LQ-510/AP-4000

T E C H N I C A L M A N U A L

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.

Epson America, Inc.
Customer Service Department
23610 Telo Avenue
Torrance, California 90505

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 should always 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 on/y 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.

REVISION SHEET

REVISION	DATE ISSUED	UPDATES
A	May 1, 1989	1st issue

FCC Compliance Statement for American Users

This equipment has been tested and found to comply with limits for a Class B digital device, pursuant to Part 16 of the FCC Rules. These limits are designed to provide reasonable protections against harmful interference in a residential installation. This **equipment** generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on. The user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help.

WARNING: The connection of a nonshielded interface cable to this equipment will invalidate the FCC Certification of this device and may cause interference levels that exceed the limits established by the FCC for this equipment. If this equipment has more than one interface connector, do not leave cables connected to unused interfaces.

For Canadian Users

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of the Canadian Department of Communications.

Le **présent** appareil **numérique n'émet** pas de bruits **radioélectriques dépassant** les **limites applicables aux** appareils **numériques** de Classe B **prescrites** dans le **règlement** sur le brouillage **radioélectriques édicté** par **le Ministère** des Communications du Canada.

Subsequent product modifications will be brought to your attention via service bulletins. Please revise the text when you receive these bulletins.

This document is subject to change without notice.

Epson America, Inc.
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Addendum

The AP4000 is mechanically and electronically the same as the LQ-510.

All the information contained herein is equally applicable to both printers.

Below is a list of unique parts for the Epson ActionPrinter 4000:

Part Number	Description
1002192	Logo plate
5000119	Individual carton box
5000133	Pad sleeve

ActionPrinter 4000 parts not listed above are identical to those for the LQ-510.

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GENERAL DESCRIPTION 1

1.1 FEATURES

The LQ-510 is a small, light-weight, low-cost printer, comparable to the LQ-500 with advanced paper-handling. Its main features are as follows:

1. Advanced paper handling: auto back-out and cut-sheet loading.
2. Expanded ESC/P-code printing, implemented as a standard feature.
3. Printing speeds in characters per second (cps): 180 cps (alphanumeric Draft 12 cpi)
   150 cps (alphanumeric Draft 10 cpi)
   60 cps (alphanumeric LQ 12 cpi)
   50 cps (alphanumeric LQ 10 cpi)
4. Optional 8100 series interface.
5. Clear, easy-to-read printing with a standard Epson font.
6. Two built-in LQ fonts (Roman and Sans Serif).
7. An optional multi-font module can provide a wide variety of fonts.
8. Control panel switch selection of Draft, Roman, Sans Serif, or slot-mounted (optional multi-font module) font.
9. Control panel switch selection of normal or condensed printing.
10. Optional cut-sheet feeder (CSF) for easy handling of cut sheets.

The LQ-510 is equipped with the standard Epson 8-bit parallel interface. Various interface options allow printing from a wide variety of computers, Table l-l lists the interface options, Table 1-2 lists the optional units available, and Figure l-l shows an exterior view of the printer.

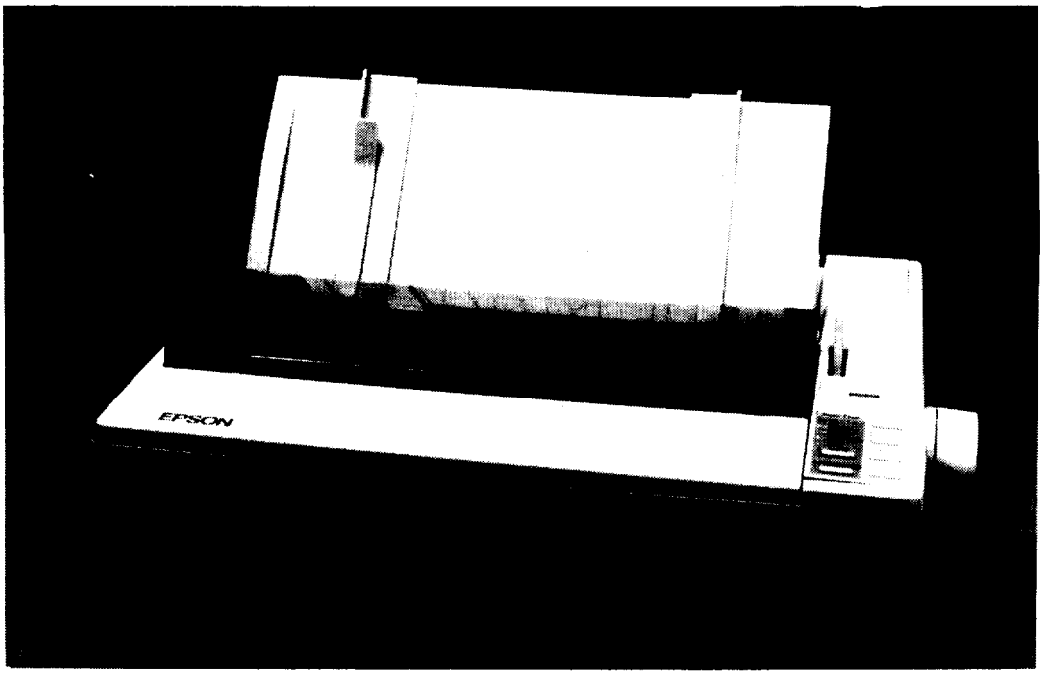
Table l-l. Interface Options

Model	Description
8143	New serial interface board
8148	Intelligent serial interface board
8165	Intelligent IEEE-488 interface board

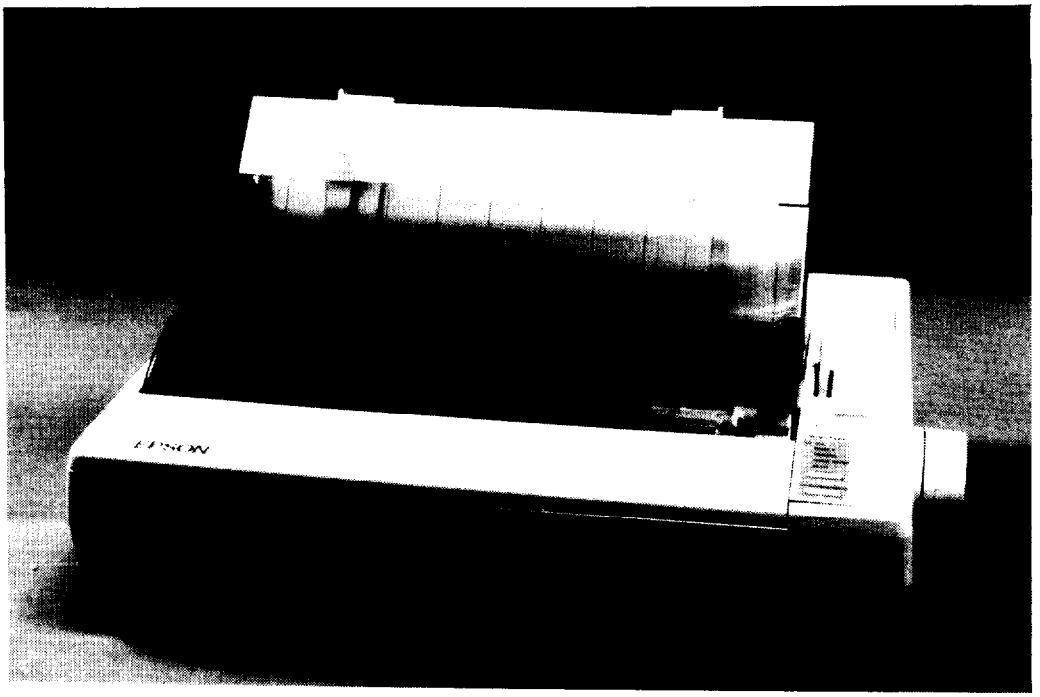
NOTE: Refer to the “Optional Interface Technical Manual” for details.

Table 1-2. Optional Units

Model	Description
C80612	Single-bin cut-sheet feeder
C80006	Pull tractor unit
7753	Ribbon cartridge (black)
7768	Film ribbon cartridge
7407	Multi-font cartridge



(Printer Cover A)



(Printer Cover B)

Figure I-l. Exterior Views of the LQ-510

1.2 SPECIFICATIONS

This section describes the specifications for the LQ-510 printer.

1.2.1 HARDWARE SPECIFICATIONS

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

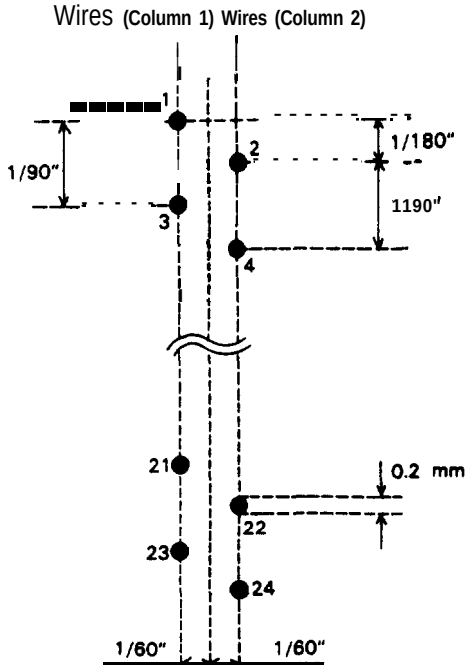


Figure 1-2. Pin Configuration

Feeding Method	Friction feed, tractor feed (push tractor: standard; pull tractor: optional)

NOTE: Be aware of the following points regarding paper handling.

Friction Feed:

1. Do not use continuous paper.
2. Do not use a single sheet shorter than 7.28 inches (182 mm) or longer than 10.28 inches (257 mm).
3. Do not perform a reverse paper feed when the paper is within .34 inch (8.5 mm) from the top or within .88 inch (22 mm) from the bottom.
4. Do not perform a reverse feed greater than 1/6 inch after the paper end has been detected.
5. Use the pull-out unit.
6. Do not use multi-part single-sheet forms.

Tractor Feed

1. Release the friction-feed mechanism.
2. Multiple copies must be joined by pasting at the perforation or tractor holes.
3. Paper for copies must be carbonless, multi-part paper.

Push Tractor Feed

1. Use the pull-out unit.
2. Do not perform reverse feeding for distances greater than 1/6 inch.
3. Accuracy of paper feed cannot be assured, and reverse feeding cannot be performed, after the paper end is detected.

Push-Pull Feed

1. Remove the pull-out unit and attach the pull tractor unit.
2. Do not lose the paper between the platen and pull tractor unit.
3. Precisely adjust the horizontal positions of the pull and the push tractors.
4. Do not perform reverse feeding for distances greater than 1/6 inch.
5. Do not perform reverse feeding after the paper end is detected.

Pull Tractor Feed

1. Remove the pull-out unit and attach the pull tractor unit.

Line Spacing	1/6 inch, or programmable in units of 1/360 inch	
Paper Insertion	From rear	
Paper-Feed Speed	Friction, without CSF	100 ms/line (at 1/6-inch line feed) 2.2 inches per second (continuous feed)
	Friction, with CSF	100 ms/line (at 1/6-inch line feed) 2.2 inches per second (continuous feed)
	Tractor	100 ms/line (at 1/6-inch line feed) 2.2 inches per second (continuous feed)
Paper Specifications	See Tables 1-3 through 1-6.	

Table 1-3. Cut-Sheet Specifications

Width	7.15 to 10.1 inches (182 to 257 mm)
Length	14.3 inches, maximum (364 mm, maximum)
Thickness	0.0025 to 0.0055 inch (0.065 to 0.14 mm)
Weight	14 to 24 pounds (52.3 g/m^2 to 90 g/m^2)
Quality	Xerographic, bond, airmail paper, etc.
Copies	Not available

Table 1-4. Continuous-Paper Specifications

Width	4 to 10 inches (101 to 254 mm)
Copies	3 sheets (1 original and 2 copies)
Quality	Bond, xerographic, airmail, etc.
Total Thickness	0.0025 to 0.01 inch (0.065 to 0.25 mm)
Weight	1 sheet - 14 to 22 pounds (52.3 g/m^2 to 82 g/m^2) 3 sheets - 12 to 15 pounds (40 g/m^2 to 58.2 g/m^2) each

Table 1-5. Envelope Specifications

Size	Number 6: 6.64 x 3.68 inches (166 x 92 mm) Number 10: 9.6 x 4.16 inches (240 x 104 mm)
Quality	Bond paper, xerographic paper, airmail
Thickness	0.0063 to 0.0197 inch (0.16 to 0.52 mm) (Within the printing area, the thickness differential must not exceed 0.0098 inch [0.25 mm]).)
Weight	12 to 24 pounds (45 g/m^2 to 91 g/m^2)

NOTES:

1. Printing on envelopes can be performed only when the temperature is normal.
2. Envelopes should be positioned horizontally.
3. For Number 6 envelopes, set the left side so that it matches the setting mark on the sheet guide.

Table 1-6. Label Specifications

Sire	Greater than 2½ x 15/16 inches (63.5 x 23.8 mm)
Thickness	0.0063 to 0.0075 inch (0.16 to 0.19 mm) *Thickness of the base paper must be 0.0028 to 0.0031 inch (0.07 to 0.09 mm)

NOTES:

1. Printing on labels is available only at normal temperatures.
2. Labels must be fanfold.
3. For printing on labels with pressure sensitive paper, the following conditions must be met:
   (1) sheets of labels must be joined at the perforation or tractor holes.
   (2) the total thickness may not be greater than 0.0118 inch (0.3 mm)
   (3) the temperature must be between + 41 °F and + 95 °F (+ 5° and + 35°C), and relative humidity between 10% and 80%
4. Examples of acceptable labels: Avery Continuous-Form Labels
   Avery Mini-Line Labels
5. Do not perform reverse feed.

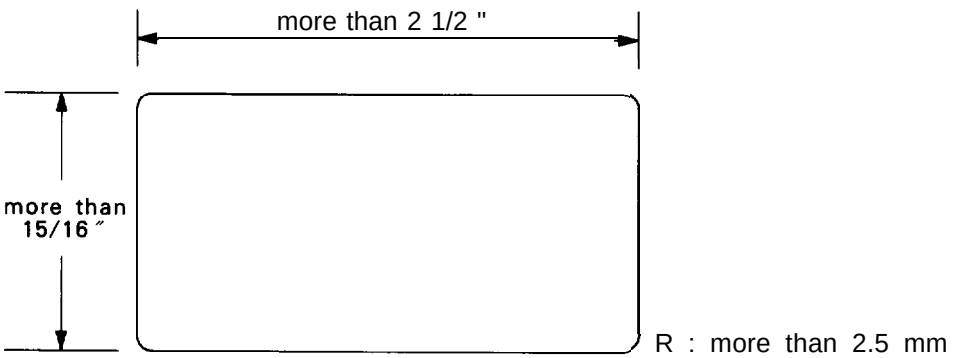


Figure 1-3. Label Dimensions

Printable Area

The figure below illustrates the printable area for cut sheets.

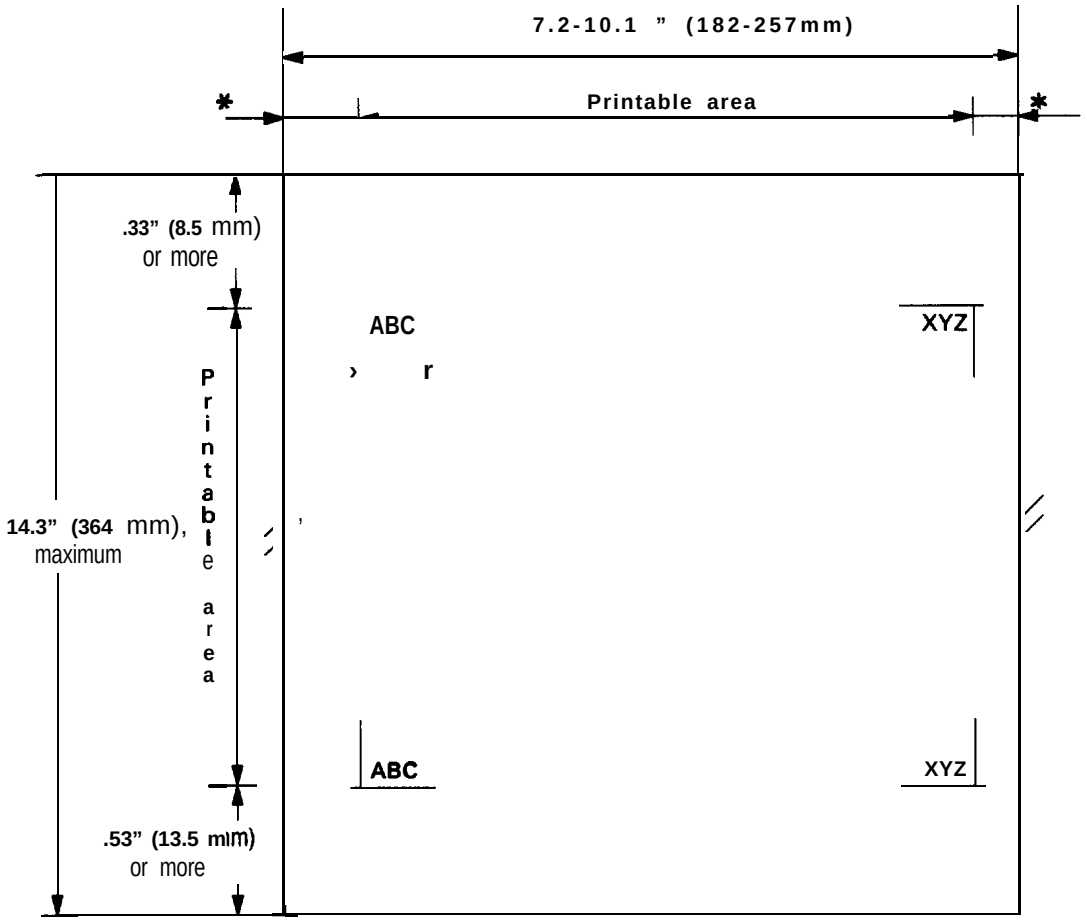


Figure 1-4. Printable Area for Cut Sheets

* At least 0.12 inch (3 mm) when paper width is less than 9 inches (229 mm); at least .9 inch (24 mm) when the paper width is 10.1 inches (257 mm).

Printing is possible approximately 1.12 inches (28 mm) from the paper's detected bottom edge; the .53 inch (13.5 mm) value (lowest print position) is for reference only. Paper feed accuracy cannot be assured within 0.87 inch (22 mm) of either the top or bottom edge.

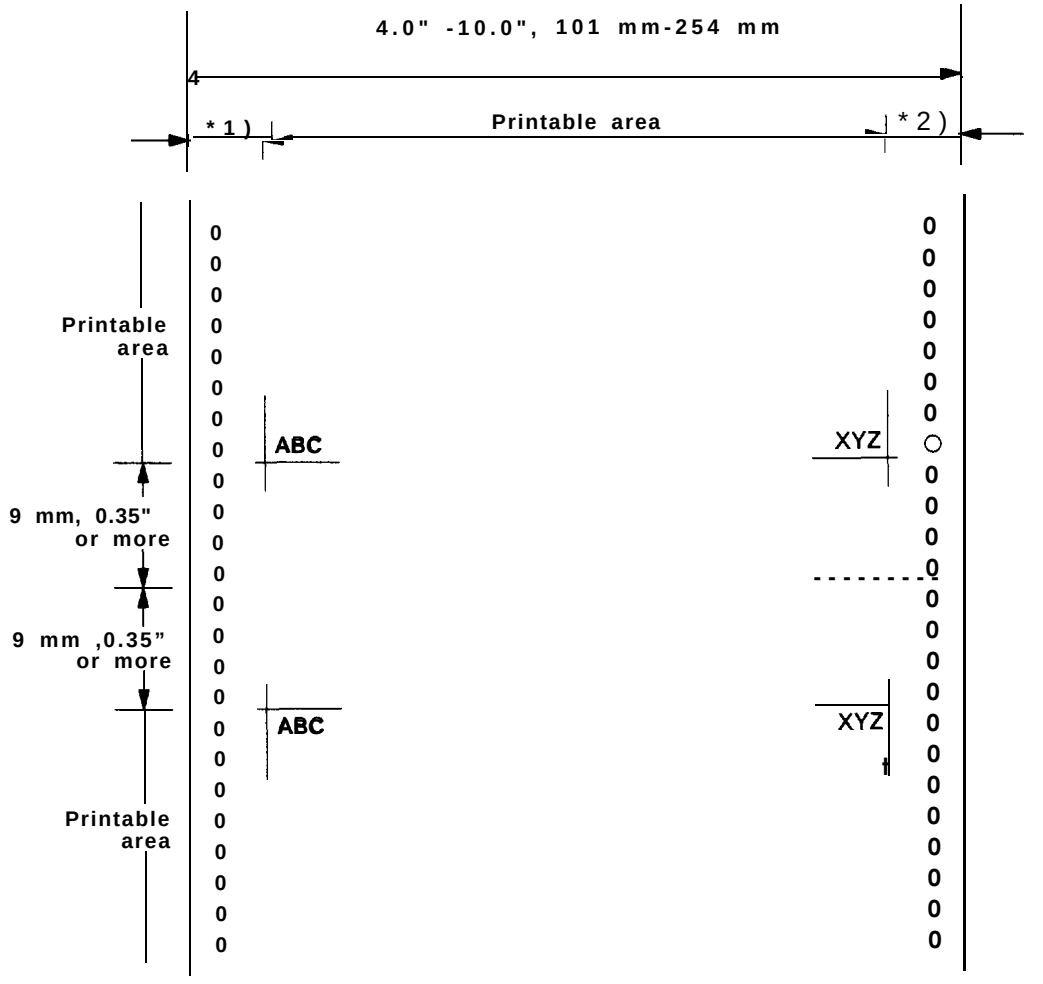


Figure 1-5. Printable Area for Continuous Paper

* **NOTES:** 1. .52 inch (13 mm) or greater for paper widths of 4 to 9.5 inches (101 to 242 mm).
1.04 inches (26 mm) or greater for paper widths of 10 inches (254 mm).
2. .52 inch (13 mm) or greater for paper widths of 4 to 9.5 inches (101 to 242 mm).
.96 inch (24 mm) or greater for paper widths of 10 inches (254 mm).

Ink Ribbon

Fabric	Model: 7753 ribbon cartridge Color: black Reliability: 2 million (LQ characters at 48 dots/character) Dimensions: 11.6 (width) x 1.36 (height) x 2.84 (depth) inches (290 mm x 34 mm x 71 mm)
Film	Model: 7768 ribbon cartridge Color: black Reliability: 2 million characters at 48 dots/character Dimensions: 11.6 (width) x 1.36 (height) x 2.84 (depth) inches (290 mm x 34 mm x 71 mm)

Reliability	Mean Cycles Between Failures (MCBF): 3 million lines (excluding printhead) Mean Time Before Failure (MTBF): 4000 Power-On Hours (25% duty)
Printhead Life	200 million strokes/wire

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	108 VAC to 132 VAC (120 V version) 198 VAC to 264 VAC (220/240 V version)
Frequency Range	49.5 to 60.5 Hz
Rating Current	1.8 A AC (120 V version) 1 A AC (220/240 V version)
Insulation Resistance	10 megohms minimum (between AC line and chassis)
Dielectric Strength	1250 VAC (rms), 1 minute (120 V version) (between AC line and chassis) 3750 VAC (rms), 1 minute (220/240 V version)

Environmental Requirements

Temperature	41° to 95°F (5 to 35°C) - operating -22° to 140° F (-30 to 60° C) - with shipment container
Humidity	10 to 80% RH - operating 5 to 85% RH - non-operating
Shock Resistance	1 G, within 1 ms - operating 2 G, within 1 ms - non-operating
Resistance to Vibration	0.25 G, 55 Hz maximum - operating 0.50 G, 55 Hz maximum - storage

Physical Specifications

Weight	13.23 pounds (6 kg)
Dimensions	16.72 (width) x 13.88 (depth) x 5.6 (height) inches (418 x 347 x 139.9 mm), excluding knobs and paper guides

1.2.2 FIRMWARE SPECIFICATIONS (ESC/P)

Control Codes	ESC/P-84 (Epson Standard Code for Printers)
Printing Direction	Bidirectional (text) Bidirectional (bit-image) (when SW 2-6 is ON and control command [ESC U 1] input) Unidirectional (bit-image)
Input Data Buffer	8K bytes (when SW 2-5 is ON)* 1K byte (when SW 2-5 is OFF) * If DIP SW 2-5 is set to ON, downloading will be ignored.
Character Code	8-bit
Character Sets	96-character ASCII and 15 international character sets
Family	Epson Roman (Family number: 0) Epson Sans Serif (Family number: 1)
Font	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 mixing of the following modes are allowed (except that 15 cpi Condensed Mode is not available): • Printing quality (draft/letter quality) • Character pitch (10, 12, 15, or proportional) • Condensed • Double-width • Double-height • Bold • Double-strike • Italic • Underlined • Double-underlined • Overscore • Strike-through • Outline • Shadow
Printing Speed	See Table 1-7.
Printing Columns	See Table 1-7.
Character Matrix	See Table 1-8.
Character Size	See Table 1-8.

Table 1-7. 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		69	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		60	15	112.5	37.5
	0	1	0		120	7.5	12.5	75
	0	1	1		60	7.5	56.3	37.5
	1	x	x		Condensed not available			
Pro-portional	0	x	0	maximum	69	8.6	—	42.9
				minimum	160	20	—	100
	0	x	1	maximum	34	4.3	—	21.4
				minimum	80	10	—	50
	1	x	0	maximum	137	17.1	—	85.7
				minimum	320	40	—	200
	1	x	1	maximum	69	8.6	—	42.9
				minimum	160	20	—	100
Pro-portional super/ subscript	0	x	0	maximum	103	12.8	—	64.3
				minimum	240	30	—	150
	0	x	1	maximum	51	6.4	—	32.1
				minimum	120	15	—	75
	1	x	0	maximum	206	25.7	—	128.6
				minimum	480	60	—	300
	1	x	1	maximum	103	12.8	—	64.3
				minimum	240	30	—	150

NOTES: 1. The "maximum" value applies when only characters of maximum width are printed.
2. The "minimum" value applies when only characters of minimum width are printed.
3. "-" indicates that the "LQ" character set is automatically selected when proportional pitch is specified.

Table 1-8. Character Matrix and Character Size

Printing mode	Face matrix	HDD	Character size H x V (mm)	Unit ESC sp
Draft 10-pitch	9 x 23	120	1.9 x 3.2	120
Draft 12-pitch	9 x 23	120	1.9 x 3.2	120
Draft 15-pitch	9 X 16	120	1.0 x 2.3	120
Draft 10-pitch, condensed	-	240	-	240
Draft 12-pitch. condensed	-	240	-	240
LQ 10-pitch	29 x 23	360	2.0 x 3.2	180
LQ 12-pitch	29 x 23	360	2.0 x 3.2	180
LQ 15-pitch	15 x 16	360	1.0 x 2.3	180
LQ 10-pitch, condensed	-	360	-	360
LQ 12-pitch, condensed	-	360	-	360
LQ proportional	37 x 23 maximum 18 x 23 minimum	360 360	2.6 x 3.2 1.0 x 3.2	180 180
LQ proportional, condensed	— —	360 360	— —	360 360
LQ proportional, super/ subscript	28 x 16 maximum 12 x 16 minimum	360 360	1.8 x 2.3 0.7 x 2.3	180 180
LQ proportional, super/ subscript, condensed	- -	360 360	- -	360 360

NOTES: 1. HDD is horizontal dot density in dots per inch.
2. Face matrix and character size indicate maximum character size. This value changes according to 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.

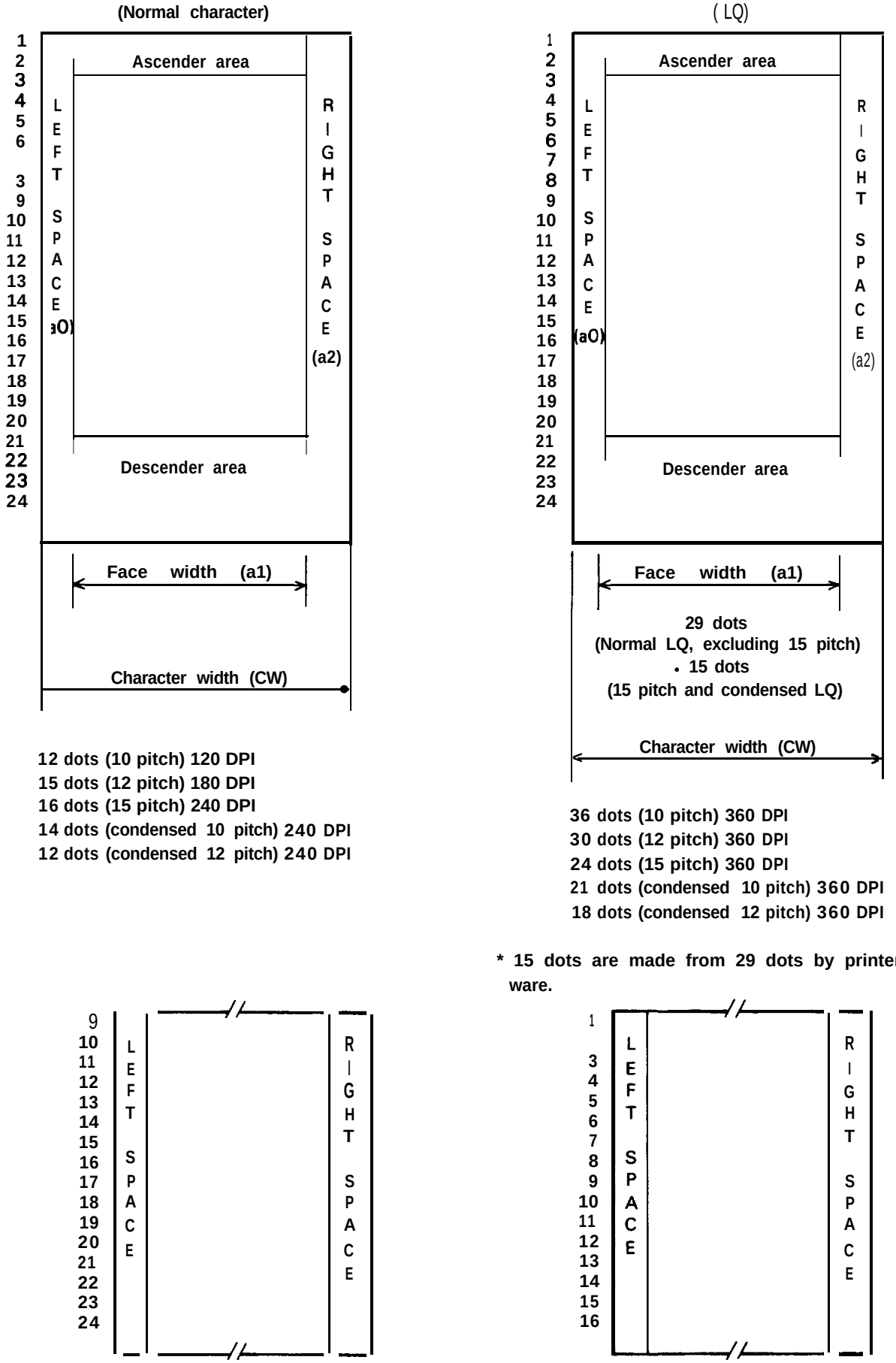


Figure 1-6. Character Matrix

1.3 INTERFACE OVERVIEW

The standard 8-bit parallel interface has the following specifications:

Data Format	8-bit parallel
Synchronization	By $\overline{\text{STROBE}}$ pulse
Handshaking	By BUSY and $\overline{\text{ACKNLG}}$ signals
Signal Level	TTL-compatible
Connector	57-30360 (Amphenol) or equivalent
Data Transmission Timing	See Figure 1-7.

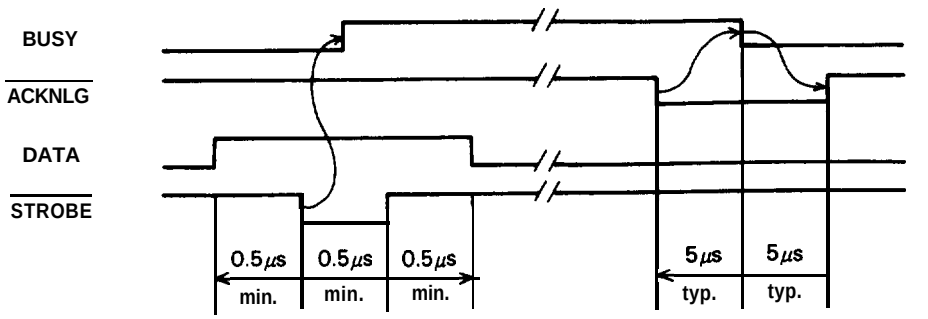


Figure 1-7. Data Transmission Timing

Table 1-9 shows the connector pin assignments and signal functions of the 8-bit parallel interface.

Table 1-9. Connector Pin Assignments and Signal Functions

Pin No.	Signal Name	Return Pin No.	Dir.	Functional Description
1	$\overline{\text{STROBE}}$	19	In	Strobe pulse to read the input data. Pulse width must be more than 0.5 μs. Input data is latched at the falling edge of this signal.
2	DATA 1	20	In	Parallel input data to the printer.
3	DATA 2	21	In	"HIGH" level means data "1."
4	DATA 3	22	In	"LOW" level means data "0."
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	$\overline{\text{ACKNLG}}$	28	out	This pulse indicates data was received and the printer is ready to accept more data. Pulse width is 11 μs, approximate.
11	BUSY	29	out	"HIGH" indicates the printer cannot accept more data.

Table 1-9 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 the $\overline{\text{ERROR}}$ signal is "LOW."
13	SLCT	-	out	Always "HIGH" output. (Pulled up to +5 V through 3.3K-ohm register.)
14	$\overline{\text{AUTOFEED-XT}}$	-	In	If "LOW" when the printer is initialized, a line feed is automatically performed when the carriage return (CR) code is received (auto LF).
15				Not used.
16	GND			Ground for twisted pair grounding.
17	Chassis GND	-	-	Chassis ground level of printer.
18				Not used.
19 - 30	GND			Grounds for twisted pair grounding.
31	INIT	16	In	Pulse (width: 50 μs, minimum, active "LOW") input for printer initialization.
32	ERROR	-	out	"LOW" indicates an error occurred in the printer.
33	GND	-	-	Ground for twisted pair grounding.
34		-	-	Not used.
35		-	out	Always "HIGH." (Pulled up to +5 V through 3.3K-ohm register.)
36	$\overline{\text{SLCT-IN}}$	-	In	If "LOW," when printer is initialized, DC1/DC3 control is disabled.

NOTES: 1. "Dir." refers to the signal flow direction 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 μs.
5. The $\overline{\text{AUTO FEED-XT}}$ signal can be set to LOW by DIP switch 2-4.
6. The $\overline{\text{SELECT-IN}}$ signal can be set to LOW by jumper 10.
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 $\overline{\text{ACKNLG}}$ signal to the $\overline{\text{STROBE}}$ signal.

Table 1-10 shows the printer select/deselect (DC1/DC3) control, including relations among ON-LINE, $\overline{\text{SELECT-IN}}$ input, DC1/DC3, and interface signals.

Table 1-10. Printer Select/Deselect Control

ON-LINE SW	$\overline{\text{SLCT-IN}}$	DC1 / DC3	$\overline{\text{ERROR}}$	BUSY	$\overline{\text{ACKNLG}}$	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 for 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 1-10, it is assumed that no $\overline{\text{ERROR}}$ status exists other than that attributable to OFF-LINE mode.

2. Once the printer has been put in the deselected state 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 $\overline{\text{SLCT-IN}}$ signal (Input Connector Number 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 $\overline{\text{SLCT-IN}}$ signal is HIGH, and is not set to LOW by jumper 10 when the printer is initialized, the printer starts from the selected (DC1) state.

1.4 DIP SWITCHES AND JUMPER SETTING

This section describes the DIP switch selections and jumper setting for the LQ-510 printer.

1.4.1 DIP SWITCH SETTINGS

The two DIP switches for the printer are located on the control panel, and function as shown in Tables 1-11 through 1-15. (Note that the status of the DIP switches is read only at power up or upon receipt of the INIT signal.)

Table 1-11. Settings for DIP Switch 1 (SW1)

No.	Description	On	Off
1 2 3	International character set selection	See Table 1-13.	
4 5	Font selection (LQ-510 ROM versions SD6-W6 or below) (LQ-1010 ROM versions TAA04C or below) Page length (LQ-510 ROM versions TBD00A or above) (LQ-1010 ROM versions TBC00A or above)	See Table 1-14.	
6	Condensed printing	On	Off
7	Code table selection	Graphic	Italic
8	Cut-sheet feeder (CSF) mode	On	Off

Table 1-12. Settings for DIP Switch 2 (SW2)

No.	Description	On	Off
1	Page length (LQ-510 ROM versions SD6-W6 or below) (LQ-1010 ROM versions TAA04C or below) Not used (LQ-510 ROM versions TBD00A or above) (LQ-1010 ROM versions TBC00A or above)	12 inches	11 inches
2	Tear-off mode	On	Off
3	1-inch skip	On	Off
4	Auto LF	On	Off
5	Input data buffer	8KB	1KB
6	Print direction for graphics *	Bidirectional	Unidirectional
7-8	Character pitch selection	See Table 1-15 below.	

* When this switch is ON and ESC U 0 is input, multi-pass characters are printed bidirectionally. Bit image graphics are always printed unidirectionally.

Table 1-13. 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 1-14. Font Select&n (ROM Version SD6-W6 or Below or TAA04C or Below)

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

Tab& 1-14. Page Length Selection (ROM Version TBD00A or Above or TBC00A or Above

1 - 4	1 - 5	Page Length
Off	Off	11 inches
On	Off	12 inches
Off	On	8.5 inches
On	On	11.7 inches

Table 1-15. Character Pitch Selection

2 - 7	2-6	*Character Pitch* (In characters per inch)
Off	Off	10 cpi
On	Off	12 cpi
Off	On	15 cpi
On	On	Proportional

1.4.2 JUMPER SETTING

Jumper 10, which is user-selectable, is located inside the option board cover. If the jumper is connected, the $\overline{\text{SLCT-IN}}$ signal is fixed to LOW, and DC1 /DC3 printer select control is ignored.

1.5 SELECTYPE FUNCTION

SelecType enables easy selection of fonts and **printing modes, and can be used to select any of the fonts listed on the control panel for either condensed or normal printing. If the printer uses an optional slot-mounted multi-font (ROM cartridge), these fonts also can be selected from the control panel. SelecType functions only when the printer is not printing, at which time the font can be** selected **by pressing the FONT switch.** The printing **mode is selected by pressing the CONDENSED switch (again,** only when the printer is not printing). The selected font and mode are indicated on the printer's control panel.

1.6 SHEET LOADING AND SHEET EJECTION

The release lever enables disengaging of the push tractor unit drive mechanism. The printer therefore provides some improved paper-handling functions through combination of the release lever and LOAD/EJECT control panel switch.

Cut-Sheet Loading and Ejection

To load a sheet of paper, position the paper-release lever back, place the sheet along the paper guide, and press the LOAD/EJECT switch. This loads the paper to the top-of-form position. Pressing the LOAD/EJECT switch after the paper has been loaded will cause the paper to be ejected.

Continuous-Paper Loading and Ejection (Back-Out)

To load fanfold paper, move the paper-release lever forward, and insert the paper into the push tractor. Pressing the LOAD/EJECT switch will then cause paper to be automatically loaded to the top-of-form position. Pressing the LOAD/EJECT switch after the fanfold paper has been loaded causes the printer to eject the paper backward from the push tractor. To back out several pages, press the LOAD/EJECT switch several times (reverse feed is performed on a page-by-page basis).

The MULTI-PART LED will flash only when the paper is loaded and the ON LINE switch pressed. This indicates that the printer has entered “top-of-form adjust” mode, and that the user may adjust the top-of-form position, as well as the loading positions for subsequent forms. Adjustment is made using the FORM FEED button, which will increment the paper forward, and the LINE FEED switch, which will increment the paper in reverse. (The minimum feed amount is 1/,80 inch.) When the cut-sheet feeder is used, the adjusted position for the top of form will be lost after the printer is reinitialized, and the top of form will be reset to the default value. When continuous paper is used, however, printer memory maintains the adjusted top-of-form position even after printer initialization.

1.7 TEAR-OFF FUNCTION

If the tear-off function is enabled by making the appropriate DIP switch setting, it operates when the release lever is set to the tractor position. In this case, if the input data buffer is empty and the printer is on line, the paper is automatically fed to the tear-off position, and the MULTI-PART LED flashes to indicate that the FORM FEED and LINE FEED switches are now available to perform micro-adjustment. The user may then adjust the paper to the desired tear-off position. This position becomes the new tear-off position default, and will remain valid even if the printer is reset and reinitialized, and regardless of whether the main power has been interrupted. When new data is input to the printer, the paper is automatically returned to its original position, and printing then starts. Paper that was advanced to the tear-off position will also be returned to its original position if the ON LINE switch is pressed (switching the printer from on line to off line).

1.8 OPERATING INSTRUCTIONS

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

1.8.1 SELF-TEST

To begin self-test printing in draft mode, turn the printer on while depressing the LINE-FEED button. To begin printing in letter-quality (LQ) mode, turn the printer on while depressing FORM FEED.

Self-test printing can be stopped and restarted by pressing ON LINE (this will not affect the ON-LINE indicator). To conclude the self-test, press the ON-LINE switch to stop the printing; then turn off the printer.

The first printed line of the self-test indicates the firmware revision number. Following this line, the current DIP switch settings are printed.

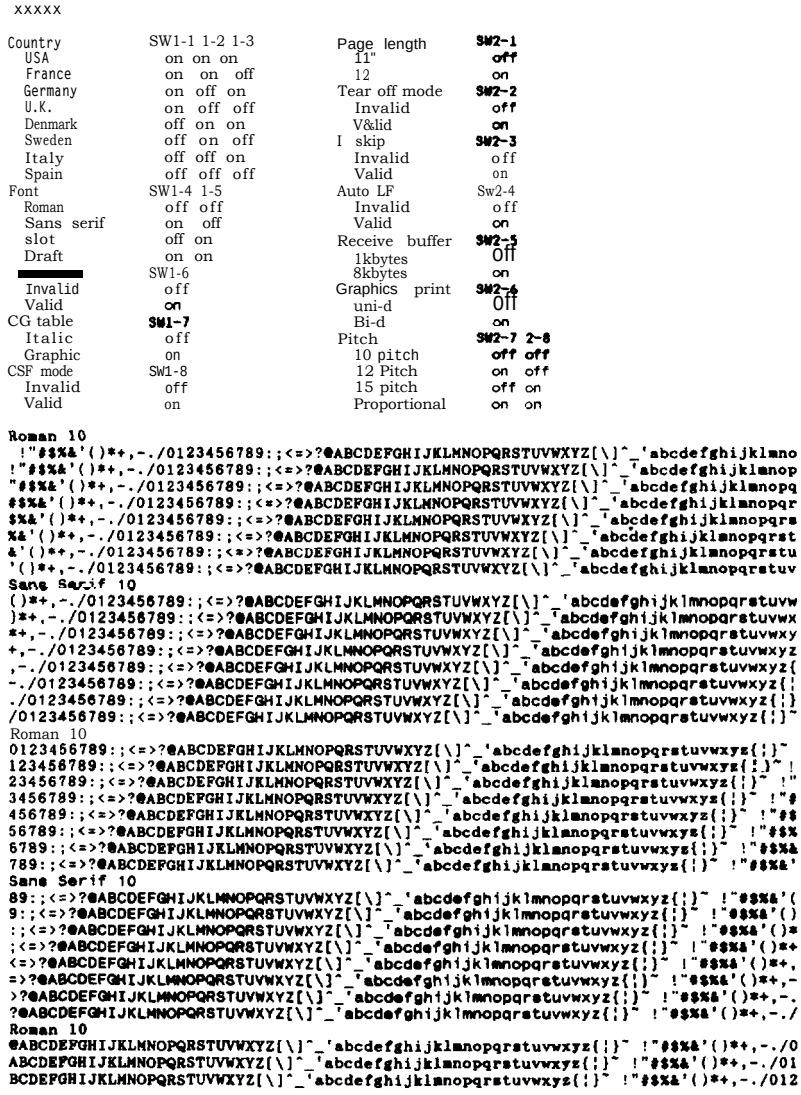


Figure 1-8. Self-Test Printout

1.8.2 HEXADECIMAL DUMP FUNCTION

HEX dump mode is activated if the printer is switched on while both the LINE-FEED and FORM-FEED buttons are depressed. When this mode is in effect, the hexadecimal representation of the input data is printed beside the corresponding printable ASCII characters. Periods (.) are printed beside control code input data. This function is useful for checking the data the printer is receiving from the host.

Data Dump Mode

```
1B 40 0D 1B 55 00 1B 33 1E 00 0D 0A 0D 0A 0D 0A   .@..U..3........
12 1B 70 00 1B 78 01 1B 57 00 1B 4D 20 20 20 20   . .p..X..W..M
43 48 41 50 54 45 52 20 31 0D 0A 20 20 20 20 47   CHAPTER 1..    G
45 4E 45 52 41 4C 20 44 45 53 43 52 49 50 54 49   ENERAL DESCRIPTI
4F 4E 0D 0A 0D 0A 20 20 20 20 31 2E 31 20 46 45   ON....    1.1 FE
41 54 55 52 45 53 0D 0A 20 20 20 20 31 2E 32 20   ATURES.    1.2
53 50 45 43 49 46 49 43 41 54 49 4F 4E 53 0D 0A   SPECIFICATIONS..
20 20 20 20 20 20 20 20 31 2E 32 2E 31 20 46 61           1.2.1 Ha
72 64 77 61 72 65 20 53 70 65 63 69 66 69 63 61   rdware Specifica
74 69 6F 6E 73 0D 0A 20 20 20 20 20 20 20 20 31   tions..        1
2E 32 2E 32 20 46 69 72 6D 77 61 72 65 20 53 70   .2.2 Firmware Sp
65 63 69 66 69 63 61 74 69 6F 6E 73 20 28 45 53   ecifications (ES
43 2F 50 29 0D 0A 20 20 20 20 31 2E 33 20 49 4E   C/P).    1.3 IN
54 45 52 46 41 43 45 20 4F 56 45 52 56 49 45 57   TERFACE OVERVIEW
0D 0A 20 20 20 20 31 2E 34 20 44 49 50 20 53 57         1.4 DIP SW
49 54 43 40 45 53 20 41 4E 44 20 4A 55 4D 50 45   ITCHES AND JUMPE
52 20 53 45 54 54 49 4E 47 0D 0A 20 20 20 20 20   R SETTING..
20 20 20 31 2E 34 2E 31 20 44 49 50 20 53 77 69       1.4.1 DIP Swi
74 63 68 20 53 65 74 74 69 6E 67 73 0D 0A 20 20   tch Settings..
20 20 20 20 20 20 31 2E 34 2E 32 20 4A 75 6D 70         1.4.2 Jump
65 72 20 53 65 74 74 69 6E 67 0D 0A 20 20 20 20   er Setting..
31 2E 35 20 53 45 4C 45 43 54 59 50 45 20 46 55   1.5 SELECTYPE FU
4E 43 54 49 4F 4E 0D 0A 20 20 20 20 31 2E 36 20   NCTION..    1.6
53 48 45 45 54 20 4C 4F 41 44 49 4E 47 20 41 4E   SHEET LOADING AN
44 20 53 48 45 45 54 20 45 4A 45 43 54 49 4F 4E   D SHEET EJECTION
0D 0A 20 20 20 20 31 2E 37 20 54 45 41 52 2D 4F   _.    1.7 TEAR-O
46 46 20 46 55 4E 43 54 49 4F 4E 0D 0A 20 20 20   FF FUNCTION..
20 31 2E 38 20 4F 50 45 52 41 54 49 4E 47 20 49    1.8 OPERATING I
4E 53 54 52 55 43 54 49 4F 4E 53 0D 0A 20 20 20   NSTRUCTIONS..
20 20 20 20 20 31 2E 38 2E 31 20 53 65 6C 66 2D         1.8.1 Self-
54 65 73 74 0D 0A 20 20 20 20 20 20 20 20 31 2E   Test.          1.
30 2E 32 20 48 65 78 61 64 65 63 69 6D 61 6C 20   8.2 Hexadecimal
44 75 6D 70 20 46 75 6E 63 74 69 6F 6E 0D 0A 20   Dump Function..
20 20 20 20 20 20 31 2E 38 2E 33 20 42 69 74         1.8.3 Bit
2D 49 6D 61 67 65 20 50 72 69 6E 74 69 6E 67 0D   -Image Printing.
0A 20 20 20 20 20 20 20 31 2E 38 2E 34 20 45      1.8.4 E
72 72 6F 72 20 43 6F 6E 64 69 74 69 6F 6E 73 0D   rror Conditions.
0A 20 20 20 20 20 20 20 31 2E 38 2E 35 20 42      1.8.5 B
75 7A 7A 65 72 20 4F 70 65 72 61 74 69 6F 6E 0D   uzzer Operation.
0A 20 20 20 20 20 20 20 31 2E 38 2E 36 20 50      1.8.6 P
72 69 6E 74 65 72 20 49 6E 69 74 69 61 6C 69 7A   rinter Initializ
61 74 69 6F 6E 0D 0A 20 20 20 20 20 20 20 20 31   ation..        1
2E 38 2E 37 20 44 65 66 61 75 6C 74 20 56 61 6C   .8.7 Default Val
75 65 73 0D 0A 20 20 20 20 20 20 20 20 31 2E 38   ues..          1.8
2E 38 20 41 64 6A 75 73 74 20 4C 65 76 65 72 20   .8 Adjust Lever
4F 70 65 72 61 74 69 6F 6E 0D 0A 20 20 20 20 20   Operation..
20 20 20 31 2E 38 2E 39 20 50 72 69 6E 74 65 72       1.8.9 Printer
20 50 72 6F 74 65 63 74 69 6F 6E 20 66 6F 72 20    Protection for
48 65 61 76 79 2D 44 75 74 79 20 50 72 69 6E 74   Heavy-Duty Print
69 6E 67 0D 0A 20 20 20 20 31 2E 39 20 4D 41 49   ing. _    1.9 MAI
4E 20 43 4F 4D 50 4F 4E 45 4E 54 53 0D 0A 20 20   N COMPONENTS..
20 20 20 20 20 20 20 31 2E 39 2E 31 20 53 41 4D         1.9.1 SAMA
20 42 6F 61 72 64 0D 0A 20 20 20 20 20 20 20 20    Board. _
31 2E 39 2E 32 20 53 41 4E 50 4E 4C 20 42 6F 61   1.9.2 SANPNL Boa
72 64 0D 0A 20 20 20 20 20 20 20 20 31 2E 39 2E   rd..           1.9.
33 20 53 41 4E 50 53 28 45 29 20 42 6F 61 72 64   3 SANPS(E) Board
0D 0A 20 20 20 20 20 20 20 20 31 2E 39 2E 34 20   ..          1.9.4
50 72 69 6E 74 65 72 20 4D 65 63 68 61 6E 69 73   Printer Mechanis
6D 20 28 4D 2D 35 37 31 30 29 0D 0A 20 20 20 20   m (M-5710)..
20 20 20 20 31 2E 39 2E 35 20 48 6F 75 73 69 6E       1.9.5 Housin
67 0D 0A 0D 0A 20 20 20 20 31 2E 31 20 46 45 41   g.. . .    1.1 FEA
54 55 52 45 53 0D 0A 0D 0A 20 20 20 20 54 68 65   TURES....    The
20 4C 51 2D 35 31 30 2F 35 35 30 20 69 73 20 61    LQ-510/550 is a
```

Figure 1-9. Hexadecimal Dump Function

1.8.3 BIT-IMAGE PRINTING

This printer offers the following four standard print densities ("dpi" indicates "dots per inch"):

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 implements the print densities as shown in Table 1-16.

Table 1-16. Print Density

Pins	m	Bit Image Printing Mode	Dot Density (dpi)	Dot Printing	256 × n2 + 1	Print Speed (ips)
8	0	Single-density	60	yes	660	15
8	1	Dual density	120	yes	1320	7.5
8	2	Double speed, dual density	120	no	1320	15
8	3	Quadruple density	240	no	2640	7.5
8	4	CRT graphics	80	yes	880	7.5
8	6	CRT graphics II	90	yes	990	10
24	32	Single density	60	yes	660	15
24	33	Dual density	120	yes	1320	7.5
24	38	CRT graphics II	90	yes	990	10
24	39	Triple density	180	yes	1980	5
24	40	Hex. density	360	no	3960	5

NOTES: 1. Dot density is in dots per inch; print speed is in inches per second.
2. The format of the graphics command is ESC* m n1 n2 [DATA]. Column 2 of the table shows the significance of the various options for m.

The firmware handles the print densities as shown in Table 1-17.

Table 1-17. Bit-Image Printing

Dot Density	Printing Method
80 dpi	Prints at 240 dpi by expanding the bit image by three: 80 x 3 = 240

1.8.4 ERROR CONDITIONS

If any of the following error conditions are 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 when the printer is already on line. This will switch the printer to off line.
- When a paper-out signal is detected and forms-override is finished.
- If "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.
$\overline{\text{ERROR}}$ becomes LOW.
No $\overline{\text{ACKNLG}}$ pulse is sent.

1.8.5 BUZZER OPERATION

The buzzer operates as follows:

- When the BEL code is sent to the printer, the buzzer sounds continuously for 0.5 seconds.
- When the paper-out error is detected, the buzzer sounds 3 times, for 0.1 second each time. The interval between sounds is 0.1 second.
- When abnormal carriage movement is detected, the buzzer sounds 5 times, for 0.5 seconds each time. The interval between sounds is 0.5 seconds.
- When the panel setting is accepted, the buzzer sounds for 0.1 second.

1.8.6 PRINTER INITIALIZATION

There are two types of initialization: hardware initialization and software initialization.

Hardware Initialization

Hardware initialization occurs when the printer power switch is turned on (provided that the AC power cord is plugged in), or when the INIT signal is received over the parallel interface line.

Upon hardware initialization, the printer does the following:

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

Software Initialization

Software initialization occurs when the printer receives the software initialize code. For a software initialization, the printer does not perform the functions listed under (a), (b), and (c) above. Instead, the settings changed by the last SelecType operation are reset.

1.8.7 DEFAULT VALUES

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

Page Position	The current paper position becomes the top-of-form position
Left and Right Margin	Released
Line Spacing	1/6 inch
Vertical Tabs	Cleared
Horizontal Tabs	Every 8 characters (relative)
VFH Channel	Channel 0
Family Number of Type Style	Font selected by DIP switch
Download Characters	Deselected (if software initialization) Cleared (if 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	All effects other than condensed printing are cleared
Condensed Printing	Setting selected by DIP switch

1.8.8 ADJUST LEVER OPERATION

The position of the adjust lever must be set to accord with the paper thickness. If the lever is set to position four or above, the MULTI-PART indicator lights and the printing speed is increased. See Table 1-18 and Figure 1-10.

Table 1-18. Lever Position

Lever Position*	Paper Thickness
2nd position	0.06 - 0.12 mm
3rd position	0.13 - 0.18 mm
4th position	0.19 - 0.25 mm

- If the printing density is light, position the adjust lever one step lower.

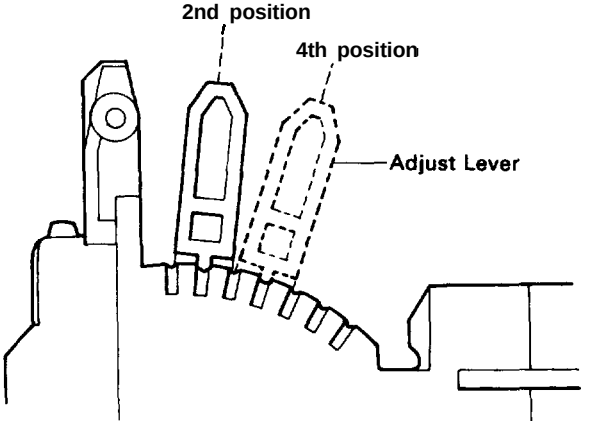


Figure 1-10. Lever Position

1.8.9 **PRINTER PROTECTION FOR HEAVY-DUTY PRINTING**

The printer incorporates “printhead protection” to safeguard it from overheating and from the potential ill effects of a voltage drop to the head driver. If the temperature of the head exceeds a specified value, printing is automatically suspended. Printing automatically resumes when the temperature drops to another specified value.

If heavy-duty printing causes the voltage to the head drive circuit to drop to a specified value, printing is immediately suspended. If the voltage recovers, the line that was being printed is completed. This protection occurs when half or more of the wires are activated simultaneously and continuously.

1.9 MAIN COMPONENTS

To facilitate maintenance and repair, the main components of the LQ-510 printer are designed so that they can be removed and replaced easily.

The main components are:

1) SAMA board: The main control board. The CPU, which is contained on this board, controls all the main functions.
2) SANPNL control panel: The control panel.
3) SANPS board: (120 V Version) The power supply circuit board.
   SANPSE Board (220/240 V Version)
4) M-5710: The printer mechanism.

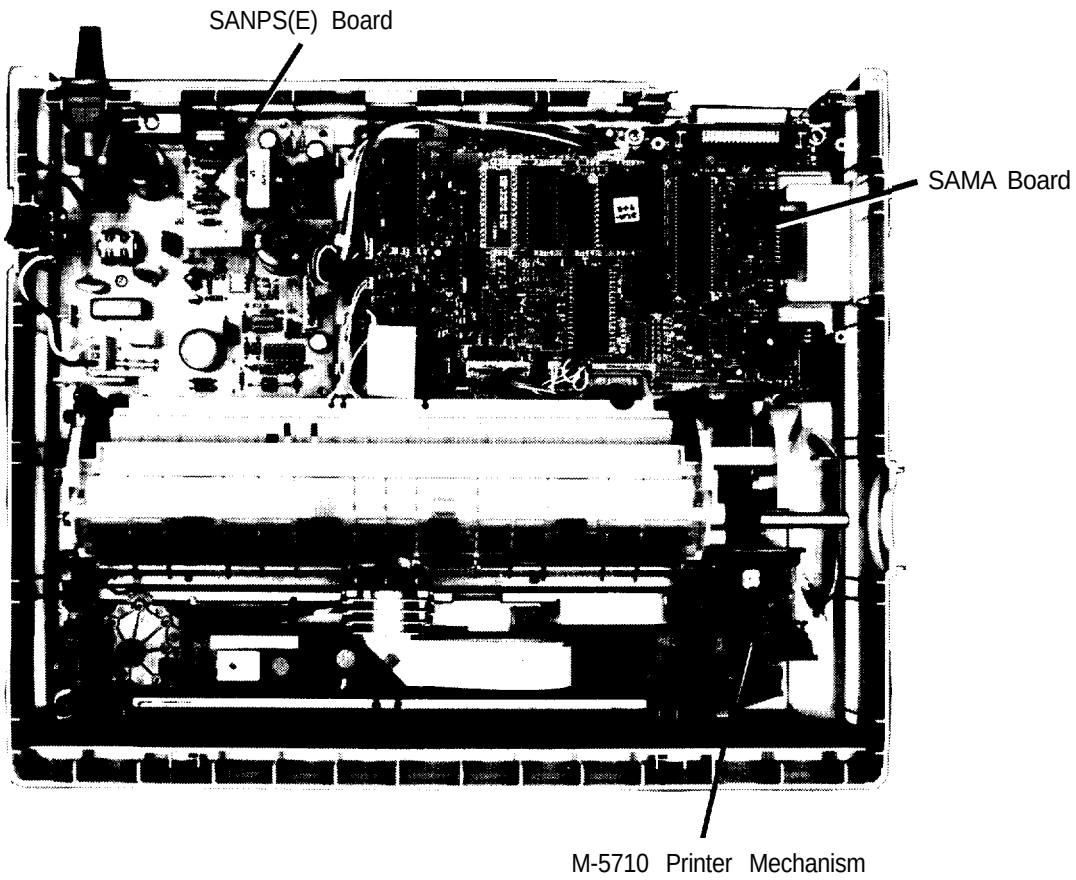


Figure 1-11. LQ-510 Component Layout

1.9.1 SAMA BOARD

The use of the μPD7810HG CPU simplifies the circuitry design of the main control board.

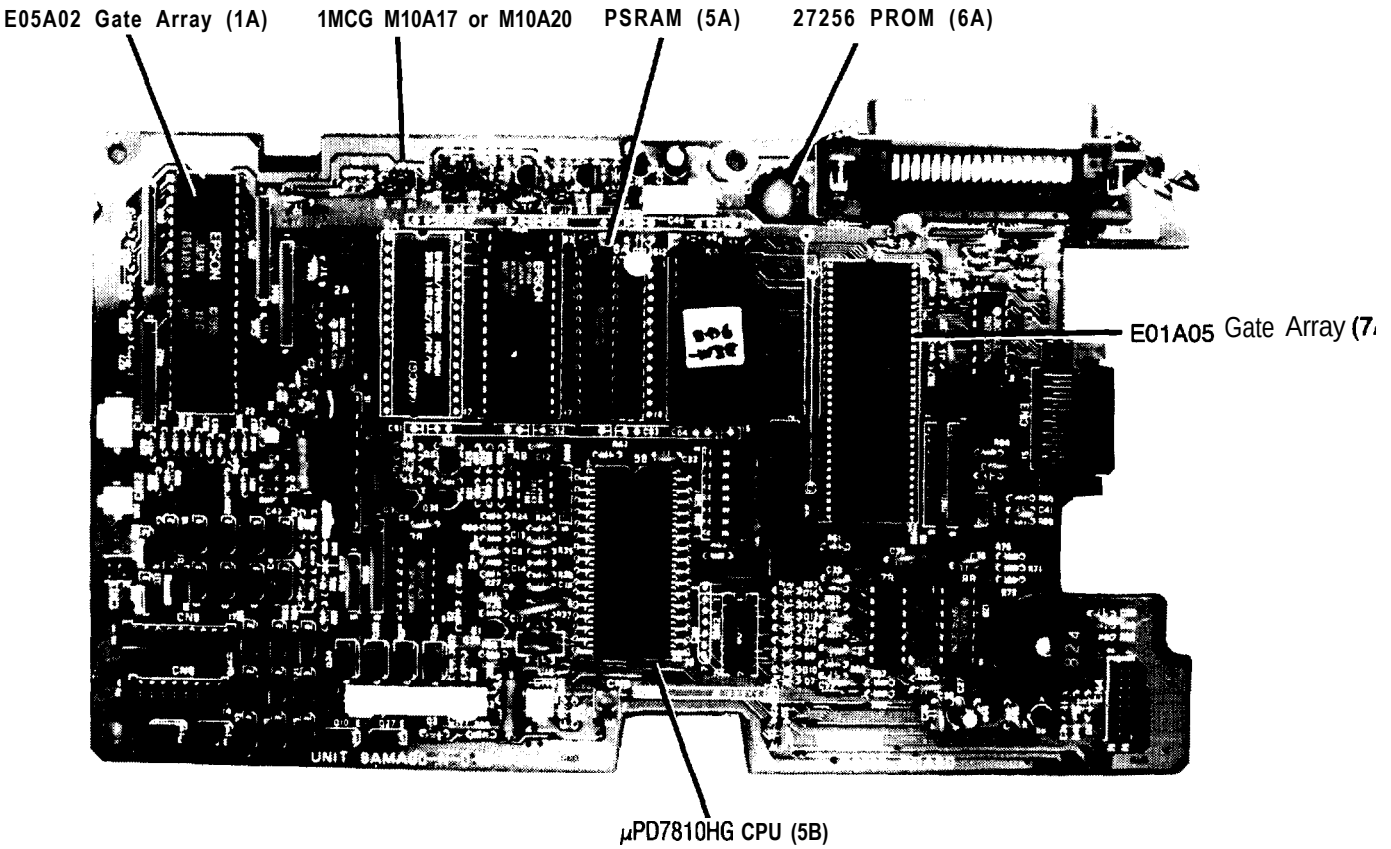


Figure 1-12. SAMA Main Control Board

1.9.2 SANPNL CONTROL PANEL

The SANPNL control panel, which is the LQ-510's control panel, contains the switches and the indicator LEDs illustrated below.

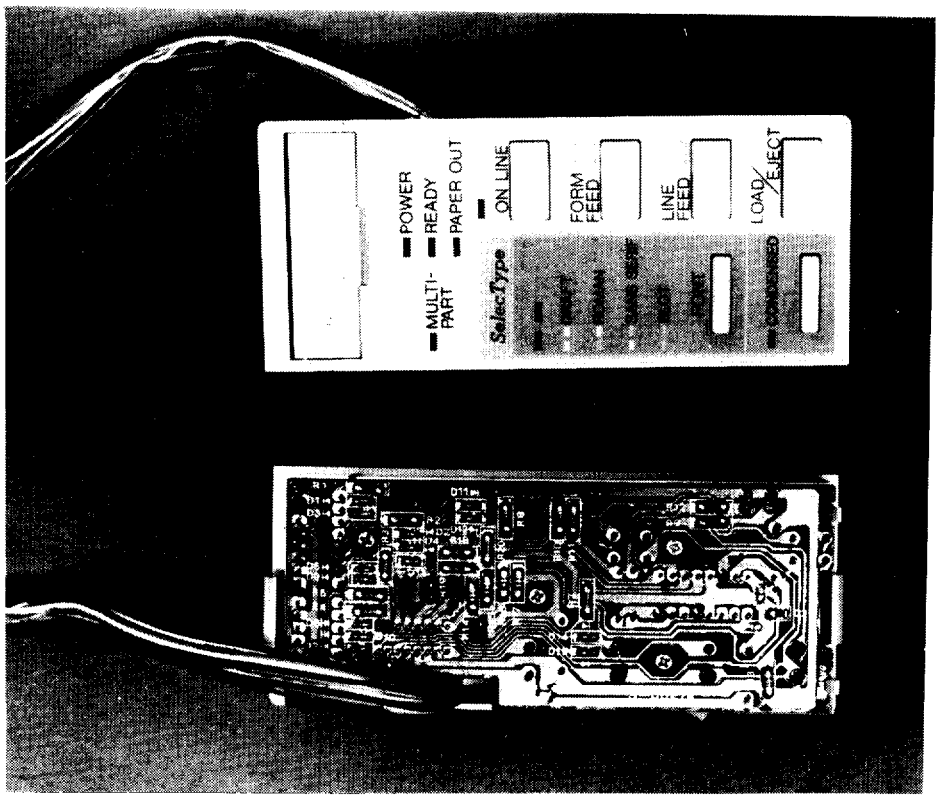
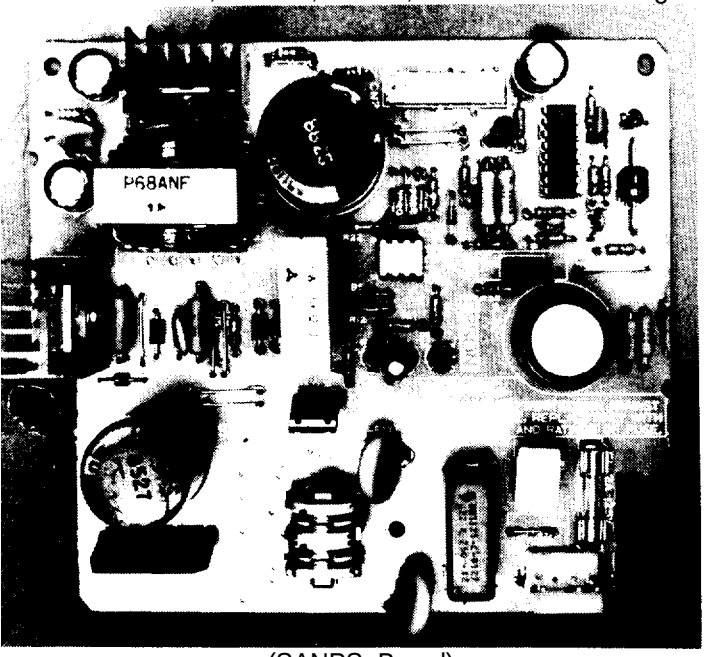


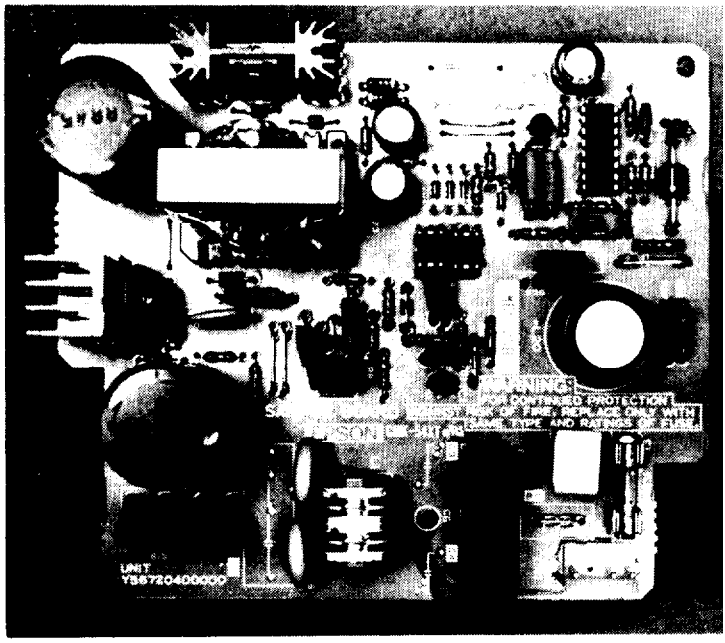
Figure 1-13. SANPNL Control Panel

1.9.3 SANPS(E) BOARD

The power supply circuit (SANPS/SANPSE board), which is housed at the upper left of the lower case, consists of a line filter, fuse, power switch, and switching regulator circuit. It converts the AC line voltage to the + 24 V, + 12 V, - 12 V, and + 5 VDC voltages used by the printer.



(SANPS Board)



(SANPSE Board)

Figure 1-14. Power Supply Filter Board

1.9.4 PRINTER MECHANISM (M-5710)

The M-5710 printer mechanism was developed expressly for use with LQ-510 printer. Its components include a carriage motor, carriage mechanism, paper-feed motor, paper-feed mechanism, ribbon-feed mechanism, printhead, and sensors.

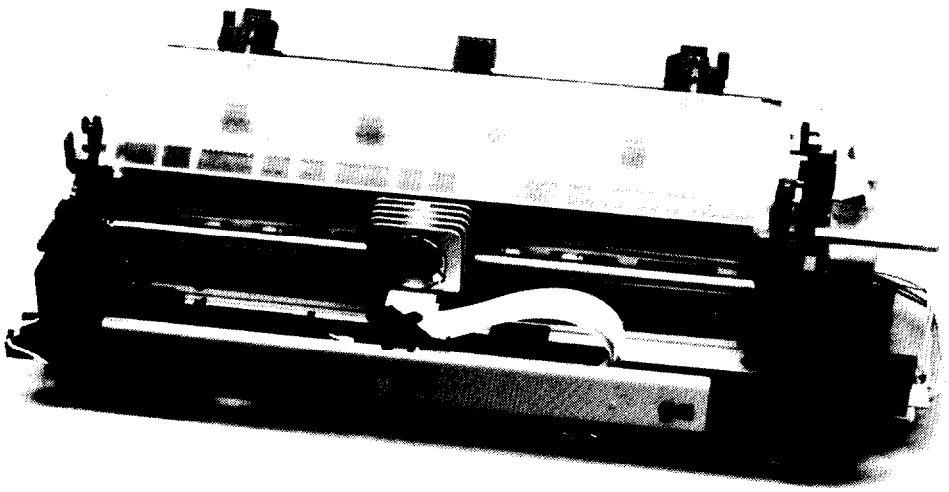


Figure 1-15. Model 5710 Printer Mechanism

1.9.5 HOUSING

The housing for the LQ-510 consists of 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 can be removed and replaced easily.

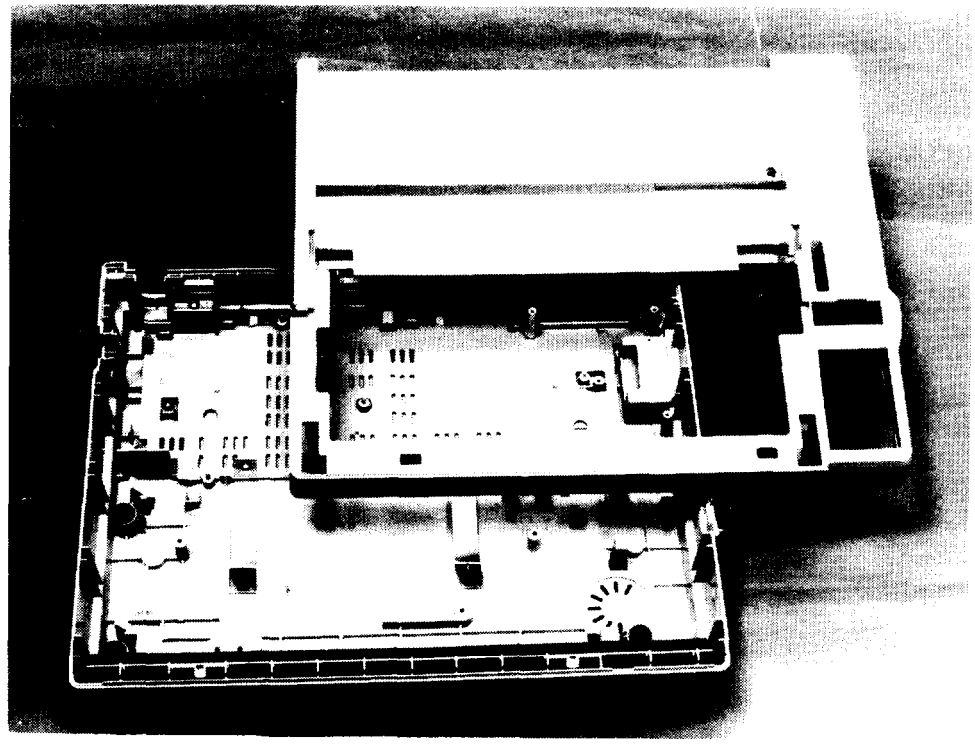


Figure 1-16. Housing

CHAPTER 2
PRINCIPLES OF OPERATION

LIST OF FIGURES

LIST OF TABLES

PRINCIPLES OF OPERATION 2

2.1 OVERVIEW

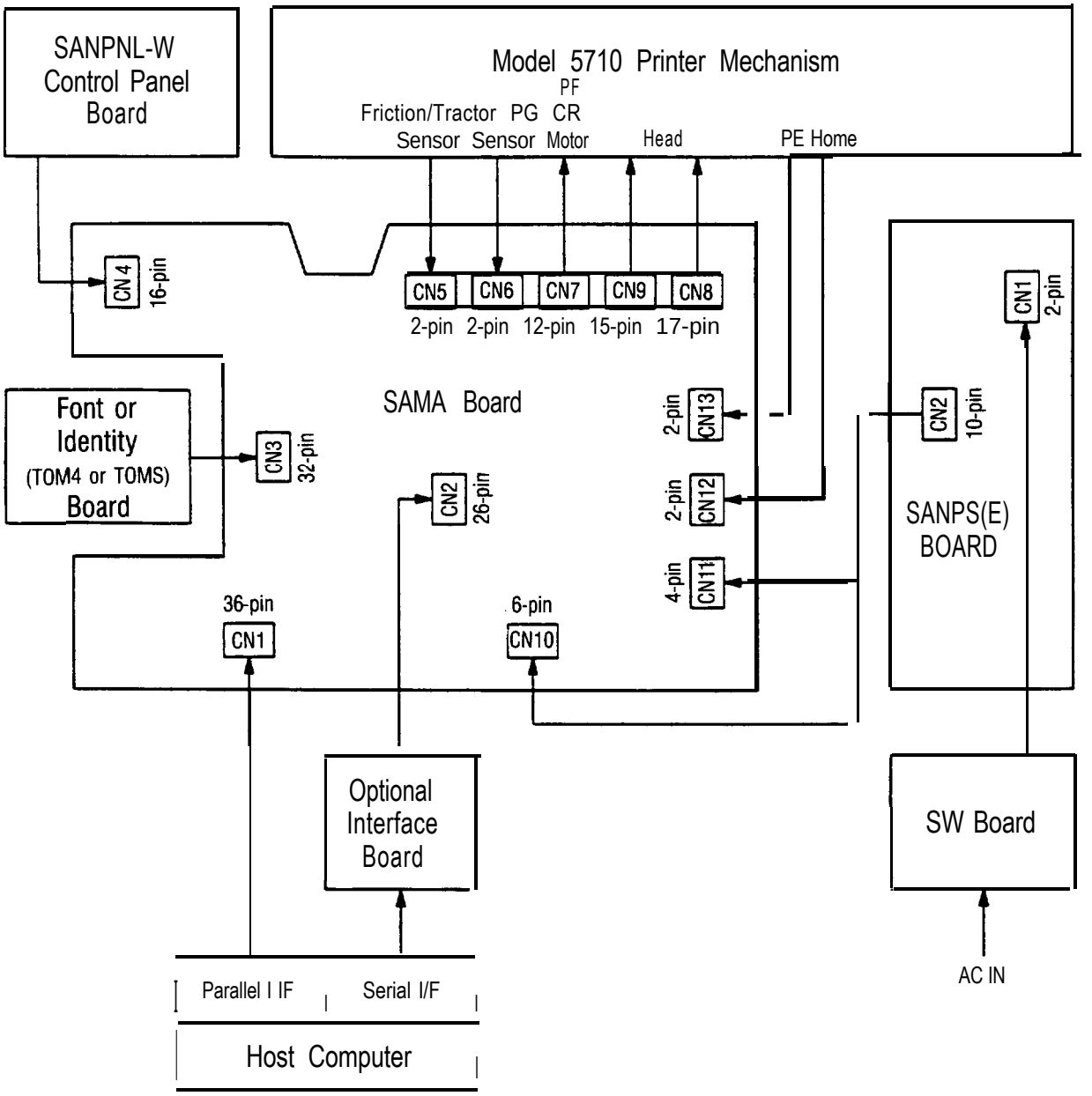
This chapter describes the signals at the connectors linking the primary components of the LQ-510. These components include the printer mechanism, power supply circuits, and control circuits. The chapter also describes the operation of the printer's circuitry and printer mechanism.

2.1.1 CONNECTOR SUMMARY

The interconnection of the primary components is illustrated in Figure 2-1. Table 2-1 summarizes the functions, sizes, and types of the connectors shown in the figure.

Table 2-1. Board Connector Summary

Board	Connector	Function	Pins	Reference Table
SAMA Board	CN1	Host I/F (Parallel)	36	1-9
	CN2	Optional I/F Board	26	A-10
	CN3	Font Module or Identity Module	32	A-11
	CN4	Control Panel	16	A-12
	CN5	Release Lever	2	A-13
	CN6	Adjust Lever	2	A-14
	CN7	CR Motor and PF Motor	12	A-15
	CN8	Head 1	17	A-16
	CN9	Head 2	15	A-17
	CN10	DC Power Input	6	A-18
	CN11	DC Power Input	4	A-19
	CN12	CR Home Position	2	A-20
	CN13	PE Signal	2	A-21
SANPS(E) Board	CN1	AC Power Input	2	—
	CN2	DC Power Output	10	—

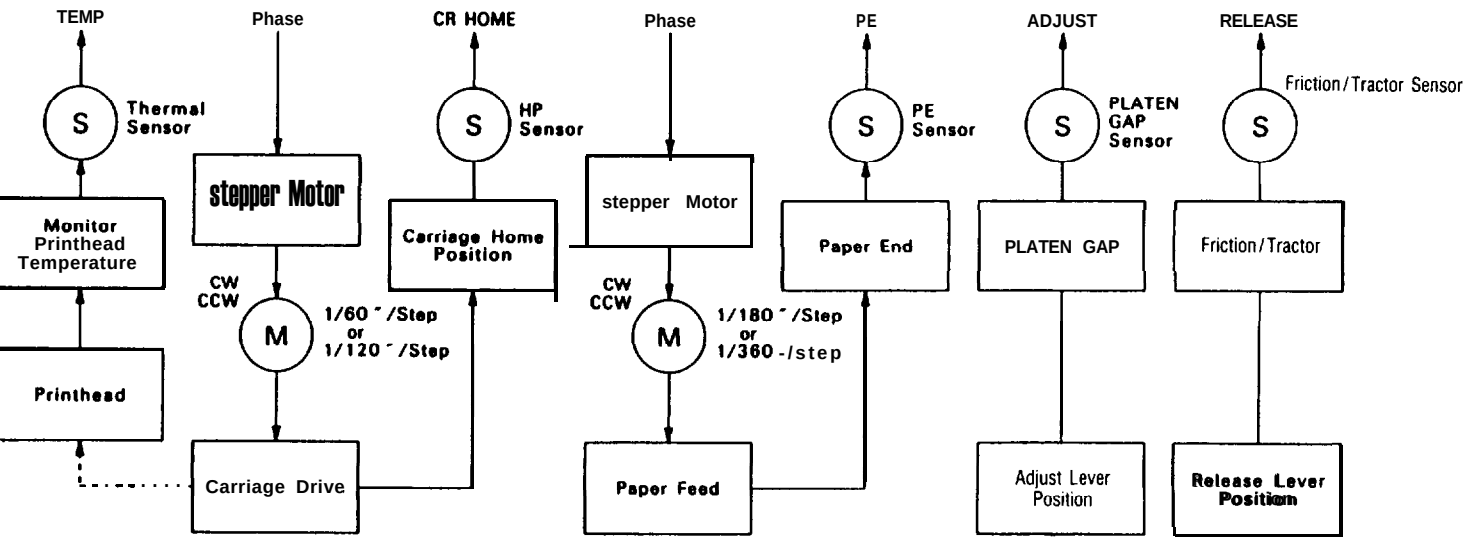


NOTE: CR = carriage.
PF = paper feed.

Figure 2-1. Cable Connections

2.1.2 OUTLINE OF PRINTER MECHANISM OPERATION

The Model 5710 printer mechanism is a serial, impact, dot-matrix mechanism that prints at 180 dots per inch (dpi) in both horizontal and vertical directions. Figure 2-2 shows a block diagram of the 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 (for sensing printhead temperature)
Platen Gap (PG) Sensor
Friction/Tractor Sensor

Paper-End Sensor (PE Sensor)

Figures 2-3 and 2-4 show the paper-end sensor. This sensor switch is ON when no paper is in place (e.g., when the paper supply has run out).

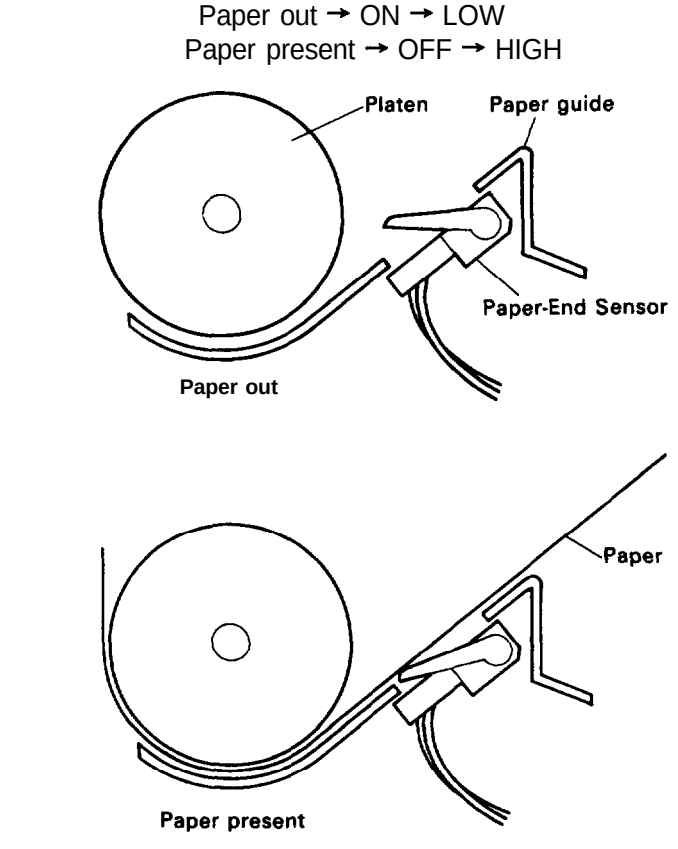


Figure 2-3. Paper-End Sensor Mechanism

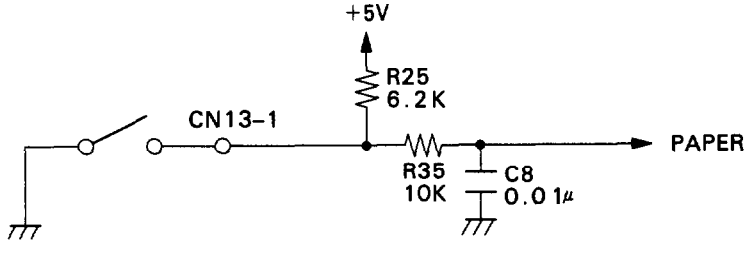


Figure 2-4. Paper-End Sensor Circuit

Home-Position Sensor (HP Sensor)

Figures 2-5 and 2-6 show the home-position sensor. The sensor switch is ON when the carriage is at the home position.

Home position → ON → LOW
Other positions → OFF → HIGH

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

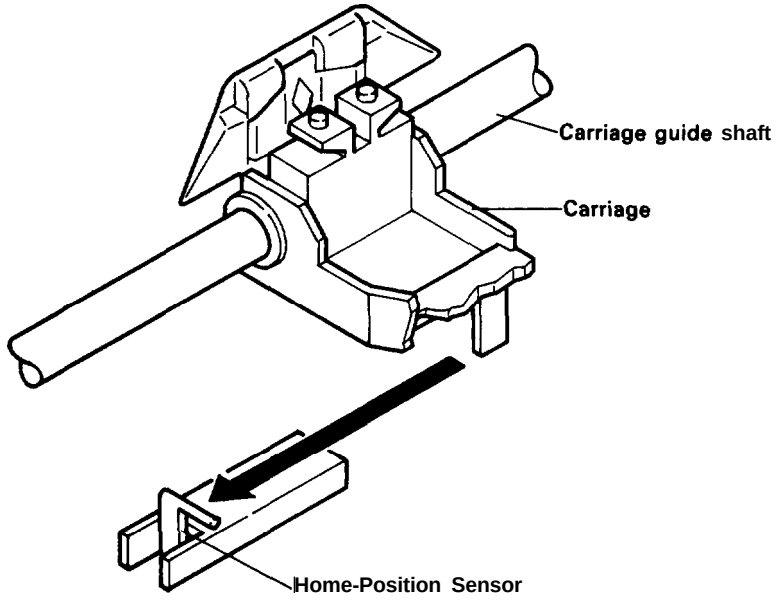


Figure 2-5. Home-Position Sensor Mechanism

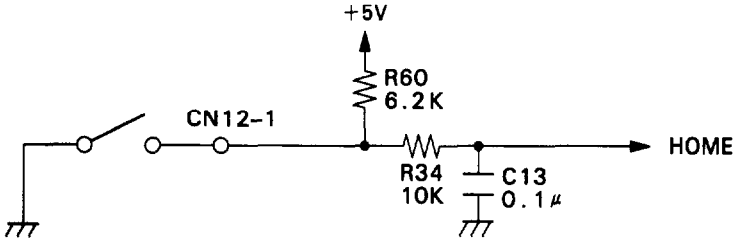


Figure 2-6. Home-Position Sensor Circuit

Thermal Sensor (Printhead Temperature Detection)

The thermal sensor in the printhead monitors the printhead temperature. If the head temperature exceeds a specified upper limit, printing is automatically suspended. Printing resumes when the temperature drops to a specified lower value. Figure 2-8 illustrates the printer's thermal-sensor circuit.

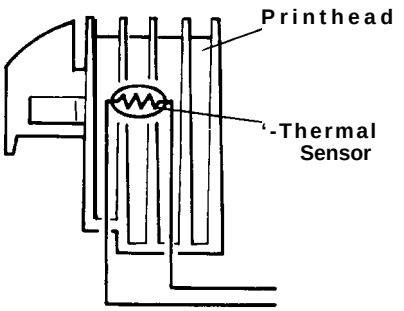


Figure 2-7. Thermal Sensor Mechanism (Printhead Temperature Detection)

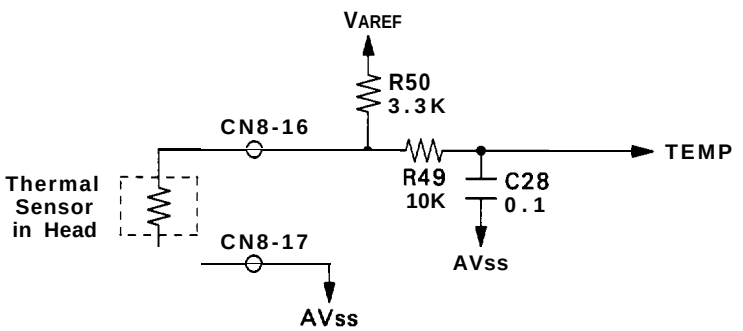


Figure 2-8. Thermal Sensor Circuit

Platen Gap (PG) Sensor

The PG sensor is ON whenever the adjust lever position is set to the fourth position or above. If the sensor is ON, printing will be in multiple copy mode, and the print speed will be relatively slow.

Adjust Lever Position 1 to 3 → OFF → HIGH
Adjust Lever Position 4 to 7 → ON → LOW

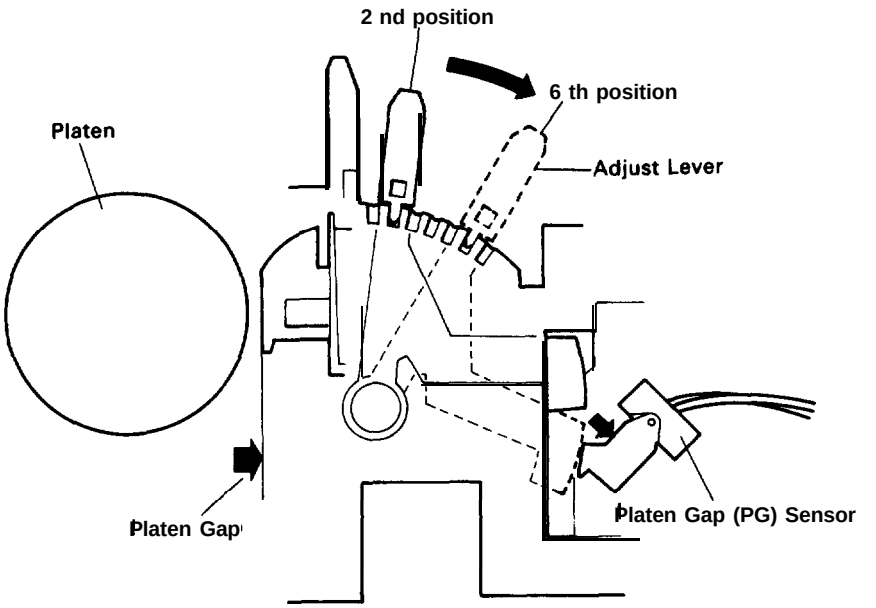


Figure 2-9. Platen Gap Sensor Mechanism

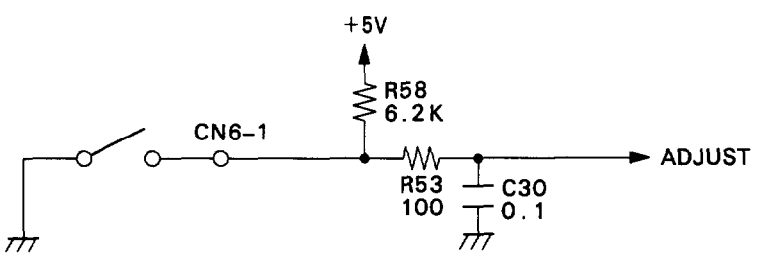


Figure 2-10. Platen Gap Sensor Circuit

Friction/Tractor Sensor

The friction/tractor sensor detects the position of the release lever to determine whether tractor feed or friction feed is in effect.

Release Lever Position: Front → Friction Feed → OFF → HIGH level
Release Lever Position: Rear → Tractor Feed → ON → LOW level

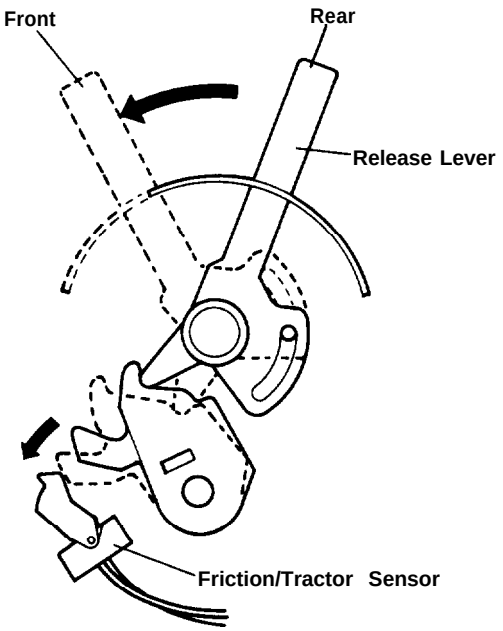


Figure 2-11. Friction/Tractor Sensor Mechanism

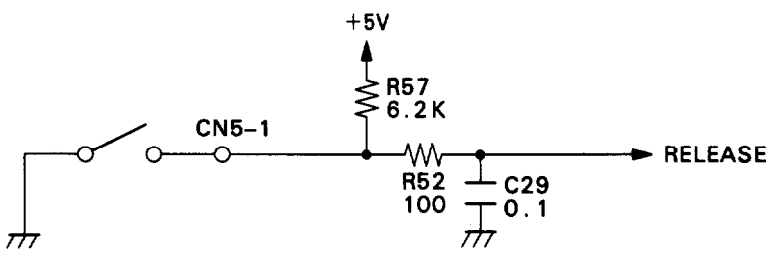


Figure 2-12. Friction/Tractor Sensor Circuit

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 four-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 is fed using a four-phase, 48-step motor operating with either 1-2 or 2-2 phase excitation, which advances the paper either 1/180 inch or 1/360 inch for each phase switch. The CPU controls the motor through an open loop.

2.1.2.3 Printhead

Figure 2-13 shows the dot-wire operation. When the head-driving coil is energized, the dot wire is pushed out. The dot wire strikes the ribbon, causing the ribbon to impact the paper, thereby printing a dot.

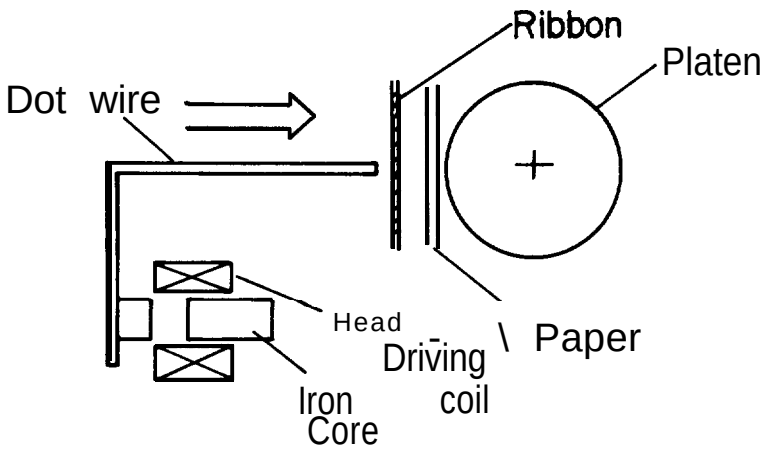


Figure 2-13. Printhead

2.1.3 Circuit Overview

This section describes the circuitry.

2.1.3.1 Overview of the Power Supply Circuit

The power circuit for this system is an SANPS(E) board. The circuit converts the AC power source to the + 24, + 5, and ± 12 VDC that the unit requires.

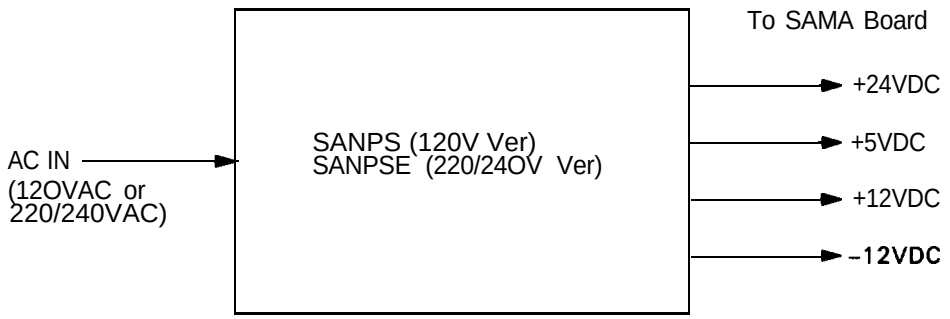


Figure 2-14. Overview of Power Supply Circuit Operation

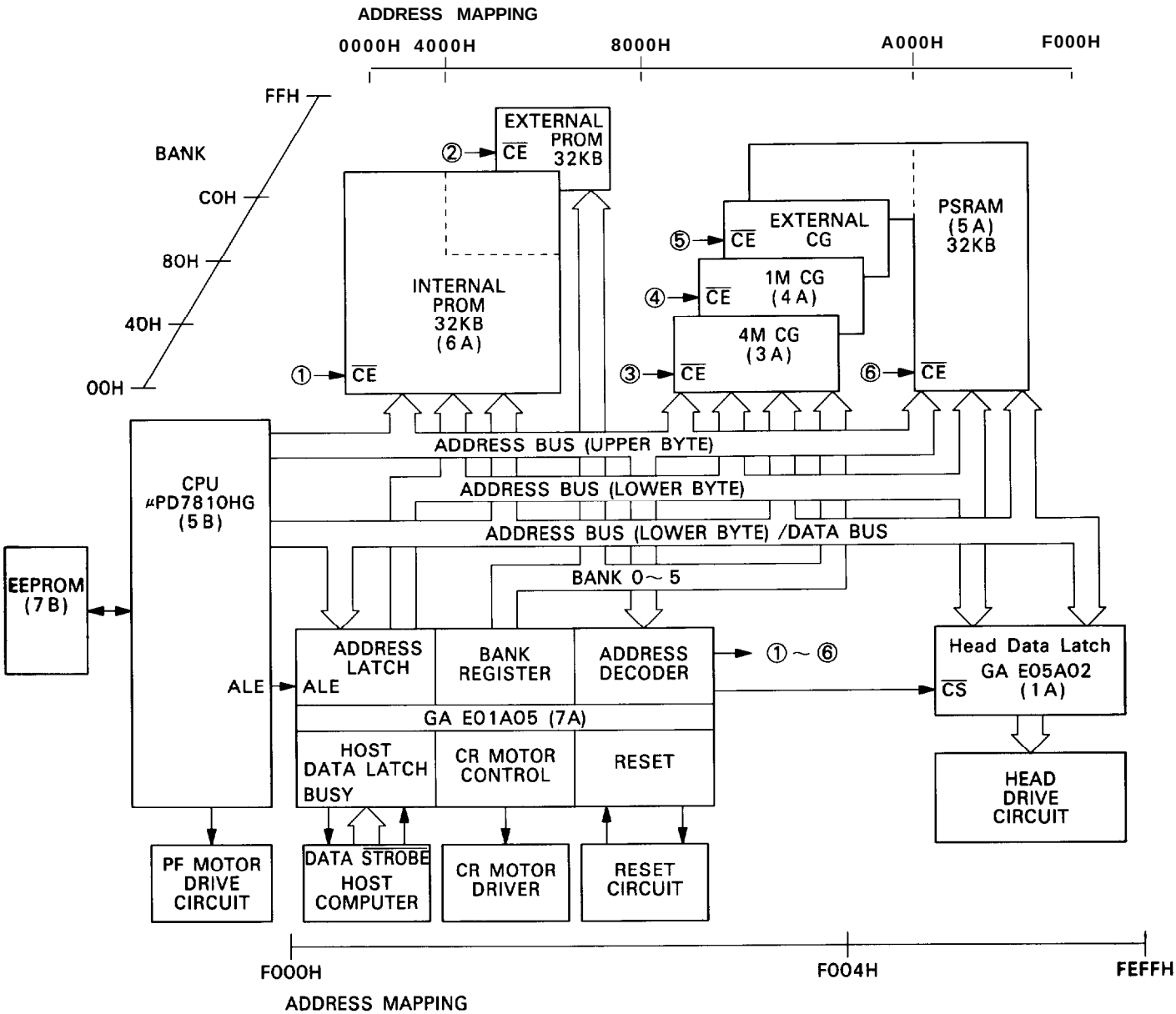
Table 2-2. Power Supply Applications

Voltage	Application
+ 5 v	Logic circuit Paper-feed motor holding voltage, 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

NOTE: The voltage Vx is generated on the SAMA board using the + 5 V power supply.

2.1.3.2 Control Circuit Block Diagram

Figure 2-15 shows a block diagram of the control circuitry.



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

Figure 2-15. Control Circuit Block Diagram

The control circuit consists mainly of the following ICs:

- µPD7810HG CPU (5B)

The µPD7810HG executes the program in the PROM (6A) and controls all the printer operations. Upon receiving the RESET signal, the CPU begins executing the program from address 0000 hex.

. PROM (6A)

The PROM includes the control program (firmware).

- HM65256 PSRAM (5A)

The HM65256 PSRAM is external memory for the CPU. It is used as an input data buffer and line buffer for expanding data, and as working area for the program.

- E01A05 Gate Array (7A)

The E01A05 functions are as follows:

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

- E05A02 Gate Array (1 A)

The E05A02 was developed for 24pin, dot-matrix printers and is used to simplify the interface between the CPU and the printhead.

- EEPROM (7B)

The EEPROM has a 128-bit memory, which is used to store the paper position.

- M10A17 or M10A20 Mask ROM (1M CG, 4A)

The M10A17 or M10A20 mask ROM incorporates the character generators. The ROM includes character design.

Other control circuits are as follows:

- Paper-Feed Motor Drive Circuit

This circuit drives the paper-feed motor, which is a four-phase, stepper motor. The CPU controls the motor's rotation (position and speed).

- Carriage Motor Drive Circuit

The carriage motor drive circuit drives the carriage motor, which is a four-phase stepper motor. The rotation of the motor (position and speed) is controlled by outputting the phase switching signal by the E01A05 gate array.

2.2 OPERATION OF THE POWER SUPPLY CIRCUIT

The power circuit used in the printer is either a 120 V SANPS board for the U.S., Taiwan, and the Middle East or a 220/240 V SANPSE board (for Europe, Asia, etc.). The basic operation of both boards is the same, however, and they are treated as one in this manual.

2.2.1 POWER SUPPLY CIRCUIT BLOCK DIAGRAM

Figure 2-18 shows the power supply circuit block diagram. The SANPS(E) board uses a forward-convertor type switching regulator circuit, and outputs + 5, + 24, and + 12 VDC.

The incoming AC power passes first through a noise filter, then through a full-wave rectifying circuit. The power then passes into the main switching circuit, which outputs + 24 V and ± 12 VDC. Stabilization is provided by an over-voltage limiting circuit located on the 24 V line, which feeds back to the main switching circuit. The 24 V line is also used to generate the 5 V output.

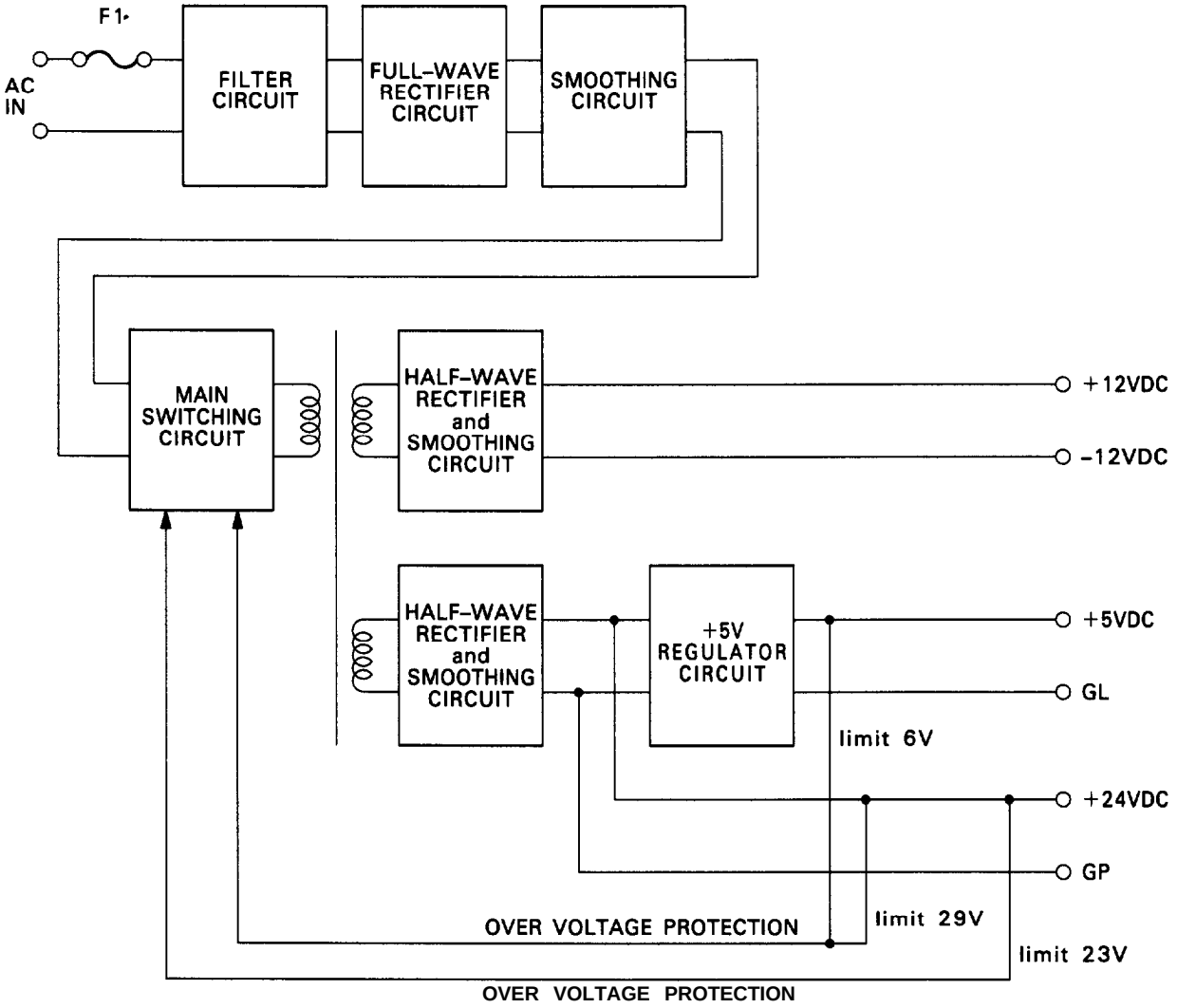


Figure 2-16. Power Supply Circuit Block Diagram

2.2.2 FILTER CIRCUIT

The input filter is a conventional LC filter circuit that functions both to dampen incoming noise and to prevent externally generated noise from running though the AC line. All the circuit's coils and condensers are designed to withstand fluctuations in the incoming AC power.

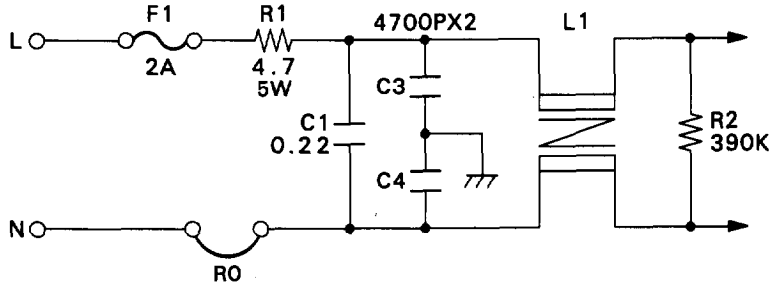


Figure 2-17. Filter Circuit (SANPS Board, 120 V Version)

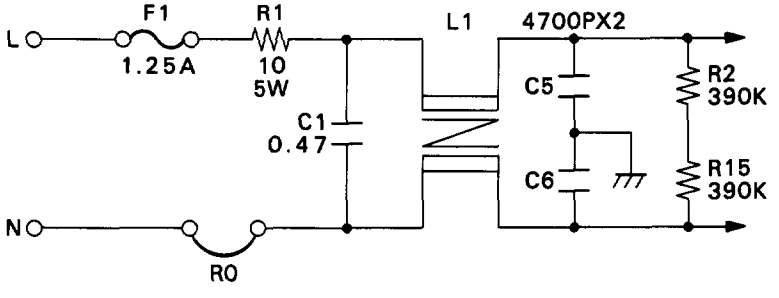
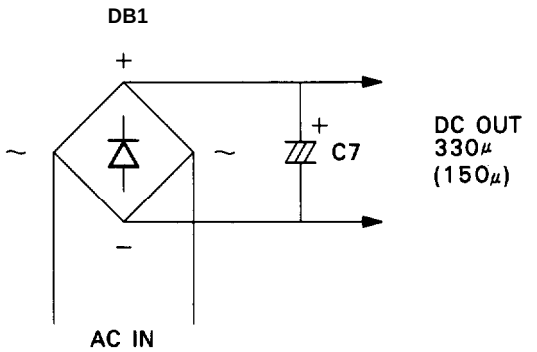


Figure 2-16. Filter Circuit (SANPSE Board, 220/240 V Version)

2.2.3 RECTIFIER AND SMOOTHING CIRCUIT

The AC IN voltage from the filter circuit is full-wave rectified by diode bridge DB1, and converted to approximately 2 x AC IN voltage by smoothing capacitor C7. The + 24 VDC, + 5 VDC, and ± 12 VDC voltages are converted from this DC voltage.



NOTE: The item in parentheses pertains to the 220/240 V version

Figure 2-19. Rectifier and Smoothing Circuit

2.2.4 STARTING CIRCUIT (MAIN SWITCHING CIRCUIT)

Figure 2-20 shows the starting circuit. The operation sequence is as follows.

(1) When the main power source is connected, the AC input passes through the input filter and is then rectified and smoothed. The resulting DC voltage V_{IN} is input into the circuit.
(2) VIN is applied to starting resistance R7 and passes through point A. Base current IB flows through transistor Q1, causing the transistor to conduct.
(3) At the same time, V_{IN} is applied to coil 4-3 of pulse transformer T1, causing a voltage of (7/60T) (V_{IN}) at 8-2, so that the positive feedback current of switching circuit I_B flows in the direction of B. This causes a sharp rise, and Q1 quickly switches on.
(4) Current I_L through coil 4-3 increases linearly over time. During this time, a voltage of (10/60T) V_{IN} is induced through coils 7-8 and 8-11, and a voltage of (19/60T) V_{IN} through coil 9-10. For all these coils, then, current attempts to flow in the direction of D; however, this direction opposes the direction of diodes D22, D23, and D20, so that no current flows through the secondary side of the circuit.

(5) Current I_L in the primary winding increases, but because the potential at point 6 of coil 6-2 is fixed, Q1 base current I_B cannot surpass a specified level. As a result of this, the value of current Ic (= I_L) flowing from coil 4-3 to the Q1 collector cannot surpass a maximum of hfe **(I_B).** Therefore, the 4-3 current value stops changing, and the coil voltage drops. At the same time, a reverse voltage is applied to coil 6-2, I_B drops, and current flows through D3 opposite to direction B. At this time, the potential at point A is higher than that at point E, and C10 absorbs the current flowing in the A-E direction. Q1 is quickly shut off by the resulting sharp drop.

(6) The above process causes the energy previously induced in the secondary side (in step (4), above) to be released from coils 7-8, 8-11, and 9-10 in the direction opposite to D, and current flows in the easy-flow direction of the diodes. Therefore, the secondary side outputs a voltage.

(7) The release of energy declines linearly over time. When energy release is completed, all T1 coil voltages momentarily reach zero. R3, however, again induces switching current lB in the direction of B, and Q1 conducts. Because the potential at point E then surpasses that at point A, the energy in C10 is released, so that I_B is maintained.

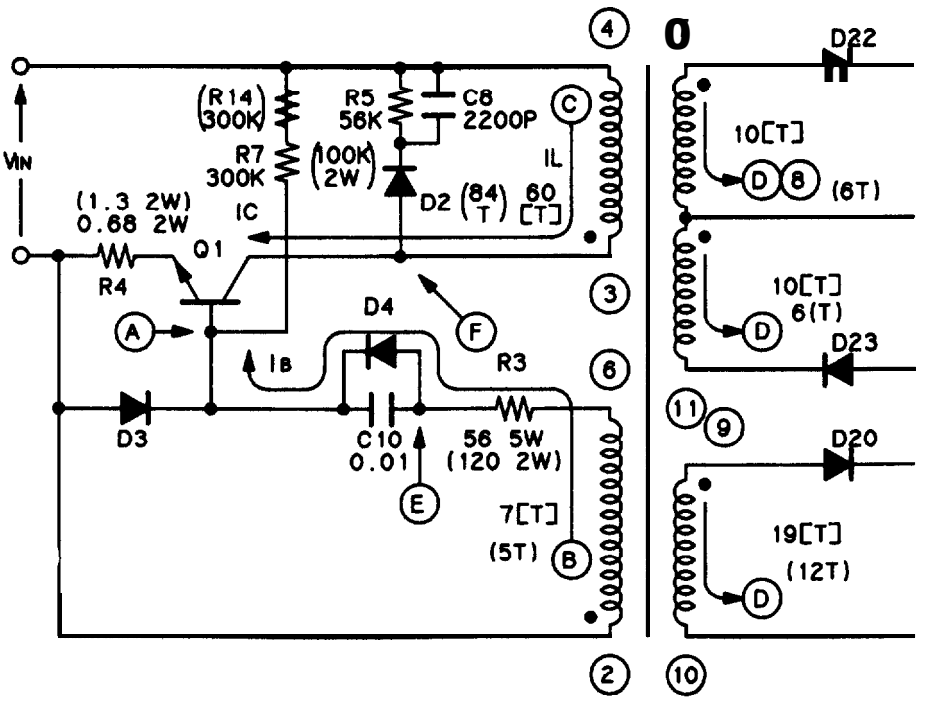
(8) The sequence returns to the stage described in (3) above. This repetition enables the circuit to maintain oscillation. R7 is involved, however, only at the start time.

The above sequence is generally known as a self-excitation type ringing choke converter (RCC) configuration.

Note that, at the instant when Q1 goes off (in step (5), above), the potential at point F jumps violently upward, but because of the action of D2, the energy is fed into R5 and consumed.

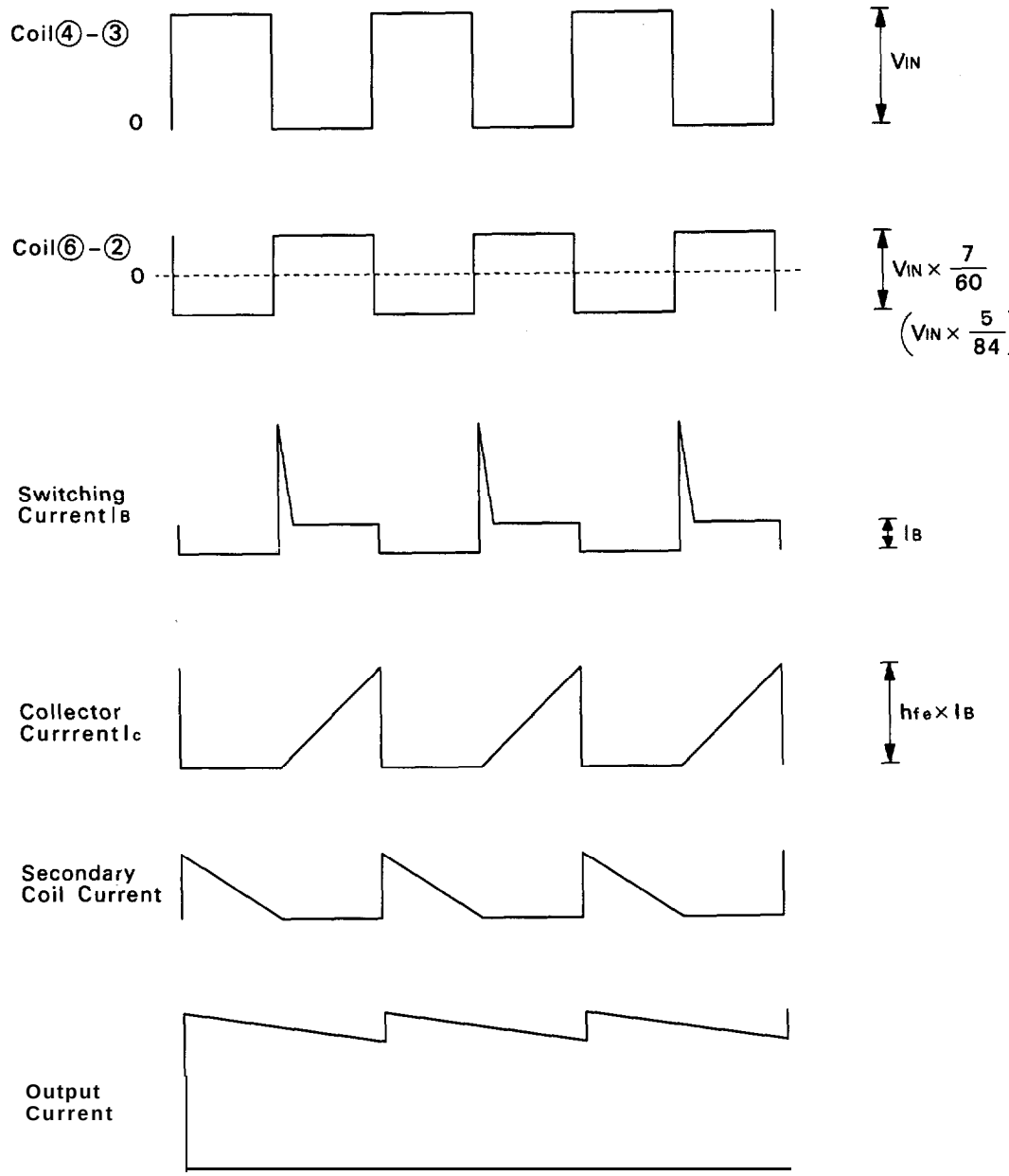
Below are shown the waveforms for each part of the circuit.

As Figure 2-21 makes clear, the output voltage is controlled by the time period that Q1 is off. In other words, the circuit is controlled by controlling the period during which Q1 is off.



NOTE: items in parentheses refer to the 220/240 V version.

Figure 2-20. Starting Circuit (Main Switching Circuit)

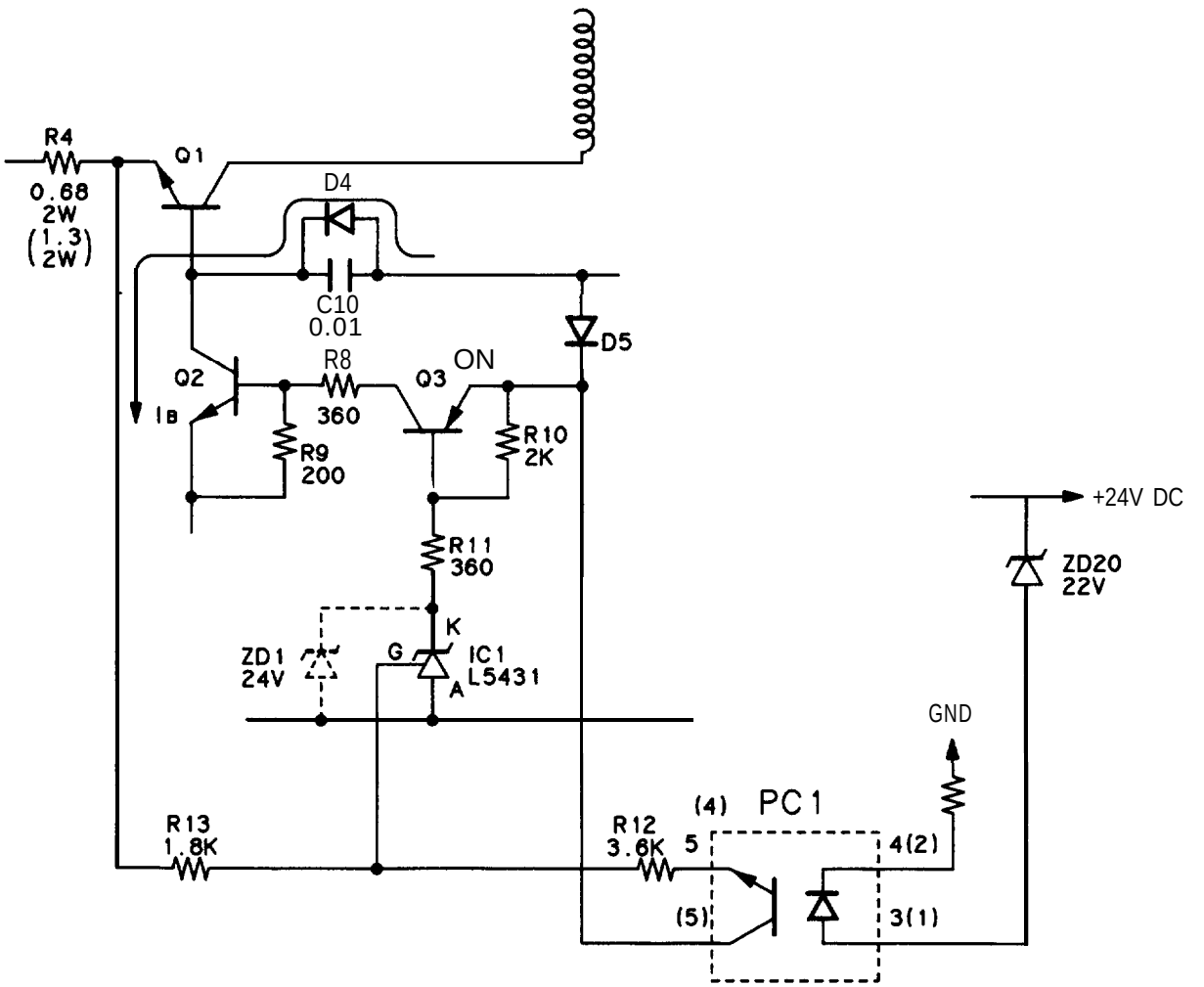


NOTE: Items in parentheses refer to the 220/240 V version.

Figure 2-21. Main Switching Circuit Waveforms

2.2.5 +24 VDC VOLTAGE CONTROL CIRCUIT

Figure 2-22 shows the + 24 VDC voltage control circuit. To maintain the correct voltage on the + 24 V line, the main switching transistor goes off if the voltage exceeds 24 V. If excess voltage occurs, reverse current flows through Zener diode ZD20, PC1 is activated, and the condition of the switching circuit is as shown in Figure 2-23.

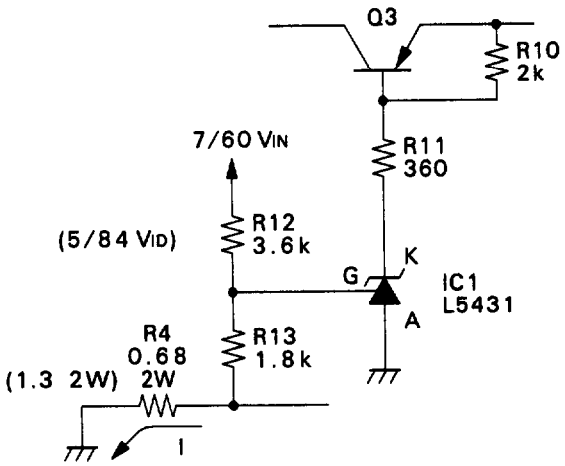


NOTE: Items in parentheses refer to the 220/240 V version.

Figure 2-22. +24 VDC Voltage Control Circuit

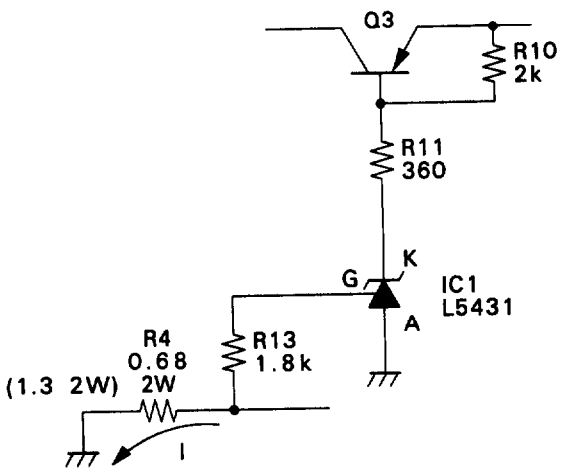
When PC1 is activated, the voltage at shunt regulator gap G reaches at least 2.5 V, K-A becomes a conductor, Q3 goes on, Q2 goes on, and shunt transistor Q1 goes off.

Even if PC1 is not activated, K-A will conduct if current I in the transformer's primary winding surpasses a certain value, creating a potential difference of at least 2.5 V across resistance R4. Resistance R4, in other words, serves as an excess current detector.



NOTE: Items in parentheses refer to the 220/240 V version.

Figure 2-23. Switching Circuit (During PC1 Operation)



NOTE: Items in parentheses refer to the 220/240 V version.

Figure 2-24. Over-Current Protection (OCP)

2.2.6 +5 VDC REGULATOR CIRCUIT

Figure 2-25 shows the + 5 VDC Regulator Circuit. The + 5 VDC is generated from the + 24 VDC by a chopper-type switching regulator circuit utilizing a TL494. Through pin 13 of the output control terminal, the TL494 can cause the IC to operate in either push-pull or parallel mode. In the illustration, pin 13 is LOW, and parallel action is in effect. In other words, the operation of the IC's two output transistors will be exactly alike.

The IC incorporates an internal oscillating circuit. The oscillating frequency is determined by the external inputs to pins 5 and 6. In this circuit, the frequency, set by R29 and C25, is about 27K Hz.

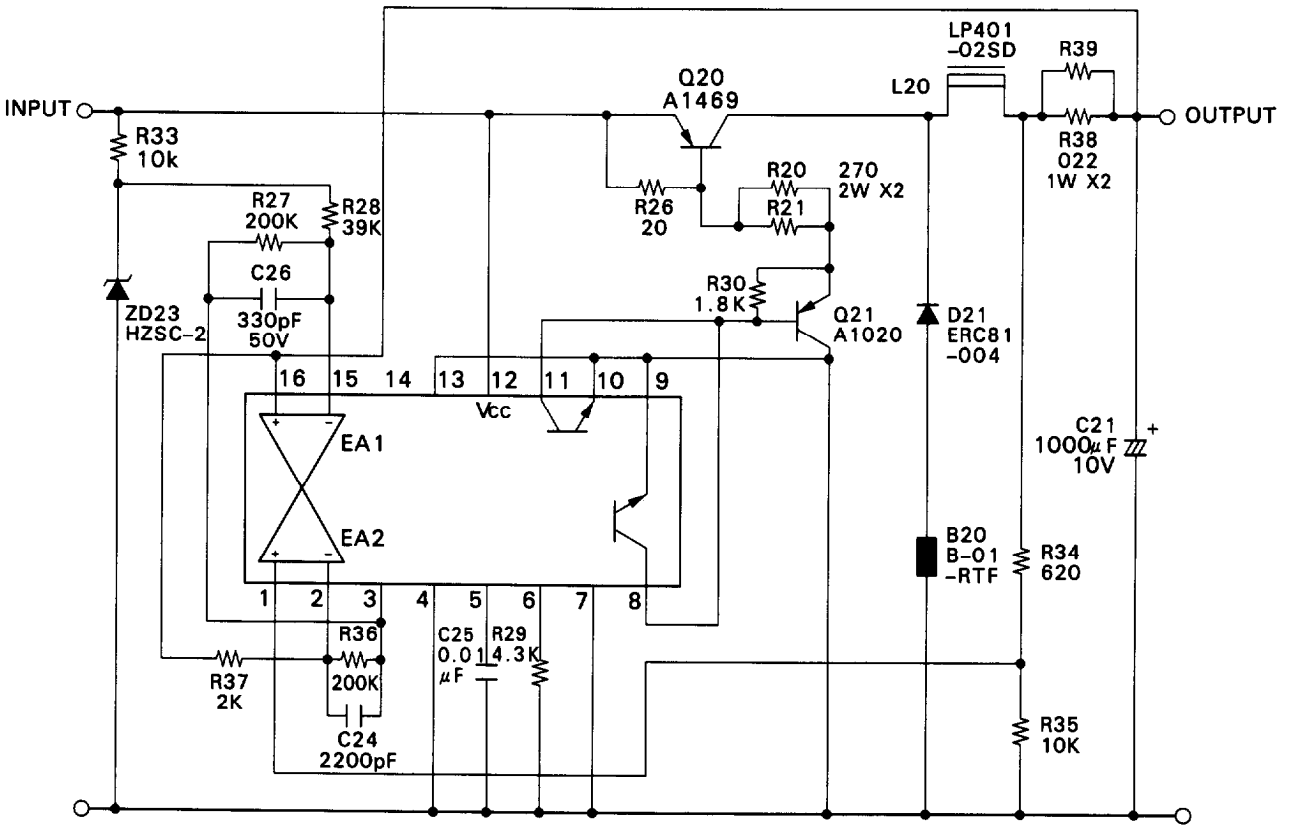
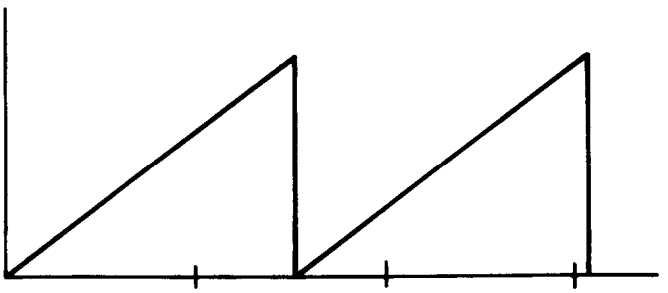


Figure 2-25. +5 VDC Regulator Circuit

EA1 and EA2 in the IC are error amplifiers. EA2 is used to detect the output voltage. Figure 2-27 illustrates the setting of the output voltage. The rated voltage of Zener diode ZD23 is 5 V. Accordingly, 5 V is input at the negative terminal of EA2.

The error amplifier works to bring the voltages at the positive and negative terminals into conformance. Voltage is output, when necessary, to bring the voltage at the positive terminal to 5 V.

Figure 2-28 shows the EA2 output conditions. If the voltage of pin 16 becomes higher than that of pin 15 (i.e., if over-voltage occurs), EA2 begins output. PWM is activated on the basis of the output level, and the circuit's output voltage is lowered. (Further details are provided subsequently.)



20µs/DIV

Figure 2-26. Oscillator Waveforms

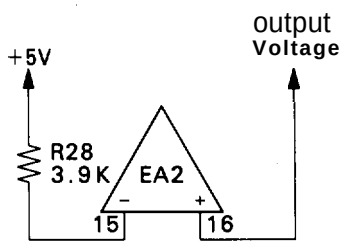


Figure 2-27. Constant Voltage Control

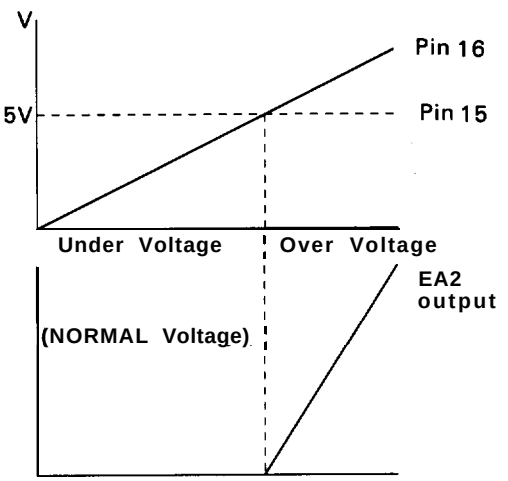


Figure 2-28. EA1 Output

EA1 is used to detect excessive output current. Figure 2-29 illustrates the mechanism. The output voltage is input to the negative terminal, and in order for equal voltage to appear at the positive terminal:

$$\frac{\text{(OUTPUT VOLTAGE)}}{\text{R35}} \times \text{R34/(R39 // R34)} = \text{I}$$

R35 becomes the load current flow (see Figure 2-29). In other words, higher current than this will trigger over-current protection, the output voltage will be reduced, and the current will, thereby, be restricted.

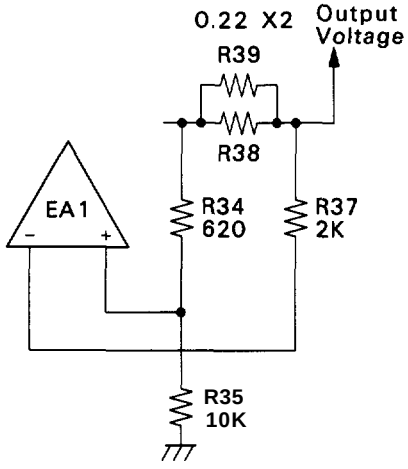


Figure 2-29. Over-Current Protection (OCP)

Pulse Width Modulation (PWM) Circuit

Figure 2-30 shows the internal circuit of the TL494lC. The output control (pin 13) is fixed at "L," and so the IC's internal push-pull circuit is never used.

The wired OR of the EA1 and EA2 outputs is input to the negative terminal of the PWM, a sawtooth waveform from the oscillator is input to the positive terminal, and the PWM modulated waveform is output as shown in Figure 2-31.

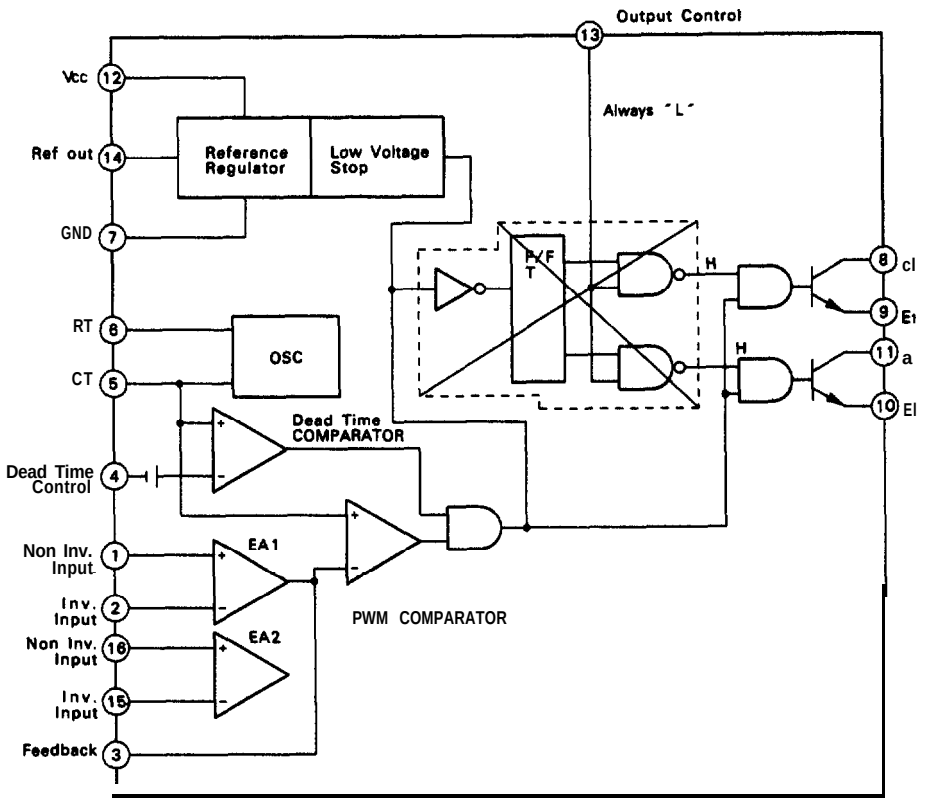


Figure 2-30. IC494 Internal Circuit

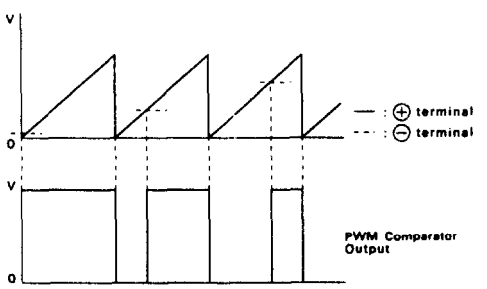
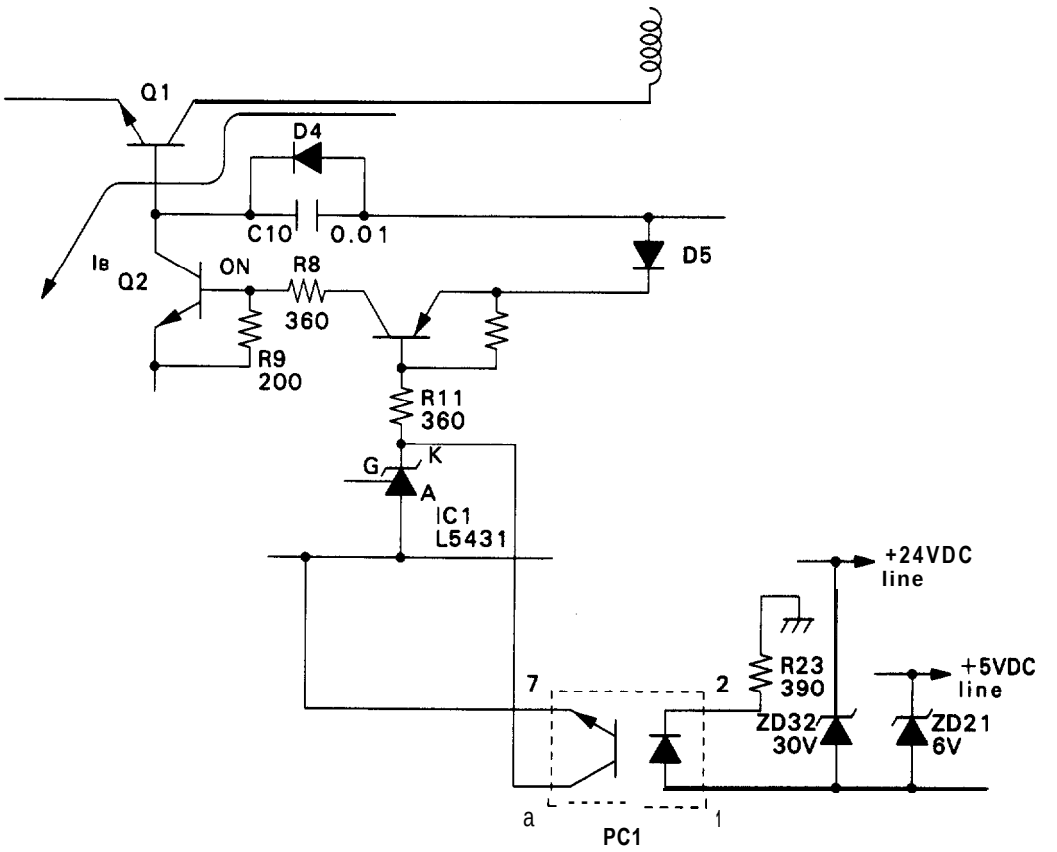


Figure 2-31. PWM Output

This circuit does not perform dead time control.

2.2.7 VOLTAGE LIMITING CIRCUIT

Figure 2-32 shows the voltage limiting circuit. In this circuit, switching transistor Q1 goes off if the voltage on the + 24 V line reaches about + 30 V, or if the voltage on 'the + 5 V line reaches about + 6 V. Zener diode ZD22 is used to detect abnormal voltage on the + 24 V line; Zener diode ZD21 is used on the + 5 V line.

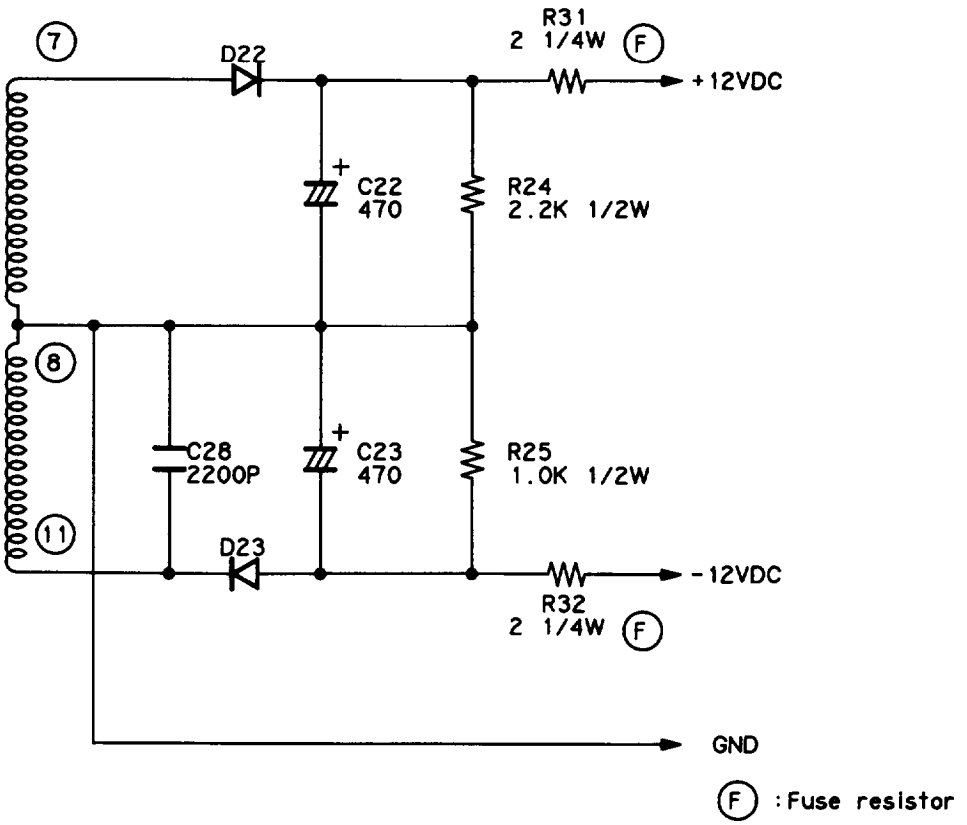


(120 V Version)

Figure 2-32. Voltage Limiting Circuit

2.2.8 ± 12 VDC SUPPLY CIRCUIT

The voltage from the transformer is rectified by D22 or D23, and + 12 VDC is produced. Theory suggests that load variations can cause large variations in the output voltage. In particular, output voltage may be quite high under no-load conditions. To prevent this problem, dummy resistors R24 and R25 are inserted into the circuit.



(120 V Version)

Figure 2-33. ± 12 VDC Supply Circuit

2.3 PRINTER MECHANISM AND CONTROL CIRCUIT OPERATION

This section describes the operation of printer mechanism and control circuit.

2.3.1 Vx VOLTAGE SUPPLY CIRCUIT

When the +24 V power supply line reaches 11.6 V (11 V + 0.6 V), transistors Q33 and Q34 turn on and Vx (+ 5 V) is output. On the other hand, if the 24 V power supply line drops to 11.6 V or less, Q33 and Q34 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 stabilizes.

- 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.

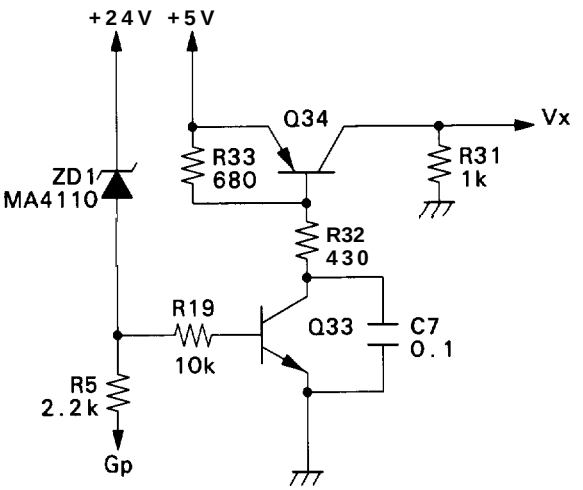


Figure 2-34. Vx Voltage Circuit

2.3.2 RESET CIRCUIT

Figure 2-35 shows the reset circuit. The $\overline{\text{RESET}}$ signal generated here is sent to the $\overline{\text{RESET}}$ terminal of CPU µPD7810HG (5B) and to connector CN2-13 (optional interface), and serves as a hardware initialization signal. The $\overline{\text{RESET}}$ signal is output from the circuit when any of the following occur:

a. Power is turned on or off.
b. A module (font or identity) is mounted or removed.
c. The CPU itself generates a reset.

Note that initialization can occur whenever the host computer sends an INIT signal.

d. The INIT signal is input from either the host interface or an optional interface.

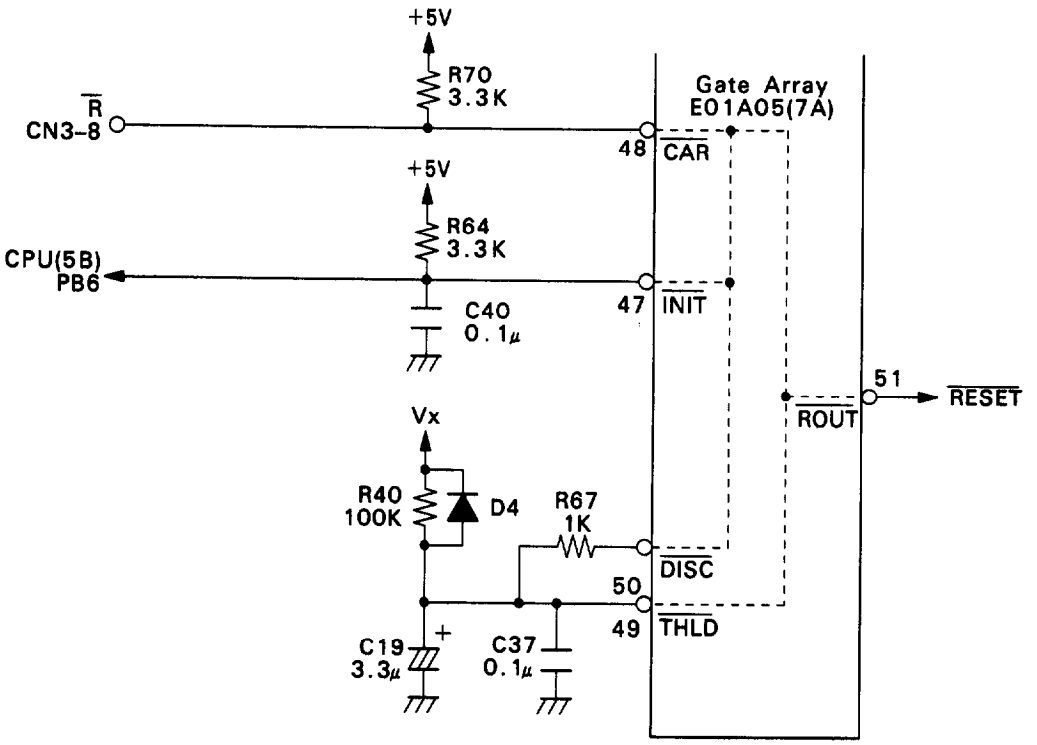


Figure 2-35. Reset Circuit

Power On or Off

D4, R40, and C19 in Figure 2-35 comprise an ON/OFF $\overline{\text{RESET}}$ circuit. The purpose of this circuit is to cause the CPU to start from address 0000 hex. when power is applied and to prevent CPU malfunctions when the power is switched off.

The rising edge of the Vx voltage cancels the $\overline{\text{RESET}}$ signal after a delay of time constant (R40 x C19), which is produced by the integration circuit of resistor R40 and capacitor C19. The falling edge of the Vx voltage activates a $\overline{\text{RESET}}$ signal by discharging capacitor C19 via diode D4.

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

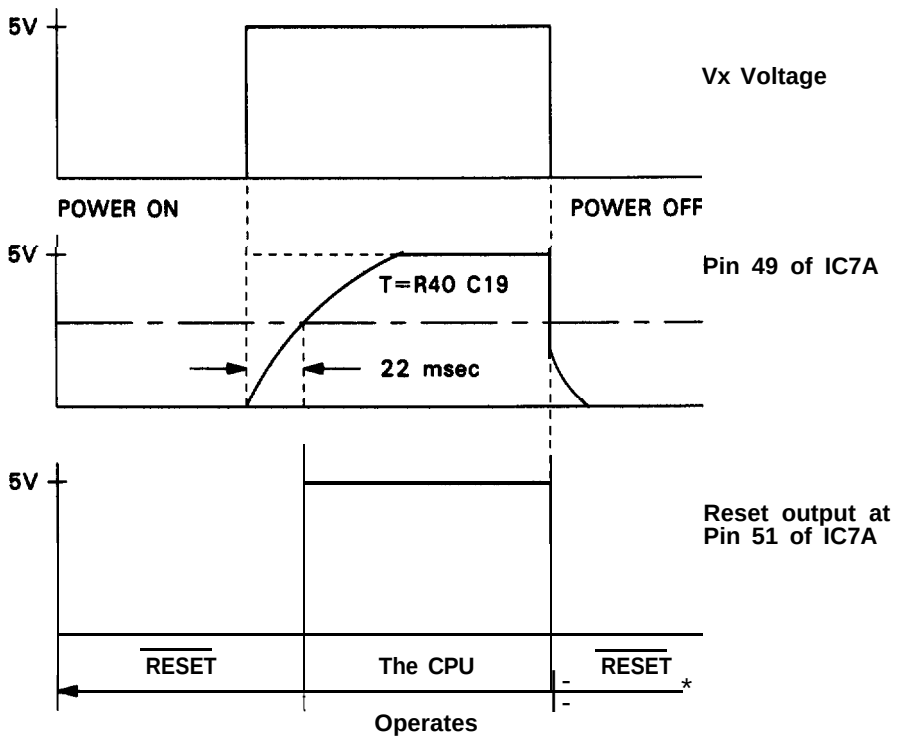


Figure 2-36. $\overline{\text{RESET}}$ Output

Module Installation or Removal

Figure 2-37 shows the $\overline{\text{RESET}}$ pulse-generation process that occurs when **a** ROM cartridge is mounted. The bracketed numbers below correspond to the circled numbers in the figure. After the ROM cartridge is mounted, the LOW signal flows into the $\overline{\text{CAR}}$ terminal of gate array (7A), **a** LOW signal is correspondingly output from the DISC terminal (1), and $\overline{\text{RESET}}$ is output from the $\overline{\text{ROUT}}$ terminal (2).

As the $\overline{\text{DISC}}$ terminal goes LOW, capacitor C19 is discharged with a time constant R67 x C19 (3). When the discharge of C19 reduces the potential at the $\overline{\text{THLD}}$ terminal to threshold voltage Vth, the $\overline{\text{RESET}}$ signal is canceled 4 , and the $\overline{\text{DISC}}$ terminal goes HIGH (5). After the DISC terminal goes HIGH, Vx voltage discharges C19 at time constant R40 x C19 (6).

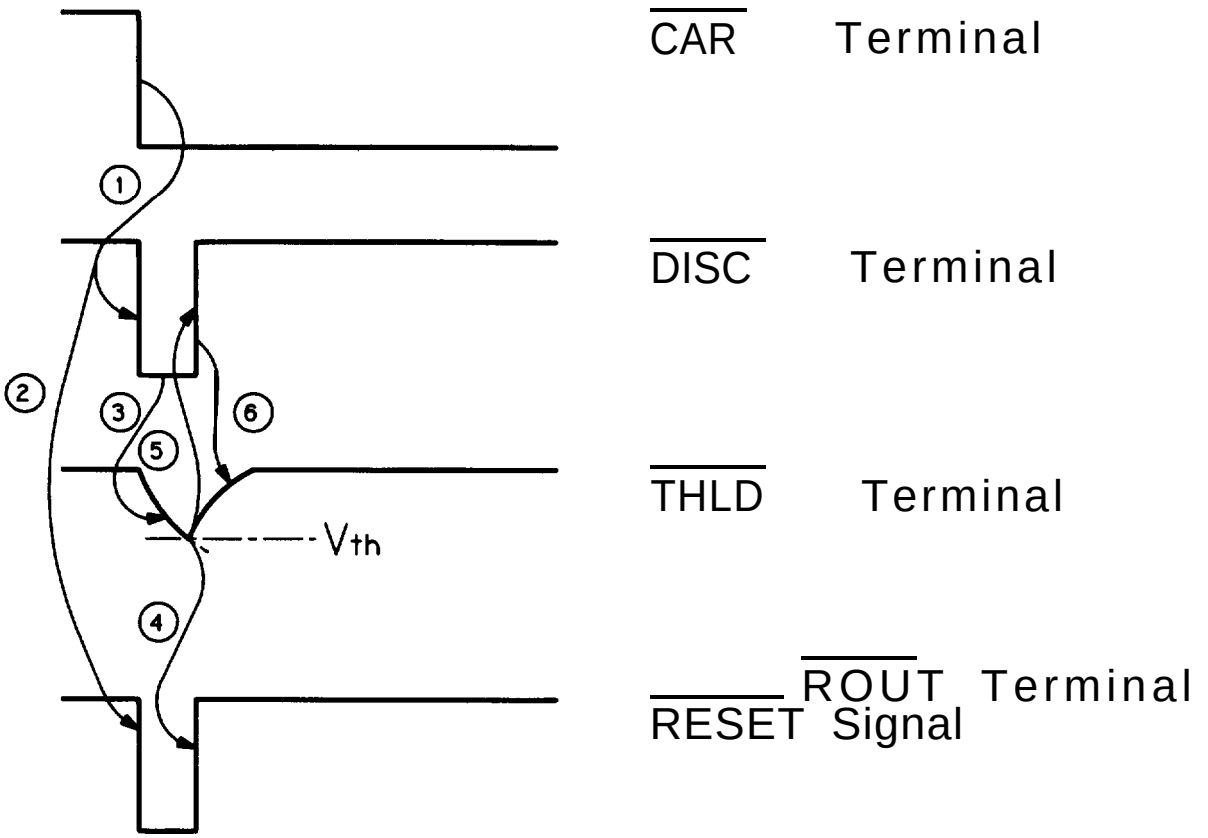


Figure 2-37. $\overline{\text{RESET}}$ Pulse Oscillation Process (Module Mounted)

When the ROM cartridge is removed (see Figure 2-38), the CAR terminal of the gate array (7A) receives a HIGH signal, the DISC terminal then outputs a LOW signal (1) and the ROUT terminal outputs a RESET signal (2). The remainder of the sequence is similar to that which occurs when a ROM cartridge is mounted; please refer to the preceding page.

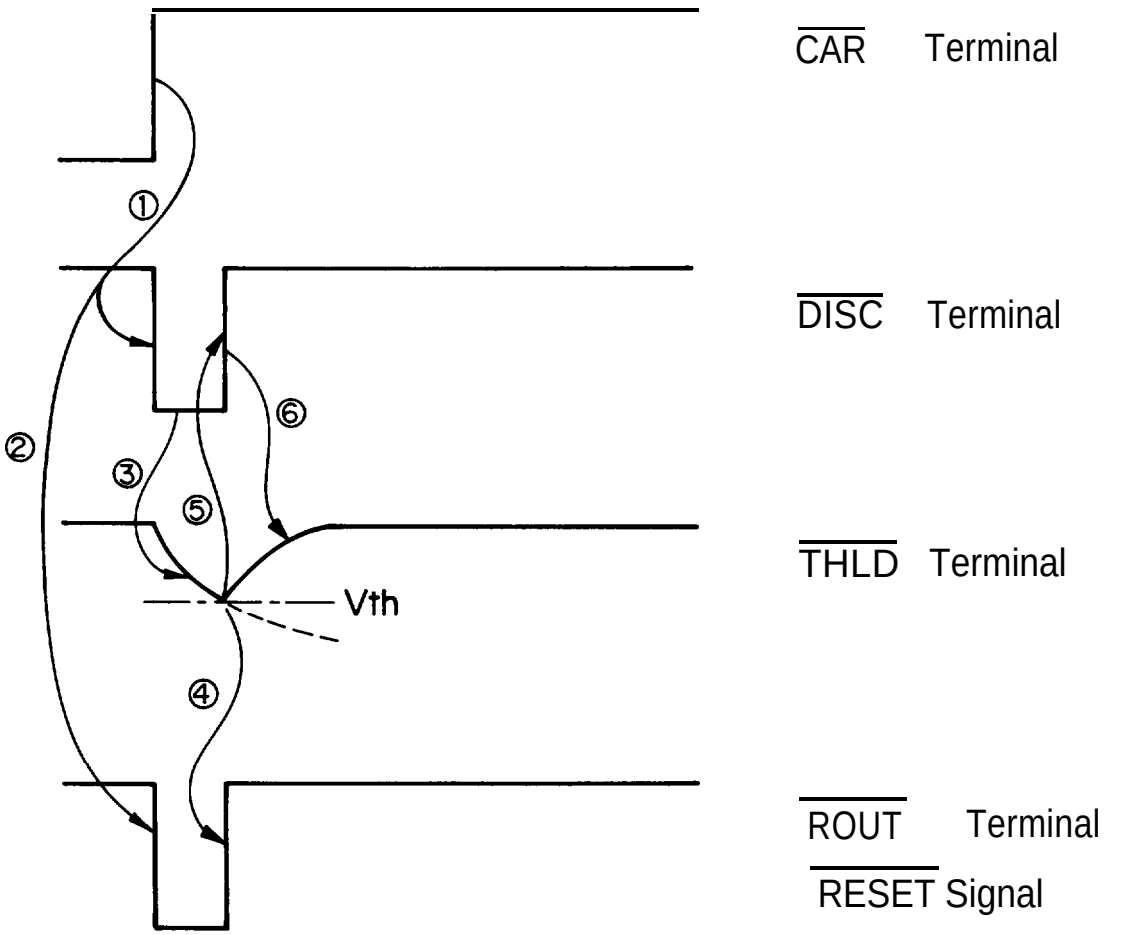


Figure 2-38. $\overline{\text{RESET}}$ Pulse Oscillation Process (Module Removed)

Reset Caused by CPU

A LOW signal from CPU port PB6 passes through the low-pass filter formed by R64 and C40 and inputs to pin 47 of the IC7A gate array. In the array, waveform shaping occurs and causes the $\overline{DISC}$ terminal to go LOW; the charge on capacitance C19 is then released, and terminal $\overline{THLD}$ of the gate array goes LOW. The reset signal is then output by the $\overline{ROUT}$ terminal.

INIT Signal Input (from CN1 or CN2)

When the INIT signal is input from either the host interface or optional interface, the CPU performs initialization. From the interface, the INIT signal passes through the low-pass filter formed by R62 and C9 and inputs to the NMI offering terminal of the CPU. The NMI offering terminal will also input the voltage of the +24 VDC line formed by Zener diode ZD2 and transistor Q32.

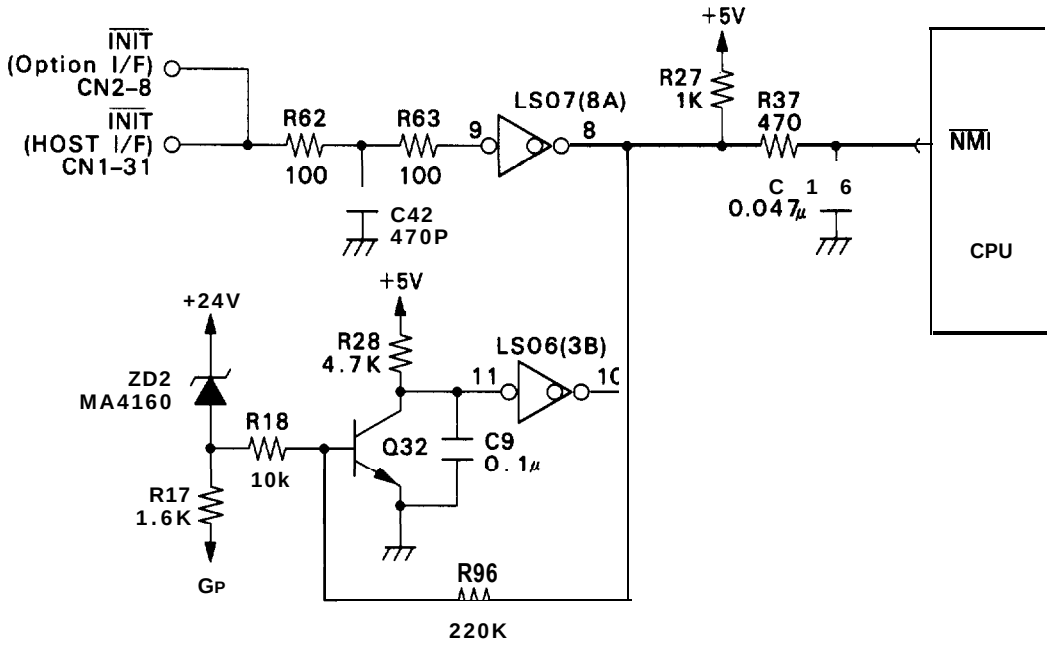


Figure 2-39. INIT Signal Input Circuit

2.3.3 ADDRESS DECODER AND BANK REGISTER

The passages below describe the address decoder and bank register.

Address Decoder

This unit includes an address decoder in gate array E01 A05 (7A). The address decoder outputs a chip-select signal to the internal PROM (6A), external PROM, 4MCG (3A), 1MCG (4A), external CG, RAM (5A), HEAD gate array (1A) via address lines AB12 through AB15 and bank lines 7 and 6 (in the gate array). The chip select for the CS, however, is generated in conjunction with the RD signal, and that of the RAM is generated in conjunction with the ALE signal.

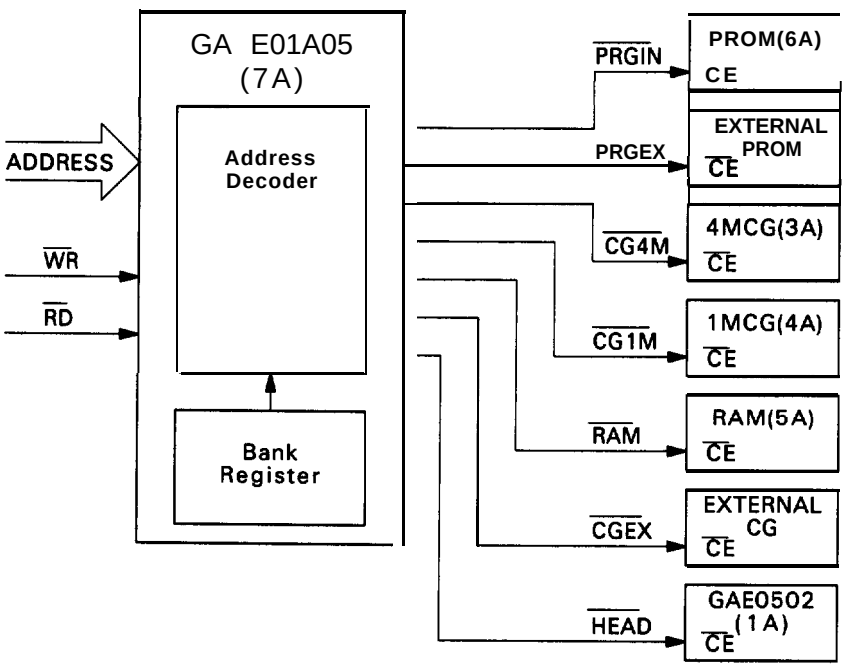


Figure 2-40. Address Decoder

Firmware performs a soft-type check to determine whether an external PROM is attached. If an external PROM is in place correctly, a LOW signal is sent to bit 7 of address F001 hex., enabling a switch-over to the external program.

Bank Register

This unit has a bank register in gate array E01A05 (7A). The bank lines are set by writing to address F002 hex., and can be checked by reading the same address.

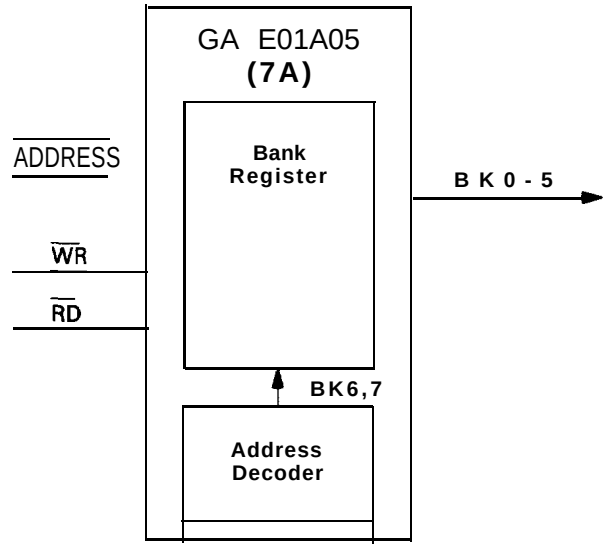


Figure 2-41. Bank Register

2.3.4 CARRIAGE OPERATION

This section describes the carriage.

2.3.4.1 Carriage Mechanism

The carriage mechanism includes the printhead, the carriage, the timing belt, the carriage motor, and the platen. Figure 2-42 shows the carriage mechanism.

The timing belt is connected into the bottom of the carriage. The 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.

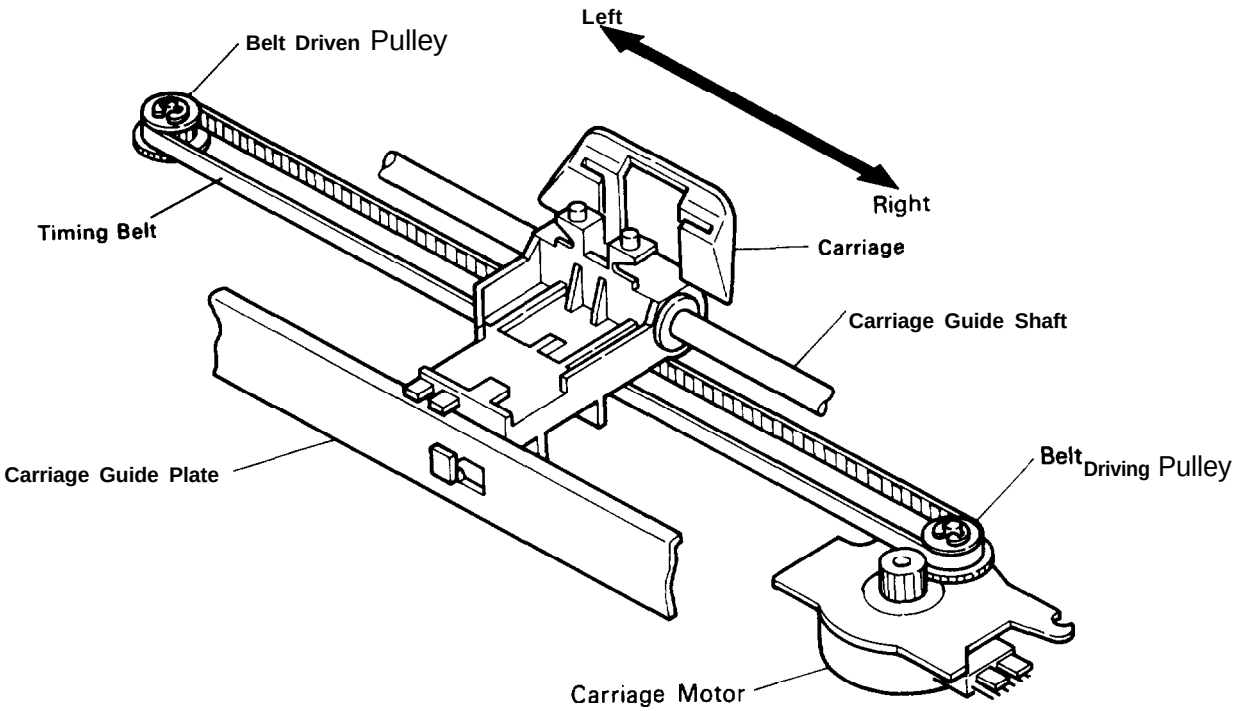


Figure 2-42. Carriage Mechanism

2.3.4.2 Carriage Motor Specifications

Specifications for the carriage motor are as follows:

Type	4-phase, 48-pole stepper motor
Drive Voltage	24 V ± 10%
Coil Resistance	36 ohms ± 7% at 77° F (25° 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: 0.05 A ± 20%

2.3.4.3 Carriage Drive Circuit Block Description

Figure 2-43 shows a block diagram of the carriage motor drive circuit. In this circuit, phase switching for the carriage motor is not directly executed by the CPU, but by the gate array (7A) using pulses from the CPU. SLA7020M is utilized to drive the carriage motor, using a stabilized current.

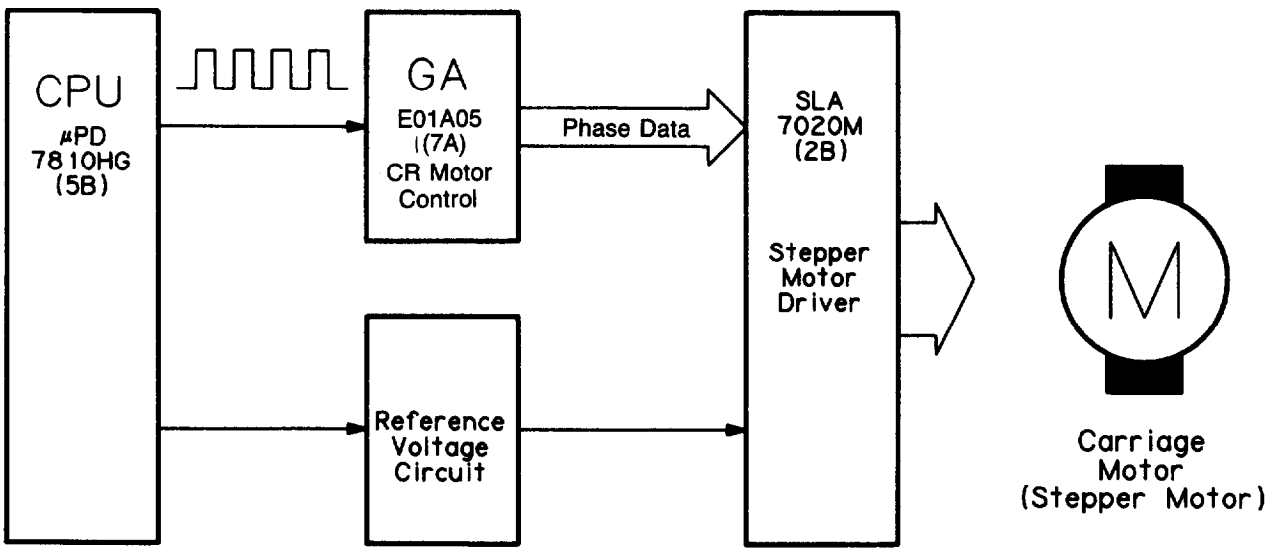
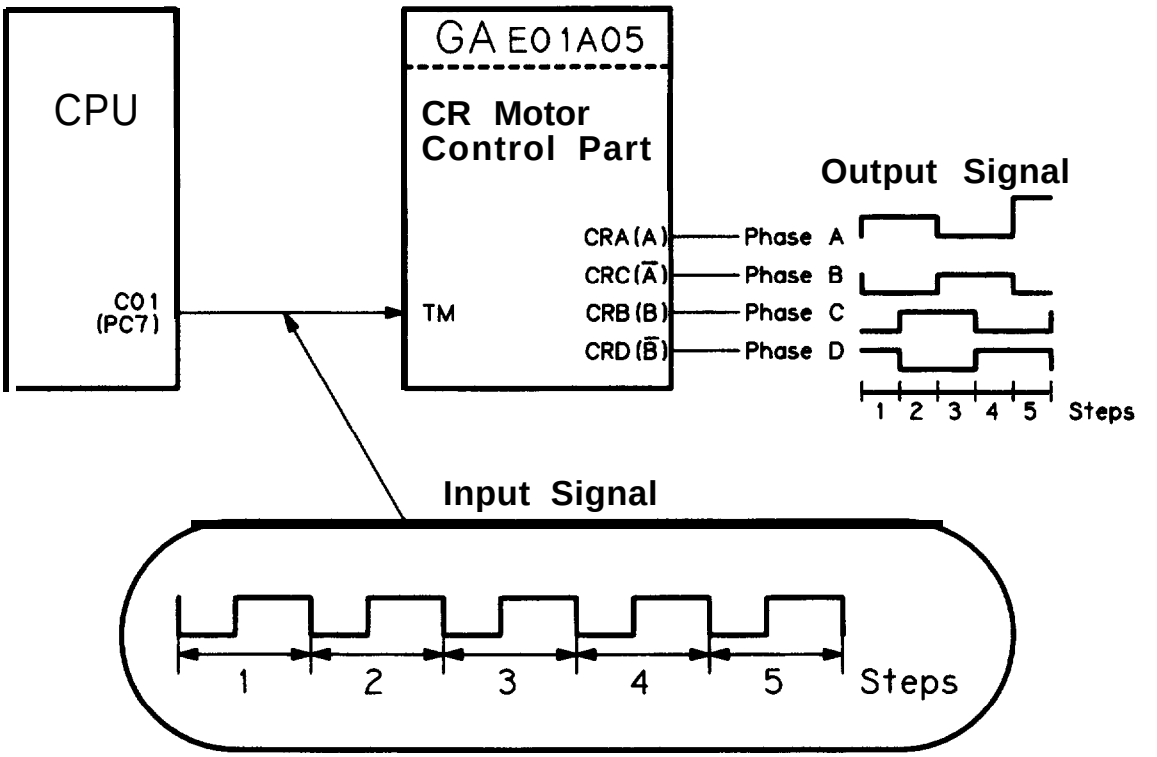


Figure 2-43. Carriage Drive Circuit Block Diagram

2.3.4.4 Gate Array E01A05 Operation in Carriage Drive Circuit

The phase switching for the carriage motor (stepper motor) is performed by gate array E01A05 (7A). 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, the array executes auto phase switching to drive the stepper motor. Figure 2-44 illustrates this process.



(For a 2-2 phase excitation setting)

Figure 2-44. Gate Array Operation

The carriage motor control port of the gate array is assigned to address F003 hex.

2.3.4.5 Carriage Motor Drive Circuit

This unit utilizes an SLA7020M IC for the stepper motor drive. This IC causes the motor to be driven at the specified current. The current value is determined by the value of the external voltage input. Within the IC, the AB (AA) phase and the CD (BB) phase are completely differentiated and create identical circuits. For convenience, only the AB (AA) circuit is explained below. Figure 2-45 shows the carriage motor drive circuit. Figure 2-46 shows the SLA7020M circuit diagram.

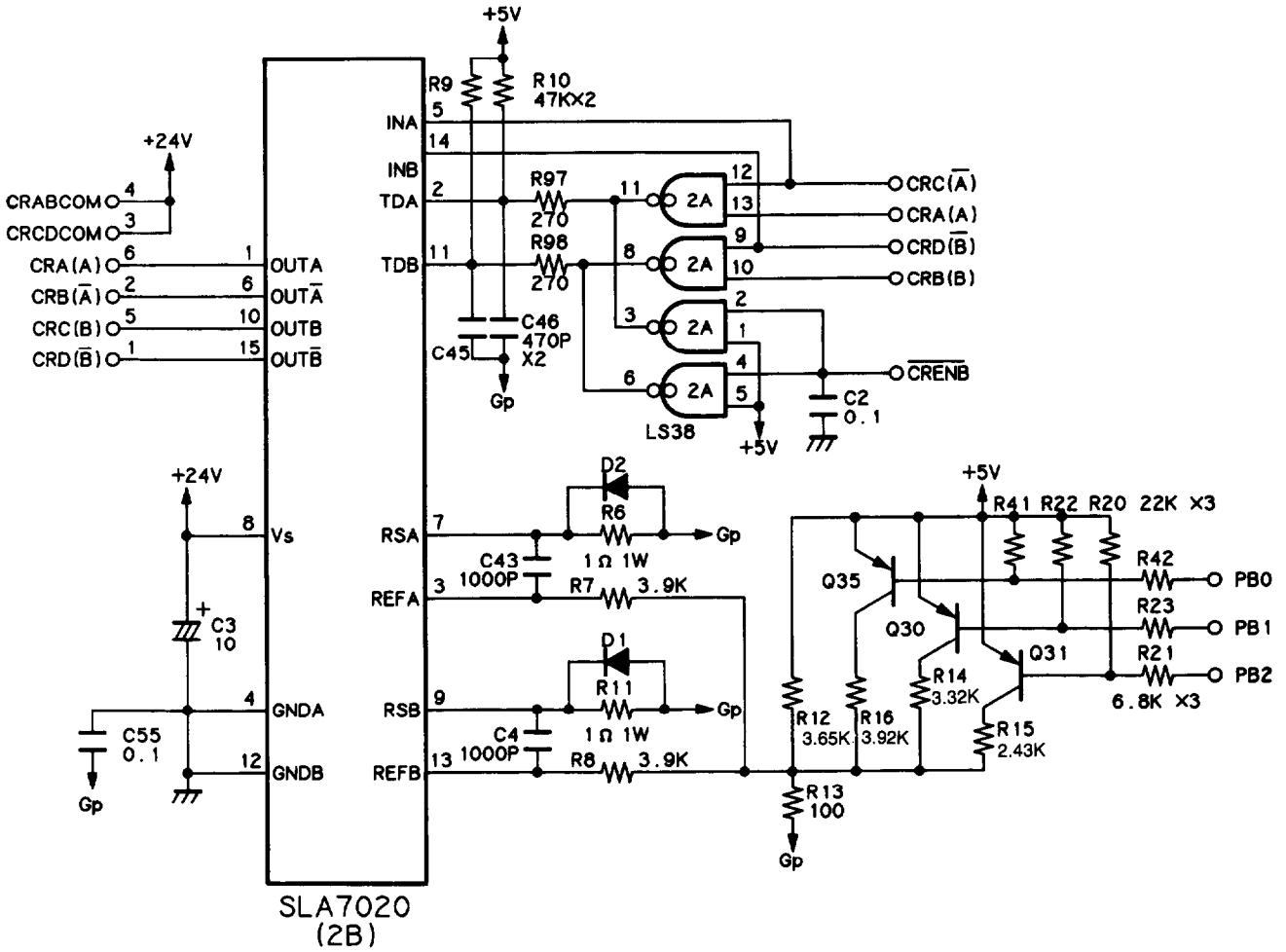
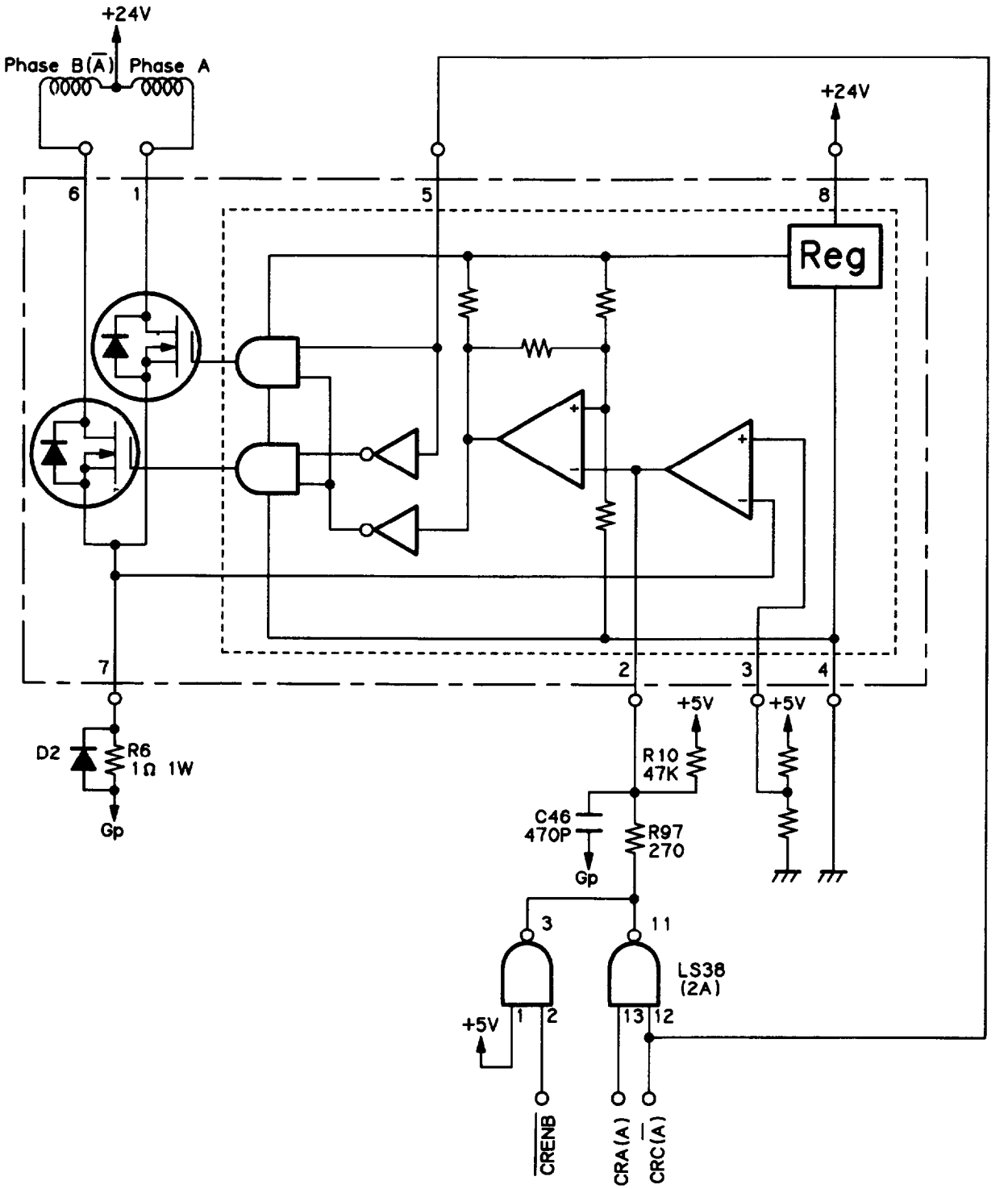


Figure 2-45. Carriage Motor Drive Circuit



NOTE: Phase CD is equivalent to the above.

Figure 2-46. SLA7020M Circuit Diagram

SLA7020M Phase Signal Input Circuit

Although most stepper-motor control ICs input four-phase data directly, the SLA7020M requires a special type of phase data. In the case of 2-2 phase excitation, Figure 2-47 shows the excitation signal input circuit.

The A-phase-side excitation signal input is via a single line. The output is divided among non-inverted A-phase output and k-phase output passed through an inverter. Therefore, the A-phase output side will be ON when the excitation input signal is HIGH. And the A-phase output side will be ON when the excitation input signal is LOW. Figure 2-48 shows the timing chart for 2-2 phase excitation.

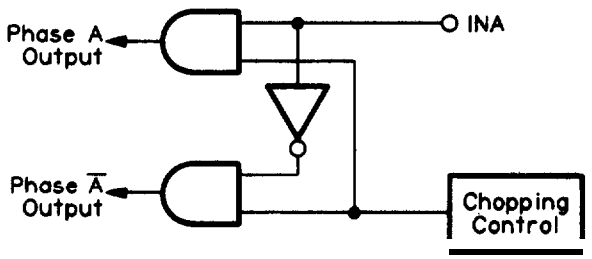


Figure 2-47. Phase Data Input Circuit (2-2 Phase)

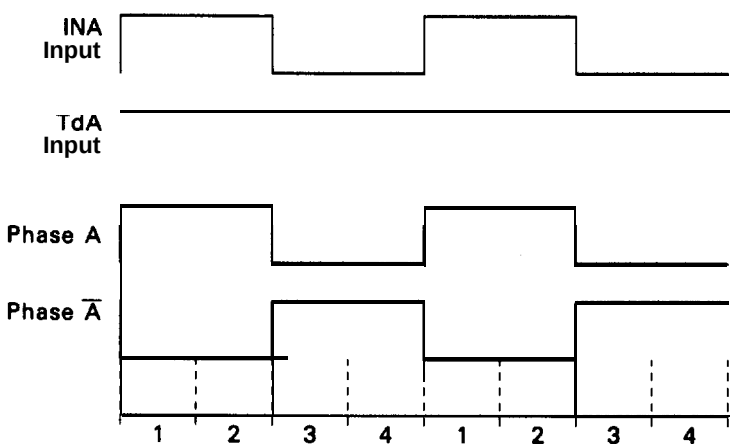


Figure 2-48. Phase Signal Timing Chart (2-2 Phase)

In the case of 1-2 phase excitation, Figure 2-49 shows the excitation signal input circuit. When the Td terminal is LOW, the SLA702M can cut off the output current. By using this function, the unaltered 2-phase excitation signal can cause the 1-2 phase excitation to be ON 3/8ths of the time, which is a suitable value. Figure 2-50 shows the timing chart.

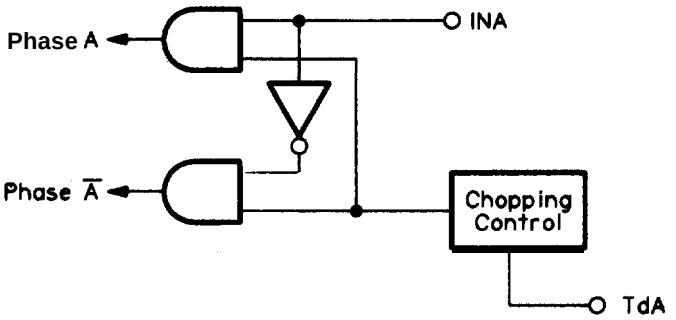


Figure 2-49. Phase Data Input Circuit (1-2 Phase)

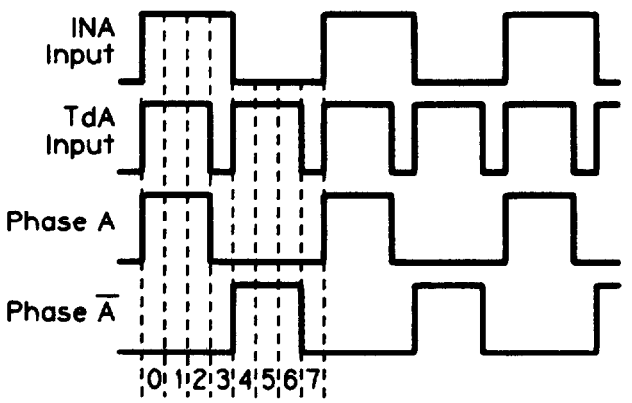


Figure 2-50. Phase Signal Timing Chart (1-2 Phase)

In order for this control to be performed easily, the circuit is constructed as shown in Figure 2-50. Further, if the $\overline{\text{CRENB}}$ signal is made HIGH, the Td terminal becomes LOW, and stepping of the motor is forced to stop.

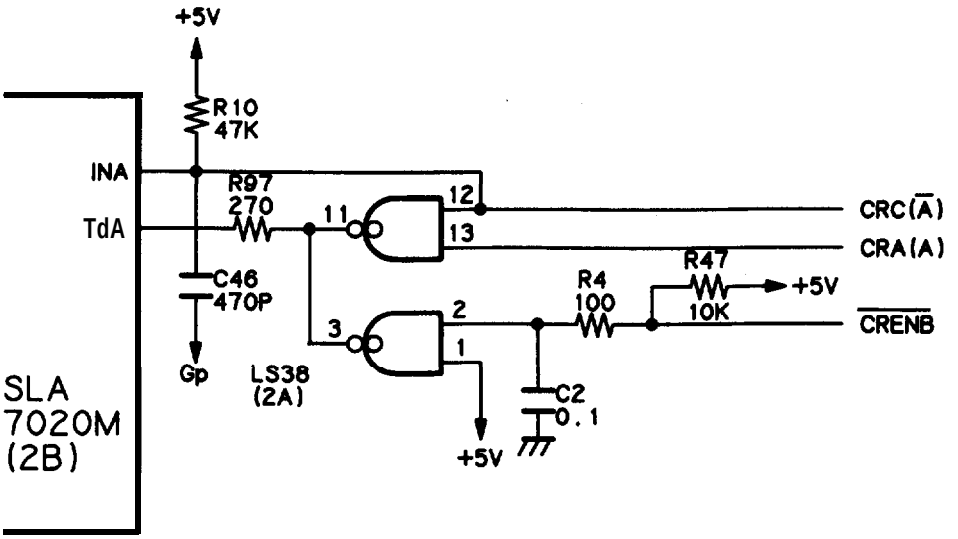


Figure 2-51. Phase Data Conversion Circuit

Reference Voltage Generation Circuit

Figure 2-52 shows the reference voltage generation circuit, and Table 2-3 shows the reference voltages. The SLA7020M drives the stepper motor based on current proportional to the reference voltages set here. There are four stages of reference voltage values (motor drive current values), and these are switched to correspond to the drive speed of the motor.

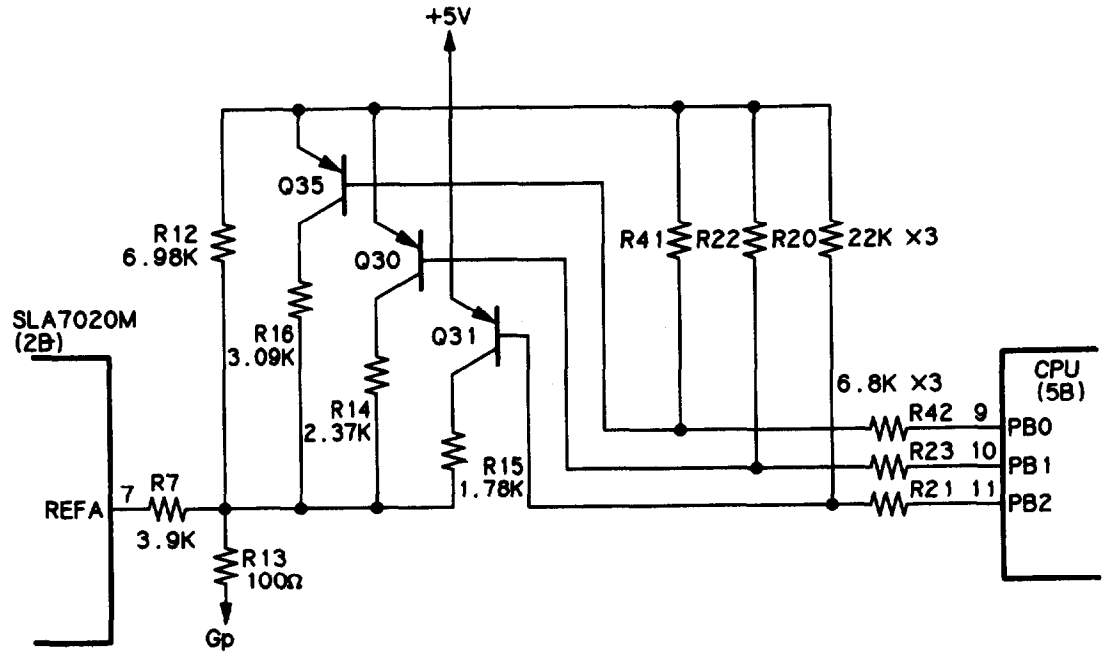


Figure 2-52. Reference Voltage Generation Circuit

Table 2-3. Reference Voltages

PB0	PB1	PB2	Reference Voltage
H	H	L	0.322 V
H	L	H	0.267 V
L	H	H	0.223 V
H	H	H	0.071 v

Constant Current Drive Circuit

The constant current drive circuit is shown in Figure 2-53 (for A-phase only), and the waveforms for each part are shown in Figure 2-54. In Figure 2-53, the reference voltage is indicated by VREF; this voltage determines the peak current through resistance R6. Resistance R10, and capacitance C46 determine the OFF time of the chopper.

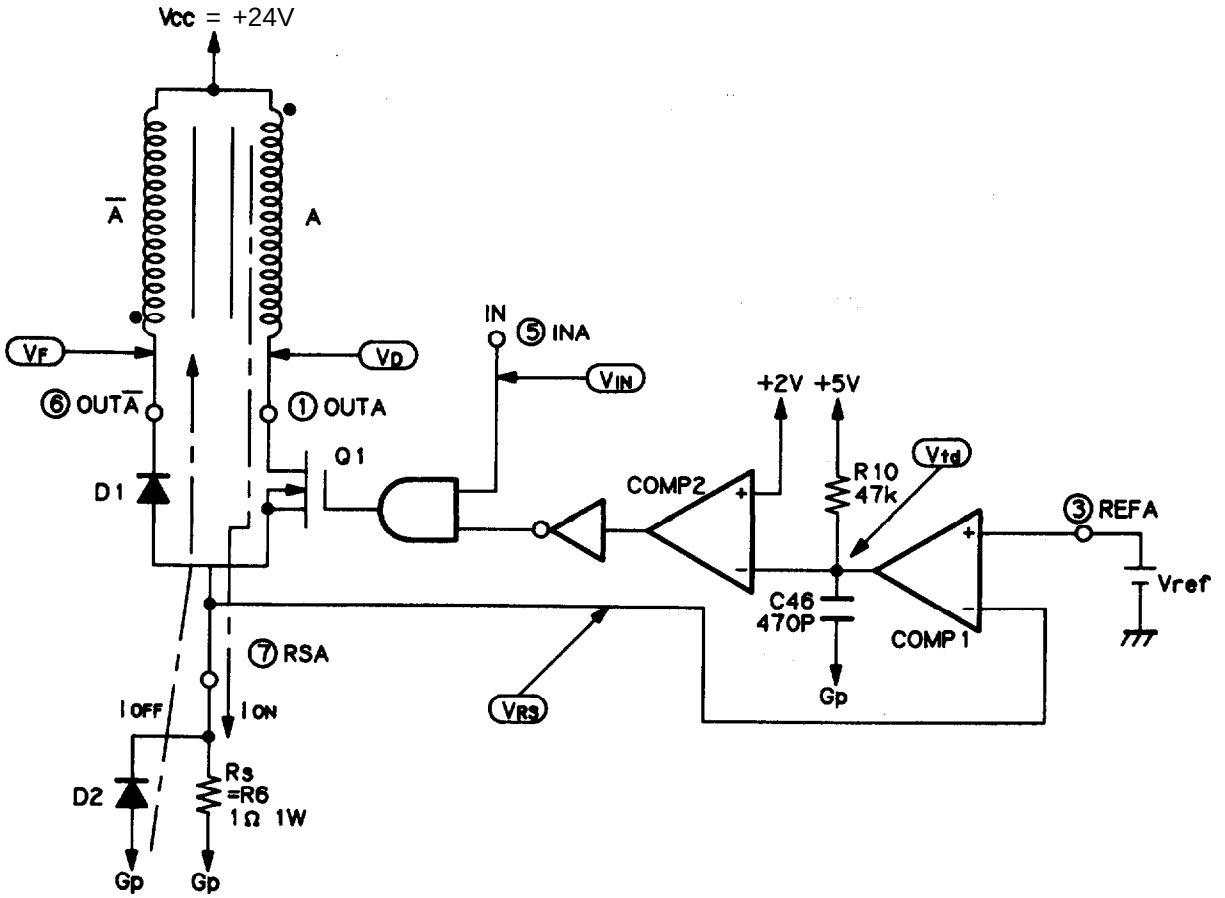


Figure 2-53. Constant Current Control Circuit

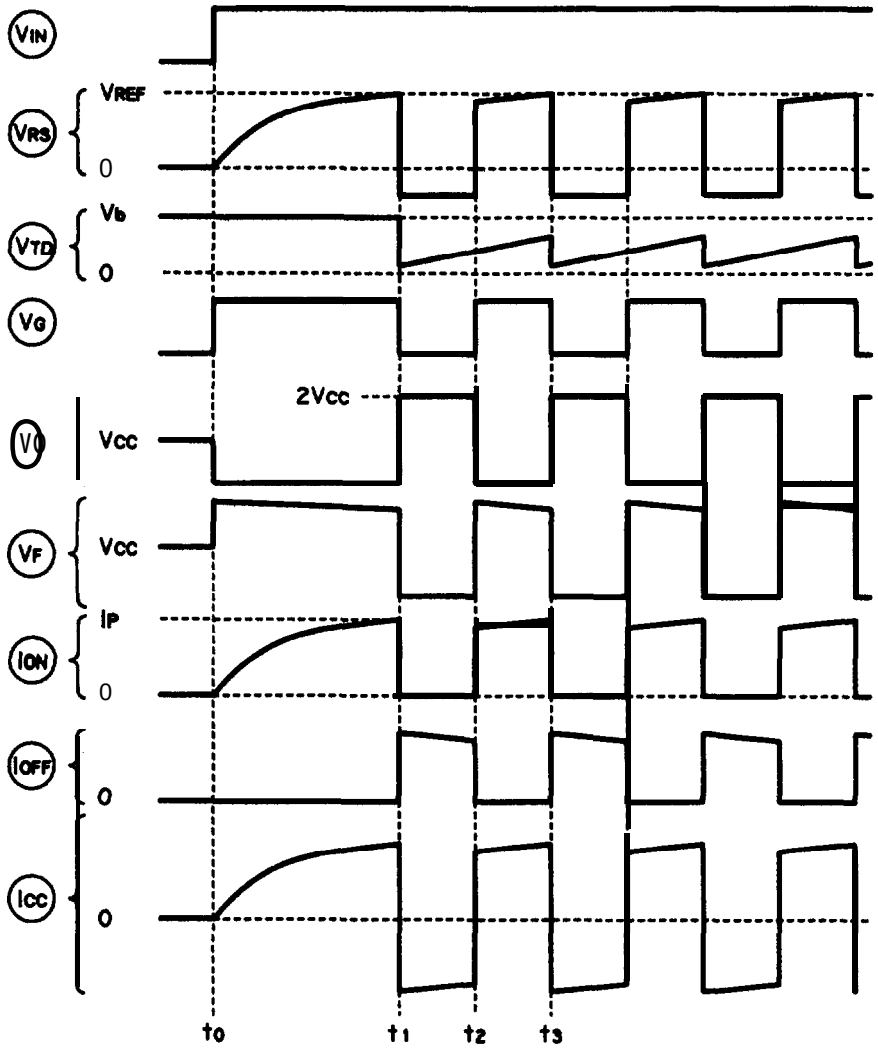


Figure 2-54. Waveforms

The circuit's constant current control process is shown above.

Peak Current Detection (to - t_1)

(1) When excitation input IN goes ON, so does MOSFET Q1. The A-coil excitation current I_{ON} then flows along the route shown by the solid line (-).
(2) As I_{ON} increases, so does the voltage at R6.
(3) When R6 voltage exceeds V_{REF}, COMP 1 inverts, and the T_D voltage falls to near zero.
(4) When V_{TD} drops below the COMP2 threshold voltage, COMP2 inverts.
(5) COMP2 inversion causes Q1 gate voltage to go LOW, and Q1 goes OFF.

Chopper OFF Time (t1-t2)

(6) When Q1 goes OFF, reverse potential is generated in the motor coil, causing the coil current route to switch from I_{ON} to I_{OFF}.
(7) I_{OFF} flow then causes current flow in R6 to change direction. COMP1 feedback voltage V_{RS} (V-) thereby drops below V_{REF}, and COMP1 again inverts.
(8) COMP1 output stages are formed by an open collector circuit. As a result of the inversion in step (7), COMP1 output goes HIGH, so that T_D voltage V_{TD} gradually rises, in line with the time constant determined by resistance R10 and capacitance C46.
(9) The MOSFET gate voltage is maintained at OFF until the value of the T_D voltage reaches the COMP2 reference voltage of 2 V.

The period above, during which V_{TD} is rising from 0 V to 2 V, is equivalent to T_{OFF}.

Chopper ON Time (t2-t3)

(10) When T_D voltage V_{TD} reaches the COMP2 reference value (2 V), COMP2 inverts, and Q1 goes on.
(11) When Q1 goes on, the current flow switches from I_{OFF} to I_{ON}.
(12) On the basis of the time content of motor coil A, I_{ON}, after a certain delay, gradually rises in response to power source voltage Vcc.
(13) As I_{ON} increases, R6 potential V_{RS} also increases. Until the value of V_{RS} reaches that of V_{REF}, Q1 remains on, supplying current I_{ON} from the power source to the motor.

The period in which V_{RS} advances toward V_{TD} is equivalent to T_{ON}.

2.3.4.6 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 2-4. The motor drive sequence for each excitation system is shown in Tables 2-5 and 2-6.

Table 2-4. Phase-Excitation Method

Carriage Speed		Phase-Excitation Method
x3	900 pps	2-2 Phase
x2	600 pps	2-2 Phase
x15	900 pps	1-2 Phase
x1	600 pps	1-2 Phase

pps = pulses per second

Table 2-5. 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 2-6. Drive Sequence (1-2 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	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	ON	OFF	OFF	ON	ON
6	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF
7	OFF	ON	OFF	ON	OFF	ON	ON	OFF
6	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.

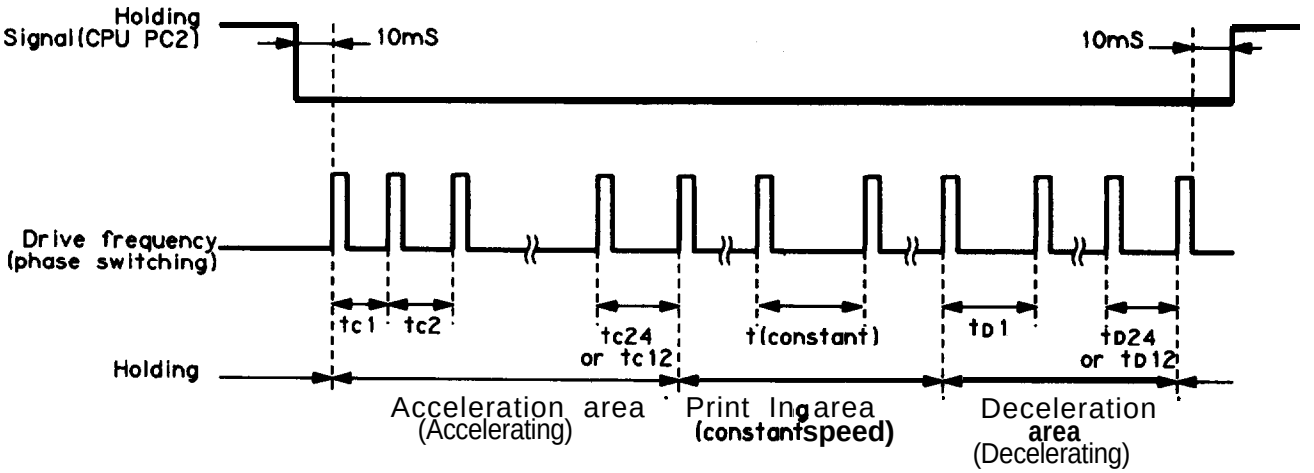


Figure 2-55. Carriage Motor Control

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 2-58 shows home-position seek operation.

When power is applied, the printer executes 2-2 phase excitation for 20 or 30 ms (regardless of the phase-switching timing) and checks the $\overline{\text{HOME}}$ signal. 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.

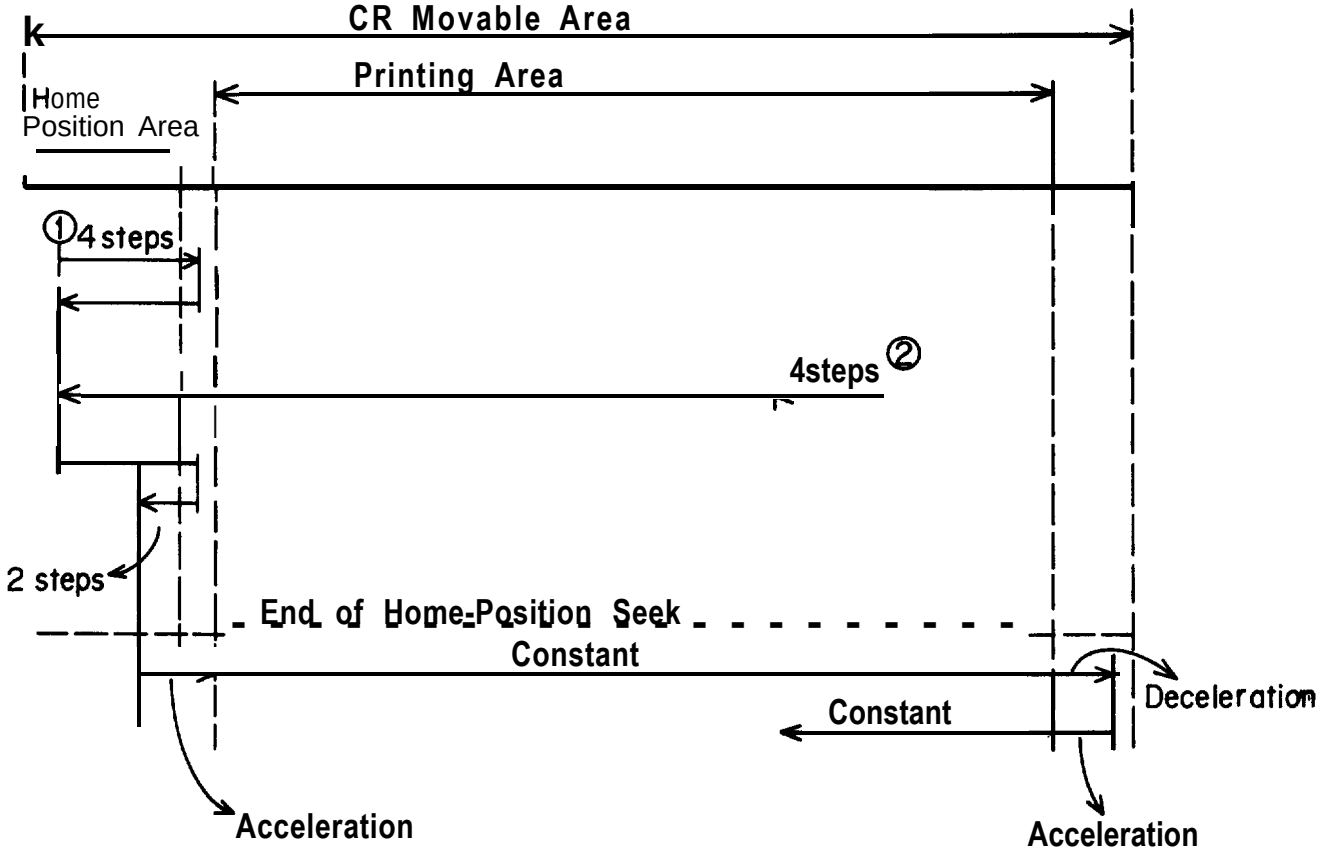
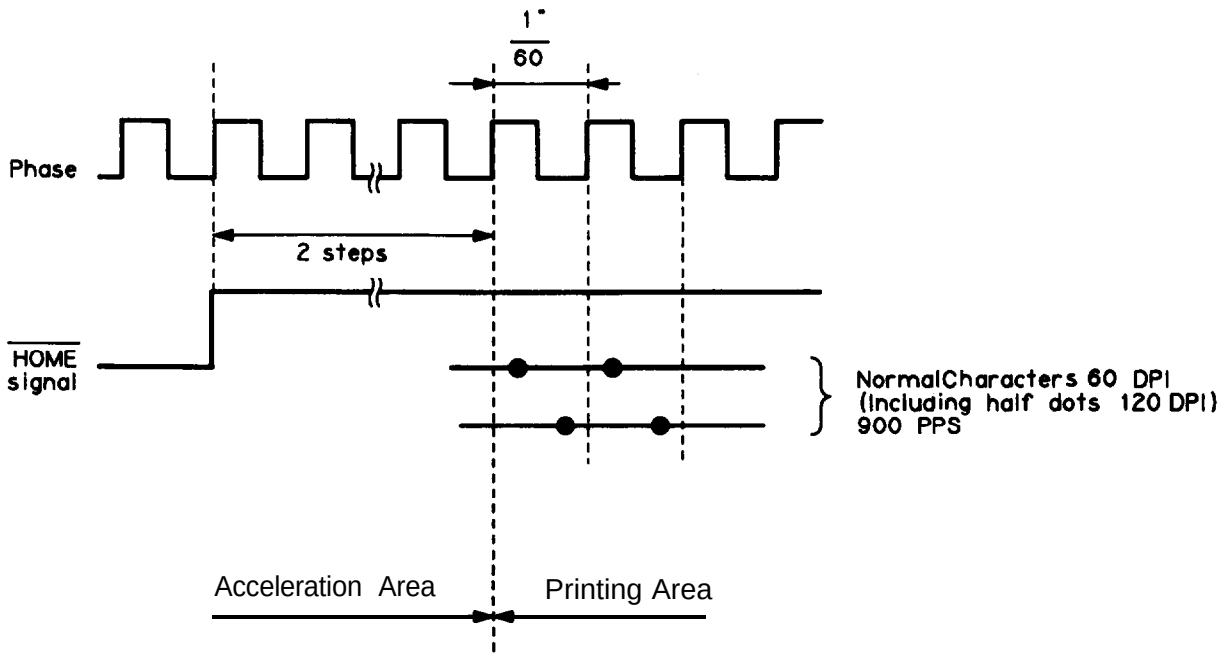


Figure 2-56. Home-Position Seek

Printing Area

The printing area is defined as starting 23 phase-switching times following the home position.



NOTE: pps = pulses per second
dpi = dots per inch

Figure 2-57. 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 occurs if the $\overline{\text{HOME}}$ signal is received in the printing area, in which case the carriage stops.

2.3.5 PAPER FEED

This section describes the paper-feed operation.

2.3.5.1 Paper-Feed Mechanism Operation

The paper-feed mechanism operates by friction feed for cut sheets and by the push tractor 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. The paper-feed motor is driven to rotate the platen gear, via the paper-feed reduction gear, in the direction shown in Figure 2-58. The rotation of the platen gear feeds the paper in the direction of the arrow, as a result of 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.

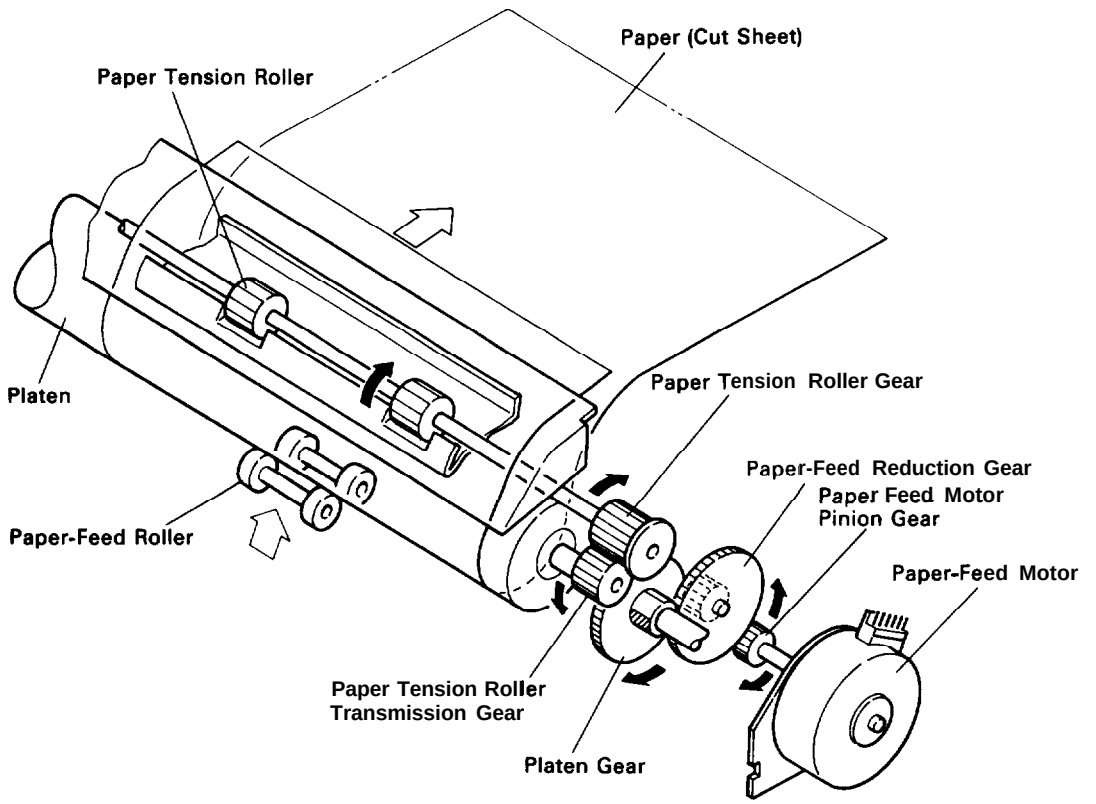


Figure 2-58. Friction-Feed Operation

Push-Tractor-Feed Operation

When the push tractor unit is used, paper is loaded so that its holes mesh with the tractor pins along the tractor belt. The paper-feed motor is driven and (via the pinion on the motor shaft) rotates the gears in the direction shown in Figure 2-59, rotating the tractor belts. This causes the tractor belt to move, and the paper advances in the direction indicated by the arrow. When push-tractor feeding is used, the pressure of the paper-feed rollers against the platen is released **by** moving the paper-release lever to its forward setting.

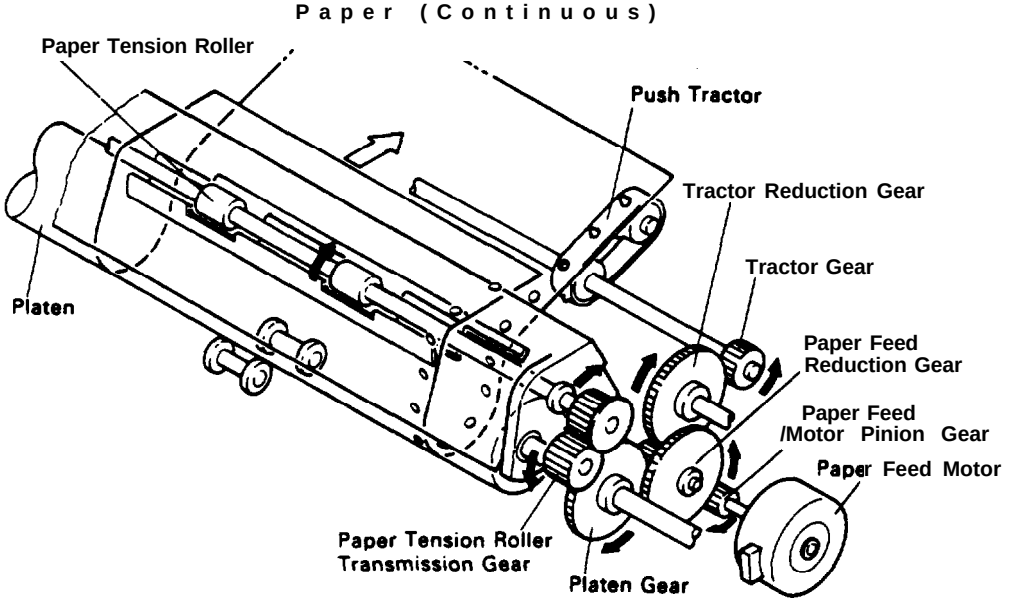


Figure 2-59. Push-Tractor-Feed Operation

2.3.5.2 Paper-Feed Motor Specifications

Paper-feed motor specifications are as follows:

Type	Four-phase, ± 48-pole stepper motor
Drive Voltage	24 VDC ± 10%
Coil Resistance	40 ohms ± 7% at 77°F(25°C)
Phase Excitation	2-2 phase or 1-2 phase excitation
Current	Maximum, 1.1 A (rush current) Driving: 0.30 A typical Holding: 0.06 A ± 20 mA
Driving Frequency	400pps

2.3.5.3 Paper-Feed Motor Drive Circuit

The paper-feed motor drive circuit is shown in Figure 2-60. The paper-feed motor is a stepper motor that can utilize either 2-2 phase or 1-2 phase excitation. When paper-feed signal PA4 is set to LOW, Q27 is turned on, and +24 V is supplied to the motor. When the paper-feed motor is not driven, +5 V is supplied, via resistor R30 and diode D3, to hold the motor.

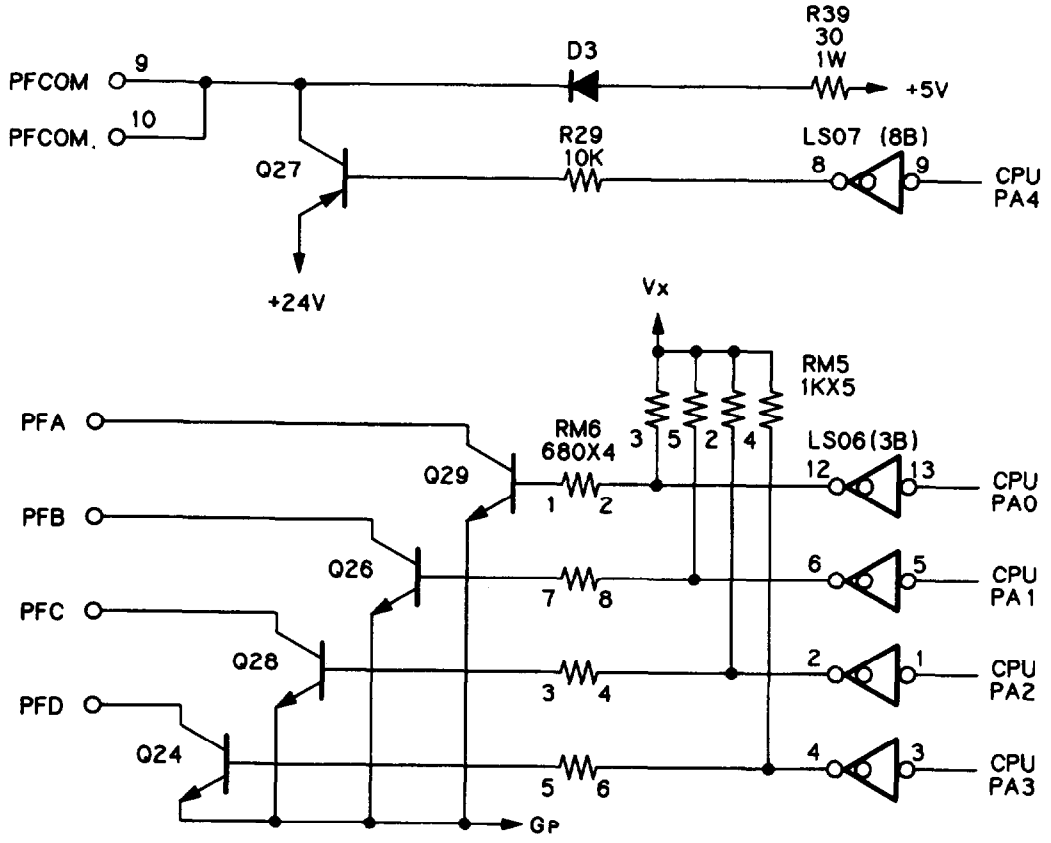


Figure 2-60. Paper-Feed Motor Drive Circuit

2.3.5.4 Paper-Feed Motor Software Control

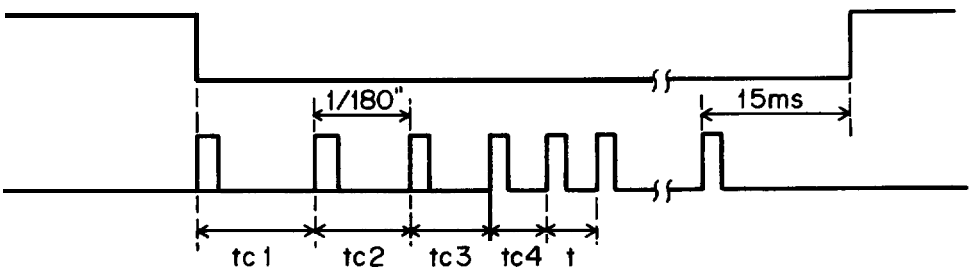
A four-phase, 48-step open-loop controlled motor is used to drive paper feeding. A 2-2 phase excitation is normally used for this printer, under which a one-step phase change drives the paper a distance of 1/180 inch. The 1-2 phase excitation is used only when it is necessary to achieve a drive distance of 1/360 inch. Table 2-7 shows the paper-feed motor excitation system.

Table 2-7. Excitation Sequence
(Clockwise: Paper Feeds Forward, 2-2 Phase Excitation)

Step No.	PA0	PA1	PA2	PA3	Phase A	Phase B	Phase C	Phase D
0	H	L	H	L	ON	OFF	ON	OFF
1	H	L	L	H	ON	OFF	OFF	ON
2	L	H	L	H	OFF	ON	OFF	ON
3	L	H	H	L	OFF	ON	ON	OFF

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

Figure 2-61 shows the paper-feed motor drive timing chart.



(For 2-2 phase excitation)

Figure 2-61. Paper-Feed Motor Drive Timing Chart

NOTE: If there are fewer than 10 steps, the speed does not change.

2.3.6 Printhead

This section describes printhead operation.

2.3.6.1 Printhead Printing Operation

Dot-wire operation during printing is as follows: when the head-driving coil for a dot wire is energized, the actuating plate (which is engaged to one end of the dot wire) is attracted to the iron core, and drives the dot wire toward the platen. The dot wire forcefully pushes both ribbon and paper against the platen to print a dot in the paper.

When the head-driving coil is de-energized, the actuating plate spring causes the actuating plate to return to its initial position. After striking the platen, the dot wire also returns to its initial position, partly in response to the impact energy, and partly as **a** result of the wire-resetting spring. The dot wire then remains engaged to the actuating plate until it is driven again. Figure 2-62 illustrates the printhead printing operation.

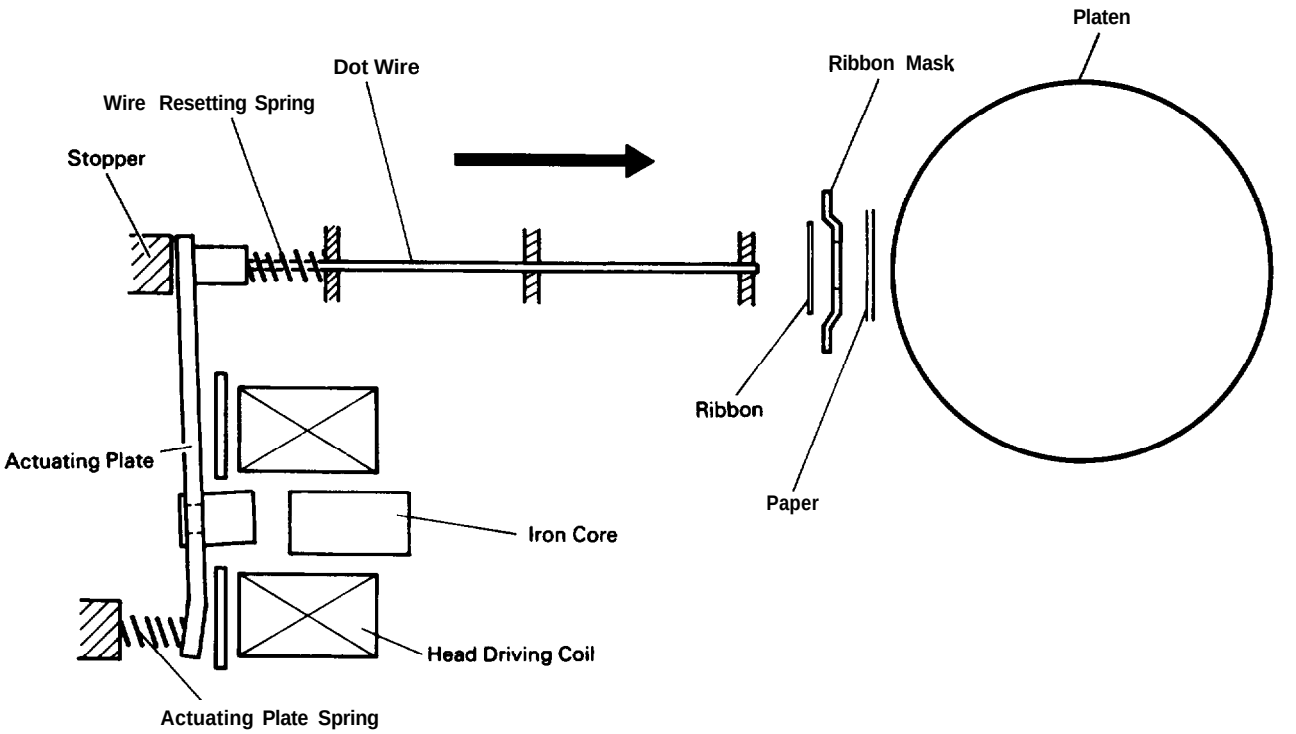


Figure 2-62. Printhead Printing Operation

2.3.6.2 Printhead Specifications

Printhead specifications are as follows:

Solenoids	24 solenoids
Wire Diameter	0.20 mm
Pin Arrangement	12 x 2, staggered
Drive Voltage	24 VDC ± 10%
Coil Resistance	19.1 ± 1.0 ohms at 77° F (25° C)

2.3.6.3 Printhead Drive Circuit Block Diagram

Gate array E05A02 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 E05A02 by monitoring the printhead drive power (+ 24 V line). The CPU also monitors the printhead temperature and suspends printing if the temperature becomes too high.

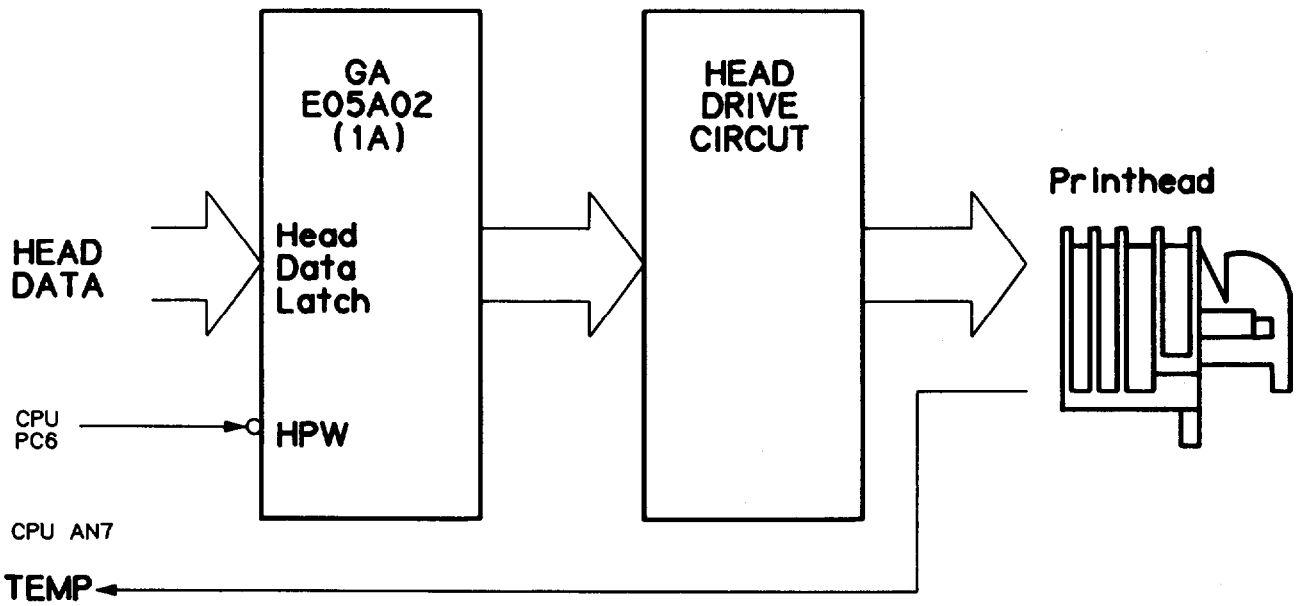


Figure 2-63. Printhead Drive Circuit Block Diagram

2.3.6.4 Gate Array E05A02 Operation in Printhead Drive Circuit

The E05A02 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 outputing printhead data.

The gate array consists mainly of an 8-bit x 3 = 24-bit data latch. The gate array has functions (commands) for writing data to all 24 bits of the data latches efficiently. Because the CS terminal of this gate array is activated by accessing address F004 hex. and F005 hex., the command output address and data output address are determined as shown in Table 2-8.

Table 2-6. E05A02 Gate Array Functions

Address (Hex.)	Function
F004	Outputs a command: Bit 7: Data latch writing sequence set-up 0: Ascending order 1: Descending order Bit 6: HPW valid/invalid setting Bit 5: Counter resetting Bit 4 to Bit 0: Optional
F005	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 HPW is valid as a command, the latched head data is inverted, then output while HPW is LOW.

NOTE: When the $\overline{\text{HPW}}$ setting is invalid, $\overline{\text{HPW}}$ output is in the open-drain ON state, independent of the $\overline{\text{HPW}}$ input. The drive pulse is input to the $\overline{\text{HPW}}$ terminal.

2.3.6.5 Printhead Drive Circuit

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

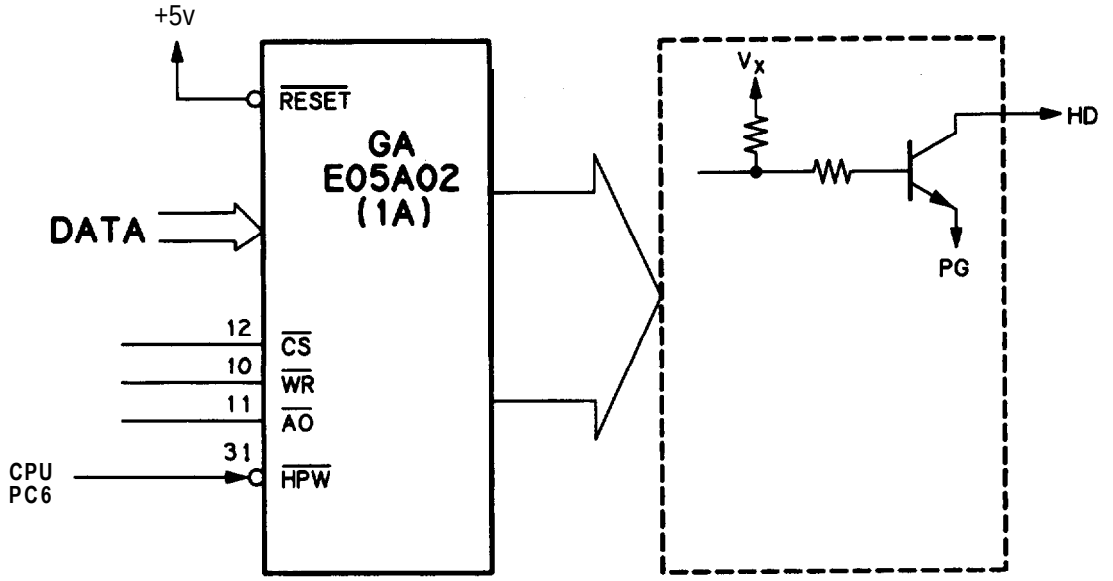


Figure 2-64. Printhead Drive Circuit

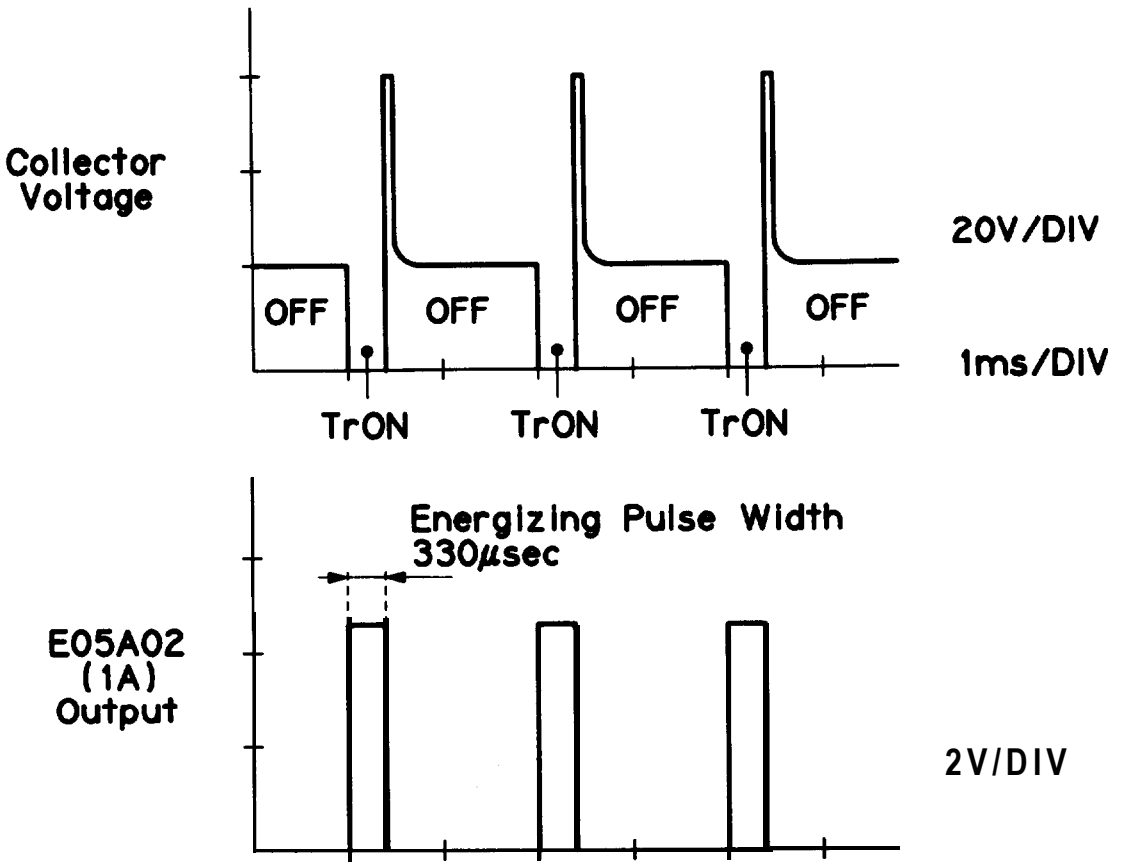


Figure 2-65. Printhead Driving Waveforms

2.3.6.6 Printhead Software Control

During operation at 900 pulses per second (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 2-67.

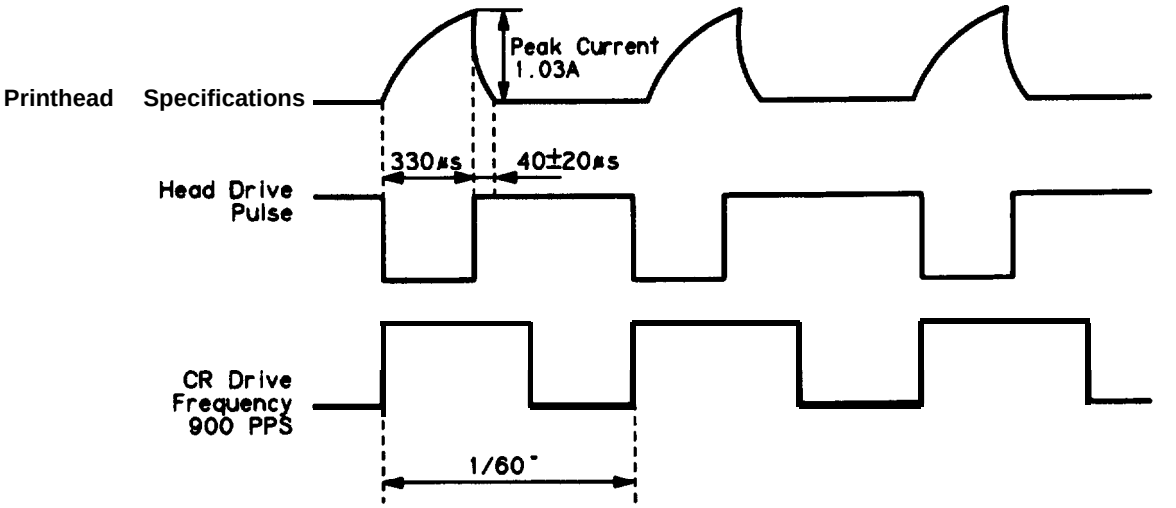


Figure 2-66. Print Timing

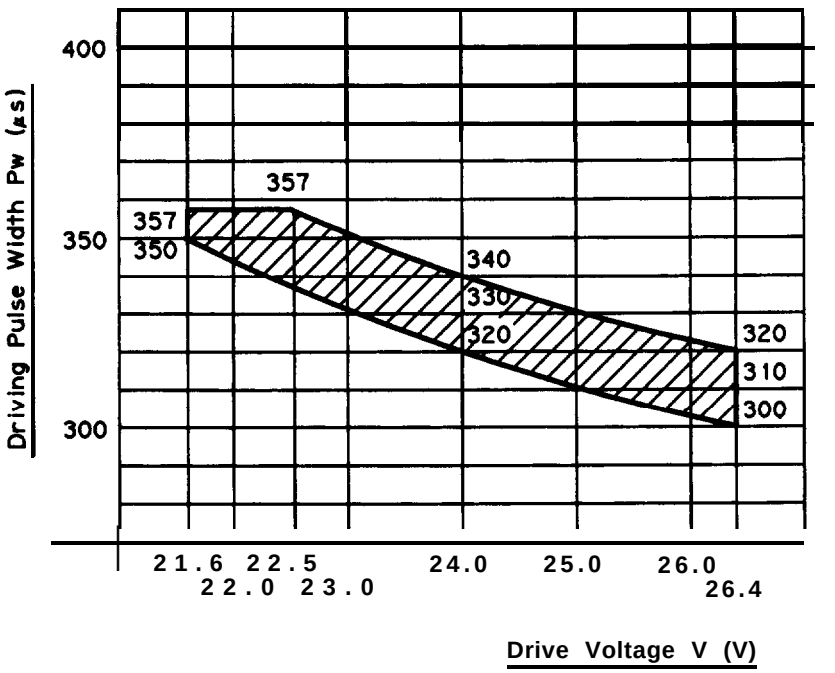


Figure 2-67. Relationship between Head Driver Voltage and Print Driving Pulse Width

2.3.7 A/D CONVERTER CIRCUIT

Figure 2-68 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 value of the setting of the bidirectional adjustment (DIP switches).
- Reads the control panel switches.

The circuit's reference voltage V_{REF} is set, based on shunt regulator TL431 CLPB, R44, and R45, as follows:

$$VREF = \frac{2.5\ v}{R45} \quad (R45 + R44) = 4.5\ V$$

NOTE: The shunt regulator reference voltage value is 2.5 V.

With this voltage serving as the reference, the +24 V line is monitored by AN6, the head temperature is monitored by AN7, and the DIP switches, bidirectional adjustment (DIP switches), and control panel switches are read using AN0 through AN5.

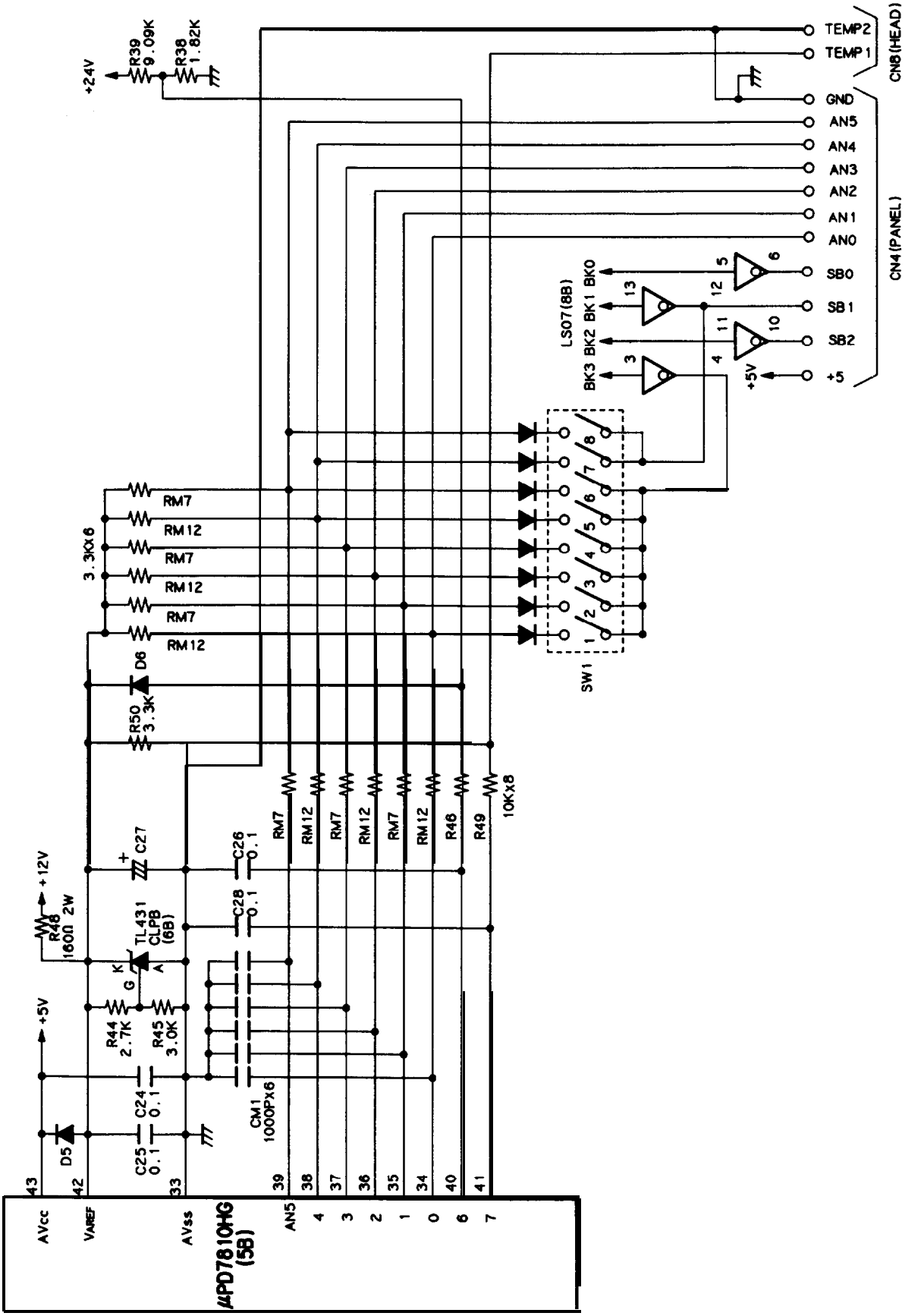


Figure 2-68. A/D Converter Circuit

Table 2-9 **shows the** relationship between the scan lines and DIP switches.

Table 2-9. Scan Lines and DIP Switches

Switch	Scan Line			
	BK0	BK1	BK2	BK3
Panel DIP SW 1-3,1-6, 2-1, 2-4, 2-6, 2-8	L	H	H	H
Panel DIP SW 1-2, 1-5, 1-8, 2-3 SAMA DIP SW 7, 8	H	L	H	H
Control Panel SW	H	H	L	H
SAMA DIP SW 1, 2, 3, 4, 5, 6	H	H	H	L
Panel DIP SW 1-1, 1-4, 1-7, 2-2, 2-5, 2-8	H	H	H	H

2.3.8 HOST INTERFACE

The host interface circuit is shown in Figure 2-69. STROBE pulses from the host computer pass through the low-pass filter, consisting of R66 and C42, 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.

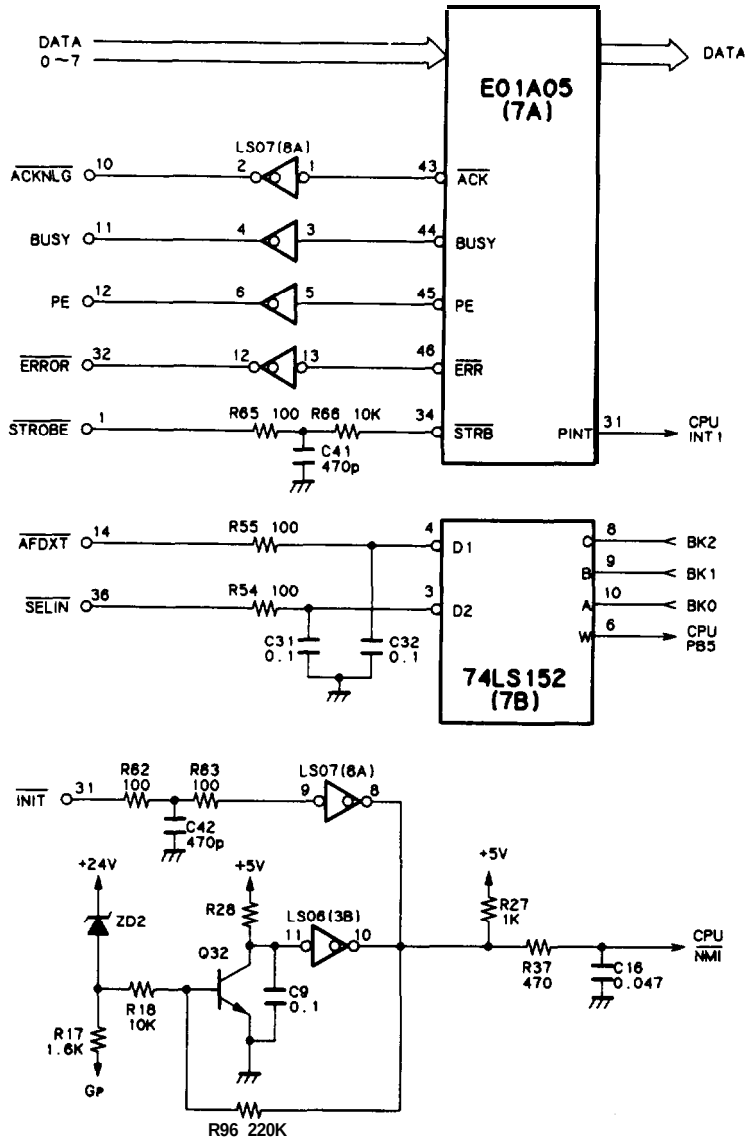


Figure 2-69. Host Interface

2.3.9 EEPROM CIRCUIT

The EEPROM can store the position of continuously fed paper, so that this information can be maintained even if power goes off. Figure 2-70 shows the EEPROM circuit. Note that this is external to the CPU's memory space.

In order to write to the EEPROM, CPU port PA5 goes HIGH. Once the EEPROM has been selected, the data to be sent is set in bank line B2, and is fed bit-by-bit to the EEPROM in line with rising pulses from bank line B1's clock. Data is read, bit-by-bit, in line with falling clock pulses. The EEPROM receives commands to indicate whether to read or write data, and to indicate addresses.

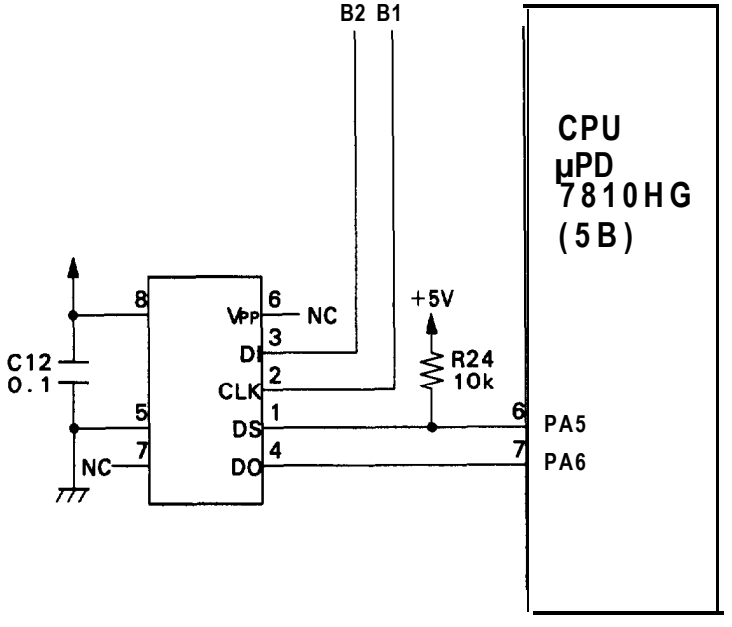


Figure 2-70. EEPROM Circuit

2.3.10 RIBBON-FEED MECHANISM

The ribbon-feed mechanism consists of the ribbon cartridge and the ribbon-feed section. The ribbon-driving gear always is driven counterclockwise (regardless of the timing-belt direction) via the gear trains shown in Table 2-10.

Table 2-10. Ribbon-Feed Gear Train

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

Figure 2-71 shows the ribbon-feed mechanism. The inked ribbon is held in the cartridge case between the ribbon-feed and the ribbon-pressure roller mounted on the ribbon-driving gear. The ribbon configuration is such that the ribbon can feed endlessly. The ribbon-driving gear drives the rollers, which causes the ribbon to be fed. To prevent ribbon slack, a ribbon-braking spring is attached at the exit of the cartridge case. A ribbon mask is installed to prevent the ribbon from staining the paper.

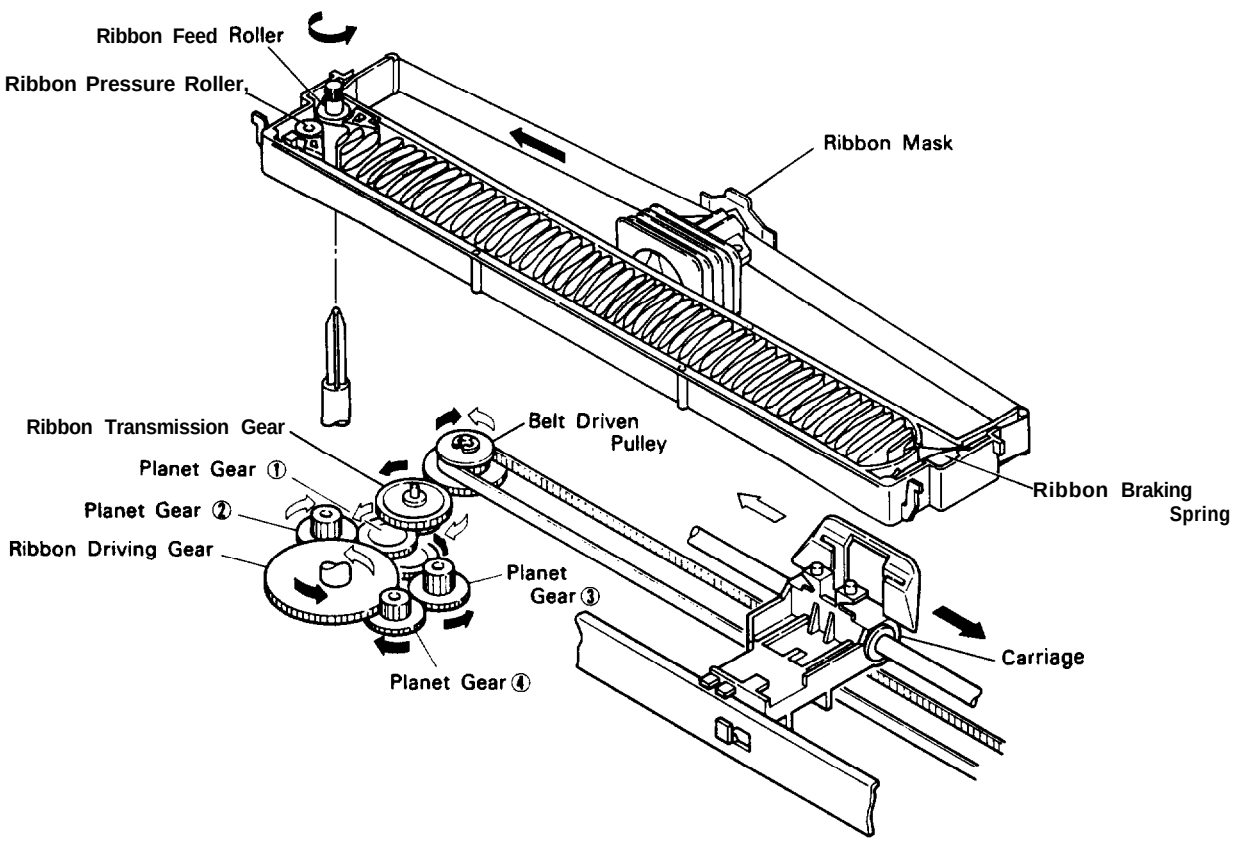


Figure 2-71. Ribbon-Feed Mechanism

CHAPTER 3
OPTIONAL EQUIPMENT

LIST OF FIGURES

LIST OF TABLES

OPTIONAL EQUIPMENT 3

3.1 INTERFACE OPTIONS

The LQ-510 can utilize Model 8100 series optional interfaces. The main interfaces are listed in Table 3-1.

Table 3-1. Optional Interfaces

	Model	Description			
RS-232C Current Loop		Buffer Size	Flag Control	X-ON /OFF Control	Max. Bit Rates (bps)
	8143	None	-	-	-
	8148	2K/8K	o	o	19200
IEEE-488 (GP-IB)		Buffer Size	Function	Listen-Only Operation	Address Operation
	8165	2K/8K	AH, L, DC	o	o

NOTE: For details, refer to the "Optional Interfaces Technical Manual."

3.1.1 MODEL 8143 SERIAL INTERFACE OPERATION

With the optional Model 8143 interface, the printer can support the RS-232C data protocol and a 20 mAA 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 none*
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 [n] (current ON)
	Space = logical "0" (current OFF)
Handshaking	By REV signal or X-ON/OFF code
	(Signal polarity can be inverted by jumper setting.)

• Selectable by DIP switch.

NOTE: If the parallel interface cable is connected, disconnect it before using the 8143 board, because parallel interface input is used to read jumper settings and DIP switch status.

Jumper Settings

Table 3-2. Jumper Settings

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

DIP Switch Settings

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-bit	8-bit
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	See Table 3-4.	
1-7 (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	OFF
300	ON	OFF	OFF	ON	19200	OFF	OFF	ON	OFF
600	ON	OFF	OFF	ON	19200	OFF	OFF	OFF	OFF
1200	ON	OFF	OFF	OFF	19200	OFF	OFF	OFF	OFF

NOTE: For current loop operation, a data transfer rate greater than 1200 bps cannot be guaranteed.

Handshaking Timing

When the amount of buffer space for input data falls to 256 bytes, the printer indicates that it is “not ready to receive data” by outputting the X-OFF code and/or REV signal (polarity can be selected by jumper setting). When the available buffer space reaches 528 bytes, the printer indicates that it is “ready to receive data” by outputting the X-ON code and/or changing the REV signal.

Error Handling

An asterisk (*) is printed when a parity error is detected. Other errors (e.g., “overrun error” and “framing error”) are ignored.

3.2 MULTI-FONT MODULE (TOM4 BOARD)

The optional multi-font module (7407) provides the LQ-510 with seven additional fonts.

1. This module provides seven different font types (Courier, Prestige, Script, OCR-B, OCR-A, Orator, Orator-S).
2. “Orator” and “Orator-S” are new additions.
3. A rotary switch can be used for selecting the font.

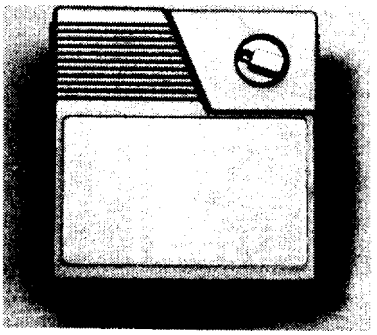


Figure 3-1. External Appearance of the Multi-Font Module

At power up, the font choice is based on the setting of the module’s rotary switch. Settings 2 through 8 indicate fonts shown in Table 3-5. If the switch is set to “0,” "1", or “9,” the printer ignores the module. Font selection occurs immediately following the printer selection of the module slot, and the module must be installed at that time if font selection is to occur.

Table 3-5. Character Sets

Number	Font Type	Character Setting
2	Courier	10, 12, 15 cpi
3	Prestige	10, 12, 15 cpi
4	Script	10, 12, 15 cpi
5	OCR-B	10 cpi
6	OCR-A	10 cpi
7	Orator	10 cpi
8	Orator-S	10 cpi

3.3 C80612 CUT-SHEET FEEDER

The LQ-510 printer can use the C80612 cut-sheet feeder. This cut-sheet feeder has the following features:

1. Cut sheets may be handled in the same way as fanfold paper.
2. Sheets may be inserted manually.
3. The feeder is mounted and dismounted easily from the printer.
4. The feeder requires no electrical connection to the printer.
5. The feeder is extremely reliable.
6. A high level of performance can be achieved.

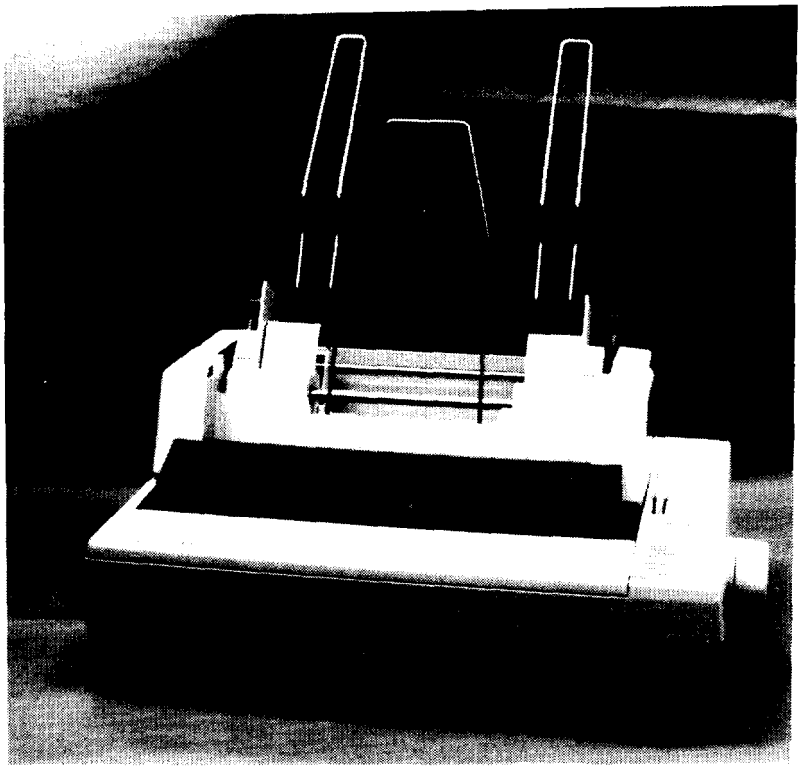


Figure 3-2. LQ-510 with Cut-Sheet Feeder

3.3.1 C80612 CUT-SHEET FEEDER SPECIFICATIONS

This section describes specifications for the C80612 cut-sheet feeder.

3.3.1.1 General Specifications

Hopper Capacity:	For paper weight of:	
	17 pounds (64 g/m^2)	185 sheets maximum
	24 pounds (90 g/m^2)	100 sheets maximum

NOTE: If the weight of the paper differs from the above, total thickness of the stack of paper must be less than 0.59 inches (15 mm).

Stacker Capacity:	17 pounds (64 g/m^2) paper	100 sheets maximum
	24 pounds (90 g/m*) paper	55 sheets maximum

Reliability:
MCBF (Mean Cycles Between Failures): 100,000 cycles

Environmental Requirements:
Operating temperature range - + 41 to 95°F (+ 5 to 35°C)
Storage temperature range - - 22 to 149°F (- 30 to 65°C)
Operating humidity range - 15% to 80% (with no condensation)
Storage humidity range - 5% to 85% (with no condensation)

3.3.1.2 Paper Specifications

Cut-sheet paper must be new or like new, must not be curled or curved, and must be free of surface and edge damage.

Paper type and quality: Plain bond, typewriter, or PPC-quality paper with a minimum wood pulp content

NOTE: Paper with higher wood content, very light, and very heavy paper, must be tested operationally prior to regular use. Paper with a textured embossed, glossy, or hammered surface also must be tested.

Paper width and length:	Width - 7.17 inches (182 mm) to 8.50 inches (216 mm) Length - 10.1 inches (257 mm) to 14.3 inches (364 mm)
Paper thickness:	0.0028 inches (0.07 mm) to 0.0039 inches (0.1 mm)
Paper weight:	17 pounds to 24 pounds (64 to 90 g/m^2)
Angular deviation:	Less than ± 0.02 inches (0.5 mm)

Recommended conditions for paper storage:

Temperature:	**+ 64** to 72° F (18 to 22°C)
Humidity:	**40%** to 60%

3.3.1.3 Printable Area

See Figure 3-3.

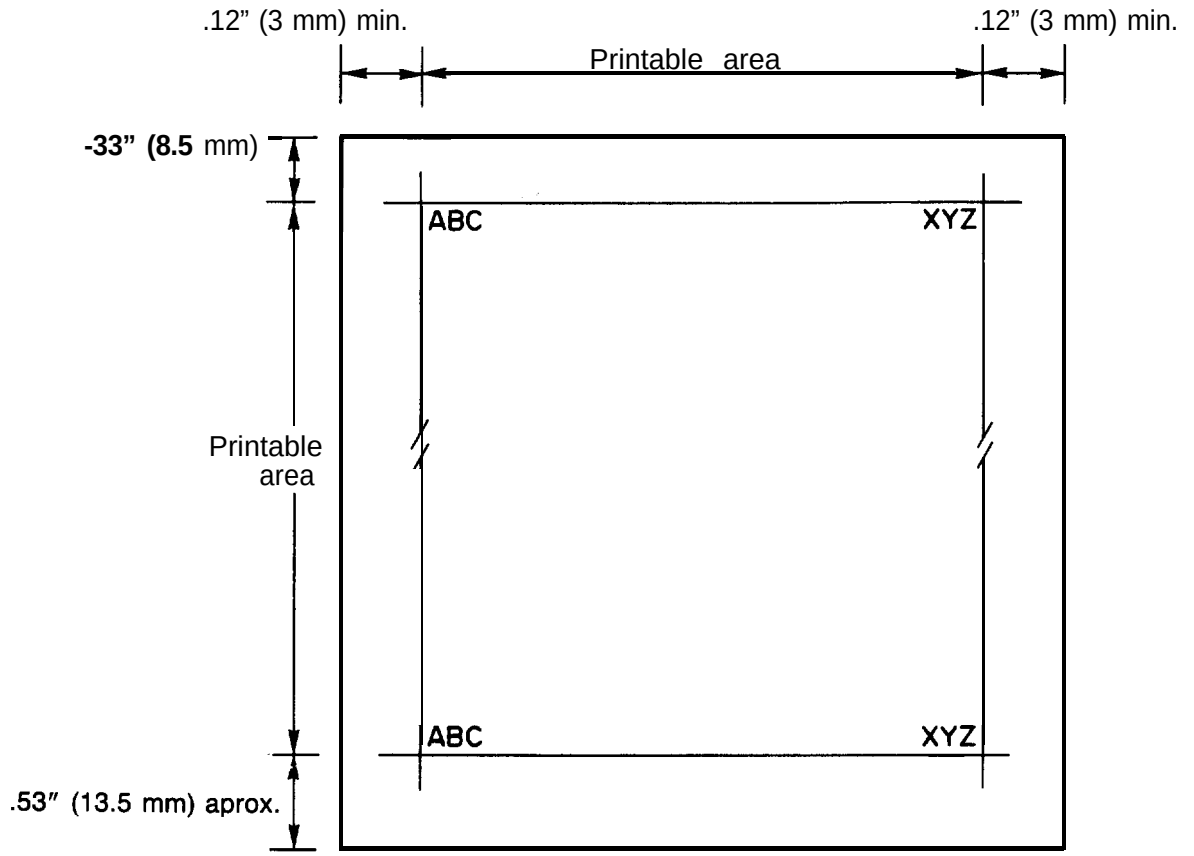


Figure 3-3. Printable Area

NOTES: The printable length is approximately 0.87 inches (22 mm) less than the actual page length. Paper-feed accuracy cannot be assured within 0.87 inches (22 mm) from either top or bottom edge.

3.3.1.4 Dimensions and Weight

Dimensions: 17.5 inches (444 mm) (width) x 17.1 inches (434 mm) (depth) x 16.4 inches (416 mm) (height) including paper-feed knob

NOTE: Dimensions were measured with the cut-sheet feeder mounted on the printer.

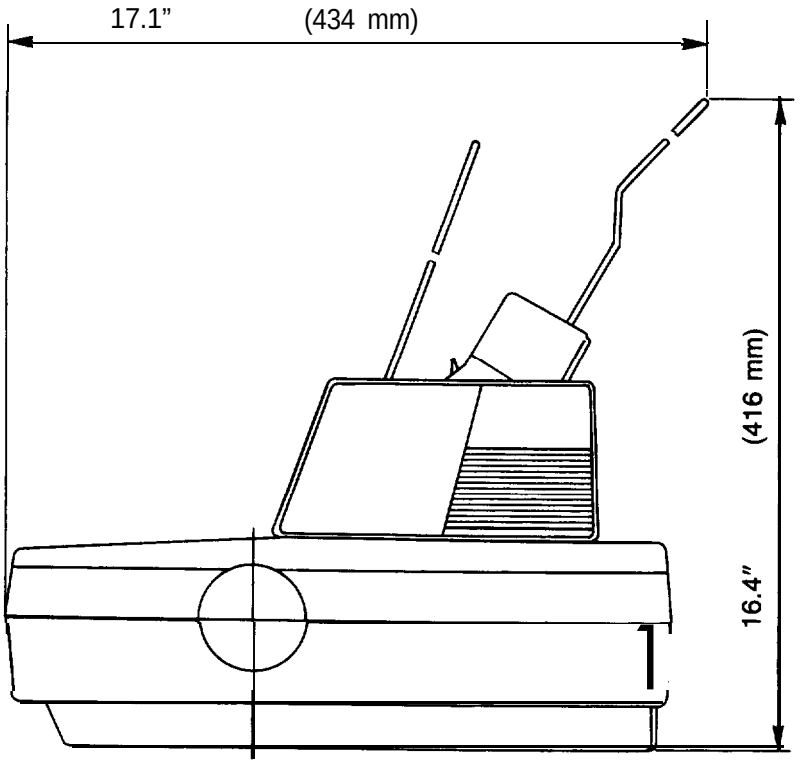


Figure 3-4. Dimensions

Weight: Approximately 2.42 pounds (1.1 kg) excluding covers

3.3.2 OPERATING PRINCIPLES OF THE CUT-SHEET FEEDER

The cut-sheet feeder is driven by firmware incorporated in the printer. The feeder need not be electronically connected to the printer. Cut-sheet feeder mode can be selected either by DIP switch or by command.

Selection by DIP Switch

The cut-sheet mode is set by DIP switch as shown in the table below.

Table 3-6. DIP Switch Selection

DIP Switch	Function	ON	OFF
1-8	Cut-Sheet Feeder Mode	Valid	Invalid

Selection by Command

After the cut-sheet feeder has been mounted on the printer, the following command can be used.

Command: ESC EM

Format: CHR$(27); CHR$(25); "n"
where "n" signifies the following:

n = 0 cancels the CSF mode
n = 4 specifies the CSF mode
n = R ejects a sheet

NOTE: This command should be input when paper is loaded.

3.3.2.1 Mechanism Operation

Paper is loaded between the paper holder and the paper-loading rollers. When the paper-feed motor rotates in reverse, the gears, via the pinion on the motor's shaft, rotate in the direction of the white arrows (see Figure 3-5) and friction causes the paper to advance to the paper guide. When the paper comes into contact with the platen, the rotation of the paper-feed motor changes to the forward direction, and the gears rotate in the direction indicated by the black arrows. Friction causes the paper to advance between the platen and the paper-feed rollers. As it advances, the paper is further guided by the paper-ejecting rollers. Figure 3-5 illustrates the feed operation.

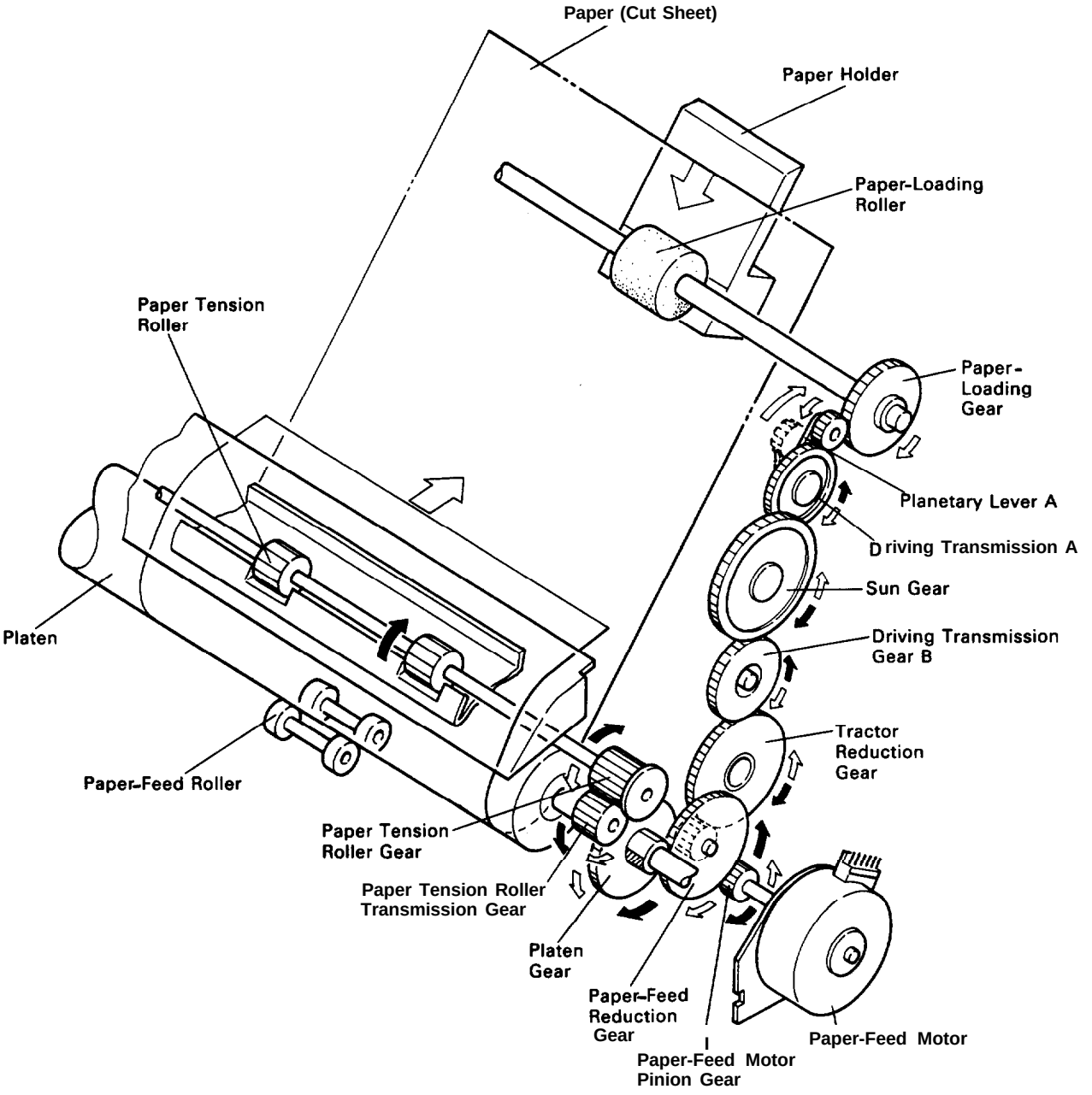


Figure 3-5. Cut-Sheet Feeder Operation

3.3.3 CUT-SHEET FEEDER DISASSEMBLY AND REASSEMBLY

This section describes the procedure for removing the hopper unit of the C80612 cut-sheet feeder. Unless otherwise specified, reassembly is performed by reversing the sequence. The diagrams in Figure A-34, which are provided as reference for disassembly and reassembly, show an exploded view of the parts configuration. The required tools are listed in Table 3-7.

Table 3-7. Tools for Assembly or Disassembly

Tool	Availability	Part No.
Phillips screwdriver no. 2	o	8743800200
E-ring holder #6	o	8740800800

o: commercially available

CAUTION

For safety, wear gloves during disassembly and assembly.
Dismount the cut-sheet feeder from the printer before starting disassembly.
Do not allow oil or grease to contaminate the paper path. If contamination does occur, wipe it away with alcohol.

WARNING

If it is necessary to replace one of the paper-loading rollers, both right and left rollers must be replaced at the same time.

1. Remove side covers L and R.

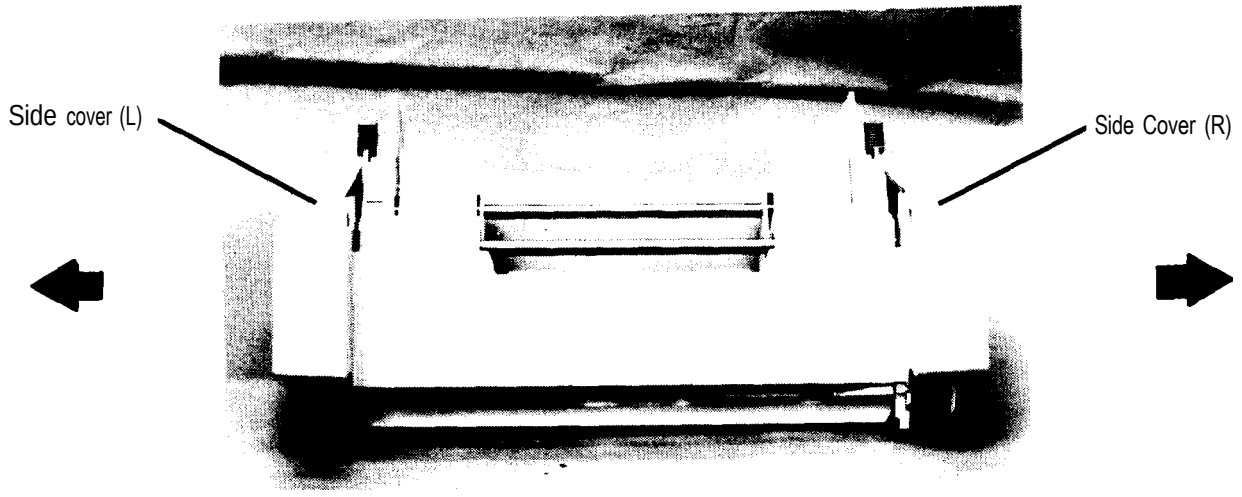


Figure 3-6. Side Cover Removal

2. Remove the E-ring (6) on the paper-loading roller shaft, and then remove the shaft.

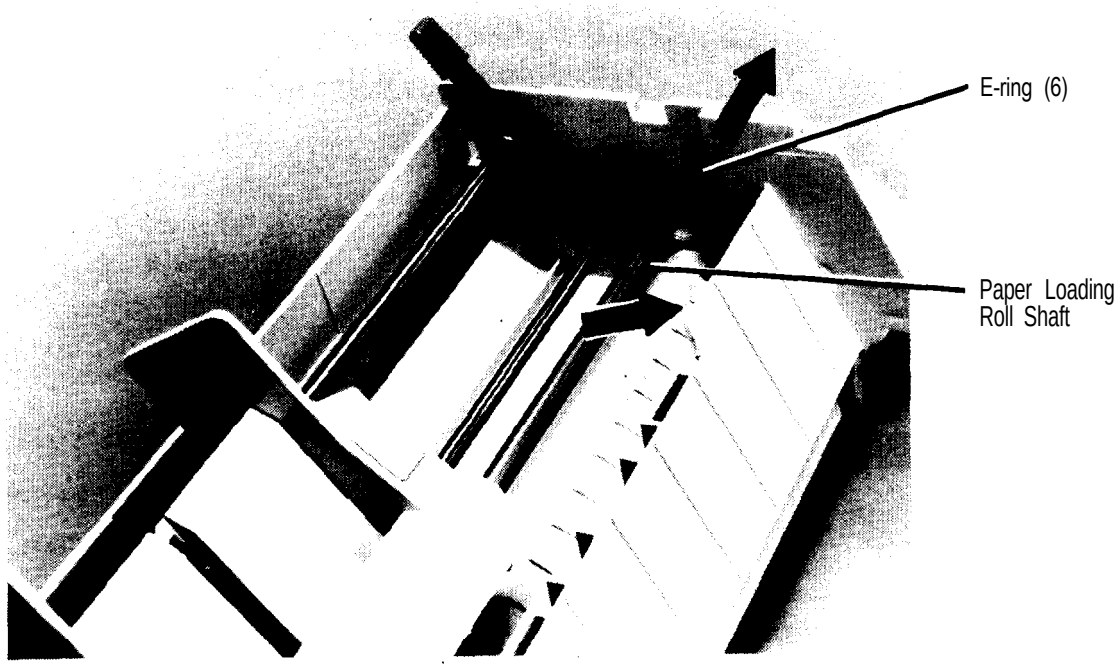


Figure 3-7. Paper-Loading Roller Shaft Removal

3. Remove the two E-rings (6) on the paper support shaft.

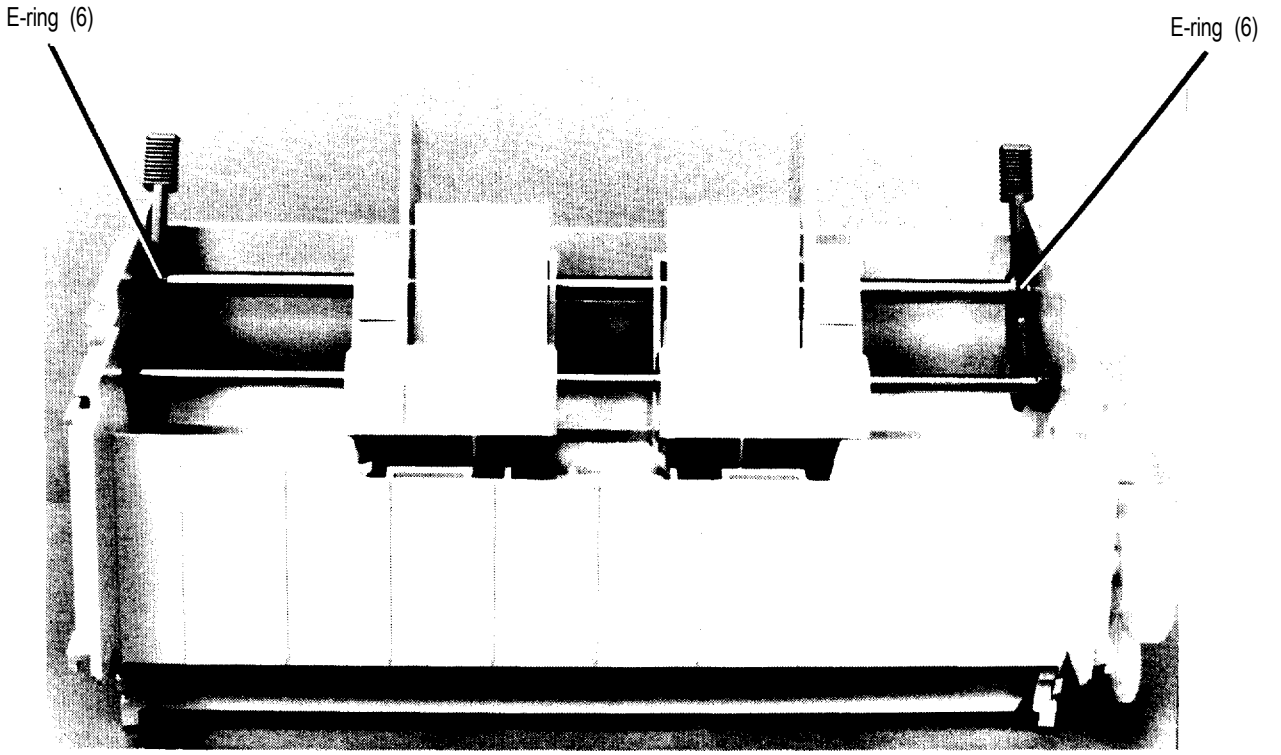


Figure 3-8. E-Ring Removal

4. Remove the shaft holder fastening the paper support shaft to frame L.

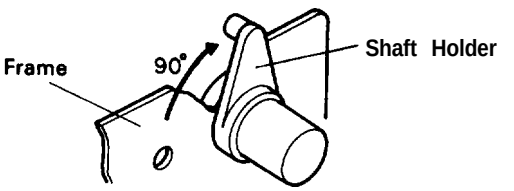


Figure 3-9. Shaft Holder Removal

5. Remove the E-ring (6) on the paper support shaft (see Figure 3-10).
6. Lift the hopper unit and the paper support shaft together.

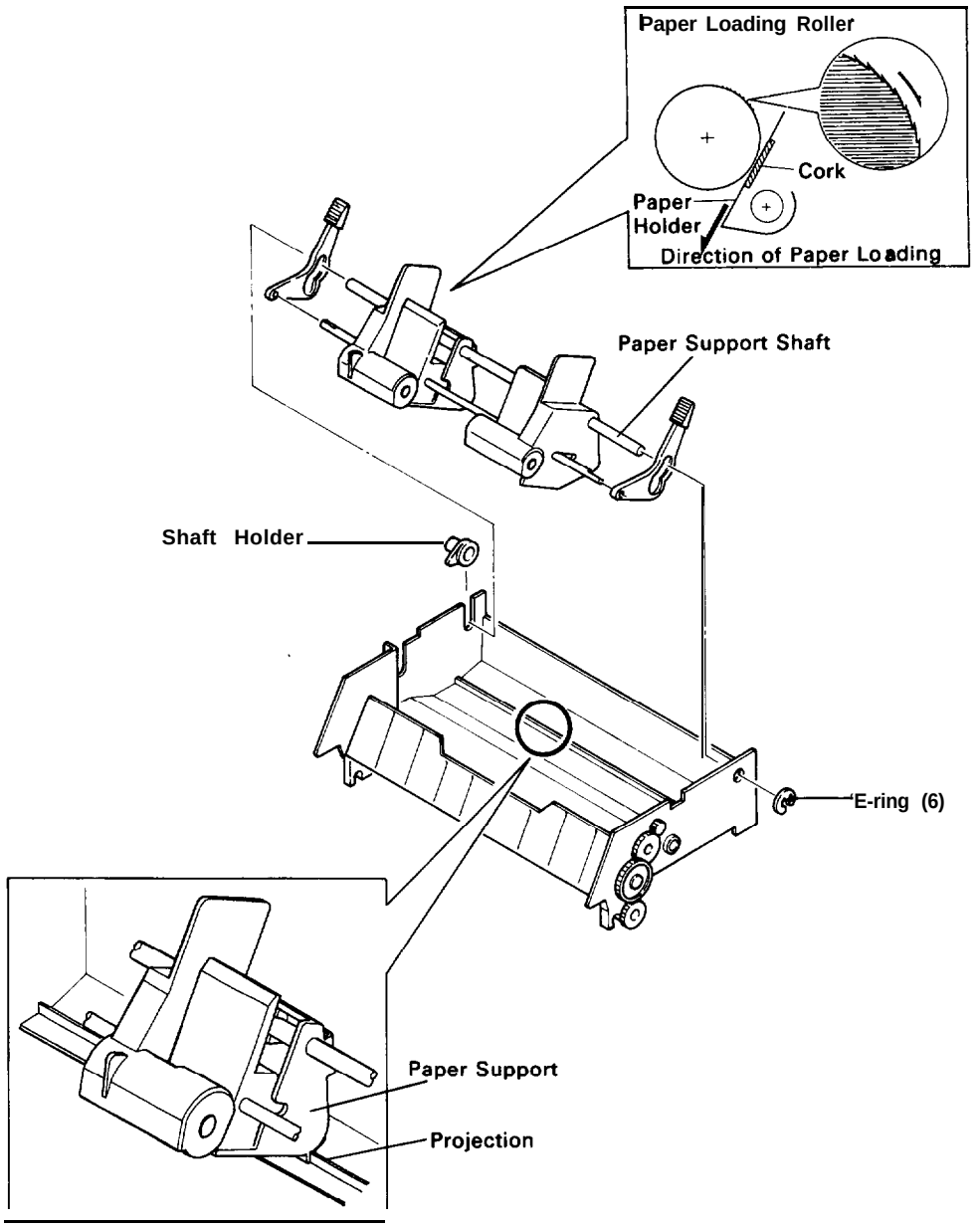


Figure 3-10. Hopper Unit Removal

3.3.4 PREVENTIVE MAINTENANCE FOR THE CUT-SHEET FEEDER

The C80612 cut-sheet feeder is well designed and requires only a minimum of **preventive maintenance, as** follows:

- General cleaning of the device.
- Checking the mechanical functions.

3.3.4.1 Cleaning

- Brush off all paper dust.
- Check the surfaces of the paper-loading and paper-ejecting rollers.

NOTE: If one of the paper-loading rollers is damaged, or if wear is uneven, both rollers must be replaced.

WARNING

Regularly check the shafts of the paper-loading and paper-ejecting rollers. If the printer fails to move the **paper, open** the right side cover and check the gear wheels for wear or damage.

3.3.4.2 Lubrication

Epson recommends that the points indicated in Figures 3-11 and 3-12 be lubricated with Epson O-3 and G-14 (see Table 3-8). These lubricants have been thoroughly tested and have been found to comply fully with the needs of the cut-sheet feeder.

Table 3-8. Lubricants

Type	Designation	Capacity	Availability	Part No.
Oil	O-3	40 cc	E	B710300001
Grease	G-14	40 g	E	B701400001

E: Epson-exclusive product

Lubricate the paper support shaft and the paper holder shaft using a cloth moistened with O-3.

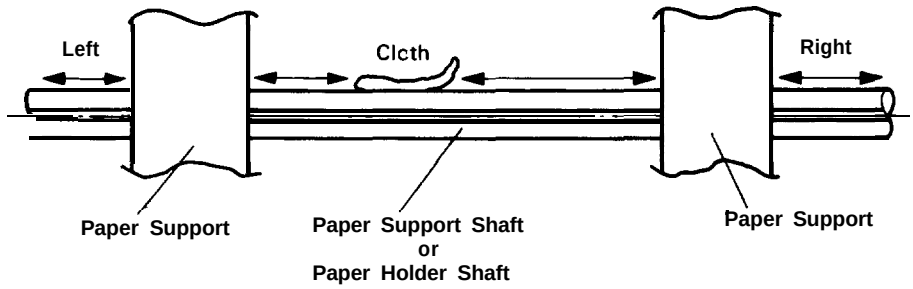


Figure 3-11. Lubrication Points (1)

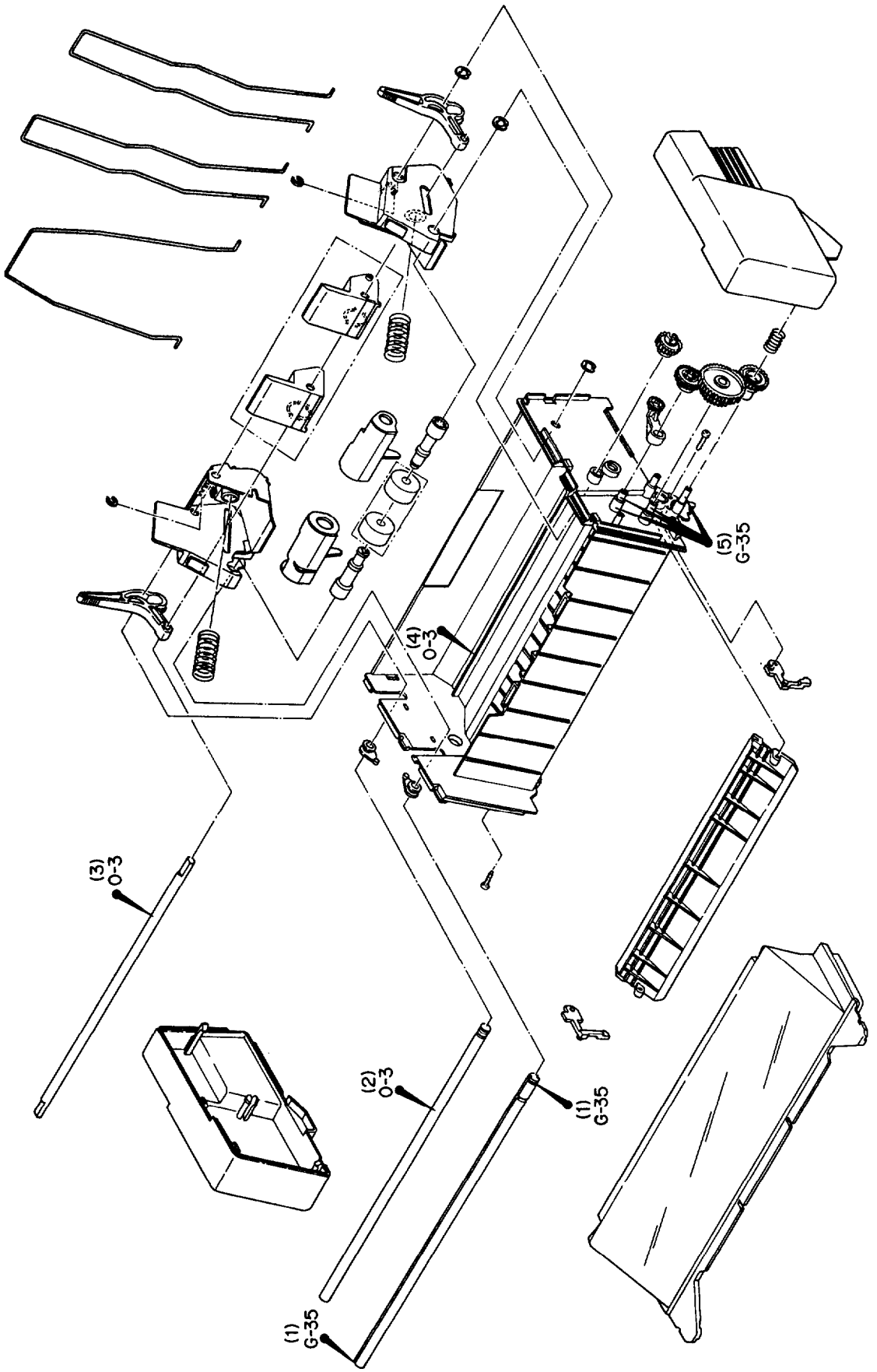


Figure 3-12. Lubrication Points (2)

3.4 C80006 PULL TRACTOR

The optional C80006 pull tractor provides optimum continuous paper handling. The pull tractor is especially useful with continuous multi-part forms and labels.

3.4.1 PULL TRACTOR OPERATION

When using the push-pull feed method, fit the paper holes onto the pins along the sprocket wheel and also onto the tractor pins along the tractor belt. The paper-feed motor is driven, via the pinion on the motor's shaft, to rotate the gears in the direction shown in Figure 3-13. The gears, in turn, rotate the sprocket wheels and tractor belt, advancing the paper in the direction indicated by the arrow.

Shifting the release lever forward moves the feed rollers away from the platen and releases the feed.

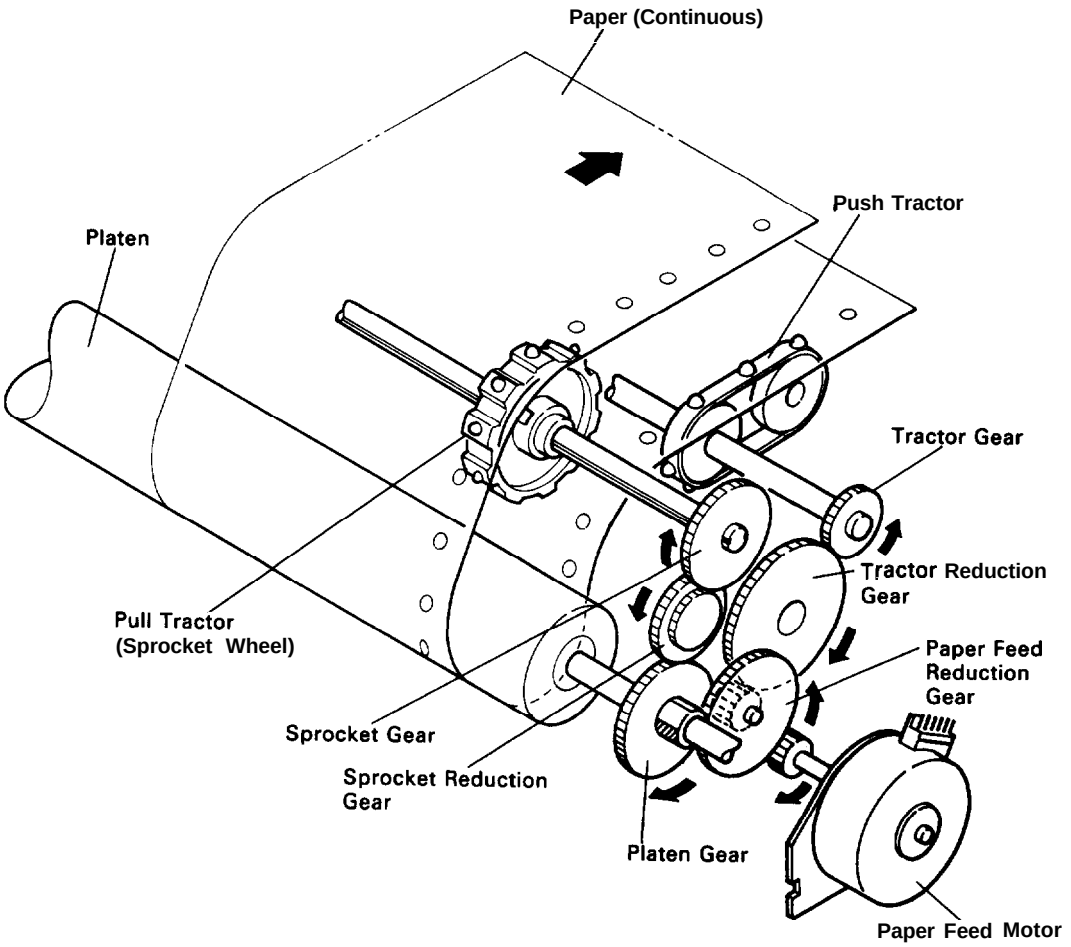


Figure 3-13. Push-Pull Feed Operation

3.4.2 PULL TRACTOR DISASSEMBLY AND REASSEMBLY

1. Remove the catch fastening the sprocket reduction gear to sprocket mounting plate R. Then remove the reduction gear.
2. From the sprocket shaft, remove the E-ring (6), the sprocket gear, the sprocket gear spring, and the washer.
3. Remove the E-ring (6) on the inside of mounting plate R.

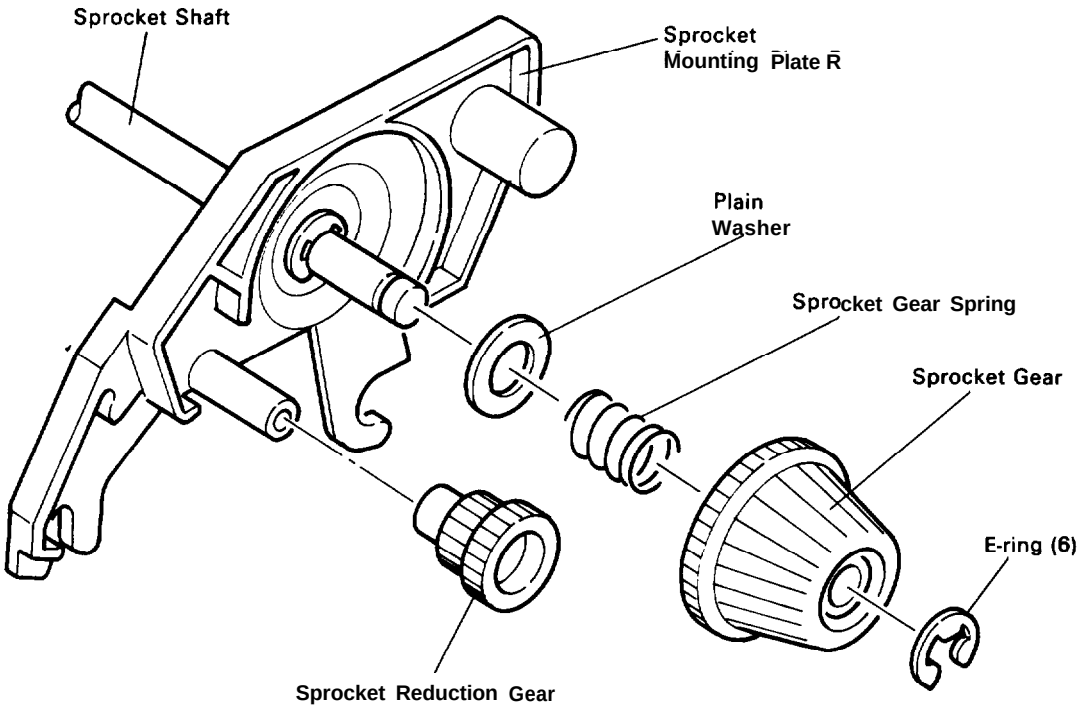


Figure 3-14. Removal of Sprocket Reduction Gear and Related Parts

4. Pull to remove the sprocket shaft and the sprocket support shaft from mounting plate L.

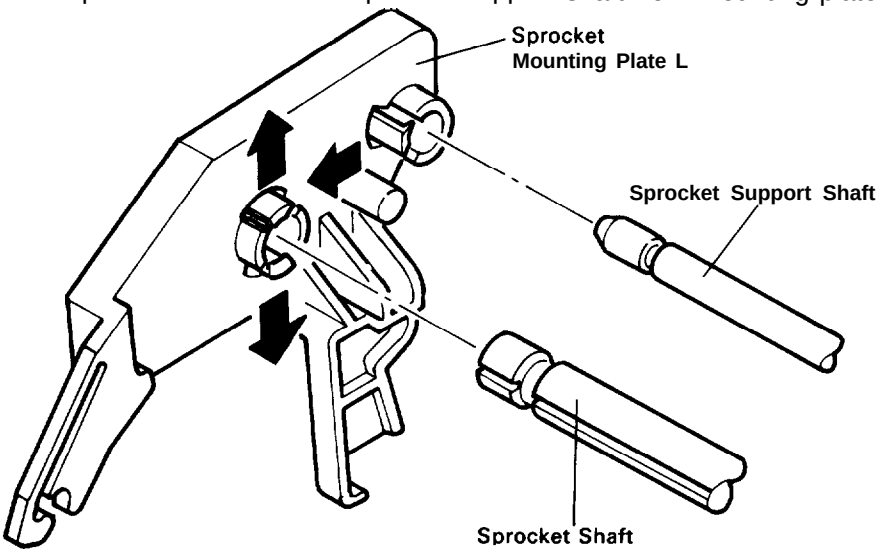


Figure 3-15. Removal of Sprocket Mounting Plate L

5. Remove the E-ring (6) from the sprocket shaft, then remove sprocket mounting plate R.

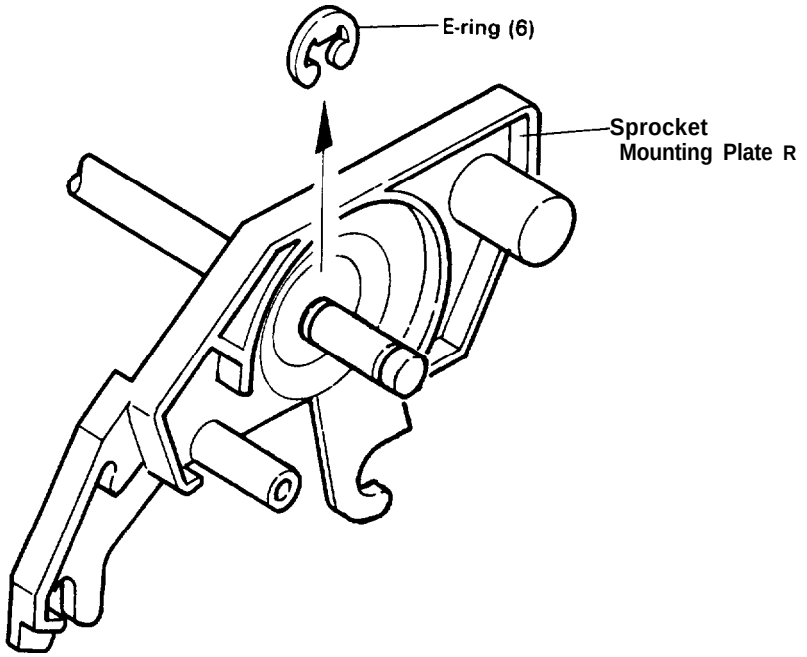


Figure 3-16. Removal of Sprocket Mounting Plate

6. From the sprocket shaft and the sprocket support shaft, pull and remove sprocket set R, the paper guide roller, and sprocket set L. In separating the paper guide roller, pull in the same direction as the side on which the T-shaped notch is located. (When reassembling, insert from the same side.)

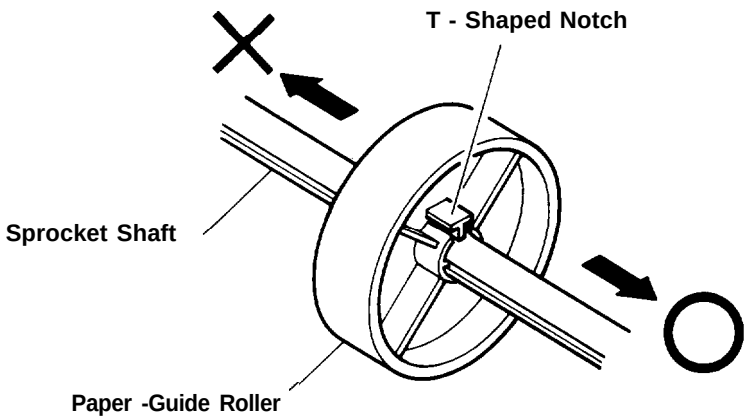


Figure 3-17. Direction of Paper Guide Roller Removal

Reassembly

1. Insertion of the paper guide roller onto the sprocket shaft should be in the direction indicated in Figure 3-18.
2. When inserting the sprocket roller into the sprocket shaft, the marked sides of both wheels should face to the left, and the markings should be analogously positioned.

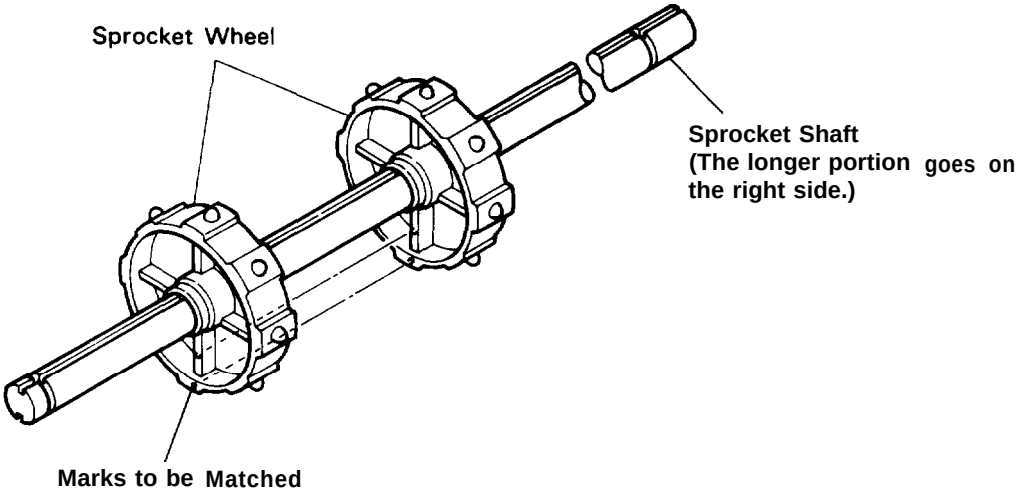


Figure 3-18. Direction for Insertion of Sprocket Wheels

CHAPTER 4
DISASSEMBLY, ASSEMBLY, AND ADJUSTMENT

LIST OF FIGURES

LIST OF TABLES

DISASSEMBLY, ASSEMBLY, AND ADJUSTMENT 4

4.1 GENERAL REPAIR INFORMATION

This chapter describes the procedures for removing, replacing, and adjusting the main components of the LQ-510.

CAUTION

- Prior to beginning any of these procedures, be certain that the AC power cord is disconnected.
- To help prevent hands from being cut by the printer mechanism or sharp plate edges, wear gloves when performing these procedures.

WARNING

- The printer mechanism, boards, and other parts are sometimes held in place with plastic clips rather than screws. Be careful not to damage these clips when removing them.

Tables 4-1 and 4-2 list tools and measuring instruments recommended for carrying out disassembly and repair.

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 (0.44)	o	
Thickness gauge (0.47)	o	

NOTES: 1. (*)indicates the tool that is used to attach the (2.3 mm) E-ring.
2. o = Commercially available

Table 4-2. Measuring Instruments

Description	Specification	Priority
Oscilloscope	50 MHz	A
Tester		A
Slide calipers		A
Multimeter		B
Logic Analyzer		B

NOTE: A = required; B = recommended

To ensure optimal printer performance, be sure to lubricate, apply adhesive, clean, and maintain the printer following reassembly and adjustment, according to the procedures described in Chapter 6.

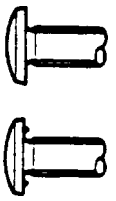
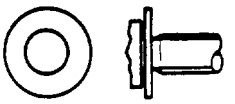
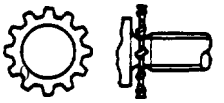
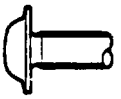
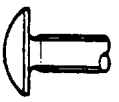
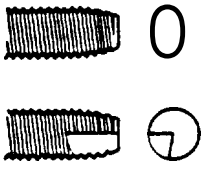
In referring to small parts, this manual utilizes the abbreviations listed in Table 4-3.

Table 4-3. Abbreviations for Small Parts

Abbreviation	Description
CBB(c)	Cross-recessed Bind head, Cone point, B-tight screw
CBS(c)	Cross-recessed Bind head, Cone point, S-tight screw

Table 4-4 correlates the forms of the screws with their abbreviated part names.

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

Head		Body	Washer (assembled)
1. Cross-recessed head 	1. Bind  (with Notch)	1. Normal 	1. Plain washer 
2. Slotted head 	**2.** Pan 	2. Tap tight 	2. Outside toothed lock washer 
	3. Cup 	Stight Btight 	3. Spring washer 
	4. Truss 	3. Tapping 	

4.2 DISASSEMBLY AND REASSEMBLY

This chapter details the disassembly procedures for the LQ-510. As a rule, reassembly is performed simply by reversing the disassembly procedures. A number of special notes, however, are provided under the heading "Notes for Reassembly." When a disassembly or reassembly procedure requires that an adjustment be performed, the adjustment is described under the heading, "Required Adjustment." Perform these adjustments as indicated.

WARNING

Be sure that you have read Section 4.1 "General Repair Information" before performing disassembly Remove paper and the ribbon cartridge before disassembly.

The disassembly procedure detailed below is completed in the following sequence: (1) removal of the printhead, (2) removal of the cases, (3) removal of the circuit boards, (4) removal of the printer mechanism unit, and (5) disassembly of the printer mechanism, Exploded diagrams of the LQ-510 and of the printer mechanism are provided in Figures A-31 to A-32.

4.2.1 PRINTHEAD REMOVAL

1. Remove the printer cover, and confirm that paper and ribbon cartridge have been removed.
2. Open the cover of the paper tension unit.

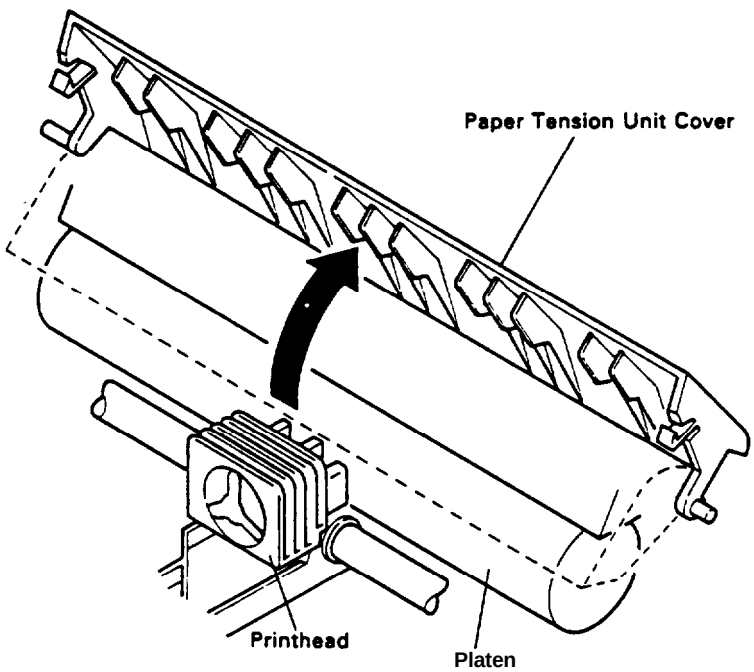


Figure 4-1. Paper Tension Unit Cover

3. Unlock the two levers securing the printhead to the carriage by pulling them down. Then lift and remove the printhead.

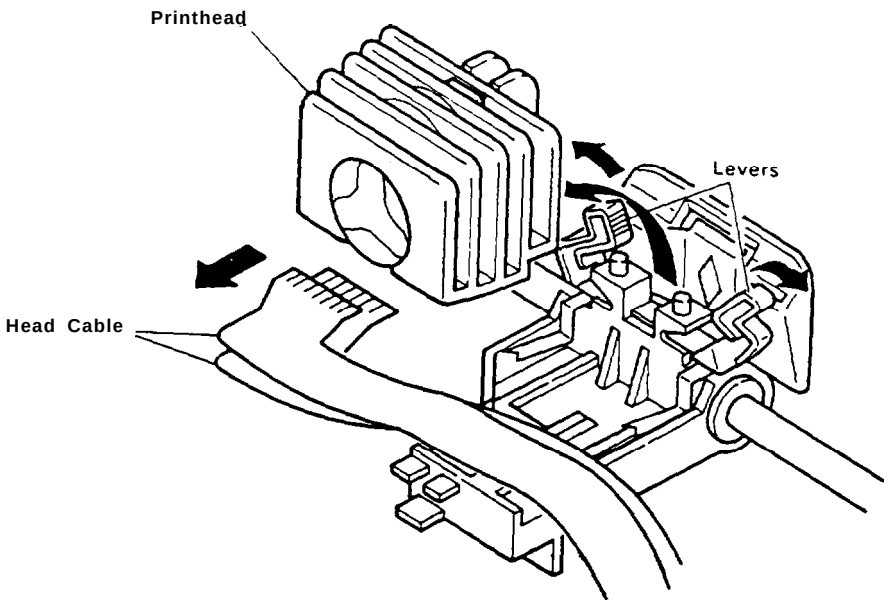


Figure 4-2. Printhead Removal

4. Disconnect the head cables from the connector on the printhead.

NOTE: For the European version of the printer, a net is mounted on the printhead.

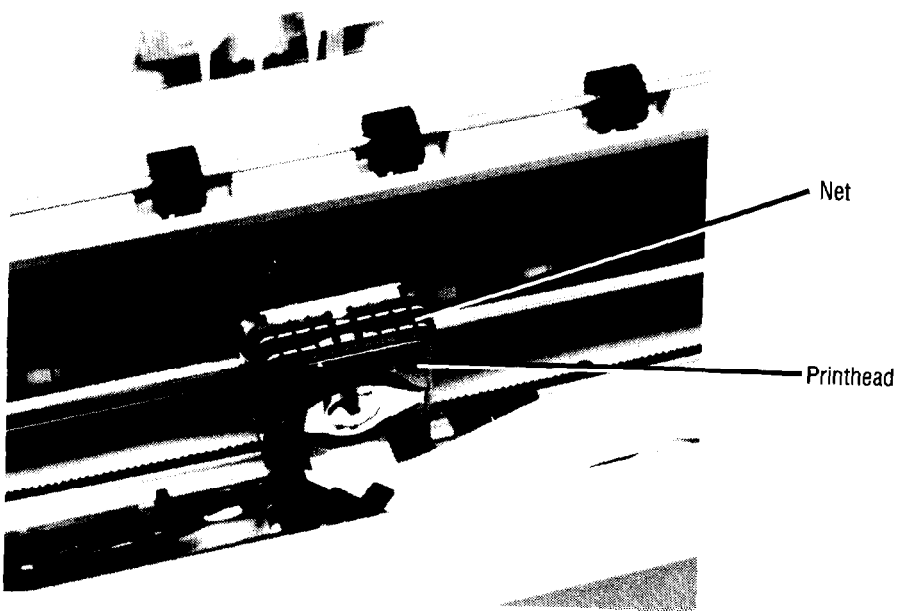


Figure 4-3. Net

4.2.2 REMOVAL OF CASES

This section details the procedure for removing the upper case and the control panel (SANPNL).

4.2.2.1 Upper Case Removal

1. Remove the sheet guide assembly, printer cover, and paper-feed knob.
2. Push in the two notches securing the push tractor to the printer mechanism, and remove the push tractor from the printer mechanism.

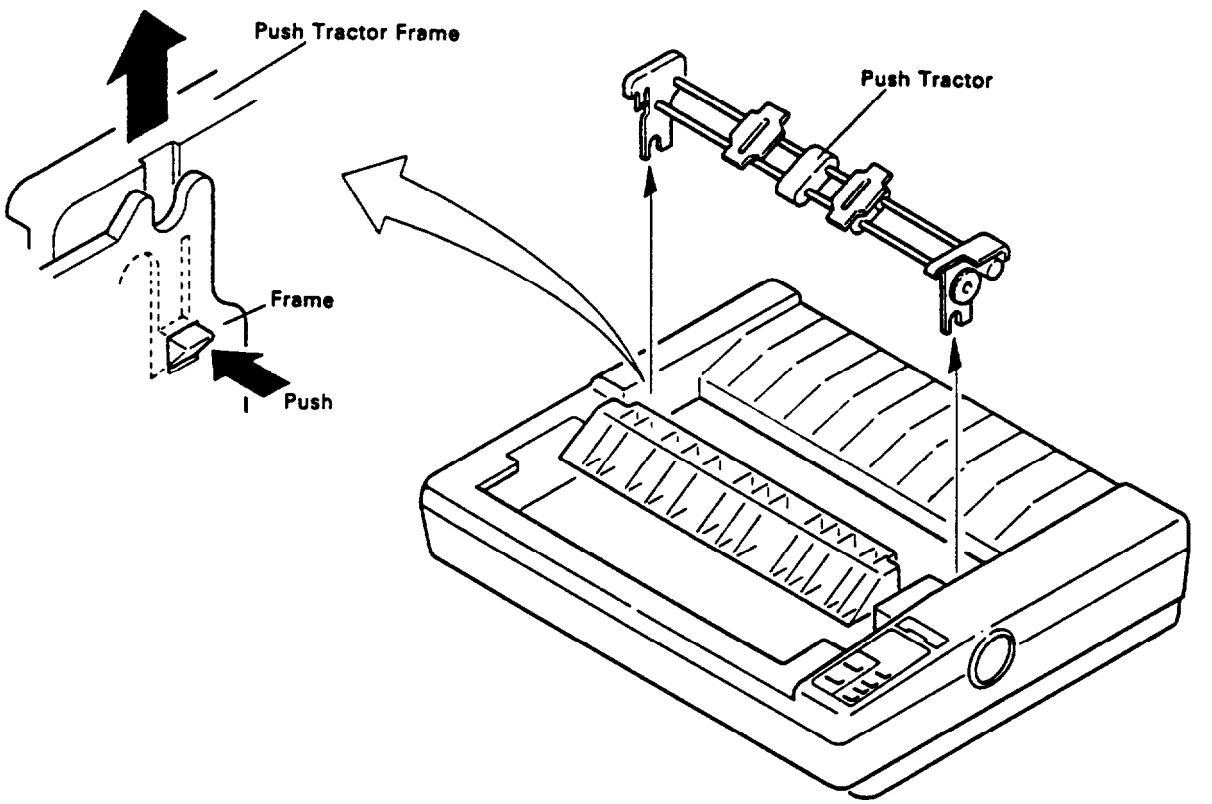


Figure 4-4. Push Tractor Removal

3. Insert a standard screwdriver into each of the two holes at the front of the lower case, and gently push (see Figure 4-5) to unlock the notches.

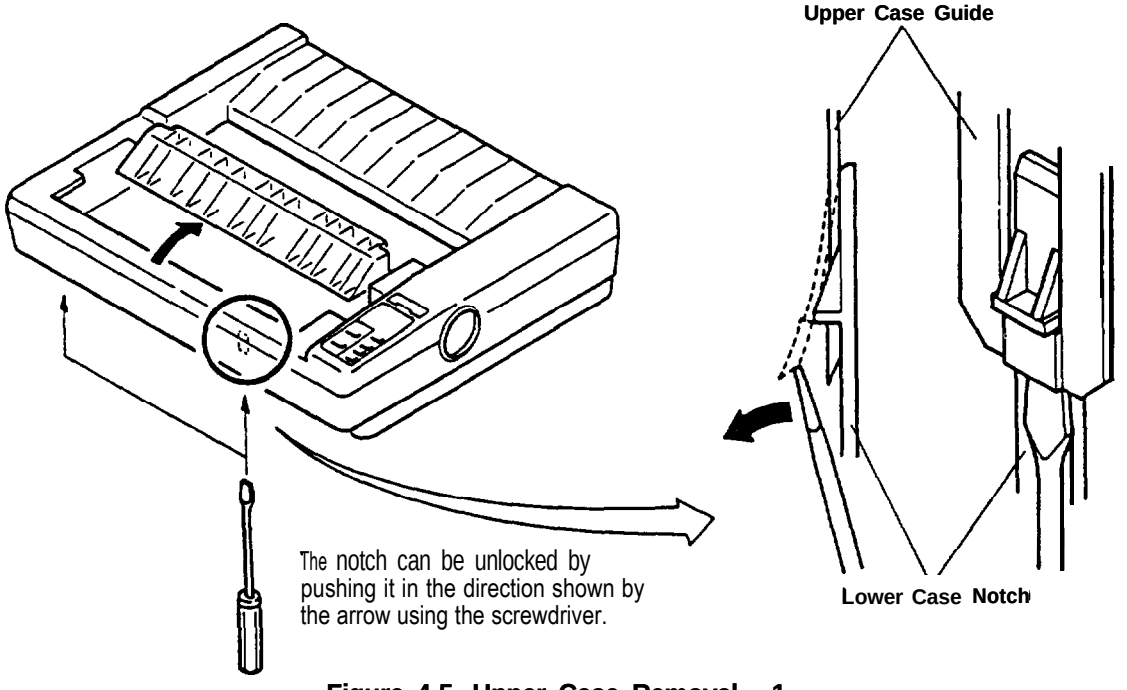


Figure 4-5. Upper Case Removal - 1

4. While lifting the upper case, disconnect the cable of the control panel (SANPNL) from connector CN4 on the SAMA board. Then remove the upper case.

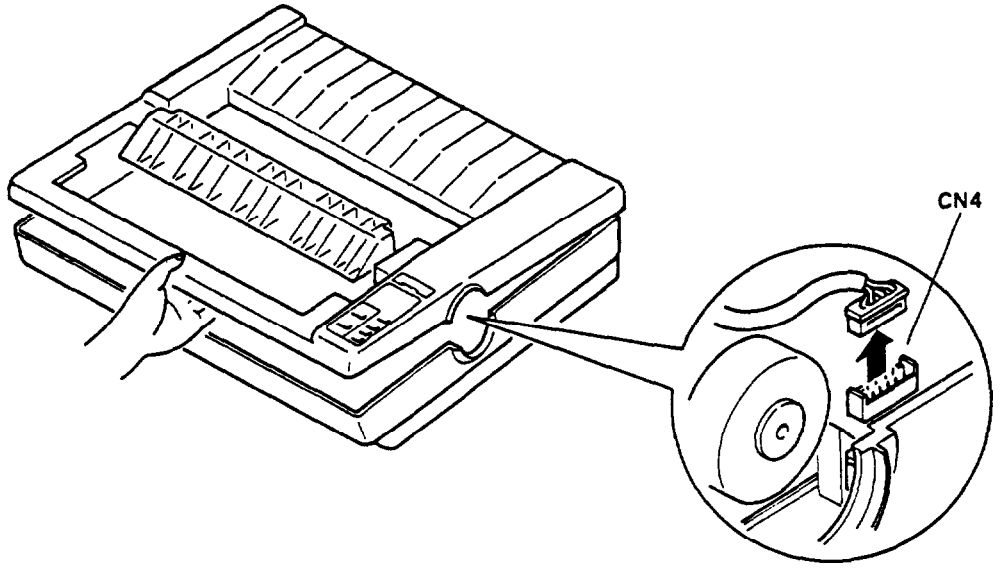


Figure 4-6. Upper Case Removal - 2

4.2.2.2 Control Panel (SANPNL) Removal

1. Remove the upper case (as described in the previous section).
2. Turn the upper case over, push in the two notches on the case that secure the control panel to it, and remove the control panel.

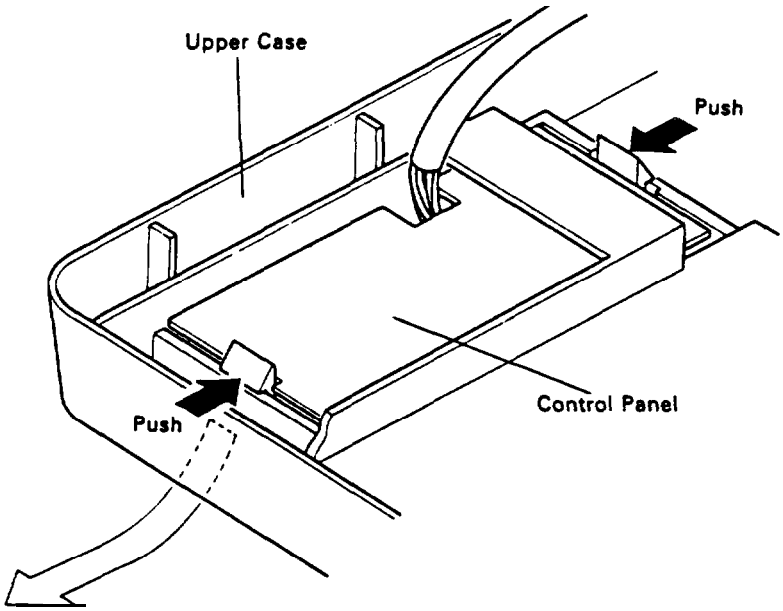


Figure 4-7. Control Panel Removal

4.2.3 REMOVAL OF CIRCUIT BOARDS

This section describes the procedure for removing the SAMA board and the SANPS(E) board.

4.2.3.1 SAMA Board Removal

1. Remove the upper case (refer to Section 4.2.2.1). The following connectors on the SAMA board, connecting it to external components, should be disconnected: CN5 (red), CN6 (yellow), CN7 (white), CN8 (flexible flat cable, or "FFC"), CN9 (FFC), CN13 (black), CN12 (white), CN11 (white), and CN10 (white).

WARNING

Do not pull roughly on the connectors or you may damage the board Remove them by pulling gently while holding the board at the same time.

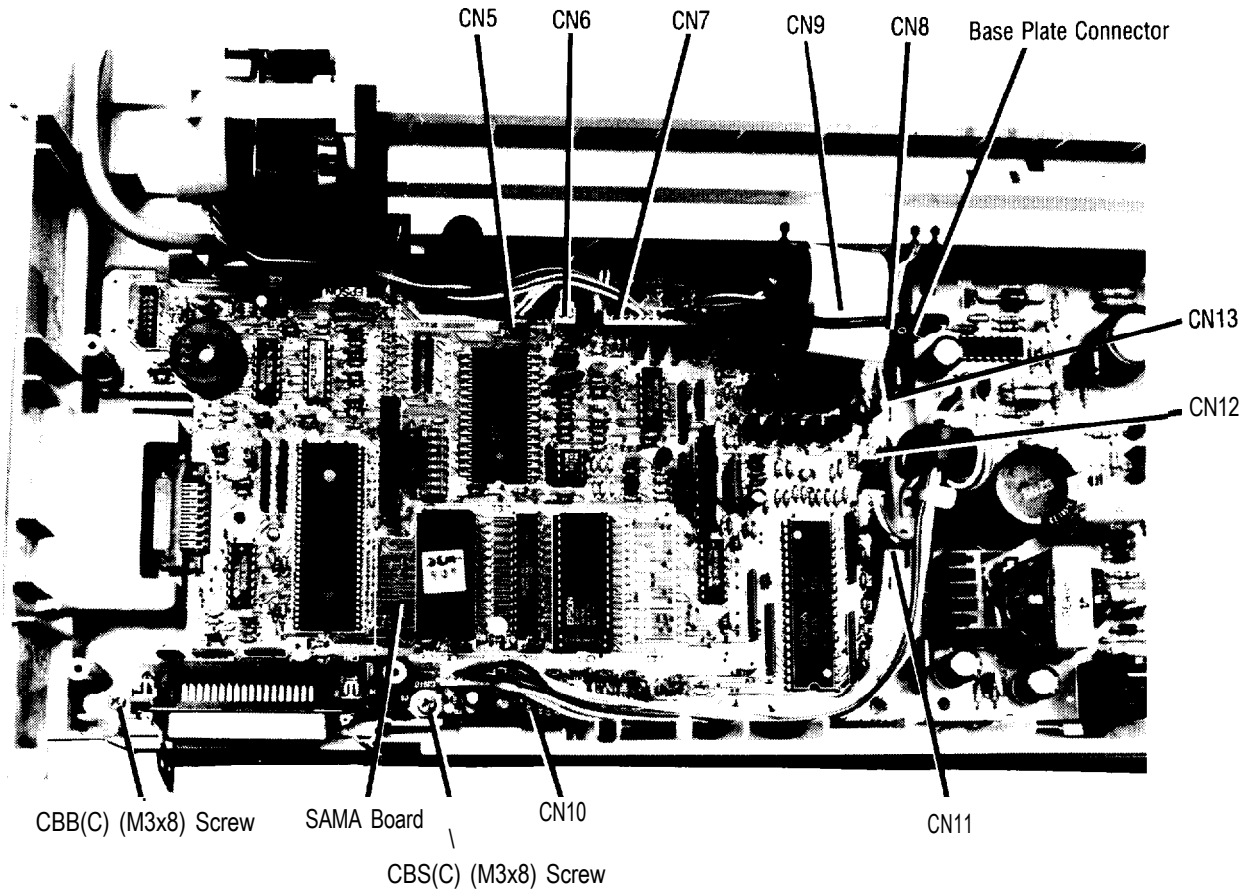


Figure 4-8. SAMA Board Removal

3. Remove the CBB(c) (M3 x 10) screw and the CBS(c) (M3 x 8) screw securing the SAMA board to the base plate and the lower case.
4. Loosen the four bent tabs on the lower case, securing it to the SAMA board. Then remove the SAMA board.

WARNING

Be careful not to bend the tabs too far. Also, when pushing the tabs, be careful not to break them or to cause damage to components on the SAMA board.

NOTES FOR REASSEMBLY

The figure below shows the appropriate way to handle the cable connecting the SAMA and SANPS(E) boards.

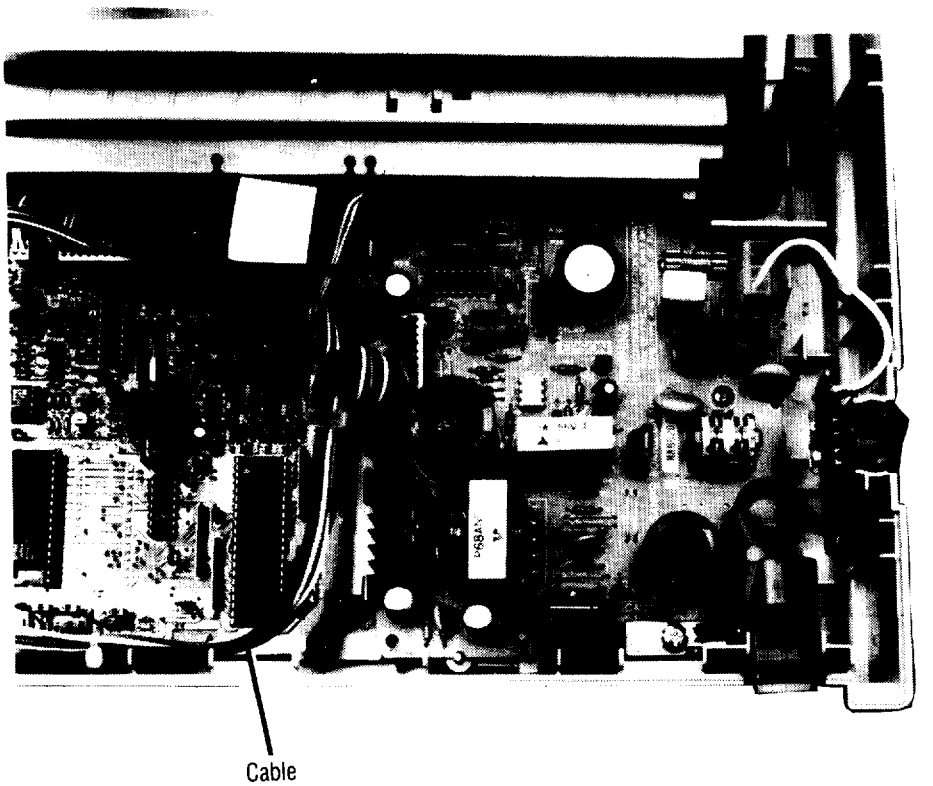


Figure 4-9. Cable

4.2.3.2 SANPS(E) Board Removal

1. Remove the upper case (refer to Section 4.2.2.1).
2. Disconnect connector CN1 from the SANPS(E) board. This connector connects the board to the power switch.
3. Disconnect connector CN2 from the SANPS(E) board. This connector connects the board to the SAMA board.
4. Remove the CBS(c) (M3 x 8) screws securing the SANPS(E) board, and then remove the board.

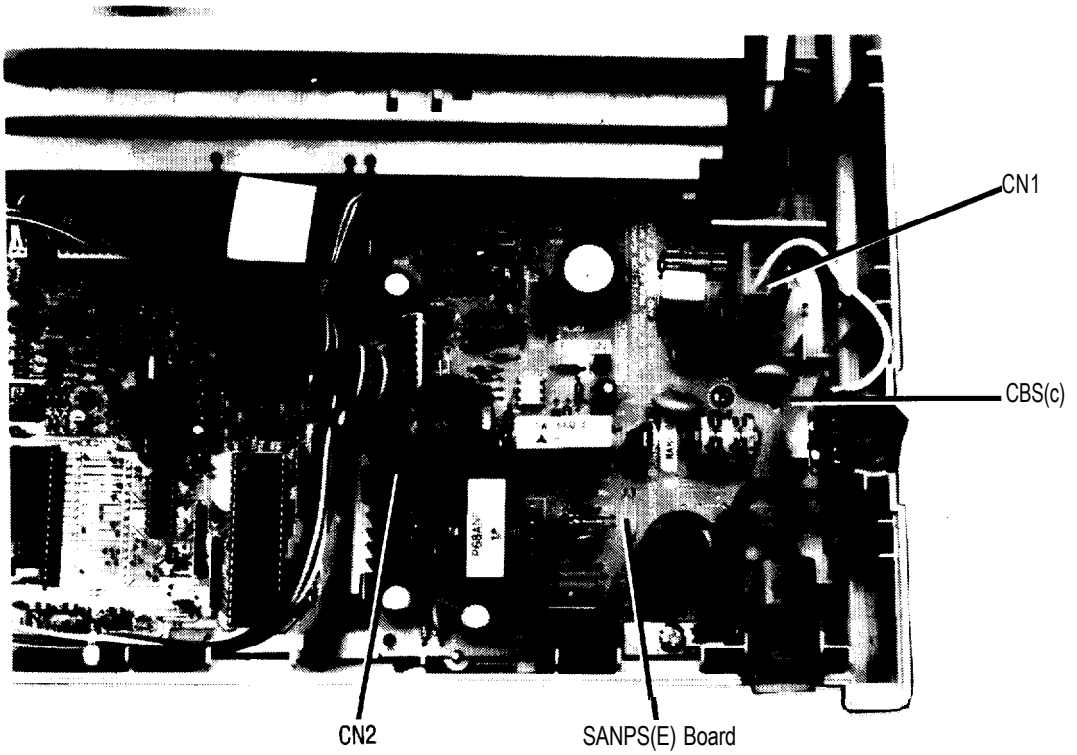


Figure 4-10. SANPS(E) Board Removal

4.2.4 REMOVAL OF PRINTER MECHANISM

This section describes the removal of the platen unit, paper guide, and printer mechanism. The platen unit and paper guide are removed first to enable quick and easy removal of the printer mechanism.

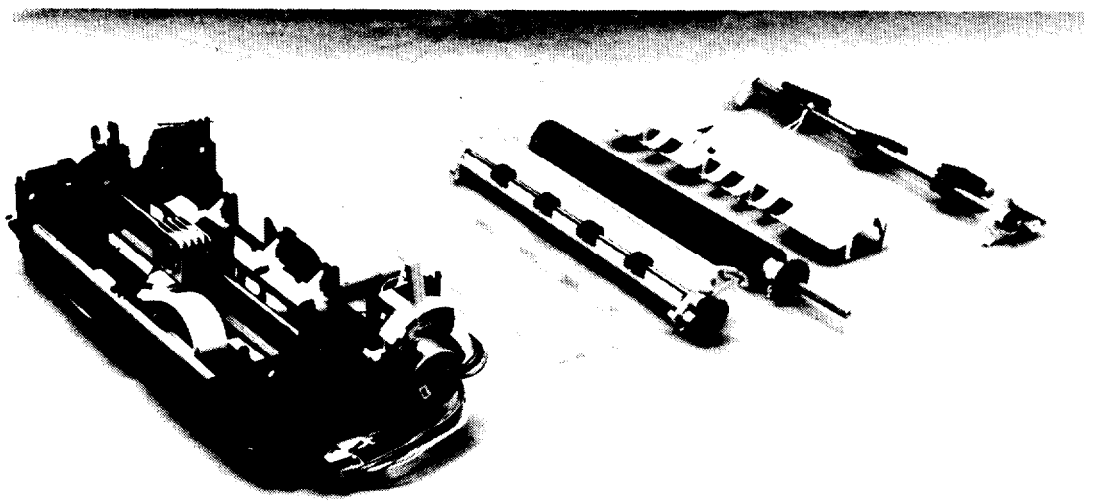


Figure 4-11. Printer Mechanism Removal

4.2.4.1 Removal of Platen Unit and Paper Guide

1. Remove the upper case (refer to Section 4.2.1.1).
2. Remove the cover of the paper tension unit.

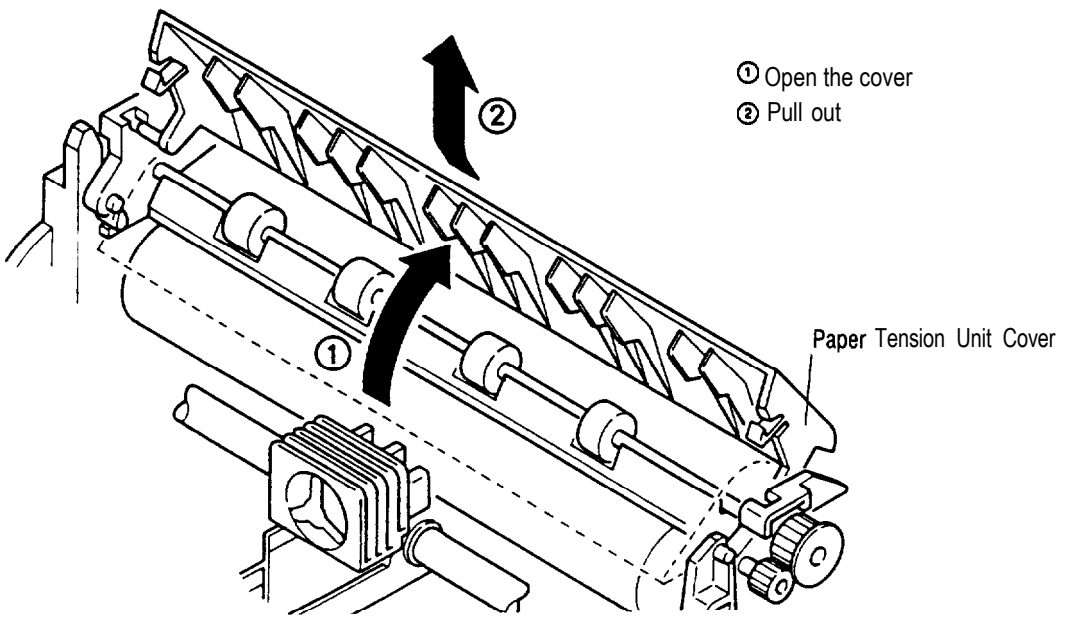


Figure 4-12. Removal of Paper Tension Unit Cover

3. Remove the paper tension unit.
   a. Lift **up** gently on the locking tabs at the rear left and right ends of the paper tension unit to release unit from the printer mechanism.
   b. Roll paper tension unit toward printhead and lift straight up.

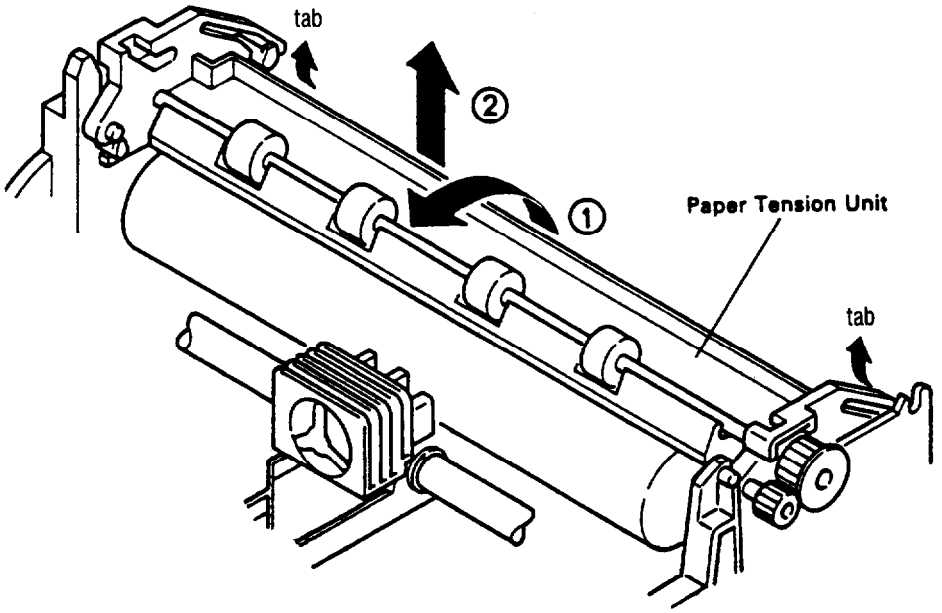


Figure 4-13. Paper Tension Unit Removal

4. Turn the shaft holders at the left and right sides of the platen unit as shown in Figure 4-14. Lift and remove the platen unit.
   a. Use a screwdriver to push the shaft holder outward.
   b. Turn the shaft holder counterclockwise.

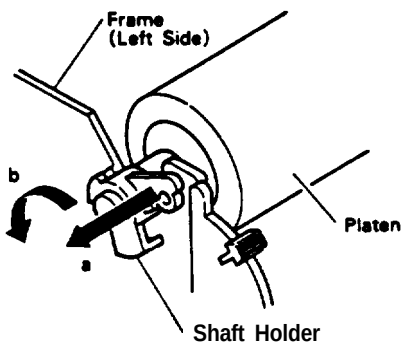


Figure 4-14. Platen Unit Removal

5. Disconnect the cable from CN13 on the SAMA board.
6. Unlock the two notches of the paper guide by pushing them forward from the rear side of the printer mechanism. Remove the paper guide.

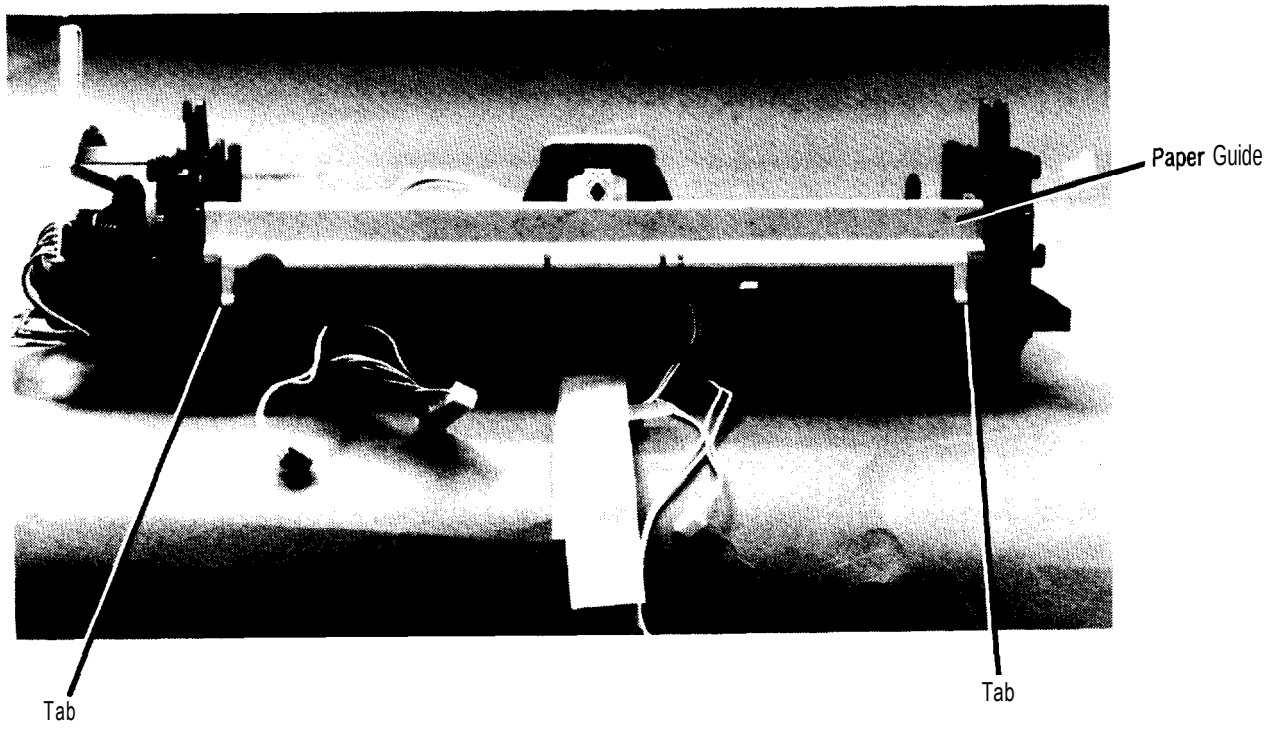


Figure 4-15. Rear View of Printer Mechanism

REQUIRED ADJUSTMENT

If, following the reinstallation or replacement of the platen unit, problems occur (such as non-uniformity of print density), adjust the platen gap. Platen gap adjustment is detailed in Section 4.3.1.

4.2.4.2 Removal of Printer Mechanism

1. Remove the platen unit and paper guide (see Section 4.2.4.1).
2. Disconnect the cables from the following connectors on the SAMA board: CN5 (red), CN6 (yellow), CN7 (white), CN8 (flexible flat cable, or "FFC"), CN9 (FFC), and CN12 (white). Refer to Figure 4-8.
3. Disconnect the cable at the base plate. This cable connects the SAMA board to the printer mechanism. Refer to Figure 4-6.
4. With a screwdriver, push and loosen the six tabs securing **the** printer mechanism to the lower case. For easiest removal, follow the procedure below.

WARNING

Be sure to push the tabs GENTLY, so not to damage the lower case or printer mechanism.

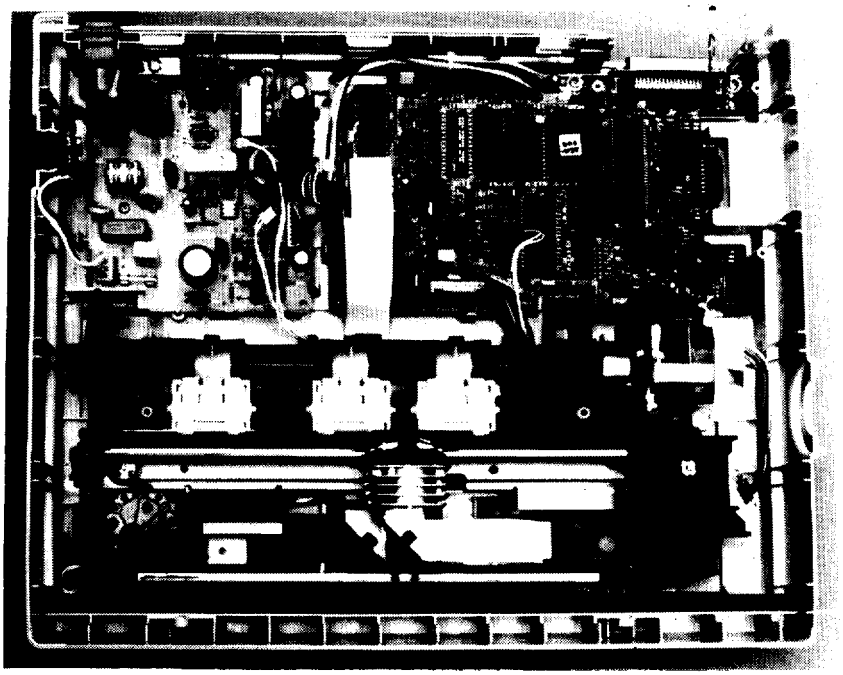


Figure 4-18. Printer Mechanism Removal

a. Loosen tabs 1 and 2, and lift the left side of the frame about half an inch (1 cm) above the lower case.
b. Loosen tab 3, and raise the left side farther, so that it is about 2.5 inches (6 cm) above the lower case.
c. Loosen tabs 4, 5, and 6, and remove the printer mechanism.

4.2.5 DISASSEMBLY OF PRINTER MECHANISM

This section details the removal of components from the printer mechanism. Figure A-32 shows an exploded diagram of the printer mechanism, illustrating the various components. Table A-22 lists the components by name.

4.2.5.1 Removal of the Paper-Feed Mechanism

1. Remove the printer mechanism (refer to Section 4.2.4).
2. Remove the three paper-feed rollers from the frame.

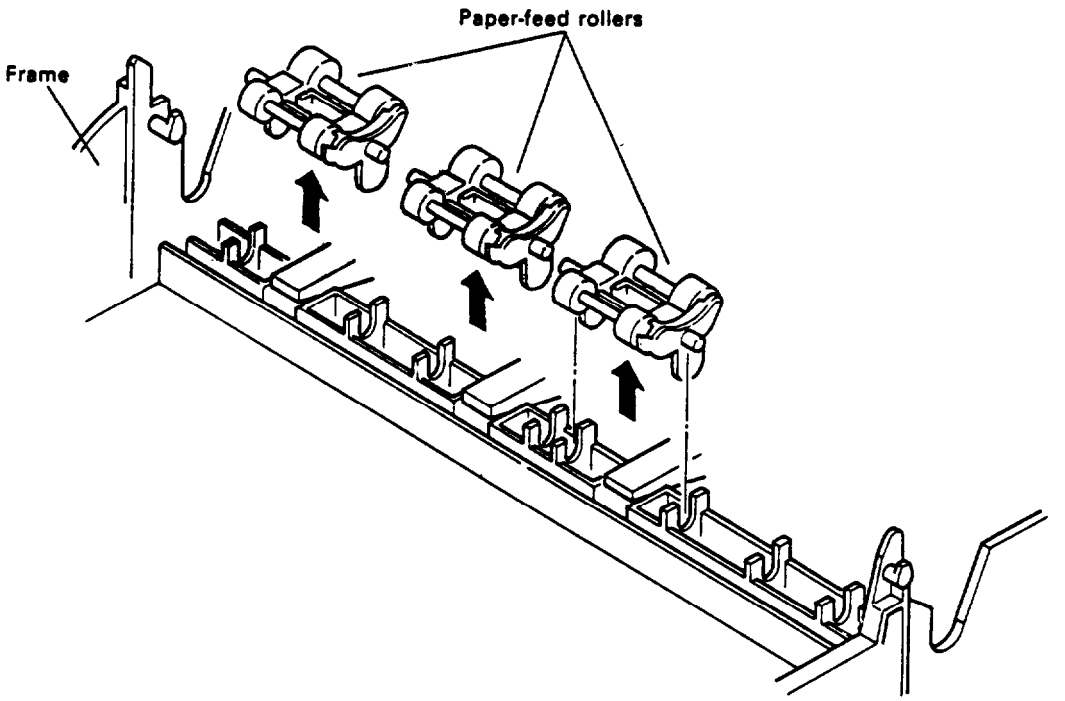


Figure 4-17. Removal of Paper-Feed Rollers

3. Loosen the two tabs securing the paper guide plate and spacer to the frame, and lift and remove the plate.

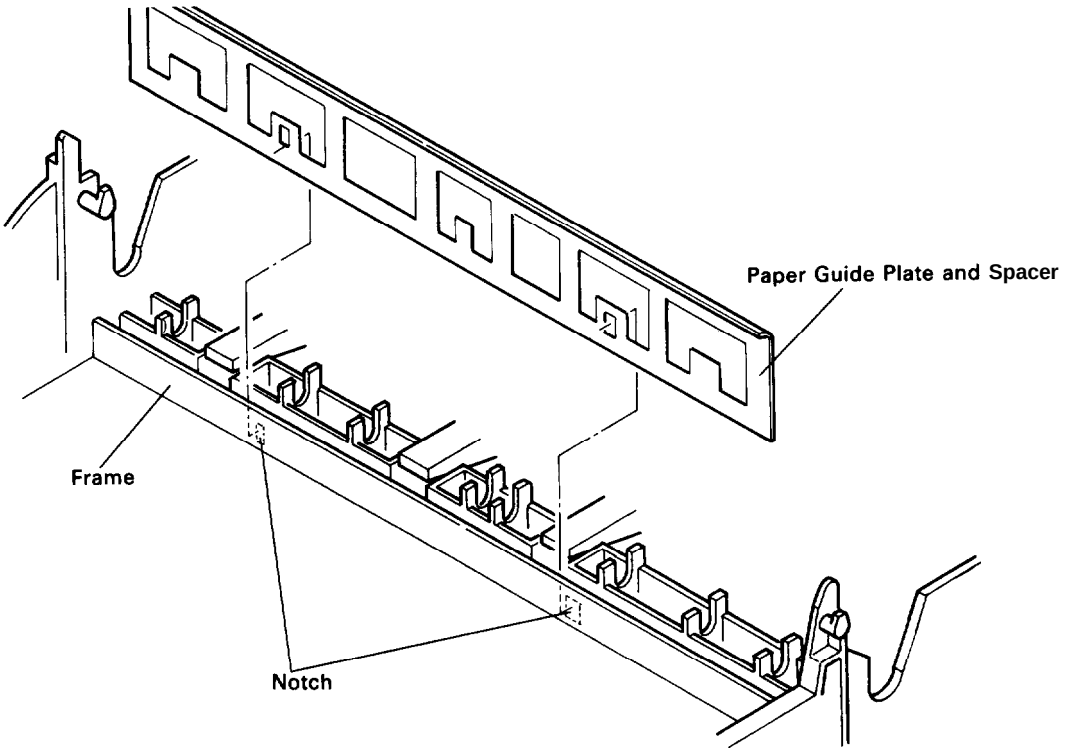


Figure 4-18. Removal of Paper Guide Plate

NOTES FOR REASSEMBLY

When remounting the paper guide plate and spacer to the frame, refer to Figure 4-19 for the mounting direction.

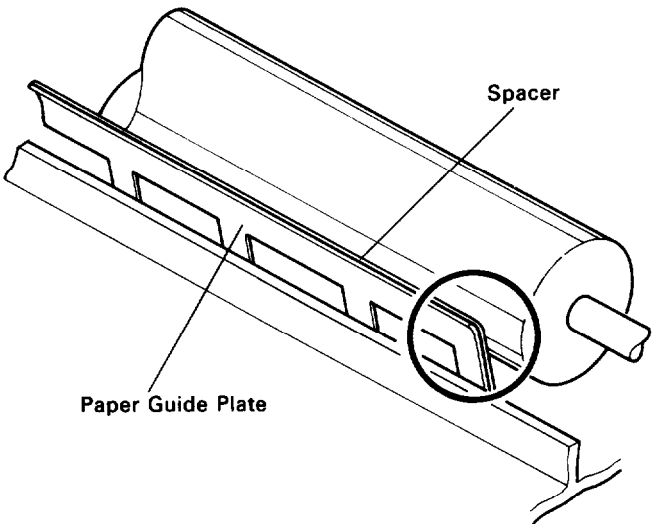


Figure 4-19. Mounting Direction for Paper Guide Plate

4.2.5.2 Removal of Paper-Feed Motor, Release Lever, and Release/Tractor Sensor

1. Remove the printer mechanism (refer to Section 4.2.4).
2. Disconnect the motor cable from the paper-feed motor.
3. Loosen the two bent tabs on the frame securing the paper-feed motor, and remove the paper-feed motor.

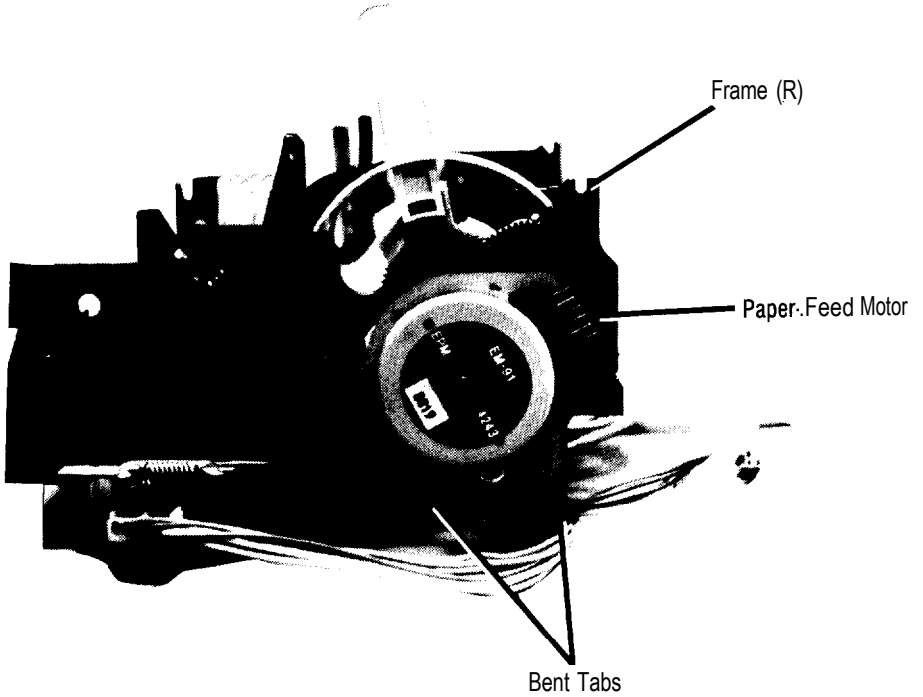


Figure 4-20. Removal of Paper-Feed Motor

4. Remove the tractor reduction gear spring, the tractor reduction gear, and the paper-feed reduction gear.

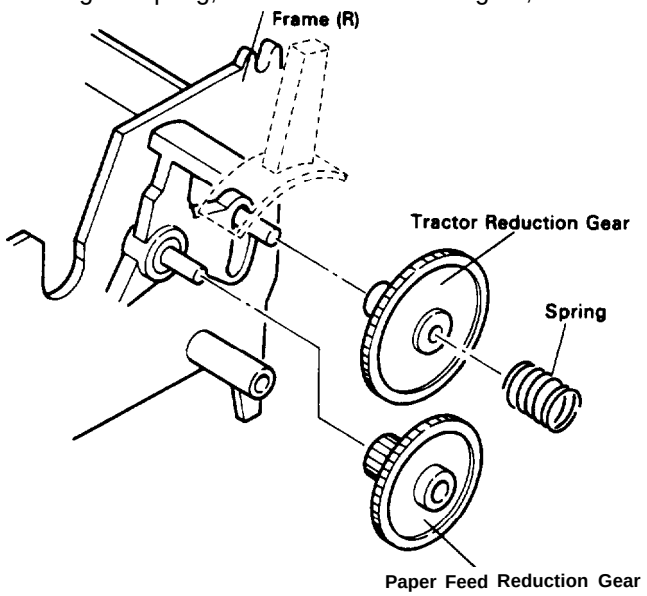


Figure 4-21. Spring and Gear Removal

5. From the inside of the frame, push the notch of the release lever outward. Remove the release lever.

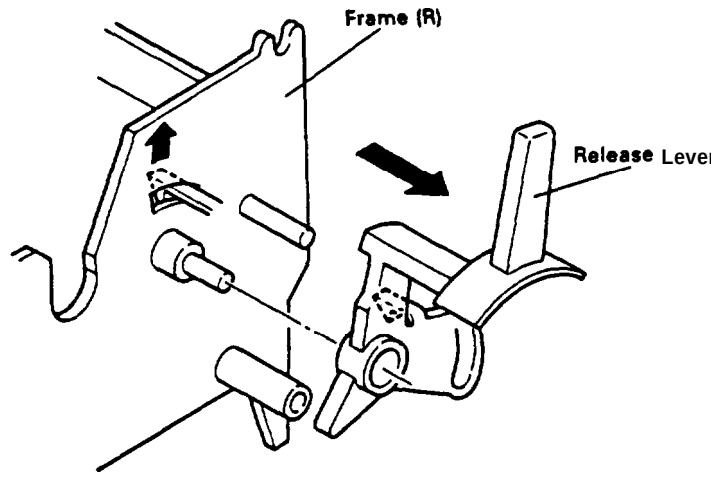


Figure 4-22. Removal of the Release Lever

6. Push the two notches securing the release/tractor sensor, and remove the sensor.

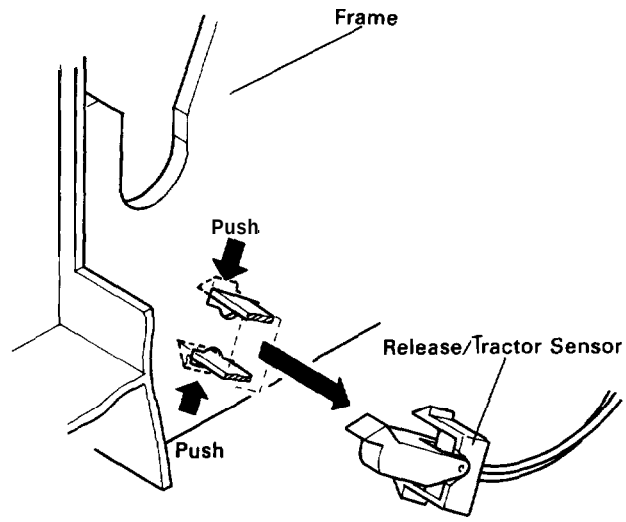


Figure 4-23. Removal of Release/Tractor Sensor

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 guide. Using point A (refer to the figure below) as a fulcrum, rotate the sensor in the direction indicated by the arrow, and remove it.

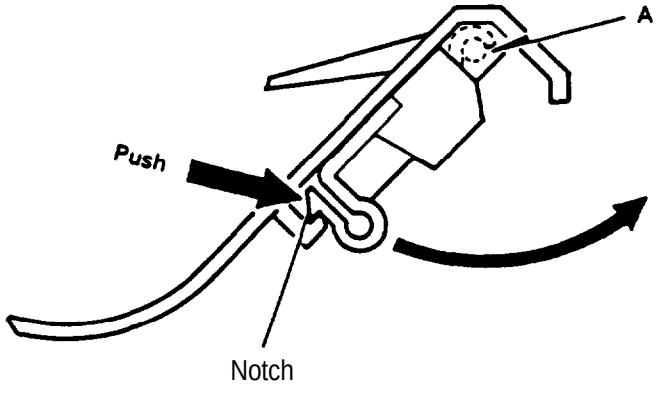


Figure 4-24. Removal of Paper-End Sensor

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.
3. Pull out the platen gear on 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.

NOTES FOR REASSEMBLY

When reassembling the platen unit, refer to Figure 4-25 and be sure that the flat spring and shaft holder are installed correctly. Verify that the gap between the platen and the platen gear is adequate.

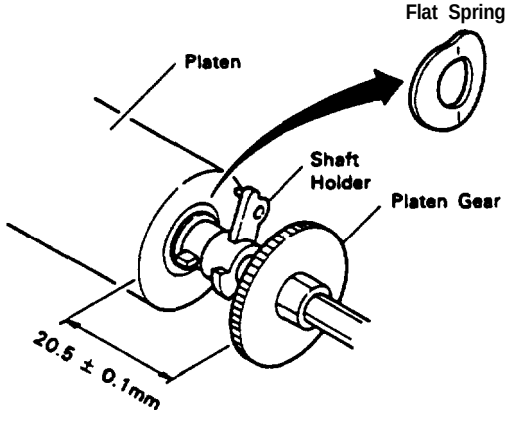


Figure 4-25. Platen Unit Reassembly

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 upside down, and manually move the carriage unit until it is at the cut-out section of the carriage motor frame, The joint of the carriage unit and timing belt should be visible through the cut-out.

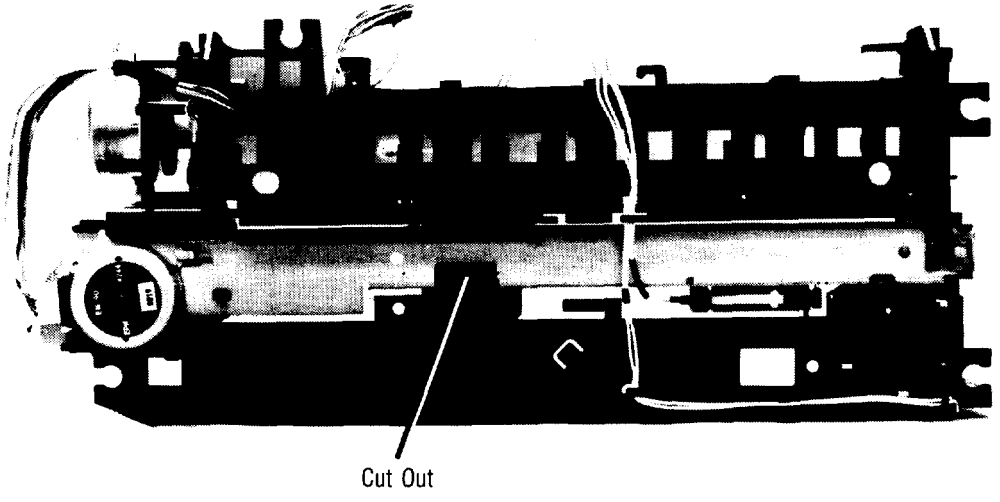


Figure 4-26. Bottom View of Printer Mechanism

4. Using round-nose pliers, detach the timing belt from the carriage unit. Be careful not to cause any damage.
5. Lift portion A (see Figure 4-27) of the carriage guide shaft ground plate to free the plate from the notch on the carriage motor frame. Slide the plate so that it can be removed from the frame (through the cut-out at portion B of the plate).

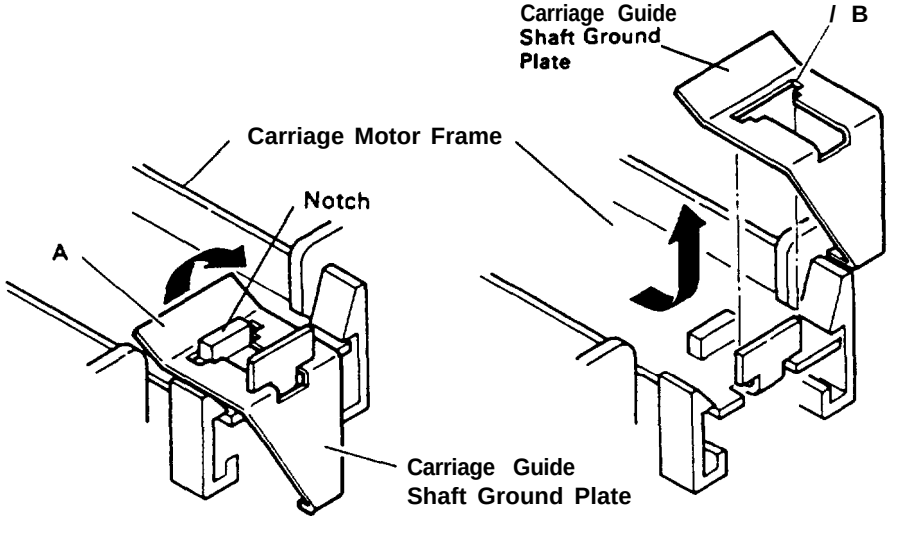


Figure 4-27. Removal of Carriage Guide Shaft Ground Plate

6. Turn the printer mechanism over so that it is again face up. Rotate the lever on the left side of the carriage guide shaft counterclockwise, and pull it out through cut-out A. Rotate the lever on the right side of the guide shaft clockwise, and remove it in the same way.

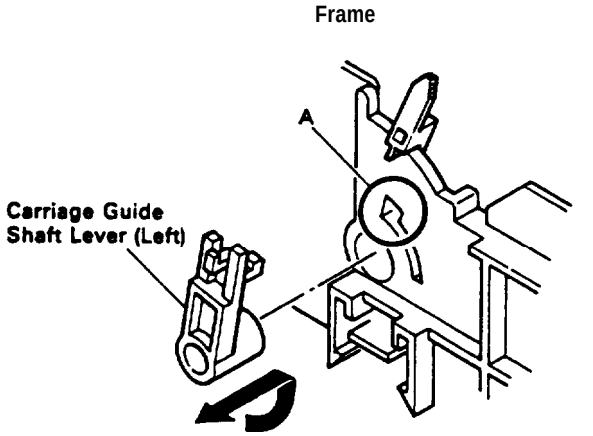


Figure 4-28. Removal of Carriage Guide Shaft

7. Push the notch on the frame that is securing the carriage guide plate, and slide the plate to remove it.

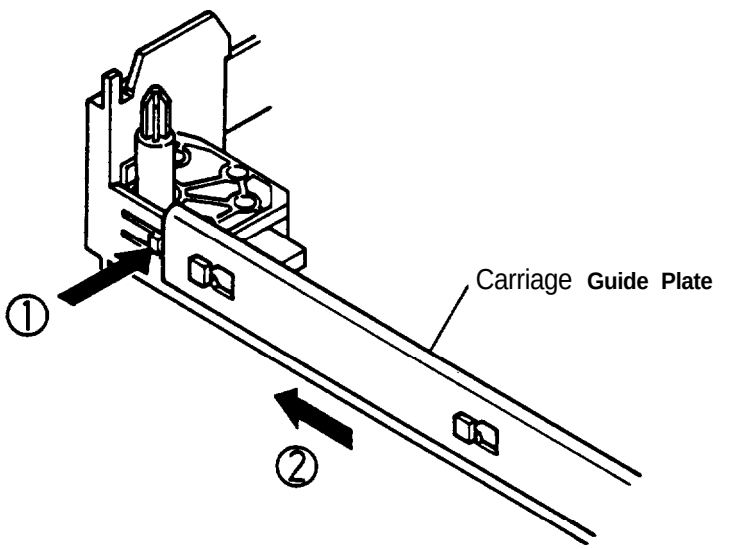


Figure 4-29. Removal of Carriage Guide Plate

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

NOTES FOR REASSEMBLY

1. When reinstalling, position the carriage guide shaft and the head adjust lever as shown in Figure 4-30.

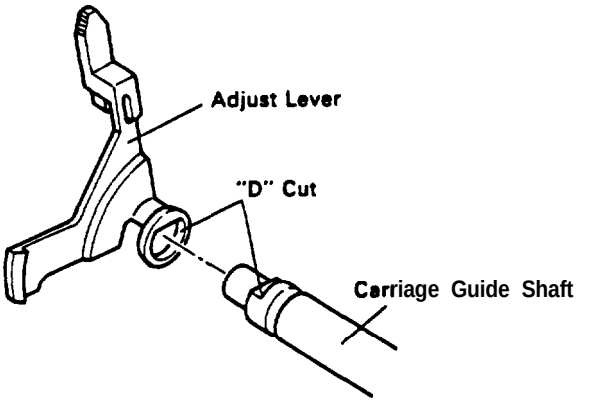


Figure 4-30. Carriage Guide Shaft and Head Adjust Lever

2. The lever for the left side of the guide shaft is gray; the lever for the right side is black. Slide each lever onto the appropriate side of the shaft.
3. When connecting the head cable, be sure to pass it correctly through the FFC guide on the frame.

REQUIRED ADJUSTMENT

Following reassembly of the carriage unit adjust the platen gap Platen gap adjustment is detailed in

4.2.5.6 Removal of Carriage Motor

1. Perform steps 1 to 5 of Section 4.2.5.4.
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 4-31.)
3. With a screwdriver, loosen the four tabs securing the carriage motor frame to the chassis frame. Remove the carriage motor frame.

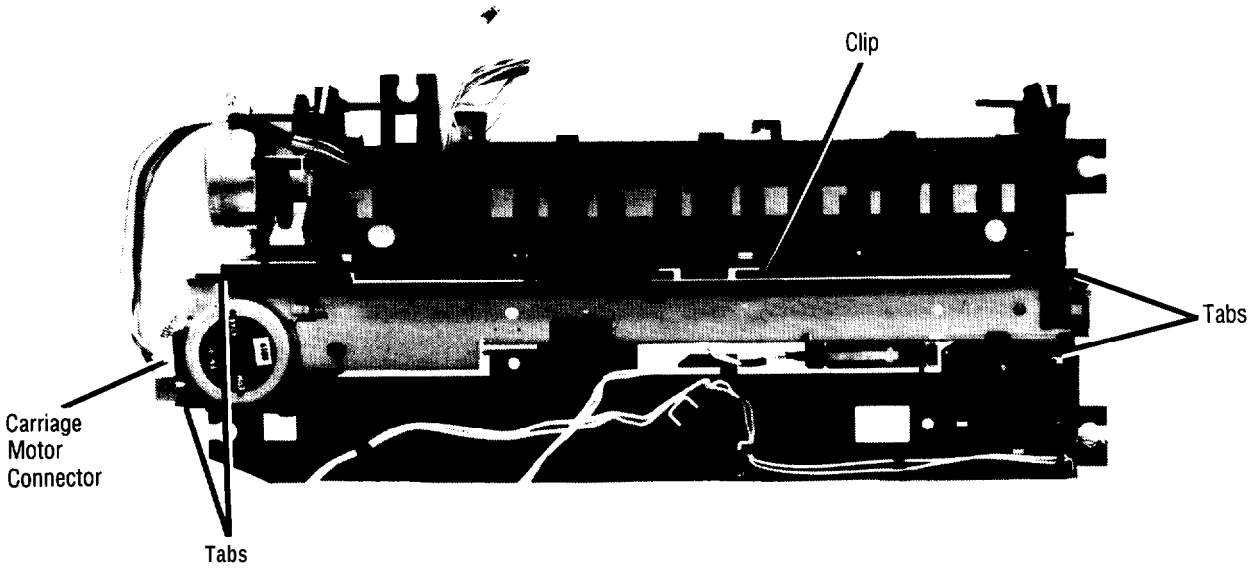


Figure 4-31. Carriage Motor Frame Removal

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 shaft holder, belt pulley, and timing belt.

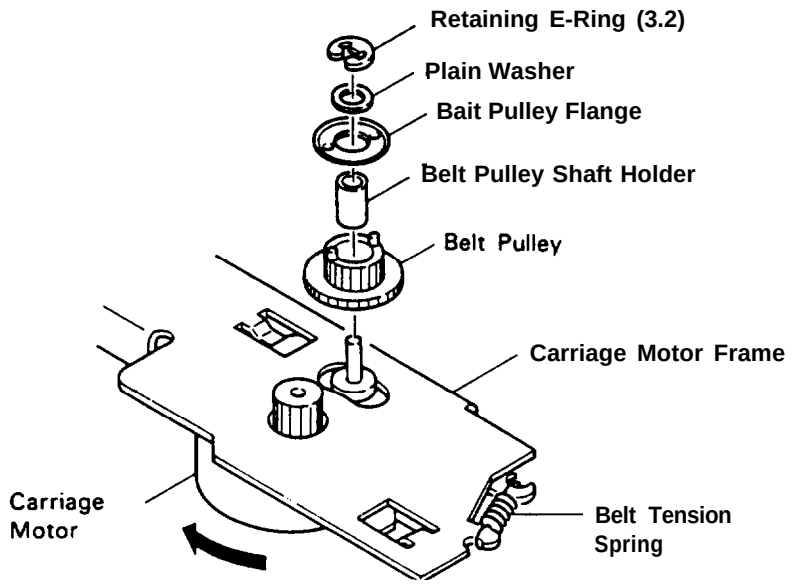


Figure 4-32. Removal of Carriage Motor

5. Remove the carriage motor by moving it in the direction shown by the arrow above.

NOTES FOR REASSEMBLY

The following apply to E-ring reattachment:

- When attaching a ring to the left pulley shaft, place it so that its opening faces left.
- When attaching a ring to the right pulley shaft, place it so that its opening faces right.
- Use tweezers to check that the attached retaining rings are firmly in place and will not move.

4.2.5.7 Removal of Home-Position Sensor

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

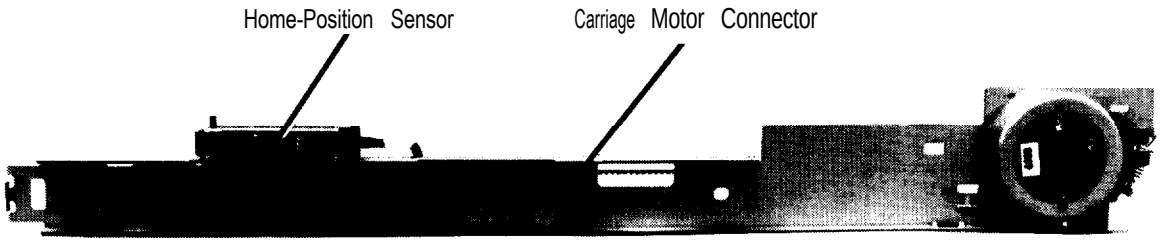
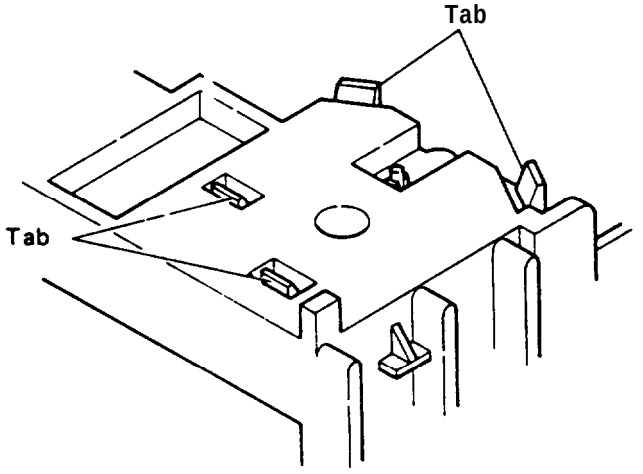


Figure 4-33. Removal of Home-Position Sensor

4.2.5.8 Disassembly of Ribbon-Feed Mechanism

1. Remove the printer mechanism (refer to Section 4.2.4.2).
2. Turn the printer mechanism upside down, and use a screwdriver to loosen the four bent tabs securing the ribbon gear cover slightly. Only loosen the tabs slightly, and do not yet remove the cover. If the cover is removed while the printer mechanism is upside down, the gears will scatter.



(Bottom view of printer mechanism)

Figure 4-34. Removal of Ribbon Gear Cover

3. Turn the printer mechanism over so that it is again face up, then lift and remove the ribbon gear **cover.**

4.2.5.9 Disassembly of the Tractor Unit

1. Remove the E-ring on the tractor shaft.
2. Pull and remove the tractor shaft from the tractor frame.
3. Pull and remove the sprocket guide shaft from the tractor frame.

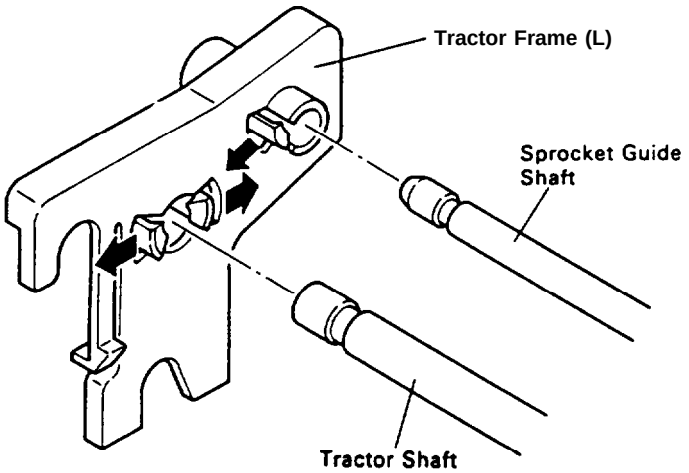


Figure 4-35. Removal of Tractor Frame L

4. Remove tractor set L, the paper support, and tractor set R from the tractor and sprocket guide shafts.

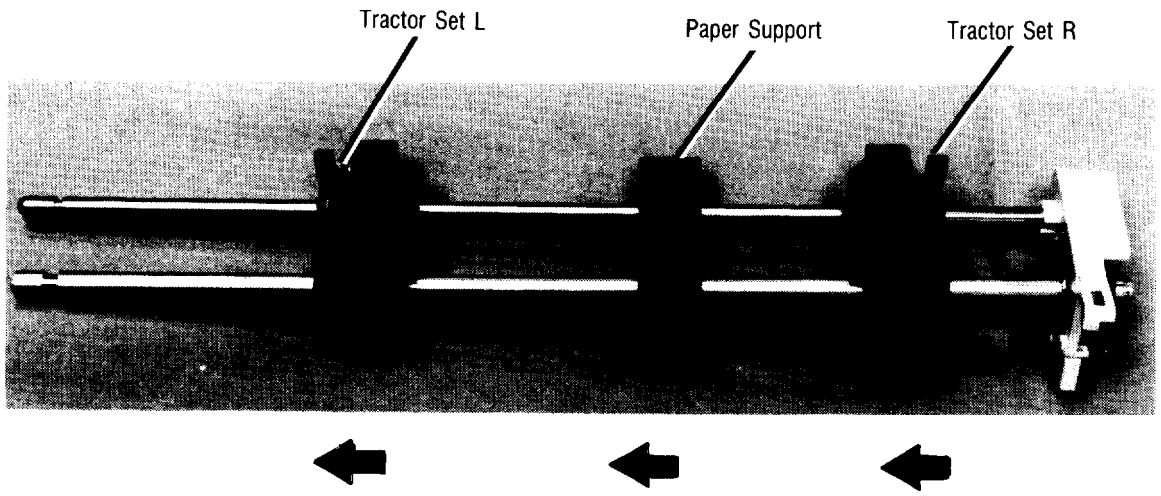


Figure 4-36. Removal of Tractor Set L, Paper Support, and Tractor Set R

NOTES FOR REASSEMBLY

When reassembling, align the phases **as** shown below.

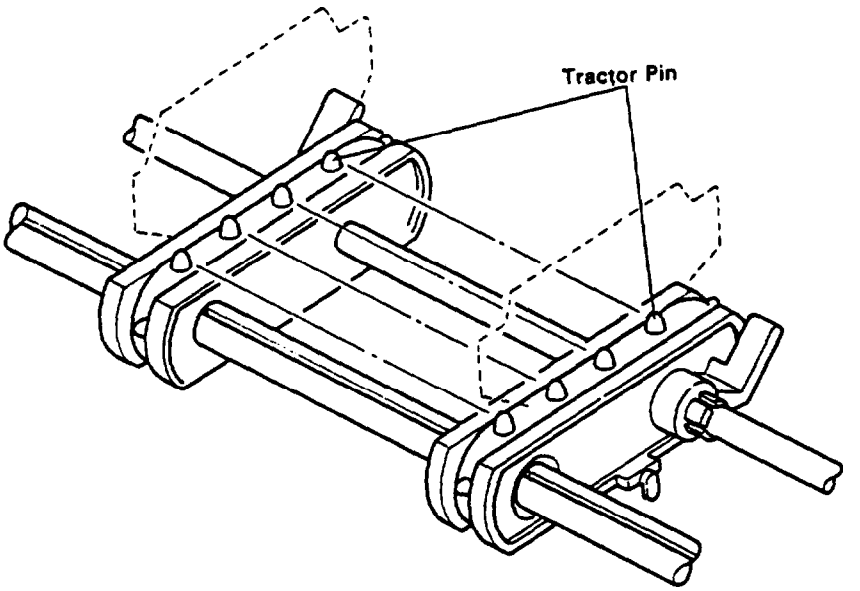


Figure 4-37. Tractor Phase Alignment

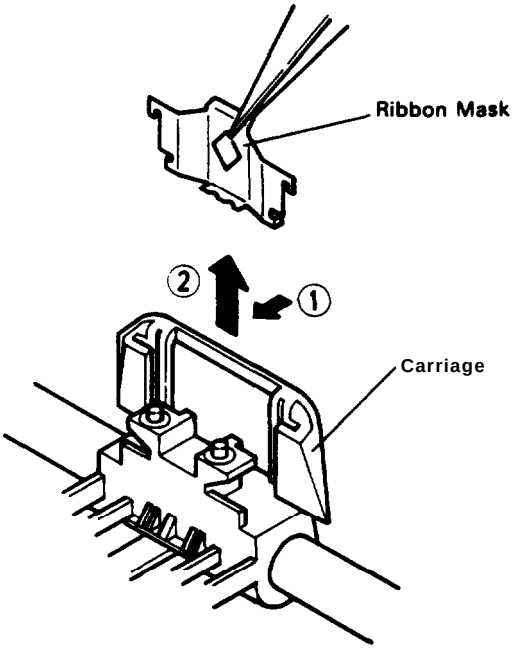
4.3 ADJUSTMENT

This section describes the adjustment procedures necessary when the LQ-510 printer is reassembled or when parts are reinstalled or replaced. These procedures are necessary to ensure the correct operation of the printer.

4.3.1 PLATEN GAP ADJUSTMENT

Following the removal of the carriage guide shaft or carriage guide shaft levers, or if printing is abnormal, adjust the gap between the platen and the printhead.

1. Remove the printhead. Using tweezers, remove the ribbon mask by pulling it slightly **forward,** then lifting.



2. **Reinstall the printhead.**
3. **Set the head adjust lever to the second position.**
4. **Set the release lever to the friction-feed position (back position).**
5. Manually move the carriage **to** column 10.
6. **M-5710 Mechanism:**
   Adjust the platen so that the gap between the head and the platen allows unimpeded insertion of the 0.44 mm gap gauge, but does not allow insertion of the 0.47 mm gap gauge.

   M-5711 Mechanism:
   Adjust the platen so that the gap between the head and the platen allows unimpeded insertion of the 0.42 mm gap gauge, but does not allow insertion of the 0.45 mm gap gauge.

CAUTION

When positioning the carriage guide shaft lever, do not try to insert tabs A and B into the notch at the same time. The design allows only one of the tabs to enter.

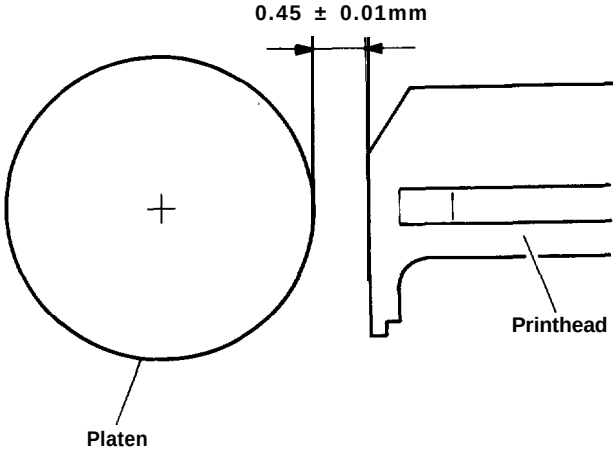


Figure 4-39. Platen Gap

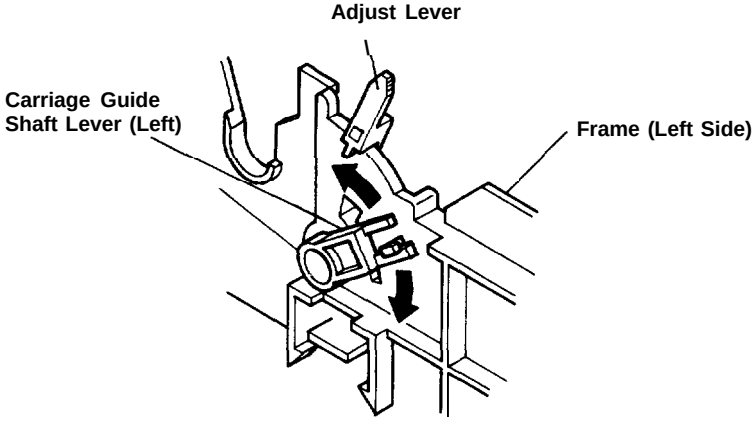


Figure 4-40. Carriage Guide Shaft Lever Movement

Carriage guide shaft (left):	Clockwise rotation widens gap. Counterclockwise rotation narrows gap.
Carriage guide shaft (right):	Clockwise rotation narrows gap. Counterclockwise rotation widens the gap.

Perform gap adjustment at the 10th and 70th column positions and also at the center of the platen. The gaps at all three positions should match.

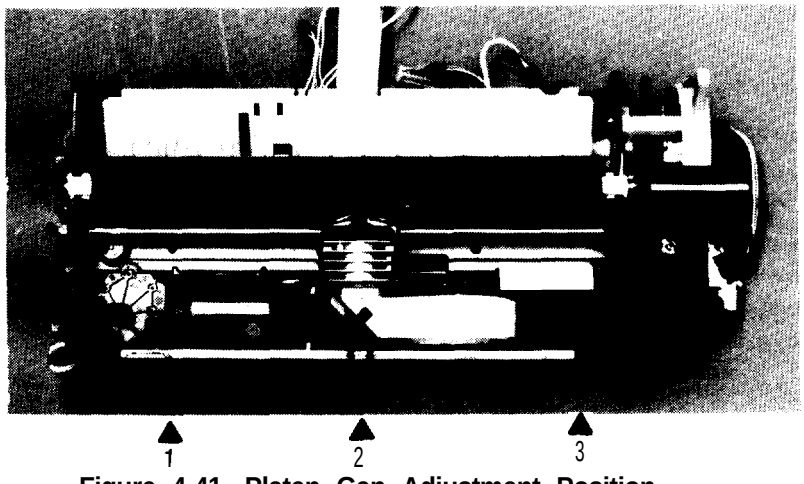


Figure 4-41. Platen Gap Adjustment Position

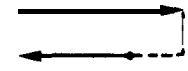
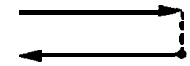
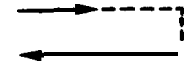
4.3.2 ADJUSTMENT OF BIDIRECTIONAL PRINTING ALIGNMENT

This this type of adjustment must be performed when bidirectional printing results in misaligned lines or characters. This adjustment is also required following replacement of the SAMA board or of the printing mechanism.

4.3.2.1 Bidirectional Adjustment DIP Switch

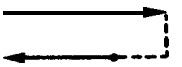
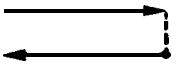
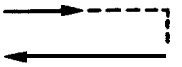
Bidirectional printing alignment is adjusted using the bidirectional adjustment DIP switches on the SAMA board. DIP SWs 1-1, 1-2, 1-3, and 1-4 are for draft mode, and DIP SWs 1-5, 1-8, 1-7, and 1-8 are for LQ mode. Tables 4-5 and 4-8 show the specifications for DIP switch settings. Note that misalignment generally occurs when the carriage is moving from left to right.

Table 4-5. Draft Mode

Control, Value	DIP SW				Direction and Value of Shift	
	I-I	1-2	1-3	1-4		
- 7	ON	ON	ON	ON	$^{7}/_{240}$ inch	
- 6	ON	ON	ON	OFF	$^{6}/_{240}$ inch	
- 5	ON	ON	OFF	ON	$^{5}/_{240}$ inch	
- 4	ON	ON	OFF	OFF	$^{4}/_{240}$ inch	
- 3	ON	OFF	ON	ON	$^{3}/_{240}$ inch	Printing starts $^{n}/_{240}$ inch to the left of the reference position.
- 2	ON	OFF	ON	OFF	$^{2}/_{240}$ inch	
-1	ON	OFF	OFF	ON	$^{1}/_{240}$ inch	
0	ON	OFF	OFF	OFF	Normal position	 Printing starts here (reference position).
+1	OFF	OFF	OFF	ON	$^{1}/_{240}$ inch	
+ 2	OFF	OFF	ON	OFF	$^{2}/_{240}$ inch	
+ 3	OFF	OFF	ON	ON	$^{3}/_{240}$ inch	
+ 4	OFF	ON	OFF	OFF	$^{4}/_{240}$ inch	
+5	OFF	ON	OFF	ON	$^{5}/_{240}$ inch	Printing starts n/240 inch to the right of the reference position.
+ 6	OFF	ON	ON	OFF	$^{6}/_{240}$ inch	
+ 7	OFF	ON	ON	ON	$^{7}/_{240}$ inch	

NOTE: If all DIP switches are OFF, the control values will be set to the provisional test values.

Table 4-6. LQ Mode

Control Value	DIP SW				Direction and Value of Shift	
	1-5	1-6	1-7	1-6		
- 7	ON	ON	ON	ON	7/720 inch	
- 6	ON	ON	ON	OFF	**6/720** inch	
- 5	ON	ON	OFF	ON	5/720 inch	
- 4	ON	ON	OFF	OFF	4/720 inch	
- 3	ON	OFF	ON	ON	3/720 inch	Printing starts n/720 inch to the left of the reference position.
- 2	ON	OFF	ON	OFF	**2/720** inch	
- 1	ON	OFF	OFF	ON	**1/720** inch	
0	ON	OFF	OFF	OFF	Normal position	 Printing starts here (reference position).
+1	OFF	OFF	OFF	ON	**1/720** inch	
+2	OFF	OFF	ON	OFF	2/720 inch	
+3	OFF	OFF	ON	ON	**3/720** inch	
+4	OFF	ON	OFF	OFF	**4/720** inch	
+5	OFF	ON	OFF	ON	5/720 inch	Printing starts n/720 inch to the right of the reference position.
+6	OFF	ON	ON	OFF	**6/720** inch	
+7	OFF	ON	ON	ON	**7/720** inch	

NOTE: If all DIP switches are OFF, the control values will be set to the provisional test values.

4.3.4.2 Adjustment Procedures

Because the adjustment mode is incorporated into the unit, the following adjustment procedure requires no special equipment. All that is required is paper. The adjustment procedure is outlined in Figure 4-42. Note that the adjustment must be carried out twice - once for Draft mode (120 dpi) and once for LQ mode (360 dpi).

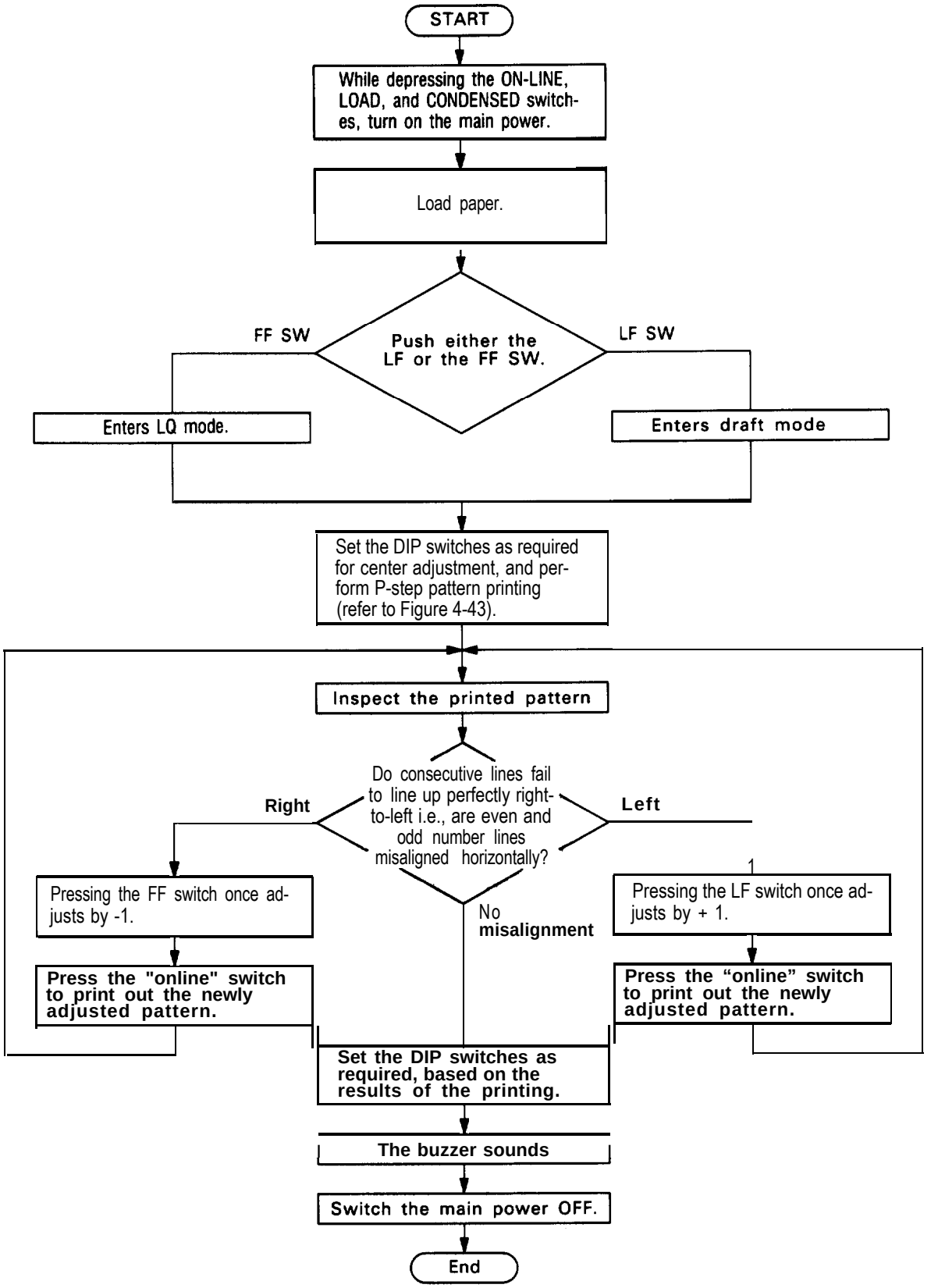


Figure 4-41. Procedure for Bidirectional Adjustment

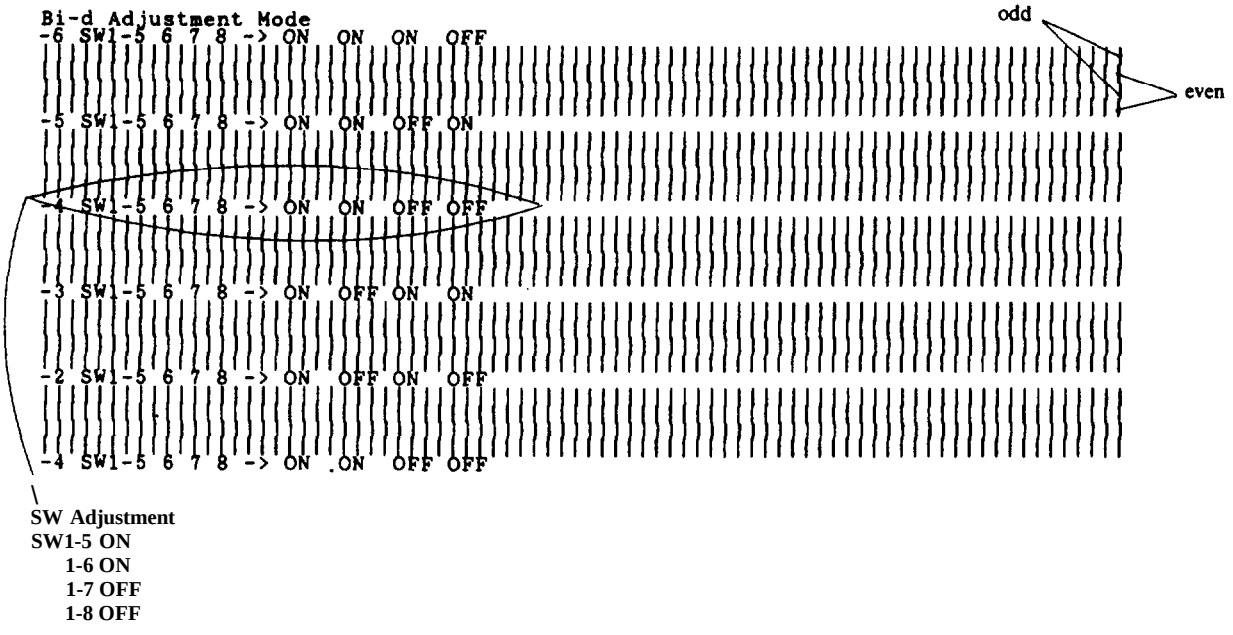


Figure 4-42. Bidirectional Adjustment Pattern

CHAPTER 5
TROUBLESHOOTING

LIST OF FIGURES

LIST OF TABLES

TROUBLESHOOTING 5

5.1 GENERAL

Troubleshooting is based on the concept that error symptoms vary according to the defective component. Troubleshooting may involve either unit replacement or unit repair, each of which is treated separately below. First try to determine the defective unit by referring to Section 5.2. The flow charts in the section should help you isolate the defective unit. Then refer to Section 5.3 for instructions for further checking and for replacement. Section 5.3 lists, for various symptoms, the potentially defective units that may account for them. In addition, the section mentions the appropriate waveforms and resistance values that should be checked for. If trouble occurs in the printer mechanism, refer to Section 5.3.3, which specifies procedures for identifying defective components, and the replacements, adjustments, and lubrication which should be carried out.

5.2 UNIT REPLACEMENT

This section correlates symptoms with the potentially defective units that may be causing them. The unit numbers are listed in Table 5-1.

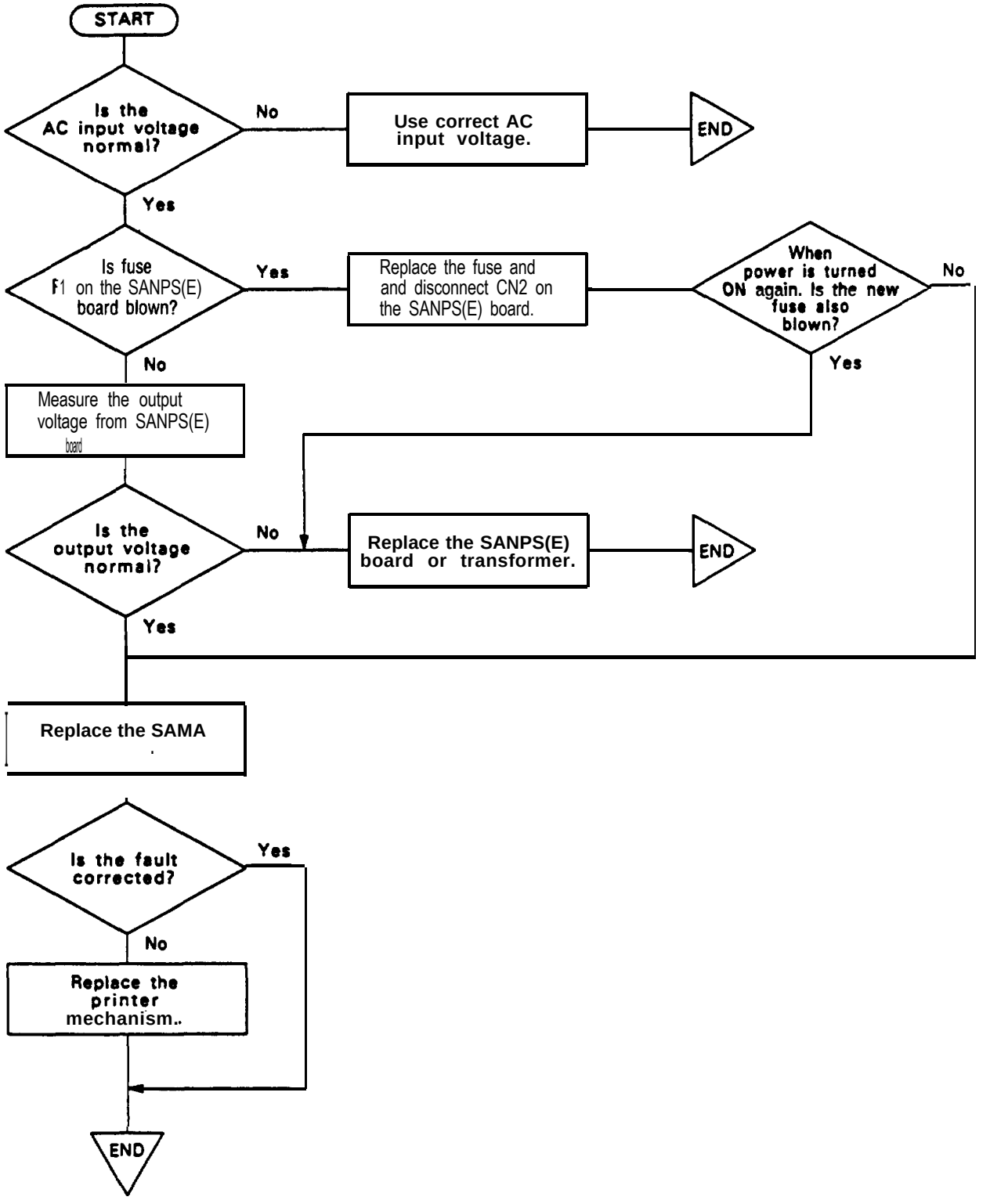
Table 5-1. Unit Replacement Numbers

Name of Unit	Description	Unit No.
SANPS Board	120 V Power Supply Board	Y567202000
SANPSE Board	220/240 V Power Supply Board	Y567204000
SAMA Board	Main Board	Y567201000
SANPNL-W	Control Panel Board	Y567502000
Model-5710	Printer Mechanism	Y567590200
Model-5710 (TUV)	Printer Mechanism	Y567590300
Printhead		F423400000
Printhead (TUV)		F423500000
Fuse (SANPS)	ULTSC2.0 A-N1	X502061011
Fuse (SANPSE)	BET 1.25A	X502063040

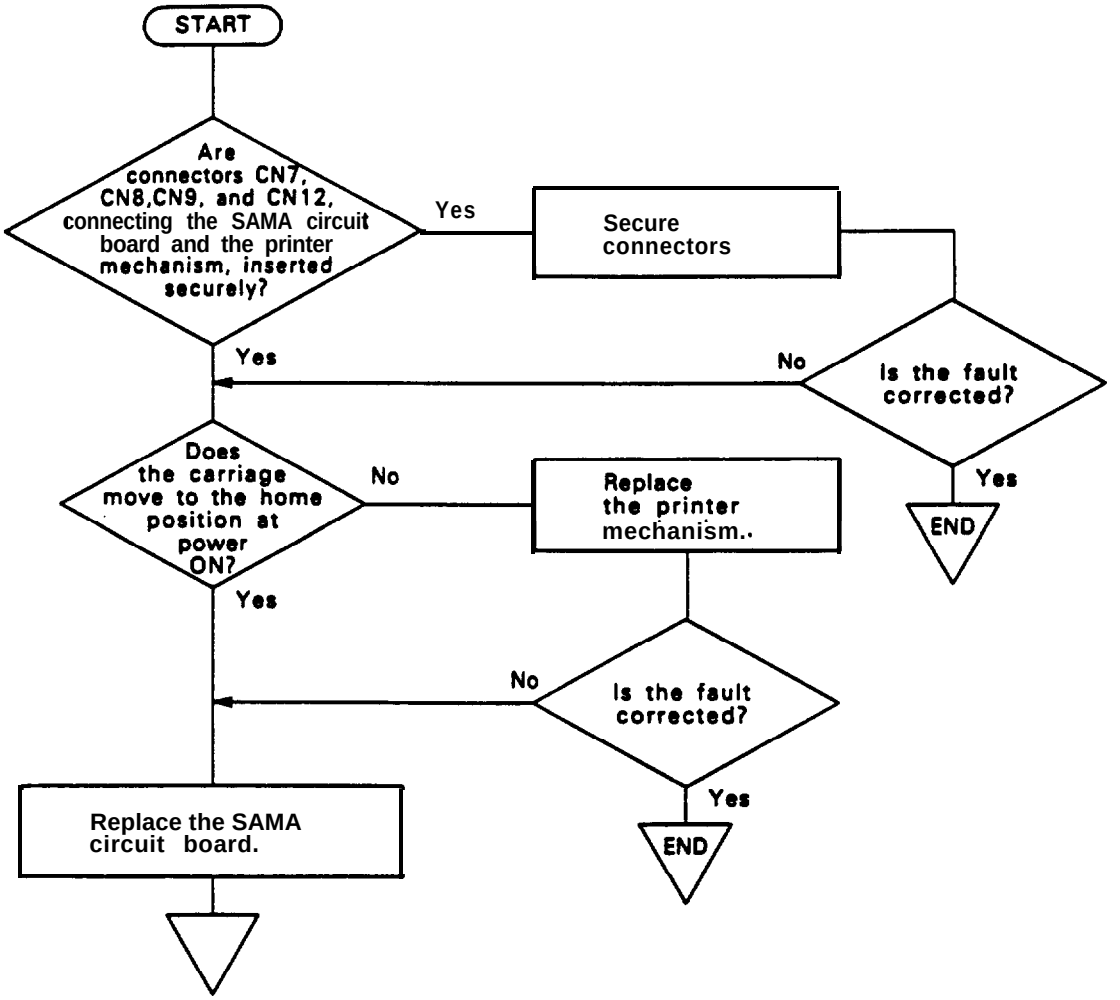
Table 5-2. Symptom and Reference Pages

Symptom	Problem	Reference Page
Printer fails to operate with power switch on.	• Carriage does not move. • Control panel indicator lamp does not light.	5-3
Abnormal carriage operation.	• Carriage moves away from home position at power on. • The carriage correctly returns to the home position, but the printer then fails to enter ready mode.	5-4
Faulty printing during self-test, but carriage operation is normal.	• No printing at all. • Faulty printing — some of the dots are not printed.	5-5
Abnormal paper feed.	• No paper is fed. • Irregular paper feed and variation in the separations between lines.	5-7
Abnormal control panel operation.	• When the LF or FF switch is activated in off-line mode, no paper is fed. • No operation mode is set from the control panel. • On-line or off-line mode cannot be activated.	5-8
Faulty printing in on-line mode.	• Carriage operates normally at power on, and self-test is executed correctly. • Print data from the computer, however, is not printed correctly.	5-9

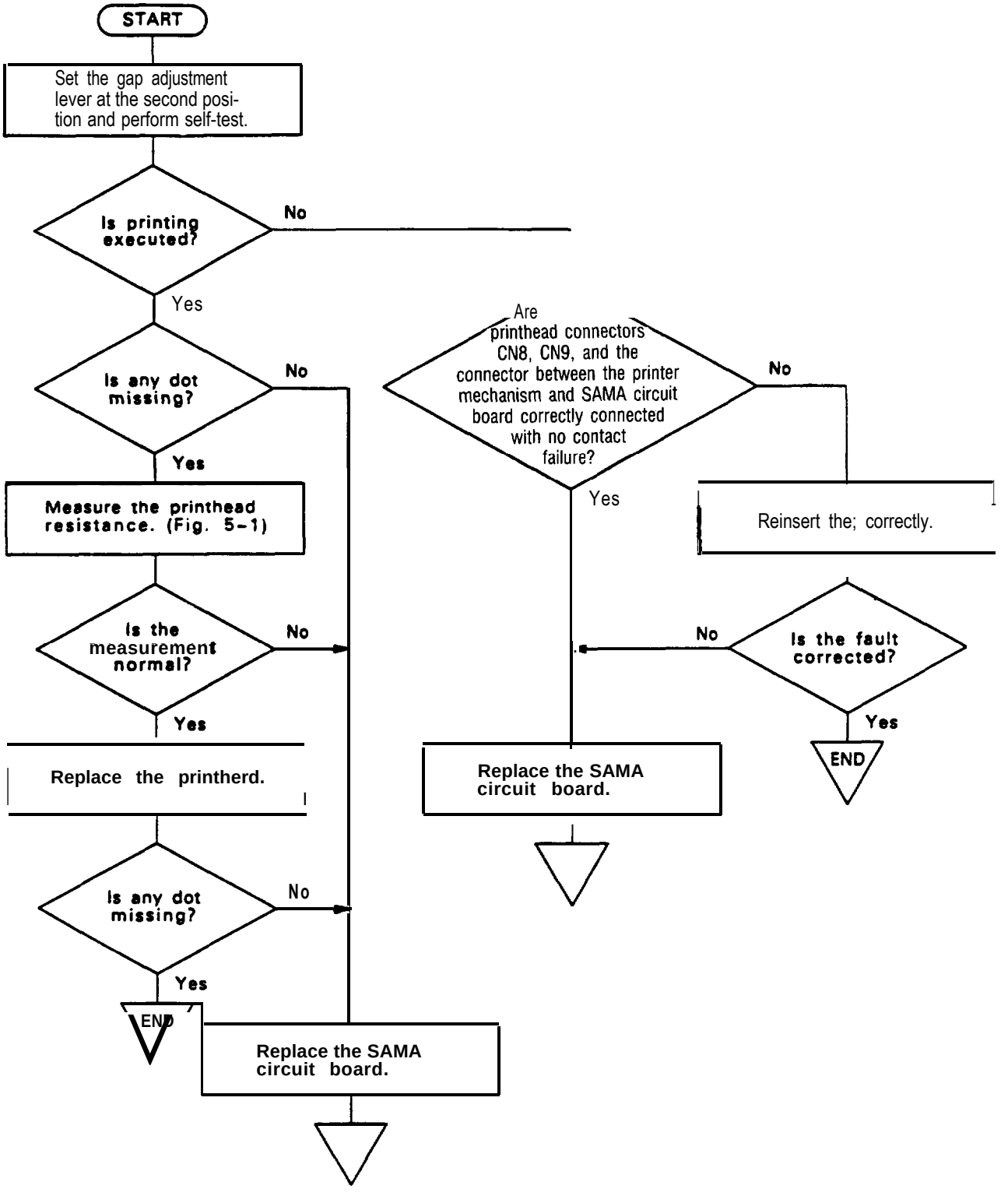
(1) Printer Fails to Operate with Power Switch on



(2) Abnormal Carriage Operation



(3) Faulty Printing During Self-Test, but Carriage Operation is Normal



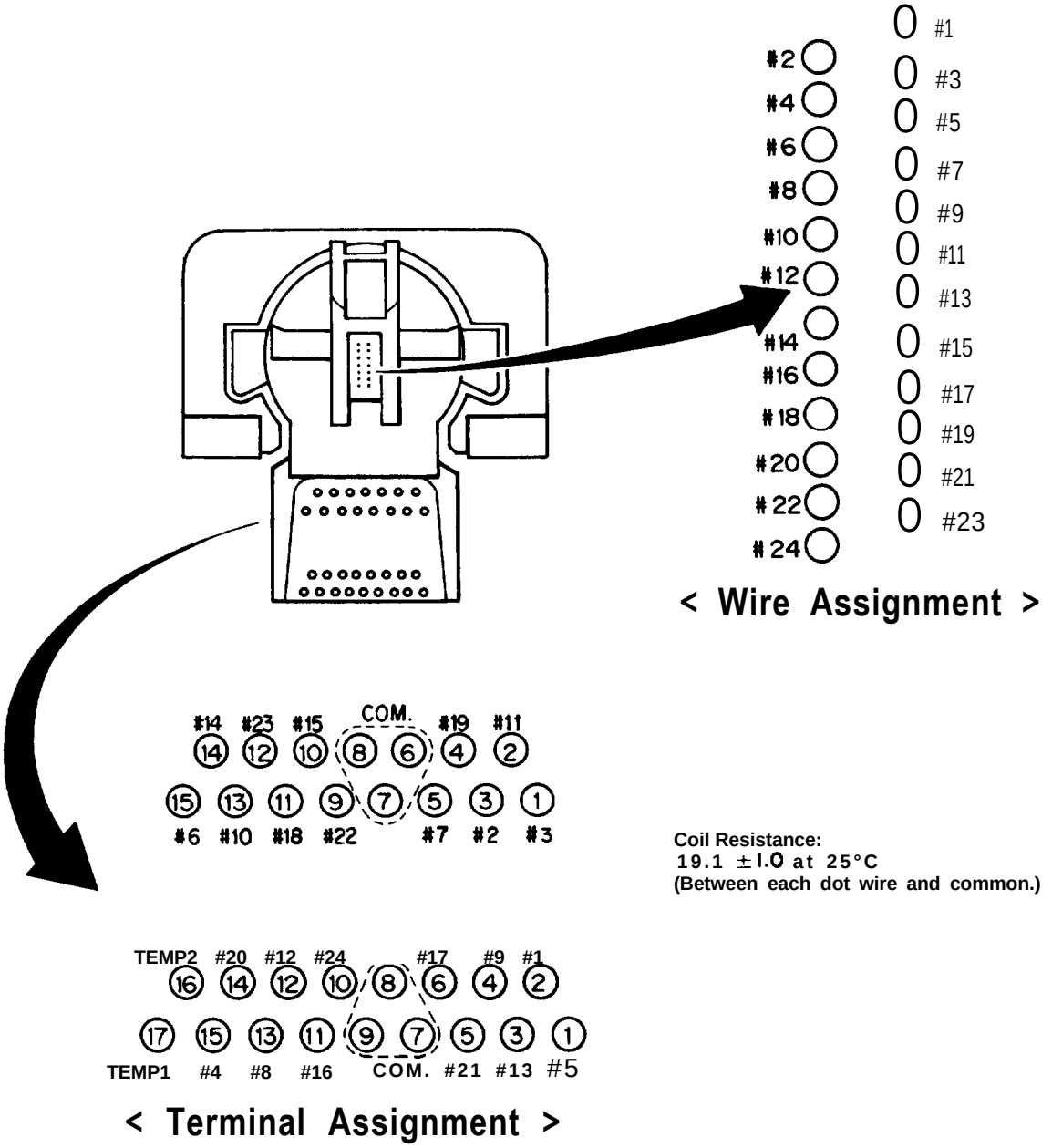
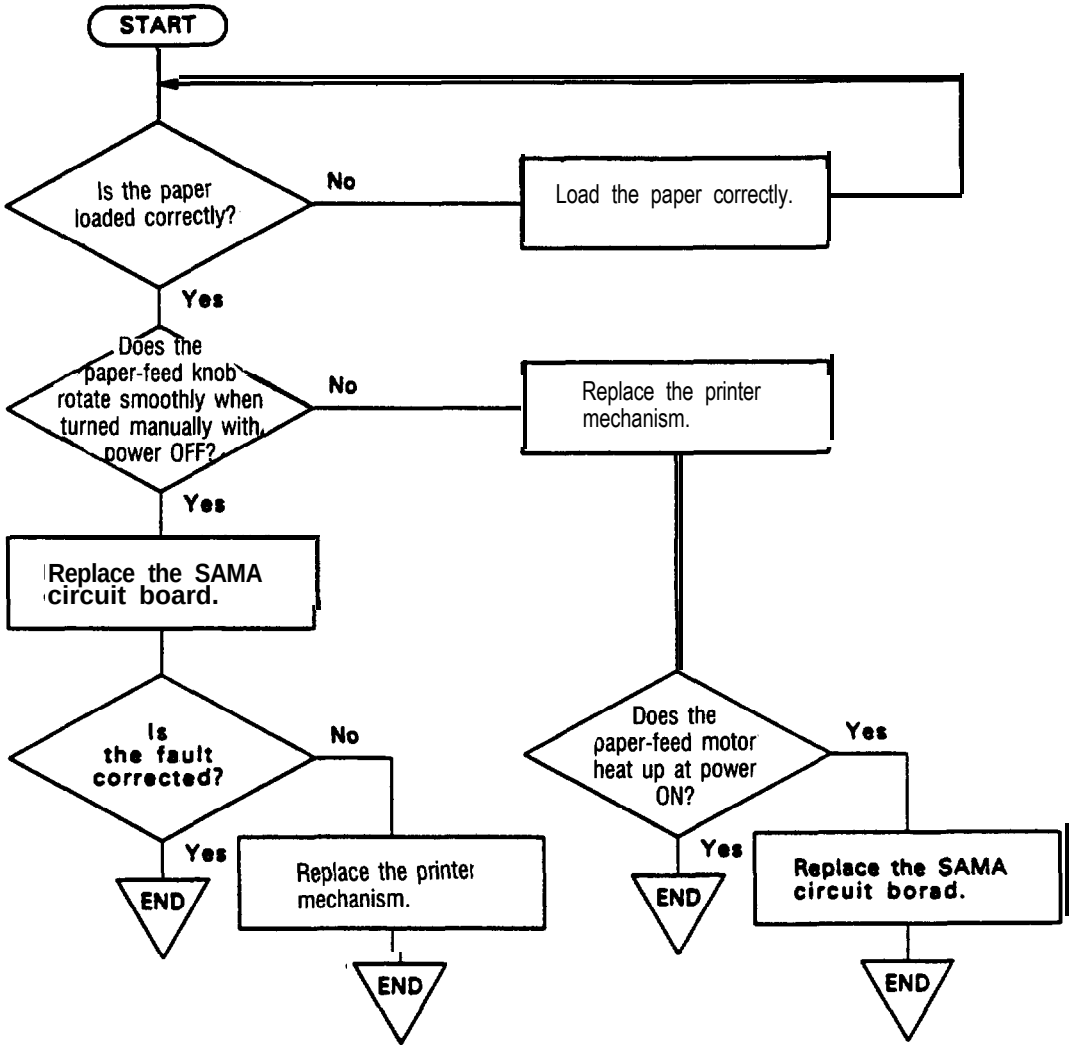
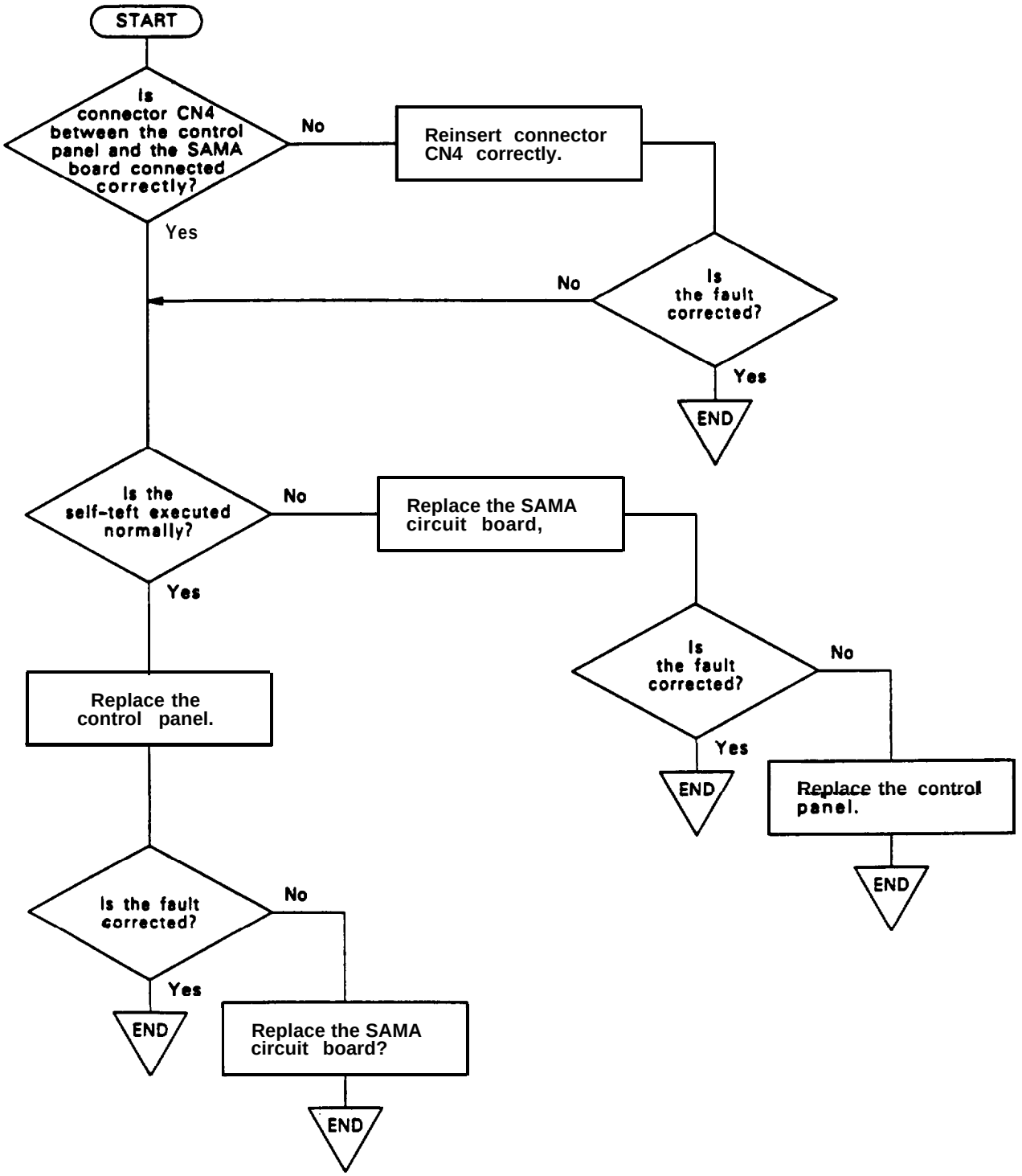


Figure 5-1. Printhead Resistance

(4) Abnormal Paper Feed (but Normal Printing)

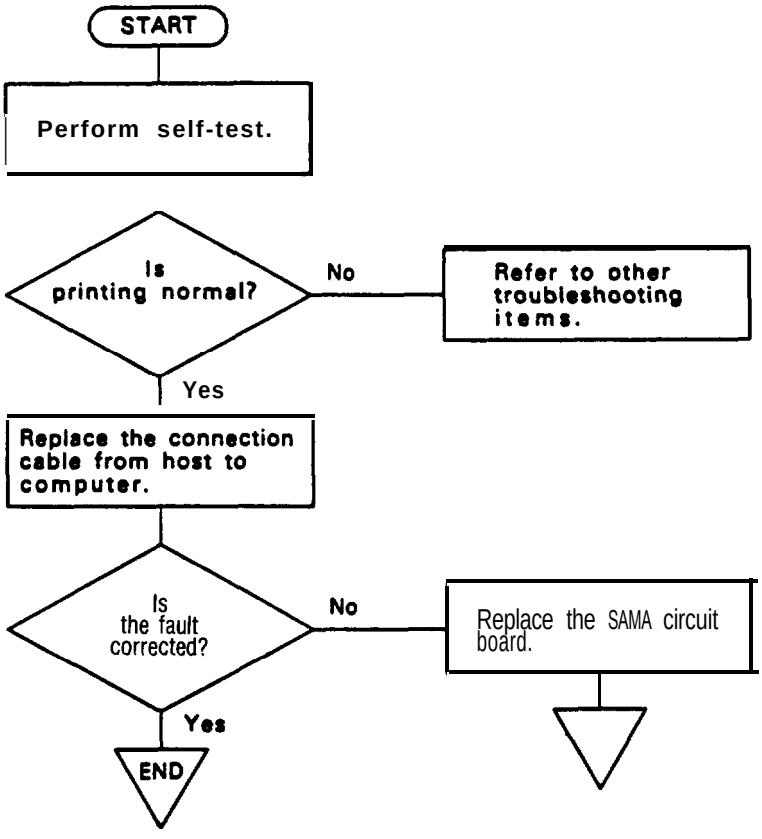


(5) Abnormal Control Panel Operation



(6) Faulty Printing in ON-LINE Mode

NOTE: It is assumed here that the host computer is operating normally.



5.3 UNIT REPAIR

This section indicates the points to be checked in response to problems and the measures to be taken based on the result of the check. Utilize the checkpoints to determine and correct defective components. Tables 5-5, 5-7, and 5-9 below are divided into the five following columns:

Problem:	Indicates the difficulty.
Symptom:	Indicates potential condition which may be underlying the problem. You must check to see which if any of the symptoms apply.
Cause:	Indicates the potential source of the problem.
Checkpoint:	Perform this check to determine whether the problem is the result of the cause listed at left.
Solution:	Indicates the repair that will correct the fault.

Table 5-3. Troubleshooting Tools

Item	Description	Part Number
Driver Circuit Checker E685	Check the driver circuit by reading the LED indication.	B765113101

5.3.1 SANPS/SANPSE POWER BOARD UNIT REPAIR

The following chart shows the main components used on the SANPSE board.

Table 5-4. SANPS(E) Board Parts List

Board Name	Location	Part Names	Description	Part No.
SANPS(E)	IC1	L5431-AA	Adjustable Precision Regulator	X440164319
	IC20	TL494CN	PWM Control	X440034940
	Q20	2SA1469	Transistor 60 V 5 A 20 W	X300146900
	Q3, 21	2SA1020	Transistor 50 V 2 A 900 mW	X300102009
	Q2	2SC3746	Transistor 60 V 5 A 20 W	X302374600
	R31, 32		Fusible resistor 2 ohms 1/4 W ± 5%	X175400207
SANPS	Q1	2SC3831	Transistor 500 V 10 A	X302383100
	DB1	D3SBA40	Diode Bridge 400 V 4.0 A	X340330120
	F1	ULTSC 2.0A-N1	Fuse 125 V 2.0 A	X502061011
	T1	PT-P68A-NF	Transformer	Y567204003
SANPSE	Q1	2SC3460	Transistor 800 V 6 A 100 W	X302346000
	DB1	RBV-406	Diode Bridge 600 V 4.0 A	X340400321
	F1	BET 1.25A	Fuse 1.25 A 250 V	X502063040
	T1	PT-P68E-NF	Transformer	Y567204002

Table 5-5. SANPS(E) Power Board Unit Repair

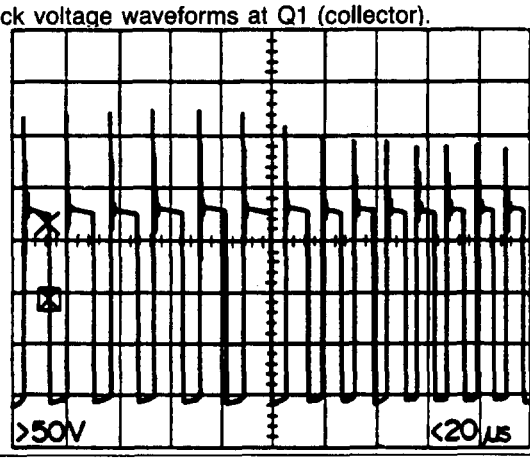
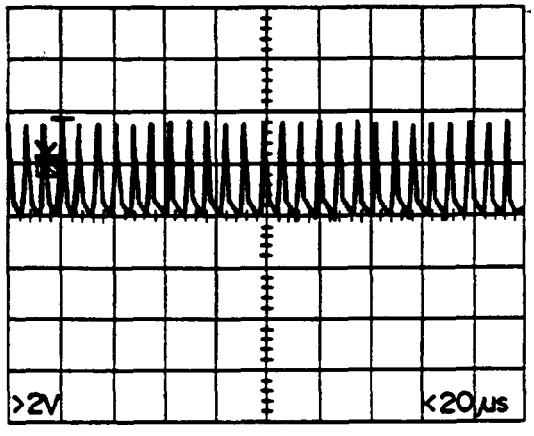
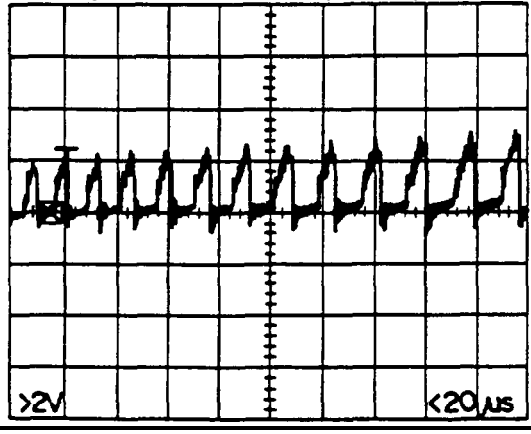
Problem	Symptom	Cause	Checkpoint	Solution
Printer does not operate at all.	The +24V line is dead.	Transformer oils are open.	Measure the resistance of T1 transformer coils. 4-3, 6-2,11-12.	Replace T1 .
		Q1 is dead.	Check voltage waveforms at Q1 (collector). 	Replace Q1 .
	The voltage on the + 24 V line is below normal.	23, IC1, 'CI, or ZD20 is dead.	Check voltage wave forms at Q3 (collector). 	Replace Q3, IC1, PC1, or ZD20.
		Q2 is dead.	Check voltage waveforms at Q2 (collector). 	Replace Q2.

Table 5-5. SANPS(E) Power Board Unit Repair (Cont.)

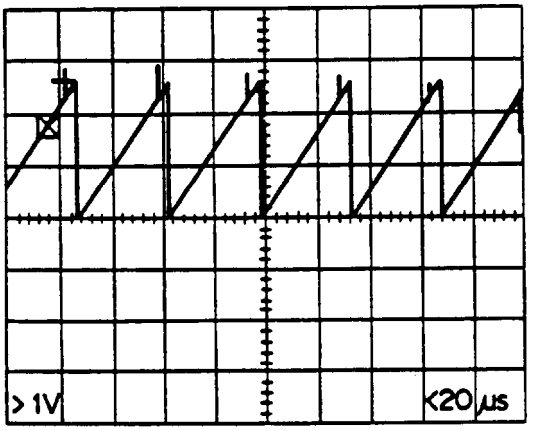
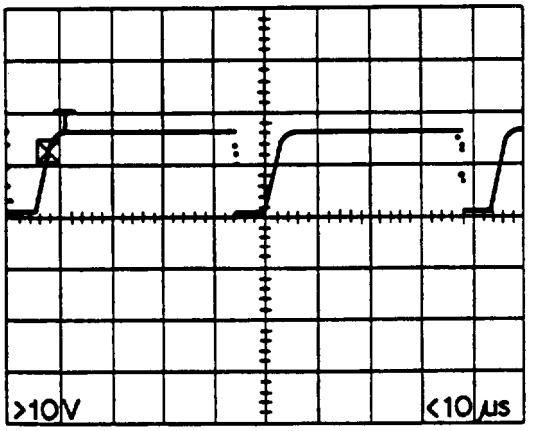
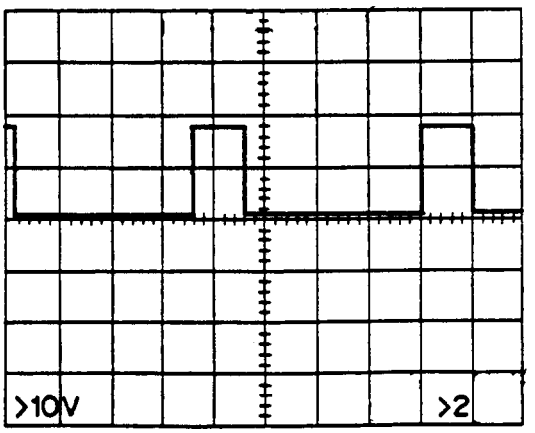
Problem	Symptom	Cause	Checkpoint	Solution
Printer does not operate at all.	The voltage at +5 V line is dead.	The + 24 V line is dead.	Check the + 24 V line.	
		IC20 is dead.	Check the oscillation waveform and the switching waveform.  Oscillation waveform (IC20, pin 5)  Switching waveform (IC20, pin 8)	Replace IC20.
		Q20 or Q21 is dead.	Check the switching waveform.  Q20, collector	Replace either Q20 or Q21.

Table 5-5. SANPS(E) Power Board Unit Repair

Problem	Symptom	Cause	Checkpoint	Solution
Printer does not operate at all.	Voltage on the ±12V line is dead.	The +24V power supply circuit is dead.	Check the +24 V line.	
		Fuse resistor R31 or R32 is open.	Measure the resistance values of R31 and R32.	Replace either R31 or R32.
		Transformer coils are open.	Measure the resistances of transformer coils 7-8, 8-11.	Replace T1.

5.3.2 SAMA CONTROL BOARD UNIT REPAIR

The following chart shows the main components on the SAMA board.

Table 5-6. SAMA Board Parts List

Location	Part ID	Description	Part No.
5B	µPD7810HG	CPU	**X400078101**
7A	E01A05	Gate Array	Y566800009
1A	E05A02	Gate Array	Y453800004
5A	HM65256BLSP-12	PSRAM	X400062565
4B	S-29401	EEPROM	X400029400
2B	SLA7020M	Stepper Motor Driver	X440070200
3B	74LS06	Hex Inverter	X420300060
8A, 8B	74LS07	Hex Buffer	X420300070
2A	74LS38	Quad 2-In NAND Buffer	X420380380
7B	74LS152	10-Step Real Cord	X420301520
6B	TL431CLPB	Adjustable Precision Shunt Regulator	X440034313
Q30, 31, 35	2SA1015-TPE2	Transistor 50 V 150 mA 400 mW	X300101509
Q34	2SA1020-TPE6	Transistor 50 V 2 A 900 mW	X300102009
Q27	2SB1093-T	Transistor 80 V 1.5 A 1 W	X301109309
Q32, 33	2SC1815Y-TEP2	Transistor 50 V 150 mA 400 mW	X302181589
Q24, 26, 28, 29	2SD2010P-T105	Transistor 60 V ± 2 A 1.2 W	X303201039
Q1-23, 25	2SD1843L-T	Transistor 60 V 1 A 10 W	X303184329

Table 5-7. SAMA Board Unit Repair

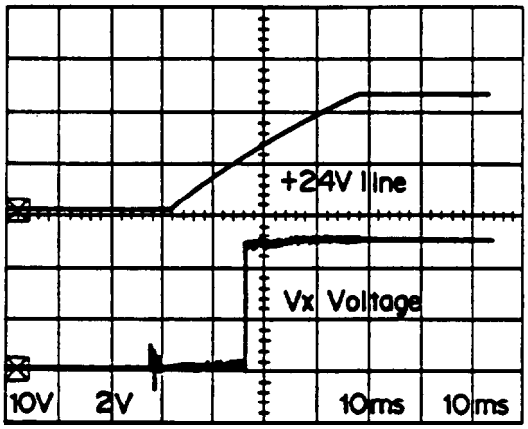
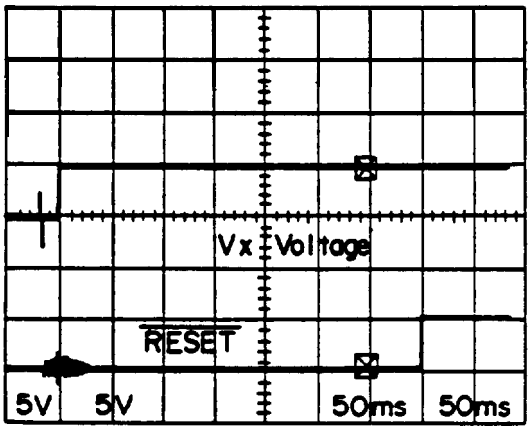
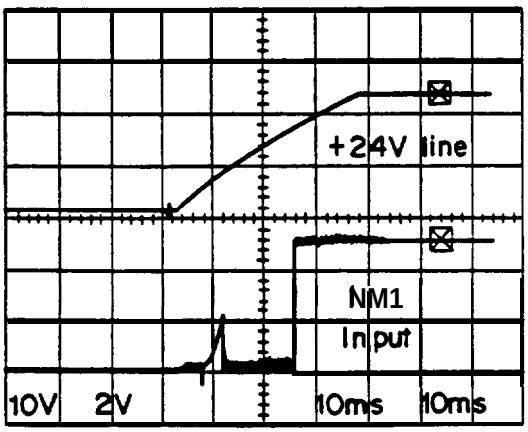
Problem	Symptom	Cause	Checkpoint	Solution
Printer does operate at all.	CPU is not operating.	Vx voltage is not being output.	Check voltage waveforms for the Vx voltage and for the 24 V line. 	Replace ZD1, Q33, or Q34.
		The reset circuit is not operating.	Check voltage waveforms at Vx voltage and for the $\overline{\text{RESET}}$ signal. 	Replace IC7A.
		$\overline{\text{NIT}}$ signal input circuit is dead.	Check voltage waveforms for the +24 V line and for he NMI interrupt signal. 	Replace IC3B or Q32.

Table 5-7. SAMA Board Unit Repair (Cont.)

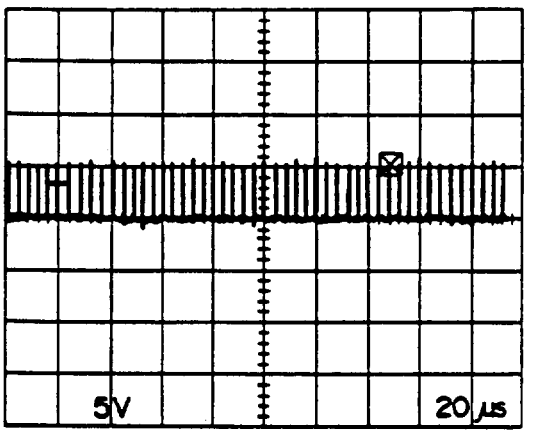
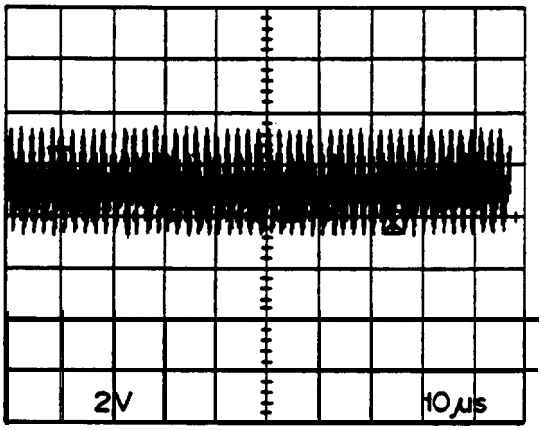
Problem	Symptom	Cause	Checkpoint	Solution
Printer does operate at all.	CPU is not operating.	Selection of control ROM is abnormal.	Check pin 2 of IC7A for a changing signal HIGH/LOW. 	Replace IC7A.
		Either ROM or RAM is defective.		Replace either IC6A or IC5A.
		CPU is defective.	Check for oscillator signal at either pin 31 or pin 32 of he CPU. 	If a signal is detected, replace IC5B. Otherwise, replace the CR1.

Table 5-7. SAMA Board Unit Repair (Cont.)

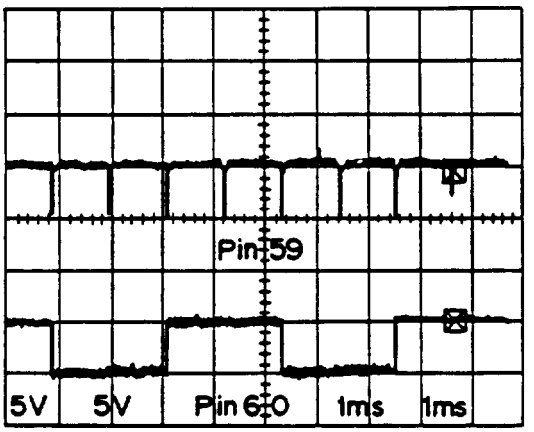
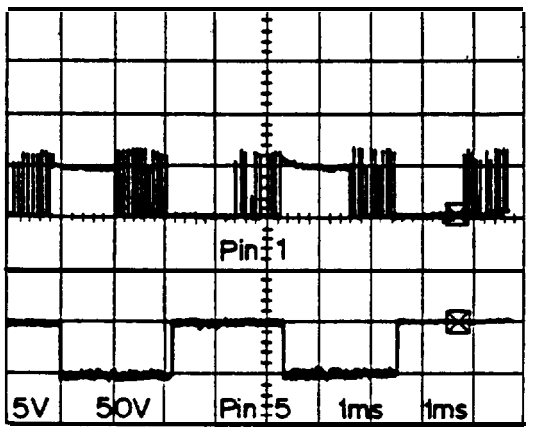
Problem	Symptom	Cause	Checkpoint	Solution
Carriage operates abnormally.	Carriage does not operate at all.	IC7A is defective.	At IC7A, check the input waveform at pin 59 and the output signals at pins 60, 61, 62, and 63. 	Replace IC7A.
		IC2A is defective.	Check input signal and output signal.	Replace IC2A.
		IC2B is defective.	At IC2B, check the input signal at pin 5 and the output waveform at pin 1. 	Replace IC2B.
	Carriage operation is unstable (lack of torque).	Reference voltage generating circuit is faulty.	Check transistors Q30, Q31, and Q35.	Replace Q30, Q31, and Q35.

Table 5-7. SAMA Board Unit Repair (Cont.)

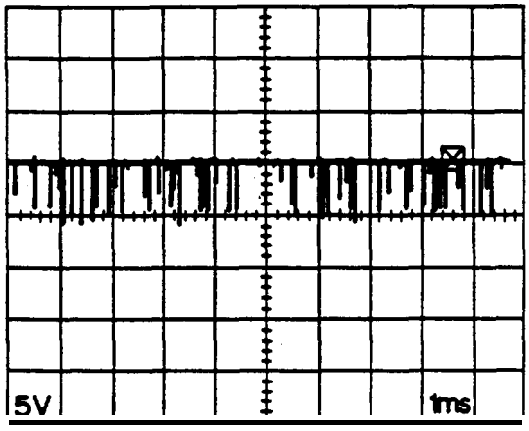
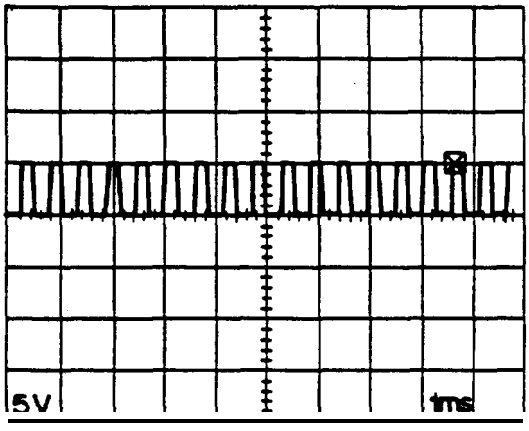
Problem	Symptom	Cause	Checkpoint	Solution
Self-test printing is abnormal.	Self-test printing is not executed.	CPU cannot measure voltage on the 24 V line.	Measure voltage at VAref (pin 42) of IC5B. The normal voltage is 4.75 V.	Replace IC6B.
		IC7A is defective.	Check output of the IC1A chip select signal at pin 58 of IC7A. 	Replace IC7A.
		IC1A is defective.	At IC1A, check HPW input signal (pin 31) and printhead drive signal of 1A. 	Replace IC1A.

Table 5-7. SAMA Board Unit Repair (Cont.)

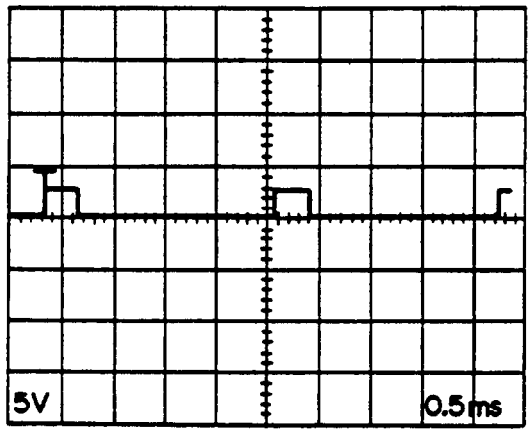
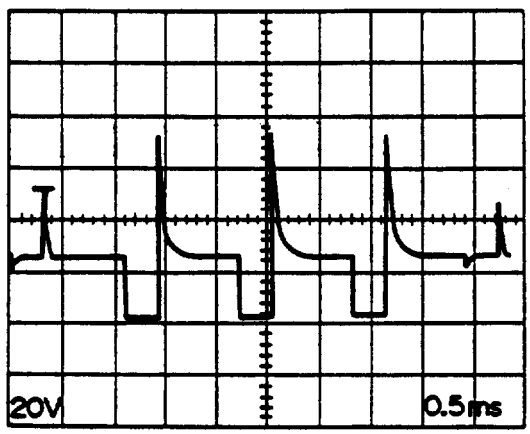
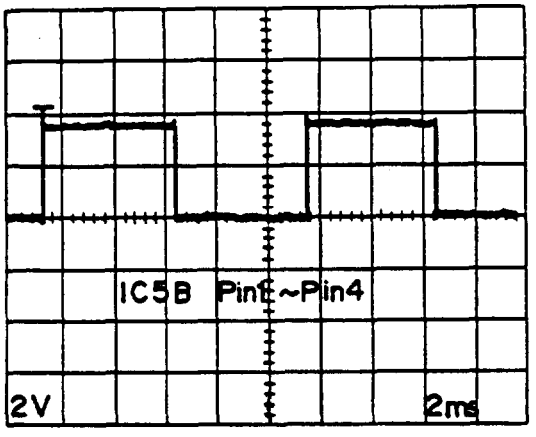
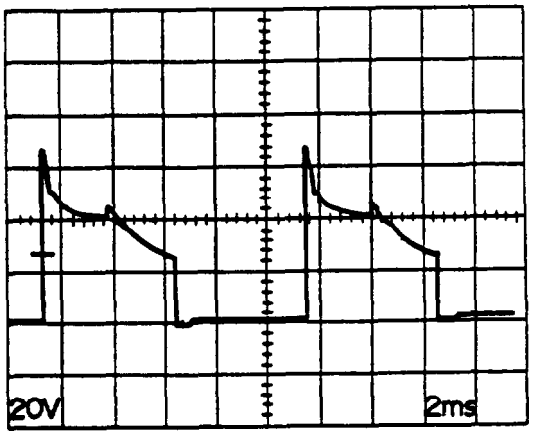
Problem	Symptom	Cause	Checkpoint	Solution
Self-test printing abnormal.	A particular dot is not being printed.	IC1A is defective.	Check the printhead drive signal at IC1A. 	Replace IC1A.
		A printhead drive transistor is defective.	Check the printhead drive transistor corresponding to the dot.  Head drive transistor collector	Replace the printhead drive transistor.

Table 5-7. SAMS Board Unit Repair (Cont.)

Problem	Symptom	Cause	Checkpoint	Solution
Paper is not fed normally.	Paper feed pitch is abnormal (open-phase).	Paper feed motor drive transistor is defective.	Check the paper-feed motor drive signal and paper-feed motor drive transistor.   Paper-feed motor drive transistor collector	Replace the paper-feed motor drive transistor.
	Paper does not feed, or feed pitch is abnormal (lack of torque).	Q27 or IC8B is defective.	Check transistor Q27.	Replace Q27.
Printing in on-line node is abnormal.	Data corruption occurs when the parallel interface is used.	IC7A or IC7B is defective.	Check input/output signals of IC7A or IC7B.	Replace IC7A or IC7B.

5.3.3 PRINTER MECHANISM REPAIR

For detailed procedures for replacing or adjusting parts, refer to Sections *4.3, Disassembly and Reassembly,* and 4.4, *Adjustment.* If a problem or symptom recurs following an attempted repair, refer to the tables to try to find other potential causes.

Table 5-8. Printer Mechanism Repair

Problem	Symptom	Cause	Checkpoint	Solution
Carriage motor fails to operate.	Carriage motor completely fails to activate at power on.	Foreign substances are lodged in the gears or elsewhere in the mechanism. The carriage motor is defective.	Manually move the timing belt to see if this causes the motor to rotate. Measure the coil resistance of the motor. The resistance should be about 11 ohms.	Remove foreign substances. Replace the carriage motor.
Carriage does not operate normally at power on (when the carriage has been manually centered prior to power on).	Carriage motor rotates, but the carriage does not move.	Belt pulley is defective.	Check for broken or worn pulley.	Replace the belt pulley.
		The timing belt is defective.	Check that the timing belt is correctly inserted into the bottom of the carriage.	Reinsert the timing belt.
			Check for a broken timing belt.	Replace the timing belt.
	Carriage moves slightly left, then stops.	Carriage movement is not smooth.	Check whether the carriage moves smoothly when moved imanually.	Clean and lubricate.
	Carriage moves to the left end, then stops.	Home-position sensor is defective.	Use a tester to check the home-position sensor.	Replace the home-position sensor.
Self-test printing does not execute.	Carriage moves, but no printing is performed.	Common wires of the printhead FFC are disconnected.	Check the connector for the common wires of the printhead FFC.	Replace the FFC.
	Printing stops before the page end.	Paper guide plate is not correctly positioned.	Check whether the paper guide plate is mounted in the right position.	Reset the paper guide plate.

Table 5-8. Printer Mechanism Repair (Cont.)

Problem	Symptom	Cause	Checkpoint	Solution
Self-test printing is abnormal.	A particular dot fails to print.	Printhead is defective.	Measure coil resistance of the printhead. The normal value is approx. 19.1 ohms.	Replace the printhead.
			Check whether the dot wire is broken.	Replace the printhead.
	Printing is too light, or the print density is not uniform.	Printhead is defective.	Check whether the tip of the dot wire is worn or not.	Replace the printhead.
		Platen gap is not properly adjusted.	Set the gap adjust lever to the second position, and check the gap between the tip of the printhead and the platen. The appropriate value is 0.45 mm.	Adjust the gap (refer to Section 4.3.1, ***Platen Gap Adjustment).***
Paper feed is defective.	Printing is performed, but the paper is not fed, or is not fed uniformly.	Foreign substances are lodged in the paper path.	Perform a visual check of the paper path.	Remove any foreign substances.
		Paper-feed motor is not driving the gear correctly.	Check that no foreign substance is lodged between the gears, and that the gears are not broken or worn.	● Remove the foreign substance. ● Replace the paper-feed reduction gear. ● Replace the platen gear.
		Paper-feed motor is defective.	Measure coil resistance of the paper-feed motor. The appropriate value is approximately 40 ohms.	Replace the paper-feed motor.

Table 5-8. Printer Mechanism Repair (Cont.)

Problem	Symptom	Cause	Checkpoint	Solution
Ribbon feeds defective.	Ribbon is not fed.	Ribbon cartridge is defective.	Dismount the ribbon cartridge, rotate its knob manually, and check whether the ribbon feeds normally.	Replace the ribbon cartridge.
		Foreign substances are caught in the gears.	Check whether the ribbon driving gear rotates when the carriage is moved manually.	Remove any foreign substance. Replace the ribbon-feed mechanism.
	Ribbon feeds properly only with the carriage moving in one direction (i.e., fails to feed when the carriage moves in the other direction).	Planetary lever is defective.	Move carriage manually, and check whether the planetary lever turns in reverse and engages the gear.	Replace the ribbon-feed mechanism.
Paper becomes stained.	Ink stains appear on areas where there is printing.	Ribbon mask is not correctly positioned.	Check whether the ribbon mask is in the correct position.	Reset the ribbon mask.
		Platen gap is adjusted.	Set the gap to the second position, and check the gap between the tip of the printhead and the platen. The appropriate value is 0.45 mm.	Adjust the gap (refer to Section 4.3.1, ***Platen Gap Adjustment).***
Printing continues past the end of paper, or when no paper is in place.	Printing continues past the end of paper.	Paper-end sensor is defective.	Check paper-end sensor switch.	Replace the paper-end sensor.

CHAPTER 6
MAINTENANCE

LIST OF FIGURES

LIST OF TABLES

MAINTENANCE 6

Proper maintenance is essential to assuring optimal and long-term printer performance and to minimizing malfunction frequency.

6.1 PREVENTIVE MAINTENANCE

Clean the case exterior regularly with alcohol. Occasionally vacuum clean the mechanism's interior to remove accumulated dust and paper particles. After cleaning the unit, check that it is adequately lubricated (refer to Section 6.2) immediately below. Before returning the printer to the customer, inspect the springs, paper-feed rollers, and the basic operation of the unit.

WARNING

Be sure to disconnect the printer from the power supply before maintenance. Do not apply thinner, trichloroethylene, or ketone-based solvents to any of the printer's plastic components.

6.2 LUBRICATION AND ADHESIVE APPLICATION

Epson recommends lubrication at the points illustrated in Figure 6-3. Table 6-2 provides a list of these points, and the recommended lubricant to use for each. The lubricants - EPSON O-2, EPSON G-20, EPSON G-26, and EPSON G-37 - have all been thoroughly tested and fully meet the needs of this printer. (Table 6-1 lists details of these lubricants.) Before applying any lubricant, make sure that the part to be lubricated is clean. Do not apply excess lubrication, as this could potentially cause damage.

Following its disassembly or replacement, adhesive must be applied to the part indicated in Table 6-3. Epson recommends application of Neji lock #2 (G) adhesive to the point illustrated in Figure 6-1. When applying the adhesive, be careful that no excess overflows onto nearby parts.

Table 6-1. Lubrication and Adhesive

Type	Name	Capacity	Availability	Part No.
Oil	O-2	40 cc	E	B710200001
Grease	G-20	40 gm	E	B702000001
Grease	G-26	40 gm	E	B702600001
Grease	G-37	40 gm	E	B703700001
Adhesive	Neji lock #2 (G)		E	B730200200

E: Epson-exclusive product

Table 6-2. Lubrication Points (Refer to Figure 6-3)

Ref. No.	Lubrication Points	Lubricant
(1)	Shaft that holds paper-feed reduction	G-26
(2)	Contact portion of sub paper release lever and paper release lever	G-26
(3)	Oil pad	O-2
(4)	Carriage guide shaft (at both left and right sides of carriage)	G-26
(5)	Carriage guide plate (the portion that contacts the carriage)	G-26
(6)	Platen gear	G-26
(7)	Belt pulley gear	G-26
(8)	Ribbon transmission gear	G-26
(9)	Paper-tension roller shaft	G-26
(10)	Gear portion of the ribbon gear	G-26
(11)	Shaft that holds the ribbon gears	G-26
(12)	Paper-feed roller shaft	G-37
(13)	Contact portion of tractor frame L and tractor shaft .	G-26
(14)	GND spring on platen shaft	G-20

NOTE: 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
Where the timing belt engages the carriage.	1

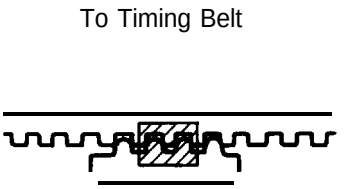


Figure 6-1. Correct Adhesive Application

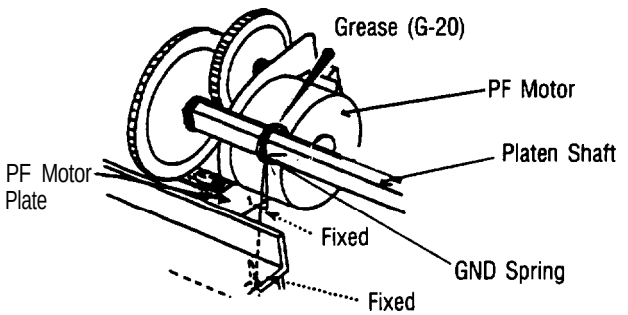


Figure 6-2. GND Spring Lubrication Point

REV .-A

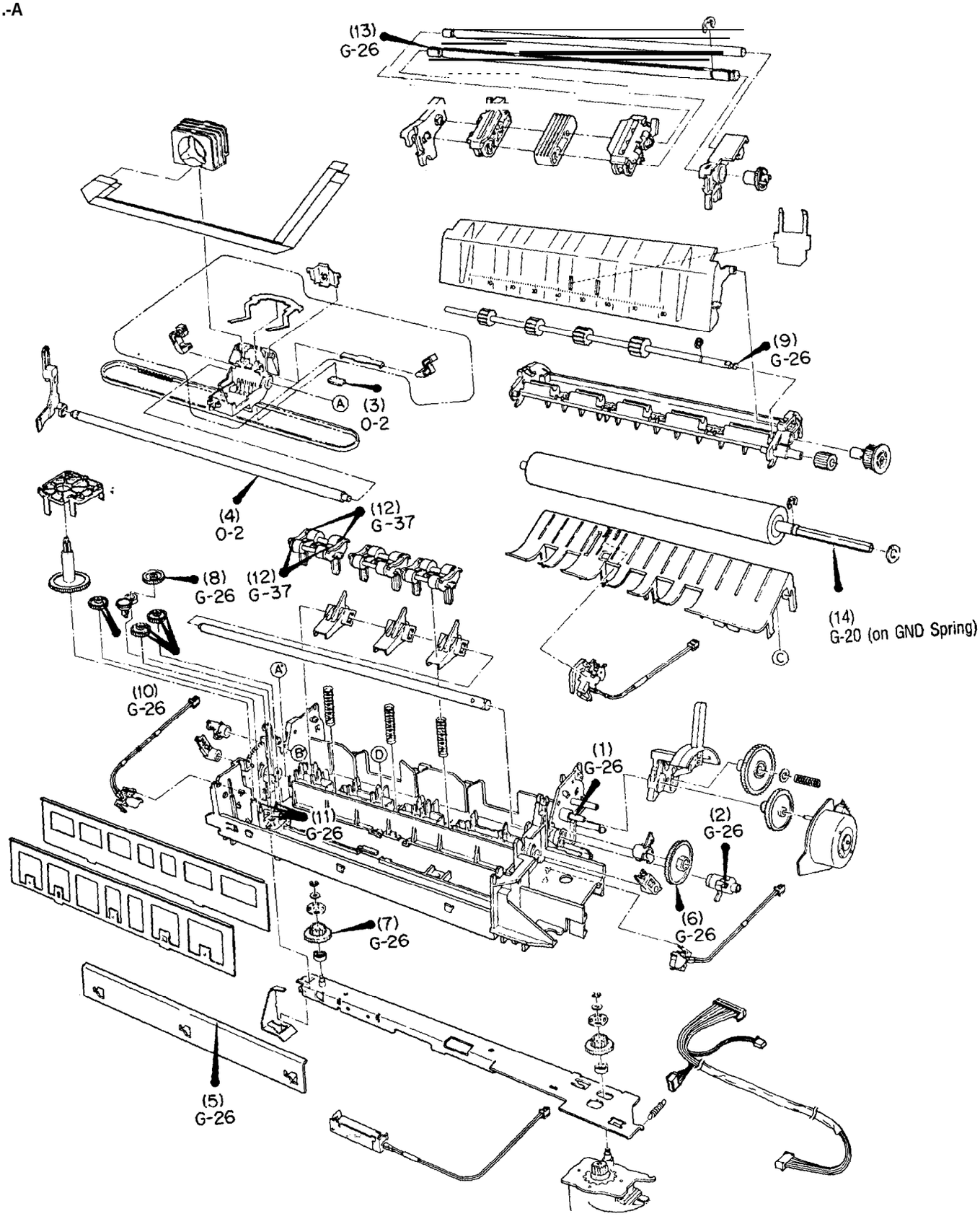


Figure 6-3. LQ-510 Lubrication Points

APPENDIX

LIST OF FIGURES

LIST OF TABLES

APPENDIX

This appendix provides detailed information about the integrated circuits, signal functions, capabilities, and other aspects of the components of the LQ-510 printer.

A.1 INTEGRATED CIRCUITS WITHIN THE LQ-510

This section describes the integrated circuits in the LQ-510.

A.1.1 SAMA BOARD MAIN COMPONENTS

Table A-l shows SAMA board ICs.

Table A-1. SAMA Board ICs

Location	Name of IC	Type
5B	µPD7810HG	15 MHz CPU
7A	E01A05	
1A	E05A02	
5A	HM65256BLSP	PSRAM 32 K x 8 bit
2B	SLA7020M	Stepper motor driver
4B	S-2940I	EEPROM
6B	TL431CLPB	Adjustable precision shunt regulator
3B	74LS06	Hex. OC inverters
8A, 8B	74LS07	Hex. OC buffers
2A	74LS38	Quad 2-in NAND buffers
7B	74LS152	lo-step real cord

A.1.1.1 CPU µPD7810HG (5B)

The µPD7810/7811HG is comprised of an 8-bit timer counter, an 8-bit A/D converter, 256 bytes of RAM, and a serial interface. A system can be constructed easily with this IC, whose main features are listed below.

- 256 bytes of built-in RAM (addresses FF00-FFFF hex.)
- 4096 bytes mask ROM (addresses 0-0FFF hex.) for the 7811 CPU
- Direct addressing of up to 64K
- 8-bit A/D converter
- 158 instructions
- 0.8 µs 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: 24bit edge detection, 4 inputs)
- Zero cross detection
- Standby function
- Built-in clock pulse circuit
- NMOS

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

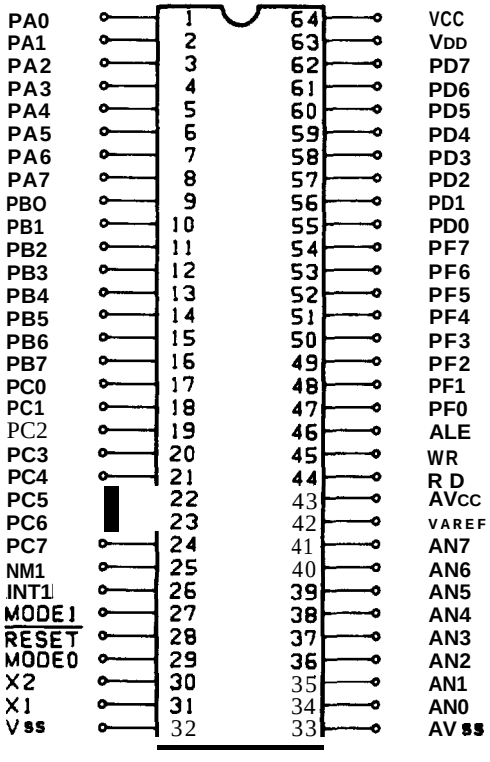


Figure A-l. µPD7810/7811 Pin Diagram

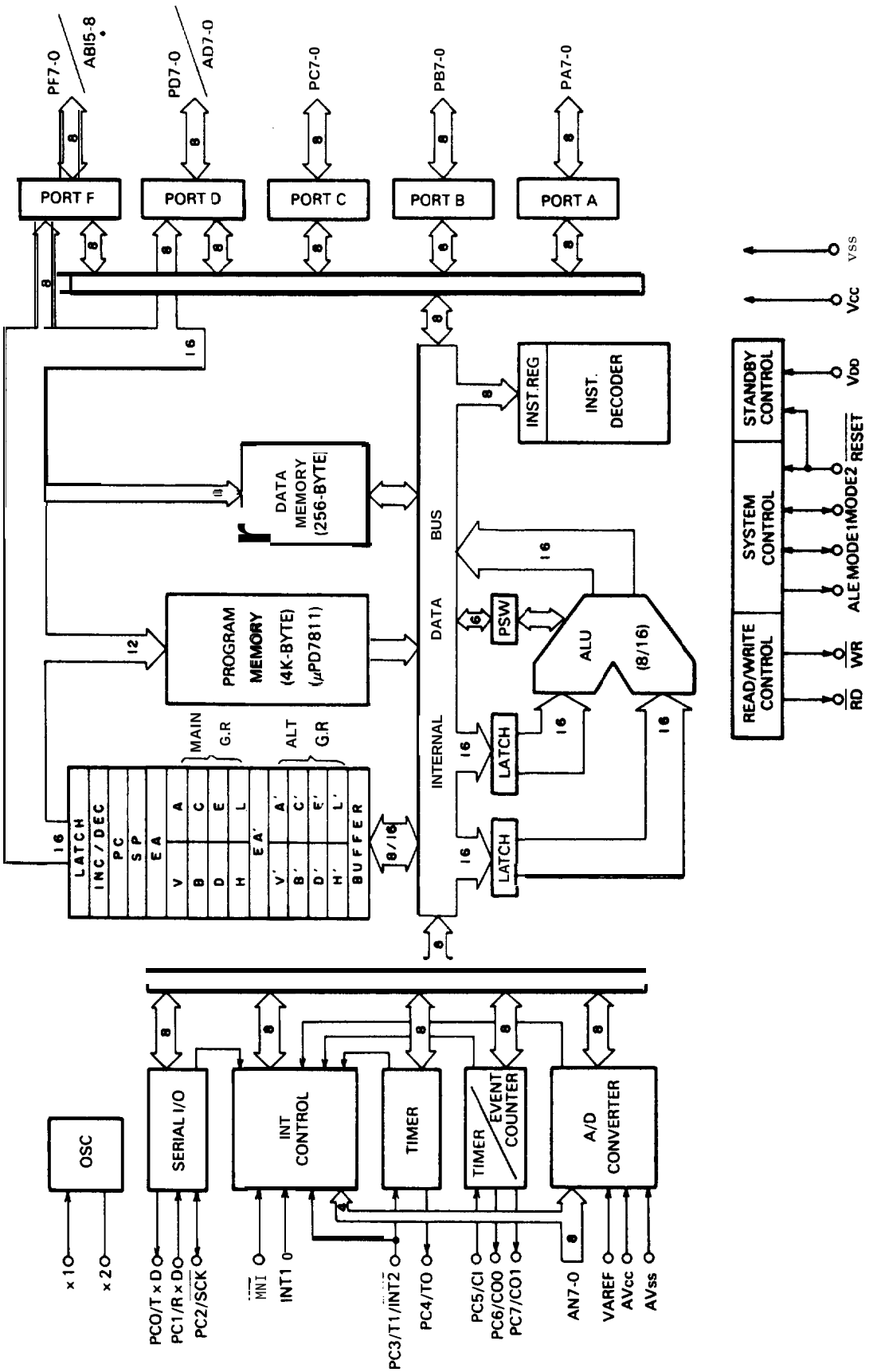


Figure A-2. μPD7810/7811 Block Diagram

Table A-2. μPD7810 Mode Setting

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

Table A-3. μPD7811 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 (max.)
Port	Port	AB13	AB12	AB11	AB10	AB9	AB8	16K (max.)
AB15	AB14	AB13	AB12	AB11	AB10	AB9	AB8	60K (max.)

Table A-4. μPD7810 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. µPD7810/7811 Port Functions

Pins	Signal	Direction	Descriptions
1-8	PA0-7	In/Out	Port A: 8-bit I/O with output latch. I/O possible with mode A (MA) register. Output HIGH.
9-16	PB0-7	In/Out	Port B: 8-bit I/O with output latch. I/O possible with mode B (MB) register. Output HIGH.
17-24	PC0-7	In/Out	Port C: 8-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	MODE1,0	In/Out	7611: 0 = LOW and 1 = HIGH. 7810 modes set according to external memory (see Table A-2).
28	$\overline{\text{RESET}}$	In	LOW reset.
30, 31	X2, X1	-	Crystal connection for built-in clock pulse. When clock pulses are supplied externally, input must be to XI.
32	Vss	-	Supply voltage, Vss, 0V.
33	AVss	-	Analog Vss.
34-41	AN0-7	In	8 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: 7611: 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 mode 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 acts as the multiplexed address/data bus (AD7-0). 7810: Multiplexed address/data bus to access external memory.
63	V_{DD}	-	Supply voltage, V_{DD} +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, and 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, and 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 at 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.

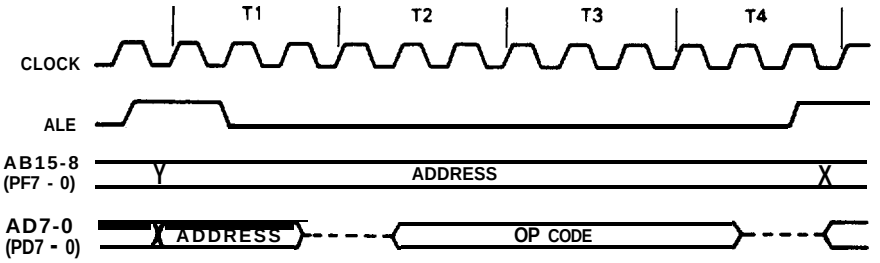


Figure A-3. OP Code Fetch Timing

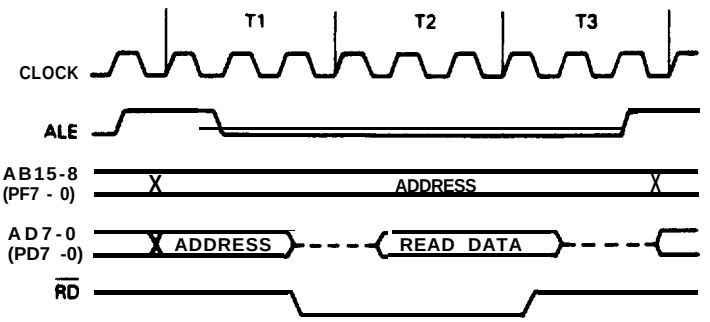


Figure A-4. Memory Read Timing

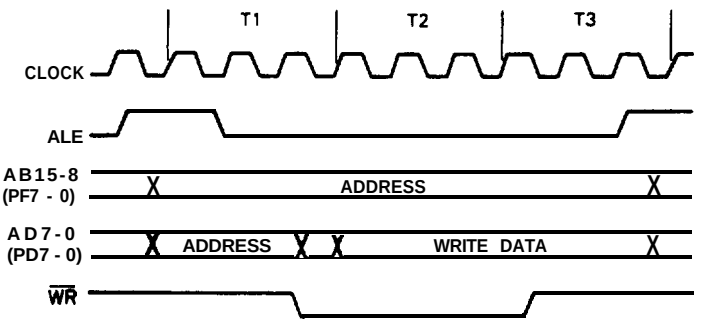


Figure A-5. Memory Write Timing

A.1.1.2 E01A05 (7A)

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 E01A05 pin diagram; Table A-6 shows pin functions for the E01A05.

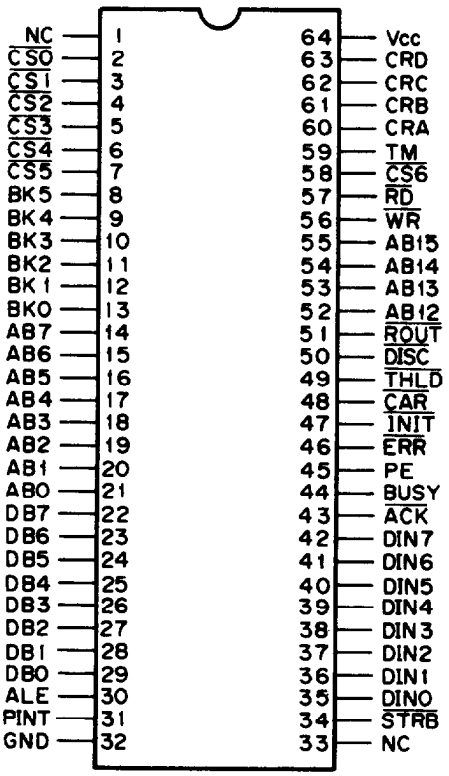


Figure A-6. E01A05 Pin Diagram

Table A-6. E01A05 Pin Functions

Pin No.	Signal	I/O	Function
2-7, 58	$\overline{CS0\text{-}6}$	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	$\overline{STRB}$	I	DIN0-7 signal latch signal
35-42	DIN0-7	I	Parallel I/F input data
43	$\overline{ACK}$	O	Parallel I/F $\overline{ACK}$ signal
44	BUSY	O	Parallel I/F BUSY signal
45	PE	O	Parallel I/F PE signal
46	$\overline{EER}$	O	Parallel I/F $\overline{ERR}$ signal
47	$\overline{INIT}$	I	Parallel I/F $\overline{INIT}$ signal
48	$\overline{CAR}$	I	Cartridge reset
49	$\overline{THLD}$	I	Power reset
50	$\overline{DISC}$	O	Reset circuit condenser discharge
51	$\overline{ROUT}$	O	$\overline{RESET}$ signal
52-55	AB12-15	I	Address decoding by AB12-15
56	$\overline{WR}$	I	Write enable
57	$\overline{RD}$	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.1.1.3 E05A02 (1A)

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-7 shows the E05A02 pin diagram; Table A-7 shows the pin functions.

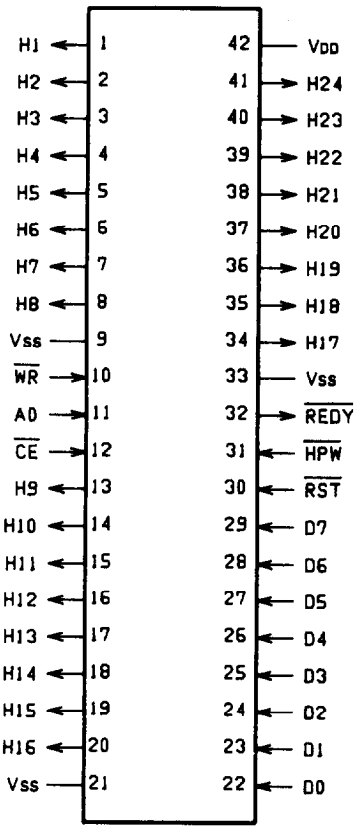


Figure A-7. E05A02 Pin Diagram

Table A-7. E05A02 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	$\overline{A0}$	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	D0-7	I	Data/command input
30	RST	I	Reset
31	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. 1.1.4 HM65256BLSP (5A)

The HM65256BLSP is a 32K-word x 8-bit pseudo-static RAM (PSRAM) which features low power consumption (because CMOS peripheral circuits are used) and high speed and capacity (because a single transistor memory cell is used). The pin diagram of the HM65256BLSP is provided in Figure A-8, and a block diagram in Figure A-9.

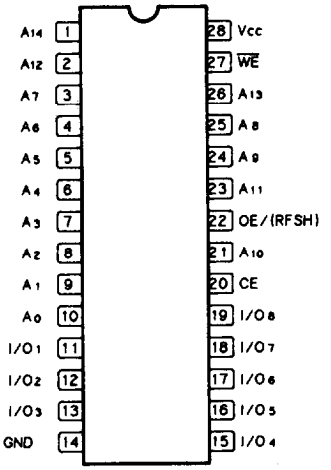


Figure A-8. HM65256BLSP Pin Diagram

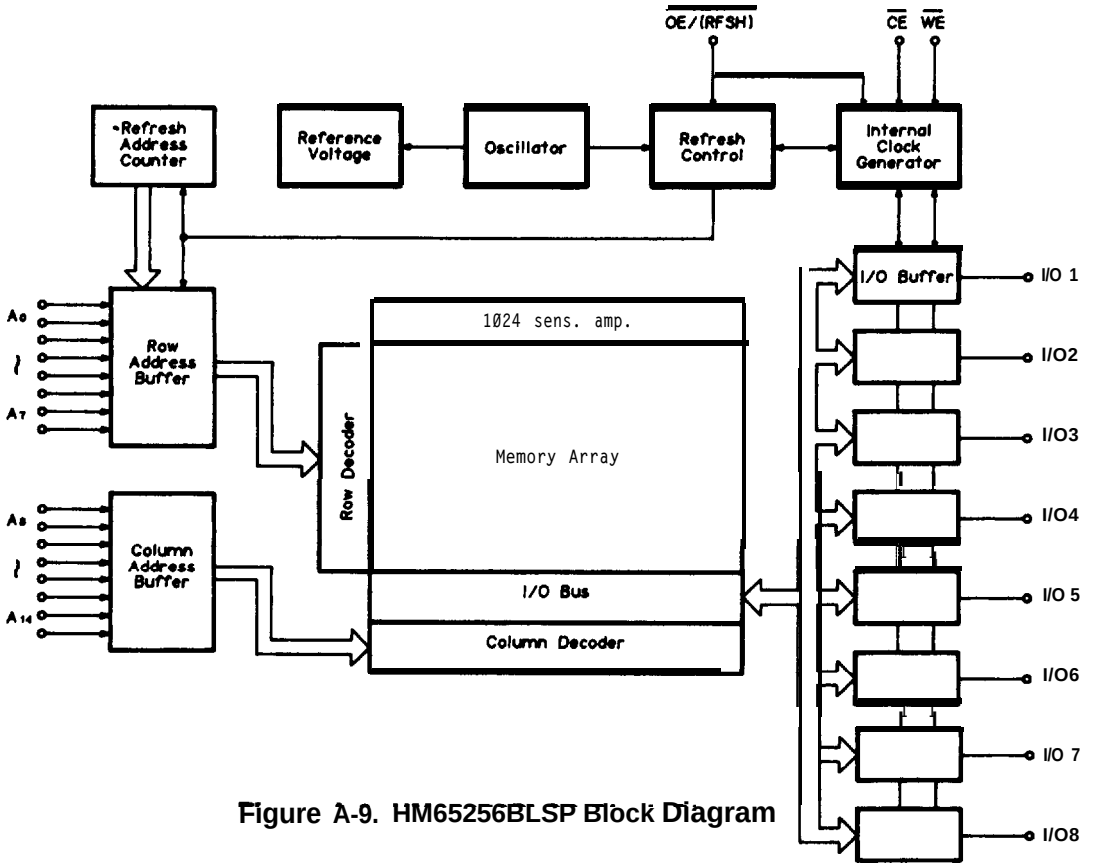


Figure A-9. HM65256BLSP Block Diagram

A.1 .1.5 SLA7020M (2B)

The SLA7020M is a two-circuit, 4-phase stepper motor driver for unipolar, constant current driving.

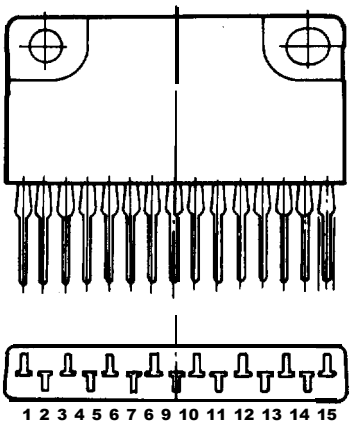


Figure A-10. SLA7020M Case Outline Drawing

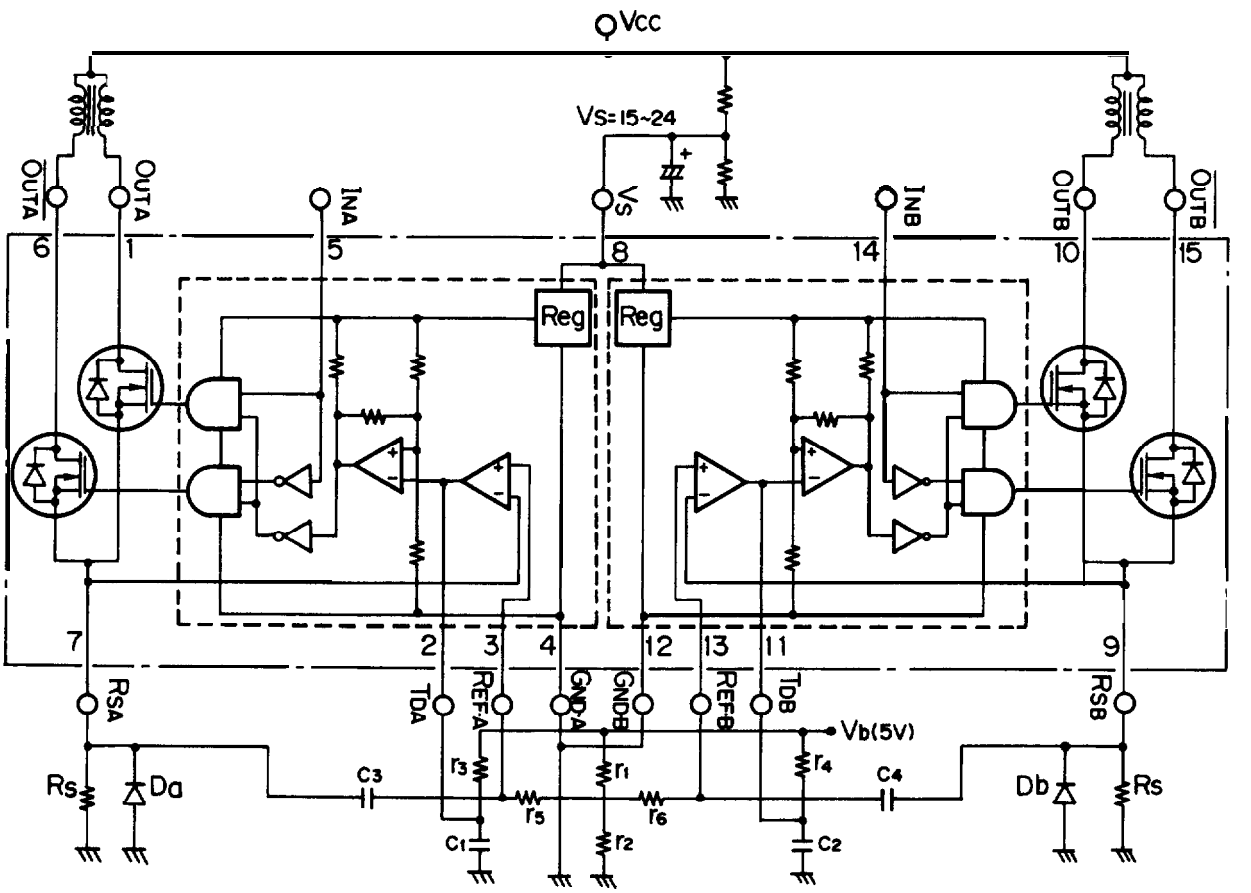


Figure A-11. SLA7020M Functional Equivalent Circuit

A.1.1.6 S-2940I (4B)

The S-2940I is a 16 x 8-bit EEPROM. The pin diagram is given in Figure A-12, and the block diagram in Figure A-13; Table A-8 lists and describes the commands.

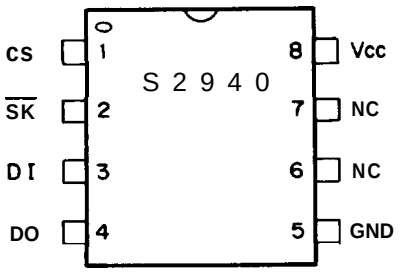


Figure A-12. S-2940I Pin Diagram

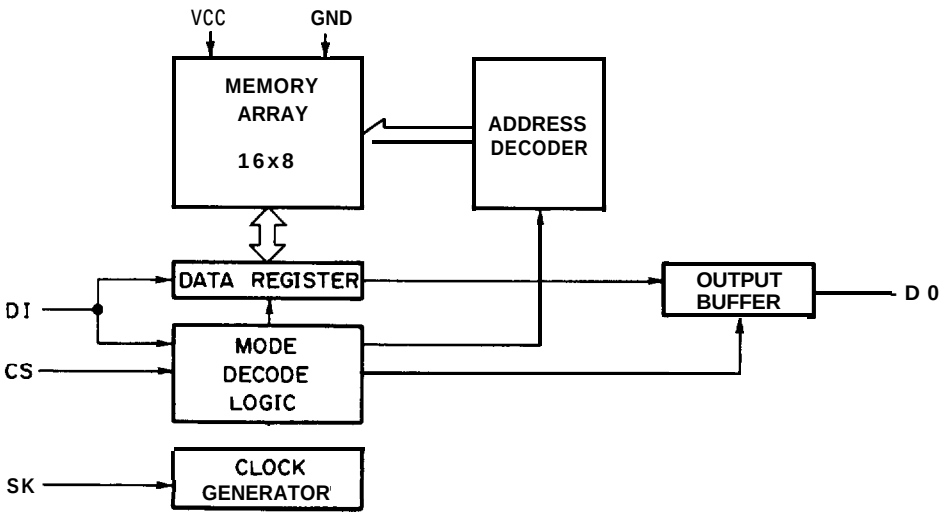


Figure A-13. S-2940I Block Diagram

Table A-8. S-2940I Commands

Command	Opcode	Command Set		Function
		Address	Data	
READ	1001	AAAA	D0-D7	READ ADDRESS
PROGRAM	0110	AAAA	D0-D7	PROGRAM ADDRESS
PEN	0000	0000	-	PROGRAM ENABLE
PDS	1111	0000	-	PROGRAM DISABLE
ERAL	1100	0000	-	ERASE ALL ADDRESS
WRAL	0011	0000	-	PROGRAM ALL ADDRESS

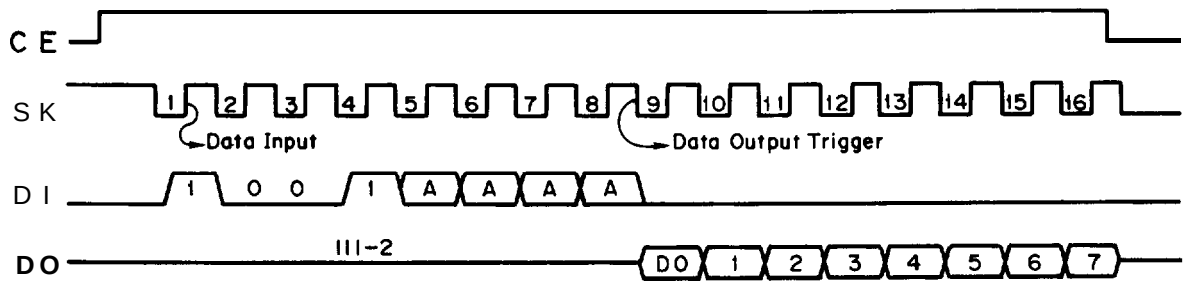


Figure A-14. Timing Chart (Read)

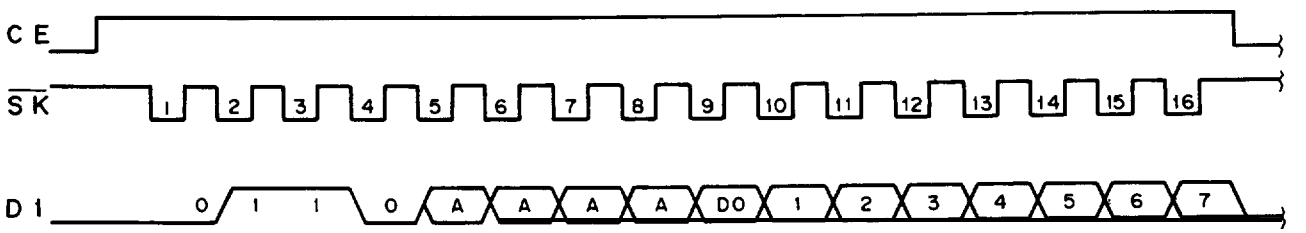


Figure A-15. Timing Chart (Write)

A.1.1.7 TL431CLPB (6B)

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

- Temperature-compensated reference voltage (50 ppm C typical)
- High response speed
- Low noise

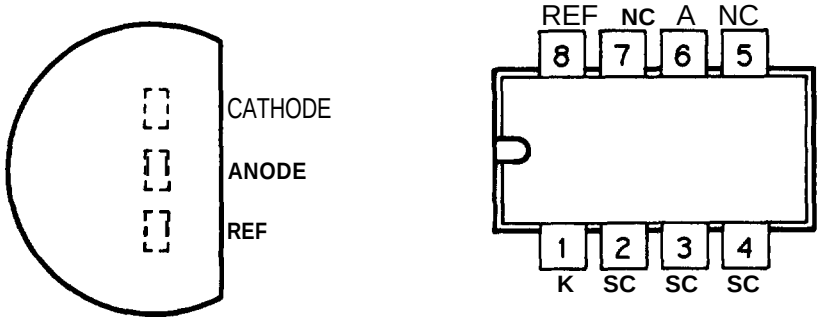


Figure A-16. TL431CLPB Pin Diagram

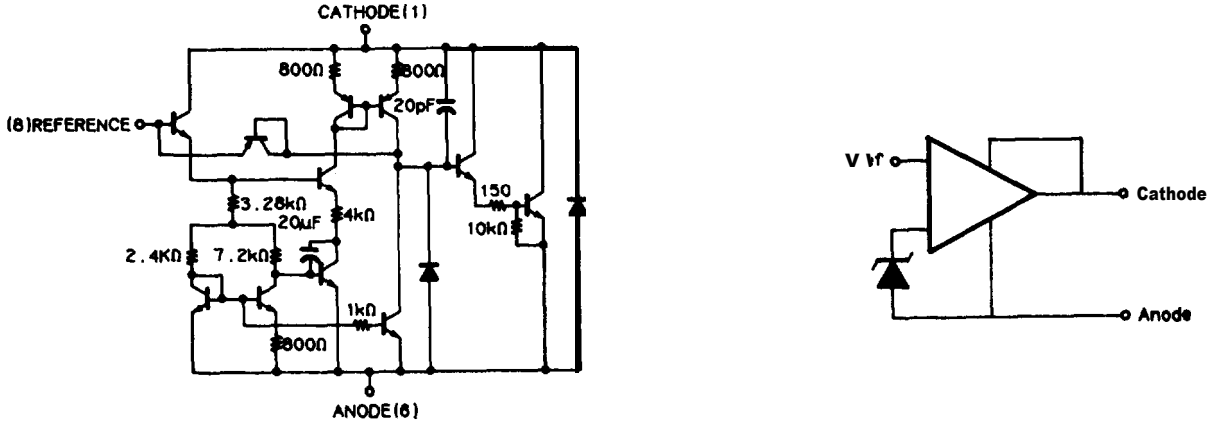


Figure A-17. TL431CLPB Internal Circuit

A.1.1.8 TTL

The internal circuitry of the TTLs is shown below.

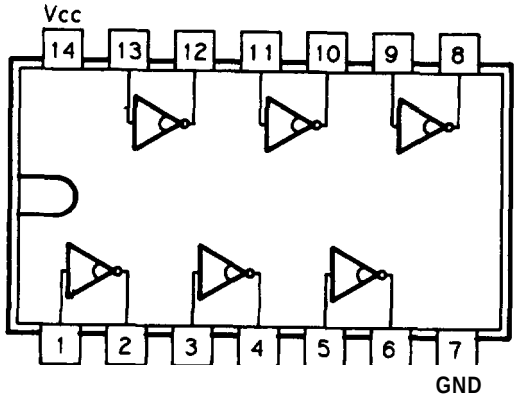


Figure A-18. 74LS06 Internal Circuit

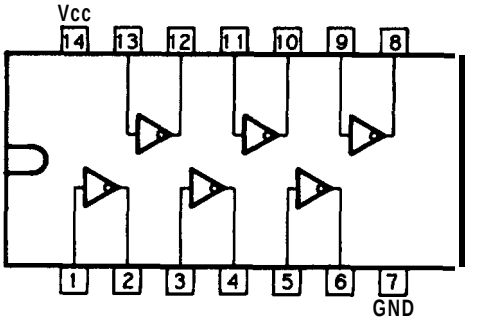


Figure A-19. 74LS07 Internal Circuit

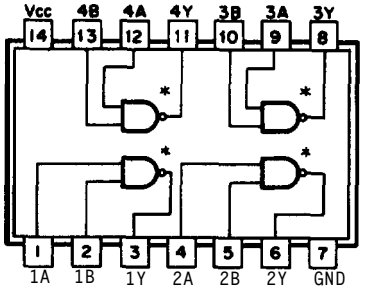


Figure A-20. 74LS38 Internal Circuit

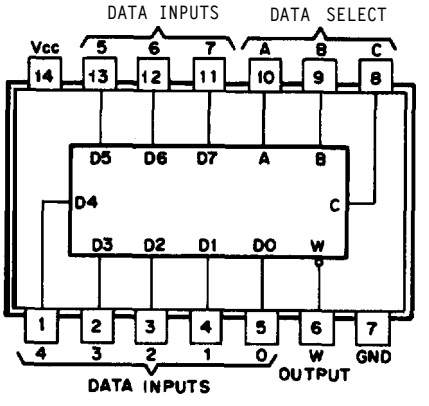


Figure A-21. 74LS152 Internal Circuit

A.1.2 SANPS/SANPSE Board Main Components

Table A-9 shows SANPS/SANPSE board ICs.

Table A-9. SANPS/SANPSE Board ICs

Location	Name of IC	Type
IC1	L5431	Adjustable precision shunt regulator
IC20	TL494	Pulse-width modulation control

4.1.2.1 TL494 (IC20)

The TL494 provides pulse-width modulation control. Its block diagram is shown in Figure A-22.

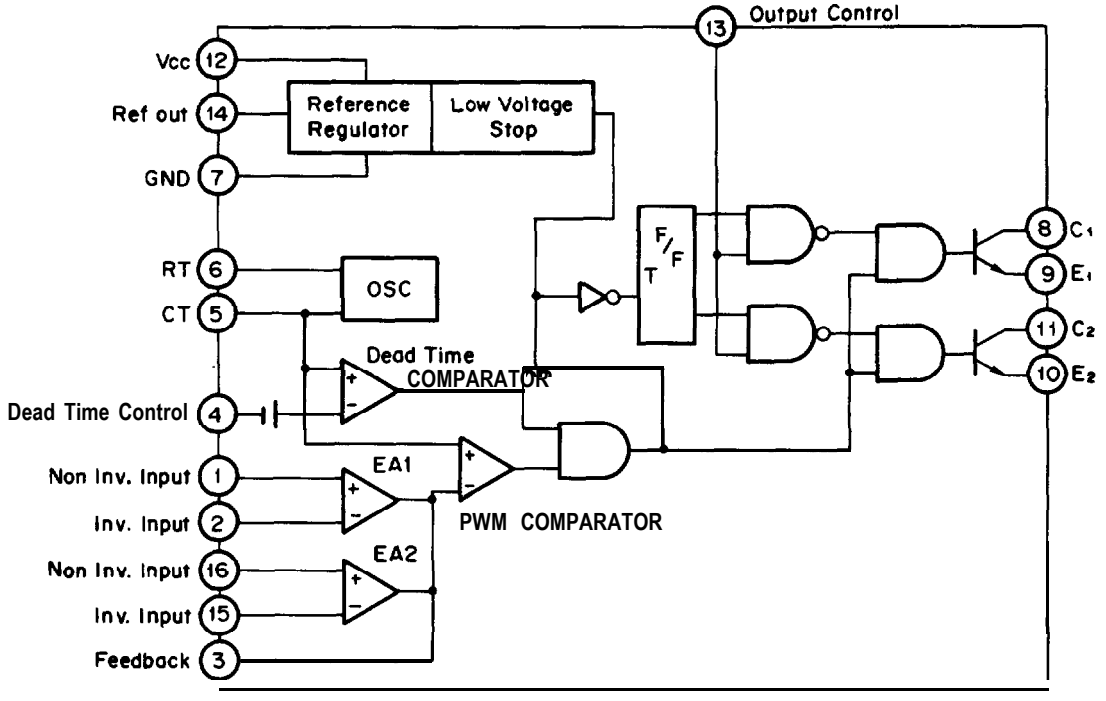


Figure A-22. TL494 Block Diagram

A.2 EXPLODED DIAGRAMS AND SCHEMATICS

The exploded and schematic diagrams shown in Figures A-23 to A-38 are provided as additional reference.

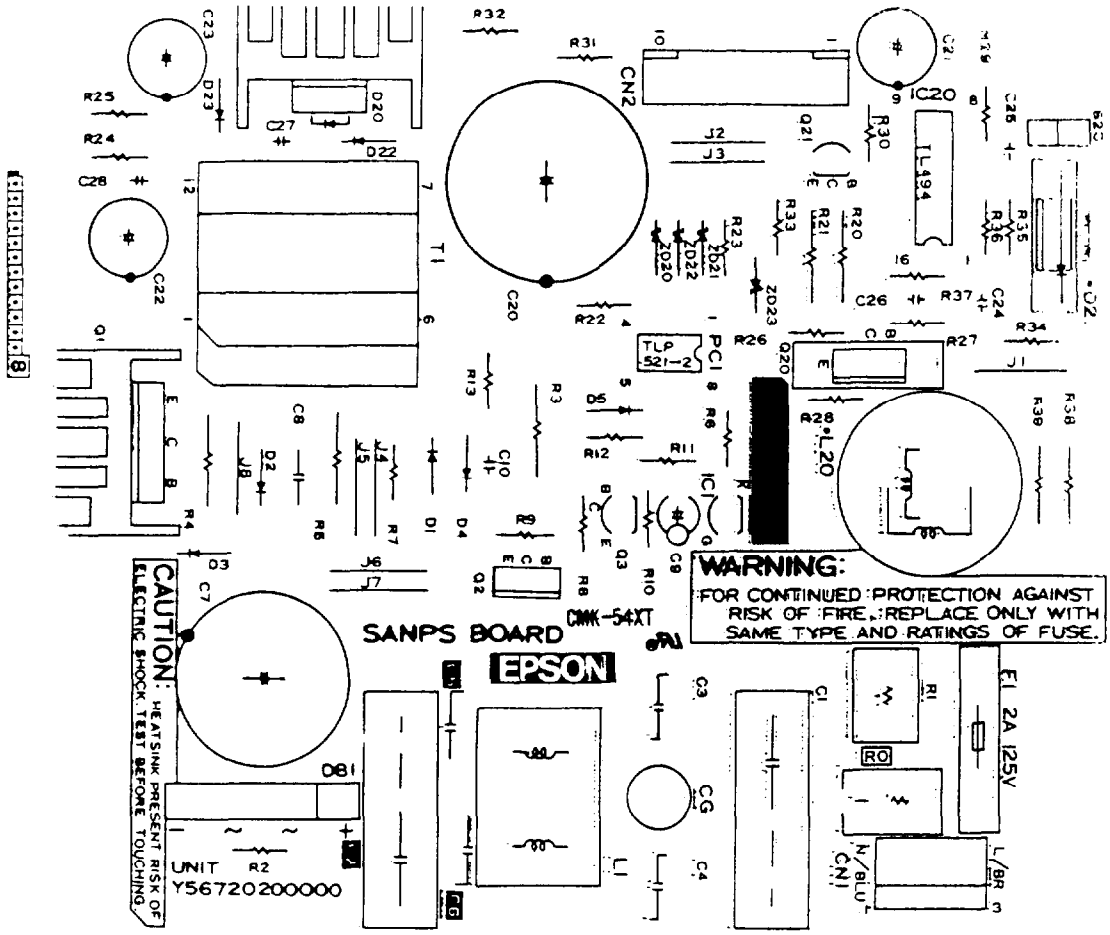


Figure A-23. SANPS Board Component Layout

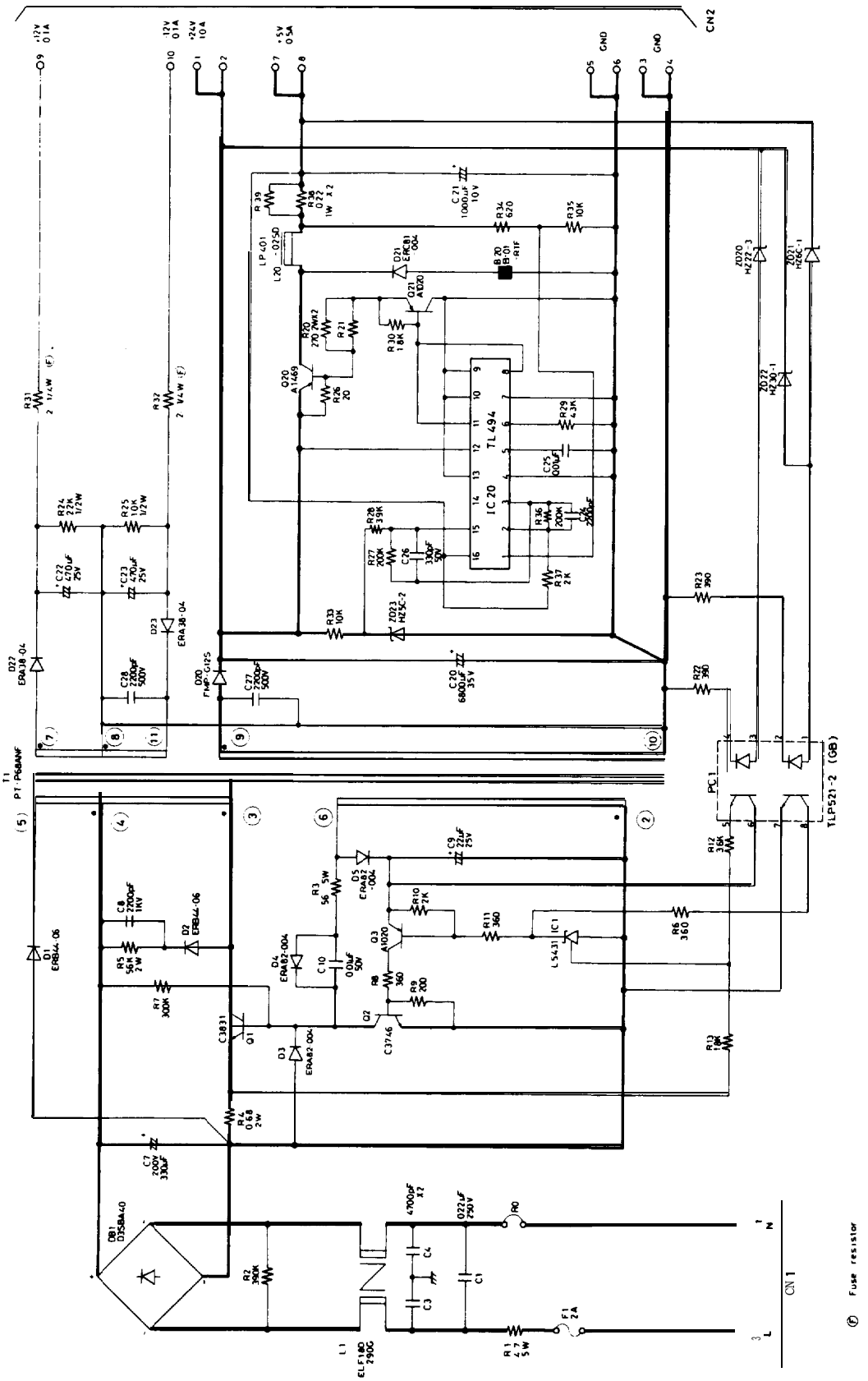


Figure A-24. SANPS Board Circuit Diagram

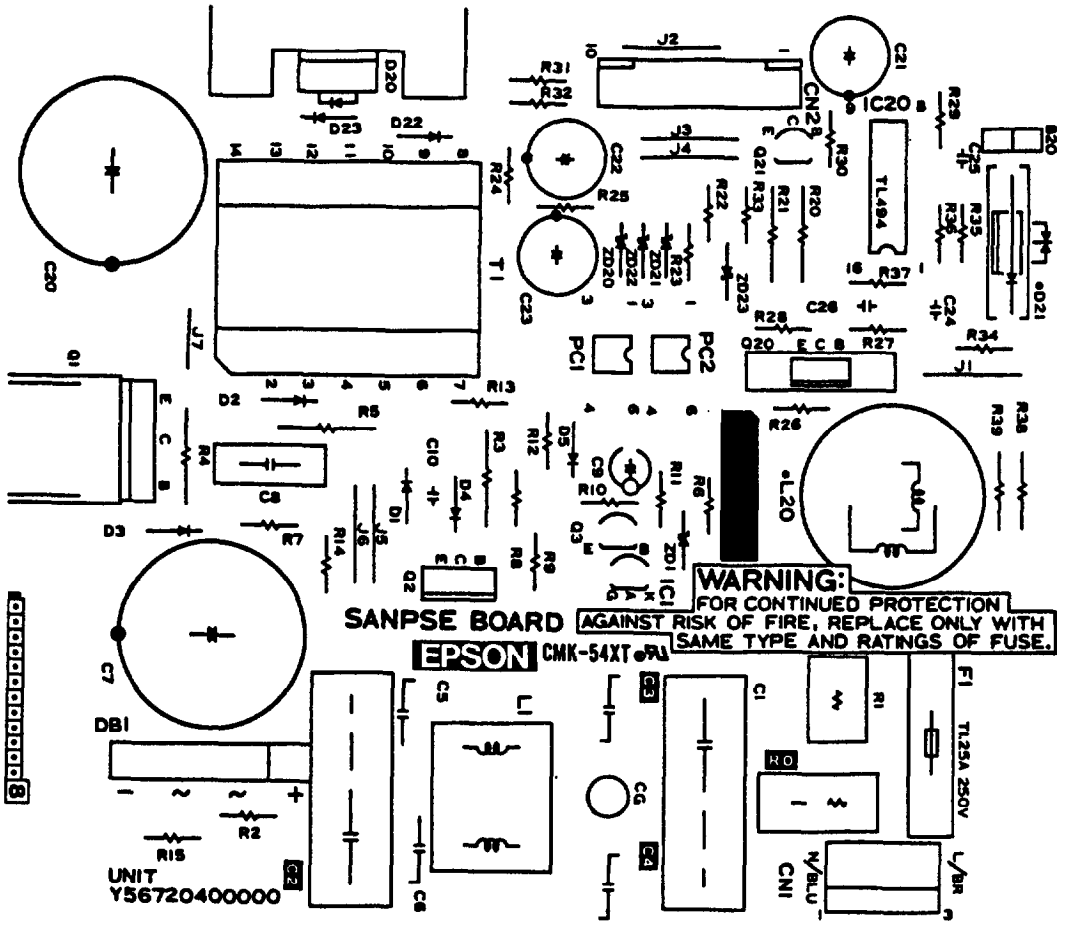


Figure A-25. SANPSE Board Component Layout

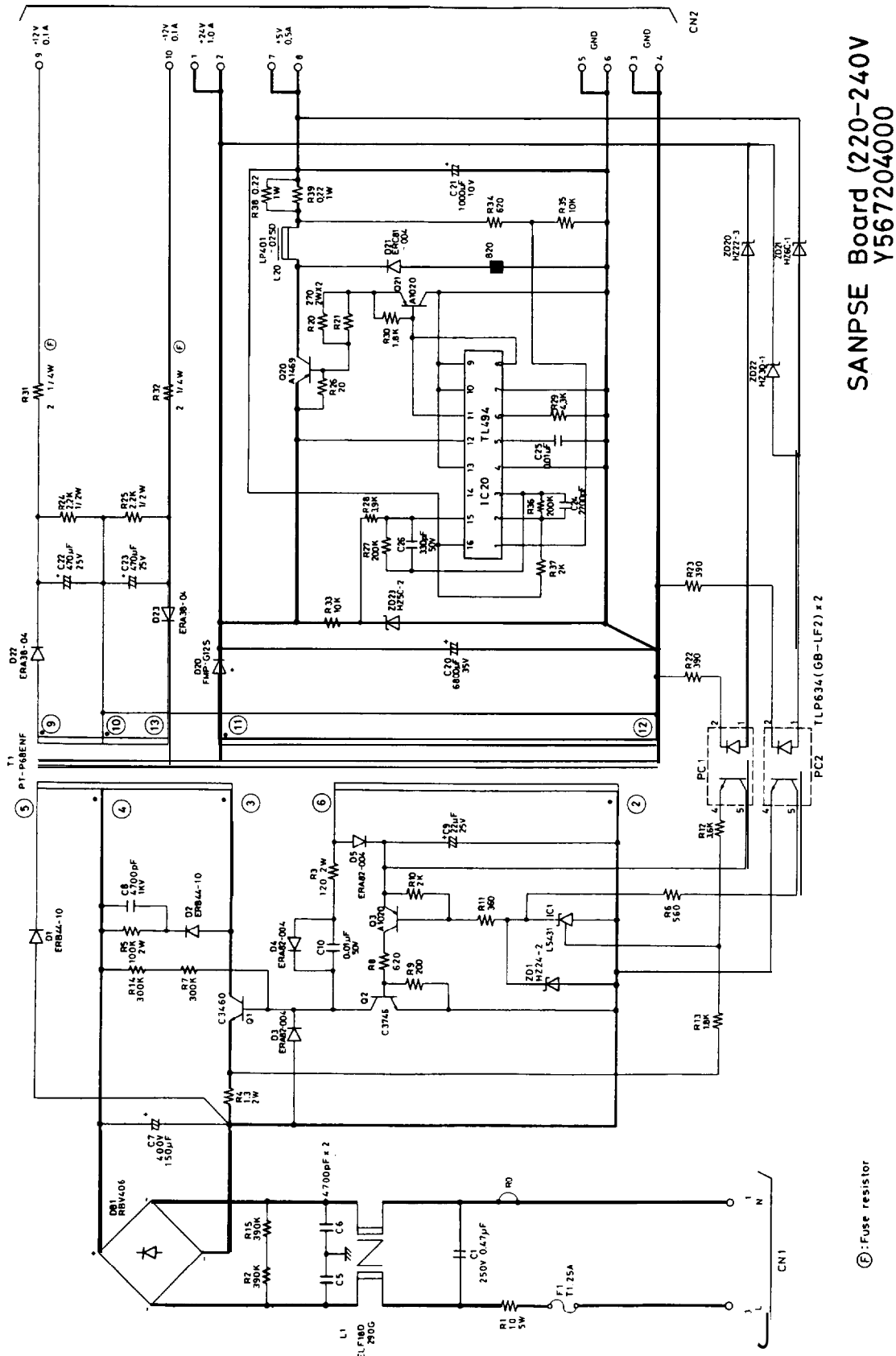


Figure A-26. SANPSE Board Circuit Diagram

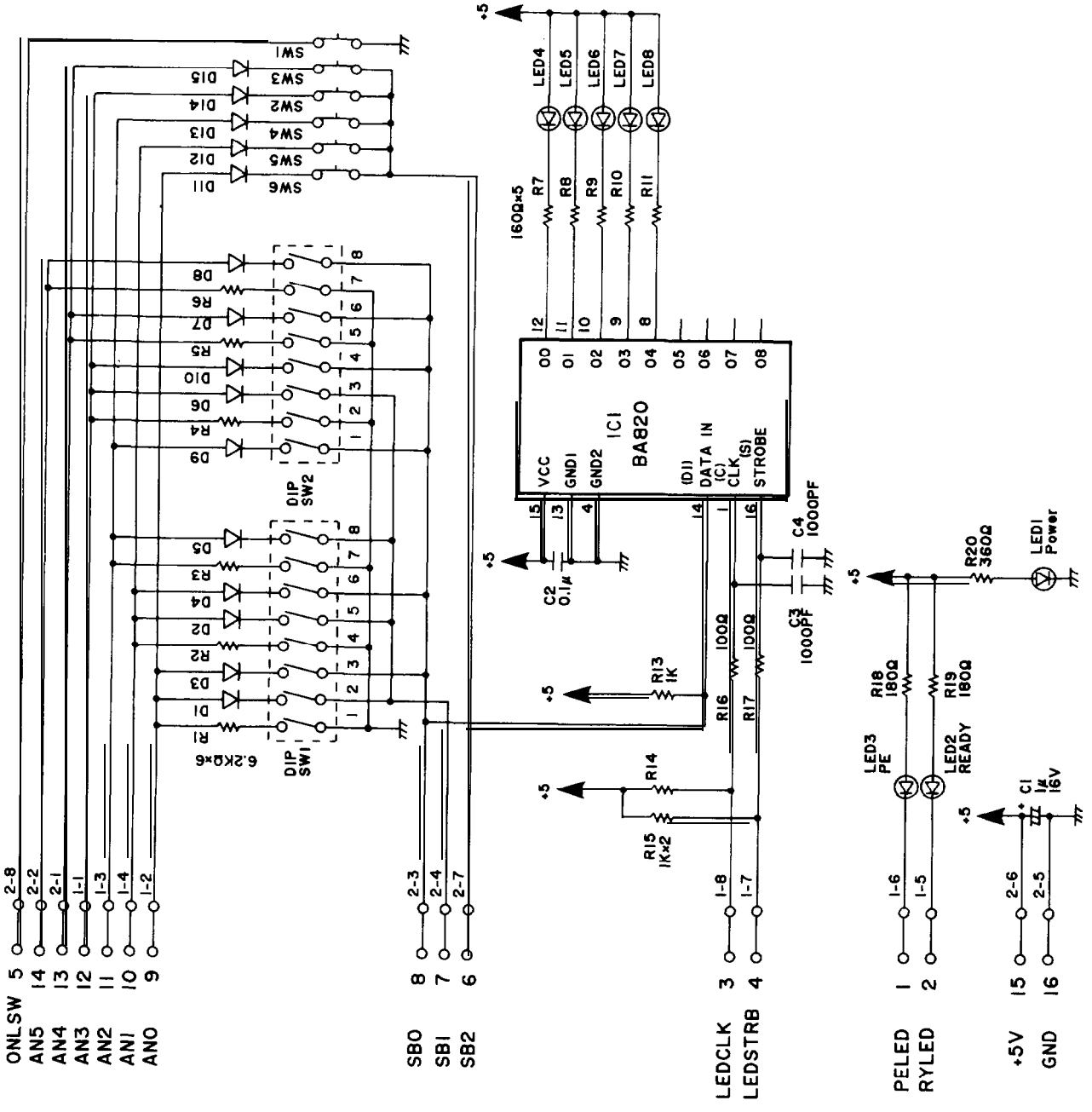


Figure A-27. SANPNL-W Board Circuit Diagram

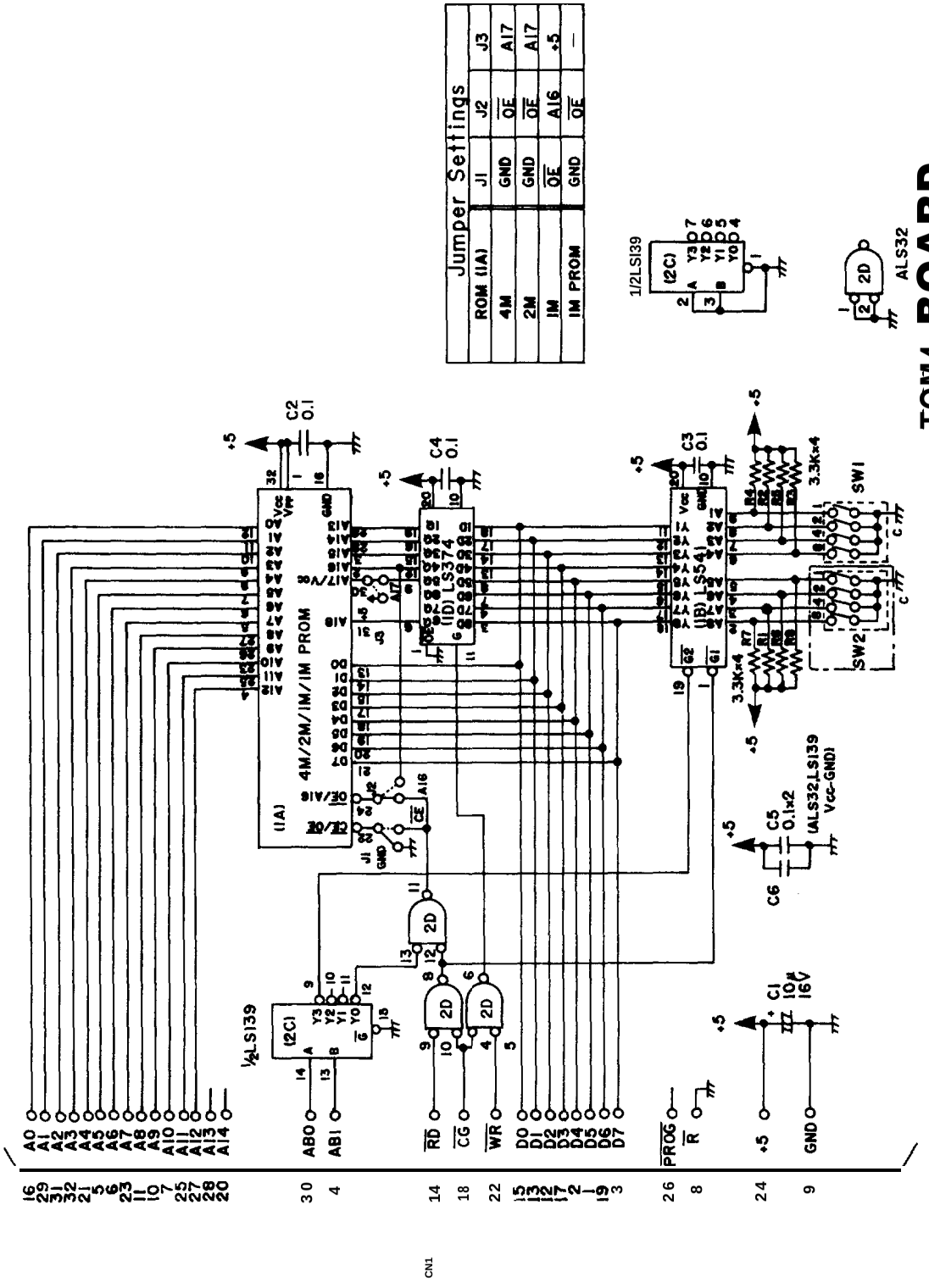


Figure A-28. TOM4 Board Circuit Diagram

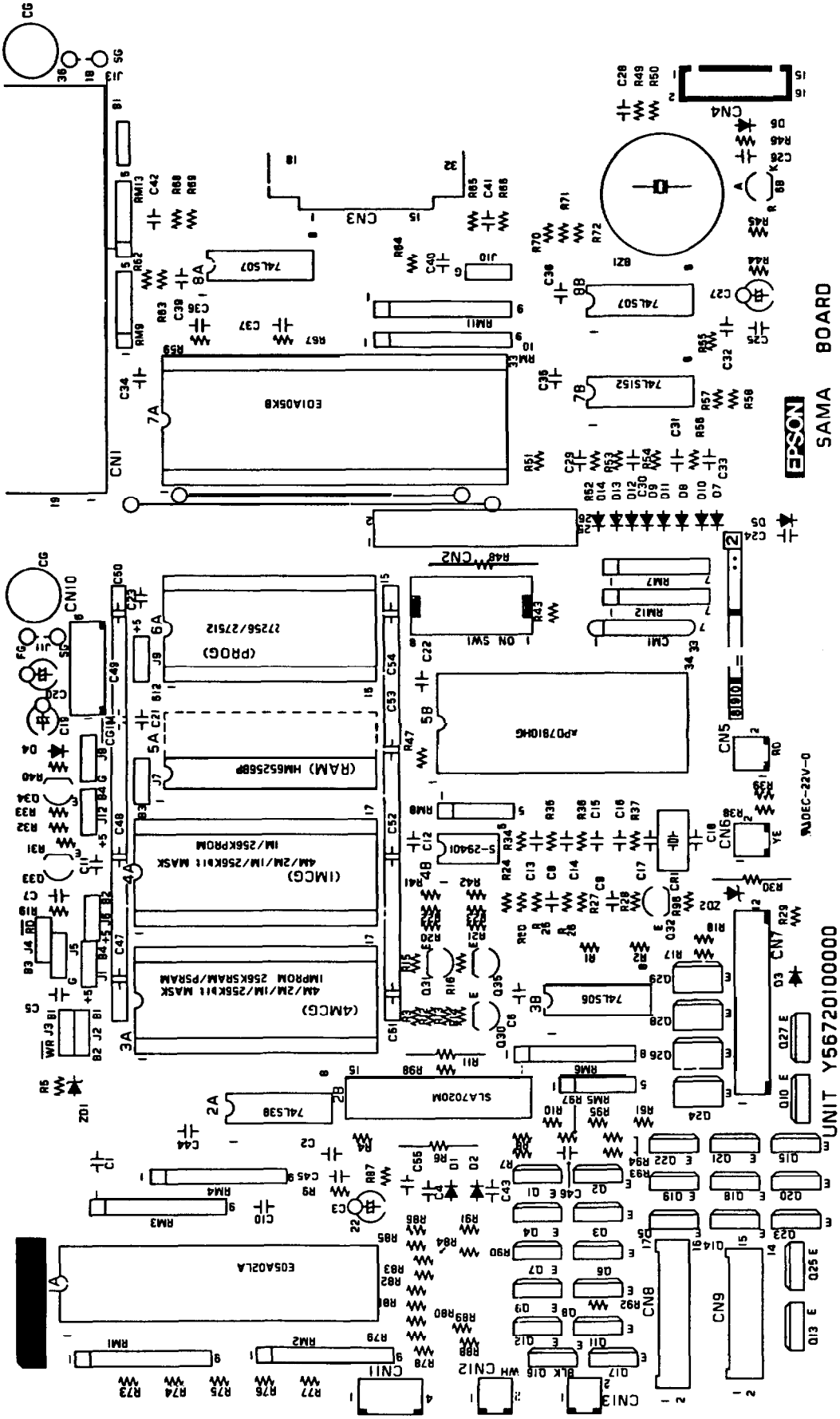
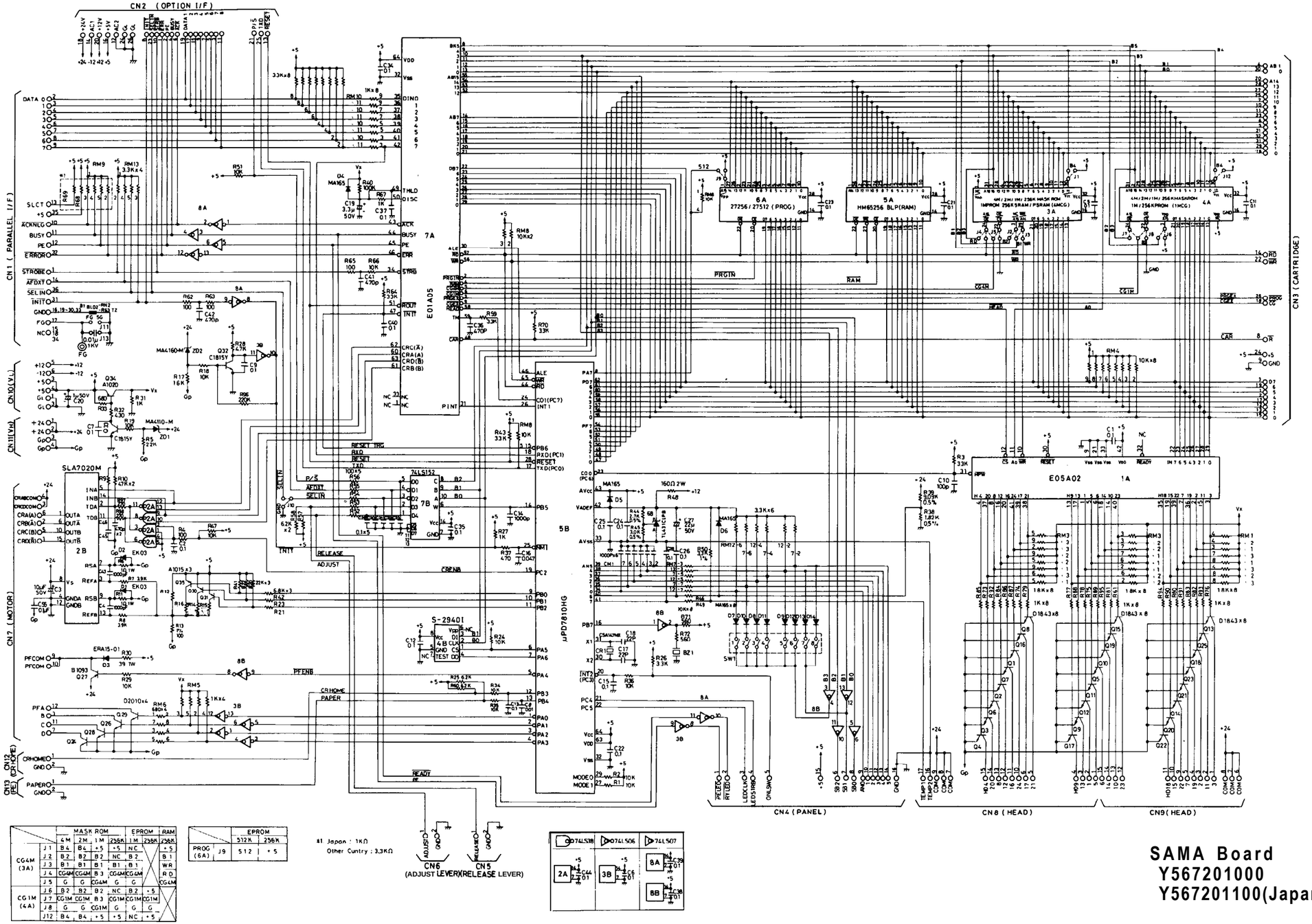


Figure A-29. SAMA Board Component Layout



SAMA Board
Y567201000
Y567201100(Japan)

Figure A-30. SAMA Board Circuit Diagram

Table A-10. CN2 Connector

In No.	Signal	I/O	Function
1	ERR	0	Error Signal
2	PE	0	PE Signal
3	D6	I	Data Bit 6
4	BUSY	0	BUSY Signal
5	D 5	I	Data Bit 5
6	ACK	0	ACKNLG Signal
7	D4	I	Data Bit 4
8	D3	I	Initialize
9	$\overline{STB}$	I	Data Bit 3
10		I	Strobe Signal
11	D7	—	Data Bit 7
12	AC2		GND
13	RS	0	Reset Signal
14	AC1	—	-12 VDC
15	D2	I	Data Bit 2
16	+5 V	—	+5 VDC
17	D1	I	Data Bit 1
18	+24 V	—	+ 24 VDC
19	D0	I	Data Bit 0
20	12 V	-	+12 VDC
21	PS	I	Parallel/Serial
22			
23	SLCTIN		SLCTIN- Signal
24	GND	-	GND
25	TXD	0	TXD
26	GND	-	GND

Table A-11. CN3 Connector

n 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	0	Address Bit 14
5	A5	0	Address Bit 5
6	A6	0	Address Bit 6
7	A10	0	Address Bit 10
8	R	I	Reset
9	GND	—	GND
10	A9	0	Address Bit 9
11	A8	0	Address Bit 8
12	D1	I	Data Bit 2
13	RD	I	Data Bit 1
14		0	Read Signal
15	D0	I	Data Bit 0
16	D3	0	Address Bit 0
17	CG	I	Data Bit 3
18		0	CG ROM Select Signal
19	D6	I	Data Bit 6
20	A14	0	Address Bit 14
21	A4	0	Address Bit 4
22	WR	0	Write Signal
23	A7	0	Address Bil 7
24	+5 V	—	+5VDC
25	A 1 1	0	Address Bit 11
26	PROG	0	PROM Select Signal
27	A12	0	Address Bit 12
28	A13	0	Address Bit 13
29	AI	0	Address Bit 1

Table A-11. CN3 Connector (Cont.)

Pin No.	Signal	I/O	Function
30	AB0	0	Address Bit 13
31	A2	0	Address Bit 2
32	A3	0	Address Bit 3

Table A-12. CN4 Connector

Pin No.	Signal	I/O	Function
1	PELED	O	Paper-End LED
2	RYLED	O	Ready LED
3	LEDCLK	O	LED Drive IC CLK
4	LEDSTRB	O	LED Drive IC STRB
5	ONLSW	I	ON LINE SW
6	SB2	O	Switch Bank 2
7	SB1	O	Switch Bank 1
8	SB0	O	Switch Bank 0
9	AN0	I	Analog Input 0
10	AN1	I	Analog Input 1
11	AN2	I	Analog Input 2
12	AN3	I	Analog Input 3
13	AN4	I	Analog Input 4
14	AN5	I	Analog Input 5
15	+5 V	—	+5 VDC
16	GND	—	GND

Table A-13. CN5 Connector

Pin No.	Signal	I/O	Function
1	RELEASE	I	Release SW
2	GND	—	GND

Table A-14. CN6 Connector

Pin No.	Signal	I/O	Function
1	ADJUST	I	PG Sensor
2	GND	—	GND

Table A-15. CN7 Connector

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

Table A-16. CN8 Connector

Pin No.	Signal	I/O	Function
1	HD5	I	Head Data 5
2	HD1	I	Head Data 1
3	HD13	I	Head Data 13
4	HD9	I	Head Data 9
5	HD21	I	Head Data 21
6	HD17	I	Head Data 17
7	COM	—	Common
8	COM	—	Common
9	COM	—	Common
10	HD24	I	Head Data 24
11	HD16	I	Head Data 16
12	HD12	I	Head Data 12
13	HD8	I	Head Data 8
14	HD20	I	Head Data 20
15	HD4	I	Head Data 4
16	TEMP2	I	TEMP Signal
17	TEMP1	I	TEMP Signal

Table A-17. CN9 Connector

Pin No.	Signal	I/O	Function
1	HD3	I	Head Data 3
2	HD11	I	Head Data 11
3	HD2	I	Head Data 2
4	HD19	I	Head Data 19
5	HD7	I	Head Data 7
6	COM	—	Common
7	COM	—	Common
8	COM	—	Common
9	HD22	I	Head Data 22
10	HD15	I	Head Data 15
11	HD18	I	Head Data 18
12	HD23	I	Head Data 23
13	HD10		Head Data 10
14	HD14	I	Head Data 14
15	HD6	I	Head Data 6

Table A-19. CN10 Connector

Pin No.	Signal	I/O	Function
1	GL	—	GND Logic
2	GL	—	GND Logic
3	+5 V	—	+5 VDC
4	+5 V	—	+5 VDC
5	+12 V	—	+12 VDC
6	-12 V	—	-12 VDC

Table A-19. CN11 Connector

Pin No.	Signal	I/O	Function
1	+24 V	-	+ 24 VDC
2	+24 V	-	+ 24 VDC
3	GP	-	GND (Power)
4	GP	-	GND (Power)

Table A-20. CN12 Connector

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

Table A-21. CN13 Connector

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

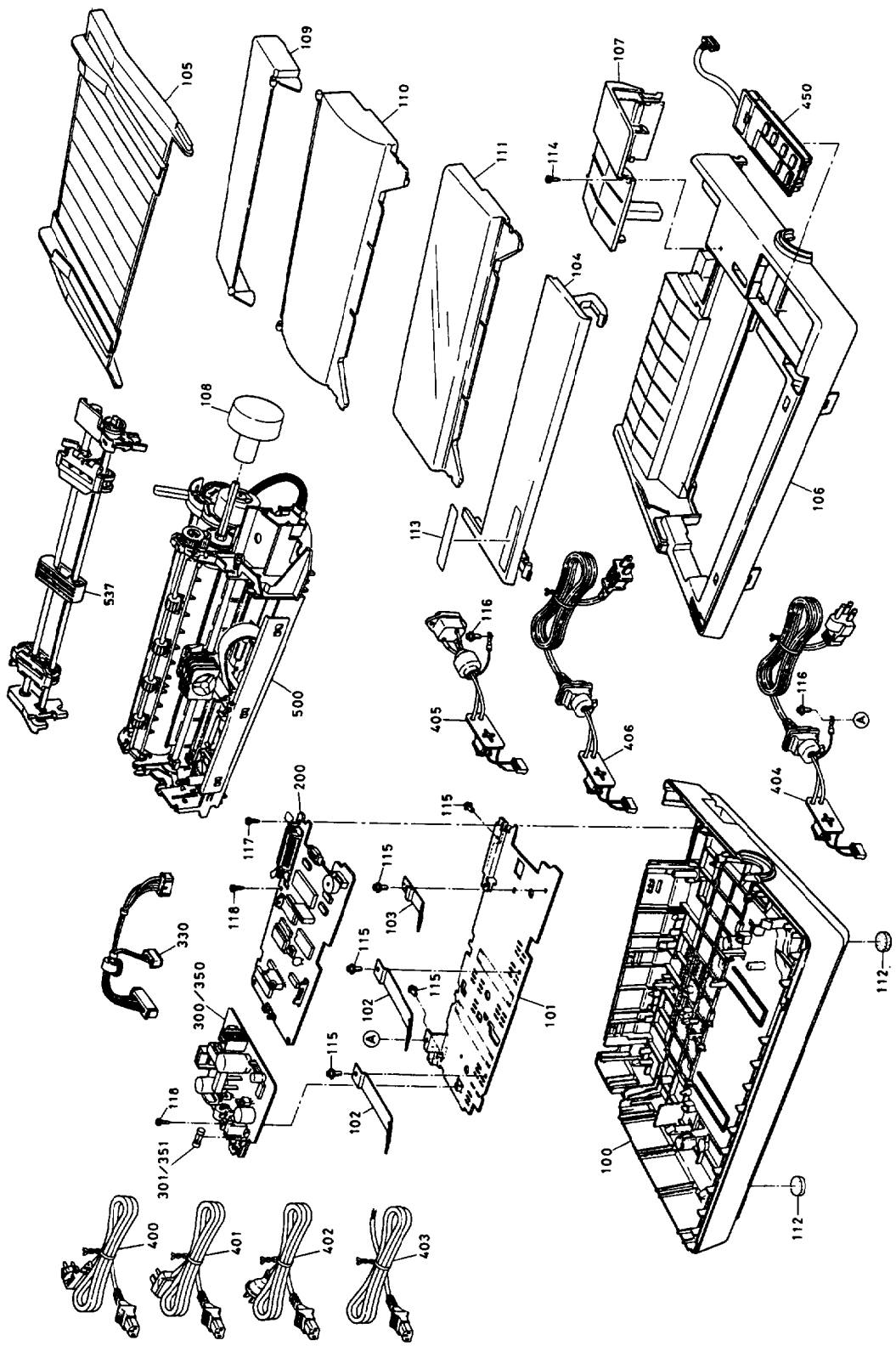


Figure A-31. LQ-510 Exploded Diagram

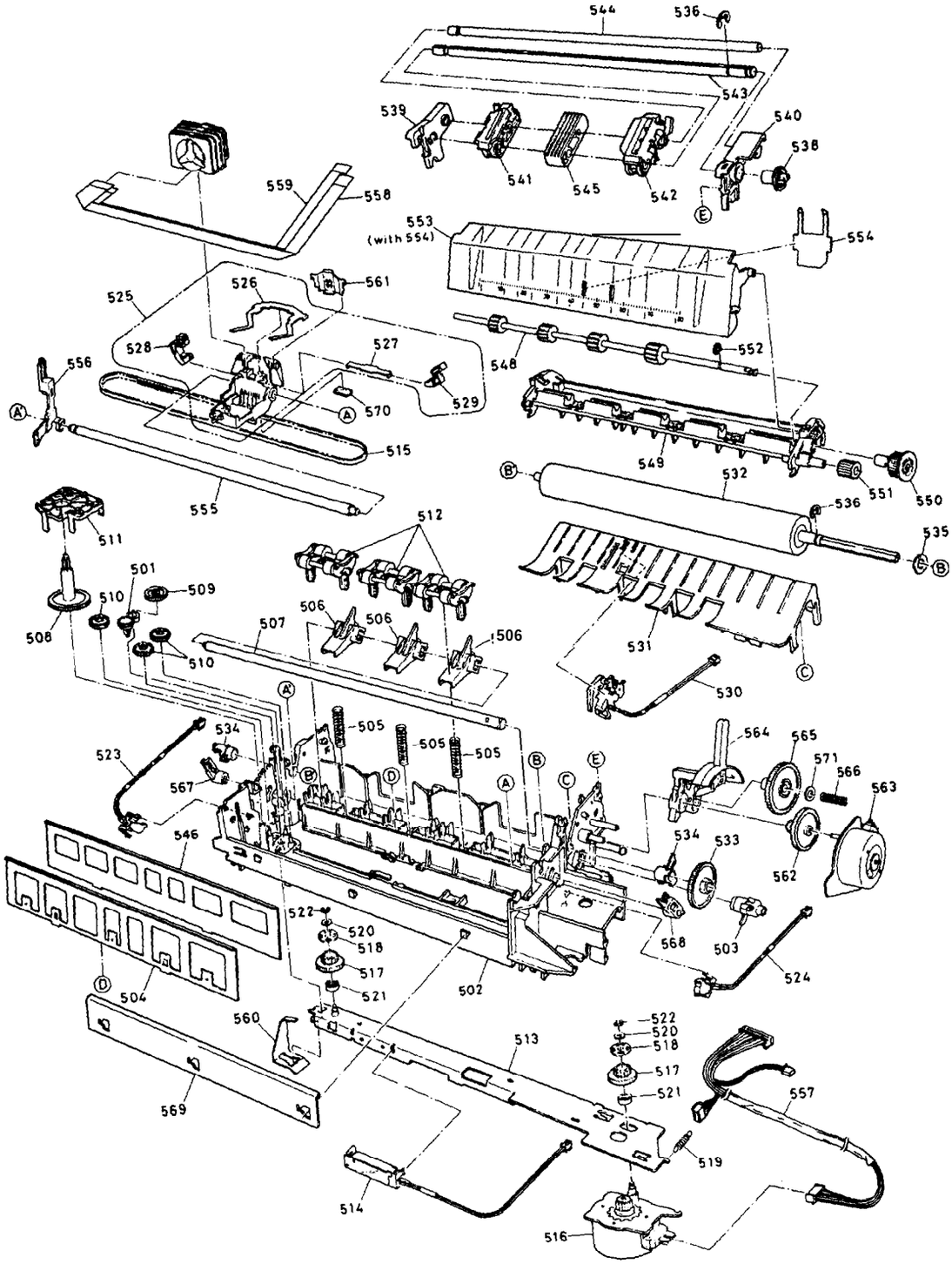


Figure 14.32. Model 5710 Printer Mechanism Exploded Diagram

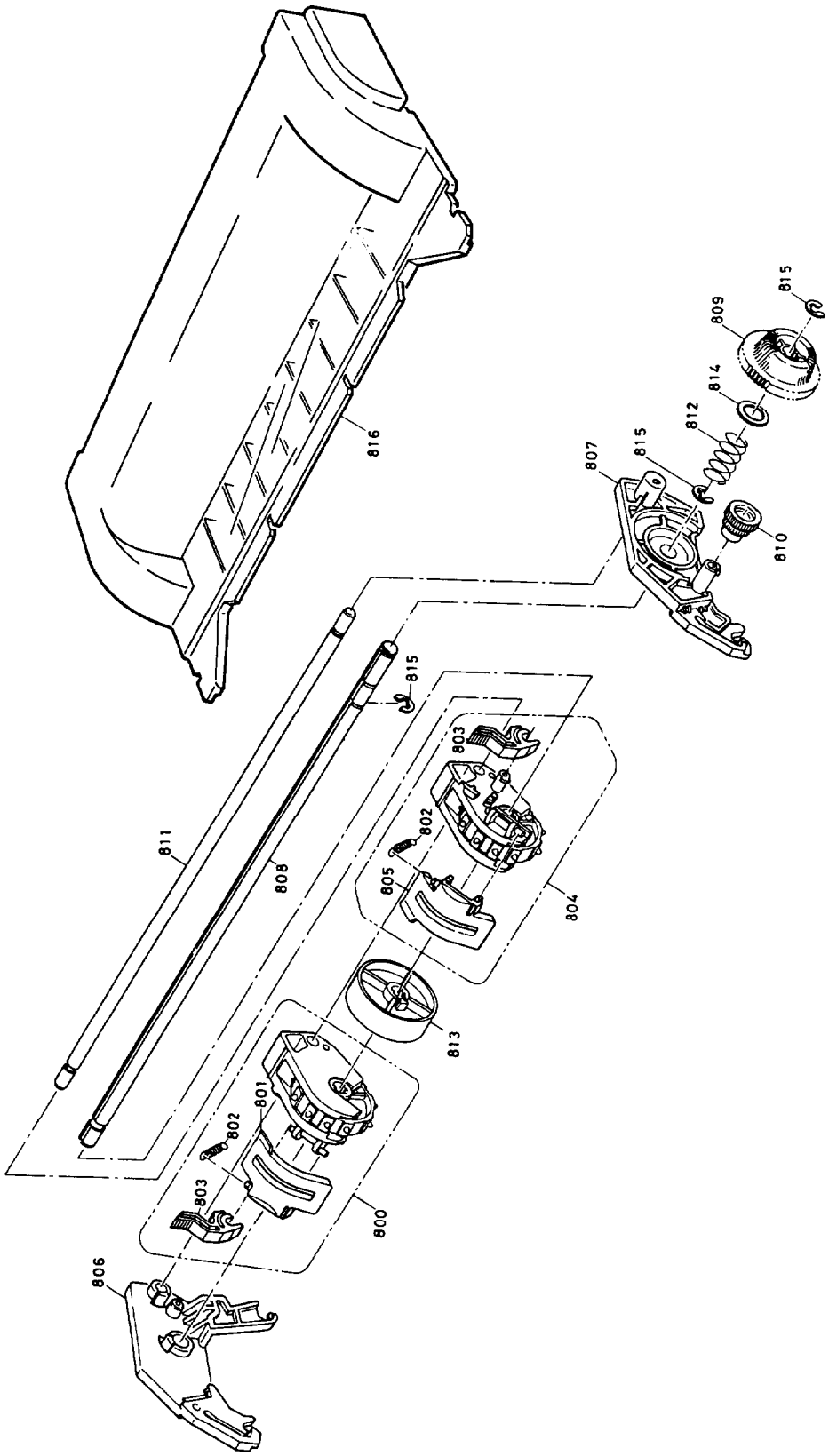


Figure A-33. C80006 Pull Tractor Exploded Diagram

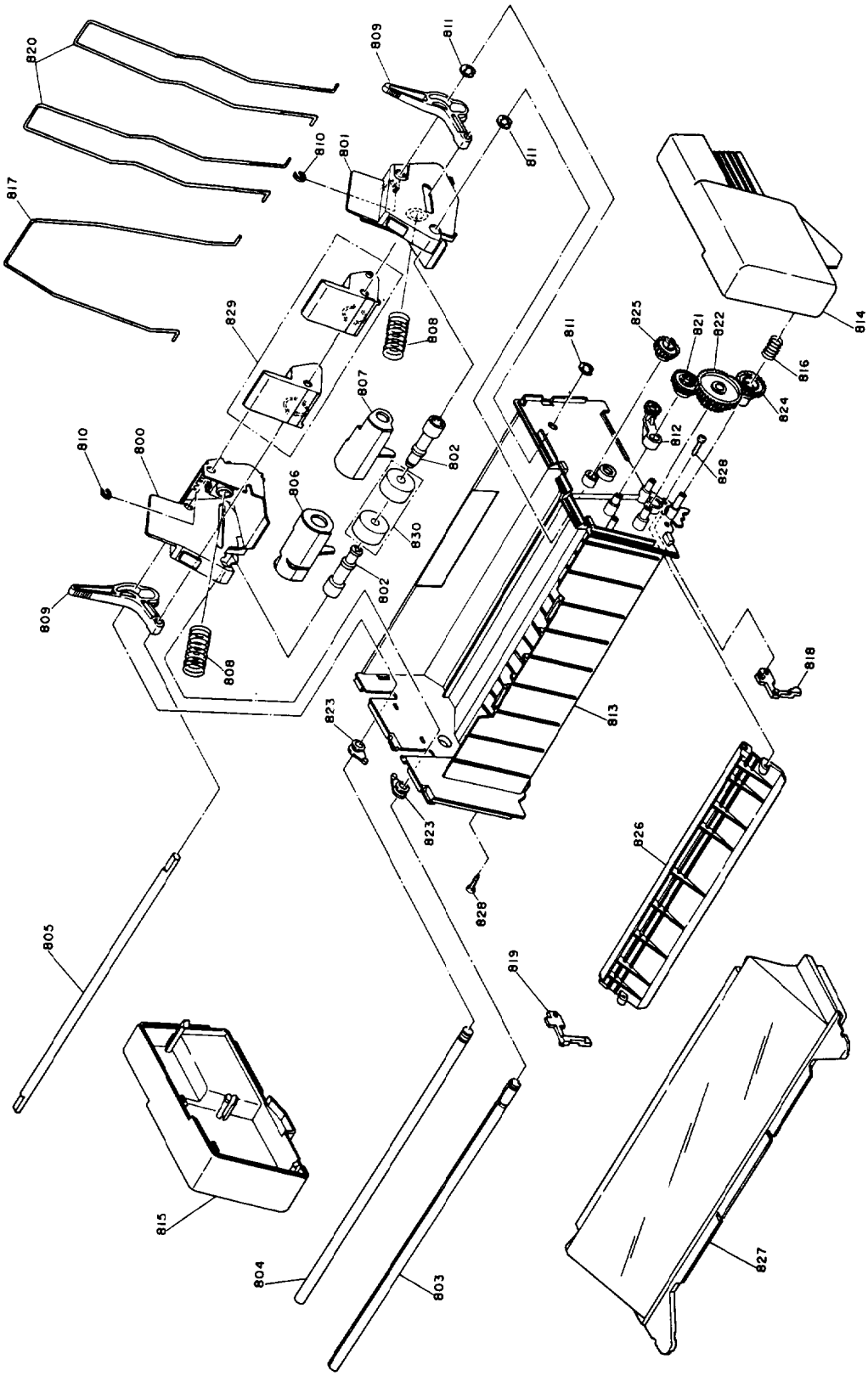


Figure A-34. C80612 Cut-Sheet Feeder Exploded Diagram

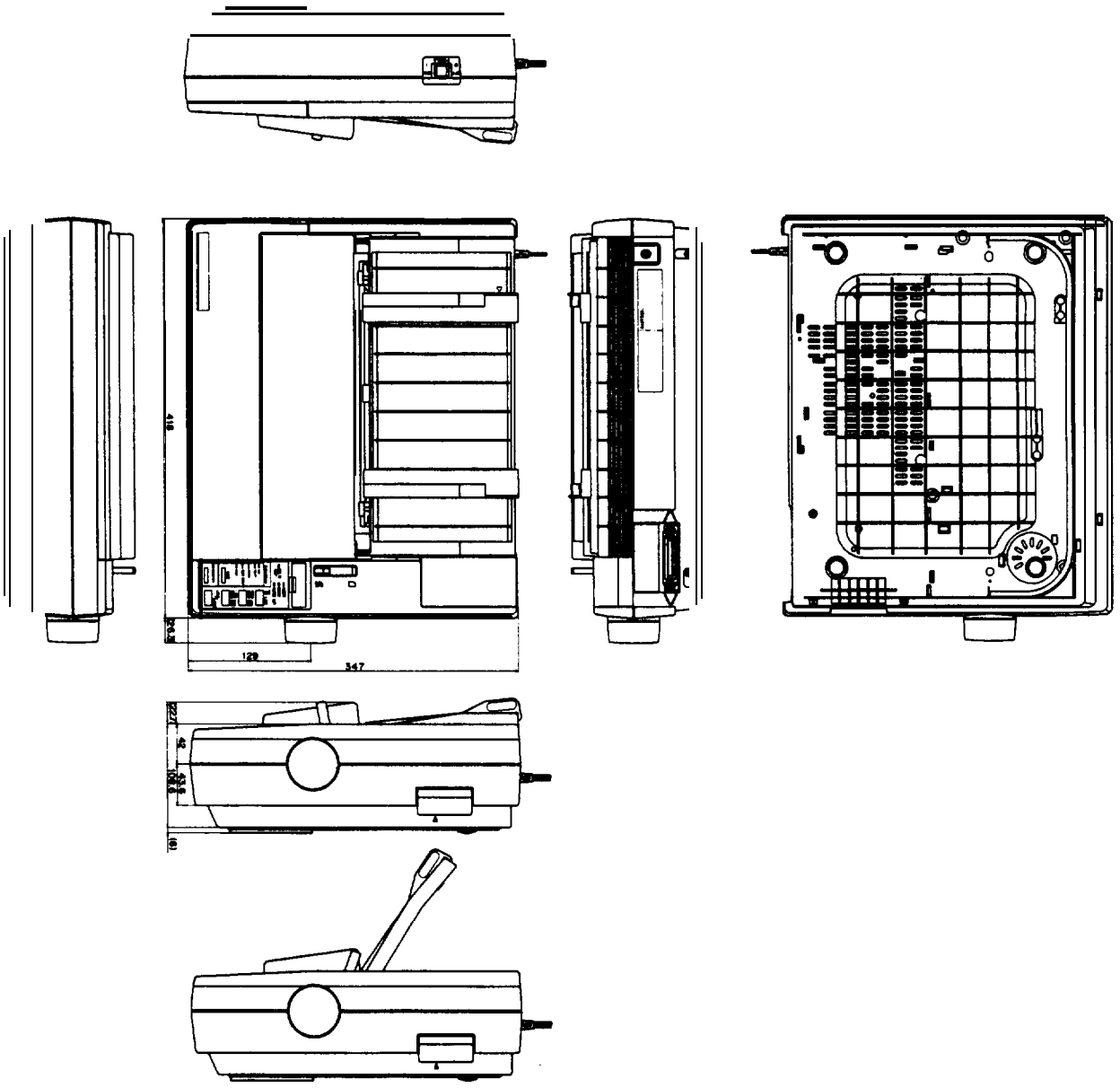


Figure A-35. LQ-510 Printer Cover A Case Outline Drawing

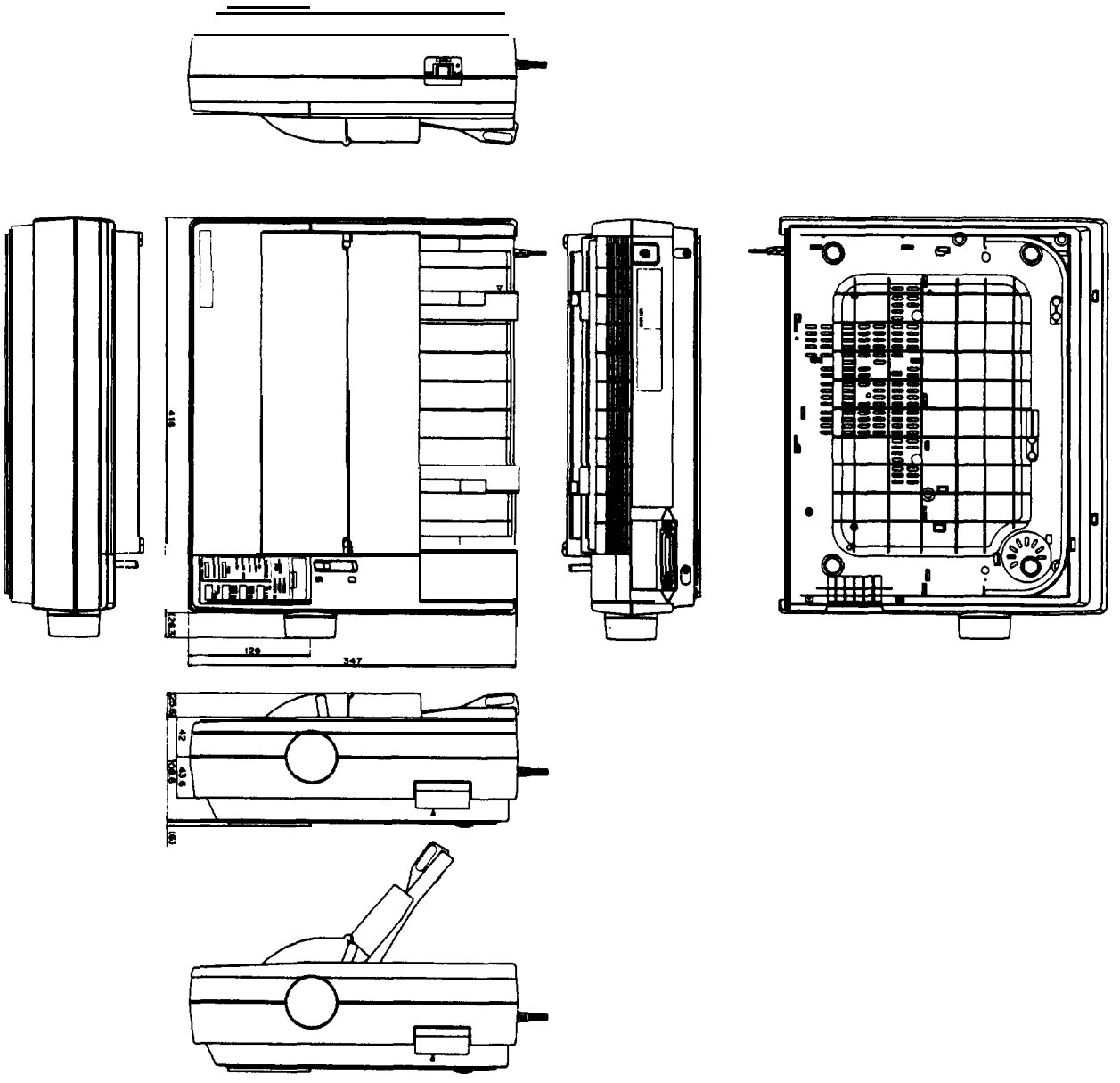


Figure A-36. LQ-510 Printer Cover B Case Outline Drawing

Table A-22. Part No. Reference Table
(Refer to the exploded diagrams in Figures A-31 through A-34.)

Ref. No.	Description
	LQ-510
100	LOWER CASE ASSEMBLY
101	BASE PLATE
102	GROUND PLATE A
103	GROUND PLATE B
104	PRINTER COVER A
105	SHEET GUIDE ASSEMBLY
106	UPPER CASE
107	OPTION BOARD COVER
108	PLATEN KNOB
109	SHEET GUIDE COVER
110	PRINTER COVER 02
111	PRINTER COVER U
112	RUBBER FOOT
113	LOGO PLATE
114	CBP(C) SCREW
115	CBS(O) SCREW
116	CB(O) SCREW
117	CBS(C) SCREW
118	CBS(C) SCREW
200	SAMA BOARD UNIT
300	SANPS BOARD UNIT
301	FUSE (125 V/2.0 A)
330	CABLE SET 8DT
350	SANPSE BOARD UNIT
351	FUSE (250 V/l 1.25 A)
400	POWER CABLE (220/240 V)
401	POWER CABLE (240 V)
402	POWER CABLE (240 V)
403	POWER CABLE (220 V)
404	CABLE SET 8E9
405	CABLE SET 8EB
406	CABLE SET 8EA
450	SANPNL-W PANEL
500	PRINTER MECHANISM (M-5710)
501	RIBBON PLANETARY ASSEMBLY
502	FRAME
503	SUB PAPER RELEASE LEVER
504	PAPER GUIDE PLATE
505	PAPER-FEED ROLLER SPRING
506	PAPER-FEED LEVER
507	PAPER-FEED LEVER SHAFT
508	RIBBON-DRIVING GEAR
509	RIBBON TRANSMISSION GEAR
510	RIBBON GEAR
511	RIBBON GEAR COVER
512	PAPER-FEED ROLLER ASSEMBLY
513	CARRIAGE MOTOR FRAME
514	HOME-POSITION SENSOR
515	TIMING BELT
516	CARRIAGE MOTOR
517	BELT PULLEY
518	BELT PULLEY FLANGE
519	BELT TENSION SPRING
520	PLAIN WASHER
521	BELT PULLEY SHAFT
522	RETAINING RING E (2. 3)
523	PLATEN GAP SENSOR
524	FRICTION/TRACTOR SENSOR
525	CARRIAGE UNIT
526	HEAD GROUND PLATE
527	HEAD LOCK LEVER SPRING
528	HEAD LOCK LEVER (LEFT)
529	HEAD LOCK LEVER (RIGHT)
530	PAPER-END SENSOR
531	PAPER GUIDE
532	PLATEN
533	PLATEN GEAR
534	SHAFT HOLDER
535	LEAF SPRING
536	RETAINING RING
537	TRACTOR UNIT
538	TRACTOR GEAR
539	TRACTOR FRAME (LEFT)
540	TRACTOR FRAME (RIGHT)
541	TRACTOR ASSEMBLY (LEFT)
542	TRACTOR ASSEMBLY (RIGHT)
543	TRACTOR SHAFT
544	TRACTOR GUIDE SHAFT
545	PAPER SUPPORT
546	PAPER GUIDE PLATE SPACER
547	PAPER TENSION UNIT
548	PAPER TENSION ROLLER ASSEMBLY
549	PAPER TENSION FRAME
550	PAPER TENSION CARRIAGE GUIDE PLATE B
551	PAPER TENSION ROLLER TRANSMISSION GEAR
552	RETAINING RING
553	PAPER TENSION UNIT COVER
554	PAPER TENSION SPRING
555	CARRIAGE GUIDE SHAFT
556	HEAD ADJUSTMENT LEVER
557	MOTOR CABLE
558	HEAD CABLE (FRONT)
559	HEAD CABLE (REAR)
560	CARRIAGE GUIDE SHAFT GROUND PLATE
561	RIBBON MASK
562	PAPER-FEED REDUCTION GEAR
563	PAPER-FEED MOTOR
564	PAPER-RELEASE LEVER
565	TRACTOR REDUCTION GEAR
566	TRACTOR REDUCTION SPRING
567	CARRIAGE GUIDE SHAFT LEVER (LEFT)
568	CARRIAGE GUIDE SHAFT LEVER (RIGHT)
569	CARRIAGE GUIDE PLATE B
570	OIL PAD
571	PLAIN WASHER
	PULL TRACTOR
800	SPROCKET ASSEMBLY (LEFT)
801	PAPER-HOLDING COVER (LEFT)
802	PAPER-HOLDING COVER SPRING
803	SPROCKET LOCK LEVER
804	SPROCKET ASSEMBLY (RIGHT)
805	PAPER HOLDING COVER (RIGHT)
806	SPROCKET MOUNTING PLATE (LEFT)
807	SPROCKET MOUNTING PLATE (RIGHT)
808	SPROCKET SHAFT
809	SPROCKET GEAR
810	SPROCKET REDUCTION GEAR
811	SPROCKET SUPPORT SHAFT
812	SPROCKET GEAR SPRING
813	PAPER GUIDE ROLLER
814	PLAIN WASHER 8.2 x 0.5 x 15
815	RETAINING RING TYPE-E (5)
816	TRACTOR COVER
	CSF
800	PAPER SUPPORT (LEFT)
801	PAPER SUPPORT (RIGHT)
802	PAPER-HOLDER ROLLER BUSH
803	PAPER-LOADING ROLLER SHAFT
804	PAPER SUPPORT SHAFT
805	PAPER-HOLDER SHAFT
806	PAPER-LOADING ROLLER COVER (LEFT)
807	PAPER-LOADING ROLLER COVER (RIGHT)
808	PAPER-HOLDER SPRING
809	PAPER-RELEASE LEVER
810	SLIDE LOCK BUSH
811	RETAINING RING TYPE-E (6)
812	PLANETARY LEVER A
813	FRAME
814	SIDE COVER (RIGHT)
815	SIDE COVER (LEFT)
816	DRIVING TRANSMISSION GEAR B SPRING
817	STACKER PAPER STAND
818	CSF LOCK LEVER (RIGHT)
819	CSF LOCK LEVER (LEFT)
820	HOPPER PAPER STAND
821	DRIVING TRANSMISSION GEAR A
822	SUB GEAR
823	SHAFT HOLDER
824	DRIVING TRANSMISSION GEAR B
825	PAPER-LOADING GEAR
826	PAPER GUIDE PLATE
827	CSF COVER
828	CPB SCREW M3 x 14
829	PAPER HOLDERS
830	PAPER-LOADING ROLLERS