuit Parts List

Location	Name	Description
8C	NJM2355	Pulse width modulation control
Q25	2SC1815	50 V, 150 mA, 400 mW
Q26,Q36	2SA1020	-50 V, -2 A, 0.9 W
Q33	2SC4169	50 V, 1.2 A, 1 W
Q34	2SC3746	60 V, 5 A, 2 W
Q35	2SC3748	60 V, 10 A, 2W

Table 5-6. Power Supply Circuit Unit Repair

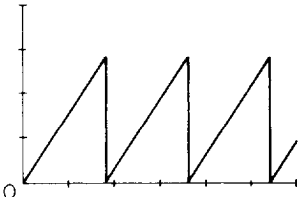
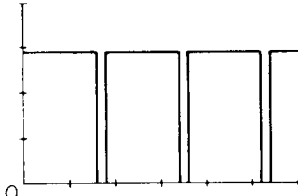
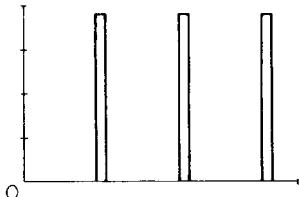
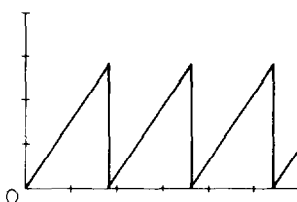
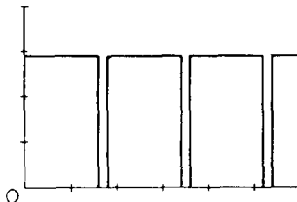
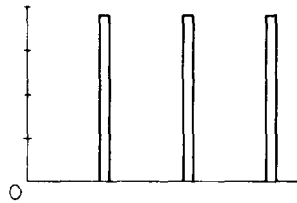
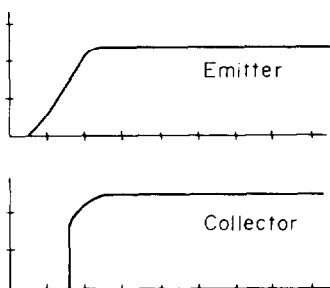
Symptom	Cause	Check Point	Solution
The +5 V supply is dead.	IC 8C is defective.	<p>Observe the oscillation waveform and the switching waveform.</p>  <p>1V/DIV, 20μs/DIV</p> <p>Oscillation Waveform (Pin 2 of IC 8C)</p>  <p>10V/DIV, 20μs/DIV</p> <p>Switching Waveform (Pin 9 of IC 8C)</p>	Replace IC 8C.
	Transistors Q33 and Q34 are defective.	<p>Observe the chopping waveform</p>  <p>10V/DIV, 20μs/DIV</p> <p>Chopping Waveform (Emitter of Q34)</p>	

Table 5-6. Power Supply Circuit Unit Repair (cont.)

Symptom	Cause	Check Point	Solution
The +24 V dead.	IC 8C is defective.	<p>Observe the oscillation waveform and the switching waveform.</p>  <p>1V/DIV, 20μs/DIV</p> <p>Oscillation Waveform (Pin 2 of IC 8C)</p>  <p>10V/DIV, 20μs/DIV</p> <p>Switching Waveform (Pin 11 of IC 8C)</p>	Replace IC 8C.
	Transistors Q35 and Q36 are defective.	<p>Observe the chopping waveform</p>  <p>10V/DIV, 20μs/DIV</p> <p>Chopping Waveform (Emitter of Q35)</p>	
Vx voltage is not output.	Q25, Q26, and ZD1 defective.	<p>Observe the Vx voltage, when printer power is turned on.</p>  <p>2V/DIV, 5ms/DIV</p> <p>Vx Voltage Waveform (Q26)</p>	Replace Q25, Q26, or ZD1.

5.3.2 Control Circuit

The control circuit can be repaired using the diagnostic tool to identify the problem. Table 5-7 lists the main parts of the control circuit.

Table 5-7. Control Circuit Parts List

Location	Name	Description
4B	μ PD7810HG	CPU 15 MHz
6C	E01A05KA	
7A	E05A02LA	
2C	HM65256BSP	PSRAM 32K \times 8 bits
7C	STK6981B	Stepper motor driver
5B	TL431CLPB	Adjustable precision shunt regulator
2B	74LS06	Hex. OC inverters
4A, 1B	7407	Hex. OC buffers
Q1-Q24	2SD1843	60 V, 1 A, 10 W
Q27	2SB1093	-80 V, -1.5 A, 10 W
Q28-Q31	2SC4169	50 V, 1.2 A, 1 W
Q32		
Q37	2SA1015	-50 V, 150 mA, 400 mW

5.3.3 Model 5410 Printer Mechanism

Use the diagnostic tool to detect malfunctions among the carriage motor, paper-feed motor, and sensor. Table 5-8 lists the specifications for these components. Use the printing test, and also inspect visually.

Table 5-8. Device List

Name	Description
Carriage Motor	Type: 4-phase, 48-step, PM stepper motor Voltage: 24 VDC \pm 10% Coil Resistance: 21 ohms \pm 7% (at 25 degrees C) /phase
Paper-Feed Motor	Type: 4-phase, 48-step, PM stepper motor Voltage: 24 VDC \pm 10% Coil Resistance: 58 ohms \pm 7% (at 25 degrees C) /phase

CHAPTER 6

MAINTENANCE

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Proper maintenance is essential to assure optimal printer performance for the longest possible period and to minimize malfunction frequency.

6.1 PREVENTIVE MAINTENANCE

Preventive maintenance includes regular cleaning of the case exterior using alcohol and occasional vacuuming of the mechanism interior to remove dust and paper particles.

Following cleaning, refer to Section 6.2 to verify that the unit is adequately lubricated. Before returning the serviced printer to the consumer, inspect the springs, paper-feed rollers, and the basic operation of the unit.

WARNING

Disconnect the printer from the power supply before performing maintenance. Do not use thinner, trichloroethylene, or ketone-based solvents on the plastic components of the printer.

6.2 LUBRICATION AND ADHESIVE APPLICATION

Epson recommends that the printer be lubricated at the points illustrated in Figure 6-2. These lubrication points are listed in Table 6-2, along with the recommended lubricant for each point, Epson O-2 or G-27, both of which have been tested extensively and found to comply with the needs of this printer. (Refer to Table 6-1 for detailed information about O-2, G-19, G-26, and G-27.)

Be sure that the parts to be lubricated are clean before applying lubricant, and avoid excessive application, which may damage related parts,

Adhesive application is necessary at the point indicated in Table 6-3 when the part is disassembled or replaced. Epson recommends Neji lock #2 (G) adhesive be applied to the point diagramed in Figure 6-1. Avoid overflow of excess to related parts.

Table 6-1. Lubricants and Adhesive

Type	Name	Capacity	Availability	Parts No.
Oil	O-2	40 cc	E	B710200001
Grease	G-27	40 gm	E	B702700001
Grease	G-19	40 gm	E	B701900001
Grease	G-26	40 gm	E	B702600001
Adhesive	Neji lock #2 (G)		E	B730200200

E: Epson-exclusive product

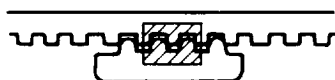
Table 6-2. Lubrication Points (Refer to Figure 6-2)

Ref. No.	Lubrication Points	Lubricant
(1)	Carriage guide shaft (on both left and right sides of carriage)	O-2
(2)	Carriage guide plate (portion in contact with the carriage) 50 mm (L) × 2 mm (W)	G-26
(3)	Platen gear (a quarter of the way around the gear)	G-26
(4)	Shaft that sets the ribbon gears	G-27
(5)	Gear portions of the ribbon gears	G-27
(6)	Felt	O-2
(7)	Paper-guide-plate release lever	G-27
(8)	Paper-release lever	G-27
(9)	Ribbon planetary lever assembly	G-19
(10)	Belt pulley	G-26

NOTES: Lubrication is necessary in the process of assembly.

Table 6-3. Adhesive Application Point (Refer to Figure 6-1)

Adhesive Application Point	No. of Points
Part where timing belt engages the carriage	1

**Figure 6-1. Correct Adhesive Application**

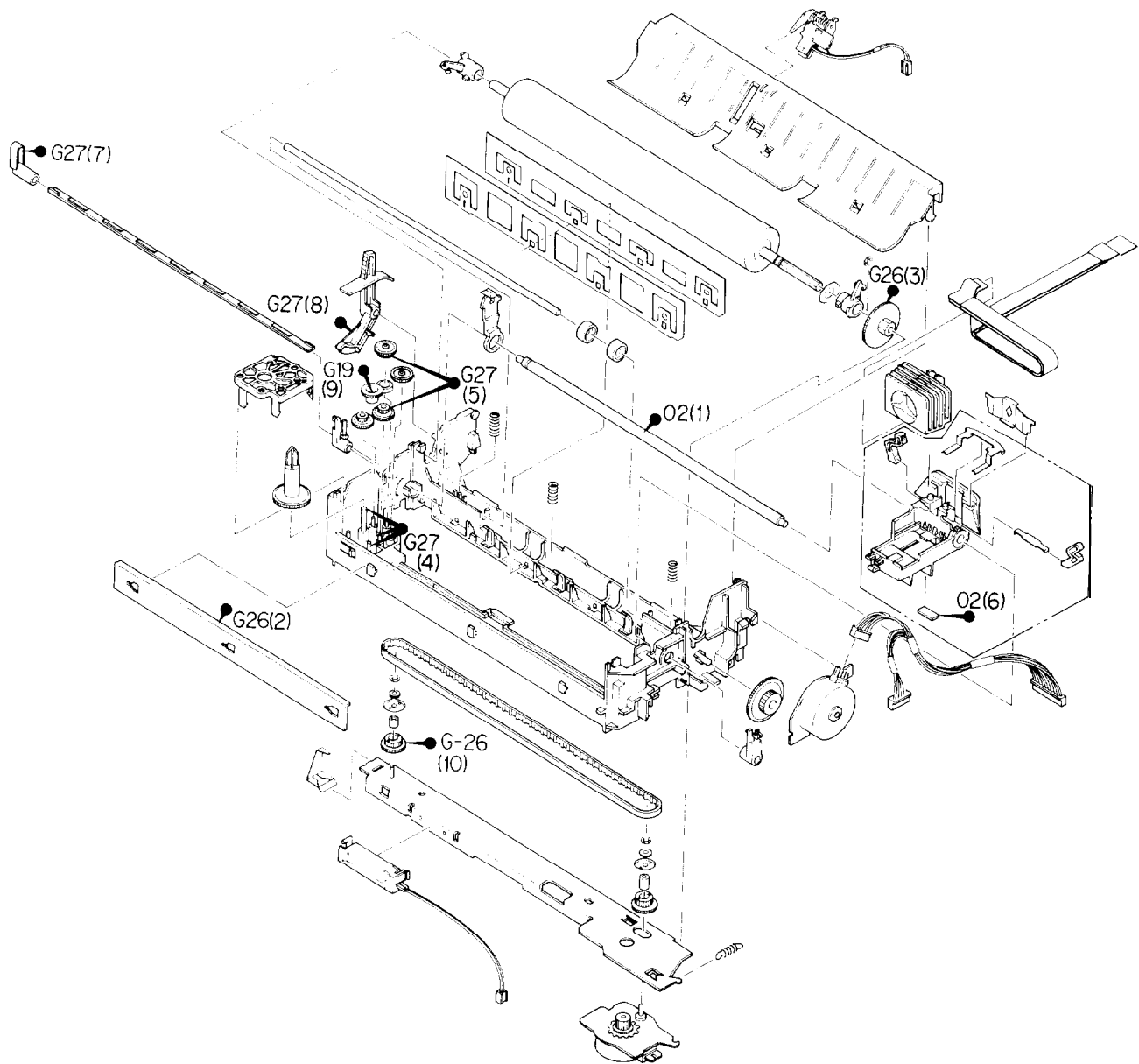


Figure 6-2. LQ-500/L-1000 Lubrication Points

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This appendix provides detailed information about the integrated circuits, signal functions, capabilities, etc., of components of the LQ-500/L-1000 printer.

A.1 INTEGRATED CIRCUITS WITHIN THE LQ-500/L-1000

Table A-I shows LQ-500/L-1000 ICs.

Table A-I. LQ-500/L-1000 ICs

Location	Name of IC	Type
4B	μ PD7810HG	CPU 15 MHz
6C	E01A05KA	
7A	E05A02LA	
2C	HM65256BSP	PSRAM 32 K \times 8 Bits
7C	STK6981B	Stepper motor driver
8C	NJM2355	Pulse-width modulation control
5B	TL431CLPB	Adjustable precision shunt regulator
2B	74LS06	Hex. OC inverters
4A, 1B	7407	Hex. OC buffers
Q1-Q24	2SD1843	60 V, 1 A, 10 W
Q25	2SC1815	50 V, 150 mA, 400 mW
Q26, Q36	2SA1020	-50 V, -2 A, 0.9 W
Q27	2SB1093	-80 V, -1.5 A, 10 W
Q28-Q31	2SC4169	50 V, 1.2 A, 1 W
Q32, Q33, Q37	2SA1015	-50 V, -150 mA, 400 mW
Q34	2SC3746	60 V, 5 A, 2 W
Q35	2SC3748	60 V, 10 A, 2 W

A.1.1 CPU μ PD7810HG (4B)

The μ PD7810/7811HG contains two 8-bit timer/counters, an 8-bit A/D converter, 256 bytes of RAM, and a serial interface. A system can be constructed easily using this IC. The main features of this IC are as follows:

- 256 bytes built-in RAM (addresses FF00 hex.-FFFF hex.)
- 4096 bytes mask ROM (addresses 0 -0FFF hex.) for the 7811 CPU
- Direct addressing of up to 64K bytes
- 8-bit A/D converter
- 158 instructions
- 0.8 μ s instruction cycle (15 MHz)
- 16-bit event counter
- Two 8-bit timer/counters
- 3 external and 8 internal interrupts; 6 priority levels; and 6 interrupt addresses
- General-purpose serial interface (asynchronous, synchronous, and I/O modes)
- I/O line (7811: 40-bit I/O port; 7810: 24-bit edge detection, 4 inputs)
- Zero cross detection
- Standby function
- Built-in clock pulse circuit
- NMOS

Figures A-1 and A-2 illustrate the 7810/7811 HG microprocessor, and Tables A-2 through A-5 describe its functions.

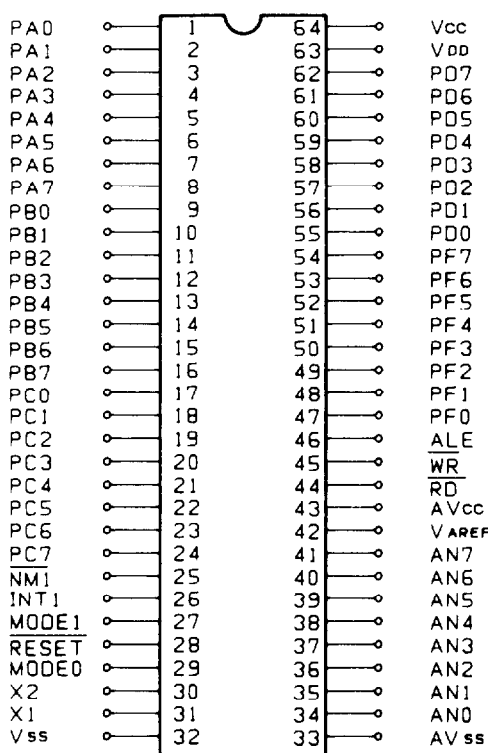


Figure A-I. μ PD7810/7811 Pin Diagram

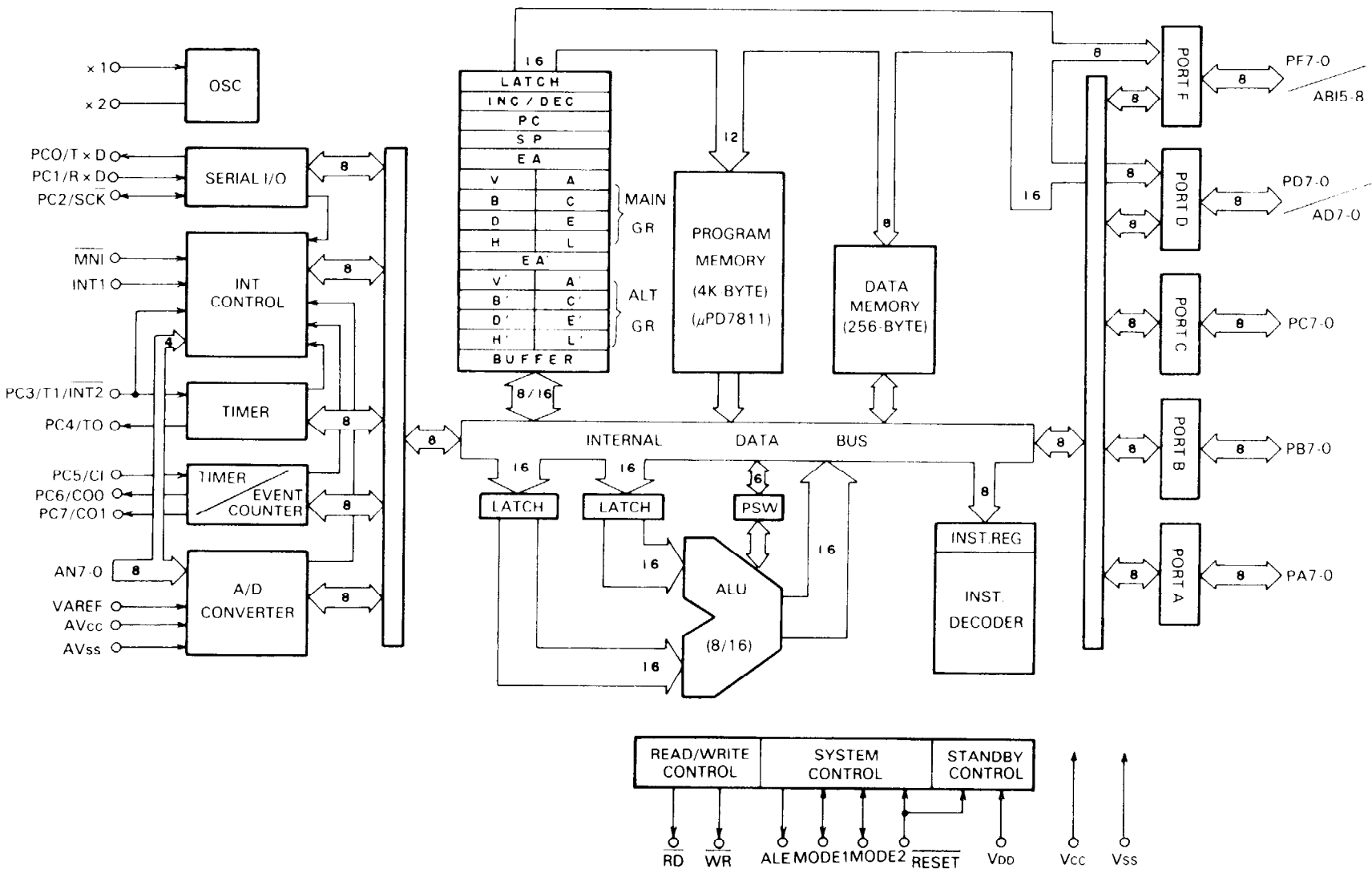


Figure A-2. μ PD7810/7811 Block Diagram

Table A-2. μ PD7810 Mode Setting

Mode 1	Mode 0	External Memory
0	0	4K bytes, Addresses 0 to 0FFF
0	1 (Note)	16K bytes Addresses 0 to 3FFF
1 (Note)	1 (Note)	64K bytes Addresses 0 to 0FFF

NOTE: Pull-up is performed.

Table A-3. μ PD7811 PF Operation

PF7	PF6	PF5	PF4	PF3	PF2	PF1	PF0	External Memory
Port	Port	Port	Port	Port	Port	Port	Port	256 bytes (max.)
Port	Port	Port	Port	AB11	AB10	AB9	AB8	4K bytes (max.)
Port	Port	AB13	AB12	AB11	AB10	AB9	AB8	16K bytes (max.)
AB15	AB14	AB13	AB12	AB11	AB10	AB9	AB8	60K bytes (max.)

Table A-4. μ PD7810 PF Operation

MODE 1	MODE 0	PF7	PF6	PF5	PF4	PF3	PF2	PF1	PF0	External Memory
0	0	Port	Port	Port	Port	AB11	AB10	AB9	AB8	4K bytes (max.)
0	1	Port	Port	AB13	AB12	AB11	AB10	AB9	AB8	16K bytes (max.)
1	1	AB15	AB14	AB13	AB12	AB11	AB10	AB9	AB8	64K bytes (max.)

Table A-5. μ PD7810/7811 Port Functions

Pin	Signal	Direction	Description
1-8	PA0-7	In/Out	Port A. Eight-bit I/O with output latch. I/O possible by mode A (MA) register. Output HIGH.
9-16	PB0-7	In/Out	Port B. Eight-bit I/O with output latch. I/O possible by mode B (MB) register. Output HIGH.
17-24	PC0-7	In/Out	Port C. Eight-bit I/O with output latch. Port/control mode can be set by mode control C (MCC) register. Output HIGH.
25	NMI	In	Non-maskable interrupt of the edge trigger (trailing edge).
26	INT 1	In	Maskable interrupt input of the edge trigger (leading edge). Also used as the AC input zero cross detecting terminal.
27, 29	MODE 1,0	In/Out	7811: 0 = LOW and 1 = HIGH. 7810: modes set in accordance with external memory (see Table A-2).
28	RESET	In	LOW reset.
30, 31	X2, X1	—	Crystal connection for built-in clock pulse. When clock pulses are supplied externally, input must be to X1.
32	Vss	—	Supply voltage, Vss, 0 V.
33	AVss	—	Analog Vss.
34-41	AN0-7	In	Eight analog inputs of the A/D converter. AN7-4 can be used as the input terminals to detect the leading edge and to set the test flag upon detection of the trailing edge.
42	VAref	In	Reference voltage.
43	AVcc	—	Analog Vcc.
44	RD	Out	Read strobe. LOW at the read machine cycle and at reset, HIGH at other times.
45	WR	Out	Write strobe. LOW during the write machine cycle and at reset, HIGH at other times.
46	ALE	Out	Address latch enable. Latches the lower B address bits to access external memory.
47-54	PF0-7		Port F. 7811: Port bit-by-bit I/O possible by mode F register. In extension mode gradual address output assignment is possible in accordance with the size of external memory. See Table A-3. 7810: By setting modes 0 and 1, assignment to the address bus (AB15-8) can be made in accordance with the size of the external memory. The remaining terminals can be used as I/O ports. See Table A-4.
55-62	PD0-7		Port D. 7811: Port bit-by-bit I/O possible. In extension mode, PD7-0 act as the multiplexed address/data bus (AD7-0). 7810: Multiplexed address/data bus to access external memory.
63	VDD	—	Supply voltage, VDD + 5 V.
64	Vcc	—	Supply voltage, Vcc + 5 V.

● CPU Timing

Refer to Figures A-3 through A-5 for CPU timing diagrams.

Three oscillations define one state. The OP code fetch requires four states; during T1 to T3, program memory is read; instructions are interpreted during T4. Address bus lines 15-8 are output from T1 to T4. Address bus lines 7-0 (PD7-0) are used in the multiplex mode; the address is latched during T1 at the ALE signal. Since the memory addressed is enabled after disengaging the driver (AD7-0), RD is output from T1-T3, fetched at T3, and processed internally at T4. The ALE and RD signals are executed from T1-T3; the OP code fetch for these two signals is performed at T4. The WR signal is output from the middle of T1 to the beginning of T3. The address and ALE timing is the same as that for memory read; however following address output AD7-0 (PD7-0) are not disabled, and write data is output at AD7-0 at the beginning of T1 and the end of T3.

NOTE: When PD7-0 are set to the multiplexed address/data bus (AD7-0) and PF7-0 to the address bus (AB7-0), the RD and WR signals in the machine cycle are HIGH when memory is not being accessed.

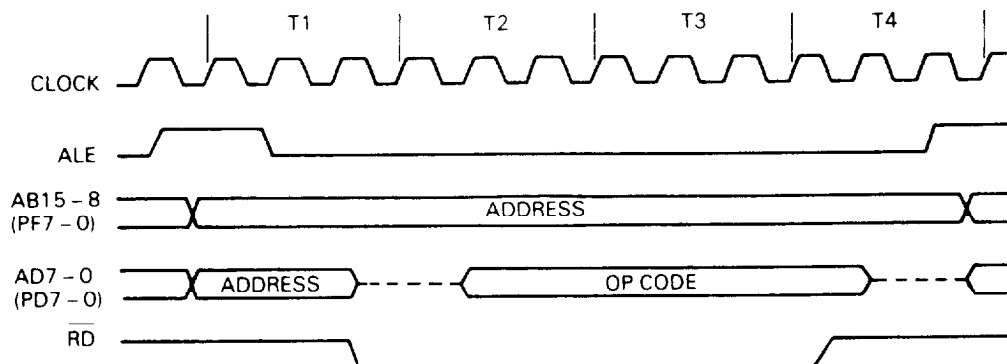


Figure A-3. OP Code Fetch Timing

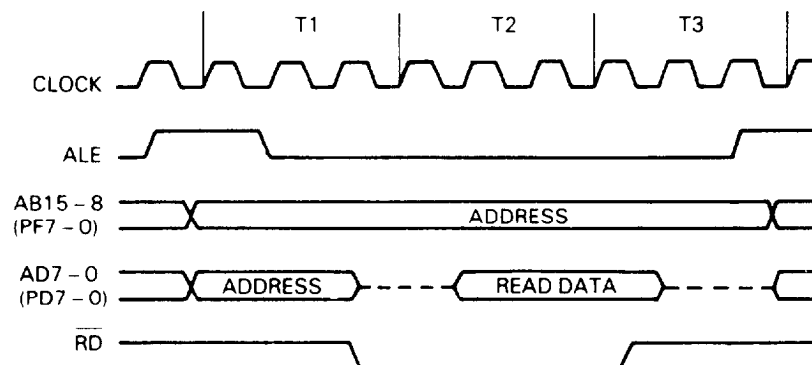


Figure A-4. Memory Read Timing

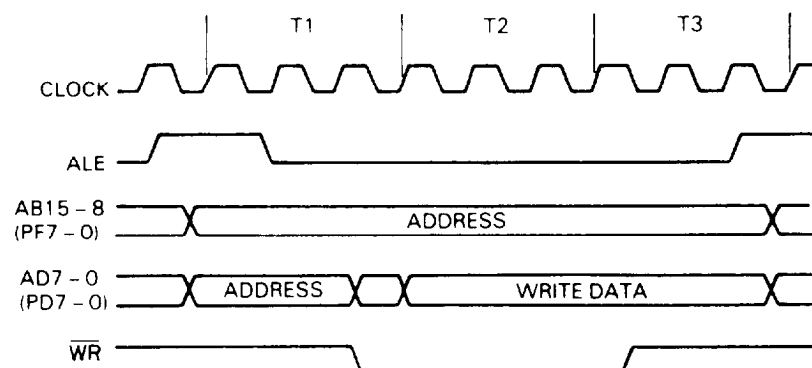


Figure A-5. Memory Write Timing

A.12 E015KA (6C)

This gate array was newly developed for this printer. Its functions are as follows:

1. Parallel I/F
2. Address decoder
3. Bank register
4. Data address multiplexer
5. Reset
6. CR motor control

Figure A-6 shows the E015KA pin diagram; Figure A-7 shows the E015KA block diagram; Table A-6 shows pin functions for the E015KA.

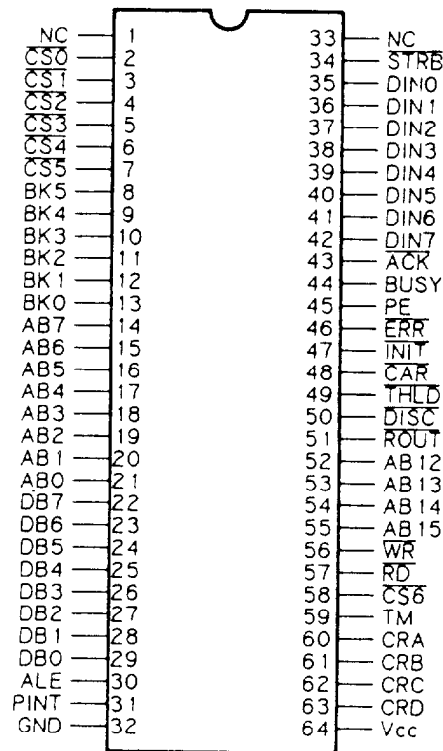


Figure A-6. E01A05KA Pin Diagram

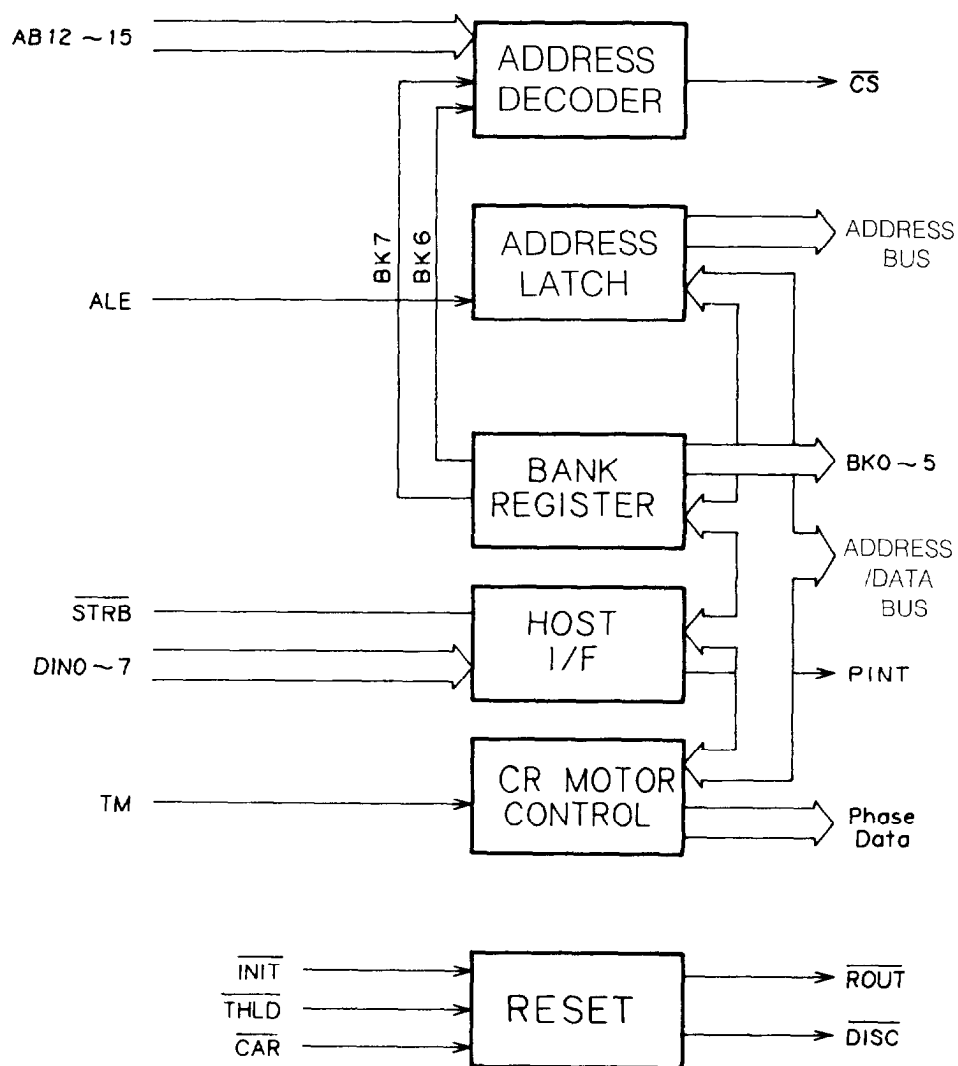


Figure A-7. E01A05KA Block Diagram

Table A-6. E01A05KA Pin Functions

Pin No.	Signal	I/O	Function
2-7,58	$\overline{\text{CS0-6}}$	O	Chip-select signal
8-3	BK0-7	O	Bank line
14-21	AB0-7	O	Lower address latched by ALE
22-29	DB0-7	I/O	Multiplex address/data bus
30	ALE	I	Address latch enable
31	PINT	O	STRB signal step-down monitor signal
32	GND	-	GND
34	$\overline{\text{STRB}}$	I	DINO-7 signal latch signal
35-42	DINO-7	I	Parallel I/F input data
43	$\overline{\text{ACK}}$	O	Parallel I/F ACK signal
44	BUSY	O	Parallel I/F BUSY signal
45	PE	O	Parallel I/F PE signal
46	$\overline{\text{EER}}$	O	Parallel I/F ERR signal
47	$\overline{\text{INIT}}$	I	Parallel I/F INIT signal
48	$\overline{\text{CAR}}$	I	Cartridge reset
49	$\overline{\text{THLD}}$	I	Power reset
50	$\overline{\text{DISC}}$	O	Reset circuit condenser discharge
51	$\overline{\text{ROUT}}$	O	RESET signal
52-55	AB12-15	I	Address decoding by AB12-15
56	$\overline{\text{WR}}$	I	Write enable
57	$\overline{\text{RD}}$	I	Read enable
59	TM	I	CR motor phase changed by TM pulse
60-63	CRA-D	O	CR motor control port
64	Vcc	—	Power supply
1,33	NC	—	Not connected

A.1.3 E05A02LA (7A)

This gate array was developed for 24-pin, dot-matrix printers and is used to simplify the interface between the CPU and the printhead. Figure A-8 shows the E05A02LA pin diagram; Figure A-9 shows the E05A02LA block diagram; Table A-7 shows pin functions for the E05A02LA.

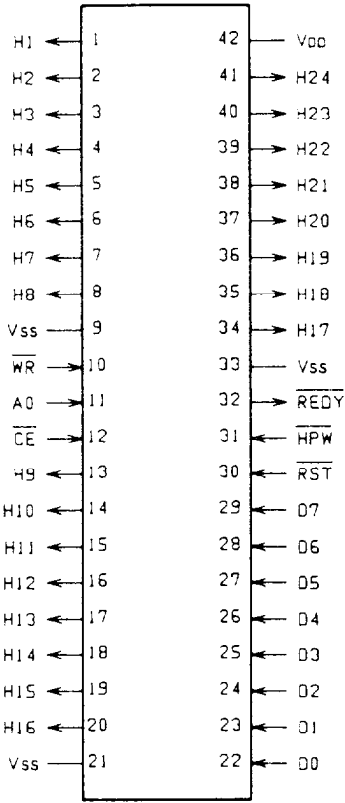


Figure A-8. E05A02LA Pin Diagram

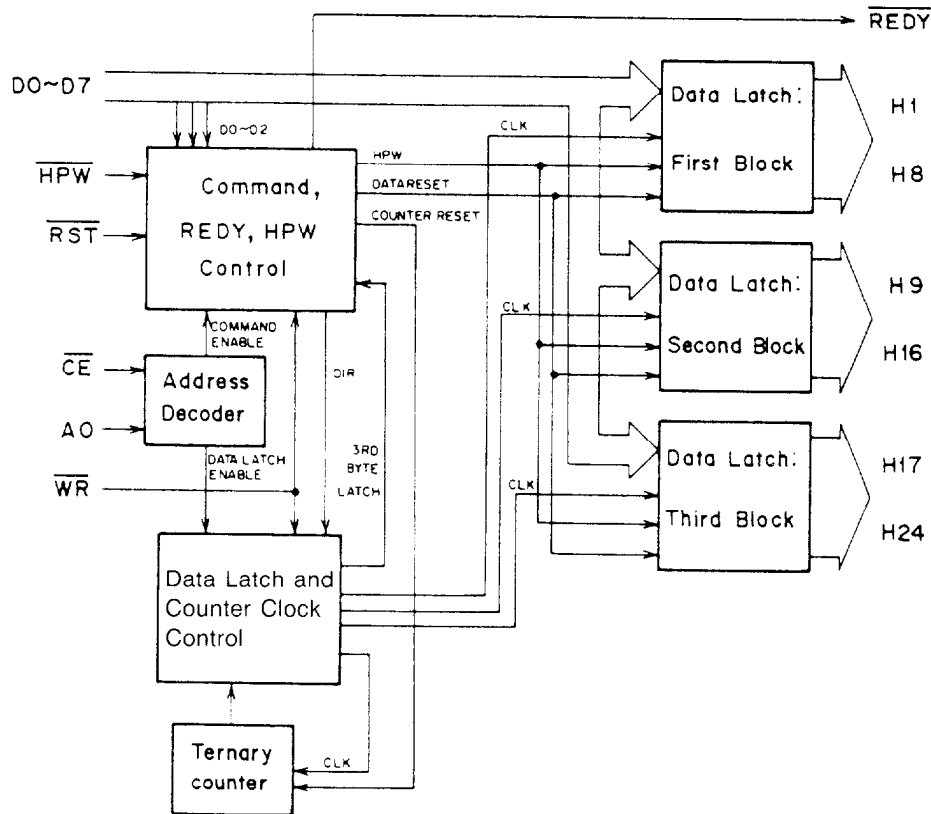


Figure A-9. E05A02LA Block Diagram

Table A-7. E05A02LA Pin Functions

Pin No.	Signal	I/O	Function
1-8	H1-8	O	Head data 1-8 output
9	Vss	-	GND
10	\overline{WR}	I	Write enable
11	A0	I	Address bit 0
12	\overline{CE}	I	Chip enable
13-20	H9-16	O	Head data 9-16 output
21	Vss	-	GND
22-29	DO-7	I	Data/Command Input
30	\overline{RST}	I	Reset
31	\overline{HPW}	I	Head-driving pulse width
32	\overline{REDY}	I	
33	Vss	-	GND
34-41	H17-24	O	Head data 17-24 output
42	Vdd	-	+5 V

A.1.4 HM65256BSP (2C)

The HM65256BSP is a 32K-word x 8-bit pseudo-static RAM (PSRAM) featuring low power consumption, due to the employment of CMOS peripheral circuits, high speed, and large capacity, as a consequence of its usage of a single transistor memory cell. Figure A-10 shows the HM65256BSP pin diagram. Figure A-11 shows the HM65256BSP block diagram.

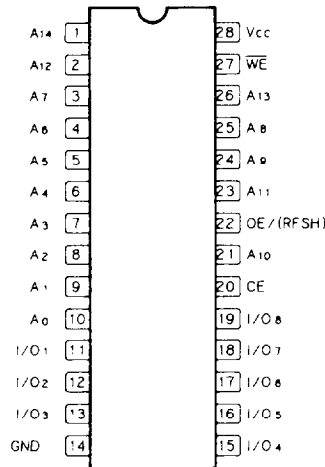


Figure A-10. HM65256BSP Pin Diagram

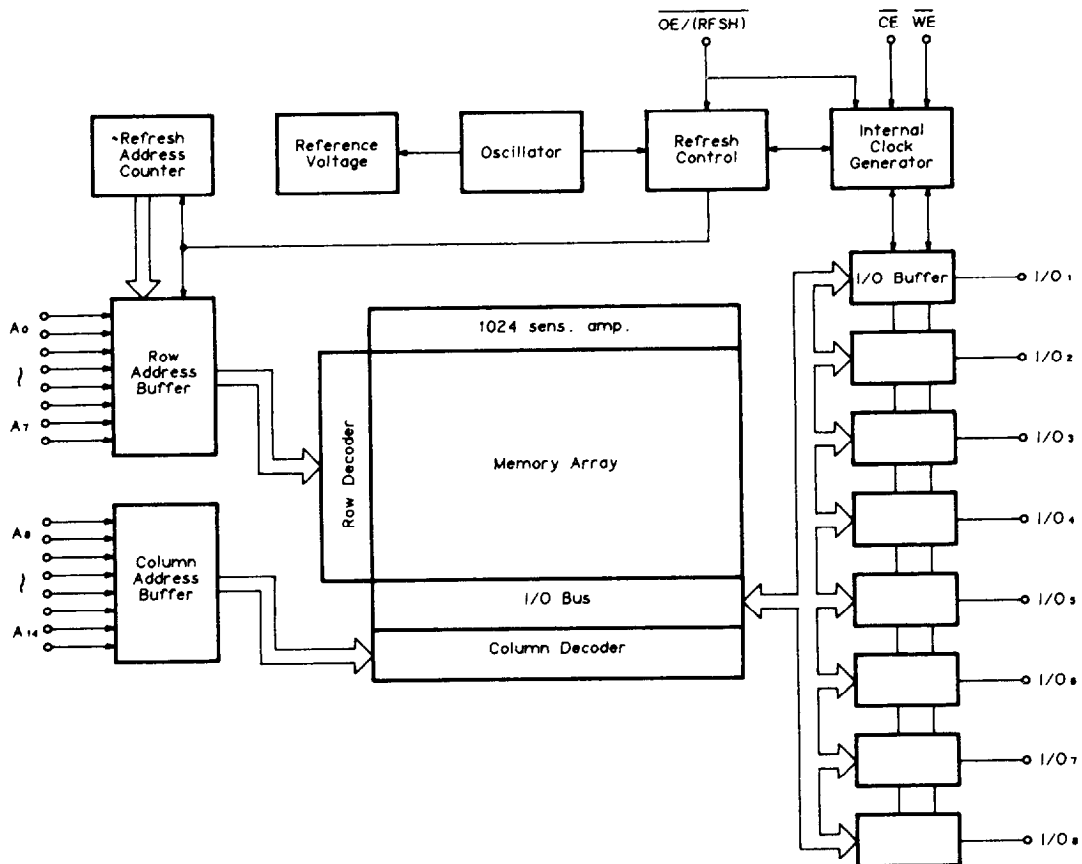


Figure A-11. HM65256BSP Block Diagram

A.1.5 STK6981 B (7C)

The STK6981 B is a two-circuit, 4-phase stepper motor driver for unipolar constant-current driving. The chopping operation is performed to improve the start-up characteristics and minimize heat generation with the constant current.

The holding terminal included in the STK6981B controls temporary holding

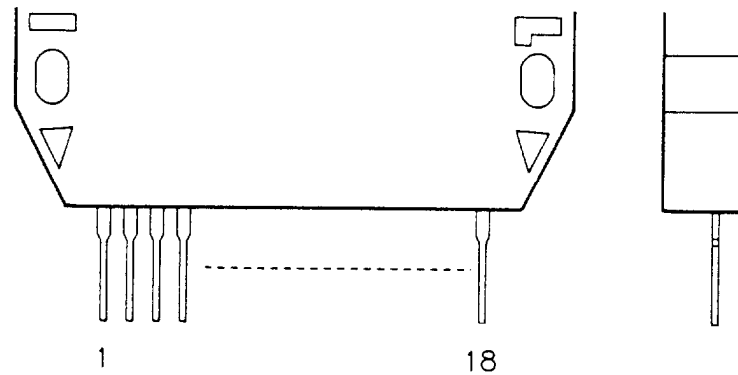


Figure A-12. STK6981B Case Outline Drawing

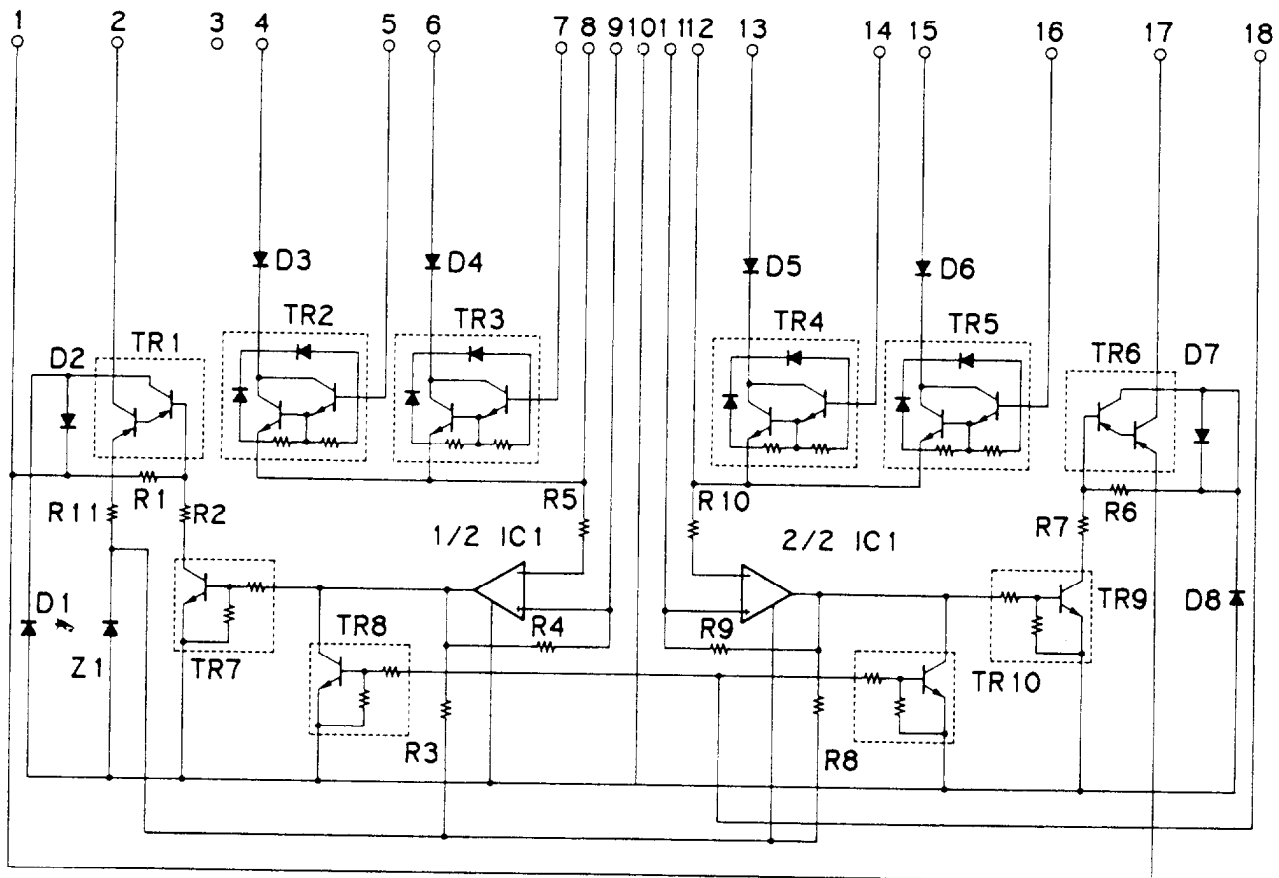


Figure A-13. STK6981 B Functional Equivalent Circuit

A.1.6 NJM2355 (8C)

The NJM2355 functions are identical to the TL494 functions. It is a pulse-width modulation control circuit IC. Figure A-14 shows the NJM2355 internal circuit diagram.

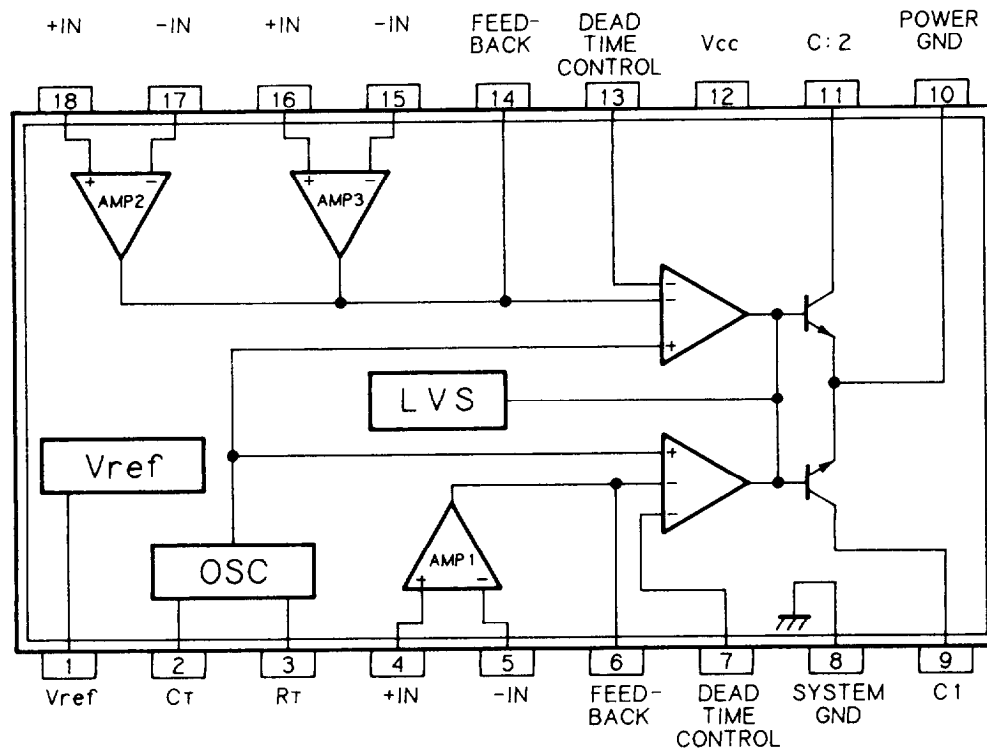


Figure A-14. NJM2355 Internal Circuit Diagram

A.1.7 TL431 CLPB (58)

The TL431 is a high-accuracy, temperature-compensated shunt regulator. The output voltage can be set anywhere between 2.5 V and 36 V by adding two external resistors. The TL431 is very stable and outputs a large current so that it can replace various Zener diodes. It is especially suitable for driving the photodiode in the photocoupler section of the feedback circuit, employed in the RCC system switching regulator.

- Temperature-compensated reference voltage (50 ppm/C TYP)
- High response speed
- Low. noise

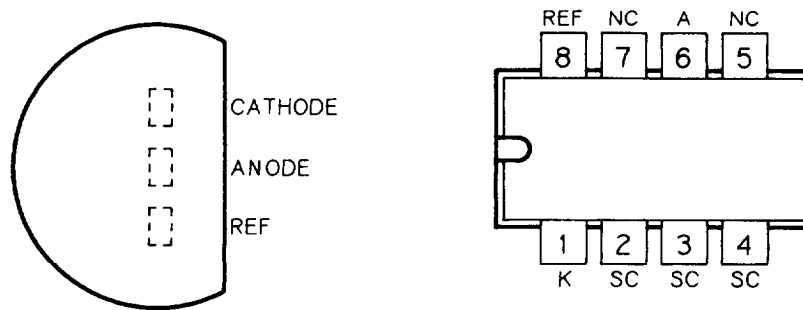


Figure A-15. TL431CLPB Pin Diagram

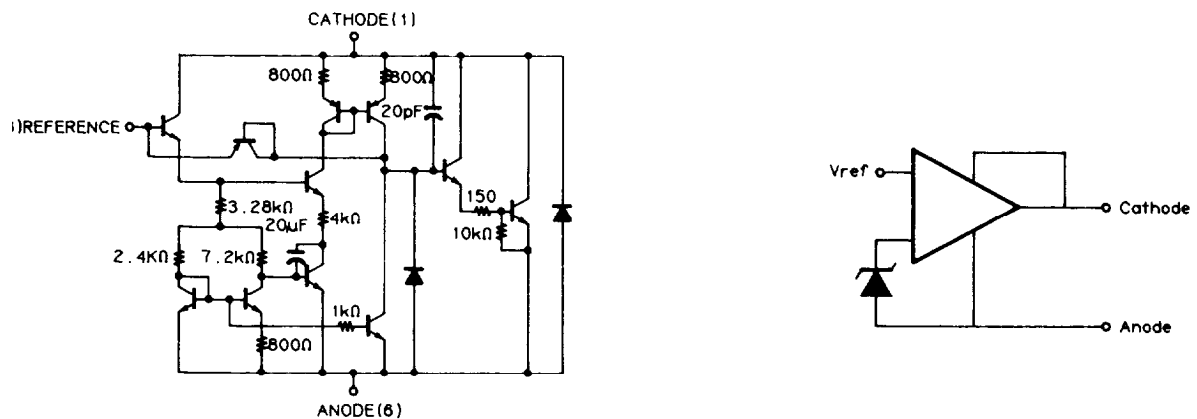


Figure A-16. TL431CLPB Internal Circuit

A.1.8 TTL**74LS06 Hex. OC Inverters**

The internal circuitry of the 74LS06 hex. OC inverter is shown below.

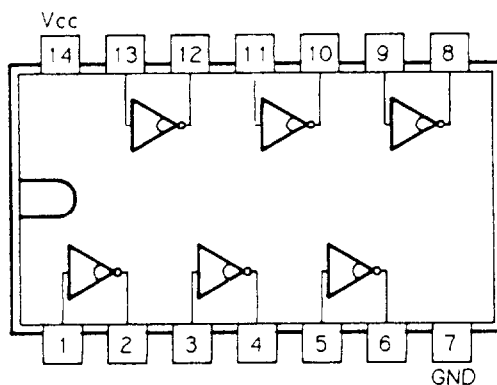


Figure A-17. 74LS06 Internal Circuit

7407 Hex. OC Buffers

The illustration below shows the internal circuitry of the 7407 hex. OC buffer.

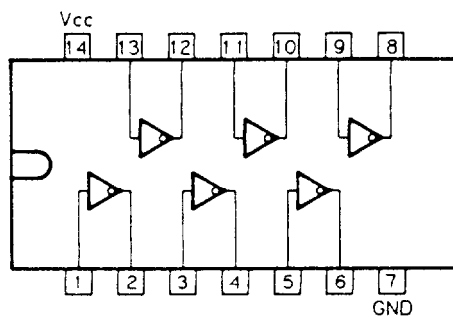


Figure A-18. 7407 Internal Circuit

A.2 EXPLODED DIAGRAMS AND SCHEMATICS

Figures A-19 through A-30 are exploded (assembly) and schematic diagrams provided to supplement the text.

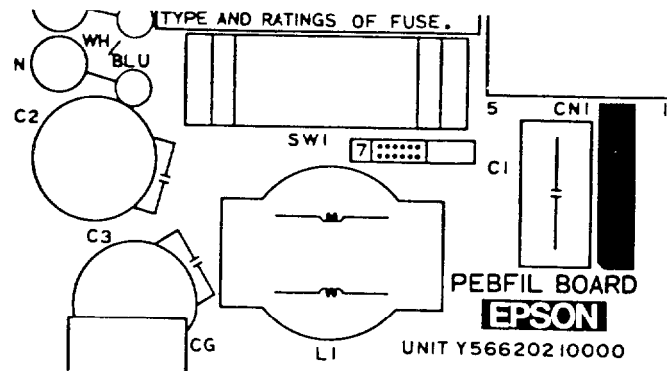


Figure A-19. PEBFIL Board Component Layout

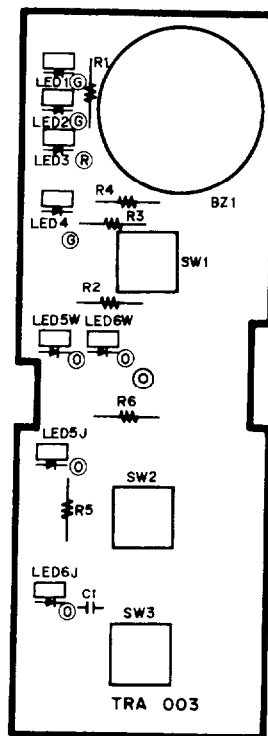
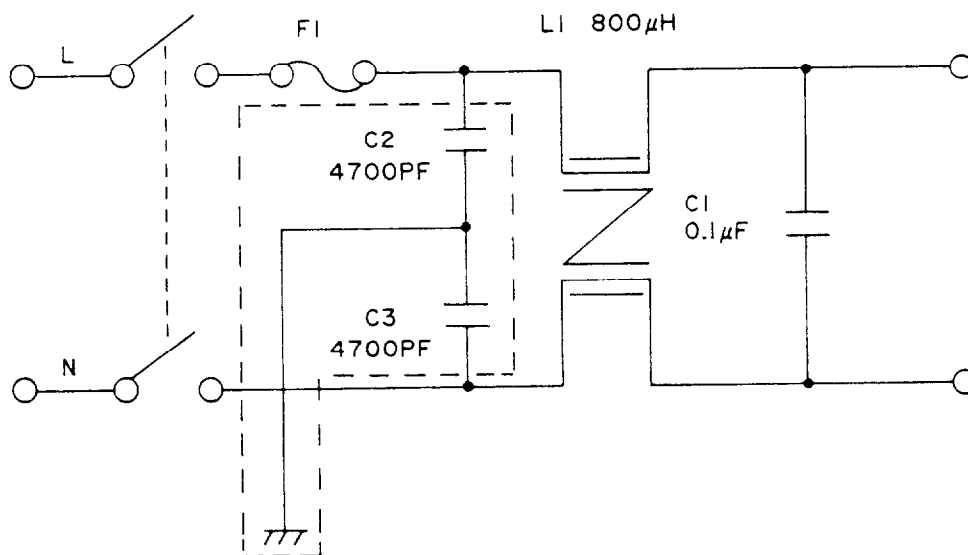


Figure A-20. PEBPNL Board Component Layout

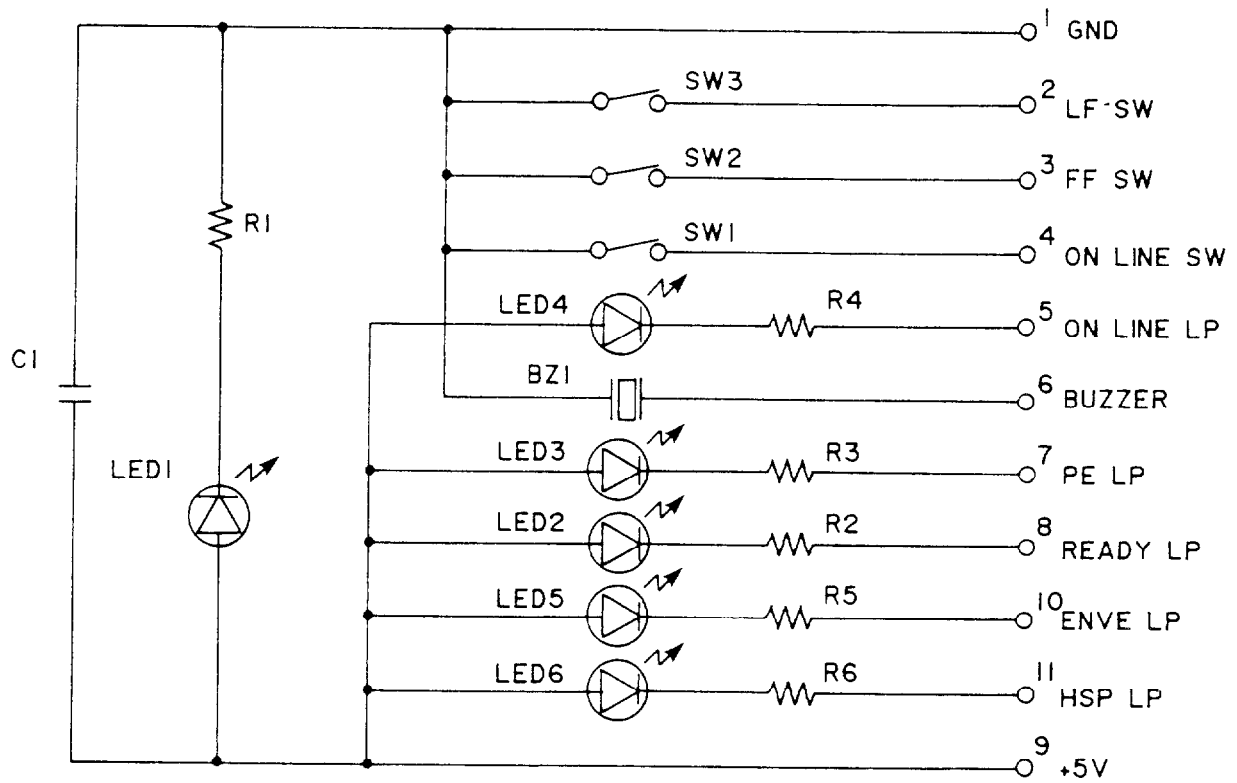


(220/240 V Version Only)

F1: 2A 125 V (100 V Version)
 2A 125 V (120 V Version)
 1.25A 250 V (220/240 V Version)

PEBFIL BOARD
 Y566202000 (100 V Version)
 Y566202100 (120 V Version)
 Y566202200 (220/240 V Version)

Figure A-21. PEBFIL Board Circuit Diagram



PEBPNL BOARD
 Y566501000 (JAPAN-ONLY)
 Y566502000

Figure A-22. PEBPNL Board Circuit Diagram

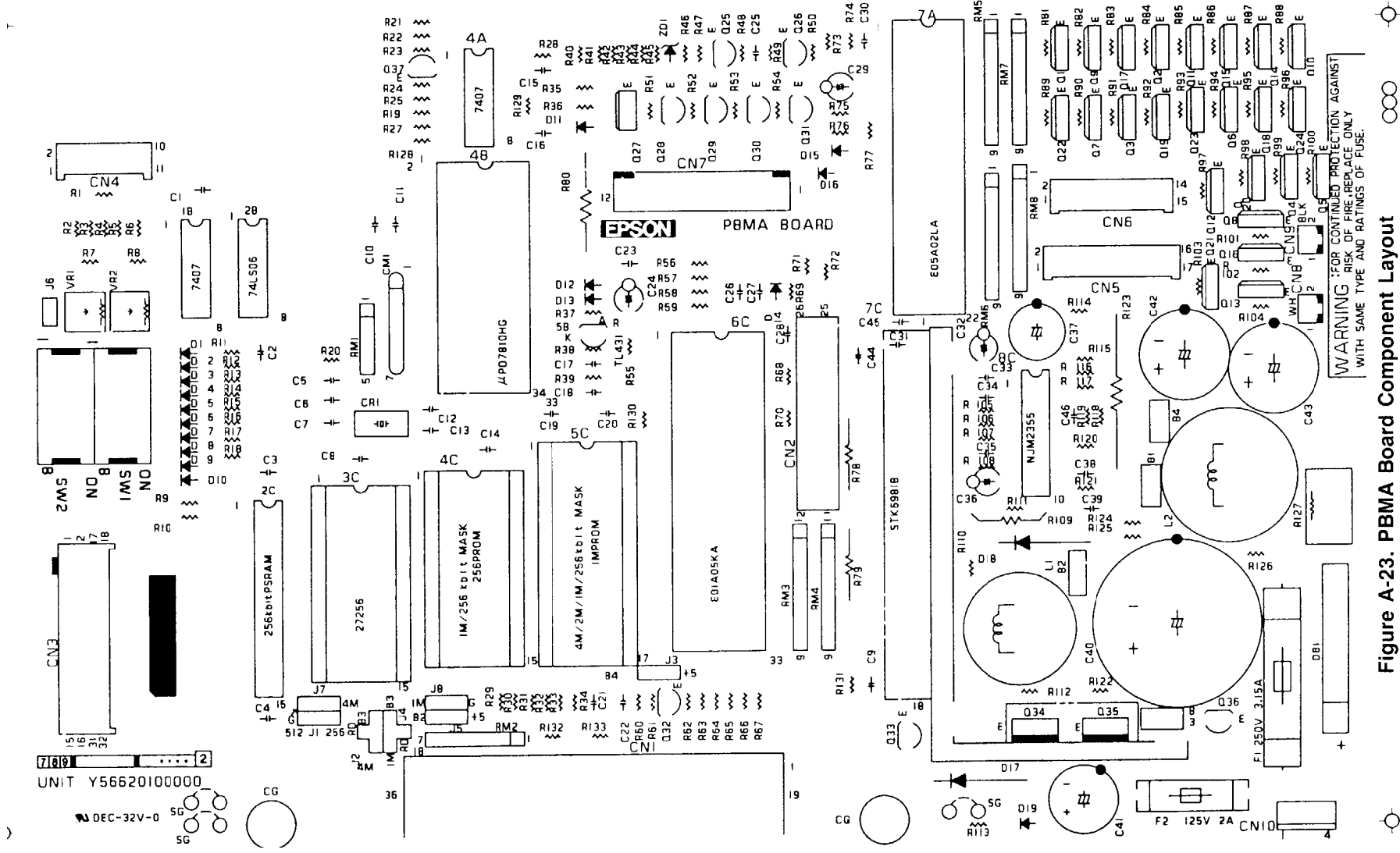


Figure A-23. PBMA Board Component Layout

Table A-8. CN2 Connector

Pin No.	Signal	I/O	Function
1	ERR	O	Error Signal
2	PE	O	PE Signal
3	D6	I	Data Bit 6
4	BUSY	O	BUSY
5	D5	I	Data Bit 5
6	ACK	O	ACKNOWLEDGE
7	D4	I	Data Bit 4
8	INIT	I	Initialize
9	D3	I	Data Bit 3
10	STB	I	Strobe Signal
11	D7	I	Data Bit 7
12	GND	—	GND
13	RS	O	Reset Signal
14	AC12	—	AC12
15	D2	I	Data Bit 2
16	+5 V	—	+5 V
17	D1	I	Data Bit 1
18	+24 V	—	+24 V
19	D0	I	Data Bit 0
20	+12 V	—	+12 V
21	P/S	I	Parallel/Serial
22	—	—	Not Connected
23	SLIN	I	Select-in Signal
24	GND	—	GND
25	TXD	O	TXD
26	GND	—	GND

Table A-9. CN3 Connector (Cont.)

Pin No.	Signal	I/O	Function
8	R	I	Reset Input
9	GND	—	GND
10	A9	O	Address Bit 9
11	A8	O	Address Bit 8
12	D2	I	Data Bit 2
13	D1	I	Data Bit 1
14	RD	O	Read Signal
15	D0	I	Data Bit 0
16	A0	O	Address Bit 0
17	D3	I	Data Bit 3
18	CG	O	CG ROM Select Signal
19	D6	I	Data Bit 6
20	A14	O	Address Bit 14
21	A4	O	Address Bit 4
22	WR	O	Write Signal
23	A7	O	Address Bit 7
24	+5 V	—	+5 V
25	A11	O	Address Bit 11
26	PROG	O	PROM Select Signal
27	A12	O	Address Bit 12
28	A13	O	Address Bit 13
29	A1	O	Address Bit 1
30	AB0	O	Address Bit 13
31	A2	O	Address Bit 2
32	A3	O	Address Bit 3

Table A-9. CN3 Connector

Pin No.	Signal	I/O	Function
1	D5	I	Data Bit 5
2	D4	I	Data Bit 4
3	D7	I	Data Bit 7
4	AB1	O	Address Bit 14
5	A5	O	Address Bit 5
6	A6	O	Address Bit 6
7	A10	O	Address Bit 10

Table A-10. CN4 Connector

Pin No.	Signal	I/O	Function
1	GND	—	GND
2	LFSW	I	LF SW
3	FFSW	I	FF SW
4	ON-LINE SW	I	ON-LINE SW
5	ON-LINE LP	O	ON-LINE LED Drive
6	BUZZER	O	BUZZER Drive
7	PE LP	O	PE LED Drive
8	READY LP	O	READY LED Drive
9	+5 V	—	+5 V

Table A-10. CN4 Connector (Cont.)

Pin No.	Signal	I/O	Function
10	ENVELP	—	Not Connected
11	HSPLP	—	Not Connected

Table A-11. CN5 Connector

Pin No.	Signal	I/O	Function
1	TEMP1	I	TEMP Signal
2	TEMP2	I	TEMP Signal
3	HD 4	O	Head Data 4
4	HD 20	O	Head Data 20
5	HD 8	O	Head Data 2
6	HD 12	O	Head Data 12
7	HD 16	O	Head Data 16
8	HD 24	O	Head Data 24
9	COM	—	Head Common GND
10	COM	—	Head Common GND
11	COM	—	Head Common GND
12	HD 17	O	Head Data 17
13	HD 21	O	Head Data 21
14	HD 9	O	Head Data 9
15	HD 13	O	Head Data 13
16	HD 1	O	Head Data 1
17	HD 5	O	Head Data 5

Table A-12. CN6 Connector

Pin No.	Signal	I/O	Function
1	HD 6	O	Head Data 6
2	HD 14	O	Head Data 14
3	HD 10	O	Head Data 10
4	HD 23	O	Head Data 23
5	HD 18	O	Head Data 18
6	HD 15	O	Head Data 15
7	HD 22	O	Head Data 22
8	COM	—	Head Common GND
9	COM	—	Head Common GND
10	COM	—	Head Common GND
11	HD 7	O	Head Data 7

Table A-12. CN6 Connector (Cont.)

Pin No.	Signal	I/O	Function
12	HD 19	O	Head Data 19
13	HD 2	O	Head Data 2
14	HD 11	O	Head Data 11
15	HD 3	O	Head Data 3

Table A-13. CN7 Connector

Pin No.	Signal	I/O	Function
1	CRD	O	CR Phase D
2	CRB	O	CR Phase B
3	CR CD-COM	—	CR CD Common GND
4	CR AB-COM	—	CR AB Common GND
5	CRC	O	CR Phase C
6	CRA	O	CR Phase A
7	PFC	O	PF Phase D
8	PFB	O	PF Phase B
9	PF COM	—	PF Common GND
10	PF COM	—	PF Common GND
11	PFC	O	PF Phase C
12	PFA	O	PF Phase A

Table A-14. CN8 Connector

Pin No.	Signal	I/O	Function
1	HOME	I	Home-Position Signal
2	GND	—	GND

Table A-15. CN9 Connector

Pin No.	Signal	I/O	Function
1	PE	I	Paper-End Signal
2	GND	—	GND

Table A-16. CN10 Connector

Pin No.	Signal	I/O	Function
1	AC1	I	AC
2	AC1	I	AC
3	AC2	I	AC
4	AC2	I	AC

Table A-17. Part No. Reference Table

REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
100	LOWER CASE ASSEMBLY	417	CARRIAGE MOTOR
101	RUBBER PAD	418	TIMING BELT
102	UPPER CASE	419	BELT PULLEY
103	GEAR WHEEL COVER (LQ-500 ONLY)	420	BELT PULLEY FLANGE
104	PRINTER COVER A	421	BELT TENSION SPRING
105	CARTRIDGE COVER	422	PLAIN WASHER 3.2 × 0.5 × 7
106	PAPER-FEED KNOB	423	RETAINING RING TYPE-E (2.3)
107	SHEET GUIDE FRAME (LQ-500 ONLY)	424	BELT PULLEY SHAFT HOLDER
110	PAPER GUIDE	425	CARRIAGE UNIT
111	SHIELD PLATE	426	HEAD GROUND PLATE
112	PRINTER COVER B	427	HEAD LOCK LEVER SPRING
113	PRINTER COVER JOINT	428	HEAD LOCK LEVER (LEFT)
114	TRACTOR COVER	429	HEAD LOCK LEVER (RIGHT)
115	LOGO PLATE	430	PAPER-END SENSOR
120	CTBB SCREW (M4 × 5)	431	PAPER GUIDE
121	CTBB SCREW (M4 × 12)	432	PLATEN
122	CBO SCREW (M4 × 8)	433	SHAFT HOLDER
123	CTPS(O) SCREW (M3 × 6)	434	PLATEN GEAR
124	CBO SCREW (M4 × 8)	435	LEAF SPRING 8.2 × 0.15 × 15
200	PBMA BOARD UNIT	436	RETAINING RING TYPE-E
250	PEBPNL BOARD UNIT	437	HEAD ADJUSTMENT LEVER
300	PEBFIL BOARD UNIT (120 V)	438	HEAD CABLE (UPPER)
301	FUSE (125 V/1.25 A)	439	HEAD CABLE (LOWER)
310	PEBFIL BOARD UNIT (220 V/240 V)	440	PAPER-FEED MOTOR
311	FUSE (250 V/0.63 A)	441	PAPER-FEED ADJUSTMENT
315	POWER CABLE	442	CARRIAGE GUIDE SHAFT
316	POWER CABLE	443	CARRIAGE GUIDE SHAFT LEVER (LEFT)
317	POWER CABLE	444	CARRIAGE GUIDE SHAFT LEVER (RIGHT)
318	POWER CABLE	445	CARRIAGE GUIDE SHAFT GROUND PLATE
350	POWER TRANSFORMER	446	CARRIAGE GUIDE
400	PRINTER MECHANISM	447	MOTOR CABLE
401	RIBBON PLANETARY LEVER ASSEMBLY	448	RIBBON MASK
402	FRAME	449	FELT
403	PAPER-FEED ROLLER	501	SPROCKET ASSEMBLY (LEFT)
404	PAPER-RELEASE LEVER	502	SPROCKET ASSEMBLY (RIGHT)
405	PAPER GUIDE PLATE	503	PAPER HOLDING COVER (LEFT)
406	PAPER-GUIDE-PLATE RELEASE SHAFT	504	PAPER HOLDING COVER (RIGHT)
407	PAPER-GUIDE-PLATE RELEASE LEVER	505	PAPER HOLDING COVER SPRING
408	PAPER-FEED ROLLER SHAFT	506	SPROCKET LOCK LEVER
409	RIBBON-DRIVING GEAR	507	SHAFT HOLDER
410	RIBBON TRANSMISSION GEAR	508	SPROCKET MOUNTING PLATE (LEFT)
411	RIBBON GEAR	509	SPROCKET MOUNTING PLATE (RIGHT)
412	RIBBON GEAR COVER	510	SPROCKET SHAFT
413	PAPER GUIDE PLATE SPACER	511	SPROCKET GEAR
414	PAPER-FEEDING ROLLER SPRING	512	SPROCKET TRANSMISSION GEAR
415	CARRIAGE MOTOR FRAME	513	SPROCKET GUIDE SHAFT
416	HOME-POSITION SENSOR	514	SIDE COVER (LEFT)
		515	SIDE COVER (RIGHT)
		516	PAPER GUIDE ROLLER

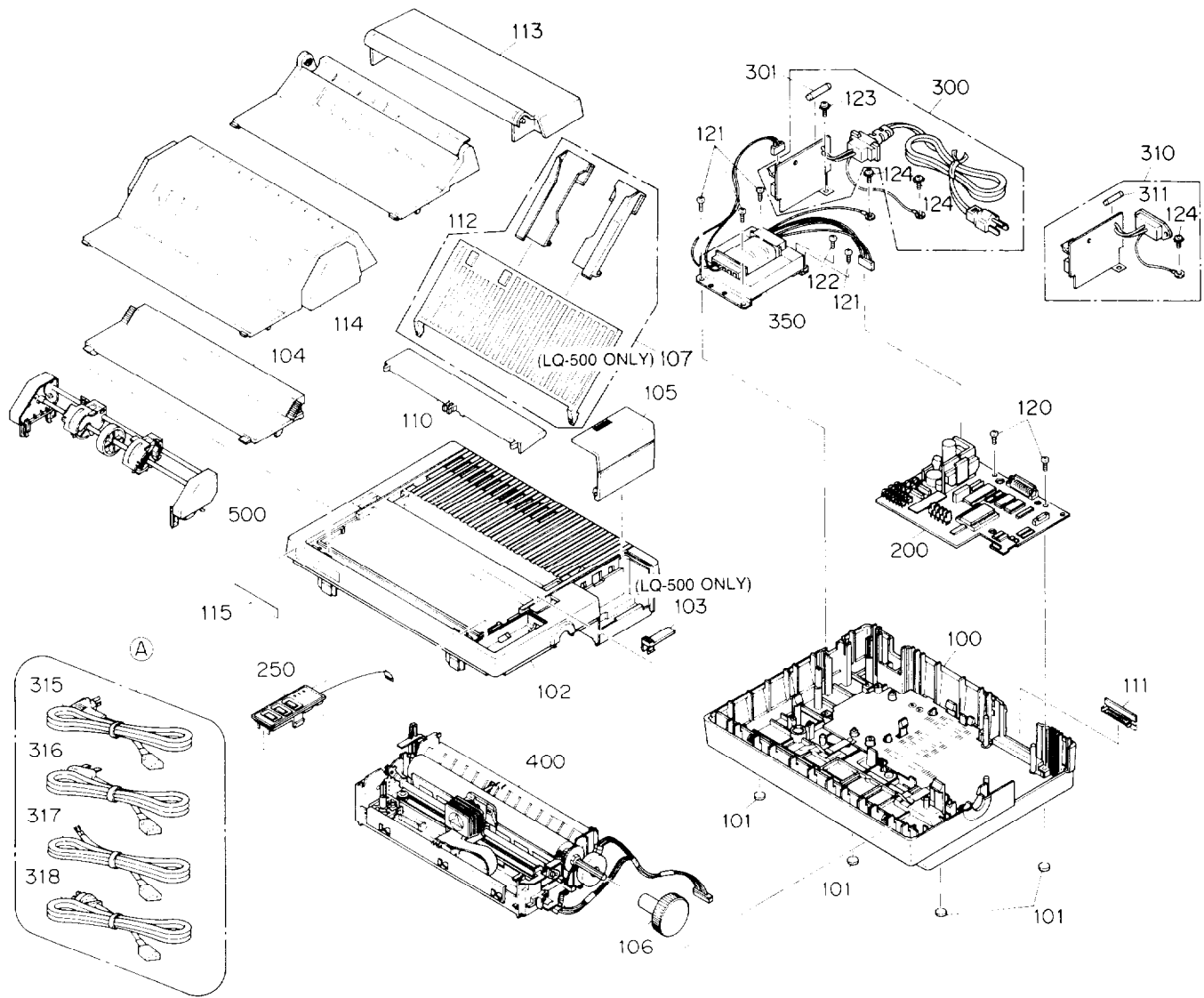


Figure A-24. LQ-500 Exploded Diagram

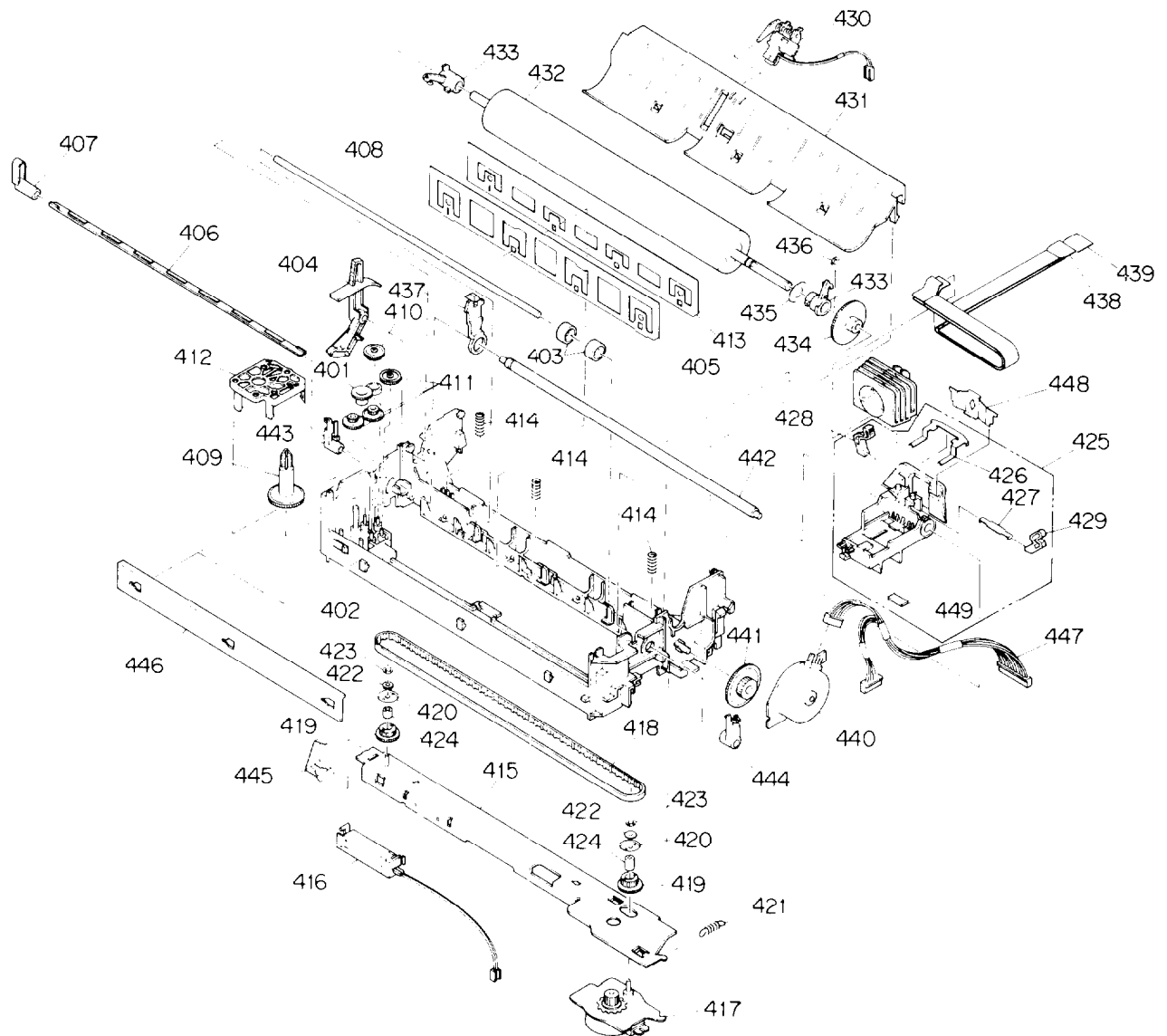


Figure A-25. M5410 Printer Mechanism Exploded Diagram

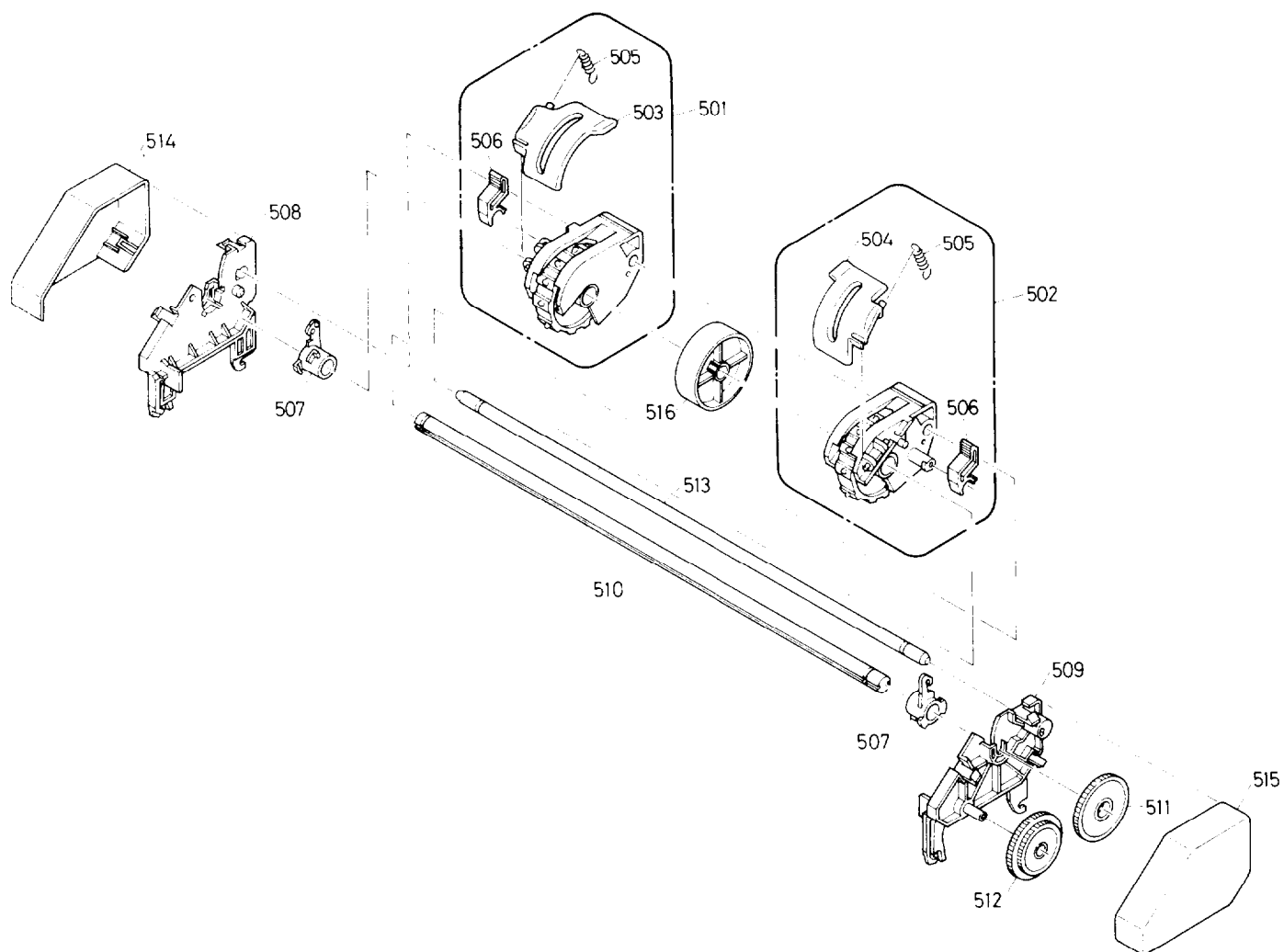
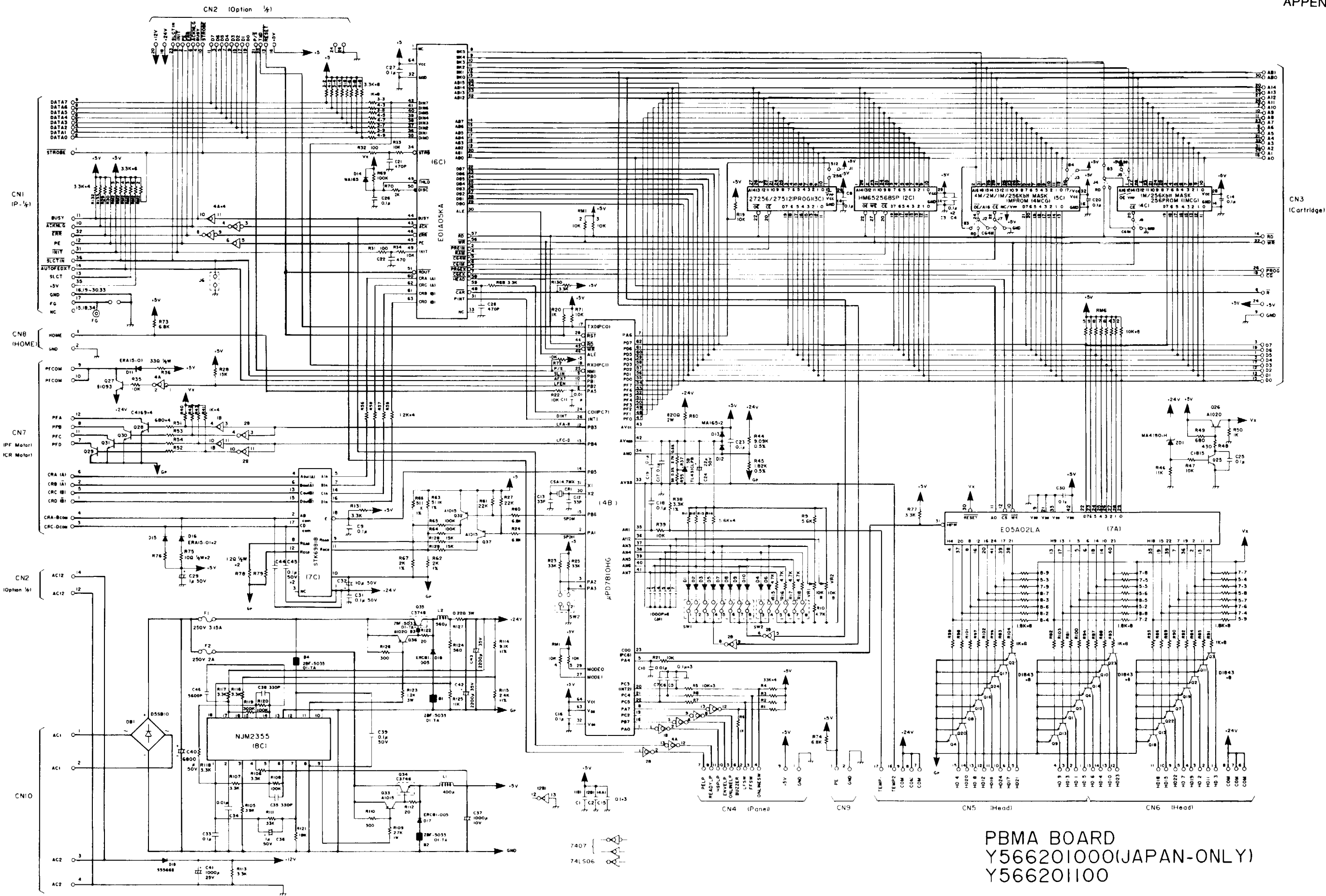


Figure A-26. Tractor Unit



PBMA BOARD
Y56620I000(JAPAN-ONLY)
Y56620I100