Keysight M1971E Waveguide Harmonic Mixer, 55/60 to 90 GHz

KEYSIGHT TECHNOLOGIES

User's Guide

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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:

www.keysight.com/find/smartmixers

www.keysight.com/find/pxa

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

www.keysight.com/find/emailupdates

Information on preventing analyzer damage can be found at:

www.keysight.com/find/tips

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

CE	The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.	CE ICES/NMB-001 ISM GRP 1-A	ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada.
	The RCM mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australia EMC Framework regulations under the terms of the Radio Communication Act of 1992.		This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.
40	This symbol 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.	MSIP-REM-Kst-WNM1971E	This instrument is Class A suitable for professional use and is for use in electromagnetic environments outside of the home. 이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

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Product category

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a “Monitoring and Control Instrument” product.

The affixed product label is as shown below.

Do not dispose in domestic household waste.

To return this unwanted instrument, contact your nearest Keysight Service Center, or visit http://about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.

Sales and Technical Support

To contact Keysight for sales and technical support, refer to the support links on the following Keysight websites:

- www.keysight.com/find/smartmixers or www.keysight.com/find/pxa (product-specific information and support, software and documentation updates)
- www.keysight.com/find/assist (worldwide contact information for repair and service)

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1 Overview

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This chapter provides an overview of the Keysight M1971E Waveguide Harmonic Mixer.

Description

The Keysight M1971E Waveguide Harmonic Mixer is an un-preselected mixer that is used to extend the frequency range of the Keysight 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.

Operation of the M1971E mixer can be categorized into three modes:

- **Normal Path**: This path should be used for I/Q measurements. The mixer's IF frequency supplied to the host analyzer depends on the host analyzer's IF Path selected.
- **Dual Conversion Path**: Provides the widest image-free range since the first conversion is to a higher IF frequency, and the mixer uses the host analyzer's 10 MHz external reference out to generate a second LO signal for the second IF down-conversion. Intended only for swept measurements of wideband modulated carriers. The mixer's IF bandwidth is wide enough to support all host instrument resolution bandwidth settings, but not wide enough for I/Q acquisitions.
- **Aux Equipment Path**: The mixer down-converts the input signal to an IF frequency defined by the user, and this IF is available at a separate mixer output port for connection to external equipment (e.g. oscilloscope). The signal analyzer's signal path is not used, since the signal analyzer only provides an LO signal to the mixer. This path is designed for I/Q acquisitions of bandwidths wider than those supported by the internal instrument IF paths.

  Since the spectrum analyzer's signal path is not used, there is no Signal Identification or automatic amplitude correction for mixer conversion loss and IF flatness. You must determine which signals are real and which are images or multiples. The mixer's conversion loss and IF flatness data for this path is contained in a file on the signal analyzer.

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 Keysight Technologies for service.

Table 1-1 Standard shipped items

Item	Description
User's Guide	Provides instructions on usage, retrofit requirements, troubleshooting, specifications, and general information.
SMA cable	RF cable required to connect the mixer to the signal analyzer EXT MIXER connector.
USB cable	USB cable required to connect the mixer to the signal analyzer.
Certificate of calibration	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 Keysight Technologies office.
- Keep the shipping materials for the carrier's inspection.
- If you must return the instrument to Keysight Technologies, use the original (or comparable) shipping materials. See "Returning an M1971E Mixer for Service" on page 48.

Mixers Covered by This Guide

- M1971E Option 001: 60 to 90 GHz waveguide harmonic mixer
- M1971E Option 003: 55 to 90 GHz waveguide harmonic mixer

Serial numbers

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

Figure 1-1 Mixer overview

Figure 1-2 Mixer side view

Instrument Options

The following options are available:

Table 1-2 Instrument options

Option number	Description
M1971E-101	Cable, SMA, 1 meter
M1971E-102	Cable, SMA, 3 meters
M1971E-201	Cable, USB, 1.8 meter
M1971E-202	Cable, USB, 3 meters
M1971E-301	Jackstand

Spectrum Analyzer Retrofit Requirements

N9040B signal analyzer (Option EXM standard)

The N9040B is fully hardware-compliant since option EXM is standard on all instruments.

NOTE The N9040B software revision must be A.16.05 or later.

N9030A signal analyzer (requires Option EXM and Windows 7)

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

To retrofit Option EXM:

Table 1-3 Option EXM retrofit for N9030A

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	

NOTE The N9030A software revision must be A.16.05 or later.

N9020A signal analyzer (requires Option EXM and Windows 7)

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

To retrofit Option EXM:

Table 1-4 Option EXM retrofit for N9020A

N9020A	Serial number prefix		
	< MY/SG/US5233	MY/SG/US5233 to 5328	≥ MY/SG/US5328
	No upgrade available	N9020AK-EXM	N9020AK-HL6

NOTE The N9020A software revision must be A.16.05 or later.

N9010A signal analyzer (requires Option EXM)

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

To retrofit Option EXM:

Table 1-5 Option EXM retrofit for N9010A

N9010A frequency option	Upgrade kit
532 or 544	N9010AK-EXM

NOTE The N9010A software revision must be A.16.05 or later.

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This chapter provides the operating information for the M1971E Waveguide Harmonic Mixer.

Operating Precautions

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
- Peak pulse: No greater than 24 dBm at <1 μs pulse width

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 non-conductive 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 M1971E Mixer with the N9030A, N9020A, and N9010A Signal Analyzers (Option EXM)

Refer to "Spectrum Analyzer Retrofit Requirements" on page 20 for the configuration requirements.

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

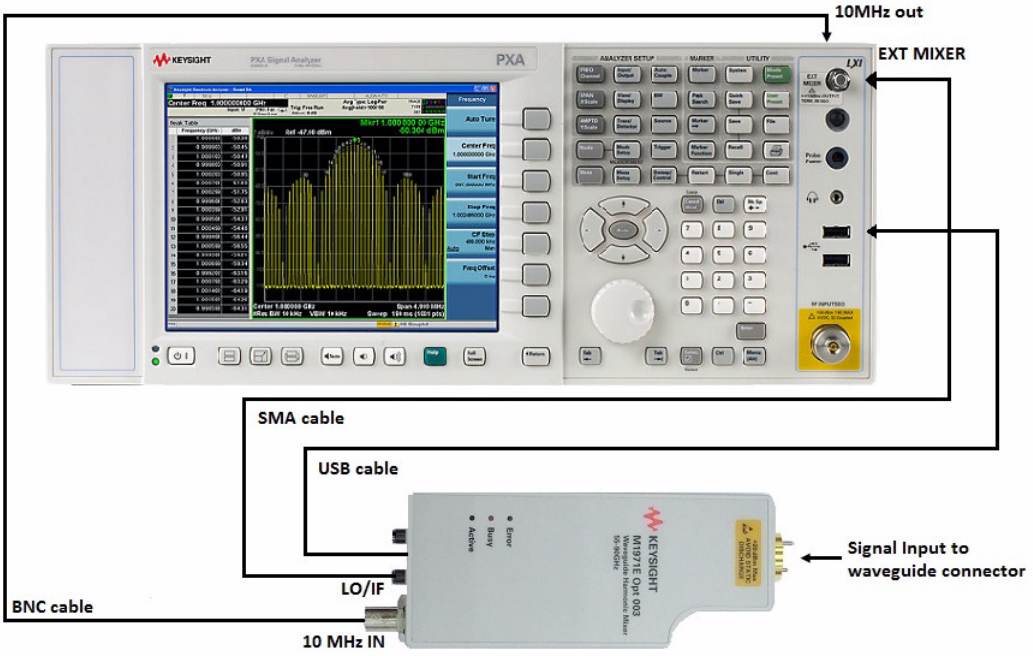
For additional information regarding use with a particular X-Series analyzer, refer to that analyzer's User's and Programmer's Reference Guide.

Equipment setup (mixer's path Normal mode or Dual Conversion mode)

Table 2-1 Equipment setup for the M1971E mixer and the N9030A, N9020A, and N9010A signal analyzers (Option EXM)

Step	Action	Notes
SMA connection	a. Connect an SMA cable from the mixer to the spectrum analyzer EXT MIXER front panel SMA.	The torque for the SMA cables and adapters should not exceed 8 in-lbs. 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.
USB connection	a. Connect a USB cable from the mixer to the spectrum analyzer.	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.
BNC connection (Dual conversion path only)	a. Connect a BNC cable from the mixer's 10 MHz In to the signal analyzer's rear panel 10 MHz Out.	The 10 MHz signal from the signal analyzer provides the LO signal to the mixer's second converter in the dual conversion path.

Table 2-1 Equipment setup for the M1971E mixer and the N9030A, N9020A, and N9010A signal analyzers (Option EXM)

Step	Action	Notes
		
	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

Table 2-2 Operation of the M1971E mixer and the N9030A, N9020A, and N9010A signal analyzers (Option EXM)

Step	Action	Notes
Tune the analyzer	a. Apply a signal to the mixer input.	–
	b. Press **FREQ Channel** and enter a center frequency or a start and stop frequency.	Multiple responses may appear on screen. Most of these responses are images or multiples of the mixing process and not true signals.

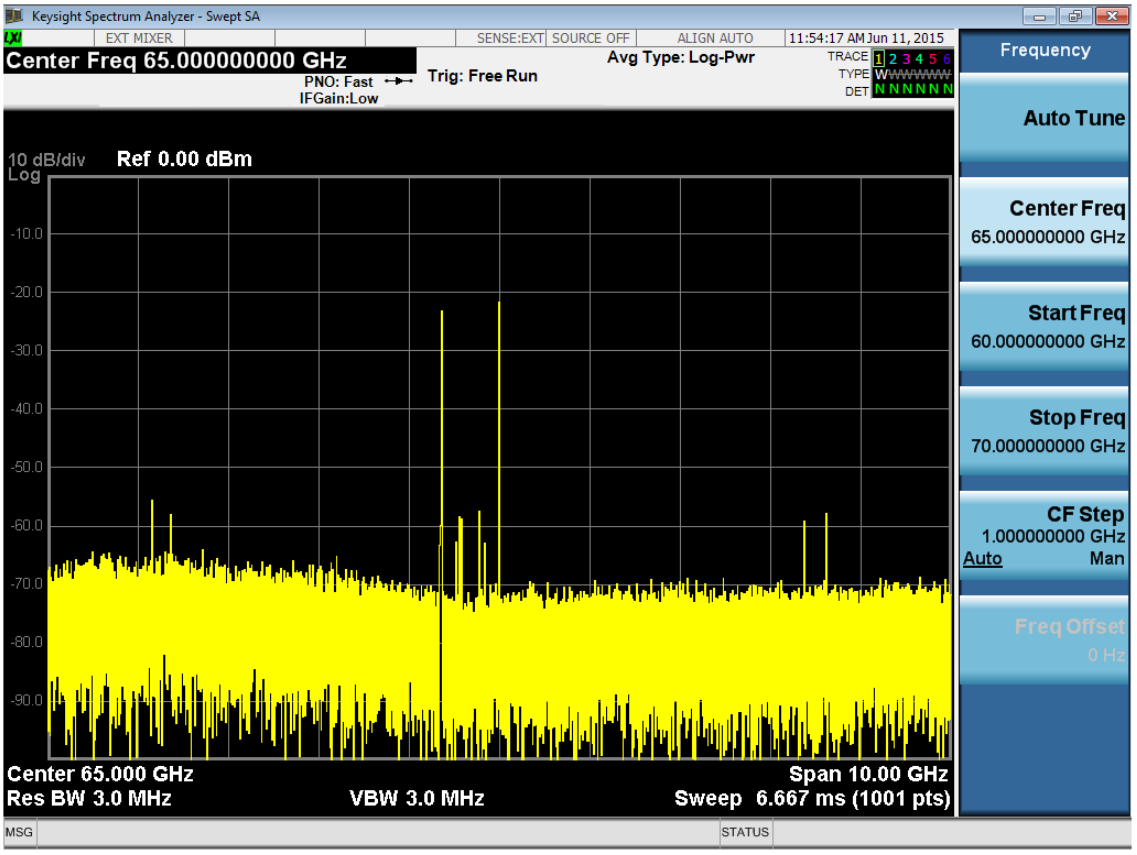
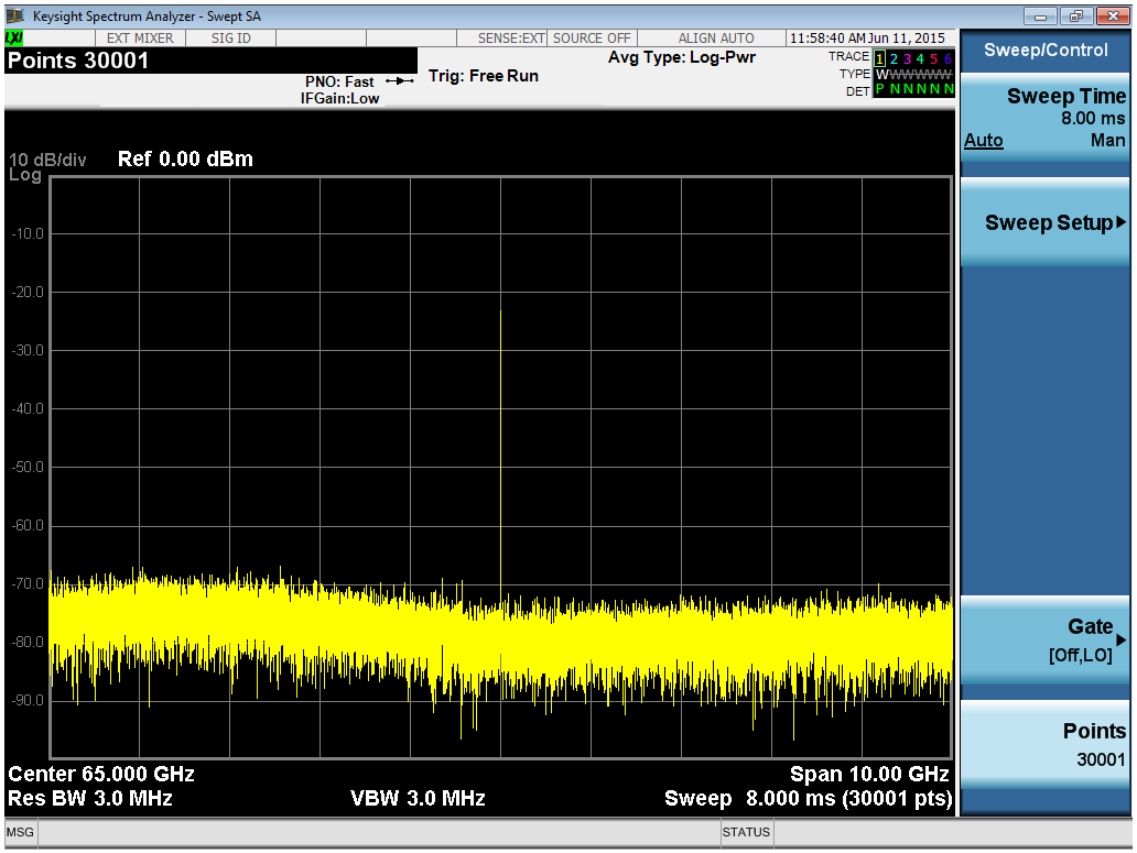


Table 2-2 Operation of the M1971E mixer and the N9030A, N9020A, and N9010A signal analyzers (Option EXM)

Step	Action	Notes
Turn on the signal identification function.	a. Press **Input/Output**, **External Mixer**, **Signal ID** to **On**, **Signal ID Mode**, **Image Suppress**.	This enables you to identify true signals from images and harmonics. Refer to the following graphic.
		
With wide spans, increasing the number of sweep points may improve the effectiveness of image suppressing.	a. Press **Sweep/Control**, **Points**, enter the number, and press **Enter**.	

Automatic correction

The M1971E mixer automatically downloads a conversion loss file (magnitude and phase information) 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**.

Viewing the external mixer setup screen

The mixer setup screen contains information such as the mixer serial and model numbers, harmonic mixing used, and 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**.

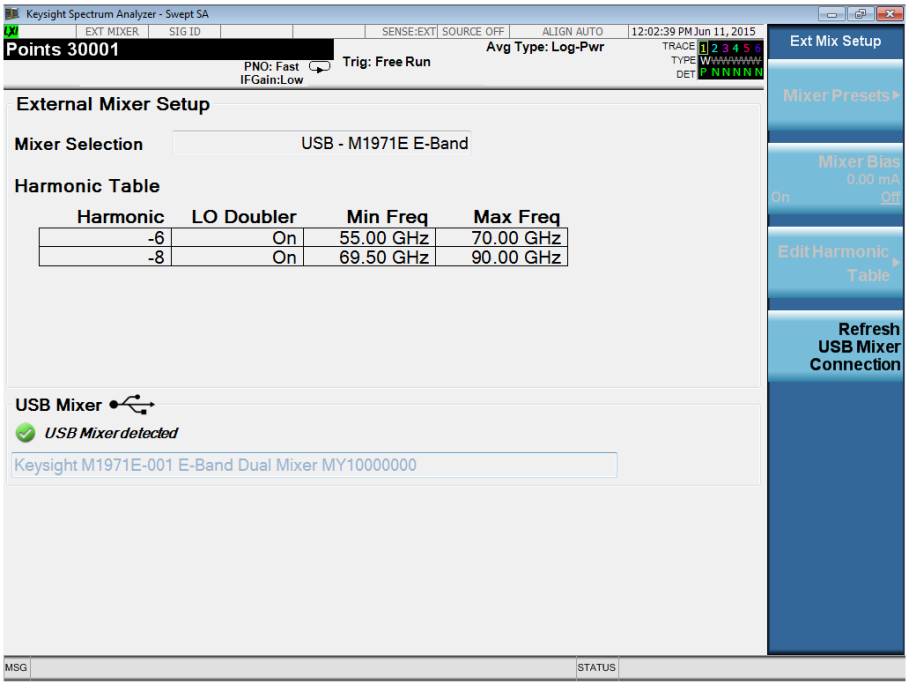


Figure 2-1 External mixer setup screen

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 the 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.**

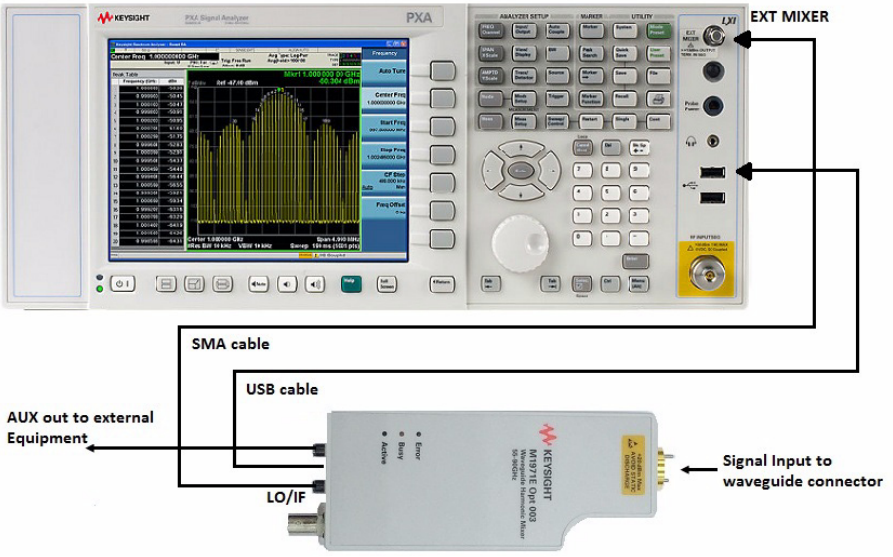
To synchronize in the Image Shift mode, turn off Signal ID and then initiate a single sweep.

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.

Equipment setup (mixer's path Aux equipment)

Table 2-3 Equipment setup for the M1971E mixer's path AUX and the N9030A, N9020A, and N9010A signal analyzers (Option EXM)

Step	Action	Notes
SMA connection	a. Connect an SMA cable from the mixer to the spectrum analyzer EXT MIXER front panel SMA.	The torque for the SMA cables and adapters should not exceed 8 in-lbs. 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.
USB connection	a. Connect a USB cable from the mixer to the spectrum analyzer.	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 the external mixing mode, and the mixer model number and mixer option are used to set the start and stop frequencies for the mixing band.
AUX connection	a. Connect an SMA cable from the mixer's AUX output to an external equipment.	External equipment examples are a wide BW digitizer or an oscilloscope.



NOTE Refer to Table 2-7 for "Operation of the M1971E mixer's path AUX Equipment" on page 42.

Using the M1971E Mixer with the N9040B Signal Analyzer (Option EXM)

Refer to "Spectrum Analyzer Retrofit Requirements" on page 20 for the configuration requirements.

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

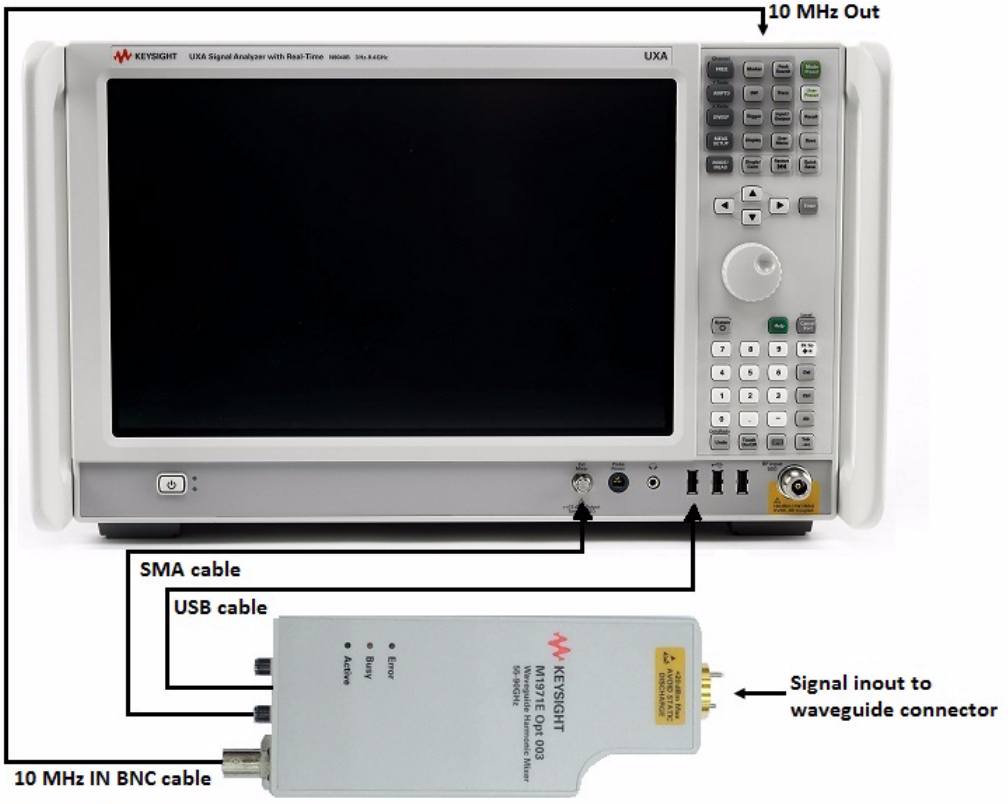
For additional information regarding use with a particular X-Series analyzer, refer to that analyzer's User's and Programmer's Reference Guide.

Equipment setup (mixer's path Normal mode or Dual Conversion mode)

Table 2-4 Equipment setup for the M1971E mixer and the N9040B signal analyzer (Option EXM)

Step	Action	Notes
SMA connection	a. Connect an SMA cable from the mixer to the spectrum analyzer EXT MIXER front panel SMA.	The torque for the SMA cables and adapters should not exceed 8 in-lbs. 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.
USB connection	a. Connect a USB cable from the mixer to the spectrum analyzer.	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.
BNC connection (Dual conversion path only)	a. Connect a BNC cable from the mixer's 10 MHz In to the signal analyzer's rear panel 10 MHz Out.	The 10 MHz signal from the signal analyzer provides the LO signal to the mixer's second converter in the dual conversion path.

Table 2-4 Equipment setup for the M1971E mixer and the N9040B signal analyzer (Option EXM)

Step	Action	Notes
		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

Table 2-5 Operation of the M1971E mixer and the N9040B signal analyzer (Option EXM)

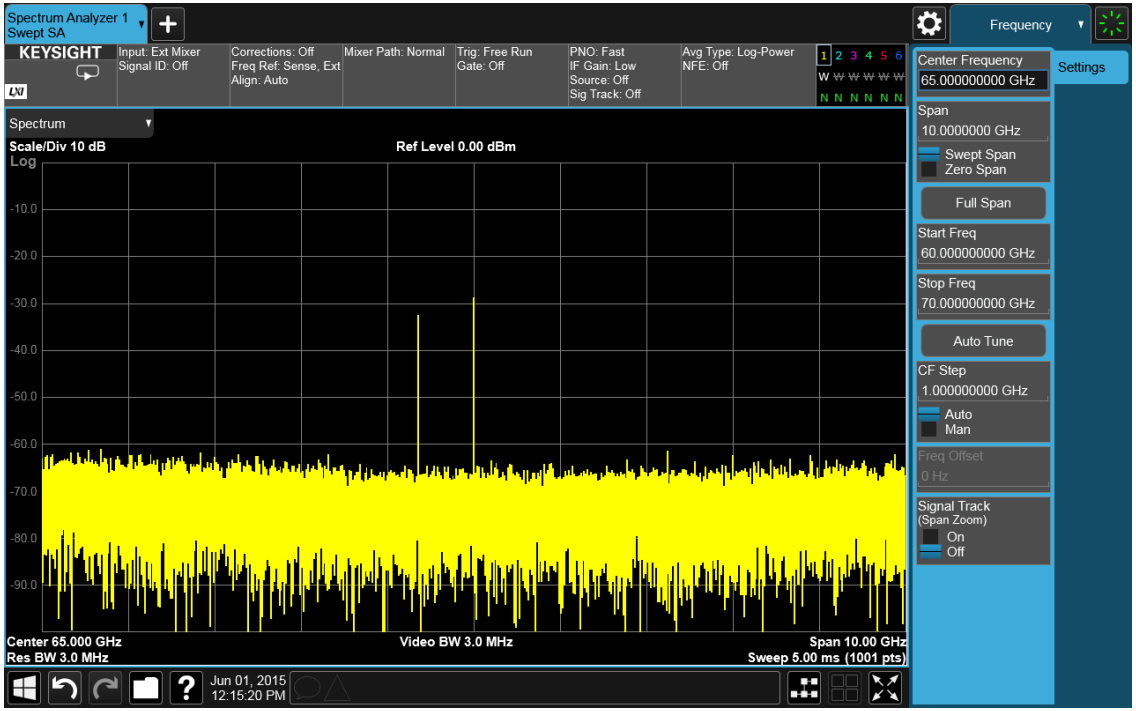
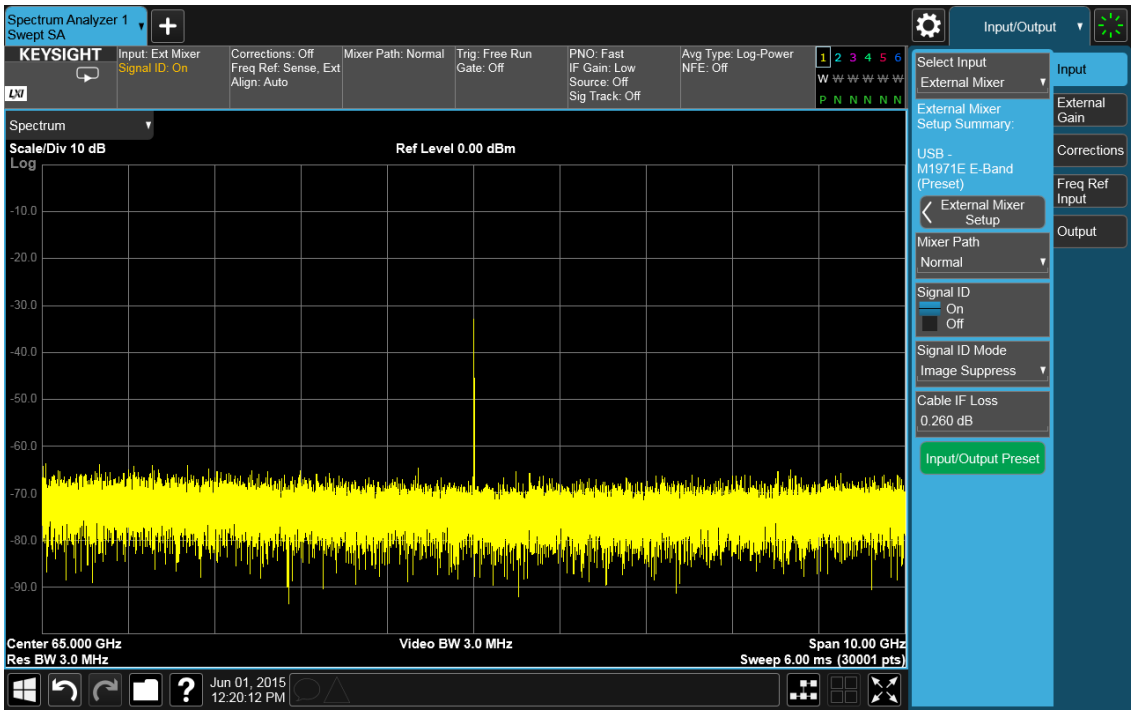
Step	Action	Notes
	a. Apply a signal to the mixer **input**.	–
Tune the analyzer	b. Press the **FREQ** hardkey and on the screen tap **Center Frequency** or a Start and Stop frequency and enter a value.	Multiple responses may appear on screen. Most of these responses are images or multiples of the mixing process and not true signals. The default mixer path Normal is used in this example.
		
Turn on the signal identification function.	a. Press the **Input/Output** hardkey. Tap **Signal ID** to toggle Signal ID on.	This enables you to identify true signals from images and multiples. Refer to the graphic on the next page. See "Signal ID" on page 39 for more information.

Table 2-5 Operation of the M1971E mixer and the N9040B signal analyzer (Option EXM)

Step	Action	Notes
		
With wide spans, increasing the number of sweep points may improve the effectiveness of image suppressing.	a. Press the **Sweep** hardkey and tap **Sweep Config**. Tap **Points** twice and enter **30001**.	

Automatic correction

The M1971E mixer automatically downloads a conversion loss file (magnitude and phase information) 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 the **System** hardkey and then tap **Alignments**, **Align Now**, **External Mixer**.

Viewing the external mixer setup screen

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

To view the setup screen, press the **Input/Output** hardkey and tap **External Mixer Setup**. Tap **Close** to exit this screen.

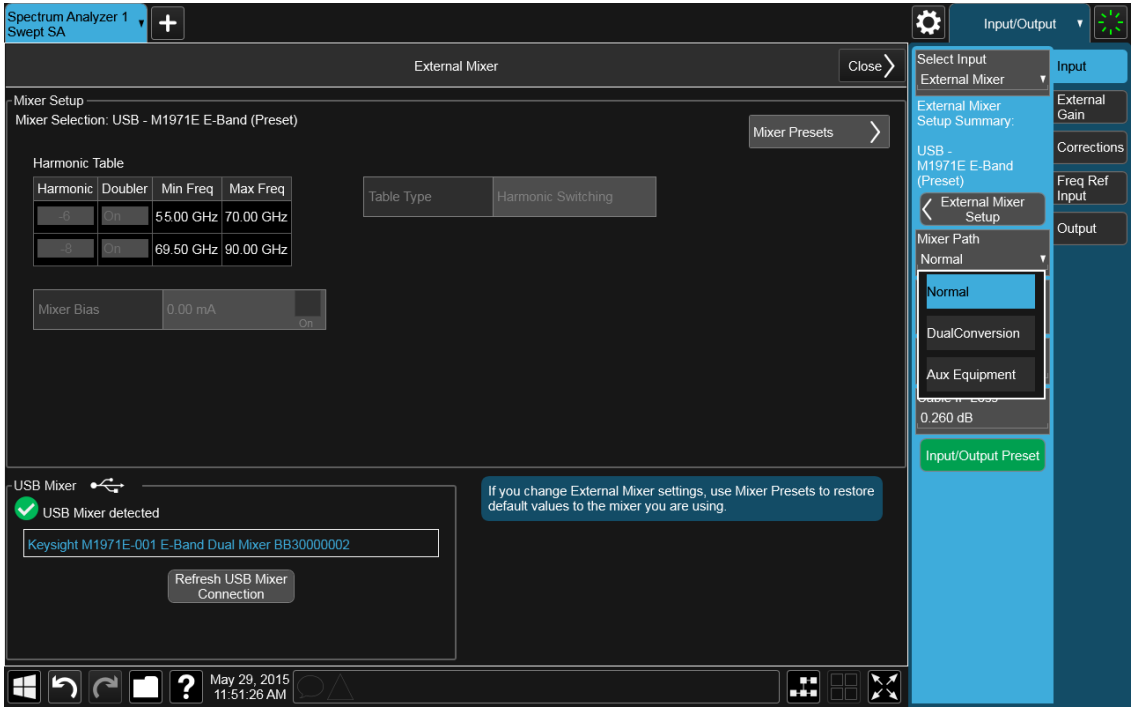


Figure 2-2 External mixer setup screen

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 the 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.

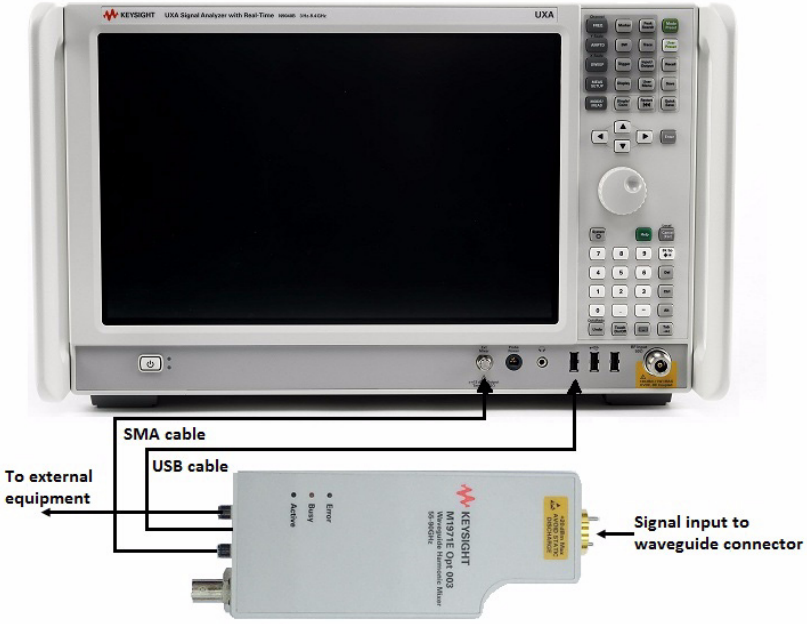
NOTE This function takes control of and uses Trace 1 and Trace 2. Any data in these traces prior to activating Image Shift will be lost.

To synchronize in the 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.

Equipment setup (mixer's path Aux Equipment)

Table 2-6 Equipment setup for the M1971E mixer's path AUX and the N9040B (Option EXM)

Step	Action	Notes
SMA connection	a. Connect an SMA cable from the mixer to the spectrum analyzer EXT MIXER front panel SMA.	The torque for the SMA cables and adapters should not exceed 8 in-lbs. 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.
USB connection	a. Connect a USB cable from the mixer to the spectrum analyzer.	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 the external mixing mode, and the mixer model number and mixer option are used to set the start and stop frequencies for the mixing band.
AUX connection	a. Connect an SMA cable from the mixer's AUX output to an external equipment.	External equipment examples are a wide BW digitizer or an oscilloscope.



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.

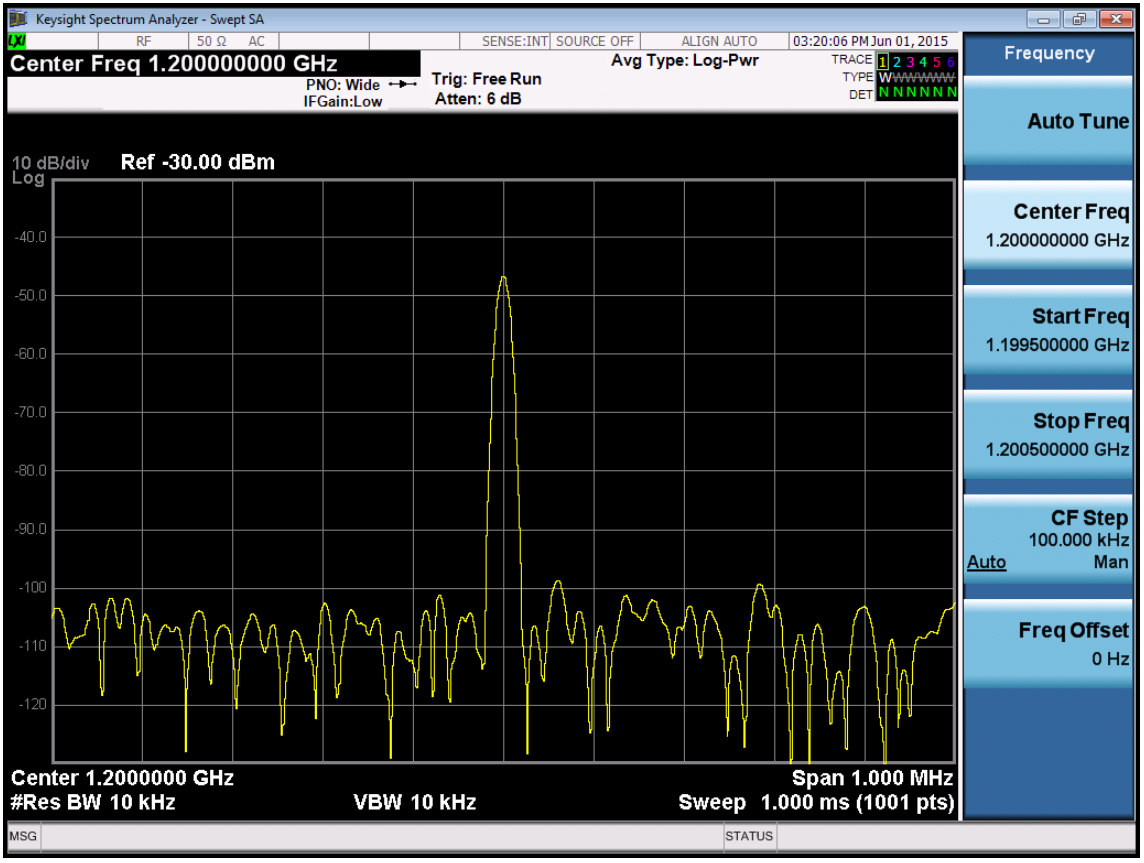
Operation

Table 2-7 Operation of the M1971E mixer's path AUX Equipment

Step	Action	Notes
Tune the analyzer	a. Choose the Normal path.	Press **Input/Output**, **External Mixer**, **Mixer Path**, and choose **Normal**. This is because starting in the Normal path allows you to see the signal on the analyzer screen which makes the initial setup easier.
	b. Apply a signal to the mixer input.	
	c. N9030A, N9020A, and N9010A: Press **FREQ Channel** and enter a center frequency or a start and stop frequency. N9040B: Press **FREQ** and enter a center frequency or a start and stop frequency.	Be sure the signal is centered on the screen since the analyzer will be set to Zero Span when the Aux Equipment path is selected.
Turn on the Aux Equipment path	N9030A, N9020A, and N9010A: Press **Input/Output**, **External Mixer**, **Mixer Path**, and choose **Aux Equipment**. N9040B: Press **Input/Output**, tap **Mixer Path**, and choose **Aux Equipment**.	The signal will disappear from the analyzer screen, since the mixer is only providing a signal to the Aux Out port. The analyzer will be set to Zero Span.
Select the User IF Frequency	N9030A, N9020A and N9010A: Press **Input/Output**, **External Mixer**, **Mixer Path**, **Aux Equipment**, and set **User IF Frequency**. N9040B: Tap **User IF Frequency** and set the frequency value.	Default setting is 1.2 GHz.

Table 2-7 Operation of the M1971E mixer's path AUX Equipment

Step	Action	Notes
"View" the signal on the external spectrum equipment		The screen image below shows the Aux output of the mixer displayed on an external analyzer. The analyzer center frequency corresponds to the user set IF Frequency.



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3 Troubleshooting and Maintenance

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Maintenance 47
Returning an M1971E Mixer for Service 48

This chapter guides you on how to troubleshoot and maintain the M1971E Waveguide Harmonic Mixer.

CAUTION **The M1971E mixer is not field-repairable, and requires return to Keysight for both repair and calibration. Do not attempt to open the mixer enclosure.**

Troubleshooting

Table 3-1 Troubleshooting procedure

Problem	Possible cause/troubleshooting process
Green Active LED does not turn on when mixer is connected to spectrum analyzer through USB cable.	Spectrum analyzer not providing power. Faulty or loose USB cable. Faulty mixer. **Troubleshooting**: Connect another USB device to the signal analyzer.
Red Error LED on mixer lights up (mixer fails the LO alignment routine).	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. The SMA cable is damaged or has too much loss (cable length is too long). Replace the SMA cable with one that is < 3 meters. The 10 MHz reference is not connected during dual conversion mode. Faulty mixer. The signal analyzer LO output is faulty: To test the LO output, remove the SMA cable from the Ext Mixer connector, and unplug the USB cable. **1** Press **Input/Output**, **External Mixer**, **Ext Mix Setup**, **Mixer Presets**. **2** Select **Single Harmonic w/doubler**, select **V-Band**. **3** Press the **Freq** key, **Center Frequency**, **60 GHz**. Then press **Span**, **Zero Span**. **4** Connect a spectrum analyzer capable of measuring a 13 GHz signal to the Ext Mixer connector. **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.
Yellow Busy LED does not come on when USB cable is attached and LO Align does not start.	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.

Error Messages

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

Table 3-2 Error messages

Error message	Possible cause/troubleshooting process
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 waveguide 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

Table 3-3 Replaceable parts

Part number	Description
1390-0671	Socket head cap screw, captive, 4-40 thread, 0.29 inches long (waveguide flange connecting screw for E-band)
1401-0227	Waveguide cap

Returning an M1971E Mixer for Service

Contacting Keysight

Assistance with test and measurement needs and information or finding a local Keysight office are available on the Web at:

www.keysight.com/find/assist

If you do not have access to the Internet, contact your field engineer.

NOTE **In any correspondence or telephone conversation, refer to the Keysight product by its model number and full serial number. With this information, the Keysight representative can determine the warranty status of your unit.**

Shipping your product to Keysight for service or repair

If you wish to send your product to Keysight for service or repair:

- Include a complete description of the service requested or of the failure and a description of any failed test and any error message.
- Remove and retain the front handles and all rack mount hardware. The product should be sent to Keysight in the same configuration as it was originally shipped.
- Ship the product using the original or comparable antistatic packaging materials.
- Contact Keysight for instructions on where to ship your product.

4 Specifications

General Specifications 50
Physical Characteristics 52
Environmental Specifications 53

This chapter provides the specifications of the M1971E Waveguide Harmonic Mixer.

NOTE

Specifications describe warranted performance over the temperature range of 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 Specifications

Table 4-1 General specifications

Description	Specification	Supplemental information
Calibration cycle	1 year	
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 < 1 μs pulse width, < 40% duty cycle (average power: 20 dBm)	
Maximum LO power	20 dBm	
IF frequency		Normal mode[a]: 100 MHz to 1.2 GHz Dual conversion mode: 1.5175 GHz AUX mode: 100 MHz to 3.0 GHz
EMC	Complies with European EMC Directive 2004/108/EC – IEC/EN 61326-1 – CISPR Pub 11 Group 1, Class A – AS/NZS CISPR 11 – ICES/NMB-001 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
AUX connector		SMA female
10 MHz connector		BNC female

[a] Supports all signal analyzer IF Path options.

Description		M1971E Opt 001	M1971E Opt 003
RF frequency range		60 to 90 GHz	55 to 90 GHz
LO harmonic number[a]		–6 and –8	–6 and –8
LO frequency range (GHz)[b]		8.3 to 12.4	8.3 to 12.4
Conversion loss[c]	Normal mode (IF = 322.5 MHz)	20 dB (nominal) 27 dB (maximum)	20 dB (nominal) 27 dB (maximum)
	Dual conversion mode (IF = 1.5175 GHz)	20 dB (nominal) 27 dB (maximum)	20 dB (nominal) 27 dB (maximum)
	AUX mode (IF = 100 MHz to 3.0 GHz)	15 dB (nominal) 25 dB (maximum)	15 dB (nominal) 25 dB (maximum)
Calibration accuracy[d] (nominal)		±2.2 dB	±2.2 dB
Gain compression level (1 dB) (nominal)		0 dBm	0 dBm
Input SWR (nominal)		2:1	55 to 60 GHz: 3.57:1
			60 to 90 GHz: 2:1
Noise figure[e] (nominal)	Normal mode	36 dB	36 dB
	Dual conversion mode	40 dB	40 dB
System Displayed Average Noise Level (DANL) at 1 Hz resolution bandwidth[f] (nominal)	Normal mode	–138 dBm	–138 dBm
	Dual conversion mode	–134 dBm	–134 dBm

[a] "–" signifies that the LO frequency times the LO harmonic number is higher than the RF input frequency. LO × N = RF + IF. Harmonic number is dependent on the start and stop frequencies. Harmonic –6 is used from 50 GHz to 70 GHz and harmonic –8 is used above 69.5 GHz.

[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 M1971E 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 M1971E-only calibration accuracy due to SWR effects between the M1971E 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 M1971E 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 M1971E. 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 and BNC connectors.

Table 4-2 Physical characteristics

Model	Flange	Weight	Height	Width	Length
M1971E Opt 001	WR-12	0.66 kg (1.46 lbs)	41.00 mm (1.61 in)	58.90 mm (2.32 in)	145.66 mm (5.73 in)
M1971E Opt 003					

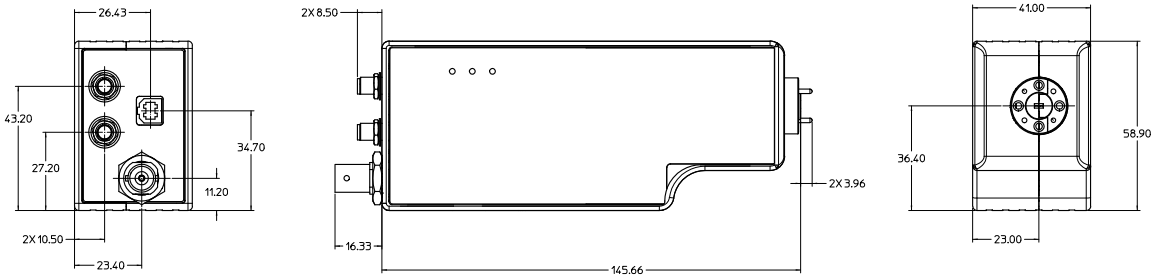

Figure 4-1 M1971E dimensions

Environmental Specifications

The M1971E is designed to fully comply with Keysight Technologies' product operating environment specifications. The following are the summarized environmental specifications for these products.

Table 4-3 Environmental specifications

Description	Specification
Temperature range:	
– Operating	0 to 55 °C
– Storage	-40 to +70 °C
Relative humidity:	
– Operating	95% RH at 40 °C (non-condensing)
Shock:	
– End-use handling shock	ΔV: 1.6 m/s (60 in/s) ± 5%
– Transportation shock	30 g
Vibration:	
– Operating	0.21 g rms
– Survival	2.09 g rms
Altitude:	
– Operating	< 4572 meters (15000 feet)
ESD immunity:	
– Contact discharge	4 kV per IEC 61000-4-2
– Air discharge	8 kV per IEC 61000-4-2

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