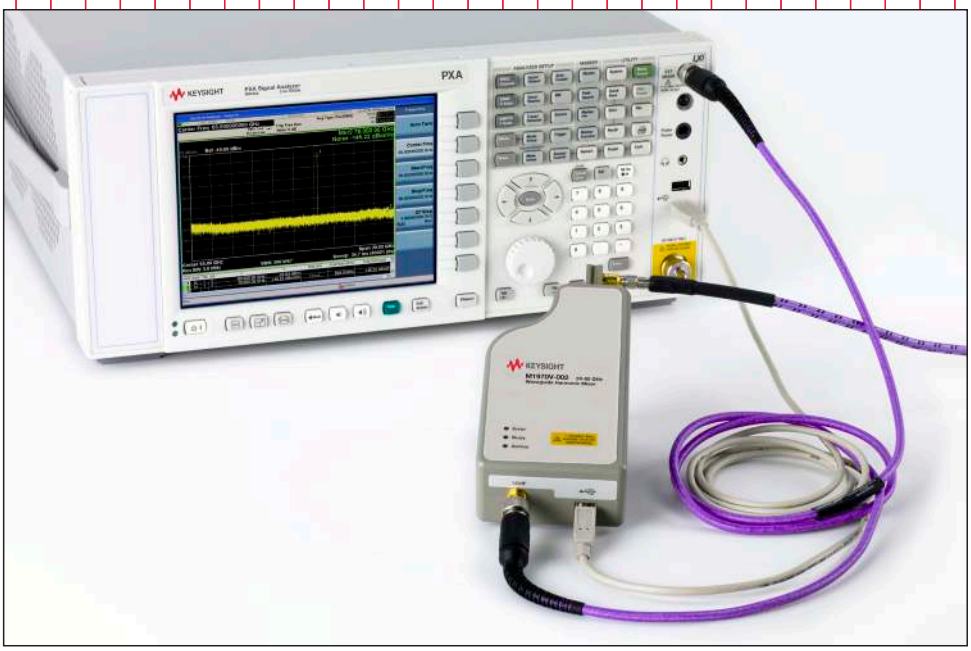
Keysight Technologies

Why Migrate to the Keysight M1970 Series Smart Harmonic Mixers?

Technical Overview



KEYSIGHT TECHNOLOGIES

Introduction

Get the best high frequency measurement performance from your PXA/MXA/EXA signal analyzer with a Keysight Technologies Inc. M1970 Series smart harmonic mixer. The smart harmonic mixer merges effortlessly with the PXA/MXA/EXA to give you clearer insight into your millimeter wave designs.

- **Smooth Integration –** Streamlined interface simplifies setup
- **High Sensitivity** – Low power signals become more visible
- **Measurement Confidence** – Minimize the uncertainty

Overview

The Keysight M1970 Series smart harmonic mixers take the PXA/MXA/EXA industry leading performance to new heights for millimeter and high frequency applications. The M1970 Series replaces the legacy 11970 Series waveguide harmonic mixers (V- and W-band) as the ideal external mixing solution for Keysight's N9030A PXA, N9020A MXA, and N9010A EXA for signals up to 110 GHz. Keysight offers models for three frequency bands: E-band (60 to 90 GHz), V-band (50 to 75 GHz) and W-band (75 to 110 GHz). We also offer an expanded V-band model that further extends the range to 80 GHz for special applications.

In addition to vastly improving performance specifications over legacy mixers, the M1970 Series introduces numerous embedded features that automate setup procedures and provide a higher level of measurement accuracy. The simple to use USB interface simultaneously links the smart harmonic mixer with PXA/MXA/EXA signal analyzers, while triggering an automated configuration sequence. This USB plug-and-play innovation combined with the single coaxial IF/LO interface promises an effortless setup procedure that takes only minutes.

Why migrate to a smart harmonic mixer?

Go smart with USB plug-and-play

The functions embedded within the smart harmonic mixer stand out as market precedents for harmonic mixers. The distinction as a "smart mixer" is used to emphasize the unique active role the smart harmonic mixer plays in setting up and maintaining the integrity of the test environment. Some of the built in features of the smart harmonic mixers include:

- Automatic upload of a conversion-loss correction file to the signal analyzer. Legacy mixers require the operator to take additional steps to manually install a similar set of correction information. The smart harmonic mixer eliminates these steps as a convenience and to prevent potential input error on the part of the user.
- Alignment of the PXA, MXA, and EXA local oscillator based on operating temperatures of the analyzer and the harmonic mixer
- Auto alignment for cable insertion losses of up to 10 dB (~ 3 meters)
- Identification of serial number and model
- The analyzer frequency range defaults to the mixer operating band

Integrating an M1970 Series mixer into a test fixture is simple and effortless. The legacy mixers, which have separate IF and LO terminals, require a diplexer to interface with the single IF/LO terminal on the PXA, MXA, and EXA. Since the smart harmonic mixer contains an internal diplexer, it only requires a single SMA cable for device testing within 3 meters of the signal analyzer. Connecting via the USB plug-and-play finishes preparing the PXA, MXA, and EXA for analysis in minutes.

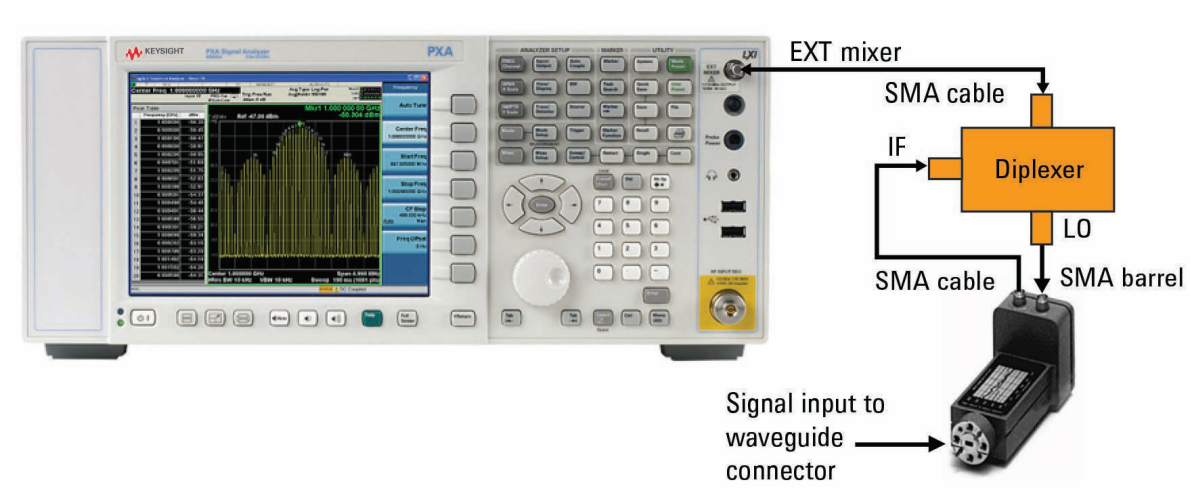


Figure 1. The legacy 11970 mixer's connectivity includes a diplexer and additional components to interface with a PXA signal analyzer.

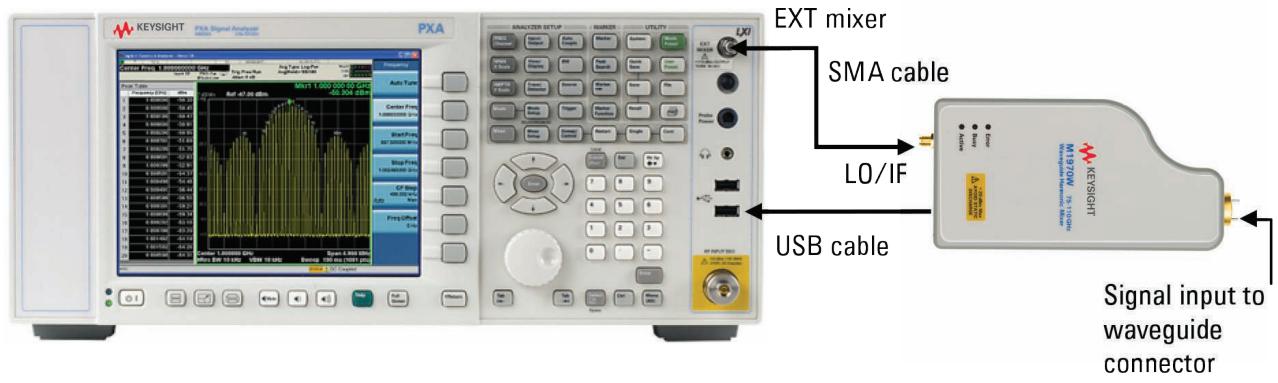


Figure 2. The smart harmonic mixer's economical connectivity is minimized to a single SMA coaxial cable and a USB cable.

Superb sensitivity

The smart harmonic mixer has been designed specifically for the PXA, MXA, and EXA to fully take advantage of its industry-leading sensitivity and dynamic range. By selecting a range of LO frequencies far beyond those used by the 11970 mixers, the M1970 Series mixers utilize lower harmonics, which dramatically improves performance characteristics. These lower harmonics exchange more power from the input signal to the IF terminal, ultimately translating to low conversion losses of 27 dB (E-band), 23 dB (V-band) and 25 dB (W-band).

The hefty signal power at the IF terminal diminishes the role of the IF gain stage which amplifies both the signal and the internally generated noise, thereby lowering the displayed average noise level (DANL). Measurements show nominal DANL values of -136 dBm (E-band), -141 dBm (V-band) and -138 dBm (W-band). This leap in noise suppression improves the ability to resolve low level signals and expands the dynamic range.

Comparison of nominal signal analyzer noise at 1 Hz RBW tested with PXA signal analyzer

Band Series	11970	M1970 Series
E	N/A	–136 dBm
V	–126 / –124 dBm	–141 dBm
V+	N/A	–141 dBm
W	–118 dBm	–138 dBm

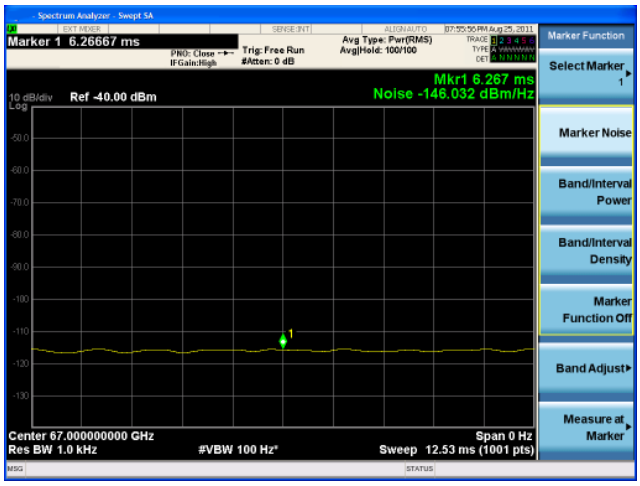


Figure 3. An example DANL measurement for an 11970 mixer at 67 GHz normalized to a 1 Hz resolution bandwidth yields –128.6 dBm.

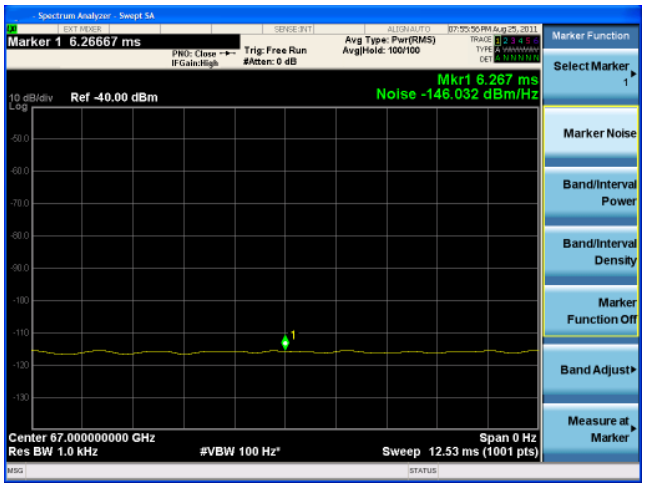


Figure 4. The same DANL measurement with a smart harmonic mixer at 67 GHz normalized to a 1 Hz resolution bandwidth yields –146.0 dBm.

Measurement confidence

The system embedded within the smart harmonic mixer was devised for the purpose of accomplishing utmost signal clarity with maximum convenience. This commitment to signal precision is evidenced by the fact that each smart harmonic mixer is calibrated for the entire frequency range, with nominal uncertainties of 2.2 dB for both bands, an improvement over uncertainties of up to 3.2 dB for the legacy mixers.

Smart harmonic mixers minimize conversion loss, a common problem among harmonic mixers that results in degradation of sensitivity. Additionally, to upload the conversion loss data to a spectrum/signal analyzer can be cumbersome with conventional methods such as loading the file from an external storage source, like a floppy disc. The USB conveniently triggers the smart harmonic mixer to upload a high resolution amplitude correction file that spans the entire frequency band. The corrections are then automatically applied to the displayed signal and are protected from alteration or corruption.

As a more adaptive corrective feature, the LO alignment process limits amplitude uncertainty due primarily to cable insertion loss. This cycle runs through the entire LO sweep as a detector within the smart harmonic mixer and compares the power it receives to an internal reference. If the smart harmonic mixer locates discrepancies between the two, it may flag the analyzer to modify the LO accordingly. This adjustment process can correct for losses of up to 10 dB, which translates to about 3 meters of cable. The PXA, MXA, and EXA continue to solidify analysis confidence by monitoring the operating temperatures of both devices and will realign if any deviations obstruct analysis accuracy.

Specifications

Comparison between V-band 11970 and M1970 mixers tested with Keysight PXA signal analyzer

Performance characteristics	11970V	M1970V
RF frequency range	50 to 75 GHz	50 to 75 GHz (Opt 001)
	50 to 86 GHz (Option E01)	50 to 80 GHz (Opt 002)
LO harmonic number [1]	12– /14–	6–
LO input frequency range	3.55 to 5.33 GHz	8.39 to 12.56 GHz (Opt 001)
		8.39 to 13.39 GHz (Opt 002)
LO amplitude range	+14 to +18 dBm	Automatic adjustment by analyzer
Maximum conversion loss	40 dB	23 dB [2]
Calibration accuracy	±2.6 dB (LO ampl +14.5 to +16 dBm)	±2.2 dB (nominal)
	±3.2 dB (LO ampl +16 to +18 dBm)	
Gain compression level (< 1 dB)	–3 dBm	0 dBm (nominal)
Input SWR	< 2.6:1	2.6:1 (nominal)
System displayed average noise level (DANL) at 1 Hz RBW	–126/–124 dBm	–141 dBm (nominal)
USB plug-and-play	No	Yes
Automatic conversion loss amplitude correction	No	Yes
Auto LO amplitude adjustment	No	Yes
Auto calibration when time and temperature changes	No	Yes

1. "–" signifies that the LO frequency multiplied by the LO harmonic number is higher than the RF input frequency. LO x N = RF + IF.
2. Conversion loss values shown include the effect of an internal IF amplifier.

Comparison between W-band 11970 and M1970 mixers tested with Keysight PXA signal analyzer

Performance characteristic	11970W	M1970W
RF frequency range	75 to 110 GHz	75 to 110 GHz
LO harmonic number [1]	18–	8–
LO input frequency range	3.55 to 5.33 GHz	9.42 to 13.80 GHz
LO amplitude range	+14 to +18 dBm	Automatic adjustment by analyzer
Maximum conversion loss	46 dB	25 dB [2]
Calibration accuracy	±2.6 dB (LO ampl +14.5 to +16 dBm)	±2.2 dB (nominal)
	±3.2 dB (LO ampl +16 to +18 dBm)	
Gain compression level (< 1 dB)	–1 dBm	0 dBm (nominal)
Input SWR	2.6:1	2.6:1 (nominal)
System displayed average noise level (DANL) at 1 Hz RBW	–118 dBm	–138 dBm (nominal)
USB plug-and-play	No	Yes
Automatic conversion loss amplitude correction	No	Yes
Auto LO amplitude adjustment	No	Yes
Auto calibration when time and temperature changes	No	Yes

E-band M1970 mixers tested with Keysight PXA signal analyzer

Performance characteristic	M1970E
RF frequency range	60 to 90 GHz
LO harmonic number [1]	-6/-8
LO input frequency range	9.42 to 12.56 GHz
LO amplitude range	Automatic adjustment by analyzer
Maximum conversion loss	27 dB(2)
Calibration accuracy	±2.2 dB (nominal)
Gain compression level (< 1 dB)	0 dBm (nominal)
Input SWR	< 2.6:1(nominal)
System displayed average noise level (DANL) at 1 Hz RBW	-136 dBm (nominal)
USB plug-and-play	Yes
Automatic conversion loss amplitude correction	Yes
Auto LO amplitude adjustment	Yes
Auto calibration when time and temperature changes	Yes

Physical comparison of 11970 vs. M1970 Series mixers

General characteristic	11970 Series	M1970 Series
Dimensions (H x W x D)	51.0 mm x 36.0 mm x 90 mm	45.0 mm x 81.3 mm x 161.5 mm
	2.0 in x 1.4 in x 3.0 in	1.7 in x 3.2 in x 6.4 in
Weight	0.14 kg	0.70 kg
	0.32 lb	1.54 lb

1. "–" signifies that the LO frequency multiplied by the LO harmonic number is higher than the RF input frequency. LO x N = RF + IF.
2. Conversion loss value shown include the effect of an internal IF amplifier.

Applications

A smart harmonic mixer can enhance the design process for the following applications:

- Satellite communications
- Military radar and electronic warfare (EW)
- Automotive collision avoidance radar
- Point-to-point radio
- IEEE 802.11ad
- IEEE 802.15.3c

Ordering Information

Model/Option	Description
M1970E	60 to 90 GHz waveguide harmonic mixer
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
LO/IF cable options (optional)	
Option 101	1 meter LO/IF cable (default)
Option 102	3 meter LO/IF cable
USB cable options (optional)	
Option 201	1.8 meter USB cable (default)
Option 202	3 meter USB cable
Jackstand (optional)	
Option 301	Standard jackstand for mixer

Literature

N9030A PXA X-Series Signal Analyzer – Brochure
Literature number 5990-3951EN

N9020A MXA X-Series Signal Analyzer – Data Sheet
Literature number 5989-4942EN

N9010A EXA X-Series Signal Analyzer – Data sheet
Literature number 5989-6529EN

Keysight Waveguide Harmonic Mixers – Technical Overview
Literature number 5990-7718EN

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