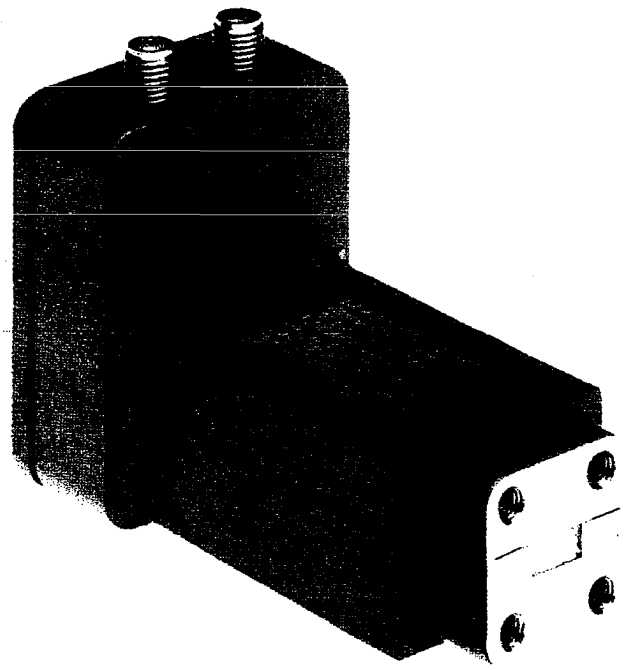
OPERATION AND SERVICE MANUAL

11971 SERIES HARMONIC MIXERS



CERTIFICATION

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

WARRANTY

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

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

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

LIMITATION OF WARRANTY

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

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

EXCLUSIVE REMEDIES

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

ASSISTANCE

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

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

HEWLETT PACKARD

OPERATION AND SERVICE MANUAL

11971 SERIES HARMONIC MIXERS (K, A, Q, U, and V Models)

SERIAL NUMBERS

This manual applies directly to HP 11971K and A mixers with serial numbers prefixed 2332A, to HP 11971Q mixers with serial numbers prefixed 2525A, and to HP 11971U and V mixers with serial numbers prefixed 2526A.

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

1212 VALLEY HOUSE DRIVE, ROHNERT PARK, CALIFORNIA, 94928-4999, U.S.A.

MANUAL PART NUMBER: 11971-90014
Microfiche Part Number: 11971-90015

Printed: August 1985

CONTENTS

SECTION I
GENERAL INFORMATION

INTRODUCTION

The HP Models 11971K, 11971A, 11971Q, 11971U and 11971V are general-purpose harmonic mixers with very flat frequency response characteristics and low conversion loss. Collectively, they cover the frequency range of 18 to 75 GHz. The 11971K covers 18 to 26.5 GHz, the 11971A covers 26.5 to 40 GHz, the 11971Q covers 33 to 50 GHz, the 11971U covers 40 to 60 GHz and the 11971V covers 50 to 75 GHz. The overall local oscillator (LO) frequency range of the HP 11971 Series Mixers is 2.0 to 4.5 GHz. Each model in the series employs a different LO harmonic, and as a result has a different LO range within the overall range of the series. The LO ranges of these mixers make them fully compatible with the HP Model 8569B Spectrum Analyzer. The HP 11971 Mixers use the HP Model 11975A Amplifier to raise the LO power to their required LO power level of +14 to +18 dBm. By taking advantage of the power leveling capability of the HP 11975A. The mixers are able to achieve maximum measurement accuracy at their optimum LO input level of +16 dBm. (See also Signal Analyzer High Power LO Options below.)

A label on the top of each mixer shows a Conversion Loss Calibration graph plotted especially for that particular mixer. An 8-1/2 by 11-inch calibration table shipped with the mixer provides a larger, easier to read version of the same graph shown on the label, plus a list which shows the conversion loss and reference level offset at significant points across the mixer's frequency range. The calibration table, accurate to ±2 dB, can be employed for absolute amplitude measurements. Also supplied with each mixer are five screws (four required) for attaching the mixer RF input flange to the waveguide.

MIXERS COVERED BY MANUAL

Serial Numbers

Attached to your mixer is a label which shows both the mixer model number and its serial number. The serial number is in two parts. 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 all identical mixers; it changes only when a change is made to the mixer. The suffix, however, is assigned sequentially and is different for each mixer. The contents of this manual apply to mixers with the serial number prefixes listed under SERIAL NUMBERS on the title page.

Manual Updating Supplement

A mixer 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 the mixer is different from those described in this manual. The manual shipped with this newer mixer is accompanied by a yellow Manual Updating

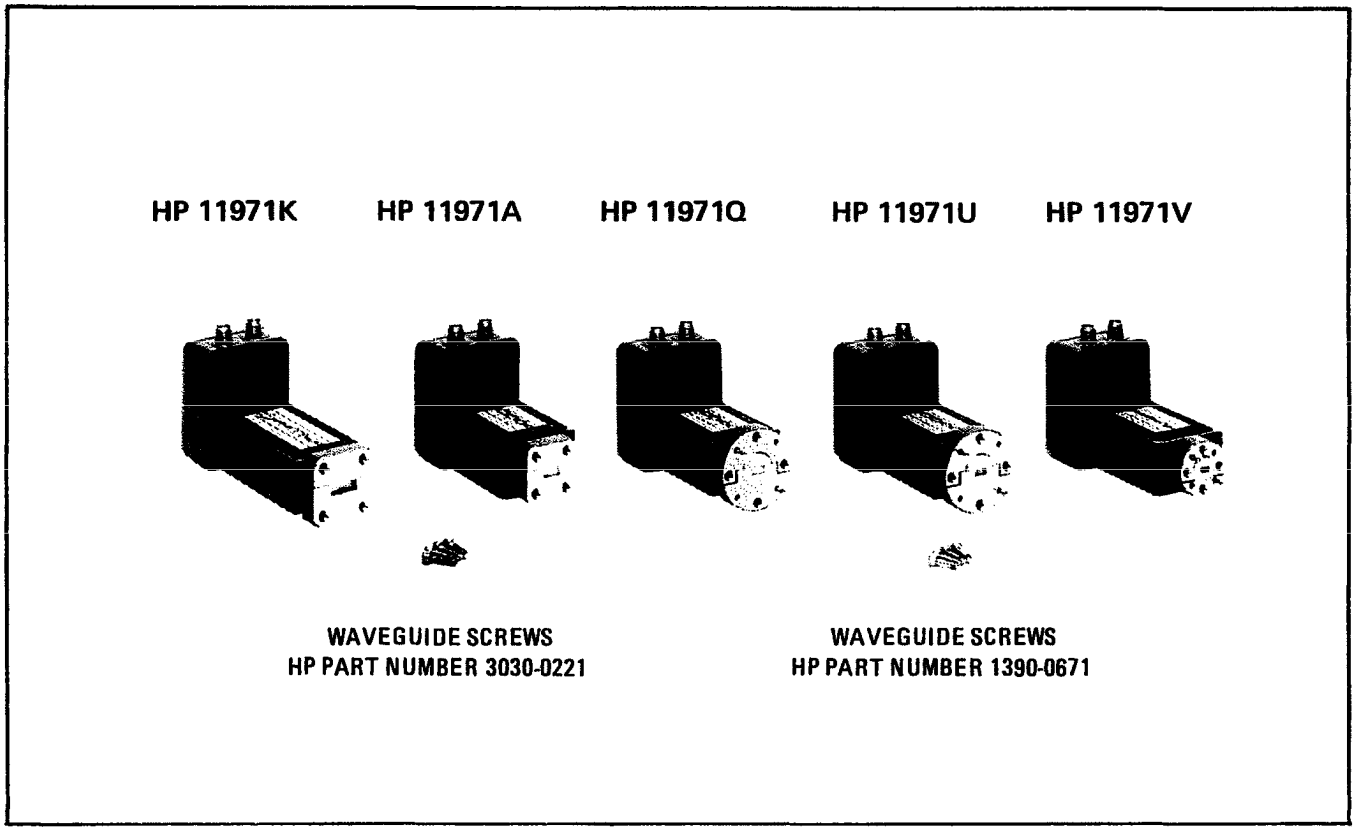


Figure 1-1. HP 11971 Series Harmonic Mixers

supplement. This supplement contains change information which explains how to adapt the manual to the newer mixer.

In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Updating supplement. The supplement for this manual is identified with this manual's print date and part number, both of which appear on the manual title page. Complementary copies of the supplement are available from your nearest Hewlett-Packard office. Addresses of major offices worldwide are listed on the inside rear cover of this manual.

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

OPTIONS

Option 009, shown in Figure 1-2, is a Mixer Connection Kit. It includes three low-loss SMA cables (HP Part Number 5061-5458), one hex-head ball-driver (HP Part Number 8710-1539) for tightening the waveguide connector screws, and one .312-inch open-end wrench (HP Part Number 8710-0510) for use on the SMA connectors.

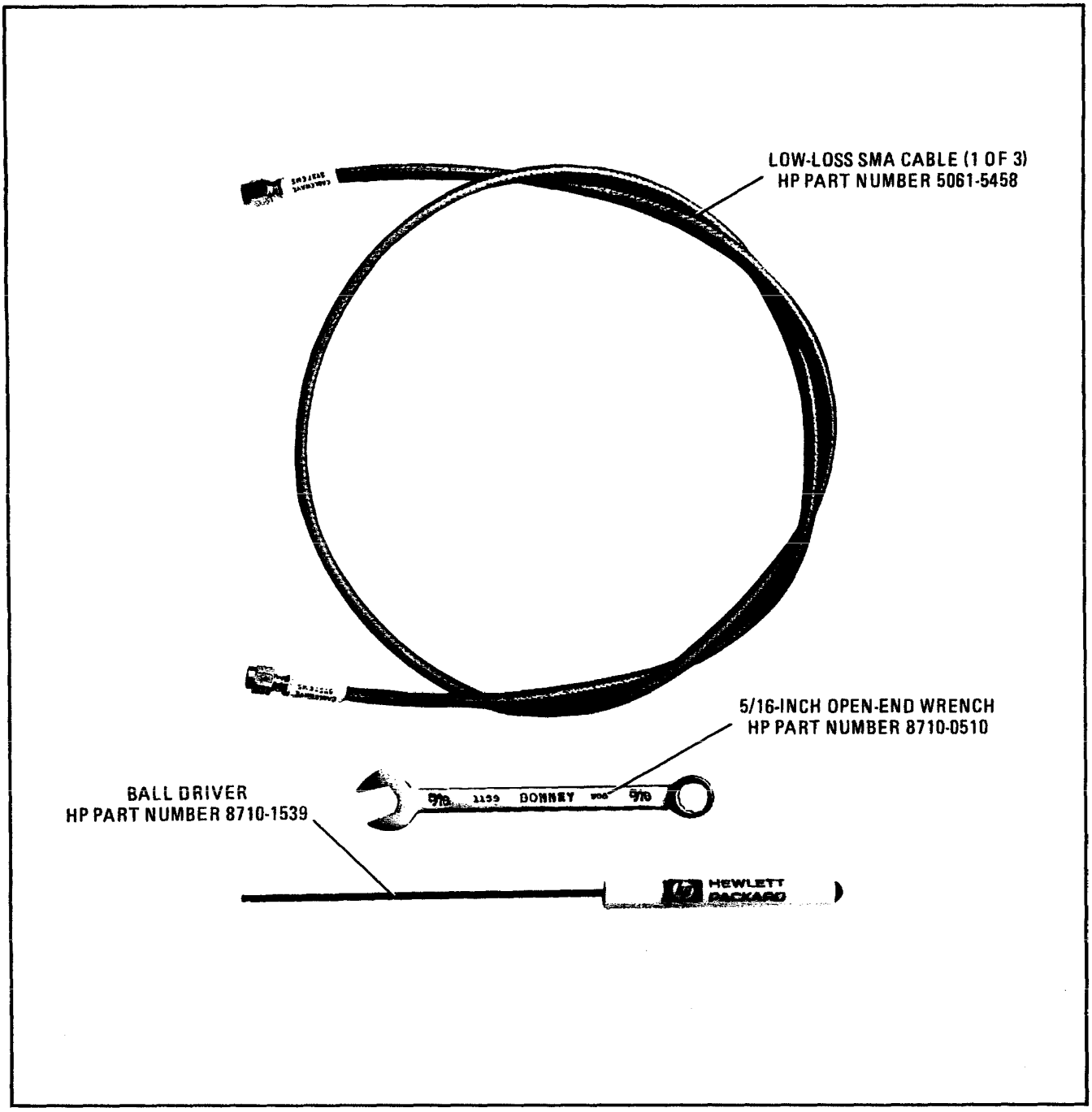


Figure 1-2. Mixer Connection Kit, Option 009

SPECTRUM ANALYZER HIGH POWER LO OPTIONS

Option 003 for the HP Model 8569B Spectrum Analyzer adds an internal amplifier to the analyzer's LO output. With this optional amplifier, the analyzer's LO output power level is increased to meet the LO input power requirement of the mixers, and the HP Model 11975A Amplifier (or its equivalent) normally used for this purpose can be eliminated from the test setup.

Option 013 for the HP 8569B adds an internal amplifier to the analyzer's LO output and also provides the analyzer with an internal comb generator. As with Option 003, Option 013 eliminates the need for an external amplifier to increase the analyzer's LO output power to the level required by the mixer.

For further information about HP 8569B Option 003 and its installation, refer to HP Service Note 8569B-2. Option 013 is described in HP Service Note 8569B-3.

SPECIFICATIONS

Specifications for the HP Model 11971 Series Mixers are listed in Table 1-1. These are the performance standards against which the mixers are tested (performance tests are provided in Section III). Typical or nominal operating values are listed in Table 1-2, Supplemental Characteristics. Supplemental characteristics are included only as additional information; they are not specifications.

EQUIPMENT SUPPLIED

Waveguide Connector Screws

Five hex-head screws (includes one spare), HP Part Number 3030-0221 or1390- 0671, are supplied with each mixer. Use **ONLY** the screws supplied with it to attach the mixer to the waveguide. The special ball-driver hex screwdriver available in the Option 009 Mixer Connection Kit simplifies installation of the waveguide screws.

TEST EQUIPMENT AND ACCESSORIES AVAILABLE

Equipment and accessories recommended for testing the Model 11971 Series Mixers are listed in Section III.

The HP 11969A is a wooden, internally padded, transportation and storage case (HP Part Number 5061-5459). See Figure 1-3. This case will hold as many as five different mixers and a Mixer Connection Kit.

ENVIRONMENTAL LIMITATIONS

The HP 11971 Series Mixers meet or exceed the environmental requirements of MIL-T-28800C, Type III, Class 3, Style C. Their specific environmental qualifications are as follows:

Temperature, Non-operating: -40°C to +75°C
Temperature, Operating: 0°C to +55°C
Relative Humidity: 95 ±5% up to 30°C
Altitude, Non-operating: Less than 12,195 meters (40,000 ft.)
Altitude, Operating: Less than 3,048 meters (10,000 ft.)
Maximum Vibration Levels: 2 G's at 5 Hz to 2000 Hz
Maximum Shock: 30 G's

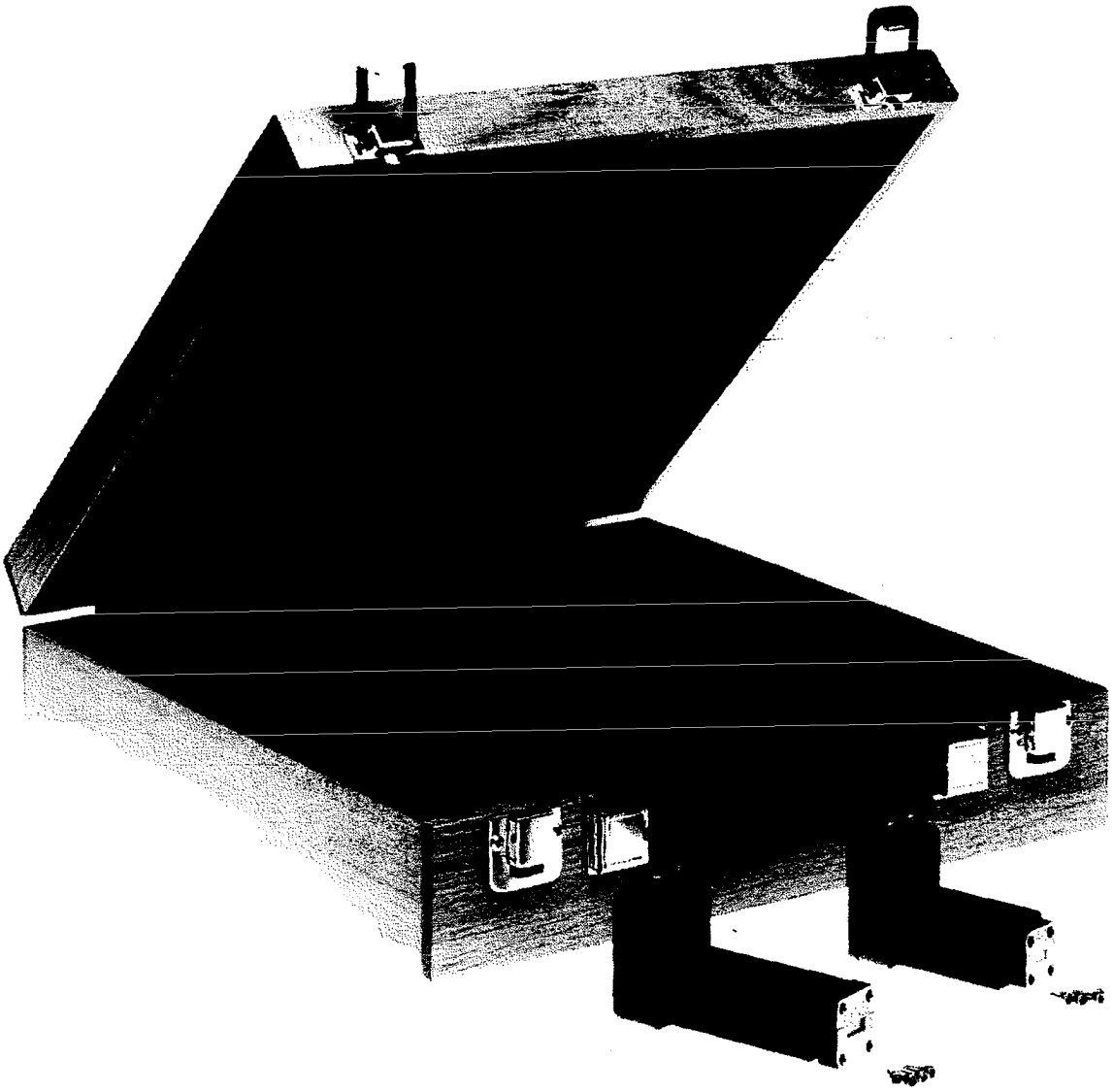


Figure 1-3. HP 11969A Transportation and Storage Case

Table 1-1. HP 11971 Series Mixer Specifications (1 of 2)

NOTE

Unless otherwise stated, all specifications apply for an IF of 321.4 MHz and for RF input amplitudes of less than −20 dBm.

GENERAL

LO Amplitude Range:
+14 to +18 dBm[1]

Calibration Accuracy:
11971K/A/Q/U:
±2.0 dB with LO amplitude range of 14.5 to 16 dBm
11971V:
±2.2 dB with LO amplitude range of 14.5 to 16 dBm
11971K/A/Q/U:
±3.0 dB with LO amplitude range of 16 to 18 dBm
11971V:
±3.2 dB with LO amplitude range of 16 to 18 dBm

Bias Requirements:
None

Maximum CW RF Input Level:
+20 dBm (100 mW)

Maximum Peak Pulse Power:
+24 dBm with <1 μs pulse
(avg. power: +20 dBm)

Environmental:
Meets MIL-T-28800C, Type III, Class 3, Style C

IF/LO Connectors:
SMA female (replaceable)

MODEL 11971K

RF Frequency Range:
18 – 26.5 GHz

LO Harmonic Number: 6

LO Input Frequency Range:
2.95 – 4.36 GHz

Maximum Conversion Loss: 24 dB

HP 8569B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:
−110 dBm

Frequency Response at +14.5 to +16 dBm LO Input Power:
±2.1 dB

Frequency Response at +14 to +18 dBm LO Input Power:
±3.0 dB

MODEL 11971A

RF Frequency Range:
26.5 – 40 GHz

LO Harmonic Number: 10

LO Input Frequency Range:
2.62 – 3.97 GHz

Maximum Conversion Loss: 28 dB

HP 8569B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:
−106 dBm

Frequency Response at +14.5 to +16 dBm LO Input Power:
±2.1 dB

Frequency Response at +14 to +18 dBm LO Input Power:
±3.0 dB

[1]The HP 11975A Amplifier, or a similar amplifier, must be used to provide sufficient LO power (14 to 18 dBm) to the mixers. Leveled power capability of +16 dBm, as is available with the HP 11975A, is necessary to achieve the maximum amplitude accuracy with the mixers.

Table 1-1. HP 11971 Series Mixer Specifications (2 of 2)

MODEL 11971Q	MODEL 11971U
RF Frequency Range: 33 – 50 GHz	**RF Frequency Range:** 40 – 60 GHz
LO Harmonic Number: 16	**LO Harmonic Number:** 16
LO Input Frequency Range: 2.04 – 3.10 GHz	**LO Input Frequency Range:** 2.48 – 3.73 GHz
Maximum Conversion Loss: 40 dB	**Maximum Conversion Loss:** 40 dB
HP 8569B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power: –92 dBm	**HP 8569B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:** –92 dBm
Frequency Response at +14.5 to +16 dBm LO Input Power: ±2.3 dB	**Frequency Response at +14.5 to +16 dBm LO Input Power:** ±2.3 dB
Frequency Response at +14 to +18 dBm LO Input Power: ±3.2 dB	**Frequency Response at +14 to +18 dBm LO Input Power:** ±3.2 dB

MODEL 11971V

RF Frequency Range:
50 – 75 GHz[1]

LO Harmonic Number: 16

LO Input Frequency Range:
3.10 – 4.42 GHz

Maximum Conversion Loss: 42 dB

HP 8569B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:
–89 dBm

Frequency Response at +14.5 to +16 dBm LO Input Power:
±2.5 dB

Frequency Response at +14 to +18 dBm LO Input Power:
±3.2 dB

[1]The maximum frequency is 71 GHz when used with the HP 8569B Spectrum Analyzer.

Table 1-2. HP 11971 Supplemental Characteristics

NOTE

Supplemental characteristics are included only as additional information; they are not specifications.

3 dB IF Bandwidth: DC to 1.3 GHz

Spectrum Analyzer Absolute Amplitude Accuracy (using calibration data with a +14.5 to +16 dBm LO):
11971K, 18 – 26.5 GHz: ±3.3 dB
11971A, 26.5 – 40 GHz: ±3.3 dB
11971Q, 33 – 50 GHz: ±3.3 dB
11971U, 40 – 60 GHz: ±3.3 dB
11971V, 50 – 75 GHz: ±3.4 dB[1]

RF Input SWR:
11971K: <2.9:1 First 20% of band
11971K: <2.2:1 Last 80% of band
11971Q/U: <2.2:1 Full band
11971V: <2.6:1 Full band

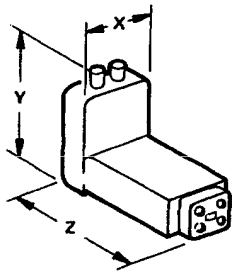
Odd Order Mixing Product Suppression:
11971K/A: >20 dB
11971Q/U/V: >15 dB

Gain Compression Level (<1 dB):
11971K: −3 dBm
11971A: −7 dBm
11971Q: −3 dBm
11971U: −3 dBm
11971V: −3 dBm

5061-5458 Cable Insertion Loss:
.8 dB at 2 GHz
1.1 dB at 6 GHz

PHYSICAL CHARACTERISTICS

Model	Flange[2]	Weight	X	Y	Z
11971K	UG-595/U WR-42	0.17 kg 0.36 lb	36 mm 1.4 in	51 mm 2.0 in	90 mm 3.5 in
11971A	UG-599/U WR-28	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	71 mm 2.8 in
11971Q	UG-383/U WR-22	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	76 mm 3.0 in
11971U	UG-383/U-M WR-19	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	76 mm 3.0 in
11971V	UG-385/U WR-12	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	76 mm 3.0 in



[1]The maximum frequency is 71 GHz when used with HP 8569B Spectrum Analyzer.
[2]Waveguide attachment screws enter blind holes in the flanges of the mixers.

SECTION II
OPERATION

INTRODUCTION

This section provides information on how to make effective use of the HP 11971 Mixers.

OPERATING PRECAUTIONS

Do not exceed the maximum ratings listed below or permanent damage to the mixer will result.

RF Input Power

CW: No greater than +20 dBm
Pulse: No greater than +24 dBm at $\leq$ 1 µSec
Average: No greater than +20 dBm

LO Input Power

No greater than +20 dBm

Electrostatic Discharge

When installing the mixer, always connect the SMA cables to the spectrum analyzer and LO amplifier **BEFORE** connecting them to the mixer. This will minimize the danger of an electrostatic discharge damaging the mixer diodes.

HP 11975A ALC Switch

BEFORE using the HP 11975A Amplifier to increase the LO input power, set the amplifier ALC switch to the ON position. When this switch is in the OFF position the LO power can be greater than +20 dBm. This level of LO power can destroy the mixer diodes. The ALC switch is on the amplifier rear panel.

Waveguide Protection Foam

Do not remove, displace, or damage the white, non-conductive foam installed in the open end of the waveguide. Since the mixer is amplitude calibrated with this foam in place, tampering with it affects the calibration.

GETTING STARTED

NOTE

See Section I for information relating to High Power LO options for HP Model 8569B Spectrum Analyzers.

The HP Model 11971 series of millimeter wave mixers have no bias or back-short adjustments.

HP 11971 Mixers require an LO power of +14 to +18 dBm at the LO input. If the analyzer you use with the HP 11971 Mixer does not have sufficient LO power, use the HP 11975A Amplifier or an equivalent to increase the LO power.

CAUTION

Before connecting the HP 11975A Amplifier, set its rear panel ALC switch to ON. Failure to do this will damage the mixer.

With the three SMA cables (HP Part Number 5061-5458) provided in the Option 009 Mixer Connection Kit, connect the HP 11971 Mixer, the spectrum analyzer, and the HP 11975A Amplifier as shown in Figure 2-1.

Leave the waveguide cap on whenever the mixer is not connected to a device under test. This protects the flange mating surface from dust and scratches, which can degrade the mixer's performance. Use an appropriate waveguide attenuator if the output power of the unit under test exceeds the Maximum RF Input Power shown in the specifications.

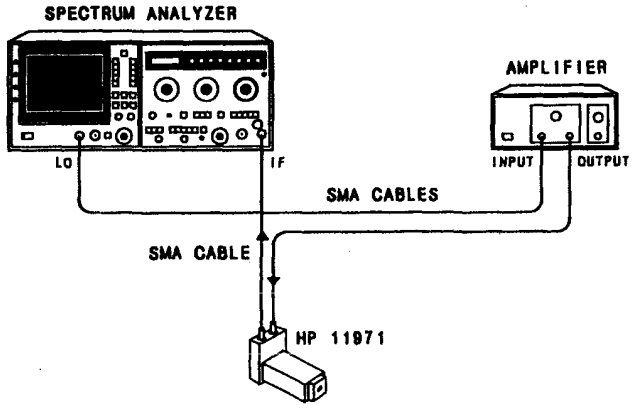


Figure 2-1. HP 11971 Mixer Connections

MEASUREMENTS WITH THE HP 11971 MIXERS

The control settings used in this section are for the HP 8569B Spectrum Analyzer for two reasons: First, the HP 8569B IF input requires a 321.4 MHz signal, and this is compatible with the IF calibration frequency of the HP 11971 Mixers. This output, specifically designed for a 321.4 MHz IF, is coupled through a 1.5 GHz low-pass filter. Second, the frequency range of the HP 8569B 1st LO output is between 2.5 and 4.5 GHz, which fulfills the LO input frequency requirements of the HP 11971.

BASIC FREQUENCY MEASUREMENT

Set the controls on the HP 8569B as follows:

1. Push in all green pushbuttons except MIXING MODE [INT] and FREQUENCY SPAN MODE [PER DIV]. (See **Normal Settings** in the HP 8569B Spectrum Analyzer Operation manual.) Set VIDEO FILTER to OFF (green position), SWEEP TIME/DIV to AUTO (green position), and line up the green arrows on the FREQUENCY SPAN/DIV and RESOLUTION BW controls.
2. Press MIXING MODE [EXT].
3. Press the FREQUENCY BAND GHz pushbutton corresponding to the mixer's frequency band.
4. Set the FREQUENCY SPAN MODE to [FULL BAND].
5. Set the FREQUENCY SPAN/DIV control to 100 MHz.
6. Set the INPUT ATTEN (dB) control to 0.
7. Set REFERENCE LEVEL to -10 dBm and FINE to 0 dB.
8. Set EXT MIXING BIAS in detent positon (center). This turns off the mixing bias. It is not required for HP 11971 Mixers.

When using an external mixer, set the spectrum analyzer internal attenuator to 0 dB to maintain the correct reference level. Except for this internal attenuator control of the reference level, operation of the HP 8569B in the external mixing mode is identical with the standard operation described in the HP 8569B Spectrum Analyzer Operation Manual.

If the frequency of the signal is known, rotate the FREQUENCY TUNING control until the frequency is shown on the digital display. For a more detailed analysis of the signal, set the HP 8569B to the PER DIV mode and rotate the FREQUENCY SPAN knob to obtain the desired resolution.

IDENTIFYING SIGNALS WITH THE HP 8569B

Signal Analyzer Signal Identifier

The built-in signal identifier can be used to verify that the displayed response is the desired signal. For this verification, set the SPAN/DIV control to 2 MHz/DIV. Center the response on the display, then press SIG IDENT. If the response is correct, a second signal, shifted one division to the left, appears on the display. (See Figure 2-2.)

Signals with residual FM, or FM pulse modulation, might not be successfully identified with the Signal Identification routine. If you are in doubt about the identification, use the "image frequency method" of signal identification described below.

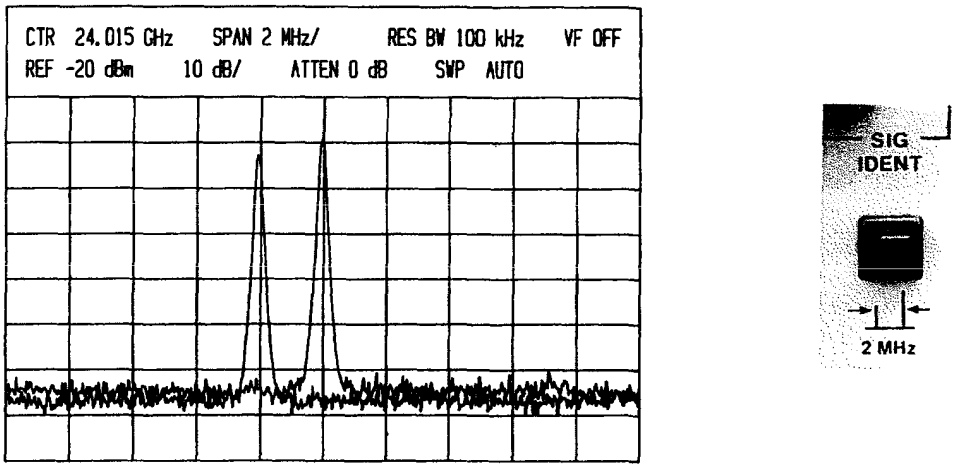


Figure 2-2. Signal Identifier

Image Frequency Method

The "image frequency method" of signal identification depends on the fact that the correct response has an image that is displayed 643 MHz (twice the 321.4 MHz IF) above it on the spectrum analyzer CRT.

Knowledge of the harmonic mixing process makes the "image frequency method" easier and faster to use. Figure 2-3 shows a typical display on the HP 8569B with a 24 GHz signal applied to the HP 11971K Mixer. A reduced version of the HP 8569B Spectrum Analyzer harmonic mixing tuning curves (shown in Figures 2-4 and 2-5) is included in Figure 2-3 to aid in identifying the signals present on the display. HP 11971K Mixers are factory-calibrated for the 6+ mixing mode, which gives them a corresponding LO frequency range of 2.95 to 4.36 GHz. By reference to the tuning curves in Figures 2-4 and 2-5, it can be determined that the signals displayed in approximately the first four divisions of the display are the result of the RF mixing with LO frequencies of less than 3 GHz. Because these signals are obviously not the desired responses, there is no need to investigate them further. The large response pair near the fourth division of the CRT can be seen to be the result of the RF input mixing with the 8th harmonic of the LO. The desired 6+ harmonic response is the large response pair near the 8th division of the CRT.

The shaded areas on the chart in Figures 2-4 and 2-5 represent the regions for each HP 11971 Series Mixer where the responses are imprecise, a result of the RF mixing with LO frequencies outside the LO range of the mixer. Any signal falling inside a shaded area can be ignored.

1. To begin the identification procedure, set the HP 8569B controls as described in Basic Frequency Measurement paragraph.

2. Using the chart in Figures 2-4 or 2-5, determine the limits on the display within which the desired image pair can appear.

3. Rotate the HP 8569B TUNING control to place the marker between a pair of possibly correct responses.

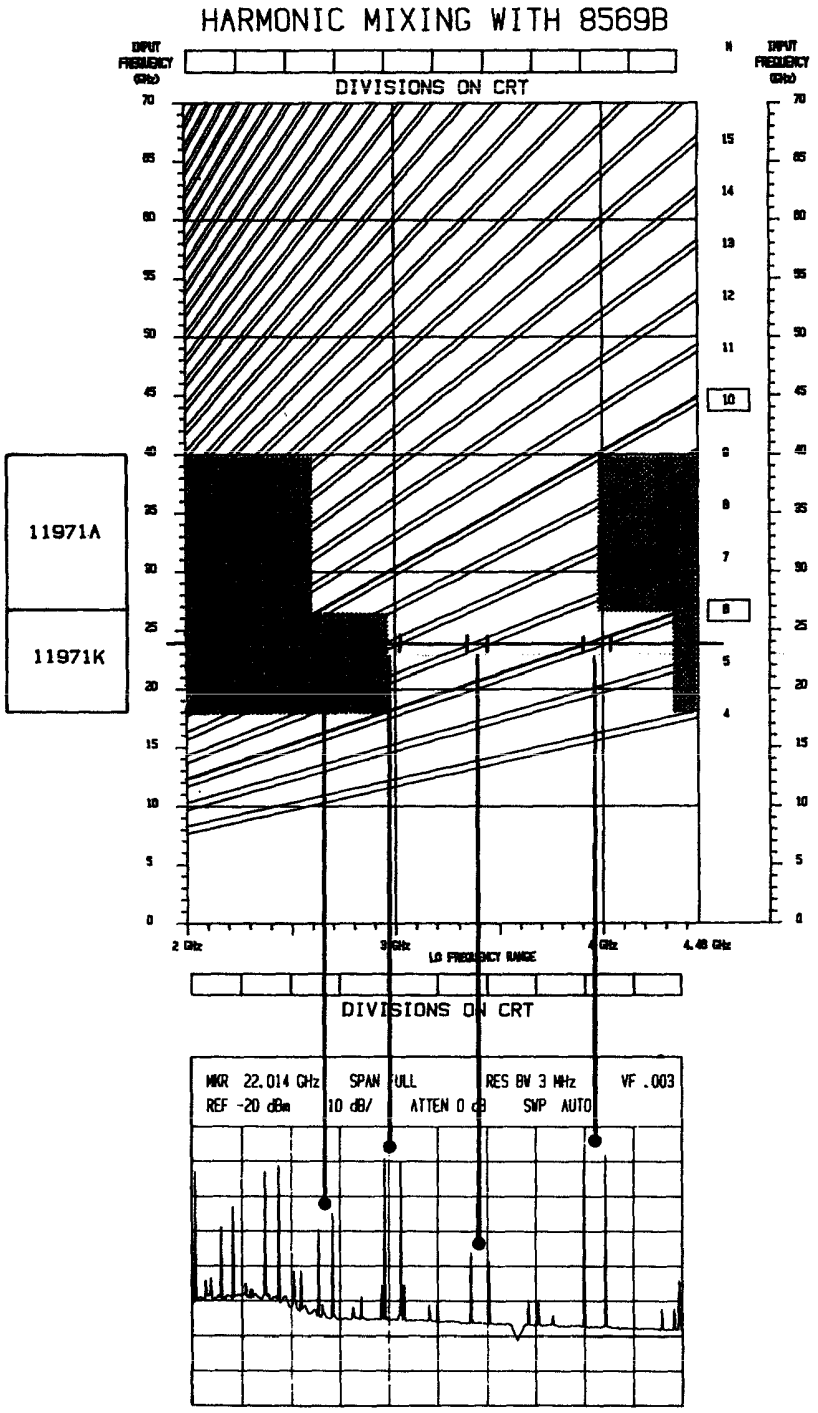


Figure 2-3. Harmonic Mixing Curves for Signal ID

4. Set the spectrum analyzer to the per division mode by pressing the FREQUENCY SPAN MODE **[PER DIV]** pushbutton.

5. If the separation between the pair of responses is 6.4 divisions (that is, 643 MHz) on the display, you have located the desired pair. Of the two responses, the correct mixing product is always the one on the left, and the right-hand response is its image. In general, if the separation is less than 6.4 divisions, the desired pair of responses is lower in frequency than the observed pair.

AMPLITUDE CALIBRATED MEASUREMENTS

The HP 8569B Spectrum Analyzer can make amplitude calibrated measurements of millimeter signals with the HP 11971 Mixers. A calibration table like the one shown in Figure 2-6 is provided with each mixer. A smaller version of the graph shown on the table is on the mixer itself. The table shows conversion loss and a correction factor to be added to the display reading as a function of frequency. The graph shows two plots: Mixer Conversion Loss, and ADD TO DISPLAY amplitude correction data for use with the HP 8569B Spectrum Analyzer.

In the external mixing mode, the HP 8569B gain is automatically increased to compensate for the conversion loss of the HP 11971 Mixer. Each external mixing band has two adjustments available on the HP 8569B. The OFFSET adjustment compensates for the average conversion loss and the "SLOPE" adjustment compensates for the average variation over the band.

The calibration table contains the data required to calibrate the HP 8569B for use with its associated mixer. This information is repeated on the labels on the mixer body. The procedure for calibrating the HP 8569B for a particular HP 11971 Mixer is provided in Secton IV.

Obtaining an amplitude calibrated measurement using the HP 11971 Mixer with the HP 8569B is simple. To the signal amplitude display on the CRT a correction factor must be added. The correction factor is the ADD TO DISPLAY data shown in the calibration table and plotted on the graph on the mixer label. For example, referring to the table in Figure 2-6, if the displayed signal is -21 dBm at 22 GHz, and the ADD TO DISPLAY (ATD) is -0.5 dBm, the correct amplitude is -21.5 dBm.

NOTE

For the REFERENCE LEVEL to function properly, the INPUT ATTENUATOR must be set to 0 dB. Additionally, for proper operation of the HP 11971 Mixers, the EXT MIXING BIAS control must be set to the detent position.

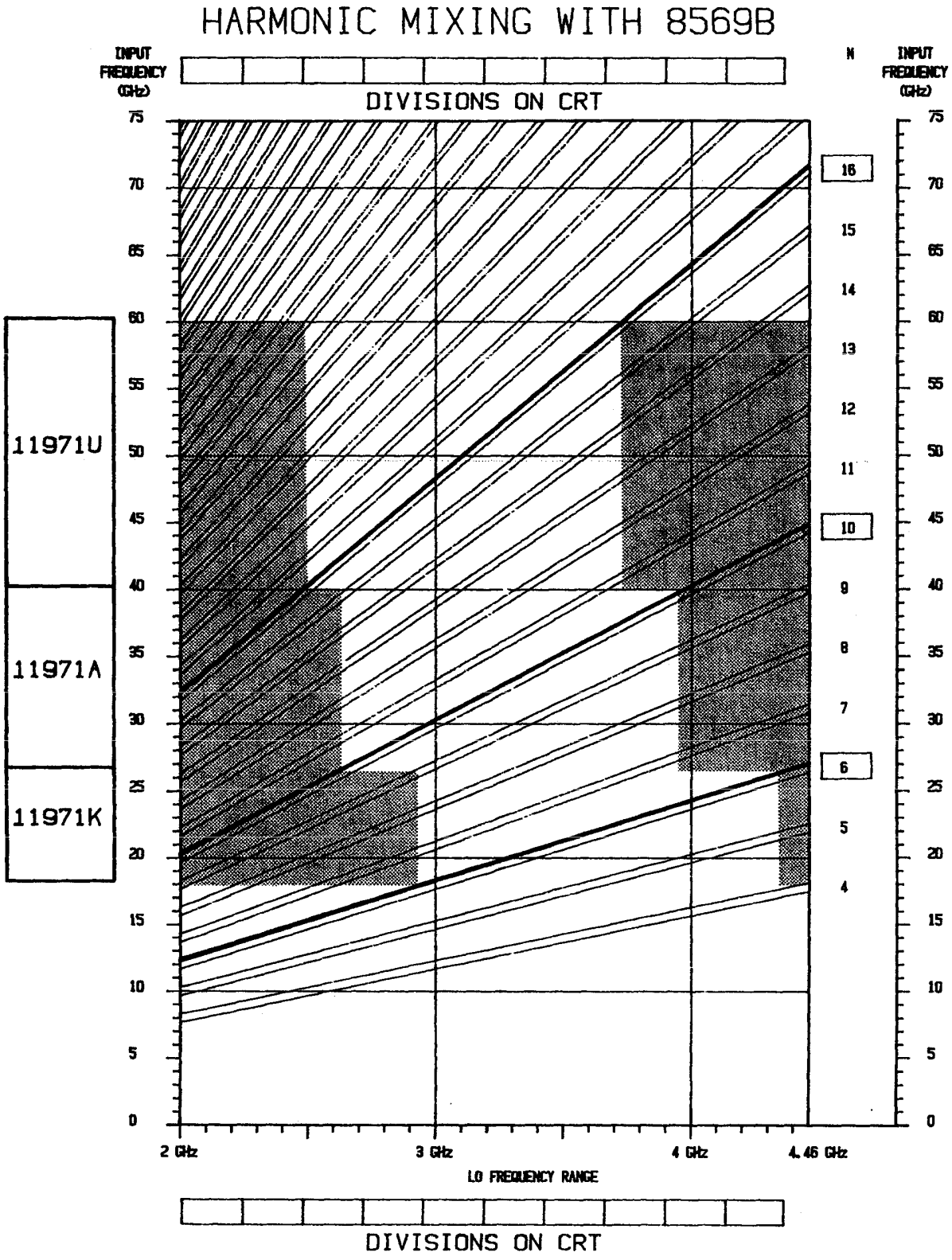


Figure 2-4. Harmonic Mixing Tuning Curves for HP 8569B

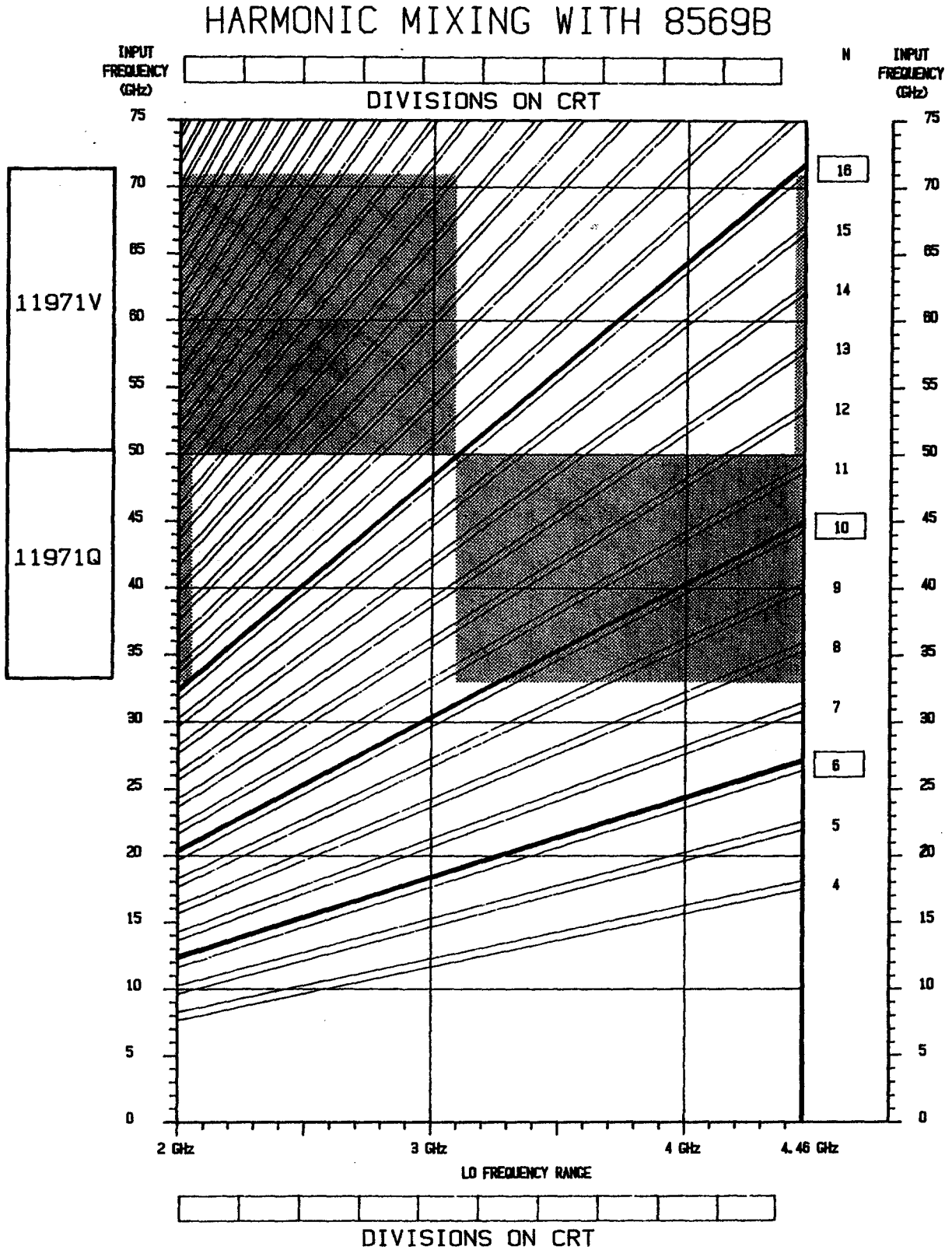
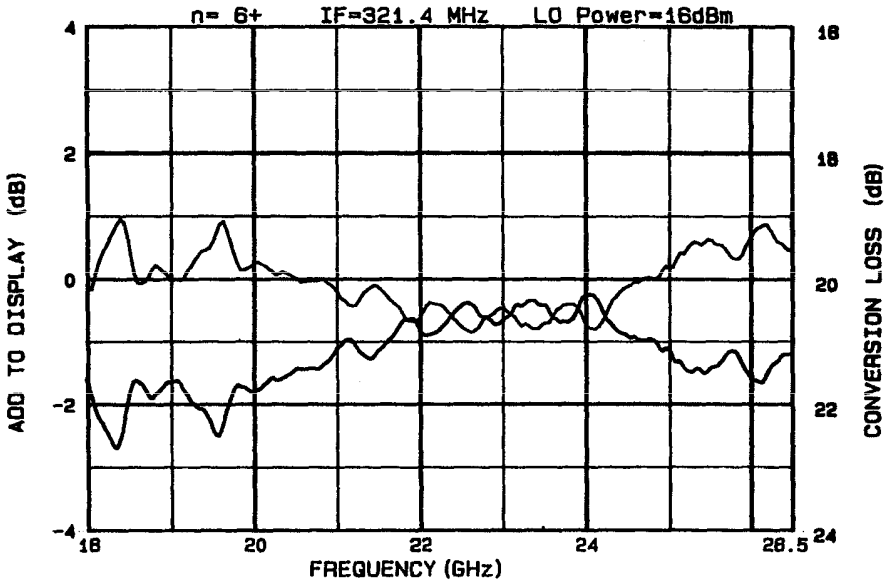


Figure 2-5. Harmonic Mixing Tuning Curves for HP 8569B

11971K CALIBRATION

SER. NO. :



FREQ.	CONV. LOSS	ADD TO DISPLAY	FREQ.	CONV. LOSS	ADD TO DISPLAY
18.00	21.8	-0.2	22.50	20.5	-0.7
18.50	21.9	0.2	23.00	20.7	-0.4
19.00	21.8	-0.0	[illegible]	20.4	-0.7
19.50	22.3	0.7	[illegible]	20.3	-0.7
20.00	21.8	0.[illegible]	[illegible].50	20.9	-0.1
20.50	21.5	[illegible]	25.00	21.1	0.2
21.00	21.2	[illegible]	25.50	21.5	0.7
21.50	21.2	-0.2	26.00	21.5	0.8
22.00	20.8	-0.5	26.50	21.2	0.5

8569B CALIBRATION *

FREQUENCY	IF GAIN	ADJUST
12.40	22.50	A20 B7A OFFSET
26.50	20.70	A20 B7B SLOPE

* REFER TO 8569B OPERATION AND SERVICE MANUAL FOR ADJUSTMENT PROCEDURE

Figure 2-6. Sample Mixer Calibration Table

SECTION III
PERFORMANCE TESTS

INTRODUCTION

This section contains instructions for testing the performance of the HP 11971 Series Mixers. Performance tests are used to check the mixers at incoming inspection and for periodic evaluation. The tests verify the specifications listed for the mixers in Table 1-1.

Test equipment required for the performance tests is listed in Table 3-1 for the HP 11971K, Table 3-2 for the HP 11971A, Table 3-3 for the HP 11971Q, Table 3-4 for the HP 11971U and Table 3-5 for the HP 11971V. Test instruments other than those listed may be used, provided their performance equals or exceeds the critical specifications listed in Tables 3-1 through 3-5.

TEST RECORD

At the back of this section are performance test records, which can be used for recording the performance test data. Make copies of the test records and use them as worksheets when doing the tests.

PERFORMANCE TEST PROCEDURES

Each performance test procedure is contained in a single paragraph. The first entry in each paragraph is the specification for the parameter being measured as described in Table 1-1. This is followed by a general description of the test and any special instructions or problem areas. Appropriate test setup illustrations are included in this section and are referenced in the procedures. You must do the tests, and the steps within each test, in the order they are given.

Table 3-1. Recommended Test Equipment for the HP 11971K

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8569B
Synthesized Sweeper	Frequency: 18 to 26.5 GHz Output Level: > – 10 dBm	HP 8340A
Amplifier	Output Level: >18 dBm leveled Frequency Range: 3 to 4.5 GHz	HP 11975A
Power Meter	Compatible with Power Sensor	HP 436A
Power Sensor	SWR: <1.3	HP 8485A
Directional Coupler*	Coupling: 10 dB Directivity: >40 dB Primary Arm SWR: <1.05 Auxiliary Arm SWR: <1.2	HP K752C
Isolator	Insertion Loss: <1.5 dB Isolation: >20 dB SWR: <1.2	HP P/N 0960-0081
Adapter (2 required)	3.5 mm female to WR-42 SWR: <1.1	HP K281C
Cables (3 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396

*Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.

Table 3-2. Recommended Test Equipment for the HP 11971A

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8569B
Synthesized Sweeper	Frequency: 8 to 13.5 GHz Output Level: >0 dBm	HP 8340A
Amplifier	Output Level: >+18 dBm leveled Frequency Range: 3 to 5 GHz	HP 11975A
Amplifier	Frequency Range: 8 to 13.5 GHz Output Level: >+15 dBm	HP 8349A
Power Meter	Compatible with Power Sensor	HP 436A
Power Sensor	SWR: <2.0	HP R8486A
Power Sensor	SWR: <1.3 @ 6 GHz	HP 8485A
Directional Coupler[1]	Coupling: 20 dB Directivity: >40 dB Primary Arm SWR: <1.05 Auxiliary Arm SWR: <1.2	HP R752D
Isolator	Insertion Loss: <1.5 dB Isolation: >20 dB SWR: <1.2	HP P/N 0960-0082
Frequency Tripler	Conversion Loss: <15 dB	Spacekom Microwave[2] TKa-1
Adapter	SMA female to SMA female	HP P/N 1250-1158
Adapter (2 required)	Type N male to SMA female	HP P/N 1250-1250
Adapter	SMA female to Type N female	HP P/N 1250-1404
Cables (4 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA male Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396

[1]Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.

[2]Honeywell, Inc. Spacekom Microwave Center, Santa Barbara, CA

Table 3-3. Recommended Test Equipment for the HP 11971Q

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8569B
Synthesized Sweeper	Frequency: 11.0 to 16.7 GHz Output Level: >0 dBm	HP 8340A
Amplifier	Output Level: >+18 dBm leveled Frequency Range: 3 to 5 GHz	HP 11975A
Amplifier	Frequency Range: 11.0 to 16.7 GHz Output Level: >+15 dBm	HP 8349A
Power Meter	Compatible with Power Sensor	HP 436A
Power Sensor	SWR: <2.0	HP Q8486A
Power Sensor	SWR: <1.3 @ 6 GHz	HP 8485A
Directional Coupler[1]	Coupling: 20 dB Directivity: >30 dB SWR: <1.2	HP Q752D
Isolator	Insertion Loss: <2.0 dB Isolation: >20 dB SWR: <1.5	HP Q365A
Frequency Tripler	Conversion Loss: <20 dB	Spacekom Microwave[2] TB-1
Adapter	SMA female to SMA female	HP P/N 1250-1158
Adapter (2 required)	Type N male to SMA female	HP P/N 1250-1250
Adapter	SMA female to Type N female	HP P/N 1250-1404
Cables (4 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA male Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396

[1]Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.
[2]Honeywell, Inc. Spacekom Microwave Center, Santa Barbara, CA

Table 3-4. Recommended Test Equipment for the HP 11971U

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8569B
Synthesized Sweeper	Frequency: 13.3 to 20.0 GHz Output Level: >0 dBm	HP 8340A
Amplifier	Output Level: >+18 dBm leveled Frequency Range: 3 to 5 GHz	HP 11975A
Amplifier	Frequency Range: 13.3 to 20.0 GHz Output Level: >+15 dBm	HP 8349A
Power Meter	Compatible with Power Sensor	HP 432A
Power Sensor	SWR: <2.0	Hughes[1] 45773H-1100
Power Sensor	SWR: <1.3 @ 6 GHz	HP 478A
Directional Coupler[2]	Coupling: 20 dB Directivity: >30 dB SWR: <1.2	HP U752D
Isolator	Insertion Loss: <1.5 dB Isolation: >20 dB SWR: <1.2	HP U365A
Frequency Tripler	Conversion Loss: <20 dB	Spacekom Microwave[3] TQ-1
Adapter	SMA female to SMA female	HP P/N 1250-1158
Adapter (2 required)	Type N male to SMA female	HP P/N 1250-1250
Adapter	SMA female to Type N female	HP P/N 1250-1404
Cables (4 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA male Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396

[1]Hughes Aircraft Co. Electron Dynamics Division, Torrance, CA
[2]Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.
[3]Honeywell, Inc. Spacekom Microwave Center, Santa Barbara, CA

Table 3-5. Recommended Test Equipment for the HP 11971V

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8569B
Synthesized Sweeper	Frequency: 12.5 to 18.8 GHz Output Level: >0 dBm	HP 8340A
Amplifier	Output Level: >+18 dBm leveled Frequency Range: 3 to 5 GHz	HP 11975A
Amplifier	Frequency Range: 12.5 to 18.8 GHz Output Level: >+15 dBm	HP 8349A
Power Meter	Compatible with Power Sensor	HP 432A
Power Sensor	SWR: <2.0	Hughes[1] 45774H-1100
Power Sensor	SWR: <1.3 @ 6 GHz	HP 478A
Directional Coupler[2]	Coupling: 20 dB Directivity: >20 dB Auxiliary Arm SWR: <1.5	Hughes [1] 45324H-1220
Isolator	Insertion Loss: <2 dB Isolation: >20 dB SWR: <1.5	Hughes[1] 45114H-1000
Frequency Quadrupler	Conversion Loss: <25 dB	Spacek[3] V-4X
Adapter	SMA female to SMA female	HP P/N 1250-1158
Adapter (2 required)	Type N male to SMA female	HP P/N 1250-1250
Adapter	SMA female to Type N female	HP P/N 1250-1404
Cables (4 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA male Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396

[1]Hughes Aircraft Co. Electron Dynamics Division, Torrance, CA
[2]Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.
[3]Spacek Labs Inc. MM Wave Technologies, Santa Barbara, CA

CONVERSION LOSS AND FREQUENCY RESPONSE

SPECIFICATIONS

Conversion Loss:

For a CW input power of less than -20 dBm

HP 11971K: 24 dB maximum
HP 11971A: 28 dB maximum
HP 11971Q: 40 dB maximum
HP 11971U: 40 dB maximum
HP 11971V: 42 dB maximum

Frequency Response:

For an LO amplitude between +14.5 and +16.0 dBm

HP 11971K: ±2.1 dB
HP 11971A: ±2.1 dB
HP 11971Q: ±2.3 dB
HP 11971U: ±2.3 dB
HP 11971V: ±2.5 dB

For an LO amplitude between +14.0 and +18.0 dBm

HP 11971K: ±3.0 dB
HP 11971A: ±3.0 dB
HP 11971Q: ±3.2 dB
HP 11971U: ±3.2 dB
HP 11971V: ±3.2 dB

DESCRIPTION

The frequency response and conversion loss are checked at four LO power levels. This is accomplished by calibrating the HP 8569B as a 321.4 MHz receiver. A known input power is applied to the input of the mixer. The spectrum analyzer is tuned to the signal frequency and the mixer IF output power is measured on the spectrum analyzer. From these measurements, the conversion loss and frequency response are determined.

1. On the spectrum analyzer, push in all the green pushbuttons and set all rotary controls with green positions to green. (See **Normal Settings** in the HP 8569B Spectrum Analyzer Operaton manual.) Then make the following control settings:

   FREQUENCY BAND GHz to .01--1.8
   FREQUENCY SPAN/DIV to 1 MHz
   RESOLUTION BW to 1 MHz
   INPUT ATTEN to 10 dB
   REFERENCE LEVEL to -10 dBm
   REFERENCE LEVEL FINE to 0 dB
   AMPLITUDE SCALE to 1 dB

2. Connect the 100 MHz CAL OUTPUT signal to the INPUT connector, then center the signal on the CRT display with the TUNING control.

3. Adjust the REF LEVEL CAL control to position the peak of the signal on the top graticule of the CRT display.

4. Calibrate the HP 8569B for External Mixing as described in Section IV. Set the signal generator for an output level of -40 dBm, instead of -10 dBm.

5. Connect an SMA cable from the 1st LO OUTPUT of the spectrum analyzer to the INPUT of the amplifier. Connect a second SMA cable to the OUTPUT of the amplifier.

6. For HP 11971K: Set the Cal Factor to 100 percent, then zero and calibrate the power meter. For the 11971A, 11971Q, 11971U and 11971V: Connect the HP 478A Power Sensor to the power meter sensor cables, then zero the power meter.

7. On the spectrum analyzer, push in all the green pushbuttons and set all rotary controls with green positions to green. (See **Normal Settings** in the HP 8569B Spectrum Analyzer Operation manual.) Then make the following control settings:

   MIXING MODE to EXT
   FREQUENCY SPAN MODE to ZERO SPAN
   FREQUENCY BAND to:
   12.4--26.5 for HP 11971K
   21--44 for HP 11971A
   33--71 for HP 11971Q
   33--71 for HP 11971U
   33--71 for HP 11971V
   FREQUENCY GHz TO:
   22 for HP 11971K
   36 for HP 11971A
   42 for HP 11971Q
   50 for HP 11971U
   61 for HP 11971V

CAUTION

When you are using an HP 11975A Amplifier with an HP 11971 Mixer, set the amplifier rear-panel ALC switch to ON before connecting the amplifier into the test setup. If the ALC switch is left in the OFF position, the amplifier output power is high enough to damage the mixer diodes.

8. On the HP 11975A Amplifier, set the rear panel ALC switch to ON, then connect the power sensor to the free end of the cable installed on the OUTPUT connector of the amplifier. Set the power meter Cal Factor to the appropriate value for a frequency of 3.5 GHz.

9. Adjust the amplifier OUTPUT POWER LEVEL for a reading of +14.0 ±0.1 dBm on the power meter.

10. Connect the equipment as shown in Figure 3-1.

CAUTION

Make sure the HP 8349A Amplifier, used in the signal generator system for HP 11971A, Q, U, and V tests, is set for external leveling before you turn it on. Failure to set this amplifier for external leveling may allow the amplifier output to rise about +18 dBm, which is high enough to damage the frequency tripler or quadrupler.

11. Set the signal generator for a CW output signal at the frequencies listed below:

    HP 11971K: 18.0 GHz
    HP 11971A: 26.5 GHz
    HP 11971Q: 33.0 GHz
    HP 11971U: 40.0 GHz
    HP 11971V: 50.0 GHz

12. Adjust the output power of the signal generator for a reading of approximately -12 dBm on the power meter for the HP 11971K, or -3 dBm for the HP 11971A, 11971Q, 11971U, or 11971V.

13. On the spectrum analyzer, push in all the green pushbuttons and set all rotary controls with green positions to green. (See **Normal Settings** in the HP 8569B Spectrum Analyzer Operation manual.) Then make the following control settings:

    MIXING MODE to EXT

    FREQUENCY BAND to:
    12.4--26.5 for HP 11971K
    21--44 for HP 11971A
    33--71 for HP 11971Q
    33--71 for HP 11971U
    33--71 for HP 11971V

    FREQUENCY SPAN/DIV to 2 MHz
    RESOLUTION BANDWIDTH to 1 GHz
    AMPLITUDE SCALE to 2 dB/DIV
    INPUT ATTEN (dB) to 0
    EXTERNAL MIXING BIAS to detent position
    REFERENCE LEVEL to -10 dBm

14. Rotate the frequency TUNING control to display the signal on the screen. Use SIG IDENT to identify the response as a "true" signal. (If necessary, increase the frequency span/division to help locate the true signal.) Record the signal frequency in Table 3-6.

15. Adjust the REFERENCE LEVEL controls to place the signal peak at the top graticule of the display. Record the REFERENCE LEVEL control settings in Table 3-6.

NOTE

Record the actual REFERENCE LEVEL control settings, not the REF value shown on the CRT annotation.

16. Set the power meter CAL FACTOR to the setting corresponding to the signal frequency. Record the power meter reading in Table 3-6. If the power meter correction factor (in dB) is available, record that value in the table also.

17. Record the directional coupler coupling factor in Table 3-6.

NOTE

For the purposes of this measurement, the directional coupler coupling factor is defined as the ratio of the power at the output flange to the power at the coupled flange.

18. Calculate the conversion loss of the mixer with the following equation:

Conversion Loss = power meter reading + power meter correction factor(dB) - directional coupler coupling factor - (spectrum analyzer reference level - 30)

[The -30 term corrects for the fact that the top of the display is calibrated for -40 dBm when the reference is set to -10 dBm, as described in Section IV.]

For example:
Power Meter Reading = -12.58 dBm
Power Meter Correction Factor = 0.42 dBm
Coupling Factor = 8.93 dB
Reference Level = -12.8 dBm
Conversion Loss = -12.58 + 0.42 - 8.93 - (-12.8 - 30) = 21.7 dBm

Record the conversion loss in Table 3-6.

NOTE

The conversion loss indicated on the mixer calibration label includes the loss in the IF cable. If other than the specified cable is used, the loss in that cable must be compensated for when making amplitude measurements.

19. Increment the frequency of the signal generator 500 MHz higher.

20. Repeat steps 14 through 19 until the appropriate frequency listed below is reached.

    HP 11971K: 26.5 GHz
    HP 11971A: 40.0 GHz
    HP 11971Q: 50.0 GHz
    HP 11971U: 60.0 GHz
    HP 11971V: 71.0 GHz

21. Repeat steps 5 through 20 for LO inputs to the mixer of +14.5 dBm, +16.0 dBm and 18.0 dBm. In step 9, measure each of these levels at the end of the cable normally connected to the mixer LO input.

22. Frequency response is the difference between the maximum and minimum conversion losses recorded in Table 3-6. For LO power levels between 14.5 and 16.0 dBm, this difference must be less than:

    4.2 dB for HP 11971K and 11971A
    4.6 dB for HP 11971Q and 11971U
    5.0 dB for HP 11971V

    For LO power levels between 14.0 and 18.0 dBm, the difference must be less than:

    6.0 dB for HP 11971K and 11971A
    6.4 dB for HP 11971Q, 11971U and 11971V
    (LO power levels must be measured at the LO input connector of the mixer.)

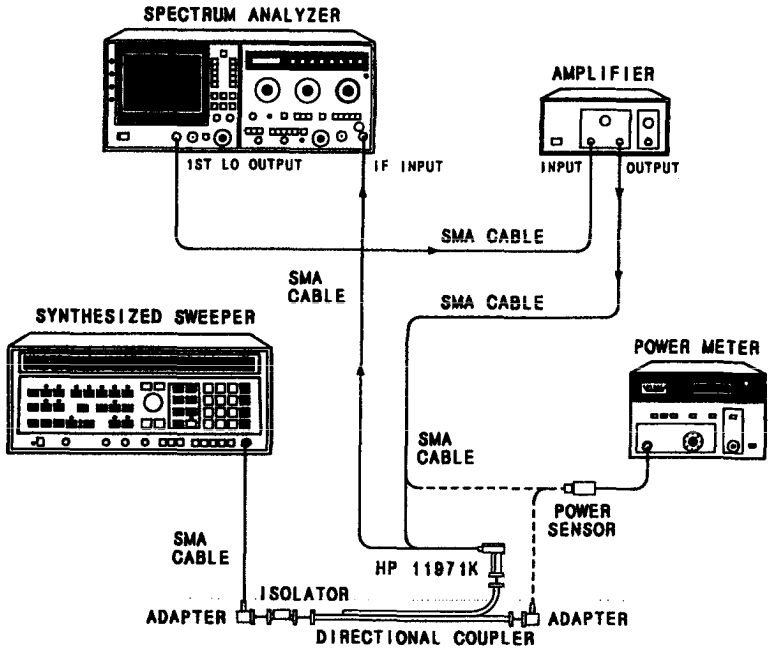
23. Maximum conversion loss must not exceed the following limits: For an LO input power between +14.0 and +18.0 dBm:

    HP 11971K: 24 dB
    HP 11971A: 28 dB
    HP 11971Q: 40 dB
    HP 11971U: 40 dB
    HP 11971V: 42 dB

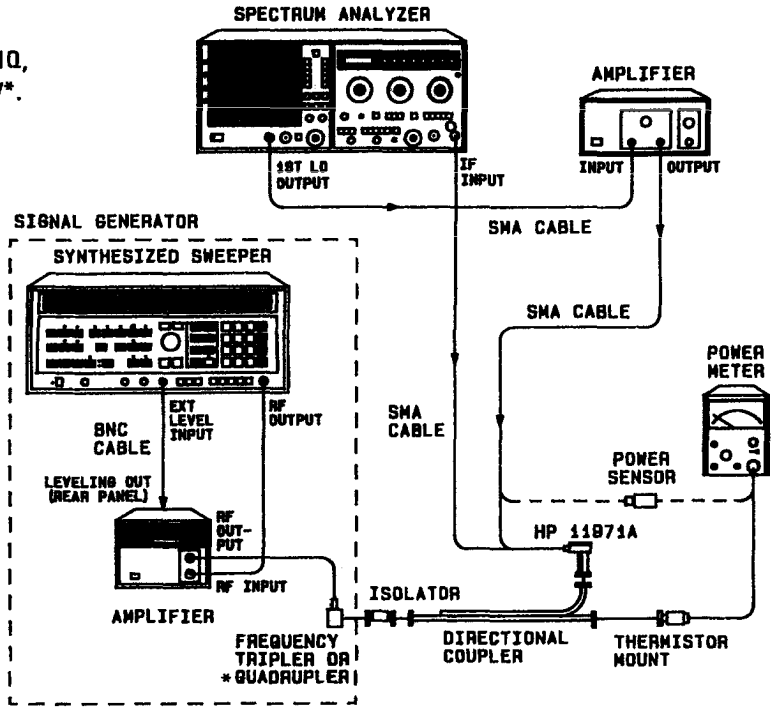
NOTE

Recalibrate the HP 8569B for use with the HP 11971 Mixer unless the Average Noise Level Performance Test is to be performed. Refer to Section IV for the calibration procedure.

EQUIPMENT SETUP FOR
THE HP 11971K



EQUIPMENT SETUP FOR
THE HP 11971A, HP 11971Q,
HP 11971U OR HP 11971V*.



*THE QUADRUPLER IS USED WITH THE HP 11971V.

Figure 3-1. Performance Test Setups

Table 3-6. Conversion Loss and Frequency Response Test Record (1 of 2)

CONVERSION LOSS and FREQUENCY RESPONSE for an LO POWER of _____dBm					
Model Number _____ Serial Number _____			Date _____ Tested by _____		
Signal Frequency	**Reference Level**	**Power Meter Readings**	**Power Sensor Cal Factor**	**Directional Coupler Coupling Factor**	**Conversion Loss**
GHz	**dBm**	**dBm**	**% or dB**	**dB**	**dB**

Tabl 3-6. Conversion Loss and Frequency Response Test Record (2 of 2)

Signal Frequency	Reference Level	Power Meter Readings	Power Sensor Cal Factor	Directional Coupler Coupling Factor	Conversion Loss
GHz	dBm	dBm	% or dB	dB	dB
Frequency Response = _____dB					

AVERAGE NOISE LEVEL TEST

SPECIFICATION

HP 11971K: -110 dBm
HP 11971A: -106 dBm
HP 11971Q: -92 dBm
HP 11971U: -92 dBm
HP 11971V: -89 dBm

DESCRIPTION

The average displayed noise level using external mixing is measured at several LO power levels. The HP 8569B Spectrum Analyzer is calibrated as a fixed 321.4 MHz receiver. A known signal is applied to the mixer. The difference between the amplitude of the known signal and the noise floor is measured in a 1 MHz bandwidth. From these measurements the average displayed noise level is determined.

NOTE

Steps 1 through 4 can be omitted if they were done earlier in the Conversion Loss and Frequency Response Test.

1. On the spectrum analyzer, push in all the green pushbuttons and set all rotary controls with green positions to green. (See **Normal Settings** in the HP 8569B Spectrum Analyzer Operation manual.) Then make the following control settings:

   FREQUENCY BAND GHz to 0.01--1.8
   FREQUENCY SPAN/DIV to 1 MHz
   RESOLUTION BW to 1 MHz
   INPUT ATTEN to 10 dB
   REFERENCE LEVEL to -10 dB
   REFERENCE LEVEL FINE to 0 dB
   AMPLITUDE SCALE to 1 dB

2. Connect the spectrum analyzer 100 MHz CAL OUTPUT signal to the INPUT, then center the signal on the CRT with the TUNING control.

3. Adjust the REF LEVEL CAL control to position the peak of the signal on the top graticule of the display.

4. Calibrate the HP 8569B for external mixing as described in Section IV, except set the signal generator for an output level of -40 dBm, instead of -10 dBm.

5. Connect an SMA cable from the 1st LO OUTPUT of the spectrum analyzer to the INPUT of the amplifier. Connect a second SMA cable to the OUTPUT of the amplifier.

CAUTION

Make sure the HP 8349A Amplifier, used in the signal generator system for HP 11970A, Q, U, and V tests, is set for external leveling before you turn it on. Failure to set this amplifier for external leveling may allow the amplifier output to rise about +18 dBm, which is high enough to damage the frequency tripler or quadrupler.

6. For the HP 11971K: Zero and calibrate the power meter. For the HP 11971A, 11971Q, 11971U and 11971V: Connect the HP 478A power sensor to the power meter sensor cables, then zero the power meter.

7. On the spectrum analyzer, push in all the green pushbuttons except MIXING MODE [INT] and set all rotary controls with green positions to green. (See **Normal Settings** in the HP 8569B Operation manual.) Then make the following control settings:

   MIXING MODE to **[EXT]**
   FREQUENCY SPAN MODE to **[ZERO SPAN]**
   FREQUENCY BAND to:
   12.4--26.5 for 11971K
   21--44 for 11971A
   33--71 for 11971Q
   33--71 for 11971U
   33--71 for 11971V
   FREQUENCY GHz to:
   22 for 11971K
   36 for 11971A
   42 for 11971Q
   50 for 11971U
   61 for 11971V

CAUTION

When you are using an HP 11975A Amplifier with an HP 11971 Mixer, set the amplifier rear-panel ALC switch to ON before connecting the amplifier into the test setup. If the ALC switch is left in the OFF position, the amplifier output power is high enough to damage the mixer diodes.

8. On the HP 11975A Amplifier, set the rear-panel ALC switch to ON, then connect the power sensor to the free end of the cable installed in the OUTPUT connector of the amplifier. Set the power meter CAL FACTOR to the appropriate value for a frequency of 3.5 GHz.

9. Adjust the amplifier OUTPUT POWER LEVEL for a reading of +14.5 ±0.1 dBm on the power meter.

10. Connect the equipment as shown in Figure 3-1.

11. Set the signal generator for a CW output signal at the frequency given below:

    HP 11971K: 18.0 GHz
    HP 11971A: 26.5 GHz
    HP 11971Q: 33.0 GHz
    HP 11971U: 40.0 GHz
    HP 11971V: 50.0 GHz

12. Adjust the output power of the signal generator for a reading of approximately -12 dBm on the power meter for the HP 11971K, or -3 dBm for the HP 11971A, 11971Q, 11971U, or 11971V.

13. Set the spectrum analyzer controls to green (refer to step 7), then make the following control settings:

    MIXING MODE to [EXT]
    FREQUENCY BAND to:
    12.4--26.5 for 11971K
    21--44 for HP 11971A
    33--71 for HP 11971Q
    33--71 for HP 11971U
    33--71 for HP 11971V

    FREQUENCY SPAN to 2 MHz/DIV
    RESOLUTION BANDWIDTH to 1 MHz
    INPUT ATTEN to 0 dB
    EXT MIXING BIAS to its detent position (center)
    REFERENCE LEVEL to -10 dBm

14. Adjust the frequency TUNING control to display the true signal on the CRT. (If necessary, increase the FREQUENCY SPAN/DIV to help locate the true signal.) Record the signal frequency in Table 3-7.

15. Set the power meter CAL FACTOR to the appropriate value for the signal frequency recorded in step 14. Record the power meter reading in Table 3-7.

16. Record the power meter correction factor (in dB), if it is available, in Table 3-7. Record the directional coupler coupling factor in the table also.

NOTE

For the purposes of this measurement, the directional coupler coupling factor is defined as the ratio of the power at the output flange to the power at the coupled flange.

17. Adjust the REFERENCE LEVEL controls to place the signal peak at the top graticule of the display. Record this value in Table 3-7.

18. Press the DGTL AVG pushbutton. After the noise level has been averaged, record the value on Table 3-7. (The correction factor for measuring the noise in a 1 MHz, rather than a 1 kHz, bandwidth is 10log(1 MHz/1 kHz)).

19. Calculate the Average Noise Level as follows:

    Average Noise Level = power meter reading (step 15) + power meter correction factor (step 16) - directional coupler coupling factor (step 16) - signal amplitude (step 17) + noise floor average (step 18) - 10log(1 MHz/1 kHz)

    For example:
    Average Noise Level = (-12.58) + .42 - 9.93 - (-11.8) + (-67.2) - 30 = -107.5 dBm

    Enter the calculated value in Table 3-7.

    The average Noise Level must be:
    < -110 dBm for the 11971K
    < -106 dBm for the 11971A
    < -92 dBm for the 11971Q
    < -92 dBm for the 11971U
    < -89 dBm for the 11971V

20. Press the DGTL AVG pushbutton again to turn off the digital averaging mode.

21. Repeat steps 14 through 20 at the following center frequencies:

    HP 11971K: 22 and 26.5 GHz
    HP 11971A: 33 and 40 GHz
    HP 11971Q: 42 and 50 GHz
    HP 11971U: 50 and 60 GHz
    HP 11971V: 63 and 71 GHz

22. Repeat steps 5 through 21 for a power level of 16.0 dBm at the HP 11971 Mixer LO connector.

Tabl 3-7. Average Noise Test Record

AVERAGE NOISE LEVEL								
Model Number _____ Date _____ Serial Number _____ Tested by _____								
	Signal Frequency	Power Meter Reading	Power Sensor Correction Factor	Directional Coupler Coupling Factor	Signal Amplitude	Noise Floor Amplitude	Bandwidth Correction Factor	Average Noise Level
Units	GHz	dBm	dB	dB	dBm	dB	dB	dBm
Step	14	15	16	16	17	18	18	19
LO Power = 14.5	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____
LO Power = 16.0	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____	_____ _____ _____

SECTION IV
SPECTRUM ANALYZER CALIBRATION

INTRODUCTION

Before it is used for amplitude measurements, the HP 8569B Spectrum Analyzer must be calibrated in a specific manner to adapt it to the particular HP 11971 Mixer in use with it. The step-by-step calibration procedure is described below.

WARNING

In the following procedure it is necessary to remove the top cover from the spectrum analyzer to gain access to internal adjustments. Removing the analyzer's top cover exposes potentially lethal voltages at various locations inside the instrument. Because of this danger, the calibration must be performed only by a skilled person who knows the hazard involved.

1. Set the HP 8569B controls as follows:
   a. Push in all the green pushbuttons except MIXING MODE [INT].
   b. Set VIDEO FILTER to OFF (green position), SWEEP TIME/DIV to AUTO (GREEN POSITION), and line up the green arrows on the FREQUENCY SPAN/DIV and RESOLUTION BW controls.
   c. Press MIXING MODE [EXT].
   d. Press the FREQUENCY BAND GHz pushbutton corresponding to the mixer's frequency.
   e. Set the FREQUENCY SPAN MODE to [ZERO SPAN].
   f. Set the INPUT ATTEN (dB) control to 0.
   g. Set the RESOLUTION BANDWIDTH to 10 kHz.
   h. Set the REFERENCE LEVEL to -10 dBm.
   i. Set the AMPLITUDE SCALE to 1 dB/DIV.
   j. Set the EXT MIXING BIAS control to its detent position (center).
2. Remove the top cover from the HP 8569B Spectrum Analyzer.

3. Rotate the TUNING knob to set the digital FREQUENCY display to the beginning of the spectrum analyzer's external mixing band. For example: 12.4 GHz for the HP 11971K or 21 GHz for the HP 11971A.

4. Set the signal generator frequency to 321.4 MHz.

5. Connect the power sensor to the SMA cable (see Figure 4-1) and adjust the signal generator output level for a power meter reading of -10 dBm minus the IF gain shown on the calibration table or mixer label for the low end of the mixer band. For example: If the calibration table or mixer label shows the IF gain at the low end of the mixer frequency band to be 21.9 dB, the signal generator output must be set for a reading of -31.9 dBm on the power meter.

6. Disconnect the SMA cable from the power sensor and connect it to the 321.4 MHz IF INPUT on the HP 8569B.

7. Vary the frequency of the signal generator to peak the response on the spectrum analyzer CRT display. If the signal goes off the top of the display, return it by adjusting the appropriate (frequency band) OFFSET control on bias assembly A20 (see Figure 4-2).

8. After the signal is peaked within the IF, adjust the appropriate OFFSET control (frequency band) on A20 to place the trace on the top graticule line of the display.

9. Rotate the TUNING knob to set the digital FREQUENCY display to the end of the spectrum analyzer's external mixing band. For example: 26.5 GHz for the HP 11971K or 44 GHz for the HP 11971A.

10. Connect the power sensor to the SMA cable and adjust the signal generator output level for a power meter reading of -10 dBm minus the IF gain shown on the calibration table or mixer label for the high end of the mixer band. For example: If the calibration table or mixer label shows the IF gain at the high end of the mixer frequency band to be 20.5 dB, the signal generator output must be set for a reading of -30.5 dBm on the power meter.

11. Disconnect the SMA cable from the power sensor and connect it to the 321.4 MHz IF INPUT on the HP 8569B.

12. Adjust the appropriate SLOPE control on bias assembly A20 (see Figure 4-2) to place the trace on the top graticule line of the display.

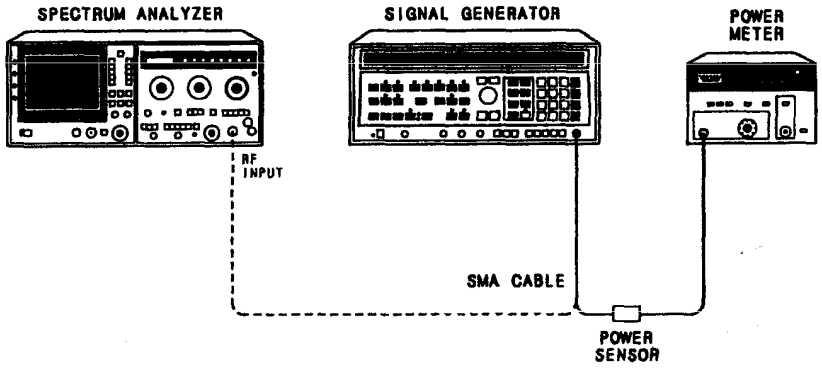


Figure 4-1. Amplitude Calibration Test Setup

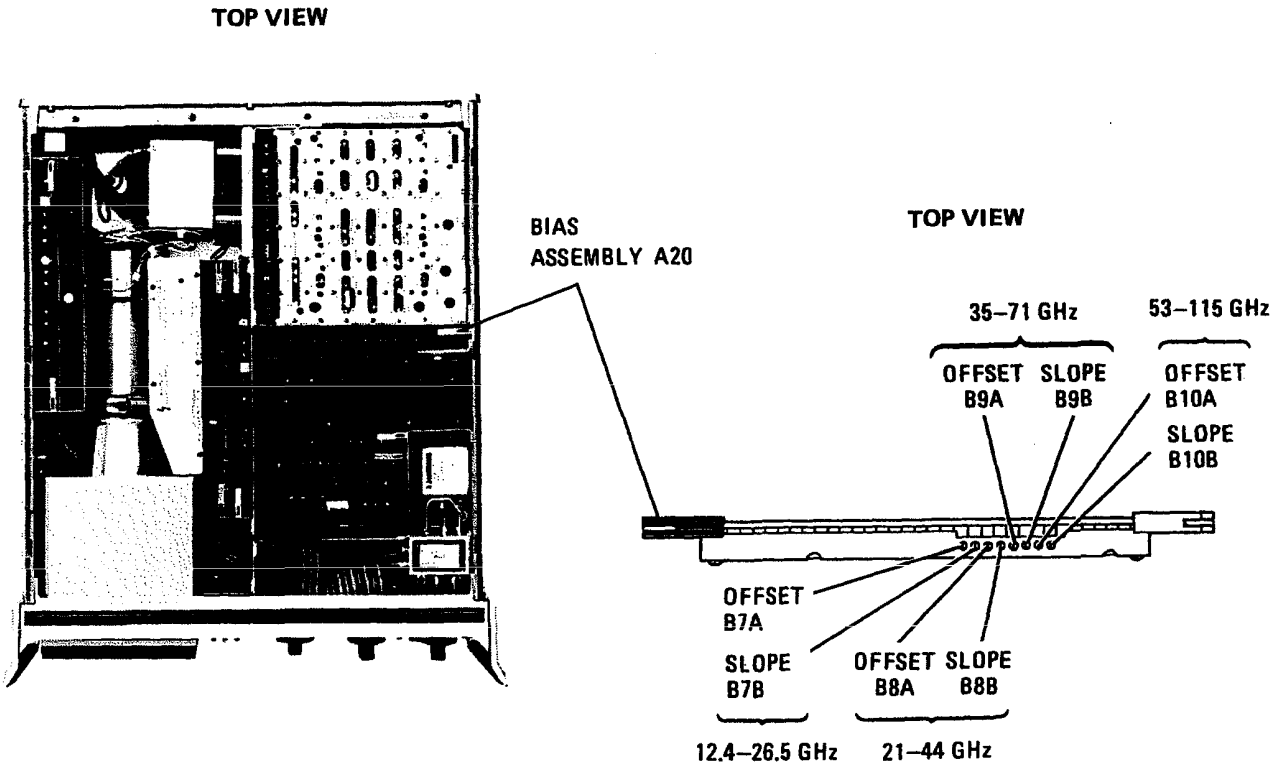


Figure 4-2. Offset and Slope Adjustment Locations

SECTION V
SERVICE

MAINTENANCE

The only maintenance required for the HP 11971 Series Mixers is preventive maintenance. When you are not using your mixer, cover its waveguide input with its waveguide cap. Also, though the HP 11971 Mixers can absorb more punishment than is normal for such devices, you should avoid subjecting them to unnecessary shock or vibration. If you have the wooden case, HP 11969A, you should keep the mixers in it when they are not in use.

REPAIRS

Except for replacement of the SMA connectors, the HP 11971 Mixers are **NOT** field-repairable. If your mixer fails, **DO NOT** try to repair it yourself, you will void the warranty. Instead, notify the nearest Hewlett-Packard office.

REPLACEABLE PARTS

Replaceable parts for the mixers are limited to the SMA connectors and waveguide caps. These items, and the accessories available for use with the mixers, are listed with their part numbers in Table 5-1.

REPLACEMENT OF SMA CONNECTORS

If you must replace an SMA connector, Hewlett-Packard recommends that you use the Hermetic Connector Installation Tool manufactured by the M/A-COM Omni Spectra Corporation of Merrimack, New Hampshire. This is a one-piece tool specially designed for removing and installing SMA type connectors. A complete set of instructions for its use is supplied with it. See Table 5-1 for the manufacturer's part number.

CIRCUIT DESCRIPTION

A schematic diagram of an HP 11971 Series Harmonic Mixer is shown in Figure 5-1. The mixing circuit employs two diodes arranged as an anti-parallel pair. These diodes are the termination for the open end of the waveguide output. By employing a matched diode pair, even harmonic mixing is enhanced while odd harmonic mixing is suppressed.

The waveguide input is exponentially tapered in both height and width. The height taper provides impedance matching between the high impedance waveguide input and the low, dynamic impedance of

the diodes. The width taper creates a high-pass filter response which isolates the LO harmonics from the standard-height waveguide. Without this isolation, the LO harmonics would reflect from the standard-height waveguide back into the mixer and destructively interfere with the desired mixing product.

LO harmonics are confined to the immediate vicinity of the diode pair by the low-pass filter, which has as its first element a metal-insulator-semiconductor (MIS) capacitor. This improves the out-of-band response. The diplexer separates the 2.6--4.4 GHz LO signal from the 321.4 MHz IF signal.

Table 5-1. Accessories and Replaceable Parts

HP Part Number	CD	Description
5061-5460	1	Mixer Connector Kit (Option 009, includes the following three items)
5061-5458	7	Cable, 1 meter long, SMA male connectors (3 required)
8710-0510	2	Wrench, 5/16-inch, open-end
8710-1539	7	Ball Driver, 3/32-inch
5061-5459	8	Storage Case, with packing foam (HP 11969A)
3030-0221	5	Socket Head Cap Screw, 4-40 thread, .375 inches long (flange connecting screw for HP 11971K and HP 11971A)
1390-0671	9	Socket Head Cap Screw, captive, 4-40 thread, .290 inches long (flange connecting screw for HP 11971Q, HP 11971U, or HP 11971V)
11970-40001	7	HP 11971K Waveguide Cap
11970-40002	8	HP 11971A Waveguide Cap
11970-40003	9	HP 11971Q and HP 11971U Waveguide Cap
5041-3932	6	HP 11971V Waveguide Cap
1250-1802	4	SMA Connector, for IF and LO connector replacement
		For Replacing SMA Connectors:
		Hermatic Connector Installation Tool, M/A-COM Omni Spectra Corporation, Merrimack, New Hampshire, M/A-COM Omni Spectra part number 2098-0248-54.

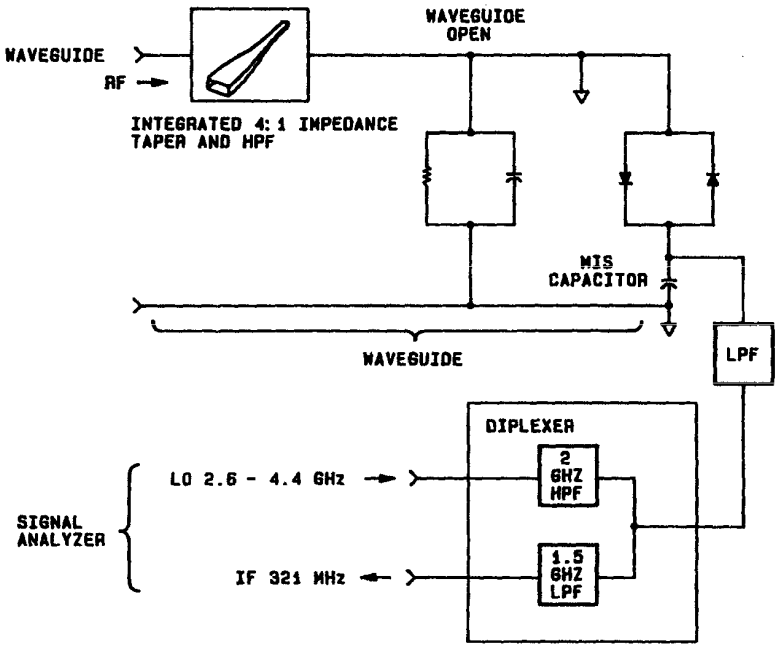


Figure 5-1. HP 11971 Series Mixer Schematic Diagram

HEWLETT-PACKARD SALES AND SERVICE OFFICES

To obtain servicing information or to order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office listed in the HP Catalog, or contact the nearest regional office listed below:

IN THE UNITED STATES

CALIFORNIA
P.O. Box 4230
1421 South Manhattan Avenue
Fullerton 92631

GEORGIA
P.O. Box 105005
2000 South Park Place
Atlanta 30339

ILLINOIS
5201 Tollview Drive
Rolling Meadows 60008

NEW JERSEY
W. 120 Century Road
Paramus 07652

IN CANADA

Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
Kirkland, Quebec H9J 2M5

IN FRANCE

Hewlett-Packard France
F-91947 Les Ulis Cedex
Orsay

IN GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Berner Strasse 117
Postfach 560 140
D-6000 Frankfurt 56

IN GREAT BRITAIN

Hewlett-Packard Ltd.
King Street Lane
Winnersh, Wokingham
Berkshire RG11 5AR

IN OTHER EUROPEAN COUNTRIES

SWITZERLAND
Hewlett-Packard (Schweiz) AG
29 Chemin Chateau Bloc
CH-1219 LeLignon-Geneva

IN ALL OTHER LOCATIONS

Hewlett-Packard Inter-Americas
3200 Hillview Avenue
Palo Alto, California 94304

HP Part Number 11971-90014

Printed in U.S.A.