SERVICE MANUAL

HP 7090A

MEASUREMENT PLOTTING SYSTEM

HEWLETT PACKARD

HP 7090A

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SERIAL NUMBERS

This manual applies directly to measurement plotting systems with serial numbers prefixed 2430 and below.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section I.

16399 W. BERNARDO DRIVE, SAN DIEGO, CALIFORNIA 92127-1899

MANUAL PART NO. 07090-90000
Microfiche Part No. 07090-90050

Printed: SEPTEMBER 1984

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLES

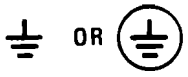
ILLUSTRATIONS

ILLUSTRATIONS (Continued)

General Definitions of Safety Symbols Used On Equipment

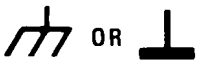
International caution symbol (refer to manual): the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current

Direct current

Alternating or direct current

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury.

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

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Figure 1-1. HP 7090

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This Service Manual contains information required to test and service the Hewlett-Packard Model 7090 Measurement Plotting System. This manual is divided into eight sections as follows:

SECTION I	GENERAL INFORMATION
SECTION II	INSTALLATION
SECTION III	OPERATION
SECTION IV	PERFORMANCE TESTS
SECTION V	ADJUSTMENTS
SECTION VI	REPLACEABLE PARTS
SECTION VII	MANUAL CHANGES
SECTION VIII	SERVICE

1-3. This General Information section includes a description of the Measurement Plotting System, its specifications, available options, accessories supplied, and recommended test equipment.

1-4. Also listed on the title page of this manual is a Microfiche part number. This number can be used to order 4 × 6-inch microfilm transparencies of this manual. Each microfiche contains up to 96 photo-duplicates of the manual pages. The microfiche package also includes the latest Manual Update Packages as well as pertinent Service Notes.

1-5. Information for interfacing, operating and programming the HP 7090 is contained in the following publications:

TITLE	HP PART NO.
HP Model 7090 Interfacing and Programming Manual	07090-90001
HP Model 7090 Operator's Manual	07090-90002
HP Model 7090 Pocket Guide	07090-90004

1-6. SPECIFICATIONS

1-7. Table 1-1 lists the specifications for the HP 7090. These specifications include the performance standards against which the instrument is tested. Table 1-2 lists supplemental characteristics. Supplemental characteristics are not specifications but are typical characteristics included as additional information for the user. Figure 1-2 illustrates the outside dimensions of the HP 7090.

1-8. SAFETY CONSIDERATIONS

1-9. Safety information relevant to the service procedures is provided in the appropriate sections of this manual. The HP 7090 and this manual should be reviewed for safety markings and instructions before service work is begun.

1-10. INSTRUMENTS COVERED BY MANUAL

1-11. The instrument serial number is located on the rear panel. Hewlett-Packard uses a two-part serial number consisting of a four-digit prefix and a five-part suffix separated by a letter (0000A00000). The prefix is the same for all identical instruments and changes only when a modification is made that affects parts compatibility. The letter indicates country of manufacture. The suffix is assigned sequentially and is different for each instrument. This manual applies directly to instruments with the serial prefix shown on the title page.

1-12. If the serial number prefix of your instrument is higher than the one shown, one or more update packages of revised pages are supplied with the manual. Use these new pages to replace the original pages, and insert the old pages in the Manual Changes section of this manual. If two or more update packages are supplied, insert them in order by revision letter; that is Revision A first, then Revision B, etc. The title page will then show the latest serial prefix and the manual will apply directly to instruments with that prefix.

1-13. If the instrument at hand has a lower serial prefix than the one shown on the title page, information in the Manual Changes section will adapt this manual to that instrument. To maintain this feature, it is necessary that when revised pages are inserted in the manual, the old pages be added to this section. In addition to instrument changes, revised pages may correct errors in the manual or include improved procedures.

1-14. DESCRIPTION

1-15. The HP 7090, shown in Figure 1-1, is a six-pen microprocessor controlled Measurement Plotting System. It produces cartesian coordinate graphic plots on ISO A3 (297 × 420 mm), 11 × 17 in., ISO A4 (210 × 297 mm), and 8½ × 11 in. paper or special transparency plastic. Disposable pens are available in various colors and line widths.

1-16. The HP 7090 can be used as a graphics plotter, data acquisition device or a conventional X-Y recorder. It is programmable through its Hewlett-Packard Interface Bus (HP-IB) and recognizes the Hewlett-Packard Graphics Language (HP-GL) commands. The Hewlett-Packard Recorder Language (HP-RL) is used to remotely control the HP 7090 in the data acquisition and recorder modes. Refer to the HP 7090 Interfacing and Programming manual for information on HP-GL and HP-RL.

1-17. The Measurement Plotting System, when in the Plotter mode, accepts digital information to produce

Table 1-1. Specifications

Inputs:

Zero offset:	±2 times full scale setting, or ±100 V maximum
Input voltage:	±200 V dc or peak ac maximum
Input resistance:	1 Megohm, shunted by 45 PF
Source resistance:	10 kΩ maximum
Common mode rejection ratio:	140 dB dc; 100 dB ac @ 60 Hz with 1 kΩ unbalance in LOW terminal, on most sensitive range @ 25 °C, 50% relative humidity

Dynamic Performance:

Bandwidth (−3 dB):	3 kHz for all full scale ranges ≥ 20 mV 2.6 kHz for all full scale ranges < 20 mV
Peak Capture:	250 μs at fastest timebase range

Timebase:

Range:	30 milliseconds to 24 hours (buffer mode) 1 second to 24 hours (direct record mode)
Accuracy:	±0.1%

Trigger Characteristics:

Display:	Up to 100% pre-trigger Up to 24 hours post-trigger delay

Electrical Accuracy @ 25 °C			Electrical Accuracy Temperature Coefficient from 25 °C		
Range	**Constant Inaccuracy**	**Percent Reading Inaccuracy**	**Range**	**Constant Inaccuracy Per °C**	**Percent Reading Inaccuracy Per °C**
5 mV	±0.013 mV		5 mV	±0.0022 mV	
10 mV	±0.021 mV		10 mV	±0.0028 mV	
20 mV	±0.036 mV		20 mV	±0.0040 mV	
50 mV	±0.082 mV		50 mV	±0.0076 mV	
100 mV	±0.158 mV		100 mV	±0.0136 mV	
200 mV	±0.306 mV		200 mV	±0.0256 mV	
500 mV	±0.760 mV	±0.055%	500 mV	±0.0616 mV	±0.01%
1 V	±0.0015 V		1 V	±0.0001 V	
2 V	±0.0030 V		2 V	±0.0002 V	
5 V	±0.0076 V		5 V	±0.0006 V	
10 V	±0.0152 V		10 V	±0.0012 V	
20 V	±0.0304 V		20 V	±0.0024 V	
50 V	±0.0760 V		50 V	±0.0060 V	
100 V	±0.1520 V		100 V	±0.0120 V	

Electrical Accuracy @ 25 °C (A/D Converter Counts)			Electrical Accuracy Temperature Coefficient from 25 °C (A/D Converter Counts)		
Range	**Constant Inaccuracy**	**Percent Reading Inaccuracy**	**Range**	**Constant Inaccuracy Per °C**	**Percent Reading Inaccuracy Per °C**
5 mV	±6		5 mV	±0.88	
10 mV	±5	±0.055%	10 mV	±0.56	±0.01%
20 mV	±4		20 mV	±0.40	
50 mV	±3		50 mV	±0.30	
↓	↓		↓	↓	
100 V	±3		100 V	±0.30	

Table 1-2. Supplemental Characteristics

WRITING SYSTEM:

6-pen carousel with automatic pen capping.
Fiber-tip pens for paper or transparencies.

DIGITAL PLOTTING:

Over 40 HP-GL instructions. Five built-in character sets including: ANSI ASCII, French/German, Scandinavian, Spanish/Latin American and HP 9825.

FRONT-PANEL CONTROLS:

P1, P2; pen position cursors; pen selection. Interface modes (user selectable). Listen only; listen/talk.

MEDIA:

Paper, overhead transparency film.
Paper sizes are selectable:
210 × 297 mm (ISO A4), 8½ × 11 in. (ANSI A)
297 × 420 mm (ISO A3), 11 × 17 in. (ANSI B)

PROGRAMMING:

HP-IB control of all recorder and plotter functions. Software lockable front panel.

SCOPE OUTPUT:

Allows use of oscilloscope to preview buffer contents.
Vertical and horizontal BNCs.
Output: −10 V to +10 V (0 V corresponds to origin on chart); refreshed every 15 ms.

EXTERNAL PEN CONTROL:

TTL level or contact closure to ground.

ANALOG-TO-DIGITAL CONVERSION:

Sampling rate is dependent upon measurement time. (maximum sample rate is 33.3 k samples/second)

REAL-TIME CLOCK:

Front-panel set; second, minute, hour, day, and year.
Battery backup.

ENVIRONMENTAL:

Operating temperature: 0–50 °C.

POWER REQUIREMENTS:

Source: 100, 120, 220, 240 V~ −10%+5%.
Frequency: 48–66 Hz.
Consumption: 140 W.

SIZE:

Height: 205.5 mm (8.1 in.)
Width: 575.0 mm (22.6 in.)
Depth: 465.0 mm (18.3 in.)

WEIGHT:

Net: 15.7 kg (34.6 lbs)
Shipping: Approximately 23.6 kg (52 lbs)

multicolor graphic plots. The Plotter mode is the default mode of the HP 7090. The Data Acquisition mode allows the HP 7090 to send data to an external controller whenever the data is ready and the HP 7090 is requested to talk. When in the Recorder mode, the HP 7090 can plot two variables against each other (X vs. Y), one variable against time (X or Y vs. T) or two variables against time (X and Y vs. T). Measurement can be accomplished either manually or by user preset trigger conditions.

1-18. OPTIONS

1-19. No options are available for the HP 7090 Measurement Plotting System.

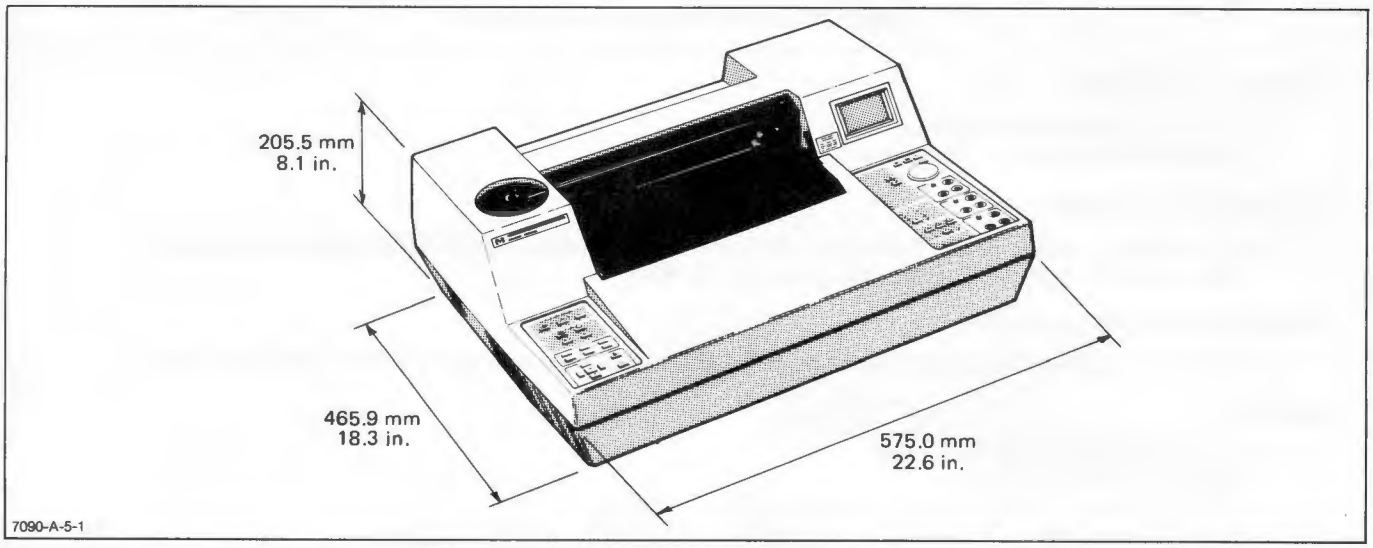

Figure 1-2. Dimension Drawing

1-20. ACCESSORIES SUPPLIED

1-21. The items listed in Table 1-3 are supplied with each HP 7090.

1-22. RECOMMENDED TEST EQUIPMENT

1-23. Equipment required to maintain the HP 7090 is listed in Table 1-4.

Table 1-3. Accessories Supplied

DESCRIPTION	QTY	HP PART NUMBER
HP Model 7090 Interfacing and Programming Manual	1	07090-90001
HP Model 7090 Operator's Manual	1	07090-90002
HP Model 7090 Pocket Guide	1	07090-90004
*Plotter paper, pad, 8½ × 11 in. (A) or 210 × 297 mm (A4), 50 sheets	1	9280-0589 9280-0588
*Plotter paper, pad, 11 × 17 in. (B) or 297 × 420 mm (A3), 50 sheets	1	9280-0614 9280-0615
Package of 4 fiber-tip pens, 0.3 mm nib width, 1 each: red, blue, green, black	1	5060-6810
Package of 5 fiber-tip pens, 0.3 mm nib width, 5 each: black	1	5060-6787
Package of 6 fiber-tip pens, 0.3 mm nib width, 1 each: burnt orange, brown, violet, turquoise, gold, and lime green	1	5060-6894
Pen Carousel	1	5061-5080
*Power Cord	1	As ordered

*Paper size and power cord supplied is based on the country of destination for the system.

Table 1-4. Recommended Test Equipment

TYPE	MODEL	SPECIFICATIONS
*DC Voltage Standard	Datron 4000.	Absolute accuracy better than ±2.0 μV at 10 mV output range (±0.02%); ±0.01% all other ranges.
	Data Precision 8200 has acceptable accuracy above 20 mV. Noise output is marginal below 100 mV range.	Pk-to-Pk noise on 100 mV range and under, less than 0.2 μV average over 1 line cycle (16.7 ms). At 2.5 kHz bandwidth, less than 2 μV RMS. Less than 0.001% of range on all other ranges.
Digital Multimeter	HP 3435A	3½-digit display.
Oscilloscope (dual ch.)	HP 1740A or HP 1741A	100 MHz response.
Signature Analyzer	HP 5004A, HP 5005A/B or HP 5006A	
Function Generator	HP 3311A	Sine and Square wave output frequencies from 0.1 Hz through 100 Hz.
Counter	HP 5314A	10 MHz minimum frequency.
HP-IB controller	HP-85A/B or HP 9826A	32K byte memory, I/O capability via HP-IB interface. For HP-85A, I/O ROM required and 16K byte memory module.
Hewlett-Packard External Diagnostics program set.	HP 07090-18030 (HP-85) or HP 07090-18031 (HP 9825).	

*HP-IB interface option required to use 7090 external diagnostic automatic calibration program.

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SECTION II

INSTALLATION

2-1. INTRODUCTION

2-2. This section provides installation instructions for the HP 7090 Measurement Plotting System (MPS). Included are instructions for line voltage and fuse selection, power cord selection, storage and shipment. For additional installation information refer to the HP 7090 Operator's Manual.

2-3. INSTALLATION

CAUTION

To ensure adequate heat dissipation, a clearance of at least two inches on all sides of the HP 7090 is required.

2-4. The HP 7090 is designed for horizontal installation on a flat surface capable of supporting a weight of 15.7 kg (34.6 lbs). Ease of access to the line power switch, rear and side panels should be considered during installation.

2-5. LINE VOLTAGE AND FUSE SELECTION

WARNING

To prevent an electrical shock hazard the line power cord and power outlet must have a protective earth (ground) terminal.

CAUTION

To prevent damage to the HP 7090, make sure the line voltage and fuse are correct before applying line power.

2-6. The HP 7090 primary power circuit can be configured to operate from any one of the following power sources at a line frequency of 48 to 66 Hz, single phase. Maximum power consumption is 140 W.

100 Vac −10%, +5%

120 Vac −10%, +5%

220 Vac −10%, +5%

240 Vac −10%, +5%

2-7. Line voltage selection is identified on a rear-panel label located above the power cord receptacle. If the HP 7090 is reconfigured for a different line voltage, the rear label must be repositioned to display the newly selected voltage.

CAUTION

Applying a line voltage of 220 V or 240 V to the HP 7090 while the line voltage selection is set for 100 V or 120 V operation may damage the HP 7090 circuits.

2-8. The line voltage selection may be changed to conform to the available line voltage using the following procedure.

WARNING

The following procedure should be performed only by service-trained personnel who are aware of the electrical shock hazards involved.

a. Set the HP 7090 LINE switch to OFF (O) and disconnect the line cord.

b. Remove the HP 7090 top case by removing the screws indicated in Figure 2-1.

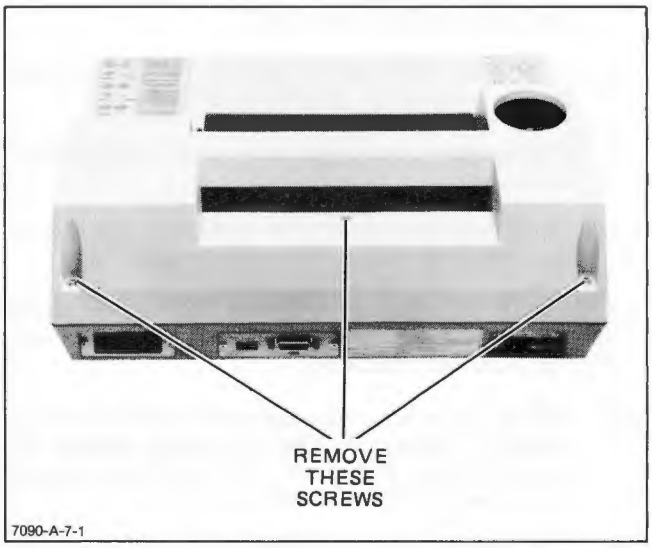


Figure 2-1. Top Cover Removal

c. Gently lift the rear of the top case until the liquid crystal display (LED) connector is accessible. See Figure 2-2.

d. Disconnect the LCD connector and remove the top cover.

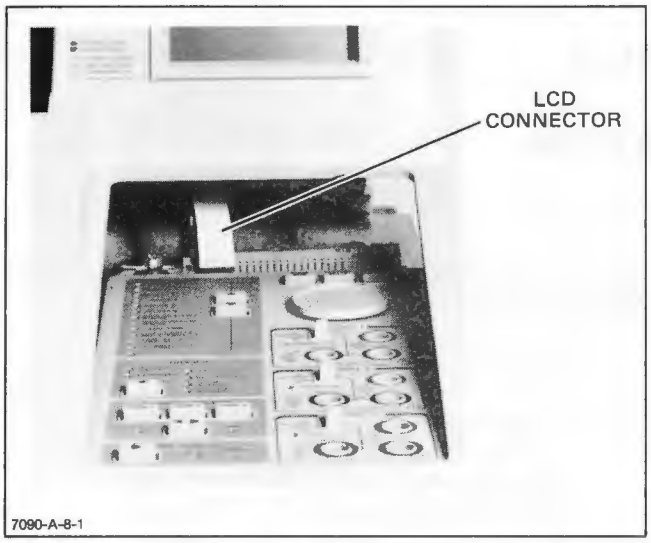


Figure 2-2. LCD Connector

CAUTION

Do not touch the heatsinks mounted on the power supply PCA. See Figure 2-4. They become very hot when the HP 7090 has been powered on for a long time.

e. See Figure 2-3. Loosen the two screws labeled "A". Remove the nine screws labeled "B".

f. Push chassis base assembly toward rear of the HP 7090 until it is clear of the two front screws.

g. Lift front of assembly, which is hinged at rear, and secure with support rod.

h. Disconnect indicated connectors. Note which plug goes to which jack. See Figure 2-4.

i. Disengage support rod and lower chassis base assembly.

j. While holding assembly in a slightly raised position, pull forward and remove the assembly.

k. Remove primary cover shield and connect transformer primary connector to the appropriate voltage jack. See Figure 2-5.

l. Install a line fuse with the appropriate rating as listed in Table 2-1. The fuseholder cap is the bayonet type. Press and turn the cap counterclockwise to remove, clockwise to lock.

m. Reverse procedure to install the chassis base and top cover. Make sure that the paper hold lever extends through the top cover and that the LCD cable is connected.

n. Arrange the line voltage label block at rear of the top cover so that the voltage selected is visible.

o. Reassemble in reverse order.

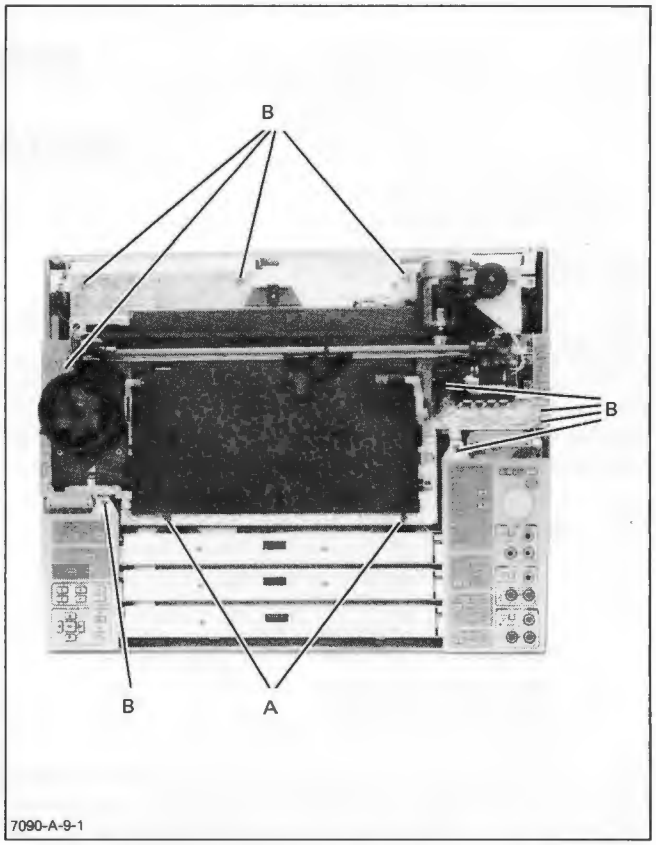


Figure 2-3. Chassis Base Removal

Table 2-1. Line Fuses

LINE VOLTAGE	FUSE RATING	FUSE HP PART NO.	FUSE-HOLDER CAP HP PART NO.
U.S.			
100/120 V	2.5 AT	2110-0380	2110-0565
220/240 V	1.25 AT	2110-0305	2110-0565
Metric (European fuse for 220 V line)			
220/240 V	1.25 AT	2110-0472	2110-0567

2-9. POWER CORD

2-10. The HP 7090 is supplied with a three-wire power cord. Install the proper power cord for the line voltage available. Note the type of mains outlet to which the cord is to be connected. See Figure 2-6.

2-11. STORAGE

2-12. When the HP 7090 is to be stored for a period of time, the pens should be removed. Seal the HP 7090 in a moisture-proof covering and repackage it in a container similar to the original factory carton.

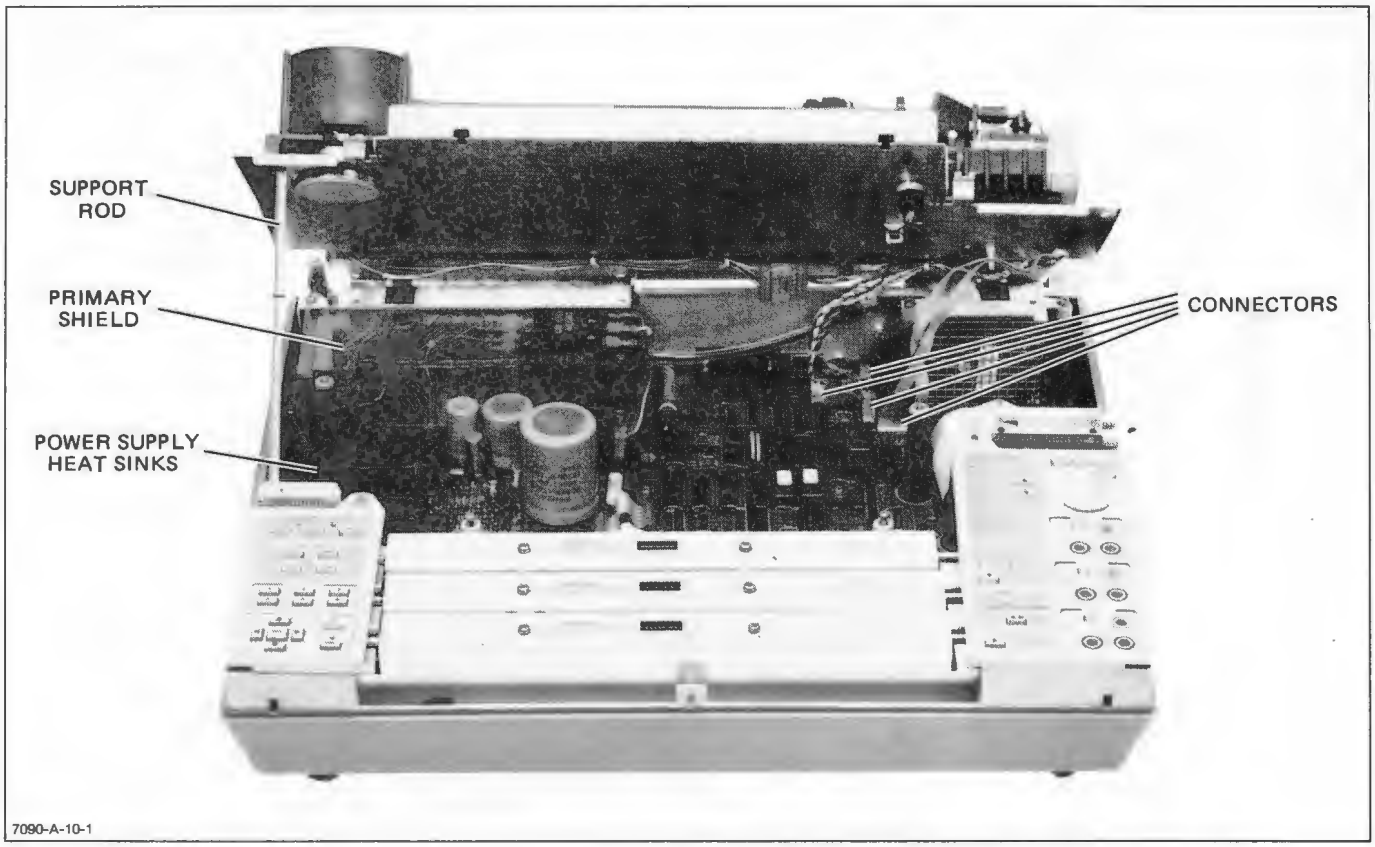


Figure 2-4. Connector Locations

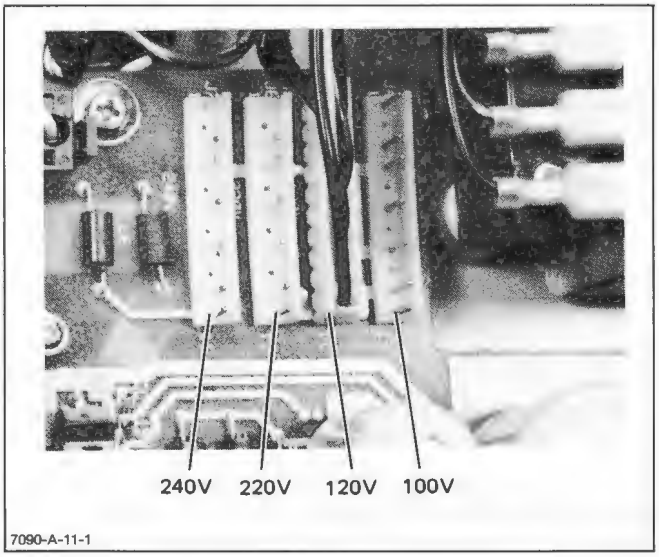


Figure 2-5. Voltage Selection

2-13. STORAGE ENVIRONMENT

Temperature: −40 °C to +75 °C
Humidity: less than 95% relative at > 40 °C
Altitude: less than 15 500 metres (50 000 feet)

2-14. SHIPMENT

2-15. When the HP 7090 is to be shipped, it is absolutely essential to use only the original packing materials and carton. If the original packing materials and carton are not available, replacements may be ordered through Hewlett-Packard Sales and Support Offices.

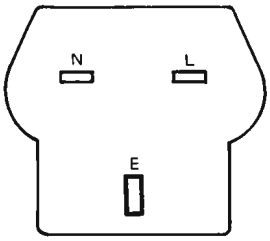
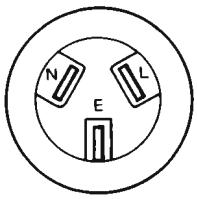
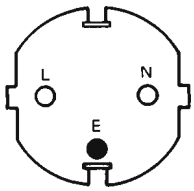
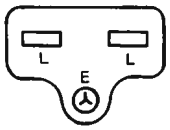
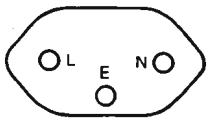
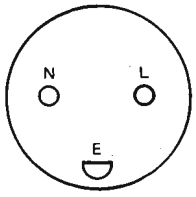
CAUTION

Before shipping the HP 7090 remove all pens.

2-16. If the HP 7090 is being returned to Hewlett-Packard, for any reason, contact the nearest HP Sales and Support Office for shipping instructions. Attach a tag to the HP 7090 stating the type of service required, your return address, HP 7090 model number, and full serial number.

NOTE

When returning the HP 7090 to Hewlett-Packard for repair, do not send the power cord, accessory kit, or other operating accessories.

		Option No.
BS 1363A 	HP Part Number 8120-1351; 250 V, 13 A, 1 ϕ plug rating. For use in United Kingdom, Cyprus, Nigeria, Zimbabwe, Singapore.	900
AS C112 	HP Part Number 8120-1369; 250 V, 10 A, 1 ϕ plug rating. For use in Australia, New Zealand.	901
CEE 7-VII 	HP Part Number 8120-1689; 250 V, 10/16 A, 1 ϕ plug rating. For use in East and West Europe, Saudi Arabia, Egypt, South Africa, India.	902
NEMA 5-15P 	HP Part Number 8120-1378; 125 V, 15 A, 1 ϕ plug rating. For use in Canada, Japan, Mexico, Philippines, Taiwan, UL approved in United States.	903
NEMA 6-15P 	HP Part Number 8120-0698; 250 V, 15 A, 1 ϕ plug rating. For use in Canada, UL approved in United States.	904
SEV 1011 	HP Part Number 8120-2104; 250 V, 10 A, 1 ϕ plug rating. For use in Switzerland.	906
DHCK-107 	HP Part Number 8120-2956; 250 V, 10 A, 1 ϕ plug rating. For use in Denmark.	912

NOTE: All plugs are viewed from connector end.

L = Line or Active Conductor (also called "live" or "hot")
N = Neutral or Identified Conductor
E = Earth or Safety Ground

1-A-18-4

Figure 2-6. Power Cord Configurations

SECTION III

OPERATION

3-1. INTRODUCTION

3-2. This section provides a brief description of controls, indicators, and connectors on the HP 7090. Included are basic operating tests that verify proper operation of the HP 7090. Refer to the HP 7090 Operator's Manual for additional information.

3-3. CONTROLS, CONNECTORS, AND INDICATORS

3-4. The features of the front, rear, and side panels are illustrated and described in Figure 3-1.

3-5. BASIC OPERATING TESTS

3-6. The front-panel controls can be used to test basic operation of the HP 7090 and draw a demonstration plot; however, these procedures do not test the I/O circuits.

a. Make sure six pens are installed in the pen carousel.

b. Set the rear panel paper-format switch located on the rear panel to ANSI for U.S. paper sizes (8½× 11 in. and 11 × 17 in.) or to ISO for metric paper sizes (A3 and A4).

WARNING

To prevent injury, keep hands, hair, and clothing away from the paper-moving mechanism and pen holder while power is applied.

CAUTION

Before applying power to the HP 7090, make sure the selected line voltage and fuse rating are correct. If not, refer to Line Voltage and Fuse Selection in Section II of this manual.

A minimum clearance of two inches around all sides of the HP 7090 must be maintained for adequate ventilation.

c. Apply power to the HP 7090 and observe that "HP" and "7090" appear separately in the LCD. Also note that all LCD annunciators are visable, and all front-panel indicators turn ON and then OFF.

NOTE

If the letter "E" and a number appear in the LCD after power-up, an internal error has been detected. Refer to Self-Test in Section VIII of this manual.

d. Press PAPER SIZE button (right-front panel) to indicate paper size you are using.

e. With PAPER LOAD lever in the LOAD position, place a sheet of paper against the left-hand rail and rear stop. Lower the lever to the PAPER HOLD position.

f. Select a pen by pressing one of the six pen pushbuttons. Press PEN DOWN pushbutton, and using the cursor controls, draw vertical, horizontal and diagonal lines. All lines should be smooth.

3-7. HEWLETT-PACKARD GRAPHICS LANGUAGE

3-8. The HP 7090 recognizes the Hewlett-Packard Graphics Language (HP-GL) instructions listed in Table 3-1 which are used for control of all plotting activities. The Hewlett-Packard Recorder Language (HP-RL) instructions listed in Table 3-2 are used to remotely control the HP 7090 front panel. The HP-RL also controls the HP 7090 in the data acquisition and recorder modes. Refer to the HP 7090 Interfacing and Programming Manual for detailed information about HP-GL and HP-RL.

3-9. DEMONSTRATION PLOT

3-10. The HP 7090 contains a demonstration plot stored in Read Only Memory (ROM). Running this plot will verify proper operation of most logic circuits and the paper and pen drive mechanisms. Running the demonstration plot does not test the I/O circuitry. To run the demonstration plot, proceed as follows:

WARNING

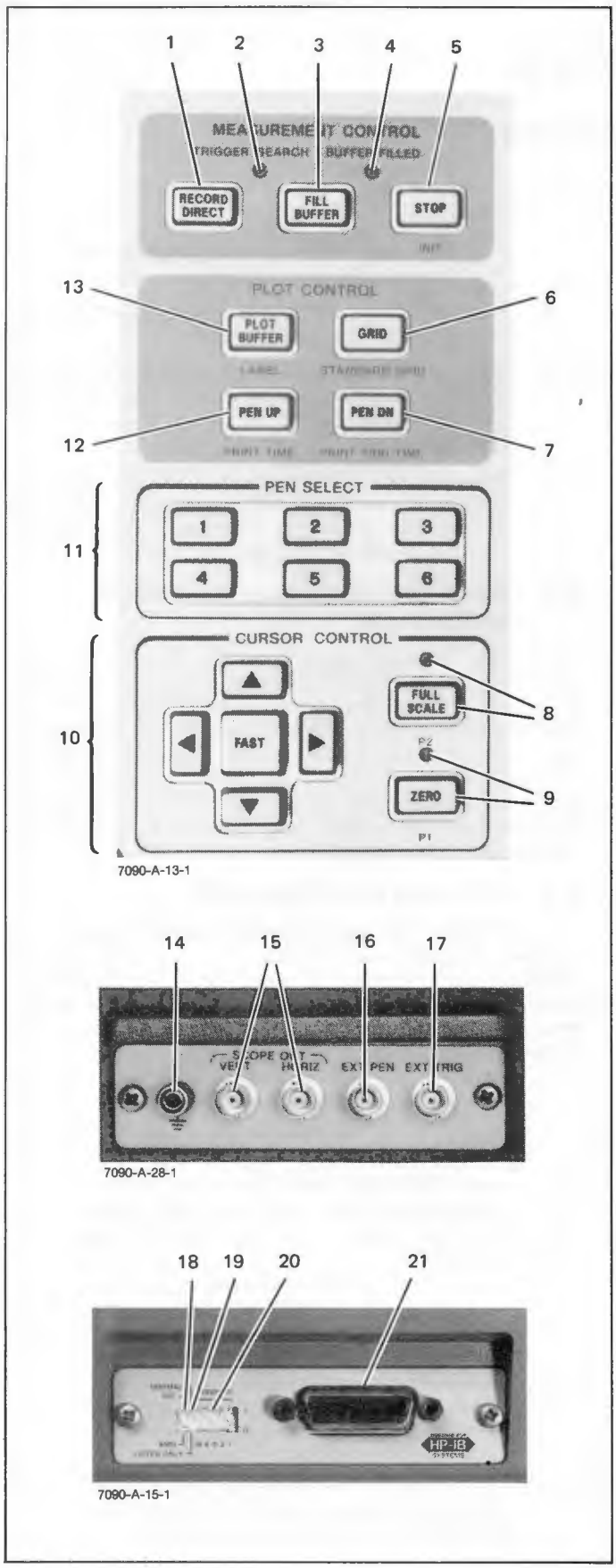
To prevent injury, keep hands, hair, and clothing away from the paper-moving mechanism and pen holder when loading paper or performing plotting functions.

CAUTION

Before applying power to the HP 7090, make sure the selected line voltage and fuse rating are correct. If not, refer to Line Voltage and Fuse Selection in Section II of this manual.

A minimum clearance of two inches around all sides of the HP 7090 must be maintained for adequate ventilation.

(Continued on page 3-5)



Left Panel

1. Starts direct recording.
2. Indicates status of trigger search; when lit, machine is looking for trigger.
3. Starts buffered recording once trigger occurs.
4. Indicates status of buffer. When off, buffer is empty; when blinking, buffer is filling; when lit, buffer is full.
5. Terminates all measurement or plotting functions except labeling; with **SHIFT**, initializes the machine.
6. Automatically draws specified grid; with **SHIFT**, draws standard 1-cm grid on entire sheet of paper.
7. Lowers pen; with **SHIFT**, prints trigger time.
8. Sets full-scale point. When pressed, LED turns ON and pen moves to present setting. For new full scale, user moves pen to desired position and presses button again. LED turns OFF and new value is entered. With **SHIFT**, sets P2 for plot functions.
9. Sets zero point same as above; with **SHIFT**, sets P1 for plot functions.
10. Moves pen in direction of arrows; with **FAST**, pen speed increases 6 times.
11. Selects corresponding pen; with **SHIFT**, returns pen to carousel.
12. Raises pen; with **SHIFT**, prints time and date.
13. Plots buffer; with **SHIFT**, labels setup conditions.

Side Panel

14. Provides connection to chassis ground.
15. BNC connectors send buffer contents to external scope.
16. BNC connector provides external pen control at TTL levels.
17. BNC connector provides external triggering at TTL levels.

Rear Panel

18. ISO/ANSI switch selects metric or US paper format.
19. Listen-only/address mode switch.
20. HP-IB address switches; factory-set to 5.
21. HP-IB connector for external controller.

Figure 3-1. Controls, Connectors, and Indicators (1 of 2)

Right Panel

1. Select paper; size displayed on LCD.
2. Recalls setup conditions; with **SHIFT**, saves setup conditions.
3. Accesses secondary pushbutton functions labeled in blue.
4. Allows coarse tuning of setup conditions.
5. Rotary knob selects desired setup condition values; values displayed on LCD.
6. Guard switch connects guard shield to internal low terminal or allows connection to external common mode voltage (CMV) source.
7. Overflow indicator lights when input signal exceeds range setting.
8. Floating/guarded input jack for inputs up to 200 V dc or peak ac.
9. Guard terminal jack used to connect external guarding.
10. Used to display current or recorded data on LCD.
11. Selects Channel 3 on timebase as X-axis.
12. Selects Y-axis input.
13. Used to select method of triggering; LEDs indicate selected condition.
14. Used to select setup conditions. LEDs indicate selected condition; values displayed on LCD.
    - **range** — sets input voltage; full-scale sensitivity ranges from 0.005 V to 100 V.
    - **offset** — shifts zero position of input signal; offsets are ±2 times range setting up to ±100 V.
    - **X/Y grid divisions** — specifies the number of grid divisions to be drawn, from 1 to 100.
    - **total time** — specifies length of measurement in direct recording mode, range is 1 second to 24 hours; in buffered recording mode, range is 30 ms to 24 hours.
    - **post-trigger/pre-trigger** — sets delay time between trigger and measurement; or sets amount of pre-trigger viewing desired.
    - **trigger level** — specifies input signal voltage level causing measurement to begin.
    - **trigger width** — specifies equal upper and lower boundaries of trigger window.
    - **time and date** — accessible with **SHIFT** key; sets internal real-time clock.

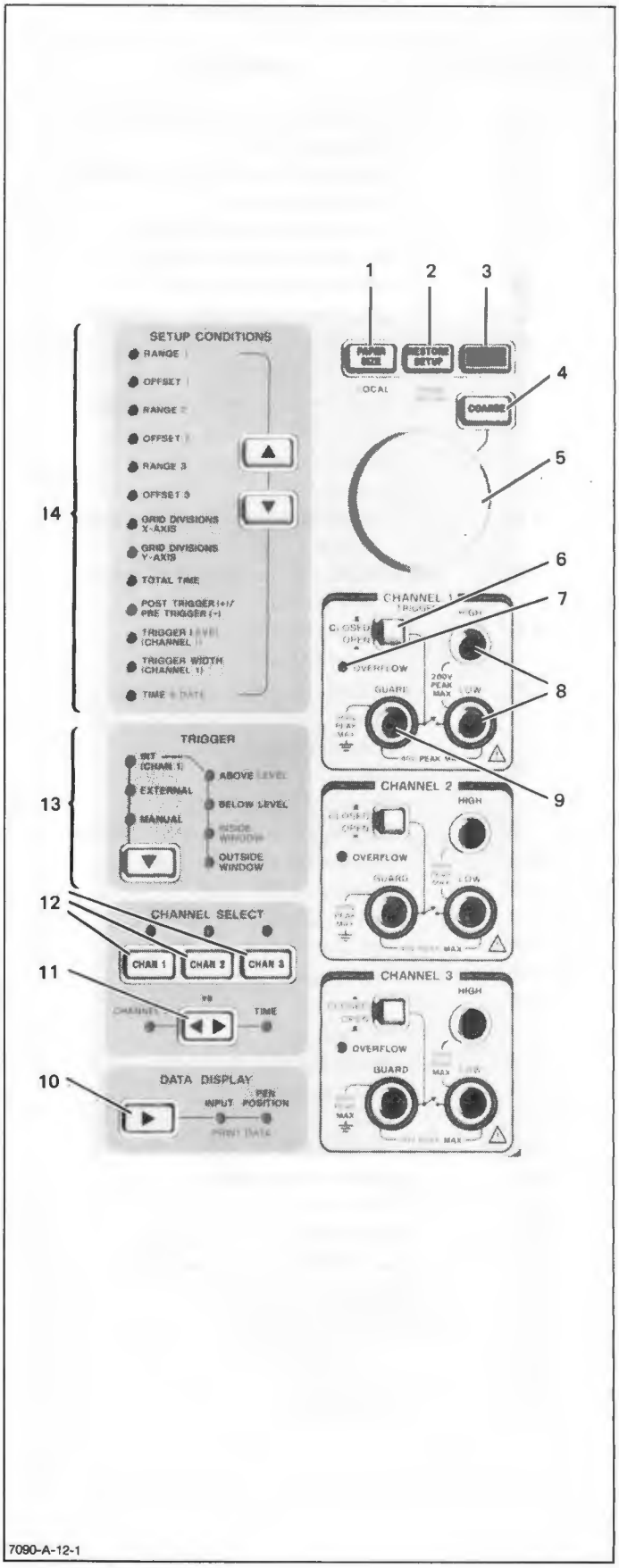


Figure 3-1. Controls, Connectors, and Indicators (2 of 2)

Table 3-1. HP-GL Instruction Set

INSTRUCTION	DEFINITION
CA	Designate alternate character set
CP	Character plot
CS	Designate standard character set
DF	Set default values
DI	Set absolute label direction
DR	Set relative label direction
DT	Define label terminator
IM	Input error and polling masks
IN	Initialize
IP	Input P1 and P2
IW	Input window (soft-clip limits)
LB	Label ASCII string
LO	Set label origin
LT	Set line type
OA	Output actual position and pen status
OC	Output commanded position and pen status
OE	Output error
OF	Output factors
OH	Output hard-clip limits
OI	Output identification
OO	Output options
OP	Output P1 and P2
OS	Output plotter status
OW	Output window (soft-clip limits)
OZ	Output command string
OY	Locate syntax error
PA	Plot absolute
PD	Pen down
PR	Plot relative
PS	Paper size
PU	Pen up
RO	Rotate coordinate system
SA	Select alternate set
SC	Scale
SI	Set absolute character size
SL	Set character slant
SM	Set symbol mode
SP	Select pen
SR	Set relative character size
SS	Select standard set
TL	Set tick length
VS	Velocity select
XT	X-axis tick
YT	Y-axis tick

Table 3-2. HP-RL Instruction Set

INSTRUCTION	DEFINITION
DG	Draw Grid
DO	Set data output
GL	Set grid divisions
IR	Set full scale range
IT	Set real-time clock
IZ	Set zero and full scale
MS	Measurement start
MT	Measurement terminate
PL	Plot buffer
QA	Query trigger level and width
QB	Query total time
QC	Query channel status
QD	Query direct A/D data samples
QG	Query post- and pre-trigger time
QI	Query buffered A/D data samples
QL	Query grid divisions
QM	Query recording mode
QR	Query full scale range
QS	Query recorder status
QT	Query trigger mode
QU	Query trigger time
QV	Query DC offset
QW	Query real-time clock
QZ	Query zero and full scale points
RE	Set recording mode
RL	Remote/local
SD	Set sample delay
SV	Set DC offset
TA	Set trigger level and width
TB	Set total time
TD	Label time and date
TG	Set post- and pre-trigger time
TM	Set trigger mode
XS	Set plotter or recorder status byte for polling

a. Make sure six pens are installed in the carousel.

b. Apply power to the system and set paper size.

c. With the PAPER LOAD lever in the LOAD position, place a sheet of paper (ISO A4/ 8½ × 11 in. or ISO A3/ 11 × 17 in.) against the left-hand rail and the rear stop. Lower the lever to the PAPER HOLD position.

d. Press the Left and Right cursor arrow controls and Shift pushbuttons simultaneously. See Figure 3-2.

e. The resultant plot is shown in Figure 3-3.

3-11. CLEANING

WARNING

Disconnect the HP 7090 from the power source prior to performing any maintenance. DO NOT allow water to run onto electrical components and circuits or through openings in the enclosure or into the front panel input jacks as this may create an electrical shock hazard.

3-12. Thorough cleaning should be performed periodically. Cleaning intervals are determined by the type of operation, local air contamination, and climatic conditions. Cleaning procedures should include the following:

a. Blow away the dust accumulation with compressed air, if available. Dust may also be removed with a lint-free cloth.

b. Clean the outer surface of the HP 7090 with a damp sponge or cloth. Use a mild soap and water solution if necessary. Wipe dry after cleaning.

3-13. INPUT JACK CLEANING

3-14. The front panel analog input jacks should be cleaned using a cotton swab and isopropyl alcohol. Cleaning the input jacks will help reduce input noise.

3-15. PEN STALL CLEANING

3-16. Before using overhead transparency pens, remove leftover ink from the capping hole in the pen stalls of the carousel using a cotton swab. This will prevent the transfer of other inks to the plots.

3-17. GRIT WHEEL CLEANING

CAUTION

Do not attempt to clean the grit wheels with a cleaning solvent. Cleaning solutions may dissolve the adhesive which secures the grit particles to the wheels. Use only a nylon bristle brush such as: HP Part Number 8710-1386.

3-18. To clean the grit wheels, simply brush the grit surface while rotating the grit wheel.

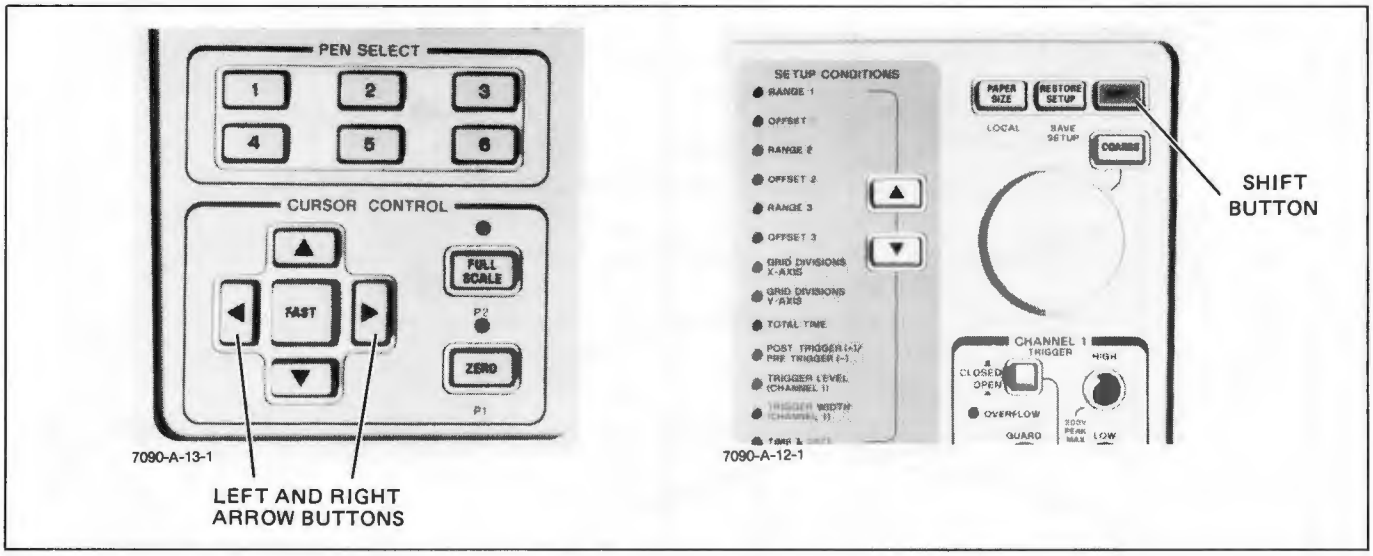


Figure 3-2. Demonstration Plot Buttons

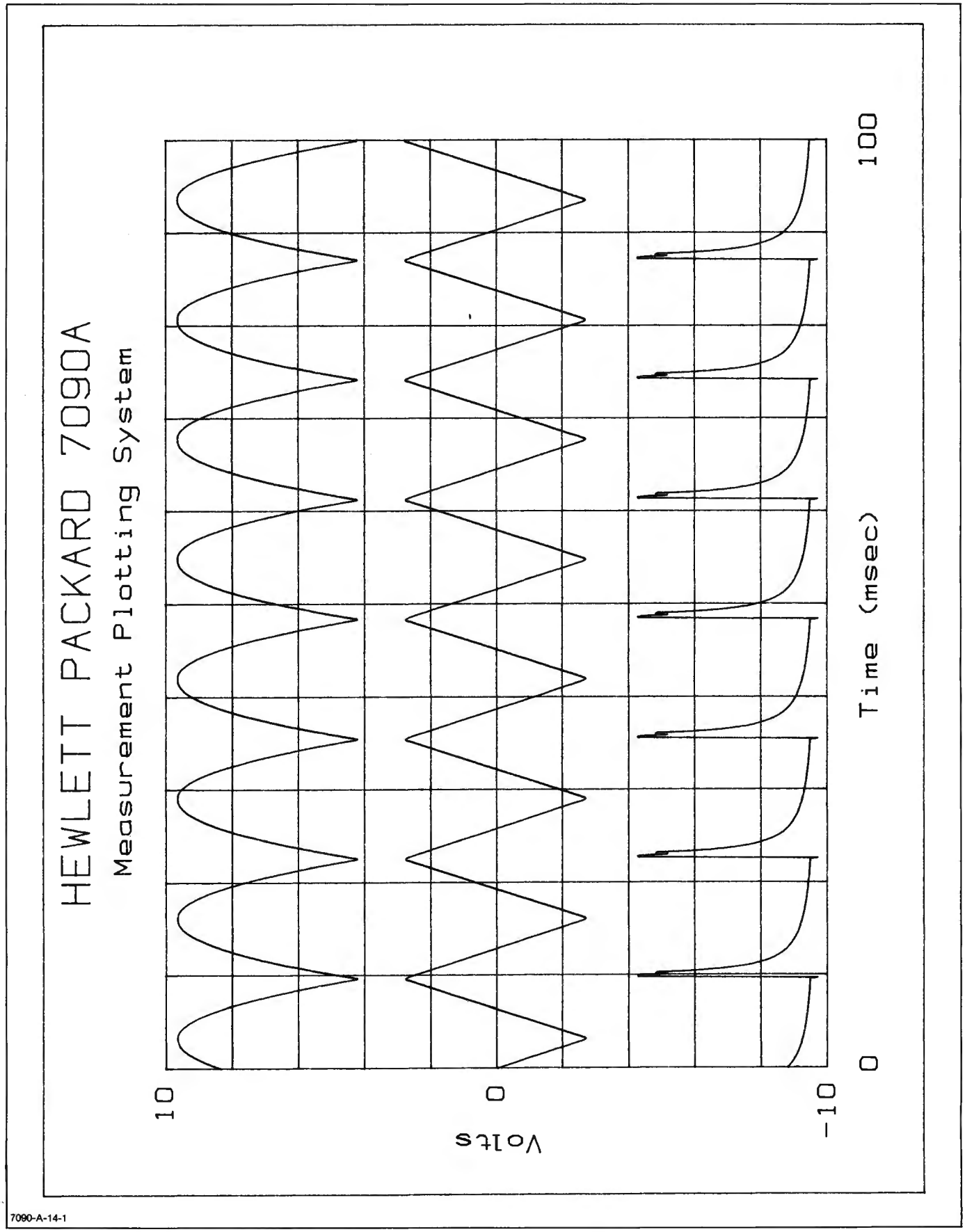


Figure 3-3. Demonstration Plot

SECTION IV

PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. The procedures in this section test the electrical performance of the HP 7090. If the HP 7090 fails any of the performance tests, refer to Section VIII of this manual for service information.

4-3. RECOMMENDED TEST EQUIPMENT

4-4. Equipment required for accomplishing performance tests is listed in Table 4-1.

4-5. REAR PANEL SWITCHES

4-6. ADDRESS

4-7. The HP 7090 must be set to the same address as the external controller to which it is connected. The HP-IB address is set on the HP 7090 by five of the seven switches on the rear panel. Use the | and O labels on the rear panel to determine the address in binary coded decimal. See Figure 4-1.

Table 4-1. Recommended Test Equipment

TYPE	MODEL	SPECIFICATIONS
*DC Voltage Standard	Datron 4000.	Absolute accuracy better than ±2.0 μV at 10 mV output range (±0.02%), ±0.01% all other ranges.
	Data Precision 8200 has acceptable accuracy above 20 mV. Noise output is marginal below 100 mV range.	Pk-to-Pk noise on 100 mV range and under, less than 0.2 μV average over 1 line cycle (16.7 ms). At 2.5 kHz bandwidth, less than 2 μV RMS. Less than 0.001% of range on all other ranges.
Digital Multimeter	HP 3435A	3½-digit display.
Oscilloscope (dual ch.)	HP 1740A or HP 1741A	100 MHz response.
Signature Analyzer	HP 5004A, HP 5005A/B or HP 5006A	
Function Generator	HP 3311A	Sine and square wave output frequencies from 0.1 Hz through 100 Hz.
Counter	HP 5314A	10 MHz minimum frequency.
HP-IB controller	HP-85A/B or HP 9826A	32K byte memory, I/O capability via HP-IB interface. For HP-85A, I/O ROM required and 16K byte memory module.
Hewlett-Packard External Diagnostics program set.	HP 07090-18030 (HP-85) or HP 07090-18031 (HP 9825).	

*HP-IB interface option required to use 7090 external diagnostic automatic calibration program.

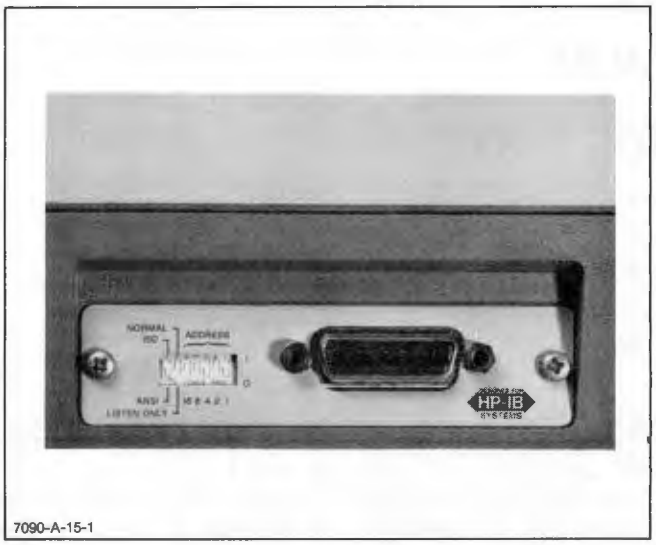


Figure 4-1. Rear Panel

4-8. ANSI/ISO

4-9. This switch is used to program the writing area for four paper sizes:

Paper Size	Switch Position	Maximum Writing Area
A3	ISO	275 × 402 mm
B	ANSI	10.2 × 16.3 in.
A4	ISO	192 × 175 mm
A	ANSI	7.5 × 10.2 in.

4-10. LISTEN ONLY/NORMAL

4-11. When this switch is in the Listen Only position, the HP 7090 will only be able to receive data and cannot respond to any output requests. When in the Normal position, the HP 7090 can receive information and respond to output requests.

4-12. TEST PROGRAM

4-13. The program in Table 4-3 at the end of this section is written in Basic language specifically for the HP-85 personal computer. It may however, be adapted to other controllers. This program tests the input/output (I/O) circuits of the HP 7090, the majority of the logic circuits, and the paper and pen drive mechanisms. The resultant verification plot is illustrated in Figure 4-2.

4-14. PERFORMANCE TESTS

4-15. INPUT IMPEDANCE

4-16. The Analog channel input impedance is verified by measuring the voltage output of a divider network formed by the HP 7090's nominal 1 megohm input impedance and an external 10 kΩ resistor. Proceed as follows:

a. Set the HP 7090 line switch to OFF (O).

b. Set output of dc standard to zero.

c. Connect the dc standard to channel one of the HP 7090 as illustraded in Figure 4-3.

CAUTION

Before applying power to the HP 7090, make sure the selected line voltage and fuse rating are correct. If not, refer to Line Voltage and Fuse Selection in Section II of this manual.

A minimum clearance of two inches around all sides of the HP 7090 must be maintained for adequate ventilation.

d. Apply power to the dc standard and the HP 7090.

e. Press channel one select and data display pushbuttons on the HP 7090 (Right front panel).

f. Set full scale range of channel one to 10 V.

g. Set the dc standard for an output of 10.00 V.

h. The LCD on the HP 7090 should display a voltage of greater than or equal to 9.9 V.

i. Repeat procedure for the other two channels.

4-17. ELECTRICAL ACCURACY

NOTE

The Front Panel LCD is accurate to only three digits. To obtain data of greater accuracy for the Analog Channel buffers, an HP-IB controller can be used to perform the Electrical Accuracy test.

4-18. Electrical Accuracy is verified by applying 56 different voltage inputs from a DC Standard and computing an average measured value for each input from data stored in the Analog Channel data buffer. The process is repeated for each of the three Analog Channels. To perform the electrical accuracy test proceed as follows:

a. Set the HP 7090 line power switch to OFF (O).

b. Set output of the dc standard to zero.

c. Connect output of dc standard to channel one input of the HP 7090.

d. Apply power to the dc stantard and the HP 7090.

e. Press Channel Select "Chan 1" and Data Display "→"pushbuttons on the HP 7090 (Right front panel) to display channel one input.

(Continued on page 4-3)

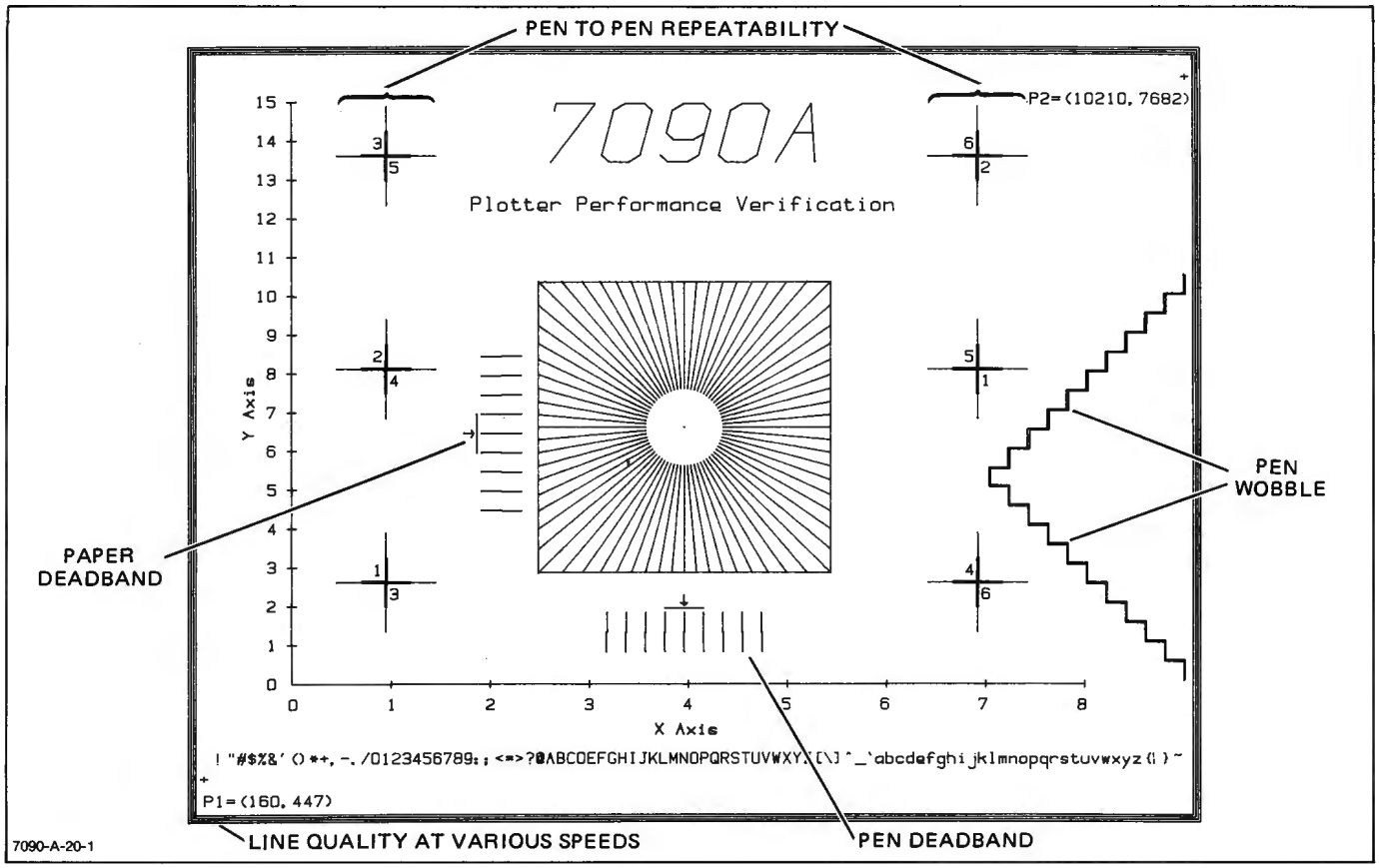


Figure 4-2. Verification Plot

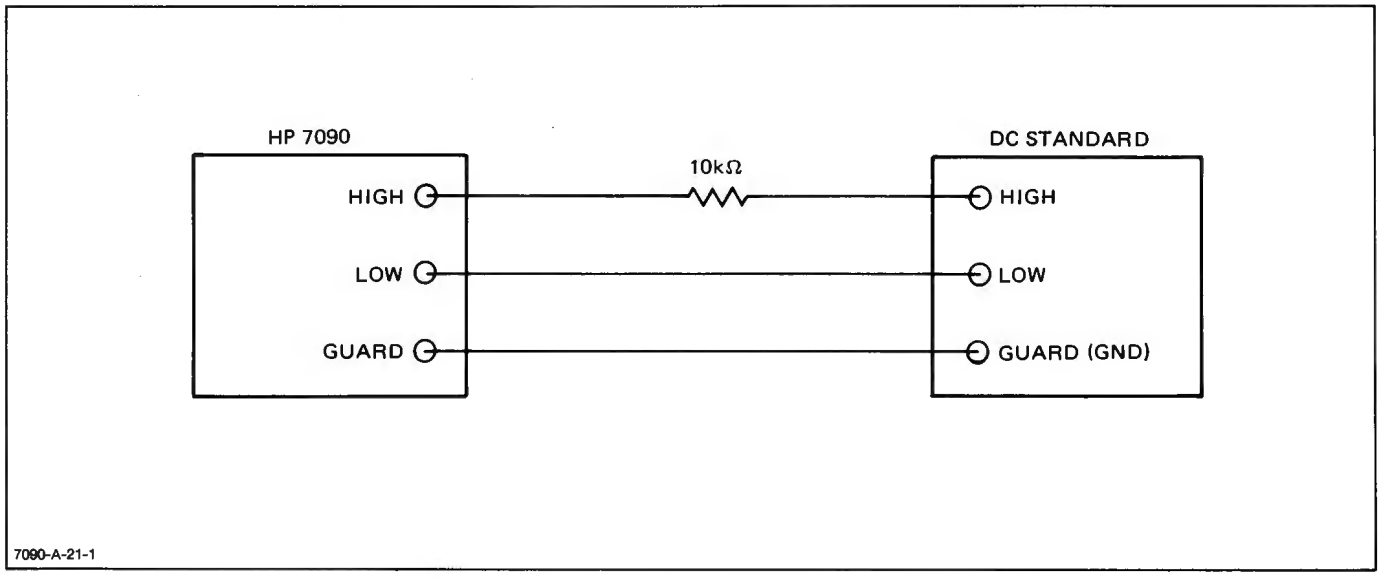


Figure 4-3. Input Impedance

f. Set full scale range of channel one to 5.0 mV.

g. Using the dc standard, apply the following voltages and observe the LCD on the HP 7090.

−50% of full scale (e.g. −2.5 mV)
−100% of full scale (e.g. −5.0 mV)
0.0 volts
+50% of full scale (e.g. +2.5 mV)
+100% of full scale (e.g. +5.0 mV)

h. For each voltage input, the LCD should indicate the input voltage within the tolerance applicable to the full scale range. Refer to Table 4-2 for applicable tolerances.

i. Repeat steps f. through h., substituting the following values in step f.

10.0 mV	1.00 V
20.0 mV	2.00 V
50.0 mV	5.00 V
100.0 mV	10.00 V
200.0 mV	20.00 V
500.0 mV	100.00 V

j. Repeat procedure for remaining two channels.

NOTE

In the program examples which follow, the word "OUTPUT" is used to transmit information to the HP 7090. The word "ENTER" is used to read information from the HP 7090, and, the word "DISPLAY" is used to show the test results to the user on the controller's CRT or other output device. They must be replaced with statements and syntax appropriate for the HP-IB controller being used.

4-19. The following program places the HP 7090 into the data acquisition mode and acquires 20 randomly timed measurement samples. The samples are then averaged and an error value is calculated.

Vin = Test voltage used in paragraph 4-18, step g.

Vfs = Full scale voltage used in paragraph 4-18, step f.

Z = channel under test

```
1000 OUTPUT "DO";Z;"1,0,0;"
1010 SUM=0
1020 FOR I=1 TO 20
1030 OUTPUT "QD;"
1040 ENTER VOLTAGE
1050 SUM=SUM+VOLTAGE
1060 WAIT (RANDOM * 0.166)
1070 NEXT I
1080 ERROR=(SUM/20)-VIN
1090 DISPLAY ERROR
```

Table 4-2. Electrical Accuracy

Electrical Accuracy @ 25 °C			Electrical Accuracy Temperature Coefficient from 25 °C		
Range	**Constant Inaccuracy**	**Percent Reading Inaccuracy**	**Range**	**Constant Inaccuracy Per °C**	**Percent Reading Inaccuracy Per °C**
5 mV	±0.013 mV		5 mV	±0.0022 mV	
10 mV	±0.021 mV		10 mV	±0.0028 mV	
20 mV	±0.036 mV		20 mV	±0.0040 mV	
50 mV	±0.082 mV		50 mV	±0.0076 mV	
100 mV	±0.158 mV		100 mV	±0.0136 mV	
200 mV	±0.306 mV		200 mV	±0.0256 mV	
500 mV	±0.760 mV	±0.055%	500 mV	±0.0616 mV	±0.01%
1 V	±0.0015 V		1 V	±0.0001 V	
2 V	±0.0030 V		2 V	±0.0002 V	
5 V	±0.0076 V		5 V	±0.0006 V	
10 V	±0.0152 V		10 V	±0.0012 V	
20 V	±0.0304 V		20 V	±0.0024 V	
50 V	±0.0760 V		50 V	±0.0060 V	
100 V	±0.1520 V		100 V	±0.0120 V	
Electrical Accuracy @ 25 °C (A/D Converter Counts)			**Electrical Accuracy Temperature Coefficient from 25 °C (A/D Converter Counts)**		
Range	**Constant Inaccuracy**	**Percent Reading Inaccuracy**	**Range**	**Constant Inaccuracy Per °C**	**Percent Reading Inaccuracy Per °C**
5 mV	±6		5 mV	±0.88	
10 mV	±5		10 mV	±0.56	
20 mV	±4	±0.055%	20 mV	±0.40	±0.01%
50 mV	±3		50 mV	±0.30	
↓	↓		↓	↓	
100 V	±3		100 V	±0.30	

4-20. DC COMMON MODE REJECTION

WARNING

HIGH VOLTAGES (250 Vdc) will be present on all analog inputs and the metal guard shield, which houses the analog input channel under test. DO **NOT** perform this test with the top cover removed!

4-21. In the following test procedure, the range of the channel under test is set to 5 mV full scale and a dc voltage of 250 V is applied between the high input and ground. A measurement is initiated for a period of approximately 0.25 seconds. The results are retrieved from the data buffer of the HP 7090 as binary formatted values. All 1000 values are averaged and the dc common mode rejection (CMR) is computed. An infinite common mode rejection would result in exactly zero volts for all 1000 measurements. The actual value of the dc CMR should exceed 140 dB. To perform the dc common mode rejection test, proceed as follows:

a. Set the HP 7090 line power switch to off (O).

b. Connect the HP-IB controller to the HP 7090.

c. Apply power to the HP 7090 and manually set range of analog channel under test to 5 mV. Set ranges of other two analog channels to 100 V. To set ranges using the external controller, send the following instruction to the HP 7090;

For channel		Instruction
1	1000	OUTPUT "IR0.005 , 100 , 100 ;"
2	1000	OUTPUT "IR100 , 0.005 , 100 ;"
3	1000	OUTPUT "IR100 , 100 , 0.005 ;"

d. Connect a dc standard to the HP 7090 as illustrated in Figure 4-4.

e. Set dc standard for an output voltage of 250 V dc.

f. Load the following controller program and substitute the channel number under test for the variable "Z". The program sends instruction to the HP 7090 causing it to send 2K bytes of binary data (representing 1000 two byte measurement values) to the external controller. The controller then converts the data into 1000 measurement values. The measurement values are averaged and the dc CMR is computed.

```
1010 DIMENSION DATA(1000)
1020 OUTPUT "TB0.25 ; DO" ; Z ; "1000 , 0 , 0 ; MS1 ; QI ;"
1030 ENTER DATA(*)
1040 AVERAGE = 0
1050 FOR I = 1 TO 1000
1060 AVERAGE = AVERAGE + DATA(I)
1070 NEXT I
1080 DCCMR = 20 * LGT(AVERAGE/250)
1090 DISPLAY "DCCMR = " ; DCCMR ; "DB."
```

g. The DC CMR should be greater than 140 dB.

h. Repeat steps a. through g. for other channels.

4-22. AC COMMON MODE REJECTION

4-23. In the following test procedure, the range of the channel under test is set to 5 mV full scale and a 60 Hz 20 V (p-p) sine wave is applied between the high input and ground. A measurement is initiated for a period of approximately 0.25 seconds. The results are retrieved from the data buffer of the HP 7090 as binary formatted data. The difference between the maximum and minimum values of this data is calculated and the ac common mode rejection (CMR) is computed. The value of the dc CMR should exceed 100 dB. To perform the ac common mode rejection test, proceed as follows:

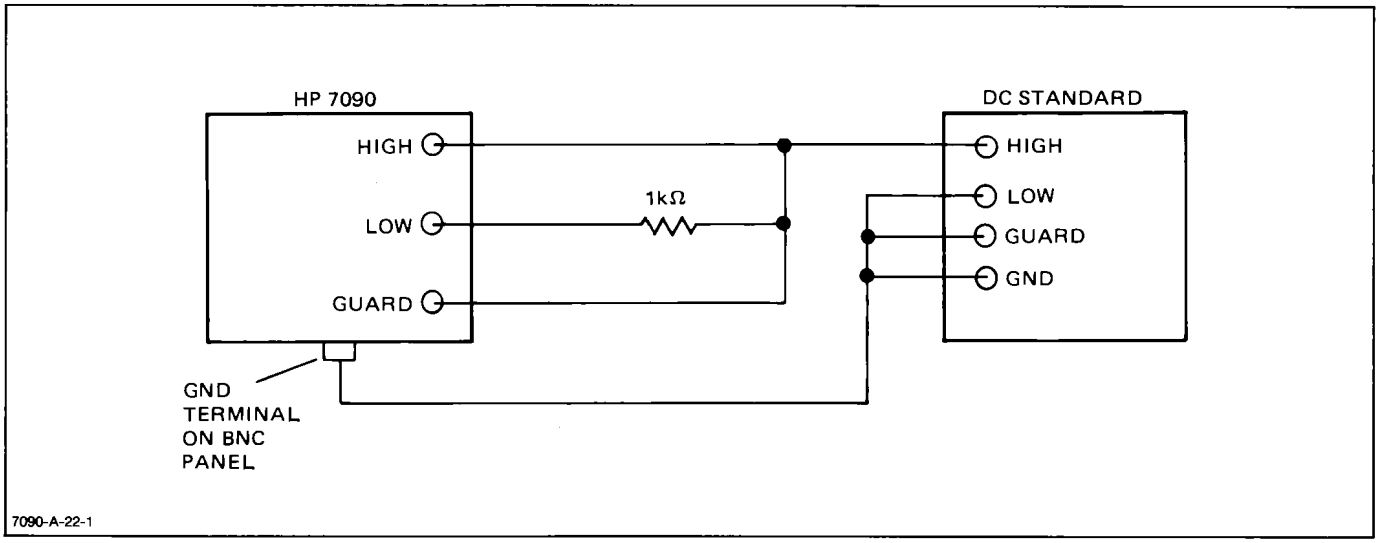


Figure 4-4. DC Common Mode Rejection

a. Set the HP 7090 line power switch to off (O).

b. Connect the HP-IB controller to the HP 7090.

c. Apply power to the HP 7090 and manually set range of analog channel under test to 5 mV. Set ranges of other two analog channels to 100 V. To set ranges using the external controller, send the following instruction to the HP 7090;

For channel		Instruction
1	1000	OUTPUT "IR0.005 , 100 , 100 ;"
2	1000	OUTPUT "IR100 , 0.005 , 100 ;"
3	1000	OUTPUT "IR100 , 100 , 0.005 ;"

d. Connect a function generator to the HP 7090 as illustrated in Figure 4-5.

e. Set function generator for a 60 Hz, 20 Vp-p sine wave signal.

f. Load the following controller program and substitute the channel number under test for the variable "Z". The program causes the HP 7090 to send 2K bytes of binary data to the external controller and then converts the data into 1000 measurement values. The difference between the maximum and minimum measurement values is found and the AC CMR is computed.

```
1010 DIMENSION DATA (1000)
1020 OUTPUT "TB0.1 ; DO" ; Z ; "1000 , 0 , 0 ; MS1 ; QI ;"
1030 ENTER DATA(*)
1040 MINIMUM = 1000
1050 MAXIMUM = -1000
1060 FOR I = 1 TO 1000
1070 IF DATA (I) >MAXIMUM THEN MAXIMUM =
     DATA(I)
1080 IF DATA (I) <MINIMUM THEN MINIMUM =
     DATA(I)
1090 NEXT I
1100 VOLTS = MAXIMUM - MINIMUM
1110 ACCMR = 20 * LGT(VOLTS/20)
1120 DISPLAY "ACCMR = " ; ACCMR ; "DB."
```

g. The AC CMR should be greater than 100 dB.

h. Repeat steps a. through g. for other channels.

4-24. ANALOG CHANNEL BANDWIDTH

4-25. To perform the analog channel bandwidth test, proceed as follows:

a. Set the HP 7090 line power switch to off (O).

b. Connect the HP-IB controller to the HP 7090.

c. Connect the function generator to the HP 7090 as illustrated in Figure 4-6.

d. Set function generator for a 2.8 kHz sine wave output with a peak-peak amplitude (Vin) of 40.0 V.

e. Apply power to the HP 7090 and set channel under test for a range of 50 V.

f. Send the following instructions from the external controller to the HP 7090.

```
1010 DIMENSION DATA (1000)
1020 OUTPUT "TB0.1 ; DO" ; Z ; "1000 , 0 , 0 ; MS1 ; QI ;"
1030 ENTER DATA(*)
1040 MINIMUM = 1000
1050 MAXIMUM = -1000
1060 FOR I = 1 TO 1000
1070 If DATA(I) >MAXIMUM THEN MAXIMUM =
     DATA(I)
1080 If DATA(I) <MINIMUM THEN MINIMUM =
     DATA(I)
1090 NEXT I
1100 VOLTS = MAXIMUM - MINIMUM
1110 ACCMR = 20 * LGT(VOLTS/20)
1120 DISPLAY "ACCMR = " ; ACCMR ; "DB."
```

g. Record the result (attenuation) displayed by the external controller.

h. Set the function generator for a 3.8 kHz sine wave output and repeat steps f. and g.

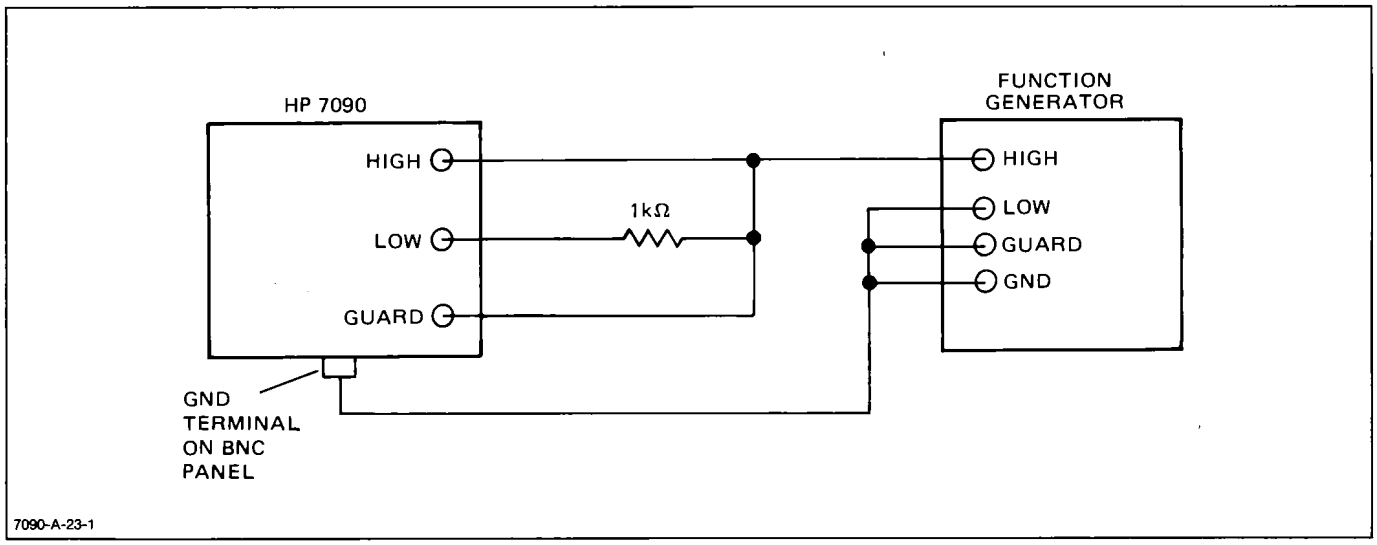


Figure 4-5. AC Common Mode Rejection

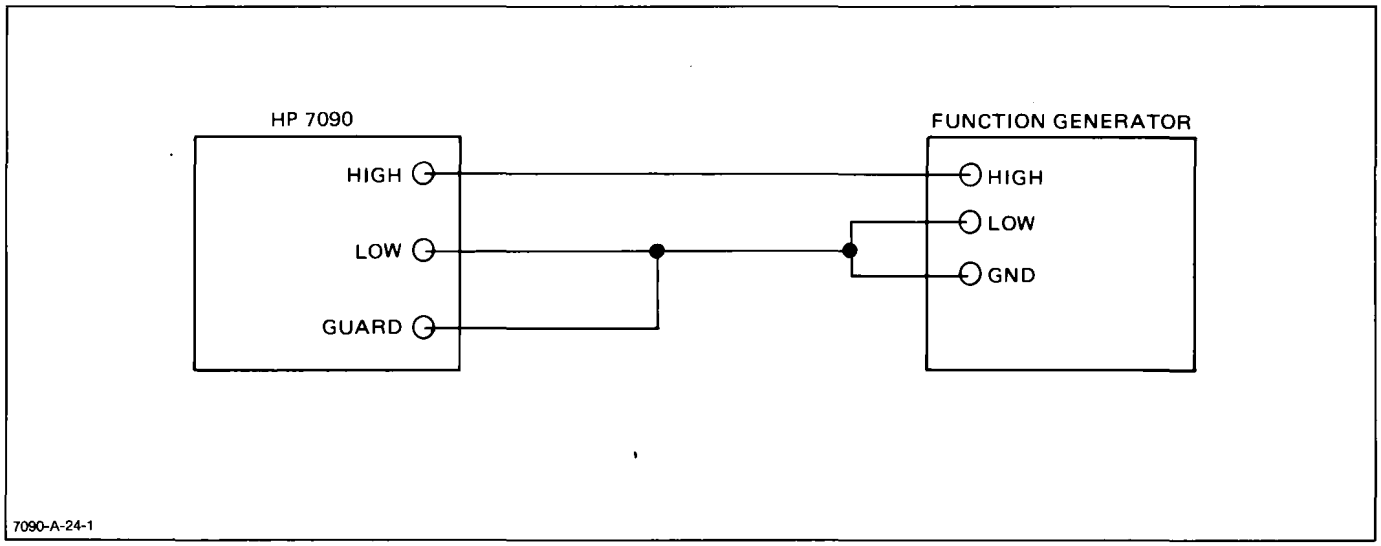


Figure 4-6. Analog Channel Bandwidth

i. The results with 2.8 kHz input should be less than 3 dB down and the results with a 3.8 kHZ sine wave input should be greater than 3 dB down.

j. Repeat procedure for other two analog channels.

4-26. TIME BASE ACCURACY

4-27. The Time Base Accuracy test requires removal of the top cover. Refer to Section VIII for time base accuracy test procedure.

Table 4-3. Performance Verification Program

```
1000 !          'VERIFY'
1010 !
1020 !     7090A PERFORMANCE
1030 !     VERIFICATION PLOT
1040 !
1050 ! HP85 VERSION FOR HP7090A
1060 ! EXTERNAL DIAGNOSTICS AND
1070 ! VERIFICATION PROGRAM SET
1080 ! P/N 07090-18030   (2427)
1090 !
1100 ! ************************
1110 CLEAR
1120 DISP "              7090A"
1130 DISP " PERFORMANCE VERIFICATION PLOT"
1140 DISP
1150 DISP " * * * * * * * * * * * * * * * *"
1160 DISP @ DISP
1170 DISP "WHAT IS YOUR HP85 COMPUTER'S"
1180 DISP "HP-IB INTERFACE SELECT CODE?"
1190 DISP "(DEFAULT = 7)"
1200 BEEP 41,100 @ BEEP 72,80 @ BEEP 23,300
1210 !
1220 INPUT N$
1230 D=VAL(N$&"0")
1240 IF D=0 THEN N=705
1250 D=D/10
1260 IF D>100 THEN N=D+5
1270 IF D>1 AND D<10 THEN N=D*100+5
1280 IF D>9 AND D<100 THEN BEEP 450,60 @ BEEP 650,70 @ DISP "WHAT????  THAT'S NO
T POSSIBLE!" @ GOTO 1170
1290 CLEAR
1300 DISP "SET 7090A HP-IB ADDRESS TO '5'."
1310 DISP
1320 DISP "INSTALL 6 NEW NARROW WIDTH PENS"
1330 DISP "AND A PIECE OF 8.5 X 11 INCH"
1340 DISP "PAPER.  PRESS THE SOFT KEY "
1350 DISP "'CONT' WHEN YOU ARE READY."
1360 ON KEY# 1," CONT " GOTO 1410
1370 ON KEY# 4," QUIT " GOTO 2620
1380 BEEP 41,100 @ BEEP 72,80 @ BEEP 23,300
1390 KEY LABEL
1400 GOTO 1400
1410 CLEAR
1420 A$=""
1430 N9=(N-5)/100
1440 SET TIMEOUT N9;1000
1450 OUTPUT N ;"OI;"
1460 ENTER N ; A$
1470 IF A$[1,4]="7090" THEN 1540
1480 RESET N9
1490 DISP "THE 7090A IS NOT TURNED ON, "
1500 DISP "THE HP-IB ADDRESS IS NOT SET"
1510 DISP "CORRECTLY, OR SOMETHING ELSE"
1520 DISP "IS WRONG.  PLEASE TRY AGAIN."
1530 DISP @ GOTO 1300
1540 CLEAR @ DISP USING "3/,32A" ; "    7090A VERIFICATION PLOT"
1550 RESET N9 @ SET TIMEOUT N9;0
1560 P=1
1570 IMAGE 4(5D,",",5D,","),";PU;"
1580 IMAGE "PA",5D,",",5D,"PD;"
1590 IMAGE "PA",5D,",",5D,"PU;"
1600 IMAGE #,5D,",",5D,","
1610 !
1620 ! INITIALIZE 7090A & OUTPUT P1,P2 & WINDOW COORDINATES
1630 !
1640 OUTPUT N USING "#,K" ; "PS4;IN;OP;"
```

7090-A-16-1

Table 4-3. Performance Verification Program (Continued)

```
1650 ENTER N ; X1,Y1,X2,Y2
1660 OUTPUT N USING "#,K" ; "OW;"
1670 ENTER N ; X3,Y3,X4,Y4
1680 !
1690 ! DRAW '+' AT P1 & P2 & LABEL COORDINATES
1700 !
1710 OUTPUT N USING "#,K" ; "SP1;PA5080,4064;PD;PU;SM+;PA";X1;",";Y1
1720 OUTPUT N USING "#,K" ; "CP0.1,-1.3;LBP1=("&VAL$(X1)&","&VAL$(Y1)&")"&CHR$(3
)&";"
1730 OUTPUT N USING "#,K" ; "PA";X2;",";Y2;"SM;"
1740 OUTPUT N USING "#,K" ; "CP-14,-1.3;LBP2=("&VAL$(X2)&",";VAL$(Y2)&")"&CHR$(3
)&";"
1750 OUTPUT N USING "#,K" ; "PA2022,2464;"
1760 GOSUB 2700
1770 OUTPUT N USING "#,K" ; "PA8088,4664;"
1780 GOSUB 2750
1790 !
1800 ! DRAW & LABEL AXIS
1810 !
1820 OUTPUT N USING "#,K" ; "SP2;PA9184,1416;PD;"
1830 FOR I=1 TO 8
1840 OUTPUT N USING "#,K" ; "XT;PR-1016,0;"
1850 NEXT I
1860 FOR I=1 TO 15
1870 OUTPUT N USING "#,K" ; "PR0,400;YT"
1880 NEXT I
1890 OUTPUT N USING "#,K" ; "PU;PA2022,4664;"
1900 GOSUB 2700
1910 OUTPUT N USING "#,K" ; "PA8088,6864;"
1920 GOSUB 2750
1930 OUTPUT N USING "#,K" ; "SP3;PA600,4000;DIO,1;LBY Axis";CHR$(3)
1940 OUTPUT N USING "#,K" ; "PA700,7366;DI;"
1950 FOR I=15 TO 0 STEP -1
1960 IF I<10 THEN OUTPUT N USING "#,K" ; "CP1,0;"
1970 OUTPUT N USING "#,K" ; "LB";VAL$(I);CHR$(13);CHR$(3);"PR0,-400;"
1980 NEXT I
1990 OUTPUT N USING "#,K" ; "PA2022,6864;"
2000 GOSUB 2700
2010 OUTPUT N USING "#,K" ; "PA2022,2464;"
2020 GOSUB 2750
2030 OUTPUT N USING "#,K" ; "PA1032,1156;SP4;"
2040 FOR I=0 TO 8
2050 OUTPUT N USING "#,K" ; "LB";VAL$(I)&CHR$(13)&CHR$(3)&"PR1011,0;"
2060 NEXT I
2070 OUTPUT N USING "#,K" ; "PA4830,916;LBX Axis"&CHR$(3)&";"
2080 OUTPUT N USING "#,K" ; "PA8088,2464;"
2090 GOSUB 2700
2100 OUTPUT N USING "#,K" ; "PA2022,4664;"
2110 GOSUB 2750
2120 !
2130 ! DRAW CIRCULAR FAN
2140 !
2150 OUTPUT N USING "#,K" ; "SP4;PA5080,4064;"
2160 OUTPUT N USING "#,K" ; "SP1;IW3580,2564,6580,5564;PA3580,2564;"
2170 OUTPUT N USING "#,K" ; "PD;PR0,3000,3000,0,0,-3000,-3000,0;PU;SP5;"
2180 DEG
2190 FOR I=0 TO 355 STEP 5
2200 X5=5080+400*COS(I)
2210 Y5=4064+400*SIN(I)
2220 OUTPUT N USING 1580 ; X5,Y5
2230 X5=5080+2200*COS(I)
2240 Y5=4064+2200*SIN(I)
2250 OUTPUT N USING 1590 ; X5,Y5
2260 NEXT I
2270 OUTPUT N USING "#,K" ; "IW;PA8088,4664;"
2280 GOSUB 2700
```

7090-A-17-1

Table 4-3. Performance Verification Program (Continued)

```
2290 OUTPUT N USING "#,K" ; "PA2022,6864;"
2300 GOSUB 2750
2310 !
2320 ! DRAW LABELS
2330 !
2340 OUTPUT N USING "#,K" ; "SP6;PA3610,6800;"
2350 OUTPUT N USING "#,K" ; "VS;SI1,1.5;SL0.27;LB7090A"&CHR$(3)
2360 OUTPUT N USING "#,K" ; "PA2900,6300;"
2370 OUTPUT N USING "#,K" ; "SI.23,.34;SL;LBPlotter Performance Verification"&CH
R$(3)
2380 OUTPUT N USING "#,K" ; "PA8088,6864;"
2390 GOSUB 2700
2400 OUTPUT N USING "#,K" ; "PA8088,2464;"
2410 GOSUB 2750
2420 OUTPUT N USING "#,K" ; "PA300,600;SR0.7,1.5;SL;LB"
2430 FOR I=33 TO 127
2440 OUTPUT N USING "#,K" ; CHR$(I)
2450 NEXT I
2460 OUTPUT N USING "#,K" ; CHR$(3)&";SI;"
2470 !
2480 ! FRAME PLOT
2490 !
2500 OUTPUT N USING "#,K" ; "PA5080,4064;PD;PU;"
2510 FOR I=1 TO 4
2520 OUTPUT N USING "#,K" ; "PA"&VAL$(X3)&","&VAL$(Y3)&"VS"&VAL$(18*I)&";PD;PA"
2530 OUTPUT N USING 1570 ; X3,Y4,X4,Y4,X4,Y3,X3,Y3
2540 X3=X3+25
2550 Y3=Y3+25
2560 X4=X4-25
2570 Y4=Y4-25
2580 NEXT I
2590 GOSUB 2790
2600 GOSUB 3280
2610 OUTPUT N ;"SP0;PA"&VAL$(X4)&","&VAL$(Y4)&";"
2620 BEEP 41,90 @ BEEP 72,90 @ BEEP 23,175
2630 BEEP 41,80 @ BEEP 72,100 @ BEEP 41,200
2640 CLEAR
2650 DISP USING "3/,32A" ; "     VERIFICATION COMPLETE"
2660 END
2670 !
2680 ! PEN TO PEN REPEATABILITY SUBROUTINES
2690 !
2700 OUTPUT N USING "#,K" ; "PR9,-9;PD;PR247,0,0,18,-247,0,0,247,-18,0,0,-247,"
2710 OUTPUT N USING "#,K" ; "-247,0,0,-18,247,0,0,-247,18,0,0,247;PU;"
2720 OUTPUT N ;"SI;CP-1.2,0.4;LB";VAL$(P);CHR$(3)&"CP0.2,-0.4;"
2730 RETURN
2740 !
2750 OUTPUT N USING "#,K" ; "PR0,512;PD;PR0,-1024;PU;PR-512,512;PD;PR1024,0;PU;"

2760 OUTPUT N USING "#,K" ; "PR-512,0;CP0.4,-0.8;LB"&VAL$(P)&CHR$(3)&"CP-1.4,0.8
;"
2770 P=P+1
2780 RETURN
2790 !
2800 !  DEADBAND TESTS
2810 !
2820 A=1
2830 M=0
2840 X1=4280
2850 Y1=1750
2860 L=0
2870 GOSUB 3130
2880 X1=5880
2890 Y1=1952
2900 M=2
2910 L=0
```

7090-A-18-1

Table 4-3. Performance Verification Program (Continued)

```
2920 GOSUB 3130
2930 OUTPUT N ;"PA4680,2200;PD;PA5480,2200;PU;"
2940 OUTPUT N ;"PA5080,2175;DI-1,0;CS1;CP-.33,-.75;"
2950 OUTPUT N ;"LB"&CHR$(94)&CHR$(3)
2960 A=0
2970 M=0
2980 L=0
2990 X1=3210
3000 Y1=3200
3010 GOSUB 3130
3020 X1=2998
3030 Y1=4800
3040 M=0
3050 L=2
3060 GOSUB 3130
3070 OUTPUT N ;"PA2950,4400;PD;PA2950,3600;PU;"
3080 OUTPUT N ;"PA2975,4000;DIO,-1;CP-.33,-.75;LB"&CHR$(94)&CHR$(3)
3090 RETURN
3100 !
3110 ! DRAW DEADBAND TEST SCALE
3120 !
3130 IF M=0 AND L=0 THEN S=1
3140 IF M<>0 OR L<>0 THEN S=-1
3150 IF A<>1 THEN 3180
3160 J=0
3170 I=200
3180 IF A<>0 THEN 3210
3190 I=0
3200 J=200
3210 FOR K=1 TO 9
3220 X2=X1+S*((K-1)*I+M*(5-K))
3230 Y2=Y1+S*((K-1)*J+L*(5-K))
3240 OUTPUT N USING 1580 ; X2,Y2
3250 OUTPUT N USING 1590 ; X2+J,Y2+I
3260 NEXT K
3270 RETURN
3280 !
3290 ! PEN WOBBLE TEST
3300 !
3310 OUTPUT N USING "#,K" ; "SP1;PA10200,1450;PD;VS;PR"
3320 A0=0
3330 A1=200
3340 FOR I=1 TO 10
3350 OUTPUT N USING 1600 ; A0,A1,-A1,A0
3360 NEXT I
3370 FOR I=1 TO 10
3380 OUTPUT N USING 1600 ; A0,A1,A1,A0
3390 NEXT I
3400 OUTPUT N USING "#,K" ; "0,200;PU;PR15,-15;PD;PR"
3410 FOR I=1 TO 9
3420 OUTPUT N USING 1600 ; A0,-A1,-A1,A0
3430 NEXT I
3440 OUTPUT N USING "#,K" ; "0,-200,-200,0,0,-170,200,0,"
3450 FOR I=1 TO 9
3460 OUTPUT N USING 1600 ; A0,-A1,A1,A0
3470 NEXT I
3480 OUTPUT N ;"0,-200;PU;"
3490 RETURN
```

7090-A-19-1

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SECTION V

ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section describes mechanical adjustments required to return the HP 7090 to its normal operating condition after repairs have been made. There are no electrical adjustments in the HP 7090.

5-3. EQUIPMENT REQUIRED

5-4. The adjustment procedures require use of the following tools:

Gram Gauge (0 to 40 grams)
Allen wrench (0.050 in.)
100 mm ruler
Tweezers

5-5. MECHANICAL ADJUSTMENTS

5-6. PEN DOWN FORCE ADJUSTMENT

5-7. Pen down force must be adjusted if the pen carriage or pen holder assemblies have been replaced or disassembled.

CAUTION

To avoid damage to the HP 7090 the following procedure should be performed only by service-trained personnel.

a. Install an unused (new) pen in stall one of the pen carousel.

CAUTION

Before applying power to the HP 7090, make sure the selected line voltage and fuse rating are correct. If not, refer to Line Voltage and Fuse Selection in Section II of this manual.

A minimum clearance of two inches around all sides of the HP 7090 must be maintained for adequate ventilation.

b. Apply power to the HP 7090.

c. With the PAPER LOAD lever in the LOAD position, place a sheet of paper against the left-hand rail and the rear stop. Lower the lever to the PAPER HOLD position. Make sure that the HP 7090 is set for the proper paper size.

d. Select pen one and lower it onto center of platen.

e. Place the tip of a gram gauge under the lip of the pen body and check that the pen *just* starts to lift with 12 to 28 grams of force. See Figure 5-1, Detail A. If the pen down force does not meet this requirement, proceed to the next step.

NOTE

One of four different springs can be used to achieve the correct pen down force. Refer to Section VII for part numbers and description.

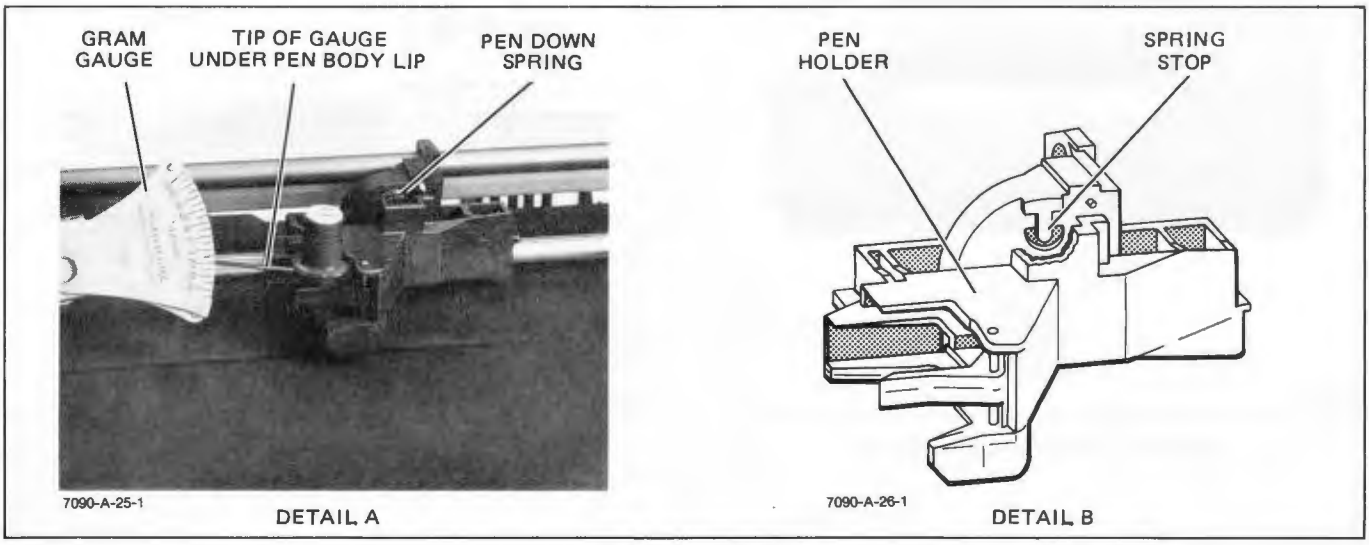


Figure 5-1. Measuring Pen Down Force

f. Set the HP 7090 LINE switch to OFF (O) and disconnect the line cord.

g. Carefully remove pen from pen holder.

h. While pressing down on the pen holder remove the pen down spring using a pair of tweezers. Replace with a longer spring if more force is required or a shorter spring if less force is needed. Make sure that the top front of the spring is positioned completely down against the spring stop located on the pen carriage. See Figure 5-1, Detail B.

i. Check pen down force and repeat procedure as necessary.

5-8. PEN HEIGHT ADJUSTMENT

5-9. Pen height adjustment is necessary if the pen carriage assembly is disassembled or replaced.

WARNING

The following procedure should be performed only by service-trained personnel who are aware of the electrical shock hazards involved.

a. Set the HP 7090 LINE switch to OFF (O) and disconnect the line cord.

b. Remove the HP 7090 top cover by removing the screws indicated in Figure 5-2.

c. Gently lift the rear of the top cover until the liquid crystal display (LCD) connector is accessible. See Figure 5-3.

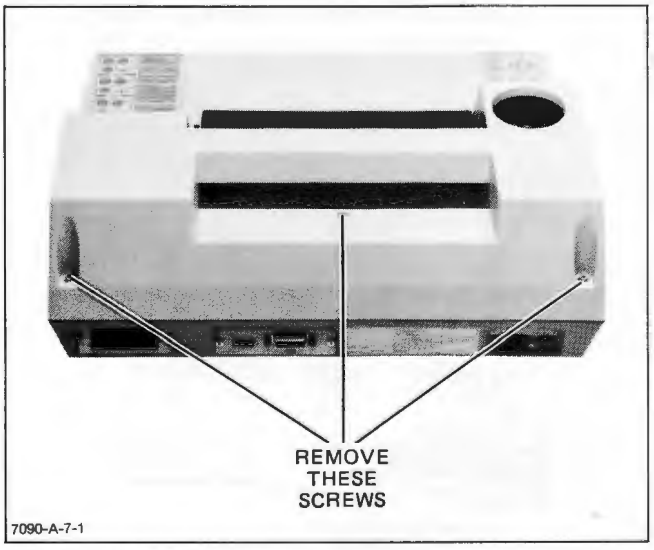


Figure 5-2. Top Cover Removal

d. Disconnect the LCD connector and remove top cover.

e. Position pen holder at center of platen.

f. Using the 100 mm ruler, measure the distance from the platen to bottom of pen holder. It should be 10.5 mm. See Figure 5-4.

g. To adjust pen height, insert a 0.050 in. Allen wrench through hole at rear of pen carriage. Turn clockwise to decrease height and counter-clockwise to increase pen height. See Figure 5-5.

h. Reverse procedure to replace top cover.

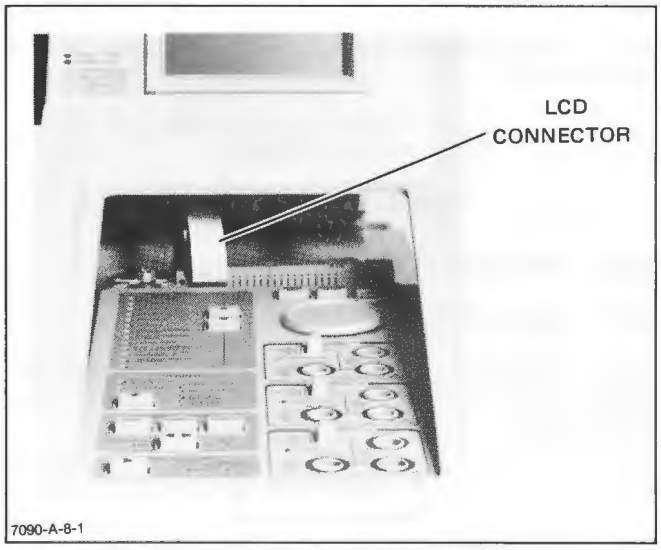


Figure 5-3. LCD Connector

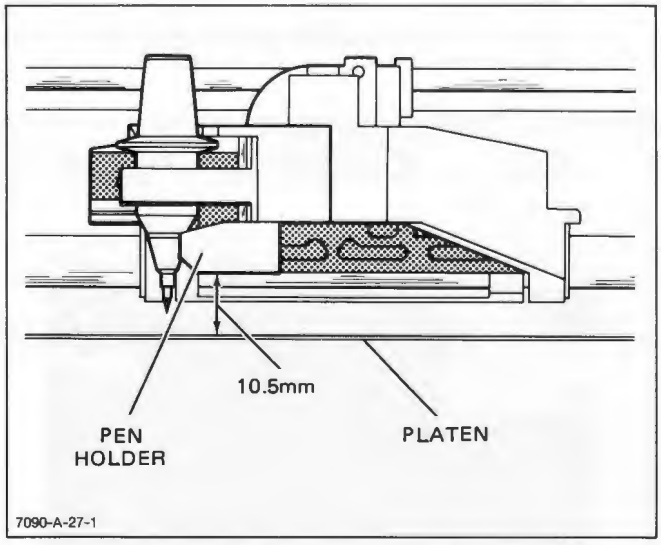


Figure 5-4. Measuring Pen Height

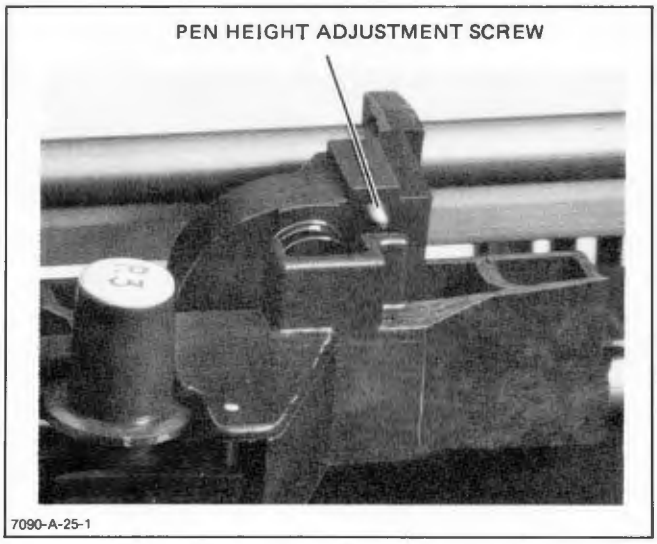


Figure 5-5. Pen Height Adjustment

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering parts for the HP 7090. Included are lists of electrical and mechanical parts and an illustration of mechanical parts.

6-3. CABLE ASSEMBLIES

6-4. Interconnecting cable assemblies with their respective part numbers are illustrated in Figure 6-1.

6-5. EXCHANGE ASSEMBLIES

6-6. Part numbers for assemblies that are available on an exchange basis are listed in Table 6-1. These factory repaired and tested assemblies are available only on a trade-in basis; therefore, the defective assembly must be returned for credit. For this reason, assemblies required for spare parts stock must be ordered using the new part number.

6-7. REPLACEABLE PARTS LISTS

6-8. Electrical parts for the HP 7090 are listed in Tables 6-2 through 6-6. Tables 6-7 and 6-8 list the mechanical parts which are illustrated in Figures 6-2 and 6-3 respectively.

6-9. ORDERING INFORMATION

6-10. To obtain replacement parts or assemblies, address an order or inquiry to the nearest Hewlett-Packard Sales and Support Office. Include the HP part number, the check digit (listed under the heading "CD" in the parts list), the instrument model number, part location and description, and the quantity required.

6-11. CODE LIST OF MANUFACTURERS

6-12. Table 6-9 lists the five-digit code numbers assigned to the manufacturers of parts used in the HP 7090. These code numbers appear with the parts in Table 6-1 through 6-8 as an aid for ordering replacement parts directly from the manufacturer.

6-13. DESIGNATIONS AND ABBREVIATIONS

6-14. Table 6-10 lists designations and abbreviations used throughout this manual. Abbreviations in the parts lists are always capital letters. In other parts of the manual both upper and lower case abbreviations are used.

6-15. DIRECT MAIL ORDER SYSTEM

6-16. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Chassis and electrical parts are available at the Customer Service Center in Mountain View; consumable items (pens, ink, graph paper, slidewire cleaner) can be ordered from the HP San Diego Division. Advantages of this system are:

a. Direct ordering and shipment from the HP Parts Center in Mountain View, California or HP San Diego Division, San Diego, California.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP office when the orders require billing and invoicing).

c. Pepaid transportation (there is a small handling charge for each order).

d. No invoices — to provide these advantages, a check or money order must accompany each order.

6-17. Mail order forms and specific ordering information is available through your local HP office.

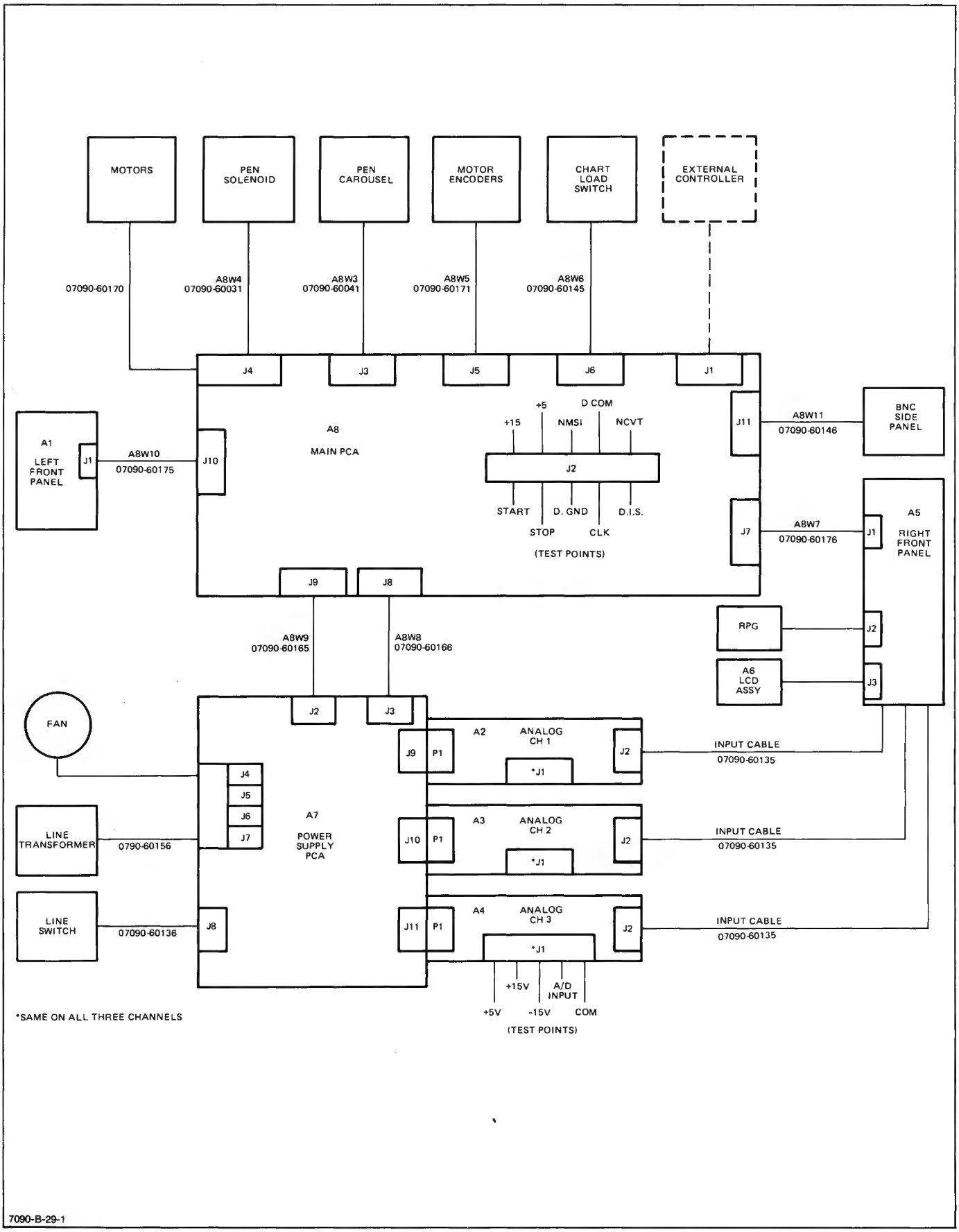


Figure 6-1. Interconnecting Cables

Table 6-1. Exchange Assemblies

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2, A3, A4	07090-66075	5	3	ANALOG INPUT ASSEMBLY	28480	07090-66075
A8	07090-66110	9	1	PCA, MAIN	28480	07090-66110

Table 6-2. Front Panel PCA — RH

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	07090-60130	1	1	PCA-FRONT PNL, LH	28480	07090-60130
A1DS1-A1DS4	1990-0665	3	4	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V RED	28480	1990-0665
A1J1	1251-4058	0	1	CONNECTOR 26-PIN M RECTANGULAR	28480	1251-4058

Table 6-3. Front Panel PCA — LH

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5	07090-60120	9	1	PCA-FRONT PNL RH	28480	07090-60120
A5DS1-A5DS30	1990-0665	3	30	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V RED	28480	1990-0665
A5J1	1251-3782	5	1	CONNECTOR 40-PIN M RECTANGULAR	28480	1251-3782
A5J2	1200-1134	0	1	CONN, SIP 4	28480	1200-1134
A5J3	1251-8593	6	1	CONN-POST TYPE .100-PIN-SPCG 4-CONT	28480	1251-8593

Table 6-4. Parts List, Analog Channel PCA

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2, A3, A4	07090-60150	5	1	PCA-ANALOG CHAN	28480	07090-60150
C1	0180-2986	7	3	CAPACITOR-FXD 330UF+-20% 50VDC AL	28480	0180-2986
C2	0180-0291	3	6	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
C3	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
C4	0180-1735	2	2	CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
C5	0160-4835	7	8	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C6	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
C7	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C8	0160-5830	4	1	CAPACITOR-FXD 6250PF +-1% 300VDC POLYP	28480	0160-5830
C9	0160-5829	1	1	CAPACITOR-FXD 460PF +-1% 300VDC POLYP	28480	0160-5829
C10	0160-5827	9	1	CAPACITOR-FXD 130PF +-5% 50VDC POLYP	28480	0160-5827
C11	0160-3847	9	23	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C12	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C13	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C14	0180-2984	5	3	CAPACITOR-FXD 47UF+-20% 50VDC AL	28480	0180-2984
C15	0180-2984	5		CAPACITOR-FXD 47UF+-20% 50VDC AL	28480	0180-2984
C16	0180-2986	7		CAPACITOR-FXD 330UF+-20% 50VDC AL	28480	0180-2986
C17	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
C18	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C19	0160-5846	2	2	CAPACITOR-FXD .01UF +-10% 100VDC POLYP	28480	0160-5846
C20	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C21	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C22	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C23	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C24	0180-2986	7		CAPACITOR-FXD 330UF+-20% 50VDC AL	28480	0180-2986
C25	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C26	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C27	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C28	0180-1735	2		CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
C29	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
C30	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C31	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
C32	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C33	0160-4812	0	1	CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
C34	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C35	0160-5846	2		CAPACITOR-FXD .01UF +-10% 100VDC POLYP	28480	0160-5846
C36	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C37	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C38	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C39	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C40	0180-2984	5		CAPACITOR-FXD 47UF+-20% 50VDC AL	28480	0180-2984
C41	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C42	0160-5828	0	1	CAPACITOR-FXD 180PF +-5% 300VDC POLYP	28480	0160-5828
C43	0160-2903	6	1	CAPACITOR-FXD .05UF +-20% 500VDC CER	28480	0160-2903
C44	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C45	0160-4801	7	1	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
C46	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C47	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C48	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C49	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C50	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C51	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C52	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C53	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C54	0160-6004	6	1	CAPACITOR-FXD 1UF +100-0% 100VDC TA	28480	0160-6004
C55	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
CR1	1901-0704	4	6	DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
CR2	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
CR3	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
CR4	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
CR5	1901-0518	8	1	DIODE-SM SIG SCHOTTKY	28480	1901-0518
CR6	1901-1129	9	8	DIODE 1A 50V	28480	1901-1129
CR7	1901-1129	9		DIODE 1A 50V	28480	1901-1129
CR8	1901-1129	9		DIODE 1A 50V	28480	1901-1129
CR9	1901-1129	9		DIODE 1A 50V	28480	1901-1129
CR10	1901-0050	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
CR11	1901-1129	9		DIODE 1A 50V	28480	1901-1129
CR12	1901-1129	9		DIODE 1A 50V	28480	1901-1129
CR13	1901-1129	9		DIODE 1A 50V	28480	1901-1129
CR14	1901-1129	9		DIODE 1A 50V	28480	1901-1129
CR15	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002

Table 6-4. Parts List, Analog Channel PCA (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
CR16	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
E1	0360-1917	4	3	TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	28480	0360-1917
E2	0360-1917	4		TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	28480	0360-1917
E3	0360-1917	4		TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	28480	0360-1917
E4	1970-0076	8	1	VOLT SURGE PROTECTOR TUBE-ELCTRN 350L	28480	1970-0076
E5	1970-0081	5	1	VOLT SURGE PROTECTOR 600L	28480	1970-0081
F1	2110-0713	9	1	FUSE 10A 125V	28480	2110-0713
H1	07090-20030	6	1	STANDOFF	28480	07090-20030
H2	07090-60040	2	1	DEFLECTOR-AIR	28480	07090-60040
H3	0515-1069	6	1	SCREW-MACHINE ASSEMBLY M4 X 0.7 10MM-LG	28480	0515-1069
J1	1251-3835	9	1	CONNECTOR 9-PIN M POST TYPE	28480	1251-3835
J2	1251-8952	1	1	CONN 4 POSITION	28480	1251-8952
K1	0490-1310	6	1	RELAY-REED 2A 250MA 400VDC 5VDC-COIL 5VA	28480	0490-1310
K2	0490-1411	8	1	RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1411
L1	9100-1620	5	6	INDUCTOR RF-CH-MLD 15UH 10% .166DX.385LG	28480	9100-1620
L2	9100-1620	5		INDUCTOR RF-CH-MLD 15UH 10% .166DX.385LG	28480	9100-1620
L3	9100-1620	5		INDUCTOR RF-CH-MLD 15UH 10% .166DX.385LG	28480	9100-1620
L4	9100-1620	5		INDUCTOR RF-CH-MLD 15UH 10% .166DX.385LG	28480	9100-1620
L5	9100-1620	5		INDUCTOR RF-CH-MLD 15UH 10% .166DX.385LG	28480	9100-1620
L6	9100-1620	5		INDUCTOR RF-CH-MLD 15UH 10% .166DX.385LG	28480	9100-1620
P1	1251-7628	6	1	CONN-POST TYPE .100-PIN-SPCG 20-CONT	28480	1251-7628
Q1	1855-0532	7	8	TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0532
Q2	1855-0532	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0532
Q3	1855-0532	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0532
Q4	1855-0532	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0532
Q5	1855-0532	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0532
Q6	1855-0532	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0532
Q7	1855-0532	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0532
Q8	1855-0532	7		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0532
Q9	1855-0533	8	4	TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0533
Q10	1855-0298	2	2	TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
Q11	1855-0298	2		TRANSISTOR J-FET N-CHAN D-MODE TO-92	28480	1855-0298
Q12	1855-0533	8		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0533
Q13	1855-0533	8		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0533
Q14	1855-0533	8		TRANSISTOR J-FET N-CHAN D-MODE TO-92 SI	28480	1855-0533
R1	0699-1156	0	1	RESISTOR 72K .1% .125W F TC=0+-25	28480	0699-1156
R2	0698-8711	5	1	RESISTOR 6.601K .1% .125W F TC=0+-25	28480	0698-8711
R3	0699-0154	6	1	RESISTOR 7.2K .1% .125W F TC=0+-25	28480	0699-0154
R4	0757-0442	9	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R5	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R6	0757-0405	4	2	RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
R7	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
R8	0698-3382	6	1	RESISTOR 5.49K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5491-F
R9	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R10	0698-4002	9	3	RESISTOR 5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5001-F
R11	0698-4449	8	1	RESISTOR 309 1% .125W F TC=0+-100	24546	C4-1/8-T0-309R-F
R12	0698-4002	9		RESISTOR 5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5001-F
R13	0698-4002	9		RESISTOR 5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5001-F
R14	0698-6305	9	1	RESISTOR 900K .1% .25W F TC=0+-25	28480	0698-6305
R15	0698-3446	3	3	RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F
R16	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F
R17	0698-3440	7	1	RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
R18	0757-0438	3	2	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
R19	0757-0416	7	5	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
R20	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
R21	0698-4433	0	4	RESISTOR 2.26K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2261-F
R22	0698-4433	0		RESISTOR 2.26K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2261-F
R23	0698-4433	0		RESISTOR 2.26K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2261-F
R24	0698-4433	0		RESISTOR 2.26K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2261-F
R25	0699-1256	1		RESISTOR 6.2K 5% .3W F TC=0+-100	28480	0699-1256
R26	0698-1256	9	1	RESISTOR 6.2K .1% .125W F TC=0+-100	28480	0698-1256
R27	0698-6342	4	1	RESISTOR 90K .1% .125W F TC=0+-25	28480	0698-6342
R28	0698-4002	9		RESISTOR 5K 1% .125W F TC=0+-100	28480	0698-4002
R29	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-TO-383R-F
R30	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
R31	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
R32	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F
R33	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
R34	0698-6360	6	1	RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
R35	0698-6625	6	1	RESISTOR 6K .1% .125W F TC=0+-25	28480	0698-6625

Table 6-4. Parts List, Analog Channel PCA (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
R36	0698-6624	5	1	RESISTOR 2K .1% .125W F TC=0+-25	28480	0698-6624
R37	0698-6362	8	2	RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
R38	0699-1068	3	1	RESISTOR 600 .1% .125W F TC=0+-25	28480	0699-1068
R39	0698-6377	5	1	RESISTOR 200 .1% .125W F TC=0+-25	28480	0698-6377
R40	0698-6323	1	2	RESISTOR 100 .1% .125W F TC=0+-25	28480	0698-6323
R41	0698-6323	1		RESISTOR 100 .1% .125W F TC=0+-25	28480	0698-6323
R42	0698-6343	5	1	RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
R43	0698-6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
R44	0764-0047	5	1	RESISTOR 82K 5% 2W MO TC=0+-200	28480	0764-0047
R45	0698-3446	0	2	RESISTOR 383 1% .125W F TC=0+-100	28480	0698-3446
R46	0698-3446	0		RESISTOR 383 1% .125W F TC=0+-100	28480	0698-3446
R47	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R48	0698-3492	9	2	RESISTOR 2.67K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2671-F
R49	0757-0288	1	1	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
R50	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
R51	0698-3492	9		RESISTOR 2.67K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2671-F
R52	0757-0450	9	3	RESISTOR 22.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2212-F
R53	0757-0450	9		RESISTOR 22.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2212-F
R54	0698-4009	6	1	RESISTOR 50K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5002-F
R55	0757-0450	9		RESISTOR 22.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2212-F
R56	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
R57				NOT ASSIGNED		
R58	0757-0367	7	1	RESISTOR 100K 1% .5W F TC=0+-100	28480	0757-0367
RN1	1810-0231	9	1	NETWORK-RES 8-SIP2.2K OHM X 7	01121	208A222
RN2	1810-0456	0	1	NETWORK-RES 16-DIP56.0K OHM X 15	11236	761-1-R56K
RN3	1810-0485	5	1	NETWORK-RES 14-DIP22.0K OHM X 7	28480	1810-0485
RV1	0837-0285	0	1	VSTR V56MA2B	28480	0837-0285
T1		2	1	TRANSFORMER	28480	T-86948
TP1	1251-0600	0	4	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
U1	1826-1103	9	1	A/D 12-1/2-BIT 32-FL-PAK	28480	1826-1103
U2	1826-0208	3	1	IC OP AMP GP 8-DIP-P PKG	27014	LM310N
U3	1826-0840	9	3	IC SMPL/HOLD 14-DIP-C PKG	24355	AD583
U4	1826-0961	5	2	IC OP AMP LOW-BIAS-H-IMPD 8-DIP-P PKG	28480	1826-0961
U5	1826-1081	2	1	IC OP AMP PRCN 8-DIP-P PKG	28480	1826-1081
U6	1826-1101	7	1	D/A 12-BIT 18-DIP-C CMOS	28480	1826-1101
U7	1826-0961	5		IC OP AMP LOW-BIAS-H-IMPD 8 DIP-P PKG	28480	1826-0961
U8	1990-0444	6	1	OPTO-ISOLATOR LED-PDIO/XSTR IF=25MA-MAX	28480	6N136
U9	1820-2634	1	2	IC INV TTL ALS HEX	01295	SN74ALS04N
U10	1820-3172	4	1	IC FF CMOS/74HC J-K BAR POS-EDGE-TRIG	28480	1820-3172
U11	1826-1102	8	1	ANALOG SWITCH 2 SPST 14 -DIP-P	28480	1826-1102
U12	1826-0840	9		IC SMPL/HOLD 14-DIP-C PKG	24355	AD583
U13	1826-0550	8	1	IC CONV 8-B D/A 16-DIP-P PKG	07263	UA0801EPC
U14	1820-0471	0	1	IC INV TTL HEX 1-INP	01295	SN7406N
U15	1820-3050	5	4	IC FF CMOS/74HC D-M/S POS-EDGE-TRIG COM	28480	1820-3058
U16	1820-3058	5		IC FF CMOS/74HC D-M/S POS-EDGE-TRIG COM	28480	1820-3058
U17	1826-1108	4	1	IC OP AMP PRCN 8-TO-99 PKG	28480	1826-1108
U18	1820-3479	4	2	IC DRVR TTL ALS NOR QUAD 2-INP	28480	1820-3479
U19	1820-2634	1		IC INV TTL ALS HEX	01295	SN74ALS04N
U20	1990-0461	7	2	OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	5082-4364
U21	1990-0429	7	1	OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	1990-0429
U22	1990-0461	7		OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	5082-4364
U23	1820-3479	4		IC DRVR TTL ALS NOR QUAD 2-INP	28480	1820-3479
U24	1820-1423	4	1	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
U25	1820-3181	5	2	IC SHF RGTR CMOS/74HC SYNC/ASYNC	28480	1820-3181
U26	1820-3082	5	2	IC-MC74HC374N	28480	1820-3082
U27	1820-3181	5		IC SHF RGTR CMOS/74HC SYNC/ASYNC	28480	1820-3181
U28	1820-3082	5		IC-MC74HC374N	28480	1820-3082
U29	1820-3058	5		IC FF CMOS/74HC D-M/S POS-EDGE-TRIG COM	28480	1820-3058
U30	1820-3058	5		IC FF CMOS/74HC D-M/S POS-EDGE-TRIG COM	28480	1820-3058
U31	1826-0138	8	3	IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
U32	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
U33	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
U34	1826-1106	2	1	IC V RGLTR-FXD-POS 14.85/15.15V TO-220	28480	1826-1106
U35	1826-0214	1	1	IC V RGLTR TO-220	04713	MC7915CT
U36	1826-1104	0	1	IC V RGLTR-FXD-POS 4.95/5.05V TO-220 PKG	28480	1826-1104
VR1	1902-0025	4	3	DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.06%	28480	1902-0025
VR2	1902-0025	4		DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.06%	28480	1902-0025
VR3	1902-0025	4		DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.06%	28480	1902-0025

Table 6-4. Parts List, Analog Channel PCA (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
W1	8150-3774	8	1	WIRE 22AWG W TFE 1X22 105C	28480	8150-3774
W2	8150-4104	0	1	WIRE 22AWG W TFE 1X22 105C	28480	8150-4104
W3	8150-3775	9	1	WIRE 22AWG W TFE 1X22 105C	28480	8150-3775
W4	8159-0005	0	3	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
W5	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
W6	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

Table 6-5. Parts List, Main PCA

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8	07090-60110	7	1	PCA-MAIN (DATE CODE: 2430-11)	28480	07096-60110
C1	0160-3847	9	39	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C2	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C3	0160-3847	9		CAPACITOR-FXD .01UF +100 0% 50VDC CER	28480	0160-3847
C4	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C5	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C6	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C7	0160-4835	7	7	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C8	0180-2984	6	5	CAPACITOR-FXD .47UF +-20% 50VDC	28480	0180-2984
C9	0160-0127	2	1	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
C10	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C11	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C12	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C13	0160-4795	8	1	CAPACITOR-FXD 4.7PF +-.5PF 100VDC CER	28480	0160-4795
C14	0160-4791	4	1	CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
C15	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C16	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C17	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C18	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C19	0160-2585	0	1	CAPACITOR-FXD 2000PF +-1% 100VDC MICA	28480	0160-2585
C20	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C21	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C22	0160-3097	1	4	CAPACITOR-FXD .47UF +80-20% 50VDC CER	20932	5033ES50RD474Z
C23	0160-3097	1		CAPACITOR-FXD .47UF +80-20% 50VDC CER	20932	5033ES50RD474Z
C24	0160-3097	1		CAPACITOR-FXD .47UF +80-20% 50VDC CER	20932	5033ES50RD474Z
C25	0160-3097	1		CAPACITOR-FXD .47UF +80-20% 50VDC CER	20932	5033ES50RD474Z
C26	0180-2984	6		CAPACITOR-FXD .47UF 20% 50VDC	28480	0180-2984
C27	0180-2984	6		CAPACITOR-FXD .47UF 20% 50VDC	28480	0180-2984
C28	0180-2984	6		CAPACITOR-FXD .47UF 20% 50VDC	28480	0180-2984
C29	0180-2984	6		CAPACITOR-FXD .47UF 20% 50VDC	28480	0180-2984
C30	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C31	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C32	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C33	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C34	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C35	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C36	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C37	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C38	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C39	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C40	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C41	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C42	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C43	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C44	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C45	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C46	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C47	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C48	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C49	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C50	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C51	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C52	0160-0153	4	2	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
C53	0180-0228	6	3	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
C54	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
C55	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
C56	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C57	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C58	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C59	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C60	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C61	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C62	0140-0208	8	1	CAPACITOR-FXD 680PF +-5% 300VDC MICA	72136	DM15F681J0300WV1CR
C63	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
C64	0160-5271	7	1	CAPACITOR-FXD 30PF +-5% 100VDC CER 04-30	28480	0160-5271
CR1	1901-0841	0	1	DIODE-SM SIG SCHOTTKY	28480	HSCH-1001
CR2	1901-1065	2	1	DIODE-PWR RECT 1N4936 400V 1A 200NS	14936	1N4936
CR3-CR17	1901-0050	3	15	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
DS1	1990-0486	6	1	LED-LAMP LUM INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4684

Table 6-5. Parts List, Main PCA (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
E1-						
E4			4	HEAT SINK	28480	
E5	1970-0095	1	4	VOLT SURGE PROTECTOR	28480	1970-0095
E6	1970-0095	1		VOLT SURGE PROTECTOR	28480	1970-0095
E7	1970-0095	1		VOLT SURGE PROTECTOR	28480	1970-0095
E8	1970-0095	1		VOLT SURGE PROTECTOR	28480	1970-0095
E9						
E14	0340-1005	9	6	INSULATOR-XSTR POLYI	28480	0340-1005
F1,F2	2110-0684	3	2	FUSE 2A 125V NTD .3X.103 UL	28480	2110-0684
H1	2200-0207	7	2	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	28480	2200-0207
H2	2200-0207	7		SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	28480	2200-0207
H3-						
H8	1251-5595	2	6	POLARIZING KEY-POST CONN	28480	1251-5595
H9-						
H12	0515-0912	6	4	SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0912
H13-						
H16	0535-0031	2	4	NUT-HEX W/LKWR M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
H17-						
H20	3050-1021	7	4	WASHER-SHLDR NO.4 .116-IN-ID .215-IN-OD	28480	3050-1021
J1	1251-7651	5	1	CONN-RECT CHAMP 24-CKT 24-CONT	28480	1251-7651
J2	1251-5238	0	1	CONNECTOR 10-PIN M POST TYPE	28480	1251-5238
J3	1251-5238	0	1	CONN 7 PIN G	28480	1251-5238
J4	1251-8136	3	1	CONN-POST TYPE .156-PIN-SPCG 8-CONT	28480	1251-8136
J5	1251-8877	9	1	CONN 2 PIN G	28480	1251-8877
J6	1252-0146	1	2	CONN 9 M	28480	1252-0146
J7	1251-8828	0	2	40 POSITION CONN	28480	1251-8828
J8	1251-8940	7	1	CONN-POST TYPE .156-PIN-SPCG 6-CONT	28480	1251-8940
J9	1251-8828	0		40 POSITION CONN	28480	1251-8828
J10	1251-8248	8	1	CONN-POST TYPE .100-PIN-SPCG 26-CONT	28480	1251-8248
J11	1252-0146	1		CONN 9 M	28480	1252-0146
Q1	1855-0548	5	5	TRANSISTOR MOSFET N-CHAN E-MODE TO-220	28480	1855-0548
Q2	1854-0832	8	13	TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q3	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q4	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q5	1854-0637	1	4	TRANSISTOR NPN 2N2219A SI TO-5 PD=800MW	01295	2N2219A
Q6	1855-0517	8	4	TRANSISTOR MOSFET P-CHAN E-MODE TO-220	28480	1855-0517
Q7	1855-0548	5		TRANSISTOR MOSFET N-CHAN E-MODE TO-220	28480	1855-0548
Q8	1854-0637	1		TRANSISTOR NPN 2N2219A SI TO-5 PD=800MW	01295	2N2219A
Q9	1855-0517	8		TRANSISTOR MOSFET P-CHAN E-MODE TO-220	28480	1855-0517
Q10	1855-0548	5		TRANSISTOR MOSFET N-CHAN E-MODE TO-220	28480	1855-0548
Q11	1854-0637	1		TRANSISTOR NPN 2N2219A SI TO-5 PD=800MW	01295	2N2219A
Q12	1855-0517	8		TRANSISTOR MOSFET P-CHAN E-MODE TO-220	28480	1855-0517
Q13	1855-0548	5		TRANSISTOR MOSFET N-CHAN E-MODE TO-220	28480	1855-0548
Q14	1854-0637	1		TRANSISTOR NPN 2N2219A SI TO-5 PD=800MW	01295	2N2219A
Q15	1855-0517	8		TRANSISTOR MOSFET P-CHAN E-MODE TO-220	28480	1855-0517
Q16	1855-0548	5		TRANSISTOR MOSFET N-CHAN E-MODE TO-220	28480	1855-0548
Q17	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q18	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q19	1853-0419	5	4	TRANSISTOR PNP SI PD=310MW FT=200MHZ	01295	2N4403
Q20	1853-0419	5		TRANSISTOR PNP SI PD=310MW FT=200MHZ	01295	2N4403
Q21	1853-0419	5		TRANSISTOR PNP SI PD=310MW FT=200MHZ	01295	2N4403
Q22	1853-0419	5		TRANSISTOR PNP SI PD=310MW FT=200MHZ	01295	2N4403
Q23	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q24	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q25	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q26	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q27	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q28	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q29	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
Q30	1854-0832	8		TRANSISTOR NPN PD=350MW FT=250MHZ	28480	1854-0832
R1	0683-3915	0	1	RESISTOR 390 5% .25W FC TC=-400/+600	01121	CB3915
R2	0698-3441	8	11	RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R3	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R4	0698-3441	0		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R5	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4 1/8-T0-215R-F
R6	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
R7	0757-1099	4	1	RESISTOR 900 1% .125W F TC=0+-100	24546	C4 1/8-T0-901-F
R8	0683-8215	3	1	RESISTOR 820 5% .25W FC TC= 400/1600	01121	CB8215
R9	0683-1065	7	1	RESISTOR 10M 5% .25W CC TC=-900/+1100	01121	CB1065
R10	0683-1545	8	1	RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
R11	0757-0437	2	4	RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4 1/8-T0-4751-F
R12	0698-3245	0	1	RESISTOR 20.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2052-F
R13	0757-0437	2		RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4751-F
R14	0757-0461	2	1	RESISTOR 68.1K 1% .125W F TC=0+-100	24546	C4 1/8-T0-6812 F
R15	0757-0416	7	4	RESISTOR 511 1% .125W F TC=0+-100	24546	C4 1/8 T0-511R-F

Table 6-5. Parts List, Main PCA (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
R16	0698-3444	1	6	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
R17	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
R18	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
R19	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
R20	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
R21	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
R22	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
R23	0683-3915	0	4	RESISTOR 390 5% .25W FC TC=-400/+500	01121	CB3915
R24	0811-3683	2	4	RESISTOR 150 1% 1W F TC=0+-100	28480	0811-3683
R25	0683-1025	9	4	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
R26	0683-3815	0		RESISTOR 390 5% .25W FC TC=-400/+500	01121	CB3915
R27	0811-3683	2		RESISTOR 150 1% 1W F TC=0+-100	28480	0811-3683
R28	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
R29	0683-3815	0		RESISTOR 390 5% .25W FC TC=-400/+500	01121	CB3915
R30	0811-3683	2		RESISTOR 150 1% 1W F TC=0+-100	28480	0811-3683
R31	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
R32	0683-3815	0		RESISTOR 390 5% .25W FC TC=-400/+500	01121	CB3915
R33	0811-3683	2		RESISTOR 150 1% 1W F TC=0+-100	28480	0811-3683
R34	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
R35	0757-0446	3	3	RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
R36	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R37	0757-0446	3	3	RESISTOR 15K 1% .125W F TC=0+-100	24546	CA-1/8-TO-1502
R38	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R39	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R40	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R41	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R42	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R43	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
R44	0698-4002	9		RESISTOR 5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5001-F
R45	0698-0084	9	2	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
R46	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
R47	0698-3620	5	2	RESISTOR 100 5% 2W MO TC=0+-200	28480	0698-3620
R48	0698-3620	5		RESISTOR 100 5% 2W MO TC=0+-200	28480	0698-3620
R49	0764-0044	2	2	RESISTOR 8.2K 5% 2W MO TC=0+-200	28480	0764-0044
R50	0764-0044	2		RESISTOR 8.2K 5% 2W MO TC=0+-200	28480	0764-0044
R51	0757-0442	9	2	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R52	0757-0437	2		RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4751-F
R53	0698-4002	9		RESISTOR 5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5001-F
R54	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R55	0757-0446	3		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
R56	0757-0446	3		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
R57	0698-4002	9		RESISTOR 5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5001-F
R58	0757-0437	2		RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4751-F
R59	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
R60	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
RN1	1810-0279	5	3	NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
RN2	1810-0279	5		NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
RN3	1810-0282	0	2	NETWORK-RES 10-SIP220.0K OHM X 9	01121	210A224
RN4	1810-0282	0		NETWORK-RES 10-SIP220.0K OHM X 9	01121	210A224
RN5	1810-0269	3	2	NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0269
RN6	1810-0269	3		NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0269
RN7	1810-0279	5		NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
S1	3101-2723	7	1	SWITCH P-B SPST	28480	3101-2723
S2	3101-2722	6	1	SWITCH SLIDE	28480	3101-2722
S3	3101-1973	7	1	SWITCH-SL 7-1A DIP-SLIDE-ASSY .1A 50VDC	28480	3101-1973
TP1-TP10	1251-0600	0	10	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
U1	1820-2549	7	1	IC-8291A P HPIB	28480	1820-2549
U2	1820-2485	0	1	IC RCVR TTL LS BUS OCTL	01295	SN75160N
U3	1820-1112	8	5	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
U4	1820-2493	8	1	IC RCVR TTL LS BUS OCTL	01295	SN75161N
U5	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
U6	1820-1438	1	4	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
U7	1820-1438	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
U8	1820-1838	9	5	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
U9	T-33021	1	1	IC DRVR TTL QUAD IC-2069D	28480	T-33021
U10	1820-3361	3	1	IC-PROGRAMMABLE INTERVAL TIMER,DC-2MHZ	28480	1820-3361
U11	1820-2813	8	1	IC-MM58167	28480	1820-2813
U12	1818-3220	8	1	IC NMOS 4096 (4K) EAROM 450-NS 3-S	28480	1818-3220
U13	1820-1438	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
U14	1820-1207	2	2	IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
U15	1820-1438	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
U16	1820-3432	9	1	IC GATE-ARY CMOS	28480	1820-3432
U17	1826-0412	1	1	IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
U18	1820-2075	4	2	IC MISC TTL LS	01295	SN74LS245N
U19	1820-3663	8	1	IC-P8279-5	28480	1820-3663
U20	1820-0471	0	1	IC INV TTL HEX 1-INP	01295	SN7406N

Table 6-5. Parts List, Main PCA (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
U21	1818-3022	8	4	IC CMOS 16384 (16K) STAT RAM 200-NS	28480	1818-3022
U22	1818-3022	8		IC CMOS 16384 (16K) STAT RAM 200-NS	28480	1818-3022
U23	1818-3022	8		IC CMOS 16384 (16K) STAT RAM 200-NS	28480	1818-3022
U24	1818-3022	8		IC CMOS 16384 (16K) STAT RAM 200-NS	28480	1818-3022
U25	07090-18001	6	1	IC ROM 07-24-84 REV E	28480	07090-18001
U26	07090-18002	7	1	IC ROM 07-24-84 REV E	28480	07090-18002
U27	1820-1216	3	2	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
U28	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
U29	1820-1207	2		IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
U30	1820-1208	3	5	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
U31	1820-1917	1	2	IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS240N
U32	1820-0511	9	1	IC GATE TTL AND QUAD 2-INP	01295	SN7408N
U33	1820-1281	2	2	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS139N
U34	1820-1430	3	1	IC CNTR TTL LS BIN SYNCHRO POS-EDGE-TRIG	01295	SN74LS161AN
U35	1820-1197	9	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
U36	1820-3433	0	1	IC GATE-ARY CMOS	28480	1820-3433
U37	1820-2075	4		IC MISC TTL LS	01295	SN74LS245N
U38	1820-2624	9	1	IC-MPU; CLK FREQ=2MHZ, ENHANCED 6800	28480	1820-2624
U39	1820-2024	3	3	IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
U40	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
U41	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
U42	1820-1199	1	3	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
U43	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
U44	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
U45	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
U46	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
U47	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
U48	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
U49	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
U50	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
U51	1826-1105	1	1	D/A 10-BIT 24-PLASTIC BPLR	28480	1826-1105
U52	1826-0550	8	1	IC CONV 8-B-D/A 16-DIP-P PKG	07263	UA08B1EPC
U53	1820-1917	1		IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS240N
U54	1820-1203	8	1	IC GATE TTL LS AND TPL 3-INP	01295	SN74LS11N
U55	1820-1281	2		IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS139N
U56	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
U57	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
U58	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
U59	07090-18003	8	1	IC ROM 07-24-84 REV E	28480	07090-18003
U60	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
U61	1820-1204	9	2	IC GATE TTL LS NAND DUAL 4-INP	01295	SN74LS20N
U62	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
U63	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
U64	1820-1433	6	1	IC SHF-RGTR TTL LS R-S SERIAL-IN PRL-OUT	01295	SN74LS164N
U65	1820-1204	9		IC GATE TTL LS NAND DUAL 4-INP	01295	SN74LS20N
U66	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
U67	1820-1202	7	1	IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
U68	1826-0139	9	1	IC OP AMP GP DUAL 8-DIP-P PKG	3L505	CA1458G
VR1	1902-0555	5	4	DIODE-ZNR 13V 5% PD=1W IR=5UA	28480	1902-0555
VR2	1902-0555	5		DIODE-ZNR 13V 5% PD=1W IR=5UA	28480	1902-0555
VR3	1902-0555	5		DIODE-ZNR 13V 5% PD=1W IR=5UA	28480	1902-0555
VR4	1902-0555	5		DIODE-ZNR 13V 5% PD=1W IR=5UA	28480	1902-0555
VR5	0837-0283	6	2	TRANS, SUPP	28480	0837-0283
VR6	0837-0283	6		TRANS, SUPP	28480	0837-0283
XBT1	1400-1249	2	1	HOLDER-BAT FOR PENCELL CELLS AL	28480	1400-1249
XU12	1200-0541	1	1	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
XU25	1200-0567	1	3	SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
XU26	1200-0567	1		SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
XU38	1200-0654	7	1	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
XU39	1200-0567	1		SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
Y1	0410-1518	0	1	XTPL	28480	0410-1518
Y2	1813-0188	1	1	XTAL-CLOCK-OSCILLATOR 8-MHZ 0.01% TTL	28480	1813-0188

Table 6-6. Parts List, Power Supply PCA

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7	07090-60100	5	1	PCA-POWER SUPPLY	28480	07090-60100
C1	0160-4832	4	2	CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
C2	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
C3	0160-2347	2	1	CAPACITOR-FXD 1UF +-10% 200VDC MET-POLYE	28480	0160-2347
C4	0180-3453	5	1	CAP 16000UF	28480	0180-3453
C5	0160-0165	8	1	CAPACITOR-FXD .056UF +-10% 200VDC POLYE	28480	0160-0165
C6	0160-0194	3	1	CAPACITOR-FXD .015UF +-10% 200VDC POLYE	28480	0160 0194
C7	0180-3436	4	1	CAPACITOR-FXD 2600UF +-10% 5VDC	28480	0180-3436
C8	0160-4441	1	1	CAPACITOR-FXD .47UF +-10% 50VDC CER	28480	0160-4441
C9	0180-3077	9	1	CAPACITOR-FXD 680UF+100-10% 50VDC AL	28480	0180-3077
C10	0160-2672	6	1	CAPACITOR-FXD .047UF +-5% 80VDC POLYE	28480	0160-2672
C11	0180-1735	2	2	CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
C12	0160-4835	7	2	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
C13	0180-0291	3	1	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
C14	0180-0059	1	2	CAPACITOR-FXD 10UF+75-10% 25VDC AL	56289	30D106G025DB2
C15	0160-4830	2	2	CAPACITOR-FXD 2000PF +-10% 50VDC CER	28480	0160-4830
C16	0180-3437	5	1	CAP 600UF 12V	28480	0180-3437
C17	0180-0059	1		CAPACITOR-FXD 10UF+75-10% 25VDC AL	56289	30D106G025BB2
C18	0180-1735	2		CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
C19	0180-2866	2	1	CAPACITOR-FXD 22UF+100-10% 50VDC AL	28480	0180-2866
C20	0180-0197	8	1	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
C21	0160-0127	2	2	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
C22	0160-4830	2		CAPACITOR-FXD 2000PF +-10% 100VDC CER	28480	0160-4830
C23	0160-5229	5	1	CAPACITOR-FXD .33UF +-10% 50VDC CER	28480	0160-5229
C24	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
C25	0160-2212	0	1	CAPACITOR-FXD 560PF +-5% 300VDC MICA	28480	0160-2212
CR1	1906-0053	6	1	DIODE-FW BRDG 100V 5A	28480	1906-0053
CR2	1901-0704	4	2	DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
CR3	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
CR4	1901-0987	5	1	DIODE-PWR RECT 100V 8A	28480	1901-0987
CR5	1901-0450	7	1	DIODE-SWITCHING 50V 100MA 10NS DO-7	28480	1901-0450
E1	1205-0525	1	1	HEAT SINK	28480	1205-0525
E2	07090-20085	1	1	HEAT SINK	28480	07090-20085
E3-E6	0340-1005	9	4	INSULATOR-XSTR POLYI	28480	0340-1005
E7	0340-0150	3	4	INSULATOR-FLG BSHG NYLON	28480	0340-0150
E8	0340-0150	3		INSULATOR-FLG-BSHG NYLON	28480	0340-0150
E9	0340-0150	3		INSULATOR-FLG-BSHG NYLON	28480	0340-0150
E10	0340-0150	3		INSULATOR-FLG-BSHG NYLON	28480	0340-0150
E11	1205-0570	6	1	HEAT-SINK-XSTR	28480	1205-0570
E12	1200-0043	8	2	INSULATOR-XSTR ALUMINUM	28480	1200-0043
E13	1200-0043	8		INSULATOR-XSTR ALUMINUM	28480	1200-0043
F1	2110-0699	0	1	FUSE-SUBMINIATURE 5A 125V NTD .28X.0955	28480	2110-0699
F2	2110-0684	3	1	FUSE 2A 125V NTD .3X.103 UL	28480	2110-0684
F3	2110-0683	2	2	FUSE .75A 125V NTD .3X.103 UL	28480	2110-0683
F4	2110-0683	2		FUSE .75A 125V NTD .3X.103 UL	28480	2110-0683
F5	2110-0674	1	3	FUSE 1A 250V	28480	2110-0674
F6	2110-0713	9	2	FUSE 5A 125V .281X.093	28480	2110-0713
F7	2110-0674	1		FUSE 1A 250V	28480	2110-0674
F8	2110-0713	9		FUSE 5A 125V .281X.093	28480	2110-0713
F9	2110-0674	1		FUSE 1A 250V	28480	2110-0674
H1	1251-5595	2	2	POLARIZING KEY-POST CONN	28480	1251-5595
H2	1251-5595	2		POLARIZING KEY-POST CONN	28480	1251-5595
H3	0515-1040	3	4	SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	28480	0515-1040
H4	0515-1040	3		SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	28480	0515-1040
H5	0515-1040	3		SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	28480	0515-1040
H6	0515-1040	3		SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	28480	0515-1040
H7	0535-0043	6	5	NUT-HEX W/LKWR M4 X 0.7 3.2MM-THK	28480	0535-0043
H8	0535-0043	6		NUT-HEX W/LKWR M4 X 0.7 3.2MM-THK	28480	0535-0043
H9	0535-0043	6		NUT-HEX W/LKWR M4 X 0.7 3.2MM-THK	28480	0535-0043
H10	0535-0043	6		NUT-HEX W/LKWR M4 X 0.7 3.2MM-THK	28480	0535-0043
H11	0180-1969	4	1	CLAMP-CAP 2-DIA STL	56289	4586-48
H12				NOT ASSIGNED		
H13	0515-0352	8	5	SCREW-MACHINE ASSEMPLY M3 X 0.5 12MM-LG	00000	ORDER BY DESCRIPTION
H14	0535-0043	6		NUT-HEX W/LKWR M4 X 0.7 3.2MM-THK	28480	0535-0043
H15	0624-0341	6	2	SCREW-TPG 6-32 .625-IN-LG B2 DEG	00000	ORDER BY DESCRIPTION
H16	0624-0341	6		SCREW-TPG 6-32 .625-IN-LG B2 DEG	00000	ORDER BY DESCRIPTION
H17	0380-0661	5	2	SPACER-RVT-ON .125-IN-LG .152-IN-ID	00000	ORDER BY DESCRIPTION
H18	0380-0661	5		SPACER-RVT-ON .125-IN-LG .152-IN-ID	00000	ORDER BY DESCRIPTION
H19-H22	0515-0912	6	4	SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0912

Table 6-6. Parts List, Power Supply PCA (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
H23-						
H26	3050-1021	7	4	WASHER-SHLDR NO.4 .116-IN-ID .215-IN-OD	28480	3050-1021
H27-						
H30	0515-0352	8		SCREW-MACHINE ASSEMPLY M3 X 0.5 12MM-LG	00000	ORDER BY DESCRIPTION
H31-						
H34	0535-0031	2	4	NUT-HEX W/LKWR M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
H35	07090-20085	1		STDOFF SLDR IN	28480	07090-20085
J1	1251-3192	1	1	CONNECTOR 3-PIN M POST TYPE	28480	1251-3192
J2	1251-8828	0	1	40 POSITION CONN	28480	1251-8828
J3	1251-8940	7	1	CONN-POST TYPE .156-PIN-SPCG 6-CONT	28480	1251-8940
J4	1251-6890	2	4	CONNECTOR-11 PIN MULTIPLY	28480	1251-6890
J5	1251-6890	2		CONNECTOR-11 PIN MULTIPLY	28480	1251-6890
J6	1251-6890	2		CONNECTOR-11 PIN MULTIPLY	28480	1251-6890
J7	1251-6890	2		CONNECTOR-11 PIN MULTIPLY	28480	1251-6890
J8	1251-4780	5	1	CONNECTOR 2-PIN M UTILITY	28480	1251-4780
J9	1251-7626	4	3	CONN-POST TYPE .100-PIN-SPCG 20-CONT	28480	1251-7626
J10	1251-7626	4		CONN-POST TYPE .100-PIN-SPCG 20-CONT	28480	1251-7626
J11	1251-7626	4		CONN-POST TYPE .100-PIN-SPCG 20-CONT	28480	1251-7626
L1	9100-1788	6	6	CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
L2	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
L3	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
L4	9100-1788	6	1	CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
L5	9140-0903	9	1	INDUCTOR 87.5 MH	28480	9140-0903
L6	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
L7	9100-1788	6		CHOKE-WIDE BAND ZMAX=680 OHM@ 180 MHZ	02114	VK200 20/48
Q1	1855-0554	3	1	TSTR F.E. J305	28480	1855-0554
Q2	1804-0231	4	1	THYRISTOR-SCR TO-220AB VRRM=100	3L585	S2800A
Q3	1854-0467	5	1	TRANSISTOR NPN 2N4401 SI TO-92 PD=310MW	03508	2N4401
Q4	1854-0477	7	1	TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
Q5	1853-0271	7	1	TRANSISTOR PNP 2N4403 SI TO-92 PD=310MW	04713	2N4403
Q6	1855-0517	8	1	TRANSISTOR MOSFET P-CHAN E-MODE TO-220	28480	1855-0517
Q7	1854-0982	9	1	TRANSISTOR NPN SI DARL TO-3 PD=5W	28480	1854-0982
Q8	1853-0463	9	1	TRANSISTOR PNP SI TO-220AB PD=2W	04713	TIP105
Q9	1854-0840	8	1	TRANSISTOR NPN DARL TO-220AB PD=2W	01295	TIP100
Q10	1853-0543	6	1	TRANSISTOR PNP SI DARL TO-3 PD=5W	28480	1853-0543
R1	0698-3201	8	1	RESISTOR 80K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8002-F
R2	0698-4005	2	2	RESISTOR 12.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1252-F
R3	0698-4005	2		RESISTOR 12.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1252-F
R4	0757-0442	9	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R5	0698-8827	4	3	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
R6	0698-4391	9	1	RESISTOR 69.8 1% .125W F TC=0+-100	24546	C4-1/8-T0-69R8-F
R7	0757-0465	6	4	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
R8	0698-3245	0	1	RESISTOR 20.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8002-F
R9	0698-8827	4	1	RESISTOR 1M 1% .125W F TC=+-100	28480	0698-8827
R10	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
R11	0757-0180	2	1	RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
R12	0757-0446	3	2	RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
R13	0757-0444	1	1	RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
R14	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R15	0757-0440	7	2	RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
R16	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
R17	0757-0459	8	1	RESISTOR 56.2K 1% .125W F TC=0+-100	28480	0757-0459
R18	0757-0446	3		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
R19	0757-0443	0	1	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
R20	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
R21	0757-0283	6	4	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
R22	0686-2015	5	1	RESISTOR 200 5% .5W CC TC=0+529	01121	EB2015
R23	0698-4499	8	1	RESISTOR 54.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5492-F
R24	0699-0833	8	1	RESISTOR 100 2% .25W F TC=0+-100	28480	0699-0833
R25	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
R26	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
R27	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
R28	0698-6587	9	1	RESISTOR 37.4K 1% .125W F TC=0+-25	28480	0698-6587
R29	0698-8531	7	1	RESISTOR 90.9K .1% .125W F TC=0+-25	28480	0698-8531
R30	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R31	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
R32	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
R33	0757-0449	6	1	RESISTOR 20K 1% .125W F TC=0+-100	28480	0757-0449
R34	0603-3275	9	1	RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB2705
R35	0757-0465	6		RESISTOR 100k 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
R36	0698-3157	3	1	RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
R37	0698-3439	4	1	RESISTOR 17.8K 1% .125W F TC=0+-100	28480	0698-3439

Table 6-6. Parts List, Power Supply PCA (Continued)

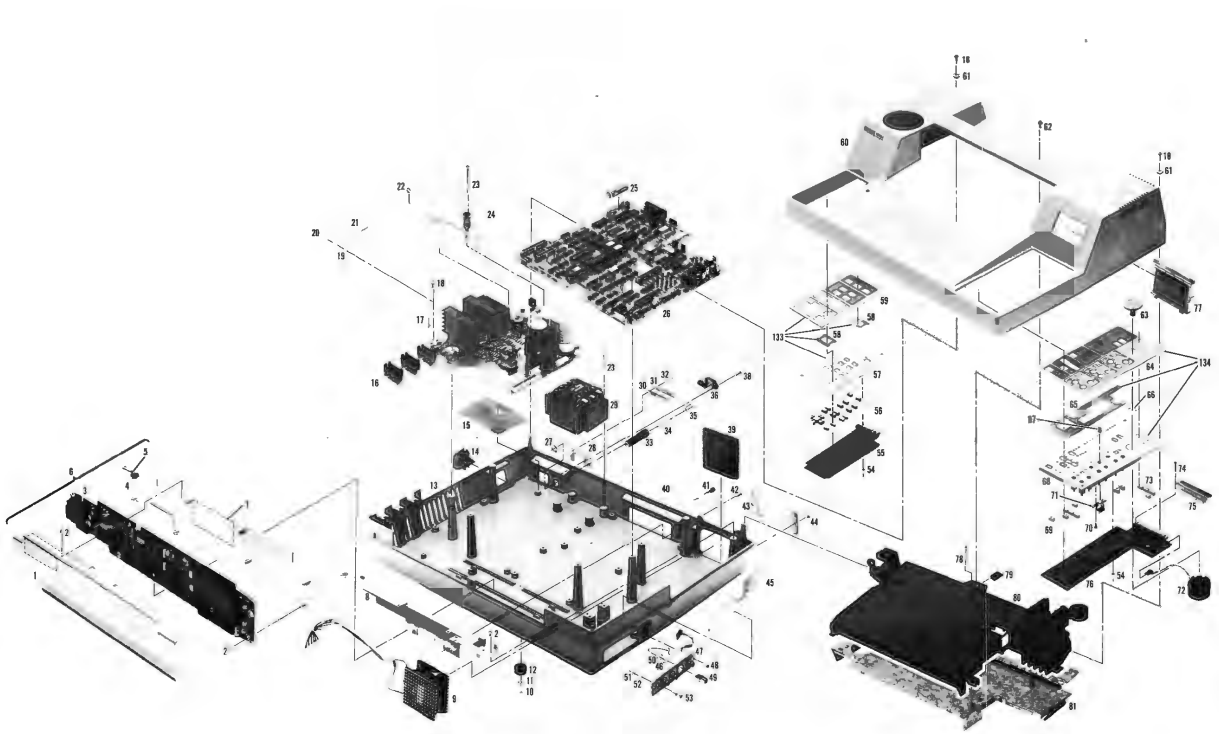
Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
TP1-TP10	1251-0600	0	10	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
U1	1826-1109	5	1	IC MISC 14-DIP-C PKG	28480	1826-1109
U2	1826-1106	2	1	IC V RGLTR-FXD-POS 14.85/15.15V TO-220	28480	1826-1106
U3	1826-0214	1	1	IC V RGLTR TO-220	04713	MC7915CT
U4	1826-0315	3	1	IC OP AMP GP QUAD 14-DIP-P PKG	27014	LM340N
U5	1826-0412	1	1	IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
U6	1826-1171	1	1	IC-MC1436	28480	1826-1171
U7	1826-1117	5	1	IC V RGLTR-SWG 16-DIP-P PKG	28480	1826-1117
VR1	1902-3092	1	1	DIODE-ZNR 4.99V 2% DO-35 PD=.4W	28480	1902-3092
VR2	1902-0244	9	2	DIODE-ZNR 30V 5% PD=1W IR=5UA	28480	1902-0244
VR3	1902-3105	7	1	DIODE-ZNR 5.62V 2% DO-35 PD=.4W	28480	1902-3105
VR4	1902-0965	1	2	DIODE-ZNR 20V 5% DO-35 PD=.4W TC=+.092%	28480	1902-0965
VR5	1902-0965	1		DIODE-ZNR 20V 5% DO-35 PD=.4W TC=+.092%	28480	1902-0965
VR6	1902-0244	9		DIODE-ZNR 30V 5% PD=1W IR=5UA	28480	1902-0244
XF5A	2110-0589	7	6	FUSEHOLDER-CLIP TYPE 10A 250 V	28480	2110-0589
XF5B	2110-0589	7		FUSEHOLDER-CLIP TYPE 10A 250 V	28480	2110-0589
XF7A	2110-0589	7		FUSEHOLDER-CLIP TYPE 10A 250 V	28480	2110-0589
XF7B	2110-0589	7		FUSEHOLDER-CLIP TYPE 10A 250 V	28480	2110-0589
XF9A	2110-0589	7		FUSEHOLDER-CLIP TYPE 10A 250 V	28480	2110-0589
XF9B	2110-0589	7		FUSEHOLDER-CLIP TYPE 10A 250 V	28480	2110-0589

Table 6-7. Parts List, Chassis Assembly

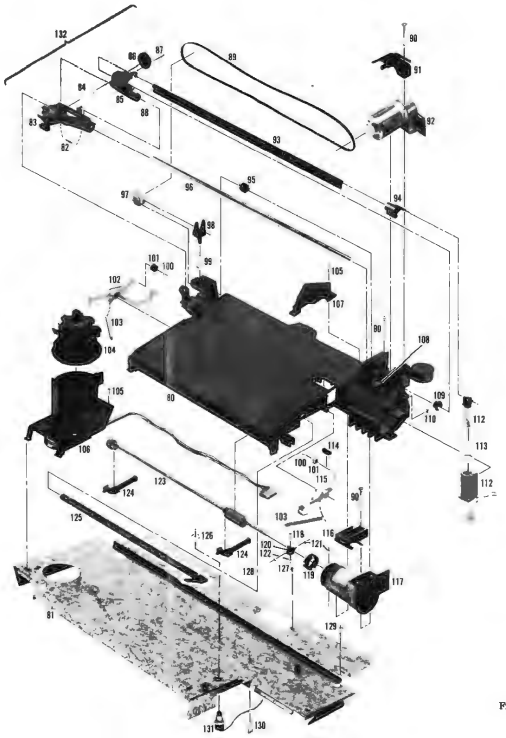
Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
1	07090-60035	5	3	SHIELD-FRONT, MKD.	28480	07090-60035
2	0515-1040	3	14	SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	28480	0515-1040
3	07090-60150	5	3	PCA-ANALOG INPUT	28480	07090-60150
4	07090-00076	8	3	SHIELD-REAR	28480	07090-00076
5	7121-4672	5	1	LABEL - NUMBER "1"	28480	7121-4672
	7121-4673	6	1	LABEL - NUMBER "2"	28480	7121-4673
	7121-4674	7	1	LABEL - NUMBER "3"	28480	7121-4674
6	07090-60075	3	3	ANALOG INPUT ASSEMBLY	28480	07090-60075
7	9320-5461	6	3	LABEL BLANK (CALIBRATION CONSTANTS)	28480	9320-5461
8	07090-00115	6	1	ELECTROSTATIC DISCHARGE SHIELD-REAR	28480	07090-00115
9	07090-60080	0	1	FAN & PRIMARY ASSEMBLY	28480	07090-60080
10	0515-1069	6	19	SCREW-MACHINE ASSEMBLY M4 X 0.7 10MM-LG	28480	0515-1069
11	3050-0139	6	21	WASHER-FL MTLC NO. 8 .172-IN-ID	28480	3050-0139
12	07470-40053	5	6	FOOT	28480	07470-40053
13	07090-60190	3	1	BOTTOM CASE	28480	07090-60190
14	3101-2721	5	1	SWITCH-RKR BASIC DPST 16A 250VAC Q CONN	28480	3101-2721
15	07090-00125	8	1	INSULATOR-PRIMARY	28480	07090-00125
16	07090-60100	5	1	POWER SUPPLY PCA	28480	07090-60100
17	07090-00156	5	1	SUPPORT BRACKET	28480	07090-00156
18	0515-1069	6		SCREW-MACHINE ASSEMBLY M4 X 0.7 10MM-LG	28480	0515-1069
19	2190-0199	3	1	WASHER-FL NM NO. 4 .125-IN-ID .312-IN-OD	28480	2190-0199
19A	0535-0019	6	12	NUT-HEX PLSTC-LKG M3 X 0.50 4MM-THK	00000	ORDER BY DESCRIPTION
20	0515-0064	9	1	SCREW-MACH M3 X 0.5 16MM-LG PAN-HD	28480	0515-0064
21	07090-20155	6	1	SUPPORT ROD	28480	07090-20155
22	0900-0017	9	1	O-RING .208-IN-ID .07-IN-XSECT-DIA NTRL	76680	AS-009 B46
23	0515-0964	8	5	SCREW-MACH M4 X 0.7 45MM-LG PAN-HD	28480	0515-0964
24	07090-60090	2	1	SHIELD-PRIMARY MKD	28480	07090-60090
25				BATTERY LITHIUM		
26	07090-60110	7	1	MAIN PCA	28480	07090-60110
27	2110-0569	3	1	FUSEHOLDER COMPONENT NUT; THREAD M12.7	28480	2110-0569
28	07090-00155	4	1	PANEL - A.C.	28480	07090-00155
29	9100-4398	0	1	TRANSFORMER	28480	9100-4398
30	07090-60210	8	1	TAG-LV DSPLY (100/120V)	28480	07090-60210
31	07090-60211	9	1	TAG-LV DSPLY (220/240V)	28480	07090-60211
32	0515-0169	3	2	SCREW-MACHINE ASSEMPLY M3 X 0.5 10MM-LG	00000	ORDER BY DESCRIPTION
33	2110-0610	5	1	FUSEHOLDER-EXTR POST 16A 250 V	28480	2110-0610
34	2110-0380	6	1	FUSE 2.5A 250V TD 1.25X.25	28480	2110-0380
	2110-0305	5	1	FUSE 1.25A 250V TD 1.25X.25 UL	75915	3131.25
	2110-0472	7	1	FUSE 1.25A 250V IEC	28480	2110-0472
35	2110-0565	9	1	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
	2110-0567	1	1	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0567
36	07090-20015	7	1	LINE FILTER	28480	07090-20015
37				NOT ASSIGNED		
38	0515-0426	7	1	SCREW-MACH M3 X 0.5 10MM-LG	00000	ORDER BY DESCRIPTION
39	07090-00017	7	1	FILTER AIR	28480	07090-00017
40	07090-60072	0	1	PANEL HP-IB, MKD.	28480	07090-60072
41	1251-7828	8	2	STANDOFF-LOCK AMPHENOL 17 CONN	28480	1251-7828
42	0515-1069	6		SCREW-MACHINE ASSEMBLY M4 X 0.7 10MM-LG	28480	0515-1069
43	07090-60019	5	1	BEZEL FILTER	28480	07090-60019
44	0515-1040	3		SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	28480	0515-1040
45	07090-00025	7	1	ELECTROSTATIC DISCHARGE SHIELD-SIDE.	28480	07090-00025
46	0360-1190	5	4	TERMINAL-SLDR LUG PL-MTG FOR-#3/8-SCR	28480	0360-1190
47	07090-60073	1	1	PANEL - BNC	28480	07090-60073
48	0515-1069	6		SCREW-MACHINE ASSEMBLY M4 X 0.7 10MM-LG	28480	0515-1069
49	1250-0118	3	4	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0118
50	2950-0001	8	5	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
51	2950-0072	3	1	NUT-HEX-DBL-CHAM 1/4-32-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
52	2190-0740	0	1	WASHER-LK HLCL 1/4 IN .255-IN-ID	28480	2190-0740
53	1510-0038	8	1	BINDING POST ASSY SGL THD-STUD	28480	1510-0038
54	0535-0019	6		NUT-HEX PLSTC-LKG M3 X 0.50 4MM-THK	00000	ORDER BY DESCRIPTION
55	07090-60130	1	1	PCA-FRONT PNL, LH	28480	07090-60130
56	07090-40120	7	3	KEYBOARD, LH	28480	07090-40120
57	07090-40115	0	1	SUBPANEL, LH	28480	07090-40115
58	07090-00100	9	2	UNDERLAY - PANEL, LH	28480	07090-00100
59	07090-60070	8	1	FRONT PANEL, LH-MKD	28480	07090-60070
60	07090-60065	1	1	TOP COVER	28480	07090-60065
61	07090-20020	4	2	WASHER-SHOULDER	28480	07090-20020
62	0515-0771	5	1	SCREW-MACHINE ASSEMBLY M4 X 0.7 12M-LG	28480	0515-0771
63	5041-3466	1	1	KNOB	28480	5041-3466
64	07090-60071	9	1	FRONT PANEL, RH-MKD	28480	07090-60071
65	07090-00101	0	1	UNDERLAY - PNL, RH	28480	07090-00101
66	2950-0043	8	1	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
67	0370-0603	4	3	PUSHBUTTON 0.230 IN SQ; 0.425 IN HGT	28480	0370-0603
68	07090-40116	1	1	SUBPANEL - RH	28480	07090-40116

Table 6-7. Parts List, Chassis Assembly (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
69	07090-40120	7		KEYBOARD	28480	07090-40120
70	0624-0629	3	4	SCREW-TPG 3-24 .25-IN-LG PAN-HD-POZI STL	28480	0624-0629
71	3101-2725	9	3	SWITCH-PB SPST-NO ALTNG .125A 115VAC	28480	3101-2725
72	07090-60125	4	1	ROTARY PULSE GENERATOR, ASSY	28480	07090-60125
73	07090-40120	7		KEYBOARD	28480	07090-40120
74	0624-0591	8	4	SCREW-TPG 3-24 .5-IN-LG PAN-HD-POZI STL	28480	0624-0591
75	07090-00220	4	1	BRACKET-L.C.D.	28480	07090-00220
76	07090-60120	9	1	PCA-FRONT PNL, RH	28480	07090-60120
77	07090-60085	5	1	L.C.D. HOLDER	28480	07090-60085
78	0515-0751	1	1	SCREW-MACH M4 X 0.7 20MM-LG PAN-HD	28480	0515-0751
79	5090-1471	7	1	NUT-SHEET METAL	28480	5090-1471
80	5040-8667	2	1	CHASSIS	28480	5040-8667
81	07090-00065	5	1	BASE-CHASSIS MOUNTING	28480	07090-00065
82	1460-2027	2	1	SPRING-EXT 2.7-MM-OD SST PSVT	28480	1460-2027
83	5040-0651	4	1	PEN HOLDER	28480	5040-8651
84	1460-2023	8	1	SPRING-CPRSN .334-IN-OD 1.01-IN-OA-LG	28480	1460-2023
	1460-2029	4	1	SPRING-CPRSN .334-IN-OD 1.18-IN-OA-LG	28480	1460-2029
	1460-2030	7	1	SPRING-CPRSN .334-IN-OD 1.29-IN-OA-LG	28480	1460-2030
	1460-2043	2	2	SPRING-CPRSN .585-IN-OD 1-IN-OA-LG	28480	1460-2043
85	5040-8650	3	1	PEN CARRIAGE	28480	5040-8650
86	07475-40005	2	1	DAMPER-SILICONE RUBBER	28480	07475-40005
87	0515-0832	9	1	SCREW-SET M2.5 X 0.45 10MM-LG OVAL-PT	28480	0515-0832
88	1460-2024	9	1	SPRING-CPRSN .425-IN-OD .36-IN-OA-LG SST	28480	1460-2024
89	1500-0649	6	1	BELT-GEAR .188-WD 392-T .082-P	28480	1500-0649
90	0515-0296	9	3	SCREW-MACH M4 X 0.7 35MM-LG PAN-HD	28480	0515-0296
91	07470-40049	9	2	MOTOR CLAMP	28480	07470-40049
92	07470-60049	1	1	PEN DRIVE MOTOR ASSEMBLY	28480	07470-60049
93	5020-6302	6	1	PEN LIFT BAR	28480	5020-6302
94	07470-40016	0	1	PEN LIFT CAP	28480	07470-40016
95	5040-8672	9	1	END CAP	28480	5040-8672
96	5020-6301	5	1	SLIDER ROD	28480	5020-6301
97	5020-6306	0	1	IDLER-PULLEY	28480	5020-6306
98	07470-40027	3	1	BELT TENSIONER	28480	07470-40027
99	1460-1940	6	1	SPRING-CPRSN .36-IN-OD .875-IN-OA-LG	28480	1460-1940
100	0510-0015	0	2	RETAINER-RING E-R EXT .125-IN-DIA STL	28480	0510-0015
101	07550-20127	9	2	PINCH WHEEL	28480	07550-20127
102	5040-8666	1	1	ARM-PINCH ROLLER (LEFT)	28480	5040-8666
103	1460-2033	0	2	SPRING-EXT .187-IN-OD SST PSVT	28480	1460-2033
104	5061-5000	1	1	PEN CAROUSEL ASSEMBLY	28480	5061-5000
105	0624-0591	8		SCREW-TPG 3-24 .5-IN-LG PAN-HD-POZI STL	28480	0624-0591
106	07475-60175	9	1	PEN CAROUSEL HOUSING ASSY	28480	07475-60175
107	5040-8668	3	1	PEN DROP SHIELD	28480	5040-8668
108	07470-40037	5	1	PEN LIFT BUMPER	28480	07470-40037
109	5040-8673	0	1	BUSHING	28480	5040-8673
110	0515-0733	9	1	SCREW	28480	0515-0733
111				NOT ASSIGNED		
112	07090-60030	0	1	SOLENOID	28480	07090-60030
113	1460-2043	2		SPRING-CPRSN .585-IN-OD 1-IN-OA-LG	28480	1460-2043
114	5040-8665	0	1	SPACER	28480	5040-8665
115	07090-40135	4	1	ARM PINCHWHEEL (RIGHT)	28480	07090-40135
116	07470-40049	9		MOTOR CLAMP	28480	07470-40049
117	07090-60001	5	1	PAPER DRIVE MOTOR	28480	07090-60001
118	0515-0615	6	1	SCREW-MACH M2 X 0.4 10MM-LG PAN-HD	28480	0515-0615
119	5040-8674	1	1	RING-COUPLER	28480	5040-8674
120	07470-40005	7	1	COUPLER-GRIT WHEEL SHAFT	28480	07470-40005
121	0905-0996	3	4	O-RING .094-IN-ID .05-IN-XSECT-DIA SIL	28480	0905-0996
122	0535-0018	5	1	NUT-HEX DBL-CHAM M2 X 0.4 1.6MM-THK	00000	ORDER BY DESCRIPTION
123	5061-5074	3	1	GRIT WHEEL SHAFT ASSEMBLY	28480	5061-5074
124	5040-8669	4	2	CLAMP-BEARING	28480	5040-8669
125	5040-8663	8	1	HANDLE-PINCHROLLER	28480	5040-8663
126	2950-0001	0		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
127	0515-1040	3		SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG	28480	0515-1040
128	07090-00119	0	1	COVER	28480	07090-00119
129	1410-0746	3	1	BEARING-SLV .376-IN-ID .469-IN-OD	28480	1410-0746
130	1400-1220	9	4	CLAMP-CABLE PLSTC	28480	1400-1220
131	3101-2724	8	1	SWITCH-PB SPST-NC MOM 1A 115VAC BLK BTN	28480	3101-2724
132	5061-5075	4	1	PEN HOLDER ASSEMBLY	28480	5061-5075
133	07090-60204	0	1	SUB PANEL ASSEMBLY (LH)	28480	07090-60204
134	07090-60205	1	1	SUB PANEL ASSEMBLY (RH)	28480	07090-60205



7090-D-01-1



7090-D-30-1

Figure 6-2. HP 7090 Exploded View

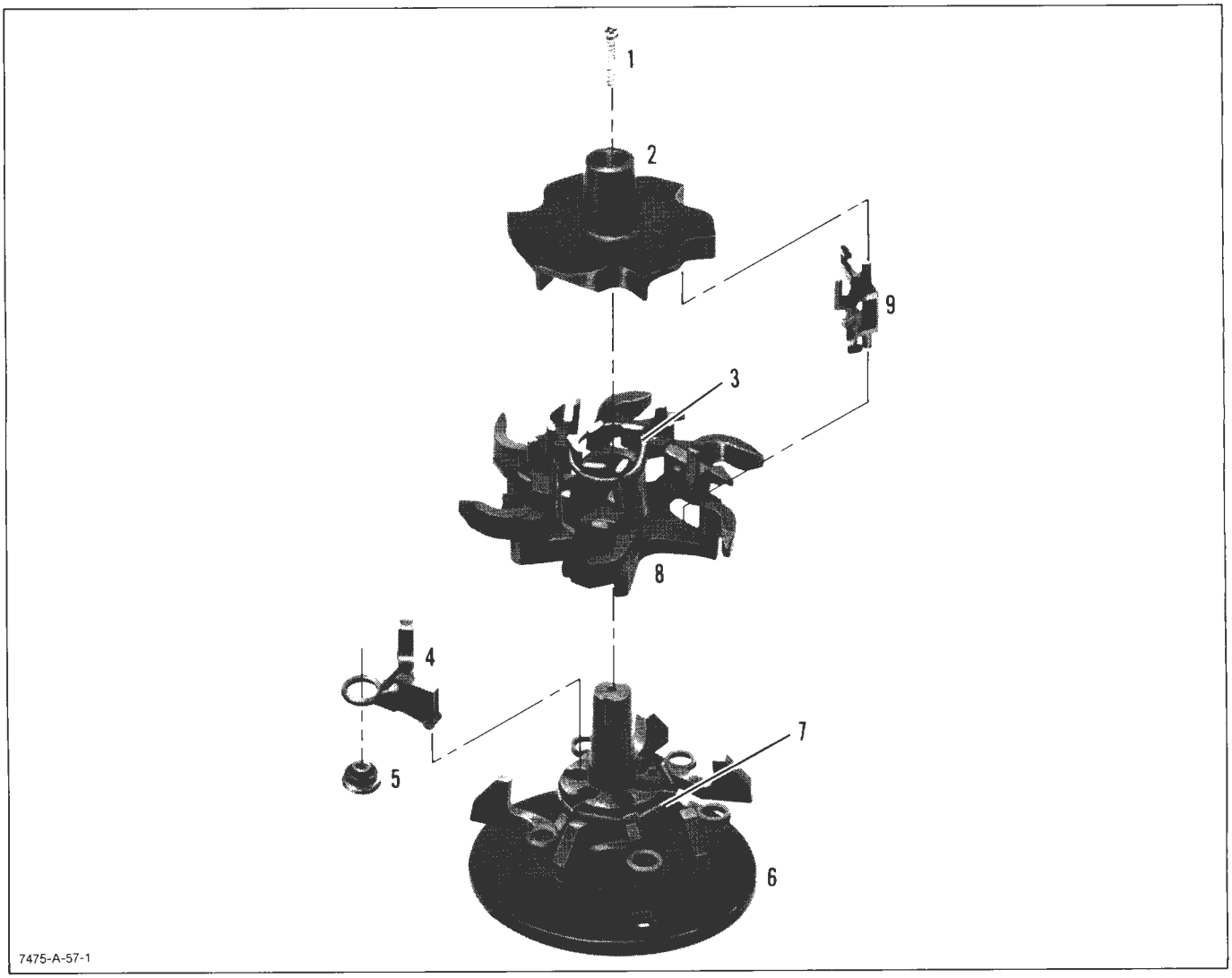


Figure 6-3. Pen Carousel Parts

Table 6-8. Parts List, Pen Carousel

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
1	0624-0591	8	1	SCREW-SELF TAPPING	28480	0624-0591
2	5040-8661	6	1	PLATE-CAROUSEL TOP	28480	5040-8661
3	1460-2034	1	1	SPRING-PAWL	28480	1460-2034
4	5040-8658	1	6	CAPPER-PEN	28480	5040-8658
5	07475-40002	9	6	BOOT-PEN	28480	07475-40002
6	5040-8657	0	1	HUB-CAROUSEL	28480	5040-8657
7	1460-2028	3	1	SPRING-CAPPER	28480	1460-2028
8	5040-8659	2	1	SPIDER-CAROUSEL	28480	5040-8659
9	5040-8660	5	6	PAWL-CAROUSEL	28480	5040-8660

Table 6-9. Code List of Manufacturers

MFR. NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
00000	Any Satisfactory Supplier		
0003J	Nippon Electric Company		
00779	Amp, Inc.	Harrisburg, PA	17105
00853	Sangamo Electric Company, South Carolina Div.	Pickens, SC	29671
01121	Allen-Bradley Company	Milwaukee, WI	53204
01295	Texas Instruments, Inc., Semiconductor Component Div.	Dallas, TX	75222
0192B	RCA Corporation, Solid State Div.	Somerville, NJ	08876
02111	Spectrol Electronics Corp.	City of Industry, CA	91745
02114	Ferroxcube Corporation	Saugerties, NY	12477
03508	GE Company, Semiconductor Prod. Dept.	Syracuse, NY	13201
03888	KDI Pyrofilm Corporation	Whippany, NJ	07981
04713	Motorola Semiconductor Products	Phoenix, AZ	85062
07263	Fairchild Semiconductor Div.	Mountain View, CA	94042
11815	Cherry Rivet Div., Townsend Company	Santa Ana, CA	92707
13606	Sprague Electric Company, Semiconductor Div.	Concord, NH	03301
14936	General Instruments Corp., Semiconductor Prod. GP	Hicksville, NY	11802
19701	Mepco/Electra Corporation	Mineral Wells, TX	76067
24355	Analog Devices, Inc.	Norwood, MA	02062
24546	Corning Glass Works (Bradford)	Bradford, PA	16701
24655	General Radio Co.	Concord, MA	01742
27014	National Semiconductor Corporation	Santa Clara, CA	95051
27167	Corning Glass Works (Wilmington)	Wilmington, NC	28401
28480	Hewlett-Packard Company, Corporate Headquarters	Palo Alto, CA	94304
31471	American Micro Systems, Inc.	Santa Clara, CA	95051
32293	Intersil, Inc.	Cupertino, CA	95014
32694	Optron, Inc.	Carrollton, TX	75006
34649	Intel Corporation	Mountain View, CA	95051
56289	Sprague Electric Company	North Adams, MA	01247
72136	Electro Motive Corporation, Sub. IEC	Willimantic, CT	06226
75042	TRW, Inc., Philadelphia Div.	Philadelphia, PA	19108
75915	Littlefuse, Inc.	Des Plaines, IL	60016
83259	Parker Seal Co., Div. Parker-Hannifin	Culver City, CA	90231
84411	TRW, Capacitor Div.	Ogallala, NE	69153
86928	Seastrom Mfg. Co.	Glendale, CA	91201
91637	Dale Electronics, Inc.	Columbus, NE	68601

Table 6-10. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

A ..... assembly	E ..... miscellaneous electrical part	P ..... electrical connector (movable portion); plug	V ..... electron tube
AT ..... attenuator; isolator; termination	F ..... fuse	Q ..... transistor; SCR; triode thyristor	VR ..... voltage regulator; breakdown diode
B ..... fan; motor	FL ..... filter	R ..... resistor	W ..... cable; transmission path; wire
BT ..... battery	H ..... hardware	RT ..... thermistor	X ..... socket
C ..... capacitor	HY ..... circulator	S ..... switch	Y ..... crystal unit (piezo-electric or quartz)
CP ..... coupler	J ..... electrical connector (stationary portion) jack	T ..... transformer	Z ..... tuned cavity; tuned circuit
CR ..... diode; diode thyristor; varactor	K ..... relay	TB ..... terminal board	
DC ..... directional coupler	L ..... coil; inductor	TC ..... thermocouple	
DL ..... delay line	M ..... meter	TP ..... test point	
DS ..... annunciator; signaling device (audible or visual); lamp; LED	MP ..... miscellaneous mechanical part	U ..... integrated circuit; microcircuit	

ABBREVIATIONS

A ..... ampere	COEF ..... coefficient	ELECT ..... electrolytic	kg ..... kilogram
ac ..... alternating current	COM ..... common	ENCAP ..... encapsulated	kHz ..... kilohertz
ACCESS ..... accessory	COMP ..... composition	EXT ..... external	kΩ ..... kilohm
ADJ ..... adjustment	COMPL ..... complete	F ..... farad	kV ..... kilovolt
A/D ..... analog-to-digital	CONN ..... connector	FET ..... field-effect transistor	lb ..... pound
AF ..... audio frequency	CP ..... cadmium plate	F/F ..... flip flop	LC ..... inductance-capacitance
AFC ..... automatic frequency control	CRT ..... cathode-ray tube	FH ..... flat head	LED ..... light-emitting diode
AGC ..... automatic gain control	CTL ..... complementary transistor logic	FIL H ..... fillister head	LF ..... low frequency
AL ..... aluminum	CW ..... continuous wave	FM ..... frequency modulation	LG ..... long
ALC ..... automatic level control	cw ..... clockwise	FP ..... front panel	LH ..... left hand
AM ..... amplitude modulation	cm ..... centimetre	FREQ ..... frequency	LIM ..... limit
AMPL ..... amplifier	D/A ..... digital-to-analog	FXD ..... fixed	LIN ..... linear taper (used in parts list)
APC ..... automatic phase control	dB ..... decibel	g ..... gram	lin ..... linear
ASSY ..... assembly	dBm ..... decibel referred to 1 mW	GE ..... germanium	LK WASH ..... lock washer
AUX ..... auxiliary	dc ..... direct current	GHz ..... gigahertz	LO ..... low; local oscillator
avg ..... average	deg ..... degree (temperature interval) or difference	GL ..... glass	LOG ..... logarithmic taper (used in parts list)
AWG ..... American wire gauge	° ..... degree (plane angle)	GRD ..... ground(ed)	log ..... logarithm(ic)
BAL ..... balance	°C ..... degree Celsius (centigrade)	H ..... henry	LPF ..... low pass filter
BCD ..... binary coded decimal	°F ..... degree Fahrenheit	h ..... hour	LV ..... low voltage
BD ..... board	°K ..... degree Kelvin	HET ..... heterodyne	m ..... metre (distance)
BE CU ..... beryllium copper	DEPC ..... deposited carbon	HEX ..... hexagonal	mA ..... milliampere
BFO ..... beat frequency oscillator	DET ..... detector	HD ..... head	MAX ..... maximum
BH ..... binder head	diam ..... diameter	HDW ..... hardware	MΩ ..... megohm
BKDN ..... breakdown	DIA ..... diameter (used in parts list)	HF ..... high frequency	MEG ..... meg (10^6) (used in parts list)
BP ..... bandpass	DIFF AMPL ..... differential amplifier	HG ..... mercury	MET FLM ..... metal film
BPF ..... bandpass filter	div ..... division	HI ..... high	MET OX ..... metallic oxide
BRS ..... brass	DPDT ..... double-pole, double-throw	HP ..... Hewlett-Packard	MF ..... medium frequency; microfarad (used in parts list)
BWO ..... backward-wave oscillator	DR ..... drive	HPF ..... high pass filter	MFR ..... manufacturer
CAL ..... calibrate	DSB ..... double sideband	HR ..... hour (used in parts list)	mg ..... milligram
ccw ..... counter-clockwise	DTL ..... diode transistor logic	HV ..... high voltage	MHz ..... megahertz
CER ..... ceramic	DVM ..... digital voltmeter	Hz ..... Hertz	mH ..... millihenry
CHAN ..... channel	ECL ..... emitter coupled logic	IC ..... integrated circuit	mho ..... mho
cm ..... centimetre	EMF ..... electromotive force	ID ..... inside diameter	MIN ..... minimum
CMO ..... cabinet mount only	EDP ..... electronic data processing	IF ..... intermediate frequency	min ..... minute (time)
COAX ..... coaxial		IMPG ..... impregnated	' ..... minute (plane angle)
		in ..... inch	MINAT ..... miniature
		INCD ..... incandescent	mm ..... millimetre
		INCL ..... include(s)	MOD ..... modulator
		INP ..... input	
		INS ..... insulation	
		INT ..... internal	

NOTE

All abbreviations in the parts list will be in upper-case.

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Table 6-10. Reference Designations and Abbreviations (Continued)

MOM ..... momentary
MOS ..... metal-oxide semiconductor
ms ..... millisecond
MTG ..... mounting
MTR ..... meter (indicating device)
mV ..... millivolt
mVac ..... millivolt, ac
mVdc ..... millivolt, dc
mVpk ..... millivolt, peak
mVp-p ..... millivolt, peak-to-peak
mVrms ..... millivolt, rms
mW ..... milliwatt
MUX ..... multiplex
MY ..... mylar
μA ..... microampere
μF ..... microfarad
μH ..... microhenry
μmho ..... micromho
μs ..... microsecond
μV ..... microvolt
μVac ..... microvolt, ac
μVdc ..... microvolt, dc
μVpk ..... microvolt, peak
μVp-p ..... microvolt, peak-to-peak
μVrms ..... microvolt, rms
μW ..... microwatt
nA ..... nanoampere
NC ..... no connection
N/C ..... normally closed
NEG ..... negative
nF ..... nanofarad
NI PL ..... nickel plate
N/O ..... normally open
NOM ..... nominal
NORM ..... normal
NPN ..... negative-positive-negative
NPO ..... negative-positive zero (zero temperature coefficient)
NRFR ..... not recommended for field replacement
NSR ..... not separately replaceable
ns ..... nanosecond
nW ..... nanowatt
OBD ..... order by description
OD ..... outside diameter
OH ..... oval head
OP AMPL ..... operational amplifier
OPT ..... option
OSC ..... oscillator
OX ..... oxide
oz ..... ounce
Ω ..... ohm
P ..... peak (used in parts list)
PAM ..... pulse-amplitude modulation
PC ..... printed circuit
PCM ..... pulse-code-modulation; pulse-count modulation
PDM ..... pulse-duration modulation
pF ..... picofarad
PIV ..... peak inverse voltage
pk ..... peak
PNP ..... positive-negative-positive
P/O ..... part of
POLY ..... polystyrene
PORC ..... porcelain
POS ..... positive; position(s) (used in parts list)
POSN ..... position
POT ..... potentiometer
p-p ..... peak-to-peak
PP ..... peak-to-peak (used in parts list)
PPM ..... pulse-position modulation; parts per million
PREAMPL ..... preamplifier
PRF ..... pulse-repetition frequency
PRR ..... pulse repetition rate
ps ..... picosecond
PT ..... point
PTM ..... pulse-time modulation
PWN ..... pulse-width modulation
PWV ..... peak working voltage
RC ..... resistance-capacitance
RECT ..... rectifier
REF ..... reference
REG ..... regulated
REPL ..... replaceable
RF ..... radio frequency
RFI ..... radio frequency interference
RH ..... round head; right hand
RLC ..... resistance-inductance-capacitance
RMO ..... rack mount only
rms ..... root-mean-square
RND ..... round
ROM ..... read only memory
R & P ..... rack and panel
RWV ..... reverse working voltage
S ..... scattering parameter
s ..... second (time)
" ..... second (plane angle)
S-B ..... slow-blow (fuse) (used in parts list)
SCR ..... silicon controlled rectifier; screw
SE ..... selenium
SECT ..... sections
SEMICON ..... semiconductor
SHF ..... superhigh frequency
SI ..... silicon
SIL ..... silver
SL ..... slide
SNR ..... signal-to-noise ratio
SPDT ..... single-pole, double-throw
SPG ..... spring
SR ..... split ring
SPST ..... single-pole, single-throw
SSB ..... single sideband
SST ..... stainless steel
STL ..... steel
SQ ..... square
SWR ..... standing-wave ratio
SYNC ..... synchronize
T ..... timed (slow-blow fuse)
TA ..... tantalum
TC ..... temperature coefficient
TD ..... time delay
TERM ..... terminal
TFT ..... thin-film transistor
TGL ..... toggle
THD ..... thread
THRU ..... through
TI ..... titanium
TOL ..... tolerance
TRIM ..... trimmer
TSTR ..... transistor
TTL ..... transistor-transistor logic
U ..... micro (10^{-6}) (used in parts list)
UF ..... microfarad (used in parts list)
UHF ..... ultrahigh frequency
UNREG ..... unregulated
V ..... volt
VA ..... voltampere
Vac ..... volts, ac
VAR ..... variable
Vdc ..... volts, dc
VDCW ..... volts, dc, working (used in parts list)
Vpk ..... volts, peak
Vp-p ..... volts, peak-to-peak
Vrms ..... volts, rms
VTVM ..... vacuum-tube voltmeter
V(X) ..... volts, switched
W ..... watt
W/ ..... with
WIV ..... working inverse voltage
WW ..... wirewound
W/O ..... without
Z_o ..... characteristic impedance

NOTE

All abbreviations in the parts list will be in upper-case.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

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SECTION VII

MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section normally contains information for adapting this manual to instruments for which the content does not apply directly. Since this manual does apply directly to instruments having the serial number prefix listed on the title page, no change information is given here. Refer to "Instruments Covered by Manual" in Section I for additional important information about serial number coverage.

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SECTION VIII

SERVICE

8-1. INTRODUCTION

8-2. This section contains information needed for maintenance and repair of the HP 7090, including:

Circuit Description
Troubleshooting Information
Parts Removal and Replacement
Schematic Diagrams
Component Location Figures

8-3. SIMPLIFIED CIRCUIT DESCRIPTION

8-4. The HP Model 7090 uses microprocessor based logic to convert digital instructions or analog signals into a graphic plot. See Figure 8-1 for a simplified block diagram of the HP 7090. The microprocessor receives digital instructions from either an internal Read Only Memory (ROM) program or an external controller through the Hewlett-Packard Interface Bus (HP-IB). Instructions issued by the microprocessor to the Servo Gate Array (SGA), pen and paper drive motor systems, and pen down circuit produce the resultant plot.

8-5. Analog signals received by any of three analog input channels are preamplified, sampled, converted to digital data, and sent to the Front End Gate Array (FEGA). The converted analog signal can be plotted by the HP 7090 or stored in a 1×12K Random Access Memory (RAM) location. This stored signal can be viewed on an oscilloscope connected to the BNC side panel, plotted by the HP 7090, or sent to an external controller through the HP-IB. Data remains in RAM until new data is sent to the RAM location or power is removed from the system.

8-6. Front panel circuits are provided for manually entering analog measurement parameters which include: range, offset, trigger conditions and mode of operation as well as entry of X and Y position data, reset, pen control, and chart hold data. A Liquid Crystal Display (LCD) is provided for displaying set-up conditions and monitoring analog measurement parameters. An Electrically Erasable Programmable Read Only Memory (EEPROM) stores calibration and setup parameters for later recall. Connectors for remote control of pen up and down circuits and external trigger are provided on the BNC side panel.

8-7. POWER SUPPLIES

8-8. The Power Supply PCA converts the line input ac voltage into the necessary dc voltages to operate the HP 7090. The power supply also provides voltage to the dc power supplies located on each Input Channel PCA. Circuitry for the microprocessor RESET and POWER DETECT functions are also located on the Power Supply PCA.

8-9. FUNCTIONAL CIRCUIT DESCRIPTION

8-10. The following information describes the circuits that are shown on the Functional Block Diagram, Service Sheet 1 and the schematic diagrams on Service Sheets 2 through 8.

8-11. ANALOG INPUT ASSEMBLY

8-12. Three identical and interchangeable analog input assemblies consist of a printed circuit assembly (PCA) surrounded by a metal shield. The shield is connected to the Front Panel guard terminal to help protect the sensitive PCA from external electrical noise and common mode voltages. Optical isolators couple control information and output data to the Analog Input PCAs, and electrically isolate the input PCAs from the Main and Power Supply PCAs. This allows floating measurements of ± 200 Vdc (maximum). Each PCA has its own power supply which develops the $+5$ and ± 15 dc voltages used by the analog input circuitry. The supplies are driven by a 425Hz sine wave from the Power Supply PCA. There are no manual adjustments on the PCA. Range, offset, and other compensation adjustments are microprocessor controlled.

8-13. The analog input accepts voltages from ± 5 mV to ± 100 V full scale. An attenuator and several variable gain amplifiers scale this input voltage and combine it with the desired offset voltage. Two parallel sample and hold circuits monitor the scaled voltage and are alternately switched to the input of a 12-bit analog-to-digital converter (ADC). When an input voltage is applied the attenuation, gain, and offset are such that the ADC will see a maximum range of ± 10 volts, regardless of the offset voltage selected. The 12-bit ADC output represents a count value of between 0 and 4095. Since the input signal can be positive or negative, a zero volt input is represented by a count of 2048. A count of 74 represents a full scale negative input voltage. A full scale positive input voltage is represented by a count of 4022. This allows some margin in the operating range of the ADC and keeps internal offset and gain errors from causing an input to the ADC from exceeding the ADC's ± 10 volt range. The timing of each analog-to-digital (A/D) conversion is controlled by the microprocessor and depends on the total measurement time selected by the user. The 12-bits of serial data and a clock signal, also generated during the A/D conversion, are passed through optical isolators to the Front End Gate Array and into a data buffer.

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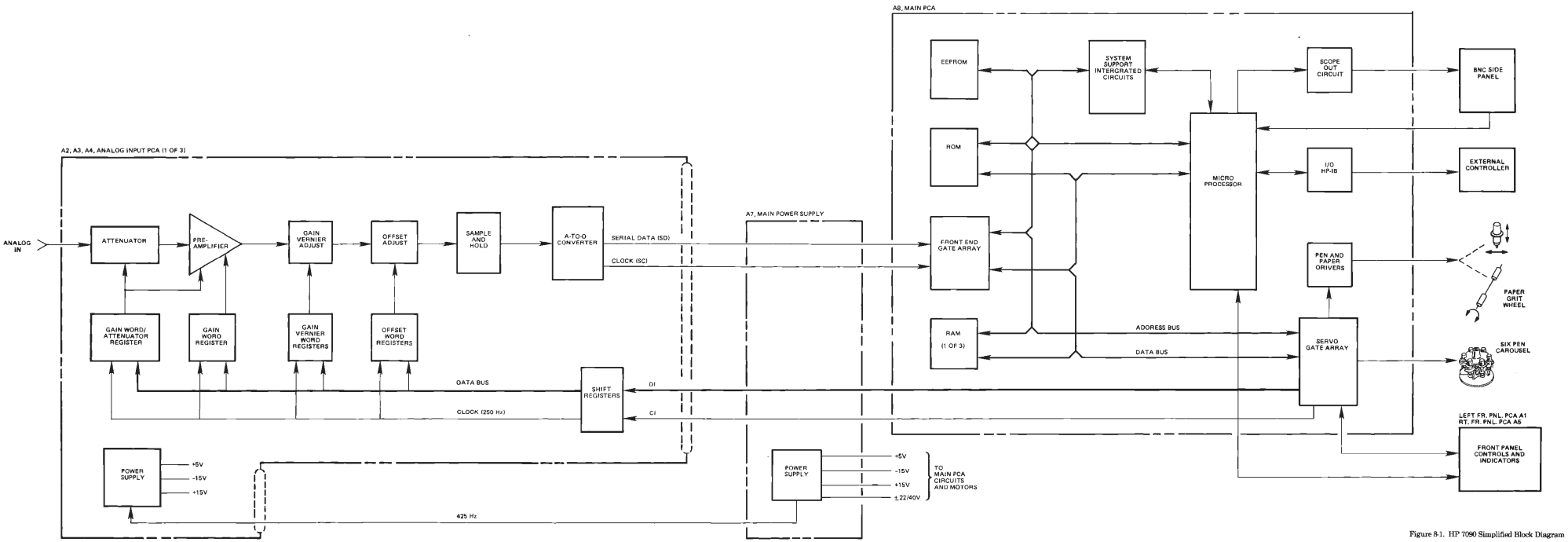

Figure 8-1. HP 7090 Simplified Block Diagram

8-14. ANALOG INPUT CIRCUITS

8-15. The following paragraphs contain a description of the analog channel circuits by function, This description refers to Figures 8-2 through 8-10.

8-16. INPUT PROTECTION

8-17. See Figure 8-2. Voltage suppressor E1 and associated components form an electro-static discharge protection circuit. Voltages of 350 volts dc or ac peak cause E1 to arc, charging capacitor C43. The stored voltage is passed to common through resistor R44. RV1 limits the differential voltage between the lo and guard terminals to about 50 volts.

8-18. INPUT ATTENUATOR

8-19. See Figure 8-2. Resistor network R14, R27, R42, and R43 provide attenuation to input signals in four steps: divide by 1, 10, 100, and 1000. Input signals for the 5 mV to 500 mV full scale ranges are directly coupled without attenuation through relay K1 and resistor R26 to the preamplifier stage. Resistor R26 performs as a current limiting resistor for these ranges. Input signals for 1 V to 5 V full scale ranges are sent through R14 and relay K2, while input signals for the 10 V to 50 V full scale ranges are sent through R14, R27, and Q14. The 100 V full scale inputs are taken from the junction of R42 and R43 through Q13. Refer to Table 8-1 for attenuator and gain settings. The specific attenuation range required is determined by data loaded into attenuator control register U29. This data is made available under microprocessor control. Regardless of the attenuation value selected, the maximum working voltage at the input of the preamplifier U17, for any full scale range is ±1.0 volt. Field effect transistor (FET) Q12 is switched on during zero offset compensation periods. These adjustment periods occur at power-up and about every five minutes thereafter. The zero offset compensation cycle is described later in this section. Preamplifier overload protection is provided by FET'S Q10 and Q11. They prevent the input voltage of preamplifier U17 from exceeding ±10.7 volts. Zener diodes VR2 and VR3 prevent the voltage at the gates of FET's Q10 and Q11 from exceeding ±10.6 volts.

8-20. PREAMPLIFIER

8-21. The preamplifier circuit is a dc amplifier which includes integrated circuit (IC) U17 and its associated components, FETs Q1 through Q9 and gain resistor network R34 through R41. See Figure 8-3, Detail A. FETs Q1 and Q2 are connected as low leakage diodes to clamp pin 2 of U17 at ±5.6 volts and help provide proper biasing for FETs Q3-Q9. These FETs (Q3-Q9) serve as switches for selecting the appropriate gain resistors (R34-R41) required to set the correct preamplifier gain. FETs Q3-Q9 are controlled by drivers U31-U33, (U33 not shown). When a change in the gain setting is required all zeros are loaded into the preamplifier gain control register U30. This results in switching of FETs Q3-Q9. A gain control word from the microprocessor representing the desired gain is loaded into register U30. The gain control word is placed on the output of register U30 causing the appropriate FETs to be switched on. The gain is selected so that the voltage at the output of preamplifier U17 is ±2.0 volts for any full scale voltage listed in Table 8-1. The gain resistors are selected in a break-before make fashion with a waiting period of approximately 30 microseconds, before switching is complete.

8-22. IC U7 provides the pullup voltage for all FETs in the attenuator and preamplifier circuits. This pullup voltage is at about the same potential as the inverting input of U17. This ensures that the FETs can be switched on and off by the ±10 V control signal at the gate of each FET. The pullup voltage (U7 pin 6) is also connected to a shielding trace that surrounds the preamplifier circuit. See Figure 8-3, Detail B. This ensures minimum voltage differential and input leakage current for the preamplifier.

Table 8-1. Attenuator/Preamplifier Gain

FULL SCALE RANGE	INPUT DIVIDER (ATTENUATION)	GAIN	TOTAL GAIN
±5 mV to ±9.99 mV	1.0	200	200
±10 mV to ±19.99 mV	1.0	100	100
±20 mV to ±49.9 mV	1.0	50	50
±50 mV to ±99.9 mV	1.0	20	20
±100 mV to ±1999 mV	1.0	10	10
±200 mV to ±499 mV	1.0	5	5
±500 mV to ±999 mV	1.0	2	2
±1.000 V to ±1.999 V	0.1	10	1
±2.1 V to ±4.99 V	0.1	5	0.5
±5.0 V to ±9.99 V	0.1	2	0.2
±10.0 V to ±19.99 V	0.01	10	0.1
±20.0 V to ±49.99 V	0.01	5	0.05
±50.0 V to ±99.99 V	0.01	2	0.02
±100 V	0.001	10	0.01

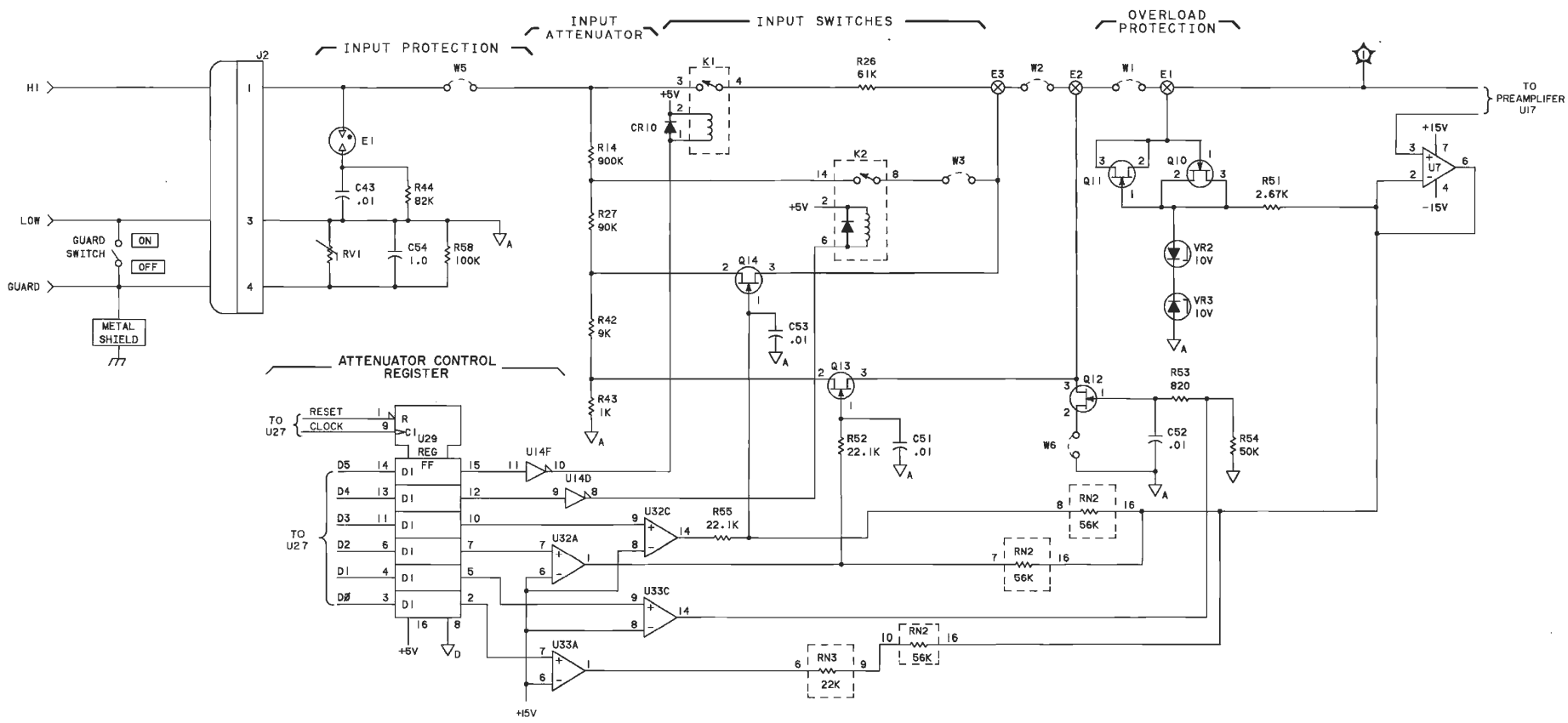

Figure 8-2. Input Attenuator

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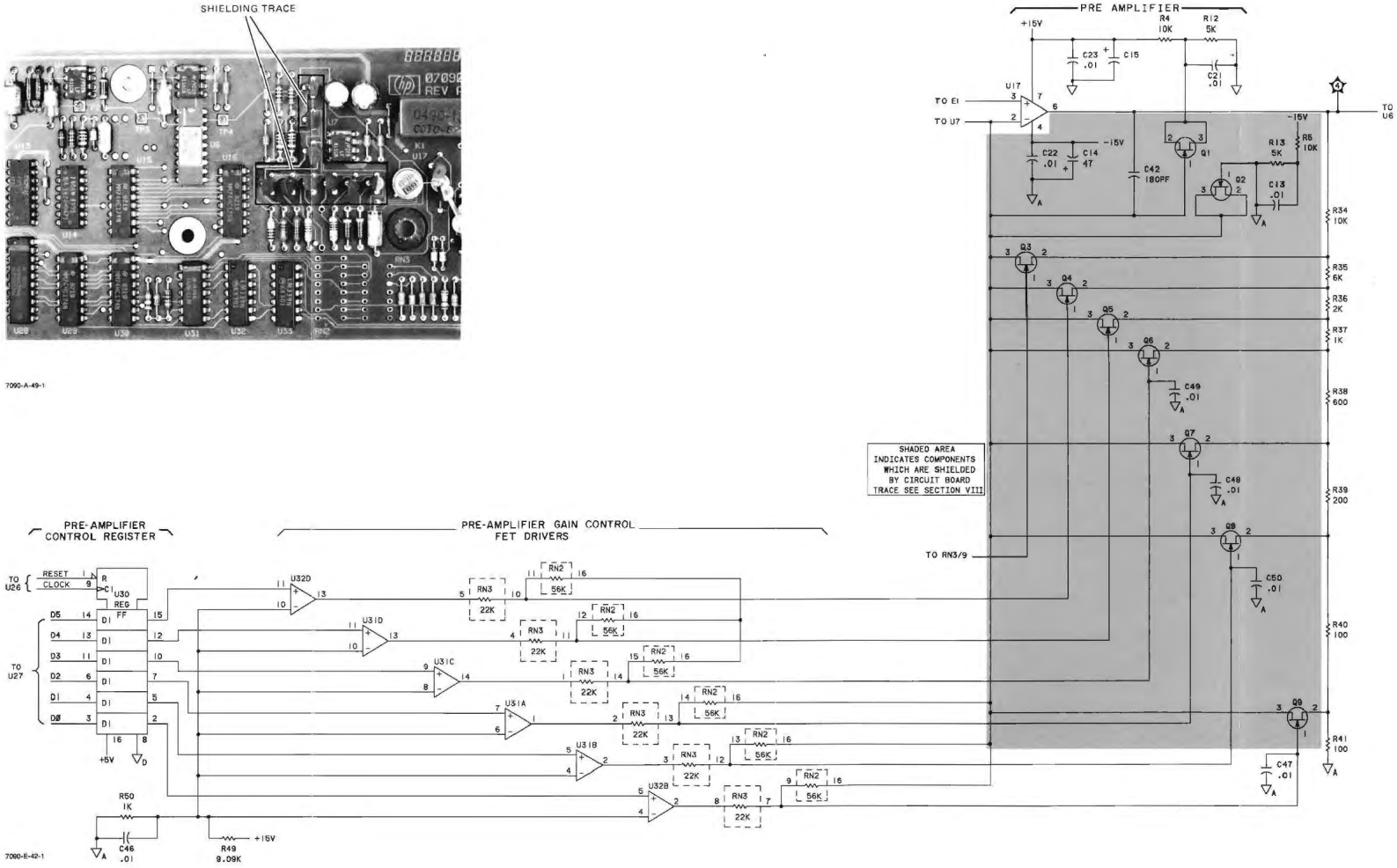


Figure 8-3. Preamplifier

8-23. VERNIER GAIN AMPLIFIER

8-24. Digital-to-Analog converter (DAC) U6, operational amplifier U5 and their associated components form a programmable vernier gain amplifier (see Figure 8-4, Detail A). The DAC multiplies the voltage from preamplifier U17 by the value of a 12-bit gain word applied to its digital inputs. The gain word is provided by gain control registers U15 and U16 under microprocessor control. Inside DAC U6 a 12-step binary weighted resistor ladder sums the currents derived from the input reference voltage according to the value of the 12-bit gain word. See Figure 8-4, Detail B.

8-25. The sum of the outputs flowing from U6 pin 1 to U5 pin 2 and from U6 pin 2 to common is constant. This is true for any given input voltage, regardless of the gain word value. Operational amplifier U5 changes the DAC's output current to a voltage that is proportional to the DAC's input reference voltage multiplied by ratio of the actual gain word, divided by 4096, or:

$$V_{out} = V_{in} \times h/4096$$

where: h = gain word value 0 to 4095

Some tolerance must be allowed for the effects of gain error and voltage offset compensation in the attenuator and preamplifier stages. Therefore the maximum value of the gain word is restricted to 3901. The output of amplifier U5 may be described as:

$$V_{out} = V_{in} \times G\ compression \times G\ range$$

where: V_{in} = Voltage output of U17

G compression = 3901/4096
G range = 0 to 4095/4096

The microprocessor selects the value of G range so that whichever full scale range is selected, the voltage at U5 pin 6 (TP3) will not exceed 0.95 volt.

8-26. OFFSET ADJUST AMPLIFIER

8-27. See Figure 8-5. The programmable offset adjust circuit incorprates operational amplifier U4, DAC U13, and their associated components. DAC U13 receives an 8-bit offset word from offset control register U28. This data represents the user selected offset voltage value. Converter U13 changes this data into an equivalent voltage which is applied to offset adjust amplifier U4. Resistors R1 and R3 give the amplifier a gain of 10 while resistors R2, capacitors C8 and C9 form a 3.3 kHz low pass filter. The output voltage at U4 pin 6 (TP2) can be found by:

$$(V_{in} - V_{offset}) \times 10$$

Due to gain compression in the gain vernier circuit, for any positive or negative nominal full scale input, the maximum voltage at test point 2 will be approximately ±9.52 volts.

8-28. ANALOG-TO-DIGITAL CONVERSION

8-29. See Figure 8-6. The analog output of U4 must be converted to a digital equivalent before being sent to the Main PCA for processing. This conversion is accomplished by the 12-bit successive approximation analog-to-digital converter U1 and associated components. The output of offset amplifier U4 is applied to parallel sample and hold (S/H) amplifiers U3 and U12. These S/H amplifiers operate 180 degrees out of phase with each other. That is; when one is acquiring a voltage sample from U4, the other is holding the voltage sample previously acquired. The voltage being held is switched by U11 to the input of analog-to-digital converter (ADC) U1. Control of the S/H amplifiers and switch U11 is provided by J-K flip-flop U10. See Figure 8-7.

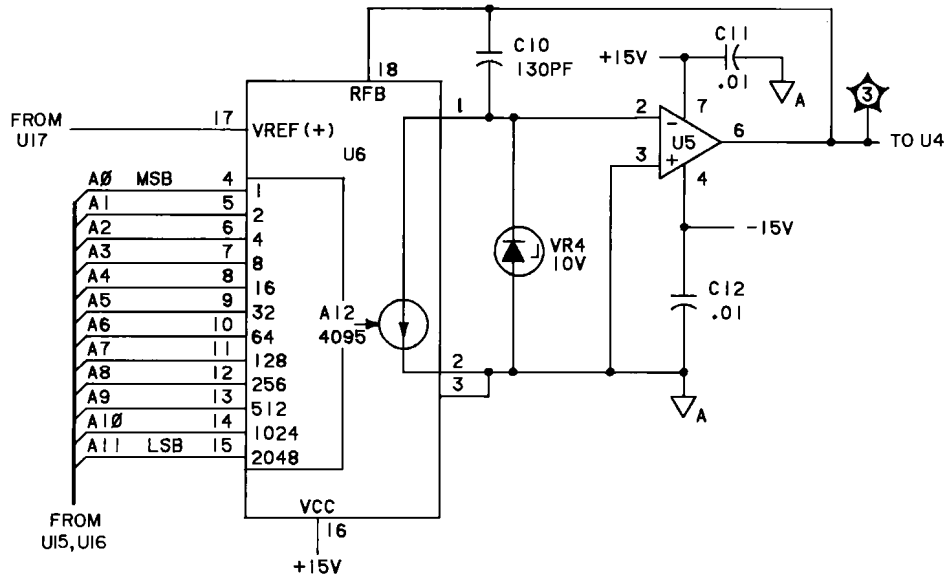
8-30. During any microprocessor reset, a control word is shifted into shift register U27 and U25. See Figure 8-8. This word is latched into control register U26 where the logic 1 bit appearing at pin 15 is inverted by U9A. The control word creates a negative going reset transition which is used to clear the gain word registers U15 and U16. The offset word register U28 and S/H control flip-flop U10A/B. This sets S/H amplifier U3 to the sample state and U12 to the hold state.

8-31. The microprocessor generates convert pulses of approximately one microsecond duration. About 1000 convert pulses will occur during the selected measurement period. For the fastest possible measurement period (30 ms) convert pulses occur at 30 microsecond intervals. These pulses are simultaneously coupled into each analog channel through optical isolators U21 and pass to flip-flop U24. This shaped pulse, now 1 microsecond wide, triggers U10 causing the S/H amplifier state to change and initiates the analog-to-digital (A-to-D) conversion cycle.

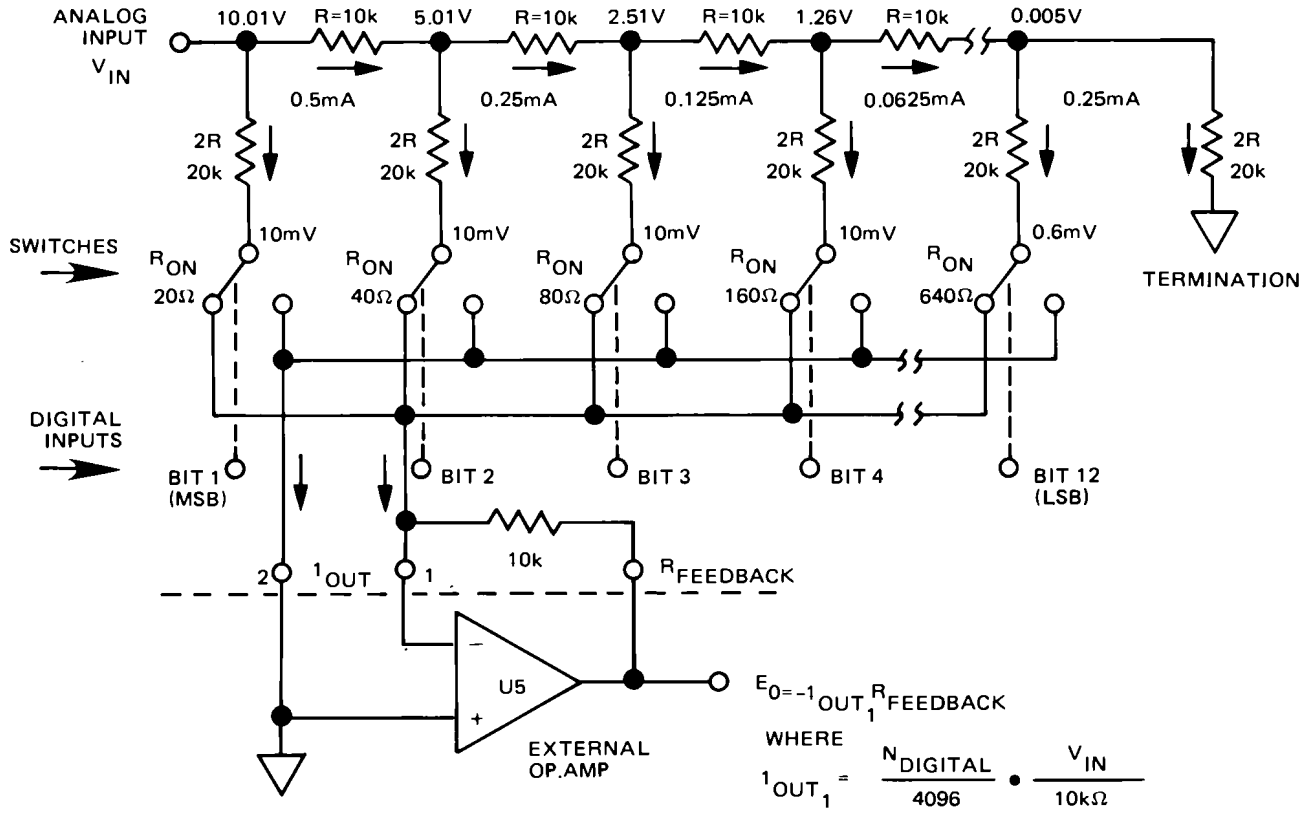
8-32. The A-to-D conversion cycle takes about 25 microseconds. During this time the ADC's status line goes high and the digital data is clocked out of the ADC and coupled through optical isolator U22. The clock signal (U1 pin 23) is also shaped and inverted by flip-flop U24 then coupled through optical isolator U22 to the Main PCA. Thirteen rising edges of the analog-to-digital clock occur during conversion. The first is discarded, the following twelve are inverted and centered on the 12 serial data bits. At the end of the 25 μs conversion cycle the ADC status line goes low and is coupled through inverter U9F to the input of J-K flip-flop U10. The negative status signal causes U10A to change state and switches ADC switch U11 pin 14 to the alternate S/H amplifier for the next conversion cycle.

8-33. CONTROL CIRCUIT

8-34. Control of the programmable input attenuator, gain and offset adjust registers is accomplished by control information from the Main PCA. This information is processed by control circuit ICs U25–U27. See Figure 8-8. Control data (DI) in serial format along with the control data clock signals (CI) are coupled through buffer U18 to optical isolator U20. IC U20 provides electrical isolation between the Main PCA and the analog input channel. The serial control data and clock signals are inverted by IC U9, and then applied to shift registers U25 and U27 which form a serial-to-parallel converter. Serial data introduced at the input of U25 and U27 are sent through on the positive transition of the data clock 'CI' (U25/27 pin 8). The parallel formatted output of U27 is sent to either the attenuator select registers (U29/30), gain adjust registers (U15/16), or the offset adjust register



DETAIL A



DETAIL B

Figure 8-4. Vernier Gain Amplifier

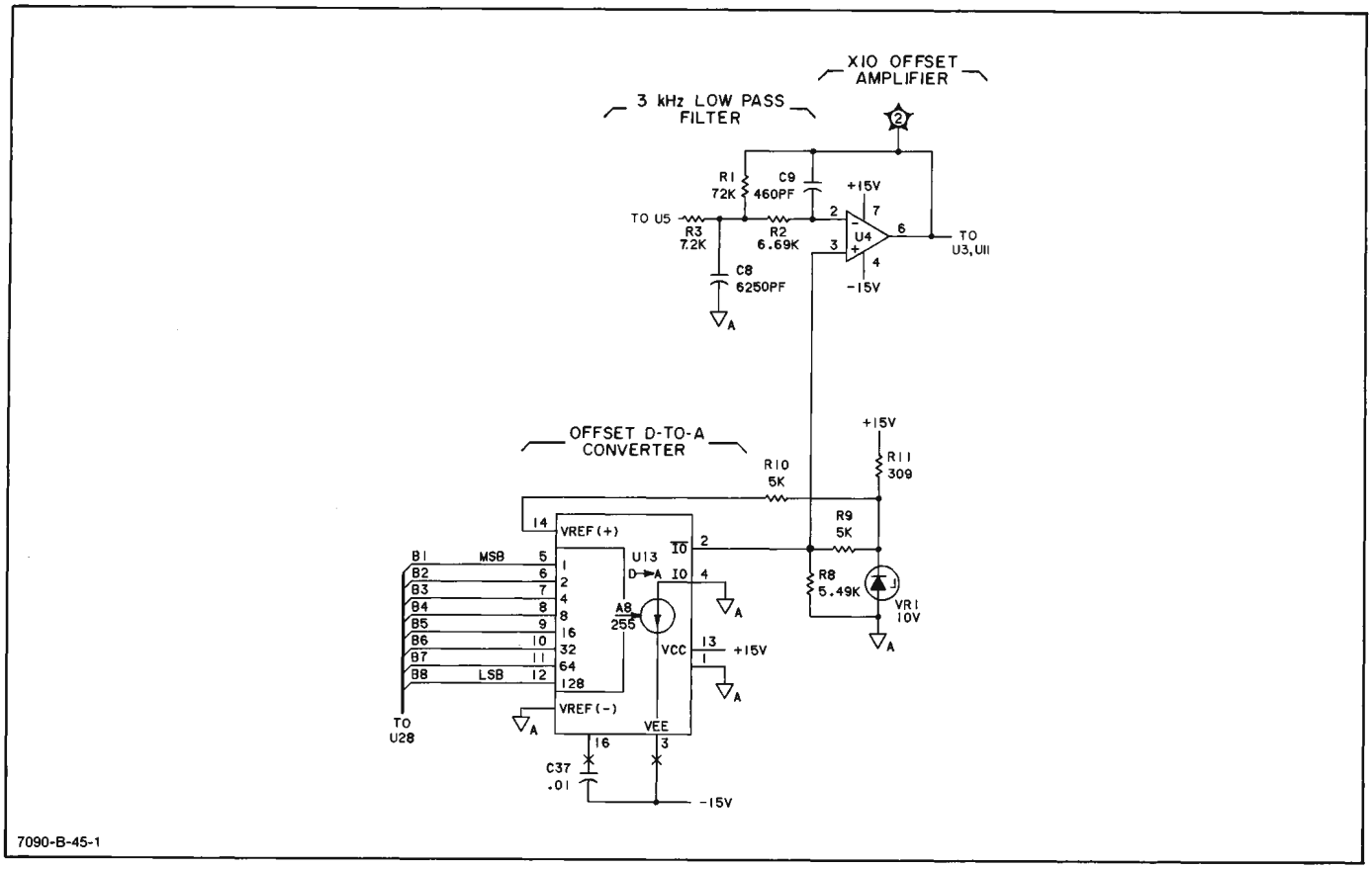


Figure 8-5. Offset Adjust Amplifier

(U28). Selection of these registers for receiving control data from IC U27 is accomplished by control register U26. Control register load signals (FE) are coupled through buffer U18, optical isolator (U8), and inverter U9 to register U26. The positive transistion of 'FE' (U26 pin 1) causes the logic states on the input of U26 to appear on its output lines.

8-35. ANALOG CHANNEL ERROR CORRECTION

8-36. In the analog channel operation discussion it was assumed that all attenuation and gain factors were ideal and there were no internal voltage offsets or leakage currents generated. However, voltage offsets and leakage currents do exist and internal adjustments must be made to compensate for these errors. Two types of compensation are used in the HP 7090; internal offset compensation and voltage gain conversion correction.

8-37. INTERNAL OFFSET VOLTAGE COMPENSATION

8-38. Analog components used in the HP 7090 as well as the construction techniques in the most critical areas have been selected to reduce internal offset voltages. Approximately every five minutes after power is applied to the HP 7090, or the microprocessor is reset, the microprocessor performs an internal voltage offset measurement. During this measurement cycle all the input attenuator switches are opened. The FET switch Q12 (Figure 8-2) is switched to analog common and the input and all amplifier gains are set for maximum gain (representative of ±5 mV full scale). The count from the A/D converter (see Figure 8-7) represents the magnitude of total offset voltages of all the analog components. The difference between this value and true zero (2048) is stored in RAM and added or subtracted from each measurement conversion to obtain a correct value.

8-39. INTERNAL VOLTAGE GAIN COMPENSATION

8-40. The voltage gain and conversion correction compensates for all gain errors in the channel by multiplying the A/D converter output by one of 14 correction factors. These correction factors are calculated and stored in EEPROM during channel calibration. A factor is calculated for each of the combination of input attenuator and preamplifier gain listed in Table 8-1. Whenever the analog components in a channel are replaced the channel must be recalibrated. Channel assemblies replaced by exchange and those moved to a different location need to have their factory calibration factors entered into the EEPROM location corresponding to the new channel location. Refer to the calibration procedures in this Section.

8-41. ANALOG INPUT POWER SUPPLY

8-42. Analog Input PCA operating voltages of +5 volts and ±15 volts are developed by an on-board power supply circuit. See Figure 8-9. A 425 Hz sine wave from the main Power Supply PCA is supplied through plug P1 to transformer T1 located on the Analog Input PCA.

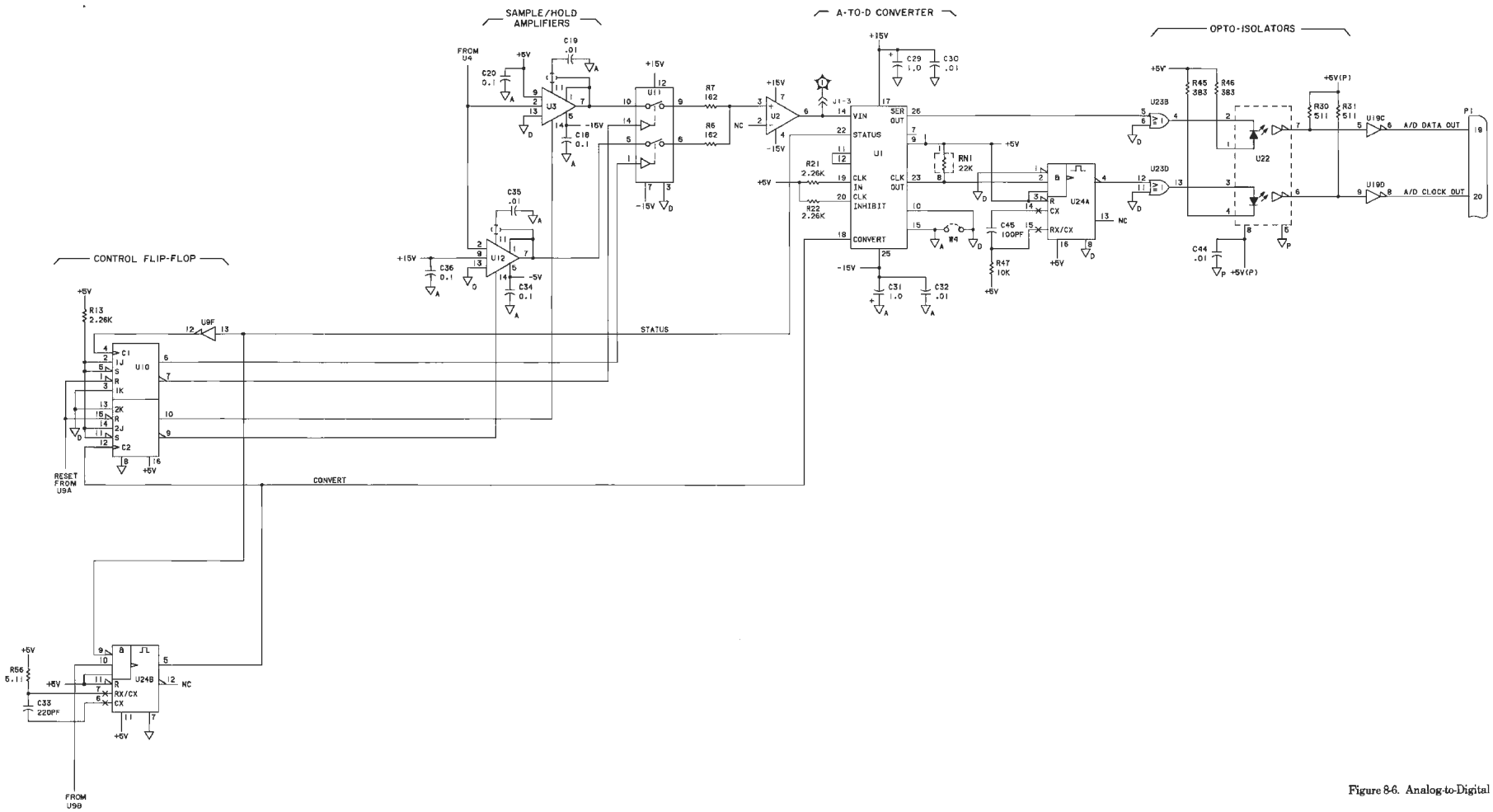
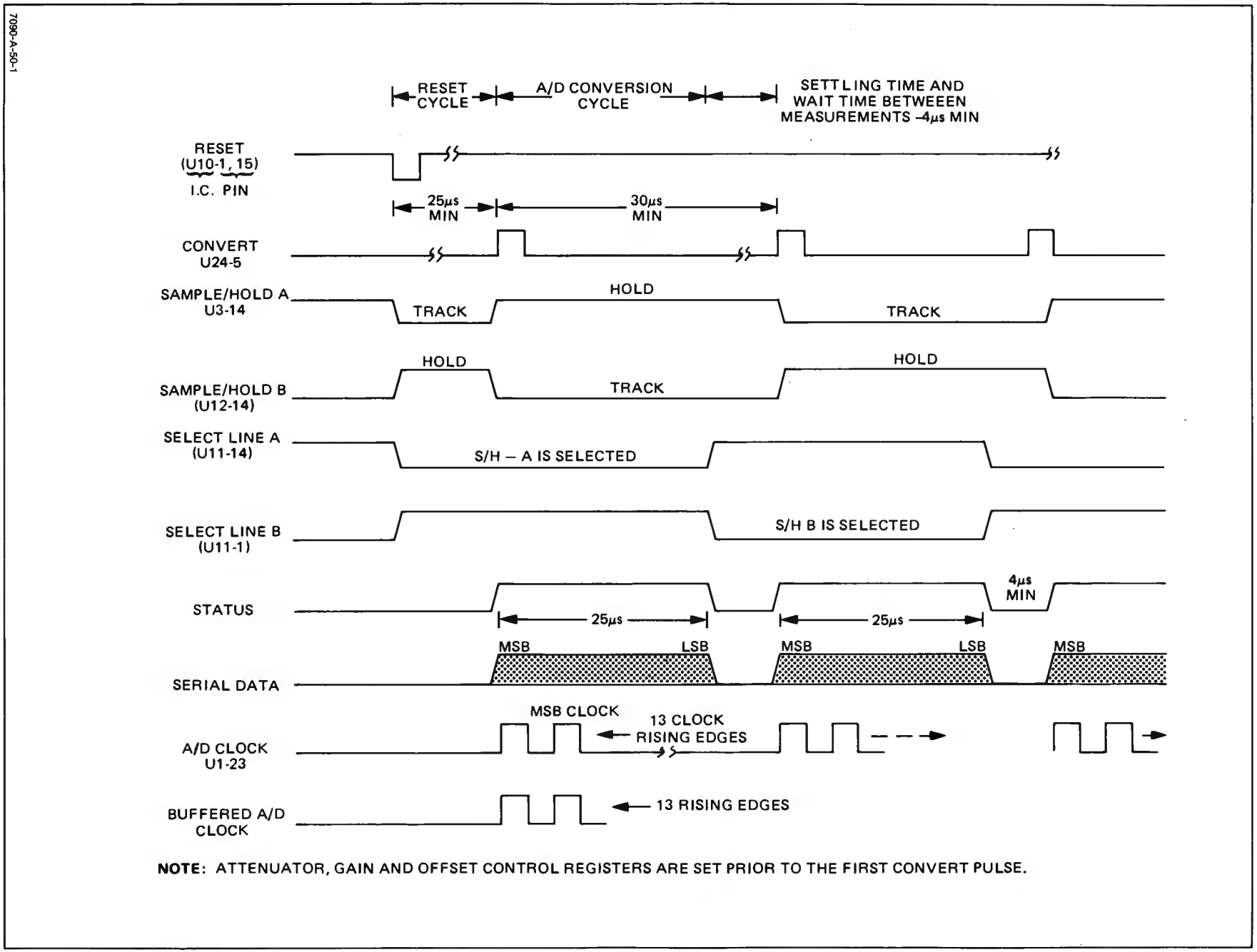


Figure 8-6. Analog-to-Digital Converter



NOTE: ATTENUATOR, GAIN AND OFFSET CONTROL REGISTERS ARE SET PRIOR TO THE FIRST CONVERT PULSE.

Figure 8-7. Analog-to-Digital Conversion Timing Diagram

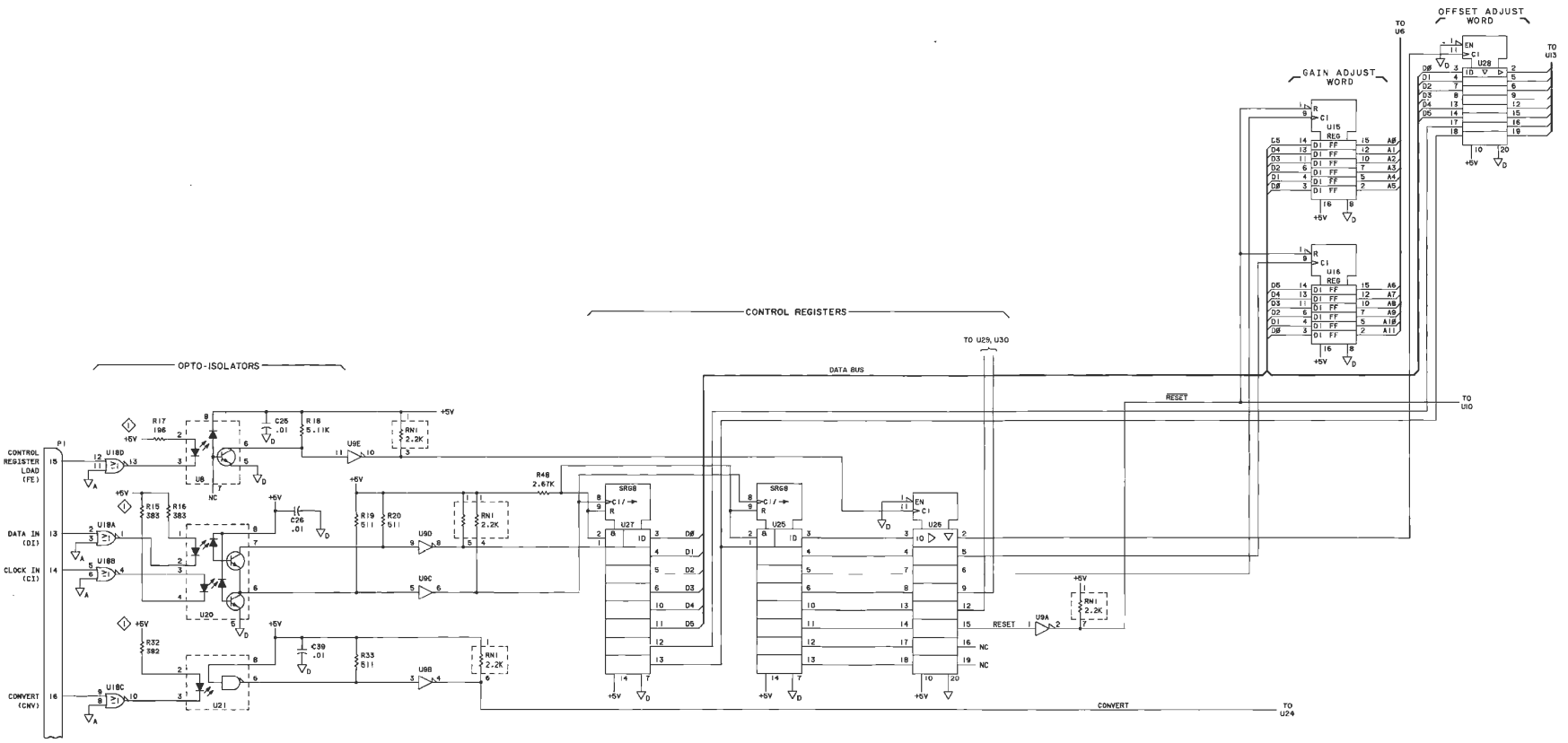


Figure 8-8. Control Registers

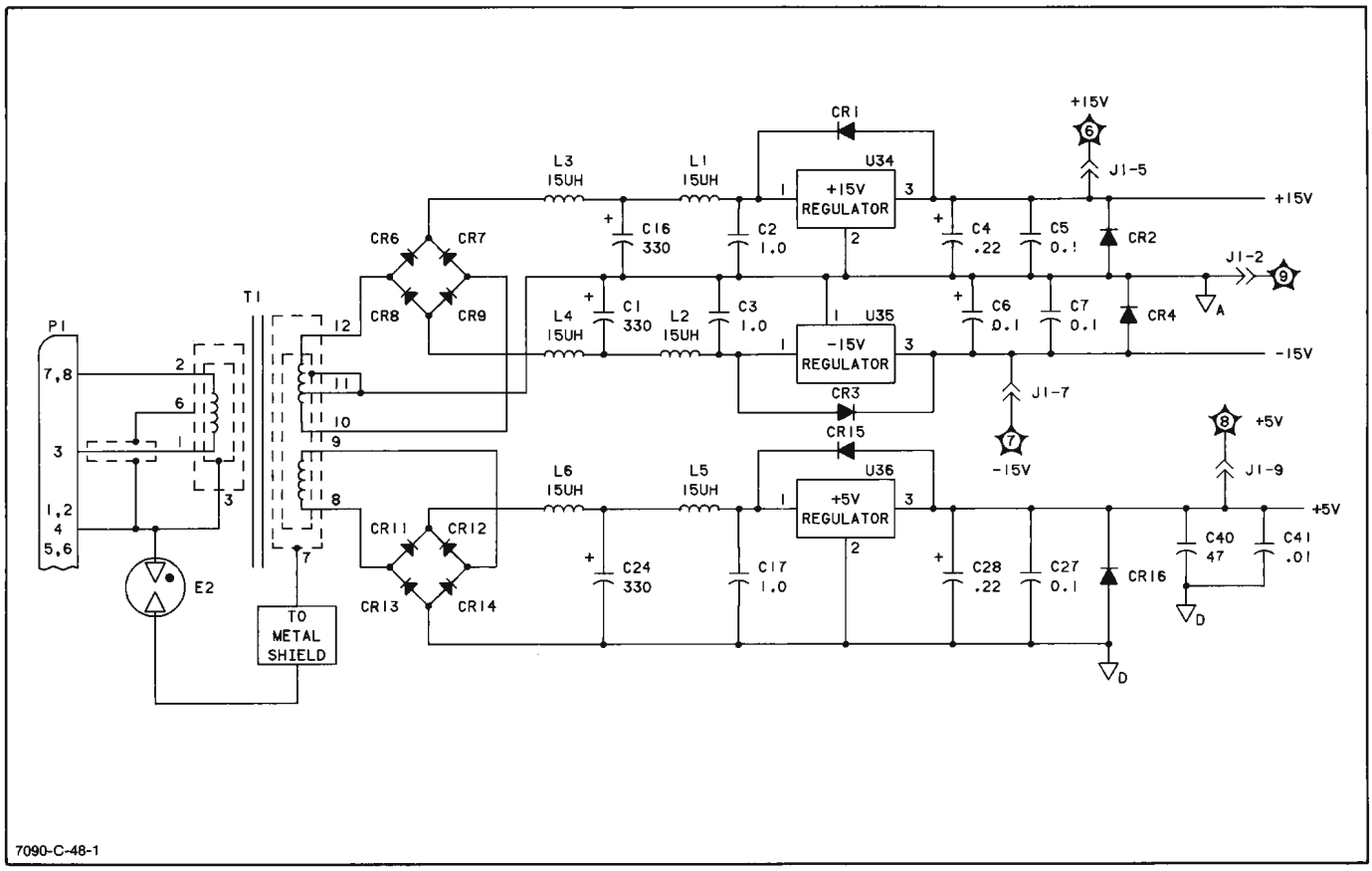


Figure 8-9. Analog Channel Power Supply

Transformer T1 provides the proper step-down voltage to bridge rectifiers in the ±5 volts and ±15 volts circuitry.

8-43. +5 VOLTS SUPPLY

8-44. Diodes CR11-CR14 form the bridge rectifier for the +5 volts supply. Capacitors C24 and C17 along with inductors L5 and L6 provide radio frequency interference (RFI) filtering. Regulator U36 converts it's unregulated input voltage to a regulated +5 volts. Diode CR15 protects IC U36 from input voltage loss while diode CR16 and and its associated capacitors provide additional filtering and bypass.

8-45. ±15 VOLTS SUPPLY

8-46. Bridge rectifier diodes CR6-CR9 provide the ±15 volts regulators with the proper dc voltage input. RFI filtering is accomplished by capacitors C1-C3, C16 and inductors L1-L4. The regulated ±15 volts outputs are provided with additional filtering and bypass through capacitors C4-C7. Diodes CR1-CR4 perform voltage bypass functions for regulator protection.

8-47. MAIN PCA

8-48. The Main PCA contains the microprocessor and its support circuitry, read-only memory, random-access memory, clock circuit, analog channel logic array and control circuits, pen and paper drive circuits, and all system I/O logic. See Service Sheet 1.

8-49. MICROPROCESSOR

8-50. The 8-bit 68B09 microprocessor (U38) generates the appropriate timing signals needed to properly sequence and control the processing of data and instructions. The processor's 16 address lines permit a total address space of 64 K bytes. A total of 40 K bytes of read only memory (ROM) contain firmware instructions for the microprocessor. In addition, 8 K bytes of random-access memory (RAM) is available for system variables and analog channel data buffers. The microprocessor also contains an input buffer for the external HP-GL and HP-RL instructions received from a controller.

8-51. When the HP 7090 is first powered up, or whenever the internal RESET switch is pressed, the microprocessor's RESET line is low. When the line goes high, the processor goes to the address specified by the top of memory location (U59, address FFFF) and begins execution of the initialization and power-up self test routines stored in ROM. Thereafter the processor continuously executes firmware instructions from the ROM memory. Data is obtained from ROM, RAM, or hardware locations, as required by the instructions.

8-52. Timing for all processor activity, is provided by an 8 MHz crystal controlled oscillator. Circuitry within the microprocessor develops two quadrature clock signals "E" and "Q". The leading edge of these clock pulses are used to enable the various memory locations and to indicate valid data. A Read/$\overline{\text{Write}}$ control line is used to

indicate whether data is to be read from (line high) or written to (line low) the memory location specified by the address lines.

8-53. Three microprocessor control lines are used by various control circuits to cause a microprocessor interrupt:

Interrupt Request ($\overline{IRQ}$)

Fast Interrupt Request ($\overline{FIRQ}$)

Non-Maskable Interrupt Request ($\overline{NMI}$).

Each interrupt request alters the microprocessor's normal sequence of operation. These inputs are latched by the falling edge of every Q clock pulse except during a Direct Memory Access (DMA) operation when only the $\overline{NMI}$ input is latched. Interrupts are recognized by the microprocessor after at least one bus cycle has occured and the HALT line is at logic 1. An additional control line, $\overline{DMA/BREQ}$ is used by the front end gate array to request control of the data and address lines so that measurement data can be written directly into the analog channel buffer.

8-54. INTERRUPT REQUEST ($\overline{IRQ}$)

8-55. $\overline{IRQ}$ is a low level signal which can be invoked by one of six activities:

1. Input Channel Overflow Interrupt (OVI)
2. Front Panel Interrupt (FPI)
3. Real Time Clock Interrupt (RTCI)
4. Chart Load Interrupt ($\overline{CLI}$)
5. Rotary Pulse Generator Interrupt ($\overline{RPGI}$)
6. Input/Output Interrupt ($\overline{IOI}$)

8-56. In order to service an interrupt request, the interrupt mask bit in the microprocessor's condition code register must be cleared. This bit is set during a microprocessor reset and then cleared by a firmware instruction. When the interrupt mask bit is set high, no further interrupts can occur. The contents of the index register, program counter, accumulators, and condition code register are stored on the microprocessor's stack. At the end of the cycle a 16-bit address is loaded onto the microprocessor address bus which points to a vectoring address located in processor memory. The vectoring address causes the microprocessor to branch to an interrupt routine in memory. This interrupt request has the lowest priority of the three interrupt requests.

8-57. FAST INTERRUPT REQUEST ($\overline{FIRQ}$)

8-58. $\overline{FIRQ}$ is a low level input which is initiated by the front end gate array U36 (FEGA) requesting bus access after conversion of the analog input signal to parallel data. This interrupt is acknowledged and processing will begin provided it's mask bit in the microprocessor's condition code register is clear (logic 0). The $\overline{FIRQ}$ stacks only the contents of the condition code register and the program counter. $\overline{FIRQ}$ has a higher priority than $\overline{IRQ}$.

8-59. NON MASKABLE INTERRUPT ($\overline{NMI}$)

8-60. The $\overline{NMI}$ input cannot be masked by software and has the highest priorty of the three interrupt inputs. It enables the servo loops to be closed through the microprocessor. Low logic pulses will appear at this input to the microprocessor with a period between 1 and 2 ms whenever the $\overline{ENMI}$ signal is low.

8-61. DIRECT MEMORY ACCESS/BUS REQUEST

8-62. The $\overline{DMA/BREQ}$ input provides the means by which the Front End Gate Array U36 (FEGA) can suspend instruction execution by the microprocessor and acquire the data and address buses. A low level on this input occurring during the Q clock high time suspends instruction execution at the end of the current cycle. The microprocessor acknowledges acceptance of this input by setting the bus access (BA) output high to signify the bus grant state.

8-63. RANDOM ACCESS MEMORY

8-64. The random access memory (RAM) U21 through U24 each have 2 K bytes of memory. Converted analog input signals are stored in U21 through U23. RAM U24 is used to store processor variables. All RAM is enabled by select RAM (SRO-SR3) from decoder U55. Read and write operations to the RAM are controlled by the microprocessor.

8-65. READ ONLY MEMORY

8-66. The read-only memory (ROM) U25, U26 and U59 contain 40 K bytes of fixed routines required for system operation. Data outputs are 3-state which effectively disconnects them from the data bus while the ROM is not enabled. ROMs U26 and U59 each have 16 K bytes of memory and U25 has 8K bytes of memory.

8-67. FRONT END GATE ARRAY (FEGA)

8-68. The front end gate array (U36) is the direct memory access (DMA) controller. It receives serial data from the analog input channels, converts the data to a parallel output and writes that data into RAM. The FEGA also generates overflow interrupt (OVI) and fast interrupt request (FIRQ).

8-69. Serial data (SD1-SD3) are clocked into the FEGA on the rising edge of clock signals SC1-SC3. Start convert (NCVT) begins a timer in the the FEGA that allows each channel input circuit of the gate array 25.5 μs to 26.5 μs to clock in all 13 bits, (the last bit is invalid).

8-70. When the timer has timed out a negative pulse is generated. This pulse in turn generates an overflow interrupt (OVI) if the FEGA receives all ones or zeros from any of the analog input channels. An OVI means that an analog input signal has exceeded the maximum operating range of the input channel. The front panel overflow indicator will come on and remain on until the overflow condition passes.

8-71. DIRECT MEMORY ACCESS (DMA)

8-72. The DMA CYCLE starts at the end of the serial-to-parallel conversion. During this cycle the converted

analog data is written into RAM in six bytes. The first byte, one for each channel, contains the eight most significant bits of data and the second byte contains the four least significant bits of data. After the FEGA completes the serial-to-parallel conversion the DMA request line (NDB) is set low. The FEGA waits for the microprocessor to grant bus access by setting Bus Access (BA) high. This BA signal change causes the DMA valid memory access signal ($\overline{DMA/VMA}$) to go low for one clock cycle indicating that the bus control is changing and that bus data is invalid for the clock cycle.

8-73. During the DMA cycle with low Read/$\overline{Write}$ (RNW) the address and data are placed on their respective buses. BA1-BA10 come from the FEGA buffer address counter, while BA0, BA12 and BA13 are obtained from a second counter, (active during DMA cycle only). The second counter address also determines which byte of data is placed on the bus. The data is made available in six consecutive clock cycles as follows:

BA13	BA12	BA0	DATA ON BUS
0	1	0	CH. 1 Higher Byte
0	1	1	CH. 1 Lower Byte
1	0	0	CH. 2 Higher Byte
1	0	1	CH. 2 Lower Byte
1	1	0	CH. 3 Higher Byte
1	1	1	Ch. 3 Lower Byte

When BA0, BA12 and BA13 are set to logic 1, on the next clock cycle, the DMA request is cleared. The microprocessor takes over bus control and DMA/VMA is set high for one clock cycle, ending the DMA cycle.

8-74. SERVO GATE ARRAY

8-75. The SERVO GATE ARRAY (SGA) U16 controls the following circuits:

Servo Motors
Pen Carousel Motor
Pen Down
Parallel-to-Serial Converter

8-76. SERVO MOTORS

NOTE

The axes on the HP 7090 are referred to as the pen drive axis and the paper drive axis instead of X and Y, because the axes will change with a change in paper size. Using A/A4 paper, the pen drive is the X-axis and the paper drive is the Y-axis. Using B/A3 paper the pen drive is the Y-axis and the paper drive is the X-axis. On the schematic diagrams, X and Y are used to designate logic functions.

8-77. The SGA converts the quadrature encoder signals from the paper and pen axis optical encoders into an 8-bit relative position count. These relative position counts are stored in the SGA and read by the microprocessor. The SGA also contains logic that generates the pulse width modulated (PWM) control signals to the motor drivers for the two axes. The pulse width modulator circuits have a programmable gain register which determines the period of the PWM signals. In addition there is a pulse width register which is loaded under the control of the SGA control byte, bit 0. When this bit is set to logic one the position counters are fed directly to the pulse width modulator registers; providing a low gain position feedback servo loop to hold the motors at rest, enabling the microprocessor to supervise other tasks. When bit 0 of the SGA control byte is at zero the control loops are closed through the microprocessor. This state exists during any motion of the mechanics. The nonmaskable interrupts are enabled at this time and the NMI routine is responsible for reading the position counters and calculating the value to be written into the pulse width registers.

8-78. PEN CAROUSEL

8-79. The pen carousel is driven by a reversible dual coil stepper motor. To drive the motor, pen select data generated by the microprocessor is received by the Pen Pulse Width Modulator (PPWM) in the SGA. The resulting outputs PT0-PT3, which are inverted signals of the data written into the pen carousel register, also a part of the SGA, drives the carousel motor either clockwise or counterclockwise. When at rest all four outputs are at logic 0.

8-80. PEN DOWN

8-81. When the microprocessor receives a pen down instruction, a 62.5 kHz pulse signal is issued by the SGA through transistor Q2 to the pen down driver Q1. See Service Sheet 7. Because more power is required to activate the pen solenoid than is needed to hold it after activation, the pulse is widened for a short period of time to provide this extra power. The duration of the pulse-width-modulated signal is controlled by the gate array as a function of the 22/40 Vdc unregulated power supply voltage. An air damper on the pen carriage assembly, slows the descent of the pen to protect the pen tip.

8-82. PARALLEL-TO-SERIAL CONVERTER

8-83. In the SGA the parallel-to-serial converter takes a 16-bit word, which can represent control data for the analog input channels or front panel display data, and outputs it on pin 18 serial output data (SOT). The data changes on the rising edge of the Serial data clock NCK (pin 38) and is valid on the clock's falling edge.

8-84. HP-IB INTERFACE

8-85. HP-IB interface connections are shown in the schematic diagram at the end of this section. Input/Output voltage levels must meet TTL requirements (low = −0.8 V; high = −2.0 V). All signals are active low (true). Figure 8-10 is a block diagram of the HP-IB Interface Circuits.

8-86. All data and control signals to and from the HP-IB go through bus transceivers U2 and U3 which are enabled to transmit or to receive by the interface adapter U1 in response to HP-IB commands. The interface adapter automatically handles all handshake requirements on the HP-IB. When the HP 7090 power is on, the bus

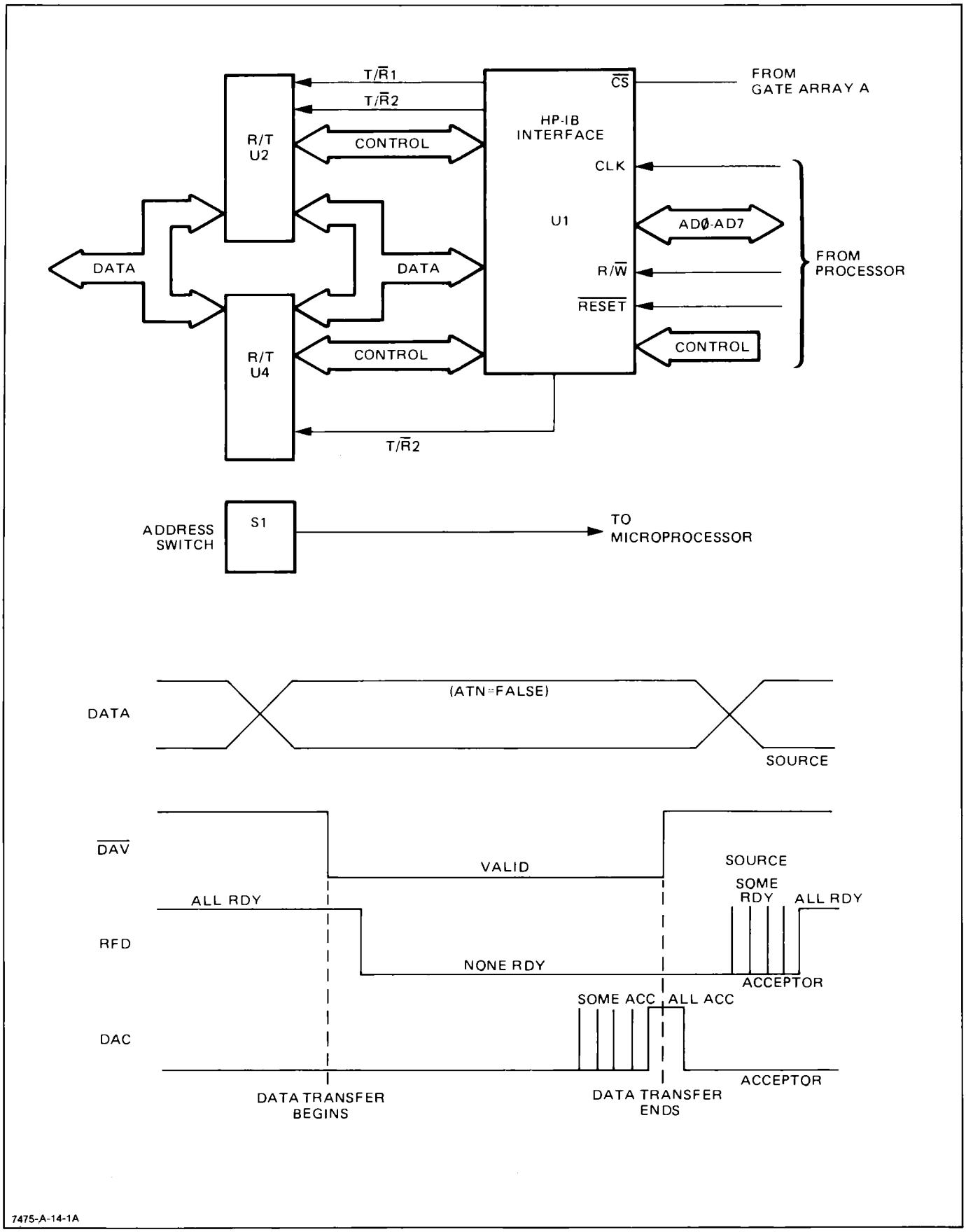


Figure 8-10. HP-IB Interface Circuits and Handshake Timing Diagram

transceiver inputs are high impedance to prevent loading the data lines. When the HP 7090 power is off, the bus transceivers present an open circuit to all data lines; consequently, the HP 7090 does not interfere with other HP-IB operations.

8-87. A 16 line bus is used to carry data and control information and is divided into three sets of lines.

a. Data bus—8 signal lines—DIO1 through DIO8.

b. Data transfer control—3 signal lines—(Handshake).

c. Interface management—5 signal lines.

8-88. The data bus transfers 8-bit data or control words between the controller and the HP 7090. The words are in bit parallel byte serial form. The words are transfered bidirectionally and asynchronously.

8-89. The three data transfer control lines, or "handshake lines" are used to control the transfer of information on the data bus. These lines are identified as follows:

a. DATA VALID (DAV) — Used to indicate that valid information is available on the data lines.

b. NOT READY FOR DATA (NRFD) — Used to indicate the rediness of the HP 7090 to accept information.

c. NOT DATA ACCEPTED (NDAC) — Used to indicate the acceptance of information by the HP 7090.

8-90. The five interface management lines are used to provide an orderly flow of information across the interface bus. The lines are identified as follows:

a. ATTENTION (ATN) — Used by the controller to specify how data on the DIO signal lines are to be interpreted, (command, data, or parallel poll response) and which devices on the bus must respond to the data.

b. SERVICE REQUEST (SRQ) — Used to indicate that the HP 7090 needs of attention and to request an interruption of the current sequence of events.

c. INTERFACE CLEAR (IFC) — Used by the controller to place the bus in a known quiescent condition.

d. END OR IDENTIFY (EOI) — Used by a talker to indicate the end of a multiple byte transfer sequence or in conjunction with ATN to excute a polling sequence.

e. REMOTE ENABLE (REN) — Used to enable a remote control mode.

8-91. Positive true logic is used within the HP 7090 circuitry. Therefore a positive false NRFD on the HP-IB bus will be converted to a positive true RFD within the HP 7090.

8-92. When the HP-IB interface IC U1 receives a RESET pulse from the microprocessor U38 it sets the DAC and RFD lines passive true, indicating the ready condition. The controller will set ATN true indicating a bus message or address, and put the device address on data lines DIO1 through DIO5. The interface chip compares the address on the bus with the setting of the HP-IB address switch read at power up. If the address is valid, the HP-IB chip will then decode the lines DIO6 and DIO7, to determine if the HP 7090 is being addressed as an acceptor (listener) or source (talker). When the controller sends a valid address with DIO6 true and DIO7 false, the HP 7090 is being addressed as a listener. When the controller is ready to transfer data on the bus it sends ATN false and EOI false. Refer to Figure 8-10 for the handshake timing. When the HP 7090 receives these two signals it starts the handshake sequence:

a. The HP 7090 indicates that it is ready to accept data by setting RFD true and DAC false.

b. After RFD has gone true the controller places a data byte on the eight data line and sets DAV true.

c. After the DAV line has gone true, the HP 7090 sets the RFD false, accepts the data and sets DAC true.

d. After the DAC line has gone true, the controller can set DAV false again and take the data off the line. When DAV goes false, the HP 7090 sets DAC false.

e. When the HP 7090 can accept a new byte of data it puts RFD true and the sequence is ready to start from step a.

8-93. When the ATN input is true, the HP 7090 compares the data on the HP-IB DIO lines to the address set by the rear panel address switches, and responds when addressed by the bus controller to listen or talk. When the ATN input is false and the HP 7090 is addressed to listen, the interface adapter accepts and processes the data on the DIO lines.

8-94. The interface adapter (U1) is enabled by a low true Chip Select from IC U27. When the interface adapter is enabled and its Read/$\overline{\text{Write}}$ (R/$\overline{\text{W}}$) input is high, data can be read from the adapter, and when the R/$\overline{\text{W}}$ input is low, data can be written by the processor into the adapter. The R/$\overline{\text{W}}$ input in the interface adapter and three register selection inputs, RS1-RS3 select the proper register in the interface adapter.

8-95. OSCILLOSCOPE OUTPUT

8-96. Converted analog data stored in RAM (U21-U23) can be made available for viewing with an oscilloscope at the BNC panel. Conversion of this digital data is accomplished by Digital-to-Analog converter (DAC) U51 and U52. Enable Scope Out ($\overline{\text{ESO}}$) is received from register U46 and is OR'ed with the selected buffer RS1, RS2 or RS3 (RAM select). Only one buffer can be selected at a time when conducting a channel vs time measurement. Buffer data is sent to the X-latch U48 and Y-latch U50 through data bus buffer U45. Flip-Flop U28 provides sequencing signals for writing data into the digital-to-analog converters.

8-97. SUPPORT CIRCUITRY

8-98. Intergrated Circuits that perform specialized support functions in the HP 7090 are:

ELECTRICALLY ERASEABLE PROGRAMMABLE READ ONLY MEMORY (EEPROM)

DISPLAY INTERFACE

INTERNAL TIMER

REAL TIME CLOCK

8-99. ELECTRICALLY ERASABLE PROGRAMMABLE READ ONLY MEMORY

8-100. An EEPROM (U12) provides a non-volatile storage for measurement setup parameters and calibration constants. Pressing the right front panel SHIFT and RESTORE SETUP buttons stores these parameters in the EEPROM. Pressing the RESTORE SETUP button copies the stored data into RAM for microprocessor execution.

8-101. DISPLAY INTERFACE

8-102. Intergrated circuit (IC) U19 has two sections: keyboard and display. The keyboard section is the interface between the front panel switches and the microprocesor. Return lines RL0-RL7 are connected to scan lines SL0-SL3 through the front panel switches. The return lines are held high by pullups inside U19. Pressing any front panel switch causes a corresponding return line to go low. This low signal is received by U19's switch sensor RAM where the signal can be accessed by the microprocessor on data bus DD0-DD7. The display section drives the front panel indicators. The front panel pushbutton status on the data bus is sent to the display RAM of U19 under microprocessor control, the data is sent to the appropriate front panel indicator. The direction of data flow is determined by the Read (RD) or Write ($\overline{WRT}$) signals. Data flow is enabled when Chip Select ($\overline{CS}$) is low. A logic 0 at BA0 (pin 21) means the information on lines DD0-DD7 is data for the front panel indicators and a logic 1 means that lines DD0-DD7 have switch status information on them. Operating commands are loaded into U19 from the data bus on the rising edge of $\overline{WRT}$ with BA0 at logic 1 and CS at logic 0.

8-103. INTERNAL TIMER

8-104. Internal timer U10 is a programmable interrupt timer used to generate the start convert pulse for the Front End Gate Array. The internal timer also generates the Non-Maskable Interrupt pulses. These pulses are used to enable the microprocessor to be part of the servo loop.

8-105. REAL TIME CLOCK

8-106. The real time clock (RTC) U11 provides time and date information for the HP 7090. The time base for the RTC is produced from a 32.768 kHZ crystal controlled oscillator. A 4.2 volt battery provides back-up power in the absence of main line power. The battery should be checked on an annual basis and replaced every three to five years. This will ensure continued operation of the RTC.

8-107. POWER SUPPLY

8-108. The power supply assembly consists of PCA A7, a rear panel and power transformer which is mounted in the lower case assembly.

8-109. PRIMARY CIRCUITS

8-110. The ac line input connection is through the receptacle mounted on the rear panel. The ac line fuse holder is also located here. The ac line input is wired, from the ac receptacle through the ac line fuse and line switch to plug P1. Plug P1 is connected to jack J8 located on the Power Supply PCA. Mounted on this PCA are the broad band line filters L6, L7 and voltage selection jacks J4-J7. The jacks provide the means for matching one of four ac line voltages to the primary of transformer T1 through plug P2. The ventilating fan receives its power through plug P2 as well. The transformer's secondary is connected through J1 (via P4) to the filter and rectifier circuits of the unregualted +22/40V supply on the Power Supply PCA A7. The fan is wired so that it will be supplied with a nominal 120 Vac, regardless of the line voltage selected.

8-111. UNREGULATED SUPPLY. The ±22/40 volts supply provides power to the ±15 volts regulated supplies, the +5 volts switching supply and the 425 Hz oscillator circuit. This unregulated supply also provides power to the pen, paper and carousel motor drivers.

8-112. ±15 VOLTS REGULATED SUPPLIES. Regulators U6 and U7 are uses to develop ±15 volts from the +22/40 volts unregulated supply. Circuit protection is provided by fuses F4 and F5. Transistors Q8 and Q9 serve as pre-regulators. They limit the voltage drop across U7 and U8 to approximately 5 volts. This relduces the heat produced by the voltage supply, thus permitting regulator operation without the use of heatsinks. Additional circuit filtering and bypass are provided by capacitors C19, C23 and diodes CR2 and CR5.

8-113. +5 VOLT SWITCHING SUPPLY. The +22/40 volts are applied to field effect transistor (FET) Q6. A current ramp is developed in inductor L4 when FET Q6 conducts charging C14 to the output voltage of +5 volt. Pulse-width-modulator U3 monitors the +5 volt output and adjusts the duty cycle (0-40%) according to load requirements. Silicon controlled rectifier (SCR) Q2 protects against voltage overload.

8-114. 425 Hz OSCILLATOR. A sine wave of 425 Hz (±17.5 volts) from waveform generator U1 is sent through buffers U2A and U2C to operational amplifier U5. The output of U5, a 425 Hz sine wave, is sent through drivers Q7 and Q10 to the analog input channel power supplies. Capacitor C24 stores the positive peak amplitude of the 425 Hz sine wave. This voltage is sent through diode CR4 and reduced to a 5 V level by resistors R31 and R32. Operational amplifier U2B compares the voltage developed at the junction of resistors R31 and R32 to a 5 V reference source. The output of U2B is applied to FET Q1 which acts as a programmable resistor and adjusts the sine wave amplitude of waveform generator U1.

Transistors Q3, Q5 and associated components prevent overvoltage for operational amplifier U5 (±31 volts max.).

8-115. POWER-UP RESET. The reset circuit, U4A and associated components provide a positive going signal at power up. The positive going edge of this signal is used to reset the microprocessor and enable the motor drivers.

8-116. POWER DETECT. Comparator U4B monitors the +22/40V supply. If the unregulated supply drops below +18 volts a negative pulse is developed at pin 7 of U4B. The edge of this negative signal, signals the microprocessor not to store any measurement parameters during a power failure.

8-117. EXCHANGE PRINTED CIRCUIT ASSEMBLIES

8-118. The printed circuit assemblies available on an exchange basis; that is, factory-repaired and tested assemblies may be ordered and the defective assemblies returned for credit. Refer to Section VI for ordering instructions and the exchange part numbers for your particular assembly. Because of the complexity of the circuits, it is recommended that you replace and return a defective printed circuit assembly to Hewlett-Packard rather than attempt repair.

8-119. RECOMMENDED TEST EQUIPMENT

8-120. Test equipment needed to maintain the HP 7090 is listed in Table 8-2.

8-121. TOP COVER REMOVAL

8-122. Many of the following service procedures require access to the inside of the HP 7090. To remove the top cover proceed as follows:

WARNING

Some maintenance procedures described herein are performed with power applied to the plotter and the top cover removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the line cord should be disconnected.

Do not touch the heatsinks on the Power Supply PCA. They become very hot when the HP 7090 has been powered on for a long time.

NOTE

When replacing the top cover, make sure the PAPER LOAD/HOLD lever extends through the cover and the tabs inside the front of the top cover align properly with the holes in the bottom case.

a. Set the HP 7090 LINE switch to OFF (0) and disconnect the line cord.

b. Remove the HP 7090 top cover by removing the screws indicated in Figure 8-11.

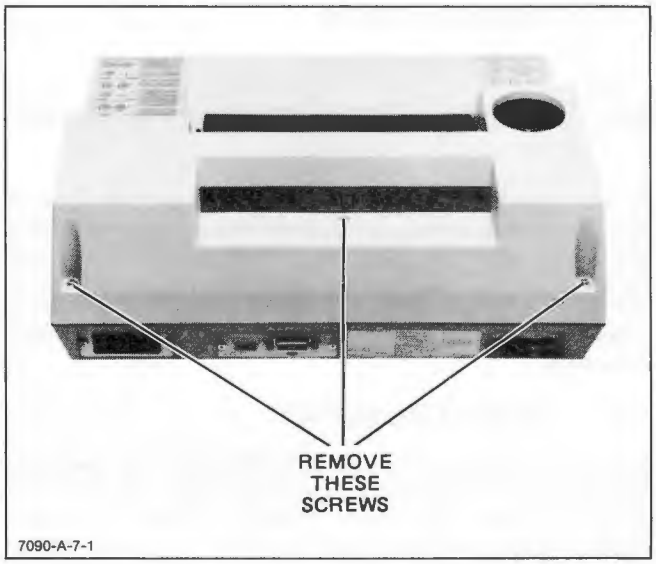


Figure 8-11. Top Cover Removal

c. Gently lift the rear of the top cover until the liquid crystal display (LCD) connector is accessible. See Figure 8-12.

d. Unplug LCD connector and remove top cover.

8-123. TIME BASE ACCURACY TEST

a. Set the HP 7090 LINE switch to off (0) and remove line cord.

b. Remove top cover as instructed in TOP COVER REMOVAL.

c. Remove screw and open cover on rear electrostatic discharge (ESD) shield. See Figure 8-13.

d. Connect counter to test points J2 pin 6 (start) and J2 pin 2 (digital com).

e. Set counter to measure a 5 volt (peak) 9.99901 to 10.00090 second pulse.

f. Apply power to the HP 7090 and counter.

g. Self the self-test switches S0 through S4 to 14 and press the self-test start pushbutton S1. See Figure 8-13.

h. Counter should indicate a period between 9.99901 and 10.00090 seconds.

i. Replace all covers.

Table 8-2. Recommended Test Equipment

TYPE	MODEL	SPECIFICATIONS
*DC Voltage Standard	Datron 4000.	Absolute accuracy better than ±2.0 μV at 10 mV output range (±0.02%), ±0.01% all other ranges.
	Data Precision 8200 has acceptable accuracy above 20 mV. Noise output is marginal below 100 mV range.	Pk-to-Pk noise on 100 mV range and under, less than 0.2 μV average over 1 line cycle (16.7 ms). At 2.5 kHz bandwidth, less than 2 μV RMS. Less than 0.001% of range on all other ranges.
Digital Multimeter	HP 3435A	3½-digit display.
Oscilloscope (dual ch.)	HP 1740A or HP 1741A	100 MHz response.
Signature Analyzer	HP 5004A, HP 5005A/B or HP 5006A	
Function Generator	HP 3311A	Sine and square wave output frequencies from 0.1 Hz through 100 Hz.
Counter	HP 5314A	10 MHz minimum frequency.
HP-IB controller	HP-85A/B or HP 9826A	32K byte memory, I/O capability via HP-IB interface. For HP-85A, I/O ROM required and 16K byte memory module.
Hewlett-Packard External Diagnostics program set.	HP 07090-18030 (HP-85) or HP 07090-18031 (HP 9825).	

*HP-IB interface option required to use 7090 external diagnostic automatic calibration program.

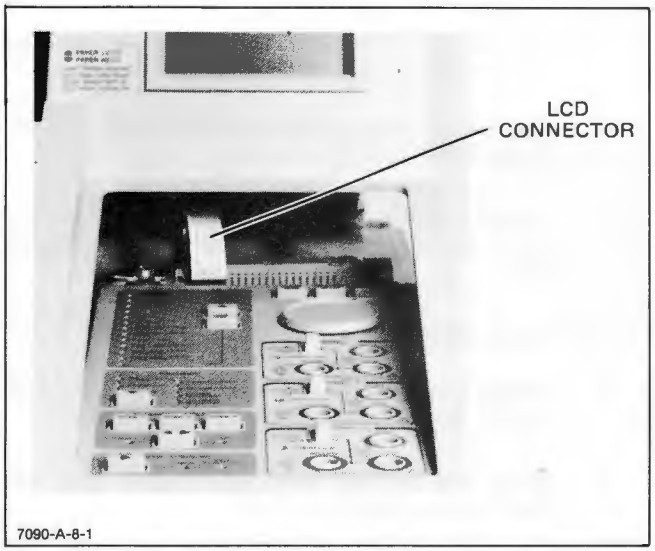


Figure 8-12. LCD Connector

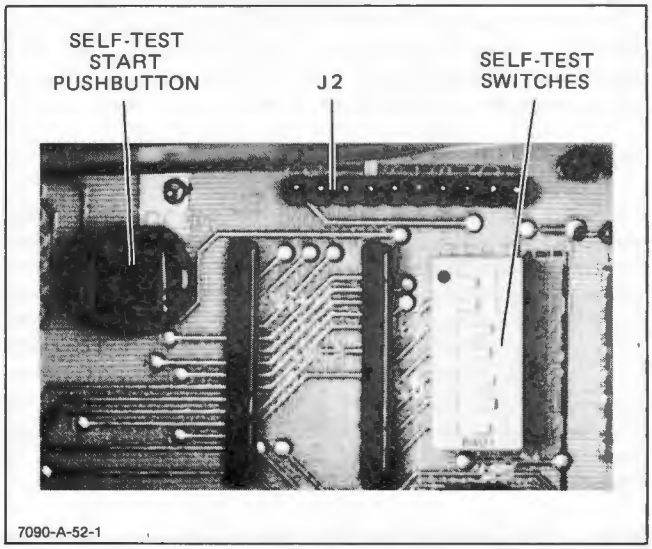


Figure 8-13. Self-Test Switches and Test Points

8-124. BATTERY REPLACEMENT

WARNING

Explosion hazard. Do not incinerate the lithium battery or expose to temperatures above 150 °C. Do not attempt to recharge a spent lithium battery.

8-125. To replace the lithium battery proceed as follows:

a. Remove top cover as instructed in TOP COVER REMOVAL.

b. See Figure 8-14. Loosen the two screws labeled "A" and remove the nine screws labeled "B".

c. Push chassis base assembly toward rear until it is clear of the two front screws.

d. Lift front of assembly and secure with support rod. See Figure 8-15.

e. Remove old battery and dispose of properly.

f. Install new battery observing correct polarity.

g. Replace all covers.

8-126. TROUBLESHOOTING

8-127. SELF-TEST

8-128. Fourteen self-test routines are used by the HP 7090 to detect circuit malfunctions. Following a power-on or reset operation the first eight self-test routines are automatically performed. If a malfunction is detected, an error code will be displayed in the front panel LCD. In the case of multiple malfunctions, error codes will be displayed in succession. There are two types of error codes: FATAL and NON-FATAL. Fatal error codes indicate malfunctions which may generate new failures in the HP 7090. A malfunction of this type, detected during a power-on or reset operation, will prohibit normal operation of the HP 7090. Non-Fatal error codes indicate malfunctions that are not likely to prohibit normal operation but affect only a portion of the normal circuit operation.

8-129. Each of the fourteen self-tests can be performed using the self-test switch and the five rocker test switches located on the Main PCA. When initiated, the selected self-test begins by displaying the test number in the front panel LCD, and lighting the self-test LED on the Main PCA. After successful completion of the test, the self-test LED blinks and "P 00" is displayed in the front panel LCD. If the selected self-test fails, an error code will be displayed in the LCD. Table 8-3 lists: self-test description, items required for successful completion of test and error codes.

8-130. To perform the self-test routines proceed as follows:

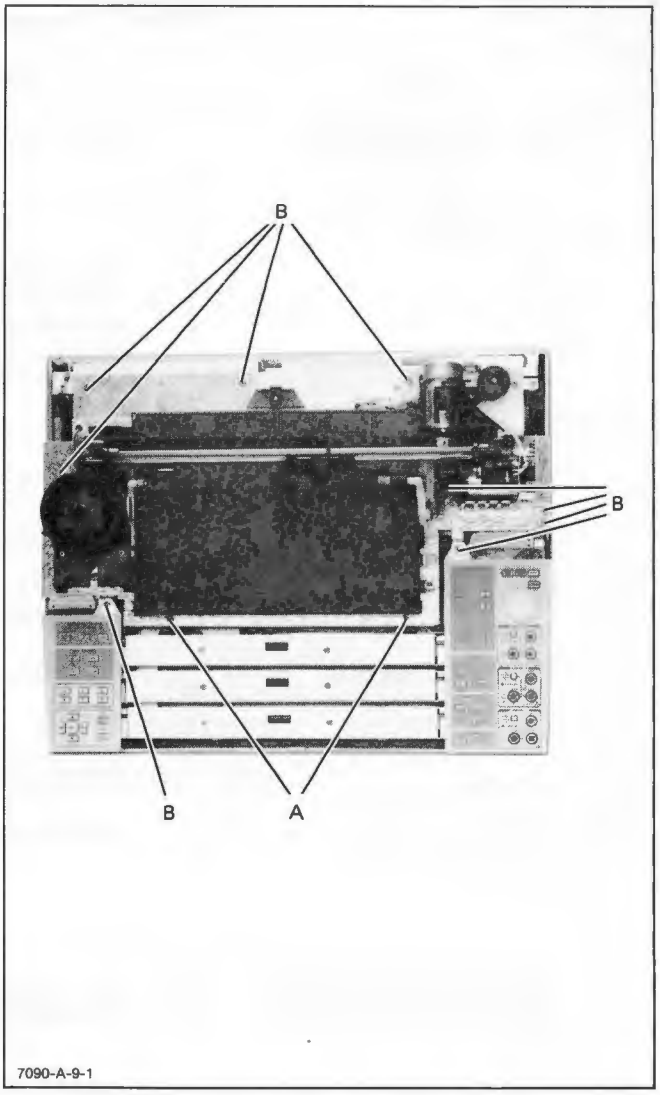


Figure 8-14. Opening Chassis Base

a. Set the HP 7090 LINE switch to OFF (0) and remove line cord.

b. Remove top cover as instructed in **TOP COVER REMOVAL.**

c. Remove screw and open cover on rear electrostatic discharge shield (ESD) as shown in Figure 8-13.

d. Apply power to the HP 7090.

e. Using switches S0 through S4, select the self-test to be performed. Refer to Table 8-3.

f. Press the self-test start pushbutton (S1) and observe the front panel LCD.

g. Replace all covers.

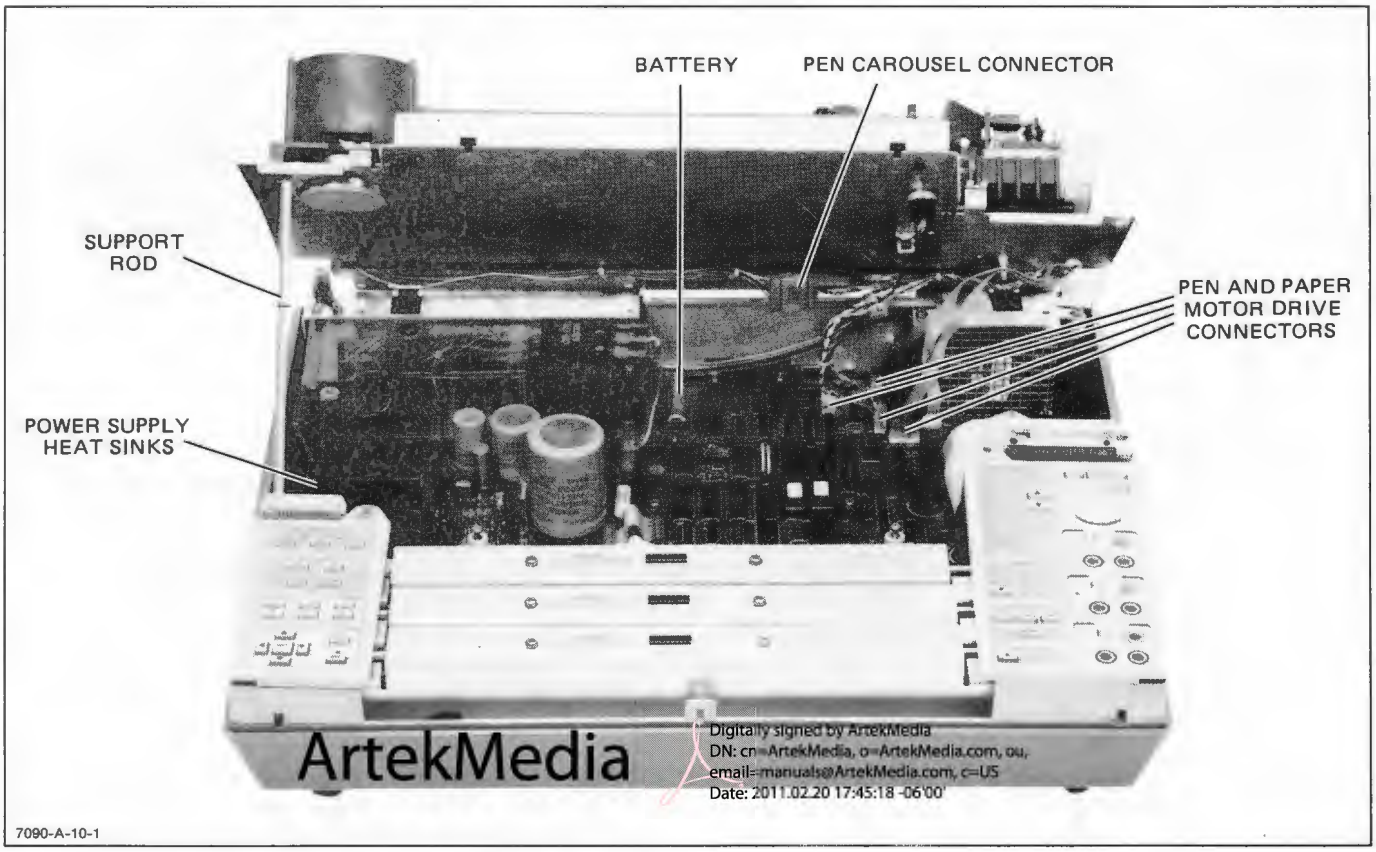


Figure 8-15. Battery/Connector Locations

Table 8-3. Self-Test

DISPLAY READING	SWITCH SETTING	DESCRIPTION
*P 01	00001	**TEST:** Performs a checksum on each of the three ROMs (U59, U26, and U25) **REQUIREMENTS:** Processor, address decoding, data bus and ROM U59 must function correctly. **ERROR CODES:** E 01 ROM U59 checksum incorrect. E 01 ROM U26 checksum incorrect. E 03 ROM U25 checksum incorrect. If self-test fails, check items listed under requirements.
*P 02	00010	**TEST:** Copies information from ROM to RAM and compares contents. Checks RAM for stuck at 0 or 1 faults and adjacent bits stuck together. **REQUIREMENTS:** Self-test P 01 must pass and RAM must be good. **ERROR CODES:** E 04 RAM U24 data incorrect. E 05 RAM U23 data incorrect. E 06 RAM U22 data incorrect. E 07 RAM U21 data incorrect. If self-test fails, check items listed under requirements.
*P 03	00011	**TEST:** Exercises the servo gate array in test mode checking the encoder decoding circuitry, the pen and paper axes pulse width modulators, the pen lift pulse width, and the parallel to serial converter. **REQUIREMENTS:** Self-test P 02 must pass and the Servo Gate Array must be good. **ERROR CODE:** E 08 Servo Gate Array failure. If self-test fails, check items listed under requirements.
*P 04	00100	**TEST:** Checks ability of Programmable Counter to count at programmable rates. **REQUIREMENTS:** Self-test P 03 must pass and the Programmable Counter I.C. and support circuitry must be good. **ERROR CODES:** E 09 Programmable Counter 0 failure. E 10 Programmable Counter 1 failure. E 11 Programmable Counter 2 failure. If self-test fails, check items listed under requirements.
P 05	00101	**TEST** Checks annunciators on front panel LCD and front panel LEDs. **REQUIREMENTS:** Self test P 04 must pass and front panel LCD, LEDs and controller I.C. must be good. **ERROR CODES:** None. Failure of leds to light or LCD annunciators to be visible are test fail indications. If self-test fails, check items listed under requirements.

*Denotes FATAL ERROR, instrument will not operate with a fatal error.

Table 8-3. Self-Test (Continued)

DISPLAY READING	SWITCH SETTING	DESCRIPTION
P 06	00110	**TEST:** Checks ability of the Front End Gate Array to complete a Direct Memory Access cycle and transfer data to RAM. **REQUIREMENTS:** Self-test P 02 and P05 must pass and the Front End Gate Array must be good. **ERROR CODES:** E 12 Front End Gate Array failure. If self test fails, check FEGA and support circuits.
P 07	00111	**TEST:** Checks ability of the input channels to change offset, range, and attenuation correctly. Also checks sample and hold function and stuck at 0 or 1 faults as well. **REQUIREMENTS:** Self-test P 03 and P 06 must pass and all three input channels must be good. **ERROR CODES:** E 13 Channel 1 offset failure. E 14 Channel 2 offset failure. E 15 Channel 3 offset failure. E 16 Channel 1 sample/hold failure. E 17 Channel 2 sample/hold failure. E 18 Channel 3 sample/hold failure. E 19 Channel 1 stuck at failure. E 20 Channel 2 stuck at failure. E 21 Channel 3 stuck at failure. E 22 Channel 1 gain adjust failure. E 23 Channel 2 gain adjust failure. E 24 Channel 3 gain adjust failure. If self-test fails, check items listed under requirements.
P 08	10000	**TEST:** Checks front panel controller IC for proper initialization and the ability to correctly read/write display RAM. **REQUIREMENTS:** Self-test P 02 must pass and the front panel controller must be good. **ERROR CODES:** E 28 Front panel controller IC failure. If self-test fails, check items listed under requirements.
P 09	01001	**TEST:** Checks HP-IB controller IC for proper initialization and ability to talk/listen. Sends 'HP7090crlf' over HP-IB bus. **REQUIREMENTS:** Self-test P 02 must pass and HP-IB controller must be good. **ERROR CODES:** E 29 HP-IB controller IC failure. If self-test fails, check items listed under requirements.
P 10	01010	**TEST:** Verifies that Real Time Clock is counting at the proper rate. **REQUIREMENTS:** Self-test P 02 must pass. The Real Time Clock and associated circuits must be good. **ERROR CODES:** E 30 Real Time Clock failure. If self-test fails, check R.T.C. and associated circuits.

Table 8-3. Self-Test (Continued)

<table>
<tr><th>DISPLAY READING</th><th>SWITCH SETTING</th><th>DESCRIPTION</th></tr>
<tr><td>P 11</td><td>01011</td><td>TEST: Checks ability of the processor to program and read the EEPROM.

REQUIREMENTS: Self-test P 02 must pass and the EEPROM must be good.

ERROR CODES: E 31 Nonfunctional EEPROM.

If self-test fails, check items listed under requirements.</td></tr>
<tr><td>P 12</td><td>01100</td><td>TEST: Checks ability of Front End Gate Array to correctly receive analog input data and control direct memory access cycles.

REQUIREMENTS: Self-tests P 03 and P 06 must pass. The analog input assemblies must be removed and jumpers added as follows:

<table><tr><th>FROM Main PCA</th><th>TO Power Supply PCA</th></tr><tr><td>J6</td><td>J9, 10, 11 pin 19</td></tr><tr><td>J7</td><td>J9, 10, 11 pin 20</td></tr></table>
ERROR CODES: E 32 FEGA Channel 1 bad data.
E 33 FEGA Channel 2 bad data.
E 34 FEGA Channel 3 bad data.

If self-test fails, check items listed under requirements.</td></tr>
<tr><td>*P 13</td><td>01101</td><td>TEST: Checks ability of the processor to respond to (NMI) Non-Maskable Interrupts and exercises the motor drive, pen lift and pen carousel driver circuitry. Proper operation of the pulse width modulators (PWM) is verified with an oscilloscope. All PWMs sweep through all gains and valid pulse widths. All four pen carousel driver bits will toggle in unison. The LCD will display a count derived from the NMI. To make viewing the PWMs easier the count derived from the NMI will not be at a constant rate.

REQUIREMENTS: Self-tests P 03, P 04, and P 05 must pass and the pen carousel, pen lift, motors and encoders must be unplugged.

Note: All connections from chassis to Main PCA must be disconnected before running test. Test runs indefinitely to allow debugging of driver circuitry with an oscilloscope.

ERROR CODES: E 35 NMI did not occur before timeout.

If self-test fails, check items listed under requirements.</td></tr>
<tr><td>P 14</td><td>01110</td><td>TEST: Checks ability of the processor to respond to a FIRQ, (Fast interrupt request). The FIRQs are generated by the programmable counter and a counter is updated in the LCD at a 1 Hz rate.

REQUIREMENTS: Self-test P 03, P 04, and P 05 must pass.

ERROR CODES: E 36 FIRQ did not occur before time out.

If self-test fails, check items listed under requirements.</td></tr>
</table>

*Denotes FATAL ERROR, instrument will not operate with a fatal error.

8-131. ANALOG CHANNEL CALIBRATION

8-132. Internal voltage gain errors are compensated for by multiplying the output of A/D converter U1 by one of fourteen calibration constants. These calibration constants are calculated and stored in the EEPROM during the analog channel calibration procedure. This procedure consists of measuring a specified voltage from an external dc standard and caculating the calibration constants. The calibration procedure is controlled by the calibration program listed in Table 8-4. This program is available as part of an External Diagnostic programs tape (P/N 07090-18030) designed for the HP-85 or programs tape (P/N 07090-18031) for HP 9826A controllers.

8-133. Calibration of an analog channel is required whenever any analog component on the analog channel PCA is replaced. Analog channel assemblies replaced with a new assembly and those moved to a different location in the HP 7090 must have their calibration constants entered into the EEPROM location that corresponds to the analog channel assemblies' new location. When the main PCA is replaced, the EEPROM must be removed from the defective assembly and used in the replacement assembly. No calibration is then required. If the EEPROM transfer is not made, calibration of each analog channel must be done.

8-134. A label listing the appropriate calibration constants for an analog channel appears on the rear cover of the analog channel assembly. The constants may be entered in the EEPROM using any HP-IB controller and the calibration program listed in Table 8-4. Even though all three analog channels are identical and may be interchanged during troubleshooting, the stored calibration constants are associated with the channel location, not the specific channel assembly. If a channel is repositioned to another location, it must be recalibrated. An adhesive label indicating the original calibrated location is applied to each analog channel during final assembly. The label can be easily transferred to another assembly if necessary.

8-135. DIAGNOSTIC PROGRAMMING INSTRUCTIONS

8-136. Three special HP-GL programming instructions are used during analog channel calibration and with several of the external diagnostic aids contained on the 7090A External Diagnostic programs tape (P/N 07090-18030). The instructions consist of a two character mnemonic followed by a comma, one or more parameters and a terminating semicolon. No spaces or other punctuation should be included. The instructions are: ENABLE MEMORY (EM), READ MEMORY LOCATION (RM) and WRITE MEMORY LOCATION (WM).

Instruction: ENABLE MEMORY

Syntax: EM,7090;

Purpose: Enables access to any memory location in the 7090 through the READ MEMORY and WRITE MEMORY instructions. This instruction sets a flag which remains in effect until the next initialization operation.

Instruction: READ MEMORY LOCATION

Syntax: RM,n;

Where: "n" is the decimal address of the byte in memory to be read.

Purpose: Causes the 7090 to output the instruction or data byte located at the specified memory address (n). The memory address is formated as an interger in the range of 0 to 255. The HP-IB End or Identify control line is used to signal the last byte transmitted.

NOTE

The READ MEMORY instruction must be preceded by the ENABLE MEMORY instruction. If not, an HP-GL error code "1" is set and the instruction ignored.

In addition, both CAL and CAL/TEST switches of self-test switch S3 must be in the CAL position. If the switches are not set correctly no write operation will occur.

CAUTION

Unpredictable results and/or damage to the HP 7090 can occur if improper values are written to the memory locations.

Instruction: WRITE MEMORY

Syntax: WM,n,d;

Where: "n" is the decimal address in memory where the data is to be written. Valid addresses are 0000 through FFFF (hex). "d" is the decimal value of the 8-bit data byte to be written in memory location n. The valid range is 0 to 255.

Purpose: Allows data to be entered into specific memory locations by way of the HP-IB controller. While any memory location is valid as an address parameter, only Read/Write memory locations and certain hardware registers can actually accept data. The valid RAM locations are at addresses 0000 through 3FFF and 5400 through 55FF (hex).

NOTE

The WRITE MEMORY instruction must be preceded by the ENABLE MEMORY instruction. If not, an HP-GL error code "1" is set and the instruction ignored.

Table 8-4. Calibration Program

```
1000 !
1010 !
1020 !        CALIBRATION CONSTANT DATA ENTRY PROGRAM FOR THE HP7090A
1030 !                      MARCH 1, 1984      (2409)
1040 !
1050 ! ***************************************************************
1060 !
1070 !
1080 ! THIS PROGRAM IS USED TO ENTER CALIBRATION DATA FOR THE HP7090A
1090 ! ANALOG CHANNEL ASSEMBLIES.  CALIBRATION DATA FOR EACH CHANNEL IS FOUND
1100 ! ON A LABEL ON THE REAR OF EACH ASSEMBLY.  THE DATA CONSISTS OF FOURTEEN
1110 ! PAIRS OF NUMBERS, CALLED THE HIGH BYTE AND THE LOW BYTE, WHICH,
1120 ! TOGETHER, FORM A SET OF RANGE CORRECTION FACTORS.  THE DATA MUST
1130 ! BE RE-ENTERED ANY TIME AN ANALOG CHANNEL IS EXCHANGED, MOVED TO
1140 ! ANOTHER LOCATION, OR TO ANOTHER INSTRUMENT.  IF A CHANNEL HAS
1150 ! BEEN REPAIRED, IT MUST BE RE-CALIBRATED.  REFER TO SECTION 6.0 OF
1160 ! THE 7090A SERVCE MANUAL FOR INSTRUCTIONS ON INSTRUMENT RE-CALIBRATION.
1170 !
1180 !
1190 !                  ***** SELF TEST SWITCH SETTINGS *****
1200 !
1210 ! THE PROGRAM REQUIRES THAT THE INTERNAL SELF TEST SWITCHES, LOCATED
1220 ! AT THE REAR OF THE MAIN PCA, BE SET TO THE 'ZERO' POSITION
1230 ! (TO THE RIGHT AS VIEWED THROUGH THE ACCESS COVER FROM THE FRONT).
1240 ! THE REAR-MOST SWITCH MUST BE SET TO THE LEFT, OR '1' POSITION.
1250 ! THE PROGRAM USES SPECIAL UNDOCUMENTED SERVICE COMMANDS TO READ
1260 ! AND WRITE DATA INTO THE MEMORY.  THE COMMANDS SHOULD NEVER BE
1270 ! USED IN ANY OTHER PROGRAM AS UN-PREDICTABLE RESULTS OR DAMAGE TO
1280 ! THE INSTRUMENT MAY OCCUR.
1290 !
1300 !
1310 ! INITIALIZE PROGRAM VARIABLES AND READ CURRENTLY STORED DATA
1320 !
1330 CLEAR
1340 DISP "ENTER THE HP-IB ADDRESS FOR YOUR 7090A (E.G. '705')"
1350 INPUT D
1360 D1=INT(D/100)
1370 SET TIMEOUT D1;1000 !       SET HP-IB INTERFACE TIMEOUT TO 1 SECOND
1380 ON TIMEOUT D1 GOTO 3090 !   AND ESTABLISH ERROR HANDLING ROUTINE
1390 DIM V(14,6),A$[10]
1400 FOR I=1 TO 14
1410 FOR J=1 TO 6
1420 V(I,J)=0
1430 NEXT J
1440 NEXT I
1450 C=0
1460 D0=0
1470 OUTPUT D ;"IN;0I;"
1480 ENTER D ; A$
1490 IF A$="7090A" THEN 1530
1500 DISP "**** ERROR ****"
1510 DISP "THE 7090A IS NOT AT ADDRESS";D;"."
1520 GOTO 3120
1530 DISP
1540 DISP "READING DATA FROM THE 7090A."
1550 DISP "FIFTEEN SECONDS, PLEASE."
1560 OUTPUT D ;"EM,7090;"
1570 OUTPUT D ;"RM,19456;"
1580 ENTER D ; S
1590 IF S=192 OR S=128 OR S=64 THEN 1650
1600 DISP " **** ERROR ****"
1610 DISP
1620 DISP "THE INTERNAL SELF TEST SWITCHES ARE NOT SET CORRECTLY."
1630 DISP "CORRECT THEM AND RE-RUN THIS PROGRAM."
1640 GOTO 2490
1650 !
```

7090-A-70-1

Table 8-4. Calibration Program (Continued)

```
1660 !   READ CURRENT EEPROM CONTENTS
1670 !
1680 FOR C=1 TO 3
1690 FOR R=1 TO 14
1700 OUTPUT D ;"RM,";21760+((C-1)*14+(R-1))*2
1710 ENTER D ; HO
1720 V(R,C*2-1)=HO
1730 OUTPUT D ;"RM,";21760+((C-1)*14+(R-1))*2+1
1740 ENTER D ; LO
1750 V(R,C*2)=LO
1760 NEXT R
1770 NEXT C
1780 C=0
1790 !
1800 !   LOOP TO ENTER NEW CALIBRATION DATA
1810 !
1820 C=C+1
1830 IF C>=4 AND DO=0 THEN 2540
1840 IF C>=4 AND DO<>0 THEN 2060
1850 DISP
1860 DISP "DO YOU WISH TO ENTER DATA FOR CHANNEL NUMBER";C;"(Y/N)"
1870 GOSUB 3210
1880 IF A$[1,1]<>"Y" THEN GOTO 1800
1890 !
1900 !   ENTER DATA FOR CHANNEL 'C'
1910 !
1920 CLEAR
1930 DO=1
1940 DISP "ENTER NEW CALIBRATION DATA FOR CHANNEL";C;"FOR EACH RANGE AS"
1950 DISP "REQUESTED. ENTER TWO VALUES, THE HIGH BYTE FOLLOWED BY THE "
1960 DISP "LOW BYTE, AND SEPARATED BY A COMMA.  PRESS RETURN AFTER EACH ENTRY."
1970 FOR R=1 TO 14
1980 DISP "RANGE ";R;":";
1990 INPUT V(R,C*2-1),V(R,C*2)
2000 NEXT R
2010 CLEAR
2020 DISP "YOU HAVE ENTERED THE FOLLOWING"
2030 GOSUB 2810
2040 GOSUB 2930
2050 GOTO 1800
2060 DISP "WOULD YOU LIKE A PRINTED LIST OF ALL CALIBRATION DATA STORED"
2070 DISP "IN YOUR INSTRUMENT'S EEPROM (Y/N)"
2080 GOSUB 3210
2090 IF A$[1,1]<>"Y" THEN 2170
2100 DISP "CURRENT CALIBRATION INFORMATION"
2110 DISP "-------------------------------"
2120 DISP USING "//"
2130 FOR C=1 TO 3
2140 GOSUB 2810
2150 NEXT C
2160 !
2170 !   WRITE CALIBRATION DATA TO EEPROM
2180 !
2190 CLEAR
2200 DISP USING "///"
2210 DISP "WRITING DATA TO THE 7090 EEPROM."
2220 DISP "THIRTY SECONDS, PLEASE . . ."
2230 FOR C=1 TO 3
2240 FOR R=1 TO 14
2250 OUTPUT D ;"WM,";21760+((C-1)*14+(R-1))*2;",";V(R,C*2-1)
2260 OUTPUT D ;"WM,";21760+((C-1)*14+(R-1))*2+1;",";V(R,C*2)
2270 NEXT R
2280 NEXT C
2290 !
2300 !   COMPARE WITH CONTENTS OF EEPROM
2310 !
```

7090-A-71-1

Table 8-4. Calibration Program (Continued)

```
2320 FOR C=1 TO 3
2330 FOR R=1 TO 14
2340 OUTPUT D ;"RM,";21760+((C-1)*14+(R-1))*2
2350 ENTER D ; H1
2360 OUTPUT D ;"RM,";21760+((C-1)*14+(R-1))*2+1
2370 ENTER D ; L1
2380 IF H1<>V(R,C*2-1) OR L1<>V(R,C*2) THEN 2710
2390 NEXT R
2400 NEXT C
2410 CLEAR
2420 DISP
2430 DISP "CALIBRATION CONSTANTS HAVE BEEN ENTERED INTO THE 7090A EEPROM"
2440 DISP "AND VERIFIED.  PLEASE RESET THE INTERNAL SELF TEST SWITCHES TO THEIR"
2450 DISP "NORMAL POSITION.  IF YOU WISH TO VERIFY CALIBRATION, RUN THE "
2460 DISP "PROGRAM 'CALIB' ON THE HP7090A DIAGNOSTIC AND VERIFICATION TAPE"
2470 DISP "P/N 07090-18030 (HP85A VERSION) OR P/N 07090-18031 (HP9826A VERSION).
   "
2480 DISP "A LOW NOISE DC VOLTAGE STANDARD IS REQUIRED FOR CALIBRATION."
2490 DISP
2500 DISP
2510 DISP " . . . . . DONE . . . . . ."
2520 STOP
2530 !
2540 !   NO CHANNEL SPECIFIED FOR NEW DATA ENTRY
2550 !
2560 DISP "CURRENT CALIBRATION INFORMATION"
2570 DISP "------------------------------"
2580 DISP USING "//"
2590 FOR C=1 TO 3
2600 GOSUB 2810
2610 NEXT C
2620 DISP
2630 DISP "YOU DID NOT REQUEST TO ENTER NEW CALIBRATION DATA FOR AT LEAST"
2640 DISP "ONE CHANNEL.  PLEASE REVIEW THE LIST OF DATA CURRENTLY STORED"
2650 DISP "IN YOUR INSTRUMENT. IS IT CORRECT (Y/N)"
2660 GOSUB 3210
2670 IF A$[1,1]="Y" THEN 2410
2680 C=0
2690 GOTO 1800
2700 !
2710 !   ERROR IN WRITING CALIRATION DATA
2720 !
2730 CLEAR
2740 DISP
2750 DISP "AN ERROR HAS OCCURRED IN WRITING THE NEW CALIBRATION DATA INTO THE"
2760 DISP "EEPROM. VERIFY CORRECT OPERATION OF THE 7090A BY PERFORMING ALL"
2770 DISP "EEPROM RELATED INTERNAL SELF TESTS.  REFER TO THE SERVICE MANUAL,"
2780 DISP "SECTION 6.0 FOR HELP."
2790 GOTO 2490
2800 !
2810 !   DISPLAY DATA VALUES SUBROUTINE
2820 !
2830 CLEAR
2840 DISP "DATA FOR CHANNEL NUMBER";C;":"
2850 DISP USING "//"
2860 DISP "RANGE     HIGH BYTE     LOW BYTE"
2870 FOR R=1 TO 14
2880 DISP USING "X,3D,9X,3D,9X,3D" ; R,V(R,C*2-1),V(R,C*2)
2890 NEXT R
2900 DISP USING "////"
2910 RETURN
2920 !
2930 !   DATA ENTRY CORRECTION SUBROUTINE
2940 !
2950 CLEAR
2960 DISP
```

7090-A-72-1

Table 8-4. Calibration Program (Continued)

```
2970 DISP "HAVE ALL THE CALIBRATION VALUES FOR CHANNEL";C;"BEEN ENTERED"
2980 DISP "CORRECTLY (Y/N)";
2990 GOSUB 3210
3000 IF A$[1,1]="Y" THEN 3070
3010 DISP "ENTER THE RANGE NUMBER, THE HIGH BYTE, AND THE LOW BYTE, EACH"
3020 DISP "SEPARATED BY A COMMA, FOR THE FIRST RANGE WITH INCORRECT VALUES."
3030 INPUT R,H2,L2
3040 V(R,C*2)=H2
3050 V(R,C*2-1)=L2
3060 GOTO 2930
3070 RETURN
3080 !
3090 !   HP-IB INTERFACE TIMEOUT
3100 !
3110 DISP "   *  *  *  HP-IB INTERFACE TIMEOUT  *  *  *"
3120 DISP
3130 RESET D1
3140 DISP "CHECK THE 7090A TO BE SURE THE POWER IS ON, THE INTERFACE CABLE IS"
3150 DISP "CONNECTED PROPERLY, THE ADDRESS IS SET TO";D-D1*100;"AND THE SELF TES
   T"
3160 DISP "SWITCHES ARE SET CORRECTLY.  RE-RUN THIS PROGRAM AFTER YOU HAVE"
3170 DISP "CHECKED EVERYTHING.  IF YOU ARE STILL UN-SUCCESSFULL, REFER TO THE"
3180 DISP "7090A SERVICE MANUAL, SECTION 6.X, FOR HELP."
3190 GOTO 2490
3200 !
3210 !   USER RESPONSE SUBROUTINE
3220 !
3230 INPUT A$
3240 A$=UPC$(A$)
3250 IF A$[1,1]="Y" OR A$[1,1]="N" THEN RETURN ELSE GOTO 3260
3260 DISP "   *  *  *  ERROR  *  *  *"
3270 DISP "ANSWER WITH 'Y' OR 'N' PLEASE!"
3280 GOTO 3230
3290 END
```

7090-A-73-1

8-137. PARTS REMOVAL AND REPLACEMENT

8-138. PEN CAROUSEL HOUSING REMOVAL

a. Remove the top cover as instructed in **TOP COVER REMOVAL.**

b. See Figure 8-14. Loosen the two screws labeled "A" and remove the nine screws labeled "B".

c. Push chassis base assembly toward rear, until it is clear of the two front screws.

d. Lift front of assembly and secure with support rod. See Figure 8-15.

e. Disconnect the pen carousel cable connector and remove cable from holders and grommet.

f. Lower the base chassis assembly and slide under the two forward screws.

g. Remove the screw that secures the pen carousel housing to the base chassis assembly. See Figure 8-16.

h. To reassemble, reverse steps a through g.

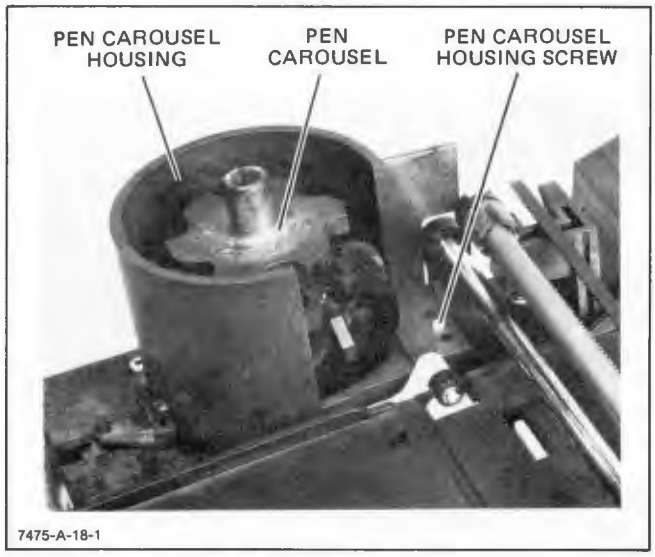


Figure 8-16. Pen Carousel Housing

8-139. PAPER DRIVE MOTOR ASSEMBLY REMOVAL

a. Remove the top cover. Refer to **TOP COVER REMOVAL.**

CAUTION

Do not remove the encoder printed circuit assembly or the drive coupler from the motor. The entire unit must be assembled and calibrated at the factory.

b. Disconnect the paper drive motor cable (twisted pair) and the encoder cable. See Figure 8-17.

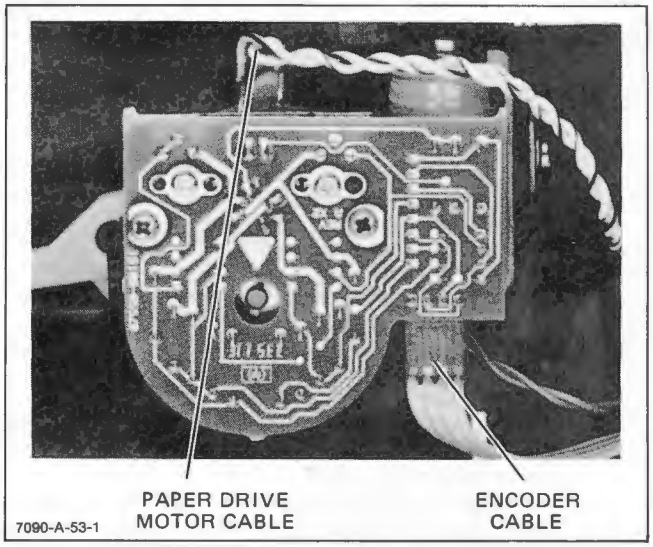


Figure 8-17. Paper Drive Motor

c. Remove the pen drop shield. See Figure 8-18.

d. Loosen the motor clamp and remove the motor from its mounting. See Figure 8-18.

e. When replacing the motor, make sure that the rubber O-rings on the drive shaft coupler and the motor shaft coupler fit inside the grooves of the coupler ring, and the boss (key) on the underside of the motor casting fits into the corresponding hole in the chassis. See Figure 8-19.

f. Make sure the pen carriage slider rod is all the way to the left, then replace the motor clamp. The arm on the clamp should hold the slider rod to the left. Tighten the clamp screw securely.

g. Loosen the clamping screw in the paper drive shaft coupler just enough to allow the coupler to slide on the shaft. Make sure the nut remains in the coupler.

h. Hold the drive shaft to the left by pushing (with a finger) on the left gritwheel, and push the drive shaft coupler to the right (with another finger) so that the coupler parts fit fit together snugly. Tighten the shaft coupler clamping screw securely.

i. Reconnect all cables.

8-140. PEN SOLENOID

a. Remove the top cover. Refer to **TOP COVER REMOVAL.**

b. Disconnect the solenoid cable.

c. Loosen the solenoid mounting screw enough to allow removal of the solenoid. See Figure 8-20.

d. Reverse procedure to reassemble.

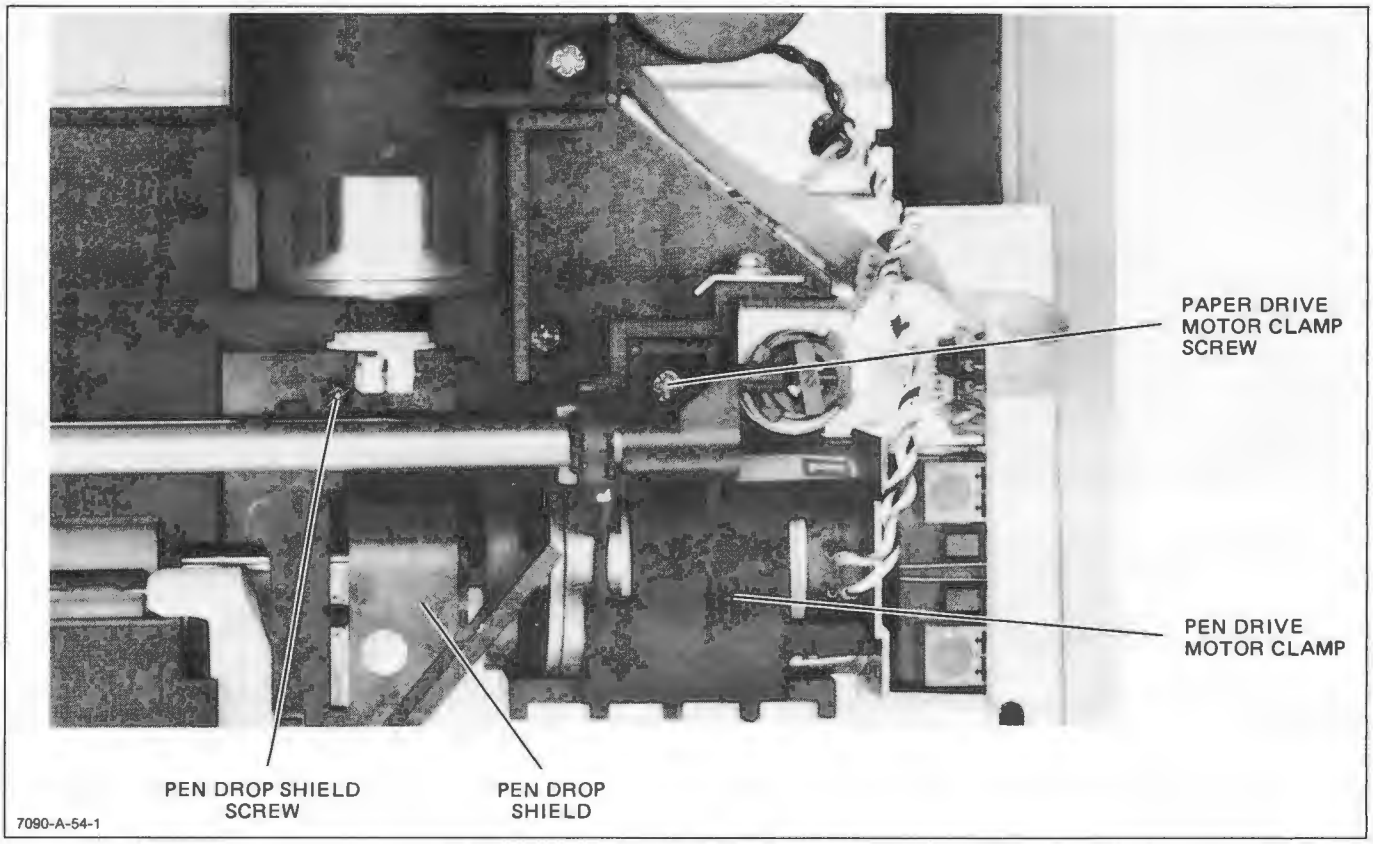


Figure 8-18. Paper Drive Motor Clamp and Pen Drop Shield

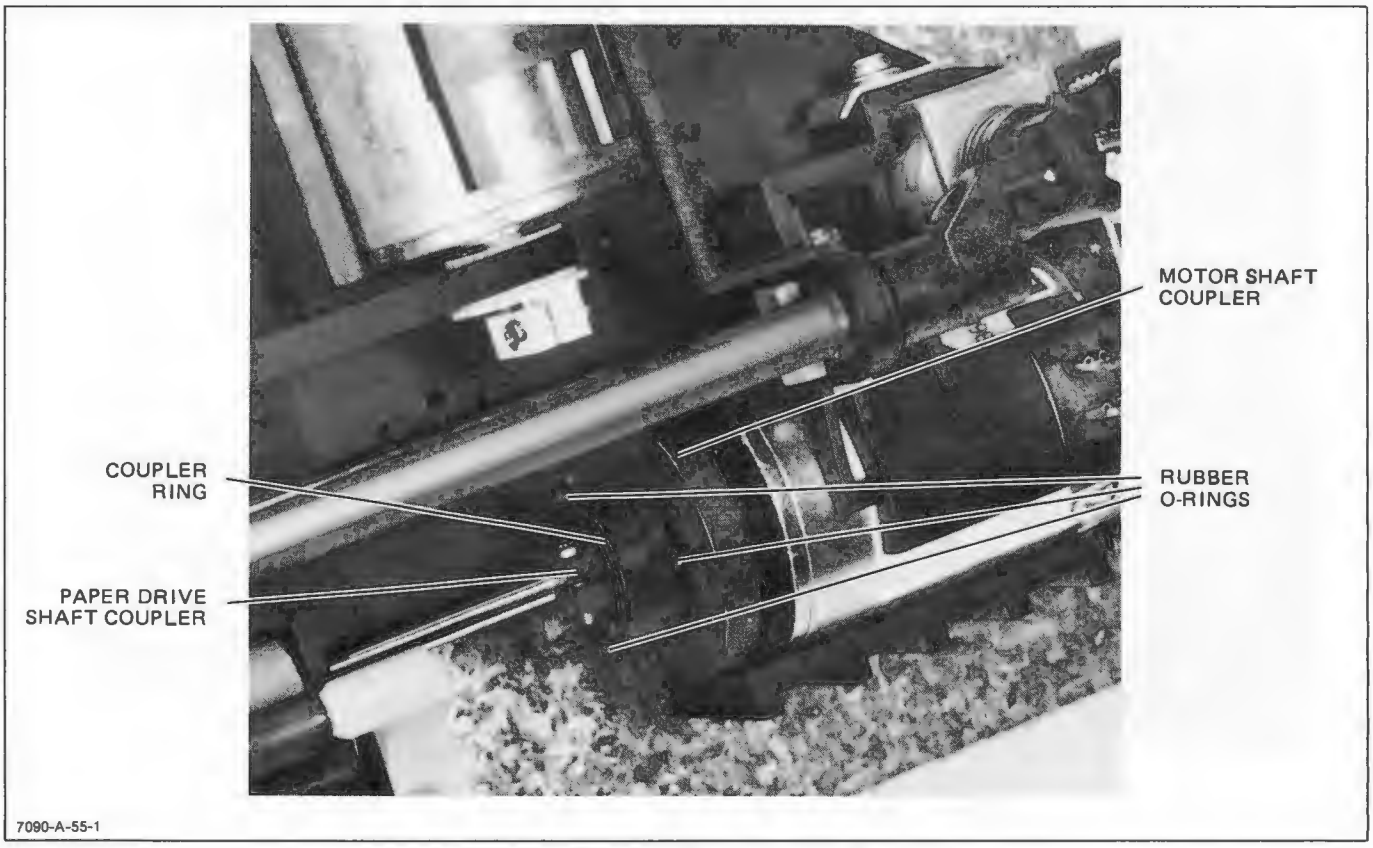


Figure 8-19. Paper Drive Coupler Parts

Figure 8-20. Pen Solenoid

8-141. PEN DRIVE MOTOR AND BELT

8-142. To remove the pen drive motor and belt, proceed as follows:

a. Remove the top cover. Refer to **TOP COVER REMOVAL.**

CAUTION

Do not remove the encoder printed circuit assembly or drive pulley from the motor. The entire assembly must be assembled and calibrated at the factory.

b. Disconnect the pen drive motor cable (twisted pair) and the encoder cable connector. See Figure 8-21.

c. Remove the belt tensioner by pressing downward on the tensioner and sliding the tang at the bottom out of the slot in the chassis. See Figure 8-22.

d. Loosen the pen drive motor clamp and remove the motor. See Figure 8-21.

e. To remove the belt, slide it from the pen carriage. See Figure 8-23.

f. Loosen the pen solenoid mounting screw shown in Figure 8-20. Slide the solenoid to the right and remove the armature and spring.

g. Slide the pen lift bar to the right just far enough to allow removal of the belt.

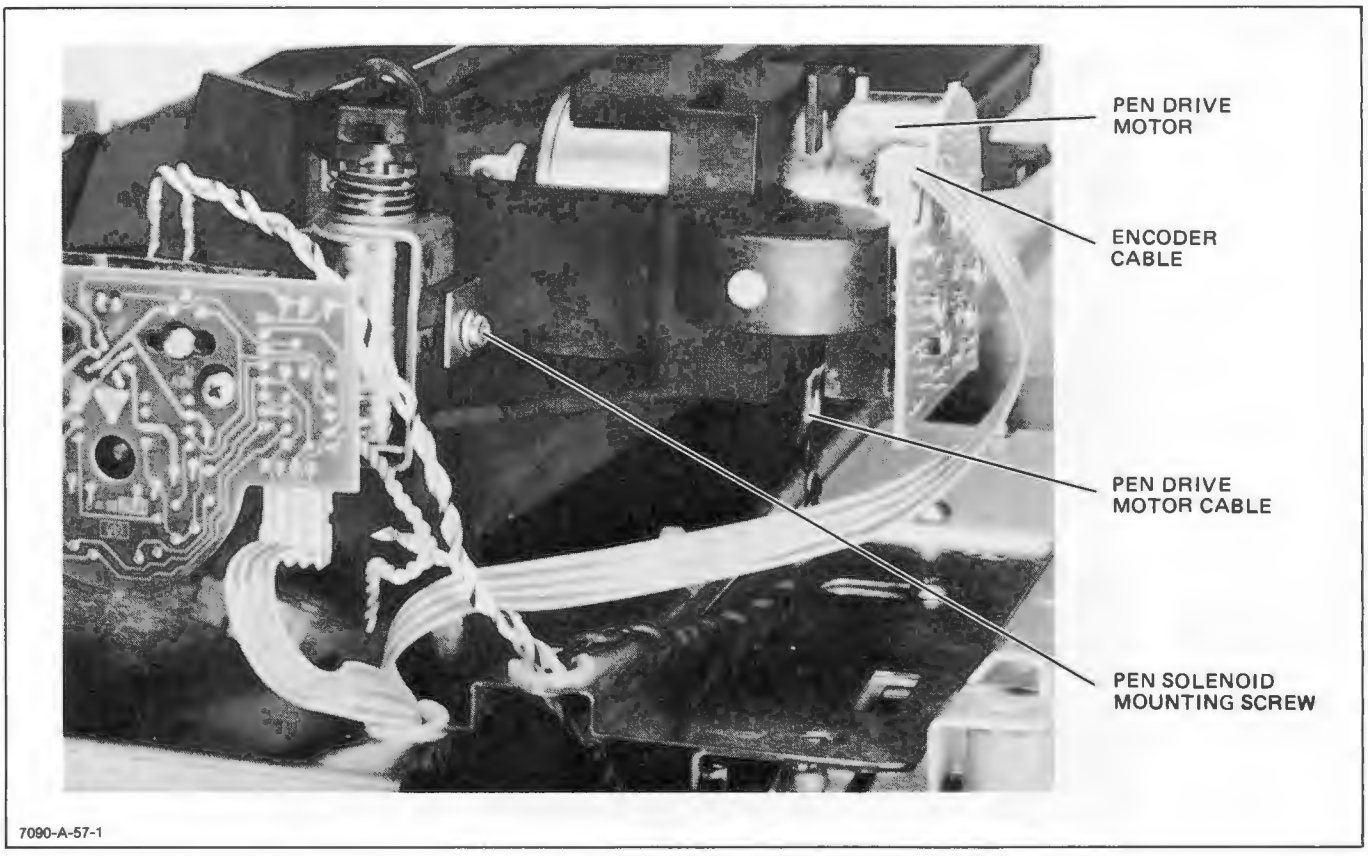


Figure 8-21. Pen Drive Motor

8-143. To replace the belt and motor, proceed as follows:

a. Place the belt in position and replace the pen lift bar.

b. Replace the solenoid spring and armature and secure the solenoid back into place.

c. Slide the belt into the pen carriage. See Figure 8-23.

d. Place the idler pulley in position.

e. Slide the pen drive motor into place and tighten the clamp. (A boss key on the side of the motor casting must fit into a notch in the chassis.)

f. Place the belt over the drive pulley.

g. Replace the belt tensioner and spring. Move the pen carriage from side to side and make sure the belt and pulleys are properly aligned.

h. Connect the motor and encoder cables to the pen drive motor.

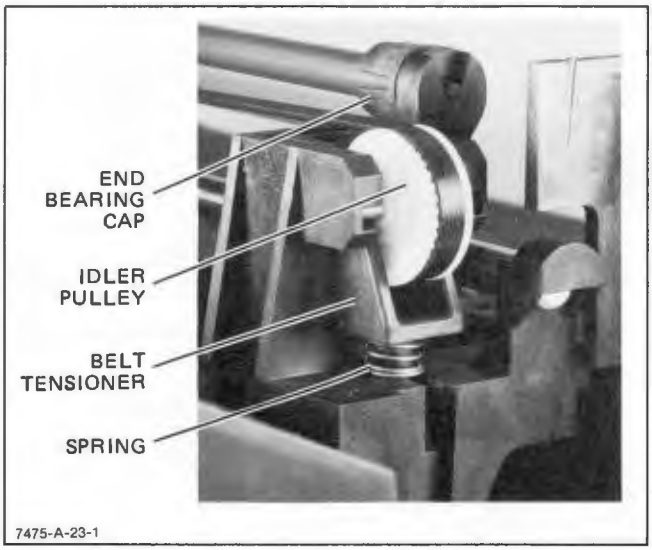


Figure 8-22. Pen Drive Belt Tensioner

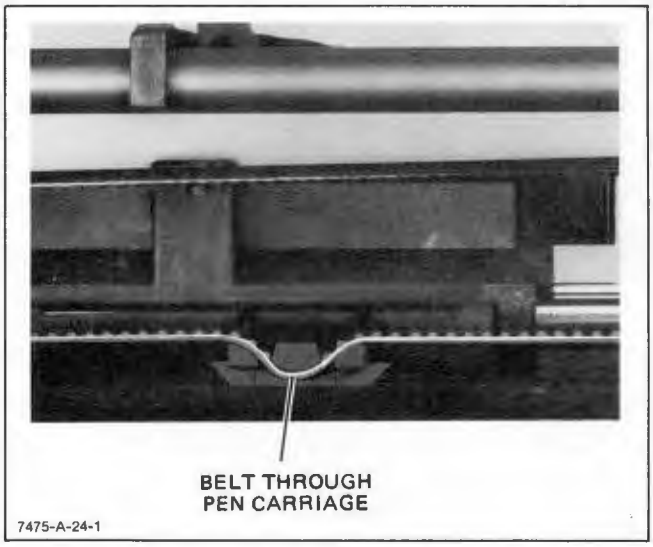


Figure 8-23. Pen Carriage

i. Replace the top cover, making sure the PAPER LOAD/HOLD lever extends through the cover and the tabs inside the front of the cover align properly.

8-144. PEN CARRIAGE, PENHOLDER, AND DAMPER REMOVAL

8-145. To remove the pen carriage, penholder, and damper, proceed as follows:

a. Remove the top cover. Refer to **TOP COVER REMOVAL.**

b. Remove the paper drive motor. Refer to **PAPER DRIVE MOTOR ASSEMBLY REMOVAL.**

c. Remove the pen solenoid. Refer to **PEN SOLENOID REMOVAL.**

d. Remove the pen drive motor. Refer to **PEN DRIVE MOTOR AND BELT REMOVAL** steps b., c., and d.

e. Slide the belt from the pen carriage and move the pen carriage to the left. See Figure 8-23.

NOTE

To compensate for possible variations in damper elasticity and spring tension, there are four pen down springs available. All four springs should be readily accessible before any further disassembly. The springs are described in Section VI.

CAUTION

Two springs will be released during the next two steps — the pen down spring and a preload spring on the slider rod between the carriage and penholder parts. Proceed carefully.

f. Remove the end bearing cap while sliding the pen lift bar to the right and out of the carriage assembly. See Figure 8-22. (To replace the end cap on the lift bar, merely slide the cap onto the bar.)

g. Move the slider rod to the right just far enough to release the left end of the rod from its mounting. See Figure 8-21. Slide the rod to the left and out of the carriage/penholder assembly.

h. The rubber damper is merely pressed into the carriage and penholder parts. Remove carefully.

8-146. To reassemble, proceed as follows:

a. Carefully replace the damper.

b. Place the pen down and preload springs into position and hold the parts together while inserting the slider rod from the left. Make sure the pre-load spring is positioned over the rod properly so that it does not drag on the slider rod.

c. Replace the slider rod in the chassis.

d. Replace the pen lift bar.

e. Replace the pen solenoid.

f. Replace the paper drive motor, making sure that the rubber O-rings on the drive shaft coupler and the motor shaft coupler fit inside the grooves of the coupler ring, and the boss (key) on the under side of the motor casting fits into the corresponding hole in the chassis. See Figure 8-19.

g. Make sure the pen carriage slider rod is all the way to the left, then replace the motor clamp. The arm on the clamp should hold the slider rod to the left. Tighten the clamp screw securely.

h. Loosen the clamping screw in the paper drive shaft coupler just enough to allow the coupler to slide on the shaft. Make sure the nut remains in the coupler.

i. Hold the drive shaft to the left by pushing (with a finger) on the left gritwheel, and push the drive shaft coupler to the right (with another finger) so that the coupler parts fit together snugly. Tighten the shaft coupler clamping screw securely.

j. Reconnect all cables.

k. Replace the pen drive motor and belt as instructed in **PEN DRIVE MOTOR** and **BELT**, steps a. through h.

l. Measure the pen down force by using a gram gauge. To do this; it is necessary to apply power to the plotter, select and lower a pen onto the platen. Place the tip of the gram gauge under the lip of the pen body and check that the pen just starts to lift with 12 to 28 grams of force. See Figure 8-24. If adjustment is required, refer to Section V.

m. Measure the pen height by positioning the pen holder to the center of the platen. Using a 100 mm ruler measure the distance from the platen to the bottom of the pen holder. The distance should be 10.5 mm. See Figure 8-25. If adjustment is necessary, refer to Section V.

n. Replace the pen carousel and the top cover, making sure the PAPER LOAD/HOLD lever extends through the cover and the tabs inside the front of the cover are properly aligned.

8-147. PINCH ROLLERS REMOVAL AND REPLACEMENT

a. Remove the top cover. Refer to **TOP COVER REMOVAL**.

b. Remove the retaining ring that secures the pinch roller. See Figure 8-26.

c. Remove the pinch roller.

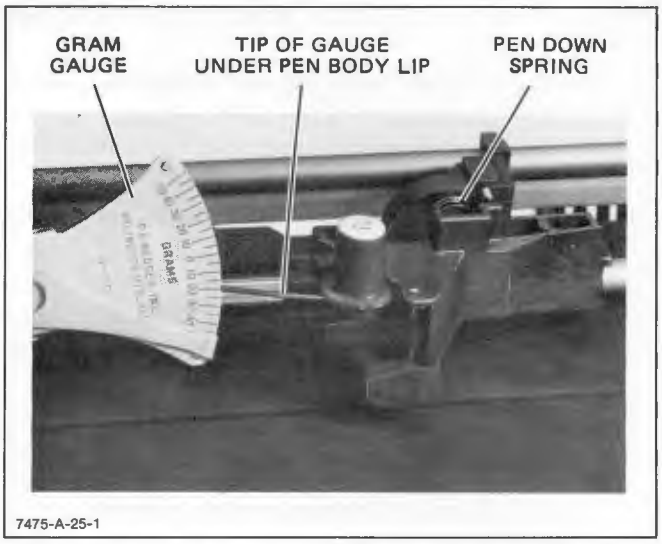


Figure 8-24. Measuring Pen Down Force

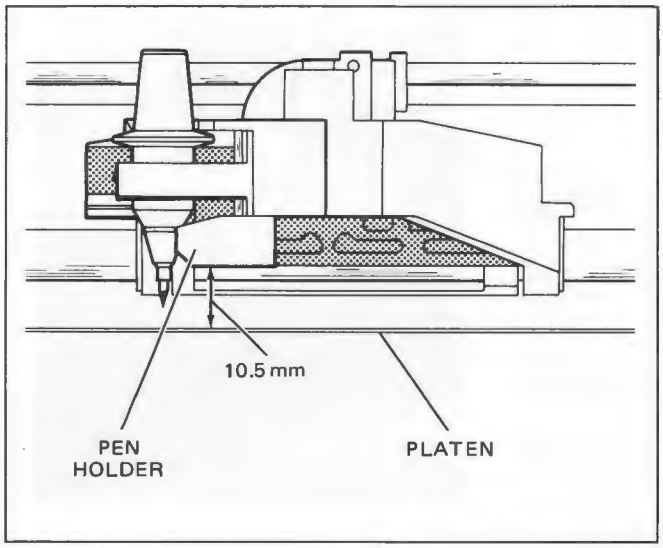


Figure 8-25. Measure Pen Height

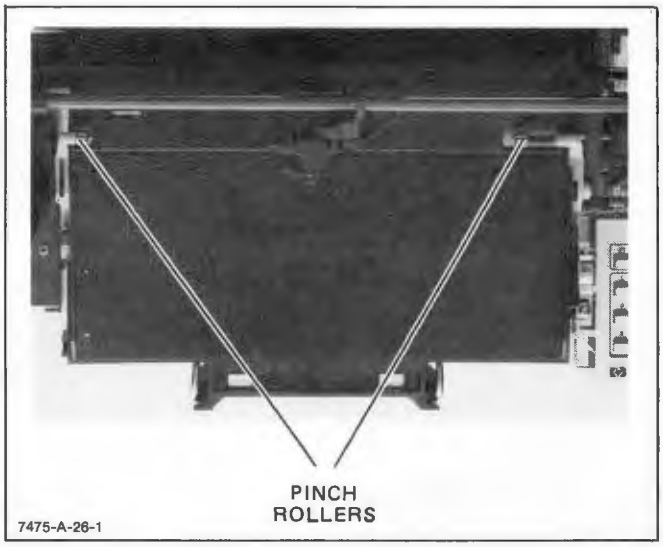


Figure 8-26. Pinch Rollers

d. Replace the pinch roller. The larger diameter end of the pinch roller must be toward the outer edge of the plotting surface. This is necessary to keep the plotting media in place.

e. Replace the retaining ring.

f. Replace the top cover making sure the PAPER LOAD/HOLD lever extends through the cover and the tabs inside the front of the cover are properly aligned.

8-148. PRINTED CIRCUIT ASSEMBLY REMOVAL

a. Remove the top cover. Refer to **TOP COVER REMOVAL.**

WARNING

Do not touch heatsinks on Power Supply PCA. They become very hot when the HP 7090 has been powered on for a long time.

b. See Figure 8-14. Loosen the two screws labeled "A" and remove the nine screws labeled "B".

c. Push chassis base assembly toward rear until it is clear of the two front screws.

d. Lift front of assembly and secure with support rod. See Figure 8-15.

e. Disconnect all cables from Main PCA jacks J3 through J6. See Figure 8-27.

f. Lower the chassis base assembly, pull forward and remove.

8-149. Main PCA removal is accomplished as follows:

a. Disconnect all cables from Main PCA jacks J7 through J11.

b. Remove the nine screws holding the Main PCA to the bottom case.

c. Lift the front end of the printed circuit assembly and remove from the bottom case.

d. Reassemble in reverse order.

8-150. Analog Channel PCA removal is accomplished as follows:

NOTE

Each analog channel assembly must be replaced in the same channel position from which is is removed. If an old analog channel assembly is replaced by a new one the new assembly must be calibrated. Refer to ANALOG CHANNEL CALIBRATION in this section.

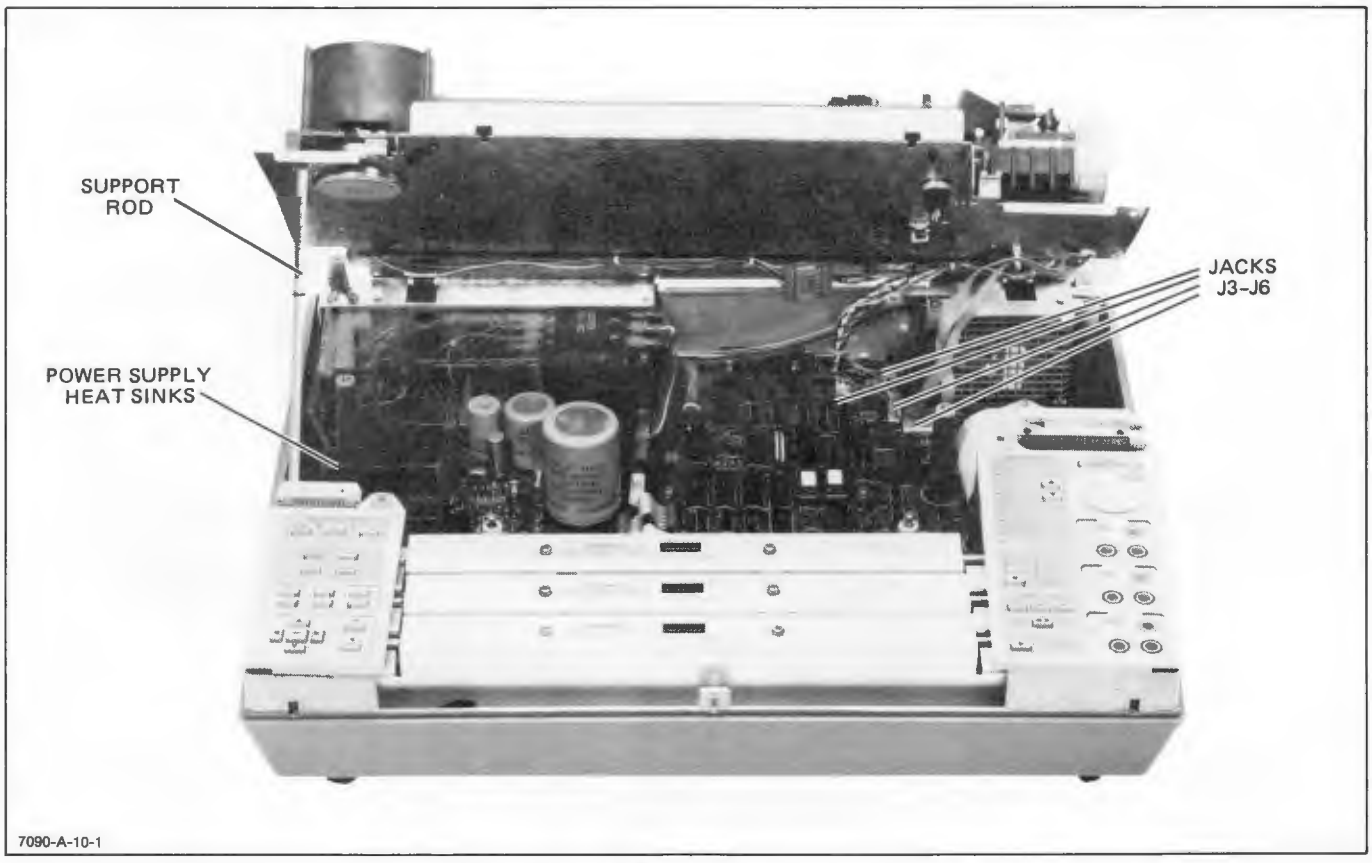


Figure 8-27. Base Chassis Removal

CAUTION

If repair of the Analog Channel PCA is necessary, handle the PCA only by the edges. Use only ROSIN MILDLY ACTIVATED solder (HP Part No. 8090-0098). DO NOT clean the Analog Channel PCA after repair.

a. Remove the two screws holding the analog channel assembly. See Figure 8-28.

b. Grasp the analog channel assembly at each end and gently lift out.

c. Reverse procedure to replace analog channel assemblies.

8-151. Power Supply PCA removal is accomplished as follows:

a. Remove all analog channel assemblies.

b. Disconnect all cables from the power supply PCA. See Figure 8-28.

c. Remove the primary shield and disconnect voltage selector connector.

d. Remove screws holding the Power Supply PCA and remove PCA.

e. Reassemble in reverse order. When replacing the top cover, make sure the PAPER LOAD/HOLD lever extends through the cover and the tabs inside the front are properly aligned.

8-152. PINCH ROLLER MECHANISM REMOVAL

8-153. To remove the pinch roller lever and bar or the right or left pinch roller arm, proceed as follows:

a. Remove the top cover. Refer to **TOP COVER REMOVAL.**

b. To remove the right pinch roller arm, the pen drop shield must be removed. See Figure 8-18.

c. Remove the chassis assembly as instructed in **PRINTED CIRCUIT ASSEMBLY REMOVAL,** steps b. through f.

d. Place the chassis assembly upside down on the work surface. See Figure 8-29.

e. Remove the pinch roller spring.

f. To remove the pinch roller lever and bar, move the lever in an upward position and merely slip out of the chassis.

g. Slide the pinch roller arm from its pivot and remove from the chassis.

h. Replace all parts in reverse order.

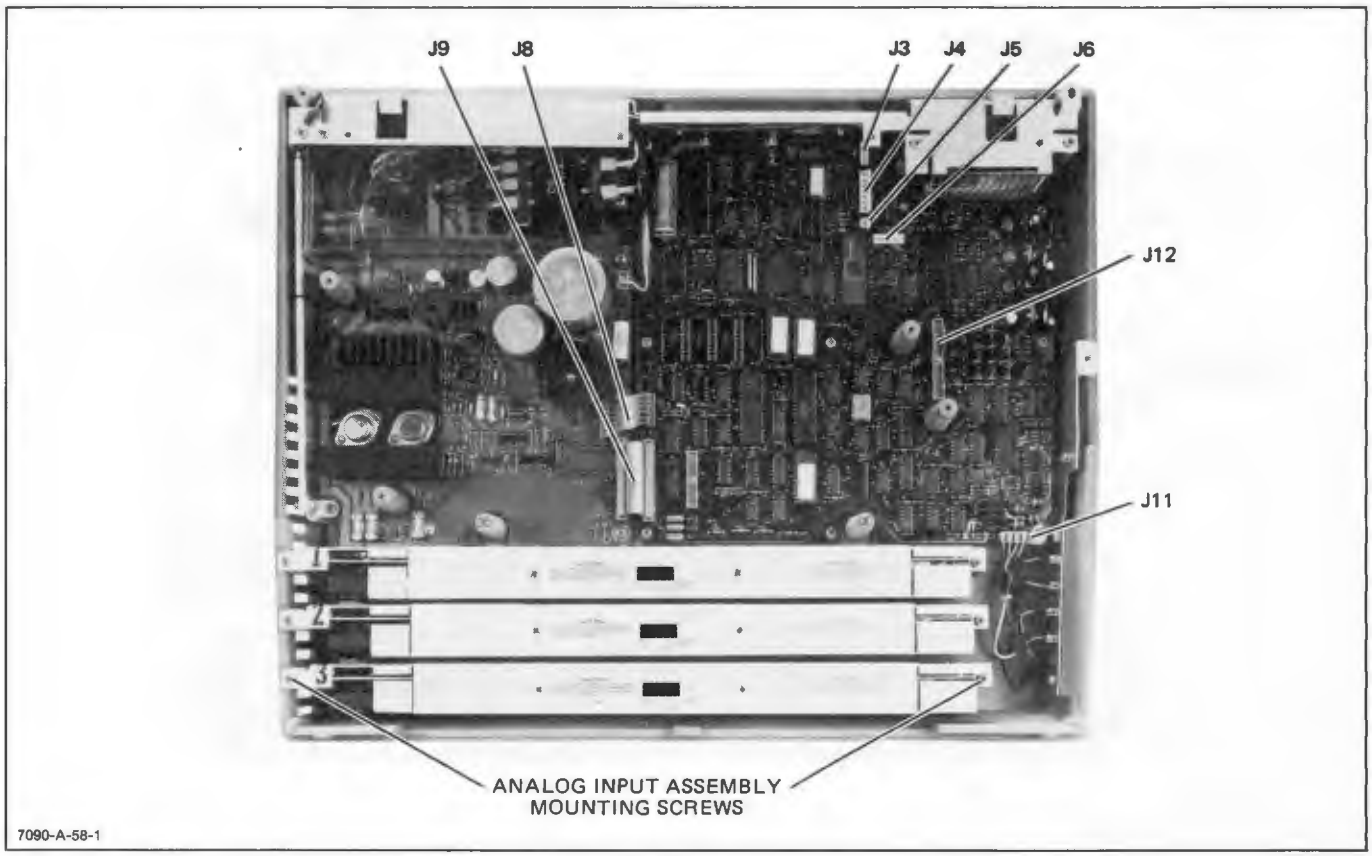


Figure 8-28. PCA Removal

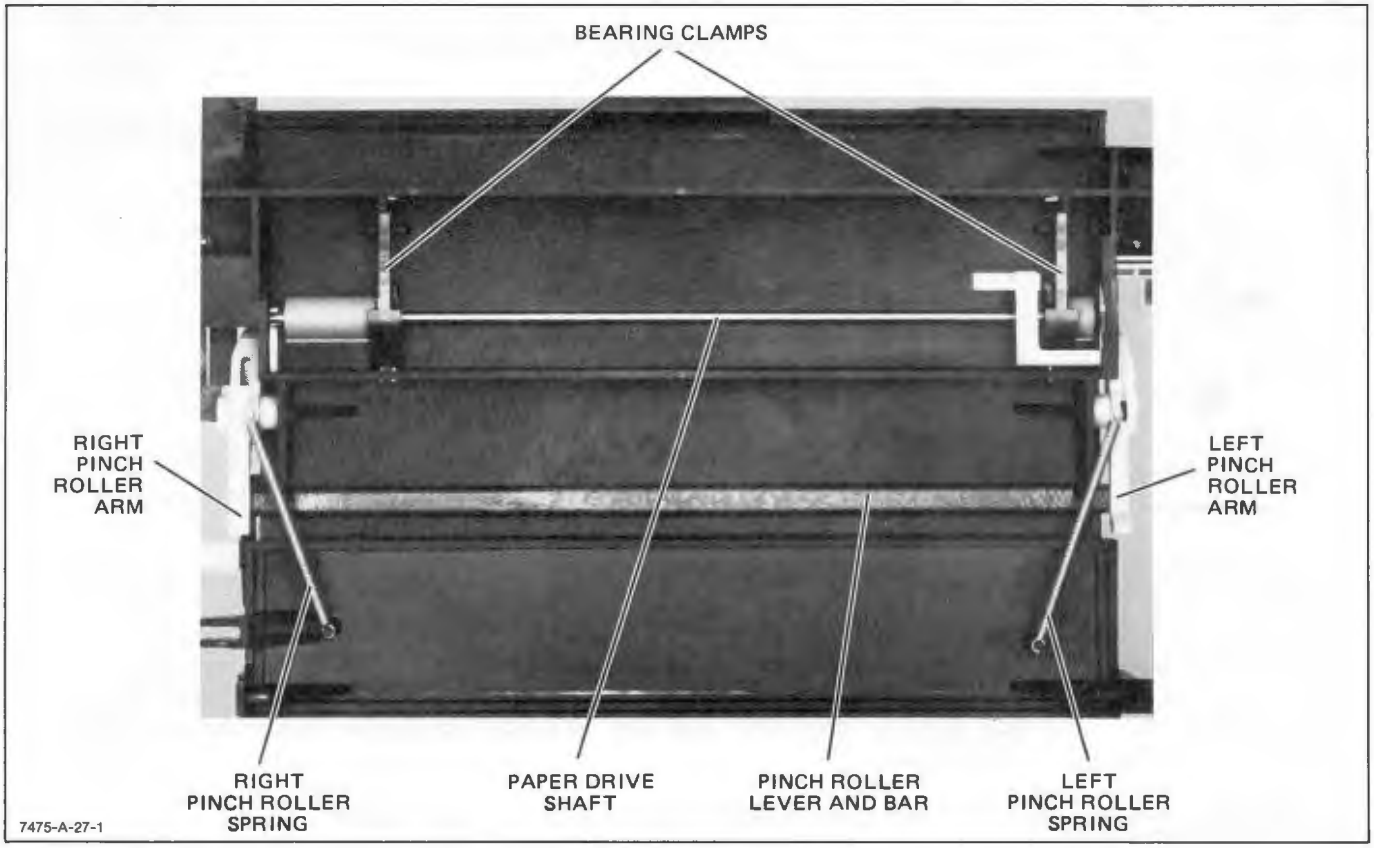


Figure 8-29. Underside of Chassis Assembly

8-154. PAPER DRIVE SHAFT AND COUPLER REMOVAL

a. Remove the top cover. Refer to **TOP COVER REMOVAL.**

b. Remove the chassis assembly as instructed in **PRINTED CIRCUIT ASSEMBLY REMOVAL,** steps b. through f.

c. Remove the pinch roller springs and remove the right and left pinch roller arms from the chassis.

d. Remove both bearing clamps by pressing down and inward on the clamps. See Figure 8-29.

e. Remove paper drive shaft toward the left.

CAUTION

Do not attempt to replace grit wheels or bearings individually. The grit wheels must be press fitted at the factory to the proper position.

f. Loosen the coupler clamping screw and remove the coupler from the shaft.

g. When replacing the coupler and drive shaft, place the coupler on the end of the shaft, leaving the clamping screw loose enough to allow the coupler to slide.

h. Place the drive shaft in position, making sure that the rubber O-rings on the drive shaft coupler and the motor shaft coupler fit inside the grooves of the coupler ring. Replace the bearing clamps. See Figure 8-19.

i. Place the chassis assembly right side up.

NOTE

Step i assumes that the paper drive motor is in position and its clamp tightened securely. If not, refer to **PAPER DRIVE MOTOR ASSEMBLY.**

j. Hold the drive shaft to the left by pushing (with a finger) on the left gritwheel, and push the drive shaft coupler to the right (with another finger) so that the coupler parts fit together snugly. Tighten the shaft coupler clamping screw securely.

k. Replace all parts in reverse order.

8-155. DIAGRAMS

8-156. Figure 8-30 explains symbols which may appear on the schematic diagrams, and Figure 8-31 illustrates logic symbols used. HP 7090 PCA signal descriptions are listed in Table 8-5. Figures 8-32 through 8-47 are schematics of the HP 7090 circuits.

SCHEMATIC DIAGRAM NOTES

Resistance in ohms, capacitance in microfarads, inductance in millihenries unless otherwise noted.

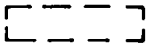
* Asterisk denotes a factory-selected value. Value shown is typical. Part might be omitted.

Indicates a NOTE on the schematic diagram.

Tool-aided adjustment.

Manual control.

Encloses a front-panel or circuit assembly silkscreened designator.



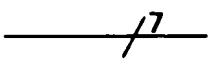
Encloses a rear-panel silkscreened designator.

Circuit assembly borderline.

Other assembly borderline. Also used to indicate mechanical interconnection (ganging) and RF shielding.

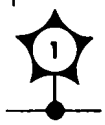
Heavy line with arrows indicates path and direction of main signal.

Heavy dashed line with arrows indicates path and direction of main feedback.



Indicates cable run with seven lines.

Wiper moves toward CW with clockwise rotation of control (as viewed from shaft or knob).

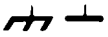


Numbered Test point. Measurement aid (metal post, circuit pad, etc.) provided.

Lettered Test point. No measurement aid provided.

( ) Encloses wire color code. Code used is the same as the resistor color code. First number identifies the base color, second number identifies the wider stripe, third number identifies the narrower stripe (e.g., (947) denotes white base, yellow wide stripe, violet narrow stripe).

A direct conducting connection to the earth, or a conducting connection to a structure that has a similar function (e.g., the frame of an air, sea, or land vehicle).



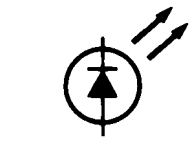
A conducting connection to a chassis or frame.

Common connections. All like-designated points are connected. When accompanied by a letter, indicates the type common (i.e., A = Analog, D = Digital, F = Floating).

1-A-1-2

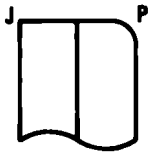
Figure 8-30. Schematic Diagram Notes

SCHEMATIC DIAGRAM NOTES (Continued)

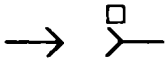


Light Emitting Diode (LED).

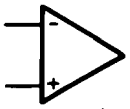
Photo-Transistor.



Cable and circuit assembly connectors.
J – Fixed Portion
P – Moveable Portion

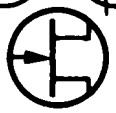


Circuit assembly square-pin connectors.



Operational Amplifier (integrated circuit).

Voltage regulator (breakdown diode).

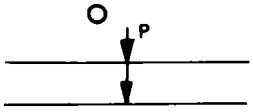


Denotes Field Effect transistor (FET) with N-type base.

Denotes FET with P-type base.

Denotes Silicon Controlled Rectifier (SCR).

Denotes spring-loaded switch.



Indicates twisted pair.

Identifies service sheet for quick reference.

Signal line identification.

Combined service sheet and signal line identification.

1-A-2-1A

Figure 8-30. Schematic Diagram Notes (Continued)

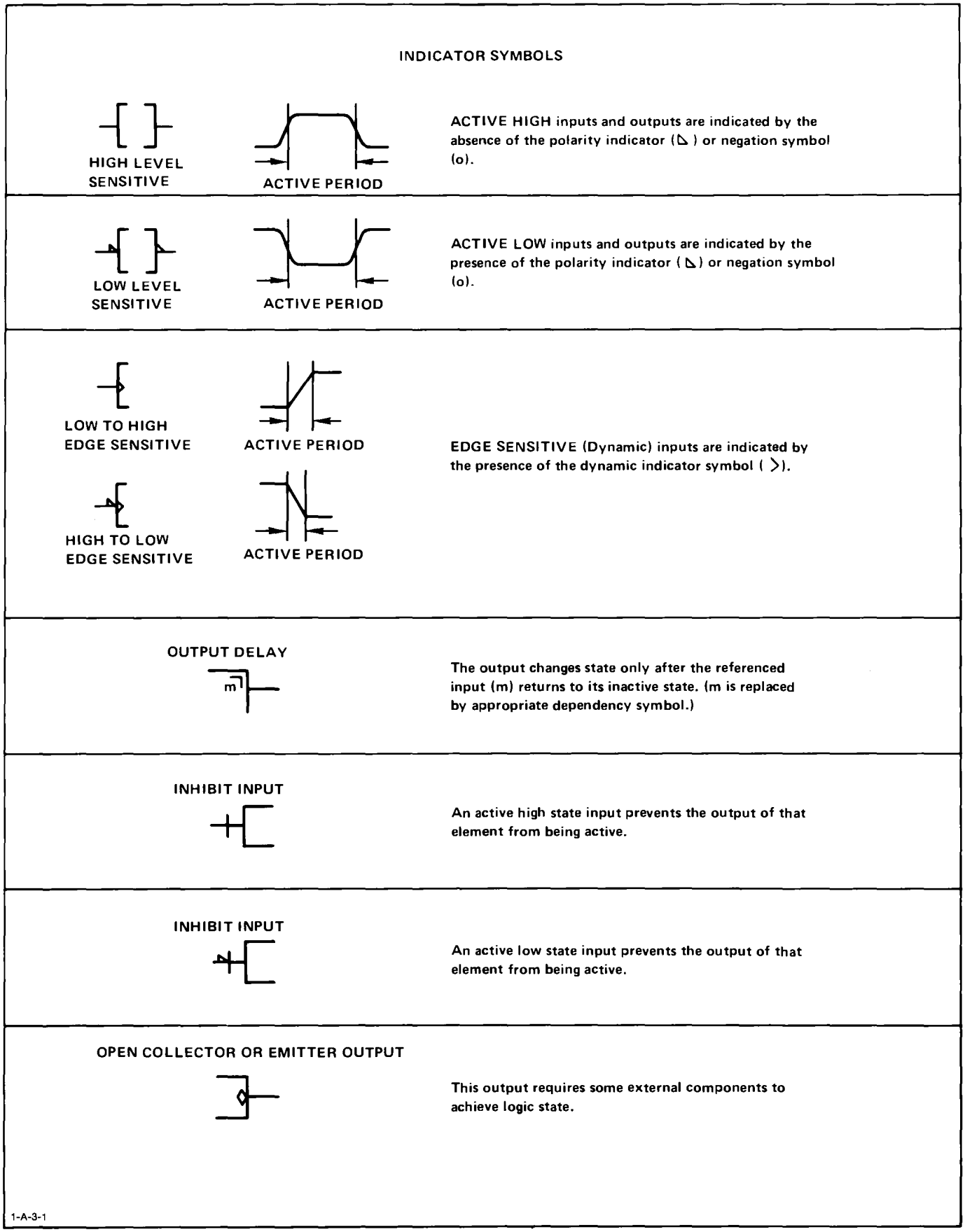


Figure 8-31. ANSI Logic Symbols

INDICATOR SYMBOLS (Continued)

SCHMITT TRIGGER

AND GATE WITH HYSTERESIS

Schmitt Trigger-⊓ indicates that hysteresis exists in the device.

Dependency Notation

G1
1

The input that controls or gates other inputs is labeled with a "C" or a "G", followed by an identifying number. The controlled or gated input or output is labeled with the same number. In this example, "1" is controlled by "G1".

G1
X_1

OR

G1
1X

When the controlled or gated input or output already has a functional label (X is used here), that label will be prefixed or subscripted by the identifying number.

C
X_C

If a particular device has only one gating or control input then the identifying number may be eliminated and the relationship shown with a subscript.

G1
G2
1,2X

G1
G2
$X_{1,2}$

If the input or output is affected by more than one gate or control input, then the identifying numbers of each gate or control input will appear in the prefix or subscript, separated by commas. In this example "X" is controlled by "G1" and "G2".

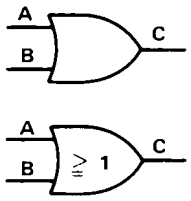
GATE	IEEE STANDARD 91 ANSI Y32.14	TRUTH TABLE	FLIP FLOP	ANSI Y32.14 CONTROL DESIGNATIONS FOR F.F.	DESCRIPTION
AND	A, B → C; A, B → & → C	A B | C L L | L H H | H L H | L H L | L	R-S	R, S → FF → Q, $\overline{Q}$	R S | Q $\overline{Q}$ L L | N/C N/C L H | H L H L | L H H H | undetermined

1-A-4-1

Figure 8-31. ANSI Logic Symbols (Continued)

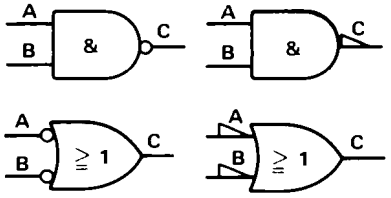
INDICATOR SYMBOLS (Continued)

OR



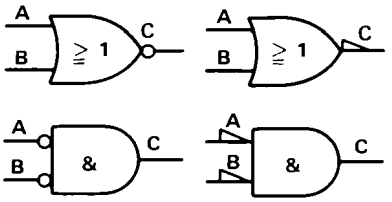
A	B	C
L	L	L
H	H	H
L	H	H
H	L	H

NAND



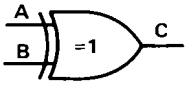
A	B	C
L	L	H
H	H	L
L	H	H
H	L	H

NOR



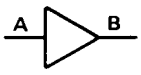
A	B	C
L	L	H
H	H	L
L	H	L
H	L	L

XOR



A	B	C
L	L	L
H	H	L
L	H	H
H	L	H

BUFFER

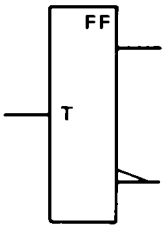


A	B
1	1
0	0

INVERTER

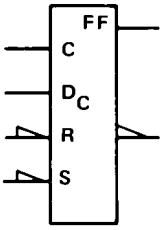
A	B
1	0
0	1

T



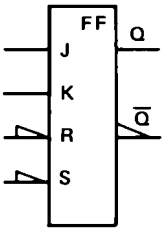
Toggles with every clock pulse

D



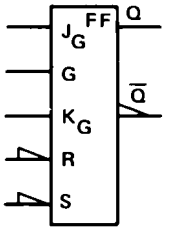
Data output follows data input. Input is gated by C.

J-K



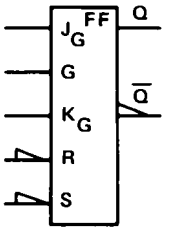
J	K	Q	Q̄
L	L	N/C	N/C
L	H	L	H
H	L	H	L
H	H	toggles	

J-K (gated)



J and K inputs are gated by G.

J-K (master slave)



This output is dependent upon negative going edge of the signal.

S Set input – when active causes the flip-flop to set (Asynchronous)

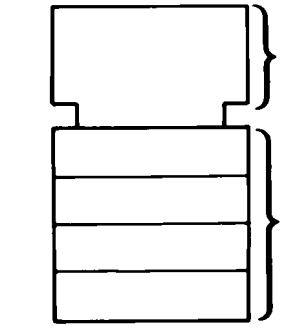
R Reset input – when active causes the flip-flop to reset (Asynchronous)

N/C No Change

1-A-5-1

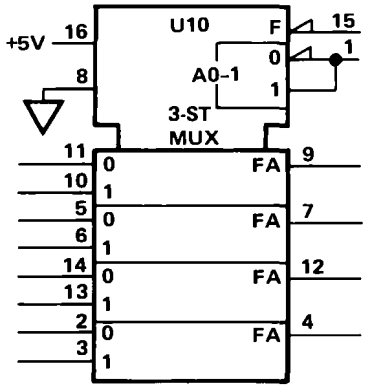
Figure 8-31. ANSI Logic Symbols (Continued)

INDICATOR SYMBOLS (Continued)



COMMON CONTROL BLOCK

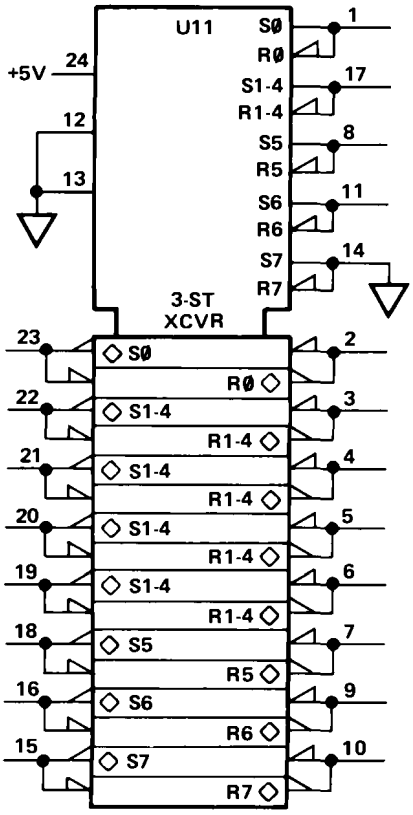
The Control Block is used to show when common control signals are applied to a group of mechanically connected, but functionally separate units.



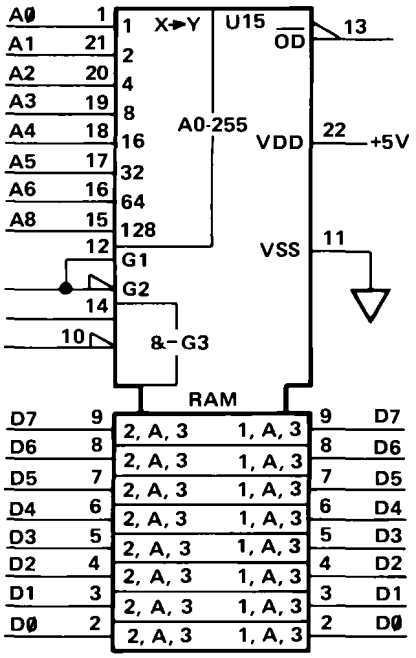
F input must be low to enable outputs. When F is high, outputs are high impedance. Address input determines whether 0 or 1 input will pass to output.

1-A-6-2

Figure 8-31. ANSI Logic Symbols (Continued)



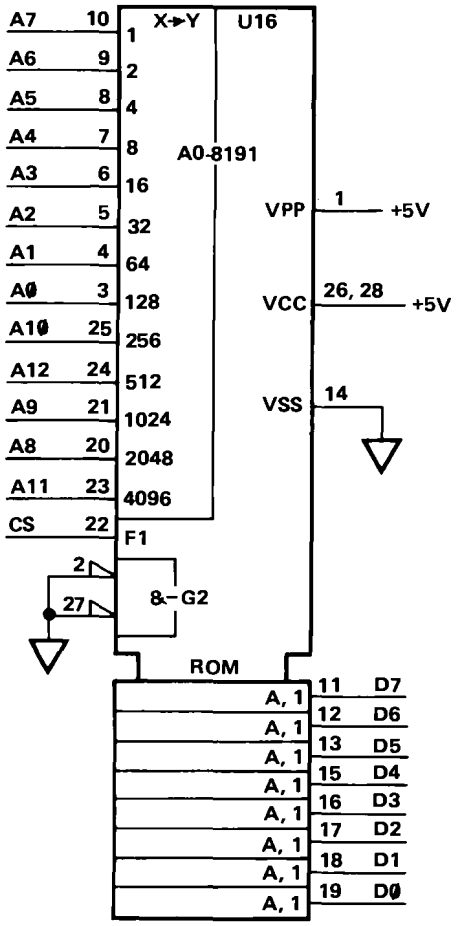
Level of inputs in control block (S/R) determines direction of data flow.



Random access memory with 256 addresses and 8-bit parallel inputs and outputs on the same pins. Each data location is selected by the 8-bit address in the upper left corner of the control block. The data input (write) function is enabled when gates G1/G2 are low and G3 is true (pin 14 high, pin 10 low). The read function when G1/G2 are high and G3 is true.

1-A-28-1

Figure 8-31. ANSI Logic Symbols (Continued)



Read only memory with 8192 addresses and 8-bit parallel output. Each output byte is selected by the 12-bit address in the upper left corner of the control block. Output is enabled only when F1 is high and G2 is low.

1-A-27-1

Figure 8-31. ANSI Logic Symbols (Continued)

Table 8-5. HP 7090 Signal Description

SIGNAL	DESCRIPTION
BA	BUS AVAILABLE
BA0-BA133	BUFFERED ADDRESS LINES
BE	BUFFERED E CLOCK
BOV1	CHANNEL 1 OVERFLOW LED
BOV2	CHANNEL 2 OVERFLOW LED
BOV3	CHANNEL 3 OVERFLOW LED
BR/W	BUFFERED READ/WRITE
CAL	CALIBRATE
CI1	SERIAL CLOCK TO ANALOG INPUT CHANNEL 1
CI2	SERIAL CLOCK TO ANALOG INPUT CHANNEL 2
CI3	SERIAL CLOCK TO ANALOG INPUT CHANNEL 3
CLI	CHART LOAD INTERRUPT
CLP	CLEAR CHART LOAD INTERRUPT
CNV1	SELECT CONTROL REGISTER 1
CNV2	SELECT CONTROL REGISTER 2
CNV3	SELECT CONTROL REGISTER 3
DCLK	DISPLAY CLOCK
DDAT	DISPLAY DATA
DI1	SERIAL DATA TO ANALOG INPUT CHANNEL 1
DI2	SERIAL DATA TO ANALOG INPUT CHANNEL 2
DI3	SERIAL DATA TO ANALOG INPUT CHANNEL 3
*DMA/VMA	DIRECT MEMORY ACCESS/VALID MEMORY ADDRESS
E	SYSTEM CLOCK 2.0 MHz
ENMI	ENABLE NONMASKABLE INTERRUPT
ESC	ENABLE START CONVERT
ESO	ENABLE SCOPE OUT
FPI	FRONT PANEL INTERRUPT
FE1	CHANNEL 1 DATA STROBE
FE2	CHANNEL 2 DATA STROBE
FE3	CHANNEL 3 DATA STROBE
HM	0.5 MHz CLOCK

*Disables chip select during transitions in and out of the DMA cycle.

Table 8-5. HP 7090 Signal Description (Continued)

SIGNAL	DESCRIPTION
INT IOI	INTERRUPT STATUS REGISTER INPUT/OUTPUT INTERRUPT
LED	SELECT LED CONTROL REGISTER
NCVT	START CONVERT PULSE (Hardware generated)
NDB	DIRECT MEMORY ACCESS REQUEST
NFQ	FAST INTERRUPT REQUEST
NSFE	SELECT FRONT END GATE ARRAY
NSMI	NONMASKABLE INTERRUPT (Cannot be disabled)
NSTC	START CONVERT
OVI	OVERFLOW INTERRUPT (From analog input channel)
PDD	POWER DOWN DETECT
PRS	POWER UP RESET
PS1	SERIAL DATA SELECT LINE (Data to analog input channel)
PS2	SERIAL DATA SELECT LINE (Data to analog input channel)
PWC	POWER UP/DOWN DETECT
RED	READ STROBE (Real Time Clock)
RLO-RL7	FRONT PANEL SCANNER RETURN LINES
ROMC	SELECT ROM U59 (C000-FFFF)
RPGC	ROTARY PULSE GENERATOR INTERRUPT CLEAR
RPGD	ROTARY PULSE GENERATOR DIRECTION
RPGI	ROTARY PULSE GENERATOR INTERRUPT
RST	RESET
RTCI	REAL TIME CLOCK INTERRUPT
SC1	ANALOG INPUT CLOCK, CHANNEL 1
SC2	ANALOG INPUT CLOCK, CHANNEL 2
SC3	ANALOG INPUT CLOCK, CHANNEL 3
SD1	ANALOG INPUT DATA, CHANNEL 1
SD2	ANALOG INPUT DATA, CHANNEL 2
SD3	ANALOG INPUT DATA, CHANNEL 3
SEE	SELECT EEPROM
SIO	SELECT INPUT/OUTPUT CHIP
SKB	SELECT FRONT PANEL CONTROLLER CHIP

Table 8-5. HP 7090 Signal Description (Continued)

SIGNAL	DESCRIPTION
SL0-SL3	FRONT PANEL SCANNER SELECT LINES
SOC	SCOPE OUT CLEAR
SOT	SERIAL OUTPUT DATA (Front the servo gate array)
SR0	SELECT RAM 0 (U24)
SR1	SELECT RAM 1 (U23)
SR2	SELECT RAM 1 (U22)
SR3	SELECT RAM 1 (U21)
SRDY	SYNCHRONIZED REAL TIME CLOCK READY
SSE	OVERFLOW INTERRUPT (From analog input channel)
STC	START CONVERT (Firmware generated)
STI	SELECT TIMER CHIP
SWC	SELECT HP-IB/SELF-TEST SWITCHES
VMS	MOTOR VOLTAGE SENSE LINE
WRT	WRITE STROBE
WR	WRITE STROBE (Real Time Clock)
1M	ONE MHz CLOCK
2M	TWO MHz CLOCK
8M1	8 MHz CLOCK

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Artek Media

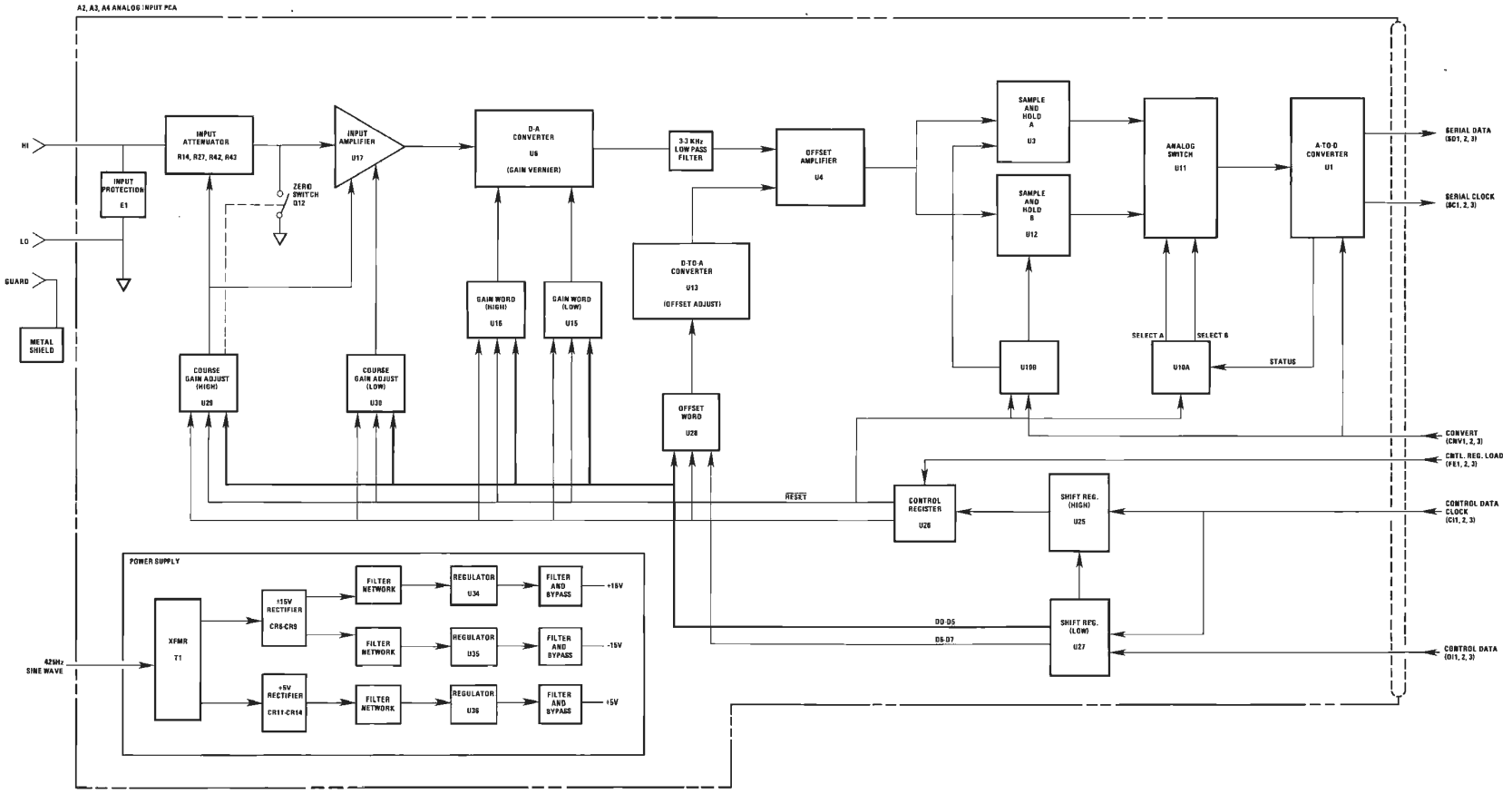

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Figure 8-32. Analog Input PCA Functional Block Diagram

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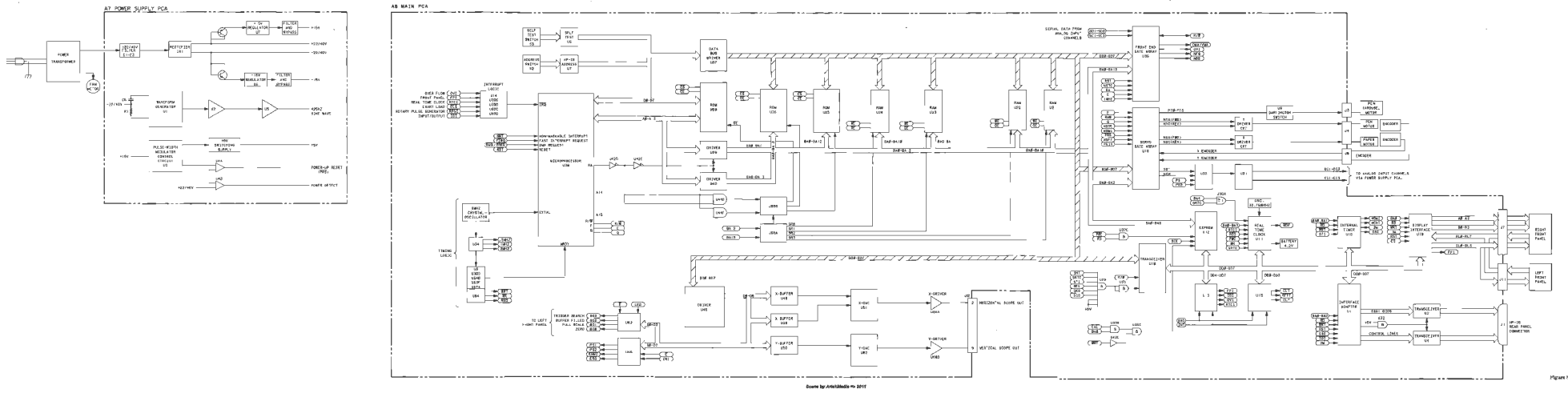

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(Sheet 2 of 2)

Figure 8-53. Main PCA, Functional Block Diagram

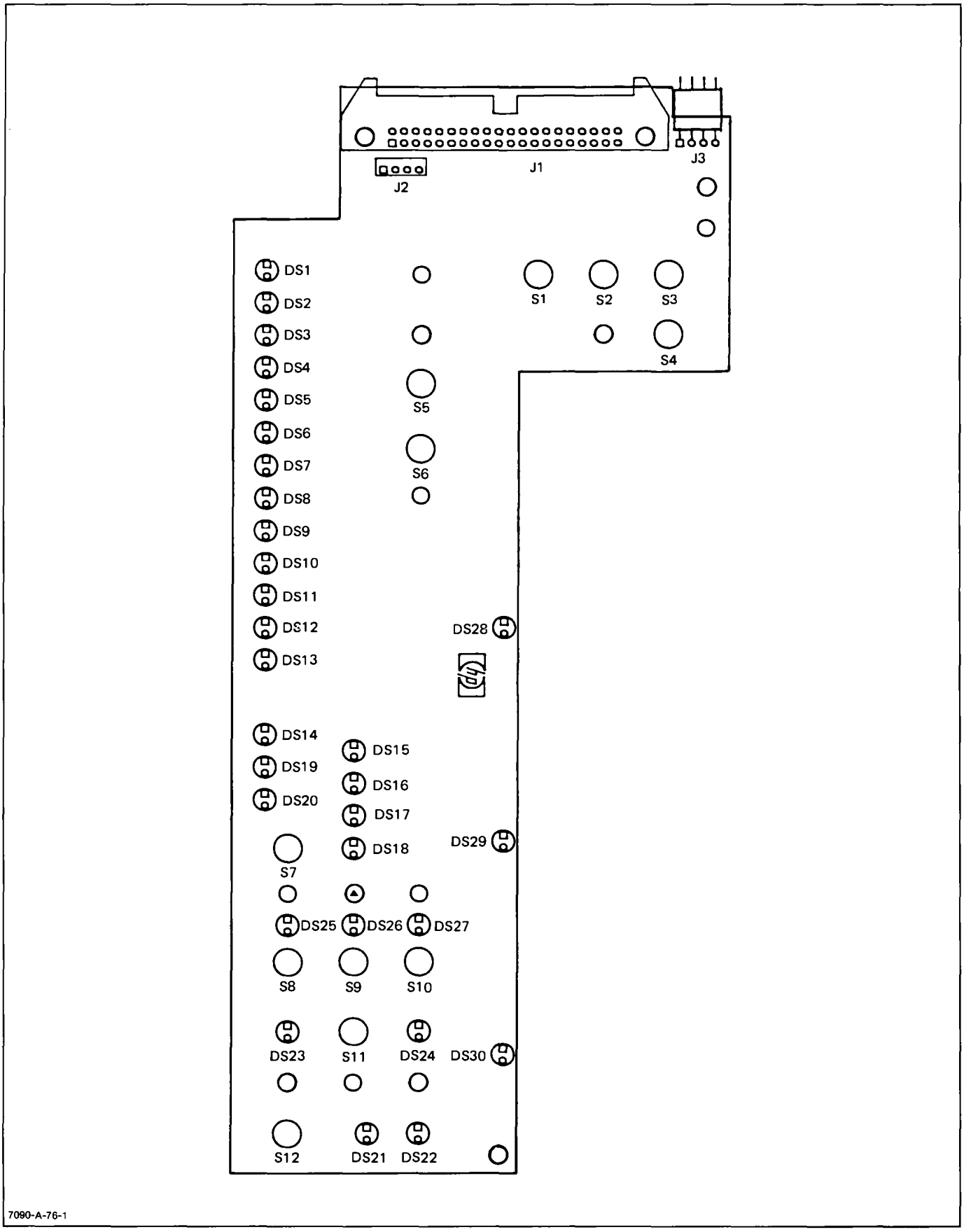
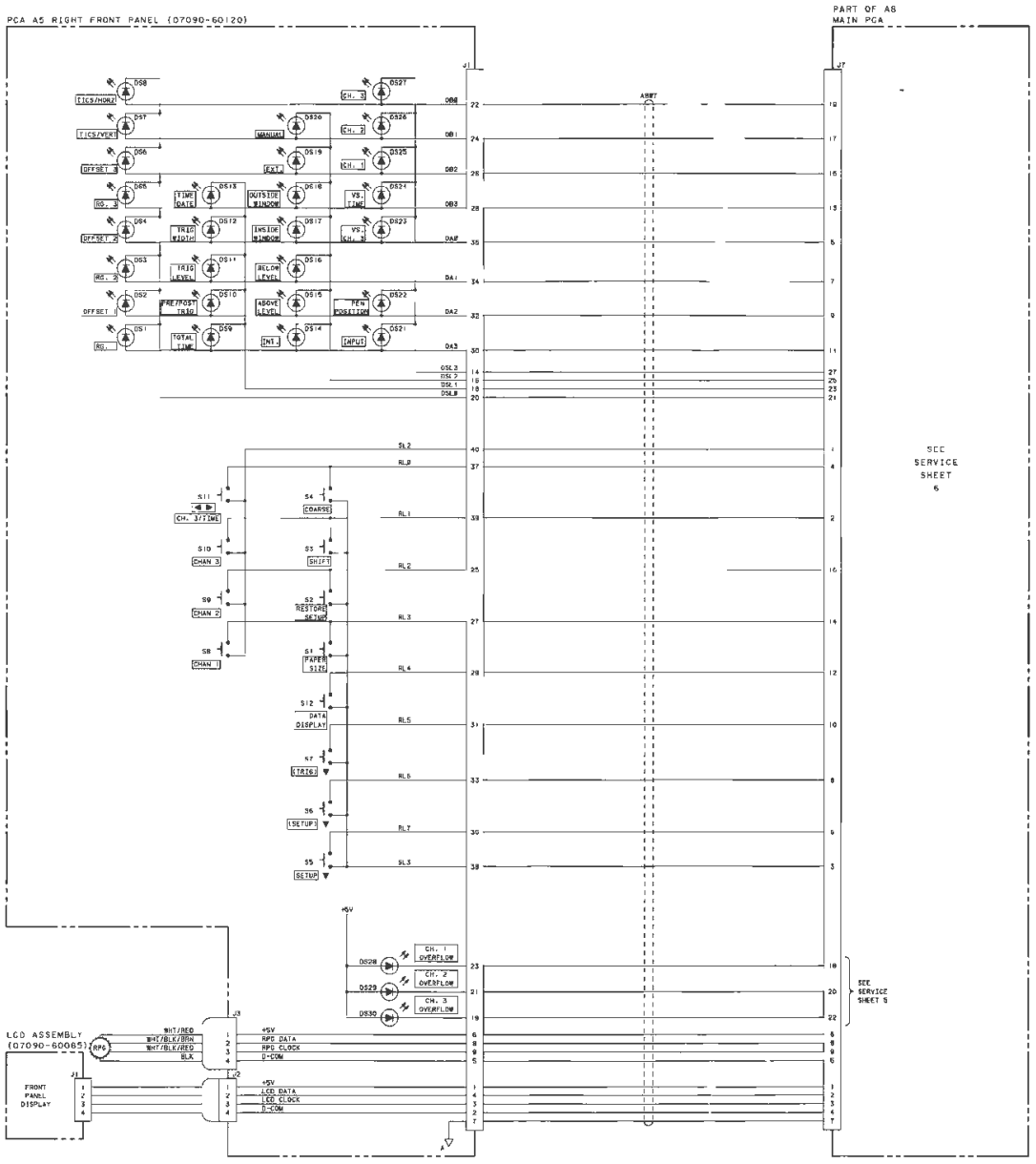


Figure 8-34. Right Front Panel Component Location



7090-E-59-1

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Figure 8-35. Right Front Panel Schematic

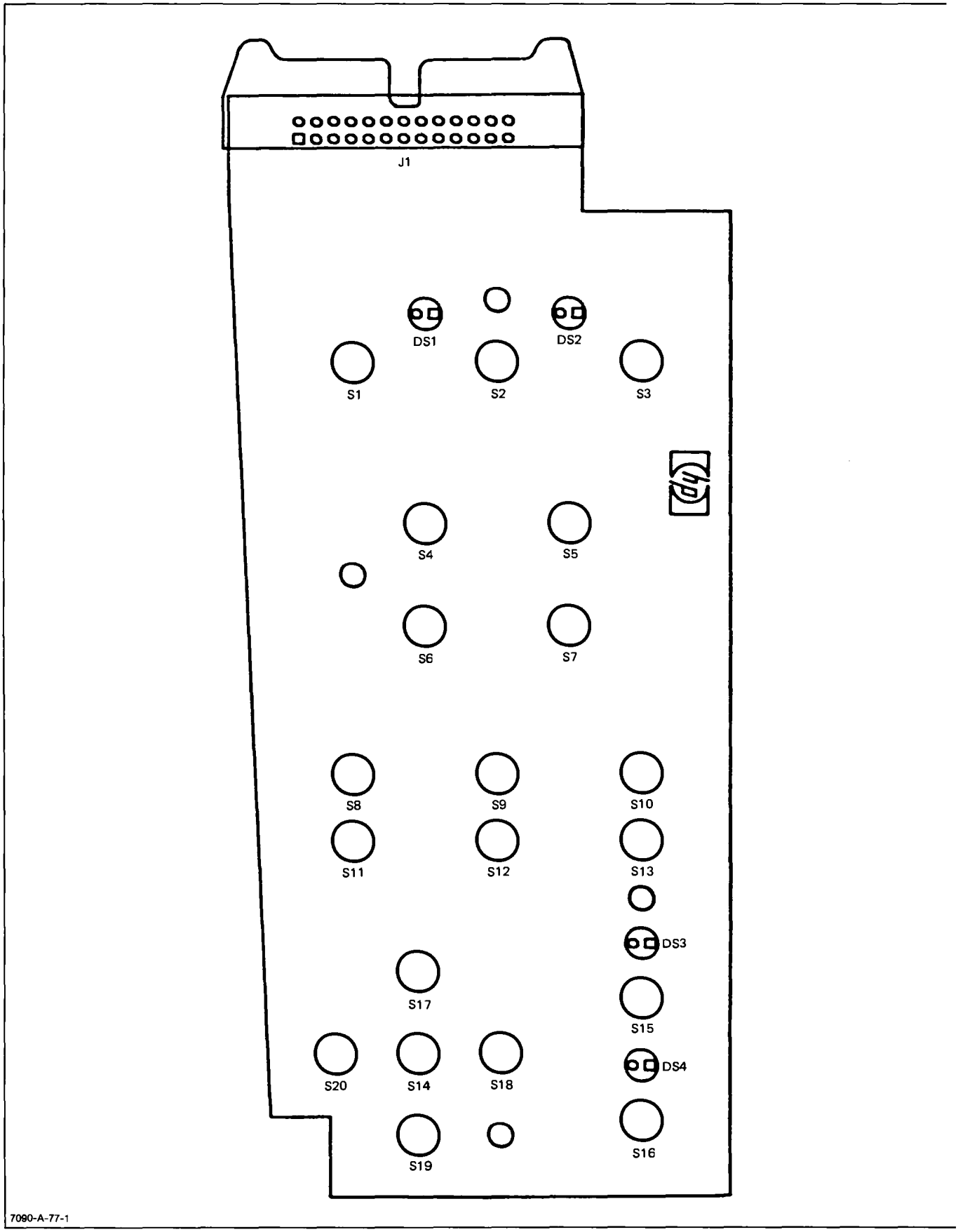

Figure 8-36. Left Front Panel Component Location

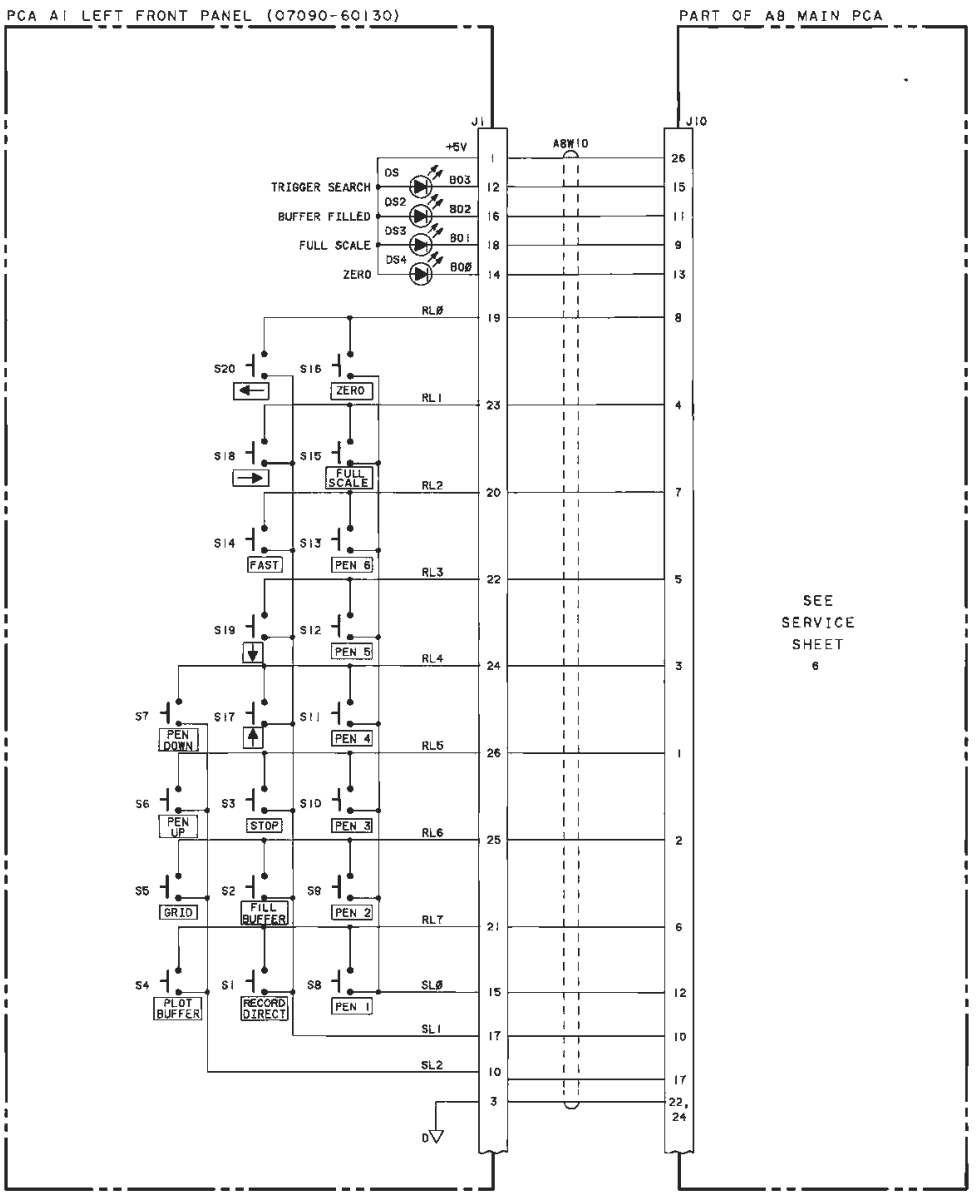

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Figure 8-37. Left Front Panel Schematic

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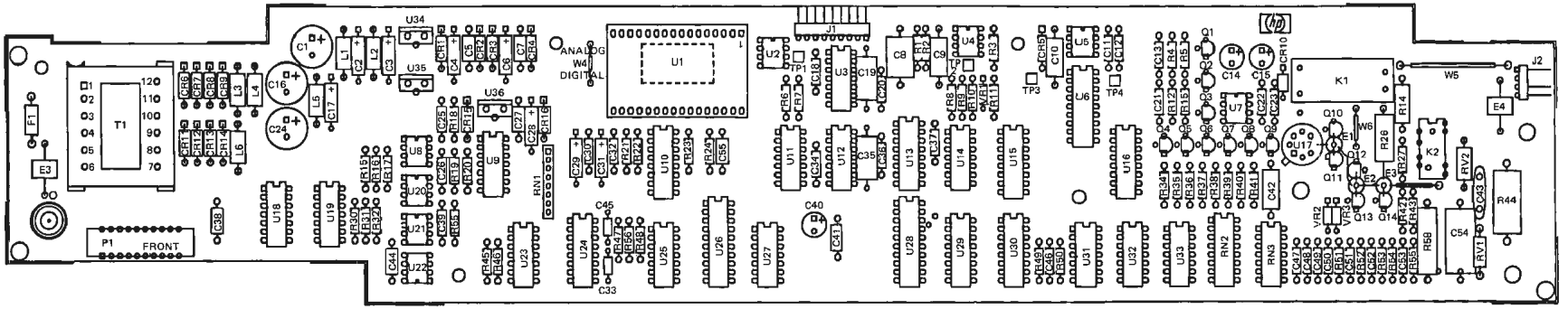

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Figure 8-38. Analog Input PCA Component Location

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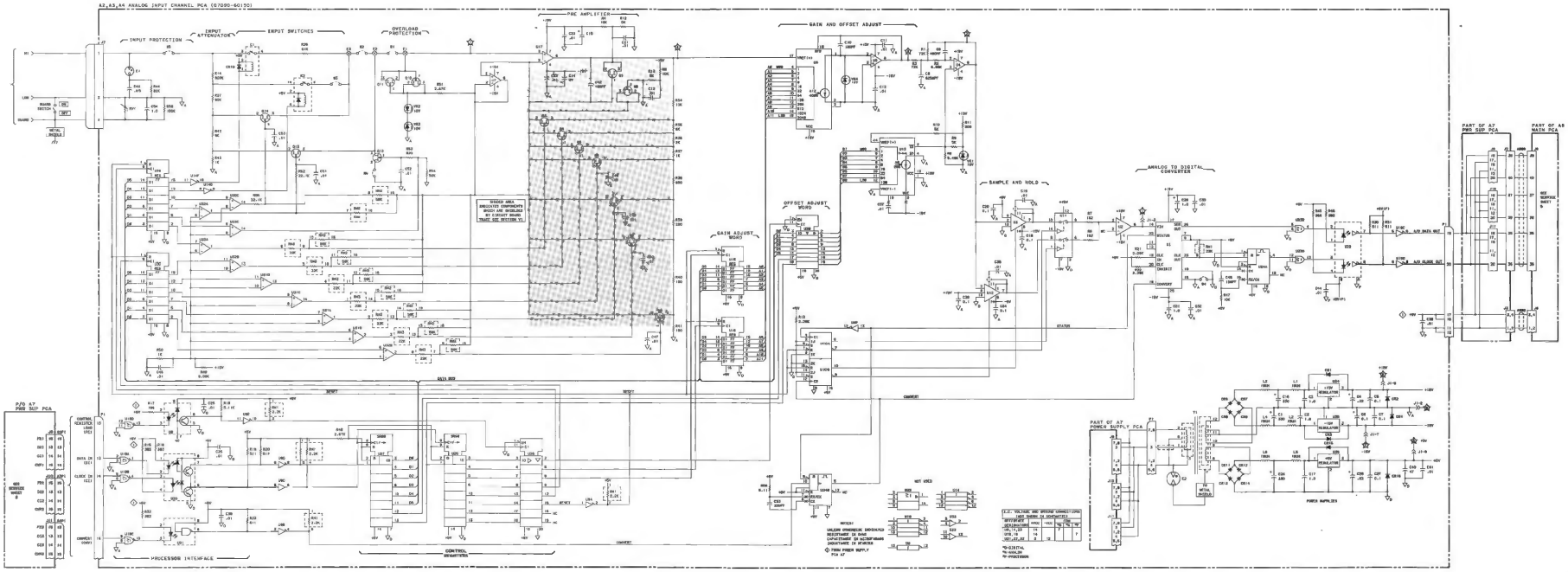

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SERVICE SHEET
(Sheet 2 of 2)

Figure 8-39. Analog Channel PCA Schematic

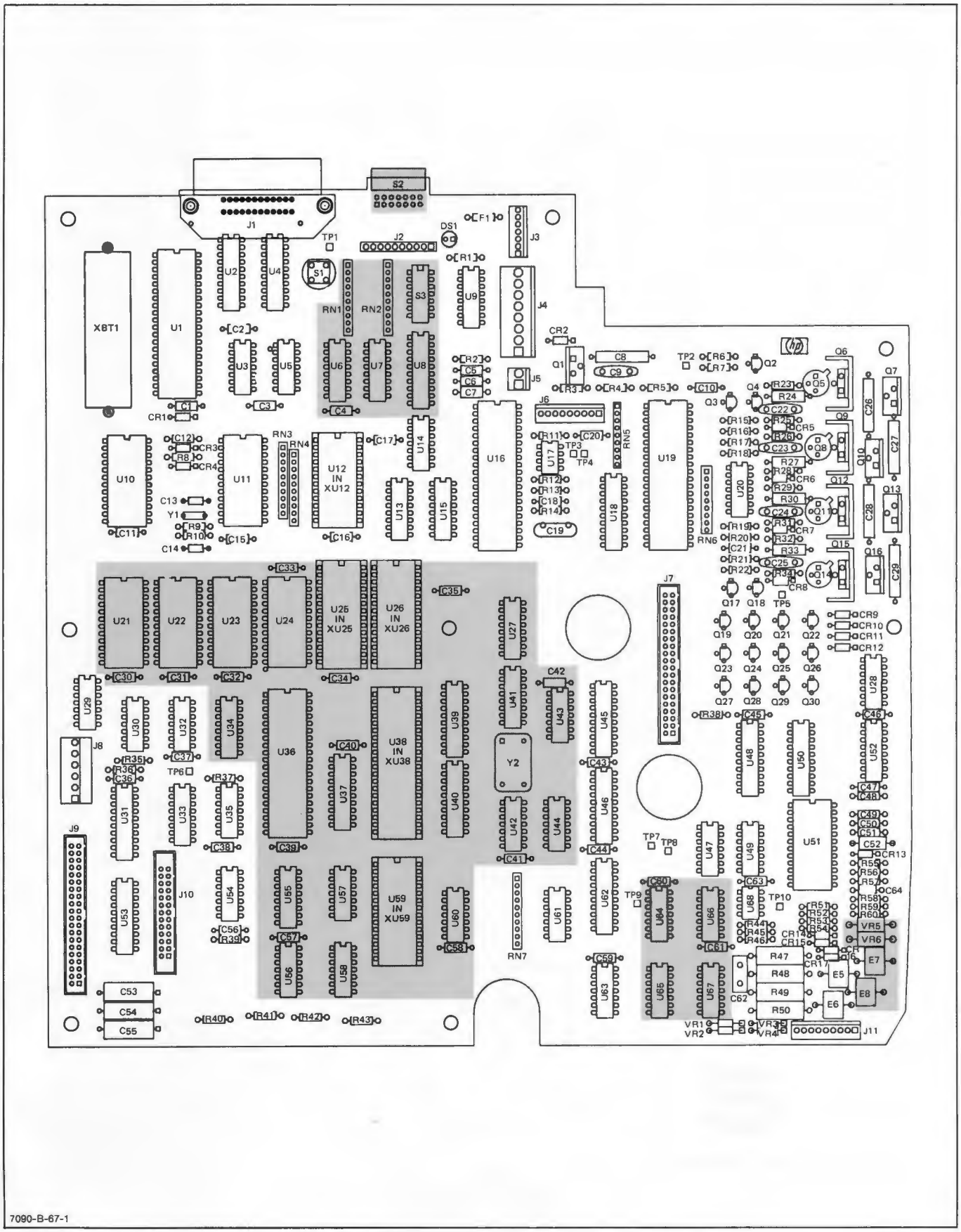


Figure 8-40. Processor/Memory Circuits Component Location

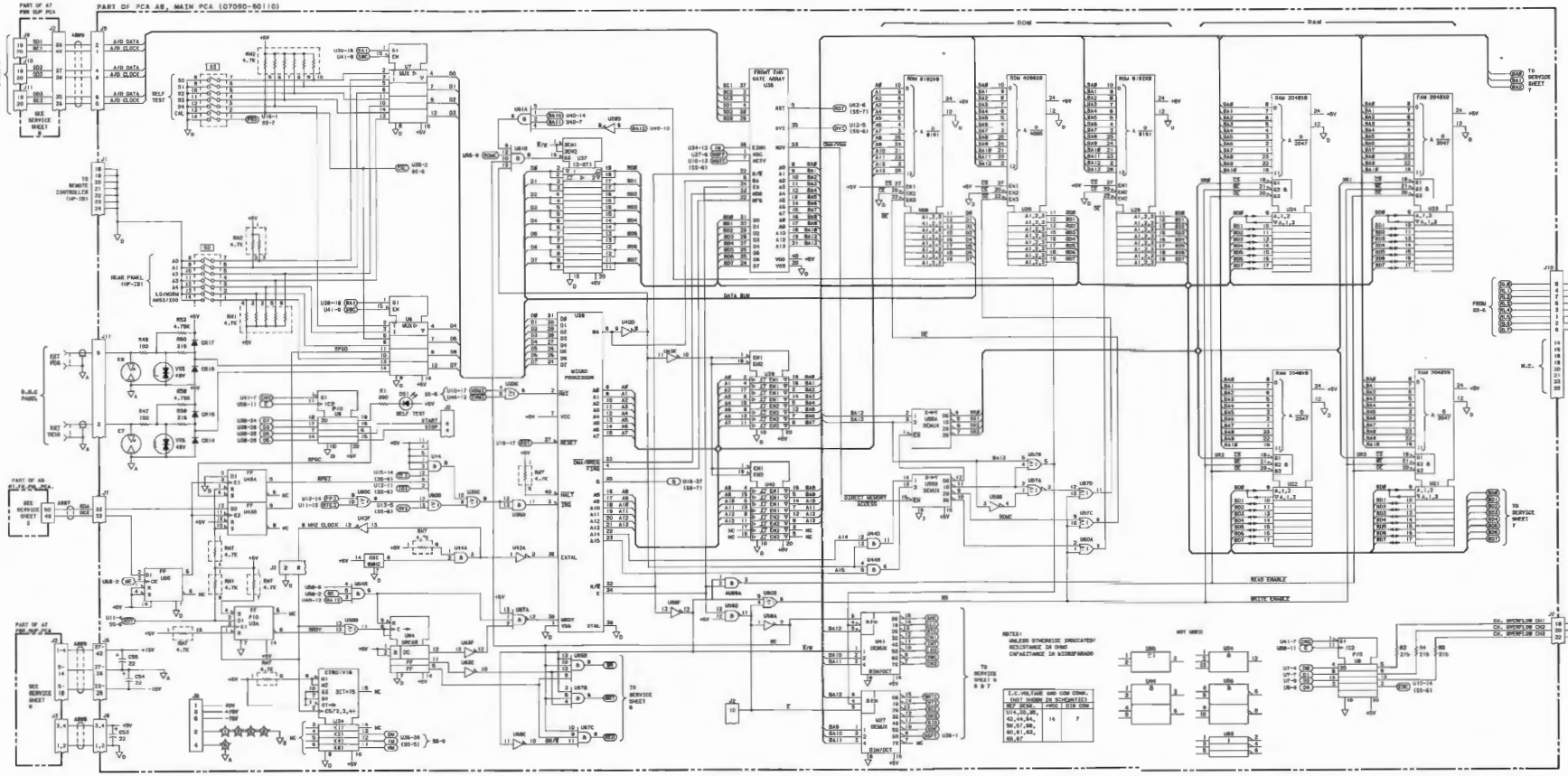


Figure 8-41. Processor/Memory Circuits Schematic

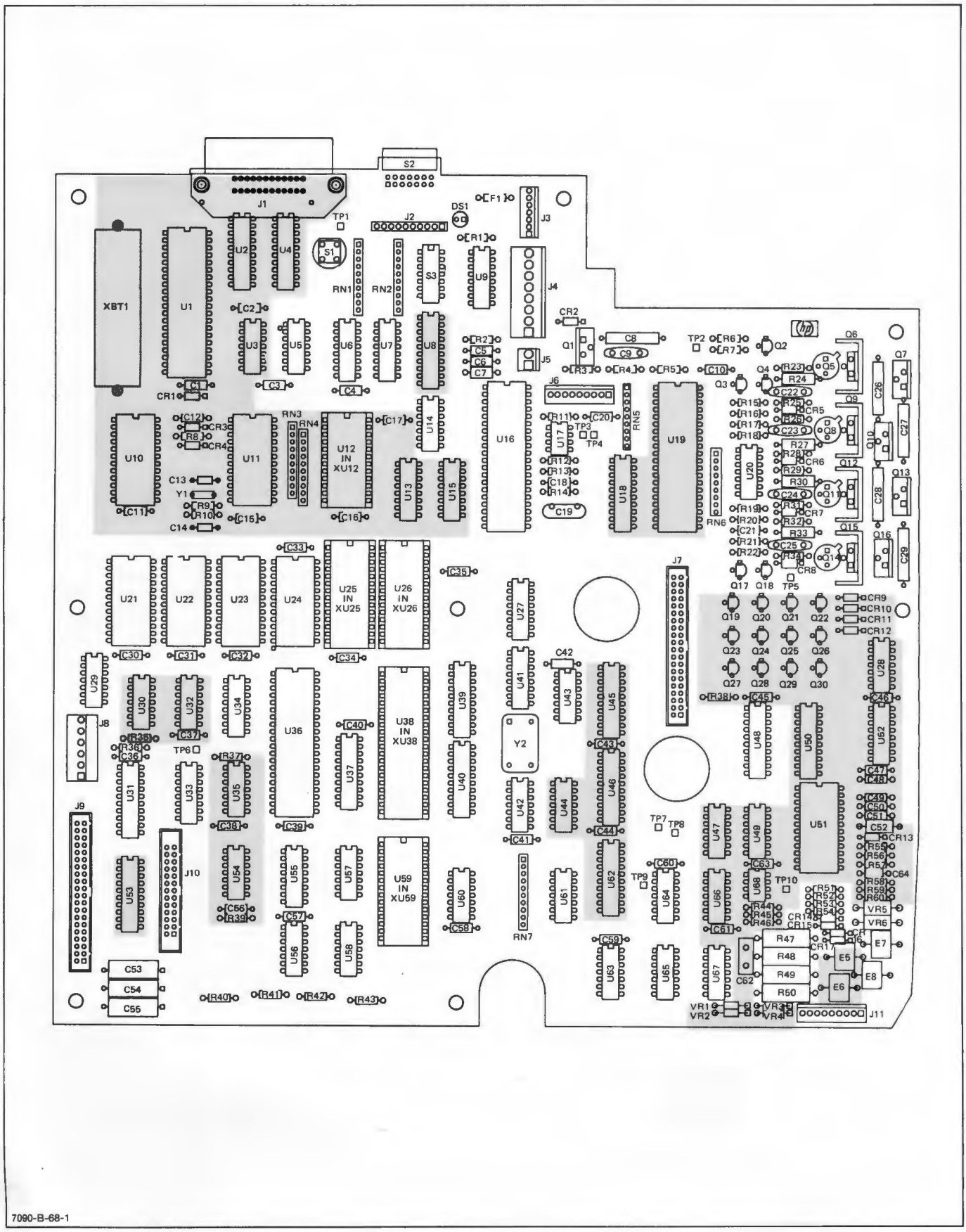


Figure 8-42. I/O and Oscilloscope Output Circuits Component Location

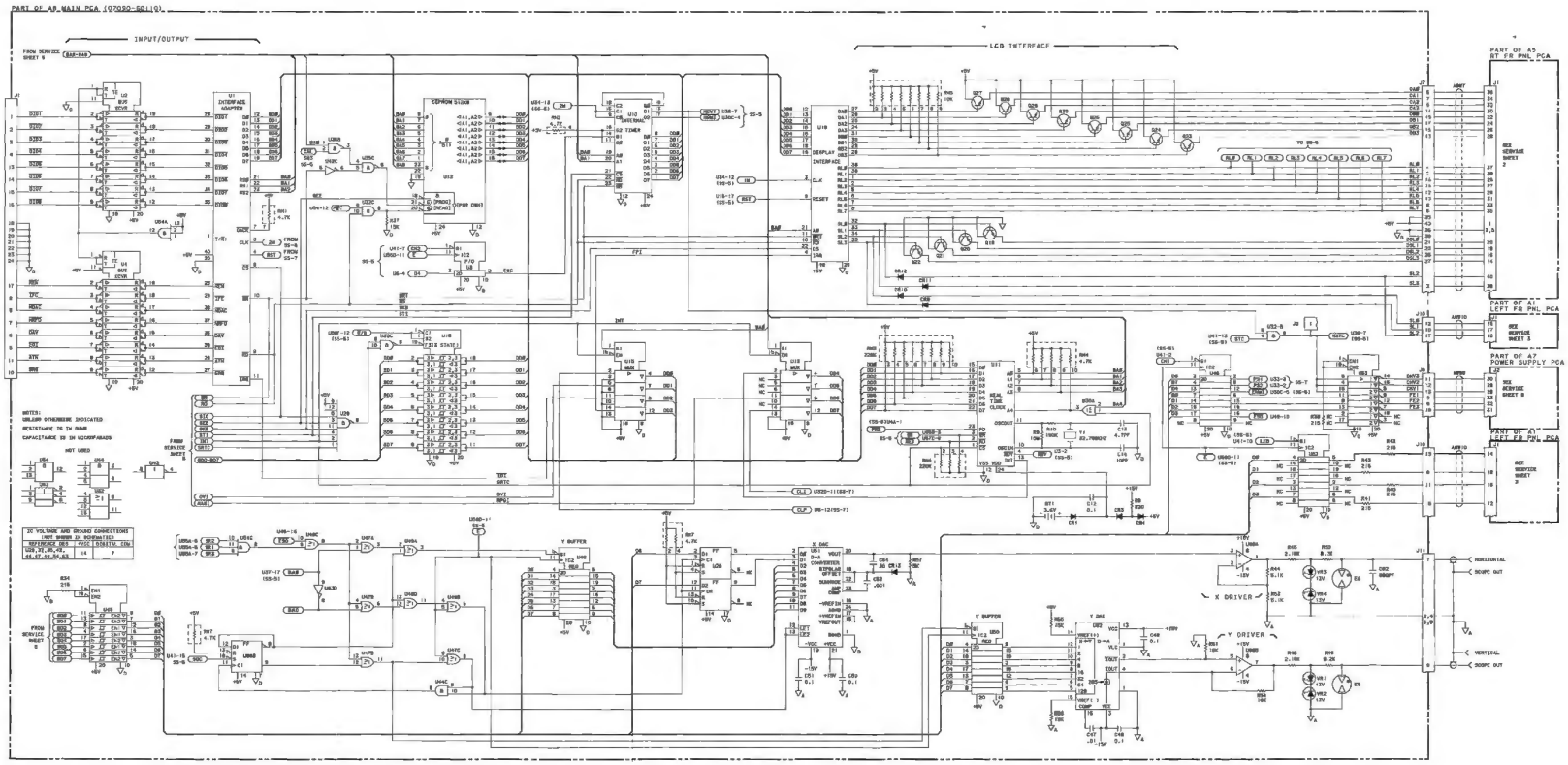


Figure 8-43. I/O and Oscilloscope Output Circuits Schematic

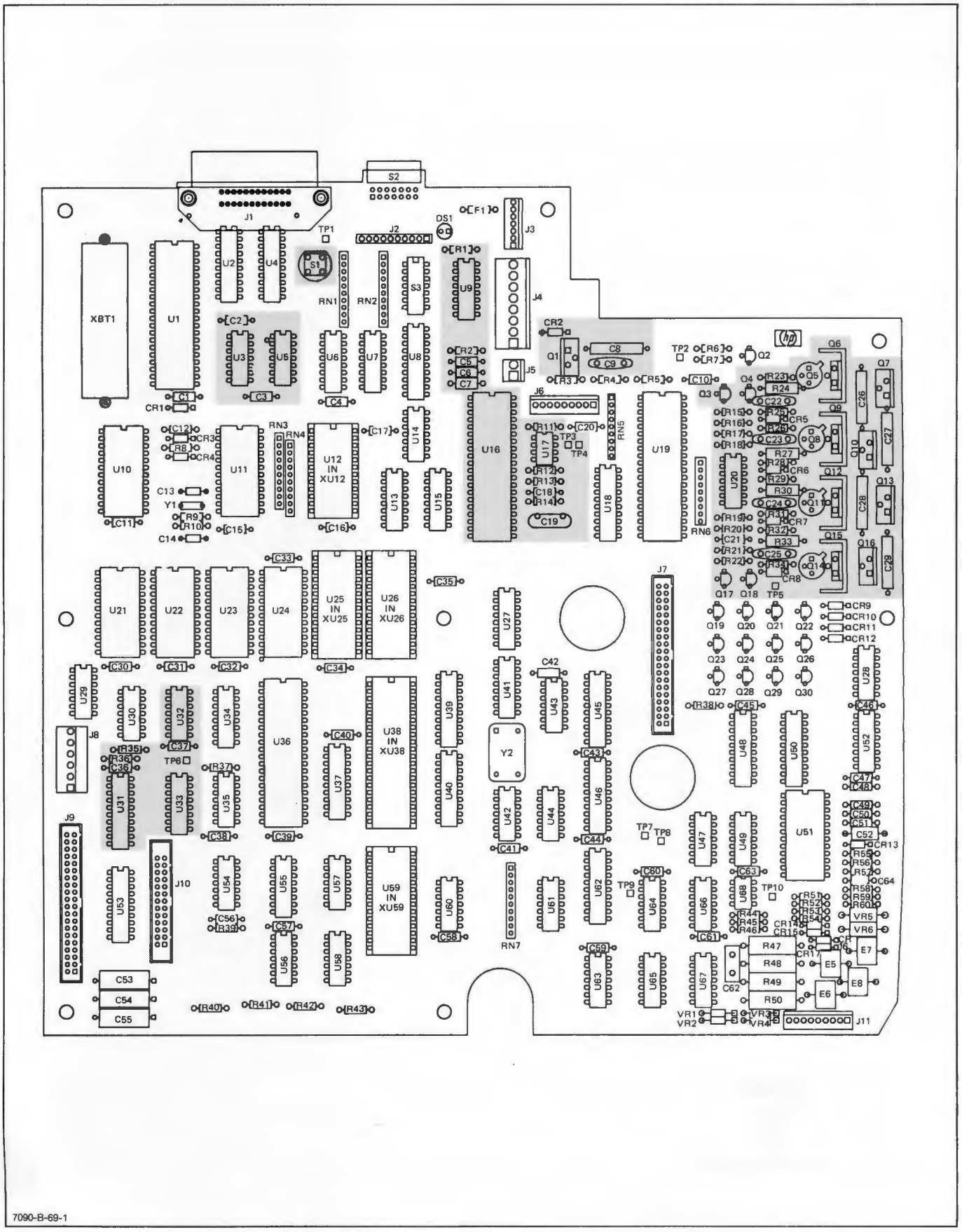
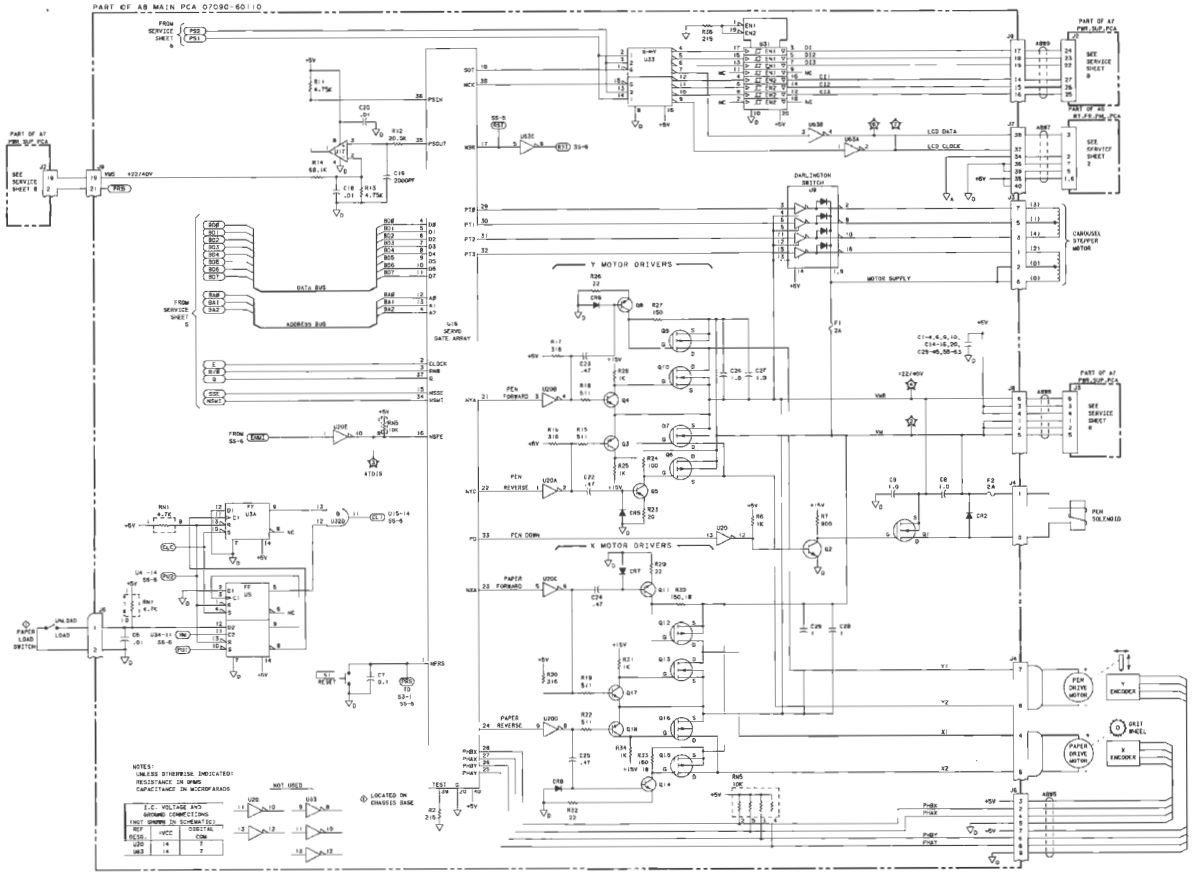


Figure 8-44. Motor Driver Circuit Component Location



7090-E-84-1

7

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Figure 8-45. Motor Driver Circuit Schematic

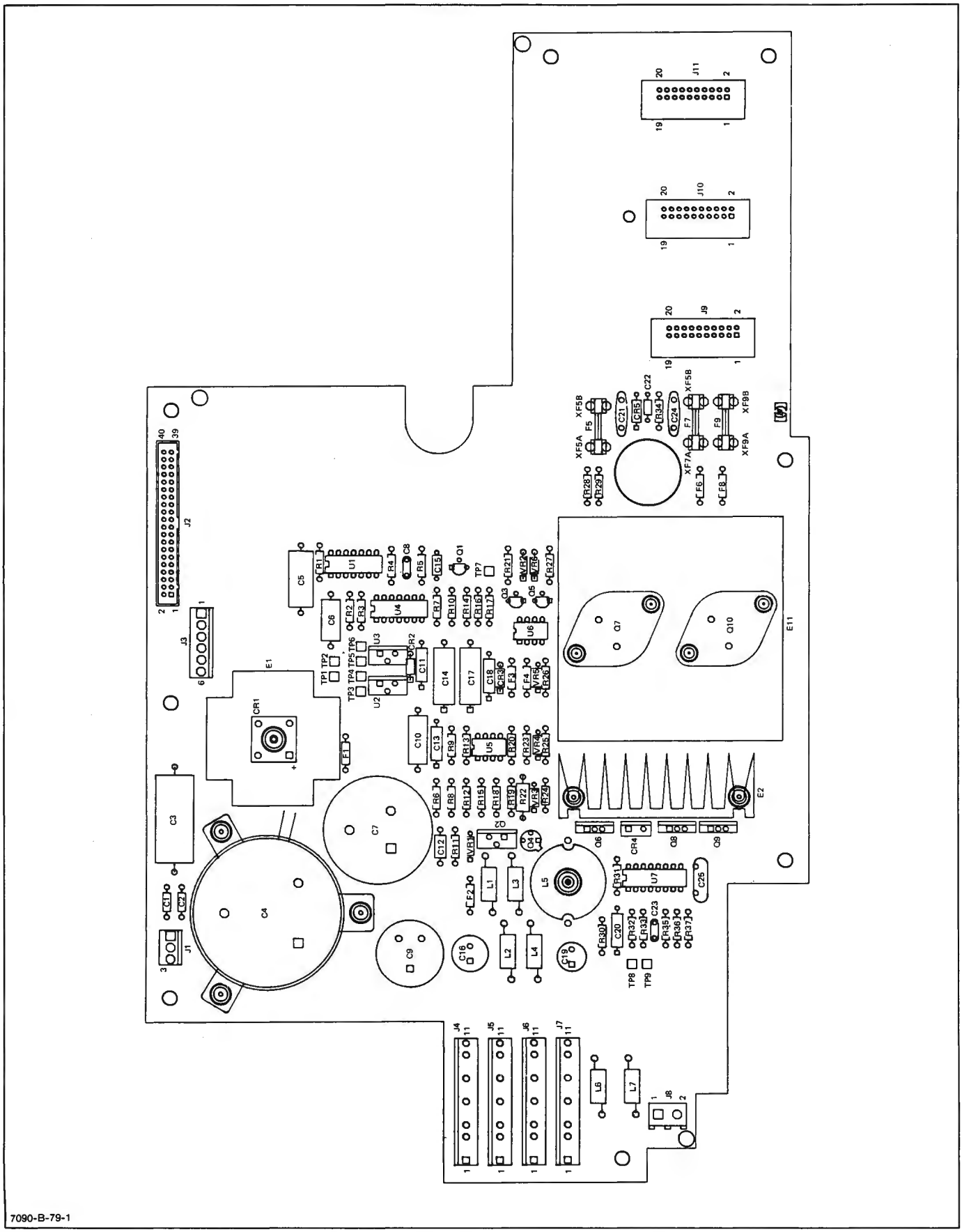

Figure 8-46. Power Supply Component Location

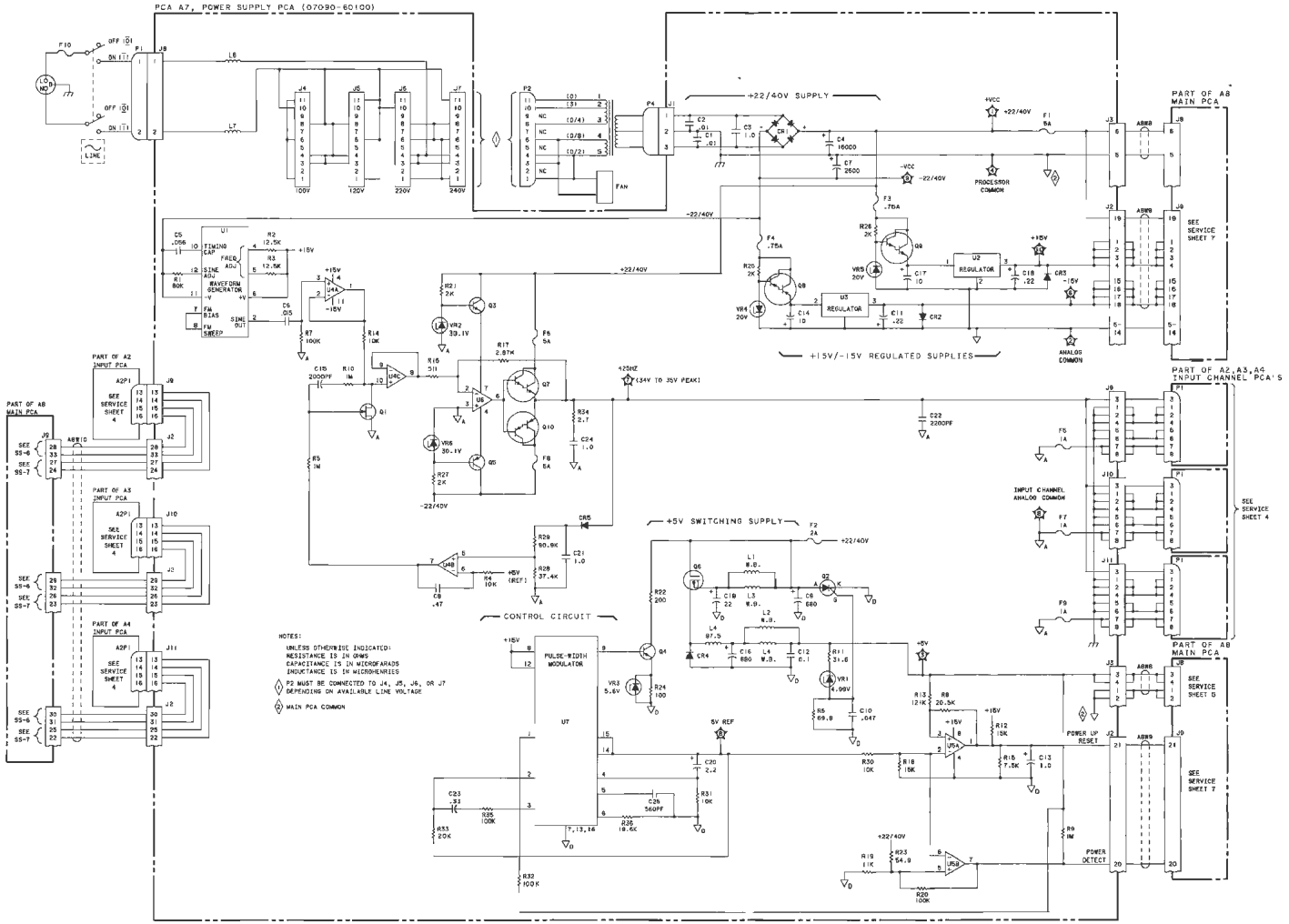

Figure 8-47. Power Supply Schematic