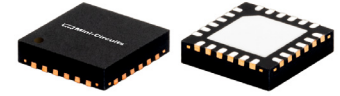




### THE BIG DEAL

- Wideband RF & LO, 5 to 14 GHz
- Wideband IF, DC to 7 GHz
- Excellent Image Rejection, Typ. 30 dBc
- High LO-RF Isolation, Typ. 41 dB
- High Input IP3, Typ. +27 dBm
- Usable as Image Reject Mixer & SSB Converter
- 4x4 mm, 24-Lead QFN-Style Package

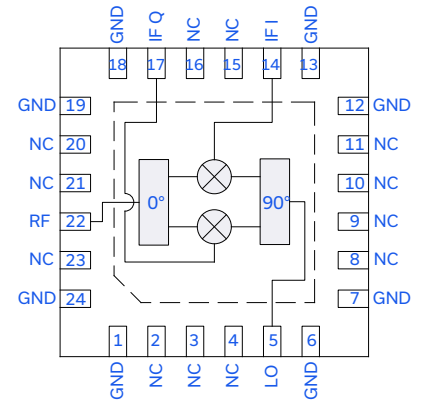


Generic photo used for illustration purposes only

### APPLICATIONS

- Test and Measurement Equipment
- Back Haul Radio
- Satellite Communications
- Radar, EW, and ECM Defense Systems

### FUNCTIONAL DIAGRAM



### PRODUCT OVERVIEW

The SMIQ-5143H+ is a passive, wideband in-phase/quadrature (I/Q) mixer fabricated using GaAs HBT technology. This model is usable as a single-sideband upconverter for transmit applications or an image rejection mixer for receiver applications. The SMIQ-5143H+ is ideal for wideband frequency translation applications that require inherent rejection of image signals and spurious mixing products. The mixer covers a broad band with RF and LO frequency ranges of 5 to 14 GHz and an IF frequency range of DC to 7 GHz. As a passive mixer, the SMIQ-5143H+ offers lower noise figure than active mixers, enabling superior dynamic range for high-performance applications. The mixer is housed in a compact 4x4 mm 24-Lead QFN-style package, and no DC bias is needed for operation.

### KEY FEATURES

Feature	Advantages
High Image Rejection, Typ. 30 dBc	Provides inherent rejection of unwanted image signals without the need for external filtering.
High Isolation, • LO-RF, Typ. 41 dB • LO-IF, Typ. 46 dB	Enables excellent carrier rejection in single-sideband upconverter transmit applications. Minimizes filtering requirements needed to ensure signal integrity.
Wide RF/LO Bandwidth, 5 to 14 GHz	Useful in wideband systems or in reconfigurable narrowband systems across multiple bands with minimal component changes.
Wide IF Bandwidth, DC to 7 GHz	High IF conversion reduces filtering requirements. With IF operation as low as DC this mixer is perfect for phase detector applications.
Small Size, 4x4 mm QFN-Style Package	Tiny footprint saves space in dense layouts, while providing low inductance and repeatable transitions. Industry standard packaging allows for ease of assembly in high volume manufacturing processes.



MMIC SURFACE MOUNT

## IQ Mixer

SMIQ-5143H+

50Ω Level 18 (LO Power +18 dBm) 5 to 14 GHz

ELECTRICAL SPECIFICATIONS<sup>1</sup> AT +25°C, Z<sub>0</sub> = 50Ω, LO POWER = +18 dBm, IF = 200 MHz, UNLESS OTHERWISE NOTED.

Parameter	Frequency (GHz)	Min.	Typ.	Max.	Unit
RF Frequency Range		5		14	GHz
LO Frequency Range		5		14	GHz
IF Frequency Range		DC		7	GHz
LO Power		+17	+18	+19	dBm
Conversion Loss <sup>2</sup>	5 - 8		6.9	8.2	dB
	8 - 14		7.9	9.9	
Amplitude Unbalance	5 - 8		±0.1	±0.6	dB
	8 - 14		±0.1	±0.9	
Phase Unbalance (Relative to 90°)	5 - 8		1	7	deg
	8 - 14		3	11	
Image Rejection <sup>3</sup> (Tested as a Downconverter)	5 - 8		37		dBc
	8 - 14		26		
Single Sideband Rejection <sup>4</sup> (Tested as an Upconverter)	5 - 8		29		dBc
	8 - 14		32		
LO-RF Isolation	5 - 8	33	41		dB
	8 - 14	33	41		
LO-I Isolation	5 - 8	29	36		dB
	8 - 14	33	51		
LO-Q Isolation	5 - 8	31	41		dB
	8 - 14	33	49		
RF-I Isolation	5 - 8	21	31		dB
	8 - 14	27	35		
RF-Q Isolation	5 - 8	21	27		dB
	8 - 14	16	26		
Input Power at 1dB Compression	5 - 14		+10		dBm
Input IP3 (I) Lower Side Band	5 - 8		+29		dBm
	8 - 14		+31		
Input IP3 (Q) Lower Side Band	5 - 8		+29		dBm
	8 - 14		+31		
Input IP3 (I) Upper Side Band	5 - 8		+25		dBm
	8 - 14		+29		
Input IP3 (Q) Upper Side Band	5 - 8		+25		dBm
	8 - 14		+27		

1. Measured on Mini-Circuits Characterization Test Board TB-SMIQ-5143HC+. See Figures 2, 3, & 4. Board loss de-embedded to the device.

2. Conversion loss (dB) = RF Power (dBm) minus worse of I/Q Port Power (dBm) minus 3 dB theoretical loss of an Ideal External Hybrid, measured as a Downconverter. See measurement block diagram Figure 2.

3. Level of undesired image signal below desired RF signal. See measurement block diagram Figure 2.

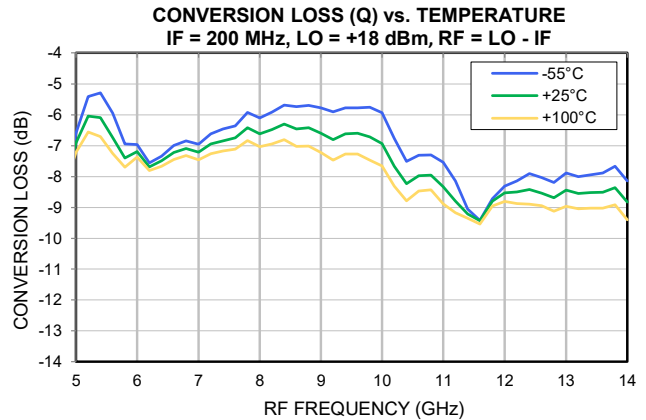
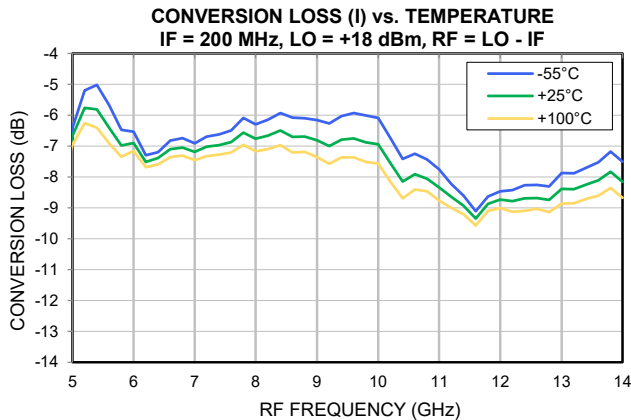
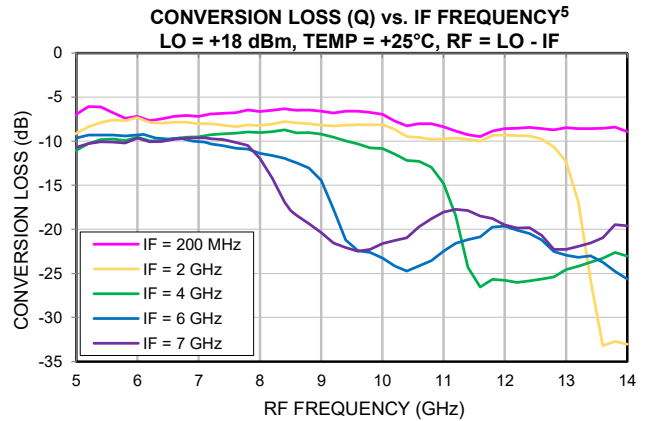
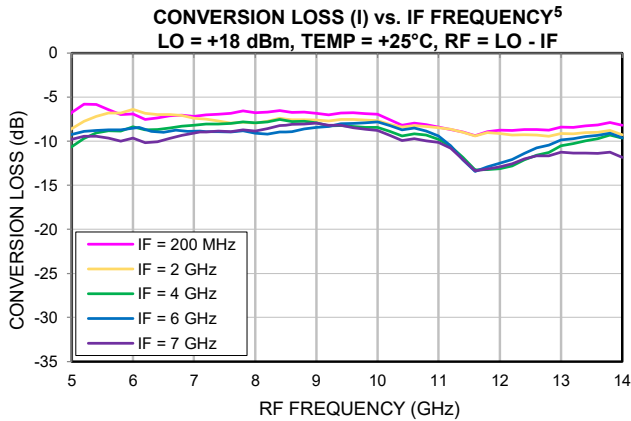
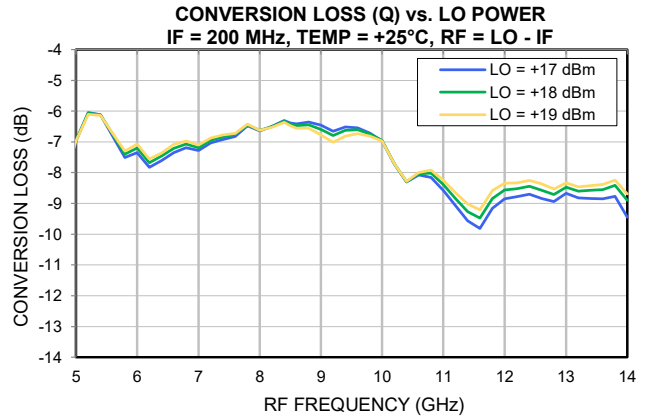
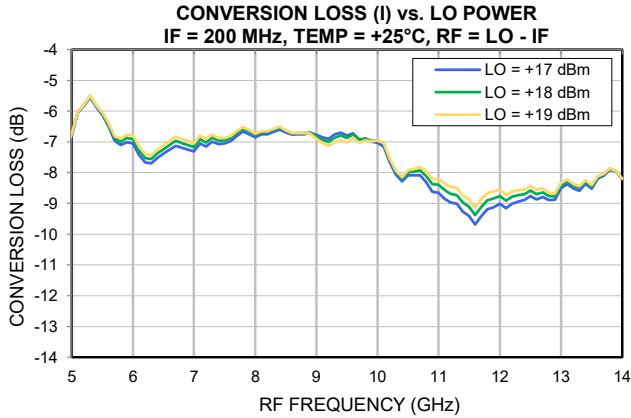
4. Level of undesired sideband below desired sideband. See measurement block diagram Figure 3.





### TYPICAL PERFORMANCE GRAPHS

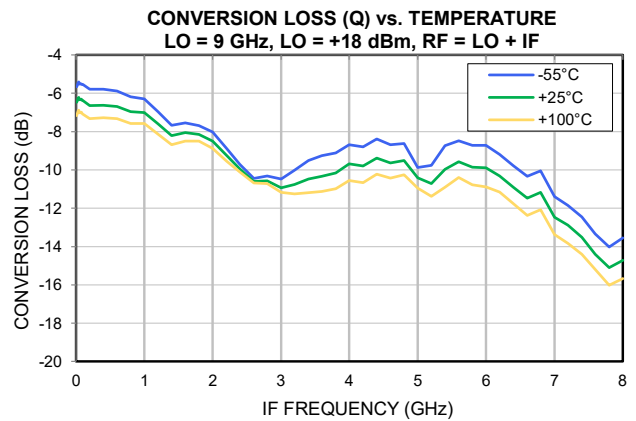
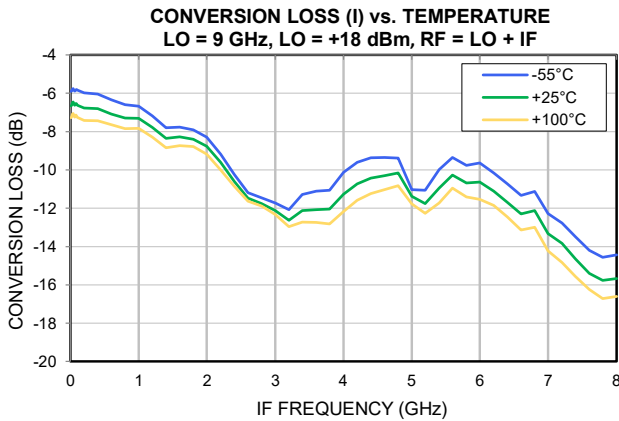
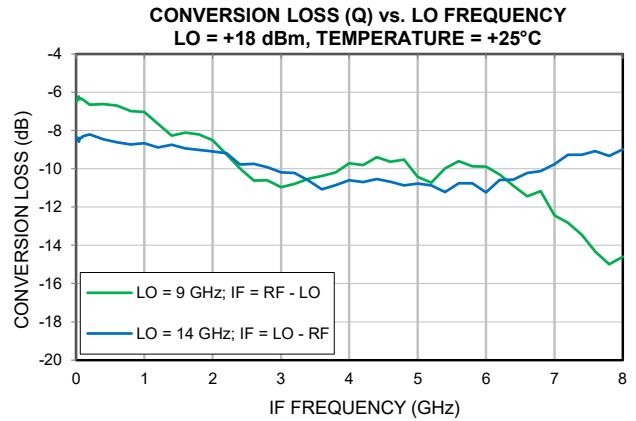
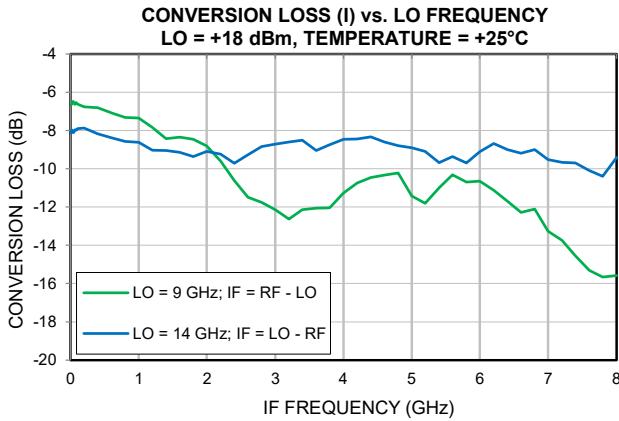
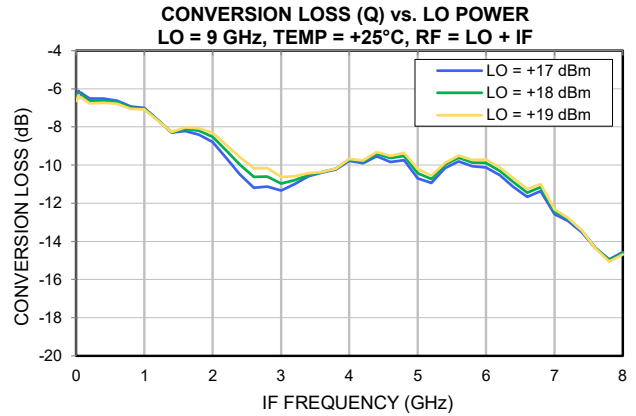
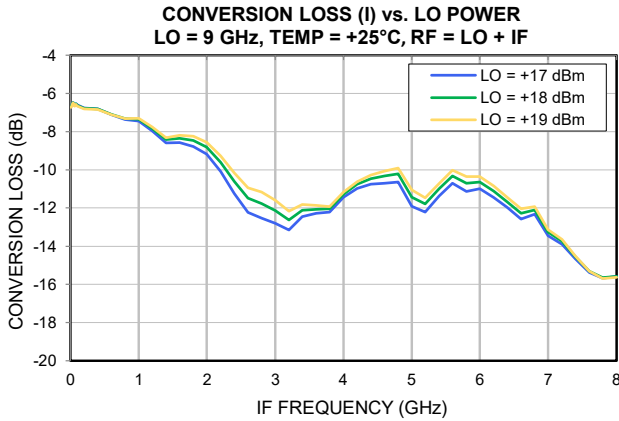
Conversion loss (dB) = RF Power (dBm) minus worse of I/Q Port Power (dBm) minus 3 dB theoretical loss of an Ideal External Hybrid, measured as a Downconverter



5. Performance degrades when LO is outside of the specified 5 GHz to 14 GHz range.

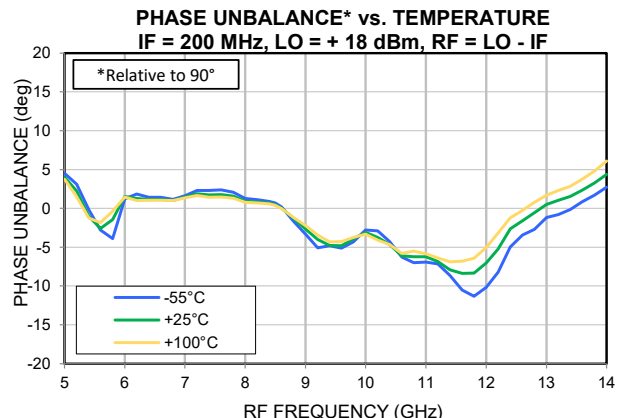
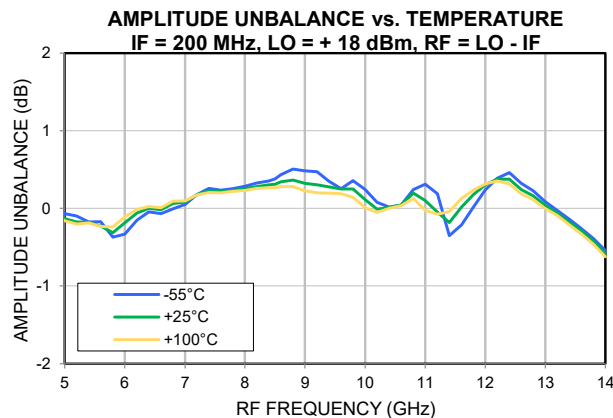
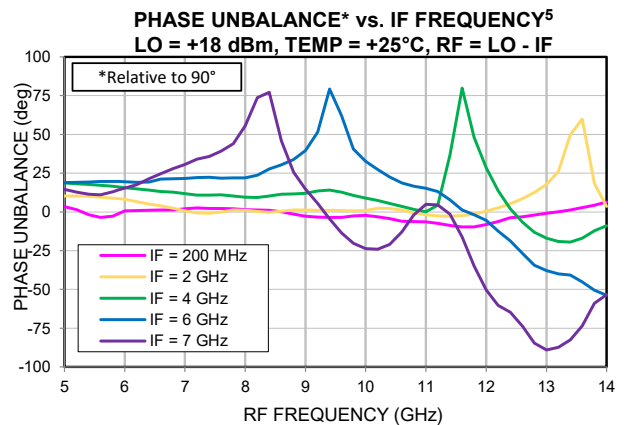
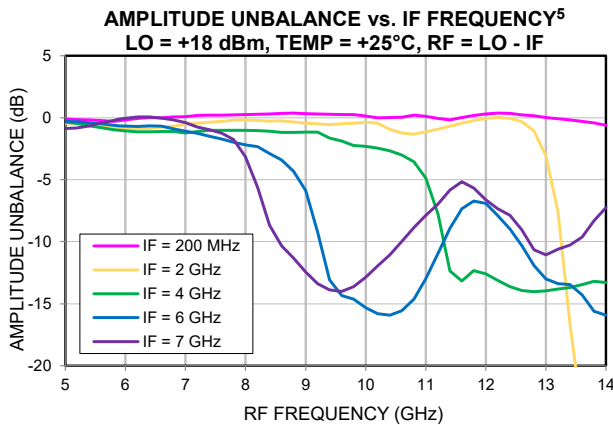
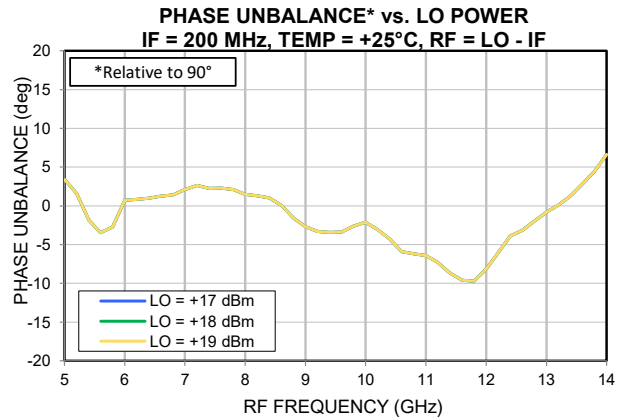
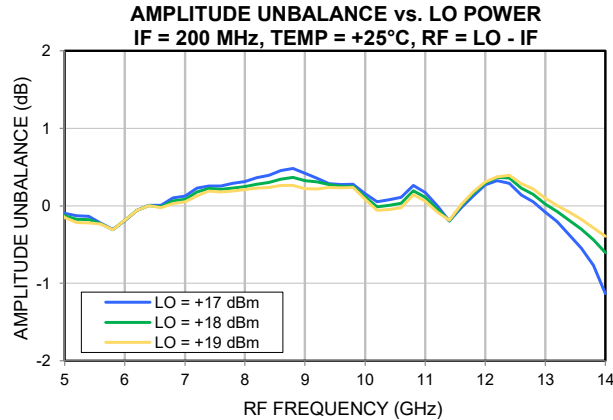


### TYPICAL PERFORMANCE GRAPHS





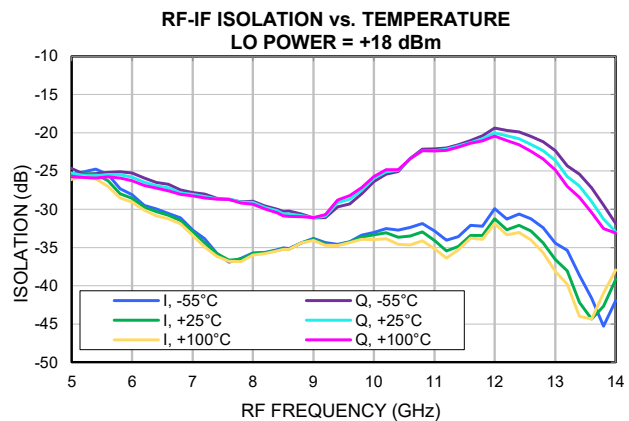
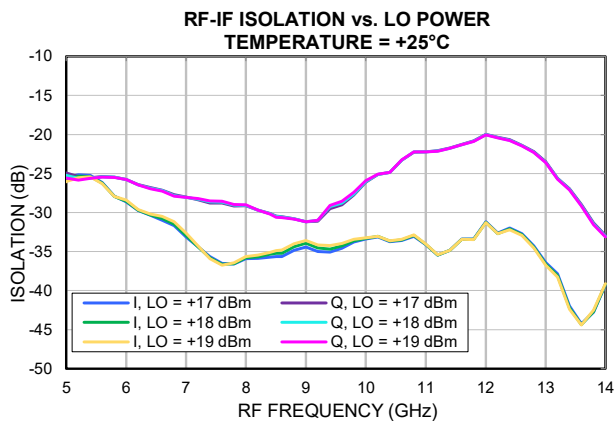
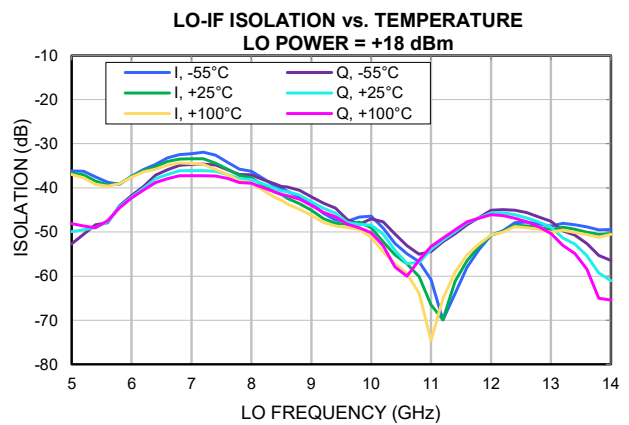
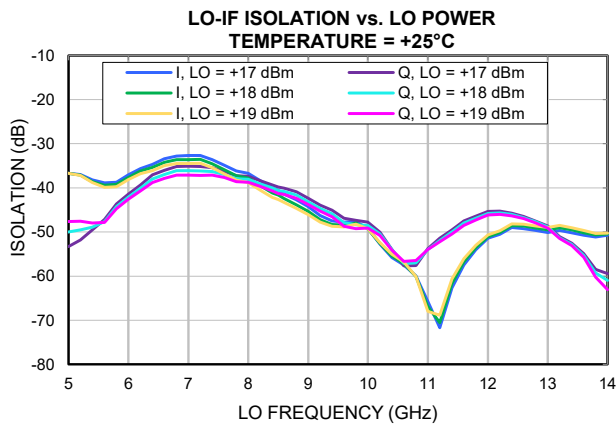
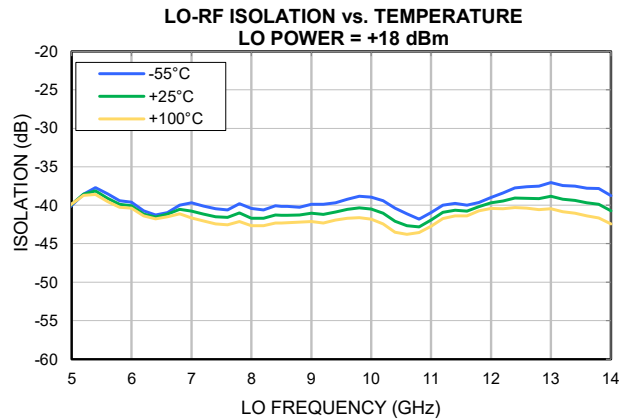
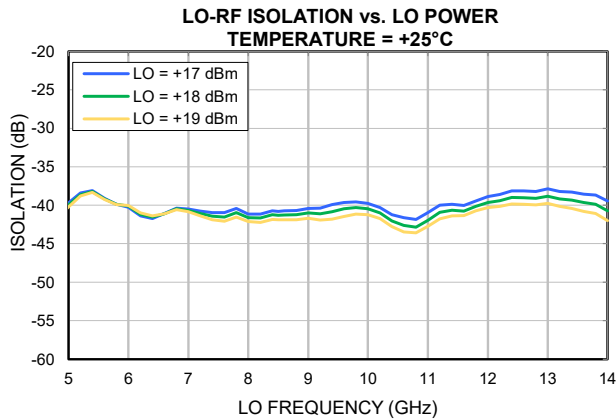
### TYPICAL PERFORMANCE GRAPHS



5. Performance degrades when LO is outside of the specified 5 GHz to 14 GHz range.

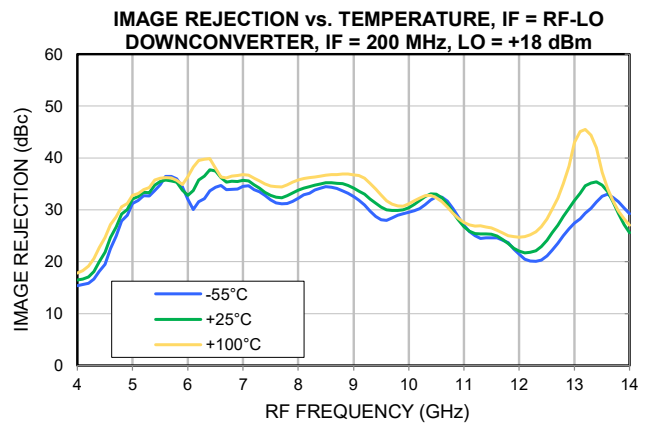
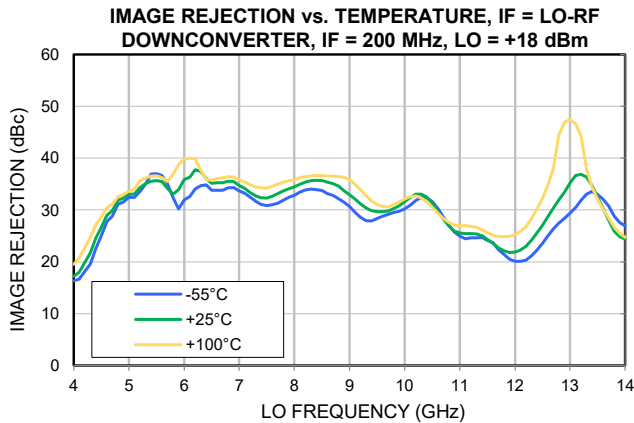
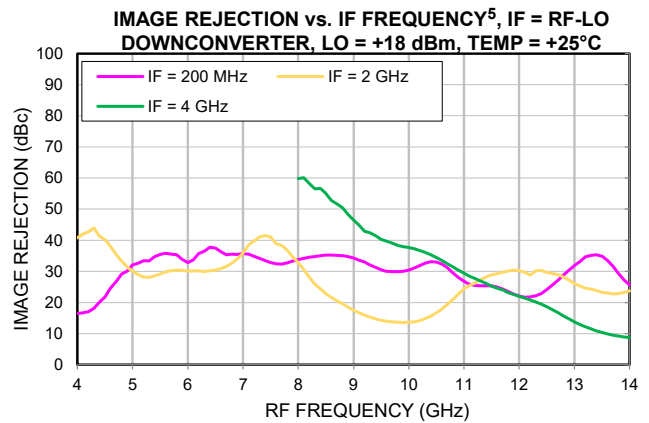
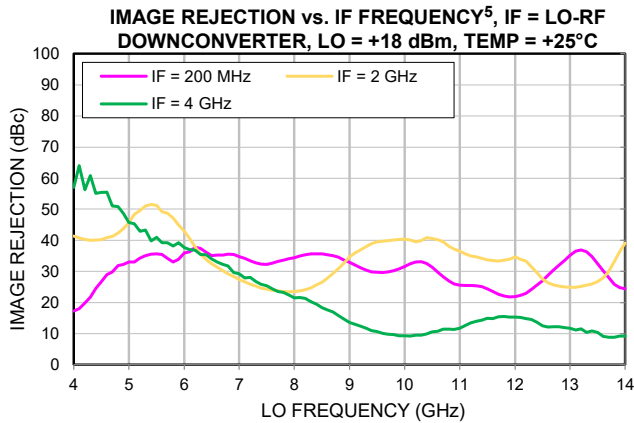
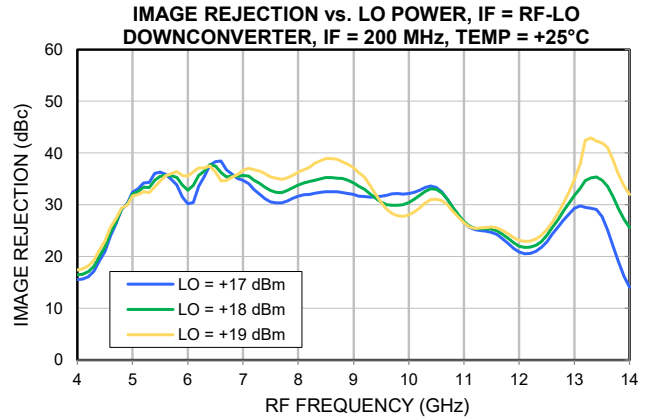
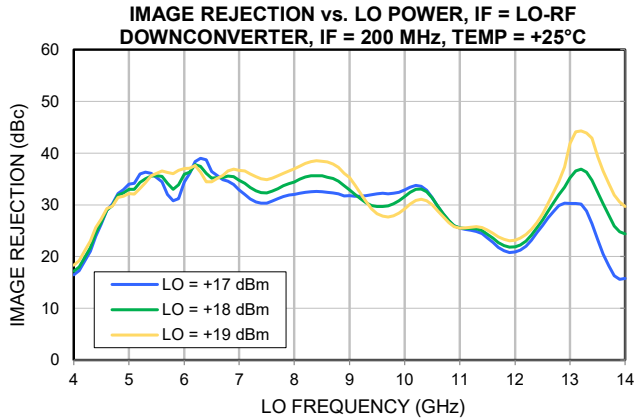


### TYPICAL PERFORMANCE GRAPHS





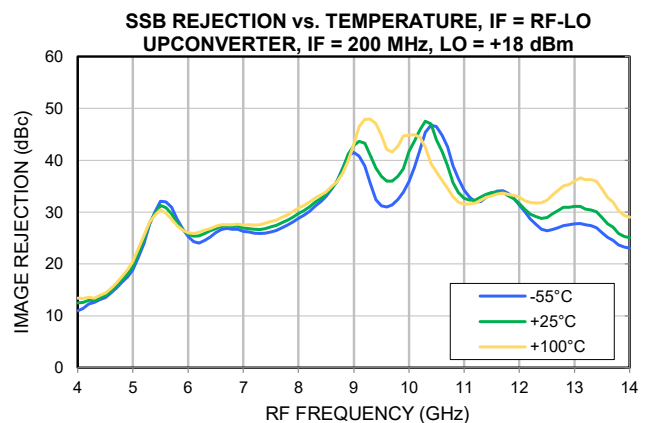
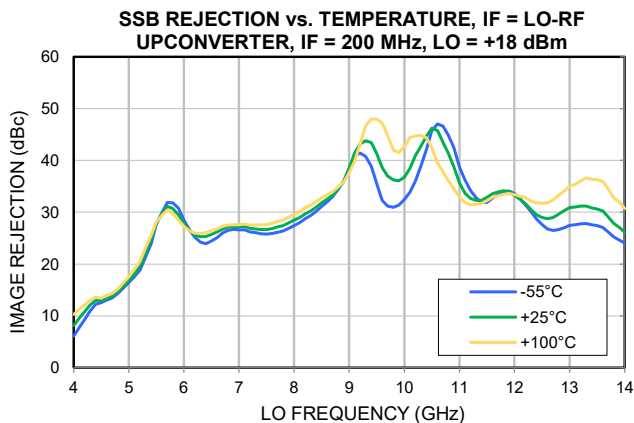
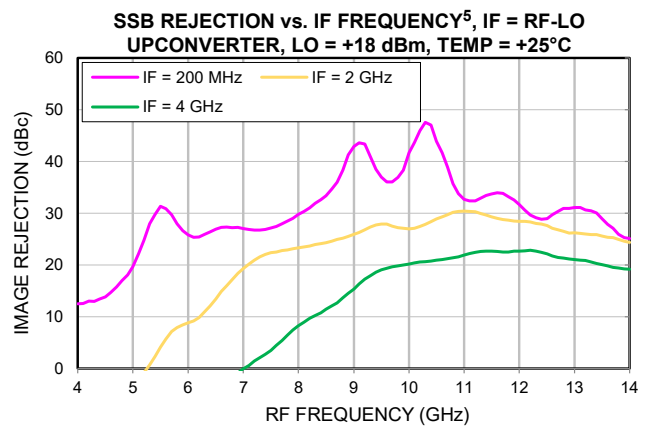
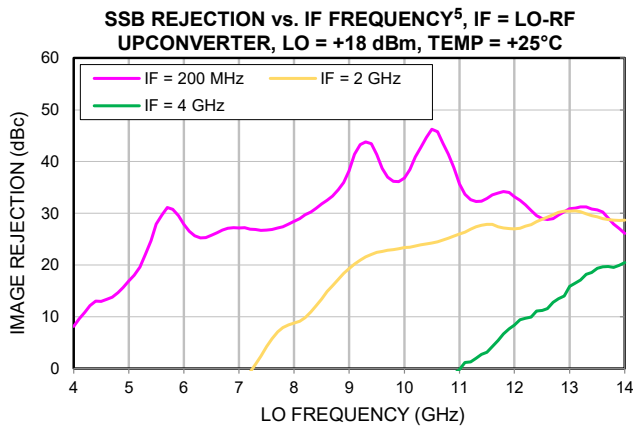
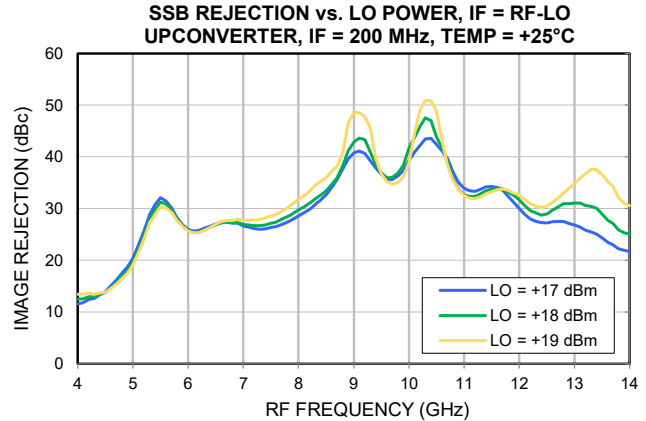
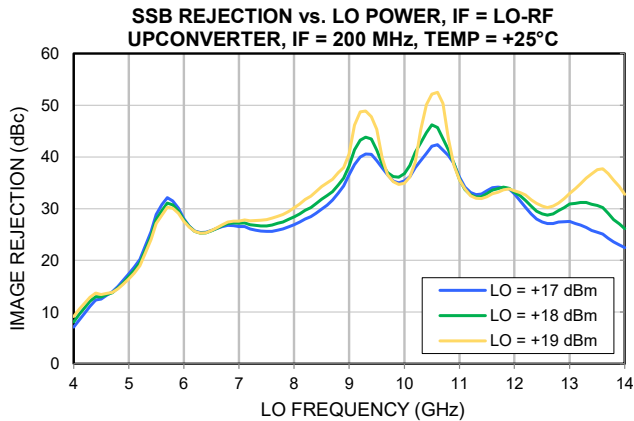
### TYPICAL PERFORMANCE GRAPHS



5. Performance degrades when LO is outside of the specified 5 GHz to 14 GHz range.



### TYPICAL PERFORMANCE GRAPHS



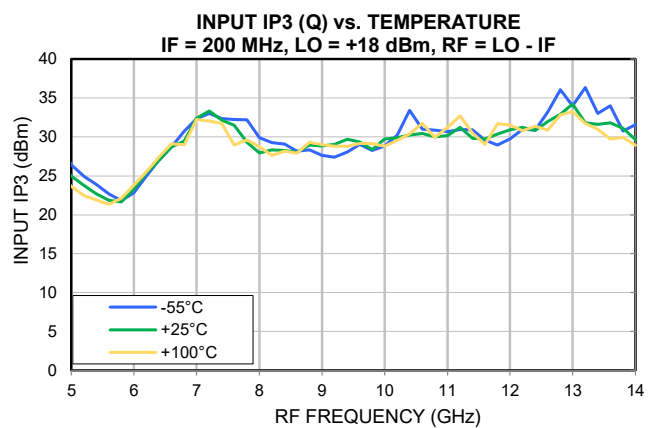
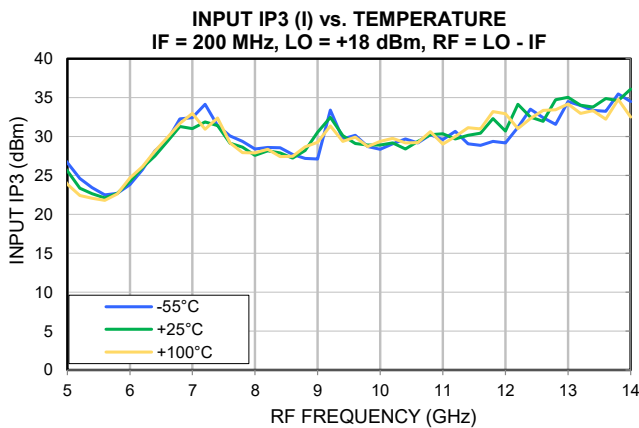
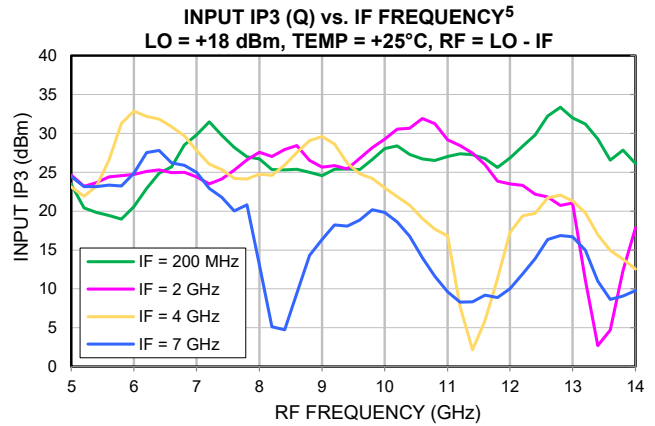
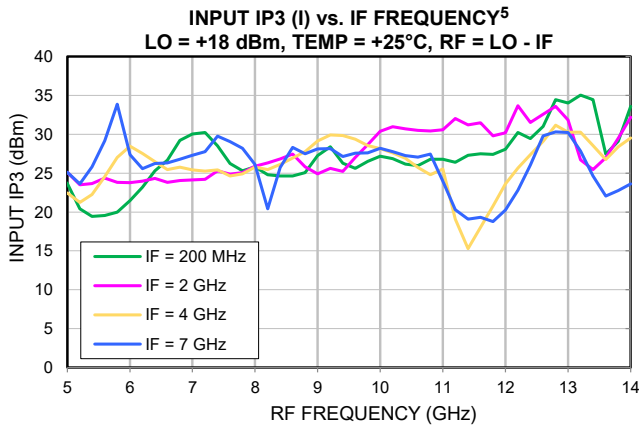
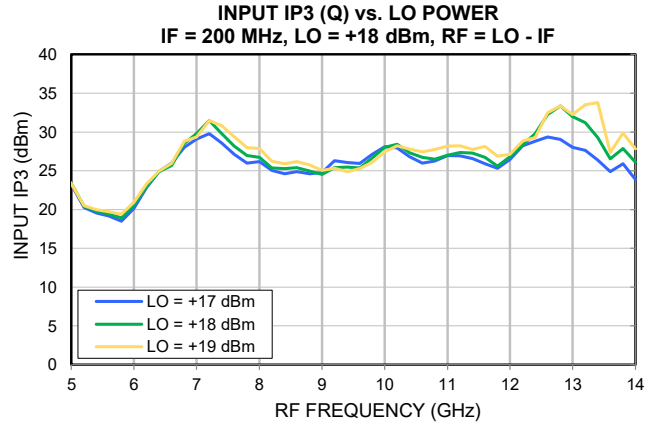
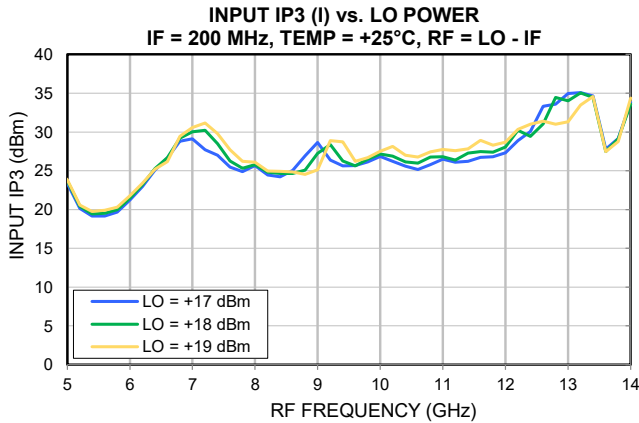
5. Performance degrades when LO is outside of the specified 5 GHz to 14 GHz range.





### TYPICAL PERFORMANCE GRAPHS

$P_{IN} = -10$  dBm/Tone with 1 MHz spacing (RF2 = RF1 + 1 MHz)



5. Performance degrades when LO is outside of the specified 5 GHz to 14 GHz range.



### ABSOLUTE MAXIMUM RATINGS<sup>6</sup>

Parameter	Ratings
Operating Temperature	-55°C to +105°C
Storage Temperature	-65°C to +150°C
Junction Temperature	+175°C
RF Power	+28 dBm
LO Power	+28 dBm
I/Q Power	+28 dBm
IF Current	49 mA

6. Permanent damage may occur if any of these limits are exceeded. Electrical maximum ratings are not intended for continuous normal.

### ESD RATING

	Class	Voltage Range	Reference Standard
HBM	1A	250 to < 500 V	ANSI/ESDA/JEDEC JS-001-2023
CDM	C3	≥ 1000 V	ANSI/ESDA/JEDEC JS-001-2022



ESD HANDLING PRECAUTION: This device is designed to be Class 1A for HBM. Static charges may easily produce potentials higher than this with improper handling and can discharge into DUT and damage it. As a preventive measure Industry standard ESD handling precautions should be used at all times to protect the device from ESD damage.

### MSL RATING

Moisture Sensitivity: MSL1 in accordance with IPC/JEDEC J-STD-020E /JEDEC J-STD-033C



### FUNCTIONAL DIAGRAM

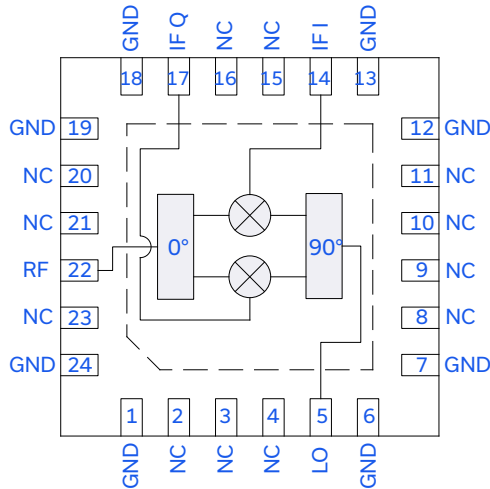
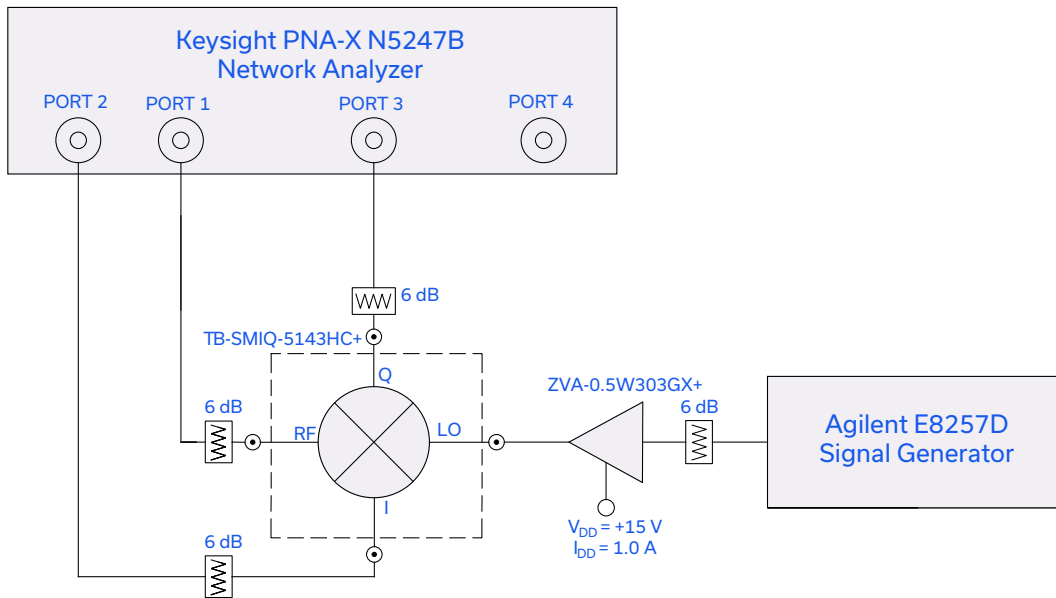


Figure 1. SMIQ-5143H+ Functional Diagram

### PAD CONNECTIONS

Function	Pad #	Description
RF	22	RF Port. Connects to RF Output for Upconverters or RF Input for Downconverters.
LO	5	LO Port. Connects to LO Input.
IF I	14	IF I Port. Connects to the IF I Input for Upconverters or IF I Output for Downconverters.
IF Q	17	IF Q Port. Connects to the IF Q Input for Upconverters or IF Q Output for Downconverters.
GND	1, 6, 7, 12, 13, 18, 19, 24, Paddle	Connects to ground.
NC	2-4, 8-11, 15, 16, 20, 21, 23	No connection. Grounded on test board.

### CHARACTERIZATION TEST CIRCUITS



6 dB attenuators P/N BW-E6-1W653+

Figure 2. Block diagram of test circuit used to characterize: Conversion Loss, Amplitude Unbalance, Phase Unbalance, Isolation, Return Loss, Image Rejection (Downconverter), Compression, and Input IP3

#### Test conditions:

##### For Conversion Loss, Return Loss, Isolation, and Image Rejection (Downconverter):

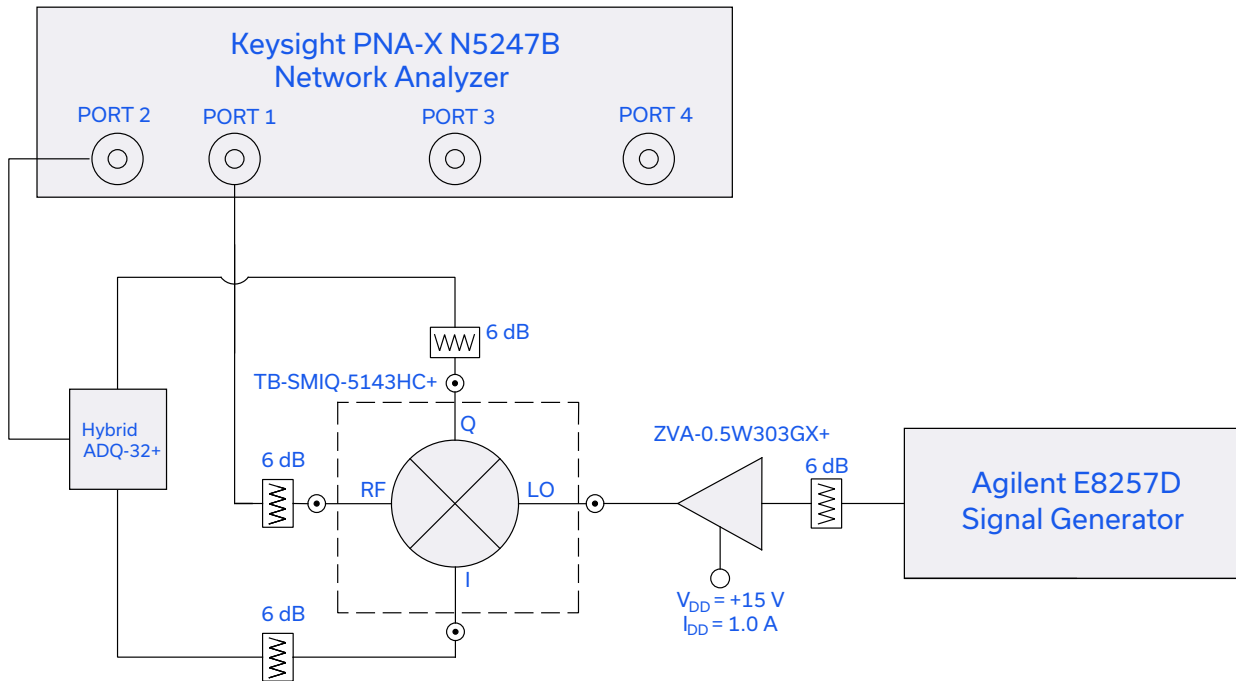
RF Input Power = -10 dBm, LO Input Power = +17 to +19 dBm, IF = 200 MHz, 1 GHz, 2 GHz, 3 GHz, 4 GHz, 5 GHz, 6 GHz, and 7 GHz

For Input IP3: RF Input Power = 0 dBm/Tone, LO Input Power = +17 to +19 dBm. Two tones, spaced 1 MHz apart.

##### For Compression:

RF Input Power = -10 dBm and +10 dBm, LO Input Power = +17 to +19 dBm, IF = 200 MHz, 1 GHz, 2 GHz, 3 GHz, 4 GHz, 5 GHz, 6 GHz, and 7 GHz

Compression = (Conversion Loss @ RF Power = +10 dBm) - (Conversion Loss @ RF Power = -10 dBm)



6 dB attenuators P/N BW-E6-1W653+

Figure 3. Block diagram of Test Circuit used for characterization of Single Side Band Rejection (Upconverter)

**Test conditions:**

IF Input Power = -10 dBm, LO Input Power = +17 to +19 dBm, IF = 200 MHz, 1 GHz, 2 GHz, 3 GHz, 4 GHz, 5 GHz, 6 GHz, and 7 GHz



### APPLICATION CONFIGURATION FOR IMAGE REJECT AND SINGLE SIDE BAND MIXER

In Image Reject or Single Sideband Upconverter applications an external 90° Hybrid is needed. Refer to Mini-Circuits extensive portfolio of 90° Hybrids.

#### IMAGE REJECT MIXER APPLICATION

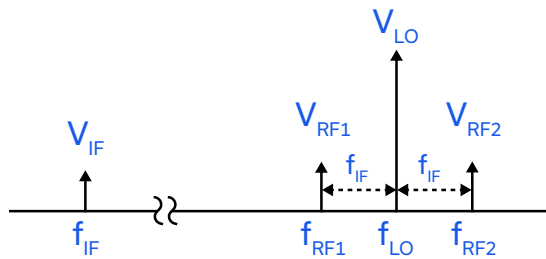


Figure 4. Spectral representation of Signals

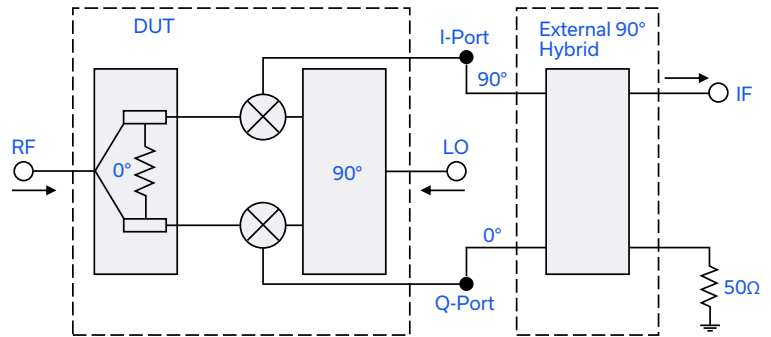


Figure 5. Block Diagram of Image Reject Mixer

If  $f_{RF1}$  is the desired signal and  $f_{RF2}$  is the image, connect the I port of DUT to the 90° port of the external hybrid and the Q port to the 0° port of the hybrid. This will send the  $f_{RF2}-f_{LO}$  IF signal to the terminated output of the external 90° hybrid and desired IF signal  $f_{LO}-f_{RF1}$  to IF port.

If  $f_{RF2}$  is the desired signal and  $f_{RF1}$  is the image signal, connect the I port of DUT to the 0 deg port of the external 90° hybrid and the Q port to the 90° port of the external hybrid. This will send  $f_{LO}-f_{RF1}$  IF signal to the terminated output of the external 90° hybrid and desired IF signal  $f_{RF2}-f_{LO}$  to IF port.

#### SINGLE SIDE BAND (SSB) UPCONVERTER APPLICATION

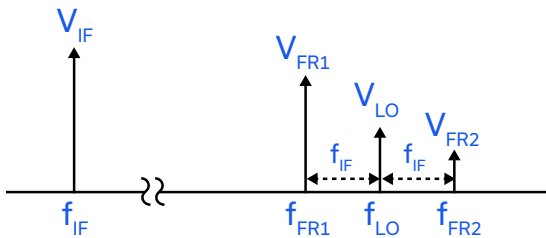


Figure 6. Spectral representation of Signals

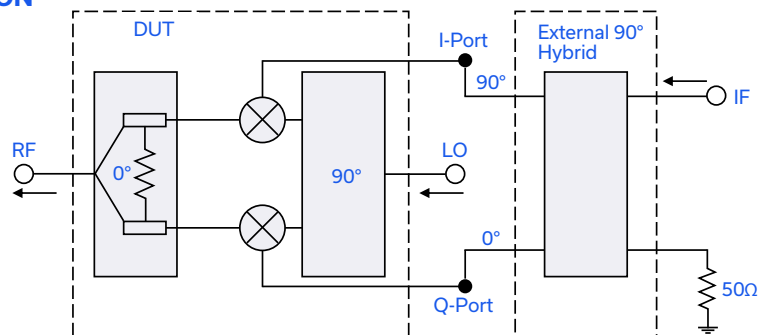


Figure 7. Block Diagram of Single Side Band Mixer

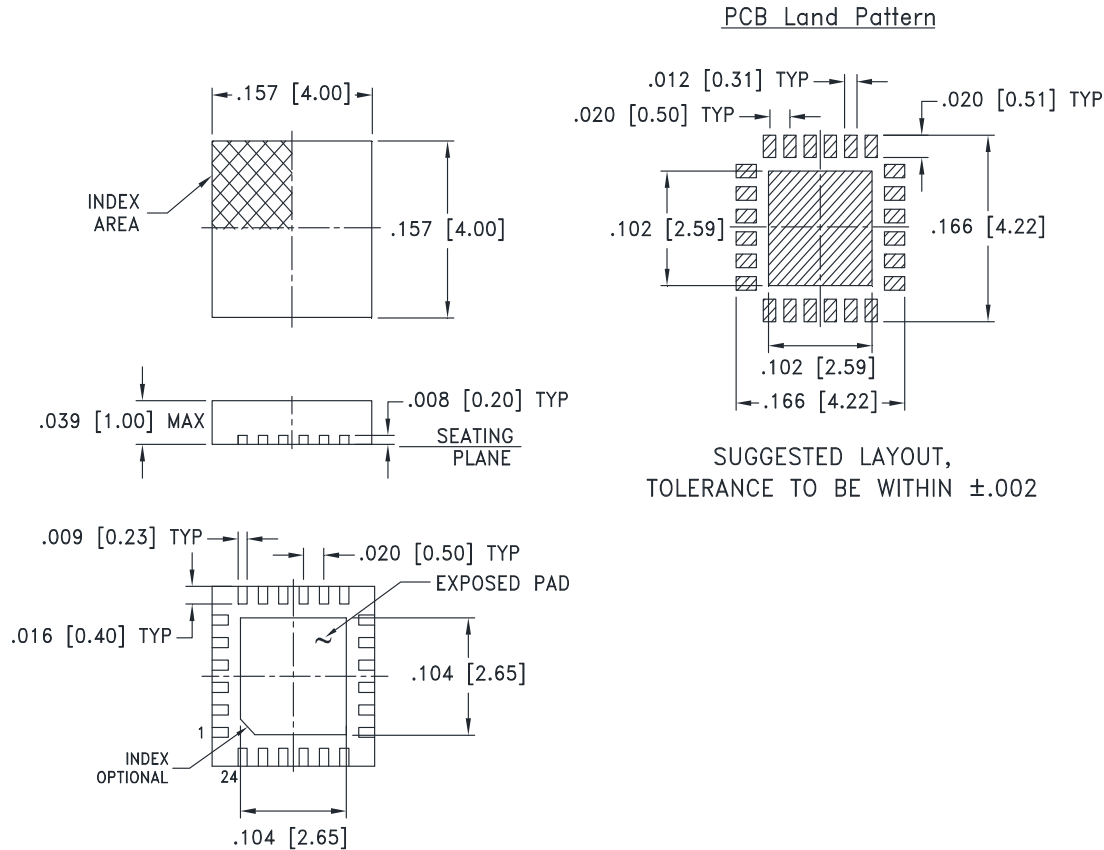
For upper sideband selection connect the I port to the 90° port of the external 90° hybrid and the Q port to the 0° port of the external hybrid. This will cause cancellation of the lower sideband signal in the 0° RF splitter of the DUT and the upper sideband signal will be present at the RF port.

For lower sideband selection connect the I port to the 0° port of the external 90° hybrid and the Q port to the 90° port of the hybrid. This will cause cancellation of the upper sideband signal in the 0° RF splitter of the DUT and the lower sideband signal will be present at the RF port.

Refer to Mini-Circuits blog, I&Q Mixers, Image Reject Down-Conversion & Single Sideband (SSB) Up-Conversion for a detailed explanation.



### CASE STYLE DRAWING

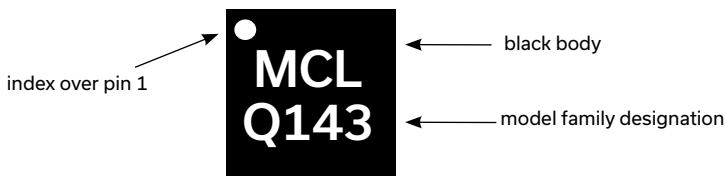


SUGGESTED LAYOUT,  
TOLERANCE TO BE WITHIN ±.002

Weight: .04 Grams

Dimensions are in inches [mm]. Tolerances (values are in inches): 2 Pl. ± .01; 3 Pl. ± .005

### PRODUCT MARKING



Marking may contain other features or characters for internal lot control



MMIC SURFACE MOUNT

# IQ Mixer

## SMIQ-5143H+

50Ω Level 18 (LO Power +18 dBm) 5 to 14 GHz

ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASHBOARD [CLICK HERE](#)

<b>Performance Data and Graphs</b>	Data Graphs Data Set (.zip file)
<b>Case Style</b>	DG1847 Plastic package, exposed paddle, lead finish: Matte-Tin
<b>RoHS Status</b>	Compliant
<b>Tape &amp; Reel</b> Standard quantities available on reel	F68 7" reels with 20, 50, 100, 200, 500, or 1K devices
<b>Suggested Layout for PCB Design</b>	PL-793
<b>Evaluation Board</b>	TB-SMIQ-5143HC+
<b>Environmental Ratings</b>	ENV08T1

#### NOTES

- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
- B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
- C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the standard terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at [www.minicircuits.com/terms/viewterm.html](http://www.minicircuits.com/terms/viewterm.html)

