

# Keysight Technologies

## Waveguide Harmonic Mixers

M1971E: 55/60 to 90 GHz

M1971V: 50 to 75 GHz

M1971W: 75 to 110 GHz

### Technical Overview





## Introduction

The Keysight Technologies, Inc. M1971E/V/W waveguide harmonic mixer is an unpreselected mixer that is designed to extend the frequency of Keysight's high-performance signal analyzers (N9040B UXA, N9030A PXA, N9020A MXA and N9010A EXA) and S-series oscilloscopes (MSOS404/604/804A and DSOS404/604/804A) for millimeter-wave applications up to 110 GHz. The M1971E/V/W 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/V/W uses a simple USB plug-and-play connection that can automatically configure the X-series signal analyzers 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/V/W 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)
- Vector correction data includes magnitude and phase improving EVM measurement
- Auto detect mixer model/serial number when used with X-series 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/V/W mixers can be categorized into three modes.

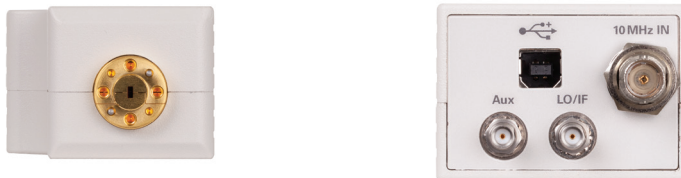


Figure 1. View of the M1971E/V/W connectors

- 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/V/W 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	M1971V	M1971W
RF frequency range	60 to 90 GHz	55 to 90 GHz	50 to 75 GHz	75 to 110 GHz
IF frequency		100 MHz to 1.2 GHz		
Normal mode <sup>1</sup>		100 MHz to 1.2 GHz		
Dual conversion mode		1.5175 GHz		
Auxiliary mode <sup>1</sup>		100 MHz to 3.0 GHz		
LO harmonic number <sup>1</sup>	-6 and -8		-4 and -6	-6 and -8
LO frequency range <sup>2</sup>	8.3 to 12.4 GHz		8 to 14 GHz	8 to 14.3 GHz
Conversion loss <sup>3</sup>		20 dB (nominal)/27 dB (maximum)		
Normal mode (IF= 322.5 MHz)		20 dB (nominal)/27 dB (maximum)		
Dual conversion mode (IF = 1.5175 GHz)		20 dB (nominal)/27 dB (maximum)		
Auxiliary mode (IF = 100 MHz to 2.5 GHz)		15 dB (nominal)/25 dB (maximum)		
Calibration accuracy <sup>4</sup> (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	2.1	2.1
Noise Figure <sup>5</sup> (nominal)				
Normal mode	33 dB		31 dB	32 dB
Dual conversion mode	35 dB		32 dB	33 dB
System displayed average noise level (DANL) at 1 Hz resolution bandwidth <sup>6</sup> (nominal)				
Normal mode	-141 dBm		-142 dBm	
Dual conversion mode	-139 dBm		-141 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 <sup>7</sup>	SMA (f)			
AUX connector	SMA (f)			
10 MHz connector	BNC (f)			

- "-" Signifies that the LO frequency times the LO harmonic number is higher than the RF input frequency.  $LO \times N = RF + IF$ . Harmonic number is dependent on the start and stop frequencies.
- Exact LO frequency is dependent on the IF path setting of the signal analyzer.
- Conversion loss value shown includes the effect of an internal IF amplifier.
- Calibration accuracy is the difference between the conversion loss factors measured and programmed into the M1971E/V/W 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/V/W only calibration accuracy due to the SWR effects between the M1971E/V/W and the X-Series IF input, and due to gain accuracy at the IF input of the X-Series analyzer used.
- The values shown are the noise figures of the M1971E/V/W 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.
- System DANL includes the effect of an X-Series analyzer and cable as well as the M1971E/V/W. DANL is defined with log-scale averaging according to the industry conventions. The noise density is about 2.25 dB higher than DANL.
- Cable loss at IF frequency 322.5 MHz (typical) is 0.21 dB for 1 meter LO cable and 0.64 dB for 3 meters LO cable

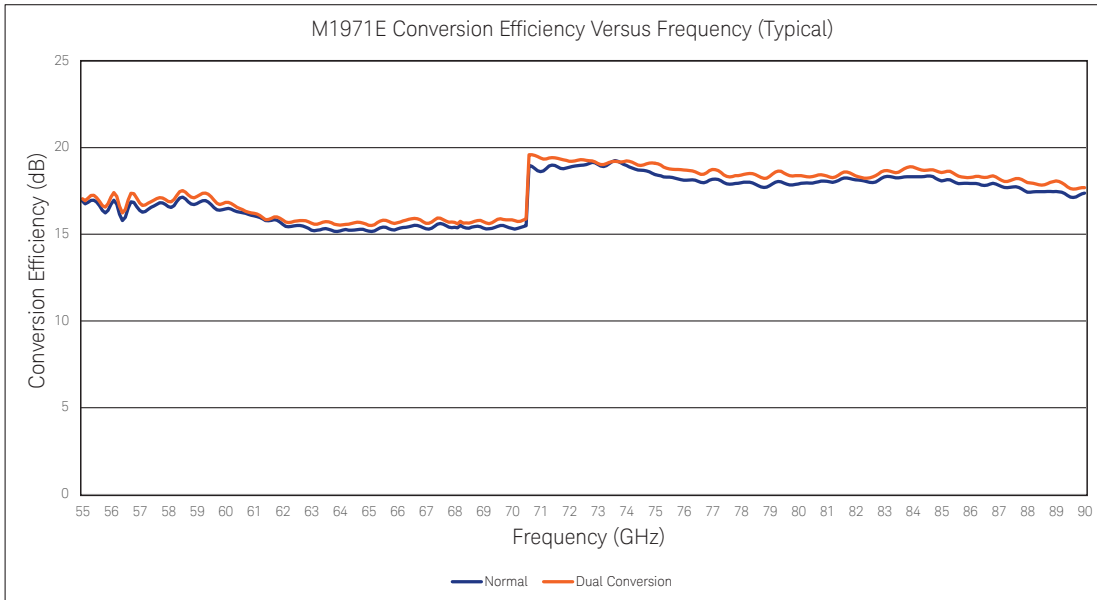


Figure 2. M1971E conversion efficiency versus frequency (normal & dual-conversion mode)

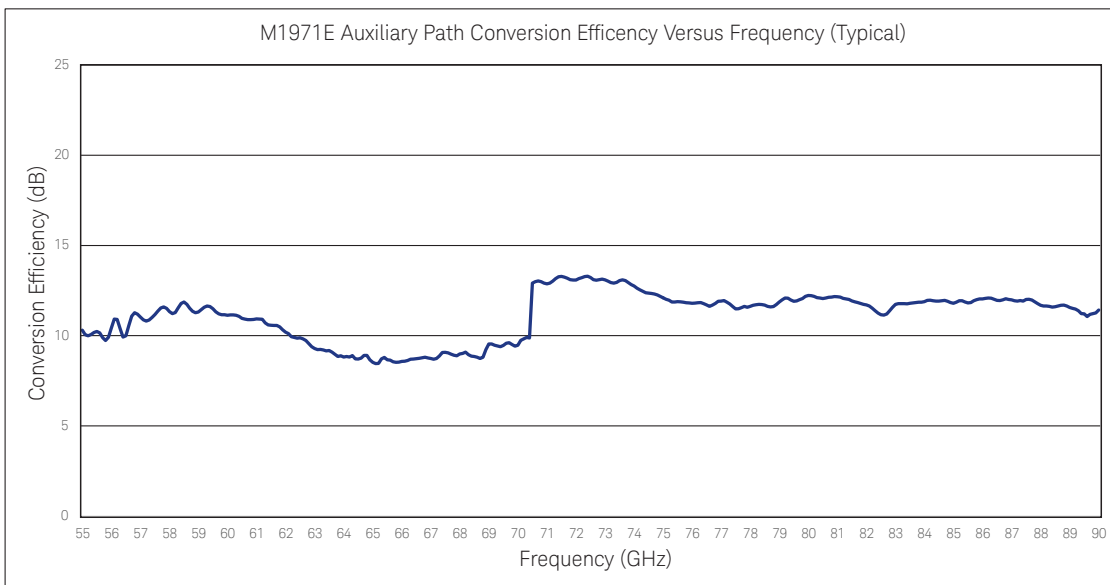


Figure 3. M1971E conversion efficiency versus frequency (auxiliary path)

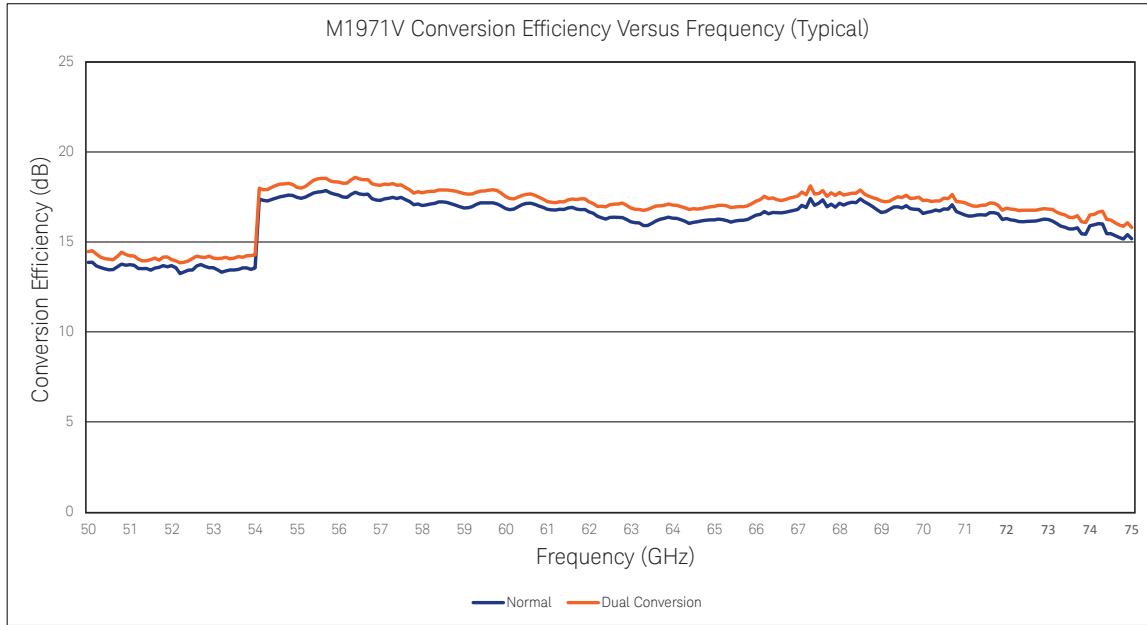


Figure 4. M1971V conversion efficiency versus frequency (normal & dual-conversion mode)

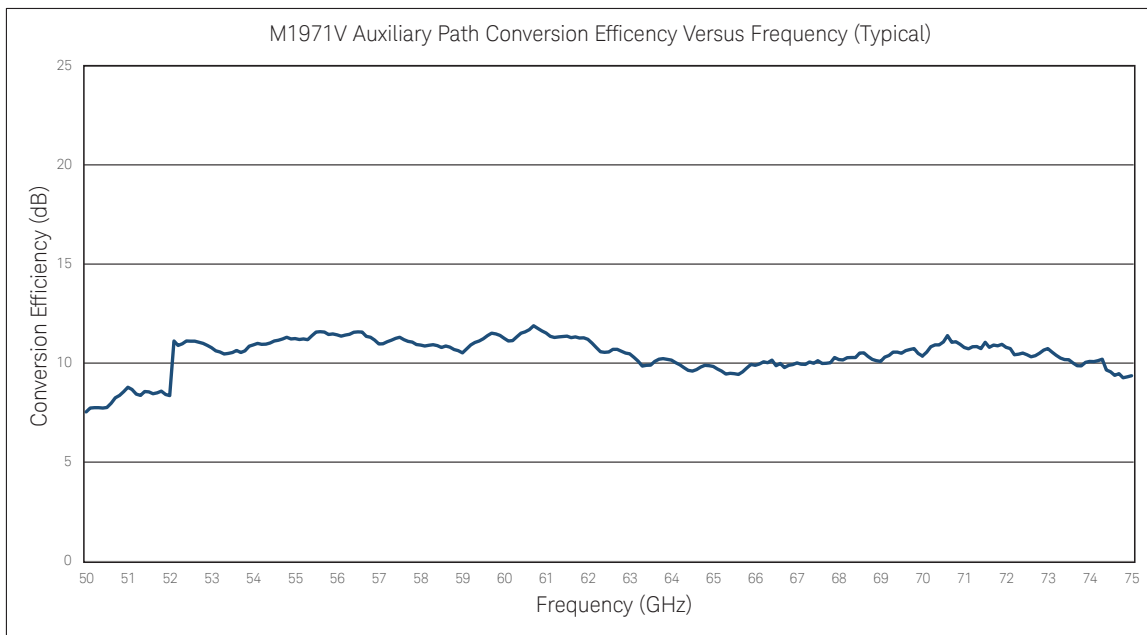


Figure 5. M1971V conversion efficiency versus frequency (auxiliary path)

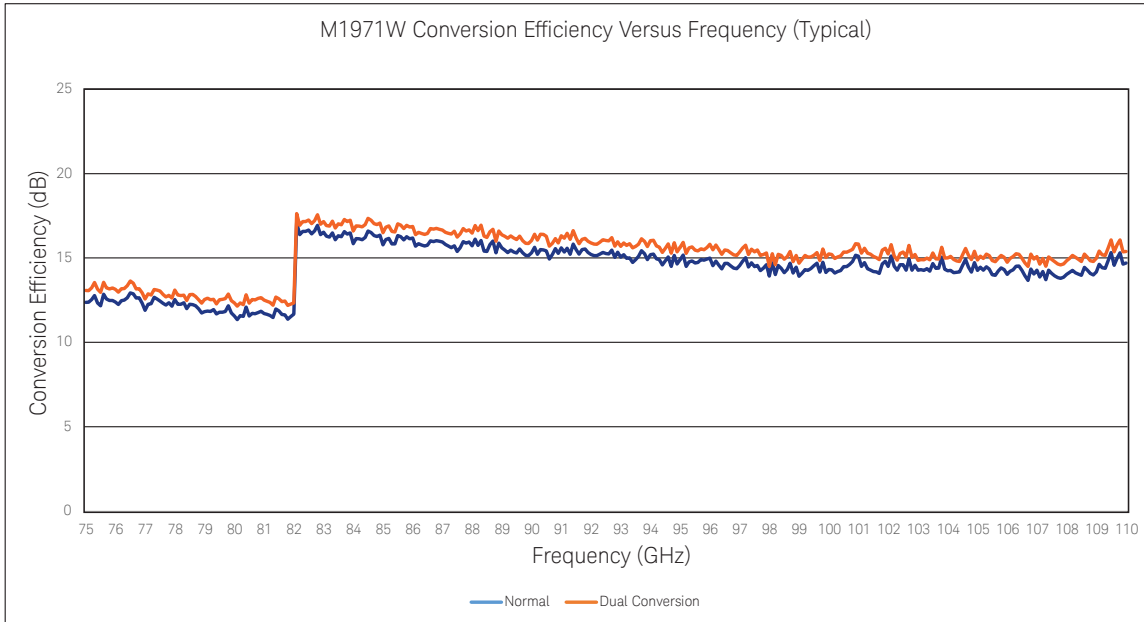


Figure 6. M1971W conversion efficiency versus frequency (normal & dual-conversion mode)

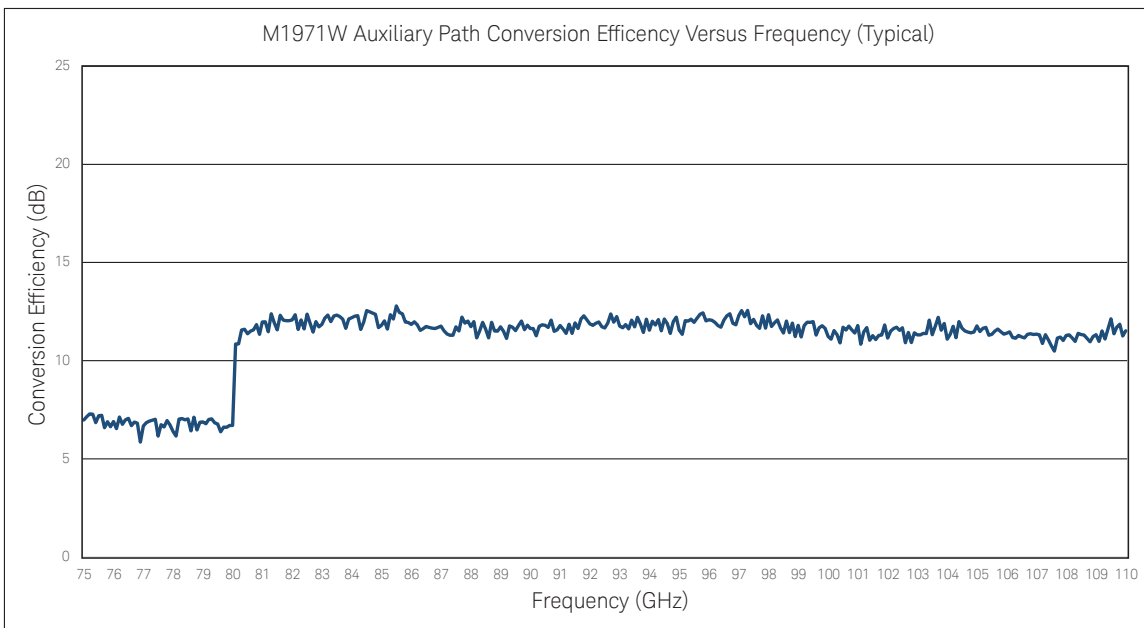


Figure 7. M1971W conversion efficiency versus frequency (auxiliary path)



## Environmental Specifications

Keysight M1971E/V/W 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.

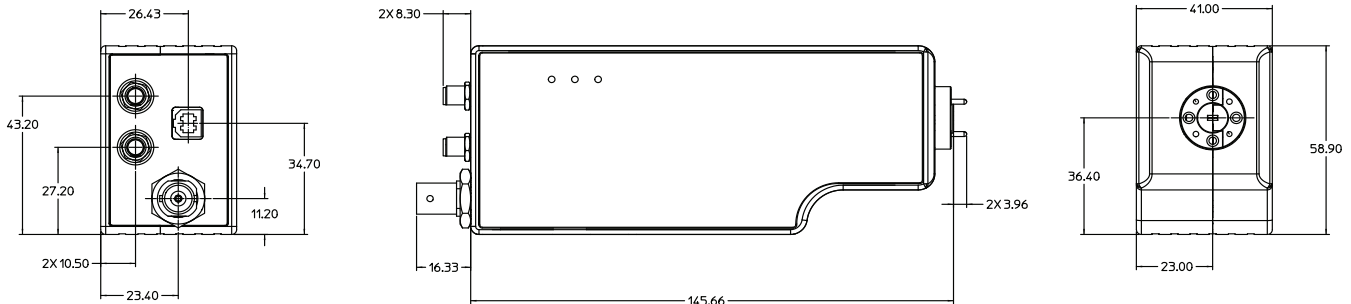
Environmental Specifications	
Temperature range	
Operating	0 to 55 °C
Storage	- 40 to 70 °C
Relative Humidity	
Operating	95 % RH at 40 °C (non-condensing)
Shock	
End-use handling shock	$\Delta V$ : 1.6 m/s (60 in/s) $\pm$ 5%
Transportation shock	30 g
Vibration	
Operating	0.21 g rms
Survival	2.09 g rms
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.

Model	Flange	Weight	Height	Width	Length
M1971E (Option 001)	UG-387/U WR-12	0.68 kg (1.49 lbs)	41.00 mm (1.61 in)	58.90 mm (2.32 in)	145.66 mm (5.73 in)
M1971E (Option 003)					
M1971V	UG-385/U WR-15				
M1971W	UG-387/ U-M WR-10				

\*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
M1971V		50 to 75 GHz Waveguide harmonic mixer
M1971W		75 to 110 GHz Waveguide harmonic mixer

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### LO cable options

Option 101		1 meter LO cable
Option 102		3 meter LO cable

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### USB cable options

Option 201		1.8 meter USB cable
Option 202		3 meter USB cable

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### Jackstand<sup>1</sup>

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

## Recommended signal analyzers

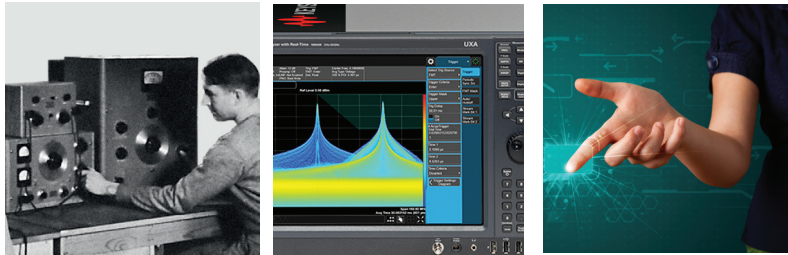
N9040B UXA signal analyzer [www.keysight.com/find/uxa](http://www.keysight.com/find/uxa)  
 N9030A/B PXA signal analyzer [www.keysight.com/find/pxa](http://www.keysight.com/find/pxa)  
 N9020A/B MXA signal analyzer [www.keysight.com/find/mxa](http://www.keysight.com/find/mxa)  
 N9010A/B EXA signal analyzer [www.keysight.com/find/exa](http://www.keysight.com/find/exa)

## Recommended oscilloscopes

E-band Signal Analysis Solution  
 MSOS404/604/804A oscilloscopes  
 DSSO404/604/804A oscilloscopes

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Our unique combination of hardware, software, support, and people can help you reach your next breakthrough. **We are unlocking the future of technology.**



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