



MMIC DIE

IQ Mixer

SMIQ-6243H-D+

50Ω 6 to 24 GHz Level 18 (LO Power +18 dBm)

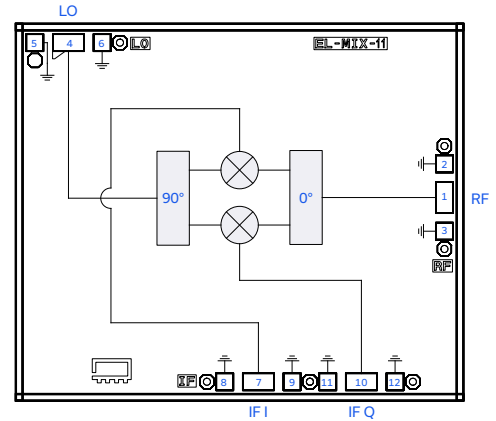
THE BIG DEAL

- Wideband RF & LO, 6 to 24 GHz
- Wideband IF, DC to 6 GHz
- Excellent Image Rejection, Typ. 29 dB
- High LO-RF Isolation, Typ. 40 dB
- High Input IP3, Typ. +25 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-6243H-D+ is a passive, wideband in phase/quadrature (I/Q) mixer die fabricated using GaAs HBT technology. The SMIQ-6243H-D+ is usable as a single-sideband upconverter for transmit applications or an image rejection mixer for receiver applications. The SMIQ-6243H-D+ is ideal for wideband frequency translation applications that require inherent rejection of image signals and spurious mixing products. The mixer covers a wide frequency range with RF and LO frequency range of 6 to 24 GHz and an IF frequency range of DC to 6 GHz. As a passive mixer, the SMIQ-6243H-D+ offers lower noise figure than active mixers ensuring superior dynamic range for high performance applications. No DC bias is needed for operation.

KEY FEATURES

Features	Advantages
High Image Rejection, 29 dB typical	Provides inherent rejection of unwanted image signals without the need for external filtering
High LO-RF Isolation, 40 dB typical	Enables excellent carrier rejection in single-sideband upconvert applications
High LO-IF Isolation, 46 dB typical	Minimizes filtering requirements needed to ensure signal integrity
Wide Bandwidth, 6 to 24 GHz	Useful in wideband systems or in several narrowband systems requiring fewer components
Wide IF Bandwidth, DC to 6 GHz	Enables use of high IF conversion to reduce filtering requirements. Also operates as low as DC for use in vector modulation applications.
Unpackaged Die	Enables integration into hybrid chip and wire assemblies



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ELECTRICAL SPECIFICATIONS¹ AT +25°C, LO POWER= +18 dBm, UNLESS NOTED OTHERWISE

Parameter	Frequency (GHz)	Min.	Typ.	Max.	Unit
RF Frequency Range		6		24	GHz
LO Frequency Range		6		24	GHz
IF Frequency Range		DC		6	GHz
LO Power		+17	+18	+20	dBm
Conversion Loss ²	6 - 20		8.3		dB
	20 - 24		9.6		
Amplitude Unbalance	6 - 20		±0.2		dB
	20 - 24		±0.2		
Phase Unbalance (Relative to 90°)	6 - 20		±4.3		Deg.
	20 - 24		±1.7		
Image Rejection ³ (Tested as a Downconverter)	6 - 20		29		dBc
	20 - 24		27		
Single Sideband Rejection ⁴ (Tested as an Upconverter)	6 - 20		29		dBc
	20 - 24		32		
LO-RF Isolation	6 - 20		41		dB
	20 - 24		37		
LO-I Isolation	6 - 20		50		dB
	20 - 24		34		
LO-Q Isolation	6 - 20		47		dB
	20 - 24		38		
RF-I Isolation	6 - 20		29		dB
	20 - 24		31		
RF-Q Isolation	6 - 20		32		dB
	20 - 24		35		
Input Power at 1dB Compression	6 - 24		+10		dBm
Input IP3	6 - 20		+20		dBm
	20 - 24		+25		

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 3dB theoretical loss of an Ideal External Hybrid, measured as a Down Converter. See measurement block diagram Figure 2.

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

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





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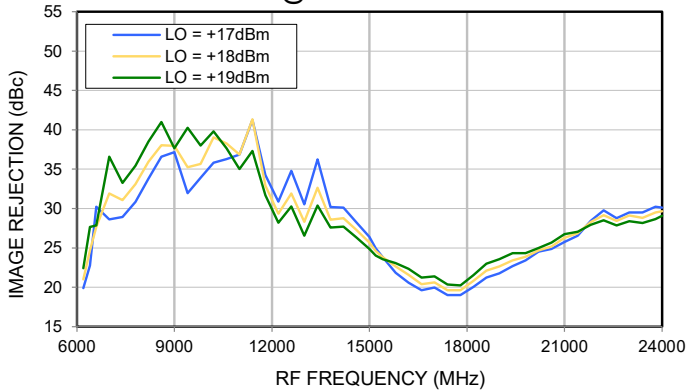
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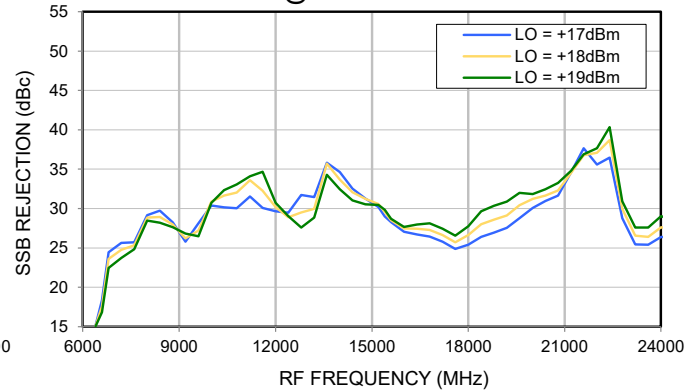
50Ω 6 to 24 GHz Level 18 (LO Power +18 dBm)

TYPICAL PERFORMANCE GRAPHS

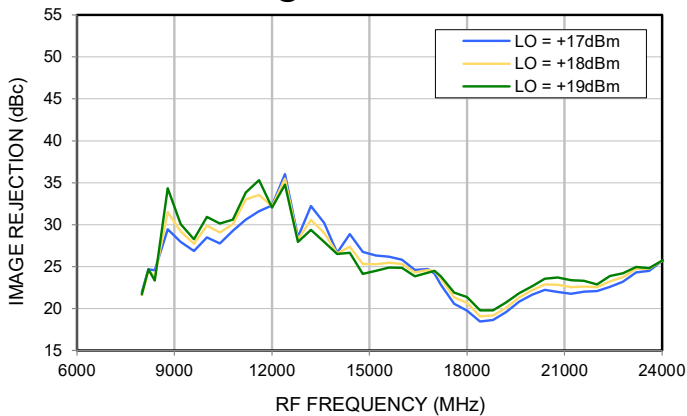
**IMAGE REJECTION (DOWNCONVERTER)
@ IF = 200 MHz**



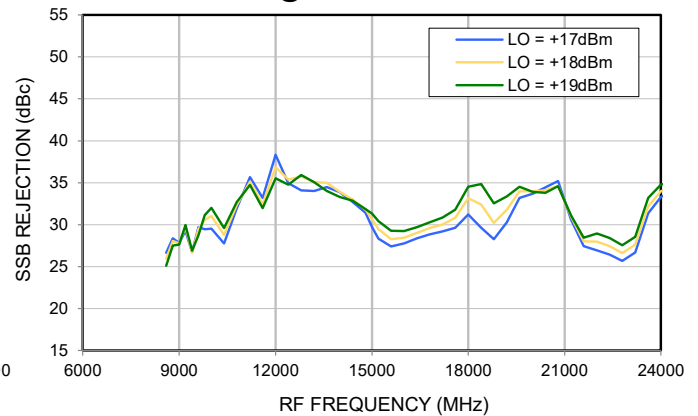
**SSB REJECTION (UPCONVERTER)
@ IF = 200 MHz**



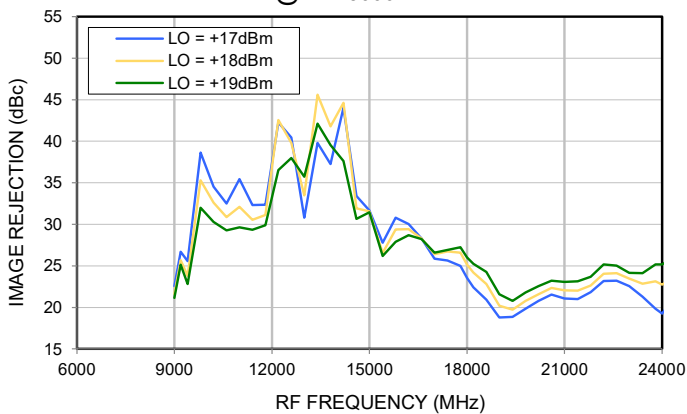
**IMAGE REJECTION (DOWNCONVERTER)
@ IF = 2000 MHz**



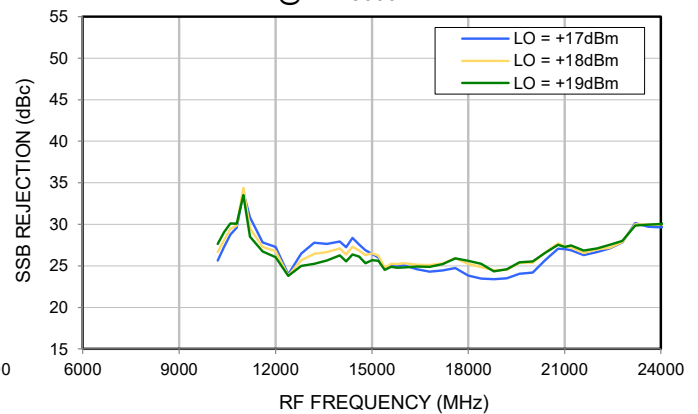
**SSB REJECTION (UPCONVERTER)
@ IF = 2000 MHz**



**IMAGE REJECTION (DOWNCONVERTER)
@ IF = 3000 MHz**



**SSB REJECTION (UPCONVERTER)
@ IF = 3000 MHz**





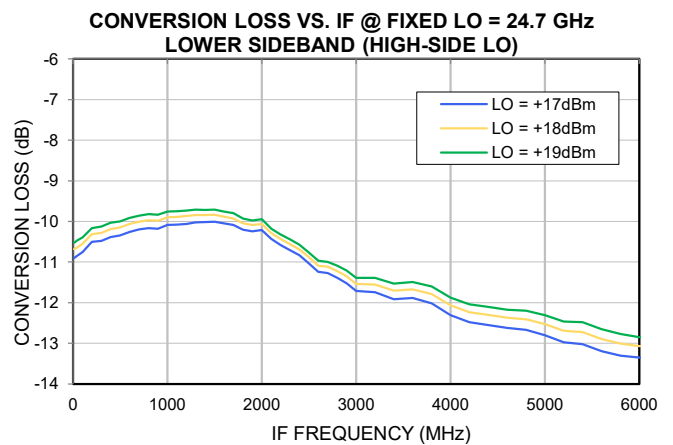
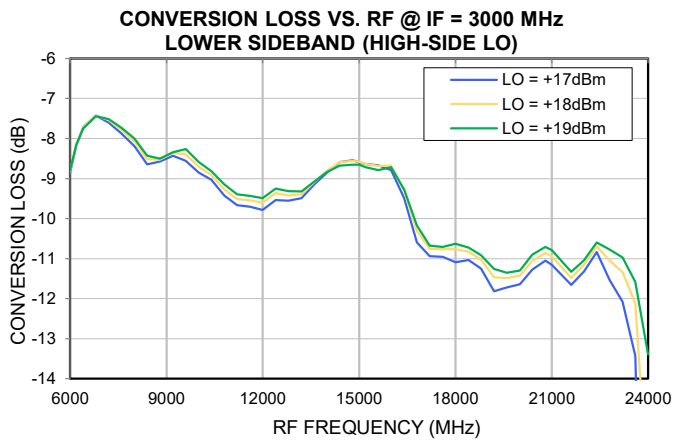
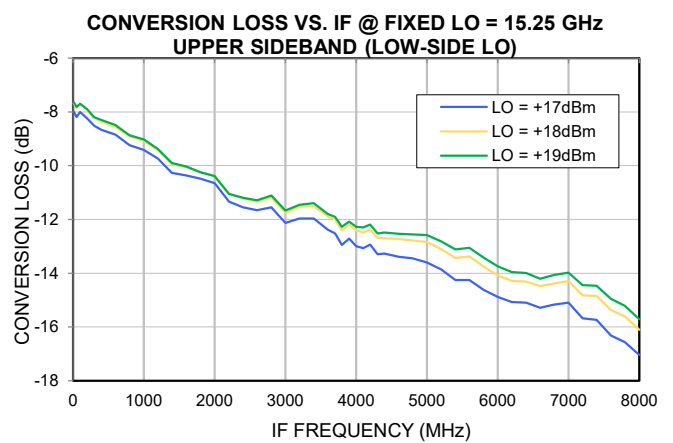
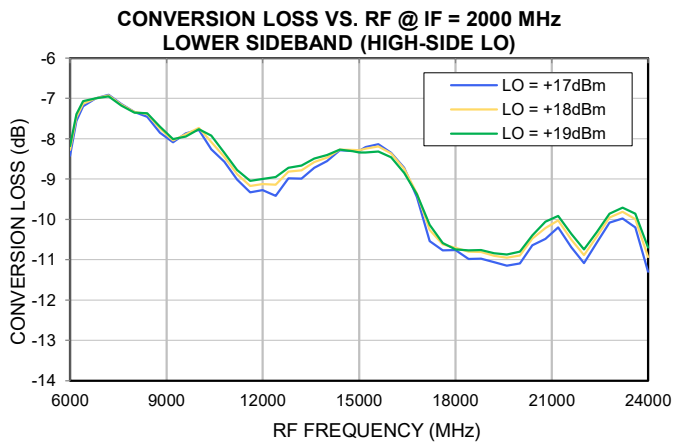
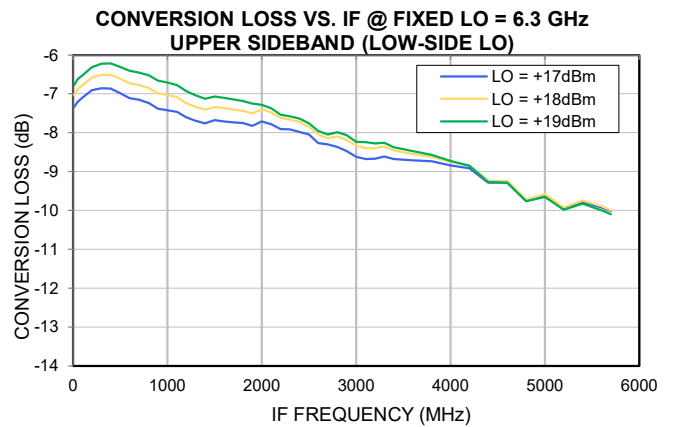
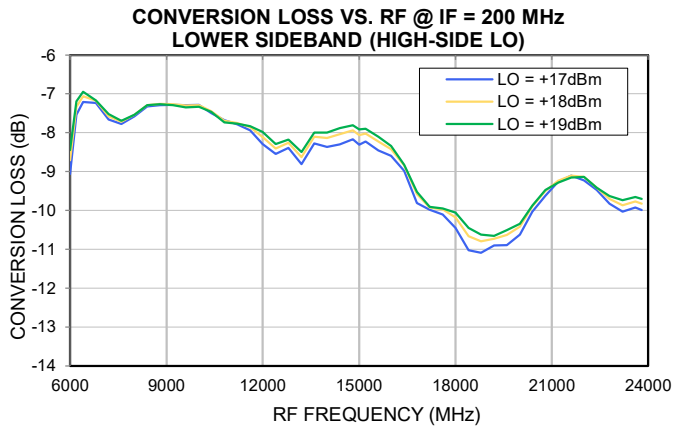
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TYPICAL PERFORMANCE GRAPHS





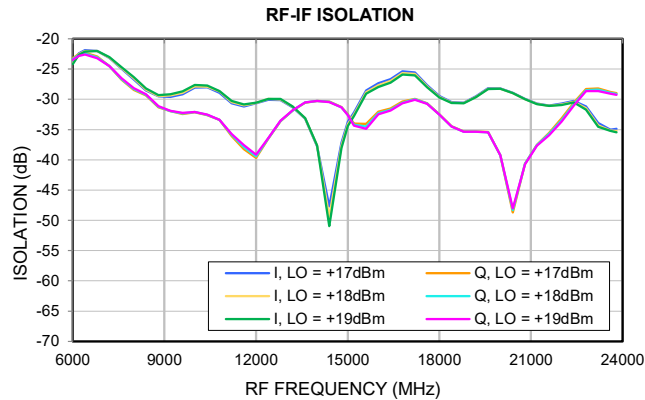
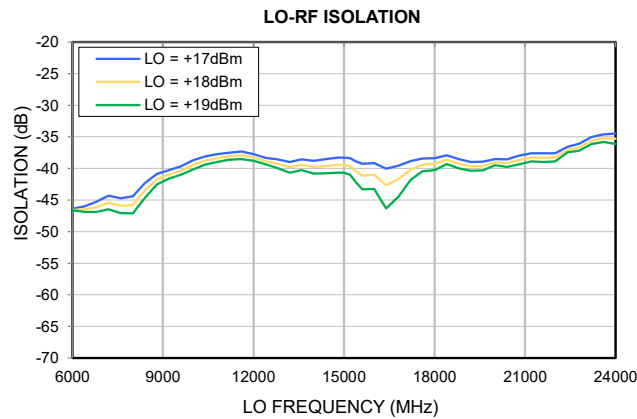
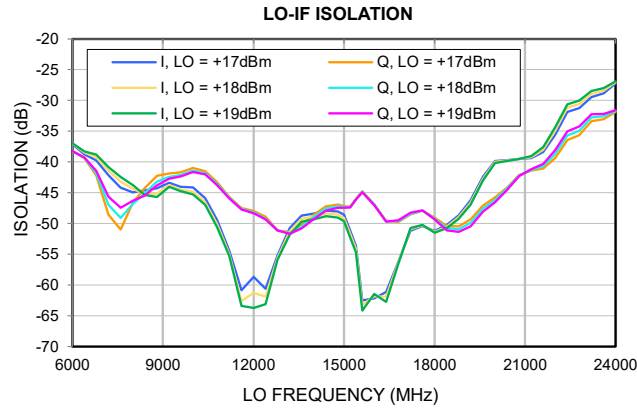
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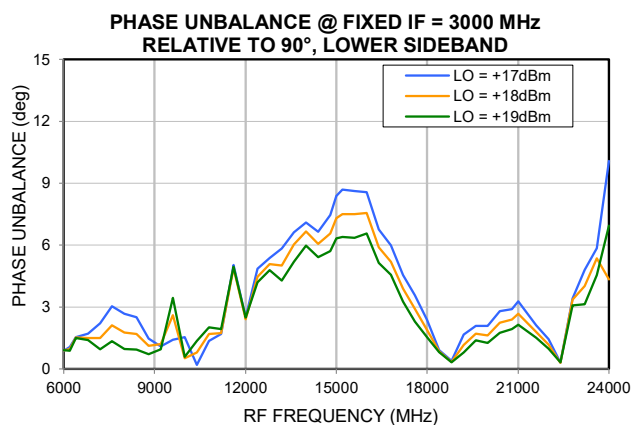
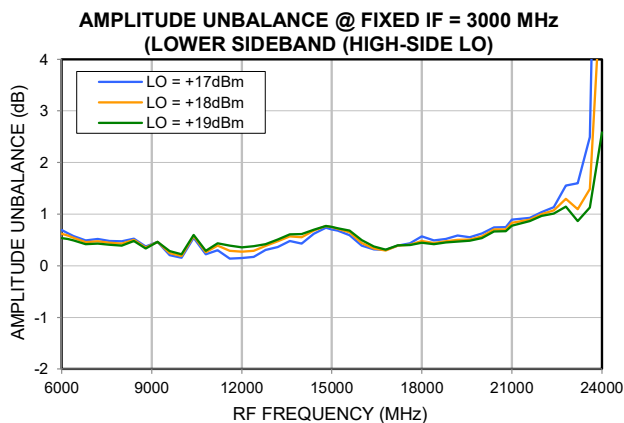
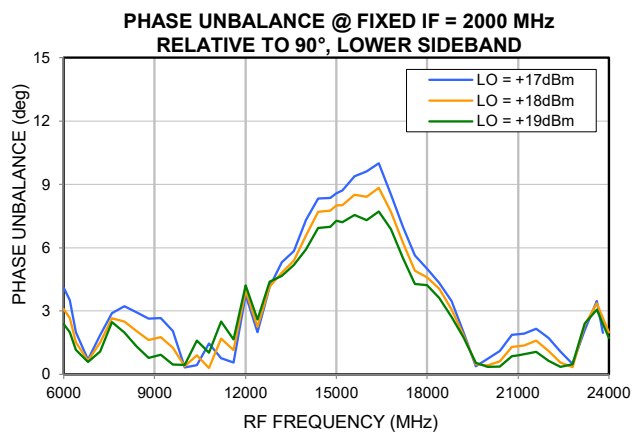
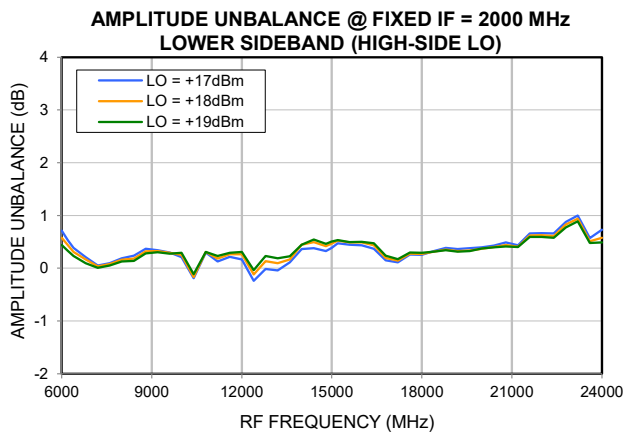
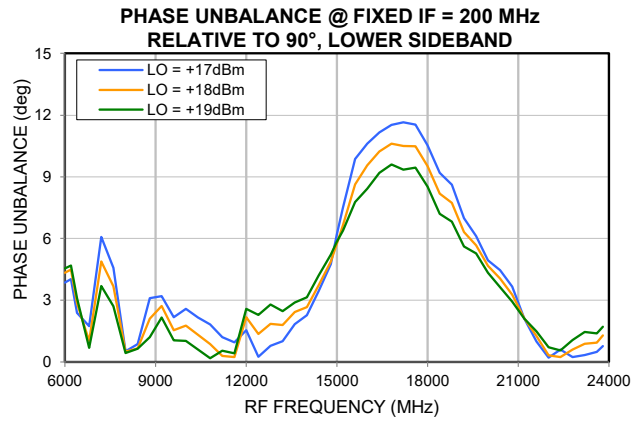
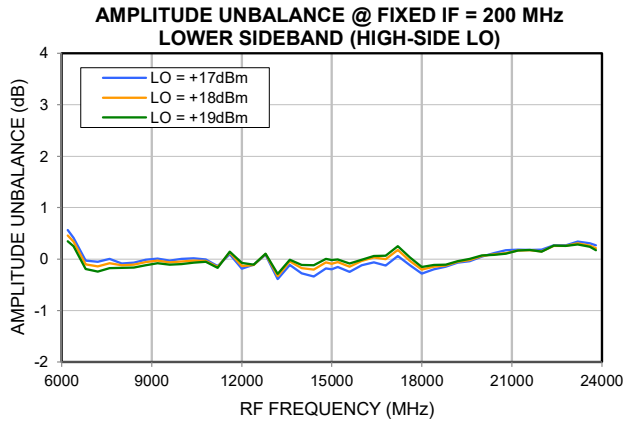
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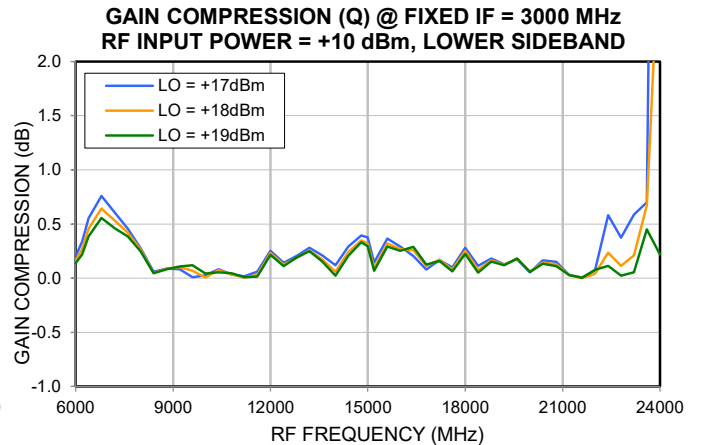
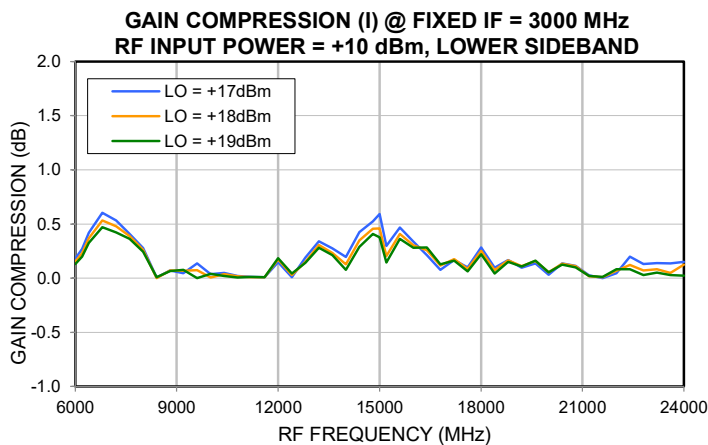
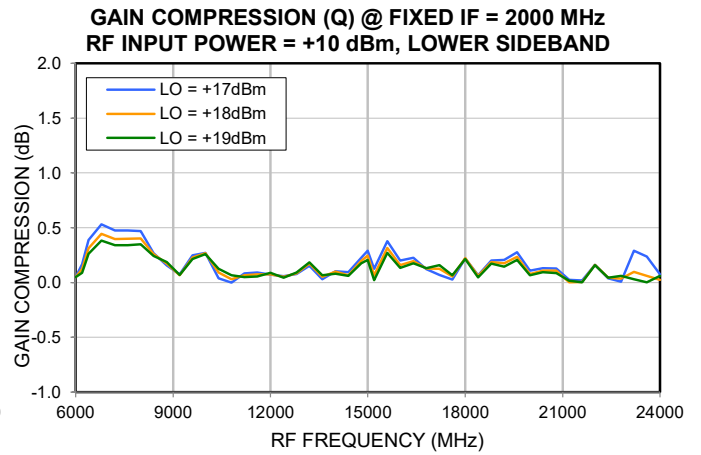
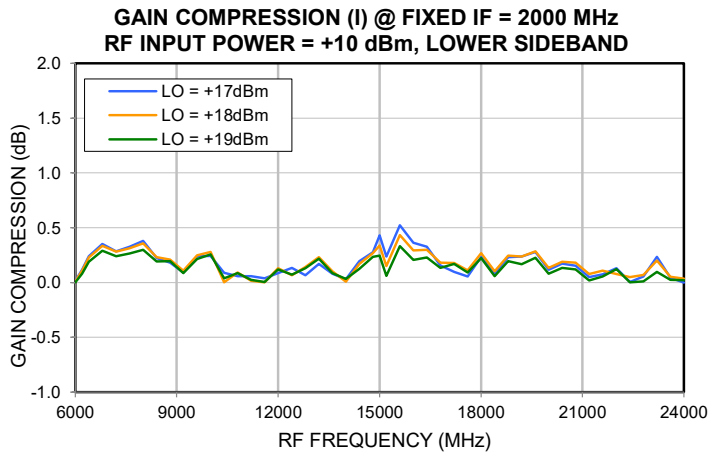
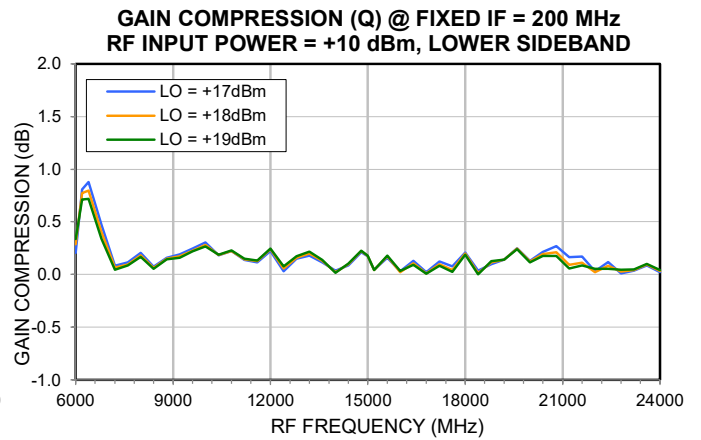
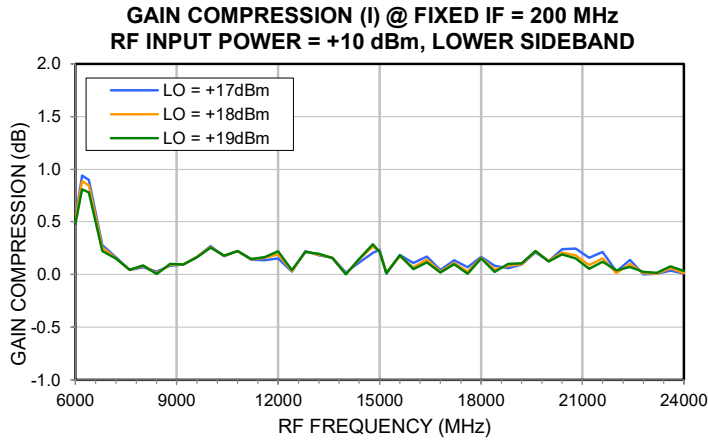
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Mini-Circuits

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TYPICAL PERFORMANCE GRAPHS





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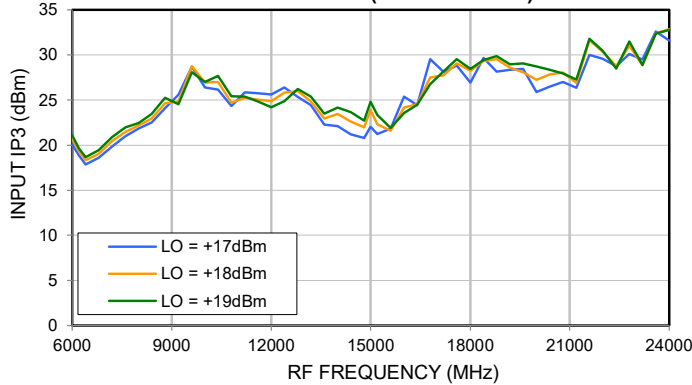
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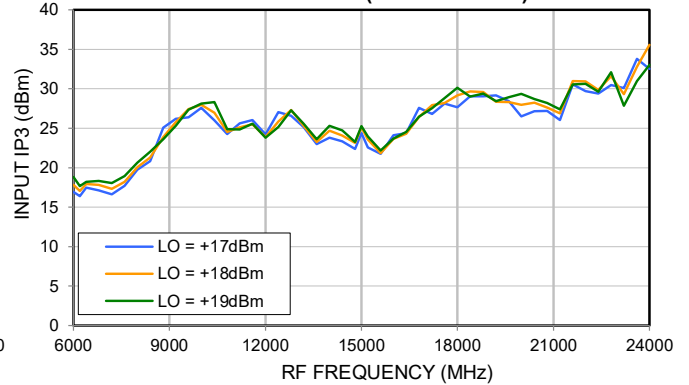
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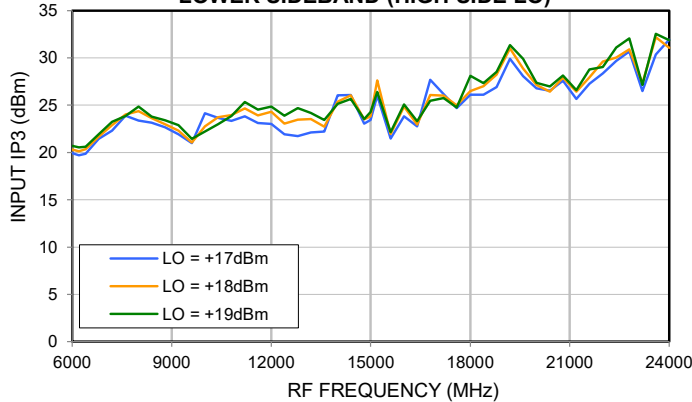
**INPUT IP3 (I) @ FIXED IF = 200 MHz
LOWER SIDEBAND (HIGH-SIDE LO)**



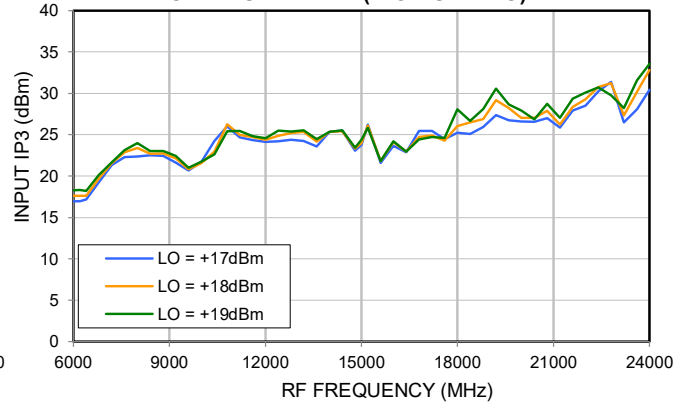
**INPUT IP3 (Q) @ FIXED IF = 200 MHz
LOWER SIDEBAND (HIGH-SIDE LO)**



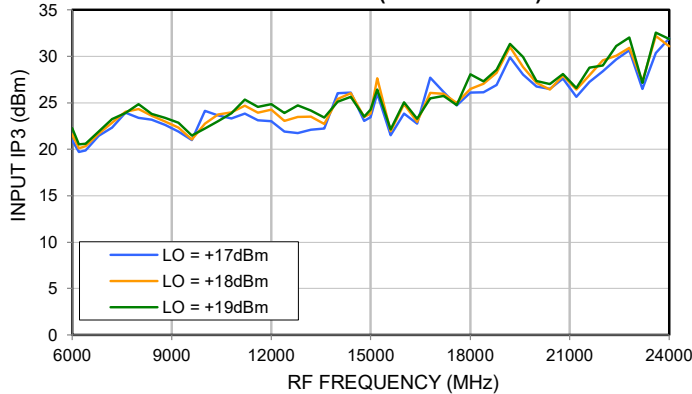
**INPUT IP3 (I) @ FIXED IF = 2000 MHz
LOWER SIDEBAND (HIGH-SIDE LO)**



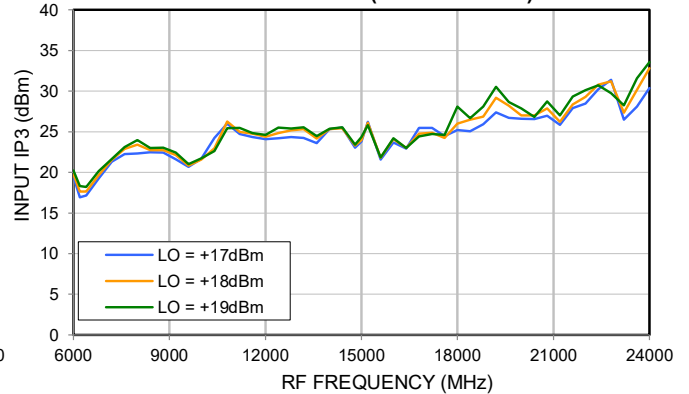
**INPUT IP3 (Q) @ FIXED IF = 2000 MHz
LOWER SIDEBAND (HIGH-SIDE LO)**



**INPUT IP3 (I) @ FIXED IF = 3000 MHz
LOWER SIDEBAND (HIGH-SIDE LO)**



**INPUT IP3 (Q) @ FIXED IF = 3000 MHz
LOWER SIDEBAND (HIGH-SIDE LO)**





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ABSOLUTE MAXIMUM RATINGS⁵

Parameter	Ratings
Operating Temperature ⁶	-40°C to +85°C
Storage Temperature (for Die) ⁷	+20°C to +35°C
LO Power	+25 dBm
RF Power	+25 dBm
DC Current on I & Q Ports	16 mA
Junction Temperature ⁸	175°C

5. Permanent damage may occur if any of these limits are exceeded. Maximum ratings are not intended for continuous normal operation.

6. Bottom of Die

7. For die shipped in Gel-Pak see ENV-80 (limited by packaging).

8. Hot spot temperature on die.

ESD RATING⁹

	Class	Voltage Range	Reference Standard
HBM	1A	250 to <500V	ANSI/ESDA/JEDEC JS-001-2017
CDM	C4	500 to <1000V	JESD22-C101F



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.

9. ESD tested in 4x4mm 24-Lead MCLP package.



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FUNCTIONAL DIAGRAM

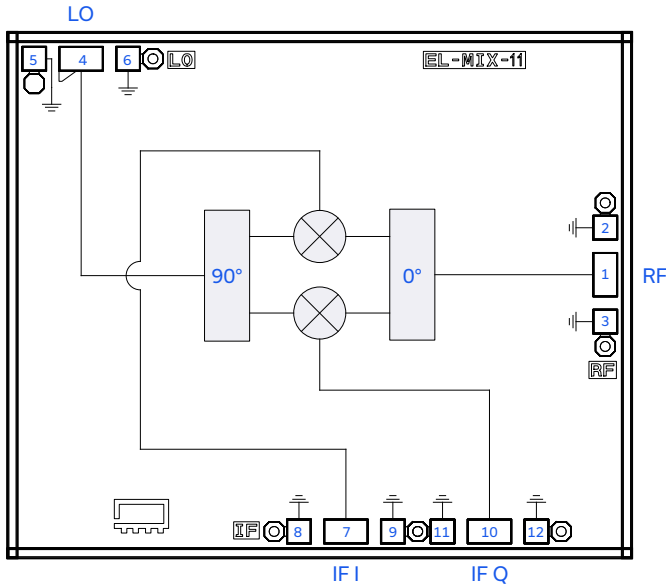
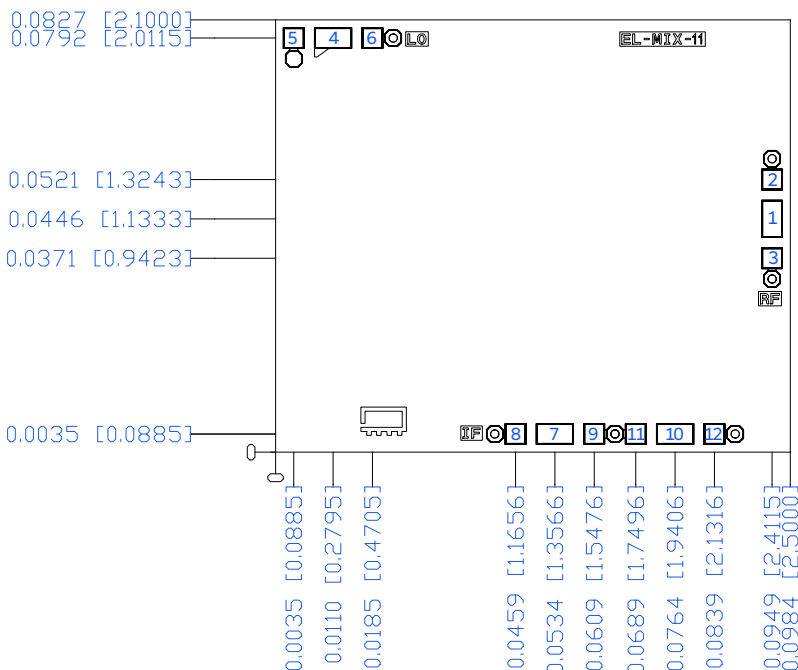


Figure 1. SMIQ-6243H-D+ Functional Diagram

PAD DESCRIPTION

Function	Pad #	Description (Refer to Figure 1)
RF	1	RF Port. Connects to RF Output for Up converters and RF Input for Down converters.
LO	4	LO Port. Connects to LO Input
IF-I	7	IF-I Port. Connects to the IF-I Input for Up converters and IF-I Output for Down converters
IF-Q	10	IF-Q Port. Connects to the IF-Q Input for Up converters and IF-Q Output for Down converters
GND	2, 3, 5, 6, 8, 9, 11, 12	Connected to backside of Die thru vias. Bond wires to ground are optional.

DIE OUTLINE: inches [mm], Typical



DIMENSIONS: inches [mm], Typical

Die Size	0.0827 x 0.0984 [2.1 x 2.5]
Die Thickness	0.040 [0.100]
Bond Pad Sizes:	
Pads 1, 4, 7, & 10	0.0036 x 0.0068 [0.092 x 0.172]
Pads 2, 3, 5, 6, 8, 9, 11, & 12	0.0036 x 0.0036 [0.092 x 0.092]
Plating (Pads & Bottom of Die)	Gold





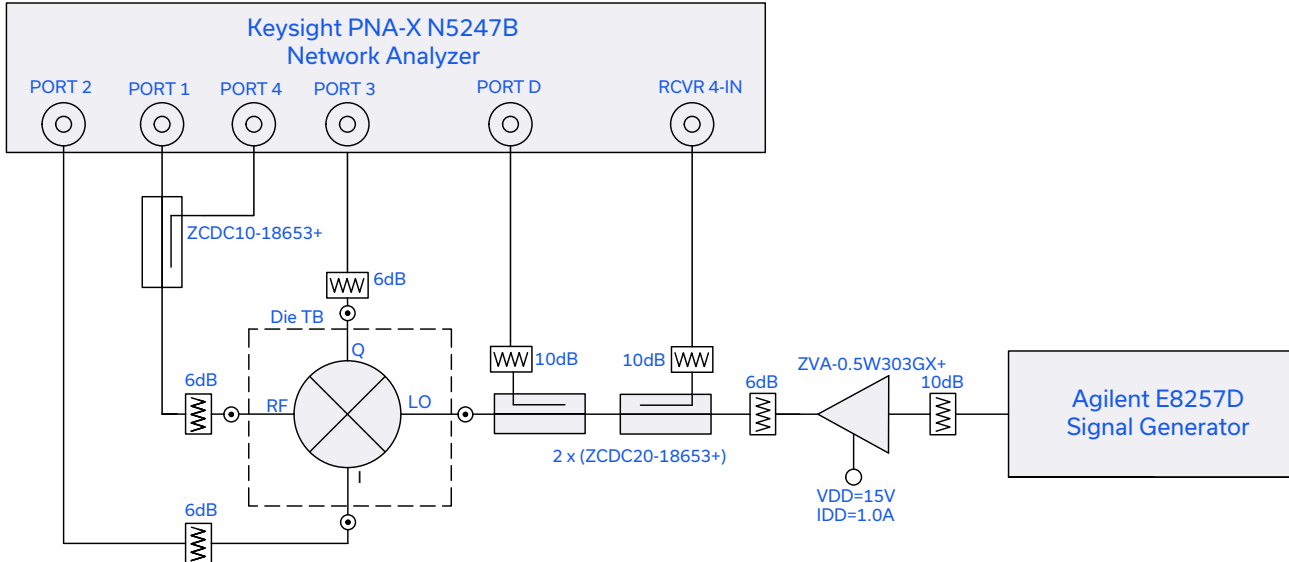
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CHARACTERIZATION TEST BLOCK DIAGRAMS



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

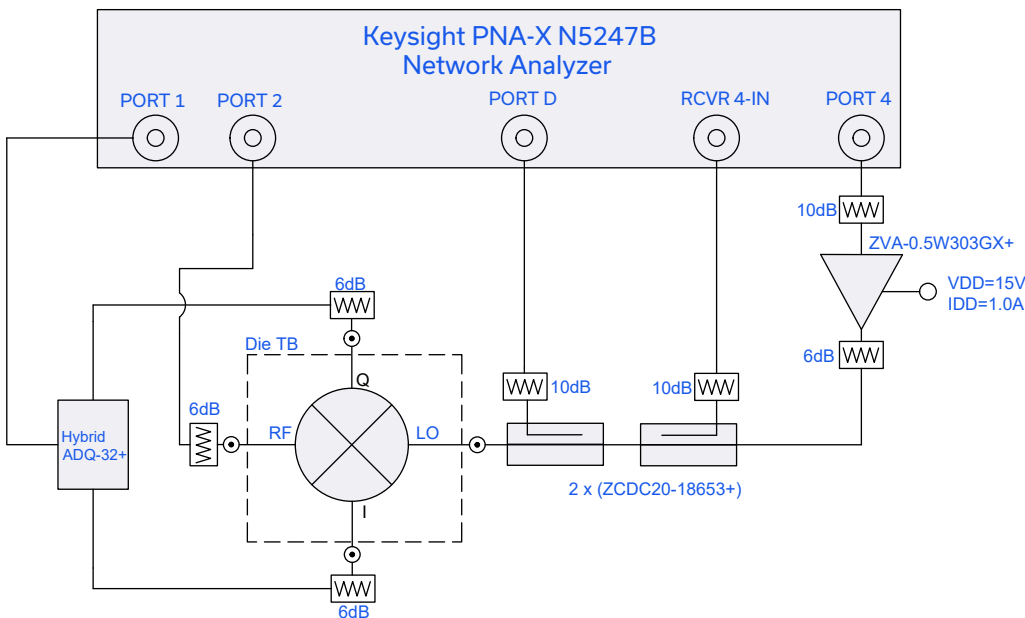
Figure 2. Block diagram of test circuit used to characterize: Conversion Loss (CL), Amplitude Unbalance, Phase Unbalance, Isolation, Return Loss (RF, LO, I & Q) & Input IP3

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 = -10 dBm/Tone, LO Input Power = +17 to +19 dBm. Two tones, spaced 1 MHz apart



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

Figure 3. 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



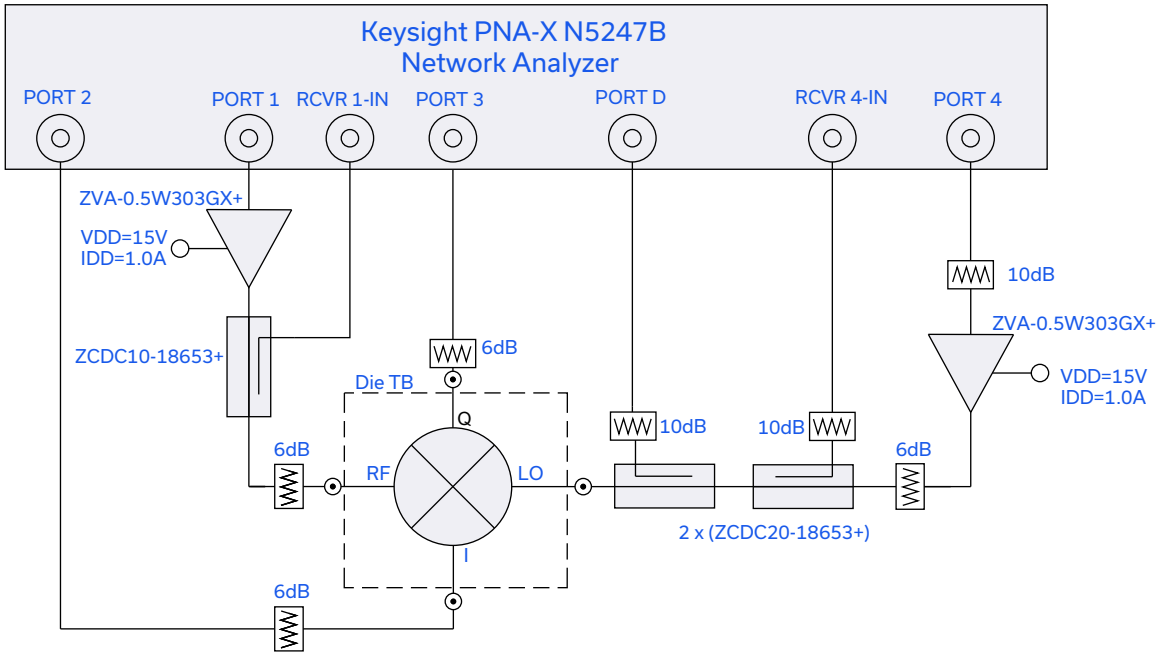


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10 dB attenuators P/N BW-E10-1W653+
 6 dB attenuators P/N BW-E6-1W653+

Figure 4. 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 portofolio of 90° Hybrids.

IMAGE REJECT MIXER APPLICATION

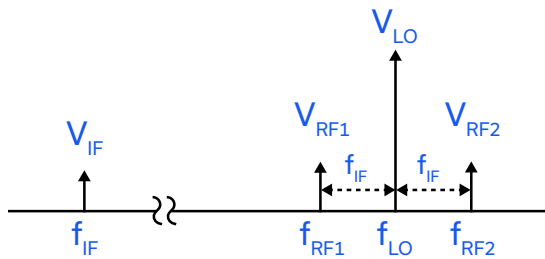


Figure 5. Spectral representation of Signals

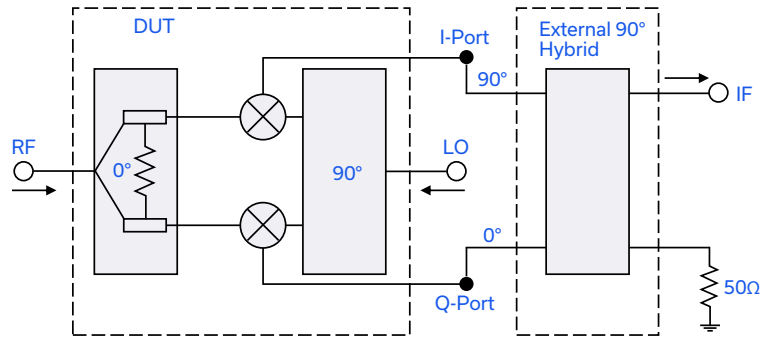


Figure 6. Block Diagram of Image Reject Mixer

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

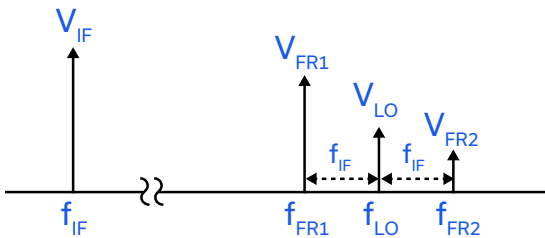


Figure 7. Spectral representation of Signals

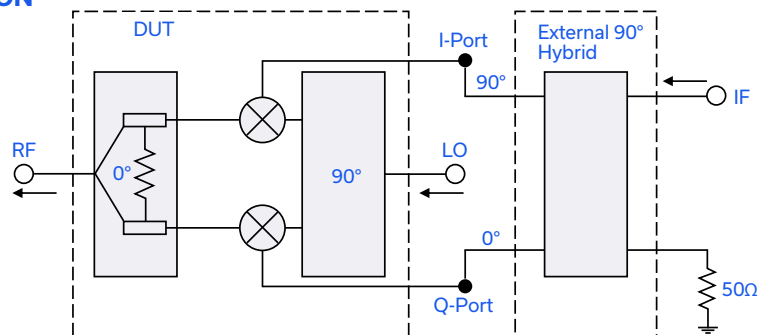


Figure 8. Block Diagram of Single Side Band Mixer

For upper side band 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 send the lower sideband band signal to the isolation resistor of the 0° RF splitter in DUT and upper sideband at RF port.

For lower side band 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 send the upper sideband band signal to the isolation resistor of the 0° RF splitter in DUT and lower sideband out of 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

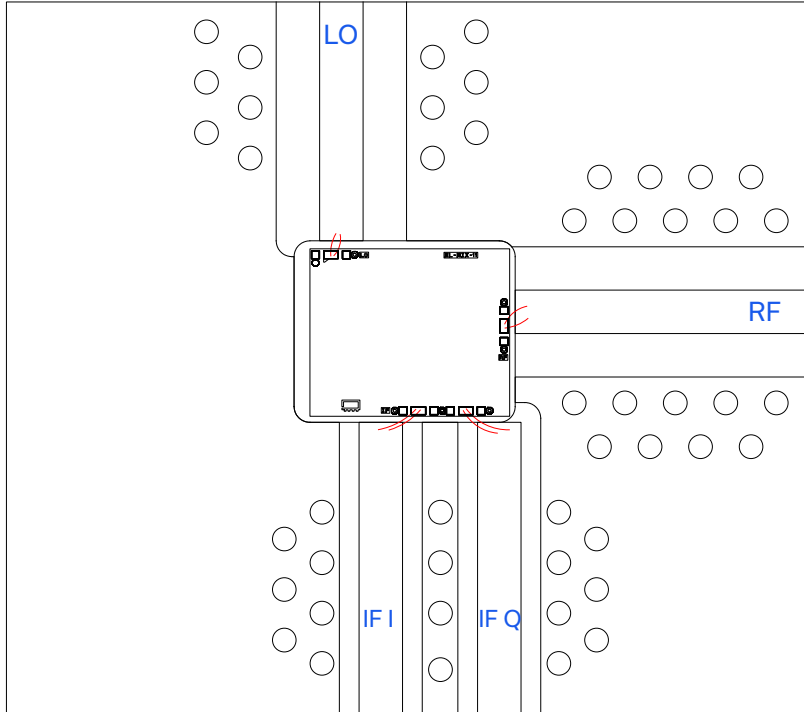



Figure 9. SMIQ-6243H-D+ Assembly Diagram

- Bond wire diameter: 1 mil
- Bond wire lengths from Die Pad to PCB at RF port: 23 ± 2 mils
- Bond wire lengths from Die Pad to PCB at LO port: 27 ± 2 mils
- Bond wire lengths from Die Pad to PCB at IF ports: 41 ± 2 mils
- Typical Gap from Die edge to PCB edge: 3 mils
- PCB thickness and material: 10 mil RO4350B (Thickness: 12.8 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	<table> <tr> <td>Quantity, Package</td> <td>Model No.</td> </tr> <tr> <td>Gel - Pak: 5, 10, 50 KGD*</td> <td>SMIQ-6243H-DG+</td> </tr> <tr> <td>Medium†, Partial wafer: KGD*<460</td> <td>SMIQ-6243H-DP+</td> </tr> <tr> <td>Full wafer†</td> <td>SMIQ-6243H-DF+</td> </tr> </table> <p>†Available upon request contact sales representative. Refer to AN-60-067</p>	Quantity, Package	Model No.	Gel - Pak: 5, 10, 50 KGD*	SMIQ-6243H-DG+	Medium†, Partial wafer: KGD*<460	SMIQ-6243H-DP+	Full wafer†	SMIQ-6243H-DF+
Quantity, Package	Model No.								
Gel - Pak: 5, 10, 50 KGD*	SMIQ-6243H-DG+								
Medium†, Partial wafer: KGD*<460	SMIQ-6243H-DP+								
Full wafer†	SMIQ-6243H-DF+								
Die Marking	EL-MIX-11								
Environmental Ratings	ENV-80								

* Known Good Die ("KGD") means that the die in question have been subjected to Mini-Circuits DC test performance criteria and measurement instructions and that the parametric data of such die fall within a predefined range. While DC testing is not definitive, it does provide a higher degree of confidence that die are capable of meeting typical RF electrical parameters specified by Mini-Circuits.

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-Circuits' applicable established test performance criteria and measurement instructions.
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