MMIC DIE

IQ Mixer

SMIQ-1844H-D+

50Ω 18 to 43.5 GHz Level 18 (LO Power +18 dBm)

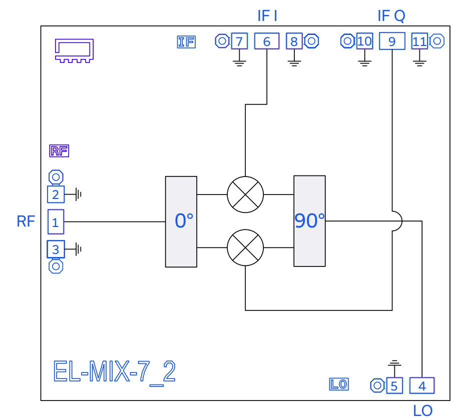
THE BIG DEAL

- Wideband RF & LO, 18 to 43.5 GHz
- Wideband IF, DC to 7 GHz
- Excellent Image Rejection, Typ. 30 dB
- High LO-RF Isolation, Typ. 38 dB
- High Input IP3, Typ. +31 dBm
- Usable as Image Reject Mixer & SSB Converter

APPLICATIONS

- Test and Measurement Equipment
- 5G mmWave and Back Haul Radio
- Satellite Communications
- Radar, EW, and ECM Defense Systems

FUNCTIONAL DIAGRAM



SEE ORDERING INFORMATION ON THE LAST PAGE

PRODUCT OVERVIEW

The SMIQ-1844H-D+ is a passive wideband in phase/quadrature (I/Q) mixer die fabricated using GaAs HBT technology. The SMIQ-1844H-D+ is usable as a single-sideband upconverter for transmit applications or an image rejection mixer for receiver applications. The SMIQ-1844H-D+ 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 range of 18 to 43.5 GHz and an IF frequency range of DC to 7 GHz. As a passive mixer, the SMIQ-1844H-D+ offers lower noise figure than active mixers enabling superior dynamic range for high performance applications. No DC bias is needed for operation.

KEY FEATURES

Features	Advantages
High Image Rejection, 30 dB typ.	Provides inherent rejection of unwanted image signals without the need for external filtering.
High Isolation • LO-RF, 38 dB typ. • LO-IF, 40 dB typ.	Enables excellent carrier rejection in single-sideband upconverter applications. Minimizes filtering requirements needed to ensure signal integrity.
Wide RF/LO Bandwidth, 18 to 43.5 GHz	Useful in wideband systems or in reconfigurable narrowband systems across multiple bands with minimal changes.
Wide IF Bandwidth, DC to 7 GHz	Enables use of high IF conversion to reduce filtering requirements. IF operation as low as DC enables use in phase detector applications.
Unpackaged Die	Enables integration into hybrid chip and wire assemblies

REV. OR
ECO-020345
SMIQ-184H-D+
MCL NY
231220

ELECTRICAL SPECIFICATIONS[1] AT +25°C, LO POWER= +18 dBm, UNLESS NOTED OTHERWISE

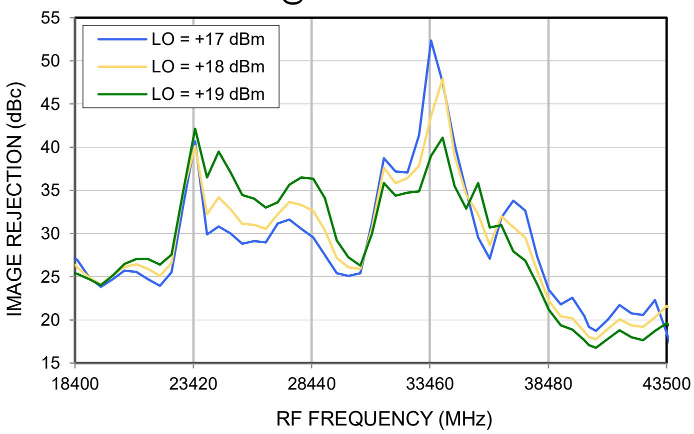
Parameter	Frequency (GHz)	Min.	Typ.	Max.	Unit
RF Frequency Range		18		43.5	GHz
LO Frequency Range		18		43.5	GHz
IF Frequency Range		DC		7	GHz
LO Power		+17	+18	+19	dBm
Conversion Loss[2]	18 – 26.5		8.8		dB
	26.5 – 40		9.4		
	40 – 43.5		10.8		
Amplitude Unbalance	18 – 26.5		±0.2		dB
	26.5 – 40		±0.2		
	40 – 43.5		±1.0		
Phase Unbalance (Relative to 90°)	18 – 26.5		±2.7		Deg.
	26.5 – 40		±1.8		
	40 – 43.5		±7.5		
Image Rejection[3,5] (Tested as a Downconverter)	18 – 26.5		30		dBc
	26.5 – 40		31		
	40 – 43.5		19		
Single Sideband Rejection[4,5] (Tested as an Upconverter)	18 – 26.5		26		dBc
	26.5 – 40		25		
	40 – 43.5		17		
LO-RF Isolation	18 – 26.5		41		dB
	26.5 – 40		38		
	40 – 43.5		33		
LO-I Isolation	18 – 26.5		42		dB
	26.5 – 40		41		
	40 – 43.5		31		
LO-Q Isolation	18 – 26.5		49		dB
	26.5 – 40		39		
	40 – 43.5		25		
RF-I Isolation	18 – 26.5		24		dB
	26.5 – 40		28		
	40 – 43.5		29		
RF-Q Isolation	18 – 26.5		32		dB
	26.5 – 40		31		
	40 – 43.5		37		
Input Power at 1dB Compression[5]	18 – 43.5		+10		dBm
Input IP3[5]	18 – 26.5		+29		dBm
	26.5 – 40		+29		
	40 – 43.5		+27		

1. Electrical specifications are measured on Mini-Circuits Die Characterization Test Board. Board loss is de-embedded to the device. Unless otherwise specified IF = 200 MHz.
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 3 .
3. Level of undesired image signal below desired RF signal. See measurement block diagram Figure 4.
4. Level of undesired sideband below desired sideband. See measurement block diagram Figure 4.
5. Tested in 4x4 mm 24-Lead Package (SMIQ-1844H+).

TYPICAL PERFORMANCE GRAPHS

Note: All data on this page represents the Die attached in a 4x4mm 24-Lead QFN style package and measured on Mini-Circuits Characterization Test Board TB-SMIQ-1844HC+

IMAGE REJECTION (DOWNCONVERTER) @ IF = 200 MHz



SSB REJECTION (UPCONVERTER) @ IF = 200 MHz

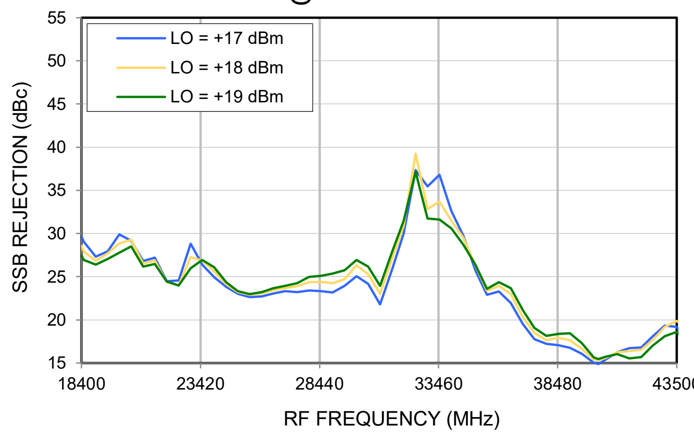
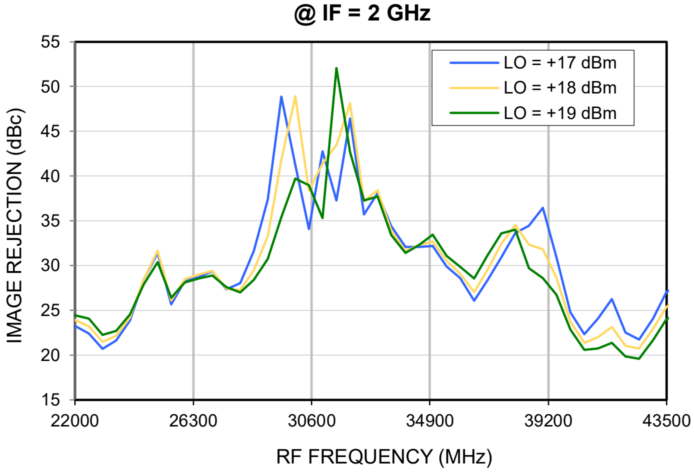


IMAGE REJECTION (DOWNCONVERTER) @ IF = 2 GHz



SSB REJECTION (UPCONVERTER) @ IF = 2 GHz

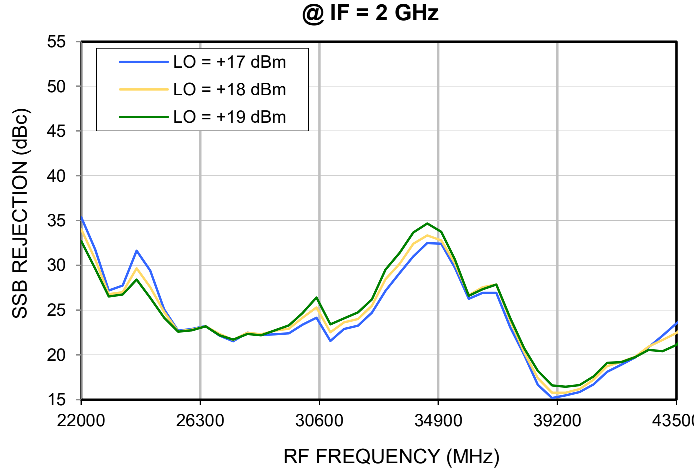
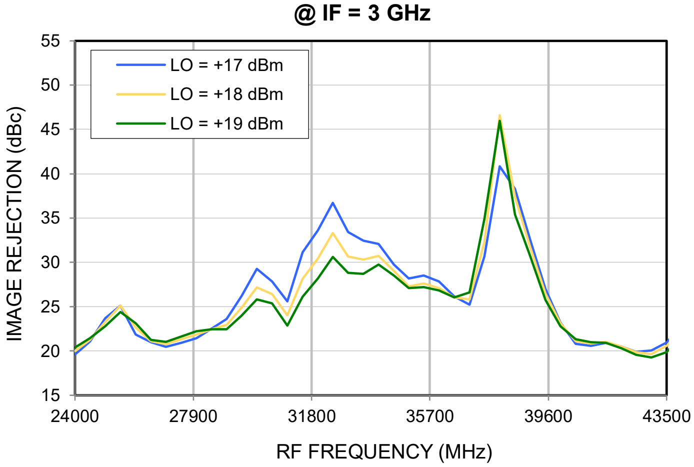
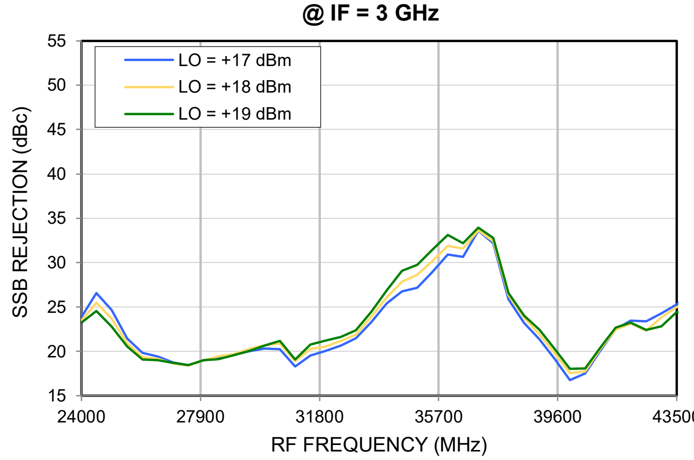


IMAGE REJECTION (DOWNCONVERTER) @ IF = 3 GHz



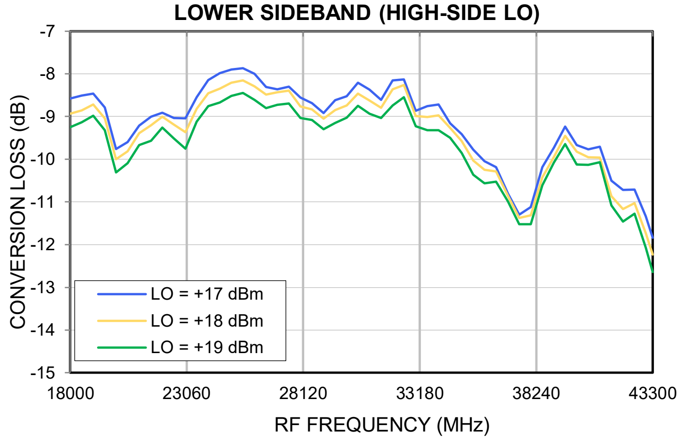
SSB REJECTION (UPCONVERTER) @ IF = 3 GHz



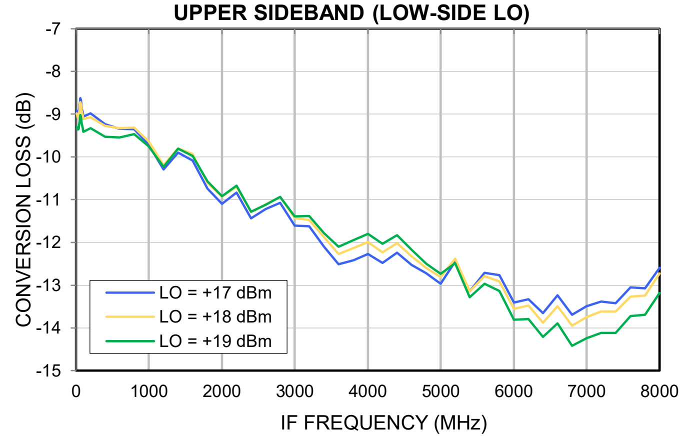
TYPICAL PERFORMANCE GRAPHS

Note: 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.

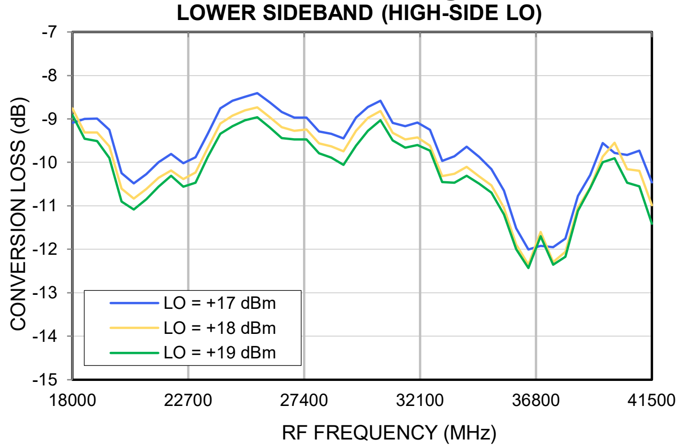
CONVERSION LOSS VS. RF @ IF = 200 MHz
LOWER SIDEBAND (HIGH-SIDE LO)



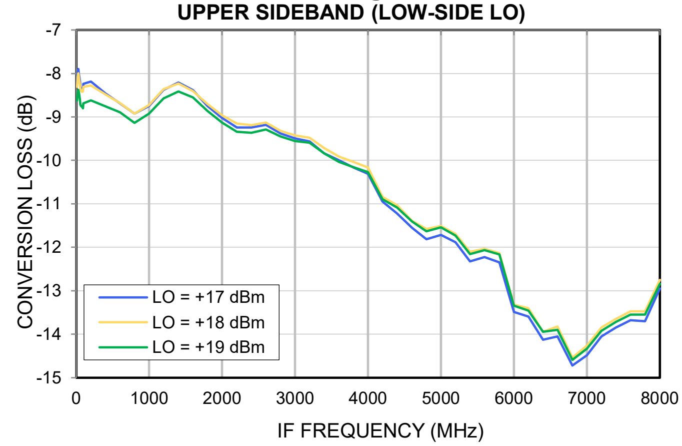
CONVERSION LOSS VS. IF @ FIXED LO = 18 GHz
UPPER SIDEBAND (LOW-SIDE LO)



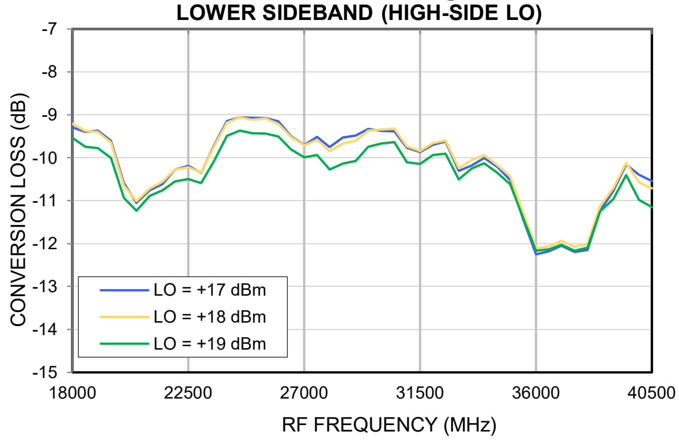
CONVERSION LOSS VS. RF @ IF = 2 GHz
LOWER SIDEBAND (HIGH-SIDE LO)



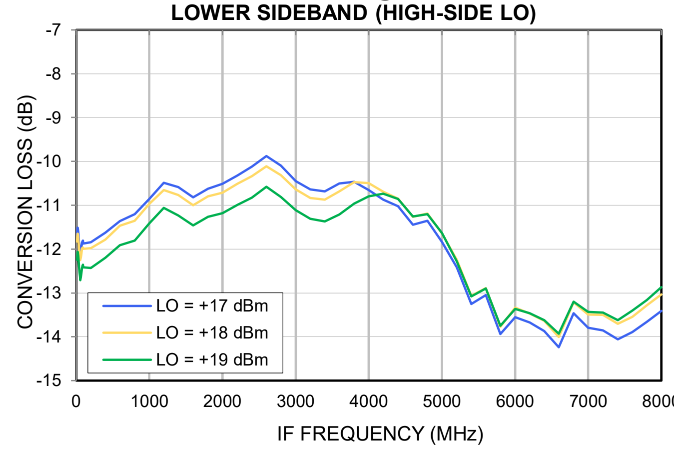
CONVERSION LOSS VS. IF @ FIXED LO = 30.75 GHz
UPPER SIDEBAND (LOW-SIDE LO)



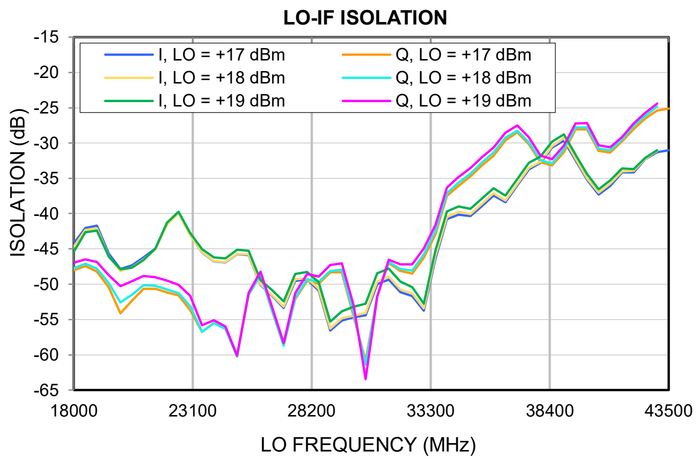
CONVERSION LOSS VS. RF @ IF = 3 GHz
LOWER SIDEBAND (HIGH-SIDE LO)

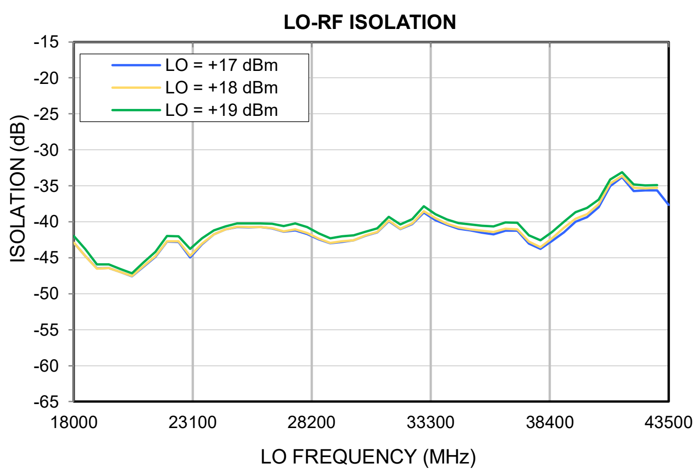


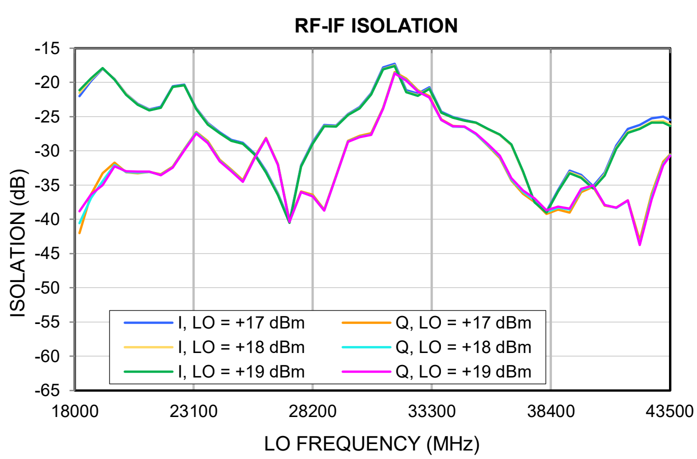
CONVERSION LOSS VS. IF @ FIXED LO = 43.5 GHz
LOWER SIDEBAND (HIGH-SIDE LO)



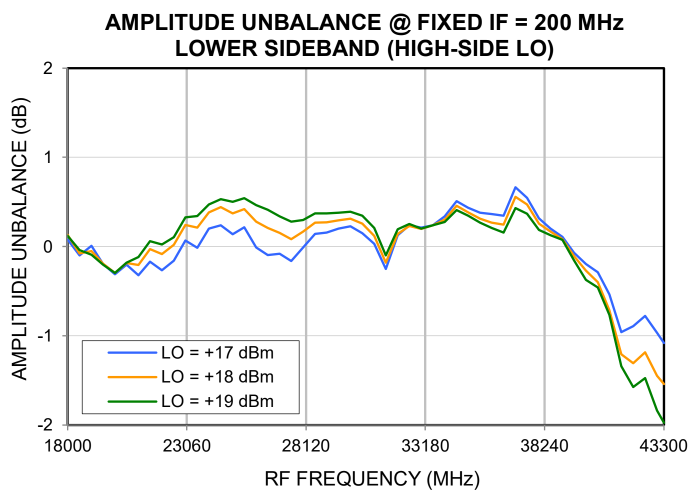
TYPICAL PERFORMANCE GRAPHS

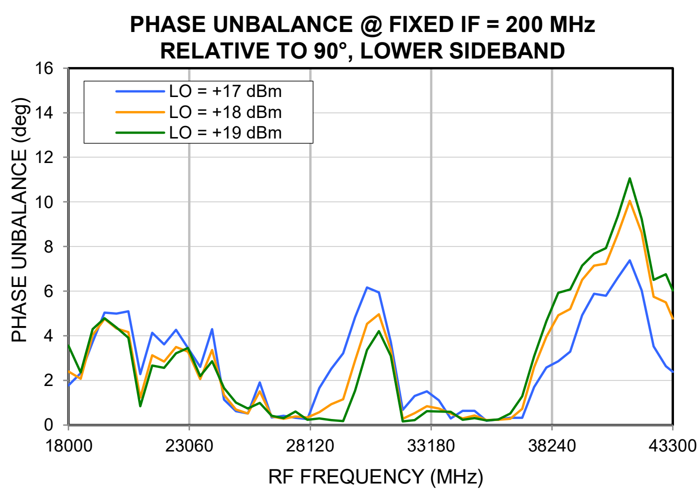


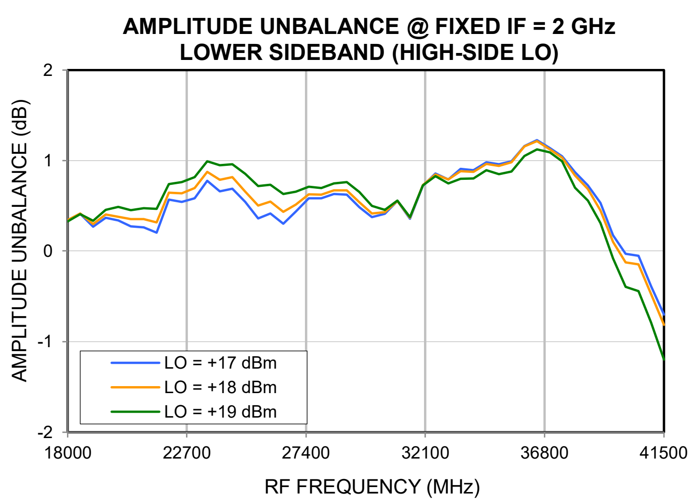


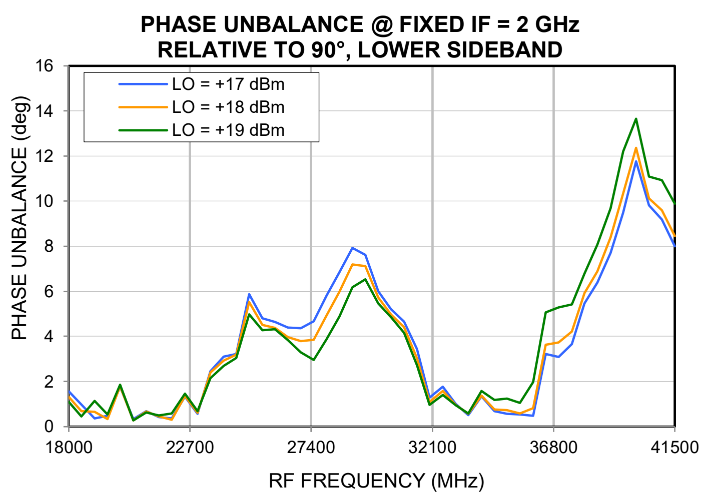


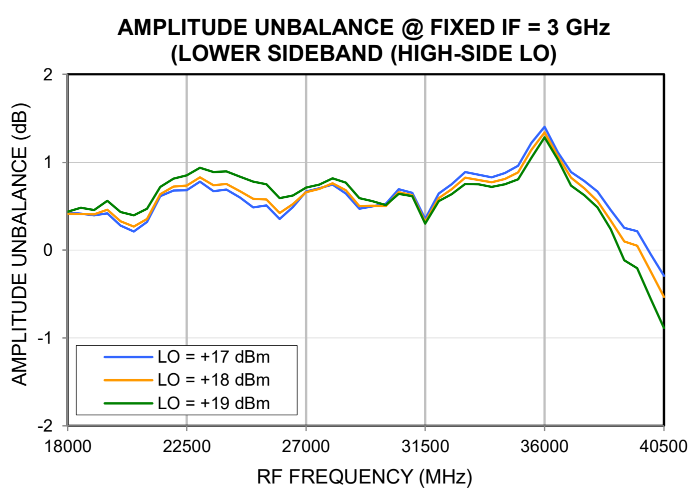
TYPICAL PERFORMANCE GRAPHS

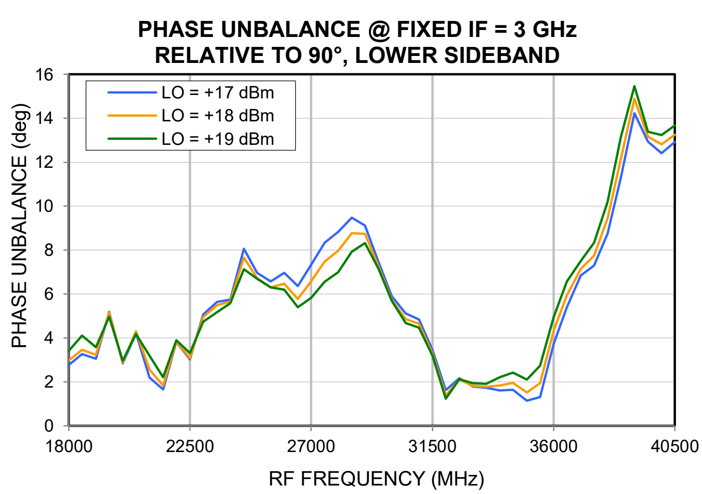






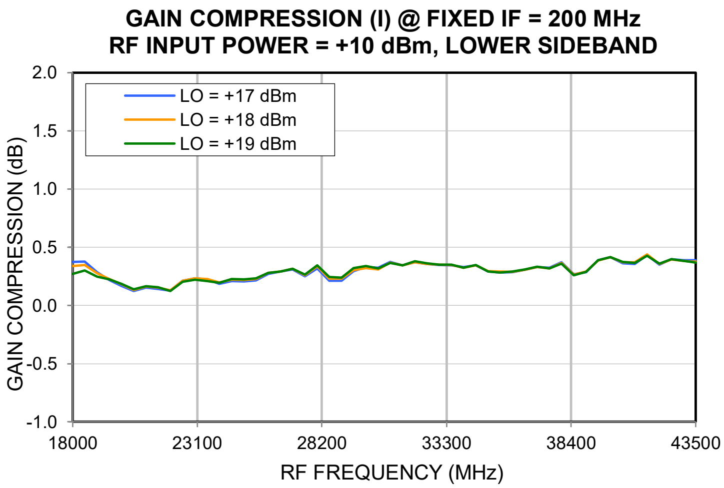


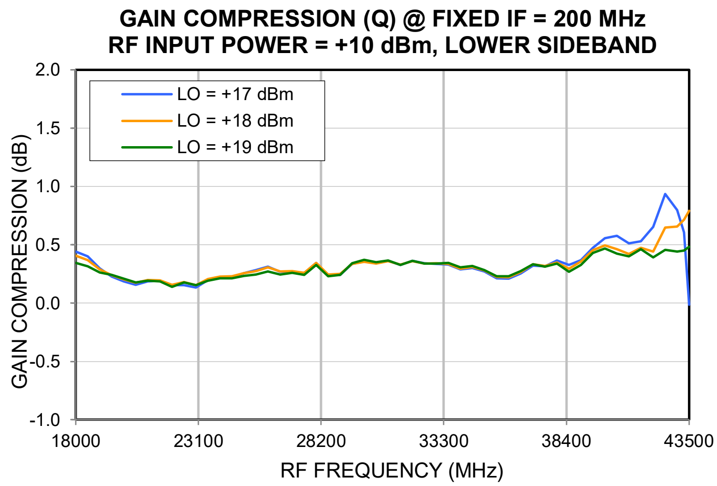


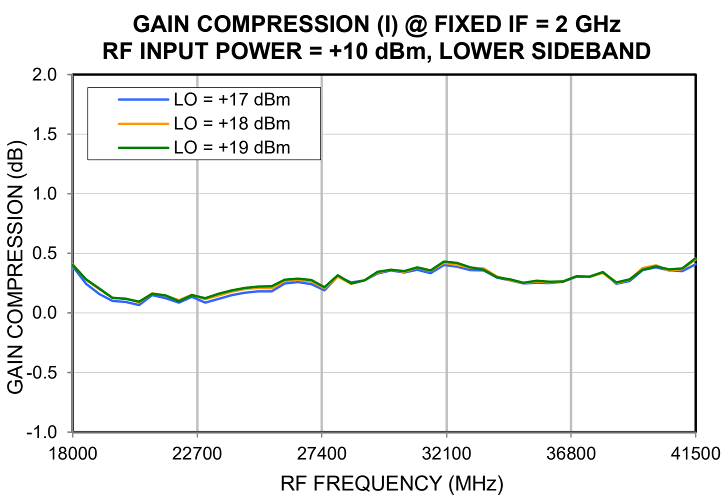


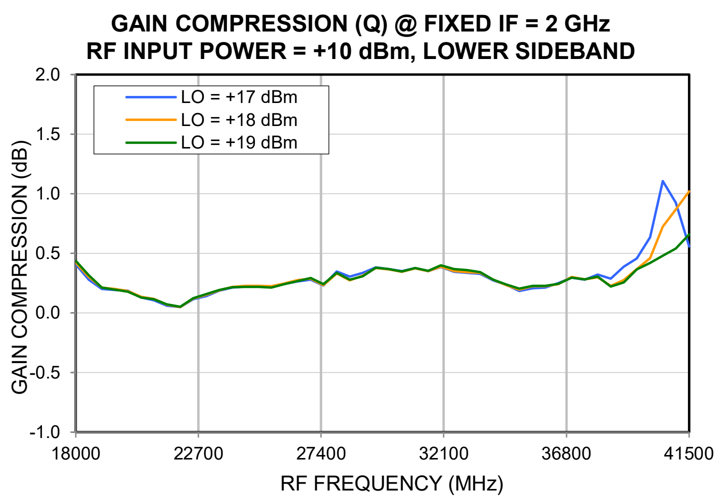
TYPICAL PERFORMANCE GRAPHS

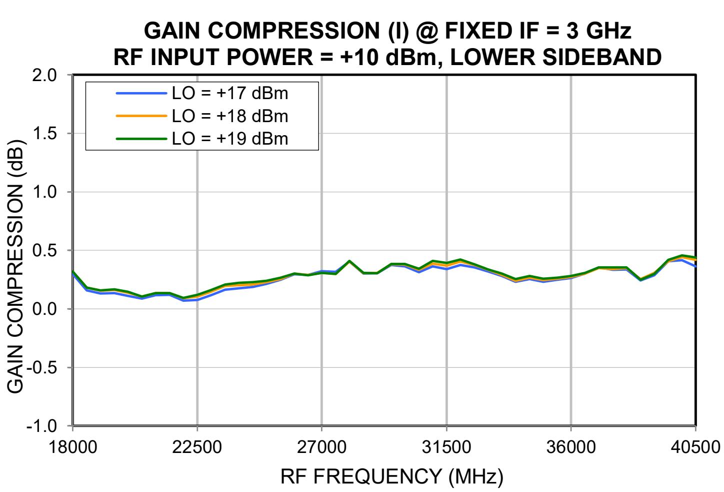
Note: All data on this page represents the Die attached in a 4x4mm 24-Lead QFN style package and measured on Mini-Circuits Characterization Test Board TB-SMIQ-1844HC+

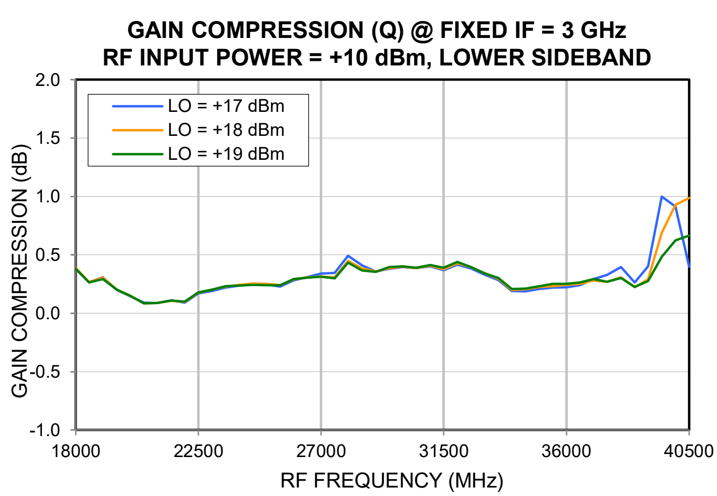








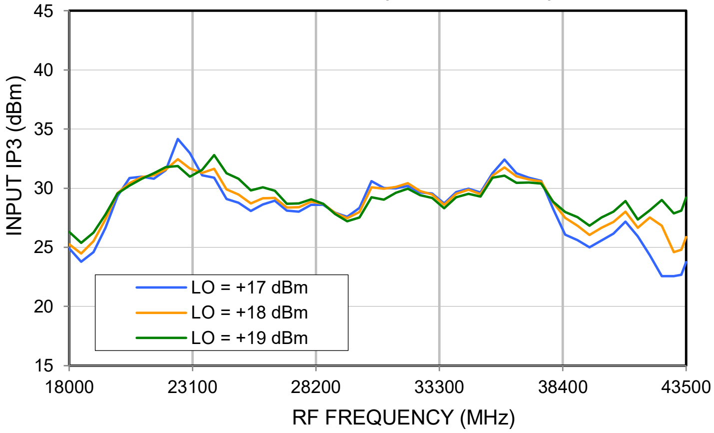




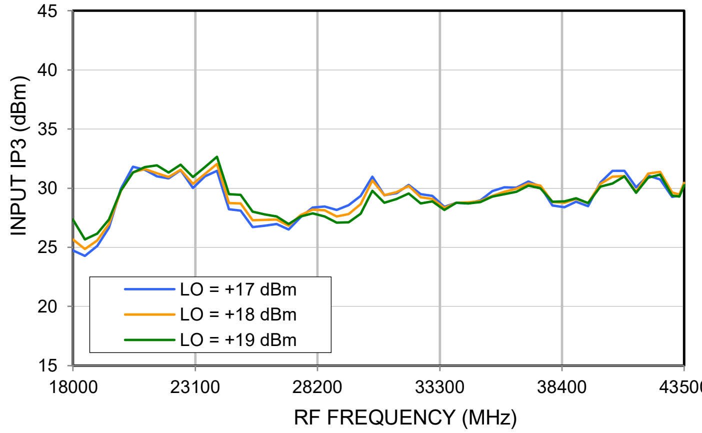
TYPICAL PERFORMANCE GRAPHS

Note: All data on this page represents the Die attached in a 4x4mm 24-Lead QFN style package and measured on Mini-Circuits Characterization Test Board TB-SMIQ-1844HC+
P_{IN} = 0 dBm/Tone with 1 MHz spacing (RF2 = RF1 + 1 MHz)

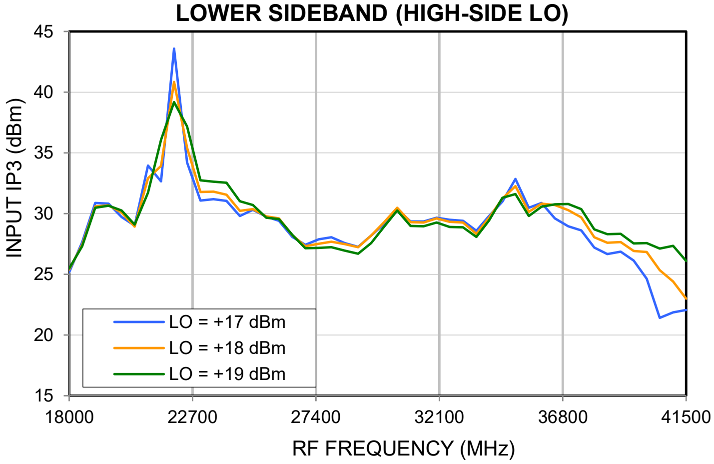
INPUT IP3 (I) @ FIXED IF = 200 MHz LOWER SIDEBAND (HIGH-SIDE LO)



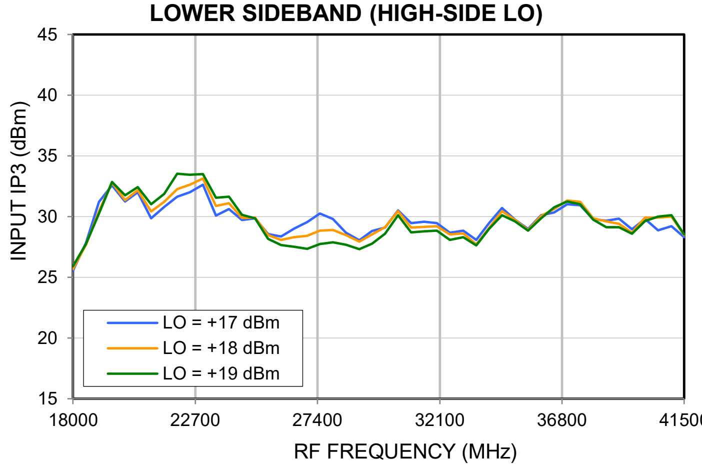
INPUT IP3 (Q) @ FIXED IF = 200 MHz LOWER SIDEBAND (HIGH-SIDE LO)



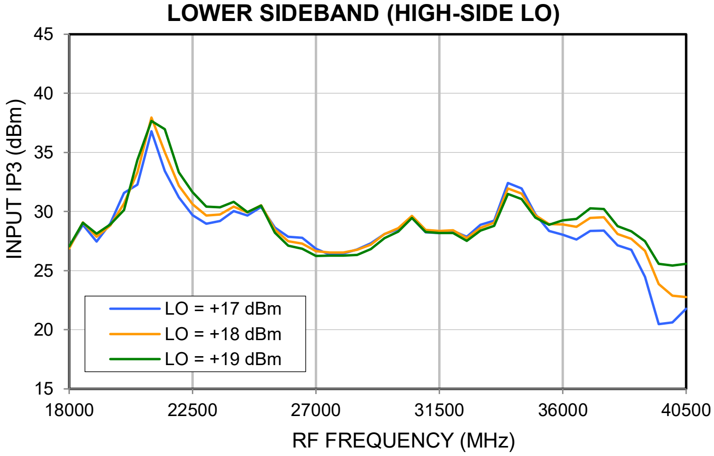
INPUT IP3 (I) @ FIXED IF = 2 GHz LOWER SIDEBAND (HIGH-SIDE LO)



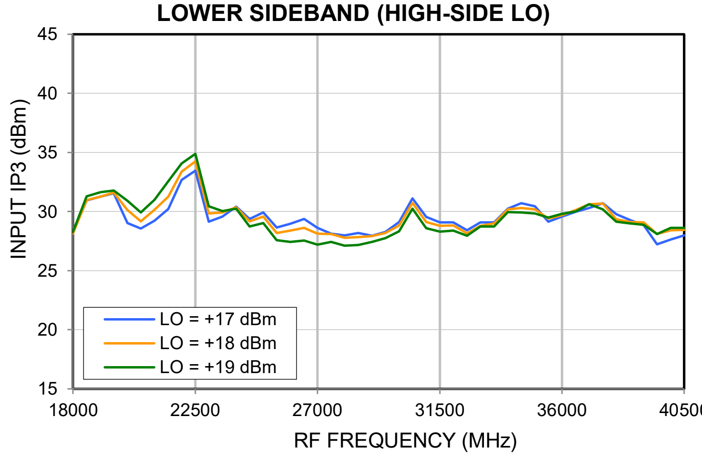
INPUT IP3 (Q) @ FIXED IF = 2 GHz LOWER SIDEBAND (HIGH-SIDE LO)



INPUT IP3 (I) @ FIXED IF = 3 GHz LOWER SIDEBAND (HIGH-SIDE LO)



INPUT IP3 (Q) @ FIXED IF = 3 GHz LOWER SIDEBAND (HIGH-SIDE LO)



ABSOLUTE MAXIMUM RATINGS[6]

Parameter	Ratings
Operating Temperature[7]	-55°C to +105°C
Storage Temperature (for Die)[8]	-65°C to +150°C
Junction Temperature[9]	+175°C
LO Power	+24 dBm
RF Power	+24 dBm
I/Q Power	+23 dBm
DC Current on I & Q Ports	16 mA

6. Permanent damage may occur if any of these limits are exceeded. Maximum ratings are not intended for continuous normal operation.
7. Bottom of Die
8. For die shipped in Gel-Pak see ENV-80 (limited by packaging).
9. Hot spot temperature on die.

ESD RATING[10]

	Class	Voltage Range	Reference Standard
HBM	1B	500 to < 1000 V	ANSI/ESDA/JEDEC JS-001-2017
CDM	C3	≥ 1000 V	JESD22-C101F

ESD HANDLING PRECAUTION: This device is designed to be Class 1B 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.

10. ESD tested in 4x4mm 24-Lead QFN-Style package.

FUNCTIONAL DIAGRAM

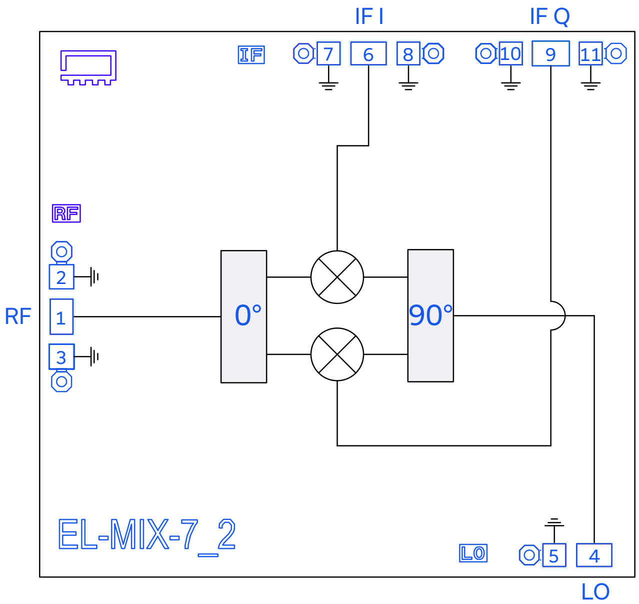


Figure 1. SMIQ-1844H-D+ Functional Diagram

PAD DESCRIPTION

Function	Pad #	Description (Refer to Figure 1)
RF	1	RF Port. Connects to RF Output for Upconverters and RF Input for Downconverters.
LO	4	LO Port. Connects to LO Input
IF I	6	IF I Port. Connects to the IF I Input for Upconverters and IF I Output for Downconverters
IF Q	9	IF Q Port. Connects to the IF Q Input for Upconverters and IF Q Output for Downconverters
GND	2, 3, 5, 7, 8, 10, 11	Connected to backside of Die thru vias. Bond wires to ground are optional.

DIE OUTLINE: inches [mm], Typical

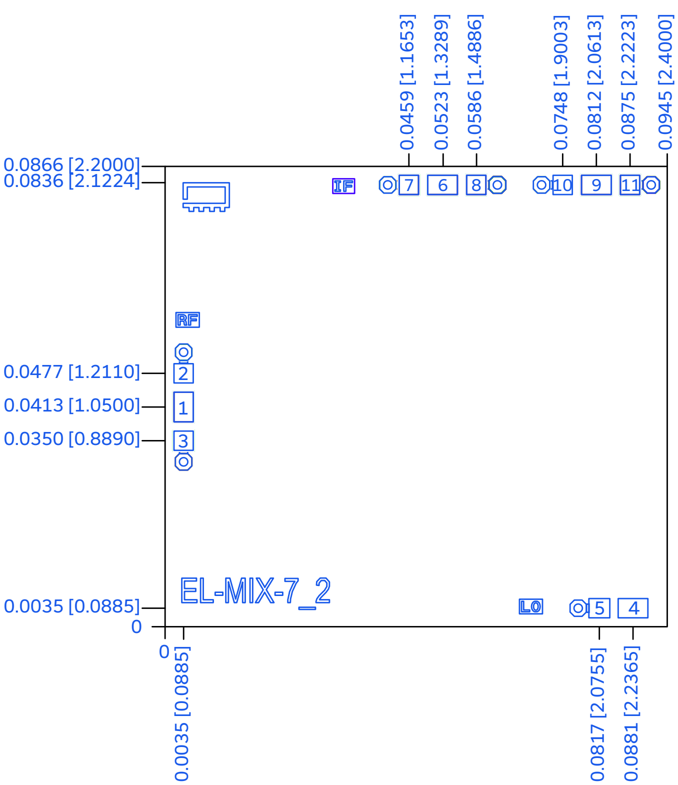
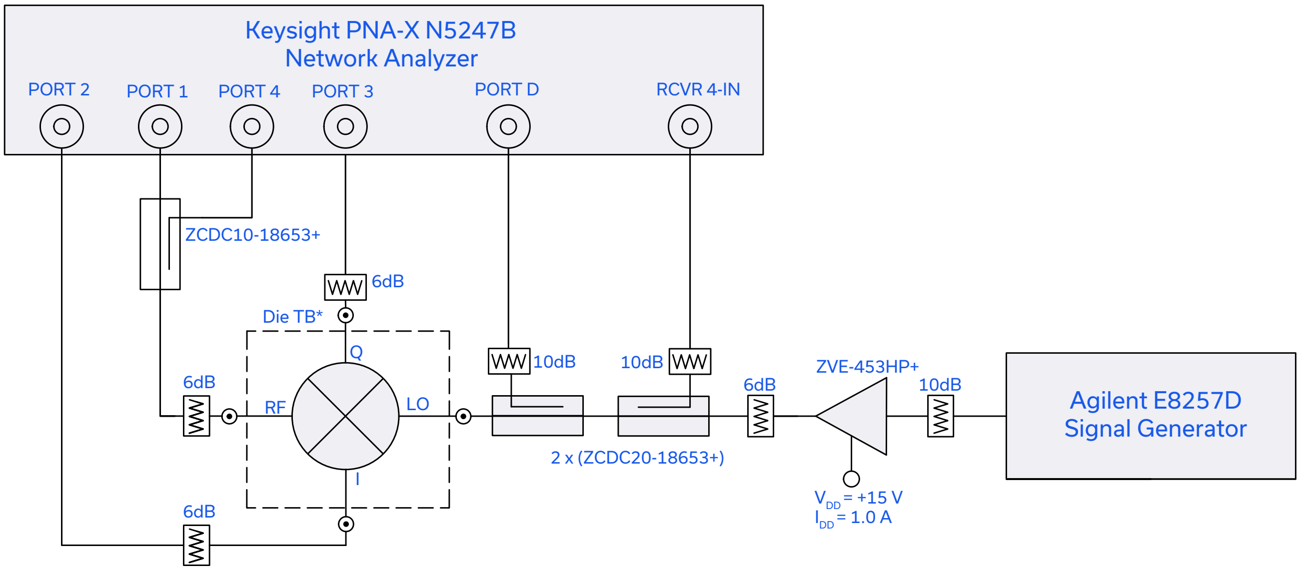


Figure 2: SMIQ-1844H-D+ Die Outline.

DIMENSIONS: inches [mm], Typical

Die Size	0.0866 x 0.0945 [2.200 x 2.400]
Die Thickness	0.0040 [0.1000]
Bond Pad Sizes:	
Pads 1, 4, 6, & 9	0.0059 x 0.0040 [0.1500 x 0.1000]
Pads 2, 3, 5, 7, 8, 10, & 11	0.0040 x 0.0040 [0.1000 x 0.1000]
Plating (Pads & Bottom of Die)	Gold

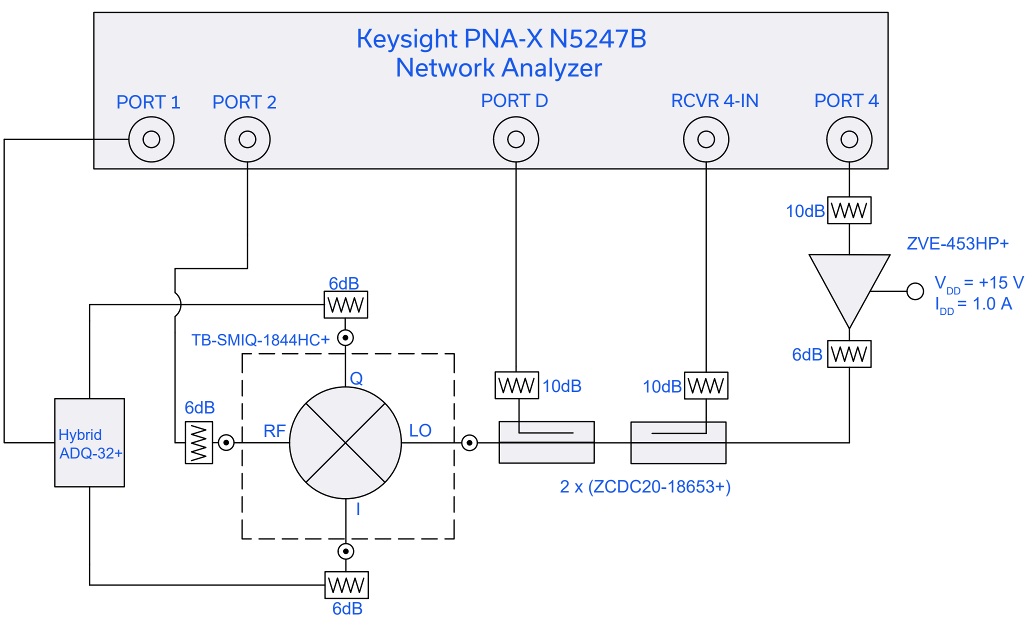
CHARACTERIZATION TEST BLOCK DIAGRAMS



10 dB attenuators P/N BW-E10-1W653+
6 dB attenuators P/N BW-E6-1W653+

Figure 3. Block diagram of test circuit used to characterize: Conversion Loss (CL), Amplitude Unbalance, Phase Unbalance, Isolation, Return Loss (RF, LO, I&Q) & Input IP3

Test conditions:
For CL, Return Loss and Isolation:
RF Input Power = -10 dBm, LO Input Power = +17 to +19 dBm, IF = 200 MHz, 2 GHz, 3 GHz
For Input IP3: RF = 0 dBm/Tone, LO Input Power = +17 to +19 dBm. Two tones, spaced 1 MHz apart.
*IIP3Tested in 4x4 mm 24-Lead package using TB-SMIQ-1844HC+



10 dB attenuators P/N BW-E10-1W653+
6 dB attenuators P/N BW-E6-1W653+

Figure 4. Block diagram of Test Circuit used for characterization of Image Rejection and Single Side Band Rejection

Test conditions:
RF Input Power = -10 dBm, LO Input Power = +17 to +19 dBm, IF = 200 MHz, 2 GHz, 3 GHz

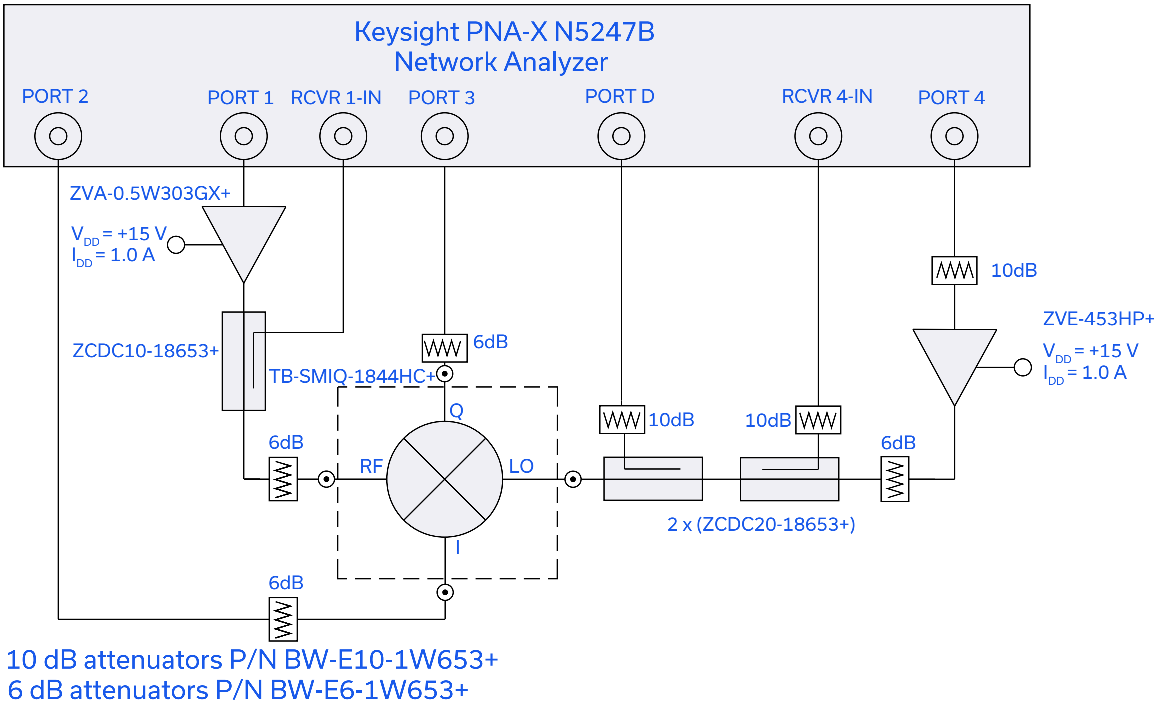


Figure 5. Block diagram of test circuit used to characterize Compression

Test Conditions:
RF Input Power = -10 dBm to +10 dBm, LO Input Power = +17 to +19 dBm, IF = 200 MHz, 2 GHz, and 3 GHz
Compression = (Conversion Loss @ RF Power = +10 dBm) – (Conversion Loss @ RF Power = -10 dBm)

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

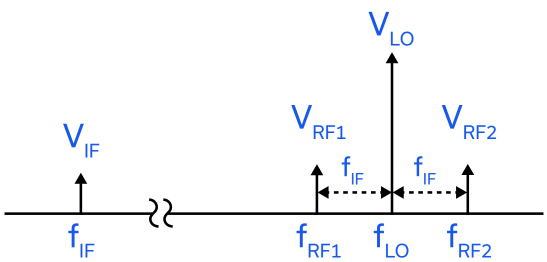


Figure 6. Spectral representation of Signals

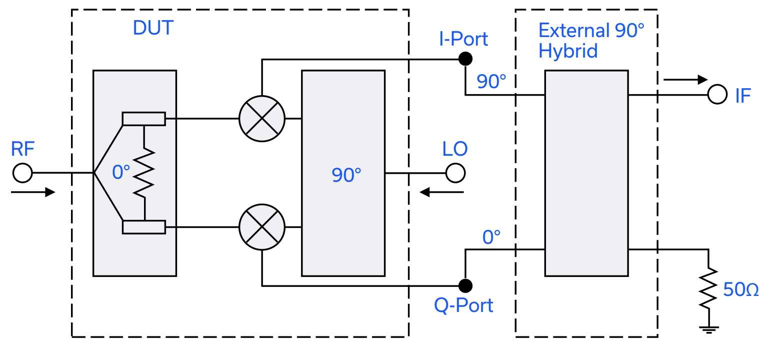


Figure 7. Block Diagram of Image Reject Mixer

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

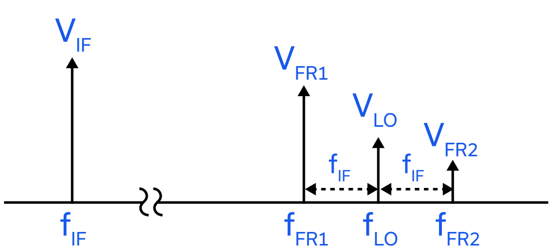


Figure 8. Spectral representation of Signals

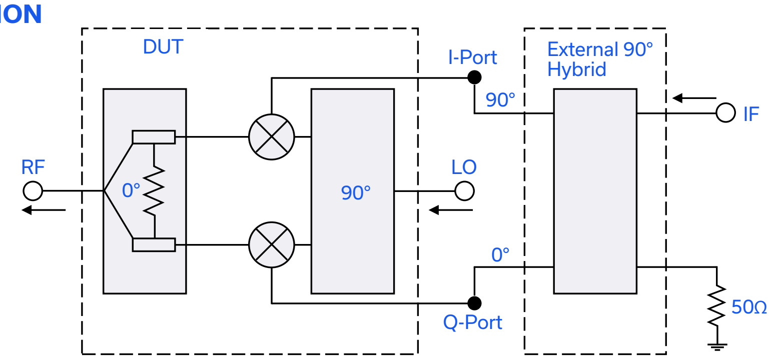


Figure 9. Block Diagram of Single Side Band Mixer

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.

ASSEMBLY DIAGRAM

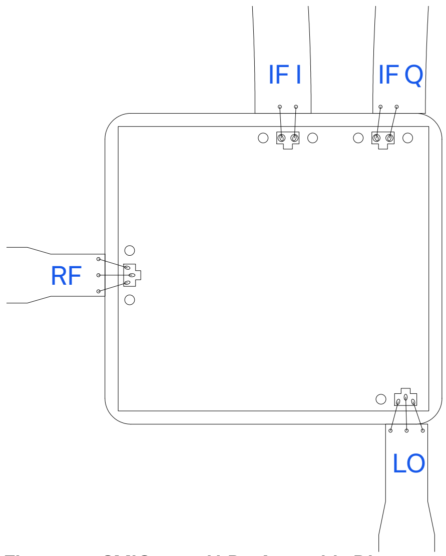


Figure 10. SMIQ-1844H-D+ Assembly Diagram

- Bond wire diameter: 1 mil
- Bond wire lengths from Die Pad to PCB at RF port: 19 ± 2 mils
- Bond wire lengths from Die Pad to PCB at LO port: 19 ± 2 mils
- Bond wire lengths from Die Pad to PCB at IF ports: 36 ± 2 mils
- Typical Gap from Die edge to PCB edge: 3 mils
- PCB thickness and material: 8 mil RO4003C (Thickness: 10.8 mils copper to copper).

ASSEMBLY AND HANDLING PROCEDURE

1. Storage
Die should be stored in a dry nitrogen purged desiccator or equivalent.
2. ESD Precautions
MMIC mixer die are susceptible to electrostatic and mechanical damage. Die are supplied in anti-static protected material, which should be opened only in clean room conditions at an appropriately grounded anti-static workstation.
3. Die Handling and Attachment
Devices require careful handling using tools appropriate for manipulating semiconductor chips. It is recommended to handle the chips along the edges with a custom designed collet. The surface of the chips have exposed air bridges and should not be touched with a vacuum collet, tweezers or fingers.
The die mounting surface must be clean and flat. Using conductive silver-filled epoxy, apply sufficient adhesive to meet the required bond line thickness, fillet height and coverage around the total periphery of the device. The recommended epoxy is Ablestik 84-1 LMISR4 or equivalent. Parts should be cured in a nitrogen-filled atmosphere per manufacturer's recommended cure profile.
4. Wire Bonding
Openings in the surface passivation above the gold bond pads are provided to allow wire bonding to the die. Thermosonic bonding is recommended with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. The suggested interconnect is pure gold, 1 mil diameter wire. Bonds are recommended to be made from the bond pads on the die to the package or substrate. All bond wire length and bond wire height should be kept as short as possible, unless specified by design, to minimize performance degradation due to undesirable series inductance.

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ADDITIONAL DETAILED INFORMATION IS AVAILABLE ON OUR DASH BOARD CLICK HERE

Performance Data	Table Graphs	
Case Style	Die	
RoHS Status	Compliant	
Die Ordering and Packaging Information	Quantity, Package	Model No.
	Gel - Pak: 5, 10, 50 KGD*	SMIQ-1844H-DG+
	Medium†, Partial wafer: KGD*<440	SMIQ-1844H-DP+
	Full wafer†	SMIQ-1844H-DF+
	†Available upon request contact sales representative. Refer to AN-60-067	
Die Marking	EL-MIX-7-2	
Environmental Ratings	ENV-80	

* Known Good Dice ("KGD") means that the dice in question are taken from PCM good wafer and visually inspected according to Mini-Circuits inspection criteria. While this is not definitive, it does help to provide a high degree of confidence that dice are capable of meeting typical RF electrical parameters specified by Mini-Circuits.