OPERATING AND SERVICE MANUAL

HP 11729C
CARRIER NOISE TEST SET
(Including Options 003, 007, 011, 015, 019, 023, 027, 130 and 140)

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2509A.

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

HEWLETT PACKARD

E. 24001 MISSION AVE., TAF C-34, SPOKANE, WASHINGTON, U.S.A. 99220

OPERATING AND SERVICE MANUAL PART NUMBER: 11729-90017
MICROFICHE PART NUMBER: 11729-90018

Printed: MARCH 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 autotransformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the mains supply).

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

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

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

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

SAFETY SYMBOLS

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

⚡ Indicates hazardous voltages.

⏚ Indicates earth (ground) terminal.

WARNING The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

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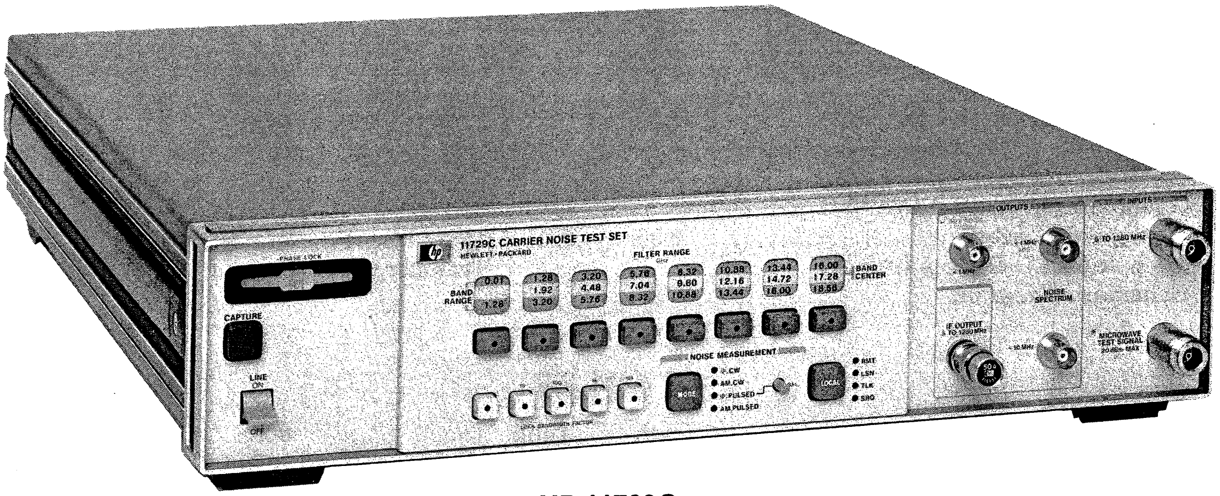
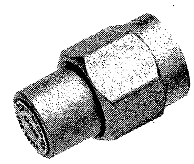


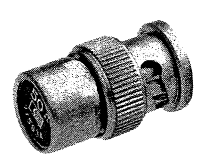
HP 11729C

CABLE AND ATTENUATOR

Cable-attenuator assembly used to configure the internal 640 MHz oscillator.



SMA TERMINATION



BNC TERMINATION

The 50Ω termination is installed on the IF OUTPUT port as shown in the photograph.

POWER CABLE

Figure 1-1. HP Model 11729C Carrier Noise Test Set with Accessories Supplied

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

This manual contains information required to install, operate, test, adjust and service the Hewlett-Packard Model 11729C Carrier Noise Test Set. Figure 1-1 shows the Carrier Noise Test Set with all of its externally supplied accessories.

The Carrier Noise Test Set Operating and Service manual has eight sections. The subjects addressed 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

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 may be 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. Typical system performance when using the Carrier Noise Test Set with the HP 8662A or 8663A is given in Table 1-3.

1-3. SAFETY CONSIDERATIONS

This product is a Safety Class I instrument, that is, one provided with a protective earth terminal. The Carrier Noise Test Set 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 THIS 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 the serial number prefix(es) 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 information" that explains how to adapt this 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 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 11729C Carrier Noise Test Set is an integral part of a phase noise measurement system.

The Carrier Noise Test Set can perform the following operations:

- Up converts an external (or internal) reference signal.

DESCRIPTION (cont'd)

- Down converts the signal under test to an intermediate frequency (IF).
- Phase demodulates the phase noise of the test signal using the Phase Detector Method.
  - —When the Phase Detector Method is used the signal under test is phase locked to a reference signal.
  - —The signal under test is then phase detected against the same reference signal.
- Frequency demodulates the phase noise of the test signal using the Frequency Discriminator Method.

With the addition of Option 130 the Carrier Noise Test Set is capable of detecting the signal under test for making AM noise measurements.

The Carrier Noise Test Set can be used in two methods of making phase noise measurements:

- Phase Detector Method
- Frequency Discriminator Method

The number of drive signals required for the Carrier Noise Test Set to be completely operational depends on the phase noise measurement method used and the frequency of the signal under test. The drive signals are supplied from an external RF source.In addition to the external RF source, one of the drive signals (640 MHz) can be supplied by the Carrier Noise Test Set. The Carrier Noise Test Set can be configured to provide an internally generated 640 MHz signal; the 640 MHz signal is available by connecting the provided cable-attenuator assembly (HP 11729-60096 or HP 11729-60098 [Option 140]) between two rear panel connectors. The absolute system noise floor will be degraded close-in to the carrier when using the internally generated 640 MHz signal, compared to the 640 MHz signal being supplied by the HP 8662A Synthesized Signal Generator.

The following table lists when the drive signals are required:

Drive Signals	Phase Detector Method		Frequency Discriminator Method	
	Frequency Range of Signal Under Test		Frequency Range of Signal Under Test	
	10 MHz to 1.28 GHz	1.28 GHz to 18 GHz	10 MHz to 1.28 GHz	1.28 GHz to 18 GHz
Fixed 640 MHz	Not Needed	X	Not Needed	X
Tunable 5 MHz—1280 MHz	X	X	Not Needed	Not Needed
X = Drive signal is used.				

When using the Phase Detector Method the signal under test is first down-converted to the 5 MHz—1280 MHz range and then phase detected against the tunable 5 MHz—1280 MHz signal. Phase detecting produces a dc signal with simultaneous ac voltage fluctuations. These ac components are proportional to the combined phase noise of the two input signals (the signal under test and the tunable 5 MHz—1280 MHz signal), at rates corresponding to the offset frequency from the signal under test. The phase detected output signal is also used as an error voltage to keep the signal under test and the tunable 5 MHz—1280 MHz signal in phase quadrature (that is, 90 degrees out-of-phase).

When using the Frequency Discriminator Method, the down-converted signal under test is phase detected against itself using an external delay line and the internal mixer/phase detector. The phase detected signal is proportional to the phase noise on the signal under test. In the Frequency Discriminator Method the signal under test does not have to be phase locked to an external reference signal.

The Carrier Noise Test Set accepts test signals from 10 MHz—18 GHz, at a level of +7 dBm to +20 dBm. The broad frequency range is user selectable from the front panel (local) or by using the Hewlett-Packard Interface Bus (remote). When using the Carrier Noise Test Set in the Phase Detector Method the controls for acquiring and maintaining phase lock are user selectable from the front panel (local) or by using the Hewlett-Packard Interface Bus (remote).

The Carrier Noise Test Set is compatible with HP-IB to the extent indicated by the following codes: SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT0, and C0. The Carrier Noise Test Set interfaces with the bus via three-state 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.

1-7. OPTIONS

1-8. Electrical Options

Option 003. Option 003 has two bands installed, 10 MHz to 1.28 GHz and 1.28 GHz to 3.2 GHz.

Option 007. Option 007 has two bands installed, 10 MHz to 1.28 GHz and 3.2 GHz to 5.76 GHz.

Electrical Options (cont'd)

Option 011. Option 011 has two bands installed, 10 MHz to 1.28 GHz and 5.76 GHz to 8.32 GHz.

Option 015. Option 015 has two bands installed, 10 MHz to 1.28 GHz and 8.32 GHz to 10.88 GHz.

Option 019. Option 019 has two bands installed, 10 MHz to 1.28 GHz and 10.88 GHz to 13.44 GHz.

Option 023. Option 023 has two bands installed, 10 MHz to 1.28 GHz and 13.44 GHz to 16.00 GHz.

Option 027. Option 027 has two bands installed, 10 MHz to 1.28 GHz and 16.00 GHz to 18.00 GHz.

Option 130. Option 130 adds AM noise measurement capabilities.

Option 140. Option 140 places all front panel connectors on the rear panel.

1-9. Mechanical Options

The following options may have been ordered and received with the Carrier Noise Test Set. If they were not ordered with the original shipment and are now desired, they can be ordered from the nearest Hewlett-Packard office using the part numbers included in each of the following paragraphs.

Instrument Slide Kit (Option 160). The Carrier Noise Test Set can be easily removed from the instrument rack by using the instrument slide kit. The part number of the slide kit is HP 1494-0026.

Front Handle Kit (Option 907). Ease of handling is increased with the front panel handles. The Front Handle Kit part number is HP 5061-0088.

Rack Flange Kit (Option 908). The Carrier Noise Test Set can be solidly mounted to the instrument rack using the flange kit. The Rack Flange Kit part number is HP 5061-9674.

Rack Flange and Front Handle Combination Kit (Option 909). This is a unique part which combines both functions. It is not simply a front handle kit and a rack flange kit packaged together. The Rack Flange and Front Panel Combination Kit part number is HP 5061-9675.

1-10. ACCESSORIES SUPPLIED

The accessories supplied with the Carrier Noise Test Set are shown in Figure 1-1.

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

b. An additional fuse is shipped only with instruments that are factory configured for 100/120 Vac operation. This fuse has a 0.5A rating and is for reconfiguring the instrument for 220/240 Vac operation.

c. A 50 ohm BNC termination is supplied to be connected to the IF OUTPUT on the front panel. With the 50 ohm termination in place the Carrier Noise Test Set meets the requirements of MIL STD 461 RE02.

NOTE

The 50 ohm termination must be connected to the IF OUTPUT if the IF OUTPUT is not being used.

d. The Carrier Noise Test Set has two connectors on the rear panel labeled 640 MHz OUT and 640 MHz IN. The 640 MHz OUT is connected to the 640 MHz IN to configure the internally generated 640 MHz signal for use during a measurement. A cable-attenuator assembly (HP 11729-60096 or HP 11729-60098 [Option 140]) is supplied to make this connection. The length and attenuation of this cable assembly is critical for the generation of the 640 MHz signal.

e. A 50Ω SMA termination is supplied to be connected to the 640 MHz OUT connector on the rear panel. For proper operation of an amplifier, in the Carrier Noise Test Set, the termination must be in place when the 640 MHz OUT connector is not being used.

1-11. EQUIPMENT REQUIRED BUT NOT SUPPLIED

For the Carrier Noise Test Set to be completely operational it will require one or two drive signals (either a fixed 640 MHz signal or a 5 MHz—1280 MHz signal or both) that are supplied from an external RF source. Critical specifications of the RF source are in Table 1-4 in this section.

If desired the 640 MHz drive signal can be supplied by the Carrier Noise Test Set. On the rear panel of the Carrier Noise Test Set the 640 MHz OUT connector is connected to the 640 MHz IN connector, using the cable-attenuator assembly (HP 11729-60096 or HP 11729-60098 [Option 140]) supplied with the instrument. The absolute system noise floor will be degraded close-in to the carrier when

EQUIPMENT REQUIRED BUT NOT SUPPLIED (cont'd)

using the internally generated 640 MHz signal, compared to the 640 MHz signal being supplied by the HP 8662A Synthesized Signal Generator.

The following table lists the coaxial cables required to connect the Carrier Noise Test Set to the HP 8662A or 8663A Synthesized Signal Generators. Also listed are the cables necessary to connect the Carrier Noise Test Set to a spectrum analyzer.

HP Part No.	Description	Use on Carrier Noise Test Set
11170B	BNC(M)-BNC(M) (24 inches)	5 to 1280 MHz INPUT
11170C	BNC(M)-BNC(M) (48 inches)	640 MHz IN FREQ-CONT DC-FM FREQ-CONT X-OSC NOISE SPECTRUM <10 MHz OUTPUT <1 MHz OUTPUT

Table 1-1. Specifications (1 of 2)

Electrical Characteristics	Performance Limits	Conditions
TEST SIGNAL		
Frequency Range[1]	10 MHz to 18 GHz	External low-pass filtering may be required for test signals <20 MHz and ±20 MHz around band centers
Band Center Frequencies	1.92 GHz 4.48 GHz 7.04 GHz 9.60 GHz 12.16 GHz 14.72 GHz 17.28 GHz	
IF OUTPUT		
Bandwidth	5 MHz to 1280 MHz	
Level	+7 dBm Minimum	
AM NOISE DETECTION (Option 130)		
Frequency Range	10 MHz to 18 GHz	
Input level	0 dBm to +18 dBm	
AM Noise Floor		At +10 dBm input level
Offset from Carrier (Hz)	AM Noise (dBc/Hz)	
1k	−138	
10k	−145	
100k	−155	
1M	−160	
RESIDUAL NOISE		
Offset From Carrier(Hz)	dBc/Hz	With a <1.28 GHz input signal
10	−115	
100	−126	
1k	−135	
10k	−142	
100k	−151	
1M	−156	

[1] In eight (8) bands, excluding ±5 MHz around band center frequencies.

Table 1-1. Specifications (2 of 2)

Electrical Characteristics	Performance Limits	Conditions
RESIDUAL NOISE (cont'd)		
Offset From Carrier (Hz)	dBc/Hz	With a 10 GHz input signal
10	−90	
100	−105	
1k	−115	
10k	−127	
100k	−137	
1M	−142	
GENERAL		
Line Voltage	100,120,220 or 240V (+5%,−10%)	
Line Frequency	48 to 66 Hz	
Power Dissipation	75 V·A maximum	
Temperature:		
Operating	0 to +55°C	
Weight:		
Net	10.4 kg (23 lb.)	
Dimensions[2]:		
Height	99 mm (3.9 in.)	
Width	425 mm (16.8 in.)	
Depth	551 mm (21.7 in.)	
Remote Operation (HP-IB)[3]		
IEEE STD 488-1978 Compatibility Code: SH1, AH1, T5,TE0, L3, LE0, SR1, RL1,PP1, DC1, DT0,C0.		
ELECTROMAGNETIC COMPATIBILITY		
Electromagnetic Interference	Conducted and radiated interference is within the requirements of CE03 and RE02 as called out in MIL-STD 461, and within the requirements of VDE 0871 and CISPR Publication 11.	

[2]For ordering cabinet accessories the module sizes are 3-1/2H, 1MW (module width), 20D.

[3]The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's implementation of IEEE STD 488-1978, "Digital Interface for Programmable Instrumentation." All front panel functions with the exception of the line switch are HP-IB programmable.

Table 1-2. Supplemental Characteristics (1 of 2)

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

TEST SIGNAL

Level: For test signals >1.28 GHz: +7 dBm to +20 dBm Typically useable down to −15 dBm with potential noise floor degradation.

For test frequencies <1.28 GHz: −5 dBm to +10 dBm. Typically usable down to −15 dBm with potential noise floor degradation; optimal level from −2 dBm to +3 dBm.

IF OUTPUT

Typically useable to 1500 MHz dependent on the test frequency.

NOISE SPECTRUM OUTPUTS

<10 MHz Output (The < 10 MHz Output is amplified by an internal 40 dB Low Noise Amplifier)

Bandwidth: 10 Hz to 10 MHz. (3 dB BW: 10 Hz to 15 MHz typical.)
Flatness: ±1 dB typical, 50 Hz to 10 MHz
Output impedance: 50Ω nominal

<1 MHz Output (The < 1 MHz Output is a non-amplified output)

Bandwidth: dc to 1 MHz. (3 dB BW: dc to 1.5 MHz typical.)
Flatness: ± 1 dB typical
Output impedance: 600Ω nominal

Auxiliary Noise
Output impedance: 600Ω nominal
Bandwidth: dc to 1 MHz typical

PHASE LOCK LOOP FUNCTION

FREQUENCY CONTROL OUTPUTS

Freq-Cont X-Osc
Output level: ±10V nominal
Nominal Output impedance: 100Ω.

Freq-Cont DC-FM
Output level: ±1V nominal
Nominal Output impedance: 50Ω.

Lock Bandwidth Factor: 1, 10, 100, 1k, 10k nominal. (Selectable by front panel pushbuttons.)

Loop characteristics: dependent on method of phase lock (crystal or DC-FM) used and loop VCO chosen.

Loop Characteristics when using the HP 8662A Electronic Frequency Control input for phase locking with the HP 8662A front panel output at 0 dBm:

Loop Holding Range (LHR):

$$\frac{\pm f_{dut}}{10^7} \quad \text{(Hz nominal)}$$

Loop Bandwidth (LBW):

$$\frac{\text{HP 11729C LBF} \times f_{dut}}{10^{10}} = \text{(Hz nominal)}$$

Loop Bandwidth Maximum: 2 kHz typical

f = frequency
dut = Device under test
LBF = Lock Bandwith Factor set on HP 11729C

Loop Characteristics when using the HP 8662A dc FM modulation input for phase locking with the HP 8662A front panel output at 0 dBm:

Loop Holding Range (LHR): ± FM deviation set on HP 8662A (Hz nominal).

Loop Bandwidth (LBW):

$$\frac{\text{(HP 8662A FPD)} \times \text{HP 11729C LBF nom.}}{10^3} = \text{(Hz nom.)}$$

Loop Bandwidth Maximum: 100 kHz typical.

LBF = Lock Bandwidth Factor set on HP 11729C
FPD = Front Panel Deviation

LOOP TEST PORTS

Loop Test Input:
Source: random noise source, tracking generator, or sinusoidal input.
Bandwidth: dc to 100 kHz typical.
Input level: less than 0.1V peak, typical.
Input impedance: dc coupled, 10 kΩ nominal

Loop Test Output:
Bandwidth: dc to 100 kHz, typical.
Output level: gain outside loop bandwidth = 1
Output impedance: dc coupled, 1 kΩ. nominal

AM NOISE DETECTION
(Option 130)

AM Noise Floor (at +10 dBm input level):

Offset From Carrier (Hz)	Typical AM Noise(dBc/Hz)
1k	−147
10k	−152
100k	−161
1M	−165

Table 1-2. Supplemental Characteristics (2 of 2)

RESIDUAL NOISE

Offset from carrier (Hz)	Carrier			
	<1.28GHz (dBc/Hz)	5 GHz (dBc/Hz)	10 GHz (dBc/Hz)	18 GHz (dBc/Hz)
10	−125	−112	−106	−100
100	−133	−120	−116	−110
1k	−140	−130	−125	−119
10k	−147	−137	−132	−126
100k	−156	−146	−141	−135
1M	−160	−148	−144	−138
10M	−160	−148	−144	−138

The absolute phase noise of the internal saw oscillator with a 10 GHz input signal.

Offset From Carrier (Hz)	dBc/Hz
1k	−86
10k	−116
100k	−135
1M	−145
10M	−147

Sensitivity of the HP 11729C using the internal saw oscillator and a 10 GHz input signal. The Frequency Discriminator Method was used which had a delay line with the following characteristics: delay was 100 ns, attenuation was <10 dB and the cable used was RG-223.

Offset From Carrier (Hz)	dBc/Hz
1k	−80
10k	−106
100k	−131
1M	−144

1-12. ELECTRICAL EQUIPMENT AVAILABLE

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

1-13. RECOMMENDED TEST EQUIPMENT

Table 1-4 lists the test equipment recommended for use in testing, adjusting and servicing the Carrier Noise Test Set. 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.

Table 1-4 also includes some alternate equipment listings. These alternate instruments are highlighted in Table 1-5 which also indicates the possible advantages of using them as substitutes.

The following information is supplied to aid the user when configuring the Carrier Noise Test Set in a system. The system specifications are for the HP 11729C and the HP 8662A.

Also given are the general requirements for an unknown RF source being used with the HP 11729C.

Table 1-3. System Specifications (1 of 2)

ABSOLUTE SYSTEM NOISE FLOOR

System noise is specified only when the HP 11729C is used with an HP 8662A Option 003[1].

Phase Detector Method (locking via EFC):

HP 11729C/8662A Absolute System Noise[2, 3] (dBc/Hz):

Offset from Carrier (Hz)	Band 1 5 to 1280 MHz		Band 2 1.28 to 3.2 GHz		Band 3 3.2 to 5.76 GHz		Band 4 5.76 to 8.32 GHz	
	Typ.	Spec.	Typ.	Spec.	Typ.	Spec.	Typ.	Spec.
1	-58	-48	-53	-43	-47	-37	-43	-33
10	-88	-78	-83	-73	-77	-67	-73	-63
100	-108	-98	-103	-93	-97	-87	-93	-83
1k	-119	-115	-115	-110	-109	-104	-105	-100
10k	-130	-125	-129	-124	-127	-123	-125	-121
100k	-130	-126	-130	-126	-130	-126	-129	-125
1M	-140		-140		-138		-135	

Offset from Carrier (Hz)	Band 5 8.32 to 10.88 GHz		Band 6 10.88 to 13.44 GHz		Band 7 13.44 to 16.0 GHz		Band 8 16.0 to 18.0 GHz	
	Typ.	Spec.	Typ.	Spec.	Typ.	Spec.	Typ.	Spec.
1	-40	-30	-38	-28	-37	-27	-35	-25
10	-70	-60	-68	-58	-67	-57	-65	-55
100	-90	-80	-88	-78	-87	-77	-85	-75
1k	-102	-97	-100	-95	-99	-94	-97	-92
10k	-123	-119	-122	-118	-121	-116	-119	-115
100k	-129	-125	-128	-125	-127	-124	-127	-123
1M	-134		-132		-131		-129	

[1]The HP 8663A Option 003 (operated below 1280 MHz) may be used in place of the HP 8662A with no change in system performance.

[2]These system noise floor specifications apply for locking via the EFC of the HP 8662A crystal oscillator. Locking via the HP 8662A dc FM changes the phase noise on the tuna ble HP 8662A signal and therefore total system noise. Use the system phase noise equation at the end of footnote 3 to determine system phase noise when locking via the HP 8662A dc FM.

[3]The absolute system phase noise is dependent on the test signal frequency, therefore, the actual system noise may be lower than specified. Since the noise contribution of the HP 8662A front panel signal is a function of frequency selected, the overall system noise may improve for test frequencies <640 MHz from band centers. For example, for frequencies over the narrow range of 8.96 to 10.24 GHz, typical system phase noise at a 100 kHz offset is −134 dBc/Hz. To determine the system phase noise for any test frequency, see the system phase noise equation below.

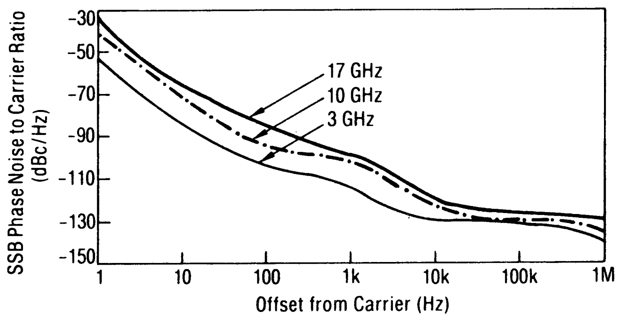
$$\mathcal{L}_{system} = 10 \log \left(N^2 \times \frac{\mathcal{L}_1}{10^{10}} + \frac{\mathcal{L}_2}{10^{10}} + \frac{\mathcal{L}_3}{10^{10}} \right)$$

where N = center frequency of selected filter/640 MHz

$\mathcal{L}_1$ = absolute SSB phase noise of the 640 MHz reference signal (dBc/Hz)

$\mathcal{L}_2$ = absolute SSB phase noise of the 5 to 1280 MHz tunable signal (dBc/Hz)

$\mathcal{L}_3$ = residual noise of the HP 11729C (dBc/Hz)



Typical HP 11729C/8662A system noise (phase detector method, locking via EFC).

Frequency Discriminator Method:

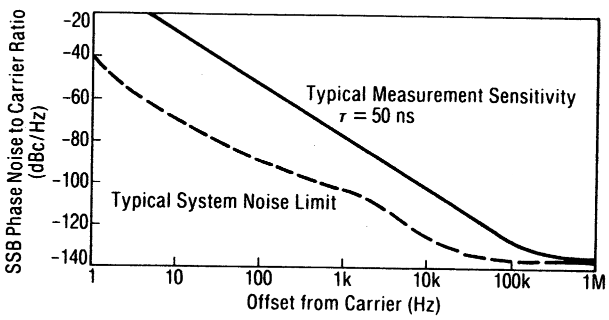
HP 11729C/8662A System Noise and Sensitivity: In the frequency discriminator mode, the lower limit of the measurement system sensitivity is set by the noise contribution of the 11729C/8662A. Typical system noise contribution of the HP 11729C/8662A is shown in the table below.

Offset from Carrier (Hz)	Typical System Noise (dBc/Hz) (frequency discriminator)		
	1.26 to 3.2 GHz	8.32 to 10.88 GHz	16.0 to 18.0 GHz
1	-54	-40	-35
10	-84	-70	-65
100	-104	-90	-85
1k	-116	-102	-97
10k	-139	-125	-120
100k	-149	-135	-130
1M	-149	-135	-130

The actual HP 11729C/8662A measurement sensitivity in the frequency discriminator method largely depends on the delay line (delay time) used. The longer the delay time, the closer the measurement sensitivity approaches the system noise limit. The graph shows the HP 11729C/8662A noise contribution, and a typically obtainable system sensitivity. A 34 foot section of flexible RF cable (RG 225) was used as the external time delay element $\tau = 50$ ns.

Table 1-3. System Specifications (2 of 2)

Frequency Discriminator Method (cont'd)



Typical noise contribution of HP 11729C/8662A (frequency discriminator method) at X-band and typical system sensitivity using a 50 ns delay line discriminator.

Listed below are general requirements for the RF source when used with the HP 11729C in a system:

640 MHz signal source:

Frequency: 640 MHz ±50 ppm.
Level: +1 dBm minimum, +4 dBm maximum.
Frequency control: dependent on method of phase lock chosen.

5—1280 MHz tunable source:

Frequency: 5—1280 MHz.
Level: 0 dBm ±1 dB. Typically usable to ϵ10 dBm with change in loop bandwidth and system noise floor.

Frequency control: dependent on method of phase lock chosen; could require dc coupled frequency controlled input accepting ±1V or ±10V, with necessary deviation dependent on source under test.

Use the following procedure to calculate the Absolute System Noise Floor of the HP 11729C and an RF source other than the HP 8662A.

Absolute System Noise Floor (general case):

Measurement system noise floor is dependent on the RF reference source(s) used. For the frequency discriminator method, system noise is a composite of the noise on the multiplied 640 MHz signal plus the residual noise of the HP 11729C. For the phase detector method, system noise has the additional noise of the RF tunable source at the phase detector input. System noise can be described by

$$\mathcal{L}_{system} = 10 \log \left(\frac{\mathcal{L}_1}{N^2 \times 10^{10}} + \frac{\mathcal{L}_2}{10^{10}} + \frac{\mathcal{L}_3}{10^{10}} \right)$$

where N = center frequency of selected filter/640 MHz

$\mathcal{L}_1$ = absolute SSB phase noise of the 640 MHz reference signal (dBc/Hz)

$\mathcal{L}_2$ = absolute SSB phase noise of the 5 to 1280 MHz tunable signal (dBc/Hz)

$\mathcal{L}_3$ = residual noise of the HP 11729C (dBc/Hz)

Table 1-4. Recommended Test Equipment (1 of 3)

Instrument	Critical Specifications	Recommended Model	Use*
Amplifier	Input Frequency: 640 MHz Gain: 22 dB Noise Figure: < 10 dBm	HP 8447E/F	P
Attenuator	Input Frequency Range: 640 MHz to 1 GHz Incremental Attenuation: 1 dB steps Maximum attenuation: 10 dB	HP 355C	P
Cable (RF)	BNC(m) to BNC(m) (9 inches)	HP 10502A	P
Cable (RF)	BNC(m) to BNC(m) (24 inches)	HP 11170B	OPAT
Carrier Noise Test Set	(There isn't any substitute instrument for the Carrier Noise Test Set) Band Range: 8.32 GHz to 10.88 GHz IF output bandwidth: 400 MHz IF output level: +7 dBm Residual Phase Noise: (Using a 10 GHz Test Signal) **Offset From Carrier (Hz)** — **Level (dBc/Hz)** 10 — − 90 100 — −105 1k — −115 10k — −127 100k — −137 1M — −137	HP 11729C[1]	P
Controller	Minimum controller capability as defined by IEEE Standard 488-1975 and the identical ANSI Standard MC1.1: SH1, AH1, T4, TE0, L2, LE0, SR0, RL1, PP0, DC0, DT0, and C1-4,26.	HP 85B	OA
Digital Multimeter	Input Range: 0 to 15 Vdc Accuracy: ±1 mVdc	HP 3468A	AT
Function Generator	Frequency: 1 kHz Function: sinewave Amplitude: 500 mVdc to 5 Vdc DC Offset Capability	HP 3312A	P
Isolator	Power Input level: +15 dBm Frequency Input: 10 GHz	HP 0955-0178[2]	P

*A = Adjustments; O = Operator's Checks; P = Performance Tests; T = Troubleshooting

[1]This Carrier Noise Test Set must contain a Band Range that is included in the Carrier Noise Test Set under test.

[2]Under certain conditions an attenuator can be used in place of the isolator. For more information see the AM Noise Floor Performance Test in Section IV.

Table 1-4. Recommended Test Equipment (2 of 3)

Instrument	Critical Specifications	Recommended Model	Use*
Low Frequency Spectrum Analyzer	Frequency Range: 0 Hz to 1 kHz Measurement Range: −75 dBm to 0 dBm Resolution Bandwidth: 30 MHz Video Averaging Video Readout Accuracy: ±0.5 dB	HP 3582A HP 3561A	P
Low Noise Oscillator	One Frequency between: 5 MHz and 18 GHz Amplitude: +10 dBm AM noise: **Offset From Carrier (Hz)** — **Level (dBc/Hz)** 100k — <−155 1M — <−160	MA 86651A[3] (M/A Com)	P
Microwave Synthesized Source	Frequency Range: 2 GHz to 10 GHz Amplitude: >+10 dBm Short term Frequency stability: 1 part in 10^7 External AM Modulation capability	HP 8340A HP 8673B	OPAT
Oscilloscope	Bandwidth: 100 Hz Vertical Sensitivity: 5 mV/div AC Coupled	HP 1740A	T
Power Meter	Accuracy: ±0.2 dBm	HP 436A	PA
Power Sensor	Frequency Range: 100 MHz to 10 GHz Power Range: 0 dBm to 15 dBm Input Impedance: 50Ω SWR: < 1.25	HP 8481A	PA
Power Splitter	Input Frequency Range: 400 MHz to 700 MHz Output tracking: <0.25 dB	HP 11667A	P
Power Splitter	Input Frequency: 10 GHz Output tracking: <0.25 dB	HP 11667A	P
Power Supply	Voltage Output: +10 Vdc maximum	HP 6214B	P
RF Spectrum Analyzer	Frequency Range: 1 kHz to 10 MHz Dynamic Range: −75 dBm to 0 dBm Resolution Bandwidth: 100 Hz and 100 kHz Video Filtering Marker capability Reference Level Control Video Readout Accuracy: ± 0.5 dB Sensitivity: −117 dB	HP 8566B	OPT

*A = Adjustments; O = Operator's Checks; P = Performance Tests; T = Troubleshooting
[3]Commercial Sources Division, M/A-COM, South Avenue, Burlington, MA 01803

Table 1-4. Recommended Test Equipment (3 of 3)

Instrument	Critical Specifications	Recommended Model	Use*
RF Synthesized Signal Generator	Auxillary 640 MHz Signal: Absolute Phase Noise: Offset From Carrier (Hz) / Level (dBc/Hz) 1 / − 54 10 / − 84 100 / −104 1 k / −121 10 k / −145 100 k / −157 1 M / −157 Level: >+1 dBm to <+4 dBm Electronic Frequency Control: ± 1 Vdc or ± 10 Vdc RF Output: Frequency Range: 300 MHz to 700 MHz Frequency resolution: 10 Hz Amplitude: −40 dBm to 0 dBm External AM Modulation capability	HP 8662A[4] (Opt. 003) HP 8663A[4] (Opt. 003)	OPAT
Termination	50 ohms BNC	HP 11593A	P
Waveguide	UG-135/U to N(f)	HP X281C	P

* A = Adjustments; O = Operator's Checks; P = Performance Tests; T = Troubleshooting

[4]For one HP 8662A or 8663A to operate with the Carrier Noise Test Set and give the best phase noise performance, two rear panel connectors are required. One connector must supply 640 MHz and the other connector must accept the Electronic Frequency Control signal from the Carrier Noise Test Set. As of April 1984 these two connectors are on the rear panel of each standard HP 8662A or 8663A. Before April 1984 these two connectors were specified by options H03 and H12. The HP 8662A or 8663A option 003 includes testing the phase noise of the 640 MHz signal.

Table 1-5. Recommended Alternate Test Equipment

Instrument Type	Suggested Alternate	Instrument Replaced	Advantages of Alternate
RF Synthesized Signal Generator	HP 8663A	HP 8662A	The HP 8663A is a direct substitute for the HP 8662A.
Microwave Synthesized Source	HP 8673B	HP 8340A	Less expensive
Low Frequency Spectrum Analyzer	HP 3561A	HP 3582A	Better Accuracy

SECTION II
INSTALLATION

2-1. INTRODUCTION

This section provides the information needed to install the Carrier Noise Test Set. Included is information pertinent to initial inspection, power requirememts, line voltage selection, power cables, interconnection, environmemt, 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, displays).

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 test, 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 Carrier Noise Test Set requires a power source of 100, 120, 220 or 240 Vac, +5% to −10%, 48 to 66 Hz single phase. Power consumption is 75 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 through the 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.

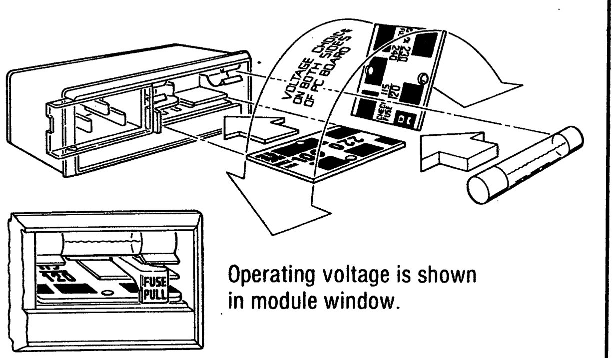
Verify that the line voltage selection card and the fuse are matched to the power source. Refer to Figure 2-1, Line Voltage and Fuse Selection.

Fuses may be ordered under HP part numbers 2110-0001, 1.0A (250V) for 100/120 Vac operation and 2110-0012, 0.5A (250V) for 220/240 Vac operation.

2-6. Power Cables

WARNING

BEFORE CONNECTING THIS INSTRUMENT, the protective earth terminal 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).



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).

Figure 2-1. Line Voltage and Fuse Selection

Power Cables (cont'd)

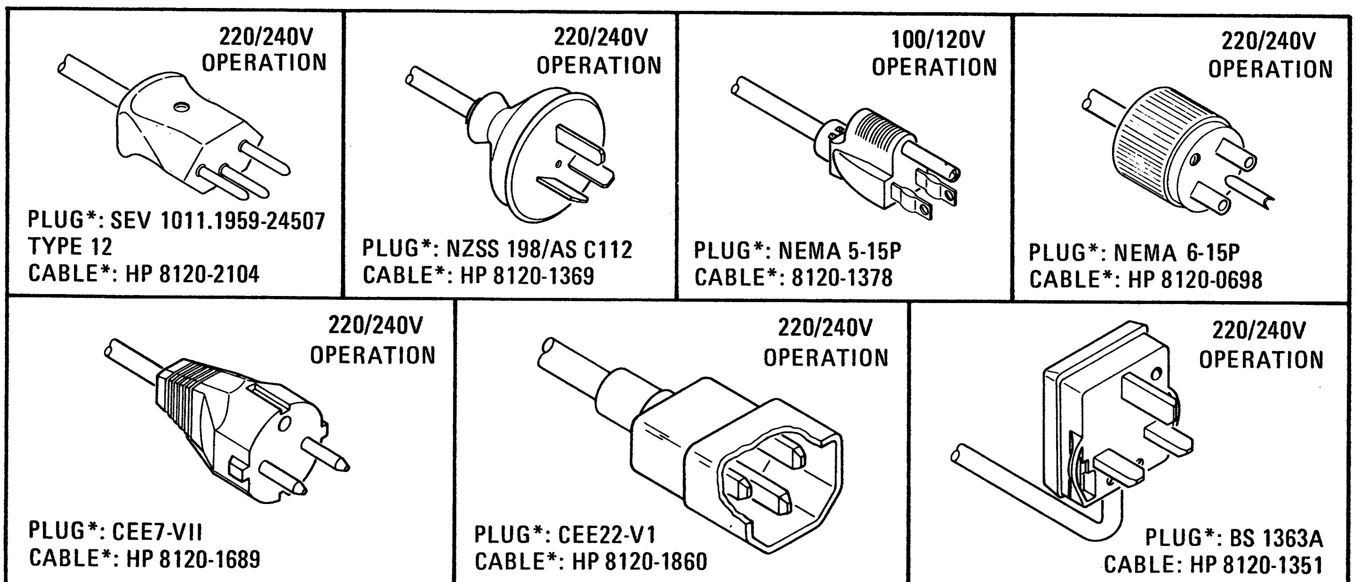
This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The power cable plug shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the part numbers of power cables available.

2-7. HP-IB Address Selection HP-IB

The HP-IB address is switch-selectable through five miniature slide switches located on the rear panel of the Carrier Noise Test Set. These switches provide the means to select one of 31 valid HP-IB addresses (00 through 30). HP-IB addresses greater than 30 (decimal) are invalid. Refer to Table 2-1 for the allowable HP-IB address codes. Listed are the valid address switch settings and equivalent ASCII character and decimal value. When the instrument is shipped from the factory, the HP-IB address is preset to 06 (decimal). (In binary, this is 00110.) This preset address is shown shaded in Table 2-1.

The following procedure describes how to change the settings of the HP-IB address switches.

Use a small screwdriver to set the switches to the desired HP-IB address in binary. The five switches are labeled A1 through A5, where A1 is the least significant address bit and A5 is the most signifi-



*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.

Figure 2-2. Power Cable and Mains Plug Part Numbers

Table 2-1. Allowable HP-IB Address Codes

Decimal Equivalent[1]	Listen Address Character	Talk Address Character	Address Switches[1]				
			A5	A4	A3	A2	A1
0	SP	@	0	0	0	0	0
1	!	A	0	0	0	0	1
2	"	B	0	0	0	1	0
3	#	C	0	0	0	1	1
4	$	D	0	0	1	0	0
5	%	E	0	0	1	0	1
6	&	F	0	0	1	1	0 [2]
7	'	G	0	0	1	1	1
8	(	H	0	1	0	0	0
9	)	I	0	1	0	0	1
10	*	J	0	1	0	1	0
11	+	K	0	1	0	1	1
12	,	L	0	1	1	0	0
13	-	M	0	1	1	0	1
14	.	N	0	1	1	1	0
15	/	O	0	1	1	1	1
16	0	P	1	0	0	0	0
17	1	Q	1	0	0	0	1
18	2	R	1	0	0	1	0
19	3	S	1	0	0	1	1
20	4	T	1	0	1	0	0
21	5	U	1	0	1	0	1
22	6	V	1	0	1	1	0
23	7	W	1	0	1	1	1
24	8	X	1	1	0	0	0
25	9	Y	1	1	0	0	1
26	:	Z	1	1	0	1	0
27	;	[	1	1	0	1	1
28	<	\	1	1	1	0	0
29	=	]	1	1	1	0	1
30	>	0	1	1	1	1	0

[1]Decimal characters and the five address switches relate to the last five bits of both talk and listen addresses.

[2]Factory-set address.

HP-IB Address Selection (cont'd)

cant address bit. Sliding the switch downward (as viewed from the rear of the instrument) "sets" the corresponding address bit to "1" while sliding the switch upwards "clears" the bit (bit=0). Setting all of the address bits to "1" will result in an invalid HP-IB address (31 decimal). In this case an HP-IB address of 30 (decimal) will be stored in memory once the instrument is powered up.

If the HP-IB address is changed when the instrument is on the instrument will have to be turned off then turned on again. This is necessary so the new address can be read by the microprocessor and stored in memory.

Along with the five address switches (A1 through A5) there are two other switches. These two switches are labeled "LO" LISTEN ONLY and "TO" TALK ONLY. When either the "LO" or "TO" switch is set to "1" the Carrier Noise Test Set becomes either a TALKER ONLY or a LISTENER ONLY and the HP-IB address is overridden. At the factory the "LO" and "TO" switches are set to "0".

2-8. Interconnections

For the Carrier Noise Test Set to be fully operational it may have to be connected to an external RF source for one or both of the drive signals (5—1280 MHz and 640 MHz). The drive signals are essential to the operation of the Carrier Noise Test Set.

One of the drive signals can be supplied by the Carrier Noise Test Set. An internally generated 640 MHz reference signal can be provided by connecting the supplied cable-attenuator assembly between the proper rear panel connectors. For proper operation, it is essential that the supplied cable-attenuator assembly (HP 11729-60096 or HP 11729-60098 [Option 140]) be used to make the connection.

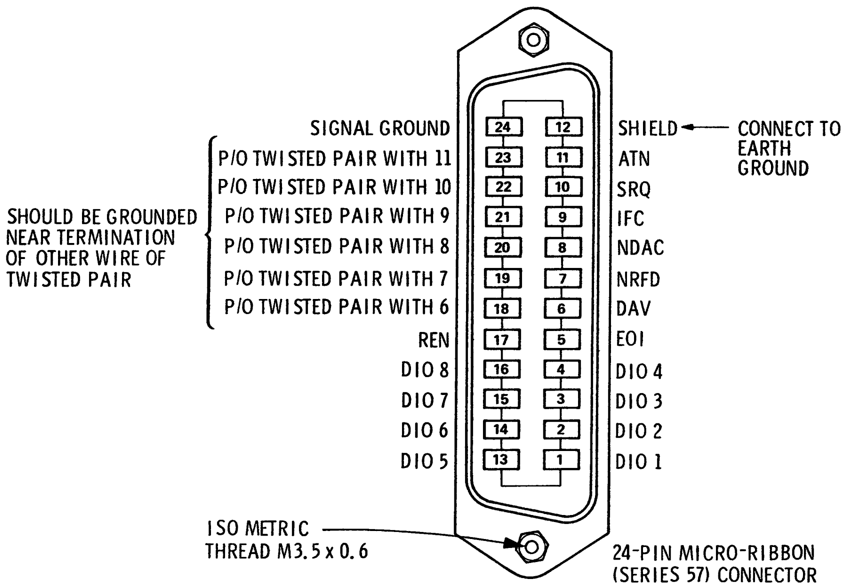
The following figures, in Section III OPERATION, show the interconnections to the Carrier Noise Test Set:

- Figure 3-4 Phase Noise Measurement Setup (Phase Detector Method)
- Figure 3-7 Phase Noise Measurement Setup (Frequency Discriminator Method)
- Figure 3-8 AM Noise Measurement Setup

Interconnection data for the Hewlett-Packard Interface Bus is provided in Figure 2-3.

2-9. Mating Connectors

HP-IB Interface Connector. The HP-IB mating connector is shown in Figure 2-3. Note that the two securing screws are metric.



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 (65.5 ft).

Figure 2-3. Hewlett-Packard Interface Bus Connection

Mating Connectors (cont'd)

Coaxial Connectors. Coaxial mating connectors used with the Carrier Noise Test Set should be 50 ohm Type N and 50 ohm BNC male connectors.

2-10. Operating Environment

The operating environment should be within the following limitations:

Temperature .... 0 to +55C
Humidity .... .5% to 95% relative at 40°C
Altitude .... <4600 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-alignment of instruments when they are stacked.) The tilt stands raise the front of the Carrier Noise Test Set for easier viewing of the front panel.

2-12. Rack Mounting

WARNING

The Carrier Noise Test Set weighs 10.4 kg (23 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 at 40°C
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.

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 service center, complete one of the blue tags mentioned above 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 an appropriate type of cushioning material to prevent damage during shipment.

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 Carrier Noise Test Set. Included are general operation instructions; detailed descriptions of each front and rear panel key, connector, switch and annunciator; information on remote operation; operator's checks; and operator's maintenance procedures.

3-2. Local Operation

Information covering local operation of the Carrier Noise Test Set is given in two places, namely detailed panel features and general operating instructions.

Detailed Panel Features. Figure 3-1 and Figure 3-2 illustrate the front and rear panels of the Carrier Noise Test Set and provide descriptions of each key, connector, switch and annunciator.

General Operating Instructions. Under general operating structions the following topics are covered:

- Power-on sequences
- Power-on procedure
- Phase noise measurement using the Phase Detector Method
- Phase noise measurement using the Frequency Discriminator Method
- AM noise measurement

3-3. Remote Operation (HP-IB) HP-IB

The Carrier Noise Test Set is capable of remote operation via the Hewlett-Packard Interface Bus. Knowledge of local operation is essential for HP-IB programming since most of the data messages contain the same keystroke-like sequences. HP-IB information is presented in the following areas of this section:

- A summary of HP-IB capabilities is provided in Table 3-3.
- A summary of program codes is provided in Table 3-4.

3-4. Operator's Checks

Operator's checks are simple procedures designed to verify that the main functions of the Carrier Noise Test Set operate properly.

These procedures require a microwave synthesized source, an RF synthesized signal generator, a spectrum analyzer, a controller (for HP-IB checks) and interconnecting cables.

3-5. Operator's Maintenance

WARNING

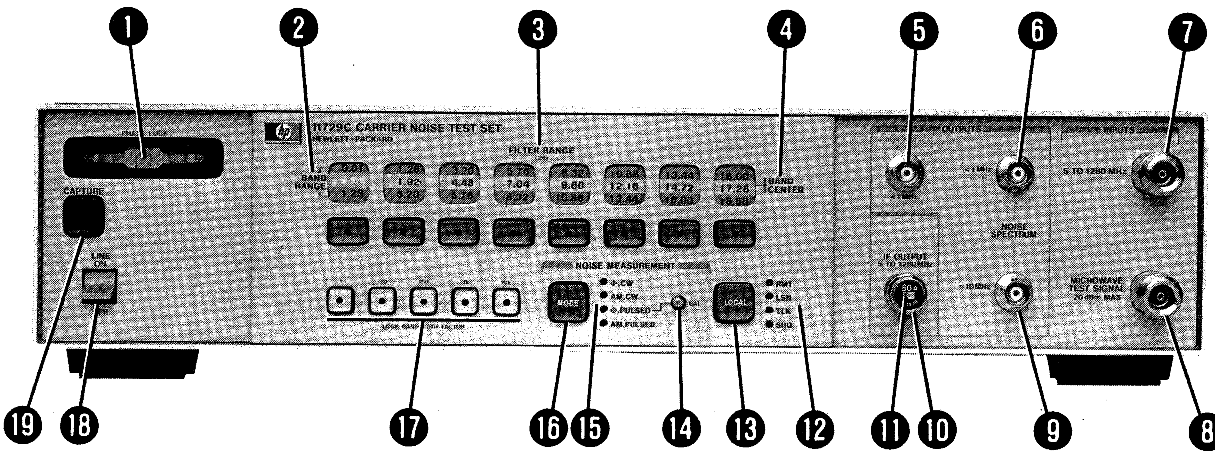
For continued protection against fire hazard, replace the line fuse with a 250V fuse of the same rating only. Do not use repaired fuses or short-circuited fuseholders.

The only maintenance that the operator should normally perform is the replacement of the primary power fuse. All other maintenance should be referred to qualified service personnel.

The primary power fuse is located within the Line Power Module. Refer to Figure 2-1 for instructions on how to change the fuse.

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.

FRONT PANEL FEATURES



1. **PHASE LOCK INDICATOR.** The primary purpose of the PHASE LOCK INDICATOR is to show when the device under test and the tunable 5—1280 MHz source are in phase quadrature (that is, 90 degrees out of phase). When the device under test and the tunable 5—1280 MHz source are in phase quadrature a green LED will be illuminated in the center of the PHASE LOCK INDICATOR. When the two sources are greater than 100 kHz apart a red LED will be illuminated to the left or right of the green LED. As the frequency difference decreases all the LEDs will light up dimly. Finally, as the two sources approach quadrature the LEDs will fully light one at a time, from left to right. When the center green LED is illuminated the two sources are in phase quadrature.

2. **BAND RANGE.** BAND RANGE describes the range of microwave test signals that can be input for each of the buttons below FILTER RANGE. The BAND RANGE chosen must contain the microwave test signal. The BAND RANGE desired is enabled by pressing the button below that BAND RANGE.

3. **FILTER RANGE.** FILTER RANGE describes the range of microwave test signals that can be accepted by the Carrier Noise Test Set (0.010—18 GHz).

4. **BAND CENTER.** The broad range of microwave test signals is possible because of a 640 MHz comb generator in the Carrier Noise Test Set. Through a series of filters certain harmonics from the comb generator are passed. The BAND CENTER frequency of the BAND RANGE chosen is the only harmonic (combline) from the comb generator that is passed. The filter used for selecting the harmonic is a 200 MHz passband filter centered around the combline.

5. **AUX NOISE.** This is a female BNC connector with an output impedance of 600Ω. The signal output is a dc level that is proportional to the phase difference between the microwave test signal and the tunable 5—1280 MHz signal. The dc level has ac fluctuations directly proportional to the phase noise of the microwave test signal, if the phase noise of the 640 MHz signal and the tunable 5—1280 MHz signal is less than the microwave test signal. The output and an oscilloscope can be used as an external quadrature monitor, because of the direct proportionality of the dc level to the phase difference of the microwave test signal and the tunable 5—1280 MHz signal.

6. **NOISE SPECTRUM < 1 MHz OUTPUT.** This is a female BNC connector with an output impedance of 600Ω. This output is useful for measuring the phase noise of the device under test at offsets from the carrier of dc to 1 MHz.

   The signal output is a dc level directly proportional to the phase difference between the microwave test signal and the tunable 5—1280 MHz signal. The dc level has ac fluctuations that are directly proportional to the phase noise of the the microwave test signal, if the phase noise of the 640 MHz signal and 5—1280 MHz signal is less than the microwave test signal.

Figure 3-1. Front Panel Features (1 of 3)

FRONT PANEL FEATURES

NOTE

The bandwidth (dc to 1 MHz) is not completely flat. The 3 db points are at dc and 1.5 MHz.

7. **5 to 1280 MHz INPUT.** This is a female type-N connector with a 50Ω input impedance. The frequency of the input signal is 5—1280 MHz from a tunable source. The frequency of the signal input is set to equal the microwave test signal minus the BAND CENTER frequency of the BAND RANGE chosen. The input level should be 0 dBm ±1 dBm. The user sets this signal in phase quadrature (that is, 90 degrees out of phase) with the microwave test signal. The IF OUTPUT is connected to this input, through a delay line, for the Frequency Discriminator Method of making a phase noise measurement.

8. **MICROWAVE TEST SIGNAL INPUT.** This is a female type-N connector with a 50Ω input impedance. This connector is used to connect the microwave test signal to the Carrier Noise Test Set. The input frequency range is 10 MHz to 18 GHz. The input level should be as follows:

   For test frequencies >1.28 GHz: +7 dBm to +20 dBm (Typically usable down to −15 dBm with potential noise floor degradation). The optimal level is +7 dBm to +20 dBm.

   For test frequencies <1.28 GHz: −5 dBm to +10 dBm (Typically usable down to −15 dBm with potential noise floor degradation. The optimal level is from −2 dBm to +3 dBm.)

9. **NOISE SPECTRUM < 10 MHz OUTPUT.** This is a female BNC connector with an output impedance of 50Ω and 40 dB of gain over the <1 MHz OUTPUT. This output is useful for measuring the phase noise or amplitude (AM) noise of the device under test at offsets from the carrier of 10 Hz to 10 MHz.

   The signal output is a dc level that is directly proportional to the phase difference between the microwave test signal and the tunable 5—1280 MHz signal. The dc level has ac fluctuations that are directly proportional to the phase noise of the microwave test signal, if the phase noise of the 640 MHz signal and the tunable 5—1280 MHz signal is less than the microwave test signal.

NOTE

The bandwidth (10 Hz to 10 MHz) is not completely flat. The 3 dB points are at 10 Hz and 15 MHz.

10. **IF OUTPUT 5—1280 MHz.** This is a female BNC connector with an output impedance of 50Ω. The output frequency will be 5 to 1280 MHz. The exact frequency is the intermediate difference frequency (IF) from the mixing of the microwave test signal and the BAND CENTER frequency of the BAND RANGE chosen. The output level is +7 dBm minimum.

11. **50 OHM TERMINATION.** With the 50Ω termination connected to the IF OUTPUT the Carrier Noise Test Set meets the requirements of MIL-STD 461 RE02. The IF OUTPUT is fully useable, just replace the 50 Ohm termination when the IF OUTPUT is not being used.

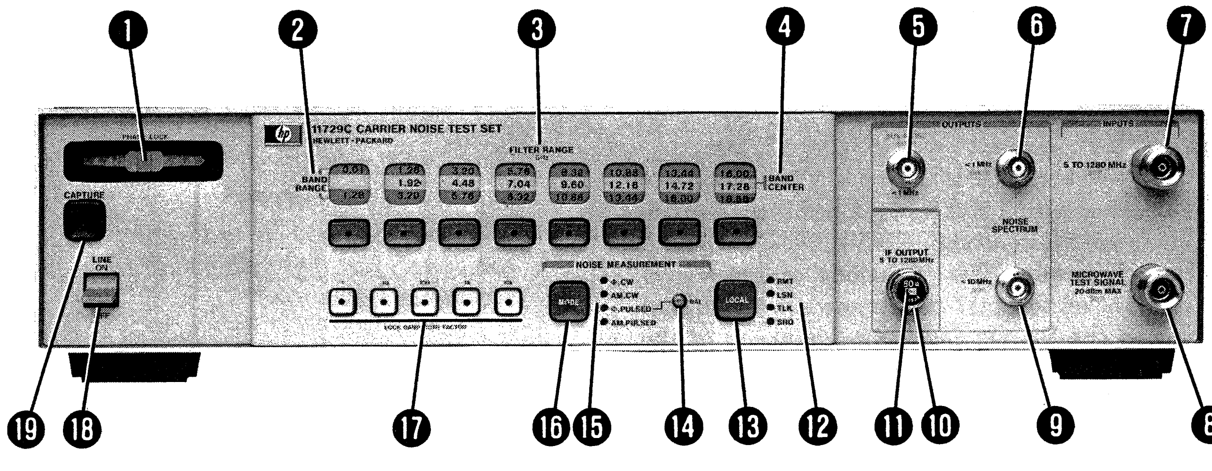
12. **HP-IB ANNUNCIATORS.** Display the HP-IB status. The REMOTE (RMT) annunciator lights when the Carrier Noise Test Set is in the remote mode. The TALK (TLK) annunciator lights when the Carrier Noise Test Set is addressed to talk. The LISTEN (LSN) annunciator lights when the Carrier Noise Test Set is addressed to listen. The SRQ annunciator lights when the Carrier Noise Test Set is sending a Require Service message to the controller.

13. **LOCAL.** Returns the Carrier Noise Test Set to local operation (front panel control) from remote HP-IB control provided that the instrument is not in Local Lockout.

14. **BAL.** This adjustment is used when making a measurement on a pulsed signal. This adjustment with the aid of an oscilloscope connected to the AUX NOISE connector on the front panel, is used to eliminate the dc offset in the phase lock loop.

Figure 3-1. Front Panel Features (2 of 3)

FRONT PANEL FEATURES



15. **MEASUREMENT ANNUNCIATORS.** When a continuous wave (CW) phase noise measurement is selected the ϕ, CW annunciator will be illuminated. When a continuous wave (CW) AM noise measurement is selected the AM, CW annunciator will be illuminated. When a pulsed phase noise measurement is selected the ϕ, PULSED annunciator will be illuminated. When a pulsed AM noise measurement is selected the AM, PULSED annunciator will be illuminated.

16. **MODE.** Used to select either a phase noise (CW or pulsed) or AM noise (CW or pulsed) measurement. AM noise is only installed with Option 130.

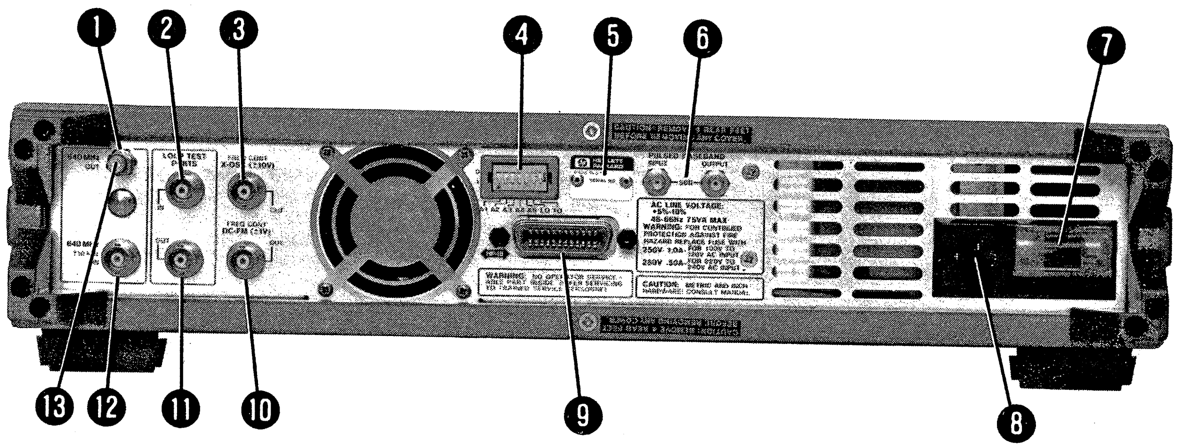
17. **LOCK BANDWIDTH FACTOR.** These five switches partially control the bandwidth of the phase lock loop, by setting the gain for a number of operational amplifiers in the Carrier Noise Test Set. Another factor in determing the loop andwidth is the frequency of the microwave test signal or the FM deviation set on the device under test or the tunable 5—1280 MHz source.

18. **LINE SWITCH.** Applies ac power to the Carrier Noise Test Set when set to the ON position.

19. **CAPTURE.** When CAPTURE is pressed the phase lock loop is changed from a second order loop to a first order loop. The phase lock loop consists of a voltage controlled oscillator (the tunable 5—1280 MHz source or the device under test), a phase detector and loop filter. The phase detector and loop filter are in the Carrier Noise Test Set. By changing to a first order loop the bandwidth of the loop is widened. By widening the loop bandwidth, acquiring phase quadrature is made easier. When CAPTURE is pressed the LOCK BANDWIDTH FACTOR buttons are overridden.

Figure 3-1. Front Panel Features (3 of 3)

REAR PANEL FEATURES



1. **640 MHz OUT.** This is a female SMA connector with an output impedance of 50 Ohms. The output frequency is 640 MHz. The output level is 11-13 dBm. This output is used to generate an internal 640 MHz signal when connected to the 640 MHz IN connector. When this output is not in use it must be terminated with the 50 Ohm termination that was shipped with the Carrier Noise Test Set.

2. **LOOP TEST PORT IN.** If a phase noise measurement is made within the phase lock loop bandwidth some of the phase noise will be suppressed. The LOOP TEST PORT IN connector lets the user input a signal to determine the transfer characteristic of the phase lock loop. Once the transfer characteristic is known the amount of noise suppression at any offset within the loop bandwidth can be determined. The amount of phase noise suppression is then used to correct the measured phase noise level.

   This is a dc coupled female BNC connector with a nominal input impedance of 10kΩ. The signal input should be from a random noise source, a tracking generator or a variable frequency sine wave source. The input level is typically less than 0.1 volts peak. The typical bandwidth is dc to 100 kHz.

3. **FREQ-CONT X-OSC.** This output is to be connected to the frequency control input of the tunable 5—1280 MHz source or the device under test (whichever is being used as the loop VCO) if the loop VCO requires ±10 volts dc for tuning. When so connected the loop VCO will change frequency to maintain phase quadrature between the device under test and the tunable 5—1280 MHz source.

   This is a female BNC connector with an output impedance of 100Ω. The output level is nominal from −10 volts dc to +10 volts dc.

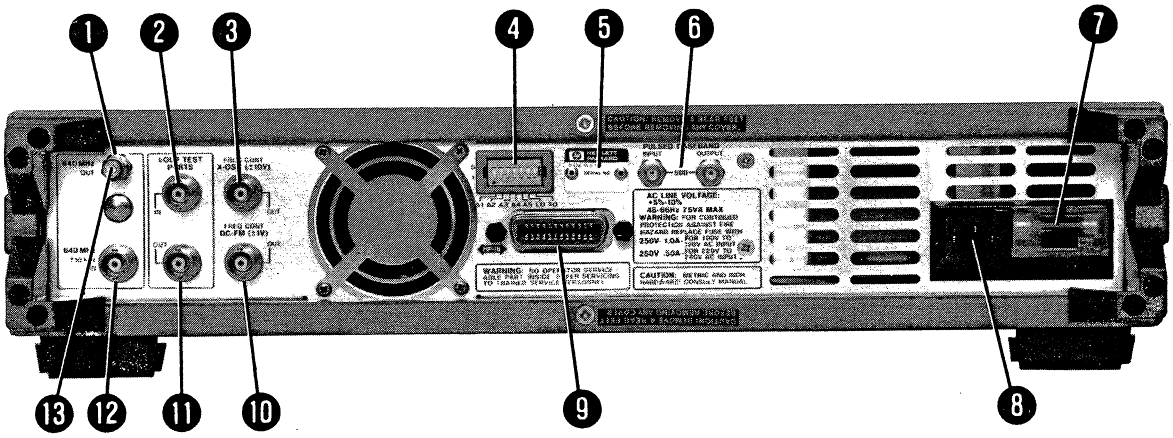
4. **HP-IB ADDRESS SWITCH.** Used to select one of 31 valid HP-IB addresses (00 through 30). The address is set in binary with A5 as the most significant bit and A1 as the least significant. To set a bit, "bit=", slide the switch down. To clear a bit, "bit=0", slide the switch up. By setting TALK ONLY "TO" or LISTEN ONLY "LO" TO "1" the HP-IB address is overriden. When the address is changed the Carrier Noise Test Set must be turned off then back on. This is necessary so the microprocessor will be aware of the address change.

5. **SERIAL NUMBER PLATE.** First four digits and letter constitute the prefix which defines the instrument configuration. The last five digits form a sequential suffix that is unique to each instrument. The plate also indicates any options supplied with the instrument.

6. **PULSED BASEBAND.** These connectors are used when making a pulsed measurement. The

Figure 3-2. Rear Panel Features (1 of 2)

REAR PANEL FEATURES



user connects a filter between the input and output to filter the pulse repetition frequency off the carrier. The filter chosen is dependent on the pulse repetition frequency of the carrier. The design of the filter must be such that the pulse repetition frequency and its multiples are terminated into 50 Ohms.

7. **FUSE.** Ordering information is presented in Section II, Installation.

8. **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 connected to the chassis for earth grounding.

9. **HP-IB CONNECTOR.** 24-pin female connector used to connect the Carrier Noise Test Set to the Hewlett-Packard Interface Bus (HP-IB) for remote operation. Connection information is presented in Section II, Installation.

10. **FREQ-CONT DC-FM.** This output is to be connected to the frequency control input of the tunable 5—1280 MHz source or the device under test (whichever is being used as the loop VCO) if the loop VCO requires ±1 volt dc for tuning. When so connected the loop VCO will change frequency to maintain phase quadrature between the device under test and the tunable 5—1280 MHz source.

    This is a female BNC connector with a nominal output impedance of 50Ω. The output level is nominal from −1 volt dc to +1 volt dc.

11. **LOOP TEST PORT OUT.** Once a signal has been input at the LOOP TEST PORT IN connector, this output is connected to a spectrum analyzer for displaying the phase lock loop transfer characteristic.

    This is a dc coupled female BNC connector with a nominal output impedance of 1 kΩ. The gain outside the phase lock loop bandwidth is equal to one.

12. **640 MHz INPUT.** This is a female BNC connector with a 50 Ohm input impedance. The input frequency must be 640 MHz ±32kHz. The input level must be +1 dBm to +4 dBm.

13. **50 Ohm TERMINATION.** For proper operation of an amplifier inside the Carrier Noise Test Set this termination must be connected to the 640 MHz OUT connector. The 640 MHz OUT connector is fully usable, just replace the 50 Ohm termination when the 640 MHz OUT connector is not being used.

Figure 3-2. Rear Panel Features (2 of 2)

OPERATOR'S CHECKS

3-6. OPERATOR'S CHECKS

Description Use the test set-up shown below to verify the front panel controlled functions are being executed by the microprocessor.

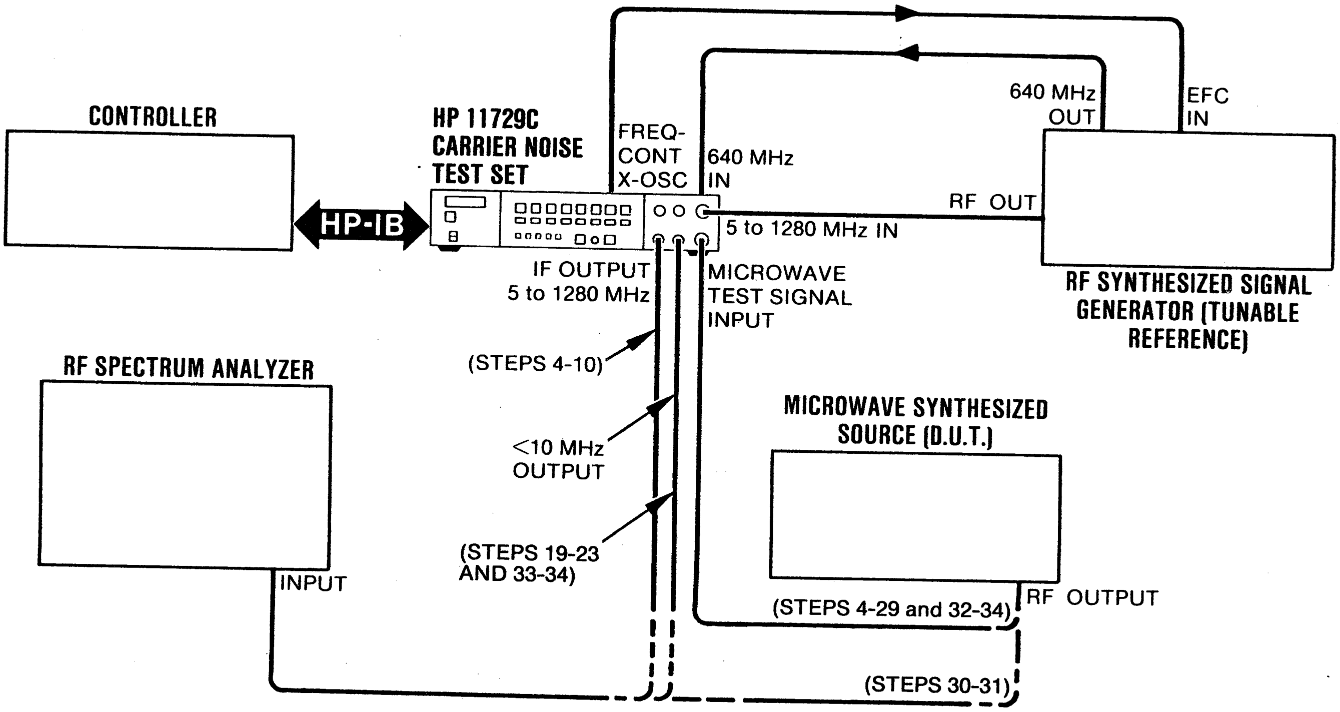


Figure 3-3. Basic Functional Checks Test Setup

Equipment

RF Synthesized Signal Generator .... HP 8662A
(tunable reference) (Option 003)
Microwave Synthesized Source ...... HP 8340A
(D.U.T.)
Computer Controller .... HP 85B
RF Spectrum Analyzer .... HP 8566B

Procedure

Microprocessor Checks

1. Turn on and warm up all instruments for 30 minutes before proceeding.

2. Switch the Carrier Noise Test Set to ON and observe the front panel annunciators. An internal memory check of ROM and RAM is initiated when the Carrier Noise Test Set is switched on. If the memory system is working properly, all front panel annunciators will light for approximately 1.5 seconds. This also provides a quick visual inspection of each front panel annunciator.

   If memory failure is detected, no front panel annunciators will light during the 1.5 second time period.

OPERATOR'S CHECKS

3-6. OPERATOR'S CHECKS (cont'd)

Procedure (cont'd)

3. Press the FILTER RANGE buttons and MEASUREMENT MODE button. The clicking sound verifies the switching control of the microprocessor and the switch operation.

IF OUTPUT Check (Using an external source to supply the 640 MHz signal)

4. Set the D.U.T. as follows:

   Frequency .... 2.32 GHz
   Amplitude .... +10 dBm

5. Set the Carrier Noise Test Set as follows:

   Band center .... 1.92 GHz
   Measurement Mode .... ϕ, CW

6. Adjust the spectrum analyzer to display the 400 MHz IF OUTPUT (D.U.T. frequency minus BAND CENTER frequency).

NOTE

Present at the IF OUTPUT will be the IF signal (signal under test minus the BAND CENTER frequency of the BAND RANGE chosen), IF harmonics and spurious signals. Any IF harmonics or spurious signals can be disregarded. The signal with the highest amplitude is the desired signal.

The harmonics of the IF signal do not affect the phase noise measurement since the NOISE SPECTRUM OUTPUTS are filtered. The spurious signals may appear as sidebands on the IF signal and as spurs at the NOISE SPECTRUM OUTPUTS.

7. Check that the IF OUTPUT level is above the specified limit of +7 dBm minimum. Record the actual value of the IF OUTPUT frequency and level in Table 3-1.

8. If the IF OUTPUT frequency and level did not measure within specified limits check the frequency and power level of the 640 MHz IN signal and the microwave test signal. If a problem still exists refer to the troubleshooting on Service Sheet 1.

9. Change the frequency of the D.U.T to the next microwave test signal frequency listed in Table 3-1. Change the BAND RANGE on the front panel to the next BAND CENTER listed in Table 3-1.

10. Measure the IF OUTPUT frequency and level with the spectrum analyzer. Record the values and repeat the measurement for each of the BAND CENTER frequencies listed.

IF OUTPUT Check (Using the 640 MHz oscillator in the Carrier Noise Test Set)

11. Leave the settings on the D.U.T. and Carrier Noise Test Set to those that were used for the last measurement in step 10.

OPERATOR'S CHECKS

OPERATOR'S CHECKS (cont'd)

Procedure (cont'd)

12. Disconnect the cable to the 640 MHz IN connector, on the rear panel of the Carrier Noise Test Set.

13. Disconnect the SMA termination from the 640 MHz OUT connector, on the rear panel of the Carrier Noise Test Set.

14. Connect the 640 MHz OUT connector to the 640 MHz IN connector using the cable-attenuator assembly (HP 11729-60096 or HP 11729-60098 [Option 140]) that was shipped with the Carrier Noise Test Set.

NOTE

It is essential that the cable-attenuator assembly that was shipped with the Carrier Nosie Test Set be used to make the connection.

15. Measure the IF OUTPUT frequency and level with the spectrum analyzer. Verify that the typical frequency measured is 400 MHz and the level is greater than +7 dBm.

16. Disconnect the cable between the 640 MHz OUT and 640 MHz IN connectors.

17. Reconnect the 50 Ohm SMA termination to the 640 MHz OUT connector.

18. Reconnect the 640 MHz signal from the tunable reference to the 640 MHz IN connector on the Carrier Noise Test Set.

Table 3-1. IF Output Check

Microwave Test Signal (GHz)	Band Center (GHz)	IF Output Frequency (MHz)		IF Output Level (dBm)	
		Actual	Typical	Minimum	Actual
2.32	1.92	______	400	+7	______
4.88	4.48	______	400	+7	______
7.44	7.04	______	400	+7	______
10.00	9.60	______	400	+7	______
12.56	12.16	______	400	+7	______
15.12	14.72	______	400	+7	______
17.68	17.28	______	400	+7	______

Phase Lock Check

19. Connect the <10 MHz OUTPUT from the Carrier Noise Test Set to the RF spectrum analyzer.

20. Set the Carrier Noise Test Set as follows:

    Lock Bandwidth Factor 100
    Measurement Mode .... ϕ, CW
    Band Range .... 8.32 to 10.88 GHz

OPERATOR'S CHECKS

OPERATOR'S CHECKS (cont'd)

Procedure (cont'd)

NOTE

If this filter is not included in the Carrier Noise Test Set, select an available BAND RANGE.

21. Set the D.U.T. as follows:

    Frequency .... 10 GHz
    Amplitude .... +10 dBm

NOTE

The test signal is tuned 400 MHz above the center frequency of the BAND RANGE selected on the Carrier Noise Test Set

22. Set the tunable reference as follows:

    Frequency .... 400 MHz
    Amplitude .... 0 dBm

23. Press and release CAPTURE, on the Carrier Noise Test Set, to phase lock the D.U.T. to the tunable reference.

    If the sources do not phase lock (green bar does not remain illuminated on the front panel phase lock indicator) the tunable reference must be tuned closer in frequency to the IF frequency ($f_{IF} = f_{D.U.T.} - f_{band\ center\ frequency}$). Press CAPTURE while tuning the tunable reference in 1 kHz steps. Watch the phase lock indicator on the Carrier Noise Test Set. When the LED's on the indicator all light up, reduce the resolution of the tunable reference by a factor of 10.

NOTE

Connect the spectrum analyzer to the <10 MHz OUTPUT, on the Carrier Noise Test Set, if difficulties occur in determining the direction to tune the tunable reference to acquire phase lock.

The signals displayed on the spectrum analyzer represent the frequency difference between the two inputs to an internal mixer/phase detector in the Carrier Noise Test Set. The signals will decrease in frequency to dc when tuning towards phase lock and increase in frequency when tuning away from phase lock.

Press CAPTURE and tune in this reduced resolution. Watch the red LEDS on the Carrier Noise Test Set phase lock indicator step through one side of the display - to the green bar - then to the other side of the display. Again reduce the resolution on the tunable reference by a factor of 10. Tune in this finer resolution until the green LED is illuminated. When the green LED is illuminated release CAPTURE.

Display Deviation Check

24. If the Carrier Noise Test Set is not phase locked perform the phase lock check (steps 19-23).

25. Hold CAPTURE in and increase the tunable reference in 10 Hz steps until the loop becomes unlocked. Watch the phase lock indicator, the red LEDs should fully light

OPERATOR'S CHECKS (cont'd)

Procedure (cont'd)

one at a time and move to the right. When the last LED is illuminated and you tune further the entire indicator should dimly light.

With CAPTURE pressed decrease the tunable reference in 10 Hz steps. The dimly illuminated indicator should change back to the red LEDs one at a time fully illuminated and moving to the left. When the last LED on the left is illuminated and you tune further, the entire indicator will dimly light.

26. When the last LED on the left or right lights and the tunable reference is increased or decreased further, the indicator should immediately dimly light. If the indicator goes blank perform the phase lock indicator adjustments in Section V.

AM Mode Check

NOTE

Perform this check only when the AM Noise Option is installed.

27. Set the Carrier Noise Test Set as follows:

    Measurement Mode .... AM, CW
    All other functions .... Not used

28. Set the D.U.T. as follows:

    Frequency .... 1 GHz
    Amplitude .... +10 dBm

29. AM modulate the microwave test signal at a 1 kHz rate.

30. Adjust the spectrum analyzer to view the 1 GHz signal and the 1 kHz AM sidebands.

31. Adjust the percent of AM modulation so that the 1 kHz AM sidebands are 40 dB below the 1 GHz carrier. (approximately a 2% depth)

32. Disconnect the microwave test signal from the spectrum analyzer. Connect the microwave test signal to the MICROWAVE TEST SIGNAL INPUT on the Carrier Noise Test Set.

33. Connect the <10 MHz OUTPUT, on the Carrier Noise Test Set, to the spectrum analyzer.

34. Adjust the spectrum analyzer to view the 1 kHz detected signal. AM MODE is operating if the 1 kHz signal level is -7 dBm ± 3 dBm.

HP-IB Address Verification

35. Press and hold the front panel LOCAL key. The LED's on the BAND RANGE select buttons will display the current address in binary.

36. Check the address switch setting on the rear panel of the Carrier Noise Test Set to verify the display on the BAND RANGE select buttons is correct.

OPERATOR'S CHECKS (cont'd)

Procedure (cont'd)

Local/Remote Operation Check

37. Set the Carrier Noise Test Set to remote using the following:

Remote 706

38. Press any front panel key except LOCAL to verify that the front panel keys are disabled.

39. Press the LOCAL key. This switches the instrument out of the remote mode.

NOTE

When the local key is pressed the REMOTE annunciator will turn off, but the LISTEN annunciator will stay illuminated.

Now press any front panel key to verify the front panel keys are enabled.

Status Byte Check

40. Enter Program 1 into the computer. Insert the correct select code and HP-IB address, for your Carrier Noise Test Set, into the SPOLL function. The HP-IB address of the Carrier Noise Test Set is factory preset to 06. The user can select the HP-IB address by changing the position of the HP-IB address switches on the rear panel of the Carrier Noise Test Set. (Refer to Section II paragraph 2-7, HP-IB Address Selection, for further information.)

PROGRAM 1

```
10 A = SPOLL(###)      (### = Current Carrier Noise Test Set select code
20 DISP A              and address.)
30 GOTO 10             Example: 706
                                  7 = Select code
                                  06 = Address
```

This program monitors the status byte of the Carrier Noise Test Set and displays the equivalent decimal value on the computer. The status of the phase lock detector sent out over HP-IB should agree with the phase lock indicator on the front panel. Table 3-2 defines the status bits and their decimal equivalents for the two phase lock conditions.

Table 3-2. Status Bits and Their Decimal Equivalents for Two Phase Lock Conditions

Phase Condition	Status Bits-Binary								Computer Output*
	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1	
unlocked	0	0	0	0	0	1	0	0	4
locked (green Bar)	0	0	0	0	0	0	1	0	2

*If no other bits are logical one.

OPERATOR'S CHECKS

OPERATOR'S CHECKS (cont')

Procedure (cont'd)

41. Set the Carrier Noise Test Set to the phase lock condition (green LED is illuminated on the front panel phase lock display). For help use the phase lock check (steps 19-23).

42. Run Program 1 and compare the number displayed on the computer to the phase condition of the phase lock indicator on the Carrier Noise Test Set. The computer displays a decimal 2 when in the phase lock condition.

43. Increase the frequency of the tunable reference by 1 MHz. Verify that the unlocked condition (red LED adjacent to the left of the green LED) is detected by the microprocessor. A decimal 4 should be displayed on the computer.

    If the number (2 or 4) displayed on the computer does not correspond to the phase lock condition, displayed on the front panel phase lock indicator, perform the phase lock indicator adjustment procedures in Section V. Run Program 1 again to verify the adjustments.

3-7. GENERAL OPERATING INSTRUCTIONS

WARNING

Before the Carrier Noise Test Set 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 Carrier Noise Test Set 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 Carrier Noise Test Set 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 Carrier Noise Test Set performs a quick memory check (ROM and RAM) at turn-on. During this check, all front panel annunciators light for approximately 1.5 seconds to allow a quick visual inspection of each front panel annunciator. If a memory failure is detected the front panel annunciators will not light during the 1.5 second time period.

Following the memory check the Carrier Noise Test Set powers up as follows:

Measurement — ϕ, CW

Band Range — Band 1 (0.010—1.28 GHz)

Lock Bandwidth Factor — 100

NOTE

For the Carrier Noise Test Set to be operational it may require one or both of the following drive signals when making a phase noise measurement:

- *A synthesized 640 MHz signal*
- *A tunable 5 to 1280 MHz signal*

The drive signals can be supplied by an external RF source or the Carrier Noise Test Set can be configured to provide an internally generated 640 MHz signal that can supply the 640 MHz drive signal. The absolute system noise floor will be degraded close-in to the carrier when using the internally generated 640 MHz signal, compared to the 640 MHz signal being supplied by the HP 8662A Synthesized Signal Generator.

When using the Carrier Noise Test Set to make an AM noise measurement none of the drive signals are required.

The number of drive signals required is dependent on the measurement method chosen and the frequency of the signal under test.

The following table lists when the drive signals are required:

Drive Signal	Phase Detector Method		Frequency Discriminator Method	
	Frequency Range of Signal Under Test		Frequency Range of Signal Under Test	
	10 MHz to 1.28 GHz	1.28 GHz to 18 GHz	10 MHz to 1.28 GHz	1.28 GHz to 28 GHz
Fixed 640 MHz	Not needed	X	Not needed	X
Tunable 5—1280 MHz Source	X	X	Not needed	Not needed
X = Drive signal is needed.				

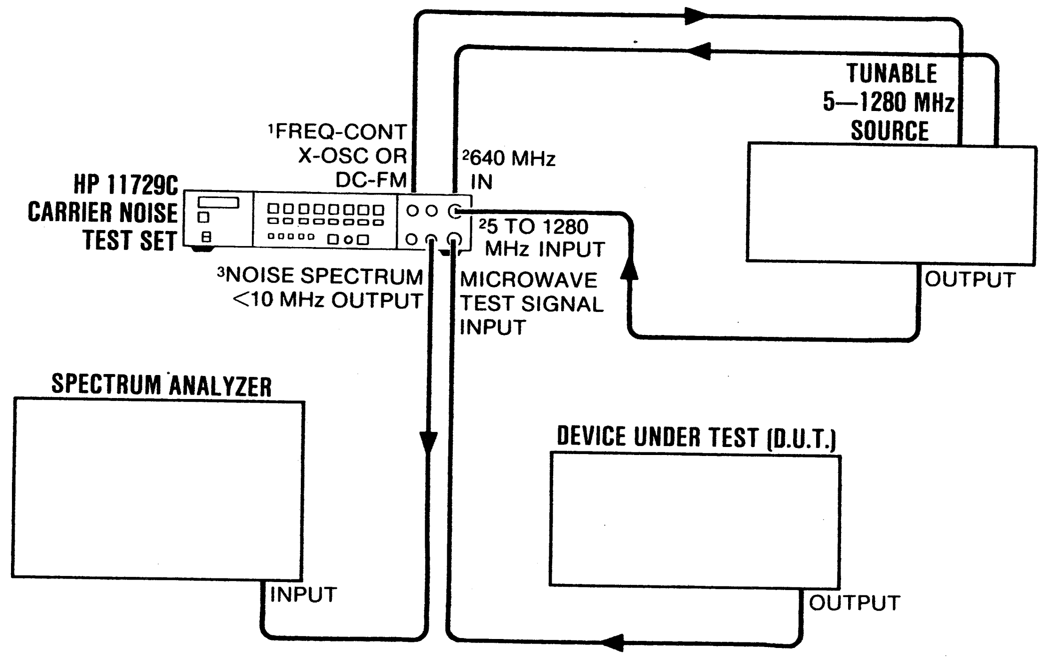
3-9. PHASE NOISE MEASUREMENT

3-10. Phase Detector Method

NOTE

The 640 MHz and 5–1280 MHz signals may come from the following sources:

- *Two synthesized sources.*
- *One synthesized source and one cavity tuned source.*
- *Two cavity tuned sources.*



[1]The FREQ-CONT signal can be connected to the source supplying the 5—1280 MHz signal or the device under test.

[2]Two sources can supply the 640 MHz and 5—1280 MHz signals. For important information see the note at the beginning of paragraph 3-10

[3]The NOISE SPECTRUM, (<1 MHz or <10 MHz) that is connected to the spectrum analyzer, depends on the offset of interest and the input impedance of the spectrum analyzer.

Figure 3-4. Interconnections to the Carrier Noise Test Set when making a Phase Noise Measurement (Using the Phase Detector Method)

Phase Detector Method (cont'd)

Each configuration will have a different absolute system noise floor. The absolute system noise floor is a function of the noise contributions from the 640 MHz signal, 5-1280 MHz signal and the HP 11729C.

To calculate the absolute system noise floor use the following formula:

$$\mathcal{L}_{system} = 10 \log \left(N^2 \times 10^{\frac{\mathcal{L}_1}{10}} + 10^{\frac{\mathcal{L}_2}{10}} + 10^{\frac{\mathcal{L}_3}{10}}\right)$$

where

N = center frequency of selected filter/640 MHz

$\mathcal{L}_1$ = absolute SSB phase noise of the 640 MHz reference signal (dBc/Hz)

$\mathcal{L}_2$ = absolute SSB phase noise of the 5-1280 MHz tunable signal dBc/Hz

$\mathcal{L}_3$ = residual noise of the HP 11729C (dBc/Hz)

Two synthesized sources with their crystal time bases connected externally will give the lowest close in noise floor performance. When a synthesized source and a cavity tuned source are used the 640 MHz signal should come from the synthesized source. A synthesized source is desired for the 640 MHz signal since the 640 MHz signal multiplied to a microwave frequency is the major contributor to the system noise floor. If the cavity tuned source selected has a wide DC-FM bandwidth and Loop Holding Range this will help to phase lock a drifting source. If two cavity tuned sources are used the absolute system noise floor close-in will be degraded but the noise floor further out will be better.

1. Figure 3-4 shows the interconnections to the Carrier Noise Test Set when making a phase noise measurement.

2. Be sure the LINE MODULE, on the rear panel, is set to the available line voltage. If it needs to be changed see Figure 2-1 in Section II.

Phase Detector Method (cont'd)

3. Plug the Carrier Noise Test Set into the available line supply.

4. Turn the Carrier Noise Test Set on and allow a 30 minute warm-up before making any measurements.

5. If the microwave test signal is in the range of 0.010—1.28 GHz go to step 6. If the microwave test signal is greater than 1.28 GHz follow the instructions for step 5.

   Using a coaxial cable connect the synthesized 640 MHz source to the 640 MHz IN connector on the rear panel.

   To configure and use the internal 640 MHz oscillator connect the 640 MHz OUT connector to the 640 MHz IN connector with the cable-attenuator assembly (HP 11729-60096 or HP 11729-60098 [Option 140]) provided. Both connectors are on the rear panel. Be sure to make the connection using the cable-attenuator assembly that was shipped with the Carrier Noise Test Set.

   NOTE

   The absolute system noise floor will be degraded close-in to the carrier when using the internally generated 640 MHz signal, compared to the 640 MHz signal being supplied by the HP 8662A Synthesized Signal Generator.

6. Using a coaxial cable connect the FREQ-CONT X-OSC or FREQ-CONT DC-FM, on the rear panel, to an electronic frequency control port on either the tunable 5—1280 MHz source or the device under test.

   Either FREQ-CONT X-OSC or FREQ-CONT DC-FM can be used to control the voltage controlled oscillator (VCO) of the phase lock loop. The output chosen will depend on the control voltage required for the VCO. FREQ-CONT X-OSC has an output voltage of −10 volts dc to +10 volts dc. FREQ-CONT DC-FM has an output voltage of −1 volt dc to +1 volt dc. When either output is used the device under test and the tunable 5—1280 MHz source will be maintained in phase quadrature (that is, 90 degrees out of phase).

7. Using a coaxial cable connect the tunable 5—1280 MHz source to the 5—1280 MHz IN connector on the front panel. Be sure the tunable 5 to 1280 MHz source is set to 0 dBm.

8. Using a coaxial cable connect the device under test to the MICROWAVE TEST SIGNAL INPUT on the front panel.

9. Using a coaxial cable connect one of the NOISE SPECTRUM OUTPUTS <1 MHz or <10 MHz, on the front panel, to a spectrum analyzer. The <1 MHz OUTPUT is useful for measuring phase noise at offsets from dc to 1 MHz. The <10 MHz OUTPUT is useful for measuring phase noise at offsets from 10 Hz to 10 MHz and has 40dB of gain over the <1 MHz OUTPUT. The <1 MHz OUTPUT has an output impedance of 600Ω and the <10 MHz OUTPUT has an output impedance of 50Ω.

   NOTE

   Do not use the <10 MHz NOISE SPECTRUM OUTPUT for test signals ±20 MHz around the BAND CENTER frequency. High feedthrough signals (mixer sum products and LO signals) saturate the Low Noise Amplifier in the Carrier Noise Test Set and possibly the spectrum analyzer.

   Do not use the <1 MHz NOISE SPECTRUM OUTPUT for test signals ±5 MHz around the BAND CENTER frequency. LO feedthrough may possibly saturate the spectrum analyzer.

   For test signals ±5 MHz to 10 MHz around the BAND CENTER frequency the measured noise level will be 0 dBm to +3 dBm greater than the actual level. The error is caused by an impedance change on the input of the internal Low Noise Amplifier.

   For test signals ±10 MHz to 20 MHz around the BAND CENTER frequency the measured noise level will be 0 dBm to +1 dBm greater than the actual level. Again the error is caused by an impedance change on the input of the Low Noise Amplifier.

   Therefore, the <1 MHz OUTPUT can be used for test signals ±5 MHz to 20 MHz around the BAND CENTER frequency by subtracting the maximum error amount from the measured level.

10. To select a PHASE NOISE MEASUREMENT press the MODE button ,on the front panel, until the LED opposite ϕ, CW is illuminated.

Phase Detector Method (cont'd)

11. Set the LOCK BANDWIDTH FACTOR to 100.

12. Select the BAND RANGE that includes the frequency of the signal under test. For example, if the frequency of the signal under test is 10 GHz then the BAND RANGE would be 8.32—10.88 GHz. Select this filter.

13. Connect the IF OUTPUT, on the front panel, to a spectrum analyzer.

NOTE

Present at the IF OUTPUT will be the IF signal (signal under test minus the BAND CENTER frequency of the BAND RANGE chosen), IF harmonics and spurious signals. The signal with the highest amplitude is the desired signal.

Adjust the spectrum analyzer to determine the frequency of the IF OUTPUT (signal under test minus the BAND CENTER frequency of the BAND RANGE chosen). Set the tunable 5—1280 MHz source to the frequency read on the spectrum analyzer. Disconnect the IF OUTPUT from the spectrum analyzer.

NOTE

The following applys to those users with an IF signal of 625 MHz to 655 MHz.

IF signals between 625 MHz to 655 MHz cause a high level spur from one or both of the NOISE SPECTRUM OUTPUTS. When setting the reference level on the spectrum analyzer, during calibration, use the beat note and not the high level spur. The high level spur is a mixer product from the 640 MHz rear panel input and the 5-1280 MHz front panel input. The spur is within the passband of the NOISE SPECTRUM OUTPUT, so it does not get filtered out.

For example: with a 635 MHz IF signal you can expect a 5 MHz high level spur from the <10 MHz OUTPUT.

14. **Calibration.** At calibration a reference level is being set on the spectrum analyzer. The Carrier Noise Test Set's effect on a given noise input is being used to set the reference level. Below is an example of how to set the reference level on the spectrum analyzer for making a phase noise measurement:

a. Increase the tunable 5—1280 MHz source by 50 kHz. This will produce a 50 kHz beat note at the NOISE SPECTRUM OUTPUTS. This 50 kHz offset is given as an example only. A different offset may be required because of the frequency range of the spectrum analyzer or to make it easier to calibrate with a fast drifting source.

b. Add 40 dB of attenuation to the tunable 5—1280 MHz signal.

CAUTION

Do not set the attenuation any higher than −30 dBm. −30 dBm or lower is necessary for a linear calibration.

c. Adjust the spectrum analyzer so the 50 kHz beat note is on the screen and placed at a convenient reference point. Record the level of the reference point for use later.

d. This reference point represents the power in the carrier minus 40 dB.

e. Remove the 50 kHz offset and 40 dB of attenuation from the tunable 5—1280 MHz signal.

f. The spectrum analyzer is now ready to be used for making a measurement.

15. **Phase Locking.** The following discussion describes two methods for phase locking the device under test and the tunable 5—1280 MHz source.

When the device under test is a synthesized or very stable source, phase locking can be accomplished using either the FREQ-CONT X-OSC or FREQ-CONT DC-FM connector and the following procedure. The FREQ-CONT X-OSC or FREQ-CONT DC-FM connector is connected to the electronic frequency control input of the tunable 5—1280 MHz source or the device under test.

The connector chosen will depend on the tuning voltage required by the loop VCO (device under test or the 5—1280 MHz source).

a. Set the LOCK BANDWIDTH FACTOR to 100.

b. On the front panel press then release CAPTURE.

Phase Detector Method (cont'd)

c. If phase lock is acquired, a green LED will be illuminated in the center of the phase lock indicator, on the left side of the front panel.

d. If the two sources did not phase lock proceed as follows. Connect the <10 MHz OUTPUT, on the front panel, to a spectrum analyzer with a 50 Ohm input impedance and a bandwidth that includes 10 Hz to 10 MHz. Adjust the spectrum analyzer to view the beat note. The beat note is the difference between the tunable 5—1280 MHz signal and the microwave test signal minus the BAND CENTER frequency of the BAND RANGE chosen.

Hold CAPTURE in while tuning the tunable 5—1280 MHz source until a green LED is seen in the center of the phase lock indicator. The frequency resolution of the tunable 5—1280 MHz source should be <1/10 of the effective tuning range of it's crystal oscillator.

Figure 3-5 shows what the spectrum analyzer display should look like if the tunable 5—1280 MHz source is being tuned in the direction of phase lock (that is, towards dc) or tuned away from phase lock. Figure 3-6 shows what the phase lock indicator, on the front panel, should be like as the two sources get closer to phase lock. Release CAPTURE and the two sources should now be phase locked.

e. If the device under test and the tunable 5—1280 MHz source are still not phase locked increase the LOCK BANDWIDTH FACTOR to 1k. Press and release CAPTURE. The two sources should now be phase locked. If phase lock was aquired go to step g. If phase lock was not aquired go to step f.

NOTE

If the HP 8662A is used as the tunable 5-1280 MHz source, and the system is locked using the crystal of the HP 8662A, the 1k LOCK BANDWIDTH FACTOR may cause an unstable phase lock loop for microwave test signals greater than 5 GHz. If the loop is unstable lower the LOCK BANDWIDTH FACTOR to 100. If the loop is still unstable try locking using DC-FM.

f. If the two sources are still not phase locked try locking using a loop VCO with a larger electronic tuning range.

g. Reduce the LOCK BANDWIDTH FACTOR if close-in measurements are desired. Make sure the phase lock indicator remains green or stays within the wide section of the indicator. If lock is broken, hold CAPTURE in while tuning the tunable 5—1280 MHz source until the center green LED is illuminated on the phase lock indicator. When the green LED is illuminated release CAPTURE. If the green LED doesn't stay illuminated increase the LOCK BANDWIDTH FACTOR and press CAPTURE to re-enable lock. For accurate measurements reduce the loop bandwidth to below the lowest offset frequency of interest. Use the following equation to find the maximum loop bandwidth for the offset frequency of interest.

NOTE

Phase noise is suppressed within the phase lock loop bandwidth.

$$\text{Nominal loop bandwidth} = \frac{f_{dut} \times LBF \times K_o}{100} \text{ (Hz)}$$

f = frequency(Hz)
dut = device under test
LBF = LOCK BANDWIDTH FACTOR
K_o = The VCO slope in Hz/volt (For the HP 8662A K_o equals $10^{\epsilon 1}$ Hz/volt)

When the device under test is a free-running source and the loop VCO has a DC-FM feature use the following procedure.

h. Connect the FREQ-CONT X-OSC or FREQ-CONT DC-FM connector to the electronic frequency control input of the loop VCO. The connector used will depend on the tuning voltage required for DC-FM.

Set the loop VCO as follows:

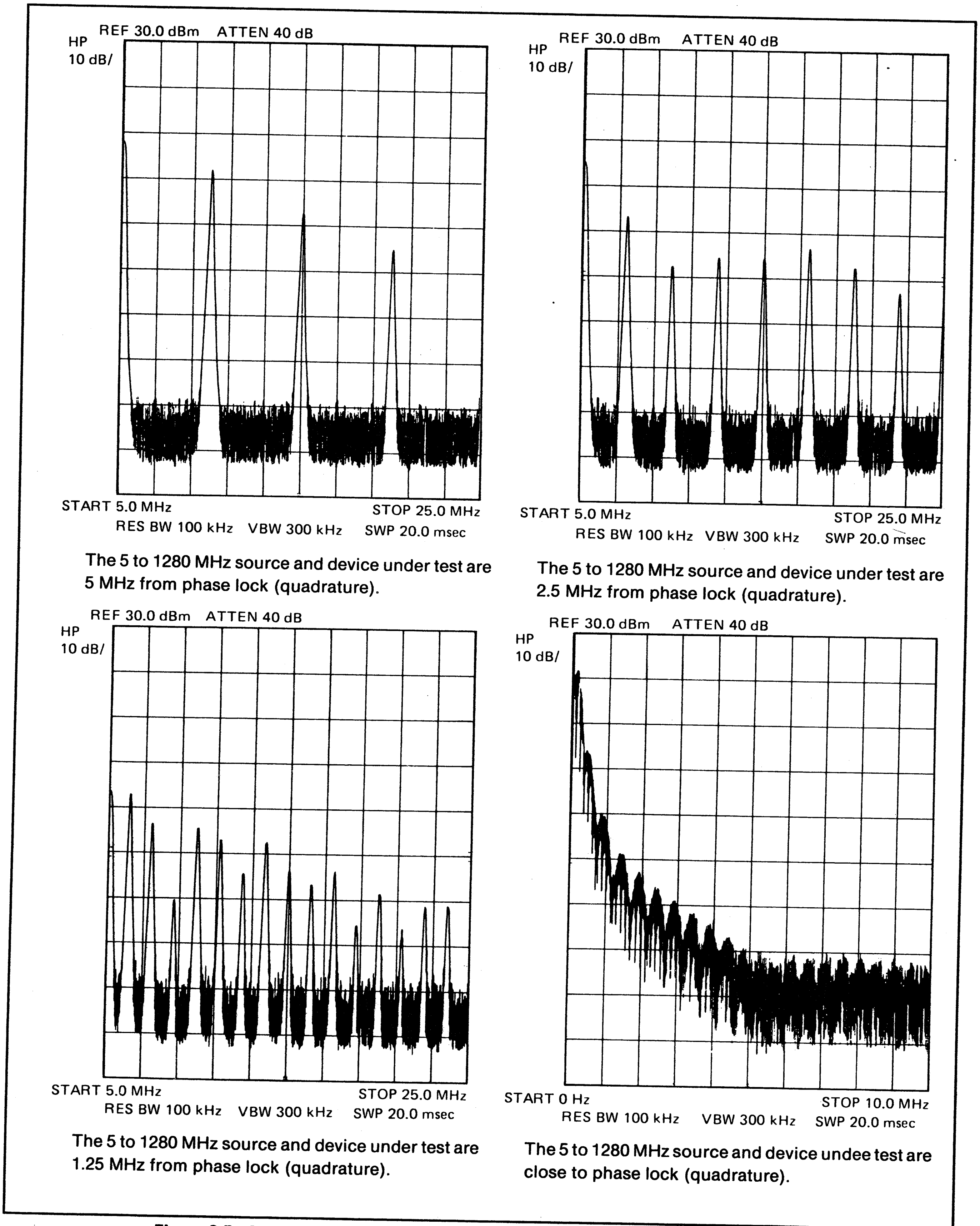
— DC-FM

— 50 kHz deviation

— Set amplitude to 0 dBm

i. Set the LOCK BANDWIDTH FACTOR to 100.

j. Connect the <10 MHz OUTPUT, on the front panel, to a spectrum analyzer with a 50 Ohm input impedance and a bandwidth that



The 5 to 1280 MHz source and device under test are 5 MHz from phase lock (quadrature).

The 5 to 1280 MHz source and device under test are 2.5 MHz from phase lock (quadrature).

The 5 to 1280 MHz source and device under test are 1.25 MHz from phase lock (quadrature).

The 5 to 1280 MHz source and device undee test are close to phase lock (quadrature).

Figure 3-5. Spectrum Analyzer Displays Used for Acquiring Phase Lock (Quadrature)

Phase Detector Method (cont'd)

includes 10 Hz to 10 MHz. Adjust the spectrum analyzer to view the beat note. The beat note is the difference between the tunable 5—1280 MHz signal and the microwave test signal minus the BAND CENTER frequency of the BAND RANGE chosen.

Hold CAPTURE in while tuning the loop VCO until a green LED is seen in the center of the phase lock indicator. The frequency resolution of the loop VCO should be <1/10 of the effective tuning range of it's crystal oscillator.

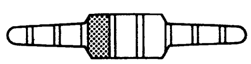
Figure 3-5 shows what the spectrum analyzer display should look like if the loop VCO is being tuned in the direction of phase lock (that is, towards dc) or tuned away from phase lock. Figure 3-6 shows what the phase lock indicator, on the front panel, should be like as the two sources get closer to phase lock. Release CAPTURE and the two sources should now be phase locked.

If the sources drift out of phase lock repeat the procedure, then after releasing CAPTURE immediately increase the FM deviation to 100 kHz. Again be sure the two sources stay phase locked.

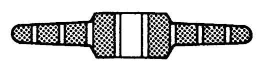
k. If the two sources are still not phase locked repeat the preceeding step, each time increasing the FM deviation until maximum deviation is reached. If maximum deviation is reached and the two sources still will not stay locked, repeat step j but this time increase the LOCK BANDWIDTH FACTOR until the two sources are phase locked. When the two sources are phase locked go to step m.

l. If the two sources are still not locked try making the measurement using the Frequency Discriminator Method.

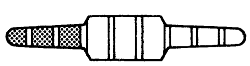
m. Reduce the LOCK BANDWIDTH FACTOR if close-in measurements are desired. Make sure the phase lock indicator remains green or stays within the wide section of the indicator.



A solid red bar, to the left of the center green bar, indicates the signal under test and the tunable 5—1280 MHz signal are not phase locked and >100 kHz apart.



With the display all illuminated the signal under test and the tunable 5—1280MHz signal are <100 kHz apart.



The red LEDs, within the display, step one at a time as the signal under test and the tunable 5—1280 MHz signal approach quadrature.

A green LED in the center of the display indicates that the signal under test and the tunable 5—1280 MHz signal are in quadrature.

Figure 3-6. Front Panel Phase Lock (Quadrature) Indicator

Phase Detector Method (cont'd)

If lock is broken, hold CAPTURE in while tuning the tunable 5—1280 MHz source until the center green LED is illuminated on the phase lock indicator. When the green LED is illuminated release CAPTURE. If the green LED doesn't stay illuminated increase the LOCK BANDWIDTH FACTOR and press CAPTURE to re-enable lock. For accurate measurements reduce the loop bandwidth to below the lowest offset frequency of interest. Use the following equation to find the maximum loop bandwidth for the offset frequency of interest.

NOTE

Phase noise is suppressed within the phase lock loop bandwidth.

$$\text{Nominal loop bandwidth} = \frac{f_{dut} \times LBF \times K_o}{100}$$

f = Frequency (Hz)
dut = Device under test
LBF = Lock Bandwidth Factor
K_o = The VCO slope in Hz/volt (For the HP 8662A K_o equals 10^{-1} Hz/volt)

16. **Measurement.** With the spectrum analyzer calibrated and phase lock acquired, a phase noise measurement may now be made. When making a phase noise measurement the following items must be taken into consideration:

— Set the spectrum analyzer span to cover the offset frequency of interest.

— Do not change the input sensitivity of the spectrum analyzer. Changing the spectrum analyzer input sensitivity between calibration and measurement decreases the measurement accuracy. For better accuracy recalibrate on a lower level calibration signal. See step 14 of this procedure.

— Select an appropriate resolution bandwidth for the the chosen frequency span (at least <1/10 frequency span).

— Because phase noise is a random quantity, some sort of averaging or video filtering is desired.

— In general, it is not advisable to take measurements on a portion of the spectrum analyzer display where the noise level is falling very rapidly (>20 dB per major division). Therefore, increase the frequency span to where the offset frequency of interest is in the center of the spectrum analyzer display.

— It is not recommended to measure noise levels that are in the bottom 10 dB of the display.

— In general, if spurious signals are seen when making a measurement they can be disregarded. Reduce the resolution bandwidth if necessary to determine the noise level near the spur. Be careful not to measure on a spur.

— With the preceeding considerations in mind, a measurement can now be made. Measure down from the reference point (step 14 c.) at the offset of interest.

17. **Corrections**[1]. Subtract the reference level set during calibration from the level of the noise measured at the offset of interest. Sum this value and the following correction factors.

— Minus 40 dB for the attenuation added during calibration.

— Minus 6 dB for conversion to $\mathcal{L}(f)$.

— Minus 10 log(1.2 x spectrum analyzer resolution bandwidth). This is for normalization to a 1 Hz noise equivalent bandwidth. The result is in dB.

— Plus 2.5 dB is the correction for log amplifiers and peak detectors used in an analog spectrum analyzer.

— Plus loop noise suppression[2] at the appropriate offset frequency. Only add loop noise suppression when making a measurement inside the loop bandwidth.

Below is an example of how to calculate the correct amount of phase noise:

−67 dBm = measured phase noise.
−10 dBm = reference level set during calibration.
−40 dB = attenuation added during calibration.

[1] For a complete explanation of the correction factors see Appendix A.

[2] See Appendix B to determine the phase lock loop transfer characteristic and the amount of loop noise suppression.

Phase Detector Method (cont'd)

−6 dB = $\mathcal{L}$(f) conversion factor

−20.8 dB = 10 log (1.2 x spectrum analyzer resolution bandwidth).

+2.5 dB = if an analog spectrum analyzer is used.

+20 dB = for loop noise suppression if the measurement is made within the loop bandwidth.

$-67 \text{ dBm} - (-10 \text{ dBm}) + (-40 \text{ dB}) + (-6 \text{ dB}) + (-20.8 \text{ dB}) + (2.5 \text{ dB}) + (20 \text{ dB}) = -101.3 \text{ dBc/Hz}$

The actual amount of phase would then be −101.3dBc/Hz.

After applying these correction factors the actual amount of phase noise is known for the particular frequency offset.

3-11. Frequency Discriminator Method

1. Figure 3-7 shows interconnections to the Carrier Noise Test Set when making a phase noise measurement.
2. Be sure the LINE MODULE on the rear panel is set to the available line voltage. If it needs to be changed see Figure 2-1 in Section II.
3. Plug the Carrier Noise Test Set into the available line supply.
4. Turn the Carrier Noise Test Set on and allow a 30 minute warm-up before making any measurements.
5. If the microwave test signal is from 0.010—1.28 GHz go to step 6. If the microwave test signal is greater than 1.28 GHz follow the instructions for step 5.

   Using a coaxial cable connect a 640 MHz source to the 640 MHz IN connector on the rear panel.

   To configure and use the internal 640 MHz oscillator connect the 640 MHz OUT connector to the 640 MHz IN connector with the cable-attenuator assembly (HP 11729-60096 or HP 11729-60098 [Option 140]) provided. Both connectors are on the rear panel. Be sure to make the connection using the cable-attenuator assembly that was shipped with the Carrier Noise Test Set.

NOTE

The absolute system noise floor will be degraded close-in to the carrier when using the internally generated 640 MHz signal compared to the 640 MHz sig-

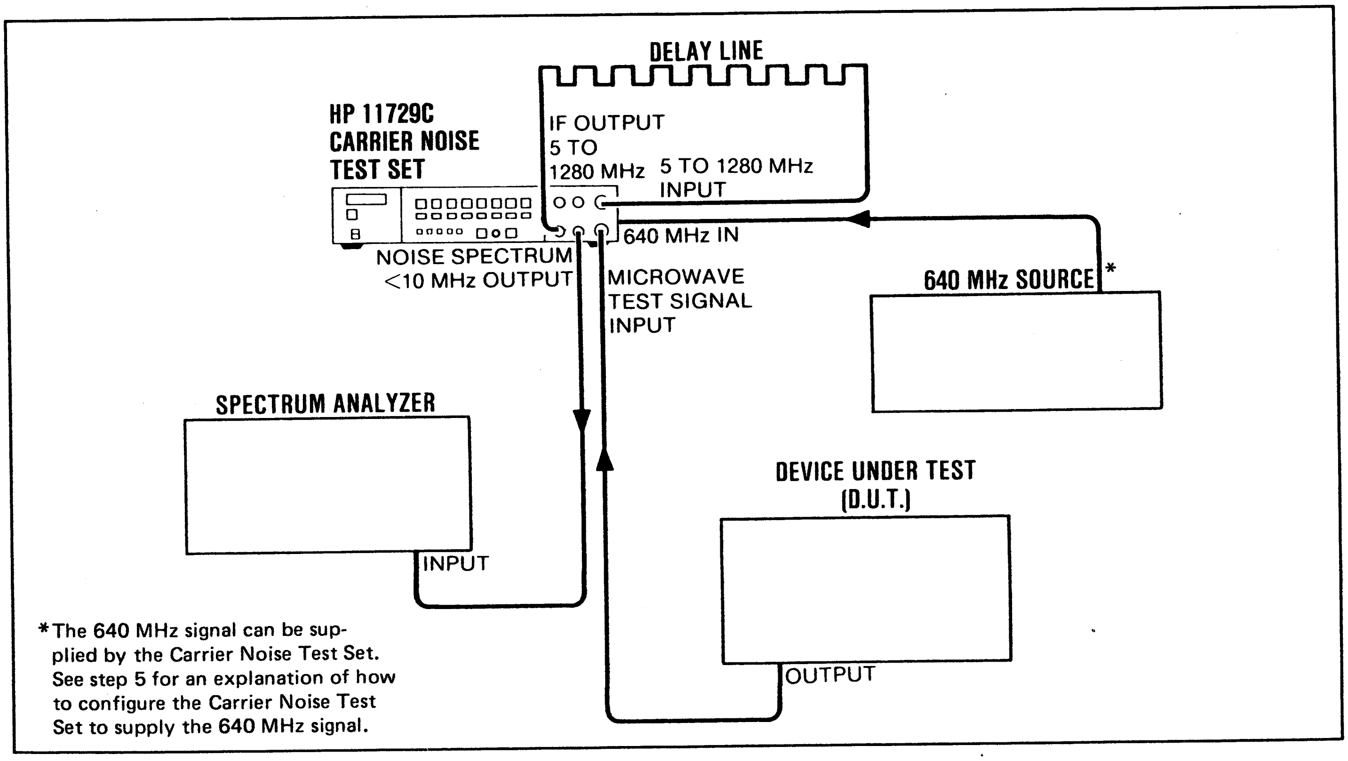


Figure 3-7. Interconnections to the Carrier Noise Test Set When Making a Phase Noise Measurement (Using the Frequency Discriminator Method)

Frequency Discriminator Method (cont'd)

nal being supplied by the HP 8662A Synthesized Signal Generator.

6. Using a coaxial cable connect the device under test to the MICROWAVE TEST SIGNAL INPUT connector on the front panel.
7. Connect the IF OUTPUT, on the front panel, to a spectrum analyzer.
8. To select a PHASE NOISE MEASUREMENT press the MODE button, on the front panel, until the LED opposite ϕ, CW is illuminated.
9. Select the BAND RANGE that includes the frequency of the signal under test. For example, if the frequency of the signal under test is 10 GHz then the BAND RANGE would be 8.32-10.88 GHz. Select this filter.
10. The LOCK BANDWIDTH FACTOR can be at any setting.
11. Using a spectrum analyzer determine the frequency at the IF OUTPUT (signal under test minus the BAND CENTER frequency of the BAND RANGE chosen).

NOTE

A number of signals will be present at the IF OUTPUT. The signals present will include the IF signal (signal under test minus the BAND CENTER frequency of the BAND RANGE chosen), IF harmonics and spurious signals. The signal with the highest amplitude is the desired signal.

Note the frequency for use later. Disconnect the IF OUTPUT from the spectrum analyzer.

12. Connect a suitable delay line (such as a length of flexible RF cable) between the IF OUTPUT and the 5—1280 MHz INPUT, on the front panel. The length of delay line effects the sensitivity of the descriminator. In general, sensitivity increases with cable length. 1.5 ns/foot is the approximate amount of delay for flexible RF cable when the cable dielectric is Teflon.
13. Set the tunable 5—1280 MHz source to the following conditions:

    Frequency: Same as measured in step 11.

    Amplitude: −10 dBm

    Modulation: FM 1 kHz rate
14. Connect the tunable 5—1280 MHz signal to the input of the spectrum analyzer.
15. Set the FM sidebands on the tunable 5—1280 MHz signal to a convenient carrier to sideband ratio. The ratio should be at least 20 dB at a 0.2 kHz rate. Note the difference between the carrier and sidebands for use later.
16. Disconnect the device under test from the Carrier Noise Test Set and the tunable 5—1280 MHz source from the spectrum analyzer. Connect the tunable 5 to 1280 MHz source to the MICROWAVE TEST SIGNAL INPUT connector on the Carrier Noise Test Set. Enable the 0.010—1.28 GHz BAND RANGE.
17. Connect the <10 MHz OUTPUT, on the Carrier Noise Test Set front panel, to the spectrum analyzer.

NOTE

Do not use the <10 MHz NOISE SPECTRUM OUTPUT for test signals ±20 MHz around the BAND CENTER frequency. High feedthrough signals (mixer sum products and LO signals) saturate the Low Noise Amplifier in the Carrier Noise Test Set and possibly the spectrum analyzer.

Do not use the <1 MHz NOISE SPECTRUM OUTPUT for test signals ±5 MHz around the BAND CENTER frequency. LO feedthrough may possibly saturate the spectrum analyzer.

For test signals ±5 MHz to 10 MHz around the BAND CENTER frequency the measured noise level will be 0 dBm to +3 dBm greater than the actual level. The error is caused by an impedance change on the input of the internal Low Noise Amplifier.

For test signals ±10 MHz to 20 MHz around the BAND CENTER frequency the measured noise level will be 0 dBm to +1 dBm greater than the actual level. Again the error is caused by an impedance change on the input of the Low Noise Amplifier.

Therefore, the <1 MHz OUTPUT can be used for test signals ±5 MHz to 20 MHz around the BAND CENTER frequency by subtracting the maximum error amount from the measured level.

Frequency Discriminator Method (cont'd)

18. Increase or decrease the frequency of the tunable 5—1280 MHz source until a green LED is seen in the center of the phase lock indicator on the Carrier Noise Test Set. The frequency resolution of the tunable 5—1280 MHz source should be <1/10 of $1/\tau_d$. τ_d is the time delay caused by the cable connected from the IF OUTPUT to the 5—1280 MHz IN. Once quadrature is established adjust the spectrum analyzer to position the 1 kHz FM sideband at the top line on the spectrum analyzer. Note the level of the 1 kHz sideband for use later.

19. Disconnect the tunable 5—1280 MHz source from the Carrier Noise Test Set. Connect the device under test to the MICROWAVE TEST SIGNAL INPUT connector on the Carrier Noise Test Set. Select the proper BAND RANGE for the frequency of the signal under test.

20. Increase or decrease the length of the delay line or the frequency of the device under test to establish quadrature. The frequency resolution of the device under test should be <1/10 of $1/\tau_d$. When quadrature is set a green LED will be illuminated in the center of the phase lock indicator on the Carrier Noise Test Set.

21. **Measurement.** With calibration completed a measurement can now be made. When making a phase noise measurement the following items must be taken into consideration:

    — The operator should be aware that voltage fluctuations caused by frequency fluctuations are being measured. Phase fluctuations are not being measured.

    — Set the spectrum analyzer span to cover the offset frequency of interest.

    — Do not change the input sensitivity of the spectrum analyzer. Changing the spectrum analyzer input sensitivity between calibration and measurement decreases the measurement accuracy. For better accuracy recalibrate on a lower level calibration signal. See steps 14—18 to recalibrate.

    — Select a resolution bandwidth that is appropriate for the chosen frequency span (at least <1/10 frequency span).

    — Because phase noise is a random quantity, some sort of averaging or video filtering is desired.

    — In general, it is not advisable to take measurements on a portion of the spectrum analyzer display where the noise level is falling very rapidly (>20 dB per major division). Therefore, increase the frequency span to where the offset frequency of interest is in the center of the spectrum analyzer display.

    — It is not recommended to measure noise levels that are in the bottom 10 dB of the display.

    — In general, if spurious signals are seen when making a measurement they can be disregarded. If necessary, reduce the resolution bandwidth to determine the noise level close to the spur.

    — With the preceding considerations in mind, a measurement can now be made. Measure down from the reference point (step 18) at the offset of interest.

22. **Corrections**[1]. Subtract the reference level set in step 18 from the measured level. Sum this result with the following correction factors:

    — Minus the carrier to sideband ratio set in step 15.

    — Minus 20 log (f_{off}/1 kHz) dB. This formula will convert frequency fluctuations at any offset to $\mathcal{L}(f)$ dBc. $\mathcal{L}(f)$ dBc = 10 log Pssb/Ps where Pssb is the power density (in one phase modulation sideband) and Ps is the total signal power.

    — Minus 10 log (1.2 x spectrum analyzer reslution bandwidth). This is for normalization to a 1 Hz noise equivalent bandwidth. The result is in dB.

    — Plus 2.5 dB is the correction for log amplifiers and peak detectors used in an analog spectrum analyzer.

    Below is an example of how to calculate the correct amount of phase noise:

    −67 dBm = measured phase noise.

    −10 dBm = reference level set during calibration.

    −20 dB = carrier to sideband ratio set in step 15.

    −10 dB = 20 log (f_{off}/1 kHz) db. This formula is used to convert frequency fluctuations at any offset to $\mathcal{L}(f)$ dBc.

[1]For a complete explanation of the correction factors see Appendix A.

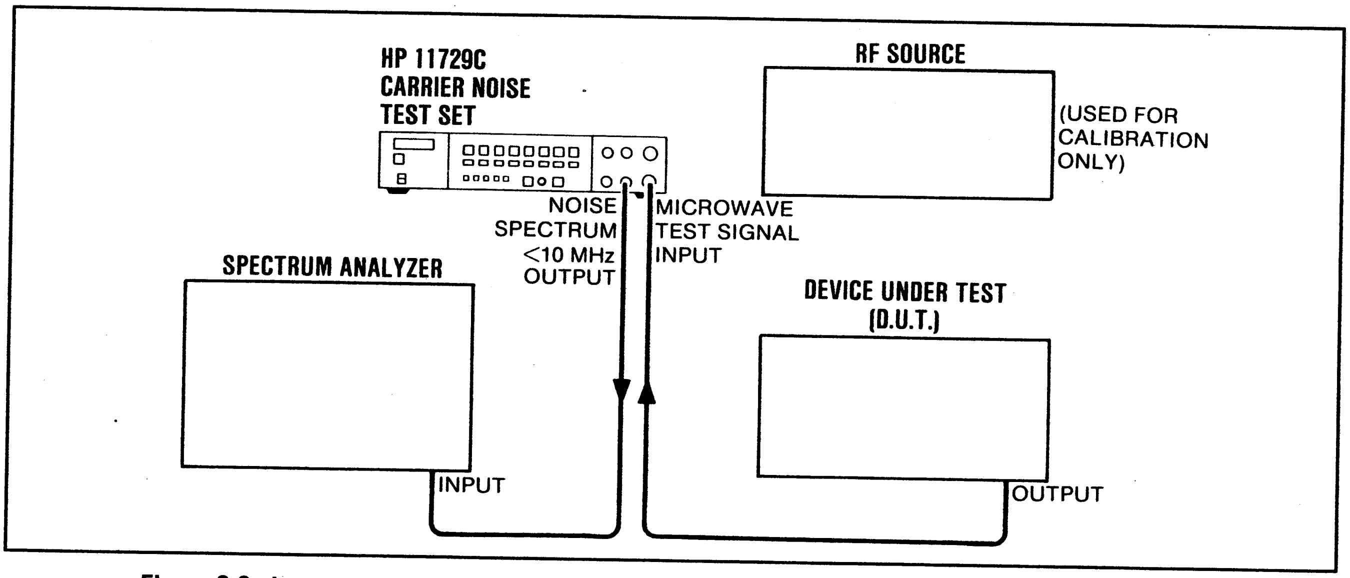


Figure 3-8. Interconnections to the Carrier Noise Test Set When Making an AM Noise Measurement

Frequency Discriminator Method (cont'd)

−20.8 dB = 10 log (1.2 x spectrum analyzer resolution bandwidth).

+2.5 dB = if an analog spectrum analyzer is used.

−67 dBm − (−10 dBm) + (−20 dB) + (−10 dB) + (−20.8 dB) + (2.5 dB) = −105.3 dBc/Hz

The actual amount of phase would then be −105.3 dBc/Hz.

After applying these correction factors the actual amount of phase noise will be known at a particular offset, provided the sensitivity, set-up with the delay line, is lower than the phase noise of the device under test.

3-12. AM Measurement (Option 130 only)

1. Figure 3-8 shows interconnections to the Carrier Noise Test Set when making an AM noise measurement.
2. Be sure the LINE MODULE on the rear panel is set to the available line voltage. If it needs to be changed see Figure 2-1 in Section II.
3. Plug the Carrier Noise Test Set into the available line supply.
4. Turn the Carrier Noise Test Set on and allow a 30 minute warm-up before making any measurements.
5. Set the device under test to the frequency of interest. Measure the power out of the device under test with a power meter. Note the power level for use later.
6. Set the RF source to 1 GHz.
7. Set the power of the RF source to the same power as that measured in step 5. Use a power meter to measure the power.
8. Connect the RF source to a spectrum analyzer. Set the displayed RF source to a convenient reference point on the spectrum analyzer.
9. Amplitude modulate the RF source at a 1 kHz rate. Adjust the AM level so the AM sidebands are −40 dBc.

NOTE

If the RF source is a non-synthesized source the modulating rate may have to be increased. This is so the AM sidebands can be seen on the spectrum analyzer display.

10. Press the MODE button, on the front panel of the Carrier Noise Test Set, until the LED next to AM, CW is illuminated. No other Carrier Noise Test Set front panel functions are used.
11. Disconnect the RF source from the spectrum analyzer. Connect the RF source to the MICROWAVE TEST SIGNAL INPUT connector on the front panel of the Carrier Noise Test Set.
12. Connect the <10 MHz OUTPUT, on the front panel of the Carrier Noise Test Set, to the spectrum analyzer.

AM Measurements (Option 130 only) (cont'd)

13. Set a reference point with the demodulated 1 kHz signal on the spectrum analyzer. Note the reference level for use later.

14. Disconnect the RF source from the Carrier Noise Test Set. Connect the device under test to the MICROWAVE TEST SIGNAL INPUT connector on the front panel of the Carrier Noise Test Set.

15. **Measurement.** With calibration completed a measurement can now be made. When making an AM measurement the following items must be taken into consideration:

    — Set the spectrum analyzer span to cover the offset frequency of interest.

    — Do not change the input sensitivity of the spectrum analyzer. Changing the spectrum analyzer input sensitivity between calibration and measurement decreases the measurement accuracy. For better accuracy recalibrate on a lower level calibration signal. Use steps 5—13 to recalibrate the spectrum analyzer.

    — Select a resolution bandwidth that is appropriate for the chosen frequency span (at least <1/10 frequency span).

    — Because AM noise is a random quantity, some sort of averaging or video filtering is desired.

    — In general, it is not advisable to take measurements on a portion of the spectrum analyzer display where the noise level is falling very rapidly (>20 dB per major division). Therefore, increase the frequency span to where the offset frequency of interest is in the center of the spectrum analyzer display.

    — It is not recommended to measure noise levels that are in the bottom 10 dB of the display.

    — In general, if spurious signals are seen when making a measurement they can be disregarded. If necessary, reduce the resolution bandwidth to determine the noise level close to the spur.

    — A measurement can now be made. Measure down from the reference point set in step 13 at the offset of interest.

16. **Corrections**[1]. Subtract the reference level in step 13 from the measured level. Sum this result with the following correction factors:

    — Minus 40 dB (The carrier to sideband ratio set in step 9)

    — Minus 10 log (1.2 x specturm analyzer resolution bandwidth). This is for normalization to a 1 Hz noise equivalent bandwidth. The result is in dB.

    — Plus 2.5 dB is the correction for log amplifiers and peak detectors used in an analog spectrum analyzer.

    Below is an example of how to calculate the correct amount of AM noise:

    −67 dBm = measured AM noise.

    −10 dBm = reference level set during calibration.

    −40 dB = The carrier to sideband ratio set in step 9.

    −20.8 dB = 10 log (1.2 x spectrum analyzer resolution bandwidth).

    +2.5 dB = if an analog spectrum analyzer is used.

    −67 dBm − (−10 dBm) + (−40 dB) + (−20.8 dB) + (2.5 dB) = −115.3 dBc/Hz

    The actual amount of AM noise would then be −115.3 dBc/Hz.

[1]For a complete explanation of the correction factors see Appendix A.

Table 3-3. HP-IB Message Reference Table (1 of 2)

HP-IB Message	Applicable	Response	Related Commands & Controls	Interface Functions
Data	Yes	All Carrier Noise Test Set functions available in local, except the LINE switch, are bus-programmable.		AH1,SH1, T5, TE0, L3, LE0
Trigger	No	The Carrier Noise Test Set has no trigger capability.		DT0
Clear	Yes	The clear message sets the Carrier Noise Test Set to the following conditions: Filter 1 ON Phase Lock Bandwidth 100 Hz Phase noise measurement Capture OFF	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 Carrier Noise Test Set is addressed to listen. The front-panel REMOTE annunciator lights when the instrument is actually in the remote mode. No instrument settings or functions are changed, but all front-panel keys except LOCAL are disabled.	REN	RL1
Local	Yes	The Carrier Noise Test Set returns to local mode (front-panel control). Responds equally to the GTL bus command and the front-panel LOCAL key. When entering 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 Carrier Noise Test Set to local (front-panel control).	LLO	RL1
Clear Lockout Set Local	Yes	The Carrier Noise Test Set 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.	REN	RL1
Pass Control Take Control	No	The Carrier Noise Test Set has no controller capability.		C0
Require Service (SRQ)	Yes	If the SRQ mask is set (see Table 3-4 HP-IB Program Codes for a description of @) and one of the following conditions is valid, then SRQ will be true. 1) Invalid command 2) System in phase lock 3) System out of phase lock	SRQ	SR1

Table 3-3. HP-IB Message Reference Table (2 of 2)

HP-IB Message	Applicable	Response	Related Commands & Controls	Interface Functions
Status Byte	Yes	The Carrier Noise Test Set 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: 1) Removing the causing condition, and 2) reading the Status Byte.	SPE,	T5, TE0
Status Bit	Yes	The status bit is used in a parallel poll, when enabled, and the SRQ line is true. The status bit position and the sense of the status bit (true high or true low) is set by the computer, with the parallel poll configure message.	PPE, PPD, PPC, PPU	PP1
Abort	Yes	The Carrier Noise Test Set stops talking and listening.	IFC	T5, TE0, L3, LE0

Complete HP-IB compatibility as defined in IEEE Standard 488 (and the identical ANSI Standard MC1.1) is: SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT0, C0.

Table 3-4. HP-IB Program Codes (Alphabetical Order by Code)

Program Code	Parameter
AM	AM noise measurement (Option 130 only)
@	Causes the Carrier Noise Test Set to accept the next data byte as a binary mask for the status byte. For example: A B C SRQ Mask [X X X X X 1 1 1 1] X = Don't care When position A is set to 1 and the corresponding bit in the status byte becomes 1, then RQS in the status byte and the SRQ line will be 1. Under the preceding condition a serial poll of the status byte will indicate that phase lock has been broken. When position B is set to 1 and the corresponding bit in the status byte becomes 1, then RQS in the status byte and the SRQ line will be 1. Under the preceding condition a serial poll of the status byte will indicate phase lock. When position C is set to 1 and the corresponding bit in the status byte becomes 1, then RQS in the status byte and the SRQ line will be 1. Under the preceding condition a serial poll of the status byte will indicate an invalid command has been received.
CA	CA1 = Capture active CA0 = Capture inactive
CS	Forces RQS and invalid command bit to zero in the status byte.
FT	Filter Bands 1 = FT1 7 = FT7 2 = FT2 8 = FT8 3 = FT3 9 = FT9 4 = FT4 10 = FT10 5 = FT5 11 = FT11 6 = FT6
LK	Phase Lock Range 1 Hz (1) = LK1 10 Hz (2) = LK2 100 Hz (3) = LK3 1 kHz (4) = LK4 10 kHz (5) = LK5
LP	When addressed to talk the Carrier Noise Test Set will send the current front panel settings in ASCII mnemonic string.
PH	Phase noise measurement
PU	Pulse measurement
?ID	When addressed to talk the Carrier Noise Test Set will send an ASCII string which contains the model number of the instrument and software revision number.
RM	When addressed to talk the Carrier Noise Test Set will send a single byte which is the binary pattern of the SRQ.
RO	When addressed to talk the Carrier Noise Test Set will send the ASCII mnemonics of the options installed.

Table 3-5. Allowable HP-IB Address Codes

Address Switches[1]					Listen Address Character	Talk Address Character	Decimal Equivalent[1]
A5	A4	A3	A2	A1			
0	0	0	0	0	SP	@	0
0	0	0	0	1	!	A	1
0	0	0	1	0	"	B	2
0	0	0	1	1	#	C	3
0	0	1	0	0	$	D	4
0	0	1	0	1	%	E	5
0	0	1	1	0	&	F	6 [2]
0	0	1	1	1	'	G	7
0	1	0	0	0	(	H	8
0	1	0	0	1	)	I	9
0	1	0	1	0	*	J	10
0	1	0	1	1	+	K	11
0	1	1	0	0	,	L	12
0	1	1	0	1	–	M	13
0	1	1	1	0	.	N	14
0	1	1	1	1	/	O	15
1	0	0	0	0	0	P	16
1	0	0	0	1	1	Q	17
1	0	0	1	0	2	R	18
1	0	0	1	1	3	S	19
1	0	1	0	0	4	T	20
1	0	1	0	1	5	U	21
1	0	1	1	0	6	V	22
1	0	1	1	1	7	W	23
1	1	0	0	0	8	X	24
1	1	0	0	1	9	Y	25
1	1	0	1	0	:	Z	26
1	1	0	1	1	;	[	27
1	1	1	0	0	<	\	28
1	1	1	0	1	=	]	29
1	1	1	1	0	>		30

[1]Decimal characters and the five address switches relate to the last five bits of both talk and listen addresses.

[2]Factory-set address.

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. A simpler operational test is included in Section III under Basic Functional Checks.

NOTE

A 30 minute warm-up period is required before any tests are performed.

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 1-4, 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.

PERFORMANCE TESTS

4-5. MEASUREMENT FREQUENCY RANGE, IF OUTPUT BANDWIDTH AND LEVEL PEFORMANCE TESTS

Specifications

Electrical Characteristics	Performance Limits	Conditions
TEST SIGNAL		
Frequency Range[1]	10 MHz to 18 GHz	External low-pass filtering may be required for test signals <20 MHz and ±20 MHz around band centers.
Band Center Frequencies	1.92 GHz 4.48 GHz 7.04 GHz 9.60 GHz 12.16 GHz 14.72 GHz 17.48 GHz	
IF OUTPUT		
Bandwidth	5 MHz to 1280 MHz	
Level	+7 dBm Minimum	

[1]Frequency range covered in eight bands, excluding ±5 MHz around band center frequencies.

PERFORMANCE TESTS

MEASUREMENT FREQUENCY RANGE, IF OUTPUT BANDWIDTH AND LEVEL PERFORMANCE TEST (cont'd)

Description

This test verifies the frequency range of the Carrier Noise Test Set. A microwave test signal is input to the Carrier Noise Test Set for each BAND RANGE; then the down converted IF OUTPUT is measured on a spectrum analyzer. The IF OUTPUT level is verified to be within specified limits for each band.

Equipment

Microwave Synthesized Source ...... HP 8340A
RF Spectrum Analyzer .... HP 8566B
RF Synthesized
Signal Generator .... HP 8662A

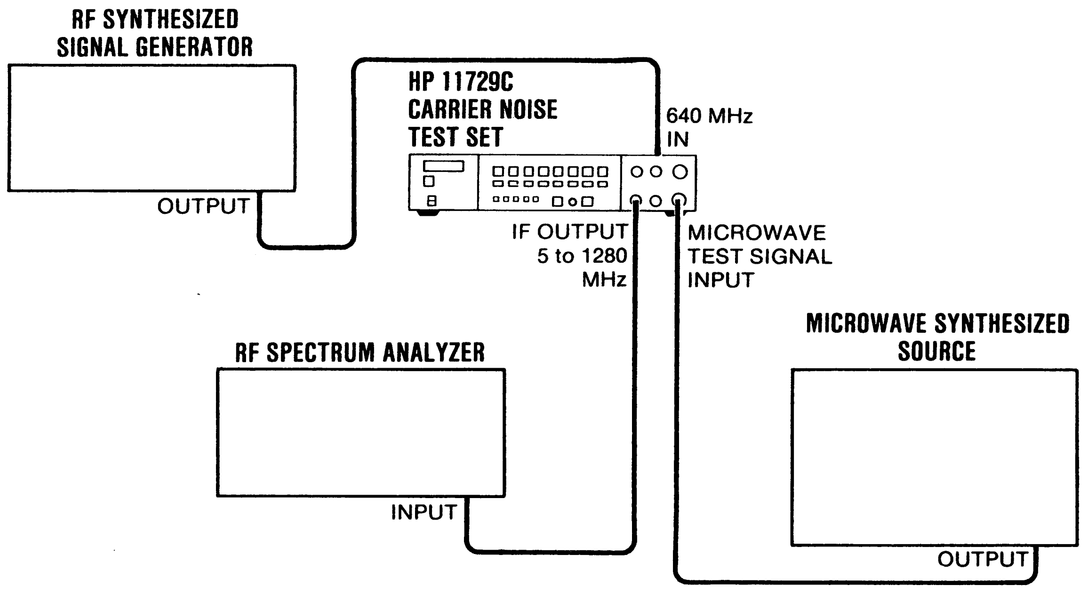


Figure 4-1. Measurement Frequency Range, and IF Output Bandwidth and Level Test Set-up

Procedure

1. Connect the test set up shown in Figure 4-1.
2. Set the Carrier Noise Test Set as follows:
   Band Center Frequency .... 1.92 GHz

   NOTE

   If the unit does not contain a filter with this band center frequency, select the next available band listed in column 2 of Table 4-1.

3. Set the Microwave Synthesized Source (D.U.T.) as follows:
   Frequency .... 2.32 GHz
   Amplitude .... +10 dBm

   NOTE

   The frequency corresponds to the microwave test signal shown in Table 4-1 for the band center frequency selected in step 2.

PERFORMANCE TESTS

MEASUREMENT FREQUENCY RANGE, IF OUTPUT BANDWIDTH AND LEVEL PERFORMANCE TESTS (cont'd)

Procedure (cont'd)

4. Adjust the RF spectrum analyzer to display the 400 MHz IF OUTPUT.

NOTE

The IF OUTPUT will have the following signals:

- The IF signal (the microwave test signal minus the band center of the band range chosen.)

- IF harmonics

- And spurious signals

ALL HARMONICS OF THE IF SIGNAL AND ANY SPURIOUS SIGNALS CAN BE DISREGARDED.

5. Verify the IF OUTPUT level is within the specified limits in Table 4-1 and record the actual value.

6. Adjust the frequency of the D.U.T. to the next microwave test signal frequency listed in column one of Table 4-1. Select the corresponding band center frequency, on the Carrier Noise Test Set, listed in column two. Verify and record the IF OUTPUT power level. Repeat this process for each microwave test signal frequency listed in Table 4-1.

7. If the IF OUTPUT power level did not measure within specified limits, refer to the troubleshooting information on Service Sheet 1.

Table 4-1. IF Output Level

Microwave Test Signal (GHz)	Band Center Frequency (GHz)	IF Output Frequency (MHz)	IF Output Level (dBm)	
		Typical	Minimum	Actual
2.32	1.92	400	+7	______
4.88	4.48	400	+7	______
7.44	7.04	400	+7	______
10.00	9.60	400	+7	______
12.56	12.16	400	+7	______
*14.740	14.72	20	+7	______
*16.00	14.72	1280	+7	______
*17.30	17.28	20	+7	______
*18.56	17.28	1280	+7	______

*Because of the power requirements of the internal mixer, the upper and lower ends of the bands with center frequencies of 14.72 GHz and 17.28 GHz are verified to be within specified limits. The comb generator's output power is lowest at the higher 640 MHz harmonics.

PERFORMANCE TESTS

4-6. RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal less than 1280 MHz)

Specification

Electrical Characteristics	Performance Limits	Conditions
Offset From Carrier	dBc/Hz	With a <1.28 GHz input signal
10 Hz	−115	
100 Hz	−126	
1 kHz	−135	
10 kHz	−142	
100 kHz	−151	
1 MHz	−156	

Description

NOTE

This test does not check the down converting circuitry in the Carrier Noise Test Set. However, the test requires less equipment than the residual phase noise test using a 10 GHz test signal.

The Carrier Noise Test Set's residual phase noise,for test signals <1280 MHz, is verified by connecting a signal generator's RF output to a power splitter. The output of the power splitter supplies the signals for both the MICROWAVE TEST SIGNAL INPUT and the 5—1280 MHz INPUT. Since the microwave test signal and the 5—1280 MHz signal are identical, the phase noise from the signal generator is canceled by the mixer/phase detector in the Carrier Noise Test Set. During the residual phase noise measurement the microwave test signal and the 5—1280 MHz signal must be in phase quadrature (that is,90 degrees out of phase). The difference in the lengths of cables A and B provide a time delay,so at a selected frequency on the signal generator the two inputs will have a 90 degree phase difference. The Carrier Noise Test Set's NOISE SPECTRUM OUTPUTS are measured on a low frequency spectrum analyzer and an RF spectrum analyzer. Correction factors are added and the residual phase noise is verified to be below the specified limit.

Equipment

RF Synthesized Signal Generator .... HP 8662A (Option 003)
Low Frequency Spectrum Analyzer .... HP 3582A
RF Spectrum Analyzer .... HP 8566B
Power Meter .... HP 436A
Power Sensor .... HP 8482A
Power Splitter .... HP 11667A
Coaxial Cable A (9 inches) .... HP 10502A
Coaxial Cable B (24 inches) .... HP 11170B
50Ω Termination .... HP 11593A

NOTE

The specified lengths of cable A and cable B in Figure 4-2 are critical for obtaining phase quadrature.

PERFORMANCE TESTS

RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal less than 1280 MHz) (cont'd)

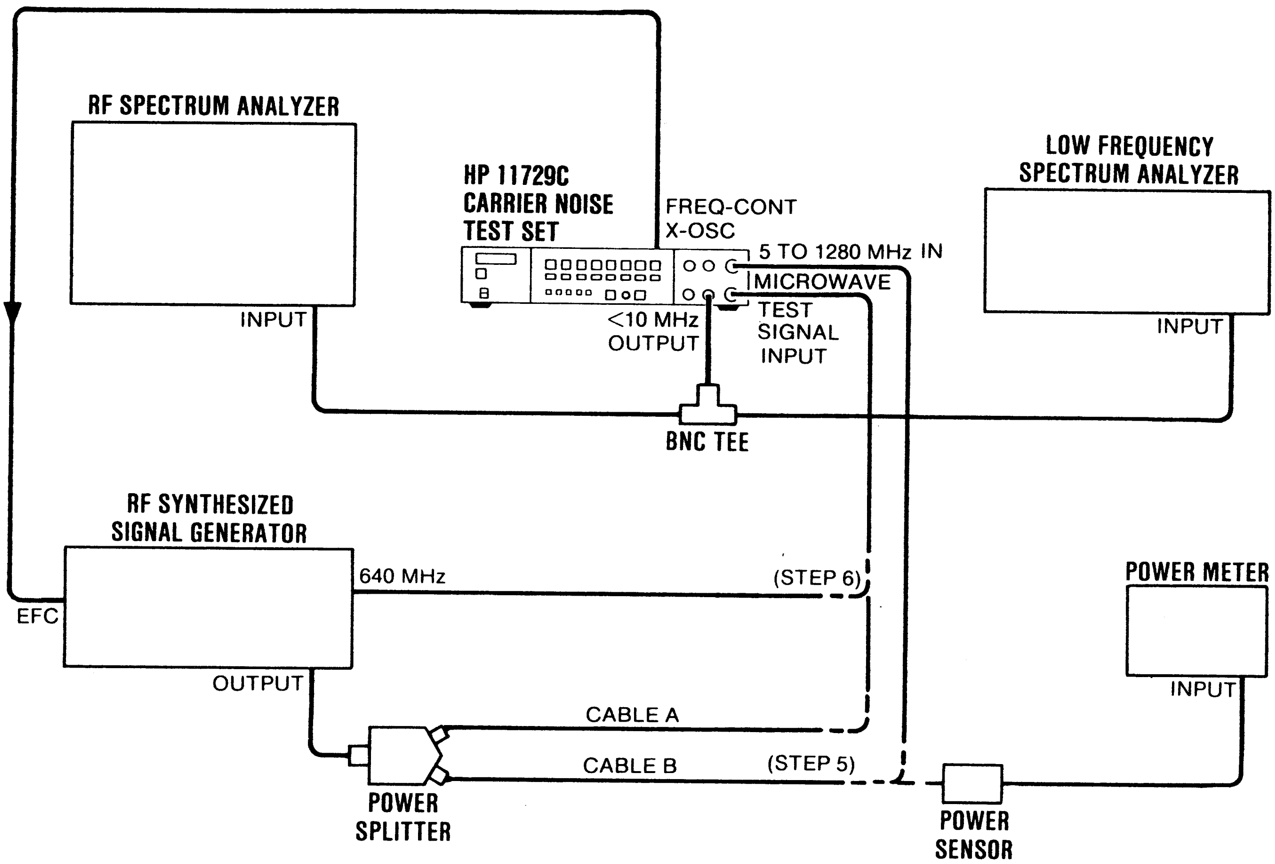


Figure 4-2. Residual Phase Noise Test Setup (Using a test signal of less than 1280 MHz)

Procedure

Calibration

1. Connect the instruments as shown in Figure 4-2.
2. Turn on and warm up all instruments in the test setup for 30 minutes.
3. Set the RF synthesized signal generator (tunable reference) as follows:

   Frequency .... 639.990 MHz
   Amplitude .... 0 dBm

4. Set the Carrier Noise Test Set as follows:

   Band Range .... 0.01 to 1.28 GHz
   Measurement Mode .... ϕ, CW
   Lock Bandwidth Factor .... Any setting

5. Measure the power of the tunable reference signal at the end of cable B and adjust the amplitude of the tunable reference until the power meter reads 0 dBm. Connect cable B to the 5—1280 MHz INPUT on the Carrier Noise Test Set.

PERFORMANCE TESTS

RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal less than 1280 MHz) (cont'd)

Procedure (cont'd)

6. Disconnect cable A from the MICROWAVE TEST SIGNAL INPUT on the Carrier Noise Test Set and terminate cable A with a 50 ohm load. Connect the 640 MHz signal, from the tunable reference rear panel, to the MICROWAVE TEST SIGNAL INPUT, on the front panel,of the Carrier Noise Test Set.
7. Decrease the amplitude of the tunable reference by 50 dB.
8. Adjust the RF spectrum analyzer to display the 10 kHz beat note. (The beat note is the result of mixing the 640 MHz and 639.990 MHz signals). Set the 10 kHz beat note to a convenient reference point.
9. Adjust the low frequency spectrum analyzer to view the 10 kHz beat note. If the spectrum analyzer has selectable filters, select a flat top filter. If RMS averaging is available, select approximately 128 averages. RMS averaging smooths out the noise floor. If RMS averaging is not available the measurement should be made at an average level on the noise floor, not a peak or valley.
10. Set the peak of the 10 kHz beat note to a convenient reference point.
11. Disconnect the 640 MHz signal from the MICROWAVE TEST SIGNAL INPUT on the Carrier Noise Test Set. Disconnect the 50 ohm load from cable A and connect cable A to the MICROWAVE TEST SIGNAL INPUT.

Residual Phase Noise Measurement

12. Increase the amplitude of the tunable reference by 50 dB. Decrease the frequency of the tunable reference, in 1 MHz steps,until phase lock is acquired (green LED is illuminated on the phase lock display). The green LED should be illuminated when the tunable reference is around 425 MHz. For details on phase locking see Section III.
13. Adjust the RF spectrum analyzer to view the noise level at a 10 kHz offset. For the most accurate measurement use the smallest possible resolution bandwidth. Use some averaging to smooth out the noise level. Measure the noise level down from the reference point at 10 kHz. Measure an average noise level, do not measure on a peak or minimum noise level. Record this noise level (A) along with the spectrum analyzer's resolution bandwidth setting (B) below. Repeat the measurement and record for offsets of 100 kHz and 1 MHz.

Offset from carrier	Noise level (A) (relative to reference level) (dB)	Resolution Bandwidth (B) (Hz)
10 kHz	________	________
100 kHz	________	________
1 MHz	________	________

PERFORMANCE TESTS

RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal less than 1280 MHz) (cont'd)

Procedure (cont'd)

14. On the low frequency spectrum analyzer, select a Hanning filter and the normalization to 1 Hz bandwidth (if the spectrum analyzer has these features available). If the spectrum analyzer does not have the normalization to a 1 Hz bandwidth this figure will have to be calculated later using the formula at the end of the test.

NOTE

Power line spurs are not specified for the Carrier Noise Test Set. Power line spurs will appear at power line frequencies and multiples of power line frequencies. Do not make a noise measurement on a spur; make the measurement on an average noise level.

15. Adjust the low frequency spectrum analyzer to view the noise level at a 10 Hz offset. For the most accurate measurement use the smallest possible resolution bandwidth. Use some averaging if required. Measure the noise level down from the reference point at 10 Hz. Measure an average noise level, do not measure on a peak or minimum noise level. Record this noise level (C) in the table below. If the measurement was not made in a 1 Hz resolution bandwidth, also record the spectrum analyzer's resolution bandwidth setting (D) below. Repeat the measurement and record for offsets of 100 Hz and 1 kHz.

Offset from carrier	Noise level (C) (relative to reference level) (dB)	Resolution Bandwidth (D) (Hz)
10 Hz	______________	______________
100 Hz	______________	______________
1 kHz	______________	______________

16. Calculate the Carrier Noise Test Set's residual phase noise at 10 kHz, 100 kHz and 1 MHz offsets from the carrier. Sum the measured noise level (A) and the 4 correction factors as shown below. The normalization bandwidth factor is determined by putting the resolution bandwidth (B) into the equation below. Verify the residual phase noise level did not exceed the specified limit, as shown at the bottom of each column.

[2]For a complete explanation of the correction factors see Appendix A.

PERFORMANCE TESTS

RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal less than 1280 MHz) (cont'd)

Procedure (cont'd)

	10 kHz	100 kHz	1 MHz
Noise level = A (relative to reference level)	______ dB	______ dB	______ dB
Normalization to 1 Hz equivalent noise bandwidth[1] −10 log ("B" x 1.2) =	______ dB	______ dB	______ dB
Calibration Attenuation (Step 7)	−50 dB	−50 dB	−50 dB
$\mathcal{L}$ (f) conversion factor	−6 dB	−6 dB	−6 dB
Correction for log amplifiers and peak detectors in analog spectrum analyzers.	+2.5 dB	+2.5 dB	+2.5 dB
Total (dBc/Hz)	______ <−142	______ <−151	______ <−156

[1]Refer to Application Note 150-4, HP 5952-1147, if additional information on calibration of spectrum analyzers for noise measurements is needed.

17. Calculate the Carrier Noise Test Set's residual phase noise at 10 Hz, 100 Hz and 1 kHz offsets from the carrier. Sum the measured noise level (C) and the 3 correction factors[2] as shown below. Do not add the normalization to 1 Hz equivalent noise bandwidth factor, when using a spectrum analyzer with normalization to a 1 Hz bandwidth. This correction factor is accounted for automatically. Verify the residual phase noise level did not exceed the specified limit as shown at the bottom of each column.

	10 Hz	100 Hz	1 kHz
Noise level = C (relative to reference level)	______ dB	______ dB	______ dB
Normalization to 1 Hz equivalent noise bandwidth[1] −10 log ("B" x 1.2) =	______ dB	______ dB	______ dB
Calibration Attenuation (Step 7)	−50 dB	−50 dB	−50 dB
$\mathcal{L}$ (f) conversion factor	−6 dB	−6 dB	−6 dB
Total (dBc/Hz)	______ <−115	______ <−126	______ <−135

[1]Refer to Application Note 150-4, HP 5952-1147, if additional information on calibration of spectrum analyzers for noise measurements is needed.

NOTE

If an analog spectrum analyzer was used to measure the noise floor at 10 Hz, 100 Hz, and 1 kHz, add +2.5 dB to the totals above as a correction for the log amplifiers and peak detectors in the analog spectrum analyzer.

[2]For a complete explanation of the correction factors see Appendix A.

PERFORMANCE TESTS

4-7. RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal of 10 GHz)

Specification

Electrical Characteristics	Performance Limits	Conditions
Offset From Carrier	dBc/Hz	With a 10 GHz input signal
10 Hz	−90	
100 Hz	−105	
1 kHz	−115	
10 kHz	−127	
100 kHz	−137	
1 MHz	−142	

Description

NOTE

This performance test is only necessary when the residual phase noise of the Carrier Noise Test Set is in question.

This test verifies the Carrier Noise Test Set's residual phase noise specifications using a 10 GHz test signal. A second Carrier Noise Test Set is required as a reference unit in this test. Since this test requires a second Carrier Noise Test Set, we recommend that the phase noise of the other instruments in the phase noise measuring system be checked before this test is performed.

During the residual phase noise measurement the microwave test signal and the 5—1280 MHz signal must be in phase quadrature (that is 90 degrees out of phase). One microwave synthesized source supplies the MICROWAVE TEST SIGNAL INPUT to both of the Carrier Noise Test Sets (device under test and reference). The IF OUTPUT of the reference Carrier Noise Test Set then supplies the 5—1280 MHz INPUT of the Carrier Noise Test Set device under test. The Carrier Noise Test Set's residual phase noise is measured on a low frequency spectrum analyzer and an RF spectrum analyzer. Correction factors are added and the residual phase noise is verified to be below the specified limit.

Equipment

Carrier Noise Test Set .... HP 11729C
(used as reference)
RF Synthesized Signal Generator .... HP 8662A (Option 003)
Microwave Synthesized Source .... HP 8340A
Low Frequency Spectrum Analyzer .... HP 3582A
RF Spectrum Analyzer .... HP 8566B
Power Meter .... HP 436A
Power Sensor .... HP 8482A
Power Splitter (quantity 2) .... HP 11667A
Amplifier .... HP 8447E/F
1 dB Step Attenuator (quantity 2) .... HP 355C

Procedure

Initial Instrument Settings

1. Connect the instruments as shown in Figure 4-3.
2. Turn on and warm-up the instruments for 30 minutes.
3. Set both step attenuators to maximum attenuation.

PERFORMANCE TESTS

RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal of 10 GHz) (cont'd)

Procedure (cont'd)

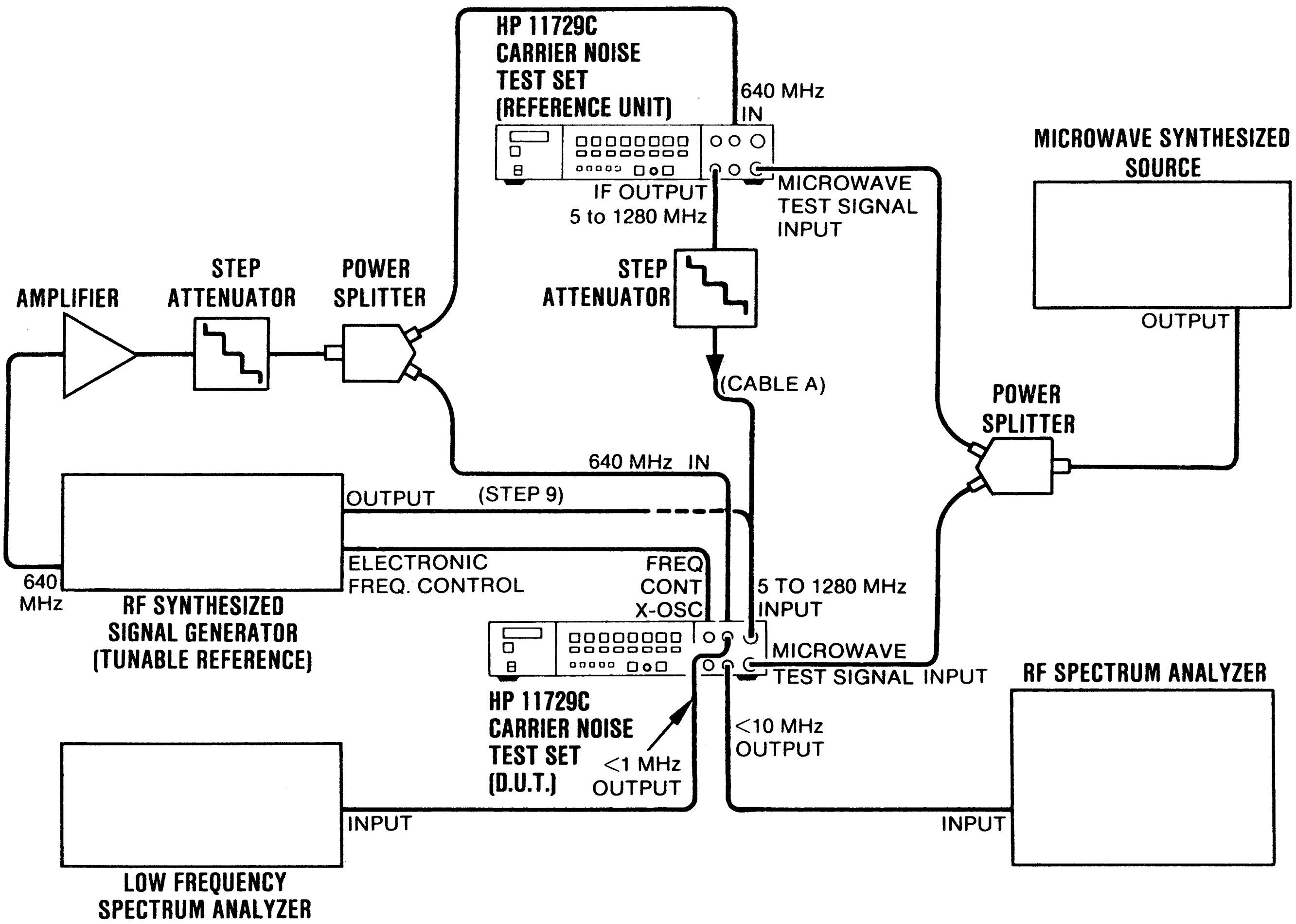


Figure 4-3. Residual Phase Noise Test Setup (Using a Test Signal of 10 GHz)

4. Set the Microwave Synthesized Soruce as follows:

   Frequency .... 10 GHz
   Output Level .... +10 dBm to +20 dBm

5. Set the RF Synthesized Signal Generator (tunable reference) as follows:

   Frequency .... 399.990 MHz
   Output Level .... 0 dBm

6. Set both Carrier Noise Test Sets as follows:

   Band Center Frequency .... 9.6 GHz
   Lock Bandwidth Factor 1
   Measurement Mode .... ϕ, CW

PERFORMANCE TESTS

RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal of 10 GHz) (cont'd)

Procedure (cont'd)

Power Level Checks

7. Disconnect the cable which goes to the 640 MHz IN connector on the rear panel of the Carrier Noise Test Set device under test. Connect the power sensor to this cable. Adjust the step attenuator that is located before the power splitter, supplying the 640 MHz signal, such that the power meter reads between 0 dBm and +3 dBm. Reconnect the cable to the 640 MHz INPUT, on the rear panel, of Carrier Noise Test Set device under test.

8. Disconnect the end of cable A which is connected to the 5—1280 MHz INPUT on the Carrier Noise Test Set device under test. Connect the cable to a power sensor. Measure the IF OUTPUT power. Adjust the 1 dB step attenuator located after the IF OUTPUT of the reference Carrier Noise Test Set until the power meter reads −1 dBm to 0 dBm. Record the exact power meter reading below.

Reference Carrier Noise Test Set IF OUTPUT power = ________ dBm

Spectrum Analyzer Calibration

9. Disconnect cable A from the power sensor. Connect the cable from the tunable reference output to the power sensor. Adjust the amplitude of the tunable reference until the power meter reads the power level recorded in step 8. Connect the tunable reference to the 5—1280 MHz INPUT on the Carrier Noise Test Set device under test.

10. Decrease the amplitude of the tunable reference by 50 dB. Adjust the RF spectrum analyzer to display the approximately 10 kHz beat note. (The beat note is the result of mixing the 400 MHz IF (MICROWAVE TEST SIGNAL INPUT minus the band center of the BAND RANGE chosen) and the 399.990 MHz tunable reference signal). Set the peak of the 10 kHz beat note to a convenient reference point.

11. Adjust the low frequency spectrum analyzer to view the approximately 10 kHz beat note. If the spectrum analyzer has selectable filters, select a flat top filter. If RMS averaging is available, select approximately 128 averages. RMS averaging smooths out the noise floor. If RMS averaging is not available the measurement should be made at an average level on the noise floor, not on a peak or valley.

12. Set the peak of the beat note to a convenient reference point.

Residual Phase Noise Measurement

13. Disconnect the tunable reference from the 5 to 1280 MHz INPUT on the Carrier Noise Test Set device under test. Reconnect cable A to the 5—1280 MHz INPUT on the Carrier Noise Test Set device under test.

14. Decrease the frequency of the Microwave Synthesized Source in 1 MHz steps, until the Carrier Noise Test Set device under test indicates phase quadrature (green LED is illuminated on the phase lock display.) Details of phase locking are found in Section III.

PERFORMANCE TESTS

RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal of 10 GHz) (cont'd)

Procedure (cont'd)

15. Adjust the RF spectrum analyzer to view the residual phase noise level at a 10 kHz offset from the carrier. For the most accurate measurement, use the smallest possible resolution bandwidth. Use averaging if required. Measure the residual phase noise level down from the reference point. Measure on an average phase noise level, do not measure on a peak or minimum phase noise level. Record the phase noise level (A) along with the measurement resolution bandwidth (B) below. Repeat this measurement for offsets of 100 kHz and 1 MHz.

Offset from carrier	Noise level (A) (relative to reference level) (dB)	Resolution Bandwidth (B) (Hz)
10 kHz	______	______
100 kHz	______	______
1 MHz	______	______

16. On the low frequency spectrum analyzer, select a Hanning filter and the normalization to a 1 Hz bandwidth (if these features are available). If the spectrum analyzer does not have the feature for normalization to a 1 Hz bandwidth this figure will have to be calculated later using the formula at the end of the test.

17. Adjust the low frequency spectrum analyzer to view the residual phase noise level at 10 Hz. Measure the residual phase noise level down from the reference point. Measure on an average phase noise level; do not measure on a peak or minimum level.

NOTE

Power line spurs are not specified for the Carrier Noise Test Set. Power line spurs will appear at power line frequencies and multiples of power line frequencies. Do not make a phase noise measurement on a spur, make the measurement on an average noise level.

18. Record the phase noise level (C) below. If the measurement was not made in a 1 Hz resolution bandwidth, also record the measurement resolution bandwidth (D). Repeat this measurement at 100 Hz and 1 kHz offsets.

Offset from carrier	Noise level (C) (relative to reference level) (dB)	Resolution Bandwidth (D) (Hz)
10 Hz	______	______
100 Hz	______	______
1 kHz	______	______

19. Calculate the residual phase noise of the Carrier Noise Test Set at 10 kHz, 100 kHz and 1 MHz offsets from the carrier. Sum the measured phase noise level (A) and the 4 correction factors[2] listed below. The normalization bandwidth factor is determined by putting the resolution bandwidth (B) into the equation below. Verify the residual phase noise level did not exceed the specified limit as shown at the bottom of each column.

[2]For a complete explanation of the correction factors see Appendix A.

PERFORMANCE TESTS

RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a test signal of 10 GHz) (cont'd)

Procedure (cont'd)

	10 kHz	100 kHz	1 MHz
Noise level = A (relative to reference level)	______ dB	______ dB	______ dB
Normalization to 1 Hz equivalent noise bandwidth[1] −10 log ("B" x 1.2) =	______ dB	______ dB	______ dB
Calibration Attenuation (Step 10)	−50 dB	−50 dB	−50 dB
$\mathcal{L}$(f) conversion factor	−6 dB	−6 dB	−6 dB
Correction for log amplifiers and peak detectors in analog spectrum analyzer	+2.5 dB	+2.5 dB	+2.5 dB
Total (dBc/Hz)	______ <−127	______ <−137	______ <−142

[1]Refer to Application Note 150-4, HP 5952-1147, if additional information on calibration of spectrum analyzers for noise measurements is needed.

20. Calculate the residual phase noise level of the Carrier Noise Test Set at 10 Hz, 100 Hz and 1 kHz offsets from the carrier. Sum the measured phase noise level (C) and the 3 correction factors[2] below. Do not add the normalization to a 1 Hz equivalent noise bandwidth factor, when the spectrum analyzer accounts for this factor automatically. Verify the residual phase noise level does not exceed the specified limit shown at the bottom of each column.

	10 Hz	100 Hz	1 kHz
Noise level = C (relative to reference level)	______ dB	______ dB	______ dB
Normalization to 1 Hz equivalent noise bandwidth[1] −10 log ("D" x 1.2) =	______ dB	______ dB	______ dB
Calibration Attenuation (Step 10)	−50 dB	−50 dB	−50 dB
$\mathcal{L}$(f) conversion factor	−6 dB	−6 dB	−6 dB
Total (dBc/Hz)	______ <−90	______ <−105	______ <−115

[1]Refer to Application Note 150-4, HP 5952-1147, if additional information on calibration of spectrum analyzers for noise measurements is needed.

NOTE

If an analog spectrum analyzer was used to measure the noise floor at 10 Hz, 100 Hz and 1 kHz add +2.5 dB to the totals above. This is the correction factor for the log amplifiers and peak detectors in the analog spectrum analyzer.

[2]For a complete explanation of the correction factors see Appendix A.

PERFORMANCE TESTS

4-8. AM NOISE FLOOR PERFORMANCE TEST

Specification

Electrical Characteristics	Performance Limits	Conditions
AM Noise Floor		At +10 dBm input level
Offset from Carrier	AM Noise (dBc/Hz)	
1 kHz	−138	
10 kHz	−145	
100 kHz	−155	
1 MHz	−160	

Description

NOTE

This test, as written, is only a partial verification of the AM Noise floor specification. The test only verifies the AM noise floor for frequency offsets of 100kHz and higher. From 1Hz to 100kHz the recommended low noise oscillator's AM noise floor is higher than the AM noise floor of the Carrier Noise Test Set. For a complete verification, an oscillator with lower AM noise specifications than the Carrier Noise Test Set would be needed.

The AM noise floor is measured at two offsets from the carrier (100 kHz and 1 MHz) to verify AM noise detection is performing within limits. A signal generator is used for calibrating the spectrum analyzer. A low noise oscillator is connected to the MICROWAVE TEST SIGNAL INPUT for the AM noise measurement. The AM noise floor is observed from the <10 MHz OUTPUT on a spectrum analyzer.

Equipment

Microwave Synthesized Source .... HP 8340A
(with AM modulation)
Spectrum Analyzer .... HP 8566B
Function Generator .... HP 3312A
Coaxial to waveguide adapter .... HP X281A
*Isolator .... HP 0955-0178
Power Supply .... HP 6214B
Power Meter .... HP 436A
Power Sensor .... HP 8481A
Low Noise Oscillator .... MA 86651A

*The isolator stabilizes load effects on the AM noise floor. When an isolator is not available an attenuator pad may be used. The attenuator pad may be used only if the output power of the oscillator is +10 dBm with the attenuator pad in place. If the measured power is +10 dBm or lower an isolator will have to be used. (See step 5 of the test procedure)

Procedure

Calibration

1. Connect the equipment as shown in Figure 4-4.

2. Connect +10 Vdc from the power supply to the low noise oscillator. Warm up the oscillator for 30 minutes.

PERFORMANCE TESTS

AM NOISE FLOOR PERFORMANCE TEST (cont'd)

Procedure (cont'd)

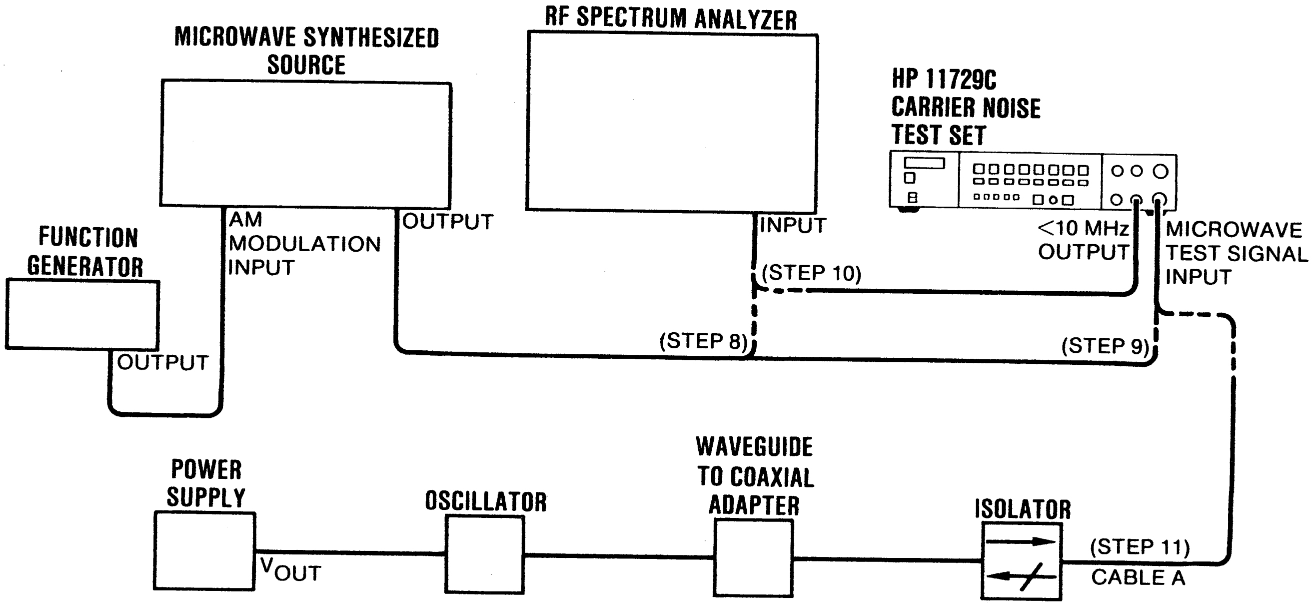


Figure 4-4. AM Noise Floor Test Set-up

3. Set the Microwave Synthesized Source as follows:

   Frequency .... 1 GHz
   AM modulation 50%

4. Set the function generator as follows:

   Function .... sinewave
   Frequency .... 100 kHz

5. Set the Carrier Noise Test Set as follows:

   Measurement Mode .... AM, CW
   All other controls .... Any setting

6. Measure the power level of the low noise oscillator at the end of cable A (the end that connects to the MICROWAVE TEST SIGNAL INPUT). The level should be approximately +10 dBm. Connect an attenuator pad at the oscillator's output if the power level is above +10 dBm. The value of the attenuator pad selected should bring the measured power level to +10 dBm. Disconnect cable A from the power sensor.

   Record the power level below.

   Low noise oscillator power level ________ dBm

PERFORMANCE TESTS

AM NOISE FLOOR PERFORMANCE TEST (cont'd)

Procedure (cont'd)

NOTE

The AM noise floor of the Carrier Noise Test Set is specified for a +10 dBm input level. Using an input signal lower than +10 dBm will increase the AM noise floor. The noise floor will increase by the amount in dB that the input signal was lowered from +10 dBm. As an example: a +7 dBm input will raise the AM noise floor by +3 dB.

Because our specifications are higher than typical measured values, an input signal of +5 dBm minimum will typically still measure within specifications.

7. Connect the end of the cable from the Microwave Synthesized Source to the power sensor. Adjust the amplitude of the Microwave Synthesized Source until the power meter reads the power level recorded in step 6.

8. Turn the Microwave Synthesized Source to external AM modulation. Connect the Microwave Synthesized Source to the spectrum analyzer. Be sure the input to the spectrum analyzer is 50 ohms.

9. Adjust the amplitude on the function generator so the sidebands displayed on the spectrum analyzer are −40 dBc. Disconnect the Microwave Synthesized Source from the spectrum analyzer and connect it to the Carrier Noise Test Set MICROWAVE TEST SIGNAL INPUT.

10. Connect the <10 MHz OUTPUT from the Carrier Noise Test Set to the spectrum analyzer. Adjust the spectrum analyzer to view the 100 kHz sidebands on the 1 GHz signal. Set the peak of the 100 kHz signal to a convenient reference point.

AM Noise Floor Measurement

11. Disconnect the Microwave Synthesized Source from the MICROWAVE TEST SIGNAL INPUT. Connect the output of the low noise oscillator to the MICROWAVE TEST SIGNAL INPUT.

NOTE

The oscillator signal should come directly from the resonator with no amplification stage in between. Under this condition, it is likely that the AM noise coming from the oscillator is less than or equal to −155 dBc/Hz at a 100 kHz offset.

12. Measure the noise level down from the reference point at a 100 kHz offset. Record the AM noise level (A) and resolution bandwidth (B) below. Measure the AM noise floor at a 1 MHz offset. Record this level with the corresponding resolution bandwidth below.

Offset from carrier	Noise level (A) (relative to reference level) (dB)	Resolution Bandwidth (B) (Hz)
100 kHz	______________	______________
1 MHz	______________	______________

PERFORMANCE TESTS

AM NOISE FLOOR PERFORMANCE TEST (cont'd)

Procedure (cont'd)

13. Calculate the AM noise floor by summing the measured AM noise level (A) and the 3 correction factors[2] shown below. The normalization bandwidth factor is determined by putting the resolution bandwidth (B) into the equation below. Verify the AM noise floor did not exceed the specified limit as shown at the bottom of each column.

	100 kHz	1 MHz
Noise level = A (relative to reference level)	______ dB	______ dB
Normalization to 1 Hz equivalent noise bandwidth[1] −10 log ("B" x 1.2) =	______ dB	______ dB
Calibration Attenuation (Step 8)	−40 dB	−40 dB
Correction for log amplifiers and peak detectors in analog spectrum analyzer	+2.5 dB	+2.5 dB
Total (dBc/Hz)	______ <−155	______ <−160

[1]Refer to Application Note 150-4, HP 5952-1147, if additional information on calibration of spectrum analyzers for noise measurements is needed.

[2] For a complete explanation of the correction factors see Appendix A.

Table 4-2. Performance Test Record

Hewlett-Packard Company
Model HP 11729C
Carrier Noise Test Set

Test by ______________________

Serial Number ______________________ Date ______________________

Para No.	Test Description			Results		
				Min.	Actual	Max.
4-5.	**MEASUREMENT FREQUENCY RANGE, IF OUTPUT BANDWIDTH AND LEVEL PERFORMANCE TEST**					
	IF Output Power					
	Mirowave Signal (GHz)	Band Center (GHz)	IF Output Freq. (MHz) Typ.			
	2.32	1.92	400	+7 dBm	______	
	4.88	4.48	400	+7 dBm	______	
	7.44	7.04	400	+7 dBm	______	
	10.00	9.60	400	+7 dBm	______	
	12.56	12.16	400	+7 dBm	______	
	14.740	14.72	20	+7 dBm	______	
	16.00	14.72	1280	+7 dBm	______	
	17.30	17.28	20	+7 dBm	______	
	18.56	17.28	1280	+7 dBm	______	
4-6.	**RESIDUAL PHASE NOISE PERFORMANCE TEST (Using a <1280 MHz Test Signal)**					
	Offset From The Carrier				(dBc/Hz)	(dBc/Hz)
		10 Hz			______	−115
		100 Hz			______	−126
		1 kHz			______	−135
		10 kHz			______	−142
		100 kHz			______	−151
		1 MHz			______	−156
4-7.	**RESIDUAL PHASE NOISE PERFORMANCE (Using a 10 GHz Test Signal)**					
	Offset From The Carrier				(dBc/Hz)	(dBc/Hz)
		10 Hz			______	−90
		100 Hz			______	−105
		1 kHz			______	−115
		10 kHz			______	−127
		100 kHz			______	−137
		1 MHz			______	−142
4-8.	**AM NOISE PERFORMANCE TEST**					
	Offset From The Carrier				(dBc/Hz)	(dBc/Hz)
		100 kHz			______	−155
		1 MHz			______	−160

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

This section contains adjustments and checks that ensure peak performance of the Carrier Noise Test Set. 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 1-4 in Section I for the minimum specifications. It is important that the test equipment meet the critical specifications listed in the table if the Carrier Noise Test Set 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.

5-5. RELATED ADJUSTMENTS

The procedures in this section can be performed in any order. However, it is advisable to check the power supply voltages first.

NOTE

The steps within a procedure must be performed in the order listed.

ADJUSTMENTS

5-6. POWER SUPPLY ADJUSTMENT

Reference Service Sheet 7

Description The +5.0 Vdc power supply is adjusted for +5.000 Vdc ±0.025 Vdc at the 5V Test Point A7TP3 using a digital multimeter.

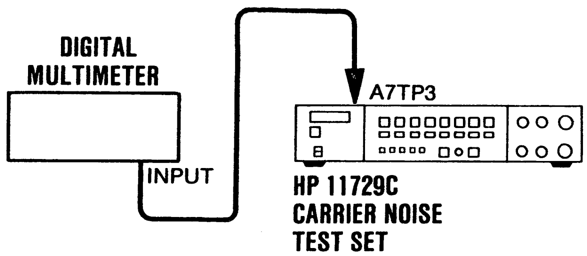


Figure 5-1. +5.0 Vdc Power Supply Adjustment Setup

Digital Multimeter ....HP 3465A

Equipment
Procedure

1. Take off the top cover of the Carrier Noise Test Set. Locate the 5V Test Point A7TP3 on the power supply board. Turn on the Carrier Noise Test Set.

2. Connect the digital multimeter to the 5V Test Point A7TP3. Adjust A7R10 (+5V ADJ) for a reading of +5.000 Vdc ±0.025 Vdc on the digital multimeter.

ADJUSTMENTS

5-7. PHASE LOCK INDICATOR ADJUSTMENT

Reference Service Sheet 3

Description The Phase Lock Board is adjusted to calibrate the lock and unlock positions on the Phase Lock Indicator. If the Phase Lock Indicator does not agree with the status byte, sent out over HP-IB, the Phase Lock Board may need adjustment. The adjustments for the Phase Lock Indicator only need to be made in one BAND RANGE. The Phase Lock Board is also adjusted to compensate for dc offsets in the switchable gain amplifier and integrator.

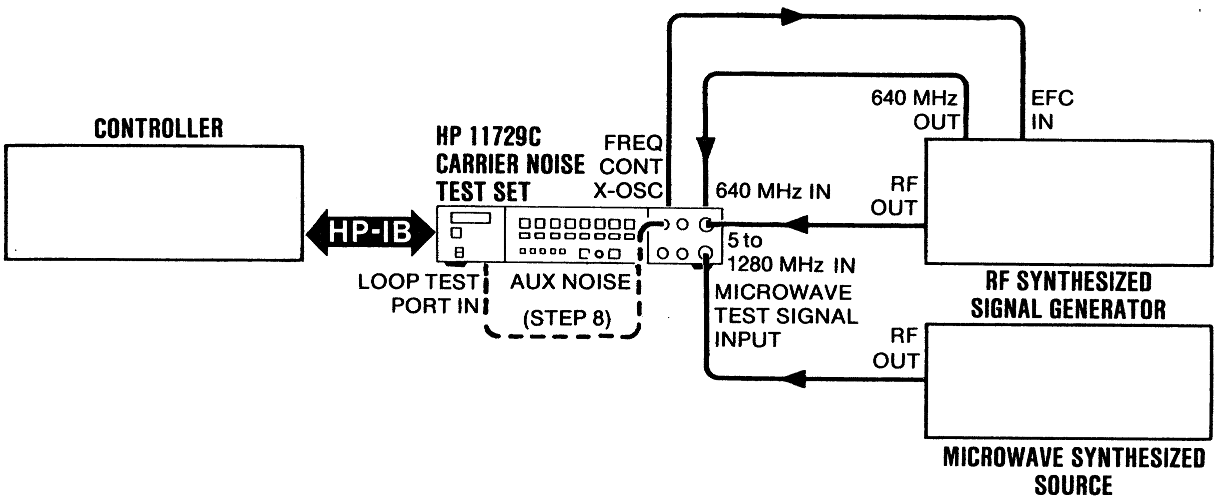


Figure 5-2. Phase Lock Indicator Adjustment Setup

Equipment

RF Synthesized Signal Generator ....HP 8662A (Option 003)
Microwave Synthesized Source ....HP 8340A
Computer Controller.......................HP 85B
Digital Multimeter ....HP 3465A
SMC to BNC adapter ....HP 1250-0831
BNC to alligator clips ....HP 8120-1292

Procedure

1. Connect the equipment as shown in Figure 5-2.

2. Turn on and warm up all instruments for 30 minutes before doing the following adjustments.

3. Set the Carrier Noise Test Set as follows:

   Lock Bandwidth Factor 100
   Measurement Mode........................ϕ, CW
   Band Range..............................8.32 to 10.88 GHz

NOTE

If this BAND RANGE is not included in the Carrier Noise Test Set, select an available range.

ADJUSTMENTS

PHASE LOCK INDICATOR ADJUSTMENT (cont'd)

Procedure (cont'd)

4. Set the Microwave Synthesized Source (D.U.T.) as follows:

   Frequency ....10 GHz
   Amplitude ....+10 dBm

   NOTE

   The test signal is tuned 400 MHz above the BAND CENTER frequency of the BAND RANGE chosen.

5. Set the RF synthesized signal generator (tunable reference) as follows:

   Frequency ....400.001 MHz
   Amplitude ....0 dBm

   NOTE

   The difference in frequency between the IF signal (D.U.T. frequency minus the BAND CENTER frequency of the BAND RANGE chosen) and the tunable reference is called a beat note. By connecting the <1 MHz or <10 MHz NOISE SPECTRUM OUTPUT to a spectrum analyzer the approximately 1 kHz beat note can be viewed.

6. Remove the top cover of the Carrier Noise Test Set. Disconnect the cable to PHASE LOCK IN (A7J9) on the Power Supply Board. Connect an SMC to BNC adapter (HP 1250-0831) to PHASE LOCK IN (A7J9). Attach a BNC to alligator clip (HP 8120-1292) to the adapter that you just connected to PHASE LOCK IN (A7J9). Short the alligator clips to simulate a perfect phase lock.

7. Adjust DSP CNTR (A5R37), on the Phase Lock Board, to center the Phase Lock Indicator. A green LED should be displayed in the center of the indicator.

8. Connect the AUX NOISE OUTPUT, on the front panel, to LOOP TEST PORT IN on the rear panel. Two red LEDs should appear, one on either side of the center green LED. If the red LEDs are not illuminated adjust DSP DEV (A5R35) on the Phase Lock Board until the two red LEDs are visible. For optimum resolution no more than two red LEDs should be illuminated.

   Fine adjust DSP CNTR (A5R37) until the red LEDs have equal intensity on both sides of the center green LED.

9. Remove the cable to the LOOP TEST PORT IN connector. Remove the short from the PHASE LOCK IN connector on the Power Supply Board and reconnect the original cable (W6) to the PHASE LOCK IN connector.

10. Set the LOCK BANDWIDTH FACTOR, on the front panel, to 1.

11. Adjust DSP DEV (A5R35), on the Phase Lock Board, until the Phase Lock Indicator displays four (4) red LEDs to either side of center. The indicator may have to be

ADJUSTMENTS

PHASE LOCK INDICATOR ADJUSTMENT (cont'd)

Procedure (cont'd)

shaded to view the LEDs. The Phase Lock Indicator now displays maximum display deviation. The D.U.T. and the tunable reference must not phase lock during the adjustment. If they phase lock while making the adjustment, disconnect the FREQ-CONT X-OSC cable, on the rear panel of the Carrier Noise Test Set, then reconnect.

12. Increase the frequency of the tunable reference by 5 MHz to unlock the display. A red LED should be illuminated to the left of the center green LED. If the red LED is not illuminated adjust UNLK DSP (A5R5) until the red LED lights.

13. Decrease the frequency of the tunable reference by 5.001 MHz.

14. Be sure the LOCK BANDWIDTH FACTOR is set to 1.

15. Press then release CAPTURE to enable phase lock. If phase lock is aquired go to step 16. If phase lock was not aquired proceed as follows:

The tunable reference must be tuned closer in frequency to the IF frequency ($f_{IF} = f_{d.u.t.} - f_{band\ center\ frequency}$). Press CAPTURE while tuning the tunable reference in 1 kHz steps. Watch the phase lock indicator on the Carrier Noise Test Set. When the LED's on the indicator all light up, reduce the resolution of the tunable reference by a factor of 10.

NOTE

Connect the spectrum analyzer to the <10 MHz OUTPUT, on the Carrier Noise Test Set, if difficulties occur in determining the direction to tune the tunable reference to acquire phase lock.

The signals displayed on the spectrum analyzer represent the frequency difference between the two inputs to an internal mixer/phase detector in the Carrier Noise Test Set. The signals will decrease in frequency to dc when tuning towards phase lock and increase in frequency when tuning away from phase lock.

Press CAPTURE and tune in this reduced resolution. Watch the red LEDS on the Carrier Noise Test Set phase lock indicator step through one side of the display — to the green bar — then to the other side of the display. Again reduce the resolution on the tunable reference by a factor of 10. Tune in this finer resolution until the green LED is illuminated. When the green LED is illuminated release CAPTURE.

16. Hold CAPTURE in and increase the tunable reference in 10 Hz steps until the loop becomes unlocked. Watch the phase lock indicator. The red LEDs should fully light one at a time and move to the right. When the last LED is illuminated and you tune further the entire indicator should dimly light. 399 999 130

399 998 000

With CAPTURE pressed decrease the tunable reference in 10 Hz steps. The dimly illuminated indicator should change back to the red LEDs one at a time fully illuminated and moving to the left. When the last LED on the left is illuminated and you tune further, the entire indicator will dimly light.

399 997 666

ADJUSTMENTS

PHASE LOCK INDICATOR ADJUSTMENT (cont'd)

Procedure (cont'd)

17. When the last LED on the left or right lights and the tunable reference is increased or decreased further, the indicator should immediately dimly light. If the indicator goes blank adjust DSP DEV (A5R35), on the Phase Lock Board, so the last LED on the right or left is illuminated. Tune further and the entire indicator should dimly light.

18. If DSP DEV did not need adjustment go to step 19. If DSP DEV was adjusted repeat steps 12—17 because the adjustments UNLK DSP and DSP DEV are interactive.

19. Set the LOCK BANDWIDTH FACTOR, on the front panel, to 100.

20. Press and hold CAPTURE while tuning the tunable reference using a 100 Hz resolution. Tune until the tunable reference and D.U.T. are phase locked (green LED). Release CAPTURE. If the display changes to a red LED adjust OFF AD (A5R34) ,on the Phase Lock Board, to center the display (green LED). If the display remains centered do not adjust OFF AD.

21. Set the LOCK BANDWIDTH FACTOR to 10. If the center green LED stays illuminated go to step 22. If the center green LED doesn't stay illuminated repeat step 20 with a 10 Hz resolution.

22. Set the LOCK BANDWIDTH FACTOR to 1. The center green LED should stay illuminated. If the center green LED doesn't stay illuminated repeat step 20 with a 1 Hz resolution.

23. Use the following procedure to verify if the adjustment for UNLK DSP is calibrated correctly:

    Enter Program 1 into a computer or controller that runs basic. Insert the correct select code and HP-IB address, for your Carrier Noise Test Set, into the SPOLL function. The HP-IB address of the Carrier Noise Test Set is factory preset to 06. The user can select the HP-IB address by changing the position of the HP-IB address switches on the rear panel of the Carrier Noise Test Set. (Refer to Section II paragraph 2-7, HP-IB Address Selection, for further information.)

    PROGRAM 1

```
10 A = SPOLL(###)
20 DISP A
30 GOTO 10
```

    (### = Current Carrier Noise Test Set select code and address.)
    Example: 706
    7=Select code
    06=Address

    This program monitors the status byte of the Carrier Noise Test Set and displays the equivalent decimal value. The status of the phase lock detector sent out over HP-IB should agree with the phase lock indicator on the front panel. Table 5-1 defines the status bits and their decimal equivalents for the two phase lock conditions.

ADJUSTMENTS

PHASE LOCK INDICATOR ADJUSTMENT (cont'd)

Procedure (cont'd)

Table 5-1. Phase Lock and Unlock Status Bits

Phase Condition	Status-Bits-Binary								Output Decimal*
	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1	
unlocked	0	0	0	0	0	1	0	0	4
locked (green bar)	0	0	0	0	0	0	1	0	2

*If no other bits are logical one.

24. Set the Carrier Noise Test Set to the phase lock condition (green LED is illuminated on the front panel phase lock indicator).

25. Run Program 1 and compare the number displayed on the computer to the phase condition of the phase lock indicator on the Carrier Noise Test Set. A decimal 2 is displayed when in the phase lock condition.

26. Increase the frequency of the tunable reference by 1 MHz. Verify that the unlocked condition (red LED adjacent to the left of the green LED) is detected by the microprocessor. A decimal 4 should be displayed on the computer.

    If the number (2 or 4) displayed on the computer does not correspond to the phase lock condition, displayed on the front panel phase lock indicator, perform steps 12—18 again. Perform steps 23—26 to verify the adjustments.

ADJUSTMENTS

5-8. OPTION SWITCH ADJUSTMENT

Reference Service Sheet 6

NOTE

If a filter is added to the Carrier Noise Test Set the inputs to the Option Switch (S1), on the microprocessor board, need to be changed.

Description The five (5) input switch (S1), on the microprocessor board, defines the options installed in the Carrier Noise Test Set. The switch should only be adjusted when the options are changed or the switch is being replaced.

Procedure

1. Take off the bottom cover of the Carrier Noise Test Set
2. Unscrew the three Pozidriv screws, on microprocessor board (A9), to access the component side of the board.
3. Locate the five (5) input switch (S1) near the front panel. Table 5-2 defines the switch positions. The 0 and 1 logic levels are etched on the board on either side of the switch.

Table 5-2. Definition of Option Switch S1

Switch Input Logic Levels					Total Number of Bands in the Carrier Noise Test Set
#5	#4	#3	#2	#1	
X	0	0	0	0	1
X	0	0	0	1	1
X	0	0	1	0	2
X	0	0	1	1	3
X	0	1	0	0	4
X	0	1	0	1	5
X	0	1	1	0	6
X	0	1	1	1	7
X	1	0	0	0	8
X	1	0	0	1	9 (exceeds capacity)
X	1	0	1	0	10 (exceeds capacity)
X	1	0	1	1	11 (exceeds capacity)
X	1	1	0	0	1
X	1	1	0	1	1
X	1	1	1	0	1
X	1	1	1	1	1
0	X	X	X	X	AM is not installed
1	X	X	X	X	AM is installed
X = Don't care					

4. If a filter is added to the instrument, switch S1 to the corresponding logic levels for the total number of filters in the Carrier Noise Test Set.

ADJUSTMENTS

OPTION SWITCH ADJUSTMENT (cont'd)

Procedure (cont'd)

4. If a filter is added to the instrument, switch S1 to the corresponding logic levels for the total number of filters in the Carrier Noise Test Set.

5. Verify that the microprocessor recognizes the change by pressing the BAND RANGE button of the newly installed filter. The filter switch will click on and the LED on the BAND RANGE button will light if the microprocessor has acknowledged the new filter.

6. Reinstall the screws on the microprocessor board and replace the bottom cover.

ADJUSTMENTS

5-9. PULSE BALANCE ADJUSTMENT

Reference Service Sheet 2

Description The COARSE BAL adjustment, on the rear of the front panel, is adjusted to center the tuning range of the front panel BAL control.

Procedure

1. Turn the Carrier Noise Test Set off.
2. Remove the top cover of the Carrier Noise Test Set.
3. Disconnect A3W11 from the IF port on the Low Pass Filter.
4. Turn the Carrier Noise Test Set on.
5. Press the MODE button, on the front panel, until the annunciator next to ϕ, PULSED is illuminated.
6. Center the rotational swing of the front panel BAL control..
7. Adjust the COARSE BAL potentiometer, on the rear of the front panel, until the front panel Phase Lock Indicator displays the center green LED.
8. Turn the Carrier Noise Test Set off.
9. Reconnect A3W11 to the IF port on the Low Pass Filter.
10. Replace the top cover of the Carrier Noise Test Set.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list and throughout the manual. Table 6-2 lists all replaceable parts in reference designator order. Table 6-3 contains the names and addresses that correspond to the manufacturers' code numbers.

6-2. ABBREVIATIONS

Table 6-1 lists abbreviations used in the parts list, schematics, and throughout the manual. In some cases, two forms of the abbreviation are used; one all in capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with both lower case and upper case letters.

6-3. REPLACEABLE PARTS LIST

Table 6-2 is the list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alpha-numerical order by reference designation.

b. Chassis-mounted parts in alpha-numerical order by reference designation.

c. Miscellaneous parts.

The information given for each part consists of the following:

a. The Hewlett-Packard part number.

b. Part number check digit (CD).

c. The total quantity (Qty) in the instrument, which appears only at the first listing of a particular part number.

d. The description of the part.

e. A typical manufacturer of the part in a five-digit code.

f. The manufacturer's number for the part.

6-4. FACTORY SELECTED PARTS (*)

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

6-5. PARTS LIST BACKDATING (†)

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

6-6. PARTS LIST UPDATING (Change Sheet)

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

6-7. ILLUSTRATED PARTS BREAKDOWN

Most mechanical parts are identified in Figures 6-1 through 6-7. These figures are located near the end of the Replaceable Parts table.

6-8. HARDWARE

Both metric and nonmetric screws are used in the Carrier Noise Test Set.

6-9. ORDERING INFORMATION

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

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

ORDERING INFORMATION (cont'd)

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."

6-10. RECOMMENDED SPARES LIST

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

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

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

REFERENCE DESIGNATIONS

A . . . . assembly
AT . . attenuator; isolator; termination
B . . . . fan; motor
BT . . . . battery
C . . . . capacitor
CP . . . . coupler
CR . . . . diode; diode thyristor; varactor
DC . . . directional coupler
DL . . . . delay line
DS . . . . annunciator; signaling device (audible or visual); lamp; LED

E . . . . miscellaneous electrical part
F . . . . fuse
FL . . . . filter
H . . . . hardware
HY . . . . circulator
J . . . electrical connector (stationary portion); jack
K . . . . relay
L . . . . coil; inductor
M . . . . meter
MP . . . . miscellaneous mechanical part

P . . . electrical connector (movable portion); plug
Q . . . . . . transistor: SCR; triode thyristor
R . . . . resistor
RT . . . . thermistor
S . . . . switch
T . . . . transformer
TB . . . . . . terminal board
TC . . . . . . thermocouple
TP . . . . test point

U . . . . . integrated circuit; microcircuit
V . . . . electron tube
VR . . . . voltage regulator; breakdown diode
W . . . . cable; transmission path; wire
X . . . . socket
Y . . . . crystal unit (piezo-electric or quartz)
Z . . . . tuned cavity; tuned circuit

ABBREVIATIONS

A . . . . ampere
ac . . . . alternating current
ACCESS . . . . . accessory
ADJ . . . . adjustment
A/D . . . . analog-to-digital
AF . . . . . audio frequency
AFC . . . . automatic frequency control
AGC . . . . . automatic gain control
AL . . . . aluminum
ALC . . . . . automatic level control
AM . . . amplitude modulation
AMPL . . . . amplifier
APC . . . . automatic phase control
ASSY . . . . assembly
AUX . . . . auxiliary
avg . . . . average
AWG . . . . American wire gauge
BAL . . . . balance
BCD . . . . . . binary coded decimal
BD . . . . board
BE CU . . . . . . beryllium copper
BFO . . . . . beat frequency oscillator
BH . . . . binder head
BKDN . . . . . . breakdown
BP . . . . bandpass
BPF . . . . . bandpass filter
BRS . . . . brass
BWO . . . . . backward-wave oscillator
CAL . . . . calibrate
ccw . . counter-clockwise
CER . . . . ceramic
CHAN . . . . channel
cm . . . . centimeter
CMO . . cabinet mount only
COAX . . . . coaxial

COEF . . . . coefficient
COM . . . . common
COMP . . . . . composition
COMPL . . . . complete
CONN . . . . connector
CP . . . . . . cadmium plate
CRT . . . cathode-ray tube
CTL . . . . complementary transistor logic
CW . . . . . continuous wave
cw . . . . clockwise
cm . . . . centimeter
D/A . . . . . digital-to-analog
dB . . . . decibel
dBm . . . . decibel referred to 1 mW
dc . . . . direct current
deg . . degree (temperature interval or difference)
° . . . . degree (plane angle)
°C . . . . . . degree Celsius (centigrade)
°F . . . . degree Fahrenheit
°K . . . . degree Kelvin
DEPC . . deposited carbon
DET . . . . detector
diam . . . . diameter
DIA . . . diameter (used in parts list)
DIFF AMPL . . differential amplifier
div . . . . division
DPDT . . . . . double-pole, double-throw
DR . . . . drive
DSB . . . . double sideband
DTL . . . . diode transistor logic
DVM . . . digital voltmeter
ECL . . . . emitter coupled logic
EMF . . electromotive force

EDP . . . . . electronic data processing
ELECT . . . . . electrolytic
ENCAP . . . . encapsulated
EXT . . . . external
F . . . . farad
FET . . . . field-effect transistor
F/F . . . . flip-flop
FH . . . . flat head
FIL H . . . . . fillister head
FM . . frequency modulation
FP . . . . front panel
FREQ . . . . frequency
FXD . . . . fixed
g . . . . gram
GE . . . . germanium
GHz . . . . gigahertz
GL . . . . glass
GRD . . . . ground(ed)
H . . . . henry
h . . . . hour
HET . . . . heterodyne
HEX . . . . hexagonal
HD . . . . head
HDW . . . . hardware
HF . . . . . . high frequency
HG . . . . mercury
HI . . . . high
HP . . . . . Hewlett-Packard
HPF . . . . . high pass filter
HR . . . . hour (used in parts list)
HV . . . . high voltage
Hz . . . . Hertz
IC . . . . integrated circuit
ID . . . . . . inside diameter
IF . . . . intermediate frequency
IMPG . . . . . impregnated
in . . . . inch
INCD . . . . . incandescent
INCL . . . . include(s)
INP . . . . input
INS . . . . insulation

INT . . . . internal
kg . . . . kilogram
kHz . . . . kilohertz
kΩ . . . . kilohm
kV . . . . kilovolt
lb . . . . pound
LC . . . . inductance-capacitance
LED . . light-emitting diode
LF . . . . . . low frequency
LG . . . . long
LH . . . . left hand
LIM . . . . limit
LIN . . . linear taper (used in parts list)
lin . . . . linear
LK WASH . . . lock washer
LO . . . low; local oscillator
LOG . . . . logarithmic taper (used in parts list)
log . . . . logrithm(ic)
LPF . . . . . low pass filter
LV . . . . low voltage
m . . . . . . meter (distance)
mA . . . . milliampere
MAX . . . . maximum
MΩ . . . . megohm
MEG . . . . meg (10^6) (used in parts list)
MET FLM . . . . metal film
MET OX . . metallic oxide
MF . . . medium frequency; microfarad (used in parts list)
MFR . . . . . . manufacturer
mg . . . . milligram
MHz . . . . megahertz
mH . . . . millihenry
mho . . . . mho
MIN . . . . minimum
min . . . . . minute (time)
. . .' . . . . . minute (plane angle)
MINAT . . . . miniature
mm . . . . millimeter

NOTE

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

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

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

NOTE

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

MULTIPLIERS

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

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	11729-60011	8	1	INDICATOR BOARD ASSEMBLY	28480	11729-60011
A1C1	0180-2617	1	4	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A1DS1	1990-0759	6	2	LED-LIGHT BAR MODULE LUM-INT=3MCD	28480	HLMP-2620
A1DS2	1990-0759	6		LED LIGHT BAR MODULE LUM-INT=3MCD	28480	HLMP-2620
A1DS3	1990-0698	2	1	LED-LIGHT BAR MODULE LUM-INT=2MCD	28480	1LM1-2500
A1J1	1200-0508	0	3	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A1MP1	5041-0377	7	1	KEY CAP FULL SMK	28480	5041-0377
A1MP2	1251-4459	5	3	CLIP-CABLE PLUG RTNG-DUAL INLINE 14 CONT	28480	1251-4459
A1R1	0698-7231	2	1	RESISTOR 619 1% .05W F TC=0+-100	24546	C3-1/8-T0-619R-F
A1R2	0698-7235	6	1	RESISTOR 909 1% .05W F TC=0+-100	24546	C3-1/8-T0-909R-F
A1R3	0698-7220	9	8	RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A1R4	0698-7220	9		RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A1R5	0698-7220	9		RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A1R6	0698-7220	9		RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A1R7	0698-7220	9		RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A1R8	0698-7220	9		RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A1R9	0698-7220	9		RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A1R10	0698-7220	9		RESISTOR 215 1% .05W F TC=0+-100	24546	C3-1/8-T0-215R-F
A1S1	5060-9436	7	16	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1U1	1826-0655	4	1	IC 18-DIP-P PKG	27014	LM3914N
A1U2	1826-0276	5	2	IC 78L05A V RGLTR TO-92	04713	MC78L05ACP
A1XDS1	1200-0507	9	2	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
A1XDS2	1200-0507	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
A1XDS3	11729-80004	1	1	SKT, STRP 4 CONT	28480	11729-80004
A2	11729-60088	9	1	FRONT PANEL KEY AND DISPLAY BOARD ASSY	28480	11729-60088
A2C1	0180-0116	1	5	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A2C2	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A2DS1	1990-0665	3	21	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS2	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS3	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS4	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS5	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS6	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS7	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS8	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS9	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS10	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS11	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS12	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS13	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
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	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS18	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS19	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS20	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2DS21	1990-0665	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0665
A2J1	1251-5722	7	1	CONNECTOR 50-PIN M POST TYPE	28480	1251-5722
A2J2	1251-8391	2	1	CONN-POST TYPE .100-PIN-SPCG 4-CONT	28480	1251-8391
A2MP1	5041-0252	7	5	KEY CAP 1/4 FOR LOCK BANDWIDTH SWITCHES	28480	5041-0252
A2MP2	5041-0252	7		KEY CAP 1/4 FOR LOCK BANDWIDTH SWITCHES	28480	5041-0252
A2MP3	5041-0252	7		KEY CAP 1/4 FOR LOCK BANDWIDTH SWITCHES	28480	5041-0252
A2MP4	5041-0252	7		KEY CAP 1/4 FOR LOCK BANDWIDTH SWITCHES	28480	5041-0252
A2MP5	5041-0252	7		KEY CAP 1/4 FOR LOCK BANDWIDTH SWITCHES	28480	5041-0252
A2MP6	5041-0352	8	8	KEY CAP FOR FILTER SWITCHES	28480	5041-0352
A2MP7	5041-0352	8		KEY CAP FOR FILTER SWITCHES	28480	5041-0352
A2MP8	5041-0352	8		KEY CAP FOR FILTER SWITCHES	28480	5041-0352
A2MP9	5041-0352	8		KEY CAP FOR FILTER SWITCHES	28480	5041-0352
A2MP10	5041-0352	8		KEY CAP FOR FILTER SWITCHES	28480	5041-0352

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2MP11	5041-0352	8		KEY CAP FOR FILTER SWITCHES	28480	5041-0352
A2MP12	5041-0352	8		KEY CAP FOR FILTER SWITCHES	28480	5041-0352
A2MP13	5041-0352	8		KEY CAP FOR FILTER SWITCHES	28480	5041-0352
A2MP14	5041-2811	8	1	KEY CAP (MODE)	28480	5041-2811
A2MP15	5041-2812	9	1	KEY CAP (LOCAL)	28480	5041-2812
A2MP16	5040-8823	2	1	KNOB JADE GRAY	28480	5040-8823
A2Q1	1853-0264	8	4	TRANSISTOR PNP SI PD=310MW FT=100MHZ	04713	2N5401
A2Q2	1853-0264	8		TRANSISTOR PNP SI PD=310MW FT=100MHZ	04713	2N5401
A2Q3	1853-0264	8		TRANSISTOR PNP SI PD=310MW FT=100MHZ	04713	2N5401
A2Q4	1853-0264	8		TRANSISTOR PNP SI PD=310MW FT=100MHZ	04713	2N5401
A2Q5	1855-0082	2	1	TRANSISTOR J-FET P-CHAN D-MODE SI	28480	1855-0082
A2R1	1810-0397	8	3	NETWORK-RES 10-SIP68.0 OHM X 9	01121	210A680
A2R2	1810-0397	8		NETWORK-RES 10-SIP68.0 OHM X 9	01121	210A680
A2R3	1810-0397	8		NETWORK-RES 10-SIP68.0 OHM X 9	01121	210A680
A2R4	0757-0280	3	19	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R6	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R7	0757-0421	4	4	RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A2R8	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A2R9	0698-3447	4	6	RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A2R10	0698-3162	0	3	RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A2R11	0698-3157	3	1	RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A2R12	2100-0558	9	1	RESISTOR-TRMR 20K 10% C TOP-ADJ 1-TRN	28480	2100-0558
A2R13	2100-4109	4	1	RESISTOR-VAR CONTROL C 2K 5% LIN	28480	2100-4109
A2S1	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S2	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S3	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S4	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S5	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S6	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S7	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S8	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S9	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S10	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S11	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S12	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S13	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S14	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2S15	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A2TP1	0360-0535	0	26	TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A2U1	1820-1208	3	1	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A2U2	1820-2973	1	15	IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A2W1	8159-0005	0	3	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A3	11729-60087	8	1	LOW PASS FILTER BOARD ASSEMBLY	28480	11729-60087
A3C1	0160-4767	4	1	CAPACITOR-FXD 20PF +-5% 200VDC CER 0+-30	28480	0160-4767
A3C2	0160-2208	4	2	CAPACITOR-FXD 330PF +-5% 300VDC MICA	28480	0160-2208
A3C3	0160-2208	4		CAPACITOR-FXD 330PF +-5% 300VDC MICA	28480	0160-2208
A3C4	0140-0210	2	2	CAPACITOR-FXD 270PF +-5% 300VDC MICA	72136	DM15F271J0300WV1CR
A3C5	0140-0210	2		CAPACITOR-FXD 270PF +-5% 300VDC MICA	72136	DM15F271J0300WV1CR
A3FL1-A3FL4	9135-0174	5	4	FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
A3J1	1250-1220	0	6	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
A3J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
A3J3	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
A3J4	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
A3J5	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
A3J6	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
A3K1	0490-1013	6	2	RELAY-REED 1C 250MA 28VDC 5VDC-COIL 3VA	28480	0490-1013
A3K2	0490-1013	6		RELAY-REED 1C 250MA 28VDC 5VDC-COIL 3VA	28480	0490-1013

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3L1	9140-0094	9	2	INDUCTOR RF-CH-MLD 680NH 10%	28480	9140-0094
A3L2	9100-1615	8	1	INDUCTOR RF-CH-MLD 1.2UH 10%	28480	9100-1615
A3L3	9140-0094	9		INDUCTOR RF-CH-MLD 680NH 10%	28480	9140-0094
A3L4	9140-0238	3	2	INDUCTOR RF-CH-MLD 82UH 5% .166DX.385LG	28480	9140-0238
A3L5	9140-0178	0	1	INDUCTOR RF-CH-MLD 12UH 10% .166DX.385LG	28480	9140-0178
A3L6	9100-1638	5	1	INDUCTOR RF-CH-MLD 130UH 5% .166DX.385LG	28480	9100-1638
A3L7	9140-0238	3		INDUCTOR RF-CH-MLD 82UH 5% .166DX.385LG	28480	9140-0238
A3MP1	2190-0124	4	18	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP2	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP3	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP4	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP5	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP6	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP7	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP8	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP9	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP10	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP11	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP12	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP13	2950-0078	9	18	NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP14	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP15	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP16	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP17	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP18	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP19	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP20	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP21	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP22	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP23	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP24	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP25	11729-20091	0	1	LOW PASS FILTER CAN	28480	11729-20091
A3MP26	3050-0079	3	8	WASHER-FL NM NO. 2 .094-IN-ID .188-IN-OD	28480	3050-0079
A3MP27	3050-0079	3		WASHER-FL NM NO. 2 .094-IN-ID .188-IN-OD	28480	3050-0079
A3MP28	3050-0079	3		WASHER-FL NM NO. 2 .094-IN-ID 188-IN-OD	28480	3050-0079
A3MP29	3050-0079	3		WASHER-FL NM NO. 2 .094-IN-ID .188-IN-OD	28480	3050-0079
A3MP30	3050-0079	3		WASHER-FL NM NO. 2 .094-IN-ID .188-IN-OD	28480	3050-0079
A3MP31	3050-0079	3		WASHER-FL NM NO. 2 .094-IN-ID .188-IN-OD	28480	3050-0079
A3MP32	2190-0009	4	5	WASHER-LK INTL T NO. 8 .168-IN-ID	28480	2190-0009
A3MP33	2190-0009	4		WASHER-LK INTL T NO. 8 .168-IN-ID	28480	2190-0009
A3MP34	2580-0002	4	5	NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
A3MP35	2580-0002	4		NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
A3MP36	2580-0002	4		NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
A3MP37	2580-0002	4		NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
A3MP38	2190-0009	4		WASHER-LK INTL T NO. 8 .168-IN-ID	28480	2190-0009
A3MP39	2190-0009	4		WASHER-LK INTL T NO. 8 .168-IN-ID	28480	2190-0009
A3MP40	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP41	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP42	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP43	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A3MP44	3050-0079	3		WASHER-FL NM NO. 2 .094-IN-ID .188-IN-OD	28480	3050-0079
A3MP45	3050-0079	3		WASHER-FL NM NO. 2 .094-IN-ID .188-IN-OD	28480	3050-0079
A3MP46	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP47	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP48	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3MP49	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A3R1	0698-7205	0	1	RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-T0-51R1-F
A3R2	0757-0417	8	2	RESISTOR 562 1% .125W F TC=0+-100	24546	C4-1/8-T0-562R-F
A3R3	0757-0417	8		RESISTOR 562 1% .125W F TC=0+-100	24546	C4-1/8-T0-562R-F
A3R4	0698-0083	8	1	RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A3R5	0698-0089	4	1	RESISTOR 1.78K 1% .5W F TC=0+-100	28480	0698-0089
	0515-0208	3	8	SCREW-MACH M3 X 0.5 14MM-LG PAN-HD (USED TO MOUNT THE A3 ASSEMBLY TO THE DECK)	28480	0515-0208
	2190-0584	0	112	WASHER-LK HLCL 3.0 MM 3.1-MM-ID (USED TO MOUNT THE A3 ASSEMBLY TO THE DECK)	28480	2190-0584

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4				NOT ASSIGNED		
A5	11729-60002	7	1	PHASELOCK BOARD ASSEMBLY	28480	11729-60002
A5C1	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A5C2	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A5C3	0160-0576	5	3	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5C4	0160-3830	0	2	CAPACITOR-FXD 5UF +-10% 50VDC MET-POLYC	28480	0160-3830
A5C5	0160-3830	0		CAPACITOR-FXD 5UF +-10% 50VDC MET-POLYC	28480	0160-3830
A5C6	0160-0571	0	2	CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A5C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5CR1	1901-0050	3	13	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5K1	0490-0916	6	2	RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-0916
A5K2	0490-0916	6		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-0916
A5L1	9100-1626	1	3	INDUCTOR RF-CH-MLD 36UH 5% .166DX.385LG	28480	9100-1626
A5L2	9100-1626	1		INDUCTOR RF-CH-MLD 36UH 5% .166DX.385LG	28480	9100-1626
A5MP1	5040-6852	3	1	EXTRACTOR, ORANGE	28480	5040-6852
A5MP2	5000-9043	6	1	PIN:P.C. BOARD EXTRACTOR	28480	5000-9043
A5R1	0757-0442	9	8	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R2	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R3	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R4	0757-0465	6	9	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R5	2100-2514	1	2	RESISTOR-TRMR 20K 10% C SIDE-ADJ 1-TRN	30983	ET50W203
A5R6	0757-0438	3	3	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A5R7	0757-0458	7	3	RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A5R8	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R9	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R10	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R11	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R12	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R13	0757-0444	1	1	RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A5R14	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A5R15	0757-0200	7	1	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A5R16	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A5R17	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A5R18	0757-0443	0	3	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A5R19	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R20	0698-3154	0	3	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A5R21	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R22	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A5R23	0757-0461	2	1	RESISTOR 68.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6812-F
A5R24	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A5R25	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A5R26	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R27	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A5R28	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A5R29	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R30	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R31	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R32	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A5R33	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R34	2100-2516	3	2	RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TRN	32997	3329W-1-104
A5R35	2100-2516	3		RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TRN	32997	3329W-1-104
A5R36	0698-3450	9	1	RESISTOR 42.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4222-F
A5R37	2100-2514	1		RESISTOR-TRMR 20K 10% C SIDE-ADJ 1-TRN	30983	ET50W203
A5R38	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R39	0698-3160	8	2	RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A5R40	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5R41	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R42	0698-3440	7	1	RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A5R43	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R44	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R45	0757-0401	0	7	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A5R46	0698-0082	7	1	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A5R47	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A5R48	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R49	0757-0394	0	1	RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A5TP1	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A5TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A5TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A5TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A5TP5	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A5TP6	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A5TP7	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A5TP8	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A5U1	1826-0600	9	2	IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL074ACN
A5U2	1826-0600	9		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL074ACN
A5U3	1820-1374	4	4	IC SWITCH ANLG QUAD 16-DIP-P PKG	24355	AD7510DIJN
A5U4	1820-1374	4		IC SWITCH ANLG QUAD 16-DIP-P PKG	24355	AD7510DIJN
A5U5	1820-1374	4		IC SWITCH ANLG QUAD 16-DIP-P PKG	24355	AD7510DIJN
A5U6	1820-1374	4		IC SWITCH ANLG QUAD 16-DIP-P PKG	24355	AD7510DIJN
A5U7	1820-1962	6	1	IC DCDR CMOS BCD-TO-DEC	3L585	CD4028BE
A5U8	1826-0276	5		IC 78L05A V RGLTR TO-92	04713	MC78L05ACP
A5U9	1826-0547	3	1	IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-P	01295	TL072ACP
A5VR1	1902-0958	2	4	DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075%	28480	1902-0958
A5VR2	1902-0951	5	2	DIODE-ZNR 5.1V 5% DO-35 PD=.4W TC=+.035%	28480	1902-0951
A6	11729-60014	1	1	LOW NOISE AMPLIFIER ASSEMBLY	28480	11729-60014
A6A1	11729-60009	4	1	LOW NOISE AMPLIFIER BOARD ASSEMBLY	28480	11729-60009
A6A1C1				NOT ASSIGNED		
A6A1C2	0180-3348	7	1	CAPACITOR-FXD 100UF	28480	0180-3348
A6A1C3	0180-3384	1	1	CAPACITOR-FXD 100UF	28480	0180-3384
A6A1C4	0180-3345	4	1	CAPACITOR-FXD 1500UF	28480	0180-3345
A6A1C5	0180-3341	0	1	CAPACITOR-FXD 330UF	28480	0180-3341
A6A1C6	0180-3383	0	1	CAPACITOR-FXD 2700UF	28480	0180-3383
A6A1C7	0160-3875	3	2	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A6A1C8	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A6A1C9	0180-3346	5	1	CAPACITOR-FXD 680UF	28480	0180-3346
A6A1C10	0180-3228	2	1	CAPACITOR-FXD 100UF +-20% 10VDC AL	28480	0180-3228
A6A1C11	0180-3347	6	1	CAPACITOR-FXD 330UF	28480	0180-3347
A6A1C12	0160-2437	1	1	CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-2437
A6A1CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6A1CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6A1CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6A1CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6A1CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6A1CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6A1CR7	1901-0028	5	1	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A6A1DS1	1990-0944	1	1	LED-RED	28480	1990-0944
A6A1E1	9170-0847	3	2	CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE COATED
A6A1E2	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE COATED
A6A1E3	9170-0962	3	1	CORE-SHIELDING BEAD	28480	9170-0962
A6A1J1	1250-1425	7	2	CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
A6A1J2	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
A6A1MP1	1205-0011	0	3	HEAT SINK TO-5/TO-39-CS	28480	1205-0011
A6A1MP2	1205-0011	0		HEAT SINK TO-5/TO-39-CS	28480	1205-0011
A6A1MP3	1205-0011	0		HEAT SINK TO-5/TO-39-CS	28480	1205-0011
A6A1MP4	1205-0037	0	1	HEAT SINK TO-18-CS	28480	1205-0037
A6A1MP5	0360-0005	9	1	TERMINAL-SLDR LUG PL-MTG FOR-#8-SCR	28480	0360-0005

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6A1MP6	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A6A1MP7	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A6A1MP8	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A6A1MP9	2190-0009	4		WASHER-LK INTL T NO. 8 .168-IN-ID	28480	2190-0009
A6A1MP10	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A6A1MP11	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
A6A1MP12	2200-0139	4	5	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0139
A6A1MP13	2200-0139	4		SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0139
A6A1MP14	2200-0139	4		SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0139
A6A1MP15	2580-0002	4		NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
A6A1MP16	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A6A1MP17	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A6A1MP18	11729-20015	8	1	COVER LOW NOISE AMPLIFIER	28480	11729-20015
A6A1Q1	1854-0597	2	6	TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
A6A1Q2	1854-0597	2		TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
A6A1Q3	1854-0597	2		TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
A6A1Q4				NOT ASSIGNED		
A6A1Q5	1853-0430	0	1	TRANSISTOR PNP 2N4959 SI TO-72 PD=200MW	04713	2N4959
A6A1Q6	1854-0597	2		TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
A6A1Q7	1854-0597	2		TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
A6A1Q8	1854-0597	2		TRANSISTOR NPN 2N5943 SI TO-39 PD=1W	04713	2N5943
A6A1Q9	1853-0405	9	1	TRANSISTOR PNP SI PD=300MW FT=850MHZ	04713	2N4209
A6A1Q10	1853-0314	9	1	TRANSISTOR PNP 2N2905A SI TO-39 PD=600MW	04713	2N2905A
A6A1R1				NOT ASSIGNED		
A6A1R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6A1R3	0757-0441	8	1	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A6A1R4	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A6A1R5	0698-3153	9	2	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A6A1R6	0698-3150	6	1	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A6A1R7	0757-0428	1	1	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A6A1R8	0698-3446	3	1	RESISTOR 383 1% .125W F TC=0+-100	24546	C4-1/8-T0-383R-F
A6A1R9	0757-0422	5	3	RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A6A1R10	0757-0416	7	1	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A6A1R11	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A6A1R12	0698-0085	0	1	RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A6A1R13	0757-0420	3	2	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A6A1R14	0757-0405	4	1	RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A6A1R15	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6A1R16	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A6A1R17	0757-0814	9	1	RESISTOR 511 1% .5W F TC=0+-100	28480	0757-0814
A6A1R18	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A6A1R19	0757-0346	2	2	RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6A1R20	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6A1R21	0757-1094	9	1	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A6A1R22	0757-1002	9	2	RESISTOR 61.9 1% .5W F TC=0+-100	28480	0757-1002
A6A1R23	0698-8822	9	2	RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A6A1R24	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A6A1R25	0757-1002	9		RESISTOR 61.9 1% .5W F TC=0+-100	28480	0757-1002
A6A1R26	0698-3435	0	1	RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A6A1R27	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A6A1TP1	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A6A1TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A6A1TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A6A1TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A6MP1	11729-20097	6	1	AMPLIFIER HOUSING	28480	11729-20097
A6MP2	0624-0077	5	6	SCREW-TPG 4-40 .312-IN-LG PAN-HD-POZI	28480	0624-0077
A6MP3	0624-0077	5		SCREW-TPG 4-40 .312-IN-LG PAN-HD-POZI	28480	0624-0077
A6MP4	0624-0077	5		SCREW-TPG 4-40 .312-IN-LG PAN-HD-POZI	28480	0624-0077
A6MP5	0624-0077	5		SCREW-TPG 4-40 .312-IN-LG PAN-HD-POZI	28480	0624-0077
A6MP6	0624-0077	5		SCREW-TPG 4-40 .312-IN-LG PAN-HD-POZI	28480	0624-0077
A6MP7	0624-0077	5		SCREW-TPG 4-40 .312-IN-LG PAN-HD-POZI	28480	0624-0077

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7	11729-60092	5	1	POWER SUPPLY BOARD ASSEMBLY	28480	11729-60092
A7C1	0180-3285	1	1	CAPACITOR-FXD ELEC 1200UF 50VDC	28480	0180-3285
A7C2	0180-3281	7	1	CAPACITOR-FXD 6500UF +75-10% 30VDC AL	28480	0180-3281
A7C3	0180-3284	0	1	CAPACITOR-FXD .015F+75-10% 15VDC AL	28480	0180-3284
A7C4	0180-3280	6	1	CAPACITOR-FXD 1800UF +100-10% 30VDC AL	28480	0180-3280
A7C5	0160-5652	8	2	CAPACITOR-FXD 2.2UF +-20% 50VDC CER	28480	0160-5652
A7C6	0180-2205	3	1	CAPACITOR-FXD .33UF+-10% 35VDC TA	56289	150D334X9035A2
A7C7	0180-1743	2	2	CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A7C8	0160-5652	8		CAPACITOR-FXD 2.2UF +-20% 50VDC CER	28480	0160-5652
A7C9	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A7C10	0180-0374	3	3	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A7C11	0180-0291	3	3	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A7C12	0180-1743	2		CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A7C13	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A7C14	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A7C15	0180-0423	3	2	CAPACITOR-FXD 100UF+50-10% 25VDC AL	28480	0180-0423
A7C16	0180-0491	5	1	CAPACITOR-FXD 10UF+-20% 25VDC TA	28480	0180-0491
A7C17	0160-4005	3	1	CAPACITOR-FXD 1UF +-20% 100VDC CER	28480	0160-4005
A7C18	0160-3876	4	1	CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A7C19	0180-0423	3		CAPACITOR-FXD 100UF+50-10% 25VDC AL	28480	0180-0423
A7C20	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A7C21	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A7C22	0160-4387	4	1	CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A7C23	0180-3644	6	1	CAPACITOR-FXD 1500UF +-20% 10UDC THERMO	28480	0180-3644
A7CR1	1901-0159	3	17	DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR2	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR3	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR4	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR5	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR6	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR7	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR8	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR9	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR10	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR11	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR12	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR13	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR14	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR15	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR16	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7CR17	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A7DS1	1990-0678	8	5	LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	1990-0678
A7DS2	1990-0678	8		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	1990-0678
A7DS3	1990-0678	8		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	1990-0678
A7DS4	1990-0678	8		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	1990-0678
A7DS5	1990-0678	8		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	1990-0678
A7F1	2110-0202	1	1	FUSE .5A 250V TD 1.25X.25 UL	75915	313.500
A7F2	2110-0002	9	1	FUSE 2A 250V NTD 1.25X.25 UL	75915	312002
A7F3	2110-0055	2	1	FUSE 4A 250V NTD 1.25X.25 UL	75915	312004
A7F4	2110-0012	1	2	FUSE .5A 250V NTD 1.25X.25 UL	28480	2110-0012
A7J1	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A7J2	1251-3475	3	1	CONNECTOR 10-PIN M POST TYPE	28480	1251-3475
A7J3	1251-7165	6	1	CONNECTOR 26-PIN M POST TYPE	28480	1251-7165
A7J4	1251-7727	6	1	CONNECTOR- 7 PIN	28480	1251-7727
A7J5	1250-0836	2	3	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0836
A7J6	1250-0836	2		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0836
A7J7	1250-0836	2		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0836
A7J8	1250-0835	1	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A7J9	1250-0835	1		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
A7L1	9100-1641	0	1	INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A7L2	9100-2247	4	1	INDUCTOR RF-CH-MLD 100NH 10% .105DX.26LG	28480	9100-2247

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7MP1	1251-4459	5		CLIP-CABLE PLUG RTNG-DUAL INLINE 14 CONT	28480	1251-4459
A7MP2	2110-0269	0	8	FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A7MP3	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A7MP4	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A7MP5	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A7MP6	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A7MP7	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A7MP8	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A7MP9	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A7Q1				NOT ASSIGNED		
A7Q2	1884-0244	9	3	THYRISTOR-SCR VRRM=400	3L585	S2600D
A7Q3	1884-0244	9		THYRISTOR-SCR VRRM=400	3L585	S2600D
A7Q4	1884-0244	9		THYRISTOR-SCR VRRM=400	3L585	S2600D
A7R1				NOT ASSIGNED		
A7R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R3	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A7R4	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A7R5	0757-0288	1	1	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
A7R6	0698-3155	1	2	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A7R7	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A7R8	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A7R9	0757-0403	2	1	RESISTOR 121 1% .125W F TC=0+-100	24546	C4-1/8-T0-121R-F
A7R10	2100-3288	8	1	RESISTOR-TRMR 50 20% C TOP-ADJ 17-TRN	28480	2100-3288
A7R11	0698-3442	9	1	RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A7R12	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A7R13	0698-3445	2	1	RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A7R14	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A7R15	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R16	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A7R17	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R18	0698-3443	0	1	RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A7R19	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A7R20	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A7R21	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A7R22	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R23	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R24	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R25	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R26	0698-3390	6	2	RESISTOR 19.6 1% .5W F TC=0+-100	28480	0698-3390
A7R27	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A7R28	0698-3390	6		RESISTOR 19.6 1% .5W F TC=0+-100	28480	0698-3390
A7R29	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A7R31	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A7R32	0698-6360	6	1	RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A7R33	0698-3156	2	1	RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A7R34	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R35	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A7R36	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7TP1	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A7TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A7TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A7TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A7TP5	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A7TP6	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A7U1-A7U4				NOT ASSIGNED		
A7U5	1826-0783	9	1	IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A7VR1	1902-0969	5	1	DIODE-ZNR 30V 5% DO-35 PD=.4W TC=+.095%	28480	1902-0969
A7VR2	1902-0644	3	1	DIODE-ZNR 1N5363B 30V 5% PD=5W TC=+29MV	28480	1902-0644
A7VR3	1902-0963	9	1	DIODE-ZNR 16V 5% DO-35 PD=.4W TC=+.088%	28480	1902-0963
A7VR4	1902-0951	5		DIODE-ZNR 5.1V 5% DO-35 PD=.4W TC=+.035%	28480	1902-0951
A7VR5	1902-1340	8	1	DIODE-ZNR 1N5355B 18V 5% PD=5W IR=500NA	04713	1N5355B

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7VR6	1902-0965	1	1	DIODE-ZNR 20V 5% DO-35 PD=.4W TC=+.092%	28480	1902-0965
A7VR7	1902-0958	2		DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075%	28480	1902-0958
A7VR8	1902-0958	2		DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075%	28480	1902-0958
A7VR9	1902-0958	2		DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.075%	28480	1902-0958
A7VR10	1902-0630	7	1	DIODE-ZNR 1N5236B 7.5V 5% DO-7 PD=.5W	04713	1N5236B
A7XA5	1251-1365	6	1	CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A8	11729-60012	9	1	HP-IB INTERCONNECT BOARD ASSEMBLY	28480	11729-60012
A8J1	1251-5615	7	2	CONNECTOR 34-PIN M POST TYPE	28480	1251-5615
A8J2	1251-3283	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3283
A8J3	1200-0508	0		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A8MP1	0380-0643	3	2	STANDOFF-HEX .255-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A8MP2	0380-0643	3		STANDOFF-HEX .255-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
A8MP3	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
A8MP4	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
A8MP5	0535-0004	9		NUT-HEX DBL-CHAM M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
A8MP6	0535-0004	9		NUT-HEX DBL-CHAM M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
A8MP7	1251-4459	5		CLIP-CABLE PLUG RTNG-DUAL INLINE 14 CONT	28480	1251-4459
A8MP8	1530-1098	4	2	CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
A8MP9	1530-1098	4		CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
A8MP10	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
A8MP11	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
A8MP12	2190-0019	6	2	WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0019
A8MP13	2190-0019	6		WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0019
A9	11729-60109	5	1	MICROPROCESSOR BOARD ASSEMBLY	28480	11729-60109
A9C1	0180-2207	5	1	CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A9C2	0180-2620	6	4	CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A9C3	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A9C4	0160-4835	7	28	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C5	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C6	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C7	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C8	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C9	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C10	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9C11	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9C12	0160-0127	2	1	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A9C13	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C14	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C15	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C16	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C17	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C18	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C19	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C20	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C21	0180-1745	4	1	CAPACITOR-FXD 1.5UF+-10% 20VDC TA	56289	150D155X9020A2
A9C22	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A9C23	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C24	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C25	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C26	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C27	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C28	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C29	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C30	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C31	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C32	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C33	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C34	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C35	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9C36	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A9C37	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A9C38	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A9C39	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A9C40	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A9CR1	1901-0376	6	1	DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A9DS1	1990-0933	8	2	LED-LAMP RED	28480	1990-0933
A9DS2	1990-0933	8		LED-LAMP RED	28480	1990-0933
A9J1	1251-5615	7		CONNECTOR 34-PIN M POST TYPE	28480	1251-5615
A9J2	1251-7335	2	1	CONNECTOR	28480	1251-7335
A9J3	1251-8967	8	1	CONN-POST TYPE .100-PIN-SPCG 29-CONT	28480	1251-8967
A9J4	1251-4428	8	1	CONNECTOR 50-PIN M POST TYPE	28480	1251-4428
A9L1	9100-1626	1		INDUCTOR RF-CH-MLD 36UH 5% .166DX.385LG	28480	9100-1626
A9MP1	0361-0009	5	3	RIVET-SEMITUB OVH .123 DIA .188LG	00000	ORDER BY DESCRIPTION
A9MP2	0361-0009	5		RIVET-SEMITUB OVH .123 DIA .188LG	00000	ORDER BY DESCRIPTION
A9MP3	0361-0009	5		RIVET-SEMITUB OVH .123 DIA .188LG	00000	ORDER BY DESCRIPTION
A9MP4	5040-1497	2	3	HINGE-MOLDED	28480	5040-1497
A9MP5	5040-1497	2		HINGE-MOLDED	28480	5040-1497
A9MP6	5040-1497	2		HINGE-MOLDED	28480	5040-1497
A9MP7	0340-0944	3	1	INSULATOR-IC NYLON BLACK	28480	0340-0944
A9R1	1810-0279	5	6	NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
A9R2	1810-0279	5		NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
A9R3	0698-0084	9	1	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A9R4	1810-0279	5		NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
A9R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A9R6	1810-0279	5		NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
A9R7	0757-0199	3	2	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A9R8	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A9R9	0757-0464	5	2	RESISTOR 90.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9092-F
A9R10	0757-0464	5		RESISTOR 90.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9092-F
A9R11	1810-0279	5		NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
A9R12	1810-0279	5		NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
A9R13	1810-0273	9	1	NETWORK-RES 10-SIP470.0 OHM X 9	01121	210A471
A9R14	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A9R15	1810-0269	3	1	NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0269
A9R16	0757-0290	5	1	RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A9R17	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A9S1	3101-2126	4	1	SWITCH-SL 5-SPDT DIP-SLIDE-ASSY .1A	28480	3101-2126
A9S2	3101-2172	0	1	SWITCH-TGL DIP-RKR-ASSY SPDT .05A 30VDC	28480	3101-2172
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	1820-1212	9	1	IC FF TTL LS J-K NEG-EDGE-TRIG	01295	SN74LS112AN
A9U2	1820-2549	7	1	IC-8291A P HPIB	28480	1820-2549
A9U3	1818-1768	5	1	IC,CMOS 16384 (16K) STAT RAM 150-NS 3-S	S0545	UPD446C-1(PER HP DWG)
A9U4	11729-80010	9	1	EPROM	28480	11729-80010
A9U5	1820-2624	9	1	IC-MPU; CLK FREQ=2MHZ, ENHANCED 6800	28480	1820-2624
A9U6	1820-2081	2	1	IC NMOS	04713	MC68A21P
A9U7	1820-1199	1	3	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A9U8	1820-1216	3	3	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A9U9	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A9U10	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A9U11	1820-1423	4	1	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A9U12	1826-0138	8	1	IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A9U13	1820-1730	6	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A9U14	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A9U15	1826-0175	3	1	IC COMPARATOR GP DUAL 14-DIP-P PKG	27014	LM319N

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9U16	11729-80002	9	1	PAL-ADRS. DECODER	28480	11729-80002
A9U17	1820-1197	9	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A9U18	1820-2024	3	5	IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A9U19	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U20	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U21	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U22	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U23	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A9U24	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A9U25	1820-1858	9	3	IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A9U26	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A9U27	1820-1858	9		IC FF TTL LS D-TYPE OCTL	01295	SN74LS377N
A9U28	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A9U29	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U30	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U31	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U32	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A9U33	1820-3513	7	1	IC TRANSCEIVER TTL S INSTR-BUS IEEE-488	28480	1820-3513
A9U34	1820-3431	8	1	IC TRANSCEIVER TTL S INSTR-BUS IEEE-488	28480	1820-3431
A9U35	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A9U36	1820-2075	4	3	IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A9U37	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A9U38	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A9U39	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A9U40	1820-1112	8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A9U41	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U42	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U43	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U44	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A9U45	1820-1851	2	2	IC ENCDR TTL LS	01295	SN74LS148N
A9U46	1820-1851	2		IC ENCDR TTL LS	01295	SN74LS148N
A9U47	1820-1587	1	4	IC DRVR TTL LED DRVR HEX 1-INP	27014	DM8859N
A9U48	1820-1587	1		IC DRVR TTL LED DRVR HEX 1-INP	27014	DM8859N
A9U49	1820-1587	1		IC DRVR TTL LED DRVR HEX 1-INP	27014	DM8859N
A9U50	1820-1587	1		IC DRVR TTL LED DRVR HEX 1-INP	27014	DM8859N
A9U51	1820-0668	7	1	IC BFR TTL NON-INV HEX 1-INP	01295	SN7407N
A9U52	1820-1470	1	1	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A9U53	1820-1445	0	1	IC LCH TTL LS 4-BIT	01295	SN74LS375N
A9U54	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U55	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U56	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9U57	1820-2973	1		IC DRVR TTL PRPHL HV DUAL	28480	1820-2973
A9XU4	1200-0567	1	1	SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A9XU5	1200-0654	7	1	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A9Y1	1813-0130	3	1	XTAL-CLOCK-OSCILLATOR 16-MHZ 0.05% TTL	28480	1813-0130
A10	11729-60086	7	1	IF AMPLIFIER ASSEMBLY	28480	11729-60086
A10FL1	9135-0174	5		FILTER-LOW PASS LEADS-TERMS	28480	9135-0174
A10J1	1250-1887	5	2	SMA FEMALE CONNECTOR	28480	1250-1887
A10J2	1250-1887	5		SMA FEMALE CONNECTOR	28480	1250-1887
A10MP1	0515-0104	8	37	SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
A10MP2	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
A10MP3	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
A10MP4	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
A10MP5	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
A10MP6	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
A10MP7	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
A10MP8	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
A10MP9	0515-0207	2	10	SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207
A10MP10	0515-0207	2		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A10MP11	0515-0207	2		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207
A10MP12	0515-0207	2		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207
A10MP13	0515-0207	2		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207
A10MP14	0515-0207	2		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207
A10MP15	0515-0207	2		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207
A10MP16	0515-0207	2		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207
A10MP17	0515-0207	2		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207
A10MP18	0515-0207	2		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	28480	0515-0207
A10MP19	0515-0276	5	12	SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP20	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP21	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP22	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP23	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP24	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP25	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP26	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP27	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP28	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP29	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP30	0515-0276	5		SCREW-MACH M2 X 0.4 8MM-LG 90-DEG-FLH-HD	28480	0515-0276
A10MP31	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A10MP32	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A10MP33	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A10MP34	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A10MP35	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A10MP36	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A10MP37	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A10MP38	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
A10MP39	2190-0654	5	12	WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP40	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP41	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP42	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP43	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP44	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP45	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP46	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP47	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP48	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
A10MP49	3050-1066	0	10	WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP50	3050-1066	0		WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP51	3050-1066	0		WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP52	3050-1066	0		WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP53	3050-1066	0		WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP54	3050-1066	0		WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP55	3050-1066	0		WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP56	3050-1066	0		WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP57	3050-1066	0		WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP58	3050-1066	0		WASHER-FL MTLC 2.0 MM 2.28-MM-ID	28480	3050-1066
A10MP59	11729-00032	7	1	COVER IF AMP	28480	11729-00032
A10MP60	11729-20049	8	1	HOUSING IF AMP	28480	11729-20049
A10MP61	0360-0374	5	1	TERMINAL-SLDR LUG PL-MTG FOR-#4-SCR	79963	9-120
A10MP62- A10MP67	0515-0264	1		SCREW-MACH M3 X 0.5 30MM-LG PAN-HD	28480	0515-0264
	0515-0264	1	16	SCREW-MACH M3 X 0.5 30MM-LG PAN-HD (USED TO MOUNT IF AMPLIFIER TO THE DECK.	28480	0515-0264
	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID USED TO MOUNT IF AMPLIFIER TO THE DECK.	28480	2190-0584
A11	11729-60071	0	1	POWER AMPLIFIER ASSEMBLY	28480	11729-60071
A11MP1	11729-00034	9	2	GASKET	28480	11729-00034
A11MP2	11729-00034	9		GASKET	28480	11729-00034
A11MP3	0960-0665	9	1	ER DIVISION	28480	0960-0665
	0515-0264	1		SCREW-MACH M3 X 0.5 30MM-LG PAN-HD (USED TO MOUNT POWER AMP TO DECK)	28480	0515-0264
	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID (USED TO MOUNT POWER AMP TO DECK)	28480	2190-0584
	3050-0105	6	51	WASHER-FL MTLC NO. 4 .125-IN-ID (USED TO MOUNT POWER AMP TO DECK)	28480	3050-0105

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				MISCELLANEOUS		
A12	0960-0443	1	1	LINE MODULE-FILTERED (PART OF W1. DOES NOT INCLUDE C1)	28480	0960-0443
AT1	0960-0053	9	1	TERMINATION-COAXIAL 50 OHMS; FREQUENCY	28480	0960-0053
AT2	0955-0178	8	1	ISOLATOR FREQ RANGE: 6 TO 18 GHZ; VSWR	28480	0955-0178
	11729-20105	7	1	PLASTIC ISOLATOR BRACKET	28480	11729-20105
	0515-0974	0	2	SCREW-MACH M2 X 0.4 16MM-LG PAN-HD (BRACKET TO POWER AMPLIFIER)	28480	0515-0974
	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID (BRACKET TO POWER AMPLIFIER)	28480	2190-0584
	2200-0169	0	2	SCREW-MACH 4-40 .5-IN-LG 82 DEG (BRACKET TO ISOLATOR)	28480	2200-0169
AT3	11593A	7	1	BNC TERMINATION	28480	11593A
B1	3160-0266	3	1	FAN-TBAX 36-CFM 6-16VDC	28480	3160-0266
C1	0160-4065	5	1	CAPACITOR-FXD .1UF +-20% 250VAC(RMS)	28480	0160-4065
CR1	1906-0231	2	1	DIODE-CT-RECT 200V 15A	28480	1906-0231
CR2	11729-60053	8	1	CRYSTAL DETECTOR (OPT. 130 ONLY)	28480	11729-60053
F1	2110-0001	8	1	FUSE 1A 250V NTD 1.25X.25 UL (FOR 100V TO 120V AC INPUT)	75915	312001
F1	2110-0012	1		FUSE .5A 250V NTD 1.25X.25 UL (FOR 220V TO 240V AC INPUT)	28480	2110-0012
FL1	0955-0222	3	1	FILTER-BANDPASS SMA FEM-TERMS (640MHZ)	28480	0955-0222
	0515-0055	8	14	SCREW-MACH M3 X 0.5 6MM-LG PAN-HD (USED TO MOUNT FL1)	28480	0515-0055
	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID (USED TO MOUNT FL1)	28480	2190-0584
	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID (USED TO MOUNT FL1)	28480	3050-0105
FL2	9135-0186	9	1	FILTER-BANDPASS SMA FEM-TERMS (1.92GHZ)	28480	9135-0186
FL3	9135-0178	9	1	FILTER-BANDPASS SMA FEM-TERMS (4.48GHZ)	28480	9135-0178
FL4	9135-0179	0	1	FILTER-BANDPASS SMA FEM-TERMS (7.04GHZ)	28480	9135-0179
FL5	9135-0180	3	1	FILTER-BANDPASS SMA FEM-TERMS (9.60GHZ)	28480	9135-0180
FL6	9135-0181	4	1	FILTER-BANDPASS SMA FEM-TERMS (12.16GHZ)	28480	9135-0181
FL7	9135-0182	5	1	FILTER-BANDPASS SMA FEM-TERMS (14.72GHZ)	28480	9135-0182
FL8	9135-0183	6	1	FILTER-BANDPASS SMA FEM-TERMS (17.28GHZ)	28480	9135-0183
G1	0955-0182	4	1	COMB GENERATOR	28480	0955-0182
G2	3160-0310	8	1	MODULE-MOTOR SPEED CONTROL FOR FAN	D3976	3.431.036.01
	0515-0597	3	2	SCREW-MACH M2.5 X 0.45 20MM-LG (USED TO MOUNT G2)	28480	0515-0597
	0535-0008	?	2	NUT-HEX DBL-CHAM M2.5 X 0.45 2MM-THK (USED TO MOUNT G2)	00000	ORDER BY DESCRIPTION
	2190-0086	7	2	WASHER-LK HLCL NO. 4 .115-IN-ID (USED TO MOUNT G2)	28480	2190-0086
	3050-0890	6	2	WASHER-FL MTLC 2.5 MM 2.78-MM-ID (USED TO MOUNT G2)	28480	3050-0890
J1	1250-0102	5	9	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0102
J2	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0102
J3	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0102
J4	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0102
J5	11729-60030	1	2	OUTPUT CONN ASSY	28480	11729-60030
J6	11729-60030	1		OUTPUT CONN ASSY	28480	11729-60030
J7				NOT ASSIGNED		
J8	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0102
J9	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0102
J10	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0102
J11	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0102
J12	1250-0102	5		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0102
J13-J26	1250-1251	7	14	ADAPTER-COAX STR F-SMA F-SMA (OPTION 140; REAR PANEL CONNECTORS)	28480	1250-1251

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP1	5061-9435	8	1	COVER-TOP ASSY	28480	5061-9435
MP2	5061-9447	2	1	COV-BOTTOM ASSY	28480	5061-9447
MP3	5060-9876	9	2	COVER SIDE	28480	5060-9876
MP4	5060-9876	9		COVER SIDE	28480	5060-9876
MP5	5060-9804	3	2	STRAP HANDLE 18 IN.	28480	5060-9804
MP6	5060-9804	3		STRAP HANDLE 18 IN.	28480	5060-9804
MP7	5041-6820	7	2	STRAP, HANDLE, CAP-REAR	28480	5041-6820
MP8	5041-6820	7		STRAP, HANDLE, CAP-REAR	28480	5041-6820
MP9	5041-6819	4	2	STRAP, HANDLE, CAP-FRONT	28480	5041-6819
MP10	5041-6819	4		STRAP, HANDLE, CAP-FRONT	28480	5041-6819
MP11	5040-7201	8	4	FOOT(STANDARD)	28480	5040-7201
MP12	5040-7201	8		FOOT(STANDARD)	28480	5040-7201
MP13	5040-7201	8		FOOT(STANDARD)	28480	5040-7201
MP14	5040-7201	8		FOOT(STANDARD)	28480	5040-7201
MP15	1460-1345	5	2	TILT STAND SST	28480	1460-1345
MP16	1460-1345	5		TILT STAND SST	28480	1460-1345
MP17	5040-7221	2	4	FOOT, REAR	28480	5040-7221
MP18	5040-7221	2		FOOT, REAR	28480	5040-7221
MP19	5040-7221	2		FOOT, REAR	28480	5040-7221
MP20	5040-7221	2		FOOT, REAR	28480	5040-7221
MP21	0515-1232	5	4	SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD	28480	0515-1232
MP22	0515-1232	5		SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD	28480	0515-1232
MP23	0515-1232	5		SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD	28480	0515-1232
MP24	0515-1232	5		SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD	28480	0515-1232
MP25	0515-1132	4	4	SCREW-MACH M5 X 0.8 10MM-LG	28480	0515-1132
MP26	0515-1132	4		SCREW-MACH M5 X 0.8 10MM-LG	28480	0515-1132
MP27	0515-1132	4		SCREW-MACH M5 X 0.8 10MM-LG	28480	0515-1132
MP28	0515-1132	4		SCREW-MACH M5 X 0.8 10MM-LG	28480	0515-1132
MP29	11729-00028	1	2	MAGNETIC SHIELD	28480	11729-00028
MP30	11729-00028	1		MAGNETIC SHIELD	28480	11729-00028
MP31	11729-00011	2	1	COVER INSULATOR	28480	11729-00011
MP32-MP60				NOT ASSIGNED		

See introduction to this section for ordering information

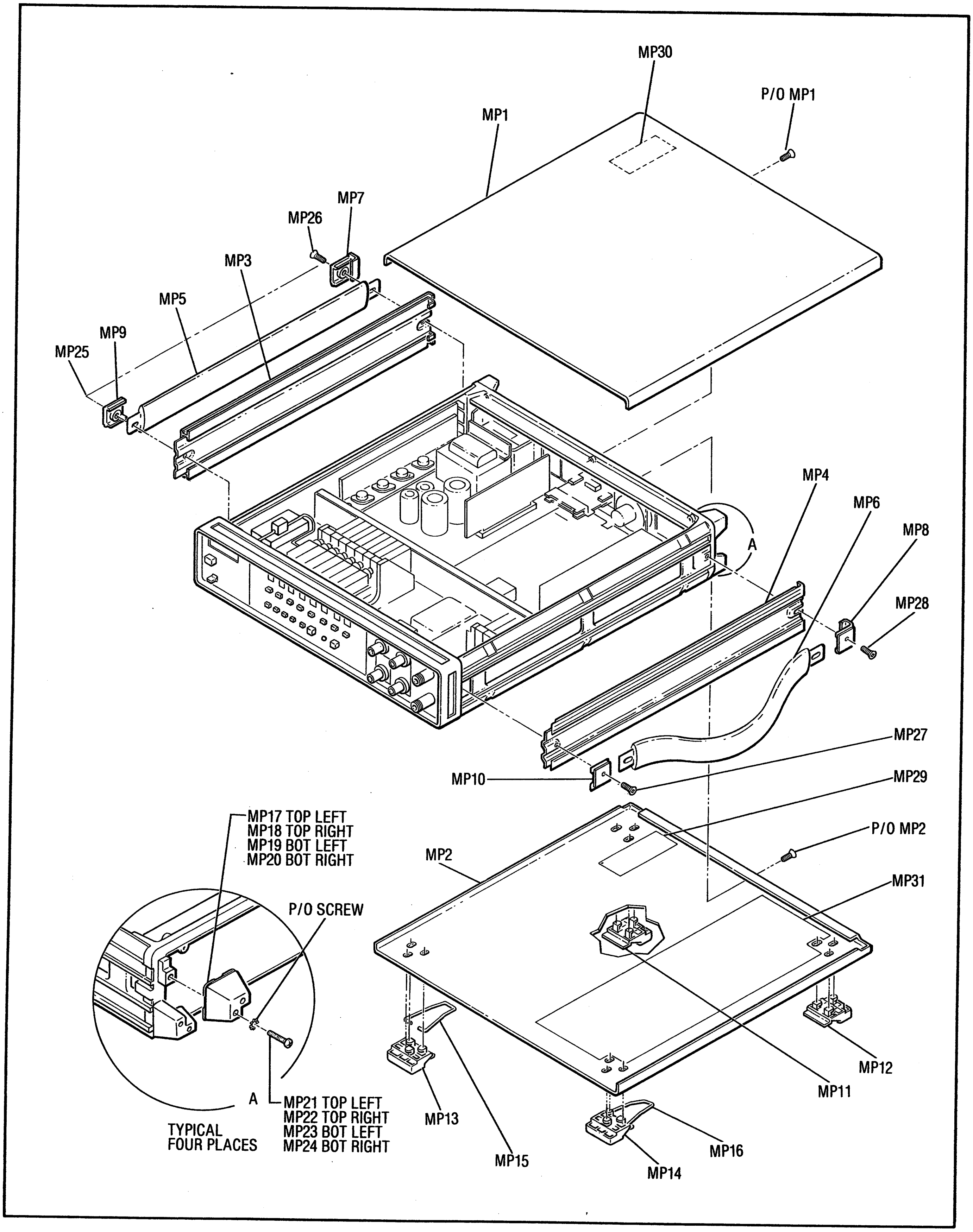


Figure 6-1. External Mechanical Parts

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP61	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP62	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP63	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP64	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP65	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP66	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP67	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP68	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP69- MP76	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP77	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP78	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP79	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP80	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP81	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP82	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP83	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP84	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP85				NOT ASSIGNED		
MP86- MP89	0515-0076	3	4	SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FLH-HD	28480	0515-0076
MP90	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP91	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP92	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP93	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP94	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP95	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP96	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP97	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP98	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP99	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP100	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP101	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP102	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP103	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP104	0515-0055	8		SCREW-MACH M3 X 0.5 6MM-LG PAN-HD	28480	0515-0055
MP105	11729-20103	5	1	FRAME REAR MOD	28480	11729-20103
MP106	5021-5801	0	1	FRONT FRAME	28480	5021-5801
MP107	11729-20094	3	1	SIDE STRUT LEFT	28480	11729-20094
MP108	11729-20101	3	1	SIDE STRUT RIGHT	28480	11729-20101
MP109	5001-0438	7	2	TRIM:SIDE	28480	5001-0438
MP110	5001-0438	7		TRIM:SIDE	28480	5001-0438
MP111	5040-7202	9	1	TRIM, TOP	28480	5040-7202
MP112	11729-00037	2	1	SUPPORT STRUT	28480	11729-00037
MP113	11729-00038	3	1	DECK MAIN	28480	11729-00038
MP114	0515-0896	5	4	SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0896
MP115	0515-0896	5		SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0896
MP116	0515-0896	5		SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0896
MP117	0515-0896	5		SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0896
MP118	0515-1331	5	4	SCREW-METRIC SPECIALTY M4 X 0.7 THD; 6	28480	0515-1331
MP119	0515-1331	5		SCREW-METRIC SPECIALTY M4 X 0.7 THD; 6	28480	0515-1331
MP120	0515-1331	5		SCREW-METRIC SPECIALTY M4 X 0.7 THD; 6	28480	0515-1331
MP121	0515-1331	5		SCREW-METRIC SPECIALTY M4 X 0.7 THD; 6	28480	0515-1331
MP122- MP139				NOT ASSIGNED		

See introduction to this section for ordering information

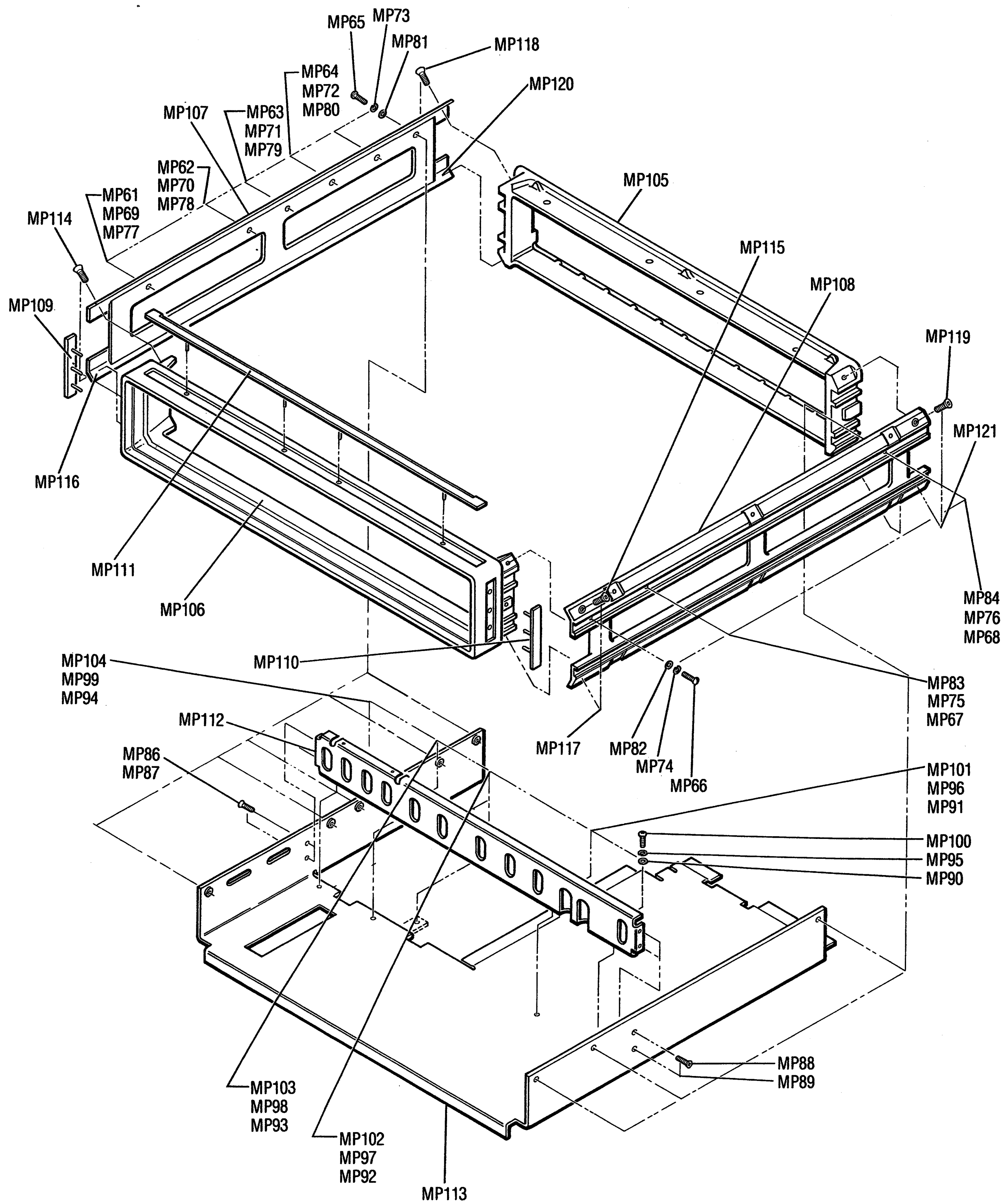


Figure 6-2. Chassis Parts

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP140- MP151	0515-0219	6	12	SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FLH-HD	00000	ORDER BY DESCRIPTION
MP152	11729-20044	3	2	SPACER DECK SUP	28480	11729-20044
MP153	11729-20044	3		SPACER DECK SUP	28480	11729-20044
MP154- MP157	2190-0068	5	9	WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
MP158	2950-0132	6	2	NUT-HEX-DBL-CHAM 7/16-28-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
MP159- MP162	2950-0054	1	9	NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
MP163	2190-0104	0	2	WASHER-LK INTL T 7/16 IN .439-IN-ID	28480	2190-0104
MP164	2190-0104	0		WASHER-LK INTL T 7/16 IN .439-IN-ID	28480	2190-0104
MP165	2950-0132	6		NUT-HEX-DBL-CHAM 7/16-28-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
MP166	0515-0443	8	3	SCREW-MACH M4 X 0.7 20MM-LG PAN-HD	28480	0515-0443
MP167	0515-0443	8		SCREW-MACH M4 X 0.7 20MM-LG PAN-HD	28480	0515-0443
MP168	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
MP169	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
MP170	3050-0139	6		WASHER-FL MTLC NO. 8 .172-IN-ID	28480	3050-0139
MP171	3050-0139	6		WASHER-FL MTLC NO. 8 .172-IN-ID	28480	3050-0139
MP172	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP173	11729-00027	0	1	FRONT PANEL RIGHT	28480	11729-00027
	11729-00053	2	1	DRESS PANEL RIGHT SIDE (OPTION 140)	28480	11729-00053
MP174	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP175	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP176	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP177	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP178	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP179	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP180	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP181	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP182	0510-1148	2	8	RETAINER-PUSH ON KB-TO-SHFT EXT	28480	0510-1148
MP183	0510-1148	2		RETAINER-PUSH ON KB-TO-SHFT EXT	28480	0510-1148
MP184	0515-0214	1	2	SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
MP185	0515-0214	1		SCREW-MACH M2 X 0.4 6MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
MP186	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
MP187	2190-0654	5		WASHER-LK HLCL 2.0 MM 2.1-MM-ID	28480	2190-0654
MP188	5040-6888	5	8	LIGHT PIPES	28480	5040-6888
MP189- MP193	5040-6888	5		LIGHT PIPES	28480	5040-6888
MP194	11729-00016	7	1	INSERT FILM	28480	11729-00016
MP195- MP200	0510-1148	2		RETAINER-PUSH ON KB-TO-SHFT EXT	28480	0510-1148
MP201- MP205	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP206- MP210	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP211- MP215	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP216	11729-00002	1	1	SUB PANEL FRT LS	28480	11729-00002
MP217	11729-00010	1	1	FRT PNL LEFT B	28480	11729-00010
MP218	11729-20042	1	1	WINDOW, FRONT	28480	11729-20042
MP219	7120-1254	1	1	NAMEPLATE .312-IN-WD .54-IN-LG AL	28480	7120-1254
MP220	11729-00052	1	1	FRT PNL CENTER B	28480	11729-00052
MP221	11729-00036	1	1	SUB PANEL CENTER	28480	11729-00036
MP222	11729-00003	2	1	SUB PANEL FRT RB	28480	11729-00003
MP223	5040-6888	5		LIGHT PIPES	28480	5040-6888
MP224	5040-6888	5		LIGHT PIPES	28480	5040-6888
MP225- MP265				NOT ASSIGNED		

See introduction to this section for ordering information

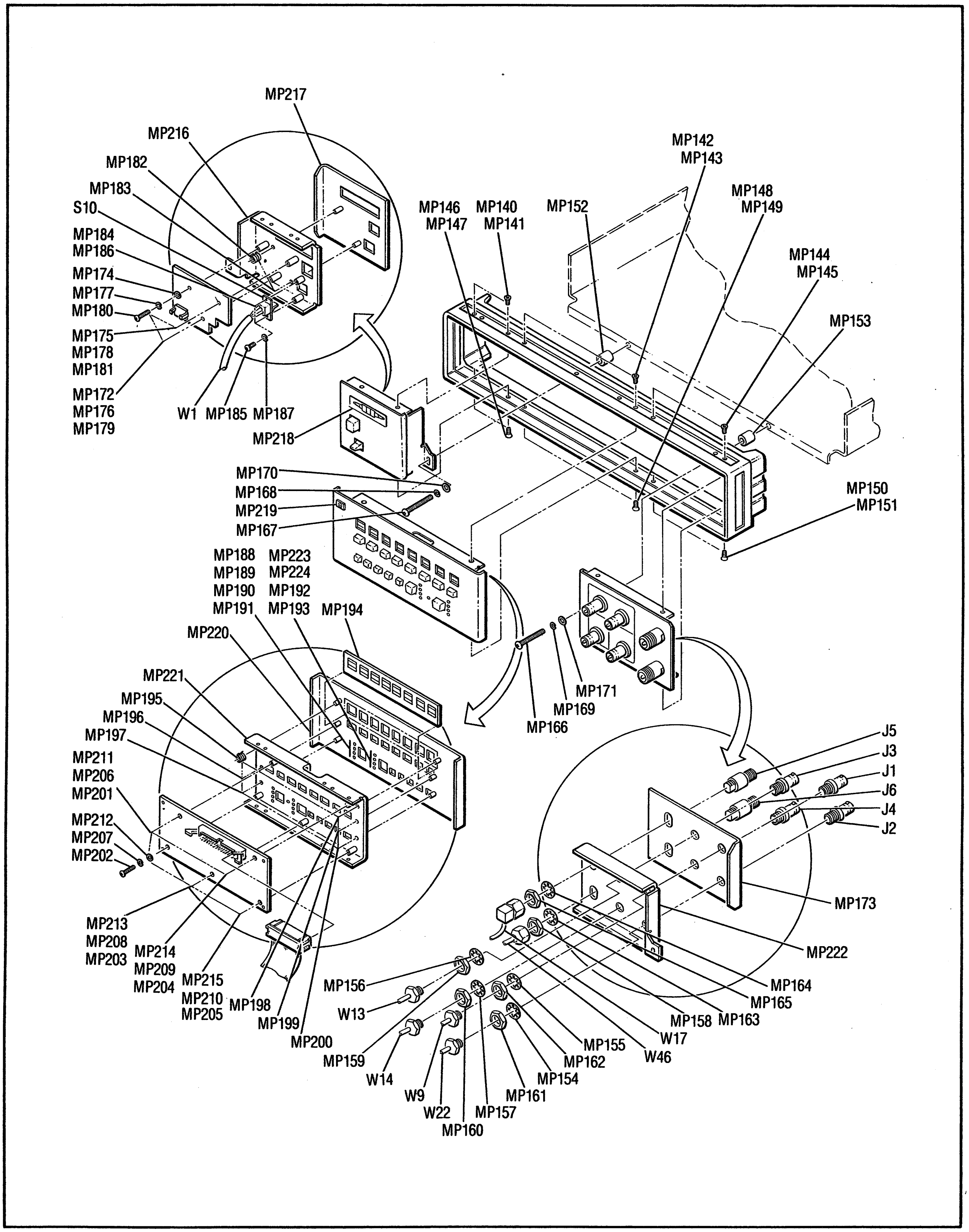


Figure 6-3. Front Panel Parts

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP266	11729-00039	4	1	PANEL REAR	28480	11729-00039
	11729-00050	9	1	PANEL REAR (OPTION 140)	28480	11729-00050
MP267	0515-0145	7	2	SCREW-MACH M3 X 0.5 8MM-LG 90-DEG-FLH-HD	00000	ORDER BY DESCRIPTION
MP268	0515-0145	7		SCREW-MACH M3 X 0.5 8MM-LG 90-DEG-FLH-HD	00000	ORDER BY DESCRIPTION
MP269	2200-0121	4	4	SCREW-MACH 4-40 1.125-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP270	2200-0121	4		SCREW-MACH 4-40 1.125-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP271	2200-0121	4		SCREW-MACH 4-40 1.125-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP272	2200-0121	4		SCREW-MACH 4-40 1.125-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP273	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP274	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP275	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP276	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP277	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP278	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP279	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP280	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP281	0590-0076	1	5	NUT-HEX-PLSTC LKG 4-40-THD .143-IN-THK	28480	0590-0076
MP282	0590-0076	1		NUT-HEX-PLSTC LKG 4-40-THD .143-IN-THK	28480	0590-0076
MP283	0590-0076	1		NUT-HEX-PLSTC LKG 4-40-THD .143-IN-THK	28480	0590-0076
MP284	0590-0076	1		NUT-HEX-PLSTC LKG 4-40-THD .143-IN-THK	28480	0590-0076
MP285	2190-0068	5		WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
MP286	2190-0068	5		WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
MP287	2190-0068	5		WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
MP288	2190-0068	5		WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
MP289	2190-0068	5		WASHER-LK INTL T 1/2 IN .505-IN-ID	28480	2190-0068
MP290	6960-0006	8	1	PLUG-HOLE DOME-HD FOR .25-D-HOLE STL	28480	6960-0006
MP291				NOT ASSIGNED		
MP292	11729-80001	8	4	SPACER FAN	28480	11729-80001
MP293	11729-80001	8		SPACER FAN	28480	11729-80001
MP294	11729-80001	8		SPACER FAN	28480	11729-80001
MP295	11729-80001	8		SPACER FAN	28480	11729-80001
MP296	0535-0004	9		NUT-HEX DBL-CHAM M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
MP297	0535-0004	9		NUT-HEX DBL-CHAM M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
MP298	1200-1103	3	3	SHIM (FOR HP-IB ADDRESS SWITCH)	28480	1200-1103
MP299	1200-1103	3		SHIM (FOR HP-IB ADDRESS SWITCH)	28480	1200-1103
MP300	1200-1103	3		SHIM (FOR HP-IB ADDRESS SWITCH)	28480	1200-1103
MP301	1200-1104	4	1	BEXEL-CONNECTOR(FOR HPIB ADDRESS SWITCH)	28480	1200-1104
MP302	11729-20045	4	1	FAN GUARD	28480	11729-20045
MP303	2950-0054	1		NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
MP304	2950-0054	1		NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
MP305	2950-0054	1		NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
MP306	2950-0054	1		NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
MP307	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP308	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP309	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP310	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP311	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP312- MP318	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP319	2950-0054	1		NUT-HEX-DBL-CHAM 1/2-28-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
MP320- MP359				NOT ASSIGNED		

See introduction to this section for ordering information

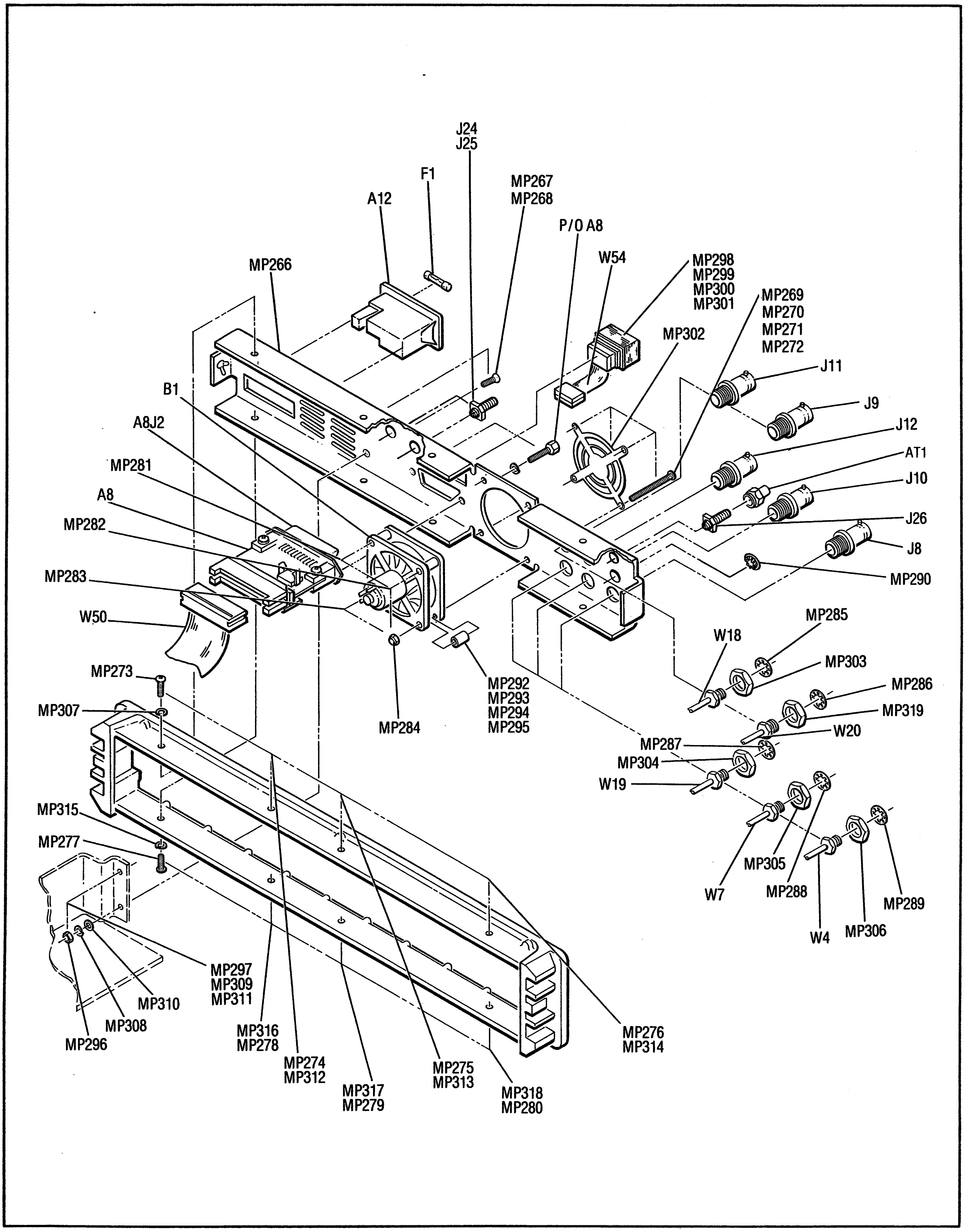


Figure 6-4. Rear Panel Parts

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP360	0590-0075	0	2	NUT-CAP 4-40-THD .25-IN-THK .25-A/F BRS	00000	ORDER BY DESCRIPTION
MP361	0590-0075	0		NUT-CAP 4-40-THD .25-IN-THK .25-A/F BRS	00000	ORDER BY DESCRIPTION
MP362	2200-0129	2	1	SCREW-MACH 4-40 2-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP363	0590-0076	1		NUT-HEX-PLSTC LKG 4-40-THD .143-IN-THK	28480	0590-0076
MP364	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP365	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP366	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
MP367	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
MP368	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
MP369	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
MP370	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
MP371	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
MP372	3050-0660	8	6	WASHER-FL MTLC NO. 8 .182-IN-ID .5-IN-OD	28480	3050-0660
MP373	3050-0660	8		WASHER-FL MTLC NO. 8 .182-IN-ID .5-IN-OD	28480	3050-0660
MP374	3050-0660	8		WASHER-FL MTLC NO. 8 .182-IN-ID .5-IN-OD	28480	3050-0660
MP375	3050-0660	8		WASHER-FL MTLC NO. 8 .182-IN-ID .5-IN-OD	28480	3050-0660
MP376	3050-0660	8		WASHER-FL MTLC NO. 8 .182-IN-ID .5-IN-OD	28480	3050-0660
MP377	3050-0660	8		WASHER-FL MTLC NO. 8 .182-IN-ID .5-IN-OD	28480	3050-0660
MP378	0515-0053	6	5	SCREW-MACH M4 X 0.7 10MM-LG PAN-HD	28480	0515-0053
MP379	0515-0053	6		SCREW-MACH M4 X 0.7 10MM-LG PAN-HD	28480	0515-0053
MP380	0515-0053	6		SCREW-MACH M4 X 0.7 10MM-LG PAN-HD	28480	0515-0053
MP381-MP384				NOT ASSIGNED		
MP385	0515-0443	8		SCREW-MACH M4 X 0.7 20MM-LG PAN-HD	28480	0515-0443
MP386	0515-0053	6		SCREW-MACH M4 X 0.7 10MM-LG PAN-HD	28480	0515-0053
MP387	0515-0053	6		SCREW-MACH M4 X 0.7 10MM-LG PAN-HD	28480	0515-0053
MP388	0570-1215	0	1	THD-ROD 4-40 UNC-2A 12-IN-LG BRS	28480	0570-1215
MP389	11729-20043	2	2	SWITCH SUPPORT (FOR S1 TO S7)	28480	11729-20043
MP390	11729-20043	2		SWITCH SUPPORT (FOR S1 TO S7)	28480	11729-20043
MP391	11729-20046	5	1	SUPPORT BAR	28480	11729-20046
MP392	11729-20029	4	2	SUPPORT COAX SWITCH (FOR S8 AND S9)	28480	11729-20029
MP393	11729-20029	4		SUPPORT COAX SWITCH (FOR S8 AND S9)	28480	11729-20029
MP394-MP429				NOT ASSIGNED		

See introduction to this section for ordering information

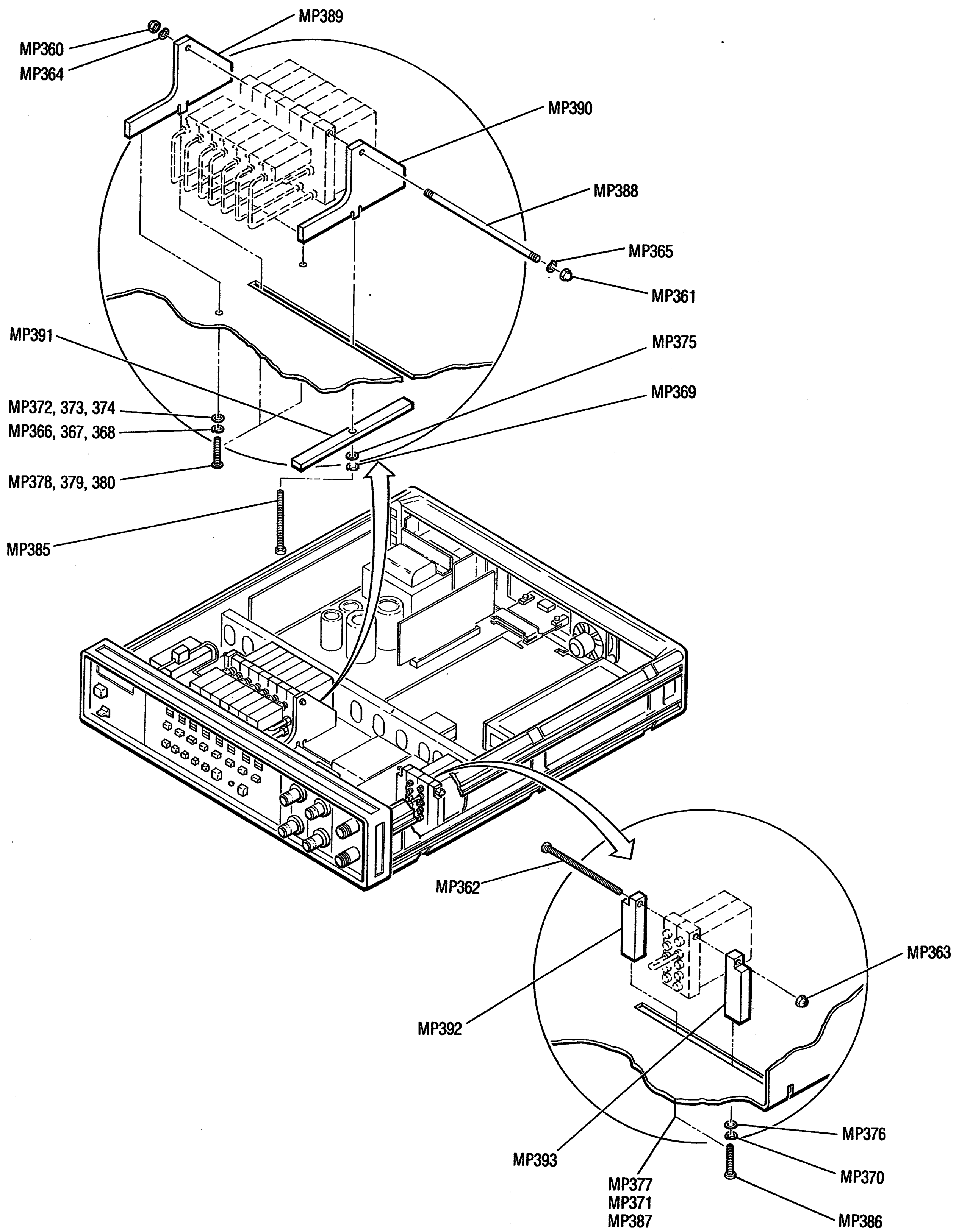


Figure 6-5. Switch Assembly Mechanical Parts

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP430	11729-20104	6	1	HEAT SINK	28480	11729-20104
MP431	11729-00020	3	1	DUCT AIR	28480	11729-00020
MP432	0515-0064	9	1	SCREW-MACH M3 X 0.5 16MM-LG PAN-HD	28480	0515-0064
MP433	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP434	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP435	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP436	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP437	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP438	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP439	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP440	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP441	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP442	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP443	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP444	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP445	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP446	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP447	0515-0208	3		SCREW-MACH M3 X 0.5 14MM-LG PAN-HD	28480	0515-0208
MP448	0515-0208	3		SCREW-MACH M3 X 0.5 14MM-LG PAN-HD	28480	0515-0208
MP449	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP450	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP451	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP452	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP453	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP454	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP455	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP456- MP460	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP461	0515-0085	4	4	SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0085
MP462	0515-0085	4		SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0085
MP463	0515-0085	4		SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0085
MP464	0515-0085	4		SCREW-MACH M4 X 0.7 10MM-LG	28480	0515-0085
MP465	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP466	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP467	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP468	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP469	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP470	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP471- MP496	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP497	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP498	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP499	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP500	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP501	2200-0139	4		SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0139
MP502	2200-0139	4		SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0139
MP503	5040-0170	6	2	GUIDE:PLUG-IN PC BOARD	28480	5040-0170
MP504	5040-0170	6		GUIDE:PLUG-IN PC BOARD	28480	5040-0170
MP505	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP506	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP507	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP508	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP509	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
MP510	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP511	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP512- MP559				NOT ASSIGNED		

See introduction to this section for ordering information

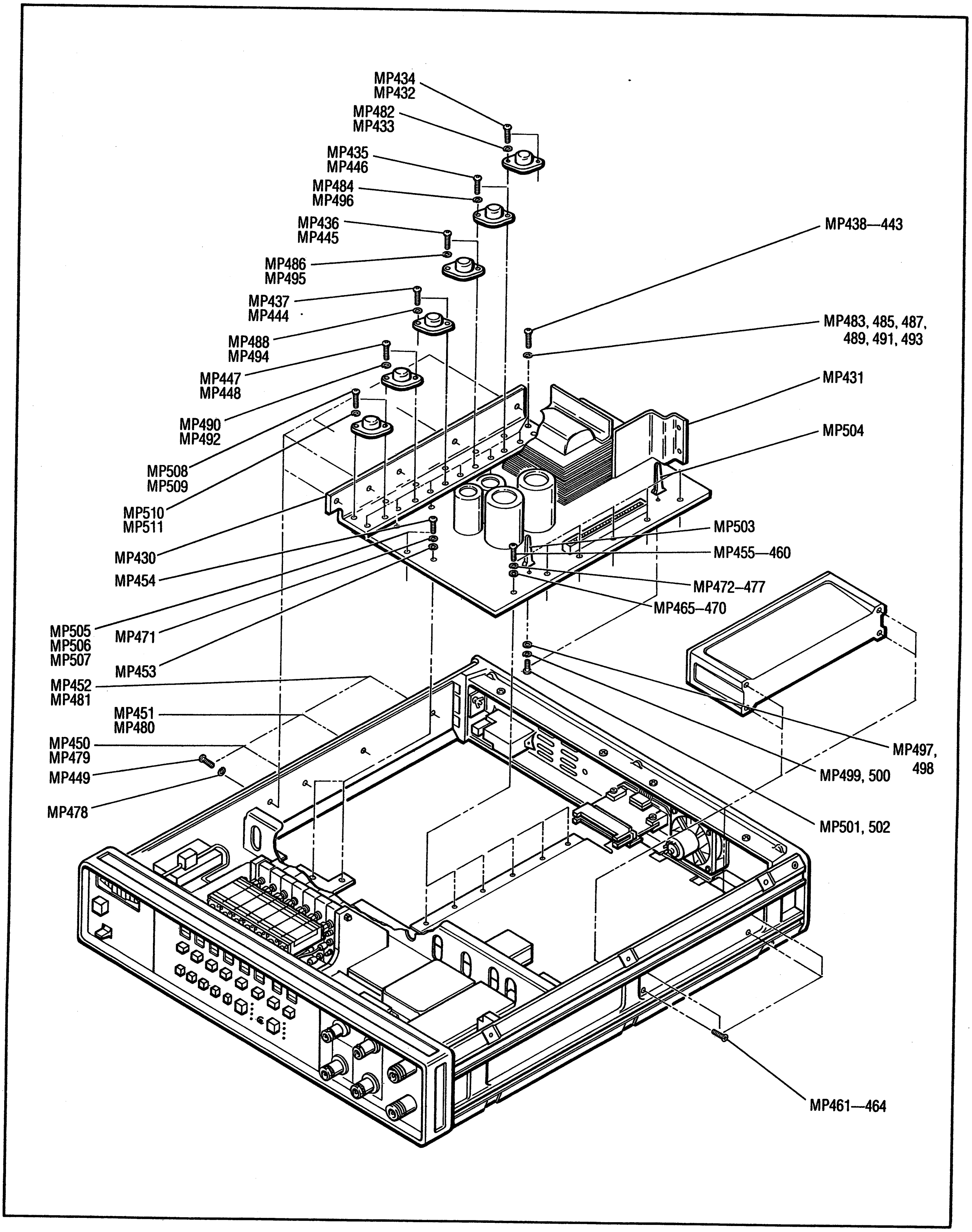


Figure 6-6. Power Supply and Low Noise Amplifier Mechanical Parts

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP560	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP561	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP562	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP563	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP564	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP565	0515-0104	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	28480	0515-0104
MP566	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP567	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP568	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP569	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP570	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP571	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP572	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP573	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP574	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP575	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP576	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP577	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP579-MP610				NOT ASSIGNED		

See introduction to this section for ordering information

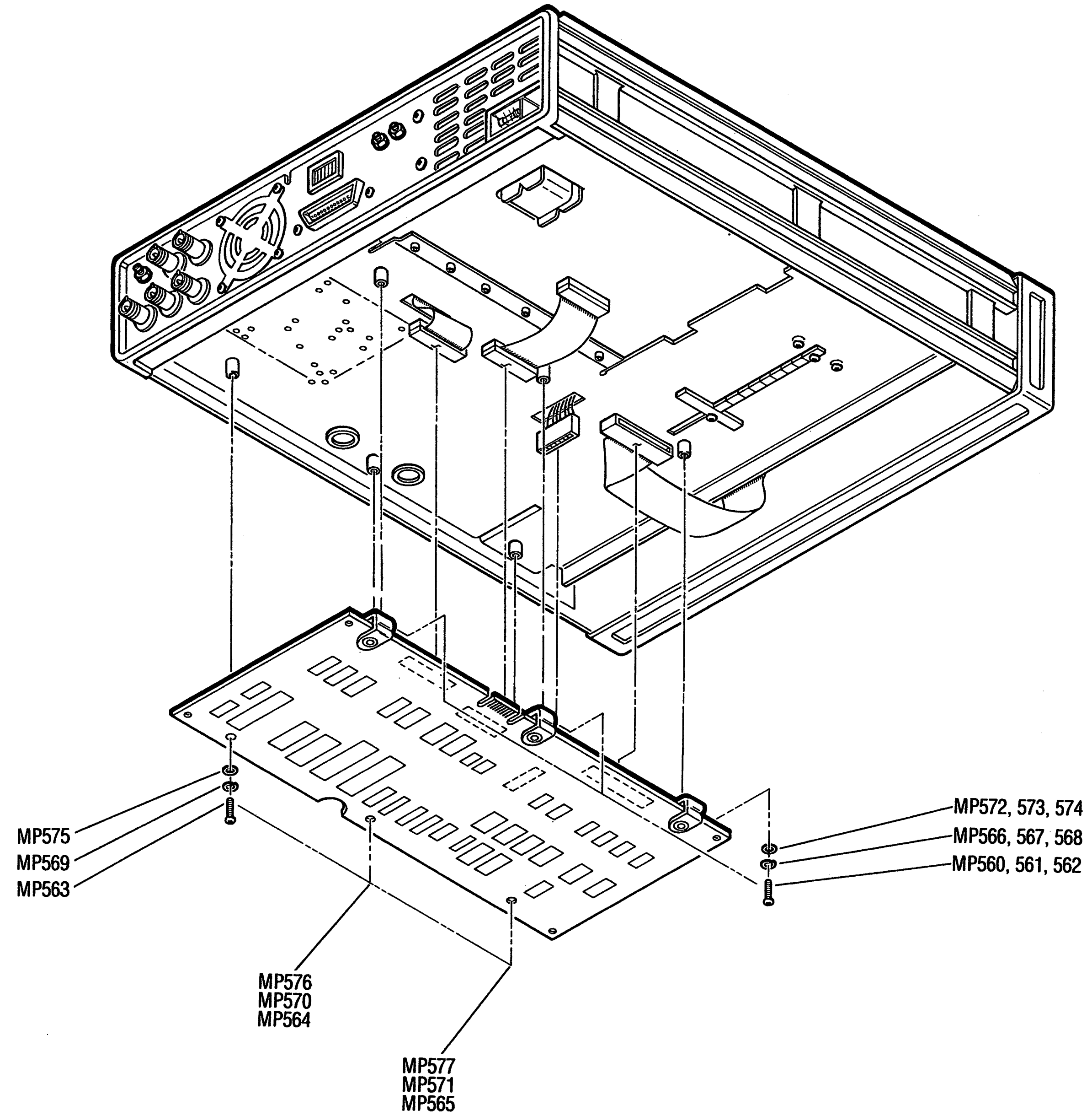


Figure 6-7. A9 Assembly Mechanical Parts

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
Q5	1854-0814	6	1	TRANSISTOR NPN SI TO-66 PD=75W FT=3MHZ	28480	1854-0814
S1	08672-60142	1	9	SWITCH ASSEMBLY 5PT	28480	08672-60142
S2	08672-60142	1		SWITCH ASSEMBLY 5PT	28480	08672-60142
S3	08672-60142	1		SWITCH ASSEMBLY 5PT	28480	08672-60142
S4	08672-60142	1		SWITCH ASSEMBLY 5PT	28480	08672-60142
S5	08672-60142	1		SWITCH ASSEMBLY 5PT	28480	08672-60142
S6	08672-60142	1		SWITCH ASSEMBLY 5PT	28480	08672-60142
S7	08672-60142	1		SWITCH ASSEMBLY 5PT	28480	08672-60142
S8	08672-60142	1		SWITCH ASSEMBLY 5PT	28480	08672-60142
S9	08672-60142	1		SWITCH ASSEMBLY 5PT	28480	08672-60142
S10	3101-2634	9	1	SWITCH-RKR SUBMIN DPDT 5A 250VAC SPD-LUG (PART OF W1)	28480	3101-2634
S11	3101-1973	7	1	SWITCH-SL 7-1A DIP-SLIDE-ASSY .1A 50VDC (HP-IB ADDRESS SWITCH)	28480	3101-1973
T1	9100-4333	3	1	TRANSFORMER-POWER	28480	9100-4333
	0515-0146	8	4	SCREW-MACH M4 X 0.7 50MM-LG PAN-HD (USED TO MOUNT T1)	28480	0515-0146
	2190-0017	4	14	WASHER-LK HLCL NO. 8 .168-IN-ID (USED TO MOUNT T1)	28480	2190-0017
	3050-0139	6	6	WASHER-FL MTLC NO. 8 .172-IN-ID (USED TO MOUNT T1)	28480	3050-0139
U1	1826-0169	5	1	IC V RGLTR TO-3	27014	LM320K-15
U2	1826-0677	0	1	IC-LM338	28480	1826-0677
U3	1826-0203	8	1	IC 7815 V RGLTR TO-3	07263	7815KC
U4	1826-0423	4	1	IC V RGLTR TO-3	27014	LM317K
U5	0955-0181	3	1	MICROWAVE MIXER	28480	0955-0181
	0515-0054	7	34	SCREW-MACH M3 X 0.5 10MM-LG PAN-HD (USED TO MOUNT U5)	28480	0515-0054
	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID (USED TO MOUNT U5)	28480	3050-0105
	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID (USED TO MOUNT U5)	28480	2190-0584
	0535-0004	9	10	NUT-HEX DBL-CHAM M3 X 0.5 2.4MM-THK (USED TO MOUNT U5)	00000	ORDER BY DESCRIPTION
U6	0955-0176	6	1	POWER-SPLITTER 2-WAY WITH 50 OHM SMA	28480	0955-0176
	0515-0065	0	4	SCREW-MACH M3 X 0.5 25MM-LG PAN-HD (USED TO MOUNT U6)	28480	0515-0065
	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID (USED TO MOUNT U6)	28480	2190-0584
U7	0955-0177	7	1	MIXER (PHASE DETECTOR)	28480	0955-0177
	0515-0065	0		SCREW-MACH M3 X 0.5 25MM-LG PAN-HD (USED TO MOUNT U7)	28480	0515-0065
	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID (USED TO MOUNT U7)	28480	2190-0584
W1	11729-60031	2	1	CABLE ASSEMBLY (INCLUDES S10 & A12)	28480	11729-60031
	1400-0031	8	2	CLAMP-CABLE .375-DIA .5-WD NYL	28480	1400-0031
	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
	2190-0584	0		WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
	0535-0004	9		NUT-HEX DBL-CHAM M3 X 0.5 2.4MM-THK	00000	ORDER BY DESCRIPTION
W2	11729-60028	7	1	CABLE ASSEMBLY	28480	11729-60028
W3	11729-60095	8	1	CABLE ASSEMBLY	28480	11729-60095
W4	11729-60103	9	1	CABLE 640	28480	11729-60103
W5	11729-60055	0	1	CABLE ASSEMBLY (OPT. 130 ONLY)	28480	11729-60055
W6	11729-60036	7	1	CABLE ASSEMBLY	28480	11729-60036
W7	11729-60034	5	1	CABLE ASSEMBLY	28480	11729-60034
W8	11729-20093	2	1	CABLE ASSEMBLY (SINGLE FILTER OPTIONS; ISOLATOR TO FILTER)	28480	11729-20093
	1250-1249	3	2	ADAPTER-COAX RTANG F-SMA M-SMA (CONNECTED TO THE POWER AMPLIFIER AND ISOLATOR FOR A SINGLE FILTER OPTION)	28480	1250-1249
W9	11729-60017	4	1	CABLE ASSEMBLY	28480	11729-60017
W10	11729-60026	5	1	CABLE ASSEMBLY	28480	11729-60026
W11	11729-60102	8	1	CABLE ASSEMBLY	28480	11729-60102
W12	11729-60054	9	1	CABLE ASSEMBLY	28480	11729-60054
W13	11729-60104	0	1	CABLE ASSEMBLY	28480	11729-60104

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
W14	11729-60023	2	1	CABLE ASSEMBLY	28480	11729-60023
W15	11729-60059	4	1	CABLE ASSEMBLY	28480	11729-60059
W16	11729-60057	2	1	CABLE ASSEMBLY	28480	11729-60057
W17	11729-60022	1	1	CABLE ASSEMBLY	28480	11729-60022
W18	11729-60032	3	1	CABLE ASSEMBLY	28480	11729-60032
W19	11729-60035	6	1	CABLE ASSEMBLY	28480	11729-60035
W20	11729-60033	4	1	CABLE ASSEMBLY	28480	11729-60033
W21				NOT ASSIGNED		
W22	11729-60025	4	1	CABLE ASSEMBLY	28480	11729-60025
W23	11729-20038	5	1	CABLE ASSY (OPT. 130 ONLY)	28480	11729-20038
W24	11729-20073	8	1	CABLE ASSEMBLY	28480	11729-20073
W25	08672-20157	4	7	CABLE ASSEMBLY	28480	08672-20157
W26	08672-20157	4		CABLE ASSEMBLY	28480	08672-20157
W27	11729-20070	5	7	CABLE ASSEMBLY	28480	11729-20070
W28	8120-1378	1	1	ASSEMBLY-CABLE (POWER CABLE)	28480	8120-1378
W29				NOT ASSIGNED		
W30	11729-60101	7	1	CABLE ASSY(FOR IF & LOW NOISE AMP)	28480	11729-60101
	1400-0510	8	2	CLAMP-CABLE .15-DIA .62-WD NYL	28480	1400-0510
W31	11729-20070	5		CABLE ASSEMBLY	28480	11729-20070
W32	08672-20157	4		CABLE ASSEMBLY	28480	08672-20157
W33	11729-20070	5		CABLE ASSEMBLY	28480	11729-20070
W34	08672-20157	4		CABLE ASSEMBLY	28480	08672-20157
W35	11729-20070	5		CABLE ASSEMBLY	28480	11729-20070
W36	08672-20157	4		CABLE ASSEMBLY	28480	08672-20157
W37	11729-20070	5		CABLE ASSEMBLY	28480	11729-20070
W38	08672-20157	4		CABLE ASSEMBLY	28480	08672-20157
W39	11729-20070	5		CABLE ASSEMBLY	28480	11729-20070
W40	08672-20157	4		CABLE ASSEMBLY	28480	08672-20157
W41	11729-20070	5		CABLE ASSEMBLY	28480	11729-20070
W42	11729-20068	1	1	CABLE ASSEMBLY	28480	11729-20068
W43				NOT ASSIGNED		
W44				NOT ASSIGNED		
W45				NOT ASSIGNED		
W46	11729-20066	9	1	CABLE ASSEMBLY	28480	11729-20066
W47	11729-20069	2	1	CABLE ASSEMBLY	28480	11729-20069
	11729-20095	4	1	CABLE ASSEMBLY (W47; OPTION 140)	28480	11729-20095
W48				NOT ASSIGNED		
W49	11729-60060	7	1	CABLE ASSEMBLY	28480	11729-60060
W50	11729-60050	5	1	CABLE ASSEMBLY (HP-IB INTERCONNECT TO MICROPROCESSOR)	28480	11729-60050
W51	11729-60058	3	1	CABLE ASSY (CABLE FROM MICROPROCESSOR TO SWITCHES)	28480	11729-60058
	1400-0619	8	5	CABLE CLAMP-HFCL .312-DIA .5-WD	28480	1400-0619
	0515-0054	7		SCREW-MACH M3 X 0.5 10MM-LG PAN-HD	28480	0515-0054
W52	11729-60045	8	1	CABLE ASSEMBLY	28480	11729-60045
	1400-0611	0	2	CLAMP-FL-CA 1-WD	06915	CFCC-8
W53	11729-60052	7	1	CABLE ASSEMBLY (FROM MICROPROCESSOR TO FRONT PANEL)	28480	11729-60052
	1400-0611	0		CLAMP-FL-CA 1-WD	06915	CFCC-8
W54	11729-60051	6	1	CABLE ASSEMBLY	28480	11729-60051
W55	11729-60107	3	1	CABLE ASSEMBLY (OPTION 140; 640MHZ IN)	28480	11729-60107
W56	11729-60077	6	1	CABLE ASSEMBLY (OPTION 140; LOOP TEST PORT OUT)	28480	11729-60077
W57	11729-60105	1	1	CABLE ASSEMBLY (OPTION 140; AUX NOISE)	28480	11729-60105
W58	11729-60076	5	1	CABLE ASSEMBLY (OPTION 140; NOISE SPECTRUM <1MHZ)	28480	11729-60076
W59	11729-60081	2	1	CABLE ASSEMBLY (OPTION 140; IF OUTPUT)	28480	11729-60081
W60	11729-60080	1	1	CABLE ASSEMBLY (OPTION 140; 5 TO 1280MHZ IN)	28480	11729-60080
W61	11729-60075	4	1	CABLE ASSEMBLY (OPTION 140; FREQ-CONT X-OSC)	28480	11729-60075
W62	11729-60074	3	1	CABLE ASSEMBLY (OPTION 140; FREQ-CONT DC-FM)	28480	11729-60074
W63	11729-60078	7	1	CABLE ASSEMBLY (OPTION 140; LOOP TEST PORT IN)	28480	11729-60078

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
W64	11729-60079	8	1	CABLE ASSEMBLY (OPTION 140; NOISE SPECTRUM <10MHZ)	28480	11729-60079
W65	11729-20074	9	1	CABLE ASSEMBLY (OPTION 140; MICROWAVE TEST SIGNAL INPUT)	28480	11729-20074
W66	11729-60091	4	1	CABLE ASSEMBLY (PULSED BASEBAND OUTPUT)	28480	11729-60091
W67	11729-60094	7	1	CABLE ASSEMBLY (PULSED BASEBAND INPUT)	28480	11729-60094
W68	11729-60108	4	1	CABLE ASSEMBLY (POWER SUPPLY FOR POWER AMPLIFIER)	28480	11729-60108
W69	11729-60090	3	1	CABLE ASSEMBLY (640 MHZ OUT)	28480	11729-60090
W70	11729-20075	0	1	CABLE ASSEMBLY (G1 TO POWER AMPLIFIER)	28480	11729-20075
W71	1250-1158	3	1	ADAPTER-COAX STR F-SMA F-SMA	28480	1250-1158
W72	11729-60089	0	1	CABLE ASSEMBLY (FRONT PANEL TO LOW PASS FILTER)	28480	11729-60089
W73	11729-60096	9	1	CABLE ASSEMBLY (USED TO CONNECT 640 MHZ OUT TO 640 MHZ IN)	28480	11729-60096
W74	11729-60098	1	1	CABLE ASSEMBLY (USED TO CONNECT 640 MHZ OUT TO 640 MHZ IN; OPTION 140)	28480	11729-60098

See introduction to this section for ordering information

Table 6-3. Code List of Manufacturers

Mfr Code	Manufacturer Name	Address		Zip Code
D3976	BUEHLER GEBR NACHFOLGER GMBH	NURNBERG	GM	7750
S0545	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
02114	FERROXCUBE CORP	SAUGERTIES	NY	12477
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85008
06915	RICHCO PLASTIC CO	CHICAGO	IL	60646
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA	94042
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
24355	ANALOG DEVICES INC	NORWOOD	MA	02062
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
25088	SIEMENS CORP	ISELIN	NJ	08830
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	
30983	MEPCO/ELECTRA CORP	SAN DIEGO	CA	92121
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE	CA	92507
52063	EXAR INTEGRATED SYSTEMS INC	SUNNYVALE	CA	94086
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
72136	ELECTRO MOTIVE CORP	FLORENCE	SC	06226
75915	LITTELFUSE INC	DES PLAINES	IL	60016
79963	ZIERICK MFG CO	MT KISCO	NY	10549

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

This section normally contains information for adapting the manual to older instruments. However, no manual changes existed when this manual was printed.

If your instrument's serial number prefix is not listed on the title page of this manual, it may be documented in a separate MANUAL CHANGES supplement. For more information about serial number prefixes, refer to INSTRUMENTS COVERED BY MANUAL in Section I.

SECTION VIII
SERVICE

8-1. INTRODUCTION

This section contains information for troubleshooting and repairing the Carrier Noise Test Set. Included are troubleshooting tests, schematic and block diagrams, and principles of operation.

8-2. SERVICE SHEETS

The foldout pages (Service Sheets) in the last part of this section are a block diagram (BD1) and schematics (1 through 7).

8-3. Block Diagrams

Block Diagram 1 (BD1) is an overall block diagram that breaks the instrument into functional sections. It serves as an index to the schematic Service Sheets and as a starting point for troubleshooting.

8-4. Schematics

Service Sheets 1 through 7 consist of assembly schematic diagrams. Symbols used in the schematic diagrams are defined in Table 8-2, Schematic Diagram Notes.

8-5. SAFETY CONSIDERATIONS

8-6. 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 cord, or supplied power cord set.

8-7. Safety

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 disconnection of the protective earth terminal will create a potential shock hazard that could result in personal injury. Grounding one conductor outlet is not sufficient. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative (that is, secured against unintended operation).

If this instrument is to be energized via an autotransformer, make sure that the autotransformer's common terminal is connected to the earth terminal of the power source.

Capacitors inside the instrument can still be charged even if the instrument is disconnected from its source of supply.

Make sure that only 250 volt fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. Do not use repaired fuses or short-circuited fuse-holders. To do so could create a shock or fire hazard.

8-8. RECOMMENDED TEST EQUIPMENT

Test equipment required to maintain the Carrier Noise Test Set is listed in Table 1-4. Equipment other than that listed may be used if it meets the listed critical specifications.

8-9. SERVICE TOOLS, AIDS AND INFORMATION

8-10. Pozidriv Screwdrivers

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

8-11. Tuning Tools

For adjustments requiring non-metalic 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.

8-12. Heat Staking Tools

The pushbutton switches on the front panel have small plastic pins protruding from the back. These tabs fit through holes in the front panel printed circuit boards (A1 and A2) 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.

8-13. Hardware

Both Unified National (inch) and metric screws are used in the Carrier Noise Test Set.

8-14. Maintenance

Hewlett-Packard recommends the dust that may accumulate inside the Carrier Noise Test Set to be blown out periodically.

Table 8-1. 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 PL11	5020-8160
De-Solder 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 TF	8500-0232
Solder	Component replacement, Circuit Board repair wiring	Rosin (flux core, high tin content (63/37 tin/lead), 18 gauge (AWG) 0.040 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.

Table 8-2. Schematic Diagram Notes (1 of 8)

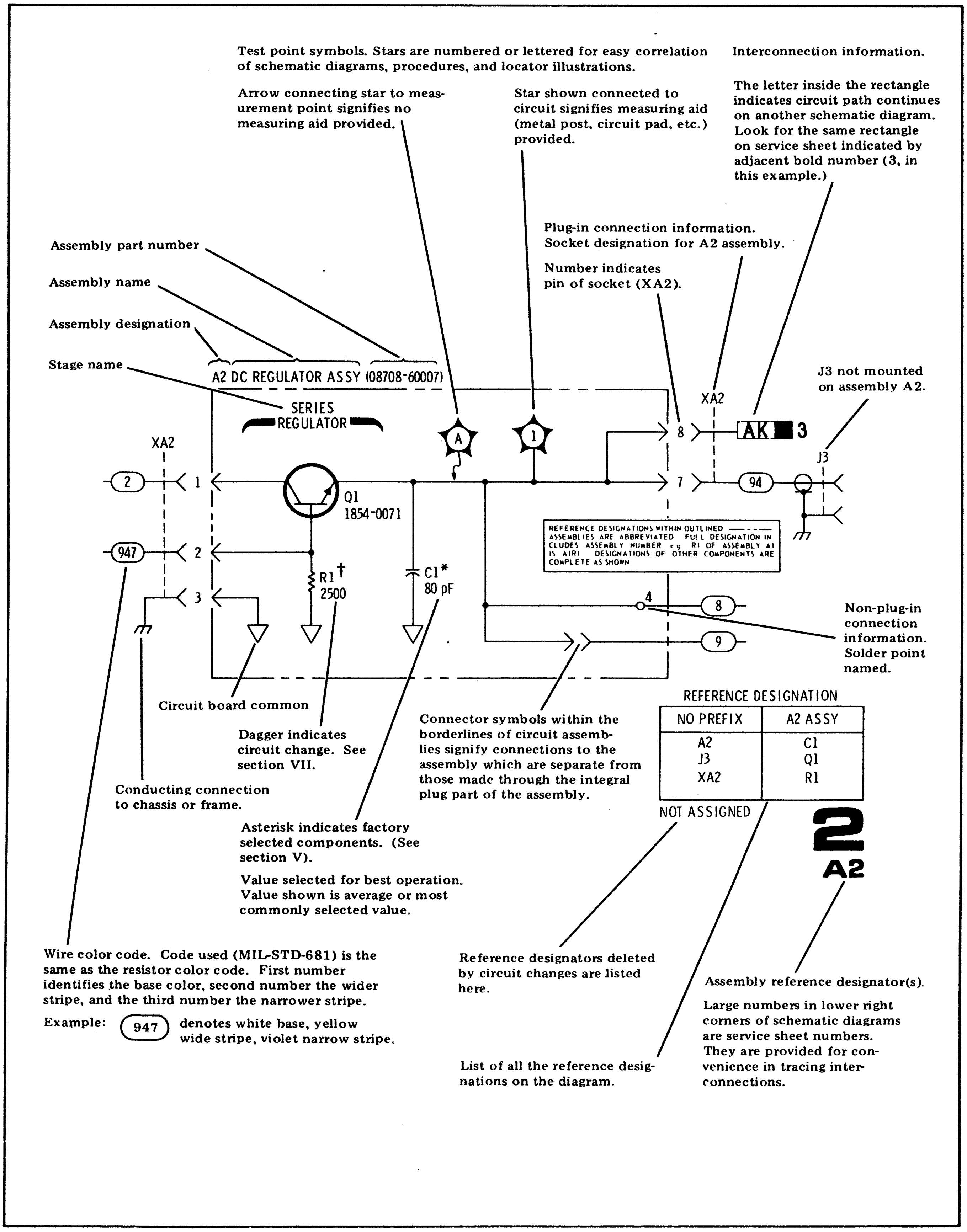


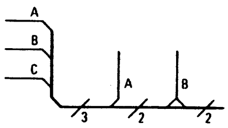
Table 8-2. Schematic Diagram Notes (2 of 8)

SCHEMATIC DIAGRAM NOTES

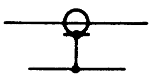
*	Asterisk denotes a factory-selected value. Value shown is typical.
†	Dagger indicates circuit change. See Section VII.
	Tool-aided adjustment. ○ Manual control.
	Encloses front-panel designation.
	Encloses rear-panel designation.
	Circuit assembly borderline.
	Other assembly borderline.
	Heavy line 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).
CW	Wiper moves toward cw with clockwise rotation of control (as viewed from shaft or knob).
1	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.
AK 12	Letters = off-page connection, e.g., AK Number = Service Sheet number for off-page connection, e.g., 12
1 THIS PAGE	Number (only) = on-page connection.

Table 8-2. Schematic Diagram Notes (3 of 8)

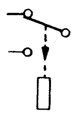
SCHEMATIC DIAGRAM NOTES



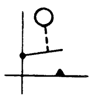
Indicates multiple paths represented by only one line. Letters or names identify individual paths. Numbers indicate number of paths represented by the line.



Coaxial or shielded cable.



Relay. Contact moves in direction of arrow when energized.



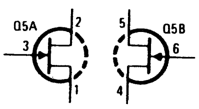
Indicates a pushbutton switch with a momentary (ON) position.

Indicates a PIN diode.

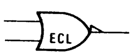
Indicates a current regulation diode.

Indicates a voltage regulation diode.

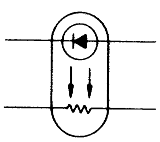
Indicates a Schottky (hot-carrier) diode.



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).

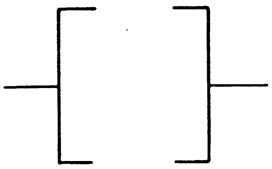


Indicates an opto-isolator of a LED and a photoresistor packaged together. The resistance of the photoresistor is a function of the current flowing through the LED.

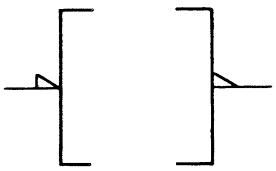
Table 8-2. Schematic Diagram Notes (4 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

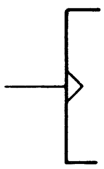
Input and Output Indicators



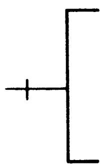
Implied Indicator—Absence of polarity indicator (see below) implies that the active state is a relative high voltage level. Absence of negation indicator (see below) implies that the active state is a relative high voltage level at the input or output.



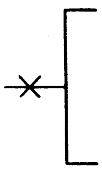
Polarity Indicator—The active state is a relatively low voltage level.



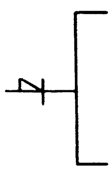
Dynamic Indicator—The active state is a transition from a relative low to a relative high voltage level.



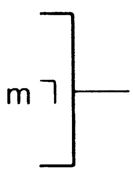
Inhibit Input—Input that, when active, inhibits (blocks) the active state outputs of a digital device.



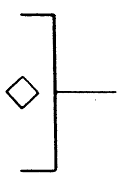
Analog Input—Input that is a continuous signal function (e.g., a sine wave).



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 8-2. 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

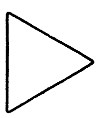
&	AND—All inputs must be active for the output to be active.
≥1	OR—One or more inputs being active will cause the output to be active.
≥m	Logic Threshold—m or more inputs being active will cause the output to be active (replace m with a number).
=1	EXCLUSIVE OR—Output will be active when one (and only 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 8-2. Schematic Diagram Notes (6 of 8)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Sequential Logic Functions

1 ⎍	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.
G ⎍⎍⎍	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 8-2. 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 8-2. 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 state 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 is as follows: A function becomes active when: • it is enabled (dependency conditions—if any—are satisfied) • and its external stimulus (e.g., voltage level) enters the active state.

SERVICE SHEET BD1
OVERALL FUNCTIONAL BLOCK DIAGRAM
PRINCIPLES OF OPERATION

General. The HP Model 11729C Carrier Noise Test Set performs four (4) major tasks:

- Up converts an external (or internal) reference signal
- Down converts the signal under test to an intermediate frequency (IF)
- Phase demodulates the phase noise of the test signal using the Phase Detector Method.
  - — When the Phase Detector Method is used the signal under test is phase locked to a reference signal.
  - — The signal under test is then phase detected against the same reference signal.
- Frequency demodulates the phase noise of the test signal using the Frequency Discriminator Method.

These four operations allow the Carrier Noise Test Set to be used as an integral part of a phase noise measurement system. With Option 130 installed, the Carrier Noise Test Set has AM noise measurement capabilities. The Carrier Noise Test Set accepts test signals from 10 MHz—18 GHz, at a level of +7 dBm to +20 dBm and −5 to +10 dBm for test signals <1.28 GHz.

For the Carrier Noise Test Set to be completely operational it may require one or two drive signals(a fixed 640 MHz signal and/or a tunable 5 MHz to 1280 MHz signal) that are supplied from an external RF source.

One of the drive signals (640 MHz) can be supplied by the Carrier Noise Test Set. The Carrier Noise Test Set can be configured to provide an internally generated 640 MHz signal; the 640 MHz signal is made available by connecting the provided cable-attenuator assembly (HP 11729-60096 or HP 11729-60098 [Option 140]) between two rear panel connectors. The absolute system noise floor will be degraded close-in to the carrier when using the internally generated 640 MHz signal, compared to the 640 MHz signal being supplied by the HP 8662A Synthesized Signal Generator.

The following discussion describes the purpose of Service Sheets 1—6.

Service Sheet 1—Reference Up-Conversion, Test Signal Down-Conversion and Phase Detecting Circuits

Service Sheet 1 has all the circuitry necessary to up-convert the reference signal, and down-convert and phase detect the signal under test.

The signal under test (10 MHz—18 GHz) is down-converted to 5 MHz—1280 MHz. For test signals from 10 MHz—1280 MHz down-converting is not required. To achieve the down-converted signal a fixed 640 MHz signal us up-converted to microwave frequencies by being input to a comb generator (step recovery diode multiplier). The comb generator outputs harmonics of the 640 MHz signal. One of the harmonics is selected with a passband filter. The filter is user selectable from the front panel (local) or by using the Hewlett-Packard Interface Bus (remote). The harmonic selected is mixed with the signal under test. The result produces a down-converted signal under test from 5 MHz—1280 MHz. The resulting signal (or direct test signal from 10 MHz—1280 MHz) is input to a mixer/phase detector along with a tunable 5 to 1280 MHz signal. The end product is a dc signal with ac components directly proportional to the phase detected difference between the signal under test and the tunable 5 MHz—1280 MHz signal.

All circuitry necessary for AM detecting the signal under test, to make an AM noise measurement, is on Service Sheet 1.

Service Sheet 2—Low Pass Filter and Low Noise Amplifier Circuits

The dc signal from the mixer/phase detector on Service Sheet 1 is filtered and output for connection to a spectrum analyzer.

The Low Noise Amplifier amplifies the filtered signal so it can be seen on a laboratory spectrum analyzer.

Service Sheet 3—Phase Lock Circuits

With the Phase Detector Method of making a phase noise measurement, the signal under test and the tunable 5 MHz—1280 MHz signal must stay in phase quadrature (that is, 90 degrees out-of-phase). A phase lock loop is used to maintain this phase relationship.

Phase lock loops consist of the following three components:

- — A Voltage Controlled Oscillator (VCO)
- — A Phase Detector
- — A Loop Filter

The VCO of the phase lock loop can be either the external RF source supplying the tunable 5 MHz—

SERVICE SHEET BD1 (cont'd)

1280 MHz signal or it can be the device under test. The other two components of the phase lock loop are supplied by the Carrier Noise Test Set. The phase detector is shown on Service Sheet 1.

The loop filter circuitry for controlling the phase lock loop bandwidth is shown on this Service Sheet. The main input to the Phase Lock Circuits is from the mixer/phase detector through a low pass filter (on Service Sheet 2). The signal from the mixer/phase detector is input to a series of amplifiers with variable gain. The gain (loop bandwidth) is user selectable in local (front panel) or remote (HP-IB) by selection of the Lock Bandwidth Factor. The signal from the mixer/phase detector is processed through the series of amplifiers and the following signals are output:

- FREQ CONT DC-FM
- FREQ CONT X-OSC

These two signals are supplied to control the frequency of the VCO. The signal chosen will depend on the tuning voltage required by the VCO. FREQ-CONT X-OSC has an output voltage of ±10 Volts dc. FREQ-CONT DC-FM has an output voltage of ±1 Volt dc. When locked, the VCO will now track these control signals.

A CAPTURE control is supplied to widen the loop bandwidth, when first trying to acquire phase lock. The CAPTURE control causes the gain of the amplifiers to be fixed. The CAPTURE control overrides any gain that was set by the Lock Bandwidth Factor.

The LOOP TEST PORTS are used to characterize the frequency response of the phase lock loop. This characterization determines how much the loop suppresses noise at different frequency offsets from the signal under test.

Service Sheet 4—Data Input Circuits

Service Sheet 4 shows how data is input to the Carrier Noise Test Set. The data can be input using the front panel or Hewlett-Packard Interface Bus (remote). All necessary circuitry for encoding the front panel keys and interfacing with the microprocessor in local is documented on Service Sheet 4.

Service Sheet 5—Data Processing Circuits

Service Sheet 5 contains the microprocessor, ROM and RAM. Information entered into the Carrier Noise Test Set is processed by this circuitry.

Service Sheet 6—Switch and LED Control Circuits

Data is entered in local or remote (HP-IB). Next it is processed by the circuitry shown on Service Sheet 5, then output to the circuitry shown on Service Sheet 6. Service Sheet 6 consists mainly of data latches and drivers. The data output from Service Sheet 5 is available to all latches in parallel. The data in the latches is used to control the filter switches and front panel LEDs.

TROUBLESHOOTING

The troubleshooting procedures are referenced to the Block Diagram by a hexagon with a checkmark and a number inside.

For example, (✓1)

Test Equipment

Digital Multimeter	HP 3456A
Microwave Synthesized Source	HP 8340A
Oscilloscope	HP 1740A
Spectrum Analyzer	HP 8566B
Power Meter	HP 436A
RF Synthesized Signal Generator	HP 8662A (Option 003)

AM SWITCH OPERATION (✓1)

The following troubleshooting will help to isolate an AM switch problem to the Microprocessor Circuits or the Reference Up-conversion, Test Signal Down-conversion and Phase Detecting Circuits.

AM Switch Drive Circuitry Verification

1. Remove the top cover of the Carrier Noise Test Set.

2. Locate the AM switch. The switch on the far right next to the IF amplifier (A10), as viewed from the front, is the AM switch.

3. Verify +24 volts is on pin 2 (center pin of the switch). If the voltage is correct, proceed to step 4. If the voltage is incorrect, inspect the switch wiring, then if necessary troubleshoot the power supply circuitry on Service Sheet 7.

4. Monitor the voltage on pin 3 (top pin of the AM switch) while pressing the MODE switch repeatedly on the front panel. The voltages measured should change as follows:

SERVICE SHEET BD1 (cont'd)

AM Switch	MODE	
	AM (CW or pulsed)	Phase Noise (CW or pulsed)
pin 1	+0.7V	+23.8V
pin 2	+23.8V	+23.8V
pin 3	+23.8V	+0.7V

5. If the voltages measured are correct proceed to step 6. If the voltages are incorrect, check the wiring to the switch or the AM switch circuitry on Service Sheet 6.

6. Check the operation of the AM switch. The proper operating conditions of the AM switch are listed below:

   A clicking sound can be heard when the MODE switch on the front panel is repeatedly pushed.

   The AM modulation on a microwave test signal input can be viewed from the <10 MHz output when the AM noise measurement mode is enabled.

MICROWAVE FILTER SWITCH OPERATION (√2)

The following troubleshooting will help to isolate a microwave filter switch problem to the Microprocessor Circuits or the Reference Up-conversion, Test Signal Down-conversion and Phase Detecting Circuits.

NOTE

Before starting to troubleshoot be sure to confirm that the 640 MHz IN signal is 640 MHz ±32 kHz at a level of +1 dBm minimum.

Microwave Filter Switch Drive Circuitry Verification

1. Remove the top cover of the Carrier Noise Test Set.

2. Locate the microwave switch that is not properly operating. The group of switches for bands 2 through 8 are located on the left side of the instrument as viewed from the front. The switches for bands 2 through 8 are setup consecutively from left to right.

   The switch for band 1 is located on the right side of the instrument as viewed from the front. If there are two (2) switches on the right side, the switch located closest to the side of the instrument is the switch for band one (1).

3. Verify that +24 volts is on pin 2 (the center pin of the switch in question).

   If the voltage is correct, proceed to step 4. If the voltage is incorrect, inspect the switch wiring, then if necessary troubleshoot the power supply circuitry on Service Sheet 7.

4. Monitor the voltage on pin 3 (top pin of switch). Select the button on the front panel that controls the band in question. Select another band to switch out the band in question. The voltages measured should change as follows:

Microwave Filter Switch	Bands 2-8		Band 1	
	Selected	Not Selected	Selected	Not Selected
pin 1	+0.7V	+23.8V	+23.8V	+0.7V
pin 2	+23.8V	+23.8V	+23.8V	+23.8V
pin 3	+23.8V	+0.7V	+0.7V	+23.8V

5. If the voltages measured are correct proceed to step 6. If the voltages are incorrect troubleshoot the wiring to the switch or the microwave filter switch circuitry on Service Sheet 6.

Microwave Filter Switch Verification

6. Proper operation of the microwave filter switch is listed below:

   Input a microwave test signal at a frequency of 400 MHz above the BAND CENTER frequency of the BAND RANGE in question. The level of the microwave test signal in band one should be 0 dBm. In bands 2—8 the level should be +10 dBm.

   Observe the IF OUTPUT, on the front panel, with a spectrum analyzer. A 400 MHz IF signal should be seen if the band is operating properly.

AM NOISE DETECTOR (√3) (Option 130 Only)

The following troubleshooting will isolate an AM Noise Detector problem to either the Reference Up-conversion, Test Signal Down-conversion and Phase Detecting Circuits or the Low Pass Filter

SERVICE SHEET BD1 (cont'd)

and Low Noise Amplifier circuits. Use the following test conditions to verify that the AM Noise Detector is operating properly:

1. Connect a 10 GHz signal at a level of +10 dBm to the MICROWAVE TEST SIGNAL INPUT connector on the front panel.
2. Push the MODE button until the AM, CW LED is illuminated.
3. Disconnect cable (W5) from the AM-DET (J2) connector on the Low Pass Filter Board Assembly. Connect a multimeter to the end of cable (W5). Set the multimeter to volts dc. The voltage on the multimeter should read typically −0.8 volts dc.
4. Push the MODE button so the ϕ, CW LED is illuminated. The multimeter should now read 0 volts dc.
5. If these voltages are correct troubleshoot the Low Pass Filter Circuits on Service Sheet 2. If these voltages are incorrect, disconnect the AM detector (CR2) from the AM switch (S9). Measure the power out of port one (1) of the AM switch. The power measured should be >+9.5 dBm.
6. If the measured power is correct check the AM detector and associated wiring. If the measured power is incorrect, refer to the AM switch operation.

IF INPUT TO LOW PASS FILTER (✓4)

The following troubleshooting will isolate an IF problem to either the Reference Up-conversion, Test Signal Down-conversion and Phase Detecting Circuits or the Low Pass Filter and Low Noise Amplifier circuits.

1. Set the following initial conditions:

Carrier Noise Test Set

BAND CENTER FREQUENCY: 9.6 GHz*
LOCK BANDWIDTH FACTOR: 10 k
MODE: ϕ, CW
Disconnect cable from frequency control (X-OSC or DC-FM) on the rear panel.

Microwave Source (See critical specifications in Section I)

FREQUENCY: 10 GHz (CW)*
LEVEL: +10 dBm
MODULATION: Off
ALL OTHER FUNCTIONS: Off

Tunable 5 to 1280 MHz Source (See critical specifications in Section I)

FREQUENCY: 400.01 MHz (CW)*
LEVEL: 0 dBm
MODULATION: Off
ALL OTHER FUNCTIONS: Off

2. Verify that the voltage out of the IF port on the U7 mixer (Phase Detector) is 0.25 Vpp into 50 ohms.
3. If the voltage is correct troubleshoot the Low Pass Filter and Low Noise Amplifier Circuits. If the voltage is incorrect, troubleshoot the Reference Up-conversion, Test Signal Down-conversion and Phase Detecting Circuits.

PHASE LOCK DETECTOR SIGNAL (✓5)

The following troubleshooting will isolate a Phase Lock Detector Signal problem to the Low Pass Filter and Low Noise Amplifier circuits or the Phase Lock Circuits.

1. Connect a 10 GHz* signal at a level of +10 dBm to the MICROWAVE TEST SIGNAL INPUT connector (J6) on the front panel.
2. Connect a 400.1 MHz* signal at a level of −40 dBm to the 5 to 1280 MHz INPUT connector on the front panel.
3. On the front panel select the BAND RANGE with a BAND CENTER frequency of 9.6 GHz*. Enable ϕ, CW MODE and a Lock Bandwidth Factor of 100.
4. On the Low Pass Filter Board Assembly disconnect cable (W10) at LNA (J4).
5. On the A7 Power Supply Board Assembly disconnect cable (W6) to the PHASE LOCK IN connector J9.
6. Connect cable W6 to a spectrum analyzer. Measure the power of the 100 kHz beat note. The power should be −48 dBm typical.
7. If the power is correct troubleshoot the Phase Lock circuits on Service Sheet 3. If the power is incorrect troubleshoot the Low Pass Filter and

*Use the following procedure if the 9.6 GHz BAND CENTER frequency is not installed:

—Select an available BAND RANGE.

—Set the microwave source to 400 MHz above the BAND CENTER frequency of the BAND RANGE selected.

—The tunable 5 to 1280 MHz source is left set to 400.01 MHz.

SERVICE SHEET BD1 (cont'd)

Low Noise Amplifier circuits on Service Sheet 2.

BANDWIDTH CONTROL (✓6)

The following troubleshooting will isolate a bandwidth control problem to either the Microprocessor Circuits or the Phase Lock Circuits.

On the A9 Microprocessor Board Assembly monitor the TTL logic levels at J2 pins 4,6 and 8 while changing the Lock Bandwidth Factor on the front panel. The TTL logic levels should be as shown below:

Lock Bandwidth Factor					A9 Microprocessor Board
1	10	100	1k	10k	
0	0	0	0	1	J2 pin 4
0	0	1	1	0	J2 pin 6
0	1	0	1	0	J2 pin 8

If the logic levels are incorrect troubleshoot the A9 Microprocessor Board Assembly. If the logic levels are correct troubleshoot the Phase Lock Circuits.

CAPTURE CONTROL (✓7)

The following troubleshooting will isolate a Capture Control problem to either the Microprocessor Circuits or the Phase Lock Circuits.

On the A9 Microprocessor Board Assembly monitor the TTL logic level at J2 pin 10 with the CAPTURE button, on the front panel, pressed and released.

The logic level should be:

Capture released = 1
Capture pressed = 0

If the logic level is incorrect troubleshoot the Microprocessor circuits. If the logic level is correct troubleshoot the Phase Lock Circuits.

OUT-OF-LOCK CONTROL (✓8)

The following troubleshooting will isolate an Out-of-Lock Control problem to either the Microprocessor circuits or the Phase Lock circuits.

1. Connect a signal of 10 GHz* at a level of +10 dBm to the MICROWAVE TEST SIGNAL INPUT connector on the front panel.
2. Connect a signal of 400 MHz* at a level of 0 dBm to the 5—1280 MHz INPUT connector on the front panel.
3. On the Carrier Noise Test Set select the BAND RANGE with a BAND CENTER frequency of 9.6 GHz*. Press the MODE button to enable ϕ, CW. Select a LOCK BANDWIDTH FACTOR of 100.
4. Press and release CAPTURE, on the Carrier Noise Test Set, to phase lock the microwave source (D.U.T.) to the tunable 5 to 1280 MHz source.

   If the sources do not phase lock (green bar does not remain illuminated on the front panel phase lock indicator) the tunable 5 to 1280 MHz source must be tuned closer in frequency to the IF frequency ($f_{IF} = f_{D.U.T.} - f_{band\ center\ frequency}$). Press CAPTURE while tuning the tunable 5 to 1280 MHz source in 1 kHz steps. Watch the phase lock indicator on the Carrier Noise Test Set. When the LED's on the indicator all light up, reduce the resolution of the tunable 5 to 1280 MHz source by a factor of 10.

   NOTE

   Connect the spectrum analyzer to the <10 MHz OUTPUT, on the Carrier Noise Test Set, if difficulties occur in determining the direction to tune the tunable 5 to 1280 MHz source to acquire phase lock.

   The signals displayed on the spectrum analyzer represent the frequency difference between the two inputs to an internal mixer/phase detector in the Carrier Noise Test Set. The signals will decrease in frequency to dc when tuning towards phase lock and increase in frequency when tuning away from phase lock.

   Press CAPTURE and tune in this reduced resolution. Watch the red LEDS on the Carrier Noise Test Set phase lock indicator step through one side of the display — to the green bar — then to the other side of the display. Again reduce the resolution on the tunable 5 to 1280 MHz source by a factor of 10. Tune in this finer resolution until the green LED is illuminated. When the green LED is illuminated release CAPTURE.

---

*Use the following procedure if the 9.6 GHz BAND CENTER frequency is not installed:

— Select an available BAND RANGE.

— Set the microwave source to 400 MHz above the BAND CENTER frequency of the BAND RANGE selected.

— The tunable 5 to 1280 MHz source is left set to 400 MHz.

SERVICE SHEET BD1 (cont'd)

5. On the A9 Microprocessor Board Assembly monitor connector J2 pin 12 with a multimeter. The microwave source and the tunable 5 to 1280 MHz source should be phase locked. When phase locked 5 volts dc should be measured at J2 pin 12.

6. Now increase the tunable 5 to 1280 MHz source by 500 kHz. The microwave source and the tunable 5 to 1280 MHz source should no longer be phase locked. Measure the voltage at J2 pin 12 again it should be 1 volt dc typically.

7. If the voltages measured at J2 pin 12 were found to be incorrect, troubleshoot the phase lock circuits. If the voltages were correct, troubleshoot the microprocessor circuits.

NAM (Not AM) (√9)

The following procedure will help to determine if the "not AM" control signal is being enabled by the Switch and LED Control Circuits.

1. If the "not AM" control signal is being enabled the AM, CW annunciator will be illuminated when the MODE button on the front panel is pressed.

2. If the AM, CW annunciator will not light measure the voltage at A2J1 pin 25. A2J1 is located on the A2 assembly, which is the printed circuit board attached to the rear of the center front panel. To service the A2 assembly the center front panel is removed in the following manner:

   a. Remove the plastic strip on the top of the front panel.

   b. Remove the two screws that hold the top of the center front panel in place.

   c. Remove the two screws that hold the bottom of the center front panel in place.

   d. Pull the panel out slowly.

   e. To re-install the panel reverse the steps for removing the panel.

   When AM, CW is enabled the voltage measured should be +2.4 volts dc. When AM, CW is not enabled the voltage should be +4.3 volts dc.

3. If the AM, CW annunciator will not light and the voltage is incorrect troubleshoot the Switch and LED Control Circuits. If the AM, CW annunciator will light and the voltage is correct troubleshoot the Front Panel Key and Display Board Assembly.

NϕPU (Not Phase Pulse) (√10)

The following procedure will help to determine if the "not phase pulse" control signal is being enabled by the Switch and LED Control Circuits.

1. If the "not phase pulse" control signal is being enabled the ϕ, PULSE annunicator will be illuminated when the MODE button on the front panel is pressed.

2. If the ϕ, PULSE annunciator will not light measure the voltage at A2J1 pin 43. A2J1 is on the A2 assembly, which is the printed circuit board located on the rear of the center front panel. To service the A2 assembly the center front panel is removed in the following manner:

   a. Remove the plastic strip on the top of the front panel.

   b. Remove the two screws that hold the top of the center panel in place.

   c. Remove the two screws that hold the bottom of the center panel in place.

   d. Pull the panel out slowly.

   e. To re-install the panel reverse the steps for removing the panel.

   When ϕ, PULSE is enabled the voltage measured should be +2.4 volts dc. When ϕ, PULSE is not enabled the voltage measured should be +4.2 volts dc.

3. If the ϕ, PULSE annunciator will not light and the voltage is incorrect troubleshoot the Switch and LED Control Circuits. If the ϕ, PULSE annunciator will light and the voltage is correct troubleshoot the Front Panel Key and Display Board Assembly.

NAMPU (Not AM Pulse) (√11)

The following procedure will help to determine if the "not AM pulse" control signal is being enabled by the Switch and LED Control Circuits.

1. If the "not AM pulse" control signal is being enabled the AM, PULSE annunciator will be illuminated when the MODE button on the front panel is pressed.

SERVICE SHEET BD1 (cont'd)

2. If the AM, PULSE annunciator will not light measure the voltage at A2J1 pin 45. A2J1 is on the A2 assembly, which is the printed circuit board on the rear of the center front panel. To service the A2 assembly the center front panel is removed in the following manner:

   a. Remove the plastic strip on the top of the front panel.

   b. Remove the two screws that hold the top of the center front panel in place.

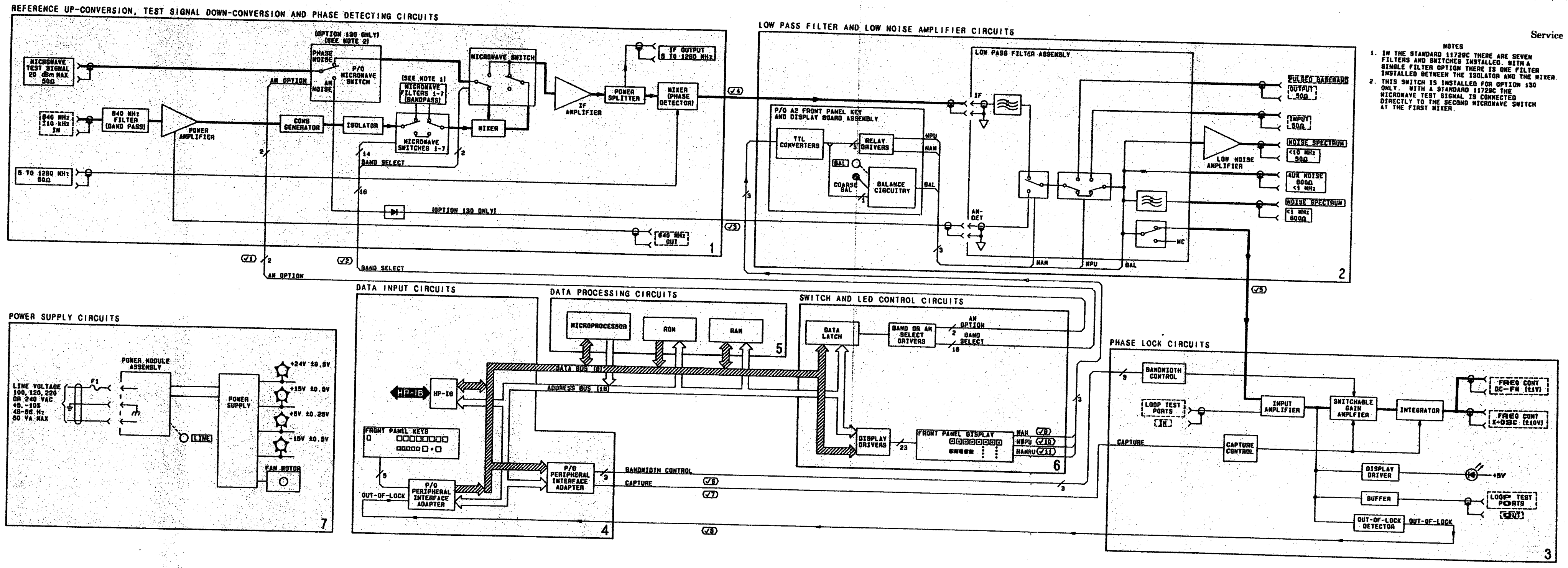
   c. Remove the two screws that hold the bottom of the center front panel in place.

   d. Pull the panel out slowly.

   e. To re-install the panel reverse the steps for removing the panel.

   When "not AM pulse" is enabled the voltage measured should be +2.4 volts dc. When "not AM pulse" is not enabled the voltage measured should be +4.3 volts dc.

3. If the annunciator will not light and the voltage is incorrect troubleshoot the Switch and LED Control Circuits. If the annunciator will light and the voltage is correct troubleshoot the Front Panel Key and Display Board Assembly.



NOTES

1. IN THE STANDARD 11729C THERE ARE SEVEN FILTERS AND SWITCHES INSTALLED. WITH A SINGLE FILTER OPTION THERE IS ONE FILTER INSTALLED BETWEEN THE ISOLATOR AND THE MIXER.
2. THIS SWITCH IS INSTALLED FOR OPTION 130 ONLY. WITH A STANDARD 11729C THE MICROWAVE TEST SIGNAL IS CONNECTED DIRECTLY TO THE SECOND MICROWAVE SWITCH AT THE FIRST MIXER.

BD1

Figure 8-1. Overall Functional Block Diagram

SERVICE SHEET 1
REFERENCE UP-CONVERSION, TEST SIGNAL DOWN-CONVERSION AND PHASE DETECTING CIRCUITS

PRINCIPLES OF OPERATION

General

Service Sheet 1 provides the circuitry for converting a 10 MHz to 18 GHz microwave test signal down to 5 to 1280 MHz. Test signals of 10 to 1280 MHz do not have to be down converted. These signals are input directly to the IF amplifier.

The 640 MHz IN reference signal enters the Carrier Noise Test Set from the rear panel. The level of this signal is >+1 dBm. This signal is filtered and amplified to assure a +27 to +28 dBm level required to drive the comb generator. The comb generator is basically a step recovery diode. Its output is a series of signals that are spaced 640 MHz apart. An isolator prevents signals from being reflected back to the comb generator. A microwave bandpass filter is selected via program or front panel control to pass one of the comb lines. This comb line is then mixed with the microwave signal under test (entered from the front panel) to produce an intermediate frequency (IF) between 5 and 1280 MHz. The IF signal is amplified and fed through a power splitter. One output of the power splitter goes to the front panel IF OUTPUT connector. The other output provides one input to a mixer/phase detector. The mixer/phase detector compares the IF signal to a reference signal of the same frequency from an external RF source (or the delayed IF OUTPUT) to detect the phase difference.

640 MHz Bandpass Filter

The purpose of this filter is to reduce any 120 MHz, 520 MHz or 760 MHz reference spurs from the 640 MHz IN signal. The insertion loss is approximately 2 dB.

Power Amplifier Assembly

After the bandpass filter, the 640 MHz signal goes into the A11 Power Amplifier Assembly. The power amplifier boosts the signal level to a minimum of +26.5 dBm. A level between +26.5 and +28 dBm is required to drive the comb generator. The power amplifier has an auxiliary output (AUX OUT) that is available on the rear panel (640 MHz OUT). The Carrier Noise Test Set can be configured to supply one of the drive signals (640 MHz) when the 640 MHz OUT is connected to the 640 MHz IN on the rear panel using the cable-attenuator assembly (HP 11729-60096 or HP 11729-60098 [Option 140]) provided with the Carrier Noise Test Set.

Comb Generator and Isolator

The next item in the chain is comb generator G1. The comb generator is a step recovery diode and uses the 640 MHz input signal to generate a series of harmonics extending beyond 18 GHz.

The comb generator is followed by an isolator. The isolator provides a 50 ohm match to the output of the comb generator preventing comb lines rejected by the following band pass filters from reflecting back into the comb generator. The isolator exhibits low insertion loss above 6 GHz. Below 6 GHz the insertion loss can be as high as 6 or 8 dB. This is not a problem, however, because the comb lines at lower frequencies have more power than the higher frequency comb lines.

Microwave Switches and Bandpass Filters

Following the isolator is a series of microwave switches and bandpass filters. There is a microwave switch associated with each filter. A standard Carrier Noise Test Set has 7 switches and 7 filters. Depending on the instrument option number, fewer switch-filter sections may exist.

The filters select one comb line (harmonic of 640 MHz) and reject all others. Rejected frequencies are attenuated at least 30 dB below the selected comb line. The insertion loss through the filter bank is 5 dB or less.

Microwave Mixer (U5)

The output from the microwave bandpass filters goes to the RF port of the microwave mixer. The signal level must be a least −20 dBm.

In bands 2 through 8, the microwave test signal provides the LO drive signal to the mixer. It should be at least 7 dBm, but measurements may also be done with input levels as low as −10 dBm with some potential degradation of the noise floor.

The microwave test signal is mixed with the comb line to produce an IF (difference frequency), which goes to the IF amplifier. The IF frequency is between 5 and 1280 MHz. The insertion loss of the microwave mixer is 14 dB or less. The lowest acceptable signal out of the mixer is −33 dBm.

In band 1, the microwave test signal bypasses the microwave mixer and goes to the IF amplifier directly. The optimum microwave test signal level is 0 dBm (instead of greater than 7 dBm, needed for bands 2 through 8.) Slightly degraded phase noise performance occurs with greater than 2 or 3 dBm into the microwave test signal port because of the action of the limiters inside the IF amplifier.

IF Amplifier Assembly

The IF amplifier boosts the signal level up to at least 14 dBm. This signal drives the LO port of the mixer/phase detector.. The frequency into the amplifier ranges from 5 to 1280 MHz.

Power Splitter and Mixer/Phase Detector

The output of the IF amplifier goes to a power splitter. The purpose of the power splitter is to provide an IF output to the front panel. This output is identical in level to the other signal coming out of the splitter, which drives the LO port of the mixer/phase detector. This level is specified to be at least +7 dBm.

◀ Overall Functional Block Diagram SERVICE SHEET **BD1**

The RF input to the mixer/phase detector, 5 to 1280 MHz, is entered via the front panel. For measurements, the typical level is 0 dBm; for calibration, a lower level signal is used. The lower level signal is used during calibration so the Low Noise Amplifier is not overdriven. In phase noise measurement mode (Phase Detector Method), the mixer phase detects the RF and LO signals and outputs a dc signal. This dc output from the IF port of the mixer/phase detector has the baseband noise superimposed on it.

The output of the mixer/phase detector goes to the A3 Low Pass Filter Board Assembly, covered on Service Sheet 2. The signal is then output to the A5 Phase Lock Board Assembly, covered on Service Sheet 3.

AM Option (Option 130)

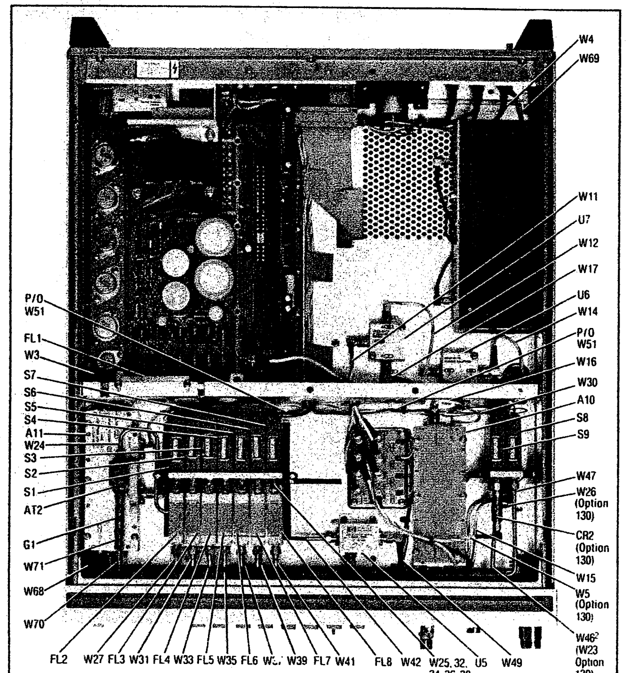
The AM option (Option 130) measures AM noise instead of phase noise. This option bypasses the microwave mixer and takes the microwave test signal directly into an AM detector. The output of the detector goes into the A3 Low Pass Filter Board Assembly, shown on Service Sheet 2.

TROUBLESHOOTING

Troubleshooting procedures are listed on the schematic.

Test Equipment

Microwave Synthesized Source	HP 8340A
RF Synthesized Signal Generator	HP 8662A (Option 003)
Power Meter	HP 436A
Oscilloscope	HP 1740A

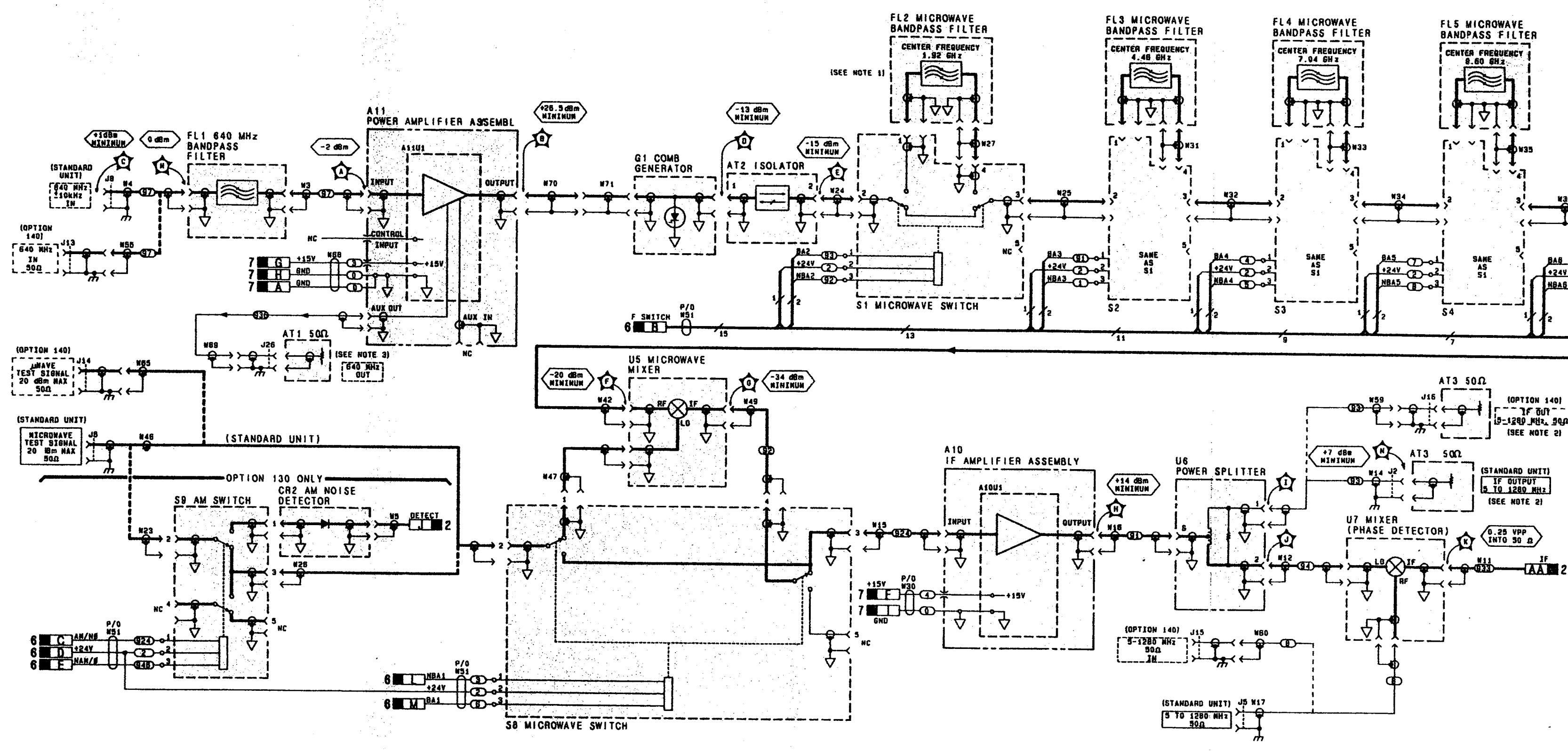


[1] These are identical cables and are located below FL2-FL8.

[2] (Standard Unit For a standard unit W46 is connected to port 2 of S8.)

The hardware used to mount the following assemblies to the deck is listed under each assembly in the replaceable parts list in Section VI:
A3, A10, A11, U5, U6 and U7.

Figure 8-2. Reference Up-Conversion, Test Signal Down-Conversion and Phase Detecting Assembly Component Locations



NOTES

1. IN THE STANDARD HP 11729C THERE ARE SEVEN FILTERS AND SWITCHES INSTALLED. WHEN A SINGLE FILTER OPTION IS ORDERED THE FILTER IS INSTALLED WITHOUT A SWITCH. ONE END OF THE FILTER IS CONNECTED TO U5 AND THE OTHER SIDE IS CONNECTED TO AT2 THROUGH W8. THE FILTER ORDERED FOR THE OPTION WILL HAVE THE SAME DESIGNATOR AS A STANDARD UNIT. FOR EXAMPLE: FL5 HAS A CENTER FREQUENCY OF 8.60 GHz.
2. THE IF OUTPUT IS FULLY USEABLE. INSTALL THE 50 Ω TERMINATION WHEN THE IF OUTPUT IS NOT BEING USED.
3. THE 640 MHz OUT IS FULLY USABLE. INSTALL THE 50Ω TERMINATION WHEN THE 640 MHz OUT IS NOT BEING USED.

* FACTORY SELECTED COMPONENTS

REFERENCE DESIGNATIONS

NO PREFIX	
AT1, 2, 3 CR2 FL1-8 G1 J2, 5, 6, 8, 13-16, 26 S1-9 U5-7 W3-5, 11, 12, 14-17, 23-27, 28-49, 51, 55, 59, 60, 65, 68-71	

MICROWAVE SWITCHES

BACK VIEW TERMINALS: 3, 2, 1
FRONT VIEW PORTS: 1, 2, 3, 4, 5

HP 11729C REFERENCE UP-CONVERSION, TEST SIGNAL DOWN-CONVERSION AND PHASE DETECTING CIRCUITS: 2432A

INITIAL CONDITIONS

WHEN THE FOLLOWING CONDITIONS ARE SET THE VOLTAGE AND POWER LEVELS, AS SHOWN ON THE SCHEMATIC, BECOME VALID. THESE LEVELS ARE A USEFUL TOOL FOR TROUBLESHOOTING.

HP 11729C
*BAND CENTER FREQUENCY - 9.6 GHz
LOCK BANDWIDTH FACTOR - 10 kHz
MODE - PHASE NOISE MEASUREMENT
DISCONNECT CABLE FROM FREQUENCY CONTROL (X-OSC OR DC-FM) ON REAR PANEL.

MICROWAVE SOURCE
(SEE CRITICAL SPECIFICATIONS IN SECTION 1)
*FREQUENCY - 10 GHz (CW)
LEVEL - +10 dBm
MODULATION - OFF
ALL OTHER FUNCTIONS - OFF

TUNABLE 5 TO 1280MHz SOURCE
(SEE CRITICAL SPECIFICATIONS IN SECTION 1)
*FREQUENCY - 400.010MHz
LEVEL - 0 dBm (-40 dBm WHEN CHECKING <10MHz OUTPUT ON FRONT PANEL)
MODULATION - OFF
ALL OTHER FUNCTIONS - OFF
PHASE LOCK THE MICROWAVE SOURCE TO THE TUNABLE 5 TO 1280MHz SOURCE. SEE SECTION III, PHASE LOCKING, IF YOU NEED HELP.

*IF THE 9.6GHz BAND CENTER FREQUENCY IS NOT AVAILABLE, SELECT AN AVAILABLE BAND RANGE. THE MICROWAVE SOURCE FREQUENCY MINUS THE BAND CENTER FREQUENCY OF THE BAND RANGE SELECTED WILL DETERMINE THE TUNABLE 5 TO 1280MHz SOURCE FREQUENCY.

1

Figure 8-3. Reference Up-Conversion, Test Signal Down-Conversion and Phase Detecting Circuits Schematic Diagram

SERVICE SHEET 2
LOW PASS FILTER AND LOW NOISE AMPLIFIER CIRCUITS

PRINCIPLES OF OPERATION

General

Service Sheet 2 consists of part of the A2 Front Panel Key and Display Board Assembly, the Low Pass Filter Board Assembly and the Low Noise Amplifier Assembly. The primary input to Service Sheet 2 is the IF signal from the mixer/phase detector, which is located on Service Sheet 1.

P/O FRONT PANEL KEY AND DISPLAY BOARD ASSEMBLY

General. This assembly provides the drive signals for the relays on the Low Pass Filter Board Assembly. A negative current is introduced to eliminate any dc offset in the phase lock loop when making a pulsed measurement; this counteracts a positive current introduced by the A5 Phase Lock Board.

Relay Drivers. Q1, Q2 and Q3 provide TTL levels that are used by the decoders U1A and U1B. U1A and U1B provide the input to relay drivers U2A and U2B. U2A and U2B provide the drive signals for relays A3K1 and A3K2 on the Low Pass Filter Board Assembly.

Balance Circuit. The balance circuit sums in a negative current at the output of an internal mixer/phase detector when making a pulsed measurement. When Q2 is turned on it turns Q4 off which turns Q5 on. With Q5 on, current flows through R12 and R13. R12 and R13 control the amount of current that is added to the phase lock loop. R13 is an internal adjustment and should only have to be set up once. R12 is a front panel adjustment which may have to be adjusted each time a pulsed measurement is made.

Low Pass Filter Board Assembly

General. The low pass filter assembly contains 2 low pass filters: a 15 MHz filter and a 1.5 MHz filter. R1 and C1, located at the input to the 15 MHz filter, appear as 50 ohms to high frequency signals. Relay K1 separates the AM-DET input from the IF input. The separation is needed because of noise that may be added to an AM noise measurement from the IF input. Relay K2 switches the IF signal through two rear panel connectors. These two connectors are used when a pulsed measurement is being made. A low pass filter, supplied by the user, is connected between the connectors to remove the pulse repetition frequency feedthrough from the detected baseband signal. The filter cutoff frequency is chosen according to the pulse repetition frequency.

15 MHz Filter. This is a Chebyshev low pass filter (that is, it has good attenuation near cutoff at the expense of allowing ripple in the passband). This filter is flat to 10 MHz. The 3 dB corner frequency occurs at approximately 15 MHz.

600Ω is used for the auxiliary noise and the 1.5 MHz filter so as to not interfere with the 50 ohm match between the 15 MHz filter and the low noise amplifier.

SERVICE SHEET 2 (cont'd)

1.5 MHz Filter. This filter is a five element Chebyshev filter. It is flat to 1 MHz and the 3 dB point is at 1.5 MHz. The 1.5 MHz filter removes any unwanted mixer products (such as LO feedthrough) that may have passed through the 15 MHz filter.

Low Noise Amplifier Assembly

General. The Low Noise Amplifier Assembly consists of a pre-amplifier and a power amplifier. The pre-amplifier provides most of the voltage gain and the power amplifier provides most of the current gain for the assembly. The low noise amplifier has one primary input and one output; both are 50Ω.

Pre-amplifier. The input stage of the low noise amplifier takes a signal and amplifies it with a cascode input stage consisting of Q1 and Q2. This stage drives Q3, which is a voltage follower to buffer the output of Q1. Feedback is applied from the output of Q3 to the base of Q2 to allow the input of the amplifier to look like 50 ohms.

E1 and E2 (on the base of Q1 and Q5, respectively) prevent oscillations around 600 MHz.

Between Q3 and Q5, there is a long signal path that is somewhat inductive. C7 is physically located halfway along this path. It peaks the frequency response that would otherwise be lost because of the inductance of the path, thus flattening the gain beyond 20 MHz.

Power Amplifier. Transistors Q5 and Q6 operate similarly to the cascode amplifier of Q1 and Q2.

Q7 and Q9, the beginning of the output stage of the power amplifier, are driven by the diode chain. For ac purposes, the inputs to Q7 and Q9 are identical. Q7 and Q9 are both voltage followers and drive their respective output transistors Q8 and Q10. R26 provides the proper output impedance for the circuit. It was selected so the output looks like 50 ohms.

TROUBLESHOOTING

The following information is supplied to assist in troubleshooting the Low Noise Amplifier Assembly and the Front Panel Key and Display Board Assembly.

Test Equipment

Microwave Synthesized Source .... HP 8340A
RF Synthesized Signal Generator .... HP 8662A (Option 003)
Spectrum Analyzer .... HP 8566B
Oscilloscope .... HP 1740A
Digital Multimeter .... HP 3456A

SERVICE SHEET 2 (cont'd)

LOW NOISE AMPLIFIER ASSEMBLY TROUBLESHOOTING

1. Connect a 640 MHz specturally pure signal to the 640 MHz rear panel input.
2. Connect a 10 GHz synthesized signal at a level of +10 dBm to the MICROWAVE TEST SIGNAL INPUT connector on the front panel.
3. Connect a 400.1 MHz synthesized signal at a level of −40 dBm to the 5—1280 MHz INPUT connector on the front panel.
4. Set the Carrier Noise Test Set as follows:

   Measurement mode .... ϕ, CW
   BAND Range .... 8.32 to 10.88 GHz

5. Remove the top cover of the Carrier Noise Test Set.
6. Disconnect the input cable (W10) to the Low Noise Amplifier. Connect an SMC(m) to BNC (f) adapter to the cable (W10). Connect a BNC cable from the adapter to a spectrum analyzer.
7. Verify that there is a 100 kHz beat note. Adjust the spectrum analyzer display to measure the level of the 100 kHz beat note.

   The input power level to the Low Noise Amplifier should be: −48 dBm typical

   If the power level measured is below the typical value, troubleshoot the Low Pass Filter on Service Sheet 2. If the measured power is correct, go to step 8.

8. Reconnect the input cable (W10) to the Low Noise Amplifier.
9. Connect the output connector (J2) on the Low Noise Amplifier to a spectrum analyzer. Measure the output power of the Low Noise Amplifier. The output power should be 40 dB higher than the input power.

   The output power level of the Low Noise Amplifier should be as follows: −8 dBm typical

   If the output power level measured is the typical value the Low Noise Amplifier if operating properly. If the measured power is incorrect go to step 10.

10. Turn off the Carrier Noise Test Set. Connect an SMC (f) 50 ohm termination to the output connector (J2) of the Low Noise Amplifier.
11. Remove the six screws that hold the Low Noise Amplifier board in the housing. Pull the Low Noise Amplifier board out of the housing. Place an insulating surface under the board to keep it from shorting out. Turn the Carrier Noise Test Set on.

SERVICE SHEET 2 (cont'd)

12. Measure the voltage peak-to-peak at TP1 and TP4 using an oscilloscope set to AC coupling. The voltage measured should be as follows:

    TP1 = 155 mVpp
    TP4 = 255 mVpp

    Use the voltages measured to isolate the failure to a particular section of the Low Noise Amplifier.

13. Disconnect the input cable to the Low Noise Amplifier. Use the following table of transistor base voltages to isolate the failure on the Low Noise Amplifier.

Transistor	Base Voltage
Q1	+7.6 Vdc
Q2	+5.1 Vdc
Q3	+14.7 Vdc
Q5	+14.0 Vdc
Q6	+3.9 Vdc
Q7	+13.9 Vdc
Q8	+13.1 Vdc
Q9	+11.1 Vdc
Q10	+11.0 Vdc

FRONT PANEL KEY AND DISPLAY BOARD ASSEMBLY TROUBLESHOOTING

The following table can be used to verify proper operation of the A2 Front Panel Key and Display Board Assembly. When an annunciator is turned on, using the MODE switch on the front panel, the typical transistor voltages should be as shown in the table below.

Front Panel Annunciator (on)	Transistor (Volts dc)									
	Q1		Q2		Q3		Q4		Q5	
	B	C	B	C	B	C	B	C	S	G
ϕ, CW	+4.3	+.25	+4.3	+.33	+4.3	+.25	+4.2	+4.7	0	+4.7
AM, CW	+4.1	+4.8	+4.2	+.27	+4.3	+.20	+4.2	+4.7	0	+4.7
ϕ, PULSE	+4.3	+.26	+4.1	+4.8	+4.3	+.24	+4.8	−14.7	−14.4	−14.7
AM, PULSE	+4.2	+.27	+4.2	+.33	+4.1	+4.7	+4.2	+4.7	0	+4.7

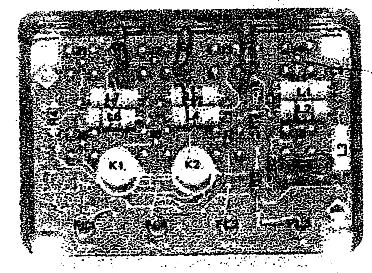
B = Transistor base
C = Transistor collector
S = FET source
G = FET gate

Reference Up-Conversion, Test Signal Down-Conversion and Phase Detecting Circuits
SERVICE SHEET 1

A2 ASSEMBLY
J1, J2 and R13 are mounted on the opposite side of this assembly

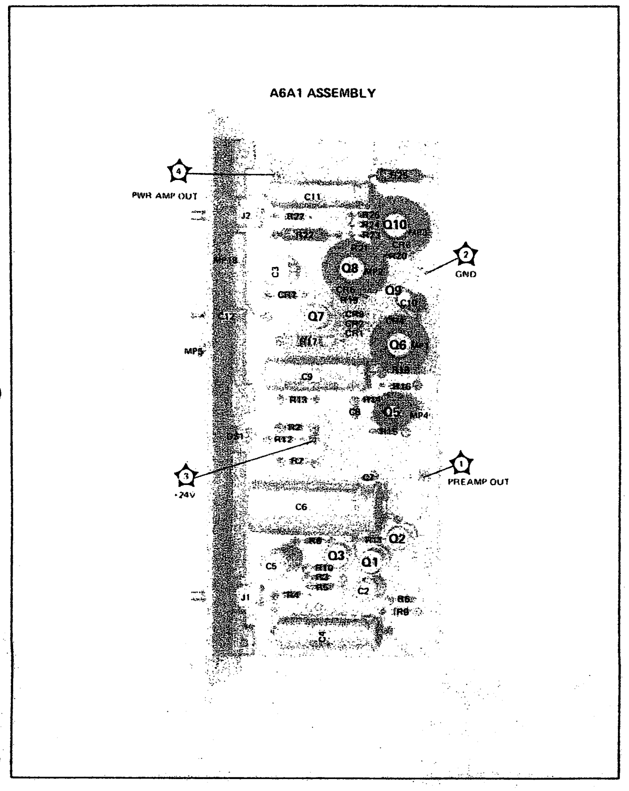
Figure 8-4. Front Panel Key and Display Board Assembly Component Locations

A3 ASSEMBLY



J1-J8 are mounted on the opposite side of this assembly

Figure 8-5. Low Pass Filter Board Assembly Component Locations



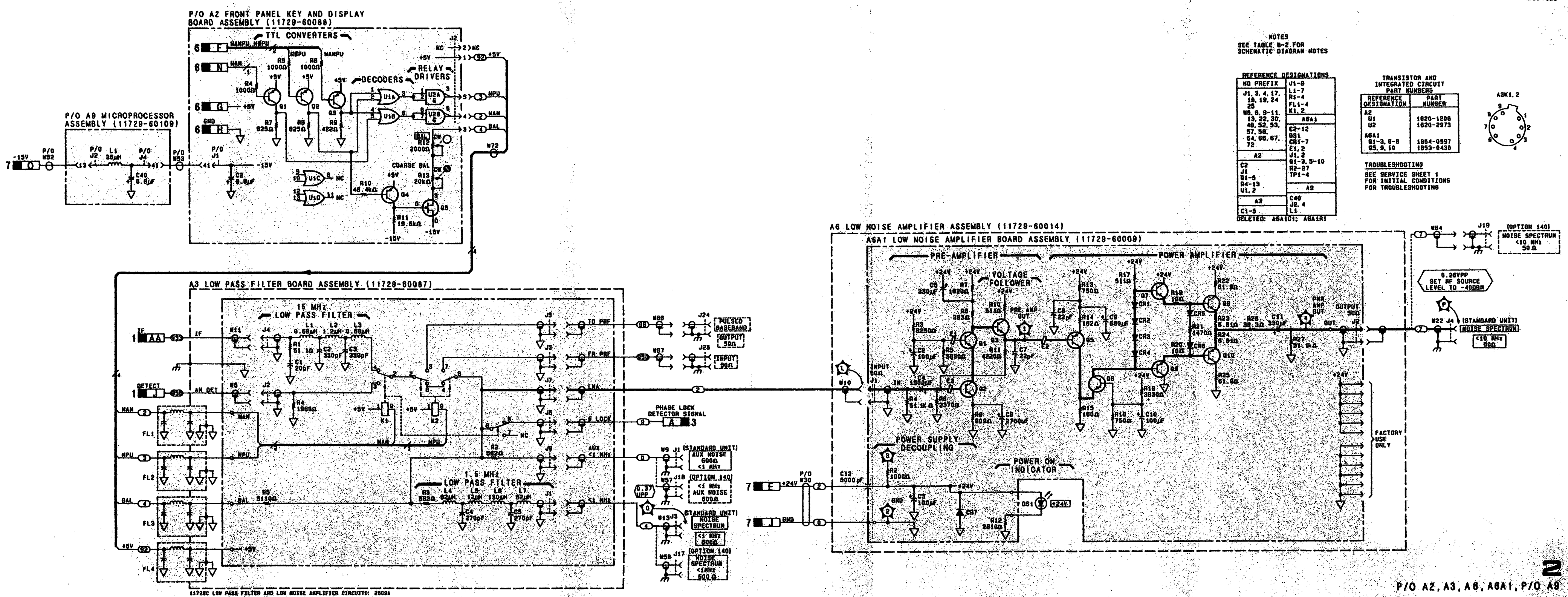


Figure 8-7. Low Pass Filter and Low Noise Amplifier Schematic Diagrams

SERVICE SHEET 3
PHASE LOCK CIRCUITS

PRINCIPLES OF OPERATION

General

The A5 Phase Lock Board Assembly is a four-stage amplifier that amplifies the output of the mixer/phase detector (see Service Sheet 1). The amplifier has two stages of fixed gain and two stages of switchable gain.

The outputs from this assembly, labeled FREQ-CONT DC-FM and FREQ-CONT X-OSC, go to the rear panel of the instrument. The difference in the two outputs is the FREQ-CONT X-OSC (±10V) is a factor of 10 volts more than FREQ-CONT DC-FM (±1V).

Input Amplifier

The input stage is U2A. This is a fixed gain stage. Operational amplifier U2A has a gain of 10. This stage sums various inputs to the phase lock circuit, among them a DC offset signal and LOOP TEST signal. When the tunable 5 to 1280 MHz signal and the device under test are phase locked, the DC offset has no effect. When they are out of lock, the DC offset ultimately shows up on the front panel as an out of lock indication. The DC offset signal is injected by a variable resistor connected to the +15V supply. The unlocked display adjustment (R5, UNLK DSP) is set to light the red LED, which is adjacent to the center green LED on the front panel indicator, when an out of lock condition occurs.

Switchable Gain Amplifier

Second stage amplifier U2B is the first switchable gain stage. CMOS switches control the gain of this stage by switching input resistors in and out of the circuit. The feedback resistor, R25, is fixed. (Gain is equal to minus the value the feedback resistor divided by the value of the input resistor.) In the second stage the gain can be switched by a factor of 100. The lock bandwidth factor that is selected on the front panel determines the switching factor. For a lock bandwidth factor of 1, the net gain of the second stage is 0.068 (R25 divided by R19). For a lock bandwidth factor of 10, the net gain is .681 (R25 divided by R18 and R19 in parallel). For any of the other lock bandwidth factors, the net gain is 6.81 (R25 divided by R17 plus the output impedance of U2A [175 ohms]). When the CAPTURE button on the front panel is pressed, the second stage amplifier is set to a fixed gain of 1.61 (R25 divided by R20 and R19 in parallel), regardless of the lock bandwidth factor setting.

The third stage, U2C, is also a switchable gain stage. The third stage adjusts the gain for lock bandwidth factors that remain constant in the second stage. For lock bandwidth factors of 1, 10 and 100, the gain of the third stage is a constant 0.1 (R41 divided by R29). For a lock bandwidth factor of 1000, the gain is 1 (R41 divided by R28 and R29 in parallel), and for a lock bandwidth factor of 10 000, the gain is 10 (R41 divided by R27 plus the out impedance of U2B [175 ohms]). When the CAPTURE button on the front panel is pressed, the third stage amplifier is set to a fixed gain of 1 (R41 divided by R29 and R32 in parallel), regardless of the lock bandwidth factor setting.

Integrator

This is the fourth stage of the amplifier. The integrator provides high DC gain but a gain of 1 for frequencies higher than 0.2 Hz. Capacitors C4 and C5 are

switched in or out of the fourth stage depending on whether or not the front panel CAPTURE key is pressed. If CAPTURE is pressed, these capacitors are removed from the circuit. The DC gain is then 1. In addition, pressing CAPTURE also changes the gain of the second and third stages to a fixed gain regardless of the lock bandwidth factor setting. An additional CMOS switch is provided for the second and third stages for the capture signal. When CAPTURE is released, the CMOS switches connect C4 and C5 into the circuit to form an integrator with the fourth stage amplifier. With the addition of C4 and C5, the phase lock loop is switched from a first order loop to a second order loop. The characteristics of this loop are as follows:

The second order loop has two poles (break points). The first pole has gain increasing from .15 Hz to 0 Hz at 12 dB/octave. The second pole has gain decreasing from .15 Hz to infinity at 6 dB/octave.

The second order loop forces the output of the mixer/ phase detector to be zero volts to maintain phase quadrature (that is, 90 degrees out of phase) between the device under test and the tunable 5 to 1280 MHz source.

Fast Charge Circuit

The fast charge circuit tracks the voltage coming out of the fourth stage (U2D) while the CAPTURE key is depressed. It precharges capacitors C4 and C5 to the same voltage as the output of U2D. When CAPTURE is released and the capacitors are switched into the circuit, a long time delay is not required to charge the capacitors because they are already precharged to the correct voltage level.

Capture Control

Comparator. When CAPTURE is pressed, the microprocessor sends a 0V capture signal to the A5 Phase Lock Board Assembly. This signal goes to comparator U1A, which controls relays K1 and K2. These relays switch C4 and C5 out of the circuit when CAPTURE is pressed.

Out-of-Lock Detector. The out-of-lock detector monitors the output of the input amplifier (U2A). It produces an output of either +5V or 0V, depending on the voltage of the signal that it is sampling. If the signal is within the lock range (± a few tenths of a volt around 0 Vdc), it outputs +5 volts denoting phase lock. If the signal is outside of that range, it outputs 0 volts, indicating the out-of-lock detection. This signal goes to the A9 Microprocessor Assembly for processing. The signal is used for out-of-lock detection over HP-IB (remote operation).

Display Drive. The output of the input amplifier (U2A) goes to the display drive circuit, which drives the front panel phase lock indicator. The display center adjustment (R37, DSP CNTR) centers the phase lock indicator for quadrature (0V from the mixer/phase detector). The display deviation adjustment (R35, DSP DEV) adjusts the gain of amplifier U1B and sets the phase lock indicator range to

cover the range of the amplified signal from the mixer/phase detector.

Buffer. The buffer drives the LOOP TEST PORT OUT signal. This signal is used to characterize the loop transfer function of the phase lock loop (if required).

Bandwidth Control

The front panel setting of the lock bandwidth factor switches determines the gain of the switchable gain amplifier. These front panel switches are read by the microprocessor. The microprocessor then sets CMOS latch U7. The output of that latch actuates the appropriate CMOS switches for the corresponding lock bandwidth factor.

Offset Voltage Source

The offset voltage source consists of a +5V regulator and a −5V source. VR2 drops the −15V supply down to −5V; U8 drops the +15V supply down to +5V. The +5V and −5V signals go into resistors that are connected to variable resistor R34, which provides the offset voltage adjustment for the switchable gain amplifier. The purpose of the offset adjustment is to compensate for any dc offsets that accumulate in the amplifier stages. The analog plus and minus 5 volt supplies give an added layer of regulation to provide a more precise voltage — this lessens the effect due to line changes and circuit changes that might cause the plus and minus 15 volt supplies to change slightly. Because the out-of-lock indicator requires a precise voltage, it is driven by these power supplies.

A1 Indicator Board Assembly

The Indicator Board Assembly takes an analog voltage and uses it to control an LED display.

R1 and R2 set the voltage at which the LEDs connected to the output of U1 will turn on. One LED is set to turn on for each +0.3 volt increase on pin 5 of U1. The resistors connected in parallel with the LEDs allow those LEDs to be dimmer than the LEDs without the resistors in parallel.

U2 is a +5 volt regulator. +15 volts is input to U2 and a regulated +5 volts is output.

TROUBLESHOOTING

The following procedure will help to isolate a problem, on the Phase Lock Board, to a particular stage on the schematic.

Test Equipment

Function Generator .... HP 3312A
Oscilloscope .... HP 1740A

Connect the following test set up as shown.

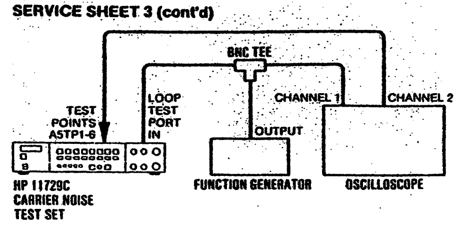


Figure 8-8. Phase Lock Board Troubleshooting Test Setup

Set the function generator as follows:

Wave form: Sine wave
Frequency: 100 Hz
Level: Minimum

Set the Carrier Noise Test Set as follows:

Measurement Mode: ϕ, CW
Lock Bandwidth Factor: 1

1. Turn the Carrier Noise Test Set off and remove the top cover.
2. On the A3 Low Pass Filter Assembly disconnect cable W11 from the IF input connector J1. Connect an SMC short to connector J1.
3. On the A5 Phase Lock Board Assembly put a short across A5C4.
4. Connect the function generator to LOOP TEST PORT IN on the rear panel. Turn the Carrier Noise Test Set on.
5. On the oscilloscope set the coupling control, for channel one to AC.
6. Adjust the level of the function generator for 5Vpp as read on channel one of the oscilloscope.
7. On the oscilloscope set channel two to DC coupling.
8. Connect channel two to Test Point 1 on the A5 Phase Lock Board. Adjust the volts/division to view the channel two input.
9. Adjust the DC offset on the function generator to center the display on channel two.
10. Measure the typical peak-to-peak voltages at Test Points 1,2, 3 and 4, on the A5 assembly, for Lock Bandwidth Factors 1 and 10. The Lock Bandwidth Factor keys are on the front panel. Compare the measured voltages to the typical voltages shown in the following table.

Lock Bandwidth Factor	Typical Peak-to-Peak Voltages			
	A5TP1	A5TP2	A5TP3	A5TP4
1	5V	0.34V	.034V	0.034V
10	5V	3.4V	0.34V	0.34V

11. With CAPTURE pressed, on the front panel, measure the peak-to-peak voltages at Test Points 1,2,3 aud 4 on the A5 assembly. Compare the measured voltages to the typical voltages shown in the following table.

Capture Button	Typical Peak-to-Peak Voltages			
	A5TP1	A5TP2	A5TP3	A5TP4
Pressed	5V	8V	8V	8V

12. Using channel one set the level of the function generator to 100 mVpp.
13. Set the LOCK BANDWIDTH FACTOR, on the front panel, to 100.
14. Connect channel two to Test Point 1 on the A5 Phase Lock Board. Observe channel two on the oscilloscope. Adjust the volts/division to view the channel two input.
15. Adjust the DC offset on the function generator to center the display on channel two.
16. Measure the typical peak-to-peak voltages at Test Points 1,2,3 and 4 on the A5 assembly for Lock Bandwidth Factors of 100, 1k and 10k. The Lock Bandwidth Factor keys are on the front panel. Compare the measured voltages to the typical voltages shown in the following table.

NOTE

With a Lock Bandwidth Factor of 10k the output from Test Point 4 may be clipped since this is the highest gain setting.

Lock Bandwidth Factor	Typical Peak-to-Peak Voltages			
	A5TP1	A5TP2	A5TP3	A5TP4
100	0.1V	0.68V	0.068V	0.068V
1k	0.1V	0.68V	0.68V	0.68V
10k	0.1V	0.68V	6.8V	6.8V

Low Pass Filter and Low Noise Amplifier Circuits P/O A2, A3, A6, A6A1 SERVICE SHEET 2

17. Using a multimeter measure the voltage at Test Points 5 and 6, on the A5 assembly. Make one measurement with the CAPTURE button, on the front panel, pressed and then with the button released. The voltages should be as shown in the following table.

Typical Voltages	Capture Pressed	Capture Released
A5TP5	5V	<0.8V
A5TP6	<0.8V	5V

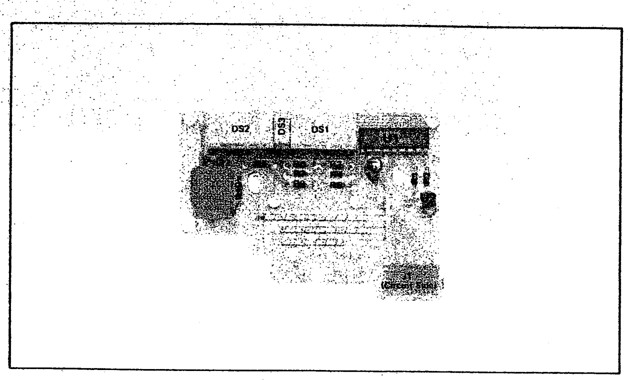


Figure 8-9. Indicator Board Assembly Component Locations

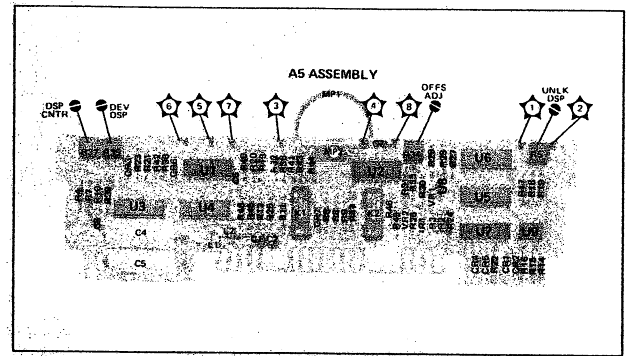
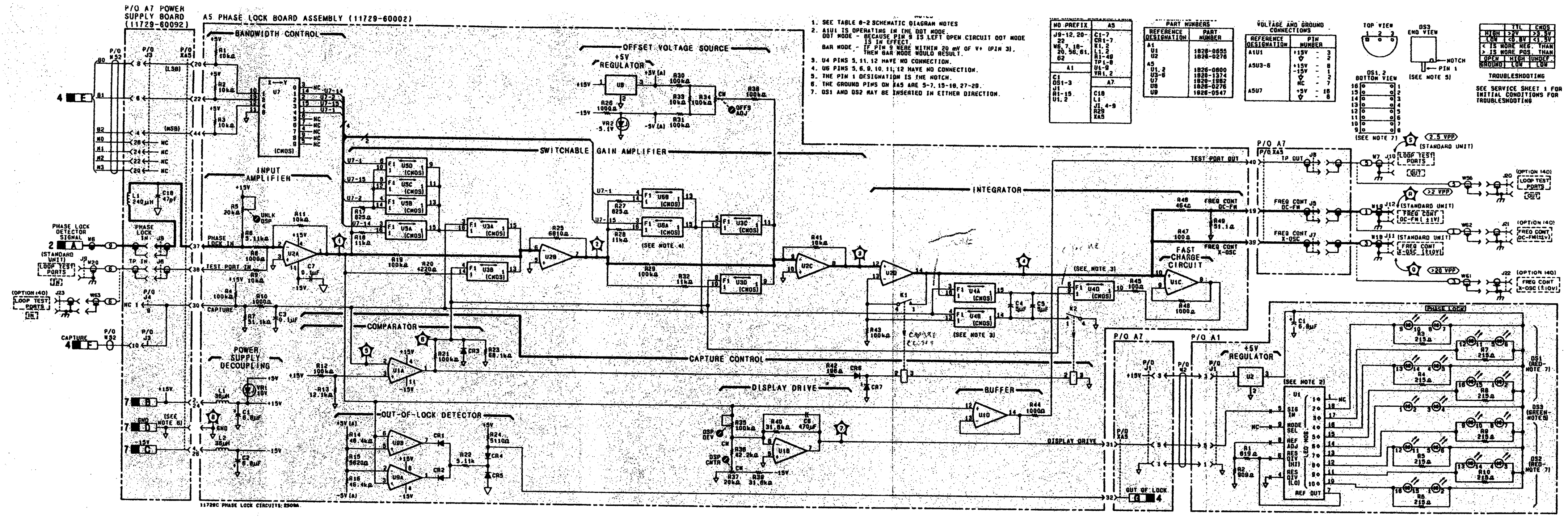


Figure 8-10. Phase Lock Board Assembly Component Locations



3

A1,A5,P/O A7

Figure 8-11. Phase Lock Circuit Schematic Diagram

SERVICE SHEET 4
PRINCIPLES OF OPERATION

General

The A9 Microprocessor Board Assembly receives data from the A2 Front Panel Key and Display Board Assembly (local) or from HP-IB (remote).

Local inputs use the following circuits:
a. keyboard encode,
b. keyboard debounce circuit, and
c. peripheral interface adapter (PIA).

The PIA manages local operation and monitors the out-of-lock signal from the A5 Phase Lock Board assembly.

Remote inputs use the following circuits:
a. HP-IB management line transceiver,
b. HP-IB data line transceiver, and
c. HP-IB interface.

The HP-IB interface manages remote operation.

Keyboard Encode

The A2 Front Panel Key and Display Board Assembly consists of 16 keys. Keyboard encode U45, U46 and U39 are connected to these keys in such a way that it becomes a 1-of-16 priority encoder. Inputs to U45 and U46 are active low. When a key is pressed, the corresponding signal line goes to 0V. U45 and U46 sense the line and encodes it to a binary number.

Keyboard Debounce Circuit

U11B adds a 21 ms delay to ensure that a key has been depressed instead of a momentary spike that is being detected. If a key is held for 21 ms, the output of flip-flop U40B goes high. U6 pin 40 (CA1) acts as a flag. If there is a high signal on this line, the peripheral interface adapter informs the microprocessor that a key has been pressed.

Out-of-Lock Debounce Circuit

This circuit detects either a negative going edge (lock to out-of-lock) or positive going edge (out-of-lock to lock). In addition, it informs the microprocessor (via the PIA) of the change in condition. A change is detected immediately when the signal goes from lock to out-of-lock. When the signal goes from out-of-lock to lock, U11A causes a 9.7 ms delay before clocking the results to the peripheral interface adapter, which notifies the microprocessor of the change. When the microprocessor is informed of a change in state, it re-enables the circuitry by enabling U6 pin 14 (PB4), which causes flip-flop U40A to reset U53. The microprocessor then looks for a signal of the opposite sense on the input to U53. U6 pin 15 (PB5) keeps track of the signal sense that the microprocessor is expecting.

Peripheral Interface Adapter (PIA)

The PIA, U6, manages the exchange of information between the front panel and the microprocessor. Lines PB4-6 control the out-of-lock debounce circuitry. Line PB7, which drives the capture signal on the A5 Phase Lock Board assembly, is activated when the CAPTURE key is pressed. Lines PA0-3 and PA7 read the

keyboard encode circuits to monitor when a front panel key is being pressed. Lines PA4-6 generate the filter ranges.

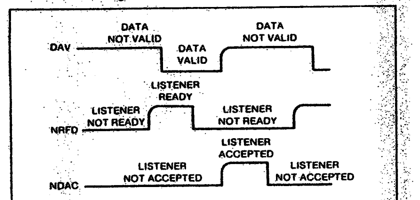
HP-IB Management Transceiver and Data Line Transceiver

These transceivers allow bi-directional signal flow on the data lines (DIO1-8) and the handshake lines (DAV, NRFD, and NDAC). The HP-IB management line transceiver manages the handshake lines and the HP-IB data line transceiver manages the data lines.

HP-IB Interface

HP-IB interface U2 manages the exchange of information between the microprocessor and the HP-IB. U2 also determines the direction of flow of information through bi-directional transceivers U33 and U34.

Remote inputs to the Carrier Noise Test Set are in the form of encoded control and data information. Control information is input to the instrument via five control lines and three handshake lines. The control lines are labeled ATN, SRQ, REN, IFC and EOI. They allow the controller to gain the Carrier Noise Test Set's attention and impart other appropriate control information. The handshake lines are labeled DAV, NRFD, and NDAC. They provide asynchronous control information for data transfer between a talker (controller) and the listener (Carrier Noise Test Set). See Figure 8-11 for a more detailed explanation of handshake lines. Data lines are labeled DI01 through DI08.



Start with the talker waiting for the listener to release NRFD (not ready for data) indicating it is ready.

When the listener is ready, NRFD goes high (false). The talker then places valid data on D101 through D108 and sets DAV (data valid) low (true).

NRFD then goes low (true) and the talker waits for the listener to indicate it has accepted the data (or ignored it) by releasing the NDAC (not data accepted) to a high (false, i.e., data is accepted).

The talker sets DAV high (false) and again waits for the listener to release NRFD.

(NOTE that if ATN is true, all instruments on the bus must handshake regardless of whether they are talkers, listeners, or bystanders. Being in remote or local has nothing to do with handshaking. If ATN is false, they only handshake if addressed).

Figure 8-12. Simplified HP-IB Handshake between a Talker (Computer Controller) and One Listener (Carrier Noise Test Set)

TROUBLESHOOTING USING SIGNATURE ANALYSIS

NOTE

Run the following tests in the sequence listed.

Test Equipment

Signature Multimeter ....HP 5005B

Address Decoding Check

Purpose. To verify the microprocessor can generate an address, transfer that address to the selected chip. The correct address is decoded at the chip.

Setup. Turn the Carrier Noise Test Set off and remove the bottom cover. Locate the A9 Microprocessor Board. Remove the 3 screws that hold the board in place. The A9 assembly is the Printed Circuit board laying parallel to the bottom of the instrument.

Connect the signature analyzer Timing Pod as follows:

1. START/ST/SP to SAST1 (A9TP4)
2. STOP/QUAL to SAST1 (A9TP4)
3. CLOCK to SACLK (A9TP3)
4. GND to GND (A9TP1)

Set the signature analyzer controls as follows:

1. Function: Signature .... Normal
2. Polarity: Clock .... Falling edge (2)
   Start .... Rising edge (1)
   Stop .... Rising edge (1)

Connect a jumper cable between NFREERUN (A9TP5) and GND (A9TP1). Turn the Carrier Noise Test Set on.

NOTE

The test setup conditions for the Address Decoding Check are the same for Service Sheets 4,5 and 6, therefore signatures may be taken concurrently on all three service sheets.

Connect the signature analyzer's probe to the points indicated in Table 8-3 and verify the signatures.

Disconnect the signature analyzer and the short between NFREERUN (A9TP5) and GND (A9TP1).

ROM Operation Check

Purpose. To verify that the microprocessor can read the data stored in ROM and then execute that code.

Table 8-3. Signatures for Verifying Address Decoding

Pin	U2	U6
8	1376	—
9	0000	—
10	0003	—
21	UUUU	0003
22	FFFF	0003
23	8484	9668
24	—	0003
35	—	UUUU
36	—	FFFF

Setup. Set the diagnostic switch A9S2 (right side of A9 assembly) to the ROM test position shown below.

Diagnostic Switch S2	ROM Test Logic Level
1	0
2	1
3	0
4	0

Locate the 8 Red LEDs between U27 and U28. The individual LEDs are numbered D0-D7 with D7 being the LED closest to the hinged portion of the microprocessor board assembly.

Turn the Carrier Noise Test Set on to reset the instrument.

Check the pattern of the flashing LEDs to see if ROM passes the test.

ROM Passes Test — D5 remains on and all the other LEDs flash on and off. This verifies that the address and data busses between ROM and the microprocessor are working.

ROM Fails Test — D5 remains on and all the other LEDs remain off. This signifies that the address and data busses have a problem. Check for short circuits.

RAM Operation Check

Purpose. To verify that the RAM is operational.

Setup. Set the diagnostic switch A9S2 to the RAM test position shown below.

Diagnostic Switch S2	RAM Test Logic Level
1	1
2	0
3	0
4	0

Turn the Carrier Noise Test Set off then on to reset the instrument.

Check the pattern of the flashing LEDs to see if RAM passes the test.

RAM Passes Test — D4 is on and D0-D3 count, all LEDs turn on then the counting sequence repeats. This verifies that the microprocessor can access RAM properly.

RAM Fails Test — D4 is on but D0-D3 do not go through counting sequence. This shows that the RAM or the control lines to the RAM may be faulty.

Turn the Carrier Noise Test Set off.

Signature Analysis Test — Microprocessor and I/O Check

Purpose. The Microprocessor runs a program to verify transmission of data from the Microprocessor to the Peripheral Interface Adapter and the HP-IB Interface.

Connect the signature analyzer Timing Pod as follows:

1. START/ST/SP to SAST2 (A9TP6)
2. STOP/QUAL to SAST2 (A9TP6)
3. CLOCK to SACLK (A9TP3)
4. GND to GND (A9TP1)

Set the signature analyzer controls as follows:

1. Function: Signature .... Normal
2. Polarity: Clock .... Falling edge (2)
   Start .... Rising edge (1)
   Stop .... Falling edge (2)

Set the Diagnostic Switch A9S2 as follows:

Diagnostic Switch S2	Signature Analysis Test Logic Level
1	1
2	1
3	0
4	0

Turn the Carrier Noise Test Set on to reset the diagnostic. Connect the signature analyzer's probe to the points indicated in Table 8-4 and verify the signatures.

NOTE

The test setup conditions for the Signature Analysis Test are the same for Service Sheets 4, 5 and 6, therefore signatures may be taken concurrently on all three service sheets.

Phase Lock Circuits
A1, A5, P/O A7
SERVICE SHEET 3

Table 8-4. Signatures for Verifying Microprocessor and Input/Output Operation

Pin	U2	U6	Pin	U2	U6
6	—	C8P8	22	—	1HCU
7	—	5HF2	23	—	3361
8	6978	FP47	24	—	1HCU
9	P04P	0000	26	—	C8H9
10	UHU1	C6FA	27	—	5U7U
11	—	4A88	28	—	HCAH
12	7997	92H3	29	—	HA4H
13	718H	5F06	30	—	FH20
14	91C9	F1A0	31	—	91C9
15	FH20	99CH	32	—	718H
16	HA4H	—	33	—	7997
17	HCAH	—	35	—	9900
18	5U7U	—	36	—	1P44
19	C8H9	3P71	39	—	7F37
21	—	UHU1			

Disconnect the signature analyzer timing pod.

Reset the Diagnostic Switch A9S2 to the normal operation position shown as follows:

Diagnostic Switch S2	Normal Operation Logic Level
1	1
2	1
3	1
4	1

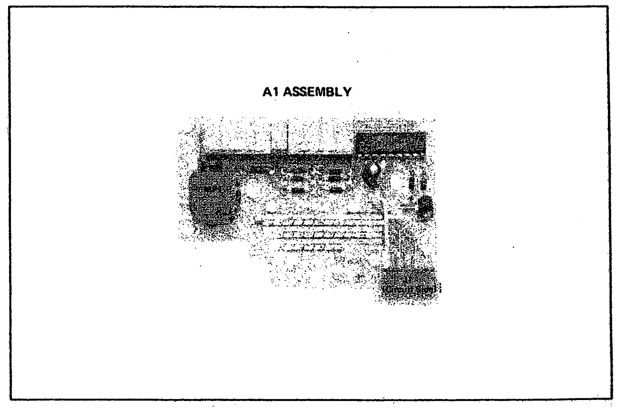


Figure 8-13. Indicator Board Assembly Component Locations

A12 ASSEMBLY

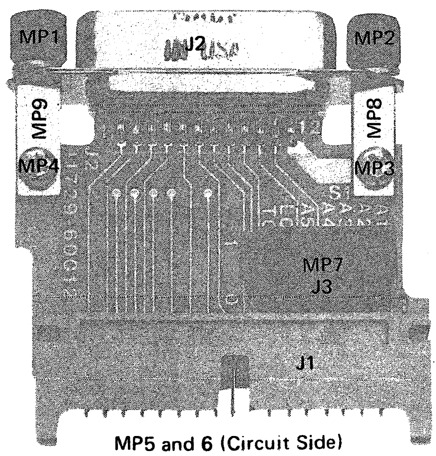


Figure 8-14. HP-IB Interconnect Board Assembly Component Locations

A2 ASSEMBLY

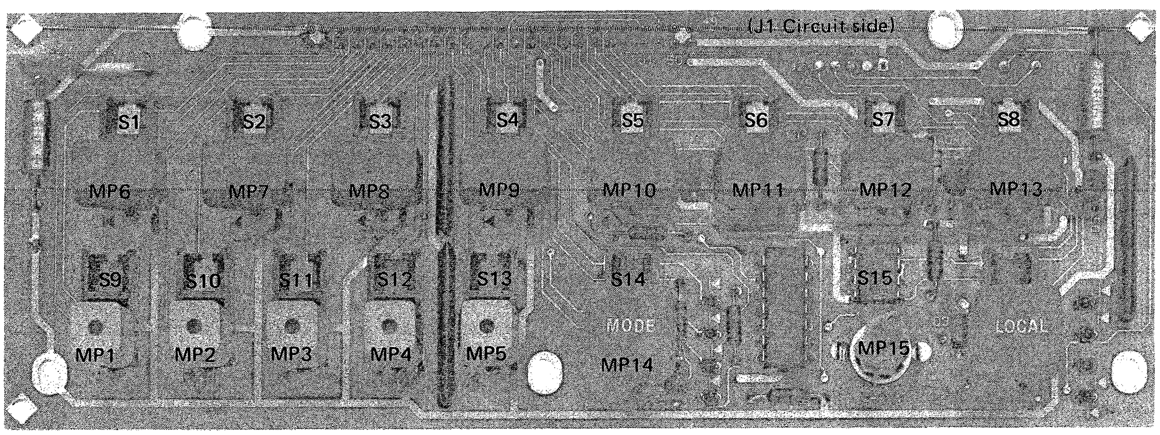


Figure 8-15. Front Panel Key and Display Board Assembly Component Locations

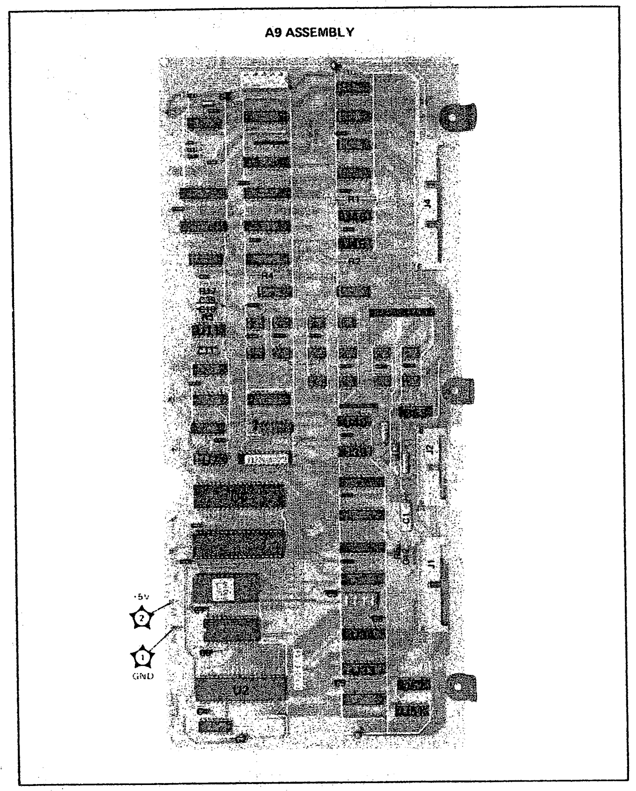
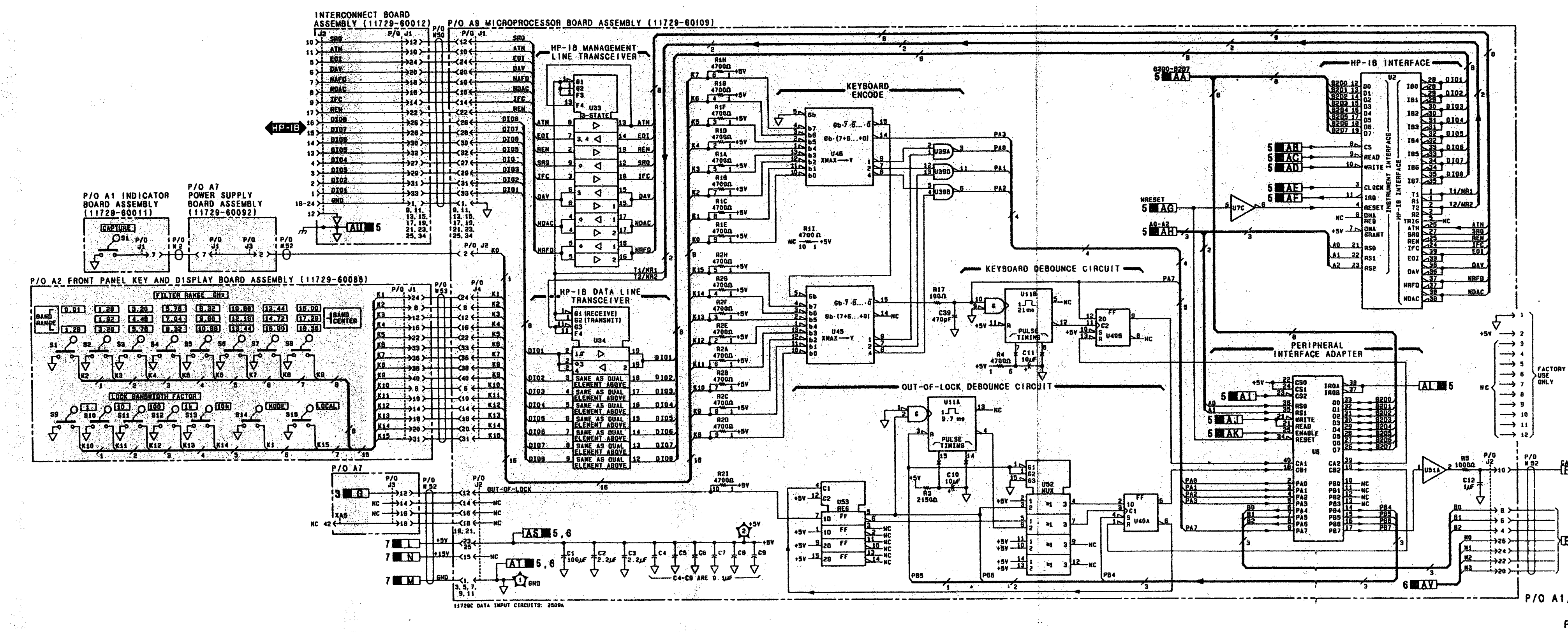


Figure 8-16. Microprocessor Board Assembly Component Locations



NOTES

1 SEE TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.

REFERENCE DESIGNATIONS

NO PREFIX	A8
S W 2, 50, 52, 53	J1-2
	A9
A1	C1-12, 39 J1, 2, 4 R1-5, 17 TP1, 2 U2, 6, 7, 11, 33, 34, 39, 40, 45, 46, 51-53
S1	
A2	
S2-15 J1	
A7	
J1, 3 XA5	

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATION	PART NUMBER
U2	1820-2549
U6	1820-2081
U7	1820-1199
U11	1820-1423
U33	1820-3513
U34	1820-3431
U39	1820-1197
U40	1820-1112
U45, 46	1820-1851
U51	1820-0668
U52	1820-1470
U53	1820-1446

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATION	PIN NUMBER
U2	+5V - 40 GND - 1
U6	+5V - 20 GND - 1
U7, 39, 40, 51	+5V - 14 GND - 7
U11, 45, 46, 52, 53	+5V - 16 GND - 8
U33	+5V - 11, 20 GND - 10
U34	+5V - 20 GND - 10

LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN		
> IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

Figure 8-17. Data Input Circuit Schematic Diagram

SERVICE SHEET 5

PRINCIPLES OF OPERATION

General

The data processing circuits provide the timing, calculation, and control for the Carrier Noise Test Set. The microprocessor executes the instructions stored in ROM (Read Only Memory). Data is exchanged between the microprocessor and other circuits on the A9 Microprocessor Board Assembly via the data bus (D0-D7). Circuits are enabled to respond to the data on the data bus by control signals. These control signals are derived from the address bus by the address decoders. Data values that must be stored are placed in the RAM (that is, Random Access Memory also known as read-write memory).

Microprocessor

Microprocessor U5 controls the functions of the instrument by executing the instructions stored in ROM.

The data bus (D0 through D7) consists of eight bidirectional lines that are used to transfer 8-bit positive-true data bytes to and from the microprocessor. The microprocessor reads data from ROM AND RAM, the PIA (local) or the HP-IB interface (remote). Information on the data bus is buffered as it enters or leaves the microprocessor.

The address bus (A0 through A15) consists of sixteen unidirectional lines that transfer an address from the microprocessor to the peripheral interface adapter, HP-IB interface, ROM, RAM and the address decoders.

Interrupt request (IRQ at pin 3) and fast interrupt request (FIRQ at pin 4) are used to interrupt program execution. IRQ detects an interrupt from the HP-IB interface. FIRQ detects an interrupt from the peripheral interface adapter. Nonmaskable interrupt (NMI at pin 2), which is active low, is connected to +5V. Therefore, it is always inactive.

The halt signal (HALT at pin 40), which is active low, is connected to +5V. Therefore, the microprocessor is never halted by this signal.

An external 4 MHz clock signal is connected to the microprocessor via pin 38 (EXTAL). An internal divide-by-4 circuit is used to develop the 1 MHz system clock E (pin 34). The XTAL signal line is grounded because external timing is used.

The reset signal (RESET at pin 37) is used to start the microprocessor from a power-down condition. When RESET is active (low), the microprocessor becomes inactive.

The memory ready signal input to the microprocessor (MRDY at pin 36) is connected to +5 volts to enable the 1 MHz system clock rate.

The read/write signal (pin 32) controls the direction of data transfer on the data bus. When the microprocessor is available to accept data, this signal is high, indicating that the microprocessor is in the read state. When data is being transferred out onto the data bus, this signal is low, indicating that the microprocessor is in the write state.

SERVICE SHEET 5 (cont'd)

ROM and RAM

The ROM (Read Only Memory) and RAM (Random Access Memory-also known as read-write memory) provide the memory for the Microprocessor. ROM U4 stores the program information. RAM U3 is used for temporary storage of keyboard and HP-IB information, and data calculations.

16 MHz Clock and 16 MHz Clock Divider

The 16 MHz clock is the master clock for the Microprocessor Assembly. Its frequency is crystal controlled. The output of the clock is fed to U1, a divide-by-4 circuit. The 4 MHz output of U1 goes to two places — pin 3 (CLOCK) of the HP-IB interface and pin 38 (EXTAL) of the microprocessor.

The microprocessor has an internal divide-by-four circuit that converts the 4 MHz to 1 MHz. This 1 MHz signal is output on U5 pin 34 (E) and provides clocking for the Carrier Noise Test Set's digital circuitry.

Reset Circuit

The reset circuitry signals the microprocessor to begin the restart sequence. A reset signal, generated during power-up of the instrument, initializes the microprocessor from the power-down condition. The instrument does a RAM test and a ROM test at power-on.

Address Decoders

U16 is a programmable array logic integrated circuit. Depending on the input levels to U16 it is used to enable the following integrated circuits or test points:

U4 ROM	U3 RAM
U38 Data Buffer	U37 Data Buffer
U36 Data Buffer	U35 Diagnostic Switch Buffer
Test Point SAST2	

U16 is also used to enable address decoders U8-U10. U8-U10 do further decoding of the address lines to enable other integrated circuits.

Address Switch

Address switch S11 consists of seven miniature slide switches. It sets the HP-IB address of the Carrier Noise Test Set. The switches labeled A1 through A5 set the address in binary. A1 is the least significant bit. For the decimal equivalent of the binary setting, allowable addresses are 0-30. The HP-IB address is set to 6 when it is shipped from the factory. The switches labeled LO and TO set the instrument to listen only or talk only, respectively, when in the "1" position. These switches are factory set to "0".

HP-IB Address Buffer

U32 is a tri-state buffer. It is read by the microprocessor at power-up to determine the setting of the address switch.

SERVICE SHEET 5 (cont'd)

Diagnostic Switch and Diagnostic Switch Buffer

Diagnostic switch S2 consists of four rocker switches which define the operation of the instrument upon power-up. S2 can be set for normal operation or it can be set to run RAM, ROM, or signature analysis diagnostics. An interpretation of the switch positions is defined in the table below. Settings not shown are undefined.

Switch				Definition
4	3	2	1	
0	0	0	0	Undefined
0	0	0	1	RAM Test
0	0	1	0	ROM Test
0	0	1	1	Signature Analysis Test
1	1	1	1	Normal Operation

The microprocessor reads the diagnostic switch buffer at power-up to determine whether or not diagnostics should be run.

TROUBLESHOOTING USING SIGNATURE ANALYSIS

NOTE

Run the following tests in the sequence listed.

Test Equipment

Signature Multimeter ....HP 5005B

Address Decoding Check

Purpose. To verify the microprocessor can generate an address, transfer that address to the selected chip and the correct address is decoded at the chip.

Setup. Turn the Carrier Noise Test Set off and remove the bottom cover. Locate the A9 Microprocessor Board. Remove the 3 screws that hold the board in place. The A9 assembly is the printed circuit board laying parallel to the bottom of the instrument.

Connect the signature analyzer Timing Pod as follows:

1. START/ST/SP to SAST1 (A9TP4)
2. STOP/QUAL to SAST1 (A9TP4)
3. CLOCK to SACLK (A9TP3)
4. GND to GND (A9TP1)

Set the signature analyzer controls as follows:

SERVICE SHEET 5 (cont'd)

1. Function: Signature .... Normal
2. Polarity: Clock .... Falling edge (2)
   Start .... Rising edge (1)
   Stop .... Rising edge (1)

Connect a jumper cable between NFREERUN (A9TP5) and GND (A9TP1).

NOTE

The test setup conditions for the Address Decoding Check are the same for Service Sheets 4,5, and 6, therefore signatures may be taken concurrently on all three service sheets.

Connect the signature analyzer's probe to the points indicated in Table 8-5 and verify the signatures.

Table 8-5. Signatures for Verifying Address Decoding

Pin	U3	U4	U5	U8	U10	U17	U16	U32	U37
1	6F9A	—	—	P763	0003	—	0000	UAH6	—
2	U759	—	—	1U5P	—	—	P763	—	—
3	0356	6F9A	—	0356	—	—	0003	—	—
4	1U5P	U759	—	—	—	—	8484	—	—
5	P763	0356	—	—	—	—	—	—	—
6	8484	1U5P	0000	—	—	—	FFFF	—	—
7	FFFF	P763	—	—	0002	—	—	—	—
8	UUUU	8484	UUUU	—	9UP1	—	UUUU	—	—
9	—	FFFF	FFFF	—	6U28	—	—	—	—
10	—	UUUU	8484	—	4868	—	—	—	—
11	—	—	P763	—	4FCA	—	—	—	—
12	—	—	1U5P	—	—	—	UUUU	—	—
13	—	—	0356	UAH6	0000	0003	—	—	—
14	—	0000	U759	9668	—	—	FFFF	—	—
15	—	—	6F9A	1376	2302	—	—	—	—
16	—	—	7791	—	546H	—	8484	—	—
17	—	—	6321	—	96FA	—	0003	—	—
18	—	—	37C5	—	—	—	P763	—	—
19	37C5	—	6U28	—	—	—	0000	UAH6	A4C6
20	0000	2302	4FCA	—	3838	—	—	—	—
21	0003	37C5	4868	—	7633	—	—	—	—
22	6321	—	9UP1	—	0000	—	—	—	—
23	7791	6U28	0002	—	A4C6	—	—	—	—
24	—	6321	—	—	—	—	—	—	—
25	—	7791	—	—	—	—	—	—	—
32	—	—	0003	—	—	—	—	—	—

Turn the Carrier Noise Test Set off.

ROM Data Check

Purpose. To verify ROM operation and the data contents stored in ROM.

SERVICE SHEET 5 (cont'd)

Connect the signature analyzer Timing Pod as follows:

1. START/ST/SP to SAST1 (A9TP4)
2. STOP/QUAL to A9U4 pin 20
3. CLOCK to SACLK (A9TP3)
4. GND to GND (A9TP1)

Set the signature analyzer controls as follows:

1. Function: Signature .... QUAL
2. Polarity: Clock .... Falling edge (2)
   Start .... Rising edge (1)
   Stop .... Rising edge (1)
   Qual .... Lo (2)

Leave the jumper connected between 'NFREERUN' (A9TP5) and GND (A9TP1). Turn the Carrier Noise Test Set on.

Connect the signature analyzer's probe to the points indicated in Table 8-6 and verify the signatures.

Table 8-6. Signatures for Verifying ROM Operation and Data Stored in ROM.

Pin	U4	U5	U36	U37
2	P254	—	2C33	2C33
3	FF4F	—	189F	189F
4	4PCC	—	A911	A911
5	A7A2	—	6946	6946
6	108P	—	HUP3	HUP3
7	5342	—	69P0	69P0
8	1100	052A	2A99	2A99
9	0108	0108	HFUF	HFUF
10	052A	1100	—	—
11	2C33	5342	—	HFUF
12	189F	108P	—	2A99
13	A911	A7A2	—	69P0
14	—	4PCC	—	HUP3
15	6946	FF4F	—	6946
16	HUP3	5HC4	—	A911
17	69P0	0P0P	—	189F
18	2A99	0F62	—	2C33
19	HFUF	H6AA	—	—
20	—	P254	—	—
21	0F62	—	—	—
23	H6AA	—	—	—
24	0P0P	—	—	—
25	5HC4	—	—	—

Turn the Carrier Noise Test Set off. Disconnect the Timing Pod and the jumper.

DATA INPUT CIRCUITS
P/O A1, P/O A2, P/O A7, P/O A8, P/O A9
SERVICE SHEET 4

SERVICE SHEET 5 (cont'd)

ROM Operation Check

Purpose. Verify that the microprocessor can read the data stored in ROM and then execute that code.

Setup. Set the diagnostic switch A9S2 (right side of A9 assembly) to the ROM test position shown below.

Diagnostic Switch S2	ROM Test Logic Level
1	0
2	1
3	0
4	0

Locate the 8 Red LEDs between U27 and U28. The individual LEDs are numbered D0-D7 with D7 being the LED closest to the hinged portion of the microprocessor board assembly.

Turn the Carrier Noise Test Set on to reset the instrument.

Check the pattern of the flashing LEDs to see if ROM passes the test.

ROM Passes Test — D5 remains on and all the other LEDs flash on and off. This verifies that the address and data busses between ROM and the microprocessor are working.

ROM Fails Test — D5 remains on and all the other LEDs remain off. This signifies that the address and data busses have a problem. Check for short circuits.

Turn the Carrier Noise Test Set off.

RAM Operation Check

Purpose. To verify that the RAM is operational.

Setup. Set the diagnostic switch A9S2 to the RAM test position shown below.

Diagnostic Switch S2	RAM Test Logic Level
1	1
2	0
3	0
4	0

Turn the Carrier Noise Test Set on to reset the instrument.

Check the pattern of the flashing LEDs to see if RAM passes the test.

RAM Passes Test — D4 is on and D0-D3 count, all LEDs turn on then the counting sequence repeats. This verifies that the microprocessor can access RAM properly.

RAM Fails Test — D4 is on but D0-D3 do not go through counting sequence. This shows that the RAM or the control lines to the RAM may be faulty.

Turn the Carrier Noise Test Set off.

Signature Analysis Test — Microprocessor and Data Transfer

Purpose. The Microprocessor runs a program to verify the functional operation of ROM, RAM, and the data buffers.

Connect the signature analyzer Timing Pod as follows:

1. START/ST/SP to SAST2 (A9TP6)
2. STOP/QUAL to SAST2 (A9TP6)
3. CLOCK to SACLK (A9TP3)
4. GND to GND (A9TP1)

Set the signature analyzer controls as follows:

1. Function: Signature .... Normal
2. Polarity: Clock .... Falling edge (2)
   Start .... Rising edge (1)
   Stop .... Falling edge (2)

Set the Diagnostic Switch A9S2 as follows:

Diagnostic Switch S2	Signature Analysis Test Logic Level
1	1
2	1
3	0
4	0

Turn the Carrier Noise Test Set on to reset the diagnostic switch.

Connect the signature analyzer's probe to the points indicated in Table 8-7 and verify the signatures.

NOTE

The test setup conditions for the Signature Analysis Test are the same for Service Sheets 4, 5 and 6, therefore signatures may be taken concurrently on all three service sheets.

SERVICE SHEET 5 (cont'd)

Table 8-7. Signatures for Verifying Microprocessor, ROM, RAM and Data Buffer Operation

Pin	U3	U4	U5	U7	U8	U16	U17	U18	U36	U37
1	5A86	—	—	—	H826	UHU1	—	0000	UHU1	UHU1
2	60H5	U9U8	—	—	AF9P	—	—	H826	8AFA	7997
3	00H6	5A86	—	—	00H6	—	—	UHU1	3915	718H
4	AF9P	60H5	—	—	3A56	—	—	CP56	55F6	91C9
5	H826	00H6	—	—	—	1HCU	—	—	630C	FH20
6	CP56	AF9P	0000	—	—	1HCU	—	1P44	9U26	HA4H
7	1P44	H826	—	—	—	F69F	—	—	4A9C	HCAH
8	9900	CP56	9900	—	—	4732	P04P	9900	6386	5U7U
9	7997	1P44	1P44	—	—	2567	—	—	83F2	C8H9
10	718N	9900	CP56	—	—	4A99	UHU1	—		
11	91C9	7997	H826	—	—	U9U8	UHU1	—	83F2	83F2
12	—	718H	AF9P	P04P	—	—	—	9900	6386	6386
13	FH20	91C9	00H6	UHU1	1HCU	0000	1HCU	—	4A9C	4A9C
14	HA4H	—	60H5	—	3361	—	—	1P44	9U26	9U26
15	HCAH	FH20	5A86	—	6978	2PC1	—	—	630C	630C
16	5U7U	HA4H	C320	—	—	1HCU	—	CP56	55F6	55F6
17	C8H9	HCAH	ACUH	—	—	1HCU	—	UHU1	3915	3915
18	4C46	5U7U	1HU2	—	—	—	—	H826	8AFA	8AFA
19	1HU2	C8H9	2567	—	—	—	—	0000	—	—
20	P04P	2PC1	U9U8	—	—	4C46	—	—	—	—
21	UHU1	—	4A99	—	—	3A56	—	—	—	—
22	ACUH	—	4732	—	—	1HCU	—	—	—	—
23	C320	—	F69F	—	—	FP0F	—	—	—	—
24	—	—	83F2	—	—	—	—	—	—	—
25	—	—	6386	—	—	—	—	—	—	—
26	—	—	4A9C	—	—	—	—	—	—	—
27	—	—	9U26	—	—	—	—	—	—	—
28	—	—	630C	—	—	—	—	—	—	—
29	—	—	55F6	—	—	—	—	—	—	—
30	—	—	3915	—	—	—	—	—	—	—
31	—	—	8AFA	—	—	—	—	—	—	—
32	—	—	UHU1	—	—	—	—	—	—	—

Turn the Carrier Noise Test Set off and disconnect the Timing Pod.

Reset the Diagnostic Switch A9S2 to the Normal Operation position shown below:

Diagnostic Switch S2	Normal Operation Logic Level
1	1
2	1
3	1
4	1

A12 ASSEMBLY

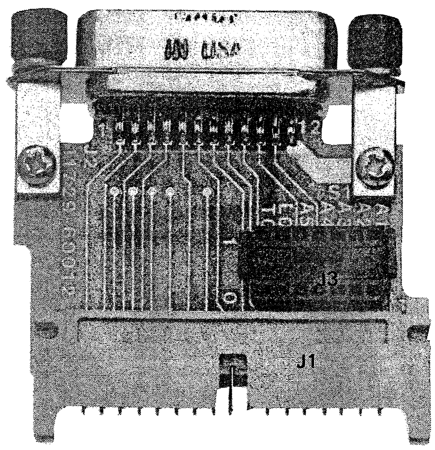


Figure 8-18. HP-IB Interconnect Board Assembly Component Locations

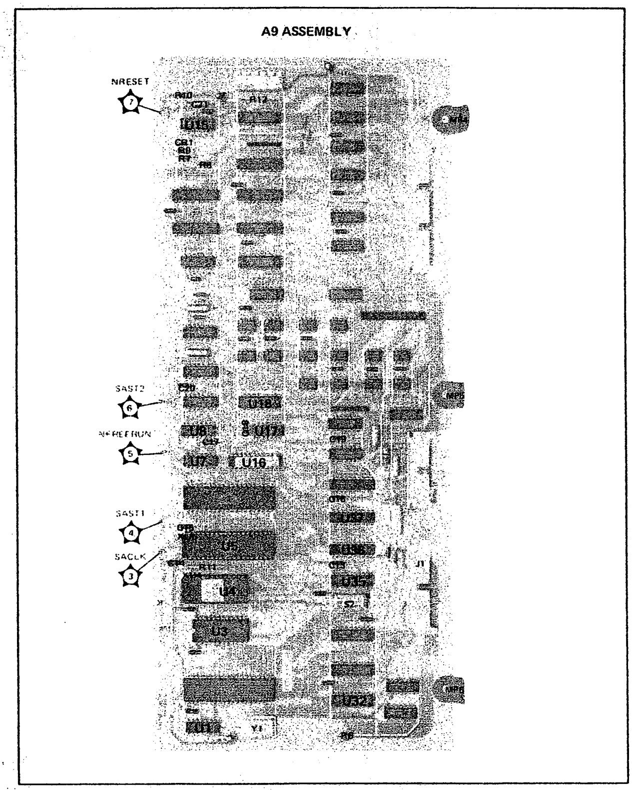
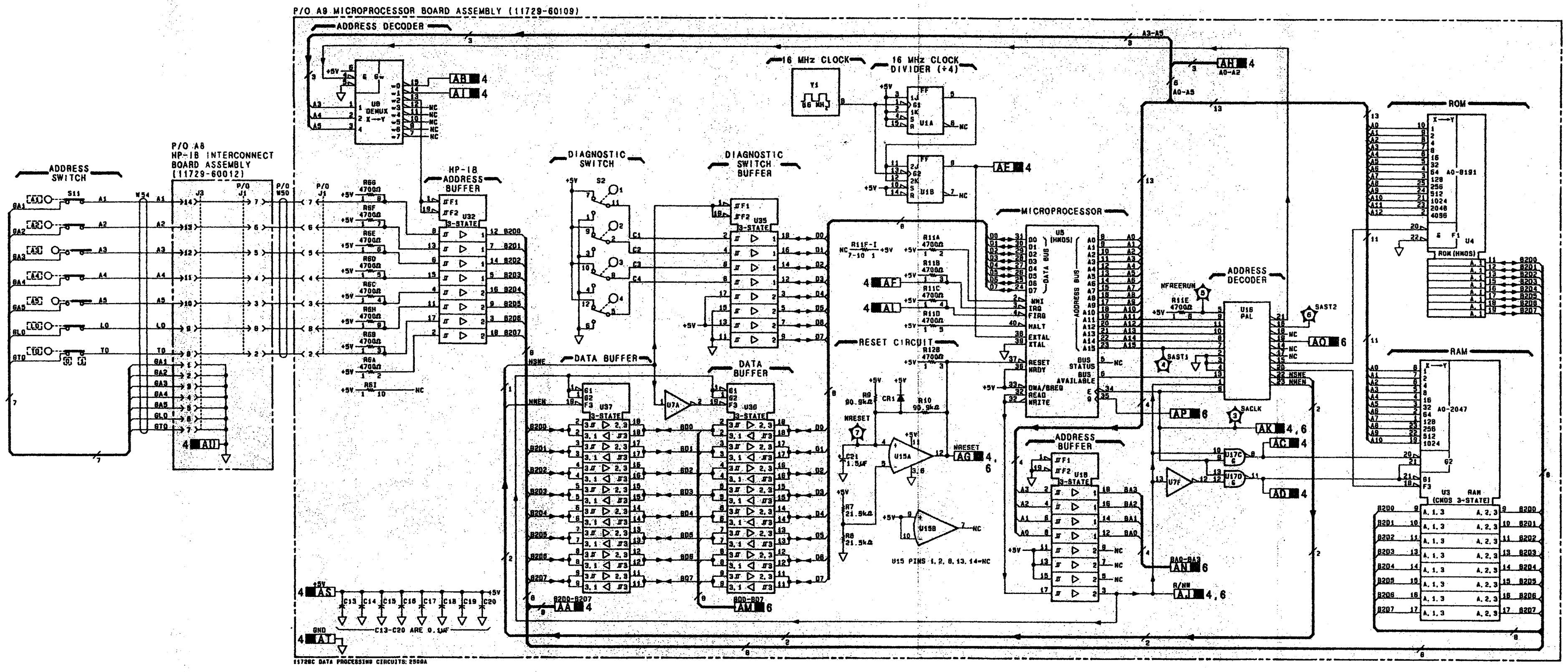


Figure 8-19. Microprocessor Board Assembly Component Locations



NOTES

1. REFER TO TABLE 8-2 FOR SCHEMATIC DIAGRAM NOTES.

REFERENCE DESIGNATIONS

NO PREFIX	A9
S W50, 54	C13-21 CR1 J1 R8-12 S2 TP3-7 U1, 3-5, 7, 8, 15-18, 32, 35-37 Y1
A8	
J1, 3	

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATION	PART NUMBER
U1	1820-1212
U3	1818-1768
U4	11729-80010
U5	1820-2624
U7	1820-1199
U8	1820-1216
U15	1826-0175
U16	11729-80002
U17	1820-1197
U18, 32, 35	1820-2024
U36, 37	1820-2075

INTEGRATED CIRCUIT VOLTAGE AND GROUND CONNECTIONS

REFERENCE DESIGNATION	PIN NUMBER
U1, 8	+5V - 16 ▽ 8
U3, 16	+5V - 24 ▽ 12
U4	+5V - 1, 26-28 ▽ - 14
U5	+5V - 7 ▽ - 1
U7, 17	+5V - 14 ▽ - 7
U18, 32, 35-37	+5V - 20 ▽ - 10
Y1	+5V - 14 ▽ - 7 NC - 1

LOGIC LEVELS

	TTL	CMOS
HIGH	>2V	>3.5V
LOW	<0.8V	<1.5V
< IS MORE NEG. THAN		
> IS MORE POS. THAN		
OPEN	HIGH	UNDEF.
GROUND	LOW	LOW

5

P/O A8, P/O A9

Figure 8-20. Data Processing Circuits Schematic Diagram

SERVICE SHEET 6

PRINCIPLES OF OPERATION

General

The switch and LED control circuits perform the following functions:

a. decode addresses of latches,
b. load data from data bus into latches, and
c. drive front panel LEDs.

Address Decoders

Address decoders U9 and U10 decode the LED driver latches.

Switch Driver Enable Latch

The switch driver enable latches prevent several relays from changing simultaneously at power-on. The +24V supply is designed to switch only a few relays at once.

At power-up, the switch driver enable latches U13 and U14 are set to 0, thus disabling the switch relay drivers. Even though the switch relay driver latches can power-up in random condition, the switch relay drivers are forced off because of these secondary latches. The microprocessor then sets the switch relay driver latches to some orderly condition. After that is done, the microprocessor enables the switch relay drivers one at a time. Once all the relay drivers are turned on, the enable latches are left alone. They are left in a state so that the relay drivers can respond to the other control lines.

Switch Relay Driver Latches

Latches U25 and U26 store data for the relays. These latches turn on and off in response to inputs from front panel keys or HP-IB.

Switch Relay Drivers

These drivers generate the current sinks to activate the relays in the microwave switches (see Service Sheet 1).

Diagnostic LED Latch

U27 drives DS1 and DS2. The individual LEDs within DS1 and DS2 are numbered D0-D7. D7 is closest to the hinged portion of the Microprocessor Board Assembly. The LEDs that correspond to the four most significant bits (D4-D7) indicate the setting of the diagnostic switch. Refer to Principles of Operation on Service Sheet 5 for an explanation of the diagnostic switch. An interpretation of the LEDs is shown in the following table.

Diagnostic	Normal Indication
RAM Test	D4 is on and D0-D3 count, then all the LEDs turn on and the sequence repeats.
ROM Test	D5 is on and all others flash.
Signature Analysis	D4 and D5 are on and all others are dim.
Self Test (power-up)	ROM-D5 is on then all others turn on. RAM-D4 is on then all others turn on. Option switch-D7 is on and the setting of the Option switch is shown in binary.

SERVICE SHEET 6 (cont'd)

Multiplex Switch Drivers and Multiplex Sense Detect Circuit

These circuits are not used in the current configuration of the instrument.

Option Switch

The option switch is set at the factory to inform the microprocessor of the options that are in the instrument. Switches 1 through 4 define (in binary) the number of bands that are in the system. The fifth switch indicates whether or not the AM option is installed. The system can handle up to 11 bands. If the switch is set to any number other than 1 through 11 (decimal), the microprocessor assumes the switch is set to band 1. Eight (8) bands are the maximum number that can be installed in the Carrier Noise Test Set. If the configuration of the instrument is ever changed to add or delete a filter, the option switch must be changed so that it shows the maximum number of bands. You can only call up (from the front panel or HP-IB) as many bands as the switch is set to allow. For example, if the switch is set for 6 bands and you really have seven bands, you will never get the seventh band. Refer to the Filter Option Switch Adjustment in Section V for a complete description of the Option Switch settings.

LED Driver/Latches

These latches drive the LEDs on the A2 Front Panel Key and Display Board assembly.

TROUBLESHOOTING USING SIGNATURE ANALYSIS

NOTE
Run the following test in the sequence listed.

Test Equipment

Signature Multimeter .... HP 5005B

Address Decoding Check (using a falling edge clock trigger)

Purpose. To verify the microprocessor can generate an address transfer that address to the selected chip and the correct address is decoded at the chip.

Setup. Turn the Carrier Noise Test Set off and remove the bottom cover. Locate the A9 Microprocessor Board. Remove the 3 screws that hold the board in place. The A9 assembly is the printed circuit board laying parallel to the bottom of the instrument.

Connect the signature analyzer Timing Pod as follows:

1. START/ST/SP to SAST1 (A9TP4)
2. STOP/QUAL to SAST1 (A9TP4)

SERVICE SHEET 6 (cont'd)

3. CLOCK to SACLK (A9TP3)
4. GND to GND (A9TP1)

Set the signature analyzer controls as follows:

1. Function: Signature .... Normal
2. Polarity: Clock .... Falling edge (2)
   Start.................................. Rising edge (1)
   Stop .... Rising edge (1)

Connect a jumper cable between NFREERUN (A9TP5) and GND (A9TP1).

Connect the signature analyzer's probe to the points indicated in Table 8-8 and verify the signatures.

NOTE
The test setup conditions for the Address Decoding Check are the same for Service Sheets 4, 5 and 6, therefore signatures may be taken concurrently on all three service sheets.

Table 8-8. Signatures Verifying Address Decoding Using a Falling Edge Clock Trigger

Pin	U9	U10	U13	U14	U47	U48	U49	U50
1	UUUU	UUUU	—	—	0003	0003	0003	0003
2	FFFF	FFFF	—	—	—	—	—	—
3	8484	8484	—	—	—	—	—	—
4	CFHU	—	—	—	—	—	—	—
5	P763	0003	—	—	—	—	—	—
10	AC67	0003	—	—	—	—	—	—
11	AH92	0003	0003	0003	—	—	—	—
12	C645	0003	—	—	—	—	—	—
13	—	0003	—	—	—	—	—	—
14	6464	0003	—	—	—	—	—	—
15	919F	0003	—	—	—	—	—	—

Address Decoding Check Using a Rising Edge Clock Trigger

Purpose. To verify the address decoding of those chips that have an early memory cycle before the data is transfered.

Setup. Change the controls on the signature analyzer as follows:

Polarity: Clock .... Rising Edge (1)

Connect the signature analyzer's probe to the points indicated in Table 8-9 and verify the signatures.

Turn the Carrier Noise Test Set off. Disconnect the Timing Pod and the jumper.

SERVICE SHEET 6 (cont'd)

Table 8-9. Signatures Verifying Address Decoding Using A Rising Edge Clock Trigger

Pin	U10	U47	U48	U49	U50
1	UUUU	H3H9	U6AP	4U69	3HA8
2	FFFF	—	—	—	—
3	8484	—	—	—	—
5	0000	—	—	—	—
10	9H3P	—	—	—	—
11	74U5	—	—	—	—
12	H3H9	—	—	—	—
13	4U69	—	—	—	—
14	3HA8	—	—	—	—
15	U6AP	—	—	—	—

ROM Operation Check

Purpose. Verify that the microprocessor can read the data stored in ROM and then execute that code.

Setup. Set the diagnostic switch A9S2 (right side of A9 assembly) to the ROM test position shown below.

Diagnostic Switch S2	ROM Test Logic Level
1	0
2	1
3	0
4	0

Locate the 8 Red LEDs between U27 and U28. The individual LEDs are numbered D0-D7 with D7 being the LED closest to the hinged portion of the microprocessor board assembly.

Turn the Carrier Noise Test Set on to reset the instrument.

Check the pattern of the flashing LEDs to see if ROM passes the test.

ROM Passes Test — D5 remains on and all the other LEDs flash on and off. This verifies that the address and data busses between ROM and the microprocessor are working.

ROM Fails Test — D5 remains on and all the other LEDs remain off. This signifies that the address and data busses have a problem. Check for short circuits.

Turn the Carrier Noise Test Set off.

RAM Operation Check

Purpose. To verify that the RAM is operational.

Setup. Set the diagnostic switch A9S2 to the RAM test position shown on the next panel.

SERVICE SHEET 6 (cont'd)

Diagnostic Switch S2	RAM Test Logic Level
1	1
2	0
3	0
4	0

Turn the Carrier Noise Test Set on to reset the instrument.

Check the pattern of the flashing LEDs to see if RAM passes the test.

RAM Passes Test — D4 is on and D0-D3 count, all LEDs turn on then the counting sequence repeats. This verifies that the microprocessor can access RAM properly.

RAM Fails Test — D4 is on but D0-D3 do not go through counting sequence. This shows that the RAM or the control lines to the RAM may be faulty.

Turn the Carrier Noise Test Set off.

Signature Analysis Test — Microprocessor and Relay Circuitry

Purpose. The Microprocessor runs a program to verify the transmission of data from the Microprocessor to the output ports. The operation of the relay circuitry is tested.

Connect the signature analyzer Timing Pod as follows:

1. START/ST/SP to SAST2 (A9TP6)
2. STOP/QUAL to SAST2 (A9TP6)
3. CLOCK to SACLK (A9TP3)
4. GND to GND (A9TP1)

Set the signature analyzer controls as follows:

1. Function: Signature .... Normal
2. Polarity: Clock .... Falling edge (2)
   Start.................................. Rising edge (1)
   Stop .... Falling edge (2)

Set the Diagnostic Switch A9S2 as follows:

Diagnostic Switch S2	Signature Analysis Test Logic Level
1	1
2	1
3	0
4	0

Turn the Carrier Noise Test Set on to reset the diagnostic switch.

Data Processing Circuits
P/O A8, P/O A9
SERVICE SHEET 5

SERVICE SHEET 6 (cont'd)

Connect the signature analyzer's probe to the points indicated in Table 8-10 and verify the signatures.

NOTE
The test setup conditions for the Signature Analysis Test are the same for Service Sheets 4,5, and 6, therefore signatures may be taken concurrently on all three service sheets.

Table 8-10. Signatures Verifying Microprocessor and Relay Circuitry Operation (1 of 3)

Pin	U9	U13	U14	U19	U20	U21	U22	U23
1	9900	—	—	2F86	HP61	H10U	4H18	H10U
2	1P44	90CF	8P37	—	—	—	—	FFCO
3	CP56	9130	9130	—	—	—	—	2F86
4	U585	7097	7097	—	—	—	—	3139
5	H826	HU34	3964	—	—	—	—	28HI
6	—	581C	1758	3139	A55P	FFC0	F5H3	356P
7	—	8A90	8A90	—	—	—	—	—
8	—	HPCP	HPCP	—	—	—	—	C074
9	—	F471	F76F	—	—	—	—	AHFC
10	1HCU	—	—	—	—	—	—	3HF8
11	H344	—	—	—	—	—	—	2077
12	1HCU	FFC2	6C97	—	—	—	—	F206
13	—	HUH9	HUH9	—	—	—	—	HUC9
14	79C0	586A	586A	—	—	—	—	—
15	3819	P92F	C0C7	—	—	—	—	—
16	—	2183	P409	—	—	—	—	—
17	—	PPF7	PPF7	—	—	—	—	—
18	—	1P1U	1P1U	—	—	—	—	—
19	—	1953	3C32	—	—	—	—	—

SERVICE SHEET 6 (cont'd)

Table 8-10. Signatures Verifying Microprocessor and Relay Circuitry Operation (2 of 3)

Pin	U25	U26	U27	U29	U30	U31	U38	U41
1	H344	3819	79C0	28H1	HUC9	2077	UHU1	AHFC
2	UF5F	673F	—	—	—	—	9130	—
3	9130	9130	9130	—	—	—	7097	—
4	8A90	8A90	8A90	—	—	—	8A90	—
5	F4U9	28H1	—	—	—	—	HPCP	—
6	HP61	2F86	—	356P	F206	3HF8	HUH9	C074
7	HUH9	HUH9	HUH9	—	—	—	586A	—
8	PPF7	PPF7	PPF7	—	—	—	PPF7	—
9	4H18	H10U	—	—	—	—	1P1U	—
11	—	—	—	—	—	—	83F2	—
12	F5H3	8494	—	—	—	—	6386	—
13	1P1U	1P1U	1P1U	—	—	—	4A9C	—
14	586A	586A	586A	—	—	—	9U26	—
15	A55P	HUC9	—	—	—	—	630C	—
16	09AA	2077	—	—	—	—	55F6	—
17	HPCP	HPCP	HPCP	—	—	—	3915	—
18	7097	7097	7097	—	—	—	8AFA	—
19	5C41	AHFC	—	—	—	—	U585	—

Table 8-10. Signatures Verifying Microprocessor and Relay Circuitry Operation (3 of 3)

Pin	U42	U43	U44	U47	U48	U49	U50	U54	U55	U56	U57
1	UF5F	8494	—	—	—	—	—	09AA	F4U9	673F	5C41
2	—	—	—	9130	9130	9130	9130	—	—	—	—
3	—	—	09AA	—	—	—	—	—	—	—	—
4	—	—	1415	7097	7097	7097	7097	—	—	—	—
5	—	—	F4U9	—	—	—	—	—	—	—	—
6	P1P3	992C	H946	8A90	8A90	8A90	8A90	1415	H946	7A83	46UP
8	—	—	46UP	—	—	—	—	—	—	—	—
10	—	—	7A83	HPCP	HPCP	HPCP	HPCP	—	—	—	—
11	—	—	673F	—	—	—	—	—	—	—	—
12	—	—	992C	HUH9	HUH9	HUH9	HUH9	—	—	—	—
13	—	—	8494	—	—	—	—	—	—	—	—
14	—	—	—	586A	586A	586A	586A	—	—	—	—

Turn the Carrier Noise Test Set off. Disconnect the Timing Pod.

Reset the Diagnostic Switch S2 to the normal operation position shown as follows:

Diagnostic Switch S2	Normal Operation Logic Level
1	1
2	1
3	1
4	1

A2 ASSEMBLY

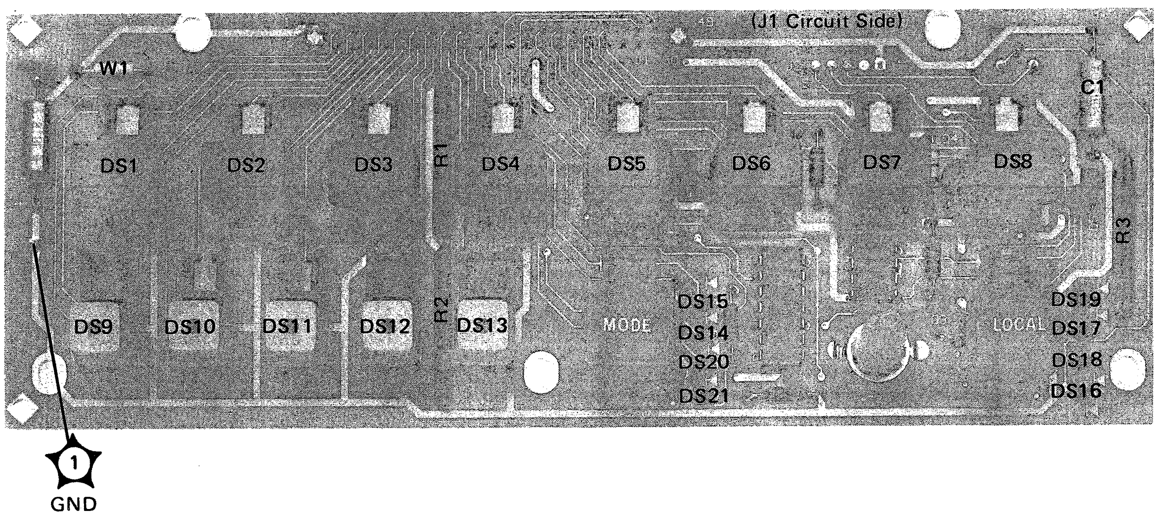


Figure 8-21. Front Panel Key and Display Board Assembly Component Locations

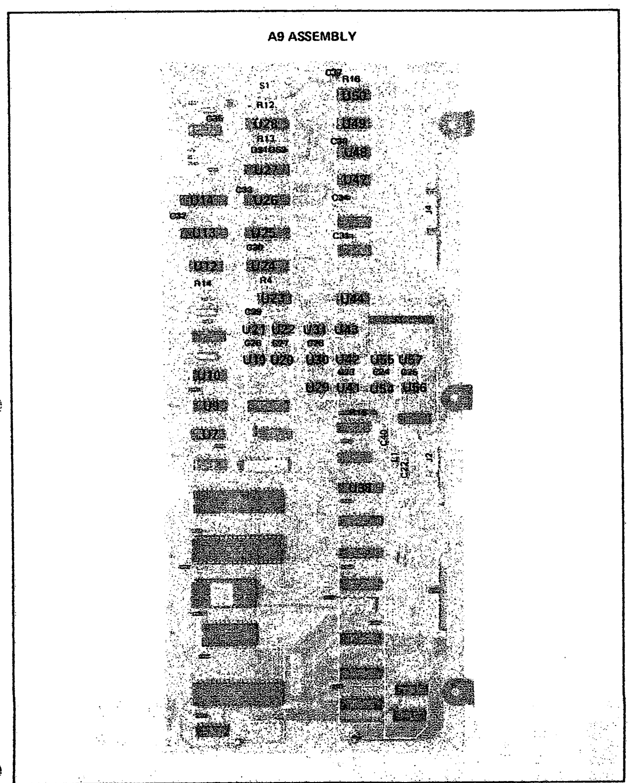


Figure 8-22. Microprocessor Board Assembly Component Locations

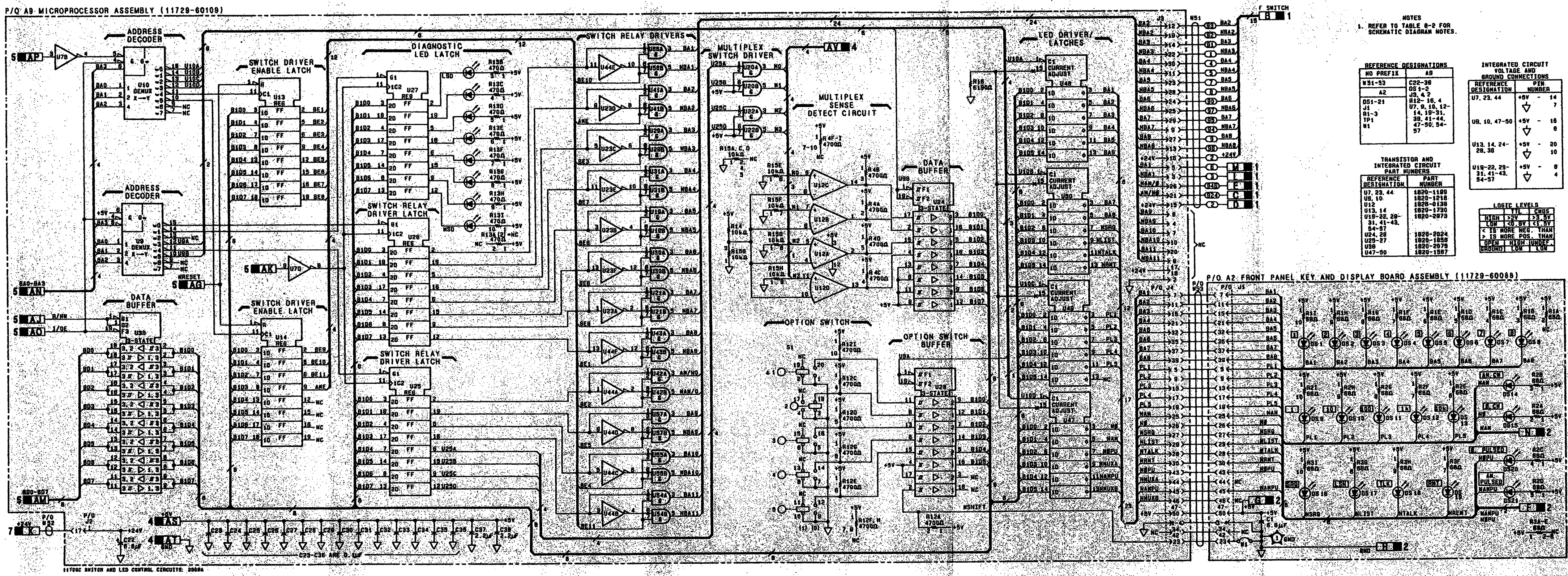


Figure 8-23. Switch and LED Control Circuits Schematic Diagram

SERVICE SHEET 7
POWER SUPPLY CIRCUITS

PRINCIPLES OF OPERATION

General

The Carrier Noise Test Set requires four power supply voltages: +24V, +15V, +5V, and −15V. The transformer supplies all the secondary voltages for the power supply. The secondary is wound as one coil and is center tapped. All the power supplies take the same form. They have a full-wave bridge rectifier that consists of 2 rectifying diodes, a fuse, filter capacitors, a voltage regulator, an overvoltage protection circuit, and an indicator that lights when that power supply is on.

+24V Power Supply

The output of the voltage regulator is dependent on the reference voltage which is set with R11 and R12.

The overvoltage protection circuit consists of a zener diode (VR2) in series with a standard rectifying diode (CR9). When the voltage across VR2 exceeds the threshold of 30 volts, the zener diode turns on. CR11 protects against any reverse voltages that may be applied or negative voltages that may get on the supply line. It protects not only the power supply but also any circuits that may be connected to the +24V supply.

The +24V supply runs the A6 Low Noise Amplifier Assembly and all the microwave switches (see Service Sheet 1).

+15V Power Supply

There are two +15 volt supplies: one supply is used for the A5 Phase Lock Board Assembly and the A10 IF Amplifier; the other supply is for the A11 Power Amplifier Assembly. Due to higher sensitivity to dc bias noise, the power amplifier needs a separate +15 volt supply.

The supply that consists of U5, Q5 and associated components is used to bias the Power Amplifier. R35 and VR10 set a reference voltage for U5. R34 and C23 filter that reference voltage mainly to reduce power line spurs. R33, C21 and R32 set the gain of U5 to maintain a constant +15 volts at the emitter of Q5. Q5 is a current source for the Power Amplifier since U5 cannot supply the necessary current needed by the Power Amplifier. L2 and C19 form a filter; it filters both noise and line spurs. CR15 supplies negative voltage protection.

The overvoltage protection circuit (for both supplies) consists of R14, R15, VR3 and Q3. The zener diode (VR3) begins to conduct if the voltage exceeds the threshold of 16 volts. Enough current is drawn through R15 to cause the SCR (Q3) to begin conducting. This blows the +15 volt supply fuse. It may also blow the fuse of any other supply that may be connected to the 15V supply. CR12 protects against negative voltages on the supply that is used for the A5 Phase Lock Board Assembly and the A10 IF Amplifier Assembly.

Switch and LED Control Circuits
P/O A2, P/O A9
SERVICE SHEET 6

SERVICE SHEET 7 (cont'd)

+5V Power Supply

The +5V supply has a 2-diode rectifier configuation. It uses a large TO-3 dual rectifier, which is part of the heat sink assembly.

The voltage regulator is adjustable. The voltage reference is set by R9, CR8, R10, and R13. Adjustment R10 is provided to set the regulator very close to +5V, which is necessary for the digital circuits.

The overvoltage protection circuit is similar to one used for the +15V supply.

The +5V supply is the digital supply and is used only on the A9 Microprocessor Assembly.

-15V Power Supply

Following the 2 diode rectifier is an overvoltage protection circuit for the entire instrument. This circuit protects against incorrect line voltages. For example, if high voltage, such as 220 or 240V, is plugged in when the line card is set for 100V or 120V, this circuit will cause the fuse (F1) to blow. If any voltage above 150 Vrms appears on the input to the transformer, this circuit will cause Q4 to begin conducting. This, in turn, blows the main fuse.

The overvoltage protection circuit for the −15V supply is similar to the one used for the +24V supply.

The −15V supply provides voltage to the A5 Phase Lock Board assembly and the fan.

TROUBLESHOOTING

As an aid in troubleshooting the Power Supply typical input voltages to the voltage regulators have been placed on the schematic. The voltages are dependent on the line voltage.

Test Equipment

Digital Multimeter .... HP 3456A

The tolerance of each of the voltage regulators is shown in the following table.

Voltage Regulator	Voltage Tolerance
U1 TP4	−15V ± .5V
U2 TP3	+ 5V ± .25V
U3 TP2	+15V ± .5V
U4 TP1	+24V ±.5V

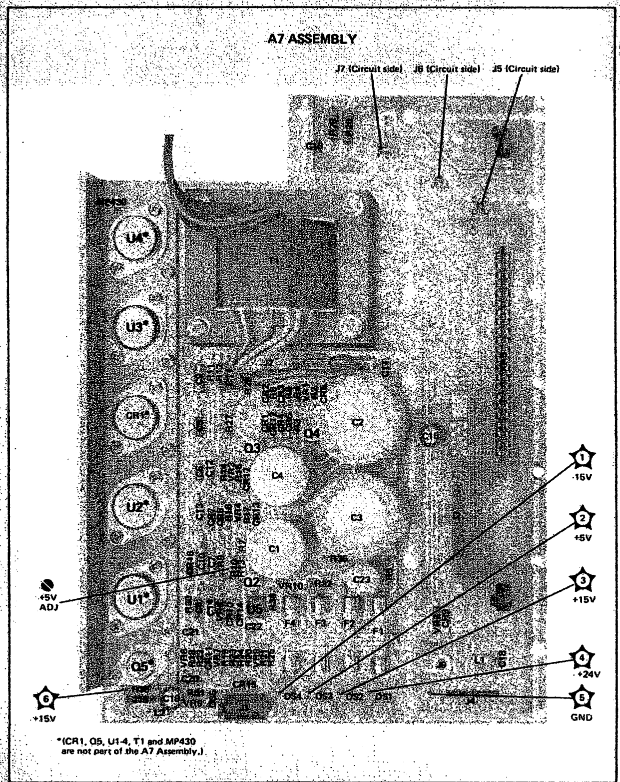
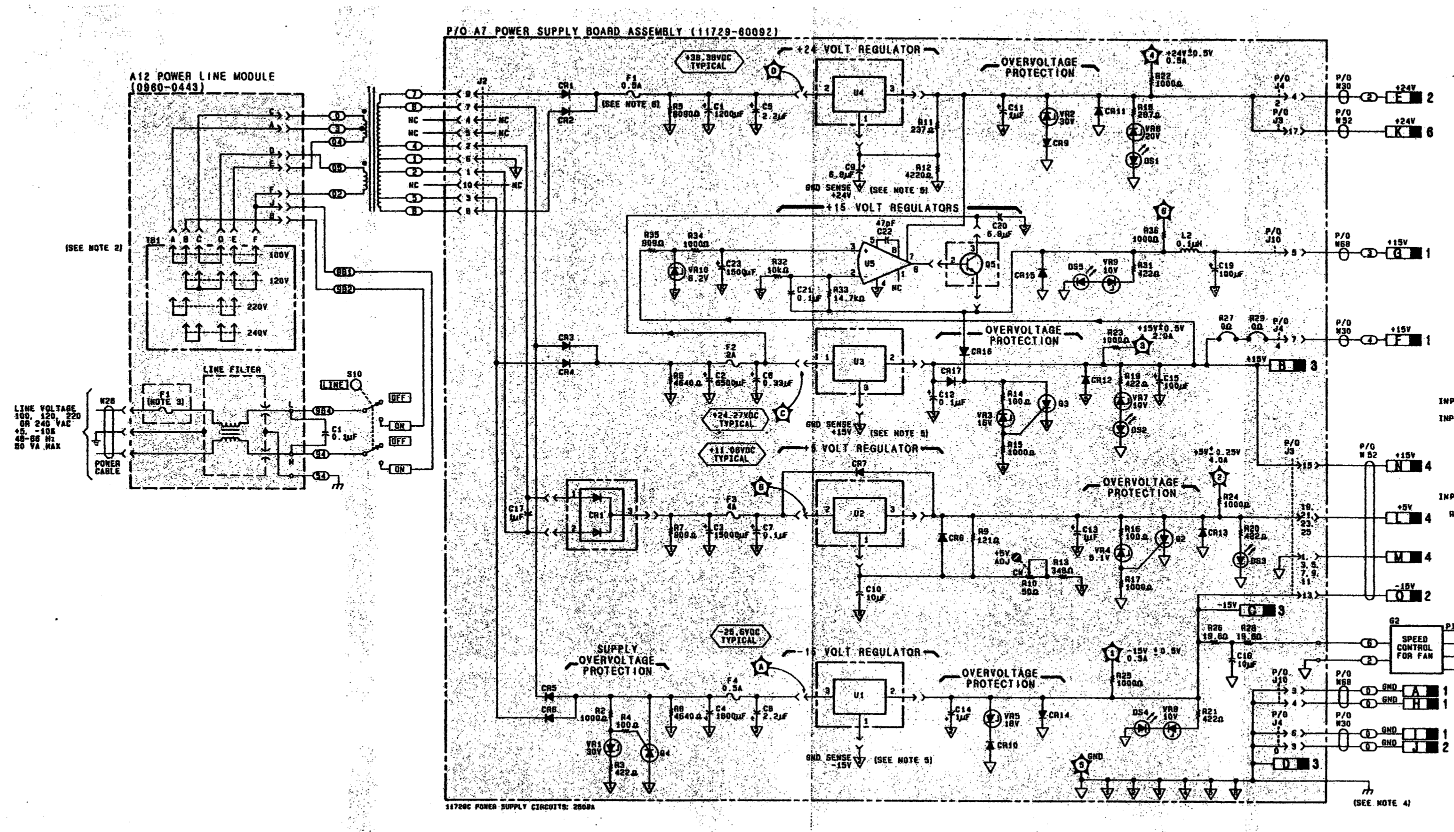


Figure 8-24. Power Supply Board Assembly Component Locations



NOTES

1. SEE TABLE 8-2 SCHEMATIC DIAGRAM NOTES.
2. TB1 IS NOT SEPARATELY REPLACEABLE; IT IS PART OF A12.
3. 1.0A 250V FOR 100V TO 120V AC INPUT. 0.5A 250V FOR 220V TO 240V AC INPUT.
4. CHASSIS GROUND IS BROUGHT ONTO THE PC BOARD THROUGH THE SCREWS HOLDING THE BOARD IN PLACE.
5. THIS GROUND IS USED TO REDUCE NOISE IN THE POWER SUPPLY.
6. THIS IS A TIME DELAY FUSE.

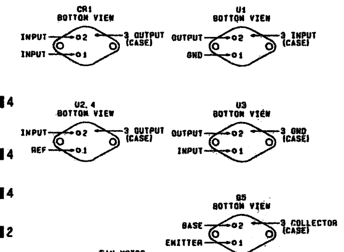
REFERENCE DESIGNATIONS

NO PREFIX	A7
B1	C1-23
C1	CR1-17
CR1	DS1-5
Q5	F1-4
S2	J2-4
T1	Q2-4
U1, 3, 4, 8	R2-36
W28, 30, 52, 60	TP1-6
	U5
	VR1-10

NOT ASSIGNED: R30

TRANSISTOR AND INTEGRATED CIRCUIT PART NUMBERS

REFERENCE DESIGNATION	PART NUMBER
CR1	1906-0231
Q5	1854-0814
U1	1828-0169
U2	1828-0077
U3	1826-0203
U4	1826-0423
A7Q3, 4	1884-0224
A7U5	1826-0783



7 P/O A7, A12

Figure 8-25. Power Supply Circuits Schematic Diagram

APPENDIX A
Phase Noise Measurement Correction Factors

Once the phase noise measurement system is set up, calibrated and the signal at the NOISE SPECTRUM OUTPUT is measured on a spectrum analyzer, correction factors are added to express the output in terms of $\mathcal{L}(f)$. $\mathcal{L}(f)$ is defined as follows:

$$\mathcal{L}(f) = \frac{\text{power density (in one phase modulation sideband)}}{\text{total signal power}}$$

This appendix explains the correction factors, that are summed with the measured noise level to give the actual amount of phase noise.

NORMALIZATION TO 1 Hz EQUIVALENT NOISE BANDWIDTH

A spectrum analyzer's resolution bandwidth is not necessarily equivalent to the noise bandwidth. It is possible for a spectrum analyzer to have a resolution bandwidth which equals the noise bandwidth. The Fast Fourier Transform (F.E.T.) spectrum analyzer is one example where the resolution bandwidth of the spectrum analyzer equals the noise bandwidth. The noise bandwidth is defined as the bandwidth of an ideal rectangular filter having the same power response as the actual IF filter in the spectrum analyzer. The definition of $\mathcal{L}(f)$ requires normalization of the single sideband phase noise to an equivalent 1 Hz noise bandwidth. For a first approximation, most Hewlett-Packard spectrum analyzers have a noise bandwidth approximately 1.2 times the nominal 3 dB resolution bandwidth setting. Therefore the resolution bandwidth multiplied by 1.2 is the equivalent noise bandwidth.

The equivalent noise bandwidth is expressed as a 1 Hz equivalent noise bandwidth by using the relationship shown below:

Correction factor to convert the spectrum analyzer's resolution bandwidth to a 1 Hz equivalent noise bandwidth = $10 \log [(BW \times 1.2)/1 \text{ Hz}]$.

where: BW is the resolution bandwidth in Hz that the spectrum analyzer is set to during the measurement.

Therefore, the resolution bandwidth used to make the phase noise measurement is normalized to a 1 Hz equivalent noise bandwidth by the following equation:

Correction factor to convert the spectrum analyzer's resolution bandwidth to a 1 Hz equivalent noise bandwidth = $10 \log (BW \times 1.2)$.

The 1 Hz equivalent noise bandwidth correction is then subtracted from the measured noise level.

This correction factor is for Hewlett-Packard spectrum analyzers only. If another spectrum analyzer is being used, the noise bandwidth of that spectrum analyzer will have to be determined. The 1 Hz equivalent noise bandwidth can then be calculated, for the resolution bandwidth being used to make the phase noise measurement.

NOTE

For best accuracy, the equivalent noise bandwidth should be measured. Hewlett-Packard has an application note that describes how to measure the equivalent noise bandwidth. To receive the application note order AN 150-4 using part number HP 5952-1147.

CALIBRATION ATTENUATION

The response of the system (Mixer/Phase Detector, Low Pass Filter and Low Noise Amplifier) is calibrated before each phase noise measurement. The 5 to 1280 MHz input is offset from the frequency of the IF output (signal under test minus the center frequency of the Band Range chosen). This produces a beat note signal at the NOISE SPECTRUM OUTPUTS. From this beat note signal, the mixer/phase detector constant $K\phi$ is determined. $K\phi$ is the slope of the sine wave at the zero crossings.

Attenuation is added during the calibration process to avoid overloading the Low Noise Amplifier (LNA) or the baseband spectrum analyzer. The LNA is designed to amplify lower level signals, not high level beat notes. Also, best accuracy is obtained if the spectrum analyzer settings are not changed during calibration and measurement. This can be accomplished by setting the attenuation, so the noise floor will be in the upper portion of the spectrum analyzer display.

The amount of attenuation added in the R path (5 to 1280 MHz signal) of the mixer/phase detector is translated to the output. Thus, the attenuation applied to the 5 to 1280 MHz input reduces the mixer/phase detector output by that amount. After calibration the attenuation is removed and a noise measurement is made. The amount of attenuation added during calibration must be subtracted from the measured noise level.

$\mathcal{L}$(f) CONVERSION FACTOR

Two signals at identical frequencies and nominally 90 degrees out of phase (known as phase quadrature) are input to the mixer/phase detector. At quadrature, the output spectrum of the mixer/phase detector is the sum of the inputs, which is filtered out, and a dc signal with a small fluctuating ac voltage. The small fluctuating ac voltage is linearly proportional to the fluctuating phase difference between the input signals.

The mixer/phase detector has a conversion factor, $K\phi$ that is called the phase detector constant. This $K\phi$ factor is the ratio of the ac voltage fluctuations, out of the mixer/phase detector, and the phase fluctuations between the two signals input to the mixer/phase detector.

A beat note condition is set up during calibration for use in determining the $K\phi$ phase constant or V peak. The value of $K\phi$ is equal to the slope of the sine wave output from the mixer/phase detector when a beat note is present. The slope of a sine wave at the zero crossings is equal to the peak amplitude of the signal. A spectrum analyzer measures the root mean square value of a signal instead of the peak amplitude. The equation "$V\text{ peak} = \sqrt{2} \times V\text{ rms}$" is used to correct the spectrum analyzer reading. The preceding equation expressed logarithmically to correspond to the power readings on the spectrum analyzer is as follows:

$$\begin{aligned} 10 \log(V_{peak})^2 &= 10 \log(\sqrt{2}\, V_{rms})^2 \\ &= 10 \log V_{rms}{}^2 + 10 \log(\sqrt{2})^2 \\ &= 10 \log V_{rms}{}^2 + 3\text{ dB} \end{aligned}$$

The logarithmically expressed equation shows that the spectrum analyzer display is 3 dB less than the peak signal. Since $\mathcal{L}$(f) is the ratio of the power in one phase modulation side band to the power in the carrier, 3 dB is subtracted from the noise power level on the spectrum analyzer display.

When the two inputs to a mixer are in phase quadrature and the sum product is filtered out, the mixer operates as a phase detector. All energy in the phase modulated sidebands is detected by the mixer. The detected phase modulation sidebands represent the phase modulation on the test signal (to within 0.2 dB) when the following condition is met:

> The energy in the phase modulation sidebands of the reference signal, is at least 15 dBm lower, than the energy in the phase modulation sidebands of the test signal.

NOTE

When the noise of the reference signal is less than 15 dB below the test signal, the measurement error will have to be determined. To determine the measurement error, use the following formula:

$$\text{error (dB)} = 10\log\left(1 + \text{antilog}\,\frac{\mathcal{L}_{ref} - \mathcal{L}_{dut}}{10}\right.$$

$\mathcal{L}_{ref}$ *= noise power of the reference*
$\mathcal{L}_{dut}$ *= noise power of the device under test*

The error has been tabulated in the following table for several values of the noise power differences.

$\mathcal{L}_{dut} - \mathcal{L}_{ref}$ *(dB)*	*0*	*1*	*2*	*3*	*4*	*5*	*10*	*15*
correction (dB)	*3.0*	*2.5*	*2.1*	*1.8*	*1.5*	*1.2*	*0.4*	*0.2*

The output of the mixer is then the spectral density of the phase modulation sidebands on the test signal frequency which is called $S\phi(f)$. A more familiar quantity is the ratio of the energy in one phase modulating sideband to total power in the test signal, $\mathcal{L}(f)$. To convert from $S\phi(f)$ to $\mathcal{L}(f)$ we use the following equation:

$$\mathcal{L}(f) = 1/2\, S\phi(f)$$

Therefore another 3 dB is subtracted from the measured noise power level.

The total $\mathcal{L}(f)$ conversion factor is −6 dB. For the $\mathcal{L}(f)$ conversion factor subtract 6 dB from the measured noise level.

CORRECTION FOR LOG AMPLIFIERS AND PEAK DETECTORS IN ANALOG SPECTRUM ANALYZERS

The spectrum analyzer's detection system is optimized for sine waves; for noise measurements some corrections must be made. In most analog spectrum analyzers there is a log amplifier followed by a peak detector. A peak or envelope detector used to measure random noise results in a reading lower than the true rms value of the average noise (typically about 1.05 dB lower). The log shaping tends to amplify noise peaks less than the rest of the noise signal, resulting in a detected signal which is smaller than its true rms value. The correction for the log display mode combined with the detector characteristics gives a total correction for Hewlett-Packard analog spectrum analyzers of 2.5 dB. The correction of 2.5 dB is added to any random noise measured in the log display. For spectrum analyzers other than those made by Hewlett-Packard, the correction factor for the log amplifier and peak detector will have to be determined.

FREQUENCY DISCRIMINATOR CORRECTION FACTOR

The frequency discriminator method outputs a voltage variation proportional to the frequency deviations of the signal under test. The proportionality of the discriminator output changes linearly with frequency offsets from the carrier. Calibration is performed at one modulating frequency to find the sensitivity of the discriminator. The discriminator output is then normalized for all modulating frequencies with the following equation:

Correction to convert frequency fluctuations at any offset to $\mathcal{L}(f) = -20\log(f_{off}/f_{cal})$

where:

f_{cal} is the modulating frequency used to calibrate the frequency discriminator.

f_{off} is the modulating frequency where the phase noise information is desired (offset frequency from the carrier).

FREQUENCY DISCRIMINATOR CORRECTION FACTOR (cont'd)

After the frequency discriminator is calibrated at one frequency (f_{cal}) and the phase noise information is measured at the desired offset frequency from the carrier (f_{off}), the correction factor is calculated. Insert the calibration frequency (f_{cal}) and the modulating frequency offset (f_{off}) into the above equation. Sum this quantity with the measured noise level.

APPENDIX B
Phase Lock Loop Characterization

A Phase Lock Loop forces the voltage controlled oscillator (VCO) to phase-track the reference for frequency offsets less than the bandwidth of the Phase Lock Loop. This tracking inside the phase lock loop bandwidth results in suppression of phase noise at the output of the phase detector. This property normally limits a phase noise measurement to offsets from the carrier greater than the loop bandwidth. However, the Carrier Noise Test Set enables the Phase Lock Loop to be characterized. When the phase lock loop is characterized the bandwidth of the phase lock loop and the amount of noise suppression within the phase lock loop can be determined.

The Carrier Noise Test Set's Loop Test Port Input allows a signal—for example, a random noise source, a tracking generator or a variable frequency sine wave—to be applied to the loop. Then, by measuring the response of the loop to the signal being input, the transfer characteristic of the phase lock loop can be determined. During characterization, the VCO and reference remain locked and in quadrature; that is, the loop is characterized in the same state that it was in during the phase noise measurement.

The characterized phase lock loop yields two important pieces of information, the phase lock loop bandwidth and the amount of noise suppression within the phase lock loop. The loop bandwidth designates the offset frequencies for which an uncorrected phase noise measurement can be made. The measured loop noise suppression versus offset frequency is used to correct the value of noise measured on the device under test, when the measurement was made inside the loop bandwidth.

PROCEDURE

The following discussion describes two methods for determining the loop transfer characteristic of the phase lock loop.

Use the following procedure when the signal input at the LOOP TEST PORT IN connector is from a random noise source or a tracking generator:

1. Calculate the nominal loop bandwidth using one of the following formulas. The formula used will depend on the method used for phase locking.

$$\text{nominal loop bandwidth} = \frac{\text{LBF} \times f_{dut}}{10^{10}}$$

(Using the 10 MHz crystal oscillator, that drives the 640 MHz reference, for phase locking. The crystal must have a tuning range of one (1) part in 10^7 Hz.)

$$\text{nominal loop bandwidth} = \frac{\text{LBF} \times \text{FM peak deviation}}{10^3}$$

(Using the DC-FM of the 5 to 1280 MHz tunable source for phase locking)

LBF = Lock Bandwidth Factor
f_{dut} = Frequency of device under test

With the nominal loop bandwidth known it will be easier to set the controls on the spectrum analyzer to view the loop transfer characteristic.

2. When determining the loop transfer characteristic, the loop must be in the same condition it was in when the phase noise measurement was made. For example, the loop should be locked and in phase quadrature; the Lock Bandwidth Factor must be set to the same position it was set to during the phase noise measurement.

3. Using a random noise source or tracking generator, input a signal at the LOOP TEST PORT IN connector, on the rear panel of the Carrier Noise Test Set. Adjust the input level, so the front panel phase lock indicator displays the center green LED with a red LED on either side.

4. Connect the LOOP TEST PORT OUT connector, on the rear panel of the Carrier Noise Test Set, to a spectrum analyzer with an appropriate frequency range and bandwidth. Adjust the spectrum analyzer controls, such as frequency span, to view the loop transfer characteristic. The nominal loop bandwidth, calculated in step 1, should give a good indication of where to set the frequency span.

5. Determine the amount of noise suppression using the following example:

Figure D-1 shows a typical phase lock loop transfer characteristic, with a bandwidth of about 90 Hz. At a 10 Hz offset, the loop suppresses the noise 20 dB. Prior to adding the signal, the device under test yielded a noise measurement of −90 dBc/Hz at 10 Hz. The loop noise suppression correction is added to this number, yielding the actual phase noise of the device under test at a 10 Hz offset:

measured noise level:	−90 dBc/Hz
loop suppressed noise:	+20 dB
actual noise level:	−70 dBc/Hz

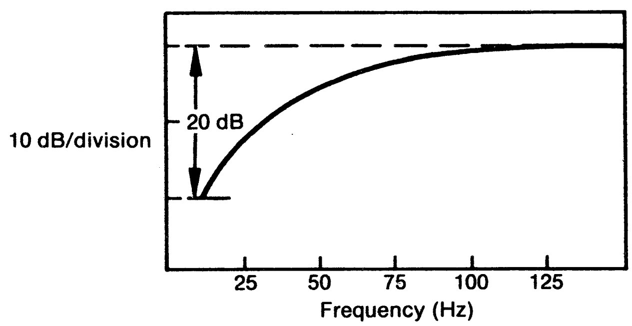


Figure B-1. Typical Phase Lock Loop Filter Transfer Characteristic.

PROCEDURE

Use the following procedure when the signal input at the LOOP TEST PORT IN connector is from a signal source that does not track the spectrum analyzer.

1. Calculate the nominal loop bandwidth using one of the following formulas. The formula used will depend on the method used for phase locking.

$$\text{nominal loop bandwidth} = \frac{\text{LBF} \times f_{dut}}{10^{10}}$$

(Using the 10 MHz crystal oscillator, that drives the 640 MHz reference, for phase locking. The crystal must have a tuning range of one (1) part in 10^7 Hz.)

$$\text{nominal loop bandwidth} = \frac{\text{LBF} \times \text{FM peak deviation}}{10^{3}}$$

(Using the DC-FM of the 5 to 1280 MHz tunable source for phase locking)

LBF = Lock Bandwidth Factor
f_{dut} = Frequency of device under test

With the nominal loop bandwidth known it will be easier to set the controls on the spectrum analyzer to view the loop transfer characteristic.

2. When determining the loop transfer characteristic, the loop must be in the same condition it was in when the phase noise measurement was made. For example, the loop should be locked and in phase quadrature; the Lock Bandwidth Factor must be set to the same position it was set to during the phase noise measurement.

3. Using the signal source, input a signal at the LOOP TEST PORT IN connector, on the rear panel of the Carrier Noise Test Set. Adjust the input level, so the front panel phase lock indicator displays the center green LED with a red LED on either side.

4. Connect the LOOP TEST PORT OUT connector, on the rear panel of the Carrier Noise Test Set, to a spectrum analyzer with an appropriate frequency range and bandwidth.

5. Plot the loop transfer characteristic by taking point to point readings starting at 0 Hz and going out to the loop bandwidth limit. The offset from point to point is up to the user. The spectrum analyzer may have to be adjusted each time a reading is taken for best accuracy.

6. Determine the amount of noise suppression using the following example:

   Figure B-1 shows a typical phase lock loop transfer characteristic, with a bandwidth of about 90 Hz. At a 10 Hz offset, the loop suppresses the noise 20 dB. Prior to adding the signal, the device under test yielded a noise measurement of −90 dBc/Hz at 10 Hz. The loop noise suppression correction is added to this number, yielding the actual phase noise of the device under test at a 10 Hz offset:

measured noise level:	−90 dBc/Hz
loop suppressed noise:	+20 dB
actual noise level:	−70 dBc/Hz