Keysight Technologies
Waveguide Harmonic Mixers
M1971E: 55/60 to 90 GHz
M1971V: 50 to 75 GHz
M1971W: 75 to 110 GHz

Technical Overview
The Keysight Technologies, Inc. M1971E/V/W 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) 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)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>RF frequency range</strong></td>
<td>60 to 90 GHz</td>
<td>55 to 90 GHz</td>
<td>50 to 75 GHz</td>
<td>75 to 110 GHz</td>
</tr>
<tr>
<td><strong>IF frequency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal mode¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual conversion mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary mode¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LO harmonic number¹</strong></td>
<td>-6 and -8</td>
<td>-4 and -6</td>
<td>-6 and -8</td>
<td></td>
</tr>
<tr>
<td><strong>LO frequency range²</strong></td>
<td>8.3 to 12.4 GHz</td>
<td>8 to 14 GHz</td>
<td>8 to 14.3 GHz</td>
<td></td>
</tr>
<tr>
<td><strong>Conversion loss³</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal mode (IF = 322.5 MHz)</td>
<td>20 dB (nominal)/27 dB (maximum)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual conversion mode (IF = 1.5175 GHz)</td>
<td>20 dB (nominal)/27 dB (maximum)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary mode (IF = 100 MHz to 2.5 GHz)</td>
<td>15 dB (nominal)/25 dB (maximum)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Calibration accuracy⁴</strong> (nominal)</td>
<td>+/- 2.2 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gain compression level (1 dB) (nominal)</strong></td>
<td>0 dBm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Input SWR (nominal)</strong></td>
<td>2.1</td>
<td>55 to 60 GHz: 3.57</td>
<td>2.1</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Conversion loss³</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal mode</td>
<td>33 dB</td>
<td>31 dB</td>
<td>32 dB</td>
<td>33 dB</td>
</tr>
<tr>
<td>Dual conversion mode</td>
<td>35 dB</td>
<td>32 dB</td>
<td>33 dB</td>
<td></td>
</tr>
<tr>
<td><strong>System displayed average noise level (DANL) at 1 Hz resolution bandwidth⁵</strong> (nominal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal mode</td>
<td>-141 dBm</td>
<td>-142 dBm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual conversion mode</td>
<td>-139 dBm</td>
<td>-141 dBm</td>
<td></td>
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</tbody>
</table>

### 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)

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1. "-" Signifies that the LO frequency times the LO harmonic number is higher than the RF input frequency. LO X N = RF + IF. Harmonic number is dependent on the start and stop frequencies.
2. Exact LO frequency is dependent on the IF path setting of the signal analyzer.
3. Conversion 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/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.
5. 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.
6. 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.
7. 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 auxiliary path 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.

<table>
<thead>
<tr>
<th>Environmental Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range</td>
</tr>
<tr>
<td>Operating</td>
</tr>
<tr>
<td>Storage</td>
</tr>
<tr>
<td>Relative Humidity</td>
</tr>
<tr>
<td>Operating</td>
</tr>
<tr>
<td>Shock</td>
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<tr>
<td>End-use handling shock</td>
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<tr>
<td>Transportation shock</td>
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<tr>
<td>Vibration</td>
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<tr>
<td>Operating</td>
</tr>
<tr>
<td>Survival</td>
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<tr>
<td>Altitude</td>
</tr>
<tr>
<td>Operating</td>
</tr>
<tr>
<td>ESD immunity</td>
</tr>
<tr>
<td>Contact discharge</td>
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<tr>
<td>Air discharge</td>
</tr>
</tbody>
</table>

Mechanical dimension*

Does not include SMA/BNC connector.

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

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1971E</td>
<td>60 to 90 GHz Waveguide harmonic mixer</td>
</tr>
<tr>
<td>Option 001</td>
<td>55 to 90 GHz Waveguide harmonic mixer</td>
</tr>
<tr>
<td>Option 003</td>
<td>50 to 75 GHz Waveguide harmonic mixer</td>
</tr>
<tr>
<td>M1971V</td>
<td>75 to 110 GHz Waveguide harmonic mixer</td>
</tr>
<tr>
<td>M1971W</td>
<td></td>
</tr>
</tbody>
</table>

**LO cable options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>1 meter LO cable</td>
</tr>
<tr>
<td>102</td>
<td>3 meter LO cable</td>
</tr>
</tbody>
</table>

**USB cable options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>201</td>
<td>1.8 meter USB cable</td>
</tr>
<tr>
<td>202</td>
<td>3 meter USB cable</td>
</tr>
</tbody>
</table>

**Jackstand¹**

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>301</td>
<td>Standard jackstand for mixer</td>
</tr>
</tbody>
</table>

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
- DSS0404/604/804A oscilloscopes
Evolving Since 1939

Our unique combination of hardware, software, services, and people can help you reach your next breakthrough. We are unlocking the future of technology. From Hewlett-Packard to Agilent to Keysight.

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www.keysight.com/find/mta
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Opt. 3 (IT)
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