Agilent 11970 Series Harmonic Mixers

This manual provides documentation for the following harmonic mixers:

K, A, Q, U, V, and W Models

User's Guide

Agilent Technologies

Notices

Manual Part Number

11970-90040
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Warranty

Technology Licenses

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Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

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

In This Guide…

This guide contains the following information:

1   General Information

This chapter covers equipment supplied, the mixers and options that are covered in this manual, as well as specifications and environmental limitations regarding the mixer.

2   Operation

Refer to this chapter for information on how to make effective use of the 11970 mixers.

3   Service

This chapter covers care and maintenance of the mixer, a list of replaceable parts and accessories, as well as contact information for additional assistance.

Certification

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

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For any assistance, contact your nearest Agilent Technologies Office listed on page 63.

This guide uses the following conventions:

Instrument Key This represents a key physically located on the instrument, or a key with a label that is determined by the instrument firmware.

`Screen Text` This indicates text displayed on the spectrum analyzer screen.

Contents

Contents

1 General Information

Introduction

The Agilent Models 11970K, 11970A, 11970Q, 11970U, 11970V and 11970W are general-purpose harmonic mixers with very flat frequency response characteristics and low conversion loss. Collectively, they cover the frequency range of 18 to 110 GHz. The 11970K covers the 18 - 26. 5 GHz range; the 11970A, the 26.5 - 40 GHz range; the 11970Q, the 33 - 50 GHz range; the 11970U, the 40 - 60 GHz range; the 11970V, the 50 - 75 GHz range; and the 11970W, the 75 - 110 GHz range.

The overall local oscillator (LO) frequency range of the 11970 Series Mixers is 3.0 to 6.1 GHz. Each of the mixers employs a different LO harmonic, and as a result has a different optimum LO range within the overall LO range of the series.

An 8 1/2 by 11 inch conversion losss table and chart is included with each mixer shippment. There is also electronic media included that is used to download the conversion loss data into a few of the Spectrum Analyzers documented in this user's guide. This conversion loss data table must 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.

Equipment Supplied

Waveguide Connector Screws

Five hex-head screws are supplied with each mixer. Four are required to make the mixer-to-waveguide connection, one is a spare. Use ONLY the screws supplied to attach the mixer to the waveguide. Because of slight differences in the way the mixers couple with the waveguide, the square-flange mixers (11970K and 11970A) and the round-flange mixer (11970Q, 11970U, 11970V and 11970W) require different screws.

If your mixer has a square waveguide flange, use four hex-head screws with Part Number 3030-0221. If it has a round waveguide flange, use four hex-head captive screws with Part Number 1390-0671. The special balldriver hex screwdriver available in the Option 009 Mixer Connector Kit simplifies installation of the waveguide connector screws.

NOTE   See Chapter 3 , "Service." for a list of replacement parts.

Mixers Covered by Manual

Serial Numbers

Attached to your mixer is a label, which shows both the mixer model number and its serial number (two parts). The first four digits and the letter of the serial number are the serial number prefix; the last five digits are the suffix. The contents of this manual apply to mixers with the serial number prefixes listed under "Serial Number Prefixes" on the title page of this manual.

11970 Series Harmonic Mixers

Figure 1-1
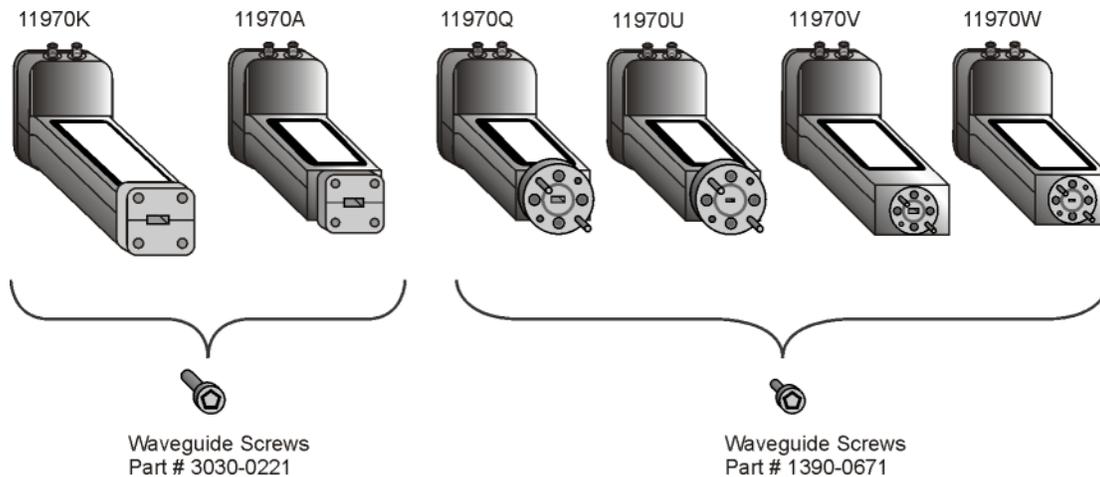
Options

Option 009, shown in Figure 1-2 on page 13, is a Mixer Connection Kit. It includes three low-loss SMA cables (Part Number 5061-5458), one hex-head balldriver (Part Number 8710-1539) for tightening the waveguide connector screws, and one 5/16-inch open-end wrench (Part Number 8710-0510) for use on the SMA connectors.

Spectrum Analyzer Retrofit Requirements

*   N9030A Signal Analyzer

    — A Diplexer is required since the N9030A has a single SMA external mixer port, and the 11970 series mixers have separate LO and IF ports. The recommended diplexer can be purchased from Agilent as p/n N9029AE13 or from OML Inc. as p/n DPL.313B.

    — Requires Option EXM

    To retrofit Option EXM:

N9030A Frequency Option	Serial Number Prefix	
	<MY/US/SG5138	≥MY/US/SG5138
550, 544, or 543	N9030AK-EXM	N9030AK-EXM
503, 508, 513, or 526	N9030AK-HL6	

    — Software revision must be A.08.01 or later

    — USB storage device (>2GB free memory)

    — The N9030A does not support the 11970K (LO range limitation).

- PSA Series E4440A, E4446A, and E4448A spectrum analyzers require Option AYZ (LO OUT and IF IN connectors). The E4443A and E4445A do not support external mixing.

- 856x Series portable spectrum analyzers with options 002 (tracking generator) and 327 (no IF IN on front panel) do not have external mixing capability.

- 856x Series Portable Spectrum Analyzers require option 008, or FW date code $\leq$ 920528, for signal identification functionality.

- Agilent E4407B spectrum analyzers require option AYZ (LO Out and IF IN connections).

- MMS analyzers using 11970 series mixers must have a front end model 70907A, 70907B, 70909A, or 70910A, as well as a 70900A/B with firmware new enough for those modules:

Model		FW Date Code: (or newer)
70907A	-	860203
70907B	-	900314
70909A	-	910802
70910A	-	910802

- The 11970 Series Mixers are fully compatible with all 8566B Spectrum Analyzers.

Figure 1-2   Mixer Connection Kit, Option 009

LOW-LOSS SMA CABLE (1 OF 3)
PART NUMBER 5061-5458

5/16-INCH OPEN-END WRENCH
PART NUMBER 8710-0510

BALL DRIVER
PART NUMBER 8710-1539
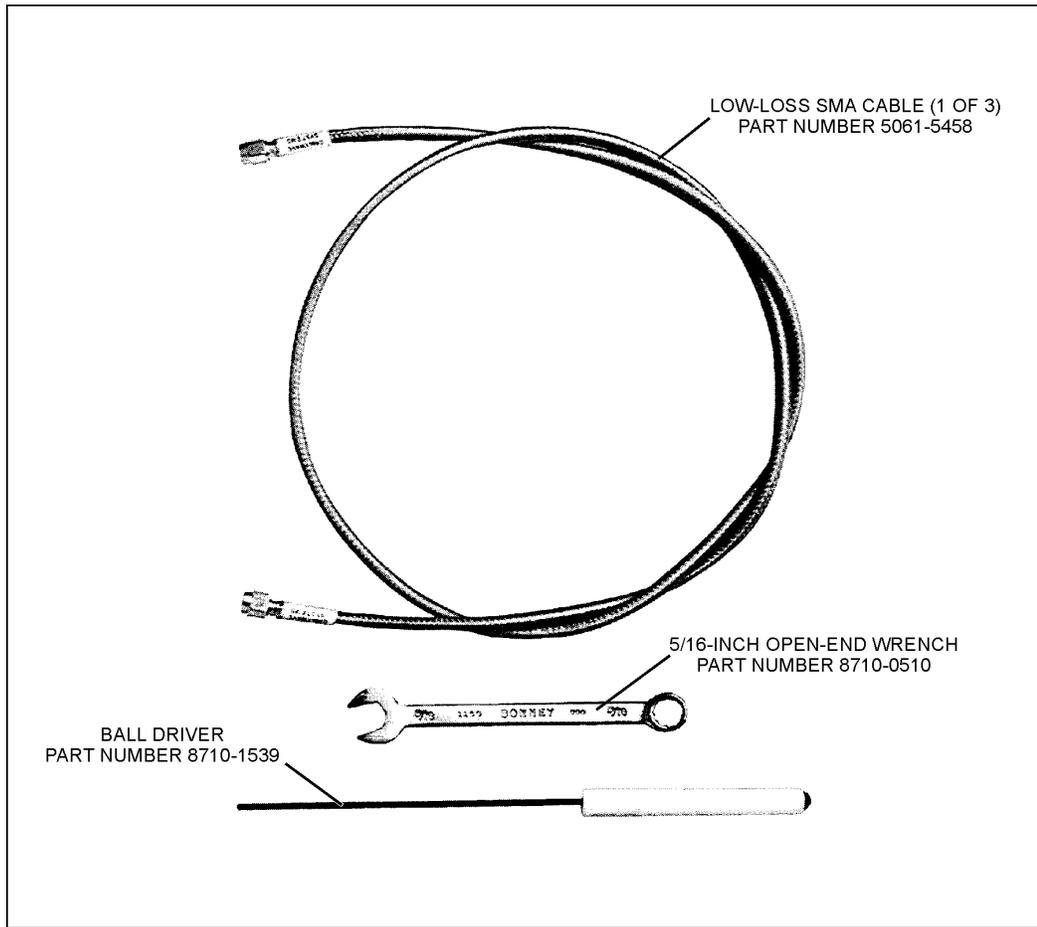
Specifications

Specifications for the 11970 Series Mixers are listed in Table 1-1 on page 15 through Table 1-7 on page 21.

NOTE	Supplemental information is included only as additional information; they are not specifications. Nominal values indicate expected performance or describe product performance that is not covered by the product warranty.

Environmental Limitations

The 11970 Series Mixers meet or exceed the environmental requirements of MIL-T-28800C, Type III, Class 3, Style C. Specific environmental qualifications for the mixers are as follows:

Temperature, Non-operating: -40oC to 75oC

Temperature, Operating: 0oC to 55oC

Relative Humidity: 95 ±5% (up to 30oC)

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 to 2000 Hz

Maximum Shock: 30 G's

NOTE	Unless otherwise stated, all specifications apply for an IF range of 300 to 322.5 MHz as required by the various spectrum analyzers covered in this user's guide. Also, the specifications only apply with RF input levels of less than −20 dBm.

Table 1-1   11970 Series Specifications

Description	Specifications	Supplemental Information
LO Amplitude Range	14 to 18 dBm	
Bias Requirements		None
Maximum CW RF Input Level	20 dBm (100 mW)	
Maximum Peak Pulse Power	24 dBm with <1μsec pulse (avg power: +20 dBm)	
3 dB Bandwidth		DC to 1.3 GHz
Environmental:		Meets MIL-T-28800C, Type III, Class 3, Style C
IF/LO Connectors		SMA female
5061-5458 Cable Insertion loss		0.8 dB at 2 GHz 1.1 dB at 6 GHz

Table 1-2   11970K Specifications

Description	Specifications	Supplemental Information
RF Frequency Range	18 to 26.5 GHz	The 11970K is not supported by the N9030A (PXA)
LO Harmonic Number	6	
Odd Order Mixing Product Suppression		>20 dB (nominal)
LO Input Frequency Range	2.95 to 4.36 GHz	
Gain Compression Level (<1 dB)		–3 dBm (nominal)
Maximum Conversion Loss	24 dB	
Calibration Accuracy[1]		±2.0 dB with LO amplitude range of 14.5 dBm to 16.0 dB (nominal) ±3.0 dB with LO amplitude range of 16 dBm to 18.0 dB (nominal)
Spectrum Analyzer Absolute Amplitude Accuracy (using conversion loss data with 14.5 to 16.0 dBm LO)		±3.2 dB + frequency response of the mixer (nominal)
Frequency response (with LO input power 14.5 to 16.0 dBm)	±1.9 dB	
Frequency response (with LO input power 14.0 to 18.0 dBm)	±2.8 dB	
Displayed Average Noise Level RBW = 1 kHz RBW Sample detector Comversion loss corrections On LO Power 14.5 to 16 dBm		–105 dBm (nominal)
Input SWR		<2.2:1 (nominal)

1. Calibration accuracy is defined as the difference between the actual mixer conversion loss and the calibration values provided with the mixer.

Table 1-3   **11970A Specifications**

Description	Specifications	Supplemental Information
RF Frequency Range	26.5 to 40 GHz	
LO Harmonic Number[1]	8	
Odd Order Mixing Product Suppression		>20 dB (nominal)
LO Input Frequency Range	3.27 to 4.96 GHz	
Gain Compression Level (<1 dB)		–5 dBm (nominal)
Maximum Conversion Loss	26 dB	
Calibration Accuracy[2]		$\pm$2.0 dB with LO amplitude range of 14.5 dBm to 16.0 dB (nominal) $\pm$3.0 dB with LO amplitude range of 16 dBm to 18.0 dB (nominal)
Spectrum Analyzer Absolute Amplitude Accuracy (using conversion loss data with 14.5 to 16.0 dBm LO)		$\pm$3.2 dB + frequency response of the mixer (nominal)
Frequency response (with LO input power 14.5 to 16.0 dBm)	$\pm$1.9 dB	
Frequency response (with LO input power 14.0 to 18.0 dBm)	$\pm$2.8 dB	
Displayed Average Noise Level RBW = 1 kHz RBW Sample detector Comversion loss corrections On LO Power 14.5 to 16 dBm		–102 dBm (nominal) For N9030A: 26.5 to 30.45 GHz: –110 dBm (nominal) >30.45 to 40 GHz: –108 dBm (nominal)
Input SWR		<2.2:1 (nominal)

1. When used with the N9030A, harmonic 6 and harmonic 8 used are dependent on the start and stop frequencies. Harmonic 6 is used from 26.5 to 30.45 GHz and harmonic 8 is used above 30.45 GHz.
2. Calibration accuracy is defined as the difference between the actual mixer conversion loss and the calibration values provided with the mixer.

Table 1-4   11970Q Specifications

Description	Specifications	Supplemental Information
RF Frequency Range	33 to 50 GHz	
LO Harmonic Number[1]	10	
Odd Order Mixing Product Suppression		>20 dB (nominal)
LO Input Frequency Range	3.27 to 4.96 GHz	
Gain Compression Level (<1 dB)		–7 dBm (nominal)
Maximum Conversion Loss	28 dB	
Calibration Accuracy[2]		±2.0 dB with LO amplitude range of 14.5 dBm to 16.0 dB (nominal) ±3.0 dB with LO amplitude range of 16 dBm to 18.0 dB (nominal)
Spectrum Analyzer Absolute Amplitude Accuracy (using conversion loss data with 14.5 to 16.0 dBm LO)		±3.2 dB + frequency response of the mixer (nominal)
Frequency response (with LO input power 14.5 to 16.0 dBm)	±1.9 dB	
Frequency response (with LO input power 14.0 to 18.0 dBm)	±2.8 dB	
Displayed Average Noise Level RBW = 1 kHz RBW Sample detector Comversion loss corrections On LO Power 14.5 to 16 dBm		–101 dBm (nominal) For N9030A: 33 to 40 GHz: –108 dBm (nominal) >40 to 50 GHz: –106 dBm (nominal)
Input SWR		<2.2:1 (nominal)

1. When used with the N9030A, harmonic 8 and harmonic 10 used are dependent on the start and stop frequencies. Harmonic 8 is used from 33 to 40 GHz and harmonic 10 is used above 40 GHz.
2. Calibration accuracy is defined as the difference between the actual mixer conversion loss and the calibration values provided with the mixer.

Table 1-5   11970U Specifications

Description	Specifications	Supplemental Information
RF Frequency Range	40 to 60 GHz	
LO Harmonic Number	10	
Odd Order Mixing Product Suppression		>20 dB (nominal)
LO Input Frequency Range	3.97 to 5.97 GHz	
Gain Compression Level (<1 dB)		–7 dBm (nominal)
Maximum Conversion Loss	28 dB	
Calibration Accuracy[1]		±2.0 dB with LO amplitude range of 14.5 dBm to 16.0 dB (nominal) ±3.0 dB with LO amplitude range of 16 dBm to 18.0 dB (nominal)
Spectrum Analyzer Absolute Amplitude Accuracy (using conversion loss data with 14.5 to 16.0 dBm LO)		±3.2 dB + frequency response of the mixer (nominal)
Frequency response (with LO input power 14.5 to 16.0 dBm)	±1.9 dB	
Frequency response (with LO input power 14.0 to 18.0 dBm)	±2.8 dB	
Displayed Average Noise Level RBW = 1 kHz RBW Sample detector Comversion loss corrections On LO Power 14.5 to 16 dBm		–101 dBm (nominal) For N9030A: 40 to 60 GHz: –106 dBm (nominal)
Input SWR		<2.2:1 (nominal)

1. Calibration accuracy is defined as the difference between the actual mixer conversion loss and the calibration values provided with the mixer.

Table 1-6   11970V Specifications

Description	Specifications	Supplemental Information
RF Frequency Range	50 to 75 GHz	
LO Harmonic Number[1]	14	
Odd Order Mixing Product Suppression		>15 dB (nominal)
LO Input Frequency Range	3.55 to 5.33 GHz	
Gain Compression Level (<1 dB)		–3 dBm (nominal)
Maximum Conversion Loss	40 dB	
Calibration Accuracy[2]		±2.2 dB with LO amplitude range of 14.5 dBm to 16.0 dB (nominal) ±3.2 dB with LO amplitude range of 16 dBm to 18.0 dB (nominal)
Spectrum Analyzer Absolute Amplitude Accuracy (using conversion loss data with 14.5 to 16.0 dBm LO)		±3.4 dB + frequency response of the mixer (nominal)
Frequency response (with LO input power 14.5 to 16.0 dBm)	±2.1 dB	
Frequency response (with LO input power 14.0 to 18.0 dBm)	±2.8 dB	
Displayed Noise Level RBW = 1 kHz RBW Sample detector Comversion loss corrections On LO Power 14.5 to 16 dBm		–92 dBm (nominal) For N9030A: 50 to 66 GHz: –96 dBm (nominal) >66to 75 GHz: –94 dBm (nominal)
Input SWR		<2.6:1 (nominal)

1. When used with the N9030A, harmonic 12 and harmonic 14 used are dependent on the start and stop frequencies. Harmonic 12 is used from 50 to 66 GHz and harmonic 14 is used above 66 GHz.
2. Calibration accuracy is defined as the difference between the actual mixer conversion loss and the calibration values provided with the mixer.

Table 1-7   **11970W Specifications**

Description	Specifications	Supplemental Information
RF Frequency Range	75 to 110 GHz	
LO Harmonic Number	18	
Odd Order Mixing Product Suppression		>15 dB (nominal)
LO Input Frequency Range	4.15 to 6.09 GHz	
Gain Compression Level (<1 dB)		–1 dBm (nominal)
Maximum Conversion Loss	46 dB	
Calibration Accuracy[1]		±2.2 dB with LO amplitude range of 14.5 dBm to 16.0 dB (nominal) ±3.2 dB with LO amplitude range of 16 dBm to 18.0 dB (nominal)
Spectrum Analyzer Absolute Amplitude Accuracy (using conversion loss data with 14.5 to 16.0 dBm LO)		±3.4 dB + frequency response of the mixer (nominal)
Frequency response (with LO input power 14.5 to 16.0 dBm)	±3.0 dB	
Frequency response (with LO input power 14.0 to 18.0 dBm)	±4.0 dB	
Displayed Noise Level RBW = 1 kHz RBW Sample detector Comversion loss corrections On LO Power 14.5 to 16 dBm		–85 dBm (nominal) For N9030A: 75 to 110 GHz: –88 dBm (nominal)
Input SWR		<2.6:1 (nominal)

1. Calibration accuracy is defined as the difference between the actual mixer conversion loss and the calibration values provided with the mixer.

PHYSICAL CHARACTERISTICS					
Model	Flange[1]	Weight	X	Y	Z
11970K	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
11970A	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
11970Q	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
11970U	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
11970V	UG-385/U WR-15	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	76 mm 3.0 in
11970W	UG-387/U -M WR-10	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	76 mm 3.0 in
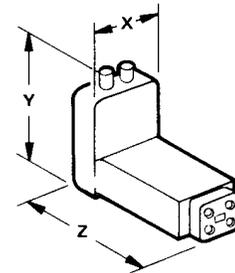
1. Waveguide attachment screws enter blind holes in the flanges of the mixers.

2   Operation

Introduction

This section provides information on how to make effective use of the 11970 mixers.

Operating Precautions

Refer to the sections below for specific parameters to follow prior to mixer operation.

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

RF Input Power

Use the following parameters:

CW: No greater than 20 dBm. See Gain Compression values for each model number. Use an appropriate waveguide attenuator if the output power of the unit under test exceeds the gain compression value.

Pulse: No greater than 24 dBm at < 1 μSec pulse width

Average: No greater than 20 dBm

LO Input Power

Make sure the LO input power is no greater than 20 dBm.

Electrostatic Discharge

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

Waveguide Protective Foam

Do not remove, displace, or damage the white, nonconductive foam installed in the open end of the waveguide. The foam keeps small objects from entering the waveguide.

Avoiding Mechanical Damage

Leave the waveguide flange cap on whenever the mixer is not connected to a device under test. This protects the flange mating surface from scratches, which can degrade the mixer's performance.

Getting Started

The 11970 series of millimeter wave mixers have no bias or back-short adjustments. 11970 Mixers require an LO power of 14 to 18 dBm at the LO input.

Mixer Connections

This chapter contains connection and operation information listed by Spectrum Analyzer model number

If you are using an 11970Q, 11970U, 11970V or 11970W Mixer, and the shoulder of its waveguide flange is not properly aligned with the flange of the device under test, amplitude measurement errors can result. To ensure proper alignment, tighten each of the four flange screws in turn by small amounts, moving clockwise around the flange.

NOTE	11970K and 11970A Mixers require flange screws that are different from those used with the 11970Q, 11970U, 11970V and 11970W; 11970K and 11970A use Part Number 3030-0221 (#4-40 hex head screw). 11970Q, 11970U, 11970V and 11970W use Part Number 1390-0671 (#4-40 hex head captive screw).

Using the Mixers with the E4407B Spectrum Analyzer (Option AYZ)

The Agilent Technologies E4407B spectrum analyzer contains an extensive menu of functions that help with millimeter measurements. The following examples explain how to connect external mixers to the spectrum analyzer, choose the band of interest, store and activate conversion-loss factors, and how to use the signal-identification functions.

Set up the equipment

1. Connect the signal source and harmonic mixer to the analyzer, as shown in Figure 2-1.

Figure 2-1   **Harmonic Mixer Setup**

SPECTRUM ANALYZER

IF INPUT   LO OUTPUT

HARMONIC MIXER

SIGNAL SOURCE

BI72b

NOTE   Agilent 5061-5458 SMA type cables should be used to connect the mixer IF and LO ports to the analyzer. Do not over-tighten the cables. The maximum torque should not exceed 112 N-cm (10 in-lb.)

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2. On the analyzer, press **Preset**, **Factory Preset**, if present.

3. Select external mixing by pressing **Input/Output**, **Input Mixer**, **Input Mixer** (Ext).

4. The analyzer frequency band will be set to **26.5 - 40 GHz (A)**. To choose a different band, press **Ext Mix Band** , then press the desired band frequency range/letter key. For this example, we will use band A, which ranges from 36.5 GHz to 40 GHz.

Amplitude Calibration

The conversion loss versus frequency data can be entered on your analyzer from one of three sources.

- From a **Conversion Loss Data Disk**, supplied with your mixer.

- Data from the calibration sheet supplied with your mixer. The 11970A, Q, and V band mixers calibrated after May 2011 have two calibration sheets. Use the sheet that contains the text "Not for use with the Agilent X-Series Signal Analyzers'. An example of the calibration sheet is shown in .

- From conversion-loss data located on the mixer body label.

Using a Conversion-Loss Data Disk

The conversion-loss data for your mixer can be quickly loaded in the memory of an ESA or PSA series analyzer from a floppy disk. The following process works with the floppy disk provided by the factory with your new mixer, or with one that you have stored the correction data. This process eliminates the time consuming and sometimes error-prone process of manually entering the data from a table.

Loading Data

1. Insert the conversion-loss data disk (from the factory or your own) into the floppy drive of the analyzer.

2. Press **File**, then **Load**.

3. Press **Type**, **More**, then select **Corrections**.

4. Press **Directory Select**, highlight drive –A–, then press **Directory Select** again.

5. Use the down arrow to select the file. The factory supplied disk has a file with the OTH extension which places the data in the corrections set "other" location.

6. Press **Load Now** to load the conversion loss values into the correction table of the analyzer.

Viewing Data

1. Press **Amplitude**, **More**, **Corrections**, **Other** (ON) and **Edit** to view the correction values.

2. Use the front-panel knob or up/down arrows to scroll through the list of correction values.

Manually Entering Conversion-Loss Data

1. The analyzer frequency band will be set to **26.5 – 40 GHz (A)**. To choose a different band, press **Ext Mix Band** and then press the desired band frequency range/letter key. For this example, we will use band A, which ranges from 26.5 GHz to 40 GHz.

NOTE   To correct for the conversion-loss of the harmonic mixer in use, the analyzer
                amplitude correction feature is used.

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2. Press **AMPLITUDE Y Scale**, **More, Corrections**. Select a correction set for use with external mixing. The recommended set to use is **Other** although any available set could be used.

3. Press **Edit** to enter the appropriate conversion loss data for the mixer in use. These values are listed on the mixer, or a calibration sheet that is supplied with the mixer.

NOTE   More correction points entered across the band in use will improve frequency
                response accuracy. Up to 200 points may be defined for each set.

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4. Once the desired correction points are entered, press **Return**, **Correction (On)** to activate correction set **Other**. This will also turn corrections on resulting in a calibrated display. It is recommended that the correction set entered be saved on the internal memory or the floppy drive for future reference. See the ESA User's and Programmer's Reference guide for information on saving correction values.

Signal Identification

The IF output of a harmonic mixer will contain a signal at the intermediate frequency of the analyzer whenever the harmonic frequency of the LO and the frequency of the RF differ by the intermediate frequency.

As a result, within a single harmonic band, a single input signal can produce multiple responses on the analyzer display, only one of which is valid (see Figure 2-2 on page 29). These responses come in pairs, where members of the valid response pair are separated by 642.8 MHz and either the right-most (for negative harmonics) or left-most (for positive harmonics) member of the pair is the correct response.

Figure 2-2

Identification of valid responses is achieved by simply turning on the signal-identification feature. (instrument preset selects the Image Suppress signal identification mode.) Press **Input/Output**, **Input Mixer**, **Signal Ident (On)** and note that now only the valid response (35 GHz) remains.

Press **Peak Search** to place a marker on the remaining response. The signal-identification routine can introduce slight amplitude errors which is indicated by the message `Signal Ident On, Amptd Uncal.` Refer to Figure 2-3.

After identifying a signal of interest, press **Signal Ident (Off)** before making final amplitude measurements. Note that Image Suppress should only be used to identify the fundamental signal and not for accurate amplitude measurements.

Figure 2-3

Using the Mixers with the E4440A, E4446A, or E4448A PSA Series Spectrum Analyzer (Option AYZ)

The Agilent Technologies PSA Series spectrum analyzers contain an extensive menu of functions that help with millimeter measurements. Prior to starting this procedure, refer to "Spectrum Analyzer Retrofit Requirements" on page 11 for instrument requirements for the PSA Series spectrum analyzers.

The following examples explain how to connect external mixers to the spectrum analyzer, choose the band of interest, store and activate conversion-loss factors, and how to use the signal-identification functions.

Set up the equipment

1. Connect the signal source and harmonic mixer to the analyzer, as shown in Figure 2-4.

Figure 2-4   Harmonic Mixer Setup

| NOTE | Agilent 5061-5458 SMA type cables should be used to connect the mixer IF and LO ports to the analyzer. Do not over-tighten the cables. The maximum torque should not exceed 112 N-cm (10 in-lb.) |

2. On the analyzer, press **Preset**, **Factory Preset**, if present.

3. Select external mixing by pressing **Input/Output**, **Input Mixer**, **Input Mixer** (Ext).

4. The analyzer frequency band will be set to **26.5 - 40 GHz (A)**. To choose a different band, press **Ext Mix Band** , then press the desired band frequency range/letter key. For this example, we will use band A, which ranges from 36.5 GHz to 40 GHz.

Amplitude Calibration

The conversion loss versus frequency data can be entered on your analyzer from one of three sources.

- From a **Conversion Loss Data Disk**, supplied with your mixer. See "Using a Conversion-Loss Data Disk" on page 27.

- Data from the calibration sheet supplied with your mixer. The 11970A, Q, and V band mixers calibrated after May 2011 have two calibration sheets. Use the sheet that contains the text "Not for use with the Agilent X-Series Signal Analyzers'. An example of the calibration sheet is shown in Figure 2-20 on page 58.

- From conversion-loss data located on the mixer body label.

Using a Conversion-Loss Data Disk

The conversion-loss data for your mixer can be quickly loaded in the memory of an ESA or PSA series analyzer from a floppy disk. The following process works with the floppy disk provided by the factory with your new mixer, or with one that you have stored the correction data. This process eliminates the time consuming and sometimes error-prone process of manually entering the data from a table.

Loading Data

1. Insert the conversion-loss data disk (from the factory or your own) into the floppy drive of the analyzer.

2. Press **File**, then **Load**.

3. Press **Type**, **More**, then select **Corrections**.

4. Press **Directory Select**, highlight drive -A-, then press **Directory Select** again.

5. Use the down arrow to select the file. The factory supplied disk has a file with the OTH extension which places the data in the corrections set "other" location.

6. Press **Load Now** to load the conversion loss values into the correction table of the analyzer.

Viewing Data

1. Press **Amplitude**, **More**, **Corrections**, **Other** (ON) and **Edit** to view the correction values.

2. Use the front-panel knob or up/down arrows to scroll through the list of correction values.

Manually Entering Conversion-Loss Data

1. The analyzer frequency band will be set to **26.5 – 40 GHz (A)**. To choose a different band, press **Ext Mix Band** and then press the desired band frequency range/letter key. For this example, we will use band A, which ranges from 26.5 GHz to 40 GHz.

NOTE   To correct for the conversion-loss of the harmonic mixer in use, the analyzer amplitude correction feature is used.

---

2. Press **AMPLITUDE Y Scale**, **More**, **Corrections**. Select a correction set for use with external mixing. The recommended set to use is **Other** although any available set could be used.

3. Press **Edit** to enter the appropriate conversion loss data for the mixer in use. These values are listed on the mixer, or a calibration sheet that is supplied with the mixer.

NOTE	More correction points entered across the band in use will improve frequency response accuracy. Up to 200 points may be defined for each set.

4. Once the desired correction points are entered, press **Return**, **Correction (On)** to activate correction set **Other**. This will also turn corrections on resulting in a calibrated display. It is recommended that the correction set entered be saved on the internal memory or the floppy drive for future reference. See the PSA User's and Programmer's Reference guide for information on saving correction values.

Signal Identification

The IF output of a harmonic mixer will contain a signal at the intermediate frequency of the analyzer whenever the harmonic frequency of the LO and the frequency of the RF differ by the intermediate frequency.

As a result, within a single harmonic band, a single input signal can produce multiple responses on the analyzer display, only one of which is valid (see Figure 2-5). These responses come in pairs, where members of the valid response pair are separated by 642.8 MHz and either the right-most (for negative harmonics) or left-most (for positive harmonics) member of the pair is the correct response.

Figure 2-5
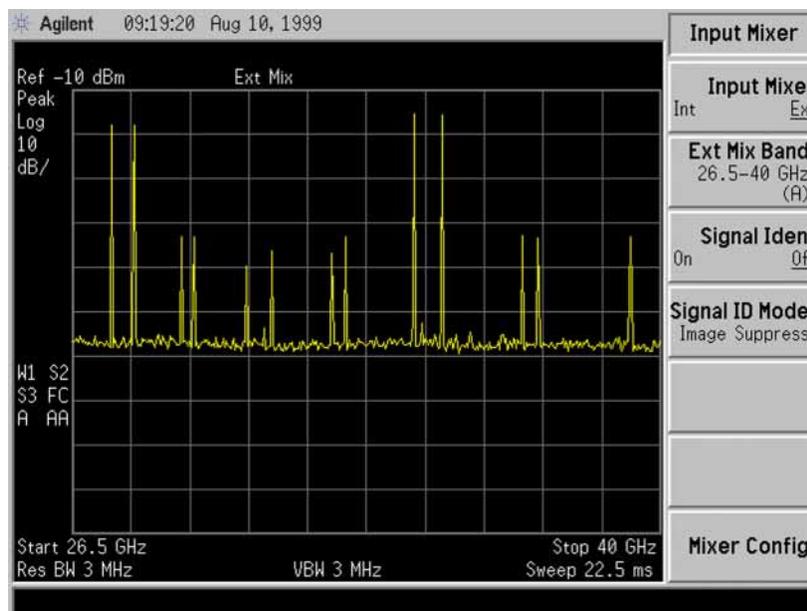
Identification of valid responses is achieved by simply turning on the signal-identification feature. (instrument preset selects the Image Suppress signal identification mode.) Press **Input/Output**, **Input Mixer**, **Signal Ident (On)** and note that now only the valid response (35 GHz) remains.

Press **Peak Search** to place a marker on the remaining response. Refer to Figure 2-6 on page 33.

After identifying a signal of interest, press **Signal Ident (Off)** before making final amplitude measurements. Note that Image Suppress should only be used to identify the fundamental signal and not for accurate amplitude measurements.

Figure 2-6
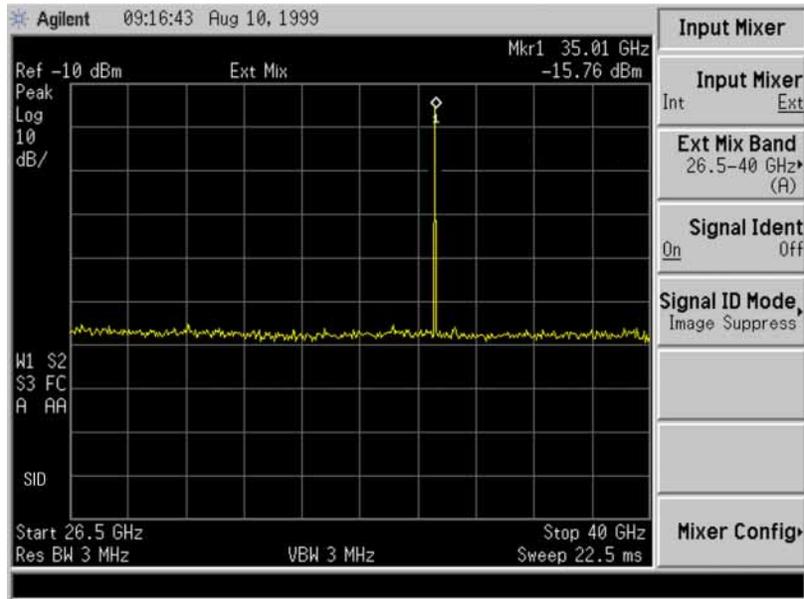
Using the 11970A, Q, U, V, and W Mixers with the X- Series Signal Analyzers (Option EXM)

Refer to "Spectrum Analyzer Retrofit Requirements" on page 11 for configuration requirements.

The following examples explain how to, connect the external mixers to the signal analyzer using a diplexer, choose the band of interest, activate conversion loss correction data, and how to use the signal-identification functions.

Set up the equipment

1. Connect the signal source, diplexer, and harmonic mixer to the signal analyzer as shown in Figure 2-7.

NOTE	The maximum torque for the SMA cables and adapters should not exceed 122 N-cm (10 in-lb.)

Figure 2-7   **External Mixer Setup**
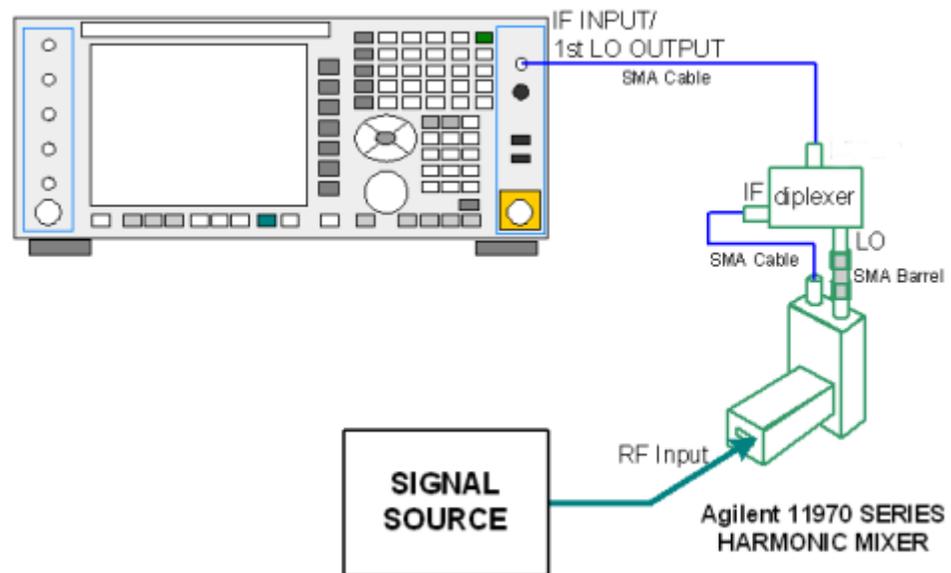
2. On the analyzer press **Mode**, **Spectrum Analyzer**.

3. Select external mixing by pressing **Input/Output**, **External Mixer**, **External Mixer**, **External Mixer Setup**.

4. The default is 11970A. To select Q, U, V or W bands, press **Mixer Presets**, **Agilent 11970**, then select the appropriate key corresponding to 11970 frequency band.

5. Press **Return** twice to view the spectrum display.

6. Tune the analyzer to the input signal frequency by pressing **FREQ Channel**, and enter a center

frequency or a start and stop frequency.

7. Many responses may appear on screen. Turn on the Signal ID function to identify true signals from images and harmonics.

    Press **Input Output**, **External Mixer**, **Signal ID Mode**, **Image Suppress**, **Signal ID On**.

    See "Signal ID" on page 38 for more information.

Amplitude Calibration

1. See Loading Conversion Loss Data for the PXA Signal Analyzer below. This will guide you through entering the conversion loss data provided with the mixer, into a corrections file that can be activated to provide amplitude corrected measurements.

2. To access corrections, press **Input/ Output**, **More**, **Corrections**, **Select Correction**.

3. Chose a correction from the list. Note that you used one of the Corrections numbered 1-6 when you entered the conversion loss data into the instrument.

4. Press **Correction On** to apply the corrections to the measurement.

NOTE	Assure only ONE correction file is turned on because it is possible to turn on multiple correction files, and if some of the files share the same frequency points, the correction that results for those shared frequency points will cause measurement errors. Therefore assure that only the correction file required for the measurement is turned on, and turn off all other corrections.

Loading Conversion Loss Data for the PXA Signal Analyzer

The conversion loss data supplied with your mixer can be loaded into your signal analyzer from one of two sources:

*   By downloading the 70xxxxxx_X.csv file located on the CD ROM disk that is provided with your mixer. The 70xxxxxx_X.csv file is transferred from the CD to a USB memory device, and then the USB memory device inserted into the PXA, and the file transferred to one of the analyzer corrections array locations. The USB memory device should be scanned for viruses before use.

*   The mixer ships with a printed copy of the conversion loss data. Find the printed copy conversion loss data that has the text "For Use with Agilent X-Series analyzers only". The conversion loss data will need to be manually entered as frequency and amplitude pairs into the analyzer corrections file. An example of calibration data is shown Figure 2-19 on page 57.

    The CD also contains 70xxxxxx_X.pdf files of the conversion loss data that can be printed, and then manually entered into a Correction array location. You will need to enter the frequency and amplitude pairs into the analyzer corrections file. An example of calibration data is shown Figure 2-19 on page 57.

Down loading the conversion loss .csv files to the analyzer corrections array

1. Install the CD ROM provided with the mixer, into a PC and view the contents of the CD.

2. Locate the 70xxxxxx_X.csv file.

NOTE	For the 11970A, 11970Q and 11970V, this is the conversion loss file used for almost all applications. However, for the mixer model numbers listed above, there are two other 70xxxxxx_.csv files on the CD that may be used in special cases.
	As an example, on the 11970Q mixers, the additional two files are 70Qxxxxxx_8.csv and 70Qxxxxxx_10.csv. The 70Qxxxxxx_8.csv file contains conversion loss data for the 8th harmonic only, and this data allows the 8th harmonic to be used to a slightly higher tuned frequency than the normal 40 GHz transition from the 8th to the 10 harmonic. However, only a portion of Q band can be covered by the 8th harmonic. See the 70Qxxxxxx_8.csv file for the exact frequency coverage.
	The 70Qxxxxxx_10.csv file contains conversion loss data for the 10th harmonic only, and this data allows the 10th harmonic to be used to a lower tuned frequency than the normal 40 GHz transition from the 8th to the 10 harmonic. The conversion loss will be worse below 40 GHz compared to using the normal 70Qxxxxx_X.csv file.
	The reason you may want to use one of these special files is when making measurements that span the normal 40 GHz, 8th to 10 harmonic mixing transition. The two files provide conversion loss data that allow calibrated measurements when you need to measure slightly above or below the normal transition frequency, and want the measurement to be made using a single harmonic.

---

3. Copy the .csv file to a USB memory device.

4. Insert the USB memory stick into one of the USB ports on the signal analyzer.

5. It is recommended that you connect a mouse and keyboard to the signal analyzer.

6. Press **Input/ Output**, **More**, **Corrections**, **Select Correction**.

7. Choose a correction array from the list of Correction 1 through Correction 6. Correction 1 has a provision to store antenna corrections, so if antenna corrections are required, reserve this array for that use. If you want to see if anything is already stored in a particular correction, press **Correction, Edit**. To delete a correction table, press **Return**, assure the **Select Correction** key corresponds to the correction you want to delete, and press **Delete Correction**.

8. Once the correction array number is selected, press **Recall**, **Data (import)**, **Amplitude Correction** and chose one of the correction array numbers.

9. Press **Open**, use the pull down arrow in the "look in" box to navigate to the USB memory stick, and locate the 70xxxxxx_X.csv file.

10. Select the 70xxxxxx_X.csv file and click **Open**. The conversion loss data will now load into the specified corrections array. To view the contents of the corrections array in the conversion loss table, press **Input/ Output**, **More**, **Corrections**, select the corrections array number, and press **Edit**. Press **Return** to go back to the measurement screen.

Loading the .csv file automatically populates the Description and Comment fields found under the Corrections, Properties key. To edit these fields, press **Input/ Output**, **More**, **Corrections**, **Select Correction**, select the correction number, press **Properties**, **Description** or **Comment**.

Compensating for IF cable and diplexer loss

The external diplexer has 1dB of loss at 300 MHz. The cable that connects the diplexer to the signal analyzer has loss depending on cable length.

1. Press **Input/Output, External Mixer, Cable IF Loss** and enter the cable loss plus the 1dB diplexer loss.

Manually entering conversion loss data

1. Locate the printed copy of the conversion loss data that has the text "For use with Agilent X-Series analyzers only".
   Or
   Insert the CD provided with the mixer into a PC and navigate to the 70xxxxxx_X.pdf file. The file contains tabular and graphic conversion loss data. Be careful to select the correct file since there are three files provided for the 11970A, Q and V band mixers. Print the 70xxxxxx_X.pdf file to create a printed copy.

NOTE   For the 11970A, 11970Q and 11970V, this is the conversion loss file that is used for almost all applications. however, for the mixer model numbers listed above, there are two other 70xxxxxx_X.csv files on the CD that can be read and printed using Windows notepad. See the notes under "Loading Conversion Loss Data for the PXA Signal Analyzer" on page 35.

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2. Press **Input/ Output**, **More**, **Corrections**, **Select Correction**.

3. Choose a correction array from the list of Correction 1 through Correction 6. Correction 1 has a provision to store antenna corrections, so if antenna corrections are required, reserve this array for that use. If you want to see if anything is already stored in a particular correction, press **Correction, Edit**. To delete a correction table, press **Return**, assure the **Select Correction** key corresponds to the correction you want to delete, and press **Delete Correction**.

4. After selecting the correction number, press **Edit**. Use the keys provided to enter the frequency and amplitude (conversion loss) points from the calibration data table. Conversion loss values are entered as positive numbers.When finished, press **Return**.

5. It is possible to add a description and a comment of what the selected correction is, and have this description appear on the Description or Comment key. Press **Properties**, and connect a keyboard to the instrument. For example, press **Comment** and type 11970V Serial XXxxxxxxxx. Press **Done**.

Signal ID

Image Suppress

The Image Suppress mode of Signal ID mathematically removes all image and multiple responses of signals present at the mixer input. Two hidden sweeps are taken in succession. The second sweep is offset in LO frequency by 2*IF/N. For each point in each trace, the smaller amplitude from the two traces is taken and placed in that point in Trace 1. Responses of each trace that lie on top of one another will remain and are valid signals, others are images and are suppressed.

NOTE   This function takes control of and uses Trace 1. Any data in this trace prior to activating Image Suppress will be lost.

In Image Suppress Mode, synchronization is ensured by first turning off Signal ID, initiating a single sweep, then turning on Signal ID followed by two single sweeps.

Image Shift

Like the Image Suppress mode, Image Shift is a two sweep sequence. The data from the first sweep is placed in Trace 1 and the data from the second (LO frequency shifted by 2*IF/N) sweep is placed in Trace 2. Signal responses of Trace 1 and Trace 2 that have the same horizontal position are considered to be in the current band and therefore can be analyzed with the amplitude and frequency measurement systems of the SA. All other responses are invalid and should be ignored.

NOTE   This function takes control of and uses Trace 1 and Trace 2. Any data in these traces prior to activating Image Shift will be lost.

To synchronize in Image Shift Mode, turn off Signal ID and then initiate a single sweep. Then turn on Signal ID and initiate two single sweeps. The results of the first sweep after Signal ID is turned on are available in Trace 1. The next sweep is shifted and the data from that sweep is available in Trace 2. The unshifted and shifted data can then be compared.

Using the Mixers with the 856X Series Spectrum Analyzers

External millimeter mixers can be used to extend the frequency coverage of the 8560 E-Series and EC-Series spectrum analyzers. (The 8560E/EC Option 002 and Option 327 do not have external mixing capability.)

The 8560 E-Series and EC-Series spectrum analyzers contain an extensive menu of functions that help with millimeter measurements. This example explains how to connect external mixers to the spectrum analyzer, choose the band of interest, store conversion-loss factors, and how to use the optional automatic signal-identification functions.

Set up the equipment

1. Figure 2-8 illustrates how to connect an external harmonic mixer to the spectrum analyzer.

Figure 2-8   External Mixer Setup
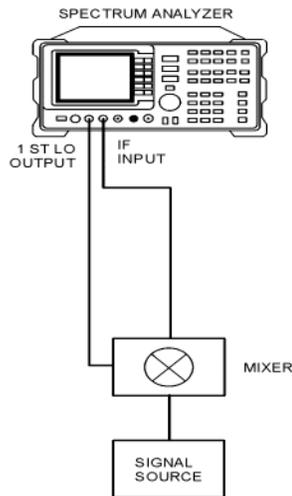
NOTE	Good-quality shielded SMA-type cables should be used to connect the mixer to the spectrum analyzer to ensure that no signal attenuation occurs. Agilent 5061-5458 SMA-type cables may be used. Do not over-tighten the cables; the maximum torque should not exceed 112 N-cm (10 in-lb.).

Select the Frequency Band

2. Specify unpreselected external mixing by pressing **CONFIG**, then **EXT MXR PRE UNPR** until UNPR is selected.

3. To select a frequency above 18 GHz:

    a. Press **AUX CTRL, EXTERNAL MIXER** to set the analyzer to external mixer mode.

    b. Enter the desired frequency directly using the center-frequency function.

    c. Notice in Table 2-1 that some frequencies overlap and fall into two bands. To be sure that the desired band is selected, refer to Table 2-1 and select the desired frequency band, then use the full band function to enter this band.

    d. In the external mixer menu, press **FULL BAND**, then press the step up ⇑ key until the letter preceding BAND in the active function area corresponds to the desired frequency band.

Table 2-1   **External Mixer Frequency Ranges**

Frequency Band	Frequency Range (GHz)	Mixing Harmonic	Conversion Loss
K	18.0 to 26.5	6–	30 dB
A	26.5 to 40.0	8–	30 dB
Q	33.0 to 50.0	10–	30 dB
U	40.0 to 60.0	10–	30 dB
V	50.0 to 75.0	14–	30 dB
E	60.0 to 90.0	16–	30 dB
W	75.0 to 110.0	18–	30 dB
F	90.0 to 140.0	24–	30 dB
D	110.0 to 170.0	30–	30 dB
G	140.0 to 220.0	36–	30 dB
Y	170.0 to 260.0	44–	30 dB
J	220.0 to 325.0	54–	30 dB

In this example, we'll look at U-band, which ranges from 40 GHz to 60 GHz, as shown in Figure 2-9. The **LOCK HARMONIC** function "locks" the spectrum analyzer in that band, ensuring that the spectrum analyzer sweeps only the chosen band. **LOCK ON OFF** is automatically set to ON when **FULL BAND** is pressed.

Figure 2-9   **Select the band of interest.**

CL 23.5dB
RL -6.5dBm   10dB/

U BAND

START 40.00GHz   STOP 60.00GHz
RBW 1.0MHz   VBW 1.0MHz   SWP 130ms
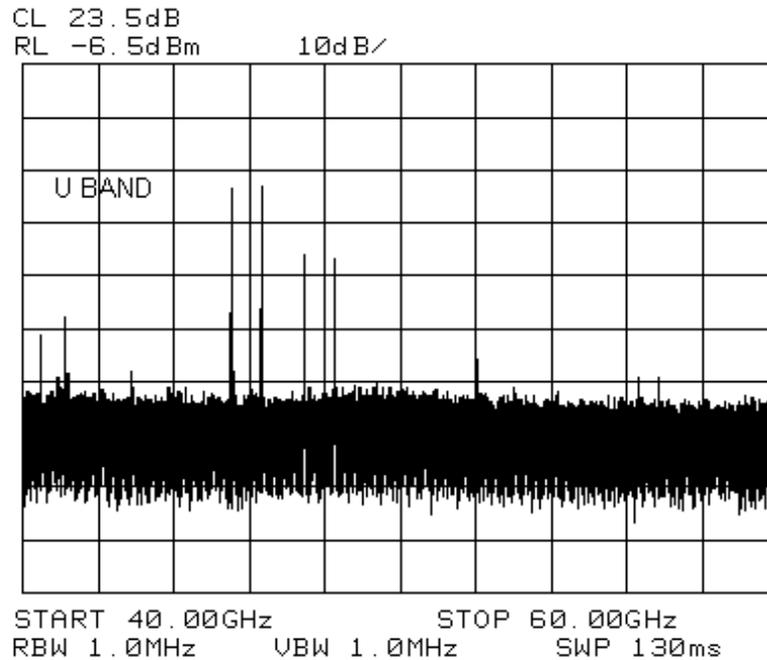
Save the average conversion-loss value

4. Default conversion-loss values that are stored in the analyzer for each frequency band are listed in Table 2-1 on page 40. These values approximate the values for the Agilent 11970 series mixers. Other conversion-loss values may be entered into the spectrum analyzer in two ways. The first method lets you to save the average conversion-loss value for the entire band using **AVERAGE CNV LOSS**. To activate this function:

    a. Press **AUX CTRL**, **EXTERNAL MIXER**, **AMPTD CORRECT**, **AVERAGE CNV LOSS**.

    b. Enter the appropriate average conversion-loss value. On Agilent 11970 Series harmonic mixers, these values are listed on the mixer, or a calibration sheet that is supplied with the mixer. The 11970A, Q, and V band mixers calibrated after May 2011 have two calibration sheets. Use the sheet that contains the text "Not for use with the Agilent X-Series signal analyzers". The U-band mixer used for this example had an average conversion loss of 23.5 dB, as shown in Figure 2-10 on page 42.

Figure 2-10   **Store and correct for conversion loss.**
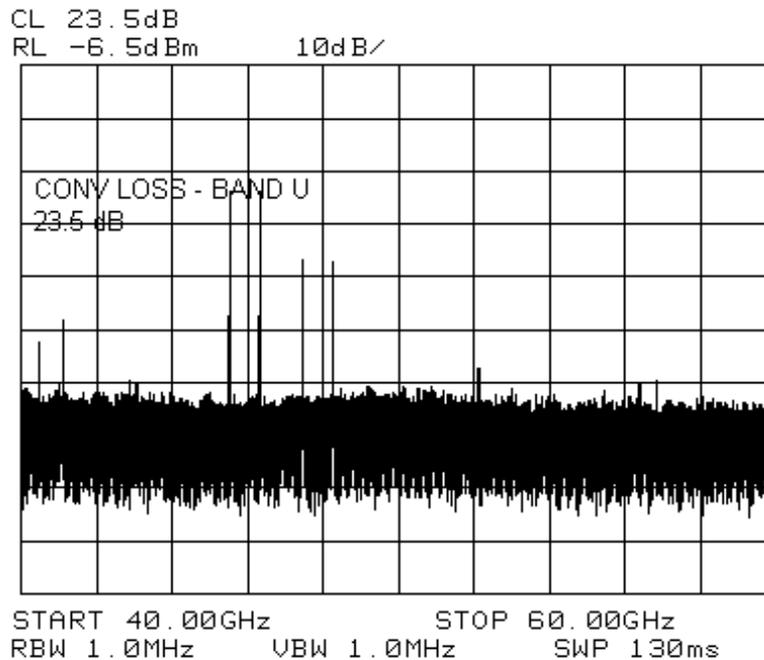
The second method for storing conversion-loss information lets you save individual conversion-loss data points at specific intervals across the harmonic band, using **CNV LOSS VS FREQ**.

To view or enter a conversion-loss data point:

a. Press **CNV LOSS VS FREQ**.

b. Enter the conversion-loss data at the frequency shown.

c. Use the step up ⇑ key to step through the band, entering the conversion loss at each step.

Signal Identification

5. The IF output of a harmonic mixer contains many mixer products (frequencies of LO ± source, 2LO ± source, 3LO ± source…nLO ± source). As a result, within a single harmonic band, a single input signal can produce many responses, only one of which is valid.

These responses come in pairs, where the members of the valid pair are spaced 621.4 MHz apart (see Figure 2-11) and the right-most member for the pair is the correct response (for this analyzer, the left member of a pair is not valid).

Figure 2-11   **Signal Responses Produced by a 50 GHz Signal in U Band**
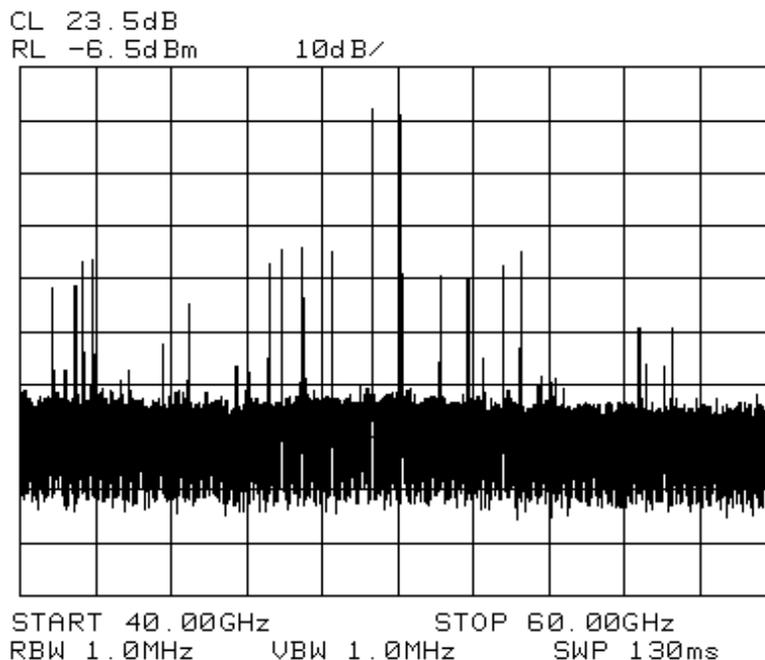
Identify signals with the frequency-shift method

6. Signal-identification routines that identify the signal and images are available on instruments with firmware revisions ≤920528, or with Option 008. The frequency-shift method of identifying valid signals uses the spectrum-analyzer function **SIG ID ON OFF**. When using this function, smaller spans will yield more accurate measurements.

   a. Span down to 50 MHz.

   b. Press **AUX CTRL**, **EXTERNAL MIXER**, **SIGNAL IDENT**.

   c. Press **SIG ID ON OFF** until **ON** is selected.

   Any signal not produced by the currently selected harmonic will be shifted horizontally on alternate sweeps (see Figure 2-12). Therefore, when viewing the display, on alternate sweeps the signal will appear, then not appear, at the frequency of interest. The correct signal produced by the selected harmonic will be shifted in a vertical direction only, as shown in Figure 2-13 on page 44.

Figure 2-12   **Response for Invalid Signals**
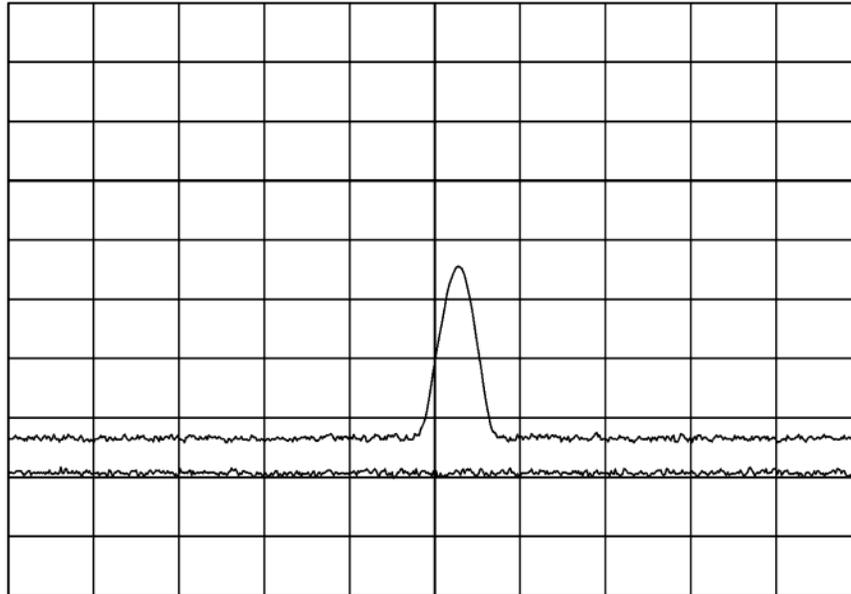
Figure 2-13   **Response for Valid Signals**

Identify signals in wide frequency spans

7. **SIG ID AT MKR** identifies signals in wide frequency spans, using harmonic search. **SIG ID AT MKR** automatically determines the proper frequency of a signal and displays its value on the spectrum analyzer.

   • Activating **SIG ID AT MKR** on an image of the signal will yield a reading in the active block, as shown in Figure 2-14. The true signal frequency is given with an identifier that the marker resides on an image. If the marker is placed on a true signal, and **SIG ID AT MKR** is activated, the signal frequency will appear without the IMAGE notation, as shown in Figure 2-15 on page 46.

8. To activate **SIG ID AT MKR**:

   a. Place a marker on a signal.

   b. Press **AUX CTRL**, **EXTERNAL MIXER**, **SIGNAL IDENT**, **SIG ID AT MKR**.

9. To exit the external mixer mode, press **AUX CTRL**, then **INTERNAL MIXER**.

Figure 2-14   **SIG ID AT MKR Performed on an Image Signal**

Figure 2-15   **SIG ID AT MKR Performed on a True Signal**


```
L  23.5dB                    MKR  -17.67dBm
RL  -6.5dBm        10dB/      50.083GHz
```

SIGNAL FREQUENCY
39.999997 GHz
N = 3

```
CENTER  50.000GHz              SPAN  5.000GHz
RBW  1.0MHz      VBW  1.0MHz      SWP  50.0ms
```

Using the Mixers with MMS Analyzers

Preliminary Operation

| NOTE	This section provides information for the Agilent 70907A (or B), however the operation of the Agilent 70909A and Agilent 70910A is similar. Minor differences may be noted, but the necessary deviations from these exact instructions will be obvious.

Equipment Connection

Connect the equipment as shown in Use the following checklist to verify the connections:

• Agilent 11970 LO IN to Agilent 70907B LO OUTPUT (SMA cable, 5061-5458)

• Agilent 11970 IF OUT to Agilent 70907B IF INPUT (SMA cable, 5061-5458)

Figure 2-16   **Agilent 11970 Connections to the Agilent 71000 Series Spectrum Analyzer**
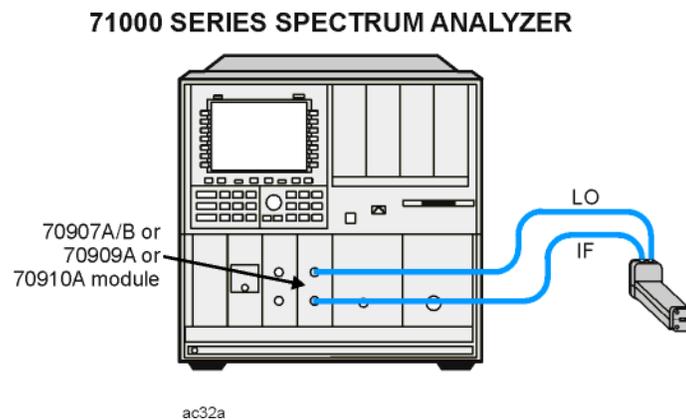
Operation

Band Selection

Use the following key sequence to enter the external mixing mode and to select the desired band of operation:

> **MENU**
>
> **Select Input** - choose external mixer input, for example: "IN 2 EM 70910A"
>
> **State**
>
> **ext mixer**
>
> **fulband KAQUVE**

Press the softkey for the desired band.

NOTE	The above band selection key sequence **must** be used to enter the external mixing band of operation. Do not enter in the center frequency of the band directly.

Amplitude Calibration for a Single Frequency

Enter the conversion loss at the desired frequency from either the data listedon the mixer label, or a calibration sheet supplied with the mixer. The 11970A, Q, and V band mixers calibrated after May 2011 have two calibration sheets. Use the sheet that contains the text "Not for use with the Agilent X-Series signal analyzers". Use the following key sequence to enter the conversion loss values:

> **State**
>
> **ext mixer**
>
> **CONV LOSS**

Enter the conversion loss value of the desired frequency, then terminate the entry with **dB**.

NOTE	The above procedure is a single-point conversion-loss correction. For an alternative procedure, available by remote programming only, refer to "Conversion Loss Versus Frequency Correction" on page 52.

General Descriptions of Agilent 71000 Series Spectrum Analyzer External-Mixing Functions

ext mixer   Allows access to the following softkey functions that control the measurement range when an external mixer extends the spectrum analyzer frequency range. The **ext mixer** softkey can be found under the **State** key.

> **fulband KAQUVE**
> **fulband WFDGYJ**
> **CONV LOSS**
> **SIGNAL IDENT**

fulband KAQUVE
and
fulband WFDGYJ Specify the frequency range for measurements made with external mixers. Twelve frequency bands are available. Table 2-2 lists the start and stop frequencies of each band and also shows which local-oscillator harmonic (N) is used for the mixing process. Once a band is selected, the frequency range is locked and the spectrum analyzer tunes with the local-oscillator harmonic for that band only.

Table 2-2   **External Mixing Bands and Associated Mixing Harmonics**

Band	Harmonic Number (N)	Frequency Range (GHz)
K	6–	18.0 to 26.5
A	8+	26.5 to 40.0
Q	10+	33.0 to 50.0
U	10+	40.0 to 60.0
V	14+	50.0 to 75.0
E	16+	60.0 to 90.0
W	18+	75.0 to 110.0
F	24+	90.0 to 140.0
D	30+	110.0 to 170.0
G	36+	140.0 to 220.0
Y	42+	170.0 to 260.0
J	50+	220.0 to 330.0

CONV LOSS

(conversion loss) Offsets the reference level to compensate for amplitude losses at the active input port. If necessary, use **select input** to activate the desired input port before specifying its conversion-loss offset.

To clear the offset, enter a conversion loss of zero.

After the instrument preset, a default value of 30 dB is activated automatically for the input port of the external-mixer-interface module.

Preset Input Sets which active input port will be selected when the **INSTR PRESET** is pressed. The preset input softkey can be accessed by pressing **State**, then **MORE**.

INSTR PRESET Resets to the preset input and to the lowest full frequency range available. (For an external mixer, this is band A.) This is a front panel key.

SIGNAL IDENT

(signal identify) Press **Frequency**, **More**, **sig id options**.

Executes a routine to identify real, in-band signals using either the image (default) or shift methods.

Several options are available under **sig id options**:

- **SIG ID ⇒ CF** Places the marker on the identified real signal and centers the signal on the display.

- **SIG ID MAN OFF** Selects manual or automatic (default) mode.

- **IMAGE/SHIFT** Selects the routine to use for identification.

- **SIG ID AMPTD Δ** Specifies the amplitude difference between the marked signal and signals tested as images or harmonics (default is 10 dB; applies only to IMAGE mode.)

- **IMAGE N START** Determines the frequency range for possible image or harmonic responses by selecting the lowest and highest local oscillator harmonic used for mixing, according to the tuning equation below:

$$F_s = N \times F_{LO} \pm IF$$

Default is 1.

- **IMAGE N STOP** See "**IMAGE N START**" definition above.

Default is 40.

NOTE	See the table below for available frequency ranges and related harmonic numbers. Use the **IMAGE N START** and **IMAGE N STOP** softkeys for the image identification only.

Table 2-3   Frequency Ranges and Corresponding Harmonic Numbers

	Band/Range	**Harmonic Number and Sign of IF (N)**
Internal Mixing - Agilent 71210C	2.9 - 6.2 6.0 - 12.7 12.5 - 19.9 19.7 - 22.0/26.5	−1 −2 +3 +4
Internal Mixing - Agilent 71200C	2.9 - 6.2 6.0 - 12.8 12.6 - 22.0	−1 −2 −4

External Mixing - Agilent 70907A
                            70907B
                            70910A
                            70909A
	K 18.0 - 26.5
	A 26.5 - 40.0
	Q 33.0 - 50.0
	U 40.0 - 60.0
	V 50.0 - 75.0
	E 60.0 - 90.0
	W 75.0 - 110.0
	F 90.0 - 140.0
	D 110.0 - 170.0
	G 140.0 - 220.0
	Y 170.0 - 260.0
	J 220.0 - 330.0
		+6
		+8
		+10
		+10
		+14
		+16
		+18
		+24
		+30
		+36
		+42
		+50

Conversion Loss Versus Frequency Correction

The Agilent 71000 Series Spectrum Analyzers with the Agilent 70907A (or B) External Mixer Interface Module installed has the amplitude-correction function (AMPCOR) available by remote programming.

Use AMPCOR to compensate for the Agilent 11970 Series frequency-dependent conversion-loss variations. Up to 200 pairs of frequency-amplitude correction points can be entered, depending on the amount of available internal memory. The frequency values entered must be in increasing order, or an error condition results. Whenever AMPCOR is on, the correction values are added to all measurement results.

The values of the correction points are applied across the active measurement range. Between points, the correction value are interpolated. When the measuring at frequencies outside of the first and last correction pairs from memory.

When AMPCOR is executed, the frequency pairs are stored in internal memory. The remote commands `DISPOSE ALL`, `FORMAT`, `ERASE`, and `DISPOSE AMP COR` erase the amplitude-correction pairs from memory.

NOTE `DISPOSE ALL`, `FORMAT`, and `ERASE` erases much more than the amplitude-correction pairs from memory. Do not use these commands without referring to the programmer's manual for the Agilent 70000 and Agilent 70900B to determine their effect on instrument programming.

Because AMPCOR adjusts IF gain and attenuation, AMPCOR should be used with care when measuring signals near the compression level (also at a frequency that is corrected by the AMPCOR command).

To use AMPCOR for the Agilent 11970 conversion loss correction, first set the single-point conversion loss function to zero with the following command:

    OUTPUT 718; "CNVLOSS 0DB;"

Then build the AMPCOR table with frequency conversion loss pairs. The following example program line shows three pairs of frequency conversion loss values for a typical Agilent 11970V.

    OUTPUT 718; "AMPCOR 50GHZ, 49.6DB, 51GHZ, 49.1DB, 52GHZ,48.6DB;"

The conversion loss corrections are activated by the AMPCOR ON command; use AMPCOR OFF to deactivate the function (be sure to manually enter a single-point conversion-loss value if AMPCOR has been used).

To print out an existing AMPCOR table, use the program listed below:

```
10 dim A$ (1:20) [30]
20 OUTPUT 718; "CONVLOSS 0DB;"
30 OUTPUT 718; "AMPCOR 50 GHZ, 46.1DB, 52GHZ, 46.7DB, 53GHZ,47.2DB;"
40 !
50 OUTPUT 718; "AMPCOR?;"
60 ENTER 718 USING "%,k";A$ (*)
70 !
80 FOR I=1 TO 10
90 PRINT "Point ";I,A$ (I)
100 NEXT I
110 END
```

Line 30:   Generates an AMPCOR table.

Line 60:   % specifies that an EOI terminates the entire statement. "K" specifies that an
                     L_F terminates the individual string entry.

Returned values are in the format where the frequency in Hz is listed first, followed by the conversion loss in dB. See the following example:

```
Point  1  50.00000000E+9,46.1
Point  2  52.00000000E+9,46.7
Point  3  53.00000000E+9,47.2
Point  4
Point  5
Point  6
Point  7
Point  8
Point  9
Point  10
Point  11
```

NOTE   For further information, consult the Agilent 70900B Local-Oscillator-Controlled Modules Programming Manual, part number 70900-90284.

Using the Mixers with the 8566B Spectrum Analyzer

Set up the equipment

1. Connect the external harmonic mixer to the spectrum analyzer, as shown in Figure 2-17.

NOTE	Good-quality shielded SMA-type cables should be used to connect the mixer to the spectrum analyzer to ensure that no signal attenuation occurs. Agilent 5061-5458 SMA-type cables may be used. Do not over-tighten the cables; the maximum torque should not exceed 112 N-cm (10 in-lb.).

Figure 2-17   **External Mixer Connection**

dd31a
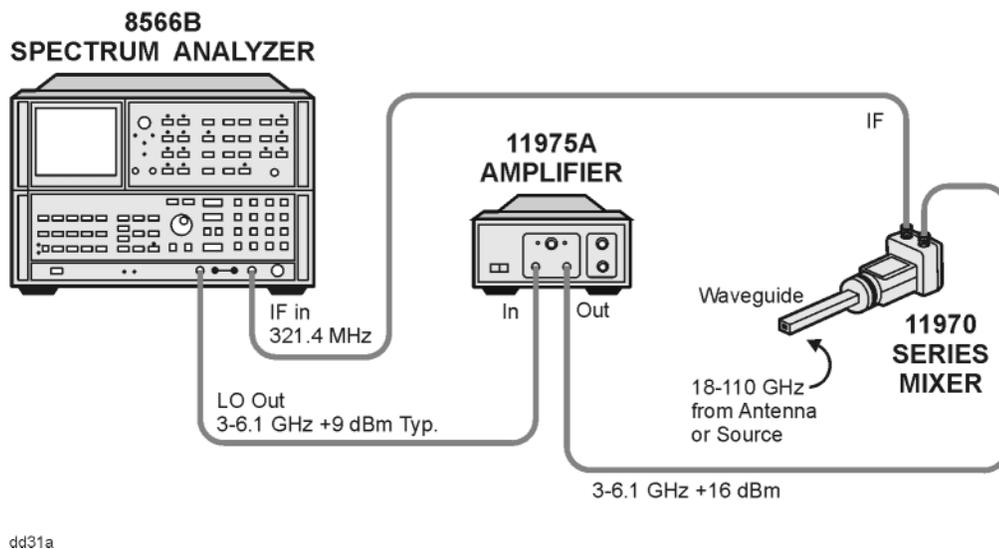
CAUTION	Before connecting the Agilent 11975A Amplifier, set the ALC switch to ON. Failure to do so can damage the mixer.

2. Power up the spectrum analyzer and then the amplifier.

3. Adjust the amplifier power to 16 dBm.

4. To access the spectrum analyzer's millimeter bands, press **SHIFT** and then the up arrow ⇑ until the desired band is displayed on the screen, as shown in Figure 2-18 on page 55. Note that this is important because toggling through the bands, causes the band to automatically harmonic lock as evidenced by the on-screen annotation of "Harmonic 6" changing to "Harmonic 6L", where "L"

stands for locked, or you could press **Shift+z** to manually harmonic lock.

Figure 2-18   **TYPICAL MILLIMETER SIGNAL DISPLAY**
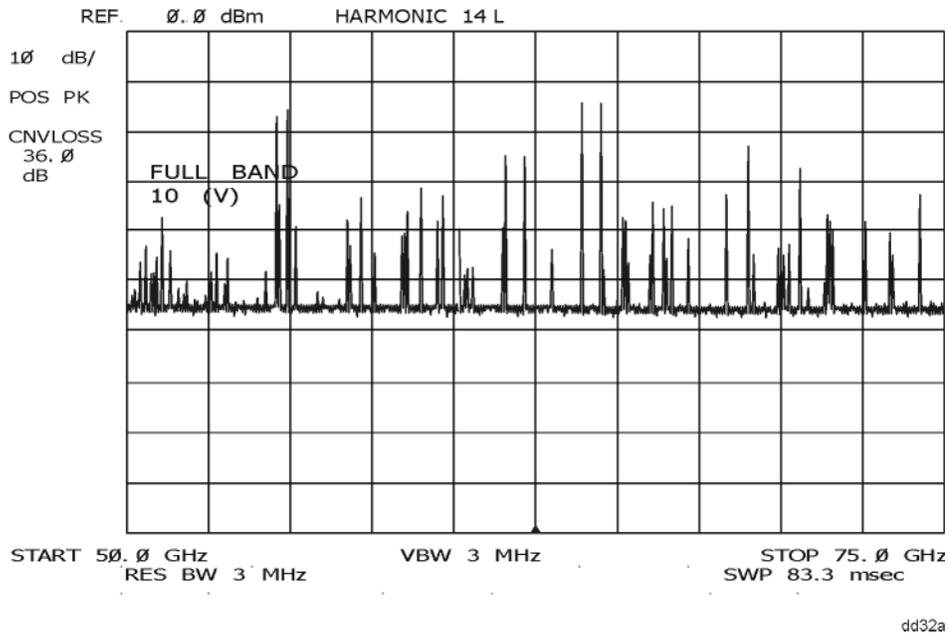
A menu of millimeter measurement functions is accessed by pressing **SHIFT**, **1**, **MHz**. Even though the spectrum analyzer is in an external mixer band, the 8566B spectrum analyzer retains full operation capability (except for use of the RF input attenuator and preselector).

Amplitude Calibration

Procedure

Each 11970 series harmonic mixer is characterized at the factory and comes with a calibration chart (See Figure 2-20 on page 58). The horizontal axis of the chart gives the frequency range of the mixer and the two vertical axis scales are calibrated in conversion loss and in reference level offset.

To correct the amplitude calibration of the spectrum analyzer to account for the conversion loss of the harmonic mixer, press **SHIFT**, **1**, **MHz**, which accesses the millimeter menu. Then press **SHIFT**, **5**, **MHz** to access conversion loss entry and key in the appropriate value on the spectrum analyzer as shown on the mixer calibration chart.

For measurements that span the entire band, choose an average value of conversion loss from the conversion loss chart. For those spectrum analyzers with date codes earlier than 13.8.86, the conversion loss is changed using the reference level function. Press **SHIFT**, then **REFERENCE LEVEL**, then key in the reference level offset shown on the right side of the mixer calibration chart.

Signal Identification

Figure 2-18 on page 55 shows a typical full-band display of a single input signal. Direct interpretation of the display is difficult because of the large number of responses produced by several local oscillator harmonics generated in the mixer. To solve this problem the 8566B spectrum analyzer uses two methods of signal identification.
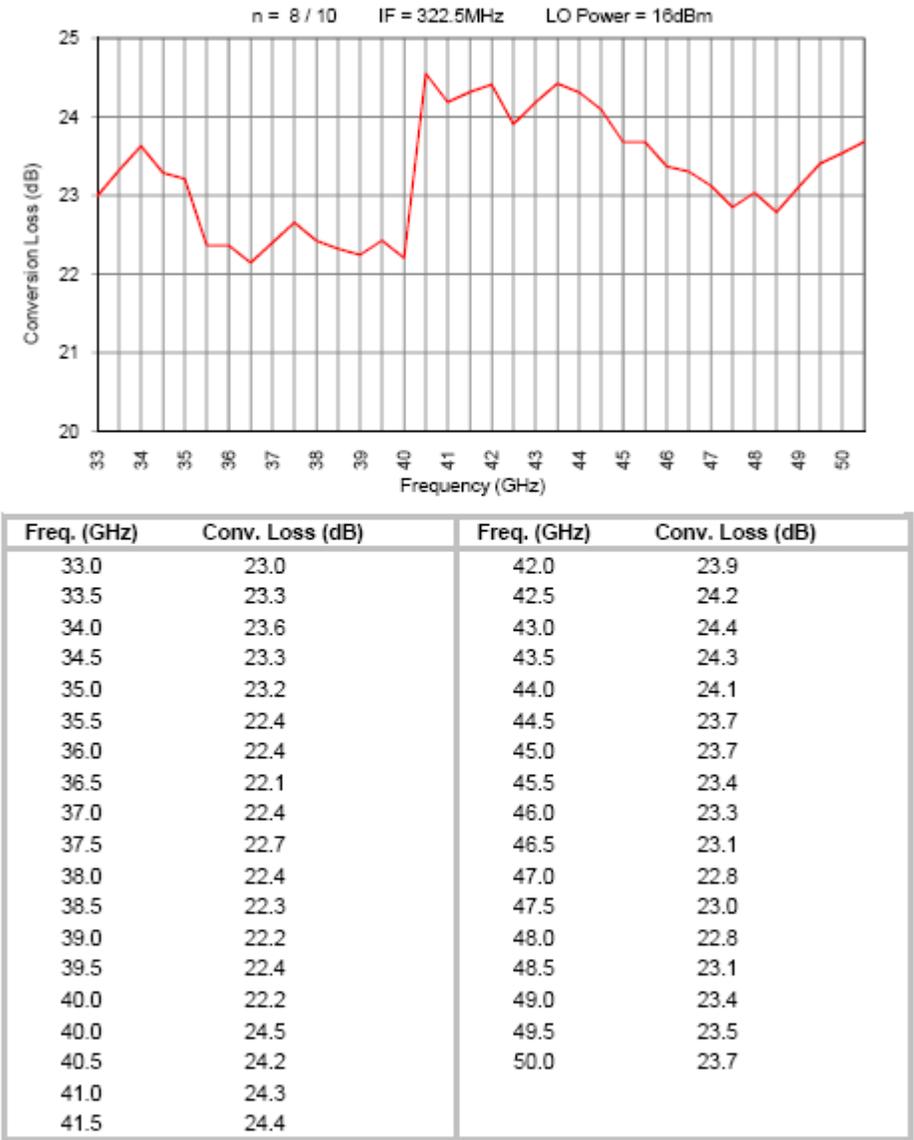
The first is an automatic image search in which the spectrum analyzer looks for a signal image within a preset range of harmonic numbers. This automatic signal identification routine is initiated by pressing **SHIFT**, **3**, **MHz**. Upon completion, one of three messages appears on the CRT: SIGNAL NOT IDENTIFIED, SIGNAL IDENTIFIED OUT OF BAND (with the frequency), or CENTER (with the identified signal frequency). The range of harmonic numbers through which the spectrum analyzer searches can be changed by accessing "search start HN" and "search stop HN," which are **SHIFT**, **7**, **MHz** and **SHIFT**, **8**, **MHz**, respectively.

The second method, manual signal identification, is a fast method of verifying that the displayed signal is a true signal in the specified band. Press **SHIFT**, **4**, **MHz** to activate this function. Positive signal identification is indicated if the signal in question does not change frequency and is reduced in amplitude by one to two divisions on alternate sweeps. A failed signal identification is indicated by the signal disappearing or shifting in frequency.

Figure 2-19

MODEL: 11970Q SER: MY30033018 DATE: 15 Mar 2011

For use with Agilent X-Series signal analyzers only. See other documents/files for other spectrum analyzers.

n = 8 / 10   IF = 322.5MHz   LO Power = 16dBm

Freq. (GHz)	Conv. Loss (dB)	Freq. (GHz)	Conv. Loss (dB)
33.0	23.0	42.0	23.9
33.5	23.3	42.5	24.2
34.0	23.6	43.0	24.4
34.5	23.3	43.5	24.3
35.0	23.2	44.0	24.1
35.5	22.4	44.5	23.7
36.0	22.4	45.0	23.7
36.5	22.1	45.5	23.4
37.0	22.4	46.0	23.3
37.5	22.7	46.5	23.1
38.0	22.4	47.0	22.8
38.5	22.3	47.5	23.0
39.0	22.2	48.0	22.8
39.5	22.4	48.5	23.1
40.0	22.2	49.0	23.4
40.0	24.5	49.5	23.5
40.5	24.2	50.0	23.7
41.0	24.3		
41.5	24.4		

Print Date: 15-Mar-11

RECOMMENDED CALIBRATION CYCLE: THREE YEARS

Figure 2-20

MODEL: 11970Q SER: MY30033018 DATE: 15 Mar 2011

Not for use with Agilent X-series signal analyzers. See other documents/files for X-series signal analyzers.

n = 10+   IF = 321.4MHz   LO Power = 16dBm
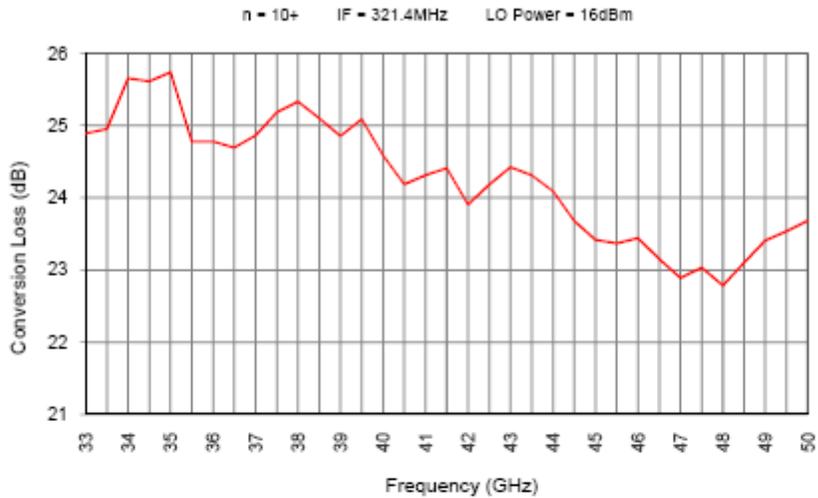
Freq. (GHz)	Conv. Loss (dB)	Ref. Lvl Ofs	Freq. (GHz)	Conv. Loss (dB)	Ref. Lvl Ofs
33.0	24.9	-5.1	42.0	23.9	-6.1
33.5	25.0	-5.0	42.5	24.2	-5.8
34.0	25.7	-4.3	43.0	24.4	-5.6
34.5	25.6	-4.4	43.5	24.3	-5.7
35.0	25.7	-4.3	44.0	24.1	-5.9
35.5	24.8	-5.2	44.5	23.7	-6.3
36.0	24.8	-5.2	45.0	23.4	-6.6
36.5	24.7	-5.3	45.5	23.4	-6.6
37.0	24.9	-5.1	46.0	23.4	-6.6
37.5	25.2	-4.8	46.5	23.2	-6.8
38.0	25.3	-4.7	47.0	22.9	-7.1
38.5	25.1	-4.9	47.5	23.0	-7.0
39.0	24.9	-5.1	48.0	22.8	-7.2
39.5	25.1	-4.9	48.5	23.1	-6.9
40.0	24.6	-5.4	49.0	23.4	-6.6
40.5	24.2	-5.8	49.5	23.5	-6.5
41.0	24.3	-5.7	50.0	23.7	-6.3
41.5	24.4	-5.6			

Print Date: 15-Mar-11

RECOMMENDED CALIBRATION CYCLE: THREE YEARS

3   Service

Maintenance

The only maintenance required for the 11970 Series Mixers is preventive maintenance. When you are not using your mixer, cover its waveguide input with its waveguide cap. Also, though the 11970 Mixers can absorb more punishment than is normal for such devices, you should avoid subjecting them to unnecessary shock or vibration.

Repairs

The 11970 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 Agilent office.

Replaceable Parts

For a list of replaceable parts and accessories, see .

Circuit Description

A schematic diagram of a 11970 Series Harmonic Mixer is shown in . The mixer 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 internal diplexer separates the 3 - 6 GHz LO signal from the 321.4 MHz IF signal.

Figure 3-1   **11970 Series Mixer Schematic Diagram**
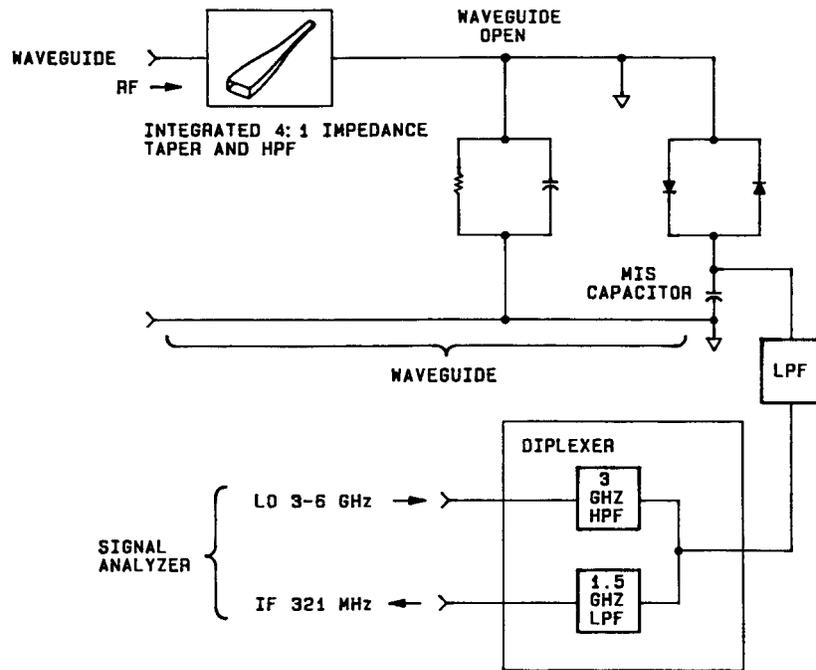
art6

Model	LPF Fco (GHz)
11970K	4.4
11970A	5.0
11970Q	5.0
11970U	6.2
11970V	5.4
11970W	6.2

Table 3-1   **Accessories and Replaceable Parts**

Part Number	Description
5061-5460:	Mixer Connector Kit (Option 009), includes the following three items:
5061-5458	Cable, 1 meter long, SMA male connectors (3 required)
8710-0510	Wrench, 5/16-inch, open-end
8710-0523	Ball Driver, 3/32-inch
3030-0221	Socket Head Cap Screw, 4-40 thread, .375 inches long (flange connecting screw for 11970K and 11970A)
1390-0671	Socket Head Cap Screw, captive, 4-40 thread, .290 inches long (flange connecting screw for 11970Q, 11970U, 11970V or 11970W)
11970-40001	11970K Waveguide Cap
11970-40002	11970A Waveguide Cap
11970-40003	Waveguide Cap for 11970Q or 11970U
08486-40103	Waveguide Cap for 11970V or 11970W

Table 3-2   **Locations for Agilent Technologies**

Online assistance: http://www.agilent.com/find/assist

Americas

Canada	Latin America	United States
1 877 894 4414	(305) 269 7500	1 800 829 4444

Asia Pacific

Australia	China	Hong Kong
1 800 629 485	800 810 0189	800 938 693
India	Japan	Korea
1 800 112 929	0 120 (421) 345	080 769 0800
Malaysia	Singapore	Taiwan
1 800 888 848	1 800 375 8100	0800 047 866
Thailand		
1 800226 008		

Europe & Middle East

Austria	Belgium	Denmark
43 (0) 1 360 277 1571	32 (0) 2 404 93 40	45 70 13 15 15
Finland	France	Germany
358 (0) 10 855 2100	0825 010 700* *0.125 Euros/minute	49 (0) 7031 464 6333
Ireland	Israel	Italy
1890 924 204	972-3-9288-504/544	39 02 92 60 8484
Netherlands	Spain	Sweden
31 (0) 20 547 2111	34 (91) 631 3300	0200-88 22 55
Switzerland	United Kingdom	
0800 80 53 53	44 (0) 118 9276201	

Other European Countries: http://www.agilent.com/find/contactus