

# HP 8970B NOISE FIGURE METER

## SERIAL NUMBERS

This manual applies to instruments with serial number prefixed 3106A and above.

With the changes described throughout the manual, this manual also applies to instruments with serial numbers 2645A, 2721A, 2742A, 2745A, 2812A, 2847A, 2932A and 2950A.

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



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PACKARD**

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1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

Service Manual Part No. 08970-90054  
HP Binder Part No. 9282-1078

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- INSTALLATION
- OPERATION
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## CERTIFICATION

*Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.*

## WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

### LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

### EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

## ASSISTANCE

*Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.*

*For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.*



## SAFETY CONSIDERATIONS

### GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

### BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed.

### SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

#### WARNINGS

*Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.) In addition, verify that a common ground exists between the unit under test and this instrument prior to energizing either unit.*

*Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.*

*If this instrument is to be energized via an auto-transformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the mains supply).*

*Servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so. Adjustments described in the manual are performed with power supplied to the instrument while protective covers*

*are removed. Energy available at many points may, if contacted, result in personal injury.*

*Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.*

*For continued protection against fire hazard, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay, etc.) Do not use repaired fuses or short-circuited fuseholders.*

### SAFETY SYMBOLS



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (see Table of Contents for page references).



Indicates hazardous voltages.



Indicates earth (ground) terminal.

#### WARNING

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. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

#### CAUTION

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. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

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## SECTION V ADJUSTMENTS

### 5-1. INTRODUCTION

This section contains adjustments and checks that assure peak performance of the Noise Figure Meter. The instrument should be readjusted after repair or after failure to pass a performance test. Allow a 30 minute warm-up period prior to performing the adjustments unless noted otherwise.

To determine which performance tests and adjustments to perform after a repair, refer to the paragraph entitled Related Adjustments. After the repair and/or adjustment, performance tests are usually required to verify performance.

### 5-2. SAFETY CONSIDERATIONS

This section contains information, cautions, and warnings which must be followed for your protection and to avoid damage to the equipment.

#### WARNINGS

*Adjustments described in this section are performed with power supplied to the instrument and with protective covers removed. Maintenance should be performed only by service trained personnel who are aware of the hazard involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.*

*Before the instrument is switched on, all protective earth terminals, extension cords, autotransformers and devices connected to it, should be connected to a protective earth grounded socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.*

*Whenever it is likely that the protection has been impaired, the instrument must*

*be made inoperative and be secured against any unintended operation.*

*Only 250V normal blow fuses with the required rated current should be used. Do not use repaired fuses or short circuited fuseholders. To do so, could cause a shock or fire hazard.*

### 5-3. EQUIPMENT REQUIRED

Each adjustment procedure contains a list of required test equipment. The test equipment is identified by callouts in the test setup diagrams where included.

If substitutions must be made for the specified test equipment, refer to Table 1-5 in Section I for the minimum specifications. It is important that the test equipment meet the critical specifications listed in the table, if the Noise Figure Meter is to meet its performance requirements.

### 5-4. FACTORY-SELECTED COMPONENTS

Factory selected components are identified on the schematics and parts list by an asterisk (\*) which follows the reference designator. The normal value or range of the components is shown. The manual change sheets may provide updated information pertaining to the selected components. Table 5-1 lists the reference designator, the criterion used for selecting a particular value, the normal range and the service sheet where the component part is shown.

### 5-5. RELATED ADJUSTMENTS

The adjustments should be performed in the order given. However, the Input Power Detector Offset and Gain Adjustment and Display Linearity and X- and Y-Axis Gain Adjustments can be performed without affecting any of the other adjustments.

Table 5-1. Factory Selected Components

Reference Designator	Service Sheet	Range of Values	Process of Selection
A6L6	1		Refer to 20 dB Input Amplifier Gain Adjustment.
A8C5	4	20—39 pF	Perform the 20 MHz IF gain adjustment. On a spectrum analyzer, set the center frequency to 19.5 MHz, frequency span to 10 MHz, reference level to -43 dBm, resolution bandwidth to 100 kHz, and scale to 1 dB/division. Connect the spectrum analyzer to the IF OUTPUT on the rear panel of the Noise Figure Meter. Center the 20 MHz IF passband on the spectrum analyzer and measure its flatness between the center frequency -1 MHz and the center frequency +1 MHz. If the flatness of the passband varies more than 1 dB over this 2 MHz frequency range, change A8C5. Increase the capacitance if the passband tilts to the right. Decrease the capacitance if the passband tilts to the left.
A6R39	1	133—196 k $\Omega$	Refer to Input Power Detector Offset and Gain Adjustment.
A9R18	18	750 $\Omega$	Refer to the Power Supply Adjustments.

## ADJUSTMENTS

### 5-6. POWER SUPPLY ADJUSTMENTS

**Reference** Service Sheets 11 and 18.

**Description** A digital voltmeter monitors the +5V supply while it is adjusted. Then, the normally pulsing +28V noise source drive supply is inhibited from pulsing off, and is set to +28V. The other supply voltages are checked.

**Equipment** Digital Voltmeter.....HP 3456A

- Procedure**
1. Set voltmeter to measure +5 Vdc. Connect the input high lead to A14TP1 (+5V) and the low lead to A14TP2 (GND).
  2. Adjust +5V ADJUST, A9R9, for  $+5.10 \pm 0.20$  Vdc at A14TP1.

#### NOTE

*If A9R9 can't be adjusted for  $+5.10 \pm 0.20$  Vdc at testpoint A14TP1, change A9R18 to 750 ohms (HP part number 0757-0420). Repeat step 2 to verify that A9R9 can now be adjusted for the stated voltage.*

3. On the Noise Figure Meter, key in 81.0 SPECIAL FUNCTION to turn the +28V supply on continuously.
4. Set voltmeter to measure +28 Vdc. Connect the voltmeter input to the front panel NOISE SOURCE DRIVE OUTPUT jack, J1. (The voltmeter high input should be connected to the jack center conductor.)
5. Adjust +28V OUT, A12R7, for a voltmeter reading of  $+28.00 \pm 0.1$  Vdc.
6. Connect the voltmeter input to the rear panel NOISE SOURCE DRIVE OUTPUT jack, J3. The voltmeter reading should be  $+28 \pm 0.1$  Vdc.
7. On the Noise Figure Meter, key in 80.0 SPECIAL FUNCTION to turn off the +28V supply. The voltmeter reading should be  $<1$  Vdc.
8. On the Noise Figure Meter, press PRESET to reinitiate pulsing of the +28V power supply.
9. Check the other supplies with the voltmeter as shown below. Connect the voltmeter low input to A9TP4 (GND).

Supply	Test Point	Voltage Limits (Vdc)	Ripple (V <sub>p-p</sub> )
+15V	A9TP2	$\pm 1.0$	$<20$ mV
-15V	A9TP1	$\pm 1.0$	$<20$ mV

## ADJUSTMENTS

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### 5-7. VOLTMETER OFFSET ADJUSTMENT

**Reference** Service Sheet 5.

**Description** The input to the A7 Voltmeter Assembly is disconnected and the Noise Figure Meter is set to read volts. The voltmeter offset is then adjusted for a front panel reading of zero.

- Procedure**
1. With the Noise Figure Meter power off, remove the cover over the A7 Voltmeter Assembly. (The assembly is accessed from the top of the instrument.) Disconnect the white-orange-yellow wire at the point marked (VIN). Turn on the Noise Figure Meter.
  2. On the Noise Figure Meter, key in 80.0 SPECIAL FUNCTION to put the instrument into voltmeter mode. Use the INCREASE and DECREASE keys to set the smoothing factor to 8. Adjust VOLTMETER OFFSET, A7R34, for a front panel display of  $0V \pm 0.00003 Vdc$ .
  3. Remove power, replace the white-orange-yellow wire to the point marked (VIN), and reinstall the cover over the Voltmeter Assembly.

## ADJUSTMENTS

### 5-8. 280 MHz OSCILLATOR ADJUSTMENT

<b>Reference</b>	Service Sheets 2 and 3.
<b>Description</b>	The tank capacitor of the third local oscillator is adjusted for a 280 MHz LO signal.
<b>Equipment</b>	Spectrum Analyzer ..... HP 8566B

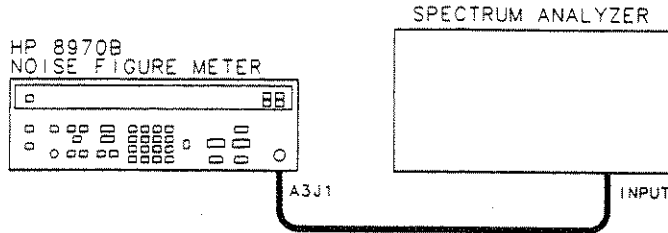


Figure 5-1. 280 MHz Oscillator Adjustment Setup

- Procedure**
1. Set the spectrum analyzer input attenuation to 20 dB, reference level to  $-30$  dBm, frequency span to 500 kHz per division, and 30 kHz resolution bandwidth. Set the center frequency to 280 MHz, trigger to free run, and video filtering off.
  2. With the Noise Figure Meter power off, remove the small 20 MHz IF cover (front left). Move A3C82 (in sockets) to connect the input from the 300 MHz IF to A3J1.
  3. With all equipment power off, connect the equipment as shown in Figure 5-1.
  4. Turn on the equipment power. Note that an error display on the Noise Figure Meter is normal when the signal path is broken. Adjust 280 MHz OSC, A4C11, until a 280 MHz signal appears on the spectrum analyzer display. Adjust A4C11 to peak the signal level on the display ( $>-40$  dBm is typical).
  5. If you are not proceeding to the next adjustment, turn off the Noise Figure Meter, place A3C82 back into its original position, and replace the 20 MHz IF cover.

## ADJUSTMENTS

### 5-9. 300 MHz IF BANDPASS FILTER ADJUSTMENT

**Reference** Service Sheets 2 and 3.

**Description** The 300 MHz IF passband is checked. If adjustment is necessary, a swept signal is injected into the 300 MHz IF while the output is monitored with a spectrum analyzer. The 300 MHz bandpass filter is aligned for proper bandpass characteristics.

**Equipment**

Signal Generator	HP 8340B
Spectrum Analyzer	HP 8566B
Sweep Oscillator	HP 8620C/86222B Opt. 002

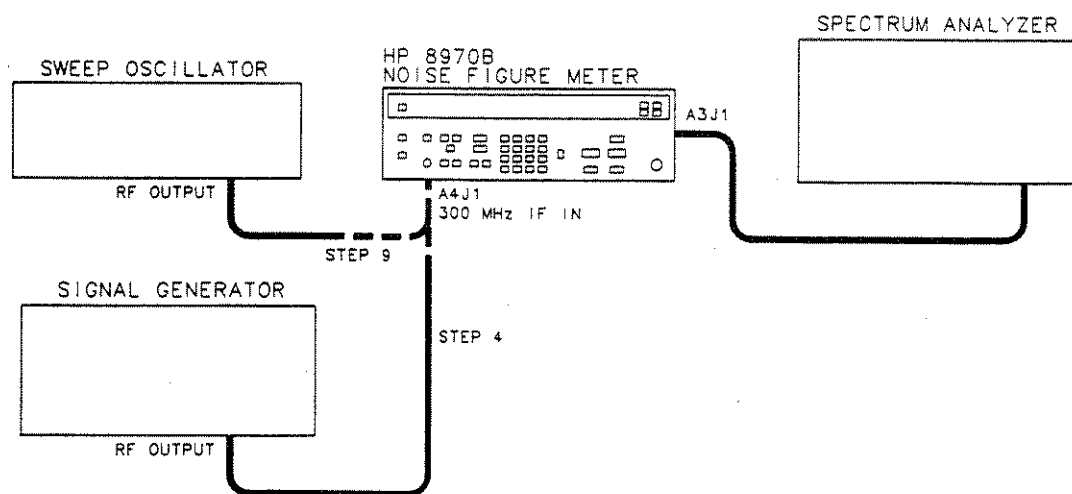


Figure 5-2. 300 MHz IF Bandpass Filter Adjustment Setup

- Procedure**
1. Set the signal generator for a 299.50 MHz CW signal at  $-30$  dBm.
  2. Set spectrum analyzer reference level to  $-18$  dBm; input attenuation to 20 dB, frequency span to 12 MHz per division, and resolution bandwidth to between 100 and 300 kHz. Set center frequency to 19.5 MHz, trigger to free run, and video filter off. Set sweep time to 0.1 seconds and vertical resolution to 2 dB per division.
  3. With the Noise Figure Meter power off, remove the small 20 MHz IF cover (front left). Move A3C82 (in sockets) to connect the input from the 300 MHz IF to A3J1.
  4. Connect the equipment as shown in Figure 5-2. Turn on the equipment. Note that an error display on the Noise Figure Meter is normal when the signal path is broken.
  5. A  $-20$  dBm signal  $\pm 1$  dB, at approximately 19.5 MHz, should be visible on the spectrum analyzer display. If the signal meets the above limits continue with step 7.



## ADJUSTMENTS

### 300 MHz IF BANDPASS FILTER ADJUSTMENT (cont'd)

#### Procedure (cont'd)

6. If no signal is visible, start by setting FLTR 1, A4C9, FLTR 2, A4C12, FLTR 3, A4C17, and FLTR 4, A4C19, to midrange, then continue with the next step. If a signal is visible, but is not at  $-20 \text{ dBm} \pm 1 \text{ dB}$ , then continue with the next step.
7. Find, then peak the signal at 20 MHz by adjusting FLTR 2, A4C12, and FLTR 3, A4C17. Continue to adjust for maximum signal strength with adjustments FLTR 1, A4C9, and FLTR 4, A4C19.
8. Set the sweep oscillator for a  $-30 \text{ dBm}$ , 80 MHz wide swept signal centered at 300 MHz. Set the sweep time to 0.01 seconds and the vernier to maximum.
9. Disconnect the signal generator, and connect the sweeper to A4J1 (300 MHz IF IN). (See Figure 5-2.)
10. Check that the passband displayed on the spectrum analyzer is centered about 19.5 MHz. The passband should be greater than 10 MHz wide at the 3-dB points and flat to within one half dB within 2 MHz of the center frequency (see Figure 5-3). If so, no further adjustment is necessary.

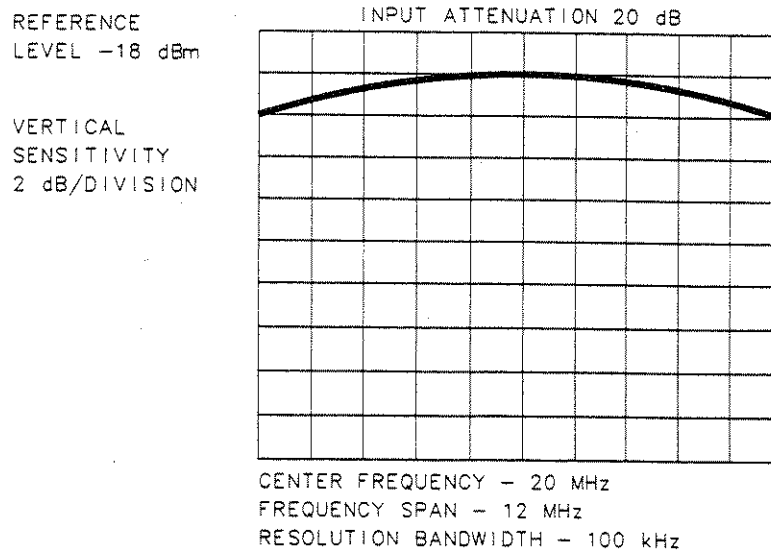


Figure 5-3. 300 MHz Passband

11. Starting with FLTR 2, A4C12, and FLTR 3, A4C17, adjust FLTR 1-4 (A4C9, C12, C17, and C19 respectively) for a passband display as described in the previous step. The gain, from the sweeper input to the IF output, on the spectrum analyzer display should be 10 dB.
12. Remove the power from the Noise Figure Meter, place A3C82 back into its original position, and replace the 20 MHz IF cover.

## ADJUSTMENTS

### 5-10. SECOND CONVERTER LO FREQUENCY ADJUSTMENT

<b>Reference</b>	Service Sheet 2.
<b>Description</b>	The second converter LO is adjusted to 1750 MHz.
<b>Equipment</b>	Frequency Counter ..... HP 5340A Adapter ..... HP 1250-1113

#### NOTE

*The special adapter in Figure 5-4 is made from a standard subminiature RF male to male adapter, HP 1250-1113. The adapter's nuts must be soldered to the body of the adapter so they will both turn with the body. Be sure to space the nuts properly before soldering. (See Figure 5-4.)*

MAXIMUM SPACE (PULL NUT TO END OF  
BODY, BOTH SIDES)



SOLDER NUTS TO BODY

Figure 5-4. Special Adapter used in Second Converter LO and Passband Adjustments

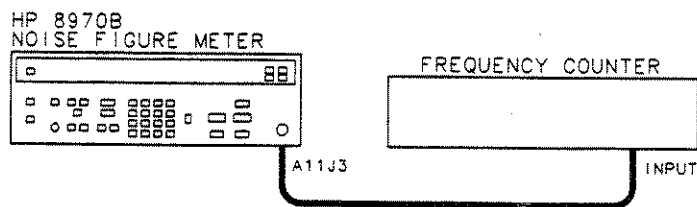


Figure 5-5. Second Converter LO Frequency Adjustment Setup

- Procedure**
1. Connect equipment as shown in Figure 5-5.
  2. Adjust SECOND LO FREQUENCY, A11Z4, for a frequency counter display of 1749.8 to 1750.2 MHz. Use an allen wrench, through the center of a drilled out 5/16 inch nut driver, to enable nut to be tightened without shifting frequency.

## ADJUSTMENTS

### 5-11. 2050 MHz BANDPASS FILTER ADJUSTMENT

<b>Reference</b>	Service Sheet 2.
<b>Description</b>	A swept 2050 MHz signal is injected into the second converter assembly, and the bandpass resonators are adjusted for best amplitude and flatness.
<b>Equipment</b>	Sweep Oscillator ..... HP 8620C/86222B Opt. 002 Spectrum Analyzer ..... HP 8566B Adapter ..... HP 1250-1113

#### NOTE

*For special modification to adapter 1250-1113, see Figure 5-4.*

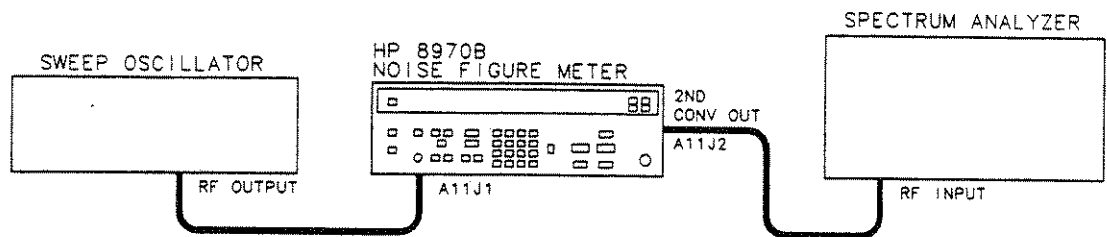


Figure 5-6. 2050 MHz Bandpass Filter Adjustment Setup

- Procedure**
1. Set the sweep oscillator for a  $-10$  dBm 100 MHz wide swept signal centered at 2050 MHz. Set the sweep time to 0.01 seconds with the vernier at maximum.
  2. Set the spectrum analyzer reference level to  $-10$  dBm, input attenuation to 20 dB, frequency span to 16 MHz, and resolution bandwidth to 100 kHz. Set the center frequency to 299.5 MHz, trigger to free run, video filter off and the vertical sensitivity to 1 dB/division.
  3. Connect the equipment as shown in Figure 5-6. Note that an error display on the Noise Figure Meter is normal when the signal path is broken.
  4. Check that the passband displayed on the spectrum analyzer is flat within 0.4 dB for 2 MHz on either side of the 299.5 MHz center frequency. Passband points at 8 MHz on either side of the center frequency should be within 1 dB of each other. (See Figure 5-7.) If these conditions are met, no adjustment is necessary.
  5. If the passband requires adjustment, start by loosening the locknuts on A11Z1, A11Z2, and A11Z3. If only minor adjustment is needed, continue with step 6. If extensive adjustment is needed, carefully turn the tuning screws clockwise until each touches on the bottom of the cavity. Then, unscrew each of the tuning screws four full turns from bottom.
  6. Adjust A11Z1 and A11Z3 for maximum passband amplitude while preserving overall flatness.

## ADJUSTMENTS

### 2050 MHz BANDPASS FILTER ADJUSTMENT (cont'd)

#### Procedure (cont'd)

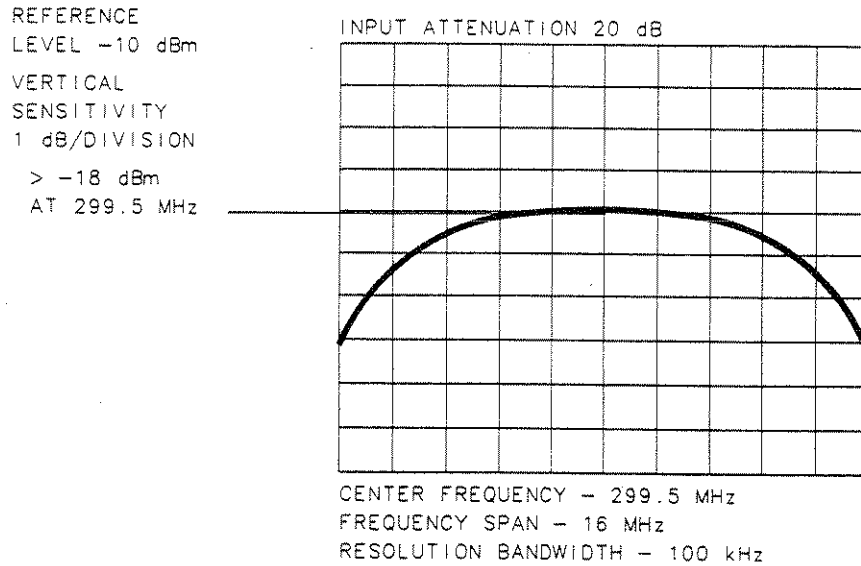


Figure 5-7. 2050 MHz Passband

7. Adjust A11Z2 for maximum passband amplitude. If necessary, readjust A11Z1 and A11Z3 to achieve the best compromise between passband flatness and amplitude. When adjustment is complete, the passband should be as described in step 4.
8. Adjust 2nd MIXER MATCH, A11L2, for best passband amplitude and shape.
9. Reconnect W5 and W6.

## ADJUSTMENTS

## 5-12. FREQUENCY CAL RF DETECTOR AND FIRST LO OFFSET ADJUSTMENTS

<b>Reference</b>	Service Sheets 3 and 7.
<b>Description</b>	The Frequency Cal RF Detector frequency and gain adjustments are set.
<b>Equipment</b>	Digital Voltmeter ..... HP 3456A Frequency Counter ..... HP 5340A Spectrum Analyzer ..... HP 8566B Attenuator, 6 dB ..... HP 8493A Opt. 006

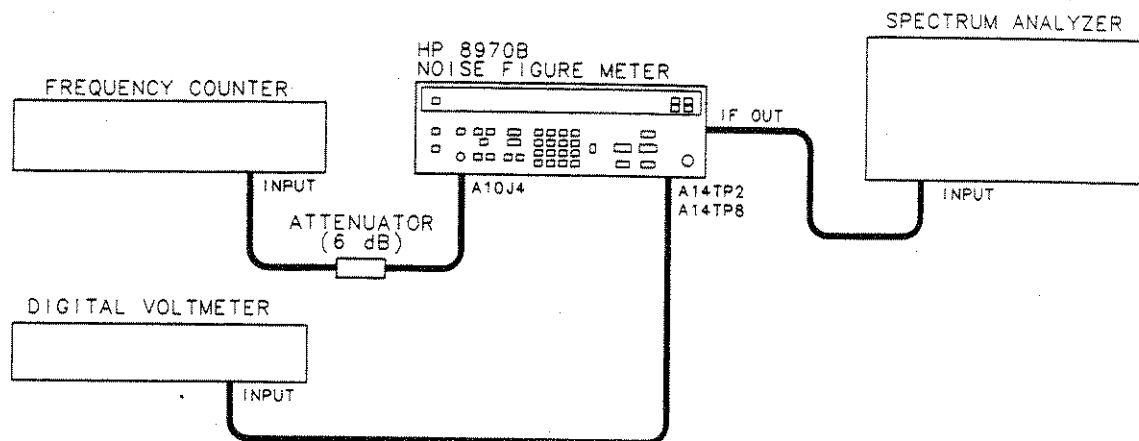


Figure 5-8. Frequency Cal RF Detector and First LO Offset Adjustment Setup

- Procedure**
1. Set the spectrum analyzer reference level to  $-10$  dBm, input attenuation to 20 dB, frequency span to 1 MHz per division, and resolution bandwidth to 30 kHz. Set the center frequency to 20 MHz, trigger to free run, with video filtering set to 0.01 (or approximately 300 Hz).
  2. On the Noise Figure Meter, press PRESET.
  3. Connect the equipment as shown in Figure 5-8. Connect the voltmeter high input to FREQ CAL DET IN, A14TP8, and the low input to GND, A14TP2.
  4. Set the center of the 20 MHz IF passband exactly on the center vertical graticule of the spectrum analyzer display by changing the spectrum analyzer center frequency.
  5. On the Noise Figure Meter, key in 70.5 SPECIAL FUNCTION to reduce the IF gain by 20 dB and 92.1 SPECIAL FUNCTION to tune the instrument to a 0 MHz input. Adjust 1st LO OFFSET, A13R11, until the signal is exactly centered on the center vertical graticule of the spectrum analyzer display. (Ignore E11 on the Noise Figure Meter during this adjustment.) Check that the frequency counter is displaying 2049.5 MHz  $\pm 0.5$  MHz.

**NOTE**

*If the displayed signal cannot be adjusted to within  $\pm 500$  kHz of the point where A13R11 needs to be set, replace A13R11.*

## ADJUSTMENTS

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### FREQUENCY CAL RF DETECTOR AND FIRST LO OFFSET ADJUSTMENTS (cont'd)

**Procedure  
(cont'd)**

6. Adjust DET FREQ, A3C43, to peak the dc voltage reading on the digital voltmeter. If no peak is apparent, set DET GAIN, A3R19, to mid-range before peaking the DET FREQ adjustment.
7. Adjust DET GAIN, A3R19, for a voltmeter reading of 2.40 to 2.60 Vdc. Adjust the voltage as close to 2.50 Vdc as possible.
8. On the Noise Figure Meter, key in 92.0 SPECIAL FUNCTION to turn off the 0 MHz hold. Tune the Noise Figure Meter to 1600 MHz. Key in 31.2 SPECIAL FUNCTION to enable frequency calibration.
9. Adjust 1st LO GAIN, A13R23, for a counter reading of 3649.5 to 3651.5 MHz.

**NOTE**

*If adjustment was performed correctly, the error E-18 should be gone.*

## ADJUSTMENTS

## 5-13. INPUT POWER DETECTOR OFFSET AND GAIN ADJUSTMENT

<b>Reference</b>	Service Sheet 1.
<b>Description</b>	The offset and gain of the Input Power Detector dc amplifier are set.
<b>Equipment</b>	Digital Voltmeter ..... HP 3456A Signal Generator ..... HP 8340B Power Meter ..... HP 436A Power Sensor ..... HP 8481A

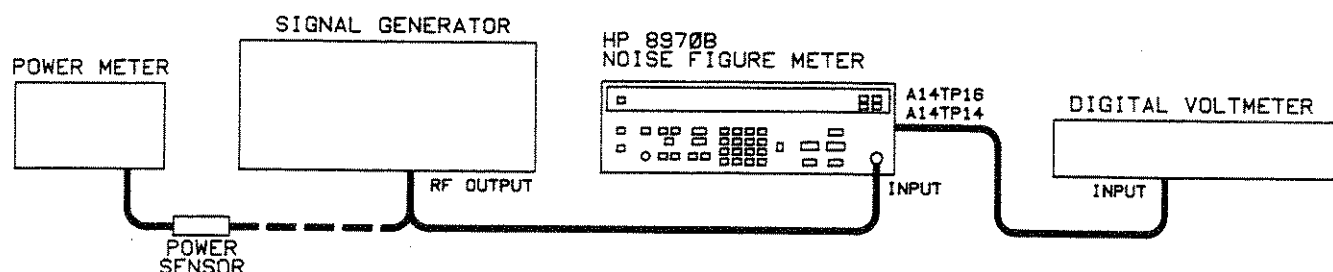


Figure 5-9. Input Power Detector Offset and Gain Adjustment Setup

- Procedure**
1. Connect the power sensor to the RF output of the signal generator. Connect the voltmeter low lead to GND, A14TP14, for a ground reference. Turn on the equipment.
  2. Set the signal generator RF output to OFF.
  3. On the Noise Figure Meter, key in 60.3 SPECIAL FUNCTION to set the RF gain to 0 dB.
  4. Adjust OFFSET, A6R41, for a digital voltmeter reading of  $0 \pm 0.01$  Vdc.
  5. Connect the equipment as shown in Figure 5-9.

**NOTE***Ignore error E-11*

6. Using the power meter, set the signal generator for an output of  $-18$  dBm  $\pm 0.1$  dB at 30 MHz.
7. Adjust GAIN, A6R42, for a digital voltmeter reading of  $6.90 \pm 0.05$  Vdc. If the voltage cannot be adjusted within this range, perform step 8; otherwise, this adjustment is completed.
8. If the adjustment in step 7 cannot be made, A6R39 must be selected as follows:
  - a. Set A6R39 fully clockwise or counterclockwise, whichever gives the closest reading to 6.9 Vdc.
  - b. Note the digital voltmeter display.
  - c. If the displayed voltage is greater than 6.9 Vdc, decrease A6R39 one standard value. If the displayed voltage is less than 6.9 Vdc, increase A6R39 one standard value.
  - d. Repeat steps 4 through 7. If the adjustment in step 7 still cannot be done, repeat step 8. The value of A6R39 must be  $\geq 133$  k $\Omega$  and  $\leq 196$  k $\Omega$ .

## ADJUSTMENTS

### 5-14. 20 dB INPUT AMPLIFIER GAIN ADJUSTMENT

**Reference** Service Sheet 1.

**Description** The 20 dB Input Amplifier is adjusted by selecting the value of L6 on the A6 Input Assembly.

#### NOTE

*This adjustment should only be performed if the Input Amplifier has been repaired or if relay chatter on the Input Assembly is noticed. If relay chatter is noticed, perform the Input Power Detector Offset and Gain Adjustment, paragraph 5-13, before this procedure.*

**Equipment**

Frequency Counter .....	HP 5340A
Power Meter .....	HP 436A
Power Sensor .....	HP 8484A
Sweep Oscillator .....	HP 8620C/86222B Opt. 002

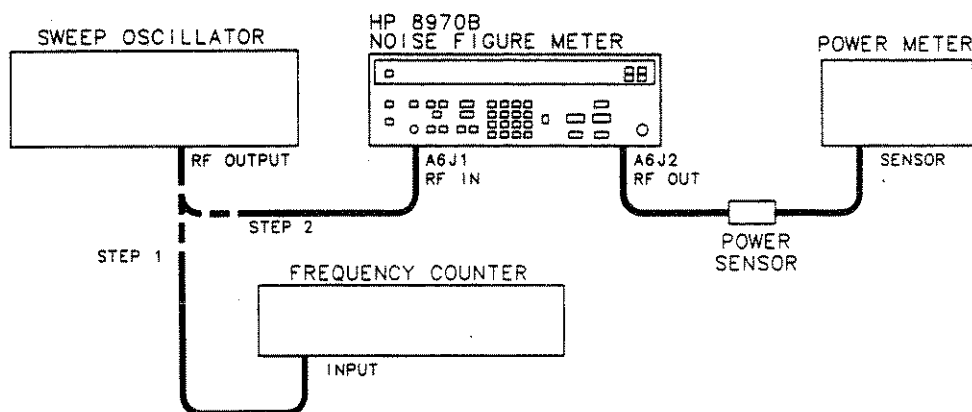


Figure 5-10. 20 dB Input Amplifier Gain Adjustment Setup

#### Procedure

1. Connect the sweep oscillator output to the frequency counter input. Set the sweep oscillator for a 1600 MHz CW signal at approximately  $-50$  dBm.
2. Connect the sweep oscillator to the Noise Figure Meter A6J1, RF IN. Connect the power sensor to A6J2, RF OUT. (See Figure 5-10.)
3. On the Noise Figure Meter, key in 63.0 SPECIAL FUNCTION to set the Input Assembly for a thru line connection.
4. Adjust the sweep oscillator for an output level of  $-50$  dBm as read on the power meter. Set a relative reference on the power meter.
5. On the Noise Figure Meter, key in 60.1 SPECIAL FUNCTION to insert the 20 dB Input Amplifier.



## ADJUSTMENTS

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### 20 dB INPUT AMPLIFIER GAIN ADJUSTMENT (cont'd)

**Procedure  
(cont'd)**

6. The power meter should indicate between 19.0 and 21.0 dB typical. If so, no adjustment is necessary.
7. If adjustment is needed, turn off the equipment, and remove the cover over the A6 Input Assembly. Unsolder the shorting wire laying across A6L6. The wire lays across one of several near shorts that span the printed circuit loop that forms L6. See (Fig 8-19) A6 input assembly component location.
8. Turn on the equipment, and reestablish the gain reading by repeating steps 3 through 5.
9. Move a shorting wire back and forth along the loop of L6 until a gain of 19.0 to 21.0 dB typical, as read on the power meter, is obtained. Solder the wire to the board in that position.

**NOTE**

*Moving the shorting wire toward A6Q1 reduces the amplifier gain.*

10. Replace the connections to the A6 Input Assembly, and replace the covers.

## ADJUSTMENTS

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### 5-15. DISPLAY LINEARITY AND X- AND Y-AXIS GAIN ADJUSTMENTS

<b>Reference</b>	Service Sheets 14 and 15.
<b>Description</b>	The X-axis and Y-axis gain adjustments are set for an output voltage range of 6 Vdc. The display linearity is set for constant horizontal spacings between display points.
<b>Equipment</b>	Oscilloscope ..... Tektronix 2235 Digital Voltmeter ..... HP 3456A
<b>Procedure</b>	<ol style="list-style-type: none"> <li>1. Set the digital voltmeter to read dc volts and connect it to the Noise Figure Meter rear panel X-AXIS output.</li> <li>2. Turn on the Noise Figure Meter, and key in 21.0 SPECIAL FUNCTION to set the X-AXIS and Y-AXIS outputs to their maximum levels. Adjust X GAIN, A13R47, for a digital voltmeter reading of <math>6 \pm 0.05</math> Vdc.</li> <li>3. Connect the digital voltmeter to the Noise Figure Meter rear panel Y-AXIS output. Adjust Y GAIN, A13R34, for a digital voltmeter reading of <math>6 \pm 0.05</math> Vdc.</li> <li>4. Connect the Noise Figure Meter rear panel X-AXIS output to the oscilloscope channel B input. Connect the Y-AXIS output to the oscilloscope channel A input. Connect the Noise Figure Meter Z-AXIS output to the oscilloscope Z-Axis input. Set the B channel gain to 0.5 volts per division dc coupled. Select the A versus B display mode on the oscilloscope.</li> <li>5. On the Noise Figure Meter, key in 7.1 SPECIAL FUNCTION to access the oscilloscope test pattern. Adjust the oscilloscope gain and position controls until the test pattern exactly fits on the oscilloscope graticule.</li> <li>6. On the Noise Figure Meter, press PRESET. Set the SWEEP STEP SIZE to 100 MHz. Key in 7.2 SPECIAL FUNCTION to select the noise figure oscilloscope display. Press the SINGLE SWEEP key. A line will be traced along the top of the oscilloscope display. When the line is halfway across the screen, press SINGLE SWEEP again, to stop the sweep. The trace should extend halfway across the top of the screen, and then continue the rest of the way at the bottom of the screen. If not, repeat this step.</li> <li>7. Adjust DISPLAY LINEARITY, A13R29, so the last line segment at the top of the oscilloscope display is best aligned with the segments before it.</li> </ol>

## ADJUSTMENTS

### 5-16. NOISE POWER DETECTOR ADJUSTMENT

**Reference**      Service Sheet 5.

**Description**      Two RF levels that differ by 5 dB are generated. The levels are measured on a power meter, and a linear power ratio is computed. The levels are simultaneously measured using the detector in the Noise Figure Meter. The detector bias adjustment is set so that the Noise Figure Meter reading of the lower of the two levels best fits the optimum detector accuracy setting.

#### NOTES

*This adjustment is difficult to perform. Proper adjustment requires minimum drift in both the measurement equipment and the Noise Figure Meter. For best results, perform the adjustment quickly.*

*Since the Noise Figure Meter is highly sensitive to RF signals at its input, spurious transmissions or noise can adversely affect performance test results. Use short well-shielded cables and a minimum of adapters when performing this adjustment.*

<b>Equipment</b>	Attenuator, 6 dB .....	HP 8491A Opt. 006
	Attenuator, 1dB Step .....	HP 8494A Opt. 001
	Calculator .....	HP 41CV
	Digital Voltmeter .....	HP 3456A
	Filter, Low-Pass .....	HP 360B
	Power Meter .....	HP 436A
	Power Sensor .....	HP 8484A
	Power Splitter .....	HP 11667A
	Signal Generator .....	HP 8340B

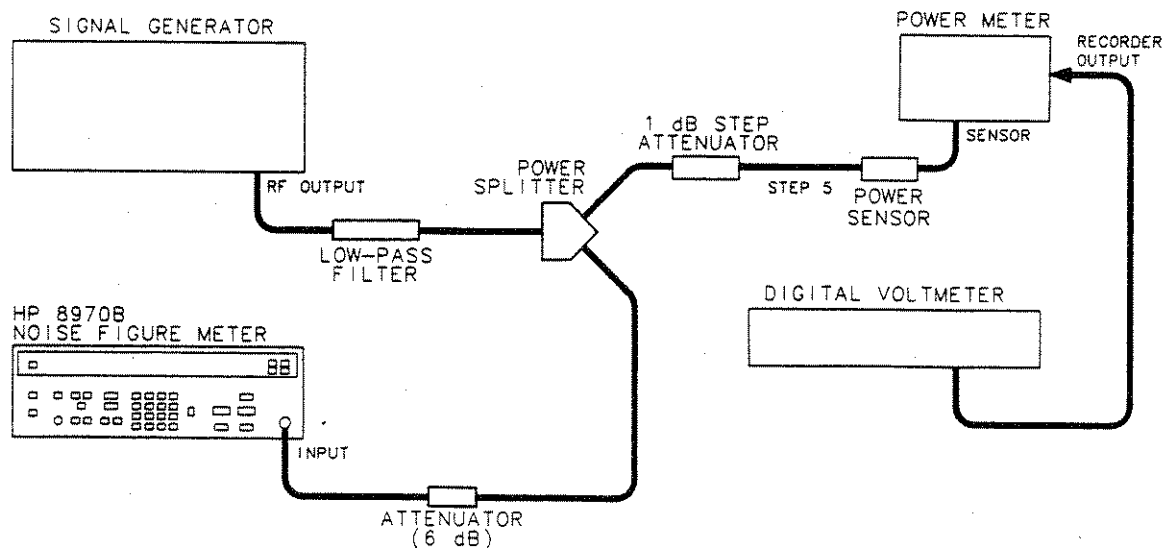


Figure 5-11. Noise Power Detector Adjustment Setup

## ADJUSTMENTS

### NOISE POWER DETECTOR ADJUSTMENT (cont'd)

**Procedure  
(cont'd)**

1. Connect equipment as shown in Figure 5-11, except do not connect the power sensor to the step attenuator.
2. Turn on all equipment and allow it to warm up for one hour.
3. Set the signal generator for a 700 MHz continuous wave output at  $-17$  dBm.
4. On the Noise Figure Meter, set FREQUENCY to 700 MHz. Key in 80.0 SPECIAL FUNCTION to display the noise power detector output in volts (voltmeter mode). Key in 31.1 SPECIAL FUNCTION to inhibit frequency calibrations. Key in 60.5 SPECIAL FUNCTION to set the input gain to  $-20$  dB. Key in 70.6 SPECIAL FUNCTION to set the IF attenuation to  $-25$  dB. Set the smoothing factor to 4 using the INCREASE and DECREASE keys.
5. Zero the power meter, and set the 1 dB step attenuator to 10 dB. Connect the power sensor to the 1 dB step attenuator as shown in Figure 5-11.
6. Peak the Noise Figure Meter display reading by tuning the signal generator up and down in frequency in 10 kHz increments.
7. Increase the signal generator power in 0.1 dB steps until the combined INSERTION GAIN and NOISE FIGURE displays on the Noise Figure Meter indicate as close as possible to 1.00000 volts. The signal generator power should be near  $-14.7$  dBm. Note this power level as read on the signal generator.  
\_\_\_\_\_ dBm
8. Set the step attenuator for a power meter reading as close as possible to but not more than  $1.000 \mu\text{W}$ .

#### NOTE

*The intent is to set the level into the power meter near the top of a power meter range. Test setup sensitivity may vary so that it may be necessary to add attenuation greater than is permitted by the 1 dB step attenuator. If more attenuation is needed, an HP 8491B fixed attenuator of appropriate value will do.*

9. Set the digital voltmeter to read dc volts on the high resolution setting. Using the manual trigger control, trigger several readings then stop on a typical reading. Note this reading using full resolution.  
(Vp1) \_\_\_\_\_ Vdc
10. Note the voltmeter mode reading on the Noise Figure Meter also using full resolution.  
(Vn1) \_\_\_\_\_ Vdc
11. Decrease the signal generator power by 5.0 dB.

## ADJUSTMENTS

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### NOISE POWER DETECTOR ADJUSTMENT (cont'd)

**Procedure  
(cont'd)**

12. Using the same technique as in step 9 take a voltmeter reading.

(Vp2) \_\_\_\_\_ Vdc

13. Compute the voltmeter mode reading, Vn2, for which the Noise Power Detector bias is to be adjusted.

$$Vn2 = (0.99885) (Vn1) \sqrt{\frac{(Vp2)}{(Vp1)}}$$

(Vn2) \_\_\_\_\_ Vdc

14. Adjust BIAS, A8R4, for a Noise Figure Meter voltmeter mode reading of the voltage computed in step 13.
15. Disconnect the signal generator output temporarily. On the Noise Figure Meter, key in 60.6 SPECIAL FUNCTION to set the RF gain to -30 dB. Key in 70.8 SPECIAL FUNCTION to set the IF attenuation to 35 dB. The Noise Figure Meter display should read  $0.016 \pm 0.005$  Vdc.
16. Reconnect the signal generator output, and perform the procedure a second time to check that the detector has been adjusted properly.

## ADJUSTMENTS

### 5-17. 20 MHz IF GAIN ADJUSTMENT

- Reference**            Service Sheet 3.
- Description**        The Noise Figure Meter is set for maximum gain. The 20 MHz IF gain is set so that the Noise Figure Meter internal voltmeter reads 1 volt with an active noise source at the instrument input.
- Equipment**        Noise Source ..... HP 346B Opt. 001
- Procedure**
1. Connect the noise source to the Noise Figure Meter INPUT. Turn on the Noise Figure Meter. Press PRESET.
  2. Tune the Noise Figure Meter to 10 MHz. Key in 81.0 SPECIAL FUNCTION to turn the noise source on and put the Noise Figure Meter into the voltmeter mode. Key in 60.1 SPECIAL FUNCTION to set the RF gain to +20 dB. Key in 70.1 SPECIAL FUNCTION to set the IF attenuation to 0 dB.
  3. Using Table 5-2, find the voltage associated with the Excess Noise Ratio (ENR), at 10 MHz, of the noise source being used.
  4. Adjust IF GAIN, A3R36, for a front panel display corresponding to the voltage obtained from Table 5-2. This display is composed of the combination of the INSERTION GAIN and NOISE FIGURE displays. Display SMOOTHING can be used to stabilize the front panel reading.

Table 5-2. Excess Noise Ratio vs. Voltage

Noise Source Excess Noise Ratio (ENR) at 10 MHz	Displayed Voltage after Adjusting IF Gain, A3R36. (Vdc)	Noise Source Excess Noise Ratio (ENR) at 10 MHz	Displayed Voltage after Adjusting IF Gain, A3R36. (Vdc)
16.00	1.10 ±0.05	15.15	0.99 ±0.05
15.95	1.09 ±0.05	15.10	0.99 ±0.05
15.90	1.08 ±0.05	15.05	0.98 ±0.05
15.85	1.08 ±0.05	15.00	0.98 ±0.05
15.80	1.07 ±0.05	14.95	0.97 ±0.05
15.75	1.07 ±0.05	14.90	0.97 ±0.05
15.70	1.06 ±0.05	14.85	0.96 ±0.05
15.65	1.05 ±0.05	14.80	0.95 ±0.05
15.60	1.05 ±0.05	14.75	0.95 ±0.05
15.55	1.04 ±0.05	14.70	0.94 ±0.05
15.50	1.04 ±0.05	14.65	0.94 ±0.05
15.45	1.03 ±0.05	14.60	0.93 ±0.05
15.40	1.02 ±0.05	14.55	0.93 ±0.05
15.35	1.02 ±0.05	14.50	0.92 ±0.05
15.30	1.01 ±0.05	14.45	0.92 ±0.05
15.25	1.01 ±0.05	14.40	0.91 ±0.05
15.20	1.00 ±0.05		

## SECTION VI REPLACEABLE PARTS

### 6-1. INTRODUCTION

This section contains information for ordering parts. Table 6-2 lists abbreviations used in the parts list and throughout the manual. Table 6-3 lists all replaceable parts in reference designator order. Table 6-4 contains the names and addresses that correspond to the manufacturer's code numbers.

### 6-2. ABBREVIATIONS

Table 6-2 lists abbreviations used in the parts list, schematics, and throughout the manual. In some cases, two forms of the abbreviation are used; one all in capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with both lower case and upper case letters.

### 6-3. REPLACEABLE PARTS LIST

Table 6-3 is the list of replaceable parts and is organized as follows:

- a. Electrical assemblies and their components in alpha-numerical order by reference designation.
- b. Chassis-mounted parts in alpha-numerical order by reference designation.
- c. Miscellaneous parts.

The information given for each part consists of the following:

- a. The Hewlett-Packard part number.
- b. Part number check digit (CD).
- c. The total quantity (Qty) in the instrument, which appears only at the first listing of a particular part number.
- d. The description of the part.
- e. A typical manufacturer of the part in a five-digit code.
- f. The manufacturer's number for the part.

### 6-4. FACTORY SELECTED PARTS (\*)

Parts marked with an asterisk (\*) are factory selected parts. The value listed in the parts list is the nominal value. Refer to Section V for information on determining what value to use for replacement.

### 6-5. PARTS LIST BACKDATING (†)

Parts marked with a dagger (†) are different in instruments with serial number prefixes lower than the one that this manual applies to directly. Table 7-1 lists the backdating changes by serial number prefix. The backdating changes are contained in Section VII.

### 6-6. PARTS LIST UPDATING (Change Sheet)

Production changes to instruments made after the publication of this manual are accompanied by a change in the serial number prefix. Changes to the parts list are recorded by serial number prefix on a MANUAL CHANGES supplement. Also, parts list errors are noted in the ERRATA portion of the MANUAL CHANGES supplement.

### 6-7. ILLUSTRATED PARTS BREAKDOWNS

Most mechanical parts are identified in Figures 6-1 through 6-6. These figures are located at the end of the Replaceable Parts table.

### 6-8. HARDWARE

The Noise Figure Meter has a mixture of United National (inch) and metric screws. The metric screws are defined in Industrial Fasteners publication (IFI 500) and are identified in the replaceable parts list as (metric). The Unified National screws are identified in the replaceable parts list as (non-metric). To prevent thread damage, ensure that the same type of screw and nut are used in each application.

### 6-9. ORDERING INFORMATION

To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number (with the check digit), indicate the quantity required and address the order to the nearest Hewlett-Packard office (see note). The check digit will ensure accurate and timely processing of your order.

To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

**NOTE**

*Within the USA, it is better to order directly from the HP Parts Center in Roseville, California. Ask your nearest HP office for information and forms for the "Direct Mail Order System." Also, your nearest HP office can supply toll-free telephone numbers for ordering parts and supplies.*

**6-10. RECOMMENDED SPARES LIST**

Stocking spare parts for an instrument is often done to ensure quick return to service after a malfunction occurs. Hewlett-Packard prepares a "Recommended Spares" list for this instrument. The contents of the list are based on failure reports and repair data. Quantities given are for one year of

parts support. A complimentary copy of the "Recommended Spares" list may be requested from your nearest Hewlett-Packard office.

When stocking parts to support more than one instrument or to support a variety of Hewlett-Packard instruments, it may be more economical to work from one consolidated list rather than simply adding together stocking quantities from the individual instrument lists. Hewlett-Packard will prepare consolidated "Recommended Spares" lists for any number or combination of instruments. Contact your nearest Hewlett-Packard office for details.

**6-11. RESTORED ASSEMBLIES**

Table 6-1 lists assemblies within the instrument that may be replaced on an exchange basis, thus affording a considerable cost saving. Exchange, factory-repaired and tested assemblies are available only on a trade-in basis; therefore, the defective assemblies must be returned for credit. For this reason, assemblies required for spare parts stock must be ordered by the new assembly part number.

**Table 6-1. Part Numbers for Restored Assemblies**

Reference Designation	Assembly Description	Part Number <sup>1</sup>	
		Restored Assembly	New Assembly
A6	Input Board Assembly	08970-69042	08970-60042
A11	Second Converter Assembly	08970-69072	08970-60072
A13	Driver Assembly	08970-69034	08970-60034
A14	Controller Assembly	08970-69033	08970-60033

<sup>1</sup> When ordering extra assemblies for spare parts stock, use new assembly part number only. Restored orders require return of the defective part.



Table 6-2. Reference Designations and Abbreviations (1 of 2)

REFERENCE DESIGNATIONS

A . . . . . assembly	E . . . . . miscellaneous electrical part	P . . . . . electrical connector (movable portion); plug	U . . . . . integrated circuit; microcircuit
AT . . . . . attenuator; isolator; termination	F . . . . . fuse	Q . . . . . transistor; SCR; triode thyristor	V . . . . . electron tube
B . . . . . fan; motor	FL . . . . . filter	R . . . . . resistor	VR . . . . . voltage regulator; breakdown diode
BT . . . . . battery	H . . . . . hardware	RT . . . . . thermistor	W . . . . . cable; transmission path; wire
C . . . . . capacitor	HY . . . . . circulator	S . . . . . switch	X . . . . . socket
CP . . . . . coupler	J . . . . . electrical connector (stationary portion); jack	T . . . . . transformer	Y . . . . . crystal unit (piezo-electric or quartz)
CR . . . . . diode; diode thyristor; varactor	K . . . . . relay	TB . . . . . terminal board	Z . . . . . tuned cavity; tuned circuit
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		

ABBREVIATIONS

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

NOTE

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

Table 6-2. Reference Designations and Abbreviations (2 of 2)

MOD . . . . . modulator	OD . . . . . outside diameter	PWV . . . . . peak working voltage	TD . . . . . time delay
MOM . . . . . momentary	OH . . . . . oval head	RC . . . . . resistance-capacitance	TERM . . . . . terminal
MOS . . . . . metal-oxide semiconductor	OP AMPL . . . . . operatio. al amplifier	RECT . . . . . rectifier	TFT . . . . . thin-film transistor
ms . . . . . millisecond	OPT . . . . . option	REF . . . . . reference	TGL . . . . . toggle
MTG . . . . . mounting	OSC . . . . . oscillator	REG . . . . . regulated	THD . . . . . thread
MTR . . . . . meter (indicating device)	OX . . . . . oxide	REPL . . . . . replaceable	THRU . . . . . through
mV . . . . . millivolt	oz . . . . . ounce	RF . . . . . radio frequency	TI . . . . . titanium
mVac . . . . . millivolt, ac	Ω . . . . . ohm	RFI . . . . . radio frequency interference	TOL . . . . . tolerance
mVdc . . . . . millivolt, dc	P . . . . . peak (used in parts list)	RH . . . . . round head; right hand	TRIM . . . . . trimmer
mVpk . . . . . millivolt, peak	PAM . . . . . pulse-amplitude modulation	RLC . . . . . resistance-inductance-capacitance	TSTR . . . . . transistor
mVp-p . . . . . millivolt, peak-to-peak	PC . . . . . printed circuit	RMO . . . . . rack mount only	TTL . . . . . transistor-transistor logic
mVrms . . . . . millivolt, rms	PCM . . . . . pulse-code modulation; pulse-count modulation	RND . . . . . root-mean-square	TV . . . . . television
mW . . . . . milliwatt	PDM . . . . . pulse-duration modulation	ROM . . . . . read-only memory	TVI . . . . . television interference
MUX . . . . . multiplex	pF . . . . . picofarad	R&P . . . . . rack and panel	TWT . . . . . traveling wave tube
MY . . . . . mylar	PH BRZ . . . . . phosphor bronze	RWV . . . . . reverse working voltage	U . . . . . micro (10 <sup>-6</sup> ) (used in parts list)
μA . . . . . microampere	PHL . . . . . Phillips	S . . . . . scattering parameter	UF . . . . . microfarad (used in parts list)
μF . . . . . microfarad	PIN . . . . . positive-intrinsic-negative	s . . . . . second (time)	UHF . . . . . ultrahigh frequency
μH . . . . . microhenry	PIV . . . . . peak inverse voltage	... . . . . second (plane angle)	UNREG . . . . . unregulated
μmho . . . . . micromho	pk . . . . . peak	S-B . . . . . slow-blow (fuse) (used in parts list)	V . . . . . volt
μs . . . . . microsecond	PL . . . . . phase lock	SCR . . . . . silicon controlled rectifier; screw	VA . . . . . voltampere
μV . . . . . microvolt	PLO . . . . . phase lock oscillator	SE . . . . . selenium	Vac . . . . . volts, ac
μVac . . . . . microvolt, ac	PM . . . . . phase modulation	SECT . . . . . sections	VAR . . . . . variable
μVdc . . . . . microvolt, dc	PNP . . . . . positive-negative-positive	SEMICON . . . . . semiconductor	VCO . . . . . voltage-controlled oscillator
μVpk . . . . . microvolt, peak	P/O . . . . . part of	SHF . . . . . superhigh frequency	Vdc . . . . . volts, dc
μVp-p . . . . . microvolt, peak-to-peak	POLY . . . . . polystyrene	SI . . . . . silicon	VDCW . . . . . volts, dc, working (used in parts list)
μVrms . . . . . microvolt, rms	PORC . . . . . porcelain	SIL . . . . . silver	V(F) . . . . . volts, filtered
μW . . . . . microwatt	POS . . . . . positive; position(s) (used in parts list)	SL . . . . . slide	VFO . . . . . variable-frequency oscillator
nA . . . . . nanoampere	POSN . . . . . position	SNR . . . . . signal-to-noise ratio	VHF . . . . . very-high frequency
NC . . . . . no connection	POT . . . . . potentiometer	SPDT . . . . . single-pole, double-throw	Vpk . . . . . volts, peak
N/C . . . . . normally closed	p-p . . . . . peak-to-peak	SPG . . . . . spring	Vp-p . . . . . volts, peak-to-peak
NE . . . . . neon	PP . . . . . peak-to-peak (used in parts list)	SR . . . . . split ring	Vrms . . . . . volts, rms
NEG . . . . . negative	PPM . . . . . pulse-position modulation	SPST . . . . . single-pole, single-throw	VSWR . . . . . voltage standing wave ratio
nF . . . . . nanofarad	PREAMPL . . . . . preamplifier	SSB . . . . . single sideband	VTO . . . . . voltage-tuned oscillator
NI PL . . . . . nickel plate	PRF . . . . . pulse-repetition frequency	SST . . . . . stainless steel	VTVM . . . . . vacuum-tube voltmeter
N/O . . . . . normally open	PRR . . . . . pulse repetition rate	STL . . . . . steel	V(X) . . . . . volts, switched
NOM . . . . . nominal	ps . . . . . picosecond	SQ . . . . . square	W . . . . . watt
NORM . . . . . normal	PT . . . . . point	SWR . . . . . standing-wave ratio	W/ . . . . . with
NPN . . . . . negative-positive-negative	PTM . . . . . pulse-time modulation	SYNC . . . . . synchronize	WIV . . . . . working inverse voltage
NPO . . . . . negative-positive zero (zero temperature coefficient)	PWM . . . . . pulse-width modulation	T . . . . . timed (slow-blow fuse)	WW . . . . . wirewound
NRFR . . . . . not recommended for field replacement		TA . . . . . tantalum	W/O . . . . . without
NSR . . . . . not separately replaceable		TC . . . . . temperature compensating	YIG . . . . . yttrium-iron-garnet
ns . . . . . nanosecond			Z <sub>0</sub> . . . . . characteristic impedance
nW . . . . . nanowatt			
OBD . . . . . order by description			

**NOTE**

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

**MULTIPLIERS**

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

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	08970-60102	4	1	KEYBOARD ASSEMBLY	28480	08970-60102
A1DS1	1990-0665	3	10	LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A1DS2	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A1DS3	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A1DS4	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A1DS5	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A1DS6	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A1J1	1252-0078	4	1	CONN-POST TYPE .100-PIN-SPCG 20-CONT	28480	1252-0078
A1J2	1252-3495	9	2	HEADER-5 POSN	28480	1252-3495
A1MP1	5041-0943	3	1	KEY CAP-HALF (LOCAL)	28480	5041-0943
A1MP2	5041-2092	7	1	KEY CAP-HALF (ENR)	28480	5041-2092
A1MP3	5041-2709	3	1	KEY CAP-HALF (ENTER)	28480	5041-2709
A1MP4	5041-0818	1	1	KEY CAP-HALF SK/GY (8)	28480	5041-0818
A1MP5	5041-0817	0	1	KEY CAP-HALF SK/GY (7)	28480	5041-0817
A1MP6	5041-2099	4	1	KEY CAP-HALF (PRESET)	28480	5041-2099
A1MP7	5041-2706	0	1	KEY CAP-SDF (NOISE FIGURE)	28480	5041-2706
A1MP8	5041-0816	9	2	KEY CAP-HALF SK/GRAY (6)	28480	5041-0816
A1MP9	5041-0352	8	2	KEY CAP-HALF SURFACE LIGHT (SINGLE)	28480	5041-0352
A1MP10	5041-2100	8	2	KEY CAP-HALF (ARROW)	28480	5041-2100
A1MP11	5041-2708	2	1	KEY CAP-HALF (SEQ)	28480	5041-2708
A1MP12	5041-0808	9	1	KEY CAP-HALF (.)	28480	5041-0808
A1MP13	5041-0819	2	1	KEY CAP-HALF SK/GRAY (0)	28480	5041-0819
A1MP14	5041-2100	8		KEY CAP-HALF (ARROW)	28480	5041-2100
A1MP15	5041-2704	8	1	KEY CAP-SDQ (DECREASE)	28480	5041-2704
A1MP16	5041-1835	4	1	KEY CAP-HALF (-)	28480	5041-1835
A1MP17	5041-2093	8	1	KEY CAP-HALF (START FREQ)	28480	5041-2093
A1MP18	5041-2096	1	1	KEY CAP-HALF SDQ (FREQUENCY)	28480	5041-2096
A1MP19	5041-0987	5	1	KEY CAP-HALF (STORE)	28480	5041-0987
A1MP20	5041-0815	8	1	KEY CAP-HALF SK/GRAY (5)	28480	5041-0815
A1MP21	5041-0814	7	1	KEY CAP-HALF SK/GRAY (4)	28480	5041-0814
A1MP22	5041-2094	9	1	KEY CAP-HALF (STOP FREQ)	28480	5041-2094
A1MP23	5041-2707	1	1	KEY CAP-SDF (NOISE FIGURE AND GAIN)	28480	5041-2707
A1MP24	5041-0816	9		KEY CAP-HALF SK/GRAY (6)	28480	5041-0816
A1MP25	5041-0352	8		KEY CAP-HALF SURFACE LIGHT (AUTO)	28480	5041-0352
A1MP26	5041-2097	2	1	KEY CAP-SDQ (FREQ INCR)	28480	5041-2097
A1MP27	5041-0810	3	1	KEY CAP-HALF (RECALL)	28480	5041-0810
A1MP28	5041-0812	5	1	KEY CAP-HALF SK/GRAY (2)	28480	5041-0812
A1MP29	5041-0811	4	1	KEY CAP-HALF SK/GRAY (1)	28480	5041-0811
A1MP30	5041-2095	0	1	KEY CAP-HALF (STEP SIZE)	28480	5041-2095
A1MP31	5041-0484	7	1	KEY CAP-HALF (SPECIAL FUNCTION)	28480	5041-0484
A1MP32	5041-0813	6	1	KEY CAP-HALF SK/GRAY (3)	28480	5041-0813
A1MP33	5041-4659	6	1	KEY CAP-HALF (NOISE MIN.)	28480	5041-4659
A1MP34	5041-4658	5	1	KEY CAP-HALF (NOISE MAX.)	28480	5041-4658
A1MP35	5041-2098	3	1	KEY CAP-SDQ (CALIBRATE)	28480	5041-2098
A1MP36	5041-4656	3	1	KEY CAP-HALF (GAIN MAX.)	28480	5041-4656
A1MP37	5041-4657	4	1	KEY CAP-HALF (GAIN MIN.)	28480	5041-4657
A1MP38	5041-2705	9	1	KEY CAP-SDQ (INCREASE)	28480	5041-2705
A1MP39	0380-1344	3	12	SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP40	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP41	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP42	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP43	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP44	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP45	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP46	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP47	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP48	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP49	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP50	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1R1	0698-0082	7	9	RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A1R2	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A1R3	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A1R4	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A1R5	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F

See introduction to this section for ordering information  
 \*Indicates factory selected value  
 †Backdating information in Section VII

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R6	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4640-F
A1S1	5060-9436	7	38	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S2	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S3	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S4	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S5	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S6	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S7	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S8	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S9	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S10	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S11	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S12	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S13	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S14	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S15	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S16	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S17	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S18	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S19	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S20	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S21	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S22	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S23	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S24	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S25	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S26	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S27	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S28	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S29	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S30	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S31	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S32	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S33	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S34	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S35	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S36	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S37	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S38	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1TP3	1251-0600	0	12	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2	08970-60044	3	1	DISPLAY ASSEMBLY	28480	08970-60044
A2C1	0180-0229	7	4	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A2C2	0160-3334	9	48	CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C3	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C4	0180-1735	2	1	CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
A2C5	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C6	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C7	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C8	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C9	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C10	0160-4574	1	3	CAPACITOR-FXD 1000PF +-10% 100VDC CER	28480	0160-4574
A2C11	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C12	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C13	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C14	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C15	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C16	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C17	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C18	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C19	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C20	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334

See introduction to this section for ordering information  
 \*Indicates factory selected value  
 †Backdating information in Section VII

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2C21	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C22	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C23	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C24	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	28480	0160-3334
A2C25	0160-4812	0	1	CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A2DS1	1990-0855	3	13	DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4	13	SOCKET-IC DIP	28480	1200-1617
A2DS2	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS3	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS4	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS5	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS6	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS7	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS8	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS9	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS10	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS11	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS12	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS13	1990-0855	3		DISPLAY-NUM-SEG 13-CHAR .3-H RED	28480	1990-0855
	1200-1617	4		SOCKET-IC DIP	28480	1200-1617
A2DS14	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A2DS15	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A2DS16	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A2DS17				NOT ASSIGNED		
A2DS18	1990-0759	6	5	LED-LIGHT BAR MODULE LUM-INT=3MCD	28480	HLMP-2620
	1200-1616	3	5	SOCKET-IC DIP	28480	1200-1616
A2DS19-				NOT ASSIGNED		
A2DS22			2	NOT ASSIGNED		
A2DS23	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=30MA-MAX BVR=5V	28480	1990-0665
A2DS24-				NOT ASSIGNED		
A2DS30	1990-0759	6		LED-LIGHT BAR MODULE LUM-INT=3MCD	28480	HLMP-2620
A2DS31	1200-1616	3		SOCKET-IC DIP	28480	1200-1616
A2DS32	1990-0759	6		LED-LIGHT BAR MODULE LUM-INT=3MCD	28480	HLMP-2620
	1200-1616	3		SOCKET-IC DIP	28480	1200-1616
A2DS33	1990-0759	6		LED-LIGHT BAR MODULE LUM-INT=3MCD	28480	HLMP-2620
	1200-1616	3		SOCKET-IC DIP	28480	1200-1616
A2DS34	1990-0759	6		LED-LIGHT BAR MODULE LUM-INT=3MCD	28480	HLMP-2620
	1200-1616	3		SOCKET-IC DIP	28480	1200-1616
A2J1	1252-3486	8	1	HEADER-9 POSN	28480	1252-3486
A2L1	9100-1611	4	2	INDUCTOR RF-CH-MLD 220NH 20%	28480	9100-1611
A2R1	0757-0279	0	12	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3161-F
A2R2	1810-0956	5	1	NETWORK-RES 14-DIP 22.0K OHM X 13	32997	4114R-64Z-223
A2R3				NOT ASSIGNED		
A2R4	0757-0123	3	2	RESISTOR 34.8K 1% .125W F TC=0+-100	28480	0757-0123
A2R5	0757-0123	3		RESISTOR 34.8K 1% .125W F TC=0+-100	28480	0757-0123
A2R6	0757-0442	9	24	RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R7	0757-0470	3		RESISTOR 162K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1623-F
A2R8	0698-0082	7		RESISTOR 484 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4840-F
A2R9	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R10	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A2R11	0757-0438	3	5	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-5111-F
A2R12				NOT ASSIGNED		
A2R13	0757-0280	3	15	RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A2R14	1810-0424	2	3	NETWORK-RES 16-DIP 4.7K OHM X 15	11236	761-1-R4.7K
A2R15				NOT ASSIGNED		

See introduction to this section for ordering information  
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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R16	1810-0330	9	13	NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R17	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R18	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R19	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R20	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R21	1810-0441	3	1	NETWORK-RES 14-DIP470.0 OHM	11236	760-1-R470
A2R22	1810-0849	5	2	NETWORK-RES 16-DIP 150.0 OHM X 15	32997	4114R-088-151
A2R23	1810-0849	5		NETWORK-RES 16-DIP 150.0 OHM X 15	32997	4114R-088-151
A2R24				NOT ASSIGNED		
A2R25				NOT ASSIGNED		
A2R26	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R27	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R28	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R29	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R30	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R31	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R32	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2R33	1810-0330	9		NETWORK-RES 16-DIP 470.0 OHM X 8	11236	761-3-R470 OHMS
A2U1	1820-1568	8	4	IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A2U2	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A2U3	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A2U4	1858-0047	5	2	TRANSISTOR ARRAY 16-PIN PLSTC DIP	13606	ULN-2003A
A2U5	1858-0047	5		TRANSISTOR ARRAY 16-PIN PLSTC DIP	13606	ULN-2003A
A2U6	1826-0759	9	1	IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A2U7	1820-1216	3	2	IC DCOR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A2U8	1820-1794	2	3	IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A2U9	1820-1987	5	3	IC SHF-RGTR TTL LS COM CLEAR STOR 8-BIT	34335	AM74LS299N
A2U10	1820-1858	9	24	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U11	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U12	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U13	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U14	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U15	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U16	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U17	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U18	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U19	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U20	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U21	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U22	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U23	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U24	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U25	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A2U26	1820-1987	5		IC SHF-RGTR TTL LS COM CLEAR STOR 8-BIT	34335	AM74LS299N
A2U27	1820-1216	3		IC DCOR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A2U28	1820-1427	8	1	IC DCOR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS156N
A2U29	1820-1416	5	4	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A2W1	8120-3299	9	1	CABLE ASSEMBLY-DISPLAY BOARD	28480	8120-3299
A3	08970-60003	4	1	20 MHZ IF ASSEMBLY	28480	08970-60003
A3C1	0160-4698	0	6	CAPACITOR-FXD 56PF +-1% 200VDC CER	28480	0160-4698
A3C2				NOT ASSIGNED		
A3C3	0160-0576	5	23	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C5	0160-5376	3	4	CAPACITOR-FXD 200PF +-1% 200VDC CER	28480	0160-5376
A3C6	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C8	0160-4698	0		CAPACITOR-FXD 56PF +-1% 200VDC CER	28480	0160-4698
A3C9				NOT ASSIGNED		
A3C10	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C11	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C12	0160-5376	3		CAPACITOR-FXD 200PF +-1% 200VDC CER	28480	0160-5376
A3C13	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C14	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C15	0160-4698	0		CAPACITOR-FXD 56PF +-1% 200VDC CER	28480	0160-4698

See introduction to this section for ordering information  
 \*Indicates factory selected value  
 †Backdating information in Section VII

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3C16	0160-0576	5	77	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C17	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C21	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C22	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C23	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C24	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C25	0160-4698	0	CAPACITOR-FXD 56PF +-1% 200VDC CER	26480	0160-4698	
A3C26			NOT ASSIGNED			
A3C27	0160-5376	3	CAPACITOR-FXD 200PF +-1% 200VDC CER	28480	0160-5376	
A3C28	0160-4698	0	CAPACITOR-FXD 56PF +-1% 200VDC CER	26480	0160-4698	
A3C29			NOT ASSIGNED			
A3C30	0160-5376	3	CAPACITOR-FXD 200PF +-1% 200VDC CER	28480	0160-5376	
A3C31	0160-4698	0	CAPACITOR-FXD 56PF +-1% 200VDC CER	28480	0160-4698	
A3C32	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C33	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C34	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C35	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C36	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C37	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C38	0160-3874	2	3	CAPACITOR-FXD 10PF +-1% 200VDC CER	28480	0160-3874
A3C39	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C40	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C41	0160-3874	2	CAPACITOR-FXD 10PF +-1% 200VDC CER	28480	0160-3874	
A3C42	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C43	0121-0451	3	3	CAPACITOR-V TRMR-AIR 1.7-11PF 175V	74970	187-0106-028
A3C44	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A3C45	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C46	0160-3879	7	5	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C47	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A3C48	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C49	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C50	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C51	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C52	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C53	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C54	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C55	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C56	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C57	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C58	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C59	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C60	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C61	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C62	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C63	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C64	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C65	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C66	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C67	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C68	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C69	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C70	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C71	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C72	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C73	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A3C74	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C75	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C76			NOT ASSIGNED			
A3C77			NOT ASSIGNED			
A3C78	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C79	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	
A3C80	0160-3879	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879	

See introduction to this section for ordering information  
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Table 6-3 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3C81	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C82	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
	1251-1556	7	3	CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A3C83	0160-3029	9	1	CAPACITOR-FXD 7.5PF +- .5PF 100VDC CER	28480	0160-3029
A3CR1	1901-0050	3	18	DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3CR3	1901-0518	8	2	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A3E1	9170-0847	3	5	CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE COATED
A3E2	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE COATED
A3J1	1250-0835	1	1	CONNECTOR-RF SMC H PC 50-OHM	28480	1250-0835
	3050-0079	3	1	WASHER-FL NM NO. 2 .094-IN-ID .188-IN-OD	28480	3050-0079
A3L1	9140-0179	1	10	INDUCTOR RF-CH-MLD 22UH 10%	28480	9140-0179
A3L2	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10%	28480	9140-0179
A3L3	9140-0611	6	5	INDUCTOR RF-CH-MLD 1.5UH 1% .105DX.26LG	28480	9140-0611
A3L4	9140-0612	7	2	INDUCTOR RF-CH-MLD 1.8UH 1% .105DX.26LG	28480	9140-0612
A3L5	9100-1617	0	8	INDUCTOR RF-CH-MLD 3.9UH 10%	28480	9100-1617
A3L6	9100-1617	0		INDUCTOR RF-CH-MLD 3.9UH 10%	28480	9100-1617
A3L7	9140-0611	6		INDUCTOR RF-CH-MLD 1.5UH 1% .105DX.26LG	28480	9140-0611
A3L8	9100-1617	0		INDUCTOR RF-CH-MLD 3.9UH 10%	28480	9100-1617
A3L9	9100-1617	0		INDUCTOR RF-CH-MLD 3.9UH 10%	28480	9100-1617
A3L10	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10%	28480	9140-0179
A3L11	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10%	28480	9140-0179
A3L12	9140-0611	6		INDUCTOR RF-CH-MLD 1.5UH 1% .105DX.26LG	28480	9140-0611
A3L13	9140-0612	7		INDUCTOR RF-CH-MLD 1.8UH 1% .105DX.26LG	28480	9140-0612
A3L14	9140-0611	6		INDUCTOR RF-CH-MLD 1.5UH 1% .105DX.26LG	28480	9140-0611
A3L15	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10%	28480	9140-0179
A3L16	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10%	28480	9140-0179
A3L17	9140-0111	1	4	INDUCTOR RF-CH-MLD 3.3UH 10%	28480	9140-0111
A3L18	9140-0111	1		INDUCTOR RF-CH-MLD 3.3UH 10%	28480	9140-0111
A3L19	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10%	28480	9140-0179
A3L20	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10%	28480	9140-0179
A3L21	9100-1617	0		INDUCTOR RF-CH-MLD 3.9UH 10%	28480	9100-1617
A3L22	9100-1617	0		INDUCTOR RF-CH-MLD 3.9UH 10%	28480	9100-1617
A3L23	9100-1617	0		INDUCTOR RF-CH-MLD 3.9UH 10%	28480	9100-1617
A3L24	9100-1617	0		INDUCTOR RF-CH-MLD 3.9UH 10%	28480	9100-1617
A3L25	9140-0111	1		INDUCTOR RF-CH-MLD 3.3UH 10%	28480	9140-0111
A3L26	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10%	28480	9140-0179
A3L27	9140-0111	1		INDUCTOR RF-CH-MLD 3.3UH 10%	28480	9140-0111
A3Q1	1854-0345	8	3	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A3Q2	1855-0235	7	5	TRANSISTOR J-FET N-CHAN D-MODE TO-52 SI	04713	U310 (SELECTED)
A3Q3	1853-0405	9	4	TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q4	1855-0235	7		TRANSISTOR J-FET N-CHAN D-MODE TO-52 SI	04713	U310 (SELECTED)
A3Q5	1854-0597	2	5	TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
	1205-0011	0	6	HEAT SINK TO-5/TO-39-CS	28480	1205-0011
A3Q6	1855-0420	2	9	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A3Q7	1855-0235	7		TRANSISTOR J-FET N-CHAN D-MODE TO-52 SI	04713	U310 (SELECTED)
A3Q8	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q9	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A3Q10	1854-0597	2		TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
	1205-0011	0		HEAT SINK TO-5/TO-39-CS	28480	1205-0011
A3Q11	1854-0597	2		TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
	1205-0011	0		HEAT SINK TO-5/TO-39-CS	28480	1205-0011
A3Q12	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A3Q13	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A3Q14	1855-0235	7		TRANSISTOR J-FET N-CHAN D-MODE TO-52 SI	04713	U310 (SELECTED)
A3Q15	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q16	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A3Q17	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A3Q18	1855-0235	7		TRANSISTOR J-FET N-CHAN D-MODE TO-52 SI	04713	U310 (SELECTED)
A3Q19	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3Q20	1854-0345	8		TRANSISTOR NPN 2N5179 SI TO-72 PD=200mW	04713	2N5179
	1205-0037	0	2	HEAT SINK TO-18-CS	26480	1205-0037
A3Q21	1854-0686	0	1	TRANSISTOR NPN SI TO-72 PD=200mW FT=4GHZ	26480	1854-0686
A3R1	0698-3153	9	8	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3831-F
A3R2	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A3R3	0757-0424	7	3	RESISTOR 1.1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1101-F
A3R4	0757-0873	0	2	RESISTOR 1.62K 1% .5W F TC=0+-100	26480	0757-0873
A3R5	0757-0394	0	5	RESISTOR 51.1 1% .125W F TC=0+-100	24546	CT4-1/8-T0-51R1-F
A3R6	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A3R7	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A3R8	0757-0402	1	2	RESISTOR 110 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1111-F
A3R9	0698-0089	4	1	RESISTOR 1.78K 1% .5W F TC=0+-100	26480	0698-0089
A3R10	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	CT4-1/8-T0-51R1-F
A3R11	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	CT4-1/8-T0-51R1-F
A3R12	0757-0463	4	2	RESISTOR 82.5K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-8252-F
A3R13	0698-3162	0	5	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4642-F
A3R14	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A3R15	0757-0465	6	13	RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A3R16	0757-0398	4	3	RESISTOR 75 1% .125W F TC=0+-100	24546	CT4-1/8-T0-75R0-F
A3R17	0757-0397	3	1	RESISTOR 68.1 1% .125W F TC=0+-100	24546	CT4-1/8-T0-68R1-F
A3R18	0757-0817	2	2	RESISTOR 750 1% .5W F TC=0+-100	26480	0757-0817
A3R19	2100-3296	8	1	RESISTOR-TRMR 1K 10% C TOP-ADJ 17-TRN	26480	2100-3296
A3R20	0757-0288	1	3	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	5033R-1/8-T0-9091-F
A3R21	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A3R22	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3831-F
A3R23	0757-0401	0	10	RESISTOR 100 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1011-F
A3R24	0757-0416	7	7	RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A3R25	0698-8606	7	1	RESISTOR 450 .1% .125W F TC=0+-25	26480	0698-8606
A3R26	0698-6364	0	1	RESISTOR 50 .1% .125W F TC=0+-25	26480	0698-6364
A3R27	0698-3434	9	1	RESISTOR 34.8 1% .125W F TC=0+-100	26480	0698-3434
A3R28	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A3R29	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A3R30	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A3R31	0698-8827	4	3	RESISTOR 1M 1% .125W F TC=0+-100	26480	0698-8827
A3R32	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4642-F
A3R33	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A3R34	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	CT4-1/8-T0-75R0-F
A3R35	0698-3430	5	1	RESISTOR 21.5 1% .125W F TC=0+-100	03888	PM55-1/8-T0-21R5-F
A3R36	2100-2060	2	1	RESISTOR-TRMR 50 20% C TOP-ADJ 1-TRN	73138	82PR50
A3R37	0757-0817	2		RESISTOR 750 1% .5W F TC=0+-100	26480	0757-0817
A3R38	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3831-F
A3R39	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A3R40	0757-0288	1		RESISTOR 9.09K 1% .125W F TC=0+-100	19701	5033R-1/8-T0-9091-F
A3R41	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A3R42	0698-6448	1	1	RESISTOR 216.2 .1% .125W F TC=0+-25	26480	0698-6448
A3R43	0698-6323	1	1	RESISTOR 100 .1% .125W F TC=0+-25	26480	0698-6323
A3R44	0757-0395	1	1	RESISTOR 56.2 1% .125W F TC=0+-100	24546	CT4-1/8-T0-56R2-F
A3R45	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A3R46	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A3R47	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-4642-F
A3R48	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1002-F
A3R49	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	CT4-1/8-T0-75R0-F
A3R50	0698-3442	9	2	RESISTOR 237 1% .125W F TC=0+-100	24546	CT4-1/8-T0-237R-F
A3R51	0757-0815	0	1	RESISTOR 562 1% .5W F TC=0+-100	26480	0757-0815
A3R52	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-3831-F
A3R53	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	CT4-1/8-T0-511R-F
A3R54	0757-0288	1		RESISTOR 9.09K 1% .125W F TC=0+-100	19701	5033R-1/8-T0-9091-F
A3R55	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1001-F
A3R56	0698-0824	7	1	RESISTOR 218.8 .1% .125W F TC=0+-25	26480	0698-0824
A3R57	0698-0825	8	1	RESISTOR 281.2 .1% .125W F TC=0+-25	26480	0698-0825
A3R58	0757-0402	1		RESISTOR 110 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1111-F
A3R59	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F
A3R60	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-T0-1003-F

See introduction to this section for ordering information  
 \*Indicates factory selected value  
 †Backdating information in Section VII

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R61	0757-0466	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-1003-F
A3R62	0757-0463	4		RESISTOR 82.5K 1% .125W F TC=0+-100	24546	CT4-1/8-TO-8252-F
A3R63	0757-0873	0		RESISTOR 1.62K 1% .5W F TC=0+-100	28480	0757-0873
A3R64	0698-3437	2	1	RESISTOR 133 1% .125W F TC=0+-100	24546	CT4-1/8-TO-133R-F
A3R65	0698-3439	4	2	RESISTOR 178 1% .125W F TC=0+-100	24546	CT4-1/8-TO-178R-F
A3RT1	0837-0015	2	1	THERMISTOR DISC 500-OHM TC=-4.4%/C-DEG	28480	0837-0015
A3TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ 50	28480	1251-0600
A3U1	1826-0217	4	3	IC OP AMP GP DUAL 8-TO-99 PKG	07933	RC4558T
A3U2	1826-0217	4		IC OP AMP GP DUAL 8-TO-99 PKG	07933	RC4558T
A3U3	1826-0217	4		IC OP AMP GP DUAL 8-TO-99 PKG	07933	RC4558T
A3VR1	1902-0955	9	1	DIODE-ZNR 7.5V 5% DO-35 PD=.4W TC=+.062%	28480	1902-0955
A3W1	8159-0005	0	18	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A3W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A3W3	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A3W4	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A3W5	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A3W6	8151-0014	5	2	WIRE 24AWG 1X24	28480	8151-0014
A3W7	8151-0014	5		WIRE 24AWG 1X24	28480	8151-0014
	0515-0885	2	25	SCREW-MACH M4 X 0.7 8MM-LG PAN-HD (METRIC; NOT PART OF THE A3 ASSEMBLY. USED TO ATTACH THE A3 ASSEMBLY TO THE CASTING.)	28480	0515-0885
A4	08970-60002	3	1	300 MHZ IF ASSEMBLY	28480	08970-60002
A4C1	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C3	0160-4389	6	3	CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A4C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C6	0160-4517	2	1	CAPACITOR-FXD 1.2PF +-25PF 200VDC CER	28480	0160-4517
A4C7	0160-3874	2		CAPACITOR-FXD 10PF +-5PF 200VDC CER	28480	0160-3874
A4C8	0160-4494	4		CAPACITOR-FXD 39PF +-5% 200VDC CER 0+-30	28480	0160-4494
A4C9	0121-0452	4	3	CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V	74970	187-0103-028
A4C10				NOT ASSIGNED		
A4C11	0121-0452	4		CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V	74970	187-0103-028
A4C12	0121-0451	3		CAPACITOR-V TRMR-AIR 1.7-11PF 175V	74970	187-0106-028
A4C13	0160-4103	2	1	CAPACITOR-FXD 220PF +-5% 100VDC CER	72982	8121-M100-COG-221J
A4C14				NOT ASSIGNED		
A4C15	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C17	0121-0451	3		CAPACITOR-V TRMR-AIR 1.7-11PF 175V	74970	187-0106-028
A4C18				NOT ASSIGNED		
A4C19	0121-0452	4		CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V	74970	187-0103-028
A4C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C21	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A4C22	0160-4381	8	1	CAPACITOR-FXD 1.5PF +-25PF 200VDC CER	28480	0160-4381
A4C23	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A4CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A4CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A4E1	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE COATED
A4J1	1250-1781	8	4	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1781
	2190-0091	4	4	WASHER-LK HLCL NO. 10 .194-IN-ID (NOT PART OF A4 ASSEMBLY)	28480	2190-0091
	2740-0001	3	7	NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK (NOT PART OF A4 ASSEMBLY)	00000	ORDER BY DESCRIPTION
	3050-0226	2	12	WASHER-FL MTLN NO. 10 .203-IN-ID (NOT PART OF A4 ASSEMBLY)	28480	3050-0226
A4L1	9140-0144	0	7	INDUCTOR RF-CH-MLD 4.7UH 10% NOT ASSIGNED	28480	9140-0144
A4L2				NOT ASSIGNED		
A4L3	9100-2247	4	1	INDUCTOR RF-CH-MLD 100NH 10%	28480	9100-2247
A4L4	08970-80003	6	4	IDCTR IF 300 MHZ	28480	08970-80003
A4L5	08970-80003	6		IDCTR IF 300 MHZ	28480	08970-80003

See introduction to this section for ordering information  
 \*Indicates factory selected value  
 †Backdating information in Section VII

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A4L6					NOT ASSIGNED		
A4L7					NOT ASSIGNED		
A4L8	08970-80003	6			IDCTR IF 300 MHZ	28480	08970-80003
A4L9	08970-80003	6			IDCTR IF 300 MHZ	28480	08970-80003
A4L10	9140-0144	0			INDUCTOR RF-CH-PLD 4.7UH +-10%	91637	IM-2 4.7UH 10%
A4MP1	08970-00015	2		1	SHIELD 300 MHZ	28480	08970-00015
A4Q1	1854-0597	2			TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
	1205-0011	0			HEAT SINK TO-5/TO-39-CS	13103	2226B
A4Q2	1854-0345	8			TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A4Q3	1853-0459	3		7	TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A4Q4	1854-0591	6		1	TRANSISTOR NPN SI PD=180MW FT=4GHZ	25403	BFR90
A4R1	0698-3154	0		1	RESISTOR 4.22K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-4221-F
A4R2	0757-0442	9			RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A4R3	0757-0441	8		1	RESISTOR 8.25K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-8251-F
A4R4	0757-0200	7		1	RESISTOR 5.62K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-5621-F
A4R5	0757-0438	3			RESISTOR 5.11K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-5111-F
A4R6	0757-0424	7			RESISTOR 1.1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1101-F
A4R7	0698-3446	3		2	RESISTOR 383 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-383R-F
A4R8	0757-0280	3			RESISTOR 1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1001-F
A4R9	0757-0279	0			RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A4R10	0698-0083	8		1	RESISTOR 1.96K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1961-F
A4R11	0698-3438	3		2	RESISTOR 147 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-147R-F
A4R12	0698-3446	3			RESISTOR 383 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-383R-F
A4TP1	1251-0600	0			CONNECTOR-SGL CONT PIN 1,14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A4U1	0955-0095	8		1	U-WAVE MIXER 500 MHZ MAX	15542	SRA-1-85
A4U1	8159-0005	0			RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZ0 1/4
A4Y1	1GA1-8000	2		1	THIN FILM CKT	28480	1GA1-8000
	3050-0786	9		1	WASHER-FL NM NO. 0 .063-IN-ID .187-IN-OD	51506	105-.015-T-1
	0515-0885	2			SCREW-MACH M4 X 0.7 8MM-LG PAN-HD (METRIC; NOT PART OF THE A4 ASSEMBLY. USED TO ATTACH THE A4 ASSEMBLY TO THE CASTING.)	28480	0515-0885
A5					NOT ASSIGNED		
A6	08970-60042	1		1	INPUT ASSEMBLY (RECOMMENDED REPLACEMENT FOR 08970-60001)	28480	08970-60042
A6	08970-69042	9		1	RESTORED 08970-60042, EXCHANGE REQUIRED	28480	08970-69042
A6C1	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C2					NOT ASSIGNED		
A6C3	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C4	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C5	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C6	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C7	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C8	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C9	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C10	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C11	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C12	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C13	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C14	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C15	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C16	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C17	0160-4031	5		1	CAPACITOR-FXD 330PF +-5% 100VDC CER	09969	RPE121-105C0G331J100V
A6C18	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6C19					NOT ASSIGNED		
A6C20	0160-3879	7			CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A6CR1	1901-0050	3			DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A6CR2	1901-0050	3			DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A6CR3	1901-0050	3			DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A6CR4	1901-0050	3			DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A6CR5	1901-0050	3			DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6CR6	1901-0941	1	1	DIODE-SCHOTTKY SM SIG	28480	1901-0941
A6J1	1250-1781	8		CONNECTOR-RF SMC M PC 50-OHM	98291	050-051-0289
	2190-0091	4		WASHER-LK HLCL NO. 10 .194-IN-ID (NOT PART OF A6 ASSEMBLY)	28480	2190-0091
	2740-0001	3		NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK (NOT PART OF A6 ASSEMBLY)	00000	ORDER BY DESCRIPTION
	3050-0226	2		WASHER-FL MTLG NO. 10 .203-IN-ID (NOT PART OF A6 ASSEMBLY)	80120	AN960C10L
A6J2	1250-1781	8		CONNECTOR-RF SMC M PC 50-OHM	98291	050-051-0289
	2190-0091	4		WASHER-LK HLCL NO. 10 .194-IN-ID (NOT PART OF A6 ASSEMBLY)	28480	2190-0091
	2740-0001	3		NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK (NOT PART OF A6 ASSEMBLY)	00000	ORDER BY DESCRIPTION
	3050-0226	2		WASHER-FL MTLG NO. 10 .203-IN-ID (NOT PART OF A6 ASSEMBLY)	80120	AN960C10L
A6K1	0490-1361	7	5	RELAY 2C 12VDC-COIL 1A 250VAC	11532	412YZS-0407
	3050-0737	0		5	WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	86928
A6K2	0490-1361	7	0	RELAY 2C 12VDC-COIL 1A 250VAC	11532	412YZS-0407
	3050-0737	0		0	WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	86928
A6K3	0490-1361	7	0	RELAY 2C 12VDC-COIL 1A 250VAC	11532	412YZS-0407
	3050-0737	0		0	WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	86928
A6K4	0490-1361	7	0	RELAY 2C 12VDC-COIL 1A 250VAC	11532	412YZS-0407
	3050-0737	0		0	WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	86928
A6K5	0490-1361	7	0	RELAY 2C 12VDC-COIL 1A 250VAC	11532	412YZS-0407
	3050-0737	0		0	WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	86928
A6L1	9140-0144	0	0	INDUCTOR RF-CH-MLD 4.7UH +-10%	91637	IM-2 4.7UH 10%
A6L2	9140-0144	0	0	INDUCTOR RF-CH-MLD 4.7UH +-10%	91637	IM-2 4.7UH 10%
A6L3	9140-0144	0	0	INDUCTOR RF-CH-MLD 4.7UH +-10%	91637	IM-2 4.7UH 10%
A6L4	9140-0144	0	0	INDUCTOR RF-CH-MLD 4.7UH +-10%	91637	IM-2 4.7UH 10%
A6L5	9140-0144	0	0	INDUCTOR RF-CH-MLD 4.7UH +-10%	91637	IM-2 4.7UH 10%
A6Q1	1854-0864	6	1	TRANSISTOR NPN PD=400MW	28480	HXTR-6105
A6Q2	1854-0863	5	1	TRANSISTOR NPN PD=450MW	28480	HXTR-2101
A6Q3	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A6Q4	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A6R1	0757-0401	0		RESISTOR 100 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-101-F
A6R2	0699-0092	1	6	RESISTOR 96.25 +-0.1% .25W TFN TC=0+-50	91637	HFF-1/4-39
A6R3	0699-0091	0	3	RESISTOR 71.15 +-0.1% .25W TFN TC=0+-50	91637	HFF-1/4-39
A6R4	0699-0092	1		RESISTOR 96.25 +-0.1% .25W TFN TC=0+-50	91637	HFF-1/4-39
A6R5	0757-0401	0		RESISTOR 100 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-101-F
A6R6	0699-1308	4	6	RESISTOR 51.1 +-1% .05W TF TC=0+-100	12498	CT3
A6R7	0699-1308	8	2	RESISTOR 5.11K +-1% .05W TF TC=0+-100	12498	CT3-1/8-T0-5111-F
A6R8	0699-1308	4		RESISTOR 51.1 +-1% .05W TF TC=0+-100	12498	CT3
A6R9	0699-1308	4		RESISTOR 51.1 +-1% .05W TF TC=0+-100	12498	CT3
A6R10	0699-1124	2	1	RESISTOR 261 +-1% .05W TF TC=0+-100	12666	MBA 0204
A6R11	0698-3447	4	1	RESISTOR 422 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-422R-F
A6R12	0699-1308	4		RESISTOR 51.1 +-1% .05W TF TC=0+-100	12498	CT3
A6R13	0699-1308	4		RESISTOR 51.1 +-1% .05W TF TC=0+-100	12498	CT3
A6R14	0757-0438	3		RESISTOR 5.11K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-5111-F
A6R15	0698-3155	1	2	RESISTOR 4.64K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-4641-F
A6R16	0699-1308	4		RESISTOR 51.1 +-1% .05W TF TC=0+-100	12498	CT3
A6R17	0699-1308	8		RESISTOR 5.11K +-1% .05W TF TC=0+-100	12498	CT3-1/8-T0-5111-F
A6R18	0699-1309	5	6	RESISTOR 61.9 +-1% .05W TF TC=0+-100	12498	CT3
A6R19	0699-1123	1	1	RESISTOR 196 +-1% .05W TF TC=0+-100	12666	MBA 0204
A6R20	0699-1309	5		RESISTOR 61.9 +-1% .05W TF TC=0+-100	12498	CT3
A6R21	0698-3132	4	2	RESISTOR 261 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2610-F
A6R22	0699-1309	5		RESISTOR 61.9 +-1% .05W TF TC=0+-100	12498	CT3
A6R23	0757-0401	0		RESISTOR 100 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-101-F
A6R24	0699-1309	5		RESISTOR 61.9 +-1% .05W TF TC=0+-100	12498	CT3
A6R25	0699-1309	5		RESISTOR 61.9 +-1% .05W TF TC=0+-100	12498	CT3
A6R26	0699-1309	5		RESISTOR 61.9 +-1% .05W TF TC=0+-100	12498	CT3
A6R27	0757-0401	0		RESISTOR 100 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-101-F
A6R28	0699-0092	1		RESISTOR 96.25 +-0.1% .25W TFN TC=0+-50	91637	HFF-1/4-39
A6R29	0699-0091	0		RESISTOR 71.15 +-0.1% .25W TFN TC=0+-50	91637	HFF-1/4-39
A6R30	0699-0092	1		RESISTOR 96.25 +-0.1% .25W TFN TC=0+-50	91637	HFF-1/4-39

See introduction to this section for ordering information  
 \*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6R31	0757-0401	0		RESISTOR 100 +-1% .125W TF TC=0--100	12498	CT4-1/8-T0-101-F
A6R32	0699-0092	1		RESISTOR 96.25 +-0.1% .25W TFN TC=0+-50	91637	MFF-1/4-39
A6R33	0699-0091	0		RESISTOR 71.15 +-0.1% .25W TFN TC=0+-50	91637	MFF-1/4-39
A6R34	0699-0092	1		RESISTOR 96.25 +-0.1% .25W TFN TC=0+-50	91637	MFF-1/4-39
A6R35	0698-3439	4		RESISTOR 178 +-1% .125W TF TC=0--100	12498	CT4-1/8-T0-178R-F
A6R36	0727-0074	0	2	RESISTOR 436.2 +-0.5% .25W CF TC=0-500	91637	DC-1/4-18
A6R37	0698-3438	3		RESISTOR 147 +-1% .125W TF TC=0--100	12498	CT4-1/8-T0-147R-F
A6R38	0727-0008	0	1	RESISTOR 11.61 +-0.5% .25W CF TC=0-500	91637	DC-1/4-18
A6R39*	0698-3451	0	1	RESISTOR 133K +-1% .125W TF TC=0--100	12498	CT4-1/8-T0-1333-F
A6R39*	0698-3452	1	2	RESISTOR 147K +-1% .125W TF TC=0--100	12498	CT4-1/8-T0-1473-F
A6R39*	0757-0470	3	2	RESISTOR 162K +-1% .125W TF TC=0--100	12498	CT4-1/8-T0-1623-F
A6R40	0727-0074	0		RESISTOR 436.2 +-0.5% .25W CF TC=0-500	91637	DC-1/4-18
A6R41	2100-3089	7	1	RESISTOR-TRMR 5K 10% TKF TOP-ADJ 17-TRN	09969	3105W502
A6R42	2100-2655	1	1	RESISTOR-TRMR 100K 10% TKF TOP-ADJ 1-TRN	73138	82PP100K
A6RT1	0839-0008	7	1	THERMISTOR DISC 1K-OHM TC=-4.4%/C-DEG	19701	D203
A6U1	1826-0266	3	1	IC OP AMP LOW-DRIFT 8-T0-99 PKG	06665	OP-05EJ
A6W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A6W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A6W3	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A6W4	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A6W5	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A6W6	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A6W7	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A6W8-				NOT ASSIGNED		
A6W10				WIRE-22 AWG		
A6W11						
A6Z1	08970-20046	1	1	PLATE CAPACITOR	28480	08970-20046
	0515-0887	4	5	SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD (METRIC; NOT PART OF THE A6 ASSEMBLY. USED TO ATTACH THE A6 ASSEMBLY TO THE CASTING.)	00000	ORDER BY DESCRIPTION
	3050-0003	3	3	WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD (NOT PART OF THE A6 ASSEMBLY. USED TO ATTACH THE A6 ASSEMBLY TO THE CASTING.)	73734	1471
	0380-0005	1	1	SPACER-RND .312-IN-LG .18-IN-ID	28480	0380-0005
	0515-0900	2	1	SCREW-MACH M3.5 X 0.6 14MM-LG PAN-HD (METRIC; NOT PART OF THE A6 ASSEMBLY. USED TO ATTACH THE A6 ASSEMBLY TO THE CASTING.)	28480	0515-0900
A7	08970-60005	6	1	VOLTMETER ASSEMBLY	28480	08970-60005
A7C1	0180-0197	8	2	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A7C2	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A7C3	0160-4404	6	2	CAPACITOR-FXD .15UF +-10% 100VDC POLYP	27735	PPAW-.15-100-10
A7C4	0160-4404	6		CAPACITOR-FXD .15UF +-10% 100VDC POLYP	27735	PPAW-.15-100-10
A7C5	0160-2055	9	5	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A7C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A7C7	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A7C8	0160-4389	6		CAPACITOR-FXD 100PF +-5% 200VDC CER	09969	RPE121-105C0G10J200V
A7C9	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A7C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A7CR1	1901-0376	6	4	DIODE-GEN PRP 35V 50MA DO-35	9N283	1N3595
A7CR2	1901-0518	8		DIODE-SCHOTTKY SM SIG	12403	5082-2800
A7CR3	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	9N283	1N3595
A7CR4	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	9N283	1N3595
A7L1	9140-0114	4	7	INDUCTOR RF-CH-MLD 10UH +-10%	91637	IM-4 10UH 10%
A7L2	9140-0114	4		INDUCTOR RF-CH-MLD 10UH +-10%	91637	IM-4 10UH 10%
A7Q1	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A7Q2	1855-0305	2	1	TRANSISTOR J-FET 2N4117A N-CHAN D-MODE	17856	2N4117A
A7Q3	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A7Q4	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	17856	2N4391
A7Q5	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7Q6	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	17856	2N4391
A7Q7	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A7Q8	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	17856	2N4391
A7R1	0757-0420	3		RESISTOR 750 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-751-F
A7R2	0757-0428	1	3	RESISTOR 1.62K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1621-F
A7R3	0757-0280	3		RESISTOR 1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1001-F
A7R4	0698-8319	9	2	RESISTOR 10K +-1% .1W TF TC=0+-10	19701	5023Z1/8-113-1002-F
A7R5	0757-0280	3		RESISTOR 1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1001-F
A7R6	0757-0280	3		RESISTOR 1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1001-F
A7R7	0699-0096	5	1	RESISTOR 12K +-0.1% .1W TF TC=0+-10	09535	PR1/10
A7R8	0699-0748	4	1	RESISTOR 57.4K +-0.1% .1W TF TC=0+-15	09535	PR1/10
A7R9	0757-0442	9		RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A7R10	0698-3150	6	4	RESISTOR 2.37K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2371-F
A7R11	0698-3153	9		RESISTOR 3.83K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3831-F
A7R12	0698-3150	6		RESISTOR 2.37K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2371-F
A7R13	0698-3153	9		RESISTOR 3.83K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3831-F
A7R14	0698-3150	6		RESISTOR 2.37K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2371-F
A7R15	0698-3153	9		RESISTOR 3.83K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3831-F
A7R16	0757-0419	0		RESISTOR 681 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-681R-F
A7R17	0757-0419	0		RESISTOR 681 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-681R-F
A7R18	0757-0419	0		RESISTOR 681 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-681R-F
A7R19	0757-0444	1	2	RESISTOR 12.1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1212-F
A7R20	0757-0289	2	1	RESISTOR 13.3K +-1% .125W TF TC=0+-100	19701	5033R-1/8-T0-1332-F
A7R21	0757-0444	1		RESISTOR 12.1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1212-F
A7R22	0683-2265	1	4	RESISTOR 22M +-5% .25W CC TC=-900/+1200	01121	CB2265
A7R23	0683-2265	1		RESISTOR 22M +-5% .25W CC TC=-900/+1200	01121	CB2265
A7R24	0683-2265	1		RESISTOR 22M +-5% .25W CC TC=-900/+1200	01121	CB2265
A7R25	0757-0280	3		RESISTOR 1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1001-F
A7R26	0757-0419	0		RESISTOR 681 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-681R-F
A7R27	0698-3150	6		RESISTOR 2.37K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2371-F
A7R28	0757-0442	9		RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A7R29	0683-2265	1		RESISTOR 22M +-5% .25W CC TC=-900/+1200	01121	CB2265
A7R30	0757-0428	1		RESISTOR 1.62K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1621-F
A7R31	0757-0428	1		RESISTOR 1.62K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1621-F
A7R32	0757-0465	6		RESISTOR 100K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1003-F
A7R33	0757-0338	2	1	RESISTOR 1K +-1% .25W TF TC=0+-100	12498	NA5-1/4-T0-1001-F
A7R34	2100-3288	8	1	RESISTOR-TRMR 50 20% TKF TOP-ADJ 17-TRN	09969	3105W500
A7R35	0757-0442	9		RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A7R36	0757-0317	7	1	RESISTOR 1.33K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1331-F
A7R37	0698-3153	9		RESISTOR 3.83K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3831-F
A7TP1	0360-0535	0	40	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A7TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A7TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A7TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A7TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A7TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A7TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A7TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A7U1	1826-0026	3	1	IC COMPARATOR PRCN 8-T0-99 PKG	27014	LM311H
A7U2	1826-0547	3	2	IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-P	01295	TL072ACP
A7VR1	1902-0786	4	1	DIODE-ZNR 1N937 9V 5% DO-7 PD=.5W	28480	1902-0786
A7VR2	1902-0928	6	4	IC V RGLTR-V-REF-FXD 6.6/7.25V T0-92 PKG	27014	LM329
	0515-0885	2		SCREW-MACH M4 X 0.7 8MM-LG PAN-HD (METRIC; NOT PART OF THE A7 ASSEMBLY. USED TO ATTACH THE A7 ASSEMBLY TO THE CASTING.)	28480	0515-0885
	3050-0226	2		WASHER-FL HTLC NO. 10 .203-IN-ID (NOT PART OF THE A7 ASSEMBLY. USED TO ATTACH THE A7 ASSEMBLY TO THE CASTING.)	80120	AN960C10L
A8	08970-60004	5	1	NOISE POWER DETECTOR ASSEMBLY	28480	08970-60004

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8C1	0160-4385	2	1	CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30 NOT ASSIGNED	04222	SR202A150JAA
A8C2						
A8C3	0160-4389	6		CAPACITOR-FXD 100PF +-5% 200VDC CER	09969	RPE121-105C0G101J200V
A8C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8C5*	0160-4386	3	1	CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30	04222	SR152A330JAA
A8C5*	0160-4493	3	1	CAPACITOR-FXD 27PF +-5% 200VDC CER 0+-30	09969	RPE121105C0G270J200V
A8C5*	0160-4494	4	2	CAPACITOR-FXD 39PF +-5% 200VDC CER 0+-30	09969	RPE121-105C0G390J200V
A8C5*	0160-4524	1	1	CAPACITOR-FXD 24PF +-5% 200VDC CER 0+-30	09969	RPE121-105C0G240J200V
A8C5*	0160-4765	2	1	CAPACITOR-FXD 36PF +-5% 200VDC CER 0+-30	09969	RPE121-105C0G360J200V
A8C5*	0160-4766	3	1	CAPACITOR-FXD 30PF +-5% 200VDC CER 0+-30	09969	RPE121-105C0G300J200V
A8C5*	0160-4767	4	1	CAPACITOR-FXD 20PF +-5% 200VDC CER 0+-30	09969	RPE121-105C0G200J200V
	1251-1556	7		CONNECTOR-SGL CONT SKT .03-IN-BSC-SZ RND	98291	006-4844-00-0-990
A8C6	0160-4350	1	1	CAPACITOR-FXD 68PF +-5% 200VDC CER 0+-30	09969	RPE121-105C0G680J200V
A8C7	0160-4387	4	2	CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	09969	RPE121-105C0G470J200V
A8C8	0160-4764	1	2	CAPACITOR-FXD 150PF +-5% 100VDC CER	09969	RPE121-105C0G151J100V
A8C9	0160-4387	4		CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	09969	RPE121-105C0G470J200V
A8C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A8CR1	1901-1085	6	4	DIODE-SCHOTTKY SM SIG	28480	5082-2835
A8CR2	1901-1085	6		DIODE-SCHOTTKY SM SIG	28480	5082-2835
A8CR3	1901-1085	6		DIODE-SCHOTTKY SM SIG	28480	5082-2835
A8CR4	1901-1085	6		DIODE-SCHOTTKY SM SIG	28480	5082-2835
A8E1	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/38 PARYLENE COATED
A8E2	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/38 PARYLENE COATED
A8J1	1250-1781	8		CONNECTOR-RF SMC M PC 50-OHM	98291	050-051-0289
	2190-0091	4		WASHER-LK HLCL NO. 10 .194-IN-ID (NOT PART OF A8 ASSEMBLY.)	28480	2190-0091
	2740-0001	3		NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK (NOT PART OF A8 ASSEMBLY.)	00000	ORDER BY DESCRIPTION
	3050-0226	2		WASHER-FL MTLC NO. 10 .203-IN-ID (NOT PART OF A8 ASSEMBLY.)	80120	AN960C10L
A8L1	9140-0503	5	1	INDUCTOR 3.6UH +-1% .1660-INX.385LG-IN	91637	IM-4 3.6UH 1%
A8L2	9140-0179	1		INDUCTOR RF-CH-MLD 22UH +-10%	91637	IM-4 22UH 5%
A8L3	9140-0611	6		INDUCTOR RF-CH-MLD 1.5UH +-1%	91637	IM-4 1.5UH 1%
A8L4	9100-1612	5	2	INDUCTOR RF-CH-MLD 330NH +-20%	91637	IM-4 .33UH 20%
A8L5	9100-1612	5		INDUCTOR RF-CH-MLD 330NH +-20%	91637	IM-4 .33UH 20%
A8L6	9140-0105	3	2	INDUCTOR RF-CH-MLD 8.2UH +-10%	91637	IM-4 8.2UH 10%
A8L7	9140-0105	3		INDUCTOR RF-CH-MLD 8.2UH +-10%	91637	IM-4 8.2UH 10%
A8Q1	1854-0597	2		TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
	1205-0011	0		HEAT SINK TO-5/TO-39-CS	13103	22268
	3050-0405	9	1	WASHER-FL NM NO. 0 .064-IN-ID .133-IN-OD	28480	3050-0405
A8Q2	1854-0719	0	1	TRANSISTOR NPN SI TO-72 PD=500MW FT=4GHZ	28480	1854-0719
	1205-0037	0		HEAT SINK TO-18-CS	98978	TXBF-019-0258
A8R1	0757-0316	6	1	RESISTOR 42.2 +-1% .125W TF TC=0+-100	D8439	MK2
A8R2	0757-0280	3		RESISTOR 1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1001-F
A8R3	0757-0394	0		RESISTOR 51.1 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-51R1-F
A8R4	2100-0569	2	1	RESISTOR-TRMR 1M 20% TKF TOP-ADJ 1-TRN	28480	2100-0569
A8R5	0757-0465	6		RESISTOR 100K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1003-F
A8R6	0757-0416	7		RESISTOR 511 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-511R-F
A8R7	0757-0416	7		RESISTOR 511 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-511R-F
A8R8	0757-0394	0		RESISTOR 51.1 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-51R1-F
A8R9	0757-0816	1	1	RESISTOR 681 +-1% .5W TF TC=0+-100	K8479	H2
A8R10	0757-0416	7		RESISTOR 511 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-511R-F
A8R11	0757-0416	7		RESISTOR 511 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-511R-F
A8R12	0757-0442	9		RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A8TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8U1	1826-0471	2	1	IC OP AMP LOW-DRIFT 8-TO-99 PKG	06665	0P-07CJ SELECTED
A8VR1	1902-0041	4	1	DIODE-ZNR 5.11V 5% DO-35 PD= .4W	07263	1N751A
	0515-0885	2		SCREW-MACH M4 X 0.7 8MM-LG PAN-HD (METRIC; NOT PART OF THE A8 ASSEMBLY. USED TO ATTACH THE A8 ASSEMBLY TO THE CASTING.)	28480	0515-0885
A9	08970-60047	6	1	POWER SUPPLY ASSEMBLY	28480	08970-60047
A9C1	0160-7120	9	6	CAPACITOR-FXD 0.47UF 100V POLYE-MET		
A9C2	0160-7120	9		CAPACITOR-FXD 0.47UF 100V POLYE-MET		
A9C3	0160-7120	9		CAPACITOR-FXD 0.47UF 100V POLYE-MET		
A9C4	0160-7120	9		CAPACITOR-FXD 0.47UF 100V POLYE-MET		
A9C5	0160-7120	9		CAPACITOR-FXD 0.47UF 100V POLYE-MET		
A9C6	0160-7120	1		CAPACITOR-FXD 0.47UF 100V POLYE-MET		
A9C7	0180-3956	3	1	CAPACITOR-FXD 1600UF+75-10% 75VDC AL	56289	36DE162G075AN2P
	2190-0011	8	3	WASHER-LK INTL T NO. 10 .195-IN-ID	78189	1910-00
A9C8	0180-3281	7	2	CAPACITOR-FXD 6500UF+75-10% 40VDC AL	56289	36DE1110
	2190-0011	8		WASHER-LK INTL T NO. 10 .195-IN-ID	78189	1910-00
A9C9	0180-3957	4	1	CAPACITOR-FXD .02F+75-10% 20VDC AL NOT ASSIGNED	56289	36DE203G020EY2P
A9C10						
A9C11	0180-0291	3	2	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A9C12	0180-5910	1	2	CAPACITOR-FXD .47UF +80-20% 25VDC CER	06383	MA14Y5V1H474Z
A9C13	0180-3281	7		CAPACITOR-FXD 6500UF+75-10% 40VDC AL	56289	36DE1110
	2190-0011	8		WASHER-LK INTL T NO. 10 .195-IN-ID	78189	1910-00
A9C14	0160-4835	7	14	CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A9C15	0160-5910	1		CAPACITOR-FXD .47UF +80-20% 25VDC CER	06383	MA14Y5V1H474Z
A9C16	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A9C17	0180-2141	6	2	CAPACITOR-FXD 3.3UF+-10% 50VDC TA	56289	150D335X9050B2
A9C18	0180-2141	6		CAPACITOR-FXD 3.3UF+-10% 50VDC TA	56289	150D335X9050B2
A9C19				NOT ASSIGNED		
A9C20	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A9C21	0180-0374	3	3	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9CR1	1901-0759	9	6	DIODE-PWR RECT 1N5406 600V 3A DO-27	71744	1N5406
A9CR2	1901-0759	9		DIODE-PWR RECT 1N5406 600V 3A DO-27	71744	1N5406
A9CR3	1901-0759	9		DIODE-PWR RECT 1N5406 600V 3A DO-27	71744	1N5406
A9CR4	1901-0759	9		DIODE-PWR RECT 1N5406 600V 3A DO-27	71744	1N5406
A9CR5	1906-0231	2	1	DIODE-CT-RECT 200V 15A	18546	R712
	0590-1076	3	6	THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	46384	KFS2-M3
	08660-40002	6	6		28480	08660-40002
	1200-0043	8	4	INSULATOR-XSTR ALUMINUM	76530	322047
	0515-0986	4	4	SCREW-MACH M3 X 0.5 20MM-LG PAN-HD (METRIC)	28480	0515-0986
	1200-1031	6	4	CONNECTOR-SGL CONT SKT .125-IN-BSC-SZ	98291	006-4806-990
	2190-0644	3	7	WASHER-LK EXT T-B 3.0 MM 3.15-MM-ID	28480	2190-0644
A9CR6	1901-0759	9		DIODE-PWR RECT 1N5406 600V 3A DO-27	71744	1N5406
A9CR7	1901-0759	9		DIODE-PWR RECT 1N5406 600V 3A DO-27	71744	1N5406
A9CR8	1901-0418	7	1	DIODE-PWR RECT 400V 1.5A	28480	1901-0418
A9CR9	1901-0328	8	2	DIODE-PWR RECT 400V 1A 6US	71744	G16-089
A9CR10	1901-0028	5	9	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A9CR11	1901-0328	8		DIODE-PWR RECT 400V 1A 6US	71744	G16-089
A9CR12	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A9CR13	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A9CR14	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A9CR15	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A9DS1	1990-0910	1	1	LED-LAMP ARRAY IF=30MA-MAX BVR=5V	28480	HLMP-6853
A9F1	2110-0518	2	1	FUSE (INCH) 3A 125V NTD BI	75915	273003
	1251-2194	1	2	CONNECTOR-SGL CONT SKT .021-IN-BSC-SZ	00779	3-331272-0
A9J1	1251-3751	8	1	CONN-POST TYPE .156-PIN-SPCG 8-CONT	28480	1251-3751
A9J2	1251-7728	7	1	CONN-POST TYPE .100-PIN-SPCG 12-CONT	28480	1251-7728
A9J3	1251-8394	5	1	CONN-POST TYPE .100-PIN-SPCG 15-CONT	28480	1251-8394
A9MP1	08970-20060	9	1	HEAT SINK MACH	28480	08970-20060
A9MP2				NOT ASSIGNED		
A9MP3	08970-00009	4	1	BRKT-PWR SUPPLY	28480	08970-00009
	0515-0887	4		SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD (METRIC)	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information  
\*Indicates factory selected value



Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number	
A9Q1	1854-0814	6	2	TRANSISTOR NPN SI TO-66 PD=75W FT=3MHZ	28480	1854-0814	
	0590-1076	3		THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	46384	KFS2-M3	
	08660-40002	6		INSULATOR, TO-3	28480	08660-40002	
	0515-1105	1		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD (METRIC)	28480	0515-1105	
	1205-0280	5		HEAT SINK TO-66-CS	28480	1205-0280	
	3050-0003	3	WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD	73734	1471		
A9Q2	1854-0814	6	2	TRANSISTOR NPN SI TO-66 PD=75W FT=3MHZ	28480	1854-0814	
	0590-1076	3		THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	46384	KFS2-M3	
	08660-40002	6		INSULATOR, TO-3	28480	08660-40002	
	0515-1105	1		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD (METRIC)	28480	0515-1105	
	1205-0280	5		HEAT SINK TO-66-CS	28480	1205-0280	
	3050-0003	3	WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD	73734	1471		
A9Q3	1884-0310	0	3	THYRISTOR-SCR TO-220AB	04713	MCR69-3	
	1205-0639	8		HEAT SINK TO-220-CS	30161	S910B	
A9Q4	1884-0310	0		THYRISTOR-SCR TO-220AB	04713	MCR69-3	
	1205-0639	8		HEAT SINK TO-220-CS	30161	S910B	
A9Q5	1884-0310	0	3	THYRISTOR-SCR TO-220AB	04713	MCR69-3	
	1205-0639	8		HEAT SINK TO-220-CS	30161	S910B	
A9R1	2100-1757	2	1	RESISTOR-TRMR 500 5% MW SIDE-ADJ 1-TRN	32997	3345W-CL4-501	
A9R2	0698-3449	6		RESISTOR 28.7K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2872-F	
A9R3	0757-0440	7		RESISTOR 7.5K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-7501-F	
A9R4	0757-0399	5		RESISTOR 82.5 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-82R5-F	
A9R5	0698-0084	9		RESISTOR 2.15K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2151-F	
A9R6	0698-3155	1		RESISTOR 4.64K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-4641-F	
A9R7	0757-0440	7		RESISTOR 7.5K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-7501-F	
A9R8	0757-0407	6		RESISTOR 200 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-201-F	
A9R9	2100-3212	8		RESISTOR-TRMR 200 10% TKF TOP-ADJ 1-TRN	28480	2100-3212	
A9R10	0757-1094	9		RESISTOR 1.47K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1471-F	
A9R11	0698-0082	7		RESISTOR 464 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-4640-F	
A9R12	0698-0082	7		RESISTOR 464 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-4640-F	
A9R13	0757-0346	2		RESISTOR 10 +-1% .125W TF TC=0+-100	D8439	MK2	
A9R14	0757-1094	9		RESISTOR 1.47K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1471-F	
A9R15	0757-0417	8		RESISTOR 562 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-562R-F	
A9R16	0698-8822	9	6	RESISTOR 6.81 +-1% .125W TF TC=0+-100	12498	L040	
A9R17	0698-8822	9		RESISTOR 6.81 +-1% .125W TF TC=0+-100	12498	L040	
A9R18*	0757-0419	0		RESISTOR 681 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-681R-F	
A9R18*	0757-0420	3		RESISTOR 750 +-1% .125W TF TC=0+-100 (RECOMMENDED REPLACEMENT FOR 0757-0417, 562 OHMS)	12498	CT4-1/8-T0-751-F	
A9R18*	0757-0418	9		RESISTOR 619 OHMS +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2610-F	
A9R19	0698-3132	4		RESISTOR 261 +-1% .125W TF TC=0+-100	12498	L040	
A9R20	0698-8922	9		RESISTOR 6.81 +-1% .125W TF TC=0+-100	12498	L040	
A9R21	0698-8822	9		RESISTOR 6.81 +-1% .125W TF TC=0+-100	12498	L040	
A9R22	0698-8822	9		RESISTOR 6.81 +-1% .125W TF TC=0+-100	12498	L040	
A9R23	0698-8822	9		RESISTOR 6.81 +-1% .125W TF TC=0+-100	12498	L040	
A9R24	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	Y20 1/4	
A9R25	0757-0440	7		RESISTOR 7.5K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-7501-F	
A9U1	1826-1181	3		IC V RGLTR-FXD-POS 14.7/15.3V TO-3 PKG	27014	LM340AK-15	
	0590-1076	3		THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	46384	KFS2-M3	
	08660-40002	6		INSULATOR, TO-3	28480	08660-40002	
	1200-0043	8		INSULATOR-XSTR ALUMINUM	76530	322047	
	0515-0986	4		SCREW-MACH M3 X 0.5 20MM-LG PAN-HD (METRIC)	28480	0515-0986	
	1200-1031	6		CONNECTOR-SGL CONT SKT .125-IN-BSC-SZ	98291	006-4806-990	
	2190-0644	3		WASHER-LK EXT T-B 3.0 MM 3.15-MM-ID	28480	2190-0644	
A9U2	1826-0677	0		1	IC V RGLTR-ADJ-POS 1.2/32V TO-3 PKG	27014	LM338K
	0590-1076	3			THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	46384	KFS2-M3
	08660-40002	6			INSULATOR, TO-3	28480	08660-40002
	1200-0043	8	INSULATOR-XSTR ALUMINUM		76530	322047	
	0515-0986	4	SCREW-MACH M3 X 0.5 20MM-LG PAN-HD (METRIC)		28480	0515-0986	
	1200-1031	6	CONNECTOR-SGL CONT SKT .125-IN-BSC-SZ	98291	006-4806-990		
	2190-0644	3	WASHER-LK EXT T-B 3.0 MM 3.15-MM-ID	28480	2190-0644		
A9U3	1826-0169	5	1	IC V RGLTR-FXD-NEG 14.4/15.6V TO-3 PKG	27014	LM320K-15	
	0590-1076	3		THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	46384	KFS2-M3	
	08660-40002	6		INSULATOR, TO-3	28480	08660-40002	
	1200-0043	8		INSULATOR-XSTR ALUMINUM	76530	322047	
	0515-0986	4		SCREW-MACH M3 X 0.5 20MM-LG PAN-HD (METRIC)	28480	0515-0986	
	1200-1031	6	CONNECTOR-SGL CONT SKT .125-IN-BSC-SZ	98291	006-4806-990		
	2190-0644	3	WASHER-LK EXT T-B 3.0 MM 3.15-MM-ID	28480	2190-0644		

See introduction to this section for ordering information  
 \*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9VR1 A9VR2 A9VR3 A9VR4	1902-3301	5	1	DIODE-ZNR 34.8V 5% DO-35 PD=.4W NOT ASSIGNED NOT ASSIGNED	28480	1902-3301
	1902-0952	6	1	DIODE-ZNR 5.6V 5% DO-35 PD=.4W TC=+.046%	28480	1902-0952
A9XA12	1251-8117	0	1	CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	04072	252-06-50-123
	0515-0885	2		SCREW-MACH M4 X 0.7 8MM-LG PAN-HD (METRIC; NOT PART OF THE A9 ASSEMBLY. USED TO ATTACH THE A9 ASSEMBLY TO THE CASTING.)	28480	0515-0885
	0515-0892	1	3	SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD (METRIC; NOT PART OF THE A9 ASSEMBLY. USED TO ATTACH THE A9 ASSEMBLY TO THE CASTING.)	00000	ORDER BY DESCRIPTION
	0515-0893	2	1	SCREW-MACH M3.5 X 0.6 10MM-LG PAN-HD (METRIC; NOT PART OF THE A9 ASSEMBLY. USED TO ATTACH THE A9 ASSEMBLY TO THE CASTING.)	28480	0515-0893
A10	08970-60051	2	1	FIRST CONVERTER ASSEMBLY (RECOMMENDED REPLACEMENT FOR 08970-60151)	28480	08970-60051
	2200-0171	4	3	SCREW-MACH 4-40 .75-IN-LG 82 DEG (NON-METRIC; NOT PART OF A10 ASSEMBLY. USED TO ATTACH THE A10 ASSEMBLY TO THE CASTING.)	00000	ORDER BY DESCRIPTION
	2260-0009	3	2	NUT-HEX-W/LKWR 4-40-THD .094-IN-THK (NOT PART OF A10 ASSEMBLY. USED TO ATTACH THE A10 ASSEMBLY TO THE CASTING.)	00000	ORDER BY DESCRIPTION
A11	08970-60072	7	1	SECOND CONVERTER ASSEMBLY	28480	08970-60072
	08970-69072	5	1	RESTORED 08970-60072. EXCHANGE REQUIRED	28480	08970-69072
A11A1	08970-60014	7	1	2ND CONVERTER OSCILLATOR 8D ASSEMBLY	28480	08970-60014
	0520-0173	2	2	SCREW-MACH 2-56 .188-IN-LG PAN-HD-POZI (NON-METRIC)	00000	ORDER BY DESCRIPTION
	2200-0115	6	1	SCREW-MACH 4-40 .75-IN-LG PAN-HD-POZI (NON-METRIC)	00000	ORDER BY DESCRIPTION
A11A1Q1	16S1-4210	1	1	TC131 IN TO-72 PKG	28480	16S1-4210
	08970-20073	4	1	INSULATOR-XSTR DAP-GL	28480	08970-20073
A11A1R1	0683-4705	8	1	RESISTOR 47 +-5% .25W CF TC=0-400	19701	(CR-25) 1-4-5P-47E
A11A1R2	0683-2715	6	1	RESISTOR 270 +-5% .25W CF TC=0-400	19701	(CR-25) 1-4-5P-270E
A11C1	0160-3036	8	2	CAPACITOR-FDTHRU 5000PF +80 -20% 200V	09553	2425-011 X5V 502Z
A11C2	0160-3036	8		CAPACITOR-FDTHRU 5000PF +80 -20% 200V	09553	2425-011 X5V 502Z
A11C3	0160-2436	0	1	CAPACITOR-FDTHRU 10PF 20% 200V CER	09553	2425-078 X5PO 100M
A11C4				NSR; P/O J2		
A11CP1	08970-00025	4	1	CPLG LOOP INPUT	28480	08970-00025
	2190-0572	6	4	WASHER-LK HLCL NO. 0 .062-IN-ID .1-IN-OD	28480	2190-0572
	3030-0422	8	4	SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302 (NON-METRIC)	00000	ORDER BY DESCRIPTION
A11CP2	08970-00027	6	2	CPLG LOOP FLTR	28480	08970-00027
	2190-0572	6		WASHER-LK HLCL NO. 0 .062-IN-ID .1-IN-OD	28480	2190-0572
	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302 (NON-METRIC)	00000	ORDER BY DESCRIPTION
A11CP3	08970-00027	6		CPLG LOOP FLTR	28480	08970-00027
	2190-0572	6		WASHER-LK HLCL NO. 0 .062-IN-ID .1-IN-OD	28480	2190-0572
	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302 (NON-METRIC)	00000	ORDER BY DESCRIPTION
A11CR1	1901-1107	3	1	DIODE-SCHOTTKY SM SIG	12403	A2X1501
	2190-0572	6		WASHER-LK HLCL NO. 0 .062-IN-ID .1-IN-OD	28480	2190-0572
	3030-0422	8		SCREW-SKT HD CAP 0-80 .188-IN-LG SST-302 (NON-METRIC)	00000	ORDER BY DESCRIPTION
A11J1	1250-1157	2	1	CONNECTOR-RF SMA FEM THD-HOLE 50-OHM	05876	901-9220
A11J2	08970-80019	4	1	CONNECTOR ASSEMBLY (INCLUDES C4)	28480	08970-80019
	2950-0078	9	1	NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
	2190-0124	4	2	WASHER-LK INTL T NO. 10 .195-IN-ID	16179	500222
A11J3	1250-1194	7	1	CONNECTOR-RF SM-SLD M SGL-HOLE-FR 50-OHM	16179	5258-5009-09
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	16179	500222

See introduction to this section for ordering information  
\*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A11L1	9100-2255	4	1	INDUCTOR RF-CH-MLD 470NH +-10%	91637	IM-2 .47UH 10%
A11L2	08559-80001	5	1	COIL 2ND CONV OT	28480	08559-80001
A11MP1	08970-20052	9	1	2ND CONVERTER COVER	28480	08970-20052
	2200-0107	6	1	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI (NON-METRIC)	00000	ORDER BY DESCRIPTION
A11MP2	08970-20058	5	1	2ND CONVERTER OSCILLATOR LID	28480	08970-20058
A11MP3	08970-80018	3	1	BLOCK CAVITY ASSEMBLY	28480	08970-80018
A11MP4	08970-00039	0	1	GASKET OSC	28480	08970-00039
A11MP5	08970-00026	5	1	MOUNTING TAB-MIXER DIODE	28480	08970-00026
A11MP6	0360-0002	6	1	TERMINAL-SLDR LUG PL-MTG FOR-#2-SCR	77147	4029
	0520-0173	2		SCREW-MACH 2-56 .188-IN-LG PAN-HD-POZI (NON-METRIC)	00000	ORDER BY DESCRIPTION
A11MP7	2200-0171	4		SCREW-MACH 4-40 .75-IN-LG 82 DEG (NON-METRIC)	00000	ORDER BY DESCRIPTION
A11R1	0757-0346	2		RESISTOR 10 +-1% .125W TF TC=0+-100	08439	PK2
	0515-0885	2		SCREW-MACH M4 X 0.7 8MM-LG PAN-HD (METRIC)	28480	0515-0885
A11Z1	3030-0397	6	4	SCREW-SET 10-32 1-IN-LG FLAT-PT BRS (NON-METRIC; NOT PART OF THE A11 ASSEMBLY. USED TO ATTACH THE A11 ASSEMBLY TO THE CASTING.)	00000	ORDER BY DESCRIPTION
	2740-0001	3		NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
	3050-0226	2		WASHER-FL MTLN NO. 10 .203-IN-ID	80120	AN960C10L
A11Z2	3030-0397	6		SCREW-SET 10-32 1-IN-LG FLAT-PT BRS (NON-METRIC)	00000	ORDER BY DESCRIPTION
	2740-0001	3		NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
	3050-0226	2		WASHER-FL MTLN NO. 10 .203-IN-ID	80120	AN960C10L
A11Z3	3030-0397	6		SCREW-SET 10-32 1-IN-LG FLAT-PT BRS (NON-METRIC)	00000	ORDER BY DESCRIPTION
	2740-0001	3		NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
	3050-0226	2		WASHER-FL MTLN NO. 10 .203-IN-ID	80120	AN960C10L
A11Z4	3030-0397	6		SCREW-SET 10-32 1-IN-LG FLAT-PT BRS (NON-METRIC)	00000	ORDER BY DESCRIPTION
	0380-0573	8	1	STANDOFF-HEX .625-IN-LG 10-32-THD	28480	0380-0573
	3050-0226	2		WASHER-FL MTLN NO. 10 .203-IN-ID	80120	AN960C10L
	08558-20074	5	1	INSULATOR-COUPLING POST	28480	08558-20074
A12	08970-60015	8	1	NOISE SOURCE DRIVE ASSEMBLY	28480	08970-60015
A12C1	0180-2055	8		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0180-2055
A12C2	0180-2206	4	1	CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A12C3	0160-4764	1		CAPACITOR-FXD 150PF +-5% 100VDC CER	09969	RPE121-10SC0G151J100V
A12C4	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	09969	RPE121-10SX7R102H100V
A12C5	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A12CR1	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A12CR2	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A12CR3	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A12CR4	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A12DS1	1990-0485	5	1	LED-LAMP LUM-INT*2MCD IF*30MA-MAX BVR*5V	28480	HLMP-1503
A12MP1	1530-1098	4	2	MACHINED PART-BRS CLEVIS	28480	1530-1098
	0515-1476	9	2	SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD (METRIC)	28480	0515-1476
	0535-0007	2	2	NUT-HEX DBL-CHAM M3.5 X 0.6 3.3MM-THK	00000	ORDER BY DESCRIPTION
	2190-0585	1	2	WASHER-LK MLCI 3.5 MM 3.6-MM-ID	28480	2190-0585
A12MP2	1530-1098	4		MACHINED PART-BRS CLEVIS	28480	1530-1098
	0515-1476	9		SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD (METRIC)	28480	0515-1476
	0535-0007	2		NUT-HEX DBL-CHAM M3.5 X 0.6 3.3MM-THK	00000	ORDER BY DESCRIPTION
	2190-0585	1		WASHER-LK MLCI 3.5 MM 3.6-MM-ID	28480	2190-0585
A12Q1	1854-0832	8	2	TRANSISTOR NPN PD=625MW FT=250MHZ	28480	1854-0832
A12Q2	1854-0832	8		TRANSISTOR NPN PD=625MW FT=250MHZ	28480	1854-0832
A12R1	0757-0424	7		RESISTOR 1.1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1101-F
A12R2	0698-3159	5	1	RESISTOR 26.1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2612-F
A12R3	0757-0440	7		RESISTOR 7.5K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-7501-F
A12R4	0757-0442	9		RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A12R5	0811-2820	7	1	RESISTOR 4.7 +-5% .75W PUI TC=0+-50	81637	RS1/2-T2-4R7-J

See introduction to this section for ordering information  
 \*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A12R6	0699-0148	8	1	RESISTOR 31.6K +-0.1% .1W TF TC=0+-15	09535	PR1/10
A12R7	2100-3109	2	1	RESISTOR-TRMR 2K 10% TKF SIDE-ADJ 17-TRN	73138	89PR2K
A12R8	0698-8319	9		RESISTOR 10K +-1% .1W TF TC=0+-10	19701	502321/8-T13-1002-F
A12R9	0698-3442	9		RESISTOR 237 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-237R-F
A12R10	0698-3444	1	1	RESISTOR 316 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-316R-F
A12TP1	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A12TP2	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A12TP3	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A12TP4	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A12U1	1826-0177	5	1	IC V RGLTR-ADJ-POS 2/37V T0-100 PKG	28480	1826-0177
A12VR1	1902-0564	6	1	DIODE-ZNR 34.8V 5% D0-15 PD=1W TC=-.078%	28480	1902-0564
A12VR2	1902-0928	6		IC V RGLTR-V-REF-FXD 6.6/7.25V T0-92 PKG	27014	LM329
A12VR3	1902-0562	4	1	DIODE-ZNR 22V 5% PD=1W IR=5UA	28480	1902-0562
A13	08970-60034	1	1	DRIVER ASSEMBLY	28480	08970-60034
	08970-69034	9	1	RESTORED 08970-60034, EXCHANGE REQUIRED	28480	08970-69034
A13C1	0160-4574	1		CAPACITOR-FXD 1000PF +-10% 100VDC CER	12474	CAC02X7R102K100A
A13C2	0160-4832	4	21	CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C3	0180-0116	1	2	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685K9035B2
A13C4	0160-5098	6	2	CAPACITOR-FXD .22UF +-10% 50VDC CER	12474	CAC05X7R224J050A
A13C5	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C6	0160-3336	1	1	CAPACITOR-FXD 100PF +-10% 50VDC CER	12474	CAC02X7R101K100A
A13C7	0180-1746	5	4	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156K9020B2
A13C8	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156K9020B2
A13C9	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336K9010B2
A13C10	0160-5098	6		CAPACITOR-FXD .22UF +-10% 50VDC CER	12474	CAC05X7R224J050A
A13C11	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C12	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C13	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C14	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C16	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C17	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C18	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C19	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C20	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C21	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C22	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C23				NOT ASSIGNED		
A13C24	0160-3726	3	2	CAPACITOR-FXD 1UF +-10% 40VDC MET-POLY	84411	HEU-428
A13C25	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C26	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C27	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C28	0160-3726	3		CAPACITOR-FXD 1UF +-10% 40VDC MET-POLY	84411	HEU-428
A13C29				NOT ASSIGNED		
A13C30	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C31	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C32	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C33	0160-5189	6	1	CAPACITOR-FXD 4700PF +-10% 100VDC POLYP	07282	472K01PP460
A13C34	0160-4803	9	2	CAPACITOR-FXD 68PF +-5% 100VDC CER 0+-30	12474	CAC02C0680J100A
A13C35	0160-4805	1	2	CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	12474	CAC02C06470J100A
A13C36	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C37	0160-5624	4	3	CAPACITOR-FXD 5600PF +-5% 100VDC	84411	HEU-684
A13C38	0160-4682	2	2	CAPACITOR-FXD 1000PF +-2.5% 160VDC POLYP	28480	0160-4682
A13C39	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C40	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C41	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C42	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C43	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C44	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C45	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C46	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C47	0160-4803	9		CAPACITOR-FXD 68PF +-5% 100VDC CER 0+-30	12474	CAC02C0680J100A
A13C48	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	12474	CAC02C06470J100A
A13C49	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A13C50	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A

See introduction to this section for ordering information  
 \*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A13C51	0160-5624		4	CAPACITOR-FXD 5600PF +-5% 100VDC	84411	HEW-684
A13C52	0160-4682		2	CAPACITOR-FXD 1000PF +-2.5% 160VDC POLYP	28480	0160-4682
A13C53	0160-4832		4	CAPACITOR-FXD .01UF +-10% 100VDC CER	12474	CAC02X7R103K100A
A13C54	0180-0229		7	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A13C55	0160-4574		1	CAPACITOR-FXD 1000PF +-10% 100VDC CER	12474	CAC02X7R102K100A
A13C56	0160-0301		4	CAPACITOR-FXD .012UF +-10% 200VDC POLYE	19701	708D1EH123PK201AX
A13C57				NOT ASSIGNED		
A13C58	0180-0116		1	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A13CR1-				NOT ASSIGNED		
A13CR5				DIODE-GEN PRP 35V 50MA DO-35	9N293	1N3595
A13CR6	1901-0376		6			
A13J1	1252-3493		7	HEADER-7 POSN	28480	1252-3493
A13J2	1252-0242		8	CONN-POST TYPE .100-PIN-SPCG 34-CONT	28480	1252-0242
A13J3	1252-3495		9	HEADER-5 POSN	28480	1252-3495
A13J4	1252-3493		7	HEADER-7 POSN	28480	1252-3493
A13J5	1251-8393		4	CONN-POST TYPE .100-PIN-SPCG 7-CONT	28480	1251-8393
A13L1	9140-0114		4	INDUCTOR RF-CH-MLD 10UH +-10%	91637	IM-4 10UH 10%
A13L2	9140-0114		4	INDUCTOR RF-CH-MLD 10UH +-10%	91637	IM-4 10UH 10%
A13L3	9140-0114		4	INDUCTOR RF-CH-MLD 10UH +-10%	91637	IM-4 10UH 10%
A13MP1	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP2	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP3	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP4	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP5	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP6	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP7	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP8	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP9	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP10	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP11	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP12	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP13	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP14	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP15	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP16	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP17	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP18	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP19	1400-0966		8	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP20	0403-0285		9	BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A13MP21	0403-0285		9	BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A13MP22	0403-0285		9	BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A13MP23	0403-0285		9	BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A13MP24	0403-0285		9	BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A13MP25	0510-1024		3	RETAINER-RING E-R EXT .188-IN-DIA STL	K5589	X-5133-18-S-ZD
A13MP26	08970-20022		3	SCREW-MODIFIED	28480	08970-20022
A13MP27	3050-0139		6	WASHER-FL MTLN NO. 8 .172-IN-ID	28480	3050-0139
A13MP28	3050-0172		7	WASHER-FL MM NO. 10 .203-IN-ID	28480	3050-0172
A13MP29	3050-0172		7	WASHER-FL MM NO. 10 .203-IN-ID	28480	3050-0172
A13Q1	1854-0810		2	TRANSISTOR NPN SI PD=625MW FT=200MHZ	56289	CT-1058
A13Q2	1855-0414		4	TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	17856	2N4393
A13Q3	1854-0456		2	TRANSISTOR NPN SI PD=65W FT=3MHZ	01295	TIP41A
	1205-0639		8	HEAT SINK T0-220-CS	30181	59108
A13R1	0698-3156		2	RESISTOR 14.7K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1472-F
A13R2-				NOT ASSIGNED		
A13R7				RESISTOR 14.7K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1472-F
A13R8	0698-3156		2	RESISTOR 14.7K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1472-F
A13R9	0698-3156		2	RESISTOR 14.7K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1472-F
A13R10	0698-3156		2	RESISTOR 14.7K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1472-F
A13R11	2100-4020		8	RESISTOR-TRMR 2K 10% TF SIDE-ADJ 26-TRN	18612	1280-2K-10%
A13R12	0698-0234		3	RESISTOR 6.915K +-0.1% .1W TF TC=0+-5	09535	PR1/10
A13R13	0757-0442		9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A13R14				NOT ASSIGNED		

See introduction to this section for ordering information  
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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A13R15	0757-0443	0	1	RESISTOR 11K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1102-F
A13R16	0699-1114	0	4	RESISTOR 7.96K +-0.1% .1W TF TC=0+-5	09535	PR1/10
A13R17	0699-1114	0	1	RESISTOR 7.96K +-0.1% .1W TF TC=0+-5	09535	PR1/10
A13R18	0699-3452	1	1	RESISTOR 147K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1473-F
A13R19	0699-1114	0	1	RESISTOR 7.96K +-0.1% .1W TF TC=0+-5	09535	PR1/10
A13R20	0698-8824	1	1	RESISTOR 562K +-1% .125W TF TC=0+-100	12498	CT4
A13R21	0699-1114	0	1	RESISTOR 7.96K +-0.1% .1W TF TC=0+-5	09535	PR1/10
A13R22	0757-0465	6	6	RESISTOR 100K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1003-F
A13R23	2100-3162	7	1	RESISTOR-TRMR 200K 10% TKF SIDE-ADJ	73138	89PR200K
A13R24	0699-0060	3	1	RESISTOR 3.06K +-0.1% .1W TF TC=0+-5	09535	PR1/10
A13R25	0699-1911	5	6	RESISTOR 214.2 +-0.1% 1W TF TC=0+-10	19701	5043ZB214R2B-13
A13R26	0699-1911	5	6	RESISTOR 214.2 +-0.1% 1W TF TC=0+-10	19701	5043ZB214R2B-13
A13R27	0699-1911	5	6	RESISTOR 214.2 +-0.1% 1W TF TC=0+-10	19701	5043ZB214R2B-13
A13R28	0698-0085	0	3	RESISTOR 2.61K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2611-F
A13R29	2100-2497	9	1	RESISTOR-TRMR 2K 10% TKF TOP-ADJ 1-TRN	73138	82PR2K
A13R30	0757-0274	5	1	RESISTOR 1.21K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1211-F
A13R31	0698-3152	8	5	RESISTOR 3.48K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3481-F
A13R32	0698-3152	8	5	RESISTOR 3.48K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3481-F
A13R33	0698-0085	0	8	RESISTOR 2.61K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2611-F
A13R34	2100-1986	9	2	RESISTOR-TRMR 1K 10% TKF TOP-ADJ 1-TRN	73138	82PR1K
A13R35	0757-0442	9	9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A13R36	0757-0442	9	9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A13R37	0757-0442	9	9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A13R38	0757-0442	9	9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A13R39	0699-1911	5	5	RESISTOR 214.2 +-0.1% 1W TF TC=0+-10	19701	5043ZB214R2B-13
A13R40	0699-1911	5	5	RESISTOR 214.2 +-0.1% 1W TF TC=0+-10	19701	5043ZB214R2B-13
A13R41	0699-1911	5	5	RESISTOR 214.2 +-0.1% 1W TF TC=0+-10	19701	5043ZB214R2B-13
A13R42				NOT ASSIGNED		
A13R43	0698-3620	5	4	RESISTOR 100 +-5% 2W MO TC=0+-200	12498	FP-69
A13R44	0698-3152	8	8	RESISTOR 3.48K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3481-F
A13R45	0698-3152	8	8	RESISTOR 3.48K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3481-F
A13R46	0698-0085	0	0	RESISTOR 2.61K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-2611-F
A13R47	2100-1986	9	9	RESISTOR-TRMR 1K 10% TKF TOP-ADJ 1-TRN	73138	82PR1K
A13R48	0698-3441	8	1	RESISTOR 215 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-215R-F
A13R49	0757-0442	9	9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A13R50	0757-0442	9	9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A13R51	0757-0442	9	9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A13R52	0757-0442	9	9	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A13R53	0757-0465	6	6	RESISTOR 100K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1003-F
A13R54	0698-3152	8	8	RESISTOR 3.48K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3481-F
A13R55	0757-1094	9	9	RESISTOR 1.47K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1471-F
A13R56				NOT ASSIGNED		
A13R57	0698-3620	5	5	RESISTOR 100 +-5% 2W MO TC=0+-200	12498	FP-69
A13R58				NOT ASSIGNED		
A13R59	0757-0280	3	3	RESISTOR 1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1001-F
A13R60				NOT ASSIGNED		
A13R61	0698-3620	5	5	RESISTOR 100 +-5% 2W MO TC=0+-200	12498	FP-69
A13R62	0698-3620	5	5	RESISTOR 100 +-5% 2W MO TC=0+-200	12498	FP-69
A13R63	0757-0280	3	3	RESISTOR 1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1001-F
A13R64	0757-0401	0	0	RESISTOR 100 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-101-F
A13R65	0757-0401	0	0	RESISTOR 100 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-101-F
A13R66				NOT ASSIGNED		
A13R67	0757-0438	3	3	RESISTOR 5.11K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-5111-F
A13R68	0757-0438	3	3	RESISTOR 5.11K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-5111-F
A13TP1	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP2	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP3	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP4	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP5	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP6	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP7	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP8	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP9	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP10	0360-0535	0	0	CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535

See introduction to this section for ordering information  
 \*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A13TP11	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP12	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP13	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP14	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP15	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP16	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP17	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP18	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP19	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP20	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13TP21	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A13U1	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A13U2	1820-1197	9	3	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A13U3	1820-1437	0	3	IC MV TTL LS MONOSTBL DUAL	01295	SN74LS221N
A13U4	1826-0220	9	1	IC V RGLTR-FXD-NEG 4.8/5.2V T0-39 PKG	28480	1826-0220
	1205-0011	0		HEAT SINK T0-5/T0-39-CS	13103	2226B
A13U5	1826-1265	4	6	IC OP AMP WB 8-DIP-P PKG	10899	LT318AN8 (SELECTED)
A13U6	1826-0727	1	3	SAMPLE AND HOLD 14 -CERDIP	06665	SMP-81FY
A13U7	1826-1265	4		IC OP AMP WB 8-DIP-P PKG	10899	LT318AN8 (SELECTED)
A13U8	1826-1265	4		IC OP AMP WB 8-DIP-P PKG	10899	LT318AN8 (SELECTED)
A13U9	1826-0188	8	2	D/A 8-BIT 16-CERDIP BPLR	04713	MC1408L-8
A13U10	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A13U11	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A13U12	1820-1794	2		IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A13U13	1820-1794	2		IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A13U14	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A13U15	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A13U16	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A13U17	1826-0861	4	1	D/A 10-BIT 16-PLASTIC CMOS	24355	AD7533LN
A13U18	1826-0520	2	1	IC OP AMP LOW-BIAS-H-IMP 8-DIP-P PKG	01295	TL071BCP
A13U19	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A13U20	1820-1437	0		IC MV TTL LS MONOSTBL DUAL	01295	SN74LS221N
A13U21	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A13U22				NOT ASSIGNED		
A13U23	1826-1265	4		IC OP AMP WB 8-DIP-P PKG	10899	LT318AN8 (SELECTED)
A13U24	1826-0727	1		SAMPLE AND HOLD 14 -CERDIP	06665	SMP-81FY
A13U25	1826-1265	4		IC OP AMP WB 8-DIP-P PKG	10899	LT318AN8 (SELECTED)
A13U26	1826-1265	4		IC OP AMP WB 8-DIP-P PKG	10899	LT318AN8 (SELECTED)
A13U27	1826-0188	8		D/A 8-BIT 16-CERDIP BPLR	04713	MC1408L-8
A13U28	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A13U29	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A13U30	1820-2096	9	2	IC CNTR TTL LS BIN DUAL 4-BIT	01295	SN74LS393N
A13U31	1820-2096	9		IC CNTR TTL LS BIN DUAL 4-BIT	01295	SN74LS393N
A13U32	1826-1386	0	1	D/A 12-BIT 18-PLASTIC CMOS	24355	AD7541AKN
A13U33	1826-1590	8	1	IC OP AMP PRCN QUAD 14-DIP-P PKG	10899	LT1014CN
A13U34	1820-1437	0		IC MV TTL LS MONOSTBL DUAL	01295	SN74LS221N
A13U35	1820-1212	9	2	IC FF TTL LS J-K NEG-EDGE-TRIG	01295	SN74LS112AN
A13U36	1826-0065	0	1	IC COMPARATOR PRCN 8-DIP-P PKG	27014	LM311N
A13U37	1820-1204	9	1	IC GATE TTL LS NAND DUAL 4-INP	01295	SN74LS20N
A13U38	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A13U39	1820-1212	9		IC FF TTL LS J-K NEG-EDGE-TRIG	01295	SN74LS112AN
A13U40	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A13U41	1820-1207	2	1	IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
A13U42	1826-1514	6	1	IC V RGLTR-V-REF-FXD 8.95/10.05V 8-DIP-P	10899	LT1021BCN8-10
A13VR1				NOT ASSIGNED		
A13VR2	1902-0961	7	1	DIODE-ZNR 13V 5% DO-35 PD=.4W TC=+.082%	28480	1902-0961
A13VR3	1902-0928	6		IC V RGLTR-V-REF-FXD 6.6/7.25V T0-92 PKG	27014	LM328
A13VR4				NOT ASSIGNED		
A13VR5	1902-0554	4	2	DIODE-ZNR 10V 5% PD=1W IR=10UA	28480	1902-0554
A13VR6	1902-0551	1	1	DIODE-ZNR 6.2V 5% PD=1W IR=10UA	28480	1902-0551
A13VR7				NOT ASSIGNED		
A13VR8	1902-0554	4		DIODE-ZNR 10V 5% PD=1W IR=10UA	28480	1902-0554

See introduction to this section for ordering information  
 \*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A13W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A13W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A13W3	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A13W4	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	11502	YZO 1/4
A13W5	8120-3300	3	1	CABLE ASSEMBLY-RIBBON (A13 TO A14)	28480	8120-3300
A14	08970-60033	0	1	CONTROLLER ASSEMBLY	28480	08970-60033
	08970-69033	8	1	RESTORED 08970-60033, EXCHANGE REQUIRED	28480	08970-69033
A14BT1	1420-0314	2	1	BATTERY 3V .16A-HR LITHIUM POLYCARBON	08712	BR-2325
	1400-1487	0	1	BATTERY HOLDER ASSY GLASS-FILLED NYLON	91833	107-911
A14C1	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A14C2	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A14C3	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C4	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C5	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A14C6	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C7	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C8	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C9	0160-5624	4		CAPACITOR-FXD 5600PF +-5% 100VDC	84411	HEW-684
A14C10	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A14C11	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C12	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C13	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A14C14	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C15	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C16	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C17	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C18	0160-4808	4	1	CAPACITOR-FXD 470PF +-5% 100VDC CER	12474	CAC02C0G471J100A
A14C19-						
A14C23				NOT ASSIGNED		
A14C24	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C25	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C26	0160-5913	4	1	CAPACITOR-FXD 36PF +-5% 200VDC CER 0+-30	06383	MA12C0G2D360J
A14C27				NOT ASSIGNED		
A14C28	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	12474	CAC04X7R104K050A
A14C29	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C30	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C31	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C32	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C33	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C34	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C35	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C36	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C37	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C38	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C39	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C40	0160-3334	9		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14C41	0160-3334	8		CAPACITOR-FXD .01UF +-10% 50VDC CER	12474	CAC02X7R103K100A
A14CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A14CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A14CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A14CR4	1901-0518	8		DIODE-SCHOTTKY SM SIG	12403	5082-2800
A14CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A14CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	9N171	1N4150
A14DS1	1990-0652	8	1	LED-LAMP ARRAY LUM-INT=200UCD IF+5MA-MAX	28480	HLMP-6620 SELECTED
A14J1	1251-8929	2	1	CONN-POST TYPE .100-PIN-SPCG 50-CONT	28480	1251-8929
A14J2	1252-3494	8	1	HEADER-6 POSN	28480	1252-3494
A14J3	1252-3493	7		HEADER-7 POSN	28480	1252-3493
A14J4	1252-3493	7		HEADER-7 POSN	28480	1252-3493
A14J5	1251-8393	4		CONN-POST TYPE .100-PIN-SPCG 7-CONT	28480	1251-8393
A14J6	1252-0242	8		CONN-POST TYPE .100-PIN-SPCG 34-CONT	28480	1252-0242

See introduction to this section for ordering information  
 \*Indicates factory selected value



Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
A14L1	9140-0114	4			INDUCTOR RF-CH-MLD 10UH +-10%	91637	IM-4 10UH 10%
A14L2	9100-1611	4			INDUCTOR RF-CH-MLD 220NH +-20%	91637	IM-4 .22UH 20%
A14L3	9140-0114	4			INDUCTOR RF-CH-MLD 10UH +-10%	91637	IM-4 10UH 10%
A14MP1	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP2	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP3	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP4	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP5	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP6	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP7	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP8	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP9	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP10	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP11	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP12	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP13	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP14	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP15	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP16	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP17	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP18	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP19	1400-0966	8			CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP20	0403-3521	2		2	BUMPER FOOT	28480	0403-3521
A14MP21	0403-0285	9			BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A14MP22	0403-0285	9			BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A14MP23	0403-0285	9			BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A14MP24	0403-0285	9			BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A14MP25	0403-0285	9			BUMPER FOOT-ADH MTG 12.7-MM-WD	76381	SJ-5018 GRAY
A14MP26	0403-3521	2			BUMPER FOOT	28480	0403-3521
A14MP27	0510-1024	3			RETAINER-RING E-R EXT .188-IN-DIA STL	K5569	X-5133-18-S-ZD
A14MP28	08970-20022	3			MODIFIED SCREW	28480	08970-20022
A14MP29	3050-0139	6			WASHER-FL MTL NO. 8 .172-IN-ID	28480	3050-0139
A14MP30	3050-0172	7			WASHER-FL NM NO. 10 .203-IN-ID	28480	3050-0172
A14MP31	3050-0172	7			WASHER-FL NM NO. 10 .203-IN-ID	28480	3050-0172
A14Q1	1853-0393	4		1	TRANSISTOR PNP SI T0-92 PD=500MW	28480	1853-0393
A14Q2	1854-0810	2			TRANSISTOR NPN SI PD=625MW FT=200MHZ	56289	CT-1058
A14R1	0757-0422	5		1	RESISTOR 909 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-909R-F
A14R2	0757-0290	5		1	RESISTOR 6.19K +-1% .125W TF TC=0+-100	19701	S033R-1/8-T0-6191-F
A14R3	0698-7089	8		1	RESISTOR 450 +-1% .125W TF TC=0+-100	12498	CT4
A14R4	0757-0279	0			RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R5	0757-0279	0			RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R6	0757-0279	0			RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R7	0698-7207	2		2	RESISTOR 61.9 +-1% .05W TF TC=0+-100	12498	C3-1/8-T0-619R-F
A14R8	0757-0279	0			RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R9	0757-0279	0			RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R10					NOT ASSIGNED		
A14R11	0698-3162	0			RESISTOR 46.4K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-4642-F
A14R12	0757-0279	0			RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R13					NOT ASSIGNED		
A14R14	0757-0279	0			RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R15					NOT ASSIGNED		
A14R16	1810-0424	2			NETWORK-RES 16-DIP 4.7K OHM X 15	11236	761-1-R4.7K
A14R17	1810-0316	1		2	NETWORK-RES 16-DIP 10.0K OHM X 8	11236	761-3-R10K
A14R18	1810-0316	1			NETWORK-RES 16-DIP 10.0K OHM X 8	11236	761-3-R10K
A14R19	1810-0424	2			NETWORK-RES 16-DIP 4.7K OHM X 15	11236	761-1-R4.7K
A14R20	0698-3435	0		2	RESISTOR 38.3 +-1% .125W TF TC=0+-100	08439	HK2
A14R21	0757-0401	0			RESISTOR 100 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-101-F
A14R22	0698-3162	0			RESISTOR 46.4K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-4642-F
A14R23	0757-0401	0			RESISTOR 100 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-101-F
A14R24	0757-0280	3			RESISTOR 1K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1001-F
A14R25					NOT ASSIGNED		
A14R26					NOT ASSIGNED		
A14R27					NOT ASSIGNED		
A14R28	0757-0442	9			RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A14R29	0757-0279	0			RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R30					NOT ASSIGNED		

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A14R31				NOT ASSIGNED		
A14R32	0757-0279	0		RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R33				NOT ASSIGNED		
A14R34	0757-0279	0		RESISTOR 3.16K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-3161-F
A14R35	0757-0465	6		RESISTOR 100K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1003-F
A14R36	0698-7207	2		RESISTOR 61.9 +-1% .05W TF TC=0+-100	12498	C3-1/8-T0-61R9-F
A14R37	0698-7212	9	3	RESISTOR 100 +-1% .05W TF TC=0+-100	12498	C3-1/8-T0-100R-F
A14R38	0698-7212	9		RESISTOR 100 +-1% .05W TF TC=0+-100	12498	C3-1/8-T0-100R-F
A14R39	0698-7212	9		RESISTOR 100 +-1% .05W TF TC=0+-100	12498	C3-1/8-T0-100R-F
A14R40	0811-1668	9	1	RESISTOR 1.5 +-5% 2W PWI TC=0+-400	11502	SPH
A14R41	0698-8827	4		RESISTOR 1M +-1% .125W TF TC=0+-100	12498	CT4
A14R42	0698-8827	4		RESISTOR 1M +-1% .125W TF TC=0+-100	12498	CT4
A14R43	0698-3458	7	2	RESISTOR 348K +-1% .125W TF TC=0+-100	12498	CT4
A14R44	0698-3458	7		RESISTOR 348K +-1% .125W TF TC=0+-100	12498	CT4
A14R45	0698-3435	0		RESISTOR 38.3 +-1% .125W TF TC=0+-100	08439	MK2
A14S1	3101-2761	3	1	SWITCH-DIP SL 7-1A 0.1A 30VDC	11236	207-7
A14TP1	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP2	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP3	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP4	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP5	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP6	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP7	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP8	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP9	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP10	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP11	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP12	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP13	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14TP14	0360-0535	0		CONNECTOR-SGL CONT TML-TS-PT	28480	0360-0535
A14U1	1820-3431	8	2	IC INTERFACE XCVR INSTRUMENT BUS IEEE	27014	DS75160AN
A14U2	1820-2548	6	1	IC GENERAL PURPOSE INTERFACE BUS ADAPTER	01295	TMS9914ANL
A14U3	1826-0547	3		IC OP AMP LOW-BIAS-H-IMP DUAL 8-DIP-P	01295	TL072ACP
A14U4	08970-80031	0	1	PAL PROGRAMMED	28480	08970-80031
A14U5	08970-80050	3	1	EPROM PROGRAMMED	28480	08970-80050
				NOTE: IF A14U5 IS BEING REPLACED FOR THE FIRST TIME AND IS FROM AN INSTRUMENT WITH PREFIX LOWER THAN 2847A, REPLACE A14U7 ALONG WITH A14U5. (RECOMMENDED REPLACEMENT FOR 08970-80026, 08970-80040)		
A14U6	1200-0567	1	2	SOCKET-IC-DIP 28-CONT DIP DIP-SLDR	01295	C8728-01
A14U7	1820-2775	1	1	IC GATE TTL ALS NAND TPL 3-INP	01295	SN74ALS10AN
				EPROM PROGRAMMED	28480	08970-80051
				NOTE: IF A14U7 IS BEING REPLACED FOR THE FIRST TIME AND IS FROM AN INSTRUMENT WITH PREFIX LOWER THAN 2847A, REPLACE A14U5 ALONG WITH A14U7. (RECOMMENDED REPLACEMENT FOR 08970-80027, 08970-80041)		
	1200-0567	1		SOCKET-IC-DIP 28-CONT DIP DIP-SLDR	01295	C8728-01
A14U8	1818-3760	1	1	IC CMOS 65536 (64K) STAT RAM 150-NS 3-S	S0562	TC5564APL-15
A14U9	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A14U10	1820-1568	8		IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A14U11	1820-3518	2	1	IC INTERFACE XCVR INSTRUMENT BUS IEEE	27014	DS75162AN
A14U12	1820-1016	1	1	IC INTERFACE DRVR OR DUAL	01295	SN75453BP
A14U13	1826-0138	8	2	IC COMPARATOR GP QUAD 14-DIP-P PKG	27014	LM339N
A14U14	1820-1208	3	3	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A14U15	1820-2024	3	5	IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A14U16	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A14U17	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A14U18	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A14U19	1818-3183	2	1	IC CMOS 65536 (64K) STAT RAM 150-NS 3-S	S4013	HM6264P-15
A14U20	08970-80029	6	1	PAL PROGRAMMED	28480	08970-80029
A14U21	1820-2075	4	5	IC TRANSCEIVER TTL LS BUS OCTL	01295	SN74LS245N
A14U22	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	01295	SN74LS245N
A14U23	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	01295	SN74LS245N
A14U24	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	01295	SN74LS245N
A14U25	1820-2635	2	3	IC GATE TTL ALS AND QUAD 2-INP	01295	SN74ALS08N
A14U26	1820-3431	8		IC INTERFACE XCVR INSTRUMENT BUS IEEE	27014	DS75160AN
A14U27	1820-1568	8		IC BFR TTL LS BUS QUAD	01295	SN74LS125AN

See introduction to this section for ordering information  
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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A14U28	1820-2549	7	1	IC-GPIB TALKER/LISTENER	34649	P8291A SELECTED
A14U29	1820-2111	9	1	IC-INTERFACE DRVR INV	01295	SN75468N
A14U30	1820-1730	6	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A14U31	1820-1987	5		IC SHF-RGTR TTL LS COM CLEAR STOR 8-BIT	34335	AM74LS299N
A14U32	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	01295	SN74LS245N
A14U33	1820-2993	3	2	IC-PERIPHERAL INTERFACE ADAPTER;CLK=2MHZ	04713	MC68B21P
A14U34	1820-2624	9	1	IC-MPU; CLK FREQ=2 MHZ, ENHANCED 6800	04713	MC68B09P
	1200-0654	7	1	SOCKET-IC-DIP 40-CONT DIP DIP-SLDR	01295	C8740-01
A14U35	1820-2993	3		IC-PERIPHERAL INTERFACE ADAPTER;CLK=2MHZ	04713	MC68B21P
A14U36	1820-3519	3	1	IC-DIRECT MEMORY ACCESS CONTROLLER	04713	MC68B44P
A14U37	1820-2634	1	3	IC INV TTL ALS HEX	01295	SN74ALS048N
A14U38	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A14U39	1820-1568	8		IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A14U40	1820-1443	8	2	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS293N
A14U41	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A14U42	1820-2058	3	2	IC-INTERFACE XCVR INSTRUMENT BUS IEEE	04713	MC3448AL
A14U43	1820-2058	3		IC-INTERFACE XCVR INSTRUMENT BUS IEEE	04713	MC3448AL
A14U44	1820-2656	7	1	IC GATE TTL ALS NAND QUAD 2-INP	01295	SN74ALS00AN
A14U45	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A14U46	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A14U47	1820-2634	1		IC INV TTL ALS HEX	01295	SN74ALS048N
A14U48	1820-2635	2		IC GATE TTL ALS AND QUAD 2-INP	01295	SN74ALS08N
A14U49	1820-2635	2		IC GATE TTL ALS AND QUAD 2-INP	01295	SN74ALS08N
A14U50	1820-2634	1		IC INV TTL ALS HEX	01295	SN74ALS048N
A14U51	1820-1443	8		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS293N
A14U52	08970-80030	9	1	PAL PROGRAMMED	28480	08970-80030
A14U53	1826-0727	1		SAMPLE AND HOLD 14 -CERDIP	06665	SMP-81FY
A14U54	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	27014	LM339N
A14U55	1826-1338	2	1	IC MISC 8-DIP-P PKG	01295	TL7705A
A14VR1	1902-0928	6		IC V RGLTR-V-REF-FXD 6.6/7.25V TO-92 PKG NOT ASSIGNED	27014	LM329
A14VR2						
A14VR3	1902-0947	9	1	DIODE-ZNR 3.6V 5% DO-35 PD=.4W TC=-.036%	28480	1902-0947
A14Y1	1813-0130	3	1	CLOCK-OSCILLATOR-XTAL 16-MHZ 0.05%	12703	RASCO PLUS-16MHZ
	0340-0944	3	1	INSULATOR-IC NYLON BLACK	13103	7717-156N
A15	0960-0443	1	1	LINE MODULE-FILTERED	05245	F20580
A16				NOT ASSIGNED		
A17	08970-60027	2	1	FIRST LO ASSEMBLY	28480	08970-60027
A17A1	08970-60045	4	1	YIG INTERFACE BOARD ASSEMBLY (RECOMMENDED REPLACEMENT FOR 08970-60017)	28480	08970-60045
A17A1C1	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A17A1C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A17A1C3	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
A17A1C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	09969	RPE121-105X7R103M100V
				NOTE: A17A1C1 THROUGH A17A1C4 ARE DIFFICULT TO REPLACE. IF A CAPACITOR NEEDS TO BE REPLACED, IT IS RECOMMENDED THAT THE ENTIRE A17A1 ASSEMBLY BE REPLACED.		
A17A1G1	0955-0343	9	1	U-WAVE YIG OSCILLATOR 3.85 GHZ MAX NOTE: A17A1G1 IS DIFFICULT TO REPLACE. IF THE YIG OSCILLATOR NEEDS TO BE REPLACED, IT IS RECOMMENDED THAT THE ENTIRE A17A1 ASSEMBLY BE REPLACED.	28480	0955-0343
A17A1J1	1252-3492	6		HEADER-8 POSN NOTE: A17A1J1 IS DIFFICULT TO REPLACE. IF THE CONNECTOR NEEDS TO BE REPLACED, IT IS RECOMMENDED THAT THE ENTIRE A17A1 ASSEMBLY BE REPLACED.	28480	1252-3492

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A17MP1	08970-00081	2	1	YIG OSCILTR DECK (RECOMMENDED REPLACEMENT FOR 08970-00080)	28480	08970-00081
A17MP2	08590-00009	4	1	SHIELD-YIG	28480	08590-00009
A17MP3	2200-0105	4	4	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI (NON-METRIC)	00000	ORDER BY DESCRIPTION
	0515-1079	8	4	SCREW-MACHINE ASSEMBLY M3 X 0.5 8MM-LG (METRIC; NOT PART OF THE A17 ASSEMBLY. USED TO ATTACH THE A17 ASSEMBLY TO THE CASTING.)	00000	ORDER BY DESCRIPTION

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 \*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
AT1	0960-0699	9	1	U-WAVE ISOLATOR 6.6 GHZ MAX	16453	PMT-9482
	0403-0275	7	1	BUMPER FOOT-ADH MTG	76381	SJ-5027-BLK
	2200-0107	6	1	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI (NON-METRIC; USED TO MOUNT THE ISOLATOR. TERMINATION-COAXIAL 50 OHMS; FREQUENCY	00000	ORDER BY DESCRIPTION
AT2	1250-2121	2	1		16179	2001-6500-00
B1	3160-0381	3	1	FAN-TBAX 30-CFM 115V 50/60-HZ 1.5KV-DIEL	09464	411M-11
	0590-1362	0	2	THREADED INSERT-PULL-IN M3 X 0.5	00613	E-632 METRIC M3 X 0.5
	0515-1756	8	2	SCREW-MACH M3 X 0.5 40MM-LG PAN-HD (METRIC)	28480	0515-1756
	2190-0584	0	6	WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
	0360-0269	7	1	TERMINAL-SLDR LUG	07679	H144
	0624-0215	3	1	SCREW-TPG 8-32 .25-IN-LG PAN-HD-POZI STL (NON-METRIC)	28480	0624-0215
	1400-0510	8	2	CLAMP-CABLE .15-DIA .62-WD NYL	02768	8511-28-00-9909
C1	0160-3451	1	3	CAPACITOR-FXD .01UF +80-20% 100VDC CER	09969	DD106NWB305YSV103Z100V
C2	0160-3451	1	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	09969	DD106NWB305YSV103Z100V
F1	2110-0001	8	1	FUSE (INCH) 1A 250V NTD FE UL (220/240 VAC OPERATION)	75915	312 001
F1	2110-0043	8	1	FUSE (INCH) 1.5A 250V NTD FE UL (100/120 VAC OPERATION)	11870	04.015
FL1	9135-0249	5	1	U-WAVE FILTER-LOWPASS 1.6 GHZ MAX	50140	8L120-X1600-0/0
	0515-0893	2	6	SCREW-MACH M3.5 X 0.6 10MM-LG PAN-HD (METRIC)	28480	0515-0893
FL2	0535-0007	2	17	NUT-HEX DBL-CHAM M3.5 X 0.6 3.3MM-THK	00000	ORDER BY DESCRIPTION
	9135-0174	5	17	FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL3	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL4	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL5	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL6	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL7	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL8	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL9	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL10	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL11	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL12	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL13	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL14	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL15	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL16	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL17	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL18	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	12168	FLT3/P/5500/REF1
FL19	9135-0040	4	1	U-WAVE FILTER 6.2 GHZ MAX	12598	F-3469
	1400-0024	9	1	CLMP-CA .25-DIA .5-WD NYL	85480	F6NY-250NA
	2200-0109	8	1	SCREW-MACH 4-40 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	3050-0105	6	1	WASHER-FL MTLCL NO. 4 .125-IN-ID	28480	3050-0105
J1	1250-0083	1	5	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM (NOISE SOURCE DRIVE)	24931	28JR130-1
	0360-1190	5	2	TERMINAL-SLDR LUG PL-MTG FOR-#3/8-SCR	79963	720-.380H
	2190-0016	3	5	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8	5	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
	0362-0227	1	2	CONNECTOR-SGL CONT SKT 1.14-MM-BSC-SZ	27264	02-05-5216
	8150-0477	2	1	WIRE 24AWG W/BR/G 300V PVC 7X32 80C	28480	8150-0477
8150-0701	5	1	WIRE 24AWG W/V/GY 300V PVC 7X32 80C	28480	8150-0701	
J2	08970-60023	8	1	CONNECTOR ASSEMBLY-INPUT	28480	08970-60023
	0515-1234	7	10	SCREW-MACH M3.5 X 0.6 8MM-LG (METRIC)	28480	0515-1234
J3	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM (REAR NOISE SOURCE DRIVE)	24931	28JR130-1
	0360-1190	5		TERMINAL-SLDR LUG PL-MTG FOR-#3/8-SCR	79963	720-.380H
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J4						
J5	1250-0083	1		NOT ASSIGNED		
	2190-0016	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM (X-AXIS)	24931	28JR130-1
	2950-0001	8		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
						ORDER BY DESCRIPTION

See introduction to this section for ordering information  
 \*Indicates factory selected value

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
J6	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM (Y-AXIS)	24931	28JR130-1
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J7	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM (Z-AXIS)	24931	28JR130-1
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-OBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J8			NSR; P/O W7 (IF)			
J9	1250-1032	2	1	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM (DET)	24931	28JR106-5
	0360-1158	5	1	TERMINAL-SLDR LUG PL-MTG .062-HOLE-ID	86928	5413-21
	2190-0068	5	1	WASHER-LK INTL T 1/2 IN .505-IN-ID	78189	1924-02
	2950-0054	1	1	NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
J10	1252-0224	6	2	CONN-RECT MICRORBN 24-CKT 24-CONT (HP-IB CONNECTOR; PART OF W10)	28480	1252-0224
J11	1252-0224	6		CONN-RECT MICRORBN 24-CKT 24-CONT (SIB CONNECTOR; PART OF W10)	28480	1252-0224
MP1	08970-20078	9	1	FRAME-FRONT MOD	28480	08970-20078
	0515-1234	7		SCREW-MACH M3.5 X 0.6 8MM-LG (METRIC)	28480	0515-1234
	0515-1331	5	16	SCREW-METRIC SPECIALTY M4 X 0.7 THD; 7MM (METRIC)	28480	0515-1331
MP2	08970-00065	2	1	REAR PANEL	28480	08970-00065
	0515-1331	5		SCREW-METRIC SPECIALTY M4 X 0.7 THD; 7MM (METRIC)	28480	0515-1331
MP3	5021-5836	1	1	CORNER STRUT	28480	5021-5836
	0515-1331	5		SCREW-METRIC SPECIALTY M4 X 0.7 THD; 7MM (METRIC)	28480	0515-1331
MP4	08970-00058	3	1	BRACKET RF SECTION-RIGHT	28480	08970-00058
	0515-0885	2	8	SCREW-MACH M4 X 0.7 8MM-LG PAN-HD (METRIC)	28480	0515-0885
MP5	08970-00059	4	1	BRACKET RF SECTION-LEFT	28480	08970-00059
	0515-0885	2		SCREW-MACH M4 X 0.7 8MM-LG PAN-HD (METRIC)	28480	0515-0885
MP6	08970-00055	0	1	STRUT-HINGE BRKT	28480	08970-00055
	0515-1331	5		SCREW-METRIC SPECIALTY M4 X 0.7 THD; 7MM (METRIC)	28480	0515-1331
MP7	5062-3734	0	1	COVER-TOP, 421.60	28480	5062-3734
	0510-0043	4	2	RETAINER-RING E-R EXT .141-IN-DIA STL	54963	1500-14-ZD
	0515-1245	0	2	SCREW-SPCL M3.5 X 0.6 12MM-LG (METRIC)	00000	ORDER BY DESCRIPTION
MP8	08970-00083	4	1	COVER BOTTOM	28480	08970-00083
	7120-8138	4	1	LABEL-WARNING 6-MM-WD 51-MM-LG VINYL	28480	7120-8138
	0515-1245	0		SCREW-SPCL M3.5 X 0.6 12MM-LG (METRIC)	00000	ORDER BY DESCRIPTION
	0510-0043	4		RETAINER-RING E-R EXT .141-IN-DIA STL	54963	1500-14-ZD
MP9	5062-3779	3	1	COVER (SIDE) W/ RECESS	28480	5062-3779
MP10	5062-3836	3	1	COVER (SIDE) PERFORATED	28480	5062-3836
MP11	5062-3703	3	2	STRAP-HANDLE ASSEMBLY (15")	28480	5062-3703
MP12	5041-8819	8	2	HANDLE-CAP (FRONT)	28480	5041-8819
	0515-1132	4	4	SCREW-MACH M5 X 0.8 10MM-LG (METRIC)	28480	0515-1132
MP13	5041-8820	1	2	HANDLE-CAP (REAR)	28480	5041-8820
	0515-1132	4		SCREW-MACH M5 X 0.8 10MM-LG (METRIC)	28480	0515-1132
MP14	5001-0539	9	2	TRIM SIDE (FRONT FRAME)	28480	5001-0539
MP15	5041-8802	9	1	TRIM-SIDE (TOP)	28480	5041-8802
MP16	1460-1345	5	1	TILT STAND SST	28480	1460-1345
MP17	5040-7201	8	1	FOOT-FULL 1/2 MOD.	28480	5040-7201
MP18	08970-00006	1	1	COVER RF SECTION (TOP)	28480	08970-00006
	0515-0887	4	34	SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD (METRIC)	00000	ORDER BY DESCRIPTION
MP19	1460-1901	9	1	WIREFORM 388-MM-W STL ZN	28480	1460-1901
MP20	1460-0107	5	1	SPRING-CPRSN .335-IN-OD 1-IN-OD-LG MUW	28480	1460-0107
MP21	08970-20072	3	1	CASTING-MACH (RECOMMENDED REPLACEMENT FOR 08970-20053.)	28480	08970-20072
MP22	08970-80025	2	1	CARDS-INFORMATION (PULLOUT) (THE CARDS ARE NOT AVAILABLE INDIVIDUALLY. THEY MUST BE PURCHASED AS A SET.)	28480	08970-80025

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
MP23- MP29 MP30	08970-00068	5		2	NOT ASSIGNED		
	0535-0007	2		1	PANEL FRONT	28480	08970-00068
	2190-0585	1	11	11	NUT-HEX DBL-CHAM M3.5 X 0.6 3.3MM-THK	00000	ORDER BY DESCRIPTION
	3050-0003	3	11	11	WASHER-LK HLCL 3.5 MM 3.6-MM-ID	28480	2190-0585
					WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD	73734	1471
MP31	08970-00067	4		1	WINDOW PANEL	28480	08970-00067
MP32	0510-1148	2	15	15	RETAINER-PUSH-ON KB-TO-SHFT EXT	78553	C4154-017-27
MP33					NOT ASSIGNED		
MP34	08970-00066	3		1	SPACER PANEL (SMALL)	28480	08970-00066
MP35	08970-00017	4		1	SPACER-PANEL (LARGE)	28480	08970-00017
MP36	5040-6889	6		4	LIGHT PIPE (19MM)	28480	5040-6889
MP37	5040-6888	5		3	LIGHT PIPE (12MM)	28480	5040-6888
MP38	08970-00016	3		1	PANEL-LIGHT PIPE	28480	08970-00016
	0510-1148	2		2	RETAINER-PUSH-ON KB-TO-SHFT EXT	78553	C4154-017-27
MP39	08970-00071	0		1	BRACKET-FRONT PANEL	28480	08970-00071
	0510-1148	2		2	RETAINER-PUSH-ON KB-TO-SHFT EXT	78553	C4154-017-27
MP40					NOT ASSIGNED		
MP41	5041-1682	9		1	KEY CAP (LINE SWITCH)	28480	5041-1682
MP42- MP44					NOT ASSIGNED		
MP45	08970-20070	1		1	WINDOW-FRONT	28480	08970-20070
MP46- MP49 MP50					NOT ASSIGNED		
	4040-1890	8		1	RETAINER, FILTER 3.803-IN-WD	28480	4040-1890
	0515-0886	3		9	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD (METRIC)	00000	ORDER BY DESCRIPTION
MP51					NOT ASSIGNED		
MP52	3160-0300	6		1	FINGER GUARD	F0794	9901-43N
	0515-0252	7		2	SCREW-MACH M3 X 0.5 40MM-LG PAN-HD (METRIC)	28480	0515-0252
	2190-0584	0		0	WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
	3050-0891	7		2	WASHER-FL HTLC 3.0 MM 3.3-MM-ID	28480	3050-0891
	0380-1361	4		2	STANDOFF-HEX 10-MM-LG M3.0 X 0.5-THD	28480	0380-1361
MP53					NOT ASSIGNED		
MP54	3150-0405	1		1	FILTER-AIR POLYU	28480	3150-0405
MP55	7100-1283	4		1	TRANSFORMER COVER .88-IN-DP	08452	C08865
MP56	08970-00040	3		1	SHIELD-POWER LINE	28480	08970-00040
	0515-0886	3		3	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD (METRIC)	00000	ORDER BY DESCRIPTION
	7120-3738	0		1	LABEL-WARNING .62-IN-WD 1-IN-LG AL	28480	7120-3738
MP57	6960-0133	2		1	PLUG-HOLE TR-HD FOR .438-D-HOLE BRS	57771	D-2783
MP58					NOT ASSIGNED		
MP59					NOT ASSIGNED		
MP60	5041-8821	2		4	STANDOFF-REAR PANEL	28480	5041-8821
	0515-1232	5		4	SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD (METRIC)	28480	0515-1232
MP61- MP70 MP71 (2745A AND BELOW) (2812A AND ABOVE)					NOT ASSIGNED		
	08970-00079	8		1	RF SECTION COVER (BOTTOM)	28480	08970-00079
	08970-00082	3		1	RF SECTION COVER (BOTTOM)	28480	08970-00082
	0515-0887	4		4	SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD (METRIC)	00000	ORDER BY DESCRIPTION
MP72	1600-1107	5		1	STAMPING-AL RF COVER-INTERNAL	28480	1600-1107
MP73	1600-1111	1		1	STAMPING-AL RF COVER-INTERNAL	28480	1600-1111
MP74	1600-1106	4		1	STAMPING-AL RF COVER-INTERNAL	28480	1600-1106
MP75	1600-1105	3		1	STAMPING-AL RF COVER-INTERNAL	28480	1600-1105
MP76	1600-1113	3		1	STAMPING-AL RF COVER-INTERNAL	28480	1600-1113
MP77	1600-1108	6		2	STAMPING-AL RF COVER-INTERNAL	28480	1600-1108
MP78	1600-1109	7		1	STAMPING-AL RF COVER-INTERNAL	28480	1600-1109
MP79	1600-1110	0		1	STAMPING-AL RF COVER-INTERNAL	28480	1600-1110
MP80	1600-1114	4		1	STAMPING-AL COVER-INTERNAL	28480	1600-1114
MP81	08970-00008	3		1	COVER-INPUT ASSEMBLY	28480	08970-00008
	0515-0887	4		4	SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD (METRIC)	00000	ORDER BY DESCRIPTION

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C	D	Qty	Description	Mfr Code	Mfr Part Number
MP82	1600-1112	2		1	STAMPING-AL RF COVER-INTERNAL	28480	1600-1112
MP83	1600-1108	6			STAMPING-AL RF COVER-INTERNAL	28480	1600-1108
MP84	08970-00077	6		1	ISOLATOR SUPPORT	28480	08970-00077
MP85	08970-00075	4		1	BRACKET-HINGE (FRONT)	28480	08970-00075
	0515-1234	7			SCREW-MACH M3.5 X 0.6 8MM-LG (METRIC: USED TO ATTACH MP85 TO THE FRONT FRAME. NOT PART OF MP85.)	28480	0515-1234
MP86	08970-00013	0		1	BRACKET-HINGE (REAR)	28480	08970-00013
	0515-0886	3			SCREW-MACH M3 X 0.5 6MM-LG PAN-HD (METRIC)	00000	ORDER BY DESCRIPTION
MP87					NOT ASSIGNED		
MP88	08970-00021	0		1	SECOND CONVERTER BRACKET	28480	08970-00021
MP89	08970-00078	7		1	SECOND CONVERTER ISOLATOR BRACKET	28480	08970-00078
MP90	0400-0201	3		1	GROMMET-RND .25-IN-ID .438-IN-GRV-OD	76385	Z-206
MP91	1400-0017	0		1	CLMP-CA .312-DIA .375-WD NYL (FOR S1)	28520	3310 RED
	0515-0893	2			SCREW-MACH M3.5 X 0.6 10MM-LG PAN-HD (METRIC)	28480	0515-0893
	3050-0892	8		4	WASHER-FL HTLC 3.5 MM 3.8-MM-ID	28480	3050-0892
	0535-0007	2			NUT-HEX DBL-CHAM M3.5 X 0.6 3.3MM-THK	00000	ORDER BY DESCRIPTION
MP92	1400-0025	0		2	CLMP-CA .5-DIA .5-WD NYL (FOR FL1)	85480	F8NY-500-NA
	0515-0893	2			SCREW-MACH M3.5 X 0.6 10MM-LG PAN-HD (METRIC)	28480	0515-0893
	3050-0892	8			WASHER-FL HTLC 3.5 MM 3.8-MM-ID	28480	3050-0892
	0535-0007	2			NUT-HEX DBL-CHAM M3.5 X 0.6 3.3MM-THK	00000	ORDER BY DESCRIPTION
P1	1252-2592	5		3	CONN-POST-TP-BDY (TO A13J5)	28480	1252-2592
	1251-4182	1		13	CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6		13	KEYING PLUG-POST CONN	18873	65307-001
P2	1252-2592	5		5	CONN-POST-TP-BDY (TO A17J1)	28480	1252-2592
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001
P3	1252-2163	6		2	CONN-POST-TP-BDY (TO A13J3)	28480	1252-2163
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001
P4	1252-3178	5		4	CONN-POST TYPE .100-PIN-SPCG 7-CONT (TO A13J4)	28480	1252-3178
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001
P5	1252-2163	6			CONN-POST-TP-BDY (TO A1J2)	28480	1252-2163
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001
P6	1252-2989	4		1	CONN-POST TYPE .100-PIN-SPCG 9-CONT (TO A2J1)	28480	1252-2989
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001
P7	1252-3178	5			CONN-POST TYPE .100-PIN-SPCG 7-CONT (TO A14J3)	28480	1252-3178
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001
P8	1252-2592	5			CONN-POST TYPE .100-PIN-SPCG 8-CONT (TO A14J5)	28480	1252-2592
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001
P9	1252-2613	1		1	CONN-POST-TP-BDY (TO A14J2)	28480	1252-2613
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001
P10	1252-3178	5			CONN-POST TYPE .100-PIN-SPCG 7-CONT (TO A14J4)	28480	1252-3178
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001
P11	1252-3178	5			CONN-POST TYPE .100-PIN-SPCG 7-CONT (TO A13J1)	28480	1252-3178
	1251-4182	1			CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	18873	47565
	1251-3808	6			KEYING PLUG-POST CONN	18873	65307-001

See introduction to this section for ordering information  
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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
P12	1251-4491	5	1	CONN-POST TYPE .100-PIN-SPCG 13-CONT (TO A9J2)	28480	1251-4491
P13	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ KEYING PLUG-POST CONN	18873	47565
	1251-3808	6			18873	65307-001
	1251-5207	3	1	CONN-POST TYPE .100-PIN-SPCG 16-CONT (TO A9J3)	28480	1251-5207
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ KEYING PLUG-POST CONN	18873	47565
	1251-3808	6			18873	65307-001
S1	08970-60170	6	1	LINE SWITCH ASSEMBLY (INCLUDES C4 AND W11. DOES NOT INCLUDE A15 OR C3.)	28480	08970-60170
S2	3103-0094	5	1	SWITCH-THRM FXD +193F 15A OPN-ON-RISE CONTACT-CONN U/W-UTIL FEM CRP	14604	3455-RBV-117-204
	1251-2411	5	1		27264	02-06-1101
	1251-7016	6	1	CONNECTOR-SGL CONT M-SNAP RND	27264	03-06-2011
	0362-0265	7	1	CONNECTOR-SGL CONT SKT 1.14-MM-BSC-SZ	27264	02-05-5204
	0515-0886	3		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD (METRIC; NOT PART OF S2. USED TO MOUNT S2 TO THE HEAT SINK ON THE POWER SUPPLY (A9).)	00000	ORDER BY DESCRIPTION
T1	9100-2640	1	1	XFMR-PWR 100/120/220/240V	28480	9100-2640
	0515-1163	1	4	SCREW-MACH M5 X 0.8 45MM-LG PAN-HD (METRIC)	28480	0515-1163
	2190-0587	3	4	WASHER-LK HLCL 5.0 MM 5.1-MM-ID	28480	2190-0587
	0535-0005	0	4	NUT-HEX DBL-CHAM M5 X 0.8 5.1MM-THK	00000	ORDER BY DESCRIPTION
VR1	1902-0943	5	1	DIODE-ZNR 2.4V 5% DO-35 PD=.4W TC=-.037%	28480	1902-0943
W1	08970-20064	3	1	CABLE ASSEMBLY-SEMI-RIGID (J2 TO FL1)	28480	08970-20064
W2	08970-20066	5	1	CABLE ASSEMBLY-SEMI-RIGID (FL1 TO A6)	28480	08970-20066
W3	08970-20062	1	1	CABLE ASSEMBLY-SEMI-RIGID (A6 TO A10)	28480	08970-20062
W4 (2745A AND BELOW) (2812A AND ABOVE)	08970-20036	9	1	CABLE ASSEMBLY-SEMI-RIGID (A10 TO AT1) NOT ASSIGNED	28480	08970-20036
W5	08970-20038	1	1	CABLE ASSEMBLY-SEMI-RIGID (AT1 TO A11)	28480	08970-20038
W6	08970-20037	0	1	CABLE ASSEMBLY-SEMI-RIGID (A11 TO A4)	28480	08970-20037
W7	08970-60058	9	1	CABLE ASSEMBLY (A8 TO J8; INCLUDES J8)	28480	08970-60058
W8	2950-0035	8	1	NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
	08970-20039	2	1	CABLE ASSEMBLY-SEMI-RIGID (G1 TO A10)	28480	08970-20039
W9				NOT ASSIGNED		
W10	08970-60066	9	1	CABLE ASSEMBLY (HP-IB AND SIB; INCLUDES J10 AND J11)	28480	08970-60066
	0380-1864	2	4	STANDOFF-HEX 14-MM-LG M3.5 X 0.6-THD	05791	LT-4278
	08970-00074	3	1	NUT PLATE	28480	08970-00074
	2190-0034	5	4	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
W11				NSR; PART OF S1		
W12				NOT ASSIGNED		
W13				NOT ASSIGNED		
W14	8120-1378	1	1	POWER CORD SET 18-AWG 3-COND 90-IN-LG WIRE - 22 AWG (A4 TO A3)	11383	PS-204-625
W15						
W16				WIRE - 22 AWG (A3 TO A8)		
W17 (2812A AND ABOVE) (2745A AND BELOW)	08970-20076	7	1	CABLE ASSEMBLY-SEMI-RIGID (FL19 TO AT1) NOT ASSIGNED	28480	08970-20076
W18 (2812A AND ABOVE) (2745A AND BELOW)	08970-20077	8	1	CABLE ASSEMBLY-SEMI-RIGID (A10 TO FL19) NOT ASSIGNED	28480	08970-20077

See introduction to this section for ordering information  
\*Indicates factory selected value

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Table 6-4. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address	Zip Code
D8439	ROEDERSTEIN/RESISTA GMBH	LANDSHUT GM	8300
F0794	ETRI/ETUDES TECH ET REPRESENTATIONS	NEUILLY/SEINE FR	92
K5569	SALTERFIX LTD	WEST MIDLANDS EG	
K8479	HOLSWORTHY ELECTRONICS LTD	HOLSWORTHY EG	
S0562	TOSHIBA CORP	TOKYO JP	
S4013	HITACHI AMERICA LTD	SUNNYVALE CA US	94086
00000	ANY SATISFACTORY SUPPLIER		
00613	USM CORP MOLLY FASTENER DIV	TEMPLE PA	19560
00779	AMP INC	HARRISBURG PA US	17111
01121	ALLEN-BRADLEY CO INC	EL PASO TX US	79935
01295	TEXAS INSTRUMENTS INC	DALLAS TX US	75265
02114	FERROXCUBE CORP	SAUGERTIES NY US	12477
02768	ITW FASTEX	DES PLAINES IL US	60016
04072	BELL INDUSTRIES INC MILLER JW DIV	COMPTON CA	90224
04222	AVX CORP	GREAT NECK NY US	11021
04713	MOTOROLA INC	ROSELLE IL US	60195
05245	CORCOM INC	LIBERTYVILLE IL US	60048
05791	LYN-TRON INC	BURBANK CA US	91505
05876	U S POLYMERIC INC	STAMFORD CT	06904
06383	PANDUIT CORP	TINLEY PARK IL US	60477
06665	PRECISION MONOLITHICS INC	SANTA CLARA CA US	95054
07263	FAIRCHILD SEMICONDUCTOR CORP	CUPERTINO CA US	95014
07282	FAIRCHILD IND INC IND PROD DIV	WINSTON-SALEM NC	27105
07679	HARDWARE SPECIALTIES CO INC	LG ISLAND CITY NY	11101
07933	RAYTHEON CO SEMICONDUCTOR DIV HQ	MOUNTAIN VIEW CA	94040
08452	WESTINGHOUSE ELEC CORP WELDING EQPT	SYKESVILLE MD	21784
08712	BROOKS INSTR DIV EMERSON ELECTRIC	STATESBORO GA	30458
09464	DRYCO MFG CO INC	CHICAGO IL	60612
09535	JOHNSON MATTHEY AND MALLORY LTD	TORONTO CN	
09553	MARCONI INSTR DIV ENGLISH ELEC CORP	ENGLEWOOD NJ	07631
09969	DALE ELECTRONICS INC	YANKTON SD US	57078
1B546	VARO INC	GARLAND TX US	75046
10899	EASTERN AIR DEVICES INC	GREAT NECK NY	11021
11236	CTS CORP	ELKHART IN US	46514
11383	AMETEK/ALUMINUM EXTRUSION	LOS ANGELES CA	90065
11502	IRC INC	BOONE NC US	28607
11532	TELEDYNE INDUSTRIES INC	LOS ANGELES CA US	90067
11870	MELABS INC	PALO ALTO CA	94304
12168	NIBCO INC	ELKHART IN	46514
12360	ALBANY PROD CO DIV OF PNEUMO DYN	NORWALK CT	06850
12403	CANFIELD H O CO OF INDIANA INC THE	SEYMOUR IN	47274
12474	BEL-RAY CO INC	FARMINGDALE NJ	07727
12498	CRYSTALONICS, DIV TELEDYNE	CAMBRIDGE MA	02140
12598	RLC ELECTRONICS INS	MT KISCO NY US	10549
12666	CANN DIV VENTRON INSTRUMENTS CORP	PARAMOUNT CA	90273
12703	JUDD WIRE	TURNERS FALLS MA	01376
13103	THERMALLOY INC	DALLAS TX US	75234
14604	ELMWOOD SENSORS INC	PAWTUCKET RI US	02861
15542	MINI-CIRCUITS LAB	BROOKLYN NY US	11235
15801	FENWAL ELECTRONICS INC	SADDLE BROOK NJ US	07862
16179	M/A-COM INC	BURLINGTON MA US	01803
16453	WESTERN MICROWAVE INC	SUNNYVALE CA US	94089
17856	SILICONIX INC	SANTA CLARA CA US	95054
18612	VISHAY INTERTECHNOLOGY INC	MALVERN PA US	19355
18873	DUPONT E I DE NEMOURS & CO	WILMINGTON DE US	19801
19701	MEPCO/CENTRALAB INC	RIVIERA FL US	33404
21627	ROHM CORP	IRVINE CA US	92713
23050	PRODUCT COMPONENT CORP	MT VERNON NY	10553
24355	ANALOG DEVICES INC	NORWOOD MA US	02062
24931	SPECIALTY CONNECTOR CO	FRANKLIN IN US	46131
25403	NV PHILIPS ELCOMA	EINDHOVEN NE	02876
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA US	95052
27264	MOLEX INC	LISLE IL US	60532
27735	F-DYNE ELECTRONICS CO	BRIDGEPORT CT	06605
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
28520	HEYCO MOLDED PRODUCTS	KENTWORTH NJ US	07033
30161	AAVID ENGINEERING INC	LACONIA NH US	03247
32997	BOURNS INC	RIVERSIDE CA US	92507
34335	ADVANCED MICRO DEVICES INC	SUNNYVALE CA US	94086
34649	INTEL CORP	SANTA CLARA CA US	95054
46384	PENN ENGINEERING & MFG CORP	DOYLESTOWN PA US	18901

Table 6-4. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address	Zip Code
50140	K & L MICROWAVE	SALISBURY MD US	21801
51506	ACCURATE SCREW MACHINE CO	MONTVALE NJ	07645
54963	ANDERTON DARBY INC	CLIFTON NJ	07015
55322	SAMTEC	NEW ALBANY IN	47150
56289	SPRAGUE ELECTRIC CO	LEXINGTON MA US	02173
57771	STIMPSON EDWIN B CO INC	BROOKLYN NY	11705
71468	ITT CORP	NEW YORK NY US	10022
71744	GENERAL INSTRUMENT CORP	CLIFTON NJ US	07012
73138	BECKMAN INDUSTRIAL CORP	FULLERTON CA US	92635
73734	FEDERAL SCREW PRODUCTS CO	CHICAGO IL	60618
74970	EF JOHNSON CO	WASECA MN US	56093
75915	LITTELFUSE INC	DES PLAINES IL US	60016
76381	3M CO	ST PAUL MN US	55144
76385	MINOR RUBBER CO INC	BLOOMFIELD NJ	07003
76530	MONADNOCK CO, THE	CITY OF IND CA	91747
77147	PATTON-MACGUYER CO DIV OF AVID CORP	PROVIDENCE RI	02905
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF	ELGIN IL	60126
78553	TINNERMAN PRODUCTS INC	CLEVELAND OH	44101
79963	ZIERICK MFG CO	MT KISCO NY	10549
80120	SCHNITZER ALLOY PRODUCTS CO	ELIZABETH NJ	07206
84411	AMERICAN SHIZUKI CORP	CANOGA PARK CA US	91304
85480	BRADY W H CO	MILWAUKEE WI	53209
86928	SEASTROM MFG CO	GLENDALE CA	91201
9N171	UNITRODE CORP	LEXINGTON MA US	02173
9N283	WORKSAFE INC	NEW YORK NY	10001
91506	AUGAT INC	MANSFIELD MA US	02048
91637	DALE ELECTRONICS INC	COLUMBUS ME US	68601
91833	KEYSTONE ELECTRONICS CORP	NEW YORK NY	10012
98291	SEAELECTRO CORP	TRUMBULL CT US	06611
98978	INTL ELECTRONIC RESEARCH CORP	BURBANK CA US	91502

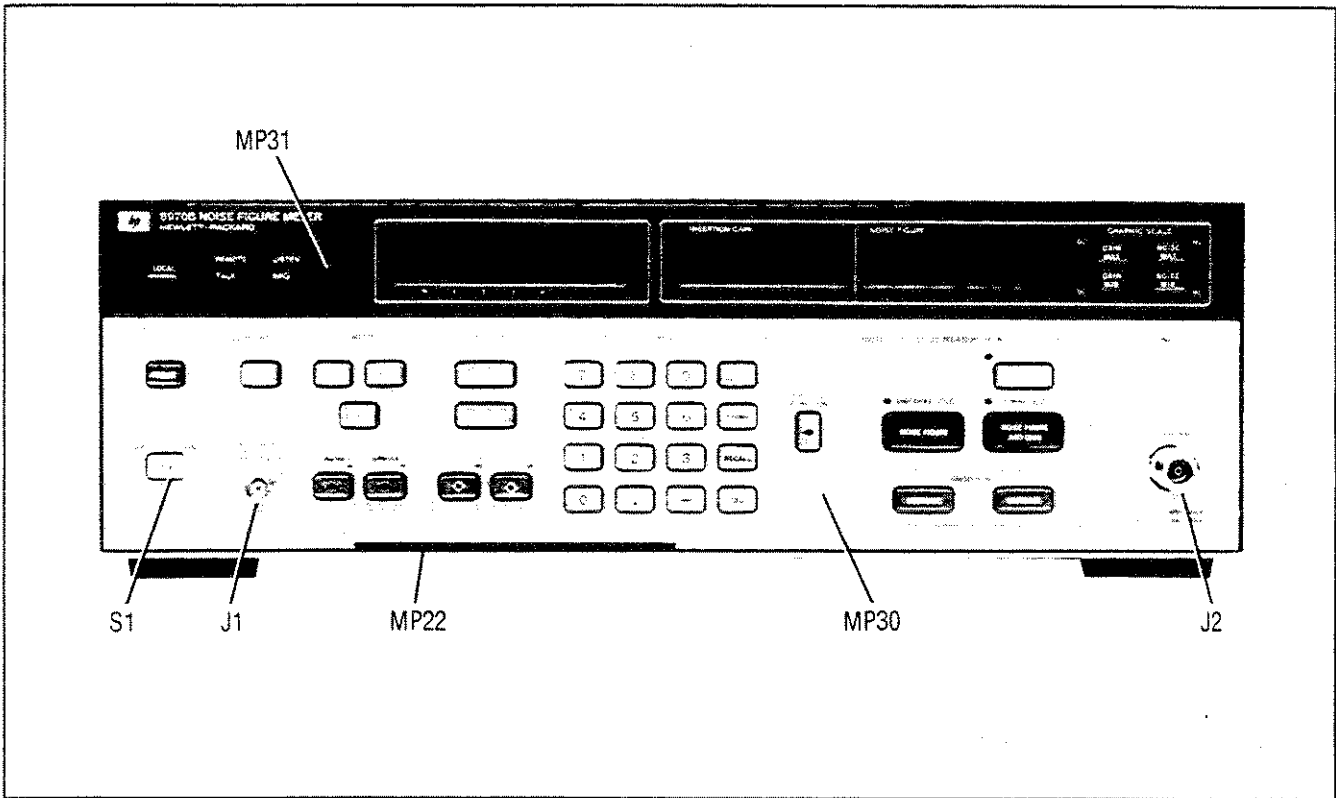


Figure 6-1. Chassis and Mechanical Parts Identification — Front Panel

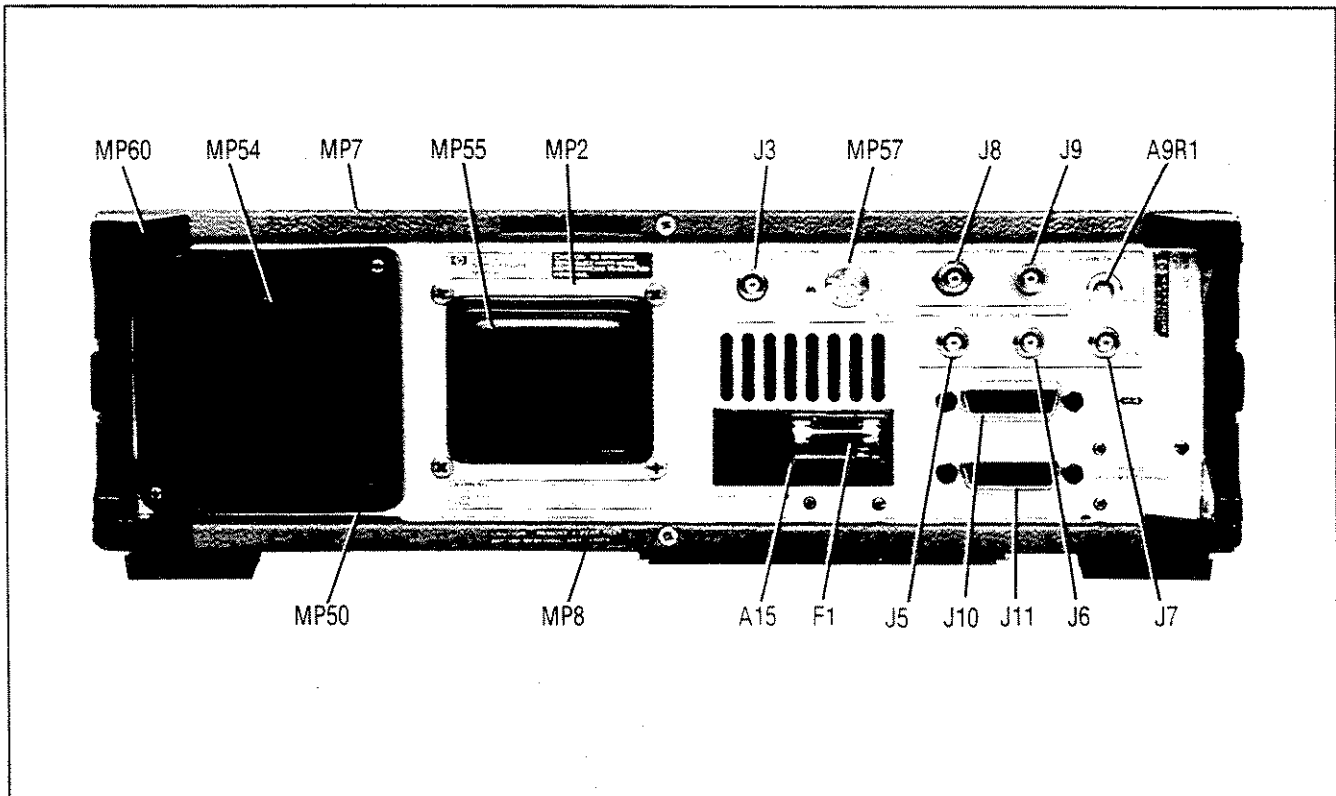


Figure 6-2. Chassis and Mechanical Parts Identification — Rear Panel

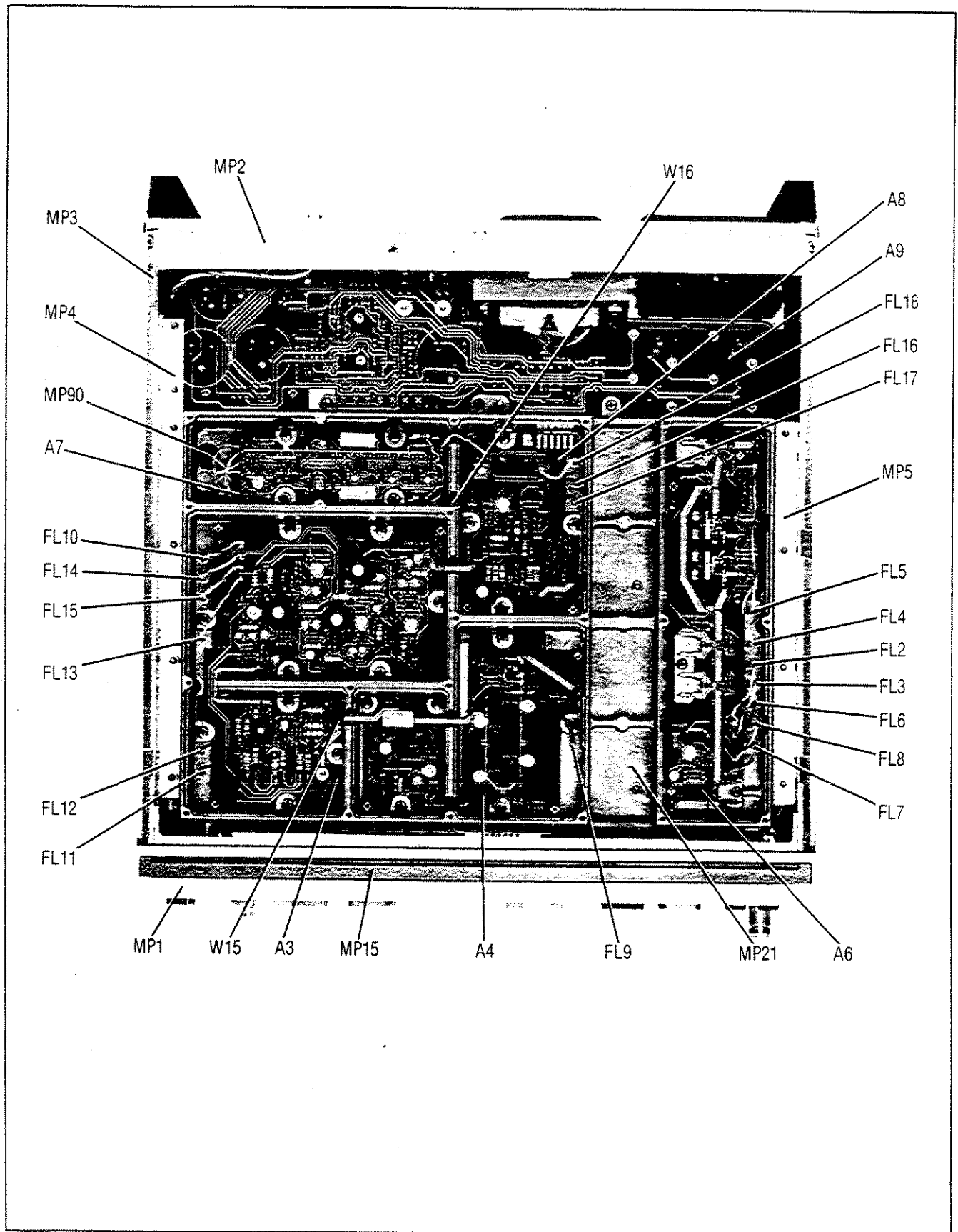


Figure 6-3. Top Chassis Parts, Mechanical Parts and Cable Identification (with RF Covers Removed)

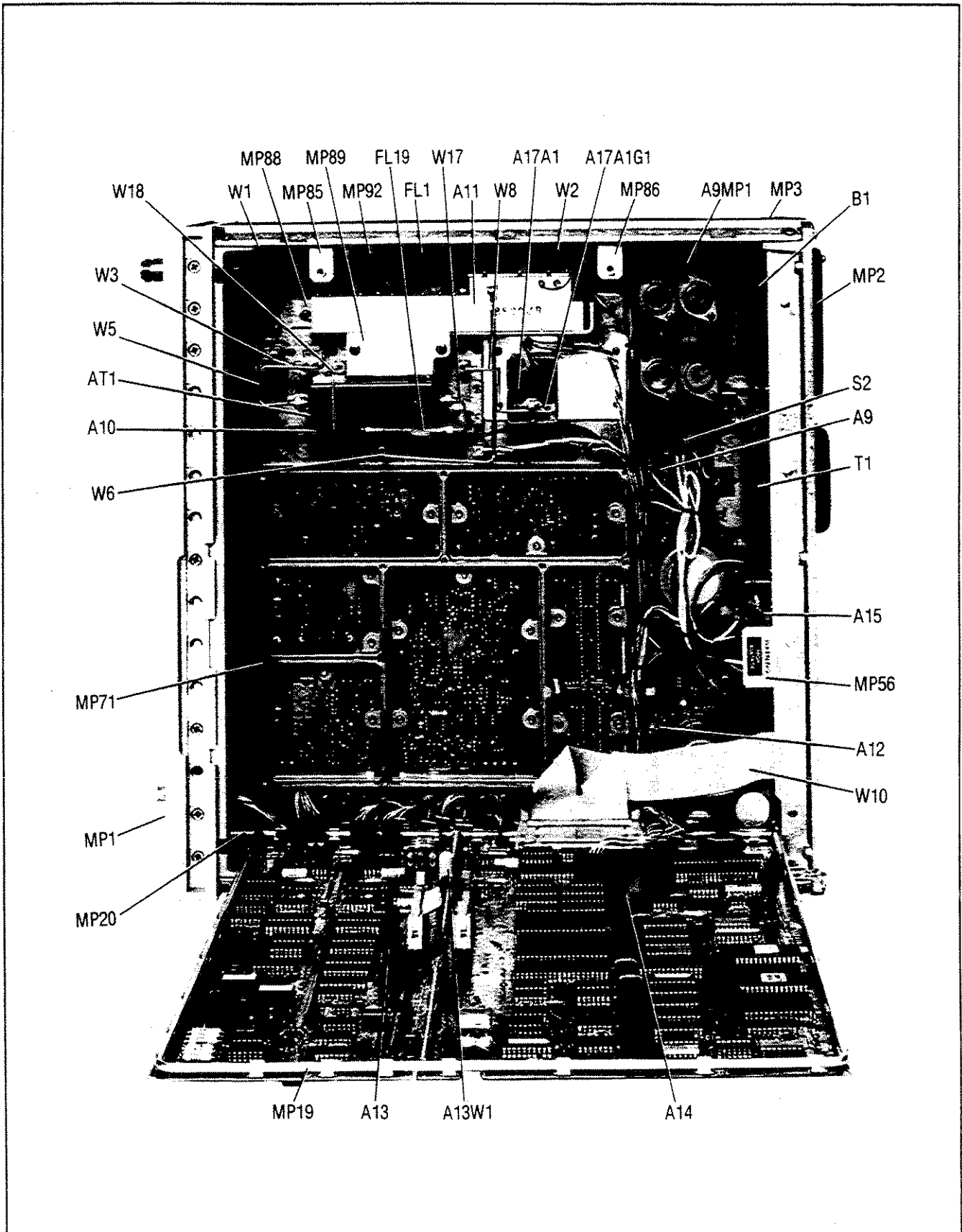


Figure 6-4. Bottom Chassis Parts, Mechanical Parts and Cable Identification (Serial Prefix 2812A and Above)

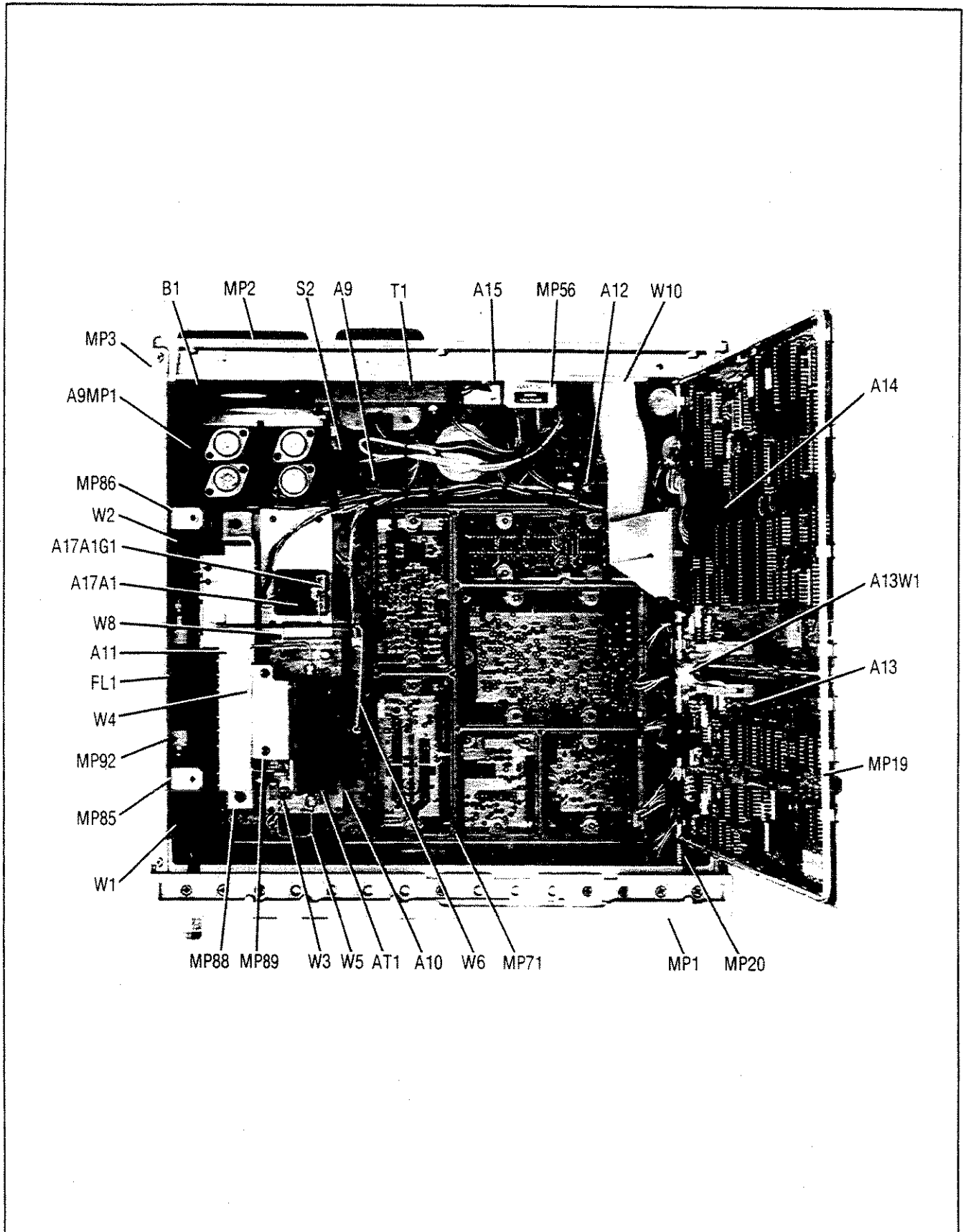


Figure 6-4. Bottom Chassis Parts, Mechanical Parts and Cable Identification (Serial Prefix 2745A and Below)

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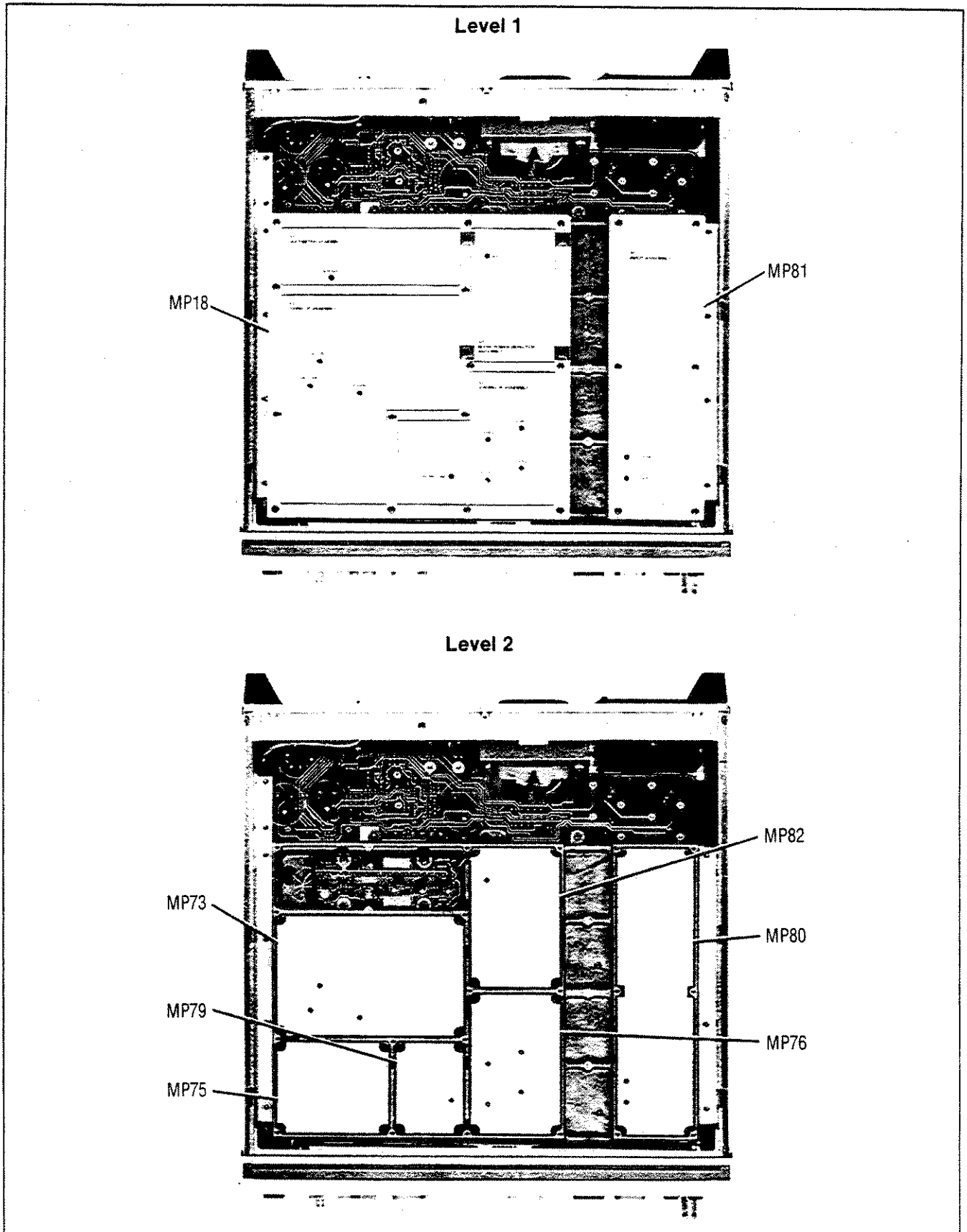


Figure 6-5. Top Internal RF Covers Identification

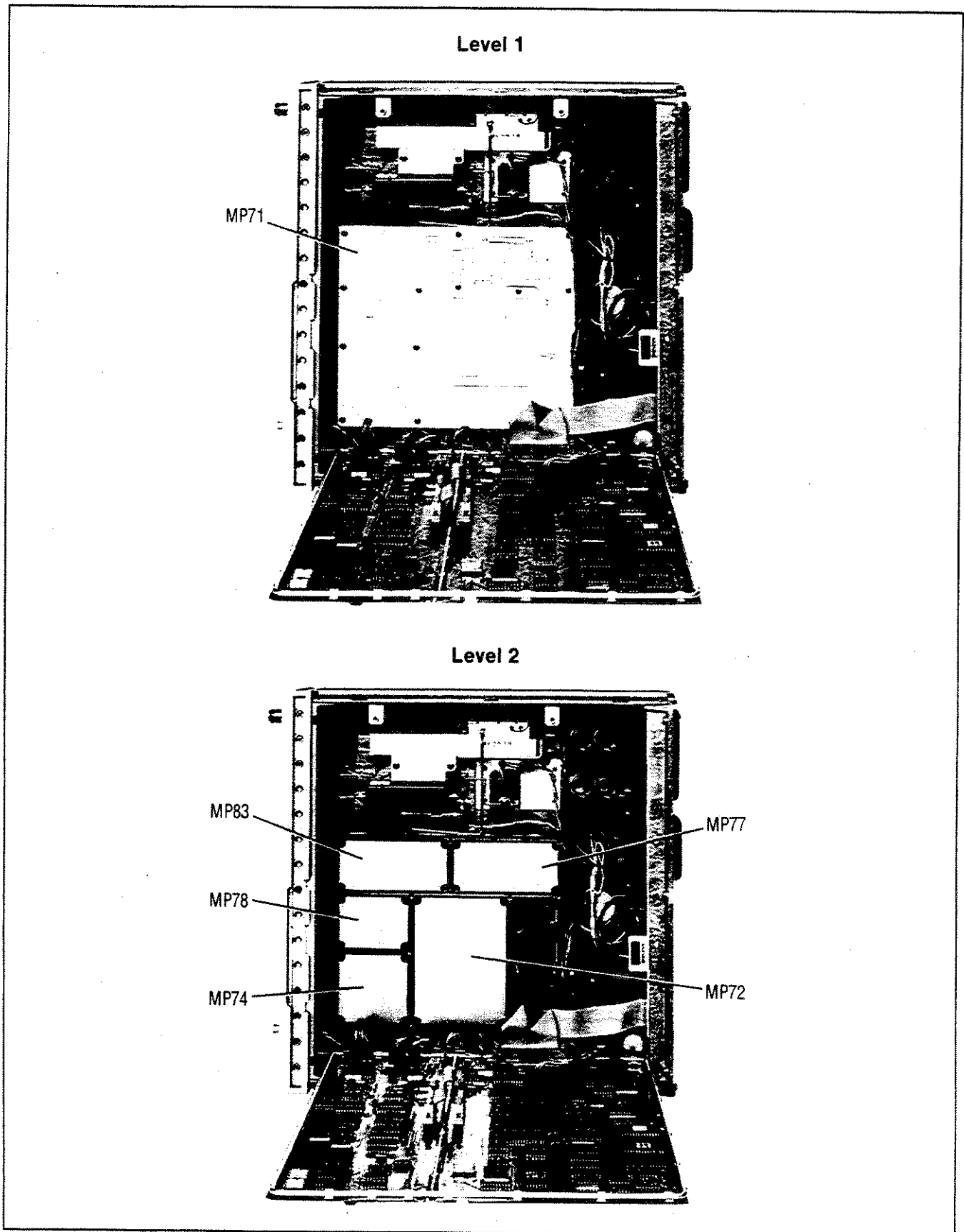


Figure 6-6. Bottom Internal RF Covers Identification (Serial Prefix 2812A and Above)

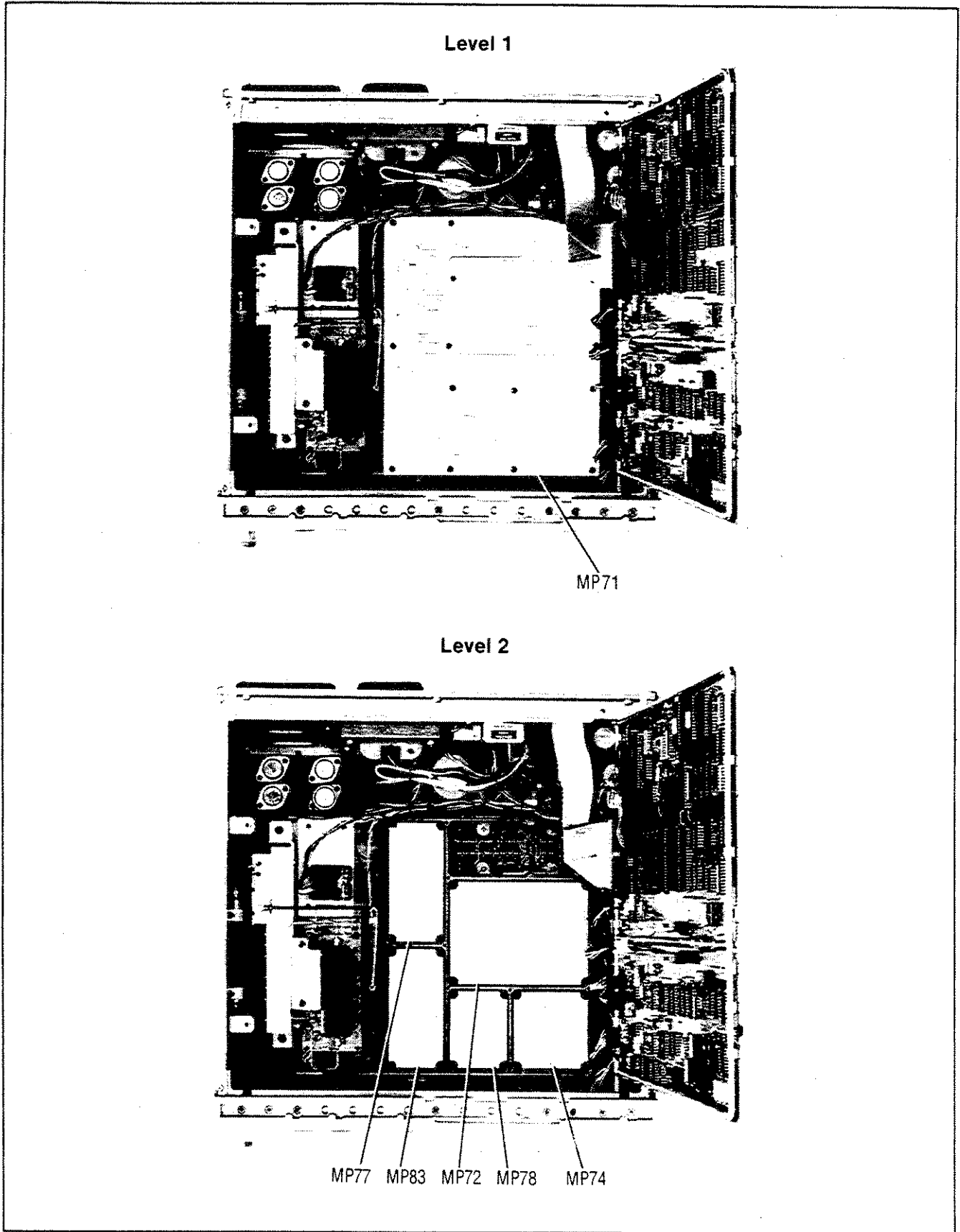


Figure 6-6. Bottom Internal RF Covers Identification (Serial Prefix 2745A and Below)

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## SECTION VII MANUAL CHANGES

This section normally contains information for adapting this manual to instruments for which the content does not apply directly. Because this

manual does apply directly to instruments having serial numbers listed on the title page, no change information is given here.



Discard pages 7-3 and 7-4.

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## SECTION VIII SERVICE

### 8-1. INTRODUCTION

This section contains information for troubleshooting and repairing the Noise Figure Meter. Included are block diagrams, schematic diagrams, principles of operation, and procedures for troubleshooting, repair, disassembly, and reassembly.

### 8-2. FAILURE MODES AND SERVICE STRATEGY

#### 8-3. General

Instrument problems usually fall into four general categories: turn-on errors, operator errors, instrument performance out of specification, and catastrophic failures. The troubleshooting strategy is different for each category.

#### 8-4. Turn-on Errors

An error message displayed on the front panel when the Noise Figure Meter is turned on, indicates that the built-in diagnostic routine has detected an error. Turn the instrument off, and then on again. If the error repeats, go to Service Sheet BD1, Check 11, to begin troubleshooting.

#### 8-5. Operator Errors

Apparent failures often result from operator errors and may take many forms. Refer to Error Message and Recovery, Section III of the Operating Manual, the Pullout Card, and Service Sheet BD1, Check 11, for additional information on these errors.

#### 8-6. Instrument Performance Out of Specification.

Specifications are listed in Table 1-1. For a complete test, perform the Performance Tests in Section IV of the Operating Manual. If a parameter is only slightly out of limits, it can often be brought into specification by an adjustment. The procedures for all adjustments are in Section V of this manual. If the adjustment fails to bring the parameter into specification, use the troubleshooting procedures starting on BD1.

#### 8-7. Catastrophic Failures

When a catastrophic failure occurs, begin troubleshooting on Service Sheet BD1. The information there is used to quickly isolate the problem to one

of the major functional sections of the instrument. Troubleshooting catastrophic failures in the Noise Figure Meter is structured into three levels:

a. The overall troubleshooting level, where problems are isolated to the power supply or one of the functional sections. This level of troubleshooting is supported by Service Sheet BD1, which includes diagrams, theory of operation, and troubleshooting information.

b. The functional section of troubleshooting isolates the malfunction to the circuit level. This level of troubleshooting is supported by Service Sheets BD2 through BD5, which includes diagrams, theory of operation, and troubleshooting information.

c. Circuit level troubleshooting isolates the problem to a stage within the circuits shown on the schematic. This level of troubleshooting is supported by Service Sheets 1—10, 14, 15, and 18 which include circuit level block diagrams, schematics, theory of operation, and troubleshooting information. It is expected that further troubleshooting, to the component level, depends on the skill and experience of the troubleshooter. Circuit level troubleshooting is not supplied for Service Sheets 11—13, 16, and 17. These service sheets document the A14 Controller Assembly. Troubleshooting for the A14 Assembly is supplied on Service Sheets BD4 and BD5. The service strategy for the A14 Assembly is board exchange. However, some component level troubleshooting is supplied on Service Sheets BD4 and BD5.

### 8-8. SERVICE SHEETS

The foldout pages in the last part of this section are the service sheets. They consist of block diagrams, circuit schematic diagrams, supplemental diagrams, theory of operation, and troubleshooting information.

### 8-9. MANUAL BACKDATING (†)

A dagger (†) by an item of service information means that the information is different for instruments with serial number prefixes lower than the one shown on the manual's title page. Table 7-1, Manual Changes by Serial Number lists the back-

## MANUAL BACKDATING (†) (cont'd)

dating changes and their related serial number prefixes. The manual changes are contained in Section VII of this manual.

### 8-10. MANUAL UPDATING (Manual Changes Supplement)

Production changes to the instrument made after the publication date of this manual are indicated by a change in the serial number prefix. Changes to this manual are identified by serial number prefix on the Manual Changes supplement. Errors are also noted in the ERRATA portion of the Manual Changes supplement.

### 8-11. SAFETY CONSIDERATIONS

#### 8-12. Before Applying Power

Verify that the instrument is set to match the available line voltage and that the correct fuse is installed. An uninterrupted safety earth ground must be provided from the main power source to the instrument input wiring terminals, power cable, or supplied power cable set.

#### 8-13. Warnings and Cautions

Pay attention to WARNINGS and CAUTIONS. They must be followed for your protection and to avoid damage to the equipment.

#### WARNINGS

*Maintenance described herein is performed with power supplied to the instrument and with protective covers 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 supplied, the power should be removed.*

*Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one side of the power outlet is not sufficient*

*protection.) In addition, verify that a common ground exists between the unit under test and this instrument prior to energizing either unit.*

*Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.*

*If this instrument is to be energized via an autotransformer (for voltage reduction) ensure that the common terminal is connected to neutral (that is, the grounded side of the main supply).*

*Servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.*

*Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.*

*Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.*

*For continued protection against fire hazard, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example normal blow, time delay, etc.). Do not bypass fuses or circuit breakers.*

#### CAUTIONS

*Do not disconnect or remove any boards in the Noise Figure Meter unless the instrument is turned off or unplugged. Some boards contain devices that can be damaged if the board is removed when the power is on.*

*Several components, including MOS devices, can be damaged by electrostatic discharge. Use conductive foam and grounding straps when servicing is required on sensitive components. Use care when unplugging ICs from high-grip sockets.*

## **SAFETY CONSIDERATIONS (cont'd)**

### **8-14. After Service Safety Checks**

Visually inspect interior of instrument for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy the cause of any such condition.

Using a suitable ohmmeter, check resistance from instrument enclosure to ground pin on power cable plug. The reading must be less than one ohm. Flex the power cable while making this measurement to determine whether intermittent discontinuities exist.

Check any indicated front or rear panel ground terminals that are marked, using the above procedures.

Check resistance from instrument enclosure to line and neutral (tied together) with the power switch on and the power source disconnected. The minimum acceptable resistance is two megohms. Replace any component that results in a failure.

Check line fuse to verify that a correctly rated fuse is installed.

### **8-15. RECOMMENDED TEST EQUIPMENT**

Test equipment and accessories required to maintain the Noise Figure Meter are listed in Table 1-5, Recommended Test Equipment. Equipment other than that listed may be used if it meets the critical specifications listed in the table.

### **8-16. SPECIAL FUNCTIONS**

#### **8-17. General**

Special Functions extend user control of the instrument beyond that normally available from the front panel. They are for the operator who must reconfigure the instrument for a wide variety of measurements, and for the service technician who needs special control of the instrument functions. During normal use, the Noise Figure Meter safeguards itself against invalid measurements.

Safeguards come in the form of level setting, frequency calibration, and error messages. When Special Functions are used, some of these safeguards may be removed. Although there may be some risk of invalid measurements, there is no risk of damage to the instrument.

To enter a Special Function, enter the Special Function code (usually a prefix, decimal point, and suffix), then press the SPECIAL FUNCTION key. The Special Function code will appear in the left display as it is being entered. If a mistake is made during entry of the Special Function code, press FREQUENCY to clear the entry and start over. When a Special Function is entered, the light in the SPECIAL FUNCTION key will sometimes go on.

This indicates that there is some internal condition that may affect user interpretation of the measurement or data being displayed. The read-out on the display will depend on the Special Function being entered. The display may be a measured quantity, an instrument setting, or a special code. In some cases, the display remains unaltered. Special Functions can be entered from the HP-IB by issuing the Special Function code followed by the code SP.

Most Special Functions also have a two-character code that can be used over the HP-IB instead of the numerical code. The two-character codes are more compact, and are somewhat mnemonically representative of the function being selected. These two-character codes are given parenthetically after each Special Function code in the descriptions of the individual functions below.

The Special Functions are grouped by prefix range as follows:

**0: Initialize Special Functions.** This consists of two Special Functions that initialize selected other Special Functions. Special Function 0.0 is similar to pressing the front panel PRESET key, except that default conditions set by PRESET are not set. Special Function 0.9 sets default values for all special functions. Refer to Special Functions in the Detailed Operating Instructions of Section III for more information on these Special Functions. Also, refer to Table 3-14 in Section III.

**1-49: User Special Functions.** These are Special Functions which are used during normal operation when a special configuration, a special measurement, or special information is required. These Special Functions are summarized in the Special Function Detailed Operating Instruction in Section

## SPECIAL FUNCTIONS (cont'd)

III. Also, they are described in depth in the Detailed Operating Instructions which are organized alphabetically by the name of the function.

**50-59: Catalog Special Functions.** These are Special Functions that are used to display the status of the Special Function settings. A full description of this group of functions is given under Special Function Catalog in the Detailed Operating Instructions of Section III.

**60-79: Auxiliary Special Instructions.** These are Special Functions which are used by both operators and service technicians. These typically involve pre-empting the Noise Figure Meter autoranging ability. Some of these functions allow the user to display the RF and IF gain settings. Use of these functions is necessary when making noise figure measurements using liquid nitrogen cooled loads. A full description of functions in this group, except Special Function 63.N, is given in the Detailed Operating Instructions. Special Function 63.N is described below, since it is intended primarily for service use.

**80-99: Service Special Functions.** These are Special Functions used to assist in troubleshooting the Noise Figure Meter. The functions available are diverse — special internal measurements, software control, and special service tests and configurations. These Special Functions are described in more detail below.

### 8-18. Service Special Functions (Prefixes 63 and 80—99)

The Service Special Functions are used to perform a variety of tasks related to service. The functions are cataloged below. A suffix N indicates that a number, other than 0, may be required to complete the Special Function Code.

**63.N RF Relay Control.** This function provides independent control of the relays on the A6 Input Assembly. Each RF attenuator, or the 20 dB Amplifier, can be inserted into the RF path individually by selecting the proper Special Function suffix. The relays referred to below can be found on Service Sheet 1.

**N=0 (Z0) Select RF Through Path.** This function energizes A6K1, A6K4, and A6K5. A6K2 and A6K3 are left de-energized. The result is that all of the input attenuators, and the 20 dB Input Amplifier, are bypassed.

**N=1 (Z1) Select 10 dB Pad Number 1.** A6K1 is de-energized inserting 10 dB Pad Number 1 into the RF path. A6K2 and A6K3 are de-energized, and A6K4 and A6K5 are energized, bypassing the 20 dB Input Amplifier and the other 10 dB pads.

**N=2 (Z2) Select the 20 dB Input Amplifier.** A6K2 and A6K3 are energized, inserting the 20 dB RF Amplifier into the RF path. All of the other RF relays are also energized, removing all of the attenuators from the signal path.

**N=4 (Z4) Select 10 dB Pad Number 2.** A6K4 is de-energized inserting 10 dB Pad Number 2 into the RF path. A6K2 and A6K3 are de-energized, and A6K1 and A6K5 are energized, bypassing the 20 dB Input Amplifier and the other 10 dB pads.

**N=5 (Z5) Select 10 dB Pad Number 3.** A6K5 is de-energized, inserting 10 dB Pad Number 3 into the RF path. A6K2 and A6K3 are de-energized, and A6K1 and A6K4 are energized, bypassing the 20 dB Input Amplifier and the other 10 dB pads.

**80.0 (VC) Voltmeter Mode — Noise Source Off.** This function causes the Noise Figure Meter to display the voltage at the output of the Noise Power Detector. Selection of this function also turns off the +28V drive at the NOISE SOURCE DRIVE OUTPUT on the front panel. The displayed value has six digits of resolution, and therefore cannot be displayed on a single front panel display window. The number displayed occupies all of the NOISE FIGURE display, and part of the INSERTION GAIN display.

**81.0 (VH) Voltmeter Mode — Noise Source On.** This function is identical to 80.0 described above, except that the NOISE SOURCE DRIVE OUTPUT is set to turn on the +28V drive.

## SPECIAL FUNCTIONS (cont'd)

**82.N Recorder Test Functions.** This Special Function allows an arbitrary voltage to be output on either of the rear panel X-AXIS or Y-AXIS outputs. The range of voltage is from 0 Vdc to 6 Vdc.

**N=0 (A7) Enable Recorder Test.** Enables the voltage, corresponding to the value keyed in under 82.1 or 82.2, to be output at the appropriate connector. 82.0 can be disabled by 0.0, or by entering another function that affects the rear panel outputs (for example 7.0). PRESET, or powering down, disables this function, and also sets the entered voltage values to 0.

**N=1 (XV) X-AXIS Test.** Allows entry of a voltage to be output at the X-AXIS output. After the Special Function code is entered, "0.000" is displayed in the left display. A voltage value can be keyed in at this time using the DATA and ENTER keys. When enabled by entry of 82.0, the entered voltage will be output.

**N=2 (YV) Y-AXIS Test.** Allows entry of a voltage to be output at the Y-AXIS output. This function operates identically to the function above except that the entered voltage is output at the Y-AXIS output.

**90.N Keyboard Test.** This Special Function gives various indications on the left display, depending upon which front panel key is pressed. It is necessary to remove power, from the Noise Figure Meter, to exit these functions, unless operating over the HP-IB.

**N=0 (KY) Display Key Codes.** This function allows the key codes for any of the front panel keys to be displayed in the left display. The two digits of the codes correspond to the keys' row position and column position respectively, as they are laid out on the panel. If no key is down, "00" is displayed. If more than one key is down, "99" is displayed.

**N=1 (K1) Key Test — Row 1.** The Noise Figure Meter keyboard is electrically laid out in an eight row by five column matrix (see Service Sheet 8). This function allows the five key positions corresponding to the columns of row 1 in the matrix to be displayed as "00000" in the left display.

When one of the keys in row 1 is pressed, a "1" appears in the digit position corresponding to the column that the key occupies. For example, after 90.1 Special Function is entered, pressing the START FREQ key, causes the left display to show "00100," indicating that the START FREQ key is in column 3.

**N=2 (K2) Key Test — Row 2.** This function is identical to the function directly above, except keyboard matrix row 2 is enabled.

**N=3 (K3) Key Test — Row 3.** This function is identical to the functions above, except keyboard matrix row 3 is enabled.

**N=4 (K4) Key Test — Row 4.** This function is identical to the functions above, except keyboard matrix row 4 is enabled.

**N=5 (K5) Key Test — Row 5.** This function is identical to the functions above, except keyboard matrix row 5 is enabled.

**N=6 (K6) Key Test — Row 6.** This function is identical to the functions above, except keyboard matrix row 6 is enabled.

**N=7 (K7) Key Test — Row 7.** This function is identical to the functions above, except keyboard matrix row 7 is enabled.

**N=8 (K8) Key Test — Row 8.** This function is identical to the functions above, except keyboard matrix row 8 is enabled.

## SPECIAL FUNCTIONS (cont'd)

**91.0 (DT) Display Test.** This Special Function executes a front panel display and annunciator test. It also generates a demonstration pattern on an oscilloscope (which has been properly connected to the rear panel X-AXIS, Y-AXIS, and Z-AXIS outputs). When this function is selected, all of the front panel displays and annunciators are illuminated.

### NOTE

*The amount of time that the displays and annunciators stay illuminated can be varied. The amount of time (in seconds) is directly proportional to the frequency that was entered, using the FREQUENCY key, just prior to Special Function 91.0 being enabled. If 30 MHz was entered, the front panel will stay illuminated for approximately 30 seconds. Hewlett-Packard recommends that 10 MHz be used.*

Next, each annunciator and key light on the front panel is illuminated in a rough left to right sequence. This is followed by the illumination of each display digit in sequence from left to right. Next, all of the "a" segments of the display digits are illuminated simultaneously.

This is followed by all of the "b" segments, etc., through the decimal points. Finally, the rear panel outputs cause a test pattern and the HP 8970B model number to be displayed on an oscilloscope.

**92.0 (U0) 0 MHz Hold Off.** This function releases the instrument from being tuned to 0 MHz. If the instrument is tuned to 0 MHz when this function is executed, it will return to the frequency it was tuned to before it was sent to 0 MHz. Refer to Special Function 92.1.

**92.1 (U1) 0 MHz Hold On.** This function tunes the instrument to 0 MHz. When tuned to 0 MHz, the first LO feeds directly into the first IF (2050 MHz), causing an analog-to-digital converter overflow error, E11. Tuning to 0 MHz is released by tuning to another frequency, pressing PRESET, or keying in 92.0SP.

**93.N ROM Inspection and RAM Inspection/Modification Utilities.** The Noise Figure Meter will allow the user to inspect all of the Random Access Memory (RAM) and all of the Read Only Memory (ROM) locations with a general set of utilities. These utilities can also modify certain RAM locations to allow for calibration data table downloading and other functions. RAM addresses are described following the Special Function 93.N summary. Some RAM locations cannot be modified until the RAM Modify Flag is set to a decimal 20299 (see RAM Modify Flag Address).

**N=0 (AI) Sets RAM Address and Auto-increment Mode.**

Example: AI65450EN

Sets RAM modify/inspect address to 65450. Auto-increment mode is enabled.

**N=1 (AD) Sets RAM Address and Disables Auto-increment Mode.**

Example: AD65458EN

Sets RAM modify/inspect address to 65458. The modify/inspect address will not be incremented following byte or floating point modify/inspect operations.

**N=2 (MB) Modify/Inspect a BYTE of RAM.**

Example: MB

Places a value (0—255), at the address set by Special Function 93.0 or 93.1, in the left display of the Noise Figure Meter. The value can be modified by entering a new value or just inspected by hitting ENTER. If auto-increment mode is in use, the RAM address will be incremented by 1. Special Function 93.2 must be entered each time a byte in RAM is to be modified/inspected.

**N=3 (MW) Modify/Inspect a WORD in RAM.**

Example: MW

Places a value (0—65535), at the address set by Special Function 93.0 or 93.1, in the left display of the Noise Figure Meter. The value can

## SPECIAL FUNCTIONS (cont'd)

be modified by entering a new value or just inspected by hitting ENTER. If auto-increment mode is in use, the RAM address will be incremented by 2. Special Function 93.3 must be entered each time a word in RAM is to be modified/inspected.

### **N=4 (MF) Modify/Inspect a FLOATING POINT VALUE in RAM.**

Example: MF

Places the floating point value, at the address set by Special Function 93.0 or 93.1, in the left display of the Noise Figure Meter. The value can be modified by entering a new value or just inspected by hitting ENTER. If auto-increment mode is in use, the RAM address will be incremented by 4. "99999" will be displayed if an illegal value is encountered. Special Function 93.4 must be entered each time a floating point value in RAM is to be modified/inspected.

The RAM modify/inspect process consists of four steps:

#### **NOTE**

*Refer to Table 8-1. If address information has been written in below the addresses on the left side of the table, go to step 3. Steps 1 and 2 may be skipped. The information that has been written in is the information that would be gathered in steps 1 and 2. Use the appropriate address in step 3.*

1. Use Special Function 93.0 or 93.1 to set the RAM modify/inspect address to one of the addresses shown in Table 8-1.
2. Use Special Function 93.3 to read the value at that RAM location. The value is the address where the information to be inspected or modified is located.

#### **NOTE**

*In Table 8-1 enter the address obtained in step 2 in the space provided below the address used in step 1. From this point forward, the addresses that have been entered in Table 8-1 will be used*

*for the RAM modify/inspect process. Steps 1 and 2 may be skipped.*

*Use Special Function 99.9 to determine the datecode of the firmware (ROM) in the Noise Figure Meter. Enter the datecode in the space provided at the bottom of Table 8-1.*

*If the ROMs are replaced and the new ROMs have the same datecode as the old ROMs, the addresses entered in Table 8-1 will not change. However, if the new ROMs have a different datecode, the addresses entered in Table 8-1 may have changed and steps 1 and 2 will need to be repeated.*

3. Use Special Function 93.0 or 93.1 to set the RAM modify/inspect address to the address read in step 2 (or found in Table 8-1).
4. Use Special Function 93.2, 93.3 or 93.4 to modify/inspect the value at the address set in step 3.

#### **NOTE**

*The addresses shown in Table 8-1 are not the addresses of RAM locations. They are the addresses that contain the addresses of the desired data or location described in Table 8-1.*

- 94.1 **(none) Disable Automatic Hysteresis Correction.** This function prevents automatic YIG oscillator hysteresis correction when the frequency is decreased. This should not be used for normal operation. The function is turned off on power-up, Preset, or Special Function 94.2.
- 94.2 **(EH) Enable Automatic Hysteresis Correction.** Enables automatic YIG oscillator hysteresis correction.
- 94.3 **(none) Enable Manual YIG Oscillator Control.** This function prevents the Noise Figure Meter from updating the YIG oscillator frequency. This allows the fine and coarse tune DACs to be set manually using the RAM modify special functions. (See Special Function 93.N) Special Function 31.1 should be used to prevent an automatic frequency calibration which would reset the fine tune DAC. Special Function 94.3 is intended for service use only and will be turned off on power-up, Preset, or Special Function 94.4.

Table 8-1. Specific RAM Address Locations

Address	Description	Address	Description
65450 ( )	<p>The address of the start of the calibration table is found at address 65450.</p> <p>The first word in the calibration data table gives the total number of words that must be read in order to gather all of the calibration data. This value will vary depending on how many measurement points exist.</p> <p>The first eighteen words (2 bytes/word) of the data consists of information such as start, stop, step size, LO, and IF frequencies during the calibration.</p> <p>The next section of data is made up of twelve words for each point in the calibration. If the start, stop and step size frequencies define five points for the sweep, the total number of words to fetch will indicate <math>18 + (5 \times 12)</math> or 78 words.</p>		<p>Bit 2 - Allow Single Sideband 3 (SSB3) even if the Noise Figure Test Set says it does not have the ability. Error code E103 is not issued.</p> <p>Bit 3 - Do not wait for the Noise Figure Test Set YIG heater to stabilize before fine tuning starts.</p> <p>Bit 4 - Send frequency set commands to the Noise Figure Test Set in Mode 1.3.</p> <p>Bit 5 - Do not reset calibration data in the Noise Figure Meter after a power loss.</p>
65452 ( )	<p>The RAM modify flag address is found at address 65452. When the RAM location, found at address 65452, is changed to ASCII 'OK,' any RAM locations in the Noise Figure Meter can be modified. ASCII 'OK' has decimal value 20299. If this RAM location is not changed to decimal 20299, only calibration data and limited other locations can be changed without getting an error code E37 (entry not allowed).</p> <p style="text-align: center;"><b>NOTE</b></p> <p style="text-align: center;"><i>In Section IV of the Operating Manual, Performance Test 4-8, steps 26a through h, show how to set the RAM modify flag.</i></p>	65460 ( )	<p>The address of the start of the IF attenuator calibration table is found at address 65460.</p> <p>The table has one byte followed by seven floating point (four byte) values. When the first byte is set to 128, the IF attenuator calibration table is valid. If error code E26 (IF attenuators are not calibrated.) has been issued, the first byte will not be 128.</p> <p>The floating point values represent the IF attenuator values in linear terms. For example, the 5 dB attenuator is stored as 3.162. Special Function 93.4 is used to read a floating point value.</p>
65458 ( )	<p>The special options flag address is found at address 65458. Special options can be set (1) or reset (0) that cannot be fully controlled via special functions. The functions are backed up and stored.</p> <p>Listed below are the conditions that are set when a bit is set to one:</p> <p>Bit 0 - Do not test for E48 (Two or more controllers are on the System Interface Bus.). Bit 0 is also set with Special Function 48.2.</p> <p>Bit 1 - Do not auto-abort Noise Figure Test Set sweeps. Error code E102 is not issued.</p>	65462 ( )	<p>The address of the plot command byte is found at address 65462.</p> <p>Bits in the plot command byte can be set (1) or reset (0). Special Function 25.X will set the plot command byte.</p> <p>Listed below are the conditions that are set when a bit is set to one:</p> <p>Bit 0 - Include a box around the plot.</p> <p>Bit 1 - Include the graticule lines.</p> <p>Bit 2 - Include the curves.</p> <p>Bit 3 - Include the annotation.</p> <p>Bit 4-6 - DO NOT SET THESE BITS.</p> <p>Bit 7 - Enable a plot (required for plotting).</p>
Datecode: _____			



## SPECIAL FUNCTIONS (cont'd)

- 94.4 (UY) Disable Manual YIG Oscillator Control.** YIG oscillator frequency is updated normally.
- 95.6 (ND) Sets Default ENR Values.** This function sets spot and all ENR table values to 15.2 dB. It also sets the noise source identifier number (Special Function 5.5) to 00000.
- 96.X User Controlled LO Control.** These special functions are used to disable or enable user controlled LO control, set the SIB address of the user controlled LO, and to tell the Noise Figure Meter whether the user controlled LO is a custom LO or not. Refer to Measurement Modes 1.6—1.9 (Comments) in Section III of the Noise Figure Meter Operating Manual for more information.
- 97.1 (Y9) Enable Coarse and Fine Tune Debug Oscilloscope Plot.** This special function will allow the oscilloscope to show the power levels that are measured during the coarse and fine tuning processes of the Noise Figure Test Set. It is helpful to select Special Function 7.1 before selecting Special Function 97.1 so that the peak found during the fine or coarse tune process will not be cleared when the Noise Figure Meter resumes normal measurements after the tuning process is complete. Refer to the Noise Figure Test Set Service Manual for more information.
- 97.2 (Y8) Disable Coarse and Fine Tune Debug Oscilloscope Plot.** Disables the Noise Figure Test Set coarse and fine tune debug oscilloscope plot.
- 97.3 (DA) Disable Sweep Abort.** This special function disables the automatic aborting of a sweep which causes the Noise Figure Test Set to switch bands more than 100 times. Selecting Special Function 97.3 is equivalent to setting bit one of the special service options byte (See Special Function 93.X). To reset this bit (allow auto-abort), use the 93.X Special Functions.
- 97.4 (none) Noise Figure Test Set Heater Reset.** Sets the Noise Figure Test Set YIG tuned filter heater regulation setpoint. The Noise Figure Test Set YIG tuned filter heater regulation control loop must stabilize before the Noise Figure Test Set can be fine tuned. The Noise Figure Meter performs this function automatically when needed.
- 97.5 (none) HP 8757A Plot Mode On.** Turns HP 8757A plot mode on. Sends noise figure and gain traces that would normally appear on the oscilloscope screen to the HP 8757A screen using HP-IB. Only two traces will appear (no grid markings).
- 97.6 (none) HP 8757A Plot Mode Off.** Turns HP 8757A Plot Mode (Special Function 97.5) off.
- 98.1 (none) HP-IB/SIB Self Test.** Refer to Service Sheet BD1 Troubleshooting, Check 7.
- 98.2 (none) Non-volatile Memory Test.** On power-up, the non-volatile memory area is checked using the checksum method. A more thorough test can be performed with this special function. The non-volatile area of memory is checked by writing to and reading from memory. The data in memory will not be lost if the RAM is operating normally and there is no power loss during the test. If the test discovers an error, E72 will be displayed. Begin troubleshooting on Service Sheet BD4.
- 98.7 (none) Noise Figure Test Set Self Test.**

### NOTE

*An HP-IB code for Special Function 98.7 does not exist. However, if the HP-IB code \*TST? is sent directly to the Noise Figure Test Set, the Noise Figure Test Set will perform a self test.*

Selecting Special Function 98.7 causes the Noise Figure Meter to tell the Noise Figure Test Set to perform a self test. Special Function 45.1 must be active for this test to work. After pressing 98.7 SPECIAL FUNCTION, the left display, of the Noise Figure Meter, will show 60000 until the results come back from the Noise Figure Test Set. The results of the self test are displayed as a decimal value in the left display of the Noise Figure Meter. If the value is zero, all of the tests passed. If the value is not zero, one or more of the tests

## SPECIAL FUNCTIONS (cont'd)

failed. To determine which test(s) failed, refer to the Noise Figure Test Set Self Test table below. The table gives a description of each test and the binary weight associated with the test. By determining the equivalent binary number for the decimal displayed on the Noise Figure Meter, the test(s) that failed can be determined. Once the failure has been determined, refer to the Noise Figure Test Set Service Manual to troubleshoot the failure.

**Noise Figure Test Set Self Test**

Binary Weight	Test Description
1	A/D converter or five volt reference to the converter is bad.
2	Input air sensor reads much too high.
4	YIG DACs, YIG coil or sense for the YIG is bad.
8	YIG heater DAC, YIG heater sense resistor or readback circuitry is bad.
16	YIG heater DAC output is bad.
32	Temperature regulation sensor or offset DAC is bad.
64	Offset DAC is bad.
128	Timer IC has failed.
256	Checksum of the program ROM is bad.
512	Checksum of the coarse tune table EEPROM is bad.

**99.1 (ER) Last Error Readback.** This special function will show the last Noise Figure Meter error. To return to normal operation, press ENTER or send the "EN" HP-IB code. If a controller is used, the error message can be sent in English. All errors are cleared when the Noise Figure Meter is turned off. So, when an error occurs, it can only be read back if power has not been turned off.

When the controller sends the "ER" HP-IB code, the Noise Figure Meter will send back the last error number that occurred. To receive the error message in English, the controller must send the error code back to the Noise Figure Meter (or send a new error code) followed by "EN." The controller must then read the message back from the Noise Figure Meter before

the Noise Figure Meter will be able to respond with its normal data message on the next controller read.

The following program shows how to read the last error that occurred and then get the English text corresponding to the error number.

Assume the Noise Figure Meter is at address 8 on an HP-IB interface card with select code 7. Also, assume an error has occurred.

### NOTE

*This program example was written in BASIC language 2.0 using the HP 9000 Series 200 Model 236 computer.*

```

200 OUTPUT 708;"H1 ER" ! Report 3 displays,
                        show the error
210 ENTER 708;W1,W2,W3 ! Get the displays of
                        the Noise Figure Meter.
220 PRINT "The last Noise Figure Meter error
                        was: ";W1
230 OUTPUT 708;"FR" ! Return to normal
                        operation
240 Error_num=W1 ! Setup for error
                        readback

```

The next few lines ask for the text of the error number that is contained in the variable Error\_num (or W1).

```

250 OUTPUT 708;"ER ";Error_num;"EN" ! Desired
                                        error text
260 ENTER 708;Errmes$ ! Read text ≤ 80
                        characters

```

**99.7 (none) Firmware Datecode of The Noise Figure Test Set.** This special function will display the firmware datecode (for example, 2705) of the Noise Figure Test Set. This number will be unique for every revision of the firmware.

**99.9 (SD) Firmware Datecode of The Noise Figure Meter.** This special function will display the firmware datecode (for example, 02725) of the Noise Figure Meter. This number will be unique for every revision of the firmware.

## 8-19. SERVICE-RELATED ERRORS (E10—E19 and E50—E106)

Refer to Service Sheet BD1, Troubleshooting, Check 11.

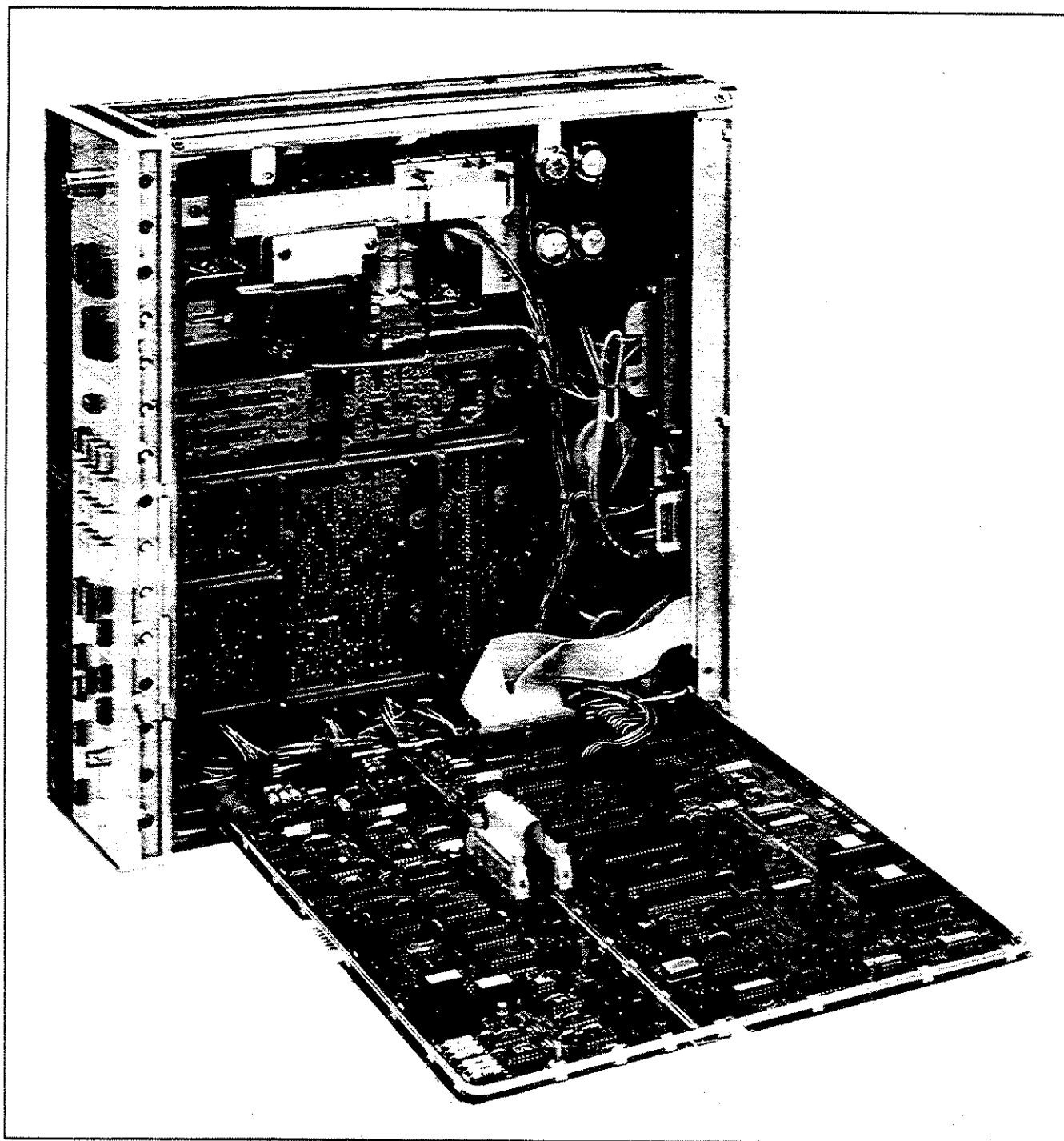


Figure 8-1. Instrument in Service Position

#### 8-20. SERVICING THE INSTRUMENT

Once an error has been detected, and the fault is known to be within the instrument, it is necessary to place the instrument in a serviceable position. Refer to the Top and Bottom Covers and Front Panel Removal procedure near the end of this section. Place the instrument in the position shown in Figure 8-1.

#### 8-21. Signature Analysis

Signature analysis is a simple method of verifying the operation of digital circuitry, and when properly used, can detect extremely subtle hardware faults. Signatures must match exactly those given in the signature tables. If even one digit is mismatched, there is an error.

### Signature Analysis (cont'd)

The Controller, Driver, and Display Assemblies are designed for troubleshooting with signature analysis. There are two configurations used for signature analysis. These are the free run mode and the execution of signature analysis routines by the microprocessor. The free run mode is accessed by setting switch A14S1, on the A14 Controller Assembly, to the FRUN position.

#### Free Run Mode

##### NOTE

*If Read Only Memory (ROM) is updated with a new version, the signatures verified in free run mode will change.*

In Free Run, data lines at the input to the microprocessor form an instruction ([D7]01011111[D0]) which causes the microprocessor to essentially do nothing. The microprocessor continually reads the instruction, increments its address lines, reads the instruction and increments its address lines. The address lines basically become a 16 bit binary counter.

Only the ROMs should have access to the data bus in this mode. During free run, the address bus, chip selects and the data bus can be probed. This determines that the microprocessor can read an instruction, and can generate a full set of addresses. All of the address decoding logic is exercised. This mode also allows the data in ROM A14U7, to be checked, and also indicates that the data bus is good.

#### Signature Analysis Tests

The signature analysis routines are selected using the SA test switch (A14S1). The possible tests are listed on the adjacent table.

##### NOTE

*If Read Only Memory (ROM) is updated with a new version, the signatures verified with the signature analysis tests will not change.*

Signature analysis can be speeded up if the following considerations are kept in mind:

1. Ensure that every step is performed as described in the set-up procedure. That is, ensure that the clock, start, and stop connections, and triggering are correct.
2. Double-check that the signatures are being taken at the correct node.

3. Ensure that the signature analyzer probe is making good contact with the pin being checked. Oxidation on pins can cause invalid signatures due to poor contact.
4. Always double check results to ensure that a bad signature has actually been detected.
5. When checking a node, check that the unstable signature indicator is not blinking. (When using the signature analyzer in the Hold mode, the unstable signature light will blink to indicate a new signature has been triggered via the probe control.)

SA Test Switch (A14S1) Tests

Test	Switches					Test Description
	SA5	SA4	SA3	SA2	SA1	
	0	0	0	0	0	Normal operating position
1	0	0	0	0	1	Non-destructive test of RAM (A14U8)
2*	0	0	0	1	0	Oscilloscope/Plotter RAM (A14U19) test
3	0	0	0	1	1	Display test
4	0	0	1	0	0	PIA2 (A14U33) and YIG DACs test
5*	0	0	1	0	1	PIA1 (A14U35), Latch A and RF attenuators test
6	0	0	1	1	0	Main HP-IB port test
7*	0	0	1	1	1	System Interface Bus (SIB) port test
8*	0	1	0	0	0	Oscilloscope Display Controller circuit exerciser test
9	0	1	0	0	1	Full RAM test (destroys IF calibration data)

\*See notes below.

#### NOTES

##### Test 2

*When taking signatures on the oscilloscope display RAM (A14U19), connect the signature analysis (SA) probe tip to +5 Vdc through a 4.7k to 10 kΩ resistor.*

##### Test 5

*Remove the connector at A14J4 to prevent the relays on the A6 Input Board Assembly from switching while signatures are being taken.*

## Signature Analysis (cont'd)

### Test 7

When taking signatures on the System Interface Bus (SIB) circuits, use the falling edge of A14TP4 (STOP2) as the CLK signal to ensure that the signatures are valid. The complete set up is shown below:

Signature Analyzer Timing Pod	A14 Assembly Connections	Signature Analyzer Setting
START	A14TP3 "STR2"	/ (rising edge)
STOP	A14TP3 "STR2"	\ (falling edge)
CLK	A14TP4 "STOP2"	\ (falling edge)
GND	A14TP2 "GND"	—

### Test 8

Since the oscilloscope display controller runs with no real synchronization to the main microprocessor, separate SA clock signals and a custom oscilloscope pattern are needed to exercise the circuits. The complete set up is shown below:

Signature Analyzer Timing Pod	A14 Assembly Connections	Signature Analyzer Setting
START	A14U20 Pin 14	\ (falling edge)
STOP	A14U20 Pin 14	\ (falling edge)
CLK	A14U20 Pin 1	/ (rising edge)
GND	A14TP2	—

During the test, an 'X' pattern will be displayed on the oscilloscope (if connected) and will be refreshed every three seconds. The refresh causes a temporary unstable signature which will show up as a quick blink of the unstable light on the signature analyzer probe. Therefore, IT IS NORMAL FOR THE UNSTABLE LIGHT TO BLINK ONCE EVERY THREE SECONDS DURING THIS TEST.

For all other signature analysis tests, the signature analyzer is set up as follows:

Signature Analyzer Timing Pod	A14 Assembly Connections	Signature Analyzer Setting
START	A14TP3 (STR2)	/ (rising edge)
STOP	A14TP4 (STOP2)	/ (rising edge)
CLK	A14TP5 (SACLK)	\ (falling edge)
GND	A14TP2 (GND)	—

With the Noise Figure Meter off, select the desired signature analysis test and turn the instrument on. The Noise Figure Meter display will show "-SA- -SA- -SA-" and the LEDs (A14DS1), on the A14 Assembly, will blink a number corresponding to the setting of SA switch A14S1 (for example, 0001, for Test 1).

If neither display is normal, the signature analyzer routine may not be running. Refer to Service Sheet BD1 troubleshooting to isolate the problem. Otherwise, continue troubleshooting the desired circuits with the signature analysis test selected.

### 8-22. Pozidriv Screwdrivers

Many screws in the Noise Figure Meter appear to be Phillips type, but are not. To avoid damage to the screw head slots, Pozidriv screwdrivers should be used. HP 8710-0899 is the No. 1 Pozidriv. HP 8710-0900 is the No. 2 Pozidriv.

### 8-23. Tuning Tools

For adjustments requiring non-metallic tuning tools, use the HP 8710-0033 blade tuning tool or the HP 8710-1010 (JFD Model No. 5284) hex tuning tool. For other adjustments, an ordinary small screwdriver or suitable tool is sufficient. No matter which tool is used, never force any adjustment control. This is especially critical when adjusting variable inductors or capacitors.

### 8-24. Heat Staking Tools

The front panel pushbutton switches have small plastic posts protruding from the back. These posts fit through holes in the front panel printed circuit board and are melted down to hold the switch in place. This process is known as heat staking. The heat staking tool is a standard soldering iron with a special tip attached.

Refer to the paragraph entitled Replacement of Key Cap and Pushbutton Switches under REPAIR in this section for the heat staking procedure.

**8-25. Hardware**

The Noise Figure Meter has a mixture of Unified National (inch) and metric screws. The metric screws are defined in Industrial Fasteners publication (IFI 500) and are identified in the replaceable parts list as (metric). The Unified National screws are identified in the replaceable parts list as (non-metric). To prevent thread damage, ensure that the same type of screw and nut are used in each application.

**8-26. Assembly Locations**

Assemblies in the Noise Figure Meter are numbered in groups, both by function and by location. Refer to the service sheets for identification of assemblies.

**8-27. Parts and Cable Locations**

The location of individual components mounted on printed circuit boards or other assemblies are shown near the schematic diagram. The part reference designator is the assembly designator plus the part designator. For example, A2R9 is R9 on the A2 assembly. For specific component descriptions and ordering information, refer to Table 6-2, Replaceable Parts, in Section VI.

**8-28. Test Points and Adjustment Locations**

Most test points and adjustments are indicated on circuit board assemblies. Test points and adjustments can also be found on the component locator figure near the assembly's schematic diagram. Test points identified on block diagrams are also shown on the service sheets in the following schematic diagram foldouts.

**8-29. Service Aids on Printed Circuit Boards**

Service aids on printed circuit boards include test points, indicator lights, reference designations, adjustment names, and assembly part numbers.

**8-30. Other Service Documents**

Service Notes, Manual Change Supplements, and other service literature are available through Hewlett-Packard. For further information, contact your nearest Hewlett-Packard office.

**8-31. REPAIR****8-32. Top and Bottom Covers and Front Panel Removal**

1. Remove either cover by removing the two top plastic standoffs on the rear panel. Use a Pozidriv screwdriver to remove the screw from each standoff.

2. Unscrew the Pozidriv screw at the middle of the rear edge of each cover. This is a captive screw and will cause each cover to push away from the frame.
3. Slide each cover back and remove it from the instrument.
4. Remove the three center Pozidrive screws from the top and bottom edges of the Front Panel.
5. Slowly pull the panel away from the instrument, and disconnect the wiring harness (two connectors) from the panel.
6. Remove the printed circuit board from the front panel by disconnecting the ribbon cable from the keyboard. Remove the ten nuts and hardware from the posts on the back of the PCB.
7. Remove the keyboard from the front panel by removing the remaining hardware from the ten posts protruding through the keyboard.
8. Replace the covers and front panel by reversing the above procedure.

**8-33. Front Panel Key Cap Replacement**

If key cap replacement is necessary, removing the front panel key cap can be done in one of two ways. If the front panel has been removed, use a small flat blade screwdriver to press on the switch side of the key cap while working it from side-to-side with your fingers. Removing the key cap without opening the instrument is done by grasping the key cap firmly with pliers. Work it from side-to-side while pulling away from the panel.

**NOTE**

*The pliers may damage the key cap unless the jaws are covered with a protective material.*

*Be sure the key cap is aligned properly before snapping it into place. Note that the key cap has 8 possible positions (see Figure 8-2).*

**8-34. Front Panel Switch Replacement****NOTE**

*The front panel switch traces and contacts are specially cleaned at the factory. Do not touch, or attempt to clean the contacts when making any repairs.*

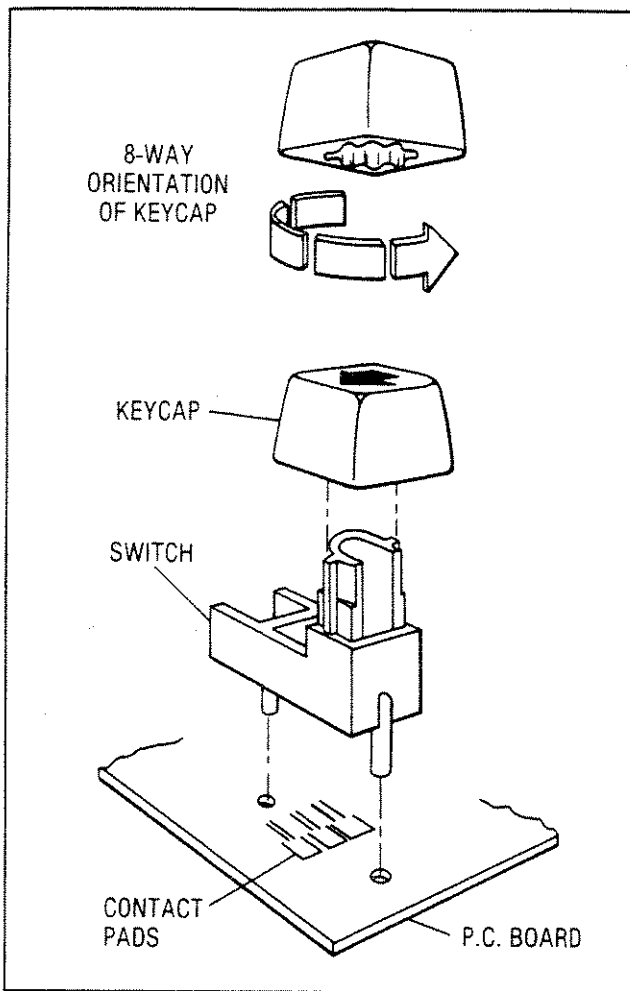


Figure 8-2. Front Panel Pushbutton Switch Assembly

### Front Panel Switch Replacement (cont'd)

The front panel switches have a very high cycle life. However, if one becomes faulty and needs replacement, follow the procedure outlined below:

1. Remove the front panel.
2. Remove the key cap.
3. Remove the switch by chipping away the melted plastic tabs at the circuit side of the keyboard.

#### NOTE

*The following operation should be done in a well ventilated area. If the heat staking tip is too hot, the plastic will vaporize and emit fumes. However, these fumes are non-toxic.*

4. For reliable operation, the switch must be mounted tightly against the printed circuit board. To facilitate the heat staking opera-

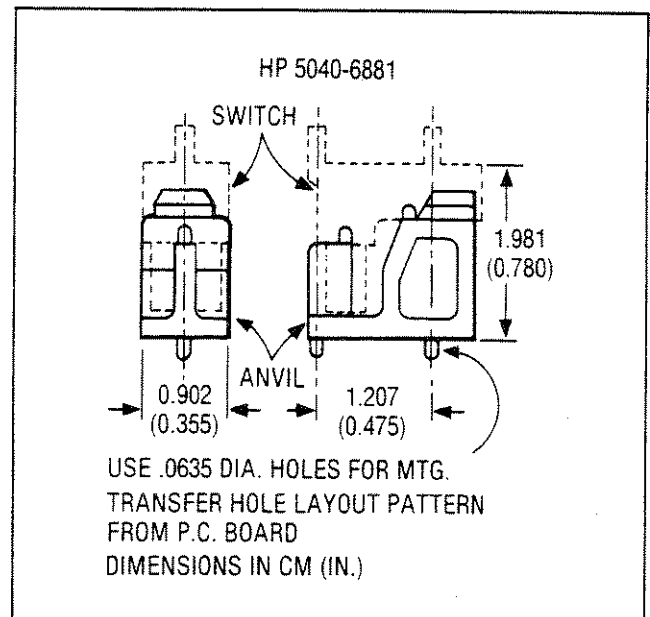


Figure 8-3. Pushbutton Switch Support Anvil

tion, specially molded support anvils (HP 5040-6881) can be ordered (Refer to Figure 8-3).

#### NOTE

*Do not disturb the assembly for at least 10 seconds after heat staking.*

*If not enough heat is applied, the plastic will tend to stick to the tip of the iron.*

*If too much heat is applied, the plastic will fume profusely, the plastic post will be irregularly shaped, and the plastic will be permanently discolored.*

*If the staking tool is worn or flaked, it will cause a misshaped plastic post and/or a contamination deposit on the surface.*

5. To ensure proper switch assembly, verify that the switch is pushed firmly against the circuit board. Using the hot (440°C or 825°F) staking tip (see Figure 8-4), push down on each of the two posts on the switch. Each post should take about one second to stake. With the proper cycle, the post should turn a darker color and, in about ten seconds, return to its original bright red color. The correctly staked post should have a smooth round rivet-like top (Refer to Figure 8-5).

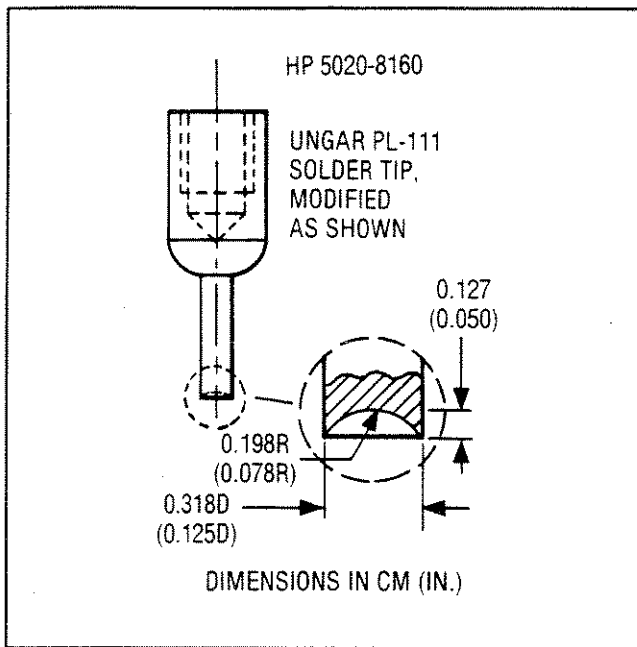


Figure 8-4. Heat Staking Tip

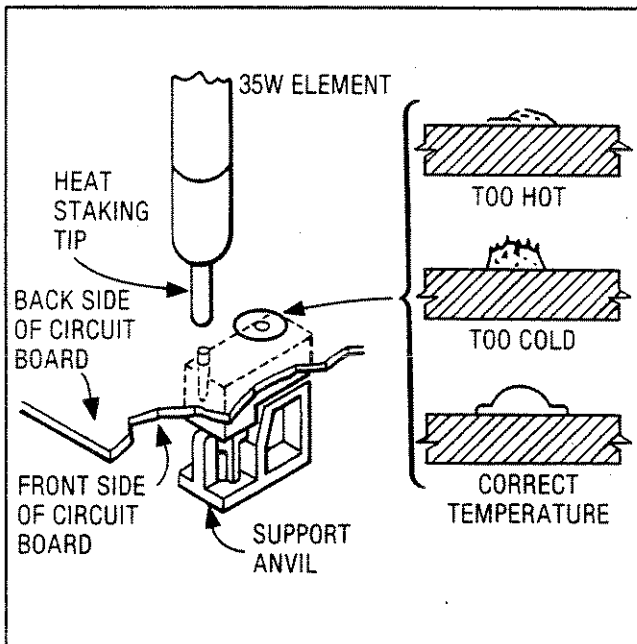


Figure 8-5. Typical Assembly for Heat Staking Operation

### 8-35. Etched Circuits (Printed Circuit Boards)

The etched circuit boards in the Noise Figure Meter have plated-through holes which make a solder path through to both sides of the insulating material. Soldering can be from either side of the board with equally good results. When soldering to any circuit board, keep in mind the following recommendations:

8-16

1. Avoid unnecessary component unsoldering and soldering. Excessive replacement can result in damage to the circuit board and/or adjacent components.
2. Do not use a high power soldering iron on etched circuit boards. A 35-watt soldering iron is recommended. Excessive heat may lift a conductor or damage the board.

#### CAUTION

*Do not use a sharp metal object such as an awl or twist drill in the following step. Sharp objects may damage the plated-through conductor.*

3. Use a suction device or wooden toothpick to remove solder from component mounting holes. When using a suction device, ensure that the equipment is properly grounded to prevent an electrostatic discharge from damaging MOS devices. Refer to Table 8-2, Etched Circuit Soldering Equipment, for information on available tools for working on etched circuit boards.

### 8-36. Electrostatic Discharge (ESD) Precautions

Electrostatic discharge (ESD) can cause damage to certain devices in the Noise Figure Meter. The damage can range from slight degradation of a parameter to catastrophic failures.

Static sensitive devices are used in this instrument. They are prone to damage from both static electricity and transient signals. They must be handled carefully. When working on the Noise Figure Meter, keep in mind the following recommendations to avoid damaging these sensitive components.

1. Use a static-free work station with a pad of conductive rubber or similar material.
2. Do not remove any board unless the Noise Figure Meter has been turned off or unplugged.
3. When removing a device from a high grip socket, be careful not to damage it. Avoid removing devices from these sockets with pullers. Instead, use a small screwdriver to pry the device up from one end, and then the other end, in a gentle rocking motion.



Table 8-2. Etched Circuit Soldering Equipment

Item	Use	Specification	Item Recommended	HP Part No.
Soldering Tool	Soldering, Heat Staking	Wattage: 35W Tip Temp.: 390°—440°C (735°—825°F)	Ungar No. 135 Ungar Division, Eldon Ind. Corp. Compton, CA 90220	8690-0167
Soldering Tip	Soldering, Unsoldering	*Shape: Chisel	*Ungar PL113	8690-0007
Soldering Tip	Heat Staking	Shape: Cupped	HP 5020-8160 or modified Ungar PL111	5020-8160
De-Soldering Aid	To remove molten solder from connection.	Suction Device	Soldapullt by Edsyn Co., Van Nuys, CA 91406	8690-0060
Rosin (flux) Solvent	To remove excess flux from soldered area before application of protective coating.	Must not dissolve etched circuit base board.	Freon	8500-0232
Solder	Component replacement; circuit board repair wiring.	Rosin (flux) core, high tin content (63/67 tin/lead), 18 gauge (SWG) 0.048" diameter preferred.		8090-0607

\*For working on circuit boards, for general purpose work, use No. 555 Handle (8690-0261) and No. 4037 Heating Unit 47½—56½ (HP 8690-0006); tip temperature of 850°—900°F; and Ungar No. PL113 ¼" chisel tip.

### Electrostatic Discharge (ESD) Precautions (cont'd)

4. Once a device has been removed from an assembly, immediately stick it into a pad of conductive foam or other suitable holding medium.
5. When replacing a device, ground the foam on which it resides to the instrument before removing it. If a device requires soldering, ensure that the assembly is lying on a pad of conductive material, and that the pad, soldering iron, and personnel, are all grounded to the assembly. Apply as little heat as possible.
6. Before turning the instrument off, remove any large ac sources that may be driving MOS switches.

### 8-37. Non-Repairable Assemblies

The A17A1G1 YIG Oscillator Assembly and the A10 First Converter Assembly are not repairable and must be discarded.

### 8-38. Factory Selected Components (\*)

Some component values are selected at the factory to provide optimum compatibility with associated components. These components are identified on individual schematics and the replaceable parts list by an asterisk (\*). Refer to Table 5-1, Factory Selected Components, for the selection procedures.

### 8-39. After Repair Adjustment Procedure

After repairs are made, adjustments may be needed to assure optimum performance. Refer to the Adjustments, in Section V of this volume to determine what, if any, adjustments are needed after any repair is made.



## SERVICE SHEET BD1 — OVERALL

### BLOCK DIAGRAM

### HP 8970B NOISE FIGURE METER

### REFERENCES

Section II — Line Voltage and Fuse Selection

Section III — Operator's Checks

Section VIII — Special Functions and  
Power-Up Checks

### PRINCIPLES OF OPERATION

#### General

The HP 8970B Noise Figure Meter is a microprocessor-controlled, triple conversion receiver, which measures noise power in a 4 MHz bandwidth, tunable from 10 MHz to 1600 MHz. The results of the measurements are both displayed and used by the microprocessor to make the calculations required to obtain noise and gain figures.

The Noise Figure Meter is functionally divided into three major sections:

1. the analog section,
2. the keyboard and display section, and
3. the digital section

The analog section (Service Sheet BD2) covers those circuits which convert the 10 to 1600 MHz RF noise signal input to a 20 MHz IF. It also covers the First Local Oscillator (LO) drive circuits, and the power supplies.

The keyboard and display section (Service Sheet BD3) covers the flow of information to and from the front panel circuits.

The digital section (Service Sheets BD4 and BD5) covers the Controller Assembly, A14, and part of the Driver Assembly, A13. The digital section (Service Sheet BD4) covers the microprocessor (MPU), memory, Hewlett-Packard Interface Bus (HP-IB), and System Interface Bus (SIB). The digital section (Service Sheet BD5) includes the Oscilloscope Display RAM and Controller, PIAs, voltmeter, X-Axis and Y-Axis DACs and their related devices, and Serial/Parallel Converter.

#### Analog Section (BD2)

The Noise Figure Meter will accept a broadband RF noise signal in the frequency range of 10 to 1600 MHz. Any RF noise above 1650 MHz is rejected by the low-pass filter which follows the input connector.

Located just after the filter are the Input Attenuators and Amplifier, which are used to set the signal power level into both the Input Power Detector and the First Converter. RF power is detected and converted to a dc voltage by the Input Power Detector circuit. The level of this voltage is used by the microprocessor to set the overall gain of these input circuits. The net gain ranges from +20 to -30 dB in 10 dB steps.

The First Converter and Filter change the 10 to 1600 MHz input noise power to a fixed 2050 MHz intermediate frequency (IF). The first local oscillator (LO) is a YIG (yttrium-iron-garnet) oscillator tunable over a range from 2060 to 3650 MHz, under normal operation. The YIG is tunable down to 2050 MHz during frequency calibration. The First LO is the only tunable oscillator in the instrument and gives the Noise Figure Meter its 1590 MHz wide input frequency range.

The Microprocessor loads the LO Data Latches with tuning data, which forms the digital inputs to the LO Tuning DACs (digital-to-analog converters). The current output from the converters is summed and amplified by the LO Drive Amplifiers. The drive current flows through the main tuning coil of the YIG oscillator, tuning its output frequency over a 2060 to 3650 MHz range during normal operation.

The 2050 MHz IF signal enters the Second Converter through a 2050 MHz Bandpass Filter. A second LO of 1750 MHz converts the first IF signal down to a second IF of 300 MHz. The signal from the Second Converter is amplified by the 300 MHz IF Amplifier. A 300 MHz Bandpass Filter selects the proper sideband for downconversion to 20 MHz. The filtered output then enters the Third Converter where it is mixed with a 280 MHz LO signal. The resulting 20 MHz output is passed to the 20 MHz IF Attenuators, Filters, and Amplifiers. The Frequency Cal Detector detects First LO feed-through during the frequency calibration operation.

The 20 MHz IF Attenuators, Filters, and Amplifiers shape the bandwidth and set the power level of the 20 MHz noise signal, which is sent to the Noise Power Detector. The nominal bandwidth of the 20 MHz IF is 4 MHz. The gain of the 20 MHz IF is set by the internal controller in 5 dB steps from +40 to +75 dB.

The 20 MHz Bandpass Filter sets the final measurement passband into the Noise Power Detector and the auxiliary IF output. The Noise Power

## **SERVICE SHEET BD1 (cont'd)**

Detector is biased to produce a dc voltage proportional to the RF voltage at its input. This dc voltage is present at the DET output and also forms one of three inputs selected by the Voltmeter Input Switches (BD5).

Four power supplies are used in the Noise Figure Meter: +28V, +15V, +5V, and -15V. The pulsed +28V supply is used to drive the external noise source. The Noise Source Drive regulates the rectified +28V secondary voltage and pulses it on and off (between +28V and ground) under command of the Controller. This voltage is connected in parallel to both the front and rear panel NOISE SOURCE DRIVE OUTPUT +28V (PULSED).

### **Keyboard and Display Section (BD3)**

Information travels between the front panel circuits and the digital circuits through a single bi-directional serial data line. Data from the front panel indicates which key has been pressed. The data is in parallel format before passing through the Serial/Parallel Converter. When a key is pressed, the Keystroke Logic detects that a key is down. This information is transmitted through one of the two control lines to the controller.

Data to the front panel is used to display measurement and entry information, and to light appropriate keys. The serial data is sent to the Serial/Parallel Converter on the front panel. There, it is converted into a parallel data format.

The controller initiates a keyscan to determine which key has been pressed, and the resulting keyscan data from the front panel is returned to the controller. The controller then determines which key is down and returns data to the front panel to light the appropriate displays and key lights.

### **Digital Section Block Diagram (BD4) Microprocessor, Memory, HP-IB, and System Interface Bus (SIB)**

The microprocessor (MPU) based Controller provides the calculations, timing, and control for the instrument. The MPU executes instructions stored in Read Only Memory (ROM). Data that must be stored is placed in Random Access Memory (RAM). Data travels between the MPU and other blocks of the Controller over the Data Bus. The elements of the Controller respond to the data when addressed by the MPU over the Address Bus.

The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's implementation of the IEEE-488 (1978) Interface Bus. It is through the HP-IB that the Noise Figure Meter can remotely communicate with another system. The HP-IB concept is explained in Section I, General Information. The use of the HP-IB is covered in Section III, Operation.

The System Interface Bus (SIB) is a private bus used by the Noise Figure Meter to control certain instruments in the Noise Figure Measurement System. The instruments controlled by the Noise Figure Meter through the SIB are the Noise Figure Test Set, the System Local Oscillator, and a plotter.

### **Digital Section Block Diagram (BD5) PIAs, Voltmeter and Oscilloscope Controller**

The Voltmeter Input Switches sequentially connect one of three inputs to the Voltage-to-Time Converter. Together, these circuits form the analog portion of a dual-slope analog-to-digital converter that automatically zeros itself once after each conversion. The output of the Voltage-to-Time Converter is a pulse with a width that is proportional to the dc voltage at the converter input. This pulse width is then measured by the Voltmeter Counters.

At the start of a measurement, the Controller connects the output of the Noise Power Detector to the Voltage-to-Time Converter (BD2). At the same time, the 4 MHz Timebase toggles the Voltmeter Counters until a carry pulse is generated. The carry pulse triggers the Input Control Logic to connect the Voltage Reference to the Voltage-to-Time Converter.

The counters are reset, and then enabled to count the timebase until the output of the Voltage-to-Time Converter changes state. The final count in the counters is the value of the unknown level from the Noise Power Detector. The Voltmeter Counters and Logic then send the count data to the Microprocessor through Peripheral Interface Adapter (PIA) 2. The Input Control Logic then grounds the input to the Voltage-to-Time Converter for zeroing.

Nearly all of the instrument control is executed by the MPU through PIAs 1 and 2. Display data is sent to the front panel by PIA 1 through the Serial/Parallel Converter. Also, level information for the Input Power Detector and the Frequency Cal Detector enter the MPU through the PIAs.

## SERVICE SHEET BD1 (cont'd)

The Oscilloscope Display Random Access Memory (RAM) can hold all of the Noise Figure and Insertion Gain results from a complete sweep. This RAM is accessed by the MPU only when new data is to be stored (that is, at the end of a measurement cycle). The remainder of the time, this RAM is under the control of the Oscilloscope Display Controller.

The Oscilloscope Display Controller sequentially steps through the addresses of the Stored Data RAM locations. This causes the RAM data to be continuously sent to the X and Y Data Latches. The data is converted by the X-Axis and Y-Axis DACs into the analog X-Axis and Y-Axis outputs for use in plotting swept measurement results. The Retrace Logic detects when the end of the sweep occurs, and pulses the Z-AXIS PEN LIFT output. The Z-AXIS PEN LIFT output is used to lift an x-y recorder pen or blank an oscilloscope beam.

## TROUBLESHOOTING

The troubleshooting checks on this block diagram are used to isolate a malfunction to one of the four major functional subsystems. Once the faulty subsystem has been isolated, refer to the appropriate subsystem Service Sheet (BD2 — Analog, BD3 — Front Panel, BD4 — Digital, and BD5 — Digital). Checks 1 to 7 must be done in the order listed. Checks 1 to 7 specify when to perform Checks 8 to 11.

### Test Equipment

Signature Multimeter .....	HP 5005B
Noise Source .....	HP 346B/C
Digital Voltmeter (DVM) .....	HP 3456A
Synthesized Sweeper .....	HP 8340B
Oscilloscope .....	Tektronix 2235

### ✓1 Line Check

#### Procedure

1. Remove the instrument bottom cover and rear feet (three screws). Loosen the two captive screws at the left (as viewed with the instrument up-side down) of the A14 Controller and A13 Driver Board Assemblies. Swing the hinge that secures these assemblies open and lock it into the service position. Refer to Figure 8-1. Switch LINE to ON.

## WARNING

*Dangerous voltages are present in the A15 Line Module Assembly and at the inputs of transformer T1. For more information on safety, refer to the Safety Considerations page at the beginning of this manual.*

2. Check the fan and the green LED of the A12 Noise Source Drive Assembly. The fan must be running, and the green LED should be lit. (It may be flashing; this is normal and will be checked later.)
3. Check the power supply voltages and ripple at the following test points (connect ground test lead to A9TP4 "GND") of the Power Supply Assembly. The normal indications are shown below.

Table 8-3. A9 Power Supply Voltages

Test Point	Power Supply	Voltage (Vdc)	Ripple
A9TP3	+5 Vdc	+5.0 to +5.6	<20 mV <sub>p-p</sub>
A9TP2	+15 Vdc	+14.0 to +16.0	<20 mV <sub>p-p</sub>
A9TP1	-15 Vdc	-16.0 to -14.0	<20 mV <sub>p-p</sub>

**In Case of Abnormal Indication:** Check the rear panel line fuse and line voltage selector. Check the Mains wiring. Continue troubleshooting on Service Sheet BD2 (or Service Sheet 18, Power Supply), if necessary.

### ✓2 Instrument Power-Up Check

#### Procedure

1. Switch the LINE switch to OFF for 5 seconds and back to ON. The instrument will perform a power-up routine which will last for approximately 5 seconds. As the instrument powers-up, the front panel display will light up in the manner described below. (See Table 8-4.)

#### NOTE

*If the front panel display seems non-functional, perform the Controller Power-Up Check (Check 8) and, if necessary, the Front Panel Interface Checks (Check 9).*

**SERVICE SHEET BD1 (cont'd)**

- All front panel LED's and annunciators light for approximately 1 second. This indicates that the controller has reset and has begun its power-up sequence.
- The left display should go blank. The message "Ctrl on" (if Special Function 48.0 is active) or "Ctrl OFF" (if Special Function 48.1 is active) should appear in the INSERTION GAIN and NOISE FIGURE displays. Part of RAM (A14U8) test is executed while the message appears.
- "Fr CAL" should appear in the INSERTION GAIN and NOISE FIGURE displays indicating that the instrument is performing a frequency calibration. Also, the UNCORRECTED NOISE FIGURE annunciator should be lit.

At this point, press the PRESET key and continue:

- The left display should show "30 MHz." The INSERTION GAIN display should go blank, the NOISE FIGURE display should show "-- FdB" or flash a high noise figure reading (typically > 29 FdB), and the UNCORRECTED NOISE FIGURE annunciator remains lit. This indicates the completion of the power-up sequence.

**Normal Indications:** If all indications are normal at this point continue with Check 3.

**Abnormal Front Panel Display:** In case of an abnormal front panel display, continue with Controller Power-Up Check (Check 8) to determine if the MPU is at fault.

**Error Message**

a. If error message E18 is displayed during the instrument power-up, perform the Frequency CAL Check (Check 10).

b. If any of the error messages E70 through E72, E74, or E75 (see Service-Related Errors [E10—E19 and E50—E106] Recovery and Checks, Check 11) is displayed on the front panel, continue troubleshooting on Service Sheet BD4 (Digital Section).

c. If any of the error messages E73, or E76 through E79 (see Service-Related Errors [E10—E19 and E50—E106] Recovery and Checks, Check 11) is displayed on the front panel, continue troubleshooting on Service Sheet BD5 (Digital Section).

d. Continue troubleshooting with Service-Related Errors (E10—E19 and E50—E106) Recovery and Checks (Check 11) for any other error message displayed.

**Table 8-4. Front Panel Indications at Power-up**

Sequence	Normal Front Panel Display
1	ALL LEDs and ANNUNCIATORS ON
2	LEFT DISPLAY: BLANK INSERTION GAIN DISPLAY: Ctrl NOISE FIGURE DISPLAY: on* ANNUNCIATOR: ALL OFF
3	LEFT DISPLAY: BLANK INSERTION GAIN DISPLAY: Fr NOISE FIGURE DISPLAY: CAL ANNUNCIATOR: UNCORRECTED NOISE FIGURE (ON)
4	LEFT DISPLAY: 30 MHz INSERTION GAIN DISPLAY: BLANK NOISE FIGURE DISPLAY: -- FdB** ANNUNCIATOR: UNCORRECTED NOISE FIGURE (ON)
* "OFF" if Special Function 48.1 is active. ** Or, flashing high noise figure (typically >29 FdB).	

## SERVICE SHEET BD1 (cont'd)

✓ 3

 General Checks

## Procedure

1. Press PRESET to set the Noise Figure Meter to a known state.

a. If the instrument does not respond to the PRESET key by showing "Fr CAL" again, continue with the Front Panel Interface Checks (Check 9).

b. The left display should show "30 MHz" and the NOISE FIGURE display should show "-- FdB" or flash a high noise figure reading (typically > 29 FdB). The UNCORRECTED NOISE FIGURE annunciator should be lit.

c. If the Noise Figure Meter appears to be working normally, continue with step 2 of this check.

d. If the Noise Figure Meter displays an error message, continue with the Service-Related Errors (E10—E19 and E50—E106) Recovery and Checks (Check 11) on this block diagram.

2. On the Noise Figure Meter, key in 81.0 SPECIAL FUNCTION. With a DVM, measure the voltage at the NOISE SOURCE DRIVE OUTPUT on the front panel of the Noise Figure Meter.

a. If the voltage is  $+28.00 \pm 0.25$  volts, continue with step 3 of this check.

b. If the voltage is not  $+28.00 \pm 0.25$  volts, there is a problem with either the +28 volt noise source drive circuit of Service Sheet 18 (BD2) or the noise source control circuit of Service Sheet 11 (BD5); check for a logical HIGH on A14J5 pin 7.

If the logic level is correct (HIGH), there is a problem with the +28 volt noise source drive of Service Sheet 18 (BD2), continue troubleshooting on Service Sheet 18 (Power Supply).

If the logic level is incorrect (LOW), there is a problem with the noise source control circuit, continue troubleshooting on Service Sheet 11, Peripheral Interface Adapter (PIA) on BD5.

3. On the Noise Figure Meter, key in 80.0 SPECIAL FUNCTION and check the voltage reading at the front panel NOISE SOURCE DRIVE OUTPUT.

a. If the voltage is  $< 0.85$  Vdc, continue with step 4 of this check.

b. If the voltage is not  $< 0.85$  Vdc, there is a problem with either the noise source control circuit or the +28 volt noise source drive; check for a logical LOW at A14J5 pin 7.

If the logic level is correct (LOW), there is a problem with the +28 volt noise source drive; continue troubleshooting on Service Sheet 18 (Power Supply).

If the logic level is incorrect (HIGH), the problem is with the noise source control circuit; continue troubleshooting on Service Sheet 11 (PIA).

4. Connect the DVM to the detector output (DET OUT) on the rear panel of the Noise Figure Meter. On the Noise Figure Meter, key in 92.1 SPECIAL FUNCTION. Verify that the Noise Figure Meter shows the error message E11 on the front panel and the DVM should read greater than +1.19 Vdc.

a. If both indications are correct, continue with step 5 of this check.

b. If the DVM reading is greater than +1.19 Vdc, but the error message E11 is not displayed on the front panel, there is a problem with the voltmeter circuits; continue troubleshooting on Service Sheet BD5.

c. If the DVM reading is less than +1.19 Vdc, but error message E11 is displayed on the front panel, the problem is with the circuit between the noise power detector and the detector output (DET OUTPUT); continue troubleshooting on Service Sheet BD2.

d. If error message E11 is not displayed and the DVM reading is less than +1.19 Vdc, there is a problem with the circuits on Service Sheet BD2 between FREQ CAL DETECTOR and the output of the NOISE POWER DETECTOR. Continue troubleshooting on Service Sheet BD2.

5. Connect a known good HP 346B/C Noise Source between the NOISE SOURCE DRIVE OUTPUT on the front panel and the RF INPUT of the Noise Figure Meter. On the Noise Figure Meter, press the PRESET key

**SERVICE SHEET BD1 (cont'd)**

and enter the correct ENR for the 10, 100, 1000, and 2000 MHz frequency points. On the Noise Figure Meter, key in 60.1, 70.1, and 81.0 SPECIAL FUNCTIONS. The voltage reading on the Noise Figure Meter and the DVM reading should be > 0.70 volts (typical, measured at the rear panel noise power detector output, DET OUTPUT).

a. If the readings are correct, continue with step 6 of this check.

b. If the Noise Figure Meter displays the error message E12, continue with the Service-Related Errors (E10—E19 and E50—E106) Recovery and Checks (Check 11) on this block diagram.

c. If the DVM reading disagrees with the Noise Figure Meter reading by more than 100 mVdc, there is a problem with the voltmeter circuits; continue troubleshooting on Service Sheet BD5.

6. With the known good HP 346B/C Noise Source still connected to the Noise Figure Meter, press the UNCORRECTED NOISE FIGURE key. The uncorrected noise figure should be less than 7 FdB.

a. If the noise figure reading is less than 7 FdB, continue with the RF Attenuators Checks (Check 4).

b. If the reading is greater than or equal to 7 FdB, verify that A14U29 pins 13 through 16 and A14U45 pins 5, 16, and 19 are all logical low.

If the logic levels are correct, there is a problem with the RF path; continue troubleshooting on Service Sheet BD2.

If any of the logic levels are incorrect, there is a problem with either the RF attenuator control or IF attenuator control circuits; continue with step 8 of the RF Attenuator Check (Check 4) and/or step 6 of the IF Attenuator Check (Check 5).

**✓ 4 RF Attenuator Checks**

**Purpose:** The objective is to verify the performance of the RF attenuators and of the 20 dB

amplifier. Any problem encountered is isolated to either the RF attenuator drive circuit Service Sheet 11 (BD5) or to the RF Attenuators and 20 dB amplifier in Service Sheet 1 (BD2).

**Procedure**

1. On the Noise Figure Meter, press PRESET and key in 63.0, 70.1, and 81.0 SPECIAL FUNCTION and set the SMOOTHING to 16.
2. Inject a 30 MHz signal at -73 dBm into the RF INPUT connector on the front panel of the Noise Figure Meter.
3. Adjust the signal generator output level until the Noise Figure Meter displays  $1.00 \pm 0.01$  volts. If error message E11 is displayed, decrease the signal until the Noise Figure Meter displays  $1.00 \pm 0.01$  volts.

If error message E12 is displayed, continue troubleshooting with the Service-Related Errors (E10—E19 and E50—E106) Recovery and Checks (Check 11). If not, continue with step 4.

4. Use the following special functions to select the three 10 dB pads and verify that the voltages displayed on the front panel of the Noise Figure Meter are correct.

**Table 8-5. 10 dB RF Attenuator Voltages**

Special Function	Pad Under Test	Voltage on Front Panel Display
63.1	10 dB Pad #1	0.28 to 0.36 Vdc
63.4	10 dB Pad #2	0.28 to 0.36 Vdc
63.5	10 dB Pad #3	0.28 to 0.36 Vdc

a. If the voltages are correct, continue with step 5 of this check.

b. If any of the voltages are incorrect, there is a problem with either the RF attenuators (Service Sheet BD2) or the RF attenuator control circuit in Service Sheet 11 (BD5); continue with step 8 to isolate the problem.

5. Decrease the signal generator output level by 20 dB.
6. On the Noise Figure Meter press 63.2 SPECIAL FUNCTION and adjust the signal generator output level until the Noise Figure Meter reads  $1.00 \pm 0.01$  volts.



## SERVICE SHEET BD1 (cont'd)

- On the Noise Figure Meter press 63.0 SPECIAL FUNCTION and verify that the Noise Figure Meter reads 0.079 to 0.126 Vdc.

a. If the voltage is correct, the RF Attenuators and 20 dB amplifier are working. Continue with the IF Attenuator Checks (Check 5).

b. If the voltage is incorrect, there is a problem with either the 20 dB amplifier on Service Sheet 1 or the 20 dB amplifier control line on Service Sheet 11 (BD5); continue with step 8 of this check.

- For each special function shown in column one of the following table, check the voltage levels shown in columns two through five:

Table 8-6. RF Attenuator Drive Circuit Voltages

Special Function	A14U29 Pin 13	A14U29 Pin 14	A14U29 Pin 15	A14U29 Pin 16
63.0	<1 Vdc	<1 Vdc	<1 Vdc	>14 Vdc
63.1	>14 Vdc	<1 Vdc	<1 Vdc	>14 Vdc
63.2	<1 Vdc	<1 Vdc	<1 Vdc	<1 Vdc
63.4	<1 Vdc	>14 Vdc	<1 Vdc	>14 Vdc
63.5	<1 Vdc	<1 Vdc	>14 Vdc	>14 Vdc

If any of these voltages are incorrect, there is a problem with the RF Attenuator drive circuit; continue troubleshooting on Service Sheet 11 (BD5).

If all of the voltages are correct, there is a problem with the RF Attenuators or 20 dB amplifier on Service Sheet 1 (BD2), continue troubleshooting there.

### ✓ 5 IF Attenuator Checks

**Purpose:** The objective is to verify the performance of the IF Attenuators. Any problem encountered is isolated to the IF attenuator drive circuit Service Sheet 11 (BD5) or to the IF Attenuators in Service Sheets 3 and 4 (BD2).

#### Procedure

- On the Noise Figure Meter, press PRESET and key in 63.0, 70.1, and 81.0 SPECIAL FUNCTION.

- Inject a 30 MHz signal at -75 dBm into the RF INPUT connector on the front panel of the Noise Figure Meter.
- Adjust the signal generator until the Noise Figure Meter displays  $+1.00 \pm 0.01$  volts.
- Use the following special functions to select the three IF Attenuators and verify that the voltages displayed on the front panel of the Noise Figure Meter are correct.

Table 8-7. IF Attenuator Voltages

Special Function	Pad Under Test	Voltage on Front Panel Display
70.2	5 dB Pad	0.50 to 0.63 Vdc
70.3	10 dB Pad	0.28 to 0.36 Vdc
70.5	20 dB Pad	0.094 to 0.106 Vdc

a. If all of the voltages are correct, the IF Attenuators are working normally. Continue with the Oscilloscope Display Check (Check 6).

b. If any of the voltages are incorrect, there is a problem with the IF attenuators on Service Sheets 3 and 4 (BD2) or the IF attenuator control circuit on Service Sheet 11 (BD5); continue with step 6 to isolate the problem.

- For each special function shown in column one of the following table, check the voltage levels shown in columns two through four.

Table 8-8. IF Attenuator Control Circuit Voltages

Special Function	A14U45 Pin 19	A14U45 Pin 16	A14U45 Pin 5
70.2	>2.0 Vdc	<0.4 Vdc	<0.4 Vdc
70.3	<0.4 Vdc	>2.0 Vdc	<0.4 Vdc
70.5	<0.4 Vdc	<0.4 Vdc	>2.0 Vdc

a. If all of the voltages are correct, the problem is with the IF attenuators in Service Sheets 3 and 4 (BD2), continue troubleshooting there.

b. If any of these voltages are incorrect, the problem is with the IF attenuator control circuit on Service Sheet 11 (BD5), continue troubleshooting there.

## SERVICE SHEET BD1 (cont'd)

✓ 6

 Oscilloscope Display Check
**Procedure**

1. Connect the oscilloscope to the X-, Y-, and Z-AXIS connectors on the rear panel of the Noise Figure Meter. Use the X-AXIS for the horizontal input (Channel A) and the Y-AXIS for the vertical input (Channel B). If the orientation of the test pattern on the oscilloscope display is incorrect, reverse the cables at the oscilloscope channel A and channel B inputs.
2. On the oscilloscope, set the horizontal and vertical gain inputs to 0.5 V/division (DC coupled) and select the A versus B display mode.
3. On the Noise Figure Meter, press PRESET and key in 7.1 SPECIAL FUNCTION.

Verify that a test pattern is displayed on the oscilloscope. It may be necessary to adjust the rear panel GAIN TRACE control to obtain the test pattern.

4. The test pattern should be  $6.0 \pm 0.5$  volts vertically and horizontally. Adjust the oscilloscope until the test pattern fills the grid area of the display (see Figure 8-6). If no problem is detected with the test pattern, continue with the HP-IB/SIB Check (Check 7).

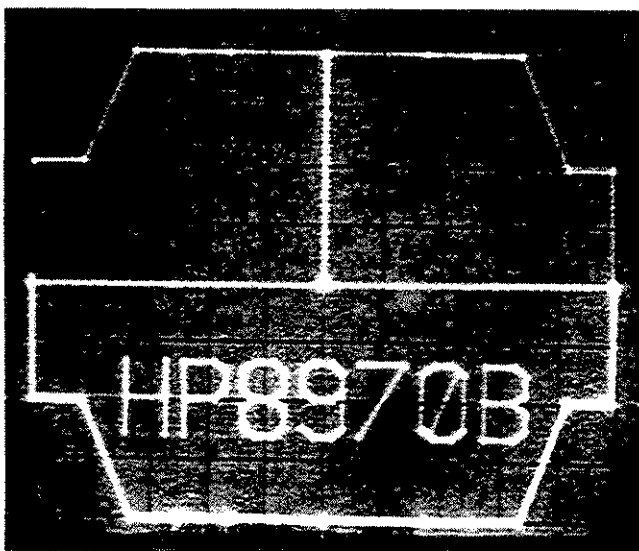


Figure 8-6. Test Pattern on Oscilloscope

5. If a problem exists with the test pattern, try displaying the test pattern using half as much X and Y gain. This may be needed because the oscilloscope being used has limited input range. If the oscilloscope still will not display the test pattern, perform the Display Linearity and X- and Y-Axis Gain Adjustment in Section V (paragraph 5-15) of this manual. If the problem persists, continue troubleshooting in Service Sheet BD5.

✓ 7

 HP-IB/SIB Check
**Procedure**

1. Turn the Noise Figure Meter off, then back on. Press PRESET.
2. Connect an HP-IB cable from the HP-IB connector to the SIB connector on the rear panel of the Noise Figure Meter. Make sure that no other instruments are connected to either the HP-IB or SIB bus.
3. On the Noise Figure Meter, key in 98.1 SPECIAL FUNCTION. "SIB tEst" should appear in the INSERTION GAIN and NOISE FIGURE displays for about 10 seconds. The NOISE FIGURE display shows the results of the test in the form "Exx". The code will be one of the following errors:

E00 No errors. Test passed.

E75 HP-IB chip (A14U28) or interface hardware not functioning.

E74 SIB chip (A14U2) or interface hardware to A14U2 not functioning (interface to HP-IB chip is good).

E01 REN or ATN line failure.

E02 Data path broken between HP-IB and SIB chips.

E03 SIB message to main HP-IB message failed.

E04 SRQ line not being set by HP-IB chip (A14U28) or not being detected by SIB chip (A14U2).

E05 SIB chip (A14U2) could not serial poll main HP-IB chip (A14U28).

E06 HP-IB collision detect circuit not functioning.

E07 Main HP-IB chip (A14U28) could not address SIB chip (A14U2).

E08 Main HP-IB message to SIB failed.

## SERVICE SHEET BD1 (cont'd)

If E00 is displayed, the HP-IB and SIB circuits are working normally.

If any code, other than E00, is displayed, try the test with another HP-IB cable to be certain the test failed. If the error still occurs, there is a problem with the HP-IB/SIB circuits, continue troubleshooting on Service Sheet BD4.

### Completion of Problem Isolation

At this point, the problem should have been isolated to either Service Sheet BD2, BD3, BD4 or BD5. If no malfunction is detected, continue with the Performance Tests (Section IV) to verify that the Noise Figure Meter is performing within specifications.

#### NOTE

*Do not perform the following checks unless otherwise instructed to in Checks 2 through 7.*

### 8 Controller Power-Up Check

This check needs to be done only if the front panel display is incorrect or the instrument does not respond properly to key presses.

**Purpose:** To verify the performance of the MPU.

#### Procedure

1. Switch the Noise Figure Meter LINE switch to ON. Carefully observe the turn-on sequence (normal sequence shown in Table 8-9) of the red LEDs (A14DS1) on the A14 Controller Board Assembly.

Table 8-9. A14DS1 Pattern at Power-up

Normal Controller Power-Up			
A14DS1 LEDs (1=ON 0=OFF)			
NSC	3	2	1
1	1	1	1
1	0	0	0
1	1	0	0
1	0	0	0
0*	0	0	1
0* BINARY COUNT**			

\*0 (OFF) if Special Function 48.0 is active or 1 (ON) if Special Function 48.1 is active  
 \*\* Continuously count in binary from 0 to 7.

- All the LEDs (A14DS1) on the A14 Controller Board Assembly will light for approximately 0.5 seconds. This indicates that the controller has reset and begun its power-up sequence.
- The A14DS1 LEDs will turn on and off as shown above. At the very end of the sequence, LED "NSC" (Not System Controller) will be either 0 (OFF, if Special Function 48.0 is active) or 1 (ON, if Special Function 48.1 is active). At the same time, LEDs A14DS1—1 to A14DS1—3 will count continuously in binary from 0 to 7.
  - a. If the error messages E70 through E72, E74, and E75 (see below) are displayed on the A14 Controller LEDs (A14DS1), the MPU self test has failed. Continue troubleshooting on Service Sheet BD4.

Table 8-10. A14DS1 Error Message Display

A14DS1 Display				Equivalent Front Panel Error Message	Error Description
NSC	3	2	1		
0	0	0	1	E75	HP-IB chip (A14U28) Self Test Failure.
0	0	1	0	E79	PIA 1 (A14U35) cannot drive hardware on the PA0—PA7 lines.
0	1	0	1	E74	SIB chip (A14U2) Self Test Failure.
0	1	1	0	E78	PIA 2 (A14U33) cannot drive hardware on the PA0—PA7 lines.
1	0	0	1	E73	Oscilloscope RAM Failure.
1	0	1	0	E77	PIA 1 (A14U35) Self Test Failure.
1	0	1	1	E71	ROM 2 (A14U7) Failure.
1	1	0	0	E72	Non-volatile RAM (A14U8) Failure.
1	1	0	1	E70	ROM 1 (A14U5) Failure.
1	1	1	0	E76	PIA 2 (A14U33) Self Test Failure.

**SERVICE SHEET BD1 (cont'd)**

b. If the error messages E73, and E76 through E79 (see Table 8-10) are displayed on the A14 Controller LEDs (A14DS1), the MPU self test has failed. Continue troubleshooting on Service Sheet BD4.

c. Continue troubleshooting with Service-Related Errors (E10—E19 and E50—E106) Recovery and Checks (Check 11) for any other error message displayed on the A14 Controller LEDs (A14DS1).

d. If the problem is resolved, return to the Instrument Power-Up Check (Check 2).

- If the MPU is operating normally, and if there is a problem with the Front Panel display or with the keyboard responses, continue with the Front Panel Interface Check (Check 9).

**✓9 Front Panel Interface Checks**

It is assumed, at this point, that the MPU is operating normally and that the problem has been isolated to either the front panel interface (Service Sheet 11) or to the Keyboard/Display assemblies.

This check must be done only if the front panel display is incorrect or the instrument does not respond properly to key presses.

**Procedure**

- Switch the Noise Figure Meter line power to OFF. Set the SA test switch A14S1, on the A14 Controller assembly, for the display signature test (Test 3) as shown below. Set the switches to all 1 when done with the signature measurement.

**SA Test Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Normal
SA1	1
SA2	1
SA3	0
SA4	0
SA5	0

- Turn the signature multimeter line power to ON, connect the signature multimeter timing pod to the following A14 Controller Assembly test points and set the polarity and threshold accordingly.

**Table 8-11. Signature Analyzer Connection and Settings**

Signal	A14 Test Point	Threshold	Polarity
START	A14TP3 "STR12"	TTL	rising edge
STOP	A14TP4 "STOP2"	TTL	rising edge
CLOCK	A14TP5 "SACLK"	TTL	falling edge
GND	A14TP2 "GND"	—	—

- Switch the Noise Figure Meter line switch to ON. Remove plug P7 from A14J3 to isolate the A2 Display assembly from the A14 Controller assembly (reconnect plug P7 after this step). Compare the signatures at the following test nodes on the A14 Controller Assembly.

**Table 8-12. Display Assembly Control Line Signatures**

Test Node	Signal Name	Signature
J3 pin -1	SERIAL DATA	1FH9*
-3	CLOCK	OC39
-4	P-LOAD	CO2F
-5	R(H)/W(L)	UU5H

\* 8F7U if P7 is disconnected from A14J3.

- If any of the signatures fail, continue troubleshooting on Service Sheet BD5. Otherwise, continue troubleshooting on Service Sheet BD3.
- Set the switches of the SA switch, A14S1, to normal operation settings (all 1's). Connect an oscilloscope to A14U35 pin 40 (PIA1). Hold down any key for a moment then release.
  - If the signal goes LOW when a key is held down and then goes HIGH when released, continue with step 6 of this check.
  - If not, continue troubleshooting on Service Sheet BD3.
- Connect the oscilloscope to A14U35 pin 39 (PIA1). Press any key.
  - If the signal toggles LOW then HIGH when a key is pressed, continue troubleshooting on Service Sheet BD3.
  - If not, continue troubleshooting on Service Sheet BD4.
- If the MPU or the Keyboard/Display Assembly fault is resolved, return to the Instrument Power-Up Check (Check 2).

## SERVICE SHEET BD1 (cont'd)

### ✓10 Frequency CAL Check

This test must be performed only if error message E18 occurs or if there is a failure of the Tuning Accuracy Test in Section IV of the HP 8970B Operating Manual.

#### Procedure

1. Perform adjustment procedure 5-12, Frequency CAL RF Detector and 1st LO Offset, in Section V of this manual. If the adjustment cannot be completed or if error message E18 persists, continue with step 2 of this check. Otherwise, skip to step 7.
2. Verify that correct data is getting to the 1st LO Tuning DACs. Switch the Noise Figure Meter line power to OFF. Set the SA test switch A14S1, on the A14 Controller assembly for the PIA2, A14U33, and YIG DACs signature analysis test (Test 4) as shown below. Set the switches to all 1 when done with the signature measurement.
3. Turn the signature multimeter line switch to ON, connect the signature multimeter timing pod to the following A14 Controller Assembly test points (see Table 8-13) and set the polarity and threshold accordingly.
4. Switch the Noise Figure Meter line switch to ON. Compare the signatures at the following test nodes (see Table 8-14) on the A13 Driver Board Assembly to determine if the data lines to the 1st LO Data Latches are at fault.

If any of the signatures fail, continue troubleshooting on Service Sheet BD5. Otherwise, continue with step 5.

SA Test Switch (A14S1) Setting

Switch	Switch Setting
Normal/Frun	Normal
SA1	0
SA2	0
SA3	1
SA4	0
SA5	0

5. Connect an oscilloscope with a 10:1 probe to A14TP8 "FREQ CAL DET IN" and set the oscilloscope to 1 V/division (DC coupled) and 1 s/division.
6. While observing the oscilloscope display, press the PRESET key to force the Noise Figure Meter to perform a frequency calibration. During the frequency calibration, the Noise Figure Meter tunes the 1st LO through the passband of the frequency calibration detector. As it tunes, the voltage from the frequency calibration detector will pulse with a peak voltage of greater than 2 volts.

If the displayed voltage on the oscilloscope reaches a peak of > +2 volts, the problem is with the Comparator and Sample/Hold circuits; continue troubleshooting on Service Sheet BD5.

If the displayed voltage on the oscilloscope doesn't reach a peak of +2 volts, the problem is with the RF path; continue troubleshooting on Service Sheet BD2.

Table 8-13. Signature Analyzer Connection and Settings

Signal	A14 Test Point	Threshold	Polarity
START	A14TP3 "STRT2"	TTL	rising edge
STOP	A14TP4 "STOP2"	TTL	rising edge
CLOCK	A14TP5 "SACLK"	TTL	falling edge
GND	A14TP2 "GND"	—	—

Table 8-14. First LO Data Latch Signatures

A13 Test Node	Signal Name	Signature
A13U16 pin 3	DA0	H913
4	DA2	HF38
7	DA4	8U55
8	DA6	C9C1
11	E6(L)	8153
13	DA7	49H3
14	DA5	796C
17	DA3	5H71
18	DA1	HF7H
A13U15 pin 11	E5(L)	7057
A13U14 pin 11	E4(L)	P3C0

## SERVICE SHEET BD1 (cont'd)

7. At this point, it is assumed that the problem with frequency calibration has been resolved and that Frequency RF CAL Detector and 1st LO Offset Adjustment (paragraph 5-12) of this manual has been performed. Perform the Tuning Accuracy Performance Test (paragraph 4-5) in the HP 8970B Operating Manual.

a. If the Noise Figure Meter fails, continue troubleshooting the Sample/Hold Amplifier, Comparator and PIA 1 circuits on Service Sheet 11 (BD5).

b. If the Noise Figure Meter passes, perform the rest of the performance tests to verify that the instrument is performing to specification.

### ✓11 Service-Related Errors (E10—E19 and E50—E106) Recovery and Checks

Service related errors are errors that typically reflect internal component malfunctions. Some of the service related errors discussed below may occur during improper operation, and therefore, might not reflect true failures. If the error troubleshooting does not isolate the cause of the error and the error remains, continue troubleshooting on Service Sheet BD1.

#### NOTE

*A complete listing of all error messages can be found in Section III of the Noise Figure Meter Operating Manual.*

*Special Function 99.1, last error read-back, can be used to display the last error that was issued.*

*Refer to Check 8 for more error message recovery information.*

**E10 Analog-to-Digital Conversion Failed.** A conversion is initiated via the CVT signal line. When the conversion cycle is completed by the analog-to-digital converter circuits, the ECVT signal line is set true. This typically will occur within 20 to 30 ms. If the ECVT signal is not received by the controller within 1 second, E10 is displayed.

#### Error Troubleshooting

1. Check for a 4 MHz TTL level clock signal at A13TP3.

If the signal is normal, continue with step 2.

If the signal is incorrect, the problem is most likely with cable assembly A13W5 or on Service Sheet 12. Use the troubleshooting information on Service Sheet BD4 that applies to Service Sheet 12 (Timing Generator) to isolate the problem further.

2. Verify that the CVT line (A13U33 Pin 17) goes to a logical low to start a conversion.

If the CVT signal is correct, continue with step 3.

If the CVT signal is not correct, the problem is most likely on Service Sheet 11. Use the troubleshooting information on Service Sheet BD5 that applies to Service Sheet 11 (A13U33).

3. Verify that the ECVT line (A13U33 Pin 40) goes low to indicate the end of conversion.

If the ECVT signal is correct, the problem is most likely on Service Sheet 11. Use the troubleshooting information on Service Sheet BD5 that applies to Service Sheet 11 (A13U33) to isolate the problem further.

If the ECVT signal is incorrect, the problem is most likely in cable assembly W9 or on Service Sheet 5 or 6.

**E11 Analog-to-Digital Converter Overflow.** This error can occur when there is no malfunction, if the operator has manually set the IF Attenuators (via Special Functions 70.1 through 70.8), or prevented them from auto-ranging (72.0). During the measurement sequence, the Noise Figure Meter adjusts the IF Attenuators. If a conversion results in the OVFL signal line being set true, and the IF Attenuators are inhibited from auto-ranging to a higher attenuation level, E11 is displayed.

If a conversion is made, and either the OVFL signal is generated or the conversion indicates >1.2V, and the IF attenuators are

## SERVICE SHEET BD1 (cont'd)

on their maximum setting (35 dB), then the microprocessor will attempt to lower the RF gain on the Input Assembly. If the RF gain is already at the minimum setting (-30 dB), or if the RF gain is inhibited from auto-ranging, E11 is displayed.

### Error Troubleshooting

#### NOTE

*If Special Function 92.1 has been selected, it is normal for E11 to be displayed.*

1. Remove any input signal from the Noise Figure Meter and press PRESET and 70.1 SPECIAL FUNCTION.

If E11 remains, continue with step 2.

If E11 is cleared, continue with step 4.

2. Verify that the voltage at the DET OUT connector on the rear panel of the Noise Figure Meter is  $\geq 1.2$  Vdc.

If the voltage is correct an over-voltage condition does exist. Continue troubleshooting on Service Sheet BD2 to remove the over-voltage condition.

If the voltage is  $< 1.2$  Vdc, continue with step 3.

3. Verify that the OVFL line (A13U33 Pin 18) goes low indicating an over-voltage condition.

If the signal goes low, the problem is most likely with the voltmeter circuits of Service Sheet 5 or 6.

If the signal does not go low, the problem is most likely on Service Sheet 11. Use the troubleshooting information on Service Sheet BD5 that applies to Service Sheet 11 (A13U33) to isolate the problem further.

4. Perform Checks 4 and 5 of Service Sheet BD1 troubleshooting to check the RF and IF Attenuators.

If there is still a problem, perform Service Sheet BD1 troubleshooting from the beginning to isolate the problem.

- E12 Input Overflow.** The microprocessor uses the Input Power Detector on the Input Assembly to set the RF gain. The Input Power Detector drives the Window Comparator on the Controller Assembly. The Window Comparator output indicates when the RF gain is optimized. If the input gain setting is at a minimum (-30 dB), and the Window Comparator still indicates that more attenuation is needed, E12 is displayed.

### Error Troubleshooting

1. With nothing connected to the Noise Figure Meter's RF INPUT, press 60.1 SPECIAL FUNCTION.

If the error remains, continue with step 2.

If the error is cleared, continue with step 3.

2. Measure the DC voltage at the Input Power Detector output (A14TP12).

If the output is less than 6.8 volts, the problem is most likely on Service Sheet 11. Use the troubleshooting information on Service Sheet BD5 that applies to Service Sheet 11 to isolate the problem further.

If the output is greater than 6.8 volts, the problem is most likely with the 20 dB Input Amplifier or Input Power Detector circuits. Continue troubleshooting on Service Sheet BD2.

3. To verify that the Input Power Detector and RF Attenuators are operating properly, use the following steps:

Perform the Input Power Detector Adjustment in Section V of this manual.

Perform Check 4 (RF Attenuator Checks) from Service Sheet BD1 troubleshooting.

- E13 IF Attenuator Calibration Failed.** Special Function 33.1 can be used to calibrate the IF attenuators on the 20 MHz IF Assembly.

#### NOTE

*Using Special Function 33.1 to calibrate the IF attenuators will reduce the Gain Measurement Uncertainty Specification*

## SERVICE SHEET BD1 (cont'd)

*to a typical value of  $\pm 0.25$  dB. See the Calibration, IF Attenuators Detailed Operating Instruction in Section III of the Noise Figure Meter Operating Manual.*

During this calibration, the Noise Figure Meter compares the 5 dB, 10 dB, 15 dB (5 and 10 dB settings combined), and 20 dB measurements to the 0 dB measurement. E13 is displayed after execution of this Special Function, if one of the following four conditions occurs:

1. If one of the analog-to-digital conversion cycles associated with this measurement results in the OVFL signal being set true.
2. If the voltage reading from the analog-to-digital converter is too low during the 0 dB measurement.
3. If there is 20% or more error in the results, when compared with the nominal value.
4. If a noise source with an ENR of  $< \approx 15$  dB is used. (Do not use an HP 346A.)

### Error Troubleshooting

Refer to the Calibrate, IF Attenuators Detailed Operating Instruction in Section III of the Operating Manual.

#### NOTE

*Using Special Function 33.1 to calibrate the IF Attenuators will reduce the Gain Accuracy specification to a typical value of  $\pm 0.25$  dB.*

If attempting to use Special Function 33.1 with an HP 346B/C Noise Source, continue with Service Sheet BD1 troubleshooting (Power-up Checks, Step 7).

Note that an HP 346A Noise Source will not work with Special Function 33.1 unless approximately 10 dB of gain at 30 MHz is inserted between the noise source and the Noise Figure Meter. Use the following procedure:

1. Connect an amplifier (20 dB gain at 30 MHz) and a 1 dB step attenuator between the HP 346A Noise Source and the Noise Figure Meter INPUT connector.
2. Set the step attenuator to 10 dB.
3. On the Noise Figure Meter, press PRESET, 81.0 SPECIAL FUNCTION, 70.1 SPECIAL FUNCTION, and 60.1 SPECIAL FUNCTION.
4. Adjust the step attenuator until the reading on the Noise Figure Meter is about 1 Vdc.
5. On the Noise Figure Meter, press 33.1 SPECIAL FUNCTION.

### E14 Cannot Select Proper IF or RF Attenuators.

The Noise Figure Meter sets the level into the Noise Power Detector between 0.52V and 1.1V. The routine that sets this level modifies the input gain and the IF attenuation until the proper level is achieved. If the proper level is not reached after 10 tries, E14 is displayed.

#### Error Troubleshooting

Continue with Service Sheet BD1 troubleshooting.

- E18 Frequency Calibration Failed.** During the frequency calibration process, the 1st LO is tuned to 2050 MHz. The LO signal passes through most of the signal path as LO feed-through. It is detected on the 20 MHz IF Assembly by the Frequency Cal RF Detector. This is a tuned detector whose passband is peaked at 2050 MHz. The LO tuning DACs are programmed to tune the LO up and down until the peak of the detected level is found. The data that peaks the signal is then remembered as the 0 MHz tuning value. If no peak is found after three tries, E18 is displayed.

#### Error Troubleshooting

Perform the Frequency Cal Check (Check 10) on Service Sheet BD1.

- E19 Noise Figure Test Set YIG Calibration Failed.**



## SERVICE SHEET BD1 (cont'd)

### Error Troubleshooting

This error can be generated for either a coarse or fine tune calibration. Check all microwave cables and ensure that the LO, RF, and IF signal paths have been properly connected. Loss after the noise source, when no preamp is used, can cause this error when doing a fine tune calibration. Some setups with loss between the noise source and the Noise Figure Test Set might require a preamp to be used for a fine tune calibration. It is possible to do a fine tune calibration with the noise source connected directly to the Noise Figure Test Set input, if no preamp is available. The noise source should have at least 12 dB ENR for a fine tune calibration to function with no preamp. If the error occurs after another attempted calibration, there is a problem with the Noise Figure Meter locating the Noise Figure Test Set YIG passband.

Special Function 97.1, along with an oscilloscope, can be used to view the power levels that the Noise Figure Meter is reading during the coarse or fine calibration. The Noise Figure Meter oscilloscope gain should be set to 120 dB (Special Function 8.3) and 500 dB (Special Function 8.4) for viewing typical peaks. These values work well when the noise source is connected directly into the Noise Figure Test Set with no preamp, higher values will be needed with a preamp. Some sort of peak will be drawn on the oscilloscope display as the coarse tune (Special Function 64.0) or fine tune (Special Function 36.3) calibration progresses. If E19 persists, refer to the Noise Figure Test Set Service Manual.

### E20—E29 Calibration Errors.

#### Error Troubleshooting

These errors are usually due to operator error. If the proper operating procedures have been followed and the error message remains, use the following steps:

1. If E26 occurs, refer to the Calibration, IF Attenuators Detailed Operating Instruction in Section III of the Operating Manual.
2. If E28 or E29 occurs, refer to the Noise Figure Meter Operating Manual (Section

III, Error Messages). If the error remains, refer to the Noise Figure Test Set Service Manual.

3. Continue with Service Sheet BD1 troubleshooting.

### E36 Undefined Special Function.

#### Error Troubleshooting

If the special function selected is valid, there may be a problem with front panel circuits (Keyboard). Perform the Front Panel Interface Checks (Check 9) on Service Sheet BD1. Continue with Service Sheet BD3 troubleshooting if no errors are found.

### E40—E42 and E44—E48 Errors That Could Indicate an HP-IB or System Interface Bus (SIB) Problem.

- E40 Undefined HP-IB code
- E41 Undefined HP-IB characters
- E42 System LO not found on the System Interface Bus (SIB)
- E44 Noise Figure Test Set not found on System Interface Bus (SIB)
- E45 Plotter not found on the System Interface Bus (SIB)
- E46 Pass through device not found on the System Interface Bus (SIB)
- E47 Controller not found on System Interface Bus (SIB) while passing control
- E48 Two or more controllers are on the System Interface Bus (SIB)

#### Error Troubleshooting

For error codes E40 through E48, use the following procedures:

1. Perform the HP-IB/SIB Test (Check 7) on Service Sheet BD1.

If there are no errors, take corrective action as described in Section III (Error Messages) of the Noise Figure Meter Operating Manual and check any other devices involved.

For example, if E45 (No Plotter Found) was displayed and the problem was not resolved by taking all of the corrective actions, verify that the plotter is operational.

### E70—E79 Hardware Errors.

- E70 ROM 1 (A14U5) Failure
- E71 ROM 2 (A14U7) Failure

**SERVICE SHEET BD1 (cont'd)**

- E72 Non-volatile RAM (A14U8) Failure
- E73 Oscilloscope Display RAM (A14U19) Failure
- E74 SIB chip (A14U2) Self Test Failure
- E75 HP-IB chip (A14U28) Self Test Failure
- E76 PIA 2 (A14U33) Self Test Failure
- E77 PIA 1 (A14U35) Self Test Failure
- E78 PIA 2 (A14U33) cannot drive hardware on the PA0—PA7 lines
- E79 PIA 1 (A14U35) cannot drive hardware on the PA0—PA7 lines

**Error Troubleshooting**

For E70 through E79 continue troubleshooting on Service Sheet BD4.

- E80 Continuous Memory Failure.** This error indicates that data stored in the non-volatile memory has in some way been erroneously modified or lost. The actual memory circuits are not bad, but the battery back-up has allowed the data to be lost. This error can be recovered from, but the stored data will remain lost. To clear the error, press any front panel key.

If the error is not cleared before power is removed, the error will reoccur at power up. Since the stored data is lost, it is necessary to re-enter the IF Attenuator values (see Calibration, IF Attenuators in Section III of the Noise Figure Meter Operating Manual) before corrected measurements can be made. Non-volatile memory can operate for a few minutes on the charge stored on the circuit board. Thus, if the instrument is turned off for only a short period of time, error E80 may not occur even if the battery is dead.

**Error Troubleshooting**

Continue troubleshooting on Service Sheet BD4.

- E101 Noise Figure Test Set Self Test Failed.**

**Error Troubleshooting**

Use Special Function 98.7 to perform another self test and display the results. Special Function 45.1 must be active for this test to work. After pressing 98.7 SPECIAL FUNCTION, the left display, of the Noise Figure

Meter, will show 60000 until the results come back from the Noise Figure Test Set. The results of the self test are displayed as a decimal value in the left display of the Noise Figure Meter. If the value is zero, all of the tests passed. If the value is not zero, one or more of the tests failed. To determine which test(s) failed, refer to the following table. The table gives a description of each test and the binary weight associated with the test. By determining the equivalent binary number for the decimal displayed on the Noise Figure Meter, the test(s) that failed can be determined. Once the failure has been determined, refer to the Noise Figure Test Set Service Manual to troubleshoot the failure.

**Noise Figure Test Set Self Test**

Binary Weight	Test Description
1	A/D converter or five volt reference to the converter is bad.
2	Input air sensor reads much too high.
4	YIG DACs, YIG coil or sense for the YIG is bad.
8	YIG heater DAC, YIG heater sense resistor or readback circuitry is bad.
16	YIG heater DAC output is bad.
32	Temperature regulation sensor or offset DAC is bad.
64	Offset DAC is bad.
128	Timer IC has failed.
256	Checksum of the program ROM is bad.
512	Checksum of the coarse tune table EEPROM is bad.

**E102—E104**

Refer to Section III (Error Messages) in the Noise Figure Meter Operating Manual.

- E105 Noise Figure Test Set YIG Filter Temperature Control Loop Will Not Lock.**

**Error Troubleshooting**

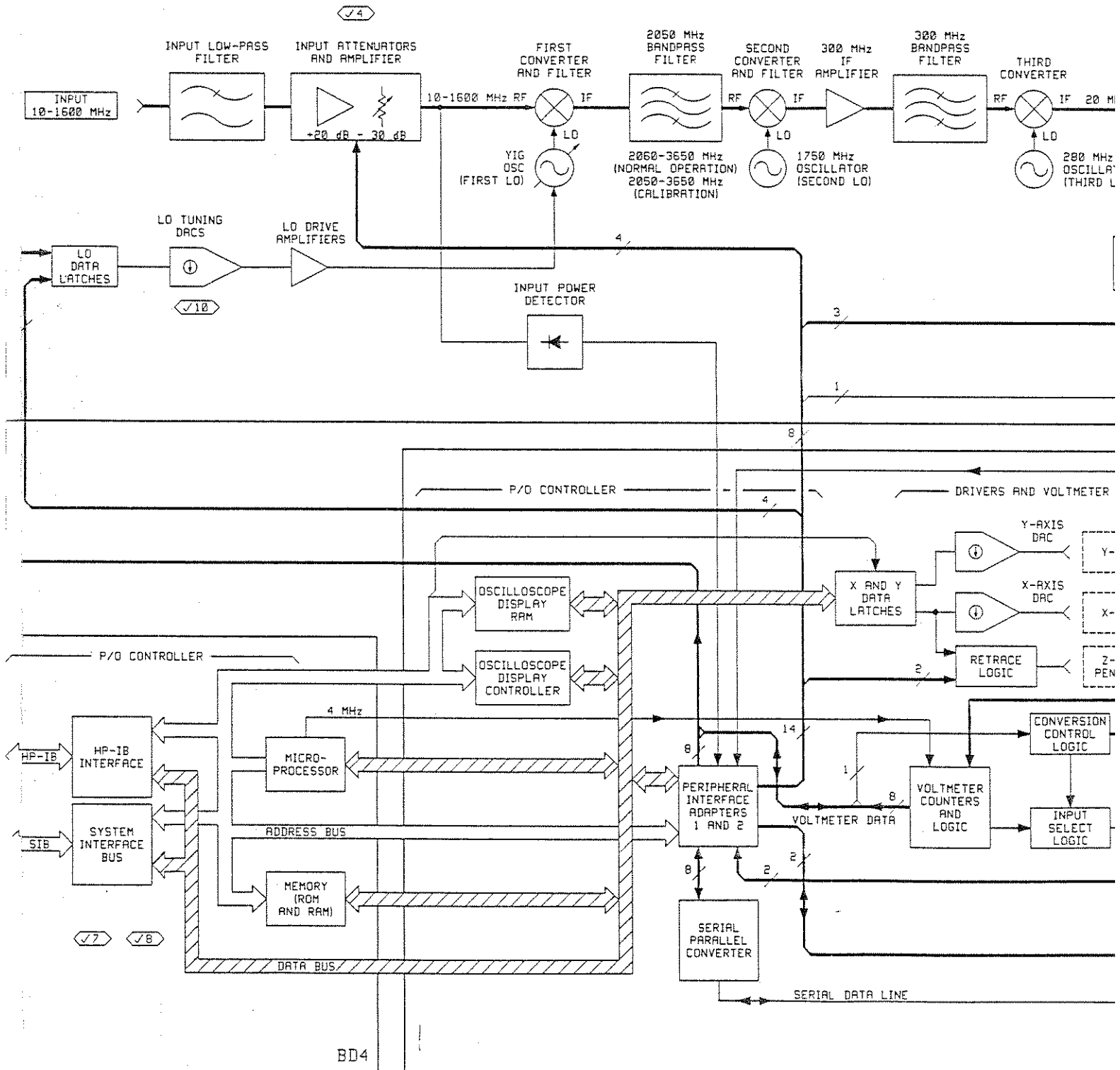
Refer to Section VIII of the Noise Figure Test Set Service Manual Also, refer to Special Function 93.X, ROM Inspection and RAM Inspection/Modification Utilities (Special Options, bit 3).

**SERVICE SHEET BD1 (cont'd)****E106 User Controlled LO Not Found on The System Interface Bus.****Error Troubleshooting**

Make sure that Special Functions 96.1 and 48.0 are set, the LO address (Special Func-

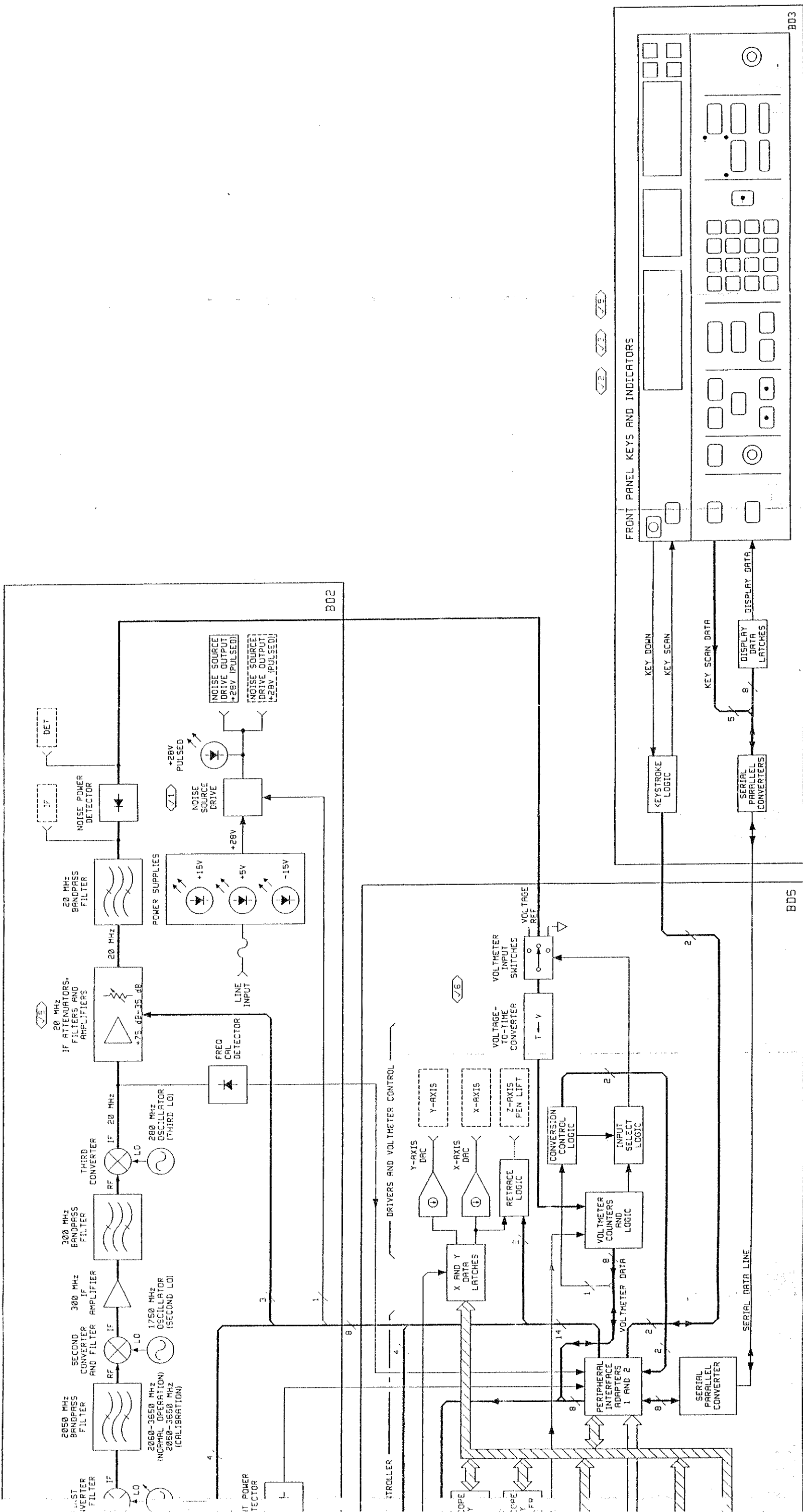
tion 96.2) is correct, and the LO type (Special Function 96.3) is correct. If necessary, refer to Special Function 98.1 to perform the HP-IB/SIB self test. If the problem is not corrected, check the user controlled LO.





BD4





BD1

Figure 8-7. Overall Block Diagram

8-37/8-38

Service





## SERVICE SHEET BD2 — ANALOG SECTION BLOCK DIAGRAM

### REFERENCES

Section III — Detailed Operating Instructions  
Section VIII — Special Functions and  
Power-Up Checks

### PRINCIPLES OF OPERATION

#### General

Block Diagram 2 covers the Noise Figure Meter's analog circuits. The analog circuits receive the 10 to 1600 MHz RF input signal and upconverts it to a fixed 2050 MHz IF. The 2050 MHz IF is then downconverted to a 300 MHz IF, and finally to a 20 MHz IF. The 20 MHz IF is routed to the Noise Power Detector and the detected dc voltage goes to an inverter in the A7 Voltmeter Assembly.

The First LO Drive circuits provide the 2050 to 3650 MHz signal to the First Converter mixer. Power Supply Assembly A9 provides the +15 Vdc, -15 Vdc, and +5 Vdc supplies for the logic and analog circuits, and the pulsed +28 Vdc for the Noise Source.

#### Input Assembly (A6)

A low-pass filter at the input of the Noise Figure Meter rejects frequencies greater than 1650 MHz. Following the filter, are a switchable 20 dB amplifier, three switchable 10 dB attenuators, a power detector, and a fixed 2 dB attenuator. These are used to set the signal power level into the following First Converter.

RF power is detected and converted to a dc voltage by the input power detector circuit. The level of the detected voltage is used by the micro-processor to set the overall gain of the Input Assembly. The net gain of the input circuits (excluding -2 dB at the output) ranges from +20 dB to -30 dB in 10 dB steps. The broadband RF power (10 to 1600 MHz) is output to the First Converter. The power is kept as high as possible, but no more than -20 dBm with the noise source on. The 2 dB attenuator on the output, is used to impedance match the Input Assembly to the First Converter Assembly.

#### First Converter Assembly (A10)

The First Converter upconverts the 10 to 1600 MHz RF input noise power to a fixed 2050 MHz intermediate frequency (IF). At the input, the noise power passes through a low-pass filter (1850 MHz for 2745A and above or 1650 MHz for 2742A and below) to the mixer. This low-pass filter rejects frequencies greater than 1850 MHz

(for 2745A and above) or 1550 MHz (for 2742A and below). The First LO signal is input through a 3 dB power splitter. One of the power splitter outputs is routed to the mixer. The other output goes to test connector J4 (LO OUT).

The 2050 MHz first IF output signal passes through a 5000 MHz low-pass filter, a 6200 MHz low-pass filter (2812A and above) and an isolator to the Second Converter. The 5000 MHz low-pass filter assures only the lower conversion sideband is allowed to pass. The 6200 MHz low-pass filter is placed between the first converter and the isolator to eliminate harmonics of the first LO from getting into the second converter (2812A and above). The isolator provides impedance (50Ω) matching, while allowing one-way signal flow, between the First Converter and the Second Converter.

#### Second Converter Assembly (A11)

The 2050 MHz IF signal enters the Second Converter through a bandpass filter consisting of three circular slug-tuned cavity resonators. The cavities provide high "Q" (good selectivity) at 2050 MHz. A second LO of 1750 MHz drives the second mixer. The second mixer downconverts the first IF signal of 2050 MHz to a second IF at 300 MHz. This signal is coupled through a low-pass matching filter to the 300 MHz IF Amplifier.

#### 300 MHz IF Amplifier Assembly (A4)

The signal from the Second Converter is amplified by a 300 MHz IF Amplifier with a gain of approximately 19 dB. A 300 MHz bandpass filter selects the proper sideband for down conversion to 20 MHz and rejects first LO feedthrough. The filtered output then enters the third converter where it is mixed with a 280 MHz LO signal. The resulting 20 MHz output is routed to the 20 MHz IF Section. The net gain through the 300 MHz IF Assembly is approximately 10 dB.

#### 20 MHz IF Assembly (A3, Service Sheet 2)

The 20 MHz IF contains a series of filters, amplifiers, and attenuators which determine the bandwidth and set the power level of the 20 MHz (center frequency) noise signal that is sent to the Noise Power Detector Assembly. The nominal bandwidth of the 20 MHz IF is 4 MHz. The bandwidth is set by two 20 MHz bandpass filters at the input of the 20 MHz IF Assembly, and the 20 MHz Bandpass Filter in the Noise Power Detector Assembly. The gain of the 20 MHz IF is set by the internal controller in 5 dB steps from +40 to +75 dB. The controller selects the appropriate combination of the 5, 10, and 20 dB attenuators.

**SERVICE SHEET BD2 (cont'd)****20 MHz IF Assembly (A3, Service Sheet 3)**

The Frequency Cal Detector detects First LO feedthrough during a frequency calibration operation, in order to determine the instrument's zero input frequency point. During a frequency calibration, the First LO is tuned to 2050 MHz. The controller sets the First LO frequency to obtain a maximum signal from the detector. This ensures that the First LO feedthrough (converted to 300 MHz, then 20 MHz) is at the center of the 20 MHz IF passband at the end of the routine. This is equivalent to tuning the instrument to zero frequency to set the frequency reference.

**Noise Power Detector Assembly (A8)**

The 20 MHz bandpass filter at the input, is the last stage of the 20 MHz IF, and is used in setting the 4 MHz passband. The output of the 20 MHz filter goes through a 32 dB attenuator and a 40 MHz low-pass filter. The filter removes harmonics, and then routes the signal to the rear panel IF output connector. The output of the 20 MHz bandpass filter also goes to the Noise Power Detector. The detector is biased for linearity and detects voltage, not power. The detector output goes to the rear panel DET connector and to the A7 Voltmeter Assembly.

**First LO Drive (P/O A13 Driver Assembly)**

The First Local Oscillator (LO) is the only tunable LO in the instrument, and is tunable over a frequency range from 2050 MHz to 3650 MHz. This gives the Noise Figure Meter its 1590 MHz input frequency range (10 to 1600 MHz), and the 2050 MHz used for the frequency calibration. The LO Data Latches are loaded with tuning data from the controller, which are the digital inputs to the Fine and Coarse Tune Digital-to-Analog Converters (DACs).

The current outputs from the converters are summed and amplified by the 1st LO Drive Amplifier. The controllable drive current flows through the main coil of the YIG and provides the tuning. During a frequency calibration, the YIG is tuned to 2050 MHz and the tuning data that yields the highest amplitude from the Frequency Cal Detector is noted as the zero frequency tuning point.

**Power Supply (A9)**

Three steady state supplies are used internally in the Noise Figure Meter: +15V, +5V, and -15V.

In addition, a pulsed +28V supply is included to drive the external noise source. The Noise Source Drive circuit regulates the rectified +28V and, under command of the controller, pulses it on and off (between +28V and ground). This voltage is routed to both the front and rear panel Noise Source Drive Outputs.

**TROUBLESHOOTING**

It is assumed that the troubleshooting information from Service Sheet BD1 was used to isolate a malfunction to this block diagram. The following information will aid in isolating a malfunction to a service sheet. Check 3 will specify when to perform Check 4.

**Test Equipment**

Signature Multimeter	.....	HP 5005B
Noise Source	.....	HP 346B/C
Digital Voltmeter (DVM)	.....	HP 3456A
Synthesized Sweeper	.....	HP 8340B
Spectrum Analyzer	.....	HP 8566B
Oscilloscope	.....	Tektronix 2235

**✓ 1 Power Supply Check****Procedure**

1. Check the power supply voltages and ripple at the following test points (connect ground test lead to A9TP4 "GND") of the A9 Power Supply Assembly. The normal indications are shown below.

Table 8-15. A9 Power Supply Voltages

Test Point	Power Supply	Voltage (Vdc)	Ripple
A9TP3	+5 Vdc	+5.0 to +5.6	<20 mVp-p
A9TP2	+15 Vdc	+14.0 to +16.0	<20 mVp-p
A9TP1	-15 Vdc	-16.0 to -14.0	<20 mVp-p

2. On the Noise Figure Meter, press PRESET and key in 81.0 SPECIAL FUNCTION. Verify that the voltage and ripple at the NOISE SOURCE DRIVE OUTPUT on the front panel connector are  $+28.00 \pm 0.25$  Vdc and  $< 20$  mVp-p, respectively. Also, verify that the voltage at the NOISE SOURCE DRIVE OUTPUT on the rear panel connector is  $+28.00 \pm 0.25$  Vdc.

**SERVICE SHEET BD2 (cont'd)**

- On the Noise Figure Meter, key in 80.0 SPECIAL FUNCTION. Verify that the voltage at the NOISE SOURCE DRIVE OUTPUT on the front panel connector changed to less than + 0.85 Vdc.

If all the indications in steps 1 through 3 are correct, continue with the next check.

If any of the indications in steps 1 through 3 are incorrect, continue troubleshooting on Service Sheet 18.

**2 General Checks**

**Procedure**

- Connect a noise source between the Noise Source Drive Output and the RF INPUT of the Noise Figure Meter.
- On the Noise Figure Meter, press PRESET and key in 70.1, 60.1, 31.1, and 81.0 SPECIAL FUNCTION.
- Verify that a voltage of > +0.70 Vdc (typical) is displayed on the front panel. Also, with a DVM, verify that the voltage at the rear panel DET OUTPUT is within 100 mV of the voltage displayed.

If both voltage readings are correct, continue with the next step.

If the voltage at the rear panel DET OUTPUT is correct, but the voltage displayed on

the Noise Figure Meter is incorrect, continue troubleshooting on Service Sheet BD5.

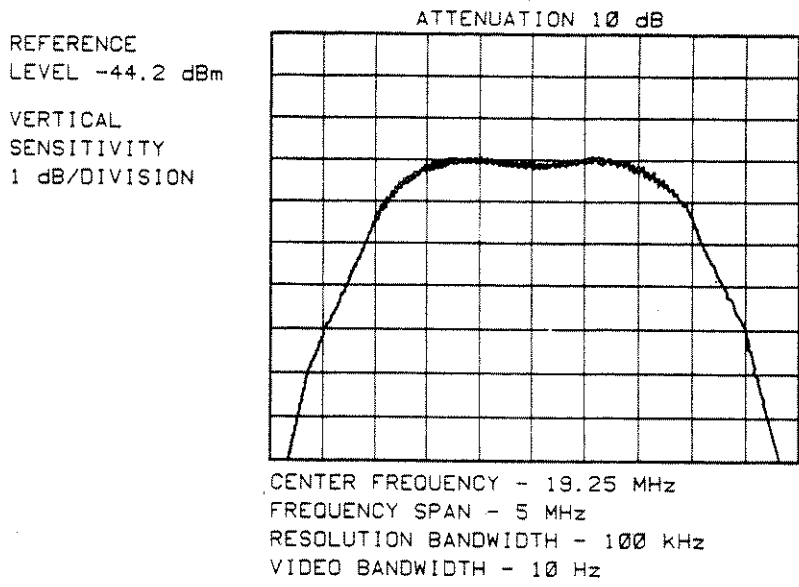
If the voltage displayed on the Noise Figure Meter is correct, but the rear panel DET OUTPUT voltage is incorrect, the problem is with the circuit between the noise power detector and the rear panel DET OUTPUT, continue troubleshooting on Service Sheet 5.

If both voltage readings are incorrect, continue with the next check.

- Connect the spectrum analyzer to the IF OUTPUT connector on the rear panel of the Noise Figure Meter. Set the spectrum analyzer as follows:

Instrument Preset .....	Press
Center Frequency .....	20 MHz
Frequency Span .....	5 MHz
Reference Level .....	-30 dBm
Resolution Bandwidth .....	100 kHz
Video Bandwidth .....	100 Hz
Log Scale .....	1 dB/division

- Adjust the reference level to set the peak of the passband to the third horizontal graticule line from the top. Center the 20 MHz IF passband on the spectrum analyzer display. Verify that the passband is 3 to 5 MHz wide as measured from the lower 3 dB point to the upper 3 dB point and is flat to within 1 dB as measured between the center frequency minus 1 MHz and the center frequency plus 1 MHz. Verify that the center frequency of the passband is  $19.5 \pm 0.5$  MHz. See Figure 8-8.



**Figure 8-8. 20 MHz IF Output**

## SERVICE SHEET BD2 (cont'd)

If the spectrum analyzer display is correct, continue with step 7 of Gain Check (Check 3).

If only the passband flatness is incorrect, change A8C5 (see Table 5-1, Factory Selected Components). Otherwise, continue troubleshooting on Service Sheets 3 and 4.

### ✓ 3 Gain Checks

#### NOTE

*If Check 2 failed and Check 3 passes, the problem is most likely the noise source.*

#### Procedure

1. With the synthesized sweeper, inject a 30 MHz CW signal with a power level of  $-73$  dBm into the RF INPUT of the Noise Figure Meter.
2. On the Noise Figure Meter, press PRESET and key in 63.0, 70.1, and 31.1 SPECIAL FUNCTION.
3. With the spectrum analyzer, measure the power level of the 2050 MHz signal at the AT1 Isolator output. The power level should be  $> -87$  dBm.

#### NOTE

*Error message E18 may appear and is normal since the RF path has been broken in steps 3 and 4. Press the FREQUENCY key to clear the error message from the display. Key in 31.1 SPECIAL FUNCTION to disable the frequency calibration routine.*

a. If the signal level is correct, continue with step 4.

b. If the signal level is incorrect, check the voltages at the RF attenuator control lines of the A6 Input Assembly. The voltages should be as shown in Table 8-16.

If the voltages are correct, continue with YIG Oscillator Output Check (Check 4).

If any of the voltages are incorrect, continue troubleshooting on Service Sheet 11 (use the troubleshooting for Service Sheet 11 found on Service Sheet BD5.)

Table 8-16. RF Attenuator Control Line Voltages

Test Node	Control Lines	Voltages
A14U29 pin 13	10 dB Pad 1	$< 1$ Vdc
A14U29 pin 14	10 dB Pad 2	$< 1$ Vdc
A14U29 pin 15	10 dB Pad 3	$< 1$ Vdc
A14U29 pin 16	20 dB Amplifier	$> 14$ Vdc

4. Reconnect the cable (W5) to the AT1 Isolator output. Move capacitor A3C82 (in sockets) to connect the output of the A4 300 MHz IF Assembly to A3J1. With the spectrum analyzer, measure the power level of the 20 MHz signal at A3J1. Record the power level. The power level should be  $> -87$  dBm.

If the signal level is correct, continue with the next step.

If the signal level is incorrect, perform adjustments 5-8 to 5-11 in Section V of this manual. If any of the adjustments cannot be performed or if the problem persists after the adjustments, continue troubleshooting on Service Sheet 2.

5. Position capacitor A3C82 between sockets "A" and "B" to connect the output of the 300 MHz IF Assembly to the input of the 20 MHz Assembly. With the spectrum analyzer, measure the power level of the 20 MHz signal at the rear panel IF OUTPUT connector. The power level should be  $>$  (the power level measured in step 4 plus 42 dB).

a. If the signal level is correct, continue with the next step.

b. If the signal level is incorrect, check the voltages at the IF attenuator control lines of A3 20 MHz IF Assembly. The voltages should be as shown below.

Table 8-17. IF Attenuator Control Line Voltages

Test Node	Control Lines	Voltages
A14U45 pin 15	20 dB Attenuator	$< +0.4$ Vdc
A14U45 pin 16	10 dB Attenuator	$< +0.4$ Vdc
A14U45 pin 19	5 dB Attenuator	$< +0.4$ Vdc

If the voltages are correct, the problem is on Service Sheet 3 or 4; continue troubleshooting there.

## SERVICE SHEET BD2 (cont'd)

If any of the voltages are incorrect, continue troubleshooting on Service Sheet 11 (BD5).

6. With the synthesized sweeper still connected to the Noise Figure Meter RF INPUT, adjust the synthesized sweeper power level until the 20 MHz IF power level is  $-32$  dBm as measured with the spectrum analyzer at the rear panel IF OUTPUT connector. On the Noise Figure Meter, key in 81.0 SPECIAL FUNCTION. The Noise Figure Meter should display  $>+0.8$  Vdc.

If the displayed voltage is correct, continue with the next step.

If the voltage displayed is incorrect, the problem is with the noise power detector circuit, continue troubleshooting on Service Sheet 5.

7. Connect an oscilloscope with a 10:1 probe to A14TP8 "FREQ CAL DET IN" and set the oscilloscope to 0.1 V/division (DC coupled) and 7 s/division. While observing the oscilloscope display, press the PRESET key to force the Noise Figure Meter to perform a frequency calibration. During the frequency calibration, the Noise Figure Meter tunes the 1st LO through the passband of the frequency calibration detector. As it tunes, the voltage from the frequency calibration detector will pulse with a peak voltage of greater than +2 volts.

If the pulse on the oscilloscope reaches a peak of  $>+2$  volts, continue with the next step.

If the pulse doesn't reach a peak of  $>+2$  volts, the problem is with the FREQ CAL DETECTOR circuit; continue troubleshooting on Service Sheet 3.

8. Perform RF and IF Attenuators Checks (Checks 4 and 5) of Service Sheet BD1 troubleshooting to verify the performance of the RF and IF attenuators.

If the RF and IF attenuators are functional, the problem is elsewhere in the instrument, continue with Service Sheet BD1 troubleshooting to isolate the problem to a block diagram.

At this point, the problem should have been isolated to a service sheet. If no malfunction is detected, continue with the Performance Tests (Section IV, of the Noise Figure Meter Operating Manual) to verify that the Noise Figure Meter is performing within the specifications.

### ✓ 4 YIG Oscillator Output Check

#### Procedure

1. Connect the spectrum analyzer to the YIG oscillator output through a 6 dB attenuator pad (minimum). Set the spectrum analyzer as follows:

Instrument Preset .....	Press
Center Frequency .....	2060 MHz
Frequency Span .....	20 MHz
Reference Level .....	20 dBm

2. Tune the Noise Figure Meter frequency to 10 MHz. On the Noise Figure Meter, key in 31.2 SPECIAL FUNCTION to force a frequency calibration.
3. Verify that the YIG oscillator output frequency is  $2060 \text{ MHz} \pm (2 \text{ MHz} + 1\% \text{ of displayed frequency})$  and that the power level is  $>+12$  dBm (be sure to account for any cable loss and the attenuator pad). Note that the YIG oscillator frequency equals 2050 MHz plus the displayed frequency on the Noise Figure Meter.
4. Tune the Noise Figure Meter to 1600 MHz (or to any other frequency of interest within its range). At the same time, tune the spectrum analyzer to the expected frequency of the YIG oscillator output signal.

If the YIG oscillator output is correct, continue troubleshooting on Service Sheet 1.

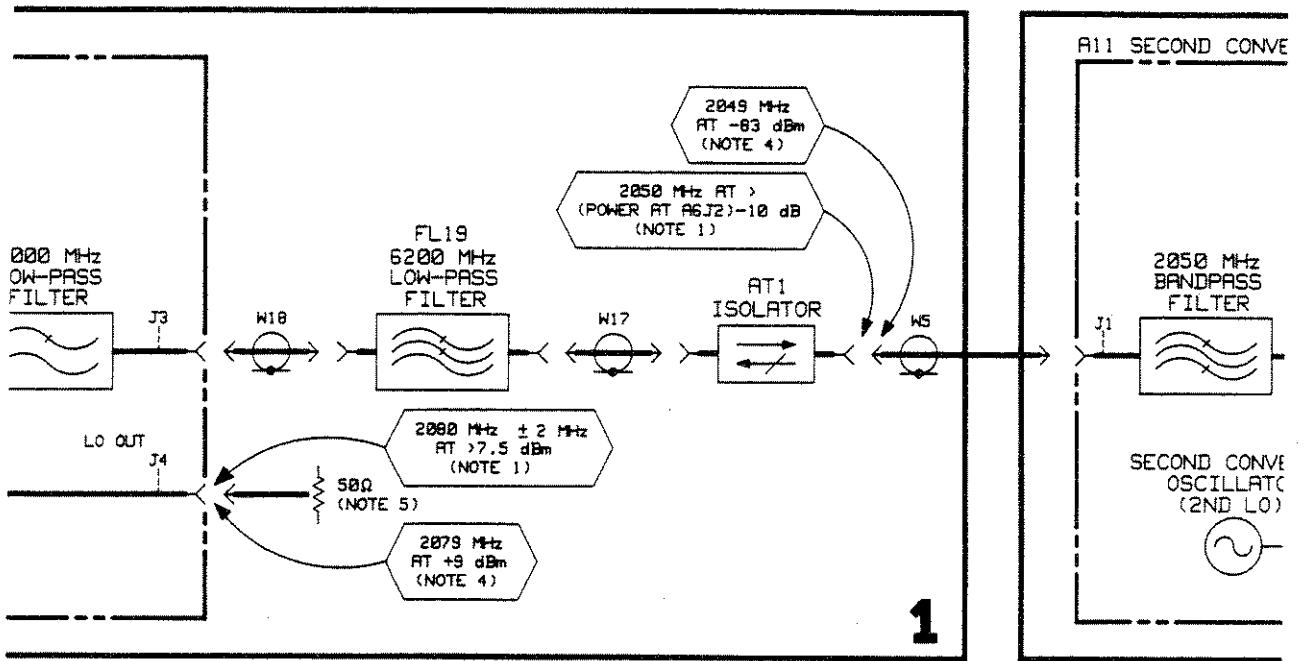
If the YIG oscillator output is incorrect, continue troubleshooting on Service Sheet 7.

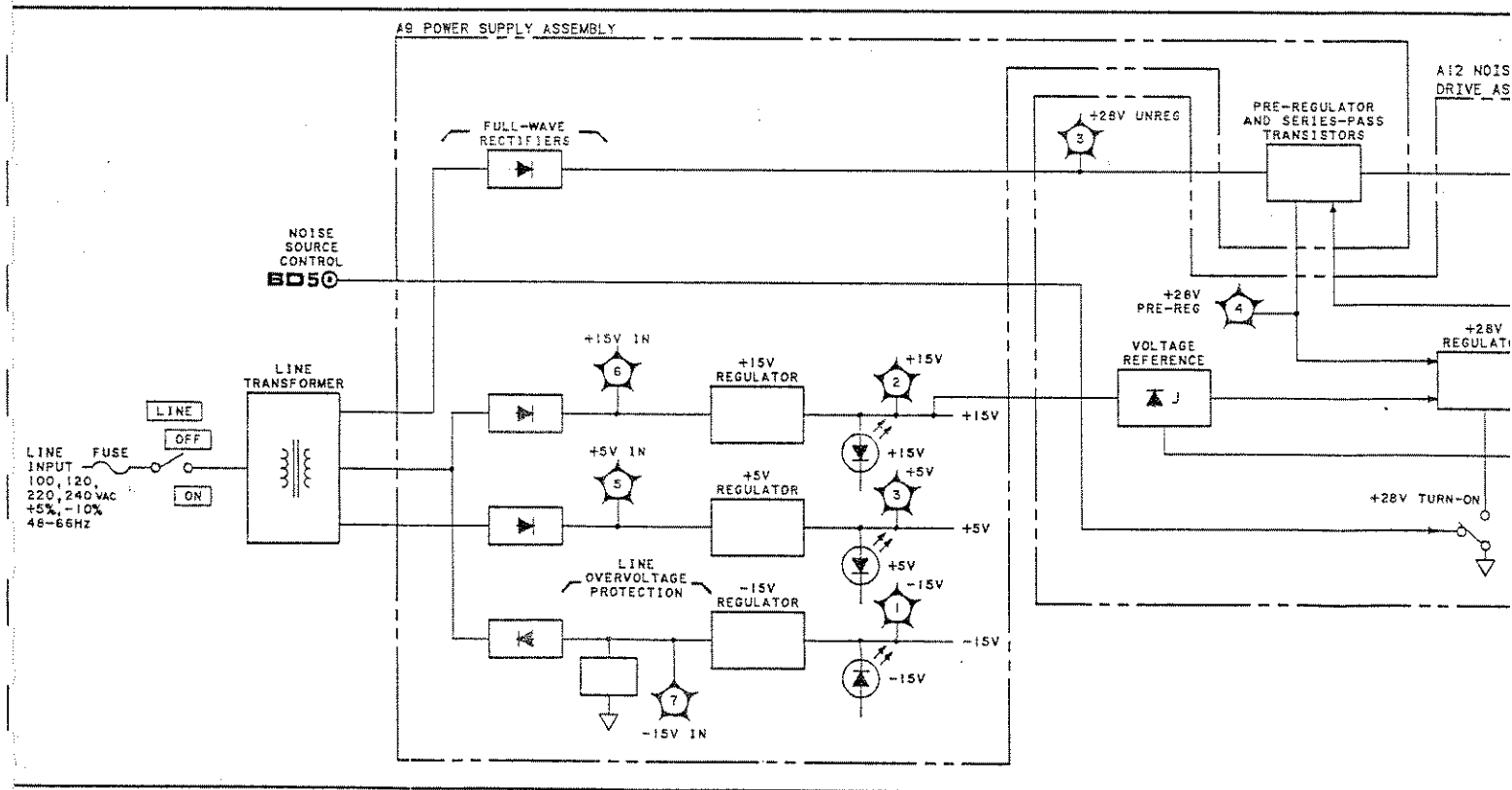
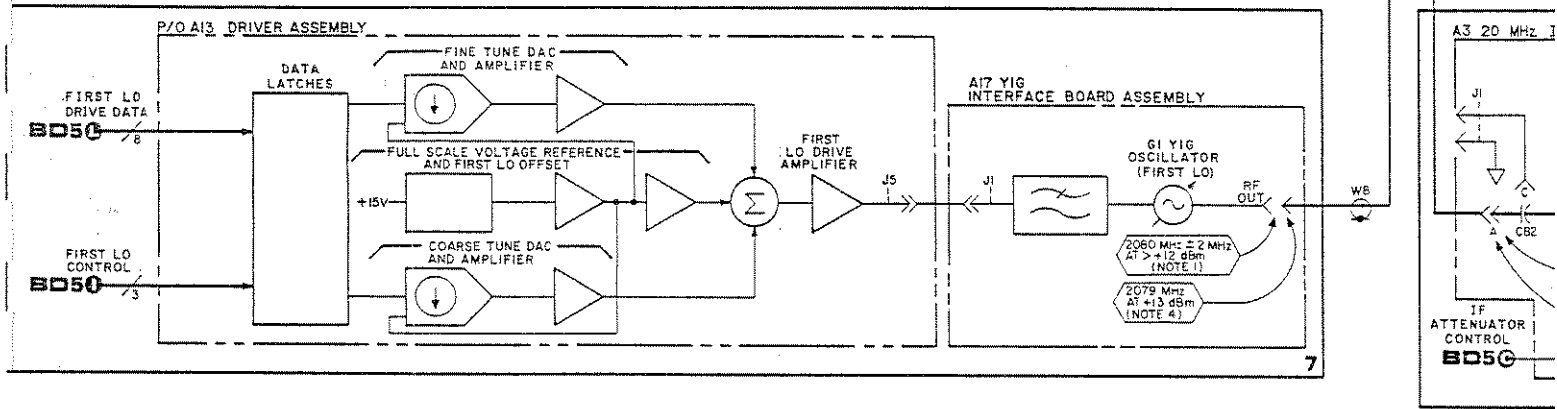
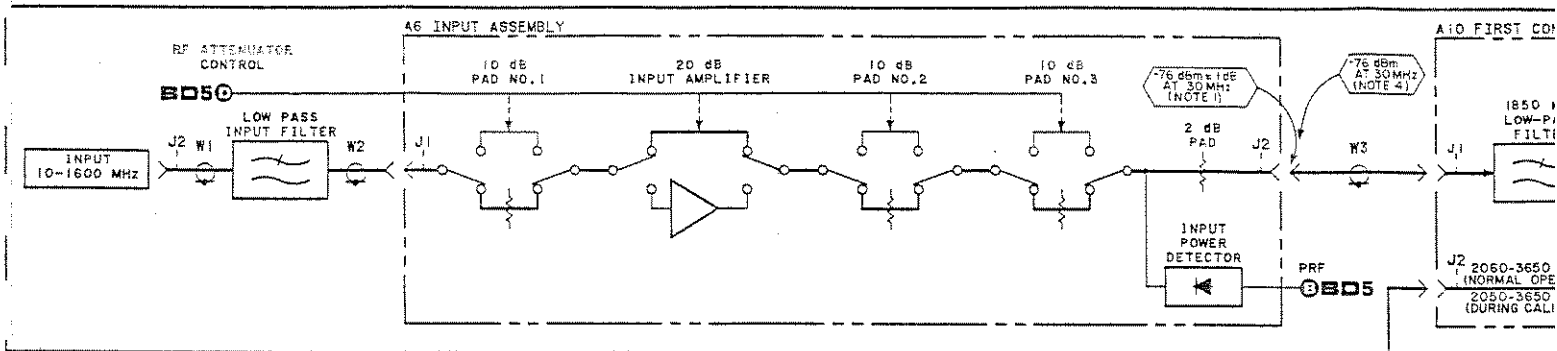
#### Completion of Problem Isolation

At this point, the problem should have been isolated to a service sheet. If no malfunction is detected, continue with the Performance Tests (Section IV, of the Operating Manual) to verify that the Noise Figure Meter is performing within specifications.

(2812A and Above)

The block diagram on page 8-45, along with this partial block diagram, documents instruments with serial numbers prefixed 2812A and above.





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## SERVICE SHEET BD3 — KEYBOARD AND DISPLAY SECTIONS BLOCK DIAGRAM REFERENCES

Section III — Detailed Operating Instructions  
 Section VIII — Special Functions, Power-Up Checks, and Signature Analysis

### PRINCIPLES OF OPERATION

#### General

Block Diagram 3 covers the Noise Figure Meter's front panel assemblies; A1 Keyboard Assembly and A2 Display Assembly. The Keyboard Assembly contains no logic of its own, but instead consists only of the front panel keys, the LEDs for the lighted keys, and the annunciators. The Display Assembly contains all of the front panel logic and the alpha-numeric displays.

#### A1 Keyboard Assembly

The Keyboard Assembly contains only keys and annunciators. When a key is pressed, circuits in the Display Assembly take control and process the information. The AUTO, SINGLE, and SPECIAL FUNCTION keys contain LEDs, and are referred to as the lighted keys.

The key LEDs are controlled by the Display Assembly annunciator circuits. Three measurement states (CALIBRATE, UNCORRECTED, and CORRECTED) have LEDs which indicate when they are active. These three annunciators are also controlled by the Display Assembly.

#### A2 Display Assembly

Information travels to and from the front panel circuits through a single line, serial link, under control of the microprocessor. The serial data is routed to a Serial/Parallel Converter on the front panel. There, it is converted into parallel data. (This link works the same way in the reverse direction.)

Data to the front panel is used to display measurement, keyed entry information, and to light the appropriate key lights. Data from the front panel indicates which key has been pressed. When a key is pressed, the keystroke logic detects that a key is down. This information is transmitted through one of the two control lines to the controller.

The controller then initiates a key scan to determine which key has been pressed. The resulting key scan data is then sent to the controller through

the serial link. The controller determines which key is down from the data, and returns appropriate data to the front panel to light the appropriate displays and key.

### TROUBLESHOOTING

It is assumed that the troubleshooting on Service Sheet BD1 was used to isolate the malfunction to Service Sheet BD3.

The troubleshooting checks on this block diagram are used to isolate a malfunction to one of the three related digital service sheets. The comments associated with each procedure on this block diagram, summarize the information known as a result of passing or failing the check. The checks must be done in the order listed.

#### Test Equipment

None Required.

#### ✓1 Display Assembly Check

##### Procedure

Enter 91.0 SPECIAL FUNCTION and observe the front panel displays and annunciators.

##### Normal Indications:

Refer to the Service Special Functions (Prefixes 63 and 80—99) in the front of Section VIII for a description of Special Function 91.0

##### Abnormal Indications:

1. If the left display fails to cycle, refer to Service Sheet 9.
2. If the right display or any annunciator fails to cycle, refer to Service Sheet 10.

#### ✓2 Keyboard Assembly Check

##### Procedure

Enter 90.N SPECIAL FUNCTION, and refer to the Service Special Functions (Prefixes 63 and 80—99) in the front of Section VIII for a description, and operating procedures, of Special Function 90.N.

##### Normal Indication:

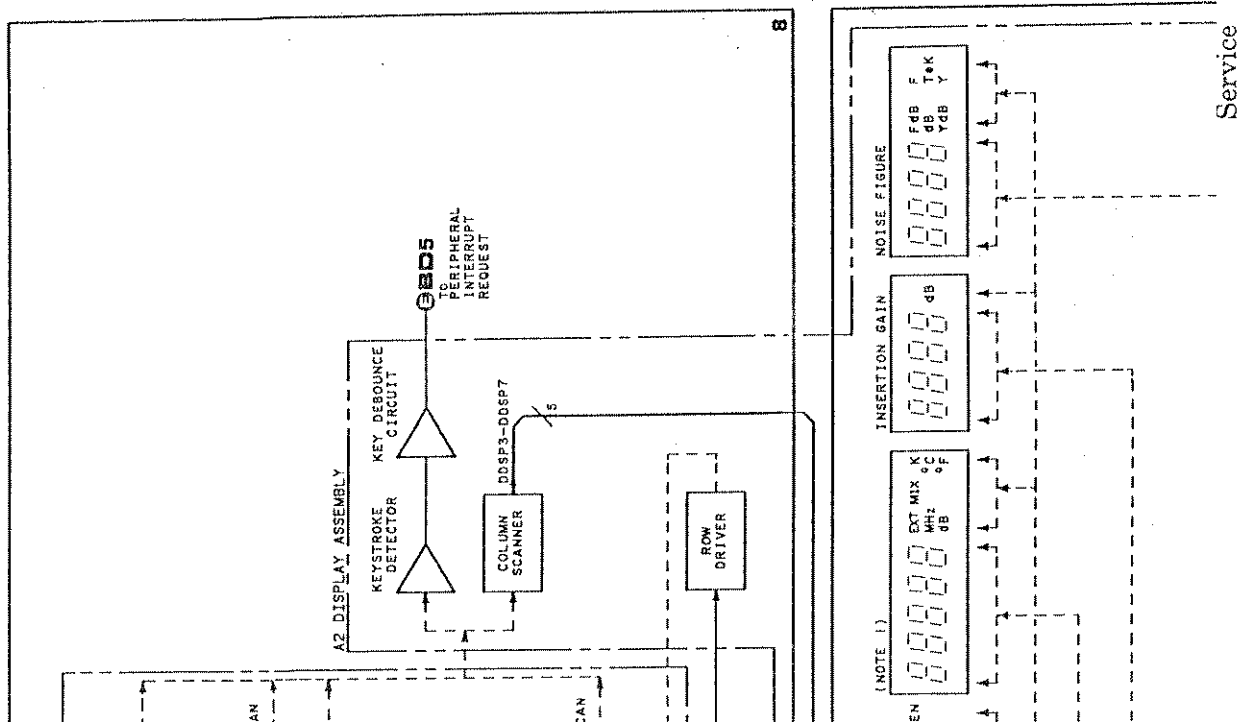
As listed in the description of Special Function 90.N.

##### Abnormal Indication:

If any key fails to function, refer to Service Sheet 8.







## SERVICE SHEET BD4 — DIGITAL BLOCK DIAGRAM

### REFERENCES

Section III — Operator's Checks  
Section VIII — Special Functions, Power-Up  
Checks, and Signature Analysis

### PRINCIPLES OF OPERATION

#### General

Block Diagram 4 covers part of the Noise Figure Meter's digital circuits. The digital circuits covered are contained in Controller Assembly A14 and are detailed on Service Sheets 12, 16, and 17. The digital circuits covered provide nearly all of the controls, calculations, memory, and remote interfaces (to external equipment) for the Noise Figure Meter.

#### Controller (Service Sheet 12)

The microprocessor (MPU) based Controller provides the timing, calculations, and control for the instrument. The MPU executes instructions stored in Read Only Memory (ROM). Data travels between the MPU and other blocks of the Controller over the data bus.

The elements of the Controller respond to the data when addressed by the MPU over the address bus. Data values which must be stored, but may change, are placed in the Random Access Memory (RAM). The MPU sends (and receives) data out of (and into) the Controller through four gateways. These are the Peripheral Interface Adapters (BD5), the X Data and Y Data Latches (BD5), the HP-IB Interface (Service Sheet 16), and the System Interface Bus (SIB) interface (Service Sheet 17).

#### Hewlett-Packard Interface Bus (Service Sheet 16)

The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's implementation of the IEEE-488 (1978) Interface Bus. It is through the HP-IB that the Noise Figure Meter can remotely communicate with another system or computer. The HP-IB concept is explained in Section I, General Information. The use of the HP-IB is covered in Section III, Operation.

#### System Interface Bus (SIB) (Service Sheet 17)

The System Interface Bus (SIB) is a private bus used by the Noise Figure Meter to control other

instruments. Instruments controlled by the Noise Figure Meter through the SIB include the HP 8971B Noise Figure Test Set, a System Local Oscillator, and a plotter.

### TROUBLESHOOTING

It is assumed that the troubleshooting information on Service Sheet BD1 was used to isolate a malfunction to this service sheet. The following information will aid in isolating a problem to a schematic service sheet.

If a problem is suspected with the HP-IB or SIB circuitry, perform the HP-IB/SIB Check (Special Function 98.1) on Service Sheet BD1. If the HP-IB/SIB Check revealed an error, continue with the HP-IB/SIB Check error messages on Check 1 of this block diagram. If no error is detected, continue with the SIB/HP-IB Data Line Signature Analysis Test of Check 4.

#### Test Equipment

Signature Multimeter ..... HP 5005B  
Digital Voltmeter (DVM) ..... HP 3456A

#### Error Messages

Find the error message of interest, either under Power-up Error Messages or HP-IB/SIB Check Error Messages, from the list below. Otherwise, continue with the General Checks (Check 2) of this block diagram.

#### Power-up Error Messages

Any of the following error messages may appear when a failure is detected during the power-up self test of the controller. See Instrument or Controller Power-up Checks on Service Sheet BD1.

**E70 ROM 1 (A14U5) Failure.** Replace ROM 1 (A14U5). If the error persists, continue with the Free Run Signature Analysis Test (Check 3), continue troubleshooting on Service Sheet 12, or replace A14 Controller Assembly.

**E71 ROM 2 (A14U7) Failure.** Replace ROM 2 (A14U7). If the error persists, continue with the Free Run Signature Analysis Test (Check 3), continue troubleshooting on Service Sheet 12, or replace A14 Controller Assembly.

**SERVICE SHEET BD4 (cont'd)**

**E72 Non-volatile RAM (A14U8) Failure.** Ensure that the PON (L) signal is low at A14U8 pin 20. If not, check the Power-up Detector Circuit on Service Sheet 12.

Replace A14U8. If the error persists, continue with the Non-destructive RAM Signature Analysis Test of Check 4, replace A14 Controller Assembly, or continue troubleshooting on Service Sheet 12.

**E74 SIB Chip (A14U2) Self Test Failure.** Replace A14U2. If the error persists, continue with the SIB/HP-IB Data Line Signature Analysis Tests of Check 4, replace A14 Controller Assembly, or continue troubleshooting on Service Sheet 17.

**E75 HP-IB Chip (A14U28) Self Test Failure.** Replace A14U28. If the error persists, continue with the SIB/HP-IB Data Line Signature Analysis Test of Check 4, replace A14 Controller Assembly, or continue troubleshooting on Service Sheet 16.

**HP-IB/SIB Check Error Messages**

The following error messages may appear during the HP-IB/SIB Check (Special Function 98.1). See HP-IB/SIB Check on Service Sheet BD1. If the message E00 appeared after the execution of the HP-IB/SIB test, the HP-IB/SIB circuits are working. Continue with the next check on this block diagram.

**E00 No errors.**

**E01 REN or ATN Line Failure.** Check the cable which connects the HP-IB and SIB ports then repeat the HP-IB/SIB Check. If the error persists, perform the SIB and HP-IB Port Signature Analysis Tests of Check 4. If the faulty component is not found, replace the following chips one at a time and in the following order: A14U42, A14U11, A14U14, and A14U43. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheets 16 or 17.

**E02 Defective Data Path Between HP-IB and SIB Chips.** Try replacing the cable connecting the two ports. Continue troubleshooting with the SIB and HP-IB Port Signature Analysis Tests of Check 4 on this block diagram. If the faulty component is not

found, replace the following chips one at a time and in the following order: A14U42, A14U26, A14U1, A14U11, and A14U43. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheets 16 or 17.

**E03 SIB Message to Main HP-IB Message Failure.** Continue with the SIB/HP-IB Data Line Signature Analysis Test of Check 4, replace A14 Controller Assembly, or continue troubleshooting on Service Sheets 16 or 17.

**E04 SRQ Line Not Being Set By HP-IB Chip (A14U28) Or Not Being Detected By SIB Chip (A14U2).** Try replacing the cable connecting the two ports. Continue troubleshooting with the SIB and HP-IB Port Signature Analysis Tests of Check 4 on this block diagram. If the faulty component is not found, replace the following chips one at a time and in the following order: A14U42, A14U11, and A14U43. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheets 16 or 17.

**E05 SIB Chip (A14U2) Could Not Serial Poll Main HP-IB Chip (A14U28).** Continue troubleshooting with the SIB and HP-IB Port Signature Analysis Tests of Check 4 on this block diagram. If the faulty component is not found, replace the following chips one at a time and in the following order: A14U43, A14U11, A14U28, and A14U43. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheets 16 or 17.

**E06 SIB Collision Detection Failure.** Replace A14U3, A14U13, and A14U12. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 17.

**E07 Main HP-IB Chip (A14U28) Could Not Address SIB Chip (A14U2).** Continue troubleshooting with the SIB/HP-IB Data Line Signature Analysis Test of Check 4 on this block diagram. If the faulty component is not found, replace the following chips one at a time and in the following order: A14U2, and A14U28. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheets 16 or 17.



**SERVICE SHEET BD4 (cont'd)**

**E08 Main HP-IB Message to SIB Failed.** Continue troubleshooting with the SIB/HP-IB Data Line Signature Analysis Test of Check 4 on this block diagram. If the faulty component is not found, replace the following chips one at a time and in the following order: A14U2, and A14U28. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheets 16 or 17.

**E75 HP-IB chip (A14U28) or Interface Hardware Failure.** Continue troubleshooting with the SIB and HP-IB Port Signature Analysis Tests of Check 4 on this block diagram. If the faulty component is not found, replace the following chips one at a time and in the following order: A14U42, A14U11, A14U26, A14U1, and A14U43. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheets 16 or 17.

**E74 SIB Chip (A14U2) or Interface Hardware (to A14U2) Failure. (Interface to HP-IB Chip Is Good).** Continue troubleshooting with the SIB and HP-IB Port Signature Analysis Tests of Check 4 on this block diagram. If the faulty component is not found, replace the following chips one at a time and in the following order: A14U42, A14U11, A14U26, A14U1, and A14U43. If the error persists,

replace A14 Controller Assembly or continue troubleshooting on Service Sheets 16 or 17.

✓ 2 **General Checks**

1. Turn the Noise Figure Meter on and verify that the voltage from A14TP1 to A14TP2 (Digital GND) is +4.7 to +5.3 Vdc. If not, continue troubleshooting on Service Sheet 18 (Power Supply).
2. Measure the frequency of the following TTL level clock signals:

**Table 8-18. Clock Signals**

A14 Assembly Measurement Point	Signal
A14U34 Pin 38	8 MHz
A14U51 Pin 4	4 MHz
A14U4 Pin 10	2 MHz
A14U51 Pin 9	1 MHz

If all of the clock signals are correct, continue with step 3.

If not, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 12.

3. Verify that the levels shown for the test points in Table 8-19 are as indicated.

**Table 8-19. Microprocessor Checks**

Test Point	Level (Vdc)	Action To Be Taken if Level is Not As Indicated
A14U34 Pin 37	>2	Replace Reset chip (A14U55). If the problem persists, replace the A14 Controller Board Assembly.
A14U34 Pin 40	>2	Check A14R14.
A14U8 Pin 20	<0.8*	Check A14Q1, A14Q2, A14U8 and associated components or replace the A14 Controller Assembly.
A14Q1 Emitter	≈+3**	Check A14Q1, A14Q2, A14U8 and associated components or replace the A14 Controller Assembly.
A14U34 Pin 2	>2	Go to Service Sheet 11 or replace the A14 Controller Assembly.
A14U34 Pin 3	>2	Perform Check 3, Free run Signature Analysis. If the problem cannot be traced to a defective component, replace A14U28. If the problem persists, go to Service Sheet 16 or replace the A14 Controller Assembly.
A14U34 Pin 4	>2	Go to Service Sheet 17 or replace A14U2.
*With the Noise Figure Meter turned on.		
**With the Noise Figure Meter turned off.		

**SERVICE SHEET BD4 (cont'd)**

If all of the levels are correct, continue with step 4.

- If the Keyboard and Display Assemblies are functional, key in 98.2 SPECIAL FUNCTION to enable the RAM test. Error message E72 will be displayed on the front panel and/or on A14DS1 LEDs if a fault is detected.

If error message E72 is displayed, refer to Power-up Error Messages under Check 1. Continue with the next check if no error is detected.

**3 Free Run Signature Analysis**

Each ROM version will have unique free run data bus signatures. For each ROM version there is a table of signatures. The instrument prefix or range of prefixes that the table applies to is shown at the top of the table. The free run chip select signatures are unique for Address Decoder-PAL (A14U4; HP P/N 08970-80028). In the set-ups below, "/" represents a rising edge and "\" represents a falling edge as set on the signature analyzer.

**Purpose:** Free Run Signature Analysis will verify the Data Bus, Address Decoding Circuits, Address Bus, and the contents and operation of the ROMs.

**Procedure**

- With the Noise Figure Meter off, set the SA test switch (A14S1) as shown below:

**SA Test Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Frun
SA1	1
SA2	1
SA3	1
SA4	1
SA5	1

- Connect the signature analyzer as shown in Tables 8-20 and 8-21. Turn on the Noise Figure Meter LINE switch, and verify the Data Bus and Chip Enable Signatures in Tables 8-20 and 8-21.

(2645A Only)

**Table 8-20. Free Run Data Bus Signatures**

Start:	A14TP6	(SAGATE1)	/
Stop:	A14TP6	(SAGATE1)	\
Clock:	A14TP5	(SACLK)	\
Test Signatures:	+5V	0001	
	GND	0000	
A14 Test Node*	Signal Name	Signature**	
U24 Pin 2	D0	21H4	
U24 Pin 3	D4	95CF	
U24 Pin 4	D1	7UCF	
U24 Pin 5	D5	F0FA	
U24 Pin 6	D2	CCC1	
U24 Pin 7	D6	8P6U	
U24 Pin 8	D7	214C	
U24 Pin 9	D3	4C41	
*These A14 test nodes can be found on Service Sheet 12.			
**These signatures are valid for ROM A14U5 with a part number of 08970-80026 and ROM A14U7 with a part number of 08970-80027.			

(2721A and Above)

**Table 8-20. Free Run Data Bus Signatures**

Start:	A14TP6	(SAGATE1)	/
Stop:	A14TP6	(SAGATE1)	\
Clock:	A14TP5	(SACLK)	\
Test Signatures:	+5V	0001	
	GND	0000	
A14 Test Node*	Signal Name	Signature**	
U24 Pin 2	D0	7P08	
U24 Pin 3	D4	887H	
U24 Pin 4	D1	8P25	
U24 Pin 5	D5	33FF	
U24 Pin 6	D2	2882	
U24 Pin 7	D6	9761	
U24 Pin 8	D7	0491	
U24 Pin 9	D3	UF9A	
*These A14 test nodes can be found on Service Sheet 12.			
**These signatures are valid for ROM A14U5 with a part number of 08970-80040 and ROM A14U7 with a part number of 08970-80041.			

# SERVICE SHEET BD4 (cont'd)

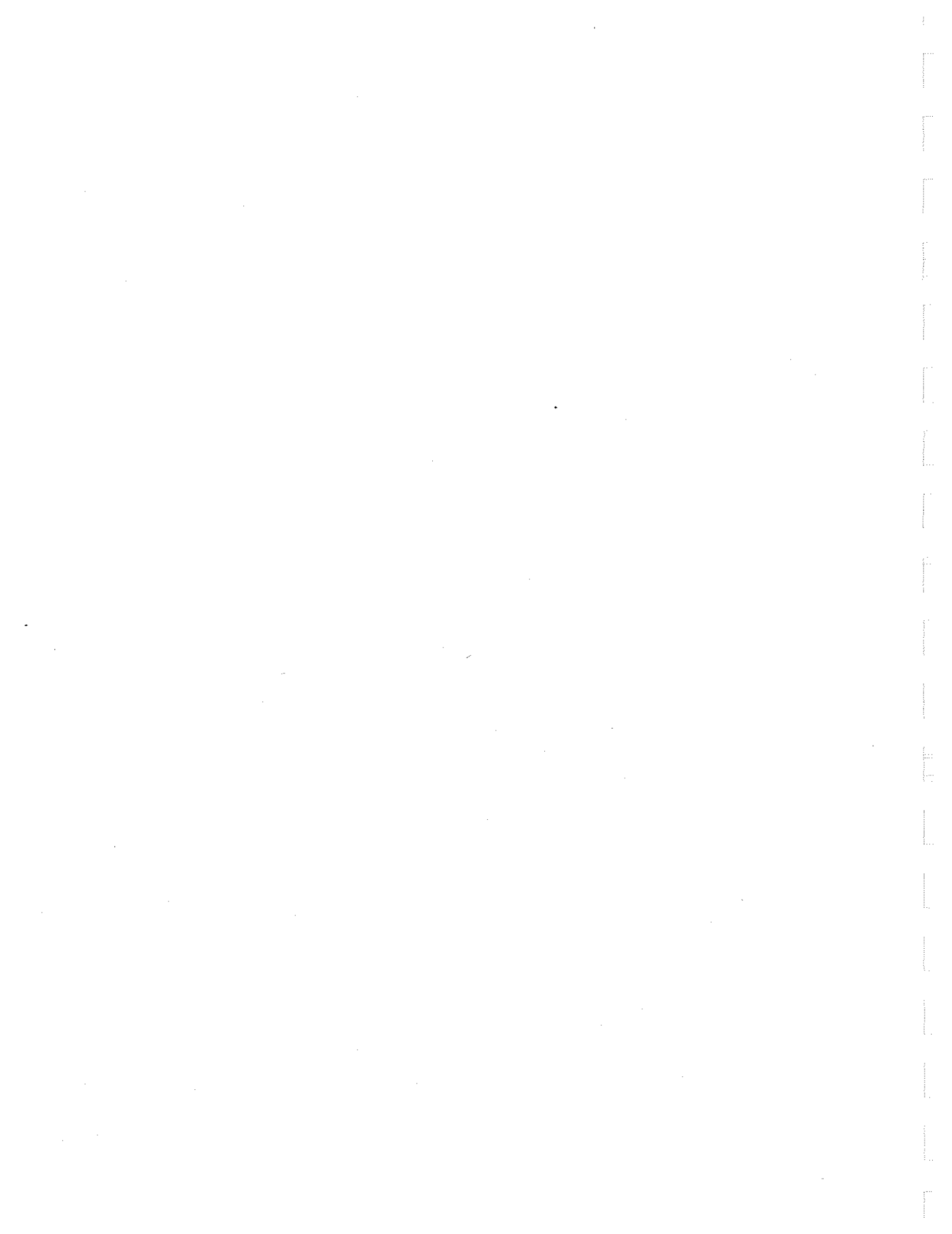
(2847A and Above)

Table 8-20. Free Run Data Bus Signatures

Start: A14TP6 (SAGATE1) /		
Stop: A14TP6 (SAGATE1) \		
Clock: A14TP5 (SACLK) \		
Test Signatures: +5V 0001		
GND 0000		
A14 Test Node*	Signal Name	Signature**
U24 Pin 2	D0	A2H3
U24 Pin 3	D4	PPA4
U24 Pin 4	D1	883P
U24 Pin 5	D5	05H5
U24 Pin 6	D2	F1FA
U24 Pin 7	D6	3C62
U24 Pin 8	D7	708P
U24 Pin 9	D3	3344
*These A14 test nodes can be found on Service Sheet 12.		
**These signatures are valid for ROM A14U5 with a part number of 08970-80050 and ROM A14U7 with a part number of 08970-80051.		

Table 8-21. Free Run Chip Enable Signatures

Start: A14TP6 (SAGATE1) \		
Stop: A14TP6 (SAGATE1) /		
Clock: A14TP5 (SACLK) \		
Test Signatures: +5V 0001		
GND 0000		
A14 Test Node*	Signal Name	Signature**
U4 Pin 14	ROM1	P025
U4 Pin 15	HP-IB2	09C2
U4 Pin 16	SA	HAF2
U4 Pin 17	ATNREM	CA64
U4 Pin 18	HP-IB1	8F8H
U4 Pin 19	DMAC	3P92
U4 Pin 20	PIA	778A
U4 Pin 21	XYRAM	9CH2
U4 Pin 22	ROM2	0001
U4 Pin 23	RAM	5FU8
U5 Pin 20	ROM1	P025
U5 Pin 22	RD(L)***	
U7 Pin 20	ROM2	0001
U7 Pin 22	RD(L)***	
U8 Pin 26	RAM	5FU9
*These A14 test nodes can be found on Service Sheet 12.		
**The signatures for A14U4 are valid for a U4 part number of 08970-80028.		
***Check for a valid TTL signal activity.		



## SERVICE SHEET BD4 (cont'd)

If both the Data Bus and the Chip Enable signatures are correct, continue with the next check. There is no need to check the Address Bus signatures.

If there is a problem with only the chip enables, replace A14U4. If the problem persists, replace A14 Controller Assembly or continue troubleshooting the Address Decoding circuitry on Service Sheet 12.

If any of the Data Bus signatures are incorrect, continue with the Address Bus signature check in step 3.

3. Verify the signatures in Table 8-22.

### NOTE

*If the Free Run Data Bus signatures are correct, there is no need to check the following Address Bus signatures. Continue with the next check.*

Table 8-22. Free Run Address Bus Signatures

Start:	A14TP6	(SAGATE1)	\
Stop:	A14TP6	(SAGATE1)	/
Clock:	A14TP5	(SACLK)	\
Test Signatures:	+5V	0001	
	GND	0000	
A14 Test Node*	Signal Name	Signature	
U7 Pin 2	AB12	3C96	
U7 Pin 3	AB7	HC89	
U7 Pin 4	AB6	52F8	
U7 Pin 5	AB5	UPFH	
U7 Pin 6	AB4	0AFA	
U7 Pin 7	AB3	5H21	
U7 Pin 8	AB2	7F7F	
U7 Pin 9	AB1	CCCC	
U7 Pin 10	AB0	5555	
U7 Pin 21	AB10	1293	
U7 Pin 23	AB11	HAP7	
U7 Pin 24	AB9	HPP0	
U7 Pin 25	AB8	2H70	
U7 Pin 26	AB13	3827	
U7 Pin 27	AB14	755U	
*These A14 test nodes can be found on Service Sheet 12.			

If all of the signatures are correct but there is a problem with the Data Bus and the Chip Enable signatures, replace A14U4.

If all of the signatures are correct but there is a problem with the RAM, HP-IB, or SIB, continue with Programmed Signature Analysis Tests (Check 4).

If any of the signatures are incorrect, trace the incorrect signatures to a defective component. If the defective component cannot be identified, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 12.

## ✓ 4 Programmed Signature Analysis Tests

### Procedure

1. Non-destructive RAM Test. For RAM related failures only.

a. With the Noise Figure Meter off, set the SA test switch A14S1 as shown below:

SA Test Switch (A14S1) Setting

Switch	Switch Setting
Normal/Frun	Normal
SA1	1
SA2	0
SA3	0
SA4	0
SA5	0

b. Connect a signature analyzer as shown in Table 8-23. Turn on the Noise Figure Meter LINE switch, and verify the signatures in Table 8-23.

If any of the signatures are incorrect, trace the incorrect signatures to a defective component or broken line. If the problem cannot be isolated, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 12.

2. SIB/HP-IB Data Line Signature Analysis Test.

### NOTE

*Continue with the SIB/HP-IB Data Line Signature Analysis Test only if the problem is SIB or HP-IB related.*

a. With the Noise Figure Meter off, set the SA test switch A14S1 as shown in the following table:

**SERVICE SHEET BD4 (cont'd)**

**SA Test Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Normal
SA1	0
SA2	1
SA3	1
SA4	0
SA5	0

b. Connect a signature analyzer as shown in Table 8-24. Turn on the Noise Figure Meter LINE switch, and verify the signatures in Table 8-24.

**Table 8-23. Non-destructive RAM Test Signatures**

Start:	A14TP3 (STR2)	/
Stop:	A14TP4 (STOP2)	/
Clock:	A14TP5 (SACLK)	\
Test Signatures:	+5V CHAP	
	GND 0000	
A14 Test Node*	Signal Name	Signature
U8 Pin 2	AB12	F649
U8 Pin 3	AB7	92U5
U8 Pin 4	AB6	9780
U8 Pin 5	AB5	3U8U
U8 Pin 6	AB4	3PU9
U8 Pin 7	AB3	9334
U8 Pin 8	AB2	P1P0
U8 Pin 9	AB1	2CP2
U8 Pin 10	AB0	63P9
U8 Pin 11	D0	UA27
U8 Pin 12	D1	59U4
U8 Pin 13	D2	849A
U8 Pin 15	D3	05F3
U8 Pin 16	D4	1A32
U8 Pin 17	D5	A302
U8 Pin 18	D6	H98P
U8 Pin 19	D7	08HU
U8 Pin 20	PON	0000
U8 Pin 21	AB10	47FU
U8 Pin 22	OE	HH09
U8 Pin 23	AB11	1F96
U8 Pin 24	AB9	1P83
U8 Pin 25	AB8	F5UH
U8 Pin 26	RAM	AF61
*The A14 test nodes are found on Service Sheet 12.		

**Table 8-24. SIB/HP-IB Data Line Signatures**

Start:	A14TP3 (STR2)	/
Stop:	A14TP4 (STOP2)	/
Clock:	A14TP5 (SACLK)	\
Test Signatures:	+5V 9443	
	GND 0000	
A14 Test Node*	Signal Name	Signature
U2 Pin 3	SIB	9443
U2 Pin 4	TIWE	688U
U2 Pin 5	DBIN	688U
U2 Pin 6	AB0	0AU1
U2 Pin 7	AB1	0FC3
U2 Pin 8	AB2	7C40
U2 Pin 9	FIRQ	9443
U2 Pin 18	4 MHz**	
U2 Pin 19	RESET	9443
U9 Pin 1	ATNREM	9442
U11 Pin 1		9443
U22 Pin 1	R(H)/W(L)	688U
U22 Pin 11	D3H	4485
U22 Pin 12	D7H	00U4
U22 Pin 13	D6H	874P
U22 Pin 14	D2H	1AH0
U22 Pin 15	D5H	A370
U22 Pin 16	D1H	362U
U22 Pin 17	D4H	PC76
U22 Pin 18	D0H	8P8C
U25 Pin 2	HP-IB	P7A2
U50 Pin 3	WE(L)	9443
U50 Pin 9	RD(L)	UFFF
*The A14 test nodes are found on Service Sheets 16 and 17.		
**Check for a 4 MHz clock signal.		

If the signature of A14U11 pin 1 is incorrect, continue troubleshooting on Service Sheet 16. For any other incorrect signatures, continue troubleshooting on Service Sheet 12.

If all of the signatures are correct, continue on Service Sheet 16 for HP-IB related problems or continue on Service Sheet 17 for SIB related problems.

The SIB data line and HP-IB data line signatures are provided in Tables 8-25 and 8-26 for convenience.

If all the signatures are correct (see Table 8-25), continue with the SIB Port Signature Analysis Test (step 3).

**SERVICE SHEET BD4 (cont'd)**

If any of the signatures are incorrect, trace the incorrect signatures to a defective component. If the problem cannot be isolated, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 16.

**Table 8-25. SIB Chip Data Line Signatures**

Start:	A14TP3	(STRT2)	/
Stop:	A14TP4	(STOP2)	/
Clock:	A14TP5	(SACLK)	\
Test Signatures:	+5V	9443	
	GND	0000	
A14 Test Node*	Signal Name	Signature	
U2 Pin 2		9443	
U2 Pin 10	D0H	A889	
U2 Pin 11	D1H	HC56	
U2 Pin 12	D2H	U743	
U2 Pin 13	D3H	6856	
U2 Pin 14	D4H	U52F	
U2 Pin 15	D5H	03C8	
U2 Pin 16	D6H	19CH	
U2 Pin 17	D7H	HFU7	
*These A14 test nodes are found on Service Sheet 17.			

**Table 8-26. HP-IB Chip Data Line Signatures**

Start:	A14TP3	(STRT2)	/
Stop:	A14TP4	(STOP2)	/
Clock:	A14TP5	(SACLK)	\
Test Signatures:	+5V	9443	
	GND	0000	
A14 Test Node*	Signal Name	Signature	
U28 Pin 4	RESET	0000	
U28 Pin 7	+5V	9443	
U28 Pin 9	READ	1C6U	
U28 Pin 10	WRITE	688P	
U28 Pin 12	DB0	A889	
U28 Pin 13	DB1	HC56	
U28 Pin 14	DB2	U743	
U28 Pin 15	DB3	6856	
U28 Pin 16	DB4	U52F	
U28 Pin 17	DB5	03C8	
U28 Pin 18	DB6	19CH	
U28 Pin 19	DB7	HFU7	
*These A14 test nodes are found on Service Sheet 16.			

If all the signatures are correct (see Table 8-26), continue with the HP-IB Port Signature Analysis Test (step 4).

If any of the signatures are incorrect, trace the incorrect signatures to a defective component. If the problem cannot be isolated, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 17.

3. **SIB Port Signature Analysis Test.** This test verifies the performance of the circuits at the connector side of the SIB chip.

a. With the Noise Figure Meter off, set the SA test switch A14S1 as shown below:

**SA Test Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Normal
SA1	1
SA2	1
SA3	1
SA4	0
SA5	0

b. Connect a signature analyzer as shown in Table 8-27. Turn on the Noise Figure Meter LINE switch, and verify the signatures in Tables 8-27 and 8-28.

**Table 8-27. SIB Port Signatures (1 of 2)**

Start:	A14TP3	(STRT2)	/
Stop:	A14TP3	(STRT2)	\
Clock:	A14TP4	(STOP2)	\
Test Signatures:	+5V	8267	
	GND	0000	
A14 Test Node*	Signal Name	Signature	
U2 Pin 21	TE	8HA6	
U2 Pin 22	REN	0081	
U2 Pin 23	IFC	924F	
U2 Pin 27	EOI	C87H	
U2 Pin 28	ATN	35HC	
U2 Pin 29	SRQ	8062	
U2 Pin 30	CONT	07U0	
U2 Pin 31	DIO8	219H	
U2 Pin 32	DIO7	F15P	
U2 Pin 33	DIO6	0UHP	
U2 Pin 34	DIO5	90C1	
U2 Pin 35	DIO4	182P	
U2 Pin 36	DIO3	C950	
U2 Pin 37	DIO2	94U4	
U2 Pin 38	DIO1	596P	
U2 Pin 39	TR	0020	
*These A14 test nodes are found on Service Sheet 17.			

**SERVICE SHEET BD4 (cont'd)**

**Table 8-28. SIB Port Signatures (2 of 2)**

Start: A14TP3 (STRT2) /		
Stop: A14TP3 (STRT2) \		
Clock: A14TP4 (STOP2) \		
Test Signatures: +5V 8267		
GND 0000		
A14 Test Node*	Signal Name	Signature
U1 Pin 2	DIO8	219H
U1 Pin 3	DIO7	F15P
U1 Pin 4	DIO6	0UHP
U1 Pin 5	DIO5	90C1
U1 Pin 6	DIO4	182P
U1 Pin 7	DIO3	C950
U1 Pin 8	DIO2	94U4
U1 Pin 9	DIO1	596P
U11 Pin 3	REN	A12C
U11 Pin 4	IFC	924F
U11 Pin 8	EOI	C87H
U11 Pin 9	ATN1	35HC
U11 Pin 10	SRQ	8062
U12 Pin 3		35HC
*These A14 test nodes are found on Service Sheet 17.		

If any of the signatures are incorrect, trace the incorrect signatures to a defective component. If the problem cannot be isolated, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 16.

**4. HP-IB Port Signature Analysis Test.** This test verifies the performance of the circuits at the connector side of the HP-IB chip.

a. With the Noise Figure Meter off, set the SA test switch A14S1 as shown below:

**SA Test Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Normal
SA1	1
SA2	1
SA3	1
SA4	0
SA5	0

b. On the rear panel connect the HP-IB connector to the SIB connector with an HP-IB cable. Connect a signature analyzer as shown

**Table 8-29. HP-IB Port Signatures**

Start: A14TP3 (STRT2) /		
Stop: A14TP3 (STRT2) \		
Clock: A14TP4 (STOP2) \		
Test Signatures: +5V 8267		
GND 0000		
A14 Test Node*	Signal Name	Signature
U28 Pin 24	IFC	924F
U28 Pin 25	REN	A12C
U28 Pin 26	ATN	35HC
U28 Pin 28	IB0	596P
U28 Pin 29	IB1	94U4
U28 Pin 30	IB2	C950
U28 Pin 31	IB3	182P
U28 Pin 32	IB4	90C1
U28 Pin 33	IB5	0UHP
U28 Pin 34	IB6	F15P
U28 Pin 35	IB7	219H
*These A14 test nodes are found on Service Sheet 16.		

in Table 8-31. Turn on the Noise Figure Meter LINE switch, and verify the signatures in Table 8-29.

If any of the signatures are incorrect, replace the cable connecting the HP-IB port to the SIB port. If replacing the cable doesn't help, trace the incorrect signatures to a defective component. If the problem cannot be isolated, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 17.

**Completion of Signature Analysis Tests**

Upon completion of the signature analysis tests, disconnect the timing pod from the A14 Controller Assembly and return the A14S1 SA test switch to its normal operation settings as shown below.

**SA Test Switch (A14S1) Setting for Normal Operation**

Switch	Switch Setting
Normal/Frun	Normal
SA1	1
SA2	1
SA3	1
SA4	1
SA5	1







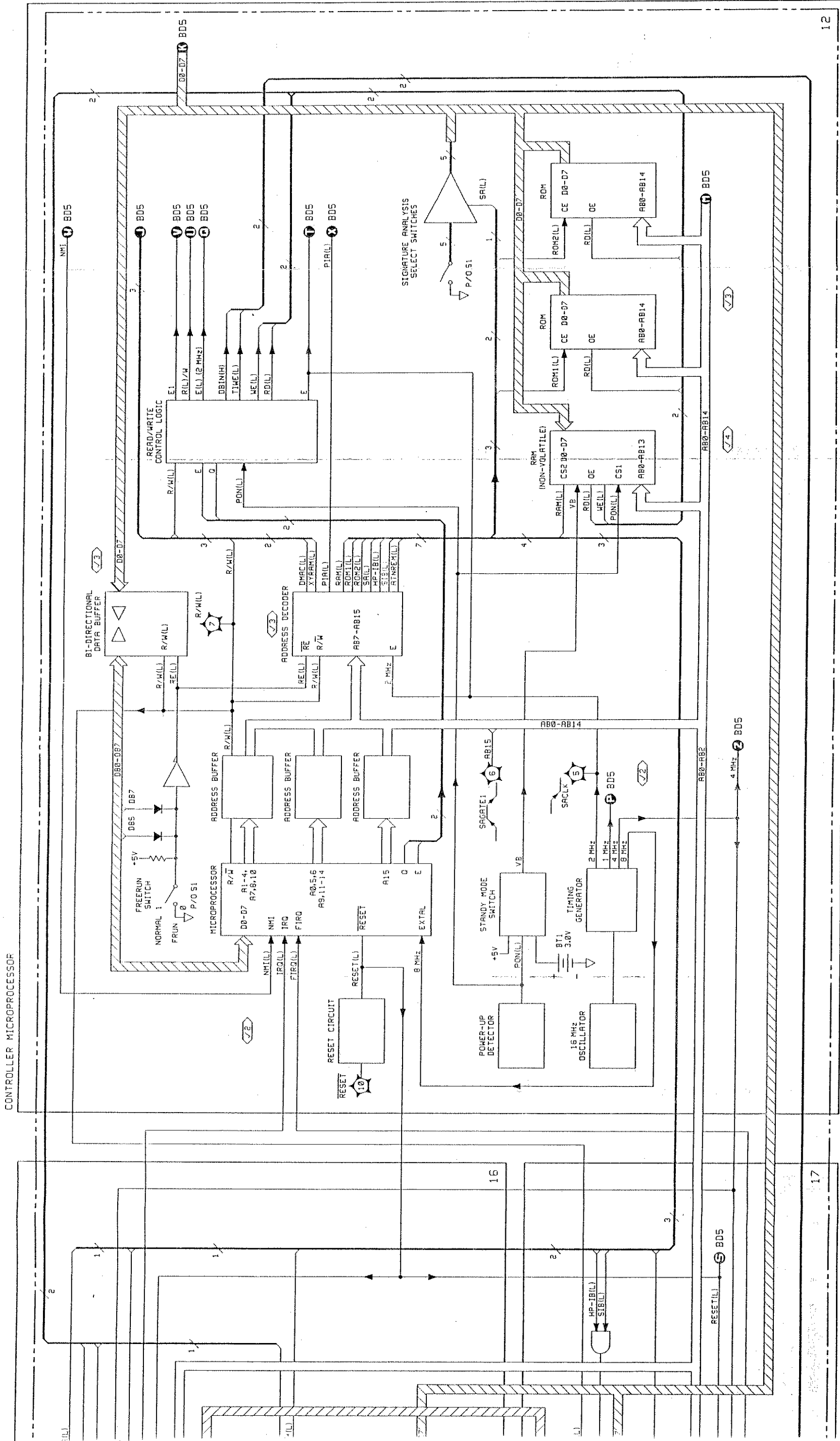


Figure 8-11. Digital Block Diagram — Microprocessor, Memory, Hewlett-Packard Interface Bus (HP-IB), and System Interface Bus (SIB)



**SERVICE SHEET BD5 —  
DIGITAL BLOCK DIAGRAM  
REFERENCES**

Section III — Operator's Checks  
Section VIII — Special Functions, Power-Up  
Checks, and Signature Analysis

**PRINCIPLES OF OPERATION**

**General**

Block Diagram 5 covers the following digital circuits:

- Peripheral Interface Adapters 1 and 2 (Service Sheet 11)
- Oscilloscope Display Controller (Service Sheet 13)
- X-Axis and Z-Axis Drives (Service Sheet 15)
- Y-Axis Drive (Service Sheet 14)
- Voltmeter circuits (Service Sheets 5 and 6).

The Peripheral Interface Adapters and their associated circuits are contained in Controller Assembly A14. The Oscilloscope Display Controller and Drivers and the Voltmeter Digital circuits are contained in Driver Assembly A13.

**Peripheral Interface Adapters 1 and 2 (Service Sheet 11)**

Nearly all of the instrument control is executed by the Microprocessor Unit (MPU) through Peripheral Interface Adapters (PIAs) 1 and 2. Measurement results are sent to the front panel by the PIAs. Information from the front panel keys and measurement data from the Voltmeter Counters enter the MPU through the PIAs. Level information from the Input Power Detector and from the Frequency CAL Detector also enter the MPU through the PIAs.

**Oscilloscope Display Controller (Service Sheet 13), Y-Axis Drive (Service Sheet 14), and X-Axis and Z-Axis Drives (Service Sheet 15)**

Measurement results are stored by the MPU in the Oscilloscope Display Random Access Memory (RAM). The RAM can hold all the Noise Figure and Insertion Gain results from one complete measurement sweep. The RAM is accessed by the MPU only when new data is to be stored (for example, at the end of a measurement cycle). The remainder of the time, the RAM is under the control of the Oscilloscope Display Controller.

The Oscilloscope Display Controller sequentially steps through the address locations of the Oscilloscope Display RAM. This causes the RAM data to be continuously sent to the X and Y Data Latches. The data is converted by the X-Axis and Y-Axis Digital-to-Analog Converters (DACs) into the analog X-Axis and Y-Axis outputs for use in plotting swept measurement results. The Retrace Logic detects the occurrence of the end of a sweep and pulses the Z-AXIS PEN LIFT output to lift an X-Y recorder pen or blank an oscilloscope beam.

**Voltmeter Assembly A7 (Service Sheet 5)**

The Voltmeter Input Switches connect one of the two voltages or ground to the Voltage-to-Time Converter. One voltage input is the dc level from the Noise Power Detector which is measured by the voltmeter. The other voltage input is the reference voltage which is used as the standard against which the detected power is compared. The ground input is used to zero the circuits for the next measurement.

Together, these circuits form the analog portion of a dual-slope converter that automatically zeros itself once each conversion. The Voltage-to-Time Converter generates a ramp with a duration that is proportional to the dc voltage at the converter input. This pulse duration is then measured by the Voltmeter Counters.

**Voltmeter Digital Circuits (Service Sheet 6)**

At the start of an analog-to-digital conversion, the Conversion Logic triggers the Input Select Logic. This results in the output of the Noise Power Detector being connected to the Voltage-to-Time Converter (through the Voltmeter Input Switches).

At the same time, the 4 MHz clock toggles the Voltmeter Counters until a carry is generated. The carry pulse triggers the Input Select Logic to switch the Voltmeter Input Switches connecting the Voltage Reference to the Voltage-to-Time Converter. The Voltmeter Counters are reset and then allowed to count the 4 MHz clock until the output of the Voltage-to-Time Converter changes state. The Input Select Logic then sets the Voltmeter Input Switches to ground the input to the Voltage-to-Time Converter for zeroing. The Voltmeter Counters and Voltmeter Data Output Drivers then send the count to the MPU through PIAs 1 and 2.

# SERVICE SHEET BD5 (cont'd)

## TROUBLESHOOTING

### General

It is assumed that the troubleshooting information on Service Sheet BD1 was used to isolate a malfunction to this service sheet. The following information will aid in isolating a problem to a service sheet. Perform the checks in the order listed.

### NOTE

Refer to Service Sheet BD1 for troubleshooting or verification of the following circuits:

- Frequency Calibration Circuits
- Noise Source Control Circuit
- IF Attenuator Control Circuit
- RF Attenuator Control Circuit
- Input Power Detector Circuit
- Keyboard Interface Circuit
- 1st LO Control/Drive Circuit

### Test Equipment

Signature Multimeter ..... HP 5005B  
 Digital Voltmeter (DVM) ..... HP 3456A  
 Oscilloscope ..... Tektronix 2235  
 Noise Source ..... HP 346B

### ✓ 1 Self-Test Error Messages

Any of the following error messages may appear when a failure is detected during the power-up self test of the controller (see Instrument Power-up Check, Check 2, or Controller Power-up Check, Check 8, on Service Sheet BD1). Find the error message of interest from the list below. Otherwise, continue with the next check on this block diagram.

**E73 Oscilloscope Display RAM (A14U19) Failure.** Continue troubleshooting with the Scope Plotter RAM Signature Analysis Test on Check 4 on this block diagram. Trace the incorrect signatures to a defective component. If the defective component cannot be identified, replace A14U19. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 11.

**E76 PIA2 Chip (A14U33) or Data Path Failure.** Continue troubleshooting with the PIA2 (A14U33) and YIG DACs Signature Analysis Test (use steps 2—4 of Check 10) on Service

Sheet BD1. Trace the incorrect signatures to a defective component. If the defective component cannot be identified, replace A14U33. If the error persists, replace A14 Controller Assembly, or continue troubleshooting on Service Sheet 11.

**E77 PIA1 Chip (A14U35) or Data Path Failure.** Replace A14U35. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 11.

**E78 PIA2 (A14U33) Cannot Drive Hardware On PA0—PA7.** Continue troubleshooting with the PIA2 (A14U33) and YIG DACs Signature Analysis Test (use steps 2—4 of Check 10) on Service Sheet BD1. Trace the incorrect signatures to a defective component. If the defective component cannot be identified, replace A14U32 or A14U33. If the error persists, replace A14 Controller Assembly, or continue troubleshooting on Service Sheet 11.

**E79 PIA1 (A14U35) Cannot Drive Hardware On PA0—PA7.** Replace the following components one at a time and in the order listed until the error message is cleared: A14U31, A14U46, A14U30, and A14U35. If the error persists, replace A14 Controller Assembly or continue troubleshooting on Service Sheet 11.

### ✓ 2 General Checks

1. Turn the Noise Figure Meter on and verify the voltages on the following power supplies:

Table 8-30. Power Supply Voltages

Test Node	Power Supply	Test Limit
A14TP1	+5V	+4.7 to +5.3
A14TP11	+15V	+14 to +16
A14TP13	-15V	-14 to -16
A13TP17	+5V	+4.7 to +5.3
A13TP12	+15V	+14 to +16
A13TP5	-15V	-14 to -16

If the voltages are correct, continue with the next step. If not, continue troubleshooting on Service Sheet 18 (Power Supply).

2. Measure the frequency of the following TTL level clock signals:

**SERVICE SHEET BD5 (cont'd)**

**Table 8-31. Clock Signals**

Test Node	Signal Name	Frequency
A13TP3	4 MHz	4 MHz
A14U36 Pin 40	E	2 MHz
A14U6 Pin 10	E1	2 MHz
A14U52 Pin 1	E(L)	2 MHz
A14U40 Pin 10	E/2	1 MHz

If all of the clock signals are correct, continue with the next step.

If any of the clock signals are incorrect, the problem is elsewhere on Service Sheet BD4. Continue troubleshooting there.

3. Check the Free Run signatures to verify the chip enable lines. In the set-ups below, “/” represents a rising edge and “\” represents a falling edge as set on the signature analyzer.

a. With the Noise Figure Meter off, set the SA test switch A14S1 as shown below:

**SA Test Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Frun
SA1	1
SA2	1
SA3	1
SA4	1
SA5	1

**Table 8-32. Free Run Chip Enable Signatures**

Start:	A14TP6	(SAGATE1)	\
Stop:	A14TP6	(SAGATE1)	/
Clock:	A14TP5	(SACLK)	\
Test Signatures:		+5V	0001
		GND	0000
A14 Test Node*	Signal Name	Signature	
U49 Pin 12	DMAC	3P92	
U50 Pin 11	PIA	778A	
U49 Pin 13	XYRAM	9CH2	

\*These A14 test nodes can be found on Service Sheet 13.

b. Connect a signature analyzer as shown in Table 8-32. Turn on the Noise Figure Meter LINE switch, and verify the signatures in Table 8-32.

If any of the signatures are incorrect, the problem is elsewhere on Service Sheet BD4; continue troubleshooting there.

If the signatures are correct, continue with the next step.

**✓ 3 Oscilloscope SA Test Pattern Check**

1. With the Noise Figure Meter off, set the SA test switch A14S1 as shown below:

**SA Test Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Normal
SA1	0
SA2	0
SA3	0
SA4	1
SA5	0

2. On the rear panel of the Noise Figure Meter, connect the oscilloscope to the X-AXIS, Y-AXIS and Z-AXIS connectors as shown below:

Chan. A ..... X-AXIS Connector  
 Chan. B ..... Y-AXIS Connector  
 Z-Input ..... Z-AXIS Connector

Set the controls on the oscilloscope as shown below:

Chan. A Input ..... 0.5 V/div. (DC coupled)  
 Chan. B Input ..... 0.5 V/div. (DC coupled)  
 Horiz. Display ..... A vs. B  
 Main Trigger ..... Internal

3. Turn on the Noise Figure Meter. Adjust the oscilloscope horizontal and vertical positions and the Channel A and Channel B calibration controls to fill the oscilloscope display with the “X” type pattern as shown in Figure 8-12.

If the oscilloscope SA test pattern is correct, continue with the Voltmeter Tests (Check 7).

## SERVICE SHEET BD5 (cont'd)

If the oscilloscope SA test pattern is incorrect, continue with the next check.

### ✓ 4 Oscilloscope Display RAM Output Signature Check

1. With the Noise Figure Meter off, set the SA test switch A14S1 to that used in step 1 of Check 3.
2. Connect a signature multimeter as shown in Table 8-33. Turn the Noise Figure Meter on and verify the signatures in Table 8-33.

#### NOTE

To avoid unstable signatures, the signature analysis (SA) probe tip must be connected through a resistor to +5 Vdc. Use a resistor between 4.7 k $\Omega$ . and 10 k $\Omega$ .

Table 8-33. Oscilloscope Display RAM Output Signatures

Start:	A14U20	Pin 14	/
Stop:	A14U20	Pin 14	\
Clock:	A14U20	Pin 1	/
Test Signatures:	+5V	865C	
	GND	0000	
Test Node*	Signal Name	Signature	
A13U1 Pin 13	ST2	UC92	
U10 Pin 1	DSPLY DISABLE	0000**	
U11 Pin 3	DS0	06F9	
U11 Pin 4	DS1	328A	
U11 Pin 7	DS2	2619	
U11 Pin 8	DS3	C38A	
U11 Pin 11	ST1	***	
U11 Pin 13	DS4	HF03	
U11 Pin 14	DS5	8UP5	
U11 Pin 17	DS6	C864	
U11 Pin 18	DS7	P890	
U37 Pin 12	PENLIFT	9F32	
U40 Pin 13	AS0	UC92	
A14U20 Pin 15	Q2	6AA2	
U20 Pin 16	Q1	35CH	
U20 Pin 17	Q0	F32H	
*These A13 and A14 test nodes can be found on Service Sheets 13, 14 and 15.			
**The probe LED blinks at the same rate as the A14DS1 LEDs.			
***Check for a valid TTL signal activity.			

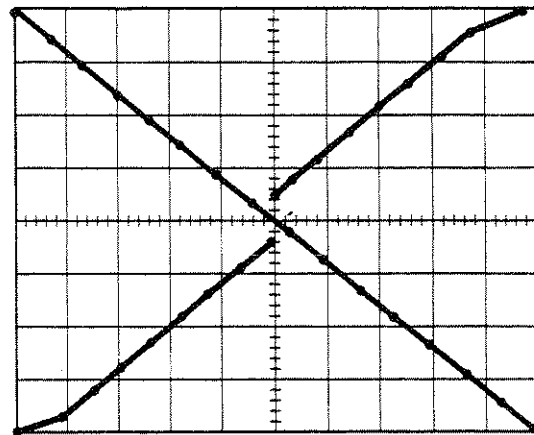


Figure 8-12. Oscilloscope Signature Analysis (SA) Test Pattern

If all the signatures are correct, continue with the next check.

If any of the signatures are incorrect, continue troubleshooting on Service Sheet 13.

### ✓ 5 X-Axis and Y-Axis Drive Test (Service Sheets 14 and 15)

1. With the Noise Figure Meter off, set the SA test switch A14S1 to that used in step 1 of Check 3.
2. On the rear panel of the Noise Figure Meter, connect Channel A of the oscilloscope to the X-AXIS connector and Channel B to the Y-AXIS connector. On the A14 Assembly, using a 1:1 probe, connect A14U20 pin 14 to the external trigger of the oscilloscope. Do not connect the rear panel Z-AXIS connector to the oscilloscope. Set the controls on the oscilloscope as shown below:
  - Chan. A Input ..... 2 V/div. (DC coupled)
  - Chan. B Input ..... 2 V/div. (DC coupled)
  - Time/division ..... 1 ms/div.
  - Horiz. Display ..... Main; Mag X10
  - Vert. Display ..... Alternate
  - Main Trigger ..... External
3. Turn on the Noise Figure Meter and verify that the signals are as shown in Figure 8-13. If both signals are correct, continue with the Z-Axis Test (Check 6).



## SERVICE SHEET BD5 (cont'd)

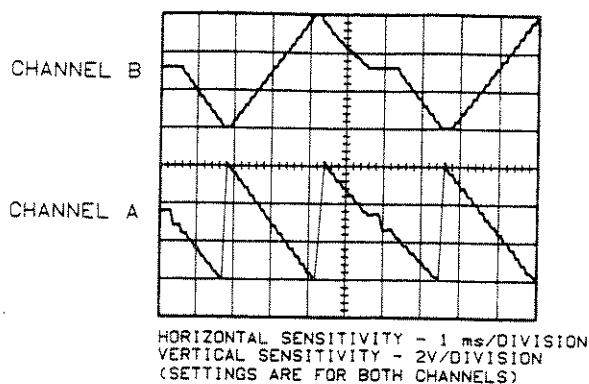


Figure 8-13. X-AXIS (Bottom) and Y-AXIS (Top) Drive Signals

If only the X-Axis drive signal is incorrect, continue troubleshooting on Service Sheet 15.

If only the Y-Axis drive signal is incorrect, continue troubleshooting on Service Sheet 14.

If both X-Axis and Y-Axis drive signals are incorrect, and yet the Oscilloscope Display RAM Output signatures are correct, continue troubleshooting with the Point-to-Point Timing circuit on Service Sheet 14.

### ✓6 Z-Axis Test

1. With the Noise Figure Meter off, set the SA test switch A14S1 to that used in step 1 of Check 3.
2. On the rear panel of the Noise Figure Meter, connect Channel A of the oscilloscope to the Z-AXIS connector. On the A14 Assembly, connect A14U20 pin 14 to Channel B of the oscilloscope using a 10:1 probe. Set the oscilloscope controls as shown below:
  - Chan. A Input .... 2.0 V/div. (DC coupled)
  - Chan. B Input .... 0.2 V/div. (DC coupled)
  - Time/division .... 1 ms/div.
  - Horiz. Display .... Main; Mag X10
  - Vert. Display ..... Alternate
  - Trigger ..... Chan. B
3. Turn on the Noise Figure Meter and verify that the signals are as shown in Figure 8-14.

If the Z-Axis signal is correct, continue with the Voltmeter Test.

If only the Z-Axis signal is incorrect, continue troubleshooting on Service Sheet 15.

### ✓7 Voltmeter Tests

1. With the synthesized sweeper, inject a 30 MHz CW signal with a power level of  $-93$  dBm into the RF INPUT of the Noise Figure Meter. On the Noise Figure Meter, key in 70.1, 60.1, and 81.0 SPECIAL FUNCTIONS.
2. Adjust the power level of the synthesized sweeper until the voltage at the detector output (DET OUTPUT) connector on the rear panel is  $+1.0 \pm 0.1$  Vdc. Verify that the voltage displayed on the front panel (combined Insertion Gain and Noise Figure displays) is also  $+1.0 \pm 0.1$  Vdc or within 100 mVdc of the voltage displayed at the DET OUTPUT.

If the voltage displayed on the Noise Figure Meter is correct, the voltmeter is functional. Go back to Service Sheet BD1 to isolate the problem to a subsystem.

If the voltage at the DET OUTPUT connector on the rear panel cannot be set, the problem is with the RF path on Service Sheet BD2. Continue troubleshooting there.

If the voltage at the DET OUTPUT connector on the rear panel is correct, but the displayed voltage on the Noise Figure Meter is incorrect, continue with the next step.

3. Check for valid TTL signal activity at test nodes A14U33 pins 10, 11, and 17. Also, check for a logical HIGH at A13TP9.

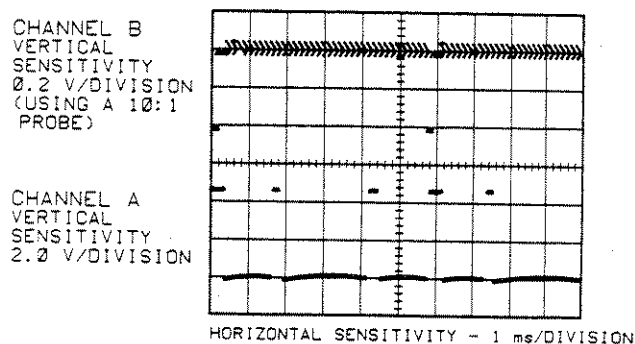


Figure 8-14. Z-AXIS (Bottom) and Trigger (Top) Drive Signals

**SERVICE SHEET BD5 (cont'd)**

If the indication at each test node is correct, continue with the next step.

If any of the indications at A13U33 pins 10, 11, and 17 are incorrect, continue troubleshooting on Service Sheet 11.

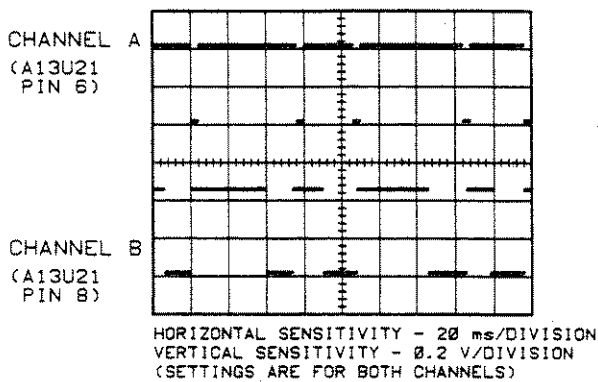
If the indication at A13TP9 is incorrect, continue troubleshooting on Service Sheet 6.

4. On the Noise Figure Meter, press the PRESET key. With an oscilloscope, check the waveform at each of the test nodes A13U21 pins 6, 8, and 10, and A13TP20. Set up the oscilloscope as follows:

Chan. A Input ..... 0.2 V/div. (DC coupled)  
 Chan. B Input ..... 0.2 V/div. (DC coupled)  
 Time/division ..... 20 ms/div.  
 Horiz. Display ..... Main  
 Vert. Display ..... Chop  
 Internal Trigger .... Chan. B  
 Main Trigger ..... Internal

- a. On the oscilloscope, using 10:1 probes, connect Channel A to A13U21 pin 6 and Channel B to A13U21 pin 8.

Verify that the waveforms are as shown in Figure 8-15.

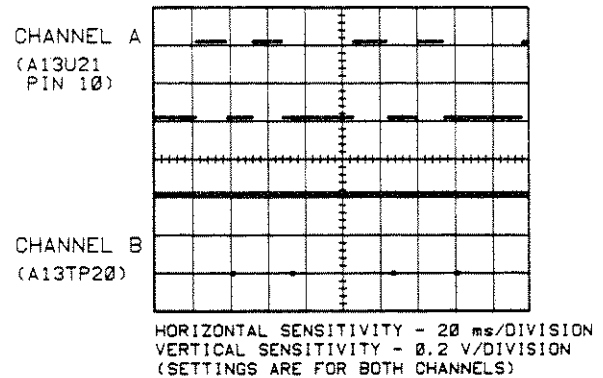


**Figure 8-15. REF (Top) and VOLT (Bottom) Control Signals**

- b. On the oscilloscope, using 10:1 probes, connect Channel A to A13U21 pin 10 and Channel B to A13TP20. Set up the oscilloscope as follows:

Chan. A Input ..... 0.2 V/div. (DC coupled)  
 Chan. B Input ..... 0.2 V/div. (DC coupled)  
 Time/division ..... 20 ms/div.  
 Horiz. Display ..... Main  
 Vert. Display ..... Chop  
 Internal Trigger .... Chan. A  
 Main Trigger ..... Internal

Verify that the waveforms are as shown in Figure 8-16.



**Figure 8-16. ZERO Control (Top) and ECVT (Bottom) Signals**

If all the waveforms are correct, continue with the next step.

If any of the waveforms are incorrect, continue troubleshooting on Service Sheet 6.

5. On the oscilloscope, using 10:1 probes, connect Channel A to A7U1 pin 7 and Channel B to A7TP1. Set up the oscilloscope as follows:

Chan. A Input ..... 0.2 V/div. (DC coupled)  
 Chan. B Input ..... 0.2 V/div. (DC coupled)  
 Time/division ..... 20 ms/div.  
 Horiz. Display ..... Main  
 Vert. Display ..... Chan. A  
 Internal Trigger .... Chan. A  
 Main Trigger ..... Internal

Verify that the waveforms at A7U1 pin 7 and at A7TP1 are as shown in Figure 8-17.

If the waveforms are correct, continue troubleshooting the voltmeter data output drivers on Service Sheet 6.

If any of the waveforms are incorrect, continue troubleshooting on Service Sheet 5.

## SERVICE SHEET BD5 (cont'd)

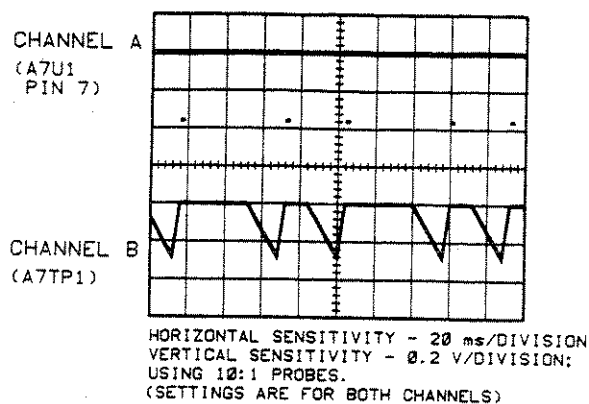


Figure 8-17. GCLK Waveforms

6. Disconnect the synthesized sweeper from the RF INPUT of the Noise Figure Meter, and key in 31.1 and 92.1 SPECIAL FUNCTIONS. Verify that the voltage at the detector output (DET OUTPUT) is  $> +1.2$  Vdc. Also check that there is valid TTL signal activity at A13TP9, and that the Noise Figure Meter displays the error message E11.

If the DET OUTPUT is  $> +1.2$  Vdc, but the signal at A13TP9 is incorrect, continue troubleshooting on Service Sheet 6.

If the voltage at the DET OUTPUT is  $> +1.2$  Vdc and the signal level at A13TP9 is correct, but the error message E11 is not displayed, continue troubleshooting on Service Sheet 11.

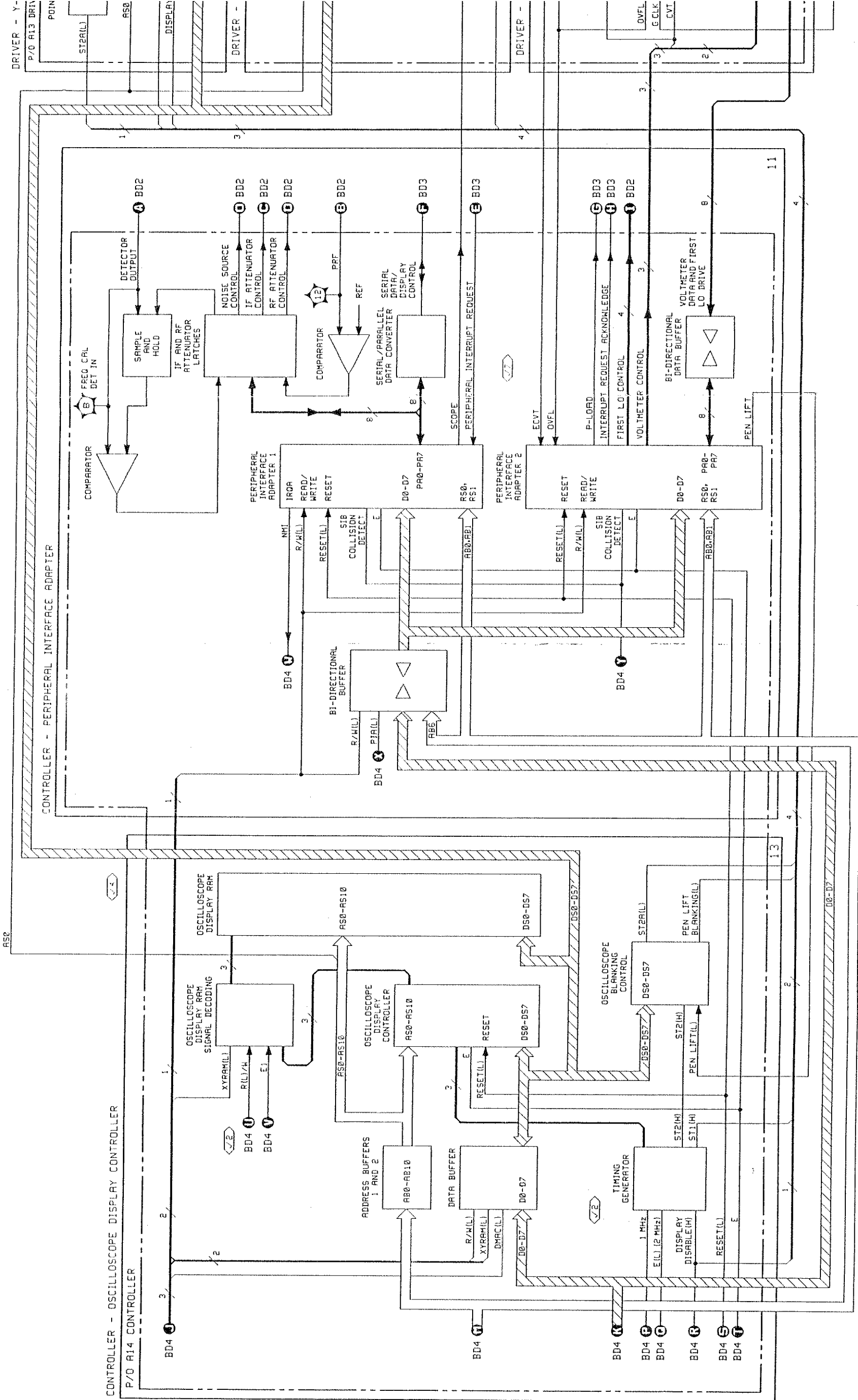
**Completion of Signature Analysis Tests**

Upon completion of the signature analysis tests, disconnect the timing pod from the A14 Controller Assembly and return the A14S1 SA test switch to its normal operation settings as shown below.

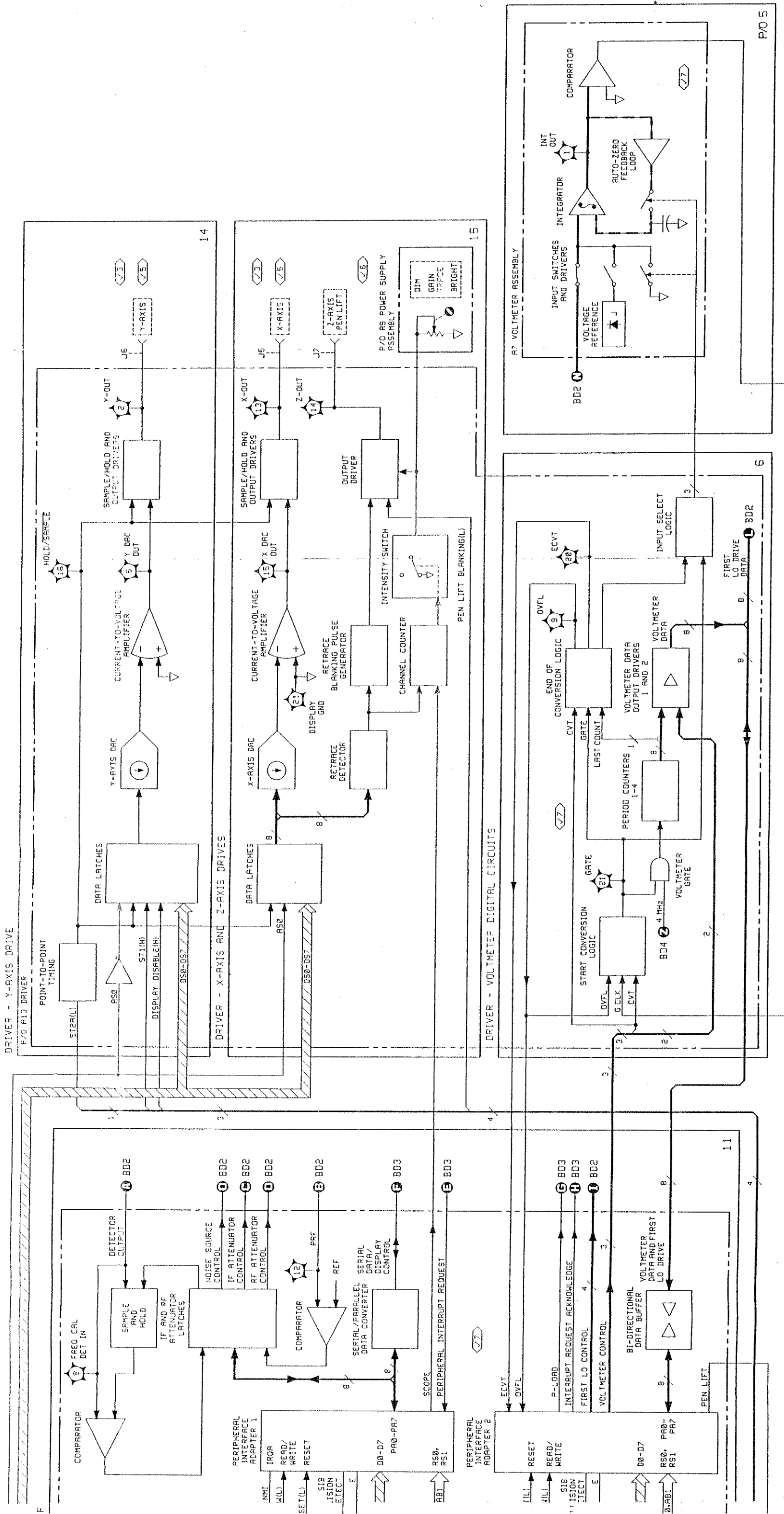
**SA Test Switch (A14S1) Setting  
for Normal Operation**

Switch	Switch Setting
Normal/Frun	Normal
SA1	1
SA2	1
SA3	1
SA4	1
SA5	1









# BD5

Figure 8-18. Digital Block Diagram — PIAs, Voltmeter and Oscilloscope Controller





**SERVICE SHEET 1****INPUT AND FIRST CONVERTER CIRCUITS****A6 INPUT ASSEMBLY****A10 FIRST CONVERTER ASSEMBLY****REFERENCES**

Block Diagram — Service Sheet BD2

Section III — Operator's Checks

Section V — Input Power Detector Offset and Gain Adjustments

Section VIII — Special Functions and Power-Up Checks

**PRINCIPLES OF OPERATION****General**

Service Sheet 1 consists of Input Assembly A6, First Converter Assembly A10, and Isolator AT1. The combined circuits of these assemblies comprise the RF front end of the Noise Figure Meter. The front end receives RF power in the frequency range from 10 MHz to 1600 MHz.

This RF is then upconverted to a fixed frequency of 2050 MHz and output to Second Converter Assembly A11. The power level at the output of the front end is detected and output as a DC voltage level. This DC level is used by Controller Assembly A14 to set the gain of Input Assembly A6.

**Input Assembly A6**

Input Assembly A6 serves two functions. The primary function is to limit the RF power into First Converter Assembly A10 to a range between  $-30$  dBm to  $-20$  dBm. This is accomplished by the use of three 10 dB pads and a  $+20$  dB amplifier, all of which are selectable by the microprocessor (MPU). There is an additional 2 dB pad wired in series with the output. This gives Input Assembly A6 a total gain range of  $+18$  dB to  $-32$  dB.

The second function of Input Assembly A6 is to detect the amount of RF power following the selectable pads. This quantity is then converted into a DC value which is used by the MPU to set the gain of A6. The gain is adjusted until it is at the acceptable level to the First Converter.

**10 dB Pads.** Each 10 dB pad is an identical 50 ohm, resistive pi network with a selectable bypass relay. When the relay is inactive, the 10 dB pad is in series with the RF path. When the relay is energized, the respective pad is bypassed.

**20 dB Input Amplifier.** The 20 dB input amplifier is a low-noise amplifier consisting of two feedback stages A6Q1 and A6Q2. Resistors A6R10

and A6R19 set the shunt feedback for the two stages, respectively. Resistors A6R6, A6R8, A6R9, A6R12, A6R13, and A6R16 provide the emitter degeneration for A6Q1.

Resistors A6R18, A6R20, A6R22, A6R24, A6R25, and A6R26 provide the emitter degeneration for A6Q2. A6Q3 and A6Q4 switch the base bias of A6Q1 and A6Q2 into the active region when the respective amplifier is selected. Multiple resistors are used in the emitters of A6Q1 and A6Q2 to reduce the effects of lead length inductance on the gain at the higher frequencies.

When a low is placed on the  $+20$  dB line, relays A6K2 and A6K3 are energized to place the  $+20$  dB input amplifier in series with the RF path. The low  $+20$  dB level also grounds the common voltage divider A6R14 and A6R15. This turns on A6Q3 and A6Q4, setting the bias voltages of A6Q1 and A6Q2.

**Input Power Detector.** Input RF power is detected by A6CR6 and amplified by DC amplifier A6U1. A6C17 serves as the detector storage and bypass capacitor. Feedback for A6U1 includes thermistor A6RT1 to compensate for temperature changes in A6CR6. The gain of A6U1 is set by GAIN potentiometer A6R42. The DC output of A6U1 is the PRF signal to Controller Assembly A14.

**First Converter Assembly**

First Converter Assembly A10 consists of two low pass filters, a mixer, and a power splitter. The RF power from Input Assembly A6 is in the range of 10 MHz to 1600 MHz. This RF is filtered by a low-pass filter (1850 MHz for *2745A and above* or 1550 MHz for *2742A and below*) and input to Mixer A10CR1A and A10CR1B. Power splitter A10R1 and A10R2 receives RF in the range of 2050 MHz to 3650 MHz which is also input to the mixer.

The result of the mixing is an upconverted input frequency fixed at 2050 MHz. The 2050 MHz RF is filtered by a 5000 MHz low-pass filter, and output to 6200 MHz low-pass filter FL19 (*2812A and above*) and isolator AT1. The isolator allows the RF to flow from First Converter Assembly A10 to Second Converter Assembly A11, but will block any RF from flowing back into A10. This improves the flatness of the instrument by eliminating SWR interactions and undesirable mixing products.

**SERVICE SHEET 1 (cont'd)**

**TROUBLESHOOTING**

Troubleshooting is done on the circuits of Service Sheet 1 when a malfunction has occurred in one of the circuits of either Input Assembly A6 or First Converter Assembly A10. If all of the tests in the following procedures indicate correct responses, the trouble is located elsewhere in the instrument, and not in the Input or First Converter circuits. Except where shown, all test values listed are approximate, and are given as a service guideline.

**Test Equipment**

Frequency Synthesizer	.....	HP 3335A
Oscilloscope	.....	Tektronix 2235
Systems DVM	.....	HP 3456A
Spectrum Analyzer	.....	HP 8566B

**✓ 1 General Checks**

1. In the power on condition, verify that the voltage from pin 7 to ground of A6U1 is +15 ±1.0 Vdc.
2. Ensure that the voltage from pin 4 to ground of A6U1 is -15 ±1.0 Vdc.

**✓ 2 DC Signal Path Tests**

1. Place the Noise Figure Meter in special function 63.0, and measure the resistance from pin 8 of A6K1 to pin 2 of A6K5.

Also check the control lines. The voltages at the control lines for the 10 dB attenuators should be ≤1 Vdc. The voltage at the 20 dB attenuator control line should be +15 ±1 Vdc.

2. Ensure a total resistance of less than 0.5 ohm. If the resistance is high, check relays A6K1 through A6K5.
3. Use Table 8-34 to enter the special function which will test the respective pad.

**✓ 3 Input Power Detector Tests**

1. Select special function 60.3 and inject a 30 MHz RF signal into the RF IN connector of Input Assembly A6.
2. Measure the DC value of the PRF output between A14TP14 (GND) and A14TP16 (PRF), and ensure that the outputs approximate the value listed in Table 8-35.

**Table 8-34. Input Assembly 10 dB Pad Test**

Special Function (63.x)	10 dB Pad No.	Correct Value (Ohms)	Value <1 Ohm	Value Wrong Resistance
63.1	1	51.95	A6K1	A6R2, A6R3, A6R4
63.4	2	51.95	A6K4	A6R28, A6R29, A6R30
63.5	3	51.95	A6K5	A6R36, A6R38, A6R40

**Table 8-35. A6 Input Power vs. Detector Output**

Input Power (dBm)	Detector Output (Vdc)
None	0.0 ± 0.01
-18	6.9 ± 0.1

3. If the first level is in error, with the input at zero, adjust OFFSET potentiometer A6R41 following the procedures in Section V, Adjustments. If the level remains in error, check A6U1 and A6CR6.
4. If the starting level is correct, but the voltage with -18 dBm in is incorrect, adjust GAIN potentiometer A6R42 following the procedures in Section V, Adjustments. If the range is still in error, check A6U1, A6CR6, and A6RT1.

**✓ 4 RF Signal Path Tests**

1. Inject a 30 MHz RF signal into the RF IN connector, connect the spectrum analyzer to the output of isolator AT1, and set the spectrum analyzer center frequency to 2050 MHz and the freq span to 10 MHz.
2. Select each special function to test each circuit as shown in Table 8-36, and ensure that the approximate outputs listed are detected.
3. If the signal is in error at the output of isolator AT1, check the signal at A6J2. See Table 8-36.
4. If the signal out of A6J2 is correct, check for a 2080 MHz, +7.5 dBm signal at A10J4.
5. If the signal at A10J4 is correct, check the problem is either the A10 Assembly, low-pass filter FL19 or Isolator AT1.

# SERVICE SHEET 1 (cont'd)

Table 8-36. Total RF Path Test

Special Function (63.x)	Input Power (dBm)	A1 Output Power (dBm)	A6J2 Output Power (dBm)	Circuit Device Tested
63.0	-10	-20 ±2 dB	-12 ±0.5 dB	Through-Path
63.1	-10	-30 ±3 dB	-22 ±1 dB	10 dB Pad #1
63.2	-10	0 ±4 dB	+8 ±2 dB	20 dB Input Amplifier
63.4	-10	-30 ±3 dB	-22 ±1 dB	10 dB Pad #2
63.5	-10	-30 ±3 dB	-22 ±1 dB	10 dB Pad #3

6. If the signal at A10J4 is in error, check the first LO output signal of A17A1G1.
7. If the LO output signal is correct, replace the A10 Assembly.

8. If the LO output signal is incorrect, continue troubleshooting on Service Sheet 7.
9. If the signal at A6J2 is incorrect, use Table 8-36, to isolate the error to the faulty circuit. If the faulty circuit is a pad, check the pad's resistors and relay.
10. If the faulty circuit is the input amplifier, check A6Q1. If A6Q1 is good, ensure that the signal is on the base of A6Q2. If the signal is correct, check the signal components of A6Q2, and then the bias components.
11. If the signal is in error, check for a low on the +20 dB line. If the +20 dB signal is in error, check A6R14, A6R15, A6Q3, and A6Q4. Otherwise, first check the signal components of A6Q1, and then the bias components.

### Completion of Testing

Upon completion of testing, place all switches in their original positions, remove all test gear, and restore the Noise Figure Meter to the normal operating condition. If repairs have been made, or adjustments changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.



# A6 ASSEMBLY

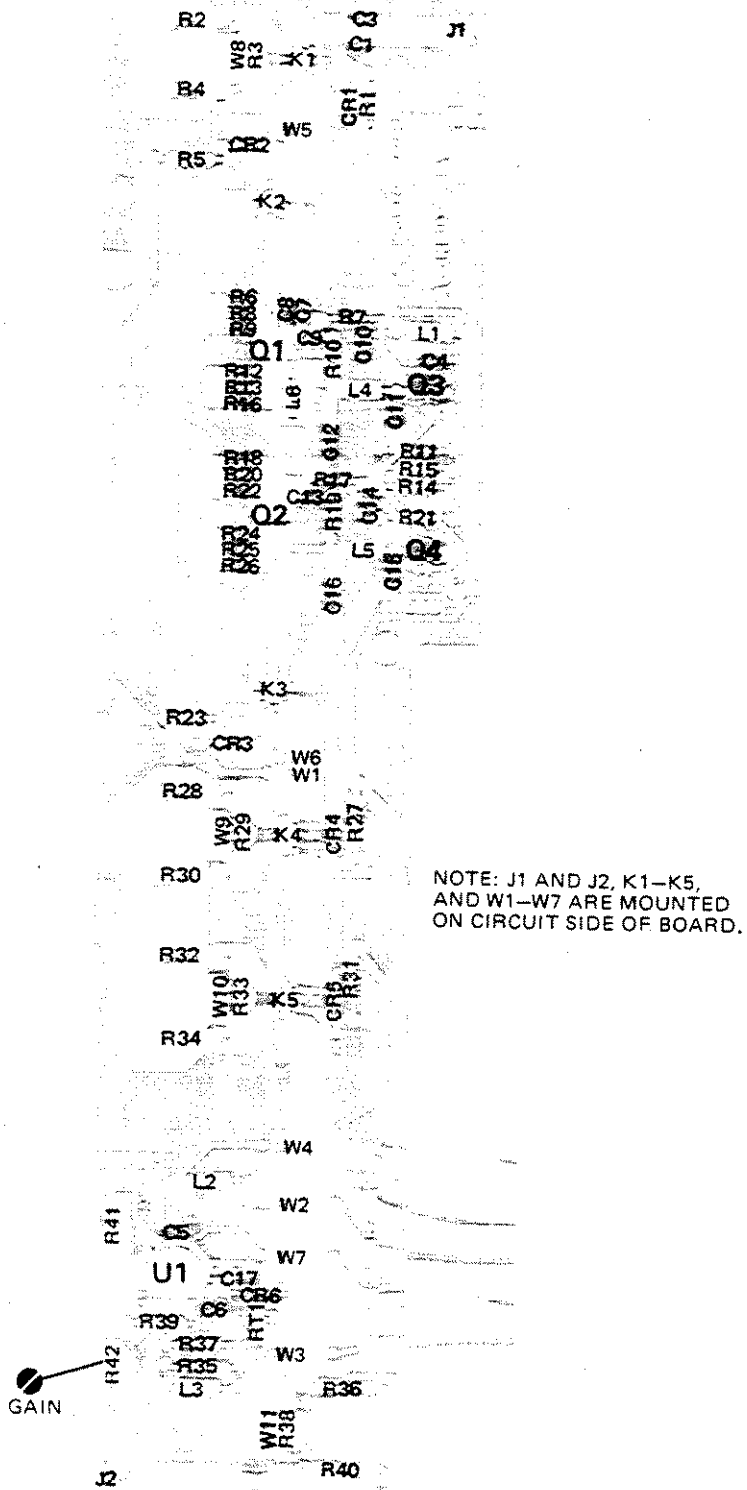
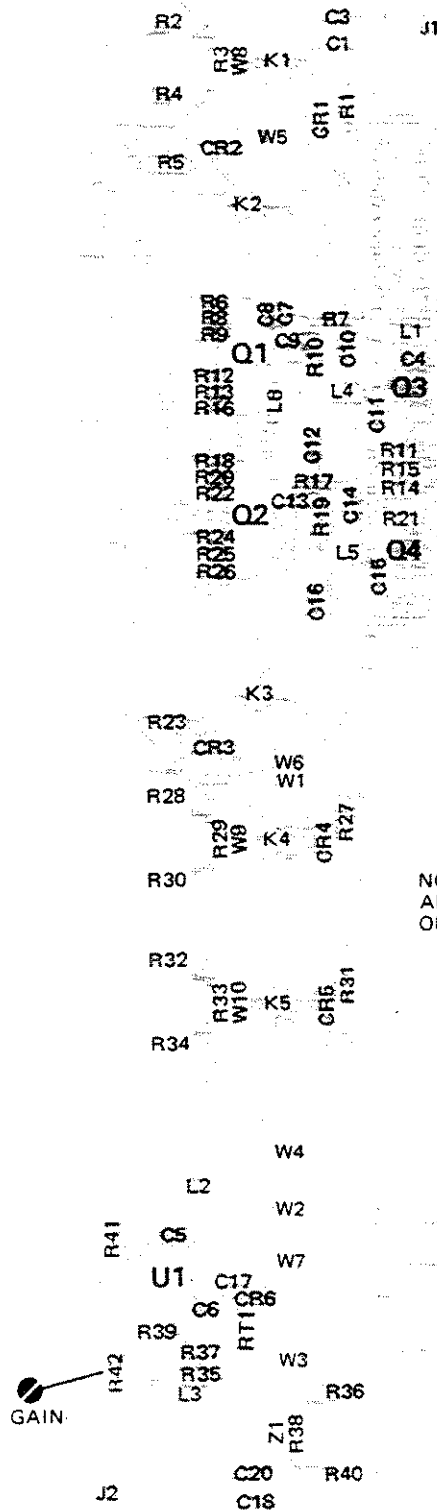


Figure 8-19. A6 Input Assembly Component Locations  
(Serial Prefix 2721A and Below)

# A6 ASSEMBLY



NOTE: J1 AND J2, K1-K5,  
AND W1-W7 ARE MOUNTED  
ON CIRCUIT SIDE OF BOARD.

Figure 8-19. A6 Input Assembly Component Locations  
(Serial Prefix 2742A and Above)

**A10 ASSEMBLY  
EXTERNAL VIEW**

AT2 (NOT PART OF THE A10 ASSEMBLY)

J4

J2

J3

J1

**INTERNAL VIEW**

J2  
(UNDERNEATH)

J3 J1  
(UNDERNEATH) (UNDERNEATH)

R1

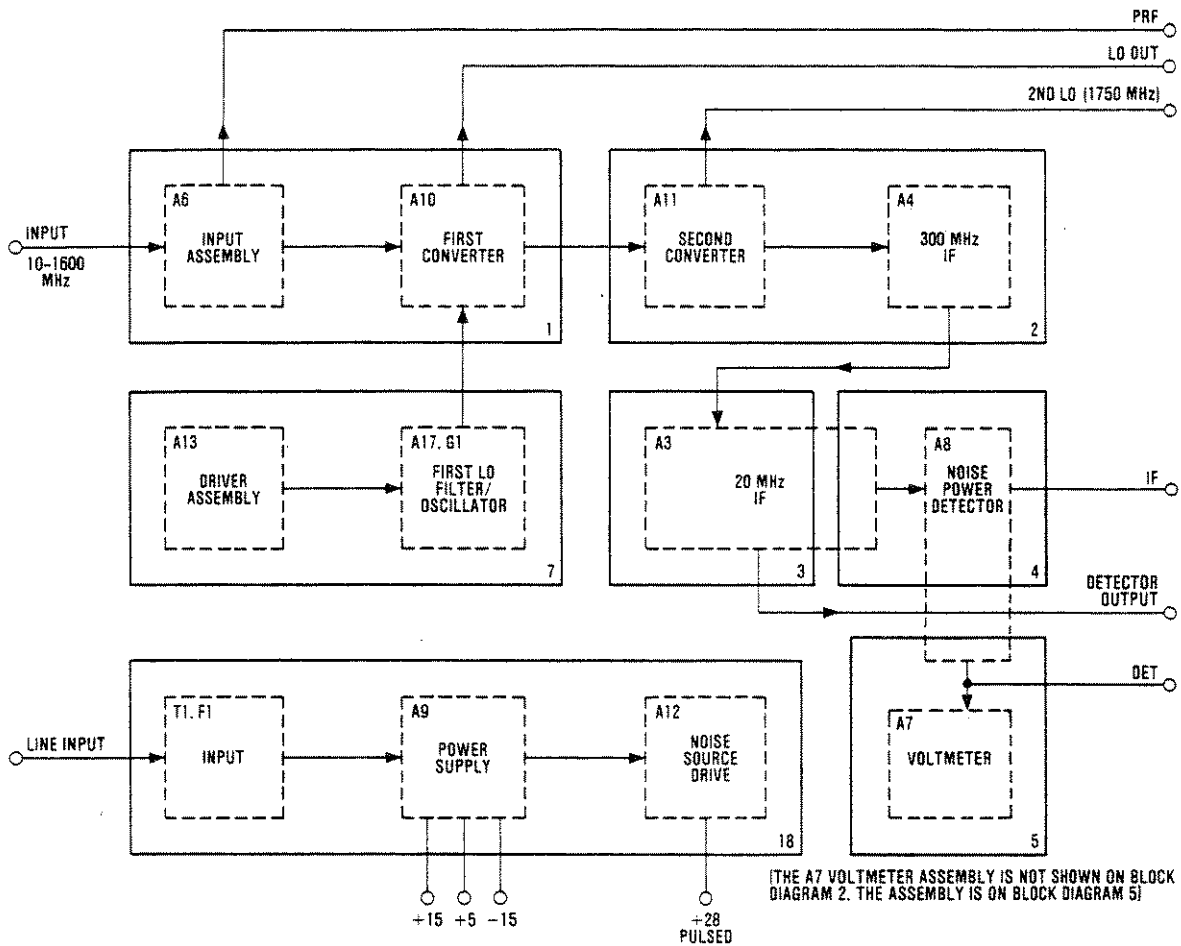
R2  
J4  
(UNDERNEATH)

CR1  
(BOTH DIODES  
REPLACED AS  
A UNIT)

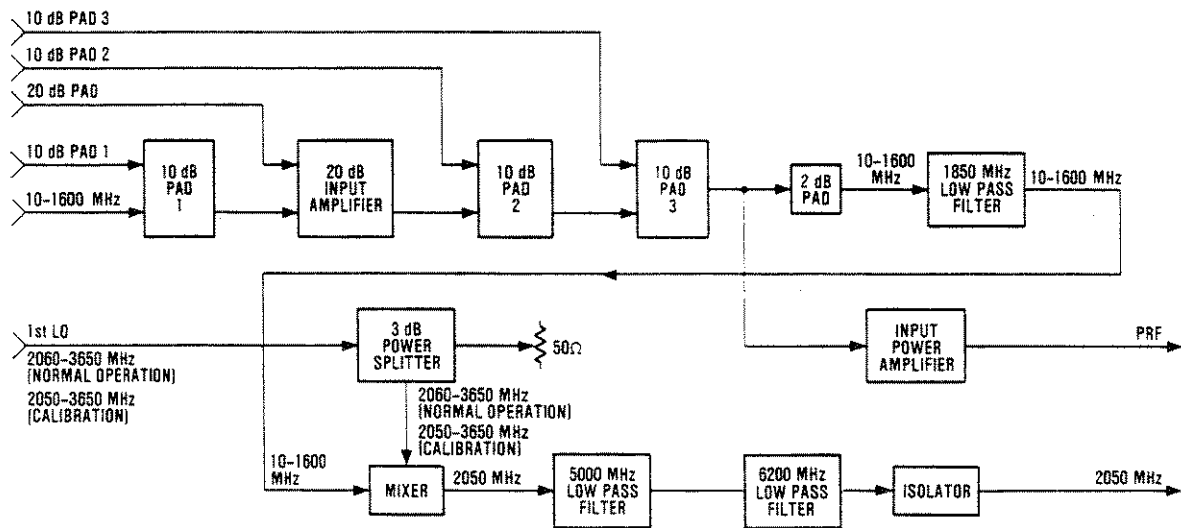
**Figure 8-20. A10 First Converter Assembly Component Locations**

**NOTE**

*This figure is used with instruments prefixed 2812A and above. The figure on page 8-77 is used with instruments prefixed 2745A and below.*



**ANALOG SECTION BLOCK DIAGRAM BD2**



**Figure 8-21. Input and First Converter Block Diagram (Serial Prefix 2812A and Above)**



*(2742A and Below)*

The schematic on page 8-77, along with these changes, documents instruments prefixed 2742A and below.

**A6 Input Assembly**

*(2721A and below)* 08970-60042 (recommended replacement for 08970-60001)

**A10 First Converter Assembly**

*(2742A and below)* 08970-60051 (recommended replacement for 08970-60151)

**1850 MHz Low Pass Filter (First Converter Assembly)**

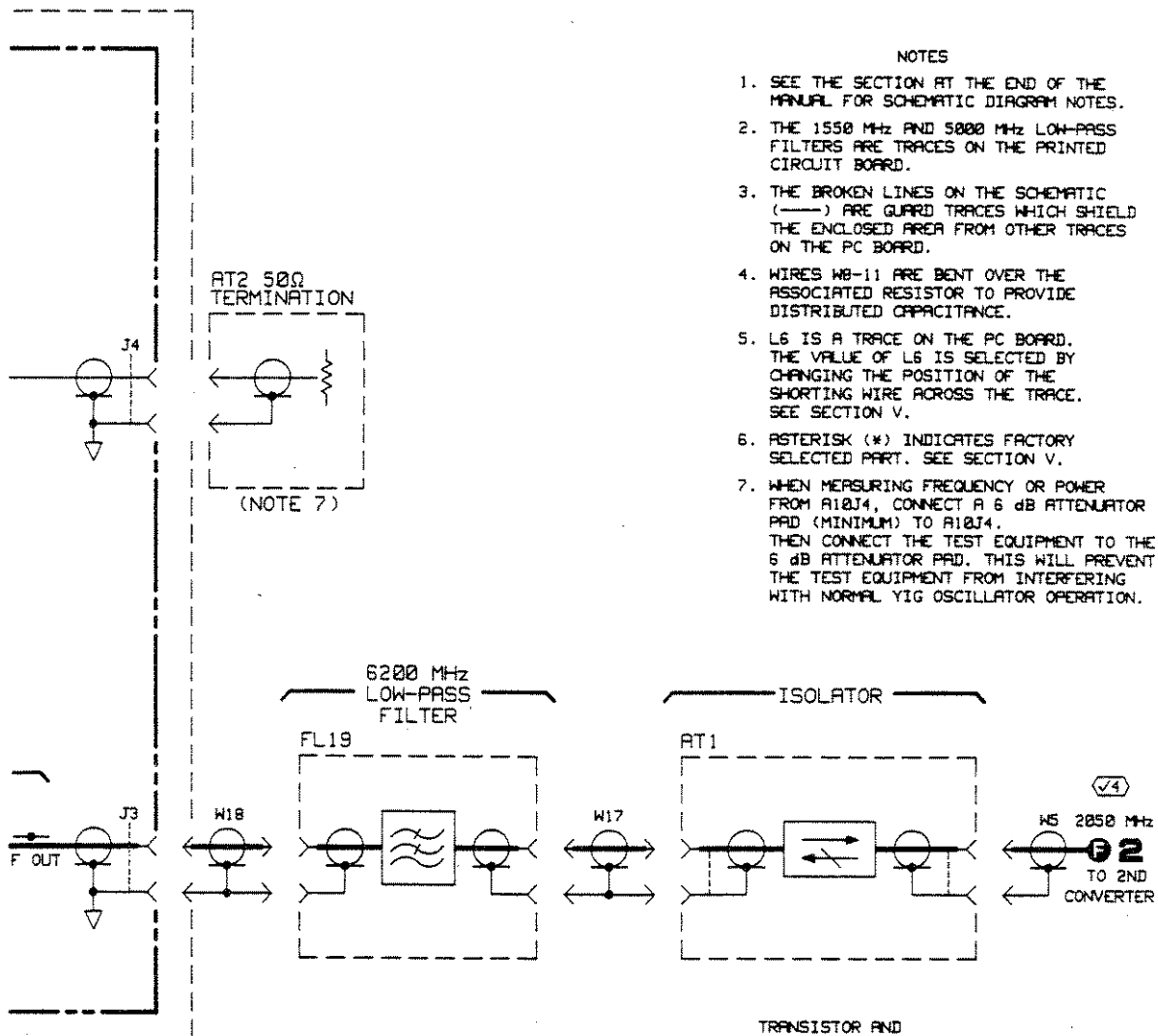
*(2742A and below)* Change to 1550 MHz Low Pass Filter

**Z1—2 dB Pad**

*(2721A and below)* Change to W11.

(2812A and Above)

The schematic on page 8-77, along with this partial schematic, documents instruments prefixed 2812A and above.

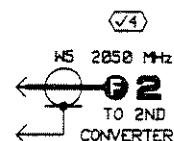
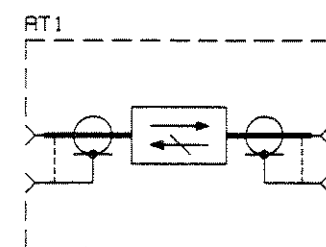
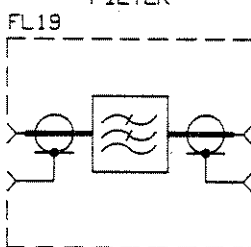


NOTES

1. SEE THE SECTION AT THE END OF THE MANUAL FOR SCHEMATIC DIAGRAM NOTES.
2. THE 1550 MHz AND 5800 MHz LOW-PASS FILTERS ARE TRACES ON THE PRINTED CIRCUIT BOARD.
3. THE BROKEN LINES ON THE SCHEMATIC (—) ARE GUARD TRACES WHICH SHIELD THE ENCLOSED AREA FROM OTHER TRACES ON THE PC BOARD.
4. WIRES W8-11 ARE BENT OVER THE ASSOCIATED RESISTOR TO PROVIDE DISTRIBUTED CAPACITANCE.
5. L6 IS A TRACE ON THE PC BOARD. THE VALUE OF L6 IS SELECTED BY CHANGING THE POSITION OF THE SHORTING WIRE ACROSS THE TRACE. SEE SECTION V.
6. ASTERISK (\*) INDICATES FACTORY SELECTED PART. SEE SECTION V.
7. WHEN MEASURING FREQUENCY OR POWER FROM A10J4, CONNECT A 6 dB ATTENUATOR PAD (MINIMUM) TO A10J4. THEN CONNECT THE TEST EQUIPMENT TO THE 6 dB ATTENUATOR PAD. THIS WILL PREVENT THE TEST EQUIPMENT FROM INTERFERING WITH NORMAL YIG OSCILLATOR OPERATION.

6200 MHz  
LOW-PASS  
FILTER

ISOLATOR



LOGIC LEVEL

	TTL
HIGH	>2V
LOW	<0.8V
<	IS MORE NEG. THAN
>	IS MORE POS. THAN
OPEN	HIGH
GROUND	LOW

TRANSISTOR AND  
INTEGRATED CIRCUIT  
PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBERS
A6	
Q1	1854-0864
Q2	1854-0863
Q3,4	1853-0459
U1	1826-0266

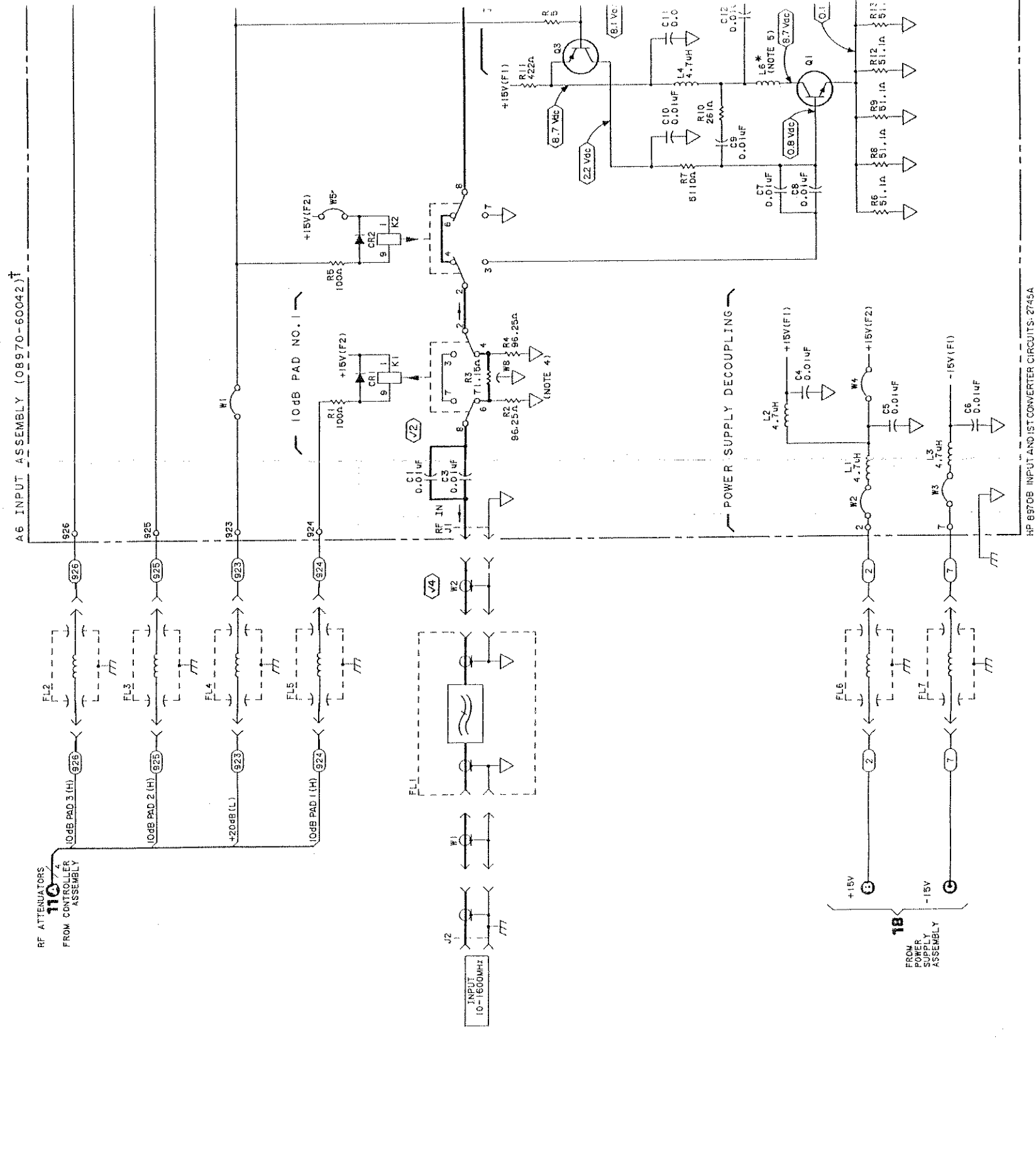
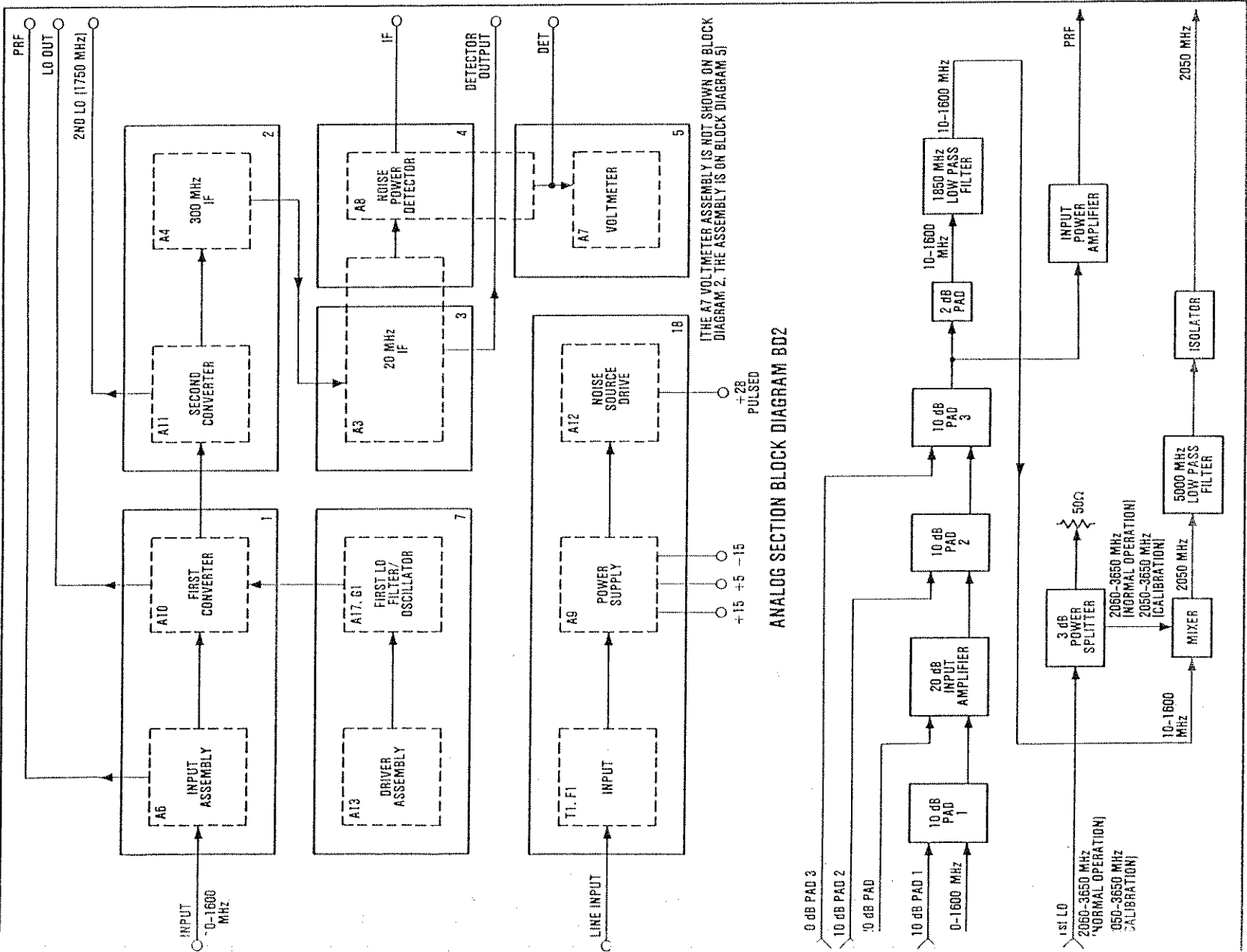


Figure 8-21. Input and First Converter Block Diagram



# A11 ASSEMBLY

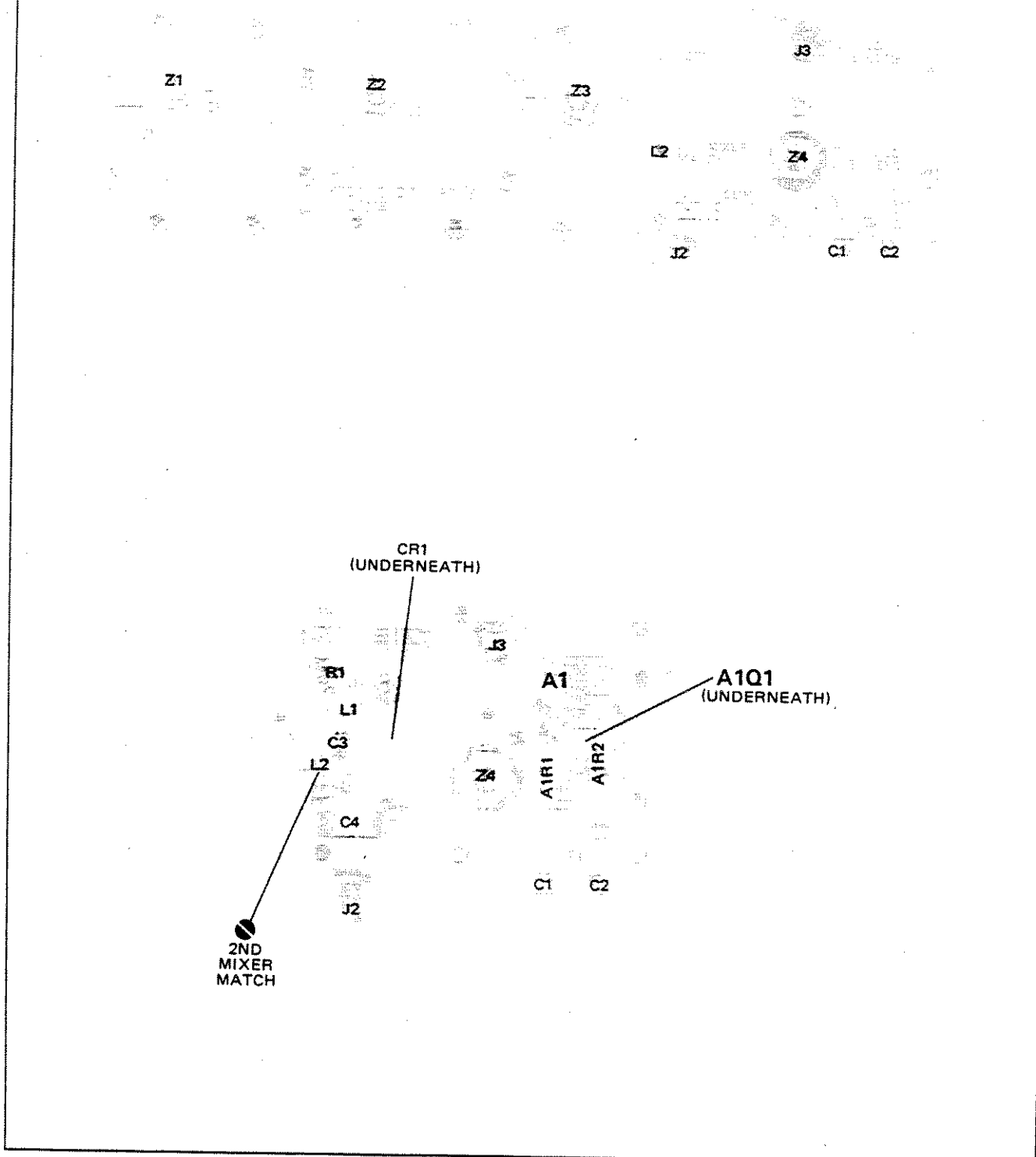


Figure 8-23. A11 Second Converter Assembly Component Locations

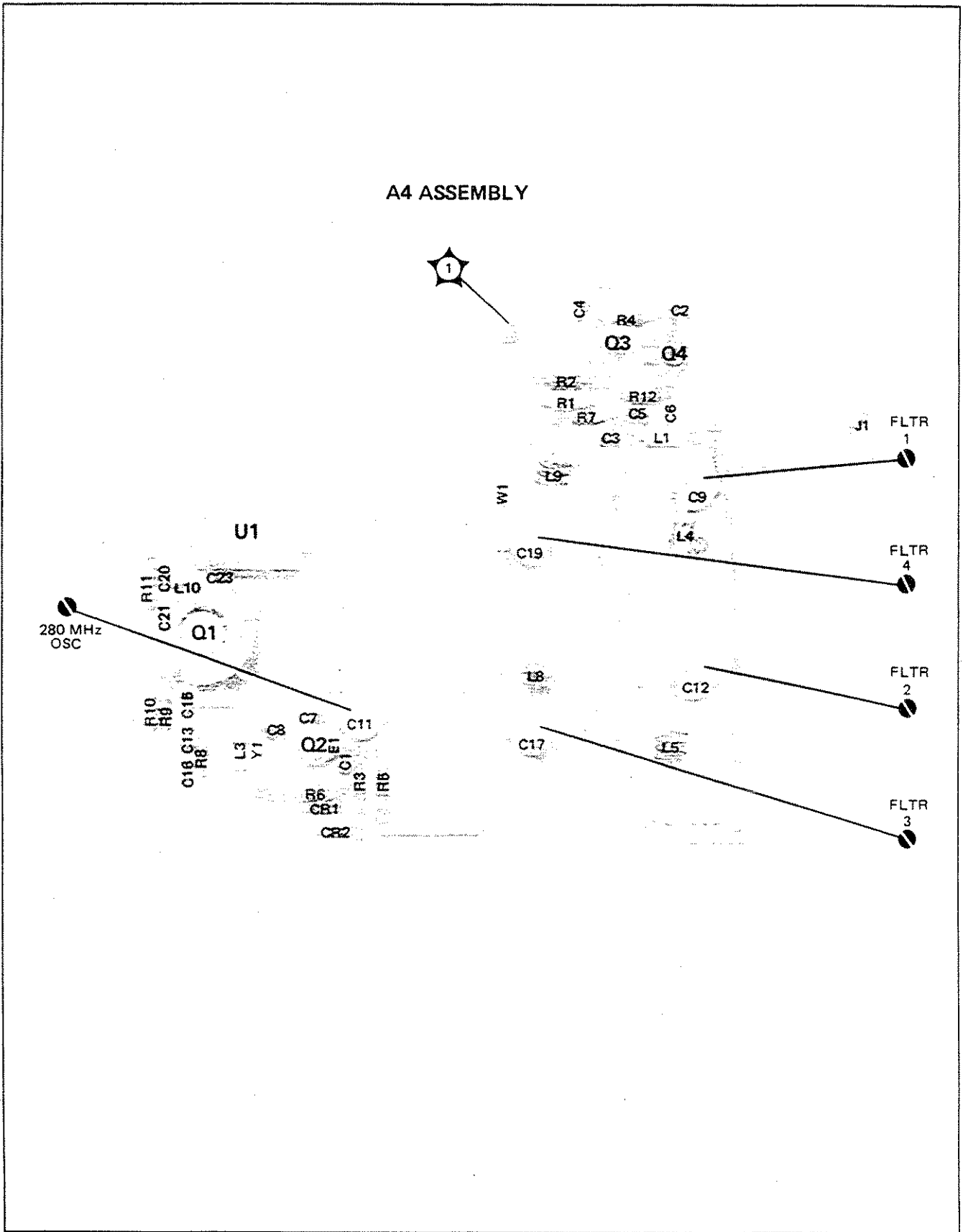


Figure 8-24. A4 300 MHz IF Assembly Component Locations

*(2645A and Above)*

The schematic on page 8-83, along with these changes, documents instruments prefixed 2645A and above.

A11A1Q1 — Part Number Table (right side of schematic)  
*(2645A and above)* 1GS1-4210

February 1989 8-82.1/8-82.2





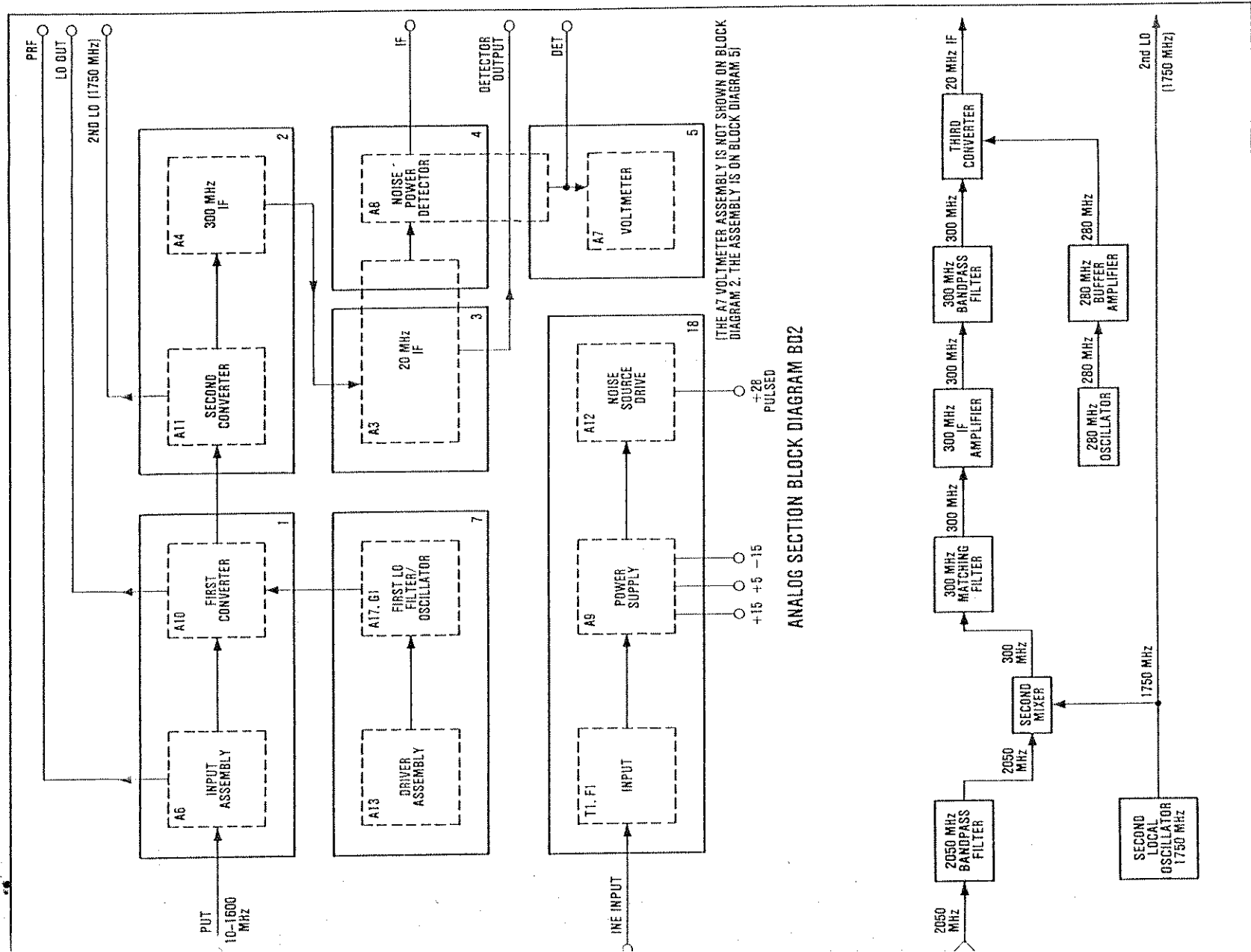
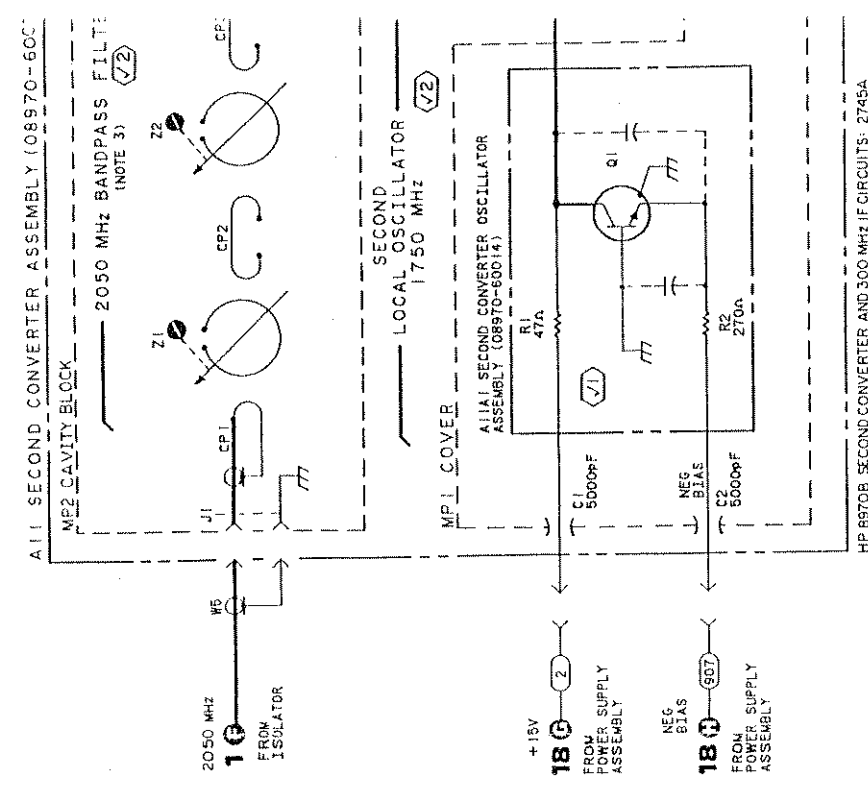


Figure 8-25. Second Converter and 300 MHz IF Block Diagram



HP 8970B SECOND CONVERTER AND 300 MHz IF CIRCUITS: 2745A







## SERVICE SHEET 3

### 20 MHz IF CIRCUITS (PART 1)

#### A3 20 MHz IF ASSEMBLY

#### REFERENCES

Block Diagram — Service Sheet BD2  
Section III — Operator's Checks  
Section VIII — Special Functions and  
Power-Up Checks

#### PRINCIPLES OF OPERATION

##### General

The 20 MHz IF section of the Noise Figure Meter is located mostly within 20 MHz IF Assembly A3. The remainder is located in Noise Power Detector Assembly A8. Due to the size of the 20 MHz IF, the circuits are drawn on two separate service sheets. Service Sheet 3 contains most of the 20 MHz IF circuitry that is located within assembly A3.

Service Sheet 4 contains the remainder of assembly A3, and those 20 MHz IF circuits located in assembly A8. The 20 MHz IF circuits shape and set the power level of the 20 MHz noise signal. The result is a 20 MHz IF with a bandwidth of 4 MHz, and an overall gain, selectable in 5 dB steps, from +40 dB to +75 dB.

##### Pre-Detector Circuits

The 20 MHz IF signal is input to the first 3-pole, 20 MHz bandpass filter (A3L3, A3L4, A3L7, A3C5, A3C8, and A3C12). The filtered signal is amplified and input to the second 3-pole, 20 MHz bandpass filter (A3L12, A3L13, A3L14, A3C27, A3C28, and A3C30).

The amplifier between the two filters is +22 dB amplifier A3Q20/A3Q21. The amplifier serves two functions, the first of which is to ensure that both filters are terminated into 50 ohm loads. The second function is to supply the +22 dB gain. A3Q21 is operated in a series-shunt feedback arrangement, with A3R3 as the shunt feedback, and the emitter resistance as the series feedback. Bias is established by resistors A3R1, A3R2, and A3R4. The gain of the stage is +28 dB.

The second stage (A3Q20) is used as a buffer stage. Resistors A3R5, A3R8, and A3R10 determine the 50 ohm loads for the two filters. Resistors A3R6, A3R7, and A3R9 provide bias for A3Q20. The loss through the buffer stage is 6 dB. This gives an overall gain for the amplifier of

+22 dB. The output of the second 20 MHz bandpass filter goes to both the temperature compensated amplifier and the frequency calibration detector.

##### Frequency Calibration Detector

The frequency calibration detector is used by the Noise Figure Meter, during frequency calibration, to determine the zero input frequency point. High gate impedance JFET A3Q2 is used at the amplifier input to avoid loading down the second 20 MHz bandpass filter. The voltage signal at the gate is converted to a current signal at the drain. The amount of gain is determined by the ratio of A3R28 to the unbypassed portion of A3R19 (DET GAIN). A3Q2 bias is set by A3R12 and A3R15.

The output current of A3Q2 goes to common-base amplifier A3Q1, which is used to drive the tuned circuit and the detector diode. A3L17, A3C41, and A3C43 comprise the tuned circuit. A3C43 (DET FREQ) is adjusted for a maximum signal, at 20 MHz, to detector A3CR3. When the instrument does a frequency calibration, the frequency of the First LO is varied until a peak is detected at A3CR3, thus ensuring that the desired frequency is centered in the IF passband.

Diode A3CR3 builds up a charge on A3C47 that is equivalent to the peak of the RF signal on the tuned circuit. This DC level is then output to Controller Assembly A14 as the DETECTOR OUTPUT signal.

##### Post Detector Circuits

**Temperature Compensated Amplifier.** Transistors A3Q4, A3Q3, and A3Q5 comprise the temperature compensated feedback amplifier. JFET A3Q4 is used to prevent loading of the previous filter. A3Q4 converts the input voltage to an output current which drives A3Q3 and A3Q5. A3R13 and A3R14 bias the gate of A3Q4.

A3Q3 and A3Q5 provide a low output impedance in order to appear as a voltage source driver to the following attenuator. Feedback is accomplished by A3R17, A3RT1, A3R24, and A3C81. Gain of the amplifier stage is from +20 dB to +23 dB as the temperature varies from zero to fifty-five degrees Celsius. Components A3C38 and A3R23 provide high frequency stability compensation.

**20 dB Switched Attenuator.** The 20 dB switched attenuator consists of two transistors (A3Q6 and A3Q9) and a voltage divider (A3R25 and A3R26).

## SERVICE SHEET 3 (cont'd)

If the signal on the 20 dB ATTENUATOR line is low, then comparator A3U1A will output a high, while A3U1B will output a low. The low (-15 Vdc) from A3U1B will turn off A3Q9, while the high (+15 Vdc) from A3U1A will turn on A3Q6. With A3Q6 on, the voltage divider network will be bypassed, and the RF will not be attenuated.

A high (+5 Vdc) on the 20 dB ATTENUATOR line will turn A3Q6 off and A3Q9 on. This will route the RF through the voltage divider network, thus attenuating the RF signal by 20 dB. Both A3Q6 and A3Q9 are JFETs. Therefore, diodes A3CR1 and A3CR2 are used to prevent forward biasing of the JFETs when the comparator output is high. A3R29 and A3R30 are used for fast turn on of the JFETs.

**Adjustable Gain Amplifier.** Transistors A3Q7, A3Q8, and A3Q11 comprise the adjustable gain amplifier. It is identical in operation to the temperature compensated amplifier, except that the temperature compensating resistor A3RT1 has been replaced by potentiometer A3R36 (IF GAIN). Therefore, the amplifier gain is manually set between +20 dB to +23 dB.

## TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 3 when a malfunction has occurred in one of the 20 MHz IF circuits in the first half of 20 MHz IF Assembly A3. If all of the tests in the following procedures indicate correct responses, the trouble is either in the second half (Service Sheet 4) of the 20 MHz IF circuits, or is located elsewhere in the instrument. Except where shown, all test values are approximate, and are given as a service guideline.

### Test Equipment

Frequency Synthesizer .....	HP 3335A
Oscilloscope .....	Tektronix 2235
Systems DVM .....	HP 3456A
Spectrum Analyzer .....	HP 8566B

### ✓1 General Checks

1. In the power on condition, verify that the voltage from pin 8 of A3U1 to ground is  $+15 \pm 1.0$  Vdc.
2. Ensure that the voltage from pin 4 of A3U1 to ground is  $-15 \pm 1.0$  Vdc.

### ✓2 Pre-Detector Circuits Tests

1. Inject a 30 MHz RF signal, at 0 dBm, into the front panel INPUT connector, and select special functions 63.0 and 31.1.
2. Remove capacitor A3C82 from the 20 MHz IF path, and place it between the W15 input line and output test connector A3J1.
3. Ensure an output (at A3J1) of -6 dBm at 20 MHz. Restore capacitor A3C82 to its original position. If the signal is in error, check A3C82. The problem is most likely in the 300 MHz IF Assembly A4 (Service Sheet 2).
4. Ensure a signal of 0.5 Vpp at 20 MHz at the junction of A3C31 and A3C33. If signal is correct, refer to the detector and post-detector circuits.
5. If the signal was in error, check for a signal of 1.7 Vpp, at 20 MHz, at the base of A3Q20. If the signal is correct, check the voltages and components of the A3Q20 stage of the 22 dB amplifier. If the values are correct, check the components of the second 20 MHz band-pass filter.
6. If the signal at the base of A3Q20 was in error, check the voltages and components of the A3Q21 stage of the 22 dB amplifier. If the values are correct, check the components of the first 20 MHz bandpass filter.

### ✓3 Frequency Calibration Detector Test

1. Connect an oscilloscope using a high impedance probe to A14TP8 (FREQ CAL DET). Set the oscilloscope to 1 V/div. and 1 sec/div. Disconnect any RF signal from the front panel input connector.
2. As the dot moves across the oscilloscope display, press PRESET on the Noise Figure Meter. The dot should rapidly rise to some peak value and then fall back to its original level. If the peak voltage is  $>2$  volts, continue with Check 4. If the peak voltage is  $<2$  volts, check A3Q2, A3Q1, and the associated components including the 938 cable connecting the A3 assembly to the A14 assembly.

### ✓4 Post Detector Circuits Test

1. Reconnect the RF signal to the front panel input and select 63.0 and 31.1 SPECIAL

### SERVICE SHEET 3 (cont'd)

FUNCTIONS. Ensure that with the instrument input still at 0 dBm, the signal on the base of A3Q5 is a distorted 7 Vpp signal riding on a +3 Vdc base. Change the input to the Noise Figure Meter to -30 dBm.

2. Ensure that the signal on the base of A3Q5 is now an undistorted signal at 1.5 Vpp. If the signal is in error, change the input back to 0 dBm, and ensure a 0.3 Vpp signal on the base of A3Q3.
3. If the signal on the base of A3Q3 is correct, check the voltages and components of A3Q5. If the signal on the base of A3Q3 is incorrect, check the voltages and components of A3Q3 and A3Q4.
4. Return the input back to -30 dBm, and select special function 70.0. Ensure a 0.1 Vpp signal at the junction of A3C50 and A3C51. If the signal is in error, check A3Q5, A3Q9, and A3U1B.

5. Select special function 70.1, and ensure that the signal at the junction of A3C50 and A3C51 goes to 1.3 Vpp. If the signal is in error, check A3Q5, A3Q6, and A3U1A.
6. Select special function 70.0, and ensure a 0.05 Vpp signal on the base of A3Q8. If the signal is in error, check the voltages and components of A3Q7 and A3Q8.
7. Ensure a 2 Vpp signal at the emitter of A3Q11. If the signal is in error, check the voltages and components of A3Q8 and A3Q11.

#### Completion of Testing

Upon completion of testing, place all switches in their original positions, remove all test gear, and restore the Noise Figure Meter to the normal operating condition. If repairs have been made, or adjustments changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

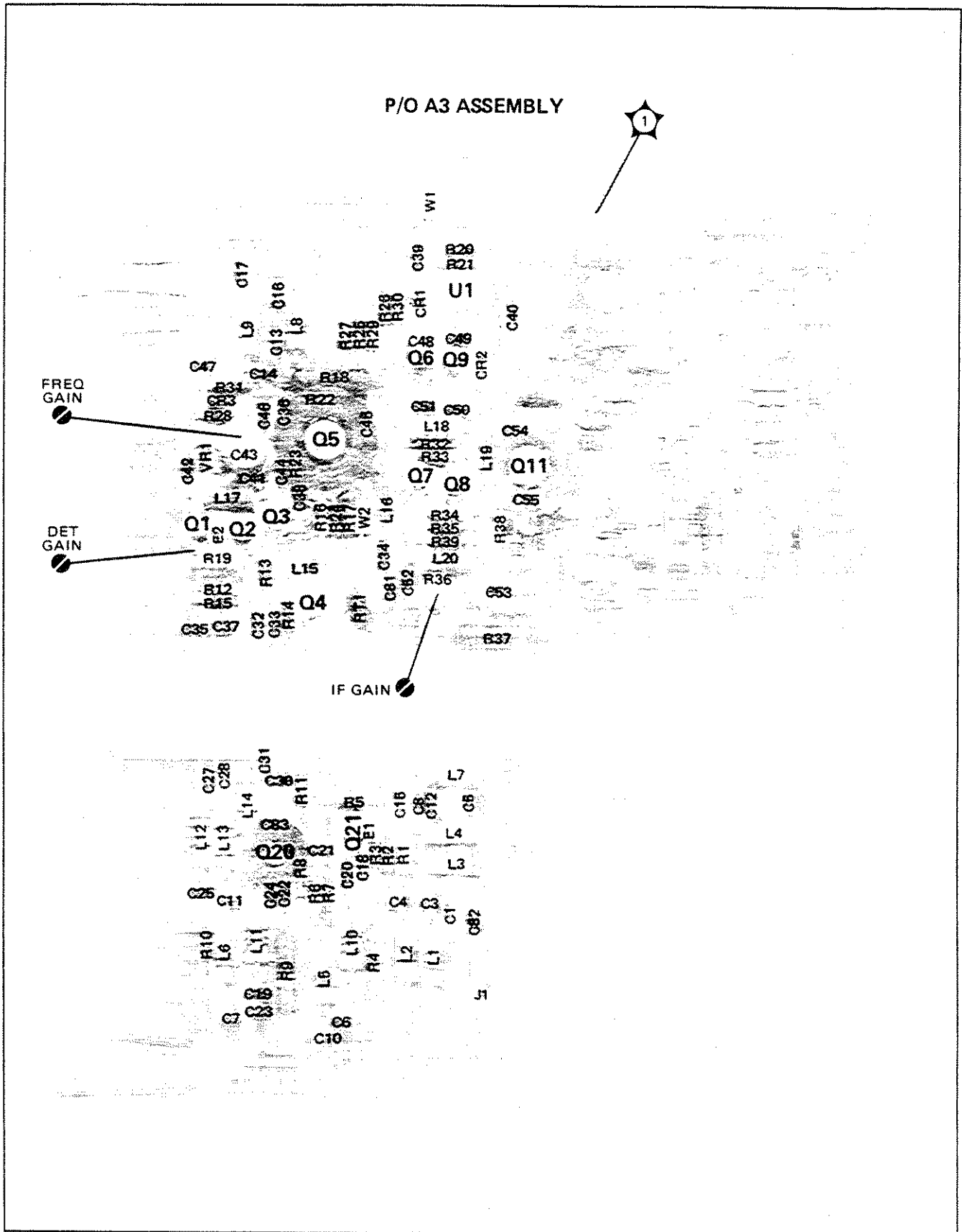
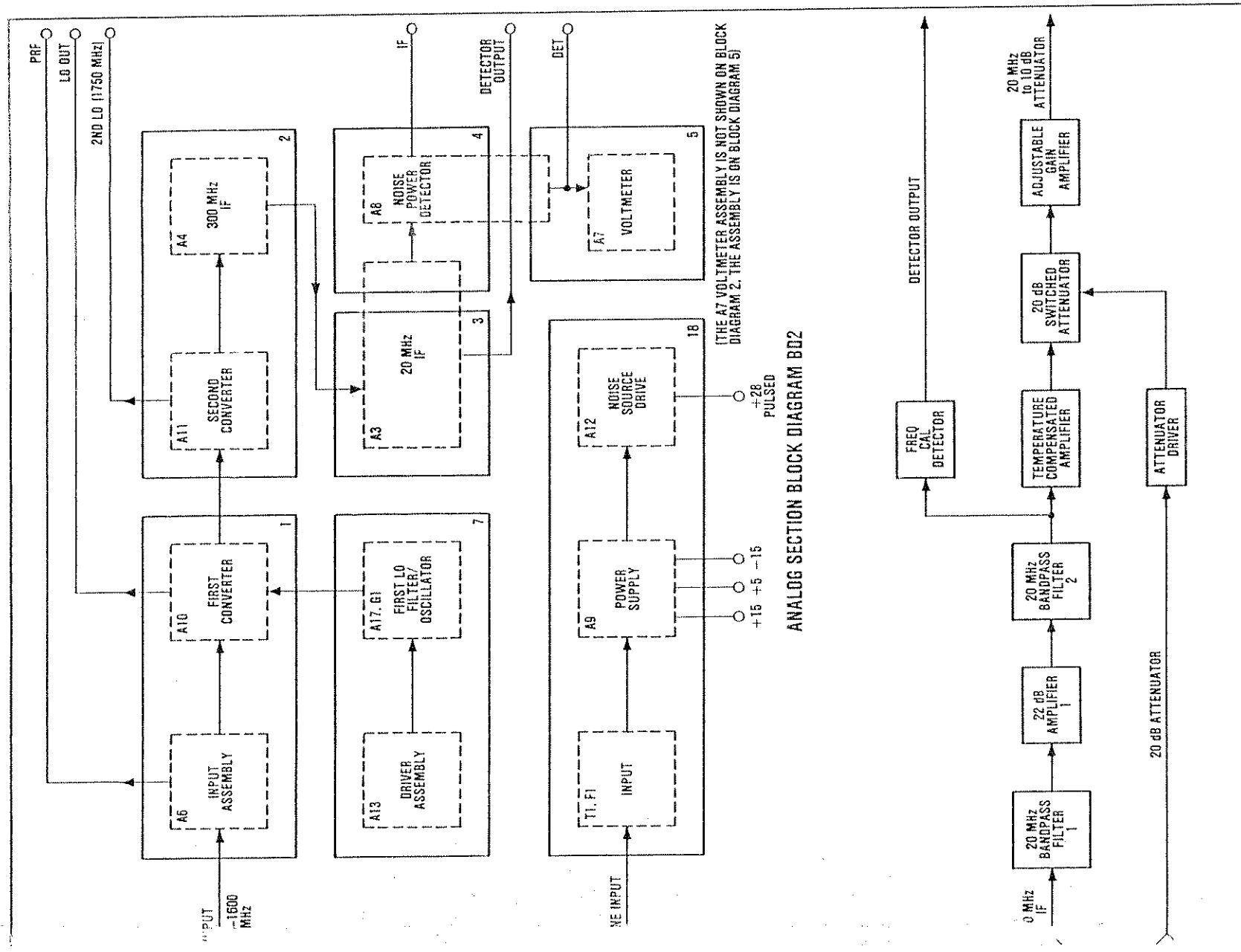


Figure 8-27. P/O A3 20 MHz IF Assembly Component Locations (Part 1)





ANALOG SECTION BLOCK DIAGRAM BD2

(THE A7 VOLTMETER ASSEMBLY IS NOT SHOWN ON BLOCK DIAGRAM 2. THE ASSEMBLY IS ON BLOCK DIAGRAM 5)

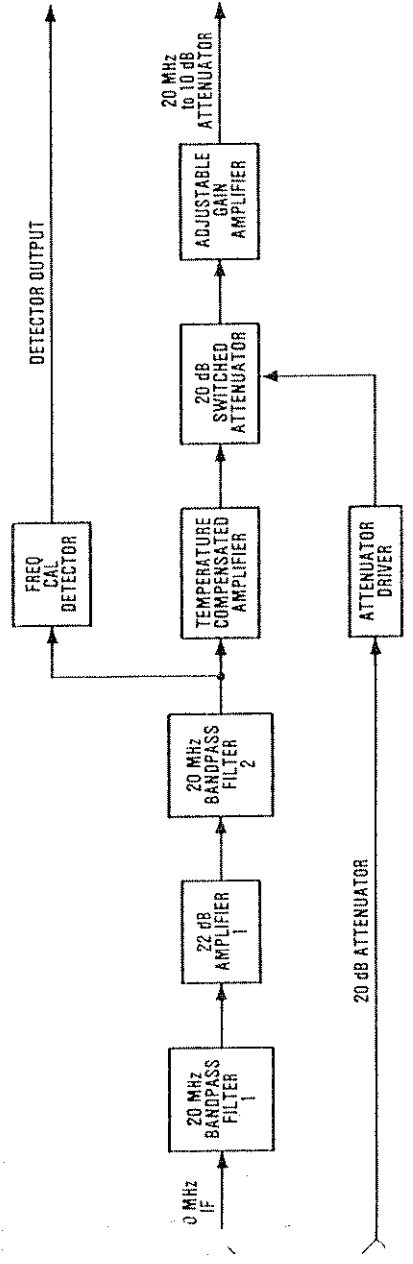
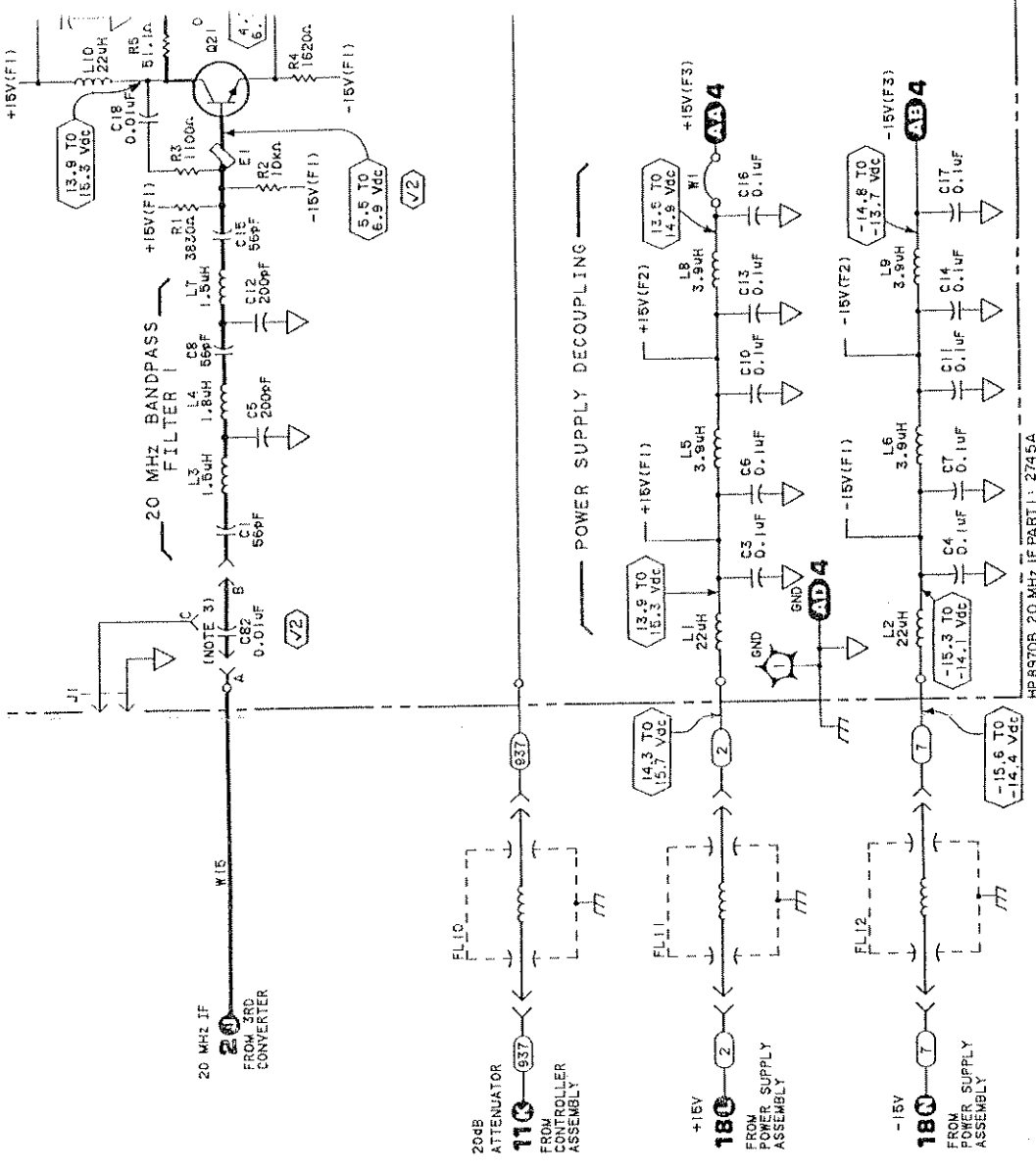
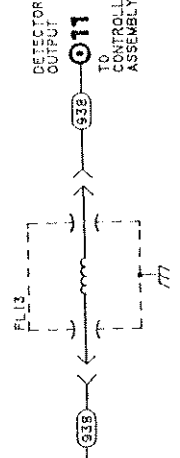
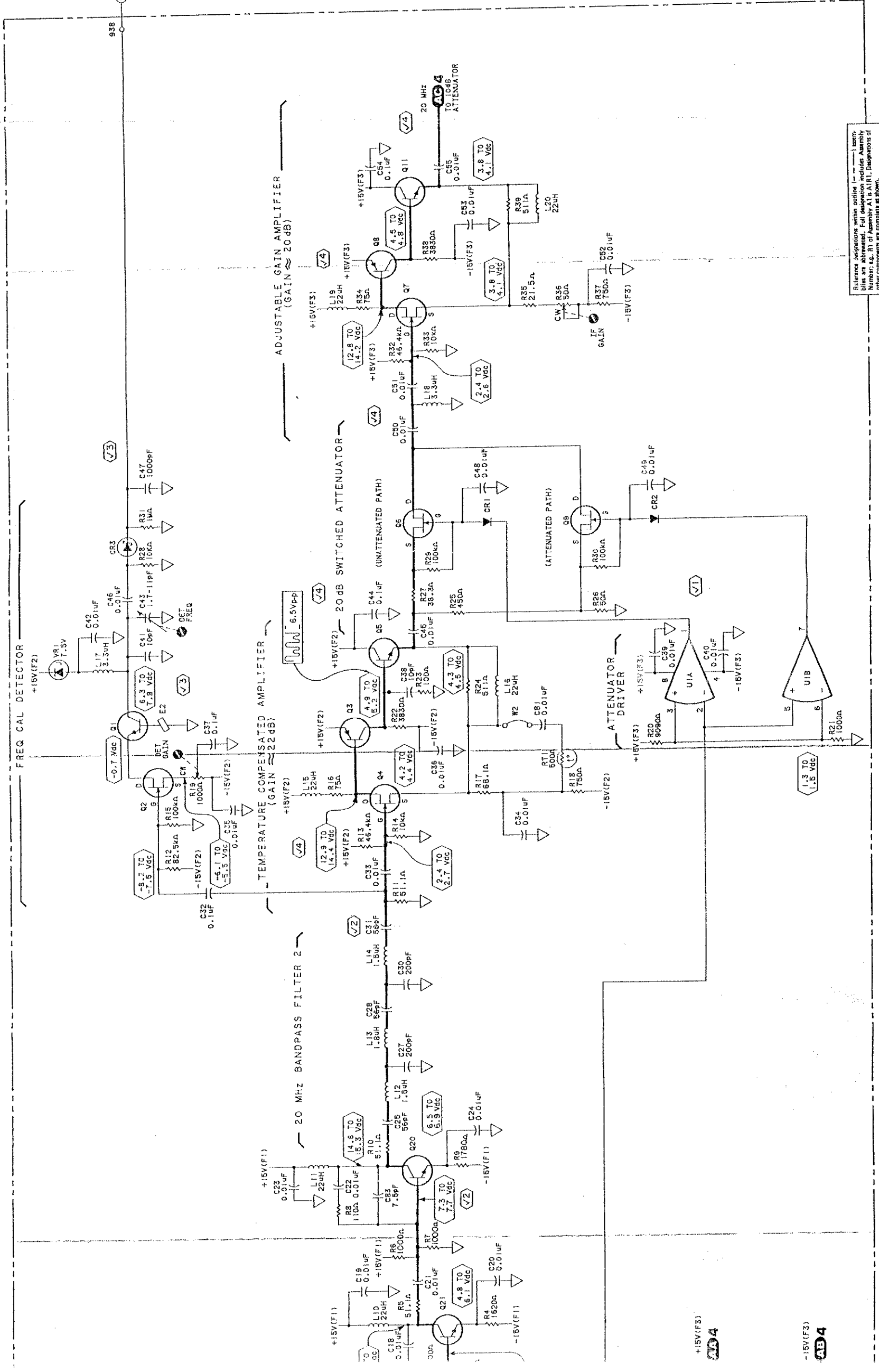


Figure 8-28. 20 MHz IF (Part 1) Block Diagram



HP 8970B 20 MHz IF PART 1: 2745A



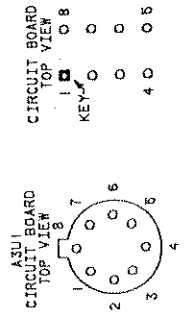


- NOTES
1. SEE THE SECTION AT THE END OF THE MANUAL FOR SCHEMATIC DIAGRAM NOTES.
  2. CHASSIS GROUND IS ACHIEVED BY MECHANICAL CONTACT THROUGH SCREWS HOLDING THE P.C. BOARD TO THE FRAME.
  3. CR2 CAN BE CONNECTED BETWEEN ANY TWO OF THE THREE CONNECTORS SHOWN.

NO PREFIX	REFERENCE DESIGNATIONS	A3
EL10-13	C1, 3-8, 10-25, 27, 28, 30-35, 31-33, 34	
W10	CR1-3	
	E1, 2	
	J1, 2	
	O1-9, 11, 20-21	
	R1-38	
	RT1	
	TP1	
	VR1	
	W1, 2	

NOT ASSIGNED:  
AS32, C91C25, C29

REFERENCE DESIGNATIONS	PART NUMBERS
Q1, Q2	1854-0345
Q3, Q4, Q5, Q6, Q7, Q8	1855-0235
Q9, 11	1853-0405
Q9, 9	1854-0697
Q9, 9	1855-0420
Q21	1854-0686
UI	1825-0217



3  
F30A3

Figure 8-29. 20 MHz IF Schematic Diagram (Part 1)

8-89/8-9C

Service

Reference designations within outline (---) symbols are abbreviated. Full designation includes Assembly Number, e.g., R1 of Assembly A1 is A1R1. Designations of other components are complete as shown.







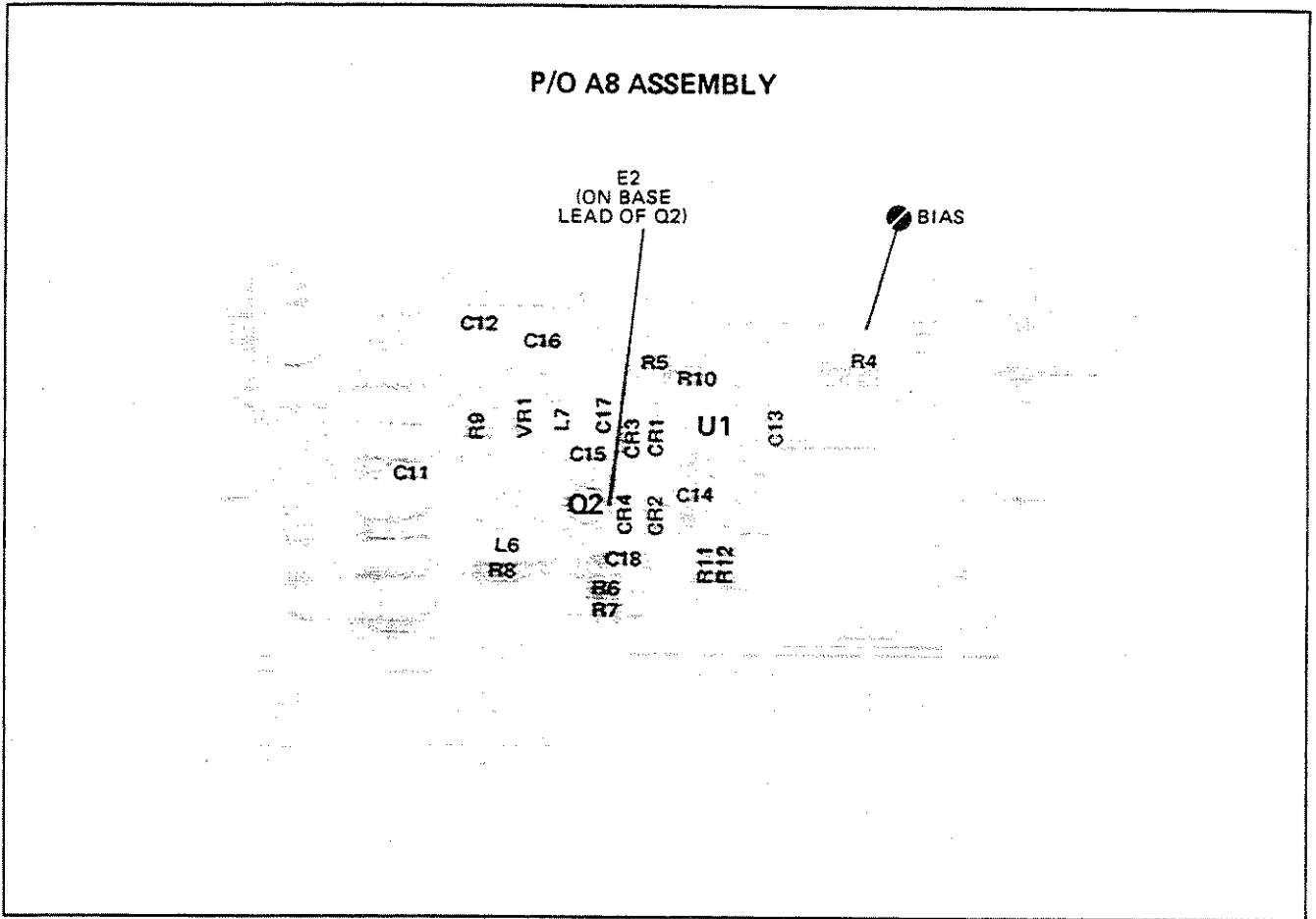


Figure 8-34. P/O A8 Noise Power Detector Assembly Component Locations (Noise Power Detector)

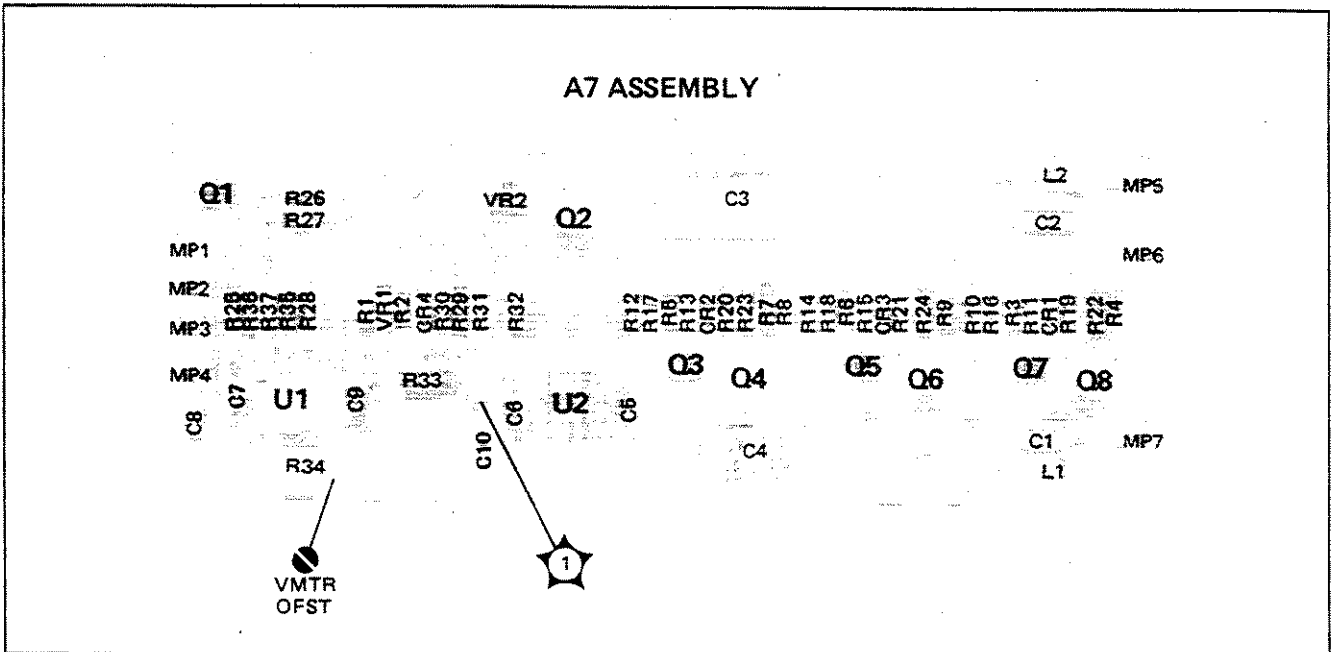


Figure 8-35. A7 Voltmeter Assembly Component Locations





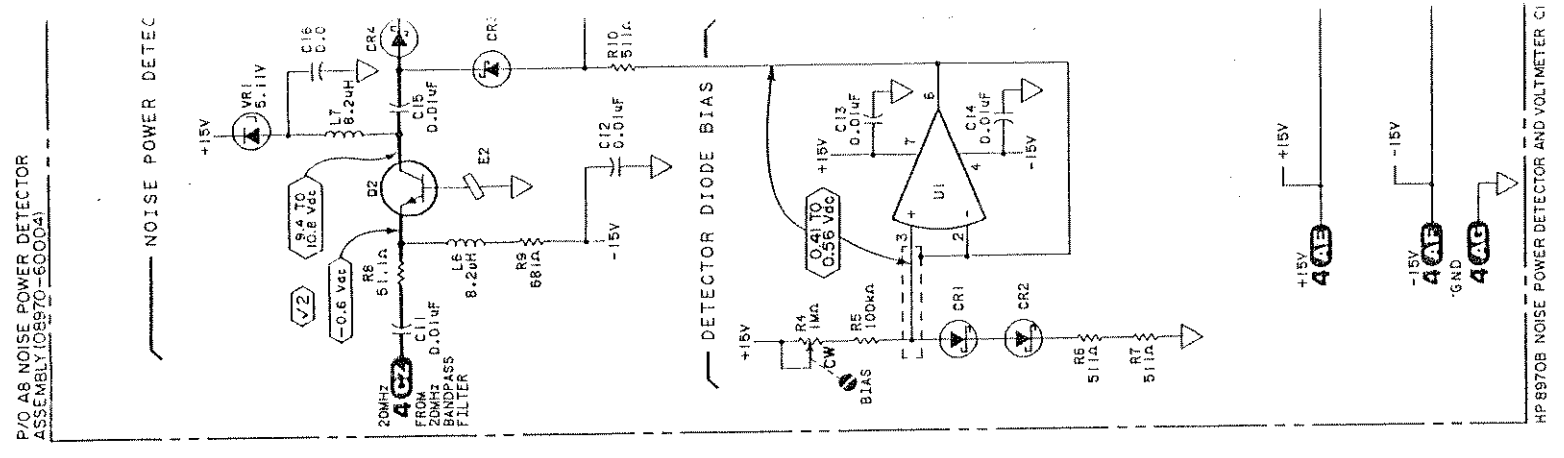
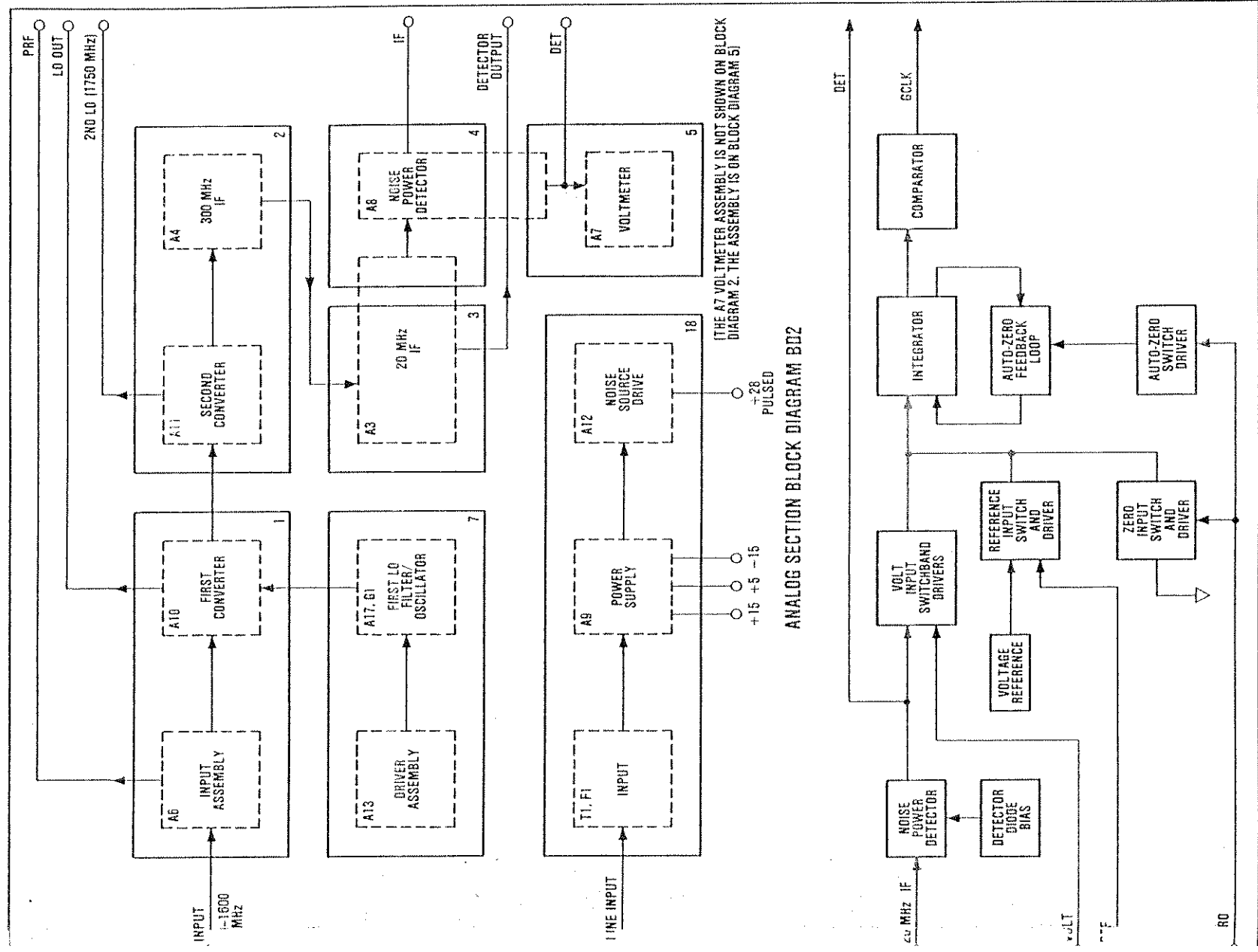
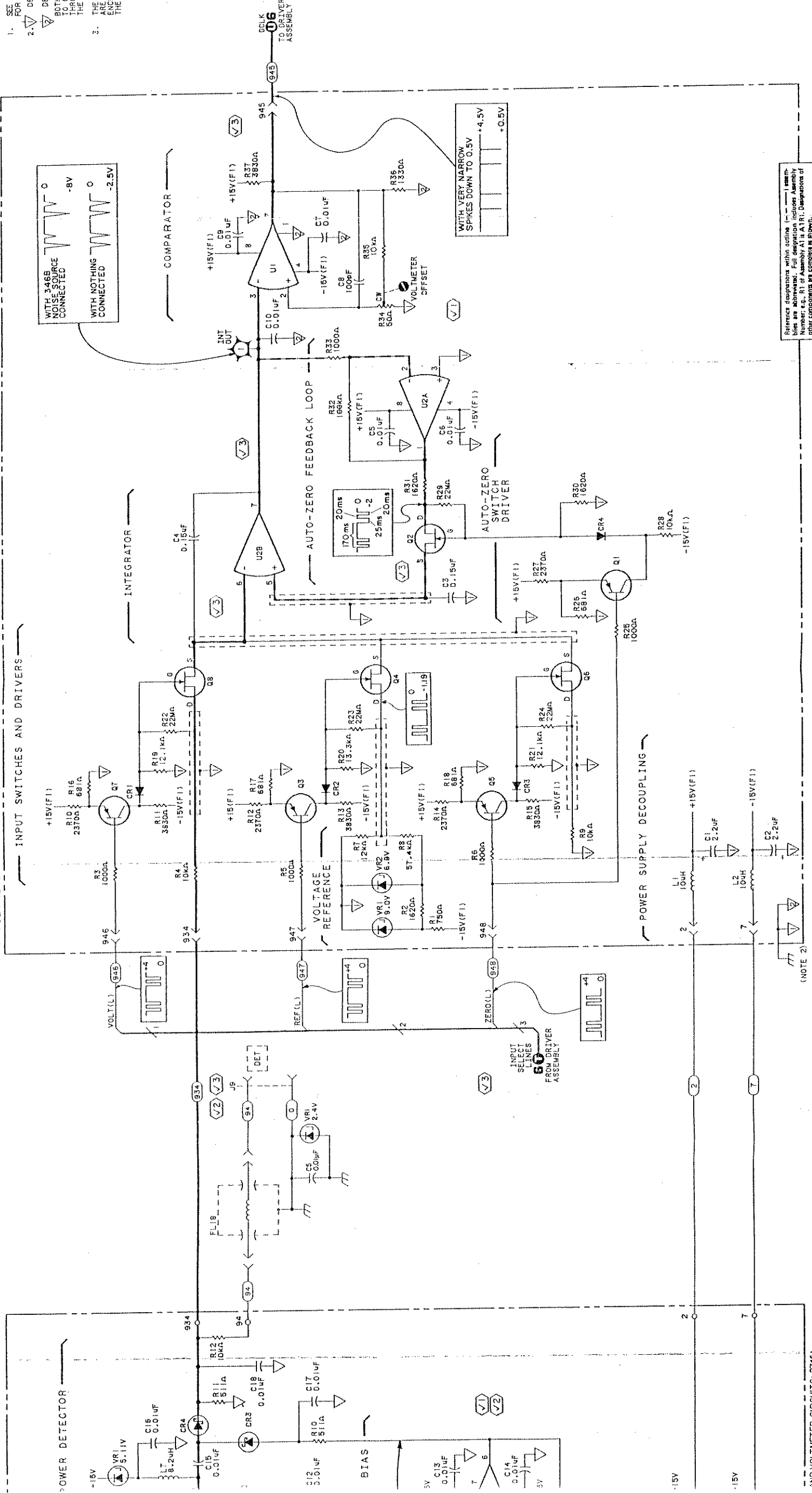


Figure 8-36. Noise Power Detector and Voltmeter Block Diagram



A7 VOLTMETER ASSEMBLY (08970-600C5)



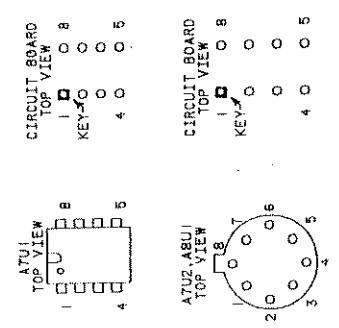
- NOTES
- SEE THE SECTION AT THE END OF THE MANUAL FOR SCHEMATIC DIAGRAM NOTES.
  - ∇ DENOTES ANALOG GROUND.
  - ∇ DENOTES DIGITAL GROUND.
  - BOTH ANALOG AND DIGITAL GROUND ARE TIED TO CHASSIS GROUND BY MECHANICAL CONTACT THROUGH SCREWS HOLDING THE PC BOARD TO THE FRAME.
  - THE BROKEN LINES ON THE SCHEMATIC ARE GROUND TRACES WHICH SHIELD THE ENCLOSED AREA FROM OTHER TRACES ON THE PC BOARD.

REFERENCE DESIGNATIONS

NO PREFIX	A8
C11-18	CR1-4
FL18	L2
	L6,7
	Q2
	R4,12
	VR1
C1-10	U1
L1-4	U2
L1-2	U1
Q1-8	U1
R1-37	U1
U1-1	U1
U1-2	U1

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBERS
A7	1825-0420
Q1, 3, 5, 7	1825-0420
Q2	1825-0420
Q4, 6, 8	1825-0420
U1	1825-0420
U2	1825-0420
A8	1854-0719
Q2	1825-0420
U1	1825-0420



LOGIC LEVEL

LOGIC LEVEL	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

AND VOLTMETER CIRCUITS: 2745A

Figure 8-37. Noise Power Detector and Voltmeter Schematic Diagram



**SERVICE SHEET 6****DRIVER — VOLTMETER DIGITAL CIRCUITS****P/O A13 DRIVER ASSEMBLY****REFERENCES**

Block Diagram — Service Sheet BD4  
 Section III — Operator's Checks  
 Section VIII — Special Functions and  
 Power-Up Checks

**PRINCIPLES OF OPERATION****General**

The Voltmeter Digital Circuits provide measurement data to the controller and maintain control of the Voltage-to-Time converter (Service Sheet 5). The measurement data consists of two eight bit bytes containing the value of the noise measurement. Additional data consists of OVERFLOW and END CVT (end of conversion) signals. A 4 MHz time base signal is provided by the controller. Conversion control is provided by the ZERO, VOLT, and REF lines which select the voltmeter input switches in the Voltage-to-Time converter.

Basically, the Voltmeter Digital Circuits consist of two circuits. The first circuit is a group of pulse stretchers (one-shots). The start conversion (CVT) pulses are too narrow for the various timing requirements of the voltmeter and controller. Therefore, the pulse stretchers widen and synchronize the CVT pulses so that they are useful to the controller.

The second basic circuit is a 17 register counter which is turned on by the CVT signal and turned off by the GCLK signal. During the time the counter is on, it counts up the 4 MHz clock pulses. The accumulated count is the number of clock counts (period) it took the analog circuit to charge up to the measured value. Therefore, this count is the digital equivalent of that measurement.

**Start Conversion (CVT)**

The start conversion (CVT) line is normally high. The CVT signal is a low true spike. This low will reset the last count flip/flop to a low output on pin 5 of A13U35A. CVT is inverted by counter reset A13U19D to reset all four period counters (A13U30A/B and A13U31A/B) to a zero count.

Start conversion pulse stretcher A13U34A will be triggered by the CVT pulse when the pulse (ending) goes from low to high. At this time,

A13U34A will output a low level 100  $\mu$ s pulse to set gate flip/flop A13U35B. This will enable A13U35B to output a high on pin 9. By this time, the CVT pulse has ended and released the resets.

The extended CVT pulse from A13U34A is required to ensure that A13U35B is actually set. When the extended pulse ends, it will have no effect on A13U35B, which will remain high (set). The high (ZERO signal) from A13U35B is input to voltmeter gate A13U21D. This enables A13U21D to pass the 4 MHz clock pulses from the timing generator, A14U51, on Service Sheet 12, to the period counters.

**Conversion Process**

The conversion has started, and the counters are counting clock pulses. The high on the ZERO line is output to the voltmeter to indicate that the counters are running (not counting zero pulses). The high on the ZERO line is also input to A13U21C of the input select logic.

The last count flip/flop is reset to output a low. This low is inverted by A13U19C, and input as a high, along with the high ZERO to A13U21C. This enables A13U21C to output a low on the VOLT line to the voltmeter. The low on the VOLT line signifies that the circuits have not reached a last count, but are still counting.

Therefore, the circuits are not at zero, have not overflowed, and are not in reference mode. This is the voltage mode, with the data representing the actual voltage measurement. The circuits will remain in this state until the conversion is ended.

**Ending Conversion**

The conversion can be ended by one of two means; either an overflow occurs, or the conversion is completed and the GCLK line is taken low. A low clock pulse on GCLK will trigger A13U35B to enter the reset state. Note that this is NOT a toggle input; GCLK can only reset A13U35B. Once A13U35B is reset, the ZERO line will be brought low.

This low on the ZERO line will cause A13U21D to stop the count, without resetting the counters. The count will remain in the counters until the next conversion is started. The controller can enable voltmeter data output driver A13U12 by placing a low on the E2 line. This will output the eight least significant bits to the data bus. The

## SERVICE SHEET 6 (cont'd)

eight most significant bits are output to the data bus by a low on the E1 line to enable voltmeter data output driver A13U13.

The voltmeter was informed of the end of the conversion by the ZERO line going low (counters counting zero pulses). The VOLT line is brought high by A13U21C to indicate that the circuits are no longer in the voltage measurement state. The REF signal remains high. The 4 MHz clock is always being output by the controller, and is not effected by the other activities of the circuits.

Finally, the low on the ZERO line will trigger end of conversion pulse stretcher A13U34B. This will cause A13U34B to output a 100  $\mu$ s low level pulse on the ECVT line. This is to inform the controller that the circuits have reached the end of the conversion.

### Overflow Condition

Another way in which the end of the conversion is reached, is when an overflow occurs. If the measured value is out of limits, or the system is in the reference value mode, the counters will fill up. Once full, the next pulse will cause period counter A13U31A to output an overflow pulse to last count flip/flop A13U35A.

This will trigger A13U35A to output a high on the LAST COUNT line. With a high on LAST COUNT, the VOLT output will be driven high by A13U19C and A13U21C. At this time, the ZERO output is also high. The ZERO and LAST COUNT highs will both be input to A13U21B, which will be enabled to output a low on the REF line. This indicates to the voltmeter that the reference state has been entered.

If the value measured is indeed the reference value, then the conversion will be ended at this time. If the value is not the reference value, but is a value which is out of limits, another count pulse will be input to the counters. This will cause last count flip/flop A13U35A to toggle back from high to low.

This will take the REF line high and the VOLT line low. But, this will have no effect, as the LAST COUNT going low will trigger overflow pulse stretcher A13U20B to output a 100  $\mu$ s high level pulse. This high pulse will enable A13U21A (ZERO still high) to trigger gate clear pulse stretcher A13U20A. One-shot A13U20A will output a 100  $\mu$ s low level pulse which is the overflow (OVFL) signal.

The low OVFL signal informs the controller that an overflow condition has occurred. OVFL also resets gate flip/flop A13U35B. This again sets the ZERO line low to stop the counters and generate the end of conversion (ECVT) pulse. The circuits are now ready for the next start conversion pulse (CVT) to restart the process.

## TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 6 when a malfunction has occurred in one of the Voltmeter Digital Driver circuits of Driver Assembly A13. If all of the tests in the following procedures indicate correct responses, the trouble is located elsewhere in the system, and not in the Voltmeter Digital Driver circuits. Except where shown, the values listed are approximate and are given as a service guideline.

### Test Equipment

Oscilloscope .....	Tektronix 2235
Systems DVM .....	HP 3456A
Logic Analyzer .....	HP 1630D
Noise Source .....	HP 346B

### ✓1 General Checks

1. In the power on condition, verify that the voltage from test point A13TP17 to test point A13TP18 (ground) is  $+5 \pm 0.05$  Vdc.
2. Ensure that the 4 MHz clock is present on test point A13TP3. If not, the problem is in the Timing Generator Circuits (Service Sheet 12) or Cable Assembly W9.
3. Refer to the Calibration procedures of Section III Operation, and configure the Noise Figure Meter to complete a series of calibration tests on the Noise Source.

### ✓2 Starting Conversion Checks

1. Ensure that the CVT low level pulse at test point A13TP10 is followed by a high level ZERO output at test point A13TP21.
2. If the CVT pulse is in error, check A13U34A, A13U19D, and A13U35A. If the ZERO level is in error, check A13U34B, A13U35B, and A13U21.
3. Ensure that each low CVT pulse (A13TP10) has a high complement output at pin 8 of A13U19D. If not, check A13U19D, A13U30, and A13U31.

## SERVICE SHEET 6 (cont'd)

### ✓ 3 Data Accumulation and Latching

1. Connect the Logic Analyzer to the output pins of A13U30, and to RESET (pins 2 and 12) and CLOCK (pins 1 and 13) of A13U30. The output pins of A13U30 are 3 through 6, and 8 through 11.
2. Ensure that each time that RESET is low, and a clock pulse is present, the counters are incremented by one. Set the Noise Figure Meter to make an out of limits measurement.
3. Ensure that the counters fill and that an overflow pulse is generated. If the CLOCK is in error, check A13U30B and A13U21D. If any output line is held high or low, check A13U30 and A13U12.
4. Connect the Logic Analyzer to the data bus output pins of A13U12, and to the E2 inputs (pins 1 and 19). The data bus pins of A13U12 are listed in Table 8-37.

Table 8-37. A13U12 Pin-Outs

DA0—3	DA1—17
DA2—5	DA3—15
DA4—7	DA5—13
DA6—9	DA7—11

5. Ensure that each time that the E2 input is low, new data is present on the outputs of A13U12. If E2 is in error, or any data line is held high or low, check A13U12 and A13U13.
6. Reconfigure the Noise Figure Meter to complete a series of calibration tests.
7. Connect the logic analyzer to the output pins of A13U31, to RESET (pins 2 and 12) of A13U30A, and to overflow input pulses (pins 1 and 13) of A13U31. The output pins of A13U31 are 3 through 6 and 8 through 11.
8. Ensure that each time RESET is low, and an overflow pulse is present, the counters are incremented by one. Set the Noise Figure Meter to make an out of limits measurement.
9. Ensure that the counters fill and that an A13U31A overflow pulse is generated. If the A13U30A overflow input is in error, check

A13U31B and A13U30A. If any output line is held high or low, check A13U31 and A13U13.

10. Connect the logic analyzer to the data bus output pins of A13U13, and to the E1 inputs (pins 1 and 19). The data bus pins of A13U13 are listed in Table 8-38.

Table 8-38. A13U13 Pin-Outs

DA0—3	DA1—17
DA2—5	DA3—15
DA4—7	DA5—13
DA6—9	DA7—11

11. Ensure that each time that the E1 input is low, new data is present on the outputs of A13U13. If E1 is in error, or any data line is held high or low, check A13U13 and A13U12.

### ✓ 4 Pulse Stretcher Circuits Checks

1. Set the Noise Figure Meter to an out of limits measurement, and ensure that the overflow pulse input at pin 1 of A13U35A toggles the LAST COUNT output at test point A13TP11. If not, check A13U35A, A13U20B, A13U19C, and A13U21B.
2. Ensure that each time the LAST COUNT pulse at A13TP11 goes low, a 100  $\mu$ s high level pulse is generated at pin 5 of A13U20B. If the pulse is in error, check A13U20B and A13U21A.
3. Ensure that a low level 100  $\mu$ s pulse is output on pin 3 of A13U21A each time that both the high level 100  $\mu$ s pulse in input on pin 1 of A13U21A, and the ZERO input on pin 2 of A13U21A is high.
4. If the low output pulse is in error, check A13U21A and A13U20A. Otherwise, ensure that each time that the input pulse at pin 2 of A13U20A returns to a high, a 100  $\mu$ s low level pulse is generated at the output pin 4 of A13U20A.
5. If the output pulse at pin 4 of A13U20A is in error, check A13U20A and A13U35B. Otherwise, ensure that each time that the ZERO input at pin 9 of A13U34B goes low, that a 100  $\mu$ s low level pulse is generated at pin 12 of A13U34B. If not, check A13U34B.

**SERVICE SHEET 6 (cont'd)**

**5 Input Select Logic Circuits Checks**

1. Ensure that each time that the LAST COUNT line is low, and the ZERO line is high, the output (VOLT) at pin 8 of A13U21C is low. If not, check A13U19C and A13U21C.
2. Ensure that each time that the ZERO line is high, and that the LAST COUNT line is high, the output (REF) at pin 6 of A13U21B is low. If not, check A13U21B.

**Completion of Testing**

Upon completion of testing, place all switches in their original positions, remove all test gear, and restore the Noise Figure Meter to the normal operating condition. If repairs have been made, or adjustments changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.



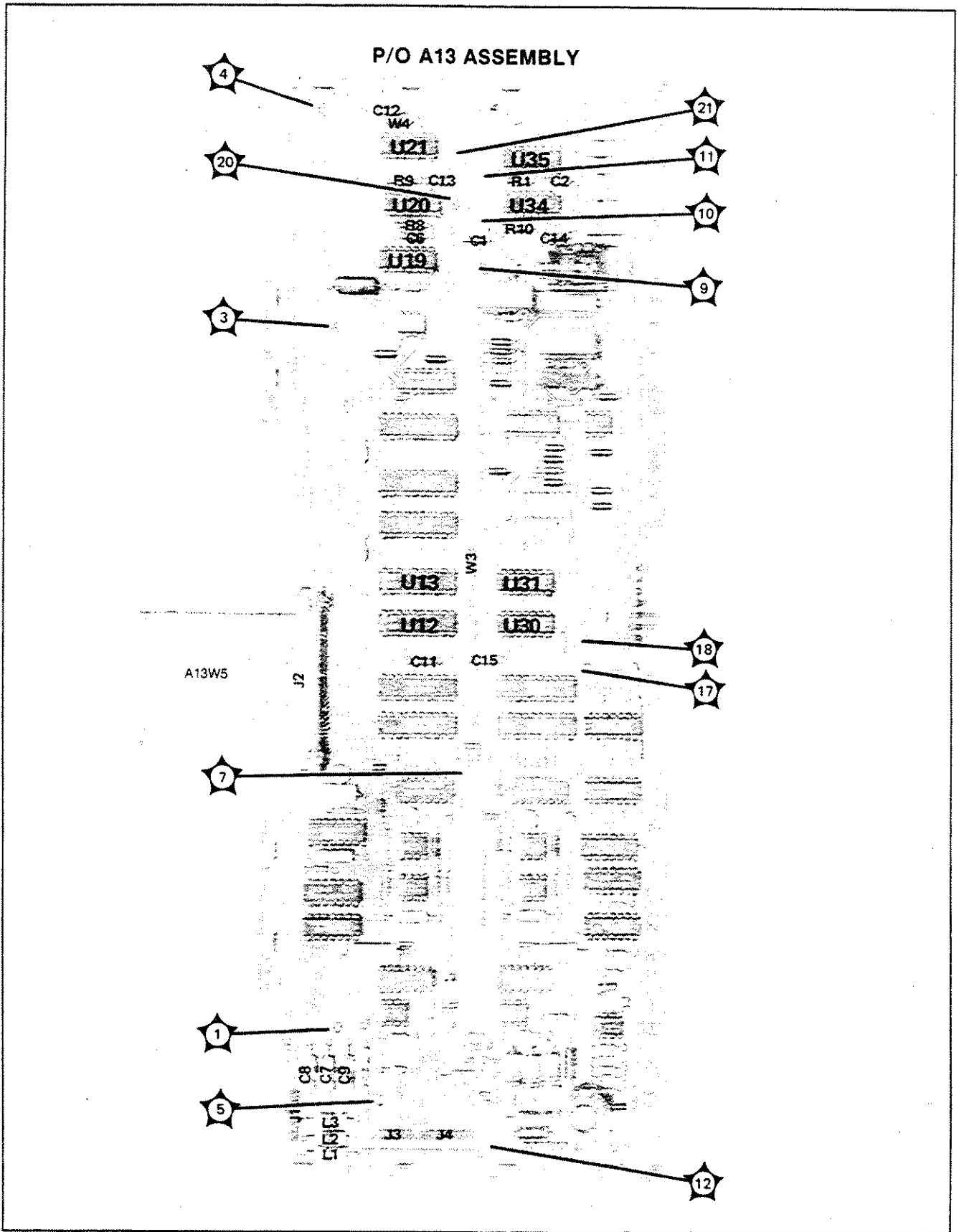


Figure 8-38. P/O A13 Driver Assembly Component Locations (Voltmeter Digital Circuits)

8-107/8-108



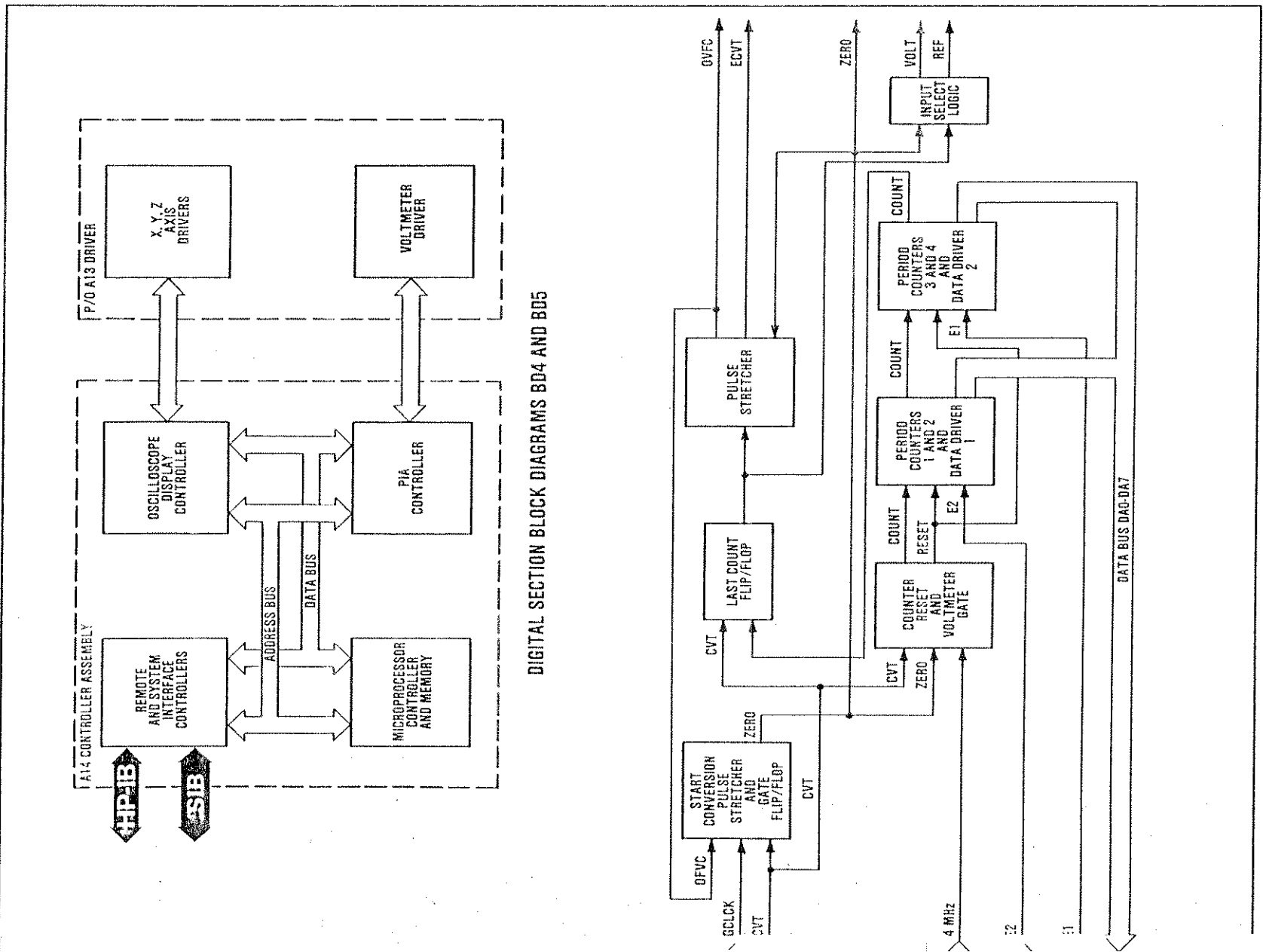
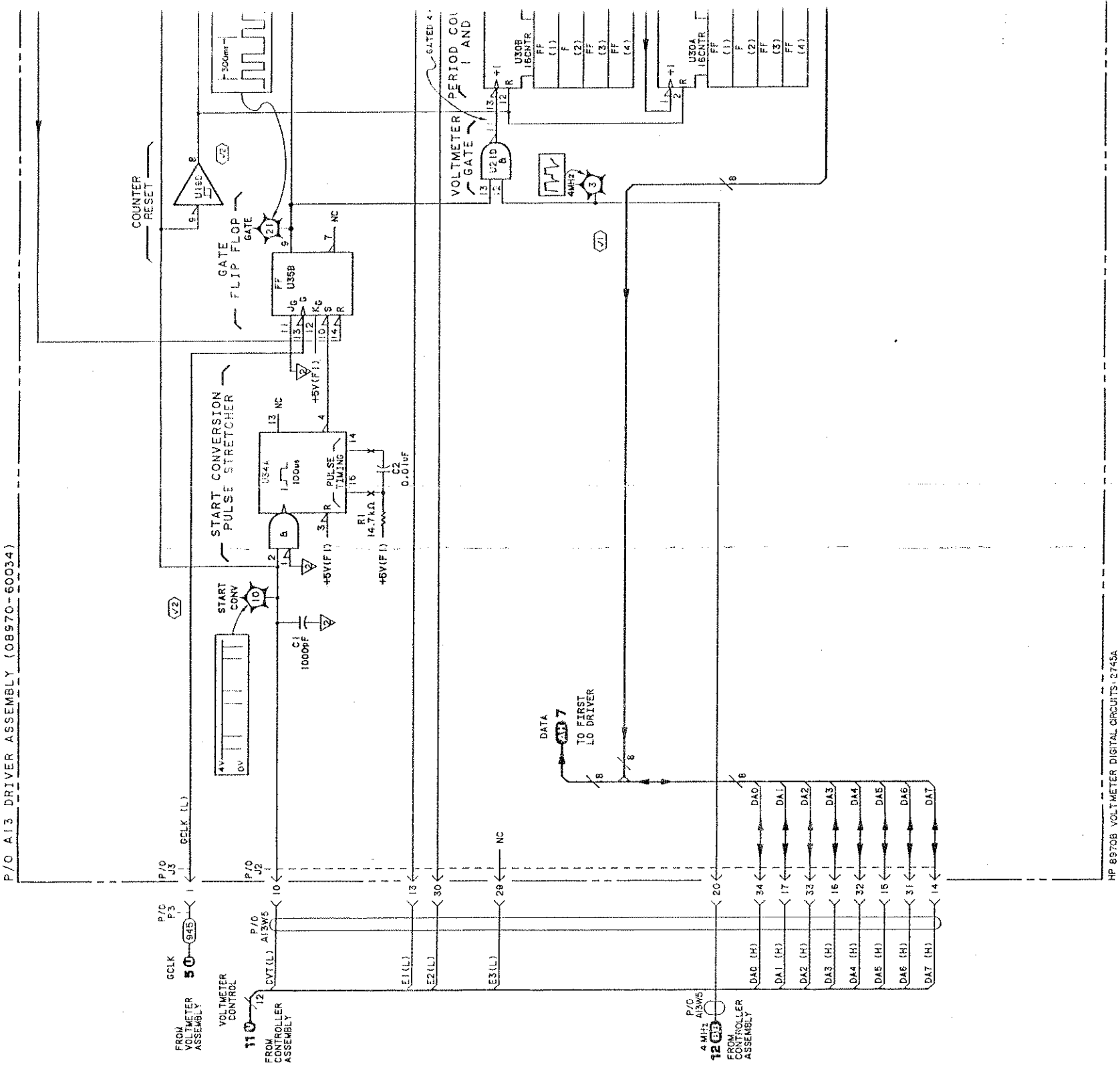


Figure 8-39. Driver - Voltmeter Digital Block Diagram



HP 8970B VOLTMETER DIGITAL CIRCUITS-2745A



NOTES

1. SEE THE SECTION AT THE END OF THE MANUAL FOR SCHEMATIC DIAGRAM NOTES.
2. ▽ AND ▽ DENOTE ANALOG GROUND. ▽ DENOTES DIGITAL GROUND.

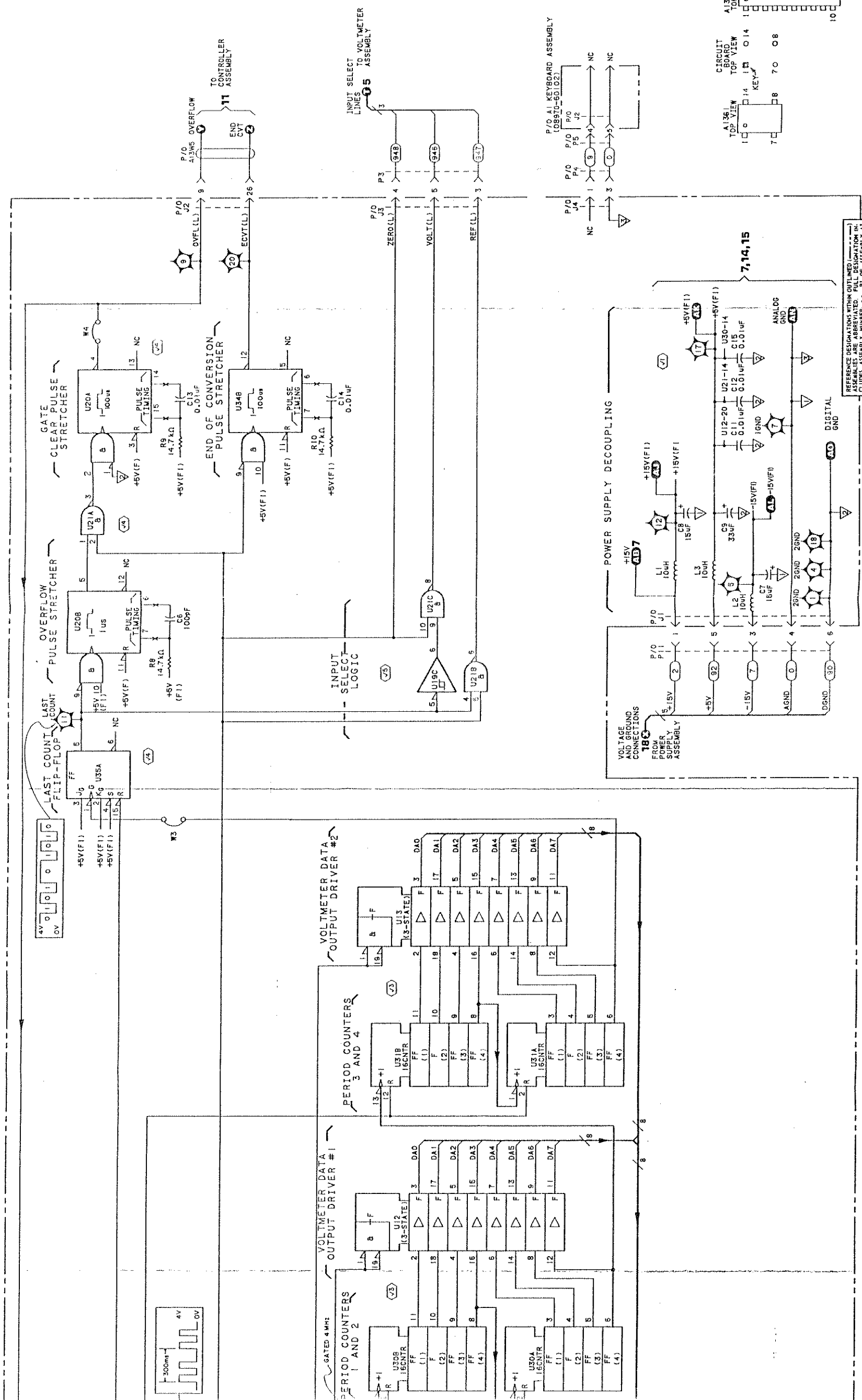
NO	REF ID	DESIGNATION	VALUE
P3-5, 11	A13	C1, 2, 6-15	100nF
W9	J1-4	U1-4	7410
	J5-7	R1-8, 10-69	100k
	J8	TP1-5, 7, 9	10k
	J9	U10-12, 17	7410
	J10	U13, 14	7410
	J11	U18, 19, 21, 30	7410
	J12	U20, 34, 35	7410
	A1	W2, 3	100k

NOT ASSIGNED: A1305-5, CRI, CR2, MI, RPT, U17, U18, U19, W1, W11, W12

LOGIC LEVEL	VALUE
HIGH	2.2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

REFERENCE DESIGNATIONS	PART NUMBERS
U13, 13	820-1716
U12, 12	820-1716
U20, 34	820-1437
U21, 1	820-1197
U30, 31	820-2086
U35, 3	820-1212

REFERENCE DESIGNATIONS	GROUND CONNECTIONS
U13, 21	+5V(F1)-7
U12, 13	+5V(F1)-20
U20, 34, 35	+5V(F1)-16
	+5V(F1)-8



REFERENCE DESIGNATIONS WITHIN OUTLINED AREAS ARE IDENTIFIED BY A NUMBER IN A CIRCLE. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.

CIRCUIT BOARD	TOP VIEW	KEY	DESIGNATION	VALUE
A1301, 19	TOP VIEW	14	KEY	0
A1301, 19	TOP VIEW	15	KEY	0
A1301, 19	TOP VIEW	16	KEY	0
A1301, 19	TOP VIEW	17	KEY	0
A1301, 19	TOP VIEW	18	KEY	0
A1301, 19	TOP VIEW	19	KEY	0
A1301, 19	TOP VIEW	20	KEY	0
A1301, 19	TOP VIEW	21	KEY	0
A1301, 19	TOP VIEW	22	KEY	0
A1301, 19	TOP VIEW	23	KEY	0
A1301, 19	TOP VIEW	24	KEY	0
A1301, 19	TOP VIEW	25	KEY	0
A1301, 19	TOP VIEW	26	KEY	0
A1301, 19	TOP VIEW	27	KEY	0
A1301, 19	TOP VIEW	28	KEY	0
A1301, 19	TOP VIEW	29	KEY	0
A1301, 19	TOP VIEW	30	KEY	0
A1301, 19	TOP VIEW	31	KEY	0
A1301, 19	TOP VIEW	32	KEY	0
A1301, 19	TOP VIEW	33	KEY	0
A1301, 19	TOP VIEW	34	KEY	0
A1301, 19	TOP VIEW	35	KEY	0
A1301, 19	TOP VIEW	36	KEY	0
A1301, 19	TOP VIEW	37	KEY	0
A1301, 19	TOP VIEW	38	KEY	0
A1301, 19	TOP VIEW	39	KEY	0
A1301, 19	TOP VIEW	40	KEY	0
A1301, 19	TOP VIEW	41	KEY	0
A1301, 19	TOP VIEW	42	KEY	0
A1301, 19	TOP VIEW	43	KEY	0
A1301, 19	TOP VIEW	44	KEY	0
A1301, 19	TOP VIEW	45	KEY	0
A1301, 19	TOP VIEW	46	KEY	0
A1301, 19	TOP VIEW	47	KEY	0
A1301, 19	TOP VIEW	48	KEY	0
A1301, 19	TOP VIEW	49	KEY	0
A1301, 19	TOP VIEW	50	KEY	0
A1301, 19	TOP VIEW	51	KEY	0
A1301, 19	TOP VIEW	52	KEY	0
A1301, 19	TOP VIEW	53	KEY	0
A1301, 19	TOP VIEW	54	KEY	0
A1301, 19	TOP VIEW	55	KEY	0
A1301, 19	TOP VIEW	56	KEY	0
A1301, 19	TOP VIEW	57	KEY	0
A1301, 19	TOP VIEW	58	KEY	0
A1301, 19	TOP VIEW	59	KEY	0
A1301, 19	TOP VIEW	60	KEY	0
A1301, 19	TOP VIEW	61	KEY	0
A1301, 19	TOP VIEW	62	KEY	0
A1301, 19	TOP VIEW	63	KEY	0
A1301, 19	TOP VIEW	64	KEY	0
A1301, 19	TOP VIEW	65	KEY	0
A1301, 19	TOP VIEW	66	KEY	0
A1301, 19	TOP VIEW	67	KEY	0
A1301, 19	TOP VIEW	68	KEY	0
A1301, 19	TOP VIEW	69	KEY	0
A1301, 19	TOP VIEW	70	KEY	0
A1301, 19	TOP VIEW	71	KEY	0
A1301, 19	TOP VIEW	72	KEY	0
A1301, 19	TOP VIEW	73	KEY	0
A1301, 19	TOP VIEW	74	KEY	0
A1301, 19	TOP VIEW	75	KEY	0
A1301, 19	TOP VIEW	76	KEY	0
A1301, 19	TOP VIEW	77	KEY	0
A1301, 19	TOP VIEW	78	KEY	0
A1301, 19	TOP VIEW	79	KEY	0
A1301, 19	TOP VIEW	80	KEY	0
A1301, 19	TOP VIEW	81	KEY	0
A1301, 19	TOP VIEW	82	KEY	0
A1301, 19	TOP VIEW	83	KEY	0
A1301, 19	TOP VIEW	84	KEY	0
A1301, 19	TOP VIEW	85	KEY	0
A1301, 19	TOP VIEW	86	KEY	0
A1301, 19	TOP VIEW	87	KEY	0
A1301, 19	TOP VIEW	88	KEY	0
A1301, 19	TOP VIEW	89	KEY	0
A1301, 19	TOP VIEW	90	KEY	0
A1301, 19	TOP VIEW	91	KEY	0
A1301, 19	TOP VIEW	92	KEY	0
A1301, 19	TOP VIEW	93	KEY	0
A1301, 19	TOP VIEW	94	KEY	0
A1301, 19	TOP VIEW	95	KEY	0
A1301, 19	TOP VIEW	96	KEY	0
A1301, 19	TOP VIEW	97	KEY	0
A1301, 19	TOP VIEW	98	KEY	0
A1301, 19	TOP VIEW	99	KEY	0
A1301, 19	TOP VIEW	100	KEY	0

Figure 8-40. Driver — Voltmeter Digital Circuits Schematic Diagram

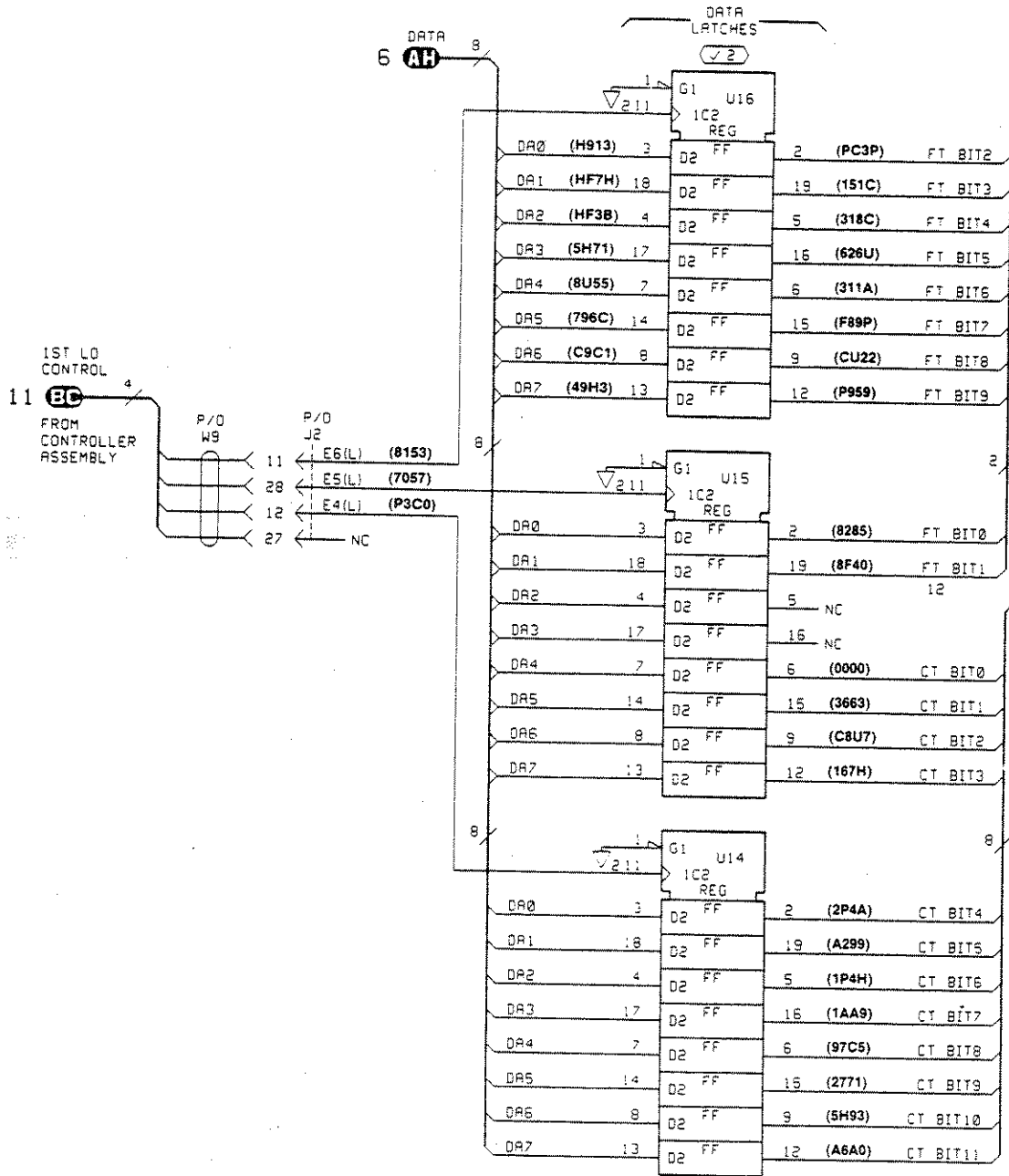


**SERVICE SHEET 7 (cont'd)**

2. With the Noise Figure Meter off, set the SA Test Switch (A14S1) as indicated in the table.
  3. Turn the Noise Figure Meter on and check the output signatures (right-hand side) in Figure 8-41.
- If the signatures are correct, continue with Check 3.

**SA Test Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Normal
SA1	0
SA2	0
SA3	1
SA4	0
SA5	0



**Figure 8-41. Data Latch Signatures**

## SERVICE SHEET 7 (cont'd)

If any of the signatures are incorrect, continue with step 4.

- Check the input signatures in Figure 8-41 (left-hand side).

If the signatures are correct, replace the appropriate data latch. If the problem remains, replace the appropriate DAC (A13U17 or A13U32).

If any of the signatures are incorrect, trace the defective line(s) back to the appropriate circuit or Service Sheet and continue troubleshooting.

### ✓ 3 Full Scale Voltage Reference and First LO Offset

- Connect the voltmeter ground to A13TP8 "1ST LO GND" and verify the voltages in Figure 8-42.

If the voltages are correct, continue with Check 4. If any of the voltages are incorrect, replace the appropriate component(s).

### ✓ 4 YIG Fine and Coarse Tune DACs

- Perform Checks 1, 2 and 3 if they have not yet been done.
- With the Noise Figure Meter off, set the SA Test Switch (A14S1) as indicated above.

The following procedure will set the DACs to three values: full scale, half scale and zero.

### SA Test Switch (A14S1) Setting

Switch	Switch Setting
Normal/Frun	Normal
SA1	0
SA2	0
SA3	0
SA4	0
SA5	0

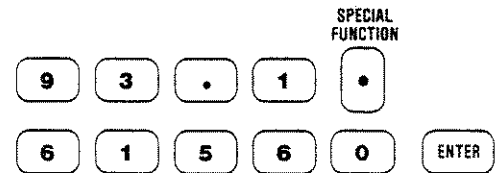
- Turn the Noise Figure Meter on and press:



and:



- To check the Fine Tune DAC, enter the special address used for DAC updating by pressing the following sequence:



- Measure the reference voltage ( $V_{ref}$ ) at A13U17 pin 15 to A13TP8 (1ST LO GND). See Figure 8-43.  $V_{ref}$  should be between 8 and 10 Vdc. For three settings, full scale, half scale and zero, the DAC voltage is shown in

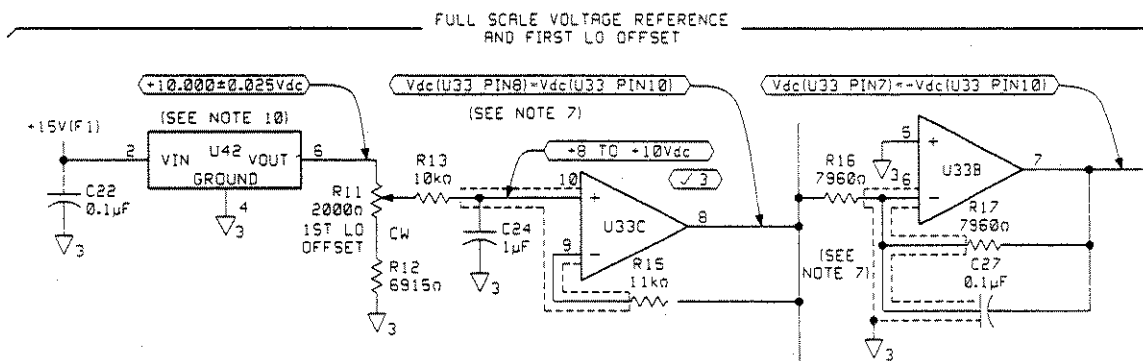


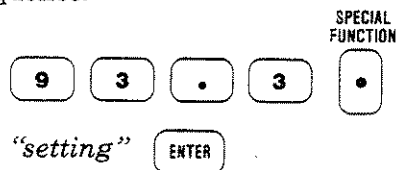
Figure 8-42. Full Scale Voltage Reference and First LO Offset Voltages



## SERVICE SHEET 7 (cont'd)

Table 8-39 as it relates to  $V_{ref}$ . Using the procedure in step 6, check the three settings of the Fine Tune DAC.

6. To change the DAC setting, press the following sequence:



"setting" is shown in column 1 of Table 8-39.

### NOTE

*The Noise Figure Meter display does not show the value of the DAC setting.*

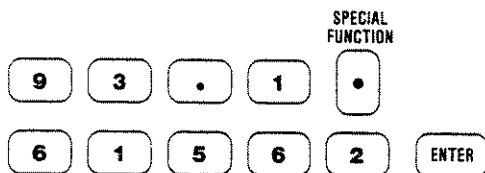
If the voltage is incorrect, replace A13U17 and/or A13U18.

### NOTE

*If A13U18 Pin 2 is within  $\pm 10$  mV of A13U18 Pin 3, chances are that A13U18 is working normally. Replace A13U17.*

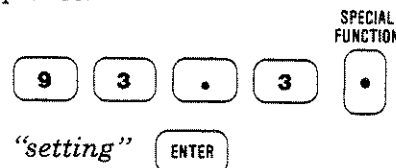
If the voltage is correct, continue with step 7.

7. To check the Coarse Tune DAC, enter the special address used for DAC updating by pressing the following sequence:



8. Note the reference voltage ( $V_{ref}$ ) at A13U32 pin 17 (8 to 10 Vdc). See Figure 8-43. For three settings, full scale, half scale and zero, the DAC voltages are shown in Table 8-40 as they relate to  $V_{ref}$ . Using the procedure in step 9, check the three settings of the Coarse Tune DAC.

9. To change the DAC setting, press the following sequence:



"setting" is shown in column 1 of Table 8-40.

### NOTE

*The Noise Figure Meter display does not show the value of the DAC setting.*

If the voltage is incorrect, replace A13U32 and/or A13U33.

### NOTE

*If A13U33 Pin 2 is within  $\pm 10$  mV of A13U33 Pin 3, chances are that A13U33 is working normally. Replace A13U32.*

If the voltage is correct, continue with Check 5.

Table 8-39. Fine Tune DAC Voltage vs. DAC Setting and  $V_{ref}$

Fine Tune DAC Range: 0 to 1023 (0 to 10 Vdc maximum)												
Setting	Bit Pattern at A13U17 Pins										A13U18 Pin 6 DAC Voltage ( $\pm 0.1$ Vdc)	Typical for $V_{ref}=9V$
	4	5	6	7	8	9	10	11	12	13		
1023	1	1	1	1	1	1	1	1	1	1	$-V_{ref}$	-9
511	0	1	1	1	1	1	1	1	1	1	$-V_{ref}/2$	-4.5
0	0	0	0	0	0	0	0	0	0	0	0	0

SERVICE SHEET 7 (cont'd)

Table 8-40. Coarse Tune DAC Voltage vs. DAC Setting and Vref

Coarse Tune DAC Range: 0 to 4095 (0 to 10 Vdc maximum)										A13U33 Pin 1 DAC Voltage ( $\pm 0.1$ Vdc)	Typical for Vref=9V	
Setting	Bit Pattern at A13U32 Pins											
	4	5	6	7	8	9	10	11	12	13	14	15
4095	1	1	1	1	1	1	1	1	1	1	1	1
2047	0	1	1	1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0

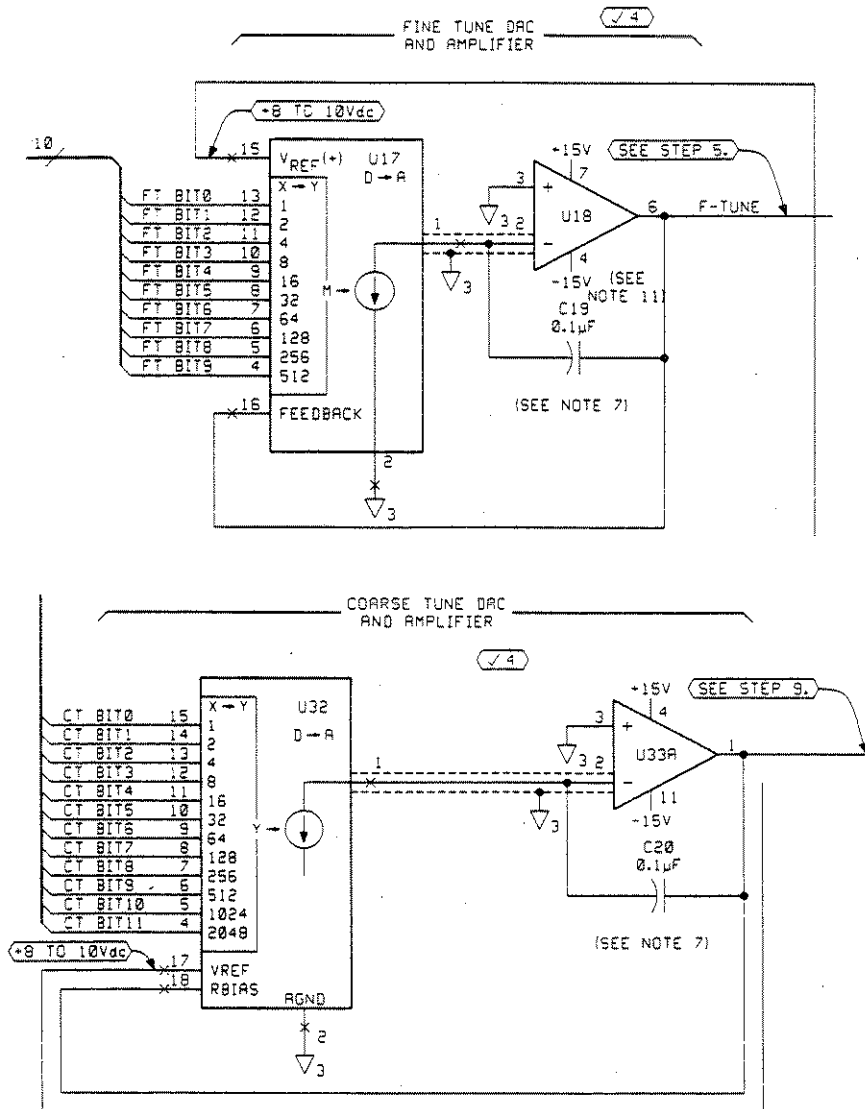


Figure 8-43. Fine Tune DAC and Coarse Tune DAC Voltages

**SERVICE SHEET 7 (cont'd)**

**✓ 5 First LO Drive Amplifier**

1. With the Noise Figure Meter off, set the SA test switch A14S1 as shown below:

**SA Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Normal
SA1	0
SA2	0
SA3	0
SA4	0
SA5	1

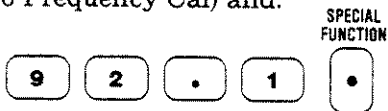
**NOTE**

*This will prevent the microprocessor from using the Fine Tune DAC to correct for changing step size. The DAC's output voltage will be constant throughout the test.*

2. Turn the Noise Figure Meter on and press:



(no Frequency Cal) and:



(0 MHz Hold; the Fine Tune DAC is set to midrange [4 to 5 volts])

3. Tune the Noise Figure Meter to 10, 1000 and 1600 MHz. Verify that the voltage at A13TP19 (1st LO Drive) varies with the magnitude of the voltage at A13U33 Pin 1 as shown in Figure 8-44.

For example, if A13U33 Pin 7 = 9 Vdc (middle line) and A13U33 Pin 1 is -2 Vdc, find -2 along the X-Axis and follow it up to where it intersects the middle line. Read the LO Drive voltage (A13TP19) on the Y-Axis. In this case the voltage would be about 4.3 volts  $\pm$  0.2 Vdc.

If the voltage at A13TP19 is within  $\pm 0.2V$  of the value obtained using the graph for the three test frequencies, continue with Check 6.

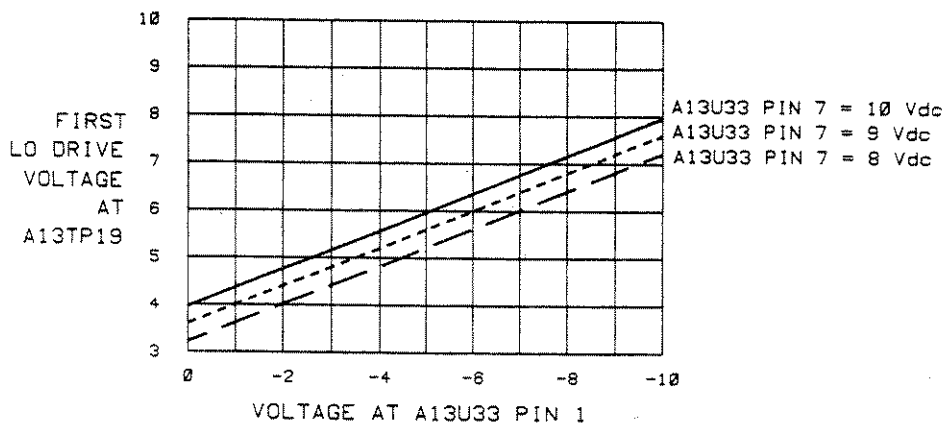
If the voltage at A13TP19 is different from the value obtained from the graph by more than  $\pm 0.2$  Vdc, continue with step 4.

4. Remove the connector A17J1 at the YIG Oscillator and short pins 1 and 5 together.
5. Repeat steps 2 and 3.

If the voltage at A13TP19 is now correct, continue with step 7.

If the voltage is still incorrect, continue with step 6.

6. If the voltage is close but is out of tolerance, the problem is most likely with one of the resistors: A13R18-24, A13R25-27, or A13R39-41. Note that A13R25-27 and A13R39-41 form a parallel combination with an equivalent resistance of about 36 ohms. These resistors can be measured in-circuit by turning the Noise Figure Meter off and con-



**Figure 8-44. First LO Drive Voltages**

## SERVICE SHEET 7 (cont'd)

necting an ohmmeter between A13TP8 and A13TP19. If one of the resistors is open, the resistance between A13TP8 and A13TP19 will be about 43 ohms.

When measuring any of the other resistors (A13R18—24), lift one end of the resistor if there is any doubt in the in-circuit reading.

If error E18 is a symptom, a likely suspect is A13R18.

7. Verify that the voltage at A13J5 Pin 7 is  $-5.0 \pm 0.2$  Vdc.

If the voltage is correct, continue with step 8. If not, replace A13U4.

8. Verify that the voltage at A13J5 Pin 6 is between  $-5$  and  $-14$  Vdc (typically there should be between 1 and 10 Vdc across A13R57). If the voltage is correct, continue with Check 6. If not, continue with step 9.

9. Disconnect the cable assembly at A13J5 and verify that the voltage from the negative side of A13C58 to A13TP1 (GND) is equal to the voltage at A13T5 ( $-15.00 \pm 0.01$  Vdc).

If the voltage is correct, the problem is most likely the heater element in the YIG Tuned Oscillator.

If the voltage is incorrect, replace A13R57 and/or A13C58.

### ✓ 6 YIG Tuned Oscillator

#### NOTE

*When connecting test equipment to the 1ST LO OUTPUT connector, A10J4, connect a 6 dB attenuator pad directly to the connector. This will prevent the test equipment from affecting the operation of the YIG Oscillator.*

1. Checks 1 through 5 should be performed before this check.
2. Connect a spectrum analyzer to the output connector of the YIG Oscillator (A17J1) and connect a DVM from A13TP19 to A13TP8.
3. Tune the Noise Figure Meter first to 10 MHz then to 1600 MHz (and anywhere in between) and verify the following:

The frequency varies with the voltage at A13TP19 as shown in Figure 8-45 and the power level is  $> +12$  dBm.

4. If the frequency and power level are correct, the YIG Oscillator is working normally.

If either the frequency or the power level is incorrect, continue with step 5.

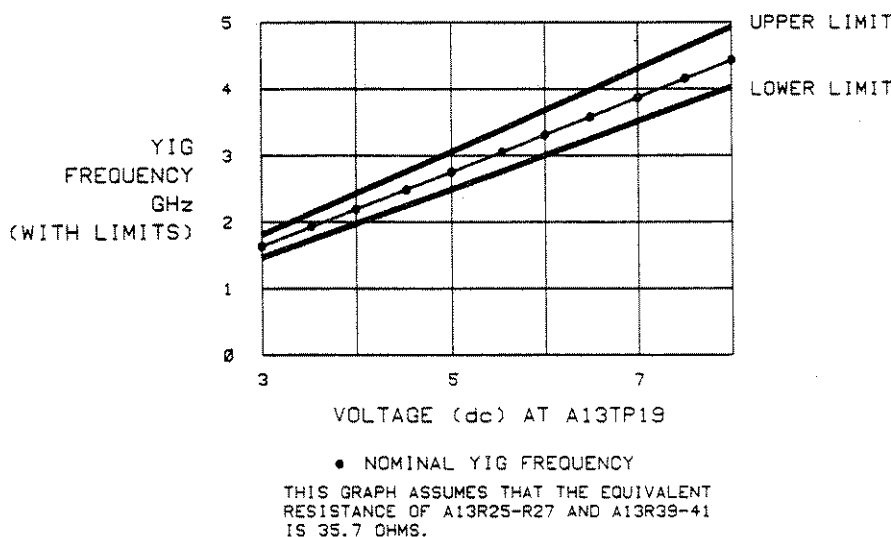


Figure 8-45. First LO Output Frequency vs. Voltage at A13TP19

**SERVICE SHEET 7 (cont'd)**

5. Using A13TP8 as ground, verify the connection to the YIG Oscillator by measuring the voltages as shown in Figure 8-46.

If any of the voltages are incorrect, replace the appropriate wire.

If all of the voltages are correct, but the output power or frequency of the YIG Oscillator is wrong, replace A17.

**Completion of Testing**

Upon completion of testing, place all switches in their original positions, remove all test gear, and restore the Noise Figure Meter to the normal operating condition. If repairs have been made, or adjustments changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

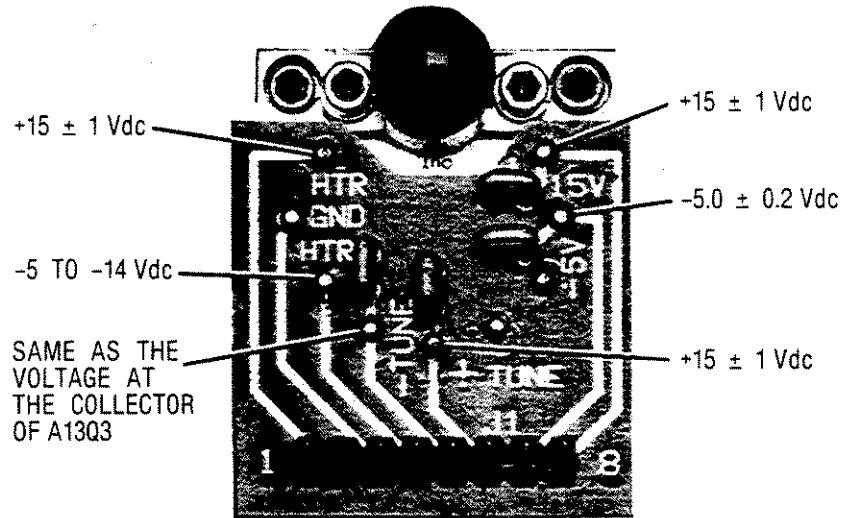


Figure 8-46. First LO Voltages at A17A1 YIG Interface Board Assembly

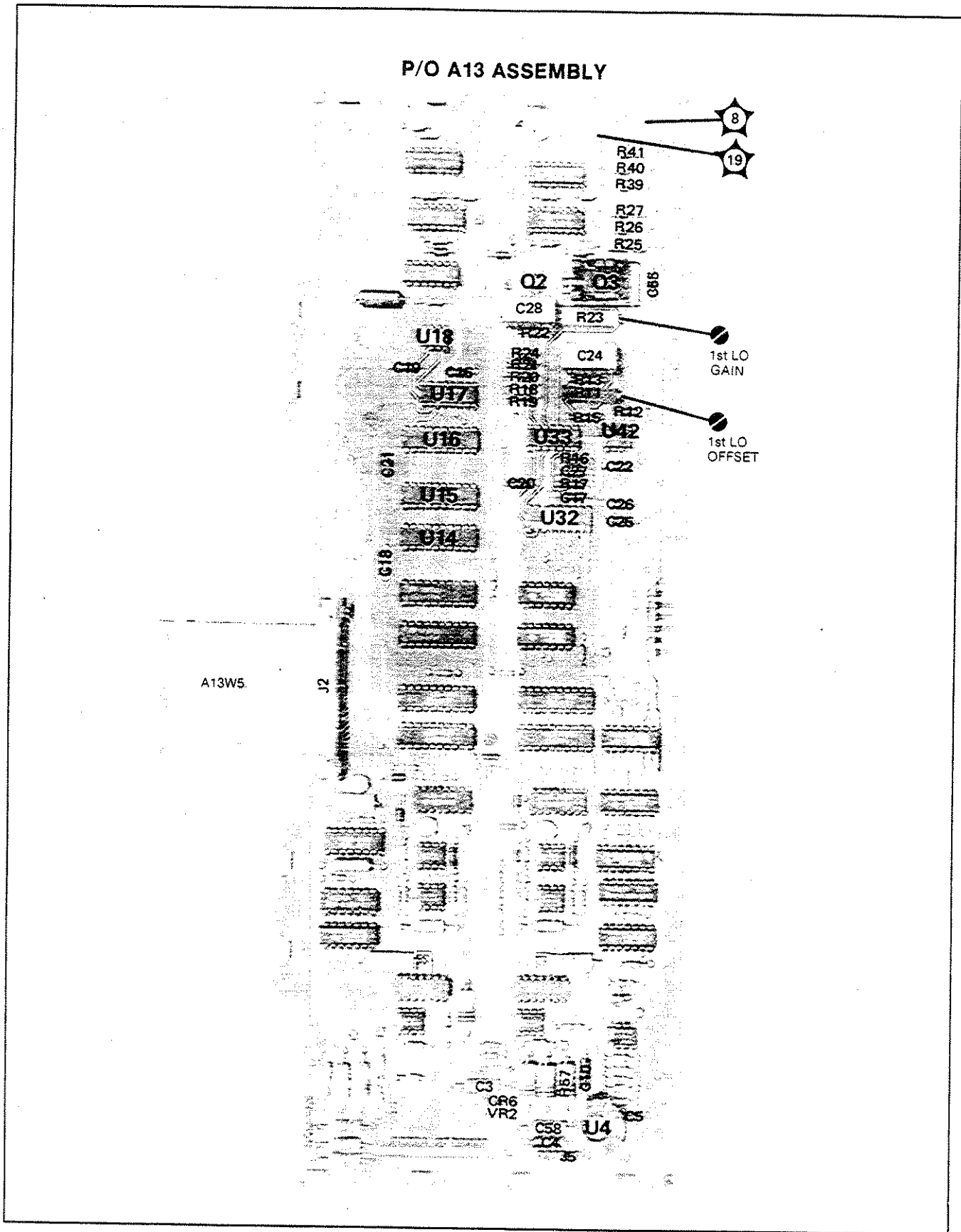


Figure 8-47. P/O A13 Driver Assembly Component Locations (First LO Drive)

### A17A1 ASSEMBLY

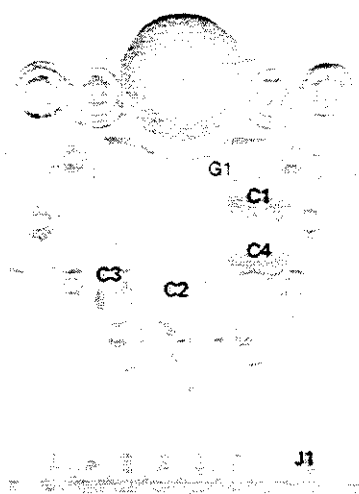


Figure 8-48. A17A1 YIG Interface Board Assembly Component Locations

*(2645A and Above)*

The schematic on page 8-123, along with these changes, documents instruments prefixed 2645A and above.

A13 Driver Assembly:

U32 — Part Number Table (right side of schematic)  
*(2645A and above)* 1826-1386

A17A1 YIG Interface Board Assembly

*(2645A and above)* 08970-60045 (recommended replacement  
for 08970-60017)



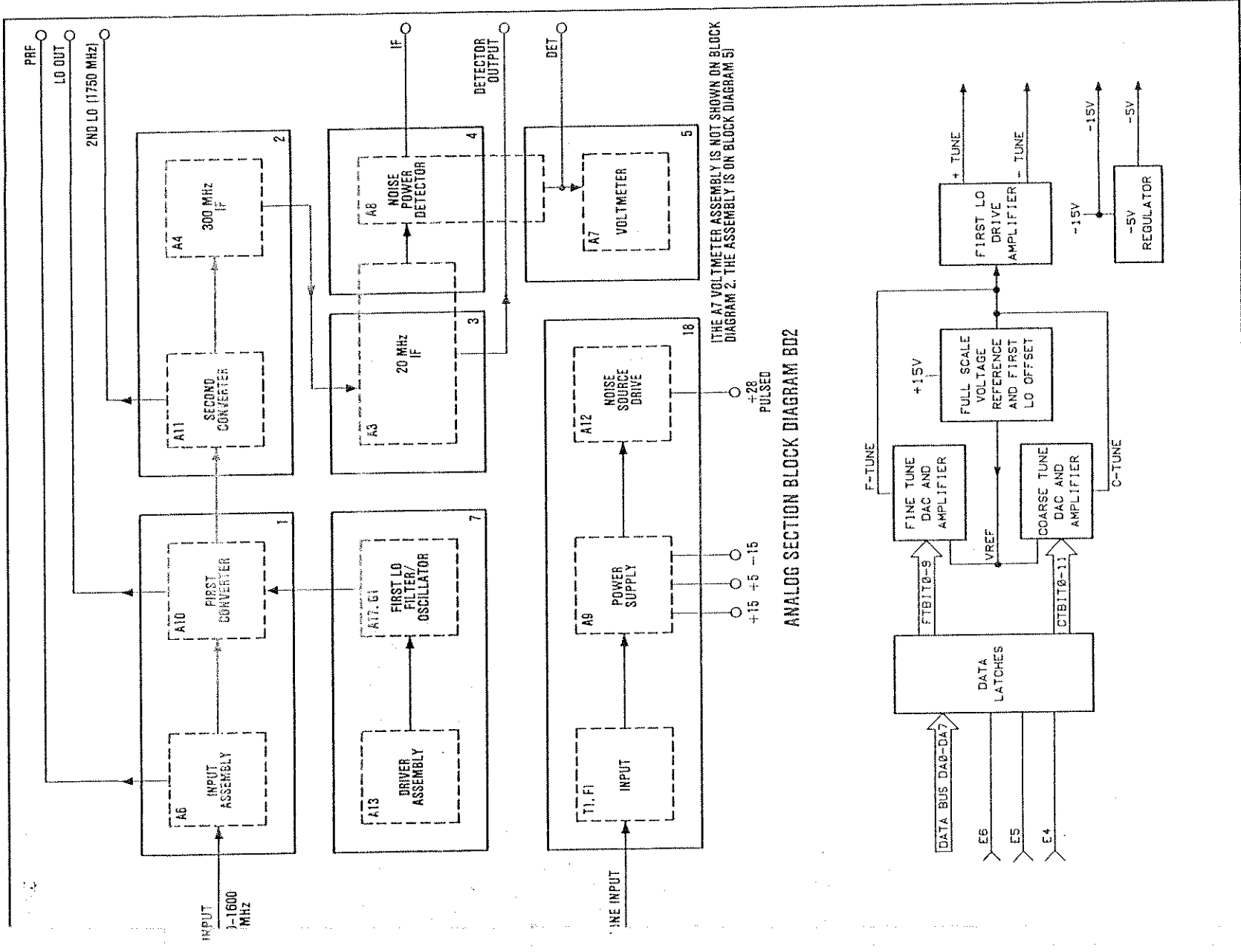
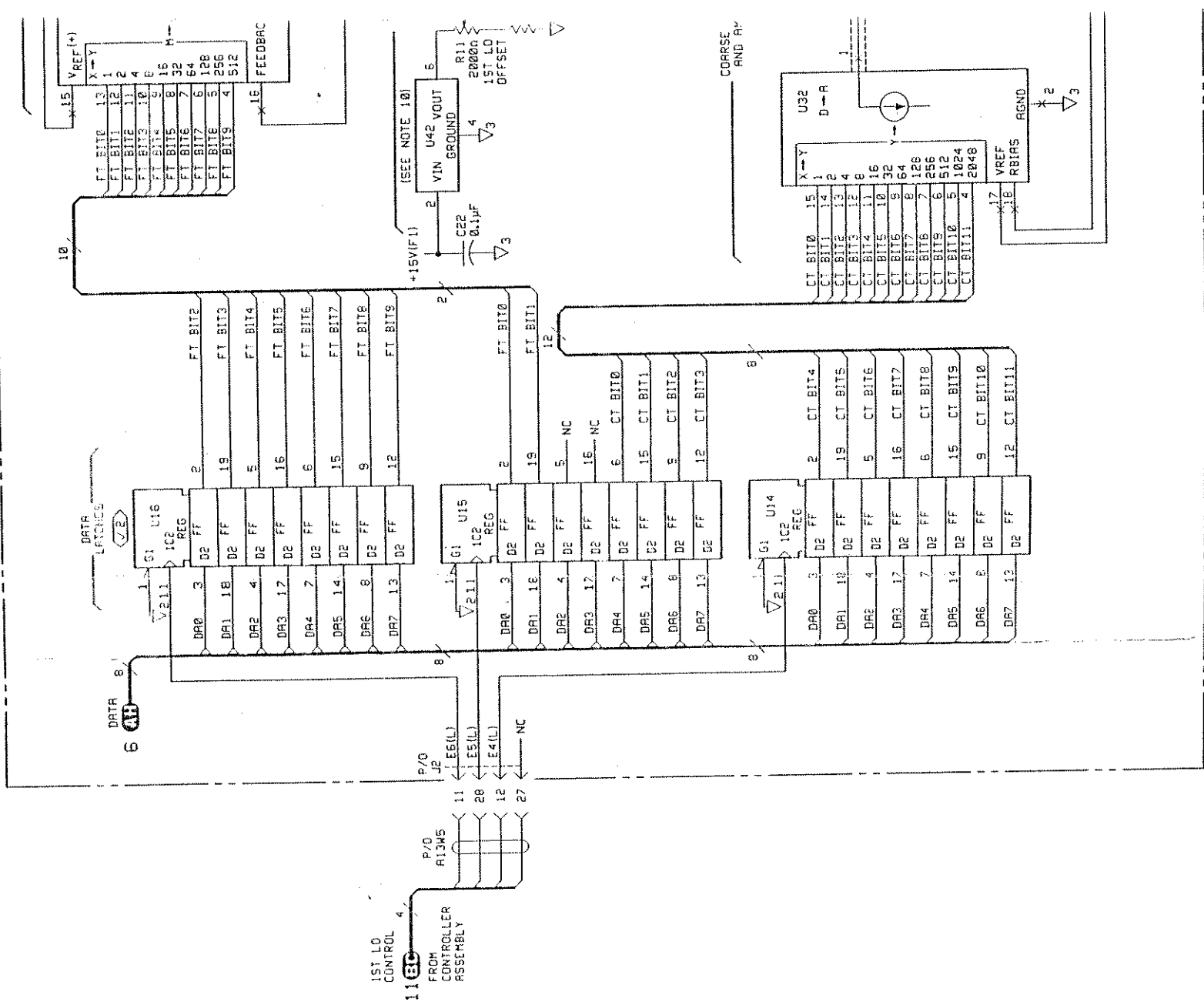


Figure 8-49. Driver — First LO Drive Block Diagram

P/O R13 DRIVER ASSEMBLY (08970-60034)



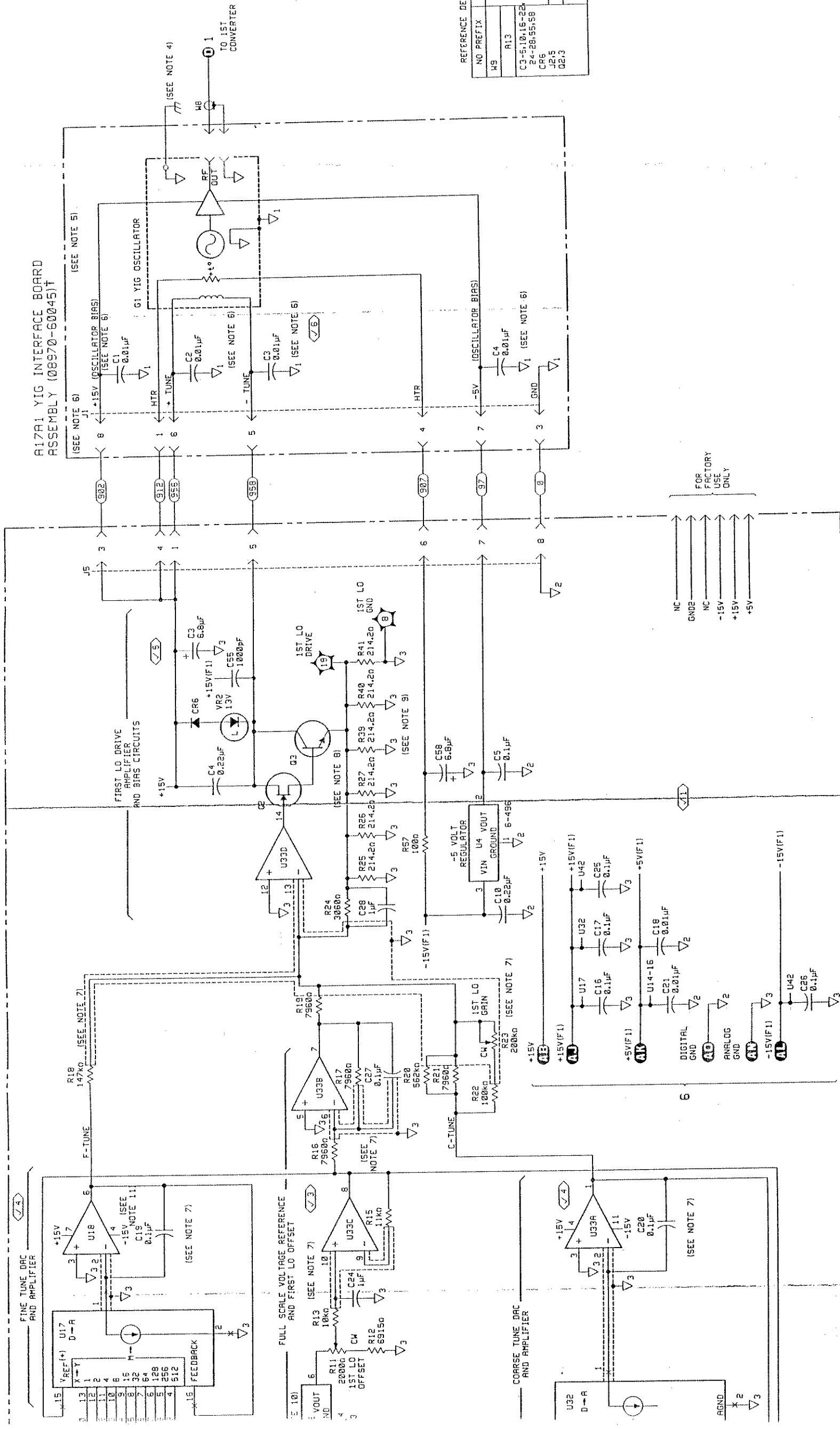
HP8970B 1ST LO DRIVE CIRCUITS: 2745B



NOTES

1. SCHEMATIC DIAGRAM NOTES ARE FOUND AT THE END OF THE MANUAL.
2.  $\nabla$  DENOTES DIGITAL GROUND.
3.  $\nabla$  DENOTES ANALOG GROUND.
4. CHASSIS GROUND IS ACHIEVED BY MECHANICAL CONTACT THROUGH SCREWS HOLDING THE YIG OSCILLATOR TO THE FRAME.
5. THE PRINTED CIRCUIT BOARD IS DIFFICULT TO REMOVE FROM THE YIG OSCILLATOR. IF THE PRINTED CIRCUIT BOARD NEEDS TO BE REPLACED, HEWLETT-PACKARD RECOMMENDS THAT THE ENTIRE A17A1 ASSEMBLY BE REPLACED.
6. THE CAPACITORS AND CONNECTOR J1 ARE DIFFICULT TO REMOVE FROM THE PRINTED CIRCUIT BOARD. IF A CAPACITOR OR J1 NEEDS TO BE REPLACED, HEWLETT-PACKARD RECOMMENDS THAT THE ENTIRE A17A1 ASSEMBLY BE REPLACED.
7. THE BROKEN LINES ON THE SCHEMATIC(---) ARE GUARD TRACES WHICH SHIELD THE ENCLOSED AREA FROM OTHER TRACES ON THE PRINTED CIRCUIT BOARD.
8. WHEN THE INSTRUMENT IS TUNED TO 10 MHz TP19 IS 3.7±0.4 Vdc; WHEN THE INSTRUMENT IS TUNED TO 1600 MHz, TP19 IS 6.5±0.7Vdc.
9. THE EQUIVALENT RESISTANCE OF R25-27 AND R39-41 IS NOMINALLY 35.7Ω WHEN MEASURED FROM TP19 TO TP8.
10. U42 PINS 1, 3, 5, 7 AND 8 HAVE BEEN LEFT UNCONNECTED.
11. U18 PINS 1, 5, AND 8 HAVE BEEN LEFT UNCONNECTED.

† CIRCULATING INFORMATION FOUND IN SECTION VII.



REFERENCE DESIGNATIONS

NO. PREFIX	A13 COMPL.
W5	R11-13, 15-27, 39-41, 57
A13	TP8, 19
C3-5, 10, 15-22	U4, 14-16, 32,
C6	33-42
J2, 5	VR2
J2, 5	A17
Q2, 3	C1-4
	J1

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBERS
Q2	1855-0414
Q3	1854-0456
U4	1826-0220
U14-16	1820-1858
U17	1825-0861
U18	1825-0520
U32	1826-1190
U33	1826-1550
U42	1826-1514

LOGIC LEVEL

TTL	
HIGH	>2V
LOW	<0.8V
< 15 MORE NEG. THAN	
> 15 MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATION	PIN NUMBER
U14-16	-5V(F1) - 20
	$\nabla$ 2 - 10
U17	+15V(F1) - 14
	$\nabla$ 2 - 3
U32	+15V(F1) - 16
	$\nabla$ 2 - 3

Figure 8-50. Driver — First LO Drive Schematic Diagram



## SERVICE SHEET 8 (cont'd)

Table 8-42. A2U8 Pin-Outs

Column 1—16	DSSP7—15
Column 2—18	DSSP6—17
Column 3—6	DSSP5—7
Column 4—4	DSSP4—5
Column 5—2	DSSP3—3
IRQ ACK—19	

7. Ensure that as the scanning takes place, the correct column is driven low, and that the low bit is output on data byte DSSP3—DSSP7. If not, check A2U8.
8. Press two keys (each in a separate column) and ensure that both keys are detected, and both low bits appear in the data byte. If not, check A2U8.

### ✓ 4 Stuck Key Check

1. Power up the Noise Figure Meter and check the keyboard for proper operation. A stuck key at power up will cause the MPU to ignore the keyboard.
2. Connect the logic analyzer to the output pins of A2U28 and to the input pins of A2U8 as listed in Table 8-43.
3. Observe the data byte as shown on the column inputs of A2U8. Locate the stuck bit, to isolate the column with the stuck key.
4. Observe the row scan data and isolate the row which is low when the column low is triggered.

Table 8-43. A2U28 and A2U8 Pin-Outs

A2U28	A2U8
Row 1—9	Column 1—16
Row 2—10	Column 2—18
Row 3—11	Column 3—6
Row 4—12	Column 4—4
Row 5—7	Column 5—2
Row 6—6	
Row 7—5	
Row 8—4	

5. Use the schematic to find which key is at the point where the isolated row and column cross. This is the stuck key.
6. If more than one key is stuck, the same process will isolate each bad key.

### ✓ 5 Keyboard Verification Check

Refer to the Keyboard Test Special Function 90.N, Section VIII, and complete the test sequence. This will verify that all keys and key annunciators are functional.

### Completion of Testing

Upon completion of testing, place all switches in their original positions, remove all test gear, and restore the Noise Figure Meter to the normal operating condition. If repairs have been made, or adjustments changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

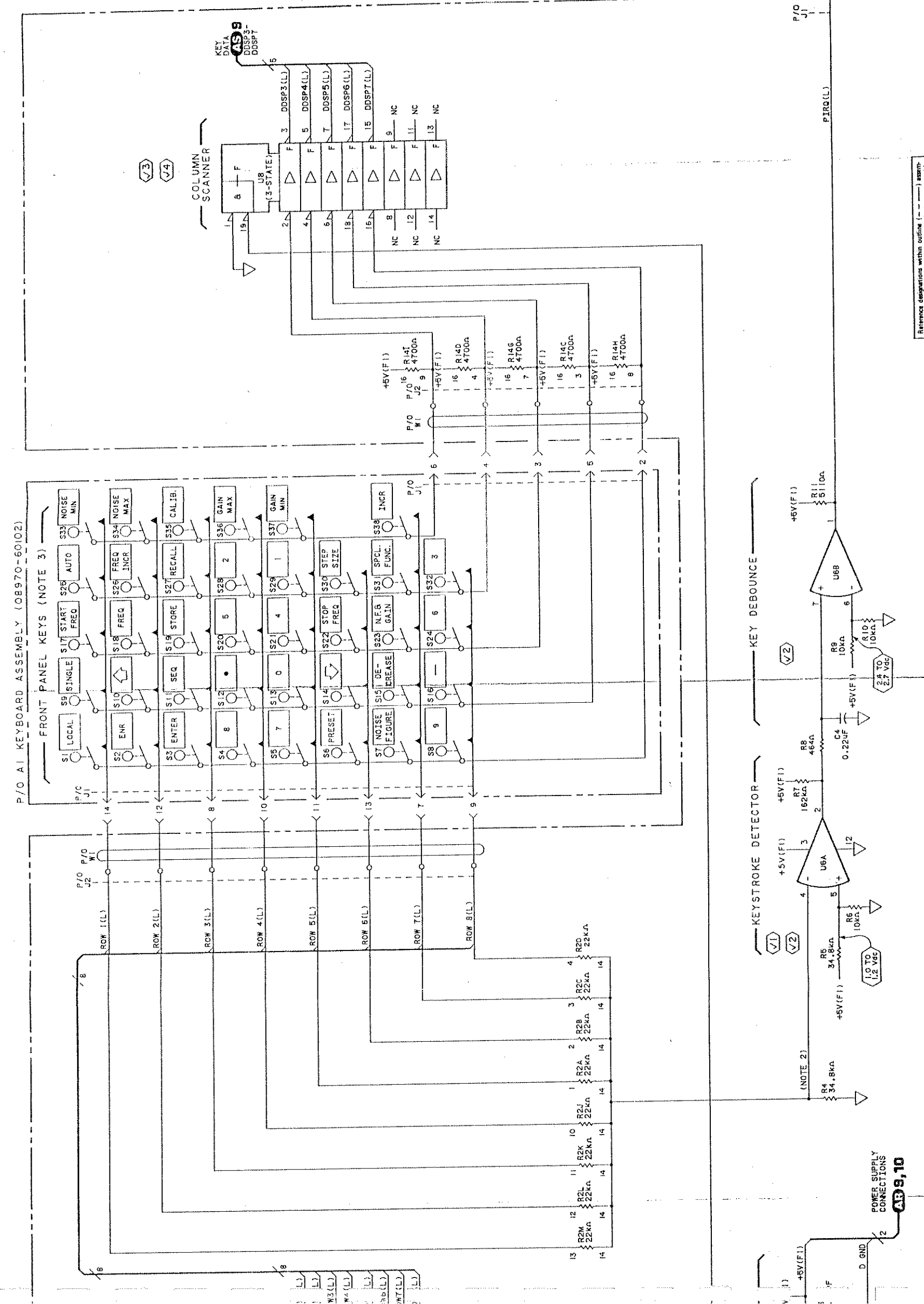








P/O A1 KEYBOARD ASSEMBLY (08970-60102)



Reference designations within outline (---) assemblies are abbreviated. Full designation includes Assembly Number; e.g., R1 of Assembly A1 is A1R1. Designations of other components are complete as shown.

- NOTES
1. SEE THE SECTION AT THE END OF THE MANUAL FOR SCHEMATIC DIAGRAM NOTES.
  2. WHEN ANY KEY IS PRESSED, THE INPUT TO THE KEYSTROKE DETECTOR IS CONNECTED TO +5V THROUGH R2. THE KEY CONTACTS, AND R1A.
  3. KEY POSITIONS MATCH SPECIAL FUNCTION NUMBERS AND DISPLAY POSITIONS (REFER TO TROUBLESHOOTING).

REFERENCE DESIGNATIONS

NO. PREFIX	A2
P6	C1-4 J1-2
A1	L1 R1, 2, 4, 11, 14 U6, 9, 28 W1
S1-34	W1

LOGIC LEVEL

TTL	
HIGH	>2V
LOW	<0.8V
S IS MORE NEG. THAN	
S IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBERS
U6	1846-0739
U8	1820-1427
U28	1820-1427

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATIONS	VOLTAGE	PIN NUMBERS
U8	+5V(F1)-20	-10
U28	+5V(F1)-16	-8

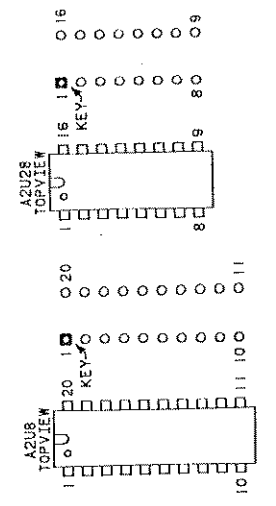
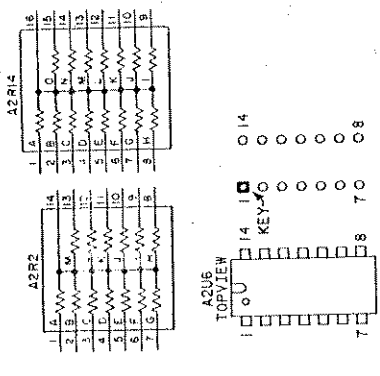


Figure 8-54. Keyboard Interface and Keys Schematic Diagram



## SERVICE SHEET 9

### LEFT DISPLAY CIRCUITS

### P/O A2 DISPLAY ASSEMBLY

### REFERENCES

Block Diagram — Service Sheet BD3  
 Section III — Operator's Checks  
 Section VIII — Special Functions and  
 Power-Up Checks

### PRINCIPLES OF OPERATION

#### General

The Left Display circuits serve two general functions. Primarily, the circuits drive (illuminate) the five left digits on the top of the front panel of the Noise Figure Meter. (These are the digits that usually display the frequency). Additionally, the circuits provide the latch and select decoding, and data interface between the instrument and the rest of the A2 Display Assembly.

#### Data Transfer

With the  $\overline{R/W}$  line at a low, data line transceiver A2U1D will be enabled to transfer serial data from the MPU to the left display circuits. This is accomplished by routing the data through inverters A2U29C/D to serial/parallel converter A2U26. The serial output of A2U26 is input to the serial input of serial/parallel converter A2U9.

This configuration requires two eight bit data bytes. The first byte is passed through A2U26 to A2U9, where it becomes the data. The second byte is retained in A2U26, where it becomes the line select command. The actual movement of the data is one bit at a time under control of the CLOCK signal from inverters A2U29A/B.

The P-LOAD line, to A2U9, is normally held low in the inactive state. This makes A2U9 a serial/parallel converter. A2U26 does not use this line, as it is ALWAYS used as a serial/parallel converter.

When the MPU wants to read data, it takes the  $\overline{R/W}$  line high. A2U1D is disabled, but A2U3F enables A2U1C. The P-LOAD line is taken high to cause a parallel data load from the data bus to A2U9. Then, the CLOCK pulses are used to output the bits serially from A2U9 through A2U1C to the MPU.

IRQ ACK is low at this time to inhibit the display function (prevent flashes) and to make A2U9 a parallel/serial converter. The data being read is the key scanning column data byte.

### Latch and Select Decoding

With the two bytes loaded into the serial/parallel converters during the MPU write mode, A2U26 outputs an eight bit word, which is the select byte. Three of the select lines (S1, S2, and S3) are routed to the keyboard scanning circuits. These three lines become the row select lines.

The entire eight select lines are input to latch decoders A2U27 and A2U7. Table 8-44 shows the decoding process by which the various latch lines are decoded. The selected line will be driven low by the respective demultiplexer.

Table 8-44. Display Assembly Latch Line Decoding

Latch Select	IC Pin	A2U27 Pins						A2U7 Pins					
		1 S1	2 S2	3 S3	4 $\overline{R/W}$	6 S4	1 S5	2 S6	3 S7	4 $\overline{R/W}$	6 S8		
Disabled													
X	X	X	X	X	H	X	X	X	X	H	X		
X	X	X	X	X	X	L	X	X	X	X	L		
A2U27													
LS1	15	L	L	L	L	H	X	X	X	L	L		
LS2	14	L	L	H	L	H	X	X	X	L	L		
LS3	13	L	H	L	L	H	X	X	X	L	L		
LS4	12	L	H	H	L	H	X	X	X	L	L		
LS5	11	H	L	L	L	H	X	X	X	L	L		
LS6	10	H	L	H	L	H	X	X	X	L	L		
LS7	9	H	H	L	L	H	X	X	X	L	L		
LS8	7	H	H	H	L	H	X	X	X	L	L		
A2U7													
LS9	15	X	X	X	L	L	L	L	L	L	H		
LS10	14	X	X	X	L	L	L	L	H	L	H		
LS11	13	X	X	X	L	L	L	H	L	L	H		
LS12	12	X	X	X	L	L	L	H	H	L	H		
LS13	11	X	X	X	L	L	H	L	L	L	H		
LS14	10	X	X	X	L	L	H	L	H	L	H		
LS15	9	X	X	X	L	L	H	H	L	L	H		
LS16	8	X	X	X	L	L	H	H	H	L	H		

For either demultiplexer to be enabled, the MPU must be in the read mode. Latch lines LS1 and LS7 through LS16 are for the center and right displays (on Service Sheet 10). Latch lines LS2 through LS6 are routed to the five left display latches A2U11 through A2U15.

## SERVICE SHEET 9 (cont'd)

### 1 $\mu$ s Delay and Strobe Inhibit Circuits

For the data to be displayed, the IRQ ACK line has to be high to enable data serial/parallel converter A2U9. Also, the data placed on the data bus by A2U9, must be strobed into the selected display latch. This is accomplished by the rising edge of a high placed on the LEFT STROBE line.

The strobe inhibit circuit consists of ICs A2U2B and A2U2C. The IRQ ACK line, again has to be high to enable the strobe gates. The other input to the strobe gates, is the output of the 1  $\mu$ s delay circuit. The delayed output is actually a delayed read mode input. Therefore, with IRQ ACK high, and the R/ $\bar{W}$  line going high, the selected display latch will output its data to the appropriate display digit.

The reason for a strobe enable is to prevent the displays from flashing during the key scanning process. The IRQ ACK is the controlling line, in that it is low to scan the keys, and high to display the data. The 1  $\mu$ s delay provides enough time for the IRQ ACK line to go low and inhibit the strobe. Otherwise, the R/ $\bar{W}$  line going high would generate a strobe, while the IRQ ACK line was still changing states to try to prevent it. Therefore, the R/ $\bar{W}$  line is delayed to the strobe gates. This is another precaution taken to prevent random display flashes.

### Left Display Latches and Left Display Circuits

The high going strobe, and the low level latch select, will enable the selected display latch to output the eight bit byte to its display. Each display latch is actually eight D-Type flip/flops in one IC. Each flip/flop is tied to one data line of the data bus.

The display is a LED type display with seven character bars and a decimal point. Each bar anode, and the decimal point anode are tied to Vcc. When the display latch wants to illuminate the bar or the decimal point, it brings the bar or decimal point cathode to ground through a resistor.

## TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 9 when a malfunction has occurred in one of the Left Display circuits of Display Assembly A2. If all of the tests in the following proce-

dures indicate correct responses, the trouble is located elsewhere in the instrument, and not in the Left Display circuits. Except where shown, the values listed are approximate and are given as a service guideline.

### Test Equipment

Noise Source ..... HP 346B  
Logic Analyzer ..... HP 1630D  
Oscilloscope ..... Tektronix 2235  
Systems DVM ..... HP 3456A

### ✓1 General Checks

1. In the power on condition, verify that the voltage from pin 20 of A2U26 to pin 10 (ground) of A2U26 is  $+5 \pm 0.05$  Vdc.
2. Refer to the Special Functions 91.0, Display Test, Section VIII, and observe the Noise Figure Meter while the special function is running. If the special function is run successfully, the Left Display is functioning properly.

### ✓2 Microprocessor (MPU) Read Data Test

1. Connect the logic analyzer to the pins listed in Table 8-45.

Table 8-45. A2U9 and A2U1C Pin-Outs

Node (IC Desig.)-Pin No.	Signal Name
A2U9-11	Serial In
A2U9-13	DDSP1
A2U9-14	DDSP3
A2U9-15	DDSP5
A2U9-16	DDSP7
A2U9-2	IRQ ACK
A2U1C-8	Serial Data Out
A2U9-7	DDSP0
A2U9-6	DDSP2
A2U9-5	DDSP4
A2U9-4	DDSP6
A2U9-12	CLOCK
A2U9-19	P-LOAD
A2U1C-10	R/ $\bar{W}$

2. Ensure that when IRQ ACK is low, R/ $\bar{W}$  is high, and CLOCK is present, that serial data is output on pin 8 of A2U1C.

## SERVICE SHEET 9 (cont'd)

3. If the error is on the IRQ ACK line, check A2U3D and A2U2B/C. If the error is on the R/ $\bar{W}$  line, check A2U1C/D, A2U3E/F, A2U27, A2U7, and A2U29C/D.
4. If the error is on the CLOCK line, check A2U29A/B and A2U9.
5. If the three enable lines (IRQ ACK, R/ $\bar{W}$ , and CLOCK) are correct, ensure that data is present on the data bus inputs to A2U9, and that the data is loaded into A2U9 when the P-LOAD line is high.
6. If data is present, check A2U9 and A2U1C. If any data bit is in error, check A2U9, and A2U11 through A2U15.

### ✓ 3 Serial/Parallel Converters Write Data Test

1. Connect the logic analyzer to the pins listed in Table 8-46.

Table 8-46. A2U26 and A2U1D Pin-Outs

Node (IC Desig.)-Pin No.	Signal Name
A2U26-7	S1
A2U26-6	S3
A2U26-5	S5
A2U26-4	S7
A2U26-17	Serial Data Out
A2U26-11	Serial Data In
A2U26-13	S2
A2U26-14	S4
A2U26-15	S6
A2U26-16	S8
A2U26-12	CLOCK
A2U1D-13	R/ $\bar{W}$

2. Ensure that when R/ $\bar{W}$  is low and CLOCK is present, that serial data is input on pin 11 of A2U26, and that serial data is output on pin 17 of A2U26.
3. If the error is in the R/ $\bar{W}$  line, check A2U1D and A2U3F. If the error is in the CLOCK line, check A2U29A/B, A2U9, and A2U26. If the error is in the serial data in, check A2U1C/D, A2U29C/D, and A2U26. If the error is in the serial data out, check A2U26 and A2U9.

4. If serial data is being properly shifted through A2U26, ensure that when the shifting stops, the last eight bits are output on the eight select lines. If not, check A2U26, A2U27, and A2U7.
5. Connect the logic analyzer to the pins listed in Table 8-47.

Table 8-47. A2U9 Pin-Outs

Node (IC Desig.)-Pin No.	Signal Name
A2U9-7	DDSP0
A2U9-6	DDSP2
A2U9-5	DDSP4
A2U9-4	DDSP6
A2U9-11	Serial Data In
A2U9-2	IRQ ACK
A2U9-13	DDSP1
A2U9-14	DDSP3
A2U9-15	DDSP5
A2U9-16	DDSP7
A2U9-19	P-LOAD
A2U9-12	CLOCK

6. Ensure that when IRQ ACK is high, P-LOAD is low, and CLOCK is present, that serial data is input on pin 11 of A2U9.
7. If the error is in the IRQ ACK line, check A2U3D, A2U9, and A2U2B/C. If the error is in the P-LOAD line, check A2U9. If the error is in the CLOCK line, check A2U29A/B, A2U9, and A2U26.
8. If serial data is being properly shifted into A2U9, ensure that when the shifting stops, the first eight bits are output on the eight data bus lines. If not, check A2U9, and A2U11 through A2U15.

### ✓ 4 Latch Select Decoders Write Data Test

1. Connect the logic analyzer to the pins listed in Table 8-48.
2. Ensure that when R/ $\bar{W}$  is low and S4 is high, that the S1, S2, and S3 inputs are decoded to place a low on the correct LS output line.

## SERVICE SHEET 9 (cont'd)

Table 8-48. A2U27 Pin-Outs

Node (IC Desig.)-Pin No.	Signal Name
A2U27-1	S1
A2U27-3	S3
A2U27-6	S4
A2U27-9	LS7
A2U27-11	LS5
A2U27-13	LS3
A2U27-15	LS1
A2U27-2	S2
A2U27-4	R/ $\bar{W}$
A2U27-7	LS8
A2U27-10	LS6
A2U27-12	LS4
A2U27-14	LS2

- If the error is in the R/ $\bar{W}$  line, check A2U3E/F, A2U1C/D, A2U7, and A2U27. If the error is in the S1, S2, S3, or S4 line, check A2U27 and A2U26.
- If the error is in latch select lines LS1, LS7, or LS8, check A2U27. If the error is in latch select lines LS2 through LS6, check A2U27 and the respective left display latch A2U11 through A2U15.
- Connect the logic analyzer to the pins listed in Table 8-49.

Table 8-49. A2U7 Pin-Outs

Node (IC Desig.)-Pin No.	Signal Name
A2U7-1	S5
A2U7-3	S7
A2U7-6	S8
A2U7-9	LS15
A2U7-11	LS13
A2U7-13	LS11
A2U7-15	LS9
A2U7-2	S6
A2U7-4	R/ $\bar{W}$
A2U7-7	LS16
A2U7-10	LS14
A2U7-12	LS12
A2U7-14	LS10

- Ensure that when R/ $\bar{W}$  is low and S8 is high, that the S5, S6, and S7 inputs are decoded to place a low on the correct LS output line.

- If the error is in the R/ $\bar{W}$  line, check A2U3E/F, A2U1C/D, A2U27, and A2U7. If the error is in the S5, S6, S7, or S8 line, check A2U7 and A2U26.
- If the error is in one of the latch select lines (LS9 through LS16), check A2U7.

### ✓5 Strobe Inhibit, Displays, and Display Latches Test

- Connect the logic analyzer to pins A2U2B-5 (IRQ ACK), A2U2B-6 (RIGHT STROBE), A2U2C-8 (LEFT STROBE), and A2U3E-11 (R/ $\bar{W}$ ).
- Ensure that when the IRQ ACK line is high, and the R/ $\bar{W}$  line goes low, that the RIGHT STROBE and LEFT STROBE lines go high 1  $\mu$ s later.
- If the error is in the R/ $\bar{W}$  line, check A2U3E/F, A2U1C/D, A2U27, and A2U7. If the error is in the IRQ ACK line, check A2U3D and A2U2B/C.
- If the error is in both strobes, check A2U2B/C and the 1  $\mu$ s delay A2U3B/C/E, A2R13, and A2C10. Otherwise, check A2U2B/C.
- If the latch select lines are functioning properly, and the data is on the data bus, but one or more displays are in error, check the respective display and driver as shown in Table 8-50.

Table 8-50. Latch Select Lines

Driver	Display
A2U11	A2DS1
A2U12	A2DS2
A2U13	A2DS3
A2U14	A2DS4
A2U15	A2DS5

### Completion of Testing

Upon completion of testing, place all switches in their original positions, remove all test gear, and restore the Noise Figure Meter to the normal operating condition. If repairs have been made, or adjustments changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

P/O A2 ASSEMBLY

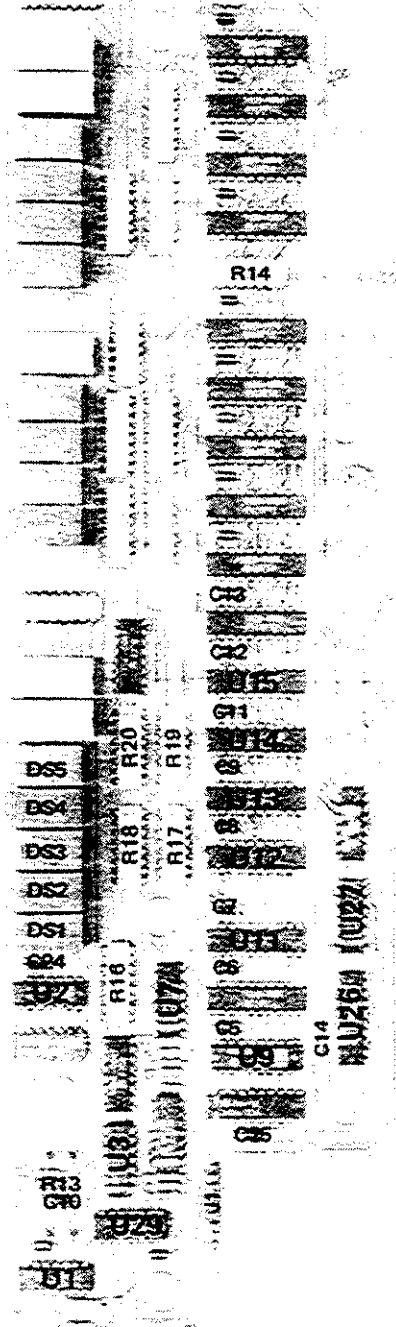


Figure 8-55. P/O A2 Display Assembly Component Locations (Left Display)

8-135/8-136





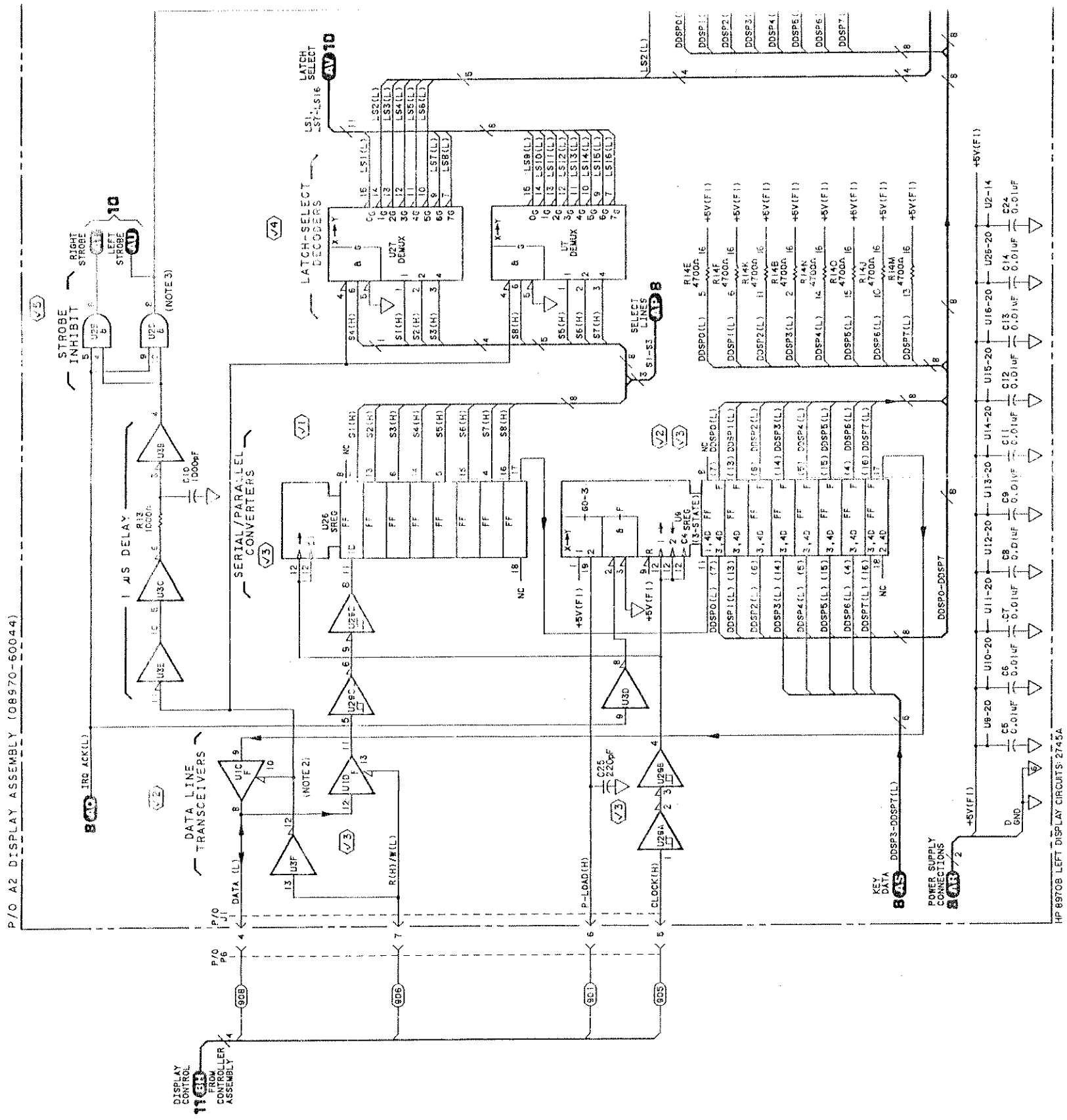
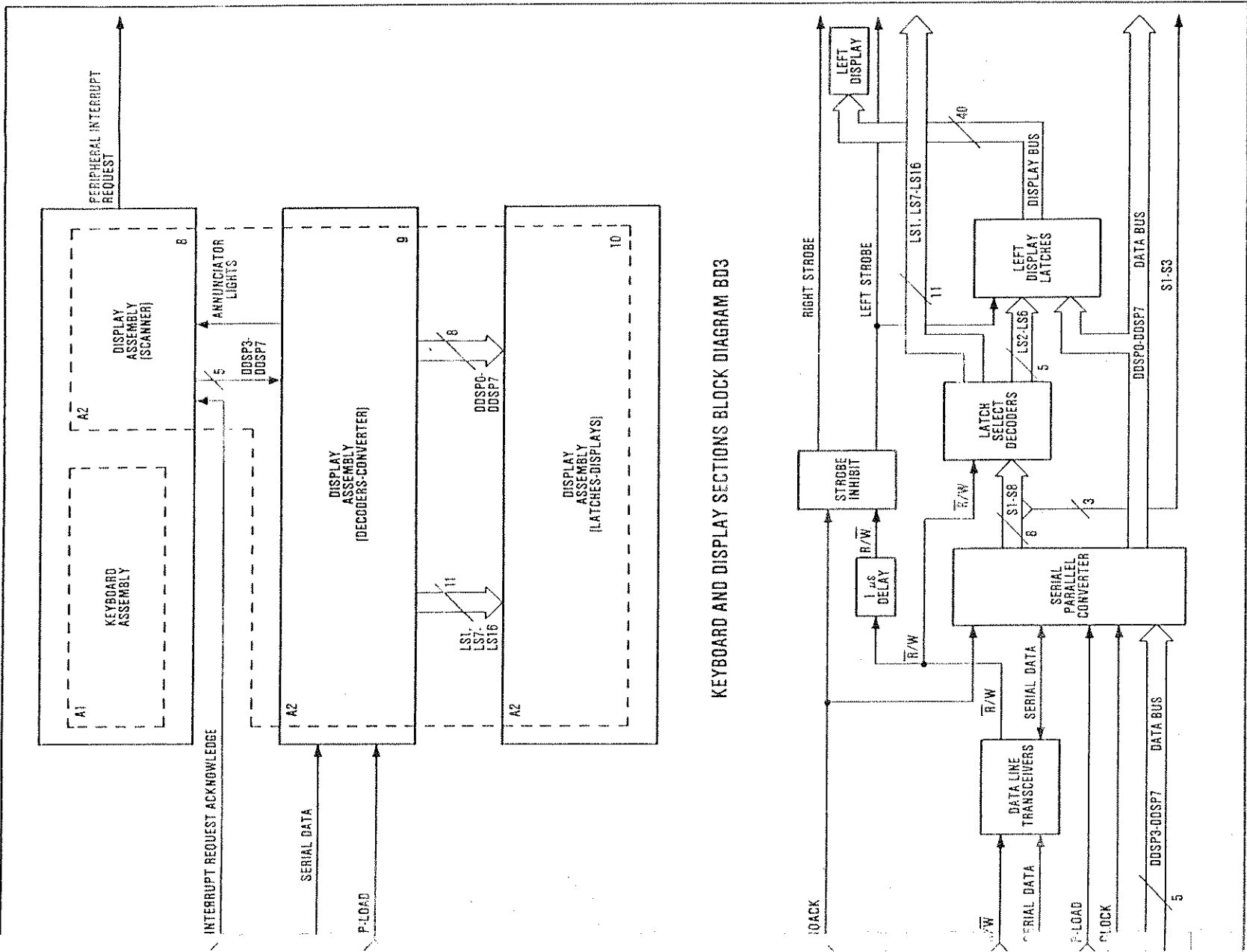


Figure 8-56. Left Display Block Diagram







## SERVICE SHEET 10

### RIGHT DISPLAY AND FRONT PANEL ANNUNCIATORS CIRCUITS

#### P/O A1 KEYBOARD ASSEMBLY

#### P/O A2 DISPLAY ASSEMBLY

### REFERENCES

Block Diagram — Service Sheet BD3  
Section III — Operator's Checks  
Section VIII — Special Functions and  
Power-Up Checks

### PRINCIPLES OF OPERATION

#### General

The Right Display and Front Panel Annunciators circuits provide the latches and drivers for the 17 indicators and eight character displays on the front panel, and for the six keyboard indicators. This is accomplished by the use of 11 data bus latches. Each latch receives its own latch select input, and either a right or left strobe for latching. See Service Sheet 9 for details of the latch select and strobe decoders and signal generators.

As each latch is enabled and strobed, it will latch the eight bit word on data bus DDSP0-DDSP7. The eight bit bus input is then decoded into the individual bits, where any low bit provides a ground path to illuminate an indicator or driver. The two drivers each consist of seven Darlington transistor arrays which are used to provide extra current for each signal path.

#### Display Annunciator Latch/Driver 1

Latch select LS1 selects first display annunciator latch A2U10, which is then strobed by the LEFT STROBE. Three of the bits are used to directly drive three single LED indicators. The remaining five bits are input to first annunciator driver A2U4.

Two additional drive lines are input to first annunciator driver A2U10 from second display annunciator latch A2U16. Two LEDs are illuminated by each of the seven drive lines. The Darlington drivers provide the current needed to drive two LEDs.

#### Display Annunciator Latch/Driver 2

Latch select LS7 selects second display annunciator latch A2U16, which is then strobed by the LEFT STROBE. Two of the bits are used by first annunciator driver A2U4. The remaining six bits are input to second annunciator driver A2U5.

Two LEDs are illuminated by each of the six drive lines. The second Darlington driver provides the current needed to drive the LEDs.

#### Keyboard Annunciator Latch

Latch select LS16 selects keyboard annunciator latch A2U25, which is then strobed by the RIGHT STROBE. Six of the bits are used to directly drive single LED indicators in the keyboard. One bit is not used. The eighth bit is used to directly drive a single LED indicator on the front panel.

#### INSERTION GAIN Display Latches

Four character displays (A2DS6 through A2DS9) are required to display the value of the insertion gain. These four displays are driven by the four display latches A2U17 through A2U20. Display latch A2U17 is selected by LS8 and strobed by LEFT STROBE.

The remaining three display latches A2U18, A2U19, and A2U20 are all strobed by RIGHT STROBE, and enabled by latch selects LS9, LS10, and LS11, respectively.

#### NOISE FIGURE Display Latches

Four character displays (A2DS10 through A2DS13) are required to display the value of the noise figure. These four displays are driven by the four display latches A2U21 through A2U24, respectively. All four display latches are strobed by RIGHT STROBE, and enabled by latch selects LS12 through LS15, respectively.

### TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 10 when a malfunction has occurred in one of the Right Display and Front Panel Annunciators circuits of Display Assembly A2. If all of the tests in the following procedures indicate correct responses, the trouble is located elsewhere in the instrument, and not in the Right Display and Front Panel Annunciators circuits. Except where shown, all values listed are approximate and are given as a service guideline.

#### Test Equipment

Oscilloscope ..... Tektronix 2235  
Systems DVM ..... HP 3456A

#### ✓ 1 General Checks

1. In the power on condition, verify that the voltage from pin 20 of A2U10 to pin 10 (ground) of A2U10 is  $+5 \pm 0.05$  Vdc.

## SERVICE SHEET 10 (cont'd)

- Refer to the Special Function 91.0, Display Test, Section VIII, and observe the Noise Figure Meter while the Special Function is running. If the Special Function is run successfully, the Right Display and Front Panel Annunciators are functioning properly.
- Ensure that the RIGHT STROBE and LEFT STROBE lines are active and changing states. If the error is in the RIGHT STROBE, check A2U18 through A2U25. If the error is in the LEFT STROBE, check A2U10, A2U16, and A2U17.
- Ensure that none of the eight data bus lines (DDSP0-DDSP7) are stuck high or low. If any bit is in error, check A2U10 and A2U16 through A2U25.

### ✓2 Display Annunciator Latch/Driver 1 Tests

- Ensure that the LEFT STROBE is a low going pulse to pin 11 of A2U10, and that LS1 is a low enable to pin 1 of A2U10. If not, check A2U10.

Table 8-51. Display Annunciator Latch/Driver 1

Indicator Name	Drive Bit	Latch Pins	Driver Pins	LED Device	Drive Resistor
*C	DDSP0	U10-7 U10-6	U4-2 U4-15	DS33B DS33G	R22D R22C
*F	DDSP1	U10-8 U10-9	U4-3 U4-14	DS33C DS33F	R25E R25F
EXT MIX	DDSP2	U10-14 U10-15	U4-4 U4-13	DS34A DS34H	R25A R25B
dB	DDSP3	U10-18 U10-19	U4-5 U4-12	DS34C DS34F	R25D R25G
MHz	DDSP4	U10-4 U10-5	U4-1 U4-16	DS34B DS34G	R25E R25C
K	DDSP2	U16-14 U16-15	U4-6 U4-11	DS33A DS33H	R22B R22A
TeK	DDSP1	U16-8 U16-9	U4-7 U4-10	DS32B DS32G	R23B R23C
REMOTE	DDSP5	U10-3 U10-2	—	DS14	R21A
LISTEN	DDSP6	U10-13 U10-12	—	DS15	R21C
SRQ	DDSP7	U10-17 U10-16	—	DS16	R21D

- Ensure that the LEFT STROBE is a low going pulse to pin 11 of A2U16, and that LS7 is a low enable to pin 1 of A2U16. If not, check A2U16.
- Use Table 8-51 to determine which LED is driven by which display annunciator latch/driver combination. In the event of an error, use Table 8-51 to isolate the faulty device.

### ✓3 Display Annunciator Latch/Driver 2 Tests

- Ensure that the LEFT STROBE is a low going pulse to pin 11 of A2U16, and that LS7 is a low enable to pin 1 of A2U16. If not, check A2U16.
- Use Table 8-52 to determine which LED is driven by which display annunciator latch/driver combination. In the event of an error, use Table 8-52 to isolate the faulty device.

### ✓4 Keyboard Annunciator Latch Tests

- Ensure that the RIGHT STROBE is a low going pulse to pin 11 of A2U25, and that LS16 is a low enable to pin 1 of A2U25. If not, check A2U16.

Table 8-52. Display Annunciator Latch/Driver 2

Indicator Name	Drive Bit	Latch Pins	Driver Pins	LED Device	Drive Resistor
YdB	DDSP0	U16-7 U16-6	U5-3 U5-14	DS31C DS31F	R23D R23E
dB	DDSP3	U16-18 U16-19	U5-6 U5-11	DS18A DS18B	R23G R23F
F	DDSP4	U16-4 U16-5	U5-2 U5-15	DS32A DS32H	R24A R23A
Y	DDSP5	U16-3 U16-2	U5-1 U5-16	DS32C DS32F	R24G R24F
dB	DDSP6	U16-13 U16-12	U5-4 U5-13	DS31B DS31G	R24E R24D
FdB	DDSP7	U16-17 U16-16	U5-5 U5-12	DS31A DS31H	R24C R24B

- Use Table 8-53 to determine which LED is driven by which display annunciator latch line. In the event of an error, use Table 8-53 to isolate the faulty device.

Table 8-53. Keyboard Annunciator Latch

Indicator Name	Drive Bit	Latch Pins	Assembly Number	LED Device	Drive Resistor
AUTO	DDSP0	U25-7 U25-6	A1	DS1	R1
UNCORR. N.F.	DDSP1	U25-8 U25-9	A1	DS2	R2
CALIB.	DDSP2	U25-14 U25-15	A1	DS3	R3
SPCL. FUNC.	DDSP3	U25-18 U25-19	A1	DS4	R4
SINGLE	DDSP4	U25-4 U25-5	A1	DS5	R5
CORR. N.F. & G	DDSP5	U25-3 U25-2	A1	DS6	R6
TALK	DDSP7	U25-17 U25-16	A2	DS23	R21B

✓ 5 **INSERTION GAIN and NOISE FIGURE Display Latches Tests**

1. Ensure that LEFT STROBE is a low going pulse to pin 11 of A2U17, and that LS8 is a low enable to pin 1 of A2U17. If not, check A2U17.
2. Ensure that RIGHT STROBE is a low going pulse to each pin 11 of latches A2U18 through A2U24. Ensure that latch selects LS9 through LS15 are each a low enable to pin 1 of their respective latch.
3. Ensure that no output lines of any latch are stuck high or low. Ensure that each segment and each decimal point, of each display is illuminated.

4. If any display is in error, first check the respective latch for a low out to that segment or point of the display. If the low is present, check the display. If the low is not present, check the respective resistor, latch, and finally, the display.

**Completion of Testing**

Upon completion of testing, place all switches in their original positions, remove all test gear, and restore the Noise Figure Meter to the normal operating condition. If repairs have been made, or adjustments changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

### P/O A2 ASSEMBLY

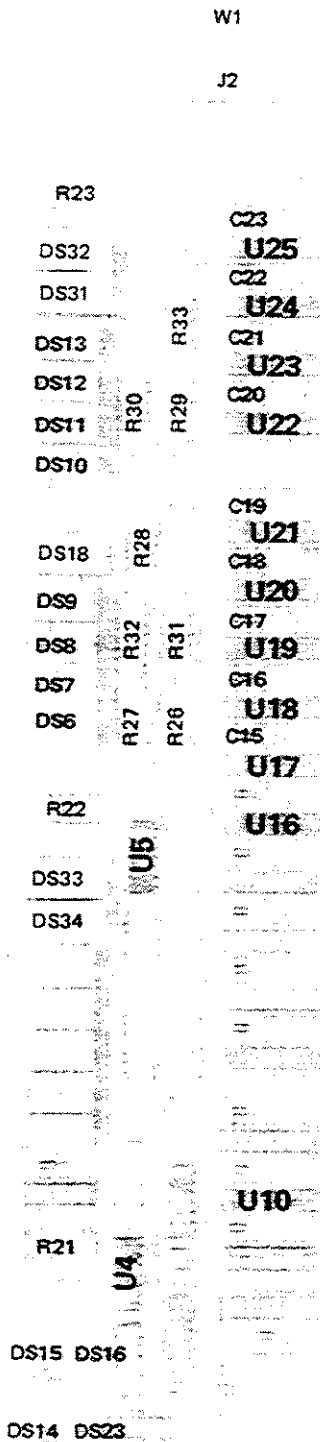


Figure 8-58. P/O A2 Display Assembly Component Locations (Right Display)

8-142

### P/O A1 ASSEMBLY

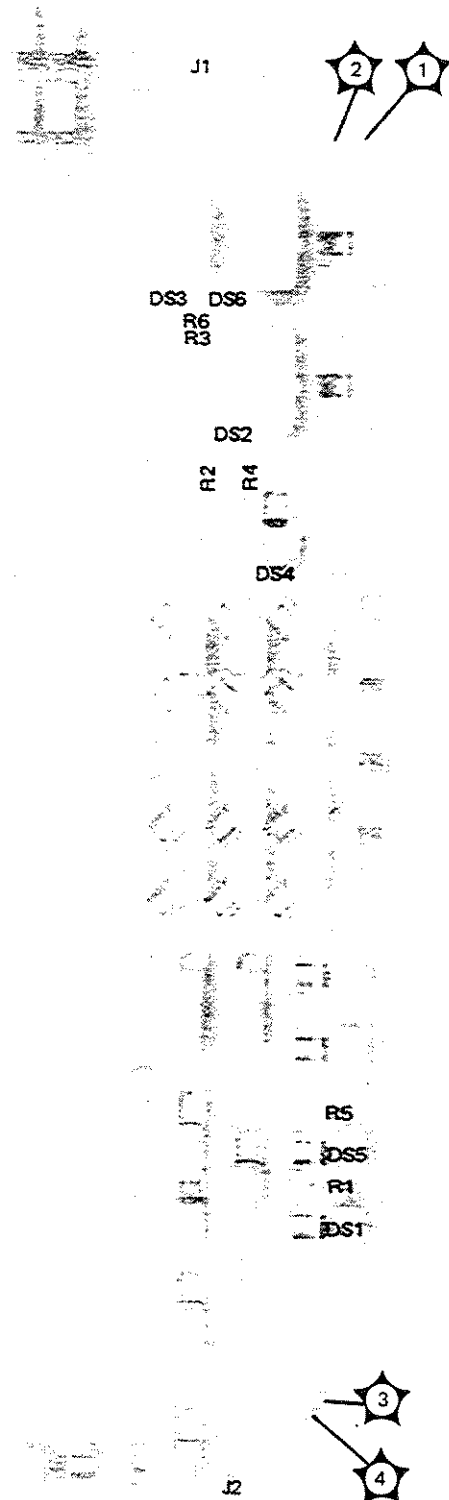


Figure 8-59. P/O A1 Keyboard Assembly Component Locations (Front Panel Annunciators)



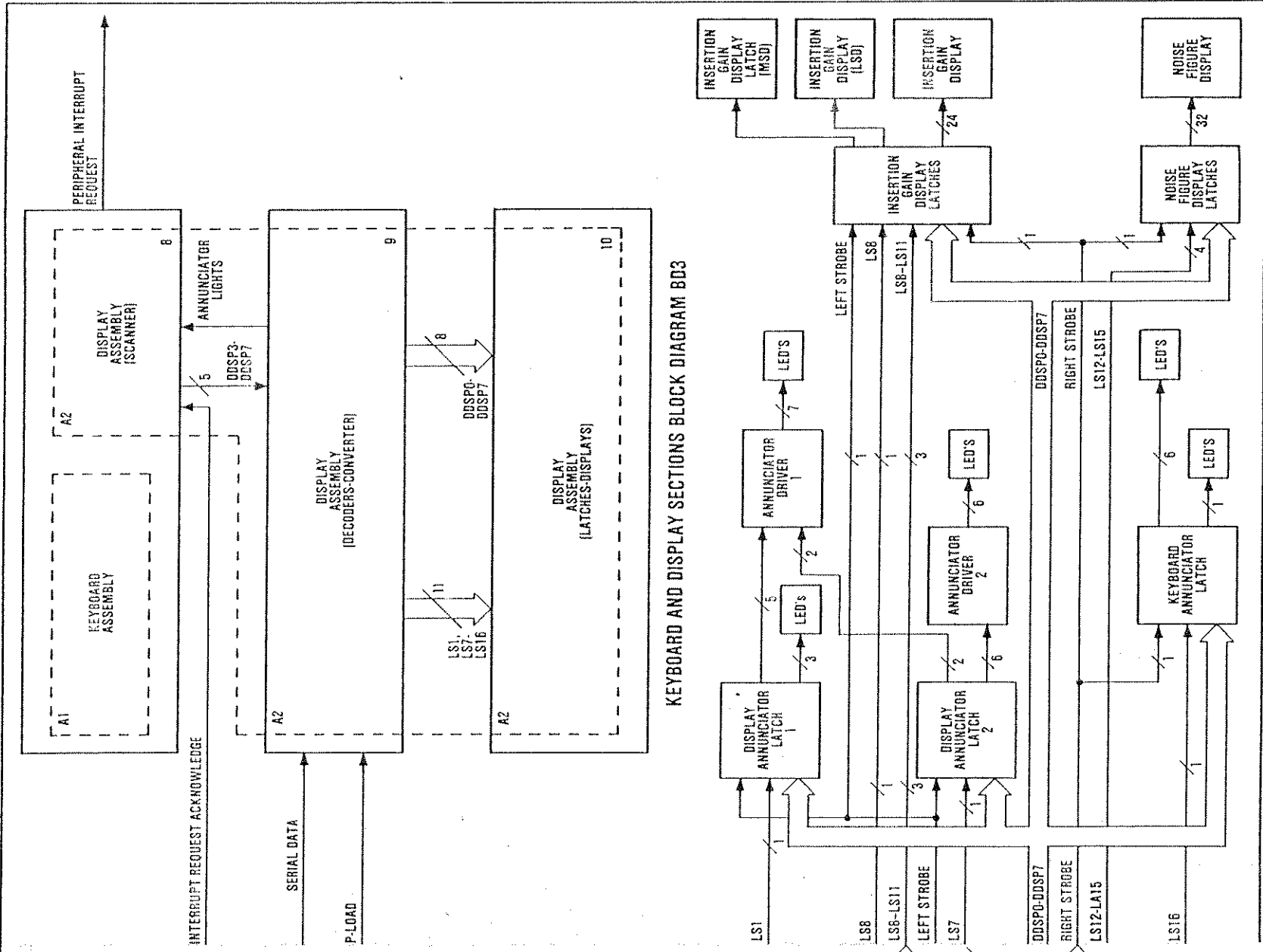
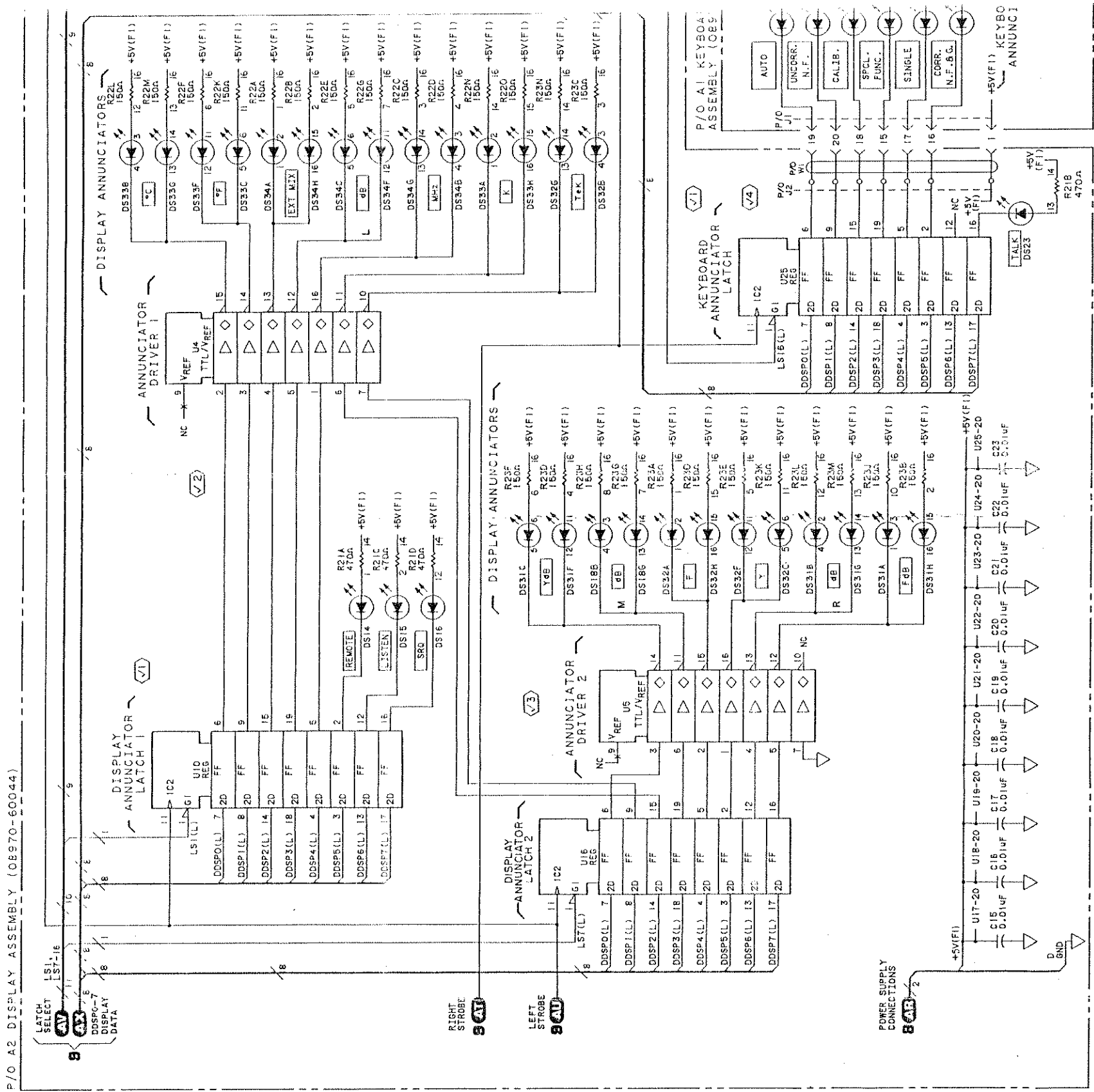


Figure 8-60. Right Display and Front Panel Annunciators Block Diagram



HP 8970B RIGHT DISPLAY CIRCUITS AND FRONT PANEL ANNUNCIATORS-2745A



NOTES

SEE THE SECTION AT THE END OF THE MANUAL FOR SCHEMATIC DIAGRAM NOTES.

REFERENCE DESIGNATIONS	
A1	A2
DS1-6	C15-23
J1-6	DS-16, 18, 23, 31-34
	R2-23, 25-23
	U4, 5, 10, 16-25
	W1

NOT ASSIGNED: A20S17, 19-22, 24-30

LOGIC LEVEL

LOGIC LEVEL	TTL
HIGH	>2V
LOW	<0.5V
X IS MORE NEGATIVE THAN Y IS MORE POSITIVE THAN	
OPEN	HIGH
GROUND	LOW

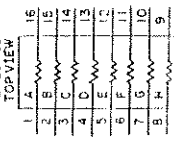
INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBERS
DS6-13	1990-C730
U4, 5	1868-0047
U10, 16-25	1820-1858

DIGITAL INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATIONS	VIN	PN
U4, 5	5V(F1)	-8
U10, 16-25	5V(F1)	-10

A226-33 TOP VIEW

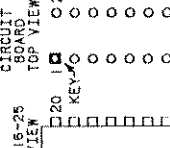


Reference designations within outline (---) lines are abbreviated. Full designation includes Assembly Number, RI of Assembly A1 & A11, Designation of some components as complete as shown.

A226-33 TOP VIEW



A226-33 TOP VIEW



A226-33 TOP VIEW

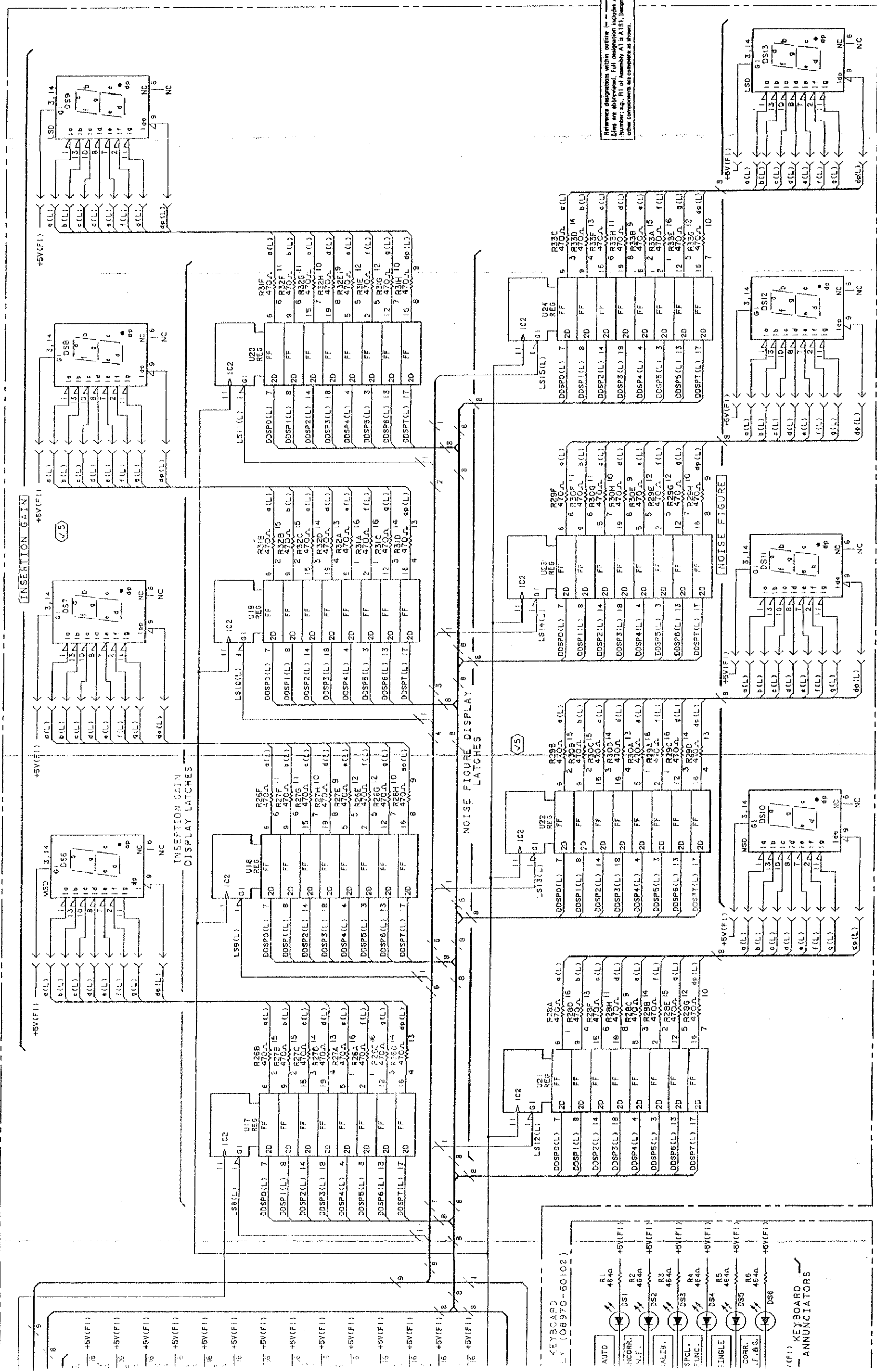
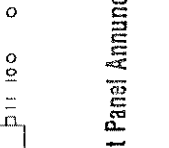


Figure 8-61. Right Display and Front Panel Annunciators Schematic Diagram



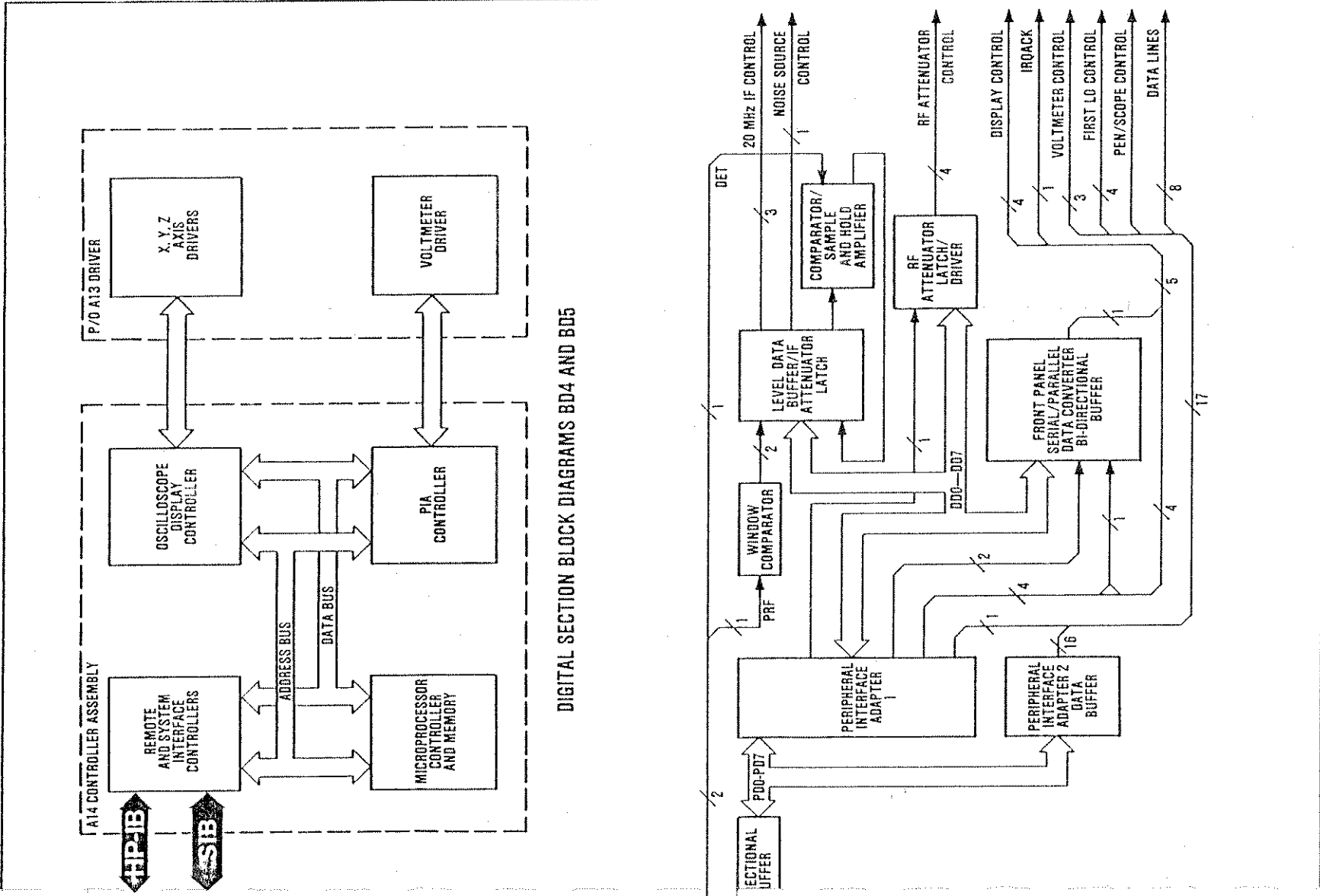
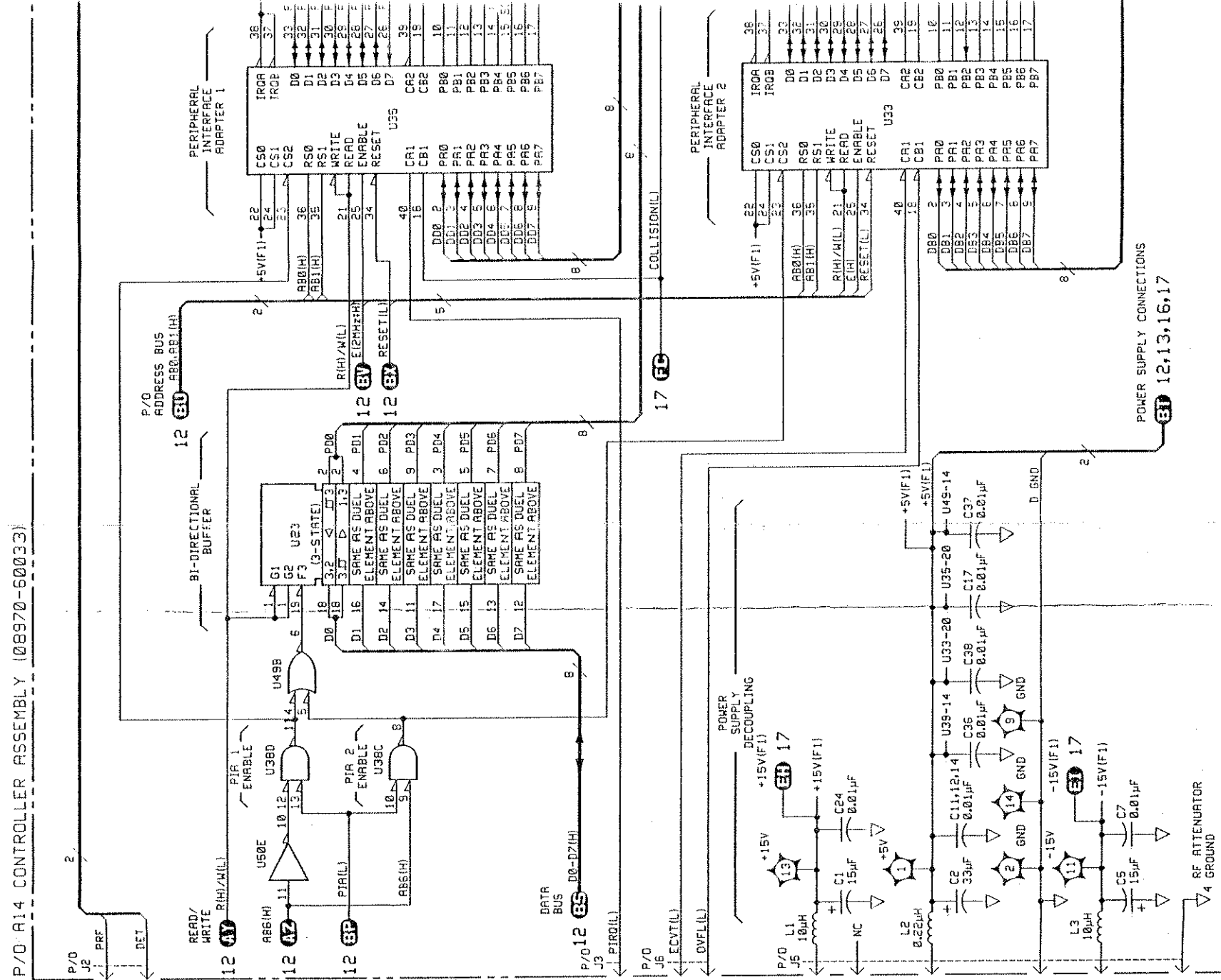


Figure 8-63. Controller — Peripheral Interface Adapter Adapter Circuits: 2745A

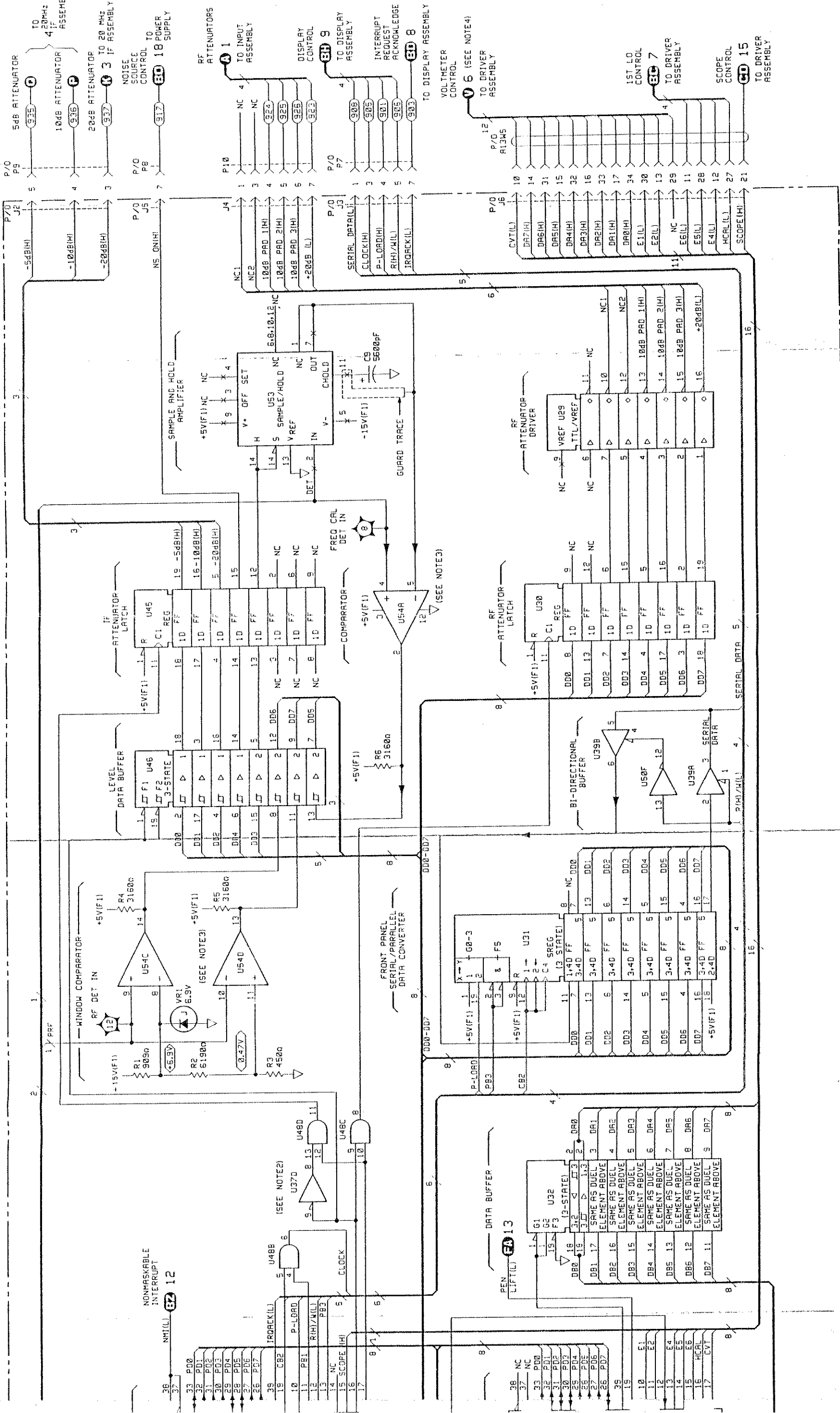


HP8970B PERIPHERAL INTERFACE ADAPTER CIRCUITS: 2745A

P/O A14 CONTROLLER ASSEMBLY (08970-60033)



NOTES  
 1. SCHEMATIC DIAGRAM NOTES ARE FOUND AT THE END OF THE MANUAL.  
 2. U37 PINS 3, 4, AND 10-13 HAVE BEEN LEFT UNCONNECTED.  
 3. U54 PINS 1, 5, AND 7 HAVE BEEN LEFT UNCONNECTED.  
 4. DATA LINES DA0-DA7 GO TO SERVICE SHEET 7 FROM SERVICE SHEET 6.



REFERENCE DESIGNATIONS

NO PREFIX	AL4 CONT.
WS	L1-3
P7-10	R1-6
	U1,2,8,9,11-14
	U17,23,28-33,
	35,37-39,45,
	46,48-50,53,
	54
	VR1

INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBERS
U23,32	1820-2075
U28	1820-2111
U30,45	1820-1730
U31	1820-1987
U33,35	1820-2983
U37,50	1820-2634
U38	1820-1208
U39	1820-1568
U45	1820-2024
U48,49	1820-2635
U53	1826-0732
U54	1826-0138

LOGIC LEVEL

LOGIC LEVEL	VOLTAGE
TTL	>2V
HIGH	<0.8V
LOW	< 15 MORE NEG. THAN
	> 15 MORE POS. THAN
OPEN	GROUND
GROUND	HIGH
	LOW

INTEGRATED CIRCUIT VOLTAGE, GROUND AND BYPASS CAPACITOR CONNECTIONS

REFERENCE DESIGNATION	PIN NUMBER	CONNECTION
U23,30-33, 45-46	+5V(F1) - 20	▽
U29	▽ 4 - 8	▽
U33-35	+5V(F1) - 20	▽
U34	+5V(F1) - 7	▽
U37-39, 48-50	+5V(F1) - 14	▽

Figure 8-64. Controller — Peripheral Interface Adapter Schematic Diagram





# P/O A14 ASSEMBLY

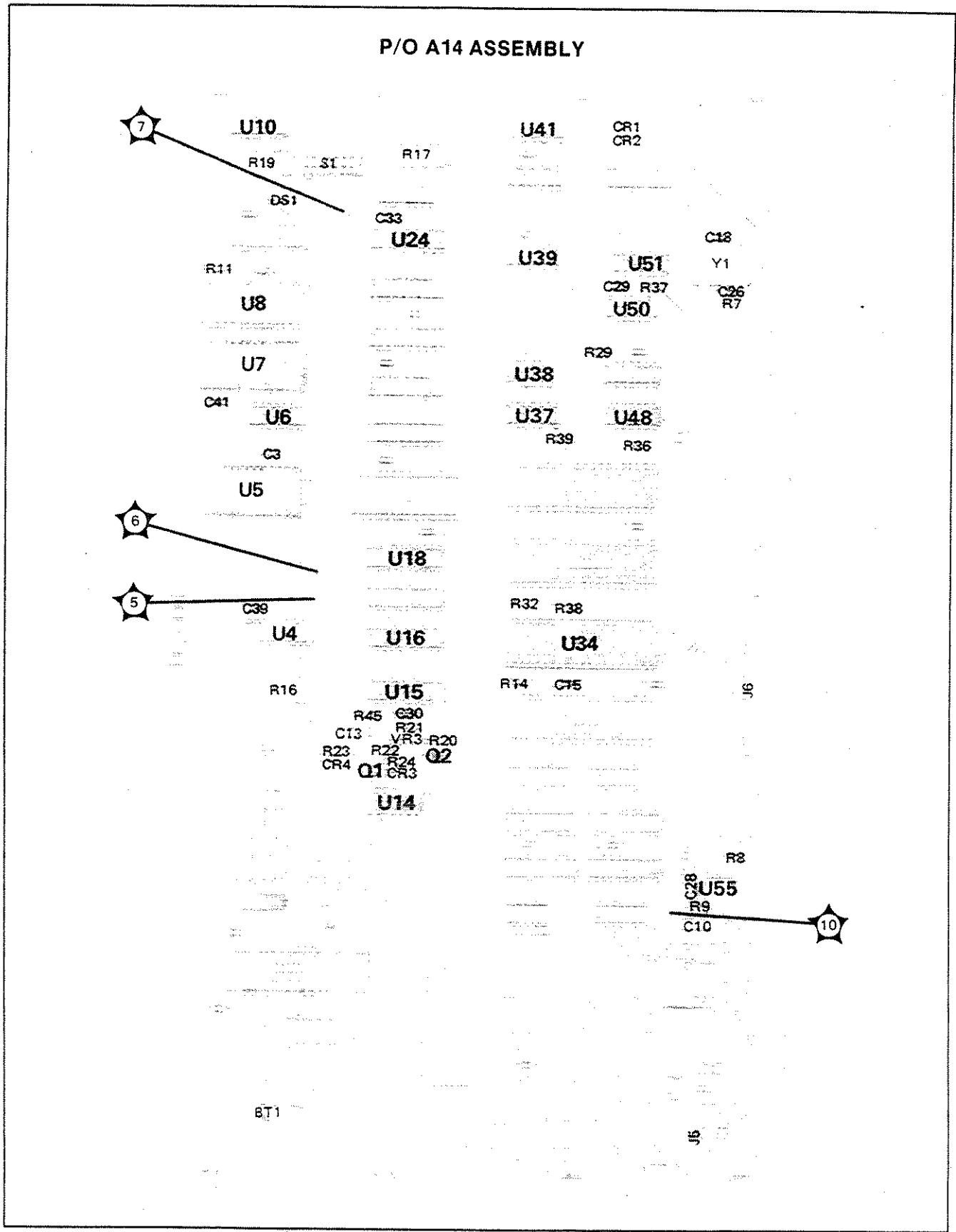


Figure 8-65. P/O A14 Controller Assembly Component Locations (Microprocessor)

(2645A and Above)

The schematic on page 8-151, along with these changes, documents instruments prefixed 2645A and above.

Part Number Table (right side of schematic):

U5

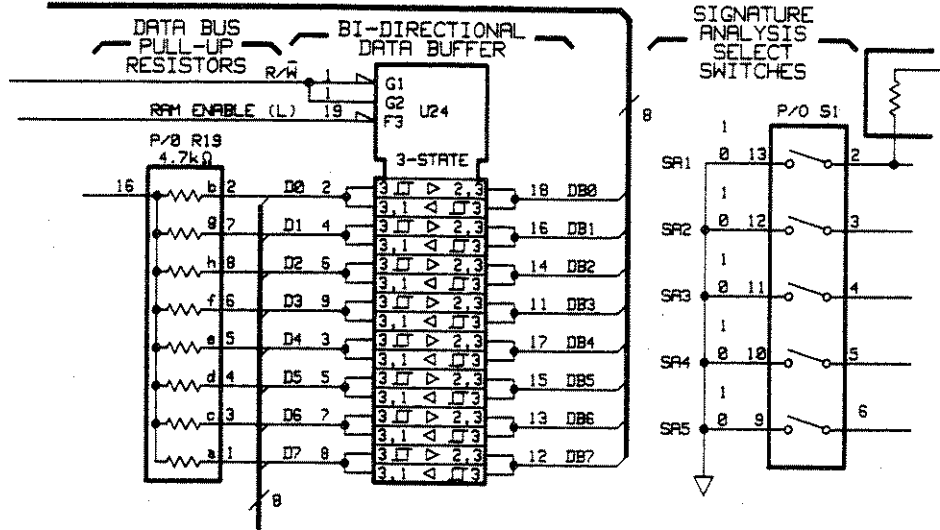
(2645A and above) 08970-80050 (recommended replacement for 08970-80026 and 08970-80040)

U7

(2645A and above) 08970-80051 (recommended replacement for 08970-80027 and 08970-80041)

(2645A and Above)

The schematic on page 8-151, along with these changes, documents instruments prefixed 2645A and above.









- NOTES
- SEE TABLE AT END OF MANUAL FOR SCHEMATIC DIAGRAM NOTES.
  - U41 PINS 12 AND 13 ARE CONNECTED TO +5V. U41 PIN 11 HAS BEEN LEFT UNCONNECTED.
  - U37 PINS 3, 11 AND 13 ARE CONNECTED TO +5V. U37 PINS 4, 10 AND 12 HAVE BEEN LEFT UNCONNECTED.
  - U14 PINS 9 AND 10 ARE CONNECTED TO +5V. U14 PIN 8 HAS BEEN LEFT UNCONNECTED.
  - THE POWER SUPPLY BYPASS CAPACITOR FOR U39 IS ON PIN 14.
- + BACKDATING INFORMATION FOUND IN SECTION VII.

REFERENCE DESIGNATIONS

A13	A14
W5	R5, 7, 11, 14, 15, 17, 19-24, 32, 36-39, 45
A14	S1
BT1	U4-8, 10, 14-16
U3	18, 24, 34
U6	18, 26, 28-30
CR1-4	37-39, 41, 48, 50, 51, 55
U6	VR3
O1, 2	Y1

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBER
O1	1853-0393
O2	1854-0810
U4	08970-80028
U5	08970-90040
U6	1820-2775
U7	08970-80041
U8	1818-3760
U10, 29	1820-1568
U14, 38, 41	1820-1208
U15, 16, 18	1820-2024
U24	1820-2075
U37, 50	1820-2634
U46	1820-2635
U51	1820-1443
U55	1825-1338
U34	1820-2824
Y1	1813-0130

LOGIC LEVELS

TTL	VOLTAJE
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATION	PIN NUMBER	CONNECTIONS
U4	+5V(F1)-24	-12
U5, 7, 8	+5V(F1)-29	-14
U6, 10, 14, 37-39, 41, 48, 50, 51	+5V(F1)-14	-7
U15, 16, 18, 24	+5V(F1)-20	-10
U34	+5V(F1)-7	-1
U55	+5V(F1)-8	-4
Y1	+5V(F1)-14	-7
		NC -1

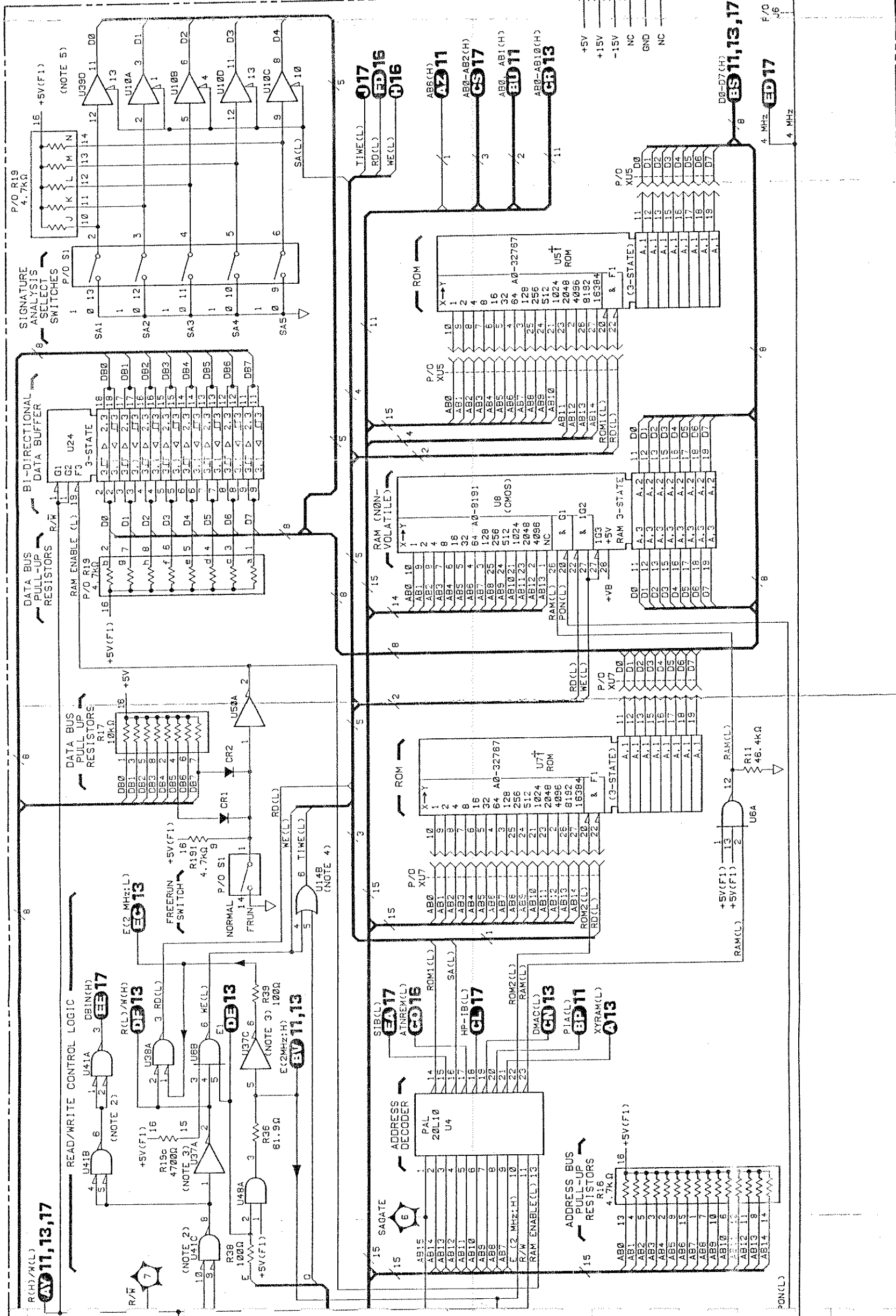


Figure 8-67. Controller — Microprocessor Schematic Diagram





**SERVICE SHEET 14 (cont'd)**

**NOTE**

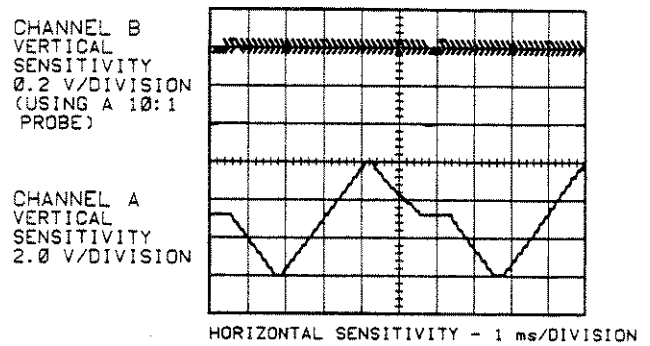
To avoid unstable signatures, the signature analyzer's probe tip must be connected through a resistor to +5 Vdc. Use a resistor between 4.7kΩ and 10kΩ.

**Table 8-54. Data Latch Signatures**

Start: A14U20 Pin 14 /		
Stop: A14U20 Pin 14 \		
Clock: A14U20 Pin 1 /		
Test Signatures: +5V 865C		
GND 0000		
A13 Test Node	Signal Name	Signature
U11 Pin 1	DSPLY DISABLE	7HF9
U10 Pin 1		0000*
Pin 3		H873
Pin 4		68AP
Pin 7		0403
Pin 8		5P40
Pin 11	HOLD/SAMPLE	7HFP**
Pin 13		3U43
Pin 14		0C0C
Pin 17		24P7
Pin 18		UU2F
* The probe LED blinks (once every 3 seconds) at the same rate as the A14DS1 LEDs.		
** Adjust the DISPLAY LINEARITY (A13R29) until the correct signature is obtained. If a signature can't be obtained, the signature is bad.		

**Table 8-55. Y-Axis DAC Signatures**

Start: A14U20 Pin 14 /		
Stop: A14U20 Pin 14 \		
Clock: A14U20 Pin 1 /		
Test Signatures: +5V 865C		
GND 0000		
A13 Test Node	Signal Name	Signature
U9 Pin 5	X128	UU2F
Pin 6	X64	6191
Pin 7	X32	4P7H
Pin 8	X16	7A35
Pin 9	X8	1C36
Pin 10	X4	4175
Pin 11	X2	2HH8
Pin 12	X1	9H05



**Figure 8-71. Y-AXIS (bottom) and Trigger (top) Waveforms**

**3 Y-Axis Drive and Point-to-Point Timing Waveforms**

**Procedure**

- With the SA test switch (A14S1) set as in step 1a of Check 2, connect channel A of the oscilloscope to the Y-AXIS connector on the rear panel and connect channel B to A14U20 pin 14 using a 10:1 probe. Set the oscilloscope as follows:  
 Channel A Input.....2 V/div (DC-coupled)  
 Channel B Input.....0.2 V/div (DC-coupled)  
 Time/Division.....1 ms/div  
 Horizontal Display ...Main; MAG X10  
 Vertical Display.....Alternate  
 Main Trigger .....Internal  
 Internal Trigger.....Channel A
- Turn on the Noise Figure Meter. Adjust the oscilloscope horizontal and vertical positions and verify that the Y-Axis drive signal is as shown in Figure 8-71.

**Completion of Testing**

Upon completion of testing, disconnect the timing pod and all other test gear, return the A14S1 SA test switch to its normal operating settings as shown below, and restore the Noise Figure Meter to the normal operating conditions. If repairs have been made or adjustments changed, refer to the applicable sections for post-testing procedures.

**SA Test Switch (A14S1)  
Setting for Normal Operation**

Switch	Switch Setting
Normal/Frun	Normal
SA1	1
SA2	1
SA3	1
SA4	1
SA5	1

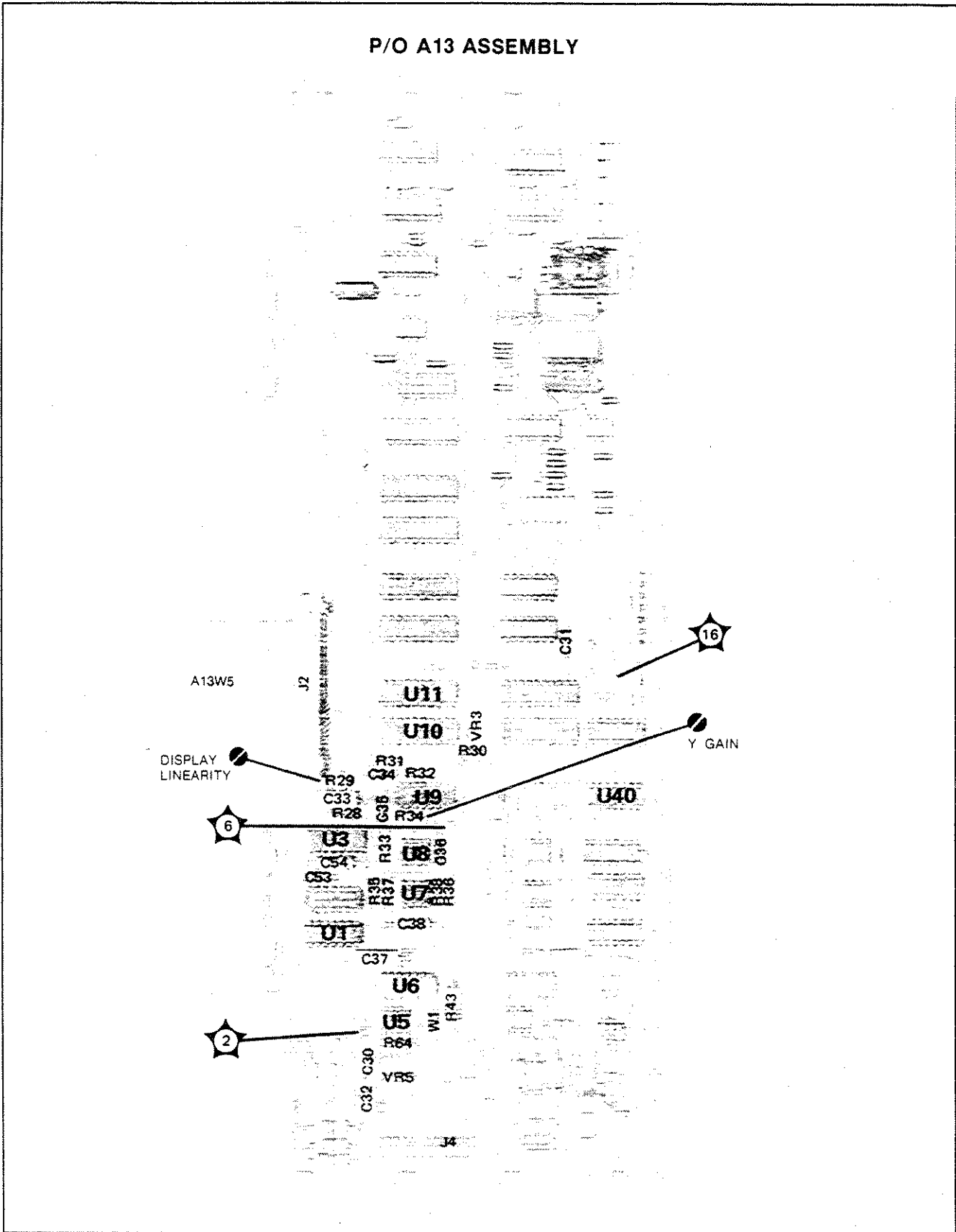
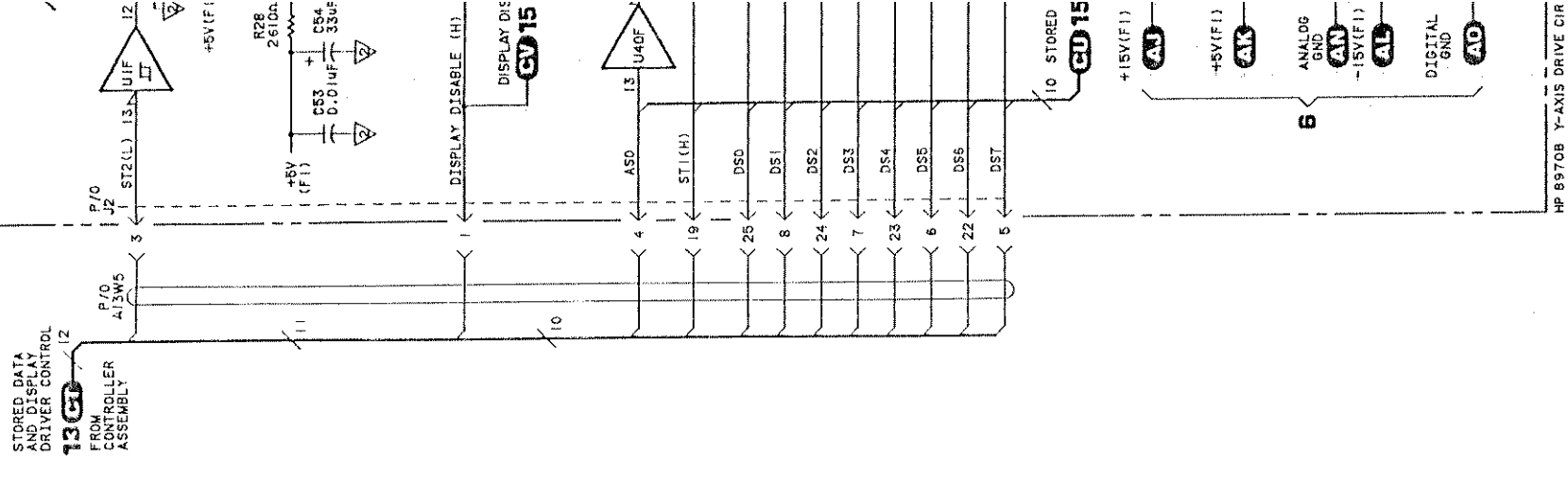


Figure 8-72. P/O A13 Driver Assembly Component Locations (Y-Axis Drive)



STORED DATA AND DISPLAY DRIVER CONTROL

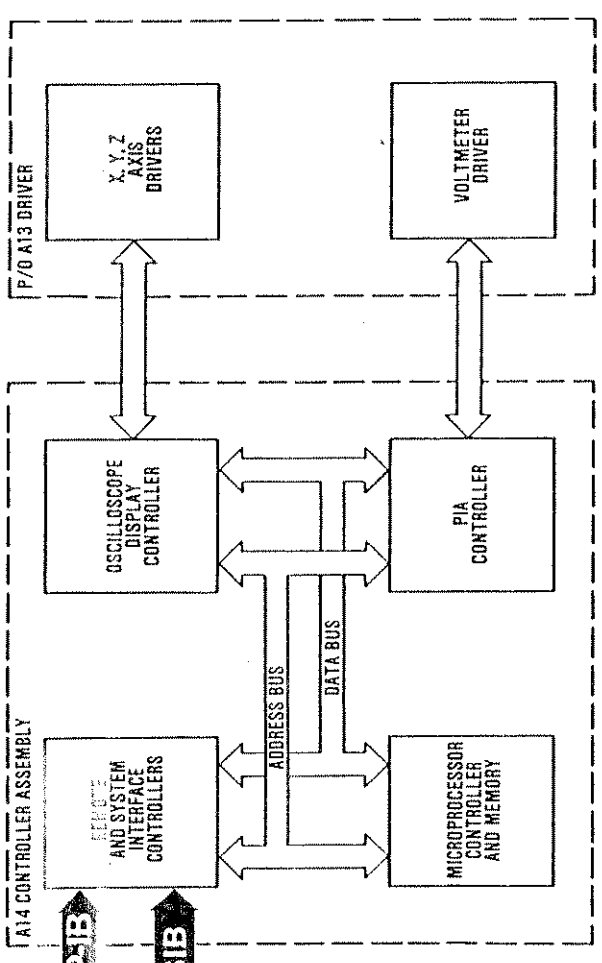
13 FROM CONTROLLER ASSEMBLY

5V(F1)

ANALOG GND

DIGITAL GND

HP 8970B Y-AXIS DRIVE CIR



DIGITAL SECTION BLOCK DIAGRAMS BD4 AND BD5

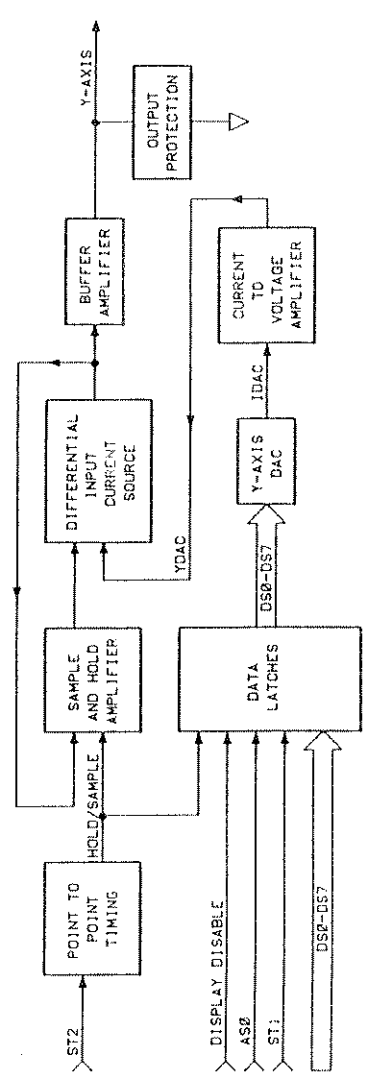
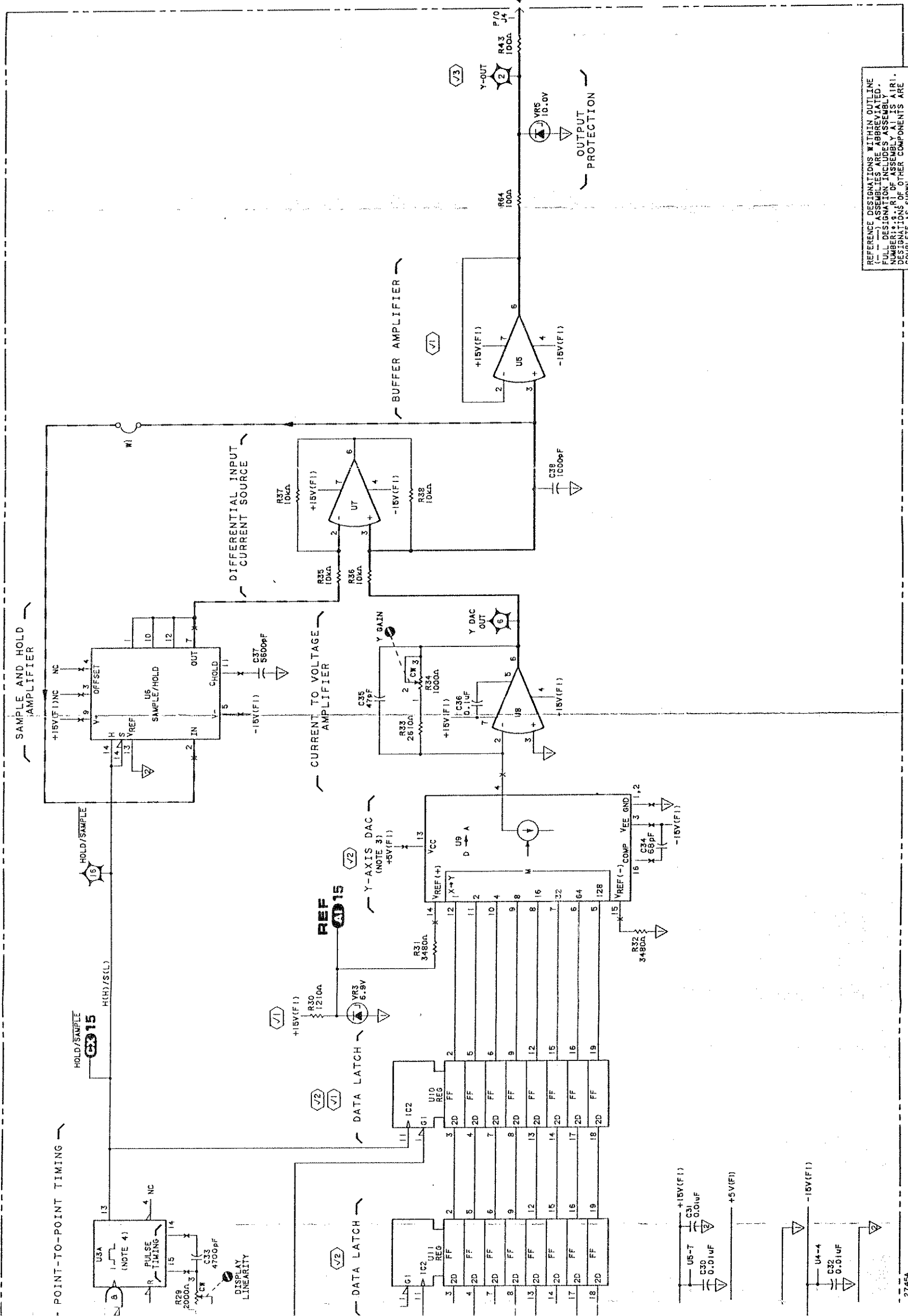


Figure 8-73. Driver — Y-Axis Drive Block Diagram





- NOTES
- SEE THE SECTION AT THE END OF THE MANUAL FOR SCHEMATIC DIAGRAM NOTES.
  - ▽ DENOTES ANALOG GROUND.
  - ▽ DENOTES DIGITAL GROUND.
  - THIS IS A CONSTANT CURRENT SINK IN THE CONTEXT OF CONVENTIONAL CURRENT.
  - A13U3A PULSE TIMING IS ADJUSTABLE FROM  $\sim 9\mu s$  TO  $\sim 15\mu s$  REFER TO SECTION V.

REFERENCE DESIGNATIONS

NO PREFIX	A13
P4	C70-38,53,54
U4	CR7
U5	J2,4
U6	R28-38,43,64
U7	TP2,5,16
U8	U1,3,5-11,40
U9	VR3,5
U10	W4

NOT ASSIGNED: A13C55, R39-42, U4, VR4

LOGIC LEVEL

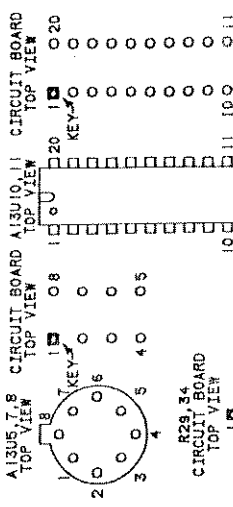
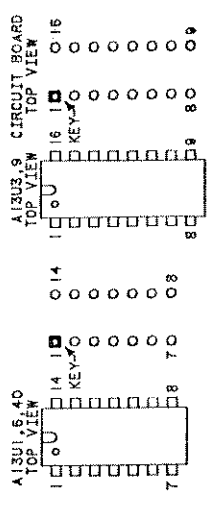
LOGIC LEVEL	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBERS
U1	1820-141B
U3	1820-1437
U5	1826-0488
U6	1826-0727
U9	1826-0188
U10,11	1820-1858
U40	1820-1199

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATIONS	PIN NUMBERS
U1,40	+5V(F1)-7
U3	+5V(F1)-8
U10,11	+5V(F1)-20



REFERENCE DESIGNATIONS WITHIN OUTLINE (---) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER, PART OF ASSEMBLY, A13 IS OCCASIONALLY USED FOR OTHER COMPONENTS ARE COMPLETE AS SHOWN.

Figure 8-74. Driver — Y-Axis Drive Schematic Diagram



## SERVICE SHEET 15 (cont'd)

blanking pulse. Once A13U37B receives a low, it will output a high to inverter A13U40D. The output of A13U40D will go low to differential amplifier A13U36.

A13U36 is a differential amplifier with an open collector output. This means that the amplifier output of A13U36 is NOT seen at output pin 7. Instead, pin 7 is the collector of a transistor which is turned on and off by the amplifier in A13U36. If the inverting input is higher than the noninverting input, the transistor will be turned off. If the noninverting input is the higher, the transistor will be turned on.

The low input from A13U40D turns off the transistor by making the inverting input lower than the noninverting input. With the transistor off, the +5 Vdc will be output from A13R59 as the PEN LIFT signal on the Z-AXIS PEN LIFT output line. This +5 Vdc will lift the pen, or fully blank the trace. Pin 1 of differential amplifier A13U36 is the emitter of the output transistor, and is taken to ground through Intensity Switch A13Q1.

### Intensity Switch

Transistor A13Q1 is normally on, and this grounds the emitter of the transistor in differential amplifier A13U36. Therefore, the output of the Pen Lift Driver is either ground (no lift or full trace intensity) or Vcc (blank or lift). If A13Q1 is turned off, the ground is then made through GAIN TRACE potentiometer A9R1.

This added resistance will form a voltage divider with A13R59 to cause the output at the Z-AXIS to be either Vcc (blanked) or partial Vcc (dim trace). This partial mode is NOT used with the plotter or recorder operations. It is only used with an oscilloscope to cause the brightness to change.

### Channel Counter

The Noise Figure Meter is capable of handling two channels of output. However, both channels are output through the same three axes connectors. In order to tell which channel is which on an oscilloscope display, the Noise Figure Meter reduces the brightness of the gain trace.

Flip/flop A13U39A is hardwired to either toggle with each clock input, or to be preset by a low input on pin 4. The DISPLAY DISABLE line going high to A13U40B is inverted and input to inverter

A13U19A. The low into A13U19A causes a high output, which is placed across RC network A13R63 and A13C56.

Again, the RC network is used to stretch the time the DISPLAY DISABLE is on the input to A13U19B. The low output of A13U19B will hold A13U39A in a set state with the output on pin 5 at a high. The high output of A13U39A will have no effect on A13U2D until the SCOPE line is also brought high.

If the SCOPE line is high, this indicates that the external device is indeed an oscilloscope, and that partial blanking is required. The DISPLAY DISABLE line will go low to turn on the display. This releases A13U39A to allow it to toggle. Each time the Retrace Detector is filled with ones, it outputs a low to toggle A13U39A.

This toggle will occur at the end of each channel having completed a full data transfer. Therefore, the output of A13U39A will alternate levels with each channel completion. Since the Oscilloscope Display Controller starts over with each data update, the same channel is partially blanked each time.

### Summary

During retrace, the pen lift driver is turned off. This outputs Vcc to totally blank the oscilloscope. During trace, the driver is turned on. When on, the driver outputs either ground for full trace intensity, or partial Vcc for partial intensity. The trace is always partially blanked on the second data transfer.

If two channels are in use, the second channel is dimmer. If only one channel is in use, the same channel is traced twice, with the second pass dimmer. However, since the second pass is written directly on top of the first pass, no difference can be detected by the operator.

### TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 15 when a malfunction has occurred in either the X-Axis Drive or the Z-Axis Drive of Driver Assembly A13. It is assumed the troubleshooting information on Service Sheet BD5 was used to isolate a malfunction to this service sheet. If all the tests in the following procedures indicate correct responses, the trouble is located elsewhere in the instrument, and not in the X-Axis Drive or

**SERVICE SHEET 15 (cont'd)**

Z-Axis Drive circuits. Except where shown, the values listed are approximate and are given as a service guideline.

**Test Equipment**

- Signature Multimeter ..... HP 5005B
- Digital Voltmeter ..... HP 3456A
- Oscilloscope ..... Tektronix 2235
- Noise Source ..... HP 346B

**✓1 General Checks**

1. Turn the Noise Figure Meter on and verify that the voltage from A13U28 pin 20 to ground is +4.7 to +5.3 Vdc.
2. On A13U23, verify that the voltage from pin 7 to ground is +15 ±1Vdc, and the voltage from pin 4 to ground is -15 ±1 Vdc.
3. On A13U27, verify that the voltage from the cathode of A13VR3 (see Service Sheet 14) to ground is +6.9 Vdc. If the voltage is incorrect, continue troubleshooting on Service Sheet 14.

**✓2 X-Axis and Z-Axis Drive Signature Analysis Test**

**Procedure**

1. Check the X-Axis and Z-Axis signatures. In the set-ups below, “/” represents a rising edge and “\” represents a falling edge, as set on the signature analyzer.
  - a. With the Noise Figure Meter off, on the A14 Assembly, set the SA test switch (A14S1) to the following positions:

**SA Test Switch (A14S1) Setting**

Switch	Switch Setting
Normal/Frun	Normal
SA1	0
SA2	0
SA3	0
SA4	1
SA5	0

2. Connect the signature multimeter as shown at the top of Tables 8-56 through 8-58. Turn the Noise Figure Meter on and verify the signatures in Tables 8-56 through 8-58. Trace

any incorrect signature to a defective component, if possible. If unable to trace the incorrect signature to a defective component, replace the A13 Driver Board Assembly.

**NOTE**

To avoid unstable signatures, the signature analyzer's probe tip must be connected through a resistor to +5 Vdc. Use a resistor between 4.7kΩ and 10kΩ.

**Table 8-56. Data Latch Signatures**

Start:	A14U20	Pin 14	/
Stop:	A14U20	Pin 14	\
Clock:	A14U20	Pin 1	/
Test Signatures:	+5V	865C	
	GND	0000	
A13 Test Node	Signal Name	Signature	
U28 Pin 1	DSPLY DISABLE	0000*	
Pin 3		781P	
Pin 4		383U	
Pin 7		9CUU	
Pin 8		PP11	
Pin 11		7HF9**	
Pin 13		84U9	
Pin 14		4HCC	
Pin 17	HOLD/SAMPLE	U477	
Pin 18		U486	
* The probe LED blinks (once every 3 seconds) at the same rate as the A14DS1 LEDs.			
** Adjust the DISPLAY LINEARITY (A13R29) until the correct signature is obtained. If a signature can't be obtained, the signature is bad.			

**✓3 X-Axis and Z-Axis Drive Waveforms**

**Procedure**

1. Set the SA test switch (A14S1) as in step 1a of Check 2. On the rear panel of the Noise Figure Meter, connect channel A of the oscilloscope to the X-AXIS connector and channel B to the Z-AXIS connector. Set the oscilloscope as follows:
  - Channel A Input.....2 V/div (DC-coupled)
  - Channel B Input.....2 V/div (DC-coupled)
  - Time/Division.....1 ms/div
  - Horizontal Display ...Main; MAG X10
  - Vertical Display.....Alternate
  - Main Trigger .....Internal
  - Internal Trigger.....Channel A



**SERVICE SHEET 15 (cont'd)**

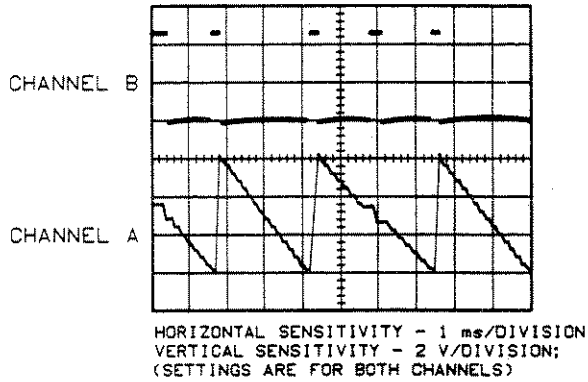
**Table 8-57. X-Axis DAC Signatures**

Start: A14U20 Pin 14 /		
Stop: A14U20 Pin 14 \		
Clock: A14U20 Pin 1 /		
Test Signatures: +5V 865C		
GND 0000		
A13 Test Node	Signal Name	Signature
U27 Pin 5	X128	3U6H
Pin 6	X64	7A3C
Pin 7	X32	26HH
Pin 8	X16	427F
Pin 9	X8	327P
Pin 10	X4	0889
Pin 11	X2	1F1U
Pin 12	X1	U979

**Table 8-58. Channel Counter and Retrace Blanking Signatures**

Start: A14U20 Pin 14 /		
Stop: A14U20 Pin 14 \		
Clock: A14U20 Pin 1 /		
Test Signatures: +5V 865C		
GND 0000		
A13 Test Node	Signal Name	Signature
U37 Pin 10		56AA
Pin 12		9F32
U38 Pin 8		H0U1
Pin 11		H0U1
Pin 12		56AA
Pin 13		56AA
U39 Pin 5		1905
U41 Pin 8		CPH2

- Turn on the Noise Figure Meter. Adjust the oscilloscope horizontal and vertical positions and verify that the X-Axis and Z-Axis drive signals are as shown in Figure 8-75.



**Figure 8-75. X-AXIS (Bottom) and Z-AXIS (Top) Drive Signals**

**Completion of Testing**

Upon completion of testing, disconnect the timing pod and all other test gear, return the A14S1 SA test switch to its normal operating settings as shown below, and restore the Noise Figure Meter to the normal operating conditions. If repairs have been made or adjustments changed, refer to the applicable sections for post-testing procedures.

**SA Test Switch (A14S1) Setting for Normal Operation**

Switch	Switch Setting
Normal/Frun	Normal
SA1	1
SA2	1
SA3	1
SA4	1
SA5	1

P/O A13 ASSEMBLY

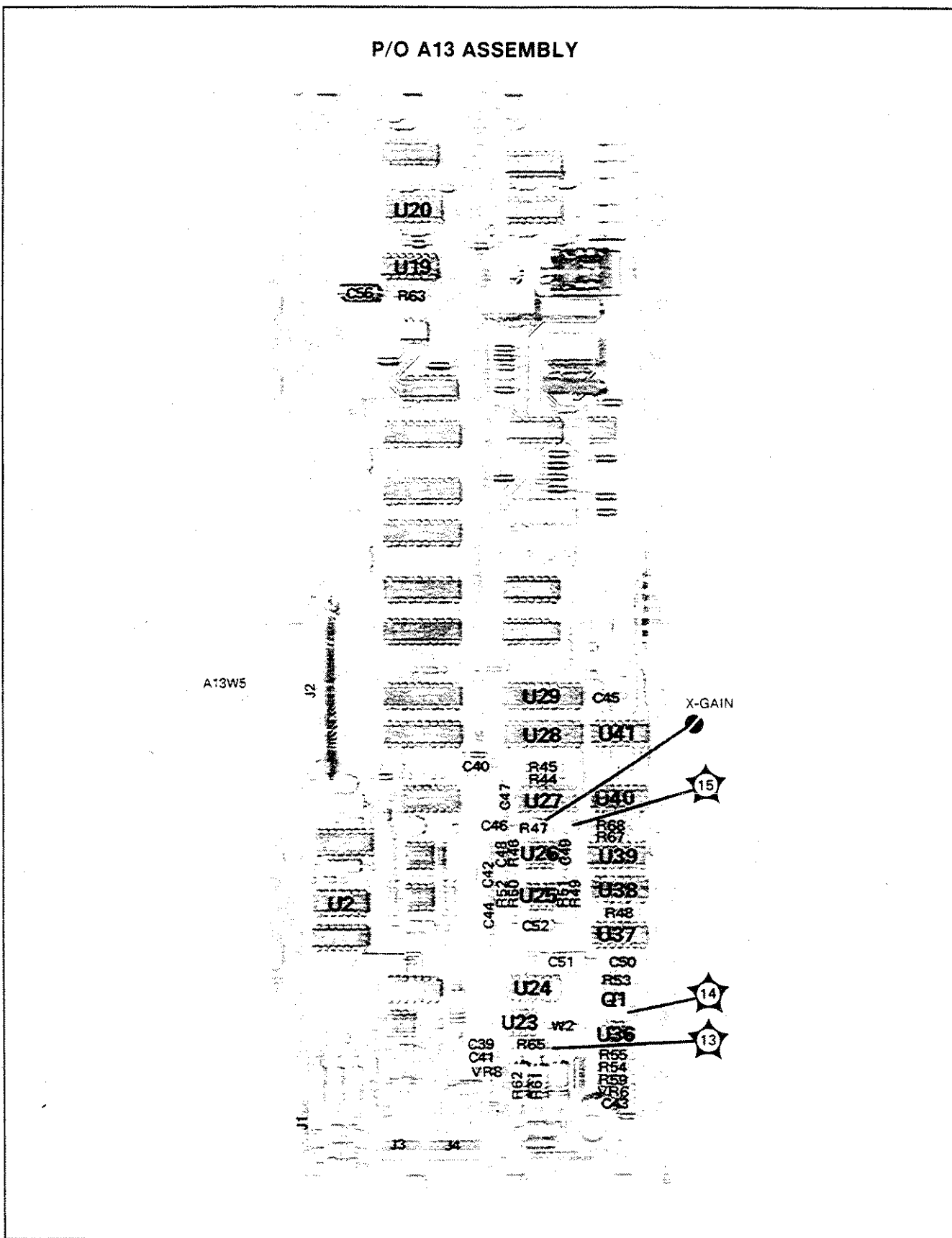
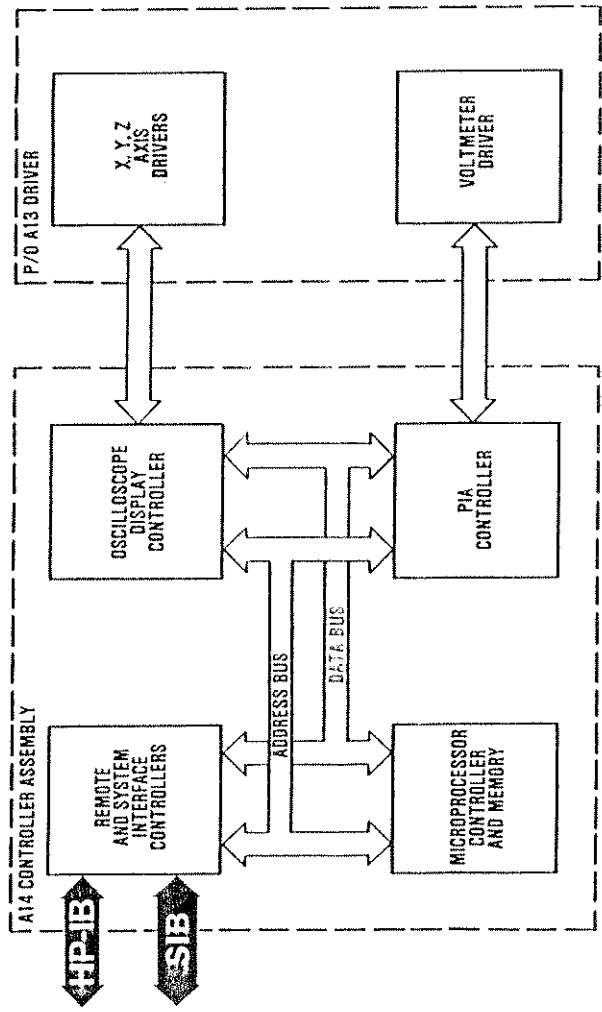


Figure 8-76. P/O A13 Driver Assembly Component Locations (X-Axis and Z-Axis Drive)



DIGITAL SECTION BLOCK DIAGRAMS BD4 AND BD5

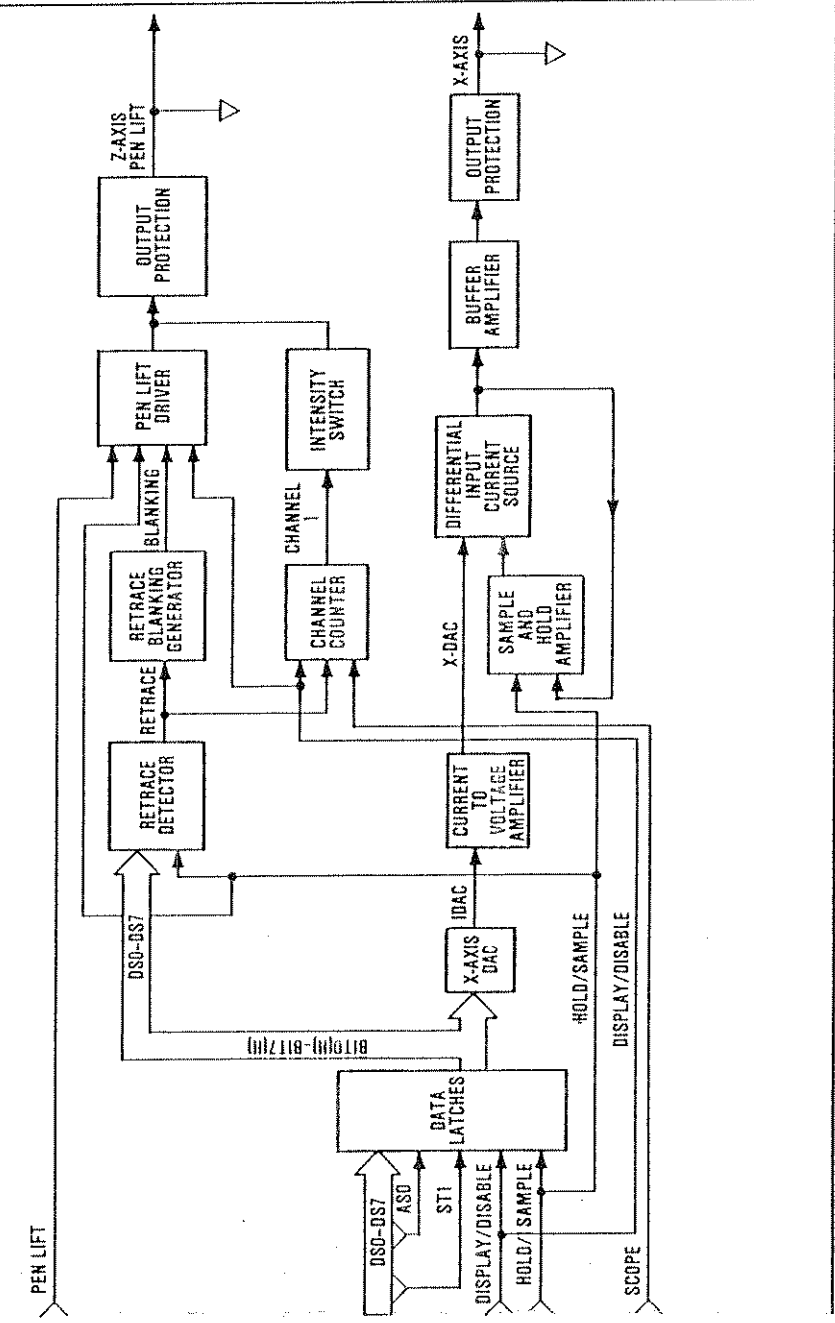
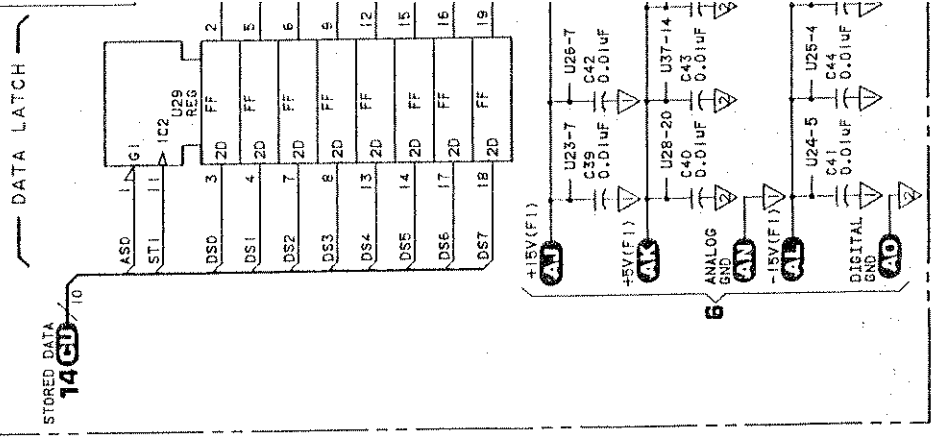
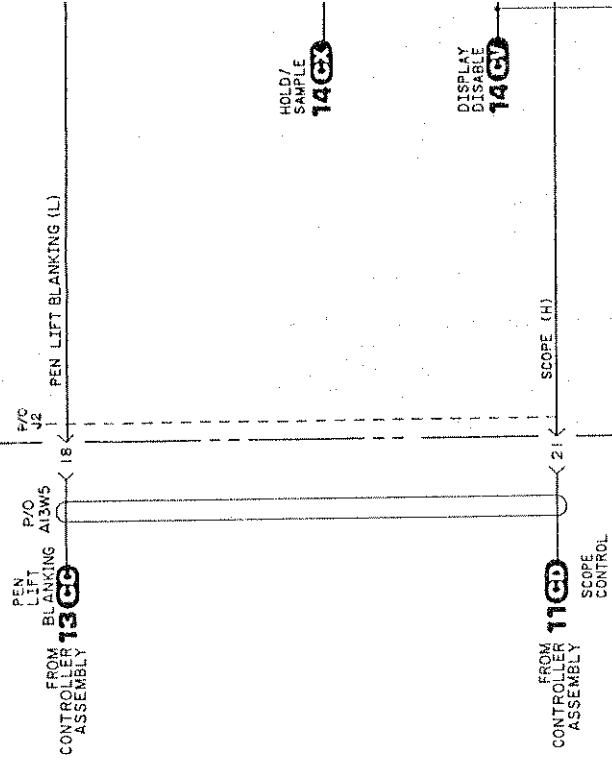
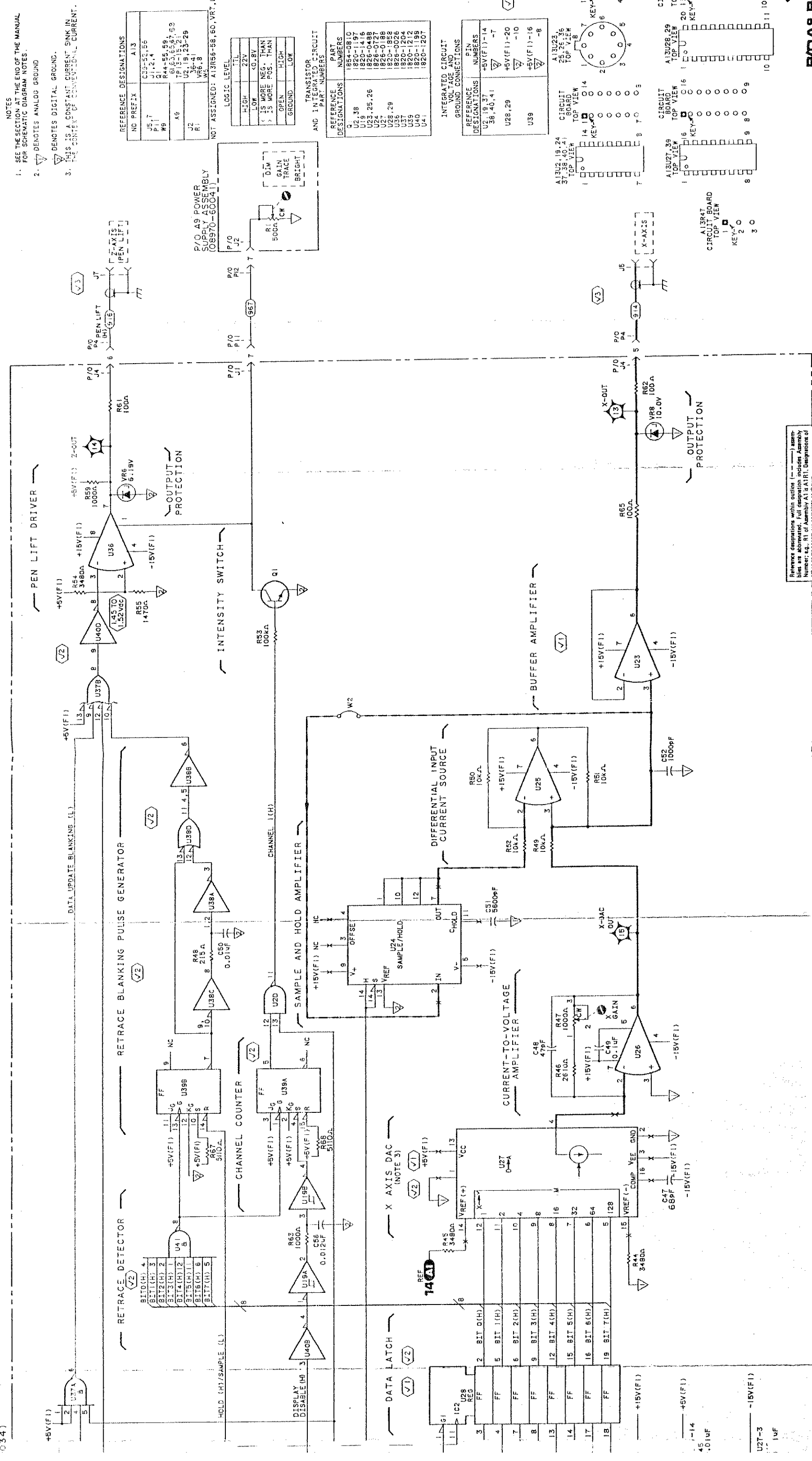


Figure 8-77. Driver - X-Axis and Z-Axis Drive Block Diagram







- NOTES
- SEE THE SECTION AT THE END OF THE MANUAL FOR SCHEMATIC DIAGRAM NOTES.
  - ▽ DENOTES ANALOG GROUND.
  - ▽ DENOTES DIGITAL GROUND.
  - THIS IS A CONSTANT CURRENT SINK IN THE CONTEXT OF CONVENTIONAL CURRENT.

REFERENCE DESIGNATIONS

NO PREFIX	A13
J5	C33-52,156
P11	J1,2,4
W9	R44,45,59
	R63,64,65,67,69
A9	T9,10,11,12,13
J2	U2,19,23-29
R1	36-41
	VR6-8

NOT ASSIGNED: A13R56-58,60,VR7,U22

LOGIC LEVEL

LOGIC LEVEL	VOLTS
HIGH	2.2V
LOW	<0.8V

< IS MORE NEG. THAN > IS MORE POS. THAN  
 OPEN HIGH  
 GROUND LOW

AND TRANSISTOR CIRCUIT AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBERS
Q1	1854-0810
U2,38	1820-1197
U19	1820-1448
U22,25,26	1820-1448
U27	1826-0727
U28,29	1826-0188
U36	1820-1852
U37	1826-0026
U39	1820-1204
U40	1820-1542
U41	1820-1207

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATIONS	VOLTAGE	PIN NUMBERS
U2,19,37	+5V(F1)-14	-7
38,40,41	+5V(F1)-20	-10
U28,29	+5V(F1)-16	-8
U39	+5V(F1)-16	-8

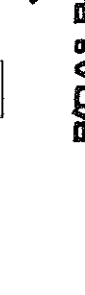
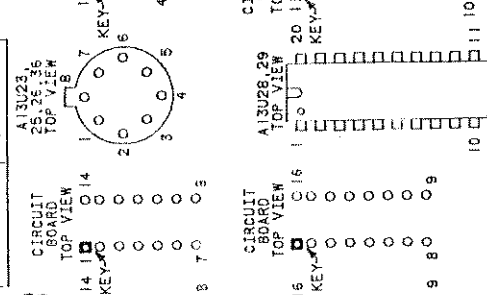


Figure 8-78. Driver — X-Axis and Z-Axis Drive Schematic Diagram



### P/O A14 ASSEMBLY

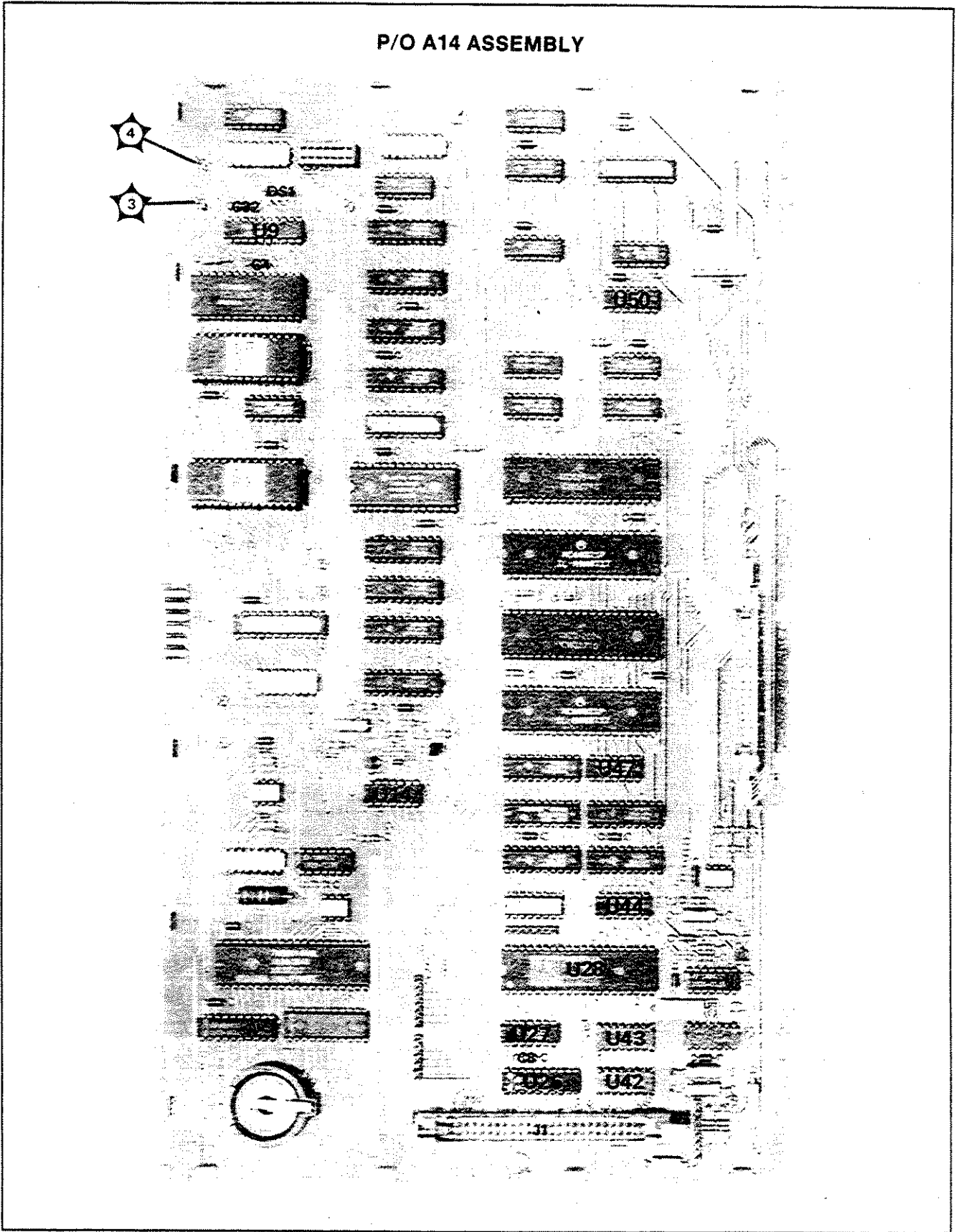
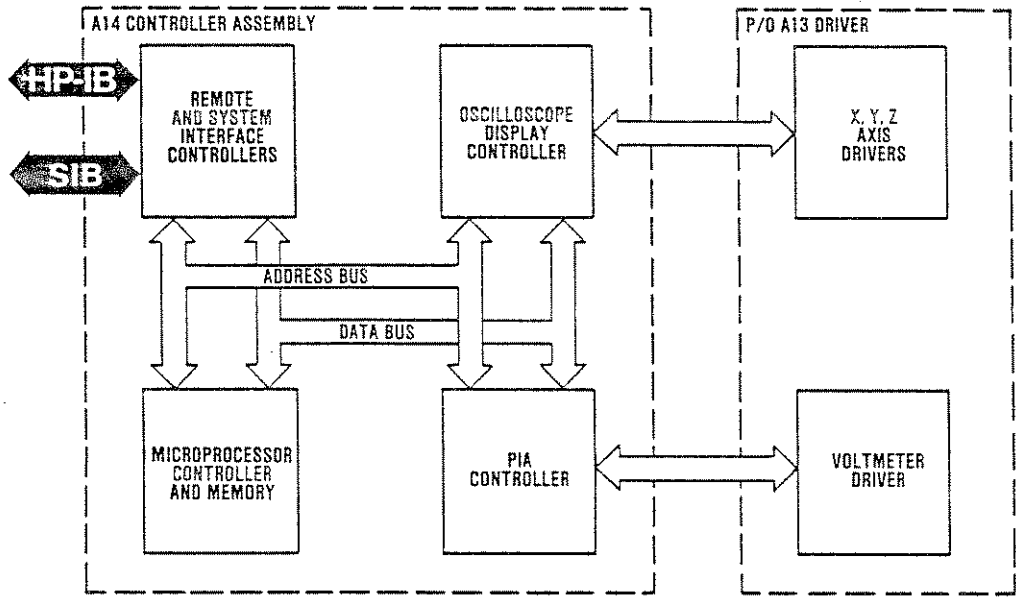


Figure 8-79. P/O A14 Controller Assembly Component Locations (Remote Interface; HP-IB)

8-171/8-172







DIGITAL SECTION BLOCK DIAGRAMS BD4 AND BD5

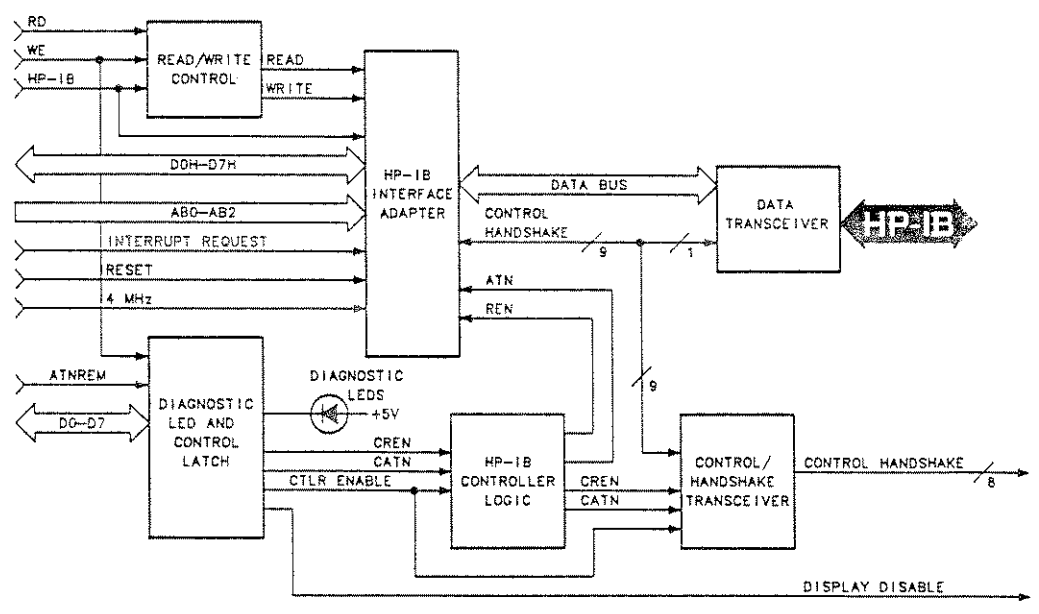


Figure 8-80. Controller — Remote Interface (HP-IB) Block Diagram

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1

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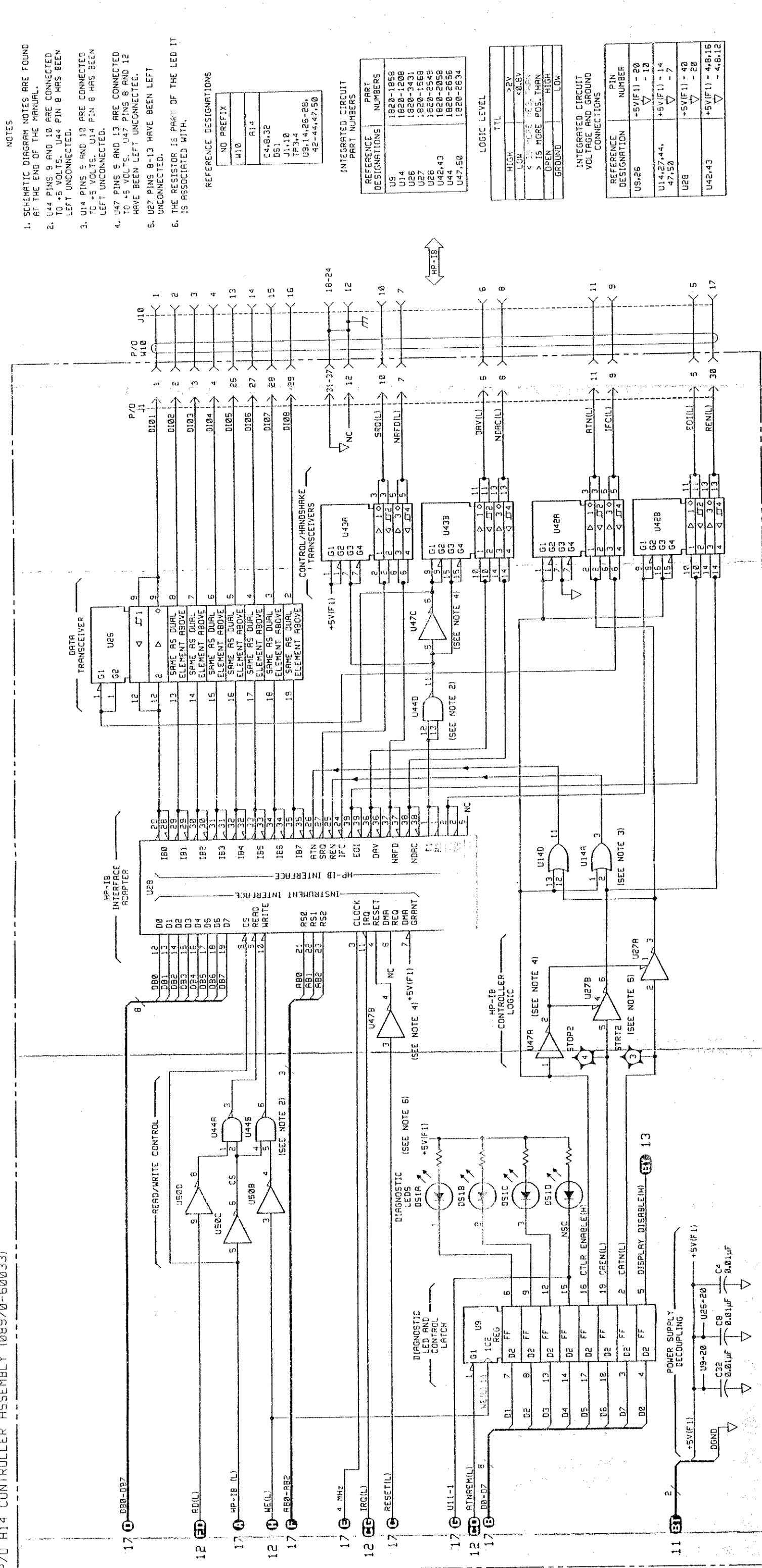
21

22

23

24

.....



NOTES

1. SCHEMATIC DIAGRAM NOTES ARE FOUND AT THE END OF THE MANUAL.
2. U44 PINS 9 AND 10 ARE CONNECTED TO +5 VOLTS. U44 PIN 8 HAS BEEN LEFT UNCONNECTED.
3. U14 PINS 9 AND 10 ARE CONNECTED TO +5 VOLTS. U14 PIN 8 HAS BEEN LEFT UNCONNECTED.
4. U47 PINS 9 AND 13 ARE CONNECTED TO +5 VOLTS. U47 PINS 8 AND 12 HAVE BEEN LEFT UNCONNECTED.
5. U27 PINS 8-13 HAVE BEEN LEFT UNCONNECTED.
6. THE RESISTOR IS PART OF THE LED IT IS ASSOCIATED WITH.

REFERENCE DESIGNATIONS

NO PREFIX	PART NUMBERS
W10	R14
C48-32	
DS1	
J1-10	
TP3,4	
U9,14,25-28,42-44,47,50	

INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATIONS	PART NUMBERS
U9	1820-1858
U14	1820-1908
U14	1820-1908
U26	1820-3431
U27	1820-1568
U28	1820-2545
U42-43	1820-2058
U44	1820-2656
U47-50	1820-2634

LOGIC LEVEL

TTL	LOGIC LEVEL
HIGH	>2V
LOW	<0.8V
< 15 MORE POS. THAN OPEN	HIGH
> 15 MORE NEG. THAN GROUND	LOW

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATION	PIN NUMBER	VOLTAGE
U9,26	+5V(F1) - 20	- 10
U14,27,44,47,50	+5V(F1) - 14	- 7
U28	+5V(F1) - 40	- 20
U42,43	+5V(F1) - 48,16	- 4,8,12

HP9970B CONTROLLER- REMOTE INTERFACE (HP-IB): 2745A

Figure 8-81. Controller — Remote Interface (HP-IB) Schematic Diagram



# P/O A14 ASSEMBLY

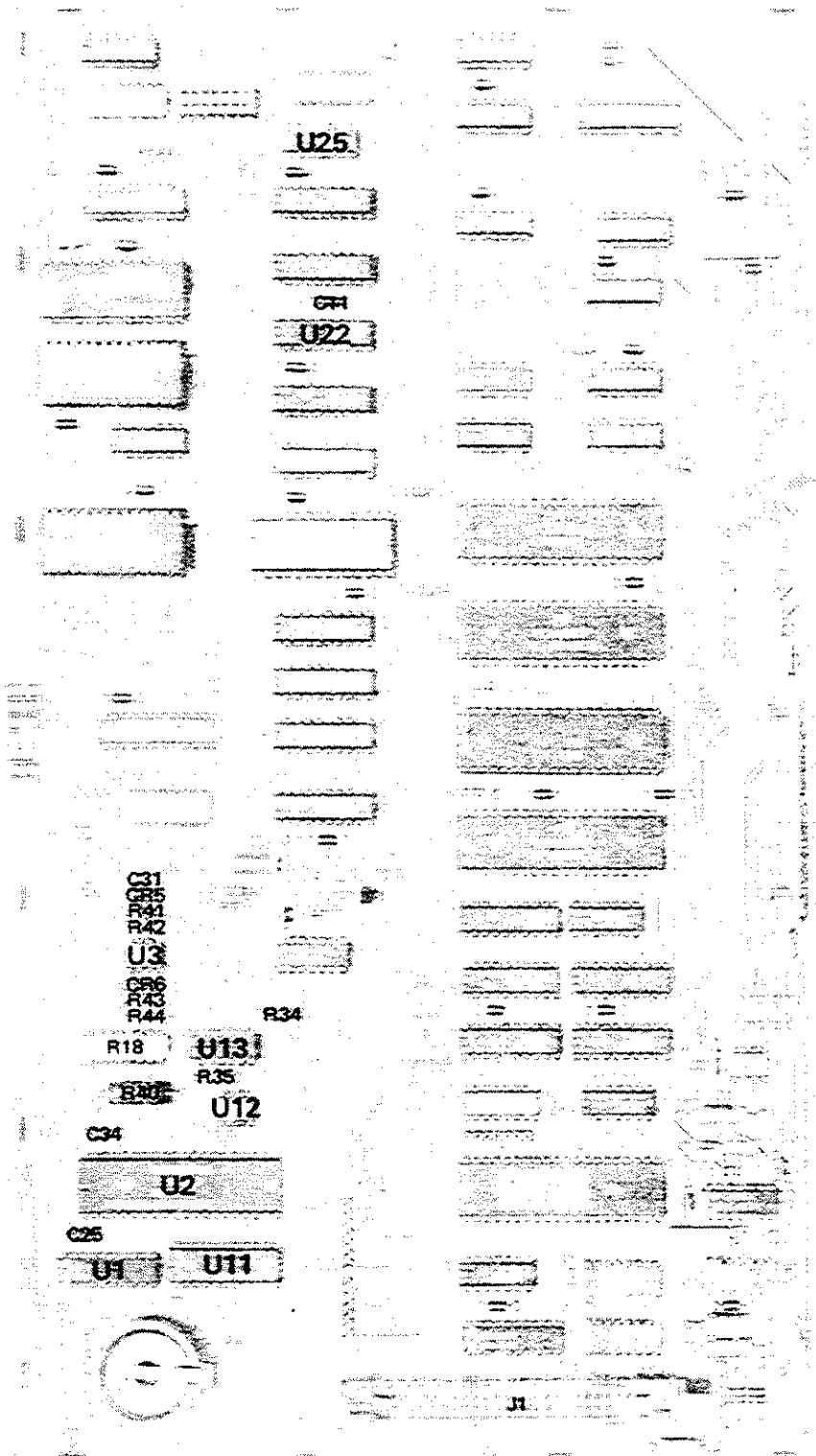


Figure 8-82. P/O A14 Controller Assembly Component Locations (Remote Interface: SIB)

8-175/8-176



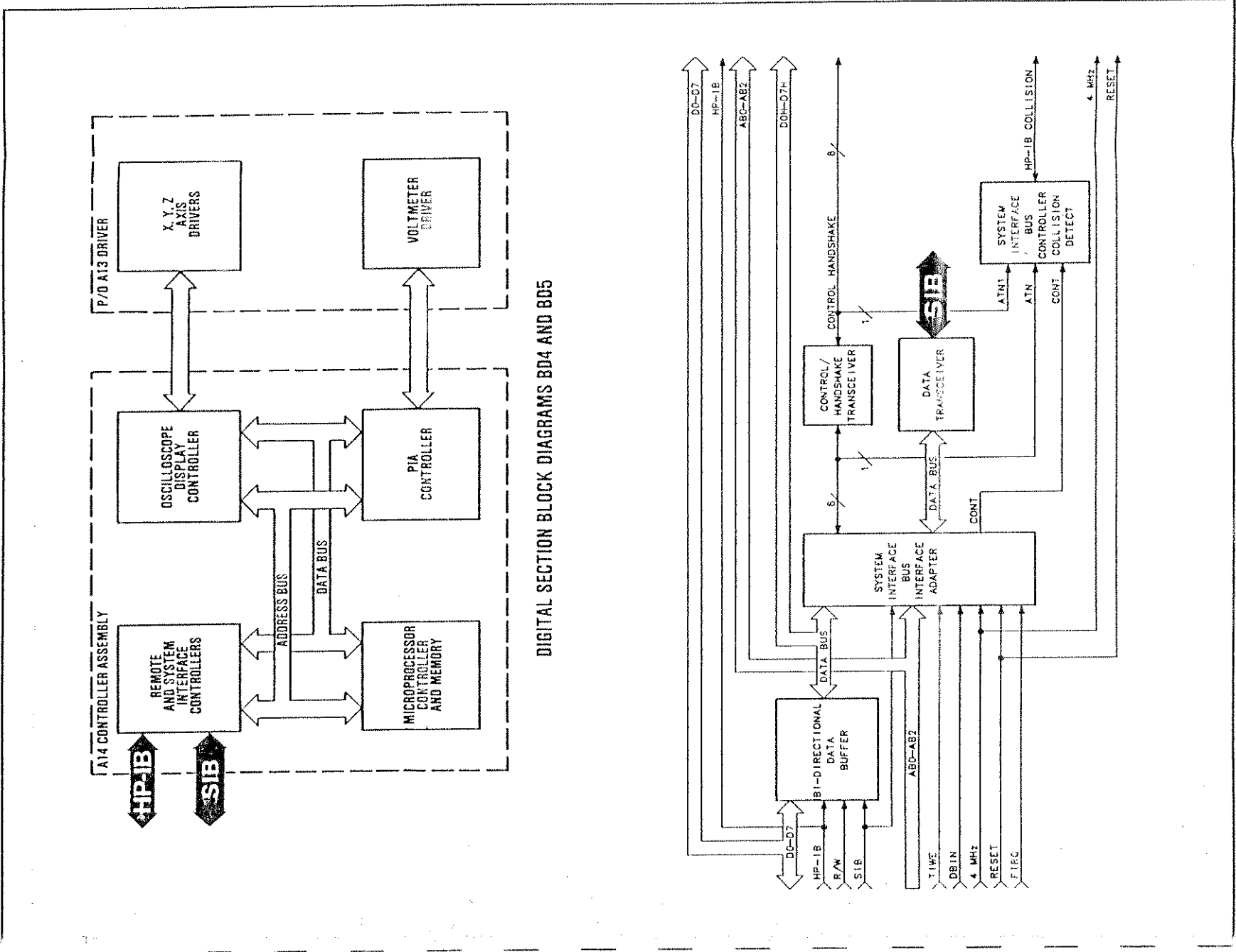
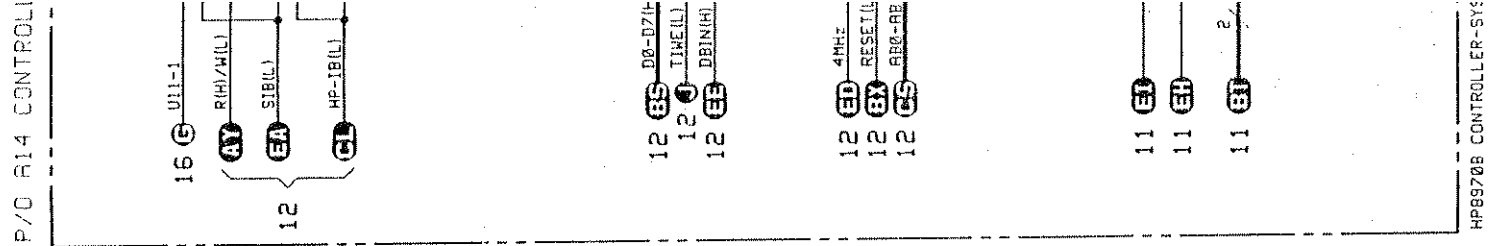


Figure 8-83. Controller — Remote Interface (SIB) Block Diagram



HP8970B CONTROLLER-SYS





NOTES

1. SCHEMATIC DIAGRAM NOTES ARE FOUND AT THE END OF THE MANUAL.
2. U12 IS CAPABLE OF HIGH OUTPUT POWER. U12 PINS 6 AND 7 ARE CONNECTED TO +5 VOLTS. U12 PIN 5 HAS BEEN LEFT UNCONNECTED.
3. U25 PINS 4, 5, 12 AND 13 ARE CONNECTED TO +5 VOLTS. U25 PINS 6 AND 11 HAVE BEEN LEFT UNCONNECTED.
4. U13 PINS 4, 5, AND 6-11 ARE GROUNDED. U13 PINS 2, 13 AND 14 HAVE BEEN LEFT UNCONNECTED.

REFERENCE DESIGNATIONS

NO PREFIX	NO PREFIX
J11	C11-25:31
	34
	CR5-6
	J1
	R18-34:35
	40-44
	U1-3,11-13
	22:25

INTEGRATED CIRCUIT PART NUMBERS

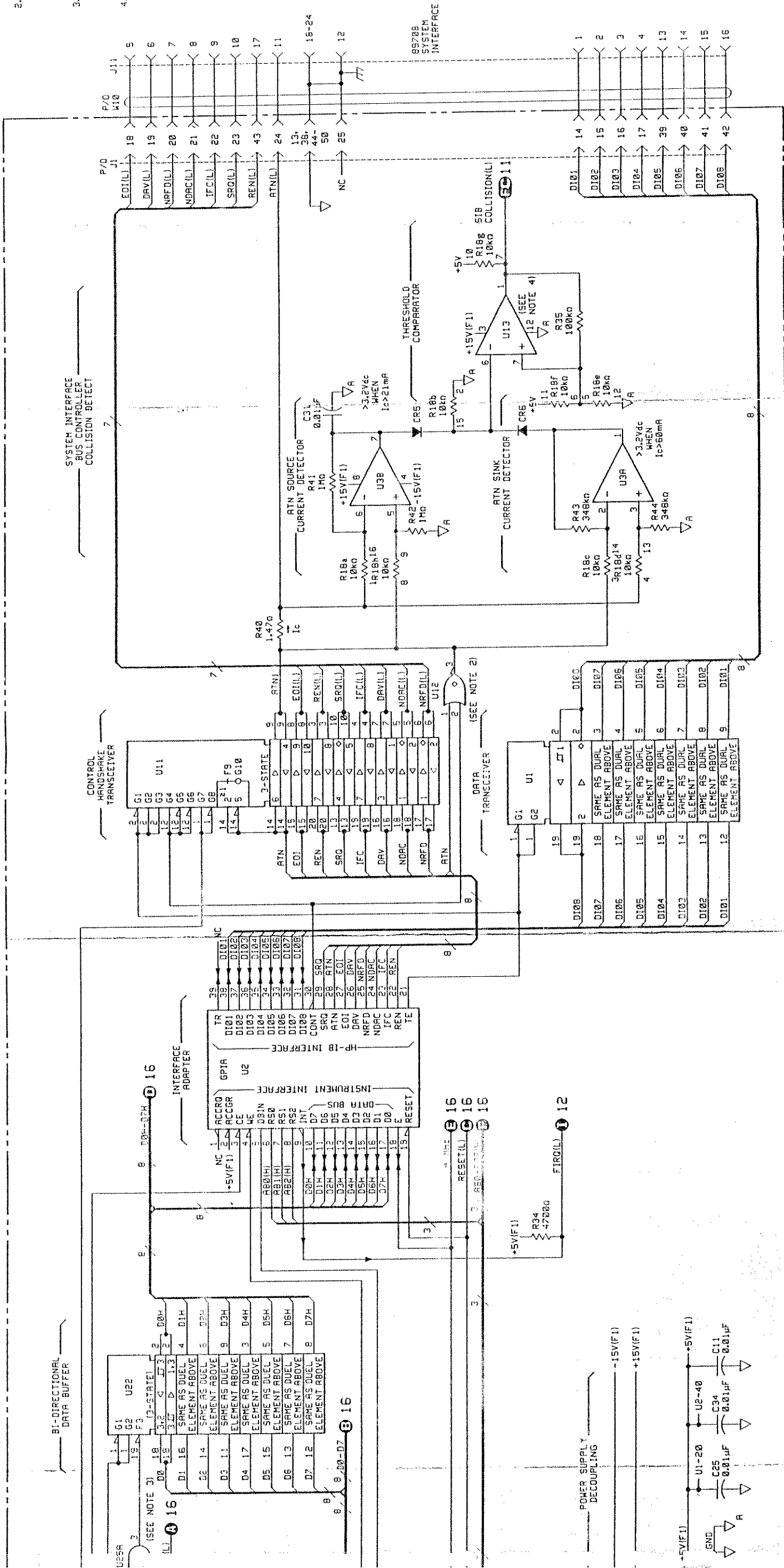
DESIGNATIONS	PART NUMBER
U1	1820-3431
U2	1820-2548
U3	1826-9547
U4	1826-9547
U5	1826-3518
U6	1826-1016
U11	1826-0138
U12	1820-2075
U25	1820-2535

LOGIC LEVEL

LOGIC LEVEL	INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTION
TTL	
HIGH	+5V
LOW	+0.8V
< 15 MORE NEG. THAN	
> 15 MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

REFERENCE DESIGNATION	PIN NUMBER
U1-22	+5V(F1) - 20
U2	+5V(F1) - 40
U11	+5V(F1) - 20
U12	+5V(F1) - 10
U25	+5V(F1) - 8
	+5V(F1) - 4
	+5V(F1) - 14
	+5V(F1) - 7

ASSEMBLY (02970-60033)





## SERVICE SHEET 18

### POWER SUPPLY AND NOISE SOURCE DRIVE

#### P/O A9 POWER SUPPLY ASSEMBLY

#### A12 NOISE SOURCE DRIVE ASSEMBLY

### REFERENCES

Block Diagram — Service Sheet BD2

Section III — Operator's Checks

Section VIII — Power-Up Checks

### PRINCIPLES OF OPERATION

#### General

The Power Supply and Noise Source Drive circuits provide all of the power required by the various circuits and circuit boards used throughout the Noise Figure Meter. The +5 Vdc is supplied to the logic circuits and is therefore regulated to within  $\pm 0.20$  Vdc. Both a +15 Vdc and a -15 Vdc is provided for the various analog devices, and are regulated to within  $\pm 1.0$  Vdc. The external Noise Source requires a pulsed +28 Vdc which is provided by the noise source drive circuit, and is regulated to within  $\pm 2.8$  Vdc.

All four power supplies share a common AC power source. The input Vac line power can be at 110V, 120V, 220V, or 240V. The selected power is routed through fuse F1; the main line fuse. The value of F1 is selected to match the input line voltage. Selection of the line voltage is made by Line Power Assembly A15, which contains a line filter and a pin-out card for the line power selection.

The selected line power is routed through LINE switch S1 to power transformer T1. Transformer T1 provides three sets of low voltage AC power, and a common ground. The +5 Vdc supply is supplied with 10.9 Vac, while the two 15V supplies share 20.3 Vac. The +28 Vdc supply is provided with an initial input of 39.9 Vac. This higher voltage is taken from the outside windings of the transformer and contains a high impedance. A short on the +28 Vdc line would not blow the main line fuse. Therefore, the +28 Vdc circuit contains its own fuse, A9F1. A filter network is connected to the outputs of the transformer for the +28V, +5V, +15V and -15V power supplies to reduce conducted emissions.

#### +5 Vdc Power

10.9 Vac is input to the +5V full wave rectifier (A9CR5A and A9CR5B). The output of the full wave rectifier is filtered by A9C9, and then regulated by A9U2 to within  $\pm 0.20$  Vdc. The voltage

is adjustable, and is set to +5 Vdc by A9R9. The regulated +5 Vdc is again filtered and routed to both +5V power on indicator A9DS1-A and the +5V overvoltage protection circuit. In the event of over voltage, zener diode A9VR4 will conduct, once the voltage across it rises above +5.6 Vdc. When the +5 Vdc supply voltage reaches about 6.3 Vdc, A9Q4 turns on and shorts out the +5 Vdc supply. This will cause A9U2 to current limit. At the same moment that A9Q4 is turned on, A9Q5 (located in the +15 volt supply) is also turned on to draw more current and blow the line fuse. A circuit overload will also either blow the main line fuse or cause A9U2 to current limit. The +5 Vdc is provided to power the Noise Figure Meter logic devices.

#### +15 Vdc Power

20.3 Vac is input to the +15V full wave rectifier (A9CR3 and A9CR4). The output of the full wave rectifier is filtered, and then regulated by A9U1 to within  $\pm 1$  Vdc. The regulated +15 Vdc is again filtered and routed to +15V power on indicator A9DS1-B. In the event of an overload, regulator A9U1 will current limit. A9Q5 is turned on by zener diode A9VR4 in the event of over voltage at the +5 volt supply to blow the line fuse. The +15 Vdc is provided to power the Noise Figure Meter analog devices. A reference +15 Vdc is also provided to the +28 Vdc supply to prevent that supply from functioning, if the +15 Vdc should fail. Since the -15 Vdc supply shares a common power source with the +15 Vdc, a failure in the -15V would cause a failure of the +15V, and also inhibit the +28 Vdc.

#### -15 Vdc Power

20.3 Vac is input to the -15V full wave rectifier (A9CR6 and A9CR7). The output of the full wave rectifier is routed to the line overvoltage protection circuit. The function of the overvoltage protection circuit is to prevent damage to the instrument in the event that the pin-out card in Line Power Assembly A15 is set to the wrong line voltage.

If this should occur, zener diode A9VR1 will conduct and turn on A9Q3. When A9Q3 conducts, it shorts out the -15V supply, and blows the main line fuse. Also, when A9Q3 conducts, A9CR8 turns off to prevent the surge current from A9C13 from damaging A9Q3. Under normal conditions the output of the -15V full wave rectifier is filtered by A9C13 and regulated by A9U3. The regulated -15 Vdc is again filtered and used to power the Noise Figure Meter analog devices.

## SERVICE SHEET 18 (cont'd)

When indicator A9DS1-C is illuminated, the -15 volt supply is up. However, the indicator provides no indication of what the actual voltage is.

### +28 Vdc Power

The +28 Vdc power is used exclusively to drive the Noise Source. Input to the +28 volt regulator circuit is from the full wave rectifier diodes A9CR1 and A9CR2. A9C7 filters the output of the full wave rectifier. A9F1 provides stress relief for the transformer in the event that A9C7 should short. A9Q2 and A12VR1 form a pre-regulator circuit which maintains a constant voltage at the series pass transistor. This limits the working range of the +28V regulator (A9Q1 and A12U1). The output level of the supply is set by A12R7. Reference voltage for the regulator is derived from the +15 Vdc supply using a divider consisting of A12R3 and A12VR2. Regulator A12U1 is turned on and off by the controller through transistors A12Q1 and A12Q2. The controller pulses the +28 Vdc output at a rate of approximately eleven times per second as indicated by the flashing of A12DS1. Current sensing resistor A12R5 causes the regulator to shut down in the event of a current overload. A12C2 prevents RF feedback from entering the power supplies. The +28 Vdc is not grounded in the A12 Power Supply Assembly. Instead, the ground is taken to the external chassis of the Noise Figure Meter.

### Grounding

All grounds are tied together and to the instrument chassis at the star ground point at the rear of the power supply printed circuit board. "3" ground is the power supply regulator ground connection to the grounding point. "2" ground is the digital ground connection to the grounding point. "1" ground is the analog ground connection to the grounding point.

## TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 18 when a malfunction has occurred in one or more power supplies or when the Noise Source is inoperative. Except where shown, all values listed are approximate and are given as a service guideline.

### Test Equipment

Oscilloscope ..... Tektronix 2235  
Systems DVM ..... HP 3456A

8-180

## ✓1 General Voltage Checks

**Purpose.** To verify that all dc voltages are present, and that the +28 Vdc is pulsing.

### WARNING

*Dangerous voltages are present in the A15 Line Power Assembly and at the inputs of transformer T1.*

1. Use test point A9TP4 for the ground reference and verify that the  $+15 \pm 1.0$  Vdc is present at test point A9TP2, and that the  $-15 \pm 1.0$  Vdc is present at test point A9TP1.
2. Verify that the +5 Vdc is present at A9TP3, and that the +28 Vdc is present at test point A12TP1.

### NOTE

*If the controller is pulsing the +28 Vdc supply, it will be necessary to use the oscilloscope to measure the level of the +28 Vdc.*

## ✓2 Total Power Failure

**Purpose.** To isolate the cause of a total power failure. (A total power failure is defined as when all four dc outputs have failed.)

1. Ensure that main line fuse F1 has not blown. If not, ensure that the unit is plugged into an active line source, and that the power switch is ON.
2. Disconnect the unit from the line source, and verify that the unit is set for the correct line voltage. If the correct line voltage is selected, use an ohmmeter to verify that temperature switch S2 is closed.
3. If fuse F1 was blown, disconnect the cables from the connectors A9J2 and A9J3. Replace the fuse and apply power.
4. If fuse F1 does not blow again, verify that all four voltages are present. If the voltages appear normal, the trouble is not in the power supply, but in one of the loads.
5. If fuse F1 does blow again, the trouble is internal to the power supply. Remove the line power, and make a visual inspection of the various power supply devices. Check for

## SERVICE SHEET 18 (cont'd)

any sign of burning or discoloration. If any device shows damage, proceed to the check for the power supply in which the device is located.

6. Measure the resistance from test points A9TP5, A9TP6, A9TP7, and A12TP3 to ground. If any test point shows a short (less than 100 ohms), proceed to that check in which the test point is located.
7. Measure the resistance from test points A9TP1, A9TP2, A9TP3, and A12TP1 to ground. If any test point shows a short (less than 100 ohms), proceed to that check in which the test point is located.

### ✓ 3 +28 Vdc Noise Source Power Supply.

**Purpose.** To verify that the +28 Vdc power supply is at the correct level and that the supply is properly pulsed.

1. If A12DS1 is not lit, verify that fuse A9F1 is not blown. If fuse is blown, disconnect the Noise Source, replace the fuse, and apply power.
2. If the fuse does not blow, verify that the +28 Vdc is present and pulsing. If the +28 Vdc is correct, the trouble is external to the instrument; otherwise, go to step 5.
3. If the fuse blows, remove power and measure the resistance from test point A12TP3 to A12TP2 (ground). If the resistance is less than 100 ohms, check the following components in the order shown; A9Q2, A9C7, A9R2, A12VR1, A9Q1, and A12U1.
4. Measure the resistance from test point A12TP1 to A12TP2. If the resistance is less than 10 ohms, check the following components in the order shown; A9Q1, A9U1, A12Q2, and A12CR4.
5. If in step 2, the fuse did not blow, but the +28 Vdc is missing or incorrect, verify that there is +6.9 Vdc on A12U1-3. If the voltage is incorrect, verify that there is +15 Vdc on A12R3.
6. If the +15 Vdc is incorrect, the trouble is in the +15 Vdc supply, otherwise check the following components in the order shown; A12U1, A12VR2, A12C1, A12R3, and A12R5.

7. If in step 2, the fuse did not blow, and the +28 Vdc is at the correct level, verify that the +28 Vdc is pulsing. If the pulsing is incorrect, verify that the control pulses are present on A12R2.
8. If the control pulses are missing, the trouble is in the controller, or a Special Function has been selected which turned off the pulsing. If the pulses are present, check the following components in the order shown; A12Q1, A12Q2, A12U1, and A12CR3.
9. Once the +28 Vdc has been restored, reconnect all cables, apply power and verify that the level is correct.

### NOTE

*If the problem recurs, there is the distinct possibility that the trouble is in the Noise Source, or in the cable connecting the Noise Source to the Noise Figure Meter.*

### ✓ 4 +15 Vdc Power Supply

**Purpose.** To verify that the +15 Vdc power supply is at the correct level.

1. If A9DS1-B is not lit, cautiously check the temperature of A9U1. If the device is hot, allow time to cool down. Disconnect the cables at A9J3 and A9J2.
2. Apply power and verify that the +15 Vdc is correct. If the level is correct, the problem is in one of the loads.
3. If the +15 Vdc is incorrect, measure the resistance from test point A9TP6 to ground. If the resistance is less than 100 ohms, check the following components in the order shown; A9U1, A9C12, A9C8, A9R3, A9CR3, A9CR4, and A9CR9.
4. Measure the resistance from test point A9TP2 to ground. If the resistance is less than 10 ohms, check the following components in the order shown; A9U1, A9CR11, A9C16, and A12U1.
5. Once the +15 Vdc has been restored, reconnect all cables, apply power and verify that the level is correct.

## SERVICE SHEET 18 (cont'd)

### ✓ 5 +5 Vdc Power Supply

**Purpose.** To verify that the +5 Vdc power supply is at the correct level.

1. If A9DS1-A is not lit, cautiously check the temperature of A9U2. If the device is hot, allow time to cool down. Disconnect the cables at A9J3 and A9J2.
2. Apply power and verify that the +5 Vdc is correct. If the level is correct, the problem is in one of the loads.
3. If the +5 Vdc is incorrect, measure the resistance from test point A9TP5 to ground. If the resistance is less than 100 ohms, check the following components in the order shown: A9U2, A9C10, A9C9, A9R5, A9C14, and A9CR5.
4. Measure the resistance from test point A9TP3 to ground. If the resistance is less than 10 ohms, check the following components in the order shown; A9U2, A9Q4, A9CR13, A9R9, and A9C17.
5. Once the +5 Vdc has been restored, reconnect all cables, apply power and verify that the level is correct. (Measure the +5 Vdc at pin A14J5-1 on the A14 Controller Assembly.)

### ✓ 6 -15 Vdc Power Supply

**Purpose.** To verify that the -15 Vdc power supply is at the correct level.

1. If A9DS1-C is not lit, cautiously check the temperature of A9U3. If the device is hot, allow time to cool down. Disconnect the cables at A9J3 and A9J2.
2. Apply power and verify that the -15 Vdc is correct. If the level is correct, the problem is in one of the loads.
3. If the -15 Vdc is incorrect, measure the resistance from test point A9TP7 to ground. If the resistance is less than 100 ohms, check the following components in the order shown; A9U3, A9Q3, A9CR6, A9CR7, A9C13, A9C15, A9R7, and A9CR12.
4. Measure the resistance from test point A9TP1 to ground. If the resistance is less than 10 ohms, check the following components in the order shown; A9U3, A9CR14, A9C18, and A9C19.
5. Once the -15 Vdc has been restored, reconnect all cables, apply power and verify that the level is correct.

### Completion of Testing

Upon completion of testing, place all switches in their original positions, remove all test gear, and restore the Noise Figure Meter to the normal operating condition. If repairs have been made, or adjustments changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

### A9 ASSEMBLY

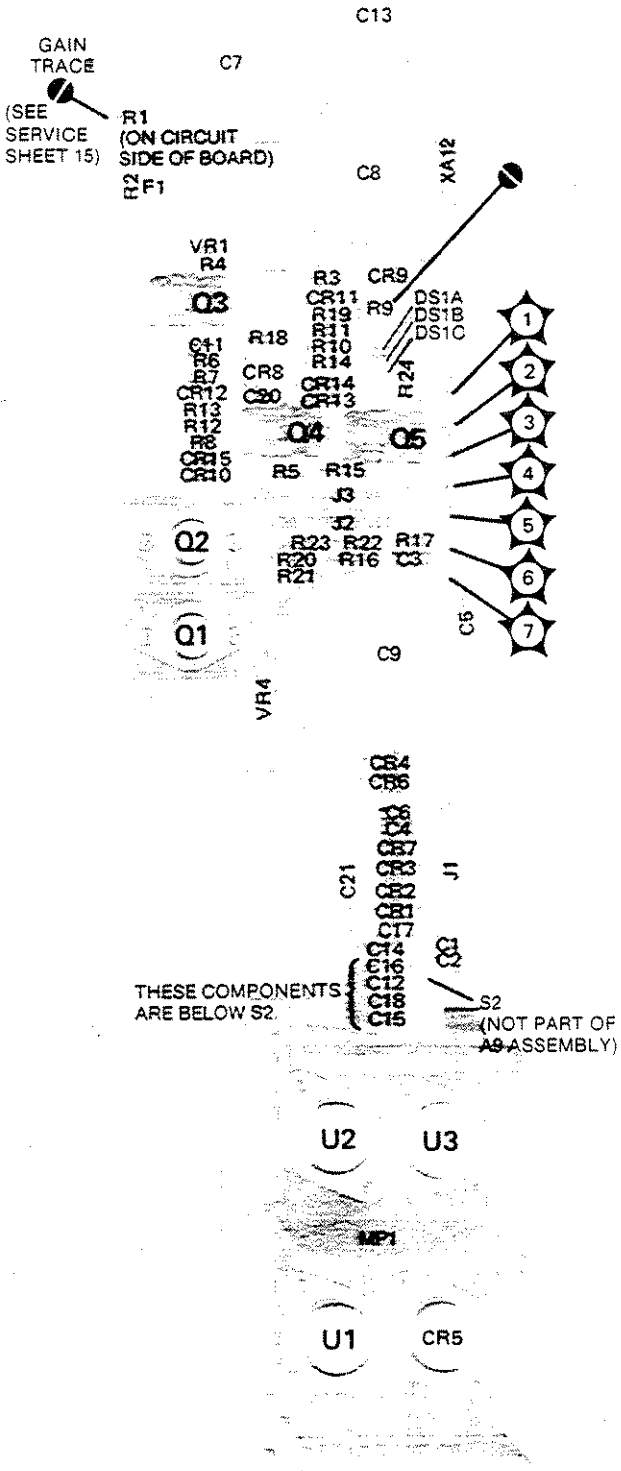


Figure 8-85. A9 Power Supply Assembly Component Locations

### A12 ASSEMBLY

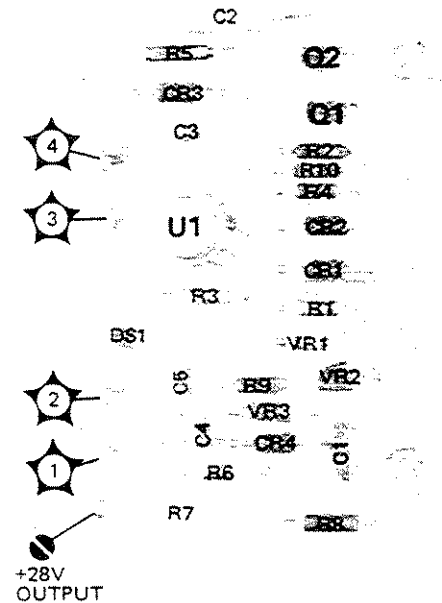


Figure 8-86. A12 Noise Source Drive Assembly Component Locations

*(2645A and Above)*

The schematic on page 8-185, along with these changes, documents instruments prefixed 2645A and above.

A9 Power Supply Assembly:

R18

*(2645A and above)* Add an asterisk.

A12 Noise Source Drive Assembly:

R1

*(2645A and above)* 1.10k ohms



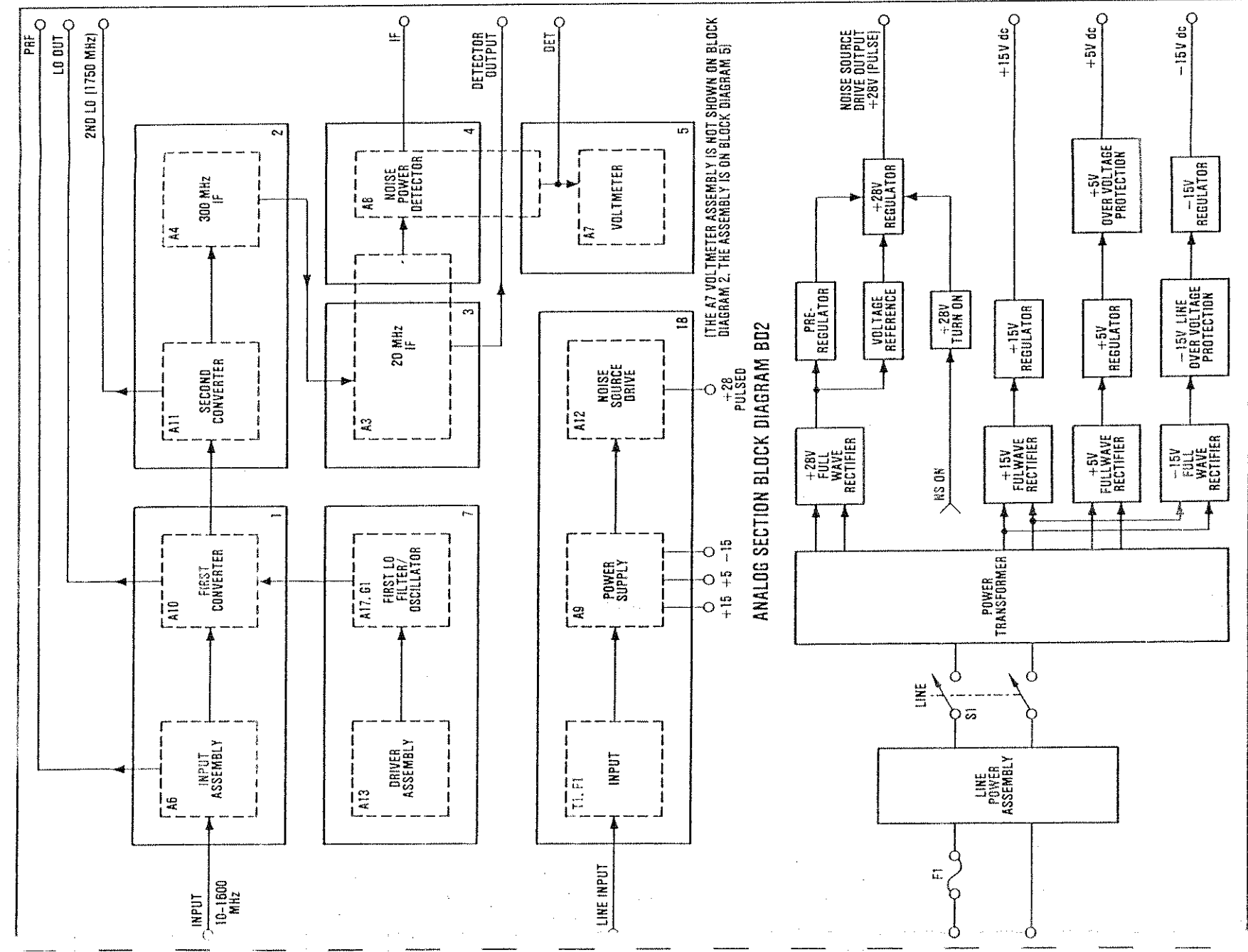
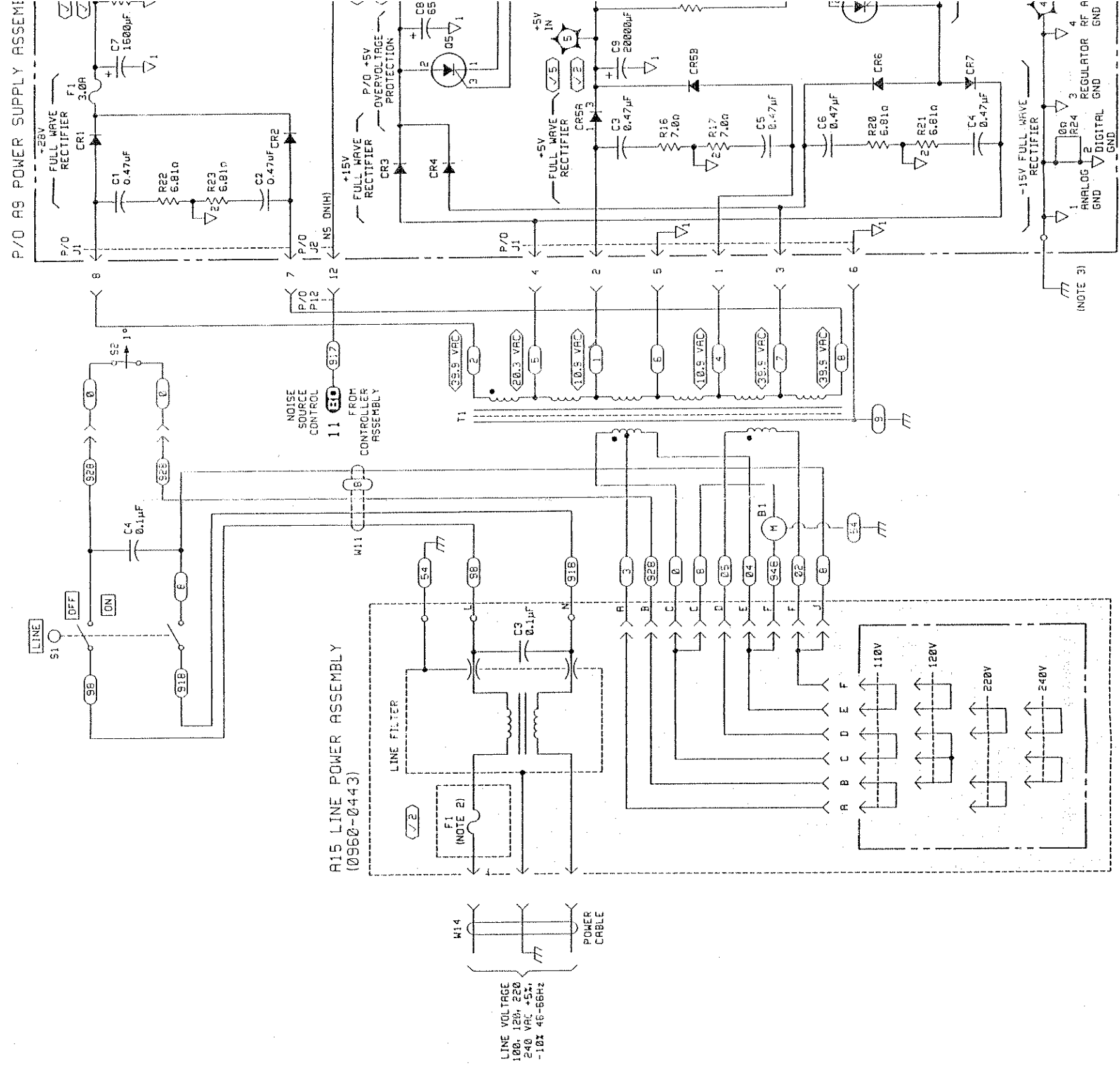


Figure 8-87. Power Supply and Noise Source Drive Block Diagram



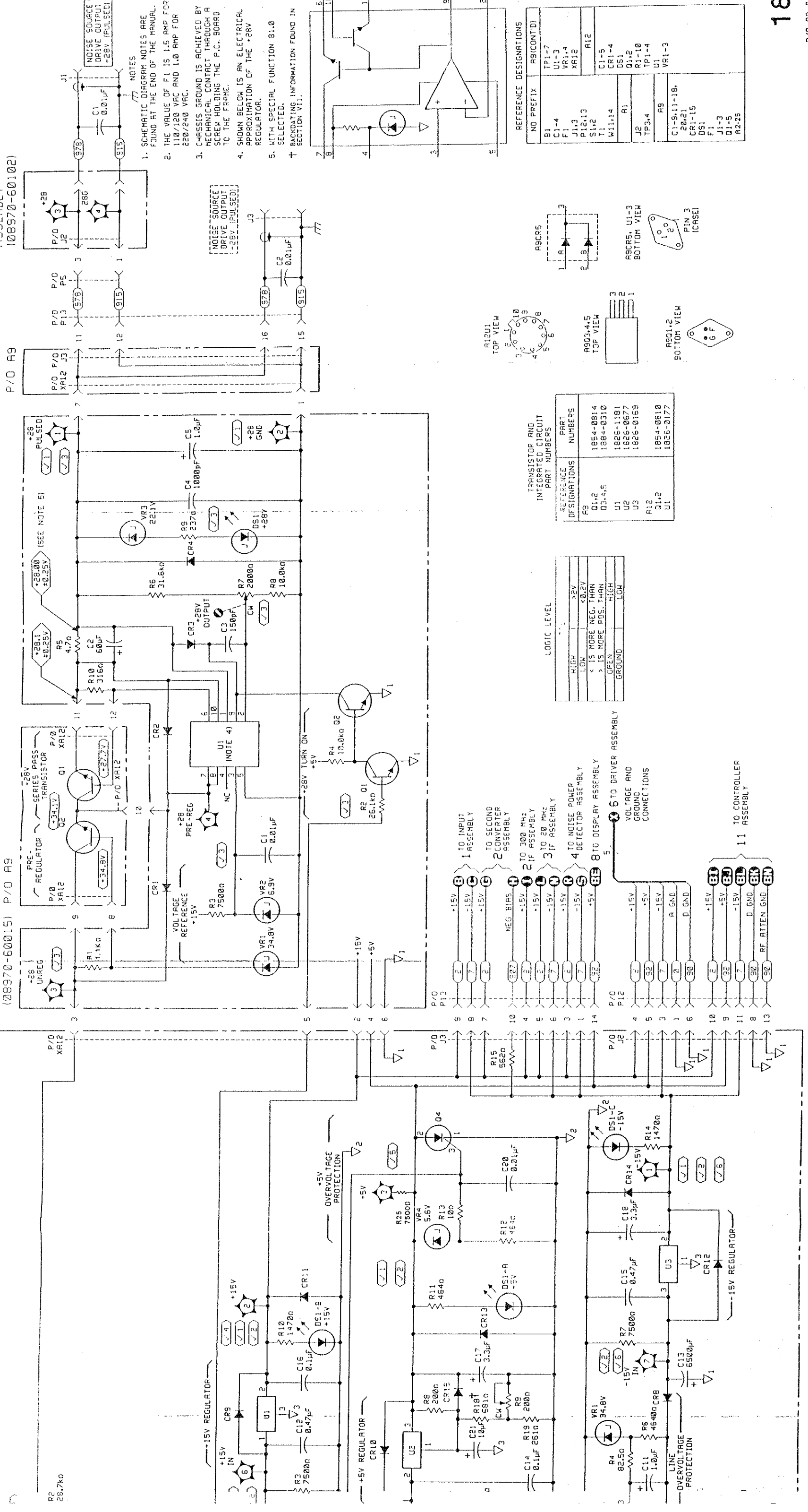
HP89708 POWER SUPPLY CIRCUITS: 2745A



Y (08970-60047)

A12 NOISE SOURCE DRIVE ASSEMBLY (08970-60015) P/O A9

P/O A1 KEYBOARD ASSEMBLY (08970-60102)



- NOTES**
1. SCHEMATIC DIAGRAM NOTES ARE FOUND AT THE END OF THE MANUAL.
  2. THE VALUE OF F1 IS 1.5 AMP FOR 110/120 VAC AND 1.0 AMP FOR 220/240 VAC.
  3. CHASSIS GROUND IS ACHIEVED BY MECHANICAL CONTACT THROUGH A SCREW HOLDING THE P.C. BOARD TO THE FRAME.
  4. SHOWN BELOW IS AN ELECTRICAL APPROXIMATION OF THE +28V REGULATOR.
  5. WITH SPECIAL FUNCTION 81.0 SELECTED.
- † BACKGATING INFORMATION FOUND IN SECTION VI.1.

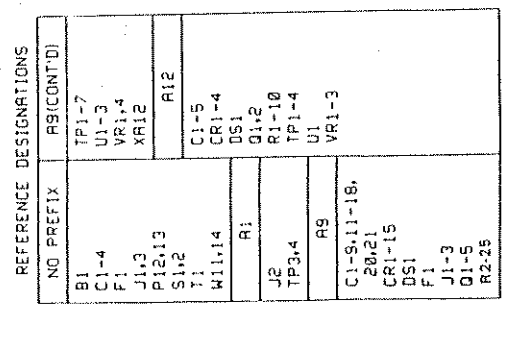
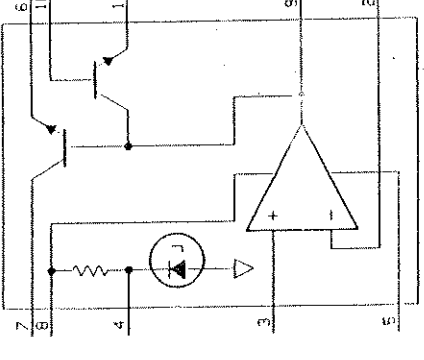


Figure 8-88. Power Supply and Noise Source Drive Schematic Diagram



## 8-40. SCHEMATIC SYMBOLOGY

### 8-41. Basic Logic Symbology

The logic symbols used in this manual are based on the American National Standards Institute (ANSI) Y32.14-1973, "Graphic Symbols for Logic Diagrams (Two State Devices)." A summary of this symbology is provided to aid in interpreting these symbols.

Power supply and ground connections are not shown on the symbols. This information is tabulated on the right margins of the service sheets.

**Gates and Qualifiers.** This section includes a brief description of the basic logic symbols used on the service sheets, a summary of indicator symbols, a discussion of contiguous blocks, control blocks, and dependency notation, and a summary of symbology for some of the more complex devices.

Qualifiers are that portion of a device symbol that denotes the logic function. For example, "&" denotes the AND function. Figure 8-89 shows some basic logic symbols and their qualifiers.

**Indicator Symbols.** Indicator symbols identify the active state of a device's input or output, as shown in Figure 8-90.

**Contiguous Blocks.** Two symbols may share a common boundary, parallel or perpendicular to the direction of the signal flow. Note that in the examples shown in Figure 8-91, there is generally no logic connection across a horizontal line, but there is always an implied logic connection across a vertical line. Notable exceptions to this rule are the horizontal lines beneath control blocks and between sections of shift registers and counters (dividers).

**Dependency Notation.** Dependency notation simplifies symbols for complex integrated circuit elements by defining the relationship between inputs and outputs without actually showing all the elements and connections involved (see Figures 8-92 through 8-94). The following examples use the letter A for address, C for control, G for AND, V for OR, and F for free dependencies.

The dependent input or output is labeled with a number that is either prefixed (e.g., 1X) or subscripted (e.g., X1). Note that many times a controlled line may already be labeled with a number that indicates input or output weighting (for example, in a coder). In this case, the controlling or gating input will be labeled with a letter.

**Common Control Block.** The control block is used

in conjunction with an array of related symbols in order to group common logic lines. Figure 8-95 shows how the control block is usually represented. Figure 8-96 shows a quad D-type flip-flop with reset. This can be redrawn as shown in Figure 8-97. Note that the representation shown in Figure 8-97 can be used when the flip-flops are functionally scattered around the schematic (i.e., not used as a quad unit).

### 8-42. Complex Device Symbology

Figures for complex device symbology show how the basic symbols can be combined to illustrate the behavior of fairly complex devices.

**Shift Register.** The shift register (see Figure 8-98) control block shows common inputs to a bidirectional shift register. Notice that ">m" means shift the contents to the right or down by "m" units. And "<m" means shift the contents to the left or up by "m" units. Note: If m=1, then "m" may be omitted. Inputs "a" and "b" are each single IC pins that have two functions.

Input "a" enables one of the inputs to the top D-type flip-flop (1D) and also shifts the register contents down "m" units. Input "b" enables one of the inputs to the bottom flip-flop (2D), and also shifts the register contents up "m" units. Input "c" loads all four flip-flops in parallel (3D). Input "d" is a common reset. The output delay indicator is used because these are master-slave flip-flops.

**AND-OR Selector.** The selector control block simplifies the AND portion of a quad AND-OR select gate (see Figure 8-99). When G1 is high, the data presented at the "1" inputs is gated through. When G2 is high, the data presented at the "2" inputs is gated through.

**UP-DOWN Counter.** The counter control block shows common inputs to a Presettable Decade UP-DOWN Counter (see Figure 8-100). Notice that "+m" means count up (increment the count) by "m"; "-m" means count down by "m." Note: if m=1, then "m" may be omitted. Since the D-type flip-flops are master-slave, the output delay indicator is used.

The "=9,+1" and "=0,-1" notation defines when the carry and borrow outputs are generated. They also define it as a decade counter; a binary counter would have the carry indicated with "=15,+1." Flip-flop weighting is indicated in parentheses. Input "C1" allows all four "D1" flip-flops to be preset in parallel.

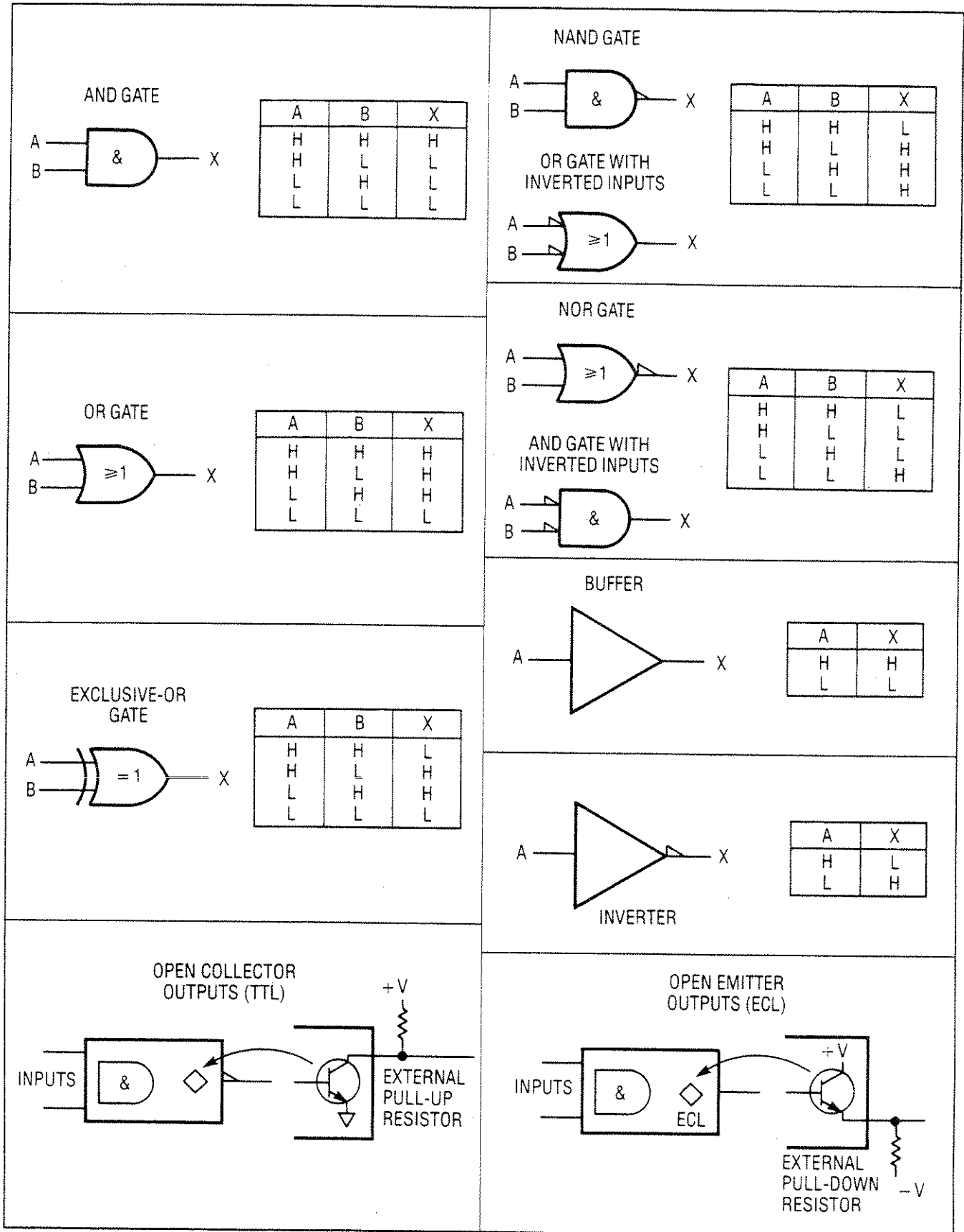


Figure 8-89. Basic Logic Symbols and Qualifiers

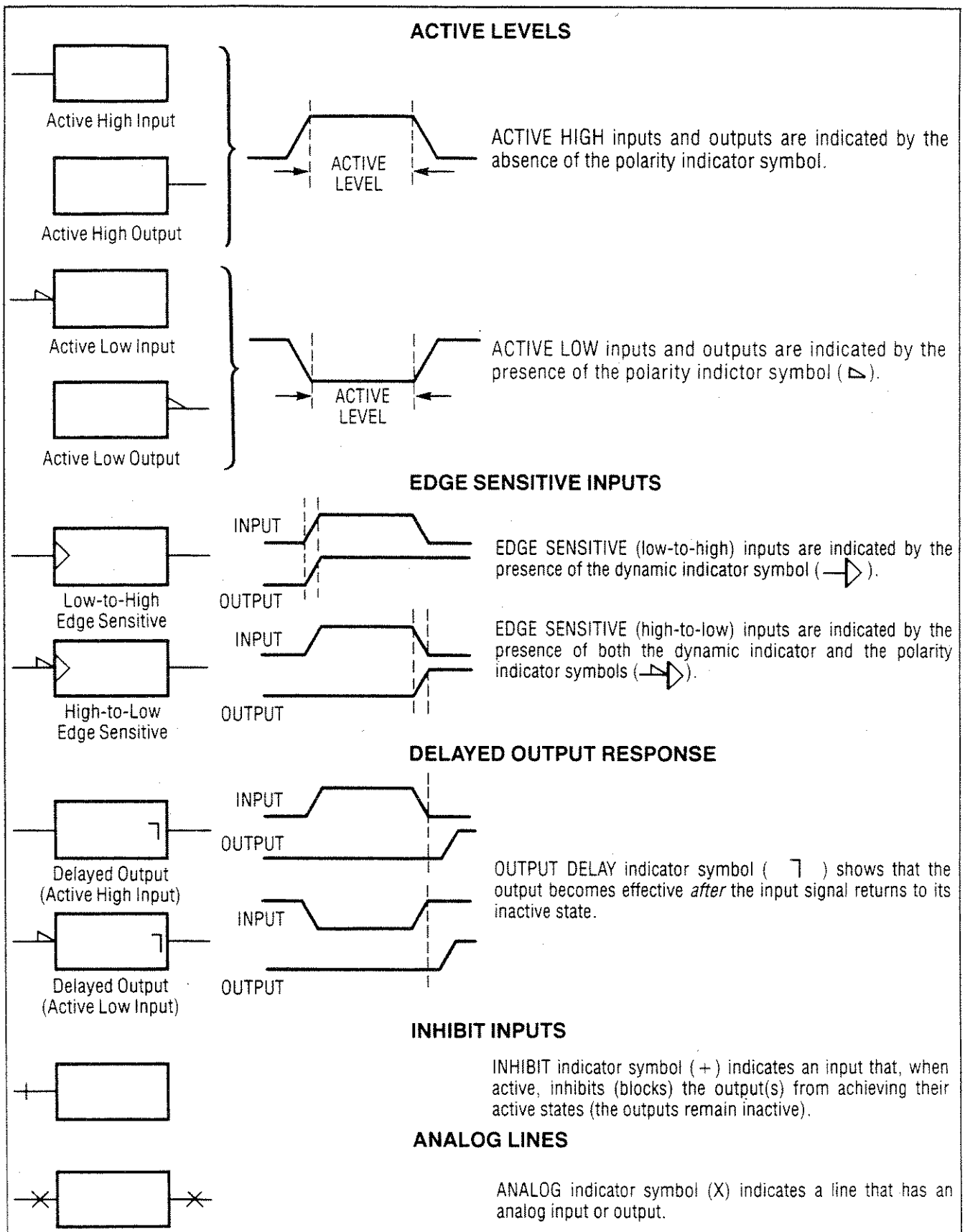


Figure 8-90. Indicator Symbols

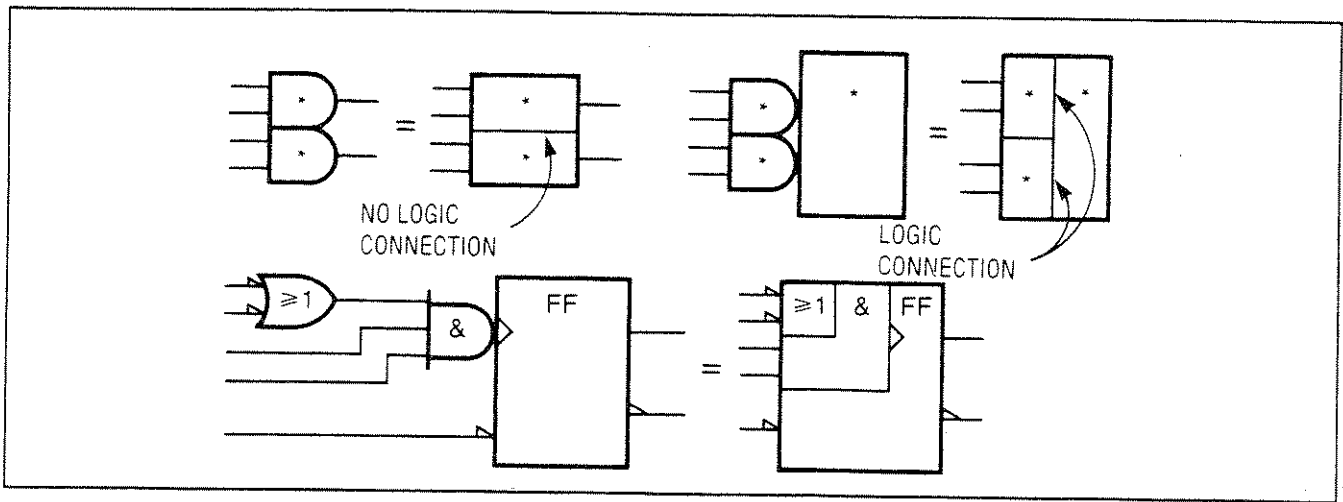


Figure 8-91. Contiguous Blocks

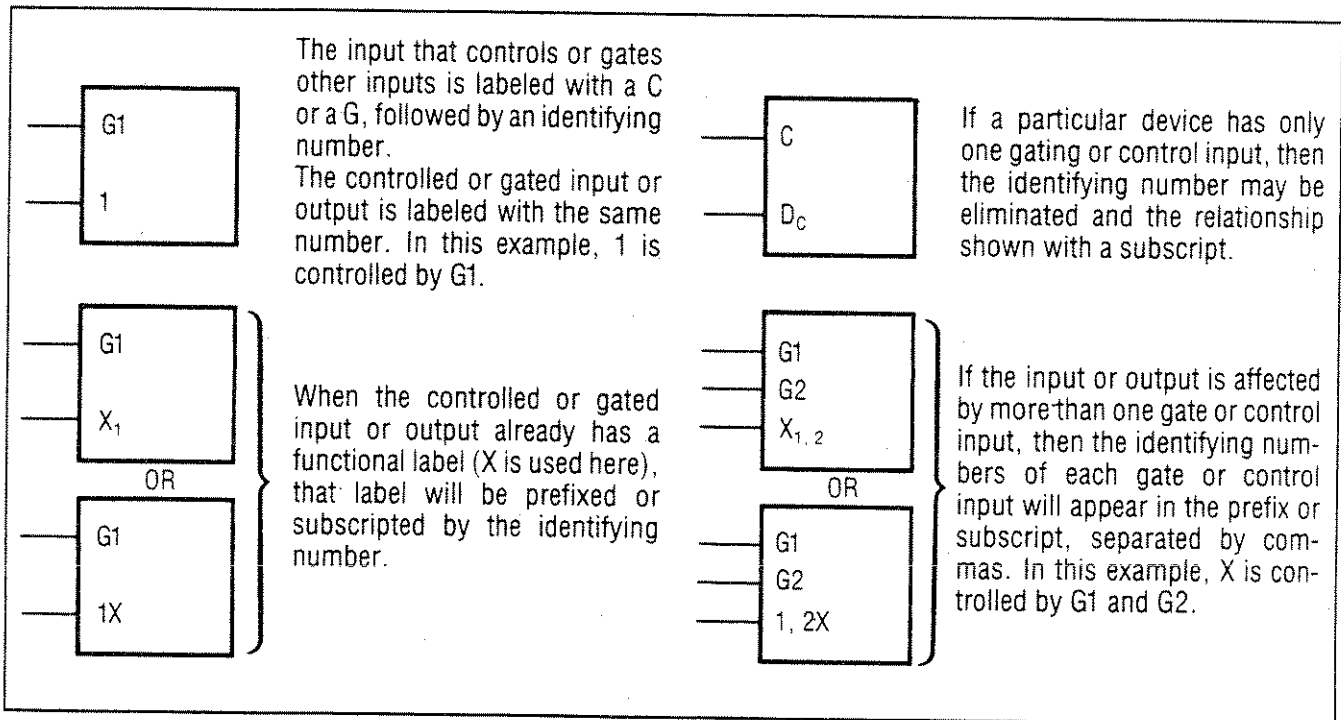


Figure 8-92. AND Dependency Notation

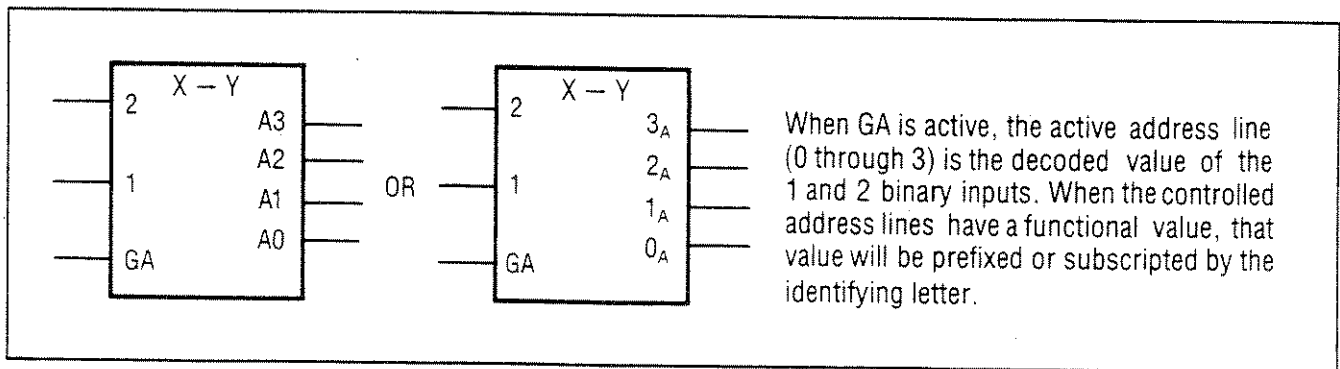


Figure 8-93. Address Dependency Notation



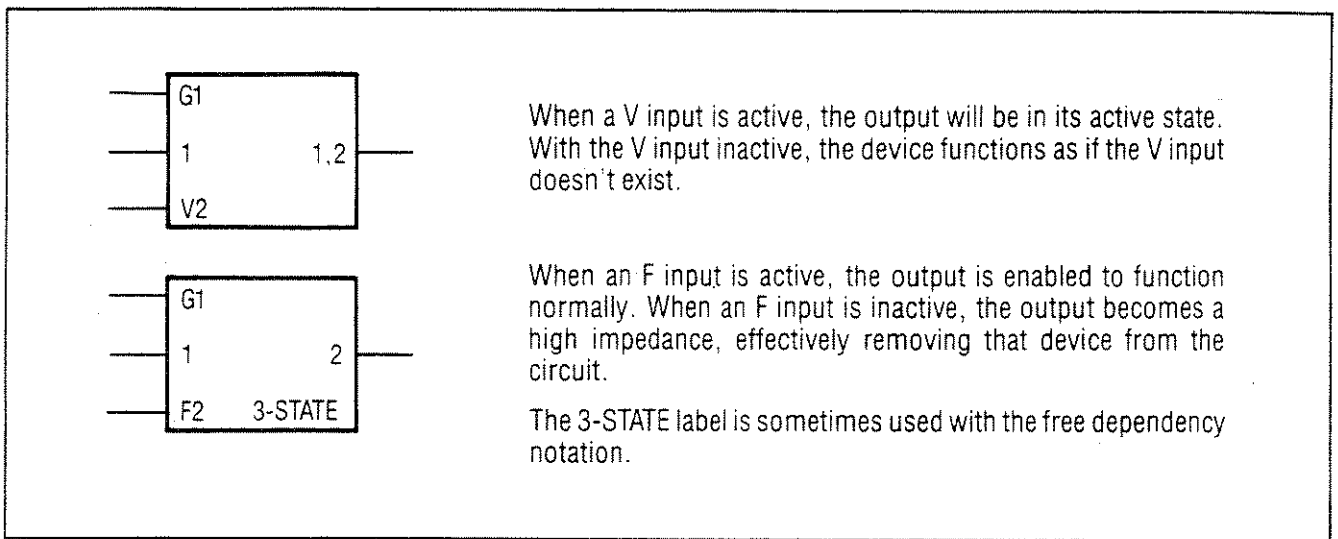


Figure 8-94. OR and Free Dependency Notation

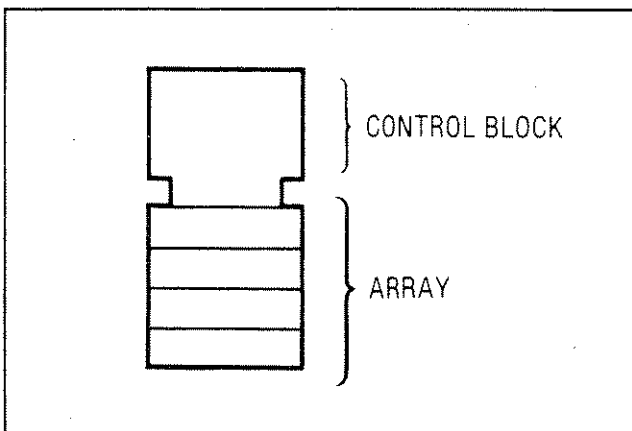


Figure 8-95. Common Control Block

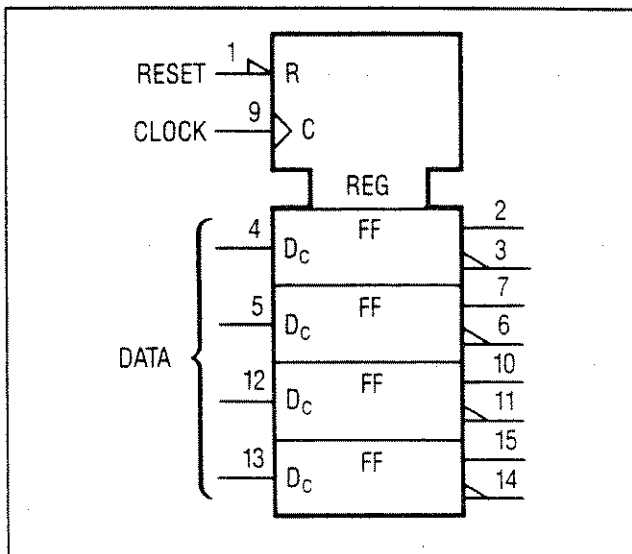


Figure 8-96. Quad D-Type Latch (Combined)

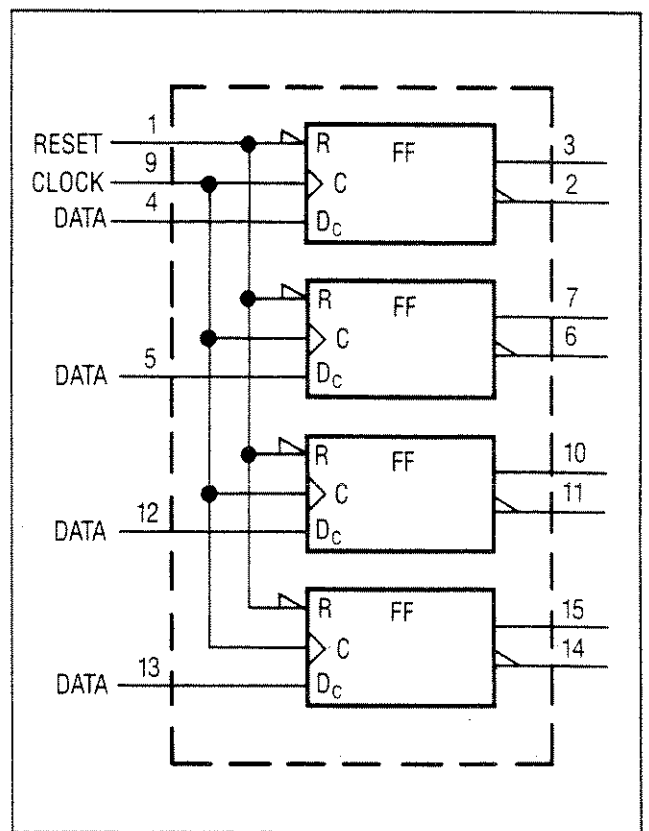


Figure 8-97. Quad D-Type Latch (Individual)

**Quad D-Type Latch.** The register control block illustrates a quad D-type latch (see Figure 8-101). There is a common active-low reset (R), and a common edge triggered control input (C). Since there is only one dependency relationship, the controlling input is not numbered and the controlled functions (D) are subscripted with a C.

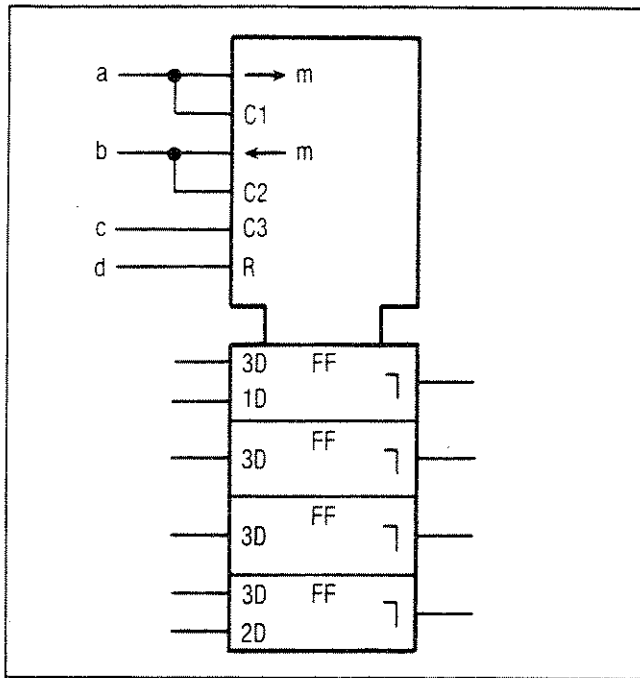


Figure 8-98. Shift Register

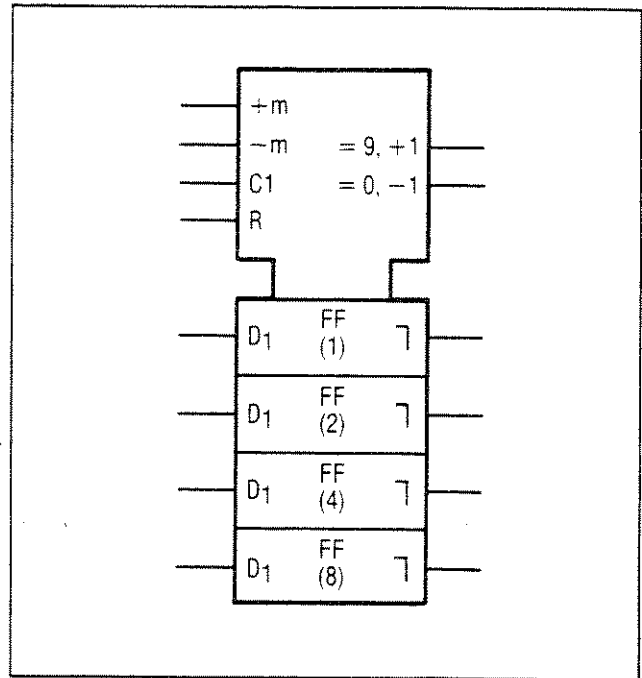


Figure 8-100. Up/Down Counter

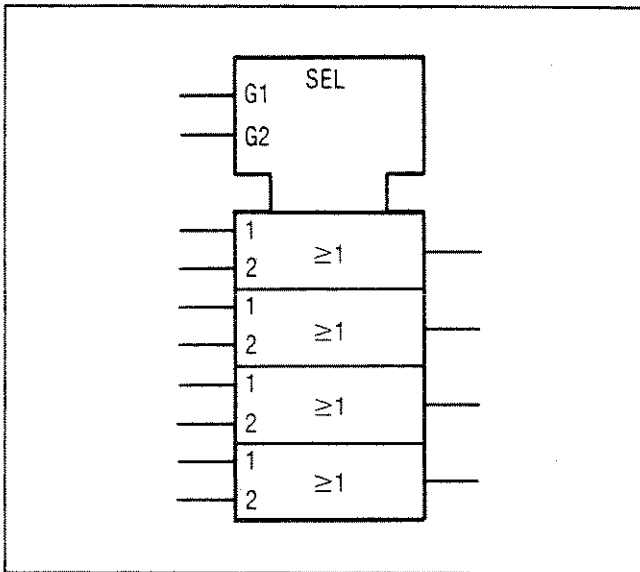


Figure 8-99. AND-OR Selector

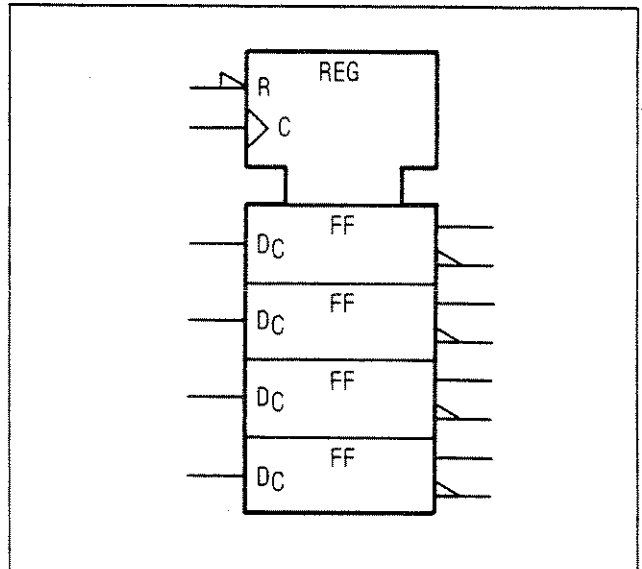


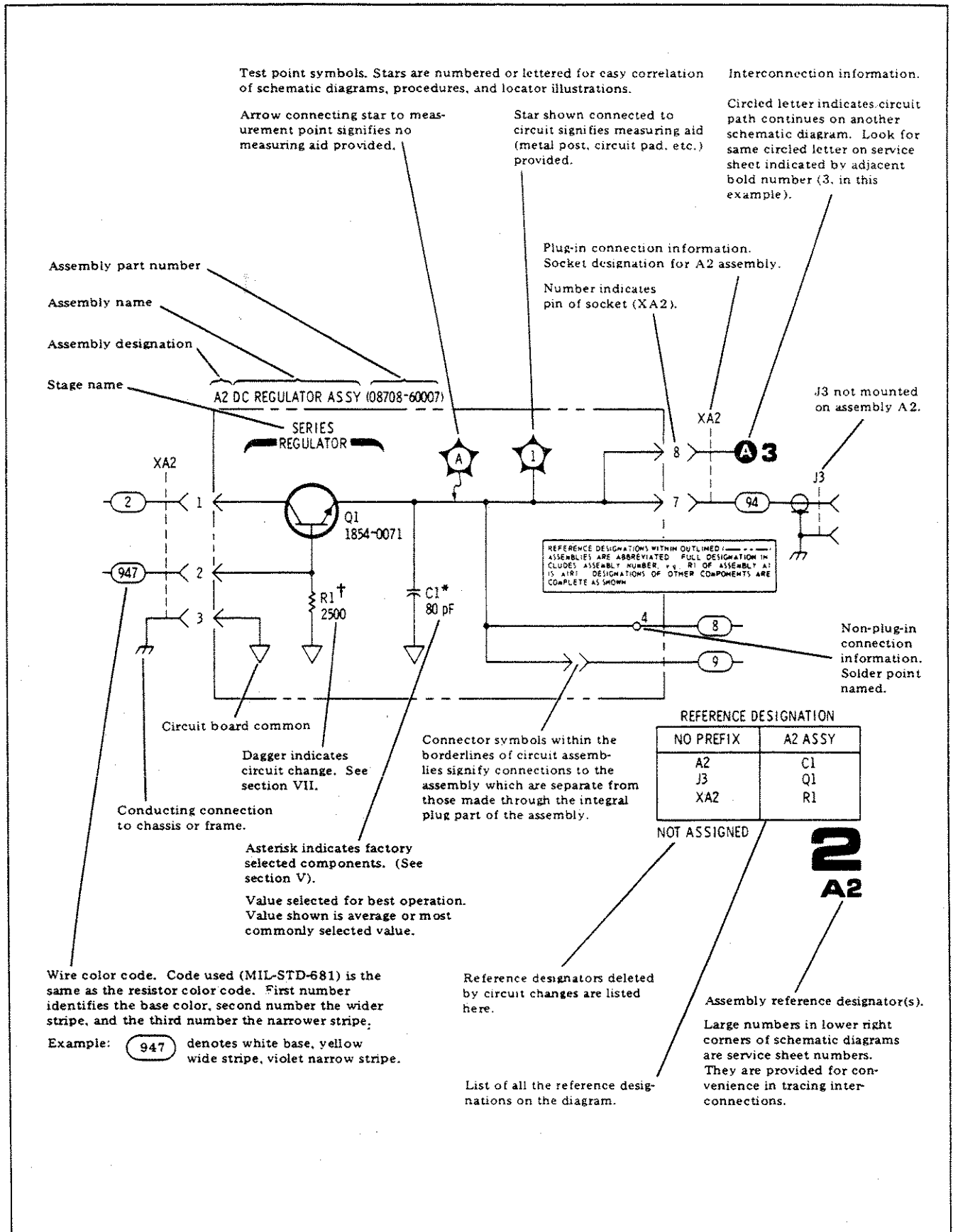
Figure 8-101. Quad D-Type Latch

**8-43. Schematic Diagram Notes**





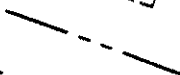
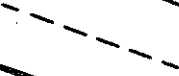


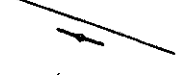










Table 8-59, Schematic Diagram Notes, has schematic diagram information and digital reference

information summarizing the symbology used to represent the devices in the Noise Figure Meter.

Table 8-59. Schematic Diagram Notes (1 of 8)



**SCHEMATIC DIAGRAM NOTES**

-  Asterisk denotes a factory-selected value. Value shown is typical.
-  Dagger indicates circuit change. See Section VII.
-  Tool-aided adjustment.
-  Encloses front-panel designation.
-  Encloses rear-panel designation.
-  Circuit assembly borderline.
-  Other assembly borderline.
-  Heavy line with arrows indicates path and direction of main signal.
-  Heavy dashed line with arrows indicates path and direction of main feedback.
-  Indicates stripline (i.e., RF transmission line above ground).
-  Wiper moves toward cw with clockwise rotation of control (as viewed from shaft or knob).
-  Numbered Test Point measurement aid provided.
-  Encloses wire or cable color code. Code used is the same as the resistor color code. First number identifies the base color, second number identifies the wider stripe, and the third number identifies the narrower stripe, e.g., denotes white base, yellow wide stripe, violet narrow stripe.
-  A direct conducting connection to 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-designation points are connected.
-  Letters = off-page connection, e.g., **AK**
-  Number = Service Sheet number for off-page connection, e.g., **12**
-  Number (only) = on-page connection.

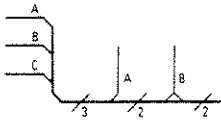


Manual control.

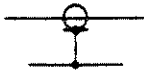
**AK12**

**1** THIS PAGE

**SCHEMATIC DIAGRAM NOTES**



Indicates multiple paths represented by only one line. Letters or names identify individual paths. Numbers indicate number of paths represented by the line.



Coaxial or shielded cable.



Relay. Contact moves in direction of arrow when energized.



Indicates a pushbutton switch with a momentary (ON) position.



Indicates a PIN diode.



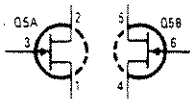
Indicates a current regulation diode.



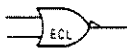
Indicates a voltage regulation diode.



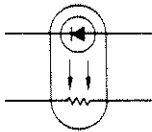
Indicates a Schottky (hot-carrier) diode.



Multiple transistors in a single package—physical location of the pins is shown in package outline on schematic.



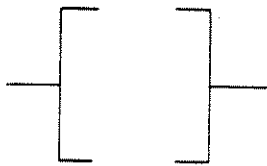
Identification of logic families as shown (in this case, ECL).



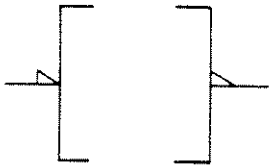
Indicates an opto-isolator of a LED and a photoresistor packaged together. The resistance of the photoresistor is a function of the current flowing through the LED.

**DIGITAL SYMBOLOGY REFERENCE INFORMATION**

**Input and Output Indicators**



Implied Indicator—Absence of polarity indicator (see below) implies that the active state is a relative high voltage level. Absence of negation indicator (see below) implies that the active state is a relative high voltage level at the input or output.



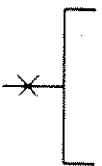
Polarity Indicator—The active state is a relatively low voltage level.



Dynamic Indicator—The active state is a transition from a relative low to a relative high voltage level.



Inhibit Input—Input that, when active, inhibits (blocks) the active state outputs of a digital device.



Analog Input—Input that is a continuous signal function (e.g., a sine wave).



Polarity Indicator used with Inhibit Indicator—Indicates that the relatively low level signal inhibits (blocks) the active state outputs of a digital device.



Output Delay—Binary output changes state only after the referenced input (m) returns to its inactive state (m should be replaced by appropriate dependency or function symbols).



Open Collector Output—Output that must form part of a distributed connection.

**DIGITAL SYMBOLOGY REFERENCE INFORMATION**

**Input and Output Indicators (Cont'd)**

**3-STATE** Three-state Output—Indicates outputs that can have a high impedance (disconnect) state in addition to the normal binary logic states.

**Combinational Logic Symbols and Functions**

**&** AND—All inputs must be active for the output to be active.

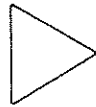
**$\geq 1$**  OR—One or more inputs being active will cause the output to be active.

**$\geq m$**  Logic Threshold— $m$  or more inputs being active will cause the output to be active (replace  $m$  with a number).

**$= 1$**  EXCLUSIVE OR—Output will be active when one (and only one) input is active.

**$= m$**   $m$  and only  $m$ —Output will be active when  $m$  (and only  $m$ ) inputs are active (replace  $m$  with a number).

**$=$**  Logic Identity—Output will be active only when all or none of the inputs are active (i.e., when all inputs are identical, output will be active).



**Amplifier**—The output will be active only when the input is active (can be used with polarity or logic indicator at input or output to signify inversion).

**X/Y** Signal Level Converter—Input level(s) are different than output level(s).



**Bilateral Switch**—Binary controlled switch which acts as an on/off switch to analog or binary signals flowing in both directions. Dependency notation should be used to indicate affecting/affected inputs and outputs. Note: amplifier symbol (with dependency notation) should be read to indicate unilateral switching.

**X-Y** Coder—Input code ( $X$ ) is converted to output code ( $Y$ ) per weighted values or a table.

**(Functional Labels)** The following labels are to be used as necessary to ensure rapid identification of device function.

**MUX** Multiplexer—The output is dependent only on the selected input.

**DEMUX** Demultiplexer—Only the selected output is a function of the input.

**CPU** Central Processing Unit

**PIO** Peripheral Input/Output

**SMI** Static Memory Interface

**DIGITAL SYMBOLOGY REFERENCE INFORMATION**

**Sequential Logic Functions**



Monostable—Single shot multivibrator. Output becomes active when the input becomes active. Output remains active (even if the input becomes inactive) for a period of time that is characteristic of the device and/or circuit.



Oscillator—The output is a uniform repetitive signal which alternates between the high and low state values. If an input is shown, then the output will be active if and only if the input is in the active state.

FF

Flip-Flop—Binary element with two stable states, set and reset. When the flip-flop is set, its outputs will be in their active states. When the flip-flop is reset, its outputs will be in their inactive states.

T

Toggle Input—When active, causes the flip-flop to change states.

S

Set Input—When active, causes the flip-flop to set.

R

Reset Input—When active, causes the flip-flop to reset.

J

J Input—Analogous to set input.

K

K Input—Analogous to reset input.

D

Data Input—Always enabled by another input (generally a C input—see Dependency Notation). When the D input is dependency-enabled, a high level at D will set the flip-flop; a low level will reset the flip-flop. Note: strictly speaking, D inputs have no active or inactive states—they are just enabled or disabled.

m

Count-Up Input—When active, increments the contents (count) of a counter by “m” counts (m is replaced with a number).

–m

Count-Down Input—When active, decrements the contents (count) of a counter by “m” counts (m is replaced with a number).

→ m

Shift Right (Down) Input—When active, causes the contents of a shift register to shift to the right or down “m” places (m is replaced with a number).

← m

Shift Left (Up) Input—When active, causes the contents of a shift register to shift to the left or up “m” places (m is replaced with a number).

**NOTE**

*For the four functions shown above, if m is one, it is omitted.*

(Functional Labels)

The following functional labels are to be used as necessary in symbol build-ups to ensure rapid identification of device function.



## DIGITAL SYMBOLOGY REFERENCE INFORMATION

## Sequential Logic Functions (Cont'd)

mCNTR	Counter—Array of flip-flops connected to form a counter with modulus $m$ ( $m$ is replaced with a number that indicates the number of states: 5 CNTR, 10 CNTR, etc.).
REG	Register—Array of unconnected flip-flops that form a simple register or latch.
SREG	Shift Register—Array of flip-flops that form a register with internal connections that permit shifting the contents from flip-flop to flip-flop.
ROM	Read Only Memory—Addressable memory with read-out capability only.
RAM	Random Access Memory—Addressable memory with read-in and read-out capability.


## Dependency Notation

mAm	Address Dependency—Binary affecting inputs of affected outputs. The $m$ prefix is replaced with a number that differentiates between several address inputs, indicates dependency, or indicates demultiplexing and multiplexing of address inputs and outputs. The $m$ suffix indicates the number of cells that can be addressed.
Gm	Gate (AND) Dependency—Binary affecting input with an AND relationship to those inputs or outputs labeled with the same identifier. The $m$ is replaced with a number or letter (the identifier).
Cm	Control Dependency—Binary affecting input used where more than a simple AND relationship exists between the $C$ input and the affected inputs and outputs (used only with D-type flip-flops).
Vm	OR Dependency—Binary affecting input with an OR relationship to those inputs or outputs labeled with the same identifier. The $m$ is replaced with a number or the letter (the identifier).
Fm	Free Dependency—Binary affecting input acting as a connect switch when active and a disconnect when inactive. Used to control the 3-state behavior of a 3-state device.

## NOTE

*The identifier ( $m$ ) is omitted if it is one—that is, when there is only one dependency relationship of that kind in a particular device. When this is done, the dependency indicator itself ( $G$ ,  $C$ ,  $F$ , or  $V$ ) is used to prefix or suffix the affected (dependent) input or output.*

**DIGITAL SYMBOLOGY REFERENCE INFORMATION****Miscellaneous**

	Schmitt Trigger — Input characterized by hysteresis; one threshold for positive going signals and a second threshold for negative going signals.
Active	Active State — A binary physical or logical state that corresponds to the true of an input, an output, or a function. The opposite of the inactive state.
Enable	Enabled Condition — A logical state that occurs when dependency conditions are satisfied. Although not explicitly stated in the definitions listed above, functions are assumed to be enabled when their behavior is described. A convenient way to think of it as follows:  A function becomes active when: <ul style="list-style-type: none"><li>• it is enabled (dependency conditions — if any — are satisfied)</li><li>• and its external stimulus (e.g., voltage level) enters the active state.</li></ul>