



MMIC DIE IQ Mixer

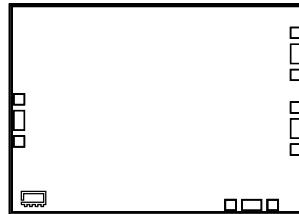
Level 18 (LO Power +18 dBm) 18 to 65 GHz

SMIQ-653H-D+

Mini-Circuits

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 Communications
- 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 SPECIFICATIONS¹ 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 RATINGS³

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

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



MMIC DIE

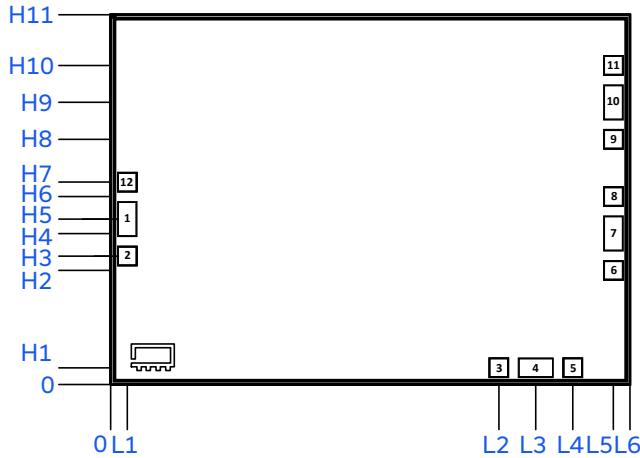
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BONDING PAD POSITION



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 x 92 |

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CHARACTERIZATION TEST AND APPLICATION CIRCUITS

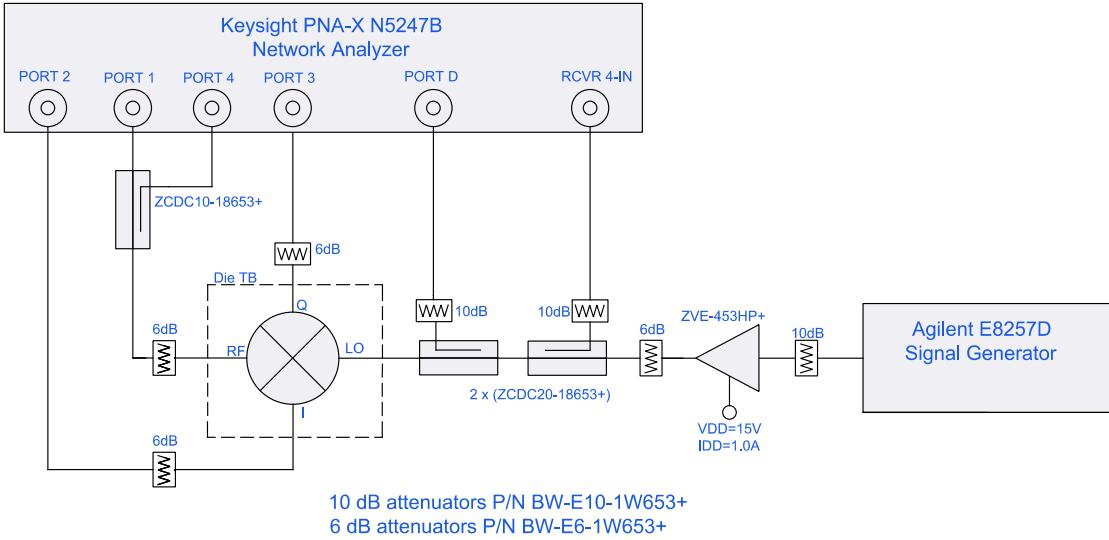


Figure 1A: Block diagram of test circuit used to characterize: Conversion Loss, Amp. Unbl., Ph. Unbl. Isolation, Return Loss (RF, I & Q) & IP3 from 20-45 GHz

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

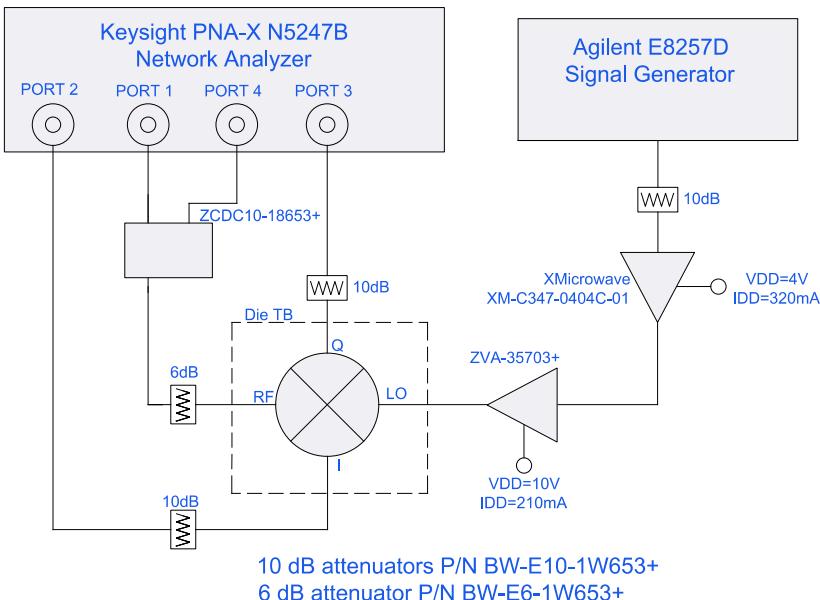


Figure 1B: Block diagram of test circuit used to characterize: Conversion Loss, Amp. Unbl., Ph. Unbl. Isolation , Return Loss (RF, I & Q) & IP3 from 35-67GHz

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

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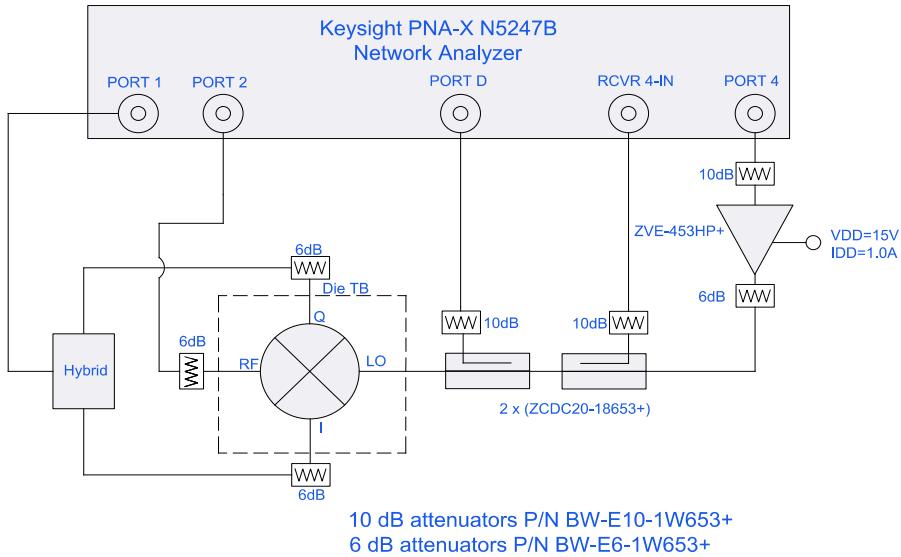


Figure 1C: Block diagram of Test Circuit used for characterization of Image Rejection from 20-45GHz

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

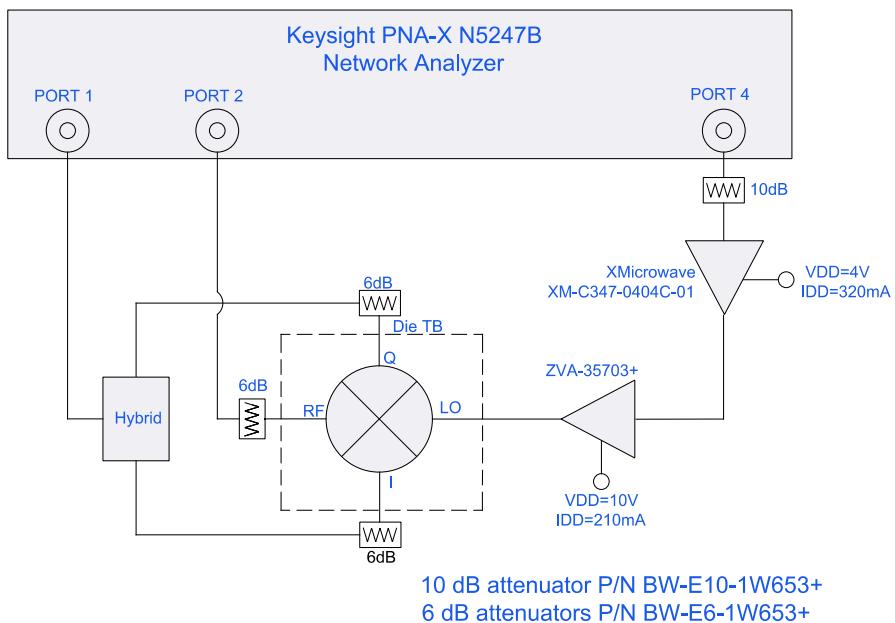


Figure 1D: Block diagram of Test Circuit used for characterization of Image Rejection from 35-67GHz

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

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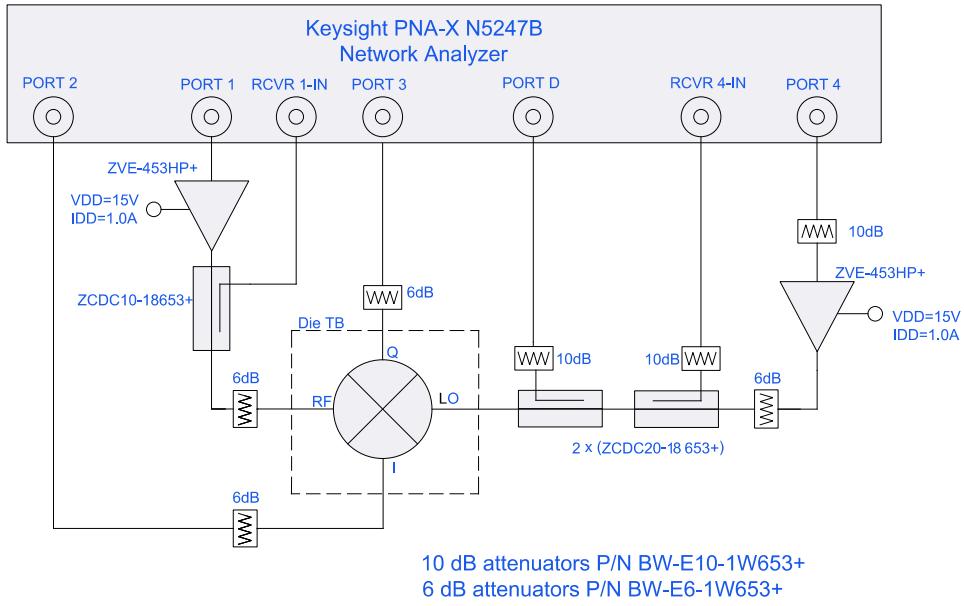


Figure 1E: Block diagram of test circuit used to characterize: Compression from 20-45GHz

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)

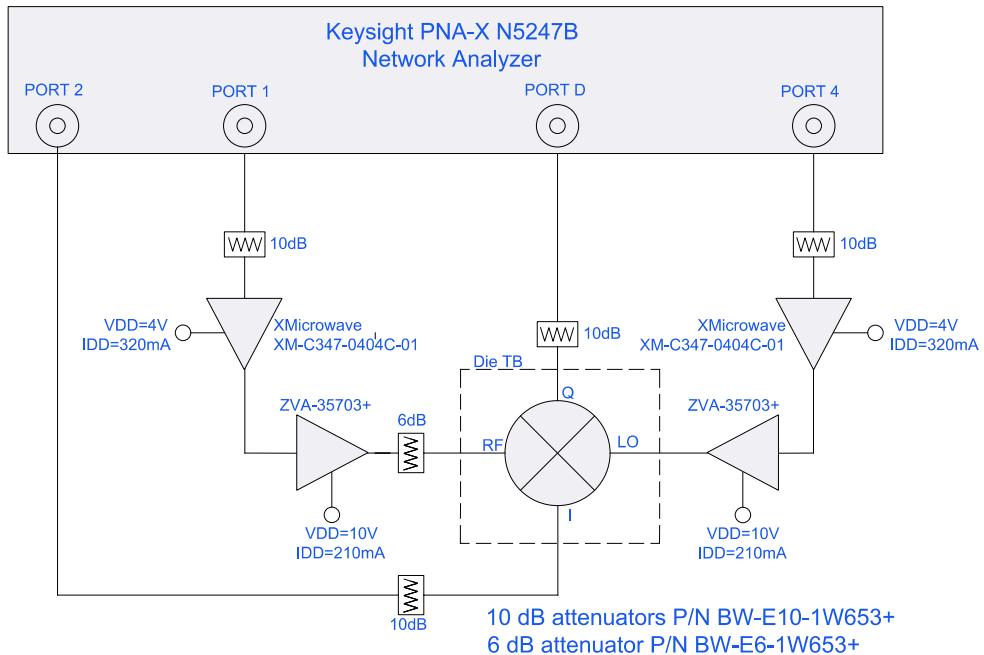


Figure 1F: Block diagram of test circuit used to characterize: Compression from 35-67GHz

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)

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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

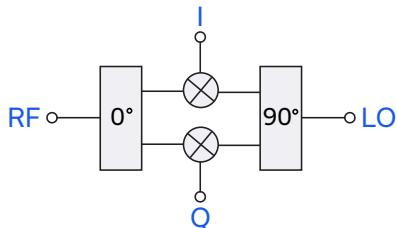
For lower side band selection connect the I port to the 90 deg port of the hybrid and the Q port to the 0deg port of the hybrid. This will send the upper sideband signal to the terminated output. For upper side band selection connect the I port to the 0 deg port of the hybrid and the Q port to the 90deg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

In Upconverter applications

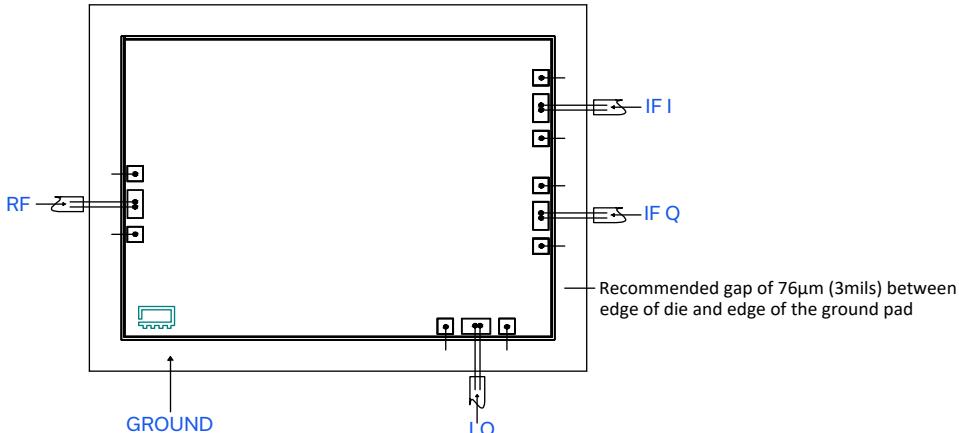
For lower side band selection connect the I port to the 0 deg port of the hybrid and the Q port to the 90deg port of the hybrid. This will send the upper sideband signal to the terminated output.

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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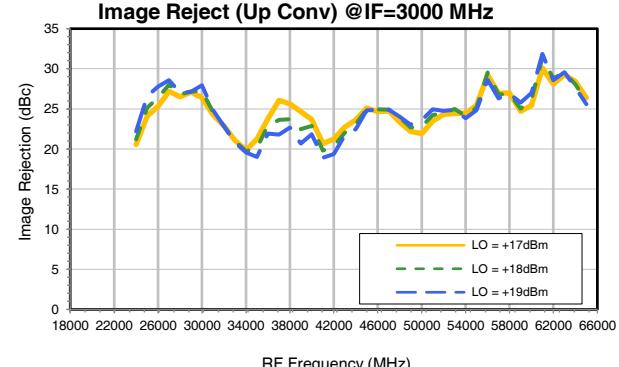
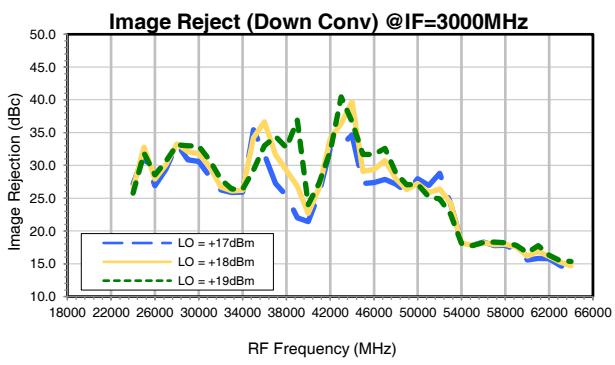
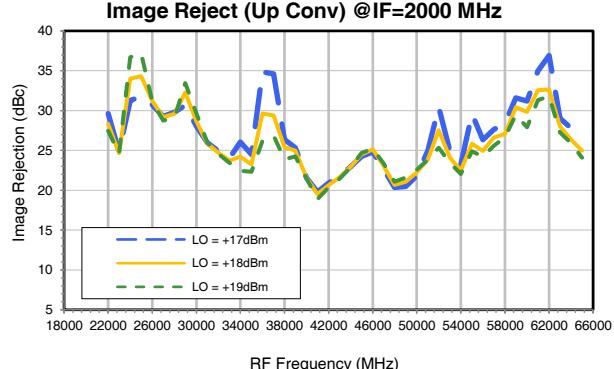
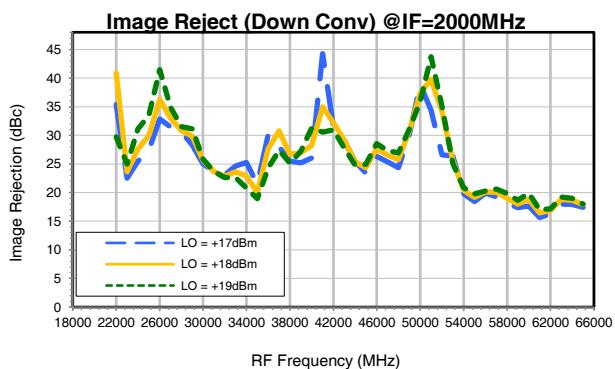
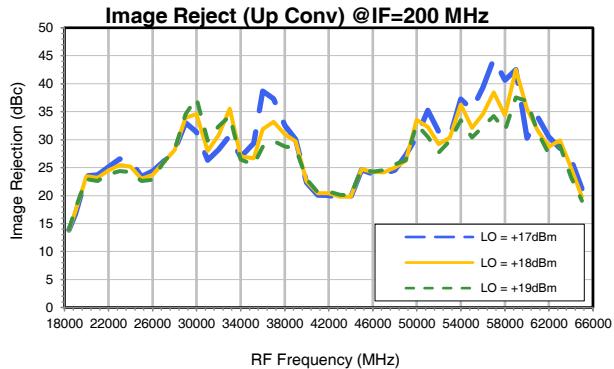
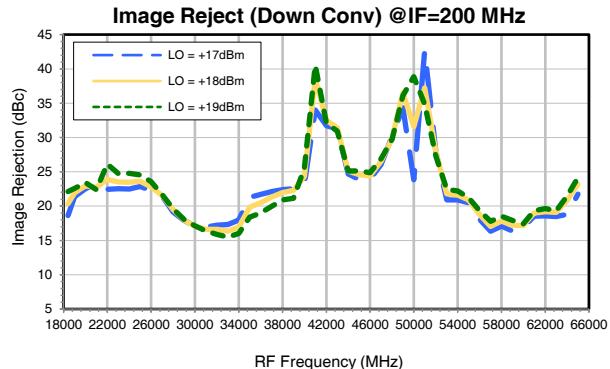
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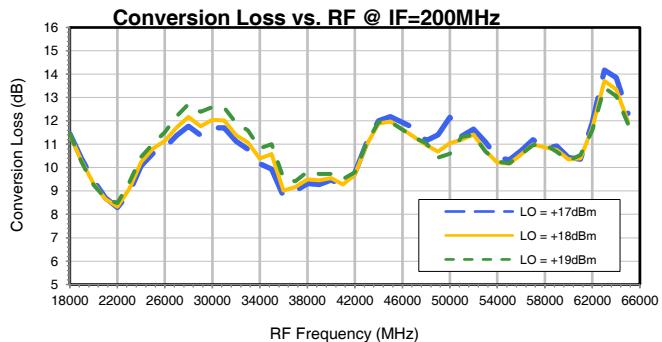
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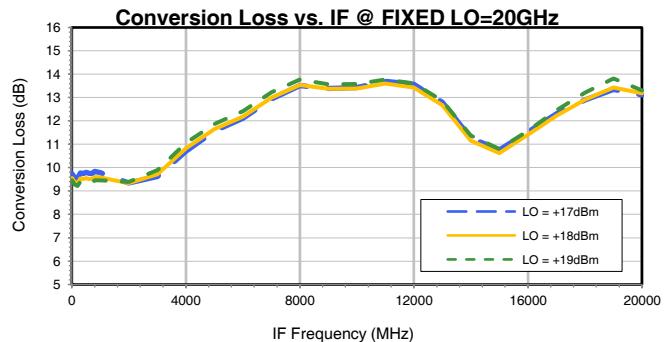
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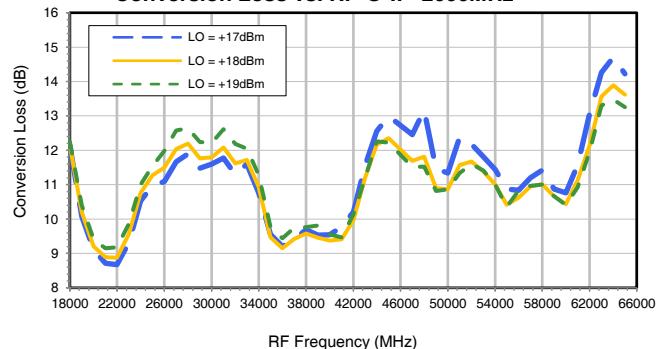
Conversion Loss with Fixed IF



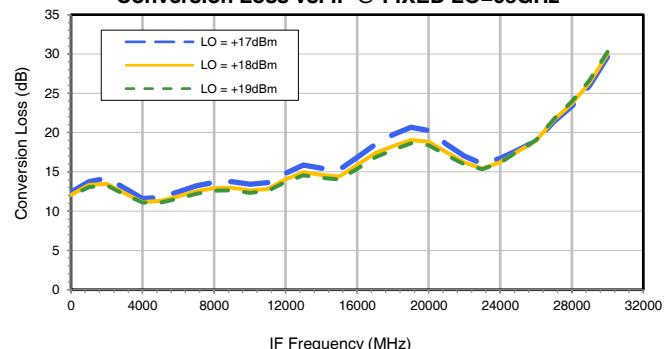
Conversion Loss with Variable IF



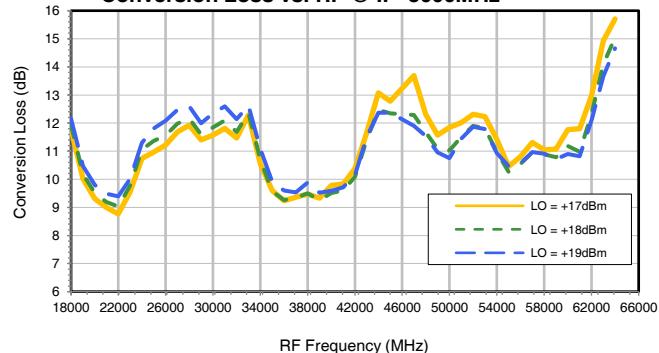
Conversion Loss vs. RF @ IF=2000MHz



Conversion Loss vs. IF @ FIXED LO=65GHz



Conversion Loss vs. RF @ IF=3000MHz





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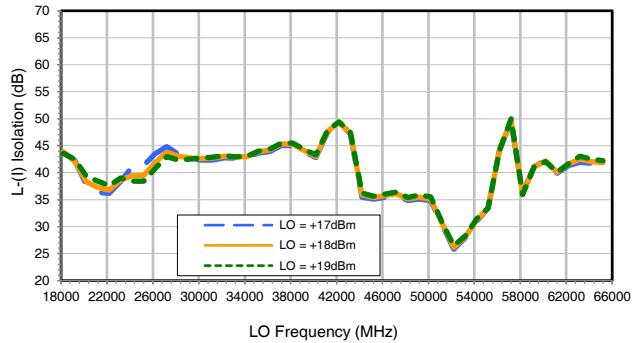
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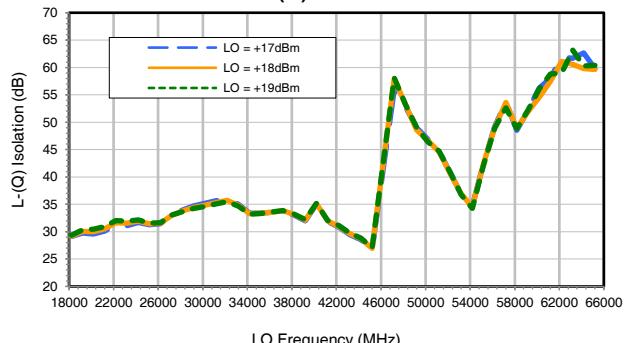
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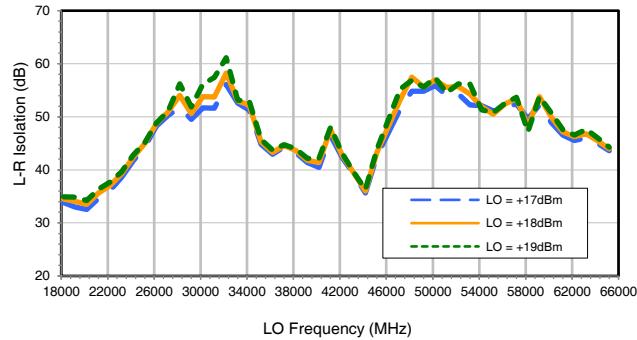
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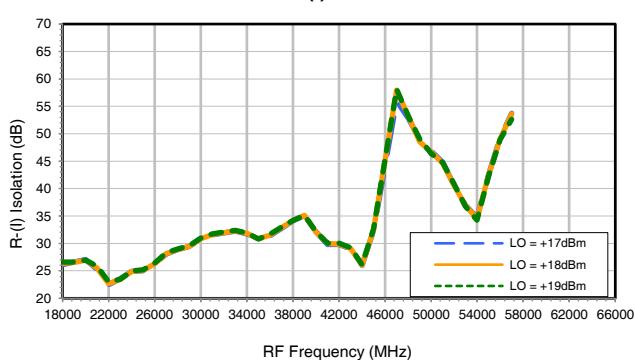
L-(Q) Isolation



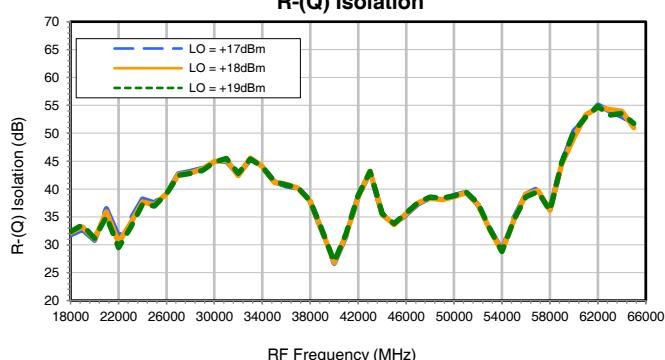
L-R Isolation



R-(I) Isolation



R-(Q) Isolation



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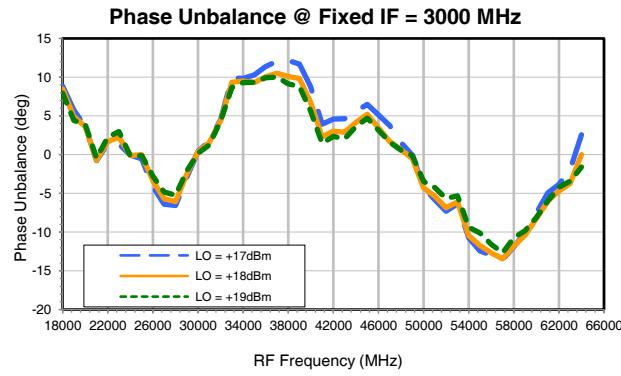
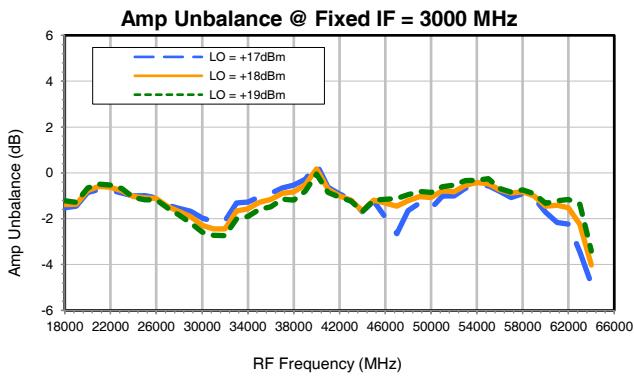
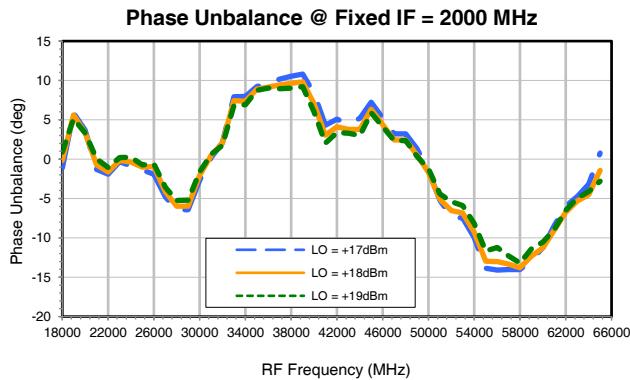
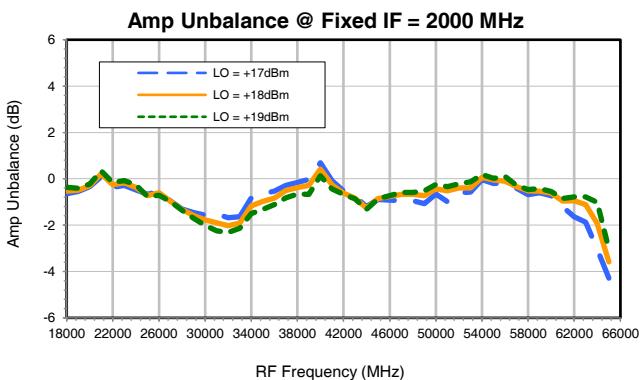
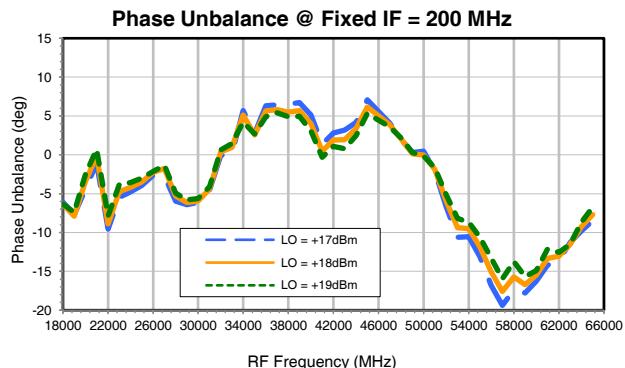
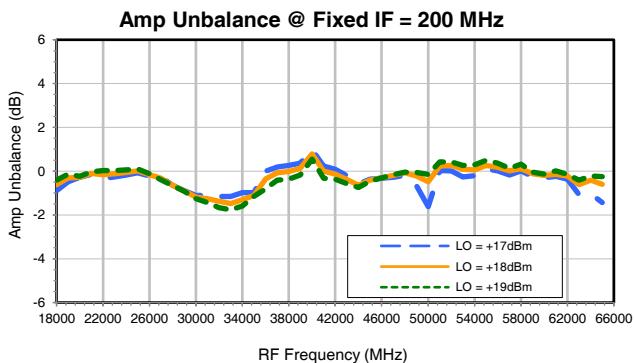
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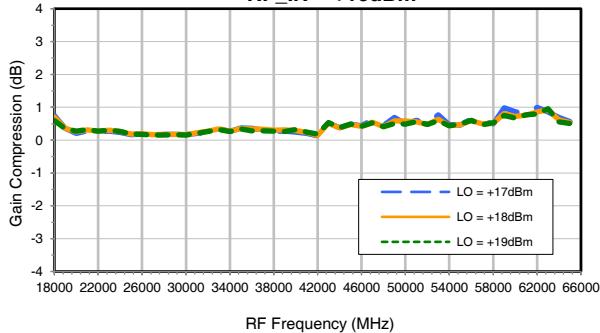
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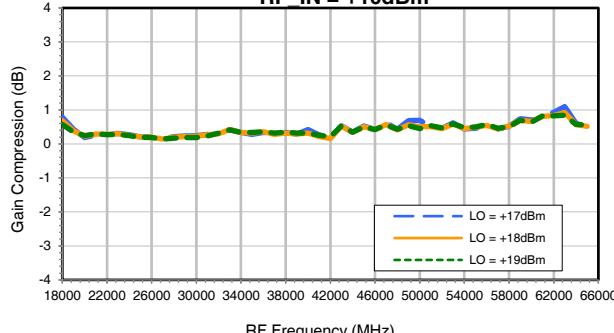
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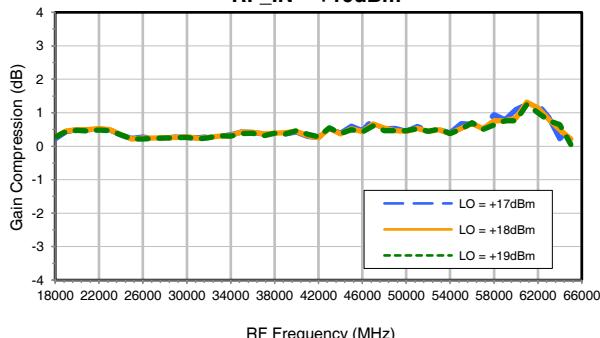
Gain Compression (I) @ Fixed IF = 200 MHz
RF_IN = +10dBm



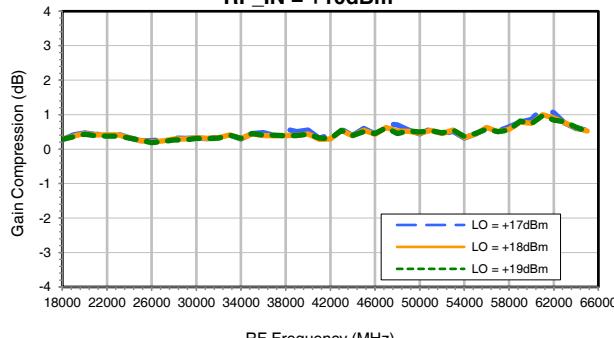
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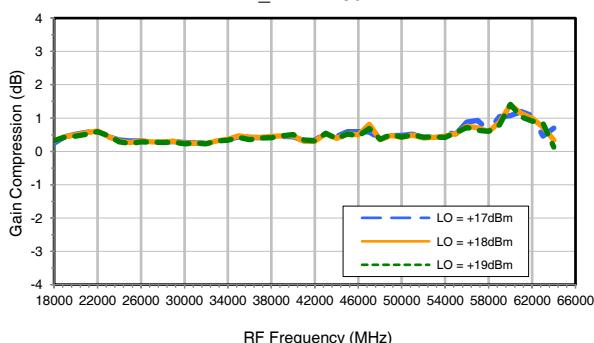
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RF_IN = +10dBm



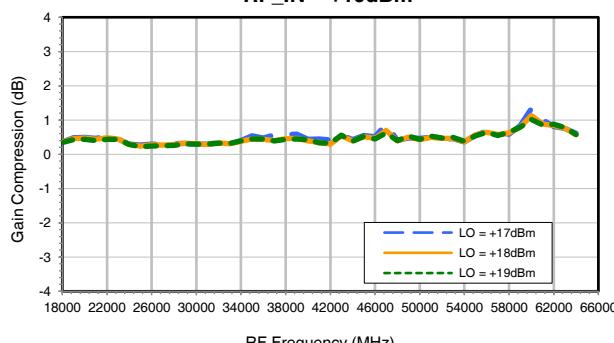
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RF_IN = +10dBm



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



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



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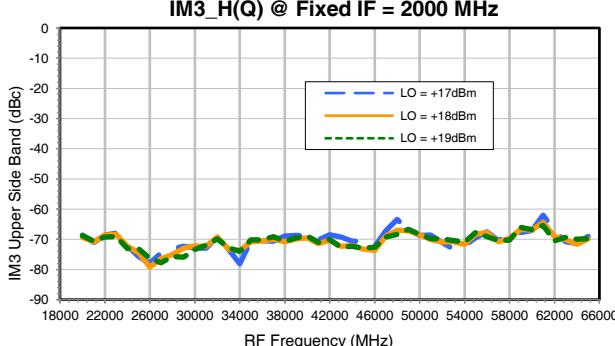
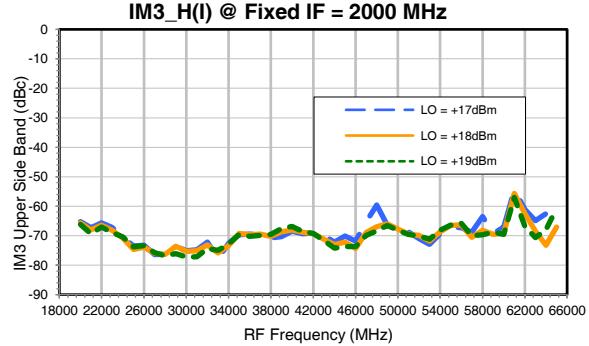
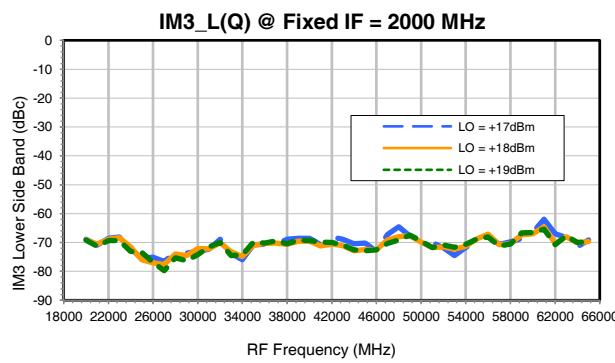
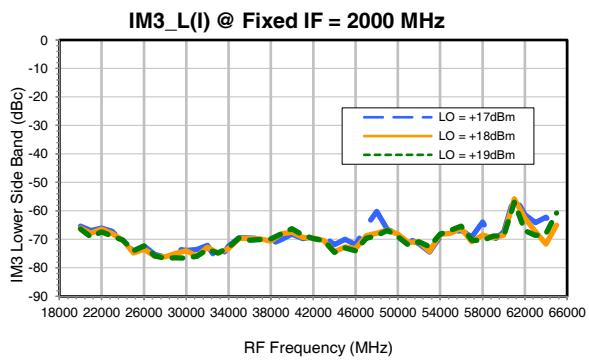
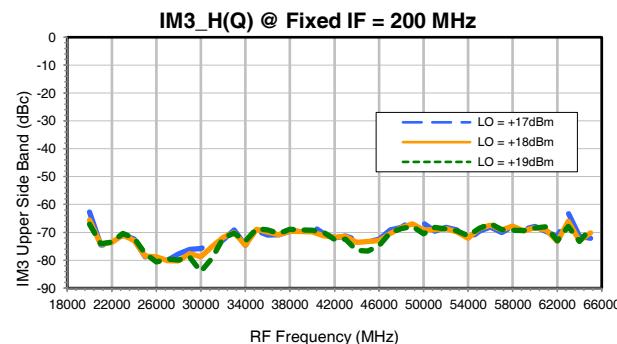
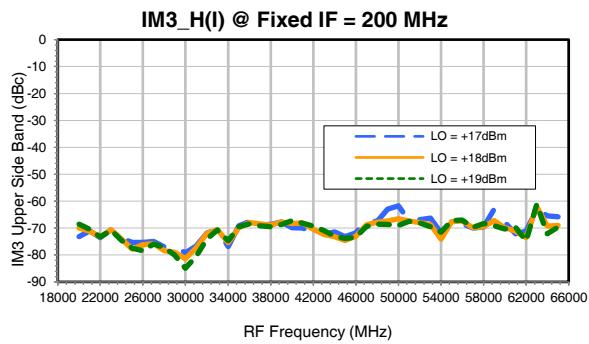
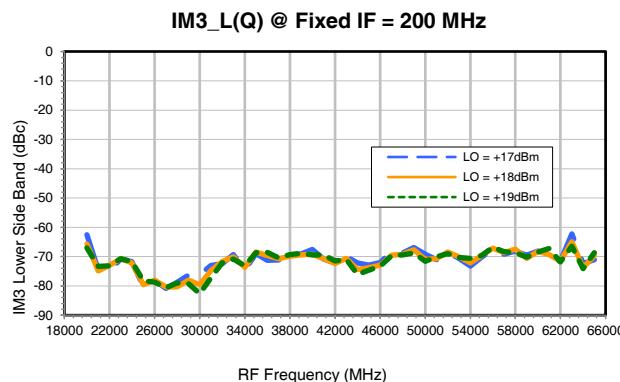
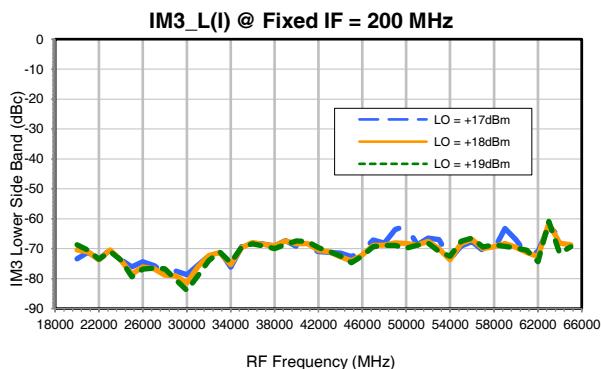


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Level 18 (LO Power +18 dBm) 18 to 65 GHz

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



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PAGE 13 OF 17



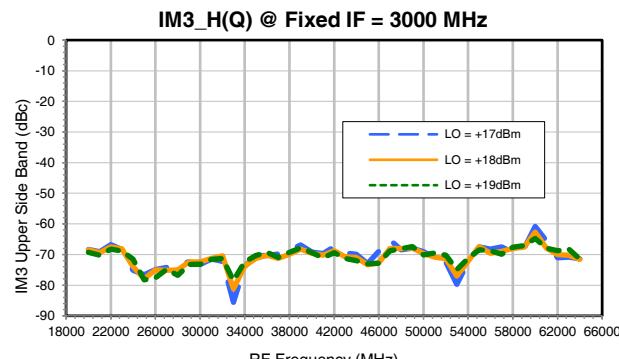
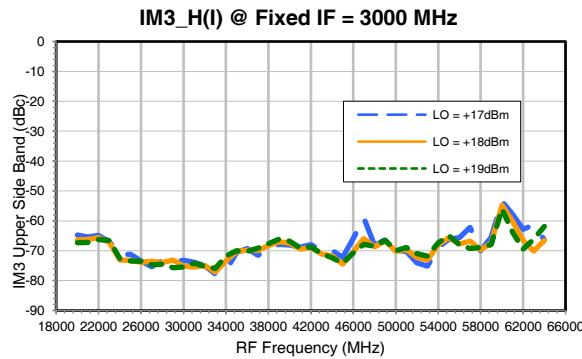
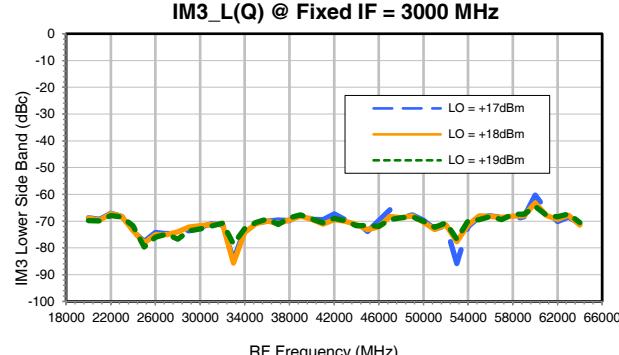
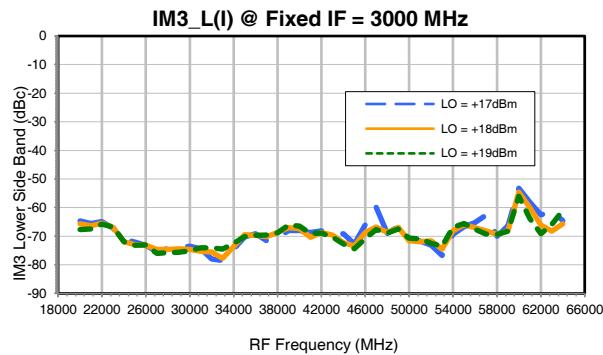
MMIC DIE IQ Mixer

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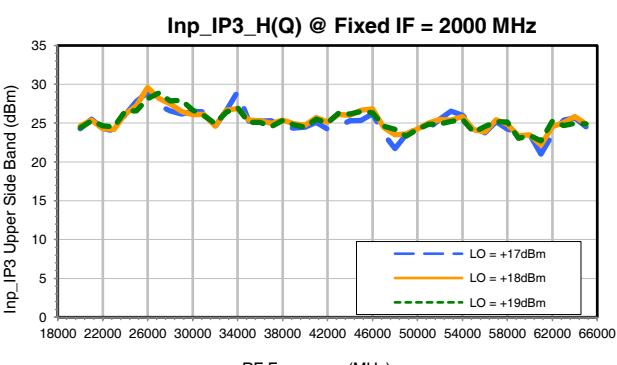
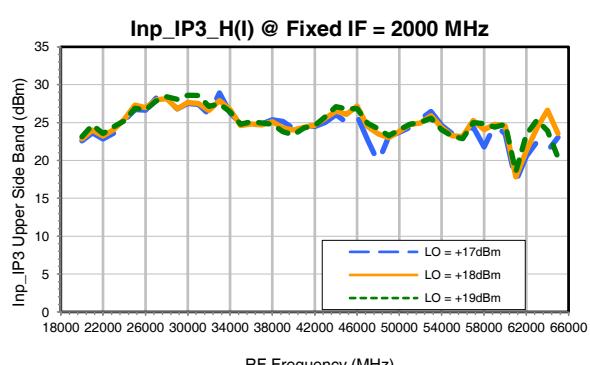
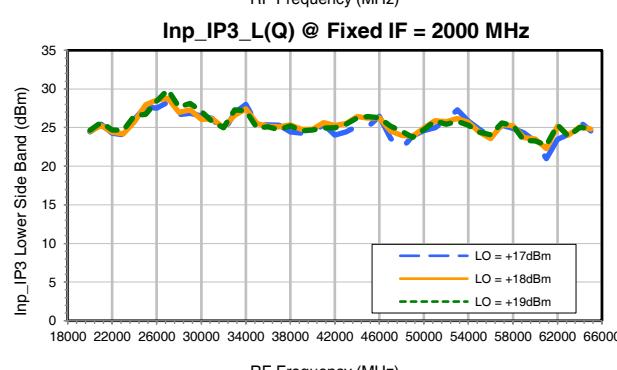
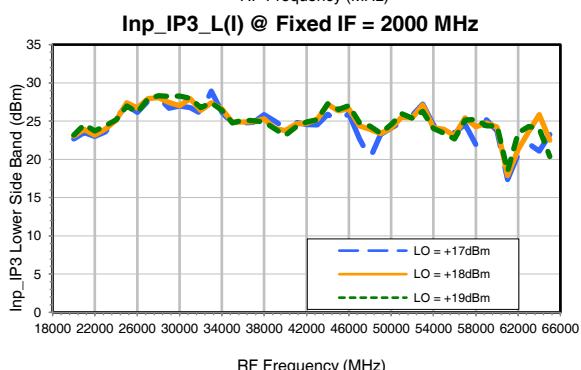
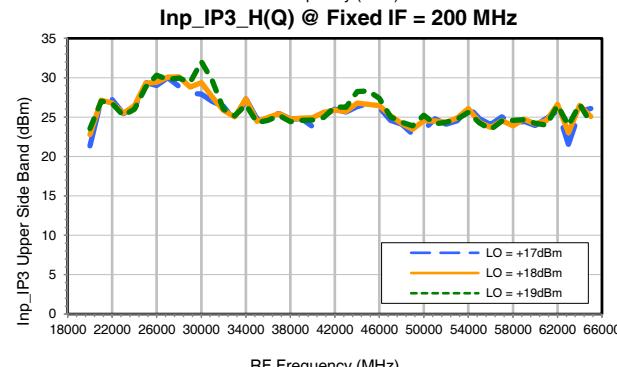
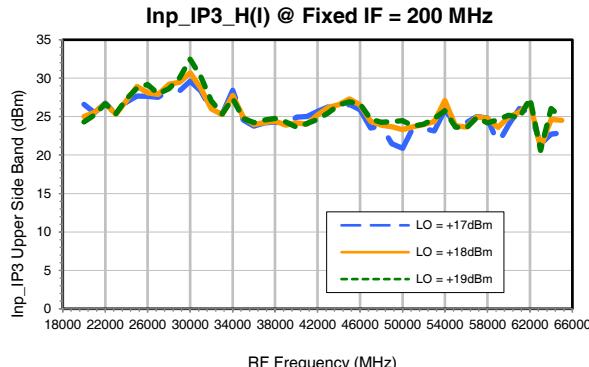
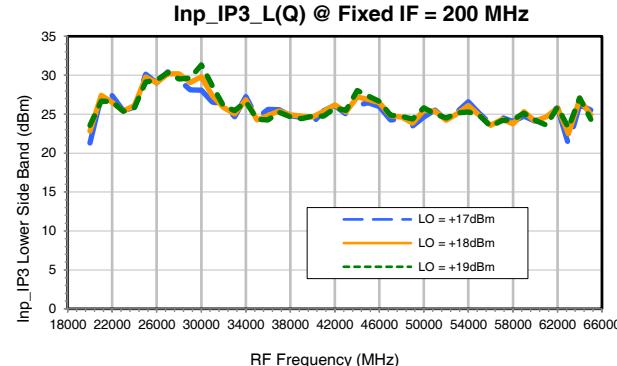
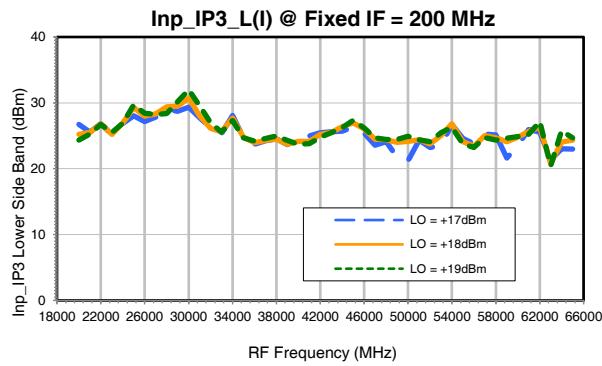


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Level 18 (LO Power +18 dBm) 18 to 65 GHz

SMIQ-653H-D+

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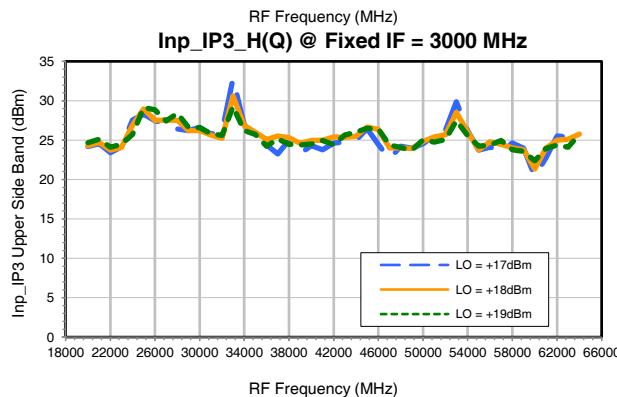
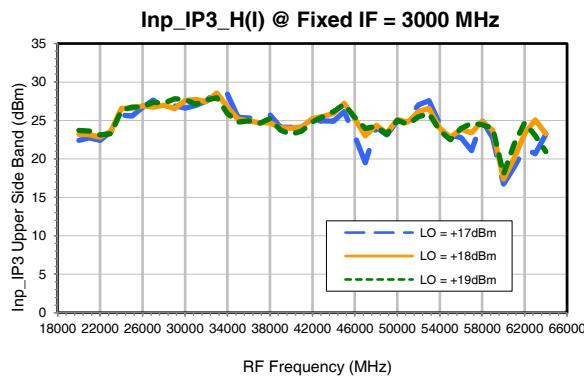
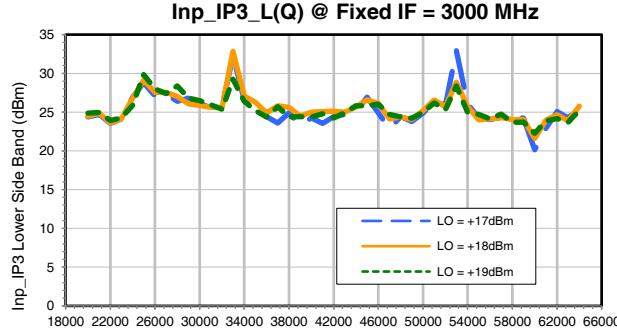
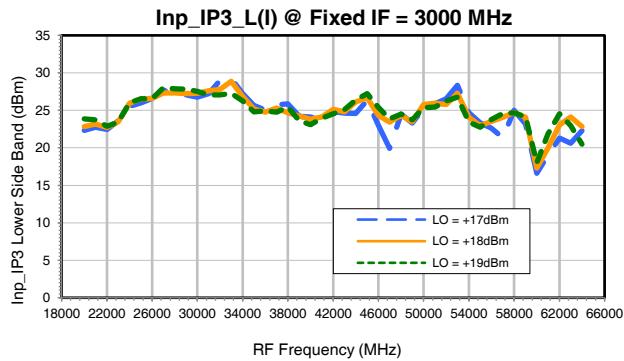
MMIC DIE IQ Mixer

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

SMIQ-653H-D+

TYPICAL PERFORMANCE CURVES

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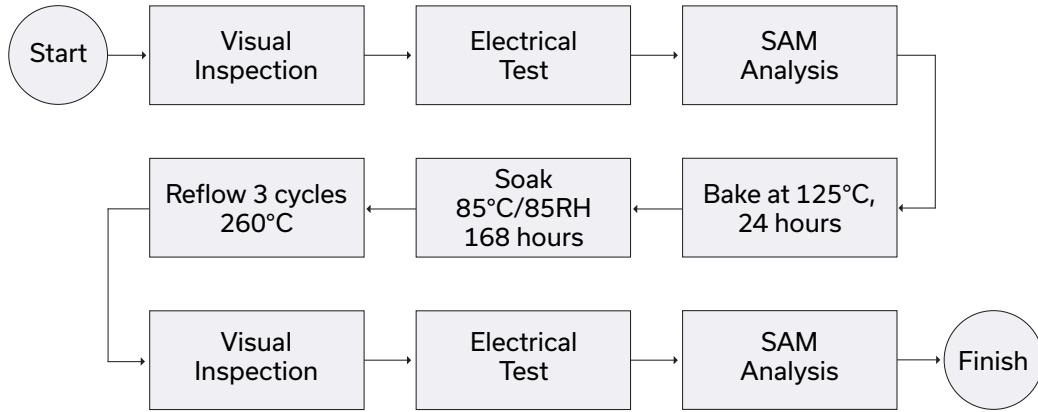
Level 18 (LO Power +18 dBm) 18 to 65 GHz

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 Small, Gel - Pak: 5,10,50,KGD* Medium [†] , Partial wafer: KGD*<475 Full wafer | Model No. SMIQ-653H-DG+ SMIQ-653H-DP+ 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



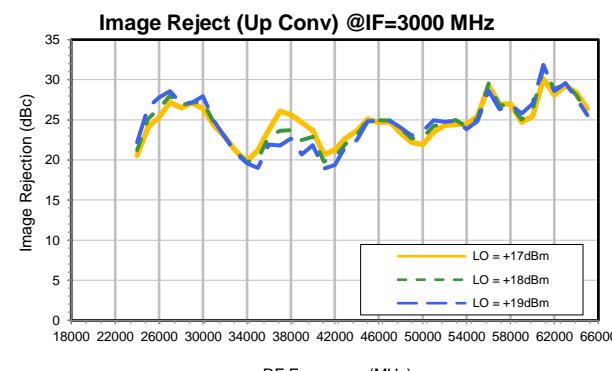
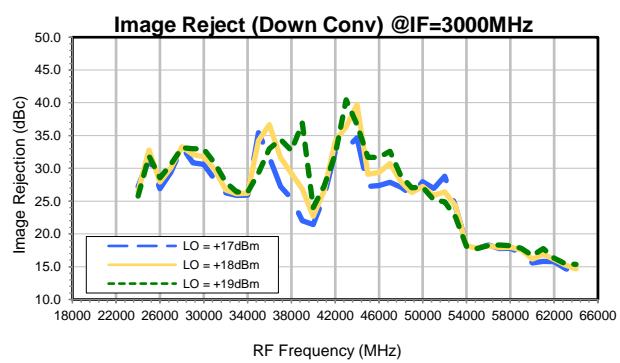
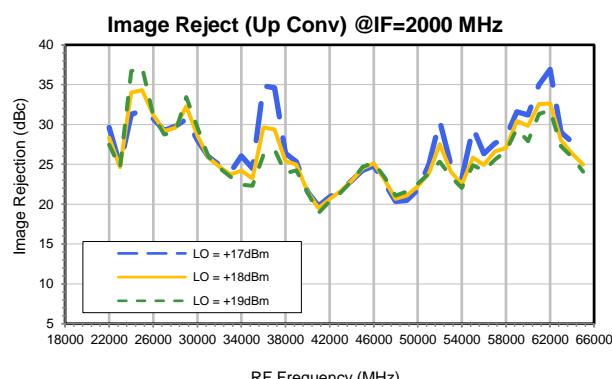
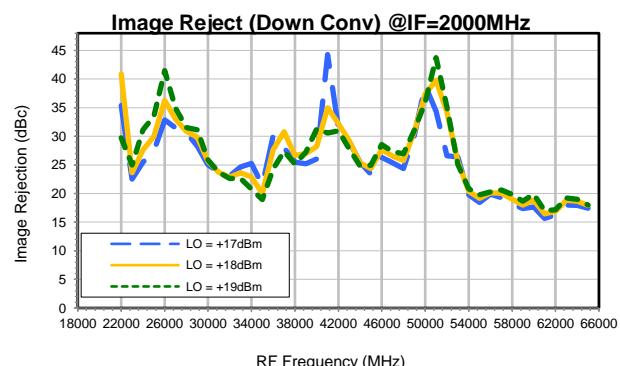
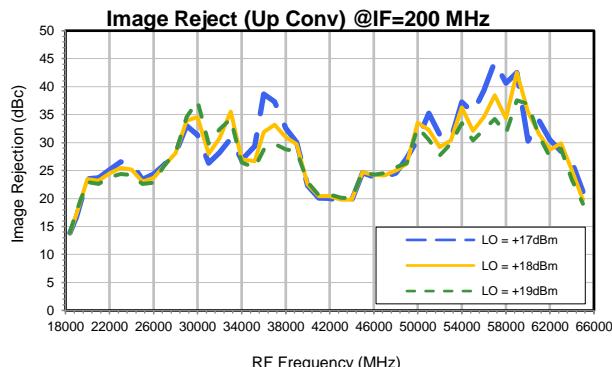
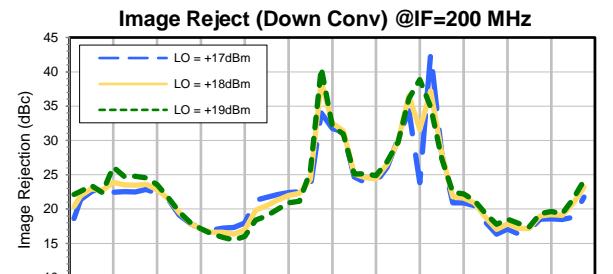
NOTES

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Frequency Mixer

SMIQ-653H-D+

Typical Performance Curves

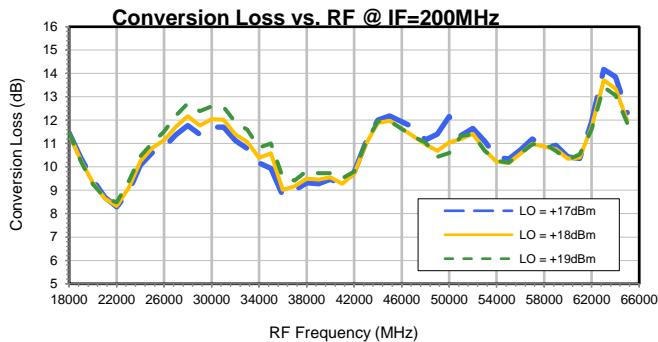


Frequency Mixer

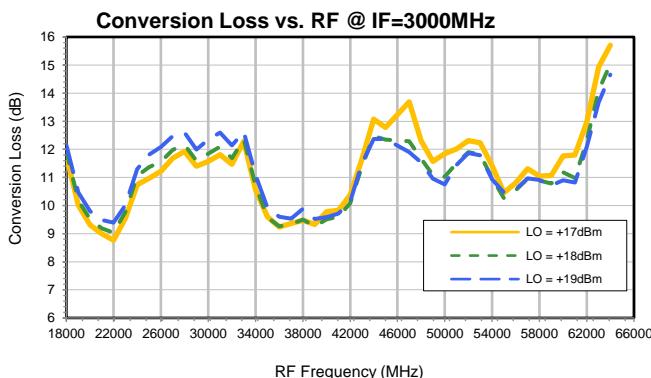
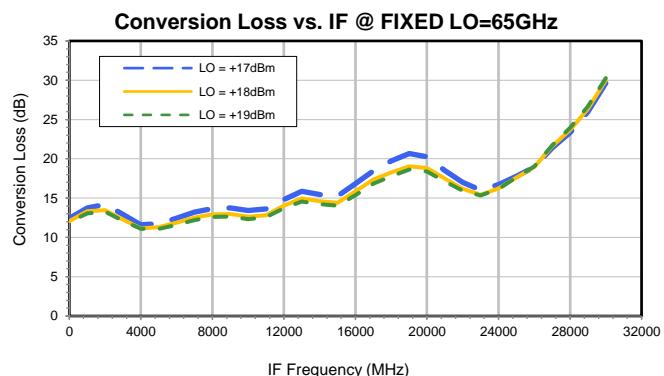
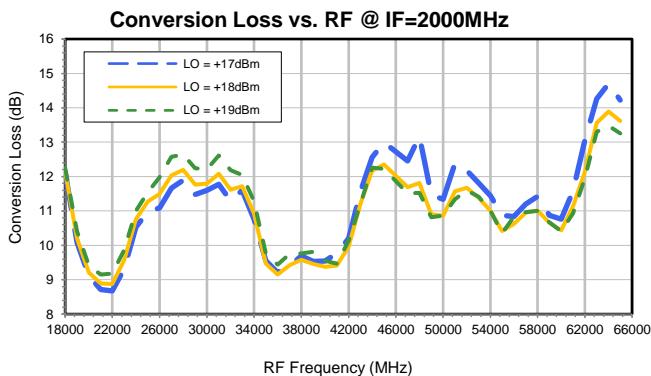
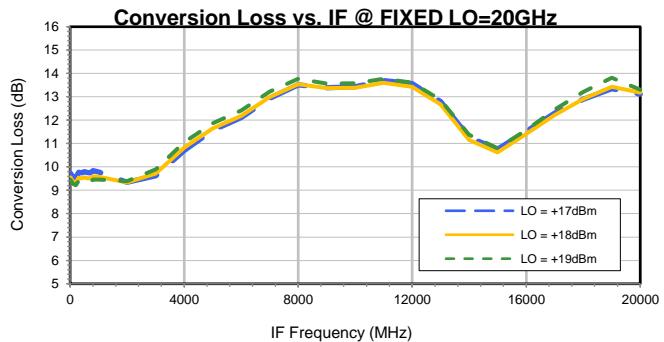
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Typical Performance Curves

Conversion Loss with Fixed IF



Conversion Loss with Variable IF



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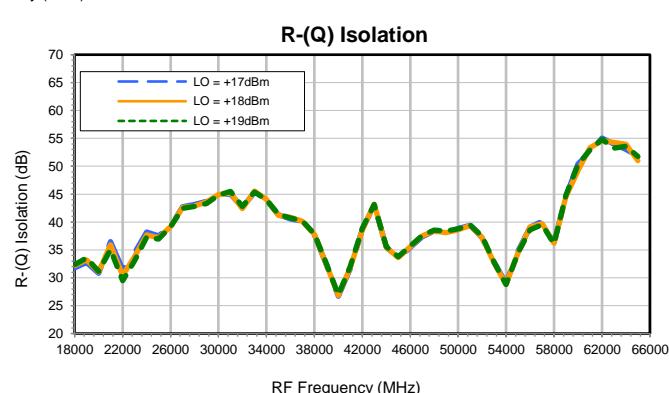
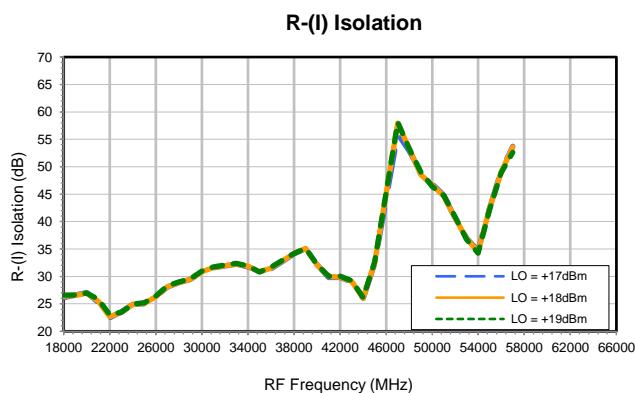
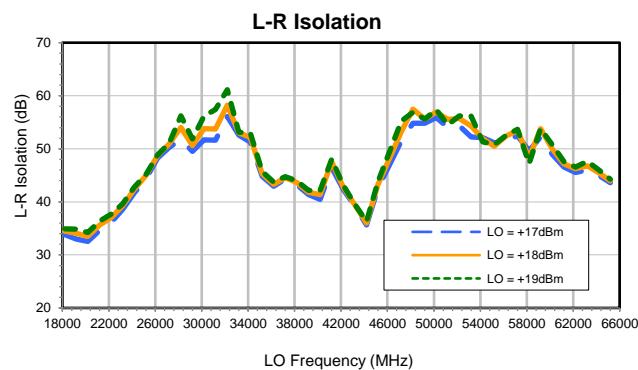
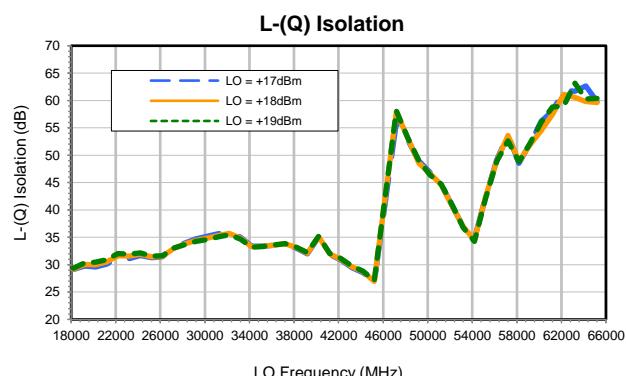
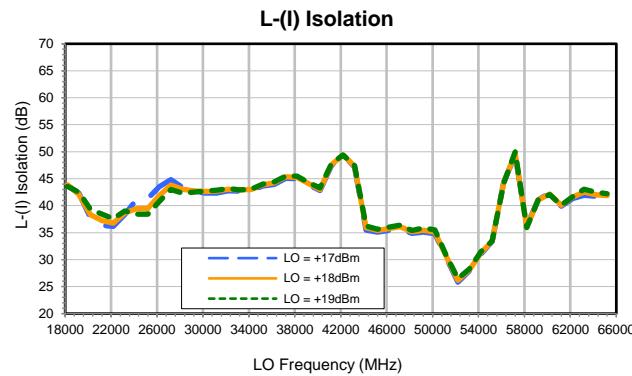

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Page 2 of 9

Frequency Mixer

SMIQ-653H-D+

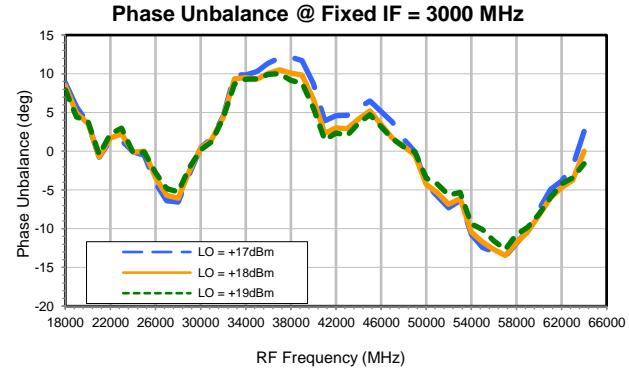
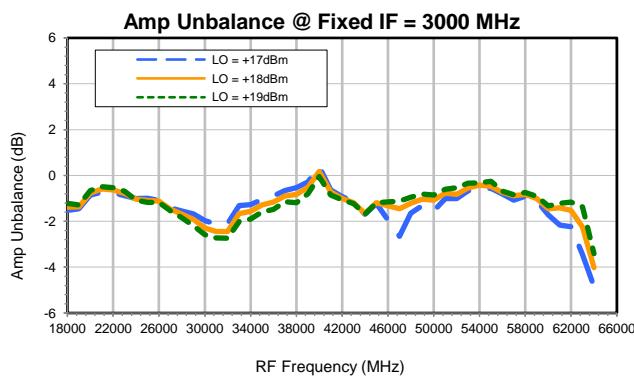
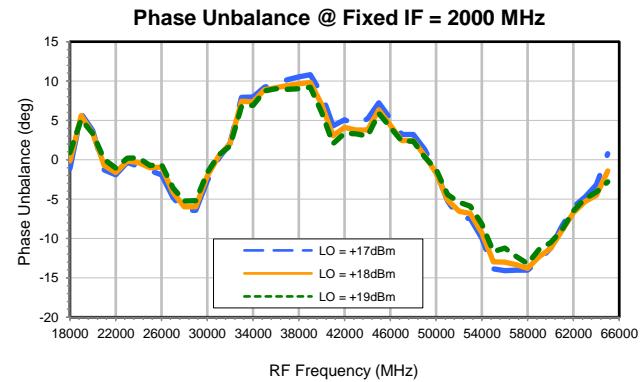
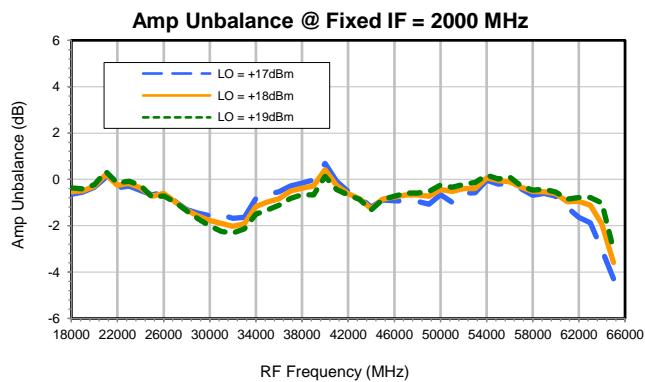
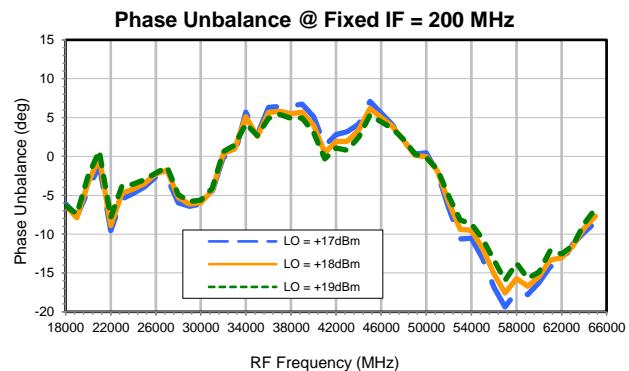
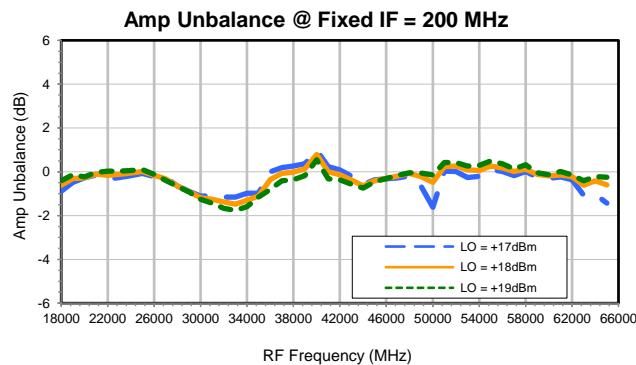
Typical Performance Curves



Frequency Mixer

SMIQ-653H-D+

Typical Performance Curves

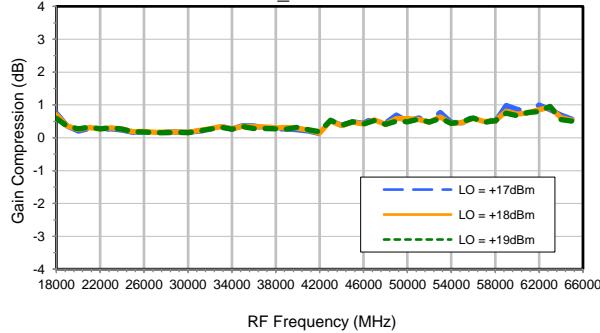


Frequency Mixer

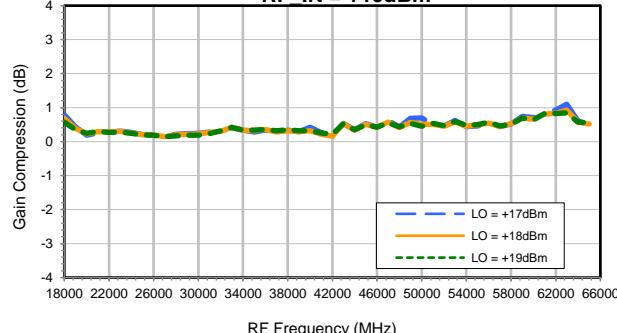
SMIQ-653H-D+

Typical Performance Curves

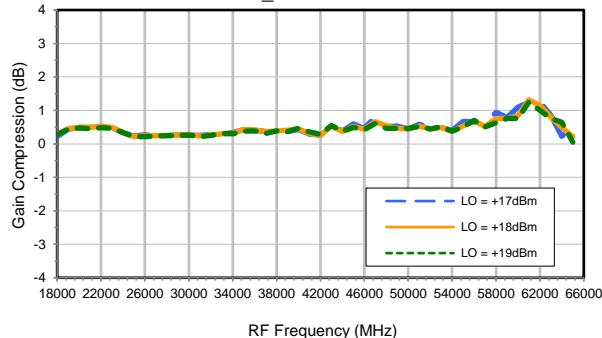
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RF_IN = +10dBm



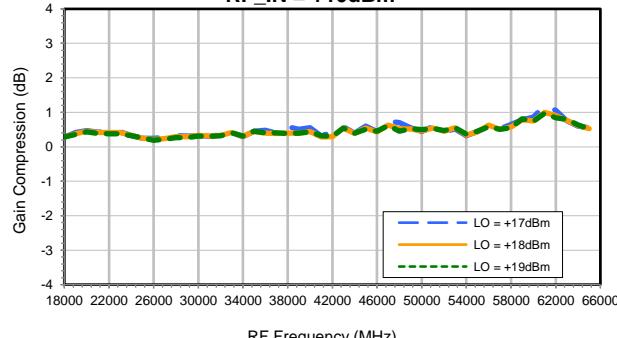
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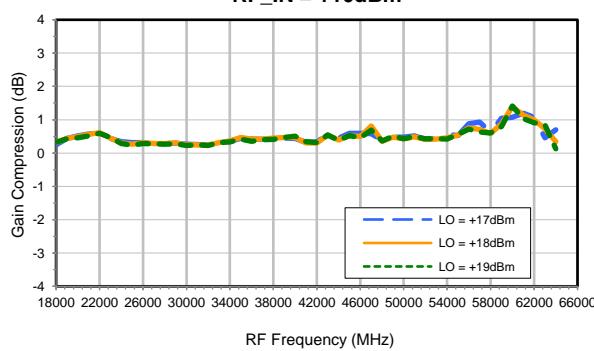
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RF_IN = +10dBm



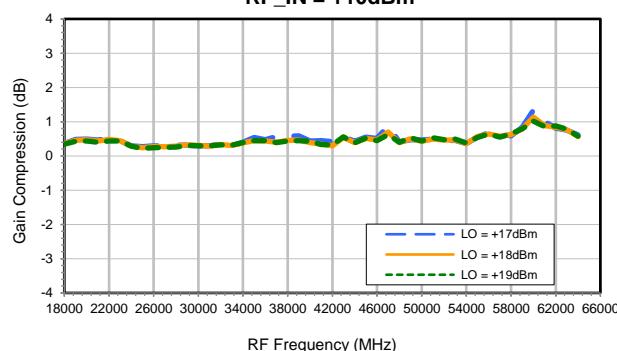
Gain Compression (Q) @ Fixed IF = 2000 MHz
RF_IN = +10dBm



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



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

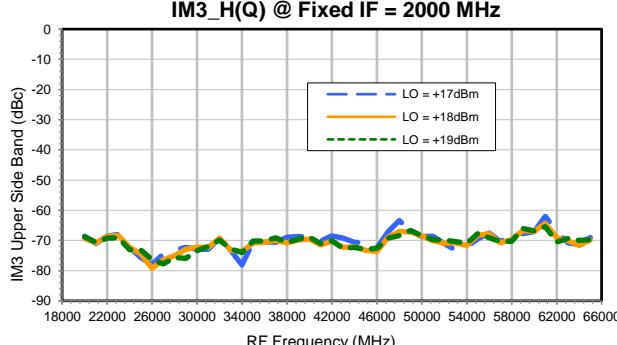
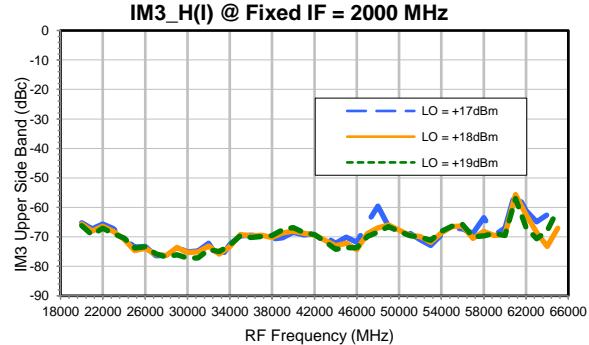
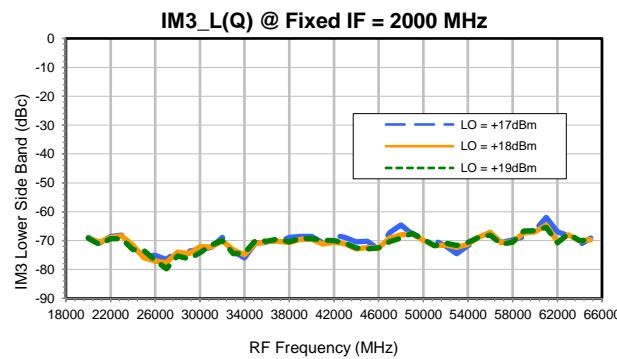
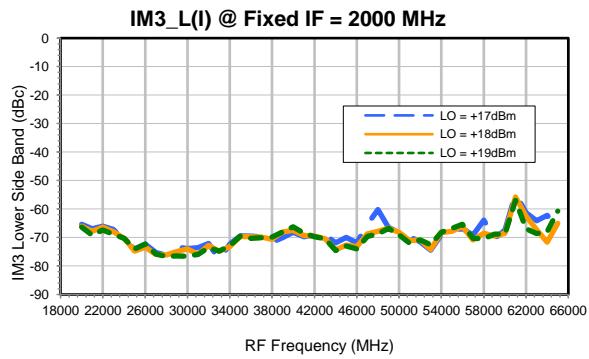
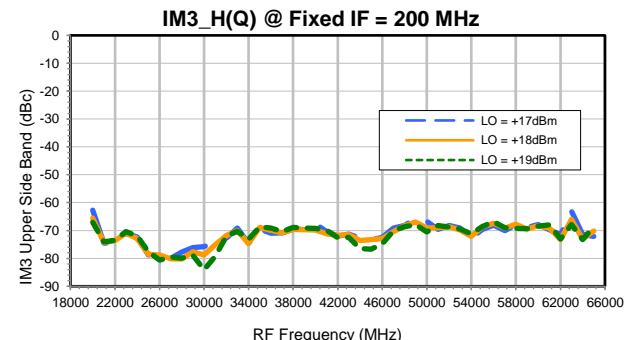
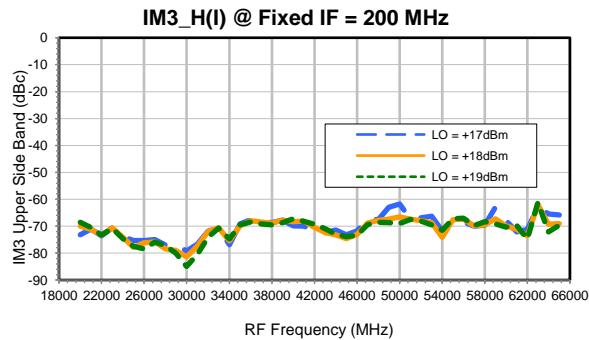
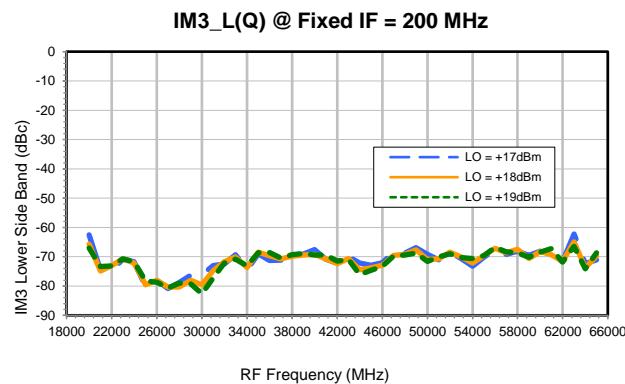
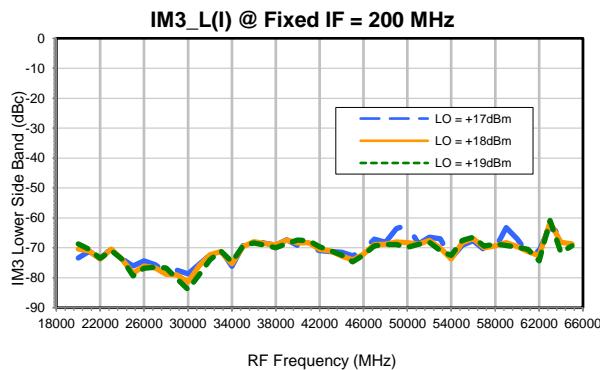


Frequency Mixer

SMIQ-653H-D+

Typical Performance Curves

Pout = -10dBm/tone with 1MHz spacing (RF2 = RF1 + 1MHz)



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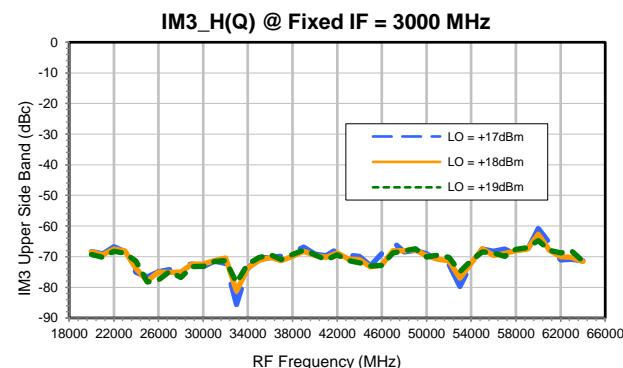
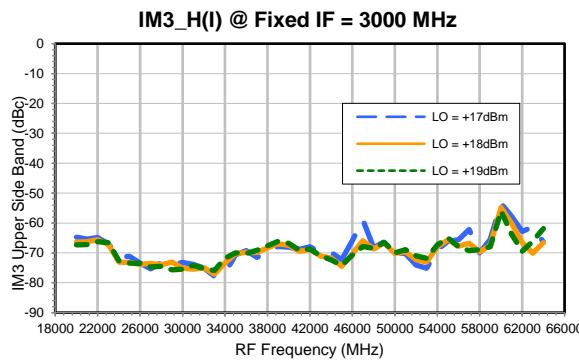
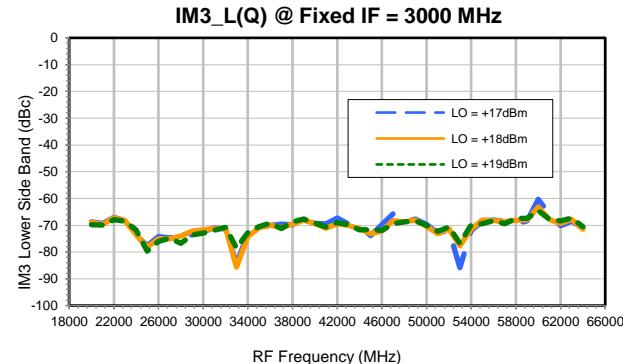
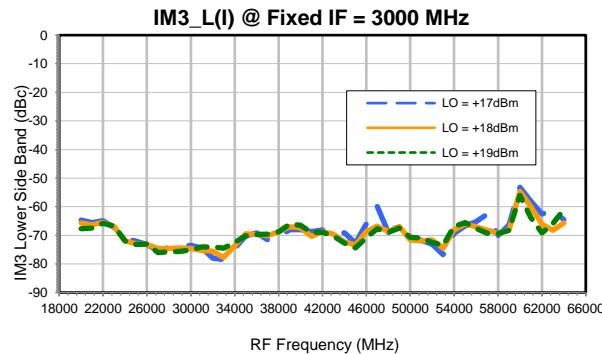
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Frequency Mixer

SMIQ-653H-D+

Typical Performance Curves

Pout = -10dBm/tone with 1MHz spacing (RF2 = RF1 + 1MHz)

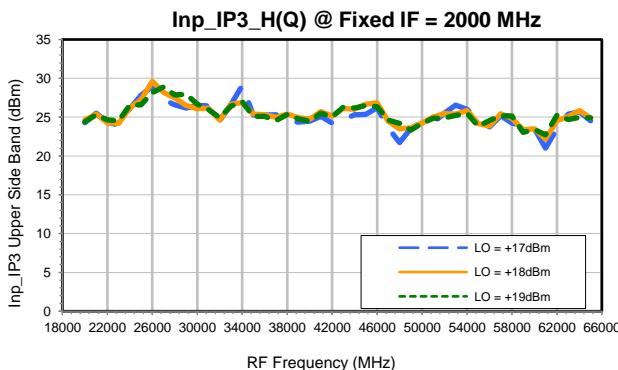
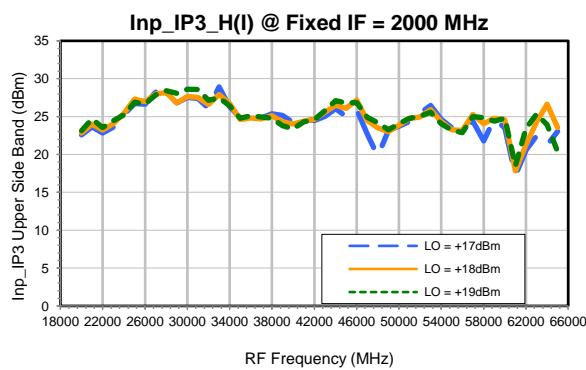
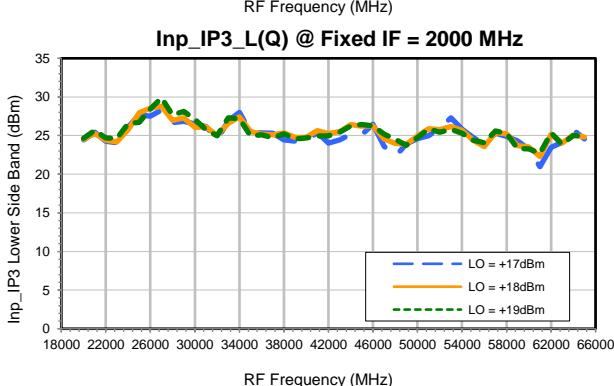
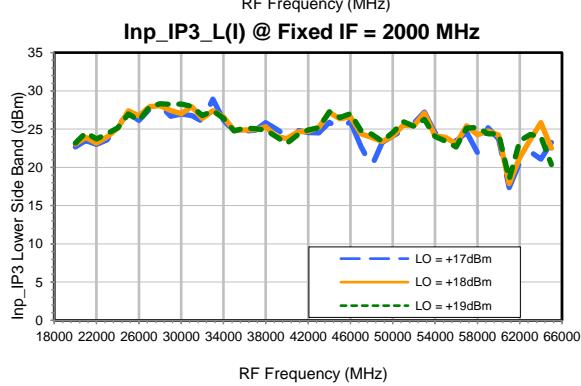
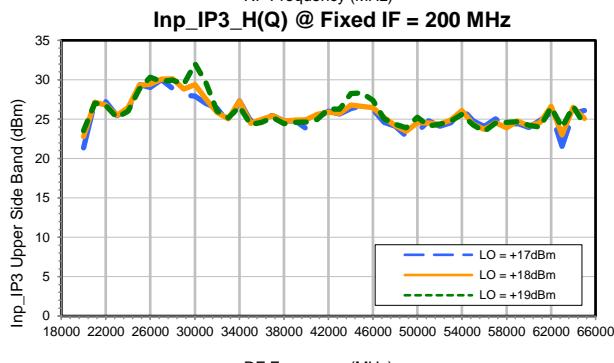
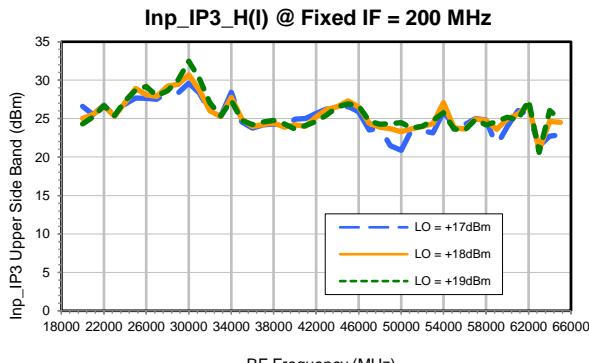
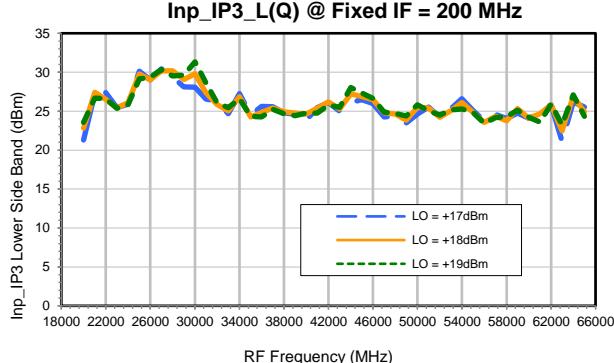
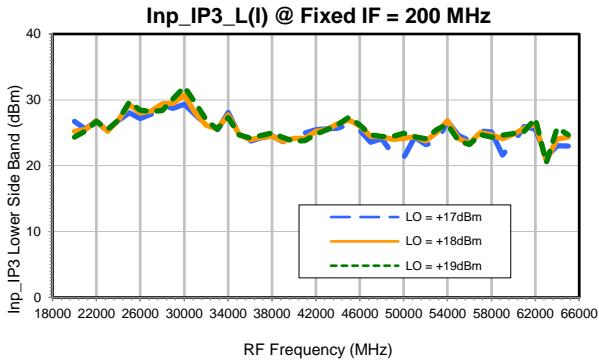


Frequency Mixer

SMIQ-653H-D+

Typical Performance Curves

Pout = -10dBm/tone with 1MHz spacing (RF2 = RF1 + 1MHz)



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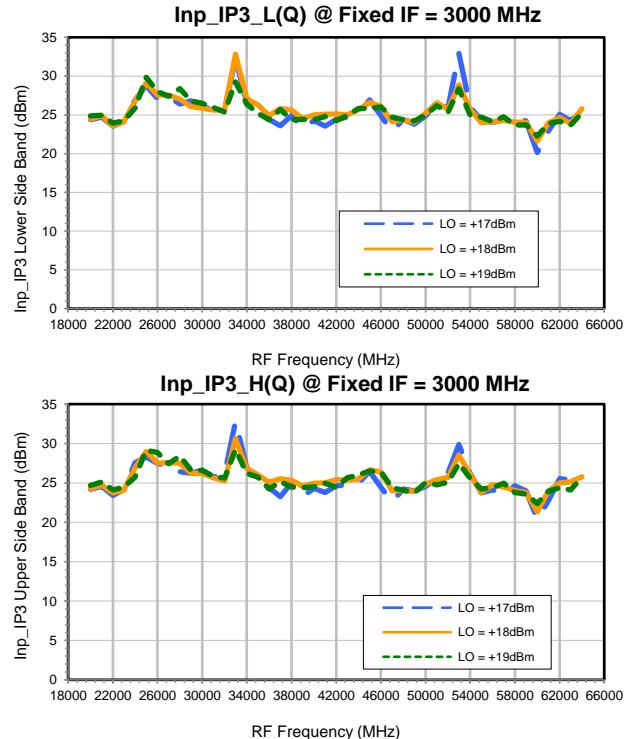
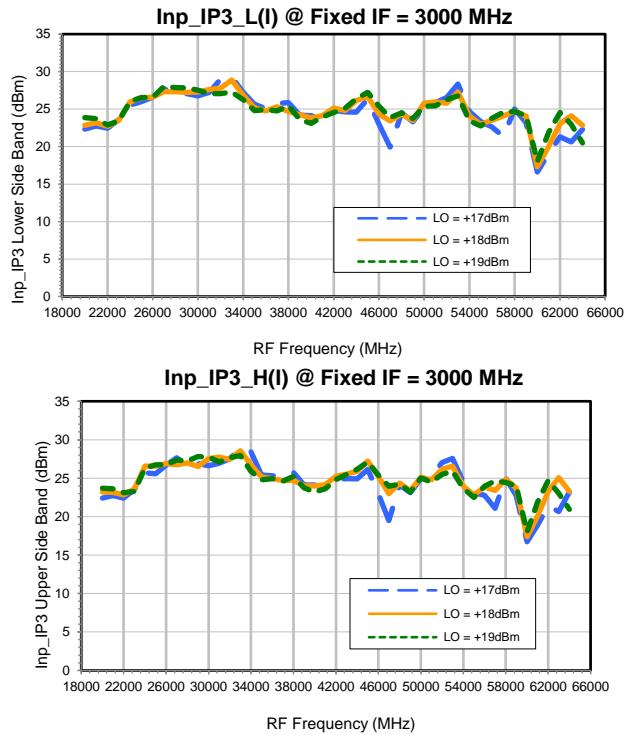
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Frequency Mixer

SMIQ-653H-D+

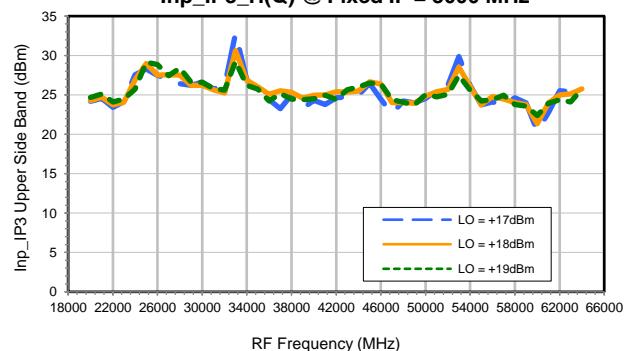
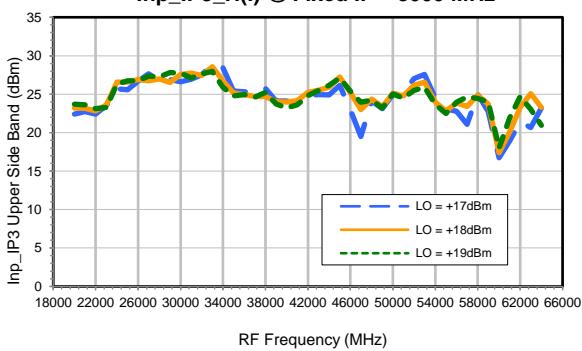
Typical Performance Curves

Pout = -10dBm/tone with 1MHz spacing (RF2 = RF1 + 1MHz)



Inp_IP3_H(I) @ Fixed IF = 3000 MHz

Inp_IP3_H(Q) @ Fixed IF = 3000 MHz





Environmental Specifications

ENV80

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

| Specification | Test/Inspection Condition | Reference/Spec |
|--------------------------------|--|--------------------------------------|
| Operating Temperature | -40° to 85° C or -40° to 105° C or -55° to 105° C or -45° to 105° C Ambient Environment | Refer to Individual Model Data Sheet |
| Storage Environment (Die) | -65° to 150°C | Individual Model Data Sheet |
| Storage Environment(Packaging) | -40° to 70°C and 40 to 60% humidity (In Factory Shipped Package) | |