

## Errata

**Title & Document Type:** 8970A Operating & Service Manual

**Manual Part Number:** 08970-90014

**Revision Date:** May 1985

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### HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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**Operating  
and Service  
Manual**

**HP 8970A  
Noise Figure Meter**

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McCaevor*

*R-315  
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OPERATING AND SERVICE MANUAL

**HP 8970A  
NOISE FIGURE METER  
(Including Option 001)**

**SERIAL NUMBERS**

This manual applies directly to instruments with serial numbers prefixed 2438A.

With the changes described in Section VII, this manual also applies to instruments with serial numbers 2116A, 2210A, 2222A, 2303A, and 2414A.

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



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

Operating Manual Part No. 08970-90014  
Operating and Service Manual Part No. 08970-90015  
Operating and Service Manual Microfiche Part No. 08970-90016

Printed: MAY 1985

# MANUAL CHANGES

## NOISE FIGURE METER

### MANUAL IDENTIFICATION

Model Number: HP 8970A  
Date Printed: May 1985  
Part Number: 08970-90015

### ABOUT THIS SUPPLEMENT

You will use this supplement to correct your manual or to update it for instrument changes that occurred after the manual was printed.

Much of the information here should be substituted for comparable information in the manual. However, since the manual is bound, physical substitution often is not practical. In these cases, we will instruct you to simply mark your manual with references to information in this supplement.

Instructions for modifying your manual appear in the first part of this supplement. The large blocks of substitute information appear in the second part.

We have arranged instructions in the manual's page-number order. Then, we have identified each instruction with the word "Errata" or with a change number. Errata changes relate to all instruments. Instructions with change numbers relate only to certain instruments. These instruments are identified by serial number or prefix in the following table.

The arrow symbol (►) identifies instructions that are appearing in the supplement for the first time.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
2509A	1	2625A	1-7
2512A	1, 2	2627A	1-8
2528A	1-3	2633A	1-9
2541A	1-4	2644A	1-10
2606A	1-5	2646A	1-11
2612A	1-6		

### CHANGE INSTRUCTIONS

#### Page 1-2, paragraph 1-6:

10-1600 MHz Range. Change the second sentence in the first paragraph to, "The Noise Figure Meter can be tuned to any frequency between 10 and 1600 MHz." (Change 1)

>1600 MHz Range. Change the third sentence in the first paragraph to, "To measure the noise figure of devices with output frequencies greater than 1600 MHz, an external mixer and local oscillator can be used to convert the frequency to the 10-1600 MHz range." (Change 1)

#### Page 1-3, paragraph 1-16:

Add the following:

Automated versions of all performance tests in Section IV are available for use with the HP 9000 Series 200 Model 236 computer. Order HP part number 08970-10002 for the automated performance test disc and software reference manual. Order HP part number 08970-90020 for the software reference manual only. (Errata)

#### NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

**CHANGE INSTRUCTIONS**

**Page 1-3, paragraph 1-18:**

Add the following sentence to the end of paragraph 1-18:

“This mixer is usable over a range of 2 to 12.4 GHz.” (Errata).

**▶Page 1-3, paragraph 1-21:**

Add the following after paragraph 1-21:

**Controller Assembly Replacement Kit**

This kit contains all the necessary components and full instructions for replacing the old Controller Assembly (HP part number 08970-60009) with the new Controller Assembly (HP part number 08970-60019). The kit also includes a procedure for extending the input frequency range of the Noise Figure Meter to 1600 MHz. Order HP part number 08970-60063. (Errata)

**Page 1-4, Table 1-1:**

Add the following specifications under NOISE FIGURE MEASUREMENT (Change 3):

Electrical Characteristics	Performance Limits	Conditions
Spurious Response	<0.03 dB change in measured noise figure	For spurious levels below -45 dBm in the 10 to 2100 MHz range and -15 dBm in the 2.1 to 18 GHz range.
Jitter	Peak-to-peak <sup>1</sup> Y-factor variation <0.15 dB Peak-to-peak <sup>1</sup> Y-factor variation <0.02 dBm	At minimum smoothing  With increased smoothing (smoothing factor set to 64).  Note: Jitter in noise figure is equivalent to jitter in Y factor to within 10% for ENR >14 dB and F <4 dB. At minimum smoothing, jitter can limit accuracy. The small jitter at high smoothing does not.
<sup>1</sup> Peak-to-peak is considered as five times the standard deviation of a statistically valid set of readings. Five standard deviations about the mean includes 99% of the readings for a Gaussian distribution.		

Under GAIN MEASUREMENT, change the Instrumentation Uncertainty performance limits to ±0.25 dB.” (Change 6)

Under INPUT, change the Frequency Range performance limits to, “Tunable from 10 to 1600 MHz.” (Change 1)

Under INPUT, change the Input SWR (reflection coefficient) conditions to, “10 to 1600 MHz (50 ohm reference impedance).” (Change 1)

Add the following specification under INPUT (Change 3):

Electrical Characteristics	Performance Limits	Conditions
Reducing System Noise Figure with Pre-amplification	<1.8 dB + noise figure of the external system	Low noise external preamplification with net gain >20 dB

**Page 1-5, Table 1-1:**

Under General, Remote Operation (HP-IB), in the Performance Limits column, change the first compatibility code to SH1. (Errata)

**CHANGE INSTRUCTIONS**

**Page 1-7, Table 1-3:**

Add the following to the table (Change 3):

Instrument	Specifications	Recommended Model	Use
Directional Coupler	Frequency Range: 1380 to 2300 MHz	HP 778D	P

**Page 1-8, Table 1-3:**

Add the following to the table (Change 3):

Instrument	Specifications	Recommended Model	Use
Signal Generator	Frequency Range: 1380 to 2300 MHz Output Level: +10 dBm Fundamental signal generator	HP 8614A	P

**►Page 2-3, Table 2-1:**

Change the ASCII talk character for decimal 30 to ^ . (Errata)

**Section III:**

The Noise Figure Meter's frequency range changed to 10—1600 MHz, and the default STOP FREQ value changed to 1600 MHz. These changes should be noted in the following places. (Change 1)

- Table 3-1, Operating Characteristics
- Simplified Operation
- Figure 3-2, Display and Remote Features
- Table 3-6, Response to a Clear Message (or Pressing PRESET)
- Fixed Frequency Increment Instruction
- Fixed Frequency Tuning Instruction
- Measurement Modes Instruction
- Measurement Mode 1 0 Instruction
- Measurement Mode 1.1 Instruction
- Measurement Mode 1 2 Instruction
- Measurement Mode 1 3 Instruction
- Measurement Mode 1.4 Instruction
- Preset Conditions and Power-up Sequence Instruction
- Sweep Instruction.

**►Page 3-33, Table 3-8:**

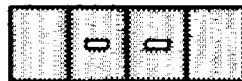
Change the program code for FREQUENCY to "FR". (Errata)

**►Page 3-34, Table 3-8:**

For program code "NE", change the parameter description to read "Enter and Use Spot ENR". (Errata)

**►Page 3-62:**

Place the following figure in the space above the first paragraph (Errata)



Place the following figure in the space above the second paragraph: (Errata)



**CHANGE INSTRUCTIONS**

►Page 3-72:

In the table, change the ASCII talk character for decimal 30 to ^ (Errata)

**Section IV.**

Spurious Response and Jitter performance tests are shown on pages 4-15A through 4-15E. (Change 3)

**Page 4-4, paragraph 4-6:**

Change the specifications to, "INPUT SWR (reflection coefficient): <1.7 (0.26); 10 to 1600 MHz (50 ohms reference impedance)." (Change 1)

**Page 4-10, paragraph 4-8:**

Change the specification to: "GAIN MEASUREMENT CHARACTERISTICS Range: -20 to +40. Instrumentation Uncertainty: ±0.25 dB." (Change 6)

**Page 4-13, paragraph 4-8:**

Change the last sentence in Step 27 to "The error should be within ±0.25 dB." (Change 6)

**Page 4-17, Table 4-1:**

For the Gain Measurement Uncertainty Performance Test change the min. results to -0.25 dB and the max. results to +0.25 dB. (Change 6)

Add the following to the table (Change 3).

Para. No.	Test	Results		
		Min.	Actual	Max.
4-10	<b>SPURIOUS RESPONSE PERFORMANCE TEST</b>			
	Noise Figure (Sig. Gen. Power Off)			
	Step 9	—	_____	0.03 dB
	Step 13	—	_____	0.03 dB
	Step 17	—	_____	0.03 dB
	Step 21	—	_____	0.03 dB
	Noise Figure (Sig. Gen. Power On)			
	Step 8		_____	0.03 dB
	Step 12		_____	0.03 dB
	Step 16		_____	0.03 dB
	Step 20		_____	0.03 dB
	Step 27		_____	0.03 dB
4-11	<b>JITTER PERFORMANCE TEST</b>			
	Minimum Smoothing 5 X Standard Deviation		_____	0.15 dB
	Increased Smoothing 5 X Standard Deviation		_____	0.02 dB

**Page 5-2, paragraph 5-1:**

Change the range of values for A13R19 to 1.0—2.0 kΩ. (Change 1)

**Page 5-15, paragraph 5-13:**

In step 9, change the first sentence to, "Tune the Noise Figure Meter to 1600 MHz." (Change 1)

**CHANGE INSTRUCTIONS****Page 6-5, Table 6-3:**

For all Noise Figure Meters that don't have an analog meter, the recommended replacement for the A1 assembly, if it fails, is found in Change 10. (Errata)

Change the part number of the A1 assembly to 08970-60049 CD8. (Change 10)

The recommended replacement for A1J1, if it needs to be replaced, is found in Change 10. (Errata)

Change the part number of A1J1 to 1252-0078 CD8. (Change 10)

**Page 6-6, Table 6-3:**

The recommended replacement for the A2 assembly, if it fails, is found in Change 10. If the A2 assembly is being replaced, make all changes for the A2 assembly listed for Change 11. (Errata)

Change the part number of the A2 assembly to 08970-60044 CD3. (Change 11)

Change the part numbers and descriptions of A2C2, 3, 5 through 9 and 11 through 24 to 0160-3334 CD9 CAPACITOR-FXD .01  $\mu$ F  $\pm$ 10% 50 VDC CER. (Change 11)

Change the part number and description of A2C10 to 0160-4574 CD1 CAPACITOR-FXD 1000 PF  $\pm$ 10% 100 VDC CER. (Change 11)

Add A2C25 0160-4103 (CD2) CAPACITOR-FXD 220PF  $\pm$ 5% 100VDC CER 72982 8121-M100-C06 221J (Change 4)

Change the part number of A2C25 to 0160-4812 CD0. (Change 11)

**Page 6-7, Table 6-3:**

Change the part number and description of A2DS18 to 1990-0759 CD8 LED-LIGHT BAR MODULE LUM-INT=3MCD (Change 11)

Change the socket part number and description below A2DS18 to 1200-1124 CD8 SOCKET-IC 16-CONT DIP-DIP-SLDR (Change 11)

Change the part number and description of A2J1 to 1251-8962 CD3 CONN-POST TYPE .100-PIN-SPCG 8-CONT. (Change 11)

Change the part number and description of A2R2 to 1810-0956 CD5 NETWORK-RES 14-DIP 22.0K OHM X13. (Change 11)

Delete A2R3 and A2R12. (Change 11)

Change the part number and description of A2R14 to 1810-0424 CD2 NETWORK-RES 16-DIP 4.7K OHM X15. (Change 11)

Delete A2R15. (Change 11)

**Page 6-8, Table 6-3:**

Change the part number and description of A2R21 to 1810-0441 CD3 NETWORK-RES 14-DIP 470.0 OHM X13. (Change 11)

Change the part numbers and descriptions of A2R22 and A2R23 to 1810-0849 CD5 NETWORK-RES 16-DIP 150.0 OHM X15. (Change 11)

Delete A2R24 and A2R25. (Change 11)

Delete A2W2. (Change 11)

**Page 6-13, Table 6-3:**

- ▶ Under A4U1, delete part number 1251-3172 and its description. (Errata)
- ▶ The recommended replacement for the A6 assembly, if it fails, is found in Change 11. (Errata)
- ▶ Change the part number of the A6 assembly to 08970-60042 CD1. (Change 11)
- Change the part numbers of A6K1 through A6K5 to 0490-1361 CD7. (Errata)

**▶Page 6-14, Table 6-3:**

Add the following to the description for A6W11:

(A6W11 is used with A6 assemblies with an HP part number of 08970-60001.) (Errata)

Add the following parts below A6W11:

A6Z1 08970-20046 CD1 PLATE CAPACITOR (A6Z1 is used with A6 assemblies with an HP part number of 08970-60042) (Change 11)

0380-0005 CD1 SPACER-RND .312-IN-LG .18-IN-ID (Change 11)

0515-0900 CD2 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.) (Change 11)



## CHANGE INSTRUCTIONS

**Page 6-15, Table 6-3:**

If A7CR2 fails, replace it with the part described in Change 3. (Errata)  
Change A7CR2 to 1901-0518 (CD8) DIODE-SM SIG SCHOTTKY. (Change 3)

**Page 6-17, Table 6-3:**

The recommended replacement for A9C1, A9C2, A9C4 and A9C6, if they fail, is found in Change 10. (Errata)  
Change the part numbers and descriptions for A9C1, A9C2, A9C4 and A9C6 to 0160-4005 CD3 CAPACITOR-FXD  
1  $\mu$ F  $\pm$ 20% 100 VDC CER. (Change 11)  
Under A9CR5, change 0515-0410 to 0515-0986 (CD4) SCREW-MACH M3 X 0.5 20MM-LG PAN-HD. (Errata)

**Page 6-18, Table 6-3:**

Change the second entry under A9MP3 (0515-0212) to 0515-0887 (CD4) SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD. (Errata)  
Change the second entry under A9Q1 (0515-0211) to 0515-0886 (CD3) SCREW-MACH M3 X 0.5 6MM-LG PAN-HD. (Errata)  
Change the second entry under A9Q2 (0515-0211) to 0515-0886 (CD3) SCREW-MACH M3 X 0.5 6MM-LG PAN-HD. (Errata)  
The recommended replacement for A9U1, if it fails, is found in Change 10. (Errata)  
Change the part number and description for A9U1 to 1826-1181 CD3 IC V RGLTR-FXD-POS 14. 7/15 3V TO-3 PKG. (Change 11)  
Under A9U1, change 0515-0410 to 0515-0986 (CD4) SCREW-MACH M3 X 0.5 20MM-LG PAN-HD. (Errata)  
Under A9U2, change 0515-0057 to 0515-0986 (CD4) SCREW-MACH M3 X 0.5 20MM-LG PAN-HD. (Errata)  
Under A9U3, change 0515-0057 to 0515-0986 (CD4) SCREW-MACH M3 X 0.5 20MM-LG PAN-HD. (Errata)

**Page 6-19, Table 6-3:**

- ▶ The recommended replacement for the A10 assembly, if it fails, is found in Change 11. (Errata)
- ▶ Change the part number of the A10 assembly to 08970-60051 CD2. (Change 11)
- ▶ The recommended replacement for A10CR1, if it fails, is found in Change 11. (Errata)
- ▶ Change A10CR1 to the following: 5062-0785 CD5. (Change 11)
- ▶ The recommended replacement for the A11 assembly, if it fails, is found in Change 11. (Errata)
- ▶ Change the part number of the A11 assembly to 08970-60072 CD7. (Change 11)  
Change A11MP2 to 08970-80018 (CD3) BLOCK-CAVITY 2ND CONVERTER. (Change 1)  
Delete A11MP9. (Change 1)

**Page 6-20, Table 6-3:**

Under A12MP1, change 0515-0165 to 0515-1476 (CD4) SCREW-MACH M3.5 x 0.6 12MM-LG PAN-HD. (Errata)  
The recommended replacement for A12Q1 and A12Q2, if they fail, is found in Change 10. (Errata)  
Change the part numbers and descriptions for A12Q1 and A12Q2 to 1854-0832 CD8 TRANSISTOR NPN PD=625 MW FT=250 MHz. (Change 10)  
Change A12R1 to 0757-0424 (CD7) RESISTOR 1.1K 1% .125W F TC=0 $\pm$ 100 24546 C4-1/8-T0-1101-F. (Errata)  
Change A13 to 08970-60021 (CD6) DRIVER ASSEMBLY. (Change 1)  
Change A13C1 to 0160-4574 (CD1) CAPACITOR-FXD 1000 PF  $\pm$ 10% 100VDC CER. (Change 1)  
Change A13C2 to 0160-4832 (CD4) CAPACITOR-FXD .01UF  $\pm$ 10% 100VDC CER. (Change 1)  
Change A13C6 to 0160-3336 (CD1) CAPACITOR-FXD 100PF  $\pm$ 10% 50VDC CER. (Change 1)

**Page 6-21, Table 6-3:**

Change A13C10—21 to 0160-4832 (CD4) CAPACITOR-FXD .01UF  $\pm$ 10% 100VDC CER. (Change 1)  
Change A13C27 to 0160-4832 (CD4) CAPACITOR-FXD .01UF  $\pm$ 10% 100VDC CER. (Change 1)  
Change A13C30—32 to 0160-4832 (CD4) CAPACITOR-FXD .01UF  $\pm$ 10% 100VDC CER. (Change 1)  
Change A13C33 to 0160-5189 (CD6) CAPACITOR-FXD 4700PF  $\pm$ 10% 100VDC POLYP. (Change 1)  
Change A13C34 to 0160-4803 (CD9) CAPACITOR-FXD 68PF  $\pm$ 5% 100VDC CER 0 $\pm$ 30. (Change 1)  
Change A13C35 to 0160-4805 (CD1) CAPACITOR-FXD 47PF  $\pm$ 5% 100VDC CER 0 $\pm$ 30. (Change 1)  
Change A13C36 to 0160-4835 (CD7) CAPACITOR-FXD .1UF  $\pm$ 10% 50VDC CER. (Change 1)  
Change A13C39—46 to 0160-4832 (CD4) CAPACITOR-FXD .01UF  $\pm$ 10% 50VDC CER. (Change 1)

## CHANGE INSTRUCTIONS

## Page 6-21. Table 6-3 (cont'd):

Change A13C47 to 0160-4803 (CD9) CAPACITOR-FXD 68PF  $\pm 5\%$  100VDC CER 0 $\pm$ 30. (Change 1)

Change A13C48 to 0160-4805 (CD1) CAPACITOR-FXD 47PF  $\pm 5\%$  100VDC CER 0 $\pm$ 30. (Change 1)

Change A13C49 to 0160-4835 (CD7) CAPACITOR-FXD .1UF  $\pm 10\%$  50VDC CER. (Change 1)

Change A13C50 and C53 to 0160-4832 (CD4) CAPACITOR-FXD .01UF  $\pm 10\%$  100VDC CER. (Change 1)

Change A13CR7 to 1901-0539 (CD3) DIODE-SM SIG SCHOTTKY. (Change 1)

The recommended replacement for A13J2, if it needs to be replaced, is found in Change 10. (Errata)

Change the part number of A13J2 to 1252-0242 CD8. (Change 10)

## Page 6-22. Table 6-3:

Change A13R1 to 0698-3156 (CD2) RESISTOR 1.47K 1% .125W F TC=0 $\pm$ 100 24546 C4-1/8-T0-1472-F. (Change 1)

Change A13R8-10 to 0698-3156 (CD2) RESISTOR 14.7K 1% .125W F TC=0 $\pm$ 100 24546 C4-1/8-T0-1472-F. (Change 1)

The recommended replacement for A13R12 and A13R14, if they fail, is found in Change 11. If one of the resistors is replaced, the other resistor must be replaced at the same time. (Errata)

Change the part number and description for A13R12 and A13R14 to 0698-8093 CD6 RESISTOR 40k .1% .1W TF TC=0 $\pm$ 5. (Change 11)

Change A13R26 to 0698-3397 (CD3) RESISTOR 42.2 1% .5W F TC=0 $\pm$ 100. (Change 1)

Change A13R28 to 0698-0885 (CD0) RESISTOR 2.61K 1% .125W F TC=0 $\pm$ 100 24546 C4-1/8-T0-2611-F. (Change 1)

Change A13R29 to 2100-2497 (CD9) RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN 73138 82PR2K. (Change 1)

## Page 6-23. Table 6-3:

Add A13R70 0698-3155 (CD1) RESISTOR 4.64K  $\pm 1\%$  .125W F TC=0 $\pm$ 100 24546 C4-1/8-T0-4641-F. (Change 1)

Change A13U3 to 1820-1437 (CD0) IC MV TTL LS MONOSTBL DUAL 01295 SN74LS221N. (Change 1)

Change A13U20 to 1820-1437 (CD0) IC MV TTL LS MONOSTBL DUAL 01295 SN74LS221N. (Change 1)

## Page 6-24. Table 6-3:

Change A13U34 to 1820-1437 (CD0) IC MV TTL LS MONOSTBL DUAL 01295 SN74LS221N. (Change 1)

Change A13U42 to 1826-0753 (CD3) IC OP AMP LOW-BIAS H-IMPQ QUAD 14-DIP-C 04713 MC34004BL. (Change 1)

The recommended replacement for A14J3, if it needs to be replaced, is found in Change 10. (Errata)

Change the part number of A14J3 to 1252-0277 CD9. (Change 10)

## Pages 6-24 through 6-27. Table 6-3:

For A14 Controller Assembly, refer to pages 6-24/6-25A through 6-26/6-27A. (Changes 4 and 5)

Note: Order Controller Assembly Replacement Kit (HP part number 08970-60063) to replace A14 Controller assemblies with HP part number 08970-60009. (Errata)

The recommended replacement for A14J6, if it needs to be replaced, is found in Change 10. (Errata)

Change the part number of A14J6 to 1252-0242 CD8. (Change 10)

A14U2: For instruments with serial number prefix 2541A, A14U2 part number is 08970-80115. However, the part shown on page 6-25/6-26A is the recommended replacement. Therefore, no further manual change is suggested.

## Page 6-26. Table 6-3:

Under A14U10, change the first entry to 08970-80022 (CD9) ROM #10. (Change 1)

Under A14U12, change the first entry to 08970-80023 (CD0) ROM #12. (Change 1)

Under A14U13, change the first entry to 08970-80024 (CD1) ROM #13. (Change 1)

The recommended replacement for A14U39, if it fails, is found in Change 10. (Errata)

Change the part number and description for A14U39 to 1820-1416 CD5 IC SCHMITT-TRIG TTL LS INV HEX 1-INP. (Change 10)

## Page 6-27. Table 6-3:

Change A14VR2 to 1902-0948 (CD0) DIODE-ZNR 3.9V 5% DO-35 PD= 4W TC=-.012%. (For Serial Number Prefixes 2528A and Below Only)

Under A16MP3, change 0515-0165 to 0515-1476 (CD4) SCREW-MACH M3.5 X 0.6 12MM-LG PAN HD. (Errata)

**CHANGE INSTRUCTIONS****Page 6-28, Table 6-3:**

Change the part number of AT1 (for instruments prefixed 2627A and below) to the following part number: 08970-60025 CD0 08970-60025 is a kit that contains the isolator (AT1) and other components. If the kit (08970-60025) was ordered previously and the isolator needs to be replaced, it can be ordered separately. The part number of the isolator is 0960-0699 CD9. (Errata)

Change the part number for AT1 to the following: 0960-0699 CD9. (Change 9)

Place the following part number and description below AT1:

0403-0275 CD7 BUMPER FOOT-ADH MTG. (The bumpers are placed on the side of the isolator (AT1) closest to the bottom cover.) (Change 9)

Under B1, change 0515-0252 to 0515-1642 (CD1) SCREW-MACH M3 X 0.5 40MM-LG PAN-HD. (Errata)

Change FL1 to 9135-0249 (CD5) FILTER LOW-PASS. This part number is the recommended replacement for all serial prefixes. (Change 1)

Under G1 make the following changes.

1. Delete the entries for 08558-0076, 0520-0136, 2190-0014 and 0610-0001. (Change 7)

2. Add 1400-0482 (CD3) CABLE-TIE .062-3-DIA .14-WD NYL. (Change 7)

Change J2 to 08970-60023 (CD8) CONNECTOR ASSY-INPUT (EXCEPT OPT. 001). (Change 2)

**Page 6-29, Table 6-3:**

Add the following part numbers and descriptions below J11-

2950-0035 CD8 NUT-HEX-DBL-CHAM 15/32-32-THD

2190-0068 CD5 WASHER-LK INTL T 1/2 IN .505-IN-ID. (Errata)

Change MP1 to 08970-20027 (CD8) FRAME-FRONT MOD. (Change 2)

Change MP2 to 08970-00057 (CD2) REAR PANEL. (Change 2)

Change MP3 (both entries) to the following:

5021-5836 (CD1) CORNER STRUTS (15") (Change 2)

0515-1331 (CD5) SCREW M4 x 0.7 (Change 2)

Change MP4 to 08970-00058 (CD3) BRACKET-RF SECTION (RIGHT). (Change 2)

Change MP5 (both entries) to the following:

08970-00059 (CD4) BRACKET-RF SECTION (LEFT) (Change 2)

0515-1331 (CD5) SCREW M4 x 0.7. (Change 2)

Under MP6, change 0515-0210 to 0515-0885 (CD2) SCREW-MACH M4 x 0.7 8MM-LG PAN-HD. (Errata)

Under MP6, change the first entry to 08970-00055 (CD0) STRUT-HINGE BRACKET. (Change 2)

Change MP7 to 5061-9434 (CD7) COVER (TOP). (Change 2)

Change MP8 to only two entries:

08970-00056 (CD1) COVER (BOTTOM) (Change 2)

7120-8138 (CD4) LABEL-INFO. (Change 2)

Change MP12 to 5041-6819 (CD4) HANDLE-CAP (FRONT). (Change 2)

Change MP13 to 5041-6820 (CD7) HANDLE-CAP (REAR). (Change 2)

Under MP18, change 0515-0225 to 0515-0893 (CD2) SCREW-MACH M3.5 X 0.6 10MM-LG PAN-HD. (Errata)

▶ The recommended replacement for MP21, if it needs to be replaced, is found in Change 11. (Errata)

▶ Change the part number of MP21 to 08970-20072 CD3. (Change 11)

Under MP21, change 0515-0210 to 0515-0885 (CD2) SCREW-MACH M4 X 0.7 8MM-LG PAN-HD. (Errata)

Delete MP23, 24, and 25. (Change 1)

Add MP26 08970-80021 (CD8) OPERATING INFO PULL-OUT CARDS. (Change 1)

Change MP30 to: 08970-00062 (CD9) PANEL (FRONT). (Change 1)

0515-1234 (CD7) SCREW-MACH M3.5 x 0.6 8MM-LG. (Change 1)

Change the first entry under MP30 to 08970-00069 (CD6) PANEL-FRONT. (Change 8)

Under MP31, change the first entry to 08970-00049 (CD2) PANEL-WINDOW. (Change 1)

Change MP31 (both entries) to the following:

08970-00070 (CD9) PANEL-WINDOW. (Change 8)

0510-1148 (CD2) RETAINER-PUSH ON KB-TO-SHFT EXT. (Change 8)

Change MP39 to:

08970-00061 (CD8) BRACKET-FRONT PANEL. (Change 1)

2190-0585 (CD1) WASHER-LK HLCL 3.5MM 3.6MM-ID (Change 1)

0535-0007 (CD2) NUT-HEX DBL-CHAM M3.5 x 0.6 2.8MM-THK. (Change 1)

## CHANGE INSTRUCTIONS

**Page 6-29, Table 6-3 (cont'd):**

Under MP39, add the following parts:

0515-1234 (CD7) SCREW-MACH M3.5 x 0.6 8MM-LG. (Change 4)

3050-1192 (CD3) WASHER-FL MTLC 3.5MM 3.8MM-ID. (Change 4)

Change the first entry under MP39 to 08970-00071 (CD0) BRACKET-FRONT PANEL. (Change 8)

- ▶ The recommended replacement for MP40, if it needs to be replaced, is found in Change 11. (Errata)
- ▶ Change the part number and description for MP40 to the following:  
7121-4963 CD7 NAMEPLATE 9.23-MM-WD 13.7-MM-LG CU. (Change 11)

**Page 6-30, Table 6-3:**

Under MP50, change 0515-0211 to 0515-0886 (CD3) SCREW-MACH M3 X 0.5 6MM-LG PAN-HD. (Errata)

Change MP55 to 7100-1283 (CD4) TRANSFORMER COVER. (Change 4)

Under MP56, change 0515-0211 to 0515-0886 (CD3) SCREW-MACH M3 X 0.5 6MM-LG PAN-HD. (Errata)

- ▶ The recommended replacement for MP57, if it needs to be replaced, is found in Change 11. (Errata)
- ▶ Change the part number and description for MP57 to the following:

6960-0133 CD2 PLUG-HOLE TR-HD FOR .438-D-HOLE BRS. (Change 11)

Change MP58 to 0515-0892 (CD1) SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD. (Errata)

Under MP59, delete the second entry, 2360-0195. (Errata)

Under MP60, add 2360-0195 (CD0) SCREW-MACH 6-32 .312-IN-LG PAN-HD POZI. (Errata)

Under MP60, change 2360-0195 (described above) to 0515-1132 (CD4) SCREW-MACH M5 x 0.8. (Change 2)

Make the following changes to MP61:

1. Change the first entry to 08970-00076 (CD5) BRACKET-YIG OSCILLATOR. (Change 7)
2. Change the second entry to 0515-0886 (CD3) SCREW-MACH M3 X 0.5 6MM-LG PAN-HD. (Errata)
3. Add 3050-0891 (CD5) WASHER-FL MTLC 3.0MM 3.3-MM-ID. (Change 7)

Delete MP62. (Change 7)

Change MP63 to 0515-0738 (CD4) SCREW-MACH M4 X 0.7 70MM-LG PAN-HD. (Change 7)

Change MP64 to 0515-1105 (CD1) SCREW-MACH M3 X 0.5 10MM-LG PAN-HD. (Change 7)

Change MP65 to 0515-0885 (CD2) SCREW-MACH M4 X 0.7 8MM-LG PAN-HD. (Errata)

Change MP71 to 08970-00079 CD8. (Change 9).

Under MP71, change 0515-0212 to 0515-0887 (CD4) SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD (Errata)

Under MP81, change 0515-0212 to 0515-0887 (CD4) SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD. (Errata)

Change MP85 (both entries) to the following:

08970-00060 (CD7) BRACKET-HINGE (FRONT) (Change 2)

0515-1234 (CD7) SCREW-MACH M3.5 x 0.6 8MM-LG (Change 2)

Under MP86, change 0515-0211 to 0515-0886 (CD3) SCREW-MACH M3 X 0.5 6MM-LG PAN-HD. (Errata)

Change MP87 (three entries) to the following:

08970-20074 (CD5) BRACKET-POWER SWITCH (Change 2)

0515-0211 (CD8) SCREW-MACH M3 x 0.5 6MM-LG PAN-HD (Change 2)

0515-0891 (CD0) SCREW M3.5 x 0.6 (Change 2)

Under MP87 (above), change entry 0515-0891 to 0515-1234 (CD7) SCREW-MACH M3.5 x 0.6 8MM-LG. (Change 4)

Under MP87 (above), change 0515-0211 to 0515-0886 (CD3) SCREW-MACH M3 X 0.5 6MM-LG PAN-HD. (Change 7)

Under MP88, change 0515-0210 to 0515-0885 (CD2) SCREW-MACH M4 X 0.7 8MM-LG PAN-HD. (Errata)

Change MP89 to 08970-00078 CD7. (Change 9).

**Page 6-31, Table 6-3:**

Under MP91, change 0515-0224 to 0515-0892 (CD1) SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD. (Errata)

Under MP92, change 0515-0224 to 0515-0892 (CD1) SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD. (Errata)

Add MP96 using the following part number and description: (Change 9)

08970-00077 CD6 ISOLATOR SUPPORT

Under MP96, add the following part number and description: (Change 9)

0515-0885 CD2 SCREW-MACH M4 X 0.7 8MM-LG PAN-HD (used to mount MP96 to MP89).

**Page 6-32, Table 6-3:**

Under S2, change 0515-0211 to 0515-0886 (CD3) SCREW-MACH M3 X 0.5 6MM-LG PAN-HD. (Errata)

Under T1, make the following changes:

1. Change 0515-0125 to 0515-1163 (CD1) SCREW-MACH M5 X 0.8 45MM-LG PAN-HD (EXCEPT OPT. 001). (Errata)

## CHANGE INSTRUCTIONS

## Page 6-32, Table 6-3 (cont'd):

2. Change 0515-0295 to 0515-0984 (CD2) SCREW-MACH M5 X 0.8 50MM-LG PAN-HD (OPTION 001 ONLY). (Errata)

Change the part number for W4 to 08970-20036 CD9 (Change 9).

Change the part number for W5 to 08970-20038 CD1 (Change 9).

Change the part number for W6 to 08970-20037 CD0 (Change 9).

Change W8 to 08970-20035 (CD8) CABLE ASSY-SEMIRIGID (G1 TO A10). (Change 7)

## ►Page 7-9, Change C:

Under A13U17, add the following parts:

0360-0124 CD3 CONNECTOR-SGL CONT PIN .04-IN-BSC-SZ RND

1200-0639 CD8 SOCKET-IC 20-CONT DIP DIP-SLDR (Change 11)

Under BT1 (bottom of page), change 08672-00011 to 85660-00054 CD6. (Errata)

## ►Page 7-13, Figure 7-6:

Replace the portion of Figure 7-6 using the partial schematic found in Figure 1. (Change 11)

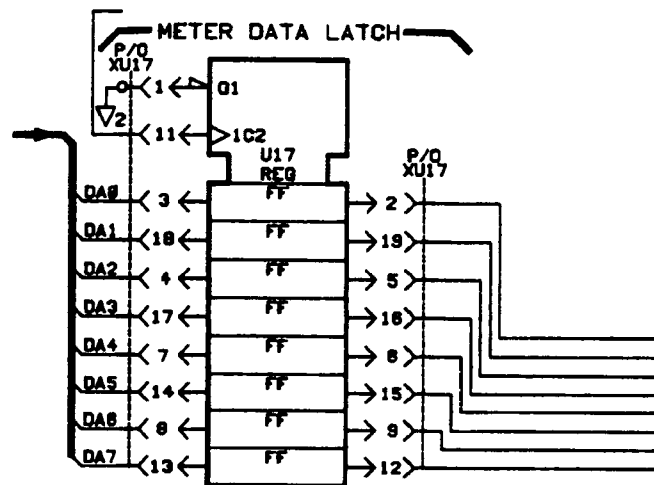


Figure 1. P/O Figure 7-6. Schematic 6 (P/O Change C)

## Pages 8-6 and 8-7, paragraph 8-19:

**Power-Up Checks.** For Change 4, a different check is needed. Mark your manual with a reference to page 8-6/8-7A.

## Page 8-8:

Change the description for E51 to, "A14U2, failed Power-Up Check 5." (Change 4)

Delete error codes E52 through E71. (Change 4)

Change the description of E72 to, "A14U4, failed Power-Up Check 1 or 3." (Change 4)

Change the description of E73 to, "A14U5, failed Power-Up Check 4." (Change 4)

Change the description of E74 to, "A14U12, failed Power-Up Check 7." (Change 4)

Delete error codes E75 through E78. (Change 4)

## Pages 8-29 through 8-33, Service Sheet BD1 (text and schematic):

Change the input frequency range to 10—1600 MHz. (Change 1)

Change the frequency range of the first LO (YIG oscillator) to 2060—3650 MHz during normal operation and 2050—3650 MHz during calibration. (Change 1)

On page 8-31, in the second column under "If Indication Abnormal," change the first paragraph to read as follows:

1. If error E72 is displayed, the CMOS RAM Stack Power-Up Check has failed. Suspect A14U4. Refer to the Power-Up Checks on page 8-6/8-7A of this supplement. (Change 4)

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**CHANGE INSTRUCTIONS**


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**►Page 8-32:**

In step 3, under Table 8-5, change "E65 through E78" to "E72 through E74". (Change 4)

In step 4, under Table 8-5, change the first sentence to read "If error E51 is displayed, the ROM check has failed". (Change 4)

**Pages 8-34 through 8-35/8-36. Service Sheet 8D2 (text and schematic):**

Change the input frequency range to 10—1600 MHz. (Change 1)

In the A10 First Converter Assembly, change the 1550 MHz low-pass filter to a 1650 MHz low-pass filter. (Change 1)

In the A10 First Converter Assembly, change the frequencies into the 3 dB power splitter to 2060—3650 MHz during normal operation and 2050—3650 MHz during calibration. (Change 1)

Under TROUBLESHOOTING, √ 7 Power Supply and Input Assembly Checks, change "A12TP2" to "A12TP1" (2 places). (Errata)

**Pages 8-38 through 8-43. Service Sheet 8D4:**

In the troubleshooting paragraph titled Free Run Signatures, change the software date code to 30119. (Change 1)

Table 8-9. Change the signatures as indicated below. (Change 1)

Node (ref. des.)-pin	Signal Name	Signature
U36-2	D0	2C77
-4	D1	80PU
-6	D2	9F0P
-9	D3	F966
-3	D4	CF9A
-5	D5	U1U8
-7	D6	C688
-8	D7	UH03

For Changes 4 and 5, a different service sheet is needed. Mark your manual with references to pages 8-38/8-42A through F and page 8-43A.

**Pages 8-44 through 8-47, Service Sheet 1 (text and schematic):**

- On the component locator photograph (Figure 8-23), add Z1 next to W11 (bottom of figure). (Change 11)
- Change the part number of the A6 assembly (upper left side of schematic) to 08970-60042. (Change 11)  
Change the input frequency range to 10—1600 MHz. (Change 1)
- On the A6 assembly under "2 dB Pad" (right side of schematic), add Z1 next to W11. (Change 11)
- Change the part number of the A10 assembly (right side of schematic) to 08970-60051. (Change 11)  
In the A10 First Converter Assembly, change the 1550 MHz low-pass filter to a 1650 MHz low-pass filter. (Change 1)
- At connector J1 on the A10 assembly, change the frequency of the low-pass filter to 1850 MHz. (Change 1)  
At the input to A10 First Converter Assembly, change the frequencies to 2060—3650 MHz during normal operation and 2050—3650 MHz during calibration. (Change 1)

**►Pages 8-48 through 8-51. Service Sheet 2 (schematic):**

Change the part number of the A11 assembly (left side) to 08970-60072. (Change 11)

**Page 8-61. Service Sheet 6 (schematic):**

At the top left of the schematic, change A13 part number to 08970-60021 (Change 1)

In the Start Conversion Pulse Stretcher, change R1 to 14.7k $\Omega$ , and delete the ground connection at the junction of C2 and U34A pin 14. (Change 1)

In the Overflow Pulse Stretcher, change R3 to 14.7 k $\Omega$ , and delete the ground connection at the junction of C6 and U20B pin 6. (Change 1)

In the Gate Clear Pulse Stretcher, change R9 to 14.7 k $\Omega$ , and delete the ground connection at the junction of C13 and U20A pin 14. (Change 1)

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**CHANGE INSTRUCTIONS**


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**Page 8-61. Service Sheet 6 (schematic) (cont'd):**

In the End of Conversion Pulse Stretcher, change R10 to 14.7 k $\Omega$ , and delete the ground connection at the junction of C14 and U34B pin 6. (Change 1)

In the Integrated Circuit Part Numbers table, change the part numbers for U20 and U34 to 1820-1437. (Change 1)

**Page 8-64. Service Sheet 7, Figure 8-45:**

For Change 1, a different figure is needed. Mark your manual with a reference to page 8-64A.

**Page 8-67. Service Sheet 7 (schematic):**

At the top left of the schematic, change A13 to 08970-60021. (Change 1)

► Change the value of A13R12 and A13R14 (above U42D; center of the schematic) to 40k Ohms. (Change 11)

Change R26 to 42.2 $\Omega$ . (Change 1)

In the Transistor and Integrated Circuit Part Numbers table, change U42 to 1826-0753. (Change 1)

**Page 8-68. Service Sheet 8 (text):**

Under Key Closure Detection (paragraph 4) delete "(or A2R3)". (Change 11)

Under Key Closure Detection Test (step 2) change "A2R12" to "A2R14" (two places) and delete "A2R3" (two places). (Change 11)

**Page 8-68. Figure 8-49:**

Replace Figure 8-49 with Figure 8-49 (Page 8-68A) in this supplement. (Change 11)

**Page 8-69. Service Sheet 8 (schematic):**

Change the part number (upper left side of schematic) to 08970-60044. (Change 11)

On the lower left side of the schematic, change the destination of line BF (D GND) from 19 to 11. (Change 4)

Replace the portions of the schematic with the partial Figure 8-52 (Page 8-69A) in this supplement. (Change 11)

In note 2 (upper right side of service sheet) delete "or R3" and change "R12" to "R14". (Change 11)

**Page 8-71. Figure 8-53.**

Replace Figure 8-53 with Figure 8-53 (Page 8-71A) in this supplement. (Change 11)

**Page 8-73. Service Sheet 9 (schematic):**

Change the part number (upper left side of schematic) to 08970-60044. (Change 11)

Delete W2 (lower left side of schematic). Connect the two grounds together. (Change 11)

On the left side of the schematic, add C25, 220 pF, between U9 pin 19 and ground. (Change 4)

Replace the portion of the schematic with the partial Figure 8-55 (Page 8-73A) in this supplement. (Change 11)

**Page 8-74. Service Sheet 10 (Table 8-42):**

Under "LED Device", make the following changes.

Change DS33C to DS33F.

Change DS33F to DS33C.

Change DS34B to DS34G.

Change DS34G to DS34B.

Change DS32B to DS32G.

Change DS32G to DS32B. (Change 11)

Under "Drive Resistor", make the following changes:

Change R22D to R22K.

Change R22C to R22L.

Change R25E to R22E.

Change R25F to R22J.

Change R25A to R22A.

Change R25B to R22B.

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**CHANGE INSTRUCTIONS**

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**Page 8-74, Service Sheet 10 (Table 8-42) (cont'd):**

- Change R25D to R22D.
- Change R25G to R22F.
- Change R25E to R22C.
- Change R25C to R22D.
- Change R22B to R22M.
- Change R22A to R22N. (Change 11)

**Page 8-74, Service Sheet 10 (Table 8-43):**

Under "LED Device", make the following changes:

- Change DS18A to DS18B.
- Change DS18B to DS18G.
- Change DS32C to DS32F.
- Change DS32F to DS32C. (Change 11)

Under "Drive Resistor", make the following changes:

- Change R23D to R23F.
- Change R23E to R23D.
- Change R23G to R23H.
- Change R23F to R23G.
- Change R24A to R23A.
- Change R23A to R230.
- Change R24G to R23E.
- Change R24F to R23K.
- Change R24E to R23L.
- Change R24D to R23M.
- Change R24C to R23J.
- Change R24B to R23B. (Change 11)

**Page 8-74, Figure 8-56:**

Replace Figure 8-56 (Page 8-74A) with Figure 8-56 in this supplement. (Change 11)

**Page 8-75, Service Sheet 10 (schematic):**

- Change the part number (upper left side of schematic) to 08970-60044 (Change 11)
- Replace the portions of the schematic with the partial Figure 8-59 (Page 8-75A) in this supplement. (Change 11)
- Change the pin numbers for R21B (below the Keyboard Annunciator Latch) as follows: "1" to "14" and "3" to "13". (Change 11)

**Pages 8-76 through 8-83, Service Sheet 11:**

For Change 4, a different service sheet is needed. Mark your manual with references to pages 8-76A through F, pages 8-77A, 8-78A, 8-79A, 8-80A, 8-81A, 8-82A, and 8-83A.

**Pages 8-84 through 8-89, Service Sheet 12:**

For Change 4, a different service sheet is needed. Mark your manual with references to pages 8-84/8-87A through I, 8-88A, and 8-89A.

**Pages 8-90 through 8-91, Service Sheet 13:**

Delete the entire service sheet. (Change 4)

**Pages 8-92 through 8-93, Service Sheet 14:**

On the schematic, in the Integrated Circuit Part Numbers table, make the following changes:

- U10 to 08970-80022 (Change 1)
- U12 to 08970-80023 (Change 1)
- U13 to 08970-80024 (Change 1)

For Change 4, delete the entire service sheet.



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**CHANGE INSTRUCTIONS**

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**Pages 8-94 through 8-97, Service Sheet 15:**

For Change 4, a different service sheet is needed. Mark your manual with references to pages 8-94A through F, 8-95/8-96A, and 8-97A.

**Page 8-99, Service Sheet 16 (schematic):**

At the top-left of the schematic, change A13 to 08970-60021. (Change 1) In the Point-to-Point Timing circuit, make the following changes:

R28 to 2610 $\Omega$  (Change 1)

R29 to 2000 $\Omega$  (Change 1)

C33 to 4700 pF (Change 1)

Change C35 to 47 pF. (Change 1)

Add R70, 4.64 k $\Omega$ , between CR7 and J4 pin 7. (Change 1)

On the right side of the schematic, change the destination of line DD from 13 to 12. (Change 4)

In the Integrated Circuit Part Numbers table, change U3 to 1820-1437. (Change 1)

**Page 8-102, Service Sheet 17, Figure 8-78:**

Change reference designator R49 to R50. (Errata)

Change reference designator R50 to R51. (Errata)

Change reference designator R51 to R52. (Errata)

Change reference designator R52 to R49. (Errata)

**Page 8-103, Service Sheet 17 (schematic):**

At the top-left of the schematic, change A13 to 08970-60021. (Change 1)

Change C48 to 47 pF. (Change 1)

**Pages 8-104 through 8-105, Service Sheet 18:**

For Change 4, a different service sheet is needed. Mark your manual with references to pages 8-104A through F, and 8-105A.

**Pages 8-109, Service Sheet 19 (schematic):**

Delete the connection between A9J3 pin 13 and line BF (D GND). (Change 4)

**PERFORMANCE TESTS**

**4-10. SPURIOUS RESPONSE PERFORMANCE TEST**

<b>Specification</b>	<b>SPURIOUS RESPONSE:</b> Change in noise figure < 0.03 dB for spurious levels below -45 dBm in the 10 to 2100 MHz range and -15 dBm in the 2.1 to 18 GHz range.
<b>Description</b>	The signal generator power level is adjusted to give the desired power out of the directional coupler. Noise figure readings are taken at several frequencies with the signal generator power on and off. The difference between the two readings should be less than 0.03 dB.
<b>Equipment</b>	Attenuator, 10 dB ..... HP 8491A Opt. 010 Directional Coupler ..... HP 778D Noise Source ..... HP 346B Opt. 001 Power Meter ..... HP 436A Power Sensor ..... HP 8484A Signal Generator ..... HP 8614A

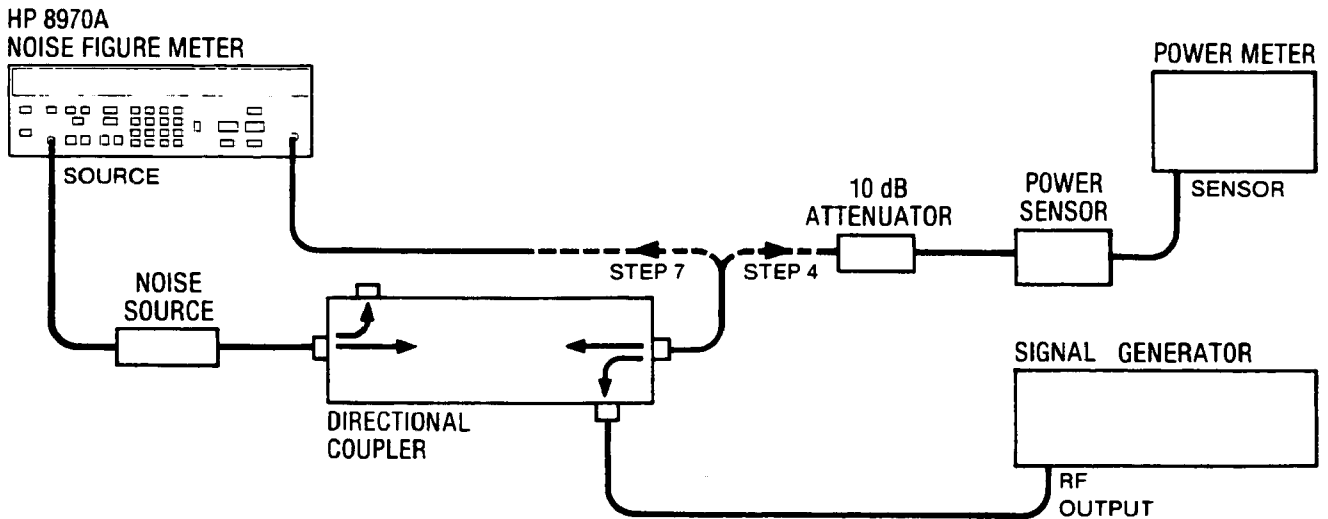


Figure 4-4. Spurious Response Test Setup

- Procedure**
1. Set the signal generator frequency to 1380 MHz.
  2. On the Noise Figure Meter press PRESET, then key in 13.1 SPECIAL FUNCTION, 13.2 SPECIAL FUNCTION and 32 ENTER to set the arithmetic smoothing factor to 32.
  3. On the Noise Figure Meter, set FREQUENCY to 500 MHz.
  4. Connect the equipment as shown in Figure 4-4.
  5. On the Noise Figure Meter, key in 80.0 SPECIAL FUNCTION to turn the noise source off.
  6. Adjust the signal generator output power to give a reading of -55 dBm on the power meter.

## PERFORMANCE TESTS

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**Procedure  
(cont'd)**

7. Connect the input of the directional coupler to the INPUT connector of the Noise Figure Meter, then press NOISE FIGURE.
8. Note the noise figure reading with the signal generator power off. \_\_\_\_\_ dB
9. Note the noise figure reading with the signal generator power on. \_\_\_\_\_ dB
10. Subtract step 9 from step 8. The difference should be less than 0.03 dB. \_\_\_\_\_ dB
11. On the Noise Figure Meter, set FREQUENCY to 1400 MHz.
12. Note the noise figure reading with the signal generator power off. \_\_\_\_\_ dB
13. Note the noise figure reading with the signal generator power on. \_\_\_\_\_ dB
14. Subtract step 13 from step 12. The difference should be less than 0.03 dB. \_\_\_\_\_ dB
15. Set the signal generator frequency to 1420 MHz.
16. Note the noise figure reading with the signal generator power off. \_\_\_\_\_ dB
17. Note the noise figure reading with the signal generator power on. \_\_\_\_\_ dB
18. Subtract step 17 from step 16. The difference should be less than 0.03 dB. \_\_\_\_\_ dB
19. Set the signal generator frequency to 2050 MHz. Repeat steps 4 through 7.
20. Note the noise figure reading with the signal generator power off. \_\_\_\_\_ dB
21. Note the noise figure reading with the signal generator power on. \_\_\_\_\_ dB
22. Subtract step 21 from step 20. The difference should be less than 0.03 dB. \_\_\_\_\_ dB
23. Set the signal generator frequency to 2300 MHz.
24. Repeat steps 4 through 7, but adjust the signal generator output to give a reading of  $-25$  dBm on the power meter.
25. Note the noise figure reading with the signal generator power off. \_\_\_\_\_ dB
26. Note the noise figure reading with the signal generator power on. \_\_\_\_\_ dB
27. Subtract step 26 from step 25. The difference should be less than 0.03 dB. \_\_\_\_\_ dB

**PERFORMANCE TESTS**

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**4-11. JITTER PERFORMANCE TEST**

**Specification**     JITTER: Peak-to-peak<sup>1</sup> Y-factor variation < 0.15 dB with minimum smoothing; peak-to-peak<sup>1</sup> Y-factor variation < 0.02 dB with increased smoothing (for smoothing set to 64).

<sup>1</sup>Peak-to-peak is defined as five times the standard deviation of a statistically valid set of readings. Five standard deviations about the mean includes 99% of the readings for a Gaussian distribution.

**Description**     The Noise Figure Meter is set to read Y-factor in dB. A large number of noise figure readings are taken with the noise source connected directly to the Noise Figure Meter's INPUT connector. Measurement hold and trigger are used to allow data to be recorded manually. Data is then examined to determine compliance with the specification.

**NOTES**

*This procedure is very time consuming. If you have an HP 9826/36 controller, you can use the program listed at the end of this procedure to test this specification automatically.*

*This specification is statistical in nature. The truly correct way to make the measurement would be to take several hundred measurements to ensure a statistically valid sample has been gathered.*

**Equipment**     Noise Source .....HP 346B Opt. 001

- Procedure**
1. Turn on the Noise Figure Meter and allow a 1 hour warm-up.
  2. Press PRESET to set the instrument to standard conditions. Connect the noise source directly to the INPUT connector.
  3. Key in 10.2 SPECIAL FUNCTION to set the instrument to read Y-factor in dB.
  4. Key in 30.1 SPECIAL FUNCTION to set the instrument to trigger hold.
  5. Execute 30.2 SPECIAL FUNCTION 100 times to get 100 separate readings. Record the readings. If you are using a computer or a calculator with statistical computation capabilities (that is, standard deviation), enter the data points as they are read from the Noise Figure Meter.
  6. Find the standard deviation. If you are using a calculator that does not have the standard deviation function, first calculate the mean.

$$\text{Mean} = (\text{Total of all points})/\text{Number of points}$$

Mean \_\_\_\_\_

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**PERFORMANCE TESTS**


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**JITTER PERFORMANCE TEST (cont'd)****Procedure  
(cont'd)**

Then compute the standard deviation.

$$\sqrt{\sum_{i=1}^N \frac{(X_i - \text{mean})^2}{N-1}} \text{ for } N = 100$$

Standard Deviation \_\_\_\_\_

7. Multiply the standard deviation by 5. The result should be <0.15 dB. If the result is >0.15 dB, perform steps 5 and 6 using a larger number of points. Also, make sure the noise source is properly connected to the INPUT connector. \_\_\_\_\_ dB
8. Set the smoothing to 64 by pressing the SMOOTHING INCREASE key until 64 appears in the left display.
9. Repeat steps 5 and 6, but allow 10 seconds after triggering the reading before recording the data.
10. Multiply the standard deviation by 5. The result should be <0.02 dB. If the result is >0.02 dB, perform steps 5 and 6 using a larger number of points. Also, make sure the noise source is properly connected to the INPUT connector. \_\_\_\_\_ dB

### Automated Jitter Performance Test for HP 9826/36 with BASIC 2.0

```

10  PRINTER IS 701
20  PRINT "SPEC. LIMIT      HP 8970B JITTER"
30  DIM Point(100)
40  OUTPUT 708;"PR 13.1SP 13.2SP 1EN 10.2 SP FR100MZ"
50  |
60  |*****
70  | Set HP 8970B for arithmetic smoothing with N=1, display Y factor *
80  | in dB, set frequency to 100 MHz
90  |*****
100 |
110 N=100
120 Spec=.150
130 Starttest:
140 Quantity=0
150 Total=0
160 |
170 |*****
180 FOR I=1 TO N
190     ENTER 708;Reading
200     Point(I)=Reading
210     Total=Total+Reading
220     DISP I;" OF ";N
230 NEXT I
240 |*****
250 |
260 Average=Total/N
270 FOR I=1 TO N
280     Quantity=(Point(I)-Average)^2+Quantity
290 NEXT I
300 Jitter=5*SQR(Quantity/(N-1))
310 |
320 |*****
330 |
340 IF Jitter>Spec THEN
350     Fail_sym$=".. FAIL .."
360 ELSE
370     Fail_sym$=".. PASS .."
380 END IF
390 PRINT " ";Spec;" ";
400 PRINT USING 410;Jitter;" ";Fail_sym$
410 IMAGE Z.DDD,K,K
420 |
430 |*****
440 |
450 IF Spec=.02 THEN 510
460 |
470 Spec=.020
480 DISP "PLEASE WAIT"
490 OUTPUT 708;"13.2SP 64EN"
500 GOTO Starttest
510 PRINTER IS 1
520 END

```

Table 6.3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A14	08970-60019	2	1	CONTROLLER BD AY	28480	08970-60019
A14C1	0180-1746	5	14	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A14C2	0180-0229	1		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A14C3	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C4	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C5	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A14C6	0160-3334	9	1	CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C7	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C8	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C9	0160-5624	4		CAPAL. OF FXD 5600PF +-5% 100VDC	28480	0160-5624
A14C10	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A14C11	0160-3334	9	1	CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C12	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C13	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A14C14	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C15	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C16	0160-3334	9	1	CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C17	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C18	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C19	0160-3334	9		CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C20- A14C22					NOT ASSIGNED	
A14C23	0160-3334	9	1	CAPACITOR-FXD 01UF +-10% 50VDC CER	28480	0160-3334
A14C24	0160-3336	1		CAPACITOR-FXD 100PF +-10% 50VDC CER	28480	0160-3336
A14CR1	1901-0050	3	3	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A14CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A14CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A14J1	1251-8392	3	2	CONN-POST TYPE .100-PIN-SPEC 6-CONT	28480	1251-8392
A14J2	1251-8281	9		CONN-POST TYPE .100-PIN-SPEC 5-CONT	28480	1251-8281
A14J3	1251-5671	5		CONNECTOR 20-PIN M POST TYPE	28480	1251-5671
A14J4	1251-8392	3		CONN-POST TYPE .100-PIN-SPEC 6-CONT	28480	1251-8392
A14J5	1251-8393	4		CONN-POST TYPE .100-PIN-SPEC 7-CONT	28480	1251-8393
A14J6	1251-5720	5	1	CONNECTOR 34-PIN M POST TYPE	28480	1251-5720
A14J7	0360-0124	3		CONNECTOR-SGL CONT PIN .04 IN-BSC-SZ RND	28480	0360-0124
A14L1	9140-0114	4	2	INDUCTOR RF-CH-MLD 10UH 10% .166DX .385LG	28480	9140-0114
A14L2	9100-1611	4		INDUCTOR RF-CH-MLD 220NH 20%	28480	9100-1611
A14L3	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX .385LG	28480	9140-0114
A14MP1	08970-20022	3	19	MODIFIED SCREW	28480	08970-20022
A14MP2	3050-0139	6		WASHER-FL MTLG NO. 8 .172-IN-ID	28480	3050-0139
A14MP3	0510-1024	3		RETAINER-RING E-R EXT .189-IN-DIA STL	28480	0510-1024
A14MP4	1400-0966	8		CLIP-CHPNT .17- .185-DIA .195-WD STL	91506	6015-13AT
A14MP5	0403-0285	9		BUMPER FOOT-ADH MTG 12.7-MM-WD	28480	0403-0285
A14MP6	3050-0172	7		WASHER-FL NM NO 10 .203-IN-ID	28480	3050-0172
A14Q1	1853-0393	4	2	TRANSISTOR PNP SI TO-18 PD=500MW	28480	1853-0393
A14Q2	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A14Q3	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A14Q4	1854-0811	3		TRANSISTOR NPN SI PD=625MW FT=100MHZ	28480	1854-0811
A14Q5	1854-0811	3		TRANSISTOR NPN SI PD=625MW FT=100MHZ	28480	1854-0811
A14R1	0757-0422	5	6	RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909P-F
A14R2	0757-0290	5		RESISTOR 6.19k 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A14R3	0698-7089	8		RESISTOR 450 1% .125W F TC=0+-100	28480	0698-7089
A14R4	0757-0279	0		RESISTOR 3.16k 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R5	0757-0279	0		RESISTOR 3.16k 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R6	0757-0419	0		RESISTOR 3.16k 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R7	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A14R8	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A14R9	0757-0442	9		RESISTOR 10k 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A14R10	0757-0465	6		RESISTOR 100k 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A14R11	0698-3162	0		RESISTOR 3.16k 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A14R12	0757-0279	0		RESISTOR 3.16k 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R13	0757-0279	0		RESISTOR 3.16k 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R14	0757-0279	0		RESISTOR 3.16k 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R15					NOT ASSIGNED	

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A14R16	1810-0424	2	2	NETWORK-RES 16-DIP4 7K OHM X 15	11236	761-1-R4 7K
A14R17	1810-0316	1	1	NETWORK-RES 16-DIP10 0K OHM X 8	01121	316B103
A14R18				NOT ASSIGNED		
A14R19	1810-0424	2	2	NETWORK-RES 16-DIP4 7K OHM X 15	11236	761-1-R4 7K
A14R20	0698-3435	0	1	RESISTOR 38 3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A14R21	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A14R22	0698-3162	0		RESISTOR 46 4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A14R23	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A14R24	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A14R25				NOT ASSIGNED		
A14R26	0698-3162	0		RESISTOR 46 4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A14R27	0757-0419	0	1	RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A14R28	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A14R29	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A14R30	0757-0438	3	1	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A14R31				NOT ASSIGNED		
A14R32	0698-3162	0		RESISTOR 46 4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A14S1				NOT ASSIGNED		
A14S2	3101-2135	5	1	SWITCH-RFR DIP-RFR-ASSY DPDT 05A 30VDC	28480	3101-2135
A14TP1	0360-0535	0	21	TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP5	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP6	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP7	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP8	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP9	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP10	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP11	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP12	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP13	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP14	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP15	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP16	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP17	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP18	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP19	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP20	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP21	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14U1	08970-80116	2	1	PAL PROGRAMMED	28480	08970-80116
A14U2	08970-80117	3	1	EPRON 1 PGMD-MOS	28480	08970-80117
A14U3	1820-2775	1	1	IC GATE TTL ALS NAND TPL 3-INP	01295	SN74ALS10N
A14U4	1818-1768	5	3	IC CMOS 16384 (16K) STAT RAM 150-NS 3-5	S0545	UPD446C-1 (PER HP DWG)
A14U5	1818-1768	5	5	IC CMOS 16384 (16K) STAT RAM 150-NS 3-5	S0545	UPD446C-1 (PER HP DWG)
A14U6	1820-1858	9	1	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A14U7	1820-1208	3	3	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A14U8	1820-1794	2	5	IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U9	1820-1794	2		IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U10	1820-1794	2		IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U11	1820-1794	2		IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U12	1818-1768	5		IC CMOS 16384 (16K) STAT RAM 150-NS 3-5	S0545	UPD446C-1 (PER HP DWG)
A14U13	1820-2075	4	5	IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U14	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U15	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U16	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U17	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A14U18	1820-3431	6	1	IC TRANSCEIVER TTL S INSTR-BUS IEEE-488	28480	1820-3431
A14U19	1820-1566	8	2	IC BFR TTL LS BUS QUAD	01295	SN74LS25AN
A14U20	1820-2549	7	1	IC 8291A P HP18	28480	1820-2549
A14U21	1856-0047	5	1	TRANSISTOR ARRAN 16-PIN PLSTC DIP	13606	ULN-2003A
A14U22	1820-1730	6	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A14U23	1820-1987	5	1	IC SHF-RGTR TTL LS COM CLEAR STOR 8-BIT	01295	SN74LS299N
A14U24	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U25	1820-1481	4	2	IC NMOS	04713	MC6821L

See introduction to this section for ordering information



Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A14U26	1820-2099	2	1	IC MICPROC NMOS 8-BIT	04713	MC6802P
A14U27	1820-1481	4		IC NMOS	04713	MC6821L
A14U28	1820-2463	4	1	IC DIRECT MEMORY ACCESS CONTROLLER, 16	28480	1820-2463
A14U29	1820-2634	1	3	IC INV TTL ALS HEX	01295	SN74ALS04N
A14U30	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A14U31	1820-1568	8		IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A14U32	1820-1443	8	1	IC CNTR TTL LS BIN ASYNCRD	01295	SN74LS293N
A14U33	1820-0661	0	1	IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A14U34	1820-2058	3	2	IC MISC TTL 5 QUAD	07263	MC3448AL
A14U35	1820-2058	3		IC MISC TTL 5 QUAD	07263	MC3448AL
A14U36	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A14U37	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A14U38	1820-1794	2		IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U39	1820-2634	1		IC INV TTL ALS HEX	01295	SN74ALS04N
A14U40	1820-2635	2	2	IC GATE TTL ALS AND QUAD 2-INP	01295	SN74ALS08N
A14U41	1820-2635	2		IC GATE TTL ALS AND QUAD 2-INP	01295	SN74ALS08N
A14U42	1820-2634	1		IC INV TTL ALS HEX	01295	SN74ALS04N
A14U43	1820-1423	4	1	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A14U44	1826-0727	1	1	IC SMLP/HOLD 14-DIP-C PKG	06665	SMP-81FY
A14U45	1826-0759	9	1	IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A14VR1	1902-0928	6	1	DIODE-ZNR 6.9V 4% TO-92 TC++ .002%	27014	LM329
A14VR2	1902-0948	0	1	DIODE-ZNR 3.9V 5% DO-35 PD=.4W TC=-.012%	28480	1902-0948
A14VR3	1902-0947	9	1	DIODE-ZNR 3.6V 5% DO-35 PD=.4W TC=-.036%	28480	1902-0947
A14W1	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A14XU1 - A14XU19				NOT ASSIGNED		
A14XU20	1200-0654	7	5	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A14XU21 - A14XU24				NOT ASSIGNED		
A14XU25	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A14XU26	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A14XU27	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A14XU28	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654

See introduction to this section for ordering information

## 8-19. POWER-UP CHECKS

When the Noise Figure Meter is first turned on, or when A14TP20 and A14TP21 are shorted together, the instrument performs a series of operational checks. If a check is failed, an error code is displayed on the front panel. The operation of the Noise Figure Meter is then halted, until the error is cleared.

1. **RAM Stack Check.** The microprocessor writes to, then reads from, that portion of A14U4 that is used for controller stack operations (hexadecimal addresses 0C00 through 0CFF). The controller performs this check twice, with a different pattern each time, so that each memory location is modified to both possible states. E72 is displayed on the front panel if U4 fails this check.
2. **Front Panel Indicator Check.** All of the front panel display segments and annunciators are illuminated. This allows a visual check to ensure that all of the indicators are operating. The indicators remain lit until a different panel indication is needed (such as an error display), or until the Power-Up Checks are complete.
3. **RAM 1 Check.** The remainder of CMOS RAM A14U4 is checked using the same method that was used for the stack check described above.
4. **Continuous Memory RAM Check.** The information stored in continuous memory, A14U5, is transferred into the memory that was tested in step 3, above. A14U5 is then checked using the same method that was used for the RAM stack check. If U5 fails this check, E73 is displayed. After this check is complete, the original information is restored into the continuous memory.

Errors generated by the RAM checks, and the reference designators of the corresponding failed RAM, are shown below in Table 8-1. Only the error that corresponds to the first detected failure will be displayed.

Table 8-1. CMOS RAM Errors

Error Code	RAM Ref. Desig.
E72	A14U4
E73	A14U5

5. **ROM Check.** Once the stack is verified, an eight-bit checksum is computed by reading all of the data stored in the ROM. The computed checksum is compared to the preprogrammed checksum that is stored in ROM. If ROM A14U1 fails this check, E51 will be displayed.
6. **Continuous Memory Data Check.** The information stored in continuous memory is checked by means of a checksum. Then, the contents of specific data locations are checked against bit patterns known to have been stored there. If the data fails either of these checks, E80 is displayed. Refer to Service-Related Errors for additional information about E80.
7. **Scope/Plotter RAM Check.** The Noise Figure Meter used CMOS RAM to store measurement results. The results are output to an oscilloscope or X-Y recorder through the rear panel X, Y, and Z AXIS outputs. This RAM is checked by the same method used for the stack check. If A14U12 fails this check, E74 is displayed.

## **SERVICE SHEET BD4 — DIGITAL SECTION BLOCK DIAGRAM**

### **REFERENCES**

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

### **PRINCIPLES OF OPERATION**

#### **General**

Block Diagram 4 covers the Noise Figure Meter's digital circuits. The digital circuits are contained in Controller Assembly A14 and part of Driver Assembly A13. Controller Assembly A14 is covered in detail in Service Sheets 11, 12, 15, and 18. Those related circuits of Driver Assembly A13 are covered in detail in Service Sheets 6, 16, and 17.

The digital circuits provide all controls, calculations, memory, and remote interfaces (to external equipment) for the Noise Figure Meter.

#### **Controller**

The microprocessor-based Controller provides the timing, calculation, and control for the instrument. The Microprocessor (MPU) executes instructions stored in Read Only Memory (ROM). Data travels between the MPU and other blocks of the Controller on the Data Bus.

The elements of the Controller are enabled to respond to the data of the Data Bus by being addressed on the Address Bus. Data values which must be stored, but which may change, are placed in the Random Access Memory (RAM). The MPU sends (and receives) data out of (and into) the Controller through three gateways. These are the Peripheral Interface Adapters (Service Sheet 11), the X Data (Service Sheet 17) and Y Data (Service Sheet 16) Latches, and the HP-IB Interface, Service Sheet 18).

#### **Peripheral Interface Adapters 1 and 2 (Service Sheet 11)**

Nearly all of the instrument control is executed by the 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 the Frequency Cal Detector also enter the MPU through the PIAs.

#### **Stored Data RAM and DMA Controller (Service Sheet 15), X-Axis (Service Sheet 17) and Y-Axis (Service Sheet 16) DACs, and Retrace Logic (Service Sheet 17)**

Measurement results are stored by the MPU in the Stored Data RAM. The Stored Data RAM can hold all of the Noise Figure and Insertion Gain results from one complete sweep. This RAM is accessed by the MPU only when new data is to be stored (i.e. at the end of a measurement cycle). The remainder of the time, this RAM is under the control of the Direct Memory Access controller (DMA).

The DMA sequentially steps through the address locations of the Stored Data 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

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

Converters (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 a sweep occurs, and pulses the Z-AXIS PEN LIFT output to lift an X-Y recorder pen, or blank an oscilloscope beam.

**Hewlett-Packard Interface Bus (Service Sheet 18)**

The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's implementation of the IEEE-488 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.

**4 MHz Timebase, Voltmeter Counters and Logic, and Conversion Logic (Service Sheet 6)**

At the start of an analog-to-digital conversion, the Conversion Logic triggers the Input Control Logic. This results in the output of the Noise Power Detector being connected to the Voltage-to-Time Converter (through the Voltmeter Input Switches).

**NOTE**

*The Input Control Logic, Noise Power Detector, Voltage-to-Time Converter, Voltmeter Input Switches, and Voltage Reference are all described on Service Sheet BD2, Analog Section.*

At the same time, the 4 MHz Timebase toggles the Voltmeter Counters until a carry is generated. The carry pulse triggers the Input Control Logic to switch the Voltmeter Input Switches connecting the Voltage Reference to the Voltage-to-Time Converter.

The counters are reset and then allowed to count the timebase again, until the output of the Voltage-to-Time Converter changes state. The Input Control Logic then sets the Voltmeter Input Switches to ground the input to the Voltage-to-Time Converter for zeroing. The Voltmeter Counters and Logic then send the count data to the MPU through PIAs 1 and 2.

**TROUBLESHOOTING**

The troubleshooting checks on this block diagram are used to isolate a malfunction to one of the seven digital service sheets. The digital circuits lend themselves to easy testing using signature analysis on the block diagram level. For a detailed description of signature analysis, refer to the front of Section VIII. Each check must be completed in the order listed.

Each check has the Service Sheet listed (in parenthesis) for those circuits being tested by the respective signature analysis routine. If a single signature is different, in any way, from that which is shown, there is an error. Immediately refer to the Service Sheet.

**Test Equipment**

Signature Multimeter .....	HP 5005B
Oscilloscope Measuring System .....	HP 1980A
Noise Source .....	HP 346B

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

**Free Run Signatures**

These signatures represent software date code 50308 (Change 4) or 60130 (Change 5). This date code can be confirmed using 99.9 SP. In the set-ups noted below, “/” represents a rising edge (signature analyzer button out), and “\” represents a falling edge (signature analyzer button in).

These signatures (Tables 8-8 through 8-10) are obtained when Free Run Switch A14S2A is set to the FREE RUN position. Refer to the discussion entitled Signature Analysis in the front part of Section VIII.

**Description.** The Free Run Test will verify the operation of

- 1) Data Bus
- 2) Address Decoding (except for RAM 1 and RAM 2)
- 3) Address Bus
- 4) The contents and operation of the ROM.

If the Free Run Test of the Data Bus is normal, then the Address Bus does not need to be checked.

**Table 8-8. Signature Analysis Data Bus  
(For Software Date Code 50308, P/O Change 4)**

Data Bus: Start: A14TP12, (A15), / Stop: A14TP12, (A15), \ Clock: A14TP11, (φ2), \ Test Signatures +5V: 0001 (Service Sheet 12) Gnd: 0000		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U2-11	D0	70P8
-12	D1	1044
-13	D2	4568
-15	D3	PP52
-16	D4	UF37
-17	D5	H968
-18	D6	0809
-19	D7	14U6

**Table 8-8. Signature Analysis Data Bus  
(For Software Date Code 60130, P/O Change 5)**

Data Bus: Start: A14TP12, (A15), / Stop: A14TP12, (A15), \ Clock: A14TP11, (φ2), \ Test Signatures +5V: 0001 (Service Sheet 12) Gnd: 0000		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U2-11	D0	AAC9
-12	D1	C0AH
-13	D2	6UC1
-15	D3	2FFF
-16	D4	AA1A
-17	D5	F1CP
-18	D6	2977
-19	D7	14A6

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

**Table 8-9. Signature Analysis Chip Enables**

Chip Enables:      Start: A14TP12, (A15), / Stop: A14TP12, (A15), / (Service Sheet 12) Clock: A14TP11, ( $\phi$ 2), \		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U1-14	ROM	0001
-16	SA	C315
-17	SEL CTLR	FU5F
-18	HPIB	ACAC
-19	DMAC	HC7U
-20	PIAS	69CP
-21	XYRAM	85H6
-22	RAM1	0003
-23	RAM2	0003

If both the Data Bus and the Chip Enables are good, perform the Miscellaneous Circuit Checks and proceed to Signature Analysis Routine Signatures.

If there was a problem with only the chip enables, continue troubleshooting the Address Decoding circuitry on Service Sheet 12.

If there was a problem with the Data Bus, check the signatures for the Address Bus.

**Table 8-10. Signature Analysis Address Bus**

Address Bus:      Start: A14TP12, (A15), \ Stop: A14TP12, (A15), \ (Service Sheet 12) Clock: A14TP11, ( $\phi$ 2), \		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U8-3	A7	HC89
-5	A4	0AFA
-7	A3	5H21
-9	A1	CCCC
-11	A2	7F7F
-15	A10	1293
-17	A8	2H70
A14U9-3	A6	52F8
-5	A13	3827
-7	A14	755U
-9	A0	5555
-11	A11	HAP7
-13	A12	3C96
-15	A9	HPP0
-17	A5	UPFH

If there is a problem with any of the Address lines, continue with the Free Run Tests on Service Sheet 12.

If the Address Bus is good, then continue with the Data Bus Tests on Service Sheet 12.

**Miscellaneous Circuit Checks**

1. In Free Run Mode, check the signature at A14U42-10, using the following setup:

Start: A14TP12 (A15) /  
 Stop: A14TP12 (A15) /  
 Clock: A14TP11 ( $\phi$ 2) \

It should be U75A.

2. Verify that A14U39-4 goes high when TP20 and TP21 are shorted together.

If there was a problem with either of these checks, continue troubleshooting on Service Sheet 12.

3. Check the Standby Mode Switch:
  - a) With power on, the emitter of A14Q1 should be approximately 5 volts.
  - b) With power off, the emitter of A14Q1 should be approximately 3 volts.

**X-Axis, Y-Axis and Z-Axis Checks**

**Procedure.** Connect the noise source to the instrument and press PRESET. Connect the oscilloscope to the X-Axis (horizontal), Y-Axis (vertical), and Z-Axis outputs. Enter 7.1 SPECIAL and adjust the oscilloscope for a test pattern as shown in Figure 3-9, in Section III.

**Normal Indications.** A test pattern will be generated as shown in the figure.

**Abnormal Indications.** If the test pattern is not as shown, recheck the GAIN TRACE adjustment. If the pattern is still not correct, refer to Service Sheet 16 for the Y-AXIS, Service Sheet 17 for the X-AXIS and Z-AXIS, and Service Sheet 11 for PIA 1.

**Hewlett-Packard Interface Bus (HP-IB) Checks**

If the remote system cannot communicate with the Noise Figure Meter, the trouble is most likely in the HP-IB circuits. Connecting a second known good system to the instrument will verify that the trouble is actually in the Noise Figure Meter. If the trouble persists, refer to Service Sheet 18.

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

**Signature Analysis Routine Signatures**

The signature analysis routine (for Tables 8-11 through 8-14) is built into the Noise Figure Meter. It is accessed by setting the Signature Analysis Program Switch A14S2B to the SA position, and then turning the LINE switch first OFF, and then back ON. Refer to the discussion entitled Signature Analysis near the front of Section VIII.

**SA Mode Troubleshooting.** SA Mode troubleshooting will verify the operation of

1. RAM 1 and RAM 2 (Service Sheet 12)
2. Stored Data RAM (Service Sheet 15)
3. LO Drive Circuits (Service Sheet 11)

**Procedure.**

1. Disconnect A14J4.
2. Put instrument into SA mode.
3. If instrument will not run the SA routine, continue troubleshooting on Service Sheet 12.
4. Take the following signatures:

**Table 8-11. Signature Analysis RAM 1 and RAM 2**

Data Bus: Start: A14TP9, (D2), Stop: A14TP8, (D1), Clock: A14TP11, (φ2), Test Signatures +5V: 06PU (Service Sheet 12) Gnd: 0000		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U16-2	D0	3610
-3	D4	6PF8
-4	D1	FPF1
-5	D5	4740
-6	D2	0C2P
-7	D6	AP9F
-8	D7	F9U7
-9	D3	F57F
A14U3-6	WE	*
A14TP18	R/W	CU6F
A14U1-22	RAM 1	6P09
-23	RAM 2	U50A

\*The probe light should blink indicating signal activity.

If there is a problem with any signal, continue troubleshooting on Service Sheet 12.

**Table 8-12. Signature Analysis Stored Data Ram**

Stored Data RAM: Start A14TP8, (D1), Stop: A14TP9, (D2), Clock: A14TP11, (φ2), Test Signatures +5V: 06PU (Service Sheet 15) Gnd: 0000		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U12-9	DS0	F089
-10	DS1	AAPF
-11	DS2	279H
-13	DS3	2F74
-14	DS4	8725
-15	DS5	04C4
-16	DS6	F609
-17	DS7	9C66
A14U1-21	XYRAM	40PF

If there is a problem with the signature at A14U1-21 (XYRAM), continue troubleshooting on Service Sheet 12.

If there is a problem with one or more of the DS0-DS7 signatures, continue troubleshooting on Service Sheet 15.

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

**LO Drive Circuits.**

**Table 8-13. Signature Analysis LO Drive (1)**

LO Drive Start: A14TP8, (D1), / Circuits: Stop: A14TP9, (D2), / Clock: A14TP11, (φ2), \ Test Signatures +5V- U185 (Service Sheet 11) Gnd: 0000		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U25-21	R/ $\bar{W}$	*
-23	CS2	7A23
-26	PD7	98U8
-27	PD6	42H2
-28	PD5	2482
-29	PD4	0848
-30	PD3	AU66
-31	PD2	381A
-32	PD1	1C4H
-33	PD0	97C1
-35	A1	7A74/A690**
-36	A0	020U/9532**
-39	CA2	0000
-2	PA0	66C1
-3	PA1	098H
-4	PA2	CA74
-5	PA3	73C0
-6	PA4	F298
-7	PA5	757H
-8	PA6	AF3F
-9	PA7	P37P
-12	E3	13A4
-13	E4	75A3
-14	E5	7110
-15	E6	4937
U24-2	DA0	66C1
-3	DA1	098H
-4	DA2	CA74
-5	DA3	73C0
-6	DA4	F298
-7	DA5	757H
-8	DA6	AF3F
-9	DA7	P37P
* Check for valid TTL signal activity. The line should not be stuck high or low. ** Datecode 60130 only.		

If there is a problem with any of these signatures, continue troubleshooting with Service Sheet 11.

**Table 8-14. Signature Analysis LO Drive (2)**

LO Drive Start: A14TP8, (D1), / Circuits: Stop: A14TP9, (D2), / Clock: A14TP11, (φ2), \ (Service Sheets 6 and 11)		
Node (Ref. Desig.)-pin	Signal Name	Signature
A13U14-11	E4	75A3
A13U15-11	E5	7110
A13U16-11	E6	4937
A13U33-4	FT BIT 0	9HA9
-5	FT BIT 1	3219
-6	FT BIT 2	1946
-7	FT BIT 3	4FCA
-8	FT BIT 4	H76P
-9	FT BIT 5	PUHP
-10	FT BIT 6	U31P
-11	FT BIT 7	P6C1
-12	FT BIT 8	FC62
-13	FT BIT 9	P0A3
A13U32-13	CT BIT 0	0000
-14	CT BIT 1	F8PU
-15	CT BIT 2	90A5
-16	CT BIT 3	8073
-17	CT BIT 4	14A4
-18	CT BIT 5	C082
-19	CT BIT 6	H90A
-20	CT BIT 7	P994
-21	CT BIT 8	F6HP
-22	CT BIT 9	42U2
-23	CT BIT 10	206A
-24	CT BIT 11	A62A

If there is a problem with any of these signatures, continue troubleshooting with Service Sheet 11.



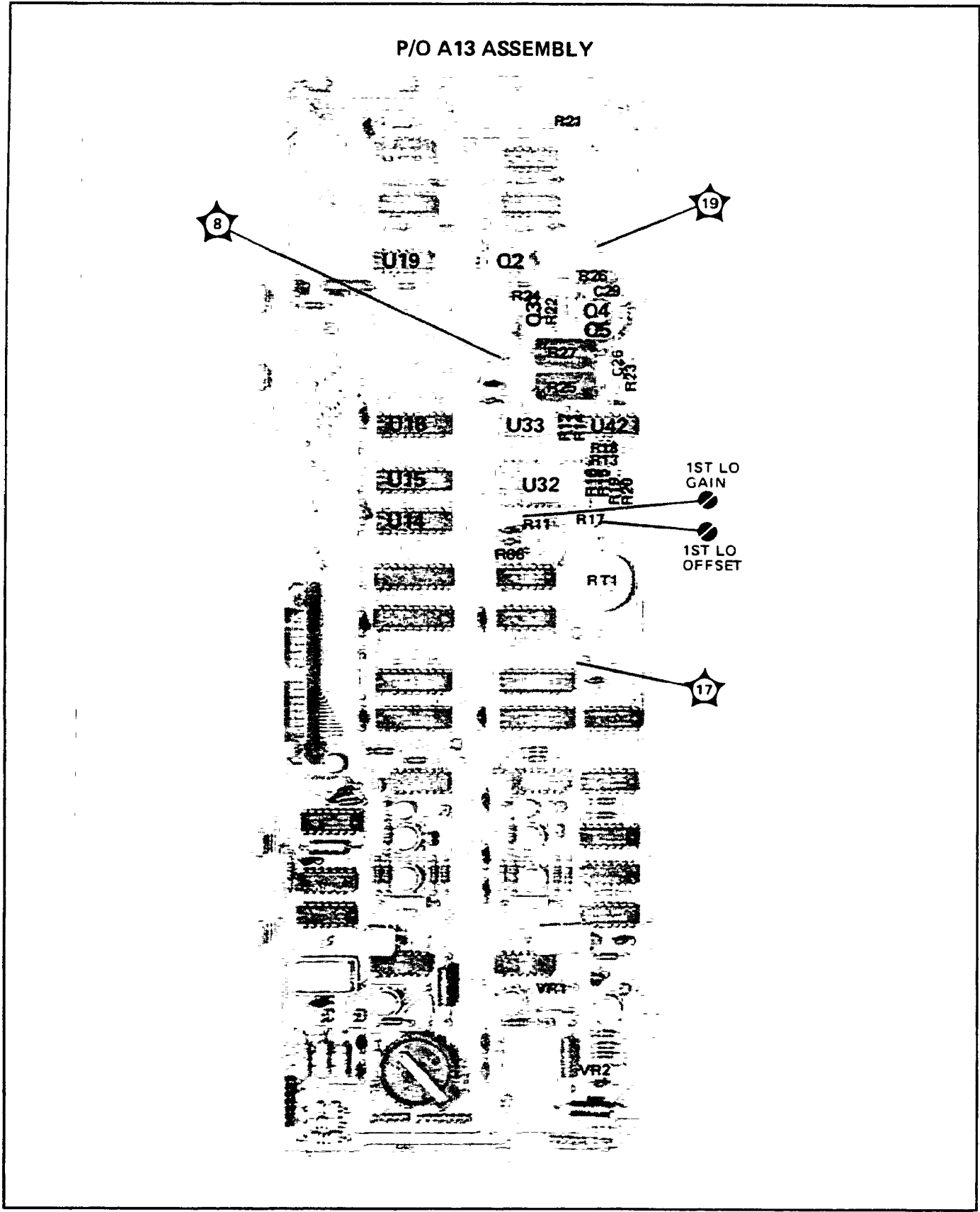


Figure 8-45. P/O A13 Driver Assembly Component Locations (First LD Drive)

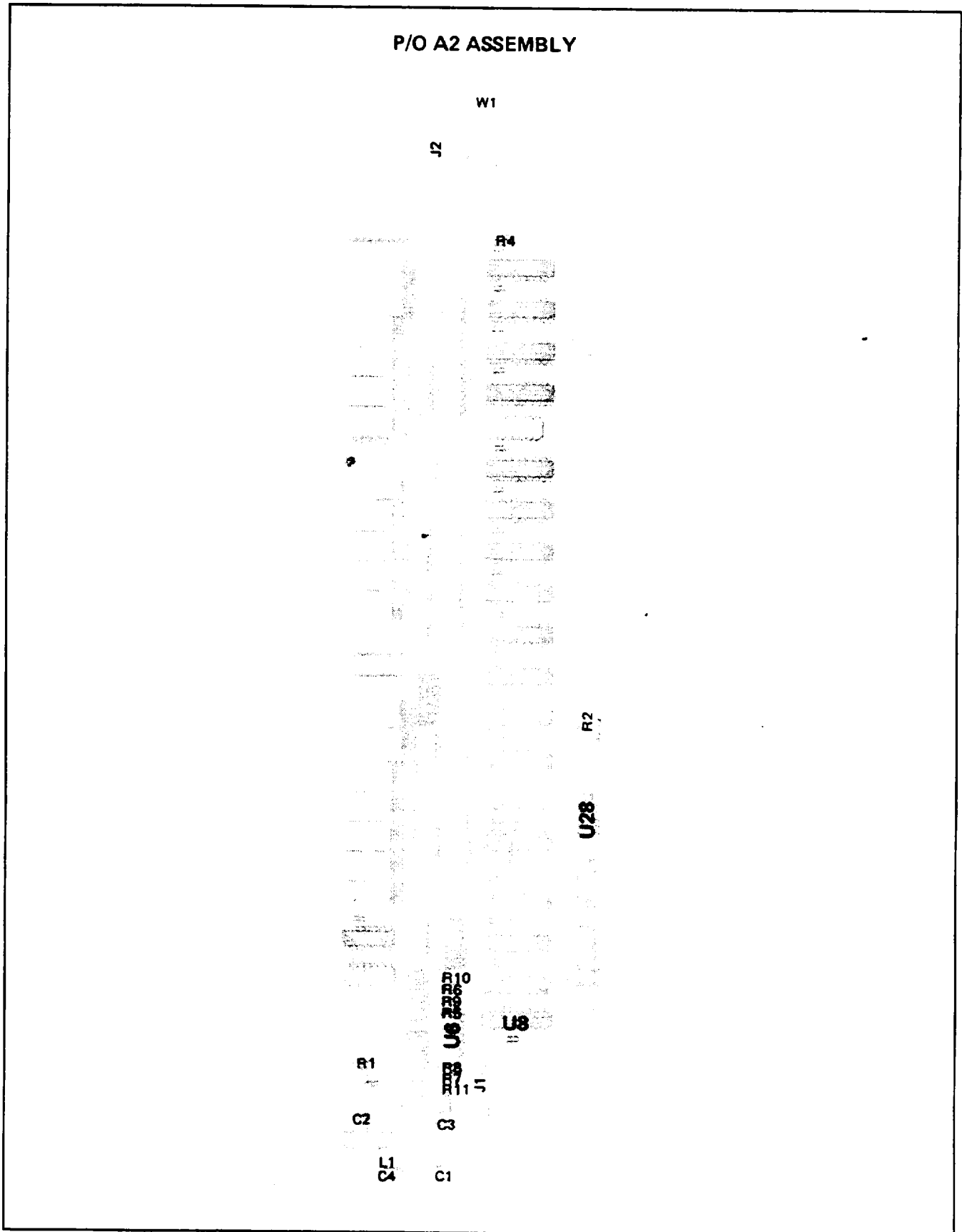
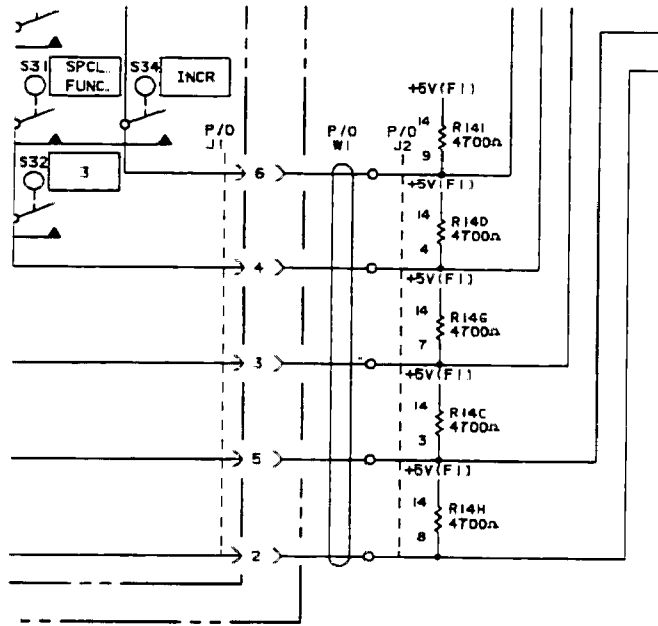
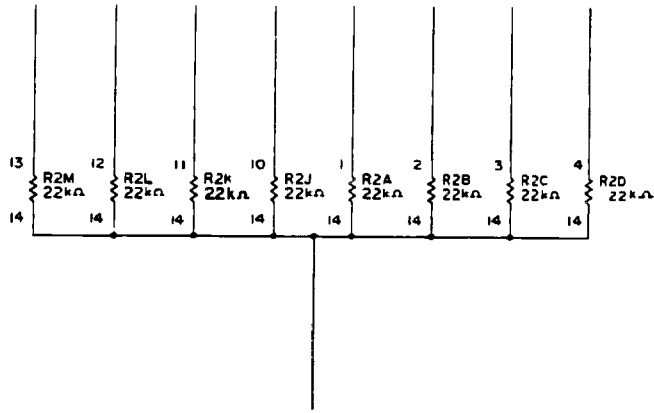


Figure 8-49. P/O A2 Display Assembly Component Locations (Keyboard Interface)

(8-68A P/O Change 11)



P/O Figure 8-52 Keyboard Interface and Keys Schematic Diagram

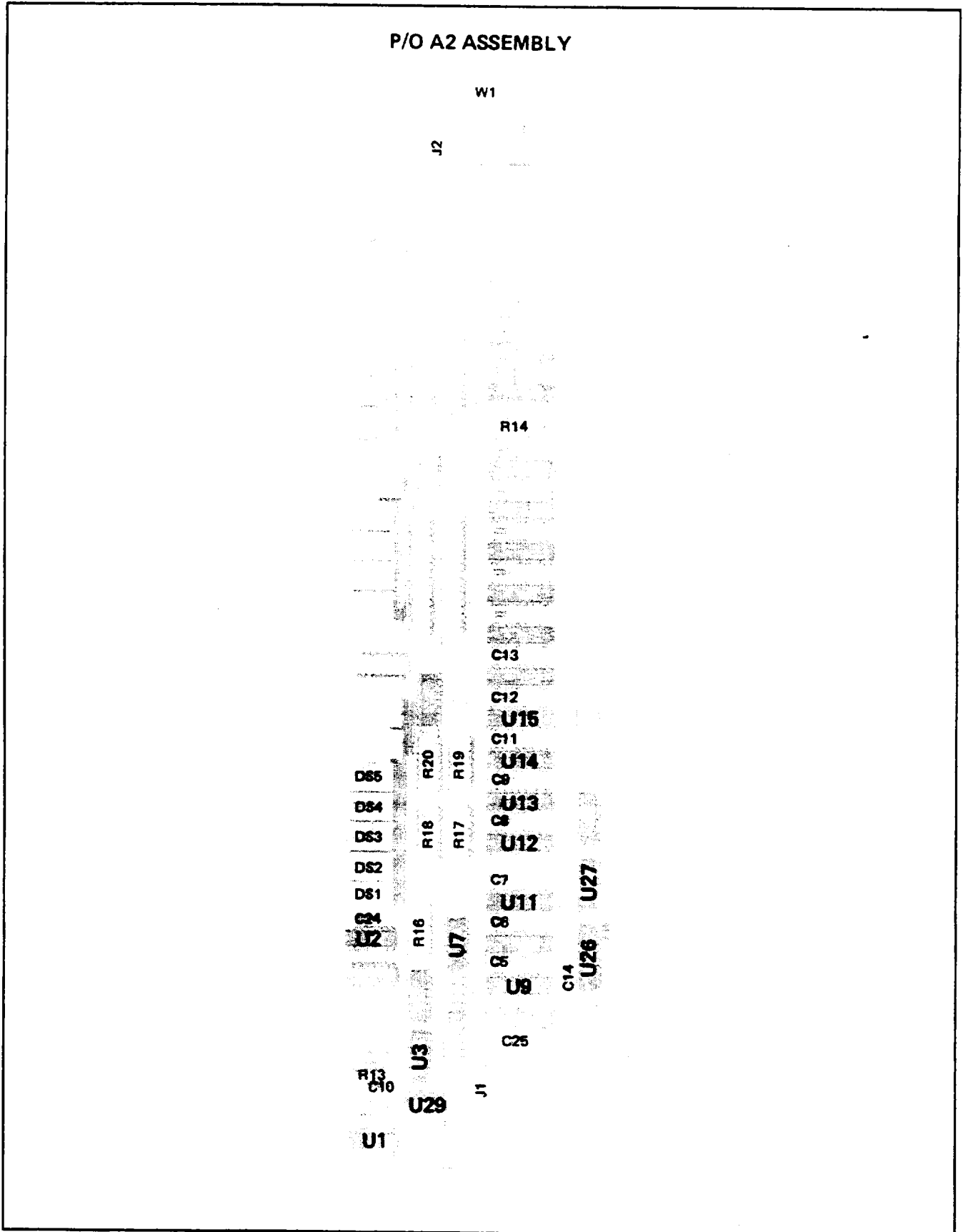
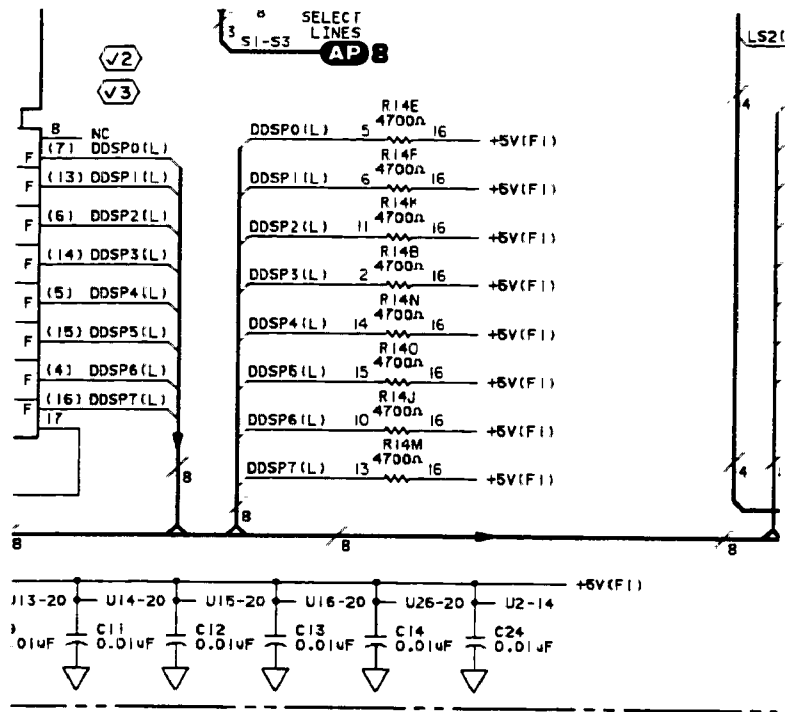


Figure 8-53. P/O A2 Display Assembly Component Locations (Left Display)

(8-71A P/O Change 11)



P/O Figure 8-55 Left Display Schematic Diagram

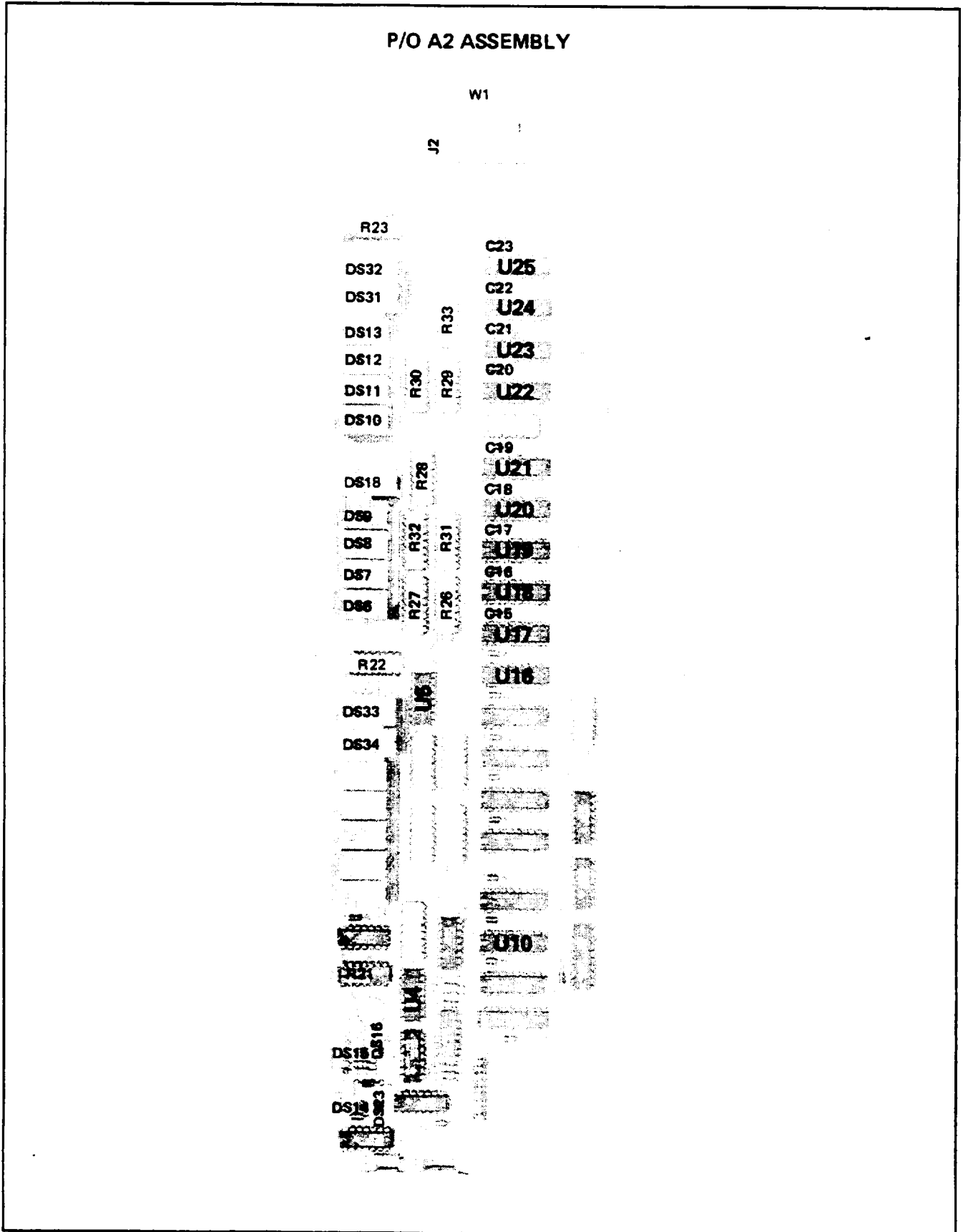
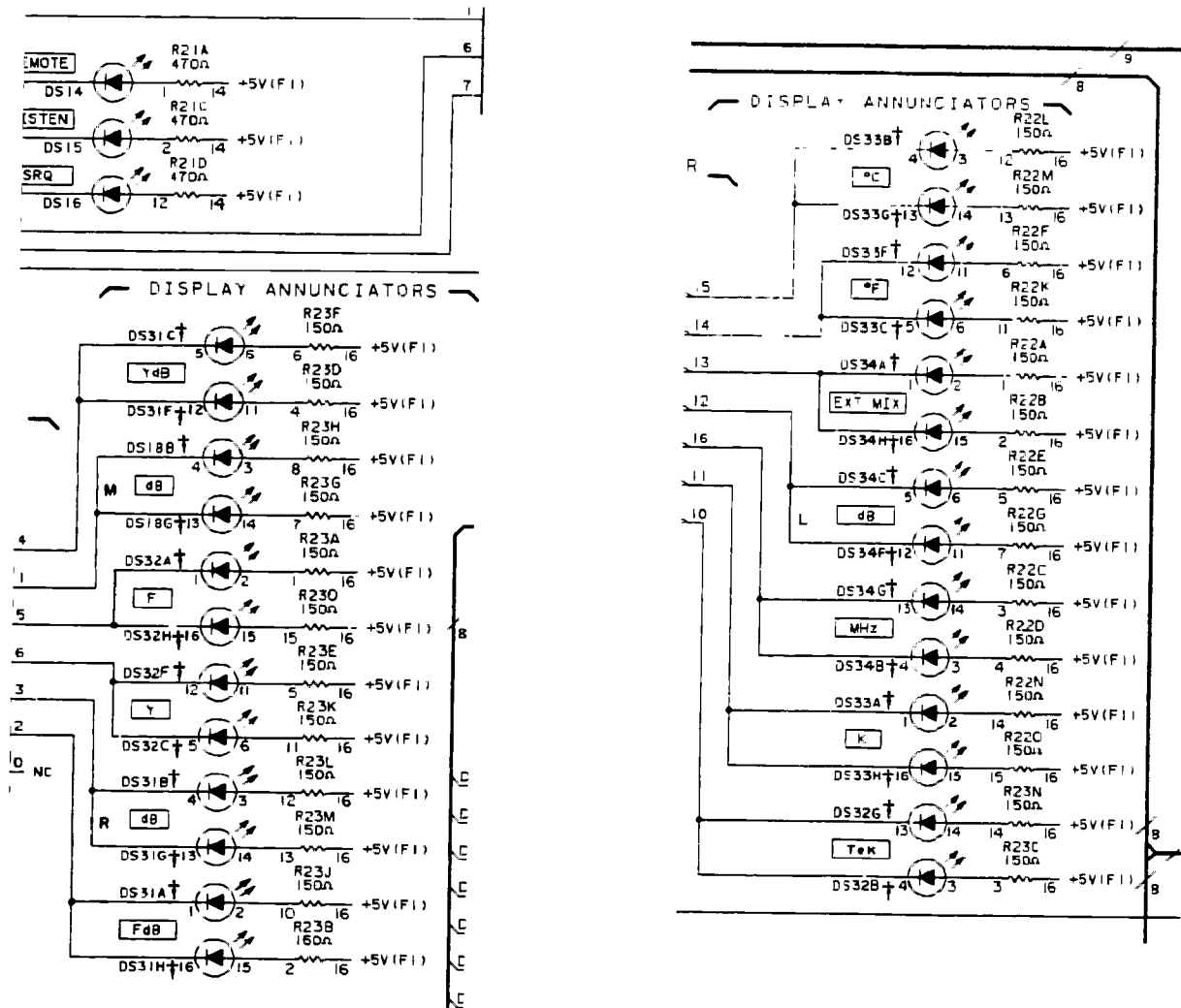


Figure 8-56. P/O A2 Display Assembly Component Locations (Right Display)

(8-71A P/O Change 11)



P/O Figure 8-59 Right Display and Front Panel Annunciators Schematic Diagram

## **SERVICE SHEET 11**

### **CONTROLLER - PERIPHERAL INTERFACE ADAPTER**

### **P/O A14 CONTROLLER ASSEMBLY**

#### **REFERENCES**

Block Diagram - Service Sheet BD4  
 Section III - Operators Checks  
 Section VIII - Special Functions and Power-Up Checks  
 Section VIII - Signature Analysis

#### **PRINCIPLES OF OPERATION**

##### **General**

The Peripheral Interface Adapter (PIA) is a device which allows the Microprocessor Unit (MPU) to communicate with the various devices throughout a system. The PIA, used in the Noise Figure Meter, is an eight data bit three port device. The MPU transfers data between the selected PIA and the MPU through the MPU data port (D0—D7). The PIA transfers data between the appropriate peripheral device (under control of the MPU) through one of the two eight bit peripheral ports. All three ports are bi-directional.

PIA A14U27 uses its A Bus (Port PA0—PA7) to drive the RF attenuators in the Input Assembly, and to send serial data to the Front Panel Assembly. This bus also sets the frequency calibrations, drives the Noise Source, and sends input power data to the MPU. The B Bus (Port PB0—PB7) has control of the various latches and buffers used by the PIAs, the front panel, and the keyboard scan circuits.

PIA A14U25 uses its A Bus to transfer data from the Voltmeter Assembly A7 to the MPU, and transfers frequency data to the First LO on the Driver Assembly A13. The B Bus controls the latches and the converter on the voltmeter and the latches and the hysteresis on the First LO.

##### **Peripheral Interface Adapter (PIA)**

The PIA used in the Noise Figure Meter consists of an MPU data port (D0—D7) and its bus register. It also contains two control registers and two data direction registers which control the two peripheral ports. There are also two output registers (A and B), and their respective peripheral ports (PA0—PA7 and PB0—PB7). All ports are bi-directional. All activities within the PIA are tied directly to the ENABLE input at pin 25. This is actually the clock input and is usually tied to the system clock.

A PIA chip is selected only when both CS0 and CS1 are high, while CS2 is low. The MPU, having selected the PIA, now uses the RS0 and RS1 inputs, in conjunction with a CONTROL word (software command), to select which PIA register will output the data. The MPU then places a low on the R/ $\bar{W}$  input to direct the PIA to accept data into its bus input register from the MPU. Under control of the MPU, the PIA control and data direction registers transfer the data from the bus input register to the selected output register. The data is then sent to the peripheral through the respective peripheral port. For the MPU to receive data from the peripheral, the PIA data direction registers reverse the flow, while the MPU holds the R/ $\bar{W}$  input high.

All registers are reset by a low on the RESET input. The PIA informs the MPU of a need to communicate by placing a low on either the IRQA or IRQB output lines. The peripherals inform the PIA of a need to communicate by



## SERVICE SHEET 11 (cont'd)

placing a high on either the CA1 or CB1 input lines. The CA2 and CB2 lines can be used either as additional input peripheral interrupts or as additional outputs.

### Display Control

Action involving the PIAs can occur from one of two sources. If there is a need to adjust the RF signal path, the MPU software will detect this need and use the PIAs to make adjustments. If the operator should initiate a request by pressing a key on the front panel, the MPU software will detect and service this request.

The display is controlled by PIA A14U27. There are five signal lines between the display and the PIA. The MPU software will periodically load the output register with a value in which a high is placed on pin 12 (PB2) of the PIA. This is the R/ $\bar{W}$  line to the Display Assembly, and informs the Display Assembly that the MPU wants to read its data. This data is in serial form and is transferred over the DATA line to the front panel serial/parallel data converter A14U23. It is clocked into A14U23 by the clock signals on the CLOCK line.

The Display Assembly CLOCK originates as clock pulses from pin 19 (CB2) of PIA A14U27. It is enabled by the MPU placing a high on pin 11 (PB1). A14U23 converts the serial data into parallel data. The data is transferred to the PIA when the MPU places a high on pin 10 (PB0) of the PIA. This parallel load command (P-LOAD) is sent to both the front panel serial/parallel data converter and to the Display Assembly. Data is loaded from the front panel serial/parallel converter into the PA0—PA7 port of PIA A14U27 and output to the MPU.

The MPU examines the data and detects the key switch closure. The MPU then acknowledges the request by placing a low on pin 39 (CA2) of PIA A14U27. This is the IRQACK signal to the Display Assembly. At other times, the MPU is busy sending data from memory to the Display Assembly. This is accomplished by placing a high on the R/ $\bar{W}$  line to the Display Assembly. This commands the Display Assembly to accept data from the PIA. The MPU then loads the parallel data into the B Output register of the PIA.

On command, this data is parallel loaded into the front panel serial/parallel data converter A14U23 and converted into serial data. The serial data is clocked into the Display Assembly. There, it is converted into data for visual display on the front panel.

### Automatic RF Level Adjustment

**RF Attenuation Control.** PIA A14U27 is the peripheral control for the automatic RF level adjusting. On Input Assembly A6, the Input Power Detector is located immediately after the adjustable RF attenuators. The output of this detector is a dc representation of the RF power level at the output of the attenuators. This dc level (PRF) is input to both sides of window comparator A14U45C/D. Normally, the two outputs are both at a logical low indicating a proper RF signal level.

**SERVICE SHEET 11 (cont'd)**

If the PRF level exceeds +6.9V, comparator A14U45C output will go high. If the level goes below 0.47V, then comparator A14U45D output will go high. The high of either comparator is held by data buffer A14U38 until the MPU places a low on pin 17 (PB7) of PIA A14U27. This will transfer the data to the MPU through the PA0—PA7 port.

The MPU will examine the data and decide whether the RF signal path requires more or less attenuation. The MPU software will select the required amount of attenuation. The MPU will then send this amount, as a data word, to PIA A14U27. There, it will be output on the PA0—PA7 port to RF attenuator latch A14U22. Only data bits D4 through D7 are used, and these are loaded into RF attenuator driver A14U21. The loading will take place when the MPU enables the clock input of A14U22 using both pins 17 (PB7) and 16 (PB6) of the PIA.

The four lines from A14U21 are input to the Input Assembly. The levels on D4 through D7 will result in the attenuation shown in Table 8-45.

**Table 8-45. RF Attenuation Control**

Data Bit	Signal Name	Active Level	Attenuation Added to RF Path
D4	10dB PAD 1	high	-10 dB
D5	10dB PAD 2	high	-10 dB
D6	10dB PAD 3	high	-10 dB
D7	+20dB	low	+20 dB

**20 MHz IF Assembly A3 Attenuation Control.** PIA A14U27 is the peripheral control for the automatic IF level adjusting. On Noise Power Detector Assembly A8, the Noise Power Detector is located immediately after the adjustable IF attenuators. The output of this detector is the dc representation of the IF power level at the output of the attenuators. This dc level is input to the Voltmeter Assembly A7.

Voltmeter Assembly A7 is essentially an Analog-to-Digital (A/D) converter which converts the dc level into a clock (G CLK) which is routed to the voltmeter driver circuits in Driver Assembly A13. Within the Driver Assembly, G-CLK is used to enable the voltmeter counter circuits. These circuits count the length of time it takes the detector dc level to charge an RC circuit in the voltmeter. The driver circuits then repeat the process with a known reference, and the difference is a digital quantity which represents the value of the IF level.

Driver Assembly A13 outputs this value as an eight bit data word to PIA A14U25. The Driver Assembly also outputs an end of conversion signal (ECVT) and an overflow signal (OVFL) to PIA A14U25 as interrupt levels. The MPU then examines the PIA to

**SERVICE SHEET 11 (cont'd)**

see if either an end of conversion or an overflow has occurred. If the end of conversion has occurred without an overflow, then the data is read and displayed by the MPU. If an overflow has occurred, the MPU software will select an amount of attenuation. The MPU will send the required amount, as a data word, to PIA A14U27. There, it will be output on the PA0—PA7 port to IF attenuator buffer/latch A14U38/A14U37.

Only data bits D0 through D2 are used, and these are first loaded into the buffer A14U38 by a low on pin 16 (PB6) of PIA A14U27. The data is then latched into A14U37 by enabling its clock input from pins 16 (PB6) and 17 (PB7) of PIA A14U27. The three lines from latch A14U37 are input to the 20 MHz IF Assembly. The levels on D0 through D2 will result in the attenuation shown in Table 8-46.

**Table 8-46. IF Attenuation Control**

Data Bit	Signal Name	Active Level	Attenuation Added to IF Path
D0	-5dB	high	-5 dB
D1	-10dB	high	-10 dB
D2	-20dB	high	-20 dB

**Automatic Frequency Calibration.** PIA A14U27 is the peripheral control for the automatic frequency calibration. The Frequency Cal Detector, on 20 MHz IF Assembly A3, is located after the second 20 MHz bandpass filter, and prior to the selectable attenuators. The output of this detector is a dc representation of the RF power level at the output of the 20 MHz filters. This dc level (DET) is input to both comparator A14U45A and sample/hold A14U44.

The comparator output can be either high or low, and is only significant during the actual frequency calibration. The input RF is attenuated, filtered, and input to the First Converter Assembly A10. There, it is mixed with the First Local Oscillator (LO) to upconvert the signal to a 2050 MHz IF. The 2050 MHz IF is later twice down converted to achieve the desired 20 MHz IF. Only the First LO is tunable.

The First LO is tunable over a range of 2050 MHz to 3650 MHz. The input RF ranges from 10 MHz to 1600 MHz. The input signal is mixed with a signal between 2060 MHz and 3650 MHz from the First LO. (The 2050 MHz setting of the First LO is used while doing frequency calibration.) The mixing yields the 2050 MHz IF. The Q (Quality) of the filters is such that a relatively sharp rolloff occurs outside of the 2050 MHz IF.

As the First LO is swept, under control of the MPU, sample/hold A14U44 is commanded to take a sample of the DET dc level. The sample command is a low on pin 5 (PA3) of PIA A14U27. This is data bit D3 to level data buffer A14U38. This sample is then held

**SERVICE SHEET 11 (cont'd)**

by changing D3 to a high. The MPU then sweeps the frequency a little more and the sample/hold output is compared by A14U45A with the new DET dc level. If the new DET level is higher, the comparator will output a high to A14U38 buffer. If the new DET level is lower, the comparator will output a low.

Comparator A14U45A output to the buffer, appears on the buffer as data bit DD5 to PIA A14U27. This bit is read by the MPU, and the MPU sweeps the First LO by issuing the command on pins 13 (PB3) through 16 (PB6) of PIA A14U25. The MPU continues sweeping the First LO until the DET dc level changes directions. The instant the level changes, the MPU knows the peak has just been passed, and the MPU sets the First LO to this peak.

**Associated Data**

**Noise Control Source.** The Noise Source is turned on by a high pin 6 (PA4) of PIA A14U27. This bit is the DD4 bit to level data buffer A14U38. A low on DD4 will turn the Noise Source off. Under normal conditions, DD4 is constantly changing levels approximately seven times per second.

**Pen Lift and Scope Control.** The Pen Lift signal is active when a low is placed on pin 19 (CB2) of PIA A14U25. The Scope Control signal is active when a high is placed on pin 15 (PB5) of PIA A14U27.

**TROUBLESHOOTING**

Troubleshooting is done on the circuits of Service Sheet 11 when a malfunction has occurred in one of the control functions. Controlled units include the IF Attenuators, Noise Source, RF Attenuators, Voltmeter and First Local Oscillator (LO) (through Driver Assembly A13), and the Display Assembly. The troubleshooting provided, is based primarily on signature analysis. Refer to the beginning of Section VIII for information on using signature analysis. If all of the signatures on this service sheet are correct, the trouble is located in the circuit under control, and not in the controller. Except where shown, all values listed are approximate and are given as a service guideline.

**Test Equipment**

Signature Multimeter .....	HP 5005B
Oscilloscope Measuring System .....	HP 1980A
Signal Generator .....	HP 8656A
Systems DVM .....	HP 3456A

**✓1 Voltage Checks**

1. Verify that the voltage from test point A14TP17 to test point A14TP19 (ground) is  $+15 \pm 1$  Vdc.
2. Verify that the voltage from test point A14TP1 to test point A14TP19 (ground) is  $+5 \pm 0.05$  Vdc.

**SERVICE SHEET 11 (cont'd)**

3. Verify that the voltage from test point A14TP15 to test point A14TP19 (ground) is  $-15 \pm 1$  Vdc.

**NOTE**

*The +28 Vdc is controlled only by these circuits. The actual +28 Vdc supply does not appear on the Controller Assembly A14.*

**Signature Analysis Pre-Test Setup**

Connect the signature multimeter as follows:

1. GND to A14TP19 (GND)
2. CLK to A14TP11 ( $\phi 2$ ) \
3. START to A14TP5 (D0) /
4. STOP to A14TP8 (D1) /

Set up the Noise Figure Meter as follows:

1. Disconnect A14J2 and A14J4
2. Place switch A14S2B to the SA position
3. Place the LINE switch (front panel) to the ON position

**√2 IF Attenuator and Noise Source Control****NOTE**

*Disconnect A14J2 and A14J4 before verifying the signatures in Table 8-47.*

Connect the probe to each node listed in Table 8-47, and verify that each signature is correct and stable. If all signatures are correct, reconnect A14J2, and verify that the relays are functioning within the 20 MHz IF Assembly A3.

**Level Data Buffer A14U38.** The first device tested is A14U38. If pin 19 is in error, the identical data should appear on A14U27-16. This is the A14U38 ENABLE. Check for shorts or opens on the trace between the two pins and to pins A14U29D-9 and A14U40C-9. If the traces are clean, but the line is tied high (FFFF) or low (0000), then check devices A14U38, A14U29, A14U40, and A14U27 for probable failure. If the signature is not tied high or low, but is in error, then proceed to the A14U27 PIA tests. If the PIA appears good on all other pins, check the following components for failure in the order shown: A14U38, A14U27, A14U40, and A14U29.

The remaining five pins of A14U38 are the data input pins (DD0—DD4). An error on any of these pins can be the result of a failure of device A14U38,

(8-76F, P/O Change 4)

**Table 8-47. IF Attenuator and Noise Source Drive Logic**

Node	Signature	Signal Name
A14U38-19	9376	U38 ENABLE
A14U38-2	P6F3	DD0
A14U38-18	8FF7	DD1
A14U38-4	AA76	DD2
A14U38-16	3U90	DD3
A14U38-6	CA74	DD4
A14U37-11	A773	U37 CLOCK (enable)
A14U37-18	7FFP	DD0
A14U37-17	F7P2	DD1
A14U37-4	0PPP	DD2
A14U37-13	3P72	DD3
A14U37-14	C261	DD4
A14U37-15	4U64	NS ON
A14U37-12	647F	HOLD/SAMPLE
A14U37-5	681H	-20 dB
A14U37-16	458U	-10 dB
A14U37-19	HFU9	-5 dB
A14U27-16	9376	PB6 (U38 enable)
A14U27-17	FA5C	PB7 (U37 enable)
A14U27-35	01U3/63FF*	A1 (RS1)
A14U27-36	9CU1/8210*	A0 (RS0)

\*Datecode 60130 only.

or bad data from A14U27. Also, a failure of either device A14U22 or A14U23 (which share the data bus) can cause a bus error at A14U38.

**IF Attenuator Latch A14U37.** The next device tested is A14U37. If pin 11 (A14U37 ENABLE) is in error, proceed to the A14U27 PIA tests. If pins 16 and 17, of the PIA, are correct, then a failure has occurred in or around devices A14U37, A14U40, or A14U29. The next five pins of A14U37 are the data input pins (DD0—DD4). An error on any of these pins indicates a failure of either device A14U37 or A14U38. Verify the signatures of A14U37, and check all traces and pins around both devices. The last five pins of A14U37 are the five output pins. An error on pin 19, 16, or 5 indicates a failure of A14U37 or a trouble in the 20 MHz IF Assembly A3. An error on pin 15 indicates a failure of A14U37 or a trouble in the Power Supply Assembly A9 (+28 VDC Noise Source Control circuit). An error on pin 12 indicates a failure of either device A14U37 or A14U44.

**Peripheral Interface Adapter 1 (PIA1) A14U27.** Only four pins are tested on the PIA. The first two (16 and 17) are the A14U38 ENABLE and the A14U37 ENABLE. A failure on either of these

**SERVICE SHEET 11 (cont'd)**

pins can be caused by the failure of device A14U38, A14U37, A14U40, A14U29, or A14U27. The remaining two pins (35 and 36) are the two reset inputs RS1 and RS0. A failure on either of these two pins indicates a failure on the controller address bus. Check devices A14U27 and A14U25 as the probable cause.

**√ 3 RF Attenuator Control**

**NOTE**

*Disconnect A14J4 before verifying the signatures in Table 8-48.*

Connect the probe to each node listed in Table 8-48, and verify that each signature is correct and stable. If all signatures are correct, reconnect A14J4, and verify that the relays are functioning within Input Assembly A6.

**RF Attenuator Latch A14U22.** The first device tested is A14U22. If pin 11 (A14U22 ENABLE) is in error, proceed to the A14U27 PIA tests. If pins 16 and 17, of PIA A14U27, are correct, then a failure has occurred in or around device A14U22, A14U40, or A14U29. The remaining seven pins of A14U22 are the data input pins (DD0—DD4 and DD6—DD7). An error on any of these pins can be the result of a failure of device A14U22, or bad data from A14U27. Also, a failure of either device A14U38 or A14U23 (which share the data bus) can cause a bus error at A14U22.

**Table 8-48. RF Attenuator Drive Logic**

Node	Signature	Signal Name
A14U22-11	6H28	U22 CLOCK (enable)
A14U22-18	HA3F/14A8*	DD7
A14U22-3	C4HF	DD6
A14U22-4	CA74	DD4
A14U22-14	3U90	DD3
A14U22-7	AA76	DD2
A14U22-13	8FF7	DD1
A14U22-8	P6F3	DD0
A14U21-7	U7PH	DD2
A14U21-5	PC8P	DD3
A14U21-4	F7F5	DD4 (10 dB pad 1)
A14U21-3	C104	DD5 (10 dB pad 2)
A14U21-2	965U	DD6 (10 dB pad 3)
A14U21-1	U7PH	DD7 (+20 dB)

\* Datecode 60130 only

**RF Attenuator Driver A14U21.** The six pins of A14U21 that are tested are the data input pins (DD2—DD7). An error on any of these pins are the result of a failure of either device A14U21 or A14U22.

**√ 4 Display Assembly Control**

**NOTE**

*Disconnect A14J4 before verifying the signatures in Table 8-49.*

Connect the probe to each node listed in Table 8-49, and verify that each signature is correct and stable. If all signatures are correct, refer to the Display Assembly A2 testing procedures.

**Table 8-49. Display Assembly Drive Logic**

Node	Signature	Signal Name
A14U27-23	5234	PIA 1 ENABLE (CS2)
A14U27-26	5FHC	PD7
A14U27-27	UF91	PD6
A14U27-29	2C68	PD4
A14U27-30	8UU0	PD3
A14U27-31	259H	PD2
A14U27-32	A0PA	PD1
A14U27-33	HAAU	PD0
A14U27-21	*	R/W
A14U27-2	P6F3	DD0
A14U27-3	8FF7	DD1
A14U27-4	AA76	DD2
A14U27-5	3U90	DD3
A14U27-6	CA74	DD4
A14U27-8	C4HF	DD6
A14U27-9	HA3F/14A8**	DD7
A14U23-2	PC8P	PB3
A14U23-12	H893	CB2
A14U23-19	9279	P-LOAD
A14U31-1	C167	U31A ENABLE
A14U31-3	539U	DATA (serial display)
A14U31-4	5AP9	U31B ENABLE
A14U40-6	AC5U	CLOCK (display)

\* Check for valid TTL signal activity The line should not be stuck high or low.  
 \*\* Datecode 60130 only

**Peripheral Interface Adapter 1 (PIA1) A14U27.** The first device tested is PIA1. An error on Pin 23 is an error on the PIA1 ENABLE line, which is tied to the CS2 input of the PIA. A failure on this line is probably caused by device A14U27,

**SERVICE SHEET 11 (cont'd)**

A14U30, or A14U41. The next seven pins are the data input pins (PD0—PD4 and PD6—PD7). An error on any of these pins is probably caused by one of the three devices which share this common data bus; A14U425, A14U27, or A14U15. Pin 21 is the Read/Write (R/ $\bar{W}$ ) input. An error on this pin is most probably caused by A14U15, A14U25, or A14U27. The final seven pins are the data output pins (PD0-PD4 and PD6—PD7). An error on any of these pins is probably caused by one of the four devices which share this common data bus; A14U27, A14U23, A14U22, or A14U38.

**NOTE**

*On PIA1, the IRQACK signal on pin 39 (CA2) will go low in response to a front panel keystroke. The NMI signal on pin 38 (IRQA) will contain one low spike for each keystroke. The  $\phi$ 2 clock signal on pin 25 (ENABLE) is a 4V, 1 MHz, squarewave.*

**Front Panel Serial/Parallel Data Converter A14U23.**

The next device tested is A14U23. Pin 2 is the PB3 input which enables A14U23. This is the same PB3 line from pin 13 of PIA A14U27 (PB3). An error on this pin is caused by either A14U23 or A14U27. An error on pin 12 of A14U23 is an error on the clock (CB2) input of A14U23, and can be caused by a failure in A14U23, A14U40, or A14U27. Pin 19 is the P-LOAD input from the PIA. A failure on this line is probably caused by A14U23, A14U27, or a failure in the Display Assembly A2.

**Bi-Directional Buffer A14U31.** Pin 1 is the R/ $\bar{W}$  input to A14U31A. Device A14U42F inverts the signal and inputs it to A14U31B. This way, only one half of U31 is active at any one time. An error on this line is probably caused by A14U31, A14U42, A14U27, or a failure in the Display Assembly A2. Pin 3 of A14U31 is the serial DATA output. An error on this pin is caused by either A14U31, or a failure in the Display Assembly A2. An error on pin 4 of A14U31 is caused by either A14U31 or A14U42.

**AND Gate A14U40.** Pin 6 of A14U40 is the CLOCK signal to the Display Assembly A2. A failure on this line is caused by either A14U40 or a failure in the Display Assembly A2.

**NOTE**

*On Bi-Directional Buffer A14U31, the DATA signal will appear as packets of data approximately 12 ms wide, and approximately 160 ms apart for corrected  $NF < Gain$  or, approximately 140 ms apart for uncorrected data. On AND gate A14U40, the CLOCK signal on pin 6 will appear as a 200  $\mu$ s burst, followed by a 60  $\mu$ s space. This pattern will continue to repeat, stopping only when all data has been sent to the front panel.*

**✓5 Voltmeter and First LO Control**

Change the START and STOP connections as shown below:

START to A14TP8 (D1) /  
STOP to A14TP9 (D2) /

**NOTE**

*Disconnect A14J4 before verifying the signatures in Table 8-50.*

Connect the probe to each node listed in Table 8-50, and verify that each signature is correct and stable. If all signatures are correct, refer to either the Voltmeter Assembly A7 or the First Converter Assembly A10 testing procedures.

**Peripheral Interface Adapter 2 (PIA2) A14U25.**

The first device tested is PIA2. Pin 21 is the Read/Write (R/ $\bar{W}$ ) input. An error on this pin is probably caused by device A14U25, A14U27, or A14U15. Pin 23 is the PIA 2 ENABLE (CS2) input. (This pin is high most of the time.) An error on this pin is probably caused by device A14U25, A14U30, or A14U41. The next eight pins are the data input pins (PD0—PD7) to the PIA. An error on any of these pins is probably caused by device A14U15, A14U27, or A14U25.

Pins 35 and 36 are the A1 (RS1) and A0 (RS0) inputs to the PIA and are from the Controller address bus. An error on either line is the result of a probable failure of either A14U27 or A14U25. Pin 39 is the CA2 output of the PIA, and is the enable to device A14U24. An error on this line is probably caused by either A14U24 or A14U25. The next eight lines are the data output lines (PA0—PA7). All eight of these lines are input only to A14U24.

## SERVICE SHEET 11 (cont'd)

Table 8-50. Voltmeter and First LO Drive Logic

Node	Signature	Signal Name
A14U25-21	*	R $\bar{W}$
A14U25-23	7A23	PIA 2 ENABLE (CS2)
A14U25-26	98U8	PD7
A14U25-27	42H2	PD6
A14U25-28	2482	PD5
A14U25-29	0848	PD4
A14U25-30	AU66	PD3
A14U25-31	381A	PD2
A14U25-32	1C4H	PD1
A14U25-33	97C1	PD0
A14U25-35	7A74/A690**	A1 (RS1)
A14U25-36	020U/9532**	A0 (RS0)
A14U25-39	0000	CA2 (U24 enable)
A14U25-2	66C1	PA0
A14U25-3	098H	PA1
A14U25-4	CA74	PA2
A14U25-5	73C0	PA3
A14U25-6	F298	PA4
A14U25-7	757H	PA5
A14U25-8	AF3F	PA6
A14U25-9	P37P	PA7
A14U25-12	13A4	PB2 (E3)
A14U25-13	75A3	PB3 (E4)
A14U25-14	7110	PB4 (E5)
A14U25-15	4937	PB5 (E6)
A14U24-2	66C1	DA0
A14U24-3	098H	DA1
A14U24-4	CA74	DA2
A14U24-5	73C0	DA3
A14U24-6	F298	DA4
A14U24-7	757H	DA5
A14U24-8	AF3F	DA6
A14U24-9	P37P	DA7

\* Check for valid TTL signal activity. The line should not be stuck high or low.  
\*\* Datecode 60130 only.

Therefore, an error on any of these lines is caused by either A14U24 or A14U25. The final four lines are the data output lines (PB2—PB5). Pin 12 is the E3 (PB2) signal to the Driver Assembly (voltmeter circuit) A13. An error on this line is caused by either A14U25 or a failure in Driver Assembly A13. Pins 13, 14, and 15 are the E4 (PB3), E5 (PB4), and E6 (PB5) signals to the Driver Assem-

bly (First LO circuit) A13. An error on any of these lines is caused by either A14U25, or a failure in Driver Assembly A13.

**Data Buffer A14U24.** On this device, the eight data output lines (DA0—DA7) are tested. All eight of these lines are routed directly to Driver Assembly A13. An error on any of these lines is caused by either A14U24 or a failure in Driver Assembly A13.

### Completion of Signature Analysis Testing

Upon completion of Signature Analysis testing, place switch A14S2B in the NORMAL position, reconnect A14J4, remove all test equipment, 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.

### 6 Peripheral Interface Adapter (PIA) Troubleshooting Aids

Troubleshooting a Peripheral Interface Adapter (PIA) is accomplished on two levels. The signature analysis routines will usually isolate the failure to the general area. It is then necessary to proceed on a manual level. Observe and/or complete the following steps:

1. Ensure that there is  $+5 \pm 0.5$  Vdc on pin 20 of the PIA.
2. Ensure that SYSTEM CLOCK  $\phi 2$  is on pin 25.

### NOTE

*The PIA appears, at first glance, to be just another type of dual channel multiplexer. This is NOT the case. The PIA is a programmable device with built-in registers that store and process BOTH data and PIA control words. The following steps outline what must occur for the PIA to function.*

3. The PIA must be selected before any action can be taken. This is accomplished by the CS0, CS1, and CS2 inputs. On the Noise Figure Meter, the CS0 and CS1 lines are tied high. Therefore, it is necessary only to pull the CS2 line low, to select the PIA.



**SERVICE SHEET 11 (cont'd)**

4. When the microprocessor is ready to use the PIA, it will take the RESET line low. The duration of this reset must be between 0.5  $\mu$ s and 0.66  $\mu$ s. This must be followed by a 1  $\mu$ s delay before the microprocessor can address the PIA.
5. The first data entered into the PIA is the control word. This word is used in conjunction with the RS0 and RS1 inputs to select which internal register will receive the data.
6. Among other things, the control word selects which output register (data port) will be used, and in which direction the data will flow.

**NOTE**

*The  $R\bar{W}$  input does not control the peripheral ports data flow. This command relates to the PIA communicating with the microprocessor.*

7. Once the PIA has been programmed, the read or write cycle can take place. During this time, the RS0, RS1, CS0, CS1, and CS2 lines MUST be stable for the duration of the clock pulses.

**✓ 7 Sample/Hold and Comparator Troubleshooting Aids**

A problem located within the Sample/Hold and Comparator circuit is more in the nature of an analog problem than a digital one. One method of troubleshooting this circuit is as follows:

1. Ensure that comparator A14U45A has +15  $\pm$ 1 Vdc on pin 3, and that sample/hold amplifier A14U44 has +15  $\pm$ 1 Vdc on pin 9 and -15  $\pm$ 1 Vdc on pin 5.
2. Connect channel 1 of the oscilloscope to A14U44-2 and channel 2 to A14U44-14. Set both channels to DC.
3. Using the signal generator, inject a signal of approximately 800 MHz into the Noise Figure Meter INPUT at any level less than -10 dBm. Allow time for the signals on A14U44 to stabilize.
4. Slowly change the input frequency (direction is optional). Ensure that the signal on pin 14 (H/ S) begins to toggle as the controller begins the sampling process.

5. Failure to toggle, should have been detected in the signature analysis routine. This can be the result of a short on the data bus of bit DD3; check A14U44, A14U37, A14U38, A14U22, A14U23, or A14U27. Ensure the PIA (A14U27) is receiving the correct data.
6. As the input frequency is shifted, ensure that the signal on A14U44 (DET) is a changing dc level. Direction and amount of change will depend on direction and speed of frequency shift.
7. Failure of a dc level shift is the result of a failure in either A14U44, A14U45A, or in the Frequency Cal Detector circuit in the 20 MHz IF Assembly A3.
8. Move the oscilloscope channel 1 from A14U44-2 to A14U44-7, and again slowly change the input frequency. Ensure that the dc level on pin 7 changes as pin 14 toggles.
9. Failure of the dc level on A14U44-7 to change is caused by a failure of either A14U44 or A14U45A.
10. Move the oscilloscope channel 1 probe to comparator A14U45A-4, and channel 2 probe to A14U45A-5. Slowly change the input frequency while closely observing the two traces.
11. Ensure that both dc levels change, and that one dc level is lagging the other. As to which level lags, and by how much, will again depend on the direction and amount of input frequency shift.
12. Failure of either dc level to change, or for one level to lag the other, is caused by a failure in either A14U44 or A14U45A.

**NOTE**

*Step 13 requires the use of a third channel of signal verification. If the scope in use does not have a third channel, or another scope is not available, the following steps can still be completed. Note the movements of the two input levels to the comparator and then move one of the scope channels to the output of the comparator while observing the other input. Then repeat the process with the other channel.*

**SERVICE SHEET 11 (cont'd)**

13. Connect the third oscilloscope channel (or second oscilloscope channel) to comparator A14U45A-2. Again, change the input frequency and observe all three traces. The leading channel can be either positive or negative in relation to the lagging channel, depending on the direction of the frequency shift.
14. In either event, the dc level with the highest positive level will cause the output of comparator A14U45A at pin 2 to go high (+5 Vdc) or low (0 Vdc).
15. Ensure that if the new DET dc level at pin 4 is higher than the last sampled level at pin 5, the output at pin 2 is high. If the last sampled level is the higher, then ensure that the output at pin 2 is low.
16. This process will continue as long as the frequency continues to change. Allow the frequency to hold at some fixed point, and observe the two dc input levels (pins 4 and 5) of the comparator.
17. Ensure that the two levels close on each other and finally cross over each other. This indicates locking onto the input frequency.
18. A failure in any of steps 13 through 18 is the result of a failure in either A14U45A or A14U38.
19. If all steps are completed successfully, the sample/hold and comparator circuit is functioning correctly. Disconnect all test gear and restore the Noise Figure Meter to operation.

**IF and RF Attenuator Latches Troubleshooting Aids**

A problem in the attenuator latches is purely digital in nature and should be quickly isolated by the signature analysis routines. If all of the latches appear to have proper outputs, then the trouble is most likely in Driver Assembly A13. If there is a need to further isolate the trouble, it can be accomplished manually.

Refer to Table 8-51 for the IF Attenuator Latch logic or to Table 8-52 (following page) for the RF Attenuator Latch logic. Then, refer to the

Detailed Operating Instructions, Section III, for the IF and RF Attenuator Selection procedures. Follow the instructions given, to manually select the desired attenuators, and use the logic table to verify proper logic level outputs.

**Table 8-51. IF Attenuator Latch Logic**

Data Bit at Input to A14U37					Total	Sample/	Noise
N5ON DD4	H/S DD3	-20 DD2	-10 DD1	-5 DD0	Latch Atten	Hold Status	Source Status
0	0	0	0	0	0	Sample	Off
0	0	0	0	1	-5	Sample	Off
0	0	0	1	0	-10	Sample	Off
0	0	0	1	1	-15	Sample	Off
0	0	1	0	0	-20	Sample	Off
0	0	1	0	1	-25	Sample	Off
0	0	1	1	0	-30	Sample	Off
0	0	1	1	1	-35	Sample	Off
0	1	0	0	0	0	Hold	Off
0	1	0	0	1	-5	Hold	Off
0	1	0	1	0	-10	Hold	Off
0	1	0	1	1	-15	Hold	Off
0	1	1	0	0	-20	Hold	Off
0	1	1	0	1	-25	Hold	Off
0	1	1	1	0	-30	Hold	Off
0	1	1	1	1	-35	Hold	Off
1	0	0	0	0	0	Sample	On
1	0	0	0	1	-5	Sample	On
1	0	0	1	0	-10	Sample	On
1	0	0	1	1	-15	Sample	On
1	0	1	0	0	-20	Sample	On
1	0	1	0	1	-25	Sample	On
1	0	1	1	0	-30	Sample	On
1	0	1	1	1	-35	Sample	On
1	1	0	0	0	0	Hold	On
1	1	0	0	1	-5	Hold	On
1	1	0	1	0	-10	Hold	On
1	1	0	1	1	-15	Hold	On
1	1	1	0	0	-20	Hold	On
1	1	1	0	1	-25	Hold	On
1	1	1	1	0	-30	Hold	On
1	1	1	1	1	-35	Hold	On

Notes Data Bits DD5 through DD7 are not used  
1 = High 0 = Low

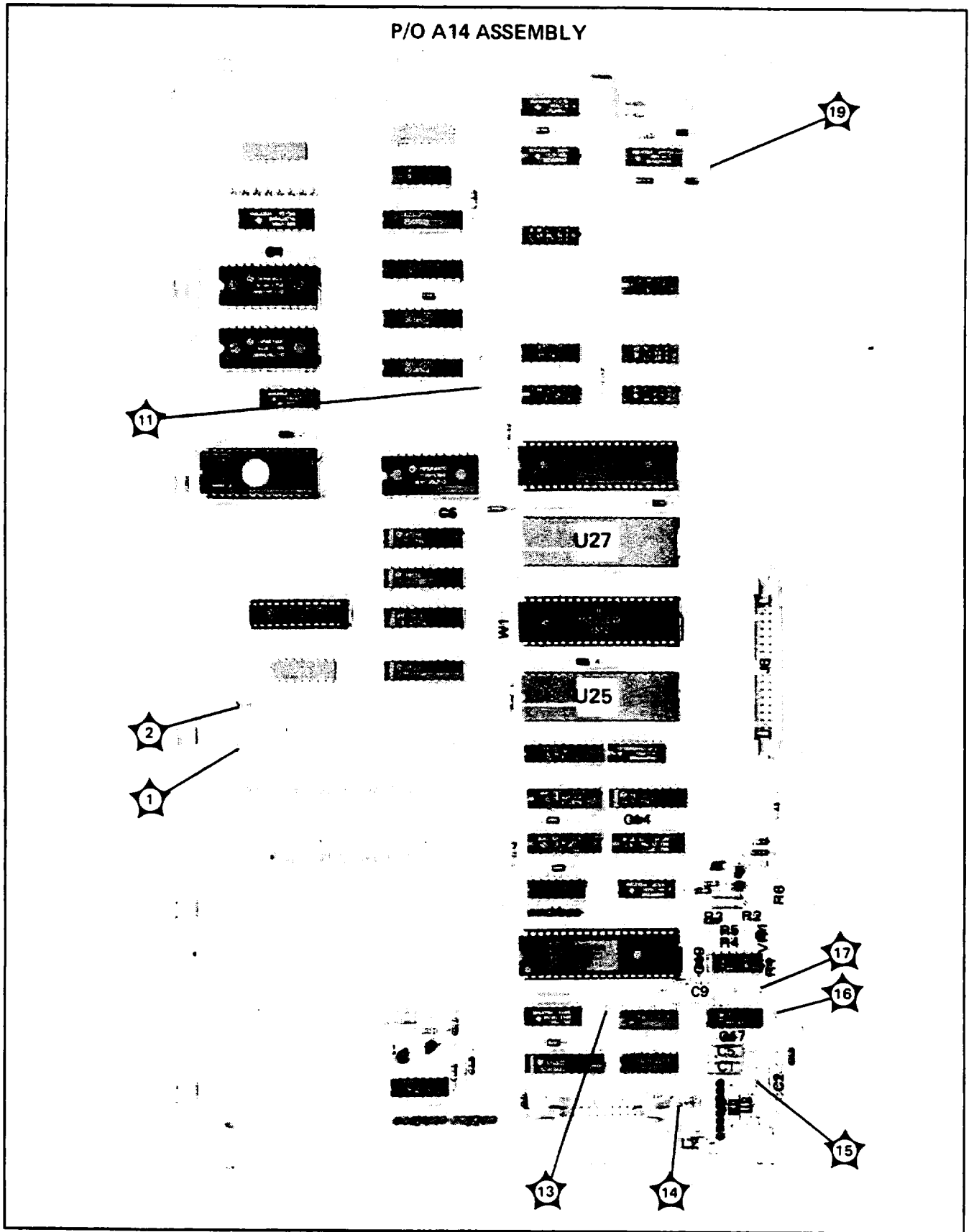
**SERVICE SHEET 11 (cont'd)****Table 8-52. RF Attenuator Latch Logic**

Data Bits at input to A14U22				Total
-20 DD7	-10 DD6	-10 DD5	-10 DD4	RF Atten
0	0	0	0	0
0	0	0	1	-10
0	0	1	0	-10
0	0	1	1	-20
0	1	0	0	-10
0	1	0	1	-20
0	1	1	0	-20
0	1	1	1	-30
1	0	0	0	+20
1	0	0	1	+10
1	0	1	0	+10
1	0	1	1	0
1	1	0	0	+10
1	1	0	1	0
1	1	1	0	0
1	1	1	1	-10

Notes: Data Bits DD0 through DD3 are not used.  
1 = High 0 = Low

**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 reference listed in the front of this section. Then refer to the applicable sections for post-testing procedures.



**Figure 8-80. P/O A14 Controller Assembly Component Locations (PIA)**

## **SERVICE SHEET 12**

### **CONTROLLER - MICROPROCESSOR**

### **P/O A14 CONTROLLER ASSEMBLY**

Block Diagram - Service Sheet BD4  
Section III - Operators Checks  
Section VIII - Special Functions and Power-Up Checks

### **PRINCIPLES OF OPERATION**

#### **General**

All activities throughout the entire instrument originate with the microprocessor (MPU). The MPU initiates a test or adjustment sequence, and controls the peripheral devices conducting that test, or making those adjustments. It then analyzes the results and provides intelligent data to the user, or makes additional corrections as required.

The entire operation begins when the reset circuits cause the MPU to initiate the start-up sequence. The MPU examines the high order addresses of FFFE and FFFF, which point to the start-up program in ROM. When the program is up and running, the MPU will communicate by placing an address on the MPU address bus ABB0—ABB15. This address is buffered and output to the address decoder and the instrument, as addresses A0—A15.

The MPU can either send or receive data over its bi-directional data bus DBB0-DBB7. The MPU data bus is in turn buffered to the instrument data bus D0-D7.

The Read Only Memory (ROM) is the long-term memory of the Noise Figure Meter. It stores the operating program for the instrument. Data within ROM can only be read by the MPU. Even through the data bus (D0-D7) is bi-directional, no data can be written into a ROM. When a ROM is selected, it places data on the data bus from its address location, as set by address bus A0-A14.

The Random Access Memory (RAM) is the short-term memory of the Noise Figure Meter. One RAM is volatile. When power is shut off, the data in the device is lost. The other RAM has a battery backup. This RAM retains its data after power down.

Data within RAM can be changed or read by the MPU. The MPU selects the desired RAM via the Address Decoding circuit. Once a RAM has been selected, it is set to either receive data or send data. The exact location in RAM, to which the data is to be stored, is determined by the address on address bus A0-A10.

RAM 2 requires a standby battery. It also requires special protection to prevent burnout. This could occur if the RAM were placed into the standby mode while the unit logic levels remained active. Under this condition, the RAM would be operating at +3.0 Vdc, while its input levels would still be at +5 Vdc. The Standby Mode Switch ensures the proper voltage level to RAM 2. The Power-Up Detector detects the level of the +5 Vdc supply and generates a low on the PON line of the +5 Vdc is correct. The PON signal is the control input to the Standby Mode Switch.

The MPU data bus, the instrument data bus, and the instrument address bus have pull-up resistors on each line. The resistors are required as part of the

## SERVICE SHEET 12 (cont'd)

internal testing circuitry. The free run switch and pull down diodes are used to initiate a test sequence in which the data buffer is disabled. Then, the addresses are each accessed in sequential order. This makes it possible to examine ROM content and to test decoder circuitry. The signature analysis program switch holds down the D0 data line. This informs the MPU to initiate the signature analysis program used for instrument troubleshooting.

### Microprocessor (MPU)

In the Noise Figure Meter, the Microprocessor (MPU) is an eight data bit, 16 address bit device. Since all addressing originates at the MPU, the address bus is output only. However, the MPU must send data to, and receive data from, the instrument. Therefore, the data bus is bi-directional. This particular MPU is a 40 pin device on which eight of the pins are dedicated to data, and 16 are for addressing. Of the remaining 24 pins, four are for power supplies, and two are not connected.

In the Noise Figure Meter, the HALT and MR inputs are not used. Both are tied high to prevent false signaling. The RESET input is used to cause a total instrument reset. The MPU is directed to examine the high order addresses of FFFE and FFFF and to begin the start-up sequence. The NMI (non maskable interrupt) input is used to cause a partial system reset. This interrupt will cause the MPU to examine the high order addresses of FFFC and FFFD. The IRQ (interrupt request) input is the only hardware interrupt which is responded to by the MPU at its software convenience.

When the MPU is communicating over the address bus, it will place a high on the VMA (valid memory address) line to inform the instrument that the present address is valid. The MPU will then inform the instrument as to the direction of data flow. If the MPU wants to receive data, it places a high on the  $R/\bar{W}$  line. A low on  $R/\bar{W}$  will allow the MPU to send data to the instrument. The MPU has its own RAM built into the chip. In the Noise Figure Meter, this RAM is disabled by tying the RE input to ground.

No action can take place within the MPU, or the instrument, without a common timing reference. This is the purpose of the 4 MHz clock at the EXTAL input of the MPU. The MPU is designed to use either a crystal or an external clock, such as in this application. The MPU routes the clock to the instrument on the E (enable) output as the  $\phi 2$  (SYSTEM CLOCK) signal.

### Reset Circuit Description

The reset circuit is used to place a low on the RESET input to the MPU. Once this has occurred, the MPU can initiate the program start-up sequence. The reset circuit has three different means of causing a reset. A high can be placed on the RESTART line which is input to pin 9 of inverter A14U39D. This high is the required input for inverter A14U39D to generate the RESET signal to the MPU.

**SERVICE SHEET 12 (cont'd)**

If A14TP20 and TP21 are shorted together, this will ground resistor A14R9 and discharge A14C10. The ground on the base of transistor A14Q3, will turn it off, and allow a high into A14U39D. The purpose of A14C10 is to cause a minimum 100 ms delay after the test points are disconnected. This ensures that the reset signal is low long enough to allow the MPU to complete the instrument reset.

The PON line to the base of transistor A14Q4 is normally a low to indicate that the power is ON. A power failure will cause this line to go high and turn on A14Q4, which will turn on A14Q5. Transistor A14Q5 will ground A14R7, which is the same as shorting A14TP20 and TP21 together. When the power is turned on, A14Q5 quickly drains A14C10, thereby ensuring that the power on reset circuit will be ready to operate after even a brief power failure.

**Power-Up Detector Circuit Description**

The Power-Up Detector consists of basically A14Q2 and A14VR3. When power is turned on, the +5V(F1) line will apply +5 Vdc to A14VR3. Zener diode A14VR3 will avalanche and apply the voltage to the base of A14Q2. This turns A14Q2 on, and grounds the +VB on the collector of A14Q2. This places a low on the PON line to indicate that the power is on. Note that the base of A14Q2, with the emitter grounded, will have a power up voltage of +0.8 Vdc to ground. The collector voltage will be pulled down to +0.02 Vdc.

The loss of +5V(F1) power will ground the base of A14Q2 through A14R21. This will turn off A14Q2 and allow the +VB line to apply approximately +3.0 Vdc on the PON line. This is the standby battery voltage, and is high enough to be a logical high on the PON line. A high on the PON line is an indication of power loss. The function of A14VR3 is to prevent the Power-Up Detector from reacting to the lower battery voltage, and initial start-up power. Only when +5V(F1) reaches +3.6 Vdc, will the detector operate.

**Standby Mode Switch Circuit Description**

The Standby Mode Switch consists basically of A14Q1 and A14CR3. It must be noted that A14Q1 is a PNP transistor which appears to be drawn wrong on the schematic. However, this is not the case. The transistor is actually wired backwards on purpose. When the PON line is low (to indicate power on), this low is placed on the base of A14Q1 through A14R24. This turns A14Q1 on and allows it to saturate. With A14Q1 saturated, the +VB voltage is pulled up to approximately the +5V(F1) level.

The reason that A14Q1 is in backwards, is that it is being used as a solid state switch. The saturation voltage of the transistor is lower when the transistor is used in reverse. Therefore, the switch resistance (voltage drop across A14Q1) is lower, and the +VB will be within 0.1 Vdc of the +5V(F1). This is necessary to prevent RAM 2 burnout from the logic levels being higher than the RAM 2 power supply. During this time, A14CR3 is actually bypassed by A14Q1.

## SERVICE SHEET 12 (cont'd)

A loss of power [+5V(F1)] will place the +VB voltage, of approximately +3.0 Vdc, on the PON line. This will turn off A14Q1, and A14CR3 will prevent the +VB power from draining through the +5V(F1) lines. The battery is charged through A14R23. When power is on, the voltage drop across A14R23 will be approximately -0.95 Vdc [+VB to +5V(F1)]. When the power is off, the drop is approximately +0.0003 Vdc. A14C13 is used to filter out any transients caused by power shifting. In a total power loss, the battery will keep the RAM active. The current drain on the battery is very small. Should the battery be removed from the circuit, the charge on A14C13 will keep the RAM active for a significant period of time.

### Microprocessor and Bus Buffers

The microprocessor (MPU) A14U26 will continue to process data and address various devices as long as the 4 MHz clock is present at the EXTAL input, since the HALT line is tied high. The MPU can be totally reset (RESET), forced to service an interrupt (NMI), or told to service an interrupt (IRQ) at its convenience. The MPU will output clock E as  $\phi 2$ . It will either read data ( $R/\overline{W}$  high) from the instrument, or write ( $R/\overline{W}$  low) data to the instrument.

The MPU will transfer the data to and from the instrument by sending an address to the instrument, and then informing the instrument that the address is valid (VMA high). However, the MPU is very limited in driver power, thus requiring external buffer/drivers. A14U8 and A14U9 are both tri-state buffers that have been hard wired to only transfer signals from the MPU to the instrument. A14U29 (E and F) are inverter/drivers. These devices make up the address buffer, which accepts addresses from the MPU address bus ABB0—ABB15, and outputs the addresses on the instrument address bus A0—A15.

Since the MPU is the only source of addresses, the address buffer is output only. However, the MPU sends and receives data. Therefore, the data bus is bi-directional. A14U16 is a tri-state buffer/driver which is the sole data bus buffer. It interfaces the MPU data bus DBB0—DBB7 to the instrument data bus D0—D7.

### Address Decoder

Address Decoder A14U1 is a programmable array logic (PAL) device. Inputs to the PAL are addresses A7 through A15, microprocessor signals VMA (valid memory address) and E (system clock), and RAM ENABLE. Outputs from the PAL are active low. Outputs ROM, RAM 1, RAM 2 and DMA provide the select enables to the respective devices. PIA is the peripheral interface adapter select enable. Output XYRAM is used to enable the DMA Stored Data RAM. The SEL CTRLR output enables the HP-IB controller logic by enabling the general purpose driver. The SA output enables the Signature Analysis logic.



## **SERVICE SHEET 12 (cont'd)**

### **Free Run and Signature Analysis Circuits**

Under normal conditions, the eight MPU data bus lines (DBB0—DBB7) are toggling as data is transferred through the bus. When not in use, the lines are held high by the pull-up resistors. When the FREE RUN switch A14S2A is placed in the FREE RUN position, free run will pull down diodes A14CR1 and A14CR2 and hold data bus lines DBB5 and DBB7 at ground. These lows will result in the data word 5F which will be interrupted by the MPU as the instruction CLR B (clear accumulator B).

Inverter A14U42A will have a low input from the FREE RUN switch. This low will be inverted to place a high on pin 19 of data buffer A14U16. The data buffer will be disabled, so that the MPU will only see the now hard-wired instruction 5F every time it looks for data. If the instrument is powered-up in this condition, the MPU will start at the first address and clear accumulator B. It will then increment the address by one and try again. Since it will always get the same instruction, it will step through all addresses. The end result is that no data is processed, but all addresses are sequenced. This allows all addresses to be examined during the troubleshooting process.

When SIGNATURE ANALYSIS switch A14S2B is placed in the SA position (FREE RUN switch is in the NORMAL position), a low is input to driver A14U31D. If the Address Decoder has placed a low on pin 13 of A14U31D, then the low SA input will be output to the data bus D0 line. This will hold the D0 line low to the instrument and to the MPU. This informs the MPU that the signature analysis routine is required, and that the instrument is in the troubleshooting mode.

### **Read Only Memory (ROM)**

In the Noise Figure Meter, the ROM is an eight bit data word with 32K of memory space. The device has 28 pins, with three pins for power. Fifteen pins are used for the address inputs of A0 through A15. This gives an addressing count from 0 to 32767 (32K). Eight of the pins are the data pins of D0 through D7. These pins are tri-state, in that the data can be sent to the data bus, or when the device is not selected, the data pins float at a high impedance.

The ROM is selected when a low is placed on both pins 20 and 22. Once selected, the ROM outputs a data word onto the data bus. The specific word is selected by the address on address bus A0-A14.

### **Random Access Memory**

In the Noise Figure Meter, each RAM device is an eight bit data word with 2K of memory space. Both RAMs are CMOS devices.

**SERVICE SHEET 12 (cont'd)**

**Free Run and Signature Analysis Circuits (cont'd)**

RAM 1 memory is volatile; RAM 2 is provided with a backup battery to make the memory nonvolatile.

Each device has 24 pins, with two of the pins for power. Eleven pins are used for the address inputs of A0 through A10. This gives an addressing count from 0 to 2047 (2K). Eight pins are the data pins of D0 through D7. These pins are tri-state, meaning that the data can be pulled high or low when the device is selected. When the device is not selected, the data pins float at a high impedance to prevent affecting the other devices.

The device is selected when a low is placed on the select (F3) input. The device receives data (MPU write mode) when a low is placed on the R(H)/W(L) line. The device sends data (MPU read mode) when the R(H)/W(L) line is high.

**TROUBLESHOOTING**

Troubleshooting is done on the circuits of Service Sheet 12 when a malfunction has occurred in the microprocessor (MPU), Data Bus, Address Bus, Address Decoding Circuits, RAM 1, RAM 2, or ROM. If all of the tests in the following procedures indicate correct responses, the trouble is located elsewhere in the control unit, and not on Service Sheet 12. Except where shown, all values listed are approximate and are given as a service guideline.

**Test Equipment**

Oscilloscope Measuring System . . . . . HP 1980A  
Systems DVM . . . . . HP 3456A

**✓1 General Checks**

1. Verify that the voltage from test point A14TP19 (ground) to A14U26 pin 8 is +5 ±0.05 Vdc. If not, continue troubleshooting on Service Sheet 19 (Power Supply).
2. Verify that the 4 MHz clock is present at A14U26 pin 39. If not, continue troubleshooting on Service Sheet 6.
3. Verify that the 1 MHz clock is present at A14U29 pin 6. If not, look for the signal at A14U26 pin 37 and U40 pin 3. Replace the appropriate component (U26, U40, or U29).

4. Verify that A14U26 pins 2, 4, and 6 are at a logical high.

If pin 2 was bad check A14R14. If pin 4 was bad check A14R13. (If R13 is good continue on Service Sheet 18.) If pin 6 was bad check A14R12. (If R12 is good continue on Service Sheet 11.)

5. Verify that A14U26 pin 40 is not held at a logical low. If it is, continue troubleshooting with the Reset Circuit section of this Service Sheet.

**✓2 Reset Circuit**

1. Verify the following voltages and, if necessary, replace the appropriate component:

Q4-Base	Logical low
Q3-Base	0.7 Volts
U39-9	Logical low
U39-8	Logical high
U39-4	Logical low

2. Short A14TP20 (RESET) to A14TP21 (ground), verify the following voltages, and replace any defective components:

U39-9	Logical high
U39-8	Logical low
U39-4	Logical high

**✓3 Free Run Troubleshooting**

To verify that the microprocessor is in the free run mode:

1. Check the data lines (DBB0-DBB7) at the microprocessor

A14U26-26	Logical low
-27	Logical high
-28	Logical low
-29	Logical high
-30	Logical high
-31	Logical high
-32	Logical high
-33	Logical high

These voltages should all be dc levels. If any or all have an ac signal present, make sure the data buffer (U16) is disabled by verifying that U16 pin 19 is a logical high. If not, check U42 and switch S2. Otherwise, replace U16.

2. If you haven't already done the General Checks, do them now.

**SERVICE SHEET 12 (cont'd)**

**Free Run Troubleshooting (cont'd)**

3. Verify that there is a signal present at A14TP12 (A15). If not, check U26 pin 25. If there is a signal here, replace U29.

If all of these checks are normal, then the micro-processor is in the Free Run mode. Proceed to Data Bus Tests, Address Bus Tests, Address Decoding Tests, or RAM Tests as necessary.

**Data Bus Tests**

1. If you haven't already done the General Checks, do them now.
2. Remove the ROM (U2) from its socket and put the instrument into Free Run mode. Verify that all the Data lines are high. If any Data lines are low or have a signal on them, then go on to step 3. If the Data lines are all high, check for a signal at U30 pin 3. If U30 pin 3 is correct, replace ROM (U2). If U30 pin 3 is incorrect, verify:

U30-2	Logical low	If good, replace U30
U33-8	Logical high	If good, replace U29
U33-10	Logical high	If good, replace U33
U8-14	Logical high	If good, replace U8

If all of these points are incorrect, replace U26.

3. With instrument off, check A14R17 and A14R19. Connect the common lead of an ohmmeter to TP1 (+5V) and measure the resistance. A14R17 pins 1 through 8 should be about 10KΩ. A14R19 pins 1 through 15 should be about 4.7KΩ.

If any of the pins are incorrect, try reversing the ohmmeter leads.

If the problem is with R17 and reversing the ohmmeter leads didn't help, remove the micro-processor (U26) from its socket and try again. If the problem persists, replace A14R17 and/or A14U16. Otherwise, replace the microprocessor (U26).

If the problem is with R19 and reversing the ohmmeter leads didn't help, replace one or more of the following components:

- A14R19 A14U16 A14U4 A14U5
- A14U13

\* If you want to try isolating the problem further, you can use a logic pulser and current tracer to find the bad node.

Note that if two Data lines are shorted together, the resistance measured on both pins will be 1/2 of the expected value.

**Address Bus Tests**

1. If you haven't already done the Free Run Tests on Block Diagram 4, do them now. If there is no problem with the Address Bus then the following steps do not need not to be performed.
2. If you haven't already done the Free Run Troubleshooting test on this Service Sheet, do it now.
3. With the instrument in Free Run Mode, check the following signatures:

Address Bus Start: A14TP12(A15) \		
Stop: A14TP12(A15) /		
Clock: A14TP11 (φ2) \ -		
Test Point	Signal Name	Signature
A14U26-9	A0	5555
-10	A1	CCCC
-11	A2	7F7F
-12	A3	5H21
-13	A4	0AFA
-14	A5	UPFH
-15	A6	52F8
-16	A7	HC89
-17	A8	2H70
-18	A9	HPP0
-19	A10	1293
-20	A11	HAP7
-22	A12	3C96
-23	A13	3827
-24	A14	755U

If any signature is bad, replace the micro-processor (U26).

If all signatures are good, turn the instrument off and check R16:

1. Connect the common lead of the ohmmeter to to A14TP1 (+5V).
2. Measure the resistance at R16 pins 1 - 15. They should be about 4.7KΩ. If one or more pins

**SERVICE SHEET 12 (cont'd)**

**Free Run Troubleshooting (cont'd)**

are bad, replace R16 and re-check the Address Bus signatures.

**NOTE**

*If any pins are bad, try reversing the ohmmeter leads before replacing R16. Also, you only need to check the pins on R16 which connect to bad Address lines.*

If R16 is good and the signatures taken on Block Diagram 4 were bad, replace the appropriate Address Buffer (U8 or U9).

**Address Decoding Circuits**

1. If you haven't already performed the Free Run Signature Analysis on Block Diagram 4, do so now.
2. If you haven't already done the General Checks on this Service Sheet, do them now.
3. With the instrument in Free Run mode, verify that A14U1 pin 11 is at a logical high. If it is, go on to step 4. If there is a problem with U1 pin 11, replace the microprocessor (A14U26).
4. If there is a problem with A14U1 pins 14, 16, 17, 18, 19, or 20, replace U1. Otherwise, continue troubleshooting with the RAM Tests section.

**RAM Tests**

1. Put instrument into Signature Analysis mode.
2. Set signature analyzer as follows and take the indicated signatures:

RAM 1 (U4) Start: A14TP9(D2) \ Stop: A14TP7(D4) / Clock: A14TP11 (φ2) \ Test Signatures A14TP1 (+5V): 148A A14TP2 (GND): 0000		
Test Point	Signal Name	Signature
A14U16-2	D0	0H60
-3	D4	7CU1
-4	D1	541F
-5	D5	8UFA
-6	D2	383U
-7	D6	63AC
-8	D7	4P67
-9	D3	3PC6
A1RU3-6	—	+
A14U1-22	RAM 1	CC7U

\*The probe light should blink indicating signal activity.

If all these signals are good, then RAM 1 (U4) is good.

If the RAM 1 chip enable signature is bad, replace U1.

If the Data Bus signatures are bad but the RAM 1 chip enable and the A14U3 pin 6 signals are good, replace RAM 1 (U4).

If A14U3 pin 6 is bad, check these signatures:

- A14U29-2 — 7PAU If good, replace U3
- A14U33-8 — 6A25 If good, replace U29
- A14TP18 — 6A25 If good, replace U33
- A14U26-34 — 6A25 If good, replace U8

If these signatures are bad, replace U26.

RAM 2 (U5) Start: A14TP7 (D4) \ Stop: A14TP8 (D1) / Clock: A14TP11 (φ2) \ Test Signatures A14TP1 (+5V): 148A A14TP2 (GND): 0000		
Test Point	Signal Name	Signature
A14U16-2	D0	F335
-3	D4	AH45
-4	D1	36FP
-5	D5	CACC
-6	D2	58AA
-7	D6	933H
-8	D7	4P67
-9	D3	3PC6
A1RU3-6	—	823F
A14U1-23	RAM 2	2045

If all these signatures are good, RAM 2 (U5) is good.

If the RAM 2 chip enable signature is bad, replace U1.

If the Data Bus signatures are bad but the RAM 2 chip enable signature is good, replace RAM 2 (U5).

If A14U3 pin 6 is bad, check these signatures:

- A14U29-2 — 519F If good, replace U30
- A14U33-8 — 823F If good, replace U29
- A14TP18 — 823F If good, replace U33
- A14U26-34 — 823F If good, replace U8

If these signatures are bad, replace U26.

**SERVICE SHEET 12 (cont'd)****☑ 4 Signature Analysis Mode  
Troubleshooting**

If the instrument will not go into Signature Analysis Mode but the Block Diagram Level Free Run Tests all passed, then the Signature Analysis Program Switch circuit, the RAM Chip Enables, RAMs, and Data Bus Buffer (U16) should be checked:

1. Check for a logical low at A14U16 pin 19. If incorrect, check switch S2 and A14U42.
2. Check for signal activity at the inputs and outputs of U16. If not, replace U16.
3. Put switch S2 into the SA position.
4. Verify that there is a logical low on A14U31 pin 12. If not, replace S2.
5. Put switch S2 in the Free Run position and remove ROM (U2) from its socket. Short U31 pin 13 to A14TP2 (ground) and verify that U31 pin 11 goes to a logical low. If not, replace U31.
6. If there was a RAM error on power up, check for a chip enable signal at the appropriate RAM.
  - E72 Check for Chip Enable signal at A14U4 pin 18.
  - E73 Check for Chip Enable signal at A14U5 pin 18.

If there is no signal present at either point, replace A14U1.

If there is a signal present, replace the appropriate RAM:

E72 replace U4.

E73 replace U5.

### P/O A14 ASSEMBLY

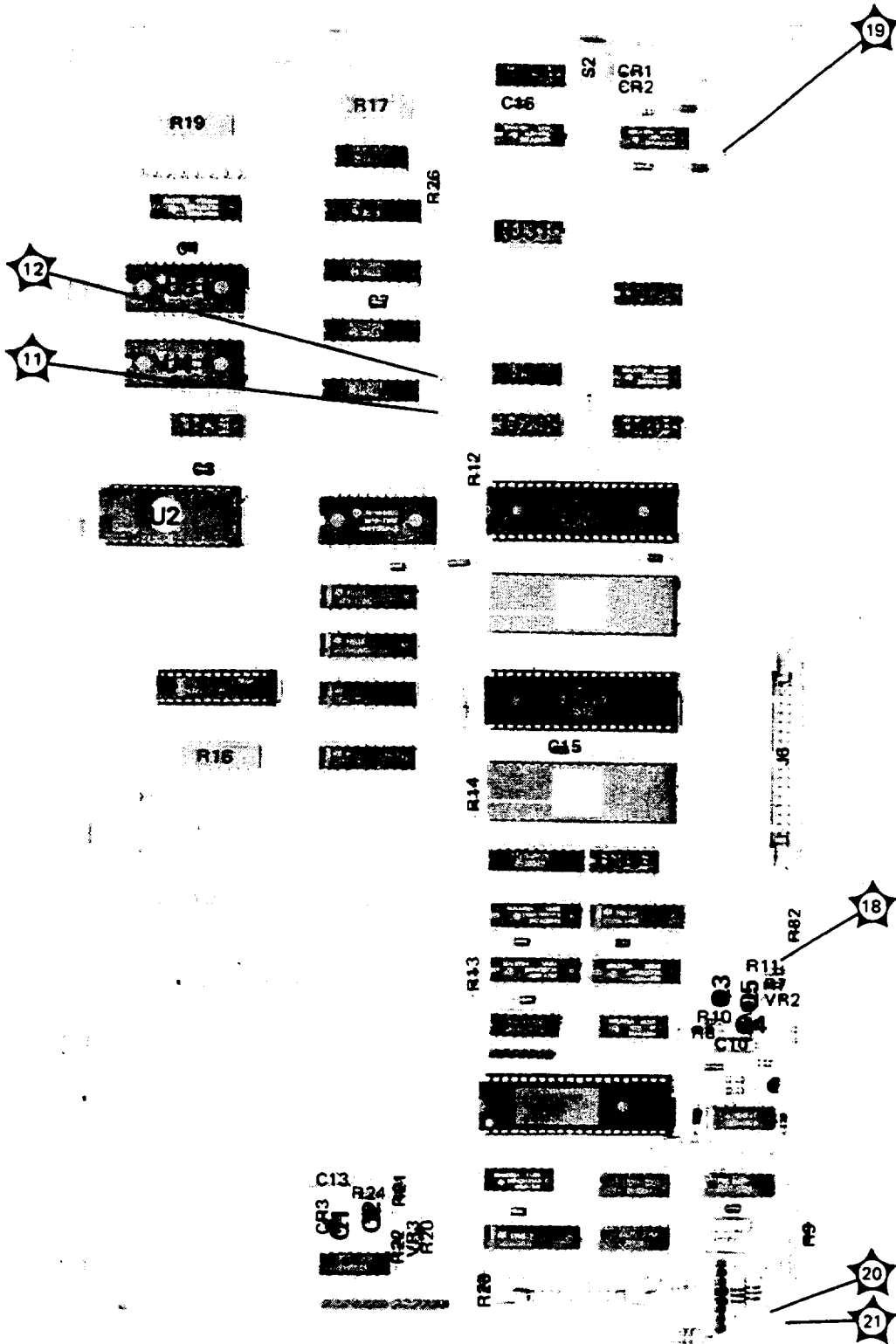


Figure 8-63. P/O A14 Controller Assembly Component Locations (Microprocessor)

(8-88A P/O Change 4)

## **SERVICE SHEET 15**

### **CONTROLLER - DIRECT MEMORY ACCESS**

#### **P/O A14 CONTROLLER ASSEMBLY**

Block Diagram - Service Sheet BD4

Section III - Operator's Checks

Section VIII - Special Functions and Power-Up Checks

### **PRINCIPLES OF OPERATION**

#### **General**

The sole purpose of the Direct Memory Access (DMA) and its circuits is to control the data for the X-Y recorder and oscilloscope displays. By using the fast speed of the DMA in this capacity, the Microprocessor (MPU) is freed for more useful tasks.

Located on the rear panel of the Noise Figure Meter are three output connectors labeled X-AXIS, Y-AXIS, and Z-AXIS/PEN LIFT (shown on Service Sheets 16 and 17). These are the three output connectors to be used with either an oscilloscope, X-Y recorder, or strip chart recorder. When used with the oscilloscope, the X-AXIS output is connected to the input which would provide horizontal motion of the trace. The X-AXIS output goes to the input for vertical motion. The Z-AXIS output goes to the input (often on the rear panel of the oscilloscope) which provides blanking or dimming of the oscilloscope trace. When used with either a strip chart recorder or X-Y recorder, the Z-AXIS/PEN LIFT line is connected to the recorder's PEN LIFT input.

The movement time of the recorder pen, between two points, is a purely mechanical function. This time period is very slow to the MPU. To minimize the time needed, the MPU remembers the location of the pen at each given plot. The MPU then looks forward to the next plot point. The MPU uses these two points to calculate the shortest path between them, and directs the pen over the calculated course.

Whereas the recorder is a relatively slow device, the requirements of the oscilloscope are quite demanding. It is necessary to update all axis data for each trace of the oscilloscope for two channels. The data demand is too great for the MPU to handle, if the MPU is to run the Noise Figure Meter as well. Therefore, a DMA is used in the display controller.

This is accomplished by effectively isolating the memory used by the DMA from the rest of the instrument. The DMA has its own buses, timing circuits, and memory. It continually outputs the data in its memory to the display channels. Only the MPU can interrupt the DMA and communicate with its RAM. And, this is done only to update the DMA data with the latest measurement.

#### **Direct Memory Access (DMA)**

The DMA is a 40 pin device, with two pins used for power. There are eight bi-directional data pins (D0—D7), and 16 address pins. The first five of the address pins (A0—A4) are bi-directional. In the Noise Figure Meter, the upper six address pins (A10—A15) are not used.

There are four transfer request pins (TxRQ0—TxRQ3), but only the first (TxRQ0) is used. Since the DMA is only used to output data from its own memory, the R/W line is tied to ground. This keeps the DMA permanently in

## SERVICE SHEET 15 (cont'd)

the write mode. For the same reason, the data bus request pin (DRQT) is inverted and routed back into the DMA data bus grant (DMA GRANT) pin. Therefore, each data bus use request is immediately granted.

The other data bus request pin (DRQH) is not used, and neither is the transfer acknowledge (TxAKA), nor interrupt request (IRQ/DEND). Clock ( $\phi 2$ ) is input directly into the DMA, as is the instrument RESET. DMA select (CS) is the DMAC input from Service Sheet 12.

### DMA Bus Structure Description

In order to isolate the DMA from the rest of the instrument, both the instrument data and address buses are buffered to the DMA. The MPU transfers data over the instrument data bus D0—D7 and into, or out of, data buffer A14U13. This data is then transferred over the DMA data bus DS0—DS7. The MPU selects the DMA data buffer by placing a low on DMAC, XYRAM, and RAM ENABLE. The MPU then either reads ( $R/\bar{W}$  high), or writes ( $R/\bar{W}$  low), the data out of, or into, the DMA RAM.

The location in memory, to which, or from which, the data is to be transferred, is determined by the address on the instrument address bus A0—A9. The two address buffers A14U10 and A14U11 are selected by the MPU placing a low on the DMAC and XYRAM lines. Since the address is input only, both address buffers have pin 1 grounded. This allows only an MPU to DMA address transfer each time the buffers are selected. The DMA address bus AS0—AS9 is routed to the DMA and to RAM.

The DMA can either receive addressing over the lower five address lines (AS0—AS4), or output addresses to the RAM over the full DMA address bus (AS0—AS9). The RAM receives all ten address inputs (A0—A9) from either the MPU or the DMA. But, under NO circumstances can the DMA and the MPU access the DMA RAM at the same time.

### Random Access Memory (RAM) Circuit Description

The RAM selected for use with the DMA is an 8-bit by 2K device. Within the 2K of memory, data is stored in a two byte sequence. The first byte is the Y-byte, and contains the vertical data. The second byte is the X-byte, and contains the horizontal data.

The digital-to-analog circuits (see Service Sheet 16), receive and latch the two bytes, to ensure that both bytes are present. Two trace oscilloscope operation is done by first sending the data for one complete trace. The X-Axis data is retained and the second set of Y-Axis data is loaded into RAM and output to the display to form the second trace on the oscilloscope.



## SERVICE SHEET 15 (cont'd)

When in the oscilloscope mode, the DMA will have data throughout its entire memory. The DMA controller will address the memory in sequential order from (hexadecimal) 00 through 3F. In the recorder mode, only two bytes of data are stored in the first two addresses of memory. These are for a single plot point, and consist of one vertical (Y-Axis) and one horizontal (X-Axis) data byte. In the recorder mode, there are only two bytes of data. One byte is the gain byte, and the other is the noise figure byte.

The RAM is selected by a low on XYRAM and a low output from the DMA on the TxSTB transfer line. The RAM is enabled to receive or send data by a high on the DISPLAY DISABLE line, a high on the E line, and the desired transfer level on the R/W line.

### Timing Circuits Description

Timing for the DMA is basically independent of the rest of the instrument. The only thing they have in common is the clock ( $\phi 2$ ). Clock is input to both the DMA and to clock divider A14U32. There, the 4 MHz clock is divided down to a 0.5 MHz clock and used to trigger A14U43A. The 0.5 MHz clock is again divided to generate the 0.25 MHz clock, which is routed to Driver Assembly A13 as ST2.

The 0.5 MHz output, that triggers transfer request pulse generator A14U43A, causes one-shot A14U43A to generate a 3  $\mu$ s high level pulse. This pulse occurs every 8  $\mu$ s, and is the transfer request pulse input to the DMA on TxRQ0. This will cause the DMA to generate a data bus request on the DRQT output. DRQT is immediately inverted and routed back into the DMA on the DMA GRANT input. The DMA sees the data bus as free, and generates the transfer strobe (TxSTB) output.

The TxSTB output is used (along with XYRAM) to select the RAM. It also triggers data strobe pulse generator A14U43B. One-shot A14U43B generates a high level 500 ns pulse which goes to Driver Assembly A13 as ST1. One byte of data is then transferred to the Driver Assembly. This is the normal operation of the DMA circuits. The address and data buffers are disabled, and the DMA outputs data to the Driver Assembly.

When the MPU completes a measurement, it updates the DMA RAM with new data. It does this by placing a high on the DISPLAY DISABLE line. This disables the clock divider, and stops the transfer request pulse generator. It also disables A14U31C, which prevents the output of TxSTB from triggering the data strobe pulse generator. Gate A14U3C is enabled to allow the MPU to either read or write to the DMA RAM. DISPLAY DISABLE is also routed to the Driver Assembly to disable the data latches.

### TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 15 when a malfunction has occurred in the Direct Memory Access (DMA) controller or related functions. If all of the tests in the following proce-

**SERVICE SHEET 15 (cont'd)**

dures indicate correct responses, the trouble is located elsewhere in the control unit, or in the external display, and not in the DMA or related circuits. Except where shown, all values are approximate and are given as a service guideline.

**Test Equipment**

Logic Analyzer .....	HP 1630D
Oscilloscope Measuring System .....	HP 1980A
Systems DVM .....	HP 3456A

**✓ 1 General Checks**

1. Verify that the voltage from pin 20 of A14U28 to ground is +5  $\pm$ 0.05 Vdc.
2. Verify that the 4 MHz clock ( $\phi$ 2) is present on pin 40 of A14U28 and pin 10 of A14U32.
3. Verify that pin 39 (RESET) of A14U28 is at a logical high.

**✓ 2 Power-Up Self-Testing**

When the Noise Figure Meter is first powered-on, a complete instrument self-test is run. In the case of the DMA, all instrument data bus and address lines are tested as part of the instrument RAM memory test. If a bus has a problem, and the trouble is isolated to the DMA circuits, a pin-by-pin inspection should be made of A14U13 for the data bus. Check the traces and pins of A14U10 and A14U11 for an address bus error.

**✓ 3 Timing Circuits**

1. Synchronize the oscilloscope on pin 10 of A14U32 (clock), and connect channel 1 of the oscilloscope to pin 32 of A14U28.
2. Ensure that one  $3 \pm 0.5 \mu\text{s}$  pulse is being generated each  $8 \mu\text{s}$ . If there is only one pulse in the time period and that pulse is correct, proceed to step 5.
3. If there is one pulse, but the width of the pulse is in error, check A14U43A and A14U28.
4. If there is more than one pulse, or no pulses present, check A14U32 and A14U43A. Ensure that the DISPLAY DISABLE line is not held low. If it is low, check A14U32, A14U31C, A14U39E and A14U3C.
5. Verify the presence of 0.25 MHz clock on pin 8 of A14U32A. If the clock is in error, check A14U32.
6. Connect the channel one probe to pin 12 of A14U43B, and ensure the presence of the  $500 \pm 50 \text{ ns}$  strobe pulse. This pulse occurs in synchronization with the strobe pulse on pin 32 of A14U28.
7. If the pulse is correct, proceed to step 11. If the pulse is present, but the width is in error, check A14U43B.

**SERVICE SHEET 15 (cont'd)**

8. If there is more than one pulse, or the pulse is missing, verify the presence of a trigger pulse on pin 34 of A14U28.
9. If the trigger is present, check A14U43B, A14U31C, and ensure that the DISPLAY DISABLE line is not held low.
10. If the trigger is missing, check A14U31C, A14U29B, and A14U28.
11. Synchronize the oscilloscope on the DISPLAY DISABLE signal, and connect channel one of the oscilloscope to pin 13 of A14U43A.
12. Connect channel two of the oscilloscope to pin 12 of A14U43B. Verify that both strobe outputs are inactive (low) during the period that DISPLAY DISABLE is high.
13. If the transfer request pulse is present, check A14U32 and A14U43A. If the data strobe pulse is present, check A14U31C, A14U43B, and A14U41A.
14. If the DISPLAY DISABLE line never goes high, check A14U32, A14U31C, A14U39E and A14U3C.

**✓ 4 RAM Circuits**

1. Connect the logic analyzer to the data pins DS0 through DS7 of the RAM; A14U12, pins 9—11 and 13—17.
2. Also, connect the logic analyzer to pins 18, 20 and 21 of the RAM. Ensure that the data lines contain all eight bits of data each time the RAM is selected, and that the bits do change.
3. If all eight bits are present and changing, proceed to step 4. If any bit is not changing, check A14U13, A14U28, and A14U12.
4. On the RAM, connect the logic analyzer to the address pins AS0 through AS9 (1—8, 19, 22 and 23), pin 18, pin 20 and pin 21. Ensure that each time the RAM is selected, the address lines are all active and changing.
5. If any line is not changing, check A14U12, A14U28, A14U10, and A14U11.

**✓ 5 Direct Memory Access (DMA)**

1. Connect the logic analyzer to the pins of DMA A14U28 as shown in Table 8-60.
2. Ensure that while the instrument is operating, RESET remains high,  $R/\bar{W}$  remains low, and clock is present. If reset or  $R/\bar{W}$  is in error, check A14U28.
3. If the clock is in error, check A14U28 and A14U32.

**SERVICE SHEET 15 (cont'd)**

4. Ensure that the Transfer Request Pulse is present (only when DISPLAY DISABLE is low). If the pulse is absent, and DISPLAY DISABLE is low, check A14U28, A14U43, and A14U32.
5. Verify that with each Transfer Request Pulse at TxRQ0, a pulse is present at DRQH, DMA GRANT, and TxSTB. If any pulse is missing, check A14U28, A14U29B, and A14U31C.
6. Ensure that all eight data lines are present and changing. If any line not changing, check A14U28, A14U13, and A14U12.
7. Move one of the data connections to the DISPLAY DISABLE line at pin 10 of A14U31C. Ensure that when DISPLAY DISABLE is high, pins 32 and 37 of the DMA are low. Ensure the MPU is able to select the DMA with a low on pin 2 (CS) of the DMA.

**Table 8-60. DMA Logic Analyzer Data Pin-Out**

Signal Line	DMA Signal	DMA Pin
DS0	D0	28
DS1	D1	27
DS2	D2	26
DS3	D3	25
DS4	D4	24
DS5	D5	23
DS6	D6	22
DS7	D7	21
TRP	TxRQ0	32
SYS CLK	$\phi 2$	40
RESET 2	RESET	39
DMA GRANT	-DRQH	38
DMAC	CS	2
GND	R/ $\bar{W}$	3
DSPG ENABLE	TxSTB	34
DRQH	DRQH	37

8. If the pulses are still present, check A14U31C, A14U39E, A14U3C, and A14U32. If the DMA was not selected, check A14U41D and A14U28.
9. Connect the logic analyzer to the pins of DMA A14U28 as shown in Table 8-61.
10. Ensure that while the instrument is operating, and CS is high, the addresses are being sequentially stepped through, and the pulse is present on TxSTB.
11. If any address line is not changing, check A14U28, A14U10, A14U11, and A14U12. If the transfer pulse is in error, check A14U28 and A14U31C. If the CS line is in error, check A14U28 and A14U41D.

**Table 8-61. DMA Logic Analyzer Address Pin-Out**

Signal Line	DMA Signal	DMA Pin
AS0	A0	4
AS1	A1	5
AS2	A2	6
AS3	A3	7
AS4	A4	8
AS5	A5	9
AS6	A6	10
AS7	A7	11
AS8	A8	12
AS9	A9	13
DMAC	CS	2
TxSTB	TxSTB	34

**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.

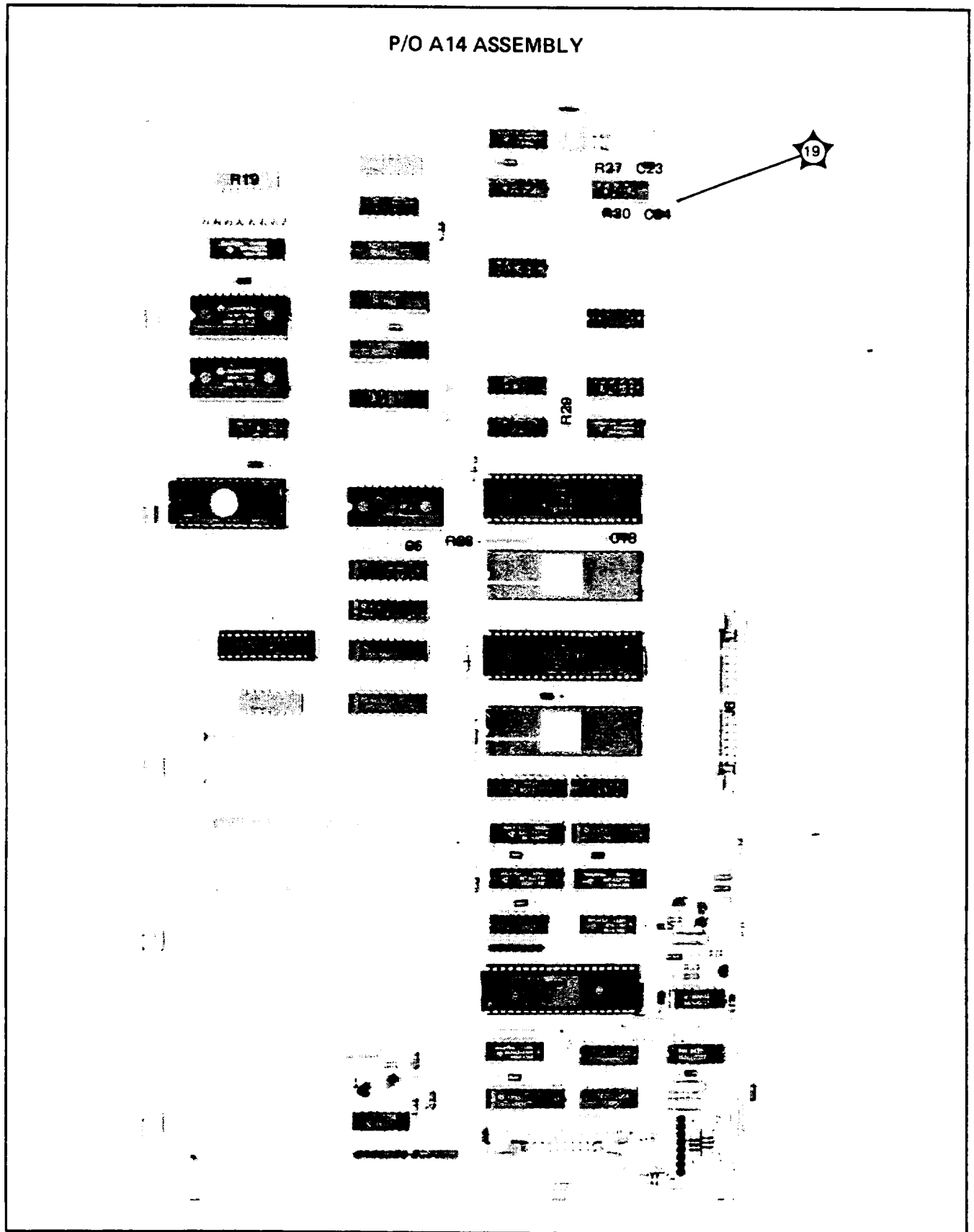


Figure 8-72. P/O A14 Controller Assembly Component Locations (Direct Memory Access Controller)

**SERVICE SHEET 18**  
**CONTROLLER - DIRECT MEMORY ACCESS**  
**P/O A14 CONTROLLER ASSEMBLY**  
**A16 HP-IB CONNECTOR 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 HP-IB connector is located on the rear panel of the Noise Figure Meter. HP-IB is Hewlett-Packard's implementation of the IEEE-488 Interface Bus. The use of the HP-IB is covered in depth in Section III, Operation. The Noise Figure Meter can be operated over HP-IB in three modes. It can be a talker/listener under the control of a computer, it can be a controller for an external local oscillator, or it can be a talker-only, sending data to a logger.

**HP-IB Interface Adapter**

At the heart of the HP-IB interface is the interface adapter. This device is essentially a special purpose microprocessor with an eight register, fully programmable latch. It has control lines and a data bus which interface with the MPU. It also has control lines and a data bus which interface with the HP-IB, and the external device.

The adapter will respond directly to certain bus commands where long delays are not allowed (such as interface clear). In other cases, it will interrupt the microprocessor when it has received data or commands addressed to the Noise Figure Meter.

**Microprocessor (MPU) Interface Circuits Description**

Clock  $\phi 2$  is input to the adapter A14U20 on pin 3. This signal determines the timing for all adapter operations. When the adapter needs to communicate with the MPU, the adapter will place a low on the IRQ line at pin 11. This initiates the interrupt request to the MPU. When the MPU is ready to communicate with the adapter, the MPU will place a low on the HPIB line. This low is input to the adapter on pin 8 as the chip select signal CS.

If there is a need, the MPU can put the adapter into an idle state by placing a high on the RESET 1 line. This causes the adapter to suspend all operations until RESET goes low. When the MPU selects the adapter, it must also select the internal adapter register with which it wants to communicate. There are eight registers within the adapter. The MPU selects the desired register by placing an appropriate address on lines A0, A1, and A2.

Along with register selection, the MPU will either write data into the selected register (pin 10 WRITE low), or read data from the register (pin 9 READ low). To obtain proper timing, the MPU uses HPIB and  $R/\bar{W}$  as inputs to the read/write control logic. A14U42C inverts HPIB and inputs it to both A14U36A and A14U36B. In A14U36A, HPIB and  $R/\bar{W}$  generate READ. A14U42B inverts  $R/\bar{W}$  and inputs it along with HPIB to generate the WRITE.

**SERVICE SHEET 18 (cont'd)**

With the register selected, and the direction of data flow set, it is only necessary to transfer the data between the MPU and the register in the adapter. Bi-directional data buffer A14U14 is the data bus (D0—D7) interface between the MPU and the adapter. The buffer is selected by a low on both HPIB and RAM ENABLE into A14U17B. The direction of data flow in A14U14 is set by the R/W line.

**HP-IB Interface Circuits Description**

To be a controller, it is necessary to have command of the ATN and REN signal lines. Since the Noise Figure Meter can be either a controller, or a controlled device, these signal lines are bi-directional. Though the adapter is capable of receiving the ATN and REN signals, the MPU controls the setting of these two lines when the instrument is configured as a bus controller.

General purpose driver A14U6 is enabled by a low on SEL CTLR to pass a byte from the instrument data bus (D0—D7) to the HP-IB controller logic. The five least significant bits are used only for observation during troubleshooting. CTLR ENABLE is the line used by the MPU to indicate that it wants to be the BUS CONTROLLER. The switching from talk to listen is handled by the adapter, which sends status data to the MPU.

The function of remote enable signal REN is to set the state of the external device. REN works in conjunction with other signals to place the external device in either its local or remote controlled state. If the external device is in its local mode, it can become the controller by seizing the REN line and placing the interface adapter in its remote state. If the external device is in its remote state, it is under control of the adapter.

The function of the attention signal (ATN) is to specify how data is to be interpreted on the HP-IB data bus. When ATN is true, D0—D7 is interpreted as address information. Otherwise D0—D7 is interpreted as data.

Interface clear signal IFC is input only from the external device to the adapter through A14U34A. It is used to place the adapter into a known quiescent state. Service request signal SRQ is an output only from the adapter to an external controller through A14U35A. It is used to inform the controller of the adapter's desire to communicate.

Data valid signal DAV is used to inform the listening device that the data available on the bus is valid. The not data accepted signal (NDAC) is used to inform the talking device that the listening device is not accepting data at this time.

Not ready for data signal NRFD is used to inform the talking device that the listening device is not prepared to accept data. This is different than the NDAC signal, in that the NDAC signal is a momentary state; for example, machine cycle busy. The NRFD is a status condition and may require longer to clear. Lines NRFD,

**SERVICE SHEET 18 (cont'd)**

NDAC, and DAV work together in what is known as a three wire handshake in which the slowest active listener controls the speed of data transfer. End or identify signal EOI is used by the bus controller to inform the listening device that the talking device has completed a multiple byte transfer sequence.

The Signal lines previously described are interfaced through HP-IB control/handshake transceivers A14U34A/B and A14U35A/B. The REN signal is under control of the MPU, when the Noise Figure Meter is the bus controller, by using the HP-IB controller logic through A14U34B. The EOI signal connects directly to the adapter through A14U34B. The IFC signal is hardwired as an input signal by A14U34A. The instrument can not generate the EOI signal. The ATN signal is under control of the MPU, when the instrument is the bus controller, by way of the HP-IB controller logic, through A14U34A. (ATN is always set by the current bus controller.)

The SRQ signal is hardwired as an output through A14U35A. The NRFD signal through A14U35A, and the DAV and NDAC signals through A14U35B, are under control of the adapter. When the adapter is ready to send data to the external device, a high is placed on the adapter T1/R1 (pin 1) line. This high is inverted by A14U36D to a low to A14U35A and A14U35B. In A14U35A, the low will allow an external device to send handshake signals to the adapter.

When the adapter is ready to receive data from the external device, a low is placed on the adapter T1/R1 line. Then the adapter will receive the DAV signal from the external device and send the NDAC and NRFD signals. Data transceiver A14U18 will be set to receive data from the HP-IB data bus (DIO1—DIO8) and input the data to the adapter.

**TROUBLESHOOTING**

Troubleshooting is done on the circuits of Service Sheet 18 when a malfunction has occurred in the HP-IB Remote Interface or related functions. If all of the tests in the following procedures indicate correct responses, the trouble is located elsewhere in the control unit, or in the external device, and not in the HP-IB or related circuits. Except where shown, all values are approximate and are given as a service guideline.

**Test Equipment**

- HP-IB Controller ..... HP 85B/82936A/  
 (ROM Drawer)/00085-15005  
 (Advanced Programming ROM)
- or-
- HP 9826A Option 011  
 (Basic 2.0 ROM based system)  
 (built-in interface)
- HP-IB Interface ..... HP 82937A  
 (for HP-85B only)



**SERVICE SHEET 18 (cont'd)**

Noise Source .....	HP 346B (Option 001)
Logic Analyzer .....	HP 1630D
Oscilloscope Measuring System .....	HP 1980A
Systems DVM .....	HP 3456A

**✓1 General Checks**

1. Verify that the voltage from pin 40 of A14U20 to ground (pin 20) is  $+5 \pm 0.05$  Vdc.
2. Verify that the 4 MHz clock ( $\phi 2$ ) is present on pin 3 of A14U20.
3. Verify that pin 4 (RESET) of A14U20 is at a logical low.
4. Verify that pin 24 (IFC) of A14U20 is at a logical high.

**✓2 Power-Up Self Testing**

When the Noise Figure Meter is first powered-on, an instrument self-test is run. In the case of the HP-IB, all instrument data bus and address lines are tested as part of the instrument RAM memory test. If the instrument data bus has a problem, and the trouble is isolated to the HP-IB circuits, a pin-by-pin inspection should be made of A14U14 and A14U6. If the problem is on the instrument address bus, check the traces and pins of A14U20 for addresses A0, A1, and A2.

**✓3 HP-IB Functional Tests**

The HP-IB interface is checked by the procedures covered in Section III, Operation, HP-IB Functional Tests. A failure in the HP-IB interface circuits should be verified by running the functional tests. Table 8-62 lists each of the functional tests and which signal lines are tested.

**Table 8-62. HP-IB Functional Tests**

Test Procedure	Signal Lines Tested
Address Recognition	ATN, NDAC, NFRD, and DIO1—DIO8
Remote and Local Messages and the Local Key	REN
Sending the Data Messages Receiving the Data Messages	DAV, NDAC, NFRD, and data
Local Lockout and Clear Lockout/Set Local Messages Clear Message	REN
Abort Message Status Byte Message	IFC
Require Service Message Trigger Message	SRQ
<p><b>Note</b> The signal lines listed above are shown in that test which is most applicable, but the signal line may be tested in other procedures as well</p>	

**SERVICE SHEET 18 (cont'd)****✓ 4 Signal Line Troubleshooting**

If the Noise Figure Meter can not use the HP-IB interface to communicate properly with the external device, complete the following steps in the order shown:

1. Repeat the Address Recognition procedure, using all valid addresses. If the problem persists, use the oscilloscope to observe the signal at pin 11 of A14U7D. Rerun the procedure, and ensure that the ATN signal toggles.
2. If ATN toggles, proceed to step 4. Otherwise, check for the ATN signal on pin 2 of A14U19A. If the signal is present, check A14U19A, A14U39A, A14U34A, A14U7D, and A14U20.
3. If the ATN signal is missing from pin 2 of A14U19A, check A14U19A, A14U6, and A14U14.
4. Repeat the Remote and Local Messages and the Local Key procedure, and ensure that the REN signal toggles on pin 3 of A14U7A.
5. If REN toggles, proceed to step 7. Otherwise, check for the REN signal on pin 5 of A14U19B. If the signal is present, check A14U19B, A14U39A, A14U34B, A14U7A, and A14U20.
6. If the REN signal is missing from pin 5 of A14U19B, check A14U19B, A14U6, and A14U14.
7. Repeat the Abort Message procedure, and ensure that the IFC signal on pin 6 of A14U34A is at a logical high level. If the signal is high, check A14U20, otherwise check A14U34A.
8. Repeat the Sending the Data Message procedure, and ensure that the DAV signal goes low on pin 10 of A14U35B, when data is available on the data bus. If the line does not go low, check A14U35B, A14U36D, A14U39C, A14U35A, A14U18, and A14U20.
9. Repeat the Sending the Data Message procedure, and ensure that the EOI signal, on pin 10 of A14U34B, toggles at the end of the data transfer. If the line does not toggle, check A14U34B and A14U20.

**NOTE**

*Some HP-IB controllers do not use the EOI signal. Verify the signal usage by referring to the controller's schematics and manuals.*

10. Repeat the Address Recognition procedure, and ensure that the NDAC signal, on pin 14 of A14U35B, toggles during addressing. If the line does not toggle, check A14U35B, A14U39C, A14U36D, A14U35A, A14U18, and A14U20.

**SERVICE SHEET 18 (cont'd)**

11. Repeat the Address Recognition procedure, and ensure that the NRFD signal, on pin 6 of A14U35A, toggles during addressing. If the line does not toggle, check A14U35A, A14U39C, A14U36D, A14U35B, A14U18, and A14U20.
12. Connect the logic analyzer to the data bus of the adapter. This is best done by connecting to pins 12 through 19 (DIO1 through DIO8) on A14U18.
13. Repeat the Sending the Data Messages procedure, but use an alternating data pattern of the letter "T" (01010101) and the character "\*" (00101010). Data line DIO8 (pin 12) is not used, and is therefore, not tested (should remain low).
14. If the data is present, and toggling on all data lines, check A14U18, A14U35B, A14U39C, A14U36D, A14U35A, and A14U20. If the data is not present, or is not toggling, check A14U18, A14U14, A14U17B, A14U36, and A14U42.
15. If the problem has not been isolated by these procedures, and the trouble appears to be in the interface, replace A14U20.

**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.

# HP 8970A NOISE FIGURE METER (Including Option 001)

## SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2438A.

With the changes described in Section VII, this manual also applies to instruments with serial numbers 2116A, 2210A, 2222A, 2303A, and 2414A.

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



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Printed: MAY 1985

## 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.

The product related to this manual is no longer in production at Hewlett Packard Co. As a service to our customers, we are supplying you with a photocopy of the original document.

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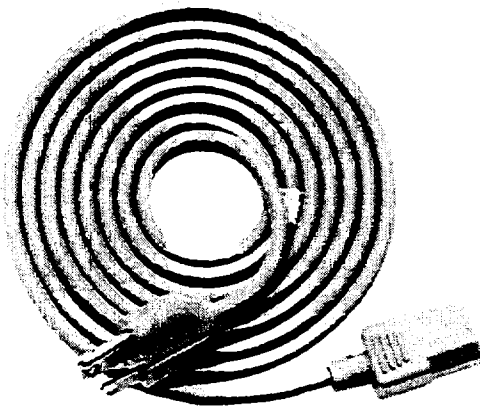
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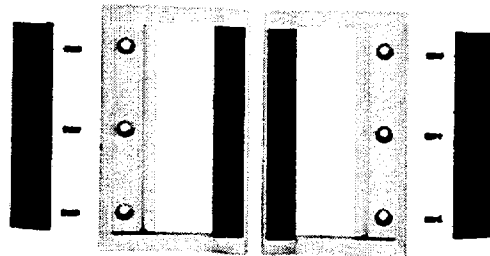
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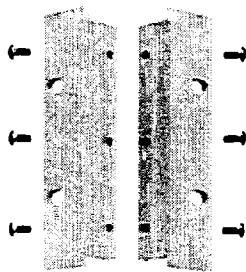
MODEL 8970A



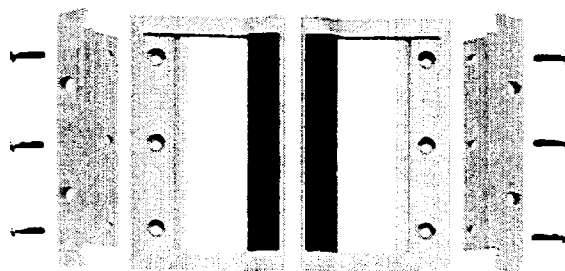
LINE POWER CABLE



OPTION 907  
FRONT HANDLE KIT



OPTION 908  
RACK FLANGE KIT



OPTION 909  
RACK FLANGE AND FRONT  
HANDLE COMBINATION KIT

Figure 1-1. HP Model 8970A Accessories Supplied, and Options 907, 908, and 909

## SECTION I GENERAL INFORMATION

### 1-1. INTRODUCTION

This manual contains information required to install, operate, test, adjust, and service the Hewlett-Packard Model 8970A Noise Figure Meter. Figure 1-1 shows the Noise Figure Meter with all of its externally supplied accessories.

The 8970A Operating and Service manual has eight major sections. They are:

- Section I, General Information
- Section II, Installation
- Section III, Operation
- Section IV, Performance Tests
- Section V, Adjustments
- Section VI, Replaceable Parts
- Section VII, Manual Changes
- Section VIII, Service

Two copies of the operating information are supplied with the Noise Figure Meter. One copy is in the form of an Operating Manual. The Operating Manual is a copy of the first three sections of the Operating and Service Manual. The Operating Manual should stay with the instrument for use by the operator. Additional copies of the Operating Manual can be ordered separately through your nearest Hewlett-Packard office. The part number is listed on the title page of this manual.

Also listed on the title page of this manual, below the manual part number, is a microfiche part number. This number may be used to order 100 x 150 millimetre (4 x 6 inch) microfilm transparencies of this manual. Each microfiche contains up to 96 photo-duplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement, as well as all pertinent Service notes.

### 1-2. SPECIFICATIONS

Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Supplemental characteristics are listed in Table 1-2. Supplemental characteristics are not warranted specifications, but are typical characteristics included as additional information for the user.

### 1-3. SAFETY CONSIDERATIONS

This product is a Safety Class I instrument, (that is, provided with a protective earth terminal). The Noise Figure Meter and all related documentation should be reviewed for familiarization with safety markings and instructions before operation. Refer to the Safety Considerations page found at the beginning of this manual for a summary of the safety information. Safety information for installation, operation, performance testing, adjustment, or service is found in appropriate places throughout this manual.

### 1-4. INSTRUMENTS COVERED BY MANUAL

Attached to the rear panel of the instrument is a serial number plate. The serial number is in the form: 0000A00000. The first four digits and the letter are the serial number prefix. The last five digits are the suffix. The prefix is the same for identical instruments; it changes only when a configuration change is made to the instrument. The suffix however, is assigned sequentially and is different for each instrument. The contents of this manual apply directly to instruments having serial number prefix(es) as listed under SERIAL NUMBERS on the title page.

### 1-5. MANUAL CHANGES SUPPLEMENT

An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the instrument is different from those documented in this manual. The manual for this newer instrument is accompanied by a Manual Changes supplement. The supplement contains change instructions that explain how to adapt the manual to the newer instrument.

In addition to change information, the supplement may contain information for correcting errors in the manual. To keep the manual as current and as accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement is identified with the manual

**MANUAL CHANGES SUPPLEMENT (cont'd)**

print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

**1-6. DESCRIPTION**

The Hewlett-Packard Model 8970A Noise Figure Meter, together with an appropriate noise source, automatically measures the noise figure and gain of the device to which it is attached. The Noise Figure Meter can be tuned between 10 and 1500 MHz. It can also be swept over all or any part of that range. To measure the noise figure of devices with output frequencies greater than 1500 MHz, an external mixer and local oscillator can be used to convert the frequency to the 10–1500 MHz range. Measured noise can be displayed as noise figure, equivalent input noise temperature or Y-Factor. Gain is displayed in dB.

Once calibrated, a single keystroke of the Noise Figure Meter can automatically remove the measurement system noise and gain contribution (called second stage correction). The Noise Figure Meter then displays only the noise figure and gain of the device under test (DUT).

The Excess Noise Ratio (ENR) of the noise source can be entered into the Noise Figure Meter for up to 27 frequencies. The Noise Figure Meter uses this data to correct for ENR versus frequency variations. For measurements made between calibration points, ENR data is interpolated. When the instrument is turned off, the ENR table is stored in continuous memory.

X- and Y-Axis outputs on the rear panel allow for noise figure and gain versus frequency to be displayed on a storage or nonstorage oscilloscope, or output to a recorder. On an oscilloscope, gain can be displayed at a lower intensity than noise figure, to distinguish between the two traces. The Z-Axis output blanks an oscilloscope or lifts a recorder pen. A storage oscilloscope can also be used, but the differences in trace intensity are obscured.

Most functions can be remotely programmed via the Hewlett-Packard Interface Bus (HP-IB) and all measurement data is available to the HP-IB.

In addition, the Noise Figure Meter has sufficient HP-IB controller capability to set the output level and to tune a local oscillator across a frequency band.

**1-7. OPTIONS****1-8. Electrical Option 001**

This option provides a rear panel (instead of front panel) connection for the INPUT jack.

**1-9. Mechanical Options**

The following options may have been ordered and received with the Noise Figure Meter. If they were not ordered with the original shipment, they can be ordered from the nearest Hewlett-Packard office using the part number included in each of the following paragraphs.

**Front Handle Kit (Option 907).** Ease of handling is increased with the front panel handles. Order HP part number 5061-9689.

**Rack Flange Kit (Option 908).** The Noise Figure Meter can be solidly mounted to the instrument rack using the flange kit. Order HP part number 5061-9677.

**Rack Flange and Front Handle Combination Kit (Option 909).** This is not a front handle kit and a rack flange kit packaged together; it is composed of a unique part which combines both functions. Order HP part number 5061-9683.

**1-10. HEWLETT-PACKARD INTERFACE BUS ****1-11. Compatibility**

The Noise Figure Meter is compatible with HP-IB to the extent indicated by the following code: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C1, C3, C28, and E1. The Noise Figure Meter interfaces with the bus via open collector TTL circuitry. An explanation of the compatibility code can be found in IEEE Standard 488 (1978), "IEEE Standard Digital Interface for Programmable Instrumentation" or the identical ANSI Standard MC1.1. For more detailed information relating to programmable control of the Noise Figure Meter, refer to Remote Operation, Hewlett-Packard Interface Bus in Section III of this manual.

**1-12. Selecting the HP-IB Address**

The Noise Figure Meter uses two HP-IB addresses. One is the address of the Noise Figure Meter. The



**Selecting the HP-IB Address (cont'd)**

second is the HP-IB address of an external local oscillator when the Noise Figure Meter is used as a controller. Refer to HP-IB Addresses in the Detailed Operating Instructions in Section III for additional information.

**1-13. ACCESSORIES SUPPLIED**

The accessories supplied with the Noise Figure Meter are shown in Figure 1-1.

a. The line power may be supplied in several configurations, depending on the destination of the original shipment. Refer to paragraph Power Cables in Section II of this manual.

b. Fuses with a 1.5A rating for 100/120 Vac operation and a 1.0A for 220/240 Vac operation are supplied. One fuse is factory installed according to the voltage available in the country of original destination. Refer to paragraph Line Voltage and Fuse Selection in Section II of this manual.

In addition, a product note titled "Applications and Operation of the 8970A Noise Figure Meter" is supplied with each instrument. Order HP part number 5952-8254 for additional copies.

**1-14. EQUIPMENT REQUIRED BUT NOT SUPPLIED**

To form a noise figure measurement system, a noise source such as HP Model 346B (346A or 346C), must be used with the Noise Figure Meter. The Noise Figure Meter supplies +28.0V pulses to drive the noise source on and off.

**1-15. ELECTRICAL EQUIPMENT AVAILABLE****1-16. Performance Test Tape**

This tape contains automated versions of all the Performance Tests in Sections IV of this manual. The tape significantly reduces the time normally required to perform the tests. An HP-85B Personal Computer with HP 82936A ROM Drawer, 00085-15005 Advanced Programming ROM, and HP 82937A HP-IB Interface are required to run the programs on the tape. Order HP part number 09870-10001.

**1-17. HP-IB Controllers **

The Noise Figure Meter has an HP-IB interface and can be used with any HP-IB compatible computing controller or computer for automatic systems applications.

**1-18. External Mixers and Local Oscillators**

An external local oscillator and balanced mixer can be used to extend the frequency range of the Noise Figure Meter. Suitable LO's include the HP 8672A or HP 8673B Synthesized Signal Generator and the HP 8350A Sweep Oscillator. A suitable mixer is the HP HMXR-5001.

**1-19. Waveguide/Coax Adapters**

The HP 346B/C Noise Source combined with the HP X281C or P281C Waveguide/Coax Adapter makes a very accurate, calibrated waveguide noise source.

**1-20. Front-to-Rear-Panel Connector Retrofit Kit**

This kit contains all the necessary components and full instructions for converting instruments with a front panel INPUT connector to a rear panel connector. Order HP part number 08970-60100. After installation and calibration, performance will be identical to 8970A Option 001.

**1-21. Rear-to-Front-Panel Connector Retrofit Kit**

This kit contains all the necessary components and full instructions for converting instruments with a rear panel INPUT connector to a front panel connector. Order HP part number 08970-60101. After installation and calibration, performance will be identical to the standard 8970A.

**1-22. MECHANICAL EQUIPMENT AVAILABLE****1-23. Chassis Slide Mount Kit**

This kit is extremely useful when the Noise Figure Meter is rack mounted. Access to internal circuits and components or the rear panel is possible without removing the instrument from the rack. Order HP part number 1494-0060 for 430 mm (17 inch) fixed sides and part number 1494-0061 for the correct adapters for non-HP rack enclosures.

**1-24. Chassis Tilt Slide Mount Kit**

This kit is the same as the Chassis Slide Mount Kit above except that it also allows the tilting of the instrument up or down 90 degrees. Order HP part number 1494-0062 for 430 mm (17 inch) tilting slides and part number 1494-0061 for the correct adapters for non-HP rack enclosures.

**1-25. RECOMMENDED TEST EQUIPMENT**

Table 1-3 lists the test equipment recommended for use in testing, adjusting, and servicing the

**RECOMMENDED TEST EQUIPMENT (cont'd)**

Noise Figure Meter. The Critical Specification column describes the essential requirements for each piece of test equipment. Other equipment can be substituted, if it meets or exceeds these critical specifications.

The Recommended Model column may suggest more than one model. The first model shown is usually the least expensive, single-purpose model. Alternate models are suggested for additional features that would make them a better choice in some applications.

Table 1-1. Specifications (1 of 2)

Characteristics	Performance Limits	Conditions
<b>NOISE FIGURE MEASUREMENT</b> Range Resolution Instrumentation Uncertainty	0 to 30 dB 0.01 dB ±0.1 dB	For a noise source in a 0 to 55°C environment with an ENR of 14 to 16 dB.
<b>GAIN MEASUREMENT</b> Range Resolution Instrumentation Uncertainty	-20 to at least +40 dB 0.01 dB 0.1 dB ±0.2 dB	For total noise figures < 30 dB Gain ≥ -9.99 dB Gain < -9.99 dB
<b>INPUT</b> Frequency Range Frequency Resolution Tuning Accuracy Noise Figure Input SWR (Reflection Coefficient) Maximum Operating Input Power Maximum Net External Gain	Tunable from 10 to 1500 MHz 1 MHz ±(1 MHz + 1% of frequency), ±6 MHz maximum < 7 dB + 0.003 dB/MHz < 1.7 (0.26) -10 dBm > 65 dB	From +10 to +40° For input power levels below -60 dBm. 10 to 1500 MHz (50Ω reference impedance). Between noise source and 8970A RF Input.
<b>ELECTROMAGNETIC COMPATIBILITY EMI</b>	MIL STD 461A CISPR publication 11, and Messem-pfaenger Postverfuegung 526/527/79	Conducted and radiated interference is in compliance with MIL STD 461A Methods CE03 and RE02, CISPR publication 11 (1975), and Messem-pfaenger-Postverfuegung 526/527/79 (Kennzeichnung Mit F-Nummer/ Funkschutzzeichen).

Table 1-1. Specifications (2 of 2)

Characteristics	Performance Limits	Conditions
<p><b>ELECTROMAGNETIC COMPATIBILITY (cont'd)</b>                      Conducted and Radiated Susceptibility</p>	<p>MIL STD 461A-1968</p>	<p>Conducted and radiated susceptibility meets the requirements of methods CS01, CS02, CS06, and CS03 (1 volt/metre) of MIL STD 461A dated 1968.</p>
<p><b>GENERAL</b>                      Noise Source Drive</p> <p>Power Requirements                      Line Voltage:                      100, 120, 220, or 240V</p> <p>Power Dissipation</p> <p>Temperature:                      Operating                      Storage</p> <p>Remote Operation (HP-IB)</p> <p>Dimensions                      Height                      Width                      Depth                      Net Weight</p>	<p>28.0 ± 0.1V</p> <p>&lt;1V</p> <p>+5, -10%</p> <p>150 VA maximum</p> <p>0 to 55°C                      -55 to 75°C</p> <p>IEEE STD 488-1978                      Compatibility Code:                      H1, AH1, T5, L4, SR1, RL1,                      PP0, DC1, DT1, C1, C3, C28,                      E1</p> <p>146 mm (5.75 in.)                      425 mm (16.8 in.)                      462 mm (18.2 in.)                      15.5 kg (34 lbs)</p>	<p>Noise source ON at up to 60 mA peak.                      Noise source OFF.</p> <p>48 to 66 Hz, single phase.</p> <p>The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's implementation of IEEE Std 488-1978, "Digital Interface for Programmable Instrumentation." Most functions are remotely programmable.</p> <p>Note: For ordering cabinet accessories, the module sizes are 5¼H, 1 MW (module width, and 17D.</p>

Table 1-2. Supplemental Characteristics

Supplemental characteristics are intended to provide information useful in applying the instrument by giving typical, but non-warranted, performance parameters.

All parameters describe performance in automatic operation or properly set manual conditions.

**Sensitivity:** no external gain required; -100 dBm; able to measure its own noise figure.

**Measurement Speed:** about 3 to 5 measurements per second.

**Maximum Safe Input Level.**  $\pm 20$  Vdc; +20 dBm at RF.

#### FUNCTIONAL PROPERTIES

**Noise Figure Display Units:** noise figure in dB or as a ratio, or uncorrected Y-Factor in dB or as a ratio, or effective input noise temperature in kelvins.

**External LO Control:** frequency control over HP-IB from 10 to 60000 MHz.

**Noise Figure Display Jitter:** <0.01 dB with appropriate smoothing.

**Cold Noise Source Data Range:** 0 to 9999K.

**Hot Noise Source Data Range:** stored table — ENR from -7 to +17 dB; spot frequency — from 0 to 14824K.

**Storage Capacity of Hot Noise Source Table:** ENR at 27 frequencies.

**Smoothing:** exponential averaging of gain and noise figure before display according to  $D = P(F-1)/F + M/F$  where D is the display result, M is the latest measurement, and F is the averaging factor (1, 2, 4, 8, 16, 32, 64, 128, 256, or 512). Straight averaging is used during swept operation.

**Rear Panel Outputs:** X-Axis and Y-Axis from 0 to 6V. Z-Axis is TTL for pen lift (on an X-Y recorder) and blanking (on an oscilloscope).

Table 1-3. Recommended Test Equipment (1 of 2)

Instrument	Specifications	Recommended Model	Use*
Attenuator, 1 dB Steps	Steps: 1 dB from 0 to 11 dB Frequency Range: 10 to 1500 MHz	HP 8494A Option 001	P, A
Attenuator, 10 dB Steps	Steps: 10 dB from 0 to 70 dB Frequency Range: 10 to 1500 MHz	HP 8495A Option 001	P
Attenuator, Fixed 6 dB	Attenuation: 6 dB Frequency Range: 10 to 1500 MHz	HP 8491A Option 006	P, A
Attenuator, Fixed 10 dB (2 required)	Attenuation: 10 dB Frequency Range: 10 to 1500 MHz	HP 8491A Option 010	P
Attenuator, Fixed 20 dB	Attenuation: 20 dB Frequency Range: 10 to 1500 MHz	HP 8491A Option 020	P
Calculator	Functions: Divide, multiply, square root Programmable	HP 41C	P, A
Controller, HP-IB	HP-IB compatibility as defined by IEEE Standard 488 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, C1, 2, 3, 4, 5	HP 85B/82936A (ROM Drawer)/00085-15005 (Advanced Programming ROM) or HP 9835A/98332A/98034A or HP 9826A Option 011 (Basic 2.0 ROM based system) (built-in interface)	C, P, T
Digital Voltmeter	DC Voltage Range: Up to 100V Resolution (in high resolution mode): 1 $\mu$ V on 1 Vdc range Accuracy (in high resolution mode): $\pm 0.003\%$ of reading +4 counts	HP 3455A or HP 3456A (Systems DVM)	P, A, T
Filter, Low-Pass	Insertion Loss: <1 dB below 0.9 times cut-off frequency Cut-Off Frequency: 1200 MHz Rejection: >50 dB at 1.25 times cut-off frequency	HP 360B	P, A
Frequency Counter	Range: 10 to 4000 MHz Resolution: 1 kHz	HP 5340A or HP 5343A	P, A
Frequency Doubler	Input Frequency Range: 10 to 760 MHz Conversion Loss: <15 dB at +13 dBm input	HP 11721A	P
Interface HP-IB	Required for HP 85B only	HP 82937A	C, P, T
Logic Analyzer	Input Lines: 43 Timing Analysis: 16 lines	HP 1630A or HP 1630D	T

\*C = Operator's Checks, P = Performance Tests, A = Adjustments, T = Troubleshooting

Table 1-3. Recommended Test Equipment (2 of 2)

Instrument	Specifications	Recommended Model	Use*
Noise Source	Power Required: +28V ENR: 15.2 dB Connector: Type N (male)	HP 346B Option 001 or HP 346A or HP 346C	C, P, T
Oscilloscope	Inputs: Two Channel (A vs B or X vs Y) and Z-Axis	HP 1740A or HP 1980A (Oscilloscope Measuring System) or HP 1980B	C, A, T
Power Meter	Uncertainty: $\pm 0.02$ dB Instrumentation: dB Relative	HP 436A	P, A, T
Power Sensor	Frequency Range: 10 to 4000 MHz or Power Range: 0.1 nW to 10 $\mu$ W SWR 30 to 4000 MHz: 1.15	HP 8484A or HP 8482A or HP 8485A	P, A, T
Power Splitter	Frequency Range: 10 to 1500 MHz	HP 11667A	P, A
Signal Generator (External LO)	Frequency Range: 10 to 760 MHz Frequency Accuracy: $\pm 1$ kHz Output Level: +13 dBm	HP 8656A or HP 3335A (Frequency Synthesizer) or HP 8672A (Synthesizer Signal Generator) or HP 8673B	C, T P, A,
Signature Multimeter (Analyzer)	Because the signatures documented are unique to a given signature analyzer, no substitution is recommended	HP 5005A or HP 5005B or HP 5006A	T
Spectrum Analyzer	Frequency Range: 10 to 1500 MHz	HP 8565A or HP 8566A	A
Sweep Oscillator	Frequency Range: 20 to 2400 MHz Attenuation: 70 dB in 10 dB steps	HP 8620C/86222B Option 002 or HP 8340A or HP 8350B	P, A, C
SWR Bridge	Frequency Range: 10 to 1500 MHz Directivity: 40 dB	Wiltron 60N50	P
Wideband Amplifier I	Frequency Range: 0.1 to 1300 MHz Gain: 26 dB Output Power for 1 dB Gain Compression: +7 dBm	HP 8447D Option 010	P
Wideband Amplifier II	Frequency Range: 0.1 to 1300 MHz Gain: 48 dB Output Power for 1 dB Gain Compression $> +15$ dBm	HP 8447F Option 010	P

\*C = Operator's Checks, P = Performance Tests, A = Adjustments, T = Troubleshooting.

## SECTION II INSTALLATION

### 2-1. INTRODUCTION

This section provides the information needed to install the Noise Figure Meter. Included is information pertinent to initial inspection, power requirements, line voltage selection, power cables, interconnection, environment, instrument mounting, storage, and shipment.

### 2-2. INITIAL INSPECTION

#### WARNING

*To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, meters).*

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. Procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

### 2-3. PREPARATION FOR USE

#### 2-4. Power Requirements

The Noise Figure Meter requires a power source of 100, 120, 220 or 240 Vac, +5% to -10%, 48 to 66 Hz single phase. Power consumption is 150 VA maximum.

#### WARNINGS

*This is a Safety Class I product (that is, provided with a protective earth terminal). 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. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.*

*If this instrument is to be energized via an external autotransformer, make sure the autotransformer's common terminal is connected to the neutral (that is, the grounded side of the Mains supply).*

### 2-5. Line Voltage and Fuse Selection

#### CAUTION

*BEFORE PLUGGING THIS INSTRUMENT into the Mains (line) voltage, be sure the correct voltage and fuse have been selected.*

Verify that the line voltage selection card and the fuse are matched to the power source. Refer to Figure 2-1, Line Voltage and Fuse Selection.

Fuses may be ordered under HP part numbers 2110-0043, 1.5A (250V, normal blow) for 100/120 Vac operation and 2110-0001, 1.0A (250V, normal blow) for 220/240 Vac operation.

### 2-6. Power Cables

#### WARNING

*BEFORE CONNECTING THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the (Mains) power cord. The Mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding).*

Operating voltage is shown in module window

**SELECTION OF OPERATING VOLTAGE**

1. Open cover door, pull the FUSE PULL lever and rotate to left. Remove the fuse.
2. Remove the Line Voltage Selection Card. Position the card so the line voltage appears at top-left corner. Push the card firmly into the slot.
3. Rotate the FUSE PULL lever to its normal position. Insert a fuse of the correct value in the holder. Close the cover door.

**WARNING**

*To avoid the possibility of hazardous electrical shock, do not operate this instrument at line voltages greater than 126.5 Vac with line frequencies greater than 66 Hz (leakage currents at these line settings may exceed 3.5 mA).*

This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The power cable plug shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the part numbers of the power cables available.

**2-7. HP-IB Address Selection HP-IB**

The Noise Figure Meter uses two HP-IB addresses. One is the address of the Noise Figure Meter. The second is the HP-IB address for an external local oscillator when the Noise Figure Meter is used as a controller. Both addresses are selectable by Special Function from the front panel. Refer to HP-IB Addresses in the Detailed Operating Instructions in Section III for additional information.

When shipped from the factory, the two addresses are:

- a. The Noise Figure Meter HP-IB address is 8 (decimal).
- b. The external local oscillator HP-IB address for use when the Noise Figure Meter is the controller is 19 (decimal).

Figure 2-1. Line Voltage and Fuse Selection

 <b>220/240V OPERATION</b>	 <b>220/240V OPERATION</b>	 <b>100/120V OPERATION</b>	 <b>220/240V OPERATION</b>
PLUG*: SEV 1011.1959-24507 TYPE 12 CABLE*: HP 8120-2104	PLUG*: NZSS 198/AS C112 CABLE*: HP 8120-1369	PLUG*: NEMA 5-15P CABLE*: 8120-1378	PLUG*: NEMA 6-15P CABLE*: HP 8120-0698
 <b>220/240V OPERATION</b>	 <b>220/240V OPERATION</b>	 <b>220/240V OPERATION</b>	
PLUG*: CEE7-VII CABLE*: HP 8120-1689	PLUG*: CEE22-V1 CABLE*: HP 8120-1860	PLUG*: BS 1363A CABLE: HP 8120-1351	
<p>*The number shown for the plug is the industry identifier for the plug only.            The number shown for the cable is an HP part number for a complete cable including the plug.</p>			

Figure 2-2. Power Cable and Mains Plug Part Numbers



Valid HP-IB addresses are 0 through 30. Refer to Table 2-1 for decimal equivalents of the ASCII Talk and Listen address codes.

Table 2-1. ASCII Address Codes to Decimal Equivalents

ASCII Address Codes		Decimal Equivalents
LISTEN	TALK	
SP	@	00
!	A	01
"	B	02
#	C	03
\$	D	04
%	E	05
&	F	06
'	G	07
(	H	08
)	I	09
*	J	10
+	K	11
,	L	12
-	M	13
.	N	14
:	O	15
0	P	16
1	Q	17
2	R	18
3	S	19
4	T	20
5	U	21
6	V	22
7	W	23
8	X	24
9	Y	25
:	Z	26
;		27
<	\	28
=		29
>	)	30

Decimal 08 is the factory set HP 8970A address  
 Decimal 19 is the factory set address for an external LO

**2-8. Interconnections**

Interconnection data for the Hewlett-Packard Interface Bus is provided in Figure 2-3.

**2-9. Mating Connectors**

**Interface Connector.** The HP-IB mating connector is shown in Figure 2-3. Note that two securing screws are metric.

**Coaxial Connectors.** Coaxial mating connectors used with the Noise Figure Meter should be 50 ohm BNC, or type N male connectors.

**2-10. Operating Environment**

The operating environment should be within the following limitations:

- Temperature ..... 0 to +55°C
- Humidity ..... <95% relative
- Altitude ..... <4570 metres (15 000 feet)

**2-11. Bench Operation**

The instrument cabinet has plastic feet and fold-away tilt stands for convenience in bench operation. (The plastic feet are shaped to ensure self-aligning of the instruments when stacked.) The tilt stands raise the front of the instrument for easier viewing of the front panel.

**2-12. Rack Mounting**

**WARNING**

*The Noise Figure Meter weighs 15.5 kg (34 lb), therefore, care must be exercised when lifting to avoid personal injury. Use equipment slides when rack mounting.*

Rack mounting information is provided with the rack mounting kits. If the kits were not ordered with the instrument as options, they may be ordered through the nearest Hewlett-Packard office. Refer to the paragraph entitled Mechanical Options in Section I.

**2-13. STORAGE AND SHIPMENT**

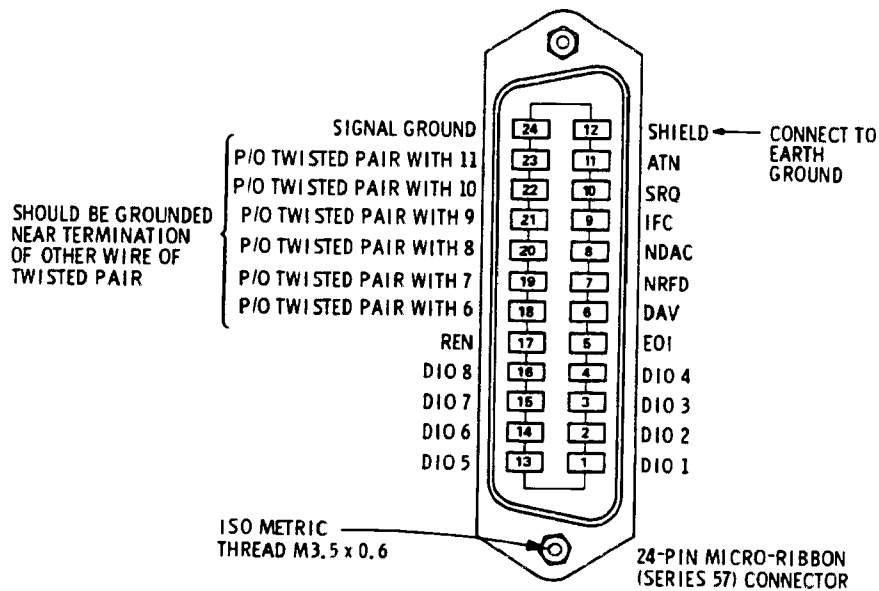
**2-14. Environment**

The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

- Temperature ..... -55°C to +75°C
- Humidity ..... <95% relative
- Altitude ..... <15 300 metres (50 000 feet)

**2-15. Packaging**

**Tagging for Service.** If the instrument is being returned to Hewlett-Packard for service, please complete one of the blue repair tags located at the back of this manual and attach it to the instrument.



**Logic Levels**

The Hewlett-Packard Interface Bus Logic Levels are TTL compatible, i.e., the true (1) state is 0.0 Vdc to +0.4 Vdc and the false (0) state is +2.5 Vdc to +5.0 Vdc.

**Programming and Output Data Format**

Refer to Section III, Operation.

**Mating Connector**

HP 1251-0293; Amphenol 57-30240.

**Mating Cables Available**

HP 10833A, 1 metre (3.3 ft), HP 10833B, 2 metres (6.6 ft)  
 HP 10833C 4 metres (13.2 ft), HP 10833D, 0.5 metres (1.6 ft)

**Cabling Restrictions**

1. A Hewlett-Packard Interface Bus system may contain no more than 2 metres (6.6 ft) of connecting cable per instrument.
2. The maximum accumulative length of connecting cable for any Hewlett-Packard Interface Bus system is 20.0 metres (65.6 ft).

Figure 2-3. Hewlett-Packard Interface Bus Connections

**Packaging (cont'd)**

**Original Packaging.** Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. Mark the container "FRAGILE" to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

**Other Packaging.** The following general instructions should be used for re-packaging with commercially available materials:

a. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard office or serv-

ice center, complete one of the blue tags and attach it to the instrument.)

b. Use a strong shipping container. A double-wall carton made of 2.4 MPa (350 psi) test material is adequate.

c. Use enough shock-absorbing material (75 to 100 mm layer; 3 to 4 inches) around all sides of the instrument to provide firm cushion and prevent movement in the container. Protect the front panel with cardboard.

d. Seal the shipping container securely.

e. Mark the shipping container "FRAGILE" to assure careful handling.

## SECTION III OPERATION

### 3-1. INTRODUCTION

This section provides complete operating information for the Noise Figure Meter. Included in this section are both general and detailed operating instructions, detailed descriptions of the front and rear panel, local and remote operator's checks, and operator's maintenance procedures.

### 3-2. Operating Characteristics

Table 3-1 briefly summarizes the major operating characteristics of the Noise Figure Meter. This table is intended to be an in-depth listing of all operations and ranges but gives a rough idea of the instrument's capabilities. For more information on the Noise Figure Meter's capabilities, refer to Table 1-1, Specifications and Table 1-2, Supplemental Characteristics. For information on HP-IB capabilities, refer to the summary contained in Table 3-3, Message Reference Table.

### 3-3. Local Operation

Information covering front panel operation of the Noise Figure Meter is given in the sections described below. To rapidly learn the operation of the instrument, begin with Simplified Operation and Operator's Checks. Once familiar with the general operation of the instrument, use the Detailed Operating Instructions for in-depth and complete information in operating the Noise Figure Meter.

**General Operating Information.** Instructions relating to the Noise Figure Meter turn-on procedure and various keystroke sequences are presented to acquaint the user with the general operation of the instrument.

**Simplified Operation.** The instructions located on the inside of this fold provide a quick introduction to front panel operation of the Noise Figure Meter. These instructions are designed to rapidly acquaint the new user with basic operating procedures and therefore are not an exhaustive listing of all Noise Figure Meter functions. However, an index to the Detailed Operating Instructions appears opposite the fold to direct the operator to the more complete discussion of the topic of interest.

**Panel Features.** Front and rear panel features are described in detail in Figures 3-1 through 3-7.

**Detailed Operating Instructions.** The Detailed Operating Instructions provide the complete operating reference for the Noise Figure Meter user. The instructions are organized alphabetically by subject and are placed at the end of this section for easy reference. They are indexed by function in Table 3-2.

**Operating Information Pull-Out Cards.** The Operating Information pull-out cards are three flexible plastic reference sheets located in a tray below the front panel. They contain a listing of user special functions, HP-IB output formats, error codes, and measurement modes.

### 3-4. Remote Operation

The Noise Figure Meter is capable of remote operation via the Hewlett-Packard Interface Bus (HP-IB). In remote operation, the Noise Figure Meter operates in one of three modes: normal talker/listener mode, talk only mode, or controller mode (where the Noise Figure Meter controls an external LO). The remote operation instructions provide information pertinent to HP-IB operation when the Noise Figure Meter is in the normal talker/listener mode or the talk only mode. Included are discussions on capabilities, addressing, input and output formats, the status byte and service requests. At the end of the discussion is a complete summary of all codes and formats.

In addition to the section described above, information concerning remote operation appears in several other locations. The controller capability of the Noise Figure Meter is described in the Detailed Operating Instructions. A summary of HP-IB codes and output formats appear on one of the Operating Information pull-out cards. Numerous examples of program strings appear throughout the Detailed Operating Instructions.

### 3-5. Operator's Checks

Operator's Checks are procedures designed to verify the proper operation of the Noise Figure Meter's main functions. Two procedures are described below.

**Basic Functional Checks.** This procedure requires only a noise source, an oscilloscope, and intercon-

### Operator's Checks (cont'd)

necting cables. It assures that most front panel controlled functions are being properly executed by the Noise Figure Meter.

**HP-IB Functional Checks.** These procedures require an HP-IB compatible computing controller, an HP-IB interface and connecting cable. The HP-IB Functional Checks assume that front panel operation has been verified by performing the Basic Functional Checks. The procedures check all of the applicable bus messages summarized in Table 3-3.

### 3-6. Operator's Maintenance

#### WARNING

*For continued protection against fire hazard, replace the line fuse with a 250V fuse of the same rating only. Do not use repaired fuses or short-circuited fuseholders.*

Operator's maintenance consists of replacing blown fuses and cleaning the air filter.

The primary power fuse is located within the Line Power Module (A15). Refer to Figure 2-1 for instructions on how to change the fuse.

The rear panel fan has a filter inserted from the outside for ease of cleaning or replacement. To service the filter, disconnect power from the instrument and remove the filter by pulling it from the rear of the fan. To clean the filter, hold it under running water or wash it in warm soapy water and then rinse it in clear water. Dry the filter thoroughly before putting it back into place. The replacement part is listed in Section VI (MP54).

If the instrument does not operate properly and is being returned to Hewlett-Packard for service, please complete one of the blue tags located at the end of this manual and attach it to the instrument. Refer to Section II for packaging instructions.

### 3-7. GENERAL OPERATING INSTRUCTIONS

#### WARNING

*Before the Noise Figure Meter is switched on, all protective earth terminals, extension cords, autotransformers, and devices connected to the instrument 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.*

#### CAUTION

*Before the Noise Figure Meter is switched on, it must be set to the same line voltage as the power source or damage to the instrument may result.*

### 3-8. Turn On

**Turn-on Procedure.** If the Noise Figure Meter is already plugged in, set the LINE switch to ON.

If the power cable is not plugged in, follow these instructions.

On the rear panel:

1. Check the line voltage selection card for correct voltage selection.
2. Check the fuse for correct current rating. The current rating is printed on the line power module label.
3. Plug in the power cable.

On the front panel, set the LINE switch to ON.

**Turn-on Sequence.** The Noise Figure Meter performs a quick internal check at turn-on. During this check, all front panel indicators light for approximately two seconds to allow a quick visual inspection of each front panel display annunciator and display segment. If a failure is detected, an error code will appear in the NOISE FIGURE display to indicate the nature of the failure. For error codes E10 through E49, and E80, refer to Error Messages and Recovery in the Detailed Operating Instructions. For error codes E50 through E80, refer to Section VIII, Service.

If the memory check was successful, four dashes "----" will appear in the NOISE FIGURE display for approximately five seconds while the Noise Figure Meter performs a frequency calibration.

After the frequency calibration, the instrument powers up to the last front panel configuration prior to being turned off. Refer to Preset Conditions and Power-Up Sequence in the Detailed Operating Instructions for additional information.

#### NOTE

*An internal battery is used to retain data in continuous memory when the Noise Figure Meter is turned off.*

*At turn-on, the Noise Figure Meter restores the same front panel configuration that was present when last powered down. Nine storage registers, the ENR table and other information are also restored.*

### 3-9. Keystroke Sequences

The Noise Figure Meter's functions can be selected in any order. However, each function selection requires a prescribed sequence of keystrokes. A keystroke sequence can be either a single keystroke or several keystrokes that must be entered in a specific order. Functions requiring only a single keystroke are: PRESET, LOCAL, CALIBRATE, UNCORRECTED NOISE FIGURE, CORRECTED NOISE FIGURE AND GAIN, INCREASE, DECREASE, AUTO, SINGLE,  $\blacktriangleleft$  and  $\blacktriangleright$ .

Frequency parameters are entered in a Function - Data - ENTER format. Data entered following a function will be interpreted for that function only

### Key Stroke Sequences (cont'd)

if terminated with the ENTER key. Data previously entered remains unaffected until the new data entry is terminated by pressing the ENTER key. If another function key is pressed before the data entry is terminated, that entry will be rejected and the last valid data for the function will remain active.

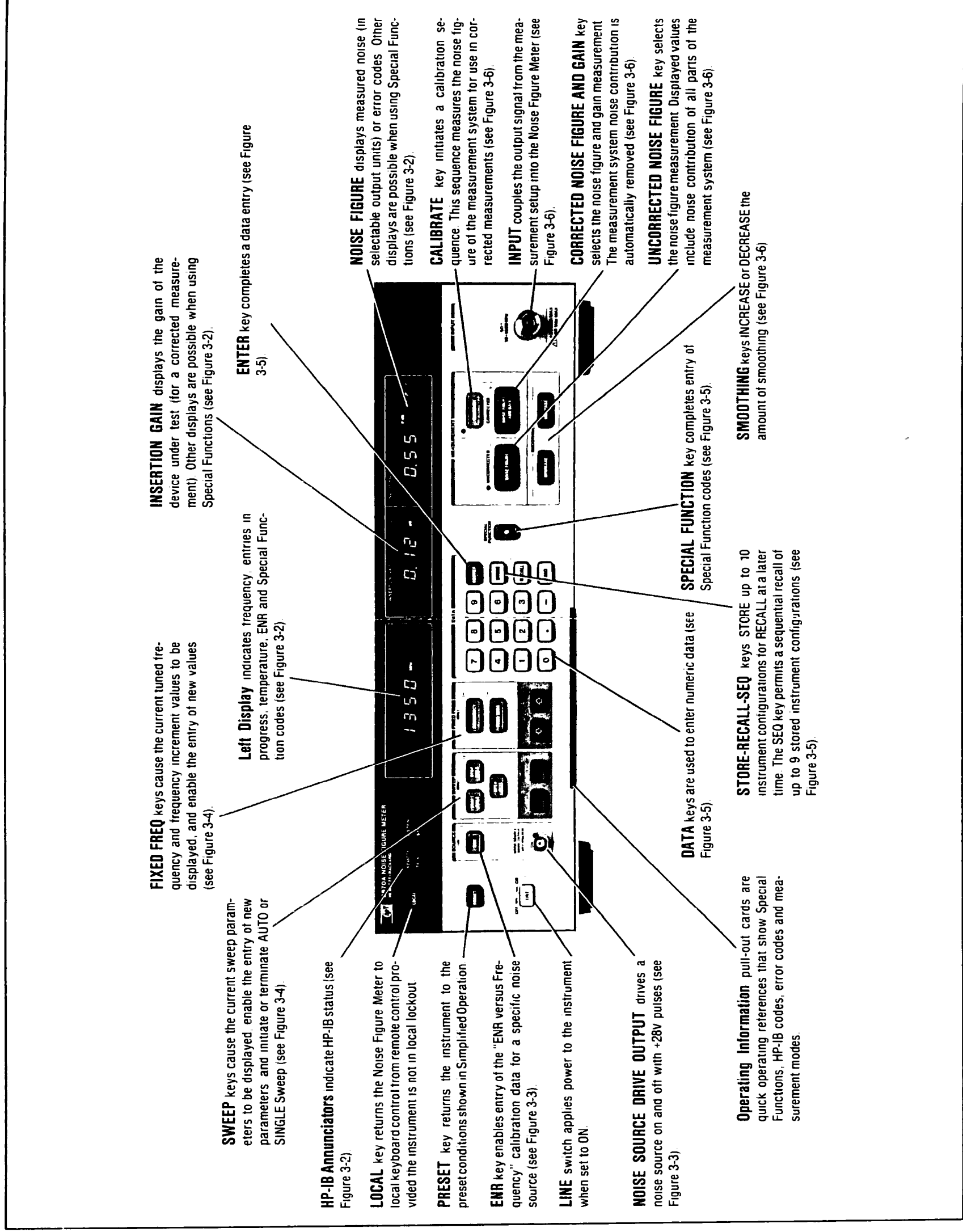
STORE and RECALL functions are entered in a Function - Data format. It is not necessary to use the ENTER key to terminate data entry. However, ENTER has no effect if it is used. Data is a single digit register number (0 through 9).

Special Functions are entered in a Code - SPECIAL FUNCTION format. The code consists of a prefix, decimal, and suffix. 7.1 is an example of a special function code where 7 is the prefix and 1 is the suffix. If the suffix is zero, the zero and the decimal point can be omitted when entering the code. For example, 7 SPECIAL FUNCTION is equivalent to 7.0 SPECIAL FUNCTION. A Code - SPECIAL FUNCTION - Data - ENTER format is used to activate and enter data for special functions that require data entry.

Table 3-1. Operating Characteristics

Measurements	Noise Figure (Corrected and Uncorrected Modes) Range: 0 to 30 dB Selectable Display Units: F dB, F, Y dB, Y, Te K Insertion Gain (Corrected Mode Only) Range: -20 to +40 dB Display Units: dB
Tuning	Fixed Frequency Range: 10 to 1500 MHz Resolution: 1 MHz Sweep Linear sweep. Range: 10 to 1500 MHz Resolution: 1 MHz Modes: Automatic, Single
Noise Source Parameters	Drive: +28V (pulsed) Entry Units: ENR in dB, °C, °F, K Hot Temp. Entry Range: 363 to 15000K Cold Temp. Entry Range: 0 to 1000K
Smoothing	Exponential or linear averaging of insertion gain and noise figure data before result is displayed. Selectable units in factors of 2.

# FRONT PANEL FEATURES



**FIXED FREQ** keys cause the current tuned frequency and frequency increment values to be displayed, and enable the entry of new values (see Figure 3-4).

**SWEEP** keys cause the current sweep parameters to be displayed, enable the entry of new parameters and initiate or terminate AUTO or SINGLE Sweep (see Figure 3-4).

**HP-IB Annunciators** indicate HP-IB status (see Figure 3-2).

**LOCAL** key returns the Noise Figure Meter to local keyboard control from remote control provided the instrument is not in local lockout.

**PRESET** key returns the instrument to the preset conditions shown in Simplified Operation.

**ENR** key enables entry of the "ENR versus Frequency" calibration data for a specific noise source (see Figure 3-3).

**LINE** switch applies power to the instrument when set to ON.

**NOISE SOURCE DRIVE OUTPUT** drives a noise source on and off with +28V pulses (see Figure 3-3).

**Operating Information** pull-out cards are quick operating references that show Special Functions, HP-IB codes, error codes and measurement modes.

**Left Display** indicates frequency, entries in progress, temperature, ENR and Special Function codes (see Figure 3-2).

**ENTER** key completes a data entry (see Figure 3-5).

**NOISE FIGURE** displays measured noise (in selectable output units) or error codes. Other displays are possible when using Special Functions (see Figure 3-2).

**CALIBRATE** key initiates a calibration sequence. This sequence measures the noise figure of the measurement system for use in corrected measurements (see Figure 3-6).

**INPUT** couples the output signal from the measurement setup into the Noise Figure Meter (see Figure 3-6).

**CORRECTED NOISE FIGURE AND GAIN** key selects the noise figure and gain measurement. The measurement system noise contribution is automatically removed (see Figure 3-6).

**UNCORRECTED NOISE FIGURE** key selects the noise figure measurement. Displayed values include noise contribution of all parts of the measurement system (see Figure 3-6).

**SPECIAL FUNCTION** key completes entry of Special Function codes (see Figure 3-5).

**STORE-RECALL-SEQ** keys STORE up to 10 instrument configurations for RECALL at a later time. The SEQ key permits a sequential recall of up to 9 stored instrument configurations (see Figure 3-5).

**SMOOTHING** keys INCREASE or DECREASE the amount of smoothing (see Figure 3-6).

SIN

PRE

T

L  
T

ME/

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H  
H  
H  
L  
L  
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H  
b  
P  
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FIXI

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STC

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Figure 3-1. Front Panel Features

## SIMPLIFIED OPERATION

### PRESET

Press: **PRESET**

This sets the front panel functions to the following:

FREQUENCY = 30 MHz  
 FREQ INCR = 20 MHz  
 START FREQ = 10 MHz  
 STOP FREQ = 1500 MHz  
 SWEEP = off  
 STEP SIZE = 20 MHz  
 SMOOTHING = 1  
 MEASUREMENT = UNCORRECTED NOISE FIGURE  
 CALIBRATE = off

In addition, default values are entered for some Special Functions. Refer to Table 3-14, Special Function Summary.

### MEASUREMENT MODES

The Noise Figure Meter has five measurement modes. Mode 1.0 is used for RF measurements in the range of 10 to 1500 MHz and requires no external equipment (except a noise source). Modes 1.1 through 1.4 are used for microwave measurements of up to 60 GHz and require an external local oscillator. Modes 1.1 and 1.2 also require an external mixer (the mixer is part of the device under test in Modes 1.3 and 1.4). Refer to the operating information pull-out card and Measurement Modes in the Detailed Operating Instructions for additional information. A Measurement Mode must be selected before performing a calibration or making a measurement. (Measurement Mode 1.0 is selected with PRESET.) Simplified Operation assumes that Measurement Mode 1.0 is selected.

### FIXED FREQUENCY TUNING

Fixed frequency parameters are selected in a Function-Data-ENTER format. For example, to set the tuned frequency to 500 MHz and the frequency increment to 100 MHz:

press **FIXED FREQ (MHz)** **5** **0** **0** **0** **ENTER**  
**FREQ INCR** **1** **0** **0** **ENTER**

**↑** or **↓** steps the frequency up or down by the 100 MHz increment set with the FREQ INCR key.

### STORE AND RECALL

The Noise Figure Meter can store instrument configurations for recall at a later time. For example, to store an instrument configuration in storage register 5:

press **STORE** **5**  
 To recall the stored instrument configuration: press **RECALL** **5**

### SWEEP FUNCTIONS

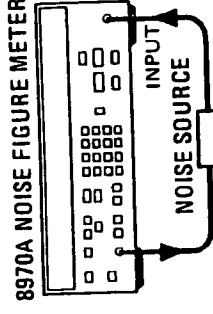
Sweep parameters are selected in a Function-Data-ENTER format. For example, to set the start frequency to 1000 MHz, the stop frequency to 1500 MHz and the step size to 100 MHz:

press **SWEEP (MHz)** **1** **0** **0** **0** **ENTER**  
**START FREQ** **1** **5** **0** **0** **ENTER**  
**STOP FREQ** **1** **0** **0** **0** **ENTER**  
**STEP SIZE**

The Noise Figure Meter can sweep the selected frequency range once (SINGLE) or repetitively (AUTO). The sweep can be terminated by pressing the same key again.

### MEASUREMENT

Connect a noise source to the Noise Figure Meter as shown:



#### Uncorrected Noise Figure

To measure uncorrected noise figure: press **NOISE FIGURE**  
 The Noise Figure Meter is measuring its own noise figure.

#### Calibrate

Calibrate measures and stores the measurement system noise characteristic at each frequency for correction of later measurements. Set START FREQ, STOP FREQ and STEP SIZE parameters. To initiate a calibration: press **CALIBRATE**

#### Corrected Noise Figure and Gain

The Noise Figure Meter must be calibrated before a corrected noise figure and gain measurement can be made.

After calibration, to measure corrected noise figure and gain: press **NOISE FIGURE AND GAIN**  
 Note that the Noise Figure Meter removes its own noise figure from the measurement results.

#### Smoothing

To change the number of measurements averaged to optimize speed of response and reduce jitter in the INSERTION GAIN and NOISE FIGURE displays: press **INCREASE** or **DECREASE**

### SPECIAL FUNCTIONS

Special Functions access capabilities of the Noise Figure Meter beyond those available with dedicated front panel keys. Special Functions are selected in a Code-SPECIAL FUNCTION format.

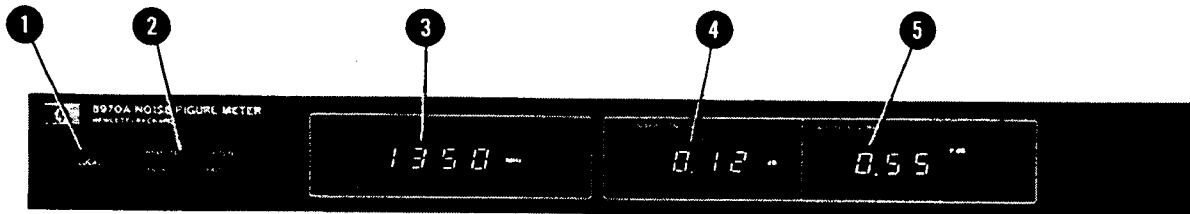
For example, to display the ENR entry currently being used: press **CODE** **5** **2** **SPECIAL FUNCTION**

Refer to the Special Functions Detailed Operating Instruction at the end of this section for more information.

Table 3-2. Detailed Operating Instructions Table of Contents (Functional)

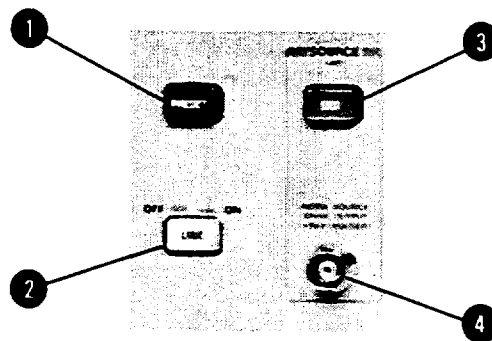
Section	Page	Section	Page
<b>Attenuation</b>		<b>Preset Conditions and Power Up</b>	
IF Attenuation Selection .....	3-74	Sequence .....	3-106
RF Attenuation Selection .....	3-119	Sequence .....	3-121
		Store and Recall .....	3-142
<b>Calibration</b>		<b>Programs</b>	
Calibrate .....	3-41	Programming an External LO .....	3-110
Calibration, Frequency .....	3-44	Programs Available to Control an	
Calibration, IF Attenuators .....	3-46	External LO .....	3-117
Calibration, Input Gain Selection .....	3-47		
<b>Displays</b>		<b>Special Functions</b>	
Display Resolution .....	3-54	Calibration, Frequency .....	3-44
Display Units Selection .....	3-56	Calibration, IF Attenuators .....	3-46
Smoothing (Averaging) .....	3-125	Calibration, Input Gain Selection .....	3-47
Temperature Units Selection .....	3-146	Controller Capability of the	
		Noise Figure Meter .....	3-48
<b>ENR</b>		Data Output to Oscilloscopes and	
ENR Table Entry .....	3-58	Recorders .....	3-50
Loss Compensation .....	3-76	Display Resolution .....	3-54
Spot ENR, $T_{hot}$ and $T_{cold}$ .....	3-140	Display Units Selection .....	3-56
Temperature Units Selection .....	3-146	Fixed IF or LO Frequency Selection .....	3-70
		HP-IB Addresses, Noise Figure Meter	
<b>HP-IB</b>		and External LO .....	3-72
Controller Capability of the		IF Attenuation Selection .....	3-74
Noise Figure Meter .....	3-48	Loss Compensation .....	3-76
HP-IB Addresses, Noise Figure Meter		Manual Measurement Functions .....	3-78
and External LO .....	3-72	Measurement Mode 1.0 .....	3-86
		Measurement Mode 1.1 .....	3-88
<b>Measurement Modes</b>		Measurement Mode 1.2 .....	3-92
Fixed IF or LO Frequency Selection .....	3-70	Measurement Mode 1.3 .....	3-95
Loss Compensation .....	3-76	Measurement Mode 1.4 .....	3-99
Measurement Modes .....	3-81	<b>Power Measurements</b> .....	3-104
Measurement Mode 1.0 .....	3-86	Preset Conditions and Power Up	
Measurement Mode 1.1 .....	3-88	Sequence .....	3-106
Measurement Mode 1.2 .....	3-92	Programming an External LO .....	3-110
Measurement Mode 1.3 .....	3-95	Programs Available to Control an	
Measurement Mode 1.4 .....	3-99	External LO .....	3-117
Sideband Selection .....	3-123	RF Attenuation Selection .....	3-119
		Sequence .....	3-121
<b>Measurements</b>		Sideband Selection .....	3-123
Manual Measurement Functions .....	3-78	Smoothing (Averaging) .....	3-125
Noise Figure (Uncorrected) and Noise		Special Function Catalog .....	3-128
Figure and Gain (Corrected) .....	3-102	Special Functions .....	3-130
Power Measurements .....	3-104	Spot ENR, $T_{hot}$ and $T_{cold}$ .....	3-140
Trigger Selection .....	3-148	Temperature Units Selection .....	3-146
		Trigger Selection .....	3-148
<b>Miscellaneous</b>		<b>Tuning</b>	
Data Output to Oscilloscopes and		Fixed Frequency Increment .....	3-66
Recorders .....	3-50	Fixed Frequency Tuning .....	3-68
Error Messages and Recovery .....	3-61	Sweep .....	3-143





- 1 LOCAL Key.** Returns the Noise Figure Meter to local operation (front panel control) from remote HP-IB control provided that the instrument is not in Local Lockout.
- 2 HP-IB Annunciators.** Display the HP-IB status. The REMOTE annunciator lights when the Noise Figure Meter is in the remote mode. The TALK annunciator lights when the Noise Figure Meter is addressed to talk, is in Talk Only mode, or is controlling an external LO. The LISTEN annunciator lights when the Noise Figure Meter is addressed to listen. The SRQ annunciator lights when the Noise Figure Meter is sending a Require Service message to the controller.
- 3 Left Display.** Depending upon the selected functions, the following information is displayed:  
 Frequency parameters — always displayed in MHz; 1 MHz resolution; 10 to 1500 MHz measurement range without external equipment; displays measurement frequency of up to 60 GHz when an external LO and a mixer are used to extend the frequency range of the Noise Figure Meter.  
 Special Function codes as they are entered.
- Spot ENR — displayed in dB.  
 Temperature of the noise source — displayed in °C, °F, or K.  
 Sequence order.  
 Smoothing factor.  
 All data as it is being entered (except ENR in the "ENR versus Frequency" table).  
 EXT MIX (external mixer) annunciator — lights when Measurement Mode 1.1, 1.2, 1.3 or 1.4 is active.
- 4 INSERTION GAIN Display.** Displays (in dB) the gain of the device under test (DUT) to two decimal places. This display also shows ENR in dB when entering the ENR table.
- 5 NOISE FIGURE Display.** Displays measured noise. Five annunciators (F dB, Y dB, F, Te K, and Y) indicate the noise figure display units. This display is also used for power measurements (displayed in dB) and error codes.

Figure 3-2. Display and Remote Features



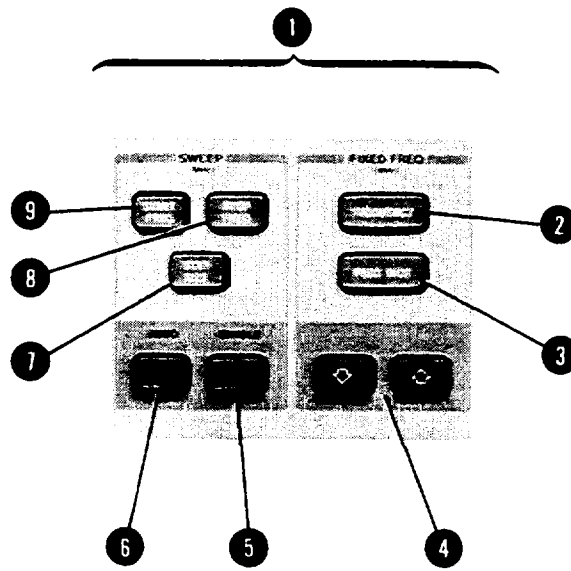
① **PRESET Key.** Returns the instrument to a known state. Refer to the Preset Conditions and Power-Up Sequence Detailed Operating Instruction for a list of preset conditions and default values.

② **LINE Switch.** Applies power to the Noise Figure Meter when set to the ON position.

③ **ENR Key.** Used to display and enable entry of the excess noise ratio (ENR) versus frequency table. ENR data for up to 27 frequencies can be stored. Frequency is shown in the left display and the corresponding ENR is shown in the INSERTION GAIN display.

④ **NOISE SOURCE DRIVE OUTPUT.** This BNC connector provides the output to drive a noise source on and off with +28 volt pulses.

Figure 3-3. LINE Switch, PRESET and SOURCE Features



**1 Frequency Function Keys.** In addition to the functions described below, the following keys are used to prefix numeric entries for the specified functions: START FREQ, STOP FREQ, STEP SIZE, FREQ, and FREQ INCR. Frequency is entered in MHz from the front panel. Frequency parameters are entered in a Function — Data — ENTER format.

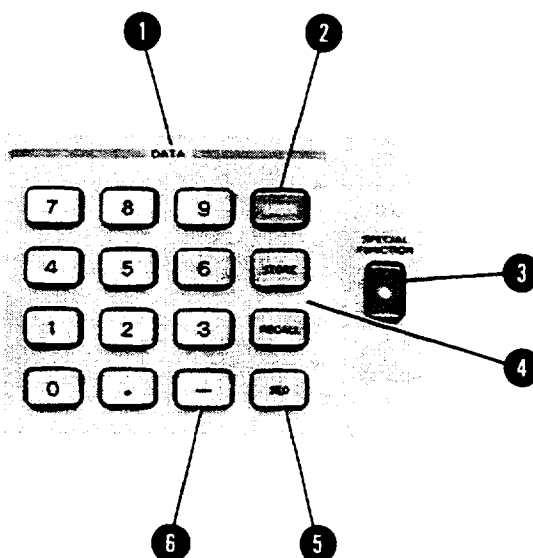
#### FIXED FREQUENCY Keys

- 2 FREQUENCY Key.** Causes the tuned frequency to appear in the left display. This key also acts as a "clear" key when an error is made during entry; that is, it returns the instrument to the measurement frequency. (Also see Frequency Function Keys.)
- 3 FREQ INCR Key.** Causes the programmed frequency increment to appear in the left display while the key is depressed. (Also see Frequency Function Keys.)
- 4  $\uparrow$  or  $\downarrow$  keys.** Increase or decrease the tuned fixed frequency by the programmed frequency increment. Holding either of these keys down causes the tuning to step continuously up or down.

#### SWEEP Keys

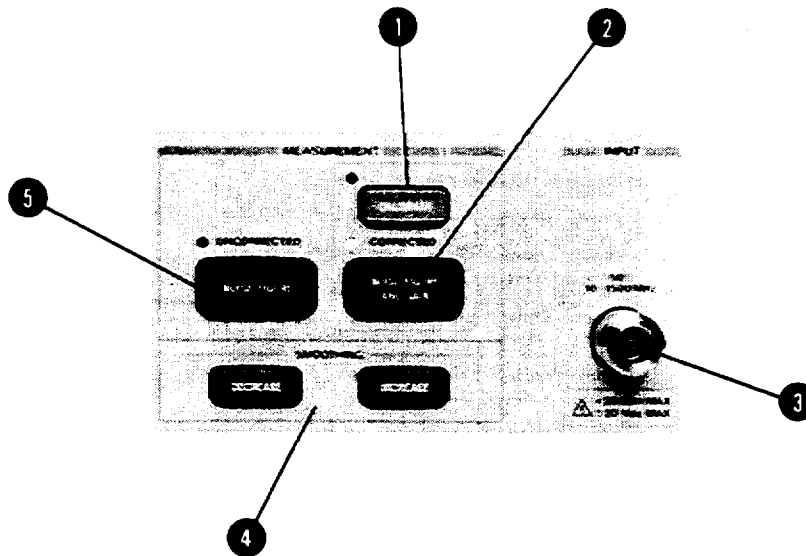
- 5 SINGLE Key.** Starts one sweep from START FREQ to STOP FREQ in increments determined by STEP SIZE. At the end of one sweep the instrument remains tuned to the stop frequency. Single sweep can be terminated by pressing the SINGLE key a second time.
- 6 AUTO Key.** Starts a sweep from the current frequency. The sweep repeats from START FREQ to STOP FREQ in increments determined by STEP SIZE until terminated. Auto sweep is terminated by pressing the AUTO key a second time.
- 7 STEP SIZE Key.** Causes the programmed frequency step size of the sweep to appear in the left display while the key is depressed. (Also see Frequency Function Keys.)
- 8 STOP FREQ Key.** Tunes the Noise Figure Meter to the programmed stop frequency and causes that frequency to appear in the left display. (Also see Frequency Function Keys.)
- 9 START FREQ Key.** Tunes the Noise Figure Meter to the programmed start frequency and causes that frequency to appear in the left display. (Also see Frequency Function Keys.)

Figure 3-4. SWEEP and FIXED FREQ Features



- 1 DATA Keys.** Enter data or Special Function codes. Entries are completed by the ENTER key or the SPECIAL FUNCTION key (except for STORE and RECALL).
  - 2 ENTER Key.** Completes keyboard entries other than Special Function codes.
  - 3 SPECIAL FUNCTION Key.** Completes the keyboard entry of a Special Function code. Special Functions are instrument operations in addition to those accessible from dedicated front panel keys. Refer to Special Functions in the Detailed Operating Instructions for a complete listing of user special functions.
  - 4 STORE and RECALL Keys.** Store and recall up to ten instrument configurations in storage registers 0 through 9. Front panel features that cannot be stored and later recalled are CALIBRATE, SMOOTHING, AUTO or SINGLE SWEEP, UNCORRECTED NOISE FIGURE and CORRECTED NOISE FIGURE AND GAIN.
- When the STORE key is used as a prefix for a numeric key (a single digit 0 — 9 to identify the register), the current instrument configuration is stored in that internal storage register.
- When the RECALL key is used as a prefix to a numeric key (a single digit 0 — 9 to identify the register), the contents stored in that register are recalled and the instrument configuration is changed to the recalled parameter values.
- 5 SEQ Key.** Recalls storage registers 1 through 9 in a preset sequence. Pressing the SEQ key momentarily displays the current storage register number. SEQ is used in conjunction with Special Function 35.
  - 6 —(Minus) Key.** Can be used as a prefix for loss, ENR, or temperature. Although the minus key can be used any time before an entry is completed, the minus sign is always inserted to the left of the entered digits. If the minus sign is used incorrectly an error message is displayed when ENTER is pressed.

Figure 3-5. DATA and SPECIAL FUNCTION Features



**1 CALIBRATE Key.** Initiates the calibration process which measures and stores the measurement system noise figure and gain. This data is used for second stage correction and gain measurements. Calibration is done from START FREQ to STOP FREQ in steps of STEP SIZE (see Figure 3-4). During calibration all front panel keys except PRESET, CALIBRATE and LOCAL are disabled. Pressing CALIBRATE a second time before calibration is complete terminates the calibration.

**2 CORRECTED NOISE FIGURE AND GAIN Key.** Configures the Noise Figure Meter to measure noise figure and gain with second stage correction (that is, only the noise figure and gain of the device under test is displayed). A calibration must be completed prior to making corrected noise figure and gain measurements.

**3 INPUT.** This female type-N INPUT connector is used to connect the device under test to the Noise Figure Meter. The nominal input impedance is 50 ohms. Specified operating input level is less than  $-10$  dBm. The frequency range at the INPUT connector is 10 to 1500 MHz.

**CAUTION**

*Damage to the instrument can be caused by connecting signals to INPUT that exceed  $+20$  dBm or  $+20$  Vdc.*

**4 SMOOTHING Keys.** INCREASE and DECREASE the number of measurements averaged (smoothing factor) when displaying measurement results. When pressed, these keys cause the smoothing factor to appear in the left display. The smoothing factor ranges from 1 to 512 and changes in factors of 2. Pressing INCREASE doubles the smoothing factor. Pressing DECREASE halves the smoothing factor. Both INSERTION GAIN and NOISE FIGURE displays are smoothed. Increasing the smoothing reduces the jitter in the display.

**5 UNCORRECTED NOISE FIGURE Key.** Configures the Noise Figure Meter to measure noise figure without second stage correction (that is, the noise contribution of the measurement system is included in the reading in the NOISE FIGURE display).

**Figure 3-6. MEASUREMENT and INPUT Features**

**INPUT** is a rear panel input for coupling the output signal from the device under test into the instrument. This input is supplied on Option 001 instruments instead of the standard front panel connection.

**CAUTION**

*Damage to the instrument can be caused by connecting signals to INPUT that exceed +20 dBm or +20 Vdc.*

**NOISE SOURCE DRIVE OUTPUT** drives a noise source on and off with +28V pulses and is in parallel to the front panel NOISE SOURCE DRIVE OUTPUT. (Only one noise source can be connected at a time.)

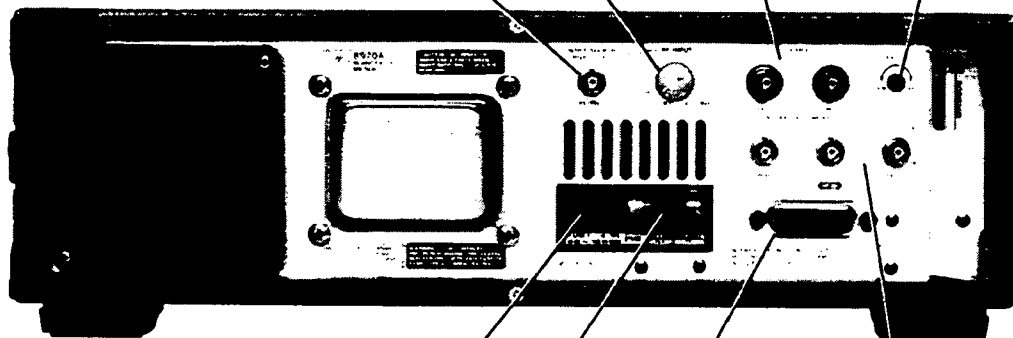
**GAIN TRACE** adjusts the intensity of the gain trace (on an oscilloscope) relative to the noise figure trace.

**IF** provides a rear panel output for the Noise Figure Meter's last IF (20 MHz) immediately prior to the detector. The power level is -50 to -30 dBm nominal. Output impedance is 50Ω nominal.

**DET** provides an output from the noise power detector. Level is 0.1 to 1.0 Vdc nominal, floating.

**NOTE**

*DET is a direct connection to the instrument's detector. Loading or injecting a signal may cause inaccurate readings. Only connect this output to instrumentation with floating inputs. Output impedance is 10 kΩ nominal.*



**Line Power Module** permits operation from 100, 120, 220 or 240 Vac. The number visible in the window indicates nominal line voltage to which the instrument must be connected (see Figure 2-1). Center conductor is a chassis connection for safety earth ground.

**Fuse.** 1.5A (250V, Normal Blow) for 100/120 Vac. 1.0 (250V, Normal Blow) for 220/240 Vac.

**HP-IB Connector** connects the Noise Figure Meter to the Hewlett-Packard Interface Bus for HP-IB operation.

**X-AXIS.** 0 to +6V output proportional to the measurement frequency when driving an oscilloscope or X-Y recorder. This output can be made proportional to noise figure for driving a strip chart recorder. Output impedance is 100Ω.

**Y-AXIS.** 0 to +6V output proportional to noise figure when driving an oscilloscope or X-Y recorder. This output can be made proportional to gain when driving a strip chart recorder. Output impedance is 100Ω.

**Z-AXIS/PEN LIFT.** TTL compatible output. When used with an oscilloscope, the Z-AXIS provides a TTL high signal for retrace blanking. When used with a recorder, the PEN LIFT provides a TTL high signal to lift the pen. Output impedance is 100Ω.

Figure 3-7. Rear Panel Features

**OPERATOR'S CHECKS**

**3-10. OPERATOR'S CHECKS**

**3-11. Basic Functional Checks**

**DESCRIPTION** The overall operation of the Noise Figure Meter is checked using a noise source and an oscilloscope. If the Noise Figure Meter is to be used to control an external LO, the optional External LO Check at the end of this procedure verifies that capability. This check should be performed sequentially.

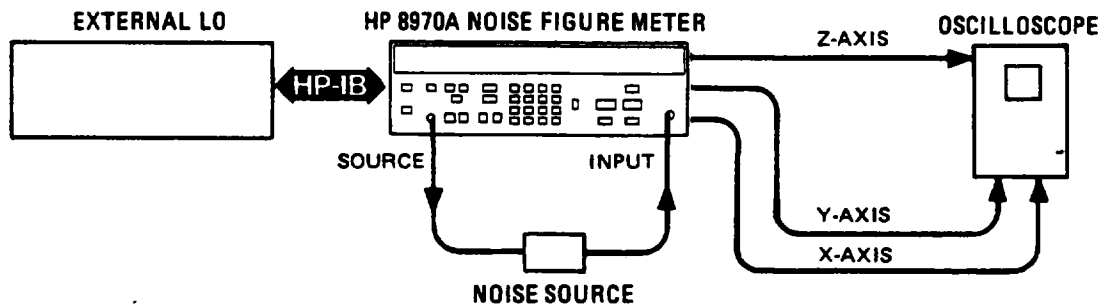


Figure 3-8. Basic Functional Checks Setup

<b>EQUIPMENT</b>	Noise Source .....	HP 346B Option 001
	Oscilloscope .....	HP 1740A
	External LO .....	HP 8672A

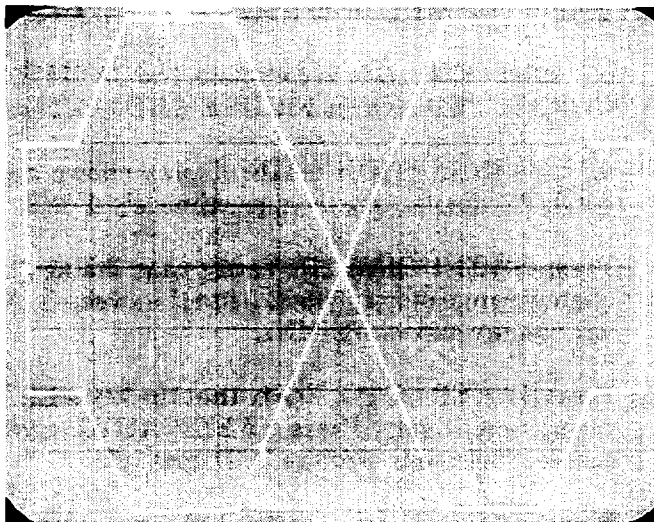
**PROCEDURE Preliminary Check**

1. Remove any cables from the Noise Figure Meter's INPUT and SOURCE. Set the LINE switch to OFF, and then back to ON. Verify the front panel LED annunciators, display segments, decimal points, and key lights turn on for approximately two seconds. Then, verify that the NOISE FIGURE display shows " — — — — " for approximately five seconds.
2. Press PRESET. After " — — — — " disappears from the NOISE FIGURE display, verify the following conditions:
  - a. Left display shows 30 MHz.
  - b. INSERTION GAIN display is blank.
  - c. NOISE FIGURE display shows " — — FdB".
  - d. UNCORRECTED NOISE FIGURE annunciator is on.
3. Connect the noise source between the Noise Figure Meter's SOURCE and INPUT (See Figure 3-8). Verify the NOISE FIGURE display shows approximately 5 dB.
4. 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 and the Y-AXIS for the vertical input.
5. On the Noise Figure Meter, press 7 . 1 SPECIAL FUNCTION. Verify that a test pattern is displayed on the oscilloscope. It may be necessary to adjust rear panel GAIN TRACE control to obtain the test pattern. Adjust the oscilloscope until the test pattern fills the grid area (see Figure 3-9). Press 7 . 0 SPECIAL FUNCTION to enable the Noise Figure Meter to output the noise figure and gain data to the oscilloscope.

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**OPERATOR'S CHECKS**


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**Basic Functional Checks (cont'd)**

**Figure 3-9. Test Pattern on Oscilloscope**

**Calibration and SWEEP Check**

6. Press **CORRECTED NOISE FIGURE AND GAIN**. Verify the **NOISE FIGURE** display shows an error message.

**NOTE**

*In step 6, error code E20 (not calibrated) is normally displayed. If error code E26 (IF attenuators not calibrated) is displayed during this check, press 33.0 **SPECIAL FUNCTION** (IF attenuator calibration). Continue with this check after the IF attenuators are calibrated (approximately 5 seconds).*

7. Press **UNCORRECTED NOISE FIGURE**. Verify that the **NOISE FIGURE** display shows approximately 5 FdB indicating that the Noise Figure Meter can make uncorrected noise figure measurements prior to being calibrated.
8. Press **CORRECTED NOISE FIGURE AND GAIN**. Verify the **NOISE FIGURE** display again shows an error message.

**NOTE**

*All frequency data must be entered in MHz.*

9. Press the following keys to enter the **SWEEP** calibration parameters:
    - a. **START FREQ 1 2 3 ENTER.**
    - b. **STOP FREQ 7 8 9 ENTER.**
    - c. **STEP SIZE 4 0 ENTER.**
  10. Press **CALIBRATE**. Verify the following conditions:
    - a. **CALIBRATE** annunciator lights.
-



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**OPERATOR'S CHECKS**

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**Basic Functional Checks (cont'd)**

- b. The frequency is swept from the start frequency (123 MHz) to the stop frequency (789 MHz) in 40 MHz steps. This sweep is performed three times.
  - c. After calibration is complete, the CALIBRATE annunciator turns off and the CORRECTED NOISE FIGURE AND GAIN annunciator lights.
  - d. The INSERTION GAIN display shows approximately 0 dB and the NOISE FIGURE display shows approximately 0 FdB.
11. Press SWEEP SINGLE. Verify that the key's LED lights. The established frequency range is swept once. After the sweep is completed, the LED turns off and the left display shows 789 MHz.
  12. Press SWEEP AUTO. Verify that the key's LED lights and the frequency range is swept repetitively. Press SWEEP AUTO again. Verify the sweep stops at the current frequency and the LED goes off.
  13. Press SMOOTHING INCREASE four times to set the smoothing (averaging) factor to 16. Press SWEEP SINGLE. Verify that the INSERTION GAIN and NOISE FIGURE displays are more stable and the time required for each measurement is longer. Press SMOOTHING DECREASE four times to return the smoothing factor to 1.

**FIXED FREQUENCY Tuning Check**

14. Press the following keys to establish the tuned FIXED FREQUENCY parameters:
  - a. FREQUENCY 5 0 0 ENTER.
  - b. FREQ INCR 3 0 0 ENTER.
15. Press . Verify that the left display shows 800 MHz and the NOISE FIGURE display show error code E21 (current frequency is out of calibrated range).
16. Press . Verify the left display shows 500 MHz and the INSERTION GAIN and NOISE FIGURE displays show approximately 0.

**ENR Table Entry Check****NOTE**

*This check verifies the capability of the ENR and ENTER keys to initiate and sequence through the ENR table. If it is necessary to change the ENR table, refer to the ENR Table Entry Detailed Operating Instruction.*

17. Press ENR. Verify the MHz annunciator in the left display is flashing.
18. Press ENTER. Verify that the MHz annunciator remains on and the dB annunciator in the INSERTION GAIN display is flashing.

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**OPERATOR'S CHECKS**

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**Basic Functional Checks (cont'd)**

19. Press and hold ENTER. Verify the two displays sequence through the ENR table entries. Release ENTER.

**NOTE**

*If ENTER is held down until all 27 frequency vs. ENR pairs have been displayed, both annunciators light and remain lit. When ENTER is released, the Noise Figure Meter returns to the measurement configuration it was in prior to pressing ENR. If ENTER is released prior to displaying all pairs, press FREQUENCY to return to the previous measurement configuration.*


20. Verify that the CORRECTED NOISE FIGURE AND GAIN annunciator lights.

**STORE, RECALL, and SEQ Check**

21. Press PRESET. Verify the left display shows 30 MHz.

**NOTE**

*During the STORE and RECALL checks the complete instrument configuration is stored and recalled. The frequency change is merely a convenient indication that different setups have been stored and recalled.*

22. Press STORE 1.
23. Press  . Verify the left display shows 50 MHz. Press STORE 2.
24. Press RECALL 1. Verify the left display shows 30 MHz. Press RECALL 2. Verify the left display shows 50 MHz.
25. Press and hold SEQ. Verify the left display shows 1. Release SEQ. Verify the left display shows 30 MHz.
26. Press and hold SEQ. Verify the left display shows 2. Release SEQ. Verify the left display shows 50 MHz.

**Minus Check**

27. Press - . Verify the left display shows - .

**External LO Check (Optional)****NOTE**

*The following steps check the Noise Figure Meter's capability to control an external LO. It is not necessary to perform this check unless the Noise Figure Meter is used for this purpose and a suitable external LO is available. It is assumed in the following check that the HP-IB addresses used by the Noise Figure Meter and the external LO are compatible.*

28. Connect the HP-IB cable between the Noise Figure Meter and the external LO (see Figure 3-8).
-

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**OPERATOR'S CHECKS**

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**Basic Functional Checks (cont'd)**

29. Press 1 . 1 SPECIAL FUNCTION. Verify the left display shows 10000 MHz and the EXT MIX annunciator lights.
30. Press one of the following sequences of keys depending upon the external LO used:
  - a. For an HP 8350B, press 41.0 SPECIAL FUNCTION.
  - b. For an HP 8672A, press 41.2 SPECIAL FUNCTION.
  - c. For an HP 8673B, press 41.3 SPECIAL FUNCTION.
31. Press 4 . 1 SPECIAL FUNCTION. Verify the TALK annunciator on the Noise Figure Meter and the remote annunciator on the external LO lights.
32. On the Noise Figure Meter, press SWEEP START FREQ. Verify the left display shows 8000 MHz and the external LO is tuned to the same frequency.
33. On the Noise Figure Meter, press SWEEP STOP FREQ. Verify the left display shows 12000 MHz and the external LO is tuned to the same frequency.

**OPERATOR'S CHECKS**

**3-12. HP-IB Functional Checks** ◀HP-IB▶

**DESCRIPTION** The following procedures check the instrument's ability to perform the following functions:

- a. Process or send all of the applicable HP-IB messages described in Table 3-3.
- b. Recognize its own HP-IB address.
- c. Set all of the bus data, handshake, and control lines (except DIO8) to both their true and false states. DIO8 is the most significant data line and is not used by the Noise Figure Meter.

These procedures do not check if all Noise Figure Meter program codes are being properly interpreted and executed by the instrument. However, if the power-up sequence (including the memory checks) and the front panel operation is good, the program codes, in all likelihood, will be correctly executed.

The validity of these checks is based on the following assumptions:

- a. The Noise Figure Meter performs properly when operated via the front panel keys (that is, in local mode). This can be verified with the Basic Functional Checks.
- b. The bus controller properly executes HP-IB operations.
- c. The bus controller's HP-IB interface properly executes the HP-IB operations.

If the Noise Figure Meter appears to fail any of these HP-IB checks, the validity of the above assumptions should be confirmed before attempting to service the instrument.

The select code of the controller's HP-IB interface is assumed to be 7. The address of the Noise Figure Meter is assumed to be 8 (its address as set at the factory). This select code address combination (that is, 708) is not necessary for these checks to be valid. However, the program lines presented here have to be modified for any other combination.

These checks are intended to be as independent of each other as possible. Nevertheless, the first four checks should be performed in order before other checks are selected. Any special initialization or requirements for a check are described at its beginning.

**INITIAL SETUP** The test setup is the same for all of the checks. Connect the Noise Figure Meter to the bus controller via the HP-IB interface. Do not connect any equipment, other than the noise source, to the Noise Figure Meter's INPUT.

**EQUIPMENT**

HP-IB Controller .....	HP 85B/82936A (ROM Drawer)/00085-15005 (Advanced Programming ROM)
—or—	HP 9826A Option 011 (Basic 2.0 ROM based system)
HP-IB Interface .....	HP 82937A (HP 85B only)
Noise Source .....	HP 346B (Option 001)



**OPERATOR'S CHECKS**

**HP-IB Functional Checks (cont'd)**

**Address Recognition**

**NOTE** This check determines if the Noise Figure Meter recognizes when it is being addressed and when it is not. This check assumes only that the Noise Figure Meter can properly handshake on the bus. Before beginning this check, set the Noise Figure Meter's LINE switch to ON, press PRESET, and then 4 . 0 SPECIAL FUNCTION.

Description	HP 858 (BASIC)	HP 9826A (BASIC)
Set the Remote Enable (REN) bus control line false.	LOCAL 7	LOCAL 7
Send the Noise Figure Meter's listen address.	OUTPUT 708	OUTPUT 708

**OPERATOR'S RESPONSE** Check that the Noise Figure Meter's REMOTE annunciator is off and that its LISTEN annunciator is on.

Unaddress the Noise Figure Meter by sending a different address.	OUTPUT 715	OUTPUT 715
--	------------	------------

**OPERATOR'S RESPONSE** Check that both the Noise Figure Meter's REMOTE and LISTEN annunciators are off.

**Remote and Local Messages and the LOCAL Key**

**NOTE** This check determines if the Noise Figure Meter properly switches from local to remote control, from remote to local control, and if the LOCAL key returns the instrument to local control. This check assumes that the Noise Figure Meter is able to both handshake and recognize its own address. Before beginning this check, press the Noise Figure Meter's PRESET key. Then press 4 . 0 SPECIAL FUNCTION.

Description	HP 858 (BASIC)	HP 9826A (BASIC)
Send the Remote message (by setting Remote Enable, REN, true and addressing the Noise Figure Meter to listen).	REMOTE 708	REMOTE 708

**OPERATOR'S RESPONSE** Check that the Noise Figure Meter's REMOTE and LISTEN annunciators are on.

Send the Local message to the Noise Figure Meter	LOCAL 708	LOCAL 708
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**OPERATOR'S RESPONSE** Check that the Noise Figure Meter's REMOTE annunciator is off but its LISTEN annunciator is on.

Send the Remote message to the Noise Figure Meter.	REMOTE 708	REMOTE 708
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**OPERATOR'S CHECKS**

**HP-IB Functional Checks (cont'd)**

**Remote and Local Messages and the LOCAL Key (cont'd)**

**OPERATOR'S RESPONSE** Check that both the Noise Figure Meter's RESPONSE and LISTEN annunciators are on. Press the LOCAL key on the Noise Figure Meter. Check that the Noise Figure Meter's REMOTE annunciator is now off, but that its LISTEN annunciator remains on.

**Sending the Data Message**

**NOTE** This check determines if the Noise Figure Meter properly issues Data messages when addressed to talk. This check assumes that the Noise Figure Meter is able to handshake and recognize its own address. Before beginning this check, press the Noise Figure Meter's LINE switch twice (OFF then ON). Then, after the power-up sequence is completed, press CORRECTED NOISE FIGURE AND GAIN and 4 . 0 SPECIAL FUNCTION. (If an HP 9826A controller is used, a short program is required to perform this check.)

Description	HP 85B (BASIC)	HP 9826A (BASIC)
Address the Noise Figure Meter to talk and store its output in variable V. (The output is E20 since the Noise Figure Meter is not calibrated.)	ENTER 708;V	10 V = 0 20 ENTER 708;V 30 DISP V 40 END
Display the value of V.	DISP V	DISP V

**OPERATOR'S RESPONSE** Check that the Noise Figure Meter's REMOTE annunciator is off but that its TALK annunciator is on. The controller's display should read 9002000000 (HP 85B) or 9.002E+1 (HP 9826A). The 90020 portion of the display corresponds to the data output for the error code E20 (not calibrated) shown in the Noise Figure Meter's NOISE FIGURE display.

**Receiving the Data Message**

**NOTE** This check determines if the Noise Figure Meter properly receives Data messages. The Data messages sent cause the 7 least significant HP-IB data lines to be placed in both their true and false states. This check assumes the Noise Figure Meter is able to handshake, recognize its own address and properly make the remote/local transitions. Before beginning this check, press the Noise Figure Meter's PRESET key. Then press 4 . 0 SPECIAL FUNCTION.

Description	HP 85B (BASIC)	HP 9826A (BASIC)
Send the first part of the Remote message (enabling the Noise Figure Meter to remote).	REMOTE 7	REMOTE 7
Address the Noise Figure Meter to listen (completing the Remote message), then send a Data message.	OUTPUT 708; "FR15MZ"	OUTPUT 708; "FR15MZ"

**OPERATOR'S RESPONSE** Check that both the Noise Figure Meter's REMOTE and RESPONSE LISTEN annunciators are on and that the left display shows 15 MHz.



**OPERATOR'S CHECKS**

**HP-IB Functional Checks (cont'd)**

**Local Lockout and Clear Lockout/Set Local Messages**

**NOTE**

This check determines if the Noise Figure Meter properly receives the Local Lockout message, disabling the LOCAL key. The check also determines if the Clear Lockout/Set Local message is properly received and executed by the Noise Figure Meter. This check assumes that the Noise Figure Meter is able to handshake, recognize its own address, and properly make the remote/local transitions. Before beginning this check, press the Noise Figure Meter's LINE switch OFF then ON and then press the PRESET key. Then press 4 . 0 SPECIAL FUNCTION.

Description	HP 85B (BASIC)	HP 9826A (BASIC)
Send the first part of the Remote message (enabling the Noise Figure Meter to remote).	REMOTE 7	REMOTE 7
Send the Local Lockout message.	LOCAL LOCKOUT 7	LOCAL LOCKOUT 7
Address the Noise Figure Meter to listen (completing the Remote message).	OUTPUT 708	OUTPUT 708

**OPERATOR'S RESPONSE**

Check that both the Noise Figure Meter's REMOTE and LISTEN annunciators are on. Press the Noise Figure Meter's LOCAL key. Both its REMOTE and LISTEN annunciators should remain on.

Send the Clear Lockout/Set Local message.	LOCAL 7	LOCAL 7
---	---------	---------

**OPERATOR'S RESPONSE**

Check that the Noise Figure Meter's REMOTE annunciator is off but its LISTEN annunciator is on.

**Clear Message**

**NOTE**

This check determines if the Noise Figure Meter properly responds to the Clear message. This check assumes that the Noise Figure Meter is able to handshake, recognize its own address, make the remote/local changes and receive Data messages. Before beginning this check press the Noise Figure Meter's PRESET key. When " - - - " disappears from the NOISE FIGURE display, press CALIBRATE. Once the LED above the CALIBRATE key turns off, press 4 . 0 SPECIAL FUNCTION.

Description	HP 85B (BASIC)	HP 9826A (BASIC)
Send the first part of the Remote message (enabling the Noise Figure Meter to remote).	REMOTE 7	REMOTE 7
Address the Noise Figure Meter to listen (completing the Remote message), then send a Data message that selects the CORRECTED NOISE FIGURE AND GAIN measurement.	OUTPUT 708; "M2"	OUTPUT 708; "M2"

**OPERATOR'S CHECKS**

**HP-IB Functional Checks (cont'd)**

**Clear Message (cont'd)**

**OPERATOR'S RESPONSE** Check that both the Noise Figure Meter's REMOTE and LISTEN annunciators are on and that the CORRECTED NOISE FIGURE AND GAIN key light is on.

Send the Clear message (setting the Noise Figure Meter's measurement to UNCORRECTED NOISE FIGURE).	CLEAR 708	CLEAR 708
--	-----------	-----------

**OPERATOR'S RESPONSE** Check that both the Noise Figure Meter's REMOTE and LISTEN annunciators are on and that the UNCORRECTED NOISE FIGURE key light is on.

**Abort Message**

**NOTE** This check determines if the Noise Figure Meter becomes unaddressed when it receives the Abort message. Before beginning this check, enter LOCAL 708 and press the Noise Figure Meter's PRESET key. Then press 4 . 0 SPECIAL FUNCTION.

Description	HP 85B (BASIC)	HP 9826A (BASIC)
Send the Remote message to the Noise Figure Meter.	REMOTE 708	REMOTE 708

**OPERATOR'S RESPONSE** Check that both the Noise Figure Meter's REMOTE and LISTEN annunciators are on.

Send the Abort message, unaddressing the Noise Figure Meter from listening.	ABORTIO 7	ABORT 7
---	-----------	---------

**OPERATOR'S RESPONSE** Check that the Noise Figure Meter's LISTEN annunciator is off.

**Status Byte Message**

**NOTE** This check determines if the Noise Figure Meter sends the Status Byte message. Before beginning this check, press the Noise Figure Meter's PRESET key. Then press 4 . 0 SPECIAL FUNCTION.

Description	HP 85B (BASIC)	HP 9826A (BASIC)
Place the Noise Figure Meter in serial-poll mode and address it to talk (causing it to send the Status Byte message).	SPOLL (708)	SPOLL (708)

**OPERATOR'S RESPONSE** Check that the controller's display reads 0.





**OPERATOR'S CHECKS**

**Require Service Message**

**NOTE**

This check determines if the Noise Figure Meter can issue the Require Service message (set the SRQ bus control line true). This check assumes that the Noise Figure Meter is able to handshake, recognize its own address, make the remote/local changes, and receive Data messages. Before beginning this check, press the Noise Figure Meter's PRESET key. Then press 4 . 0 SPECIAL FUNCTION. (If an HP 9826A controller is used, a short program is required to perform the last half of this check.)

Description	HP 85B (BASIC)	HP 9826A (BASIC)
Send the first part of the Remote message (enabling the Noise Figure Meter to remote).	REMOTE 7	REMOTE 7
Address the Noise Figure Meter to listen (completing the Remote message), then send a Data message containing an invalid HP-IB code. This enables a Require Service message to be sent.	OUTPUT 708; "<"	OUTPUT 708; "<"
Make controller wait two seconds to allow time for the Noise Figure Meter to send the Require Service message. (This step is not necessary if sufficient time is allowed.)	WAIT 2000	WAIT 2000
Read the binary status of the controller's HP-IB interface and store the data in variable V (in this step, 7 is the interface's select code).	STATUS 7,2; V	10 V = 0 20 STATUS 7,7; V
Display the value of the SRQ bit (in this step 6 (HP 85B) and 10 (HP 9826) are the SRQ bits for the controller, numbered from 0.	DISP"SRQ="; BIT(V,6)	30 DISP"SRQ="; BIT(V,10) 40 END

**OPERATOR'S RESPONSE**

Check that the SRQ value is 1, indicating the Noise Figure Meter issued the Require Service message.

**OPERATOR'S CHECKS**

**Trigger Message**

**NOTE**

This check determines if the Noise Figure Meter responds to the Trigger message. This check assumes that the Noise Figure Meter is able to handshake, recognize its own address, make the remote/local changes, and send and receive Data messages. Before beginning this check, enter LOCAL 708 and press the Noise Figure Meter's PRESET key. Then press 4 . 0 SPECIAL FUNCTION (If an HP 9826A controller is used, a short program is required to perform this check.)

Description	HP 85B (BASIC)	HP 9826A (BASIC)
Send the first part of the Remote message (enabling the Noise Figure Meter to remote).	REMOTE 7	10 REMOTE 7
Address the Noise Figure Meter to listen (completing the Remote message), then send a Data message placing the Noise Figure Meter in the Trigger Hold mode).	OUTPUT 708, "T1"	20 OUTPUT 708; "T1"
Send the Trigger message.	TRIGGER 708	30 TRIGGER 708 40 V = 0
Address the Noise Figure Meter to talk and store the data in variable V.	ENTER 708,V	50 ENTER 708; V
Display the value of V.	DISP V	60 DISP V 70 END

**OPERATOR'S RESPONSE**

Check that both the Noise Figure Meter's REMOTE and TALK annunciators are on. The controller's display should read the same as the NOISE FIGURE display.



### 3-13. REMOTE OPERATION, HEWLETT-PACKARD INTERFACE BUS

The Noise Figure Meter can be operated through the Hewlett-Packard Interface Bus (HP-IB). Bus compatibility, programming and data formats are described in the following paragraphs.

The Noise Figure Meter can operate in three mutually exclusive modes on the HP-IB:

1. Normal Talker/Listener Mode. This mode is used when the Noise Figure Meter is under the control of an HP-IB compatible computer or controller.
2. External LO Control Mode. This mode is used when the Noise Figure Meter controls the operation of an external LO.
3. Talk Only Mode. This mode is used to output data to a device that is operating in the Listen Only Mode.

Most front panel functions, special functions and remote-only functions are programmable via HP-IB. Table 3-4 lists the functions that cannot be programmed via HP-IB.

A quick test of the Noise Figure Meter's HP-IB interface is described earlier in this section under Remote Operator's Checks. These checks verify that the Noise Figure Meter can respond to or send each of the applicable bus messages described in Table 3-3.

### 3-14. HP-IB Compatibility

The Noise Figure Meter has an open-collector, TTL, HP-IB interface which can be used with any HP-IB computing controller or computer for automatic system applications. The Noise Figure Meter is programmable via the HP Interface Bus. Its programming capability is described by the twelve HP-IB messages listed in Table 3-3. The Noise Figure Meter's compatibility with HP-IB is further defined by the following list of interface functions: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C1, C3, C28 and E1. A more detailed explanation of these compatibility codes can be found in IEEE Standard 488-1978 (and the identical ANSI Standard MC1.1). For more information about HP-IB, refer to the Hewlett-Packard Electronic Instruments and Systems catalog and the booklet titled "Improving Measurements in Engineering and Manufacturing" (HP part number 5952-0058).

### 3-15. Remote Mode

**Remote Capability.** The Noise Figure Meter communicates on the bus in both remote and local modes. In remote, most of the Noise Figure Meter's front panel controls are disabled (except for the LINE switch and LOCAL key). However, front panel displays remain active and valid. In remote, the Noise Figure Meter can be addressed to talk or listen. When addressed to listen, the Noise Figure Meter can issue the Data and Status Byte messages. Whether addressed or not, the Noise Figure Meter responds to the Clear (DCL), Local Lockout, Clear Lockout/Set Local, and Abort messages. In addition, the Noise Figure Meter can issue the Require Service Message.

**Local-to-Remote Mode Changes.** The Noise Figure Meter switches to remote operation upon receipt of the Remote message. The Remote message has two parts. They are:

- a. Remote enable bus control line (REN) set true.
- b. Device listen address received once (while REN is true).

When the Noise Figure Meter switches to remote, the REMOTE annunciator on the front panel turns on.

### 3-16. Local Mode

**Local Capability.** In local, the Noise Figure Meter's front panel controls are fully operational and the instrument responds to the Remote message. Whether addressed or not, the Noise Figure Meter also responds to the Clear, Local Lockout, Clear Lockout/Set Local, and the Abort messages. When addressed to talk, the Noise Figure Meter can issue Data messages and the Status Byte message, and whether addressed or not, it can issue the Require Service message.

**Remote-to-Local Mode Changes.** The Noise Figure Meter always switches to local from remote whenever it receives the Local message (GTL) or the Clear Lockout/Set Local message. (The Clear Lockout/Set Local message sets the Remote Enable control line |REN| false.) The Noise Figure Meter can also be switched to local by pressing the front panel LOCAL key (assuming Local Lockout is not in effect).

### 3-17. Addressing

The Noise Figure Meter interprets the byte on the eight HP-IB data lines as an address or a bus command if the bus is in the command mode. The command mode is defined as attention control line (ATN) true and interface clear control line (IFC) false. Whenever the Noise Figure Meter is being addressed (if in local or remote), either the TALK or LISTEN annunciator on the front panel turns on.

The Noise Figure Meter's HP-IB address is selected by special function. To change the HP-IB address or to determine the present address setting, refer to the discussion titled HP-IB Addresses in the Detailed Operating Instructions at the end of this section.

**Local Lockout.** When a data transmission is interrupted, which can happen by pressing the LOCAL key to return the Noise Figure Meter to local mode, the data could be lost. This would leave the Noise Figure Meter in an unknown state. To prevent this, a local lockout is recommended. Local lockout disables the LOCAL key and allows return-to-local only under program control.

#### NOTE

*Return-to-local can also be accomplished by turning the Noise Figure Meter's LINE switch to OFF, then back to ON. However, this technique has some disadvantages:*

- a. *It defeats the purpose and advantage of local lockout (that is, the system controller will lose control of a system element).*
- b. *There are several HP-IB conditions that reset to default states at turn-on.*

### 3-18. Data Messages

The Noise Figure Meter communicates on the interface bus primarily with data messages. Data messages consist of one or more bytes sent over the bus' data lines when the bus is in the data mode (attention control line |ATN| false). Unless it is set to Talk Only or External LO Control, the Noise Figure Meter receives data messages when addressed to listen. Virtually all instrument operations available in local mode can be performed in remote mode via data messages. The major exceptions are changing the LINE switch setting, using the Talk Only capability, using the instrument's capability to control an external LO and changing the HP-IB address of the Noise Figure Meter (refer to Table 3-4).

### 3-19. Receiving the Data Message

Depending on the status of Special Function 4, the Noise Figure Meter can either talk only, control an external LO, or talk and listen both (normal operation). The instrument responds to Data messages when it is enabled to remote (REN control line true) and it is addressed to listen. The instrument remains addressed to listen until it receives an Abort message or until its talk address or a universal unlisten command is sent by the controller.

**Data Input Format.** The Data message string, or program string, consists of a series of ASCII codes. Each code is typically equivalent to a front panel keystroke in local mode. Thus, for a given operation, the program string syntax in remote mode is the same as the keystroke sequence in local mode. Example 1 shows a typical program string.

**Program Codes.** All of the HP-IB codes normally used by the operator to control the Noise Figure Meter are given in Tables 3-8, 3-9, and 3-10. Table

#### EXAMPLE 1: Typical Program String

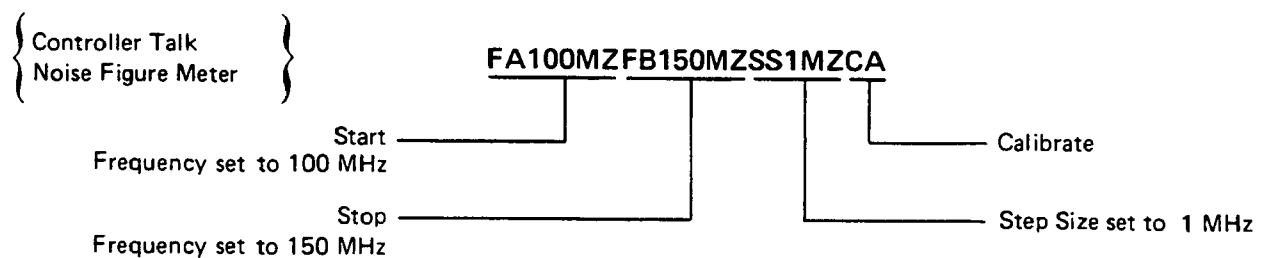


Table 3-3. Message Reference Table (1 of 2)

HP-IB Message	Applicable	Response	Related Commands and Controls	Interface Functions*
Data	Yes	Most Noise Figure Meter operations are bus programmable. All measurement results, special displays, and error outputs are available to the bus.		AH1 SH1 T5 L4
Trigger	Yes	If in remote and addressed to listen, the Noise Figure Meter makes a measurement according to previously programmed setup. It responds equally to bus command GET and program code T2, Trigger Execute (a Data message).	GET	DT1
Clear	Yes	The Noise Figure Meter is set to the same conditions established by pressing PRESET. Refer to Table 3-6.	DCL SDC	DC1
Remote	Yes	Remote mode is enabled when the REN bus control line is true. However, remote mode is not entered until the first time the Noise Figure Meter is addressed to listen. The front panel REMOTE annunciator lights when the instrument is actually in the remote mode. When entering the remote mode, no instrument settings or functions are changed, but all front panel keys except LOCAL are disabled.	REN	RL1
Local	Yes	The Noise Figure Meter returns to local mode (front panel control). It responds equally to the GTL bus command and the front panel LOCAL key. When entering the local mode, no instrument settings or functions are changed.	GTL	RL1
Local Lockout	Yes	Disables all front panel keys including LOCAL. Only the controller can return the Noise Figure Meter to local (front panel control).	LL0	RL1
Clear Lockout/ Set Local	Yes	The Noise Figure Meter returns to local (front panel control) and local lockout is cleared when the REN bus control line goes false. When entering local mode, no instrument settings or functions are changed.	$\overline{\text{REN}}$	RL1
Pass Control/ Take Control	No	The Noise Figure Meter cannot pass or take control of HP-IB. However, it does have limited control capability as indicated in the last column.		C1, 3, 28

\*Commands, Control lines, and Interface Functions are defined in IEEE Std 488-1978. Knowledge of these may not be necessary if your controller's manual describes programming in terms of the twelve HP-IB Messages shown in the left column.

Table 3-3. Message Reference Table (2 of 2)

HP-IB Message	Applicable	Response	Related Commands and Controls	Interface Functions*
Require Service	Yes	The Noise Figure Meter sets the SRQ bus control line true if an invalid program code is received (unless disabled). The following conditions also set SRQ true when they occur if they are enabled by the operator to do so: Data Ready, Instrument Error, or Calibration Complete.	SRQ	SR1
Status Byte	Yes	The Noise Figure Meter responds to a Serial Poll Enable (SPE) bus command by sending an 8-bit byte when addressed to talk. If the instrument is holding the SRQ control line true (issuing the Require Service message) bit 7 (RQS bit) in the Status Byte and the bit representing the condition causing the Require Service message to be issued will both be true. The bits in the Status Byte are latched but can be cleared by: <ol style="list-style-type: none"> <li>1. removing the causing condition, and</li> <li>2. reading the Status Byte.</li> </ol>	SPE SPD	T5
Status Bit	No	The Noise Figure Meter does not respond to a parallel poll.		PP0
Abort	Yes	The Noise Figure Meter stops talking and listening.	IFC	T5

\*Commands, Control lines, and Interface Functions are defined in IEEE Std 488-1978. Knowledge of these may not be necessary if your controller's manual describes programming in terms of the twelve HP-IB Messages shown in the left column.

Complete HP-IB capability as defined in IEEE Std 488 and ANSI Std MC1.1 is: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C1, 3, 28, and E1.

Table 3-4. Functions Not Programmable Via HP-IB

Function	Description
Control Function Selection (Special Function 4)	Normal Talker and Listener Enable External LO Control Talk Only
HP-IB Addresses (Special Function 40.0)	Display and Enter Noise Figure Meter Address
LINE Switch	Turns instrument ON and OFF.

**HP-IB****Receiving the Data Message (cont'd)**

3-8 provides an HP-IB code to parameter summary. Table 3-9 provides a special function to HP-IB code summary. Table 3-10 provides a front panel key to HP-IB code summary. All front panel keys except LOCAL have corresponding program codes. Some functions have an additional code which terminates the numeric data entry in Hz rather than MHz as indicated on the front panel. Where more than one code is given for a function, either code will serve equally. However, the mnemonic code given is recommended since it is shorter and more closely represents the function selected. Also, the mnemonic code will make deciphering program code strings easier. The first codes given are the codes used in all programming examples in this manual.

The Noise Figure Meter's response to the ASCII character set is as follows:

- a. The ASCII characters used for the program codes are the alphabet (A through Z, except O), the numbers 0 through 9, the period (.), and the minus (-).
- b. Lower case letters are treated the same as upper case letters.
- c. The letter O is treated the same as the number 0.
- d. All other characters are ignored (however, they can not be used as the second character of a two-character HP-IB program code). If any of these other characters are used as a second character or if an undefined combination of valid characters is sent, SRQ is set if the HP-IB error condition has been enabled.

**Turning Off Functions.** When operating in local mode, CALIBRATE, and SINGLE and AUTO Sweep toggle on and off with successive keystrokes. In remote mode, these functions do not toggle on and off. Instead, both require that the HP-IB code W0 be used to turn off the function.

**Programming Numeric Data.** When programming tuned frequency or issuing any numeric data

(other than specific HP-IB codes) to the Noise Figure Meter, certain precautions should be observed. Numeric data may consist of up to five digits, one decimal point, and a one-digit signed exponent.

**Triggering Measurements with the Data Message.** A feature that is available from both the front panel and via remote programming is the selection of free run, standby, or triggered operation of the Noise Figure Meter. The HP-IB codes and related Special Functions are discussed in detail in the Trigger Selection Detailed Operating Instruction later in this section.

**3-20. Sending The Data Message**

Depending on how the control functions are set, the Noise Figure Meter can either talk only, control an external LO, or talk and listen both (normal operation). If set to both talk and listen, the instrument sends Data messages when addressed to talk. The instrument then remains configured to talk until it is unaddressed to talk by the controller. To unaddress the Noise Figure Meter, the controller must send either an Abort message, a new talk address, or a universal untalk command.

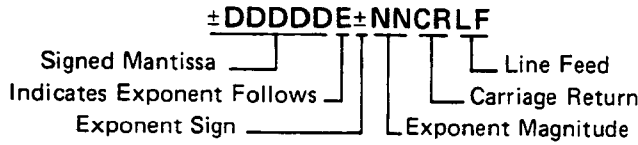
**Talk Only Mode.** If the Noise Figure Meter's Talk address is valid and Special Function 4.2 is selected, the Noise Figure Meter is placed in the Talk Only mode. In this mode the instrument is configured to send Data messages whenever the bus is in the data mode. Each time the measurement is completed, the measurement result will be output to the bus unless the listening device is not ready for data. If the listener is not ready for data, another measurement cycle is executed.

**Data Output Format.** As shown below, the output data is always formatted as a real constant: first the sign, then five digits (leading zeros not suppressed) followed by the letter E and a signed power-of-ten multiplier. The string is terminated by a carriage return (CR) and a line feed (LF), string positions 11 and 12. Data is always output in fundamental units (that is Hz, dB, etc.), and the decimal point (not sent) is assumed to be to the right of the fifth digit of the mantissa. Data values never exceed  $1 \times 10^5$ . The one exception to this format is the voltmeter mode as shown in Table 3-5, HP-IB Data Output Summary.

The general data output format is as follows:



**Sending the Data Message (cont'd)**



A summary of the different data outputs is listed in Table 3-5.

**Table 3-5. HP-IB Data Output Summary**

Front Panel Display <sup>1</sup>	HP-IB Output Format	Conditions
Left Display	+ D D D D D E + 0 6	Frequency
	± D D D D D E ± N N	Data other than frequency
INSERTION GAIN <sup>2</sup>	+ 9 0 0 0 0 E + 0 6	Display is blank
	± D D D D D E ± N N	Gain is displayed
NOISE FIGURE <sup>2</sup>	+ 9 0 0 0 0 E + 0 6	Display is blank
	± D D D D D E ± N N	Normal display
	+ D D D D D E - 0 5	Voltmeter mode
	+ 9 0 0 D D E + 0 6	Error codes where DD is the error code)
	+ 9 0 0 0 0 E + 0 6	Data not ready. Sent when the instrument receives a read command while "----" is displayed in Trigger Hold mode. Also sent when display is blank.

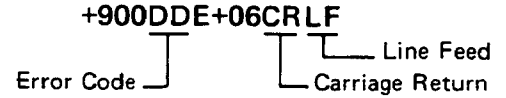
<sup>1</sup>The HP-IB data output for mode H0 is NOISE FIGURE CR/LF. The HP-IB data output for mode H1 is Left Display, INSERTION GAIN, NOISE FIGURE CR/LF. EOI is set each time LF is sent.

<sup>2</sup>The HP-IB output has one more digit of resolution than the front panel display (except for the voltmeter mode which has two more digits of resolution than the front panel NOISE FIGURE display).

When an error is output to the bus, it follows the same 12-byte format described above except most of the numeric digits have predetermined values as shown below. Error outputs always exceed 90 000 000 000. The two-digit error code is represented by the last two digits of the five-digit mantissa. The error code can be derived from the

string by subtracting 9 x 10<sup>10</sup>, then dividing the result by 1 000 000.

**Error Output Format:**



**3-21. Receiving the Clear Message**

The Noise Figure Meter responds to the Clear message by assuming the settings detailed in Table 3-6. The Noise Figure Meter responds equally to the Selected Device Clear (SDC) bus command when addressed to listen, and the Device Clear (DCL) bus command whether addressed or not. The Clear message clears any pending Require Service message and resets the Service Request Condition (Special Function 44) such that the Require Service message will be issued on HP-IB code errors only (Special Function 44.3).

Refer to Table 3-14 in the Special Functions Detailed Operating Instruction for a list of the Special Functions that are turned off or not affected by the Clear Message.

**3-22. Receiving the Trigger Message**

When in remote and addressed to listen, the Noise Figure Meter responds to a Trigger message by executing one measurement cycle. The Noise Figure Meter responds equally to a Trigger message (the Group Execute Trigger bus command |GET|) and a Data message, program code T2 (execute a measurement).

**3-23. Receiving the Remote Message**

The Remote message has two parts. First, the remote enable bus control line (REN) is held true; second, the device listen address is sent by the controller. These two actions combine to place the Noise Figure Meter in remote mode. Thus, the Noise Figure Meter is enabled to go into remote when the controller begins the Remote message, but it does not actually switch to remote until addressed to listen the first time. No instrument settings are changed by the transition from local to remote. When actually in remote, the Noise Figure Meter's front panel REMOTE annunciator lights. When the Noise Figure Meter is being addressed (whether in remote or local), its front panel LISTEN or TALK annunciator turns on.





Table 3-6. Response to a Clear Message (or Pressing PRESET)

Parameter	Condition
START FREQ	10 MHz
STOP FREQ	1500 MHz
STEP SIZE	20 MHz
SWEEP	Off
FREQUENCY	30 MHz
FREQ INCR	20 MHz
SMOOTHING	1
CALIBRATE	Off
MEASUREMENT	UNCORRECTED NOISE FIGURE
SPECIAL FUNCTION	<p><b>NOTE</b></p> <p><i>Most Special Functions are set to their zero suffix state (for example, Measurement Mode Selection is set to 1.0). Some are turned off (for example, Power Measurements). The following four Special Functions are not affected by either the Clear message or by pressing PRESET.</i></p> <ul style="list-style-type: none"> <li><i>a. Control Function Selection (Special Function 4).</i></li> <li><i>b. HP-B Addresses (Special Function 40).</i></li> <li><i>c. External LO Programs (Special Function 41).</i></li> <li><i>d. External LO Commands (Special Function 42).</i></li> </ul> <p><i>In addition, Service Request (Special Function 44) is set to enable HP-IB Code Error (Special Function 44.3).</i></p> <p>The following Special Functions are set to the indicated default values:</p>
IF (Special Function 3.0)	30 MHz
LO Frequency (Special Function 3.1)	10000 MHz
Smoothing Factor (Special Function 13.2)	1
Spot ENR (Special Function 5.3)	15.2 dB
T <sub>hot</sub> (Special Function 5.4)	9893K
T <sub>cold</sub> (Special Function 6)	296.5K
Oscilloscope Limits (Special Function 8)	
Noise Figure Lower Limit	0
Noise Figure Upper Limit	8
Gain Lower Limit	0
Gain Upper Limit	40
Loss Compensation (Special Function 34)	
Before DUT	0 dB
Temperature of Losses	0K
After DUT	0 dB
Set Sequence (Special Function 35.2)	1 through 9

### 3-24. Receiving the Local Message

The Local message is the means by which the controller sends the Go To Local (GTL) bus command. If addressed to listen, the Noise Figure Meter returns to front panel control when it receives the Local message. If the instrument was in local lockout when the Local message was received, front panel control is returned, but lockout is not cleared. Unless it receives the Clear Lockout/Set Local message, the Noise Figure Meter will return to local lockout the next time it goes to remote. No instrument settings are changed by the transition from remote to local.

When the Noise Figure Meter goes to local mode, the front panel REMOTE annunciator turns off. However, when the Noise Figure Meter is being addressed (whether in remote or local), its front panel LISTEN or TALK annunciator lights.

If the Noise Figure Meter is not in local lockout mode, pressing the front panel LOCAL key might interrupt a Data message being sent to the instrument, leaving the instrument in a state unknown to the controller. This can be prevented by disabling the Noise Figure Meter's front panel keys entirely, using the Local Lockout message.

### 3-25. Receiving the Local Lockout Message

The Local Lockout message is the means by which the controller sends the Local Lockout (LLO) bus command. If in remote, the Noise Figure Meter responds to the Local Lockout Message by disabling the front panel LOCAL key. The local lockout mode prevents loss of data or system control due to someone accidentally pressing front panel keys. If, while in local, the Noise Figure Meter is enabled to remote (that is, REN is set true) and it receives the Local Lockout message, it will switch to remote mode with local lockout the first time it is addressed to listen. When in local lockout, the Noise Figure Meter can be returned to local only by the controller (using the Local or Clear Lockout/Set Local messages) or by setting the LINE switch to OFF and back to ON or by removing the bus cable.

### 3-26. Receiving the Clear Lockout/Set Local Message

The Clear Lockout/Set Local message is the means by which the controller sets the Remote Enable (REN) bus control line false. The Noise Figure Meter returns to local mode (full front panel control) when it receives the Clear Lockout/Set Local

message. No instrument settings are changed by the transition from remote with local lockout to local. When the Noise Figure Meter goes to local mode, the front panel REMOTE annunciator turns off.

### 3-27. Receiving the Pass Control Message

The Noise Figure Meter does not respond to the Pass Control message because it does not have this control capability.

### 3-28. Sending the Require Service Message

The Noise Figure Meter sends the Require Service message by setting the Service Request (SRQ) bus control line true. The instrument can send the Require Service message in either local or remote mode. The Require Service message is cleared when a serial poll is executed by the controller or if a Clear message is received by the Noise Figure Meter. (During serial poll, the Require Service message is cleared immediately before the Noise Figure Meter places the Status Byte message on the bus.) There are four conditions that can be enabled to cause the Require Service message to be sent when they occur. All four conditions are described below.

1. Data Ready: When the Noise Figure Meter is ready to send any information except error codes.
2. HP-IB Code Error: When the Noise Figure Meter receives an invalid Data message. (Unless specifically disabled, this condition causes a Require Service message to be sent.)
3. Instrument Error: When any operator error (E10 through E49, and E99) is displayed by the Noise Figure Meter.
4. Calibration Complete: When a calibration cycle is complete.

### 3-29. Enabling the Service Request Condition

Use Special Function 44 (or the related Service Request Condition HP-IB codes) to enable the Noise Figure Meter to issue the Require Service message on any of the conditions above. The Service Request Condition Special Function is entered from either the front panel or via the HP-IB. A description of the Service Request Condition Special Function and the procedure for enabling the various conditions are given on the following page:



**Enabling the Service Request Condition (cont'd)**

**NOTE**

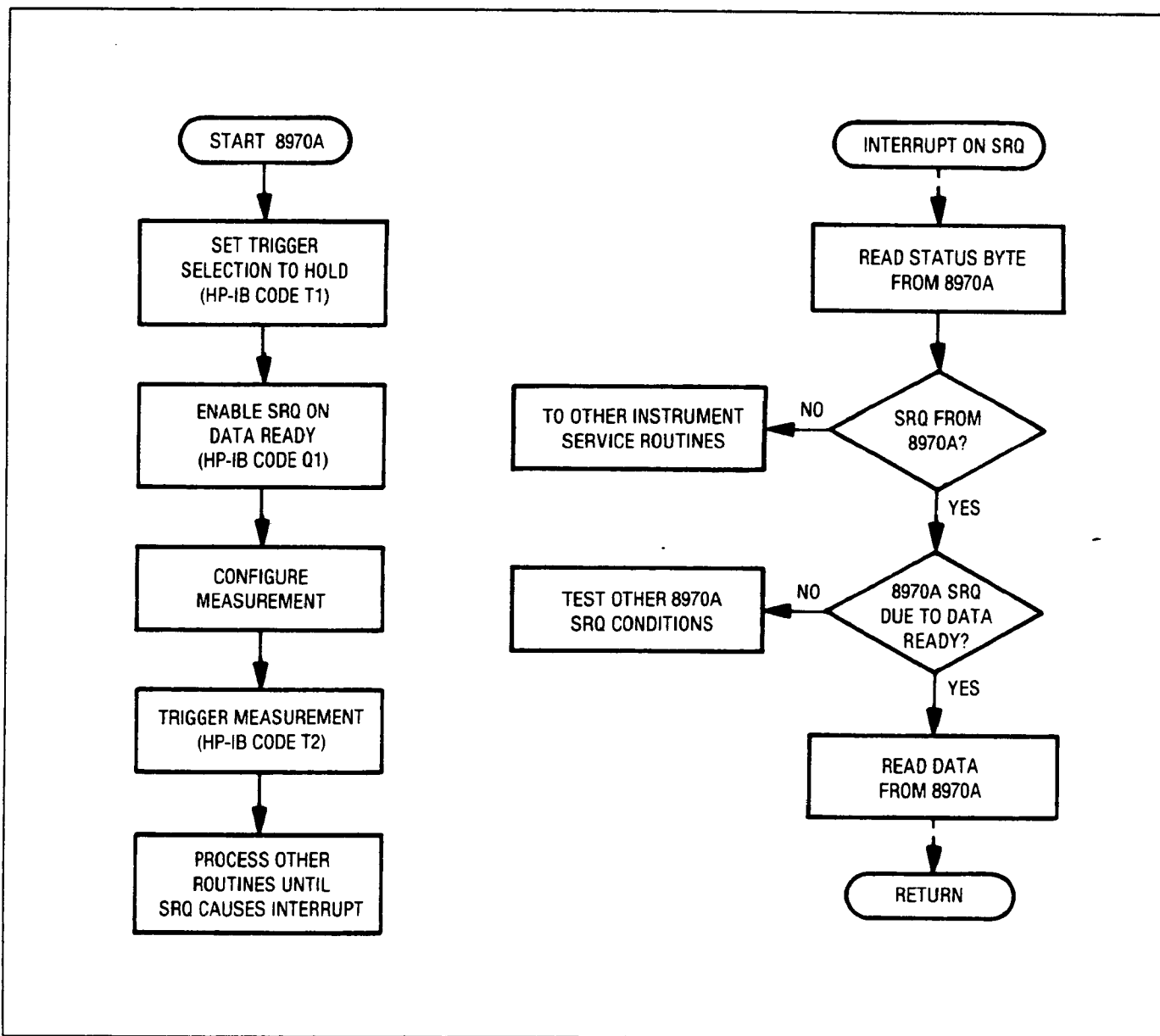
*Each condition must be enabled separately. If the enabled conditions are changed, it is a good practice to first disable the SRQ capability and then enter the required enabled conditions.*

a. Send the HP-IB Code Q0 to clear all enabled conditions.

b. Send the applicable HP-IB Codes from Table 3-7 to establish the required enabled conditions.

**Table 3-7. Service Request Enabled Conditions Summary**

HP-IB Code	Special Function	Description
Q0	44.0	Disables the SRQ capability (clears all enabled conditions)
Q1	44.1	Enable Data Ready
Q2	44.2	Enable RF Calibration Complete (not for Zero Frequency or IF Calibration)
Q3	44.3	Enable HP-IB Code Error
Q6	44.6	Enable Instrument Error



**Figure 3.10 Example Flow Chart for Driving the Noise Figure Meter Using the Require Service Message (SRQ)**

### Enabling the Service Request Condition (cont'd)

Normally, device subroutines for the Noise Figure Meter can be implemented simply by triggering measurements and then reading the output data. In certain applications, the controller must perform other tasks while controlling the Noise Figure Meter. Figure 3-10 illustrates a flow chart for developing device subroutines using the instrument's ability to issue the Require Service message when data is ready. This subroutine structure frees the controller to process other routines until the Noise Figure Meter is ready with data.

#### 3-30. Sending the Status Byte Message

The Status Byte message consists of one 8-bit byte in which 4 of the bits are set according to the enabled conditions described above under Sending the Require Service Message. If one or more of the four conditions are enabled and present, all the bits corresponding to the conditions and also bit 7, the RQS bit, will be set true (and the Require Service message is sent). If one of the above conditions occurs but has not been enabled by Special Function 44 or the HP-IB codes, neither the bit corresponding to the condition nor the RQS bit will be set (and the Require Service message will not be sent). The bit pattern of the Status Byte is shown in the HP-IB Syntax and Characteristics Summary.

Once the Noise Figure Meter receives the Serial Poll Enable bus command (SPE), it is no longer allowed to clear the Status Byte. However, it can

add additional bits to the status byte if the bit has been enabled and the condition occurs. When addressed to talk (following SPE), the Noise Figure Meter sends the Status Byte message.

After the Status Byte message has been sent it will be cleared if the Serial Poll Disable (SPD) bus command is received, if the Abort message is received, or if the Noise Figure Meter is unaddressed to talk. Nonvolatile error messages are also cleared when the Status Byte message is sent. Thus, some error messages which may have caused the Require Service Message to be issued disappear when a serial poll is performed. Refer to the Error Messages and Recovery Detailed Operating Instruction for a listing of volatile and nonvolatile errors. Regardless of whether or not the Status Byte message has been sent, the Status Byte and any Require Service message pending will be cleared if a Clear message is received.

#### 3-31. Sending the Status Bit Message

The Noise Figure Meter does not respond to a Parallel Poll Enable (PPE) bus command and thus cannot send the Status Bit message.

#### 3-32. Receiving the Abort Message

The Abort message is the means by which the controller sets the Interface Clear (IFC) bus control line true. When the Abort message is received, the Noise Figure Meter becomes unaddressed and stops talking or listening.

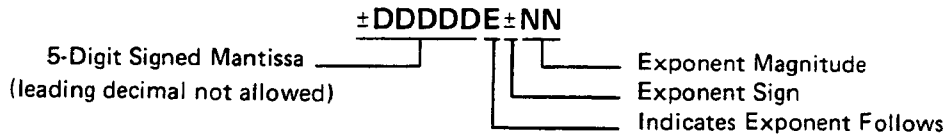


**HP-IB SYNTAX AND CHARACTERISTICS SUMMARY**

**Address:**

Selected and displayed on front panel using Special Function 44.0, Noise Figure Meter HP-IB Address.  
Factory set to 8 decimal.

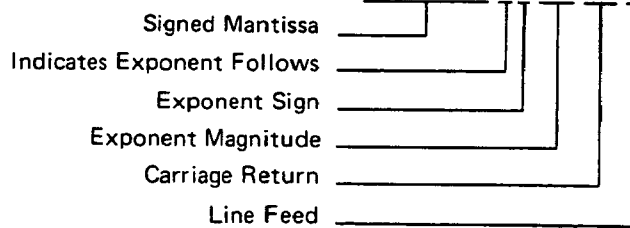
**Numeric Data Input Format: (Except in Voltmeter mode).\***



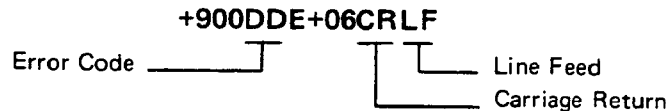
**Output Formats: (Except in Voltmeter mode).\***

HP-IB code H0 (43.0 SP):  $\pm DDDDE \pm NNCR LF$

HP-IB code H1 (43.1 SP):  $\pm DDDDE \pm NN, \pm DDDDE \pm NN, \pm DDDDE \pm NNCR LF$



**Errors:**



Reserved Number (used for the “— — —” special display or a blank display):

$+90000E+06CRLF$

**Return to Local:**

Front panel LOCAL key if not locked out.

**Status Byte:**

Bit	8	7	6	5	4	3	2	1
Weight	128	64	32	16	8	4	2	1
Service Request Condition	0 (always)	RQS Bit Require Service	Instrument Error	0 (always)	0 (always)	HP-IB Code Error	Calibration Complete	Data Ready

- Notes:
1. The condition indicated in bits 1, 2, 3 and 6 must be enabled to cause a Service Request by Special Function 44. Each condition must be enabled separately.
  2. The RQS bit (bit 7) is set true whenever any of the conditions of bits 1, 2, 3 or 6 are enabled and occur.

**Complete HP-IB Capability** (as described in IEEE Std 488-1978, and ANSI Std MC1.1):  
SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C1, C3, C28, E1..

\*For information on the Voltmeter mode refer to Section VIII. Service



Table 3-8. Noise Figure Meter HP-IB Code to Parameter Summary (1 of 2)

Program Code	Parameter	Program Code	Parameter
AC	External LO Auxiliary Commands	F7	Smoothing Factor = 128
AF	Enable Smoothing Factor	F8	Smoothing Factor = 256
A0	Output to Oscilloscope	F9	Smoothing Factor = 512
A1	Noise Figure and Gain	GL	Gain Lower Limit (for Oscilloscope)
A2	Test Pattern	GU	Gain Upper Limit (for Oscilloscope)
A3	Noise Figure Only		Special Function Catalog
A4	Gain Only	G0	Scan Catalog Lines
A5	Plot Noise Figure (for X-Y Recorder)	G1	Line 1 Status
A6	Plot Gain (for X-Y Recorder)	G2	Line 2 Status
B0	X Axis is Noise Figure and Y Axis is Gain (Strip Chart Mode)	G3	Line 3 Status
B1	Double Sideband	G4	Line 4 Status
B2	Lower Single Sideband	G5	Line 5 Status
B3	Upper Single Sideband	G6	Line 6 Status
CA	CALIBRATE	HZ	Hz
CC	Cold Calibration (Manual Measurement)	H0	HP-IB Data Output
CH	Hot Calibration (Manual Measurement)	H1	NOISE FIGURE Display Only
CS	Initialize Special Functions		Left, INSERTION GAIN, and NOISE FIGURE Displays
C0	Input Gain Calibration	IC	Calibrate IF Attenuators
C1	+20, +10, and 0 dB	IF	IF (for Modes 1.1 and 1.3)
C2	+10, 0, and -10 dB	IH	IF Attenuator Hold
C3	0, -10, and -20	IN	INCREASE Smoothing
DB	-10, -20, and -30 dB		IF Attenuation Selection
DE	dB	I0	Auto
DN	DECREASE Smoothing	I1	0 dB
D0	↓ (Step down)	I2	5 dB
D1	Noise Source Temperature Units for Data Input	I3	10 dB
D2	K	I4	15 dB
D3	°C	I5	20 dB
D4	°F	I6	25 dB
EA	Display and Enter Ext LO HP-IB Address	I7	30 dB
EN	ENTER	I8	35 dB
E0	Measurement Modes	J0	External LO Programs
E1	Mode 1.0	J2	HP 8350B Sweep Oscillator
E2	Mode 1.1	J3	HP 8672A Syn. Signal Generator
E3	Mode 1.2	LA	HP 8673B Syn. Signal Generator
E4	Mode 1.3	LB	Loss Compensation before DUT
E5	Mode 1.4	LF	Loss Compensation after DUT
FA	START FREQ	LL	LO Frequency (for Modes 1.2 and 1.4)
FB	STOP FREQ	LT	Go to Lower Left (for X-Y Recorder)
FN	FREQ INCR	L0	Temperature of Losses
FN	FREQUENCY	L1	Loss Compensation Off
F0	Smoothing Factor = 1	MC	Loss Compensation On
F1	Smoothing Factor = 2	MH	Cold Manual Measurement
F2	Smoothing Factor = 4	MN	Hot Manual Measurement
F3	Smoothing Factor = 8	MX	External LO Minimum Frequency in MHz
F4	Smoothing Factor = 16	MZ	External LO Maximum Frequency in MHz
F5	Smoothing Factor = 32	M1	MHz
F6	Smoothing Factor = 64	M2	UNCORRECTED NOISE FIGURE
			CORRECTED NOISE FIGURE AND GAIN



Table 3-8. Noise Figure Meter HP-IB Code to Parameter Summary (2 of 2)

Program Code	Parameter	Program Code	Parameter
NE	Enter and Use ENR	SE	Display Current ENR
NL	Noise Figure Lower Limit (for Oscilloscope)	SI	Display IF Attenuator Setting
NR	Enter ENR Table	SN	Enter Noise Source Identifier
NU	Noise Figure Upper Limit (for Oscilloscope)	SP	SPECIAL FUNCTION
	Noise Figure Display Units	SQ	SEQ
N0	F dB	SR	Display RF Attenuator Setting
N1	F	SS	STEP SIZE
N2	Y dB	ST	STORE
N3	Y	S0	Use ENR Table
N4	Te K	S1	Use Spot ENR
	Power Measurements	TC	T <sub>cold</sub>
N5	SOURCE Off (Uncal)	TH	T <sub>hot</sub>
N6	SOURCE On (Uncal)	TM	External LO Settling Time
N7	SOURCE Off (Cal)		Trigger Selection
N8	SOURCE On (Cal)	T0	Free Run
PR	PRESET	T1	Hold
PS	External LO CW Prefix and Suffix	T2	Execute
P0	Normal Display (to return from displaying manual measurement results)	UP	↑ (Step up)
P1	Display Manual Measurement Results	UR	Go to Upper Right (for X-Y Recorder)
	Sequence Functions	V0	Exponential Smoothing
QA	Automatic	V1	Arithmetic Smoothing
QC	Clear	W0	Sweep off
QM	Manual	W1	AUTO Sweep
QS	Set	W2	SINGLE Sweep
	Service Request		Display Resolution
Q0	Disable SRQ Capability	X0	Maximum Resolution
Q1	Enable Data Ready to Cause SRQ	X1	Less Resolution on Noise Figure
Q2	Enable Cal Complete to Cause SRQ	X2	Less Resolution on Gain
Q3	Enable HP-IB Code Error to Cause SRQ	Y0	Frequency Calibration
Q6	Enable Instrument Error to cause SRQ	Y1	Automatic
RC	RECALL	Y2	Disable Frequency Cal
RH	RF Attenuator Hold		Perform 1 Frequency Cal
	RF Attenuation Selection		Individual RF Attenuator Selection
R0	Auto	Z0	Select RF Thru Path
R1	+20 dB	Z1	Select 10 dB Pad No. 1
R2	+10 dB	Z2	Select 20 dB Input Amplifier
R3	0 dB	Z4	Select 10 dB Pad No. 2
R4	-10 dB	Z5	Select 10 dB Pad No. 3
R5	-20 dB		
R6	-30 dB		

Table 3-9. Special Function to HP-IB Code (1 of 5)

Special Function		HP-IB Code	Description
Name	Code*	HP-IB	
Initialize Special Functions	0.0	CS	Initializes many Special Functions
Measurement Mode Selection	1.0	E0	Mode 1.0 (10—1500 MHz measurement)
	1.1	E1	Mode 1.1 (fixed IF; variable freq. ext LO)
	1.2	E2	Mode 1.2 (variable IF; fixed freq. ext LO; SSB)
	1.3	E3	Mode 1.3 (fixed IF; variable freq. ext LO; mixer is DUT)
	1.4	E4	Mode 1.4 (variable IF; fixed freq. ext LO; mixer is DUT)
Sideband Frequency Offset	2.0	B0	Double Sideband (no offset)
	2.1	B1	Lower Single Sideband ( $F_{\text{signal}} < F_{\text{LO}}$ )
	2.2	B2	Upper Single Sideband ( $F_{\text{signal}} > F_{\text{LO}}$ )
Enter IF and LO Frequencies	3.0	IF	IF (for Modes 1.1 and 1.3)
	3.1	LF	LO (for Modes 1.2 and 1.4)
Control Function Selection	4.0	none	Normal Talker and Listener
	4.1	none	Enable Ext LO Control
	4.2	none	Talk Only
ENR and $T_{\text{hot}}$ Settings	5.0	S0	Use ENR Table
	5.1	S1	Use Spot ENR
	5.2	SE	Display Current ENR in dB
	5.3	NE	Enter and Use Spot ENR
	5.4	TH	Enter and Use $T_{\text{hot}}$
	5.5	SN	Enter Noise Source Identifier
$T_{\text{cold}}$ Setting	6.0	TC	Enter $T_{\text{cold}}$
Output to Oscilloscope	7.0	A0	Noise Figure and Gain
	7.1	A1	Test Pattern
	7.2	A2	Noise Figure Only
	7.3	A3	Gain Only
Enter Oscilloscope Limits	8.1	NL	Noise Figure Lower Limit
	8.2	NU	Noise Figure Upper Limit
	8.3	GL	Gain Lower Limit
	8.4	GU	Gain Upper Limit

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.





Table 3-9. Special Function to HP-IB Code (2 of 5)

Special Function		HP-IB Code	Description
Name	Code*	HP-IB	
Power Measurements	9.1	N5	SOURCE Off (uncal)
	9.2	N6	SOURCE On (uncal)
	9.3	N7	SOURCE Off (cal)
	9.4	N8	SOURCE On (cal)
Noise Figure Display Units	10.0	N0	F dB
	10.1	N1	F
	10.2	N2	Y dB
	10.3	N3	Y
	10.4	N4	Te K
Select Noise Source Temperature Units for Data Input	11.0	D0	K
	11.1	D1	°C
	11.2	D2	°F
Display Resolution	12.0	X0	Maximum Resolution
	12.1	X1	Less Resolution on Noise Figure
	12.2	X2	Less Resolution on Gain
Smoothing (Averaging)	13.0	V0	Exponential Smoothing
	13.1	V1	Arithmetic Smoothing
	13.2	AF	Smoothing Factor
Manual Measurement Functions	14.1	MC	Cold Measurement (SOURCE-off)
	14.2	MH	Hot Measurement (SOURCE-on)
	14.3	CC	Cold Calibration (SOURCE-off)
	14.4	CH	Hot Calibration (SOURCE-on)
	15.0	P0	Display Current Measurement
	15.1	P1	Display Manual Measurement Results
Recorder Functions	20.0	LL	Go to Lower Left
	21.0	UR	Go to Upper Right
	22.0	A4	Plot Noise Figure
	23.0	A5	Plot Gain
	24.0	A6	X-AXIS Output is Noise Figure and Y-AXIS Output is Gain (Strip Chart mode)

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.

Table 3-9. Special Function to HP-IB Code (3 of 5)

Special Function		HP-IB Code	Description
Name	Code*	HP-IB	
Trigger Selection	30.0	T0	Free Run
	30.1	T1	Hold
	30.2	T2	Execute
Frequency Calibration	31.0	Y0	Automatic
	31.1	Y1	Disable Frequency Cal
	31.2	Y2	Perform 1 Frequency Cal
Input Gain Calibration	32.0	C0	+20, +10 and 0 dB
	32.1	C1	+10, 0 and -10 dB
	32.2	C2	0, -10 and -20 dB
	32.3	C3	-10, -20 and -30 dB
IF Attenuators Calibration	33.0	IC	Calibrate IF Attenuators
Loss Compensation	34.0	L0	Off
	34.1	L1	On
	34.2	LA	Enter Loss before DUT in dB
	34.3	LT	Enter Temperature of Losses
	34.4	LB	Enter Loss after DUT in dB
Sequence Functions	35.0	QM	Manual
	35.1	QA	Automatic
	35.2	QS	Set
	35.3	QC	Clear
HP-IB Addresses	40.0	none	Display and Enter 8970A Address
	40.1	EA	Display and Enter Ext LO Address
External LO Programs	41.0	J0	HP 8350B Sweep Oscillator
	41.2	J2	HP 8672A Syn. Signal Generator
	41.3	J3	HP 8673B Syn. Signal Generator
External LO Commands	42.0	AC	Auxiliary Commands
	42.1	PS	CW Prefix and Suffix
	42.2	TM	Settling Time in ms
	42.3	MN	Minimum Frequency in MHz
	42.4	MX	Maximum Frequency in MHz
HP-IB Data Output Selection	43.0	H0	NOISE FIGURE Only
	43.1	H1	Frequency (left display), INSERTION GAIN, NOISE FIGURE

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.



Table 3-9. Special Function to HP-IB Code (4 of 5)

Special Function		HP-IB Code	Description
Name	Code*	HP-IB	
Service Request	44.0	Q0	Disable SRQ Capability (clears all enabled conditions)
	44.1	Q1	Enable Data Ready to cause an SRQ
	44.2	Q2	Enable Cal Complete to cause an SRQ
	44.3	Q3	Enable HP-IE Code Error to cause an SRQ
	44.6	Q6	Enable Instrument Error to cause an SRQ
	Special Function Catalog	50.0	G0
50.1		G1	Line 1 Status
50.2		G2	Line 2 Status
50.3		G3	Line 3 Status
50.4		G4	Line 4 Status
50.5		G5	Line 5 Status
50.6		G6	Line 6 Status
RF Attenuation Selection	60.0	R0	Auto
	60.1	R1	+20 dB
	60.2	R2	+10 dB
	60.3	R3	0 dB
	60.4	R4	-10 dB
	60.5	R5	-20 dB
	60.6	R6	-30 dB
Display RF Attenuator Settings	61.0	SR	Display RF Attenuators
RF Attenuator Hold	62.0	RH	RF Attenuators are held in the configuration that exists when Special Function 62.0 is activated.
Individual RF Attenuator Selection	63.0	Z0	Select RF Thru Path
	63.1	Z1	Select 10 dB Pad No. 1
	63.2	Z2	Select 20 dB Input Amplifier
	63.4	Z4	Select 10 dB Pad No. 2
	63.5	Z5	Select 10 dB Pad No. 3
IF Attenuation Selection	70.0	I0	Auto
	70.1	I1	0 dB
	70.2	I2	5 dB
	70.3	I3	10 dB

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.

Table 3-9. Special Function to HP-IB Code (5 of 5)

Special Function		HP-IB Code HP-IB	Description
Name	Code*		
IF Attenuation Selection (cont'd)	70.4	I4	15 dB
	70.5	I5	20 dB
	70.6	I6	25 dB
	70.7	I7	30 dB
	70.8	I8	35 dB
Display IF Attenuator Settings	71.0	SI	Display IF Attenuators
IF Attenuator Hold	72.0	IH	IF Attenuators are held in the configuration that exists when Special Function 72.0 is activated.

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.

Table 3-10. Front Panel Keys to HP-IB Code Summary

Front Panel Key	HP-IB Code	Front Panel Key	HP-IB Code
AUTO	W1	PRESET	PR
CALIBRATE	CA	RECALL	RC
DECREASE	DE	SEQ	SQ
ENR	NR	SINGLE	W2
ENTER	EN	SPECIAL FUNCTION	SP
FREQ INCR	FN	START FREQ	FA
↓	DN	STEP SIZE	SS
↑	UP	STOP FREQ	FB
FREQUENCY	FR	STORE	ST
INCREASE	IN	Sweep and Calibrate Off (must be used to turn these functions off over the HP-IB)	W0
NOISE FIGURE (UNCORRECTED)	M1		
NOISE FIGURE AND GAIN (CORRECTED)	M2		

Table 3-11. Commonly Used Code Conversions

ASCII	Binary	Octal	Decimal	Hexa- decimal
NUL	00 000 000	000	0	00
SOH	00 000 001	001	1	01
STX	00 000 010	002	2	02
ETX	00 000 011	003	3	03
EOT	00 000 100	004	4	04
ENQ	00 000 101	005	5	05
ACK	00 000 110	006	6	06
BEL	00 000 111	007	7	07
BS	00 001 000	010	8	08
HT	00 001 001	011	9	09
LF	00 001 010	012	10	0A
VT	00 001 011	013	11	0B
FF	00 001 100	014	12	0C
CR	00 001 101	015	13	0D
SO	00 001 110	016	14	0E
SI	00 001 111	017	15	0F
DLE	00 010 000	020	16	10
DC1	00 010 001	021	17	11
DC2	00 010 010	022	18	12
DC3	00 010 011	023	19	13
DC4	00 010 100	024	20	14
NAK	00 010 101	025	21	15
SYN	00 010 110	026	22	16
ETB	00 010 111	027	23	17
CAN	00 011 000	030	24	18
EM	00 011 001	031	25	19
SUB	00 011 010	032	26	1A
ESC	00 011 011	033	27	1B
FS	00 011 100	034	28	1C
GS	00 011 101	035	29	1D
RS	00 011 110	036	30	1E
US	00 011 111	037	31	1F
SP	00 100 000	040	32	20
!	00 100 001	041	33	21
"	00 100 010	042	34	22
#	00 100 011	043	35	23
\$	00 100 100	044	36	24
%	00 100 101	045	37	25
&	00 100 110	046	38	26
'	00 100 111	047	39	27
(	00 101 000	050	40	28
)	00 101 001	051	41	29
*	00 101 010	052	42	2A
+	00 101 011	053	43	2B
,	00 101 100	054	44	2C
-	00 101 101	055	45	2D
.	00 101 110	056	46	2E
/	00 101 111	057	47	2F
0	00 110 000	060	48	30
1	00 110 001	061	49	31
2	00 110 010	062	50	32
3	00 110 011	063	51	33
4	00 110 100	064	52	34
5	00 110 101	065	53	35
6	00 110 110	066	54	36
7	00 110 111	067	55	37
8	00 111 000	070	56	38
9	00 111 001	071	57	39
:	00 111 010	072	58	3A
;	00 111 011	073	59	3B
<	00 111 100	074	60	3C
=	00 111 101	075	61	3D
>	00 111 110	076	62	3E
?	00 111 111	077	63	3F

ASCII	Binary	Octal	Decimal	Hexa- decimal
@	01 000 000	100	64	40
A	01 000 001	101	65	41
B	01 000 010	102	66	42
C	01 000 011	103	67	43
D	01 000 100	104	68	44
E	01 000 101	105	69	45
F	01 000 110	106	70	46
G	01 000 111	107	71	47
H	01 001 000	110	72	48
I	01 001 001	111	73	49
J	01 001 010	112	74	4A
K	01 001 011	113	75	4B
L	01 001 100	114	76	4C
M	01 001 101	115	77	4D
N	01 001 110	116	78	4E
O	01 001 111	117	79	4F
P	01 010 000	120	80	50
Q	01 010 001	121	81	51
R	01 010 010	122	82	52
S	01 010 011	123	83	53
T	01 010 100	124	84	54
U	01 010 101	125	85	55
V	01 010 110	126	86	56
W	01 010 111	127	87	57
X	01 011 000	130	88	58
Y	01 011 001	131	89	59
Z	01 011 010	132	90	5A
[	01 011 011	133	91	5B
\	01 011 100	134	92	5C
]	01 011 101	135	93	5D
^	01 011 110	136	94	5E
_	01 011 111	137	95	5F
`	01 100 000	140	96	60
a	01 100 001	141	97	61
b	01 100 010	142	98	62
c	01 100 011	143	99	63
d	01 100 100	144	100	64
e	01 100 101	145	101	65
f	01 100 110	146	102	66
g	01 100 111	147	103	67
h	01 101 000	150	104	68
i	01 101 001	151	105	69
j	01 101 010	152	106	6A
k	01 101 011	153	107	6B
l	01 101 100	154	108	6C
m	01 101 101	155	109	6D
n	01 101 110	156	110	6E
o	01 101 111	157	111	6F
p	01 110 000	160	112	70
q	01 110 001	161	113	71
r	01 110 010	162	114	72
s	01 110 011	163	115	73
t	01 110 100	164	116	74
u	01 110 101	165	117	75
v	01 110 110	166	118	76
w	01 110 111	167	119	77
x	01 111 000	170	120	78
y	01 111 001	171	121	79
z	01 111 010	172	122	7A
{	01 111 011	173	123	7B
:	01 111 100	174	124	7C
}	01 111 101	175	125	7D
~	01 111 110	176	126	7E
DEL	01 111 111	177	127	7F

# Calibrate

**Description**

Pressing the CALIBRATE key initiates a calibration of the instrument and any equipment that is currently connected to the INPUT. First a frequency calibration is performed and then the noise figure is measured at each selected calibration point. The calibration data obtained is used to measure gain and to perform the "second stage correction" computations needed to make a CORRECTED NOISE FIGURE AND GAIN measurement. The calibration points are the START FREQ setting, the STOP FREQ setting, and the frequency steps determined by the setting of STEP SIZE. Refer to the Sweep Detailed Operating Instruction for additional information on these keys. During calibration, each specified frequency in the selected range is calibrated at three input gain settings as selected by Special Function 32. The default gain settings are +20, +10 and 0 dB. The calibration data is interpolated between the measured points when it is used for a gain measurement and second stage correction. Therefore, it is not necessary to calibrate at every frequency that is to be measured. However, the data is not extrapolated. If a corrected measurement is attempted at a frequency less than the START FREQ setting or more than the STOP FREQ setting of the calibration run, error code E21 (Frequency Out of Calibrated Range) is displayed.

Specific calibration setups and procedures are contained in the Detailed Operating Instructions for Measurement Modes 1.0 through 1.4.

**Procedure**

To initiate a calibration sequence, press CALIBRATE. To terminate calibration before it is complete, press CALIBRATE again. The CALIBRATE key toggles the calibration function on and off. Pressing PRESET also terminates the calibration sequence.

Front Panel Key	Program Code ◀HP-IB▶	Stored in Continuous Memory	Can Be Stored and Recalled	Preset (and HP-IB Clear) Conditions
CALIBRATE	CA	N	N	Off
Table categories are described in the Preset Conditions and Power-Up Sequence Detailed Operating Instruction.				

**Example**

To initiate calibration at the existing SWEEP function settings:

LOCAL (keystrokes)	
◀HP-IB▶ (program codes)	CA

**Program Codes**

◀HP-IB▶

CA is the program code for the CALIBRATE key. The calibration sequence can not be toggled on and off over the HP-IB. Instead, successive CA codes cause the calibration to be restarted. To terminate calibration prior to completion, use the Sweep Stop command (W0).

**Indications**

The CALIBRATE LED lights and remains lit until the calibration is complete. During frequency calibration, the NOISE FIGURE display shows four dashes " — — — —".

## Calibrate (cont'd)

### Indications (cont'd)

During second stage calibration, the left display indicates each tuned frequency and the NOISE FIGURE display indicates the noise figure at that frequency. The frequency range and step size are controlled by the SWEEP keys.

When calibration is completed, the instrument resumes making the measurement that was active when CALIBRATE was pressed. However, if the instrument was sweeping (either in AUTO or SINGLE) it does not resume sweeping. Instead, it performs the previously selected measurement at the frequency it was tuned to when CALIBRATE was pressed.

### Comments

The maximum number of frequency points that can be calibrated is 81 (that is, approximately 19 MHz steps for the full frequency range of 10 MHz to 1500 MHz).

During calibration, all of the front panel keys except LOCAL, PRESET, and CALIBRATE are disabled.

If LOCAL is pressed during calibration, the instrument returns to local control (if it was in remote, and the Local Lockout command was not in effect). Calibration is not interrupted by the LOCAL command.

Pressing PRESET or CALIBRATE terminates the calibration function. However, PRESET also resets the entire instrument to a specified set of conditions (refer to the Preset Conditions and Power-Up Sequence Detailed Operating Instruction). If either of these keys are pressed during the frequency calibration portion of the sequence (that is, the NOISE FIGURE display is “ — — — — ”, calibration is not terminated. These commands cannot be used until the frequency calibration is completed.

The calibration data cannot be stored using the STORE key and it is not retained when the instrument is turned off. Therefore, it is necessary to calibrate the instrument each time power is turned on.

If smoothing (averaging) is used during calibration, the arithmetic averaging algorithm is used. Refer to the Smoothing (Averaging) Detailed Operating Instruction for a detailed discussion of the averaging techniques used by the instrument. Note that once calibration is initiated, the SMOOTHING keys are disabled and the averaging factor cannot be changed during the calibration sequence.

If an external controller is used to control both the Noise Figure Meter and the external LO, the calibration sequence must be stepped using the HP-IB command T2 after the LO has been moved to each new frequency. Once the HP-IB command for calibration (CA) is issued, the T2 mnemonic for trigger execute must be used. The Noise Figure Meter will ignore the alternate HP-IB code of 30.2SP. Refer to the Trigger Selection Detailed Operating Instruction for additional triggering information.

It is assumed that the triggered calibration is being performed as a part of the procedure in the Comments section of the Detailed Operating Instructions for Measurement Modes 1.1 and 1.3. Step d of both these procedures requires a triggered calibration sequence. Therefore, the preliminary steps such as selecting Special Function 4.0 will have already been performed. The following general conditions must be observed when using an external controller to perform a triggered calibration:

- a. Remove the device under test (DUT) from the measurement system.
- b. Set the Noise Figure Meter's calibrate function on (HP-IB code is CA).

## Calibrate (cont'd)

### Comments (cont'd)

c. Set the external LO to the appropriate frequency. Refer to the LO's operating manual for the required HP-IB codes. Allow sufficient settling time for the output of the external LO to stabilize.

d. Trigger a measurement using the HP-IB code T2. Do not use the alternate HP-IB code 30.2SP for it will be ignored.

e. To determine when to step to a new frequency, read the noise figure results. This read operation cannot be completed until the new data is ready. It is also possible to write an SRQ interrupt routine on the Data Ready status bit. Refer to Enabling the Service Request Condition, paragraph 3-29.

f. Continue to loop through steps c, d, and e. A method for determining when the calibration is complete must be programmed into the external controller. One method is to compare the frequency that is sent to the external LO with the stop frequency programmed into the Noise Figure Meter and terminate the program after the third measurement in which they are equal. It is also possible to write an SRQ interrupt routine on the Calibration Complete SRQ. Refer to Enabling the Service Request Condition, paragraph 3-29.

If any of the 60 or 70 series of Special Functions (except 60.0 and 70.0) are active, the calibration sequence does not override them. Therefore, to calibrate on one range only, use any of these Special Functions except 60.0 or 70.0. If any of these Special Functions are inadvertently left active the calibration sequence will not cover the expected gain range.

The calibration sequence always uses the 10 to 1500 MHz portion of the ENR table.

Any loss compensation entered by Special Function 34 is ignored during the calibration sequence.

### Related Sections

Calibration, Frequency

Calibration, Input Gain Selection

Measurement Modes 1.0 through 1.4

Noise Figure (Uncorrected) and Noise Figure and Gain (Corrected)

Sweep

Trigger Selection



# Calibration, Frequency

## (Special Function 31)

### Description

Frequency Calibration is performed to ensure the accuracy of the displayed tuned frequency. During frequency calibration, the instrument's first local oscillator (the YIG oscillator) is tuned to the first IF (2050 MHz). Since the first mixer is not perfectly balanced, some of the first local oscillator power is fed through to the first IF. This signal is mixed down to the third IF. It is then detected by a special narrow-band detector (approximately 100 kHz wide).

The YIG oscillator is then stepped through the narrow-band detectors's pass band using a special fine tune digital-to-analog converter (DAC). When the peak output is detected, the YIG oscillator is tuned to 2050 MHz (first IF). This IF corresponds to 0 MHz on the front-panel frequency display. The fine tune DAC is held at this value. This correction value is then used when the YIG oscillator is tuned in response to subsequent tuning changes.

Frequency calibration is initiated by the following:

- a. The LINE switch is pressed to apply power to the instrument.
- b. Either the PRESET or the CALIBRATE key is pressed.
- c. Special Function 31 is used to initiate and control frequency calibration.

Completion of Frequency Calibration does not set the CALIBRATION COMPLETE bit of the HP-IB status byte. That bit is used only for RF calibration.

Special Function 31 is defined as follows:

- a. 31.0—Selects the automatic frequency calibration mode. In addition to the initial frequency calibration described previously, a frequency calibration is automatically initiated 15 minutes after power on, 30 minutes later, 1 hour later, 2 hours later, and then every 2 hours until the instrument is turned off or a different 31 Special Function is entered. This mode is the default condition.
- b. 31.1—Disables the frequency calibration. In this mode, frequency calibration is still done if the PRESET or CALIBRATE keys are pressed. However, frequency calibration is not initiated periodically as described in 31.0.
- c. 31.2—Initiates a frequency calibration immediately. After that frequency calibration, the operation returns to the mode active when 31.2 was entered. If 31.1 was active, it remains active after the frequency calibration is done.

### Procedure

Frequency calibration is performed as a part of the PRESET and CALIBRATE functions. In addition, the frequency calibration can be performed or disabled by keying in the corresponding Special Function code and then pressing the SPECIAL FUNCTION key.

# Calibration Frequency (cont'd)

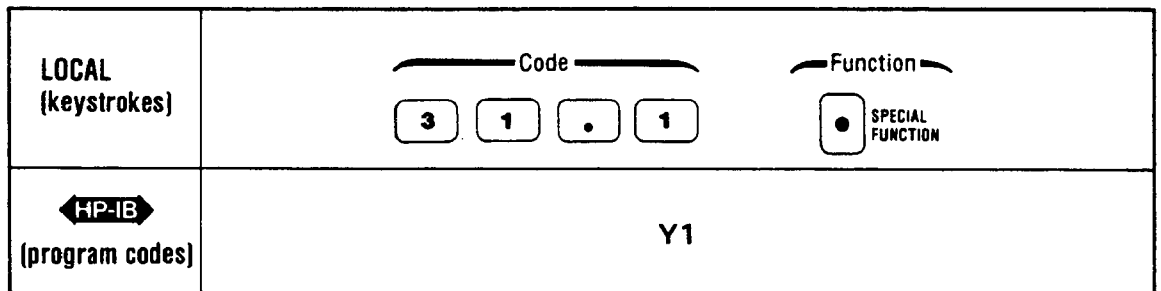
## (Special Function 31)

**Procedure  
(cont'd)**

Special Function		Program Code ↔HP-IB↔	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Automatic Frequency Calibration	31.0	Y0 or 31.0SP	N	N	N	On	On
Disable Frequency Calibration	31.1	Y1 or 31.1SP	N	N	N	Off	Off
Perform One Frequency Calibration	31.2	Y2 or 31.2SP	N	N	N	Off	Off

Table categories are explained in the Special Functions Detailed Operation Instruction.

**Example**      To select the Disable Frequency Calibration Mode:



**Program Codes**      For HP-IB codes, refer to Procedure above.



**Indications**      The INSERTION GAIN and NOISE FIGURE displays are not affected by 31.0 and 31.1. If 31.2 is entered, the Noise Figure Display shows “ — — — — ” until the frequency calibration is completed.

**Related Sections**      Calibrate  
 Preset Conditions and Power-Up Sequence  
 Special Functions

# Calibration, IF Attenuators

## (Special Function 33)

**Description**

Special Function 33 is used to calibrate the IF Attenuators. This calibration should be performed approximately every six months or if there are wide changes in the ambient temperature. The noise source **MUST** be connected to the instrument. The Noise Figure Meter turns on the noise source and uses its own internal noise power detector to measure each IF attenuator. This data is used to correct the gain readings during gain measurement. After the IF attenuation calibration is completed, this data is stored in the instrument's continuous memory and is retained when power is removed. Completion of IF calibration does not set the CALIBRATION COMPLETE bit of the HP-IB status byte.

**Procedure**

To calibrate the IF Attenuators, connect the noise source to the instrument's INPUT connector, enter 33.0, and then press SPECIAL FUNCTION.

Special Function		Program Code ↔ HP-IB ↔	Description	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Name	Code							
IF Attenuators Calibration	33.0	IC	Calibrate IF Attenuators	N	Y	N	Off	Off

Table categories are explained in the Special Functions Detailed Operating Instruction.

**Example**

LOCAL (keystrokes)	
↔ HP-IB ↔ (program codes)	IC

**Program Codes**



The HP-IB code for IF Attenuator Calibration is IC (or 33.0SP).

**Indications**

During calibration, the NOISE FIGURE display shows four dashes " — — — — ". IF Attenuator Calibration takes only a few seconds. If for any reason the IF Attenuator Calibration is not successfully completed, error E13 (IF Attenuator Calibration failed) is displayed.

**Comments**

Error code E26 is displayed if the IF Attenuator calibration data is not stored in the continuous memory. Error E26 always occurs after an error E80 (continuous memory failure). Therefore, an IF Attenuator calibration must always be performed after an error E80 has been cleared. Either an HP 346B or HP 346C Noise Source is needed for calibrating the IF attenuators. The HP 346A will work only with the addition of approximately 10 dB of gain between the Noise Source and the HP 8970A INPUT connector.

**Related Sections**

Error Messages and Recovery  
Special Functions

# Calibration, Input Gain Selection (Special Function 32)

**Description**

The gain setting for calibration can be selected using Special Function 32. Calibration is performed from the start frequency to the stop frequency in steps of the specified step size. At each frequency, calibration is done at the three most sensitive RF attenuator gain settings (that is, +20,+10, and 0 dB). These settings are the default value for Special Function 32. Three other sets of gain settings can be selected using the special functions shown below. Selection of the gain settings to be calibrated depends upon the specific application. Selecting a calibration gain setting does not initiate a calibration sequence.

**Procedure**

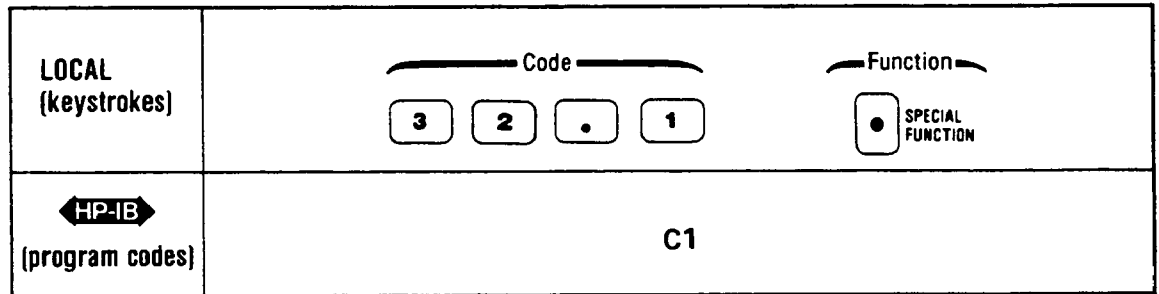
To select an alternate gain setting for calibration, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
+20, +10, and 0 dB	32.0	C0 or 32.0SP	N	N	N	On	On
+10, 0, and -10 dB	32.1	C1 or 32.1SP	Y	N	N	Off	Off
0, -10, and -20 dB	32.2	C2 or 32.2SP	Y	N	N	Off	Off
-10, -20, and -30 dB	32.3	C3 or 32.3SP	Y	N	N	Off	Off

Table categories are explained in the Special Function Detailed Operation Instruction.

**Example**

To select +10, 0 and -10 dB as the gain settings for calibration:



**Program Codes**



For HP-IB codes, refer to Procedure above.

**Comments**

The gain settings, other than the default values, are used primarily when the instrument is calibrated for use with a high gain device under test (DUT).

DUTs in the specified range of -20 to +40 dB can be measured using Special Function 32.0.

**Related Sections**

Calibrate  
Special Functions

# Controller Capability of the Noise Figure Meter (Special Function 4)

**Description** The Noise Figure Meter can be used as a limited controller for an external device. This capability is limited to acting as a controller for an external LO or operating in the Talk Only Mode (outputting data to a recording device). The Noise Figure Meter can also be controlled by an external controller when Special Function 4.0 is active. Only one of the three capabilities can be active at any one time.

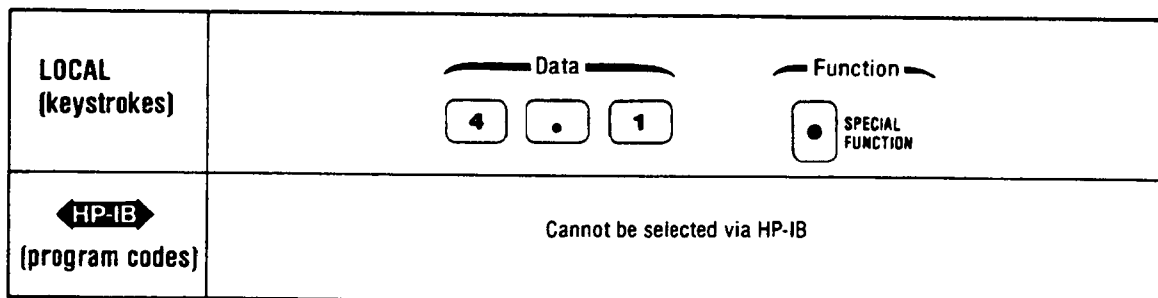
If the Controller Mode is selected, one of the stored programs described in the Programs Available To Control an External LO Detailed Operating Instruction can be selected. Stored programs are available for the HP 8350A Sweep Oscillator and the HP 8672A Synthesized Signal Generator. In addition to the stored programs, the capability to modify and generate programs for unspecified local oscillators is available. Refer to the Programming an External LO Detailed Operating Instruction for additional information.

**Procedure** To select an HP-IB control capability, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Normal Talker and Listener Mode	4.0	None	N	Y	N	NC	NC
Controller Mode (for External LO)	4.1	None	N	Y	N	NC	NC
Talk Only Mode	4.2	None	N	Y	N	NC	NC

Table categories are explained in the Special Functions Detailed Operation Instruction.

**Example** To select the Controller Mode (for an external LO).



**Indications** When Special Function 4.2 is active, the HP-IB TALK annunciator lights.

**Comments** In the Talk Only Mode, the instrument continuously outputs data to a recording device that is in the Listen Only Mode. The data output format and content is controlled by Special Function 43. Refer to the HP-IB portion of this section for additional information on this Special Function.

## Controller Capability of the Noise Figure Meter (cont'd)

### (Special Function 4)

**Comments  
(cont'd)**

In the Controller Mode, the instrument is used to control the frequency and level of the external local oscillator. Note that the instrument does not have full controller capability. For example, it cannot pass or receive control of the HP-IB. The instrument's controller capabilities are defined as C1, C3, and C28. These capabilities are explained in the HP-IB portion of this section.

An external controller cannot be used when Special Function 4.1 or 4.2 is active.

The active function of Special Function 4 is not affected by PRESET, Special Function 0.0, or the LINE switch.

**Related  
Sections**

Programming an External LO  
Programs Available to Control an External LO  
Special Functions

# Data Output to Oscilloscopes and Recorders

## (Special Functions 7, 8, and 20 through 24)

**Description** The Noise Figure Meter can output analog data to an oscilloscope, an X-Y recorder, or a strip chart recorder. However, only one of these devices can be used at a time. Since the setup procedures and operation are similar for all three devices, the operating information for all are covered in this operating instruction.

Normally it is simpler to perform a setup procedure using the oscilloscope and then switch to a recorder mode (or use an oscilloscope camera) if a permanent record is required. In the example following the general procedure, this type of setup will be shown.

**Procedure** To select one of the oscilloscope or recorder output functions, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code ◀HP-IB▶	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
<b>Output to Oscilloscope</b>							
Noise Figure and Gain	7.0	A0 or 7.0SP	N	Y	N	On	On
Test Pattern	7.1	A1 or 7.1SP	N	Y	N	Off	Off
Noise Figure Only	7.2	A2 or 7.2SP	N	Y	N	Off	Off
Gain Only	7.3	A3 or 7.3SP	N	Y	N	Off	Off
<b>Enter Oscilloscope Limits</b>							
Noise Figure Lower Limit	8.1	NL or 8.1SP	N	Y	Y	NC	0
Noise Figure Upper Limit	8.2	NU or 8.2SP	N	Y	Y	NC	8
Gain Lower Limit	8.3	GL or 8.3SP	N	Y	Y	NC	0
Gain Upper Limit	8.4	GU or 8.4SP	N	Y	Y	NC	40
<b>Recorder Functions</b>							
Go to Lower Left	20.0	LL or 20.0SP	N	N	N	Off	Off
Go to Upper Right	21.0	UR or 21.0SP	N	N	N	Off	Off
Plot Noise Figure	22.0	A4 or 22.0SP	N	Y	N	Off	Off
Plot Gain	23.0	A5 or 23.0SP	N	Y	N	Off	Off
Strip Chart Mode (X = Noise Figure; Y = Gain)	24.0	A6 or 24.0SP	N	Y	N	Off	Off
Table categories are explained in the Special Functions Detailed Operating Instruction.							

**Example** The following example shows how to set up the Noise Figure Meter to output a swept CORRECTED NOISE FIGURE AND GAIN measurement result to an oscilloscope and then to plot noise figure and gain results independently. It is assumed that the Noise Figure Meter is already making this type of measurement in one of the Measurement Modes. It is also assumed that the oscilloscope has A vs B (or X/Y) capability.

## Data Output to Oscilloscopes and Recorders (cont'd)

### (Special Functions 7, 8, and 20 through 24)

#### Example (cont'd)

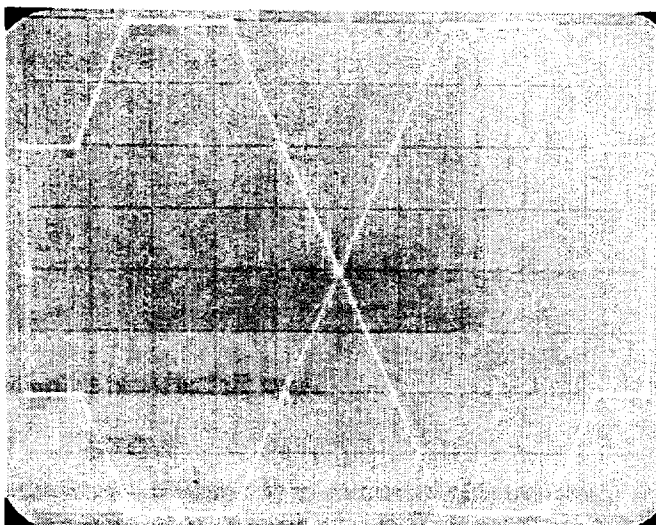
#### Data Output to an Oscilloscope

- a. Connect the X-AXIS, Y-AXIS, and Z-AXIS outputs on the rear panel of the Noise Figure Meter to the A, B, and Z (or horizontal, vertical, and Z) inputs of the oscilloscope as appropriate. Select the DC mode for all oscilloscope inputs.
- b. To display the test pattern on the oscilloscope screen press 7 . 1 SPECIAL FUNCTION (or send HP-IB code A1).

#### NOTE

*In the following step, first adjust the position controls on the oscilloscope to place the test pattern on the left side and the bottom. Then, adjust the gain controls to position the right side and top.*

- c. Adjust the oscilloscope controls until the test pattern just fills the screen (touching the outer lines on all four sides). See figure below. Verify that the diagonal lines cross near the center of the screen.



**Test Pattern on Oscilloscope**

#### NOTE

*In the following steps it is assumed that the DUT has a noise figure range of 0.5 to 4 dB and a gain range of 0 to 25 dB over the specified frequency range.*

- d. To display the noise figure and gain traces on the oscilloscope screen, press 7 . 0 SPECIAL FUNCTION (or send HP-IB code A0).
- e. To display the noise figure lower limit in the left display, press 8 . 1 SPECIAL FUNCTION (or send HP-IB code NL). If the left display shows the default value of 0.000 dB, continue with the next step. If the display shows a different value, press 0 and ENTER (or send HP-IB codes 0EN).
- f. To display the noise figure upper limit in the left display, press 8 . 2 SPECIAL FUNCTION (or send HP-IB code NU). The default value is 8.000 dB. To change the upper limit to 4 dB, press 4 and ENTER (or send HP-IB codes 4EN).



## Data Output to Oscilloscopes and Recorders (cont'd)

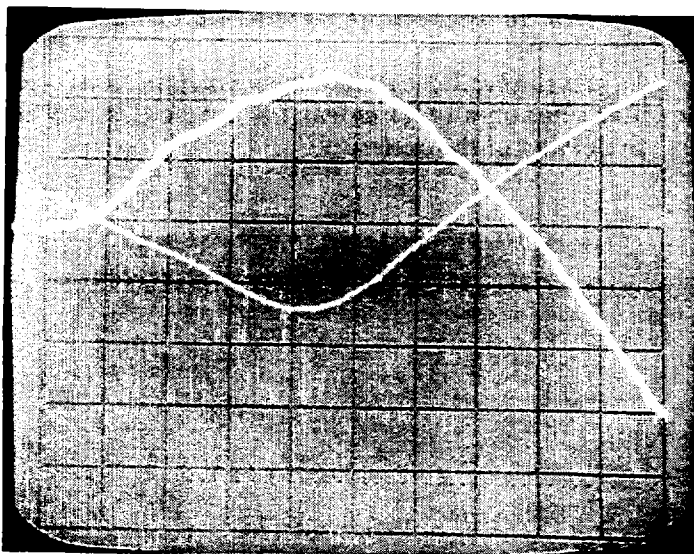
### (Special Functions 7, 8, and 20 through 24)

#### Example (cont'd)

g. In a similar manner, use Special Functions 8.3 and 8.4 (HP-IB codes GL and GU) to display and change the lower and upper limits of the gain trace. The default values of 0.000 and 40.00 are satisfactory for this example.

h. To display the corrected swept measurement, press CORRECTED NOISE FIGURE AND GAIN (or send HP-IB code M2).

i. For a repetitive swept measurement beginning at the start frequency, press START FREQ and then AUTO (or send HP-IB codes FAW1). Verify the display is similar to that shown below.



Swept Measurement on Oscilloscope

#### NOTE

*If desired, the intensity of the gain trace can be adjusted relative to the noise figure trace. This can be done by turning the GAIN TRACE adjustment on the rear panel of the Noise Figure Meter (see Figure 3-7).*

j. To stop the sweep press AUTO again (or send HP-IB code W0). Note that a different HP-IB code is required to turn off the sweep since this function cannot be toggled over the HP-IB.

#### NOTE

*Step j completes the procedure for setting up the Noise Figure Meter for an oscilloscope display. If a permanent record of the measurement results is required, use an oscilloscope camera or perform the remaining steps, which provide a typical procedure for plotting the data on an X-Y recorder.*

#### Plotting Data on an X-Y Recorder

k. Connect the X-AXIS, Y-AXIS, and Z-AXIS outputs from the Noise Figure Meter to the X, Y, and pen lift inputs of the X-Y recorder. Select DC mode on all recorder inputs.

## Data Output to Oscilloscopes and Recorders (cont'd)

### (Special Functions 7, 8, and 20 through 24)

#### Example (cont'd)

l. To adjust the lower left point on the recorder, press 20.0 SPECIAL FUNCTION (or send HP-IB code LL) and adjust the X and Y zero-set controls on the recorder.

m. To adjust the upper right point on the recorder, press 21.0 SPECIAL FUNCTION (or send HP-IB code UR) and adjust the X and Y vernier controls on the recorder.

#### NOTE

*The X-AXIS and Y-AXIS output voltages from the Noise Figure Meter vary from 0 to 6V. Therefore, it may be necessary to adjust the recorder to accommodate this range of voltages.*

n. Check both the upper and lower limits on the recorder and readjust as required.

o. To plot a single sweep of the noise figure results, press 22.0 SPECIAL FUNCTION and then SINGLE (or send HP-IB codes A4W2). When the single sweep is complete, the Noise Figure Meter remains tuned to the stop frequency.

p. To plot a single sweep of the gain results, press 23.0 SPECIAL FUNCTION and then SINGLE (or send HP-IB codes A5W2). When the single sweep is complete, the Noise Figure Meter remains tuned to the stop frequency.

q. The plotted traces should be similar to the traces that were displayed on the oscilloscope.

#### Program Codes

HP-IB

For HP-IB codes, refer to Procedure above.

#### Comments

For the oscilloscope and recorder modes, whatever is displayed in the NOISE FIGURE display is treated as a noise figure trace. For example, if Special Function 9 is active, the power measurement information displayed is output to the oscilloscope or recorder as if it were noise figure information. Noise figure is displayed in the units selected by Special Function 10 and gain is displayed in dB.

Special Function 8 is used to set both noise figure and gain limits.

Special Function 24 selects the strip chart mode. This mode is useful in plotting noise figure and gain versus time. For example, it can be used to plot noise figure versus emitter current on an X-Y recorder or to drive an external meter. The X-AXIS output is the noise figure information and the Y-AXIS output is the gain information.

#### Related Sections

Display Units Selection  
Measurement Modes 1.0 through 1.4  
Special Functions

# Display Resolution

## (Special Function 12)

**Description** The Noise Figure Meter can vary the resolution of the INSERTION GAIN and NOISE FIGURE displays.

The table below shows the maximum resolution (to the right of the decimal point) allowed by Special Function 12.

Display	12.0SP Maximum Resolution	12.1SP Less Resolution on NOISE FIGURE	12.2SP Less Resolution on GAIN
<b>NOISE FIGURE</b>			
F dB	dd.dd	dd.d	
F	d.ddd	d.dd	
Y dB	dd.dd	dd.d	
Y	d.ddd	d.dd	
Te K	ddd.d	ddd	
<b>INSERTION GAIN</b>			
dB	dd.dd		dd.d

**Procedure** To select the desired display resolution, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Maximum resolution for both INSERTION GAIN and NOISE FIGURE displays	12.0	X0 or 12.0SP	N	Y	N	On	On
Less resolution on NOISE FIGURE display	12.1	X1 or 12.1 SP	N	Y	N	Off	Off
Less resolution on INSERTION GAIN display	12.2	X2 or 12.2SP	N	Y	N	Off	Off

Table categories are explained in the Special Functions Detailed Operating Instruction.

## Display Resolution (cont'd)

(Special Function 12)

**Example** To have less resolution in the NOISE FIGURE display:

LOCAL (keystrokes)	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>Code</p> <div style="display: flex; justify-content: center; gap: 10px;"> <div style="border: 1px solid black; padding: 2px 5px; border-radius: 5px;">1</div> <div style="border: 1px solid black; padding: 2px 5px; border-radius: 5px;">2</div> <div style="border: 1px solid black; padding: 2px 5px; border-radius: 5px;">.</div> <div style="border: 1px solid black; padding: 2px 5px; border-radius: 5px;">1</div> </div> </div> <div style="text-align: center;"> <p>Function</p> <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <span style="font-size: 0.8em;">●</span> SPECIAL FUNCTION                 </div> </div> </div>
<div style="text-align: center; margin-bottom: 5px;"> <span style="border: 1px solid black; padding: 2px 5px; border-radius: 5px;">HP-IB</span> </div> (program codes)	X1

**Program Codes**

For HP-IB program codes, refer to Procedure above.



**Indications**

The NOISE FIGURE and INSERTION GAIN displays reflect the resolution corresponding to the selected Special Function.

**Comments**

Special Function 12 also affects the resolution of the HP-IB output. The HP-IB output always has one digit more of resolution than the front panel displays.

**Related Sections**

Display Units Selection  
Special Functions

# Display Units Selection

## (Special Function 10)

**Description** Noise measurements can be output in the following display units:

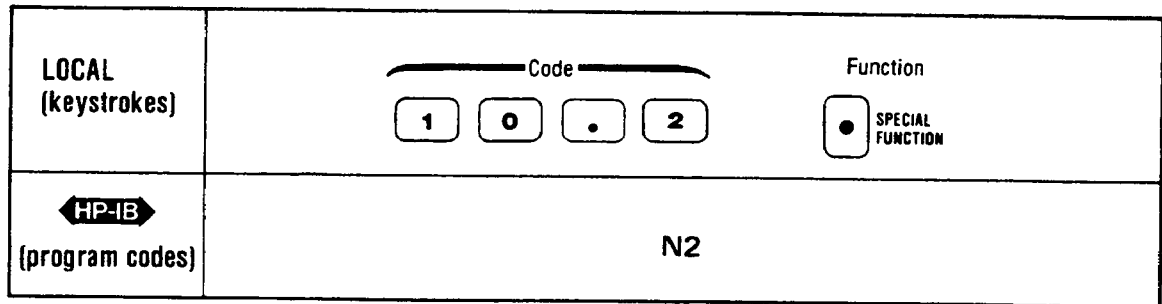
- noise figure in dB (F dB)
- noise figure as a ratio (F)
- Y factor in dB (Y dB)
- Y factor as a ratio (Y)
- equivalent input noise temperature in kelvins (Te K)

**Procedure** To select a NOISE FIGURE display unit, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code ◀HP-IB▶	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
F dB	10.0	N0 or 10.0SP	N	Y	Y	On	On
F	10.1	N1 or 10.1SP	N	Y	Y	Off	Off
Y dB	10.2	N2 or 10.2SP	N	Y	Y	Off	Off
Y	10.3	N3 or 10.3SP	N	Y	Y	Off	Off
Te K	10.4	N4 or 10.4SP	N	Y	Y	Off	Off

Table format is explained in the Special Functions Detailed Operating Instructions.

**Example** To have measured noise displayed as Y factor in dB:



**Program Codes** For HP-IB program codes, refer to Procedure above.



**Indications** The selected display unit appears on the right side of the NOISE FIGURE display. Special Function 10 has no effect on the INSERTION GAIN display.

**Comments** 32 dB is the maximum value that can be displayed in units of F dB. Readings above this value cause the NOISE FIGURE display to show two dashes “ — — ”. The smoothed number is the value that is checked against 32 dB. Therefore, if the display is flashing between approximately 30 dB and “ — — ”, increasing the smoothing may provide a stable display if the noise figure is less than 32 dB.

The maximum value allowable for Te K is 9999K (noise figure of 15.5 dB).

## Display Units Selection (cont'd)

### (Special Function 10)

#### Comments (cont'd)

The maximum value allowable for F is 9999 (noise figure of approximately 40 dB).

Equations for the display units are as follows:

$$F = \frac{\text{noise power added by DUT} + \text{noise power out due to source}}{\text{noise power out due to source}}$$

(when the source is at 290K)

$$F(\text{dB}) = 10 \log F$$

$$Y = \frac{\text{power measured with noise source On}}{\text{power measured with noise source Off}}$$

$$Y(\text{dB}) = 10 \log Y$$

$$T_e = \frac{T_{\text{hot}} - Y \times T_{\text{cold}}}{Y - 1}$$

where:  $T_{\text{hot}}$  is the equivalent temperature of the noise source when it is On  
and

$T_{\text{cold}}$  is the equivalent temperature of the noise source when it is Off.

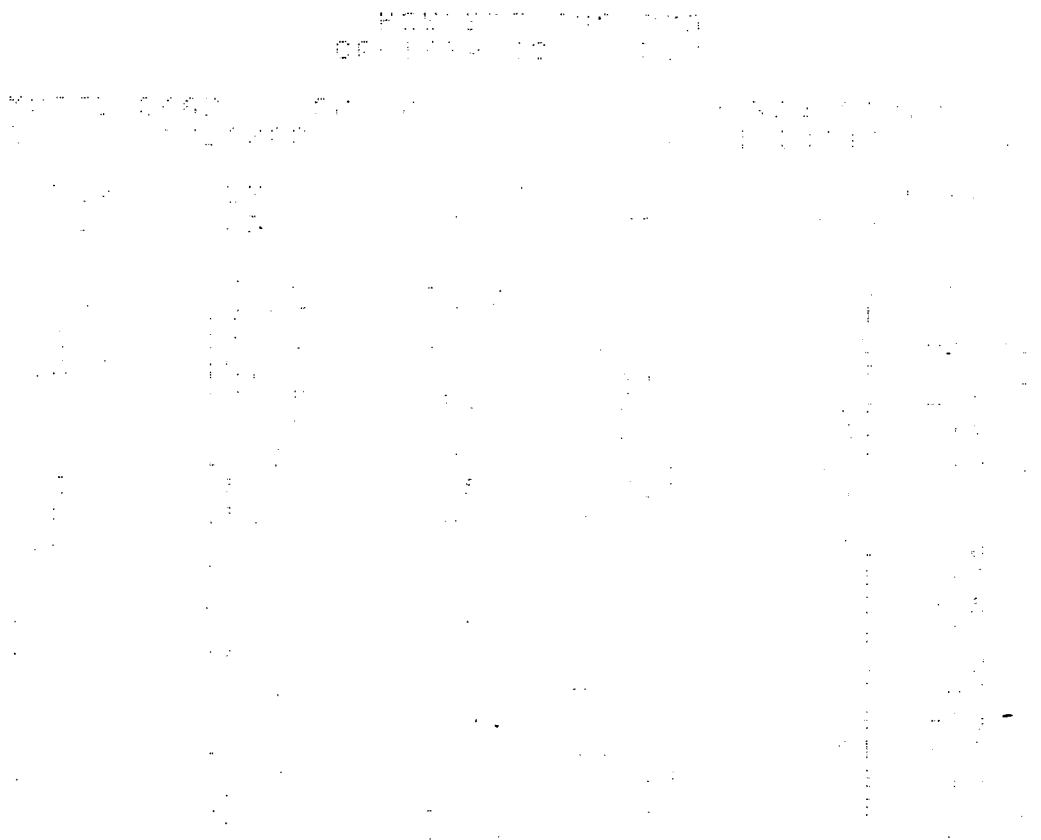
#### Related Sections

Display Resolution  
Noise Figure (Uncorrected) and Noise Figure and Gain (Corrected)  
Smoothing  
Special Functions

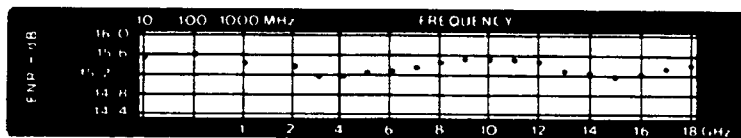
# ENR Table Entry

## Description

The ENR key allows display and entry of the noise source's calibration factors. This information is used to improve the accuracy of the noise figure and gain calculations made by the Noise Figure Meter. The information entered is the actual Excess Noise Ratio (ENR) value at the specified frequency. All ENR noise sources have this calibration information available. In the case of the HP 346A, B and C Noise Sources, a separate printout is supplied, and a graph or table is printed on its side showing the ENR versus Frequency data. The frequency points shown on the printout and graph are the default frequency values displayed when the table is entered. The ENR table can hold a maximum of 27 frequency points. The valid frequency range for entries is from 10 MHz to 60 GHz. The valid power range for the ENR entries is from -6 to +17 dB.



Example of Printout of ENR versus Frequency Data



Example of ENR Versus Frequency Data on HP 346B Noise Source

The instrument uses the noise source's calibration information starting at the first stored pair (frequency and ENR) and uses subsequent pairs until a lower frequency entry is encountered. When power is initially applied to the instrument, the ENR table contains the default value of 15.20 dB at all frequency points. After an ENR table is entered for a specific noise source, this information is retained in the continuous memory and need not be re-entered each time power is turned off and on.

## ENR Table Entry (cont'd)

### Procedure

To enter a specific set of values into the ENR table perform the following steps:

#### NOTE

*Entering the ENR table values is simply a matter of pressing the ENR key and entering the required data. The flashing annunciators indicate the type of data required. The following detailed procedure is only necessary if this is the first time the procedure has been performed.*

- a. Press the ENR key and verify that the MHz indicator in the left display is flashing.

#### NOTE

*If an error is made while entering numeric data and the error is noted before ENTER is pressed the entry can be cleared by pressing the UNCORRECTED NOISE FIGURE key. However, once ENTER is pressed, the number cannot readily be changed. Therefore, be very careful when making entries. If an incorrect entry is made and ENTER has been pressed, two possible recovery procedures are recommended:*

1. *If it is early in the entry procedure, press FREQUENCY to terminate the ENR table entry mode and start over.*

2. *If several entries have been made, ignore the incorrect input and continue with the entry procedure. After all entries have been made, use the ENTER key to sequence to the incorrect entry and make the required change. Step h. explains the use of ENTER for this purpose.*

- b. The frequency displayed is either the first calibrated frequency for the HP 346B (default value) or the last entered frequency for this point. If this is the frequency at which ENR calibration data is to be entered, just press ENTER. To change the frequency, use the numeric keyboard to enter the desired value in MHz. Note that all frequency entries must be made in MHz. If a non-interger value is entered, the instrument converts the number to the nearest MHz.

- c. After ENTER is pressed for the frequency entry, verify that the MHz indicator is on and not flashing and the indicated frequency value is correct. Verify the dB indicator in the INSERTION GAIN display is flashing.

- d. The dB value displayed is either the default value (15.20 dB) or the last entered value for this point. If this is the value to be entered, just press ENTER. To change this value, use the numeric keyboard to enter the new value and then press ENTER. Up to two significant digits after the decimal point can be entered.

- e. After ENTER is pressed for the dB value entry, verify that the dB indicator is on and not flashing and that the indicated dB value is correct. Verify the MHz indicator is flashing.

- f. Repeat steps a through e until all of the required calibration information is entered.

#### NOTE

*If less than a full table is entered, the frequency following the last entry to be used must be lower than that entry. When the ENR table is used by the instrument, only the values that are in ascending frequency order are used. The first descending frequency value terminates the table.*



## ENR Table Entry (cont'd)

### Procedure (cont'd)

g. After all required entries are complete, press **FREQUENCY**. The instrument exits the ENR table entry mode and returns to the measurement that was active when the ENR key was pressed.

h. Press the ENR key to reinitiate the ENR table entry mode. Verify that the calibration data is correct by pressing the **ENTER** key to cycle through the ENR table. Each time the **ENTER** key is pressed, the table is alternately stepped to the following frequency or dB point in the table. Holding the **ENTER** key down causes the table entries to be automatically displayed in sequential order. With the **ENTER** key held down, each frequency and dB entry is displayed for approximately one second. Releasing the key stops the table at the displayed point. If required, changes can be made to the displayed data. Note that the displays cannot be sequenced back. Therefore, if a known error exists, release the **ENTER** key one or two entries prior to the one that must be changed. Then, single step the table using the **ENTER** key until the incorrect information is displayed. Make the necessary correction and then check the rest of the table as explained previously.

### Program Code

HP-IB

The HP-IB code to enable ENR table entry is NR.

### Comments

The ENR table is used during both **UNCORRECTED NOISE FIGURE** measurements and **CORRECTED NOISE FIGURE AND GAIN** measurements.

The specific ENR vs. frequency data that is used is determined by the stimulus frequency and the measurement mode that has been selected. Refer to Measurement Modes 1.0 through 1.4 Detailed Operating Instructions for additional information.

**PRESET** has no effect on data stored in the ENR table.

### Related Sections

Measurement Modes 1.0 through 1.4  
Spot ENR,  $T_{hot}$ , and  $T_{cold}$

## Error Messages and Recovery

### Description

The instrument generates error messages to indicate operating problems, incorrect keyboard entries, or service-related problems. The error message is cleared when the error condition is removed. The error messages are grouped by error code as follows:

**Error 10 through Error 49.** These are operating and entry errors which indicate that not all conditions have been met to assure a calibrated measurement, or that an invalid keyboard or HP-IB entry has been made. Operating errors can usually be cleared by using the front panel controls, changing the equipment setup, or correcting the HP-IB code. Entry errors require that a new keyboard entry or function selection be made. A number of errors in this group may represent instrument malfunctions. The operator should try to clear the error condition using the corrective actions shown in the table below before referring the unit for service.

**Error 50 through Error 80.** These are service errors which provide service-related information. Service errors are discussed in the Service Section (VIII).

Errors may also be classified as volatile or nonvolatile.

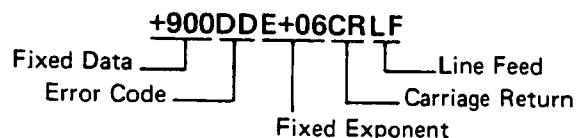
Nonvolatile errors typically occur when the instrument has received conflicting commands from the operator. The instrument stops making measurements and waits for the conflict to be resolved by the operator. An example of this type of conflict is selecting a corrected measurement when a calibration has not been performed. All hardware errors are also nonvolatile.

Volatile errors typically represent invalid entries of either frequency, special function codes, numerical data, or HP-IB characters. Volatile errors are cleared when a front panel key is pressed or when a serial poll is performed over the HP-IB. Unlike nonvolatile errors, after a serial poll has been performed, it is not possible to determine the error code of a volatile error that may have generated the Require Service message. Upon clearing a volatile error, the invalid entry is ignored by the instrument and measurements resume as if the entry was never received.

### HP-IB Output Format



The HP-IB output format for errors is:



For example, Error 10 is output to the HP-IB as +90010E+06CRLF. This format differs from normal data outputs since normal data outputs will never exceed  $1 \times 10^5$ . Once an error has been input to the computing controller, the error code is simply derived by subtracting  $9 \times 10^{10}$  from the input number, and then dividing the result by 1 000 000.

### Error Displays

There are three types of error displays. All three use the format shown above to output the error message to the HP-IB. The following examples illustrate each type:



The display above shows the general error display format. E means error while the number is the error code.

## Error Messages and Recovery (cont'd)

### Error Displays (cont'd)

This display indicates that a measurement overflow has occurred or that the measured noise figure exceeds 32 dB. This display is output to the HP-IB as E99 using the HP-IB output format above.

The display above indicates that the data is not ready. For example, this display occurs during a frequency calibration of the instrument. This display is output to the HP-IB as a special reserved number (90000E+06CRLF).

### Error Messages

The table below describes all operating and entry errors. The error code, message, and the action typically required to remove the error-causing condition are given. Additional information pertaining to particular errors is also given.

Error Code	Volatile (V) or Nonvolatile (NV)	Message	Recommended Action/Comments
<b>Hardware Error</b>			
General Remedy: Press PRESET and check that input signal is within the specified amplitude and frequency range.			
10	NV	A/D conversion failed.	Refer to Service-Related Errors in Section VIII, Service.
11	NV	A/D converter overflow.	Set IF and RF attenuators to autorange (Special Functions 70.0 and 60.0). If error persists, refer to Service-Related Errors in Section VIII, Service. Also check for proper operation of the Noise Source.
12	NV	Input overflow.	Set RF attenuators to autorange (Special Function 60.0). If error persists, refer to Service-Related Errors in Section VIII, Service.
13	NV	IF attenuator calibration failed.	Check that IF attenuator calibration (Special Function 33.0) was properly executed by operator. If error persists, refer to Service-Related Errors in Section VIII, Service.
14	NV	Proper IF or RF attenuators cannot be selected.	Refer to Service-Related Errors in Section VIII, Service.
18	NV	Frequency calibration failed.	Refer to Service-Related Errors in Section VIII, Service.

## Error Messages and Recovery (cont'd)

**Error Messages (cont'd)**

Error Code	Volatile (V) or Nonvolatile (NV)	Message	Recommended Action/Comments
<b>Not Properly Calibrated For Corrected Measurement</b>			
General Remedy: Repeat calibration.			
20	NV	Not calibrated.	Perform calibration prior to selecting CORRECTED NOISE FIGURE AND GAIN measurement.
21	NV	Current frequency is out of calibrated range.	Select frequency within calibrated range or calibrate over a new frequency range.
22	NV	Current RF attenuation not calibrated.	Select appropriate input gain calibration range (Special Function 32).
23	NV	Not calibrated in the current measurement and sideband modes.	Perform calibration in current measurement and sideband modes.
24	NV	Not calibrated for the current IF (Measurement Modes 1.1 and 1.3).	Perform calibration. (Changing the IF requires recalibration.)
25	NV	Not calibrated for the current LO frequency (Measurement Mode 1.2).	Perform calibration. (Changing the LO frequency requires recalibration)
26	NV	Internal IF attenuators not calibrated.	Perform IF attenuator calibration (Special Function 33.0). Refer to the Calibration, IF Attenuators Detailed Operating Instruction.
27	NV	Overflow while calibrating.	Too much loss in calibration system. Check input gain calibration setting (Special Function 32). Check for proper Noise Source operation. Refer to comments.
<b>Invalid Frequency Error</b>			
General Remedy: Change frequency parameter and repeat measurement.			
30	V	Start frequency is greater than stop frequency during calibration or plot. Or, the lower limit is greater than the upper limit (noise or gain) during sweep.	Set start frequency (or lower limit) to a value less than the stop frequency (or upper limit).
31	V	Number of calibration points exceeds 81.	Reduce the number of calibration points. (Reduce calibration range or increase step size.)

## Error Messages and Recovery (cont'd)

**Error Messages (cont'd)**

Error Code	Volatile (V) or Nonvolatile (NV)	Message	Recommended Action/Comments
<b>Invalid Frequency Error (cont'd)</b>			
32	V	LO frequency will be out range.	Change IF, START FREQ, STOP FREQ, or sideband selection so that LO does not tune through 0 MHz.
33	V	IF will be out of range.	Change START FREQ, STOP FREQ, or LO frequency so that the difference between the LO frequency and the start or stop frequency is greater than 10 MHz and less than 1500 MHz.
34	NV	Double sideband is not allowed in Measurement Mode 1.2	Use single sideband (Special Function 2.1 or 2.2) with Measurement Mode 1.2.
<b>Entry Error</b>			
General Remedy: Check and repeat entry.			
35	V	Entered value is out of range.	Re-enter new value.
36	V	Undefined special function.	Check, then re-enter correct special function code.
37	V	Cannot enter specified parameter.	Select proper function that allows entry of this parameter.
<b>HP-IB</b> HP-IB Errors			
General Remedy: Check and repeat entry.			
40	V	Undefined HP-IB code.	Check, then re-enter correct HP-IB code.
41	V	Invalid HP-IB characters.	Check, then re-enter valid HP-IB characters.
42	NV	No external LO is connected when in controller mode (4.1SP).	Connect an external LO or select another control function (Special Function 4).
43	V	Codes received while in Talk Only Mode (4.2SP).	Only send codes when the instrument is addressed to listen.

## Error Messages and Recovery (cont'd)

**Error Messages (cont'd)**

Error Code	Volatile (V) or Nonvolatile (NV)	Message	Recommended Action/Comments
<b>Service Errors</b>			
50-79	NV	Service-related errors.	Refer to Service-Related Errors in Section VIII, Service.
80	NV	Continuous memory failure.	Refer to Comments below.

**Comments**

Error code E27 usually occurs because the noise figure of the measurement system is too high during the calibration of the third input gain setting. Consider the error code as only a warning, and that the ability of the instrument to make valid measurements is most likely not impaired. But, if error code E22 occurs during the actual measurement, do one of the following:

1. Decrease the instrument's smoothing factor and try to recalibrate.
2. The DUT probably has 30 dB or more of gain, causing the Noise Figure Meter to use the attenuator setting of the third calibration setting. Attach a 10 dB attenuator to the output of the DUT and use special functions 34.3, 34.4, and 34.1 to correct for the loss.
3. Add a preamp to the measurement system and recalibrate.





Error code E80 indicates a continuous memory failure. The instrument may not retain data when powered down. However, the ability of the instrument to make valid measurements may not be impaired. If E80 occurs, press PRESET and proceed. The occurrence of E80 implies that stored information such as the IF attenuator calibration was not retained. Therefore, error code E26 will appear. Perform an IF attenuator calibration (refer to the Calibration, IF Attenuators Detailed Operating Instruction). If E80 persists, service should be performed on the internal battery and related circuits. Refer to Service-Related Errors in Section VIII, Service.

**Related Sections**

- Calibrate
- Calibration, IF Attenuators
- Calibration, Input Gain Selection
- IF Attenuation Selection
- Measurement Modes 1.1 through 1.4
- Remote Operation, HP-IB
- RF Attenuation Selection
- Service-Related Errors, Section VIII
- Special Functions

# Fixed Frequency Increment



## Description

The tuned frequency of the instrument can be changed by using a combination of the **FREQ INCR**, , and  keys. The **FREQ INCR** key is used to set the fixed increment size. The  and  keys step the fixed frequency up or down by the value of the current frequency increment. These keys provide a convenient method of controlling the fixed frequency of the instrument for applications such as locating the minimum noise figure of an amplifier.

The allowable range of values for a frequency increment is 1 to 1490 MHz for Measurement Modes 1.0 and 1.4, and 1 MHz to 60 GHz for Measurement Modes 1.1, 1.2, and 1.3. If an attempt is made to enter an illegal frequency increment, error code E35 is displayed and the entry is not made.

## Procedure

To change the size of the frequency increment, press the **FREQ INCR** key, enter a value for frequency in MHz, and then press the **ENTER** key.

Use  or  to step the frequency up or down by the current frequency increment.




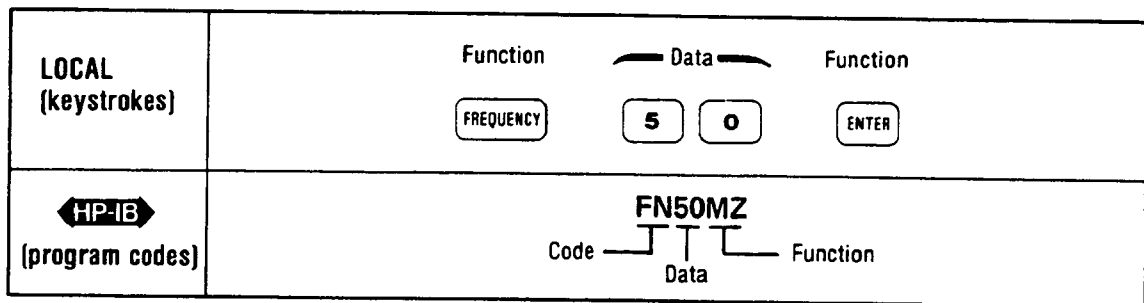
Front Panel Key	Program Code 	Stored in Continuous Memory	Can be Stored and Recalled	Preset (and HP-IB Clear) Conditions
<b>FREQ INCR</b>	FN	Y	Y	20 MHz
	UP	—	—	—
	DN	—	—	—

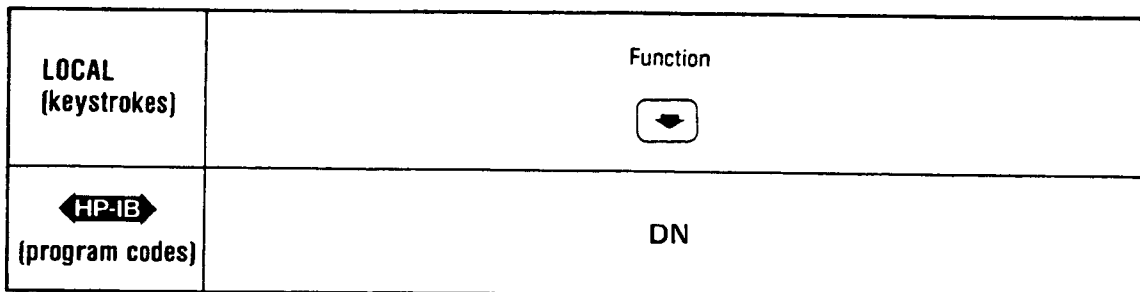
Table categories are explained in the Preset Conditions and Power-Up Sequence Detailed Operating Instruction.

## Example

To set the frequency increment to 50 MHz:





To decrease the tuned frequency by the current frequency increment:



## Fixed Frequency Increment (cont'd)

### Example (cont'd)

Holding either the  or  key down causes the frequency to step continuously. However, the frequency is slower to change when stepped downward.



### Program Codes



In addition to the HP-IB program codes given in Procedure above, HZ and MZ are the program codes for Hz and MHz, respectively.

### Indications



The currently programmed frequency increment is displayed in the left display for as long as the **FREQ INCR** key is depressed. After **FREQ INCR** is pressed, the new frequency increment data can be entered. This data is displayed in the left display until the **ENTER** key is pressed. The function is then implemented and the instrument returns to the last selected measurement.

When either  or  is pressed, the tuned frequency is changed in the selected direction. The new tuned frequency is displayed in the left display and the instrument continues with the selected measurement.

### Comments

Front panel frequency increment values should be entered in integer MHz units. If a decimal MHz entry is made, the instrument rounds the entry to the nearest integer (0.5 MHz and above is rounded up).

The Hz unit, provided for HP-IB, is for programmer convenience. The instrument rounds all HP-IB tuned frequency inputs to the nearest MHz.

If  or  is pressed rapidly in succession, the left display updates the frequency each time the key is pressed. The noise measurement may be delayed (— — — — will appear in the **NOISE FIGURE** display), especially if smoothing is used.



### Related Sections

Fixed Frequency Tuning  
Measurement Modes 1.0 through 1.4  
Preset Conditions and Power-Up Sequence



# Fixed Frequency Tuning

**Description** The FREQUENCY key is used to display the frequency to which the instrument is tuned and to enter a new fixed frequency value. The allowable frequency range is 10 to 1510 MHz in Measurement Modes 1.0 and 1.4, and 1 MHz to 60 GHz in Measurement Modes 1.1, 1.2, and 1.3.

The tuned fixed frequency of the instrument can also be changed by using a combination of the FREQ INCR key to set the increment size, and the  and  keys to step the fixed frequency in the selected direction.

The FREQUENCY key acts as a "clear entry" key. It clears entries in progress, returns the instrument to the last selected measurement with the left display showing the current tuned frequency, and halts the sweep if it is in progress.

**Procedure** To display the current tuned frequency and enter a new tuned frequency, press FREQUENCY, enter the value of the new frequency in MHz, and press ENTER.


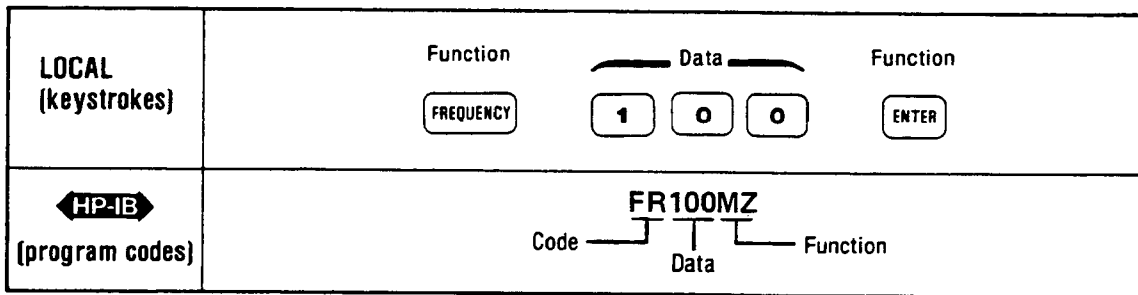
Front Panel Key	Program Code 	Stored in Continuous Memory	Can be Stored and Recalled	Preset (and HP-IB Clear) Conditions
FREQUENCY	FR	Y	Y	30 MHz

Table categories are explained in the Preset Conditions and Power-Up Sequence Detailed Operating Instruction.

**Example** To tune the instrument to a new frequency of 100 MHz:



**Program Codes** The HP-IB program code for FREQUENCY is FR. The program codes for Hz and MHz are HZ and MZ.



**Indications** Pressing the FREQUENCY key clears an incomplete entry, displays the current tuned frequency, and enables the entry of a new tuned frequency. As the entry numbers are pressed, the specific numbers appear in the left display. When ENTER is pressed, the instrument is tuned to the specified frequency and the instrument continues to make the the last selected measurement.

**Comments** Front panel frequency entries should be made in integer MHz units. If a decimal MHz entry is made, the instrument rounds the entry to the nearest integer (0.5 MHz and above is rounded up).

## Fixed Frequency Tuning (cont'd)

### Comments (cont'd)

The Hz unit, provided for HP-IB, is for programmer convenience. The instrument rounds all HP-IB tuned frequency inputs to the nearest MHz.

If no other prefix key has been pressed, any digits entered followed by ENTER will be interpreted as if the FREQUENCY key were the prefix.

### Related Sections

Fixed Frequency Increment  
Measurement Modes 1.0 through 1.4  
Preset Conditions and Power-Up Sequence

# Fixed IF or LO Frequency Selection

## (Special Function 3)

### Description

Special Function 3 displays and allows entry of the fixed IF and LO frequencies for the external mixer measurement modes.

Special Function 3.0 is used to display and enter the fixed IF for Measurement Modes 1.1 and 1.3. If no entry is made, the Noise Figure Meter uses the last entered value. The fixed IF value is ignored when the instrument is operated in Measurement Modes 1.0, 1.2, or 1.4. The allowable range of values for IF entries is 10 to 1510 MHz.

Special Function 3.1 is used to display and enter the fixed LO frequency for Measurement Modes 1.2 and 1.4. If no entry is made, the Noise Figure Meter uses the last entered value. If the instrument is operated in Measurement Modes 1.0, 1.1, or 1.3, the fixed LO frequency is ignored. The allowable range of values for LO frequency entries is 0 to 60 GHz.

Front panel frequency entries should be made in integer MHz units. If a decimal MHz entry is made, the instrument rounds the entry to the nearest integer (0.5 MHz and above are rounded up).

### Procedure

To select a fixed IF or LO frequency, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key. Next, enter the appropriate value using the DATA keys and press ENTER.

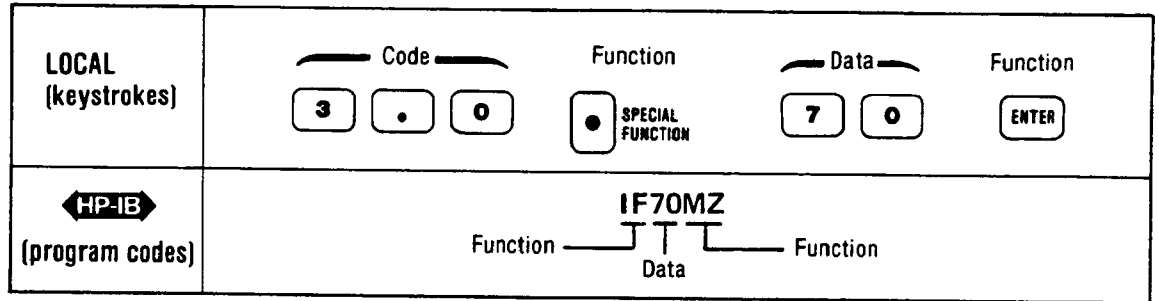
Special Function		Program Code ↔ HP-IB ↔	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Fixed IF (for modes 1.1 and 1.3)	3.0	IF or 3.0SP	N	Y	Y	NC	30 MHz
Fixed LO Frequency (for modes 1.2 and 1.4)	3.1	LF or 3.1SP	N	Y	Y	NC	10 000 MHz

Table categories are explained in the Special Functions Detailed Operating Instruction.

## Fixed IF or LO Frequency Selection (cont'd)

### (Special Function 3)

**Example** To select a fixed IF of 70 MHz:



**Program Codes**



The HP-IB codes for Hz and MHz are HZ and MZ, respectively. For Special Function 3 program codes, refer to Procedure.

**Indications**

When Special Function 3.0 or 3.1 is selected, the left display shows the current IF or LO frequency. When a new frequency value is entered, it appears in the left display only for as long as the ENTER key is depressed. When the ENTER key is released, the left display returns to the display that was present when the special function was entered.

**Comments**

If error code E32 is displayed when attempting to enter a fixed LO frequency, the entered frequency is outside the range specified for the external LO. If the entered frequency was incorrect, re-enter the correct frequency. If the external LO frequencies are incorrect, they can be changed using either Special Function 42.3 or 42.4 (refer to the Programming an External LO Detailed Operating Instruction).

The Hz unit, provided for HP-IB, is for programmer convenience. The instrument rounds all HP-IB tuned frequency inputs to the nearest MHz.

**Related Sections**

- Error Messages and Recovery
- Measurement Modes 1.1 through 1.4
- Programming an External LO
- Special Functions

# HP-IB Addresses

## Noise Figure Meter and External LO (Special Function 40)

**Description**



The Noise Figure Meter has two HP-IB addresses. One is the address of the Noise Figure Meter when it is being used over the HP-IB. The second is the HP-IB address of an external local oscillator (LO) for use when the LO is being controlled by the Noise Figure Meter (that is, Special Function 4.1 is active and Measurement Mode 1.1, 1.2, 1.3, or 1.4 is selected).

The HP-IB addresses for the Noise Figure Meter and an external LO can be displayed and changed by Special Function 40. The selected address is displayed in decimal in the left display. The decimal value of the factory set addresses are:

- a. Noise Figure Meter = 8
- b. External LO = 19

A list of allowable addresses for the Noise Figure Meter and an external LO is given below.

ASCII Address Codes		Decimal Equivalents
LISTEN	TALK	
SP	@	00
!	A	01
"	B	02
#	C	03
\$	D	04
%	E	05
&	F	06
'	G	07
(	H	08
)	I	09
*	J	10
+	K	11
,	L	12
-	M	13
.	N	14
/	O	15
0	P	16
1	Q	17
2	R	18
3	S	19
4	T	20
5	U	21
6	V	22
7	W	23
8	X	24
9	Y	25
:	Z	26
;		27
<	\	28
=		29
>	)	30

# HP-IB Addresses (cont'd)

## Noise Figure Meter and External LO (Special Function 40)

**Procedure**

To display the current HP-IB address of either the Noise Figure Meter or an external LO, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

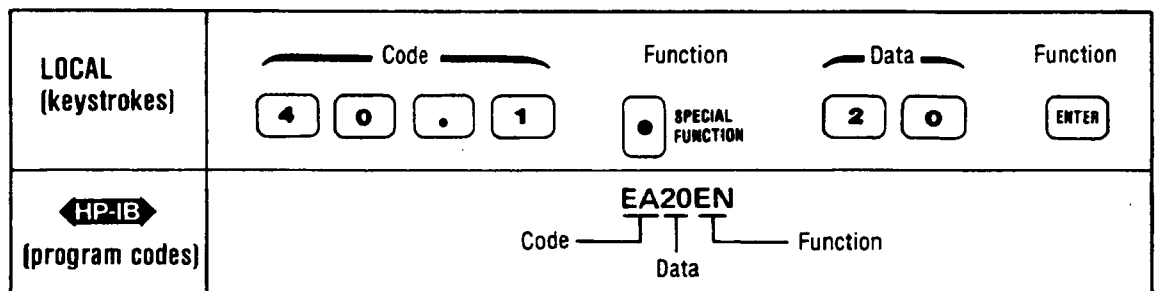
To change an HP-IB address, first display the current address. Then, enter a decimal number from 0 to 30 for the new address and press the ENTER key.

Special Function		Program Code ◀ HP-IB ▶	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Noise Figure Meter HP-IB Address	40.0	None	N	Y	N	NC	NC
External LO HP-IB Address	40.1	EA or 40.1SP	N	Y	N	NC	NC

Table categories are explained in the Special Functions Detailed Operating Instruction.

**Example**

To display the external LO address and change it to 20:



**Program Codes**



The program code to display the HP-IB address of the external LO is EA. The external LO address can be changed by entering a decimal number from 0 to 30 and then EN (the program code for ENTER). The HP-IB address of the Noise Figure Meter cannot be read or changed over the HP-IB.

**Indications**

The HP-IB address of the corresponding special function appears in the left display when either Special Function 40.0 or 40.1 is selected. When an HP-IB address is changed, the new address appears in the left display for as long as the ENTER key is depressed. When the ENTER key is released, the instrument returns to the last selected measurement.

**Comments**

Do not set the Noise Figure Meter HP-IB address equal to the external LO HP-IB address.

**Related Sections**

Controller Capability of the Noise Figure Meter  
Remote Operation, HP-IB  
Special Functions

# IF Attenuation Selection

## (Special Functions 70, 71, and 72)

**Description**

IF attenuation selection, display, and hold are available in all measurement modes. It should be noted, however, that only the hold capability (Special Function 72.0) is normally used by most operators. The hold is required during manual measurements (refer to the Manual Measurements Detailed Operating Instruction for additional information). The selection and display of specific IF attenuation settings are more likely to be used during adjustment procedures, performance tests, or troubleshooting procedures. In some specialized applications these capabilities can be helpful, but care must be exercised when using them. It is possible to introduce some very subtle errors in the measurements that the Noise Figure Meter may not be able to guard against. Additional information on how to use and interpret these Special Functions is contained in Section VIII, Service.

**Procedure**

To select a specific IF attenuation setting, display, or hold, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
<b>IF Attenuation Selection</b>							
Auto	70.0	I0 or 70.0SP	N	N	N	On	On
0 dB	70.1	I1 or 70.1SP	Y	N	N	Off	Off
5 dB	70.2	I2 or 70.2SP	Y	N	N	Off	Off
10 dB	70.3	I3 or 70.3SP	Y	N	N	Off	Off
15 dB	70.4	I4 or 70.4SP	Y	N	N	Off	Off
20 dB	70.5	I5 or 70.5SP	Y	N	N	Off	Off
25 dB	70.6	I6 or 70.6SP	Y	N	N	Off	Off
30 dB	70.7	I7 or 70.7SP	Y	N	N	Off	Off
35 dB	70.8	I8 or 70.8SP	Y	N	N	Off	Off
<b>Display IF Attenuator Settings</b>							
Display IF Attenuator	71.0	SI or 71.0SP	N	N	N	Off	Off
<b>IF Attenuator Hold</b>							
IF Attenuator Hold	72.0	IH or 72.0SP	Y	N	N	Off	Off
Table categories are explained in the Special Functions Detailed Operating Instruction.							

## IF Attenuation Selection (cont'd)

### (Special Functions 70, 71, and 72)

**Example** To select the IF attenuator hold function:

LOCAL (keystrokes)	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>Code</p> <div style="display: flex; justify-content: center; gap: 10px;"> <div style="border: 1px solid black; padding: 2px 5px;">7</div> <div style="border: 1px solid black; padding: 2px 5px;">2</div> <div style="border: 1px solid black; padding: 2px 5px;">.</div> <div style="border: 1px solid black; padding: 2px 5px;">0</div> </div> </div> <div style="text-align: center;"> <p>Function</p> <div style="border: 1px solid black; padding: 2px 5px; display: flex; align-items: center; gap: 5px;"> <span style="font-size: 0.8em;">●</span> <span style="font-size: 0.8em;">SPECIAL FUNCTION</span> </div> </div> </div>
<div style="text-align: center; margin-bottom: 5px;"> <span style="border: 1px solid black; padding: 2px 5px;">HP-IB</span> </div> (program codes)	IH

**Program Codes** For HP-IB codes, refer to Procedure.

HP-IB

**Indications** When Special Function 71 is implemented, three digits appear in the left display. The digits are either "1" (yes) or "0" (no) to indicate whether or not the corresponding attenuator is switched into the 20 MHz IF Assembly circuits (see Service Sheets 3 and 4 in Section VIII, Service). The first (most significant) digit represents 20 dB. The second digit represents 10 dB. The third (least significant) digit represents 5 dB. To obtain the IF attenuator setting, add the attenuation that is represented by each digit. For example, a display of "1 0 1" indicates an IF attenuator setting of 25 dB.

**Comments** If any of the 60 or 70 series of Special Functions (except 60.0 and 70.0) are active, the calibration sequence does not override them. Therefore, to calibrate on one range only, use any of these Special Functions except 60.0 or 70.0. It is also true that if any of these Special Functions are inadvertently active, the calibration sequence will not cover the expected gain range.

**Related Sections**

- Calibrate
- Manual Measurements
- RF Attenuation Selection
- Special Functions



# Loss Compensation

## (Special Function 34)

**Description** Special Function 34 corrects for loss between the noise source and the device under test (DUT), and the DUT and the Noise Figure Meter. The loss in dB and the temperature of the loss must be entered prior to enabling loss compensation (Special Function 34.1) or else the default values of 0 dB and 0K are used.

The temperature of the loss is the ambient temperature. Therefore, both the loss before the DUT and the loss after the DUT are assumed to be at the same temperature. Only one temperature can be entered for both losses. The temperature of the loss can be entered in Kelvins, degrees Fahrenheit, or degrees Celsius. Temperature units are selected by Special Function 11.

The allowable range of loss in Kelvins is 0 to 9999. The allowable range of loss in dB is -100 to +100.

**Procedure** To display, enter, or enable loss compensation, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Turn loss compensation off.	34.0	L0 or 34.0SP	N	Y	N	On	On
Turn loss compensation on.	34.1	L1 or 34.1SP	Y	Y	N	Off	Off
Display and enter the amount of loss between the noise source and the DUT in dB.	34.2	LA or 34.2SP	N	Y	N	NC	0 dB
Display and enter the temperature of losses (units are determined by Special Function 11).	34.3	LT or 34.3SP	N	Y	N	NC	0K
Display and enter the amount of loss between the DUT and the Noise Figure Meter in dB.	34.4	LB or 34.3SP	N	Y	N	NC	0 dB

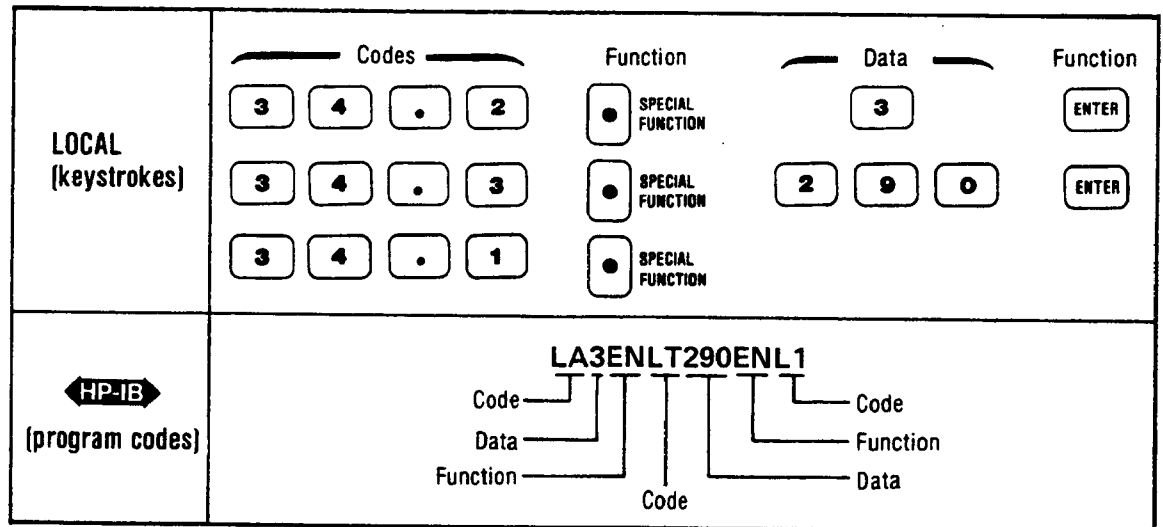
Table categories are explained in the Special Functions Detailed Operating Instruction.

## Loss Compensation (cont'd)

### (Special Function 34)

**Example**

To compensate for a loss of 3 dB between the noise source and the DUT at a temperature of 290K (assume Special Function 11.0 is active — temperature in K) and to enable the loss compensation function:



**Program Codes**



For HP-IB codes, refer to Procedure above.

**Indications**

If Special Function 34.0 or 34.1 is selected, the left display returns to the previously selected display. The INSERTION GAIN and NOISE FIGURE displays are not affected by this function.

**Comments**

When a loss compensation entry is made in dB, the temperature of the loss should also be entered.

The Noise Figure Meter assumes that the loss was not present during calibration.

**Related Sections**

Special Functions  
Temperature Units Selection

# Manual Measurement Functions

## (Special Functions 14 and 15)

**Description**

The manual measurement functions calibrate and measure noise figure using a thermal (hot/cold) noise source. They also can be used to display either the current measurement or the result of the manual measurement. Manual measurement functions are used for fixed frequency measurements only.

Three general requirements must be understood when performing manual measurements:

1. A stable reading must be stored in the Noise Figure Meter's memory prior to disconnecting the noise source. This stable reading can be obtained by either activating the next manual measurement special function or by using the Trigger Selection Special Function (30). Since activating the next special function requires fewer keystrokes, that is the method used in the example shown in this instruction.
2. The device under test (DUT) must first be connected to the measurement system and the proper RF attenuation level determined. The RF attenuators must then be held fixed (Special Function 62) for the entire manual measurement.
3. The IF attenuators must be held fixed (Special Function 72) during the two measurement readings (noise source off and on) and again during the two calibration readings (noise source off and on). However, the IF attenuators must be allowed to autorange when switching between calibration and measurements, and vice versa.

**Procedure**

To measure, calibrate, or display manual measurements, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Make cold measurements (source off).	14.1	MC or 14.1SP	N	Y	Y	Off	Off
Make hot measurements (source on).	14.2	MH or 14.2SP	N	Y	Y	Off	Off
Perform cold calibration (source off).	14.3	CC or 14.3SP	N	Y	Y	Off	Off
Perform hot calibration (source on).	14.4	CH or 14.4SP	N	Y	Y	Off	Off
Normal display mode.	15.0	P0 or 15.0SP	N	N	Y	On	On
Display manual measurement results	15.1	P1 or 15.1SP	Y	N	Y	Off	Off

Table categories are explained in the Special Functions Detailed Operating Instruction.

## Manual Measurement Functions (cont'd)

### (Special Functions 14 and 15)

**Example**

The following example is a general procedure for making manual measurements. It may be necessary to determine the requirements of a specific application and make the necessary changes to obtain the best measurement results. For example, it is possible to make manual measurements using an external controller. Additional information on this method is contained in the Comments section of this instruction.

**Find and Hold the RF Attenuation**

- a. Enter the required parameters for the Measurement Mode that is going to be used.
- b. Connect the hot noise source to the DUT input. Connect the DUT output to the measurement system setup.
- c. Press 1 4 . 2 SPECIAL FUNCTION to obtain the noise power.
- d. Press 6 2 . 0 SPECIAL FUNCTION to hold the RF attenuation setting. The RF attenuation is held at this setting for the entire measurement.

**Calibrate**

- e. Remove the DUT and connect the hot noise source to the measurement system setup.
- f. Press 1 4 . 4 SPECIAL FUNCTION to calibrate the measurement system for the hot noise source.
- g. Press 7 2 . 0 SPECIAL FUNCTION to hold the IF attenuation setting.
- h. Press 1 4 . 3 SPECIAL FUNCTION to store the hot noise source calibration reading and to select the cold noise source calibration. Note that while the cold noise source calibration is selected, the results are not stored until after the cold noise source is connected and Special Function 14.2 is activated in step j.
- i. Remove the hot noise source and connect the cold noise source to the measurement system setup.
- j. Press 1 4 . 2 SPECIAL FUNCTION to select the hot noise source measurement and to store the cold noise source calibration reading.

**Measure, then Calculate and Display Noise Figure**

- k. Connect the hot noise source to the DUT and the DUT to the measurement system setup.
- l. Press 7 0 . 0 SPECIAL FUNCTION to allow the IF attenuators to autorange.
- m. Press 7 2 . 0 SPECIAL FUNCTION to hold the IF attenuation fixed at the new value.
- n. Press 1 4 . 1 SPECIAL FUNCTION to select the cold noise source measurement and to store the hot noise measurement reading.
- o. Disconnect the hot noise source from the DUT and connect the cold noise source to the DUT.

## Manual Measurement Functions (cont'd)

### (Special Functions 14 and 15)

#### Example (cont'd)

p. Press 1 5 . 1 SPECIAL FUNCTION to calculate and display the manual measurement noise figure result. Verify that the LED in the SPECIAL FUNCTION key lights when this special function is activated. The Noise Figure Meter continues to make cold noise source measurements and update the display.

#### NOTE

*The calibration data remains stored. Therefore, if another DUT is to be tested immediately, it is only necessary to press 1 4 . 2 SPECIAL FUNCTION and repeat steps k through p. To exit manual measurements and return to the normal display, press 1 5 . 0 SPECIAL FUNCTION and then press UNCORRECTED NOISE FIGURE.*

#### Program Codes

For HP-IB codes, refer to Procedure above.

◀HP-IB▶

#### Indications

When Special Functions 15.0 and any 14.N are selected, no unit annunciators are lit in the NOISE FIGURE display. The number displayed is the power into the detector in mW.

#### Comments

When Special Function 15.1 is selected, UNCORRECTED NOISE FIGURE, CORRECTED NOISE FIGURE AND GAIN, or any noise figure display unit (Special Function 10) can be selected.

Another way to ensure that stable readings are stored in the Noise Figure Meter's memory during Manual Measurements is to use the Trigger Hold Special Function (30.1) and Trigger Execute Special Function (30.2). In this type of operation only one measurement is taken and stored. Therefore, it is not critical if the equipment is disconnected prior to switching Manual Measurement Special Functions.

#### Related Sections

IF Attenuation Selection  
RF Attenuation Selection  
Special Functions  
Trigger Selection

## Measurement Modes (Special Function 1)

### Description

The Noise Figure Meter has five Measurement Modes available. Each Measurement Mode, 1.0 through 1.4, is described individually in a separate Detailed Operating Instruction. This discussion covers the capabilities and differences of the individual modes. The following table lists the modes and shows their status in different instrument operations.

Special Function		Program Code ↔HP-IB↔	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Measurement Mode 1.0—10 to 1500 MHz	1.0	E0	N	Y	Y	On	On
Measurement Mode 1.1—variable frequency external LO; fixed IF	1.1	E1	N	Y	Y	Off	Off
Measurement Mode 1.2—fixed frequency external LO; variable IF	1.2	E2	N	Y	Y	Off	Off
Measurement Mode 1.3—variable frequency external LO; fixed IF; mixer in DUT	1.3	E3	N	Y	Y	Off	Off
Measurement Mode 1.4—fixed frequency external LO; variable IF; mixer in DUT	1.4	E4	N	Y	Y	Off	Off

Table categories are explained in the Special Functions Detailed Operating Instruction.

The five Measurement Modes can be divided into the following three subsets:

a. Measurement Mode 1.0 is a stand alone mode with no external mixer or LO required and no frequency conversion in the device under test. The frequency range in this mode is 10 to 1500 MHz.

b. Measurement Modes 1.1 and 1.3 both require a variable frequency LO and an external mixer. In either of these modes the Noise Figure Meter can be used to control the external LO and vary the LO frequency as directed by the external LO program (Special Function 41 or 42). Both modes down convert the measurement frequency to the 10 to 1500 MHz range of the Noise Figure Meter. Measurement Mode 1.1 has no down conversion in the DUT (for example, an amplifier or transistor). Measurement Mode 1.3 does down convert in the DUT (for example, a mixer or receiver).

c. Measurement Modes 1.2 and 1.4 both require a fixed frequency LO and a variable IF. As stated for the previous subset, Measurement Mode 1.2 has frequency conversion in the measurement system but not in the DUT and Measurement Mode 1.4 has frequency conversion in the DUT. Mode 1.2 must be a single sideband measurement. Additional information on sideband selection is covered later in this instruction and in the Sideband Selection Detailed Operating Instruction.

The calibration and measurement setups and procedures are illustrated and specific examples are provided in the Detailed Operating Instructions for Measurement Modes 1.0 through 1.4.

## Measurement Modes (cont'd)

### (Special Function 1)

#### Signal Comparison

In the following discussion, signals present at different points in the measurement system are compared for the different measurement modes. The following signal points are covered:

- a. The output of the noise source (for example the HP 346B).
- b. The output of the external LO.
- c. The measurement bandwidth of the Noise Figure Meter as seen looking back into the mixer (translated to the frequency range of the external LO).
- d. The input to the Noise Figure Meter.

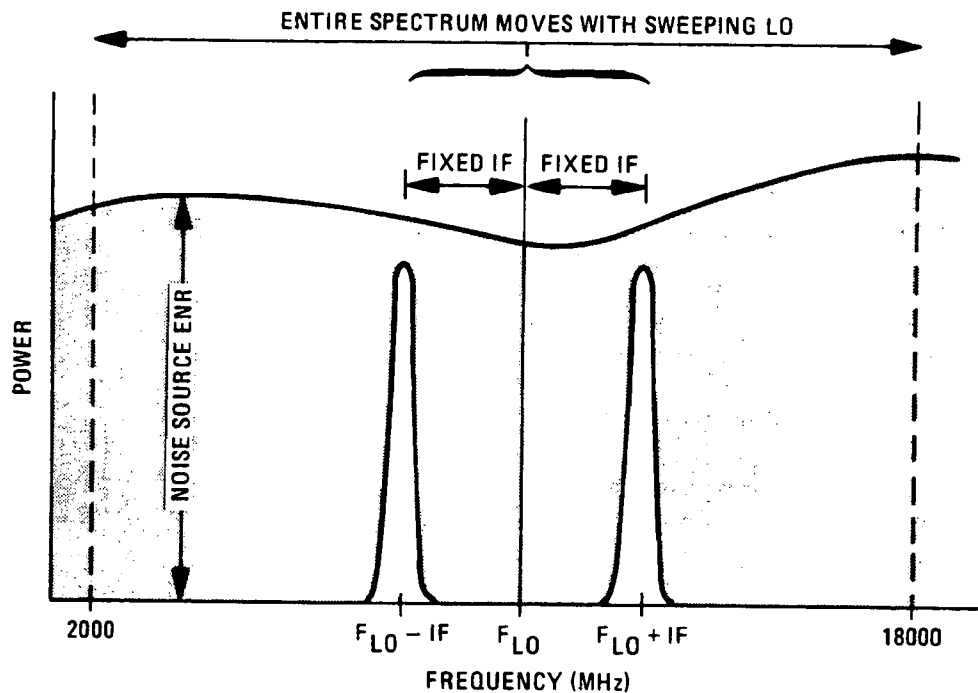
The noise source output is the same for all modes. For a noise source with a nominal Excess Noise Ratio (ENR) of 15.2 dB, the output is broadband random noise varying between approximately  $-158.8$  dBm/Hz when on (hot) and  $-174$  dBm/Hz when off (cold). The ENR of the noise source varies slightly over the frequency range of 10 to 18000 MHz. This variation in power level is compensated for in the Noise Figure Meter using the specific information entered into the ENR table. Refer to the ENR Table Entry Detailed Operating Instruction for additional information on the ENR table.

There is no external LO used in Measurement Mode 1.0. In Measurement Modes 1.1 and 1.3, the external LO can be swept over any range in the 2 to 18 GHz range using the existing external LO programs. The Noise Figure Meter's programs can be modified to sweep the LO up to 60 GHz. In Measurement Modes 1.2 and 1.4, the fixed LO frequency can be set to any point within the 10 MHz to 60 GHz range. The limiting factors within this range are the frequency ranges of the external LO and the noise source.

There is no mixer used in Measurement Mode 1.0. Looking back into the mixer in Measurement Modes 1.1 and 1.3, the Noise Figure Meter passband translates into two sidebands. Each sideband is separated from the LO frequency by a fixed IF (the receiving frequency of the Noise Figure Meter). As the LO frequency sweeps, the sidebands move with it. The frequency can be increased or decreased within the allowable frequency range. In Measurement Modes 1.2 and 1.4 the LO frequency is held fixed. As the variable IF sweeps, the sidebands move away from the LO frequency in opposite directions for an increasing IF sweep and toward the LO frequency for a decreasing IF sweep. Examples of both a fixed IF and a variable LO, and a variable IF and fixed LO are shown in the Noise Figure Meter Measurement Passband figure.

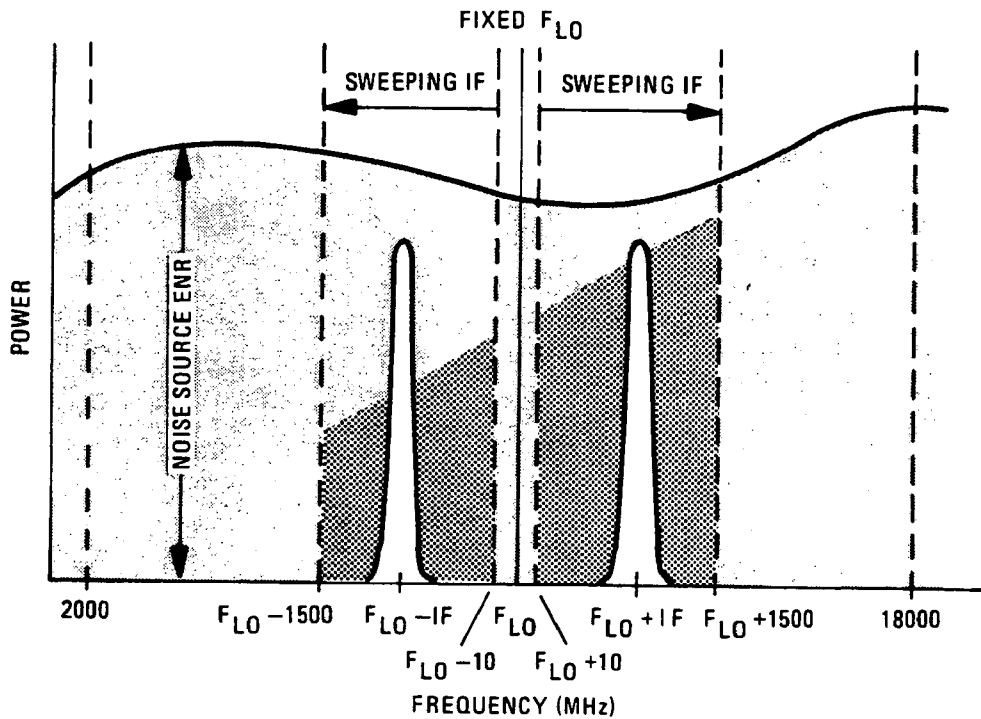
The Noise Figure Meter's input frequency range is 10 to 1500 MHz. In Measurement Mode 1.0 a swept measurement can sweep the Noise Figure Meter's 4 MHz passband over the 10 to 1500 MHz range. In Modes 1.1 and 1.3, the IF is fixed and the LO frequency is swept within the frequency ranges previously explained. In Modes 1.2 and 1.4, the LO frequency is fixed and the IF is swept across the 10 to 1500 MHz range. In Modes 1.1, 1.3, and 1.4 (because of the frequency conversion) either upper, lower, or both sidebands can be accepted by the Noise Figure Meter. However, in Mode 1.2, a double sideband measurement cannot be made (the Noise Figure Meter will display error E34). In this mode, a double sideband measurement is meaningless because the average measurement frequency is the LO frequency and it does not change as the IF is swept.

For Measurement Modes 1.1 and 1.3:



NOISE POWER FROM NOISE SOURCE WHEN ON

For Measurement Modes 1.2 and 1.4:



NOISE POWER FROM NOISE SOURCE WHEN ON

VARIABLE INTERMEDIATE FREQUENCY TUNING RANGE



## Measurement Modes (cont'd)

### (Special Function 1)

**Indications**

The frequencies displayed in the left display for various measurement conditions are shown in the following table. The displayed frequency depends upon the measurement mode used and the sideband selected (Special Function 2). In Measurement Mode 1.0, no external conversion is performed so the left display represents the measurement signal ( $F_{\text{signal}}$ ). In Measurement Modes 1.1, 1.2, 1.3, and 1.4 conversion is performed, thus creating an external IF. The Noise Figure Meter is tuned to this IF while the external local oscillator is tuned to  $F_{\text{LO}}$ .

**Noise Figure Meter Left Display**

Selected Sideband	Measurement Mode				
	1.0	1.1	1.2	1.3	1.4
Double Sideband (2.0SP)	$F_{\text{signal}}$	$F_{\text{LO}}$	not allowed	$F_{\text{LO}}$	IF
Lower Single Sideband (2.1SP)	$F_{\text{signal}}$	$F_{\text{LO}} - \text{IF}$	$F_{\text{LO}} - \text{IF}$	$F_{\text{LO}} - \text{IF}$	IF
Upper Single Sideband (2.2SP)	$F_{\text{signal}}$	$F_{\text{LO}} + \text{IF}$	$F_{\text{LO}} + \text{IF}$	$F_{\text{LO}} + \text{IF}$	IF

**Measurement Mode and Sideband Selection**

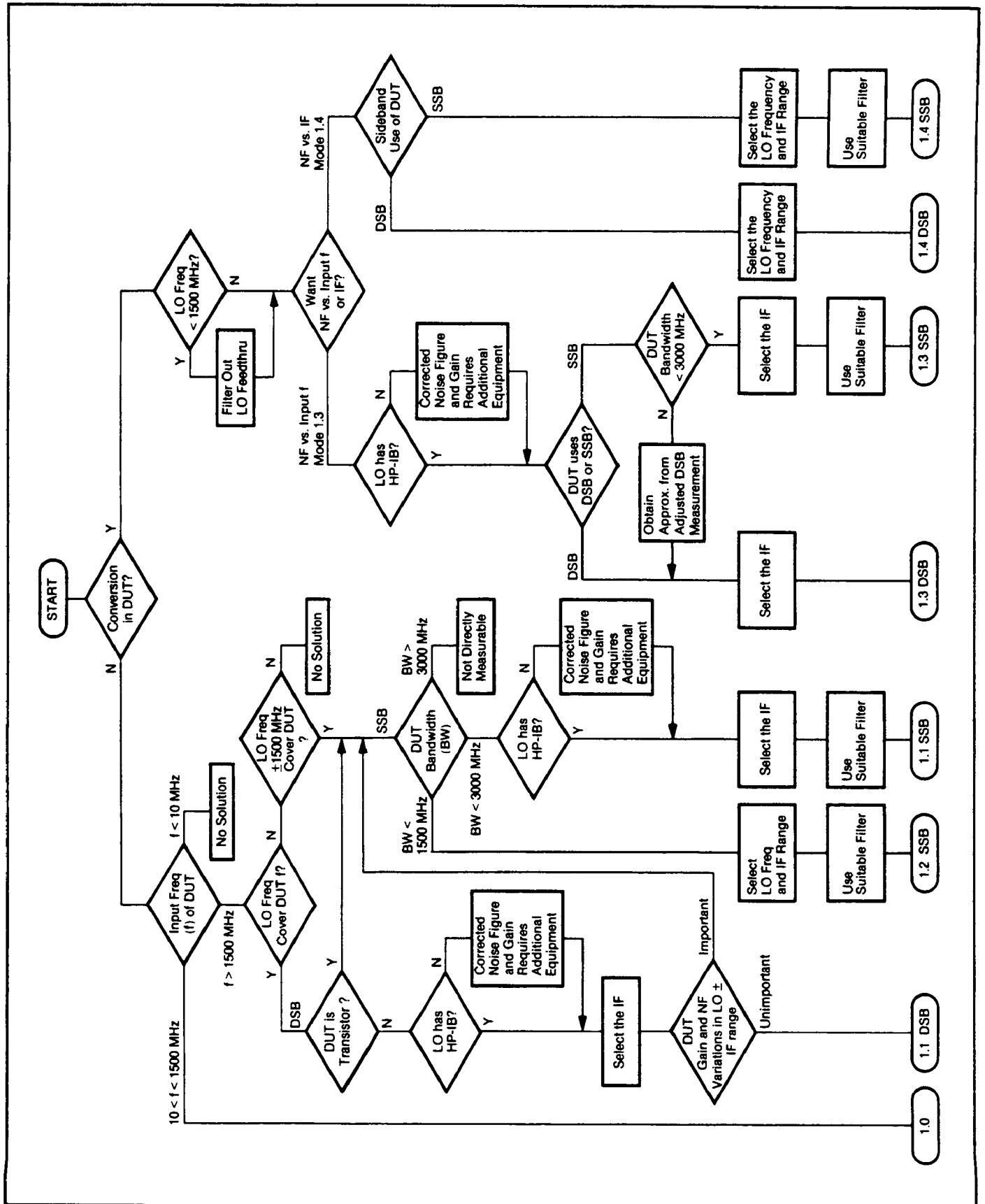
Prior to making any measurement, the Measurement Mode and sideband operation that are best suited to that specific measurement must be chosen.

The Measurement Mode and Sideband Selection Flowchart provides a means of determining which Measurement Mode will best suit a specific application and which type of sideband operation will give the best results.

Each of the Detailed Operating Instructions for Measurement Modes 1.0 through 1.4 has valid examples of the type of measurements that are made in each mode. Apply the flowchart instructions to each Measurement Mode example to illustrate the decision-making process for selecting that mode.

**Related Sections**

- Calibrate
- ENR Table Entry
- Fixed IF or LO Frequency Selection
- Measurement Modes 1.0 through 1.4
- Sideband Selection



Measurement Mode and Sideband Selection Flowchart

# Measurement Mode 1.0

(Special Function 1.0)

## Description

Measurement Mode 1.0 provides direct noise figure and gain measurements in the frequency range of 10 to 1500 MHz. No external mixer or LO is required. All of the Measurement Modes can be set up to use many of the other capabilities of the Noise Figure Meter. For example, each mode can make either **UNCORRECTED NOISE FIGURE** or **CORRECTED NOISE FIGURE AND GAIN** measurements. In addition, the measurement results for each mode can be displayed on an oscilloscope. For an explanation and comparison of the five Measurement Modes and instructions on how to choose the appropriate Measurement Mode and sideband operation, refer to the Measurement Modes Detailed Operating Instruction.

## Procedure

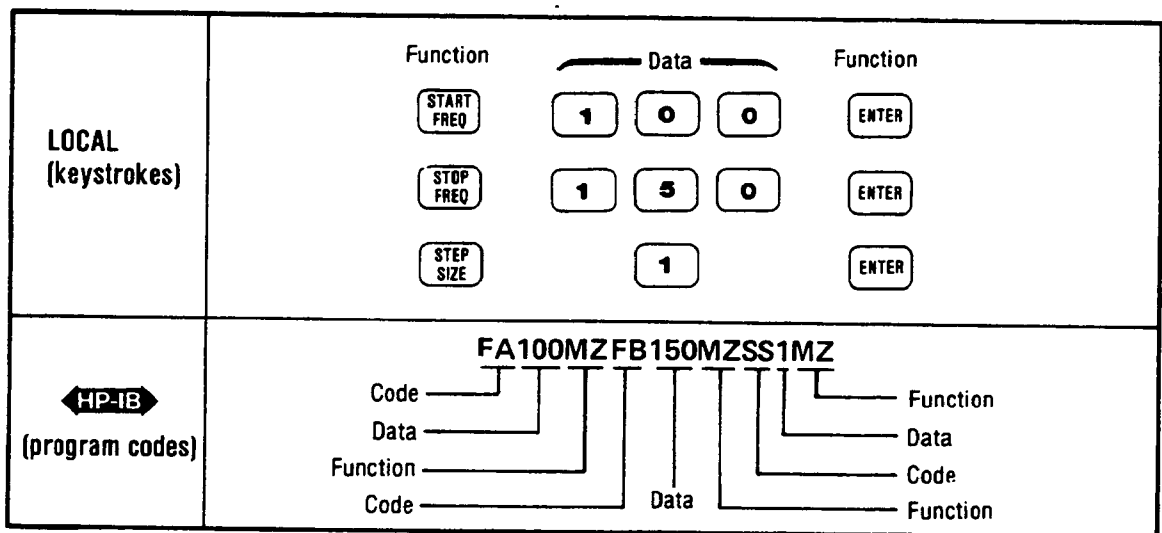
There are many possible measurement procedures. However, the following general procedure applies to all cases:

- a. Set frequency parameters.
- b. Calibrate in Mode 1.0 (this is only required for a **CORRECTED NOISE FIGURE AND GAIN** measurement).
- c. Insert DUT and measure.

## Example

To make a swept **CORRECTED NOISE FIGURE AND GAIN** measurement in the 100 to 150 MHz range in 1 MHz steps:

- a. Press **PRESET** (or send HP-IB code **PR**) to establish initial conditions. This sets the Noise Figure Meter to Measurement Mode 1.0.
- b. Set the frequency parameters for both the calibration and measurement.
- c. Enter actual ENR for the Noise Source, if this has not previously been done.

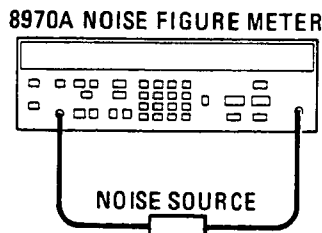


## Measurement Mode 1.0 (cont'd)

### (Special Function 1.0)

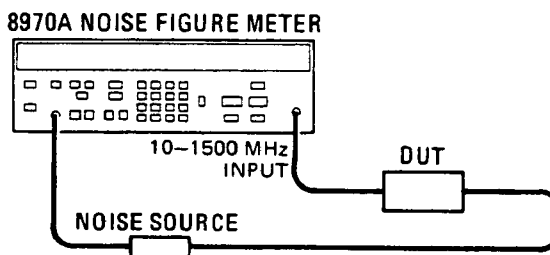
**Example (cont'd)**

d. To calibrate the Noise Figure Meter, set up the equipment as shown below.



e. Calibrate the equipment in Measurement Mode 1.0 by pressing CALIBRATE (or send HP-IB code CA). The Noise Figure Meter was set to Measurement Mode 1.0 when PRESET was pressed.

f. To make the measurement, set up the equipment as shown below.



g. Press CORRECTED NOISE FIGURE AND GAIN (or send HP-IB code M2).

h. Press SINGLE (or send HP-IB code W2). The Noise Figure Meter will sweep from 100 MHz to 150 MHz in 1 MHz steps and halt.

**Program Codes**



The HP-IB code for Measurement Mode 1.0 is E0 (or 1.0SP).

**Indications**

The left display shows each frequency at which a measurement is made. The INSERTION GAIN display shows the gain of the DUT at the displayed frequency. The NOISE FIGURE display shows the noise figure of the DUT at the displayed frequency.

**Comments**

Measurement Mode 1.0 is often referred to as an RF measurement. The other four Measurement Modes are often referred to as microwave measurements.

**Related Sections**

Calibrate  
Measurement Modes  
Special Functions

# Measurement Mode 1.1

## (Special Function 1.1)

### Description

Measurement Mode 1.1 provides a means of controlling an external LO to obtain a measurement frequency higher than 1500 MHz. This mode allows for down conversion in the measurement system but not in the device under test (DUT). Although the signal measured at the Noise Figure Meter INPUT is always in the range of 10 to 1500 MHz, the Noise Figure Meter uses the Excess Noise Ratio (ENR) of the noise source at the measurement frequency. A typical DUT is an amplifier or transistor. An external LO and a mixer are required. All of the Measurement Modes can be set up to use many of the other capabilities of the Noise Figure Meter. For example, each mode can make either UNCORRECTED NOISE FIGURE or CORRECTED NOISE FIGURE AND GAIN measurements, plus the measurement results for each mode can be displayed on an oscilloscope. For an explanation and comparison of the five Measurement Modes and instructions on how to choose the appropriate Measurement Mode and sideband operation, refer to the Measurement Modes Detailed Operating Instruction.

The following minimum requirements are necessary for the Noise Figure Meter to act as a controller in Measurement Mode 1.1:

- a. HP-IB cable connected between the Noise Figure Meter and the external LO.
- b. Special Function 4.1 (external LO control) active. If Special Function 4.1 is selected, no other controller can communicate with the Noise Figure Meter. However, it is possible to perform this function using an external controller to control both the Noise Figure Meter and the external LO. For additional information refer to Comments at the end of this instruction.
- c. The HP-IB address of the external LO must match the external LO address that is stored in the Noise Figure Meter. Use Special Function 40.1 (external LO HP-IB address) to display and change this address if necessary.
- d. The correct external LO program must be active if the Noise Figure Meter is going to control the external LO. Use Special Function 41.0 for the HP 8350B Sweep Oscillator or Special Function 41.2 for the HP 8672A Synthesized Signal Generator or Special Function 41.3 for the HP 8673B Synthesized Signal Generator. Use Special Function 42 to define a new program for other external LOs.

### Procedure

There are many possible measurement procedures. However, the following general procedure applies to all cases:

- a. Verify that the minimum requirements specified in the description are satisfied.
- b. Press 1 . 1 SPECIAL FUNCTION to set the Noise Figure Meter to Measurement Mode 1.1.
- c. Set frequency parameters (including the fixed IF, Special Function 3.0).
- d. Calibrate in Mode 1.1.
- e. Insert DUT and measure.

### Example

To make a swept double sideband CORRECTED NOISE FIGURE AND GAIN measurement in the 6 to 12 GHz range in 200 MHz steps with a fixed IF of 70 MHz:

## Measurement Modes (cont'd)

### (Special Function 1.1)

**Example  
(cont'd)**

**NOTE**

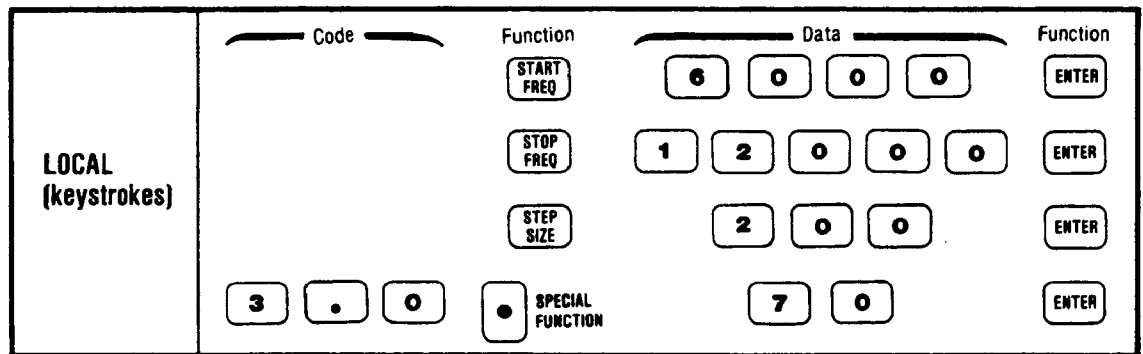
*This example assumes that the Noise Figure Meter is acting as a controller and the minimum requirements specified in the description are satisfied. Since no external controller can be used, no HP-IB codes are given in the example. Refer to Comments for a brief description of using an external controller when in Measurement Mode 1.1.*

- a. Press PRESET to establish initial conditions.

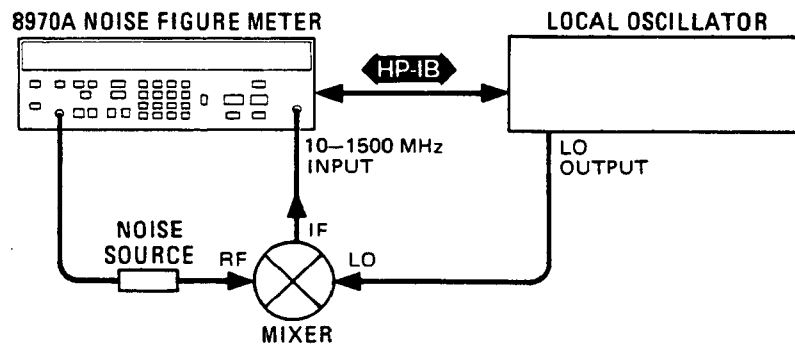
**NOTE**

*Measurement Mode 1.1 must be activated prior to entering the frequency parameters to avoid error E35 (entered value is out of range).*

- b. Press 1 . 1 SPECIAL FUNCTION to activate Measurement Mode 1.1.
- c. Set the frequency parameters for both the calibration and measurement.
- d. Enter actual ENR for the Noise Source, if this has not previously been done.



- e. To calibrate the Noise Figure Meter, set up the equipment as shown below.



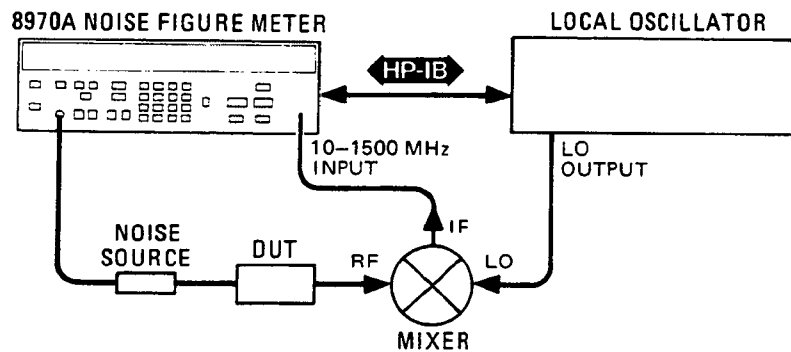
- f. Calibrate the equipment in Measurement Mode 1.1 by pressing CALIBRATE.

## Measurement Mode 1.1 (cont'd)

### (Special Function 1.1)

#### Example (cont'd)

- g. To make the measurement, set up the equipment as shown below.



- h. Press CORRECTED NOISE FIGURE AND GAIN.

- i. Press SINGLE. The Noise Figure Meter will sweep the external LO from 6 GHz to 12 GHz in 200 MHz steps and halt.

#### Program Codes



The HP-IB code for Measurement Mode 1.1 is E1 (or 1.1SP). Refer to Comments for additional information on using HP-IB program codes in Measurement Mode 1.1.

#### Indications

The left display shows each frequency at which a measurement is made and the EXT MIX annunciator lights. The INSERTION GAIN display shows the gain of the DUT at the displayed frequency. The NOISE FIGURE display shows the noise figure of the DUT at the displayed frequency.

#### Comments

An external controller can be used in place of the Noise Figure Meter to control the external LO and the Noise Figure Meter in Measurement Mode 1.1. The following general conditions must be observed when using an external controller:

- Special Function 4.0 (normal talker and listener) must be active. Note that there is no HP-IB code for this special function.
- Special Function 30.1 (trigger hold) must be active (HP-IB code is T1).
- The correct measurement parameters (for example, Measurement Mode, frequencies, etc.) must be established. Refer to Table 3-9, Special Function to HP-IB Code Summary, and Table 3-10, Front Panel Keys to HP-IB Code Summary, for applicable HP-IB codes.
- Perform a triggered calibration with the DUT out of the measurement system (refer to the Calibrate Detailed Operating Instruction)
- Insert the DUT into the measurement system.
- Set the Noise Figure Meter's SINGLE sweep on (HP-IB code is W2) or AUTO sweep on (HP-IB code is W1).

## Measurement Mode 1.1 (cont'd)

### (Special Function 1.1)

#### Comments (cont'd)

#### HP-IB

g. Set the external LO to the appropriate frequency. Refer to the LO's operating manual for the required HP-IB codes. Allow sufficient time for the output of the external LO to stabilize.

h. Trigger a measurement using the HP-IB code T2. Do not use the alternate HP-IB code 30.2SP for Special Function 30.2 as it will reset the sweep.

i. To determine when to step to a new frequency, read the noise figure results. This read operation cannot be completed until the new data is ready. It is also possible to write an SRQ interrupt routine on the Data Ready SRQ. Refer to Enabling the Service Request Condition, paragraph 3-29.

j. Continue to loop through steps g, h, and i. A method for determining when the measurements are complete must be programmed into the external controller. One method is to compare the frequency that is sent to the external LO with the stop frequency programmed into the Noise Figure Meter and terminate the program after the measurement in which they are equal.

#### Related Sections

Calibrate  
Controller Capability of the Noise Figure Meter  
Fixed IF or LO Frequency Selection  
Measurement Modes  
Sideband Selection  
Special Functions  
Trigger Selection



## Measurement Mode 1.2

### (Special Function 1.2)

#### Description

Measurement Mode 1.2 provides a means of using a fixed-frequency external LO with a variable IF in order to measure over a band of frequencies less than 1500 MHz wide. This mode allows for down conversion in the measurement system but not in the device under test (DUT). Single sideband operation and external filtering of the unwanted sideband are required. A typical DUT is an amplifier with a bandwidth of less than 1500 MHz. An external LO, an external filter and a mixer are required. Although the signal measured at the Noise Figure Meter INPUT is always in the range of 10 to 1500 MHz, the Noise Figure Meter uses the Excess Noise Ratio (ENR) of the noise source at the measurement frequency. All of the Measurement Modes can be set up to use many of the other capabilities of the Noise Figure Meter. For example, each mode can make either **UNCORRECTED NOISE FIGURE** or **CORRECTED NOISE FIGURE AND GAIN** measurements. Or, the measurement results for each mode can be displayed on an oscilloscope. For an explanation and comparison of the five Measurement Modes and instructions on how to choose the appropriate Measurement Mode and sideband operation, refer to the Measurement Modes Detailed Operating Instruction.

#### Procedure

There are many possible measurement procedures. However, the following general procedure applies to all cases:

- a. Select single sideband offset (use either Special Function 2.1 or 2.2).
- b. Press 1 . 2 **SPECIAL FUNCTION** to set the Noise Figure Meter to Measurement Mode 1.2.
- c. Set frequency parameters (including the fixed frequency for the external LO, Special Function 3.1).
- d. Calibrate in Mode 1.2 (this is only required for a **CORRECTED NOISE FIGURE AND GAIN** measurement). External filtering is required during both the calibration and the measurement.
- e. Insert DUT and measure.

#### Example

To make a swept **CORRECTED NOISE FIGURE AND GAIN** measurement of a wide-band amplifier in the 3.5 to 4.5 GHz range in 20 MHz steps:

- a. Press **PRESET** (or send HP-IB code PR) to establish initial conditions.
- b. Press 2 . 1 (or send HP-IB code B1) to select a lower sideband measurement.

#### NOTE

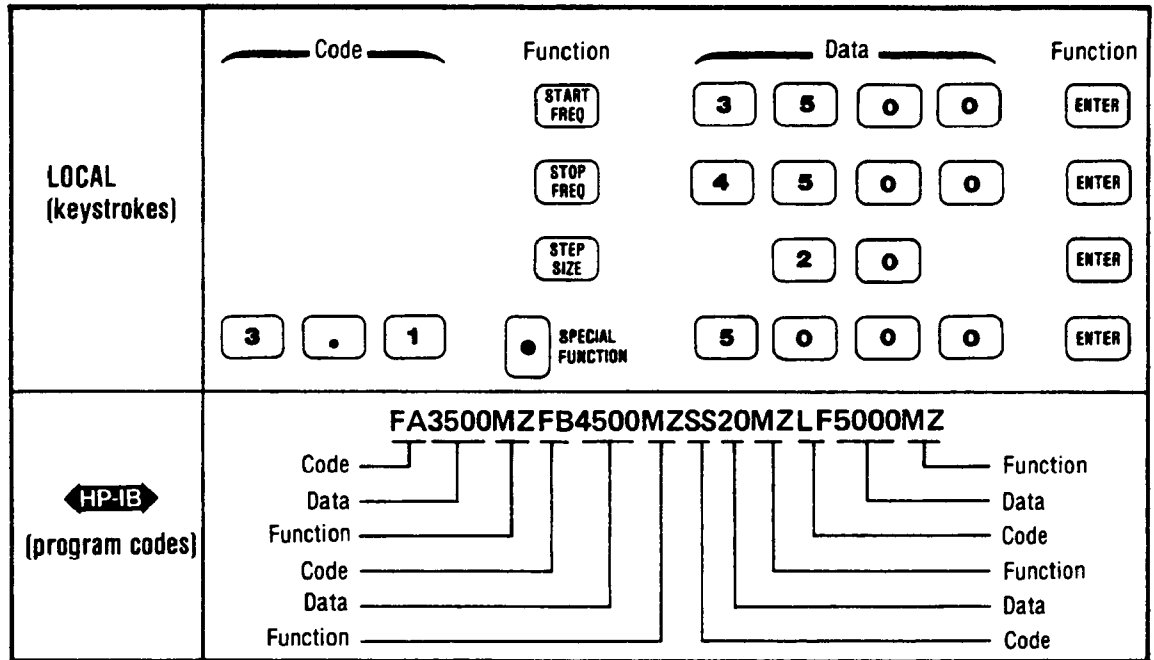
*Measurement Mode 1.2 must be activated prior to entering the frequency parameters to avoid error E35 (entered value is out of range).*

- c. Press 1 . 2 **SPECIAL FUNCTION** (or send HP-IB code E2) to activate Mode 1.2. Note that error E33 (IF will be out of range) is displayed. This error is cleared when the correct frequency parameters are entered in step d.
- d. Set the frequency parameters for both the calibration and measurement.

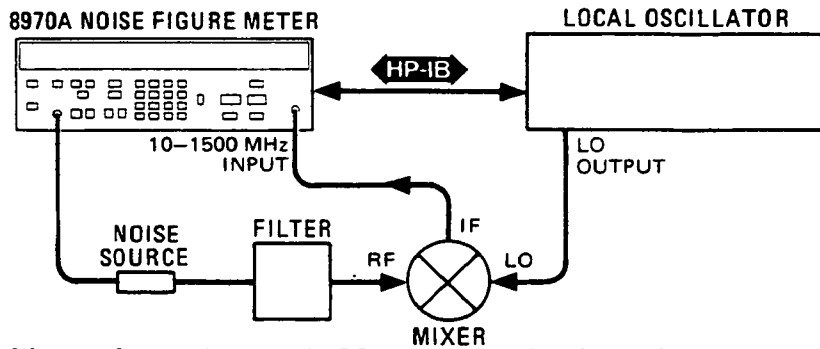
## Measurement Mode 1.2 (cont'd)

### (Special Function 1.2)

Example  
(cont'd)

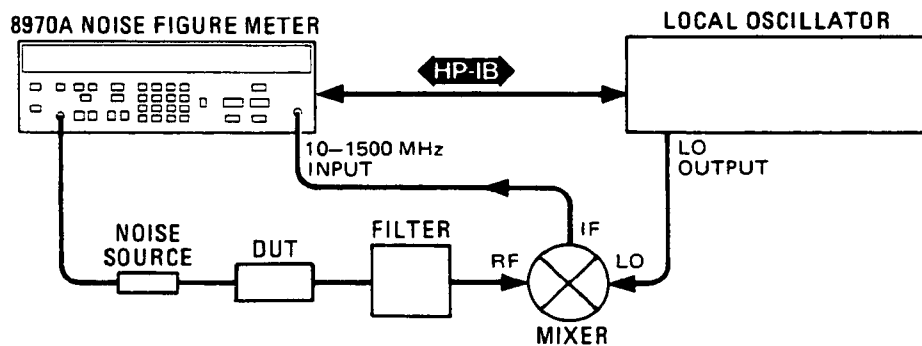


e. To calibrate the Noise Figure Meter, set up the equipment as shown below.



f. Calibrate the equipment in Measurement Mode 1.2 by pressing CALIBRATE (or sending HP-IB code CA).

g. To make the measurement, set up the equipment as shown below.



## Measurement Mode 1.2 (cont'd)

### (Special Function 1.2)

#### Example (cont'd)

#### NOTE

*This example assumes that the external LO is tuned to the specified frequency (5 GHz). If the Noise Figure Meter is controlling the LO, the LO tunes to 5 GHz when entered with Special Function 3.1 in step d. If the external LO is not controlled by the Noise Figure Meter, the LO must be separately tuned to 5 GHz. If the Enable External LO Control Special Function (4.1) is active, an external controller cannot be used with the Noise Figure Meter.*

- h. Press CORRECTED NOISE FIGURE AND GAIN (or send HP-IB code M2).
- i. Press SINGLE (or send HP-IB code W2). The Noise Figure Meter will sweep from 1500 to 500 MHz in 20 MHz steps but will display the microwave measurement frequency of 3500 to 4500 MHz. After the single sweep is completed, the instrument halts.

#### Program Codes

HP-IB

The HP-IB code for Measurement Mode 1.2 is E2 (or 1.2SP).

#### Indications

The left display shows each frequency at which a measurement is made and the EXT MIX annunciator lights. The INSERTION GAIN display shows the gain of the DUT at the displayed frequency. The NOISE FIGURE display shows the noise figure of the DUT at the displayed frequency.

#### Related Sections

Calibrate  
Controller Capability of the Noise Figure Meter  
Fixed IF or LO Frequency Selection  
Measurement Modes  
Sideband Selection  
Special Functions

## Measurement Mode 1.3

### (Special Function 1.3)

#### Description

Measurement Mode 1.3 provides a means of controlling an external LO to measure a frequency conversion device. This mode uses a fixed IF and allows for frequency conversion in the device under test (DUT). Although the signal measured at the Noise Figure Meter INPUT is always in the range of 10 to 1500 MHz, the Noise Figure Meter uses the Excess Noise Ratio (ENR) of the noise source at the measurement frequency. However, the correct 10 to 1500 MHz ENR is used during calibration. A typical DUT is a mixer or receiver. All of the Measurement Modes can be set to use many of the other capabilities of the Noise Figure Meter. For example, each mode can make either UNCORRECTED NOISE FIGURE or CORRECTED NOISE FIGURE AND GAIN measurements. Or, the measurement results for each mode can be displayed on an oscilloscope. For an explanation and comparison of the five Measurement Modes and instructions on how to choose the appropriate Measurement Mode and sideband operation, refer to the Measurement Modes Detailed Operating Instruction.

The following minimum requirements are necessary for the Noise Figure Meter to act as a controller in Measurement Mode 1.3:

- a. HP-IB cable connected between the Noise Figure Meter and the external LO.
- b. Special Function 4.1 (external LO control) active. If Special Function 4.1 is selected, no other controller can communicate with the Noise Figure Meter. Therefore, the HP-IB codes shown in the example cannot be used. However, it is possible to perform this function using an external controller to control both the Noise Figure Meter and the external LO. For additional information refer to Comments at the end of this instruction.
- c. The HP-IB address of the external LO must match the external LO address that is stored in the Noise Figure Meter. Use Special Function 40.1 to display and change this address if necessary.
- d. The correct external LO program must be active if the Noise Figure Meter is going to control the external LO. Use Special Function 41.0 for the HP 8350B Sweep Oscillator or Special Function 41.2 for the HP 8672A Synthesized Signal Generator or Special Function 41.3 for the HP 8673B Synthesized Signal Generator. Use Special Function 42 to define a new program for other external LOs.

#### Procedure

There are many possible measurement procedures. However, the following general procedure applies to all cases:

- a. Verify that the minimum requirements specified in the description are satisfied.
- b. Press 1 . 3 SPECIAL FUNCTION to set the Noise Figure Meter to Measurement Mode 1.3.
- c. Set frequency parameters (including the fixed IF, Special Function 3.0).
- d. Calibrate in Mode 1.3.
- e. Insert DUT and initiate sweep.

#### Example

To make a swept CORRECTED NOISE FIGURE AND GAIN measurement in the 3.0 to 4.5 GHz range in 20 MHz steps with a fixed IF of 70 MHz:

# Measurement Mode 1.3 (cont'd)

## (Special Function 1.3)

Example  
(cont'd)

**NOTE**

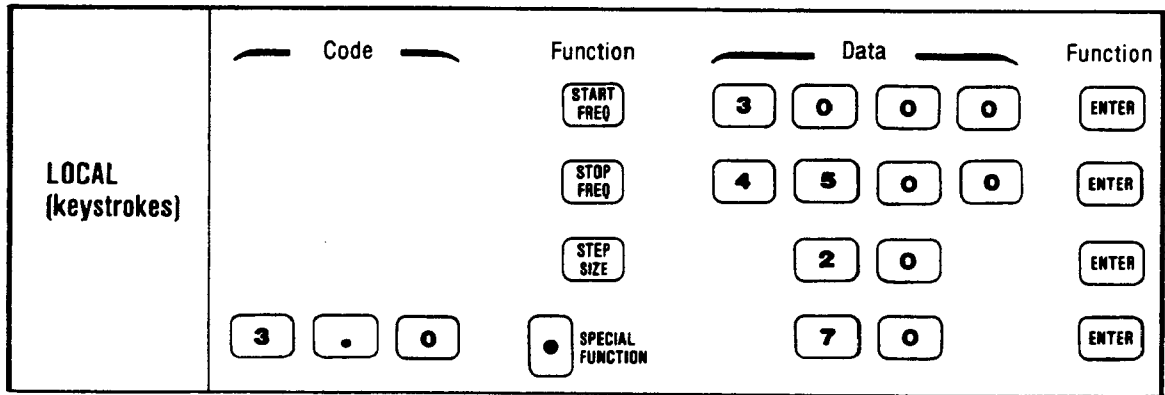
*This example assumes that the Noise Figure Meter is acting as a controller and the minimum requirements specified in the description are satisfied. Since no external controller can be used, no HP-IB codes are given in the example. Refer to Comments for a brief description of using an external controller when in Measurement Mode 1.3.*

- a. Press PRESET (or send HP-IB code PR) to establish initial conditions.

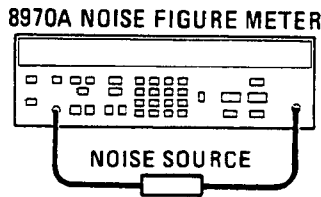
**NOTE**

*Measurement Mode 1.3 must be activated prior to entering the frequency parameters to avoid error E35 (entered value is out of range).*

- b. Press 1 . 3 SPECIAL FUNCTION to activate Measurement Mode 1.3.
- c. Set the frequency parameters for both the calibration and measurement.

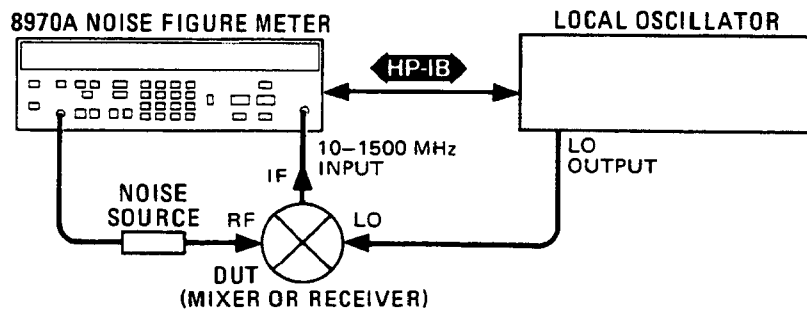


- d. To calibrate the Noise Figure Meter, set up the equipment as shown below.



- e. Calibrate the equipment in Measurement Mode 1.3 by pressing CALIBRATE.

- f. To make the measurement, set up the equipment as shown below.



## Measurement Mode 1.3 (cont'd)

### (Special Function 1.3)

#### Example (cont'd)

- g. Press CORRECTED NOISE FIGURE AND GAIN.
- h. Press SINGLE. The Noise Figure Meter will sweep the external LO from 3 GHz to 4.5 GHz in 20 MHz steps and halt.

#### Program Codes

HP-IB

The HP-IB code for Measurement Mode 1.3 is E3 (or 1.3SP). Refer to Comments for additional information on using HP-IB program codes in Measurement Mode 1.3

#### Indications

The left display shows each frequency at which a measurement is made and the EXT MIX annunciator lights. The INSERTION GAIN display shows the gain of the DUT at the displayed frequency. The NOISE FIGURE display shows the noise figure of the DUT at the displayed frequency.

#### Comments

An external controller can be used in place of the Noise Figure Meter to control the external LO and the Noise Figure Meter in Measurement Mode 1.3. The following general conditions must be observed when using an external controller:

- a. Special Function 4.0 (normal talker and listener) must be active. Note that there is no HP-IB code for this special function.
- b. Special Function 30.1 (trigger hold) must be active (HP-IB code is T1).
- c. The correct measurement parameters (for example, Measurement Mode, frequencies, etc.) must be established. Refer to Table 3-9, Special Function to HP-IB Code Summary, and Table 3-10, Front Panel Keys to HP-IB Code Summary, for applicable HP-IB codes.
- d. Perform a triggered calibration with the DUT out of the measurement system (refer to the Calibrate Detailed Operating Instruction).
- e. Insert the DUT into the measurement system.
- f. Set the Noise Figure Meter's SINGLE sweep on (HP-IB code is W2) or AUTO sweep on (HP-IB code is W1).
- g. Set the external LO to the appropriate frequency. Refer to the LO's operating manual for the required HP-IB codes. Allow sufficient time for the output of the external LO to stabilize.
- h. Trigger a measurement using the HP-IB code T2. Do not use the alternate HP-IB code 30.2SP for Special Function 30.2 as it will reset the sweep.
- i. To determine when to step to a new frequency, read the noise figure results. This read operation cannot be completed until the new data is ready. It is also possible to write an SRQ interrupt routine on the Data Ready SRQ. Refer to Enabling the Service Request Condition, paragraph 3-29.

## Measurement Mode 1.3 (cont'd)

### (Special Function 1.3)

#### Comments (cont'd)

j. Continue to loop through steps g, h, and i. A method for determining when the measurements are complete must be programmed into the external controller. One method is to compare the frequency that is sent to the external LO with the stop frequency programmed into the Noise Figure Meter and terminate the program after the measurement in which they are equal.

#### Related Sections

Calibrate  
Controller Capability of the Noise Figure Meter  
Fixed IF or LO Frequency Selection  
HP-IB Addresses  
Sideband Selection  
Special Functions  
Trigger Selection

## Measurement Mode 1.4

### (Special Function 1.4)

#### Description

Measurement Mode 1.4 provides a means of using a fixed-frequency external LO and testing over a variable IF range. This mode allows for down conversion in the device under test (DUT). Although the signal measured at the Noise Figure Meter INPUT is always in the range of 10 to 1500 MHz, the Noise Figure Meter uses the Excess Noise Ratio (ENR) of the noise source at the measurement frequency. However, the correct 10 to 1500 MHz ENR is used during calibration. A typical DUT is a mixer or receiver. An external LO is required. All of the Measurement Modes can be set up to use many of the other capabilities of the Noise Figure Meter. For example, each mode can make either UNCORRECTED NOISE FIGURE or CORRECTED NOISE FIGURE AND GAIN measurements. Or, the measurement results for each mode can be displayed on an oscilloscope. For an explanation and comparison of the five Measurement Modes and instructions on how to choose the appropriate Measurement Mode and sideband operation, refer to the Measurement Modes Detailed Operating Instruction.

#### Procedure

There are many possible measurement procedures. However, the following general procedure applies to all cases:

- a. Set frequency parameters (including the fixed frequency for the external LO, Special Function 3.1).
- b. Press 1 . 4 SPECIAL FUNCTION to set the Noise Figure Meter to Measurement Mode 1.4.
- c. Calibrate in Mode 1.4 (this is only required for a CORRECTED NOISE FIGURE AND GAIN measurement).
- d. Insert DUT and measure.
- e. The left display shows the swept IF.

#### Example

To make a swept CORRECTED NOISE FIGURE AND GAIN measurement over an IF of 10 MHz to 1 GHz using 20 MHz steps with a fixed external LO frequency of 10 GHz:

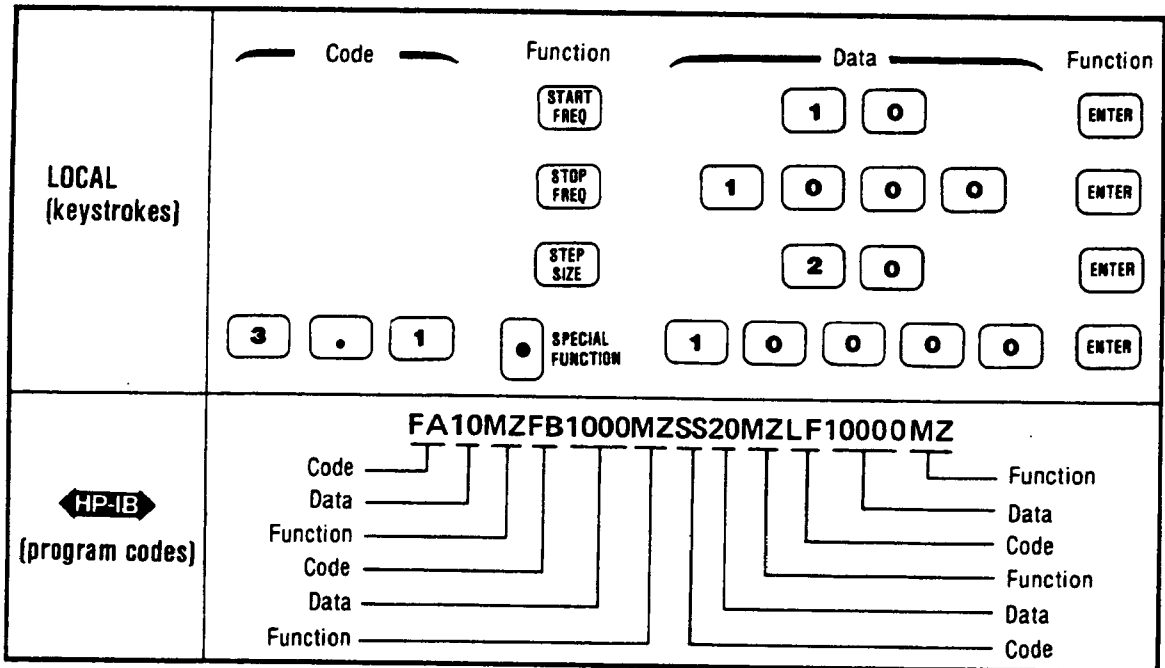
- a. Press PRESET (or send HP-IB code PR) to establish initial conditions.
- b. Set the frequency parameters for both the calibration and measurement.



## Measurement Mode 1.4 (cont'd)

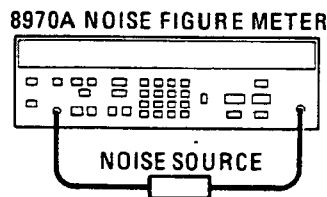
### (Special Function 1.4)

Example  
(cont'd)



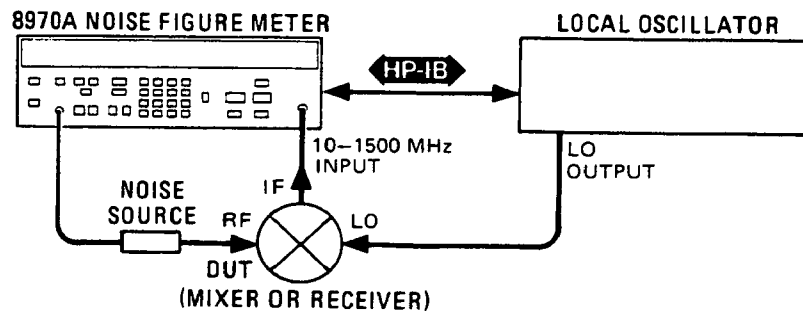
c. Press 1.4 SPECIAL FUNCTION (or send HP-IB code E4) to activate Measurement Mode 1.4.

d. To calibrate the Noise Figure Meter, set up the equipment as shown below.



e. Calibrate the equipment in Measurement Mode 1.4 by pressing CALIBRATE (or sending HP-IB code CA).

f. To make the measurement, set up the equipment as shown below.



## Measurement Mode 1.4 (cont'd)

### (Special Function 1.4)

#### Example (cont'd)

#### NOTE

*This example assumes that the external LO is tuned to the specified frequency (10 GHz). If the Noise Figure Meter is controlling the LO, the LO tunes to 10 GHz when Special Function 3.1 is entered in step b. If the external LO is not controlled by the Noise Figure Meter, the LO must be separately tuned to 10 GHz. If the Enable External LO Control Special Function (4.1) is active, an external controller cannot be used with the Noise Figure Meter.*

- g. Press CORRECTED NOISE FIGURE AND GAIN (or send HP-IB code M2).
- h. Press SINGLE (or send HP-IB code W2). The Noise Figure Meter will sweep from 10 to 1000 MHz in 20 MHz steps. After the single sweep is completed, the instrument halts.

#### Program Codes



The HP-IB code for Measurement Mode 1.4 is E4 (or 1.4SP).

#### Indications

The left display shows each IF frequency at which a measurement is made and the EXT MIX annunciator lights. The INSERTION GAIN display shows the gain of the DUT at the displayed frequency. The NOISE FIGURE display shows the noise figure of the DUT at the displayed frequency.

#### Related Sections

Calibrate  
Controller Capability of the Noise Figure Meter  
Fixed IF or LO Frequency Selection  
Sideband Selection  
Special Functions

# Noise Figure (Uncorrected) and Noise Figure and Gain (Corrected)

**Description**     **UNCORRECTED NOISE FIGURE** measures the combined noise figure of the device under test and the measurement system (including the effect of the local oscillator, mixer, cables, connectors and adapters).

**CORRECTED NOISE FIGURE AND GAIN** removes the measurement system noise contribution and allows only the noise figure and gain of the device under test to be displayed. The Noise Figure Meter must be calibrated in the measurement frequency range and measurement mode before a corrected noise figure and gain measurement can be made.

**Procedure**     To measure uncorrected noise figure, press the **NOISE FIGURE** key.

To measure corrected noise figure and gain, press the **NOISE FIGURE AND GAIN** key. If the Noise Figure Meter is not correctly calibrated, error code E20 will be displayed.

Front Panel Key	Program Code ⬅HP-IB➡	Stored in Continuous Memory	Can be Stored and Recalled	Preset (and HP-IB Clear) Conditions
NOISE FIGURE (UNCORRECTED)	M1	N	N	Active
NOISE FIGURE AND GAIN (CORRECTED)	M2	N	N	Off

Table categories are explained in the Preset Conditions and Power-Up Sequence Detailed Operating Instruction.

**Example**     To measure corrected noise figure and gain:

<b>LOCAL</b> (keystrokes)	Measurement ● CORRECTED NOISE FIGURE AND GAIN
⬅HP-IB➡ (program codes)	M2

**Program Codes**     For HP-IB program codes, refer to Procedure above.

⬅HP-IB➡

**Indications**     When the instrument is making uncorrected noise figure measurements, the **UNCORRECTED** LED above the **NOISE FIGURE** key is illuminated. The measurement result is displayed in the **NOISE FIGURE** display. In addition, the **INSERTION GAIN** display is blank.

## Noise Figure (Uncorrected) and Noise Figure and Gain (Corrected) (cont'd)

### Indications (cont'd)

When the instrument is making noise figure and gain measurements, the CORRECTED LED above the NOISE FIGURE AND GAIN key is illuminated. The gain of the device under test (DUT) appears in the INSERTION GAIN display and the noise figure of the DUT appears in the NOISE FIGURE display.

### Comments

For CORRECTED NOISE FIGURE AND GAIN measurements, it is necessary to calibrate the instrument each time there is a change in measurement modes, equipment (except the DUT), or frequency parameters (if the new frequency parameters are outside of the calibrated range).

UNCORRECTED NOISE FIGURE and CORRECTED NOISE FIGURE AND GAIN measurements are always corrected for  $T_{\text{cold}}$  and ENR.

Measured noise can be expressed in a variety of units: F, F dB, Y, Y dB, and TeK. Refer to the Display Units Selection Detailed Operating Instruction for additional information.

The noise figure measurement range is 0 to 30 dB. The gain measurement range (for total noise figures less than 30 dB) is -20 to at least +40 dB.

### Related Sections

Calibrate  
Display Units Selection  
Preset Conditions and Power-Up Sequence

# Power Measurements

## (Special Function 9)

**Description** Special Function 9 measures noise power density in dB relative to -174 dBm/Hz with the noise source on or off. Either an approximate or a calibrated measurement can be made. The value -174 dBm/Hz was chosen because this is the thermal noise at 290K in a 1 Hz bandwidth. This special function can be used to make absolute power density measurements or simply to verify that the measurement system setup is operating and the signal path is complete. To exit from Special Function 9, press either UNCORRECTED NOISE FIGURE or CORRECTED NOISE FIGURE AND GAIN.

**Procedure** To select a power density measurement, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

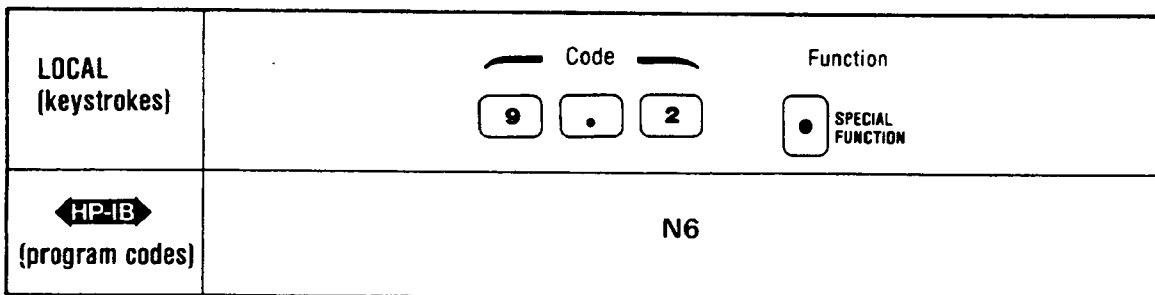
Special Functions 9.3 and 9.4 require that a calibration be performed prior to activating the special function. If the calibration has not been performed, error E20 (not calibrated) is displayed and the special function is not activated.

Since the power measurements can be performed from any Measurement Mode, refer to the applicable Detailed Operating Instruction for the correct calibration procedures.

Special Function		Program Code ◀HP-IB▶	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Preset (and HP-IB Clear) Conditions	Special Function 0.0 Conditions
Description	Code						
SOURCE Off (uncalibrated)	9.1	N5 or 9.1SP	N	Y	Y	Off	Off
SOURCE On (uncalibrated)	9.2	N6 or 9.2SP	N	Y	Y	Off	Off
SOURCE Off (calibrated)	9.3	N7 or 9.3SP	N	Y	Y	Off	Off
SOURCE On (calibrated)	9.4	N8 or 9.4SP	N	Y	Y	Off	Off

Table categories are explained in the Special Functions Detailed Operating Instruction.

**Example** To select an uncalibrated power measurement with the noise source on:



## Power Measurements (cont'd)

### (Special Function 9)

**Program Codes**

For HP-IB codes, refer to Procedure above.

**HP-IB****Indications**

The NOISE FIGURE display shows the selected power measurement result in dB.

**Comments**

Special Functions 9.3 and 9.4 measure the power density delivered from the DUT. The rest of the measurement system setup is corrected for by the calibration (second stage correction).

The units shown in the NOISE FIGURE display are dB referenced to 290K (-174 dBm/Hz). The equation is:

$$\text{Power displayed} = 10 \log \frac{\text{unknown power density}}{290} \text{ dB}$$

Special Functions 9.1 and 9.2 are similar to 9.3 and 9.4 except that they are not calibrated and they use nominal values for noise figure. These Special Functions are primarily used to verify that the measurement system is operating.

**Related Sections**

Calibrate  
Measurement Modes 1.1 through 1.4  
Special Functions

# Preset Conditions and Power-Up Sequence

## (Includes Special Function 0.0)

**Description**     **Power-Up.** When first turned on, the Noise Figure Meter performs a sequence of internal checks after which the instrument is ready to make measurements. During the power-up sequence, all front panel indicators light for approximately two seconds to allow the operator to determine if any are defective. Next, four dashes ( — — — — ) appear in the NOISE FIGURE display for approximately five seconds while the Noise Figure Meter performs a frequency calibration. When the frequency calibration is completed, the Noise Figure Meter restores the same configuration it had before the power was removed. Except that:

- a. Sweep is always off.
- b. The measurement is always UNCORRECTED NOISE FIGURE.
- c. The instrument always turns on in local mode (instead of HP-IB remote).
- d. Calibration data is not retained when power is removed.
- e. Special Functions 30 through 32, 35.1, 43, 44, and 60 through 72 are not remembered when power is removed.

**Preset.** The PRESET key sets the Noise Figure Meter to a known state. The front panel is set to the conditions listed in the "Preset and HP-IB Clear Conditions" column in Table 3-12, Front Panel Summary. Table 3-13 lists the default data values that are set for some special functions. Table 3-14, Special Function Summary, in the Special Functions Detailed Operating Instruction provides a complete list of preset conditions for special functions.

In the "Program Code" column in Table 3-12, program codes that are equivalent to front panel keystrokes are listed. HP-IB codes control the Noise Figure Meter's functions over the HP-IB.

The "Stored in Continuous Memory" column in Table 3-12 indicates whether or not the status of a front panel key is retained when the Noise Figure Meter is turned off.

The "Can Be Stored and Recalled" column in Table 3-12 indicates whether or not the status of a front panel key can be stored in an internal storage register for recall at a later time.

Special Functions are off or set to their zero-suffix mode. Exceptions are:

- a. Control Function Selection (Special Function 4)
- b. HP-IB Addresses (Special Function 40)
- c. External LO Programs (Special Function 41)
- d. External LO Commands (Special Function 42)

PRESET has no effect on the four special functions listed above.

# Preset Conditions and Power-Up Sequence (cont'd)

(Includes Special Function 0.0)

Table 3-12. Front Panel Summary

Front Panel Key	Program Code ◀HP-IB▶	Stored in Con- tinuous Memory	Can be Stored and Recalled	Preset (and HP-IB Clear) Conditions	References and Comments
AUTO Sweep	W1	N	N	Off	Sweep
CALIBRATE	CA	N	N	Off	Calibrate
DECREASE	DE	Y	N	1	Smoothing
ENTER	EN	—	—	—	General Operating Instructions
ENR	NR	Y	N	NC	ENR Table Entry
FREQ INCR	FN	Y	Y	20 MHz	Fixed Frequency Increment
▼	DN	—	—	—	Fixed Frequency Increment
▲	UP	—	—	—	Fixed Frequency Increment
FREQUENCY	FR	Y	Y	30 MHz	Fixed Frequency Tuning
INCREASE	IN	Y	N	1	Smoothing
NOISE FIGURE (UNCORRECTED)	M1	N	N	Active	Noise Figure (Uncorrected) and Noise Figure and Gain (Corrected)
NOISE FIGURE AND GAIN (CORRECTED)	M2	N	N	Off	Noise Figure (Uncorrected) and Noise Figure and Gain (Corrected)
PRESET	PR	—	—	—	Preset Conditions and Power-Up Sequence
RECALL	RC	—	—	—	Store and Recall
SEQ	SQ	—	—	—	Sequence
SINGLE Sweep	W2	N	N	Off	Sweep
SPECIAL FUNCTION	SP	—	—	—	Special Functions
START FREQ	FA	Y	Y	10 MHz	Sweep
STEP SIZE	SS	Y	Y	20 MHz	Sweep
STOP FREQ	FB	Y	Y	1500 MHz	Sweep
STORE	ST	—	—	—	Store and Recall
Sweep and Calibrate Off (must be (must be used to turn these functions off over the HP-IB)	W0	—	—	—	Sweep

Y = Yes, N = No, NC = No Change, — = Not Applicable

**Description  
(cont'd)**

Another exception is Service Request, which is set to enable an HP-IB code error to cause an SRQ (Special Function 44.3). In addition, default data values are set for the special functions listed in Table 3-13.

**Special Function 0.0.** Special Function 0.0 initializes selected special functions. It is similar to PRESET except that default data values are not set. Existing values do not change. Refer to Table 3-14, Special Function Summary, in the Special Functions Detailed Operating Instruction for a complete list of Special Function 0.0 conditions.



# Preset Conditions and Power-Up Sequence (cont'd)

(Includes Special Function 0.0)

Table 3-13. Preset Default Values for Special Functions

Special Function		Default Value
Description	Code	
IF	3.0	30 MHz
LO Frequency	3.1	10000 MHz
Loss Compensation		
Before DUT	34.2	0 dB
Temperature of Losses	34.3	0K
After DUT	34.4	0 dB
Measurement Mode 1.1,	1.1	
Measurement Mode 1.2, and	1.2	
Measurement Mode 1.3	1.3	
Start Frequency		8000 MHz
Stop Frequency		12000 MHz
Step Size		200 MHz
Oscilloscope Limits		
Noise Figure Lower Limit	8.1	0
Noise Figure Upper Limit	8.2	8
Gain Lower Limit	8.3	0
Gain Upper Limit	8.4	40
Set Sequence	35.2	1-9
Smoothing Factor	13.2	1
Spot ENR	5.3	15.2 dB
T <sub>cold</sub>	6.0	296.5K
Spot T <sub>hot</sub>	5.4	9893K

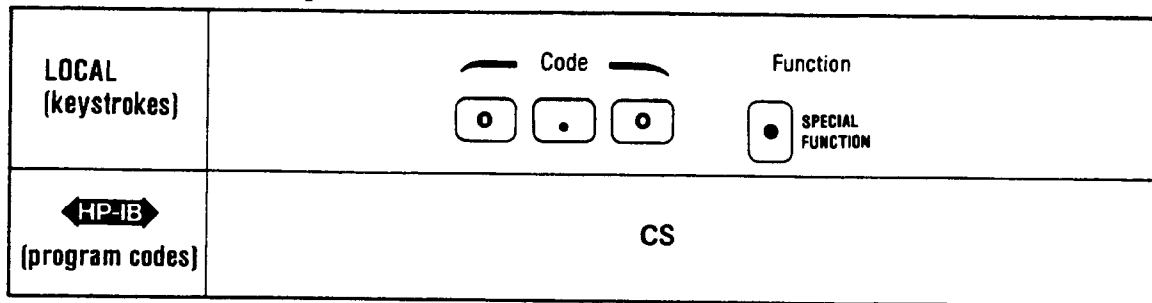
**Procedure**

To set the Noise Figure Meter to a known state, press the PRESET key.

To initialize selected special functions, key in 0.0, then press the SPECIAL FUNCTION key.

**Example**

To initialize selected special functions:



**Program Codes**



Parameter	Program Code HP-IB
PRESET	PR
Special Function 0.0	CS

## Presets Conditions and Power-Up Sequence (cont'd)

(Includes Special Function 0.0)

**Indications** After pressing PRESET, the NOISE FIGURE display shows four dashes ( — — — — ) while a frequency calibration is performed. After approximately five seconds, the left display shows 30 MHz, the INSERTION GAIN display is blank, and the NOISE FIGURE display shows noise figure in units of F dB. Also, the UNCORRECTED NOISE FIGURE LED is illuminated.

When Special Function 0.0 is executed, the SPECIAL FUNCTION key LED turns off if it was on.

**Comments** Special Function 0.0 does not affect any data entered by special functions or front panel keys.

PRESET is identical to the Device Clear command over the HP-IB.

PRESET does not effect calibration data or information in the ENR table.

PRESET and Special Function 0.0 do not modify any data in the internal storage registers.

**Related Sections** Calibration, Frequency  
Special Functions

## Programming an External LO

### (Special Function 42)

#### Description

Special Function 42 can be used to modify the predefined external LO programs for the HP 8350B Sweep Oscillator (Special Function 41.0) or the HP 8672A Synthesized Signal Generator (Special Function 41.2). It can also be used to define a new program for other external LOs provided the LO is HP-IB compatible. However, a thorough understanding of the HP-IB program requirements and restrictions that apply to the external LO is required.

The two predefined external LO programs are stored in permanent memory (ROM). Activating Special Function 41.0 or 41.2 loads the corresponding predefined program from permanent memory into temporary memory (RAM). The programs stored in the permanent memory are never changed; only the program in temporary memory can be modified. Special Function 42 can change the program data that is stored in the temporary memory. One of the predefined programs or the last modified program is always present in the temporary memory. And, only the program in temporary memory can control an external LO.

Detailed examples will be used to explain the use of Special Function 42. However, a brief definition of the purpose of the individual parts of the program that can be changed using Special Function 42 will make the programs easier to understand:

a. Special Function 42.0 is used to display and change the auxiliary commands. The purpose of the auxiliary commands is to set the external LO to continuous wave (CW) operation and to set the output signal level of the external LO (if it is variable via HP-IB).

b. Special Function 42.1 is used to display and change the CW prefix and suffix. The purpose of the prefix and suffix is to correctly format the frequency commands from the Noise Figure Meter to the external LO. The format is different for different LOs. Frequency data of up to five digits is located between the prefix and suffix. The frequency information is determined by the frequency parameters entered into the Noise Figure Meter during the measurement setup and by the measurement mode in which the instrument is operating.

c. Special Function 42.2 is used to display and change the settling time (in ms). The purpose of the settling time is to ensure that the Noise Figure Meter waits a sufficient amount of time after issuing the frequency command and the auxiliary commands to allow the external LO output to stabilize.

d. Special Functions 42.3 and 42.4 are used to display and change the minimum and maximum frequencies that the program will accept. These entries are in MHz. In most cases, they will represent the frequency capability of the external LO. However, they do not affect the external LO but are only used by the Noise Figure Meter to determine if a requested frequency parameter will be accepted. If an attempt to enter an out-of-range frequency is made, the Noise Figure Meter displays one of the invalid frequency entry error messages.

#### Predefined Program Listings

The listings for the two predefined programs are shown below. Each listing shows the data that is stored in permanent memory. Also shown are the External LO Commands (Special Functions 42.0 through 42.4) and the data that can be modified by each special function.

## Programming an External LO (cont'd)

### (Special Function 42)

**Predefined Program Listings (cont'd)**

**External LO Predefined Program Listings**

External LO Commands (Special Function 42)	HP 8350A Program (41.0)	HP 8672A Program (41.2)
42.0 Auxiliary Commands	(0) (0) (0) (0) (0) (0) (0) (0) (0)	K(75) } 0 dB atten. 0(48) } L(76) } -3 dB 6(54) } M(77) } AM off 0(48) } N(78) } FM off 7(55) } O(79) } +10 dBm 3(51) }
42.1 Prefix	C(67) W(87)	P(80) (255)
Suffix	M(77) Z(90)	Z(90) 0(48)
42.2 Settling Time	60 ms	20 ms
42.3 Minimum Frequency	2000 MHz	2000 MHz
42.4 Maximum Frequency	18000 MHz	18000 MHz

The following conventions are used in the program listings:

**HP-IB**

a. All HP-IB program codes consist of ASCII characters. The numbers and letters shown before the parentheses (in Special Functions 42.0 and 42.1) are the ASCII characters that make up valid HP-IB program codes.

b. The numbers shown within parentheses are the decimal equivalent of the required ASCII character. (It is this decimal value that is entered into the Noise Figure Meter for Special Functions 42.0 and 42.1.) For example, in the first line of the listing for the HP 8672A program, the entry is K(75). The K is the first ASCII character of a valid HP-IB program code for the HP 8672A. The 75 is the decimal equivalent of the letter K.

The two exceptions to this rule are (0) in the HP 8350B program and (255) in the HP 8672A program. The (0) entry is used as a placeholder. It is ignored by the Noise Figure Meter and is not transmitted on the HP-IB. In the HP 8350B program (Special Function 41.0), there are no preset auxiliary commands. This area contains zeros because no single program can control all possible HP 8350B configurations. This portion of the program must be correctly entered by the user to match the configuration of the HP 8350B used with the Noise Figure Meter. The (255) in the HP 8672A program is used by the Noise Figure Meter to establish that, when controlling the HP 8672A, leading zeros must be sent if they are required to complete five digits of frequency data.

c. The numbers shown without parentheses (in Special Functions 42.2, 42.3, and 42.4) are the actual values used for that function. For example, the "60 ms" shown as the settling time for the HP 8350B program is the actual settling time allowed by that program.

# Programming an External LO (cont'd)

## (Special Function 42)

**Predefined Program Listings (cont'd)**

d. The comments following the brackets in the HP 8672A program are the functions performed by each two-character HP-IB code. Note that many two-character HP-IB codes use the first character to establish the instrument function and the second character to establish the setting of that function.

In both programs, a maximum five digits of frequency information are sent between the prefix and the suffix. This information is generated by the front panel settings of frequency parameters on the Noise Figure Meter.

**Procedure**

To activate a specific programming function, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Auxiliary Commands	42.0	AC or 42.0SP	N	Y	Y	NC	NC
CW Prefix and Suffix	42.1	PS or 42.1SP	N	Y	N	NC	NC
Settling Time in ms	42.2	TM or 42.2SP	N	Y	N	NC	NC
Minimum Frequency in MHz	42.3	MN or 42.3SP	N	Y	N	NC	NC
Maximum Frequency in MHz	42.4	MX or 42.4SP	N	Y	N	NC	NC

Table categories are explained in the Special Functions Detailed Operating Instruction.

**Entering Data**

Special Function 42.0 allows for modification of the auxiliary commands of the program stored in temporary memory. If one of the two predefined external LO programs is to be modified, Special Function 41.0 or 41.2 should be activated first to ensure that the correct program is in the temporary memory.

**HP-IB** An auxiliary command is simply an HP-IB program code required to control one function of the external LO. Each program code consists of one or more ASCII character. The decimal equivalent of each ASCII character is stored in one of the ten data locations available for auxiliary commands.

The general procedure for entering data using Special Function 42.0 is as follows:

- a. Determine what external LO functions are to be controlled by the Noise Figure Meter.
- b. Use the external LO's manual to look up the HP-IB program codes for the above functions.
- c. Use Table 3-11, located in Remote Operation near the front of this section, to look up the decimal equivalent for each of the ASCII characters used for the program codes.
- d. On the Noise Figure Meter, press 42.0 SPECIAL FUNCTION to display the current number stored in the first of the ten data locations. Enter the decimal equivalent of the

## Programming an External LO (cont'd)

### (Special Function 42)

#### Procedure (cont'd)

desired ASCII character from the front panel of the Noise Figure Meter. The allowable range of decimal values is 0 to 255.

e. Press the ENTER key on the Noise Figure Meter's front panel. The next data location available for modification will appear in the Noise Figure Meter's left display. If no change to the existing data is desired, press ENTER to advance to the next data location.

f. Continue stepping through the data locations until all ten have been filled. If all of the auxiliary command data locations are not used in a specific application, always enter zeros in the remaining locations to avoid possible HP-IB command errors.

After all ten locations are displayed, the Noise Figure Meter returns to the previous front panel setup the next time ENTER is pressed. It is also possible to exit Special Function 42.0 at any time by pressing FREQUENCY (and still retain the data).

#### HP-IB

Special Function 42.1 allows for modification of the CW prefix and suffix commands for the external LO program. The prefix is the external LO's HP-IB program code for CW. The suffix is the external LO's program code for MHz. The CW prefix and suffix commands are entered in a manner similar to the auxiliary commands (that is, the decimal equivalent of each ASCII character is entered into the Noise Figure Meter). However, the prefix and suffix HP-IB program codes must each be two ASCII characters or less because only four data locations are available for this Special Function. Enter zeros in any data locations that are not used. The allowable range of decimal values is 0 to 255.

For Special Functions 42.2, 42.3, and 42.4, the decimal value is entered directly into the Noise Figure Meter. The settling time is entered in ms. The allowable range is 0 to 60000 ms. Frequency is entered in MHz. The allowable range is 0 to 60000 MHz.

Modified data can be entered in any order. For example, the settling time can be modified prior to changing the frequency prefix and suffix.

### Running the External LO Program

Before the program can be run, several conditions must be met:

a. An HP-IB cable should be connected between the Noise Figure Meter and the external LO.

b. On the Noise Figure Meter, Measurement Mode 1.1 or 1.3 (fixed IF and variable-frequency LO) should be selected. External LO programs can be run in Measurement Modes 1.2 and 1.4 (variable IF and fixed-frequency LO) but the Noise Figure Meter will send out the fixed LO frequency that was selected by Special Function 3.1.

c. The parameters associated with the selected Measurement Mode (such as frequency, fixed IF, and sideband selection) should be set.

d. Special Function 4.1 should be active to enable the Noise Figure Meter to control an external LO.

e. The HP-IB address of the external LO must match the external LO address that is stored in the Noise Figure Meter (use Special Function 40.1).

## Programming an External LO (cont'd)

### (Special Function 42)

#### Procedure (cont'd)

- f. The internal sweep of the external LO (if one exists) should be off.

Once the above conditions are met, the external LO program stored in the Noise Figure Meter's temporary memory runs whenever a frequency value is entered from the front panel of the Noise Figure Meter. The program is also triggered each time an auxiliary command is changed when an external LO is connected.

When the program is running the following sequence occurs:

- a. A frequency command and the auxiliary commands are sent to the external LO.
- b. The Noise Figure Meter waits for the programmed settling time and then makes a measurement.

This sequence is repeated until all of the frequencies required by the measurement setup have been sent and the measurement results obtained.

**HP-IB** Each time the frequency is changed the Noise Figure Meter issues an HP-IB command string. The Noise Figure Meter sends the following HP-IB commands to the external LO in the order indicated:

- a. REN and ATN are both set true.
- b. the LO's listen address is sent.
- c. ATN is released (that is, set false).
- d. the frequency command is sent.
- e. the auxiliary commands are sent.
- f. carriage return (CR) and line feed (LF) are sent.

Because the frequency command precedes the auxiliary commands, a Preset or Initialize command cannot be used in the auxiliary commands. These type of commands will prevent the external LO from tuning to the required frequencies because after the LO tunes to the requested frequency, it will be reset to its original frequency.

#### Examples

##### Example 1 – Modifying and Saving a Predefined Program

In example 1, the HP 8672A program is modified for three different output levels and the modified programs are stored. Modifying the output level will probably be the most frequent change made to this predefined program.

- a. On the Noise Figure Meter, press 4 1 . 2 SPECIAL FUNCTION to load the HP 8672A program from permanent memory to temporary memory.

#### NOTE

*A convenient relationship exists that can be used when modifying the output level on the HP 8672A. This relationship only holds true for changing the output level to a value between 0 and 13 dBm. If any other changes are required, the HP 8672A manual must be used to determine the correct HP-IB program codes. To obtain any output level between 0 and 13 dBm, change the fourth auxiliary command entry to 61 minus the desired dBm level. The standard program entry (54) results in a 7 dBm output (61 - 7 = 54).*

- b. Press 4 2 . 0 SPECIAL FUNCTION to allow modification of the auxiliary commands. Verify that the left display shows 75.

## Programming an External LO (cont'd)

### (Special Function 42)

#### Examples (cont'd)

c. Press ENTER three times. Verify the left display shows 48, 76, then 54. Pressing ENTER repetitively without entering any data does not change the stored data.

d. Change the output level to 3 dBm by pressing 5 8 ENTER (using the relationship  $61-3=58$ ).

e. To store the modified auxiliary commands in storage register 1, press STORE 1. This step stores only the auxiliary commands. The rest of the program information remains in the temporary memory and only needs to be changed when the external LO changes. This information is retained if the instrument is turned off or if PRESET is pressed.

#### NOTE

*It is a good programming practice to step through the remaining auxiliary command data locations to verify that they contain the correct information as shown in the listed program.*

f. To modify the output level to 5 dBm and store the modified program in storage register 2, repeat steps b through e. In this sequence, the fourth auxiliary command location is now 58. Change it to 56 and press STORE 2.

#### NOTE

*There are now three HP 8672A programs available to control the external LO. These programs will remain stored in the instrument unless storage registers 1 or 2 are modified using the STORE key. The standard program is always available whenever Special Function 41.2 is activated.*

g. To run the program at the 7 dBm level, press 4 1 . 2 SPECIAL FUNCTION and perform the measurement using the appropriate Measurement Mode procedure.

h. To run the program at the 5 dBm level, press RECALL 2 and perform the measurement using the appropriate Measurement Mode procedure.

i. To run the program at the 3 dBm level, press RECALL 1 and perform the measurement using the appropriate Measurement Mode procedure.

#### NOTE

*When modifying and storing a series of different programs, the capability to sequence these programs in a specific order can be useful. For information on sequencing the stored programs, refer to the Sequence Detailed Operating Instruction.*

#### Example 2 — Writing a Program for an External LO Other Than the HP 8350B or HP 8672A.

The second example shows how to write a program for an external LO other than the HP 8350B and HP 8672A. The instrument chosen for this example is the HP 8672A Synthesized Signal Generator. This instrument was chosen because it has a low noise level and could be used to test low frequency mixers. A program listing is provided first and then a brief explanation of the chosen parameters is presented.



## Programming an External LO (cont'd) (Special Function 42)

**Examples  
(cont'd)**

HP 8662A Program Listing

External LO Commands (Special Function 42)	HP 8662A Program
42.0 Auxiliary Commands	M(77) } 0(70) } Modulation Off A(65) } P(80) } amplitude function 7(55) 7 +(43) } D(68) } + dBm units (0) (0) (0)
42.1 Prefix	F(70)
Suffix	R(82) M(77) Z(90)
42.2 Settling Time	40 ms
42.3 Minimum Frequency	20 MHz
42.3 Maximum Frequency	1279 MHz

In an external LO program the auxiliary commands are most often used to program the LO to a CW output at a specific level. This is done in the HP 8672A program in the following way:

- a. The first two locations are used to send a Modulation Off command. This command sets the HP 8672A to the CW mode.
- b. The next five locations set the LO to an output level of +7 dBm.
- c. The last three locations are set to decimal zero and used as placeholders to avoid inadvertent HP-IB command outputs.

The prefix and suffix commands are those required by the HP 8672A.

The settling time is chosen to assure that the LO output is stable.

The minimum and maximum frequencies are chosen to be within the range of the LO and to satisfy the requirements of anticipated applications.

**Program  
Codes**



For HP-IB codes, refer to Procedure above.

**Comments**

When the Noise Figure Meter is in AUTO sweep, it waits for twice the entered settling time during the retrace from stop to start frequencies.

**Related  
Sections**

- HP-IB Addresses
- Programs Available to Control an External LO Sequence
- Special Functions

# Programs Available to Control an External LO (Special Function 41)

**Description** Special Function 41 selects one of two predefined programs to control an external LO. Special Function 41.0 selects the program for the HP 8350B Sweep Oscillator, Special Function 41.2 selects the program for the HP 8672A Synthesized Signal Generator, and Special Function 41.3 selects the program for the HP 8673B Synthesized Signal Generator. A listing of these programs is contained in the Comments section of this instruction.

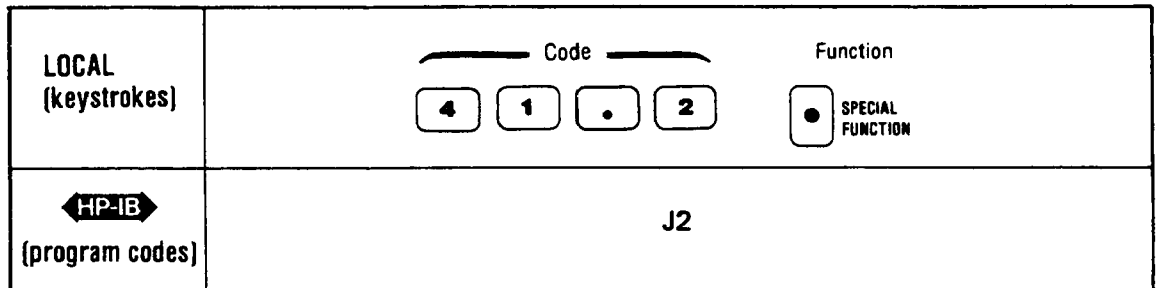
The programs are activated when Special Function 4.1 (Enable External LO Control), a Measurement Mode (1.1, 1.2, 1.3, or 1.4), and the correct predefined program have been selected. Either program can be modified using Special Function 42 (External LO Commands). Refer to the Programming an External LO Detailed Operating Instruction for additional information on how to modify these programs.

**Procedure** To select one of the predefined programs key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous Memory	Can Be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
HP 8350B Sweep Oscillator Program	41.0	J0 or 41.0SP	N	Y	N	NC	NC
HP 8672A Synthesized Signal Generator Program	41.2	J2 or 41.2SP	N	Y	N	NC	NC
HP 8673B Synthesized Signal Generator Program	41.3	J3 or 41.3SP	N	Y	N	NC	NC

Table categories are explained in the Special Functions Detailed Operating Instruction.

**Example** To select the predefined program to control the HP 8672A:



**Program Codes**  
HP-IB

For HP-IB codes, refer to Procedure above.

# Programs Available to Control an External LO (cont'd)

## (Special Function 41)

**Comments** A listing of the two predefined programs is provided here for a quick reference. A complete explanation of these programs and instructions on how to modify them are contained in the Programming an External LO Detailed Operating Instruction.

External LO Predefined Programs Listing

External LO Commands (Special Function 42)	HP 8350A Program (41.0)	HP 8672A Program (41.2)
42.0 Auxiliary Commands	(0)	K(75) } 0 dB atten.
	(0)	0(48) }
	(0)	L(76) } -3 dB
	(0)	6(54) }
	(0)	M(77) } AM off
	(0)	0(48) }
	(0)	N(78) } FM off
	(0)	7(55) }
	(0)	O(79) } +10 dBm
	(0)	3(51) }
42.1 Prefix	C(67)	P(80)
Suffix	W(87)	(255)
	M(77)	Z(90)
	Z(90)	0(48)
42.2 Settling Time	60 ms	20 ms
42.3 Minimum Frequency	2000 MHz	2000 MHz
42.4 Maximum Frequency	18000 MHz	18000 MHz

**Related Sections**

Controller Capability of the Noise Figure Meter  
 Measurement Modes 1.1 through 1.4  
 Programming an External LO  
 Special Functions

# RF Attenuation Selection

## (Special Functions 60, 61, and 62)

**Description**

RF attenuation selection, display, and hold are available in all measurement modes. It should be noted, however, that only the hold capability (Special Function 62.0) is normally used by most operators. The hold is required during manual measurements (refer to the Manual Measurements Detailed Operating Instruction for additional information). The selection and display of specific RF attenuation settings are more likely to be used during adjustment procedures, performance tests, or troubleshooting procedures. In some specialized applications these capabilities can be helpful, but care must be exercised when using them. It is possible to introduce some very subtle errors in the measurements that the Noise Figure Meter may not be able to guard against. Additional information on how to use and interpret these Special Functions is contained in Section VIII, Service.

**Procedure**

To select a specific RF attenuation setting, display, or hold, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

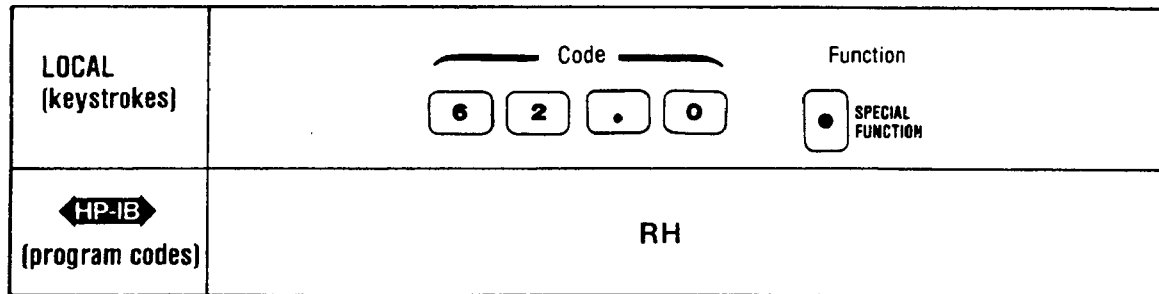
Special Function		Program Code ⬅ HP-IB ➡	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
<b>RF Attenuation Selection</b>							
Auto	60.0	R0 or 60.0SP	N	N	N	On	On
+20 dB	60.1	R1 or 60.1SP	Y	N	N	Off	Off
+10 dB	60.2	R2 or 60.2SP	Y	N	N	Off	Off
0 dB	60.3	R3 or 60.3SP	Y	N	N	Off	Off
-10 dB	60.4	R4 or 60.4SP	Y	N	N	Off	Off
-20 dB	60.5	R5 or 60.5SP	Y	N	N	Off	Off
-30 dB	60.6	R6 or 60.6SP	Y	N	N	Off	Off
<b>Display RF Attenuator Settings</b>							
Display IF Attenuator	61.0	SR or 61.0SP	N	N	N	Off	Off
<b>RF Attenuator Hold</b>							
RF Attenuator Hold	62.0	RH or 62.0SP	Y	N	N	Off	Off
Table categories are explained in the Special Functions Detailed Operating Instruction.							

## RF Attenuation Selection (cont'd)

(Special Functions 60, 61, and 62)

**Example**

To select the RF attenuator hold function:



**Program Codes**

For HP-IB codes, refer to Procedure.



**Indications**

When Special Function 61 is implemented, four digits appear in the left display. The digits are either "1" (yes) or "0" (no) to indicate whether or not the corresponding 10 dB pads and 20 dB amplifier are switched into the Input Assembly circuits (see Service Sheet 1 in Section VIII, Service). The first, third, and fourth digits each represent -10 dB (10 dB Pad No. 1, 10 dB Pad No. 2, and 10 dB Pad No. 3, respectively). The second digit represents +20 dB (20 dB Input Gain Amplifier). To obtain the RF attenuator setting, add the attenuation that is represented by each digit in the display. For example, a display of "1 1 1 0" indicates an RF attenuation setting of 0 dB.

**Comments**

If any of the 60 or 70 series of Special Functions (except 60.0 and 70.0) are active, the calibration sequence does not override them. Therefore, to calibrate on one range only, use any of these Special Functions except 60.0 or 70.0. It is also true that if any of these Special Functions are inadvertently active, the calibration sequence will not cover the expected gain range.

**Related Sections**

- Calibrate
- IF Attenuation Selection
- Manual Measurements
- Special Functions

## Sequence (Includes Special Function 35)

**Description**

The sequence feature allows the user to predetermine the recall order of the storage registers. Manual sequence (recall of registers one at a time) or automatic sequence (continuous recall of registers) can be selected.

Nine digits are used in a sequence. Any combination of registers 1 through 9 is allowed. Zeros used within a sequence are ignored.

**Procedure**

To set the sequence (that is, the recall order), key in 35.2 SPECIAL FUNCTION. The register to be recalled at each step of the sequence is displayed in turn in the left display. If a change is desired, enter the new register number and press ENTER. If no change is desired, press ENTER to advance to the next step of the sequence. After all nine registers have been displayed, the Noise Figure Meter returns to normal measurement. Pressing the FREQUENCY key at any time terminates setting the sequence.

To select the manual sequence mode, key in 35.0 SPECIAL FUNCTION. The instrument steps through the defined sequence one step at a time each time the SEQ key is pressed. When the end of a sequence is reached, it starts over.

To select the automatic sequence mode, key in 35.1 SPECIAL FUNCTION. Press the SEQ key to start automatic sequencing. The instrument starts a continuous recall of registers in the predetermined sequence. To stop an automatic sequence, press the SEQ key again.

To clear the sequence (that is, set the sequence to 000 000 000), key in 35.3 SPECIAL FUNCTION.

To set the sequence to 1 through 9 in order, press PRESET.

Special Function		Program Code ◀HP-IB▶	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Manual Sequence	35.0	QM or 35.0SP	N	N	N	On	On
Automatic Sequence	35.1	QA or 35.1 SP	N	N*	N	Off	Off
Set Sequence	35.2	QS or 35.2SP	N	Y	N	NC	1-9
Clear Sequence	35.3	QC or 35.3SP	N	N	N	Off	Off

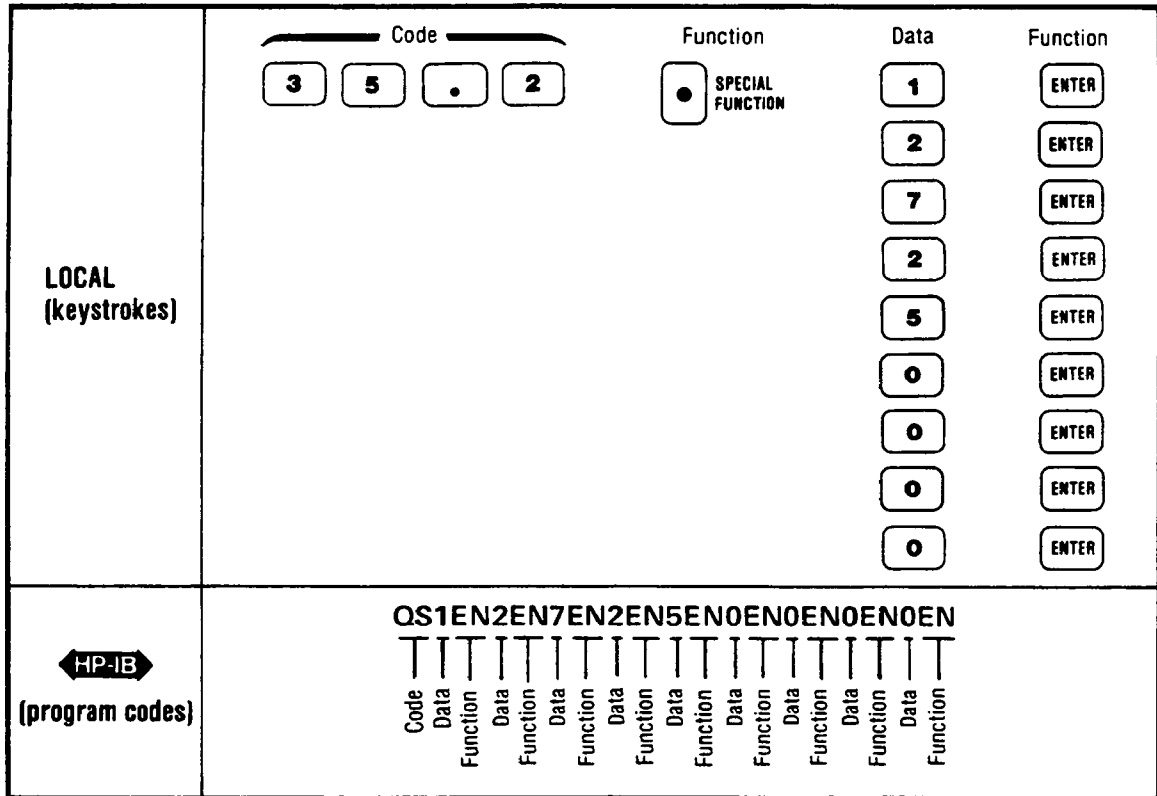
\*Enables Special Function key LED to light when SEQ is pressed.  
Table categories are explained in the Special Functions Detailed Operating Instruction.

# Sequence (cont'd)

(Includes Special Function 35)

**Example**

To set the register recall sequence to 1, 2, 7, 2 and 5:



**Program Codes**

The program code for the SEQ key is SQ. The program code for the ENTER key is EN. Refer to Procedure, above, for HP-IB program codes for Special Function 35.

**HP-IB**

**Indications**

When the Noise Figure Meter is in the manual sequence mode, pressing the SEQ key causes the storage register being recalled to appear in the left display while the key is depressed.

When the Noise Figure Meter is in the automatic sequence mode, the SPECIAL FUNCTION key LED lights. Register numbers are not displayed during automatic sequencing.

**Comments**

Register numbers can be repeated in a sequence string.  
 If fewer than nine register numbers are used for a sequence string, zeros should be entered so that the sequence always has nine digits in it.

For a list of front panel functions that can or cannot be stored and recalled (therefore, can or cannot be used in a sequence), refer to Table 3-12, Front Panel Summary, in the Preset Conditions and Power-Up Sequence Detailed Operating Instruction. For a list of special functions that can and cannot be stored and recalled, refer to Table 3-14, Special Function Summary, in the Special Functions Detailed Operating Instruction.

**Related Sections**

- Preset Conditions and Power-Up Sequence
- Special Functions
- Store and Recall

## Sideband Selection

### (Special Function 2)

**Description**

The measurement system setup dictates the sideband operation to be selected. Special Function 2 tells the Noise Figure Meter which type of sideband operation the measurement system is using. A discussion of measurement modes and sideband selection is contained in the Measurement Modes Detailed Operating Instruction. After the measurement setup is established, use Special Function 2 to convey this information to the Noise Figure Meter. Double sideband, upper single sideband, or lower single sideband can be selected.

In Measurement Mode 1.2, one of the single sideband special functions must be selected or else an error code (E34) is displayed. The reason a double sideband measurement cannot be made in Mode 1.2 is that the frequency at which the measurement is being made is ambiguous. Therefore, one of the two single sideband special functions must be selected and the other sideband must be filtered out after the DUT for a meaningful sweep. This eliminates any noise that is added by the DUT that may fall in the undesired sideband.

It is in Measurement Modes 1.1, 1.3, and 1.4 that the choice between single or double sideband becomes necessary. The following brief description will help clarify the choices available:

- a. Special Function 2.0 selects a double sideband measurement. The measured result is an average of the noise figure at two frequencies; the LO frequency plus the IF and the LO frequency minus the IF.
- b. Special Function 2.1 offsets the measurement frequency to the LO frequency minus the IF. The Noise Figure Meter uses the ENR value of the offset measurement frequency.
- c. Special Function 2.2 offsets the measurement frequency to the LO frequency plus the IF. The Noise Figure Meter uses the ENR value of the offset measurement frequency.

**Procedure**

To select a specific sideband offset, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.



## Sideband Selection (cont'd)

### (Special Function 2)

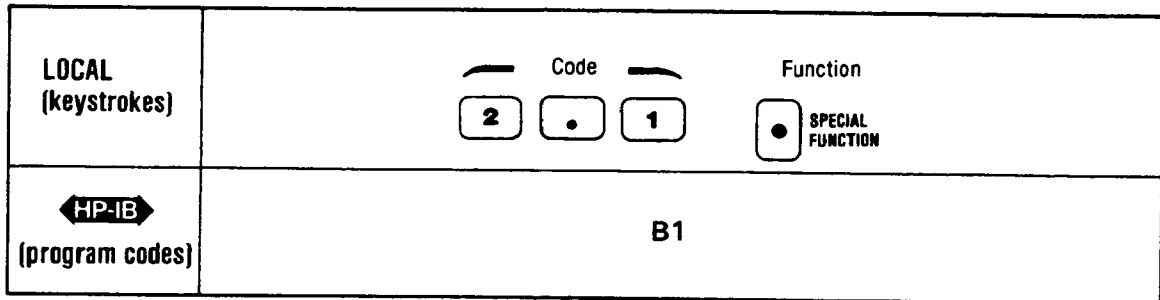
**Procedure  
(cont'd)**

Special Function		Program Code ⬅ HP-IB ➡	Lights Special Function Key	Stored in Con- tinuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Double Sideband (no frequency offset)	2.0	B0 or 2.0SP	N	Y	Y	On	On
Lower Single Sideband (measurement frequency less than LO frequency)	2.1	B1 or 2.1 SP	Y	Y	Y	Off	Off
Upper Single Sideband (measurement frequency greater than LO frequency)	2.2	B2 or 2.2SP	Y	Y	Y	Off	Off

Table categories are explained in the Special Functions Detailed Operating Instruction.

**Example**

To select lower single sideband frequency offset:



**Program Codes**

For HP-IB codes, refer to Procedure above.



**Indications**

For indications, refer to the "Lights Special Function Key" column in the table in Procedure above.

**Related Sections**

Measurement Modes  
Measurement Modes 1.1 through 1.4  
Special Functions

## Smoothing (Averaging)

### (Includes Special Function 13)

#### Description

The purpose of smoothing is to reduce jitter in both the NOISE FIGURE and INSERTION GAIN displays. Numbers that are sent to both of these displays are averaged before being displayed.

The Noise Figure Meter has two modes of smoothing: exponential and arithmetic (straight averaging). The equation for exponential smoothing is:

$$\text{new display} = \frac{\text{new measurement}}{n} + \frac{n-1}{n} (\text{previous display})$$

where n is the smoothing factor.

The equation for arithmetic smoothing is:

$$\text{new display} = \frac{n \text{ measurements}}{n}$$

where n is the smoothing factor.

The smoothing factor can range from 1 to 512 in factors of two. Each time the INCREASE key is pressed, the smoothing factor is doubled (until the smoothing factor is 512). Each time the DECREASE key is pressed, the smoothing factor is halved (until the smoothing factor is 1). A stable display can usually be obtained by increasing the smoothing factor.

When exponential smoothing is used for a fixed frequency measurement, the display is updated approximately five times per second for all smoothing factors. However, when a large smoothing factor is used, the Noise Figure Meter is slow to respond to changes in the noise measurement when tuning from one fixed frequency to another.

Arithmetic smoothing makes the number of measurements indicated by the smoothing factor and averages them before the result is displayed. The display is updated each time n measurements are made, where n is the smoothing factor. With a smoothing factor of 1, three to five measurement updates are made each second. With a smoothing factor of 512, the measurement update interval is typically fifty seconds to one minute.

Calibration and swept measurements always use arithmetic smoothing automatically. Either exponential or arithmetic smoothing can be selected for fixed frequency measurements.

#### Procedure

To display the smoothing factor, key in 13.2 SPECIAL FUNCTION. If a change is desired, key in the new smoothing factor and then press the ENTER key.

The smoothing factor can also be changed from the front panel. Press INCREASE for more smoothing or press DECREASE for less smoothing. Each time one of these keys is pressed the smoothing factor changes by a factor of two.

To select exponential or arithmetic smoothing for fixed frequency measurements only, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

# Smoothing (Averaging) (cont'd)

(Includes Special Function 13)

**Procedure**  
(cont'd)

Special Function		Program Code ↔HP-IB↔	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Exponential smoothing mode for fixed frequency measurements	13.0	V0 or 13.0SP	N	Y	N	On	On
Arithmetic smoothing mode for fixed frequency measurements	13.1	V1 or 13.1 SP	N	Y	N	Off	Off
Displays and allows entry of smoothing factor	13.2	AF or 13.2SP	N	Y	N	NC	1

Table categories are explained in the Special Functions Detailed Operating Instruction.

**Example**

To select exponential smoothing and a smoothing factor of 4:

<b>LOCAL</b> (keystrokes)	Code	Function	Data	Function
	<input type="text" value="1"/> <input type="text" value="3"/> <input type="text" value="."/> <input type="text" value="0"/>	<input checked="" type="radio"/> SPECIAL FUNCTION		
	<input type="text" value="1"/> <input type="text" value="3"/> <input type="text" value="."/> <input type="text" value="2"/>	<input checked="" type="radio"/> SPECIAL FUNCTION	<input type="text" value="4"/>	<input type="text" value="ENTER"/>
↔HP-IB↔ (program codes)	<b>V0F2</b>			

**Program Codes**



Parameter	Program Code ↔HP-IB↔
INCREASE	IN
DECREASE	DE
Smoothing Factor = 1	F0 or AF1EN
Smoothing Factor = 2	F1 or AF2EN
Smoothing Factor = 4	F2 or AF4EN
Smoothing Factor = 8	F3 or AF8EN
Smoothing Factor = 16	F4 or AF16EN
Smoothing Factor = 32	F5 or AF32EN
Smoothing Factor = 64	F6 or AF64EN
Smoothing Factor = 128	F7 or AF128EN
Smoothing Factor = 256	F8 or AF256EN
Smoothing Factor = 512	F9 or AF512EN

For HP-IB codes for Special Function 13, refer to Procedure above.

## Smoothing (Averaging) (cont'd)

(Includes Special Function 13)

**Indications** The current smoothing factor is displayed in the left display whenever the INCREASE key or the DECREASE key is depressed.

**Comments** The smoothing factor can be changed while swept measurements are in progress. However, the smoothing factor cannot be changed during calibration.

For fixed frequency measurements, arithmetic smoothing is mainly useful in HP-IB systems. Exponential smoothing is best for reading measurement results on the front panel display or on an oscilloscope.

When using exponential smoothing, any time the fixed frequency changes, a number of measurements equal to the smoothing factor is made before any results are displayed. During this time the NOISE FIGURE display shows four dashes ( — — — — ).

In exponential smoothing, to reduce the settling time after a large measurement change, press the FREQUENCY key to reset the display to the current measurement value.

**Related Sections**

Calibrate  
Fixed Frequency Tuning  
Special Functions  
Sweep

# Special Function Catalog

## (Special Function 50)

**Description**

Special Function 50 displays the contents of the six-line special function catalog either sequentially or by individual line. The catalog can be used to quickly determine the present status of many of the special functions. For a concise explanation of the special function catalog, refer to the Special Function Catalog Summary shown below. With the exception of the information added for line six, this same information appears on the pullout card in the tray at the bottom of the Noise Figure Meter.

Special Function 50.N displays the Special Function Catalog. 50.0 SP sequences thru all 6 catalog lines. 50.1 thru 50.6 SP display the specified catalog line. For example:

5 0 . 1 ● Displays the N = 1 line.

The first displayed digit (N) is the catalog line number. Each of the other digits is the suffix of a specific Special Function as shown in the table below.

14210

SP Code suffixes

This display indicates the following special functions:  
1.4, 2.2, 4.1, 5.0

LINE NO.	1	2	3	4	5
1	1	2	4	5	
2	10/9 <sup>1</sup>	11	12 <sup>2</sup>	13	
3	N/A	14	15	<sup>3</sup>	
4	30	31	32	34	
5	35	41 <sup>4</sup>	43	N/A	
6	60 <sup>5</sup>	70	<sup>6</sup>	92	

N      1      2      3      4      Digit positions

SP code prefixes N = 1

<sup>1</sup> 0—4 = 10.0 thru 10.4SP; 5 = 9.1SP; 6 = 9.2SP; 7 = 9.3SP; 8 = 9.4SP.  
<sup>2</sup> 3 = 12.1SP and 12.2SP selected.  
<sup>3</sup> Indicates selected analog output;  
 0—3 = 7.0 thru 7.3SP; 4 = 22.0SP; 5 = 23.0SP; 6 = 24.0SP; 7 = 82.0SP.  
<sup>4</sup> Indicates selected Ext LO program:  
 0 = 41.0SP (8350B); 2 = 41.2SP (8672A); 3 = 41.3SP (8673B); 0 = Custom Ext LO Program.  
<sup>5</sup> 0—6 = 60.0 thru 60.6SP; 9 = 63.0 thru 63.5SP.  
<sup>6</sup> 0 = Normal display; 1 = 80.0SP (Voltmeter Mode, Noise Source Off); 2 = 81.0SP (Voltmeter Mode, Noise Source On).

### Special Function Catalog Summary

# Special Function Catalog (cont'd)

## (Special Function 50)

**Procedure**

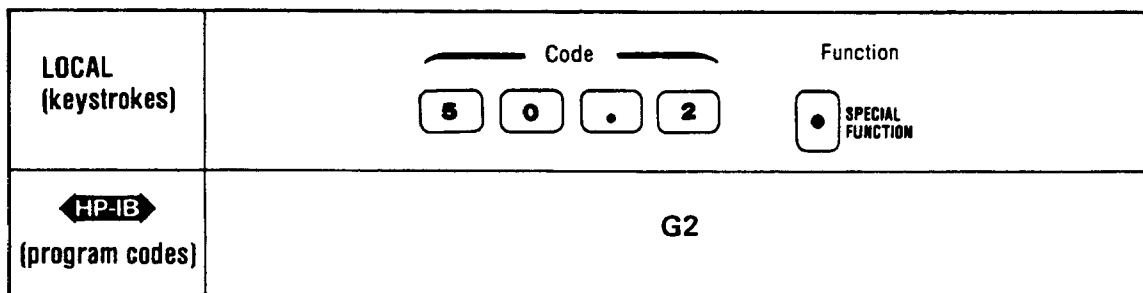
To select a specific special function catalog display, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key

Special Function		Program Code ⬅HP-IB➡	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Sequence through all six lines at once	50.0	G0 or 50.0SP	N	N	N	Off	Off
Display Line 1	50.1	G1 or 50.1SP	N	N	N	Off	Off
Display Line 2	50.2	G2 or 50.2SP	N	N	N	Off	Off
Display Line 3	50.3	G3 or 50.3SP	N	N	N	Off	Off
Display Line 4	50.4	G4 or 50.4SP	N	N	N	Off	Off
Display Line 5	50.5	G5 or 50.5SP	N	N	N	Off	Off
Display Line 6	50.6	G6 or 50.6SP	N	N	N	Off	Off

Table categories are explained in the Special Functions Detailed Operating Instruction.

**Example**

To display line 2 of the special function catalog:



**Program Codes**



For HP-IB codes, refer to Procedure above.

**Indications**

When Special Function 50.0 is selected, the Noise Figure Meter automatically sequences through all six lines, showing the status of each line for approximately one second in the left display.

When Special Functions 50.1 through 50.6 are selected, the status of the corresponding line is displayed in the left display until another function is selected.

Under the left display are reference characters N, 1, 2, 3, and 4. N refers to the line number and 1, 2, 3, and 4 refer to digit positions in the display.

**Comments**

To read the special function catalog information via HP-IB, use Special Functions 50.1 through 50.6 and read one line at a time. The HP-IB output format must be set to output all three displays (HP-IB code H1 or 43.1SP).

**Related Sections**

Special Functions

## Special Functions

### Description

**General Information.** Special Functions extend user control of the instrument beyond that normally available from dedicated front panel keys. They are accessed via keyboard entry of the appropriate numeric code terminated by the SPECIAL FUNCTION key. The codes consist of a prefix, decimal, and suffix. Special Functions are grouped by their prefixes into five categories as follows:

#### Prefix 0

This initializes selected Special Functions. Refer to Table 3-14, Special Function Summary, for a complete listing of initialized Special Function conditions.

#### Prefixes 1 to 49

These are User Special Functions which are used during normal instrument operation when a special configuration, a special measurement, or special information is required. These Special Functions are described in the Special Function Summary, Table 3-14.

#### Prefixes 50 to 59

These are Catalog Special Functions and are used to display the status of Special Function settings. Refer to the Special Function Catalog Detailed Operating Instruction for additional information.

#### Prefixes 60 to 79

These are Auxiliary Special Functions which are normally used for servicing the Noise Figure Meter. However, some of these Special Functions must be used for manual measurements (HOT and COLD). Refer to Section VIII (Service), and the IF Attenuation Selection and RF Attenuation Selection Detailed Operating Instructions for additional information.

#### Prefixes 80 to 99

These are the Service Special Functions used to assist in troubleshooting an instrument fault. The functions available are quite diverse — special internal measurements, software control, and special service tests and configurations. These Special Functions are discussed in detail in Section VIII, Service.

**Special Function Summary Table.** A summary of the Special Functions is given in Table 3-14. Most of the Special Functions are explained in more detail in other operating instructions.

The “Lights Special Function Key” column indicates which Special Functions, when active, light the SPECIAL FUNCTION key LED on the front panel.

The “Stored in Continuous Memory” column indicates whether or not the status of a Special Function can be retained when power is removed from the Noise Figure Meter.

The “Can Be Stored and Recalled” column indicates whether or not the status of a Special Function can be stored in an internal storage register for recall at a later time.

The “Special Function 0.0 Conditions” column indicates the status of each Special Function (that is, on, off, or no change) when Special Function 0.0 is selected.

## Special Functions (cont'd)

**Description (Cont'd)**

The "Preset (and HP-IB Clear) Conditions" column indicates the status of each Special Function when the front panel PRESET key is pressed (or HP-IB code PR is sent). In addition, this column indicates default data values that are set for some Special Functions.

**Procedure**

To use a Special Function, key in the corresponding code, then press the SPECIAL FUNCTION key.

**Example**

To select Measurement Mode 1.1 (Special Function 1.1):

<b>LOCAL (keystrokes)</b>	<p style="text-align: center;">Code</p>	Function
<b>(program codes)</b>	E1	

**Indications**

The numeric code appears in the left display as it is being entered. Pressing the SPECIAL FUNCTION key activates the selected Special Function. Refer to the "Lights Special Function Key" column in Table 3-14 for a list of Special Functions that light the key LED.

**Related Sections**

- Calibration, Frequency
- Calibration, IF Attenuators
- Calibration, Input Gain Selection
- Controller Capability of the Noise Figure Meter
- Data Output to Oscilloscopes and Recorders
- Display Resolution
- Display Units Selection
- Fixed IF or LO Frequency Selection
- HP-IB Addresses, Noise Figure Meter and External LO
- IF Attenuation Selection
- Loss Compensation
- Manual Measurement Functions
- Measurement Mode 1.0
- Measurement Mode 1.1
- Measurement Mode 1.2
- Measurement Mode 1.3
- Measurement Mode 1.4
- Power Measurements
- Preset Conditions and Power-Up Sequence
- Programming an External LO
- Programs Available to Control an External LO
- RF Attenuation Selection
- Sequence
- Sideband Selection
- Smoothing
- Special Function Catalog
- Spot ENR, T<sub>hot</sub>, and T<sub>cold</sub>
- Temperature Units Selection
- Trigger Selection



Table 3-14. Special Function Summary (1 of 8)

Special Function		Program Code	Description	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions	References and Comments
Name	Code*								
Initialize Special Functions	0.0	CS	Initializes many Special Functions	N	—	—	—		Preset Conditions and Power Up Sequence
Measurement Mode Selection	1.0	E0	Mode 1.0 (10—1500 MHz measurement)	N	Y	Y	On	On	Measurement Mode 1.0
	1.1	E1	Mode 1.1 (fixed IF; variable freq. ext LO)	N	Y	Y	Off	Off	Measurement Mode 1.1
	1.2	E2	Mode 1.2 (variable IF; fixed freq. ext LO; SSB)	N	Y	Y	Off	Off	Measurement Mode 1.2
	1.3	E3	Mode 1.3 (fixed IF; variable freq. ext LO; mixer is DUT)	N	Y	Y	Off	Off	Measurement Mode 1.3
	1.4	E4	Mode 1.4 (variable IF; fixed freq. ext LO; mixer is DUT)	N	Y	Y	Off	Off	Measurement Mode 1.4
Sideband Frequency Offset	2.0	B0	Double Sideband (no offset)	N	Y	Y	On	On	Sideband Selection
	2.1	B1	Lower Single Sideband ( $F_{\text{signal}} < F_{\text{LO}}$ )	Y	Y	Y	Off	Off	
	2.2	B2	Upper Single Sideband ( $F_{\text{signal}} > F_{\text{LO}}$ )	Y	Y	Y	Off	Off	
Enter IF and LO Frequencies	3.0	IF	IF (for Modes 1.1 & 1.3)	N	Y	Y	NC	30 MHz	Fixed IF or LO Frequency Selection
	3.1	LF	LO (for Modes 1.2 & 1.4)	N	Y	Y	NC	10 000 MHz	
Control Function Selection	4.0	none	Normal Talker and Listener	N	Y	N	NC	NC	Controller Capability of the Noise Figure Meter
	4.1	none	Enable Ext LO Control	N	Y	N	NC	NC	
	4.2	none	Talk Only	N	Y	N	NC	NC	

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.  
 N = No; Y = Yes; NC = No Change; — = Not Applicable

Table 3-14. Special Function Summary (2 of 8)

Special Function		Program Code	Description	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions	References and Comments
Name	Code*								
ENR and THOT Settings	5.0	S0	Use ENR Table	N	Y	Y	On	On	ENR Table Entry
	5.1	S1	Use Spot ENR	Y	Y	Y	Off	Off	
	5.2	SE	Display Current ENR in dB	N	N	N	Off	Off	
	5.3	NR	Enter and Use Spot ENR	N	Y	Y	NC	15.2 dB	
	5.4	TH	Enter and Use THOT	N	Y	Y	NC	9893K	
	5.5	SN	Enter Noise Source Identifier	N	Y	N	NC	NC	
TCOLD Setting	6.0	TC	Enter TCOLD	N	Y	Y	NC	296.5K	ENR Table Entry
Output to Oscilloscope	7.0	A0	Noise Figure and Gain	N	Y	N	On	On	Data Output to Oscilloscopes, and Recorders
	7.1	A1	Test Pattern	N	Y	N	Off	Off	
	7.2	A2	Noise Figure Only	N	Y	N	Off	Off	
	7.3	A3	Gain Only	N	Y	N	Off	Off	
Enter Oscilloscope Limits	8.1	NL	Noise Figure Lower Limit	N	Y	Y	NC	0	Data Output to Oscilloscopes and Recorders
	8.2	NU	Noise Figure Upper Limit	N	Y	Y	NC	8	
	8.3	GL	Gain Lower Limit	N	Y	Y	NC	0	
	8.4	GU	Gain Upper Limit	N	Y	Y	NC	40	
Power Measurements	9.1	N5	SOURCE Off (uncal)	N	Y	Y	Off	Off	Power Measurements
	9.2	N6	SOURCE On (uncal)	N	Y	Y	Off	Off	
	9.3	N7	SOURCE Off (cal)	N	Y	Y	Off	Off	
	9.4	N8	SOURCE On (cal)	N	Y	Y	Off	Off	
Noise Figure Display Units	10.0	N0	F dB	N	Y	Y	On	On	Display Units Selection
	10.1	N1	F	N	Y	Y	Off	Off	
	10.2	N2	Y dB	N	Y	Y	Off	Off	
	10.3	N3	Y	N	Y	Y	Off	Off	
	10.4	N4	TeK	N	Y	Y	Off	Off	
<p>*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.                      N = No; Y = Yes; NC = No Change; — = Not Applicable</p>									

Table 3-14. Special Function Summary (3 of 8)

Special Function		Program Code	Description	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions	References and Comments
Name	Code*								
Select Noise Source Temp. Units for Data Input	11.0	D0	K	N	Y	Y	On	On	Temperature Units Selection (Also see Special Functions 5.4, 6.0 and 34.3)
	11.1	D1	°C	N	Y	Y	Off	Off	
	11.2	D2	°F	N	Y	Y	Off	Off	
Display Resolution	12.0	X0	Maximum Resolution	N	Y	N	On	On	Display Resolution
	12.1	X1	Less Res. on Noise Figure	N	Y	N	Off	Off	
	12.2	X2	Less Res. on Gain	N	Y	N	Off	Off	
Smoothing (Averaging)	13.0	V0	Exponential Smoothing	N	Y	N	On	On	Smoothing (Averaging)
	13.1	V1	Arithmetic Averaging	N	Y	N	Off	Off	
	13.2	AF	Smoothing Factor	N	Y	N	NC	1	
Manual Measurement Functions	14.1	MC	Cold Measurement (SOURCE-off)	N	Y	Y	Off	Off	Manual Measurement Functions
	14.2	MH	Hot Measurement (SOURCE-on)	N	Y	Y	Off	Off	
	14.3	CC	Cold Calibration (SOURCE-off)	N	Y	Y	Off	Off	
	14.4	CH	Hot Calibration (SOURCE-on)	N	Y	Y	Off	Off	
	15.0	P0	Display Current Measurement	N	N	Y	On	On	
	15.1	P1	Display Manual Measurement Results	Y	N	Y	Off	Off	
Recorder Functions	20.0	LL	Go to Lower Left	N	N	N	Off	Off	Data Output to Oscilloscopes and Recorders
	21.0	UR	Go to Upper Right	N	N	N	Off	Off	
	22.0	A4	Plot Noise Figure	N	Y	N	Off	Off	
	23.0	A5	Plot Gain	N	Y	N	Off	Off	
	24.0	A6	X-AXIS Output is Noise Figure and Y-AXIS Output is Gain (Strip Chart mode)	N	Y	N	Off	Off	Data Output to Oscilloscopes and Recorders
	<p>*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.                      N = No; Y = Yes; NC = No Change; -- = Not Applicable</p>								

Table 3-14. Special Function Summary (4 of 8)

Special Function		Program Code	Description	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions	References and Comments
Name	Code*								
Trigger Selection	30.0	T0	Free Run	N	N	N	On	On	Trigger Selection
	30.1	T1	Hold	N	N	N	Off	Off	
	30.2	T2	Execute	N	N	N	Off	Off	
Frequency Calibration	31.0	Y0	Automatic	N	N	N	On	On	Calibration, Frequency
	31.1	Y1	Disable Frequency Cal	N	N	N	Off	Off	
	31.2	Y2	Perform 1 Frequency Cal	N	N	N	Off	Off	
Input Gain Calibration	32.0	C0	20, 10 and 0 dB	N	N	N	On	On	Calibration, Input Gain Selection
	32.1	C1	10, 0 and -10 dB	Y	N	N	Off	Off	
	32.2	C2	0, -10 and -20 dB	Y	N	N	Off	Off	
	32.3	C3	-10, -20 and -30 dB	Y	N	N	Off	Off	
IF Attenuators Calibration	33.0	IC	Calibrate IF Attenuators	N	Y	N	Off	Off	Calibration, IF Attenuators
Loss Compensation	34.0	L0	Off	N	Y	N	On	On	Loss Compensation
	34.1	L1	On	Y	Y	N	Off	Off	
	34.2	LA	Enter Loss before DUT in dB	N	Y	N	NC	0 dB	
	34.3	LT	Enter Temperature of Losses	N	Y	N	NC	OK	
	34.4	LB	Enter Loss after DUT in dB	N	Y	N	NC	0 dB	
Sequence Functions	35.0	QM	Manual	N	N	N	On	On	Sequence
	35.1	QA	Automatic	N <sup>1</sup>	N	N	Off	Off	
	35.2	QS	Set	N	Y	N	NC	1-9	
	35.3	QC	Clear	N	N	N	Off	Off	
HP-IB Addresses	40.0	none	Display and Enter 8970A Address	N	Y	N	NC	NC	HP-IB Addresses
	40.1	EA	Display and Enter Ext LO Address	N	Y	N	NC	NC	

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.  
N = No; Y = Yes; NC = No Change; — = Not Applicable

Table 3-14. Special Function Summary (5 of 7)

Special Function		Program Code	Description	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions	References and Comments
Name	Code*								
External LO Programs	41.0	J0	HP 8350B Sweep Oscillator	N	Y	N	NC	NC	Programs Available to Control an External LO
	41.2	J2	HP 8672A Syn. Signal Generator	N	Y	N	NC	NC	
	41.3	J3	HP 8673B Syn. Signal Generator	N	Y	N	NC	NC	
External LO Commands	42.0	AC	Auxilliary Commands	N	Y	Y	NC	NC	Programming an External LO
	42.1	PS	CW Prefix and Suffix	N	Y	N	NC	NC	
	42.2	TM	Settling Time in ms	N	Y	N	NC	NC	
	42.3	MN	Min Frequency in MHz	N	Y	N	NC	NC	
	42.4	MX	Max Frequency in MHz	N	Y	N	NC	NC	
HP-IB Data Output Selection	43.0	H0	NOISE FIGURE Only	N	N	N	On	On	Refer to Remote Operation, Hewlett-Packard Interface Bus
	43.1	H1	Frequency (left display), INSERTION GAIN, NOISE FIGURE	N	N	N	Off	Off	
Service Request	44.0	Q0	Disable SRQ Capability (clears all enabled conditions)	N	N	N	Off	Off	Refer to Remote Operations, Hewlett-Packard Interface Bus
	44.1	Q1	Enable Data Ready to cause an SRQ	N	N	N	Off	Off	
	44.2	Q2	Enable Cal Complete to cause an SRQ	N	N	N	Off	Off	
	44.3	Q3	Enable HP-IB Code Error to cause an SRQ	N	N	N	On	On	
	44.6	Q6	Enable Instrument Error to cause an SRQ	N	N	N	Off	Off	

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.  
 N = No; Y = Yes; NC = No Change; - - Not Applicable

Table 3-14. Special Function Summary (6 of 8)

Special Function		Program Code	Description	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions	References and Comments
Name	Code*								
Special Function Catalog	50.0	G0	Scan Special Function Catalog Lines	N	N	N	Off	Off	Special Function Catalog
	50.1	G1	Line 1 Status	N	N	N	Off	Off	
	50.2	G2	Line 2 Status	N	N	N	Off	Off	
	50.3	G3	Line 3 Status	N	N	N	Off	Off	
	50.4	G4	Line 4 Status	N	N	N	Off	Off	
	50.5	G5	Line 5 Status	N	N	N	Off	Off	
	50.6	G6	Line 6 Status	N	N	N	Off	Off	
RF Attenuation Selection	60.0	R0	Auto	N	N	N	On	On	RF Attenuation Selection
	60.1	R1	+20 dB	Y	N	N	Off	Off	
	60.2	R2	+10 dB	Y	N	N	Off	Off	
	60.3	R3	0 dB	Y	N	N	Off	Off	
	60.4	R4	-10 dB	Y	N	N	Off	Off	
	60.5	R5	-20 dB	Y	N	N	Off	Off	
	60.6	R6	-30 dB	Y	N	N	Off	Off	
Display RF Attenuator Settings	61.0	SR	Display RF Attenuators	N	N	N	Off	Off	RF Attenuation Selection
RF Attenuator Hold	62.0	RH	RF Attenuators are held in the configuration that exists when Special Function 62.0 is activated	Y	N	N	Off	Off	RF Attenuation Selection
Individual RF Attenuator Selection	63.0	Z0	Select RF through Path	Y	N	N	Off	Off	RF Attenuation Selection Refer to Section VIII, Service
	63.1	Z1	Select 10 dB Pad Number 1	Y	N	N	Off	Off	
	63.2	Z2	Select 20 dB Input Amplifier	Y	N	N	Off	Off	
	63.4	Z4	Select 10 dB Pad Number 2	Y	N	N	Off	Off	
	63.5	Z5	Select 10 dB Pad Number 3	Y	N	N	Off	Off	

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.  
 N = No; Y = Yes; NC = No Change; -- = Not Applicable

Table 3-14. Special Function Summary (7 of 8)

Special Function		Program Code	Description	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions	References and Comments
Name	Code*								
IF Attenuation Selection	70.0	I0	Auto	N	N	N	On	On	IF Attenuation Selection
	70.1	I1	0 dB	Y	N	N	Off	Off	
	70.2	I2	5 dB	Y	N	N	Off	Off	
	70.3	I3	10 dB	Y	N	N	Off	Off	
	70.4	I4	15 dB	Y	N	N	Off	Off	
	70.5	I5	20 dB	Y	N	N	Off	Off	
	70.6	I6	25 dB	Y	N	N	Off	Off	
	70.7	I7	30 dB	Y	N	N	Off	Off	
	70.8	I8	35 dB	Y	N	N	Off	Off	
Display IF Attenuator Settings	71.0	SI	Display IF Attenuators	N	N	N	Off	Off	IF Attenuation Selection
IF Attenuator Hold	72.0	IH	IF Attenuators are held in the configuration that exists when Special Function 72.0 is activated	Y	N	N	Off	Off	IF Attenuation Selection
Voltmeter Mode	80.0	VC	Noise Source Off	N	Y	Y	Off	Off	Refer to Section VIII, Service
	81.0	VH	Noise Source On	N	Y	Y	Off	Off	
Recorder Test Functions	82.0	A7	Enable Recorder Test	N	N	N	Off	Off	Refer to Section VIII, Service
	82.1	XV	X-Axis Test	N	N	N	0	NC	
	82.2	YV	Y-Axis Test	N	N	N	0	NC	
Keyboard Test	90.0	KY	Display Key Codes	N	N	N	Off	Off	Refer to Section VIII, Service
	90.1	K1	Key Test—Row 1	N	N	N	Off	Off	
	90.2	K2	Key Test—Row 2	N	N	N	Off	Off	
	90.3	K3	Key Test—Row 3	N	N	N	Off	Off	
	90.4	K4	Key Test—Row 4	N	N	N	Off	Off	
	90.5	K5	Key Test—Row 5	N	N	N	Off	Off	
	90.6	K6	Key Test—Row 6	N	N	N	Off	Off	
	90.7	K7	Key Test—Row 7	N	N	N	Off	Off	
	90.8	K8	Key Test—Row 8	N	N	N	Off	Off	

\*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.  
 N = No; Y = Yes; NC = No Change; — = Not Applicable

Table 3-14. Special Function Summary (8 of 8)

Special Function		Program Code	Description	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions	References and Comments
Name	Code*								
Display Test	91.0	DT	Enable Display Test	N	N	N	Off	Off	Refer to Section VIII, Service
0 MHz Hold	92.0	U0	Off	N	N	N	On	On	Refer to Section VIII, Service
	92.1	U1	On	Y	N	N	Off	Off	
Default ENR	95.6	ND	Sets all ENR values to 15.20 dB and Noise Source ID No. to 00000	N	N	N	Off	Off	Refer to Section VIII, Service
Software Date	99.9	SD	Display Software Date	N	N	N	Off	Off	Refer to Section VIII, Service
<p>*Most Special Functions can be programmed using either the code number followed by SP or the HP-IB Code.                      N = No; Y = Yes; NC = No Change; — = Not Applicable</p>									



## Spot ENR, $T_{hot}$ , and $T_{cold}$

### (Special Functions 5 and 6)

**Description**

Special Functions 5 and 6 perform the following functions:

- a. Special Function 5.0 enables use of the ENR (Excess Noise Ratio) table data that was previously entered (refer to the ENR Table Entry Detailed Operating Instruction). This function disables spot ENR. (Spot ENR can be re-enabled using Special Function 5.1).
- b. Special Function 5.1 enables use of the previously entered spot ENR value (refer to Special Function 5.3). The ENR table is disabled and the single spot ENR value will be used at all frequencies. (The ENR table can be re-enabled using Special Function 5.0).
- c. Special Function 5.2 enables the current value of ENR being used by the instrument to be displayed.
- d. Special Function 5.3 enables entry and use of a spot ENR value. The allowable values for spot ENR range from  $-7$  to  $+17$  dB.
- e. Special Function 5.4 enables entry and use of  $T_{hot}$ . Some noise sources are specified in terms of  $T_{hot}$  instead of ENR. The allowable values for  $T_{hot}$  (in kelvins) range from 0 to 14824. The equation to convert  $T_{hot}$  (in kelvins) to ENR is:

$$ENR = 10 \log (T_{hot}/290 - 1)$$

f. Special Function 5.5 enables display and entry of the noise source identifier. Up to five digits, within the range of 0 to 60000 can be used to identify the noise source. For example, the serial number of the noise source for which the ENR table data was entered can be used.

g. Special Function 6.0 enables entry of a value for  $T_{cold}$ .  $T_{hot}$  and  $T_{cold}$  are used for hot/cold manual measurements. The allowable values for  $T_{cold}$  (in kelvins) range from 0 to 9999.

**Procedure**

To enable use of the ENR table data or spot ENR data, or to display the current ENR, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

To display and enable entry of spot ENR,  $T_{hot}$ ,  $T_{cold}$ , or the noise source identifier, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key. Next, enter the appropriate value using the DATA keys and press ENTER.

# Spot ENR, T<sub>hot</sub>, and T<sub>cold</sub> (cont'd)

(Special Functions 5 and 6)

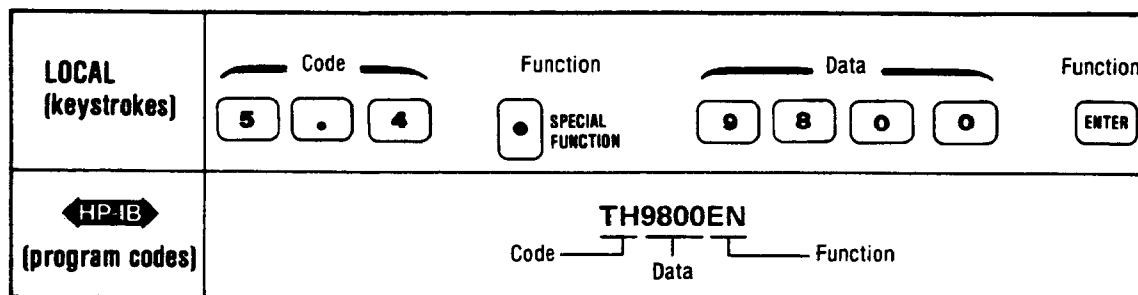
## Procedure (cont'd)

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Use ENR Table Data	5.0	S0 or 5.0SP	N	Y	Y	On	On
Use Spot ENR Data	5.1	S1 or 5.1 SP	Y	Y	Y	Off	Off
Display Current ENR in dB	5.2	SE or 5.2SP	N	N	N	Off	Off
Enter and Use Spot ENR	5.3	NE or 5.3SP	N	Y	Y	NC	15.2 dB
Enter and Use T <sub>hot</sub>	5.4	TH or 5.4SP	N	Y	Y	NC	9893K
Enter Noise Source Identifier	5.5	SN or 5.5SP	N	Y	N	NC	NC
Enter T <sub>cold</sub>	6.0	TC or 6.0SP	N	Y	Y	NC	296.5K

Table categories are explained in the Special Functions Detailed Operating Instruction.

## Example

To enter and use a value of 9800K for T<sub>hot</sub> (assuming Special Function 11.0 is active).



## Program Codes



For HP-IB codes for Special Functions 5 and 6, refer to Procedure above. The program code for ENTER is EN.

## Indications

When Special Function 5.2 or 5.3 is active, the current ENR or spot ENR is shown in the left display in units of dB. If a new spot ENR value is entered, it appears in the left display for as long as the ENTER key is depressed.

When Special Function 5.4 or 6.0 is active, T<sub>hot</sub> or T<sub>cold</sub> is shown in the left display in the temperature unit selected by Special Function 11. If a new value is entered for either T<sub>hot</sub> or T<sub>cold</sub>, it appears in the left display for as long as the ENTER key is depressed.

When Special Function 5.5 is active, the left display shows five digits. No units are displayed.

## Related Sections

- ENR Table Entry
- Manual Measurement Functions
- Special Functions
- Temperature Units Selection

# Store and Recall

**Description** Up to ten instrument configurations can be stored in the Noise Figure Meter's storage registers. Front panel settings that are stored and recalled are FREQUENCY, FREQ INCR, START FREQ, STOP FREQ, and STEP SIZE. Table 3-14, Special Function Summary, in the Special Functions Detailed Operating Instruction has a complete listing of special functions that can and cannot be stored and recalled.

**Procedure** Press STORE and a Data key (a single digit 0-9 to identify the storage register).  
 Press RECALL and a Data key (a single digit 0-9 to identify the storage register).

**Example** To recall an instrument configuration that has been stored in register 2:

LOCAL (keystrokes)	Function <b>RECALL</b>	Data <b>2</b>
<b>HP-IB</b> (program codes)	RC2 Code ———┬─── Data	

**Program Codes**

**HP-IB**

Key	Program Code <b>HP-IB</b>
STORE	ST
RECALL	RC

**Indications** When the stored contents of a register are recalled, the instrument configuration changes to the recalled parameter values.

**Comments** If any key other than a digit is pressed after STORE or RECALL, the store or recall entry will be rejected.

The data in the storage registers is not affected by PRESET or Special Function 0.0.

When the Noise Figure Meter is turned off, data stored in the registers is retained.

**Related Sections**

Preset Conditions and Power-Up Sequence  
 Sequence  
 Special Functions

## Sweep

### Description

The Noise Figure Meter can sweep the measurement frequency from START FREQ to STOP FREQ. The frequency changes in discrete steps (as set by STEP SIZE) rather than in a continuous analog manner.

The allowable sweep range depends on the measurement mode selected.

Measurement Mode	Range of Sweep	Conditions
1.0	10 to 1500 MHz	
1.1	1 MHz to 60 GHz	Depends on the frequency range of the external LO and the noise source.
1.2	>10 to <1500 MHz	External LO must be set up so that variable IF sweeps 10 to 1500 MHz.
1.3	1 MHz to 60 GHz	Depends on the frequency range of the external LO and the noise source.
1.4	10 to 1500 MHz	IF port response of mixer is being measured. Left display shows IF.

The minimum step size is 1 MHz. The maximum number of frequency points allowable in one sweep is

$$\frac{\text{STOP FREQ} - \text{START FREQ}}{\text{STEP SIZE}} + 1$$

However, the maximum number of frequency points that should be used when the sweep is displayed on an oscilloscope is 256. If more points are swept, multiple readings could occur at some points. Other limitations may be caused by the external LO.

Two sweep modes are available: Auto and Single. Each mode uses the sweep parameters that were previously set. Auto mode executes a repetitive sweep, restarting at the end of each sweep. Single mode executes one sweep only. At the end of a single sweep, the instrument remains tuned to the stop frequency.

### Procedure

**Sweep Range Selection.** The START FREQ and STOP FREQ keys set the starting and stopping points of the frequency sweep. STEP SIZE sets the frequency increment. Sweep parameters are selected in a Function - Data - ENTER format. Note that all frequency inputs from the front panel are in MHz.

**Sweep Mode Selection.** Press the desired mode key (AUTO or SINGLE) to initiate a sweep. To turn a sweep off, press the active sweep mode key a second time.

# Sweep (cont'd)

Procedure (cont'd)

Front Panel Key	Program Code ◀HP-IB▶	Stored in Continuous Memory	Can be Stored and Recalled	Preset (and HP-IB Clear) Conditions
AUTO	W1	N	N	Off
SINGLE	W2	N	N	Off
START FREQ	FA	Y	Y	10 MHz
STEP SIZE	SS	Y	Y	20 MHz
STOP FREQ	FB	Y	Y	1500 MHz

Table categories are explained in the Preset Conditions and Power-Up Sequence Detailed Operating Instruction.

Example

To sweep from 100 MHz to 400 MHz in 50 MHz steps once only:

<b>LOCAL (keystrokes)</b>	<p>Function      Data      Function</p> <p>START FREQ      1 0 0      ENTER</p> <p>STOP FREQ      4 0 0      ENTER</p> <p>STEP SIZE      5 0      ENTER</p> <p>SINGLE</p>
<b>◀HP-IB▶ (program codes)</b>	<p style="text-align: center;"><b>FA100MZFB400MZSS50MZW2</b></p> <p>Codes      Data      Function      Code      Data      Code      Function</p> <p>Function      Code      Data      Code      Function</p>

Program Codes  
◀HP-IB▶

Parameter	Program Code ◀HP-IB▶
Hz	HZ
MHz	MZ
Sweep Off	W0

For additional HP-IB program codes, refer to Procedure above.

Indications

When the START FREQ or STOP FREQ key is pressed, the left display shows the currently programmed start or stop frequency. The instrument tunes to that frequency and continues measuring there. As a new start or stop frequency is entered, it appears in the left display. When the STEP SIZE key is pressed, the left display shows the step size only for as long as the key is held down. A newly entered value is displayed for as long as the ENTER key is held down.

## Sweep (cont'd)

**Indications  
(cont'd)**

When the **AUTO** or **SINGLE** key is pressed, the LED within the corresponding key lights to indicate that the instrument is in the sweep mode.

**Comments**

If the stop frequency is less than the start frequency, the instrument sweeps downward. The sweep is slower when it operates in this manner. However, calibration and plotting must be performed in ascending frequency order only.

Pressing the **AUTO** key starts a sweep at the current frequency if the current frequency is not outside the start-stop range. If the current frequency is outside the start-stop range, the auto sweep starts at the programmed start frequency. To assure that an auto sweep starts at the programmed start frequency, press **START FREQ**, then **AUTO**.

**AUTO** and **SINGLE** are toggle keys, and they stop the sweep when pressed a second time. However, program codes **W1** and **W2** do not toggle over the **HP-IB**. Use program code **W0** to stop a sweep over the **HP-IB**.

Any front panel key except **LOCAL**, **DECREASE**, **INCREASE**, **SPECIAL FUNCTION**, **NOISE FIGURE**, and **NOISE FIGURE AND GAIN** stop the sweep when pressed.

**START FREQ**, **STOP FREQ**, and **STEP SIZE** set the calibration parameters. During calibration, the maximum number of frequency points allowed in a sweep is 81.

If the last step of a sweep causes the frequency to exceed the programmed stop frequency, the Noise Figure Meter tunes a partial step to reach the programmed stop frequency.

**Related  
Sections**

Calibrate  
Measurement Modes 1.0 through 1.4

# Temperature Units Selection

## (Special Function 11)

**Description**

Temperature units are used when loss temperature,  $T_{hot}$ , or  $T_{cold}$  data is entered into the instrument. The instrument can accept temperature data entries in three different measurement units: Kelvins (K), Fahrenheit ( $^{\circ}F$ ), or Celsius ( $^{\circ}C$ ).

**Procedure**

To select a temperature unit, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code ↔HP-IB↔	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0,0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
K	11.0	D0 or 11.0SP	N	Y	Y	On	On
$^{\circ}C$	11.1	D1 or 11.1SP	N	Y	Y	Off	Off
$^{\circ}F$	11.2	D2 or 11.2SP	N	Y	Y	Off	Off

Table categories are explained in the Special Functions Detailed Operating Instruction.

It is not necessary to select temperature units each time temperature data is entered. Once a temperature unit has been selected, all temperature data are entered and displayed in the same unit until that unit is changed (either by PRESET, Special Function 0,0, or by another temperature unit selection).

After a temperature unit has been selected, one of the special functions listed below must be active before temperature data can be entered.

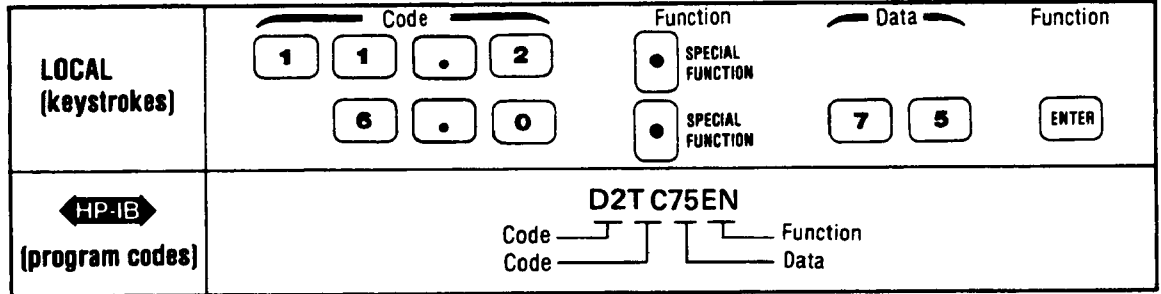
Description	Special Function Code	Range of Values		
		K	$^{\circ}C$	$^{\circ}F$
Enter and Use $T_{hot}$	5.4	0 to 14824	-273.2 to 14551	-459.7 to 26224
Enter $T_{cold}$	6.0	0 to 9999	-273.2 to 9725.9	-459.7 to 17539
Enter Temperature of Losses	34.3	0 to 9999	-273.2 to 9725.9	-459.7 to 17539

Next, key in a value for temperature (within the specified range) and press the ENTER key. Up to five digits are allowed for temperature entries. If a minus sign is used, only four digits are allowed. The maximum resolution is to three places to the right of the decimal point.

# Temperature Units Selection (cont'd)

## (Special Function 11)

**Example** To enter a value of 75 °F for T<sub>cold</sub>:



**Program Codes** For HP-IB codes, refer to Procedure above.



**Indications** When temperature data has been entered correctly, the selected unit appears in the left display.

**Comments** The equations used to convert from one temperature unit to another are:

$$K = °C + 273.15$$

$$°F = (9/5)°C + 32$$

**Related Sections**  
 ENR Table Entry  
 Loss Compensation  
 Special Functions  
 Spot ENR, T<sub>hot</sub>, and T<sub>cold</sub>



# Trigger Selection

## (Special Function 30)

**Description** Special Function 30.0 selects free run triggering for continuous measurements.

Special Function 30.1 selects trigger hold to prevent continuous measurements. When trigger hold is active, the frequency and results of the last measurement are held and displayed. No additional measurements are made and the displayed data can be read over the HP-IB as many times as required. Trigger hold is useful when the measurement setup must be reconfigured before making the next measurement.

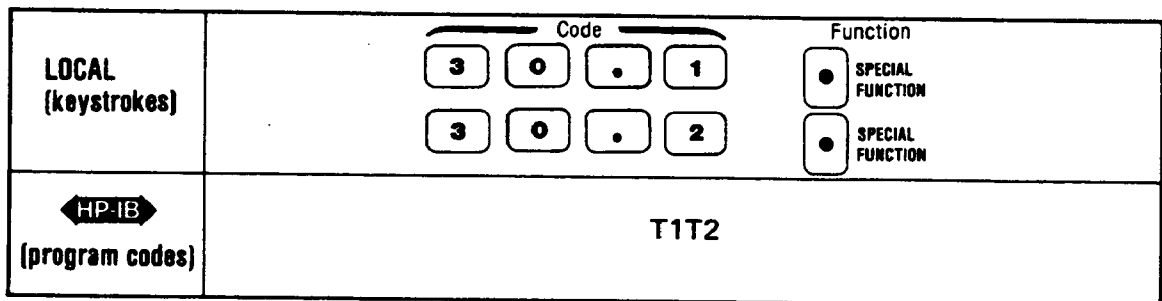
**HP-IB** Special Function 30.2 triggers one measurement and then returns to the previously selected trigger mode. Normally, this trigger execute command is used in conjunction with the trigger hold mode. Once the measurement is complete, the results are displayed and are available via the HP-IB. The measurement results are also output to an oscilloscope or recorder if one is connected to the rear panel. If a smoothing factor other than one has been selected, the Noise Figure Meter makes the number of measurements required by the selected smoothing factor before the smoothed measurement is displayed or available via the HP-IB.

**Procedure** To select a specific triggering mode, key in the corresponding Special Function code and then press the SPECIAL FUNCTION key.

Special Function		Program Code HP-IB	Lights Special Function Key	Stored in Continuous Memory	Can be Stored and Recalled	Special Function 0.0 Conditions	Preset (and HP-IB Clear) Conditions
Description	Code						
Free Run	30.0	T0 or 30.0SP	N	N	N	On	On
Hold	30.1	T1 or 30.1 SP	N	N	N	Off	Off
Execute	30.2	T2 or 30.2SP	N	N	N	Off	Off

Table categories are explained in the Special Functions Detailed Operating Instruction.

**Example** To select trigger hold and then execute a single measurement and return to trigger hold:



## Trigger Selection (cont'd)

### (Special Function 30)

**Program Codes**

For HP-IB codes, refer to Procedure.

**HP-IB****Indications**

When Special Function 30.0 is active, the front panel displays update continuously. When Special Function 30.1 is active, the front panel displays do not change. When Special Function 30.2 is active, the Noise Figure Meter makes one measurement and then returns to the last selected trigger mode.

**Comments**

When performing a triggered calibration, only the HP-IB mnemonic code T2 can be used. The Noise Figure Meter does not respond to the alternate 30.2SP code.

**Related Sections**

Calibrate  
Measurement Modes 1.0 through 1.4  
Smoothing  
Special Functions

## SECTION IV PERFORMANCE TESTS

### 4-1. INTRODUCTION

The procedures in this section test the instrument's electrical performance using the specifications of Table 1-1 as the performance standards. All tests can be performed without access to the interior of the instrument. An automated test tape is available from Hewlett-Packard which will run the performance tests. This tape is available by ordering, 8970A Performance Test Tape, Part Number 08970-10001.

#### NOTES

*Unless otherwise noted, no warm-up period is required for the tests.*

*Line voltage must be within +5% and - 10% of nominal, if the performance tests are to be considered valid.*

### 4-2. EQUIPMENT REQUIRED

Equipment required for the performance tests is listed in Table 1-3, Recommended Test Equipment

in Section I. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

### 4-3. TEST RECORD

Results of the performance tests may be tabulated on the Test Record at the end of the procedures. The Test Record lists all of the tested specifications and their acceptable limits. The results, recorded at incoming inspection, can be used for comparison in periodic maintenance and troubleshooting and after repairs or adjustments.

### 4-4. CALIBRATION CYCLE

This instrument requires periodic verification of performance. Depending on the use and environmental conditions, the instrument should be checked using the following performance tests at least once every year.

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**PERFORMANCE TESTS**


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**4-5. TUNING ACCURACY PERFORMANCE TEST**

**Specification**     TUNING ACCURACY: (from 10 to 40 C)  $\pm(1 \text{ MHz} + 1\% \text{ of frequency})$ ,  $\pm 6 \text{ MHz}$  maximum.

**Description**     The Noise Figure Meter is tuned to the frequency where accuracy is to be tested. The point of maximum IF signal level is found by stepping the signal source through the passband while monitoring the level at the internal noise power detector. A power reference is set, and the 3-dB passband frequencies are determined. The tuned center frequency of the Noise Figure Meter is then found as the average of the 3-dB frequencies. This tuned frequency is compared to limits derived from the specifications above.

**Equipment:**     Frequency Doubler ..... HP 11721A  
                          Signal Generator ..... HP 8656A

- Procedure**
1. Connect the signal generator RF output to the Noise Figure Meter INPUT.
  2. Turn on the equipment, and allow it to warm up for one half hour. Set the signal generator output level to  $-30 \text{ dBm}$ .
  3. On the Noise Figure Meter, key in 31.2 SPECIAL FUNCTION to execute a frequency calibration, then key in 31.1 SPECIAL FUNCTION to inhibit any further frequency calibrations. Key in 10.2 SPECIAL FUNCTION to set the display units to read Y-Factor in dB.
  4. Tune both the Noise Figure Meter and the signal generator to 10 MHz.
  5. On the Noise Figure Meter, key in 80.0 SPECIAL FUNCTION to display the noise power detector output in volts. Key in 62.0 SPECIAL FUNCTION to hold the RF attenuators. Key in 72.0 SPECIAL FUNCTION to hold the IF attenuators.
  6. Tune the signal generator up and down in 100 kHz steps until the maximum voltage display on the Noise Figure Meter is located. The 3-dB point should be within approximately 4 MHz of center frequency.
  7. On the Noise Figure Meter, key in 14.1 SPECIAL FUNCTION to activate the manual measurement mode and make a cold measurement. Key in 14.2 SPECIAL FUNCTION to exit the cold measurement mode (and store that value) and to make hot measurements. Finally, key in 15.1 SPECIAL FUNCTION to set the Noise Figure Meter to actively display the ratio of hot to cold values. The NOISE FIGURE display should now indicate 0.00 dB.
  8. Tune the signal generator up and down to find the 3-dB frequencies to within 100 kHz. Find the center frequency by summing the 3-dB frequencies and dividing by two. The center frequency should be within the limits in the table below.

**PERFORMANCE TESTS**

**Procedure  
(cont'd)**

9. Repeat steps 5 through 8 for each of the frequencies in the table below.

Nominal Tuned Frequency (MHz)	Lower 3-dB Frequency (MHz)	Upper 3-dB Frequency (MHz)	Center Frequency (MHz)		
			Min.	Actual	Max.
10	_____	_____	8.9	_____	11.1
100	_____	_____	98	_____	102
300	_____	_____	296	_____	304
500	_____	_____	494	_____	506

10. Insert the frequency doubler at the signal generator output.
11. Tune the Noise Figure Meter to 1000 MHz. Tune the signal generator to 500 MHz.
12. On the Noise Figure Meter, key in 80.0 SPECIAL FUNCTION to display the noise power detector output in volts.
13. Tune the signal generator up and down until the maximum voltage display is located.
14. On the Noise Figure Meter, key in 14.1 SPECIAL FUNCTION to activate the manual measurement mode and make a cold measurement. Key in 14.2 SPECIAL FUNCTION to exit the cold measurement mode (and store that value) and to make hot measurements. Finally, key in 15.1 SPECIAL FUNCTION to set the Noise Figure Meter to actively display the ratio of hot to cold values. The Noise Figure display should now indicate 0.00 dB.
15. Tune the signal generator up and down to find the 3-dB frequencies to within 10 kHz. Compute the center frequency by summing the 3-dB frequencies and dividing by two. The center frequency should be within the limits in the table below.
16. Repeat steps 12 through 15 for each of the fundamental frequencies in the table below. For each frequency in the table, tune the Noise Figure Meter to twice that frequency.

Signal Generator Frequency (MHz)	Lower 3-dB Frequency (MHz)	Upper 3-dB Frequency (MHz)	Center Frequency (MHz)		
			Min.	Actual	Max.
500	_____	_____	497	_____	503
650	_____	_____	647	_____	653
750	_____	_____	747	_____	753

Note: Frequencies shown are as indicated on the signal generator display. The Noise Figure Meter is tuned to twice these frequencies.

## PERFORMANCE TESTS

### 4-6. INPUT SWR PERFORMANCE TEST

**Specification** INPUT SWR (reflection coefficient):  $<1.7$  (0.26); 10 to 1500 MHz (50 ohms reference impedance).

**Description** The frequency range of the Noise Figure Meter is scanned for frequencies where the return loss is near specification limits. Then, each high point is checked individually against the specification. This is done for several input gain settings.

**Equipment**

Attenuator, 10 dB .....	HP 8491A Option 010
Frequency Counter .....	HP 5340A
Power Meter .....	HP 436A
Power Sensor .....	HP 8484A
Power Splitter .....	HP 11667A
Sweep Oscillator .....	HP 8620C/86222B Option 002
SWR Bridge .....	Wiltron 60N50

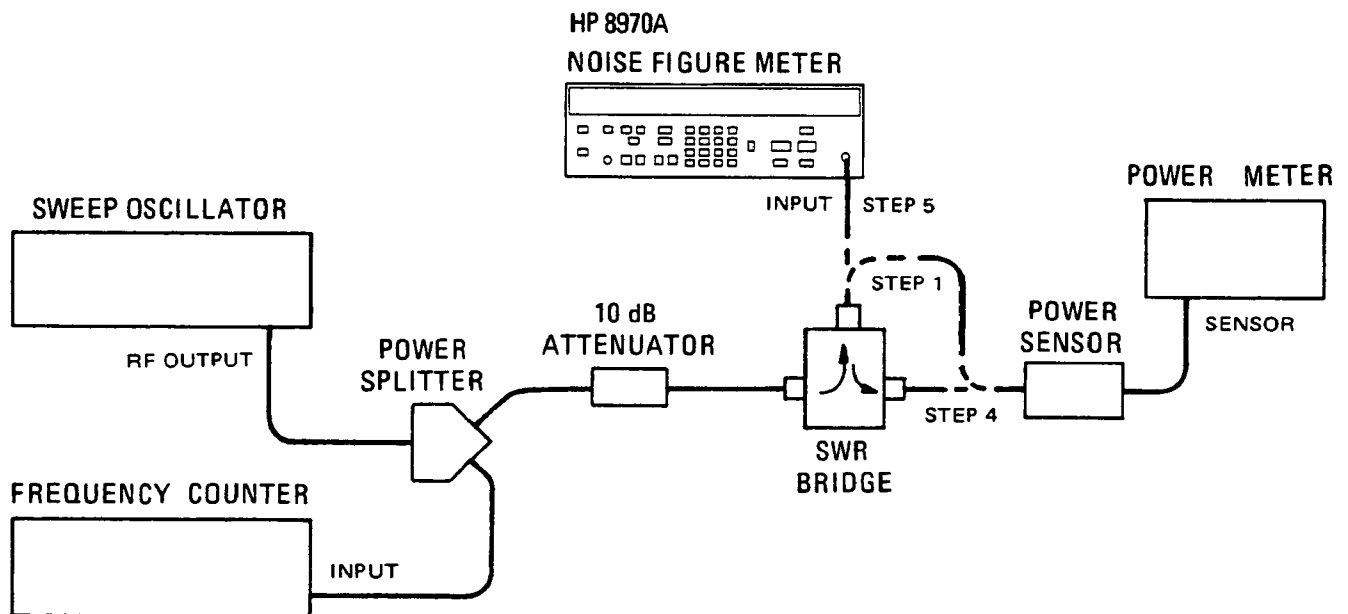


Figure 4-1. Input SWR Test Setup

**Procedure**

1. Connect equipment as shown in Figure 4-1. Note that the power sensor is connected to the test port of the SWR bridge.
2. Set the sweep oscillator for a 10 MHz continuous wave output as read on the frequency counter. Set the sweep oscillator power level to  $-23$  dBm at the test port of the SWR bridge, as read on the power meter. Sweep oscillator power should be approximately  $+3$  dBm.

**PERFORMANCE TESTS**

**Procedure  
(cont'd)**

3. On the Noise Figure Meter, key in 0.0 SPECIAL FUNCTION to initialize most Special Functions and 60.1 SPECIAL FUNCTION to set the input gain to +20 dB.
4. Tune the sweep oscillator to 1500 MHz. Connect the power sensor to the reflected output port of the SWR bridge. Set a relative reference on the power meter.
5. Connect the test port of the SWR bridge to the Noise Figure Meter INPUT. Slowly tune the sweep oscillator down in frequency to 10 MHz. While tuning, note each frequency at which the power meter reading peaks at less than 12.5 dB below the 0 dB reference set in step 4. For example, if the power meter display showed -11.0 dB, then the frequency should be noted. However, a reading of -13.0 dB indicates a return loss well within specifications.
6. For each frequency noted in step 5, tune the sweep oscillator and the Noise Figure Meter to that frequency. Disconnect the SWR bridge from the Noise Figure Meter INPUT, and set a power meter reference. Reconnect the SWR bridge to the Noise Figure Meter INPUT. The power meter should read greater than 11.73 dB below the reference.

INPUT SWR PERFORMANCE TEST	Min.	Actual	Max.
+20 dB Input Gain Setting			
Frequency			
_____ MHz		_____	-11.73 dB
_____ MHz		_____	-11.73 dB
_____ MHz		_____	-11.73 dB
+10 dB Input Gain Setting			
Frequency			
_____ MHz		_____	-11.73 dB
_____ MHz		_____	-11.73 dB
_____ MHz		_____	-11.73 dB
0 dB Input Gain Setting			
Frequency			
_____ MHz		_____	-11.73 dB
_____ MHz		_____	-11.73 dB
_____ MHz		_____	-11.73 dB

7. On the Noise Figure Meter, key in 60.2 SPECIAL FUNCTION to set the input gain to +10 dB. Repeat steps 4 through 6.
8. On the Noise Figure Meter, key in 60.3 SPECIAL FUNCTION to set the input gain to 0 dB. Repeat steps 4 through 6.

**PERFORMANCE TESTS**

**4-7. NOISE FIGURE RANGE AND ACCURACY PERFORMANCE TEST**

**Specification** NOISE FIGURE MEASUREMENT CHARACTERISTICS Range: 0.1 to 30 dB. Instrumentation Uncertainty:  $\pm 0.1$  dB for a noise source in a 0 to 55°C in a 300K environment with a noise source ENR of 14 to 16 dB.

**Description** Level ratios of -0.1 dB, -1 dB, -5 dB, -10 dB, -15 dB, and -20 dB are generated. The levels are measured on the power meter, and linear power ratios are computed. The levels are simultaneously measured on the Noise Figure Meter, and linear voltage ratios are computed. The voltage ratios are squared and then subtracted from the linear power ratios to compute the Y-Factor error. This error is compared to accuracy limits derived from the 0.1 dB noise figure accuracy specification. (A 15 dB ENR value is assumed.) The reading at -20 dB and the reading at -5 dB are used to compute a second 15 dB ratio. This ratio is also checked for accuracy.

**NOTES**

*This test is difficult to perform. Passing the test requires minimum drift in both the measurement equipment and the Noise Figure Meter. The more rapidly the test is performed, the more closely the test results will indicate the actual performance of the instrument. If the instrument fails by a narrow margin, performing the test more quickly will probably allow the instrument to pass.*

*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 test.*

<b>Equipment</b>	Attenuator, 6 dB .....	HP 8491A Opt. 006
	Attenuator, 1 dB Step. ....	HP 8494A Opt. 001
	Calculator .....	HP 41C
	Digital Voltmeter .....	HP 3455A
	Filter, Low-Pass .....	HP 360B
	Power Sensor .....	HP 8484A
	Power Splitter .....	HP 11667A
	Signal Generator .....	HP 8656A

- Procedure**
1. Connect equipment as shown in Figure 4-2, 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 50 MHz continuous wave output at -17 dBm.
  4. On the Noise Figure Meter, set FREQUENCY to 50 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 4-2.



PERFORMANCE TESTS

NOISE FIGURE RANGE AND ACCURACY PERFORMANCE TEST (cont'd)

Procedure  
(cont'd)

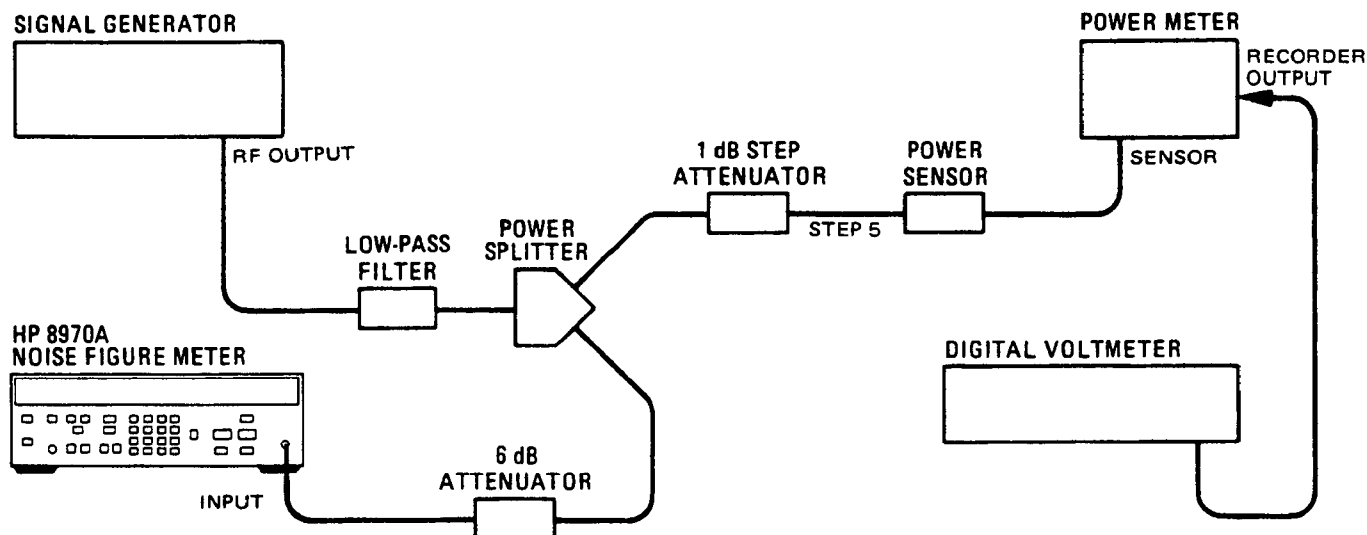


Figure 4-2. Noise Figure Instrumentation Accuracy Test Setup

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 indicated on the signal generator.  
\_\_\_\_\_ dBm
8. Set the step attenuator for a power meter reading as close as possible to 1.000 uW.
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.  
\_\_\_\_\_ Vdc
10. Note the voltmeter mode reading on the Noise Figure Meter also using full resolution.  
\_\_\_\_\_ Vdc
11. Decrease the signal generator power by 0.1 dB.
12. Using the same technique as in step 9, take a voltmeter reading.  
\_\_\_\_\_ Vdc

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**PERFORMANCE TESTS**


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**NOISE FIGURE RANGE AND ACCURACY PERFORMANCE TEST (cont'd)****Procedure  
(cont'd)**

13. Note the new voltmeter mode reading on the Noise Figure Meter. \_\_\_\_\_ Vdc
14. Decrease the signal generator output power to 1 dB below that set in step 7.
15. Using the same technique as in step 9, take a voltmeter reading. \_\_\_\_\_ Vdc
16. Note the new voltmeter mode reading on the Noise Figure Meter. \_\_\_\_\_ Vdc
17. Decrease the signal generator output power to 5 dB below that set in step 7.
18. Using the same technique as in step 9, take a voltmeter reading. \_\_\_\_\_ Vdc
19. Note the new voltmeter mode reading on the Noise Figure Meter. \_\_\_\_\_ Vdc
20. Decrease the signal generator output power to 10 dB below that set in step 7.
21. Using the same technique as in step 9, take a voltmeter reading. (Note that the power meter may change ranges for this reading. If it does, the voltmeter reading taken must be decreased by a factor of 10.) \_\_\_\_\_ Vdc
22. Note the new voltmeter mode reading on the Noise Figure Meter. \_\_\_\_\_ Vdc
23. Decrease the signal generator output power to 15 dB below that set in step 7.
24. Using the same technique as in step 9, take a voltmeter reading. (Remember to decrease this reading by a factor of 10.) \_\_\_\_\_ Vdc
25. Note the new voltmeter mode reading on the Noise Figure Meter. \_\_\_\_\_ Vdc
26. Decrease the signal generator output power to 20 dB below that set in step 7.
27. Using the same technique as in step 9, take a voltmeter reading. (Note that the power meter may change ranges again. If so this voltmeter reading must be decreased by a factor of 100.) \_\_\_\_\_ Vdc
28. Note the new voltmeter mode reading on the Noise Figure Meter. \_\_\_\_\_ Vdc
-

**PERFORMANCE TESTS**

**NOISE FIGURE RANGE AND ACCURACY PERFORMANCE TEST (cont'd)**

**Procedure  
(cont'd)**

29. Fill in the table below using the readings from the appropriate steps above. For the column on the far right, square the readings in the previous column.

Voltmeter Readings (Vdc)		Noise Figure Meter Readings		
			(Vdc)	(Vdc) <sup>2</sup>
Step 9	_____	Step 10	_____	_____
Step 12	_____	Step 13	_____	_____
Step 15	_____	Step 16	_____	_____
Step 18	_____	Step 19	_____	_____
Step 21	_____	Step 22	_____	_____
Step 24	_____	Step 25	_____	_____
Step 27	_____	Step 28	_____	_____

30. Fill in the table below by computing the indicated ratios (Y-Factors). The ratios of the second set of columns should be computed from the squared voltages from the previous table. Subtract the ratios of the second set of columns from those of the first set to yield the net error (difference). The result should be within the indicated limits.

Ratios (Y-Factors)				Difference		
				Min.	Actual	Max.
(Step 9)		(Step 10)				
(Step 12)	_____	(Step 13)	_____	-0.00053	_____	+0.00054
(Step 9)		(Step 10)				
(Step 15)	_____	(Step 16)	_____	-0.00589	_____	+0.00603
(Step 9)		(Step 10)				
(Step 18)	_____	(Step 19)	_____	-0.04922	_____	+0.05037
(Step 9)		(Step 10)				
(Step 21)	_____	(Step 22)	_____	-0.20487	_____	+0.20964
(Step 9)		(Step 10)				
(Step 24)	_____	(Step 25)	_____	-0.69706	_____	+0.71330
(Step 18)		(Step 19)				
(Step 27)	_____	(Step 28)	_____	-0.69706	_____	+0.71330

**PERFORMANCE TESTS**

**4-8. GAIN MEASUREMENT UNCERTAINTY PERFORMANCE TEST**

**Specification**    GAIN MEASUREMENT CHARACTERISTICS Range: -20 to +40 dB. Instrumentation Uncertainty: ±0.2 dB.

**Description**     Net gain is generated by removing attenuation from a high gain setup. The net gain is alternately measured first by a power meter and then by the Noise Figure Meter. The two measurements should compare within 0.2 dB.

**NOTES**

*This test is difficult to perform. Passing the test requires minimum drift in both the measurement equipment and the Noise Figure Meter. The more rapidly the test is performed, the more closely the test results will indicate the actual performance of the instrument. If the instrument fails by a narrow margin, performing the test more quickly will probably allow the instrument to pass.*

*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 test.*

<b>Equipment</b>	Attenuator, 10 dB (2 required) .....	HP 8491A Opt. 010
	Attenuator, 20 dB .....	HP 8491A Opt. 020
	Attenuator, 1 dB Step .....	HP 8494A Opt. 001
	Attenuator, 10 dB Step .....	HP 8495A Opt. 001
	Filter, Low-Pass. ....	HP 360B
	Noise Source .....	HP 346B Opt. 001
	Power Meter .....	HP 436A
	Power Sensor .....	HP 8484A
	Power Splitter .....	HP 11667A
	Wideband Amplifier I .....	HP 8447D Opt. 010
	Wideband Amplifier II .....	HP 8447F Opt. 010

- Procedure**
1. Connect the noise source directly to the Noise Figure Meter INPUT. Turn on all equipment, and allow it to warm up for a half hour.
  2. On the Noise Figure Meter, press PRESET, then key in 33.0 SPECIAL FUNCTION to perform an IF calibration.

**NOTE**

*This procedure relies critically upon the proper setup of the power meter. If readings yield results that are out of specification, check that the calibration adjustment and zero setting of the power meter are valid. Always disconnect the power sensor from the test setup when zeroing.*

3. Connect the equipment as shown in Figure 4-3.
4. On the Noise Figure Meter, press the ENR key to access the ENR table with in the Noise Figure Meter. Using the DATA keys and the ENTER key, modify the 10, 101, 1000 and 2000 MHz ENR entries to correspond to the noise source ENR chart. Exit the ENR table entry mode by pressing the FREQUENCY key.

## PERFORMANCE TESTS

## GAIN MEASUREMENT UNCERTAINTY PERFORMANCE TEST (cont'd)

## Procedure

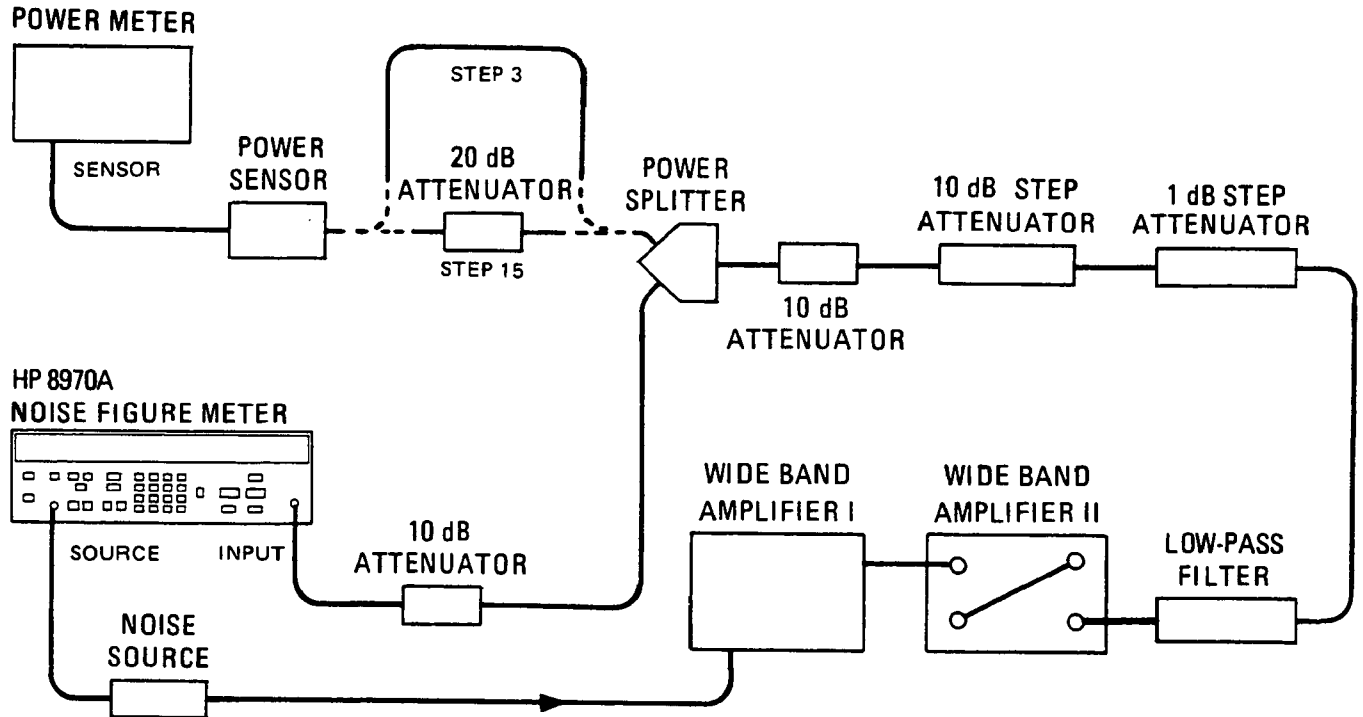


Figure 4-3. Gain Measurement Uncertainty Test Setup

5. On the Noise Figure Meter, set START FREQ, STOP FREQ, and FREQUENCY all to 1000 MHz.
6. Set the 10 dB step attenuator for 40 dB of attenuation. Set the 1 dB step attenuator for a power level no greater than  $-48$  dBm as read on the power meter.
7. On the Noise Figure Meter, press INCREASE to set the smoothing factor to 8. Press CALIBRATE.
8. When calibration is complete, key in 81.0 SPECIAL FUNCTION to turn on the noise source and display the noise power detector output in volts (voltmeter mode). Press STORE 1 to store this setting in the instrument memory.
9. Set a relative reference on the power meter. (Press dBREL key on 436A. Press NF and GAIN keys.)
10. Set the step attenuator for 30 dB of attenuation. Note the power meter reading.  
(Power Meter  $\approx$  10 dB Gain) \_\_\_\_\_ dB
11. On the Noise Figure Meter, press NOISE FIGURE AND GAIN. Note the Insertion Gain reading.  
(Noise Figure Meter  $\approx$  10 dB Gain) \_\_\_\_\_ dB
12. On the Noise Figure Meter, press RECALL 1.

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**PERFORMANCE TESTS**

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**GAIN MEASUREMENT UNCERTAINTY PERFORMANCE TEST (cont'd)****Procedure  
(cont'd)**

13. Set the step attenuator for 20 dB of attenuation. Note the power meter reading.  
(Power Meter  $\approx$ 20 dB Gain) \_\_\_\_\_ dB
  14. On the Noise Figure Meter, press NOISE FIGURE AND GAIN. Note the Insertion Gain reading.  
(Noise Figure Meter  $\approx$ 20 dB Gain) \_\_\_\_\_ dB
  15. Insert a 20 dB attenuator into the setup at the input to the power sensor.
  16. On the Noise Figure Meter, press RECALL 1.
  17. Note the power meter reading.  
(Power Meter Reference) \_\_\_\_\_ dB
  18. On the Noise Figure Meter, press NOISE FIGURE AND GAIN. Note the Insertion Gain Reading.  
(Noise Figure Meter Reference) \_\_\_\_\_ dB
  19. On the Noise Figure Meter, press RECALL 1.
  20. Set the step attenuator for 10 dB of attenuation. Note the power meter reading.  
(Power Meter  $\approx$ 30 dB Gain) \_\_\_\_\_ dB
  21. On the Noise Figure Meter, press NOISE FIGURE AND GAIN. Note the Insertion Gain reading.  
(Noise Figure Meter  $\approx$ 30 dB Gain) \_\_\_\_\_ dB
  22. On the Noise Figure Meter, press RECALL 1.
  23. Set the step attenuator for 0 dB of attenuation. Note the power meter reading.  
(Power Meter  $\approx$ 40 dB Gain) \_\_\_\_\_ dB
  24. On the Noise Figure Meter, press NOISE FIGURE AND GAIN. Note the Insertion Gain reading.  
(Noise Figure Meter  $\approx$ 40 dB Gain) \_\_\_\_\_ dB
  25. Subtract the reading of step 17 from that of step 13. This is the value of the 20 dB attenuator as seen by the power meter.  
(20 dB Attenuator) \_\_\_\_\_ dB
  26. Subtract the reading of step 18 from that of step 14. This is the Noise Figure Meter reference correction factor.  
(Noise Figure Meter Correction Factor) \_\_\_\_\_ dB
-

**PERFORMANCE TESTS**

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**GAIN MEASUREMENT UNCERTAINTY PERFORMANCE TEST (cont'd)**

**Procedure (cont'd)**

27. Fill appropriate values into the following table, then subtract the values for the Noise Figure Meter from the power meter readings above them to yield the net error. The error should be within  $\pm 0.2$  dB.

<b>Power Meter</b>	Step 10	Step 13	Step 20 + Step 25	Step 23 + Step 25
	_____ dB	_____ dB	_____ dB	_____ dB
<b>Noise Figure Meter</b>	Step 11	Step 14	Step 21 + Step 26	Step 24 + Step 26
	_____ dB	_____ dB	_____ dB	_____ dB
<b>Error</b>	_____ dB	_____ dB	_____ dB	_____ dB

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**PERFORMANCE TESTS**


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**4-9. INSTRUMENT NOISE FIGURE PERFORMANCE TEST**

**Specification** INSTRUMENT NOISE FIGURE:  $<7 \text{ dB} + 0.003 \text{ dB per MHz}$  on the most sensitive input range.

**Description** A noise source is connected to the Noise Figure Meter INPUT, and the instrument measures its own noise figure in the UNCORRECTED mode.

**Equipment** Noise Source ..... HP 346B Opt. 001

- Procedure**
1. Connect the noise source between the SOURCE output and the INPUT of the Noise Figure Meter. Turn on the Noise Figure Meter, then press PRESET. Set FREQ INCR to 100 MHz.
  2. Press the ENR key to access the ENR table within the Noise Figure Meter. Using the DATA keys and the ENTER key, modify the 10, 101, 1000, and 2000 MHz ENR entries to correspond to the noise source ENR chart. Exit the ENR table entry mode by pressing the FREQUENCY key.
  3. Key in 33.0 SPECIAL FUNCTION to perform an IF calibration. Use the INCREASE key to set the smoothing factor to 4. Select UNCORRECTED NOISE FIGURE.
  4. Note the NOISE FIGURE display reading at each frequency, while using the step up key (up arrow) to tune the Noise Figure Meter through its tuning range. The Noise Figure measurement results should be less than those shown in the table below.

Frequency (MHz)	Noise Figure (dB)	
	Actual	Maximum
10	_____	7.03
110	_____	7.33
210	_____	7.63
310	_____	7.93
410	_____	8.23



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**PERFORMANCE TESTS**

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**INSTRUMENT NOISE FIGURE PERFORMANCE TEST (cont'd)****Procedure  
(cont'd)**

Frequency (MHz)	Noise Figure (dB)	
	Actual	Maximum
510	_____	8.53
610	_____	8.83
710	_____	9.13
810	_____	9.43
910	_____	9.73
1010	_____	10.03
1110	_____	10.33
1210	_____	10.63
1310	_____	10.93
1410	_____	11.23
1510	_____	11.53

Table 4-1. Performance Test Record (1 of 2)

Hewlett-Packard Company Model 8970A Noise Figure Meter Serial Number _____		Tested by _____  Date _____		
Para. No.	Test	Results		
		Min.	Actual	Max.
4-5	<b>TUNING ACCURACY PERFORMANCE TEST</b> Tuned Frequency 10 MHz 100 MHz 300 MHz 500 MHz 1000 MHz 1300 MHz 1500 MHz	8.9 MHz 98 MHz 296 MHz 494 MHz 994 MHz 1294 MHz 1494 MHz	_____ _____ _____ _____ _____ _____ _____	11.1 MHz 102 MHz 304 MHz 506 MHz 1006 MHz 1306 MHz 1506 MHz
4-6	<b>INPUT SWR PERFORMANCE TEST</b> +20 dB Input Gain Setting Frequency ____ MHz ____ MHz ____ MHz +10 dB Input Gain Setting Frequency ____ MHz ____ MHz ____ MHz 0 dB Input Gain Setting Frequency ____ MHz ____ MHz ____ MHz		_____ _____ _____ _____ _____ _____ _____	-11.73 dB -11.73 dB -11.73 dB -11.73 dB -11.73 dB -11.73 dB -11.73 dB
4-7	<b>NOISE FIGURE RANGE AND ACCURACY PERFORMANCE TEST</b> Step 9 - Step 10 <sup>2</sup> Step 12 - Step 13 <sup>2</sup> Step 9 - Step 10 <sup>2</sup> Step 15 - Step 16 <sup>2</sup> Step 9 - Step 10 <sup>2</sup> Step 18 - Step 19 <sup>2</sup> Step 9 - Step 10 <sup>2</sup> Step 21 - Step 22 <sup>2</sup> Step 9 - Step 10 <sup>2</sup> Step 24 - Step 25 <sup>2</sup> Step 18 - Step 19 <sup>2</sup> Step 27 - Step 28 <sup>2</sup>	-0.00053 -0.00589 -0.04922 -0.20487 -0.69706 -0.69706	Difference _____ _____ _____ _____ _____ _____	+0.00054 +0.00603 +0.05037 +0.20964 +0.71330 +0.71330

Table 4-1. Performance Test Record (2 of 2)

Hewlett-Packard Company Model 8970A Noise Figure Meter Serial Number _____		Tested by _____ Date _____																																						
Para. No.	Test	Results																																						
		Min.	Actual	Max.																																				
4-8	<b>GAIN MEASUREMENT UNCERTAINTY PERFORMANCE TEST</b>																																							
	<table border="0"> <tr> <td style="text-align: center;"><b>Power Meter Reading</b></td> <td></td> <td style="text-align: center;"><b>Noise Figure Meter Reading</b></td> <td></td> </tr> <tr> <td style="text-align: center;">Step 10</td> <td style="text-align: center;">-</td> <td style="text-align: center;">Step 11</td> <td></td> </tr> <tr> <td style="text-align: center;">_____ dB</td> <td></td> <td style="text-align: center;">_____ dB</td> <td></td> </tr> <tr> <td style="text-align: center;">Step 13</td> <td style="text-align: center;">-</td> <td style="text-align: center;">Step 14</td> <td></td> </tr> <tr> <td style="text-align: center;">_____ dB</td> <td></td> <td style="text-align: center;">_____ dB</td> <td></td> </tr> <tr> <td style="text-align: center;">Step 20 + Step 25</td> <td style="text-align: center;">-</td> <td style="text-align: center;">Step 21 + Step 26</td> <td></td> </tr> <tr> <td style="text-align: center;">_____ dB</td> <td></td> <td style="text-align: center;">_____ dB</td> <td></td> </tr> <tr> <td style="text-align: center;">Step 23 + Step 25</td> <td style="text-align: center;">-</td> <td style="text-align: center;">Step 24 + Step 26</td> <td></td> </tr> <tr> <td style="text-align: center;">_____ dB</td> <td></td> <td style="text-align: center;">_____ dB</td> <td></td> </tr> </table>	<b>Power Meter Reading</b>		<b>Noise Figure Meter Reading</b>		Step 10	-	Step 11		_____ dB		_____ dB		Step 13	-	Step 14		_____ dB		_____ dB		Step 20 + Step 25	-	Step 21 + Step 26		_____ dB		_____ dB		Step 23 + Step 25	-	Step 24 + Step 26		_____ dB		_____ dB		-0.2 dB	_____	+0.2 dB
	<b>Power Meter Reading</b>		<b>Noise Figure Meter Reading</b>																																					
	Step 10	-	Step 11																																					
	_____ dB		_____ dB																																					
Step 13	-	Step 14																																						
_____ dB		_____ dB																																						
Step 20 + Step 25	-	Step 21 + Step 26																																						
_____ dB		_____ dB																																						
Step 23 + Step 25	-	Step 24 + Step 26																																						
_____ dB		_____ dB																																						
		-0.2 dB	_____	+0.2 dB																																				
		-0.2 dB	_____	+0.2 dB																																				
		-0.2 dB	_____	+0.2 dB																																				
		-0.2 dB	_____	+0.2 dB																																				
4-9	<b>INSTRUMENT NOISE FIGURE PERFORMANCE TEST</b>																																							
	<b>Frequency</b>																																							
	10 MHz		_____	7.03 FdB																																				
	110 MHz		_____	7.33 FdB																																				
	210 MHz		_____	7.63 FdB																																				
	310 MHz		_____	7.93 FdB																																				
	410 MHz		_____	8.23 FdB																																				
	510 MHz		_____	8.53 FdB																																				
	610 MHz		_____	8.83 FdB																																				
	710 MHz		_____	9.13 FdB																																				
	810 MHz		_____	9.43 FdB																																				
	910 MHz		_____	9.73 FdB																																				
	1010 MHz		_____	10.03 FdB																																				
	1110 MHz		_____	10.33 FdB																																				
	1210 MHz		_____	10.63 FdB																																				
1310 MHz		_____	10.93 FdB																																					
1410 MHz		_____	11.23 FdB																																					
1510 MHz		_____	11.53 FdB																																					

## 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 1-3 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

With one exception, the procedures in this section can be performed in any order. However, it is advisable to check the power supply voltages first. The 280 MHz Oscillator, the 300 MHz IF Bandpass Filter, the Second Converter LO Frequency, and the 2050 MHz Bandpass Filter adjustments should all be done prior to the 20 MHz IF Gain adjustment.

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.
A13R19	7	1.0— 1.33 k $\Omega$	Refer to Frequency Cal RF Detector and First LO Offset Adjustments.
A6R39	1	133— 196 k $\Omega$	Refer to Input Power Detector Offset and Gain Adjustment.
A13R66	7	5.11— 9.09 k $\Omega$	Refer to Frequency Cal RF Detector and First LO Offset Adjustments.

**ADJUSTMENTS**

**5-6. POWER SUPPLY ADJUSTMENTS**

**Reference** Service Sheets 11 and 19.

**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 3455A

- 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 +5.00 ±0.05 Vdc at A14TP1.
  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 ±0.1 Vdc.
  6. Connect the voltmeter input to the rear panel NOISE SOURCE DRIVE OUTPUT jack, J3. The voltmeter reading should be +28 ±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 fo 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)
+15V	A9TP2	±1.0
-15V	A9TP1	±1.0

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**ADJUSTMENTS**

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**5-7. VOLTMETER OFFSET ADJUSTMENT**

<b>Reference</b>	Service Sheet 5.
<b>Description</b>	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.
<b>Procedure</b>	<ol style="list-style-type: none"><li>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). Replace the cover and fasten with one screw. Turn on the Noise Figure Meter, and let it warm up one half hour.</li><li>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 <math>0V \pm 0.00003</math> Vdc.</li><li>3. Remove power, remove the cover, replace the white-orange-yellow wire to the point marked (VIN), and reinstall the cover over the Voltmeter Assembly.</li></ol>

ADJUSTMENTS

5-8. 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.*

**Equipment**

Attenuator, 6 dB .....	HP 8491A Opt. 006
Attenuator, 1dB Step .....	HP 8494A Opt. 001
Calculator .....	HP 41C
Digital Voltmeter .....	HP 3455A
Filter, Low-Pass .....	HP 360B
Power Meter .....	HP 436A
Power Sensor .....	HP 8484A
Power Splitter .....	HP 11667A
Signal Generator .....	HP 8656A

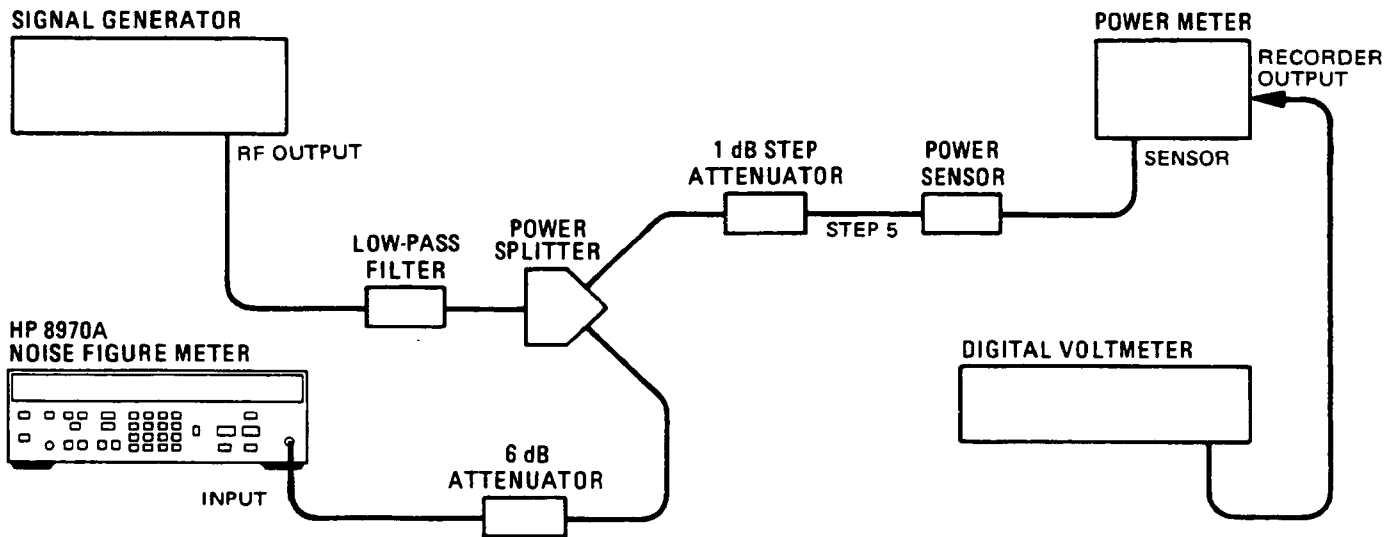


Figure 5-1. Noise Power Detector Adjustment Setup



## ADJUSTMENTS

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

#### Procedure (cont'd)

1. Connect equipment as shown in Figure 5-1, 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 5-1.
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 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.

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**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.

$$V_{n2} = (0.99885) (V_{n1}) \sqrt{\frac{(V_{p2})}{(V_{p1})}}$$

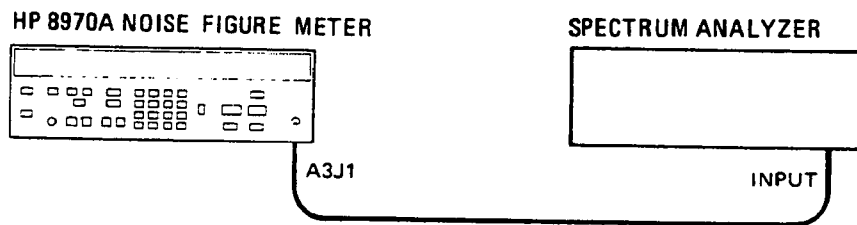
(Vn2) \_\_\_\_\_ Vdc

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

### 5-9. 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 8565A



**Figure 5-2. 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 5-2.
  4. Turn on the equipment power. Note that an error display on the Noise Figure 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.

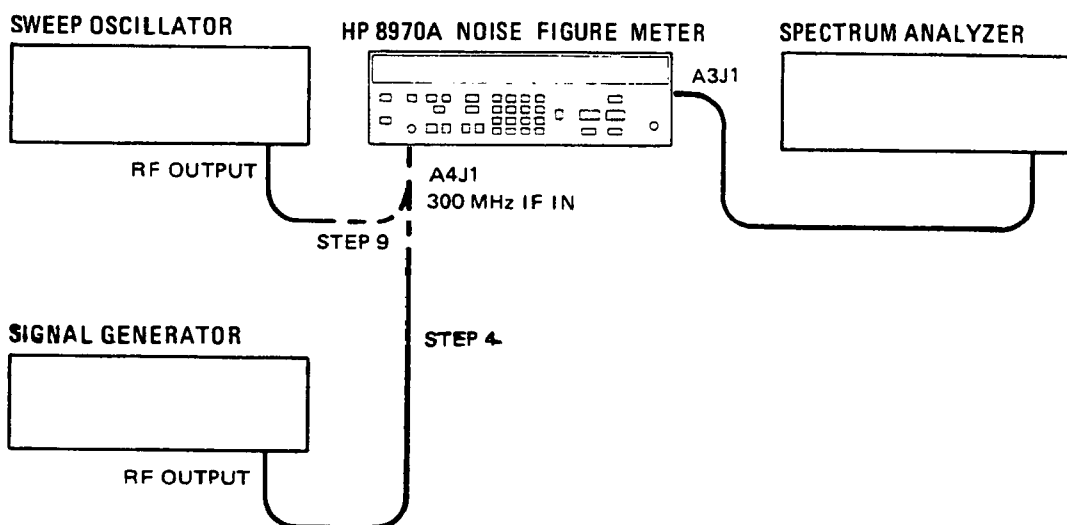
**ADJUSTMENTS**

**5-10. 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 8656A  
 Spectrum Analyzer ..... HP 8565A  
 Sweep Oscillator ..... HP 8620C/86222B Opt. 002



**Figure 5-3. 300 MHz IF Bandpass Filter Adjustment Setup**

- Procedure**
1. Set the signal generator for a 300.00 MHz CW signal at -30 dBm.
  2. Set spectrum analyzer reference level to -18 dBm, input attenuation to 20 dB, frequency span to 5 MHz per division, and resolution bandwidth to between 100 and 300 kHz. Set center frequency to 25 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 5-3. 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 should be visible at the fourth vertical graticule line from the left (at 20 MHz) on the spectrum analyzer display. If the signal meets the above limits, set the signal exactly on the fourth vertical graticule line from the left and continue with step 7.

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**ADJUSTMENTS**

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**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. When the signal strength is maximized, set the signal exactly on the fourth vertical graticule line from the left and continue with the next step.
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 5-3.)
10. Check that the passband displayed on the spectrum analyzer is centered on the fourth vertical graticule line from the left. 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. If so, no further adjustment is necessary.
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**

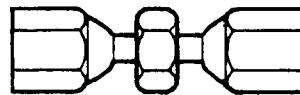
**5-11. SECOND CONVERTER LO FREQUENCY ADJUSTMENT**

<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

### 5-12. 2050 MHz BANDPASS FILTER ADJUSTMENT

**Reference** Service Sheet 2.

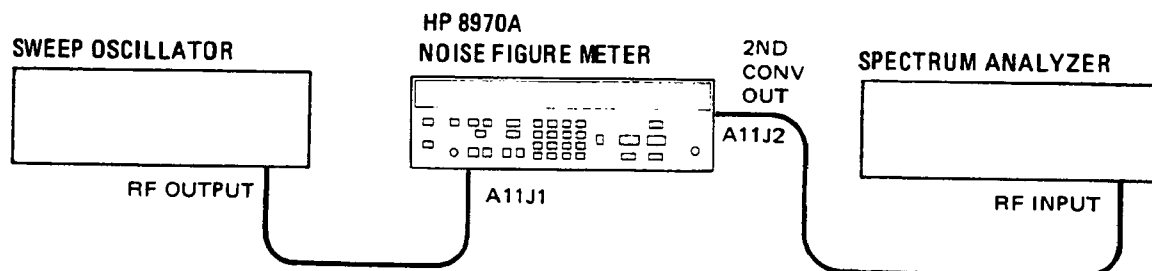
**Description** A swept 2050 MHz signal is injected into the second converter assembly, and the bandpass resonators are adjusted for best amplitude and flatness.

**Equipment**

Sweep Oscillator .....	HP 8620C/86222B Opt. 002
Spectrum Analyzer .....	HP 8565A
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 5 MHz per division, and resolution bandwidth to 100 kHz. Set the center frequency to 300 MHz, trigger to free run, and video filter off.
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 3 dB passband displayed on the spectrum analyzer is 18 to 20 MHz wide. The passband should be flat within 0.4 dB for 2 MHz on either side of the 300 MHz center frequency. Passband points at 8 MHz on either side of the center frequency should be within 1 dB of each other. 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.

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**ADJUSTMENTS**

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**2050 MHz BANDPASS FILTER ADJUSTMENT (cont'd)****Procedure  
(cont'd)**

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

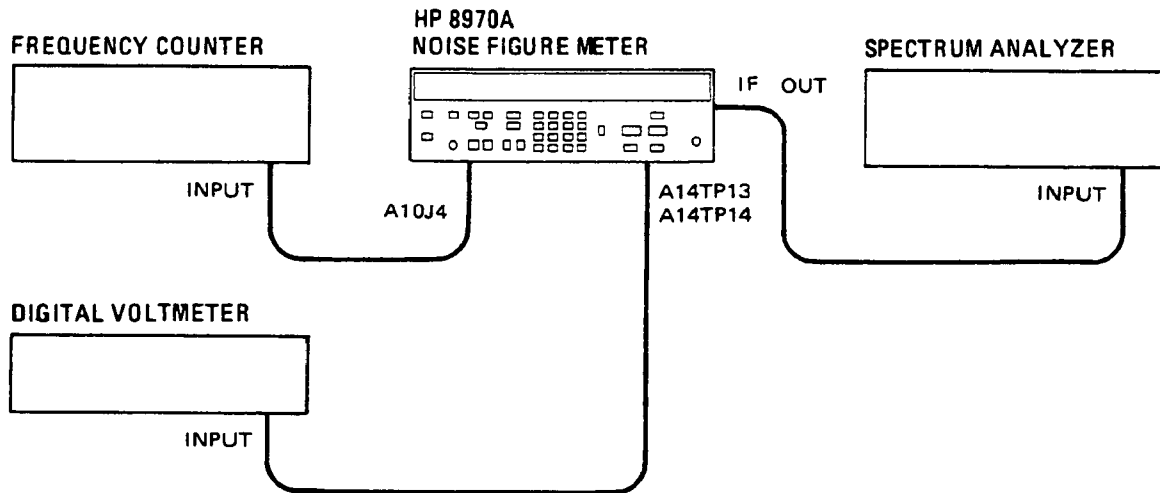
### 5-13. FREQUENCY CAL RF DETECTOR AND FIRST LO OFFSET ADJUSTMENTS

**Reference** Service Sheets 3 and 7.

**Description** The Frequency Cal RF Detector frequency and gain adjustments are set.

**Equipment**

Digital Voltmeter .....	HP 3455A
Frequency Counter .....	HP 5340A
Spectrum Analyzer .....	HP 8565A



**Figure 5-7. 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, key in 70.1 SPECIAL FUNCTION to set the IF attenuation to 0 dB.
3. Connect the equipment as shown in Figure 5-7. Connect the voltmeter high input to FREQ CAL DET IN, A14TP13, and the low input to GND, A14TP14.
4. Set the center of the 20 MHz IF passband exactly on the center vertical graticule of the spectrum analyzer display.
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, A13R17, until the signal is exactly centered on the center vertical graticule of the spectrum analyzer display. If the signal cannot be properly adjusted, perform step 6, otherwise continue with step 7.

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**ADJUSTMENTS**

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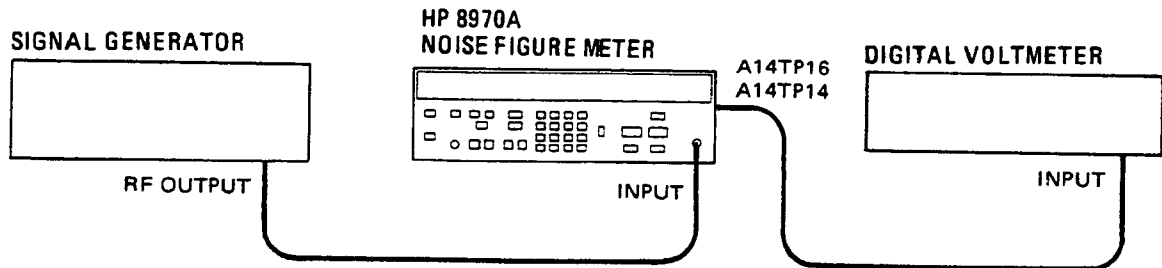
**FREQUENCY CAL RF DETECTOR AND FIRST LO OFFSET ADJUSTMENTS (cont'd)****Procedure  
(cont'd)**

6. If the adjustment in step 5 cannot be made, A13R19 must be selected as follows.
  - a. Set 1st LO OFFSET, A13R17 to midrange.
  - b. Note the frequency counter display.
  - c. If the frequency is greater than 2050 MHz, increase A13R19 one standard value. If the frequency is less than 2050 MHz, decrease A13R19 one standard value.
  - d. Readjust LO OFFSET, A13R17, until the signal is exactly centered on the center vertical graticule of the spectrum analyzer display. If this still cannot be done, repeat a through c. Note the value of A13R19 should be no less than 1000 ohms, or greater than 1470 ohms.
  - e. Continue with step 7.
7. 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.
8. Adjust DET GAIN, A3R19, for a voltmeter reading of 2.40 to 2.60 Vdc.
9. Tune the Noise Figure Meter to 1500 MHz. Adjust 1st LO GAIN, A13R11, for a counter reading of 3549.5 to 3551.5 MHz. If the frequency cannot be adjusted to within this range, perform step 10; otherwise this adjustment is complete.
10. If the adjustment in step 9 cannot be made, A13R66 must be selected as follows.
  - a. Note the frequency counter display as 1st LO GAIN, A3R11 is adjusted. If the frequency adjustment range is on the high side of 3551.5 MHz, increase A13R66 one standard value. If the frequency adjustment range is on the low side of 3549.5 MHz, decrease A13R66 one standard value.
  - b. Readjust 1st LO GAIN, A13R11, for a frequency counter reading of 3549.5 to 3551.5 MHz. If this still cannot be done, repeat a. Note the value of A13R66 should be no less than 5110 ohms, or no greater than 9090 ohms.

## ADJUSTMENTS

### 5-14. 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 3455A Signal Generator ..... HP 8656A



**Figure 5-8. Input Power Detector Offset and Gain Adjustment Setup**

#### Procedure

1. Connect equipment as shown in Figure 5-8. Connect the voltmeter low lead to GND, A14TP14, for a ground reference. Turn on the equipment, and allow the Noise Figure Meter to warm up for one hour.
2. Set the signal generator output to  $-127$  dBm.
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. Set the signal generator for an output of  $-18$  dBm at 30 MHz.
6. Adjust GAIN, A6R42, for a digital voltmeter reading of  $6 \pm 0.05$  Vdc. If the voltage cannot be adjusted within this range, perform step 7; otherwise, this adjustment is completed.
7. If the adjustment in step 6 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 6. If the adjustment in step 6 still cannot be done, repeat step 7. The value of A6R39 must be  $\geq 133$  K $\Omega$  and  $\leq 196$  K $\Omega$ .

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**ADJUSTMENTS**

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**5-15. 20 MHz IF GAIN ADJUSTMENT**

<b>Reference</b>	Service Sheet 3.
<b>Description</b>	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.
<b>Equipment</b>	Noise Source ..... HP 346b Opt. 001
<b>Procedure</b>	<ol style="list-style-type: none"><li>1. Connect the noise source to the Noise Figure Meter INPUT. Turn on the Noise Figure Meter.</li><li>2. On the Noise Figure Meter, press PRESET. 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.</li><li>3. Adjust IF GAIN, A3R36, for a front panel display of <math>1 \pm 0.05</math> Vdc. 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.</li></ol>

**ADJUSTMENTS**

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**5-16. DISPLAY LINEARITY AND X- AND Y-AXIS GAIN ADJUSTMENTS**

**Reference**            Service Sheets 16 and 17.

**Description**        The x-axis and y-axis gain adjustments are set for an output voltage range of 10 Vdc. The display linearity is set for constant horizontal spacings between display points.

**Equipment**        Oscilloscope ..... HP 1740A  
Digital Voltmeter ..... HP 3455A

- Procedure**
1. Set the digital voltmeter to read dc volts and connect it to the Noise Figure Meter rear panel X-AXIS output.
  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  $6 \pm 0.05$  Vdc.
  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  $6 \pm 0.05$  Vdc.
  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.
  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.
  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 1/2 way across the screen, press SINGLE SWEEP again, to stop the sweep. The trace should extend 1/2 way 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.
  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.

**ADJUSTMENTS**

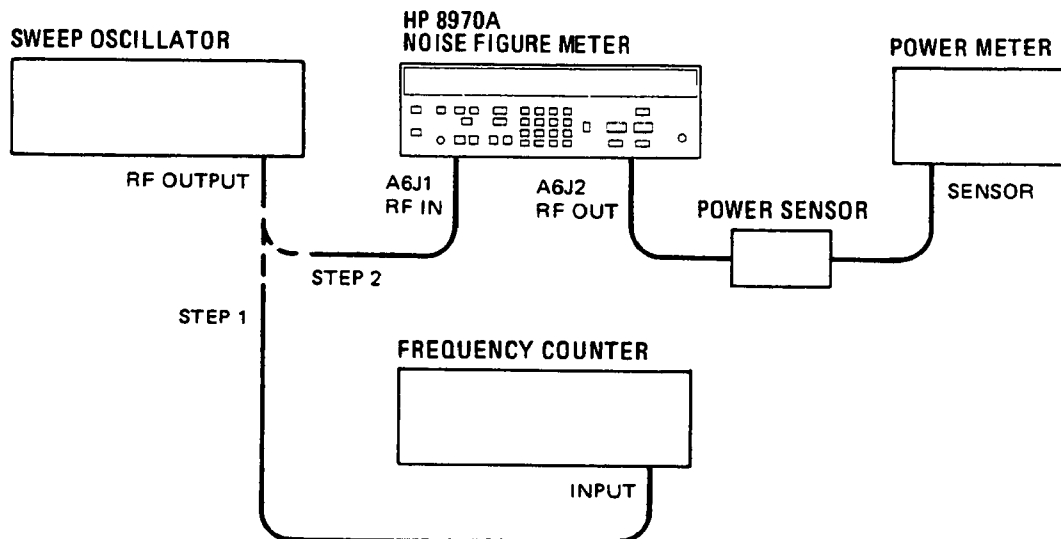
**5-17. 20 dB INPUT AMPLIFIER GAIN ADJUSTMENT**

**Reference** Service Sheet 1.

**Description** The 20 dB Input Amplifier is adjusted by selecting the value of L6 on the A6 Input Assembly. 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 5-15, before this procedure.

**Equipment**

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



**Figure 5-9. 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 1500 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 5-9.)
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.

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**ADJUSTMENTS**

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**20 dB INPUT AMPLIFIER GAIN ADJUSTMENT (cont'd)****Procedure  
(cont'd)**

6. The power meter should indicate between 19.5 and 20.5 dB. 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.
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 19.5 to 20.5 dB, 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.

## 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. RESTORED YIG OSCILLATORS

The YIG Oscillator (G1) may be replaced on an exchange basis, thus affording a considerable cost saving. Exchange, factory-repaired, and tested oscillators are available only on a trade-in basis; therefore, the defective oscillators must be returned for credit. For this reason, oscillators required for spare parts stock must be ordered by the new part number. The new YIG Oscillator part number is 5086-7080. The restored YIG Oscillator part number is 5086-6080.

### 6-3. 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.

### 6-4. 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.

### 6-5. 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 Sections V for information on determining what value to use for replacement.

### 6-6. 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.

### 6-7. 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.

### 6-8. ILLUSTRATED PARTS BREAKDOWNS

Most mechanical parts are identified in Figures 6-1 through 6-5. These figures are located near the end of the Replaceable Parts table.

### 6-9. HARDWARE

Both metric and nonmetric screws are used in the Noise Figure Meter. The nonmetric screws have a dull steel gray appearance. Metric screws have a shiny silver appearance.



**6-10. 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 Mountain View, California. Ask your nearest HP office for information and forms for the "Direct Mail Order System."*

**6-11. 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.

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	cm . . . . . centimeter	FM . . . . . frequency modulation	LG . . . . . long
AM . . . . . amplitude modulation	D/A . . . . . digital-to-analog	FP . . . . . front panel	LH . . . . . left hand
AMPL . . . . . amplifier	dB . . . . . decibel	FREQ . . . . . frequency	LIM . . . . . limit
APC . . . . . automatic phase control	dBm . . . . . decibel referred to 1 mW	FXD . . . . . fixed	LIN . . . . . linear taper (used in parts list)
ASSY . . . . . assembly	dc . . . . . direct current	g . . . . . gram	lin . . . . . linear
AUX . . . . . auxiliary	deg . . . . . degree (temperature interval or difference)	GE . . . . . germanium	LK WASH . . . . . lock washer
avg . . . . . average	° . . . . . degree (plane angle)	GHz . . . . . gigahertz	LO . . . . . low; local oscillator
AWG . . . . . American wire gauge	°C . . . . . degree Celsius (centigrade)	GL . . . . . glass	LOG . . . . . logarithmic taper (used in parts list)
BAL . . . . . balance	°F . . . . . degree Fahrenheit	GRD . . . . . ground(ed)	log . . . . . logarithm(ic)
BCD . . . . . binary coded decimal	°K . . . . . degree Kelvin	H . . . . . henry	LPF . . . . . low pass filter
BD . . . . . board	DEPC . . . . . deposited carbon	h . . . . . hour	LV . . . . . low voltage
BE CU . . . . . beryllium copper	DET . . . . . detector	HET . . . . . heterodyne	m . . . . . meter (distance)
BFO . . . . . beat frequency oscillator	diam . . . . . diameter	HEX . . . . . hexagonal	mA . . . . . milliampere
BH . . . . . binder head	DIA . . . . . diameter (used in parts list)	HD . . . . . head	MAX . . . . . maximum
BKDN . . . . . breakdown	DIFF AMPL . . . . . differential amplifier	HDW . . . . . hardware	M $\Omega$ . . . . . megohm
BP . . . . . bandpass	div . . . . . division	HF . . . . . high frequency	MEG . . . . . meg (10 <sup>6</sup> ) (used in parts list)
BPF . . . . . bandpass filter	DPDT . . . . . double-pole, double-throw	HG . . . . . mercury	MET FLM . . . . . metal film
BRS . . . . . brass	DR . . . . . drive	HI . . . . . high	MET OX . . . . . metallic oxide
BWO . . . . . backward-wave oscillator	DSB . . . . . double sideband	HP . . . . . Hewlett-Packard	MF . . . . . medium frequency; microfarad (used in parts list)
CAL . . . . . calibrate	DTL . . . . . diode transistor logic	HPF . . . . . high pass filter	MFR . . . . . manufacturer
ccw . . . . . counter-clockwise	DVM . . . . . digital voltmeter	HR . . . . . hour (used in parts list)	mg . . . . . milligram
CER . . . . . ceramic	ECL . . . . . emitter coupled logic	HV . . . . . high voltage	MHz . . . . . megahertz
CHAN . . . . . channel	EMF . . . . . electromotive force	Hz . . . . . Hertz	mH . . . . . millihenry
cm . . . . . centimeter		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 . . . . . millimeter
		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 . . . . . operational amplifier	RECT . . . . . rectifier	TFT . . . . . thin-film transistor
ms . . . . . millisecond	OPT . . . . . option	REG . . . . . regulated	TGL . . . . . toggle
MTG . . . . . mounting	OSC . . . . . oscillator	REPL . . . . . replaceable	THD . . . . . thread
MTR . . . . . meter (indicating device)	OX . . . . . oxide	RF . . . . . radio frequency	THRU . . . . . through
mV . . . . . millivolt	oz . . . . . ounce	RFI . . . . . radio frequency interference	TI . . . . . titanium
mVac . . . . . millivolt, ac	Ω . . . . . ohm	RH . . . . . round head; right hand	TOL . . . . . tolerance
mVdc . . . . . millivolt, dc	P . . . . . peak (used in parts list)	RLC . . . . . resistance-inductance-capacitance	TRIM . . . . . trimmer
mVpk . . . . . millivolt, peak	PAM . . . . . pulse-amplitude modulation	RMO . . . . . rack mount only	TSTR . . . . . transistor
mVp-p . . . . . millivolt, peak-to-peak	PC . . . . . printed circuit	rms . . . . . root-mean-square	TTL . . . . . transistor-transistor logic
mVrms . . . . . millivolt, rms	PCM . . . . . pulse-code modulation; pulse-count modulation	RND . . . . . round	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	PP . . . . . peak-to-peak (used in parts list)	SPG . . . . . spring	Vp-p . . . . . volts, peak-to-peak
NE . . . . . neon	PPM . . . . . pulse-position modulation	SR . . . . . split ring	Vrms . . . . . volts, rms
NEG . . . . . negative	PREAMPL . . . . . preamplifier	SPST . . . . . single-pole, single-throw	VSWR . . . . . voltage standing wave ratio
nF . . . . . nanofarad	PRF . . . . . pulse-repetition frequency	SSB . . . . . single sideband	VTO . . . . . voltage-tuned oscillator
NI PL . . . . . nickel plate	PRR . . . . . pulse repetition rate	SST . . . . . stainless steel	VTVM . . . . . vacuum-tube voltmeter
N/O . . . . . normally open	ps . . . . . picosecond	STL . . . . . steel	V(X) . . . . . volts, switched
NOM . . . . . nominal	PT . . . . . point	SQ . . . . . square	W . . . . . watt
NORM . . . . . normal	PTM . . . . . pulse-time modulation	SWR . . . . . standing-wave ratio	W/ . . . . . with
NPN . . . . . negative-positive-negative	PWM . . . . . pulse-width modulation	SYNC . . . . . synchronize	WIV . . . . . working inverse voltage
NPO . . . . . negative-positive zero (zero temperature coefficient)		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	08970-60007	8	1	KEYBOARD ASSEMBLY	28480	08970-60007
A1DS1	1990-0665	3	10	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A1DS2	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A1DS3	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A1DS4	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A1DS5	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A1DS6	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A1J1	1251-5649	7	1	CONNECTOR 20-PIN M POST TYPE	28480	1251-5649
A1J2*	1251-8391	2	4	CONN-POST TYPE .100-PIN-SPCG 4-CONT	28480	1251-8391
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 SM/GRAY (8)	28480	5041-0818
A1MP5	5041-0817	0	1	KEY CAP-HALF SM/GRAY (7)	28480	5041-0817
A1MP6	5041-2099	4	1	KEY CAP-HALF (PRESET)	28480	5041-2099
A1MP7	5041-2706	0	1	KEY CAP-SDQ (NOISE FIGURE)	28480	5041-2706
A1MP8	5041-0816	9	2	KEY CAP-HALF SM/GRAY (9)	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- (SEQ)	28480	5041-2708
A1MP12	5041-0808	9	1	KEY CAP-HALF (.)	28480	5041-0808
A1MP13	5041-0819	2	1	KEY CAP-HALF SM/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 SM/GRAY (5)	28480	5041-0815
A1MP21	5041-0814	7	1	KEY CAP-HALF SM/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-SDQ (NOISE FIGURE & GAIN)	28480	5041-2707
A1MP24	5041-0816	9		KEY CAP-HALF SM/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 (FRED INCR)	28480	5041-2097
A1MP27	5041-0810	3	1	KEY CAP-HALF (RECALL)	28480	5041-0810
A1MP28	5041-0812	5	1	KEY CAP-HALF SM/GRAY (2)	28480	5041-0812
A1MP29	5041-0811	4	1	KEY CAP-HALF SM/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 BUTTER-SCOTCH YELLOW (SPECIAL FUNCTION)	28480	5041-0484
A1MP32	5041-0813	6	1	KEY CAP-HALF SM/GRAY (3)	28480	5041-0813
A1MP33	5041-2098	3	1	KEY CAP-SDQ (CALIBRATE)	28480	5041-2098
A1MP34	5041-2705	9	1	KEY CAP-SDQ (INCREASE)	28480	5041-2705
A1MP35	0380-1344	3	11	SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP36	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP37	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP38	0380-1344	3		SPACER-RVT-ON 9-MM-LG 4.8-MM-ID	28480	0380-1344
A1MP39	0380-1344	3		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
A1R1	0698-0082	7	7	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A1R2	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A1R3	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A1R4	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A1R5	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A1R6	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-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
A1S1	5060-9436	7	14	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	
A1TP1†				NOT ASSIGNED		
A1TP2†				NOT ASSIGNED		
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†	08970-60018	1	1	DISPLAY ASSEMBLY	28480	08970-60018
A2C1	0180-0229	7	5	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A2C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C3	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C4	0180-1735	2		CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
A2C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C6	0160-3879	7	8	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C10	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A2C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C16	0160-3879	7	8	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C21	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C22	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C23	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A2C24	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879

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
A2DS1†	1990-0730	3	13	DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7	13	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS2†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS3†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS4†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS5†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS6†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS7†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS8†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS9†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS10†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS11†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS12†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS13†	1990-0730	3		DISPLAY-NUM-SEG 1-CHAR .3-H RED	28480	5082-7611
	1200-1123	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-1123
A2DS14	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS15	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS16	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS17†				NOT ASSIGNED		
A2DS18	1990-0696	0	1	LED-LIGHT BAR MODULE LUM-INT=3MCD	28480	1LM1-2300
	1200-0904	0	1	SOCKET-DSPL 4-CONT SIP W-WRAP	28480	1200-0904
A2DS19-				NOT ASSIGNED		
A2DS22†				NOT ASSIGNED		
A2DS23	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS24-				NOT ASSIGNED		
A2DS30†				NOT ASSIGNED		
A2DS31-	1990-0759	6	4	LED-LIGHT BAR MODULE LUM-INT=3MCD	28480	HLMP-2620
A2DS34†	1200-1124	8	1	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-1124
A2J1†	1251-7727	6	1	CONNECTOR- 7 PIN NSR: P/O A2W1	28480	1251-7727
A2L1	9100-1611	4	2	INDUCTOR RF-CH-MLD 220NH 20%	28480	9100-1611
A2MP1†	7121-2961	1	1	LABEL-INFORMATION MYLAR	28480	7121-2961
A2MP2†				NOT ASSIGNED		
A2MP3†				NOT ASSIGNED		
A2R1	0757-0279	0	8	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A2R2	1810-0207	9	1	NETWORK-RES 8-SIP22.0K OHM X 7	01121	208A223
A2R3	0757-0199	3	5	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
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	25	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R7	0757-0470	3	1	RESISTOR 162K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1623-F
A2R8	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A2R9	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R10	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R11	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A2R12	1810-0205	7	5	NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A2R13	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R14	1810-0205	7		NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A2R15	0698-3155	1	4	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A2R16	1810-0330	9	13	NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R17	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R18	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R19	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R20	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471

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
A2R21	1810-0203	5	1	NETWORK-RES 8-SIP470.0 OHM X 7	01121	208A471
A2R22	1810-0381	0	4	NETWORK-RES 8-SIP150.0 OHM X 7	11236	750-81-R150
A2R23	1810-0381	0		NETWORK-RES 8-SIP150.0 OHM X 7	11236	750-81-R150
A2R24	1810-0381	0		NETWORK-RES 8-SIP150.0 OHM X 7	11236	750-81-R150
A2R25	1810-0381	0		NETWORK-RES 8-SIP150.0 OHM X 7	11236	750-81-R150
A2R26	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R27	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R28	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R29	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R30	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R31	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R32	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2R33	1810-0330	9		NETWORK-RES 16-DIP470.0 OHM X 8	01121	316B471
A2U1	1820-1568	8	3	IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A2U2	1820-1201	6	3	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A2U3	1820-1199	1	5	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A2U4†	1858-0047	5	3	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	2	IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A2U7	1820-1216	3	3	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A2U8	1820-1794	2	8	IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A2U9	1820-1987	5	3	IC SHF-RGTR TTL LS COM CLEAR STOR 8-BIT	01295	SN74LS299N
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	01295	SN74LS299N
A2U27	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A2U28	1820-1427	8	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS156N
A2U29	1820-1416	5	3	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A2U1	8120-3299	9	1	FLAT RIBBON ASSY 28-AWG 20-COND	28480	8120-3299
A2U2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
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	25	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
A3C16	0160-0576	5		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

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
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	28480	0160-4698
A3C26				NOT ASSIGNED		
A3C27	0160-5376	3		CAPACITOR-FXD 200PF +-1% 200VDC CER	28480	0160-5376
A3C28	0160-4698	0		CAPACITOR-FXD 55PF +-1% 200VDC CER	28480	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 +- .5PF 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 +- .5PF 200VDC CER	28480	0160-3874
A3C42	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C43	0121-0451	3	2	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		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
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	1	CONNECTOR-SGL CONT SKT .018-IN HSC-SZ	28480	1251-1556
A3C83	0160-3029	8	1	CAPACITOR-FXD 7.5PF +- .5PF 100VDC CER	28480	0160-3029

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
A3CR1	1901-0050	3	16	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR3	1901-0518	8	1	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
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 M 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% .166DX.385LG	28480	9140-0179
A3L2	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10% .166DX.385LG	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% .166DX.385LG	28480	9140-0179
A3L11	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10% .166DX.385LG	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% .166DX.385LG	28480	9140-0179
A3L16	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10% .166DX.385LG	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% .166DX.385LG	28480	9140-0179
A3L20	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10% .166DX.385LG	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% .166DX.385LG	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	28480	1855-0235
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	28480	1855-0235
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	28480	1855-0235
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	28480	1855-0235
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	28480	1855-0235
A3Q19	1853-0405	9		TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A3Q20	1854-0345	8		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
	1205-0037	0	2	HEAT SINK TO-18-CS	28480	1205-0037
A3Q21	1854-0686	0	1	TRANSISTOR NPN SI TO-72 PD=200MW FT=4GHZ	28480	1854-0686

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
A3R1	0698-3153	9	8	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A3R2	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R3	0757-0424	7	2	RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A3R4	0757-0873	0	2	RESISTOR 1.62K 1% .5W F TC=0+-100	28480	0757-0873
A3R5	0757-0394	0	5	RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-S1R1-F
A3R6†	0757-0280	3	17	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R7†	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R8	0757-0402	1	2	RESISTOR 110 1% .125W F TC=0+-100	24546	C4-1/8-T0-111-F
A3R9†	0698-0089	4	1	RESISTOR 1.78K 1% .5W F TC=0+-100	28480	0698-0089
A3R10	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-S1R1-F
A3R11	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-S1R1-F
A3R12	0757-0463	4	2	RESISTOR 82.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8252-F
A3R13	0698-3162	0	8	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A3R14	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R15	0757-0465	6	12	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R16	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A3R17	0757-0397	3	2	RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A3R18	0757-0817	2	2	RESISTOR 750 1% .5W F TC=0+-100	28480	0757-0817
A3R19	2100-3296	8	1	RESISTOR-TRMR 1K 10% C TOP-ADJ 17-TRN	28480	2100-3296
A3R20	0757-0288	1	3	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
A3R21	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R22	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A3R23	0757-0401	0	12	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R24	0757-0416	7	7	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R25	0698-8606	7	1	RESISTOR 450 .1% .125W F TC=0+-25	28480	0698-8606
A3R26	0698-6364	0	1	RESISTOR 50 .1% .125W F TC=0+-25	28480	0698-6364
A3R27	0698-3434	9	1	RESISTOR 34.8 1% .125W F TC=0+-100	24546	C4-1/8-T0-34R8-F
A3R28	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R29	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R30	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R31	0698-8827	4	2	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A3R32	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A3R33	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R34	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A3R35†	0698-3430	5	1	RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-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	28480	0757-0817
A3R38	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A3R39	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R40	0757-0288	1		RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
A3R41	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R42	0698-6448	1	1	RESISTOR 216.2 .1% .125W F TC=0+-25	28480	0698-6448
A3R43	0698-6323	1	1	RESISTOR 100 .1% .125W F TC=0+-25	28480	0698-6323
A3R44	0757-0395	1	1	RESISTOR 56.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-56R2-F
A3R45	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R46	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R47	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A3R48	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R49	0757-0398	4		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A3R50	0698-3442	9	2	RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A3R51	0757-0815	0	1	RESISTOR 562 1% .5W F TC=0+-100	28480	0757-0815
A3R52	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A3R53	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R54	0757-0288	1		RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
A3R55	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R56	0699-0824	7	1	RESISTOR 218.8 .1% .125W F TC=0+-25	28480	0699-0824
A3R57	0699-0825	8	1	RESISTOR 281.2 .1% .125W F TC=0+-25	28480	0699-0825
A3R58	0757-0402	1		RESISTOR 110 1% .125W F TC=0+-100	24546	C4-1/8-T0-111-F
A3R59	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R60	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R61	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R62	0757-0463	4		RESISTOR 82.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8252-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	C4-1/8-T0-133R-F
A3R65	0698-3439	4	2	RESISTOR 178 1% .125W F TC=0+-100	24546	C4-1/8-T0-178R-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
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 SQ	28480	1251-0600
A3U1	1826-0217	4	3	IC OP AMP GP DUAL TO-99 PKG	07933	RC4558T
A3U2	1826-0217	4		IC OP AMP GP DUAL TO-99 PKG	07933	RC4558T
A3U3	1826-0217	4		IC OP AMP GP DUAL 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		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
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	1	CAPACITOR-FXD 39PF +-5% 200VDC CER 0+-30	28480	0160-4494
A4C9	0121-0452	4	4	CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V	74970	187-0103-028
A4C10				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4C11	0121-0452	4		CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V	74970	187-0103-028
A4C12	0121-0452	4		CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V	74970	187-0103-028
A4C13	0160-4103	2	1	CAPACITOR-FXD 220PF +-5% 100VDC CER	72982	8121-1100-COG-221J
A4C14				PART IS ETCHED TRACE ON CIRCUIT BOARD		
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				PART IS ETCHED TRACE ON CIRCUIT BOARD		
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	28480	1901-0050
A4CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
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
A4L1	9140-0144	0	7	INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A4L2†				NOT ASSIGNED		
A4L3	9100-2247	4	1	INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247
A4L4	08970-80003	6	4	INDUCTOR-IF 300 MHZ	28480	08970-80003
A4L5	08970-80003	6		INDUCTOR-IF 300 MHZ	28480	08970-80003
A4L6				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L7				PART IS ETCHED TRACE ON CIRCUIT BOARD		
A4L8	08970-80003	6		INDUCTOR-IF 300 MHZ	28480	08970-80003
A4L9	08970-80003	6		INDUCTOR-IF 300 MHZ	28480	08970-80003
A4L10	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
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	28480	1205-0011
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	BFR-90
A4R1†	0698-3154	0	1	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A4R2†	0757-0042	5	1	RESISTOR 12.3K 1% .5W F TC=0+-100	28480	0757-0042
A4R3	0757-0441	8	1	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A4R4	0757-0200	7	1	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A4R5	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-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
A4R6	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A4R7†	0698-3446	3	2	RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F
A4R8	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R9	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R10	0698-0083	8	1	RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A4R11	0698-3438	3	2	RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A4R12†	0698-3446	3		RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F
A4TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4U1	0955-0095	8	1	MIXER FREQ: 1 TO 500MHZ; CONVERSION LOSS	28480	0955-0095
	1251-3172	7	1	CONNECTOR-SGL CONT SKT .03-IN-BSC-SZ RND	28480	1251-3172
A4U1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A4Y1	1GA1-8000	2	1	THIN FILM CIRCUIT	28480	1GA1-8000
	3050-0786	9	1	WASHER-FL NM NO. 0 .063-IN-ID .187-IN-OD	28480	3050-0786
A5				NOT ASSIGNED		
A6	08970-60001	2	1	INPUT ASSEMBLY	28480	08970-60001
A6C1	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C2		7		NOT ASSIGNED		
A6C3	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C17	0160-4031	5	1	CAPACITOR-FXD 330PF +-5% 100VDC CER	28480	0160-4031
A6C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6C19				NOT ASSIGNED		
A6C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A6CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS D0-35	28480	1901-0050
A6CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS D0-35	28480	1901-0050
A6CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS D0-35	28480	1901-0050
A6CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS D0-35	28480	1901-0050
A6CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS D0-35	28480	1901-0050
A6CR6	1901-0941	1	1	DIODE-SM SIG SCHOTTKY	28480	1901-0941
A6J1	1250-1781	8		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1781
A6J2	1250-1781	8		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1781
A6K1†	0490-0565	1	5	RELAY 2C 12VDC-COIL	28480	0490-0565
	3050-0737	0	5	WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	28480	3050-0737
A6K2†	0490-0565	1		RELAY 2C 12VDC-COIL	28480	0490-0565
	3050-0737	0		WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	28480	3050-0737
A6K3†	0490-0565	1		RELAY 2C 12VDC-COIL	28480	0490-0565
	3050-0737	0		WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	28480	3050-0737
A6K4†	0490-0565	1		RELAY 2C 12VDC-COIL	28480	0490-0565
	3050-0737	0		WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	28480	3050-0737
A6K5†	0490-0565	1		RELAY 2C 12VDC-COIL	28480	0490-0565
	3050-0737	0		WASHER-FL NM 1/4 IN .254-IN-ID .4-IN-OD	28480	3050-0737
A6L1	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A6L2	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A6L3	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A6L4	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A6L5	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144

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
A6L6*				PART IS ETCHED TRACE ON CIRCUIT BOARD		
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 F TC=0+-100	24546	C4-1/8-T0-101-F
A6R2	0699-0092	1	6	RESISTOR 96.25 .1% .25W F TC=0+-50	28480	0699-0092
A6R3	0699-0091	0	3	RESISTOR 71.15 .1% .25W F TC=0+-50	28480	0699-0091
A6R4	0699-0092	1		RESISTOR 96.25 .1% .25W F TC=0+-50	28480	0699-0092
A6R5	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R6†	0699-1308	4	6	RESISTOR 51.1 1% .05W F TC=0+-100	08484	0699-1308
A6R7	0698-7253	8	2	RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A6R8†	0699-1308	4		RESISTOR 51.1 1% .05W F TC=0+-100	08484	0699-1308
A6R9†	0699-1308	4		RESISTOR 51.1 1% .05W F TC=0+-100	08484	0699-1308
A6R10†	0698-1124	0	1	RESISTOR-FXD 261 OHM 1% .25W	28480	0698-1124
A6R11	0698-3447	4	2	RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A6R12†	0699-1308	4		RESISTOR 51.1 1% .05W F TC=0+-100	08484	0699-1308
A6R13†	0699-1308	4		RESISTOR 51.1 1% .05W F TC=0+-100	08484	0699-1308
A6R14	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A6R15	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A6R16†	0699-1308	4		RESISTOR 51.1 1% .05W F TC=0+-100	08484	0699-1308
A6R17	0698-7253	8		RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A6R18†	0699-1309	5	6	RESISTOR 61.9 1% .05W F TC=0+-100	28480	0699-1309
A6R19†	0698-1123	9	1	RESISTOR-FXD 1960HM 1% .25W	28480	0698-1123
A6R20†	0699-1309	5		RESISTOR 61.9 1% .05W F TC=0+-100	28480	0699-1309
A6R21	0698-3132	4	1	RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A6R22†	0699-1309	5		RESISTOR 61.9 1% .05W F TC=0+-100	28480	0699-1309
A6R23	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R24†	0699-1309	5		RESISTOR 61.9 1% .05W F TC=0+-100	28480	0699-1309
A6R25†	0699-1309	5		RESISTOR 61.9 1% .05W F TC=0+-100	28480	0699-1309
A6R26†	0699-1309	5		RESISTOR 61.9 1% .05W F TC=0+-100	28480	0699-1309
A6R27	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R28	0699-0092	1		RESISTOR 96.25 .1% .25W F TC=0+-50	28480	0699-0092
A6R29	0699-0091	0		RESISTOR 71.15 .1% .25W F TC=0+-50	28480	0699-0091
A6R30	0699-0092	1		RESISTOR 96.25 .1% .25W F TC=0+-50	28480	0699-0092
A6R31	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R32	0699-0092	1		RESISTOR 96.25 .1% .25W F TC=0+-50	28480	0699-0092
A6R33	0699-0091	0		RESISTOR 71.15 .1% .25W F TC=0+-50	28480	0699-0091
A6R34	0699-0092	1		RESISTOR 96.25 .1% .25W F TC=0+-50	28480	0699-0092
A6R35	0698-3439	4		RESISTOR 178 1% .125W F TC=0+-100	24546	C4-1/8-T0-178R-F
A6R36†	0727-0074	0	2	RESISTOR 436.2 .5% .25W CF TC=0-500	28480	0727-0074
A6R37	0698-3438	3		RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A6R38†	0727-0008	0	1	RESISTOR 11.61 .5% .25W CF TC=0-500	28480	0727-0008
A6R39*	0698-3452	1	1	RESISTOR 147K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1473-F
A6R40†	0727-0074	0		RESISTOR 436.2 .5% .25W CF TC=0-500	28480	0727-0074
A6R41	2100-3089	7	1	RESISTOR-TRMR 5K 10% C TOP-ADJ 17-TRN	32997	3292W-1-502
A6R42	2100-2855	1	1	RESISTOR-TRMR 100K 10% C TOP-ADJ 1-TRN	73138	82PR100K
A6RT1	0837-0008	3	1	THERMISTOR DISC 1K-OHM TC=-3.8%/C-DEG	28480	0837-0008
A6U1	1826-0266	3	1	IC OP AMP LOW-DRIFT T0-99 PKG	06665	OP-05EJ
A6W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W3	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W4	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W5	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W6	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W7	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W8				WIRE-22AWG		
A6W9				WIRE-22AWG		
A6W10				WIRE-22AWG		
A6W11				WIRE-22AWG		

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
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	2	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A7C3	0160-4404	6	2	CAPACITOR-FXD .15UF +-10% 100VDC POLYP	28480	0160-4404
A7C4	0160-4404	6	2	CAPACITOR-FXD .15UF +-10% 100VDC POLYP	28480	0160-4404
A7C5	0160-2055	9	30	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 +-5PF 200VDC CER	28480	0160-4389
A7C9	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A7C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A7CR1	1901-0376	6	6	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A7CR2	1901-0376	6	6	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A7CR3	1901-0376	6	6	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A7CR4	1901-0376	6	6	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A7L1	9140-0114	4	7	INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A7L2	9140-0114	4	7	INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A7MP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7MP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7MP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7MP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7MP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7MP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7MP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7Q1	1853-0459	3	1	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	1	TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A7Q4	1855-0420	2	1	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A7Q5	1853-0459	3	1	TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A7Q6	1855-0420	2	1	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A7Q7	1853-0459	3	1	TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A7Q8	1855-0420	2	1	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A7R1	0757-0420	3	1	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A7R2	0757-0428	1	4	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A7R3	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R4	0698-8319	9	2	RESISTOR 10K 1% .1W F TC=0+-10	19701	502321/8-T13-1002-F
A7R5	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R6	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R7	0699-0096	5	1	RESISTOR 12K .1% .1W F TC=0+-10	28480	0699-0096
A7R8	0699-0748	4	1	RESISTOR 57.4K .1% .1W F TC=0+-15	28480	0699-0748
A7R9	0757-0442	9	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A7R10	0698-3150	6	4	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A7R11	0698-3153	9	1	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A7R12	0698-3150	6	1	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A7R13	0698-3153	9	1	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A7R14	0698-3150	6	1	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A7R15	0698-3153	9	1	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A7R16	0757-0419	0	5	RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A7R17	0757-0419	0	5	RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A7R18	0757-0419	0	5	RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A7R19	0757-0444	1	2	RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A7R20	0757-0289	2	1	RESISTOR 13.3K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-1332-F
A7R21	0757-0444	1	1	RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A7R22	0683-2265	1	4	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A7R23	0683-2265	1	4	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A7R24	0683-2265	1	4	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A7R25	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R26	0757-0419	0	5	RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A7R27	0698-3150	6	1	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A7R28	0757-0442	9	1	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A7R29	0683-2265	1	4	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A7R30	0757-0428	1	4	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F

See introduction to this section for ordering information  
 \*Indicates factory selected value  
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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7R31	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A7R32	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A7R33	0757-0338	2	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C5-1/4-T0-1001-F
A7R34	2100-3288	8	1	RESISTOR-TRMR 50 20% C TOP-ADJ 17-TRN	28480	2100-3288
A7R35	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A7R36	0757-0317	7	1	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A7R37	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A7TP1	0360-0535	0	53	TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A7U1	1826-0026	3	2	IC COMPARATOR PRCN T0-99 PKG	01295	LM311L
A7U2	1826-0547	3	1	IC OP AMP LOW-BIAS-H-IMP0 DUAL 8-DIP-P	01295	TL072ACP
A7VR1	1902-0786	4	1	DIODE-ZNR 1N937 9V 5% D0-7 PD=.5W	24046	1N937
A7VR2	1902-0928	6	5	DIODE-ZNR 6.9V 4% T0-92 TC=+.002%	27014	LM329
A8	08970-60004	5	1	NOISE POWER DETECTOR ASSEMBLY	28480	08970-60004
A8C1	0160-4385	2	1	CAPACITOR-FXD 15PF +-5% 200VDC CER 0+-30 NOT ASSIGNED	28480	0160-4385
A8C2						
A8C3	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A8C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C5*	0160-4766	3	1	CAPACITOR-FXD 30PF +-5% 200VDC CER 0+-30	28480	0160-4766
A8C6	0160-4350	1		CAPACITOR-FXD 68PF +-5% 200VDC CER 0+-30	28480	0160-4350
A8C7	0160-4387	4	2	CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A8C8	0160-4764	1	2	CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4764
A8C9	0160-4387	4		CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A8C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C17	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A8CR1	1901-1085	6	4	DIODE-SM SIG SCHOTTKY	28480	1901-1085
A8CR2	1901-1085	6		DIODE-SM SIG SCHOTTKY	28480	1901-1085
A8CR3	1901-1085	6		DIODE-SM SIG SCHOTTKY	28480	1901-1085
A8CR4	1901-1085	6		DIODE-SM SIG SCHOTTKY	28480	1901-1085
A8E1	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE COATED
A8E2	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE COATED
A8J1	1250-1781	8		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1781
A8L1	9140-0503	5	1	INDUCTOR 3.6UH 1% .166DX.385LG Q=33	28480	9140-0503
A8L2	9140-0179	1		INDUCTOR RF-CH-MLD 22UH 10% .166DX.385LG	28480	9140-0179
A8L3	9140-0611	6		INDUCTOR RF-CH-MLD 1.5UH 1% .105DX.26LG	28480	9140-0611
A8L4	9100-1612	5	2	INDUCTOR RF-CH-MLD 330NH 20%	28480	9100-1612
A8L5	9100-1612	5		INDUCTOR RF-CH-MLD 330NH 20%	28480	9100-1612
A8L6	9140-0105	3	2	INDUCTOR RF-CH-MLD 8.2UH 10%	28480	9140-0105
A8L7	9140-0105	3		INDUCTOR RF-CH-MLD 8.2UH 10%	28480	9140-0105
A8Q1	1854-0597	2		TRANSISTOR NPN 2N5943 SI T0-39 PD=1W	04713	2N5943
	1205-0011	0		HEAT SINK T0-5/T0-39-CS	28480	1205-0011
	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 T0-72 PD=500MW FT=4GHZ	28480	1854-0719
	1205-0037	0		HEAT SINK T0-18-CS	28480	1205-0037
A8R1	0757-0316	6	1	RESISTOR 42.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-42R2-F
A8R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A8R3	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A8R4	2100-0569	2	1	RESISTOR-TRMR 1M 20% C TOP-ADJ 1-TRN	28480	2100-0569
A8R5	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A8R6	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A8R7	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A8R8	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A8R9	0757-0816	1	1	RESISTOR 681 1% .5W F TC=0+-100	28480	0757-0816
A8R10	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-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
A8R11	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A8R12	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ S0	28480	1251-0600
A8U1	1826-0471	2	1	IC OP AMP LOW-DRIFT T0-99 PKG	28480	1826-0471
A8VR1	1902-0041	4	1	DIODE-ZNR 5.11V 5% D0-35 PD=.4W	28480	1902-0041
MISCELLANEOUS PARTS						
	0362-0265	7	3	CONNECTOR-SGL CONT SKT 1.14-MM-BSC-SZ	28480	0362-0265
A9	08970-60010	3	1	POWER SUPPLY ASSEMBLY	28480	08970-60010
A9C1	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C2	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C7	0180-2926	5	1	CAPACITOR-FXD 850UF+75-10% 100VDC AL	28480	0180-2926
	2190-0011	8	3	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0011
	2680-0128	7	3	SCREW-MACH 10-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A9C8	0180-3072	4	2	CAPACITOR-FXD 2900UF+75-10% 40VDC AL	28480	0180-3072
	2190-0011	8		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0011
	2680-0128	7		SCREW-MACH 10-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A9C9	0180-3117	8	2	CAPACITOR-FXD 9000UF+80-20% 20VDC AL	28480	0180-3117
A9C10	0180-3117	8		CAPACITOR-FXD 9000UF+80-20% 20VDC AL	28480	0180-3117
A9C11	0180-0291	3	3	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	1500105X9035A2
A9C12	0180-0116	1	2	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	1500685X9035B2
A9C13	0180-3072	4		CAPACITOR-FXD 2900UF+75-10% 40VDC AL	28480	0180-3072
	2190-0011	8		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0011
	2680-0128	7		SCREW-MACH 10-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A9C14	0160-4084	8	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A9C15	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	1500685X9035B2
A9C16	0180-0058	0	2	CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	300506G025CC2
A9C17	0180-2208	6	1	CAPACITOR-FXD 220UF+-10% 10VDC TA	56289	1500227X9010S2
A9C18	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	1500105X9035A2
A9C19	0180-0058	0		CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	300506G025CC2
A9C20	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9CR1	1901-0028	5	14	DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9CR2	1901-0028	5		DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9CR3	1901-0028	5		DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9CR4	1901-0028	5		DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9CR5	1906-0231	2	1	DIODE-CT-RECT 200V 15A	28480	1906-0231
	0515-0410	9	2	SCREW-MACH M3 X 0.5 20MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	0590-1076	3	6	THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	28480	0590-1076
	1200-0043	8	4	INSULATOR-XSTR ALUMINUM	28480	1200-0043
	1200-1031	6	2	CONNECTOR-SGL CONT SKT .125-IN-BSC-SZ	28480	1200-1031
	08660-40002	6	4	INSULATOR-T0-3	28480	08660-40002
A9CR6	1901-0028	5		DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9CR7	1901-0028	5		DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9CR8	1901-0418	7	1	DIODE-PWR RECT 400V 1.5A	28480	1901-0418
A9CR9	1901-0470	1	2	DIODE-HV RECT 1KV 600MA D0-41	28480	1901-0470
A9CR10	1901-0028	5		DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9CR11	1901-0470	1		DIODE-HV RECT 1KV 600MA D0-41	28480	1901-0470
A9CR12	1901-0028	5		DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9CR13	1901-0028	5		DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9CR14	1901-0028	5		DIODE-PWR RECT 400V 750MA D0-29	28480	1901-0028
A9DS1	1990-0523	2	3	LED-LAMP LUM-INT=1MCD IF=50MA-MAX BVR=5V	28480	5082-4950
A9DS2	1990-0523	2		LED-LAMP LUM-INT=1MCD IF=50MA-MAX BVR=5V	28480	5082-4950
A9DS3	1990-0523	2		LED-LAMP LUM-INT=1MCD IF=50MA-MAX BVR=5V	28480	5082-4950
A9F1	2110-0518	2	1	FUSE 3A 125V NTD .348X.25	75915	273003
	1251-2194	1	1	CONNECTOR-SGL CONT SKT .021-IN-BSC-SZ	28480	1251-2194

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9J1	1251-3751	8	1	CONNECTOR 8-PIN M POST TYPE	28480	1251-3751
A9J2†	1251-7728	7	1	CONNECTOR- 12 PIN	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	28480	08970-20060
A9MP2	1400-0440	3	1	CABLE TIE .062-1.75-DIA .184-WD NYL	28480	1400-0440
A9MP3	08970-00009	4	1	BRACKET-POWER SUPPLY	28480	08970-00009
	0515-0212	9	1	SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
A9Q1	1854-0814	6	2	TRANSISTOR NPN SI TO-66 PD=75W FT=3MHZ	28480	1854-0814
	0515-0211	8	2	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	0590-1076	3		THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	28480	0590-1076
	1205-0085	8	2	HEAT SINK TO-66-CS	28480	1205-0085
A9Q2	1854-0814	6		TRANSISTOR NPN SI TO-66 PD=75W FT=3MHZ	28480	1854-0814
	0515-0211	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	0590-1076	3		THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	28480	0590-1076
	1205-0085	8		HEAT SINK TO-66-CS	28480	1205-0085
A9Q3†	1884-0244	9	1	THYRISTOR-SCR VRPM=400	3L585	S2600D
A9Q4†	1205-0073	4	1	HEAT SINK TO-5/TO-39-CS	28480	1205-0073
A9R1	2100-1757	2	1	RESISTOR-TRMR 500 5% WW SIDE-ADJ 1-TRN	28480	2100-1757
A9R2	0757-0835	4	1	RESISTOR 6.81K 1% .5W F TC=0+-100	28480	0757-0835
A9R3	0757-1078	9	2	RESISTOR 1.47K 1% .5W F TC=0+-100	28480	0757-1078
A9R4	0698-3441	8	2	RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-TO-215R-F
A9R5	0698-0090	7	1	RESISTOR 464 1% .5W F TC=0+-100	28480	0698-0090
A9R6	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-TO-4641-F
A9R7	0757-1078	9		RESISTOR 1.47K 1% .5W F TC=0+-100	28480	0757-1078
A9R8	0757-1000	7	2	RESISTOR 51.1 1% .5W F TC=0+-100	28480	0757-1000
A9R9	2100-1768	5	1	RESISTOR-TRMR 20 5% WW TOP-ADJ 1-TRN	28480	2100-1768
A9R10	0757-0403	2	2	RESISTOR 121 1% .125W F TC=0+-100	24546	C4-1/8-TO-121R-F
A9R11	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-TO-101-F
A9R12	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-TO-422R-F
A9R13	0757-0397	3		RESISTOR 69.1 1% .125W F TC=0+-100	24546	C4-1/8-TO-69R1-F
A9R14	0757-0403	2		RESISTOR 121 1% .125W F TC=0+-100	24546	C4-1/8-TO-121R-F
A9R15	0757-0417	8	1	RESISTOR 562 1% .125W F TC=0+-100	24546	C4-1/8-TO-562R-F
A9TP1	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP5	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP6	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP7	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9U1	1826-0402	9	1	IC V RGLTR TO-3	80103	LAS-1515
	0515-0410	9		SCREW-MACH M3 X 0.5 20MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	0590-1076	3		THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	28480	0590-1076
	1200-0043	8		INSULATOR-XSTR ALUMINUM	28480	1200-0043
	1200-1301	3	2	CONN-SGL CONT SKT .125-IN-BSC-SZ	28480	1200-1301
	08660-40002	6		INSULATOR, TO-3	28480	08660-40002
A9U2	1826-0513	3	1	IC V RGLTR TO-3	80103	LAS-1905
	0590-1076	3		THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	28480	0590-1076
	1200-0043	8		INSULATOR-XSTR ALUMINUM	28480	1200-0043
	1200-1301	3		CONN-SGL CONT SKT .125-IN-BSC-SZ	28480	1200-1301
	08660-40002	6		INSULATOR, TO-3	28480	08660-40002
	0515-0057	0	2	SCREW-MACH M3 X 0.5 20MM-LG PAN-HD	28480	0515-0057
A9U3	1826-0169	5	1	IC V RGLTR TO-3	27014	LM320K-15
	0515-0057	0		SCREW-MACH M3 X 0.5 20MM-LG PAN-HD	28480	0515-0057
	0590-1076	3		THREADED INSERT-NUT M3 X 0.5 1.5-MM-LG	28480	0590-1076
	1200-0043	8		INSULATOR-XSTR ALUMINUM	28480	1200-0043
	1251-3402	6	1	CONNECTOR-SGL CONT SKT .04-IN-BSC-SZ RND	28480	1251-3402
	1200-1031	6		CONNECTOR-SGL CONT SKT .125-IN-BSC-SZ	28480	1200-1031
	08660-40002	6		INSULATOR, TO-3	28480	08660-40002
A9VR1	1902-3301	5	1	DIODE-ZNR 34.8V 5% DO-35 PD=.4W	28480	1902-3301
A9VR2	1902-1342	0	2	DIODE-ZNR 1N4742A 12V 5% PD=1W IR=SUA	04713	1N4742A
A9VR3	1902-0943	5	1	DIODE-ZNR 2.4V 5% DO-35 PD=.4W TC=-.037%	28480	1902-0943
A9VR4	1902-0952	6	1	DIODE-ZNR 5.6V 5% DO-35 PD=.4W TC=+.046%	28480	1902-0952
A9VR5	1902-1342	0		DIODE-ZNR 1N4742A 12V 5% PD=1W IR=SUA	04713	1N4742A

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
A9XA12	1251-0472	4	1	CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A10	08970-60151	3	1	FIRST CONVERTER ASSEMBLY	28480	08970-60151
A10CR1	08558-20095	0	1	DIODE ASSEMBLY	28480	08558-20095
A10J1	1250-1020	8	4	CONNECTOR-RF SMA FEM SGL-HOLE-RR 50-OHM	28480	1250-1020
A10J2	1250-1020	8		CONNECTOR-RF SMA FEM SGL-HOLE-RR 50-OHM	28480	1250-1020
A10J3	1250-1020	8		CONNECTOR-RF SMA FEM SGL-HOLE-RR 50-OHM	28480	1250-1020
A10J4	1250-1020	8		CONNECTOR-RF SMA FEM SGL-HOLE-RR 50-OHM	28480	1250-1020
A10MP1	08558-00052	7	1	GASKET-1ST CONVERTER	28480	08558-00052
A10MP2	08558-20042	7	1	COVER-1ST CONVERTER	28480	08558-20042
	2200-0606	0	15	SCREW-MACH 4-40 .438-IN-LG 82 DEG	28480	2200-0606
	2200-0171	4	4	SCREW-MACH 4-40 .75-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
	2260-0009	3	2	NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A10MP3	08558-20043	8	1	MOUNT-1ST CONVERTER	28480	08558-20043
A10R1	0698-7212	9	1	RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-T0-100R-F
A10R2	0698-7221	0	1	RESISTOR 237 1% .05W F TC=0+-100	24546	C3-1/8-T0-237R-F
A11	08970-60152	4	1	SECOND CONVERTER ASSEMBLY	28480	08970-60152
A11C1	0160-3036	8	2	CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-3036
A11C2	0160-3036	8		CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-3036
A11C3	0160-2436	0	1	CAPACITOR-FDTHRU 10PF 20% 200V CER	28480	0160-2436
A11C4	0140-0075	7	1	CAPACITOR-FDTHRU 22PF 10% 500V MICA	72982	666-053-01A0-220K
A11CP1	08970-00025	4	1	COUPLING-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	00000	ORDER BY DESCRIPTION
A11CP2	08970-00027	6	2	COUPLING-LOOP FILTER	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	00000	ORDER BY DESCRIPTION
A11CP3	08970-00027	6	1	COUPLING-LOOP FILTER	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	00000	ORDER BY DESCRIPTION
A11CR1†	1901-1107	3	1	DIODE-SCHOTTKY SM SIG	28480	1901-1107
	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	00000	ORDER BY DESCRIPTION
A11J1	1250-1157	2	1	CONNECTOR-RF SMA FEM THD-HOLE 50-OHM	28480	1250-1157
A11J2	1250-1435	9	1	CONN:RF: 500 OHM: SMC	28480	1250-1435
	2190-0124	4	2	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9	1	NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A11J3†	1250-1194	7	1	CONNECTOR-RF SM-SLD M SGL-HOLE-FR 50-OHM	28480	1250-1194
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A11L1	9100-2255	4	1	INDUCTOR RF-CH-MLD 470NH 10% .10SDX.26LG	28480	9100-2255
A11L2†	08558-80001	4	1	COIL-2ND CONVERTER	28480	08558-80001
A11MP1	08970-20052	9	1	COVER-2ND CONVERTER	28480	08970-20052
	2200-0107	6	26	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A11MP2	08558-20121	3	1	BLOCK-CAVITY 2ND CONVERTER	28480	08558-20121
A11MP3	08558-20058	5	1	LID-2ND CONVERTER OSCILLATOR	28480	08558-20058
	2200-0107	6		SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2200-0119	0	7	SCREW-MACH 4-40 1-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A11MP4	08970-00039	0	1	GASKET-OSCILLATOR	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	28480	0360-0002
	0520-0173	2	2	SCREW-MACH 2-56 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A11MP7	2200-0171	4		SCREW-MACH 4-40 .75-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
A11MP8	08565-20068	6	1	CAP-INNER ELEMENT	28480	08565-20068
A11MP9	08565-20069	7	1	CAP-OUTER ELEMENT	28480	08565-20069
A11MP1	08565-20092	6	1	CAP-DIELECTRIC	28480	08565-20092
A11R1	0757-0346	2	1	RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A11Z1	3030-0397	6	4	SCREW-SET 10-32 1-IN-LG FLAT-PT BR5	00000	ORDER BY DESCRIPTION
	2740-0001	3	3	NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
	3050-0226	2	4	WASHER-FL MTLCL NO. 10 .203-IN-ID	28480	3050-0226
A11Z2	3030-0397	6		SCREW-SET 10-32 1-IN-LG FLAT-PT BR5	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 MTLCL NO. 10 .203-IN-ID	28480	3050-0226

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
A11Z3	3030-0397	6		SCREW-SET 10-32 1-IN-LG FLAT-PT BRS	00000	ORDER BY DESCRIPTION
	2740-0001	3		NUT-HEX-DBL-CHAM 10-32-THD .109-IN-TMK	00000	ORDER BY DESCRIPTION
	3050-0226	2		WASHER-FL MTLN NO. 10 .203-IN-ID	28480	3050-0226
A11Z4	3030-0397	6		SCREW-SET 10-32 1-IN-LG FLAT-PT BRS	00000	ORDER BY DESCRIPTION
	0380-0573	8	1	STANDOFF-HEX .625-IN-LG 10-32THD	00000	ORDER BY DESCRIPTION
	3050-0226	2		WASHER-FL MTLN NO. 10 .203-IN-ID	28480	3050-0226
	08558-20074	5	1	INSULATOR-COUPLING POST	28480	08558-20074
A11A1	08970-60014	7	1	2ND CONVERTER OSCILLATOR ASSEMBLY	28480	08970-60014
	0520-0173	2		SCREW-MACH 2-56 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2200-0115	6	1	SCREW-MACH 4-40 .75-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A11A1Q1	5086-4218	7	1	HP-IB TO-72 PKG	28480	5086-4218
	08970-20073	4	1	INSULATOR-XSTR DAP-GL	28480	08970-20073
A11A1R1	0683-4705	8	1	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A11A1R2	0683-2715	6	1	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A12	08970-60015	8	1	NOISE SOURCE DRIVE ASSEMBLY	28480	08970-60015
A12C1	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C2	0180-2206	4	1	CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A12C3	0160-4764	1		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4764
A12C4	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
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=800UCD IF=30MA-MAX	28480	5082-4984
A12MP1	1530-1098	4	2	CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
	0515-0165	1	2	SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD	28480	0515-0165
	0535-0007	2	2	NUT-HEX DBL-CHAM M3.5 X 0.6 2.8MM-THK	00000	ORDER BY DESCRIPTION
	2190-0585	1	2	WASHER-LK HLCL 3.5 MM 3.6-MM-ID	28480	2190-0585
A12MP2				SAME AS A12MP1		
A12Q1	1854-0810	2	5	TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A12Q2	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A12R1	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A12R2	0698-3159	5	1	RESISTOR 26.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2612-F
A12R3	0757-0440	7	1	RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A12R4	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A12R5†	0811-2820	7	1	RESISTOR 4.7 5% .75W PW TC=0+-50	91637	RS1/2-T2-4R7-J
A12R6	0699-0148	8	1	RESISTOR 31.6K .1% .1W F TC=0+-15	28480	0699-0148
A12R7	2100-3109	2	1	RESISTOR-TRMR 2K 10% C SIDE-ADJ 17-TRN	02111	43P202
A12R8	0698-8319	9		RESISTOR 10K 1% .1W F TC=0+-10	19701	502321/8-T13-1002-F
A12R9	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A12R10	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A12TP1	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A12TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A12TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A12TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A12U1	1826-0177	5	1	IC 723 V RGLTR TO-100	15818	723BE
A12VR1	1902-0564	6	1	DIODE-ZNR 34.8V 5% DO-15 PD=1W TC=+.078%	28480	1902-0564
A12VR2	1902-0928	6		DIODE-ZNR 6.9V 4% TO-92 TC=+.002%	27014	LM329
A12VR3	1902-0562	4	1	DIODE-ZNR 22V 5% PD=1W IR=5UA	28480	1902-0562
A13†	08970-60020	5	1	DRIVER ASSEMBLY (INCLUDES CHASSIS PART W9)	28480	08970-60020
A13BT1†	1420-0314	2	1	BATTERY 3V 0.14A-HR LITHIUM POLYCARBON	28480	1420-0314
	1400-1210	7	1	HOLDER-BAT 1-WD	28480	1400-1210
A13C1	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A13C2	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
A13C3- A13C5†				NOT ASSIGNED		
A13C6	0160-3877	5	2	CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877

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	
A13C7	0180-1746	5	4	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2	
A13C8	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2	
A13C9	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2	
A13C10	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451	
A13C11	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451	
A13C12	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C13	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C14	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C15	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C16	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C17	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C18	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C19	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C20	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C21	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C22-							
A13C25				NOT ASSIGNED			
A13C26	0180-1719	2	1	CAPACITOR-FXD 22UF+-10% 25VDC TA	06001	69F146G8	
A13C27	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451	
A13C28	0160-0127	2	1	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127	
A13C29	0160-3878	6	1	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878	
A13C30	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451	
A13C31	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451	
A13C32	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451	
A13C33	0160-4401	3		CAPACITOR-FXD .01UF +-10% 100VDC POLYP	28480	0160-4401	
A13C34†	0160-4350	1	3	CAPACITOR-FXD 68PF +-5% 200VDC CER 0+-30	28480	0160-4350	
A13C35	0160-4526	3		CAPACITOR-FXD 42PF +-5% 200VDC CER 0+-30	28480	0160-4526	
A13C36	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576	
A13C37†	0160-5624	4	2	CAPACITOR-FXD 5600PF +-5% 100VDC	28480	0160-5624	
A13C38	0160-4682	2		CAPACITOR-FXD 1000PF +-2.5% 160VDC POLYP	28480	0160-4682	
A13C39	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C40	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C41	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C42	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C43	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C44	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C45	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C46	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C47†	0160-4350	1	3	CAPACITOR-FXD 68PF +-5% 200VDC CER 0+-30	28480	0160-4350	
A13C48	0160-4526	3		CAPACITOR-FXD 42PF +-5% 200VDC CER 0+-30	28480	0160-4526	
A13C49	0160-0576	5	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576		
A13C50	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C51†	0160-5624	4	2	CAPACITOR-FXD 5600PF +-5% 100VDC	28480	0160-5624	
A13C52	0160-4682	2		CAPACITOR-FXD 1000PF +-2.5% 160VDC POLYP	28480	0160-4682	
A13C53	0160-3451	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451		
A13C54	0180-0229	7	1	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2	
A13C55†				NOT ASSIGNED			
A13C56	0160-0301	4		CAPACITOR-FXD .012UF +-10% 200VDC POLYE	28480	0160-0301	
A13C57†	0160-3451	1	28	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451	
A13CR1†				NOT ASSIGNED			
A13CR2†				NOT ASSIGNED			
A13CR3	1901-0033	2	2	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033	
A13CR4	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033	
A13CR5	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376	
A13CR6	1901-0376	6	1	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376	
A13CR7†	1901-0841	0		DIODE-SM SIG SCHOTTKY	28480	HSC-1001	
A13G1†	1813-0174	5	1	XTAL-CLOCK-OSCILLATOR 4-MHZ 0.01% TTL	28480	1813-0174	
A13J1†	1251-8392	3	4	CONN-POST TYPE .100-PIN-SPCG 6-CONT	28480	1251-8392	
A13J2	1251-5720	5		2	CONNECTOR 34-PIN M POST TYPE	28480	1251-5720
A13J3†	1251-8391	2		CONN-POST TYPE .100-PIN-SPCG 4-CONT	28480	1251-8391	
A13J4†	1251-8392	3		CONN-POST TYPE .100-PIN-SPCG 6-CONT	28480	1251-8392	
A13J5†	1251-8391	2		CONN-POST TYPE .100-PIN-SPCG 4-CONT	28480	1251-8391	

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
A13L1	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A13L2	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A13L3	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A13MP1†	08970-20022	3	2	SCREW-MODIFIED	28480	08970-20022
A13MP2	3050-0139	6	2	WASHER-FL MTLIC NO. 8 .172-IN-ID	28480	3050-0139
A13MP3†	0510-0124	2	1	THREADED INSERT-NUT 6-32 .18-IN-LG STL	28480	0510-0124
A13MP4	1400-0966	8	2	CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A13MP5	0403-0115	4	2	BUMPER FOOT-ADH MTG .5-IN-WD .25-IN-THK	28480	0403-0115
A13Q1	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A13Q2	1854-0477	7	2	TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A13Q3	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A13Q4	1854-0637	1	1	TRANSISTOR NPN 2N2219A SI TO-5 PD=800MW	01295	2N2219A
	1205-0011	0		HEAT SINK TO-5/TO-39-CS	28480	1205-0011
A13Q5	1854-0811	3	3	TRANSISTOR NPN SI PD=625MW FT=100MHZ	28480	1854-0811
A13R1	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A13R2-				NOT ASSIGNED		
A13R7†				RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A13R8	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A13R9	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A13P10	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A13R11	2100-3659	7	1	RESISTOR-TRMR 20K 10% C TOP-ADJ 17-TRN	32997	3292W-1-203
A13R12	0811-3368	0	2	RESISTOR 100K 1% .05W PWV TC=0+-10	28480	0811-3368
A13P13	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A13R14	0811-3368	0		RESISTOR 100K 1% .05W PWV TC=0+-10	28480	0811-3368
A13R15	0757-0458	7	1	RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A13R16	0699-0234	3	1	RESISTOR 6.915K .1% .1W F TC=0+-5	28480	0699-0234
A13R17	2100-1738	9	1	RESISTOR-TRMR 10K 10% C TOP-ADJ 1-TRN	73138	82PR10K
A13R18	0698-3160	8	1	RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A13R19*	0757-0274	5	2	RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1211-F
A13R20	0698-8549	7	1	RESISTOR 2.1K .5% .1W F TC=0+-5	28480	0698-8549
A13R21	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R22	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A13R23	0757-0276	7	1	RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A13R24	0698-3458	7	1	RESISTOR 348K 1% .125W F TC=0+-100	28480	0698-3458
A13R25	0811-2939	9	2	RESISTOR 120 .05% .5W PWV TC=0+-5	14140	1251-1/8-C-121-A
A13R26	0757-1000	7		RESISTOR 51.1 1% .5W F TC=0+-100	28480	0757-1000
A13R27	0811-2939	9		RESISTOR 120 .05% .5W PWV TC=0+-5	14140	1251-1/8-C-121-A
A13R28	0698-0084	9	1	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A13R29	2100-1986	9	3	RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	73138	82PR1K
A13R30	0757-0274	5		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1211-F
A13R31	0698-3152	8	5	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A13R32	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A13R33	0698-0085	0	2	RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A13R34	2100-1986	9		RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	73138	82PR1K
A13R35	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R36	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R37	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R38	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R39-				NOT ASSIGNED		
A13R42				NOT ASSIGNED		
A13R43	0698-3620	5	3	RESISTOR 100 5% 2W MO TC=0+-200	28480	0698-3620
A13R44	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A13R45	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A13R46	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A13R47	2100-1986	9		RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	73138	82PR1K
A13R48	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A13R49	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R50	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R51	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R52	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R53	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A13R54	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A13R55	0757-1094	9	1	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A13R56-				NOT ASSIGNED		
A13R58				NOT ASSIGNED		

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
A13R59	0757-0280	3		RESISTOR 1K 1% .125W F TC:0+-100	24546	C4-1/8-T0-1001-F
A13R60				NOT ASSIGNED		
A13R61	0698-3620	5		RESISTOR 100 5% 2W MO TC:0+-200	28480	0698-3620
A13R62	0698-3620	5		RESISTOR 100 5% 2W MO TC:0+-200	28480	0698-3620
A13R63	0757-0280	3		RESISTOR 1K 1% .125W F TC:0+-100	24546	C4-1/8-T0-1001-F
A13R64	0757-0401	0		RESISTOR 100 1% .125W F TC:0+-100	24546	C4-1/8-T0-101-F
A13R65	0757-0401	0		RESISTOR 100 1% .125W F TC:0+-100	24546	C4-1/8-T0-101-F
A13R66†	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC:0+-100	24546	C4-1/8-T0-6811-F
A13R67†				NOT ASSIGNED		
A13R68†	0757-0438	3	5	RESISTOR 5.11K 1% .125W F TC:0+-100	24546	C4-1/8-T0-5111-F
A13R69†	0757-0398	4	4	RESISTOR 75 1% .125W F TC:0+-100	24546	C4-1/8-T0-75R0-F
A13RT1†	0837-0291	6	1	THERMISTOR DISC 10-OHM TC:-3.8%/C-DEG	28480	0837-0291
A13TP1	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP5	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP6	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP7	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP8	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP9	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP10	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP11	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP12	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP13	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP14	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP15	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP16	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP17	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP18	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP19	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP20	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP21	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13TP22	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A13U1	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A13U2	1820-1197	9	4	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A13U3	1820-1423	4	4	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A13U4				NOT ASSIGNED		
A13U5	1826-0488	1	6	IC OP AMP WB TO-99 PKG	27014	LM218H
A13U6	1826-0727	1	3	IC SNPL/HOLD 14-DIP-C PKG	06665	SMP-81FY
A13U7	1826-0488	1		IC OP AMP WB TO-99 PKG	27014	LM218H
A13U8	1826-0488	1		IC OP AMP WB TO-99 PKG	27014	LM218H
A13U9	1826-0188	8	2	IC CONV 8-B-D/A 16-DIP-C PKG	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†				NOT ASSIGNED		
A13U18†				NOT ASSIGNED		
A13U19	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A13U20	1820-1423	4		IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A13U21	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A13U22				NOT ASSIGNED		
A13U23	1826-0488	1		IC OP AMP WB TO-99 PKG	27014	LM218H
A13U24	1826-0727	1		IC SNPL/HOLD 14-DIP-C PKG	06665	SMP-81FY
A13U25	1826-0488	1		IC OP AMP WB TO-99 PKG	27014	LM218H
A13U26	1826-0488	1		IC OP AMP WB TO-99 PKG	27014	LM218H
A13U27	1826-0188	8		IC CONV 8-B-D/A 16-DIP-C PKG	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

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
A13U31	1820-2096	9		IC CNTR TTL LS BIN DUAL 4-BIT	01295	SN74LS393N
A13U32	1826-0726	0	1	IC CONV 12-B-D/A 24-DIP-P PKG	24355	AD565JN/BIN
A13U33	1826-0508	6	1	IC CONV 10-B-D/A 16-DIP-C PKG	24355	AD561JD
A13U34	1820-1423	4		IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A13U35	1820-1212	9	2	IC FF TTL LS J-K NEG-EDGE-TRIG	01295	SN74LS112AN
A13U36	1826-0026	3		IC COMPARATOR PRCN TO-99 PKG	01295	LM311L
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	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A13U41	1820-1207	2	2	IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
A13U42	1826-0600	9	1	IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL074ACN
A13VR1	1902-0579	3	1	DIODE-ZNR 5.1V 5% PD=1W IR=10UA	28480	1902-0579
A13VR2	1902-0962	8	1	DIODE-ZNR 15V 5% DO-35 PD=.4W TC=+.087%	26480	1902-0962
A13VR3	1902-0928	6		DIODE-ZNR 6.9V 4% TO-92 TC=-.002%	27014	LM329
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
A13W1				NOT ASSIGNED		
A13W2				NOT ASSIGNED		
A13W5†	8159-0005	0	19	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A13Y1†				NOT ASSIGNED		
A14	08970-60009	0	1	CONTROLLER ASSEMBLY	28480	08970-60009
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	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C5	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A14C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C7	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C9†	0160-5624	4		CAPACITOR-FXD 5600PF +-5% 100VDC	28480	0160-5624
A14C10	0180-0374	3	1	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A14C11	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C12	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C13	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A14C14	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C15	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C16	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C17	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C18	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C19	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C20	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C21	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C22	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C23	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A14C24	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A14C25				NOT ASSIGNED		
A14C26	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14C27	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A14CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A14CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A14CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A14J1†	1251-8392	3		CONN-POST TYPE .100-PIN-SPCG 6-CONT	28480	1251-8392
A14J2†	1251-8281	9	1	CONN-POST TYPE .100-PIN-SPCG 5-CONT	28480	1251-8281
A14J3	1251-5671	5	1	CONNECTOR 20-PIN M POST TYPE	28480	1251-5671
A14J4†	1251-8392	3		CONN-POST TYPE .100-PIN-SPCG 6-CONT	28480	1251-8392
A14J5†	1251-8393	4	1	CONN-POST TYPE .100-PIN-SPCG 7-CONT	28480	1251-8393

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
A14J6	1251-5720	5		CONNECTOR 34-PIN M POST TYPE	28480	1251-5720
A14L1	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A14L2	9100-1611	4		INDUCTOR RF-CH-MLD 220NH 20%	28480	9100-1611
A14L3	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A14MP1†	08970-20022	3		SCREW-MODIFIED	28480	08970-20022
A14MP2	3050-0139	6		WASHER-FL MTLIC NO. 8 .172-IN-ID	28480	3050-0139
A14MP3†	0510-1024	3	1	RETAINER-RING E-R EXT .188-IN-DIA STL	28480	0510-1024
A14MP4	1400-0966	8		CLIP-CMPNT .17-.185-DIA .195-WD STL	91506	6015-13AT
A14MP5	0403-0115	4		BUMPER FOOT-ADH MTG .5-IN-WD .25-IN-THK	28480	0403-0115
A14MP6†	3050-0172	7	1	WASHER-FL NM NO. 10 .203-IN-ID	28480	3050-0172
A14Q1	1853-0393	4	1	TRANSISTOR PNP SI T0-18 PD=500MW	28480	1853-0393
A14Q2	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A14Q3	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A14Q4	1854-0811	3		TRANSISTOR NPN SI PD=625MW FT=100MHZ	28480	1854-0811
A14Q5	1854-0811	3		TRANSISTOR NPN SI PD=625MW FT=100MHZ	28480	1854-0811
A14R1	0757-0422	5	1	RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A14R2	0757-0290	5	1	RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A14R3	0698-7089	8	1	RESISTOR 450 1% .125W F TC=0+-100	28480	0698-7089
A14R4	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R5	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R6	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R7	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A14R8	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A14R9	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A14R10	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A14R11	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A14R12	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R13	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R14	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A14R15	1810-0205	7		NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A14R16	1810-0205	7		NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A14R17	1810-0206	8	1	NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A14R18	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A14R19	1810-0205	7		NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A14R20	0698-3435	0	1	RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A14R21	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A14R22	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A14R23	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A14R24	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A14R25	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A14R26	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A14R27	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A14R28	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A14R29	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A14R30	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A14R31				NOT ASSIGNED		
A14R32	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A14S1	3101-2170	8	1	SWITCH-PB SPOT MOM	28480	3101-2170
A14S2	3101-2135	5	1	SWITCH-RKR DIP-RKR-ASSY DPDT .05A 30VDC	28480	3101-2135
A14TP1	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP5	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP6	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP7	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP8	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP9	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP10	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP11	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP12	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP13	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP14	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP15	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION

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
A14TP16	0360-0535	0			TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP17	0360-0535	0			TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP18	0360-0535	0			TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14TP19	0360-0535	0			TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A14U1	08970-80101	5		1	ROM-#1	28480	08970-80101
	1200-0541	1		13	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U2	08970-80102	6		1	ROM-#2	28480	08970-80102
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U3	08970-80103	7		1	ROM-#3	28480	08970-80103
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U4	08970-80104	8		1	ROM-#4	28480	08970-80104
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U5	08970-80105	9		1	ROM-#5	28480	08970-80105
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U6	08970-80106	0		1	ROM-#6	28480	08970-80106
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U7	08970-80107	1		1	ROM-#7	28480	08970-80107
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U8	08970-80108	2		1	ROM-#8	28480	08970-80108
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U9	08970-80109	3		1	ROM-#9	28480	08970-80109
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U10	08970-80110	6		1	ROM-#10	28480	08970-80110
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U11	08970-80111	7		1	ROM-#11	28480	08970-80111
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U12	08970-80112	8		1	ROM-#12	28480	08970-80112
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U13	08970-80113	9		1	ROM-#13	28480	08970-80113
	1200-0541	1			SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A14U14					NOT ASSIGNED		
A14U15	1820-1858	9			IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A14U16	1820-1216	3			IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A14U17	1820-1207	2			IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
A14U18	1820-1208	3		2	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A14U19	1818-0438	4		8	IC NMOS 4096 (4K) STAT RAM 450-NS 3-S	01295	TMS2114-45NL
A14U20	1818-1330	7		2	IC CMOS 4096 (4K) STAT RAM 300-NS 3-S	S0545	UPD444C-1
A14U21	1818-0438	4			IC NMOS 4096 (4K) STAT RAM 450-NS 3-S	01295	TMS2114-45NL
A14U22	1818-0438	4			IC NMOS 4096 (4K) STAT RAM 450-NS 3-S	01295	TMS2114-45NL
A14U23	1818-0438	4			IC NMOS 4096 (4K) STAT RAM 450-NS 3-S	01295	TMS2114-45NL
A14U24	1818-0438	4			IC NMOS 4096 (4K) STAT RAM 450-NS 3-S	01295	TMS2114-45NL
A14U25	1818-1330	7			IC CMOS 4096 (4K) STAT RAM 300-NS 3-S	S0545	UPD444C-1
A14U26	1818-0438	4			IC NMOS 4096 (4K) STAT RAM 450-NS 3-S	01295	TMS2114-45NL
A14U27	1820-1794	2			IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U28	1820-1794	2			IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U29	1820-1794	2			IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U30	1820-1794	2			IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U31	1818-0438	4			IC NMOS 4096 (4K) STAT RAM 450-NS 3-S	01295	TMS2114-45NL
A14U32	1818-0438	4			IC NMOS 4096 (4K) STAT RAM 450-NS 3-S	01295	TMS2114-45NL
A14U33	1820-2075	4		5	IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U34	1820-2075	4			IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U35	1820-2075	4			IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U36	1820-2075	4			IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U37	1820-1208	3			IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A14U38	1820-0495	8		1	IC DCDR TTL 4-TO-16-LINE 4-INP	01295	SN74154N
A14U39	1820-2485	0		1	IC RCVR TTL LS BUS OCTL	01295	SN75160N
A14U40	1820-1568	8			IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A14U41	1820-2549	7		1	IC-8291A P HP1B	28480	1820-2549
	1200-0654	7		5	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A14U42*	1858-0047	5			TRANSISTOR ARRAY 16-PIN PLSTC DIP	13606	ULN-2003A
A14U43	1820-1730	6		2	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A14U44	1820-1987	5			IC SHF-RGTR TTL LS COM CLEAR STOR 8-BIT	01295	SN74LS299N
A14U45	1820-2075	4			IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A14U46	1820-1481	4		2	IC NMOS	04713	MC6821L
	1200-0654	7			SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654

See introduction to this section for ordering information

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†Backdating information in Section VII

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A14U47	1820-2099	2	1	IC MICPROC NMOS 8-BIT	04713	MC6802P
	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A14U48	1820-1481	4		IC NMOS	04713	MC6821L
	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A14U49	1820-2463	4	1	IC-DIRECT MEMORY ACCESS CONTROLLER, 16	28480	1820-2463
	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A14U50	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A14U51	1820-0661	0	3	IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A14U52	1820-1568	8		IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A14U53	1820-1443	8	1	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS293N
A14U54	1820-0661	0		IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A14U55	1820-2058	3	2	IC MISC TTL S QUAD	07263	MC3448AL
A14U56	1820-2058	3		IC MISC TTL S QUAD	07263	MC3448AL
A14U57	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A14U58	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A14U59	1820-1794	2		IC BFR TTL LS NON-INV OCTL	27014	DM81LS95N
A14U60	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A14U61	1820-1201	6		IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A14U62	1820-1201	6		IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A14U63	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A14U64	1820-0661	0		IC GATE TTL OR QUAD 2-INP	01295	SN7432N
A14U65	1820-1423	4		IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A14U66	1826-0727	1		IC SMP/L/HOLD 14-DIP-C PKG	06665	SNP-81FY
A14U67†	1826-0759	9		IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A14VR1	1902-0928	6		DIODE-ZNR 6.9V 4% T0-92 TC=+.002%	27014	LM329
A14VR2	1902-0928	6		DIODE-ZNR 6.9V 4% T0-92 TC=+.002%	27014	LM329
A14VR3	1902-0947	9	1	DIODE-ZNR 3.6V 5% D0-35 PD=.4W TC=-.036%	28480	1902-0947
A14W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A15	0960-0443	1	1	MODULE-FILTER LINE	28480	0960-0443
A16	08970-60011	4	1	HP-IB CONNECTOR ASSEMBLY	28480	08970-60011
A16J1	1251-3283	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3283
A16J2	8120-3298	8	1	FLAT RIBBON ASSY 28-AWG 20-COND	28480	8120-3298
A16MP1	0380-0643	3	2	STANDOFF-HEX .255-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A16MP2	0380-0643	3		STANDOFF-HEX .255-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A16MP3	1530-1098	4		CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
	0515-0165	1		SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD	28480	0515-0165
	0535-0007	2		NUT-HEX DBL-CHAM M3.5 X 0.6 2.8MM-THK	00000	ORDER BY DESCRIPTION
	2190-0585	1		WASHER-LK HLCL 3.5 MM 3.6-MM-ID	28480	2190-0585
A17	08970-60016	9	1	FIRST LO FILTER ASSEMBLY	28480	08970-60016
A17C1	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C3	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17J1†	1251-8391	2		CONN-POST TYPE .100-PIN-SPCG 4-CONT	28480	1251-8391
A17MP1	0380-0321	4	1	SPACER-RVT-ON .125-IN-LG .152-IN-ID	00000	ORDER BY DESCRIPTION

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
AT1	0960-0472	6	1	ISOLATOR-2 PORT	28480	0960-0472
BT†	3160-0381	3	1	FAN-TBAX 30-CFM 115V 50/60-HZ 1.5KV-DIEL	28480	3160-0381
	0515-0252	7	1	SCREW-MACH M3 X 0.5 40MM-LG PAN-HD	28480	0515-0252
	0590-1362	0	1	THREADED INSERT-PULL-IN M3 X 0.5	28480	0590-1362
	2190-0584	0	2	WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
	0360-0269	7	1	TERMINAL-SLDR LUG LK-MTG FOR-#8-SCR	28480	0360-0269
	0624-0215	3	1	SCREW-TPG 8-32 .25-IN-LG PAN-HD-POZI STL	28480	0624-0215
BT1†			2	NOT ASSIGNED		
C1	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
C2	0160-3451	1		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
C3	0160-4065	5	2	CAPACITOR-FXD .1UF +-20% 250VAC(RMS)	28480	0160-4065
C4	0160-4065	5		CAPACITOR-FXD .1UF +-20% 250VAC(RMS)	28480	0160-4065
C5†	0160-3451	1	3	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-3451
F1	2110-0043	8	1	FUSE 1.5A 250V NTD 1.25X.25 UL	28480	2110-0043
F1	2110-0001	8	1	FUSE 1A 250V NTD 1.25X.25 UL	75915	312001
FL1	9135-0148	3	1	FILTER-LOW PASS	28480	9135-0148
FL2†	9135-0174	5	17	FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL3†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL4†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL5†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL6†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL7†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL8†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL9†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL10†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL11†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL12†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL13†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL14†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL15†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL16†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL17†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
FL18†	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
G1	5086-7080	7	1	YIG OSCILLATOR (NEW)	28480	5086-7080
G1	5086-6080	5	1	YIG OSCILLATOR (RESTORED)	28480	5086-6080
	08558-00076	5	1	STRAP	28480	08558-00076
	0520-0136	7	1	SCREW-MACH 2-56 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0014	1	1	WASHER-LK INTL T NO. 2 .089-IN-ID	28480	2190-0014
	0610-0001	6	1	NUT-HEX-DBL-CHAM 2-56-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
J1	1250-0083	1	5	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM (NOISE SOURCE DRIVE)	28480	1250-0083
	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
	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
	0360-1190	5	2	TERMINAL-SLDR LUG PL-MTG FOR-#3/8-SCR	28480	0360-1190
J2	08970-60057	8	2	CONNECTOR ASSY-INPUT (EXCEPT OPT. 001) (NOISE SOURCE DRIVE)	28480	08970-60057
J3	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0083
	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
	0360-1190	5		TERMINAL-SLDR LUG PL-MTG FOR-#3/8-SCR	28480	0360-1190
J4				NOT ASSIGNED		
J5	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM (X-AXIS)	28480	1250-0083
	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
J6	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM (Y-AXIS)	28480	1250-0083
	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)	28480	1250-0083
	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

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
J8				NSR; P/O W7 (IF)		
J9†	1250-1032	2	1	CONN RF BNC-BHD MTG (DET)	28480	1250-1032
	2190-0068	5	1	WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
	2950-0005	2	1	NUT-HEX-DBL-CHAM 5/16-24-THD .219-IN-THK	00000	ORDER BY DESCRIPTION
J10				NOT ASSIGNED		
J11	08970-60057	8		CONNECTOR ASSY-INPUT (OPT. 001 ONLY)	28480	08970-60057
M1†				NOT ASSIGNED		
MP1†	08970-20025	6	1	FRAME-FRONT MOD.	28480	08970-20025
MP2	08970-00024	3	1	REAR PANEL	28480	08970-00024
MP3	5020-8836	5	1	CORNER STRUTS (15°)	28480	5020-8836
	2510-0192	6	2	SCREW-MACH 8-32 .25-IN-LG 100 DEG	00000	ORDER BY DESCRIPTION
MP4	08970-00010	7	1	BRACKET-RF SECTION (RIGHT)	28480	08970-00010
MP5	08970-00011	8	1	BRACKET-RF SECTION (LEFT)	28480	08970-00011
	2510-0192	6		SCREW-MACH 8-32 .25-IN-LG 100 DEG	00000	ORDER BY DESCRIPTION
MP6	08970-00041	4	1	STRUT-HINGE BRACKET	28480	08970-00041
	0515-0210	7	4	SCREW-MACH M4 X 0.7 8MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
MP7	5060-9834	9	1	COVER (TOP)	28480	5060-9834
	0510-0043	4	2	RETAINER-RING E-R EXT .141-IN-DIA STL	28480	0510-0043
	0570-1171	7	2	SCREW-SPCL 6-32 .468-IN-LG UNCT 100	00000	ORDER BY DESCRIPTION
MP8	08970-00038	9	1	COVER (BOTTOM)	28480	08970-00038
	0510-0043	4		RETAINER-RING E-R EXT .141-IN-DIA STL	28480	0510-0043
	0570-1171	7		SCREW-SPCL 6-32 .468-IN-LG UNCT 100	00000	ORDER BY DESCRIPTION
	7120-8138	4	1	LABEL-WARNING 6-MM-WD 51-MM-LG VINYL	28480	7120-8138
MP9	5060-9879	2	1	COVER (SIDE) W/RECESS	28480	5060-9879
MP10	5060-9936	2	1	COVER (SIDE) PERFORATED	28480	5060-9936
MP11	5060-9803	2	1	STRAP-HANDLE ASSEMBLY (15°)	28480	5060-9803
MP12	5040-7219	8	1	HANDLE-CAP (FRONT)	28480	5040-7219
MP13	5040-7220	1	1	HANDLE-CAP (REAR)	28480	5040-7220
MP14	5001-0439	8	1	TRIM-SIDE (FRONT FRAME)	28480	5001-0439
MP15	5040-7202	9	1	TRIM-SIDE (TOP)	28480	5040-7202
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
	0515-0225	4	1	SCREW-MACH M3.5 X 0.6 10MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	0403-0115	4	3	BUMPER FOOT-ADM MTG .5-IN-WD .25-IN-THK	28480	0403-0115
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-0A-LG MUW	28480	1460-0107
MP21	08970-20053	0	1	CASTING-MACH	28480	08970-20053
	2190-0091	4	1	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0091
	3050-0176	1	1	WASHER-FL MTLG NO. 8 .188-IN-ID	28480	3050-0176
	0515-0210	7		SCREW-MACH M4 X 0.7 8MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	2740-0001	3	1	NUT-HEX-DBL-CHAM 10-32-THD .109-IN-THK (ATTACH BD. ASSY TO CASTING)	00000	ORDER BY DESCRIPTION
MP22	08903-00022	0	1	TRAY-INFO SHEET	28480	08903-00022
MP23	9320-4801	6	1	CARD-INFORMATION INFO CARD	28480	9320-4801
MP24	9320-4802	7	1	CARD-INFORMATION INFO CARD	28480	9320-4802
MP25	9320-4803	8	1	CARD-INFORMATION INFO CARD	28480	9320-4803
MP26- MP29				NOT ASSIGNED		
MP30†	08970-00046	9	1	PANEL (FRONT)	28480	08970-00046
	2360-0116	5	2	SCREW-MACH 6-32 .312-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
MP31†	08970-00045	8	1	PANEL-WINDOW	28480	08970-00045
	0510-1149	3	1	RETAINER-PUSH ON KB-TO-SHFT EXT	28480	0510-1149
MP32†				NOT ASSIGNED		
MP33†				NOT ASSIGNED		
MP34	08970-00018	5	1	SPACER-PANEL (SMALL)	28480	08970-00018
MP35	08970-00017	4	1	SPACER-PANEL (LARGE)	28480	08970-00017
MP36	5040-6889	6	1	LIGHT PIPES (19MM)	28480	5040-6889
MP37	5040-6888	5	1	LIGHT PIPES (12MM)	28480	5040-6888
MP38	08970-00016	3	1	PANEL-LIGHT PIPE	28480	08970-00016
MP39	08970-00003	8	1	BRACKET-FRONT PANEL	28480	08970-00003
	2190-0586	2	1	WASHER-LK HLCL 4.0 MM 4.1-MM-ID	28480	2190-0586
	0535-0006	1	1	NUT-HEX DBL-CHAM M4 X 0.7 3.2MM-THK	00000	ORDER BY DESCRIPTION
MP40	7120-1254	1	1	NAMEPLATE .312-IN-WD .54-IN-LG AL	28480	7120-1254

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

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP41	5041-1682	9	1	KEY CAP-LINE SWITCH	28480	5041-1682
MP42	08970-80002	5	1	PLUG-HOLE (OPTION 001 ONLY)	28480	08970-80002
MP43				NOT ASSIGNED		
MP44				NOT ASSIGNED		
MP45†	08970-20070	1	1	WINDOW-FRONT	28480	08970-20070
MP46-				NOT ASSIGNED		
MP49				RETAINER, FILTER 3.803-IN-WD	28480	4040-1890
MP50	4040-1890	8	1		28480	3050-0891
	3050-0891	7	1	WASHER-FL MTL C 3.0 MM 3.3-MM-ID	28480	2190-0584
	2190-0584	0	7	WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	0515-0211
	0515-0211	8	6	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
MP51	0380-1361	4	1	STANDOFF-HEX 10-MM-LG M3.0 X 0.5-THD	28480	0380-1361
MP52	3160-0300	6	1	FINGER GUARD	28480	3160-0300
MP53	4208-0220	2	1	FOAM-POLYU 6.3-MM-THK 31.8-MM-WD	28480	4208-0220
MP54	3150-0405	1	1	FILTER-AIR POLYU	28480	3150-0405
MP55	7100-0114	8	1	TRANSFORMER COVER .88-DP	28480	7100-0114
MP56	08970-00040	3	1	SHIELD-POWER LINE	28480	08970-00040
	0515-0211	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	7120-3738	0	1	LABEL-WARNING .62-IN-WD 1-IN-LG AL	28480	7120-3738
MP57	6960-0009	1	1	PLUG-HOLE FL-HD FOR .438-D-HOLE BRS (EXCEPT OPT. 001)	28480	6960-0009
MP58	0515-0224	3		SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD (FOR A9MP3)	00000	ORDER BY DESCRIPTION
MP59†	0360-1158	5	1	TERMINAL-SLDR LUG PL-MTG FOR-#1/2-SCR	86928	5413-21
	2360-0195	0	1	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	28480	2360-0195
MP60	5040-7221	2	1	STANDOFF-REAR PANEL	28480	5040-7221
MP61	08558-00008	3	1	BRACKET-YIG OSCILLATOR	28480	08558-00008
	0515-0211	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
MP62	08558-20119	9	1	STANDOFF-TAPERED	28480	08558-20119
MP63	2200-0109	8	1	SCREW-MACH 4-40 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP64	2200-0113	4	1	SCREW-MACH 4-40 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP65	0515-0210	7		SCREW-MACH M4 X 0.7 8MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
MP66†	1400-0510	8	1	CLAMP-CABLE .15-DIA .62-WD NYL	28480	1400-0510
MP67-				NOT ASSIGNED		
MP69				BUMPER FOOT-ADH MTG .5-IN-WD .25-IN-THK	28480	0403-0115
MP70	0403-0115	4				
MP71†	08970-00007	2	1	RF SECTION COVER (BOTTOM)	28480	08970-00007
	0515-0212	9	2	SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	0520-0165	2	1	SCREW-MACH 2-56 .312-IN-LG 82 DEG	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 RF COVER-INTERNAL	28480	1600-1114
MP81	08970-00008	3	1	COVER-A6	28480	08970-00008
	0515-0212	9		SCREW-MACH M3.5 X 0.6 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	3050-0003	3	1	WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD	28480	3050-0003
	0403-0115	4		BUMPER FOOT-ADH MTG .5-IN-WD .25-IN-THK	28480	0403-0115
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				NOT ASSIGNED		
MP85	08970-00012	9	1	BRACKET-HINGE (FRONT)	28480	08970-00012
	2360-0116	5		SCREW-MACH 6-32 .312-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
MP86	08970-00013	0	1	BRACKET-HINGE (REAR)	28480	08970-00013
	0515-0211	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
MP87	08970-20055	2	1	BRACKET-POWER SWITCH	28480	08970-20055
	0515-0211	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	2360-0459	9	1	SCREW-MACH 6-32 .375-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
MP88	08970-00021	0	1	BRACKET-2ND CONVERTER	28480	08970-00021
	2200-0107	6	1	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	0515-0210	7		SCREW-MACH M4 X 0.7 8MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
MP89	08970-00022	1	1	BRACKET-ISOLATOR, 2ND CONVERTER	28480	08970-00022
	2200-0111	2	1	SCREW-MACH 4-40 .5-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION

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
MP90 MP91	0400-0201	3	1	GROMMET-RND .25-IN-ID .438-IN-GRV-OD	28480	0400-0201
	1400-0017	0	1	CLAMP-CABLE .312-DIA .375-WD NYL (FOR S1)	28480	1400-0017
	2190-0018	5	2	WASHER LK HLCL NO. 6 .141-IN-ID	28480	2190-0018
	0515-0224	3	3	SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	3050-0892	8	2	WASHER-FL MTLG 3.5 MM 3.8-MM-ID	28480	3050-0892
	0535-0007	2	2	NUT-HEX DBL-CHAM M3.5 X 0.6 2.8MM-THK	00000	ORDER BY DESCRIPTION
MP92	1400-0025	0	1	CLAMP-CABLE .5-DIA .5-WD NYL (FOR FL1)	28480	1400-0025
	2190-0018	5		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0018
	0515-0224	3		SCREW-MACH M3.5 X 0.6 12MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	3050-0892	8		WASHER-FL MTLG 3.5 MM 3.8-MM-ID	28480	3050-0892
	0535-0007	2		NUT-HEX DBL-CHAM M3.5 X 0.6 2.8MM-THK	00000	ORDER BY DESCRIPTION
MP93	2360-0115	4	1	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI (A12 ASSY TO A9 ASSY)	00000	ORDER BY DESCRIPTION
MP94	1251-3720	1	1	CONNECTOR-SGL CONT SKT .04-IN-BSC-SZ RND (WIRING HARNESS TO FL2-18)	28480	1251-3720
MP95	0360-0042	4	1	TERMINAL-SLDR LUG PL-MTG FOR-#6-SCR (FOR FL12 AND FL18)	28480	0360-0042
P1	1251-5043	5	4	CONNECTOR 5-PIN F POST TYPE (TO A13J5)	22526	65039-032
	1251-4182	1	12	CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
	1251-3803	1	13	CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
P2	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
	1251-5043	5		CONNECTOR 5-PIN F POST TYPE (TO A17J1)	22526	65039-032
P3	1251-5043	5		CONNECTOR 5-PIN F POST TYPE (TO A13J3)	22526	65039-032
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
P4†	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
	1251-4492	6	2	CONNECTOR 6-PIN F POST TYPE (TO A13J4)	28480	1251-4492
	1251-4169	4	4	CONNECTOR 7-PIN F POST TYPE	28480	1251-4169
	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
P5	1251-5043	5		CONNECTOR 5-PIN F POST TYPE (TO A1J2)	22526	65039-032
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
P6	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
	1251-4741	8	1	CONNECTOR 9-PIN F POST TYPE (TO A2J1)	28480	1251-4741
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
P7	1251-4169	4		CONNECTOR 7-PIN F POST TYPE (TO A14J1)	28480	1251-4169
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
P8	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
	1251-5060	6	1	CONNECTOR 8-PIN F POST TYPE (TO A14J5)	28480	1251-5060
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
P9	1251-4492	6		CONNECTOR 6-PIN F POST TYPE (TO A14J2)	28480	1251-4492
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
P10	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
	1251-4169	4		CONNECTOR 7-PIN F POST TYPE (TO A14J4)	28480	1251-4169
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
P11	1251-4169	4		CONNECTOR 7-PIN F POST TYPE (TO A13J1)	28480	1251-4169
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
P12	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
	1251-4491	5	1	CONNECTOR 13-PIN F POST TYPE (TO A9J2)	28480	1251-4491
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ SQ	28480	1251-4182
	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803

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
P13	1251-5207	3	1	CONNECTOR 16-PIN F POST TYPE (TO A9J3)	28480	1251-5207
	1251-4182	1		CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ S0	28480	1251-4182
	1251-3803	1		CONNECTOR 12-PIN M RECT-MINTR	28480	1251-3803
S1 S2	08970-60155	7	1	LINE SWITCH ASSEMBLY (INCLUDES W11)	28480	08970-60155
	3103-0094	5	1	SWITCH-THRM FXD +1.93F 15A OPN-ON-RISE	28480	3103-0094
	0515-0211	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	1251-2410	4	1	CONTACT-CONN U/W-UTIL MALE CRP	28480	1251-2410
	1251-2411	5	1	CONTACT-CONN U/W-UTIL FEM CRP	28480	1251-2411
	1251-7015	5	1	CONNECTOR-SGL CONT FEM-SNAP RND	28480	1251-7015
T1	1251-7016	6	1	CONNECTOR-SGL CONT M-SNAP RND	28480	1251-7016
	9100-2640	1	1	TRANSFORMER-POWER 100/120/220/240V	28480	9100-2640
	0515-0125	3	1	SCREW-MACH M5 X 0.8 45MM-LG PAN-HD (EXCEPT OPT. 001)	28480	0515-0125
	3050-0139	6	1	WASHER-FL MTLC NO. 8 .172-IN-ID	28480	3050-0139
	0515-0295	8	1	SCREW-MACH M5 X 0.8 50MM-LG PAN-HD (OPTION 001 ONLY)	28480	0515-0295
	0535-0005	0	1	NUT-HEX DBL-CHAM M5 X 0.8 5.3MM-THK	00000	ORDER BY DESCRIPTION
VR1†	2190-0587	3	1	WASHER-LK HLCL 5.0 MM 5.1-MM-ID	28480	2190-0587
	1902-0943	5	1	DIODE-ZNR 2.4V 5% D0-35 PD=.4W TC=-.037%	28480	1902-0943
W1	08970-20064	3	1	CABLE ASSY-SEMIRIGID (J2 TO FL1) (EXCEPT OPT. 001)	28480	08970-20064
W2	08970-20066	5	1	CABLE ASSY-SEMIRIGID (FL1 TO A6) (EXCEPT OPT. 001)	28480	08970-20066
W3	08970-20062	1	1	CABLE ASSY-SEMIRIGID (A6 TO A10)	28480	08970-20062
W4	08970-20061	0	1	CABLE ASSY-SEMIRIGID (A10 TO AT1)	28480	08970-20061
W5	08970-20063	2	1	CABLE ASSY-SEMIRIGID (AT1 TO A11)	28480	08970-20063
W6	08970-20069	8	1	CABLE ASSY-SEMIRIGID (A11 TO A4)	28480	08970-20069
W7	08970-60058	9	1	CABLE ASSY-(A8 TO J8); INCL J8	28480	08970-60058
	0590-1011	6	1	NUT-KNRLD-R 15/32-32-THD .12-IN-THK	28480	0590-1011
W8†	08970-20023	4	1	CABLE ASSY-SEMIRIGID (G1 TO A10)	28480	08970-20023
W9	8120-3300	3	1	CABLE ASSY-RIBBON (A13 TO A14)	28480	8120-3300
W10				NSR; PART OF A16J2		
W11				NSR; PART OF S1		
W12	08970-20067	6	1	CABLE ASSY-SEMIRIGID (J11 TO FL1; OPT. 001 ONLY)	28480	08970-20067
W13	08970-20068	7	1	CABLE ASSY-SEMIRIGID (FL1 TO A6; OPT. 001 ONLY)	28480	08970-20068
W14	8120-1378	1	1	CABLE ASSY 18AWG 3-CNDCT JGK-JKT	28480	8120-1378
W15				WIRE-22AWG (A4 TO A3)		
W16				WIRE-22AWG (A3 TO A8)		
W17†				NOT ASSIGNED		

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

Table 6-4. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address	Zip Code
50545	NIPPON ELECTRIC CO	TOKYO JP	
00000	ANY SATISFACTORY SUPPLIER		
01121	ALLEN-BRADLEY CO	MILWAUKEE WI	53204
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS TX	75222
02111	SPECTROL ELECTRONICS CORP	CITY OF IND CA	91745
02114	FERROXCUBE CORP	SAUGERTIES NY	12477
03888	K D I PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
06001	MEPCO ELECTRA CORP	COLUMBIA SC	29063
06665	PRECISION MONOLITHICS INC	SANTA CLARA CA	95050
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	94042
07933	RAYTHEON CO SEMICONDUCTOR DIV HQ	MOUNTAIN VIEW CA	94040
08484	BREEZE CORPORATIONS INC	UNION NJ	07083
11236	CTS OF BERNE INC	BERNE IN	46711
13606	SPRAGUE ELECT CO SEMICONDUCTOR DIV	CONCORD NH	03301
14140	EDISON ELEK DIV MCGRAW-EDISON	MANCHESTER NH	03130
15818	TELEDYNE SEMICONDUCTOR	MOUNTAIN VIEW CA	94043
17856	SILICONIX INC	SANTA CLARA CA	95054
19701	MEPCO/ELECTRA CORP	MINERAL WELLS TX	76067
22526	BERG ELEK DIV DUPONT	NEW CUMBERLAND PA	17070
24046	TRANSITRON ELECTRONIC CORP	WAKEFIELD MA	01880
24355	ANALOG DEVICES INC	NORWOOD MA	02062
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
25403	N.V. PHILIPS-ELCOMA DEPARTMENT	EINDHOVEN HL	02876
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE NJ	
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE CA	92507
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
72982	ERIE TECHNOLOGICAL PRODUCTS INC	ERIE PA	16512
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON CA	92634
74970	JOHNSON E F CO	WASECA MN	56093
75915	LITTELFUSE INC	DES PLAINES IL	60016
80103	LAMBDA ELECTRONICS CORP	MELVILLE NY	11746
86928	SEASTROM MFG CO	GLENDALE CA	91201
91506	AUGAT INC	ATTLEBORO MA	02703
91637	DALE ELECTRONICS INC	COLUMBUS NE	68601



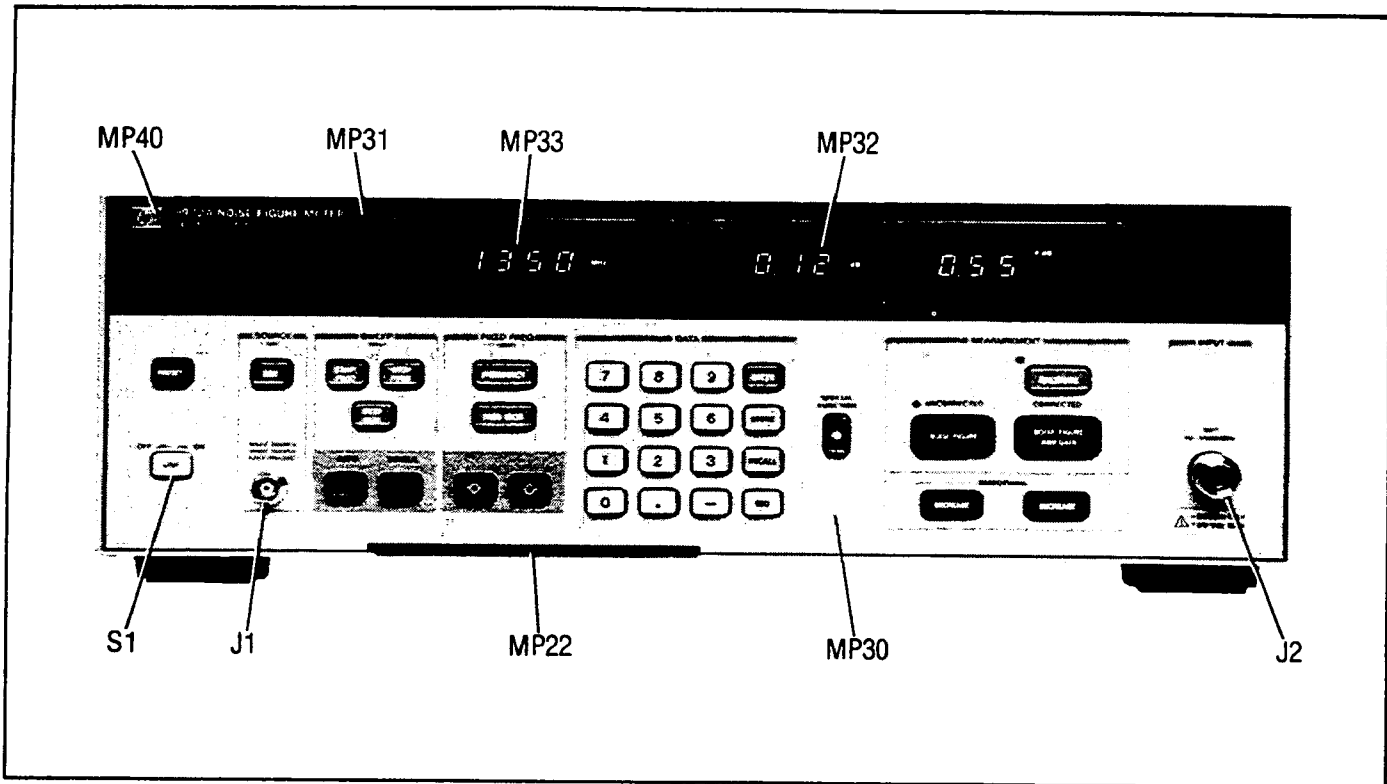


Figure 6-1. Chassis and Mechanical Parts Identification – Front Panel

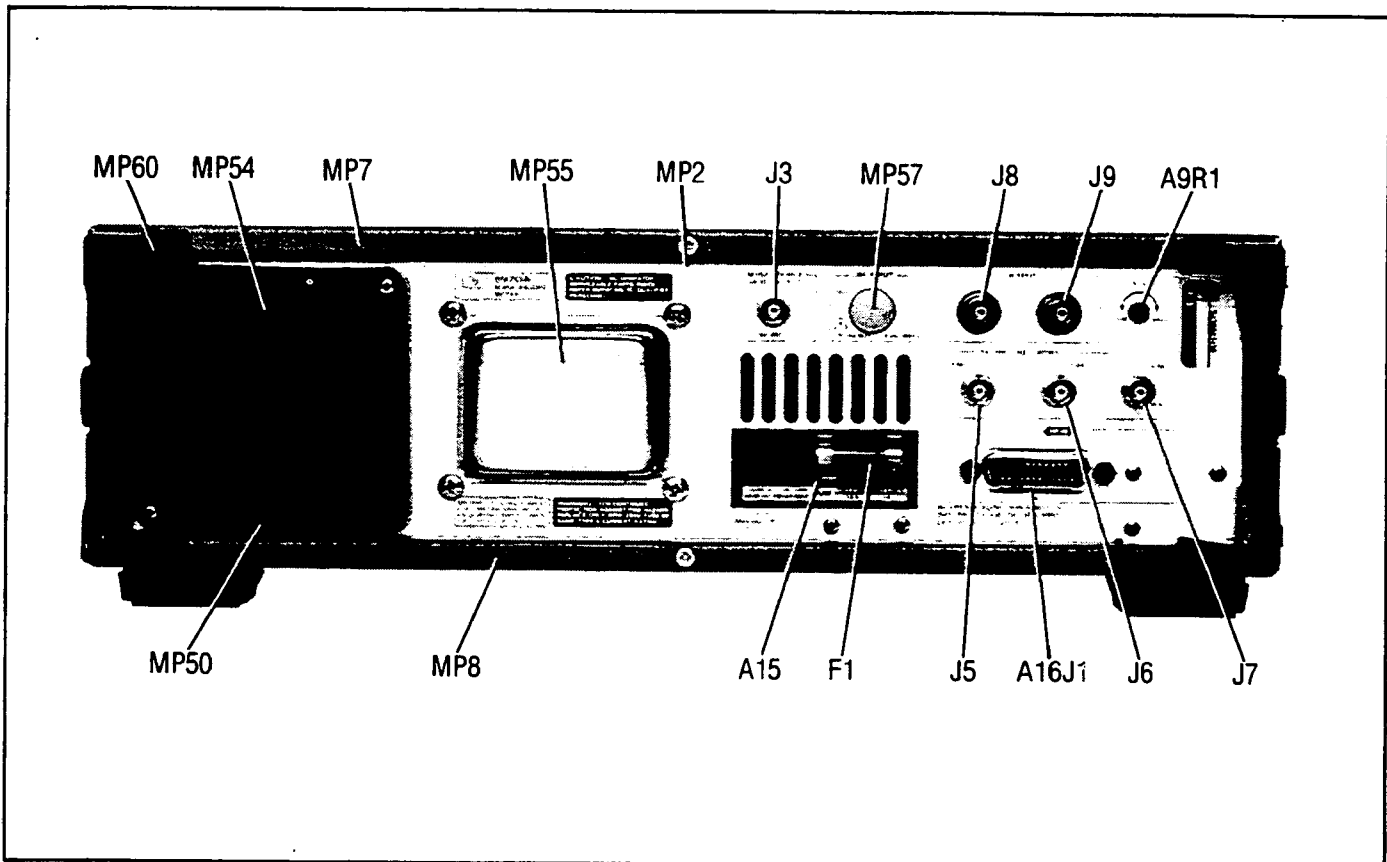


Figure 6-2. Chassis and Mechanical Parts Identification – Rear Panel

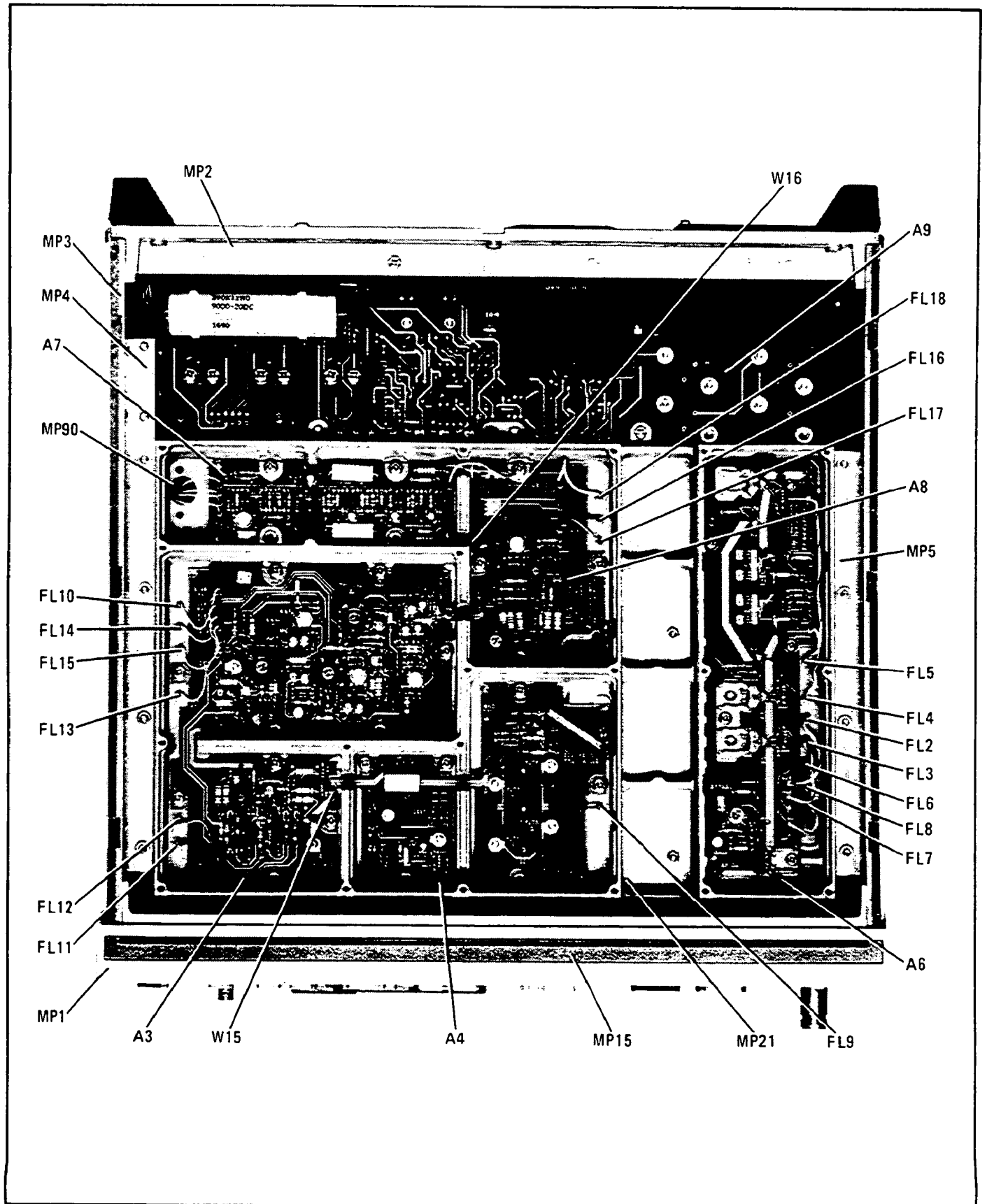


Figure 6-3. Top Chassis Parts, Mechanical Parts, and Cable Identification (with RF covers removed)

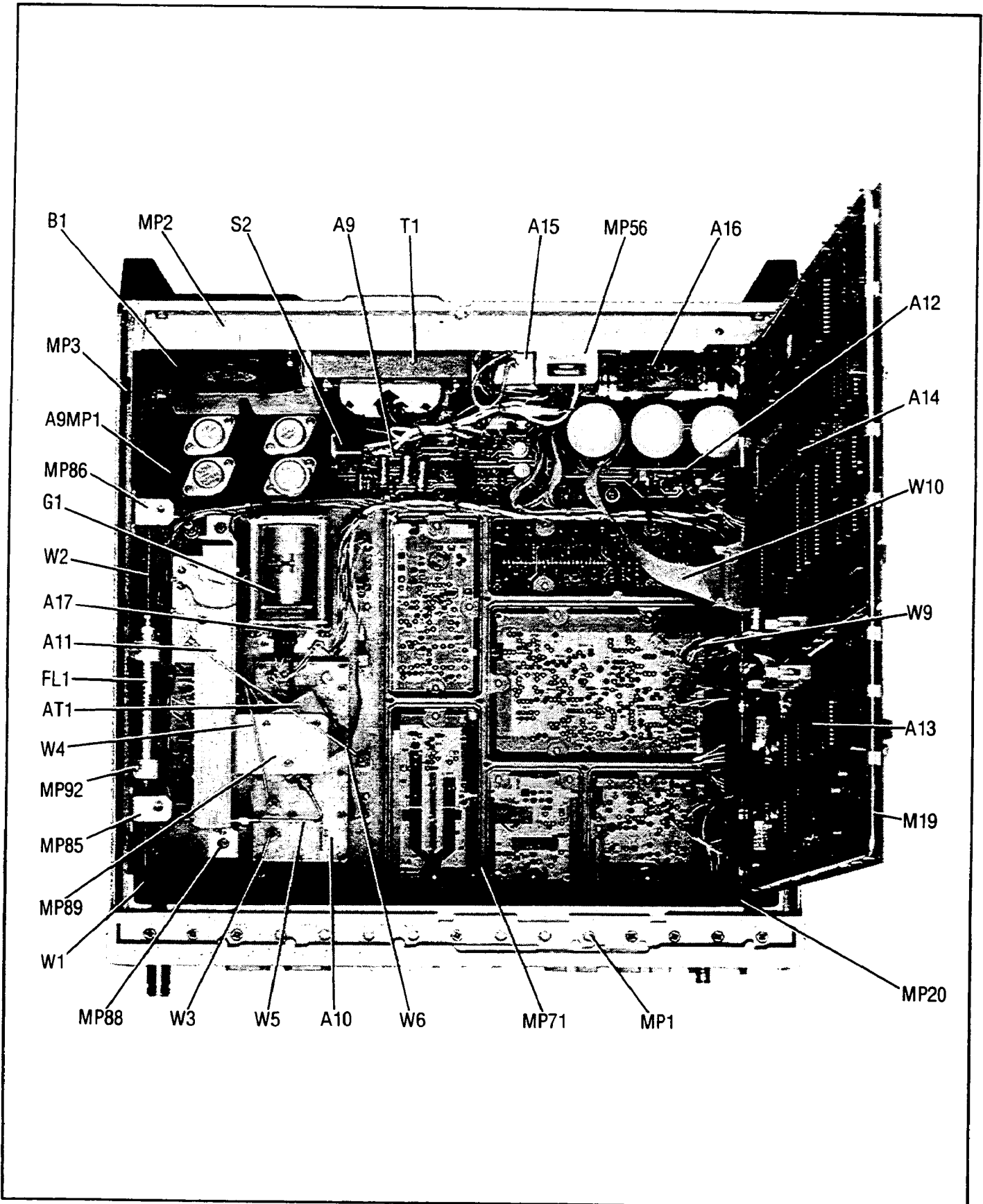


Figure 6-4. Bottom Chassis Parts, Mechanical Parts, and Cable Identification

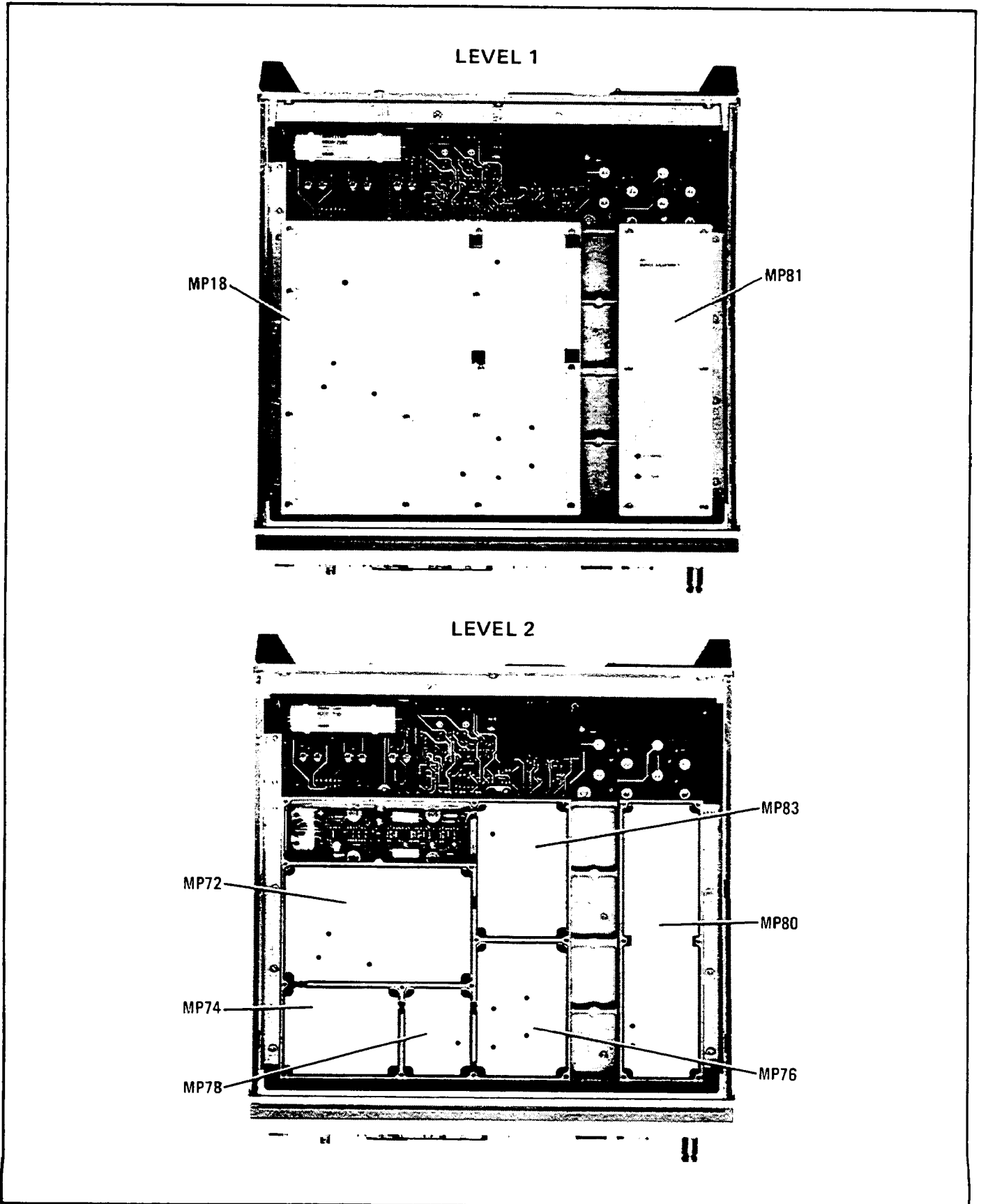


Figure 6-5. Top Internal RF Covers Identification

## SECTION VII MANUAL CHANGES

### 7-1. INTRODUCTION

This section contains manual change instructions for backdating this manual for HP Model 8970A Noise Figure Meters that have serial number prefixes lower than 2438A.

If your instrument's serial number or prefix is not listed on the title page of this manual or in Table 7-1, it may be documented on a MANUAL CHANGES supplement. For additional important information about serial number coverage, refer to INSTRUMENTS COVERED BY MANUAL and MANUAL CHANGES SUPPLEMENT in Section I of this manual.

### 7-2. MANUAL CHANGES

To adapt this manual to your instrument, refer to Table 7-1 and make all of the manual changes listed opposite your instrument's serial number or prefix. The manual changes are listed in serial number sequence and should be made in the sequence listed. For example, Change A should be made after Change B, Change B should be made after Change C, etc. Table 7-2 is a summary of changes by page number.

Table 7-1. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes
2116A	E, D, C, B, A
2210A	E, D, C, B
2222A	E, D, C
2303A	E, D
2414A	E

Table 7-2. Summary of Manual Changes by Page Number (1 of 2)

Page	Description	Changes	Page	Description	Changes	Page	Description	Changes
6-5	A1J2	D	6-14	A6R24, A6R25,		6-23	A13R66—A13R69	C
6-6	A1TP1, A1TP2	D	6-14	A6R26	D	6-23	A13RT1	D
6-6	A2	A	6-14	A6R36, A6R38	B,C	6-23	A13U17, A13U18	C
6-7	A2DS1—A2DS13	E	6-14	A6R39	C,D	6-24	A13W2—A13W5	C
6-7	A2DS17	A	6-14	A6R40	B,C	6-24	A13Y1	C
6-7	A2DS19—A2DS22	A	6-18	A9J2, A9J3	D	6-24	A14C9	C
6-7	A2DS24—A2DS30	A	6-18	A9Q3, A9Q4	D	6-24	A14J1, A14J2,	
6-7	A2DS31—A2DS34	A,E	6-19	A11CR1	C	6-24	A14J4, A14J5	D
6-7	A2J1	D	6-19	A11J3	C	6-25	A14MP1, A14MP3	B
6-7	A2MP1—A2MP3	A	6-19	A11L2	C	6-25	A14MP6	C
6-8	A2U4, A2U5	D	6-20	A12R5	C	6-26	A14U42	D
6-8	A2U6	C	6-20	A13	C	6-27	A14U67	C
6-11	A3R6, A3R7,		6-20	A13BT1		6-27	A17J1	D
6-11	A3R9	A	6-20	A13C3—A13C5,		6-28	B1	C
6-11	A3R35	B	6-21	A13C34,		6-28	BT1	C
6-12	A4C6	C	6-21	A13C37, A13C47,		6-28	C5	E
6-12	A4L2	A	6-21	A13C51, A13C55,		6-28	FL2—FL18	C
6-12	A4R1, A4R2,		6-21	A13C57	C	6-29	J9	C
6-13	A4R7, A4R12	A	6-21	A13CR1, A13CR2,		6-29	M1	B
6-13	A6K1—A6K5	C	6-21	A13CR7	C	6-29	MP1	C
6-14	A6R6, A6R8, A6R9	D	6-21	A13G1	C	6-29	MP30, MP31	B
6-14	A6R10	C	6-21	A13J1, A13J3	D	6-29	MP32, MP33	A
6-14	A6R12, A6R13,		6-21	A13J4	C,D	6-30	MP59	E
6-14	A6R16, A6R18	D	6-21	A13J5	D	6-30	MP45, MP66	A
6-14	A6R19	C	6-22	A13MP1, A13MP3	B	6-30	MP71	C
6-14	A6R20, A6R22,		6-22	A13R2—A13R7,		6-31	P4	C

Table 7-2. Summary of Manual Changes by Page Number (2 of 2)

Page	Description	Changes	Page	Description	Changes	Page	Description	Changes
6-32	VR1	E		R35	B	SS17	A13	C
6-32	W8, W17	B	SS5	C5	E		C47	C
(BD1)	Meter	B		VR1	E		R67, R68	C
(BD4)	Meter	B	SS6	Meter	B,C		W5	C
SS1	R36, R38	B,C		TP1, TP2	D	SS19	A12R5	C
	R39	C,D	SS7	A13	C		B1	C
	R40	B,C		R11, R66	C			
SS2	300MHz IF Amp	A		W17	B			
	C6	C	SS10	A2	A			
SS3	Q20	A	SS13	BT1	C			
	R6, R7, R9	A	SS16	BT1	C			

## MANUAL CHANGES

### 7-3. MANUAL CHANGE INSTRUCTIONS

#### CHANGE A

Table 6-3:

- Change A2 to 08970-60008 (CD9) DISPLAY ASSEMBLY.  
 Add A2DS17 as follows: 1990-0696 (CD0) LED-LIGHT BAR MODULE LUM-INT=3MCD. 1200-0904 (CD0) SOCKET-DISPL 4-CONT SIP W-WRAP.  
 Add A2DS19 - 22 as follows: 1990-0696 (CD0) LED-LIGHT BAR MODULE LUM-INT=3MCD. 1200-0904 (CD0) SOCKET-DISPL 4-CONT SIP W-WRAP.  
 Add A2DS24 - 30 as follows: 1990-0696 (CD0) LED-LIGHT BAR MODULE LUM-INT=3MCD. 1200-0904 (CD0) SOCKET-DISPL 4-CONT SIP W-WRAP.  
 Delete A2DS31 - 34.  
 Change A2MP1 to 08970-00042 (CD5) LABEL - LEFT DISPLAY.  
 Add A2MP2 08970-00043 (CD6) LABEL - MIDDLE DISPLAY.  
 Add A2MP3 08970-00044 (CD7) LABEL - RIGHT DISPLAY.  
 Change A3R6 to 0698-3153 (CD9) RESISTOR 3.83K 1% .125W F TC=0 ±100, 24546 C4-1/8-T0-3831F.  
 Change A3R7 to 0757-0442 (CD9) RESISTOR 10K 1% .125W F TC=0 ±100, 24546 C4-1/8-T0-1002F.  
 Change A3R9 to 0757-0873 (CD0) RESISTOR 1.62K 1% .5W F TC=0 ±100, 24546 C4-1/8-T0-51R1-F.  
 Add A4L2 9100-0346 (CD0) INDUCTOR RF-CH-MLD 50NH 20% .105DX.26LG.  
 Change A4R1 to 0757-0442 (CD9) RESISTOR 10K 1% .125W F TC=0 ±100 24546 C4-1/8-T0-1002-F.  
 Change A4R2 to 0757-0288 (CD1) RESISTOR 9.09K 1% .125W F TC=0 ±100 19701 MF4C1/8-T0-9091-F.  
 Change A4R7 to 0757-0420 (CD3) RESISTOR 750 1% .125W F TC=0 ±100 24546 C4-1/8-T0-751-F.  
 Change A4R12 to 0698-7236 (CD7) RESISTOR 1K 1% .05W F TC=0 ±100 24546 C3-1/8-T0-1001-F.  
 Add MP32 08970-20057 (CD4) WINDOW (RIGHT).  
 Add MP33 08970-20056 (CD3) WINDOW (LEFT).  
 Delete MP45.  
 Delete MP66.

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**MANUAL CHANGES**


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**CHANGE A (cont'd)**

Service Sheet 2 (schematic):

On the A4 Assembly, replace the 300 MHz IF Amplifier circuit with the following partial schematic.

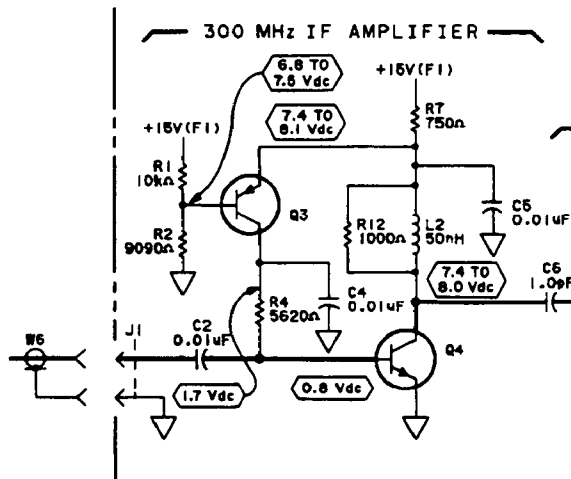


Figure 7-1. P/O Schematic 2 (P/O Change A)

Service Sheet 3 (schematic):

Change the value of R6 to 3830Ω.

Change the value of R7 to 10 kOhms.

Change the value of R9 to 1620Ω.

Change the voltage at the base of Q20 to "10.1 to 10.6 Vdc."

Change the voltage at the emitter of Q20 to "9.3 to 9.8 Vdc."

Service Sheet 10 (schematic):

Replace the appropriate portion of the schematic with the attached partial schematic.

MANUAL CHANGES

CHANGE A (cont'd)

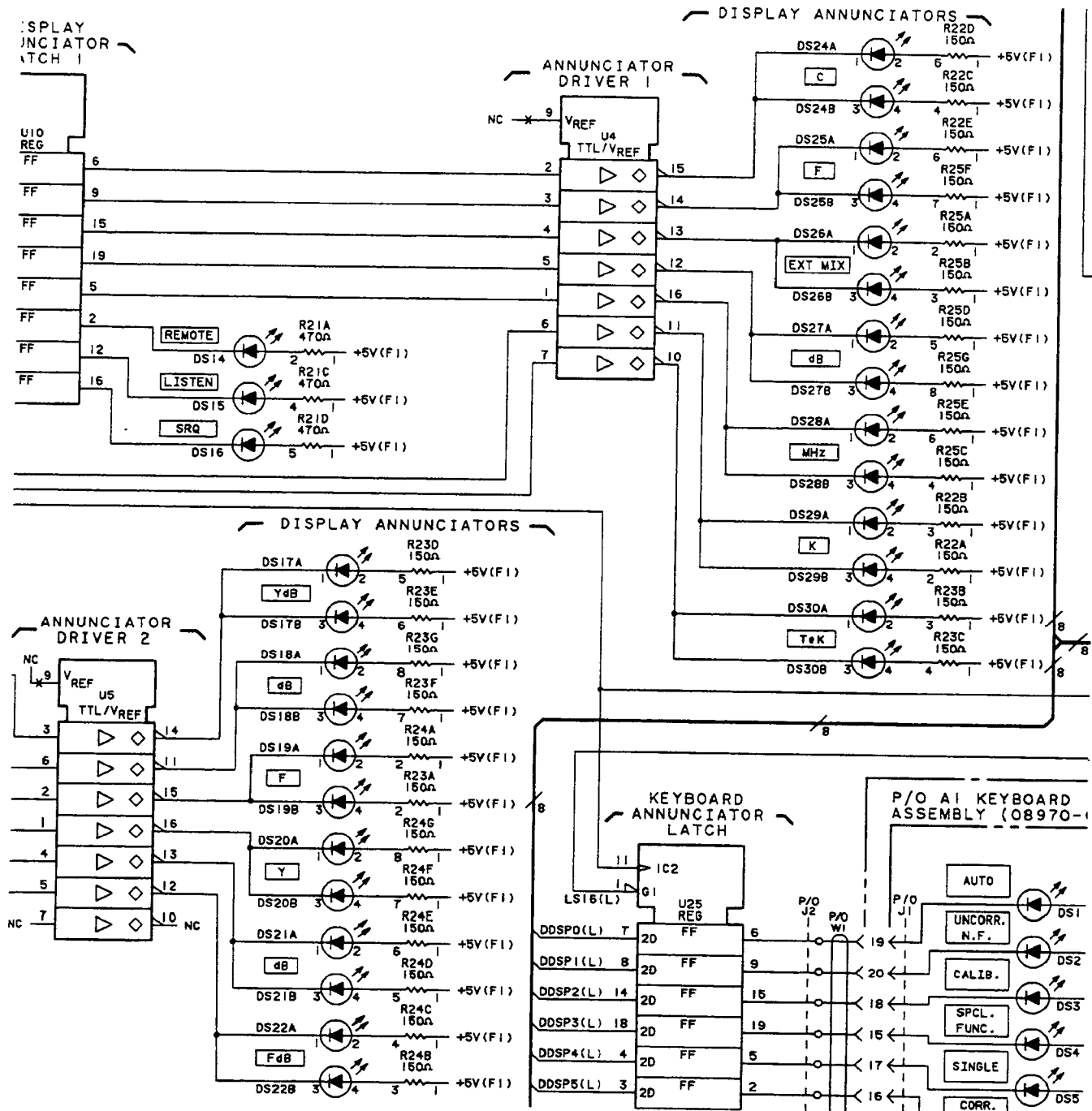


Figure 7-2. P/O Schematic 10 (P/O Change A)



**MANUAL CHANGES**

**CHANGE B**

**NOTE**

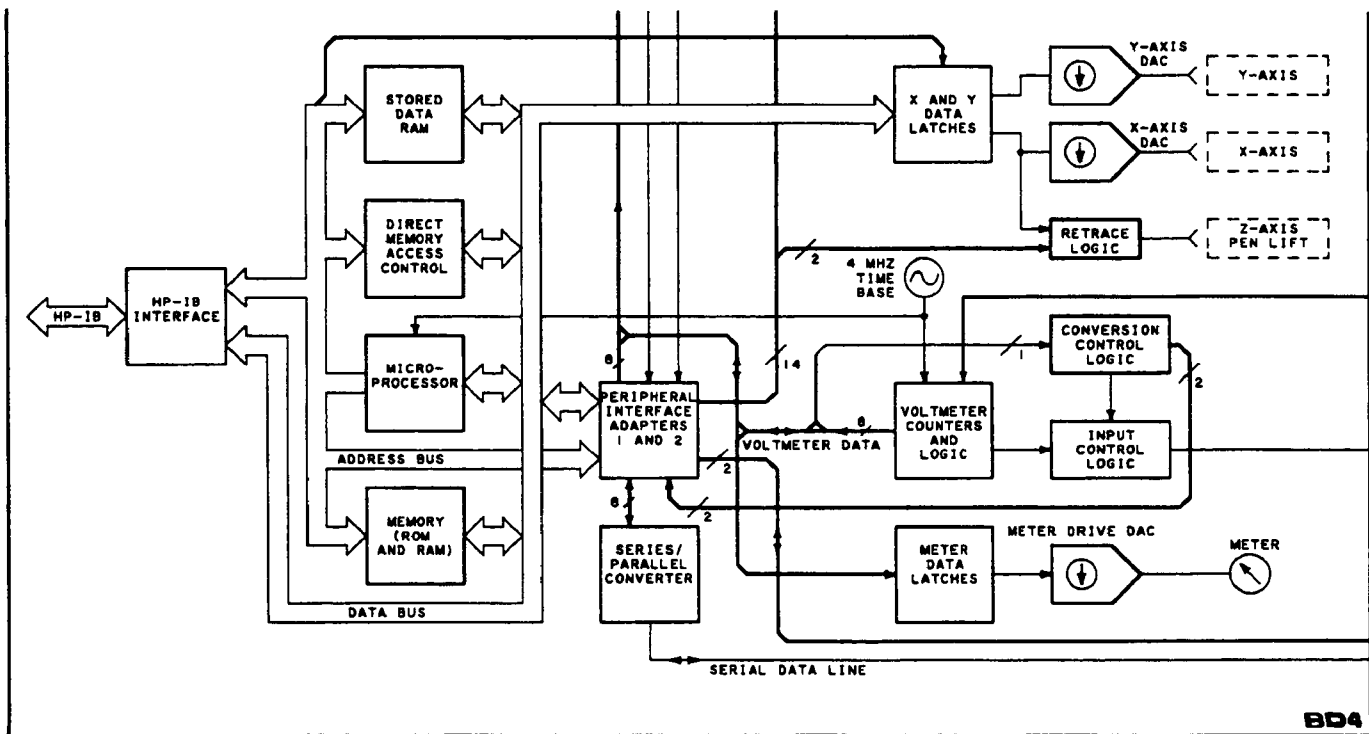
*One of the components affected by this change is front panel meter M1. The meter was originally located on the far right of the front panel, next to the NOISE FIGURE display. It should be indicated in the front panel photos in Sections I and III. The meter provides an analog indication of data shown in the NOISE FIGURE display.*

**Table 6-3:**

- Change A3R35 to 0698-3435 (CD0) RESISTOR 38.3 1% .125W F TC=0 ±100 24546 C4-1/8-T0-38R3-F.
- Change A6R36 to 0727-0074 (CD0) RESISTOR 436.2 .5% .25W CF TC=0-500.
- Change A6R38 to 0727-0008 (CD0) RESISTOR 11.61 .5% .25W CF TC=0-500.
- Change A6R40 to 0727-0074 (CD0) RESISTOR 436.2 .5% .25W CF TC=0-500.
- Change A13MP1 to 0515-0053 (CD6) SCREW-MACH M4X0.7 10MM-LG PAN HD.
- Change A13MP3 to 0510-0045 (CD6) RETAINER-RING E-R EXT .188-IN-DIA STL.
- Change A14MP1 to 0515-0053 (CD6) SCREW-MACH M4X0.7 10MM-LG PAN HD.
- Change A14MP3 to 0510-0045 (CD6) RETAINER-RING E-R EXT .188-IN-DIA STL.
- Add M1 as follows: 1120-1591 (CD3) METER 0362-0227 (CD1) CONNECTOR-SGL CONT SKT 1.14-MM-BSC-SZ 2200-0105 (CD4) SCREW MACH 4-40 .312-IN-LG PAN-HD POZI 0460-1776 (CD5) PAD-FOAM
- Change the first entry in MP30 to 08970-00001 (CD6) PANEL (FRONT).
- Change the first entry in MP31 to 08970-00002 (CD7) PANEL-WINDOW.
- W8 was originally 08970-20065 (CD4) CABLE ASSY SEMI-RIGID (W17 TO A10). W17 was originally 1250-1249 (CD3) ADAPTER-COAX RTANG F-SMA M-SMA (G1 TO W8). The recommended replacement for W8 is listed in Table 6-3. It connects G1 to A10; W17 is deleted. No manual change is recommended.

**Service Sheet BD1 (block diagram):**

Replace the appropriate portion of BD1 with the following partial block diagram.



**Figure 7-3. P/O Block Diagram 1 (P/O Change B)**

**MANUAL CHANGES**

**CHANGE B (cont'd)**

Service Sheet BD4 (block diagram):

Replace the appropriate portion of BD4 with the following partial block diagram.

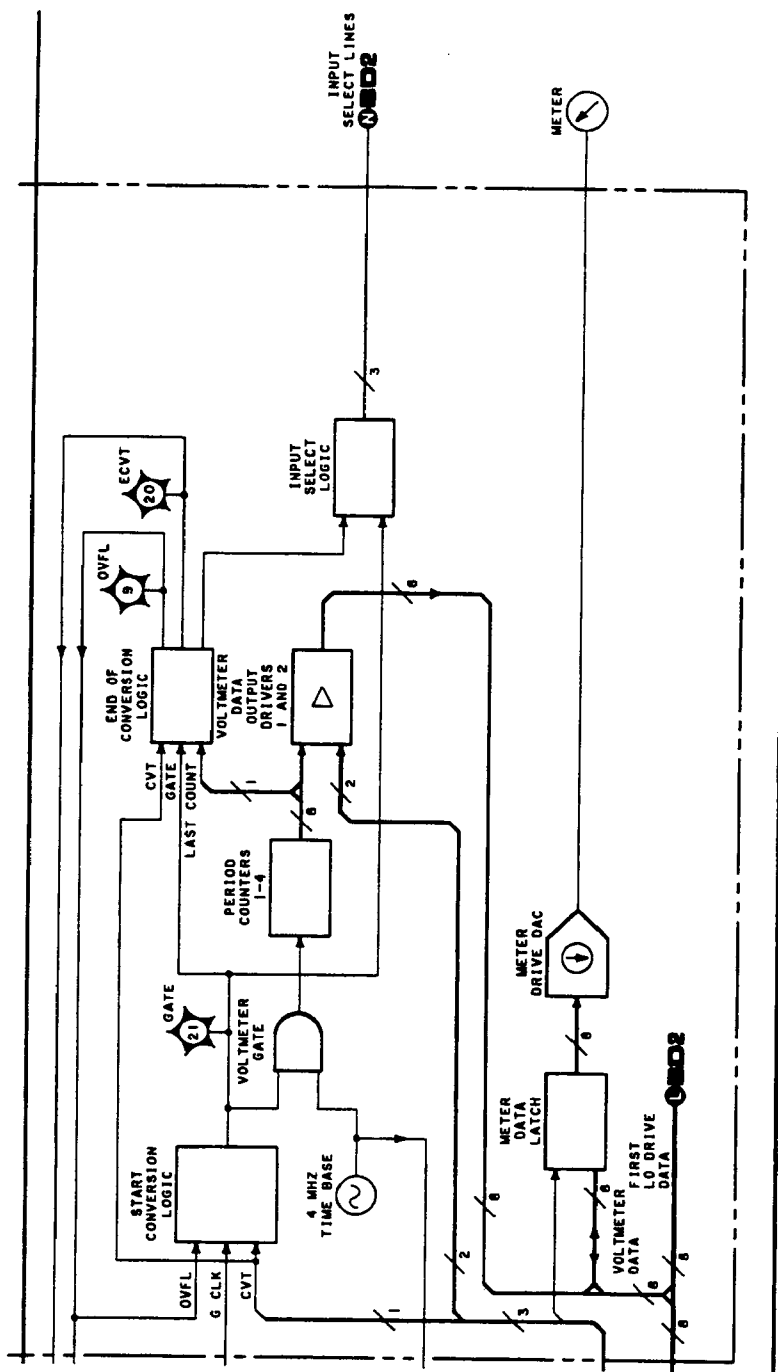


Figure 7-4. P/O Block Diagram 4 (P/O Change B)

**MANUAL CHANGES**

**CHANGE B (cont'd)**

Service Sheet BD4 (Troubleshooting):

Add the following signature analysis routine:

Meter Circuits:    Start: A14TP8, (D1), / Stop: A14TP9, (D2), / Clock: A14TP11, (φ2), \ (Service Sheets 6, 11, and 14)		
Node (Ref. Desig.)-pin	Signal Name	Signature
A13U17-3	R/ $\bar{W}$	66C1
-18	DA0	098H
-4	DA1	CA74
-17	DA2	73C0
-7	DA3	F298
-14	DA4	757H
-8	DA5	AF3F
-13	DA6	P37P
-11	DA7	13A4
U18-5	E3	H60P
-6	—	F5C6
-7	—	198A
-8	—	502F
-9	—	691H
-10	—	879C
-11	—	AHHC
-12	—	2FP7

Service Sheet 1 (schematic):

Change the value of R36 to 436.2Ω.

Change the value of R38 to 11.61Ω.

Change the value of R40 to 436.2Ω.

Change the name of the circuit circuit comprising R36, R38, and R40 to "2 dB Pad."

Service Sheet 3 (schematic):

Change the value of R35 to 38.3Ω.

## MANUAL CHANGES

### CHANGE B (cont'd)

Service Sheet 6 (schematic):

Add M1 and the wires that connect it to the A1 Keyboard Assembly as shown in the following partial schematic.

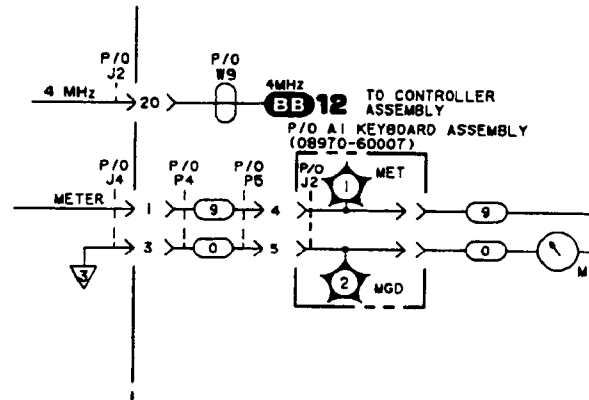


Figure 7-5. P/O Schematic 6 (P/O Change B)

Service Sheet 7 (schematic):

W17 (coax adapter) was originally inserted between W8 and G1J2. The recommended replacement deletes W17 and has W8 connected directly to G1J2, as shown in the schematic. Therefore, no manual change is recommended.

### CHANGE C

Table 5-1:

- Delete A6R39 from the table.
- Delete A13R66 from the table.

Table 6-3:

- A2U6 was originally 1826-0138 (CD8) IC COMPARATOR GP QUAD 14-DIP P PKG. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.
- A4C6 was originally 0160-0690 (CD4) CAPACITOR-FXD 1 PF  $\pm$ .5 PF 100VDC CER. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.
- Change the first entry under A6K1 - K5 to 0490-0565 (CD1) RELAY 2C 12VDC-COIL.
- A6R10 was originally 0698-7222 (CD1) RESISTOR 261 1% .05W F TC=0 $\pm$ 100. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.
- A6R19 was originally 0698-7219 (CD1) RESISTOR 196 1% .05W F TC=0 $\pm$ 100. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.
- Change A6R36 to 0727-0064 (CD8) RESISTOR 292.4 .5% .25W CF TC=0-500.
- Change A6R38 to 0727-0010 (CD4) RESISTOR 17.61 .5% .25W CF TC=0-500.
- Remove the asterisk (\*) from A6R39.
- Change A6R40 to 0727-0064 (CD8) RESISTOR 292.4 .5% .25W CF TC=0-500.
- A11CR1 was originally 1901-0633 (CD1) DIODE-SM SIG SCHOTTKY. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.
- The first entry under A11J3 was originally 1250-0829 (CD3) CONNECTOR-RF SMC M SGL-HOLE-FR 50-OHM. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.
- A11L2 was originally 08558-80009 COIL-SECOND CONVERTER. The recommended replacement is listed in Table 6-3. Therefore, no manual change is recommended.

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**MANUAL CHANGES**


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**CHANGE C (cont'd)**

## Table 6-3 (cont'd):

Change A12R5 to 0811-2822 (CD9) RESISTOR 6.8 5% .75W PW TC=0 ±50.

A13 was originally 08970-60006 (CD7) DRIVER ASSEMBLY. If this assembly is being replaced, order part number 08970-60020 (CD5).

**NOTE**

*One of the components affected by this change is battery BT1. The battery was originally rechargeable and located in the chassis. It was moved to Assembly A13 and made replaceable. The battery provides the power to the nonvolatile CMOS RAM while the instrument is turned off.*

Delete A13BT1.

Add A13C3 0160-3451 (CD1) CAPACITOR-FXD .01UF +80-20% 100VDC CER.

Add A13C4 0160-4494 (CD4) CAPACITOR-FXD 39PF ±5% 200VDC CER 0 ±30.

Add A13C5 0160-4764 (CD1) CAPACITOR-FXD 150PF ±5% 100VDC CER.

Change A13C34 and A13C47 to 0160-4385 (CD2) CAPACITOR-FXD 15 PF ±5% 200 VDC CER 0 ±30.

A13C37 and A13C51 were originally 0160-3855 (CD4) CAPACITOR-FXD 5600 PF ±5%. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

Add A13C55 0160-3456 (CD6) CAPACITOR-FXD 1000PF ±10% 1KVDC CER.

Delete A13C57.

Add A13CR1 and A13CR2 1901-0376 (CD6) DIODE-GEN PRP 35V 50MA DO-35.

Delete A13CR7.

Delete A13G1.

A13J4 was originally 1251-4989 (CD6) CONNECTOR 5-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended

Add A13R2 0698-0084 (CD9) RESISTOR 2.15K 1% .125W F TC=0±100.

Add A13R3 0757-0280 (CD3) RESISTOR 1K 1% .125W F TC=0±100.

Add A13R4 0757-0439 (CD4) RESISTOR 6.81K 1% .125W F TC=0±100.

Add A13R5 0757-0439 (CD4) RESISTOR 6.81K 1% .125W F TC=0±100.

Add A13R6 0698-0084 (CD9) RESISTOR 2.15K 1% .125W F TC=0±100.

Add A13R7 0757-0280 (CD3) RESISTOR 1K 1% .125W F TC=0±100.

Delete A13R66\*, A13R67, and A13R68.

Delete A13R69.

Add A13U17 1820-1858 (CD9) IC FF TTL LS D-TYPE OCTL 01295 SN74LS377N.

Add A13U18 1826-0188 (CD8) IC CONV 8-B-D/A 16-DIP-C-PKG 04713 MC1408L-8.

Delete A13W2—5.

Add A13Y1 0410-0465 (CD2) CRYSTAL-QUARTZ 4.00000 MHZ HC-6/U-HLDR.

A14C9 was originally 0160-3855 (CD9) CAPACITOR-FXD 5600PF ±5%. The recommended replacement is listed in Table 6-3. Therefore, no manual change is recommended.

Delete A14MP6.

A14U67 was originally 1826-0138 (CD8) IC COMPARATOR GP QUAD 14-DIP-P-PKG. The recommended replacement is listed in Table 6-3. Therefore, no manual change is recommended.

Under B1, delete TERMINAL-SLDR LUG 0360-0269 and SCREW 0624-0215.

Add BT1 as follows:

08672-60092 (CD0) BATTERY PACK.

0520-0165 (CD2) SCREW-MACH 2-56 .312-IN-LG 82 DEG.

08672-00011 (CD7) CLAMP-BATTERY.

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**MANUAL CHANGES**

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**CHANGE C (cont'd)**

## Table 6-3 (cont'd):

08970-60159 (CD1) HOLDER-BATTERY.

Change FL2-18 TO 9135-0099 (CD3) FILTER-LOW PASS SOLDER-TERMS.

Change J9 as follows:

Part Number to 1250-0018.

Delete WASHER-LK 2190-0068.

Delete NUT-HEX 2050-0005.

Add 5040-0345 (CD7) (QTY2) CONNECTOR-INSULATOR (MFR Code 28480) MFR Part Number 5040-0345.

Add 0360-1190 (CD5) TERMINAL-SLDR LUG PL-MTG FOR-#3/8 IN .377-IN-ID (MFR Code 28480) MFR Part Number 0360-1190.

Add 2190-0016 (CD3) WASHER-LK INTL T 3/8 IN .377-IN-ID (MFR Code 28480) MFR Part Number 2190-0016.

Add 2950-0001 (CD8) NUT-HEX-DEL-CHAM 3/8-32-THD .094-IN-THK (MFR Code 00000) ORDER BY DESCRIPTION.

Change MP1 to 08903-20024.

Under MP71:

Change Part Number to 0515-0224.

Add 0380-0003 (CD9) (QTY4) SPACER-RND .125 IN-LG .18 IN ID (MFR Code 00000) ORDER BY DESCRIPTION.

Change the first entry under P4 to 1251-4492 (CD6) CONNECTOR 6-PIN F POST TYPE (TO A13J4).

## Service Sheet 1 (schematic):

Change the value of R36 to 292.4 $\Omega$ .

Change the value of R38 to 17.61 $\Omega$ .

Remove the asterisk (\*) from R39.

Change the value of R40 to 292.4 $\Omega$ .

Change the name of the circuit comprising R36, R38 and R40 to "3 dB Pad."

## Service Sheet 2 (schematic):

Change the value of C6 to 1.0 pF.

## Service Sheet 6 (schematic):

Replace schematic 6 with the attached Figure 7-6 schematic.

## Service Sheet 7 (schematic):

Change the part number of the A13 Driver Assembly (at top left of the schematic) to 08970-60006.

Change the value of R11 to 20 kOhms.

Reverse pins 1 and 3 on R11; pin 3 now connects to R12.

Delete R66\*. Pin 6 of U32 now connects directly to R11 pin 1.

## Service Sheet 13 (schematic):

Add BT1 and connect the positive side of the battery to wire 912; connect the negative side of the battery to chassis ground via wire 0.

## Service Sheet 16 (schematic):

Replace schematic 16 with the attached Figure 7-7 schematic.

## Service Sheet 17 (schematic):

Change the part number of the A13 Driver Assembly (top left of the schematic) to 08970-60006.

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**MANUAL CHANGES**


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**CHANGE C (cont'd)**

Service Sheet 17 (schematic) (cont'd):

Change the value of C47 to 15 pF.

Delete R67. Pin 10 of U39B is now connected directly to +5V(F1).

Delete R68. Pin 15 of U39A is now connected directly to +5V(F1).

Delete W5. Pin 2 of U24 is now connected directly to the junction of U23 pin3 and C52.

Service Sheet 19 (schematic):

Change the value of A12R5 to 6.8Ω.

Delete green-yellow wire (54) from B1 to ground.

**CHANGE D**

Table 6-3:

A1J2 was originally 1251-5395 (CD0) CONNECTOR 5-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

Add A1TP1 and A1TP2 as 1251-0600 (CD0) (QTY 13) CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ (MFR Code 28480) MFR Part Number 1251-0600.

A2J1 was originally 1251-6855 (CD9) (QTY1) CONNECTOR 8-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

A2U4 and A2U5 were originally 1820-2111 (CD9) (QTY3) IC DRVR TTL INV (MFR Code 01295) MFR Part Number SN75468N. The part listed in Table 6-3 is the recommended replacement.

Therefore, no manual change is recommended.

A6R6, A6R8, A6R9, A6R12, A6R13, and A6R16 were originally 0698-7205 (CD6) RESISTOR 51.1 1% .05W F TC=0±100. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

A6R18, A6R20, A6R22, A6R24, A6R25, and A6R26 were originally 0698-7207 (CD2) RESISTOR 61.9 1% .05W F TC=0±100. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

Change A6R39 (and delete asterisk (\*)) to 0757-0470 RESISTOR 162K 1% .125W F TC=0 ±100.

A9J2 was originally 1251-6729 CONNECTOR 12-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

A9J3 was originally 1251-6608 CONNECTOR 16-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

Change A9Q3 and A9Q4 to 1884-0012.

Under A9Q4, delete HEAT SINK 1205-0073.

A13J1 was originally 1251-4136 (CD3) CONNECTOR 6-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

A13J3 and A13J5 were originally 1251-5395 CONNECTOR 5-PIN POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

A13J4 was originally 1251-4989 (CD6) CONNECTOR 5-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

A13RT1 was originally 0839-0006 (CD5) THERMISTOR DISC 10-OHM TC=-3.8%/C-DEG. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

A14J1 and A14J4 were originally 1251-4136 CONNECTOR 6-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

A14J2 was originally 1251-4989 CONNECTOR 5-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

A14J5 was originally 1251-5414 (CD1) CONNECTOR 7-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

Change A14U42 to 1820-2111.

A17J1 was originally 1251-5395 CONNECTOR 5-PIN M POST TYPE. The part listed in Table 6-3 is the recommended replacement. Therefore, no manual change is recommended.

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**MANUAL CHANGES**

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**CHANGE D (cont'd)**

Service Sheet 1 (schematic):

Change the value of R39 to 162 kOhms.

Service Sheet 6 (schematic):

Add TP1 (MET) and TP2 (MGD) to the A1 Keyboard Assembly (TP1 is on wire 9 and TP2 is on wire 0).

**CHANGE E**

Table 6-3:

Change the second entry under A2DS1 through A2DS13 to 1200-0859 (CD4) SOCKET-IC 14-CONT  
DIP DIP-SLDR.

Change the second entry under A2DS31 through A2DS34 to 1200-1124 (CD8) SOCKET-IC 16-PIN DIP.

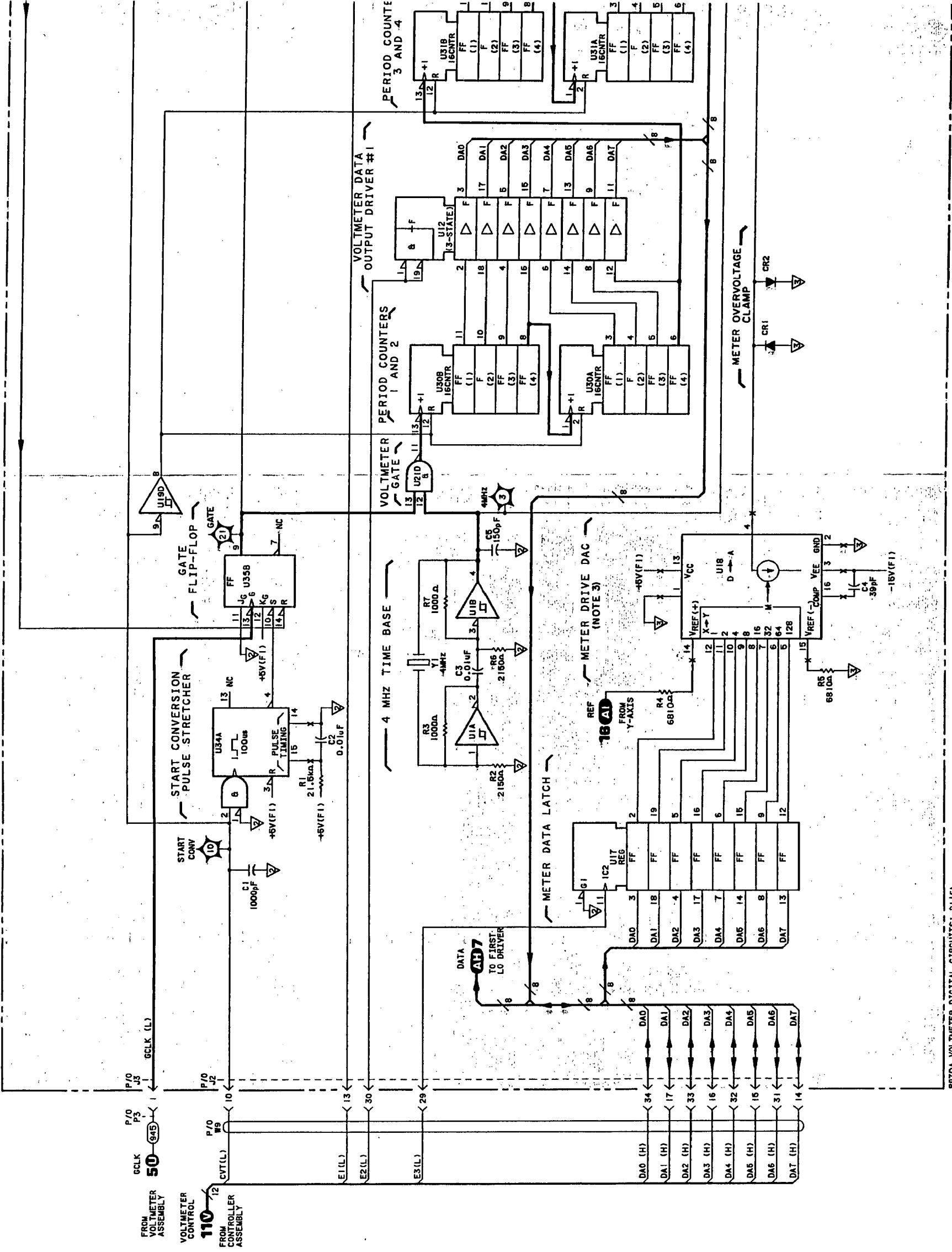
Delete C5, MP59, and VR1.

Service Sheet 5 (schematic):

Delete C5 and VR1.



P/O A13 DRIVER ASSEMBLY (0B970-60006)



# Manual Changes

## NOTES

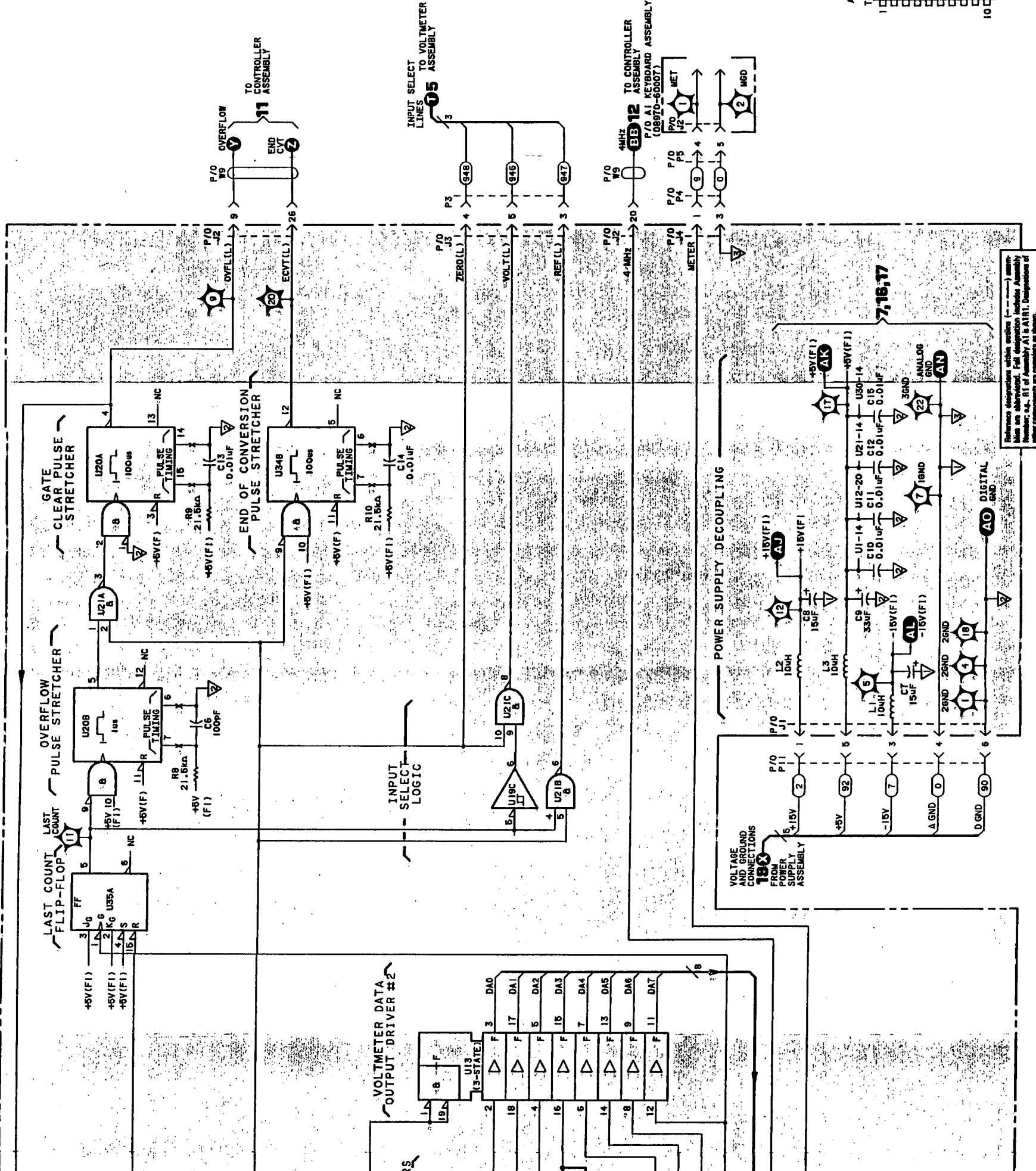
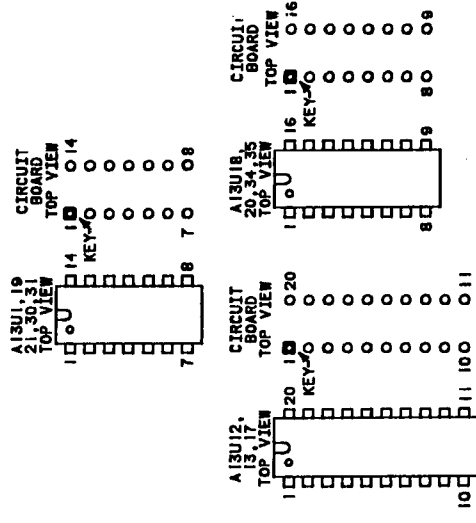
- SEE TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.
- ▽ AND ▽ DENOTE ANALOG GROUND.
- THIS IS A CONSTANT CURRENT SINK IN THE CONTEXT OF CONVENTIONAL CURRENT.

NO PREFIX	AI13
P3-5,11	C1-15
19	CRI-2
	J1-4
	L1-3
	R1-10
	T1-10
	U1-10
	U1-12,13,17
	U1-20,21
	U1-30,31
	U1-34,35
	Y1

LOGIC LEVEL
TTL
HIGH 2V
LOW 0.8V
< IS MORE NEG. THAN
> IS MORE POS. THAN
OPEN HIGH
GROUND LOW

INTEGRATED CIRCUIT PART NUMBERS	PART NUMBERS
U1,19	1820-1416
U1,13	1820-1794
U1,7	1820-1868
U1,8	1826-0188
U20,34	1820-1423
U30,31	1820-3097
U35	1820-1212

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS	PIN NUMBERS
U1,19,21	+5V(F1)-14
U12,13,17	+5V(F1)-20
U20,34,35	+5V(F1)-16
	-8

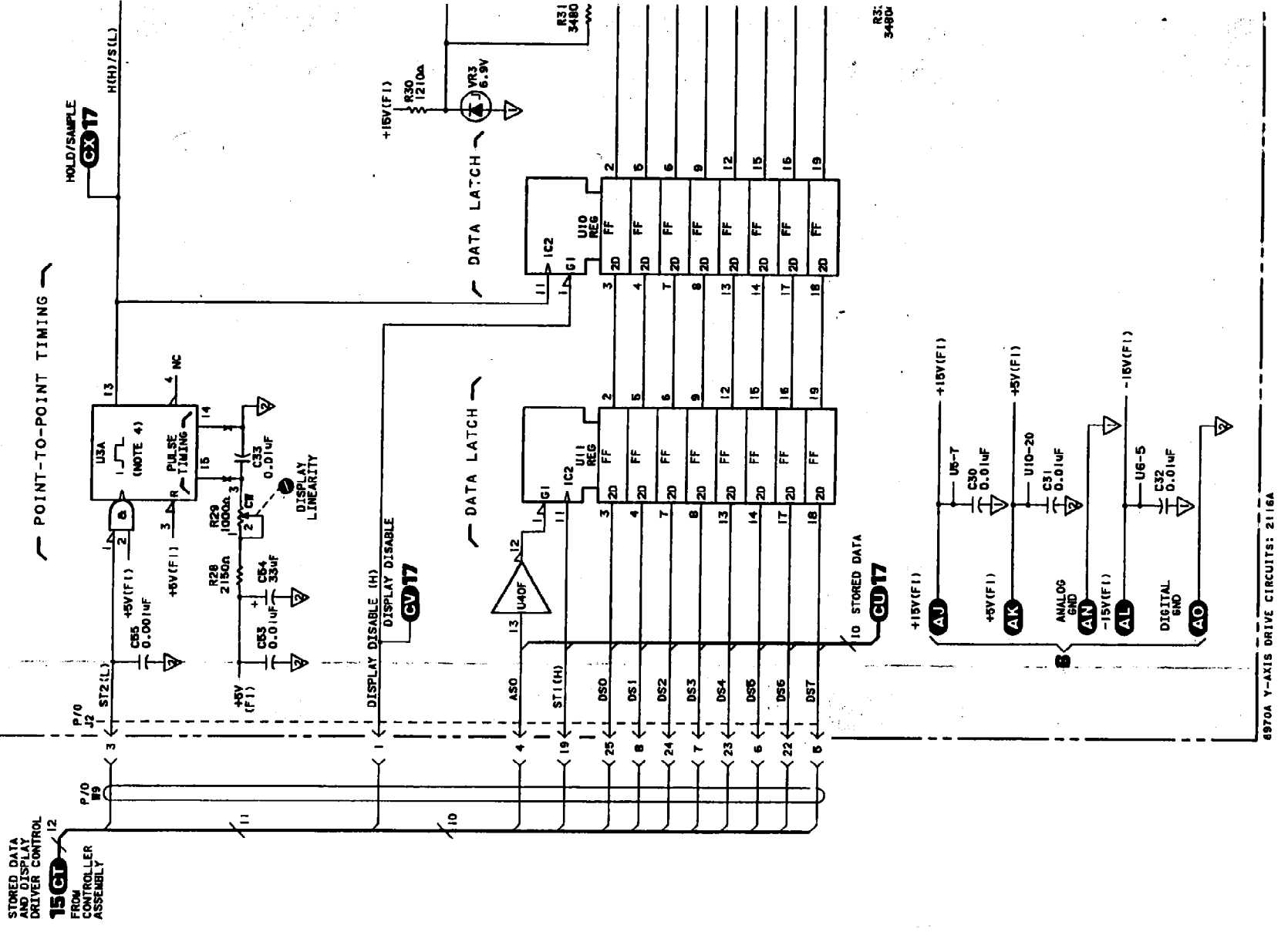


Reference designations within outlines (---) are shown as abbreviated. Full designation includes Assembly Number, e.g., R1 of Assembly A1 is A1R1. Designations of other components are complete as shown.

Figure 7-6. Schematic 6 (P/O Change C)



P/O A13 DRIVER ASSEMBLY (08970-60006)



- NOTES**
1. SEE TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.
  2.  $\nabla$  DEMOTES ANALOG GROUND.
  3.  $\nabla$  DEMOTES DIGITAL GROUND.
  4.  $\nabla$  IS A CONSTANT CURRENT SINK IN THE CONTEXT OF CONVENTIONAL CURRENT.
  5. A13USA PULSE TIMING IS ADJUSTABLE FROM -9us TO -15us. REFER TO SECTION V.

REFERENCE DESIGNATIONS

NO PREFIX	A13
J6	C30-39 83-85
W9	J21 38 43,64
	T22 6 16
	U3 6-11,40
	VR3,5

NOT ASSIGNED: R39-42,U4,VR4

LOGIC LEVEL

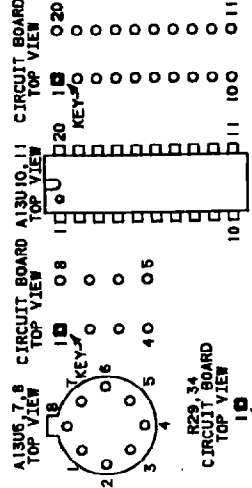
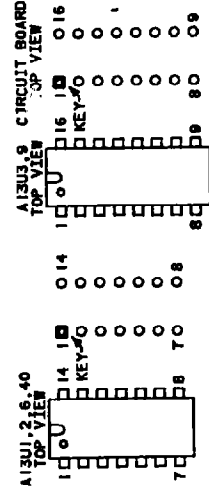
TTL
HIGH >2V
LOW <0.8V
< IS MORE NEG. THAN >
> IS MORE POS. THAN <
OPEN HIGH
GROUND LOW

INTEGRATED CIRCUIT PART NUMBERS

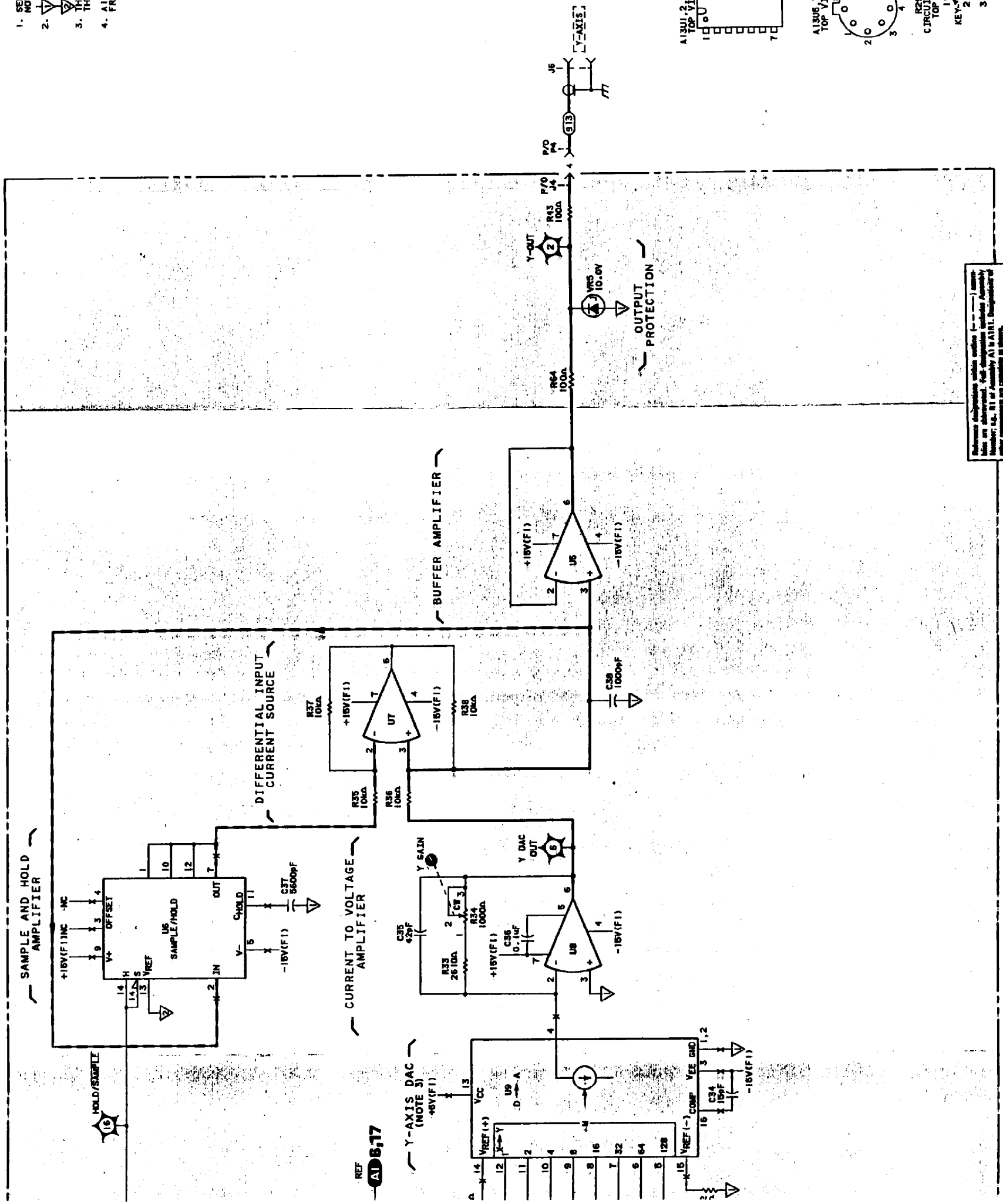
REFERENCE DESIGNATIONS	PART NUMBERS
U3	1820-1423
U3 T, 6	1826-0777
U9	1826-0188
U10, 11	1820-1888
U40	1820-1199

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATIONS	V PIN NUMBERS
U3	+8V(F1)-16
U10, 11	+8V(F1)-20
U40	+8V(F1)-14



**16**  
P/O A13



Reference designations within parentheses ( ) conform to the 1975 edition of the IEC Standard. All other designations conform to the 1975 edition of the IEC Standard. All other designations are those of the manufacturer.

Figure 7-7. Schematic 16 (P/O Change C)  
7-15/7-16

## 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 to begin troubleshooting. Refer to Power-up Checks at the end of this section for a description of the displayed errors.

#### 8-5. Operator Errors

Apparent failures often result from operator errors and may take many forms. Refer to Error Message and Recovery, Section III, and the Pullout Card 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. 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. 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 BD4, 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 1-19, 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.

### 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, troubleshooting information, and internal views.

### 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 backdating changes and their related serial number prefixes. The manual changes are contained in Section VII.

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

Production changes to the instrument made after the publication date of this manual are indicated

## MANUAL UPDATING (Manual Changes Supplement) (cont'd)

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.

Keep this manual up to date by periodically requesting the latest supplement from your Hewlett-Packard office.

### 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 outlets 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.*

#### 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.

### After Service Safety Checks (cont'd)

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 1-3, 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 readout 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:

**80-99: Initialize Special Functions.** This consists of a single Special Function that initializes selected other Special Functions. This Special Function is similar to pressing the front panel PRESET key, except that default conditions set by PRESET are not set. Refer to Special Functions in the Detailed Operating Instructions of Section III for more information on this Special Function.

**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 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.

**General (cont'd)**

**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 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.

**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



**Service Special Functions (cont'd)**

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.

**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 for approximately one second.

### Service Special Functions (cont'd)

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. The decimal points then remain illuminated while the analog meter is stepped through its range in five steps. Finally, the rear panel outputs cause the HP logo and the 8970A 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.

**95.6 (ND)** This function sets the Spot and all Table ENR values to 15.20 dB. It also sets the Noise Source Identifier Number (Special Function 5.5) to 00000.

**99.9 (SD)** This function causes the software date to be displayed in the form YMMDD. Y=last digit of the year; MM=the number of the month; DD=the number of the day of the month.

### 8-19. POWER-UP CHECKS

When the Noise Figure Meter is first turned on, or when the internal Reset switch (A14S1) is pressed, the instrument performs a series of operational checks. If a check is failed, an error code is displayed on the front panel. The operation of the Noise Figure Meter is then halted, until the error is cleared.

- 1. CMOS RAM Stack Check.** The microprocessor writes to, then reads from, that portion of the CMOS RAM that is used for controller stack operations (hexadecimal addresses 0C00 through 0CFF). The controller performs this check twice, with a different pattern each time, so that each memory location is modified to both possible states. The stack is located in A14U20 and A14U25. E65 is displayed on the front panel if U20 fails this check, and E66 is displayed if U25 fails this check.
- 2. Front Panel Indicator Check.** All of the front panel display segments and annunciators are illuminated. This allows a visual check to ensure that all of the indicators are operating. The indicators remain lit until a different panel indication is needed (such as an error display), or until the Power-Up Checks are complete.
- 3. NMOS RAM Check.** The remainder of the NMOS RAM is checked using the same method that was used for the stack check described above. The errors generated by this check, and the reference designators of the corresponding failed RAM, are shown below in Table 8-1. Only the error that corresponds to the first detected failure will be displayed.

Table 8-1. NMOS RAM Errors

Error Code	RAM Ref. Desig.
E69	A14U19
E71	A14U21
E72	A14U22
E73	A14U23
E74	A14U24
E76	A14U26

- 4. CMOS RAM Check.** The information stored in the continuous memory (CMOS RAM) is transferred into the NMOS memory that was tested in check 3 above. The rest of the CMOS RAM is then checked, using the same method that was used for the CMOS RAM stack check. If A14U20 fails this check, E70 is displayed. If A14U25 fails, E75 is displayed. After this check is complete, the original information is restored into the continuous memory.
- 5. ROM Check.** Once the stack is verified, an eight bit checksum is computed by reading all of the data stored in each ROM. The com-

**POWER-UP CHECKS (cont'd)**

puted checksum is compared to the preprogrammed checksum that is stored in each ROM. In addition to the checksum byte, a second byte is also stored in each ROM. The second byte indicates the proper address location of that ROM in the Noise Figure Meter memory. This byte is also checked against the address at which the ROM resides.

If any of the ROMs fail either portion of the check, an error that corresponds to that ROM is displayed. Since only one error can be displayed at a time, the error displayed corresponds to the first ROM that fails. The errors displayed, and the corresponding ROMs and their reference designations, are listed below in Table 8-2. (A14U14 is not currently loaded, but is reserved for future use.)

**Table 8-2. ROM Errors**

Error Code	Failed ROM No.	ROM Ref. Desig.
E51	ROM 1	A14U1
E52	ROM 2	A14U2
E53	ROM 3	A14U3
E54	ROM 4	A14U4
E55	ROM 5	A14U5
E56	ROM 6	A14U6
E57	ROM 7	A14U7
E58	ROM 8	A14U8
E59	ROM 9	A14U9
E60	ROM 10	A14U10
E61	ROM 11	A14U11
E62	ROM 12	A14U12
E63	ROM 13	A14U13
E64	ROM 14	A14U14*

\*E64, ROM 14, A14U14 are reserved for future use.

6. **Continuous Memory Data Check.** The information stored in the continuous memory (CMOS RAM) is checked by means of a checksum. Then, the contents of specific data locations are checked against bit patterns known to have been stored there. If the data fails either of these checks, E80 is displayed. Refer to Service-Related Errors for additional information about E80.
7. **Scope/Plotter RAM Check.** The Noise Figure Meter uses NMOS RAM to store the measurement results. The results are output to an oscilloscope or X-Y recorder through the rear

panel X, Y, and Z AXIS outputs. This RAM is checked by the same method used for the stack check. If A14U31 fails this check, E77 is displayed. If A14U32 fails, E78 is displayed.

**8-20. Service-Related Errors (E10—E19 and E50—E98)**

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. To ensure that improper operation is not the cause, check the input signal, then press PRESET. Pressing PRESET allows the instrument maximum autoranging flexibility.

**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.

**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 autoranging (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 autoranging to a higher attenuation level, E11 is displayed.

If a conversion is made, and either the OVFL signal is generated or the conversion indicates >1.1V, and the IF attenuators are 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 autoranging, E11 is displayed.

**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

**POWER-UP CHECKS (cont'd)**

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.

**E13 IF Attenuator Calibration Failed.** Special Function 33.0 is used to calibrate the IF attenuators on the 20 MHz IF Assembly. 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 three 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.

**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.

**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 pass-band 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.

- E51 ROM 1, A14U1, failed Power-Up Check 5.
- E52 ROM 2, A14U2, failed Power-Up Check 5.
- E53 ROM 3, A14U3, failed Power-Up Check 5.
- E54 ROM 4, A14U4, failed Power-Up Check 5.
- E55 ROM 5, A14U5, failed Power-Up Check 5.
- E56 ROM 6, A14U6, failed Power-Up Check 5.
- E57 ROM 7, A14U7, failed Power-Up Check 5.
- E58 ROM 8, A14U8, failed Power-Up Check 5.
- E59 ROM 9, A14U9, failed Power-Up Check 5.
- E60 ROM 10, A14U10, failed Power-Up Check 5.
- E61 ROM 11, A14U11, failed Power-Up Check 5.
- E62 ROM 12, A14U12, failed Power-Up Check 5.
- E63 ROM 13, A14U13, failed Power-Up Check 5.
- E64 ROM 14, A14U14, failed Power-Up Check 5. (This location and error are reserved for later use.)
- E65 RAM A14U20 stack area failed Power-Up Check 1.
- E66 RAM A14U25 stack area failed Power-Up Check 1.
- E69 RAM A14U19 failed Power-Up Check 3.
- E70 RAM A14U20 failed Power-Up Check 4.
- E71 RAM A14U21 failed Power-Up Check 3.
- E72 RAM A14U22 failed Power-Up Check 3.
- E73 RAM A14U23 failed Power-Up Check 3.
- E74 RAM A14U24 failed Power-Up Check 3.
- E75 RAM A14U25 failed Power-Up Check 4.
- E76 RAM A14U26 failed Power-Up Check 3.
- E77 RAM A14U31 failed Power-Up Check 7.
- E78 RAM A14U32 failed Power-Up Check 7.

**E80 Continuous Memory Failure.** This error indicates Power-up Check 6 failed. Data stored in the CMOS memory has in some way been erroneously modified or lost. The actual CMOS 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 execute an IF Attenuator Calibration (Special Function 33.0), before corrected measurements can be made. CMOS memories can operate for extended periods 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.

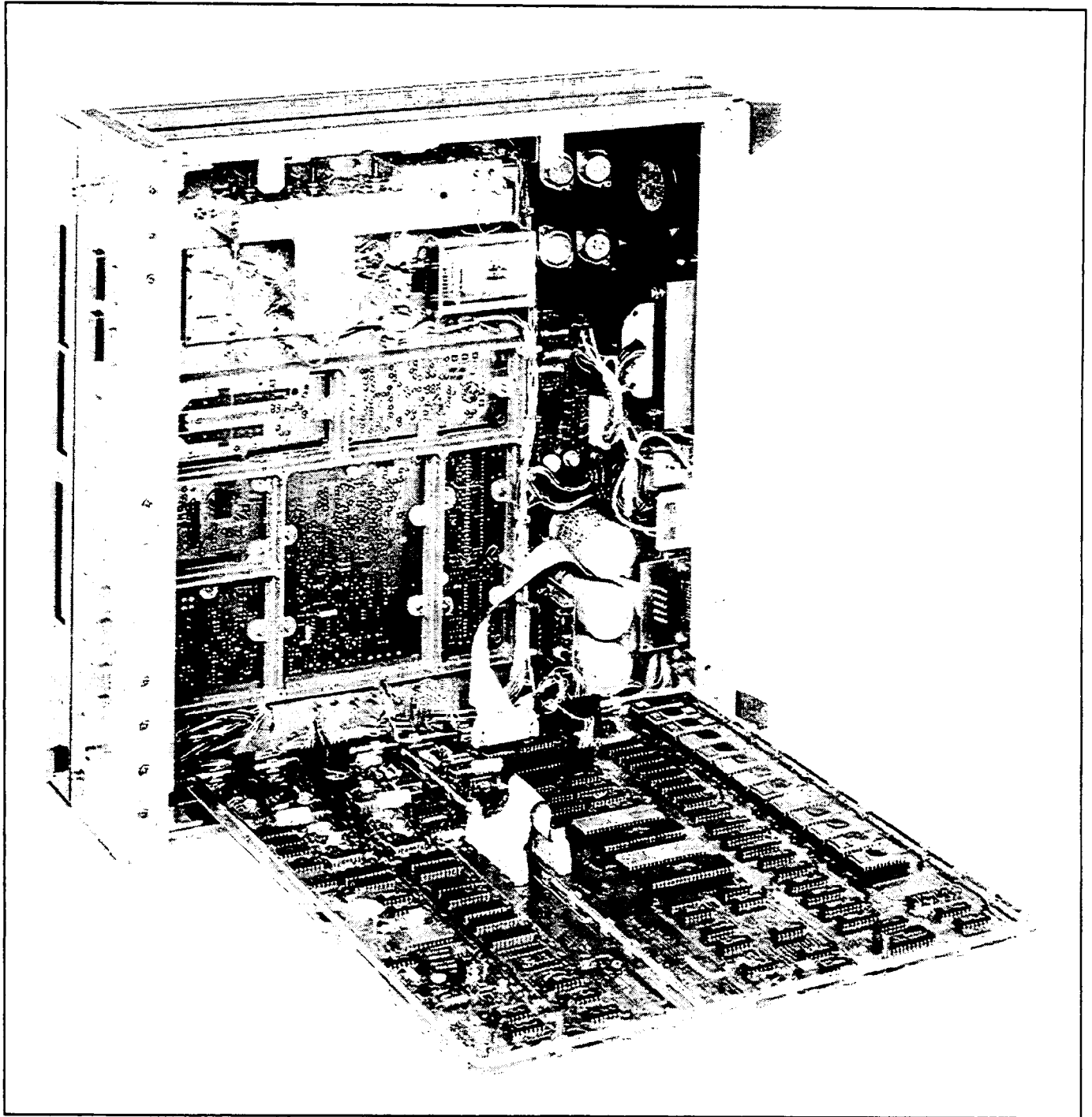


Figure 8-1. Instrument in Service Position

#### 8-21. 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.

#### 8-22. 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 the signature analysis routine by the microprocessor. The free run mode is accessed by setting Free Run Switch A14S2A, on the Controller Assembly, to the Free Run position.

In the free run mode, the processor receives an instruction that causes it to step through all addresses. Only the ROMs have access to the data bus in this mode. During free run, the address bus and the data bus can be probed. This determines that the processor 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 the ROMs to be checked, and also indicates that the data bus is good.

The second mode is entered by setting Signature Analysis Program Switch A14S2B, on the Controller Assembly, to the SA position, and then placing the LINE switch on the front panel first to OFF, and then to ON. It is recommended that the plug attached to A14J1 be removed, since this routine cycles the relays on the A6 Input Assembly. Accessing this routine causes the microprocessor to exercise nodes throughout the digital circuits on the Controller, Driver, and Display Assemblies.

After one of the signature analysis modes has been entered, the signature analyzer probe is used to check nodes in the circuit under test. The signature analyzer converts the signals at the node into a four-digit "signature," which it displays. This signature is then compared to the signature in the troubleshooting checks adjacent to the appropriate service sheet. These two signatures must be identical.

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.)

### 8-23. 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.

### 8-24. 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.

### 8-25. 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.

### 8-26. 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 M (metric). Metric screws have a shiny silver appearance and are used throughout

**Hardware (cont'd)**

the instrument. The Unified National screws have a dull steel-gray appearance. To prevent thread damage, ensure that the same type of screw and nut are used in each application.

**8-27. 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.

**8-28. 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 6-3, Replaceable Parts, in Section VI.

**8-29. 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.

**8-30. Service Aids on Printed Circuit Boards**

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

**8-31. 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.

**8-32. REPAIR****8-33. 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 Pozidriv 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.

**8-34. 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).*

**8-35. 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.*

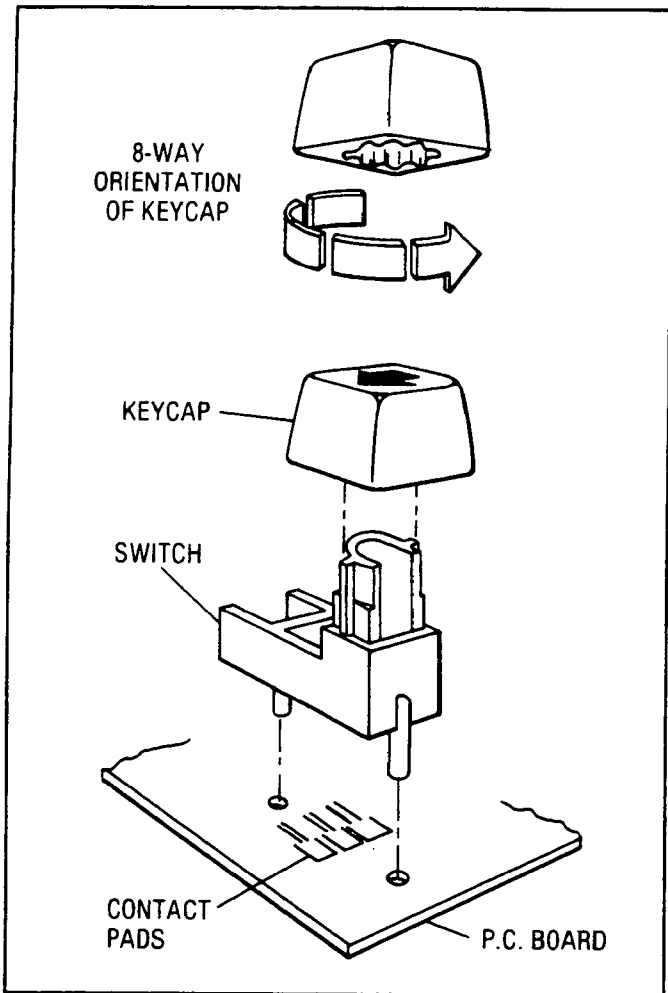


Figure 8-2. Front Panel Pushbutton Switch Assembly

**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-

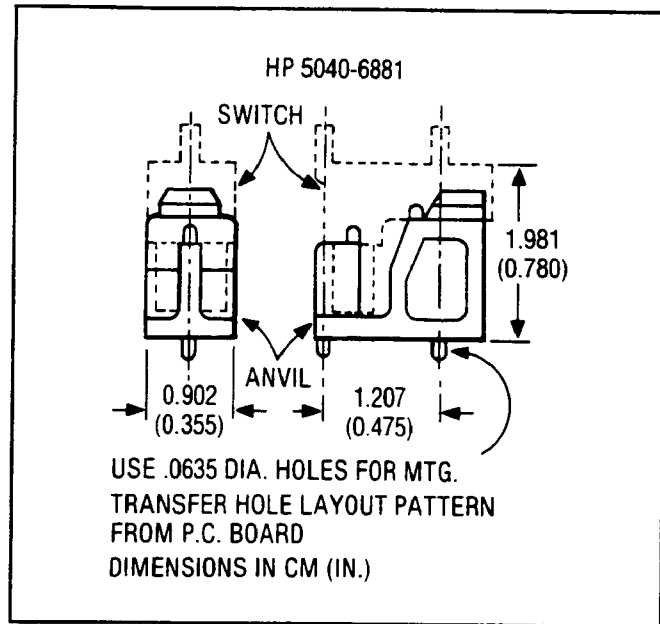


Figure 8-3. Pushbutton Switch Support Anvil

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).



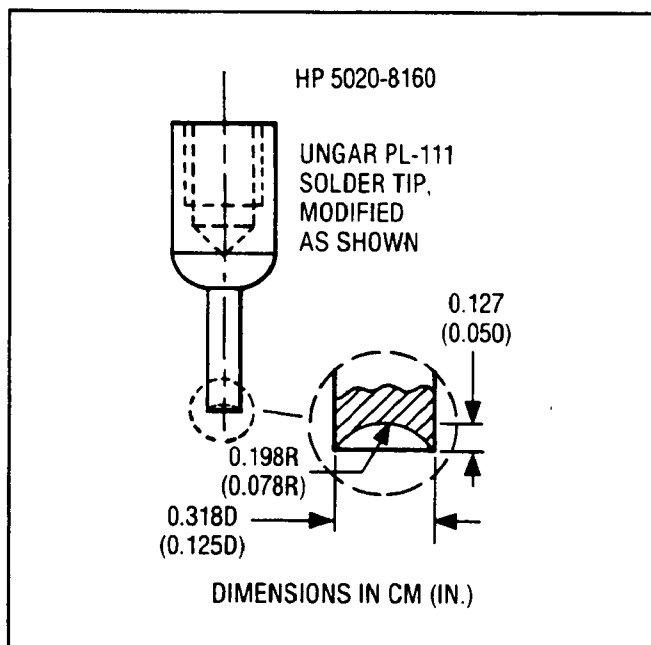


Figure 8-4. Heat Staking Tip

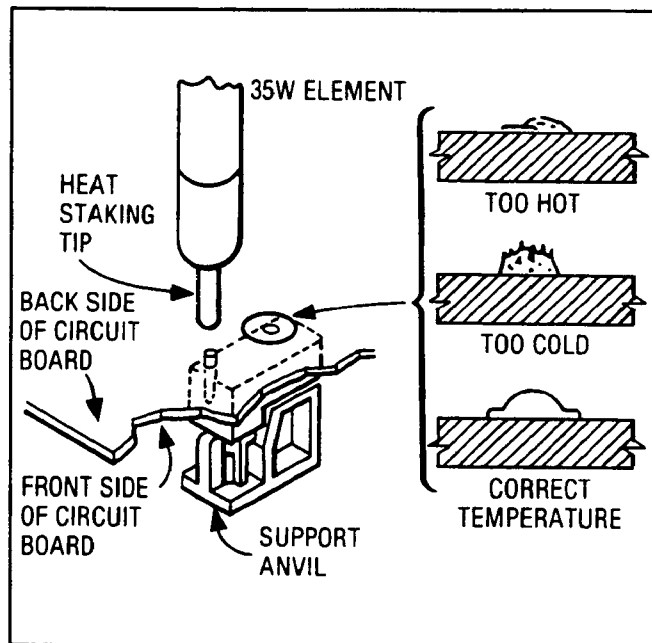


Figure 8-5. Typical Assembly for Heat Staking Operation

**8-36. 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:

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 8-3, Etched Circuit Soldering Equipment, for information on available tools for working on etched circuit boards.

**8-37. 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.

MOS, CMOS, and NMOS 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 MOS, CMOS, or NMOS 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 8-3. 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 (63/37 tin/lead), 18 gauge (SWG) 0.048 in. 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 W (HP 8690-0006); tip temperature of 850° — 900°F; and Ungar No. PL113 ⅛" chisel tip.

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

4. Once a MOS, CMOS, or NMOS 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 MOS, CMOS, or NMOS 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.

### 8-38. Non-Repairable Assemblies

Only the YIG Oscillator Assembly G1 is not repairable and must be discarded.

### 8-39. 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.

### 8-40. 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.

### 8-41. SCHEMATIC SYMBOLOGY

### 8-42. Basic Logic Symbology

The logic symbols used in this manual are based on the American National Standards Institute

### Basic Logic Symbology (cont'd)

(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. See Figure 8-6 for a summary of the 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 8-7.

**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 8-8, 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 8-9 through 8-11). 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 8-12 shows how the control block is usually represented. Figure 8-13 shows a quad D-type flip-flop with reset. This can be redrawn as shown in Figure 8-14. Note that the representation shown in Figure 8-14 can be used when the flip-flops are functionally scattered around the schematic (i.e., not used as a quad unit).

### 8-43. 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 8-15) 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 8-16). 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 8-17). 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.

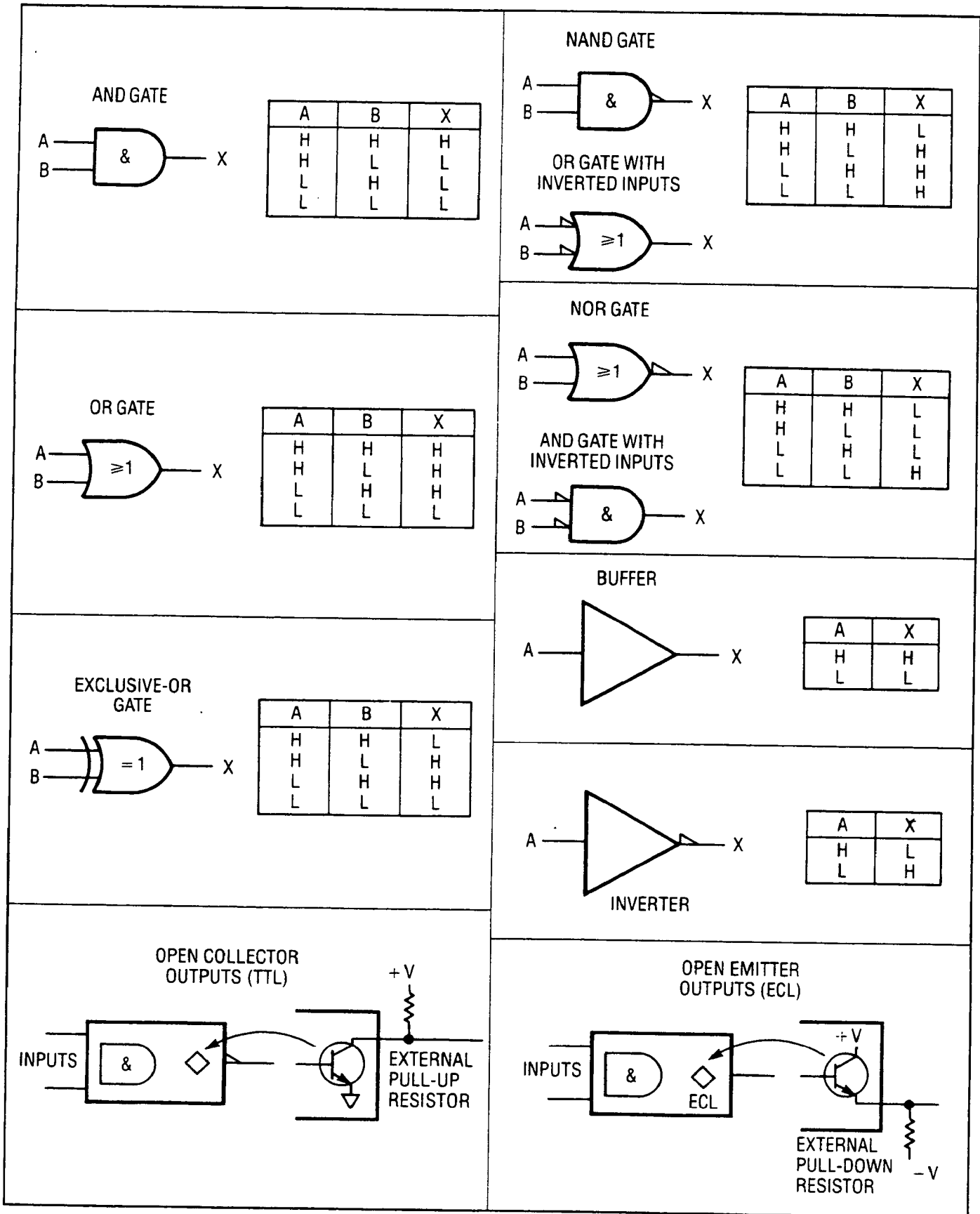


Figure 8-6. Basic Logic Symbols and Qualifiers

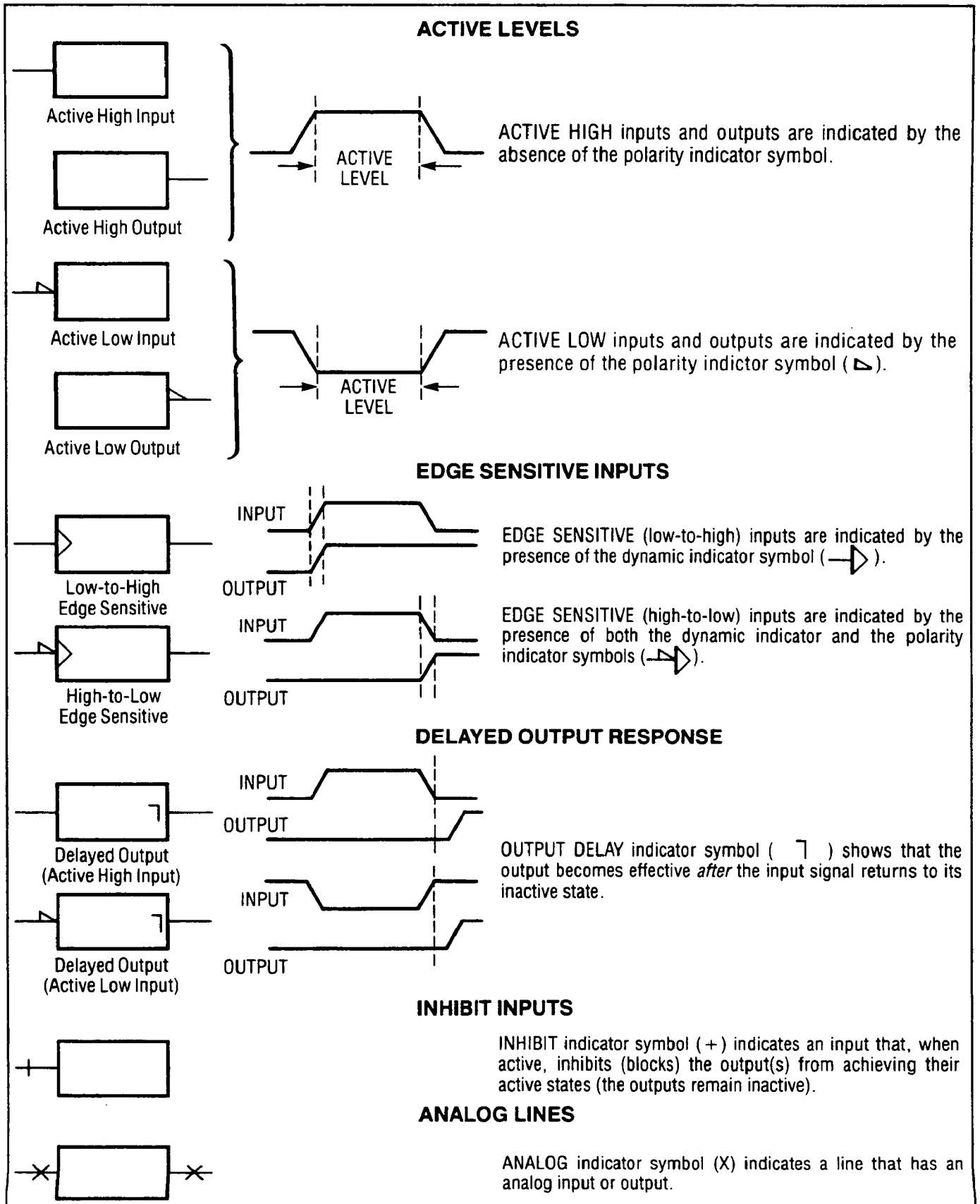


Figure 8-7. Indicator Symbols

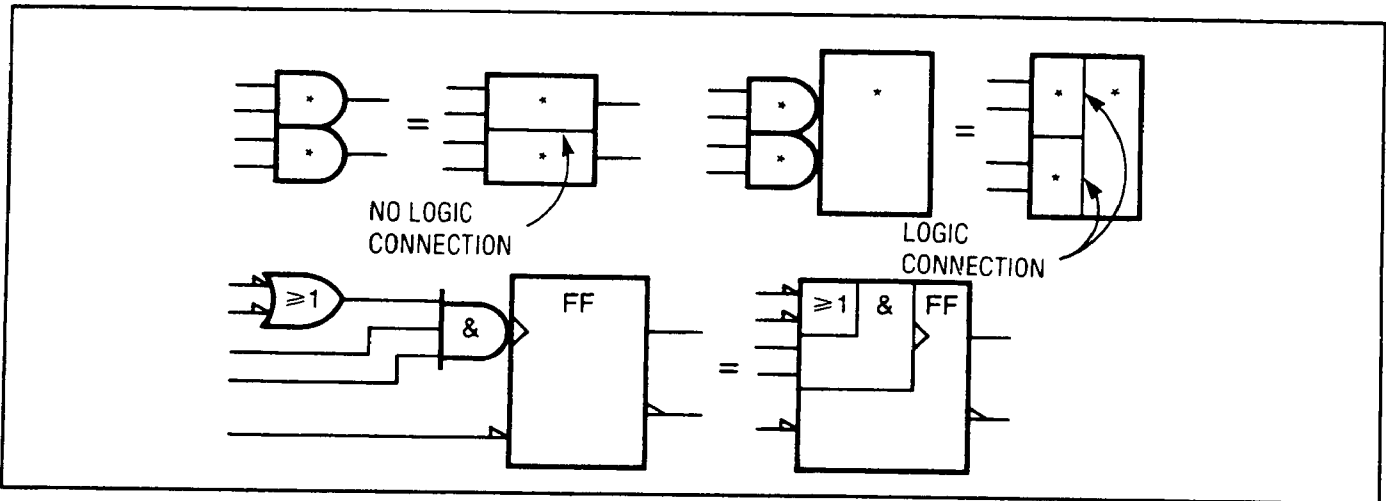


Figure 8-8. Contiguous Blocks

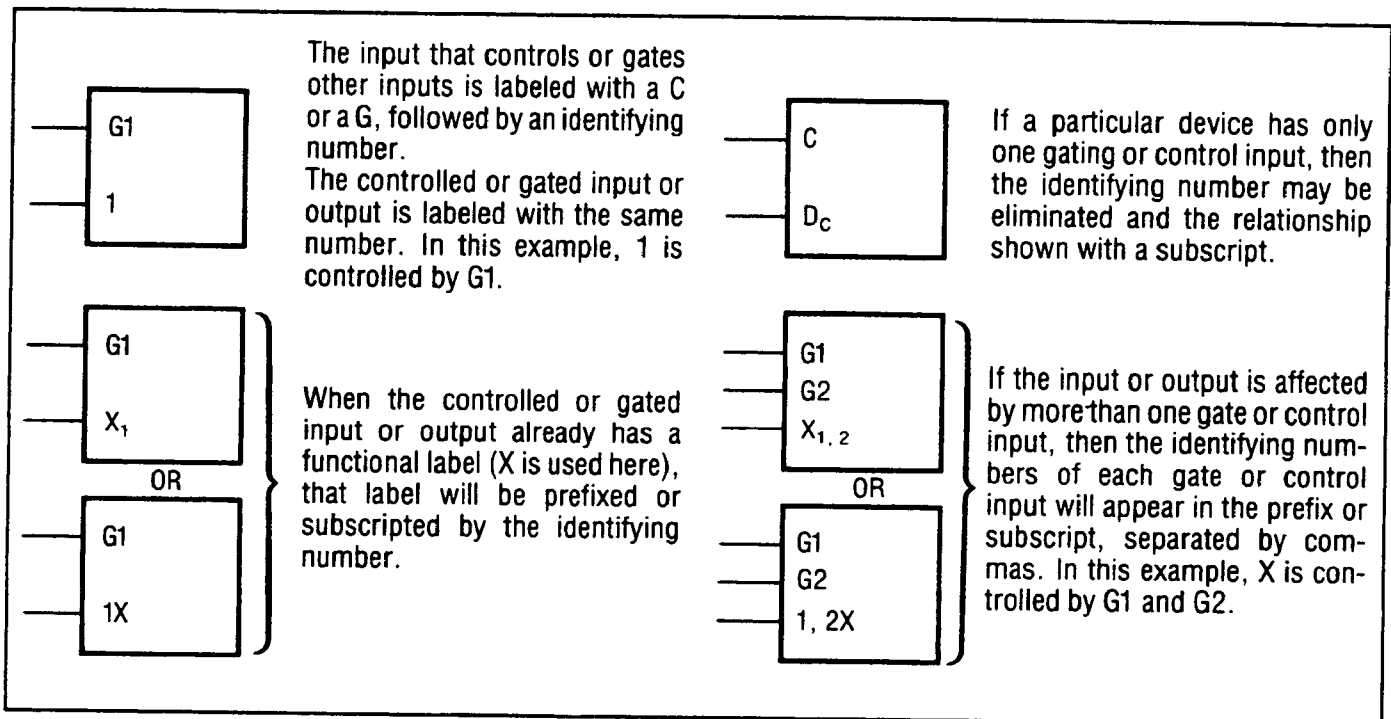


Figure 8-9. AND Dependency Notation

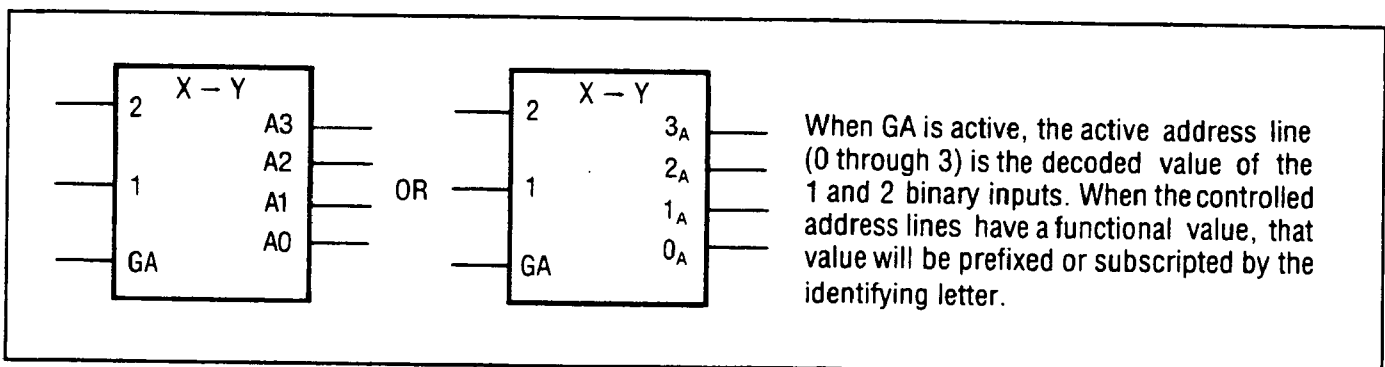


Figure 8-10. Address Dependency Notation

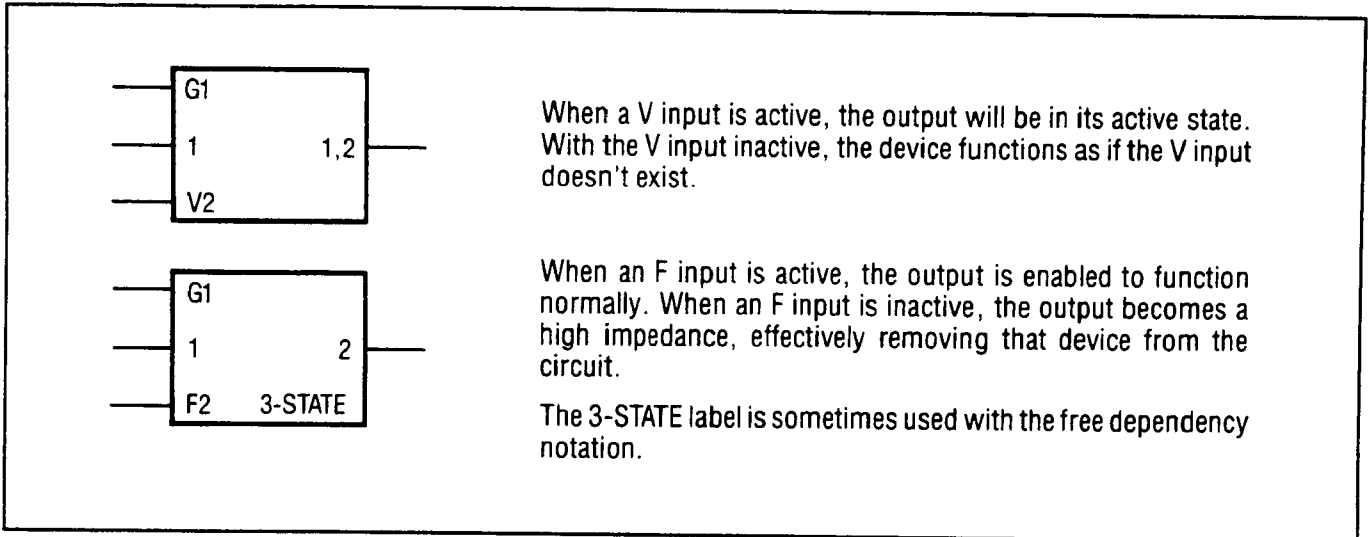


Figure 8-11. OR and Free Dependency Notation

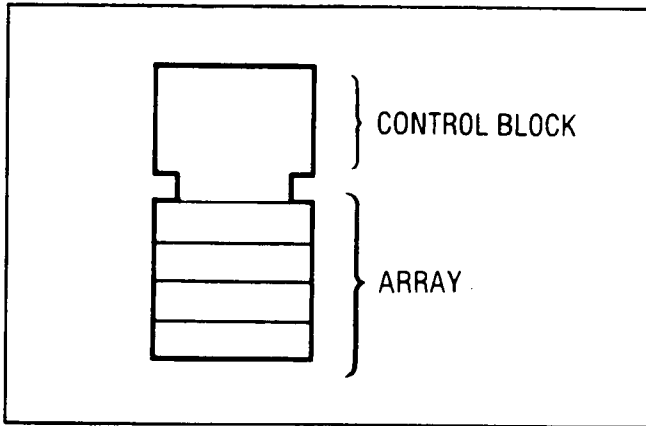


Figure 8-12. Common Control Block

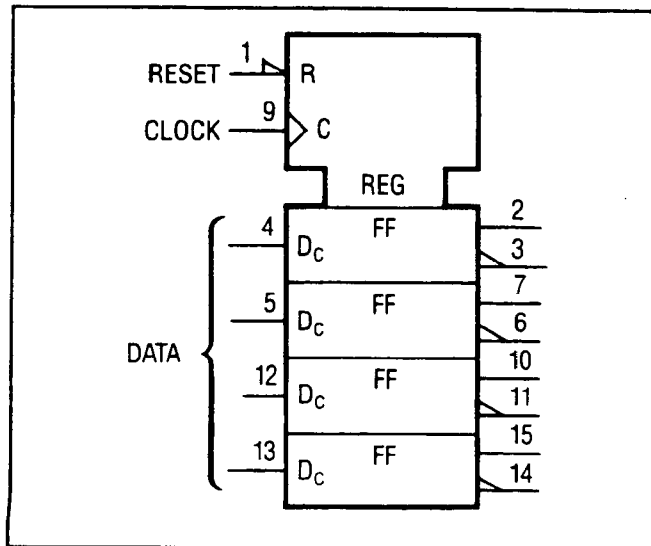


Figure 8-13. Quad D-Type Latch (Combined)

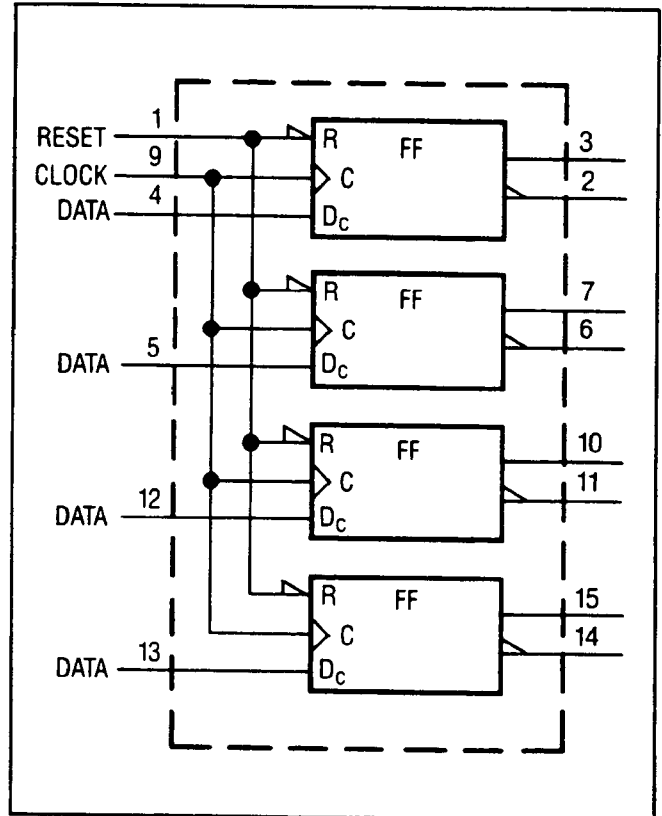


Figure 8-14. Quad D-Type Latch (Individual)

**Quad D-Type Latch.** The register control block illustrates a quad D-type latch (see Figure 8-18). 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.

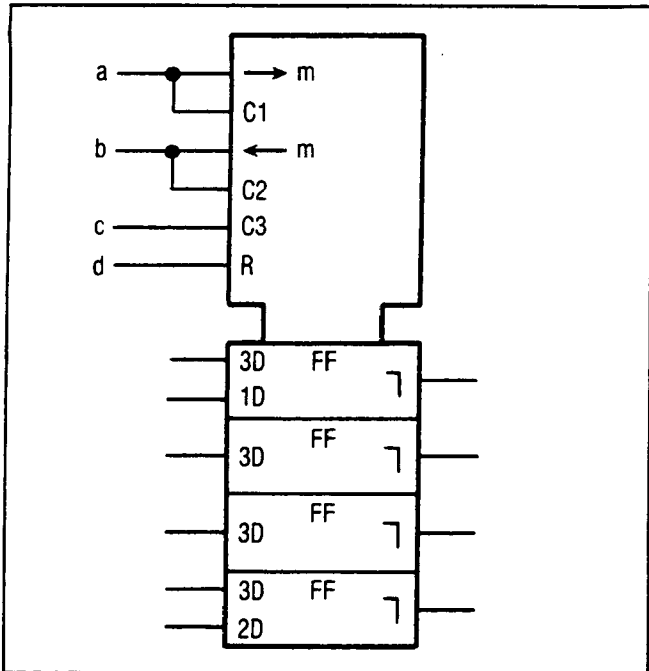


Figure 8-15. Shift Register

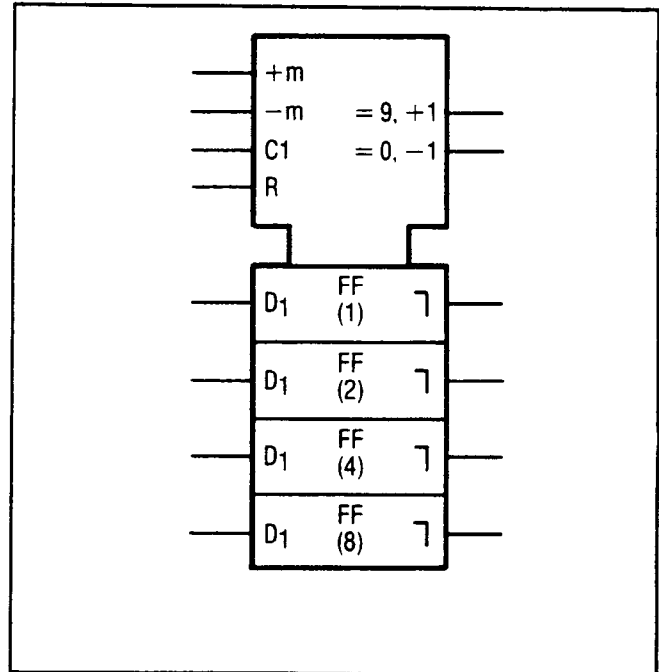


Figure 8-17. Up/Down Converter

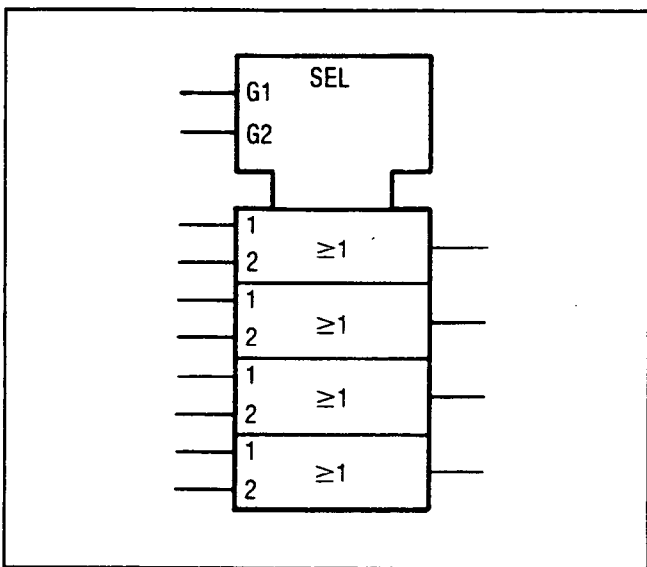


Figure 8-16. AND-OR Selector

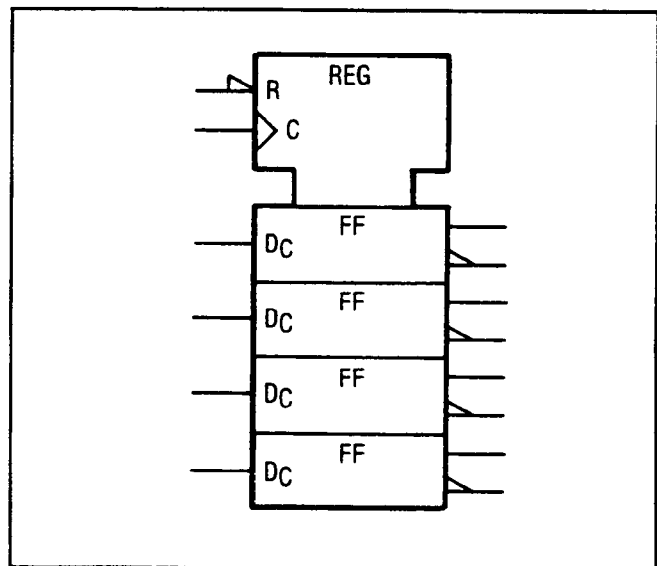


Figure 8-18. Quad D-Type Latch

**8-44. Schematic Diagram Notes**

Table 8-4, Schematic Diagram Notes preceding the foldouts, has schematic diagram information

and digital reference information summarizing the symbology used to represent the devices in the Noise Figure Meter.



Table 8-4. Schematic Diagram Notes (1 of 8)

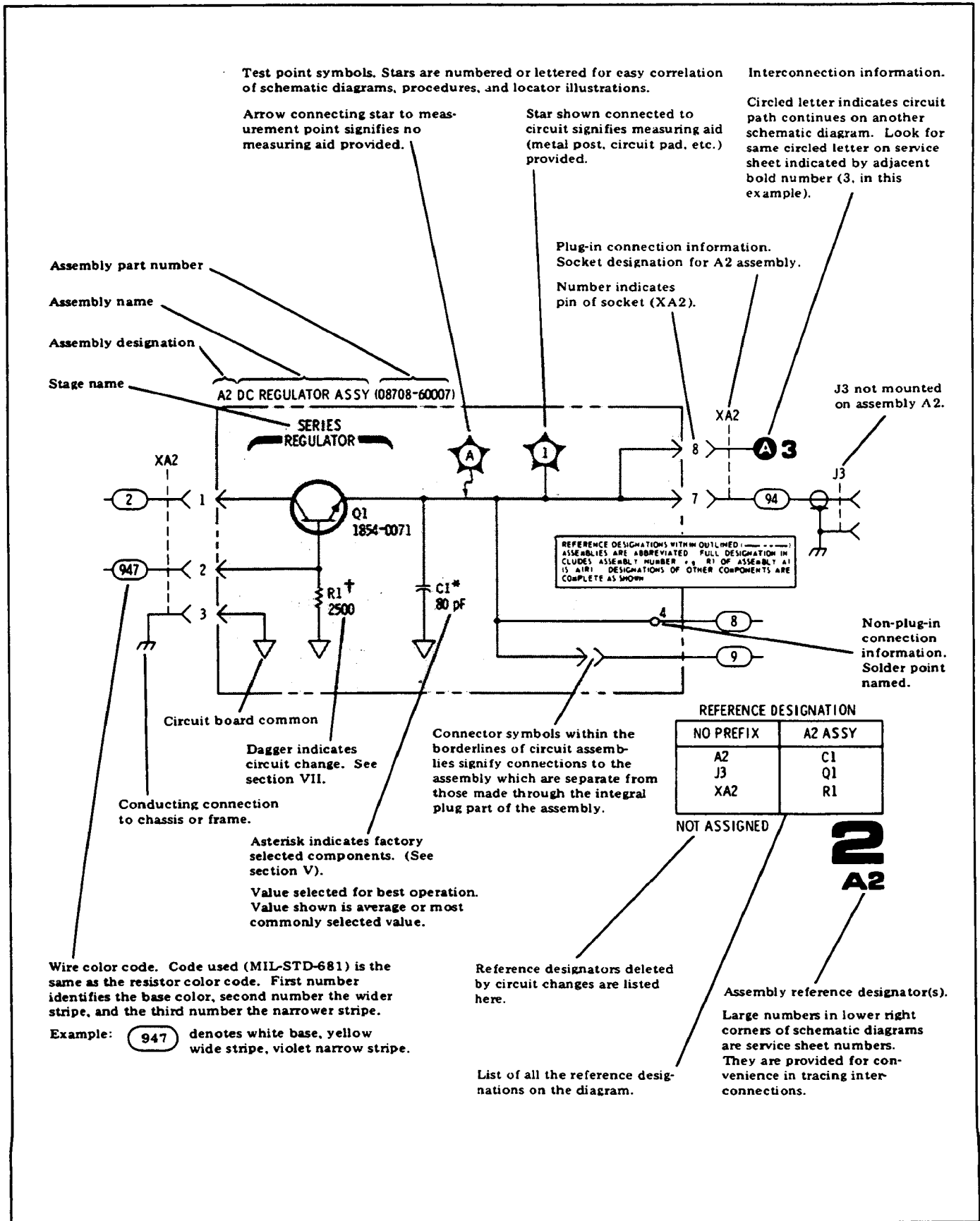


Table 8-4. Schematic Diagram Notes (2 of 8)

**SCHEMATIC DIAGRAM NOTES**


















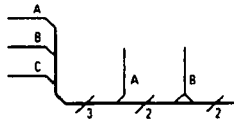
*	Asterisk denotes a factory-selected value. Value shown is typical.
†	Dagger indicates circuit change. See Section VII.
	Tool-aided adjustment.
	Manual control.
	Encloses front-panel designation.
	Encloses rear-panel designation.
	Circuit assembly borderline.
	Other assembly borderline.
	Heavy line 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., <b>AK</b> Number = Service Sheet number for off-page connection, e.g., <b>12</b>
	Number (only) = on-page connection.

Table 8-4. Schematic Diagram Notes (3 of 8)

**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.



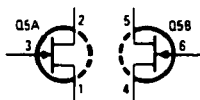
Indicates a current regulation diode.



Indicates a voltage regulation diode.



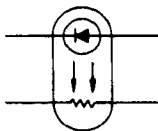
Indicates a Schottky (hot-carrier) diode.



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).

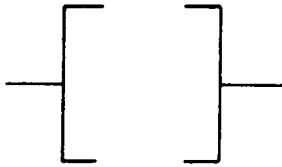


Indicates an opto-isolator of a LED and a photoresistor packaged together. The resistance of the photoresistor is a function of the current flowing through the LED.

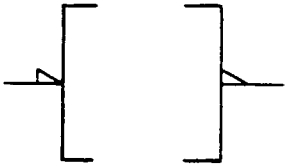
Table 8-4. Schematic Diagram Notes (4 of 8)

**DIGITAL SYMBOLOGY REFERENCE INFORMATION**

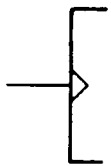
**Input and Output Indicators**



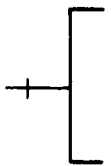
**Implied Indicator**—Absence of polarity indicator (see below) implies that the active state is a relative high voltage level. Absence of negation indicator (see below) implies that the active state is a relative high voltage level at the input or output.



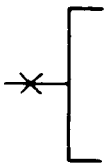
**Polarity Indicator**—The active state is a relatively low voltage level.



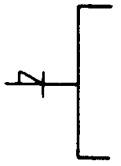
**Dynamic Indicator**—The active state is a transition from a relative low to a relative high voltage level.



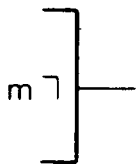
**Inhibit Input**—Input that, when active, inhibits (blocks) the active state outputs of a digital device.



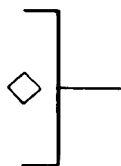
**Analog Input**—Input that is a continuous signal function (e.g., a sine wave).



**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.

Table 8-4. Schematic Diagram Notes (5 of 8)

**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.

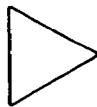
**$\geq 1$**  OR—One or more inputs being active will cause the output to be active.

**$\geq m$**  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).

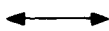
**=** Logic Identity—Output will be active only when all or none of the inputs are active (i.e., when all inputs are identical, output will be active).



**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**

Table 8-4. Schematic Diagram Notes (6 of 8)

## 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.

Table 8-4. Schematic Diagram Notes (7 of 8)

**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.*

Table 8-4. Schematic Diagram Notes (8 of 8)

**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>



## SERVICE SHEET BD1 — OVERALL BLOCK DIAGRAM

### HP 8970A 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 8970A Noise Figure Meter is a microprocessor-controlled, triple conversion receiver, which measures noise power in a 4 MHz bandwidth, tunable from 10 MHz to 1500 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 1500 MHz input RF signal to a 20 MHz IF. It also covers the First Local Oscillator (LO) drive circuits, the voltmeter 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 Sheet BD4) covers the Controller Assembly, with its microprocessor (MPU) and its related devices. The digital section includes the voltmeter control, which is the digital portion of the dual-slope analog-to-digital converter. Also covered, are the circuits driving the X-Y recorder analog outputs.

##### Analog Section (BD2)

An RF signal noise, in the range of 10 to 1500 MHz, is applied to the INPUT connector. This signal comes externally from the device under test, or internally from the IF port. The low-pass filter, following the INPUT connector, rejects frequencies greater than 1550 MHz.

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 1500 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 3550 MHz. The First LO is the only tunable LO in the instrument and gives the Noise Figure Meter its 1490 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 3550 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.

The Voltmeter Input Switches sequentially contact 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 each conversion. The output of the Voltage-to-Time Converter is a pulse with a length that is proportional to the dc voltage at the converter input. This pulse length is then measured by the Voltmeter Counters.

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 (BD4)**

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 Time base 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 PIAs 1 and 2. The Input Control Logic then grounds the input to the Voltage-to-Time Converter for zeroing.

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 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.

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 the PIAs. Information from the front panel keys and measurement data from the Voltmeter Counters are input to the MPU through the PIAs. Also, level information for the Input Power Detector and the Frequency Cal Detector enter the MPU through the PIAs.

The Stored Data 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 (i.e., at the end of a measurement cycle). The remainder of the time, this RAM is under the control of the Direct Memory Access Controller (DMA).

The DMA 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

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

detects when the end of the sweep occurs, and pulses the Z-AXIS PEN LIFT output. The PEN LIFT output is used to lift an x-y recorder pen or blank an oscilloscope beam.

**TROUBLESHOOTING****Test Equipment**

Signature Multimeter .....	HP 5005B
Noise Source .....	HP 346B

**General**

The troubleshooting checks on this service sheet are used to isolate a malfunction to one of the three major functional subsystems. Once the faulty subsystem has been isolated, refer to the appropriate subsystem service sheet (BD2 — Analog, BD3 — Front Panel, or BD4 — Digital). The comments associated with each procedure on this service sheet summarize the information known as a result of passing or failing the check. The checks must be done in the order listed.

**✓1 Line Check**

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

**Normal Indications:**

1. The fan runs indicating that the Mains wiring is operational.
2. The three green LEDs on the A9 Power Supply Assembly are lighted indicating that the +15, +5, and -15V supplies are nominally operating. The green LED on the A12 Noise Source Drive Assembly may be flashing; this is normal, and will be checked later.

**If Indication Abnormal:**

1. Check the rear panel line fuse and line voltage selector. Check Mains wiring. See Service Sheet 19.
2. Check individual regulators. See Service Sheet BD2.

**✓2 Power Up Check**

**Procedure:** Switch LINE to OFF for 5 seconds and back to ON. Observe the front panel carefully.

**Normal Indications:**

1. All front panel indicator lights for approximately 1 to 2 seconds. This indicates that the A14 Controller Assembly has reset and begun the Power-Up Checks. If the instrument passes this check, there is probably no catastrophic failure in the following circuits:
  1. Reset circuits (A14)
  2. The CMOS RAM used for stack operations (A14)
  3. The Bidirectional Buffer linking the microprocessor to the Peripheral Interface Adapters (PIA) (A14)
  4. Peripheral Interface Adapter 1 (output portion) (A14)
  5. Components of the serial link to the Display Assembly (A14 and A2)
  6. Display Assembly latch decoders (A2)
  7. Display Assembly display latches (A2)
  8. Key lights on the Keyboard Assembly (A1)
2. The left display and the INSERTION GAIN display go blank while the NOISE FIGURE display shows "—" for approximately 5 to 6 seconds. This display indicates that a frequency calibration is in progress. If the instrument initiates a frequency calibration sequence, there is probably no catastrophic failure in the following A14 circuits:
  1. Read Only Memory (ROM)
  2. Random Access Memory (RAM)
  3. Controller Data and Address Buses
  4. Battery and related circuits

**If Indication Abnormal:**

1. If error E65 or E66 is displayed, the CMOS RAM Stack Power-Up Check has failed. Suspect A14U20 or A14U25. Refer to the Power-Up Checks in the front of Section VIII and Service Sheet BD4.
2. If no indicators light and no error is displayed, check the power supply connections to the A2 Display Assembly. If good, check

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

the signatures at A14J1. Remove plug P7 at A14J1. Remove plug P10 at A14J4. Set the Signature Analysis Program Switch A14S2B to SA. Connect the signature analyzer and set its controls as listed below in Table 8-5.

**Table 8-5. Signature Analysis A14J1**

Signature Analyzer Setup		
Start:	A14TP5 (D0);	rising edge
Stop:	A14TP8 (D1);	rising edge
Clock:	A14TP11 ( $\phi$ 2);	falling edge
Ground:	A14TP19 (GND)	
A14J1 Pin No.	Signature	Signal Name
1	C6C3*	Data (L)
3	AC5U	Clock (H)
4	9279	P-Load (H)
5	C167	R(H)/W(L)
* This signature changes to 539U when plug P7 is connected.		

If these signatures are correct, the Controller outgoing interface to the A2 Display Assembly is good. The problem is in the A2 Display Assembly. Go to Service Sheet BD3.

If the signatures are not correct, the problem is in the Controller Assembly. Go to Service Sheet BD4.

3. If an E65 through E78 error is displayed, one of the RAM checks has failed. Refer to the Power-Up Checks at the front of Section VIII and Service Sheet BD4.
4. If any of errors E51 through E64 is displayed, the ROM check has failed. Refer to the Power-Up Checks at the front of Section VIII and Service Sheet BD4.

**✓ 3 Preset Check**

**Procedure:** Wait until the "----" in the NOISE FIGURE display disappears (replaced by any other indication), then press PRESET.

**Normal Indications:**

1. The left display and the INSERTION GAIN display go blank while the NOISE FIGURE display shows "----" for approximately 5

to 6 seconds. This display indicates that a frequency calibration is in progress. If these indications are correct, the following circuits are probably good:

1. The Keystroke Detector, the Key Debounce Circuit, the Row Driver, and the Column Scanner (all on the A2 Display Assembly).
2. The incoming data link from the A2 Display Assembly to the A14 Controller Assembly including PIA 1 and the associated Bidirectional Buffer.
2. The left display shows 30 MHz, the INSERTION GAIN display is blank while the NOISE FIGURE display shows either "----" or flashes a high Noise Figure reading (typically >30 dB). When the left display indicates 30 MHz, a frequency calibration has been completed. If these indications are proper, the following circuits are probably good:
  1. The LO Drive circuits (on the A13 Driver Assembly) are capable of driving the first LO back and forth around the low frequency end of its range (2050 MHz).
  2. The First LO (G1) has sufficient power to be detected through the RF signal chain.
  3. The A10 First Converter, AT1 Isolator, A11 Second Converter, A4 300 MHz IF (including the Third Converter) all have signal continuity and nominal gain.
  4. The initial gain stage and the Frequency Cal Detector on the A3 20 MHz IF Assembly are good.
  5. The Frequency Cal Sample and Hold and Comparator on the A14 Controller Assembly are good.
3. The green LED on the A12 Noise Source Drive Assembly should be flashing. The flashing LED indicates the controller Noise Source Drive Latch is operating. The +28V Turn On circuit and the +28V Regulator are probably good.

**If Indication Abnormal:**

1. If there is no response when PRESET is pressed, check the Keystroke Detector and Debounce circuits, Column Scanner, Row Driver,

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

Serial To Parallel Converter, and Data Line Transceiver on the A2 Display Assembly. Refer to Service Sheet BD3.

2. If the "----" display appears after PRESET is pressed but lasts for approximately 11 seconds followed by E18, frequency calibration has failed. Check for low First LO output power, excessive insertion loss in the signal path from the First LO to the Frequency Cal Detector, misadjustment or failure of the Frequency Cal Detector (all shown on Service Sheet BD2). If good, check the Sample and Hold, Comparator, and RF and IF Latches on the A14 Controller Assembly (shown on Service Sheet BD4).
3. If the green LED on the A12 Noise Source Drive Assembly is not on or flashing, check the +28V Regulator, the Pre-Regulator and Series Pass Transistors. Also check the Voltage Reference, and the +28V Turn On circuits on that assembly (shown on Service Sheet BD2). Check that the A14 Controller Assembly (on Service Sheet BD4) is toggling the NS ON (H) line that controls the +28V Turn On switch.

**Noise Figure Check**

**Procedure:** Perform the Instrument Noise Figure Performance Test in Section IV, and then return to this point.

**Normal Indications:**

1. Noise figure readings are within specifications and generally increase as the frequency increases. The following circuits are operational. (All but item 6 are shown on Service Sheet BD2.)
  1. The 20 dB RF Amplifier on the A6 Input Assembly.

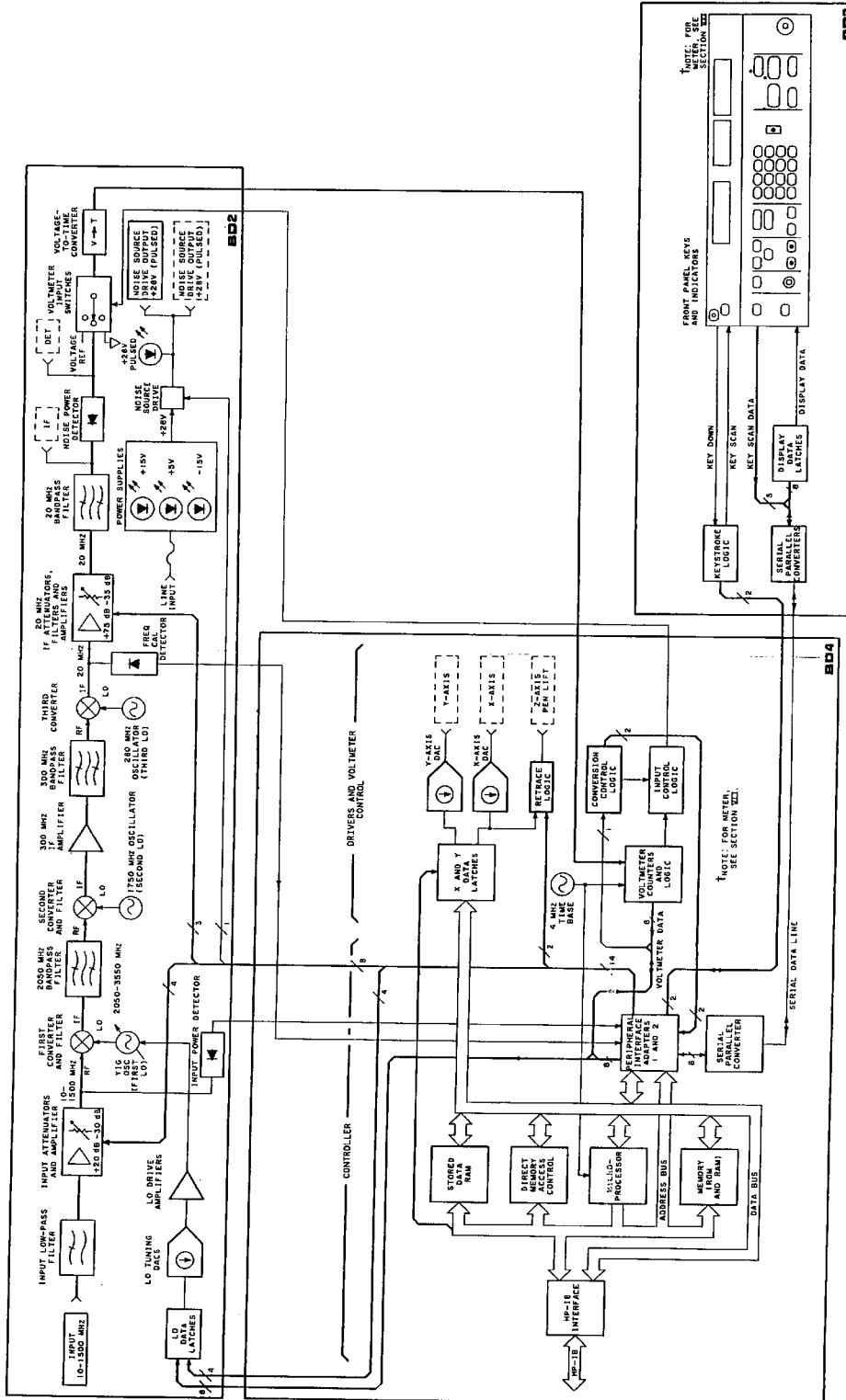
2. The Input Power Detector on the A6 Input Assembly is setting proper RF range.
3. There is continuity and nominal gain through the 0 dB attenuation path in the A3 20 MHz IF Assembly.
4. The A8 Noise Power Detector Assembly.
5. The A7 Voltmeter Assembly (voltage-to-time converter portion of the analog-to-digital conversion circuits).
6. The voltmeter control and counter circuits on the A13 Driver Assembly (shown on Service Sheet BD4).

**If Indication Abnormal:**

1. If the noise figure readings are excessively high (out of specification or if the display shows "--"), there is excessive insertion loss in the RF pathway. The loss is between the INPUT connector and the A10 First Converter Assembly, or between the Frequency Cal Detector on the A3 20 MHz IF Assembly and the A8 Noise Power Detector Assembly. The Noise Power Detector and the Voltmeter Assemblies may also be suspected.

To determine whether the instrument has set its RF gain properly, key in 61.0 SPECIAL FUNCTION. The left display should show "0100" indicating +20 dB of RF gain. If the display is not "0100," check the Input Power Detector and related circuits.

To determine whether the instrument has set its IF gain properly, key in 71.0 SPECIAL FUNCTION. The left display should show "000" indicating the 0 dB IF attenuation path is selected. If the display is not "000," check the Noise Power Detector and the Voltmeter and related circuits.



BD1

Figure 8-19. Overall Block Diagram  
8-33

## SERVICE SHEET BD2 — ANALOG SECTION BLOCK DIAGRAM

### REFERENCES

Section III, Detailed Operator 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 1500 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 3550 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 1550 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 microprocessor 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 1500 MHz) is output to the First Converter. The power is kept as high as possible, but to less 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 1500 MHz RF input noise power to a fixed 2050 MHz intermediate frequency (IF). At the input, the noise power passes through a 1550 MHz low-pass filter to the mixer. This low-pass filter reflects the first IF and LO frequencies back into the converter. 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 and an isolator to the Second Converter. The 5000 MHz low-pass filter assures only the lower conversion sideband is allowed to pass. The isolator provides impedance (50 ohm) 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.

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

#### 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.

#### 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.

#### Voltmeter Assembly (A7)

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 output of the Voltage-to-Time Converter is a pulse with a length that is proportional to the dc voltage at the converter input. This pulse length is then measured by the Voltmeter Counters.

**SERVICE SHEET BD2 (cont'd)**  
**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 3550 MHz. This gives the Noise Figure Meter its 1490 MHz input frequency range (10 to 1500 MHz), and the 2050 MHz calibration frequency. 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 LO Tune and Drive Amplifiers. The controllable drive current flows through the main coil of the YIG and provides the tuning. The First LO filter keeps noise out of the tuning signal. The dc offset amplifier provides a minimal current flow (50 mA) to keep the YIG oscillating when no other current is present. During a frequency calibration, the YIG is tuned to 2050 MHz and the tuning data that yields the highest amplitude of LO feedthrough 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**

The troubleshooting checks on this block diagram are used to isolate a malfunction to one of the seven analog 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**

Frequency Synthesizer ..... HP 8335A  
 Oscilloscope Measuring System ..... HP 1980A  
 Noise Source ..... HP 346B  
 Power Sensor ..... HP 8482A/8485A  
 Systems DVM ..... HP 3450A

**(1) General Check**

**Procedure:** Press PRESET, and connect the noise source between the DRIVE OUTPUT and RF INPUT connectors. Enter 81 SPECIAL, and read both INSERTION GAIN and NOISE FIGURE displays as one voltage indication. Note the indication, and enter 80 SPECIAL.

**Normal Indications:**

1. Displays first indicate a nominal 1V (with last digits changing rapidly).
2. Displays change to approximately 0.25 V (after pressing 80 SPECIAL).

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

**If Abnormal Indications:**

1. If the voltages displayed before and after pressing 80 SPECIAL are both at approximately 0.25 V, proceed to check 7.
2. If the voltages are not the same (0.25 V), and either not at 1V before pressing 80 SPECIAL, or not at 0.25 V after pressing 80 SPECIAL, go to Service Sheet 1.

**(2) RF Attenuator Check**

**Procedure:** Enter 81 SPECIAL, and use Table 8-6 to verify the RF Attenuator selection.

**Normal Indication:**

As shown in Table 8-6.

**If Abnormal Indication:**

1. If the voltage levels are incorrect, but ALL levels are proportionally the same to each other, and to the listed values, refer to Service Sheets 3 and 4.
2. If any voltage is off by more than ten percent from its listed value, and is not in proportion to the other values, refer to Service Sheets 1 and 2.

**(3) IF Attenuators Check**

**Procedure:** Use Table 8-7 to verify the IF Attenuator selections.

**Normal Indications:**

As shown in Table 8-7.

**If Abnormal Indications:**

1. If the voltage levels are incorrect, but ALL levels are proportionally the same to each other and to the listed values, refer to Service Sheets 1 and 2.
2. If any voltage is off by more than ten percent from its listed value, and is not in proportion to the other values, refer to Service Sheets 3 and 4.

**(4) Second Converter and 300 MHz IF Check**

**Procedure:** Remove the Noise Source, and connect the rf signal generator to the RF INPUT. Set both the generator and the instrument to 30 MHz,

and set the generator power output at +13 dBm. Connect the power meter to A10J3, enter 63.0 SPECIAL, and note the indication. Reduce the power input to -40 dBm, and note the new indication. Finally, observe the signal at jumper W12.

**Normal Indications:**

1. On the first power measurement, the level is approximately +3 dBm.
2. On the second power measurement, the level is approximately -10 dBm.
3. On jumper W12, the signal is nominally 0.4 Vp-p at 20 MHz.

**If Abnormal Indications:**

1. If the first power measurement is incorrect, proceed to Check 5.
2. If the second power measurement is incorrect, proceed to Check 6.
3. If the signal at jumper W12 is incorrect, refer to Service Sheet 2.

Table 8-6. RF Attenuation Selection

Special Function	Approximate Voltage Displayed	RF Attenuation Selected
63.0	0.16	RF Through Path
63.1	0.136	10 dB Pad #1
63.2	0.99	20 dB Input Amplifier
63.3	0.136	10 dB Pad #2
63.4	0.136	10 dB Pad #3

Table 8-7. IF Attenuation Selection

Special Function	Approximate Voltage Displayed	RF Attenuation Selected
70.1	0.99	0 dB
70.2	0.56	5 dB
70.3	0.31	10 dB
70.4	0.17	15 dB
70.5	0.098	20 dB
70.6	0.055	25 dB
70.7	0.031	30 dB
70.8	0.019	35 dB





### SERVICE SHEET BD2 (cont'd)

#### ✓5 20 MHz IF, Noise Power Detector, and Voltmeter Checks

**Procedure:** Set the signal generator to  $-37$  dBm and enter 70.1 SPECIAL. Observe the signal at the output of 20 MHz IF Assembly A3 (Cable W13). Reconnect the cable, and use the power meter to measure the level at the IF output connector.

#### Normal Indications

1. The signal at the output of the 20 MHz IF Assembly is approximately 10 Vpp at 20 MHz. A large amount of distortion is acceptable.
2. The output at the IF output connector is at a level of approximately  $-10$  dBm.

#### If Abnormal Indications

1. If the output of the 20 MHz IF Assembly is in error, refer to Service Sheet 3 and 4.
2. If the signal at the IF output is incorrect, refer to Service Sheet 4.
3. If the signals are correct, but the instrument display is in error, refer to Service Sheet 5.

#### ✓6 Input, First Converter, and Driver Checks

**Procedure:** Connect the power meter to the LO OUT connector on First Converter Assembly A10. Set the instrument to sweep from 10 MHz to 1500 MHz in 30 MHz steps. Note the indications, and then measure the output of the YIG oscillator (G1J2), if the LO of the First Converter is abnormal.

#### Normal Indications:

1. Measured power at the LO OUT connector is at a minimum of  $+7.5$  dBm across the entire band. The signal can swing above the minimum by several dB; going as high as  $+13$  dBm.

2. The output of the YIG oscillator is higher than  $+12$  dBm.

#### If Abnormal Indications:

1. If the signal at the LO OUT connector is low or missing, refer to Service Sheet 7.
2. If the output of the YIG oscillator is low or missing, refer to Service Sheet 7.
3. If both signals are correct, refer to Service Sheet 1.

#### ✓7 Power Supply and Input Assembly Checks

**Procedure:** Enter 81 SPECIAL, and measure the voltage at the Noise Source Drive Output (A12TP2). Note the indication, and enter 80 SPECIAL. Note the new indication, and connect the noise source to the instrument. Enter 81 SPECIAL, and measure the power delivered from the noise source using the power meter. (A spectrum analyzer will NOT work for this measurement.)

#### Normal Indications

1. The first voltage measurement from A12TP2 is  $+28 \pm 0.25$  Vdc.
2. The second voltage measurement is at ground.
3. The power from the noise source is  $-56 \pm 4$  dBm. This is a broadband measurement ranging from 10 MHz to 18 GHz.

#### If Abnormal Indications:

1. If either voltage is in error, refer to Service Sheet 19.
2. If the power level is in error, repair or replace the noise source after checking the noise source drive cable.

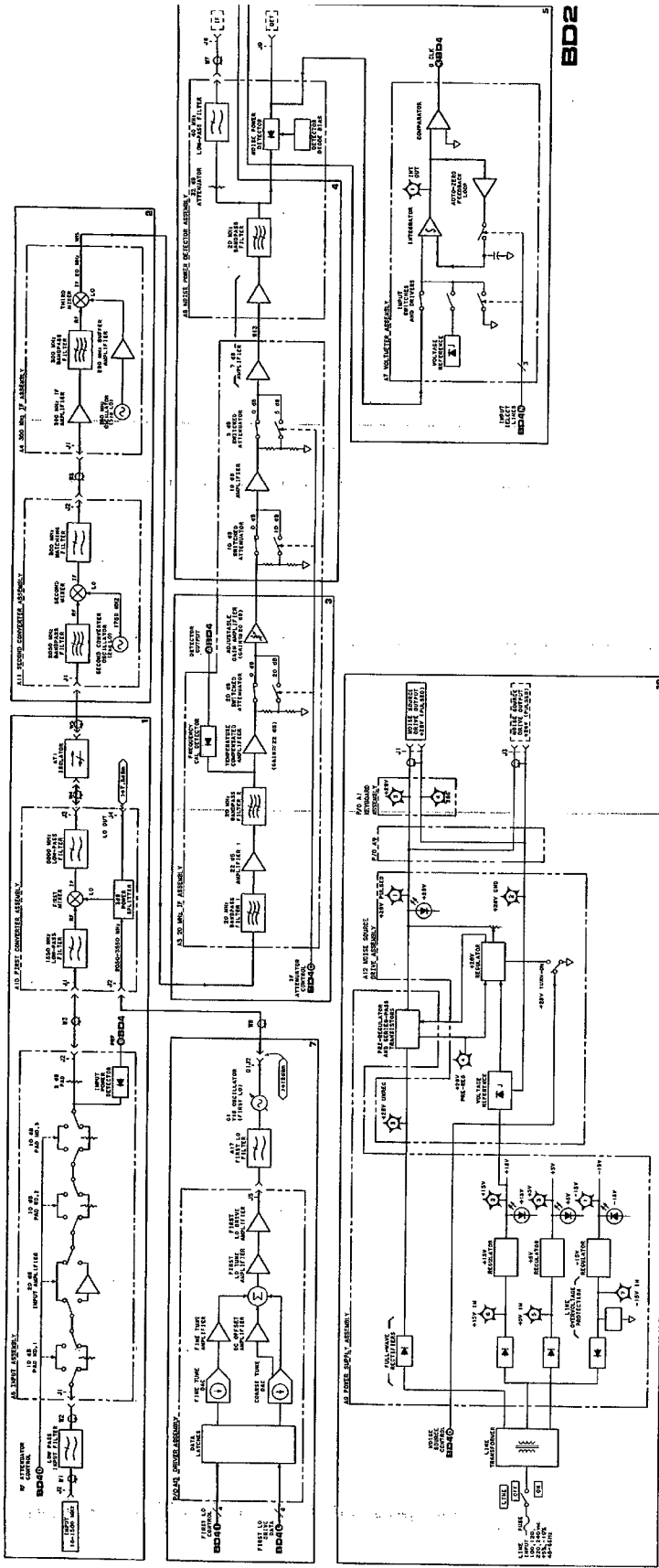


Figure 8-20. Analog Section Block Diagram  
8-35/8-36

BD2

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

### REFERENCES

Section VIII, Special Functions and Power-Up Checks

### 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

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 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 91.0 SPECIAL.

#### 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

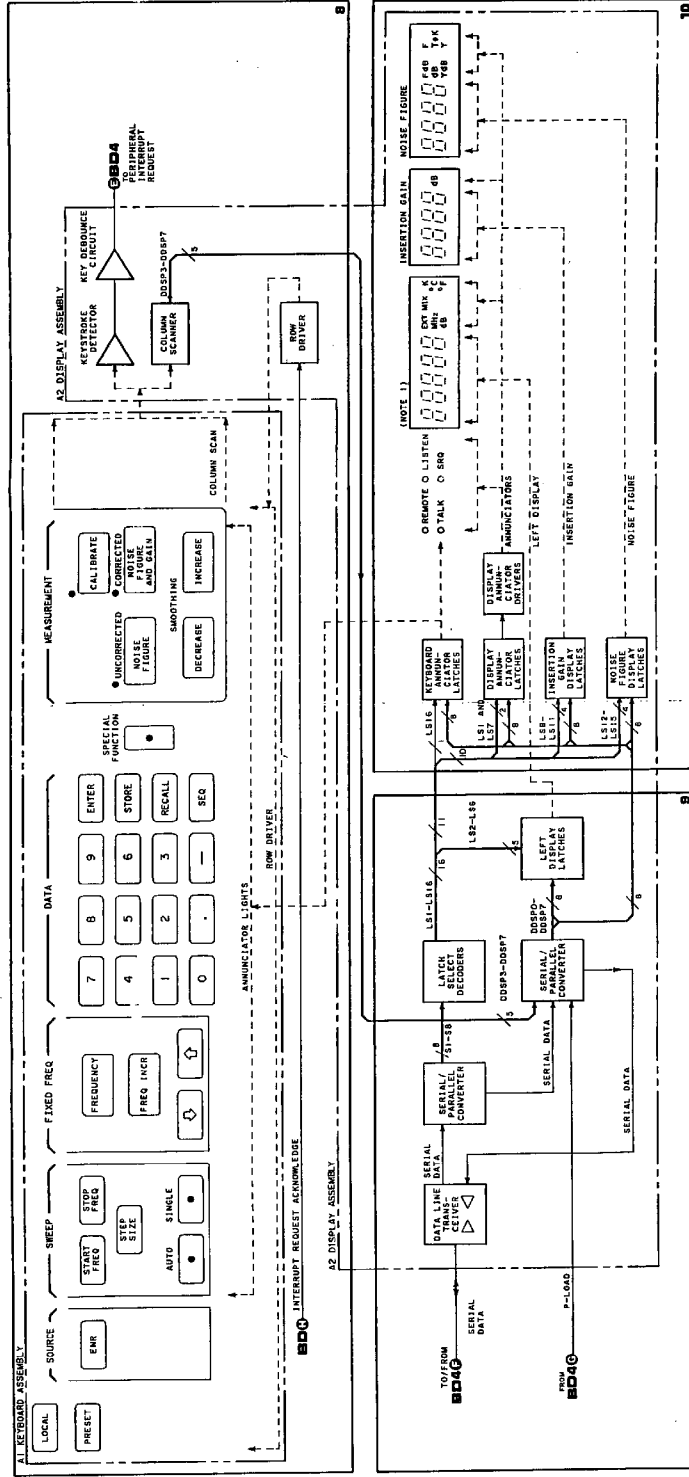
**Procedure:** Enter 90.N SPECIAL, and refer to the Service Special Functions (Prefixes 63 and 80-99) in the front of Section VIII for a description, and operating procedures, of 90.N SPECIAL.

#### Normal Indication:

As listed in the description of 90.N SPECIAL.

#### Abnormal Indication:

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



NOTES  
1. THE LEFT DISPLAY NUMERIC INDICATORS  
ARE SHOWN ON SERVICE SHEET 9.

**BD3**

Figure 8-21. Keyboard and Display Sections Block Diagram 8-37

## SERVICE SHEET BD4 — DIGITAL SECTION BLOCK DIAGRAM REFERENCES

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

### PRINCIPLES OF OPERATION

#### General

Block Diagram 4 covers the Noise Figure Meter's digital circuits. The digital circuits are contained in Controller Assembly A14 and part of Driver Assembly A13. Controller Assembly A14 is covered in detail in Service Sheets 11 through 15, and 18. Those related circuits of Driver Assembly A13 are covered in detail in Service Sheets 6, 16, and 17.

The digital circuits provide all controls, calculations, memory, and remote interfaces (to external equipment) for the Noise Figure Meter.

#### Controller

The microprocessor-based Controller provides the timing, calculation, and control for the instrument. The Microprocessor (MPU) executes instructions stored in Read Only Memory (ROM). Data travels between the MPU and other blocks of the Controller on the Data Bus.

The elements of the Controller are enabled to respond to the data of the Data Bus by being addressed on the Address Bus. Data values which must be stored, but which may change, are placed in the Random Access Memory (RAM). The MPU sends (and receives) data out of (and into) the Controller through three gateways. These are the Peripheral Interface Adapters (Service Sheet 11), the X Data (Service Sheet 17) and Y Data (Service Sheet 16) Latches, and the HP-IB Interface, Service Sheet 18.

#### Peripheral Interface Adapters 1 and 2 (Service Sheet 11)

Nearly all of the instrument control is executed by the 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 the Frequency Cal Detector also enter the MPU through the PIAs.

#### Stored Data RAM and DMA Controller (Service Sheet 15), X-Axis (Service Sheet 17) and Y-Axis (Service Sheet 16) DACs, and Retrace Logic (Service Sheet 17)

Measurement results are stored by the MPU in the Stored Data RAM. The Stored Data RAM can hold all of the Noise Figure and Insertion Gain results from one complete sweep. This RAM is accessed by the MPU only when new data is to be stored (i.e. at the end of a measurement cycle). The remainder of the time, this RAM is under the control of the Direct Memory Access controller (DMA).

The DMA sequentially steps through the address locations of the Stored Data 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

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

Converters (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 a sweep occurs, and pulses the Z-AXIS PEN LIFT output to lift an X-Y recorder pen, or blank an oscilloscope beam.

#### Hewlett-Packard Interface Bus (Service Sheet 18)

The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's implementation of the IEEE-488 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.

#### 4 MHz Timebase, Voltmeter Counters and Logic, and Conversion Logic (Service Sheet 6)

At the start of an analog-to-digital conversion, the Conversion Logic triggers the Input Control Logic. This results in the output of the Noise Power Detector being connected to the Voltage-to-Time Converter (through the Voltmeter Input Switches).

#### NOTE

*The Input Control Logic, Noise Power Detector, Voltage-to-Time Converter, Voltmeter Input Switches, and Voltage Reference are all described on Service Sheet BD2, Analog Section.*

At the same time, the 4 MHz Timebase toggles the Voltmeter Counters until a carry is generated. The carry pulse triggers the Input Control Logic to switch the Voltmeter Input Switches connecting the Voltage Reference to the Voltage-to-Time Converter.

The counters are reset and then allowed to count the timebase again, until the output of the Voltage-to-Time Converter changes state. The Input Control Logic then sets the Voltmeter Input Switches to ground the input to the Voltage-to-Time Converter for zeroing. The Voltmeter Counters and Logic then send the count data to the MPU through PIAs 1 and 2.

#### TROUBLESHOOTING

The troubleshooting checks on this block diagram are used to isolate a malfunction to one of the nine digital service sheets. The digital circuits lend themselves to easy testing using signature analysis on the block diagram level. For a detailed description of signature analysis, refer to the front of Section VIII. Each check must be completed in the order listed.

Each check has the Service Sheet listed (in parenthesis) for those circuits being tested by the respective signature analysis routine. If a single signature is different, in any way, from that which is shown, there is an error. Immediately refer to the Service Sheet.

#### Test Equipment

Signature Multimeter ..... HP 5005B  
Oscilloscope Measuring System ..... HP 1980A  
Noise Source ..... HP 346B

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

**Free Run Signatures**

These signatures represent software date 11001 (1981 Oct 1). This date can be confirmed using 99.9 SP. In the set-ups noted below, "✓" represents a rising edge (signature analyzer button out), and "∨" represents a falling edge (signature analyzer button in).

These signatures (Tables 8-8 through 8-12) are obtained when Free Run Switch A14S2A is set to the FREE RUN position. Refer to the discussion entitled Signature Analysis in the front part of Section VIII.

**Table 8-8. Signature Analysis Address Bus**

Address Bus:		Start: A14TP12, (A15), ∨	Stop: A14TP12, (A15), /
(Service Sheet 12 and all)		Clock: A14TP11, (φ2), ∨	
Node (Ref. Desig.)-pin	Signal Name	Signature	
A14U28-9	A0	5555	
U27-9	A1	CCCC	
-11	A2	7F7F	
-7	A3	5H21	
-5	A4	0AFA	
U28-17	A5	UPFH	
-3	A6	52F8	
U27-3	A7	HC89	
-17	A8	2H70	
U28-15	A9	HPP0	
U27-15	A10	1298	
U28-11	A11	HAF7	
-13	A12	3C96	
-5	A13	3827	
-7	A14	755U	

**Signature Analysis Routine Signatures**

The signature analysis routine (for Tables 8-13 through 8-21) is built into the Noise Figure Meter. It is accessed by setting the Signature Analysis Program Switch A14S2B to the SA position, and then turning the LINE switch first OFF, and then back ON. Refer to the discussion entitled Signature Analysis near the front of Section VIII.

**X-Axis, Y-Axis and Z-Axis Checks**

**Procedure:** Connect the noise source to the instrument and press PRESET. Connect the oscilloscope to the X-Axis (horizontal), Y-Axis (vertical), and Z-Axis outputs. Enter 7.1 SPECIAL, and adjust the oscilloscope for a test pattern as shown in Figure 3-9, in Section III.

**Normal Indications:**

A test pattern will be generated as shown in the figure.

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

**Abnormal Indications:**

If the test pattern is not as shown, recheck the GAIN TRACE adjustment. If the pattern is still not correct, refer to Service Sheet 16 for the Y-AXIS, Service Sheet 17 for the X-AXIS and Z-AXIS, and Service Sheet 11 for PIA 1.

**Table 8-9. Signature Analysis Data Bus and ROMs 5-14**

Data Bus and ROMs 5-14:		Start: A14TP12, (A15), ∨	Stop: A14TP12, (A15), /
(Service Sheets 12 and 14)		Clock: A14TP11, (φ2), ∨	
Node (Ref. Desig.)-pin	Signal Name	Signature	
A14U36-2	D0	0F5A	
-4	D1	76FH	
-6	D2	PUHF	
-9	D3	58FC	
-3	D4	4A65	
-5	D5	01P1	
-7	D6	F0UH	
-8	D7	7870	

**Table 8-10. Signature Analysis Data Bus and ROMs 1-4**

Data Bus and ROMs 1-4:		Start: A14TP12, (A15), ∨	Stop: A14TP12, (A15), /
(Service Sheets 12 and 14)		Clock: A14TP11, (φ2), ∨	
Node (Ref. Desig.)-pin	Signal Name	Signature	
A14U16-14	ROM3	7631	
-13	ROM2	160U	
-12	-	04UH	
-11	(NC)	CFHH	
-10	(NC)	57HH	
-9	-	96F8	
-7	SELCTR	546U	
U17-8	-	8F55	

**Hewlett-Packard Interface Buss (HP-IB) Checks**

If the remote system cannot communicate with the Noise Figure Meter, the trouble is most likely in the HP-IB circuits. Connecting a second known

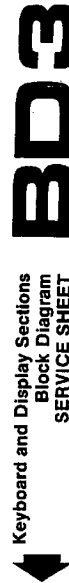
good system to the instrument will verify that the trouble is actually in the Noise Figure Meter. If the trouble persists, refer to Service Sheet 18.

**Table 8-11. Signature Analysis Chip Selects - Group 1**

Chip Selects - Group 1:		Start: A14TP12, (A15), /	Stop: A14TP12, (A15), ∨
(Service Sheet 14)		Clock: A14TP11, (φ2), ∨	
Node (Ref. Desig.)-pin	Signal Name	Signature	
A14U1-20	ROM1	8AA9	
U2-20	ROM2	160U	
U3-20	ROM3	7631	
U4-20	ROM4	383A	
U15-11	-	546U	
U52-13	-	96F8	

**Table 8-12. Signature Analysis Chip Selects - Group 2**

Chip Selects - Group 2:		Start: A14TP12, (A15), ∨	Stop: A14TP12, (A15), /
(Service Sheet 14)		Clock: A14TP11, (φ2), ∨	
Node (Ref. Desig.)-pin	Signal Name	Signature	
A14U5-20	ROM5	826U	
U6-20	ROM6	603C	
U7-20	ROM7	54F5	
U8-20	ROM8	A711	
U9-20	ROM9	AA6A	
U10-20	ROM10	A3UH	
U11-20	ROM11	H759	
U12-20	ROM12	CA11	
U13-20	ROM13	546U	
U14-20	ROM14	96F8	
U64-12	SEL1	7631	
U37-12	SEL0	383A	
U46-23	-	8P4P	
U37-9	-	9640	
U41-8	SEL3	160U	
U37-5	SEL3	04UH	
U62-2	SEL5	04UH	
U49-2	SEL4	57HH	
U37-2	-	CFHH	
U28-19	-	PC01	
U30-19	-	PC01	



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

**Table 8-13. Signature Analysis LO Drive (1)**

LO Drive Start: A14TP8, (D1), / Circuits: Stop: A14TP9, (D2), / Clock: A14TP11, (φ2), \ (Service Sheets 6, 11, and 14)		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U46-21	R/W	CF50
-23	CS2	7A23
-26	PD7	98U8
-27	PD6	42H2
-28	PD5	2482
-29	PD4	0848
-30	PD3	AU66
-31	PD2	381A
-32	PD1	1C4H
-33	PD0	97C1
-35	A1	7A74
-36	A0	020U
-39	CA2	0000
-2	PA0	66C1
-3	PA1	098H
-4	PA2	CA74
-5	PA3	73C0
-6	PA4	F298
-7	PA5	757H
-8	PA6	AF3F
-9	PA7	P37P
-12	E3	13A4
-13	E4	75A3
-14	E5	7110
-15	E6	4937
U45-2	DA0	66C1
-3	DA1	098H
-4	DA2	CA74
-5	DA3	73C0
-6	DA4	F298
-7	DA5	757H
-8	DA6	AF3F
-9	DA7	P37P

**Table 8-14. Signature Analysis LO Drive (2)**

LO Drive Start: A14TP8, (D1), / Circuits: Stop: A14TP9, (D2), / Clock: A14TP11, (φ2), \ (Service Sheets 6, 11, and 14)		
Node (Ref. Desig.)-pin	Signal Name	Signature
U14-11	E4	75A3
U15-11	E5	7110
U16-11	E6	4937
U33-4	FT BIT 0	9HA9
-5	FT BIT 1	3219
-6	FT BIT 2	1946
-7	FT BIT 3	4FCA
-8	FT BIT 4	H76P
-9	FT BIT 5	PUHP
-10	FT BIT 6	U31P
-11	FT BIT 7	P6C1
-12	FT BIT 8	FC62
-13	FT BIT 9	P0A3
U32-13	CT BIT 0	0000
-14	CT BIT 1	F8PU
-15	CT BIT 2	90A5
-16	CT BIT 3	8073
-17	CT BIT 4	14A4
-18	CT BIT 5	C082
-19	CT BIT 6	H90A
-20	CT BIT 7	P994
-21	CT BIT 8	F6HP
-22	CT BIT 9	42U2
-23	CT BIT 10	206A
-24	CT BIT 11	A62A

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

**Table 8-15. Signature Analysis NMOS and CMOS RAM (1)**

NMOS and CMOS RAM: (Service Sheet 13) Start: A14TP9, (D2), / Stop: A14TP10, (D3), / Clock: A14TP11, ( $\phi$ 2), \		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U22-8	RAM 1	U044
-10	R/ $\bar{W}$	874C
-11	D3	7596
-12	D2	U8P1
-13	D1	561A
-14	D0	870U
-1	A6	1HC4
-2	A5	6854
-3	A4	81U7
-4	A3	83FC
-5	A0	PUPH
-6	A1	F79U
-7	A2	8A8F
-15	A9	47AC
-16	A8	F1HU
-17	A7	93U5
U24-8	RAM 1	U044
-10	R/ $\bar{W}$	874C
-11	D7	087P
-12	D6	PHCF
-13	D5	84AF
-14	D4	UA32

**Table 8-16. Signature Analysis NMOS and CMOS RAM (2)**

NMOS and CMOS RAM (Continued): (Service Sheet 13) Start: A14TP10, (D3), / Stop: A14TP7, (D4), / Clock: A14TP11, ( $\phi$ 2), \		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U21-8	RAM 2	U044
-10	R/ $\bar{W}$	874C
-11	D3	7596
-12	D2	33C9
-13	D1	561A
-14	D0	870U
-1	A6	79U8
-2	A5	F0U8
-3	A4	C747
-4	A8	A686
-5	A0	230H
-6	A1	02P2
-7	A2	UAU1
-15	A9	47AC
-16	A8	F1HU
-17	A7	9385
U23-8	RAM 2	U044
-10	R/ $\bar{W}$	874C
-11	D7	087P
-12	D6	PHCF
-13	D5	84AF
-14	D4	UA73



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

**Table 8-17. Signature Analysis NMOS and CMOS RAM (3)**

NMOS and CMOS Start: A14TP7, (D4), / RAM (Continued): Stop: A14TP5, (D2), \ (Service Sheet 13) Clock: A14TP11, ( $\phi$ 2), \ 		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U19-8	RAM 3	U044
-10	R/ $\bar{W}$	874C
-11	D3	CPFP
-12	D2	U8P1
-13	D1	561A
-14	D0	874P
-1	A6	C568
-2	A5	0U9P
-3	A4	1A38
-4	A3	U64F
-5	A0	PUPH
-6	A1	0C7U
-7	A2	P8FH
-15	A9	47AC
-16	A8	F1HU
-17	A7	5U15
U26-8	RAM 3	U044
-10	R/ $\bar{W}$	874C
-11	D7	087P
-12	D6	PHCF
-13	D5	84AF
-14	D4	UA73

**Table 8-19. Signature Analysis NMOS and CMOS RAM (5)**

NMOS and CMOS Start: A14TP5, (D0), \ RAM (Continued): Stop: A14TP8, (D1), \ (Service Sheet 13) Clock: A14TP11, ( $\phi$ 2), \ 		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U20-1	A6	FA4A
-2	A5	5631
-3	A4	549C
-4	A3	1390
-5	A0	175H
-6	A1	2107
-7	A2	1CUP
-15	A9	3606
-16	A8	AC24
-17	A7	3634
U25-8	RAM 4	1H6U
-10	R/ $\bar{W}$	348A
-11	D7	A5C9
-12	D6	148U
-13	D5	F17P
-14	D4	1166

**Table 8-18. Signature Analysis NMOS and CMOS RAM (4)**

NMOS and CMOS Start: A14TP5, (D0), \ RAM (Continued): Stop: A14TP8, (D1), \ (Service Sheet 13) Clock: A14TP11, ( $\phi$ 2), \ 		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U20-8	RAM 4	1H6U
-10	R/ $\bar{W}$	348A
-11	D3	17FU
-12	D2	4A1C
-13	D1	7346
-14	D0	83A8

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

**Table 8-20. Signature Analysis NMOS Storage RAM (1)**

NMOS Oscilloscope Start: A14TP5, (D1), \		
Storage RAM: Stop: A14TP8, (D2), \		
(Service Sheet 15) Clock: A14TP11, (φ2), \		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U33-19	—	43A3
-1	R/ $\bar{W}$	U30H
-2	DS0	9891
-4	DS1	776C
-6	DS2	C79P
-9	DS3	583U
-3	DS4	C265
-5	DS5	6CC9
-7	DS6	47C6
-8	DS7	A72C
U31-8	—	1FCA
-11	DS3	583U
-12	DS2	C79P
-13	DS1	776C
-14	DS0	9891
-1	AS6	47C6
-2	AS5	6CC9
-3	AS4	AF91
-4	AS3	3HU8
-5	AS0	5903
-6	AS1	545F

**Table 8-21. Signature Analysis NMOS Storage RAM (2)**

NMOS Oscilloscope Start: A14TP8, (D1), \		
Storage RAM: Stop: A14TP9, (D2), \		
(Service Sheet 15) Clock: A14TP11, (φ2), \		
Node (Ref. Desig.)-pin	Signal Name	Signature
A14U31-7	AS2	H100
-15	AS9	67A5
-16	AS8	P3PU
-17	AS7	A72C
U32-8	—	1FCA
-11	DS7	A72C
-12	DS6	47C6
-13	DS5	6CC9
-14	DS4	C265
U29-19	—	43A3
U30-19	—	43A3

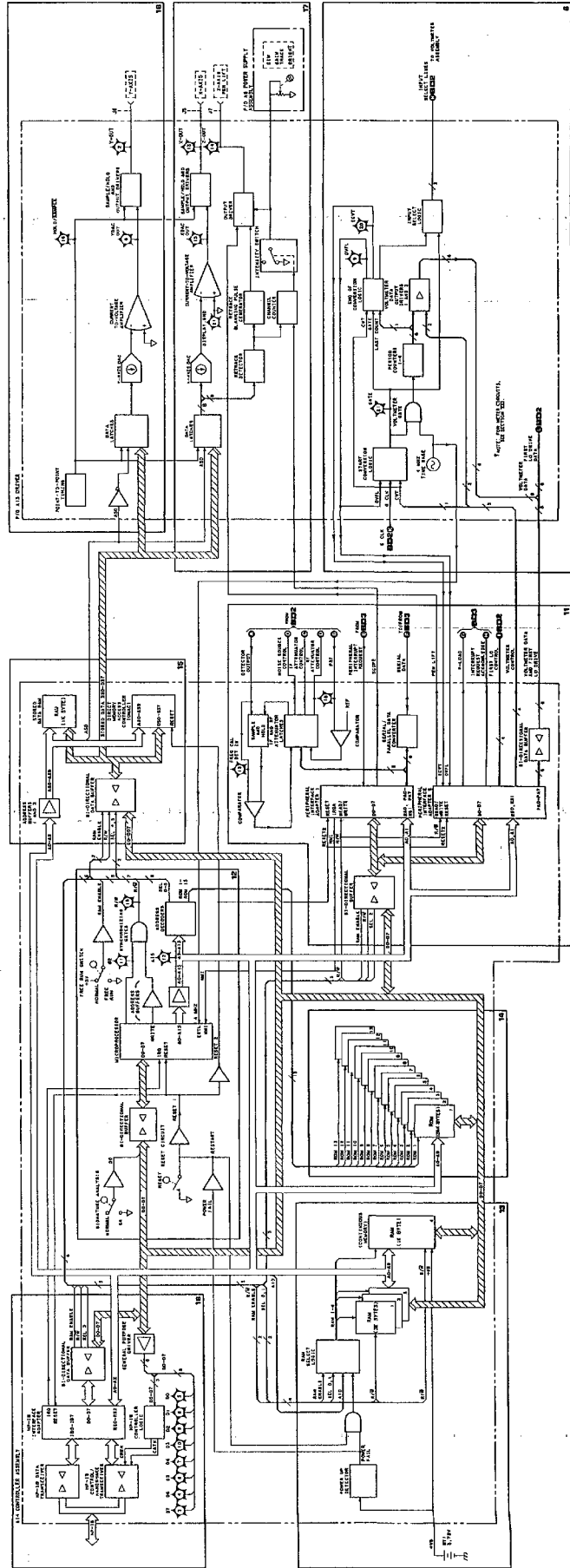


Figure 8-22. Digital Section Block Diagram 8-43

**SERVICE SHEET 1 (cont'd)**

9. 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 A6Q4, 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 if the test results are satisfactory, refer to the applicable sections for post-testing procedures.

**SERVICE SHEET 1 (cont'd)**

3. If the first level is in error, with the input set zero, adjust OFF-SET potentiometer A6R11 following the procedures in Section V. Adjustment. If the level remains in error, check A6U1 and A6C8.

4. If the starting level is correct, but the upper range is incorrect, adjust GAIN potentiometer A6R12 following the procedures in Section V. Adjustment. If the level remains in error, check A6U1, A6C8, and A6R71.

**RF Signal Path Tests**

1. Inject a 20 MHz RF signal into the RF IN connector, and connect the power meter to the output of Isolator A71.
2. Select each special function to test each circuit as shown in Table 8-24, and ensure that the approximate outputs listed are detected.

Special Function (dB)	Input Power (dBm)	Output Power (dBm)	Circuit Devices Tested
63.0	+1.0	-6.8	Thru, A71
63.2	+1.0	-1.0	20 dB Input Amplifier
63.4	+1.0	-6.0	10 dB Pad # 2
63.5	+1.0	-6.0	10 dB Pad # 3

3. If the signal is in error at the output of Isolator A71, check the signal at A6S2.
4. If the signal out of A6S2 is correct, check for a 3070 MHz, +7.5 dBm signal at A10A4.
5. If the signal at A10A4 is correct, check mixer diodes A10CRIA and A10CRLB, and the 1550 and 5000 MHz low pass filters.

**NOTE**

- The A10 First Converter Assembly can be replaced as a single module, rather than attempting component level repair.
6. If the signal at A10A4 is in error, check A10R1 and A10E2.
  7. If the signal at A6S2 is incorrect, use Table 8-24, to isolate the error to the faulty circuit. If the faulty circuit is a pad, check the pad resistors and relay.
  8. 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 on the base of A6Q2, check the signal components of A6Q4, and then the bias components.

**SERVICE SHEET 1 (cont'd)**

2. Ensure that the voltage from pin 4 to ground of A6U1 is  $-15 \pm 1.0$  Vdc.

**DC Signal Path Tests**

1. Place the Noise Figure Meter in special function 63.0, and measure the resistance from pin 8 of A6R1 to pin 2 of A6R3.
2. Ensure a total resistance of less than 0.5 ohm. If the resistance is high, check relay A6K1 through A6E2.
3. Use Table 8-22 to enter the special function which will test the respective pad.

Special Function (dB)	Input Power (dBm)	Correct Value (dBm)	Value <1 Ohm Instance
63.1	1	51.95	A6R2, A6R3, A6R4
63.4	2	51.95	A6K4, A6R29, A6R30
63.5	3	51.95	A6K5, A6R36, A6R40

**Input Power Detector Tests**

1. Select special function 63.0, 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 at pin 5 of A6U1, and ensure that the output approximate the values listed in Table 8-23.

Input Power (dBm)	Detector Output (Vdc)
None	-0.035
-50	-0.030
-40	-0.025
-35	-0.020
-30	-0.015
-25	-0.010
-20	-0.005
-15	+0.000
-10	+0.005

\*Standard - will vary slightly.

**SERVICE SHEET 1 (cont'd)**

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, relay A6E2 and A6E3 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 voltage of A6Q1 and A6Q2.

**Input Power Detector.** Input RF power is detected by A6C76 and amplified by DC amplifier A6U1. A6C17 serves as the detector and bypass capacitor. Feedback for A6U1 includes the detector A6R17. The detector is compensated for temperature change in A6C76. The output of A6U1 is the PRF signal to Controller Assembly A1A.

**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 passed through a 1550 MHz low pass filter to the mixer. The 1550 MHz low pass filter is used to filter out A10CRIA and A10CRLB. Power splitters A10R1 and A10E2 receive RF in the range of 2950 MHz to 3550 MHz which is also input to the mixer.

The output of the mixer is an unmodulated input frequency fixed at 2950 MHz. The 2950 MHz RF is filtered by a 5000 MHz low pass filter and output to Isolator A71. 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 variations and undesirable standing patterns.

**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 in the First Converter circuit. Except where shown, all test values listed are approximate, and are given as a service guideline.

**Test Equipment**

- Frequency Synthesizer ..... HP 5355A
- Challenge Measuring System ..... HP 438A
- Power Sensor ..... HP 8462A/8464
- Systems DVM ..... HP 8468A

**General Checks**

1. In the power on condition, verify that the voltage from pin 7 to ground of A6U1 is  $+10 \pm 1.0$  Vdc.

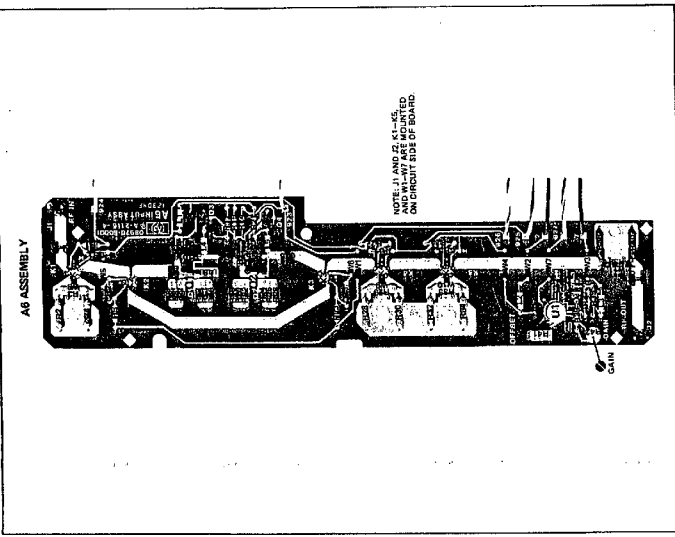
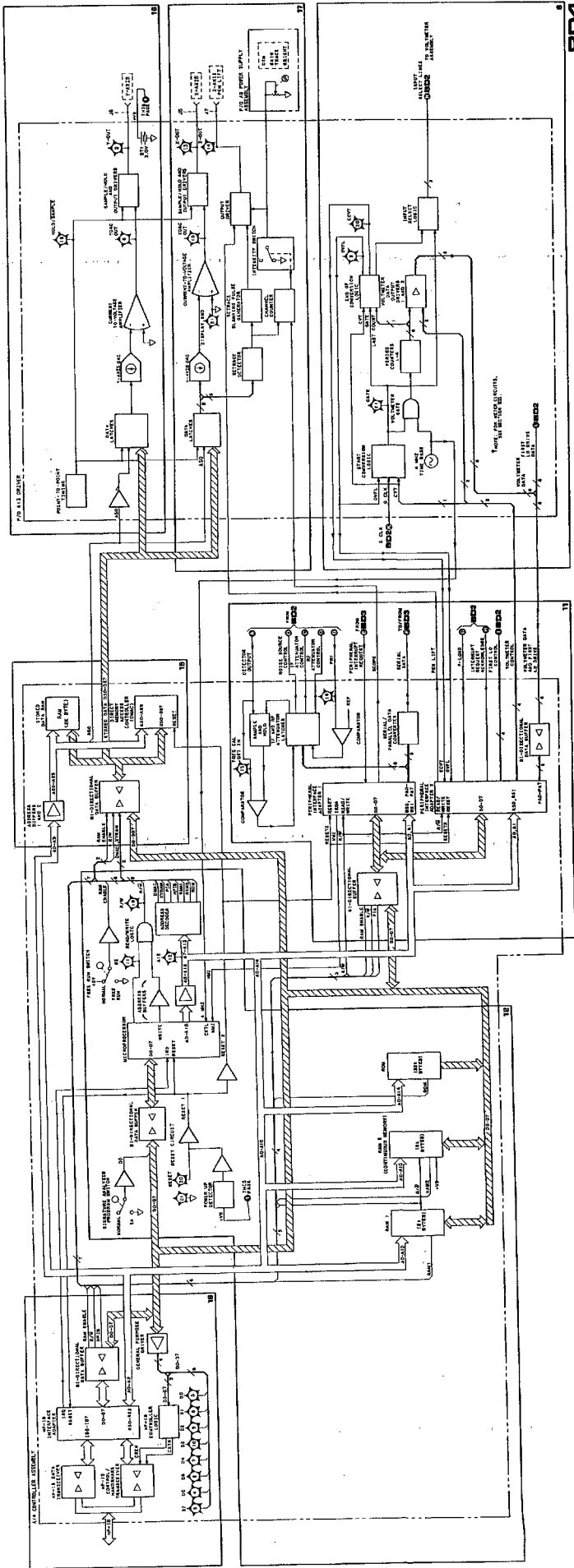
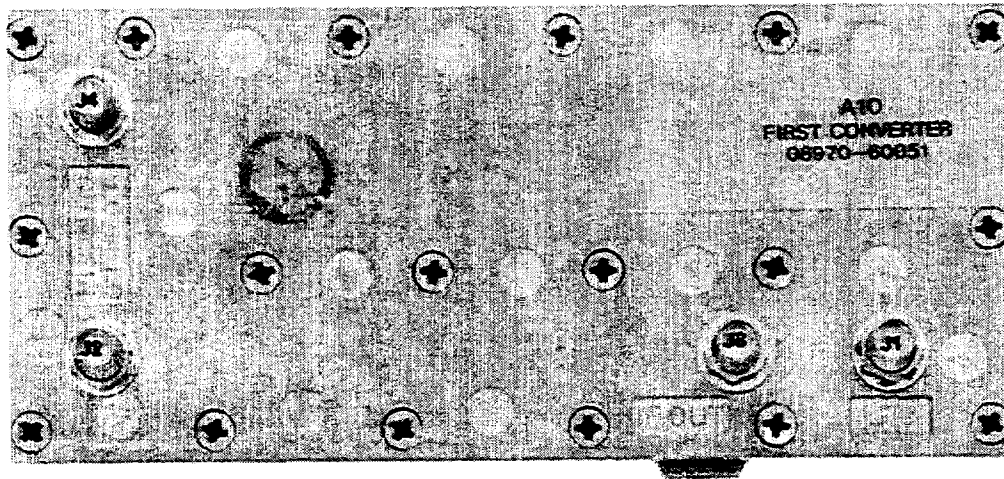


Figure 8-23. A6 Input Assembly Component Locations

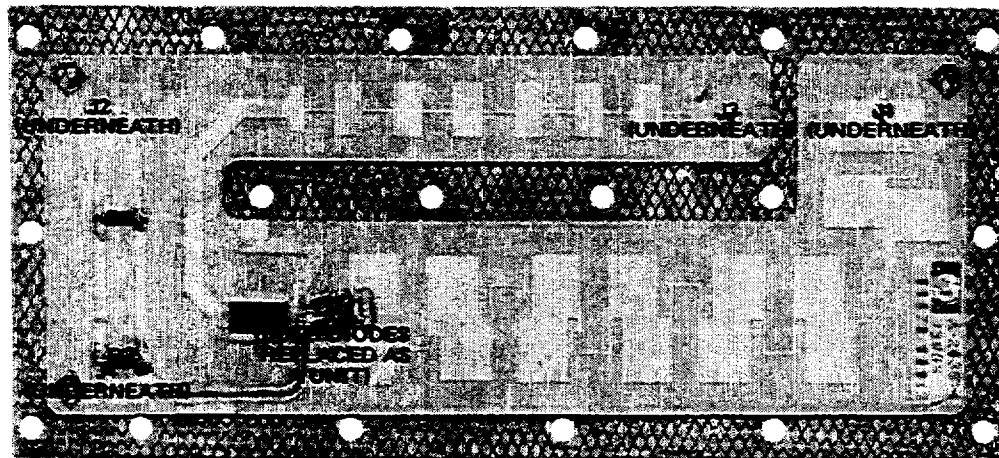


BD4  
Figure 8-22 Digital Section Block Diagram  
Block (P/O Change 4)

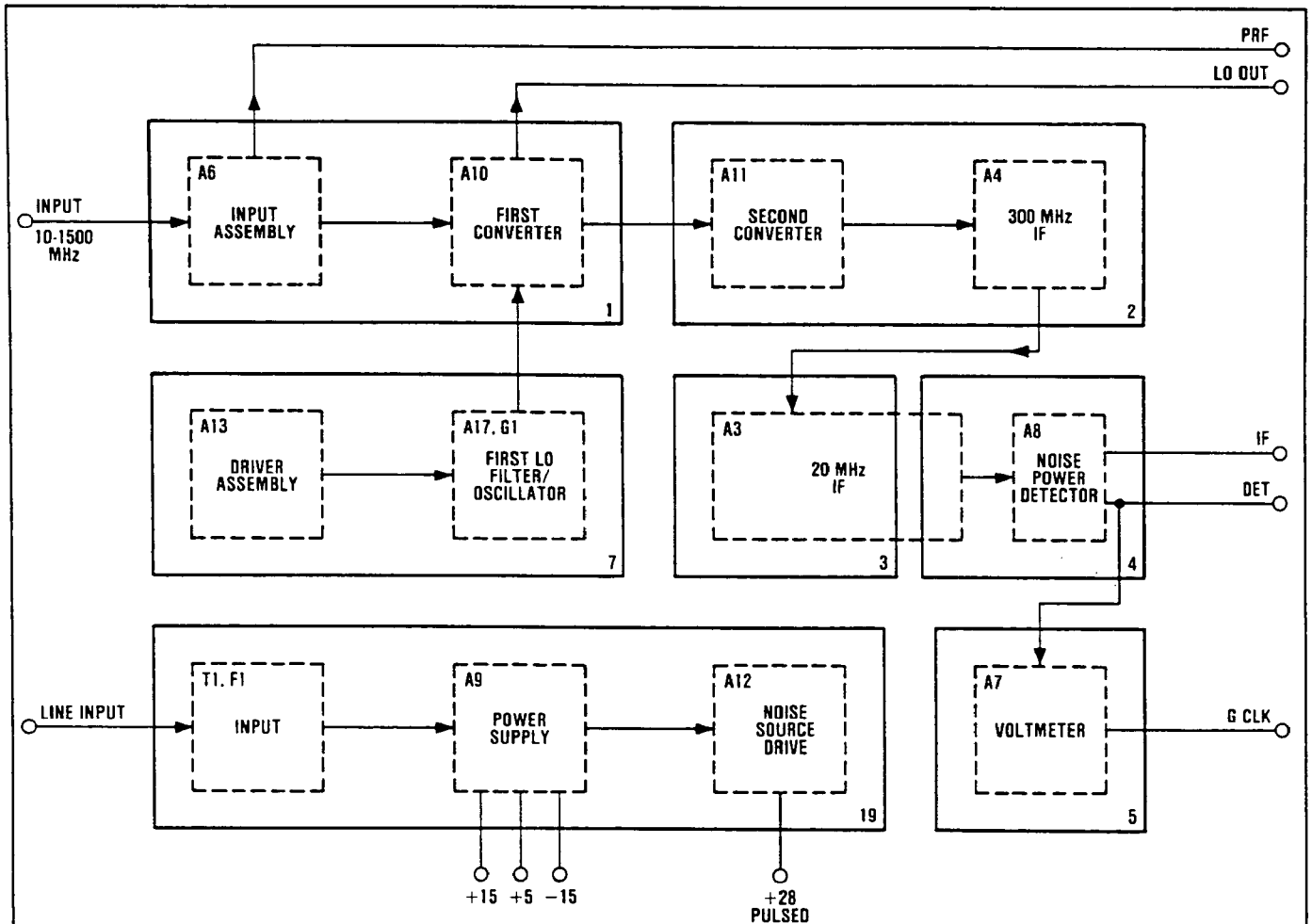
**A10 ASSEMBLY  
EXTERNAL VIEW**



**INTERNAL VIEW**



**Figure 8-24. A10 First Converter Assembly Component Locations**



ANALOG SECTION BLOCK DIAGRAM BD2

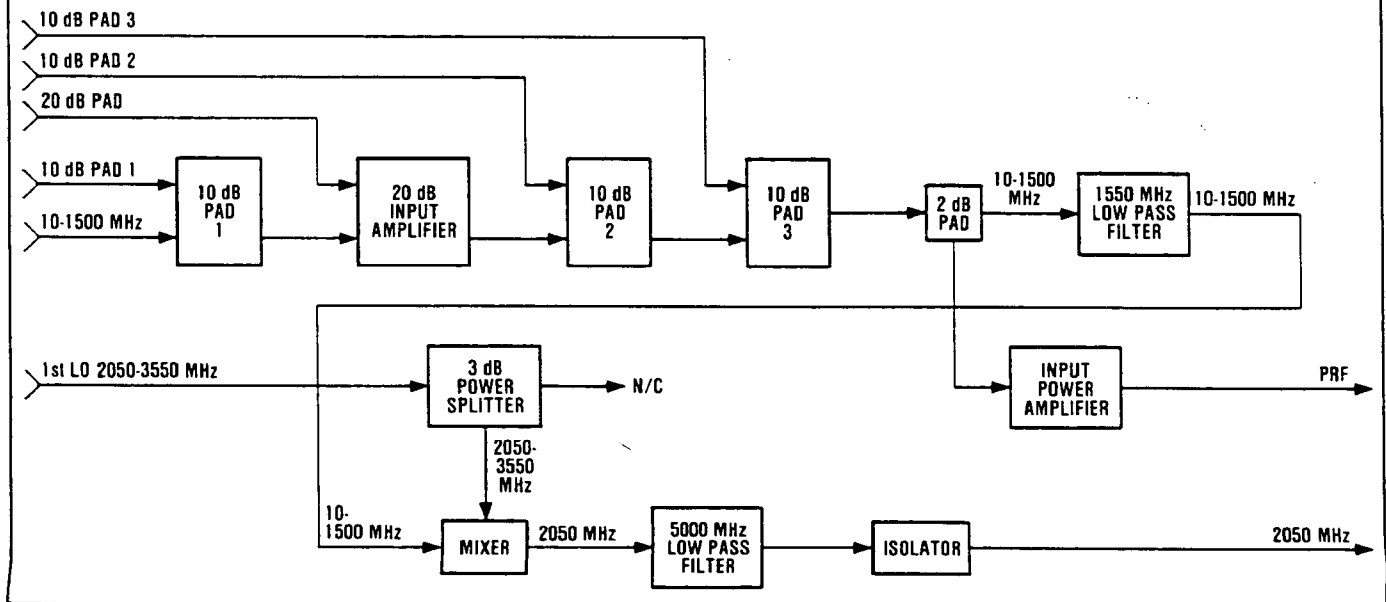
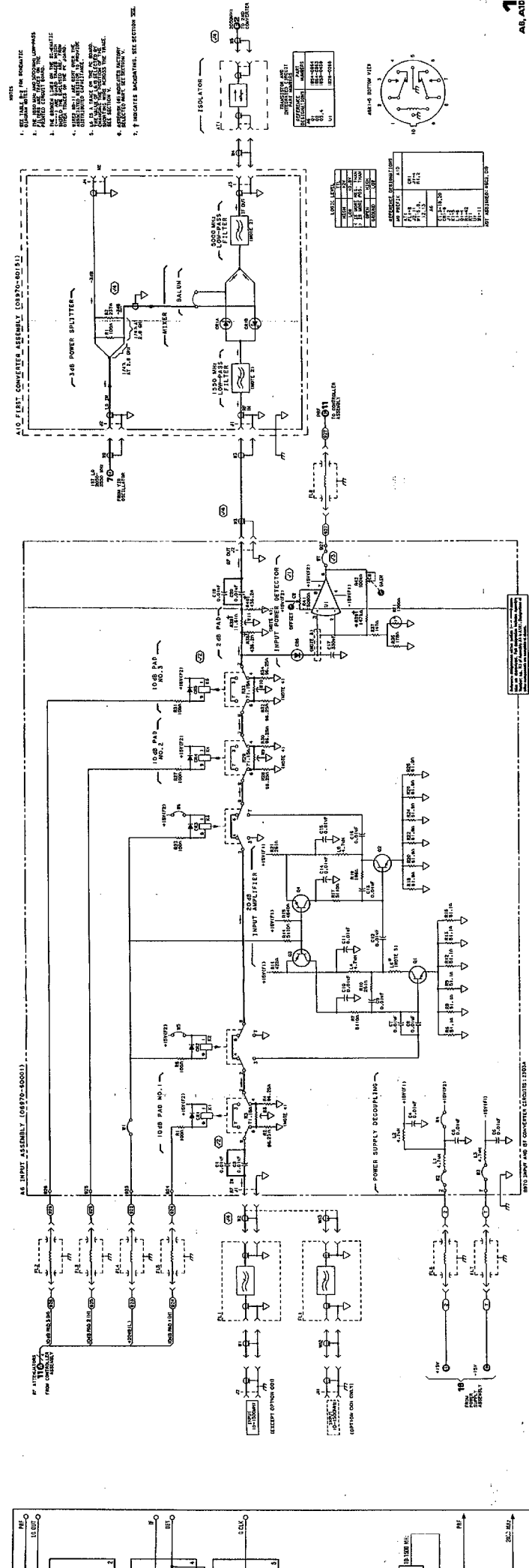
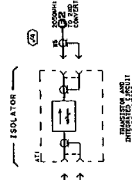


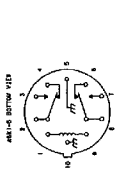
Figure 8-25. Input and First Converter Block Diagram



- NOTE:
1. SEE LABEL FOR IDENTIFICATION OF COMPONENTS.
  2. ALL PARTS ARE TO BE IDENTIFIED BY PART NUMBER AND QUANTITY.
  3. ALL PARTS ARE TO BE IDENTIFIED BY PART NUMBER AND QUANTITY.
  4. ALL PARTS ARE TO BE IDENTIFIED BY PART NUMBER AND QUANTITY.
  5. ALL PARTS ARE TO BE IDENTIFIED BY PART NUMBER AND QUANTITY.
  6. ALL PARTS ARE TO BE IDENTIFIED BY PART NUMBER AND QUANTITY.
  7. ALL PARTS ARE TO BE IDENTIFIED BY PART NUMBER AND QUANTITY.
  8. ALL PARTS ARE TO BE IDENTIFIED BY PART NUMBER AND QUANTITY.
  9. ALL PARTS ARE TO BE IDENTIFIED BY PART NUMBER AND QUANTITY.
  10. ALL PARTS ARE TO BE IDENTIFIED BY PART NUMBER AND QUANTITY.



ITEM NO.	DESCRIPTION	QTY
1	ISOLATOR	1
2	...	...
3	...	...
4	...	...
5	...	...
6	...	...
7	...	...
8	...	...
9	...	...
10	...	...



ITEM NO.	DESCRIPTION	QTY
1	...	...
2	...	...
3	...	...
4	...	...
5	...	...
6	...	...
7	...	...
8	...	...
9	...	...
10	...	...

Figure 8-26. Input and First Converter Schematic Diagram



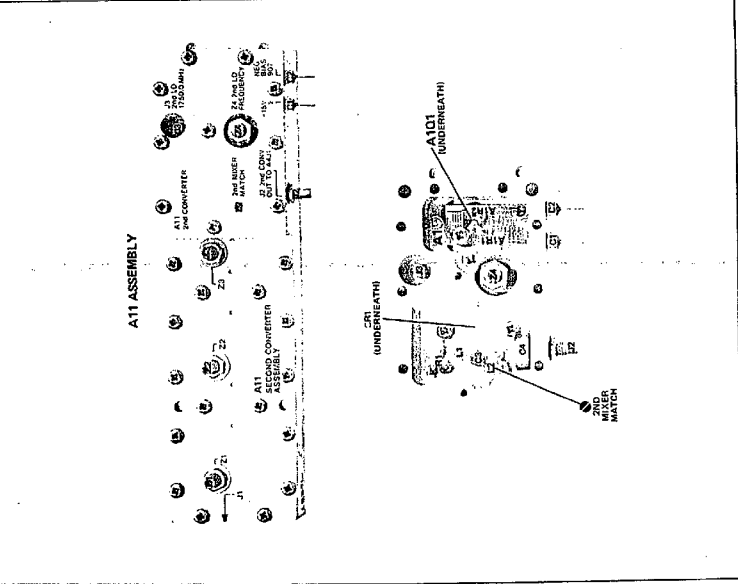


Figure 8-27. A11 Second Converter Assembly Component Locations

**SERVICE SHEET 2 (cont'd)**

6. Raise the input level to +10 dBm, and ensure that the output goes to +7 dBm (mixer saturation).
7. If any output level is in error, check for the presence of a signal to the input of the 300 MHz matching filter. If the signal is in error, attempt to restore the signal by adjusting A11L2, A11L3, and A11L4.
8. If the signal is still in error, check mixer diode A11C1. Replace the diode if it has failed, or replace assembly A11.
9. If the signal is present at the input of the 300 MHz matching filter, attempt to restore the signal output by adjusting A11L2. Otherwise, check A11C3, A11C4, A11L1, A11L2, and A11L3.

**300 MHz Assembly A4**

1. Change the 20 MHz RF input signal to 0 dBm, and ensure an approximate 1 Vpp signal at the 20 MHz IF output of assembly A4. If the signal is in error, ensure a 200 MHz RF input at +13 dBm into pin 8 of A4U1. Ensure an input of 300 MHz, at -16 dBm into pin 1 of A4U1.
2. If the signal into pin 8 of A4U1 is in error, check for a 280 MHz signal at +5 dBm, at the junction of A4L6 and A4L7. If the signal is in error, check the voltages of the 280 MHz oscillator. Also, verify that A4C11 is tuned properly.
3. If the 280 MHz oscillator output is correct, check the voltages of the +8 dB gain, 280 MHz buffer amplifier. If the voltages are in error, replace assembly A4U1.
4. If the signal into pin 1 of A4U1 is in error, check for a +18 dB gain through the 300 MHz IF amplifier. If the gain or signal is in error, check the voltages of the amplifier.
5. If the amplifier output is correct, check the 300 MHz bandpass filter for a loss of 3 dB. If the signal is in error, verify that the four filter sections of the bandpass filter are properly tuned. If the signal is still in error, check the filter section components.
6. If both inputs to third converter A4U1 are correct, ensure a maximum 7 dB loss through the converter with proper 20 MHz IF output. If the signal is in error, replace A4U1.

**Completion of Testing**

Upon completion of testing, place all switches in their original position, use 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.



**SERVICE SHEET 2 (cont'd)**

280 MHz buffer amplifier A4Q1 is an +8 dB gain amplifier, which is used to isolate the oscillator, and develop enough power to drive the LO input of third converter A4U1. The third converter mixes the 300 MHz IF with the 280 MHz oscillator frequency to derive the 20 MHz IF output.

**TROUBLESHOOTING**

Troubleshooting is done on the circuits of Service Sheet 2 when a malfunction has occurred in one of the circuits of either Second Converter Assembly A11 or 300 MHz IF Assembly A4. If all of the tests in the following procedures indicate correct responses, the trouble is located elsewhere in the instrument, and not in the Second Converter or 300 MHz IF circuits. Except where shown, all test values listed are approximate, and are given as a service guideline.

Frequency Synthesizer	HP 8385A
Power Meter	HP 1480A
Power Source	HP 438A
Systems DVM	HP 8482A/8485A
	HP 3456A

**General Checks**

1. In the power on condition, verify that the voltage from A11A1R1 to ground is +15 ±1.0 Vdc.
2. Ensure that the NEG BIAS line is supplying the negative bias (from -15 Vdc supply) to A11A1R2.
3. Ensure that the voltage from A4L10 to ground is +15 ±1.0 Vdc.

**300 MHz IF Assembly A4**

1. Ensure an output of -10 dBm, at a frequency of 1750 MHz, from 2ND LO output connector A11B3.
2. If the signal is not present, or is at the wrong frequency, check for the presence of the signal at the collector of A11A1Q1. If the signal is in error, replace A11A1.
3. If the signal at A11A1Q1 is correct, attempt to restore the signal to the proper value by adjusting A11L2. If the signal is still in error, replace assembly A11.
4. Inject a 20 MHz RF signal, at 0 dBm, into the RF IN connector (from A4U1), and connect a power meter to the output of Second Converter Assembly A11.
5. Select special functions 63.0 and 31.1, and ensure an output of -12.5 dBm at 300 MHz, from A11. Lower the input level to -10 dBm, and ensure that the output goes to -22.5 dBm.

**SERVICE SHEET 2**

**SECOND CONVERTER AND 300 MHz IF CIRCUITS**

**A11 SECOND CONVERTER ASSEMBLY**

**A4 300 MHz IF ASSEMBLY**

**REFERENCES**

- Block Diagram - Service Sheet B22
- Section III - Operator's Checks
- Section VIII - Special Functions and Power-Up Checks

**PRINCIPLES OF OPERATION**

**General**

Service Sheet 2 consists of Second Converter Assembly A11 and 300 MHz IF Assembly A4. The function of Second Converter Assembly A11 is to down convert the 2050 MHz from isolator A11L1 to the 300 MHz used by 300 MHz IF Assembly A4. The second converter also supplies the instrument with a 2ND LO signal at 1750 MHz. The function of 300 MHz IF Assembly A4 is to amplify and down convert the 300 MHz from A11 to 20 MHz used by 20 MHz IF Assembly A3.

**Second Converter Assembly A11**

Second Converter Assembly A11 receives the 2050 MHz RF from Isolator A11 into a cavity style 2050 MHz bandpass filter (A11Z1, A11Z2, and A11Z3). The output of the bandpass filter goes to mixer A11C1. The other input to the mixer is the 1750 MHz from the second local oscillator.

Second local oscillator A11A1 outputs a 1750 MHz signal to filter A11Z4. The filter serves to eliminate oscillator sidebands, isolate the oscillator, and supply a pick-off point for the 2ND LO signal. Mixer diode A11C1 combines the 2050 MHz with the 1750 MHz to derive the 300 MHz IF frequency.

The output of the mixer goes to a 300 MHz matching filter (A11L1, A11L2, A11C3, A11C4, and A11L1) which serves to eliminate the mixer sidebands, and to impedance match the mixer output to 300 MHz IF Assembly A4.

**300 MHz IF Assembly A4**

300 MHz IF Assembly A4 receives the 300 MHz RF from A11 into an IF amplifier (A4Q3/A4Q4). Transistor A4Q3 provides about 19 dB gain, while transistor A4Q4 provides about 10 dB gain. The output of the IF amplifier is filtered by the 300 MHz bandpass filter. The output of the bandpass filter is one of the two inputs into third converter A4U1. The other input is the local oscillator from the 280 MHz oscillator and buffer amplifier.

The 280 MHz oscillator is a modified Colpitts circuit with a 280 MHz Surface Acoustic Wave (SAW) resonator (A4L1). The output power of the 280 MHz oscillator is approximately +5 dBm into the buffer amplifier.

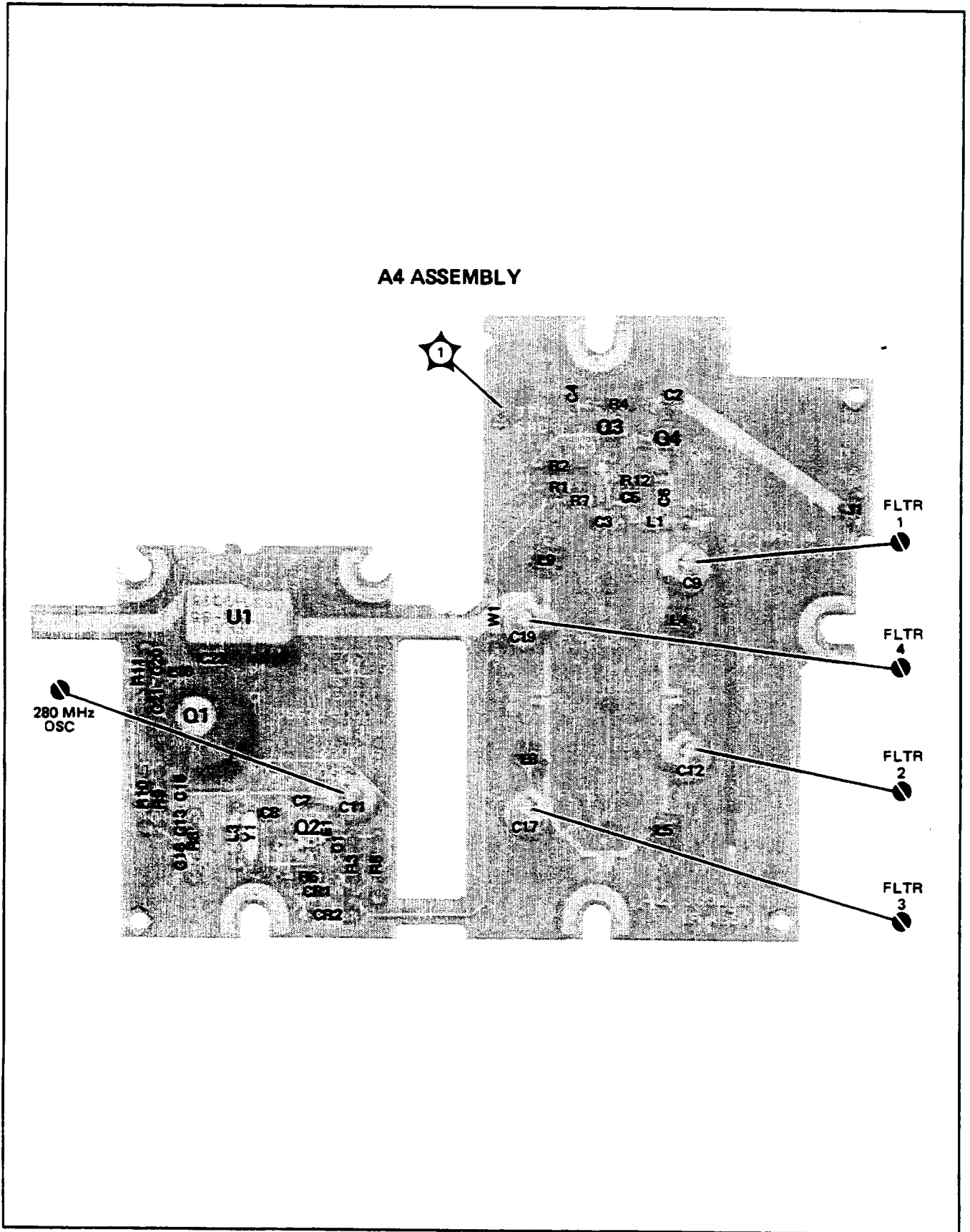
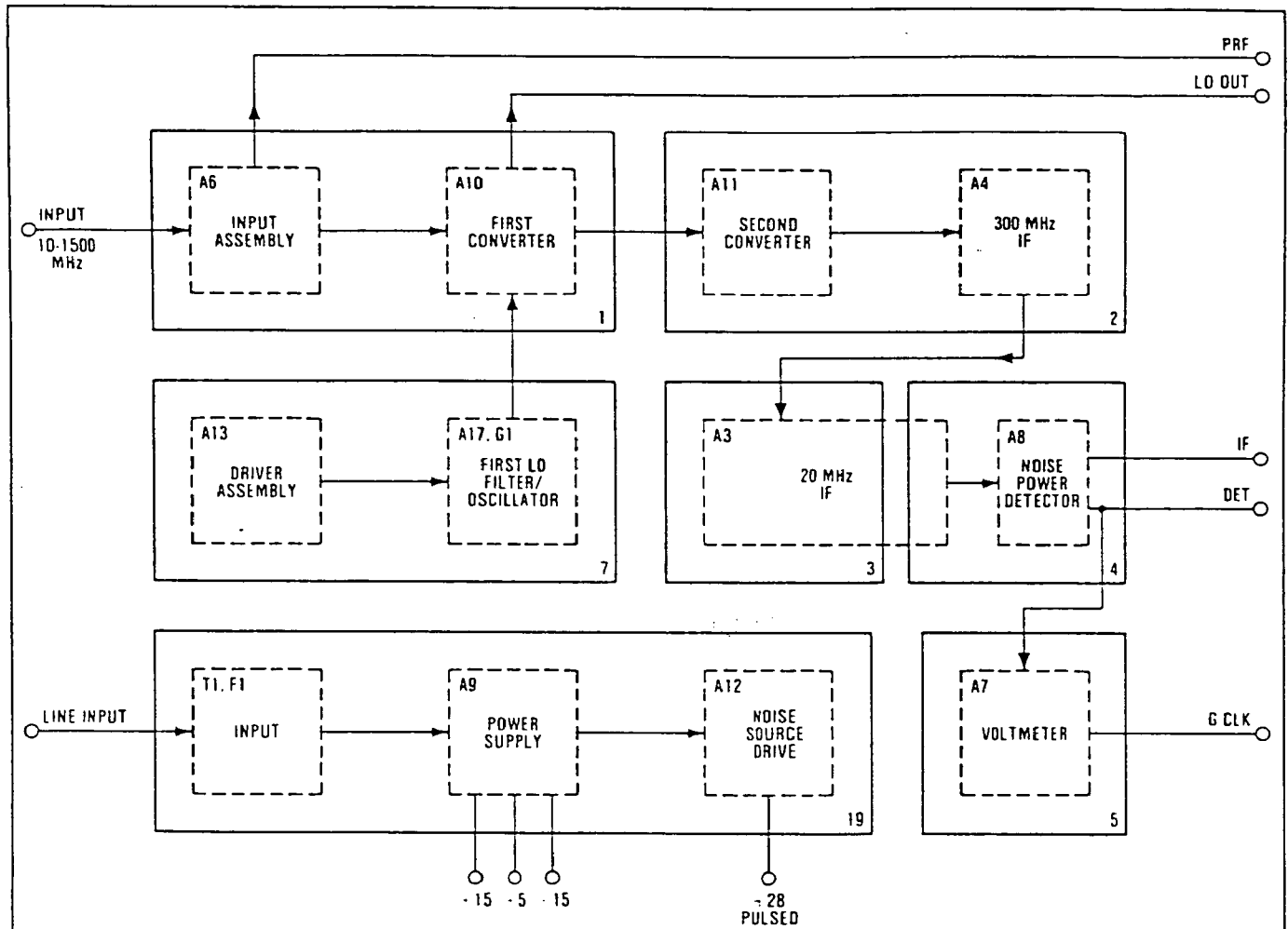


Figure 8-28. A4 300 MHz IF Assembly Component Locations



ANALOG SECTION BLOCK DIAGRAM BD2

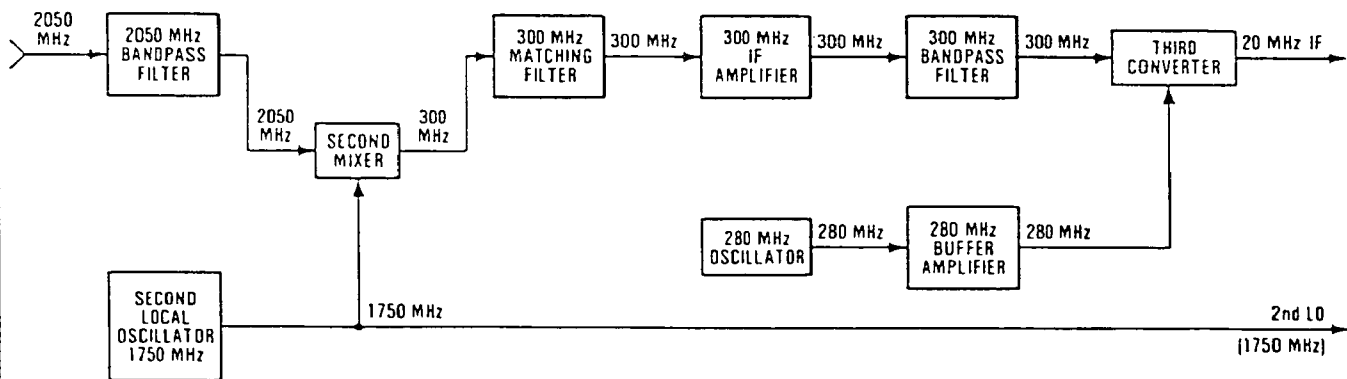
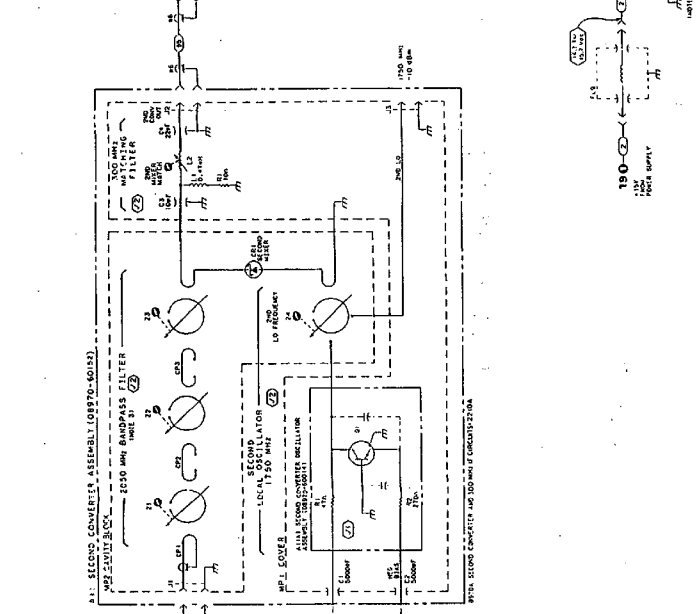
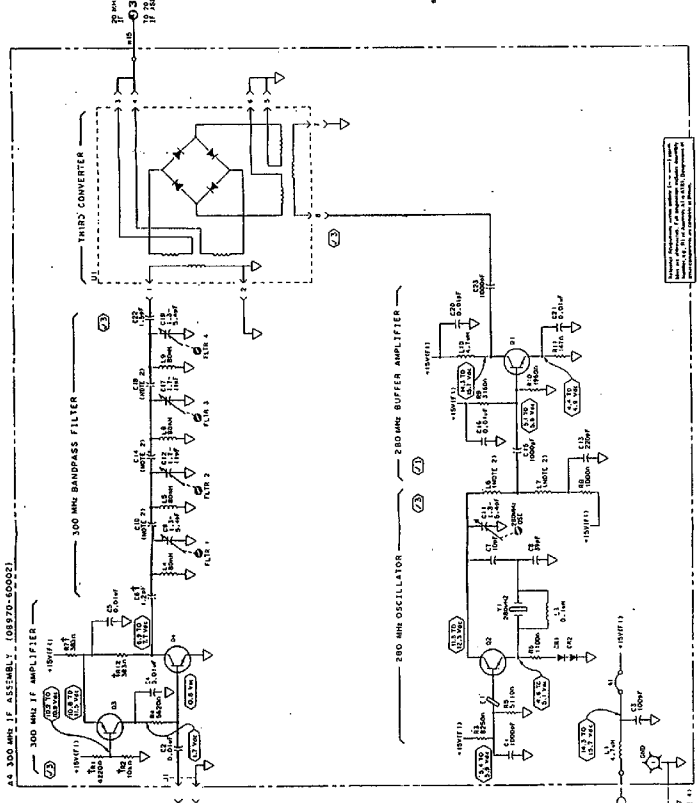


Figure 8-29. Second Converter and 300 MHz IF Block Diagram

1. REPAIR PARTS FOR IDENTIFICATION
2. ON THE IDENTIFICATION PAGE
3. IDENTIFICATION PAGE
4. IDENTIFICATION PAGE
5. IDENTIFICATION PAGE
6. IDENTIFICATION PAGE
7. IDENTIFICATION PAGE



SYMBOL	VALUE	QUANTITY	DESCRIPTION
C1	100 P.F.	1	CAPACITOR
C2	100 P.F.	1	CAPACITOR
C3	100 P.F.	1	CAPACITOR
C4	100 P.F.	1	CAPACITOR
C5	100 P.F.	1	CAPACITOR
C6	100 P.F.	1	CAPACITOR
C7	100 P.F.	1	CAPACITOR
C8	100 P.F.	1	CAPACITOR
C9	100 P.F.	1	CAPACITOR
C10	100 P.F.	1	CAPACITOR
L1	100 P.H.	1	INDUCTOR
L2	100 P.H.	1	INDUCTOR
L3	100 P.H.	1	INDUCTOR
L4	100 P.H.	1	INDUCTOR
L5	100 P.H.	1	INDUCTOR
L6	100 P.H.	1	INDUCTOR
L7	100 P.H.	1	INDUCTOR
L8	100 P.H.	1	INDUCTOR
L9	100 P.H.	1	INDUCTOR
L10	100 P.H.	1	INDUCTOR
R1	100 OHMS	1	RESISTOR
R2	100 OHMS	1	RESISTOR
R3	100 OHMS	1	RESISTOR
R4	100 OHMS	1	RESISTOR
R5	100 OHMS	1	RESISTOR
R6	100 OHMS	1	RESISTOR
R7	100 OHMS	1	RESISTOR
R8	100 OHMS	1	RESISTOR
R9	100 OHMS	1	RESISTOR
R10	100 OHMS	1	RESISTOR

Figure 8-20. Second Converter and 300 MHz IF Schematic Diagram

### SERVICE SHEET 3

#### 20 MHz IF CIRCUITS (PART ONE)

#### A3 20 MHz IF ASSEMBLY

#### REFERENCES

Block Diagram - Service Sheet BD2

Section III - Operator 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

### SERVICE SHEET 3 (cont'd)

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.

#### 280 MHz buffer amplifier A4Q1

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 A13 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, A3R21, 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). 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.

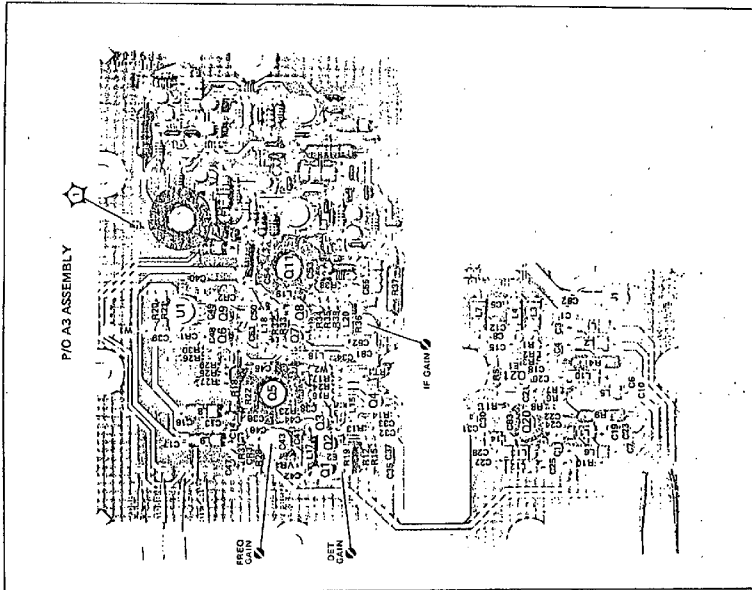


Figure 8-31. P/O A3 20 MHz IF Assembly Component Locations (Part 1)

**SERVICE SHEET 3 (cont'd)**

- the DETECTOR OUTPUT line. If the level is in error, check A3C47, A3R31, A3C33, A3VRI, and A3Q1.
- Select the 63.0 and 31.1 special functions, and ensure that the level on the DETECTOR OUTPUT line goes to 2.7 Vdc. If the level is present, but of the wrong value, adjust A3C43 for a maximum level.
  - If the level is still wrong, adjust A3R19 for the correct value. If the level is still in error, check the voltages and components of A3Q2 and A3Q1.

**(Z) Post-Detector Circuits Test**

- Ensure that with the instrument input still at 0 dBm, the signal on the base of A3Q3 is a distorted 9 Vpp signal riding on a +3 Vdc base. Change the input to the Noise Figure Meter to -30 dBm.
- Ensure that the signal on the base of A3Q5 is now an undistorted signal at 6.5 Vpp. If the signal is in error, change the input back to 0 dBm, and ensure a 1.7 Vpp signal on the base of A3Q3.
- 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.
- Return the input back to -30 dBm, and select special function 70. Ensure a 0.3 Vpp signal at the junction of A3Q9 and A3Q15. If the signal is in error, check A3Q3, A3Q9, and A3Q15.
- Select special function 70.1, and ensure that the signal at the junction of A3C50 and A3C51 goes to 3 Vpp. If the signal is in error, check A3Q3, A3Q9, and A3Q15.
- Select special function 70, and ensure a 0.13 Vpp signal on the base of A3Q8. If the signal is in error, check the voltages and components of A3Q7 and A3Q8.
- Ensure a 6 Vpp signal at the emitter of A3Q11. If the signal is in error, check the voltages and components of A3Q6 and A3Q11.

**Completion of Testing**

Upon completion of testing, place all switches in their original position, 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.

**SERVICE SHEET 3 (cont'd)**

**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 response, double-check the test stand and that the test equipment is set to 20 MHz IF. If the test stand and test equipment are correct, the test stand and test equipment values are approximate, and are given as a service guideline.

**Test Equipment**

Frequency Synthesizer	HP 3335A
Oscilloscope Measuring System	HP 1980A
Power Meter	HP 436A
Power Sensor	HP 8462A/8465A
Systems DYN	HP 3456A

**(Z) General Checks**

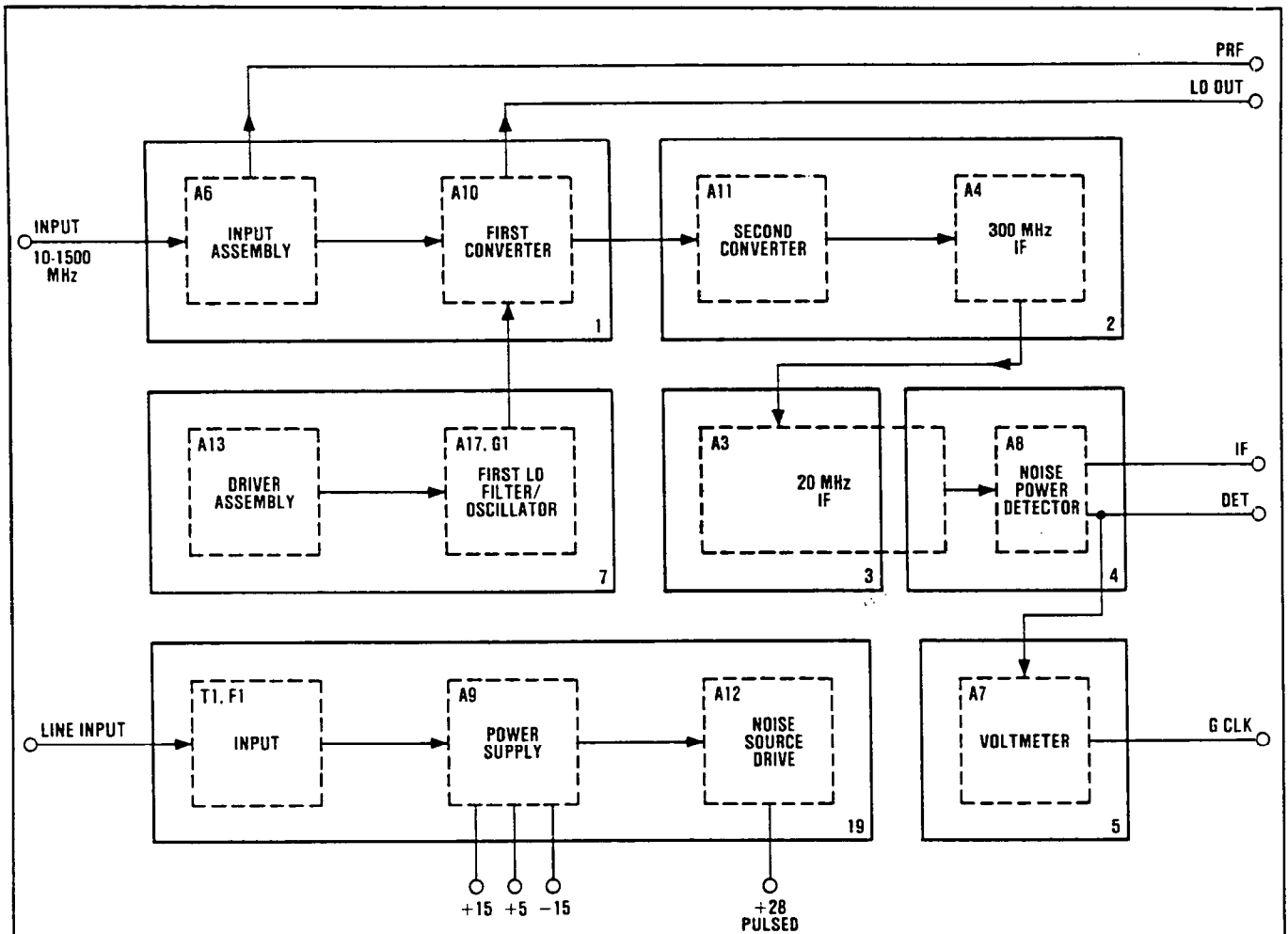
- In the power on condition, verify that the voltage from pin 8 of A3Q1 to ground is  $+13 \pm 1.0$  Vdc.
- Ensure that the voltage from pin 4 of A3U1 to ground is  $-15 \pm 1.0$  Vdc.

**(Z) Pre-Detector Circuits Tests**

- Inject a 30 MHz, RF signal, at 0 dBm, into the front panel INPUT connector, and select special functions 63.0 and 31.1.
- Remove capacitor A3C32 from the 20 MHz IF path, and place it between the W16 input line and output test connector A3J1.
- Ensure an output (at A3J1) of -1.5 dBm at 20 MHz. Restore capacitor A3C32 to its original position. If the signal is in error, check A3C32. The problem is most likely in the 300 MHz IF Assembly A4 (Service Sheet 1).
- Ensure a signal of 1.5 Vpp at 20 MHz at the junction of A3C31 and A3C33. If signal is correct, refer to the detector and post-detector circuits.
- If the signal was in error, check for a signal of 2.7 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 bandpass filter.
- 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.

**(Z) Frequency Calibration: Detector Test**

- Select the 92.1 special function and ensure a 0.25 Vdc level on



ANALOG SECTION BLOCK DIAGRAM BD2

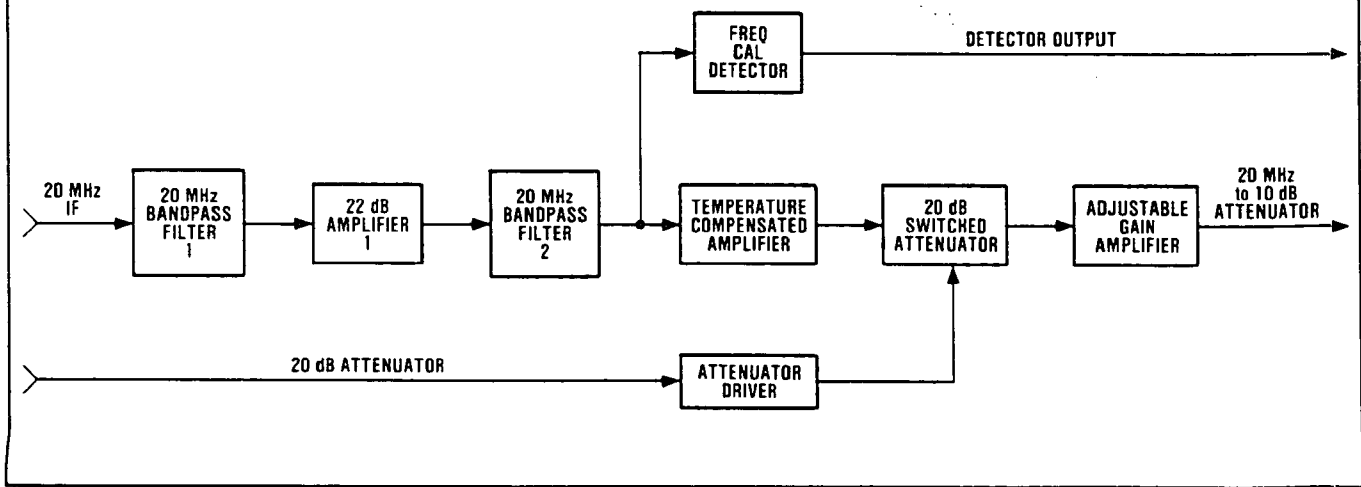


Figure 8-32. 20 MHz IF (Part 1) Block Diagram





P/O A3 ASSEMBLY

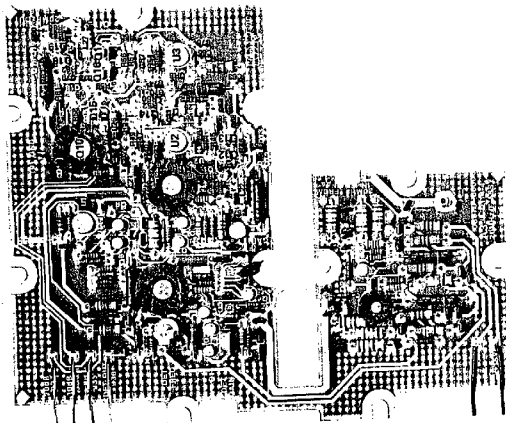


Figure 8-34. P/O A3 20 MHz IF Assembly Component Locations (Part 2)

**SERVICE SHEET 4 (cont'd)**  
If components checked, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

**SERVICE SHEET 4 (cont'd)**  
**(27) General Checks**

1. In the power on condition, verify that the voltage from pin 6 of A3Q2 to ground is +10 ±1.0 Vdc.
2. Ensure that the voltage from pin 4 of A3Q2 to ground is -15 ±1.0 Vdc.
3. Ensure that the voltage from the junction of A3R2 and A3Q4 to ground is +15 ±1.0 Vdc.

**(27) 20 MHz IF Assembly A3 Circuit Tests**

1. Inject a 30 MHz RF signal at -40 dBm, into the front panel INPUT connector and select special function 70.5.
2. With the signal is correct, the problem is most likely in Noise Power Detector Assembly A3.
3. If the signal is correct, check the input RF to -30 dBm, and increase the signal to 3 Vpp at 20 MHz at the junction of A3Q2 and A3R2. If the signal is incorrect, go to step 6.
4. If the signal is correct, reduce the RF input to -40 dBm. Select special function 70.1 and ensure a distorted output (approximately 12 Vpp) on the collector of A3Q1.
5. If the signal went up in level, check the voltages and components of A3Q14 and A3Q15. If the signal is missing, or did not change, check A3Q16, A3Q17, A3Q3, and related components.
6. Ensure a 1.5 Vpp signal on the gate of A3Q14. If the signal is incorrect, check A3Q13, A3Q12, A3Q2, and related components. If the signal is correct, ensure a 4 Vpp signal on the base of A3Q10.
7. If the signal on the base of A3Q10 is incorrect, check the voltages and components of A3Q14 and A3Q15. If the signal is correct, check the voltages and components of A3Q13 and A3Q12.

**(27) 20 MHz IF Assembly A8 Circuit Tests**

1. Inject a 20 MHz RF signal, at -40 dBm, into the front panel INPUT connector, and select Special Functions 65.0, 31.1, and 70.5.
2. Ensure a -15 dBm output at IF connector A8R. If the level is incorrect, check the voltages and components of A3Q1. Then, check the components of the two filters and the attenuator.

**Completion of Testing**

Upon completion of testing, place all switches in their original position, and return the instrument to the normal operating condition. If repairs have been made, or

**SERVICE SHEET 4 (cont'd)**

**6 dB Switched Attenuator.** The 6 dB switched attenuator consists of transistors A3Q16 and A3Q17 and voltage divider A3S6 and A3R7. If the signal is low (ground) on the 20 MHz IF line, then comparator A3U2A will output a high, while A3I3B will output a low.

The low (-15 Vdc) from A3I3B will turn off A3Q17 while the high (+15 Vdc) from A3I3A will turn on A3Q16. With A3Q16 on, the voltage divider network will be bypassed, and the 20 MHz IF signal will be attenuated. A high (+15 Vdc) from A3I3A will turn on A3Q17, which will cause the RF signal to pass through the voltage divider network, thus attenuating the RF signal by 6 dB.

Both A3Q16 and A3Q17 are JFETs. Therefore, diodes A3CR6 and A3CR7 are used to prevent forward biasing of the JFETs when the comparator output is high. A3R8 and A3R6 are used for bias turn on of the JFETs.

**7 dB Amplifier, Filters, and 40 dB Attenuator Circuits**

The 7 dB Amplifier, Transistors A3Q16, A3Q19, and A3Q1 make up the 7 dB amplifier. It is similar in operation to the 6 dB amplifier, except that the signal is attenuated by 7 dB. The 7 dB amplifier is located in two separate assemblies. The first two stages (A3Q16 and A3Q19) are located in 20 MHz IF Assembly A3. The third stage (A3Q1) is located in Noise Power Detector Assembly A8.

**Filters and Attenuator.** The 20 MHz IF signal is attenuated by the 7 dB attenuator, which consists of A3Q16, A3Q19, and A3Q1. The 20 MHz IF signal is then output to both the Noise Power Detector (Service Sheet 5), and to 32 dB attenuator A3R2 and A3R3.

After attenuation, the signal is again filtered by a 40 MHz low-pass filter consisting of A3L4, A3L5, A3C1, A3C2, and A3C3. The 20 MHz IF signal is then output to the instrument. The 20 MHz IF signal is then output to the instrument. The 20 MHz IF signal is then output to the instrument. The 20 MHz IF signal is then output to the instrument.

**TROUBLESHOOTING**

Troubleshooting is done on the circuits of Service Sheet 4 when a malfunction has occurred in one of the 20 MHz IF circuits in either the second half of 20 MHz IF or in the first half of the 20 MHz IF. If the signal is low at the test point in the following procedure, it indicates a correct response. The trouble is either in the first half (Service Sheet 3) of the 20 MHz IF circuit, or in a local diode where in the instrument. Except where otherwise indicated, all measurements are approximate, and are given in the service guidelines.

**Test Equipment**

- Frequency Synthesizer: HP 3355A
- Power Meter: HP 1980A
- Power Sensor: HP 688A
- Systems DVM: HP 8462A
- Systems DVM: HP 3465A

**SERVICE SHEET 4**

**20 MHz IF CIRCUITS (PART TWO)**  
**A3 20 MHz IF ASSEMBLY**  
**P/O A8 NOISE POWER DETECTOR**

**Block Diagram - Service Sheet 8D**

Section 8D of the Noise Figure Meter is located on Noise Figure Meter Assembly A8. Due to the size of the 20 MHz IF circuit, it is shown 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 these 20 MHz IF circuits located in the front panel of the Noise Figure Meter. The 20 MHz IF circuitry is shown on two separate service sheets. Service Sheet 3 contains most of the 20 MHz IF circuitry that is located within assembly A3.

The 20 MHz IF section of the Noise Figure Meter is located on Noise Figure Meter Assembly A8. Due to the size of the 20 MHz IF circuit, it is shown on two separate service sheets. Service Sheet 3 contains most of the 20 MHz IF circuitry that is located within assembly A3.

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The 20 MHz IF section of the Noise Figure Meter is located on Noise Figure Meter Assembly A8. Due to the size of the 20 MHz IF circuit, it is shown on two separate service sheets. Service Sheet 3 contains most of the 20 MHz IF circuitry that is located within assembly A3.

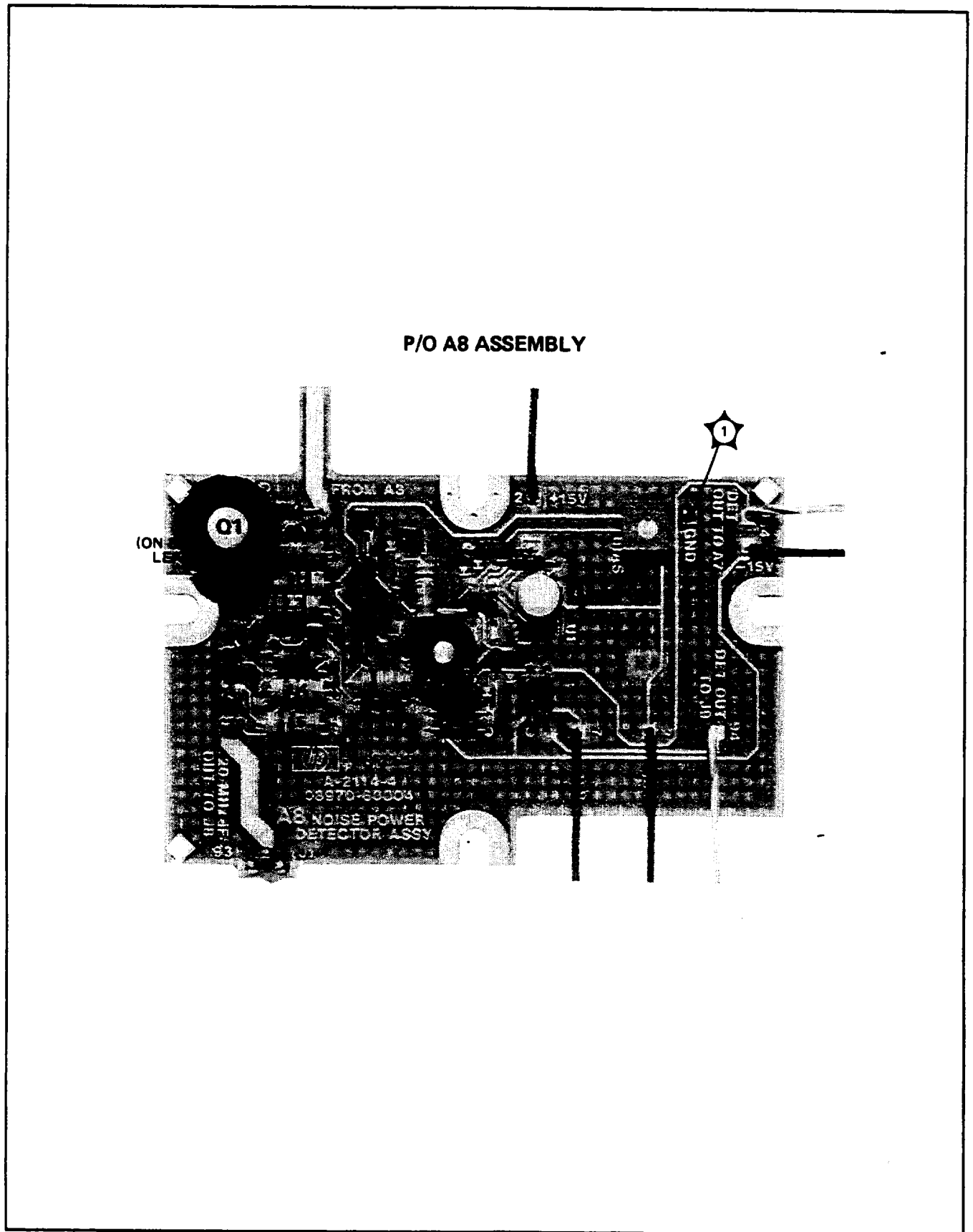
Service Sheet 4 contains the remainder of assembly A3, and these 20 MHz IF circuits located in the front panel of the Noise Figure Meter. The 20 MHz IF circuitry is shown on two separate service sheets. Service Sheet 3 contains most of the 20 MHz IF circuitry that is located within assembly A3.

The 20 MHz IF section of the Noise Figure Meter is located on Noise Figure Meter Assembly A8. Due to the size of the 20 MHz IF circuit, it is shown on two separate service sheets. Service Sheet 3 contains most of the 20 MHz IF circuitry that is located within assembly A3.

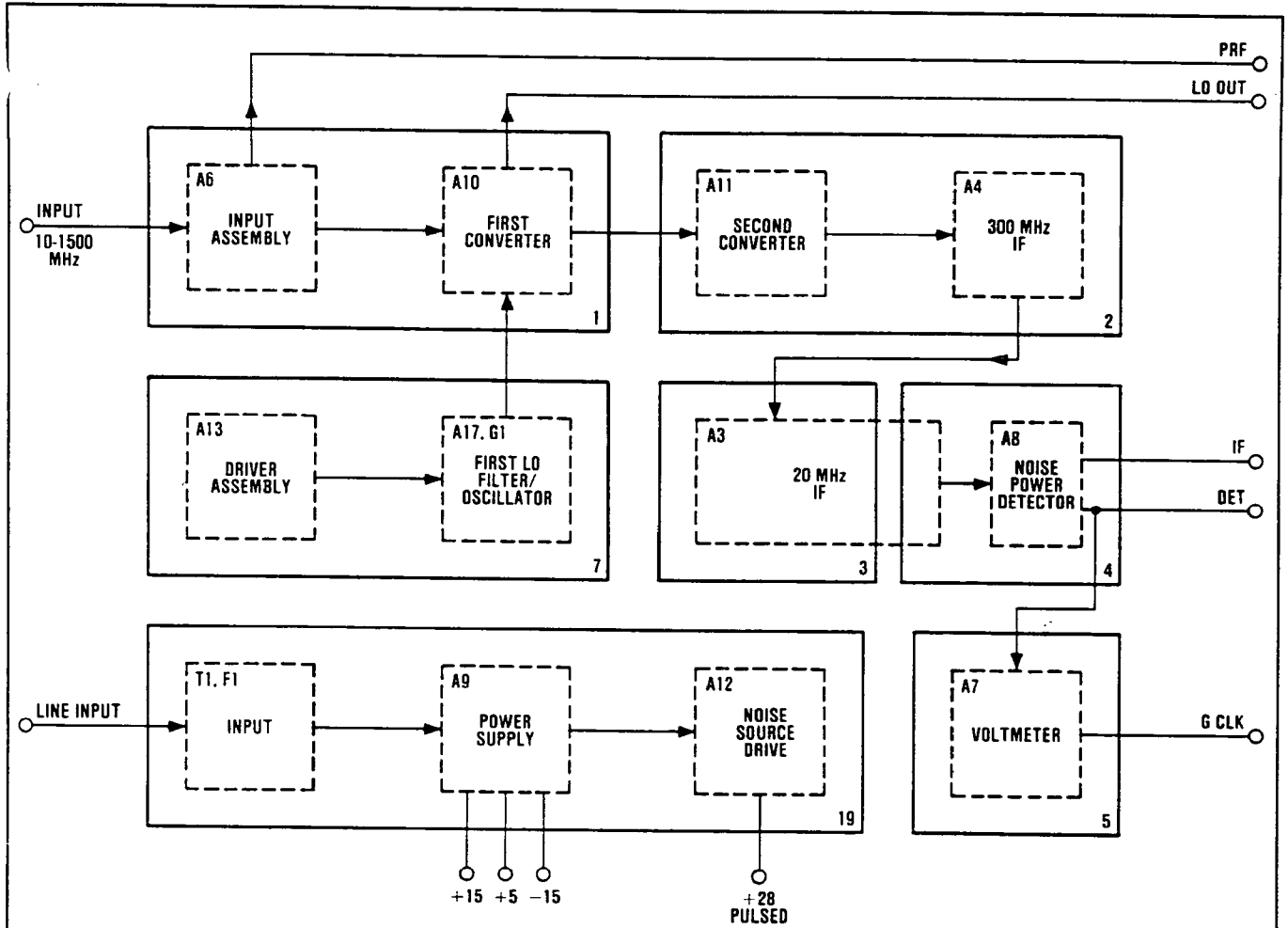
Service Sheet 4 contains the remainder of assembly A3, and these 20 MHz IF circuits located in the front panel of the Noise Figure Meter. The 20 MHz IF circuitry is shown on two separate service sheets. Service Sheet 3 contains most of the 20 MHz IF circuitry that is located within assembly A3.

The 20 MHz IF section of the Noise Figure Meter is located on Noise Figure Meter Assembly A8. Due to the size of the 20 MHz IF circuit, it is shown 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 these 20 MHz IF circuits located in the front panel of the Noise Figure Meter. The 20 MHz IF circuitry is shown on two separate service sheets. Service Sheet 3 contains most of the 20 MHz IF circuitry that is located within assembly A3.



**Figure 8-35. P/O A8 Noise Power Detector Assembly Component Locations (20 MHz IF)**



ANALOG SECTION BLOCK DIAGRAM BD2

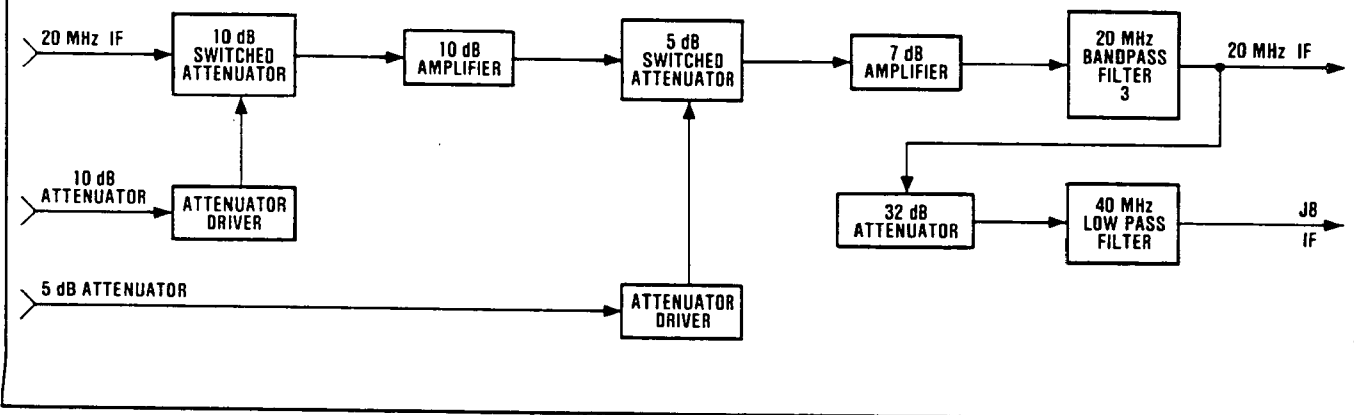


Figure 8-36. 20 MHz IF (Part 2) Block Diagram

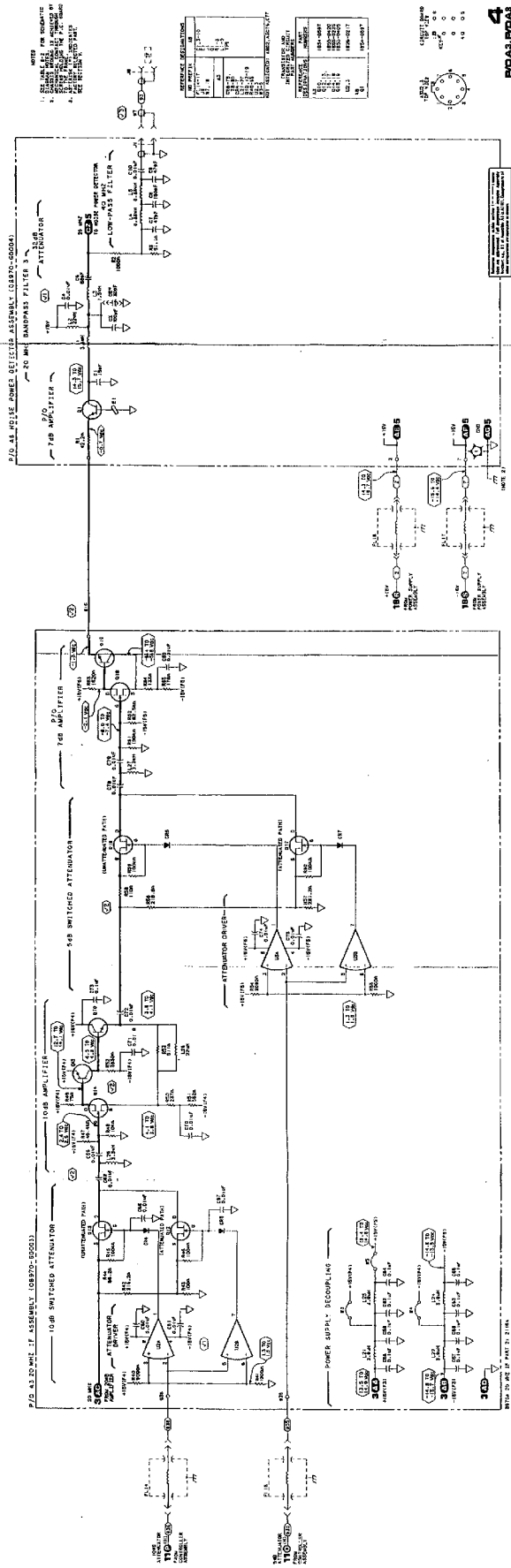


Figure 8-37. 20 MHz IF Schematic Diagram (Part 2)  
 Diagram  
 8-57

**SERVICE SHEET 5**  
**NOISE POWER DETECTOR AND VOLTMETER CIRCUITS**  
**P/O AS NOISE POWER DETECTOR**  
**AS VOLTMETER**

Block Diagram - Service Sheet 3P2  
 Block Diagram - Service Sheet 3P3  
 Section VIII - Special Operations and Power-Up Checks  
**PRINCIPLES OF OPERATION**  
**General**

As Noise Power Detector Assembly converts the RF signal from the P/O AS Noise Power Detector into a DC level, the P/O AS Noise Power Detector provides a current source to the P/O AS Noise Power Detector. The DC level is input to one of four solid state switches in the A7 Voltmeter Assembly.

A7 Voltmeter Assembly inserts two sets of clock pulses. The first set is generated from the input DC level, and enables a counter to be filled. The time that it takes to fill the counter is stored in the microprocessor (MPU). The Voltmeter Assembly then generates a set of pulses which enables the counter to be partially filled over a fixed period of time.

The MPU now has two counts, one of known time and known value, and one of known time and unknown value. It is only necessary for the MPU to subtract the two counts to derive the value of the unknown input DC level. If the input DC level is of a higher value than the known value, the counter will overflow and will fill the counter, and this generates an overflow to the MPU.

**A8 Noise Power Detector Assembly**  
 Transistor AS82 provides a current source to diodes AS83 and AS84. The output of AS83 is connected to the input DC level of the A7 Voltmeter Assembly. Capacitor AS85 provides a current source to the input DC level. During the negative half cycle, AS83 is active to bypass the negative pulses to ground.

AS81 provides just enough bias voltage (approximately 90 mV) to turn on diodes AS83 and AS84, resulting in improved detector response. The output of AS81 is connected to the input DC level. Diodes AS83 and AS84 are connected to the input DC level. Diodes AS83 and AS84 provide compensation.

**A7 Voltmeter Assembly**  
 Input Switches and Drivers. When the voltmeter is not in use, a low voltage potential is applied to the negative voltage terminal of the cathode of ATC3. The potential at ATC3 goes to zero, which removes the negative bias from the gate of ATQ6.

**SERVICE SHEET 5 (cont'd)**  
**General Checks**

This turns on ATQ6 which grounds the inverting input of ATU2B through AT8. This zeroes the integrator to prepare for the next measurement. The output of ATU2B is connected to the input of ATQ1, which turns on ATQ2 to enable the auto-zero feedback loop.

When the voltmeter is in measurement, the low impedance output of ATU2B is connected to the input of ATQ1, which turns off the second and auto-zero feedback loop switches, and turns on input DC level switch ATQ7/ATQ8. The DC level switch is similar to the second switch, except that it routes the input DC level to the integrator.

After the DC level has filled the counter, the DC level switch is turned off and the input DC level switch is turned on. The output of ATU2B is connected to the input of ATQ1, which turns on ATQ2 to enable the auto-zero feedback loop. The output of ATU2B is connected to the input of ATQ1, which turns off the second and auto-zero feedback loop switches, and turns on input DC level switch ATQ7/ATQ8. The DC level switch is similar to the second switch, except that it routes the input DC level to the integrator.

Zener AV18 provides a fixed voltage, which is not power supply dependent, to AV19. Zener AV19 provides the reference voltage across voltage divider AV17 and AV18. The voltage divider provides the -1.18 Volt reference which is routed to the integrator. The integrator and Auto-Zero Feedback Loop. The integrator consists of a feedback loop which is connected to the input of ATU2B and the output of ATU2B. The output of ATU2B is connected to the input of ATQ1, which turns on ATQ2 to enable the auto-zero feedback loop. The output of ATU2B is connected to the input of ATQ1, which turns off the second and auto-zero feedback loop switches, and turns on input DC level switch ATQ7/ATQ8. The DC level switch is similar to the second switch, except that it routes the input DC level to the integrator.

**TRUBLESHOOTING**  
 Troubleshooting is done on the signals of Service Sheet 5 when a malfunction has occurred in either Noise Power Detector Assembly A8 or Voltmeter Assembly A7. If all of the tests in the following procedure indicate correct component, the trouble is located elsewhere. The test values listed are approximate and are given as a service guideline.

**Test Equipment**  
 HP 8554A Oscilloscope  
 HP 1850A Oscilloscope Measuring System  
 Systems DVM  
 Noise Source

**SERVICE SHEET 5 (cont'd)**  
**General Checks**

In the power on condition, verify that the voltage from pin 7 of ASU1 to ground is +15 ±1.0 Vdc.  
 1. Ensure that the voltage from pin 4 of ASU1 to ground is -15 ±1.0 Vdc.  
 2. Ensure that the voltage from pin 6 of ATU2 to ground is +15 ±1.0 Vdc.  
 3. Ensure that the voltage from pin 4 of ATU2 to ground is -15 ±1.0 Vdc.  
 4. Ensure that the voltage from pin 4 of ATU2 to ground is -15 ±1.0 Vdc.

**A8 Noise Power Detector Circuit Tests**  
 1. Refer to Section 3, Operation, and set the Noise Power Meter to perform Frequency Calibration (Special Function 31).  
 2. Compare the input RF on the emitter of AS82 with the output at the DET connector AS81. Ensure that the positive pulses of the RF are being output, and are riding on the 0.6 mV bias.  
 3. If the bias (50 mV bias) is in error, attempt to correct the level by adjusting AS81 (BIAS). If the level is still in error, check ASU1, AS81, and AS82.  
 4. If the DC signal is in error, check AS82, AS83, AS84, and ASV1.

**A7 Voltmeter Circuit Tests**  
 1. Ensure that when the ZERO line is low, pin 6 of ATU2B is at ground. If not, check ATQ8, ATQ9, and ATC3.  
 2. Ensure that when the ZERO line is low, the output on pin 1 of ATU2A appears on pin 5 of ATU2B. If not, check ATQ1, ATQ2, and ATC3.  
 3. Ensure that when the REF line is low, a -1.19 Vdc is on pin 6 of ATU2B. If not, check ATQ3, ATQ4, ATC2, ATV1, and AV19.  
 4. Ensure that when the VOLT line is low, the output at DET connector AS91 is also input to pin 6 of ATU2B. If not, check ATQ1, ATQ2, and ATC3.  
 5. Ensure that during the measuring cycle, ATC3 contains a charge equivalent to the correct bias voltage (pin 6 of ASU1). If not, check ATU2 out ATC3.  
 6. Ensure that the output at pin 7 of ATU2B is integrated and input to pin 3 of ATU1. If not, check ATU2 and ATU1.  
 7. Ensure that the input to pin 3 of ATU1 is inverted and output as the CLK signal on pin 7 of ATU1. If there is evidence of

**SERVICE SHEET 5 (cont'd)**  
**Completion of Testing**

Upon completion of testing, place all switches in their original position. If the signal remains in error, check ATU1.  
 8. If the signal remains in error, check ATU1.

distortion (due to hysteresis), attempt to correct the situation by adjusting AT84 (VOLTMETER OFFSET).  
 8. If the signal remains in error, check ATU1.

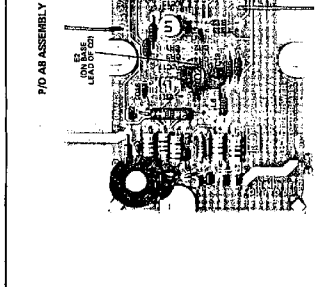


Figure 8-38. P/O AS Noise Power Detector Assembly Component Locations (Noise Power Detector)

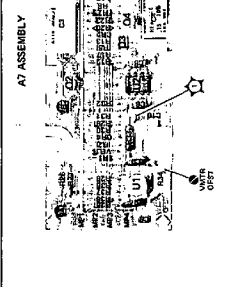


Figure 8-39. A7 Voltmeter Assembly Component Locations

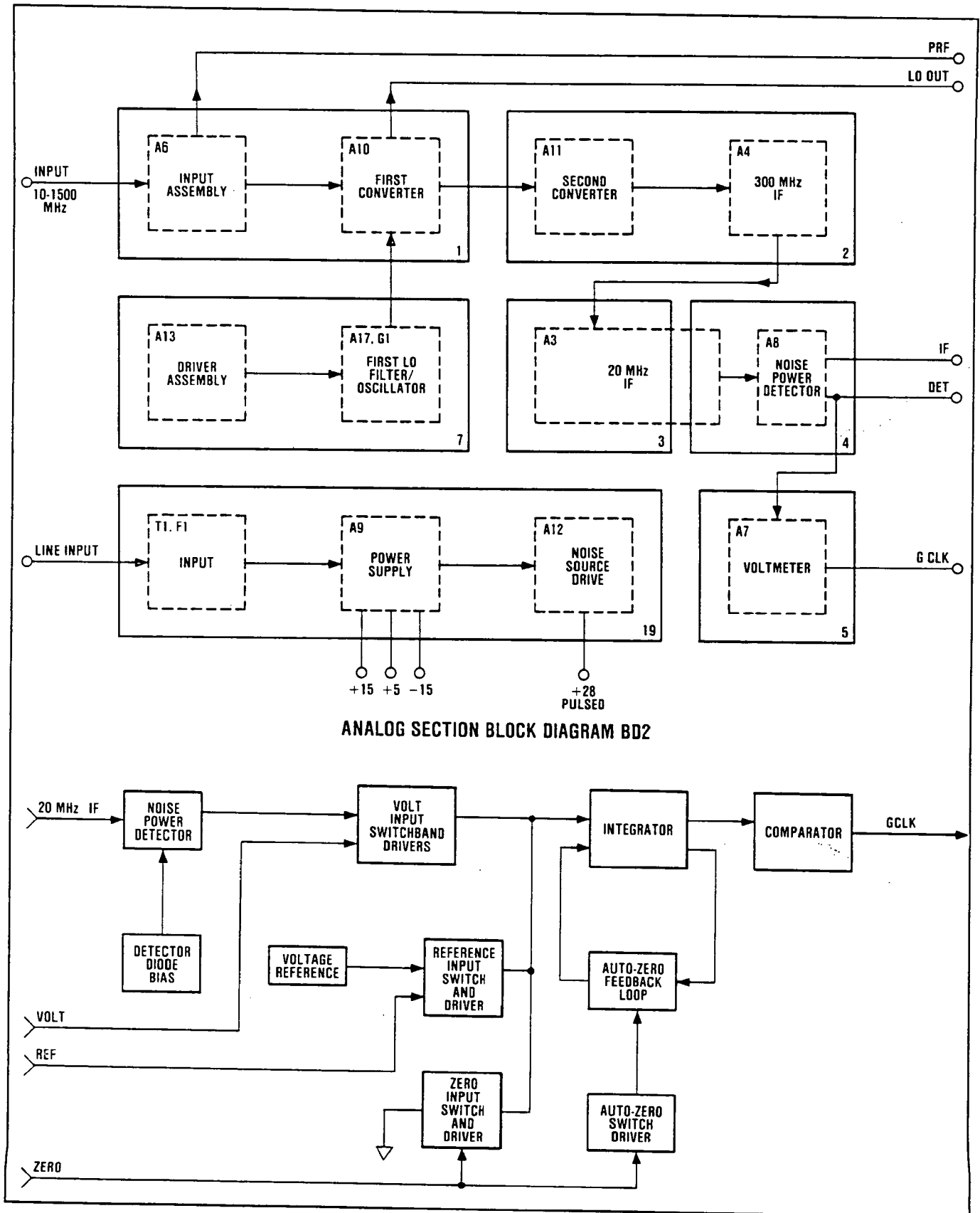


Figure 8-40. Noise Power Detector and Voltmeter Block Diagram

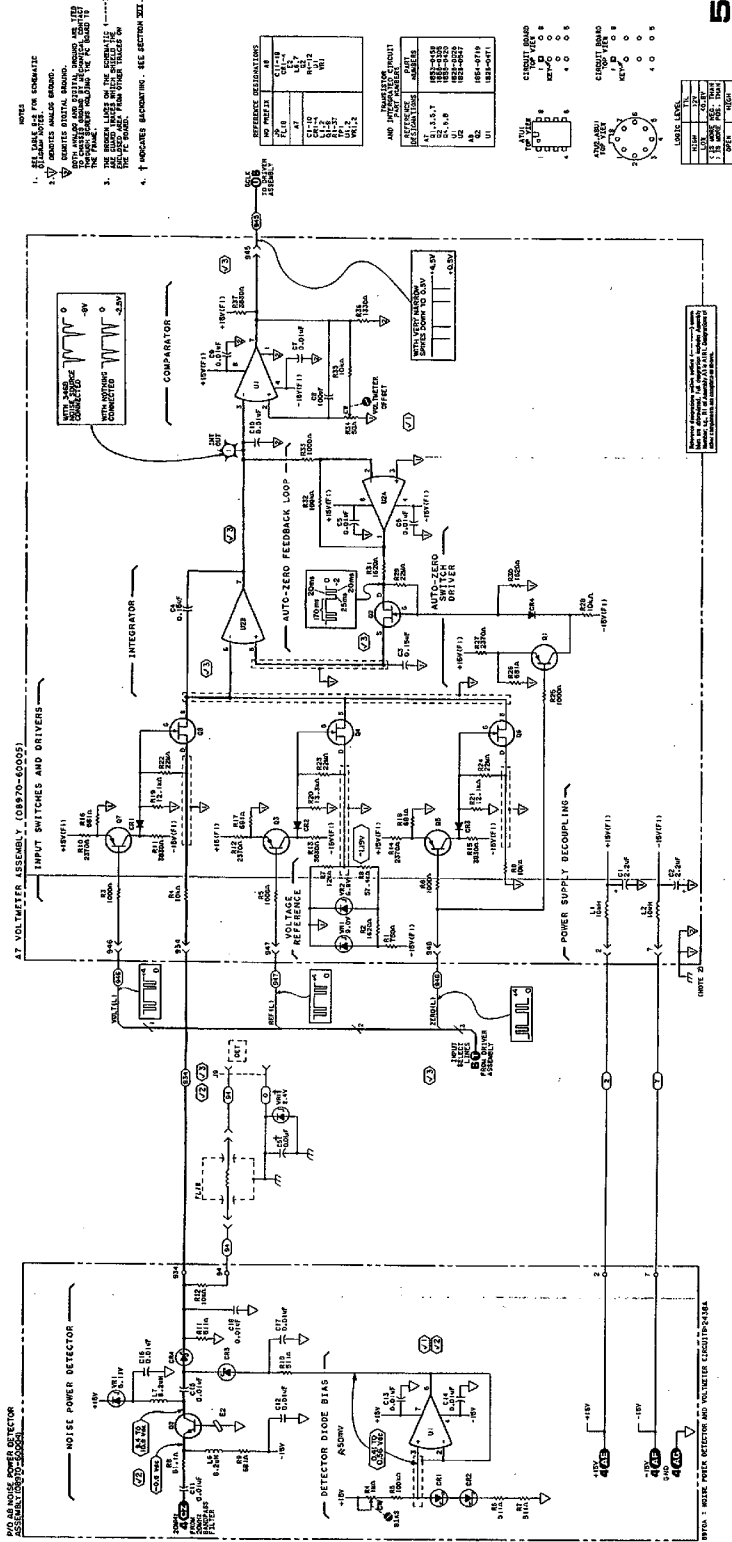


Figure 8-41. Noise Power Detector and Voltmeter Schematic Diagram

## SERVICE SHEET 6

### DRIVER — VOLTmeter DIGITAL CIRCUITS

#### P/O A13 DRIVER ASSEMBLY

#### REFERENCES

Block Diagram - Service Sheet BD4

Section III - Operator 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 also provided to 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 clock pulses from 4 MHz time base A13G1 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.

## SERVICE SHEET 6 (cont'd)

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 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 to the controller, and is not affected 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.



**SERVICE SHEET 6 (cont'd)**

**Table E24. A13U13 Pinouts**

DA1-3	DA1-17
DA2-5	DA2-15
DA3-7	DA3-13
DA4-9	DA4-11

1. Ensure that each time that the EI input is low, new data is present on the outputs of A13U13. If the output of A13U13 is in error, any data line is held high or low, check A13U10 and A13U12.

**(CZ) Pulse Stretcher Circuits Checks**

1. Set the Noise Figure Meter to an out of limits measurement, and ensure that the overflow pulse is present at test point A13T21. If not, check the A13U5A, A13U20A, A13U19C, and A13U21B.
2. Ensure that each time the LAST COUNT pulse is generated at pin 3 of A13U12, the output of A13U13 is held high or low, check A13U20B and A13U21A.
3. Ensure that a low level 100  $\mu$ s pulse is output on pin 3 of A13U12, and to the E2 inputs (pins 1 and 19). The data bus output 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. Observe the output of A13U20A and ensure that the input pulse is present at the output pin 4 of A13U20A.
5. If the output pulse at pin 4 of A13U20A is in error, check A13U20A and A13U20B. Otherwise, ensure that the ZERO input at pin 2 of A13U21A is held high or low, that a 100  $\mu$ s low level pulse is generated at pin 12 of A13U21B. If not, check A13U21B.

**(CZ) Input Select Logic Circuits Checks**

1. Ensure that each time that the LAST COUNT line is low, the ZERO line is high, the output (VOLT) at pin 8 of A13U1C is low. If not, check A13U1C 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 9 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 equipment, and return the Noise Figure Meter to its normal condition. If repairs have been made, or if measurements changed, refer to the references listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

**Noise Power Detector and Voltmeter**  
A13U10  
A13U11  
A13U12  
A13U13  
A13U14  
A13U15  
A13U16  
A13U17  
A13U18  
A13U19  
A13U20  
A13U21  
A13U22  
A13U23  
A13U24  
A13U25  
A13U26  
A13U27  
A13U28  
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A13U84  
A13U85  
A13U86  
A13U87  
A13U88  
A13U89  
A13U90  
A13U91  
A13U92  
A13U93  
A13U94  
A13U95  
A13U96  
A13U97  
A13U98  
A13U99  
A13U100

**SERVICE SHEET 6 (cont'd)**

3. Ensure that each low CVT pulse (A13T10) has a high component output at pin 8 of A13U12. If not, check A13U10, A13U20, and A13U21.

**(CZ) Data Accumulation and Latching**

1. Connect the Logic Analyzer to the output pins of A13U10, and to RESET (pins 2 and 12) and CLOCK (pins 13, 15, 17, and 19) of A13U12. The output pins of A13U10 are 3 through 6, and 8 through 11.
2. Ensure that each time that RESET is low, and a check pulse is present at the overflow pin of A13U10, the output of A13U10 is present, and that the output of A13U12 is held high or low, check A13U10 and A13U12.
3. Ensure that the counter 411 and that an overflow pulse is present at the overflow pin of A13U10, the output of A13U12 is held high or low, check A13U10B and A13U12. If any output line is held high or low, check A13U20 and A13U21.
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 E-26.

**Table E-26. A13U12 Pinouts**

DA1-3	DA1-17
DA2-5	DA2-15
DA3-7	DA3-13
DA4-9	DA4-11

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, any data line is held high or low, check A13U12 and A13U10.
6. Reconfigure the Noise Figure Meter to complete a series of calibration tests.
7. Connect the logic analyzer to the output pins of A13U12, to RESET (pins 2 and 12) of A13U10, and to overflow pulses (pins 1 and 19) of A13U12. The output pins of A13U12 are 3 through 6 and 8 through 11.
8. Ensure that each time RESET is low, and an overflow pulse is present, the counters 411 and 412 of A13U12 are present, and that the output of A13U12 is held high or low, check A13U12 and A13U10. If any overflow pulse is present, check the overflow input to A13U12, the output of A13U10, and A13U12.
9. Ensure that 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 E-26.

**SERVICE SHEET 6 (cont'd)**

If the value measured is included the reference value, then the conversion will be tested at this time. If the value is not included, the value will be a value above or below the reference value, another count pulse will be generated, and the conversion will be tested again. This will cause last count flip/flop A13U5A to toggle back from high to low.

This will take the REF line high and the VOLT line low. This will have no effect, as the LAST COUNT pulse is high. The overflow pulse signal will enable A13U21A (ZERO still high) to output a high level pulse. The output of A13U21A 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 exists. The controller will reset the counter and generate the end of conversion (EOCV) pulse. The controller will then be ready for the next test conversion pulse (CVT) to restart the process.

**TROUBLESHOOTING**

Troubleshooting is done on the basis of Service Sheet 6 when a fault is detected in one of the Voltmeter Digital Driver outputs of Driver Assembly A13. If all of the tests in the following procedures indicate correct responses, the voltage divider circuit, where in the system the fault exists, is not known. The values listed are approximate and are given as a service guideline.

**Test Equipment**

- Noise Source..... HP 348B
- Logic Analyzer..... HP 6900
- Logic Analyzer..... HP 6901
- Oscilloscope Measuring System..... HP 2455A
- Systems DVM..... HP 2455A

**(CZ) General Checks**

1. In the power on condition, verify that the voltage from test point A13T17 to test point A13T18 (ground) is +0.200 Vdc.
2. Ensure that the 4 MHz clock is present on test point A13T23.
3. Refer to the Troubleshooting procedures of Section 3 Operation, and to the Noise Figure Meter to complete a series of calibration tests on the Noise Source.

**(CZ) Starting Conversion Checks**

1. Set the Noise Figure Meter to test point A13T10 is followed by a high level ZERO output at test point A13T21.
2. If the CVT pulse is in error, check A13U5A, A13U10, and A13U20. If the ZERO level is in error, check A13U20, A13U21, and A13U22.

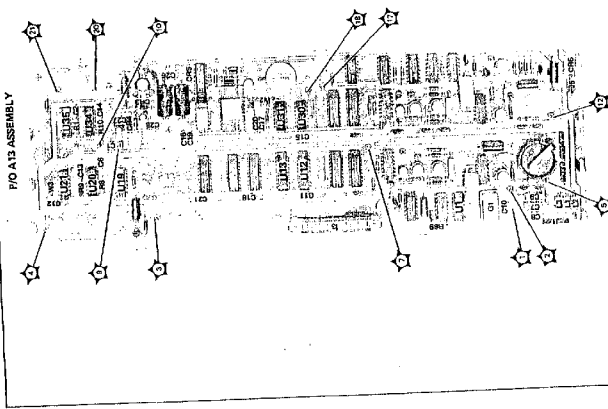
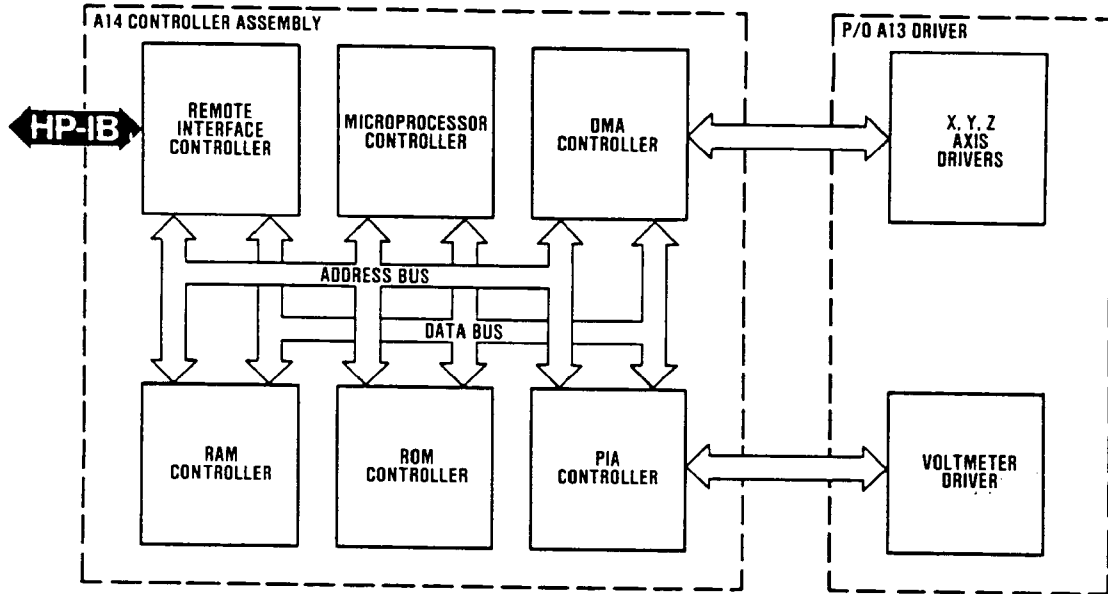


Figure 8-42. P10 A13 Driver Assembly Component Locations (Minimum Digital Circuit)



DIGITAL SECTION BLOCK DIAGRAM BD4

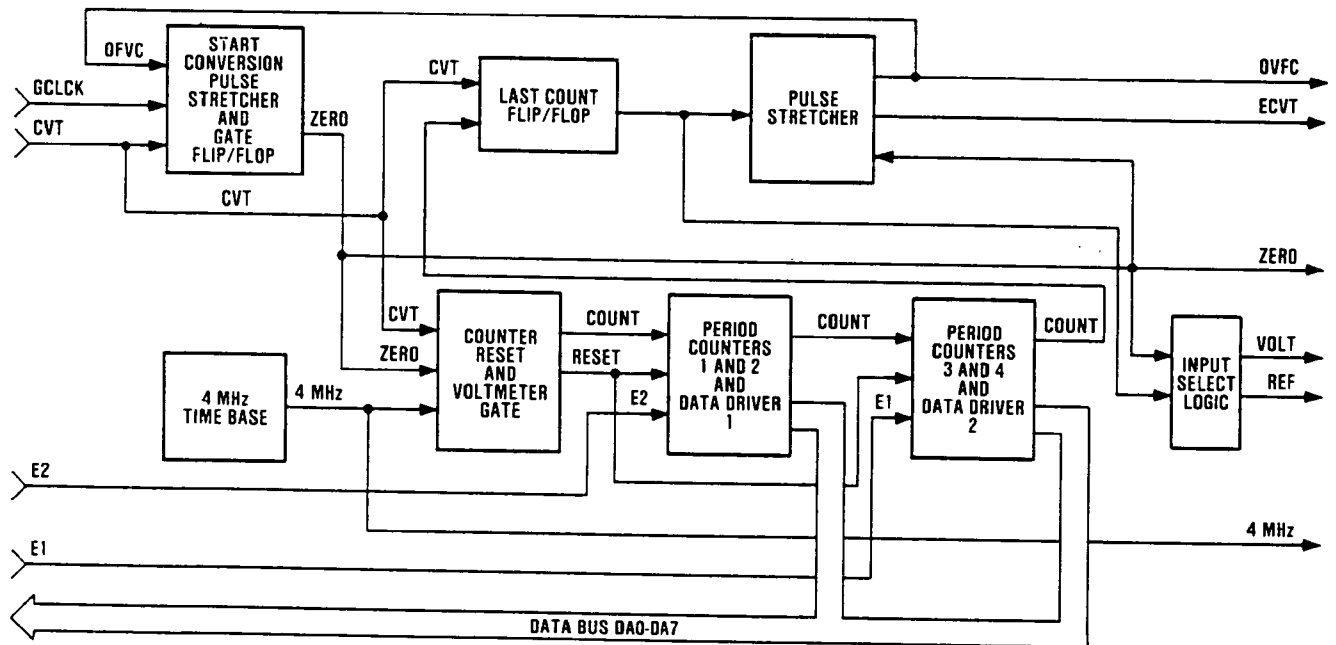


Figure 8-43. Driver — Voltmeter Digital Block Diagram





**SERVICE SHEET 7 (cont'd)****✓7 Hysteresis Calibration Test**

1. Ensure that the waveform shown on Service Sheet 7 is present on the base of A13Q3 each time the frequency is changed.
2. If the waveform is in error, check A13U19F, A13Q3, and A13CR3.
3. Ensure that the collector of A13Q3 is at ground each time the signal on the base is positive. If not, check A13Q3.
4. Ensure that each time the signal is low, A13Q3 is cut off, and the signal at pin 10 of A13U42C rises at a linear rate.

5. If the signal at pin 10 of A13U42C remains low, check A13Q3 and A13Q2. If the signal rises at a nonlinear rate, check A13Q2, A13CR4, A13R24, and A13C28.

**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 A13 ASSEMBLY

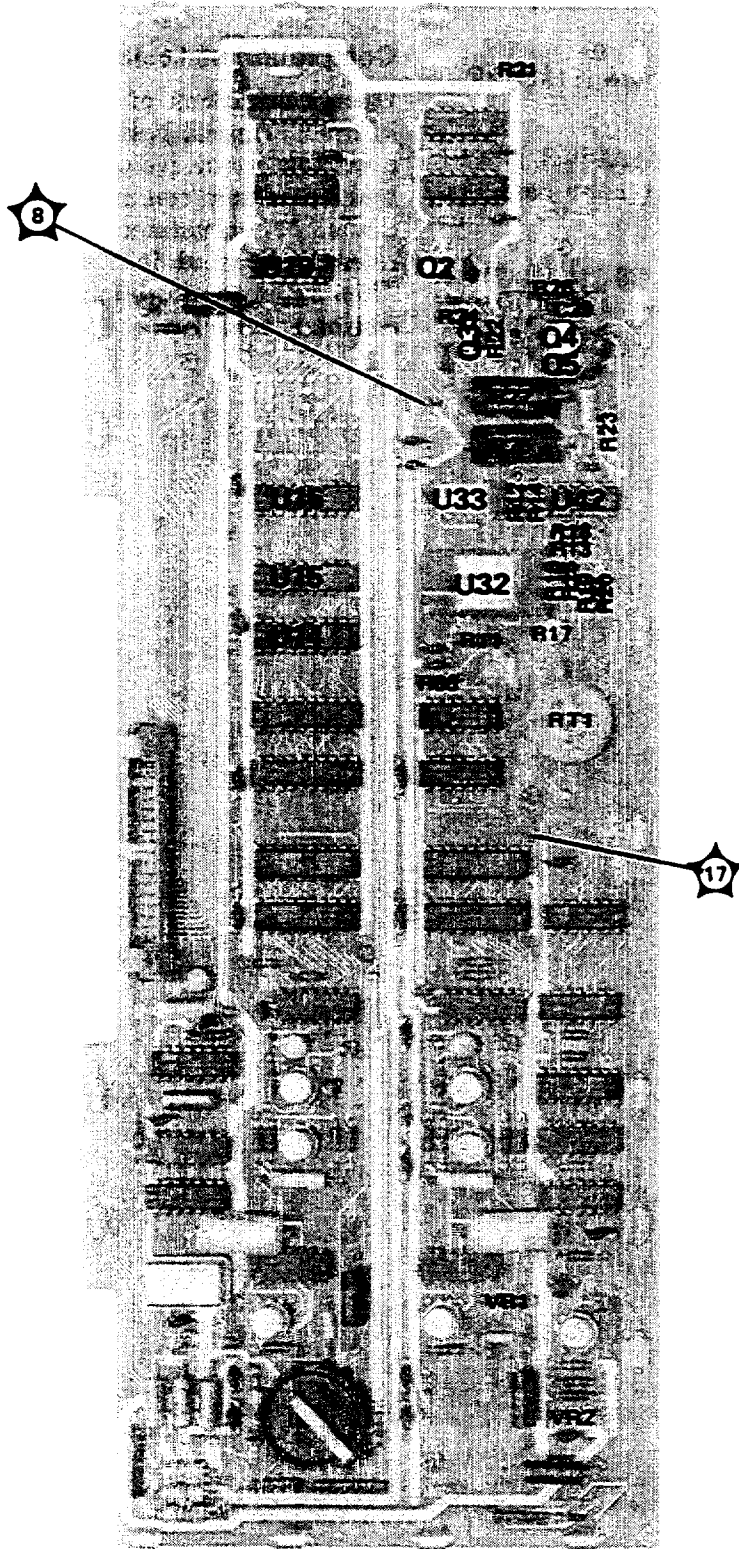


Figure 8-45. P/O A13 Driver Assembly Component Locations (First LO Drive)

A17 ASSEMBLY

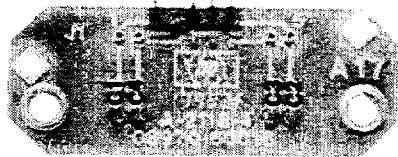
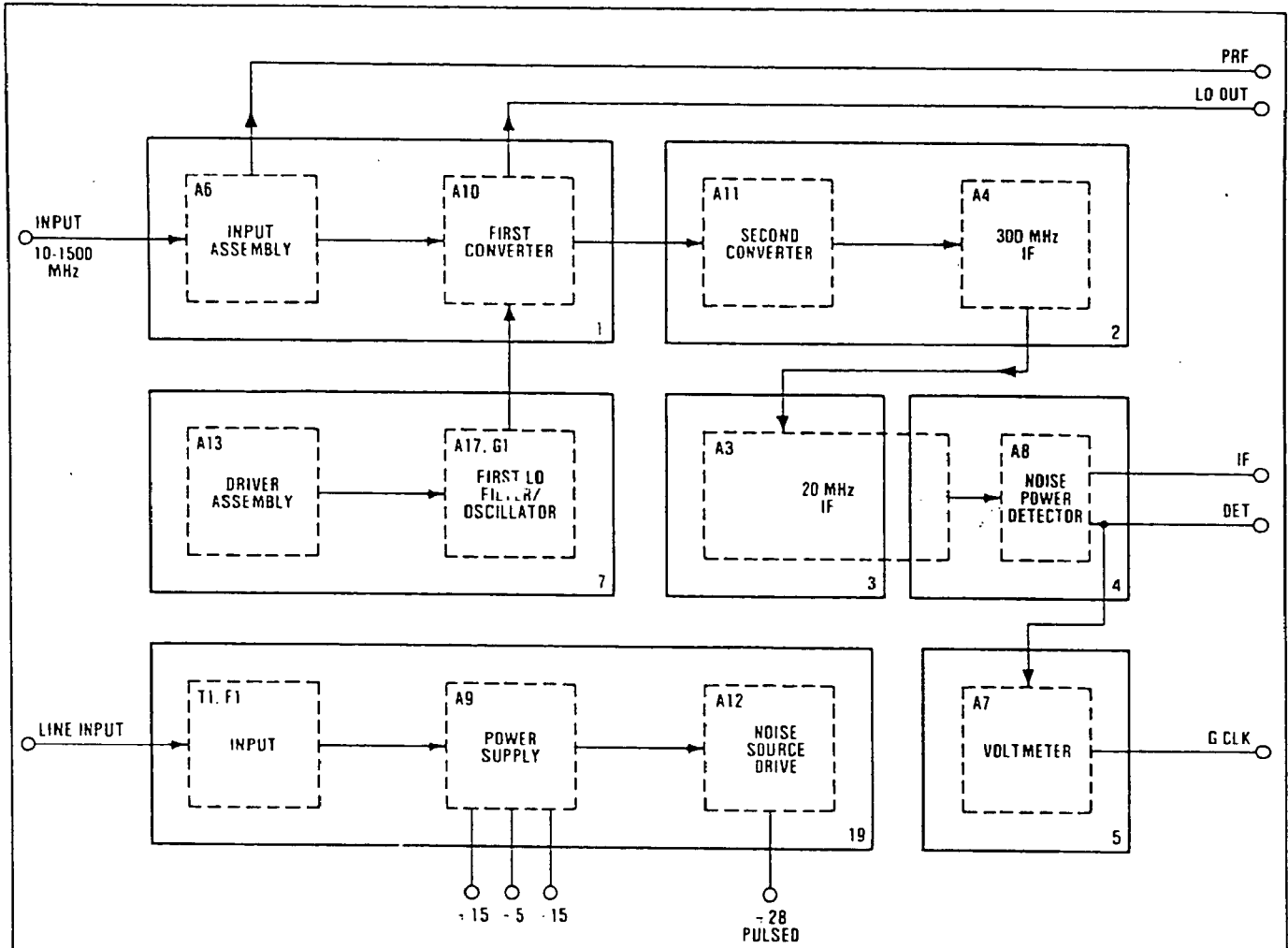


Figure 8-46. A17 First LO Filter Assembly Component Locations



ANALOG SECTION BLOCK DIAGRAM BD2

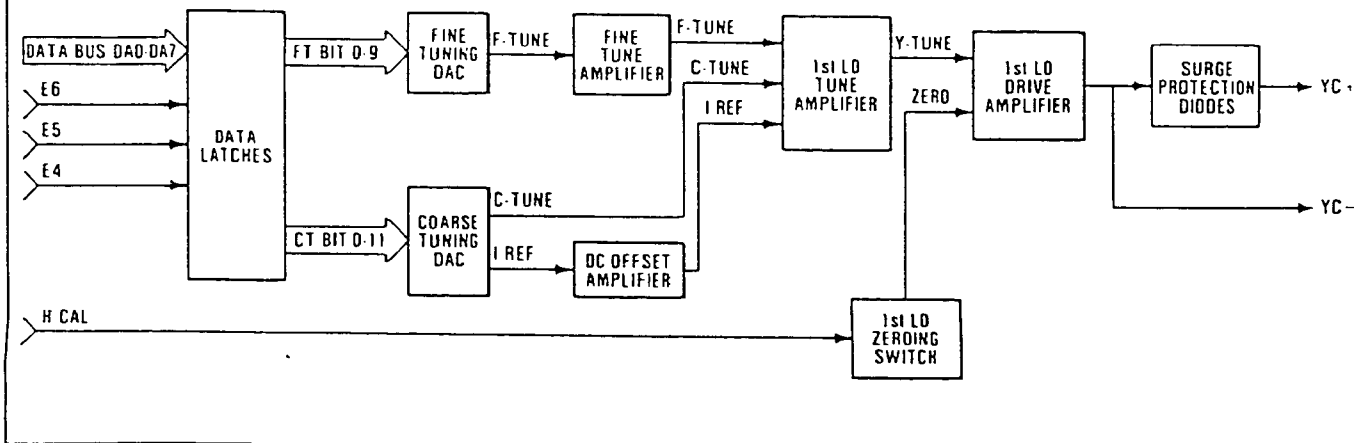
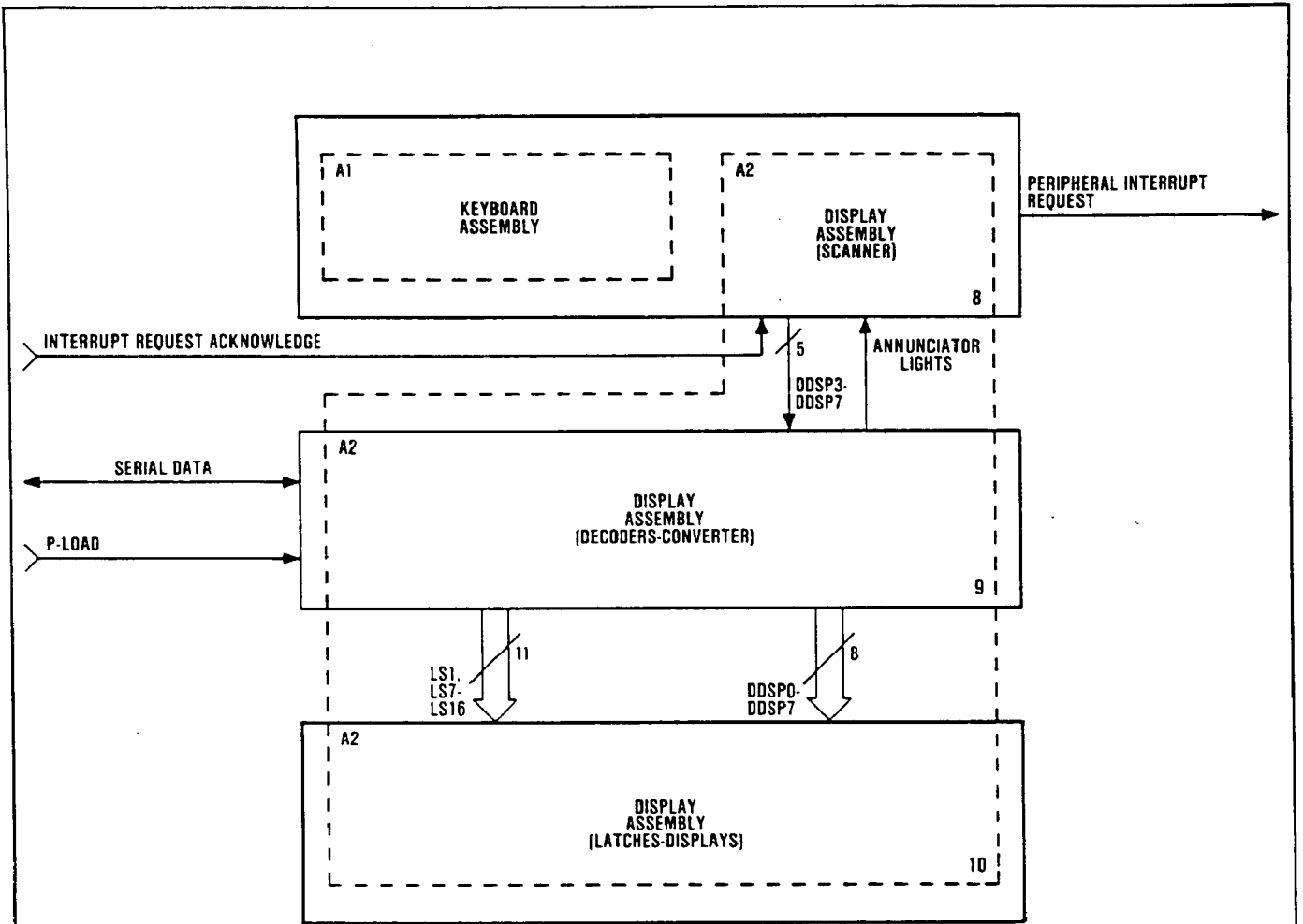


Figure 8-47. Driver — First LO Drive Block Diagram









KEYBOARD AND DISPLAY SECTIONS BLOCK DIAGRAM BD3

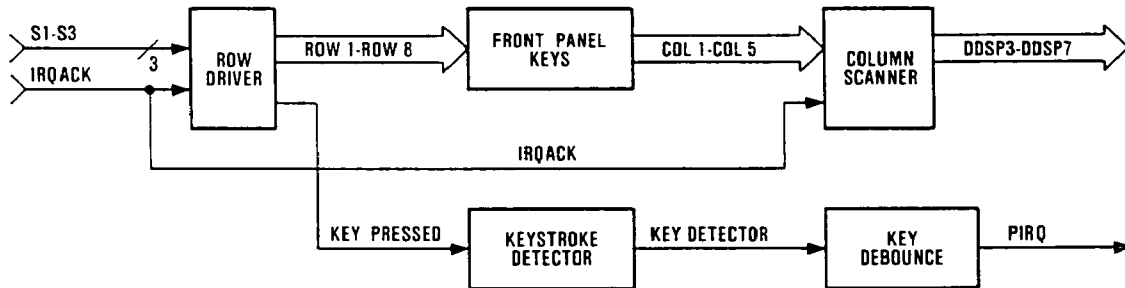


Figure 8-51. Keyboard Interface and Keys Block Diagram





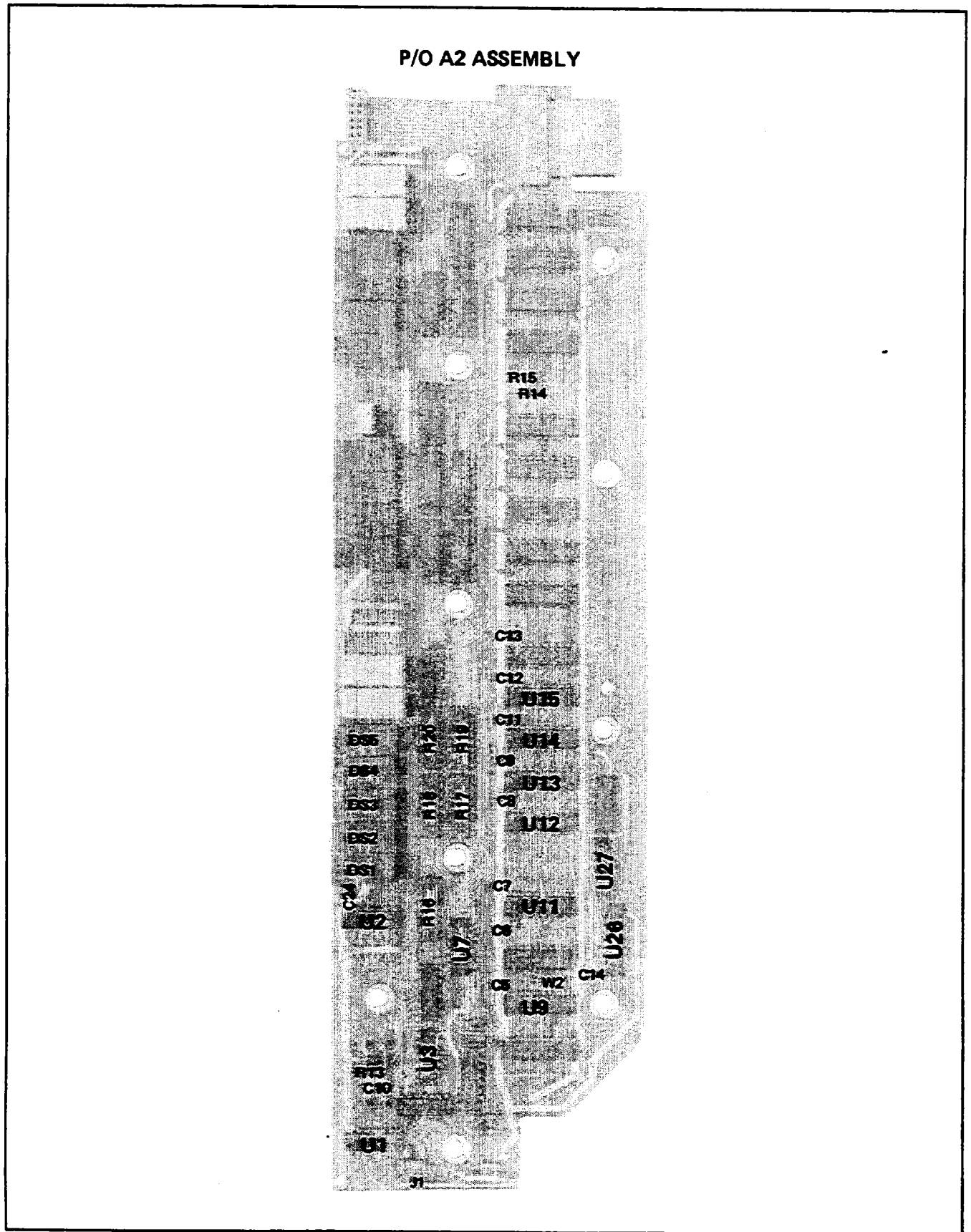


Figure 8-53. P/O A2 Display Assembly Component Locations (Left Display)

NOTE: SEE PARTS LIST FOR PARTS IDENTIFICATION.

REF. NO.	QTY.	DESCRIPTION	MANUFACTURER'S PART NO.
1	1	RESISTOR	100K
2	1	RESISTOR	100K
3	1	RESISTOR	100K
4	1	RESISTOR	100K
5	1	RESISTOR	100K
6	1	RESISTOR	100K
7	1	RESISTOR	100K
8	1	RESISTOR	100K
9	1	RESISTOR	100K
10	1	RESISTOR	100K
11	1	RESISTOR	100K
12	1	RESISTOR	100K
13	1	RESISTOR	100K
14	1	RESISTOR	100K
15	1	RESISTOR	100K
16	1	RESISTOR	100K
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30	1	RESISTOR	100K
31	1	RESISTOR	100K
32	1	RESISTOR	100K
33	1	RESISTOR	100K
34	1	RESISTOR	100K
35	1	RESISTOR	100K
36	1	RESISTOR	100K
37	1	RESISTOR	100K
38	1	RESISTOR	100K
39	1	RESISTOR	100K
40	1	RESISTOR	100K
41	1	RESISTOR	100K
42	1	RESISTOR	100K
43	1	RESISTOR	100K
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70	1	RESISTOR	100K
71	1	RESISTOR	100K
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81	1	RESISTOR	100K
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85	1	RESISTOR	100K
86	1	RESISTOR	100K
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89	1	RESISTOR	100K
90	1	RESISTOR	100K
91	1	RESISTOR	100K
92	1	RESISTOR	100K
93	1	RESISTOR	100K
94	1	RESISTOR	100K
95	1	RESISTOR	100K
96	1	RESISTOR	100K
97	1	RESISTOR	100K
98	1	RESISTOR	100K
99	1	RESISTOR	100K
100	1	RESISTOR	100K

Figure 8-43. Left Display Schematic Diagram

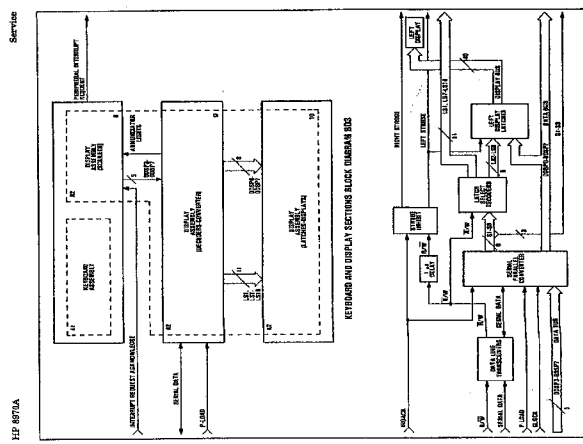
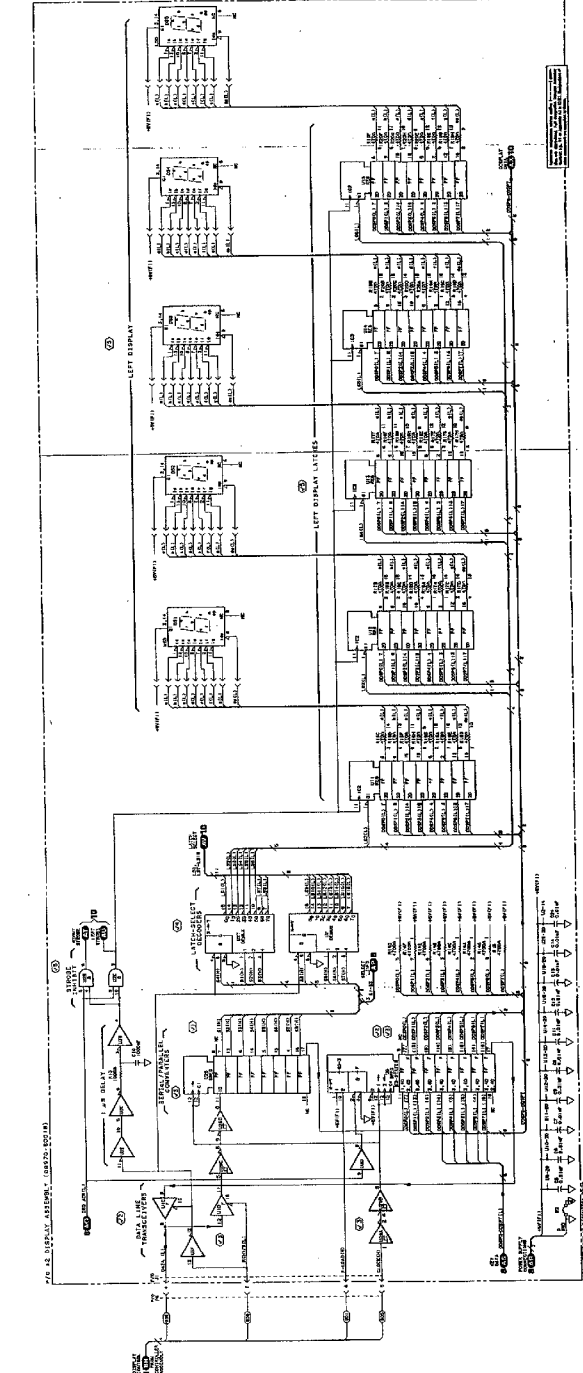
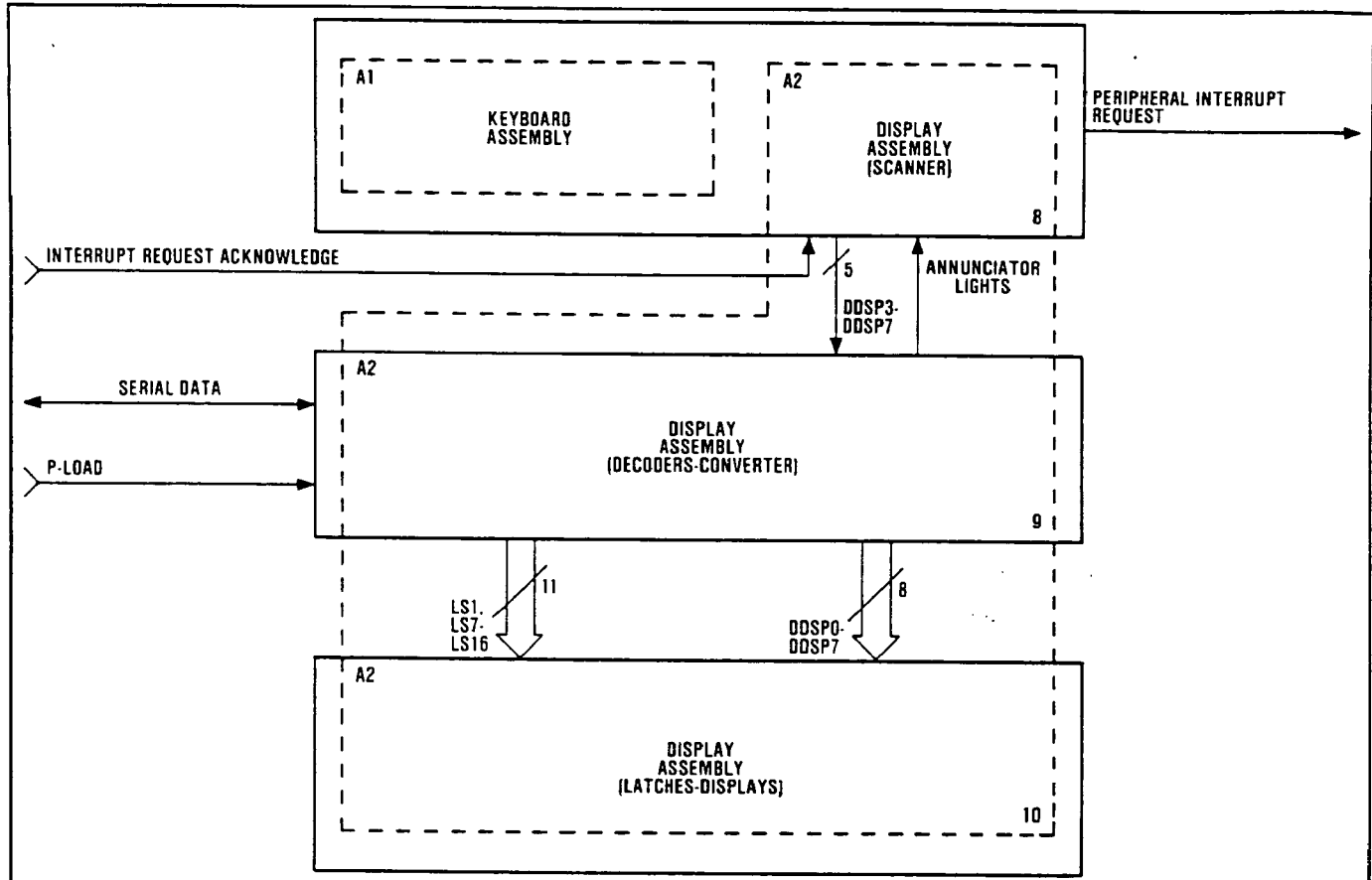


Figure 8-44. Left Display Block Diagram







KEYBOARD AND DISPLAY SECTIONS BLOCK DIAGRAM BD3

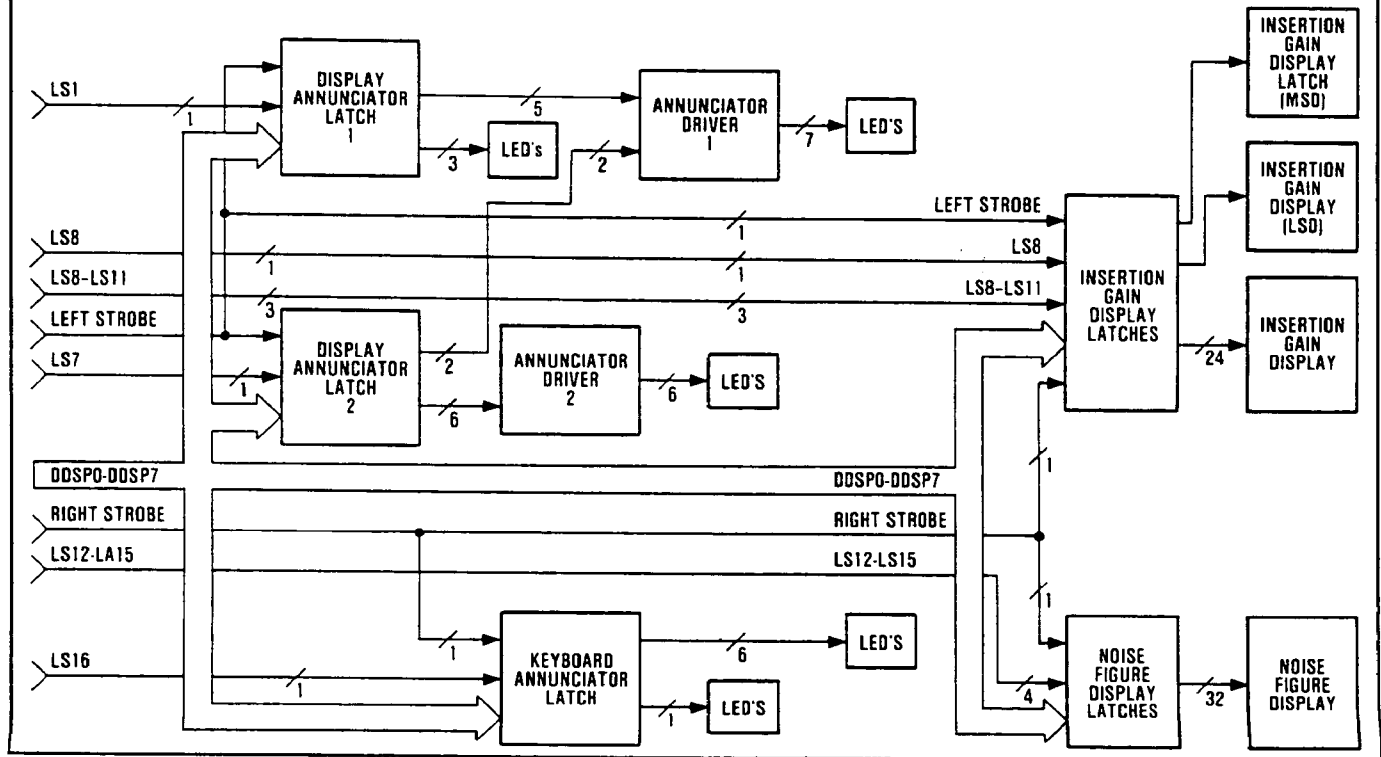


Figure 8-58. Right Display and Front Panel Annunciators Block Diagrams

1. SEE TABLE 101 FOR SCHEMATIC  
2. UNLOCATED COMPONENTS - SEE SECTION 202

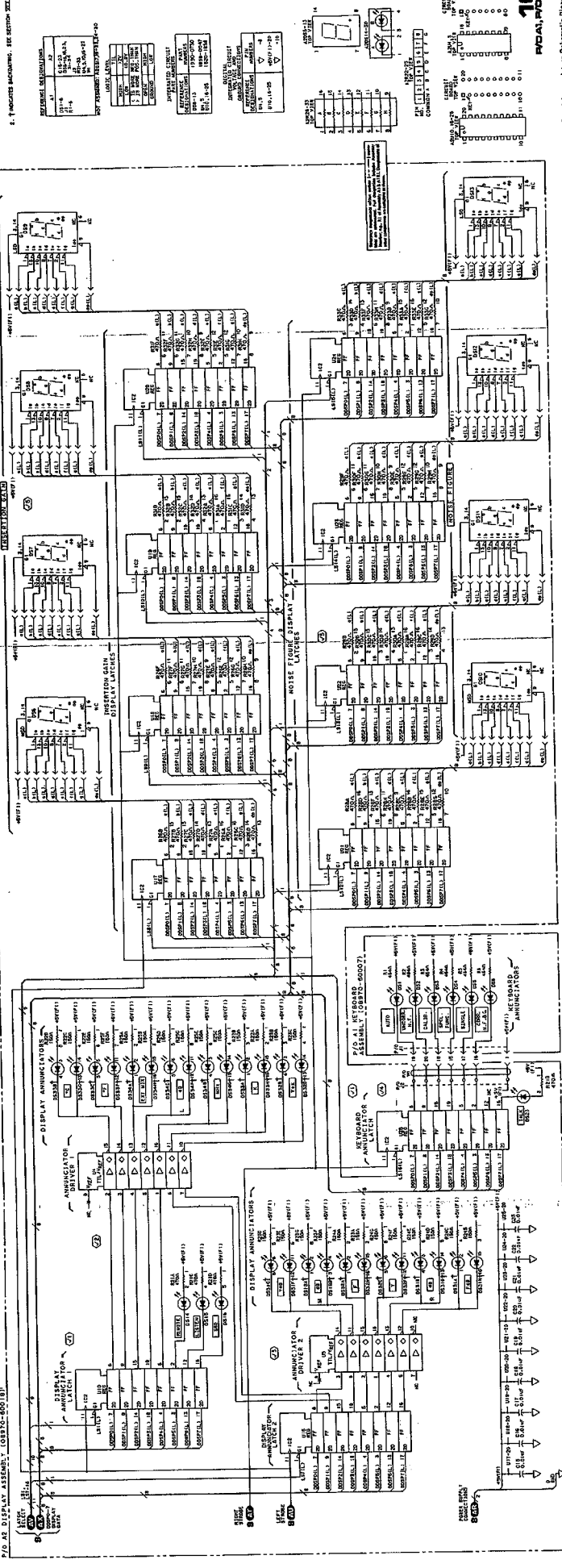


Figure 8-58. Right Display and Front Panel Annunciator Schematic Diagram



**SERVICE SHEET 11 (cont'd)**

**(✓3) RF Attenuator Control**

Connect the probe to each node listed in Table 8-48, and verify that each signature is correct and stable. If all signatures are correct, reconnect A14J1, and verify that the relays are functioning within Input Assembly A6.

**RF Attenuator Latch A14U43.** The first device tested is A14U43. If pin 11 (A14U43 ENABLE) is in error, proceed to the A14U48 PIA tests. If pins 16 and 17, of PIA A14U48, are correct, then a failure has occurred in or around device A14U43, A14U61, or A14U50. The remaining seven pins of A14U43 are the data input pins (DD0—DD4 and DD6—DD7). An error on any of these pins can be the result of a failure of device A14U43, or bad data from A14U48. Also, a failure of either device A14U59 or A14U44 (which share the data bus) can cause a bus error at A14U43.

**Table 8-48. RF Attenuator Drive Logic**

Node	Signature	Signal Name
A14U43-11	6H28	U43 CLOCK (enable)
A14U43-18	HA3F	DD7
A14U43-3	C4HF	DD6
A14U43-4	CA74	DD4
A14U43-14	3U90	DD3
A14U43-7	AA76	DD2
A14U43-13	8FF7	DD1
A14U43-8	P6F3	DD0
A14U42-7	U7PH	DD2
A14U42-5	PC8P	DD3
A14U42-4	F7F5	DD4 (10 dB pad 1)
A14U42-3	C104	DD5 (10 dB pad 2)
A14U42-2	965U	DD6 (10 dB pad 3)
A14U42-1	U7PH	DD7 (+20 dB)

**RF Attenuator Driver A14U42.** The six pins of A14U42 that are tested are the data input pins (DD2—DD7). An error on any of these pins are the result of a failure of either device A14U42 or A14U43.

**(✓4) Display Assembly Control**

Connect the probe to each node listed in Table 8-49, and verify that each signature is correct and stable. If all signatures are correct, refer to the Display Assembly A2 testing procedures.

**Table 8-49. Display Assembly Drive Logic**

Node	Signature	Signal Name
A14U48-23	5234	PIA 1 ENABLE (CS2)
A14U48-26	5FHC	PD7
A14U48-27	UF91	PD6
A14U48-29	2C68	PD4
A14U48-30	8UU0	PD3
A14U48-31	259H	PD2
A14U48-32	A0PA	PD1
A14U48-33	HAAU	PD0
A14U48-21	1U9H	R/ $\bar{W}$
A14U48-2	P6F3	DD0
A14U48-3	8FF7	DD1
A14U48-4	AA76	DD2
A14U48-5	3U90	DD3
A14U48-6	CA74	DD4
A14U48-8	C4HF	DD6
A14U48-9	HA3F	DD7
A14U44-2	PC8P	PB3
A14U44-12	H893	CB2
A14U44-19	9279	P-LOAD
A14U52-1	C167	U52A ENABLE
A14U52-3	539U	DATA (serial display)
A14U52-4	5AP9	U52B ENABLE
A14U61-6	AC5U	CLOCK (display)

**Peripheral Interface Adapter 1 (PIA1) A14U48.** The first device tested is PIA1. An error on Pin 23 is an error on the PIA1 ENABLE line, which is tied to the CS2 input of the PIA. A failure on this line is probably caused by device A14U48, A14U64, or A14U62. The next seven pins are the data input pins (PD0—PD4 and PD6—PD7). An error on any of these pins is probably caused by one of the three devices which share this common data bus; A14U46, A14U48, or A14U35. Pin 21 is the Read/Write (R/ $\bar{W}$ ) input. An error on this pin is most probably caused by A14U35, A14U46, or A14U48. The final seven pins are the data output pins (PD0-PD4 and PD6—PD7). An error on any of these pins is probably caused by one of the four devices which share this common data bus; A14U48, A14U44, A14U43, or A14U59.

**NOTE**

On PIA1, the IRQACK signal on pin 39 (CA2) will go low in response to a front panel keystroke. The NMI signal on pin 38 (IRQA) will contain one low spike for each keystroke. The  $\Phi$ 2 clock signal on pin 25 (ENABLE) is a 4V, 1 MHz, squarewave.

**SERVICE SHEET 11 (cont'd)****Front Panel Serial/Parallel Data Converter A14U44.**

The next device tested is A14U44. Pin 2 is the PB3 input which enables A14U44. This is the same PB3 line from pin 13 of PIA A14U48 (PB3). An error on this pin is caused by either A14U44 or A14U48. An error on pin 12 of A14U44 is an error on the clock (CB2) input of A14U44, and can be caused by a failure in A14U44, A14U61, or A14U48. Pin 19 is the P-LOAD input from the PIA. A failure on this line is probably caused by A14U44, A14U48, or a failure in the Display Assembly A2.

**Bi-Directional Buffer A14U52.** Pin 1 is the R/ $\bar{W}$  input to A14U52A. Device A14U63F inverts the signal and inputs it to A14U52B. This way, only one half of U52 is active at any one time. An error on this line is probably caused by A14U52, A14U63, A14U48, or a failure in the Display Assembly A2. Pin 3 of A14U52 is the serial DATA output. An error on this pin is caused by either A14U52, or a failure in the Display Assembly A2. An error on pin 4 of A14U52 is caused by either A14U52 or A14U63.

**AND Gate A14U61.** Pin 6 of A14U61 is the CLOCK signal to the Display Assembly A2. A failure on this line is caused by either A14U61 or a failure in the Display Assembly A2.

**NOTE**

*On Bi-Directional Buffer A14U52, the DATA signal will appear as packets of data approximately 12 ms wide, and approximately 160 ms apart for corrected NF < Gain or, approximately 140 ms apart for uncorrected data. On AND gate A14U61, the CLOCK signal on pin 6 will appear as a 200  $\mu$ s burst, followed by a 60  $\mu$ s space. This pattern will continue to repeat, stopping only when all data has been sent to the front panel.*

**✓ B Voltmeter and First LO Control**

Connect the probe to each node listed in Table 8-50, and verify that each signature is correct and stable. If all signatures are correct, refer to either the Voltmeter Assembly A7 or the First Converter Assembly A10 testing procedures.

**Peripheral Interface Adapter 2 (PIA2) A14U46.**

The first device tested is PIA2. Pin 21 is the Read/ $\bar{W}$  input. An error on this pin is probably caused by device A14U46, A14U48, or A14U35. Pin 23 is the PIA 2 ENABLE (CS2)

input. (This pin is high most of the time.) An error on this pin is probably caused by device A14U46, A14U51, or A14U62. The next eight pins are the data input pins (PD0—PD7) to the PIA. An error on any of these pins is probably caused by device A14U35, A14U48, or A14U46.

Pins 35 and 36 are the A1 (RS1) and A0 (RS0) inputs to the PIA and are from the Controller address bus. An error on either line is the result of a probable failure of either A14U48 or A14U46. Pin 39 is the CA2 output of the PIA, and is the enable to device A14U45. An error on this line is probably caused by either A14U45 or A14U46. The next eight lines are the data output lines (PA0—PA7). All eight of these lines are input only to A14U45.

**Table 8-50. Voltmeter and First LO Drive Logic**

Node	Signature	Signal Name
A14U46-21	CF50	R/ $\bar{W}$
A14U46-23	7A23	PIA 2 ENABLE (CS2)
A14U46-26	98U8	PD7
A14U46-27	42H2	PD6
A14U46-28	2482	PD5
A14U46-29	0848	PD4
A14U46-30	AU66	PD3
A14U46-31	381A	PD2
A14U46-32	1C4H	PD1
A14U46-33	97C1	PD0
A14U46-35	7A74	A1 (RS1)
A14U46-36	020U	A0 (RS0)
A14U46-39	0000	CA2 (U45 enable)
A14U46-2	66C1	PA0
A14U46-3	098H	PA1
A14U46-4	CA74	PA2
A14U46-5	73C0	PA3
A14U46-6	F298	PA4
A14U46-7	757H	PA5
A14U46-8	AF3F	PA6
A14U46-9	P37P	PA7
A14U46-12	13A4	PB2 (E3)
A14U46-13	75A3	PB3 (E4)
A14U46-14	7110	PB4 (E5)
A14U46-15	4937	PB5 (E6)
A14U45-2	66C1	DA0
A14U45-3	098H	DA1
A14U45-4	CA74	DA2
A14U45-5	73C0	DA3
A14U45-6	F298	DA4
A14U45-7	757H	DA5
A14U45-8	AF3F	DA6
A14U45-9	P37P	DA7

**SERVICE SHEET 11 (cont'd)**

Therefore, an error on any of these lines is caused by either A14U45 or A14U46. The final four lines are the data output lines (PB2-PB5). Pin 12 is the E3 (PB2) signal to the Driver Assembly (voltage meter circuit) A13. An error on this line is caused by either A14U46 or a failure in Driver Assembly A13. Pins 13, 14, and 15 are the E4 (PB3), E5 (PB4), and E6 (PB5) signals to the Driver Assembly (First LO circuit) A13. An error on any of these lines is caused by either A14U46, or a failure in Driver Assembly A13.

**Data Buffer A14U45.** On this device, the eight data output lines (DA0—DA7) are tested. All eight of these lines are routed directly to Driver Assembly A13. An error on any of these lines is caused by either A14U45 or a failure in Driver Assembly A13.

**Completion of Signature Analysis Testing**

Upon completion of Signature Analysis testing, place switch A14S2B in the NORMAL position, reconnect A14J1, remove all test equipment, 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.

**✓ 6 Peripheral Interface Adapter (PIA) Troubleshooting Aids**

Troubleshooting a Peripheral Interface Adapter (PIA) is accomplished on two levels. The signature analysis routines will usually isolate the failure to the general area. It is then necessary to proceed on a manual level. Observe and/or complete the following steps:

1. Ensure that there is  $+5 \pm 0.5$  Vdc on pin 20 of the PIA.
2. Ensure that SYSTEM CLOCK  $\phi 2$  is on pin 25.

**NOTE**

*The PIA appears, at first glance, to be just another type of dual channel multiplexer. This is NOT the case. The PIA is a programmable device with built-in registers that store and process BOTH data and PIA control words. The following steps outline what must occur for the PIA to function.*

3. The PIA must be selected before any action can be taken. This is accomplished by the CS0, CS1, and CS2 inputs. On the Noise Figure Meter, the CS0 and CS1 lines are tied high. Therefore, it is necessary only to pull the CS2 line low, to select the PIA.
4. When the microprocessor is ready to use the PIA, it will take the RESET line low. The duration of this reset must be between  $0.5 \mu\text{s}$  and  $0.66 \mu\text{s}$ . This must be followed by a  $1 \mu\text{s}$  delay before the microprocessor can address the PIA.
5. The first data entered into the PIA is the control word. This word is used in conjunction with the RS0 and RS1 inputs to select which internal register will receive the data.
6. Among other things, the control word selects which output register (data port) will be used, and in which direction the data will flow.

**NOTE**

*The  $R/\bar{W}$  input does not control the peripheral ports data flow. This command relates to the PIA communicating with the microprocessor.*

7. Once the PIA has been programmed, the read or write cycle can take place. During this time, the RS0, RS1, CS0, CS1, and CS2 lines MUST be stable for the duration of the clock pulses.

**✓ 7 Sample/Hold and Comparator Troubleshooting Aids**

A problem located within the Sample/Hold and Comparator circuit is more in the nature of an analog problem than a digital one. One method of troubleshooting this circuit is as follows:

1. Ensure that comparator A14U67A has  $+15 \pm 1$  Vdc on pin 3, and that sample/hold amplifier A14U66 has  $+15 \pm 1$  Vdc on pin 9 and  $-15 \pm 1$  Vdc on pin 5.
2. Connect channel 1 of the oscilloscope to A14U66-2 and channel 2 to A14U66-14. Set both channels to DC.

**SERVICE SHEET 11 (cont'd)**

3. Using the signal generator, inject a signal of approximately 800 MHz into the Noise Figure Meter INPUT at any level less than -10 dBm. Allow time for the signals on A14U66 to stabilize.
4. Slowly change the input frequency (direction is optional). Ensure that the signal on pin 14 (H/S) begins to toggle as the controller begins the sampling process.
5. Failure to toggle, should have been detected in the signature analysis routine. This can be the result of a short on the data bus of bit DD3; check A14U66, A14U58, A14U59, A14U43, A14U44, or A14U48. Ensure the PIA (A14U48) is receiving the correct data.
6. As the input frequency is shifted, ensure that the signal on A14U66 (DET) is a changing dc level. Direction and amount of change will depend on direction and speed of frequency shift.
7. Failure of a dc level shift is the result of a failure in either A14U66, A14U67A, or in the Frequency Cal Detector circuit in the 20 MHz IF Assembly A3.
8. Move the oscilloscope channel 1 from A14U66-2 to A14U66-7, and again slowly change the input frequency. Ensure that the dc level on pin 7 changes as pin 14 toggles.
9. Failure of the dc level on A14U66-7 to change is caused by a failure of either A14U66 or A14U67A.
10. Move the oscilloscope channel 1 probe to comparator A14U67A-4, and channel 2 probe to A14U67A-5. Slowly change the input frequency while closely observing the two traces.
11. Ensure that both dc levels change, and that one dc level is lagging the other. As to which level lags, and by how much, will again depend on the direction and amount of input frequency shift.
12. Failure of either dc level to change, or for one level to lag the other, is caused by a failure in either A14U66 or A14U67A.

**NOTE**

*Step 13 requires the use of a third channel of signal verification. If the scope in use does not have a third channel, or another scope is not available, the following steps can still be completed. Note the movements of the two input levels to the comparator and then move one of the scope channels to the output of the comparator while observing the other input. Then repeat the process with the other channel.*

13. Connect the third oscilloscope channel (or second oscilloscope channel) to comparator A14U67A-2. Again, change the input frequency and observe all three traces. The leading channel can be either positive or negative in relation to the lagging channel, depending on the direction of the frequency shift.
14. In either event, the dc level with the highest positive level will cause the output of comparator A14U67A at pin 2 to go high (+5 Vdc) or low (0 Vdc).
15. Ensure that if the new DET dc level at pin 4 is higher than the last sampled level at pin 5, the output at pin 2 is high. If the last sampled level is the higher, then ensure that the output at pin 2 is low.
16. This process will continue as long as the frequency continues to change. Allow the frequency to hold at some fixed point, and observe the two dc input levels (pins 4 and 5) of the comparator.
17. Ensure that the two levels close on each other and finally cross over each other. This indicates locking onto the input frequency.
18. A failure in any of steps 13 through 18 is the result of a failure in either A14U67A or A14U59.
19. If all steps are completed successfully, the sample/hold and comparator circuit is functioning correctly. Disconnect all test gear and restore the Noise Figure Meter to operation.


**IF and RF Attenuator Latches  
Troubleshooting Aids**

A problem in the attenuator latches is purely digital in nature and should be quickly isolated

**SERVICE SHEET 11 (cont'd)**

by the signature analysis routines. If all of the latches appear to have proper outputs, then the trouble is most likely in Driver Assembly A13. If there is a need to further isolate the trouble, it can be accomplished manually.

Refer to Table 8-51 for the IF Attenuator Latch logic or to Table 8-52 for the RF Attenuator Latch logic. Then, refer to the Detailed Operating Instructions, Section III, for the IF and RF Attenuator Selection procedures. Follow the instruc-

tions given, to manually select the desired attenuators, and use the logic table to verify proper logic level outputs.

**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 reference listed in the front of this section. Then refer to the applicable sections for post-testing procedures.

**Table 8-51. IF Attenuator Latch Logic**

Data Bit at Input to A14U58					Total	Sample/	Noise
NSON DD4	H/S DD3	-20 DD2	-10 DD1	-5 DD0	Latch Atten	Hold Status	Source Status
0	0	0	0	0	0	Sample	Off
0	0	0	0	1	-5	Sample	Off
0	0	0	1	0	-10	Sample	Off
0	0	0	1	1	-15	Sample	Off
0	0	1	0	0	-20	Sample	Off
0	0	1	0	1	-25	Sample	Off
0	0	1	1	0	-30	Sample	Off
0	0	1	1	1	-35	Sample	Off
0	1	0	0	0	0	Hold	Off
0	1	0	0	1	-5	Hold	Off
0	1	0	1	0	-10	Hold	Off
0	1	0	1	1	-15	Hold	Off
0	1	1	0	0	-20	Hold	Off
0	1	1	0	1	-25	Hold	Off
0	1	1	1	0	-30	Hold	Off
0	1	1	1	1	-35	Hold	Off
1	0	0	0	0	0	Sample	On
1	0	0	0	1	-5	Sample	On
1	0	0	1	0	-10	Sample	On
1	0	0	1	1	-15	Sample	On
1	0	1	0	0	-20	Sample	On
1	0	1	0	1	-25	Sample	On
1	0	1	1	0	-30	Sample	On
1	0	1	1	1	-35	Sample	On
1	1	0	0	0	0	Hold	On
1	1	0	0	1	-5	Hold	On
1	1	0	1	0	-10	Hold	On
1	1	0	1	1	-15	Hold	On
1	1	1	0	0	-20	Hold	On
1	1	1	0	1	-25	Hold	On
1	1	1	1	0	-30	Hold	On
1	1	1	1	1	-35	Hold	On

Notes: Data Bits DD5 through DD7 are not used.  
1 = High 0 = Low

**Table 8-52. RF Attenuator Latch Logic**

Data Bits at input to A14U43				Total
-20 DD7	-10 DD6	-10 DD5	-10 DD4	RF Atten
0	0	0	0	0
0	0	0	1	-10
0	0	1	0	-10
0	0	1	1	-20
0	1	0	0	-10
0	1	0	1	-20
0	1	1	0	-20
0	1	1	1	-30
1	0	0	0	+20
1	0	0	1	+10
1	0	1	0	+10
1	0	1	1	0
1	1	0	0	+10
1	1	0	1	0
1	1	1	0	0
1	1	1	1	-10

Notes: Data Bits DD0 through DD3 are not used.  
1 = High 0 = Low



P/O A14 ASSEMBLY

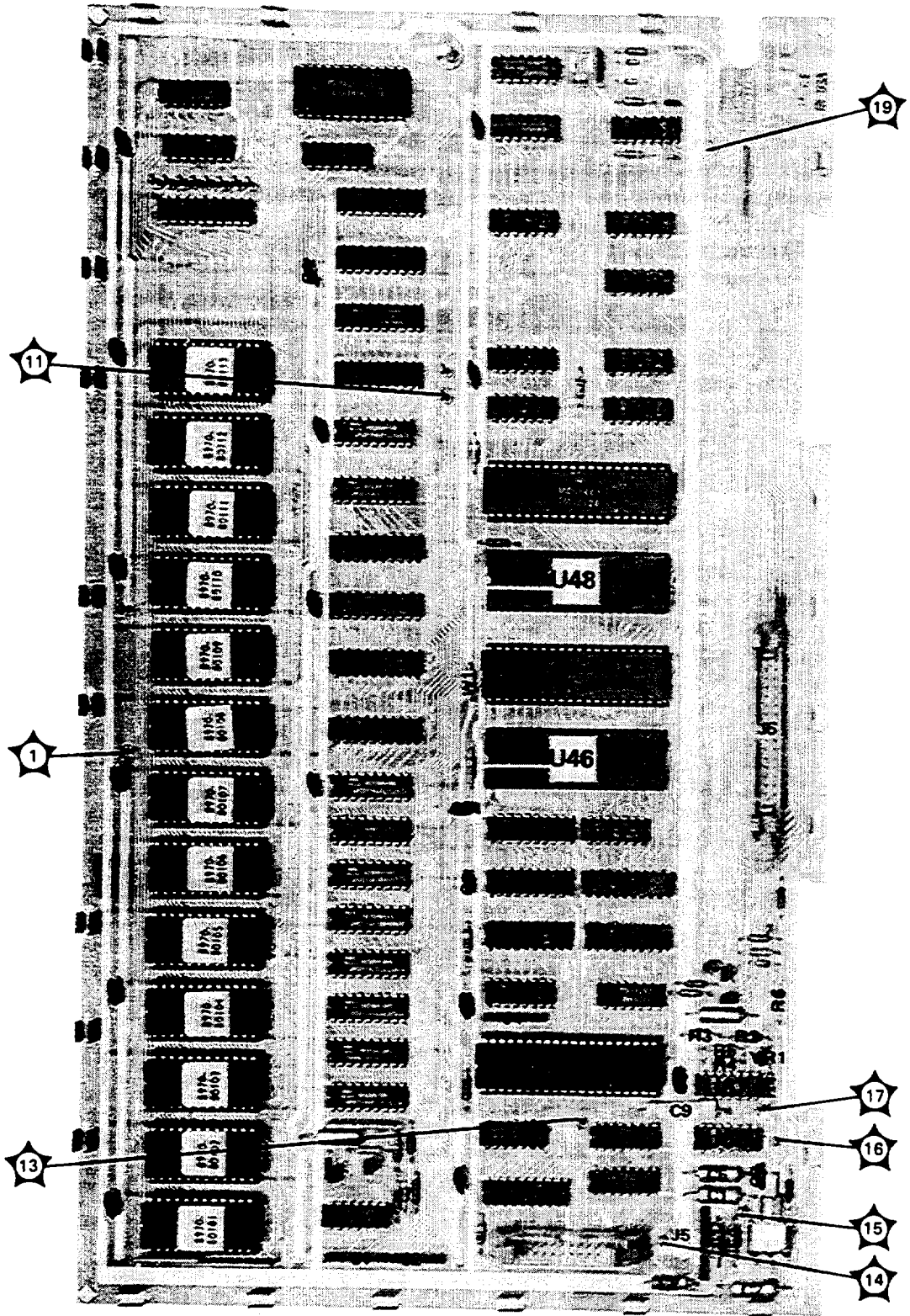
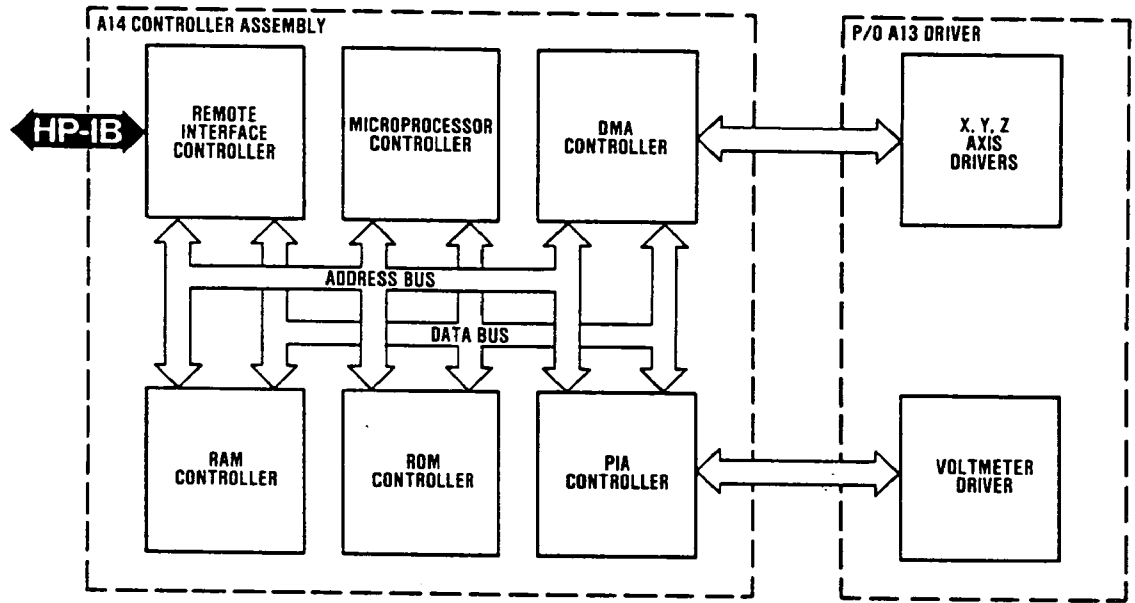


Figure 8-60. P/O A14 Controller Assembly Component Locations (Front Panel Annunciators)



DIGITAL SECTION BLOCK DIAGRAM BD4

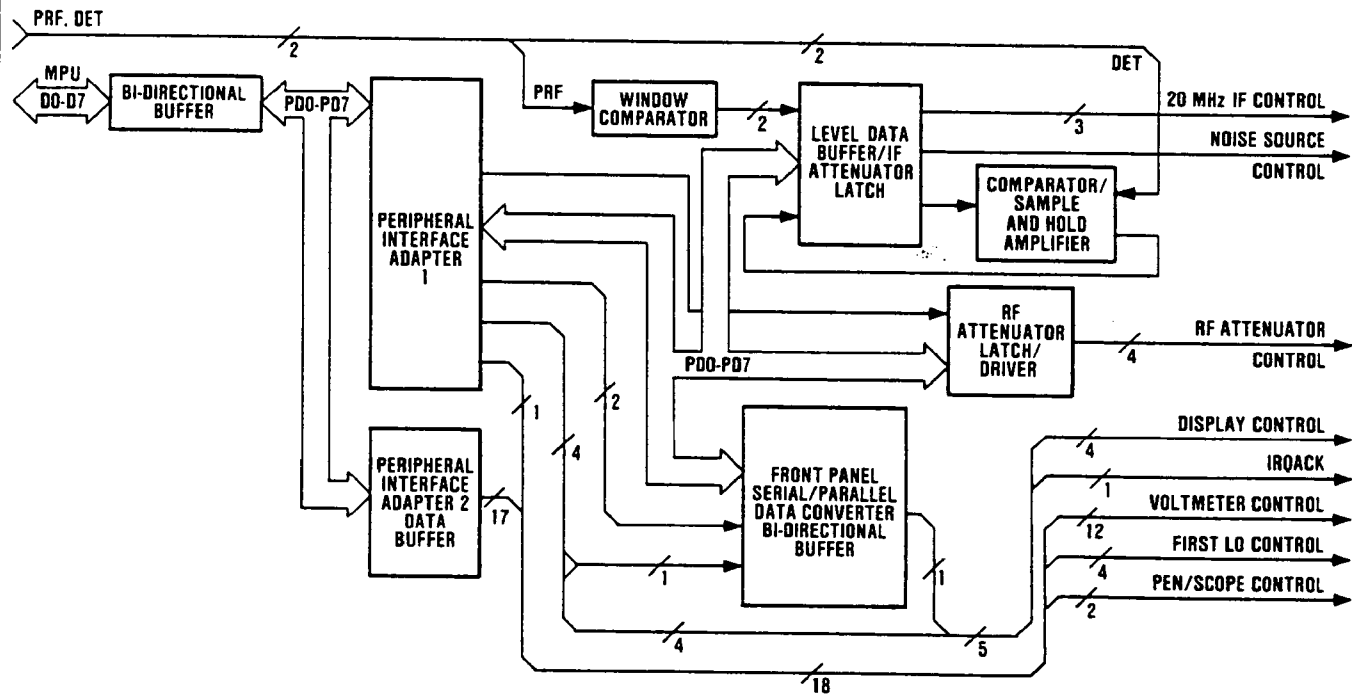


Figure 8-61. Controller — Peripheral Interface Adapter Block Diagram





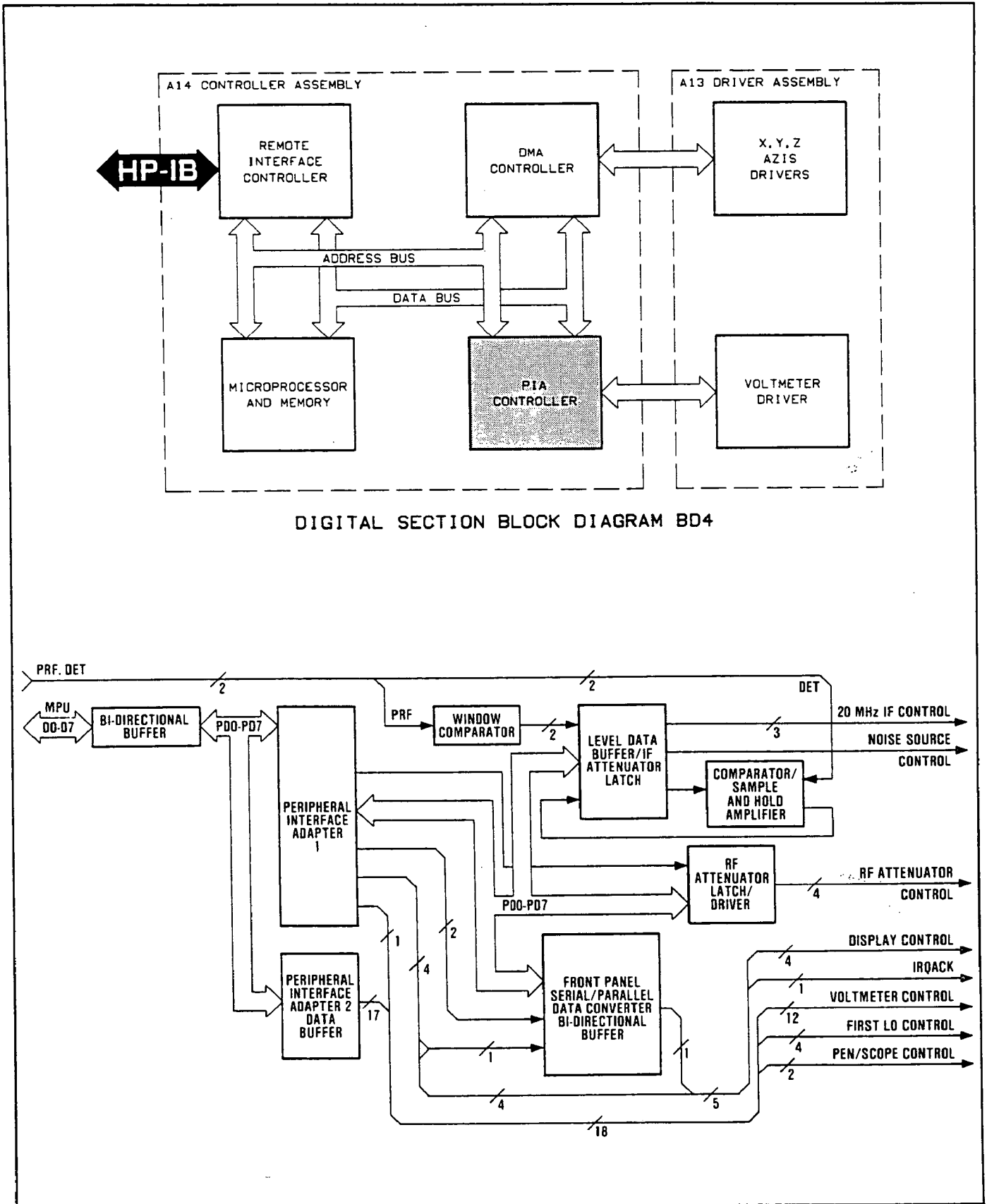


Figure 8-61. Controller-Peripheral Interface Adapter Block Diagram

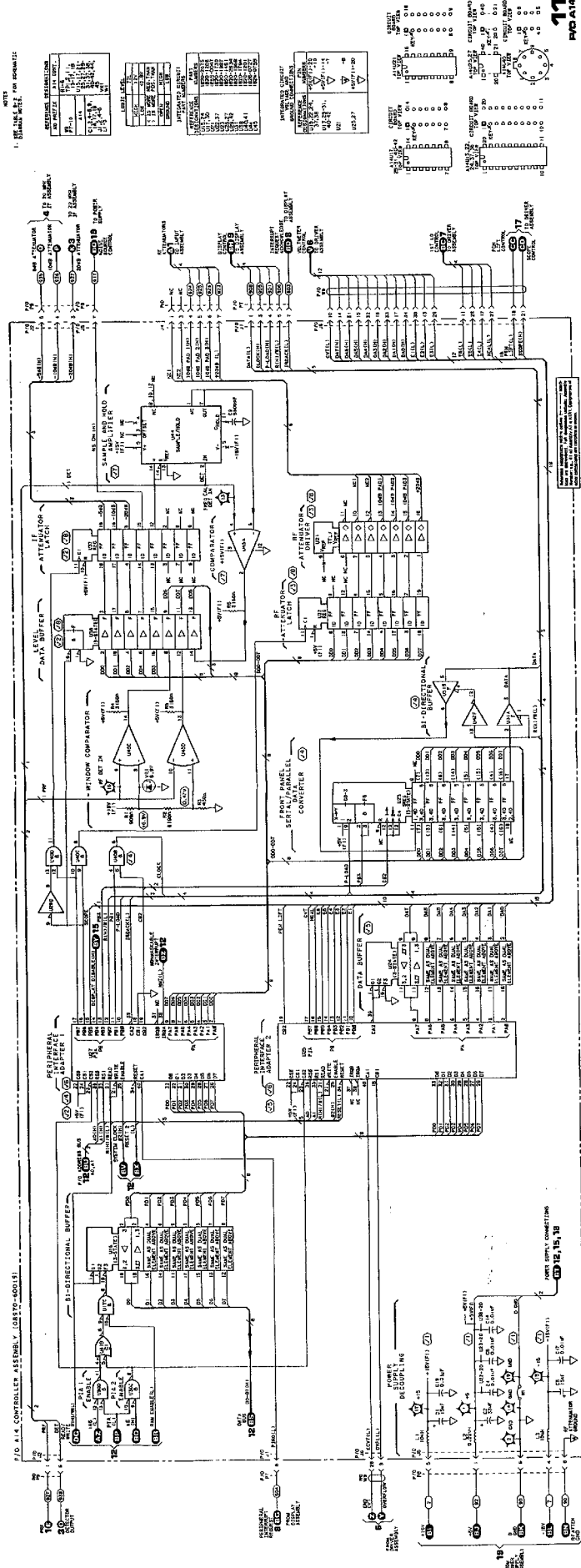


Figure 8-82. Controller-Peripheral Interface Master Schematic Diagram 8-85A (P/O Change 4)

11

FOAM

NOTES

1. REFER TO P/O FOR REVISIONS

REV.	DATE	DESCRIPTION
1	11-11-68	INITIAL ISSUE
2	01-15-69	REVISION 1
3	03-10-69	REVISION 2
4	05-05-69	REVISION 3
5	07-20-69	REVISION 4
6	09-15-69	REVISION 5
7	11-10-69	REVISION 6
8	01-05-70	REVISION 7
9	03-01-70	REVISION 8
10	05-01-70	REVISION 9
11	07-01-70	REVISION 10
12	09-01-70	REVISION 11
13	11-01-70	REVISION 12
14	01-01-71	REVISION 13
15	03-01-71	REVISION 14
16	05-01-71	REVISION 15
17	07-01-71	REVISION 16
18	09-01-71	REVISION 17
19	11-01-71	REVISION 18
20	01-01-72	REVISION 19
21	03-01-72	REVISION 20
22	05-01-72	REVISION 21
23	07-01-72	REVISION 22
24	09-01-72	REVISION 23
25	11-01-72	REVISION 24
26	01-01-73	REVISION 25
27	03-01-73	REVISION 26
28	05-01-73	REVISION 27
29	07-01-73	REVISION 28
30	09-01-73	REVISION 29
31	11-01-73	REVISION 30
32	01-01-74	REVISION 31
33	03-01-74	REVISION 32
34	05-01-74	REVISION 33
35	07-01-74	REVISION 34
36	09-01-74	REVISION 35
37	11-01-74	REVISION 36
38	01-01-75	REVISION 37
39	03-01-75	REVISION 38
40	05-01-75	REVISION 39
41	07-01-75	REVISION 40
42	09-01-75	REVISION 41
43	11-01-75	REVISION 42
44	01-01-76	REVISION 43
45	03-01-76	REVISION 44
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47	07-01-76	REVISION 46
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49	11-01-76	REVISION 48
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57	03-01-78	REVISION 56
58	05-01-78	REVISION 57
59	07-01-78	REVISION 58
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61	11-01-78	REVISION 60
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63	03-01-79	REVISION 62
64	05-01-79	REVISION 63
65	07-01-79	REVISION 64
66	09-01-79	REVISION 65
67	11-01-79	REVISION 66
68	01-01-80	REVISION 67
69	03-01-80	REVISION 68
70	05-01-80	REVISION 69
71	07-01-80	REVISION 70
72	09-01-80	REVISION 71
73	11-01-80	REVISION 72
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75	03-01-81	REVISION 74
76	05-01-81	REVISION 75
77	07-01-81	REVISION 76
78	09-01-81	REVISION 77
79	11-01-81	REVISION 78
80	01-01-82	REVISION 79
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84	09-01-82	REVISION 83
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88	05-01-83	REVISION 87
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94	05-01-84	REVISION 93
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139	11-01-91	REVISION 138
140	01-01-92	REVISION 139
141	03-01-92	REVISION 140
142	05-01-92	REVISION 141
143	07-01-92	REVISION 142
144	09-01-92	REVISION 143
145	11-01-92	REVISION 144
146	01-01-93	REVISION 145
147	03-01-93	REVISION 146
148	05-01-93	REVISION 147
149	07-01-93	REVISION 148
150	09-01-93	REVISION 149
151	11-01-93	REVISION 150
152	01-01-94	REVISION 151
153	03-01-94	REVISION 152
154	05-01-94	REVISION 153
155	07-01-94	REVISION 154
156	09-01-94	REVISION 155
157	11-01-94	REVISION 156
158	01-01-95	REVISION 157
159	03-01-95	REVISION 158
160	05-01-95	REVISION 159
161	07-01-95	REVISION 160
162	09-01-95	REVISION 161
163	11-01-95	REVISION 162
164	01-01-96	REVISION 163
165	03-01-96	REVISION 164
166	05-01-96	REVISION 165
167	07-01-96	REVISION 166
168	09-01-96	REVISION 167
169	11-01-96	REVISION 168
170	01-01-97	REVISION 169
171	03-01-97	REVISION 170
172	05-01-97	REVISION 171
173	07-01-97	REVISION 172
174	09-01-97	REVISION 173
175	11-01-97	REVISION 174
176	01-01-98	REVISION 175
177	03-01-98	REVISION 176
178	05-01-98	REVISION 177
179	07-01-98	REVISION 178
180	09-01-98	REVISION 179
181	11-01-98	REVISION 180
182	01-01-99	REVISION 181
183	03-01-99	REVISION 182
184	05-01-99	REVISION 183
185	07-01-99	REVISION 184
186	09-01-99	REVISION 185
187	11-01-99	REVISION 186
188	01-02-00	REVISION 187
189	03-02-00	REVISION 188
190	05-02-00	REVISION 189
191	07-02-00	REVISION 190
192	09-02-00	REVISION 191
193	11-02-00	REVISION 192
194	01-03-00	REVISION 193
195	03-03-00	REVISION 194
196	05-03-00	REVISION 195
197	07-03-00	REVISION 196
198	09-03-00	REVISION 197
199	11-03-00	REVISION 198
200	01-04-00	REVISION 199
201	03-04-00	REVISION 200
202	05-04-00	REVISION 201
203	07-04-00	REVISION 202
204	09-04-00	REVISION 203
205	11-04-00	REVISION 204
206	01-05-00	REVISION 205
207	03-05-00	REVISION 206
208	05-05-00	REVISION 207
209	07-05-00	REVISION 208
210	09-05-00	REVISION 209
211	11-05-00	REVISION 210
212	01-06-00	REVISION 211
213	03-06-00	REVISION 212
214	05-06-00	REVISION 213
215	07-06-00	REVISION 214
216	09-06-00	REVISION 215
217	11-06-00	REVISION 216
218	01-07-00	

**SERVICE SHEET 12 (cont'd)**

4. If the output of any pin is in error, use Table 8-53 to isolate the pin to the data buffer, and then check A14U47 and either A14U27, A14U28, or A14U50F, as applicable.
5. Move the logic analyzer probes to the output of the data buffers as shown in Table 8-54.

**Table 8-54. Instrument Address Bus Pin Selection**

Bus Bit	Device and Pin Number
A0	A14U28-9
A1	A14U27-9
A2	A14U27-11
A3	A14U27-7
A4	A14U27-5
A5	A14U28-17
A6	A14U28-3
A7	A14U27-3
A8	A14U27-17
A9	A14U28-15
A10	A14U27-15
A11	A14U28-11
A12	A14U28-13
A13	A14U28-5
A14	A14U28-7
A15	A14TP12

6. Ensure that the addresses displayed on the instrument address bus are incrementing from address 0000 0000 (00) through 1111 1111 (FF). Ensure that no pins are stuck high or low, and that the patterns are free of significant noise.
7. If any pins are in error, use Table 8-54 to isolate the pin to the data buffer. If the error is on address A15 (A14TP19), check data buffer A14U50E, A14U51B, A14U17, and A14U16.
8. If the error is on addresses A11 through A14, check A14U28, A14U38, A14U17, and A14U16. For address A9, check A14R15, A14U17, and A14U28.
9. If the error is on address A10, check A14R15, A14U17, A14U63E, and A14U27. If the error is on addresses A0 through A8, check either A14R15 or A14R16, and either A14U27 or A14U28, as applicable.

**Decoder Logic Testing.** Power the unit down and place FREE RUN switch A14S2A in the FREE RUN position. Connect the logic analyzer to pins

1 through 11 and 13 through 23 of Address Decoder 1 A14U38, and proceed as follows:

1. Address Decoder 1 is for selecting RAM, PIA, HP-IB, and ROMs 5 through 14. Ensure that when pins 18 and 19 of A14U38 are both low, the binary inputs to pins 20 through 23 are properly decoded as shown in Table 8-55.

**Table 8-55. Address Decoder 1 Decoding Table**

Address (Pin)				Output	Active
A14 (20)	A13 (21)	A12 (22)	A11 (23)	Line (Pin)	Signal Name
0	0	0	0	0 (1)	SEL0
0	0	0	1	1 (2)	SEL1
0	0	1	0	2 (3)	SEL2
0	0	1	1	3 (4)	SEL3
0	1	0	0	4 (5)	SEL4
0	1	0	1	5 (6)	SEL5
0	1	1	0	6 (7)	ROM14
0	1	1	1	7 (8)	ROM13
1	0	0	0	8 (9)	ROM12
1	0	0	1	9 (10)	ROM11
1	0	1	0	10 (11)	ROM10
1	0	1	1	11 (13)	ROM9
1	1	0	0	12 (14)	ROM8
1	1	0	1	13 (15)	ROM7
1	1	1	0	14 (16)	ROM6
1	1	1	1	15 (17)	ROM5

2. If an error is on pin 19 of A14U38, check A14U38, A14U50A, A14U51A, A14U51D, A14U61A, and A14U47. If the error is on pin 18, check A14U51B, A14U38, A14U50C, A14U50E, A14U50F, and A14U47.
3. If an error is on addresses A11 through A14, check A14U38, A14U16, A14U17, and A14U28. If the error is on one of the outputs of A14U38, then check A14U38.
4. Address Decoder 2 is for selecting ROM 1. Ensure that when pins 1 through 6, and 11 and 12 are all high input to A14U17, that a low is output on pin 8 to A14U62C.
5. Ensure that when a low is input to pin 8 of A14U62C, and a low is on pin 9, that a low is output on pin 8 to select ROM 1. If an error is on pin 9, check A14U62C and A14U16. If an error is on pin 10, check A14U62C and A14U17. If an error is on pin 8, check A14U62C.

**SERVICE SHEET 12 (cont'd)**

6. If an error is on A14U17 pins 1 through 4, check A14U17, A14U16, A14U38, and A14U28. If an error is on pin 5, check A14U17, A14U16, A14U51B, and A14U50E.
7. If an error is on A14U17 pin 6, check A14U17, A14U63D, A14U51D, and A14U16. If an error is on pin 11, check A14U17, A14U63E, A14U27, and A14R15. If an error is on pin 12, check A14U17, A14U28, and A14R15. If an error is on pin 8, check A14U17 and A14U62C.
8. Address Decoder 3 is for selecting ROMs 2 through 4, ROM 1 Enable, SA Enable, and SEL CTR. Ensure that when pin 4 of A14U16 is low (a valid address), pin 5 is low (A14), and pin 6 is high (A15), the binary inputs to pins 1, 2, and 3 are properly decoded as shown in Table 8-56.

**Table 8-56. Address Decoder 3 Decoding Table**

Address (Pin)			Output	Active
A13 (1)	A12 (2)	A11 (3)	Line (Pin)	Signal Name
0	0	0	0 (15)	ROM4
0	0	1	1 (14)	ROM3
0	1	0	2 (13)	ROM2
0	1	1	3 (12)	ROM1 Enable
1	0	0	4 (11)	Not Used
1	0	1	5 (10)	Not Used
1	1	0	6 (9)	SA Enable
1	1	1	7 (7)	SEL CTR

9. If an error is on pin 4 of A14U16, check A14U16, A14U63D, and A14U51D. If an error is on pins 1, 2, 3, or 5, check A14U16, A14U17, A14U38, and A14U28.
10. If an error is on pin 6 of A14U16, check A14U16, A14U17, A14U51B, and A14U50E. If an error is on pin 7, 13, 14, or 15, check A14U16. If an error is on pin 9, check A14U16 and A14U52D.

**ROM Data Testing.** In the event that all addressing appears correct, but the data is bad from ROM, place FREE RUN switch A14S2A in the FREE RUN position, power-up the unit, and proceed as follows:

1. Connect the logic analyzer to A14U36 pins 2 through 9. This is the instrument data bus D0—D7. Synchronize the display against pin 8 of A14U62C. This is the ROM1 select, and will allow the data (contents) of ROM 1 to be viewed. This will occur when pin 8 (ROM1 select) goes low, and the lower addresses are sequenced.

**NOTE**

*ROM 1 is the only ROM not checked by the start-up sequence of the instrument. An error on ROMs 2 through 14 will be displayed on the front panel of the unit during start-up. This assumes that the error has not prevented the front panel from proper operation.*

2. By moving the synchronization of the logic analyzer to the pins listed in Table 8-57, each ROM's contents can be examined. A low on each pin listed, indicates that the respective ROM is selected.

**Table 8-57. ROM Select Pin Assignment**

ROM	Device	Pin
1	A14U62C	8
2	A14U16	13
3	A14U16	14
4	A14U38	15
5	A14U38	17
6	A14U38	16
7	A14U38	15
8	A14U38	14
9	A14U38	13
10	A14U38	11
11	A14U38	10
12	A14U38	9
13	A14U38	8
14	A14U38	7

**✓ 4 Signature Analysis Circuit**

Signature Analysis is not required to troubleshoot the MPU and Address Decoder portion of the Controller Assembly. However, the circuit which initiates the signature analysis is located within this portion, and must be verified.

1. Power down the unit and ensure that FREE RUN switch A14S2A is in the NORMAL position.



**SERVICE SHEET 12 (cont'd)**

2. Place SIGNATURE ANALYSIS switch A14S2B in the SA position, and power up the unit.
3. Connect channel one of the oscilloscope to pin 18 (DBB0) of A14U36 and synchronize the oscilloscope on pin 12 of A14U16 (SA Enable).
4. Ensure that pin 18 of A14U36 remains low at all times. If the pin is not low, move the channel one probe to pin 11 of A14U52D.

5. If pin 11 of A14U52D is low, check A14U36, A14U47, and A14R15. If pin 11 is not low, check A14U52D, A14S2B, and A14U16.

**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 A14 ASSEMBLY

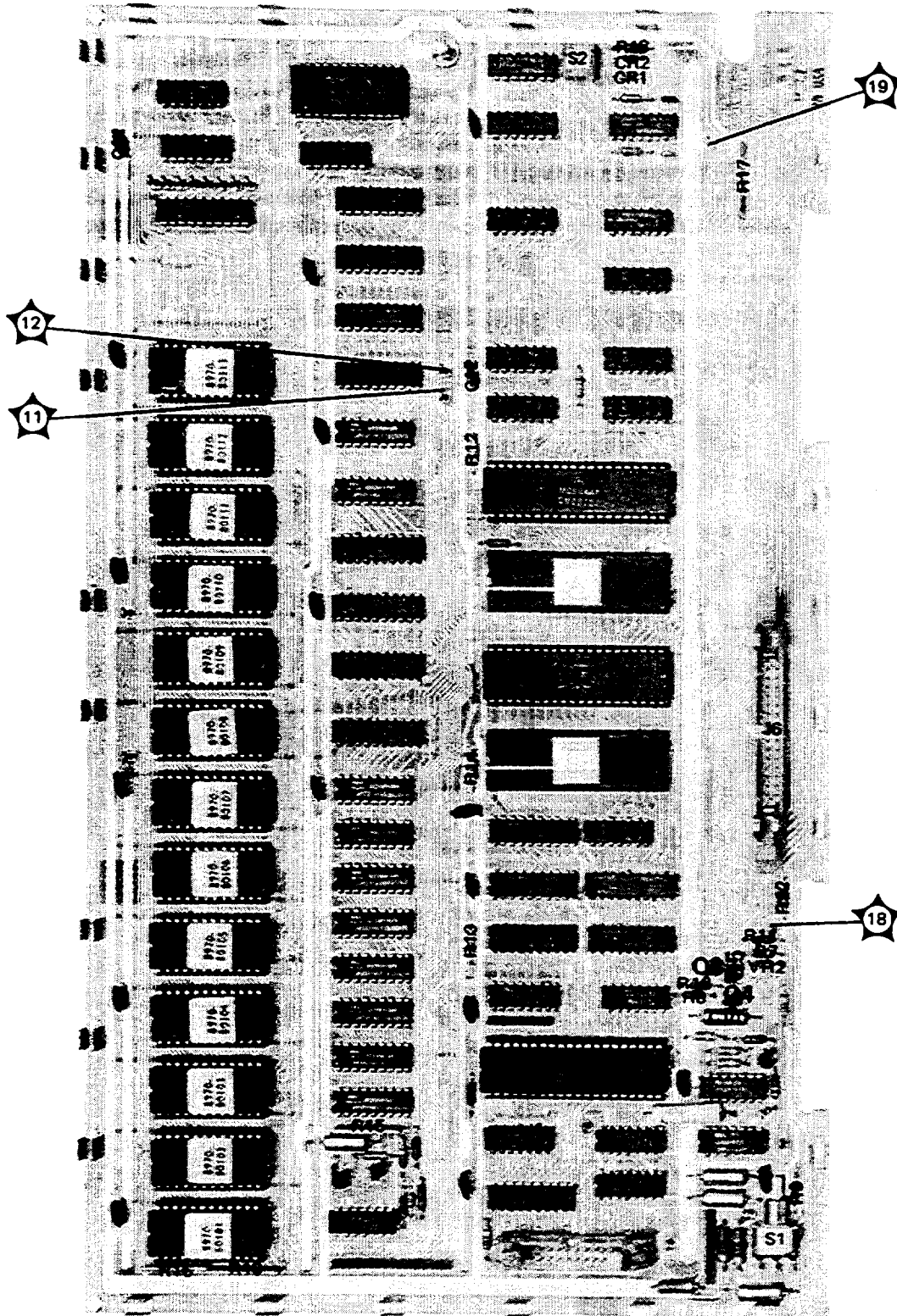


Figure 8-63. P/O A14 Controller Assembly Component Locations (Microprocessor)

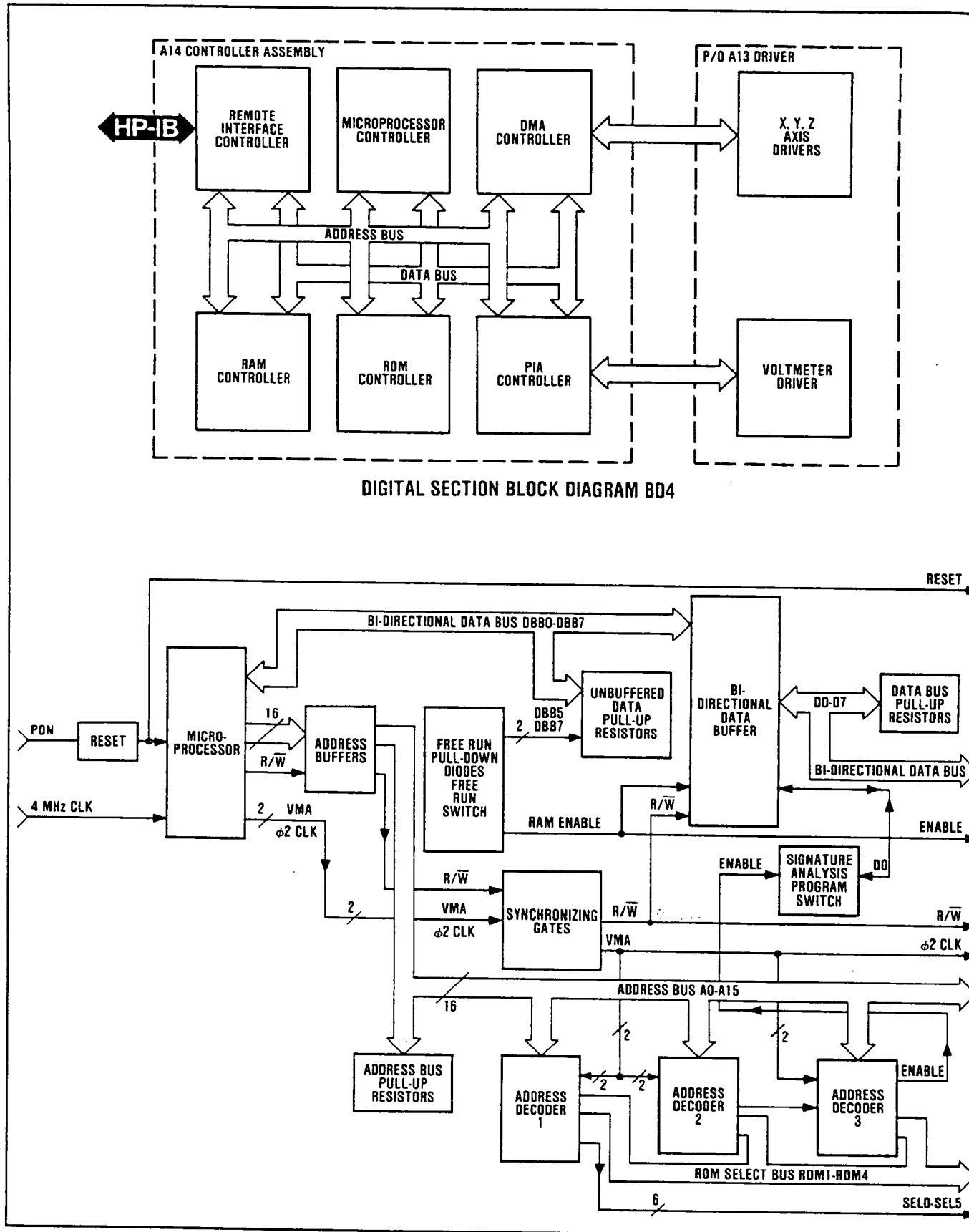


Figure 8-64. Controller — Microprocessor Block Diagram





Service  
 13  
 13  
 13

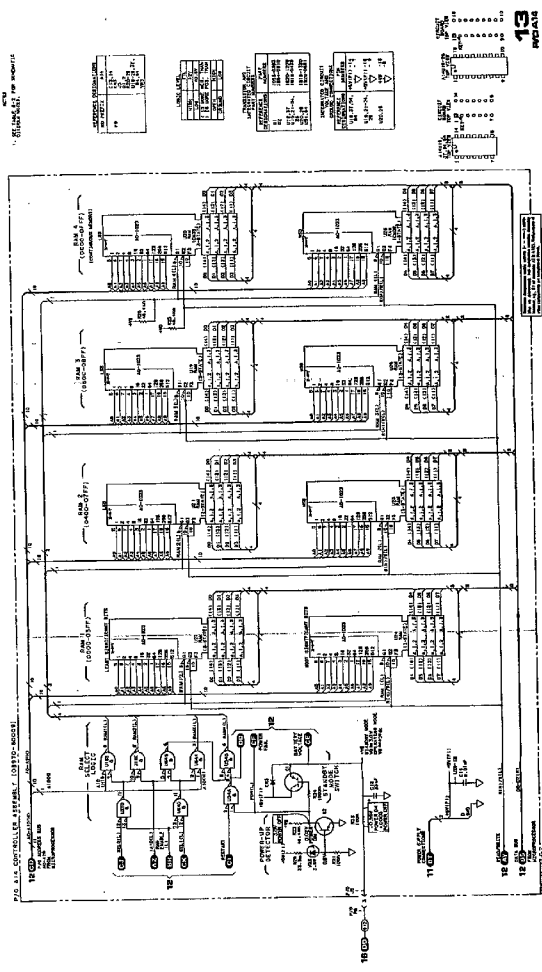


Figure 6-38. Counter - IBM Standard Design 8570A

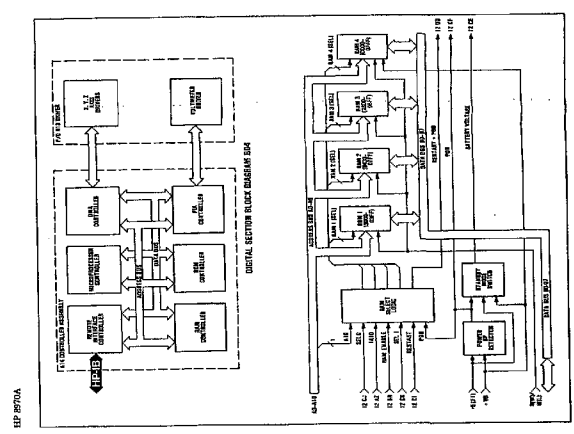


Figure 6-39. Counter - IBM Standard Design

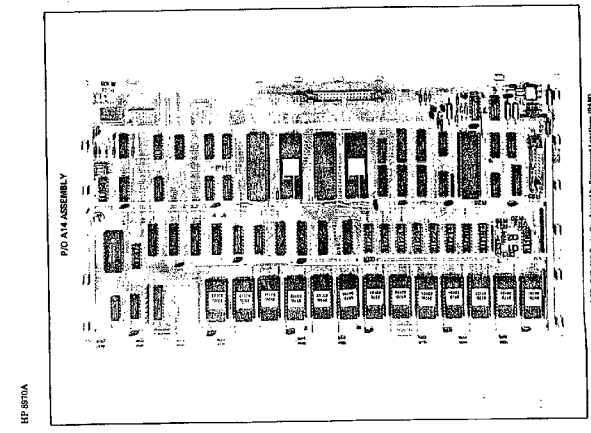


Figure 6-40. P10 A14 Counter Assembly Component Locations (P10A)

**SERVICE SHEET 14**  
**CONTROLLER - ROM**  
**P/O A14 CONTROLLER ASSEMBLY**  
**REFERENCES**

Block Diagram - Service Sheet BD4  
 Section III - Operators Checks  
 Section VIII - Special Functions and Power-Up Checks

**PRINCIPLES OF OPERATION**

**General**

The Read Only Memory (ROM) is the long-term memory of the Noise Figure Meter. In the ROMs, is stored the operating program for the instrument. The data bus used within the Noise Figure Meter, is an eight bit bus (D0-D7). Each of the ROMs are eight bit 2K ROMs. The total ROM memory is comprised of 13 ROMs for a total of 26K of memory. All ROMs are nonvolatile; they all retain their programming during power down periods.

Data within a ROM can only be read by the microprocessor (MPU). Even though the data bus (D0-D7) is bi-directional, no data can be written into a ROM. The MPU selects the desired ROM through the ROM Select Logic (shown on Service Sheet 12). When a ROM is selected, it will place data on the data bus from its address location, as set by address bus A0-A10.

**Read Only Memory (ROM)**

In the Noise Figure Meter, each ROM device is an eight bit data word with 2K of memory space. Each device is a 24 pin device, with three pins for power. Eleven pins are used for the address inputs of A0 through A10. This gives an addressing count from 0 to 2047 (2K). Eight pins are the data pins of D0 through D7. These pins are tri-state, in that the data can be sent to the data bus, or when the device is not selected, the data pins float at a high impedance.

The device is selected when a low is placed on both pins 18 and 20. In the Noise Figure Meter, each ROM pin 18 is tied to ground. Therefore, each ROM Select is a low on ROM pin 20. When a ROM is selected, it will output a data word onto the data bus. The specific word is selected by the address on address bus A0-A10. Since each ROM is programmed specifically for a particular location in the instrument, each ROM has its own part number.

**TROUBLESHOOTING**

Troubleshooting is done on the circuits of Service Sheet 14 when a malfunction has occurred in the Read Only Memory (ROM). If all of the tests in the following procedures indicate correct responses, the trouble is located elsewhere in the control unit, and not in the ROM. Except where shown, the values listed are approximate and are given as a service guideline.

**SERVICE SHEET 14 (cont'd)**

**Test Equipment**

Logic Analyzer ..... HP 1630D  
 Systems DVM ..... HP 3456A

**General Checks**

Ensure that the voltage from pin 21 to both pins 24 and 12 of each ROM is  $\pm 0.05$  Vdc.

**Power-Up Self-Testing**

When the Noise Figure Meter is first powered-on, a complete instrument self-test is run. In the case of the ROMs, ROM 1 contains the self-test program. It will check the data in the other 12 ROMs by computing an eight bit checksum of all of the data stored in that ROM. The computed checksum is compared to the preprogrammed checksum that is stored in each ROM.

In addition to the checksum byte, a second byte is also stored in each ROM to indicate the proper address of that ROM in the Noise Figure Meter memory. This byte is checked against the address at which the ROM actually resides. If a ROM fails either half of the check, an error code that corresponds to that ROM is displayed on the front panel display.

**ROM Circuit Troubleshooting**

If the ROM self-test is passed, the circuits of Service Sheet 14 are working normally. If the ROM test is failed, the first step is to isolate the failure to the general area.

1. Refer to the error code listings in Section VIII, and locate the failed ROM.
2. Connect the Logic Analyzer to the address pins of the suspected ROM, and to the ROM's Select line.
3. Run the self-test by turning the instrument off and back on, and verify the ROM failure. Note the address at which the ROM failed.
4. If a ROM fails at the first address at which it is selected, verify that it is actually selected. If selection was correct, check the circuit board traces connecting to the ROM, and if required, replace the defective ROM with an appropriate replacement part.
5. If the ROM was not selected, refer to Service Sheet 12.

**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.

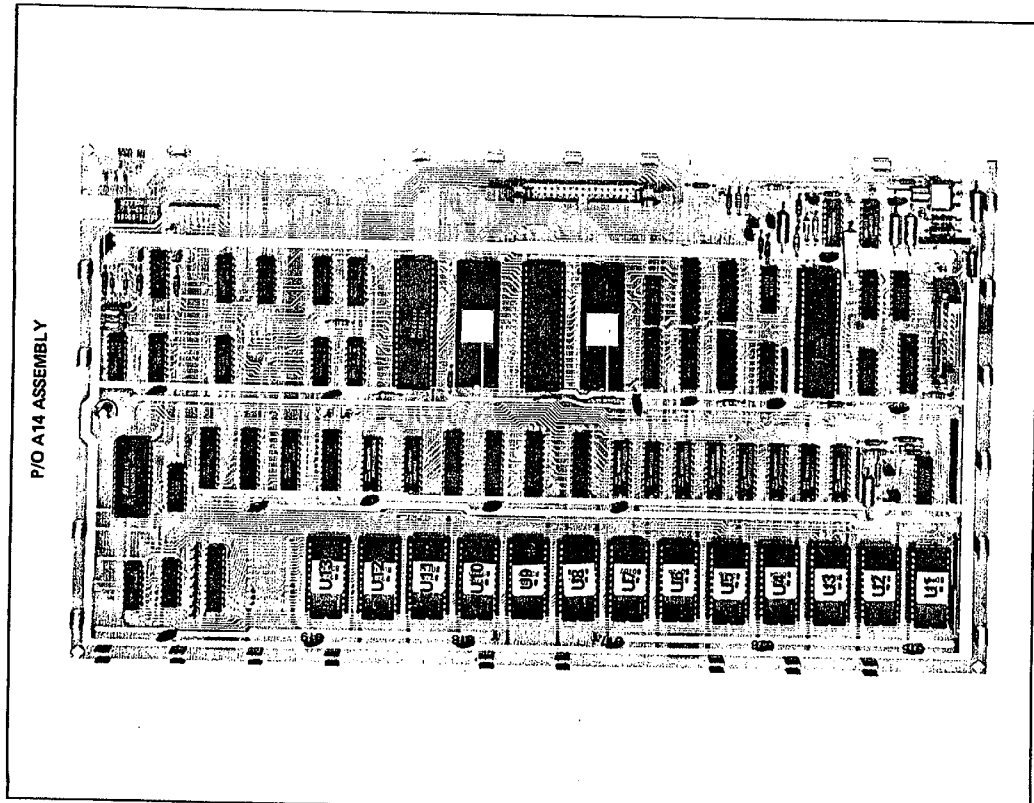


Figure B-69. P/O A14 Controller Assembly Component Locations (ROM)

NOTE: 1. SEE TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.

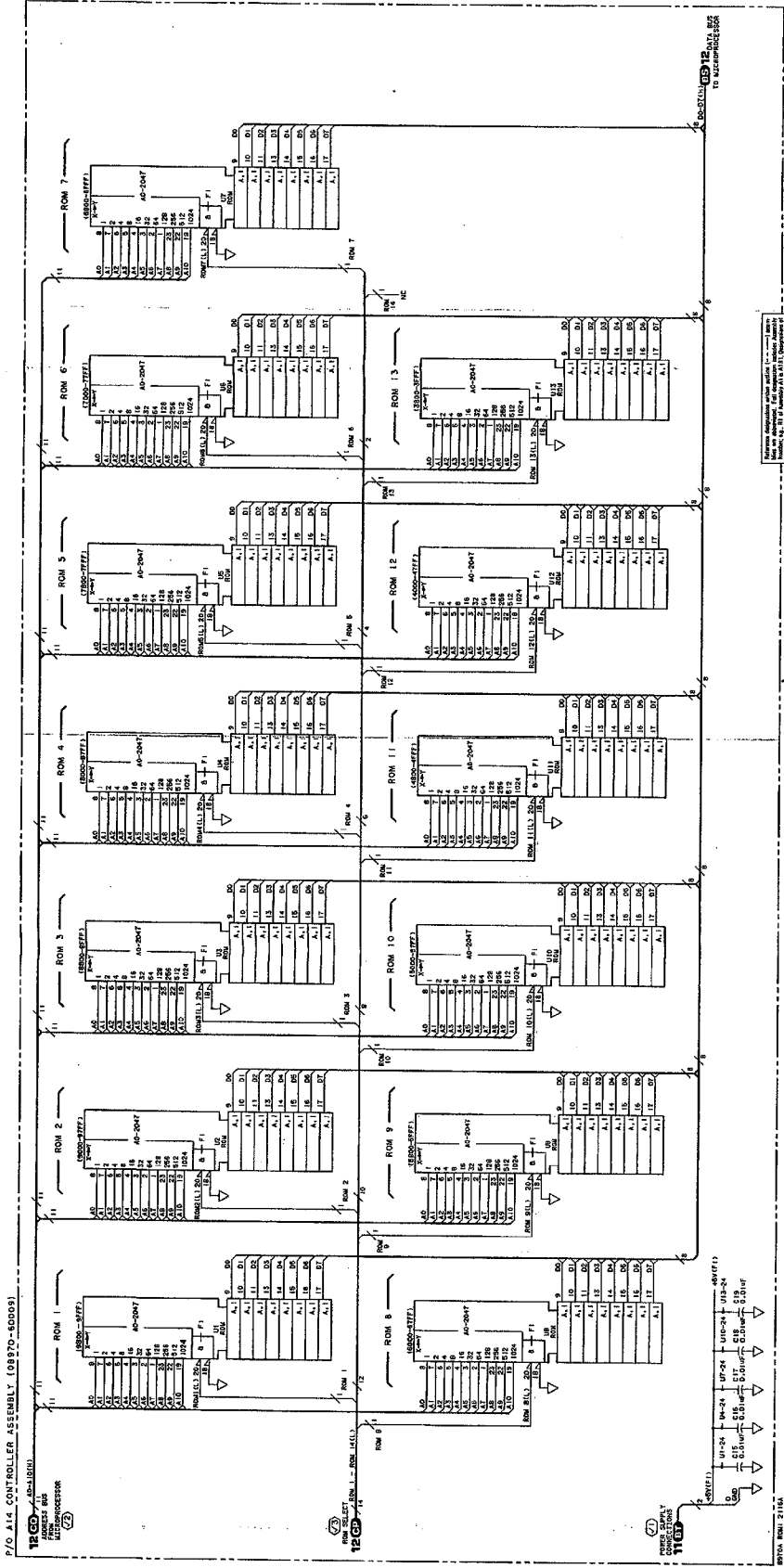
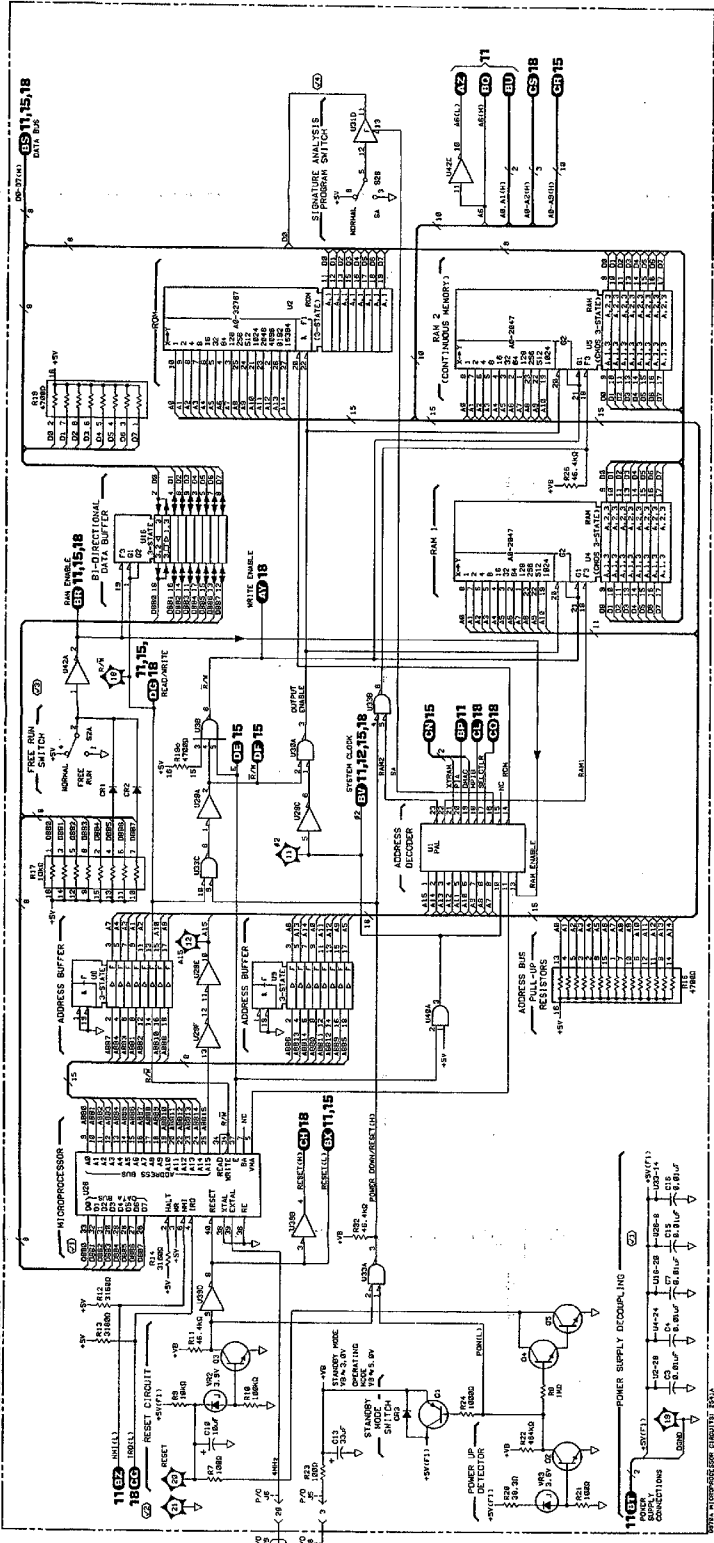


Figure 8-71. Controller - ROM Schematic Diagram









NOTES

1. SEE TABLE B-2 FOR SCHEMATIC DESIGNATION.

REFERENCE DESIGNATIONS

REF. DESIGNATION	PART NUMBER	LOGIC LEVEL
U1	80C86-010	CMOS
U2	74LS00	CMOS
U3	74LS04	CMOS
U4	74LS125	CMOS
U5	74LS138	CMOS
U6	74LS244	CMOS
U7	74LS273	CMOS
U8	74LS373	CMOS
U9	74LS541	CMOS
U10	74LS543	CMOS
U11	74LS123	CMOS
U12	74LS147	CMOS
U13	74LS244	CMOS
U14	74LS244	CMOS
U15	74LS244	CMOS
U16	74LS244	CMOS
U17	74LS138	CMOS
U18	2817	CMOS
U19	2817	CMOS
U20	10K	CMOS
U21	7805	CMOS
U22	74LS138	CMOS

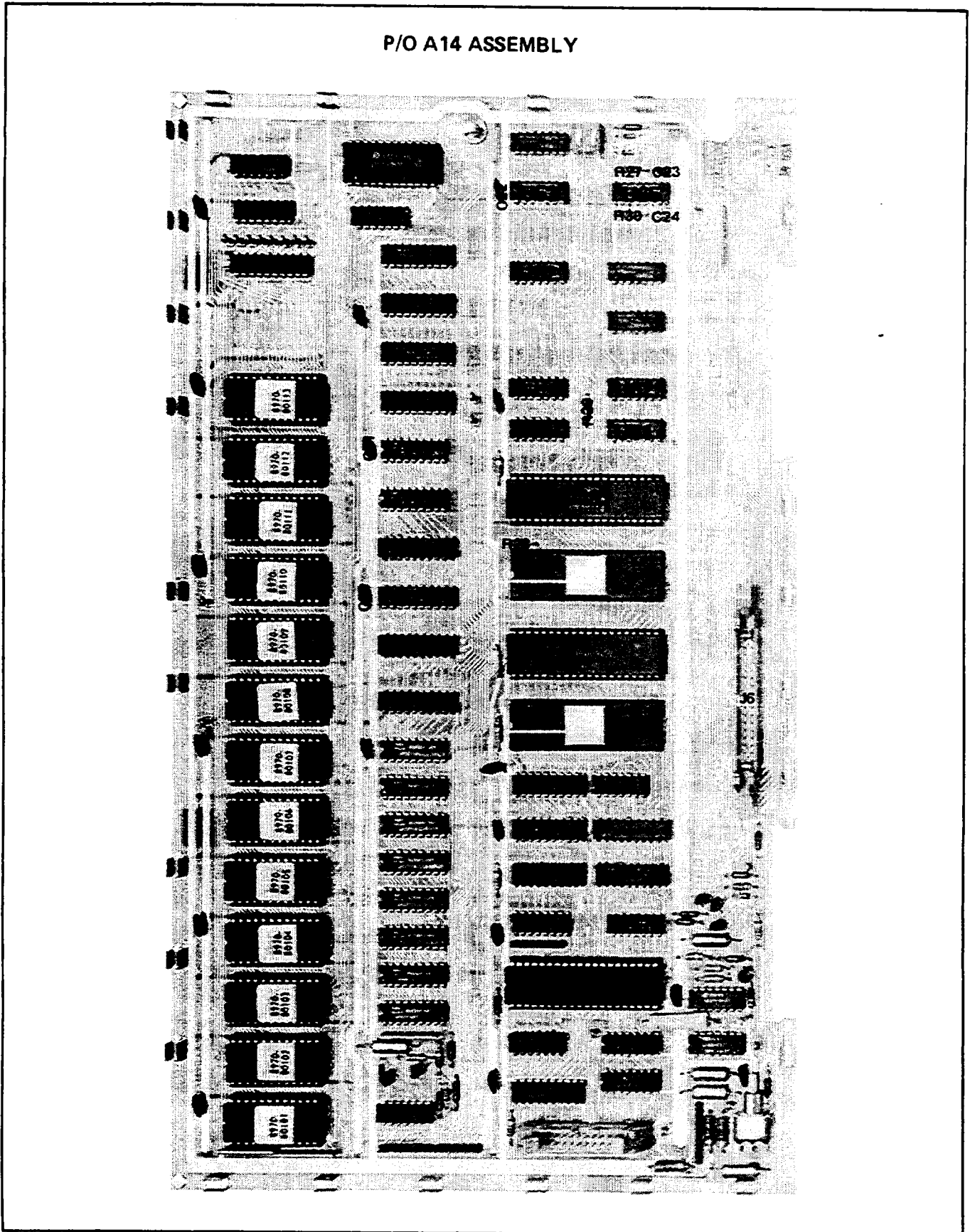
INTEGRATED CIRCUIT VOLTAGE AND GROUND

REFERENCE DESIGNATION	V <sub>CC</sub>	V <sub>EE</sub>	GROUND
U1	V <sub>CC</sub>	V <sub>EE</sub>	GND
U2	V <sub>CC</sub>	V <sub>EE</sub>	GND
U3	V <sub>CC</sub>	V <sub>EE</sub>	GND
U4	V <sub>CC</sub>	V <sub>EE</sub>	GND
U5	V <sub>CC</sub>	V <sub>EE</sub>	GND
U6	V <sub>CC</sub>	V <sub>EE</sub>	GND
U7	V <sub>CC</sub>	V <sub>EE</sub>	GND
U8	V <sub>CC</sub>	V <sub>EE</sub>	GND
U9	V <sub>CC</sub>	V <sub>EE</sub>	GND
U10	V <sub>CC</sub>	V <sub>EE</sub>	GND
U11	V <sub>CC</sub>	V <sub>EE</sub>	GND
U12	V <sub>CC</sub>	V <sub>EE</sub>	GND
U13	V <sub>CC</sub>	V <sub>EE</sub>	GND
U14	V <sub>CC</sub>	V <sub>EE</sub>	GND
U15	V <sub>CC</sub>	V <sub>EE</sub>	GND
U16	V <sub>CC</sub>	V <sub>EE</sub>	GND
U17	V <sub>CC</sub>	V <sub>EE</sub>	GND
U18	V <sub>CC</sub>	V <sub>EE</sub>	GND
U19	V <sub>CC</sub>	V <sub>EE</sub>	GND
U20	V <sub>CC</sub>	V <sub>EE</sub>	GND
U21	V <sub>CC</sub>	V <sub>EE</sub>	GND
U22	V <sub>CC</sub>	V <sub>EE</sub>	GND

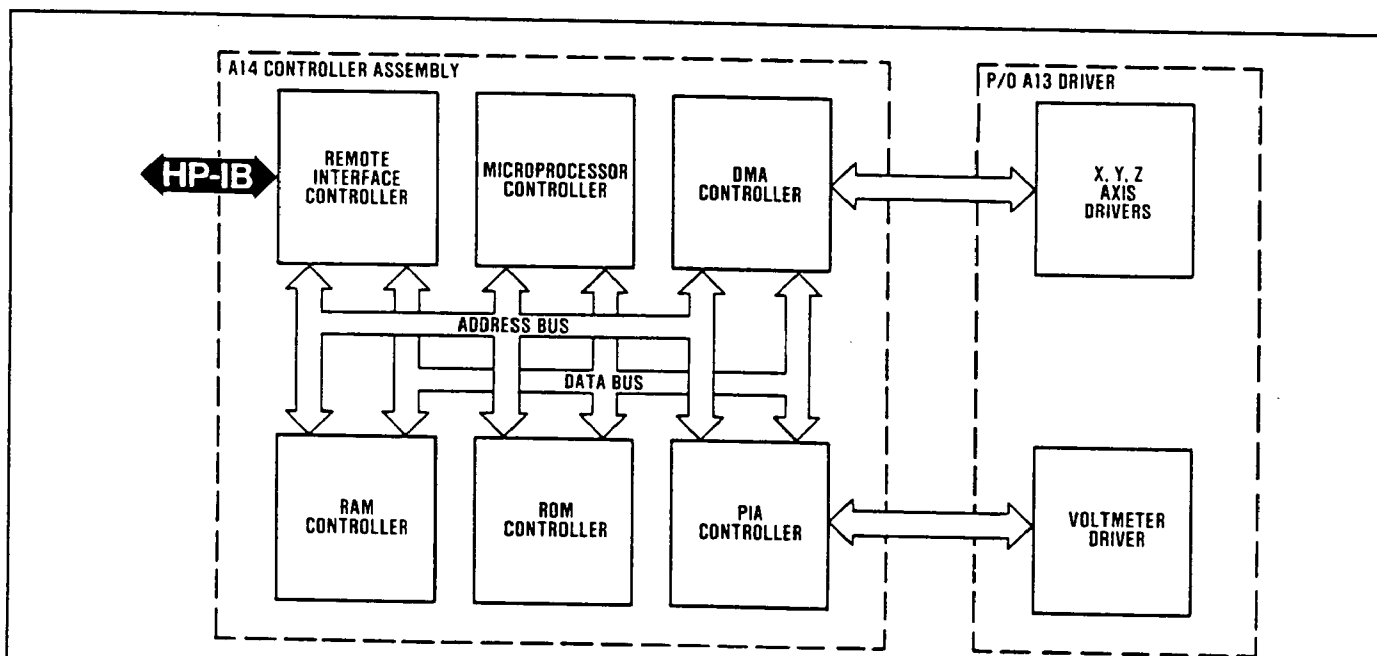
TRANSISTORS AND DIODES

REFERENCE DESIGNATION	PART NUMBER
Q1	2N2222
Q2	2N2222
Q3	2N2222
Q4	2N2222
Q5	2N2222
Q6	2N2222
Q7	2N2222
Q8	2N2222
Q9	2N2222
Q10	2N2222
Q11	2N2222
Q12	2N2222
Q13	2N2222
Q14	2N2222
Q15	2N2222
Q16	2N2222
Q17	2N2222
Q18	2N2222
Q19	2N2222
Q20	2N2222
Q21	2N2222
Q22	2N2222
Q23	2N2222
Q24	2N2222
Q25	2N2222
Q26	2N2222
Q27	2N2222
Q28	2N2222
Q29	2N2222
Q30	2N2222
Q31	2N2222
Q32	2N2222
Q33	2N2222
Q34	2N2222
Q35	2N2222
Q36	2N2222
Q37	2N2222
Q38	2N2222
Q39	2N2222
Q40	2N2222
Q41	2N2222
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Q43	2N2222
Q44	2N2222
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Q47	2N2222
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Q71	2N2222
Q72	2N2222
Q73	2N2222
Q74	2N2222
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Q77	2N2222
Q78	2N2222
Q79	2N2222
Q80	2N2222
Q81	2N2222
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Q84	2N2222
Q85	2N2222
Q86	2N2222
Q87	2N2222
Q88	2N2222
Q89	2N2222
Q90	2N2222
Q91	2N2222
Q92	2N2222
Q93	2N2222
Q94	2N2222
Q95	2N2222
Q96	2N2222
Q97	2N2222
Q98	2N2222
Q99	2N2222
Q100	2N2222

Figure 845: Controller-microprocessor Schematic Diagram 8-89A (P/O Change 4)



**Figure 8-72. P/O A14 Controller Assembly Component Locations (Direct Memory Access Controller)**



DIGITAL SECTION BLOCK DIAGRAM BD4

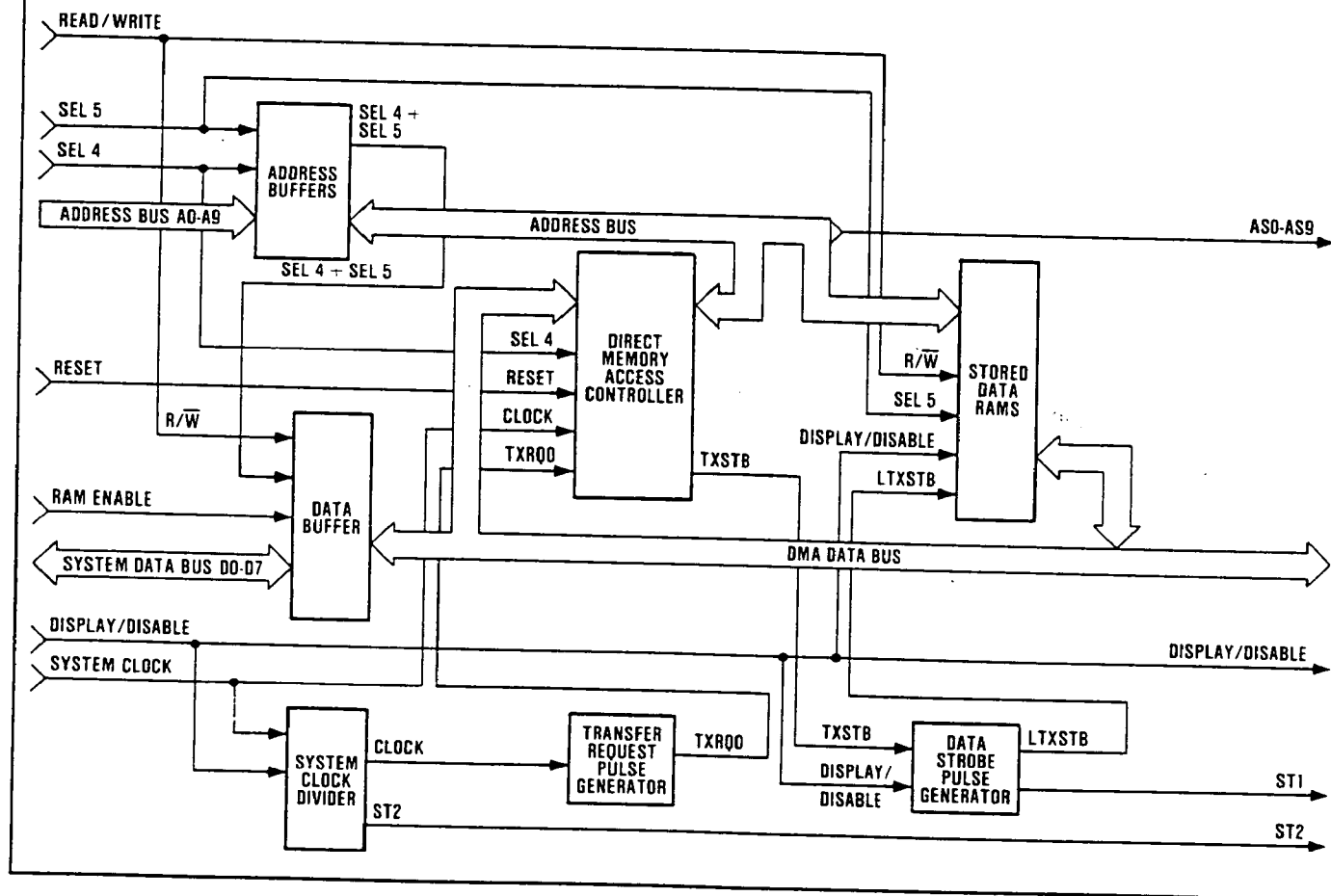


Figure 8-73. Controller — Direct Memory Access Controller (DMA) Block Diagram

1. SEE LINE 8-1 FOR SCHEMATIC  
2. DISASSEMBLY

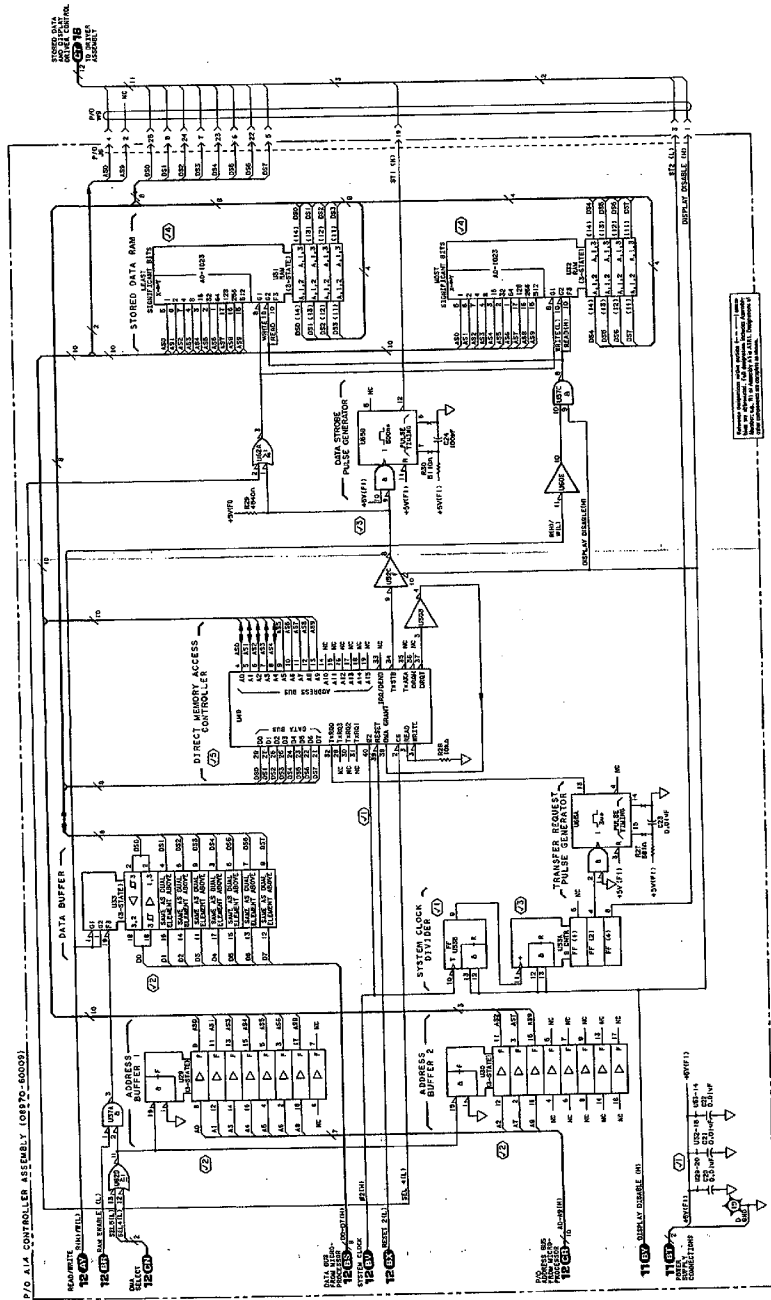


Figure 8-74. Controller - Direct Memory Access Controller Schematic Diagram

ADDRESS DESIGNATIONS

00	0000
01	0001
02	0010
03	0011
04	0100
05	0101
06	0110
07	0111
08	1000
09	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

DATA STORAGE PULSE GENERATOR

00	0000
01	0001
02	0010
03	0011
04	0100
05	0101
06	0110
07	0111
08	1000
09	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

TRANSFER REQUEST PULSE GENERATOR

00	0000
01	0001
02	0010
03	0011
04	0100
05	0101
06	0110
07	0111
08	1000
09	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

SYSTEM CLOCK DIVIDER

00	0000
01	0001
02	0010
03	0011
04	0100
05	0101
06	0110
07	0111
08	1000
09	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

STORED DATA RAM

00	0000
01	0001
02	0010
03	0011
04	0100
05	0101
06	0110
07	0111
08	1000
09	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

DISPLAY ENABLE

00	0000
01	0001
02	0010
03	0011
04	0100
05	0101
06	0110
07	0111
08	1000
09	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111



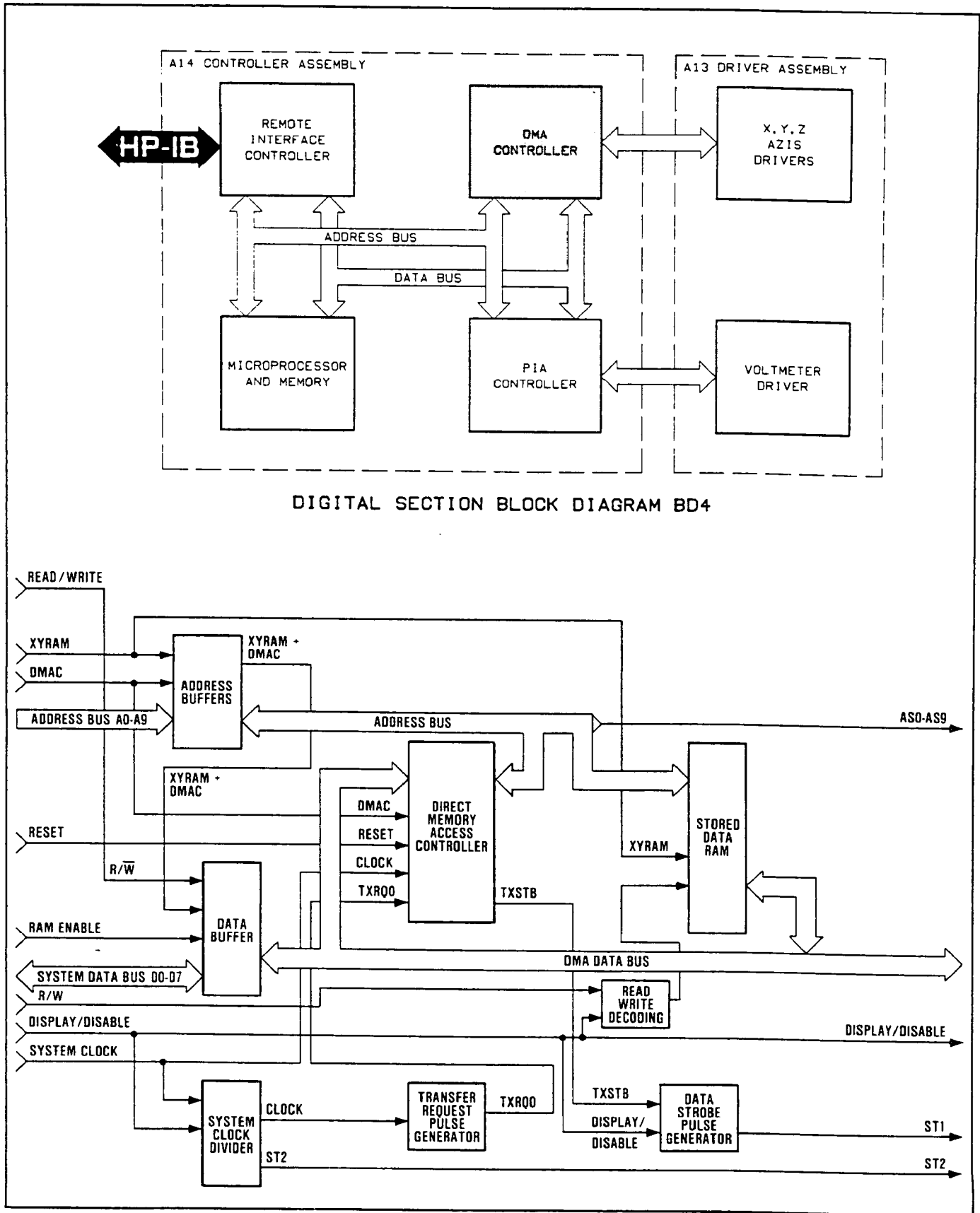
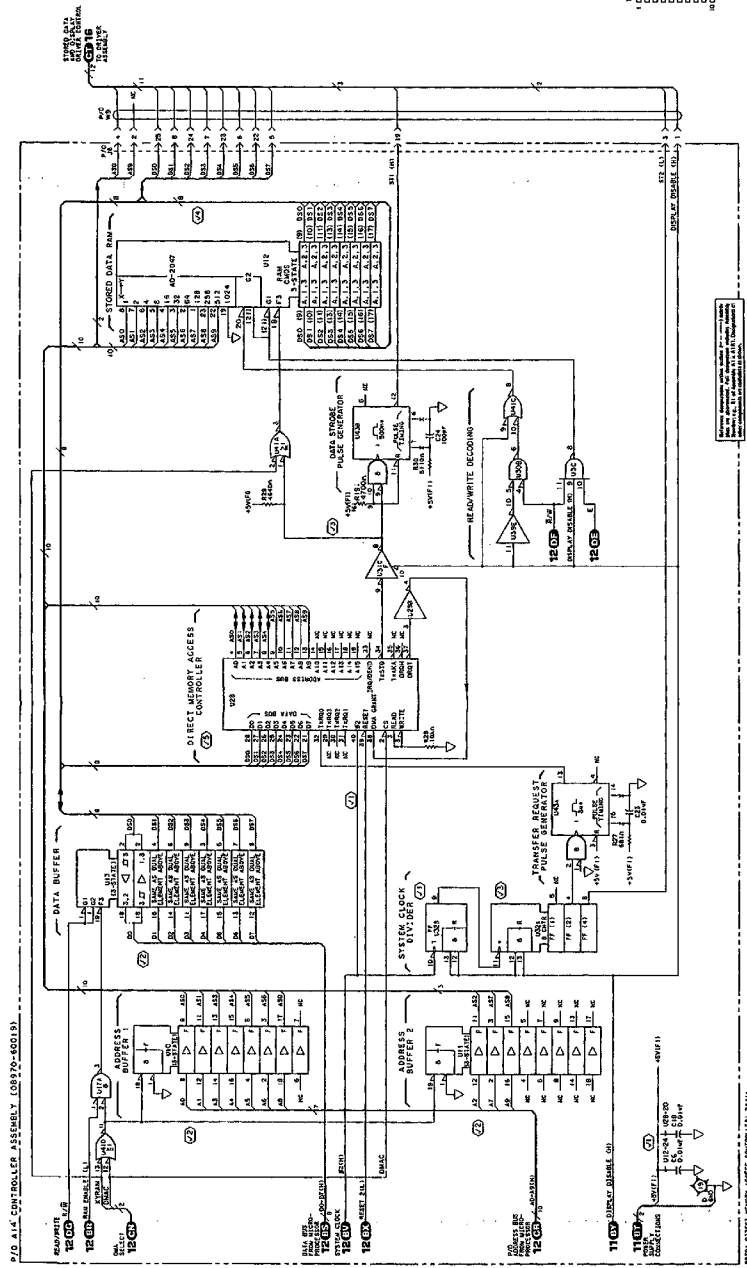


Figure 8-73. Controller-Direct Memory Access Controller (DMA) Block Diagram



NOTES  
1. SEE DRAWING 1 FOR DIMENSIONS



P/O ALU CONTROLLER ASSEMBLY (08970-60013)

REFERENCE TERMINALS

NO.	TERMINAL NO.	TERMINAL NAME
1	1	16-REG STORED DATA BUFFER
2	2	16-REG MEMORY ACCESS CONTROLLER
3	3	SYSTEM CLOCK
4	4	TRANSMIT REQUEST PULSE GENERATOR
5	5	READWRITE DECODING
6	6	READWRITE ENABLE

ADDRESS BUFFER 1

ADDRESS	DATA
0000	0000
0001	0001
0010	0010
0011	0011
0100	0100
0101	0101
0110	0110
0111	0111
1000	1000
1001	1001
1010	1010
1011	1011
1100	1100
1101	1101
1110	1110
1111	1111

ADDRESS BUFFER 2

ADDRESS	DATA
0000	0000
0001	0001
0010	0010
0011	0011
0100	0100
0101	0101
0110	0110
0111	0111
1000	1000
1001	1001
1010	1010
1011	1011
1100	1100
1101	1101
1110	1110
1111	1111

SYSTEM CLOCK

ADDRESS	DATA
0000	0000
0001	0001
0010	0010
0011	0011
0100	0100
0101	0101
0110	0110
0111	0111
1000	1000
1001	1001
1010	1010
1011	1011
1100	1100
1101	1101
1110	1110
1111	1111

TRANSMIT REQUEST PULSE GENERATOR

ADDRESS	DATA
0000	0000
0001	0001
0010	0010
0011	0011
0100	0100
0101	0101
0110	0110
0111	0111
1000	1000
1001	1001
1010	1010
1011	1011
1100	1100
1101	1101
1110	1110
1111	1111

Figure 8-7A. Central-Direct Memory Access Controller Schematic Diagram 8-97A (P/O-Change-4)



## SERVICE SHEET 17

### DRIVER - X-AXIS AND Z-AXIS DRIVES 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

One of the functions of Driver Assembly A13 is to provide the X, Y, and Z-Axis outputs which are used by an external oscilloscope, X-Y recorder, or strip chart recorder. Service Sheet 16 contains the Y-Axis schematic, while Service Sheet 17 contains the X and Z-Axes.

##### X-Axis Driver

In the X-Axis Driver, there are two points of reference required to move the pen, or trace. These two points are the previous plot point and the present plot point. The previous plot point is where the pen, or trace, was last located. This point is represented by a voltage value which is stored in the sample and hold amplifier.

New digital data is converted into an analog value which represents the present plot point. It is the function of the X-Axis Driver to move the pen, or trace, from the previous plot point to the (new) present plot point.

Under control of a point-to-point timing circuit (Service Sheet 16), the two plot point values are both input to opposite sides of a differential input current source. The difference between the values represents the amount of movement the pen, or trace, must make to move from the previous plot point to its next position at the present plot point.

The output of the current source charges capacitor A13C52 at a known linear rate. Charging will continue until the positive pulse from the point-to-point timer ends and places the sample and hold amplifier back into the sample state.

This linear rate of change is output through a buffer amplifier, and input to the external device to move the pen, or trace, from the previous plot point to the present plot point at a smooth linear rate. The distance of the movement is determined by the quantity of the differential charge, and the rate (speed) is determined as a factor of the distance and the positive pulse width (time).

At the end of the charge, the linear charge capacitor has the value of the present plot point. The sample and hold amplifier now samples this value and stores it as the previous plot point. The charging circuit is now ready to get the new present plot point.

##### Data Conversion

Data is received from the DMA controller (see Service Sheet 15) in two bytes. The first byte is loaded into data latch A13U29 when a high is placed on address A50 by the DMA. The DMA will generate strobe ST1 to forward the data to A13U26. The data is then loaded into A13U26 by a low on the DISPLAY DISABLE line.

## SERVICE SHEET 17 (cont'd)

the right side, it must be brought back to the left side to make the next trace. During this time, the left (retrace) movement, it is necessary to turn off the beam to prevent the retrace from being seen.

The turning off of the beam is called blanking, and is the same as lifting the pen. On an oscilloscope, the Z-Axis input also serves to change the brightness of a trace. In the Noise Figure Meter, this feature is used to make the noise figure traces brighter than the gain trace.

The main difference between the trace movement and the pen movement is the time required for each movement. The pen only requires two points of data, and this data is "expended" in one pen move. The one pen movement uses up all of the time of one HOLD firing pulse. The scope trace makes several traces over the time of the pulse, and may require many data points.

##### Retrace Blanking Pulse Generator

A13U95B is hard wired for only two states. A low (SAMPLE) will occur at the end of a data cycle, and hold the flip/flop in a reset state. The low reset input will override any other activity and make the active low Q output at pin 7 go high. The Q output will remain high as long as the SAMPLE is low, and thus prevent a blanking pulse. Only when the HOLD/SAMPLE line goes high (HOLD), will there be data output, with the trace movement requiring blanking.

##### Retrace Detector

Any time the MFU interrupts the DMA to update the measurement data in the DMA RAM, the DMA will restart all three axes from the beginning. This means that the DISPLAY DISABLE line will be brought high, and the data will begin at the start of the X and Y-Axes.

Data latch A13U25 inputs the composite data byte into retrace detector A13U41. When the end of the trace is reached, the data byte will be loaded with all ones. This indicates a need for a retrace, and A13U41 will output a low to both A13U39B and to A13U39A.

The low into A13U39B will clock the flip/flop to its alternate state, and the active low Q output will go low. This low will enable A13U39C to start a high. This high is placed across RC network A13U48 and A13C50. This network will charge and the high will finally cause A13U39A to output a low to A13U38D.

This second low to A13U38D has no effect, as A13U38D is already enabled. However, the next SAMPLE low will reset the flip/flop before the retrace is complete. This will immediately remove one of the enabling lows to A13U38D. The other low from A13U39A will remain low until the RC network can discharge back through A13U38C. This allows time to complete the retrace. The output of A13U38D is inverted low by A13U38B and input to gate A13U37B.

## SERVICE SHEET 17 (cont'd)

### Pen Lift Driver

Normally, all four inputs to NAND gate A13U37B are high, causing a low output to inhibit any blanking pen lifting. The low from the retrace or blanking pulse generator will cause a blanking pulse. Also, the MFU can directly take the PEN LIFT line low to cause blanking.

If the DISPLAY DISABLE and SCOPE lines both go high, this indicates that the MFU is updating data. NAND gate A13U37A will go low to cause a 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 A13U38.

A13U38 is a differential amplifier with an open collector output. This means that the amplifier output of A13U38 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 A13U38. 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 A13R29 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 caused and input to inverter A13U19A. The low into A13U19A causes a high output, which is placed across RC network A13R03 and A13C36.

**SERVICE SHEET 17 (cont'd)**

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 DMA 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 17 when a malfunction has occurred in either the X-Axis Drive or the Z-Axis Drive of Driver Assembly A13. If all of 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 the Z-Axis Drive 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 Measuring System .....	HP 1980A
Systems DVM .....	HP 3456A

**General Checks**

1. In the power on condition, verify that the voltage from pin 20 of A13U28 to ground is  $+5 \pm 0.05$  Vdc.
2. On A13U23, verify that the voltages from pin 7 to ground is  $+15 \pm 1$  Vdc, and from pin 4 to ground is  $-15 \pm 1$  Vdc.

**SERVICE SHEET 17 (cont'd)**

**2 Overall X-Axis Drive Test**

1. Refer to Section III Operation, Basic Functional Checks, and setup the oscilloscope to display the oscilloscope test pattern.

2. Ensure that the display on the oscilloscope matches the test pattern.

3. If the test pattern is correct, the X-Axis Drive is working correctly. If the pattern has curves and/or other distortions in the straight lines, attempt adjusting DISPLAY LINEARITY potentiometer A13R29 (Service Sheet 16).

4. If the adjustment corrected the pattern, the X-Axis Drive is now working. If the adjustment did not correct the pattern, leave the test running, and proceed to the next check.

**3 Data Latching and Conversion**

1. Connect the Logic Analyzer to the data bus output pins of A13U29, and to AS0 (pin 1) and ST1 (pin 11) of A13U29. The data bus pins of A13U29 are DS0-2, DS1-5, DS2-6, DS3-9, DS4-12, DS5-15, DS6-16, and DS7-19.

2. Ensure that each time that AS0 is low, and strobe ST1 is present, that new data is present on the outputs of A13U29. If address AS0 or ST1 is in error, or any data line is not changing, check A13U29.

3. Connect the Logic Analyzer to the data bus output pins of A13U28, and to HOLD/SAMPLE (pin 11) and DISPLAY DISABLE (pin 1) of A13U28. The data bus pins of A13U28 are DS0-2, DS1-5, DS2-6, DS3-9, DS4-12, DS5-15, DS6-16, and DS7-19.

4. Ensure that each time that DISPLAY DISABLE is low, and the HOLD/SAMPLE line is pulsed, new data is present on the outputs of A13U28. If DISPLAY DISABLE is in error, check A13U28, A13U40B, and A13U37A.
5. If any data line is not changing, check A13U28, A13U27, and A13U41.

6. Synchronize the oscilloscope on pin 14 of A13U24 (HOLD/SAMPLE), and ensure that a new, and changing level (X DAC) appears on test point A13TP15 with each sample/hold pulse. If the X DAC output is in error, check A13U26, A13U25, A13U24, A13U23, and A13C52.

**4 Sample/Hold and X-Axis Driver Test**

1. Synchronize the oscilloscope on pin 14 of A13U24 (HOLD/SAMPLE), and ensure that each time the pulse goes low (sample), the signal level on pin 11 of A13U24 is identical to the level on pin 2. If not, check A13U24 and A13C51.

2. Ensure that each time the pulse goes high (hold), the signal level on pin 7 of A13U24 is identical to the signal on pin 11. If not, check A13U24 and A13U25.

3. Synchronize the oscilloscope on pin 14 of A13U24 (HOLD/SAMPLE), and ensure that the two inputs (pins 2 and 3) of A13U25 are present and changing. Ensure that the level on pin 2 appears to be lagging the level on pin 3 by one timing pulse.

4. If either pulse is in error, check A13U26, A13U25, A13U24, A13U23, and A13C52. Otherwise, check A13U23 and A13VR8.

**5 Z-Axis/Pen Lift Test**

1. Connect the logic analyzer to pins 11, 12, and 1 through 6 of NAND gate A13U41. Ensure that each time all inputs are high, the output goes low. If not, check A13U41, A13U39A, and A13U89B.

2. Connect channel one of the oscilloscope to pin 3 of A13U40B, and channel 2 to pin 4 of A13U39A. Ensure that the low on pin 4 of A13U39A lags, and is stretched, in relation to the high on pin 3 of A13U40B. If not, check, A13U40B, A13U19A/B, A13U39A, A13R63, and A13C56.

3. Connect channel one of the oscilloscope to pin 4 of A13U39A, channel 2 to pin 1 of A13U36, and synchronize the oscilloscope on pin 8 of A13U41. Ensure that when pin 4 of A13U39A is high, and A13U41 outputs a low, pin 1 of A13U36 toggles with each low output. If not, check A13U39A, A13U2D, A13Q1, A13U36, and A9R1.

4. Connect channel one of the oscilloscope to pin 14 of A13U39B, channel 2 to pin 6 of A13U38B, and synchronize the oscilloscope on pin 8 of A13U41. Ensure that when pin 14 of A13U39B is high, and A13U41 outputs a low, pin 6 of A13U38B goes low. If not, check A13U39B, A13U38A-D, A13U37B, A13R48, and A13C50.



**SERVICE SHEET 17 (cont'd)**

5. If the signals are correct to this point, check A13U37A/B, A13U40D, A13U36, and A13VR6.

**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 applicable sections for post-testing procedures.

P/O A13 ASSEMBLY

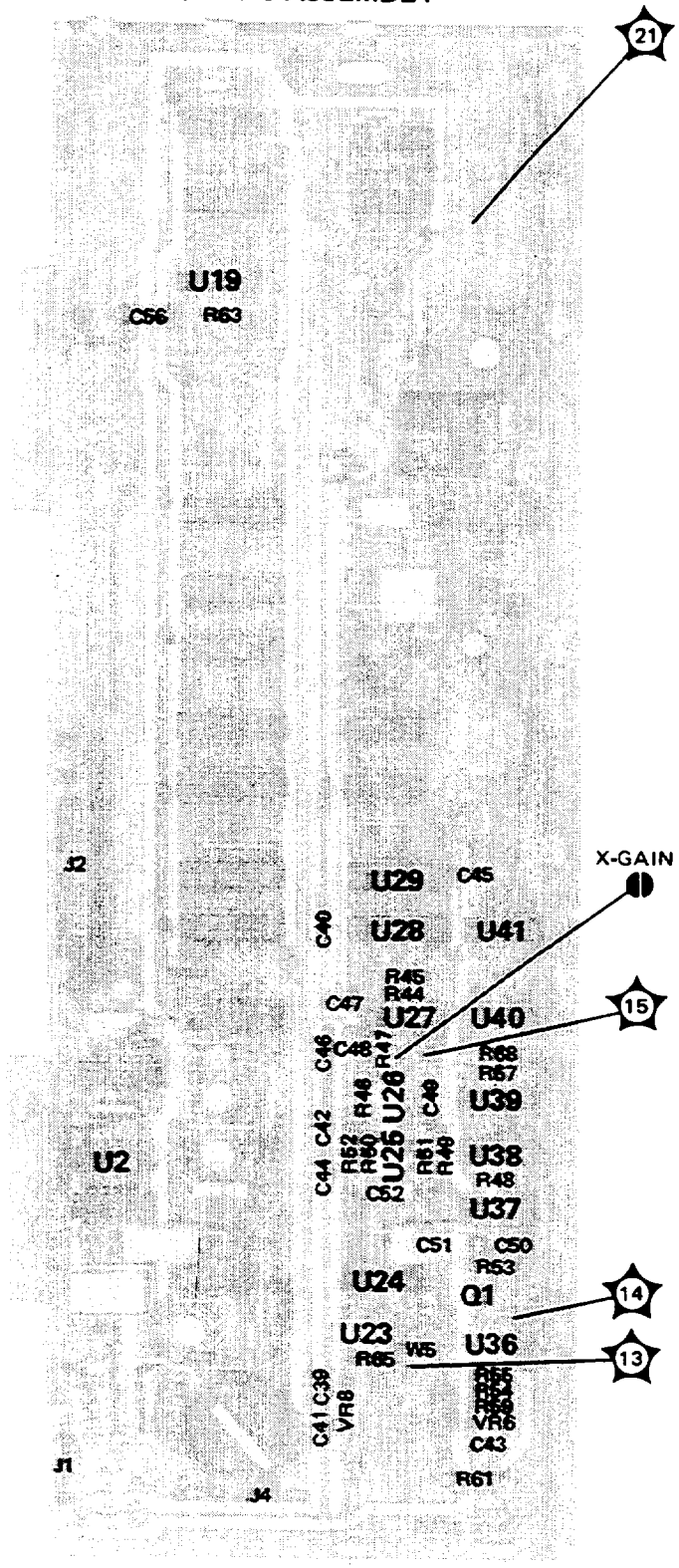


Figure 8-78. P/O A13 Driver Assembly Component Locations (X-Axis and Z-Axis Drive)

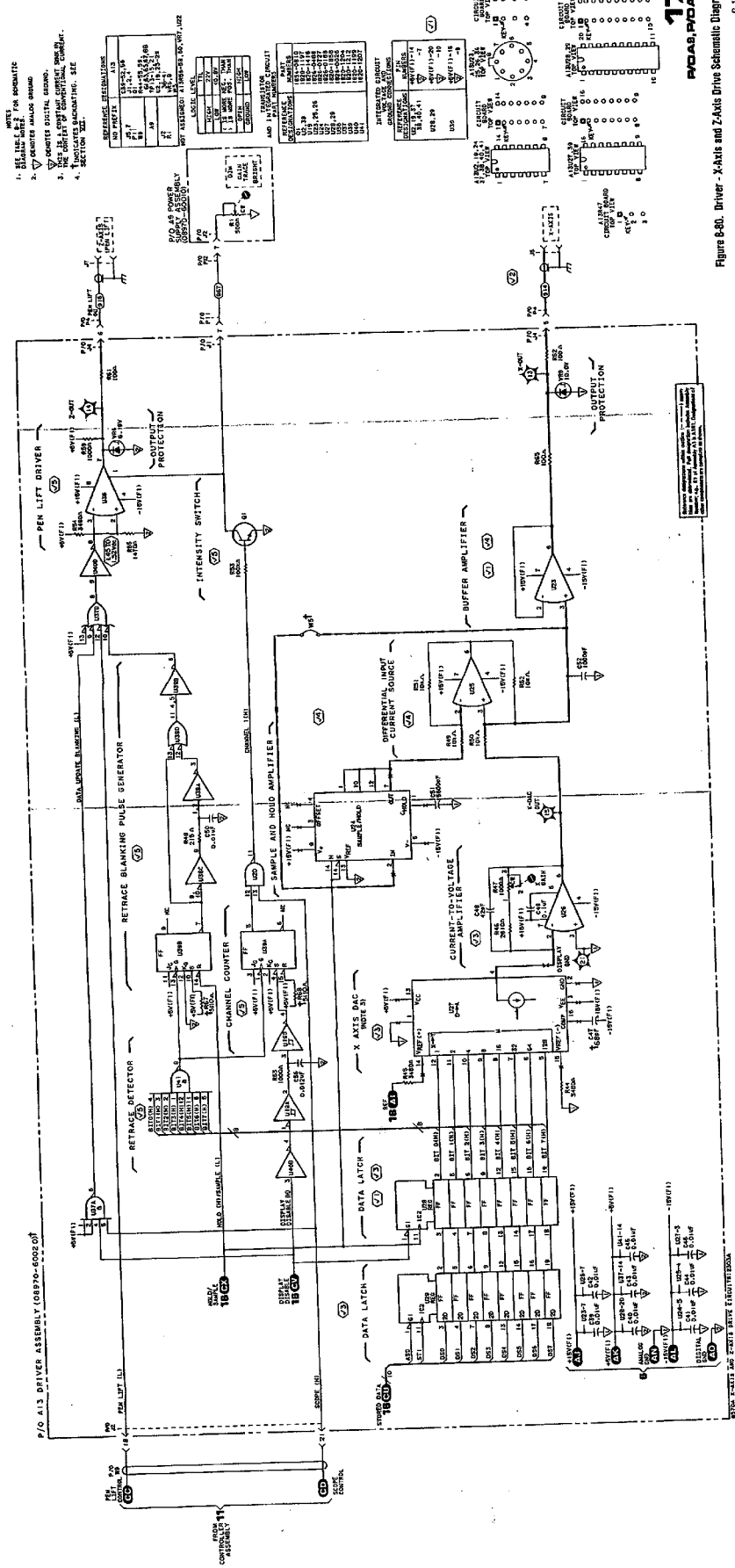


Figure 8-80. Driver - X-Axis and Z-Axis Drive Schematic Diagram

**SERVICE SHEET 18 (cont'd)**

- Noise Source ..... HP 346B (Option 000)  
 Logic Analyzer ..... HP 1689D  
 Oscilloscope Measuring System ..... HP 1598A  
 Systems DVM ..... HP 3466A

**General Checks**

- Verify that the voltage from pin 40 of A14U41 to ground (pin 20) is +5 ±0.05 Vdc.
- Verify that the 4 MHz clock (62) is present on pin 3 of A14U41.
- Verify that pin 4 (RESET) of A14U41 is at a logical low.
- Verify that pin 24 (FC) of A14U41 is at a logical high.

**Power-Up Self Testing**

When the Noise Figure Meter is first powered on, an instrument self-test is run. In the case of the HP-IB, all instrument data bus and status signals are set as part of the instrument RAM memory. If the instrument data bus has a problem, and the trouble is isolated to the HP-IB circuits, a pin-by-pin inspection should be made of A14U34 and A14U35. If the problem is on the instrument address bus, check the traces and pins of A14U41 for addresses A0, A1, and A2.

**HP-IB Functional Tests**

The HP-IB interface is checked by the procedures covered in Section III, Operation, HP-IB Functional Tests. A failure in the HP-IB interface circuits should be verified by running the functional tests in Table 8-62 lists each of the functional tests and which signal lines are tested.

Table 8-62. HP-IB Functional Tests

Test Procedure	Signal Lines Tested
Address Recognition	ATN, NDAC, NREF, and DIO1-DIO8
Remote and Local Messages and the Local Key	REN
Sending the Data Messages	DAV, NDAC, NREF, and data
Receiving the Data Messages	REN
Local Lockout and Clear	REN
Lockout/Set Local Messages	
Clear Message	IFC
Status Byte Message	SRQ
Require Service Message	
Trigger Message	

Note: The signal lines listed above are shown in dashed lines in most applications, but the signal line may be listed in other procedures as well.

**SERVICE SHEET 18 (cont'd)**

NDAC, and DAV work together in what is known as a three wire handshake in which the slowest active listener controls the speed of data transfer. End or identify signal EOI is used by the bus controller to inform the listening device that the talking device has completed a multiple byte transfer sequence.

The Signal lines previously described are interfaced through HP-IB control/handshake transceivers A14U55A/B and A14U56A/B. The REN signal is under control of the MPU. When the Noise Figure Meter is in use, the REN signal is set directly to the adapter through A14U55B. The IFC signal is hardwired to the adapter through A14U55A. The instrument can not generate an EOI signal. The ATN signal is under control of the MPU, when the instrument is the bus controller, by way of the HP-IB controller logic, through A14U55A. (ATN is always set by the current bus controller.)

The SRQ signal is hardwired as an output through A14U56A. The NREF signal through A14U56A, and the DAV and NDAC signals through A14U56B, are under control of the adapter. When the adapter is ready to send data to the external device, a high is placed on the adapter A14U56A. This signal is received by A14U56B to a low on A14U56A and A14U56B. In A14U56A, the A14U56B allow an external device to send handshake signals to the adapter.

When the adapter is ready to receive data from the external device, a low is placed on the adapter A14U56B. Then the adapter will receive the DAV signal, from the external device and send the NDAC and NREF signals. Data transceiver A14U59 will be set to receive data from the HP-IB data bus (DIO1-DIO8) and input the data to the adapter.

**TROUBLESHOOTING**

Troubleshooting is done on the circuits of Service Sheet 18 when a malfunction has occurred in the HP-IB Remote Interface or related functions. If all of the tests in the following procedure indicate correct responses, the trouble is located not in the HP-IB or related unit, or in the external device, but in the external device's circuitry. Whenever all values are approximate and are given as a service guideline.

**Test Equipment**

- HP-IB Controller ..... HP 85B/69336A/  
 (ROM Device)/00085-15005  
 (Advanced Programming ROM)  
 or  
 HP 3826A Option 011  
 (Basic 2.0 ROM based system)  
 (built-in interface) ..... HP 8937A  
 HP-IB Interface ..... HP 8937A  
 (for HP-85B only)

**SERVICE SHEET 18 (cont'd)**

With the register selected, and the direction of data flow set, it is only necessary to transfer the data to the MPU and the register in the adapter to the data bus buffer A14U34 is the data bus buffer interface between the MPU and the adapter. The buffer is selected by a low on both SEL 3 and RAM ENABLE into A14U37B. The direction of data flow in A14U34 is set by the E/W line.

**HP-IB Interface Circuits Description**

To be a controller, it is necessary to have command of the ATN and REN signal lines. Since the Noise Figure Meter can be either a controller, or a controlled device, these signal lines are bidirectional. Though the adapter is capable of receiving the ATN and REN signals, the MPU controls the setting of these two lines when the instrument is configured as a bus controller.

General purpose driver A14U15 is enabled by a low on SEL CTRL to pass a byte from the instrument data bus (DIO-D7) to the HP-IB controller logic. The instrument data bus is used only for data by the MPU to indicate that it wants to be the BUS CONTROLLER. The switching from talk to listen is handled by the adapter, which sends status data to the MPU.

The function of remote enable signal REN is to set the state of the external device. REN works in conjunction with other signals to place the external device in either its local or remote controlled state. If the external device is in its local mode, it can become the controller by seizing the REN line and placing the instrument adapter in its remote state. If the external device is in its remote state, it is under control of the adapter.

The function of the attention signal (ATN) is to specify how data is to be interpreted on the HP-IB data bus. When ATN is true, the DIO-D8 is interpreted as address information. Otherwise DIO-D8 is interpreted as data.

Interface clear-signal IFC is input only from the external device to the adapter through A14U55A. It is used to place the adapter into a known quiescent state. Since the external SRQ is an output only from the adapter to the external controller through A14U56A, it is used to inform the controller of the adapter's desire to communicate.

Data valid signal DAV is used to inform the listening device that the data available on the bus is valid. The not data accepted signal (NDAC) is used to inform the talking device that the listening device is not accepting data at this time.

Not ready for data signal NREF is used to inform the talking device that the listening device is not prepared to accept data. This is different than the NDAC signal, in that the NDAC signal is a momentary state; for example, machine cycle busy. The NREF is a status condition and may require longer to clear. Lines NREF, WRITE.

**SERVICE SHEET 18**

**CONTROLLER - REMOTE INTERFACE (HP-IB)  
 P/O A14 CONTROLLER ASSEMBLY  
 A16 HP-IB CONNECTOR ASSEMBLY**

**REFERENCES**

- Block Diagram - Service Sheet E04  
 Section III - Operator's Checks  
 Section VIII - Special Functions and Power-Up Checks

**PRINCIPLES OF OPERATION**

**General**

The HP-IB connector is located on the rear panel of the Noise Figure Meter. HP-IB is Hewlett-Packard's implementation of the IEEE-488 Interface Bus. The use of the HP-IB is covered in depth in Section III, Operation. The Noise Figure Meter can be operated over HP-IB in three modes: It can be a talker/listener under the control of a computer, it can be a controller for an external local oscillator, or it can be a talker-only, sending data to a logger.

**HP-IB Interface Adapter**

At the heart of the HP-IB interface is the interface adapter. This device is essentially a special purpose microprocessor with an eight register, fully programmable latch. It has control lines and a data bus which interface with the MPU. It also has control lines and a data bus which interface with the HP-IB, and the external device.

The adapter will respond directly to certain bus commands where long delays are not allowed (such as interface clear). In other cases, it will interpret its own responses when it has received data or commands addressed to the Noise Figure Meter.

**Microprocessor (MPU) Interface Circuits Description**

Clock #2 is input to the adapter A14U41 on pin 3. This signal determines the timing for all adapter operations. When the adapter needs to communicate with the MPU, the adapter will place a low on the IRQ line at pin 11. This initiates the interrupt request to the MPU. When the MPU is ready to communicate with the adapter, the MPU will place a low on the SEL 3 line. This low is input to the adapter on pin 8 as the chip select signal CS.

If there is a need, the MPU can put the adapter into an idle state by placing a high on the RESET line. This causes the adapter to suspend all operations until RESET goes low. When the MPU selects the adapter, it must also select the eight registers within the adapter. The MPU selects the desired register by placing an appropriate address on lines A0, A1, and A2.

Along with register selection, the MPU will either write data into the selected register (pin 10 WRITE low), or read data from the register (pin 9 READ low). To obtain proper timing, the MPU uses SEL 3 and E/W as inputs to both read/write control logic. A14U58C inverts SEL 3 and inputs it to both A14U57A and A14U57B. In A14U57A, SEL 3 and E/W generate READ. A14U63B inverts E/W and inputs it along with SEL 3 to generate the WRITE.



**SERVICE SHEET 18 (cont'd)****✓ Signal Line Troubleshooting**

If the Noise Figure Meter can not use the HP-IB interface to communicate properly with the external device, complete the following steps in the order shown.

1. Repeat the Address Recognition procedure, using all valid addresses. If the problem persists, use the oscilloscope to observe the signal at pin 11 of A14U18D. Rerun the procedure, and ensure that the ATN signal toggles.
2. If ATN toggles, proceed to step 4. Otherwise, check for the ATN signal on pin 2 of A14U40A. If the signal is present, check A14U40A, A14U60A, A14U55A, A14U18D, and A14U41.
3. If the ATN signal is missing from pin 2 of A14U40A, check A14U40A, A14U15, and A14U34.
4. Repeat the Remote and Local Messages and the Local Key procedure, and ensure that the REN signal toggles on pin 3 of A14U18A.
5. If REN toggles, proceed to step 7. Otherwise, check for the REN signal on pin 5 of A14U40B. If the signal is present, check A14U40B, A14U60A, A14U55B, A14U18A, and A14U41.
6. If the REN signal is missing from pin 5 of A14U40B, check A14U40B, A14U15, and A14U34.
7. Repeat the Abort Message procedure, and ensure that the IFC signal on pin 6 of A14U55A is at a logical high level. If the signal is high, check A14U41, otherwise check A14U55A.
8. Repeat the Sending the Data Message procedure, and ensure that the DAV signal goes low on pin 10 of A14U56B, when data is available on the data bus. If the line does not go low, check A14U56B, A14U57D, A14U60C, A14U56A, A14U39, and A14U41.
9. Repeat the Sending the Data Message procedure, and ensure that the EOI signal, on pin 10 of A14U55B, toggles at the end of the data transfer. If the line does not toggle, check A14U55B and A14U41.

**NOTE**

*Some HP-IB controllers do not use the EOI signal. Verify the signal usage by referring to the controller's schematics and manuals.*

10. Repeat the Address Recognition procedure, and ensure that the NDAC signal, on pin 14 of A14U56B, toggles during addressing. If the line does not toggle, check A14U56B, A14U60C, A14U57D, A14U56A, A14U39, and A14U41.

**SERVICE SHEET 18 (cont'd)**

11. Repeat the Address Recognition procedure, and ensure that the NRFD signal, on pin 6 of A14U56A, toggles during addressing. If the line does not toggle, check A14U56A, A14U60C, A14U57D, A14U56B, A14U39, and A14U41.
12. Connect the logic analyzer to the data bus of the adapter. This is best done by connecting to pins 12 through 19 (DIO1 through DIO8) on A14U39.
13. Repeat the Sending the Data Messages procedure, but use an alternating data pattern of the letter "T" (01010101) and the character "..." (00101010). Data line DIO8 (pin 12) is not used, and is therefore, not tested (should remain low).

14. If the data is present, and toggling on all data lines, check A14U39, A14U56B, A14U60C, A14U57D, A14U56A, and A14U41. If the data is not present, or is not toggling, check A14U39, A14U59, A14U34, A14U37B, A14U57, and A14U63.

15. If the problem has not been isolated by these procedures, and the trouble appears to be in the interface, replace A14U41.

**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.



**Driver — X-Axis and Z-Axis Drives  
P/O A13  
SERVICE SHEET**

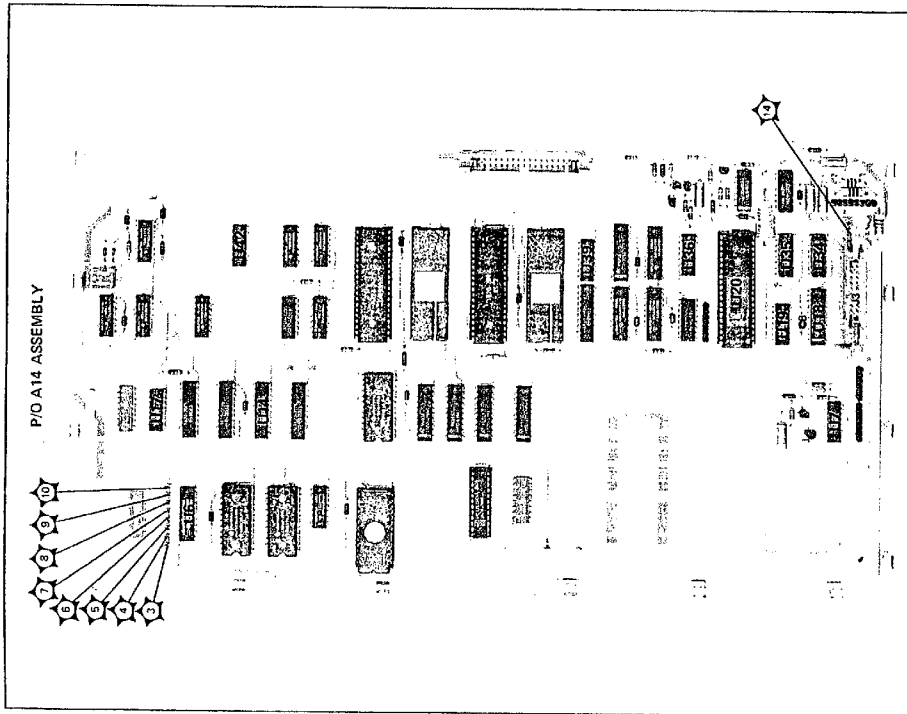


Figure 8-81. P/O A14 Controller Assembly Component Locations (Remote Interface)

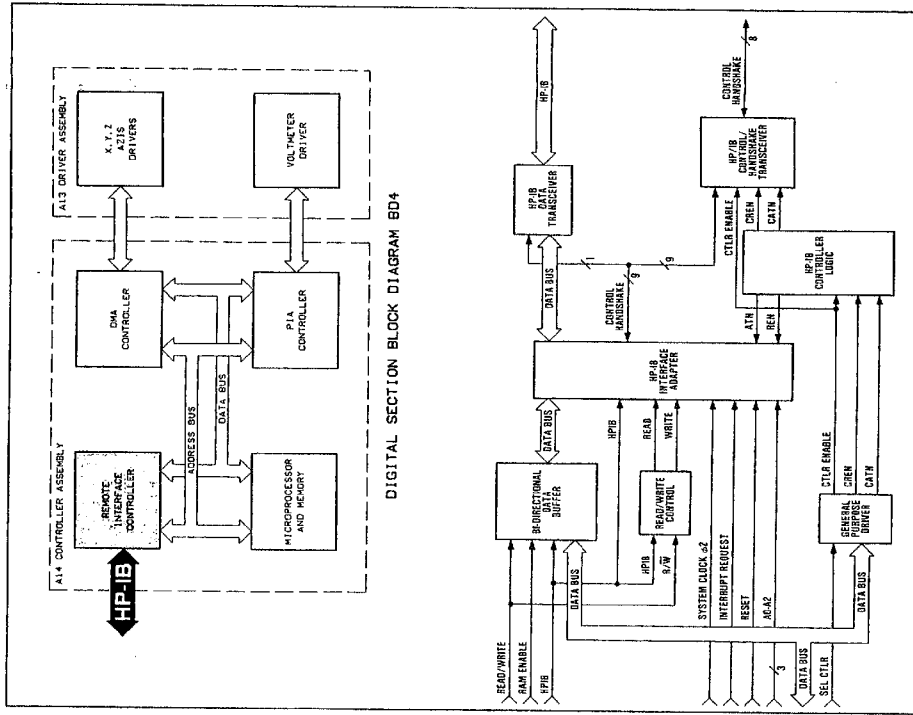


Figure 8-82. Controller-Remote Interface (HP-IB) Block Diagram

NOTES

1. SEE TABLE 8-2 FOR SCHEMATIC CONNECTOR ASSEMBLY (08970-80011)
2. CHASSIS GROUND IS ACHIEVED BY MOUNTING THE BOARD TO THE FRAME.
3. WIO IS SOLDED TO AIR2.
4. THESE ARE HP-IB CAPABILITY CONNECTIONS.

WIO PREFIX	AIR
WIO	AIR1
WIO	AIR2
WIO	AIR3
WIO	AIR4
WIO	AIR5
WIO	AIR6
WIO	AIR7
WIO	AIR8
WIO	AIR9
WIO	AIR10
WIO	AIR11
WIO	AIR12
WIO	AIR13
WIO	AIR14
WIO	AIR15
WIO	AIR16
WIO	AIR17
WIO	AIR18
WIO	AIR19
WIO	AIR20
WIO	AIR21
WIO	AIR22
WIO	AIR23
WIO	AIR24
WIO	AIR25
WIO	AIR26
WIO	AIR27
WIO	AIR28
WIO	AIR29
WIO	AIR30
WIO	AIR31
WIO	AIR32
WIO	AIR33
WIO	AIR34
WIO	AIR35
WIO	AIR36
WIO	AIR37
WIO	AIR38
WIO	AIR39
WIO	AIR40
WIO	AIR41
WIO	AIR42
WIO	AIR43
WIO	AIR44
WIO	AIR45
WIO	AIR46
WIO	AIR47
WIO	AIR48
WIO	AIR49
WIO	AIR50
WIO	AIR51
WIO	AIR52
WIO	AIR53
WIO	AIR54
WIO	AIR55
WIO	AIR56
WIO	AIR57
WIO	AIR58
WIO	AIR59
WIO	AIR60
WIO	AIR61
WIO	AIR62
WIO	AIR63
WIO	AIR64
WIO	AIR65
WIO	AIR66
WIO	AIR67
WIO	AIR68
WIO	AIR69
WIO	AIR70
WIO	AIR71
WIO	AIR72
WIO	AIR73
WIO	AIR74
WIO	AIR75
WIO	AIR76
WIO	AIR77
WIO	AIR78
WIO	AIR79
WIO	AIR80
WIO	AIR81
WIO	AIR82
WIO	AIR83
WIO	AIR84
WIO	AIR85
WIO	AIR86
WIO	AIR87
WIO	AIR88
WIO	AIR89
WIO	AIR90
WIO	AIR91
WIO	AIR92
WIO	AIR93
WIO	AIR94
WIO	AIR95
WIO	AIR96
WIO	AIR97
WIO	AIR98
WIO	AIR99
WIO	AIR100

LOGIC LEVEL	WIO PREFIX	AIR
LOW	WIO	AIR1
HIGH	WIO	AIR2
LOW	WIO	AIR3
HIGH	WIO	AIR4
LOW	WIO	AIR5
HIGH	WIO	AIR6
LOW	WIO	AIR7
HIGH	WIO	AIR8
LOW	WIO	AIR9
HIGH	WIO	AIR10
LOW	WIO	AIR11
HIGH	WIO	AIR12
LOW	WIO	AIR13
HIGH	WIO	AIR14
LOW	WIO	AIR15
HIGH	WIO	AIR16
LOW	WIO	AIR17
HIGH	WIO	AIR18
LOW	WIO	AIR19
HIGH	WIO	AIR20
LOW	WIO	AIR21
HIGH	WIO	AIR22
LOW	WIO	AIR23
HIGH	WIO	AIR24
LOW	WIO	AIR25
HIGH	WIO	AIR26
LOW	WIO	AIR27
HIGH	WIO	AIR28
LOW	WIO	AIR29
HIGH	WIO	AIR30
LOW	WIO	AIR31
HIGH	WIO	AIR32
LOW	WIO	AIR33
HIGH	WIO	AIR34
LOW	WIO	AIR35
HIGH	WIO	AIR36
LOW	WIO	AIR37
HIGH	WIO	AIR38
LOW	WIO	AIR39
HIGH	WIO	AIR40
LOW	WIO	AIR41
HIGH	WIO	AIR42
LOW	WIO	AIR43
HIGH	WIO	AIR44
LOW	WIO	AIR45
HIGH	WIO	AIR46
LOW	WIO	AIR47
HIGH	WIO	AIR48
LOW	WIO	AIR49
HIGH	WIO	AIR50
LOW	WIO	AIR51
HIGH	WIO	AIR52
LOW	WIO	AIR53
HIGH	WIO	AIR54
LOW	WIO	AIR55
HIGH	WIO	AIR56
LOW	WIO	AIR57
HIGH	WIO	AIR58
LOW	WIO	AIR59
HIGH	WIO	AIR60
LOW	WIO	AIR61
HIGH	WIO	AIR62
LOW	WIO	AIR63
HIGH	WIO	AIR64
LOW	WIO	AIR65
HIGH	WIO	AIR66
LOW	WIO	AIR67
HIGH	WIO	AIR68
LOW	WIO	AIR69
HIGH	WIO	AIR70
LOW	WIO	AIR71
HIGH	WIO	AIR72
LOW	WIO	AIR73
HIGH	WIO	AIR74
LOW	WIO	AIR75
HIGH	WIO	AIR76
LOW	WIO	AIR77
HIGH	WIO	AIR78
LOW	WIO	AIR79
HIGH	WIO	AIR80
LOW	WIO	AIR81
HIGH	WIO	AIR82
LOW	WIO	AIR83
HIGH	WIO	AIR84
LOW	WIO	AIR85
HIGH	WIO	AIR86
LOW	WIO	AIR87
HIGH	WIO	AIR88
LOW	WIO	AIR89
HIGH	WIO	AIR90
LOW	WIO	AIR91
HIGH	WIO	AIR92
LOW	WIO	AIR93
HIGH	WIO	AIR94
LOW	WIO	AIR95
HIGH	WIO	AIR96
LOW	WIO	AIR97
HIGH	WIO	AIR98
LOW	WIO	AIR99
HIGH	WIO	AIR100

INTEGRATED CIRCUIT ADDRESS	WIO PREFIX	AIR
U1	WIO	AIR1
U2	WIO	AIR2
U3	WIO	AIR3
U4	WIO	AIR4
U5	WIO	AIR5
U6	WIO	AIR6
U7	WIO	AIR7
U8	WIO	AIR8
U9	WIO	AIR9
U10	WIO	AIR10
U11	WIO	AIR11
U12	WIO	AIR12
U13	WIO	AIR13
U14	WIO	AIR14
U15	WIO	AIR15
U16	WIO	AIR16
U17	WIO	AIR17
U18	WIO	AIR18
U19	WIO	AIR19
U20	WIO	AIR20
U21	WIO	AIR21
U22	WIO	AIR22
U23	WIO	AIR23
U24	WIO	AIR24
U25	WIO	AIR25
U26	WIO	AIR26
U27	WIO	AIR27
U28	WIO	AIR28
U29	WIO	AIR29
U30	WIO	AIR30
U31	WIO	AIR31
U32	WIO	AIR32
U33	WIO	AIR33
U34	WIO	AIR34
U35	WIO	AIR35
U36	WIO	AIR36
U37	WIO	AIR37
U38	WIO	AIR38
U39	WIO	AIR39
U40	WIO	AIR40
U41	WIO	AIR41
U42	WIO	AIR42
U43	WIO	AIR43
U44	WIO	AIR44
U45	WIO	AIR45
U46	WIO	AIR46
U47	WIO	AIR47
U48	WIO	AIR48
U49	WIO	AIR49
U50	WIO	AIR50
U51	WIO	AIR51
U52	WIO	AIR52
U53	WIO	AIR53
U54	WIO	AIR54
U55	WIO	AIR55
U56	WIO	AIR56
U57	WIO	AIR57
U58	WIO	AIR58
U59	WIO	AIR59
U60	WIO	AIR60
U61	WIO	AIR61
U62	WIO	AIR62
U63	WIO	AIR63
U64	WIO	AIR64
U65	WIO	AIR65
U66	WIO	AIR66
U67	WIO	AIR67
U68	WIO	AIR68
U69	WIO	AIR69
U70	WIO	AIR70
U71	WIO	AIR71
U72	WIO	AIR72
U73	WIO	AIR73
U74	WIO	AIR74
U75	WIO	AIR75
U76	WIO	AIR76
U77	WIO	AIR77
U78	WIO	AIR78
U79	WIO	AIR79
U80	WIO	AIR80
U81	WIO	AIR81
U82	WIO	AIR82
U83	WIO	AIR83
U84	WIO	AIR84
U85	WIO	AIR85
U86	WIO	AIR86
U87	WIO	AIR87
U88	WIO	AIR88
U89	WIO	AIR89
U90	WIO	AIR90
U91	WIO	AIR91
U92	WIO	AIR92
U93	WIO	AIR93
U94	WIO	AIR94
U95	WIO	AIR95
U96	WIO	AIR96
U97	WIO	AIR97
U98	WIO	AIR98
U99	WIO	AIR99
U100	WIO	AIR100

INTEGRATED CIRCUIT ADDRESS	WIO PREFIX	AIR
U1	WIO	AIR1
U2	WIO	AIR2
U3	WIO	AIR3
U4	WIO	AIR4
U5	WIO	AIR5
U6	WIO	AIR6
U7	WIO	AIR7
U8	WIO	AIR8
U9	WIO	AIR9
U10	WIO	AIR10
U11	WIO	AIR11
U12	WIO	AIR12
U13	WIO	AIR13
U14	WIO	AIR14
U15	WIO	AIR15
U16	WIO	AIR16
U17	WIO	AIR17
U18	WIO	AIR18
U19	WIO	AIR19
U20	WIO	AIR20
U21	WIO	AIR21
U22	WIO	AIR22
U23	WIO	AIR23
U24	WIO	AIR24
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U27	WIO	AIR27
U28	WIO	AIR28
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U34	WIO	AIR34
U35	WIO	AIR35
U36	WIO	AIR36
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U38	WIO	AIR38
U39	WIO	AIR39
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U43	WIO	AIR43
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U49	WIO	AIR49
U50	WIO	AIR50
U51	WIO	AIR51
U52	WIO	AIR52
U53	WIO	AIR53
U54	WIO	AIR54
U55	WIO	AIR55
U56	WIO	AIR56
U57	WIO	AIR57
U58	WIO	AIR58
U59	WIO	AIR59
U60	WIO	AIR60
U61	WIO	AIR61
U62	WIO	AIR62
U63	WIO	AIR63
U64	WIO	AIR64
U65	WIO	AIR65
U66	WIO	AIR66
U67	WIO	AIR67
U68	WIO	AIR68
U69	WIO	AIR69
U70	WIO	AIR70
U71	WIO	AIR71
U72	WIO	AIR72
U73	WIO	AIR73
U74	WIO	AIR74
U75	WIO	AIR75
U76	WIO	AIR76
U77	WIO	AIR77
U78	WIO	AIR78
U79	WIO	AIR79
U80	WIO	AIR80
U81	WIO	AIR81
U82	WIO	AIR82
U83	WIO	AIR83
U84	WIO	AIR84
U85	WIO	AIR85
U86	WIO	AIR86
U87	WIO	AIR87
U88	WIO	AIR88
U89	WIO	AIR89
U90	WIO	AIR90
U91	WIO	AIR91
U92	WIO	AIR92
U93	WIO	AIR93
U94		

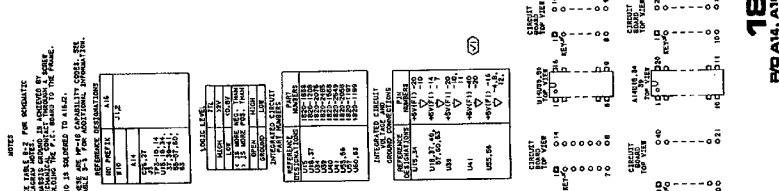


Figure 8-22. Controller - Remote Interface (RP-18) Block Diagram

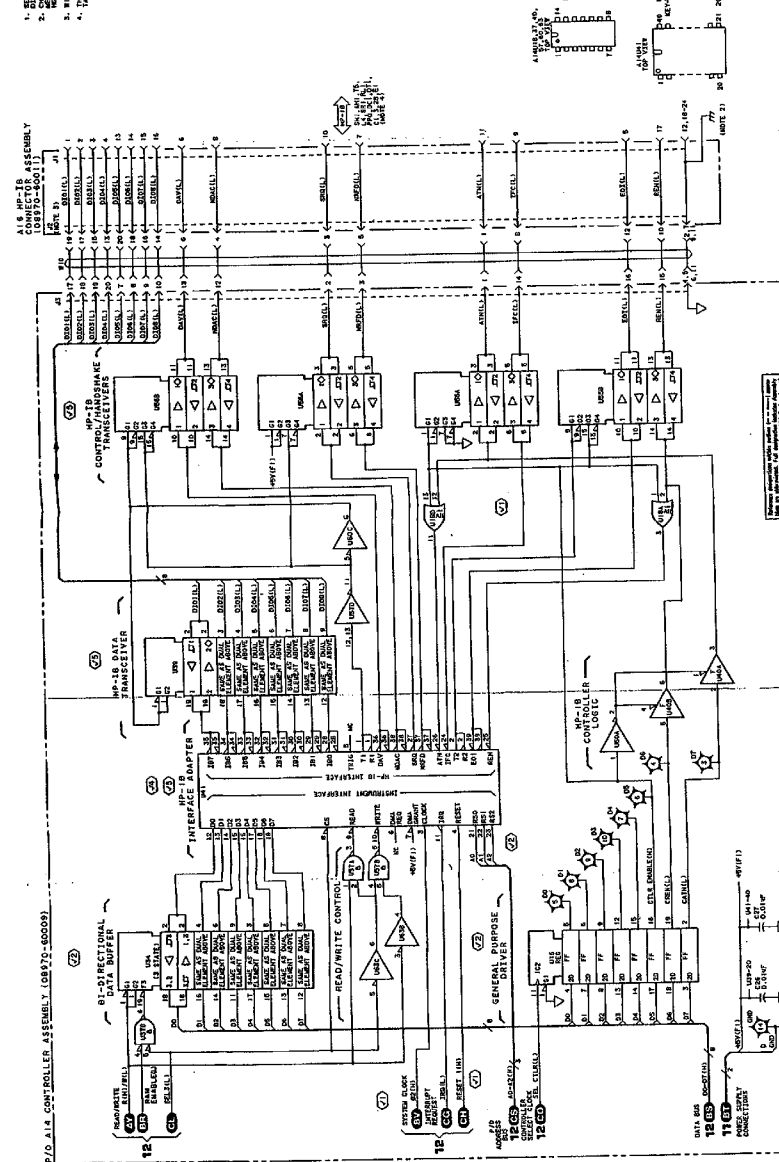


Figure 8-23. Controller - Remote Interface (RP-18) Schematic Diagram

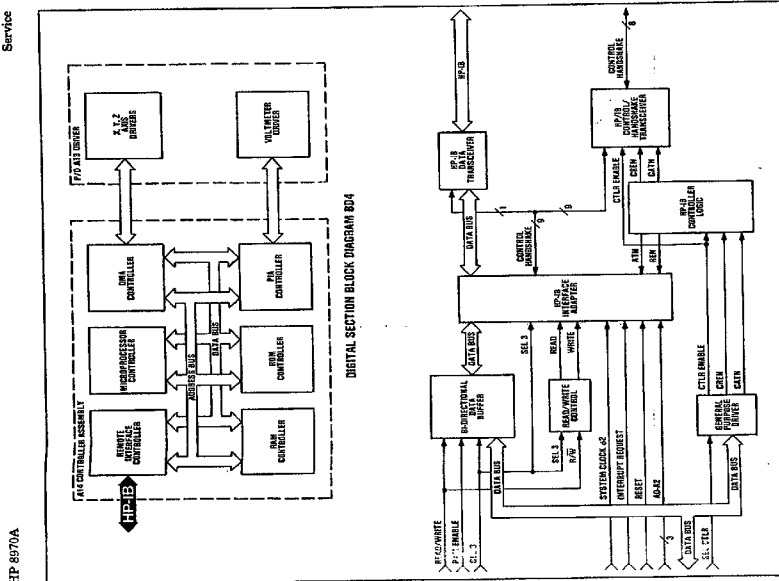


Figure 8-24. Controller - Remote Interface (RP-18) Block Diagram

## SERVICE SHEET 19

### 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  $\pm 0.05$  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.

##### +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, and then regulated by A9U2 to within  $\pm 0.05$  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 A9DS2 and the +5V overvoltage protection circuit. In the event of overvoltage, zener diode A9VR4 will conduct, once the voltage across it rises above +5.6 Vdc. A9Q4 is then turned on and shorts out the +5 Vdc supply. This will either cause A9U2 to current limit, or will blow the main 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. In the event of an overload, regulator A9U1 will

## SERVICE SHEET 19 (cont'd)

current limit. 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. Under normal conditions the output of the -15V full wave rectifier is filtered and regulated by A9U3. The regulated -15 Vdc is again filtered and used to power the Noise Figure Meter analog devices.

##### +28 Vdc Power

The +28 Vdc power is used exclusively to drive the Noise Source. 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 seven 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.

## TROUBLESHOOTING

Troubleshooting is done on the circuits of Service Sheet 19 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 Measuring System ..... HP 1980A  
Systems DVM ..... HP 3456A

### General Voltage Checks

**Purpose.** To verify that all DC voltages are present, and that the +28 Vdc is pulsing.

**SERVICE SHEET 19 (cont'd)**

**WARNING**

*Dangerous voltages are present in the A13 Line Power Assembly and at the inputs of transformer T1.*

- 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.
- 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.*

**Ⓢ 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.)

- Ensure that main line fuses F1 has not blown. If not, ensure that the main line source is plugged into an active line source, and that the power switch is ON.
- 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.
- If fuse F1 was blown, disconnect the cables from connectors A302 and A310. Replace the fuse and apply power.
- 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.
- If fuse F1 does blow again, the trouble is internal to the power supply. Remove line power, and make a visual inspection of the various power supply decouplers. Check for any sign of heat, and check for any abnormal pulsing. Verify that the power supply is set for the power supply in which the device is located.
- Measure the resistance from test points A9TP3, 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.
- Measure the resistance from test points A9TP1, A9TP2, A9TP3, and A9TP4 to ground. If any test point shows a short (less than 100 ohms), proceed to that check in which the test point is located.

**SERVICE SHEET 19 (cont'd)**

**Ⓢ +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.

- 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.
- 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 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, A9E2, A12YR1, A9Q1, and A12U1.
- 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, A12B2, and A12C8A.
- If in step 2, the fuse did not blow, but the +28 Vdc is missing or incorrect, verify that there is +6.3 Vdc on A12U1-3. If the voltage is incorrect, verify that there is +15 Vdc on A12B3.
- If the +15 Vdc is incorrect, the trouble is in the +15 Vdc supply, otherwise check the following components in the order shown: A12U1, A12YF2, A12C1, A12B3, and A12B5.
- 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 A12B2.
- 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: A12Q4, A12Q2, A12U1, and A12C8B.
- 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.*

**Ⓢ +15 Vdc Power Supply**

**Purpose.** To verify that the +15 Vdc power supply is at the correct level.

**SERVICE SHEET 19 (cont'd)**

- If A9DS1 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.
- Apply power and verify that the +15 Vdc is correct. If the level is correct, the problem is in one of the loads.
- If the +15 Vdc is incorrect, measure the resistance from test point A9TP8 to ground. If the resistance is less than 100 ohms, check the following components in the order shown: A9U1, A9C12, A9C8, A9E3, A9C93, A9CR4, and A9CR9.
- Measure the resistance from test point A9TP9 to ground. If the resistance is less than 10 ohms, check the following components in the order shown: A9U1, A9C11, A9C16, and A12U1.
- Once the +15 Vdc has been restored, reconnect all cables, apply power and verify that the level is correct.

**Ⓢ +5 Vdc Power Supply**

**Purpose.** To verify that the +5 Vdc power supply is at the correct level.

- If A9DS2 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.
- Apply power and verify that the +5 Vdc is correct. If the level is correct, the problem is in one of the loads.
- 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, A9E5, A9C14, and A9C15.
- 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, A9E9, and A9C17.
- 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.)

**Ⓢ -15 Vdc Power Supply**

**Purpose.** To verify that the -15 Vdc power supply is at the correct level.

- If A9DS3 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.

**SERVICE SHEET 19 (cont'd)**

- Apply power and verify that the -15 Vdc is correct. If the level is correct, the problem is in one of the loads.
- 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, A9C36, A9C37, A9C13, A9C15, A9E7, and A9CR12.
- 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, A9C14, A9C16, and A12U1.

**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.

order shown; A9U3, A9CR14, A9C18, and A9C19.

- Once the -15 Vdc has been restored, reconnect all cables, apply power and verify that the level is correct.

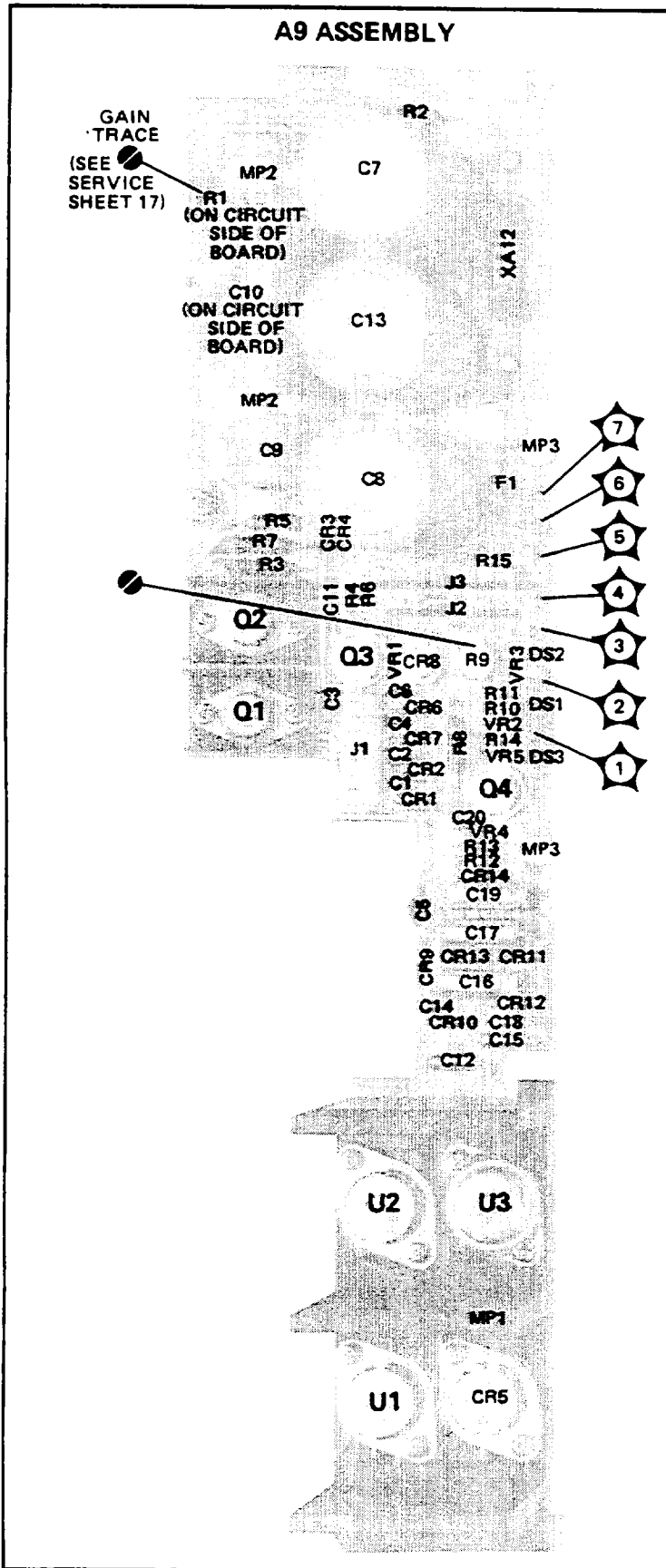


Figure 8-84. A9 Power Supply Assembly Component Locations

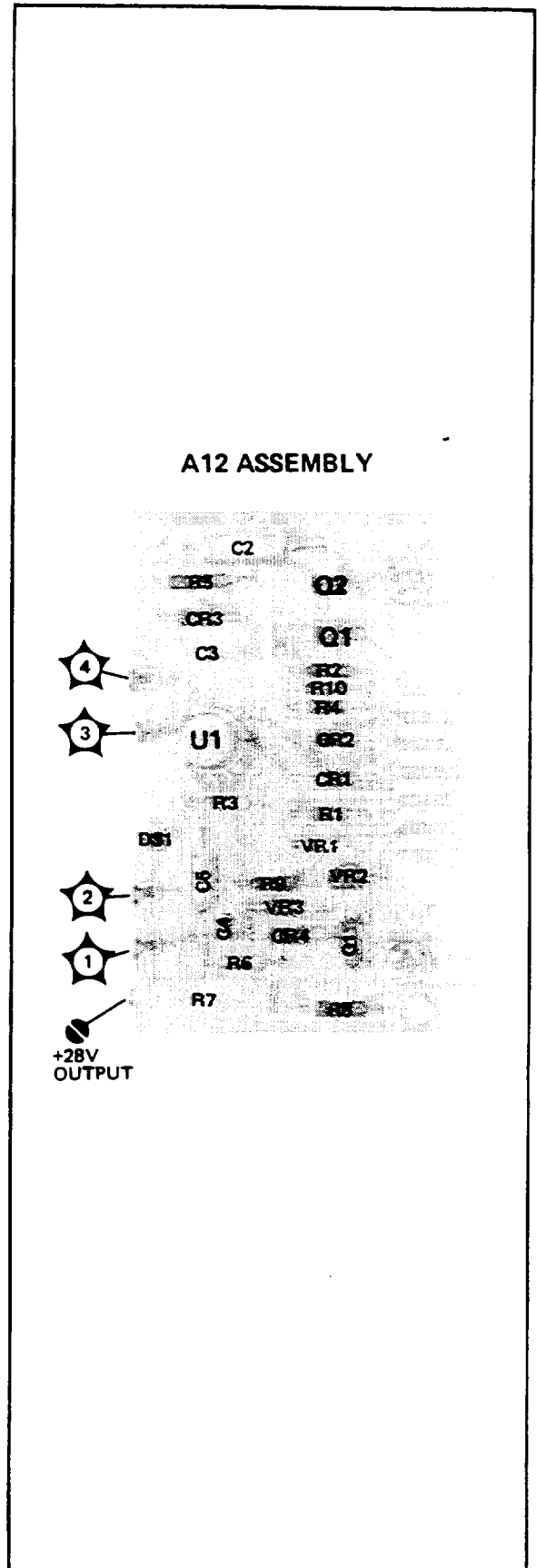
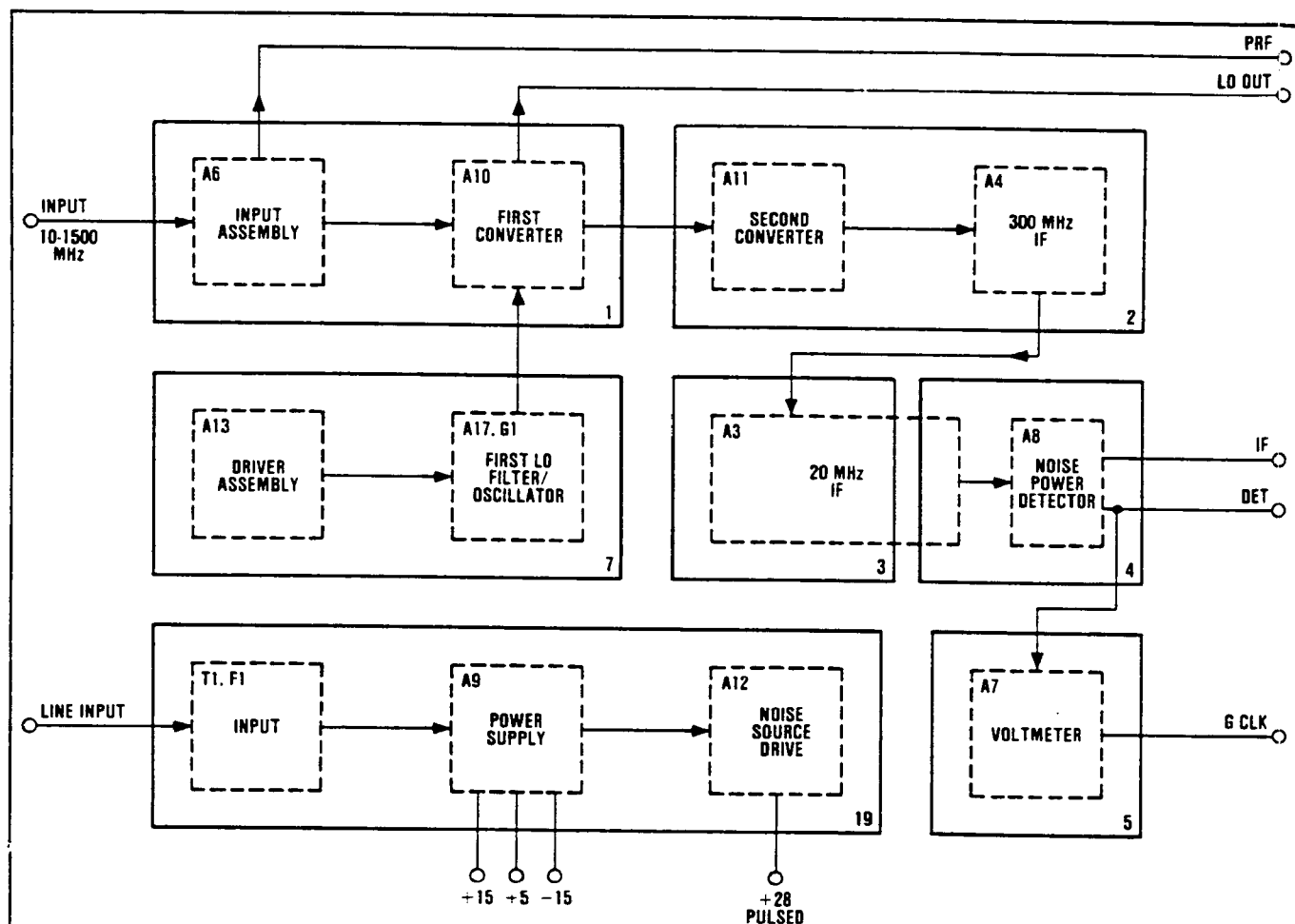


Figure 8-85. A12 Noise Source Drive Assembly Component Locations



ANALOG SECTION BLOCK DIAGRAM BD2

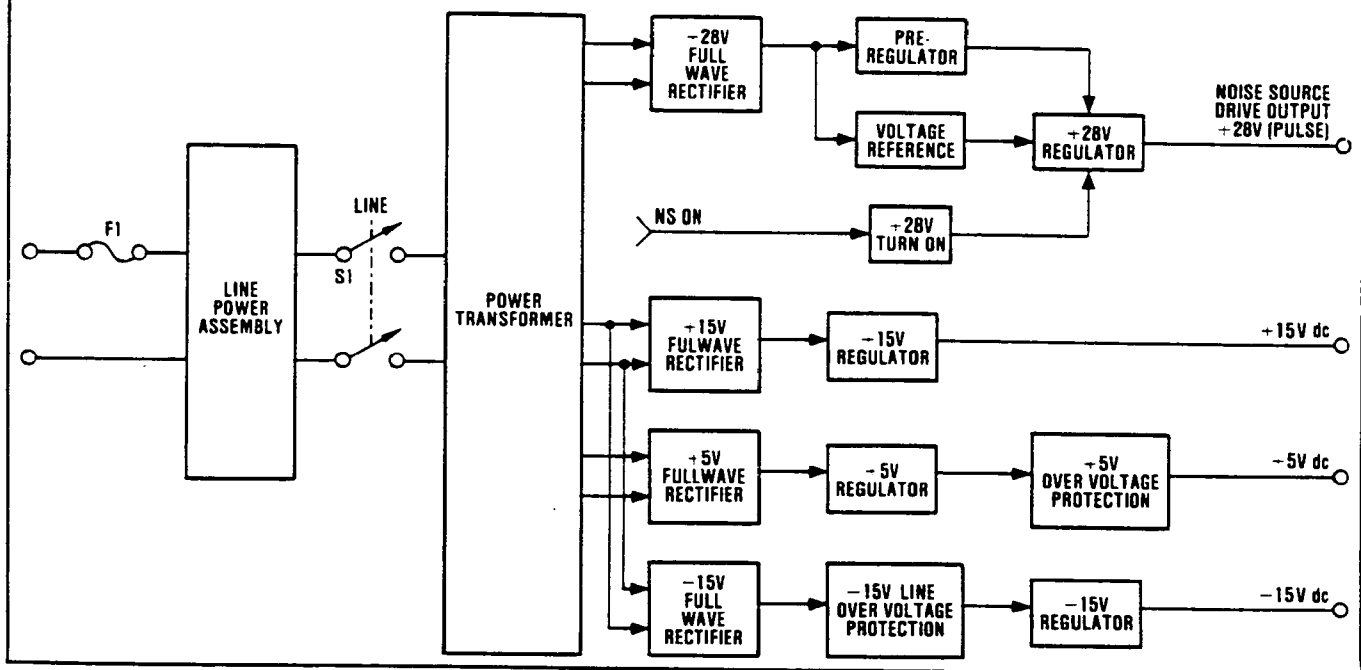
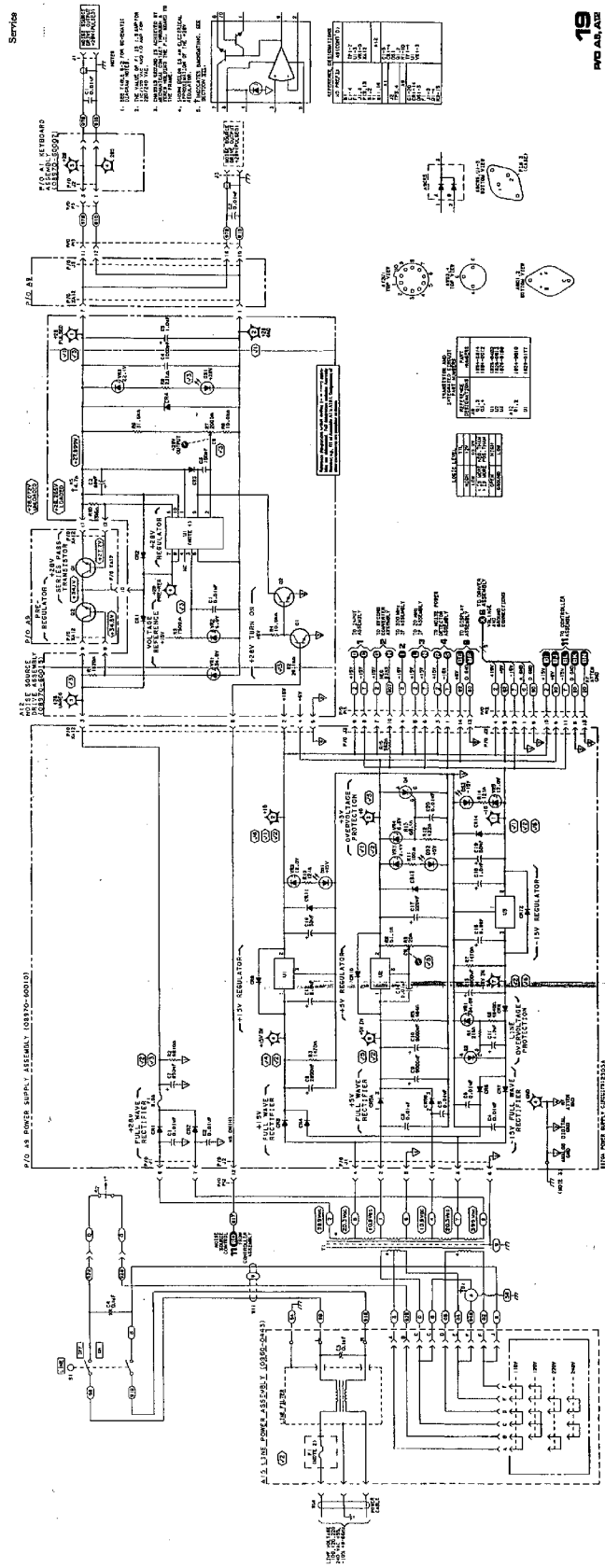


Figure 8-86. Power Supply and Noise Source Drive Block Diagram

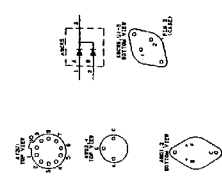




Service

1. INSURE THE MOTOR IS PROPERLY GROUNDING.
2. INSURE THE MOTOR IS PROPERLY WOUND.
3. INSURE THE MOTOR IS PROPERLY WOUND.
4. INSURE THE MOTOR IS PROPERLY WOUND.
5. INSURE THE MOTOR IS PROPERLY WOUND.

REF ID	DESCRIPTION	VALUE	UNIT
100	RESISTOR	10K	Ω
101	RESISTOR	10K	Ω
102	RESISTOR	10K	Ω
103	RESISTOR	10K	Ω
104	RESISTOR	10K	Ω
105	RESISTOR	10K	Ω
106	RESISTOR	10K	Ω
107	RESISTOR	10K	Ω
108	RESISTOR	10K	Ω
109	RESISTOR	10K	Ω
110	RESISTOR	10K	Ω
111	RESISTOR	10K	Ω
112	RESISTOR	10K	Ω
113	RESISTOR	10K	Ω
114	RESISTOR	10K	Ω
115	RESISTOR	10K	Ω
116	RESISTOR	10K	Ω
117	RESISTOR	10K	Ω
118	RESISTOR	10K	Ω
119	RESISTOR	10K	Ω
120	RESISTOR	10K	Ω



REF ID	DESCRIPTION	VALUE	UNIT
100	RESISTOR	10K	Ω
101	RESISTOR	10K	Ω
102	RESISTOR	10K	Ω
103	RESISTOR	10K	Ω
104	RESISTOR	10K	Ω
105	RESISTOR	10K	Ω
106	RESISTOR	10K	Ω
107	RESISTOR	10K	Ω
108	RESISTOR	10K	Ω
109	RESISTOR	10K	Ω
110	RESISTOR	10K	Ω
111	RESISTOR	10K	Ω
112	RESISTOR	10K	Ω
113	RESISTOR	10K	Ω
114	RESISTOR	10K	Ω
115	RESISTOR	10K	Ω
116	RESISTOR	10K	Ω
117	RESISTOR	10K	Ω
118	RESISTOR	10K	Ω
119	RESISTOR	10K	Ω
120	RESISTOR	10K	Ω

REF ID	DESCRIPTION	VALUE	UNIT
100	RESISTOR	10K	Ω
101	RESISTOR	10K	Ω
102	RESISTOR	10K	Ω
103	RESISTOR	10K	Ω
104	RESISTOR	10K	Ω
105	RESISTOR	10K	Ω
106	RESISTOR	10K	Ω
107	RESISTOR	10K	Ω
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110	RESISTOR	10K	Ω
111	RESISTOR	10K	Ω
112	RESISTOR	10K	Ω
113	RESISTOR	10K	Ω
114	RESISTOR	10K	Ω
115	RESISTOR	10K	Ω
116	RESISTOR	10K	Ω
117	RESISTOR	10K	Ω
118	RESISTOR	10K	Ω
119	RESISTOR	10K	Ω
120	RESISTOR	10K	Ω

Figure 8-27. Power Supply and Motor Drive Schematic Diagram

Reorder No. or  
Manual Part No.  
08970-90015

## S E R V I C E N O T E

SUPERSEDES:

8970A-9

**HP MODEL 8970A NOISE FIGURE METER  
Serial Prefix 2528A and below  
MICROPROCESSOR BOARD REPLACEMENT**

**Purpose**

This note provides instructions for replacing the old microprocessor board A14 assembly (HP 08970-60009) with the new microprocessor board assembly (HP 08970-60019). The procedure should take about 1 hour to complete.

If desired, the frequency range of instruments with serial prefixes 2438A and below may be extended to 1600 MHz by ordering the parts and performing the steps listed in Appendix A. Otherwise, after completing the procedure, enter 1500 MHz for the STOP FREQUENCY. Notice that PRESET will change the STOP FREQUENCY back to 1600 MHz. If this is a problem, consider using 0.0 SPECIAL FUNCTION instead of PRESET. 0.0 SPECIAL FUNCTION sets all of the SPECIAL FUNCTIONS to their PRESET condition without changing the values for START FREQUENCY, STOP FREQUENCY, STEP SIZE, etc.

**Tools Required**

1. Pozidrive screwdriver (#2, #3, and #4).
2. Open end wrench (15/64", 5/16", and 9/16").

Table 1. Parts List for HP 08970-60063 Kit

Description	HP Part No.	Qty
Capacitor-220 pF 5% 100V	0160-4103	1
Controller Bd Assy	08970-60019	1
Service Note 8970A-9A	08970-90019	1
Connector-single contact	1251-3720	1

**Procedure**

1. Remove mains power from the instrument.

I,NS,WN

02/87-04/LA

Printed in U.S.A.

HP Part No. 08970-90019



2. Remove the top and bottom covers and place the instrument in the service position as shown in Figure 8-1 of the HP 8970A Operating and Service Manual (HP 08970-90015).
3. Solder the capacitor (HP 0160-4103 provided in the kit) to the A2 Display assembly as shown in Figure 1.

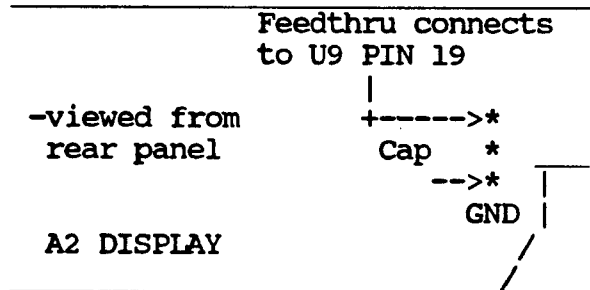


Figure 1.

4. Clip the white/black wire from A9J3 pin 13 at the connector.
5. Route the wire along the bundle of wires that connect to A14J5. You will need to pull the wire partly out of the wiring harness.
6. Replace the old microprocessor board (HP 08970-60009) with the new microprocessor board (HP 08970-60019).
7. Connect all of the cables. Clip the white/black wire leaving enough length to reach the post (A14J7) next to A14TP14.
8. Install the crimp connector (HP 1251-3720 provided in the kit) onto the white/black wire and connect it to A14J7).
9. If desired, use the procedure in Appendix A to extend the frequency range of the HP 8970A to 1600 MHz.
10. Perform the Operator's Checks in Section III of the HP 8970A Operating and Service Manual.

## APPENDIX A

### Purpose

The parts listed in Table 2 are needed to extend the Frequency range of the HP 8970A to 1600 MHz. The procedure should take about 1/2 hour to complete.

Table 2. Parts Needed for 1600 MHz Operation

Description	HP Part No.	Qty
FL1 Low Pass Filter	9135-0249	1
Label Blank	7120-1002	1
42.2 ohm 1% .5W resistor (A13R26)	0698-3397	1

### Adjustments Required

1. 5-13 FREQUENCY CAL RF AND FIRST LO ADJUSTMENTS in the HP 8970A Operating and Service Manual (no voltmeter required--omit steps 3, 7, 8).

### Procedure

1. By referring to the component locator on Service Sheet #7 (First LO Drive Circuits) of the HP 8970A Operating and Service Manual, locate and replace A13R26 (51.1 ohms) with the 42.2 ohm resistor provided in the kit.
2. Locate the old 1500 MHz Low Pass filter (9135-0148) mounted on the left side of the instrument.
3. Using a 5/16 inch open end wrench, disconnect the two semirigid cable assemblies attached to the ends of the filter.
4. Replace the old filter with the new filter and connect the semirigid cable assemblies. The filter does not have a designated input or output and therefore can be inserted in either direction.
5. Secure the A13/A14 board Assemblies.
6. Type or print "10-1600 MHz" on the blank label included in the kit. Place the label on the front panel above the INPUT connector.
7. Turn on the HP 8970A and allow it to warm up for 1/2 hour in the service position.
8. Perform adjustment procedure 5-13 in the HP 8970A Operating and Service Manual. Steps 3, 7, and 8 may be disregarded, and no voltmeter is required.
9. Attach the covers to the instrument.

**APPENDIX A****Verification**

1. On the HP 8970A, press PRESET. Then press FREQUENCY 1600 ENTER to set the frequency to 1600 MHz.
2. Using a signal generator, input a 1600 MHz signal at -40 dBm into the RF INPUT connector on the HP 8970A.
3. Press 80.0 SPECIAL FUNCTION to put the HP 8970A into voltmeter mode. Then press 62.0 SPECIAL FUNCTION and 72.0 SPECIAL FUNCTION to hold the RF and IF Attenuators.
4. By tuning the signal generator, locate the frequency where the highest voltage reading is obtained. Note the frequency and voltage. If the HP 8970A displays E11, reduce the amplitude of the input signal until the error is corrected.

\_\_\_\_\_ MHz \_\_\_\_\_ Volts

5. Tune the signal generator below the frequency in step 3 until the voltage reading is equal to .707 times the voltage in step 3 +/- 0.05 Volts. This is the lower 3 dB frequency.

\_\_\_\_\_ MHz (Lower 3 dB frequency)

6. Tune the signal generator above the frequency in step 3 until the voltage reading is equal to .707 times the voltage in step 3 +/- 0.05 Volts. This is the upper 3 dB frequency.

\_\_\_\_\_ MHz (Upper 3 dB frequency)

7. Find the center frequency as follows:

$$(\text{Lower 3 dB frequency} + \text{Upper 3 dB frequency})/2 = \text{_____ MHz}$$

8. If the frequency in step 6 is between 1594 MHz and 1606 MHz, the instrument is operating properly. If not, check all of the connections and perform adjustment procedure 5-13 again.

SUPERSEDES:  
NONE

**HP MODEL 8970A NOISE FIGURE METER**  
**Serial Prefix 2633A and below**  
**IMPROVED MEASUREMENT REPEATABILITY**

**Purpose**

This note provides instructions for replacing the old isolator AT1 (HP 0960-0472) with a new isolator (HP 0960-0699). The new isolator reduces internal reflections which will improve measurement repeatability when measuring devices with low gain. The greatest improvement in repeatability occurs at two frequencies (1260 and 1575 MHz).

**NOTE:** Use the measurement tips given on the last page of this note to maintain the best measurement accuracy and repeatability.

The internal reflections cause rapid changes in instrument noise figure with frequency. This is important because:

1. When measuring noise figure of low gain devices, instrument noise figure becomes a more significant factor in the result than when measuring devices with gains of 10 dB or more.
2. The 8970A's tuning accuracy above 500 MHz is +/- 6 MHz which allows noise figure measurements, which ideally would be at the same frequency, to be 12 MHz apart (worst-case). This may occur when the 8970A is tuned to the same frequency from different directions.

If units are experiencing measurement repeatability problems when measuring low gain devices, and the instrument still has the old isolator, use the following procedure to replace the isolator.

E,NS,WO

10/86-04/LA

### Tools Required

1. Pozidrive screwdriver (#2 and #3).
2. Open end wrench (15/64", 5/16").

Table 1. Parts List for HP 08970-60025 Kit

Description	HP Part No.	Qty.
Isolator	0960-0699	1
Support, Isolator	08970-00077	1
Bracket, A11/AT1	08970-00078	1
Cable, Assy, W4	08970-20036	1
Cable Assy, W6	08970-20037	1
Cable Assy, W5	08970-20038	1
Screws, Isolator	0515-0885	2
Bumper, Rubber	0403-0275	2
Service Note 8970A-10	08970-90028	1

### Procedure

1. Remove mains power from the instrument.
2. Remove the top and bottom covers and place the instrument in the service position as shown in Figure 8-1 of the HP 8970A Operating and Service Manual (HP 08970-90015).

**Note:** Use Figure 6-4 on page 6-36 in the 8970A Operating and Service Manual to locate the desired parts.

3. Remove the old cable assemblies W4, W5, and W6.
4. Remove 2 screws (MP88) and separate bracket (MP89) from the A11 assembly.
5. Attach new bracket (HP 08970-00078 provided in the kit) to the A11 assembly.
6. Attach the bracket/A11 assembly to the deck using 2 screws (MP88).
7. Connect the isolator support bracket (HP 08970-00077 provided in the kit) to the isolator as shown in Figure 1 of this note using 2 of the 3 screws which held the old isolator to the old A11/AT1 Bracket.
8. Attach rubber bumpers (HP 0403-0275) to the isolator as shown in Figure 1.



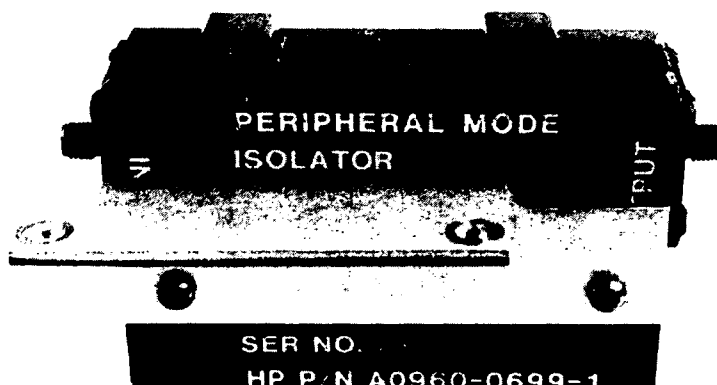


Figure 1. Isolator and Isolator Bracket Assembly

9. Connect one end of cable assembly W4 (HP 08970-20036 provided in the kit) to the IF OUT connector on the A10 assembly. Figure 2 shows how the new parts fit into the instrument.
10. Connect one end of cable assembly W5 (HP 08970-20038) to the A11 assembly.
11. Connect the other end of cable W5 to the output of the isolator and the other end of cable assembly W4 to the input of the isolator.
12. Secure the isolator to the new bracket (MP89) with 2 screws (HP 0515-0885 provided in the kit).
13. Connect cable assembly W6 as shown in Figure 2.
14. Perform adjustment procedure 5-15 20 MHz IF GAIN ADJUSTMENT in the HP 8970A Operating and Service Manual.
15. Secure the A13/A14 assembly and attach the bottom cover.

#### Measurement Tips

Use these measurement tips to obtain the best results when measuring low gain devices:

1. Use the maximum number of calibration points (or the smallest STEP SIZE) possible during calibration. This will help the 8970A characterize its own noise figure vs. frequency more accurately.
2. Avoid interpolating between calibrated frequencies whenever possible. This will help accuracy in situations of rapidly changing noise figure vs. frequency.
3. Use increased smoothing during calibration so that the HP 8970A will make a more accurate calibration.

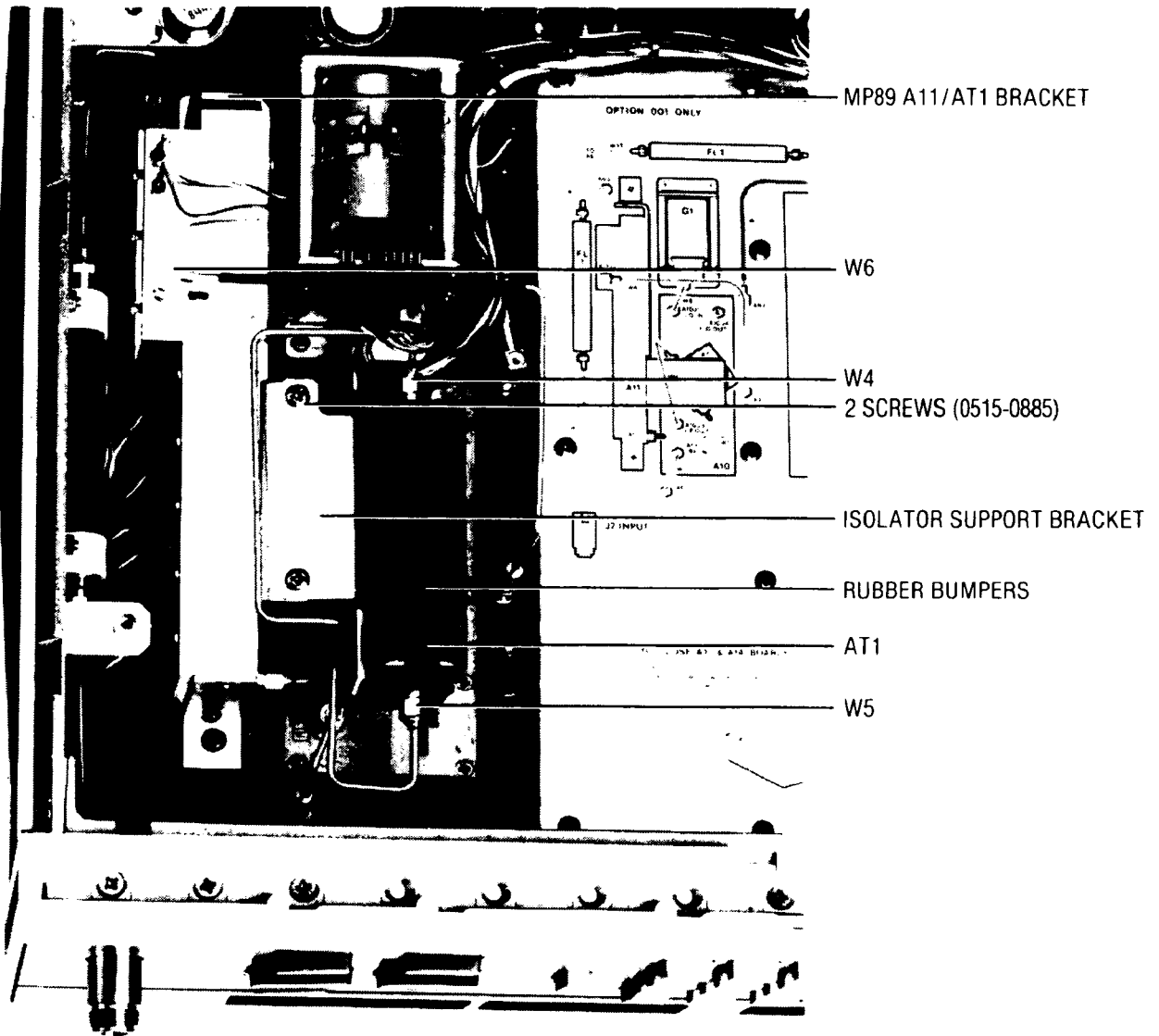


Figure 2. New Parts Identification

# **Automated Performance Tests**

## **HP 8970A Noise Figure Meter**

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PL-15

**SOFTWARE REFERENCE MANUAL**

**AUTOMATED PERFORMANCE TESTS  
HP 8970A NOISE FIGURE METER**

The software described in this manual is programmed on a 5¼ inch floppy disk. A package containing the program disk and a copy of this manual is available from Hewlett-Packard as HP part number 08970-60065.

Software Version A.01.00



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

MANUAL PART NUMBER 08970-90020  
Software and Manual Part Number 08970-60065

Printed: JULY 1985

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## **INTRODUCTION**

This manual is designed to provide a reference document for use while running the HP 8970A Automated Performance Tests. It does not provide a tutorial because the program is interactive enough that it directs even the first-time user. **The first-time user should be sure to read the Getting Started section of this manual, page 1-3.** Another helpful resource for these tests is the HP 8970A Operating and Service Manual.

This document is organized like the program to give logical correlation between the two. The interface between the user and the test routines is the main program which is covered in section 2. This section briefly describes the main program and gives a dictionary of softkeys through which the main program interacts with the user. The test routines which are the actual applications are described in Section 3. This section also has information on how to modify and halt test routines.

## **PROGRAM FEATURES**

- **4 : 1 time savings over manual testing**
- **Printed test reports with operator supplied information suitable for MIL STD calibration**
- **Extensive error checking**
- **Program guides user, little need to refer to documentation**
- **Graphic display of test setups**
- **Expandable should additional specifications need to be tested**
- **Capable of running user-defined test sequences**

## CONTROLLER AND OPERATING SYSTEM REQUIREMENTS

This program requires a Hewlett Packard Series 200 Model 36 controller (HP 9836). The operating system used is HP Basic 2.0 and HP Basic Extensions 2.1. The minimum RAM required for the test program is 100 k, assuming the operating system and extensions are in ROM. If the operating system and extensions must be loaded into RAM, an additional 455 k of RAM is required.

This program will also run with HP Basic 3.0 if the following extensions are also loaded: HPIB, ERR, GRAPH, IO, and KBD. When using HP Basic 3.0, the minimum RAM required for the test program is 105 k, assuming the operating system and extensions exist in ROM. If the operating system and extensions must be loaded into RAM, an additional 370 k of RAM will be required. **You must perform the following procedure before using this software with the HP Basic 3.0 operating system.** This procedure will store the files with the proper format so that the program will execute without displaying the following warning: PROG contains BIN with invalid revision.

- 1) Load HP Basic 3.0 and the above mentioned extensions into the operating system
- 2) Insert the HP 8970A Performance Test Disk into the disk drive
- 3) View the catalog of the HP8970A Performance Test Disk by typing CAT and pressing execute.
- 4) LOAD the first filename of the type PROG from the disk.
- 5) RE-STORE the file under the same name.
- 6) Repeat steps 4 and 5 with the next file listed in the catalog until all PROG files have been LOADED and RE-STORED.

**NOTE:** This procedure should be done with all files on the disk except CONFIG and other files of the type BDAT.

If this procedure has been performed and you wish to run the performance tests using HP Basic 2.0, the above procedure will can be used to accomplish this. The only difference is that Step 1 should be changed to read:

- 1) Load HP Basic 2.0 and HP Basic Extensions 2.1 into the operating system



**GETTING STARTED WITH THE HP 8970A AUTOMATED PERFORMANCE TESTS**

**NOTE:** You are provided with a write-protected master copy of this software. It is recommended that you copy the master to another disk for use as a work disk.

Load HP Basic 2.0 and HP Basic Extensions 2.1 into your HP9836 controller (see Controller and Operating System Requirements , pg.1- 2, if you use HP Basic 3.0 for a special procedure before continuing with this section). Next, insert your Performance Test work disk, type 'LOAD "AUTOST" ', and press EXECUTE followed by RUN.

After the initialization is completed, the program will ask you a series of questions. If you respond to a question, the response will be printed in the Test Result printout (example on page 2-2). If you do not wish to have a piece of information printed on the Test Result form, simply press ENTER to proceed. If you would like more information about these entries, refer to INFORMATION in the Softkey Dictionary (Section 3).

Once you have responded to all of the questions, the Main Menu will appear. For beginning users there are two important options in the menu, SINGLE and NEXTKEYS. Upon initial use of this program in a system, the user's instrument configuration must be told to the program. This can be done by pressing the NEXTKEYS softkey followed by the CONFIG softkey. (Please read the Notice which appears before the configuration appears.)

The model numbers and addresses in the configuration are used by the performance tests during operation. The user's setup will generally differ from the one appearing, so the configuration must be changed to reflect this. Use the softkeys to add or delete instruments and to change addresses so the configuration matches your test setup. The program will help you to enter the information in the correct format.

After you have changed the configuration to reflect your test setup, press STORE CONFIG then press EXIT followed by MAIN MENU to return to the Main Menu. You can now look at a list of routines and select one to run by pressing SINGLE. The program displays all of the test routine names and shows whether the required instruments for each test actually are on the bus. You are then asked to enter the number of the test routine you want to run. Test number 1, Instrument Noise Figure, only requires a DUT (Device Under Test, HP 8970A) and an HP 346B noise source so it is easy to run for your first try. If you do not wish to respond to a question, pressing "ENTER" will always return you to the level above the level that asked the question. So, if you do not want to run a test, press "ENTER" and you will return to the Main Menu. If you want to run test 1, type "1" and press ENTER. This will start the test and the test will guide you. When the test is complete, the Main Menu will reappear.

You can refer to Section 3 for more information on the test routines and to Section 2 to find out more about the program's functions. Good Luck!

<b>GENERAL INFORMATION</b>
----------------------------

### RECOMMENDED TEST EQUIPMENT

Instrument	Model	Critical Specifications	Used in Test #
Controller	HP 9836	No substitute	All
Printer	HP 2225A	Compatible w/ HP 9836	All
Power Meter	HP 436A	Identical HP-IB Commands	4, 5, 6
Power Sensor	HP 8484A w/ HP 11708A	Range (dBm): -60 to -20 SWR: < 1.15	4, 5, 6
Signal Generator (choose one)	HP 8656B HP 8662A HP 8340A	Identical HP-IB Commands Identical HP-IB Commands Identical HP-IB Commands	3, 4, 6
Fundamental Sig Gen	HP 8614A or HP 8616A	Klystron or Cavity Tuned Frequency: 1380-2300 MHz	7
Voltmeter	HP 3456A	Identical HP-IB Commands	6
Attenuator Driver	HP 11713A	No substitute	5, 6
Variable Attenuators	HP 8495H HP 8494H	No substitute No substitute	5, 6
Noise Source	HP 346B	15 dB ENR	1, 2, 5, 7
Amplifiers Type/Quan. Single / 2 Dual / 1	HP 8447D HP 8447F	Frequency: 0.1-1300 MHz Gain >20 dB Gain: >40 dB	5
Power Splitter	HP 11667A	Frequency: 10-1500 MHz	5, 6
SWR Bridge	Wiltron 60N50	Frequency: 10-1500 MHz Directivity: 40 dB	4
Attenuators Quantity: 1 2 1	HP 8491A Option 006 Option 010 Option 020	Frequency 10-1500 MHz Attenuation: 6 dB Attenuation: 10 dB Attenuation: 20 dB	5, 6 5 5
50 Ohm Load	HP 908A	Frequency 10-1500 MHz	4
Low Pass Filter	HP 360A	Cut-off Frequency <1500 MHz	5
Directional Coupler	HP 779D	Frequency: 1380-2300 MHz	7

TEST NUMBER KEY

Number	Test Name
1	Instrument Noise Figure
2	Measurement Jitter
3	Frequency Tuning Accuracy
4	Input SWR
5	Gain Measurement Accuracy
6	Noise Figure Range and Accuracy
7	Spurious Response

**MAIN PROGRAM INTRODUCTION**

The main program is the program which provides the interface between the user and the actual test routines (described in Section 3). This program controls all of the softkeys which are described in the Softkey Dictionary which starts on page 2-4. The main program is initiated by loading "AUTOST" from the test disk and pressing RUN. The AUTOST routine then loads "TEST\_EXEC2" and "8970" from the test disk and starts their execution. When both have been started, the operator questions are asked. For more information on the operator questions, see INFORMATION in the Softkey Dictionary. Execution then proceeds as outlined in the "Getting Started" section of this document, page 1-5.

The user will see a number of softkeys and will be asked a number of questions before the actual test routines are started. This section's Softkey Tree Diagram, page 2-3, shows how to move among various softkey menus. All of the softkeys' functions are described in the softkey dictionary which starts on page 2-4.

**OPERATING NOTES**

While the main program is operating, the operator may exit without ill effects from any situation where a question is asked by pressing ENTER. During test routine operation, if a problem occurs, there is a softkey (HALT) activated which will halt the test and return you to the Main Menu. See details under Halting Test Execution, page 3-1.

If there is ever so much information printed on the screen that some scrolls off the top, it can be brought back by using the keyboard's Knob.

During operation of the Main Program (but not during Test Routine execution) the HP 8970A will occasionally display E41. This error is caused by normal operation of the Main Program and its occurrence should be ignored.

TEST REPORT FORM

INSTRUMENT NOISE FIGURE PERFORMANCE TEST

HP 8970A NOISE FIGURE METER AUTOMATED PERFORMANCE TEST

HEWLETT PACKARD COMPANY

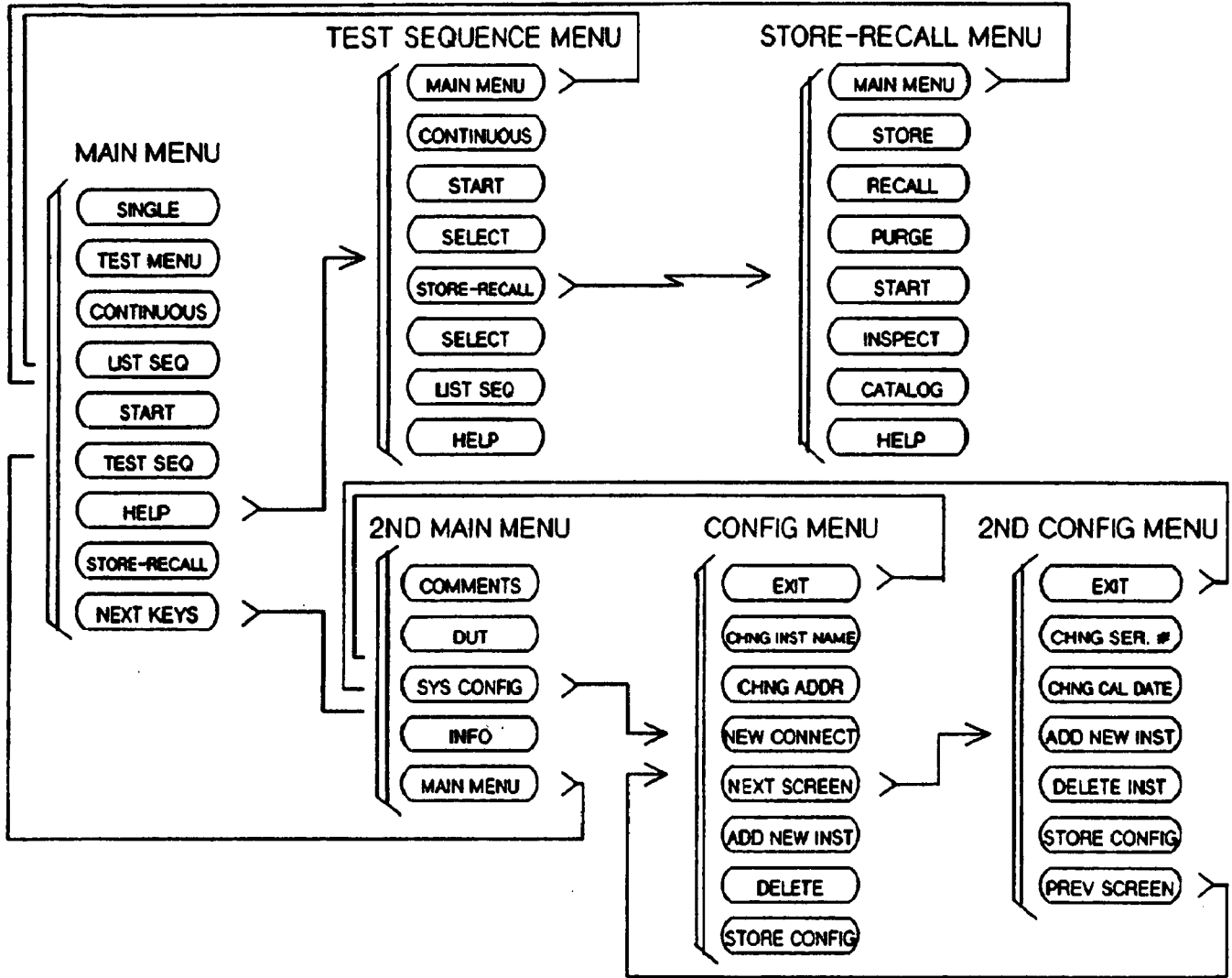
Date: 25 FEB 1985                      Serial #: 2414A01849  
Rec. Re-cal: 25 FEB 86                  R/O #: 318517794001  
Customer: A. M. D.                      Cust P.O.# P 38572018  
Operator: ERIC JENNINGS                Tech number: 007  
Temperature: 72 deg. C                 Humidity: 47% R.H.

Frequency MHz	Actual NF (dB)	NF Spec. Limit (dB)	Margin (dB)
10	4.51	< 7.03	2.52
110	4.94	< 7.33	2.39
210	4.99	< 7.63	2.64
310	5.11	< 7.93	2.82
410	5.54	< 8.23	2.69
510	5.55	< 8.53	2.98
610	5.92	< 8.83	2.91
710	6.24	< 9.13	2.89
810	6.09	< 9.43	3.35
910	6.34	< 9.73	3.39
1010	6.61	<10.03	3.42
1110	6.82	<10.33	3.51
1210	6.72	<10.63	3.91
1310	6.87	<10.93	4.06
1410	7.15	<11.23	4.08
1500	8.04	<11.50	3.46

\*\*\*\*\* PASS \*\*\*\*\*

This is an example of a Test Report printout. It has a heading that tells the name of the test and lists all of the operator-supplied information (see INFORMATION in Softkey Dictionary). Below the heading are the actual readings, the points tested, the test results, and the specification. Also indicated is whether the test passes or fails.

SOFTKEY TREE DIAGRAM



The Softkey Tree diagram above shows the progression through various softkey menus. The arrows which exit from the right side of a key lead to the group of keys which would be activated if that softkey is pressed. The function of each softkey is described in the following softkey dictionary.

**SOFTKEY DICTIONARY**

**USING THE SOFTKEY DICTIONARY**

The Softkey Dictionary refers to many softkeys and portions of the program which are explicit entities. To help the reader distinguish these items from general verbage, all softkeys are written in all capital letters and program entities have their first letters capitalized.

Examples:

PURGE . . . . . Softkey  
System Configuration . . . . . Program entity

If any softkey is referred to in a dictionary entry, it can be investigated further by referring to its own dictionary entry. Many words that are capitalized have a similar softkey which can be looked up to provide information about the entity's function.

**ADD NEW INST**

Allows you to enter a new instrument into the System Configuration.

It prompts you to enter the Model Number of the instrument that you want to add. Be sure to include the Model Number's alpha suffix (e.g. the A in 8970A) because the test routines expect it.

Next, it asks for the HP-IB address of the instrument which is being added. This address consists of the interface select code of the HP-IB bus which is in your controller followed by the 2-digit address to which the instrument is set. Usually the interface select code of an HP 9836 Controller will be 7. For example, combining an HP 8970A Noise Figure Meter whose HP-IB address is set to 08 with an HP 9836 controller whose HP-IB interface select code is set to 7 will yield an address of 708. This is the address that should be entered.

It then prompts you for the Instrument Name. This is strictly a descriptive name and is not used by the program. For example, you could describe a voltmeter with the abbreviation "DVM" or any other descriptive name.

This is followed by prompts for the Serial Number, and Recommended Calibration Date. The Recommended Calibration Date is the date when the instrument's calibration expires. See CHNG CAL DATE for more detailed information. It then asks for Connections, this is simply a place to note any special connections between test instruments. The Connections entry is not used by the program in any way.

**CATALOG**

Displays a catalog of the currently defined mass storage device, usually the system disk. This key is used to examine the files to determine the name of files containing Test Sequences. Sequences should be the only files on the disk of the type "BDAT" beside the Configuration File, "CONFIG". This assumes that no files have been randomly stored on the system disk. To continue after the Catalog is displayed, press the CONTINUE key.

**CHNG ADR**

This allows you to change the HP-IB address of an instrument in the Configuration File. It is imperative that all addresses in the Configuration File are correct because the tests will not run without correct addresses.

You are prompted for the Model Number of the instrument whose address you want to change. The Model Number must be entered exactly as it appears in the Configuration Table.

Next, it asks for the new HP-IB address. This address consists of the interface select code of the HP-IB bus which is in your controller followed by the 2-digit address to which the instrument is set. Usually the interface select code of an HP 9836 Controller will be 7. For example, combining an HP 8970A Noise Figure Meter whose HP-IB address is set to 08 with an HP 9836 controller whose HP-IB interface select code is set to 7 will yield an address of 708. This is the address that should be entered.

The program will not let you change an address to an address that already exists in the configuration. It also checks that the address entered is a valid HP-IB address. The valid addresses are:

600 - 630  
 700 - 730  
 . - .  
 . - .  
 3000 - 3030  
 3100 - 3130

**CHNG CAL DATE**

Prompts for the model number of the instrument whose Recommended Calibration Date you want to change. Then it asks for the new Recommended Calibration Date.

The Recommended Calibration Date is compared to the current date IF the current date is entered when the program is started. If any of the instruments in the Configuration File are beyond calibration, a warning will alert the test operator.

The format for the Recommended Calibration Date is very rigid: DD MON 19xx. DD is the day of the month (leading zero can be omitted). MON is the 3-letter abbreviation for the month. These month abbreviations are: JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC. 19xx is the year.

**CHNG INST NAME**

Allows you to change the descriptive Instrument Name. This is strictly a descriptive name and is not used by the program. For example, you could describe a voltmeter with the abbreviation "DVM" or any other descriptive name.

You are prompted for the Model Number of the instrument whose name you want to change. The Model Number must be entered exactly as it appears in the Configuration Table. Then you are prompted for the new name. This can be any alphanumeric string which is no longer than 15 characters.



## MAIN PROGRAM

- CHNG SER #** Prompts for the Model Number of the instrument whose Serial Number you want to change and then asks for the new Serial Number. You must enter the Model Number as it appears in the configuration file including the alpha suffix. The serial number must be no more than 15 characters long.
- COMMENTS** Asks for any comments that you would like to have appear in the test heading. There can be up to 2 full (80 character) lines of comments entered. If you make an error while entering a comment, it can be corrected using any of the common editing keys (BACKSPACE, INS CHR, etc.).
- Any comment entered will be printed on the next Test Report heading that is printed out and will not be printed after that.
- CONTINUOUS** Starts execution of the currently defined test sequence and runs it continuously.
- Once execution has begun, it can be halted by pressing the HALT softkey during test routine execution followed by the HALT softkey which appears after the "Test Complete" message appears.
- Use TEST SEQUENCE to define a test sequence or LIST SEQUENCE to view the current sequence.
- DELETE INST** This prompts you for the model number of the instrument which you wish to delete from the configuration file. When you delete an instrument, all of its associated information such as Address, Serial Number, etc. is deleted from the current Configuration File. If you want to delete from the stored Configuration, you must press the STORE CONFIG softkey after making the deletion from the current Configuration.
- DUT** Prompts for the new DUT (Device Under Test) Serial Number and Recommended Re-calibration Date. If answers are provided for these questions they will be printed on the Test Report.
- If you want to change either piece of information, just type the new information and press Enter. If you want to delete the current information without adding any information, press the space bar once and then press enter. This will cause the information not to be printed on the test heading.
- EXIT** Returns you to the Second Main Menu which has the following softkeys activated: COMMENTS, DUT, INFORMATION, SYS CONFIG, and MAIN MENU. Press the MAIN MENU softkey to return to the Main Menu.
- HELP** Prints the help screen that explains the set of softkeys which is currently active. This is used when displaying other information caused the help screen to be erased.
- HALT** This key is used to stop the execution of a test routine. It is only visible during test routine execution. There are a number of options presented after HALT is pressed. See "Halting Test Routine Execution" on page 3- for more details.

**INFORMATION**

Prompts for answers to the questions that were asked by the program at its very start.

If you want to change any of the existing answers to the questions, type the new information and press Enter.

For all of the questions except TIME OF DAY and DATE, if you want to delete the current information without adding any information, press the space bar once and then press Enter. This will cause the information not to be printed on the test heading.

For the questions TIME OF DAY and DATE, if you do not want the date printed on the Test Report, just press Enter. There is no need to press the space bar, in fact this will cause the program to re-prompt for a response since the response did not meet the required format.

The questions are (in order of occurrence):

**Time of Day**

This must be entered if you want the date to be printed on the Test Report. However, the time is never printed on the Test Report. The format is very strict: HH:MM:SS. HH is the hour; 1 AM is entered as 01; 3 PM is entered as 15. MM is the minutes part of the time and SS is the seconds reading.

If you do not want the date printed on the Test Report, just press Enter in response to the question "Time of day?" If you enter a space, the program will re-prompt you to give it properly formatted Time.

**Date**

This question will only appear if you responded to the TIME OF DAY question (see details above). If you respond to the TIME OF DAY question, you MUST enter the Date.

The format for the date is very strict: DD MON 19xx. DD is the day of the month (leading zero can be omitted). MON is the 3-letter abbreviation for the month. These abbreviations are (in order from January to December): JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC. 19xx is the year.

**Operator Name**

This asks for the name of the technician who is performing the test.

**Operator's Tech Number**

This asks for the test operator's Technician Number.

## MAIN PROGRAM

### INFORMATION (continued)

#### Dut Recommended Re-calibration Date

This asks for the next date that the DUT should be calibrated. For example, if the calibration cycle is once per year, the recommended re-calibration date would be one year from the date that this program is run.

The format for this date is not as strict as the current DATE format, but since this date is printed on the Test Report also, it is recommended that the same format be used for consistency. The format is DD MON 19XX and is described completely under DATE above.

#### Repair Order #

This asks for the Repair Order Number which is an internal order number for the service center which performs the test.

#### Customer Purchase Order #

This asks for the customer's purchase order number from the purchase order which authorized the tests.

#### Relative Humidity

This asks for the current relative humidity at the test site. The program will automatically insert '% R.H.' after the number which was entered when it prints the Relative Humidity on the Test Report.

#### Temperature

This asks for the current temperature at the test site. The units of the temperature are assumed to be degrees Centigrade, and the program will automatically insert 'deg. C.' after the temperature entry when it prints the Temperature on the Test Report.

#### Comments

Asks for any comments that you would like to have appear in the heading of the Test Report. There can be up to 2 full (80 character) lines of comments entered. If you make a error while entering a comment, it can be corrected using any of the common editing keys (BACKSPACE, INS CHR, etc.).

Any comment entered will be included on the next Test Report heading that is printed and will not be printed after that.

**INSPECT**

Allows you to view a test sequence that is on the mass storage device without bringing it into the current Test Sequence. It prompts you for the name of the sequence that you would like to inspect, and when the name is entered exactly as it appears in the Catalog, the Test Sequence is listed.

After the sequence is retrieved from the mass storage device it is listed on the screen and the program is left in the "Waiting for command . . ." state. To view the softkey explanation at this point, press HELP.

**LIST SEQ**

Lists the currently defined Test Sequence. This is a series of Test Numbers separated by commas. If you want to view the menu of Test Numbers and their Test Description, press TEST MENU and then press LIST SEQ.

**MAIN MENU**

Activates a number of softkeys and explains their functions. This is the central point in the program from which all activity branches.

SINGLE executes a single test. TEST MENU displays a menu of all available tests and their status.; CONTINUOUS initiates continuous execution of the currently defined Test Sequence. LIST SEQ lists the currently defined Test Sequence along with the displaying the Test Menu. START initiates a single execution of the currently defined Test Sequence. TEST SEQ activates another set of softkeys having to do with defining a Test Sequence. HELP re-activates the explanation of the currently active softkeys. STO-RCL activates another set of softkeys having to do with Storing and Recalling Test Sequences. NEXTKEYS activates another set of softkeys which give choices about the DUT, System Configuration, and operator-entered information.

**NEW CONNECT**

This is a comment field which allows you to note any special connections between instruments in the Configuration. Connections are not used by the program in any way.

You are prompted for the Model Number of the instrument whose Connections you want to change. The Model Number must be entered exactly as it appears in the Configuration Table. Next, it asks for the New Connection. This is any alpha-numeric field which does not exceed 40 characters.

**NEXT SCREEN**

Activates the second configuration screen and its associated softkeys. This includes a table which has instrument Model Numbers, Serial Numbers, and Recommended Calibration Dates.

The Serial Number and Recommended Calibration Dates which are in the configuration are not vital to the performance tests, and will not inhibit test operation if they are incorrect.

The CHNG SER. # softkey allows you to change the serial number of any instrument that is in the configuration. The CHNG CAL DATE softkey allows you to change the Recommended Calibration Date of any instrument in the configuration. This is used to check if the instruments used in the test setup are beyond calibration. The ADD NEW INST softkey allows you to add a new instrument to the configuration, and will ask you to enter the configuration information for the new instrument. DELETE INST will

## MAIN PROGRAM

### NEXT SCREEN (continued)

delete an instrument from the configuration. The STORE CONFIG softkey will store the current configuration to the current mass storage device, MSUS (usually the internal disk). PREV SCREEN returns you to the First Configuration Screen and EXIT returns you to the "Second Main Menu" where you can access the Main Menu by pressing the MAIN MENU softkey.

### NEXTKEYS

Displays additional softkey options having to do with the Information which will be printed on the Test Report and the System Configuration. The COMMENTS softkey allows you to enter comments to be printed on the Test Report. The DUT Ser. # softkey is used to change the serial number of the Device Under Test. INFORMATION prompts for answers to the string of questions at the very start of the program.

### PREV SCREEN

Returns you to the first Configuration Screen which displays a table of Instrument Names, Model Numbers, HP-IB addresses, and Interconnects as well as activating a number of associated softkeys.

### PURGE

Purges a sequence from the disk. It prompts for the name of the sequence which you want to purge, asks if you really want to purge the file, and if you respond "YES", it purges the sequence.

If you respond "NO" to the question, the file is not purged.

The name of the sequence must be entered exactly as it appears on the catalog of the disk. Capitalization must be taken into account whenever you enter a Sequence name but is not a consideration when responding to the question: "Do you really want to purge 'filename'? (Y/N)?".

This command ends in the "Waiting for command . . ." state. If you want to see an explanation of the current softkeys, press HELP.

### RECALL

Allows you to bring a test sequence which resides on the mass storage device into the currently defined Test Sequence. It prompts you for the name of the sequence which you want to recall and when the name is entered exactly as it appears in the Catalog, the sequence becomes the currently defined Test Sequence.

After the sequence is retrieved from the mass storage device it is listed on the screen and the program is left in the "Waiting for command . . ." state. To view the softkey explanation at this point, press HELP.

### SELECT

Allows you to define the current Test Sequence. It displays the Test Menu and asks for the Test Numbers that you want to be in the Test Sequence. The Test Numbers appear to the left of the Test Name in the Test Menu.

If the top of the Test Menu scrolls off of the screen, use the Knob to bring it back into view.

The Test Numbers which are entered into the sequence must be valid numbers, and must be separated by commas or they will be rejected by the program.

- SINGLE** Displays the Test Menu (see description under TEST MENU) and asks for the number of the test that you want to run. Upon entering a valid test number, the test will start execution. After the test is complete the Main Menu will appear.
- START** Initiates a single execution of the currently defined test sequence. Once execution has begun, it can be halted by pressing the HALT softkey during test routine execution.
- STORE** Allows you to save Test Sequences on the currently defined mass storage device, usually disk. It prompts you for the name of the file in which the sequence will be stored. A valid filename consists of a maximum of ten characters; uppercase or lowercase letters, numerals 0 through 9, and the underscore ( \_ ) are the only characters permitted. After the filename is entered and the Test Sequence is saved, the Store - Recall screen re-appears.
- STORE CONFIG** This softkey stores the configuration file on the mass-storage medium. The system configuration file on the disk will be overwritten with the new information from the current system configuration.
- If no configuration file exists on disk, one will be created and the current system configuration will be recorded on the disk.
- The default mass storage device is used for storing the configuration and if you want to use any other device, you must change it to be the default device using the HP Basic 2.0 "Mass Storage Is" command.
- STORE-RECALL** Displays a number of softkey options having to do with storing and recalling test sequences. The STORE softkey stores the current test sequence to disk. The RECALL softkey recalls test sequences from disk. PURGE and CATALOG perform the HP Basic 2.0 Purge and Cat functions. The START softkey starts the current test sequence. INSPECT allows you to view a test sequence which is on disk without disrupting the current test sequence.
- This menu does not provide the capability to Select the current Test Sequence. If you want to SELECT the Test Sequence, you must press MAIN MENU to return to the Main Menu and then press TEST SEQ to get to the SELECT sequence softkey. HELP will return the STORE-RECALL help screen if it was erased when other information was displayed.
- EXIT returns the Main Menu and its associated softkeys.
- SYS CONFIG** Displays the first screen of the system configuration which contains a table of Instrument Names, Model Numbers, HP-IB Addresses, and Interconnects. It also activates a number of softkeys that allow you to modify the configuration.
- The contents of the configuration file are passed as parameters to all of the actual test routines, so it is important to verify that its contents accurately reflect your test setup. The exceptions to this are the Serial Number, Instrument Name, and Recommended Calibration Date entries.

## MAIN PROGRAM

### SYS CONFIG (continued)

Once you have modified the Configuration File to match your test setup you must press the softkey **STORE CONFIG** to have your Configuration used for future testing sessions. If you do not save your configuration on disk, the program will use whatever configuration was previously saved on the disk the next time the program is run. You would then have to re-enter your configuration to get the test to work.

The **CHNG INST NAME** softkey allows you to change the entry in the Name column of the configuration table. The **CHNG ADDR** softkey allows you to change the HP-IB address of an instrument. The **NEW CONNECT** softkey allows you to enter a new connection in the Interconnection column of the configuration table. The **ADD NEW INST** softkey allows you to add a new instrument to the configuration and it will ask you for the instrument's Model Number, HP-IB address, Name, Serial Number, Recommended Calibration Date, and Connections. The **DELETE** softkey is used to delete instruments from the configuration. The **STORE CONFIG** softkey will store the current configuration onto the current M.S.U.S. (usually the floppy disk). **NEXT SCREEN** will activate the second System Configuration screen and its associated softkeys which allow operations on the instrument Serial Numbers and Recommended Calibration Dates. **EXIT** will return you to the "Second Main Menu" and from there the Main Menu is accessed by pressing the **MAIN MENU** softkey.

### TEST MENU

This key displays a list of performance test routines. It tells which tests can be run based on whether all of the instruments that they require are on the HP-IB. A test that cannot be run is indicated by an asterisk beside its name. If any instrument required by any test is not on the HP-IB, its name and address (as they appear in the configuration file) are listed.

If the menu scrolls off the top of the screen, the Knob can be used to bring it back into view.

The system is left in the "Waiting for command ..." state and expects a softkey to be pressed. The **HELP** softkey will display the main menu which explains the softkey choices.

### TEST SEQ

Displays a number of softkey options having to do with test sequence operations, but only the **SELECT** softkey is unique to this menu level. **SELECT** is used to enter a test sequence. Refer to its dictionary entry for a complete explanation.

**HELP** will return the **TEST SEQUENCE** help screen if it was erased when other information was displayed.

## MODIFYING TEST ROUTINES

All of the test routines reside on the disk as subprograms. They are loaded into system memory and executed when they are called by the main program. After execution is complete, the test routine subprogram is deleted from system memory to save space for the next routine which will be run. If it is necessary to modify any of the test routines, you should follow this procedure:

- 1) Type "SCRATCH" and press EXECUTE.
- 2) LOAD the subprogram which you want to modify.
- 3) Make the necessary modifications.
- 4) RE-STORE the subprogram.

This procedure assumes the disk is not write protected. The test routines are commented extensively so they can be understood if modifications are necessary. You are strongly discouraged from modifying any part of the main program (routines TEST\_EXEC2, 8970, and AUTOST) because it contains many complex, undocumented interrelations.

## HALTING TEST ROUTINE EXECUTION

While a test routine is operating, the HALT softkey is activated. This softkey will quickly stop the test routine and return the user to the main program. The softkeys are not active while the controller is paused so if a routine indicates to press CONTINUE to resume execution, the HALT softkey will not appear. To make it reappear so that the test can be halted, press CONTINUE followed immediately by HALT (k9).

If a test sequence or continuous execution of a test is halted, the following options are offered:

- 1) SINGLE displays the Test Menu and asks for the number of a single test to run.
- 2) START initiates execution of the currently defined test sequence from the beginning of the sequence.
- 3) SKIP continues test sequence execution starting with the next test in the sequence after the halted one.
- 4) REPEAT restarts the test sequence at the beginning of the last test which was completed.
- 5) RESUME continues the test sequence starting with the test which was halted.
- 6) MAIN MENU returns you to the main section of the program.



**TEST ROUTINE DESCRIPTIONS AND SETUPS****INSTRUMENT NOISE FIGURE TEST ROUTINE**

This routine is stored under the name "INF" on the test disk. It tests the instrument noise figure specification which is:

**INSTRUMENT NOISE FIGURE: < (7 dB + 0.003 dB/MHz)**

This test parallels the manual procedure in paragraph 4-9 of the HP 8970A Operating and Service Manual. Instrument noise figure is measured at 16 frequencies (specified in the DATA statement) by connecting the noise source to the HP 8970A input and reading NF over the bus. These readings are compared to the specification limit to determine if the instrument passes, and the results are printed for each frequency.

**MEASUREMENT JITTER TEST ROUTINE**

This specification does not apply to HP 8970A Noise Figure Meters with serial prefixes 2152A and below. Refer to the HP 8970A documentation to find out whether this test applies to the particular instrument that you are testing.

The routine resides under the name "JITTER" on the test disk. The Jitter specification which is tested is:

**MEASUREMENT JITTER: Y-factor standard deviation < 0.15 dB, smoothing = 1**  
**< 0.02 dB, smoothing = 64**

The program prompts the operator to connect an HP 346B Noise Source to the input of the DUT. The HP 8970A is then set to read Y-factor in dB. Smoothing is set to one. Forty Y-factor readings are taken, their standard deviation is calculated and compared to the specification, and the results are printed out on the Test Report. The same procedure is repeated with smoothing set to sixty-four, except that only thirty readings are taken.

**FREQUENCY TUNING ACCURACY**

This routine is stored under the name "TUNE" on the test disk. and it It tests the Frequency Tuning Accuracy specification which is:

**TUNING ACCURACY:  $\pm (1 \text{ MHz} + 1\% \text{ of tuned frequency}), \pm 6 \text{ MHz maximum}$**

This test parallels the manual procedure in paragraph 4-5 of the HP 8970A Operating and Service Manual. The operator is prompted to connect the output of the signal generator to the input of the HP 8970A. Then, from 7 to 11 frequencies are tested depending upon the signal generator which is being used.

For each frequency tested, the signal generator is stepped from 4 MHz below to 4 MHz above the HP 8970 frequency in 100 kHz steps. At each step the noise detector voltage is measured, sent over the HP-IB, and saved in an array. Also, the highest voltage is saved to be used as the IF peak. After the sweep is completed, the array is searched in both directions from the IF peak to find the 3 dB points (where the voltage is 1/4 of the IF peak voltage). If either 3 dB point is not encountered, the signal generator is stepped until the point is encountered (up to a maximum of 8 MHz above or below the HP 8970A's frequency). If the 3 dB point still has not been encountered, an error message is printed on the test report. Otherwise, the average of the two 3 dB frequencies is subtracted from the frequency to which the HP 8970A is tuned, yielding the frequency error. This error is compared to the specification to determine if the instrument passes the test. The results are printed on the test report and the next frequency is tested.

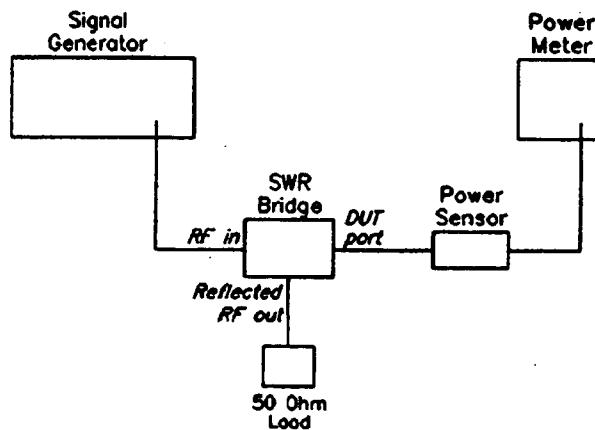
## TEST ROUTINES

### INPUT SWR TEST ROUTINE

This routine is stored under the name "SWR" on the test disk. It tests the input standing wave ratio specification which is:

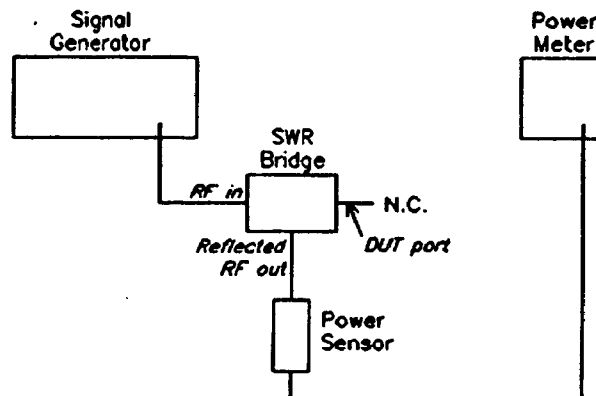
INPUT SWR: < 1.7 10 to 1500 MHz

This test parallels the manual procedure in paragraph 4-6 of the HP 8970A Operating and Service Manual. The operator is asked to make sure that the HP 8484A Power Sensor is used with the HP 436A powermeter and that they are warmed up, calibrated, and zeroed. Next, a graphic display (shown below) outlines the setup for the incident power measurement.



Incident Power Measurement Graphics

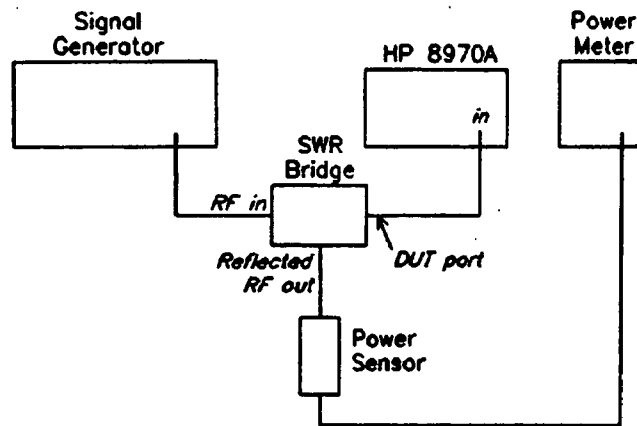
The incident power is measured and put into an array at all frequencies at which SWR will be measured. After the incident power is measured, another graphic display (below) outlines the setup for the 100% reflected power measurement.



100% Reflected Power Measurement Graphics

The reflected power is measured and put into an array at all frequencies at which SWR will be

measured. Finally, the graphic display (below) for the HP 8970A reflected power setup is displayed.



#### HP8970A Reflected Power Graphics

Power reflected from the input of the HP 8970A is measured for all 5 input gain settings at each frequency and placed into the array. Next, the SWR for all gain settings and frequencies is calculated using these equations:

$$\theta = 10^{-(100\% \text{ reflected power} - \text{HP8970A reflected power})/20}$$

$$\text{SWR} = (1 + \theta) / (1 - \theta)$$

The calculated SWR values are compared to the specification, and the test results are printed out in the test report.

## TEST ROUTINES

### GAIN MEASUREMENT ACCURACY TEST ROUTINE

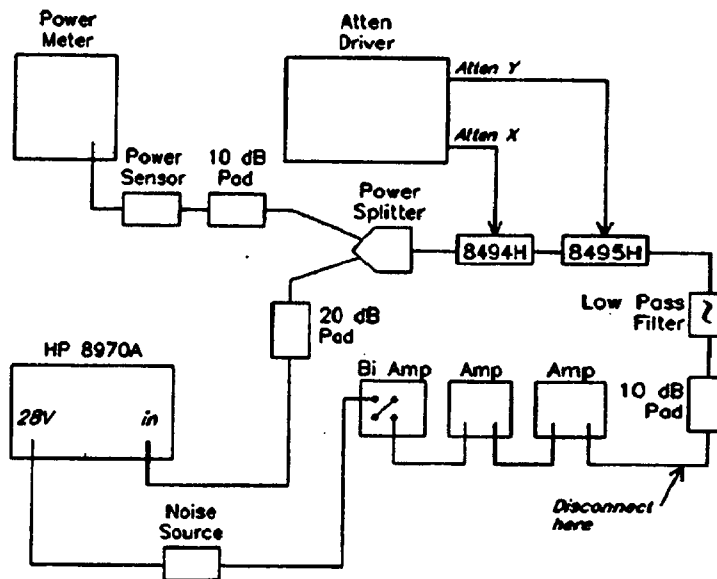
This routine is stored under the name "GAIN" on the test disk. It tests the Gain Measurement Accuracy specification which is:

GAIN MEASUREMENT UNCERTAINTY:  $\pm 0.2$  dB

This test parallels the manual procedure in paragraph 4-8 of the HP 8970A Operating and Service Manual. At least 70 dB of gain is needed to run this test. Any amplifier configuration which will provide that much gain is acceptable.

This test is extremely sensitive to drift. The HP 8970A, HP 436A, and HP 8484A must all be warmed up adequately. If the test fails, let the instruments warm up for at least an hour from turn-on and run the test again.

The operator is prompted to connect the noise source to the HP 8970A input. Then an IF calibration is performed. Next, a graphic display of the test setup (below) appears and the operator is instructed to construct it. It is very important to construct the setup exactly as shown to minimize measurement uncertainties. It is recommended that the HP 8970A, 20 dB attenuator, and power splitter be connected directly to each other without any cabling.



Gain Graphic Display

There is a message to disconnect the cable between the last amplifier and the attenuator. It is very important that the sensor is connected as indicated when it is zeroed so that the first power reading is absolutely within the meter's accuracy specification. Once this is done, the powermeter is zeroed via the HP-IB. Next, the operator is prompted to reconnect the amplifier to the 10 dB attenuator. The program sets the variable attenuators to yield -59 dBm into the power sensor. The HP 8970A then calibrates to give the zero gain point and the power meter is read for its baseline power. The attenuation is decreased (yielding gain) four times and both instruments are read at each attenuation setting. The gain read at each step is compared to the power meter's change in power (from baseline) to find the error in the gain measurement. The gain readings from both the power meter and the HP 8970A are printed on the test report as well as the error margin and whether the test passes or fails.

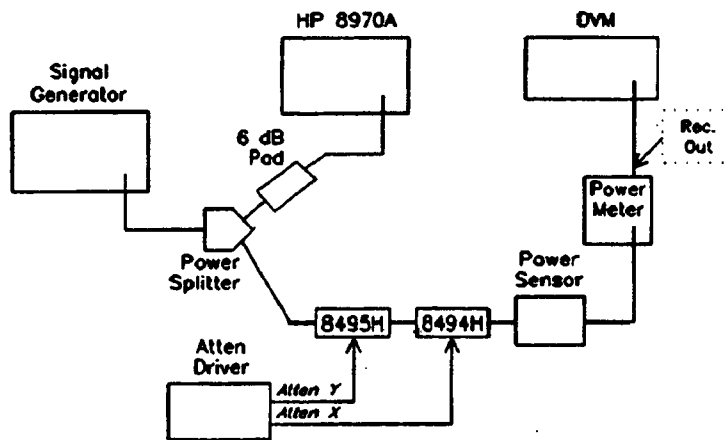
### NOISE FIGURE RANGE AND ACCURACY TEST ROUTINE

This routine is stored under the name "NFRANG" on the test disk. It tests the Noise Figure Instrumentation Accuracy specification which is:

NOISE FIGURE MEASUREMENT UNCERTAINTY:  $\pm 0.1$  dB

This test parallels the manual procedure in paragraph 4-7 of the HP 8970A Operating and Service Manual. This test is sensitive to drift and spurious signals. Make sure that the instruments are adequately warmed up and use short cables along with a minimum number of adapters. If the test fails, wait for the instruments to warm up at least an hour after they were turned on and run the test again.

The routine prompts the operator to zero and calibrate the power meter and then it displays a block diagram of the setup which the operator must construct.



Noise Figure Accuracy Graphics

After the setup is constructed, the test sweeps the signal generator (which is fed into the HP 8970A) to find the Noise Figure Meter's IF peak. This test assumes that the DUT's IF peak is within specifications at 50 MHz. The signal generator's output power is set to give just less than a one volt output from the noise power detector. This is so that the test's power changes will all be within the measurement range of the DUT. The step attenuators are then adjusted to give a reading of just less than 1 microwatt on the power meter. These two settings are used as the basis for a comparison of ratios. The power output for the signal generator is changed and the change in voltage output from the Noise Figure Meter and the change in recorder voltage output from the power meter are compared to determine how well the detector in the Noise Figure Meter tracks the power meter. After all measurements have been made, the program calculates the ratios between the Noise Figure Meter readings and compares them to the power meter ratios to give the dB error for the various noise figures being checked. These results are printed on the Test Report and whether the test passes or fails is indicated.

## TEST ROUTINES

### SPURIOUS RESPONSE TEST ROUTINE

This specification does not apply to HP 8970A Noise Figure Meters with serial prefixes 2152A and below. You should check the HP 8970A documentation to determine whether this specification applies to the particular instrument you are testing.

This routine is stored under the name "SPURS" on the test disk. The Spurious Response specification is:

**SPURIOUS RESPONSE:**  $<0.03$  dB NF, spurious input level =  $-15$  dBm, 2.1-18 GHz  
 $<0.03$  dB NF, spurious input level =  $-45$  dBm, 0.01-2.1GHz

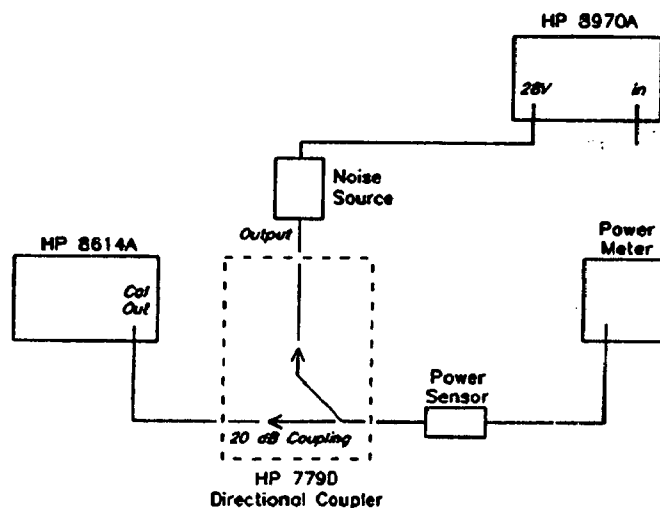
This test requires a fundamental signal generator; a synthesized signal generator will not work. The recommended signal generator is the HP 8614A. The HP 779D Directional Coupler is recommended for this test, but any coupler can be used which is rated for 1.4 - 2.3 GHz. The maximum requirement is that after coupling loss, the spurious signal level is  $-15$  dBm at the input of the DUT.

The goal of this test is to verify performance at the following points:

- 1) With spurious signals at frequencies below 2.1 GHz and far away from the HP 8970A tuned frequency
- 2) With spurious signals in the fringes of the HP 8970A pass band
- 3) With a spurious signal that is at the frequency of the HP 8970A's first LO
- 4) With spurious signals at frequencies above 2.1 GHz.

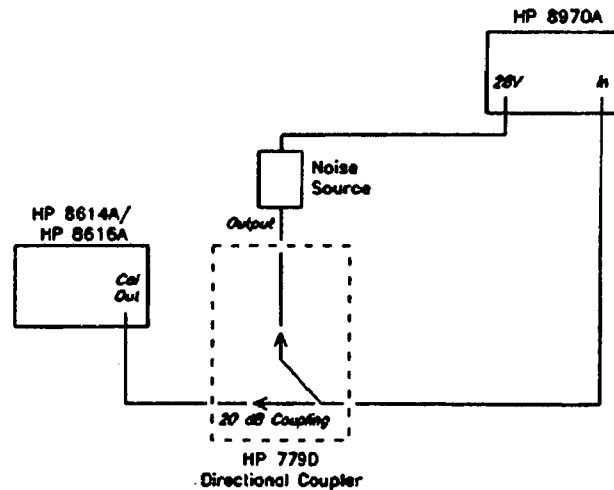
The last four paragraphs of this section correspond to the above listed four measurement points.

This routine requires a large amount of operator/program interaction due to the fact that the recommended signal generator cannot be controlled over the HP-IB. First, the routine tells the operator how to set the signal generator (assuming that an HP 8614A is being used). The HP 8970A is preset and set to voltmeter mode to turn off the noise source. Then the operator is asked to construct the following setup and set the power into the sensor to  $-45$  dBm.



Spurious Response Power Measurement Graphics

When the power has been set, another graphic display appears which tells the operator how to connect the test setup:



Spurious Response Test Setup Graphics

The noise figure meter is set to 500 MHz, and the operator is asked to turn off the signal generator's RF output so noise figure can be measured without spurious signals. The operator is prompted to turn on the signal generator's RF output and noise figure is measured ten times. The largest deviation of these ten readings is subtracted from the noise figure measured without the spurious signal, the difference is then compared to the specification limit and printed on the Test Report.

Next, the DUT frequency is set to 1400 MHz and the operator is prompted to turn the RF off. The noise figure without spurs is measured, and then the operator turns the RF back on. This noise figure with spurs is measured ten times and is treated as described above. The operator is prompted to set the signal generator frequency to 1420 MHz and the RF on/off procedure is carried out again. If either of these last two points fail, it may be because of the inherent frequency uncertainty of the HP 8614A's frequency dial. The test should be rerun using a frequency counter (which is connected to the HP 8614A's UNCAL output) to assure that the frequency settings are accurate.

The operator is prompted to set the signal generator frequency to 2050 MHz. Then the Spurious Response Measurement Graphics are displayed. The operator is asked to readjust the RF power to -45 dBm. This is because 2050 MHz is in the HP 779D directional coupler's coupling band, and more power is coupled into the DUT input than at 1380 or 1420 MHz. After the Spurious Response Setup Graphics are redisplayed and the operator reconnects the setup, the RF on/off procedure is carried out again.

For the final measurement, the operator sets the RF frequency to 2300 MHz and then sets the power into the DUT from the directional coupler to -15 dBm. Since this power level is beyond the range of the HP 8484A Power Sensor which is specified for these tests, a note appears on the screen instructing the operator to use a 10 dB pad between the sensor and directional coupler and to set this measured power level to -25 dBm. When this is done the Spurious Response Setup Graphics are displayed, the operator reconnects the setup, and the RF on/off procedure is performed. The final results of the test are then printed on the Test Report.





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