MMIC DIE

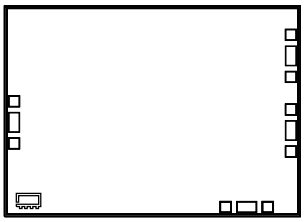
IQ Mixer

SMIQ-653H-D+

Level 18 (LO Power +18 dBm) 18 to 65 GHz

THE BIG DEAL

- Wideband RF & LO, 18 to 65 GHz
- Wideband IF, DC to 20 GHz
- High L-R Isolation, 40 dB typ. at 40 GHz
- High Input IP3, +23 dBm typ.
- Useable as Up & Down Converter



+RoHS Compliant
The +Suffix identifies RoHS Compliance.
See our website for methodologies and qualifications

SEE ORDERING INFORMATION ON THE LAST PAGE

APPLICATIONS

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

PRODUCT OVERVIEW

The SMIQ-653H-D+ is a passive, wideband in phase/ quadrature (I/Q) mixer fabricated using GaAs HBT technology. The SMIQ-653H-D+ is usable as a single-sideband upconverter for transmit applications or an image rejection mixer for receiver applications. The SMIQ-653H-D+ is ideal for application requiring excellent RF performance and a wide frequency range with RF and LO frequency range of 18 to 65 GHz and an IF frequency range of DC to 20 GHz. As a passive mixer, the SMIQ-653H-D+ offers lower noise figure than active mixers ensuring superior dynamic range for high performance applications.

KEY FEATURES

Features	Advantages
High image rejection, 25 dB typical	Improves image rejection in receiver applications
High LO-RF Isolation, 45 to 50 dB typ.	Enables excellent carrier rejection in single-sideband upconvert transmit applications
High LO-IF Isolation, 30 dB typ.	Minimizes filtering requirement in image reject mixers
Wide Bandwidth, 18 to 65 GHz	Useful in wideband systems or in several narrowband systems requiring fewer components.
Wide IF Bandwidth, DC to 20 GHz	Usable in first and second down converter applications. IF as low as DC enables use in phase detector applications
Unpackaged Die	Suitable for chip and wire hybrid assemblies.

REV. OR
ECO-015149
SMIQ-653H-D+
MCL NY
220923

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ELECTRICAL SPECIFICATIONS[1] AT +25°C, 50Ω, UNLESS OTHERWISE NOTED.

Parameter	Condition (GHz)	Min.	Typ.	Max.	Units
RF Frequency Range		18		65	GHz
LO Frequency Range		18		65	GHz
IF Frequency Range		DC		20	GHz
LO Power		+17	+18	+19	dBm
Conversion Loss	18 – 43.5 43.5 - 65		10.5 11.3		dB
Amplitude Unbalance	18 – 43.5 43.5 – 65		0.5 0.2		dB
Phase Unbalance	18 – 43.5 43.5 – 65		3.9 8.6		deg
Image Rejection (Tested as an Upconverter)	18 – 43.5 43.5 – 65		25 30		dB
Image Rejection (Tested as a Downconverter)	18 – 43.5 43.5 – 65		21 24		dB
LO-RF Isolation	18 – 43.5 43.5 – 65		45 50		dB
LO-I Isolation	18 – 43.5 43.5 – 65		43 38		dB
LO-Q Isolation	18 – 43.5 43.5 – 65		33 30		dB
RF-I Isolation	18 – 43.5 43.5 – 65		29 50		dB
RF-Q Isolation	18 – 43.5 43.5 – 65		38 41		dB
Input Power at 1dB Compression	18 – 65		10		dBm
Input IP3 (I) Lower Side Band	20 – 43.5 43.5 - 65		26 25		dBm
Input IP3 (Q) Lower Side Band	20 – 43.5 43.5 - 65		27 25		dBm
Input IP3 (I) Upper Side Band	20 – 43.5 43.5 - 65		26 25		dBm
Input IP3 (Q) Upper Side Band	20 – 43.5 43.5 - 65		27 25		dBm

1. Electrical specifications are measured by soldering Die to Mini-Circuits Die Test and characterization board. Data is de-embedded to the bondwires.
2. Unless otherwise specified IF=200 MHz, LO Power = +18 dBm.

MAXIMUM RATINGS[3]

Parameter	Ratings
Operating Temperature	-40°C to +85°C

3. Permanent damage may occur if any of these limits are exceeded.

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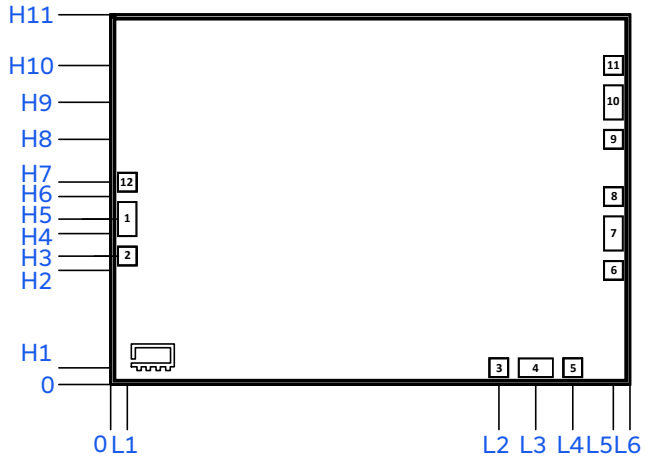
BONDING PAD POSITION



PAD DESCRIPTION

Function	Pad Number	Description
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 Q	7	IF Q Port. Connects to the IF Q Input for Up converters and IF Q Output for Down converters
IF I	10	IF I Port. Connects to the IF I Input for Up converters and IF I Output for Down converters
GROUND	2, 3, 5, 6, 8, 9, 11, 12	Ground

DIE DIMENSIONS IN µm, TYP.

L1	L2	L3	L4	L5	L6
86.0	1996.0	2186.0	2376.0	2585.0	2670.0

H1	H2	H3	H4	H5	H6
86.0	586.0	660.0	776.0	850.0	966.0

H7	H8	H9	H10	H11
1040.0	1260.0	1450.0	1640.0	1900.0

Thickness	Die Size	Pad Size 1,7 &10	Pad Size 4	Pad Size 2, 3, 5, 6, 8, 9, 11, 12
100	2670 x 1900	92 x 172	172 x 92	92 x92

CHARACTERIZATION TEST AND APPLICATION CIRCUITS

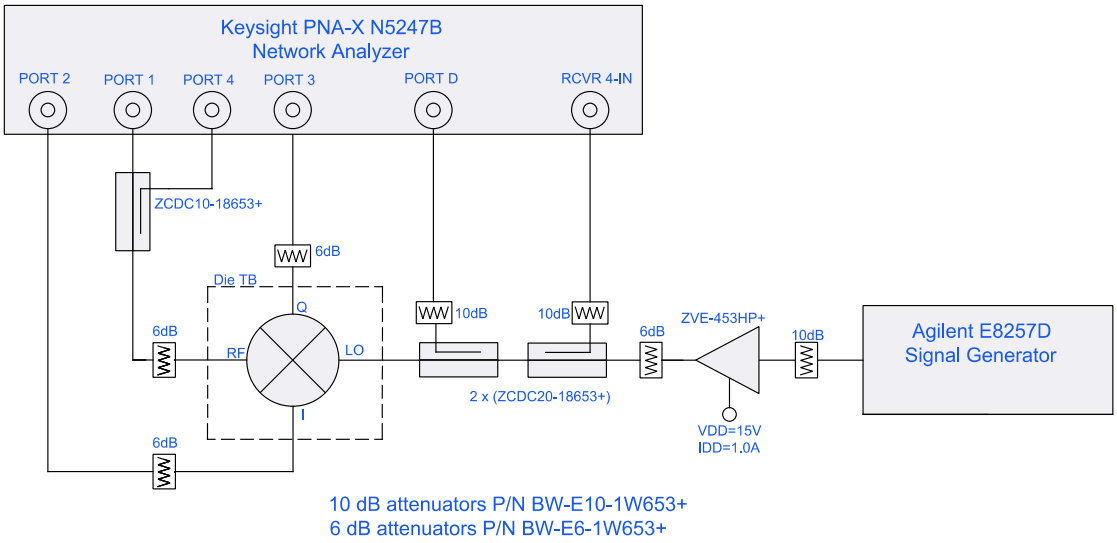


Figure 1A: Block diagram of test circuit used to characterize: Conversion Loss, Amp. Unbl., Ph. Unbl. Isolation, Return Loss (RF, I &Q) & IP3 from 20-45 GHz

Test conditions:
For CL, Return loss and isolation:
RF= -10 dBm, LO=+17 to +19 dBm, IF=200 MHz, 2 GHz, 3 GHz
For IP3: RF =-10dBm/Tone, LO= +17 to +19 dBm. Two tones, spaced 1 MHz Apart

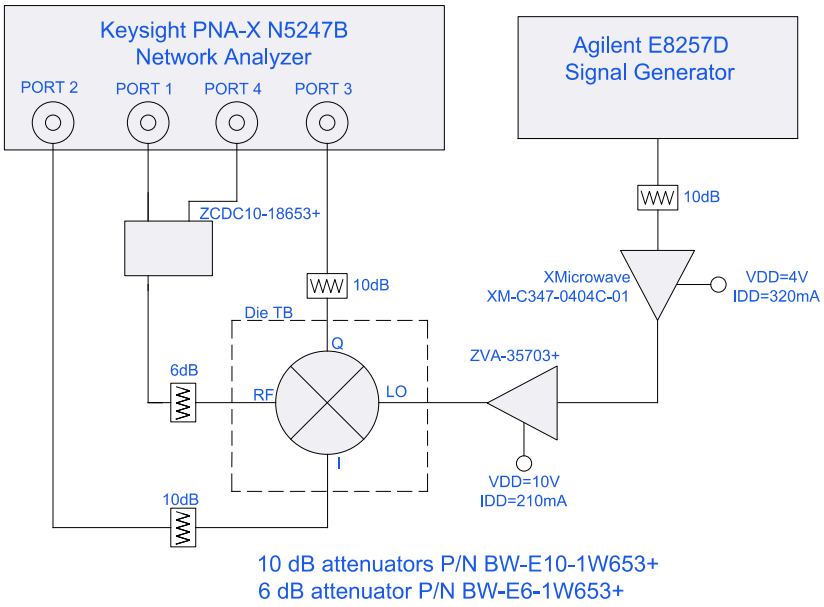


Figure 1B: Block diagram of test circuit used to characterize: Conversion Loss, Amp. Unbl., Ph. Unbl. Isolation , Return Loss (RF, I &Q) & IP3 from 35-67GHz

Test conditions:
For CL, Return loss and isolation:
RF= -10 dBm. LO=+17 to +19 dBm, IF=200 MHz, 2 GHz, 3 GHz
For IP3: RF =-10 dBm/Tone, LO= +17 to +19 dBm. Two tones, spaced 1 MHz Apart

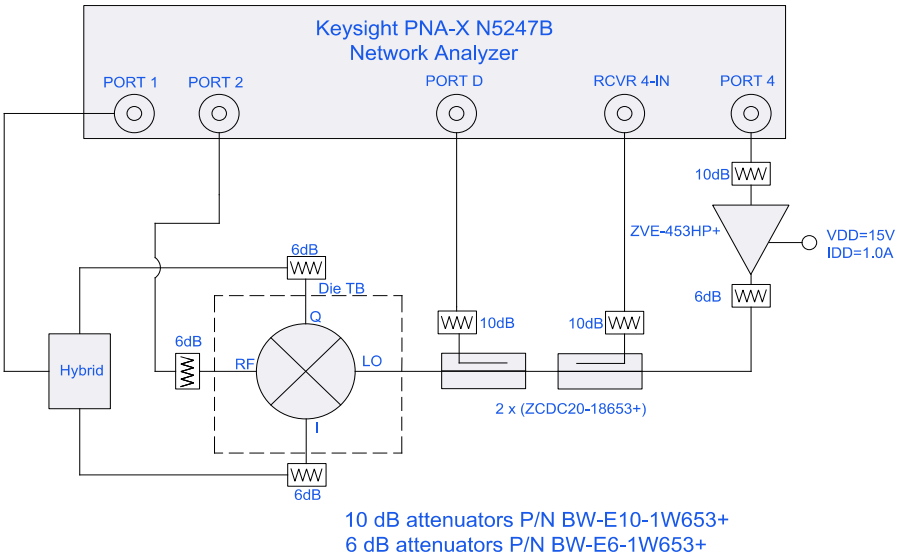


Figure 1C: Block diagram of Test Circuit used for characterization of Image Rejection from 20-45GHz

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

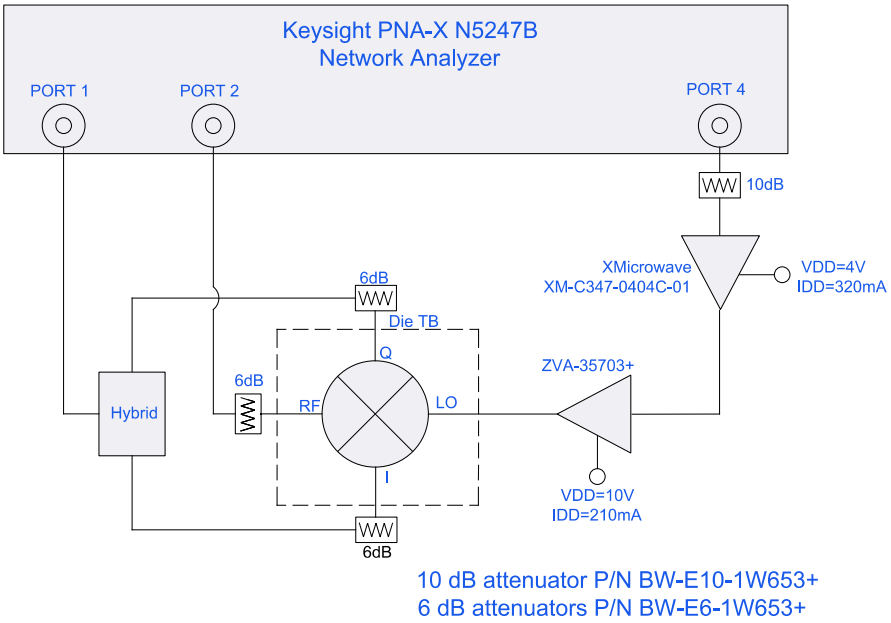


Figure 1D: Block diagram of Test Circuit used for characterization of Image Rejection from 35-67GHz

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

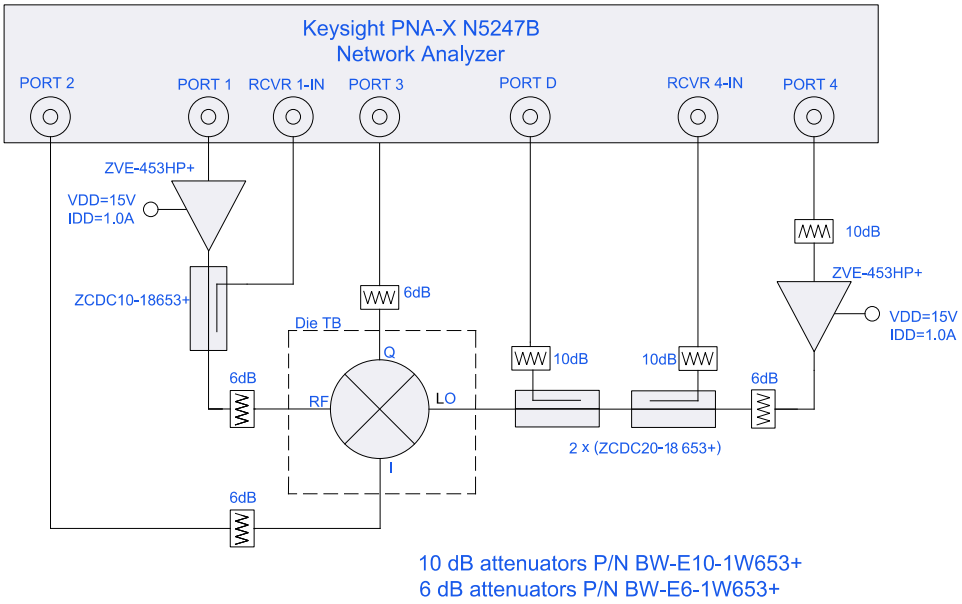


Figure 1E: Block diagram of test circuit used to characterize: Compression from 20-45GHz

Test Conditions:
RF = +10 dBm & -10 dBm, LO = +17 to +19 dBm, IF = 200 MHz, 2 GHz, 3 GHz
Compression = CL(RF=+10 dBm) - CL(RF=-10 dBm)

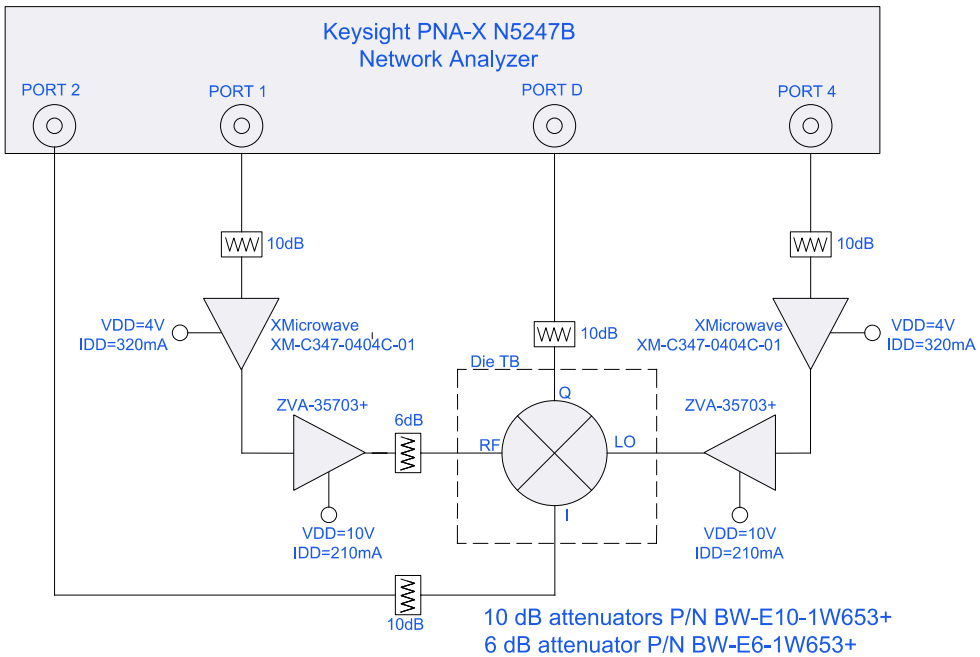


Figure 1F: Block diagram of test circuit used to characterize: Compression from 35-67GHz

Test Conditions:
RF = +10 dBm & -10 dBm, LO = +17 to +19 dBm, IF = 200 MHz, 2 GHz, 3 GHz
Compression = CL(RF=+10 dBm) - CL(RF=-10 dBm)

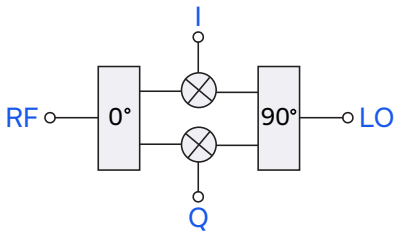
APPLICATION CONFIGURATION AND SIDE BAND SELECTION

For side band selection in up or down converter configurations an external 90deg Hybrid is needed. This will allow for the termination of the phase difference from the two IF ports. See Simplified schematic below for port orientation.

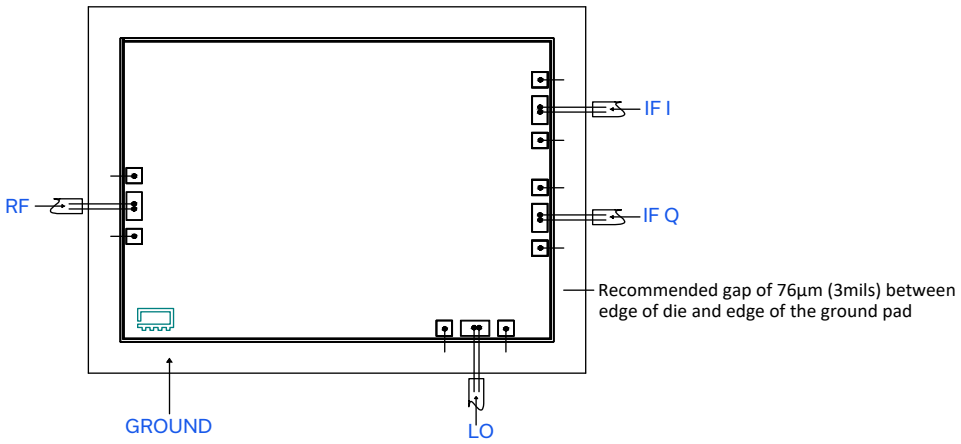
In Downconverter applications
For lower side band selection connect the I port to the 90 deg port of the hybrid and the Q port to the 0deg port of the hybrid. This will send the upper sideband signal to the terminated output. For upper side band selection connect the I port to the 0 deg port of the hybrid and the Q port to the 90deg port of the hybrid. This will send the lower sideband signal to the terminated output.

In Upconverter applications
For lower side band selection connect the I port to the 0 deg port of the hybrid and the Q port to the 90deg port of the hybrid. This will send the upper sideband signal to the terminated output.
For upper side band selection connect the I port to the 0 deg port of the hybrid and the Q port to the 90deg port of the hybrid. This will send the lower sideband signal to the terminated output.

SIMPLIFIED SCHEMATIC



ASSEMBLY DIAGRAM



ASSEMBLY PROCEDURE

1. Storage
   Die should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD
   MMIC Mixer Die are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic protected material, which should be open in clean room conditions at an appropriately grounded antistatic workstation.
3. Die Handling and Attachment
   Devices need careful handling using correctly designed collets, it is recommended to handle the chip along the edges with a custom design collet. The die mounting surface must be clean and flat. Using conductive silver filled epoxy, recommended epoxies are Ablestik 84-1 LMISR4 or equivalents. Apply sufficient epoxy to meet required epoxy bond line thickness, epoxy fillet height and epoxy coverage around total periphery. Parts shall be cured in a nitrogen filled atmosphere per manufacturer's cure condition. The surface of the chip has exposed air bridges and should not be touched with vacuum collet, tweezers or fingers.
4. Wire Bonding
   Bond pad openings in the surface passivation above the bond pads are provided to allow wire bonding to the Die gold bond pads. Thermo-sonic bonding is used with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. Suggested wire is pure gold, 1mil diameter. Bonds must be made from the bond pads on the die to the packaged or substrate. All bond wire length and bond wire height should be kept as short as possible unless specified by the Assembly Drawing to minimize performance degradation due to undesirable series inductance.

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TYPICAL PERFORMANCE CURVES

Image Reject (Down Conv) @IF=200 MHz

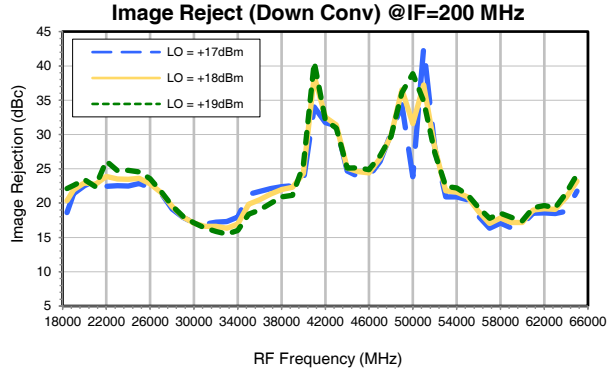


Image Reject (Up Conv) @IF=200 MHz

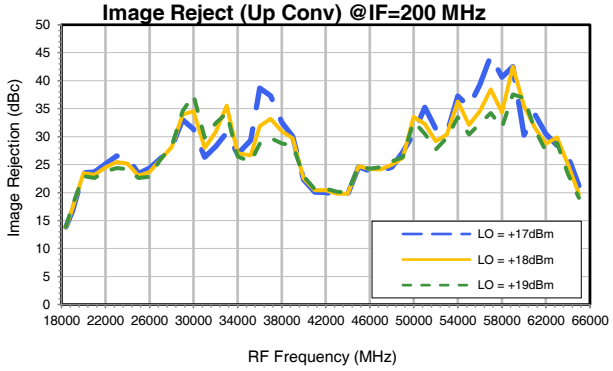


Image Reject (Down Conv) @IF=2000MHz

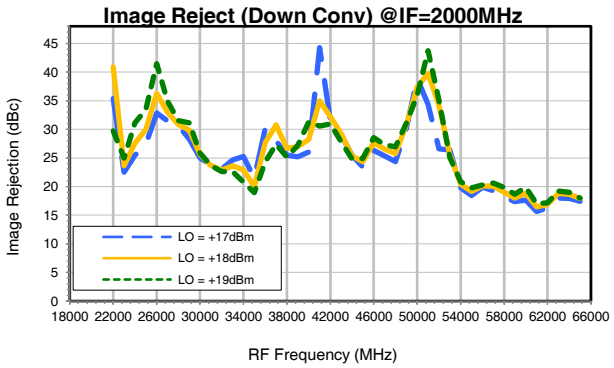


Image Reject (Up Conv) @IF=2000 MHz

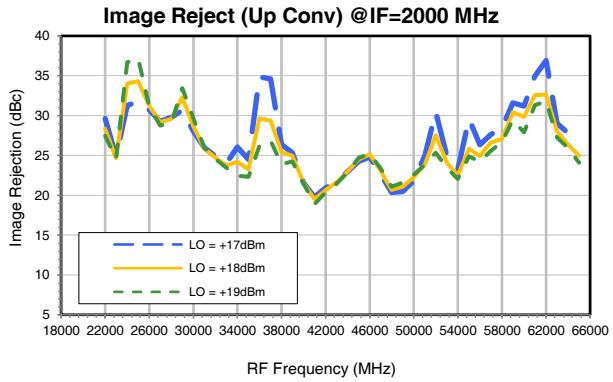


Image Reject (Down Conv) @IF=3000MHz

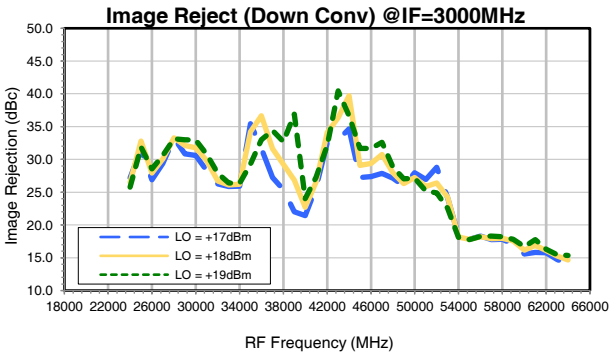
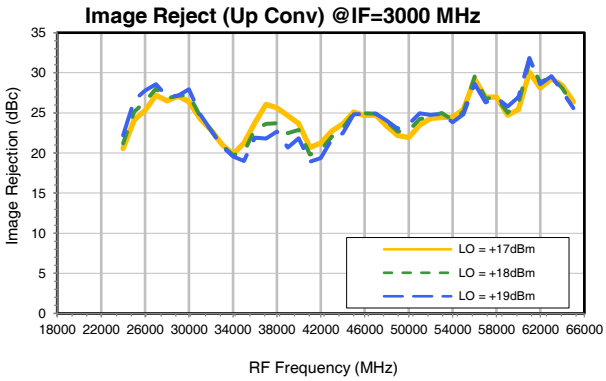


Image Reject (Up Conv) @IF=3000 MHz



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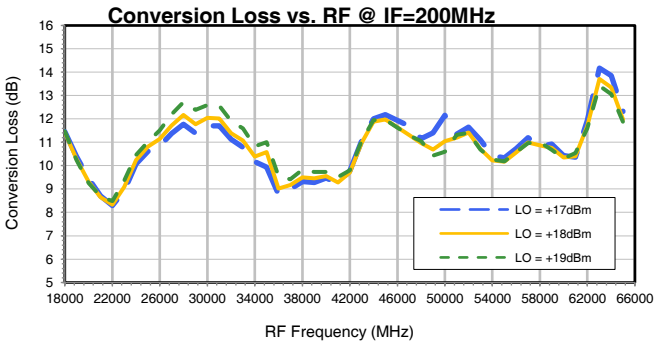
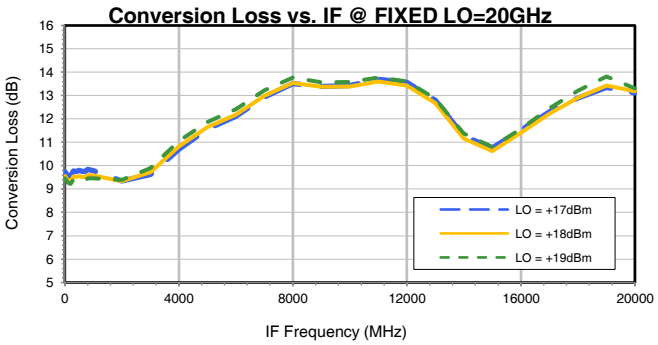
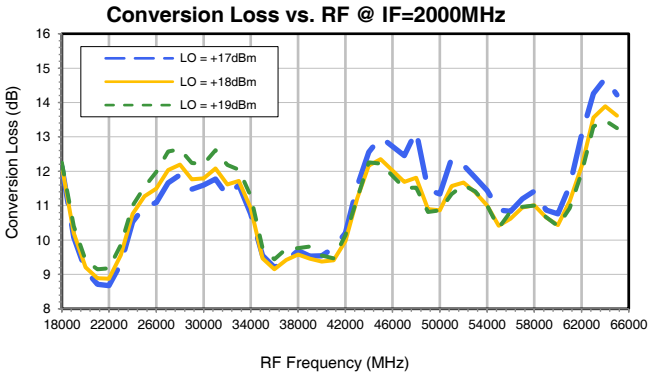
TYPICAL PERFORMANCE CURVES

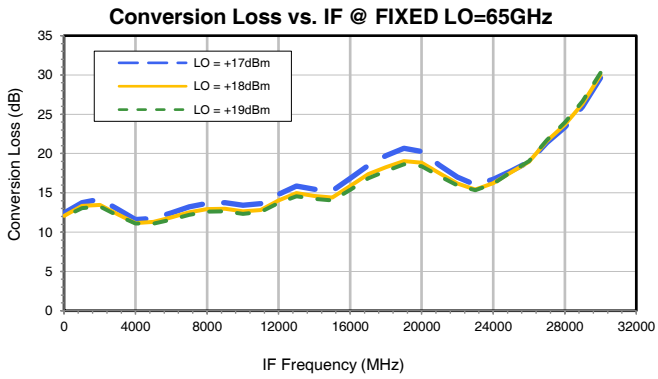
Conversion Loss with Fixed IF

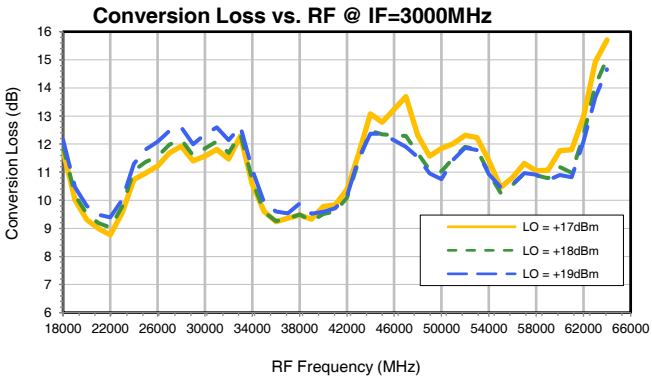
Conversion Loss with Variable IF











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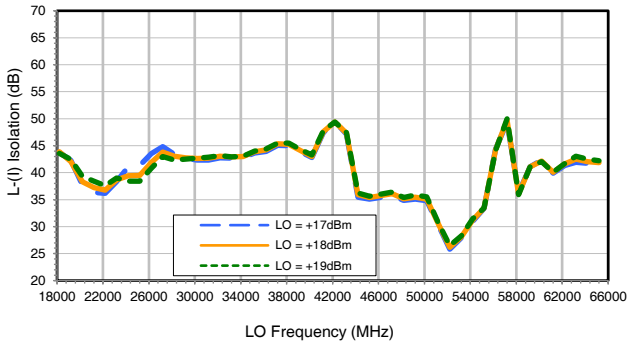
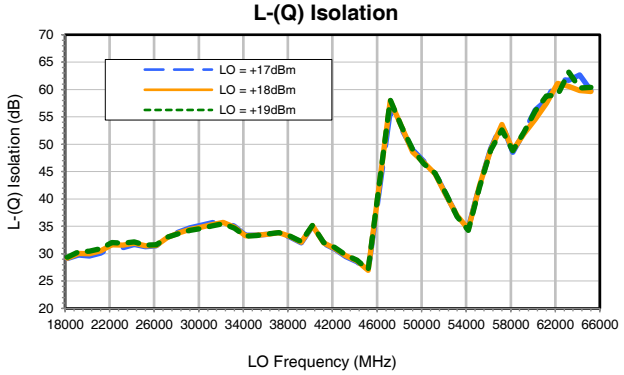
TYPICAL PERFORMANCE CURVES

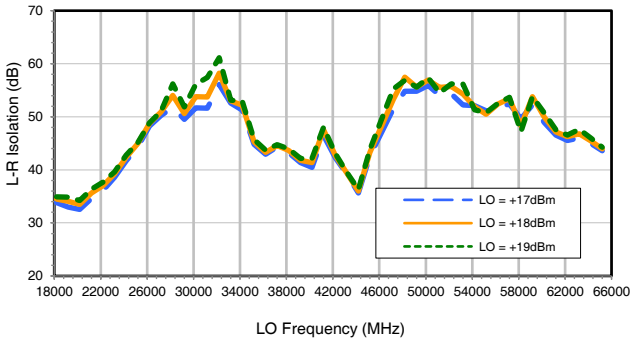
L-(I) Isolation



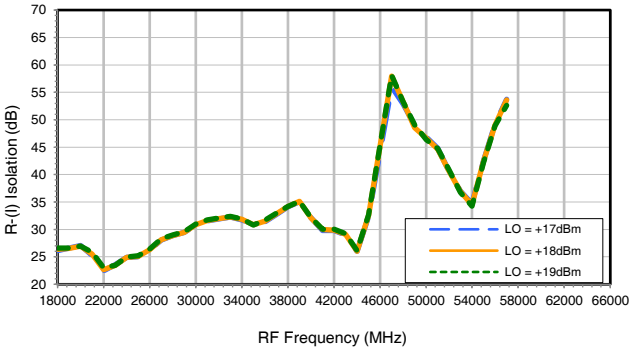
L-(Q) Isolation



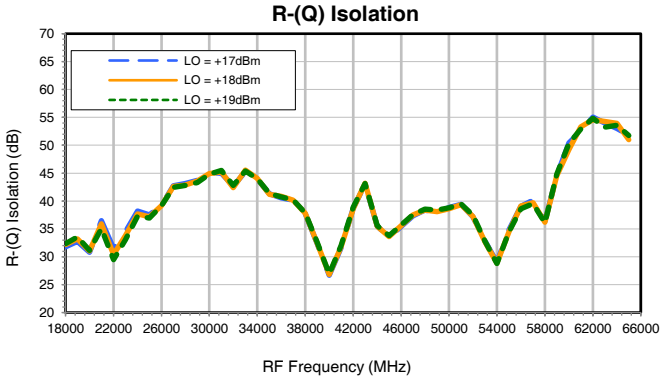
L-R Isolation



R-(I) Isolation



R-(Q) Isolation



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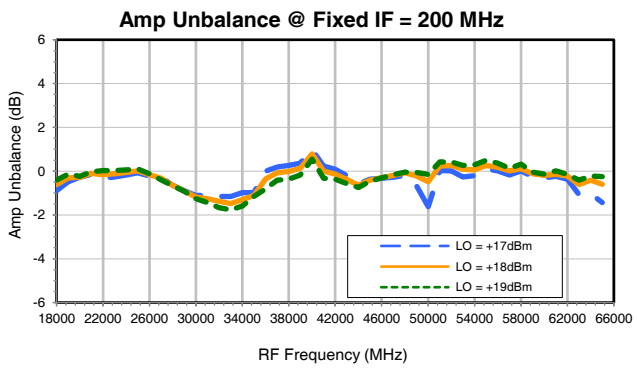

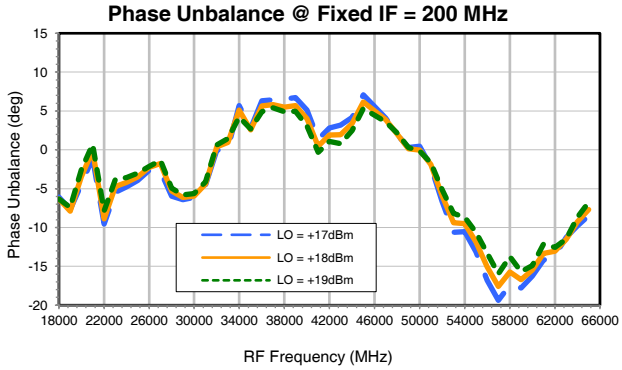

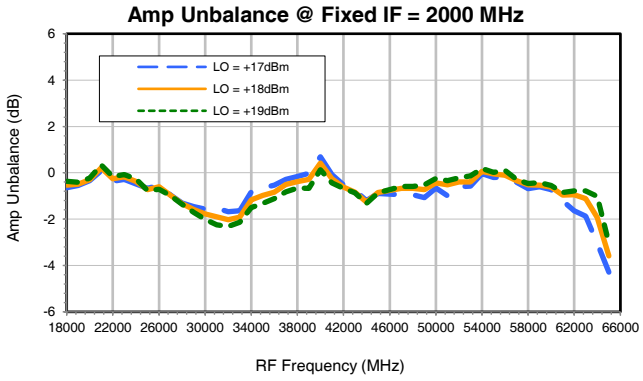

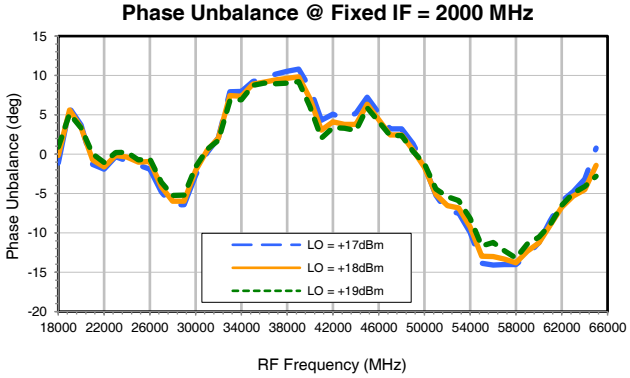

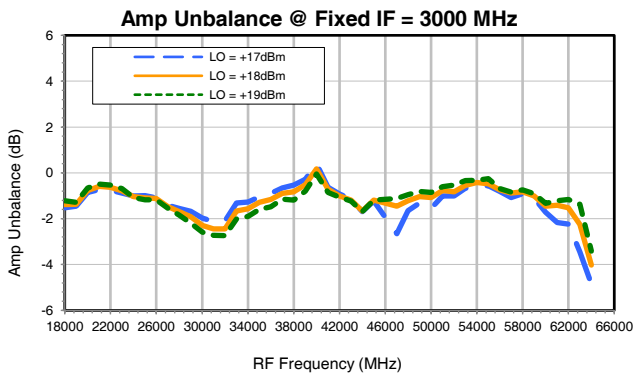

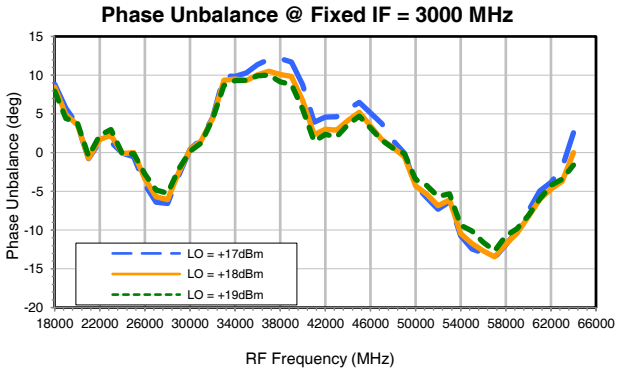

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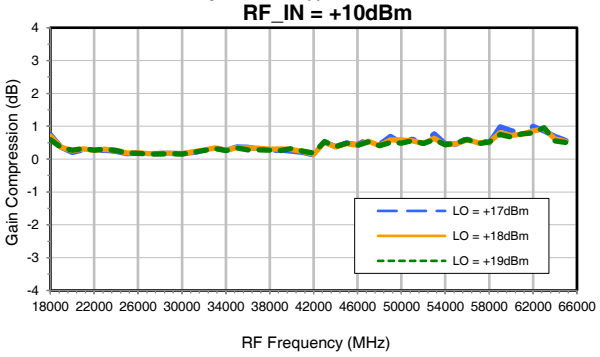
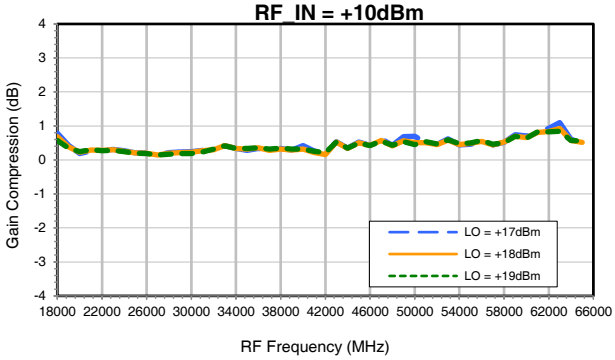
TYPICAL PERFORMANCE CURVES

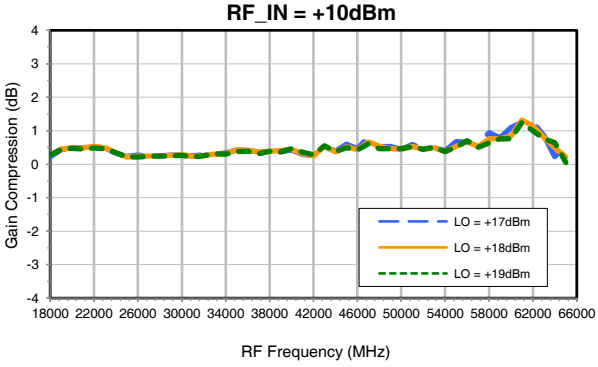
Gain Compression (I) @ Fixed IF = 200 MHz
RF_IN = +10dBm



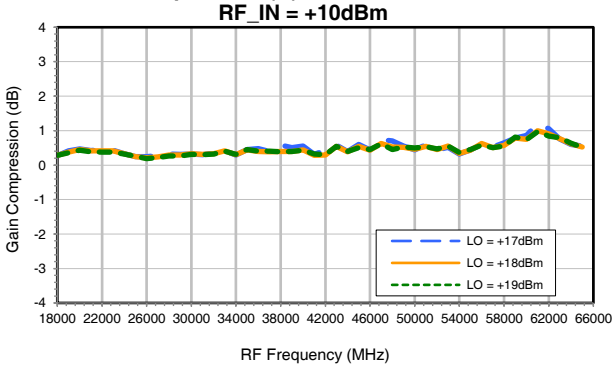
Gain Compression (Q) @ Fixed IF = 200 MHz
RF_IN = +10dBm



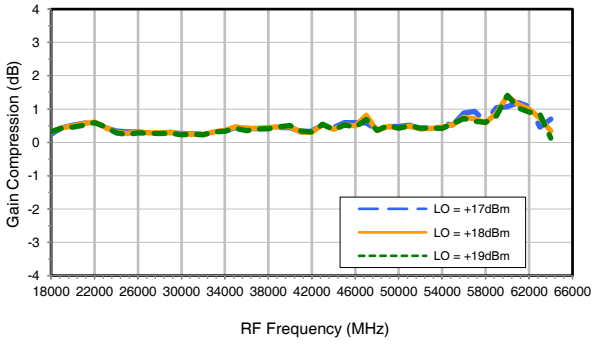
Gain Compression (I) @ Fixed IF = 2000 MHz
RF_IN = +10dBm



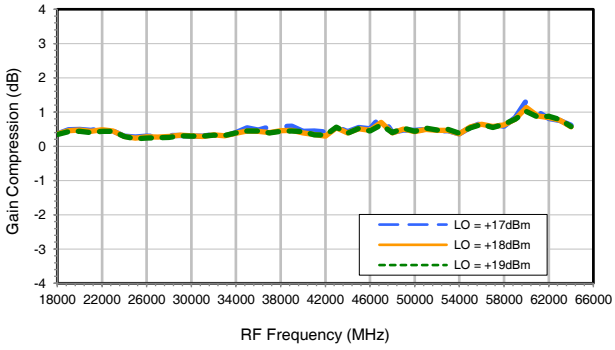
Gain Compression (Q) @ Fixed IF = 2000 MHz
RF_IN = +10dBm



Gain Compression (I) @ Fixed IF = 3000 MHz
RF_IN = +10dBm



Gain Compression (Q) @ Fixed IF = 3000 MHz
RF_IN = +10dBm



IQ Mixer

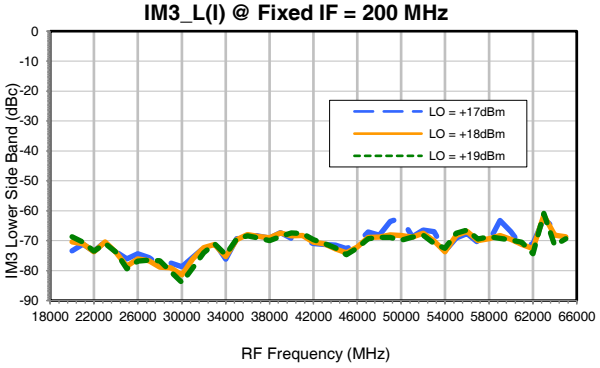
SMIQ-653H-D+

Level 18 (LO Power +18 dBm) 18 to 65 GHz

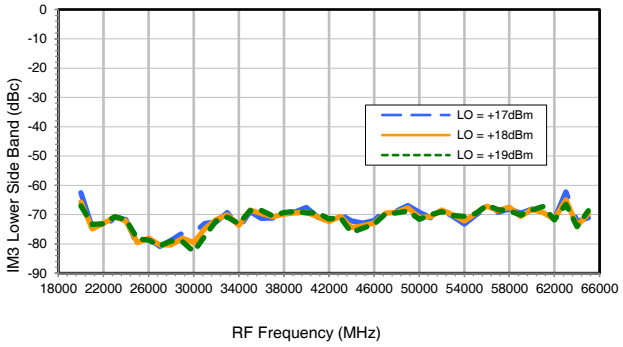
TYPICAL PERFORMANCE CURVES

POUT = -10 dBm/TONE WITH 1 MHz SPACING (RF2 = RF1 + 1 MHz)

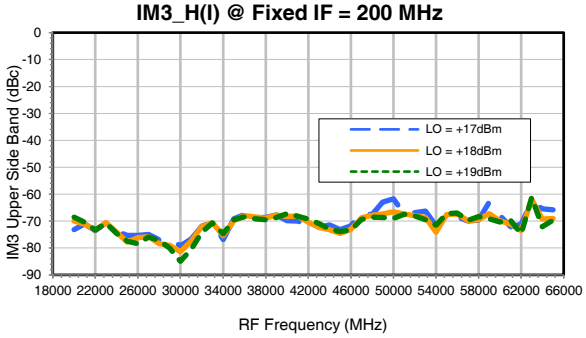
IM3_L(I) @ Fixed IF = 200 MHz



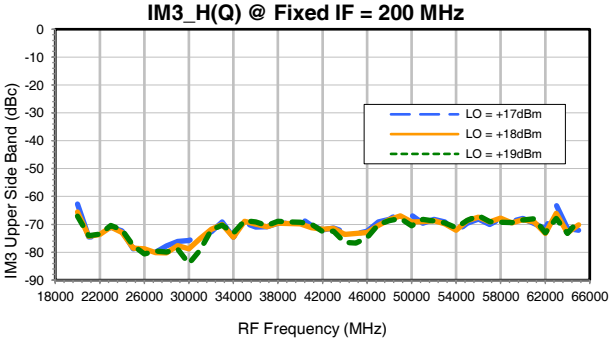
IM3_L(Q) @ Fixed IF = 200 MHz



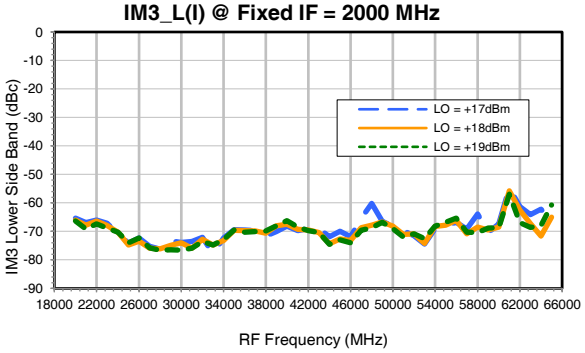
IM3_H(I) @ Fixed IF = 200 MHz



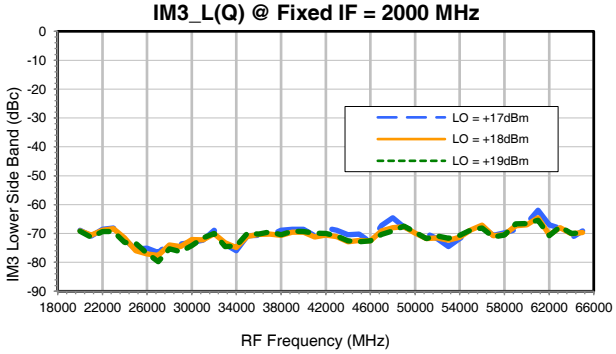
IM3_H(Q) @ Fixed IF = 200 MHz



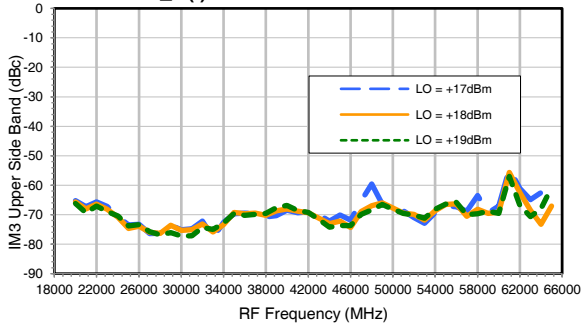
IM3_L(I) @ Fixed IF = 2000 MHz



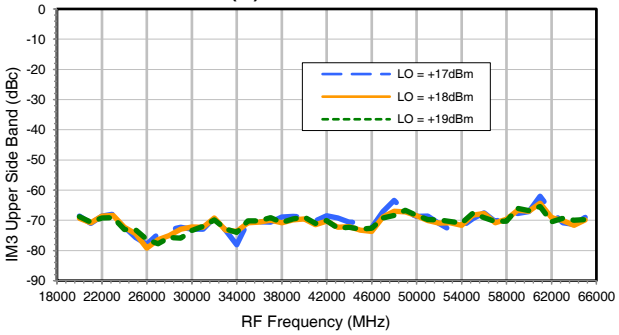
IM3_L(Q) @ Fixed IF = 2000 MHz



IM3_H(I) @ Fixed IF = 2000 MHz



IM3_H(Q) @ Fixed IF = 2000 MHz



IQ Mixer

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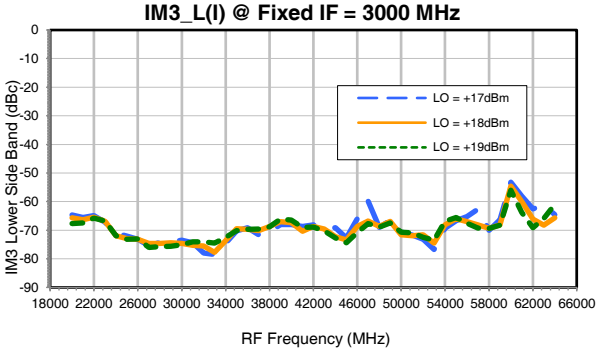
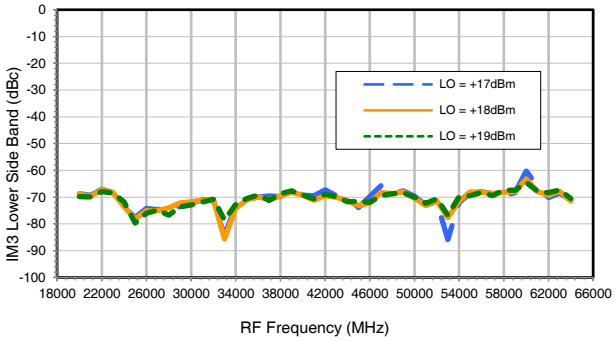
Level 18 (LO Power +18 dBm) 18 to 65 GHz

TYPICAL PERFORMANCE CURVES
POUT = -10 dBm/TONE WITH 1 MHz SPACING (RF2 = RF1 + 1 MHz)

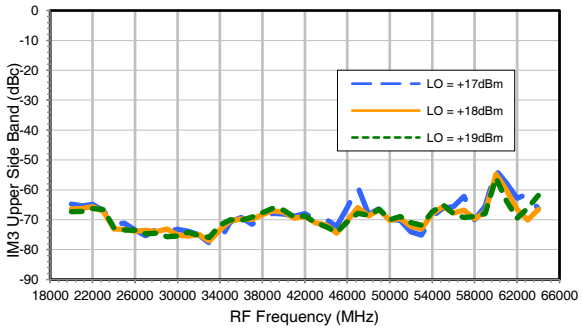
IM3_L(I) @ Fixed IF = 3000 MHz



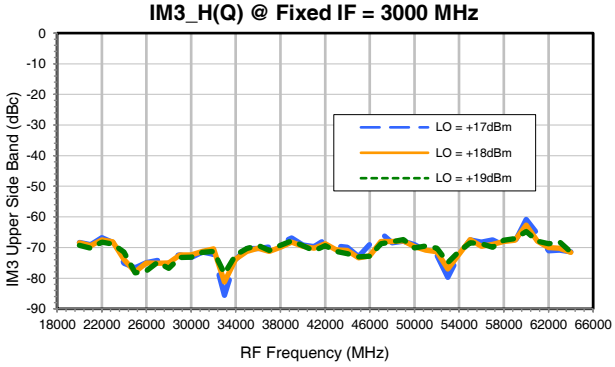
IM3_L(Q) @ Fixed IF = 3000 MHz



IM3_H(I) @ Fixed IF = 3000 MHz



IM3_H(Q) @ Fixed IF = 3000 MHz



IQ Mixer

SMIQ-653H-D+

Level 18 (LO Power +18 dBm) 18 to 65 GHz

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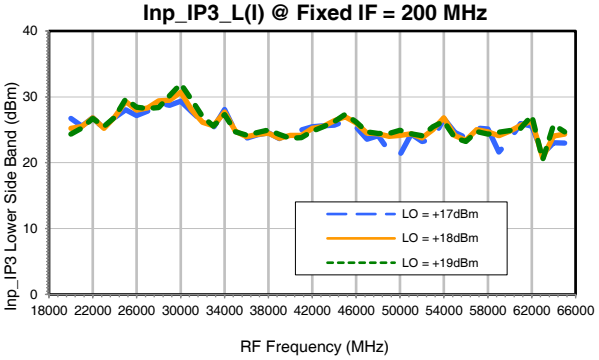
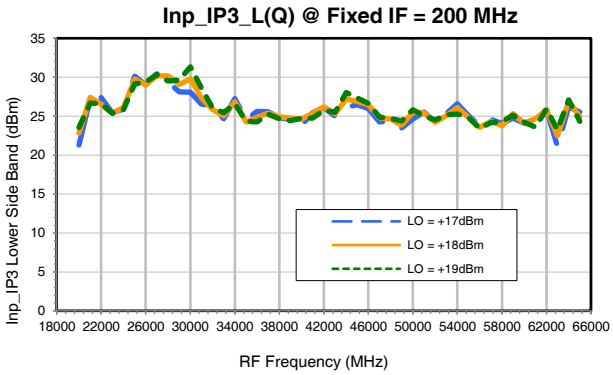
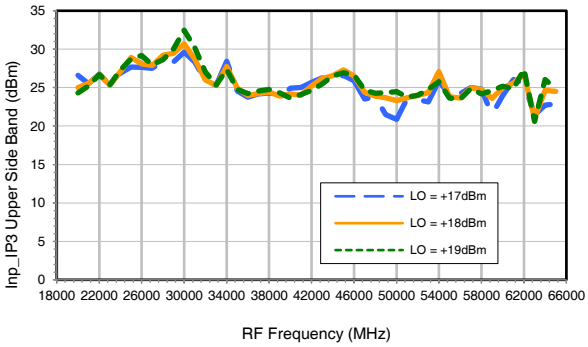
Inp_IP3_L(I) @ Fixed IF = 200 MHz



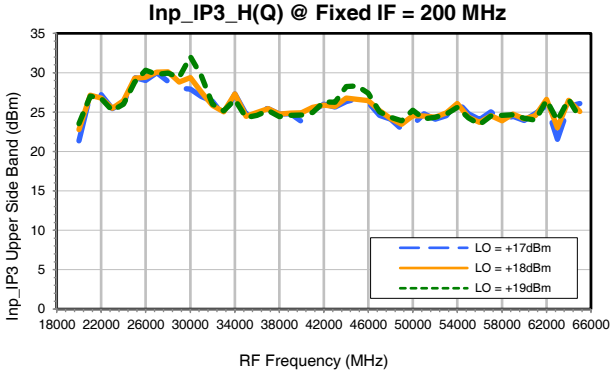
Inp_IP3_L(Q) @ Fixed IF = 200 MHz



Inp_IP3_H(I) @ Fixed IF = 200 MHz



Inp_IP3_H(Q) @ Fixed IF = 200 MHz



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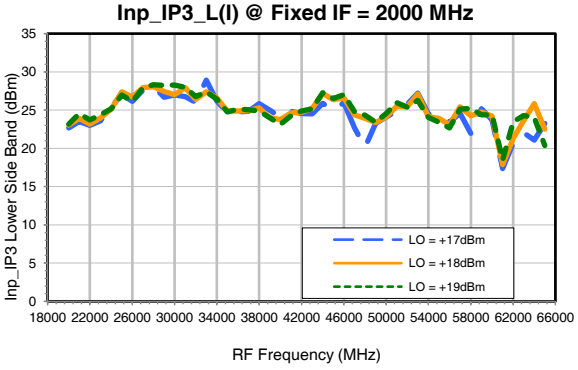
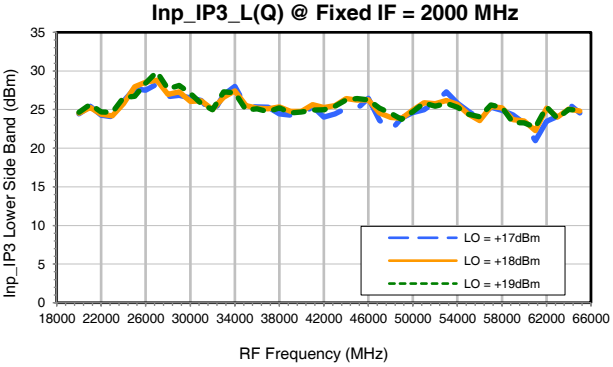
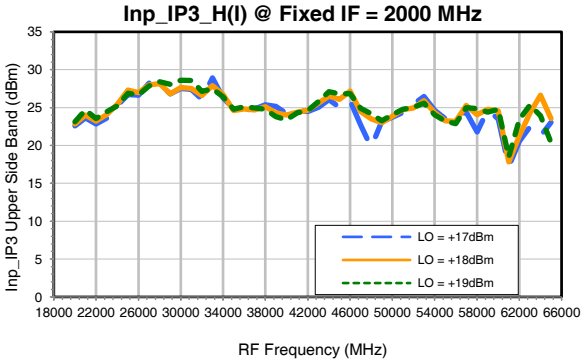


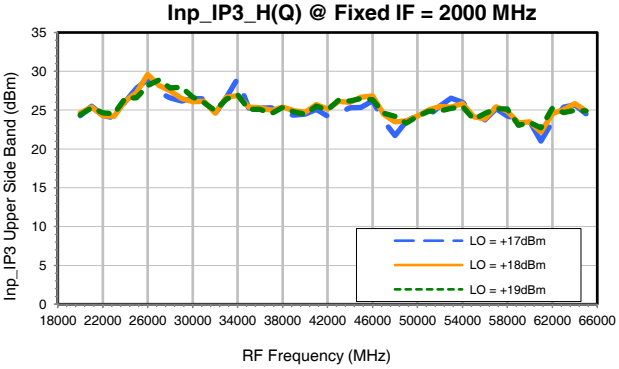
Inp_IP3_L(Q) @ Fixed IF = 2000 MHz



Inp_IP3_H(I) @ Fixed IF = 2000 MHz



Inp_IP3_H(Q) @ Fixed IF = 2000 MHz



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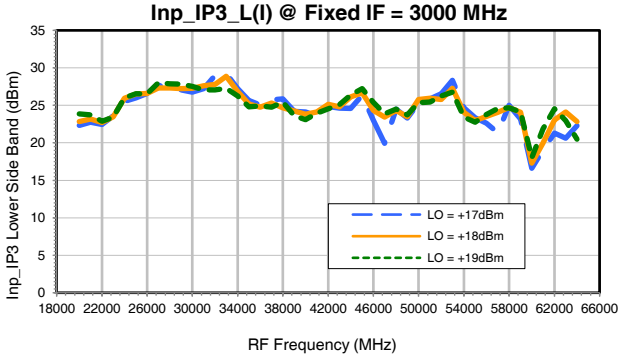
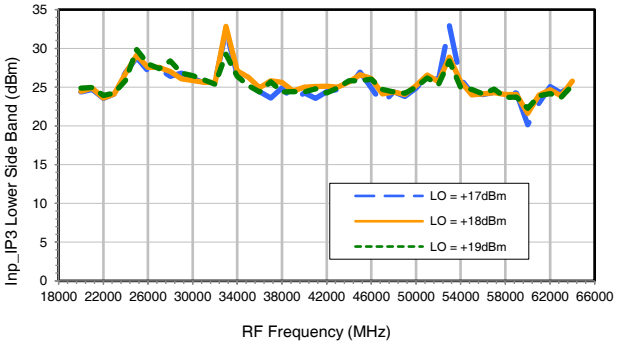
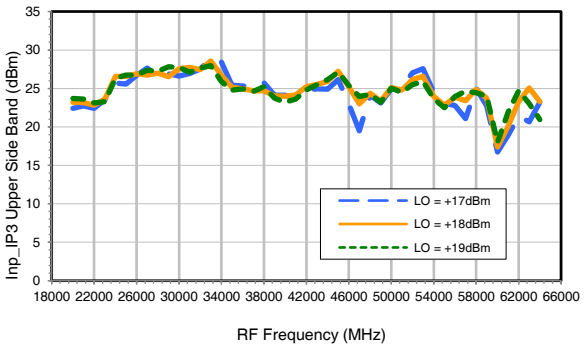


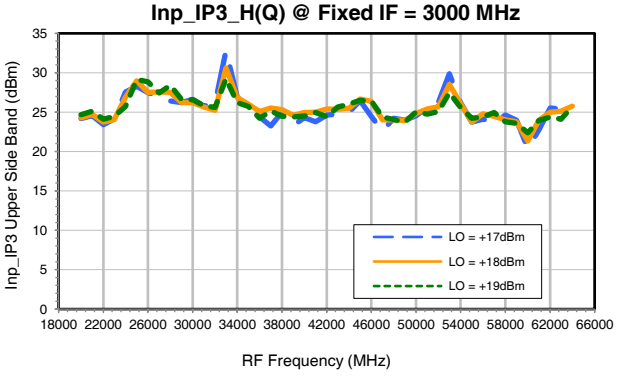
Inp_IP3_L(Q) @ Fixed IF = 3000 MHz



Inp_IP3_H(I) @ Fixed IF = 3000 MHz



Inp_IP3_H(Q) @ Fixed IF = 3000 MHz



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SMIQ-653H-D+

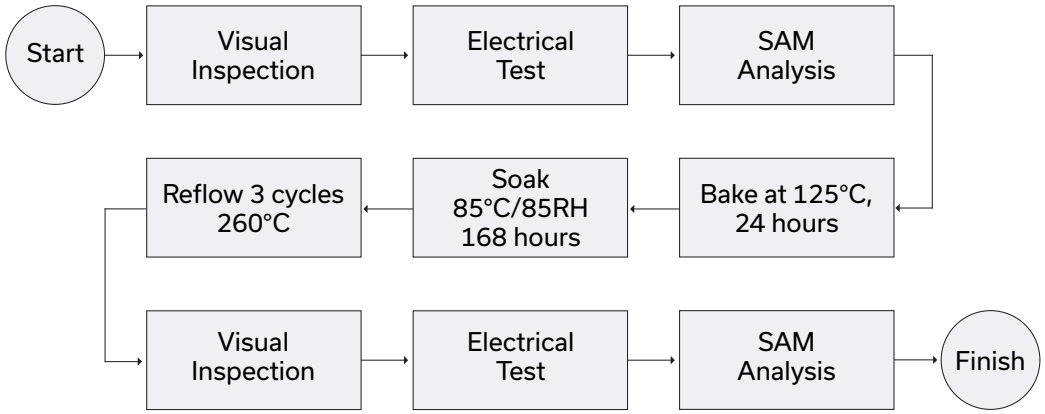
Level 18 (LO Power +18 dBm) 18 to 65 GHz

ADDITIONAL DETAILED TECHNICAL INFORMATION IS AVAILABLE ON OUR DASH BOARD.

Performance Data	Data Table Swept Graphs S-Parameter (S2P Files) Data Set with and without port extension(.zip file)
Case Style	Die
Die Ordering and packaging information	Quantity, Package — Model No. Small, Gel - Pak: 5,10,50,KGD* — SMIQ-653H-DG+ Medium†, Partial wafer: KGD*<475 — SMIQ-653H-DP+ Full wafer — SMIQ-653H-DF+ †Available upon request contact sales representative Refer to AN-60-067
Die Marking	EL-MIX-8_A
Environmental Ratings	ENV80

*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 performance specified by Mini-Circuits.

MSL TEST FLOW CHART



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