Keysight Technologies

M1971E Waveguide Harmonic Mixer

55/60 to 90 GHz

Technical Overview

KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

Introduction

The Keysight Technologies, Inc. M1971E waveguide harmonic mixer is an un-preselected mixer that is designed to extend the frequency of Keysight's high-performance signal analyzers (N9040B UXA, N9030A PXA, N9020A MXA and N9010A EXA) for millimeter-wave applications up to 90 GHz. The M1971E works ideally for applications in the area of 5G design and development, WiGig/11ad, automotive radar and millimeter-wave microwave backhaul that require wideband millimeter-wave signal analysis of more than 2 GHz.

Embedded with smart features, the mixer provides fast and the most efficient test setup with measurement accuracy that's needed in the demanding mixer application test environment. The M1971E uses a simple USB plug-and-play connection that can automatically configure the UXA, PXA, MXA and EXA to detect the specific mixer connected, then download the conversion loss data and automatically compensate for the local oscillator path loss. Therefore, it greatly shortens the overall startup process and technically improves the overall DANL and TOI of your test systems with excellent conversions and amplitude accuracy.

Break free from the conventional harmonic mixing test method and discover a smarter solution by using the M1971E waveguide harmonic mixer in combination with the X-Series signal analyzers.

Go *smart* with harmonic mixing

Smart features:

- Auto amplitude correction and transfer of conversion loss data through USB plug and play features
- Auto LO amplitude adjustment to compensate for cable loss (up to 3 m or 10 dB loss)
- Auto detect mixer model/serial number when used with N9040B UXA, N9030A PXA, N9020A MXA and N9010A EXA signal analyzers:
  - Auto setting of default frequency range and LO harmonic numbers
  - Auto LO alignment during start up
  - Auto run calibration when time and temperature changes

Operation modes

The operation of the M1971E mixers can be categorized into three modes.

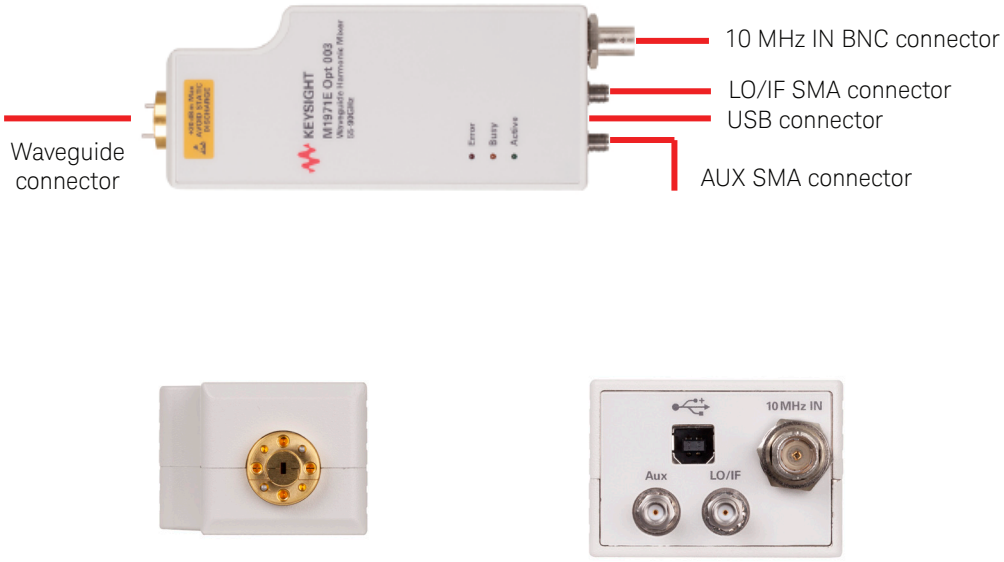


Figure 1. View of the M1971E connectors

- Normal path
  This path should be used for I/Q measurements. The mixer provides approximately 1.2 GHz IF bandwidth. The mixer's IF frequency supplied to the host signal analyzer depends on the host 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 signal analyzer's 10 MHz external reference out to generate second LO signal IF down-conversion. Intended only for swept measurements of wideband modulated carriers. The mixer's IF bandwidth is wide enough to support all host instruments resolution bandwidth settings, but not wide enough for I/Q acquisitions.

- Auxiliary 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, such as an 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 path. Since the signal 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 contain in a file on the signal analyzer.

Specifications

Specifications refer to the performance standards or limits against which the M1971E waveguide harmonic mixer is tested.

Typical characteristics are included for additional information only and they are not warranted specifications. Those denoted as "typical", "nominal" or "approximate" and are printed in italic.

Specifications subject to change.

Specifications (continued)

Specifications	M1971E Option 001	M1971E Option 003
RF frequency range	60 to 90 GHz	55 to 90 GHz
IF frequency Normal mode[1] Dual conversion mode Auxiliary mode[1]	100 MHz to 1.2 GHz 1.5175 GHz 100 MHz to 2.5 GHz	
LO harmonic number[1]	-6 and -8	
LO frequency range[2]	8.3 to 12.4 GHz	
Conversion loss[3] (*nominal*) Normal mode (IF= 322.5 MHz Dual conversion mode (IF = 1.5175 GHz) Auxiliary mode (IF = 100 MHz to 2.5 GHz)	20 dB 27 dB maximum 20 dB 27 dB maximum 20 dB 30 dB maximum	
Calibration accuracy[4] (*nominal*)	+/- 2.2 dB	
Gain compression level (1 dB) (*nominal*)	0 dBm	
Input SWR (*nominal*)	2.1	55 to 60 GHz: 3.57 60 to 90 GHz: 2.1
Noise Figure[5] (*nominal*) Normal mode Dual conversion mode	36 dB 40 dB	
System displayed average noise level (DANL) at 1 Hz resolution bandwidth[6] (*nominal*) Normal mode Dual conversion mode	-138 dBm -134 dBm	
Supplemental characteristics		
CE Data storage method	EEPROM	
Automatic amplitude correction and transfer of conversion loss data	YES	
Automatic LO amplitude adjustment	YES	
Automatic run calibration when time and temperature changes	YES	
LO amplitude	LO requirement provided by compatible signal analyzers. Maximum cable loss 10 dB nominal	
USB requirement	5 V nominal, 500 mA maximum	
Maximum CW RF input level	20 dBm (100 mW)	
Maximum RF peak pulse power	24 dBm with < 1 ms pulse (average power: 20 dBm)	
IF/LO connector	SMA (f)	
AUX connector	SMA (f)	
10 MHz connector	BNC (f)	

1. "-" Signifies that the LO frequency times the LO harmonic number is higher than the RF input frequency. LO X N = RF + IF. Hamonic number is dependent on the start and stop frequenices . Harmonic -6 is used from 50 to 70 GHz and harmonic -8 is used above 69.5 GHz.
2. Exact LO frequency is dependent on the IF path setting of the signal analyzer.
3. Connversion loss value shown includes the effect of an internal IF amplifier.
4. 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 when used with an X-Series signal analyzer and 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 the M1971E only calibration accuracy due to the 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.
5. 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 analyzer will be higher, by nominally 0.8 dB.
6. 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 the industry conventions. The noise densitiy is about 2.25 dB higher than DANL.

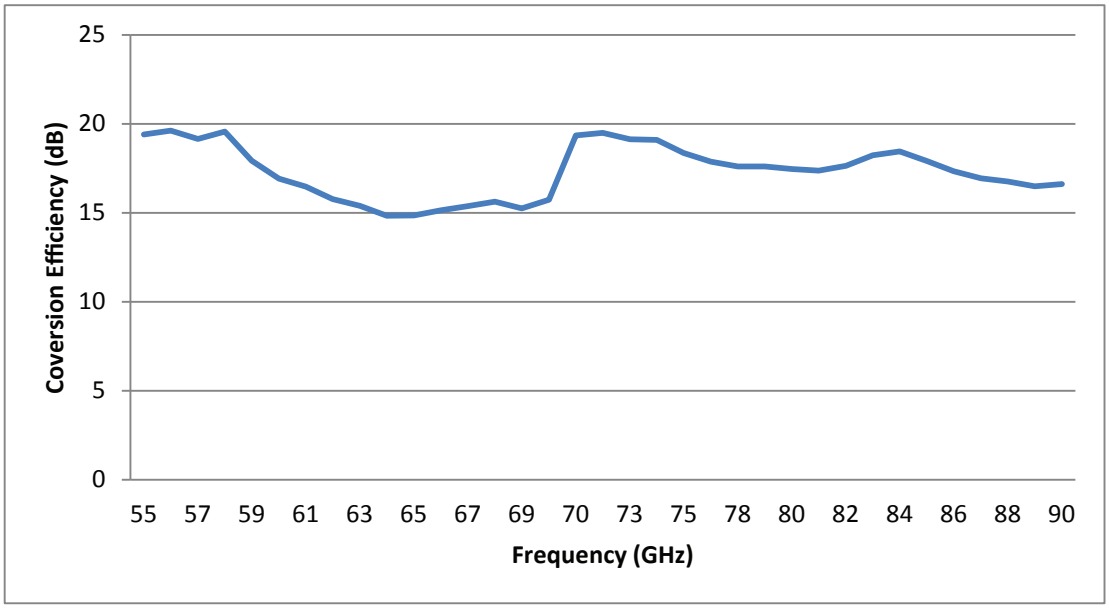


Figure 2. Conversion efficiency versus frequency (normal mode)

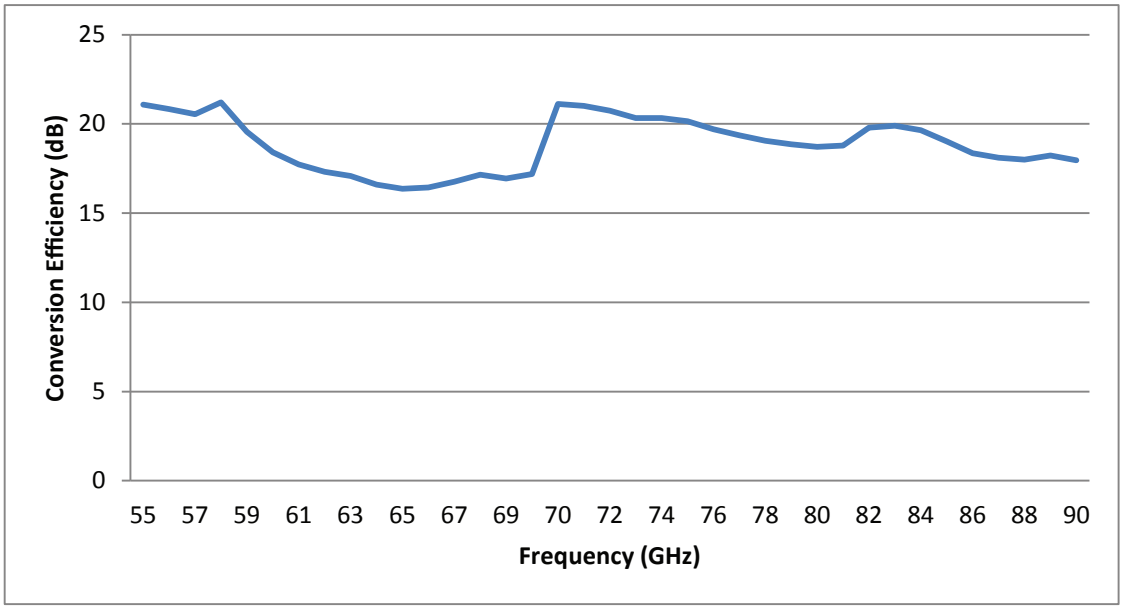


Figure 3. Conversion loss efficiency versus frequency (dual conversion mode)

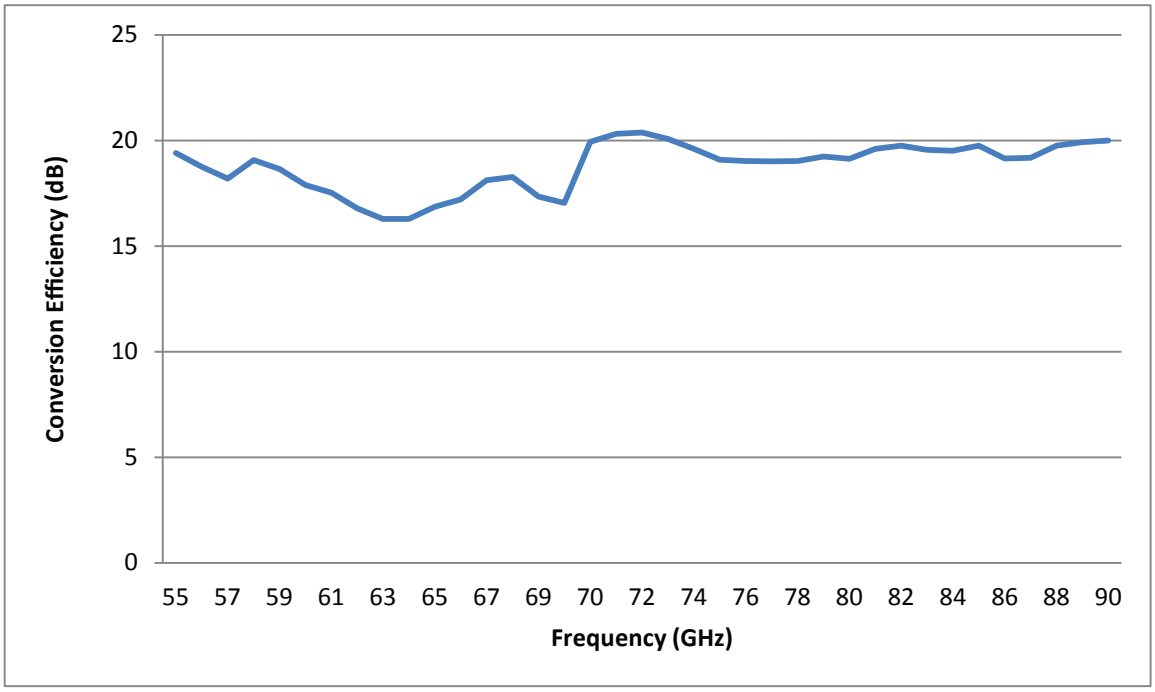


Figure 4. Conversion loss efficiency versus frequency (auxiliary mode)

Environmental Specifications

Keysight M1971E waveguide harmonic mixers are designed to fully comply with Keysight Technologies' product operating environmental specifications. The following are the summarized environmental specifications for the product.

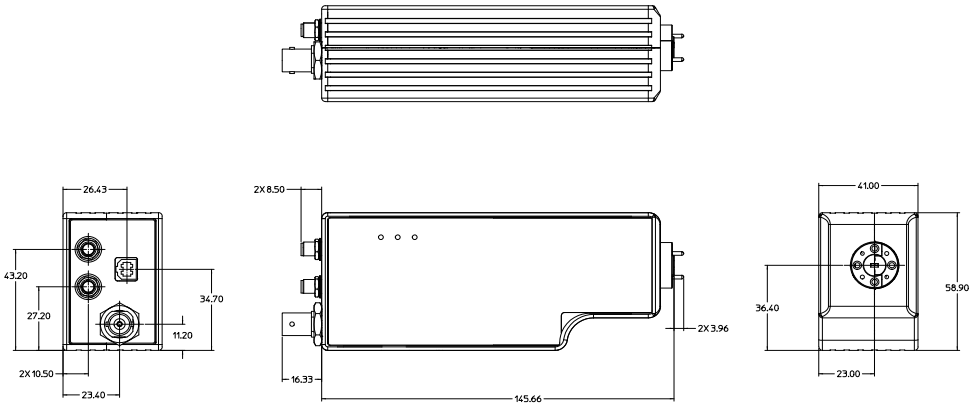
Environmental Specifications	
Temperature range	
Operating	0 to 55 °C
Storage	- 40 to 70 °C
Relative Humidity	
Operating	95 % RH at 40 °C (non-condensing)
Shock	
End-use handling shock	Δ V: 1.6 m/s (60 in/s) ± 5%
Transportation shock	30 g
Vibration	
Operating	0.21 g rms
Survival	2.09 g rms
Altitude	
Operating	< 4,572 meters (15,000 feet)
ESD immunity	
Contact discharge	4 kV per IEC 61000-4-2
Air discharge	8 kV per IEC 61000-4-2

Mechanical dimension*

Does not include SMA/BNC connector.

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

*Dimensions are in mm (inches) nominal, unless otherwise specified



Ordering Information

M1971E	
Option 001	60 to 90 GHz Waveguide harmonic mixer
Option 003	55 to 90 GHz Waveguide harmonic mixer
LO cable options	
Option 101	1 meter LO cable
Option 102	3 meter LO cable
USB cable options	
Option 201	1.8 meter USB cable
Option 202	3 meter USB cable
Jackstand[1]	
Option 301	Standard jackstand for mixer

1. Option 301 is also available for order as a standalone product

Recommended signal analyzers

N9040B UXA signal analyzer www.keysight.com/find/uxa
N9030A PXA signal analyzer www.keysight.com/find/pxa
N9020A MXA signal analyzer www.keysight.com/find/mxa
N9010A EXA signal analyzer www.keysight.com/find/exa

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