



# **M1970 Series Harmonic Mixer**

This manual provides documentation  
for use with:

X-Series Signal Analyzers (Option EXM)

## **User's Guide**



**Agilent Technologies**

# Notices

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## **Warranty**

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

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

## **Where to Find the Latest Information**

Documentation is updated periodically. For the latest information about these products, including instrument software upgrades, application information, and product information, browse to one of the following URLs, according to the name of your product:

<http://www.agilent.com/find/smartmixers>

<http://www.agilent.com/find/pxa>

To receive the latest updates by email, subscribe to Agilent Email Updates at the following URL:

<http://www.agilent.com/find/emailupdates>

Information on preventing analyzer damage can be found at:

<http://www.agilent.com/find/tips>



## **1 M1970V/W Overview**

Initial Inspection	8
Shipping Problems?	8
Mixers Covered by This Guide	9
Serial numbers	9
Instrument Options	10
Spectrum Analyzer Retrofit Requirements	11
Compliance Notices and Regulatory Information	12
Compliance with electromagnetic compatibility (EMC)	12
Regulatory Markings	12
Declaration of conformity	12

## **2 Operation**

Operating Precautions	14
RF input power	14
LO input power	14
Electrostatic discharge	14
Connect only one mixer at a time	14
Waveguide protection foam	14
Provide mechanical support for the mixer	14
Avoiding waveguide flange damage	15
Mixer waveguide connections	15
Using the M1970 Series Mixers with X-Series Signal Analyzers (Option EXM)	16
Equipment set up	16
Operation	17
Amplitude calibration	18
LO adjustment	18
Viewing the external mixer setup screen	19

## **3 Troubleshooting and Maintenance**

Troubleshooting	22
Error Messages	23

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## Contents

Maintenance	24
Replaceable parts	24
Returning an M1970 Series Mixer for Service	25
Calling Agilent Technologies	25
Locations for Agilent Technologies	25

## 4 M1970 Series Specifications

General	28
Physical Characteristics	30
Environmental Specifications	31



# 1 M1970V/W Overview







The Agilent M1970V/W waveguide harmonic mixer is an un-preselected mixer that is used to extend the frequency range of the Agilent X-Series signal analyzer for high-frequency wireless and millimeter wave applications.

With emphasis on ease-of-use, the embedded features of the mixer will automatically transfer the conversion loss data from the mixer memory to the signal analyzer through the USB plug-and-play feature. It will also auto detect the mixer model and serial number to set the default frequency range.

Once the mixer is connected to the signal analyzer via both the SMA cable connection and the USB connection, the signal analyzer and mixer can perform an LO power adjustment that will compensate for SMA cable loss (cable length <3 meters) and optimize the LO power present at the mixer.

## Initial Inspection

Inspect the shipping container and the cushioning material for signs of stress. Retain the shipping materials for future use, as you may wish to ship the instrument to another location or to Agilent Technologies for service.

Item	Deliverable	Description
User's Guide		Provides instructions on usage, retrofit requirements, troubleshooting, specifications, and general information.
SMA cable		1 meter cable required to connect the mixer to the signal analyzer EXT MIXER connector.
USB cable		1.8 meter USB cable required to connect the mixer to the signal analyzer.
Calibration certificate		Provides information regarding the instrument calibration.
Waveguide screws		Screws required for connection to the waveguide (5 ea).
Ball driver		3/32 inch hex driver for installation of the waveguide screws.
Wrench		5/16 inch for SMA cable installation.

## Shipping Problems?

If the shipping materials are damaged or the contents of the container are incomplete:

- Contact the nearest Agilent Technologies office.
- Keep the shipping materials for the carrier's inspection.
- If you must return an EMI Receiver to Agilent Technologies, use the original (or comparable) shipping materials. See ["Returning an M1970 Series Mixer for Service"](#) on page 25.



## Mixers Covered by This Guide

- M1970V Option 001: 50 to 75 GHz waveguide harmonic mixer
- M1970V Option 002: 50 to 80 GHz waveguide harmonic mixer
- M1970W: 75 to 110 GHz waveguide harmonic mixer

## Serial numbers

A serial number label is attached to your mixer that shows the serial number and country of manufacture.



## Instrument Options

The following options are available:

<b>Option Number</b>	<b>Description</b>
M1970V-101 or M1970W-101	Cable, SMA, 1 meter, for LO/IF connection
M1970V-102 or M1970W-102	Cable, SMA, 3 meter, for LO/IF connection
M1970V-201 or M1970W-201	Cable, USB, 1.8 meter
M1970V-202 or M1970W-202	Cable, USB, 3 meter
M1970V-301 or M1970W-301	Jackstand

## Spectrum Analyzer Retrofit Requirements

### **N9030A Signal Analyzer** (Requires Option EXM)

Instruments without Option EXM currently installed can be retrofitted to add the hardware and licensing.

To retrofit Option EXM:

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

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**NOTE**

N9030A software revision must be A.08.52 or later.

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## Compliance Notices and Regulatory Information

### Compliance with electromagnetic compatibility (EMC)

This product conforms with the protection requirements of EMC Directive 2004/108/EC for Electromagnetic Compatibility.

The product complies to the EMC Directive by assessment according to the IEC/EN61326-1 EMC standard.

In order to preserve the EMC performance of the product, any cable which becomes worn or damaged must be replaced with the same type and specifications.

### Regulatory Markings



The CE mark is a registered trademark of the European Community.

ICES/NMB-001

ICES/NMB-001 indicates that this ISM device complies with Canadian ICES-001.

Cet appareill ISM est conforme a la norme NMB-001 du Canada.

ISM GRP.1 CLASS A

This is the symbol of an Industrial Scientific and Medical Group 1 Class A product.



The C-Tick mark is a registered trademark of the Australian Spectrum Management Agency of Australia. This signifies compliance with the Australian EMC framework Regulations under the terms of the Radio communications Act of 1992.



This symbol indicates separate collection for electrical and electronic equipment mandated under EU law as of August 13, 2005. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive 2002/96/EC).



Indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.

### Declaration of conformity

A copy of the Manufacturer's European Declaration of Conformity for this mixer can be obtained by contacting your local Agilent Technologies sales representative, or copies can be downloaded from the Agilent Technologies, Inc. web site at:

<http://www.agilent-pra.com/doc/search.htm>



## 2 Operation

## Operating Precautions

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

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### RF input power

Use the following parameters:

CW No greater than 20 dBm

Peak Pulse No greater than 24 dBm at <1  $\mu$ sec

See the gain compression values for each model mixer. Use an appropriate waveguide attenuator if the output power of the unit under test exceeds the gain compression value.

### LO input power

LO input power is set by the internal signal analyzer LO alignment. However, the LO input must not exceed 20 dBm.

Always use a high quality low loss SMA cable since this will allow the longest cable length, and prevent damage to the mixer SMA female connector.

### Electrostatic discharge

When installing the mixer, always connect the LO/IF SMA cable to the signal analyzer BEFORE connecting to the mixer. This will minimize the danger of an electrostatic discharge damaging the mixer diodes.

### Connect only one mixer at a time

The automatic LO adjustment and mixer ID process assumes only one mixer is connected to the analyzer's USB and SMA EXT MIXER connections.

### Waveguide protection foam

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

### Provide mechanical support for the mixer

Assure the mixer body is properly supported so it does not present any stress on the waveguide connection. Instrument option 301 provides a jackstand that allows a stable support and height adjustment.

### **Avoiding waveguide flange damage**

Install the waveguide flange cap whenever the mixer is not connected to a device under test. This will protect the waveguide flange mating surface.

### **Mixer waveguide connections**

Assure the shoulder of the mixer waveguide flange is properly aligned with the flange of the device under test. To ensure proper mating, it is important to tighten all screws equally. To do this, tighten opposed screws in pairs by a small amount until all are snug. Final torque must not exceed 7 in pounds.

## Using the M1970 Series Mixers with X-Series Signal Analyzers (Option EXM)

Refer to “Spectrum Analyzer Retrofit Requirements” on page 11 for configuration requirement.

The following examples explain how to connect the external mixers to the signal analyzer, and how to use the signal-identification functions.

For additional information regarding use with a particular X-Series analyzer, refer to that analyzer's User's and Programmer's Reference Guide.

### Equipment set up

Step	Action	Notes
SMA connection	a. Connect an SMA cable from the mixer to the spectrum analyzer EXT MIXER front panel SMA.	<p>The torque for the SMA cables and adapters should not exceed 8 in-lbs.</p> <p>The LO/IF connection between the mixer and the signal analyzer must be in place before the USB cable from the mixer is connected. Connecting the USB cable automatically triggers the LO adjustment, and if the LO/IF cable is not connected the adjustment will not complete and an error will occur.</p>
USB connection	a. Connect a USB cable from the mixer to the spectrum analyzer.	<p>When a connection is made, the green LED on the mixer lights up indicating that the mixer has power and the processor inside the mixer is running. The spectrum analyzer is automatically switched to external mixing mode, and the mixer model number and mixer option are used to set the start and stop frequencies for the mixing band.</p>

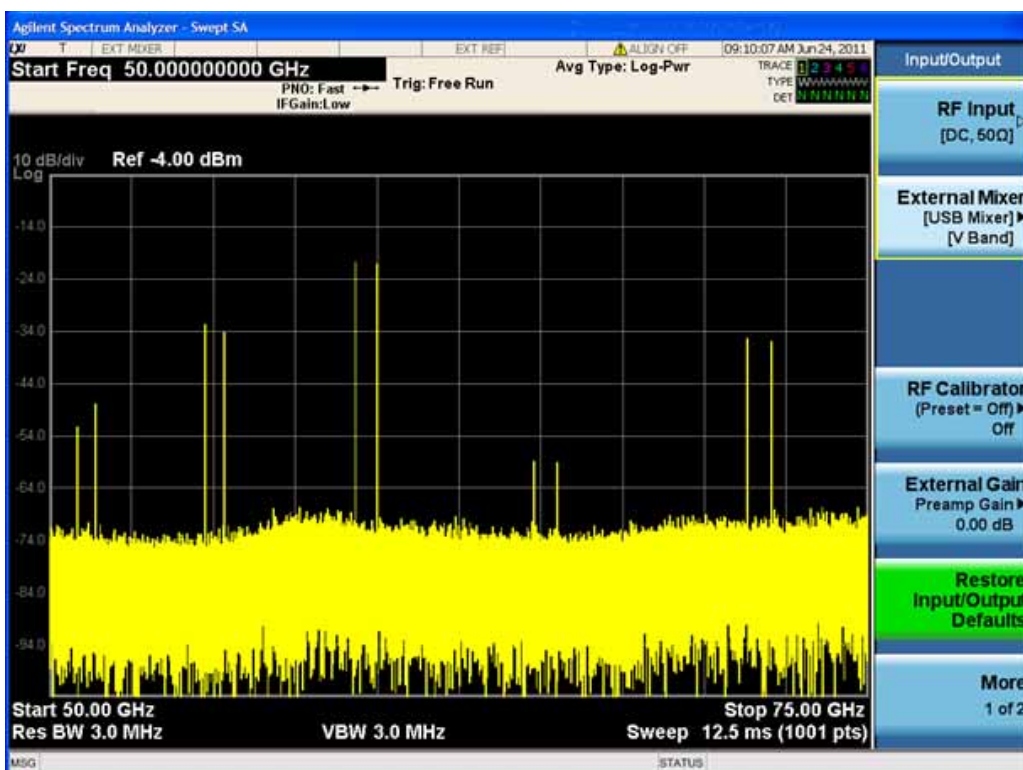


The spectrum analyzer performs an LO alignment using a detector in the mixer to set the LO Power. During the alignment the yellow Busy LED turns on. Once the alignment completes, the mixer is ready to make calibrated measurements since the conversion loss values stored in the mixer are automatically loaded to the signal analyzer.

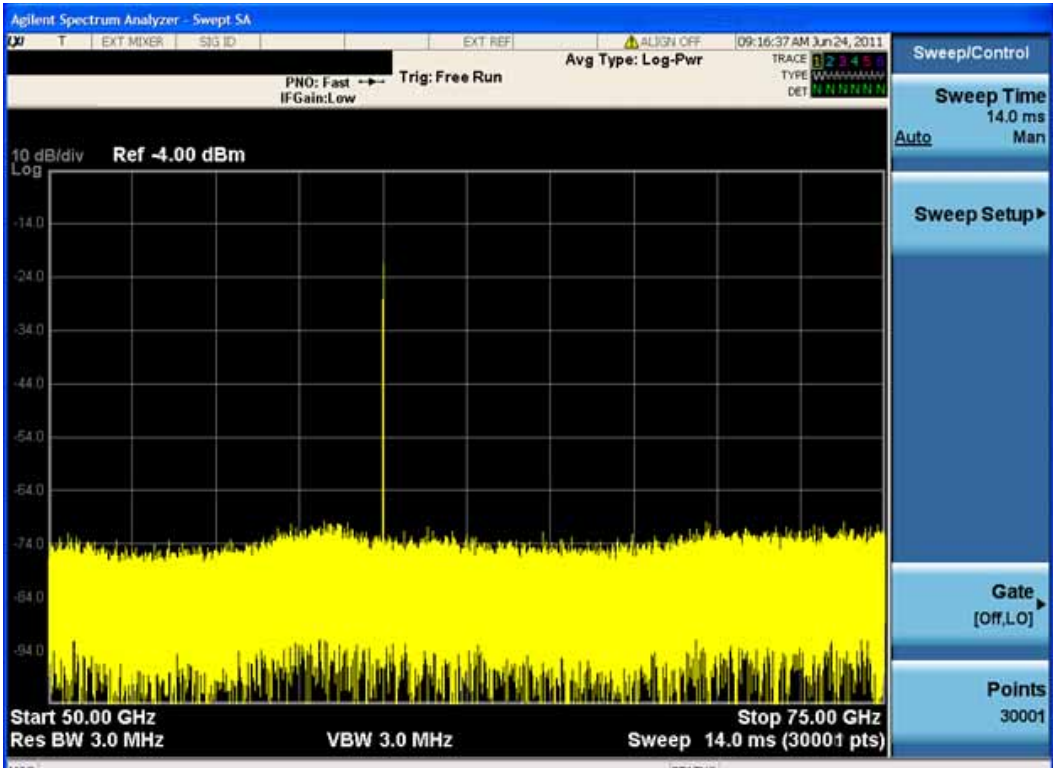


## Operation

Step	Action	Notes
Tune the analyzer	<ol style="list-style-type: none"> <li>Apply a signal to the mixer input.</li> <li>Press <b>FREQ Channel</b> and enter a center frequency or a start and stop frequency</li> </ol>	Multiple responses may appear on screen. Most of these responses are images or multiples of the mixing process and not true signals.



Turn on the signal identification function.	<ol style="list-style-type: none"> <li>Press <b>Input/Output, External Mixer, Signal ID</b> to <b>On, Signal ID Mode, Image Suppress</b>.</li> </ol>	This enables you to identify true signals from images and harmonics. Refer to the following graphic.
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Step	Action	Notes
	<p>a. Press <b>Sweep/Control</b>, <b>Points</b>, enter the number, and press <b>Enter</b>.</p>	

With wide spans, increasing the number of sweep points may improve the effectiveness of image suppressing.

### Amplitude calibration

The M1970 Series mixers automatically download a conversion loss file to the signal analyzer, and this conversion loss table is used to correct the measured amplitude. It is not possible to view or edit the conversion loss file. The Certificate of Calibration that is provided with each mixer lists the conversion loss measured at the factory.

### LO adjustment

The LO adjustment will run each time the USB connection is made, and if the signal analyzer Alignments are set to Normal, the LO adjustment will be performed based on time and temperature rules similar to the other signal analyzer alignments. Both the mixer and the spectrum analyzer temperature sensors are monitored by the alignment algorithm. If the Alignment is set to OFF, the LO Alignment will not be performed based on time and temperature, and it will be necessary for the user to determine when to perform alignments.

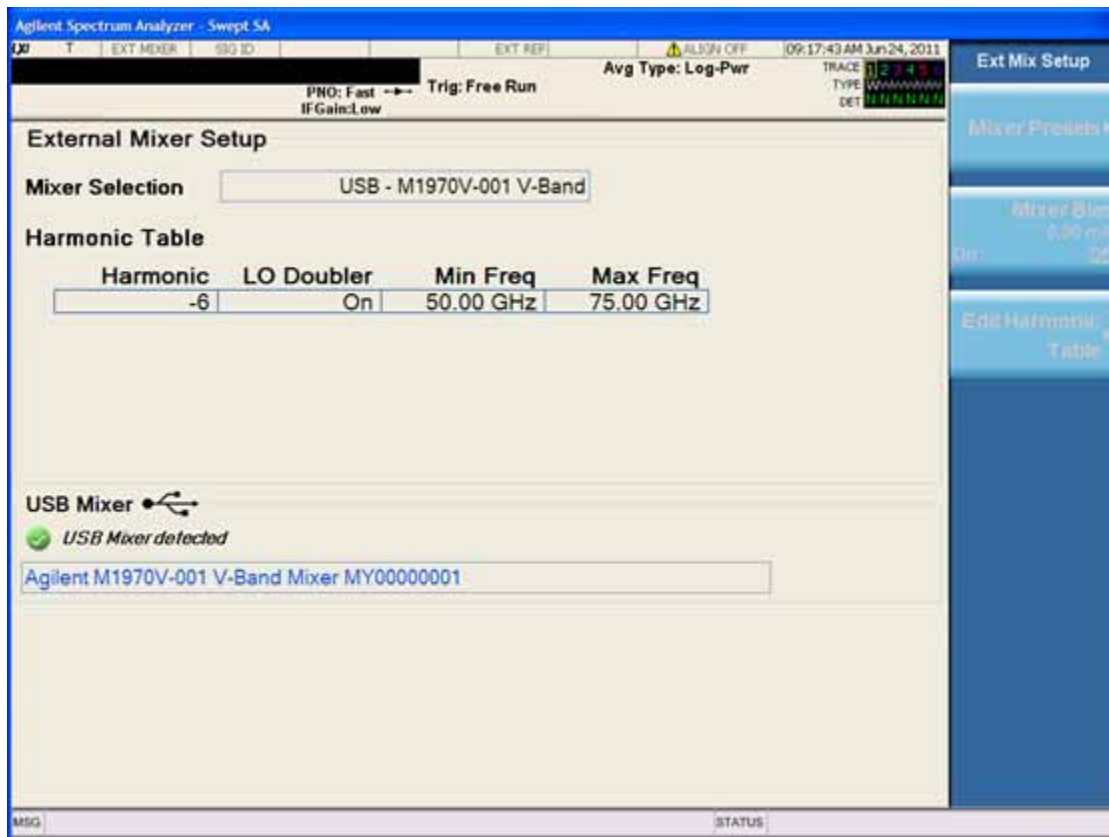
To manually trigger an LO alignment from the front panel, press **System, Alignments, Align Now, External Mixer**.

Using the M1970 Series Mixers with X-Series Signal Analyzers (Option EXM)

**Viewing the external mixer setup screen**

The mixer setup screen contains information such as mixer serial and model number, harmonic mixing used, and the status of the mixer connection. When the USB mixer is connected, the Mixer Preset, Mixer Bias and Edit Harmonic Table keys are grayed out since these keys do not apply. However, if you unplug the USB cable, the Mixer Presets key will become functional and the connection status will show USB Mixer not connected.

To view the setup screen, press **Input /Output, External Mixer, Ext Mix Setup**.



Operation

**Using the M1970 Series Mixers with X-Series Signal Analyzers (Option EXM)**



### 3 Troubleshooting and Maintenance

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**CAUTION**

The M1970 Series mixers are not field repairable, and require return to Agilent for both repair and calibration. Do not attempt to open the mixer enclosure.

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## Troubleshooting

Problem	Possible Cause/Troubleshooting Process
Green Active LED does not turn on when mixer is connected to spectrum analyzer through USB cable	<p>Spectrum analyzer not providing power. Faulty or loose USB cable. Faulty mixer</p> <p><b>Troubleshooting:</b> Connect another USB device to the signal analyzer</p>
Red Error LED on mixer lights up (mixer fails the LO alignment routine)	<p>The SMA cable must be attached before the USB cable is plugged in. If the SMA cable was not plugged in first, assure that the SMA cable is connected properly, then disconnect and reconnect the USB cable.</p> <p>The SMA cable is damaged or has too much loss (cable length is too long). Replace the SMA cable with one that is &lt; 3 meters.</p> <p>Faulty mixer.</p> <p>The signal analyzer LO output is faulty:</p> <p>To test the LO output, remove the SMA cable from the Ext Mixer connector, and unplug the USB cable.</p> <ol style="list-style-type: none"><li>1. Press Input/Output, External Mixer, Ext Mix Setup, Mixer Presets</li><li>2. Select Single Harmonic w/doubler, select V-Band</li><li>3. Press Freq key, Center Frequency, 60 GHz. Then press Span, Zero Span</li><li>4. Connect a spectrum analyzer capable of measuring a 13 GHz signal to the Ext Mixer connector</li><li>5. Tune the measuring spectrum analyzer to 10.0537 GHz center frequency, and the LO signal level at the Ext Mixer connector should be +15 dBm +/- 2 dB</li></ol>
Yellow Busy LED does not come on when USB cable is attached and LO Align does not start	<p>Assure that only one mixer is connected. Unplug any other mixer USB connection, then on the desired mixer, remove the USB cable and re-insert the USB cable to initiate the LO adjustment.</p>

## **Error Messages**

The following is a list of error messages that may appear on the signal analyzer screen.

<b>Error Message</b>	<b>Possible Cause/Troubleshooting Process</b>
LO Alignment Failure	The LO power is too low to complete the LO adjustment.  LO/IF cable not connected at time of LO adjustment routine.

## Maintenance

Preventive maintenance includes covering the wave guide with the waveguide cap when the mixer is not in use, and avoiding rough handling that could damage the SMA and USB connectors.

Do not remove the foam installed in the open end of the waveguide. The foam prevents small objects from entering the waveguide.

### Replaceable parts

Part Number	Description
1390-0671	Socket head cap screw, captive, 4-40 thread, 0.29 inches long (waveguide flange connecting screw for V and W band)
0401-0227	Waveguide cap for V and W band



## Returning an M1970 Series Mixer for Service

### Calling Agilent Technologies

Agilent Technologies has offices around the world to provide you with complete support for your mixer. To obtain servicing information or to order replacement parts, contact the nearest Agilent Technologies office listed below. In any correspondence or telephone conversations, refer to your mixer by its product number and full serial number.

### Locations for Agilent Technologies

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

#### Americas

Canada  
1 877 894 4414

Latin America  
(305) 269 7500

United States  
1 800 829 4444

#### Asia Pacific

Australia  
1 800 629 485

China  
800 810 0189

Hong Kong  
800 938 693

India  
1 800 112 929

Japan  
0 120 (421) 345

Korea  
080 769 0800

Malaysia  
1 800 888 848

Singapore  
1 800 375 8100

Taiwan  
0800 047 866

Thailand  
1 800226 008

#### Europe & Middle East

Austria  
43 (0) 1 360 277 1571

Belgium  
32 (0) 2 404 93 40

Denmark  
45 70 13 15 15

Finland  
358 (0) 10 855 2100

France  
0825 010 700\*  
\*0.125 Euros/minute

Germany  
49 (0) 7031 464 6333

Ireland  
1890 924 204

Israel  
972-3-9288-504/544

Italy  
39 02 92 60 8484

Netherlands  
31 (0) 20 547 2111

Spain  
34 (91) 631 3300

Sweden  
0200-88 22 55

Switzerland  
0800 80 53 53

United Kingdom  
44 (0) 118 9276201

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

Troubleshooting and Maintenance  
**Returning an M1970 Series Mixer for Service**



## 4 M1970 Series Specifications

Specifications describe warranted performance over the temperature range 0 to +55 °C after one hour of continuous operation unless otherwise noted.

Nominal values indicate expected performance, or describe product performance that is useful in the application of the product, but is not covered by the product warranty.

## General

Description	Specifications	Supplemental Information
Calibration Cycle	1 year	

Description	Specifications	Supplemental Information
LO Amplitude		LO requirements provided by compatible signal analyzers. Maximum cable loss 10 dB nominal.
USB Requirements		5 V nominal, 500 mA maximum
Maximum CW RF Input Level	20 dBm (100 mw)	
Maximum RF Peak Pulse Power	24 dBm with <1usec pulse (avg power: +20 dBm)	
Maximum LO Power	20 dBm	
IF Bandwidth <sup>a</sup>		200 MHz to 500 MHz
<b>EMC</b>	Complies with European EMC Directive 2004/108/EC <ul style="list-style-type: none"> <li>— IEC/EN 61326-2-1</li> <li>— CISPR Pub 11 Group 1, class B</li> <li>— AS/NZS CISPR 11</li> <li>— ICES/NMB-001</li> </ul> This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada.	
IF/LO Connector		SMA Female

- a. The M1970 series mixers are designed to work with the PXA IF frequencies. With PXA option CR3, other IF frequencies can be supported for special applications.

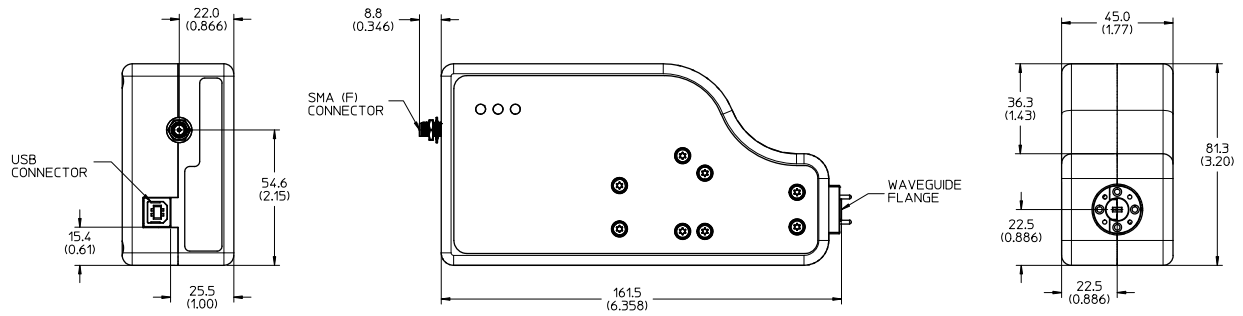
Description	M1970V	M1970V Opt 002	M1970W	Supplemental Information
RF Frequency Range	50 to 75 GHz	50 to 80 GHz	75 to 110 GHz	
LO Harmonic Number <sup>a</sup>	-6	-6	-8	
LO Frequency Range <sup>b</sup> (GHz)	8.39 to 12.56	8.39 to 13.39	9.42 to 13.80	
Maximum Conversion Loss <sup>c</sup>	23 dB	23 dB	25 dB	
Calibration Accuracy <sup>d</sup>	±2.2 dB (nominal)	±2.2 dB (nominal)	±2.2 dB (nominal)	
Odd Order Mixing Product Suppression	15 dB (nominal)	15 dB (nominal)	15 dB (nominal)	
Gain Compression Level (<1 dB)	0 dBm (nominal)	0 dBm (nominal)	0 dBm (nominal)	
Input SWR	<2.6:1 (nominal)	<2.6:1 (nominal)	<2.6:1 (nominal)	
Noise Figure <sup>e</sup>	34 dB (nominal)	34 dB (nominal)	36 dB (nominal)	
System Displayed Average Noise Level (DANL) at 1 Hz resolution bandwidth <sup>f</sup>	-141 dBm (nominal)	-141 dBm (nominal)	-138 dBm (nominal)	

- a. "-" signifies that the LO frequency times the LO harmonic number is higher than the RF input frequency.  $LO \times N = RF + IF$ .
- b. Exact LO frequency is dependent on the IF path setting of the signal analyzer.
- c. Conversion loss values shown include the effect of an internal IF amplifier.
- d. Calibration accuracy is the difference between the conversion loss factors measured and programmed into the M1970 at the factory and the actual conversion loss of the mixer experienced when used with an X-Series signal analyzer with option EXM. The values shown include test system uncertainty, interpolation error, and the effects of the difference between the X-Series environment and the factory calibration environment. The system amplitude accuracy is worse than this M1970-only calibration accuracy due to SWR effects between the M1970 and the X-Series IF input, and due to Gain Accuracy at the IF Input in Option EXM of the X-Series analyzer used.
- e. The values shown are the noise figures of the M1970 alone. They include effects of the internal IF amplifier. The system noise figure when connected to an X-Series signal analyzer will be higher, by nominally 0.8 dB.
- f. System DANL includes the effect of an X-Series analyzer and cable as well as the M1970. DANL is defined with log-scale averaging according to industry conventions. The noise density is about 2.25 dB higher than DANL.

## Physical Characteristics

Does not include SMA connector.

Model	Flange	Weight	Height	Width	Length
M9070V (001)	UG-385/U WR-15	0.70 kg (1.54 lbs)	45.0 mm (1.7 in)	81.3 mm (3.2 in)	161.5 mm (6.4 in)
M9070V (002)	UG-385/U WR-15	0.70 kg (1.54 lbs)	45.0 mm (1.7 in)	81.3 mm (3.2 in)	161.5 mm (6.4 in)
M9070W	UG-387/U-M WR-10	0.70 kg (1.54 lbs)	45.0 mm (1.7 in)	81.3 mm (3.2 in)	161.5 mm (6.4 in)



## Environmental Specifications

Agilent M1970V/W Series Harmonic Mixers are designed to fully comply with Agilent Technologies' product operating environment specifications. The following are the summarized environmental specifications for these products.

Description	Specifications	Supplemental Information
<b>Temperature Range</b>		
Operating	0 to 55°C	
Storage	–40 to +70°C	
<b>Relative Humidity</b>		
Operating	95% RH at 40°C (non-condensing)	
<b>Shock</b>		
End use handling shock	Half sine wave form	
Transportation shock	30g	
<b>Vibration</b>		
Operating	0.21g rms	
Survival	2.09g rms	
<b>Altitude</b>		
Operating	<4,572 meters (15,000 feet)	
<b>ESD immunity</b>		
Direct discharge	6.0 kV per IEC 61000-4-2	
Air discharge	15 kV per IEC 61000-4-2	