

# MT3L-0113HCH-2

## GaAs MMIC High Dynamic Range Mixer

### DEVICE OVERVIEW

#### General Description

MT3L-0113H is a GaAs MMIC triple balanced mixer with high dynamic range and low conversion loss. This mixer belongs to the T3 family which offers high IP3, P1dB, and broad operating bandwidths for applications in the S, C and X bands. MT3L-0113H is the monolithic cousin of the MT3-0113HCQG and sister of the MT3H-0113HCH targeted towards lower IF applications in a small footprint. The MT3L-0113H is available as both wire bondable die and a connectorized module.



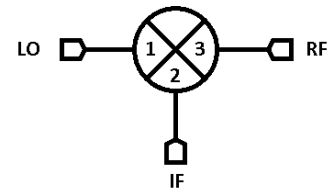
#### Features

- Low IF band
- Broad, overlapping RF/LO & IF bands
- High >+30 dBm IP3

#### Applications

- Test and Measurement Equipment
- S/C/X band radar

#### Functional Block Diagram



#### Part Ordering Options

Part Number	Description	Package	Connectors	Green Status	Product Lifecycle	Export Classification
<a href="#">MT3L-0113HS</a>	GaAs MMIC High Dynamic Range Mixer	S	<a href="#">Standard</a>	REACH RoHS	Released	EAR99
MT3L-0113HCH-2	GaAs MMIC High Dynamic Range Mixer	CH	-	REACH RoHS	Released	EAR99

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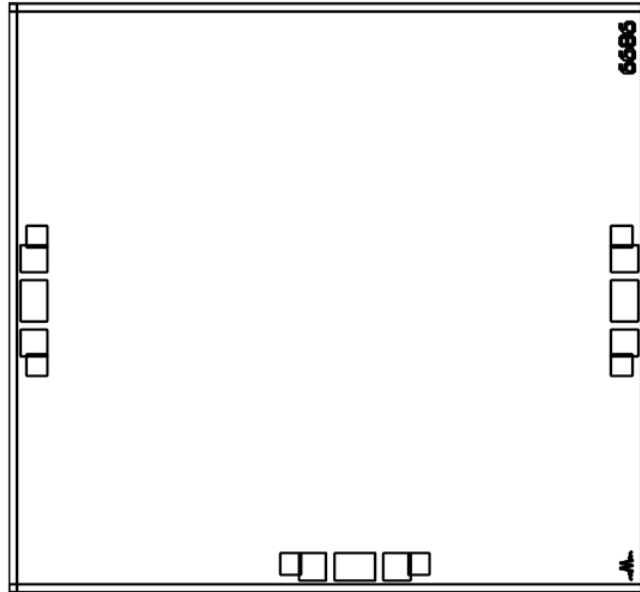
**Revision History**

Revision Code	Revision Date	Comment
-	2019-01-01	Datasheet Initial Release

## Port Configuration and Functions


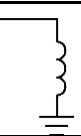

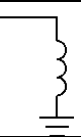
### Port Diagram

A top-down view of the MT3L-0113H's CH package outline drawing is shown below. The MT3L-0113H has the input and output ports given in Port Functions. The MT3L-0113H can be used in either an up or down conversion. For configuration A, input the LO into port 1, use port 3 for the RF, and port 2 for the IF. For configuration B, input the LO into port 3, use port 1 for the RF, and port 2 for the IF.


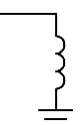




## Port Functions

### Configuration A

Port	Function	Description	Equivalent Circuit for Package
GND	Ground	CH package ground path is provided through the substrate and ground bond pads.	<b>GND</b> 
Port 1	LO	Port 1 is DC short for the CH and S packages.	<b>P1</b> 
Port 2	IF	Port 2 is DC open for the CH and S package.	<b>P2</b> 
Port 3	RF	Port 3 is DC short for the CH and S packages.	<b>P3</b> 

**Configuration B**

Port	Function	Description	Equivalent Circuit for Package
GND	Ground	CH package ground path is provided through the substrate and ground bond pads.	<b>GND</b> 
Port 1	RF	Port 1 is DC short for the CH and S packages.	<b>P1</b> 
Port 2	IF	Port 2 is DC open for the CH and S package.	<b>P2</b> 
Port 3	LO	Port 3 is DC short for the CH and S packages.	<b>P3</b> 

## Specifications

### Absolute Maximum Ratings

The Absolute Maximum Ratings indicate limits beyond which damage may occur to the device. If these limits are exceeded, the device may be inoperable or have a reduced lifetime.

Parameter	Maximum Rating	Unit
Maximum Operating Temperature	100	°C
Maximum Storage Temperature	125	°C
Minimum Operating Temperature	-55	°C
Minimum Storage Temperature	-65	°C
Port 1 DC Current	150	mA
Port 2 DC Current	150	mA
Power Handling, at any Port	33	dBm

### Package Information

Parameter	Details	Rating
ESD	250 to < 500 Volts	HBM Class 1A
Dimensions	-	2.28x2.09mm

### Recommended Operating Conditions

The Recommended Operating Conditions indicate the limits, inside which the device should be operated, to guarantee the performance given in Electrical Specifications. Operating outside these limits may not necessarily cause damage to the device, but the performance may degrade outside the limits of the electrical specifications. For limits, above which damage may occur, see Absolute Maximum Ratings.

Parameter	Min	Nominal	Max	Unit
LO Input Power	15	-	25	dBm
Ambient Temperature	-55	25	100	°C

### Sequencing Requirements

There is no requirement to apply power to the ports in a specific order. However, it is recommended to provide a 50Ω termination to each port before applying power. This is a passive diode mixer that requires no DC bias.

**Electrical Specifications**

The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for the connectorized S package mixer used with a +20 dBm sine wave LO. Min and Max limits apply only to our connectorized units and are guaranteed at TA=+25°C. All bare die are 100% DC tested and visually inspected.

Parameter	Port Configuration	Test Conditions	Min	Typ	Max	Unit
Conversion Loss <sup>1</sup>	A	RF/LO = 1.5 - 13 GHz I = 0.25- 0.75 GHz	-	10.5	-	dB
Conversion Loss <sup>2</sup>	A	RF/LO = 1.5 - 13 GHz I = 0.75- 5 GHz	-	9.5	-	dB
Conversion Loss <sup>3</sup>	A	RF/LO = 1.5 - 13 GHz I = 0.75 GHz	-	8.5	11.5	dB
Input 1 dB Gain Compression Point (P1dB) <sup>4</sup>	A	-	-	20	-	dBm
Input IP3	A	RF/LO = 1.5 - 13 GHz I = 0.75 GHz	-	31	-	dBm
Conversion Loss <sup>5</sup>	B	RF/LO = 1.5 - 13 GHz I = 0.25- 0.75 GHz	-	11	-	dB
Conversion Loss <sup>6</sup>	B	RF/LO = 1.5 - 13 GHz I = 0.75- 5 GHz	-	11	-	dB
Conversion Loss <sup>7</sup>	B	RF/LO = 1.5 - 13 GHz I = 0.75 GHz	-	10	13	dB
Input 1 dB Gain Compression Point (P1dB) <sup>8</sup>	B	-	-	20	-	dBm
Input IP3 <sup>9</sup>	B	RF/LO = 1.5 - 13 GHz I = 0.75 GHz	-	31	-	dBm
IF Frequency Range	-	-	0.25	-	5	GHz
Isolation, LO to IF	-	IF/LO = 1.5 - 13 GHz	-	41	-	dB
Isolation, LO to RF	-	RF/LO = 1.5 - 13 GHz	-	43	-	dB
Isolation, RF to IF	-	RF/IF = 1.5 - 13 GHz	-	39	-	dB
LO Frequency Range	-	-	1.5	-	13	GHz
Noise Figure <sup>10</sup>	-	RF/LO = 1.5 - 13 GHz I = 0.75 GHz	-	8.5	-	dB
RF Frequency Range	-	-	1.5	-	13	GHz

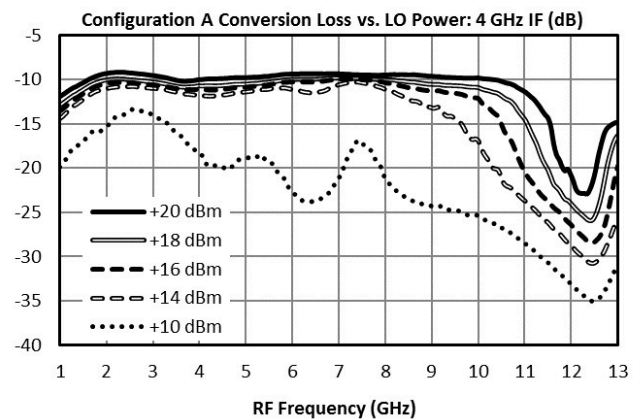
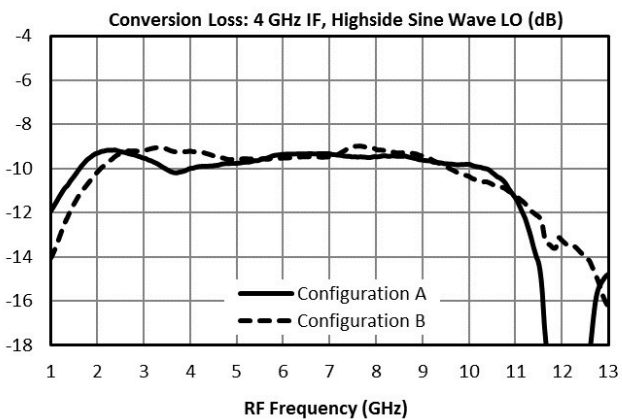
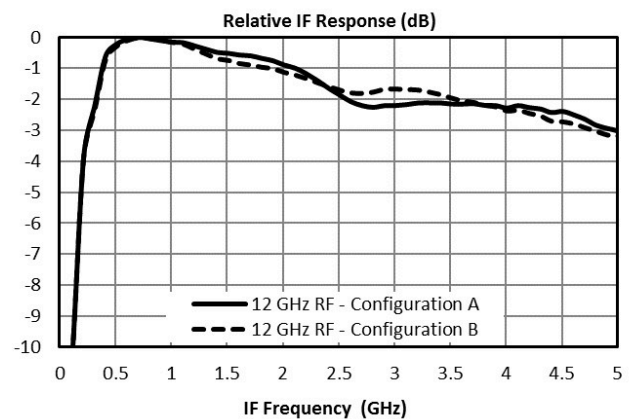
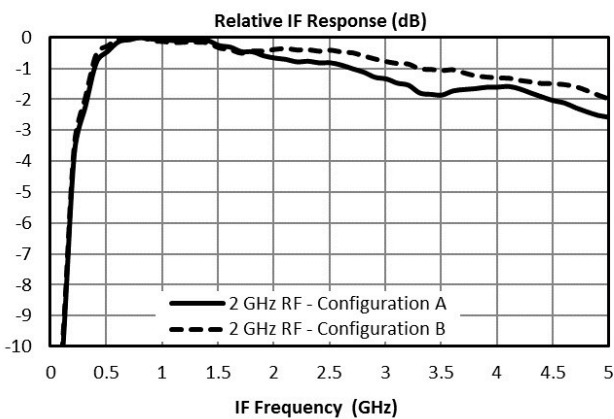
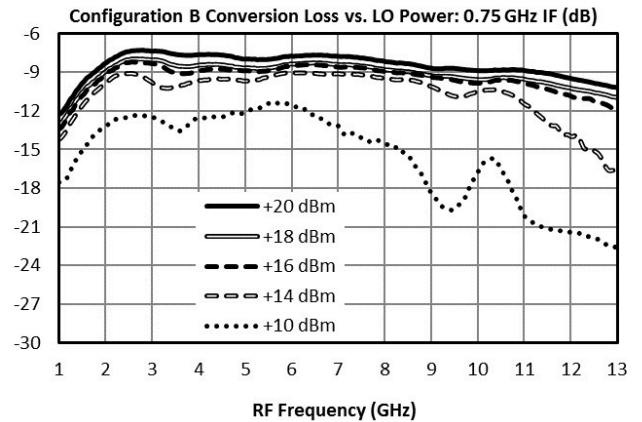
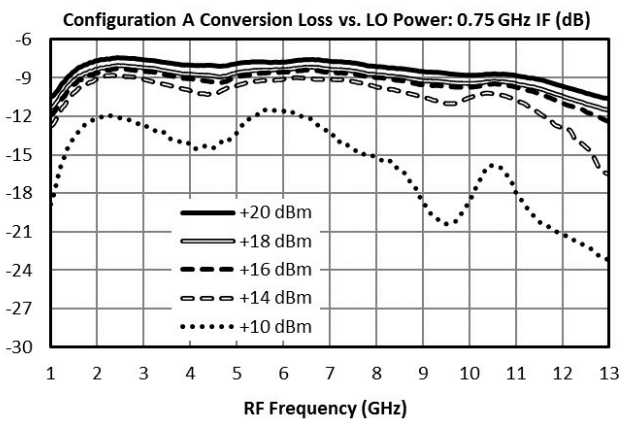
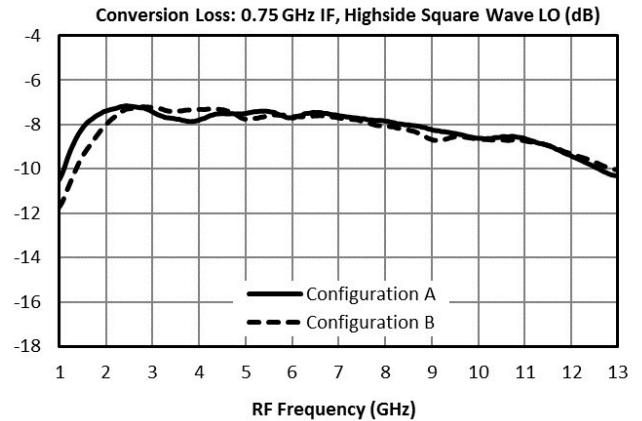
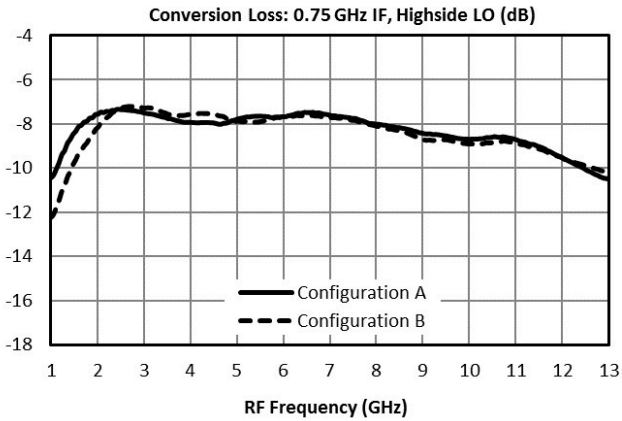
[1][2][3][5][6][7] Measured as a down converter to a fixed 750 MHz IF. Unless otherwise stated, frequency conversion done using a highside LO.

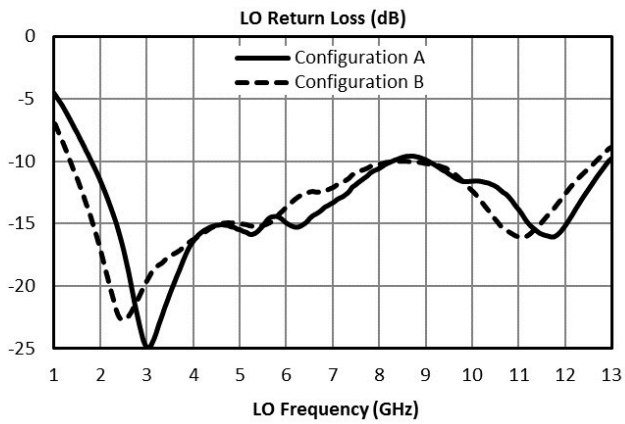
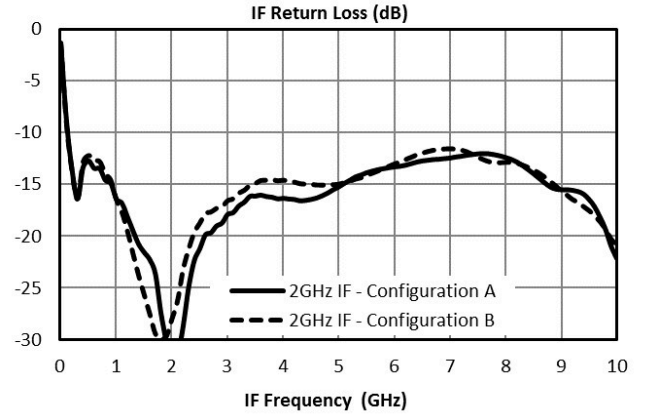
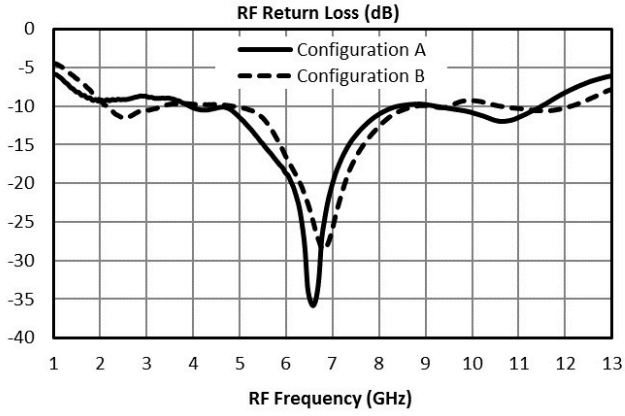
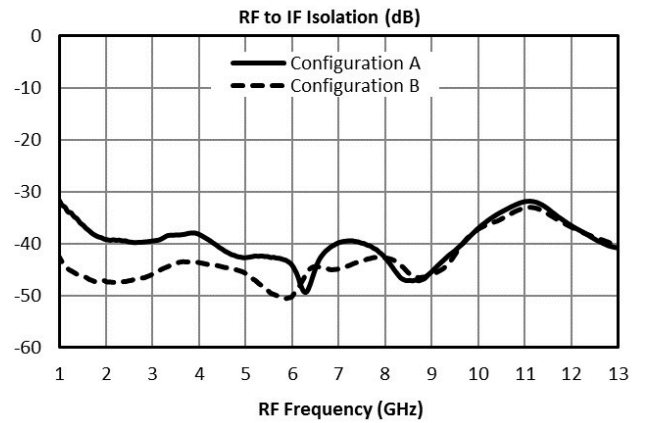
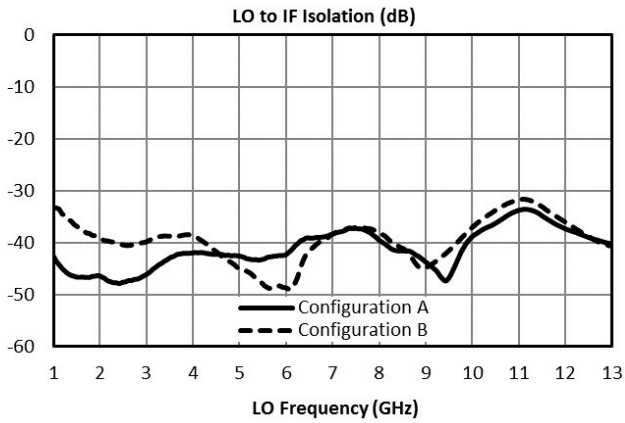
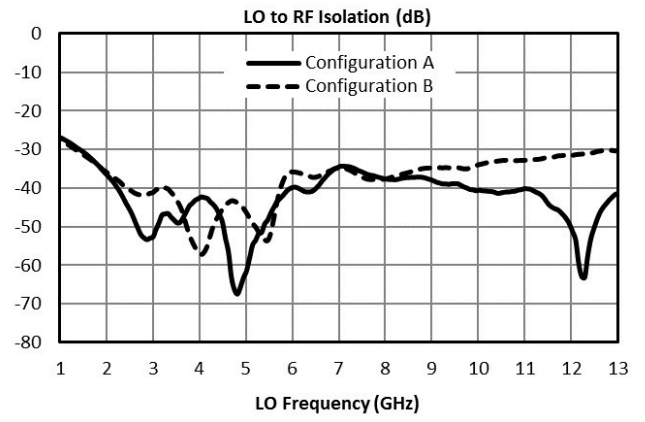
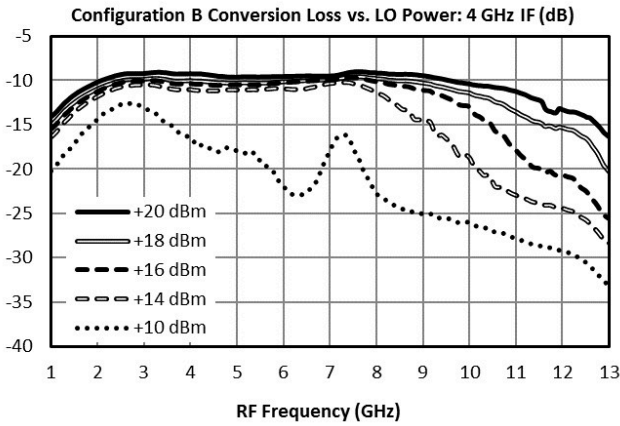
[4][8] P1dB is measured using a +23 dBm square wave LO.

[9] IP3 depends on LO drive condition. Reported table value is measured with a square wave LO formed using 2x ADM1-0026PA in series with +10 dBm input into the first stage. LO Power reported in plots is of the fundamental tone only. Square wave LO power in plots is stepped down using broadband DC-40 GHz attenuators.

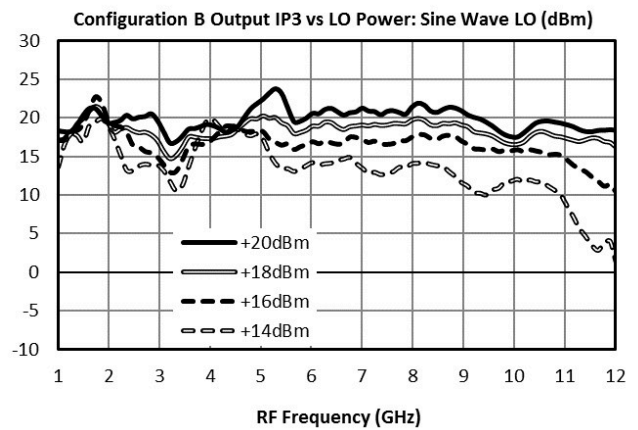
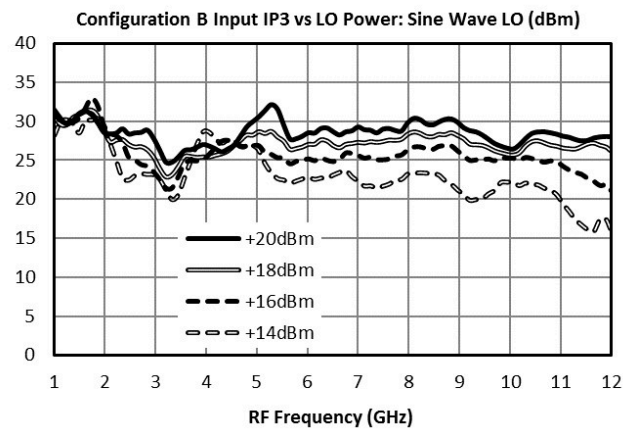
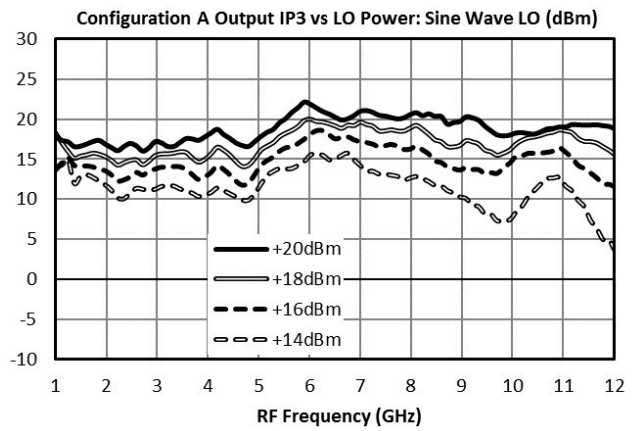
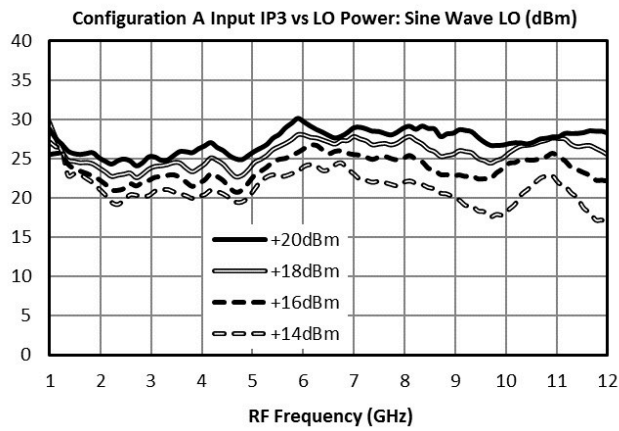
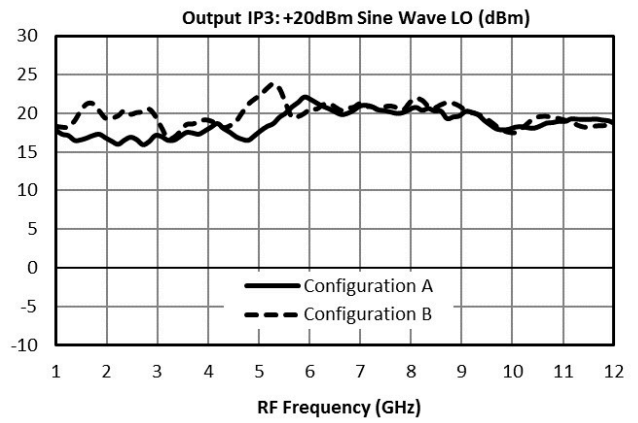
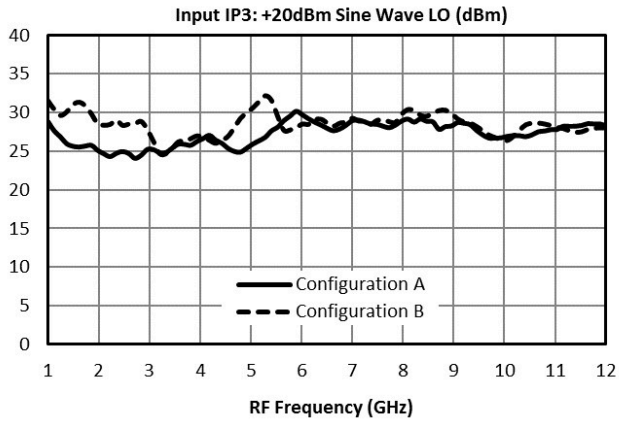
[10] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

**Typical Performance Plots**

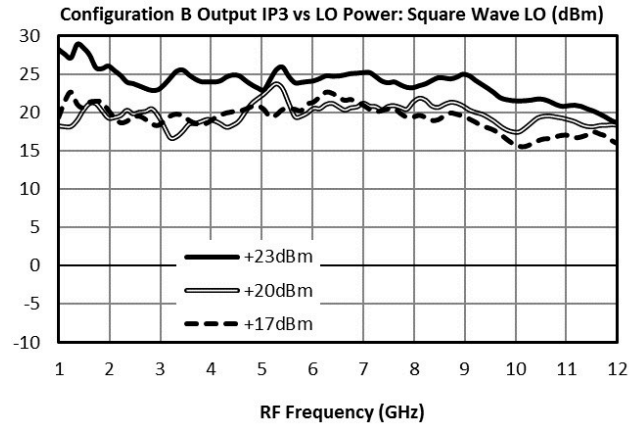
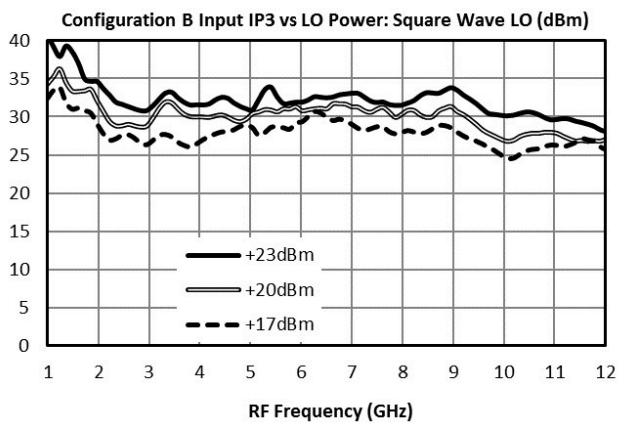
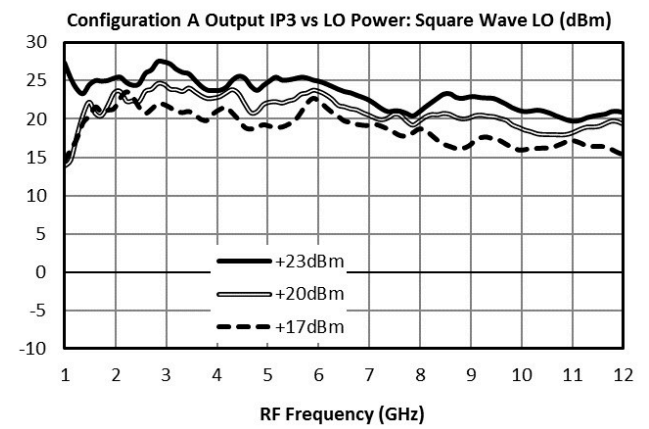
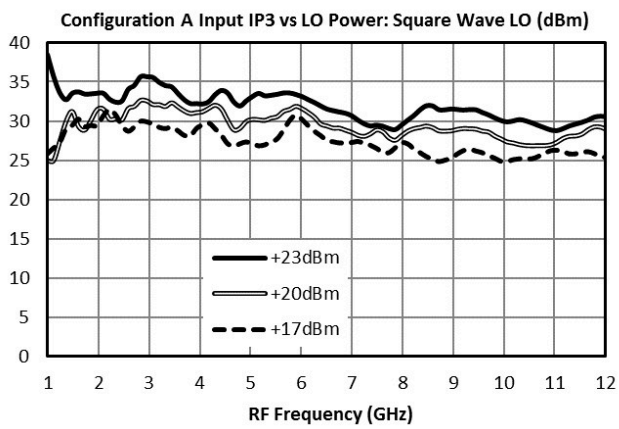
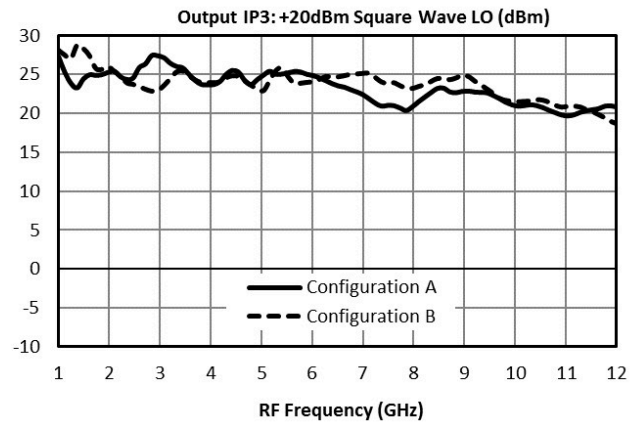
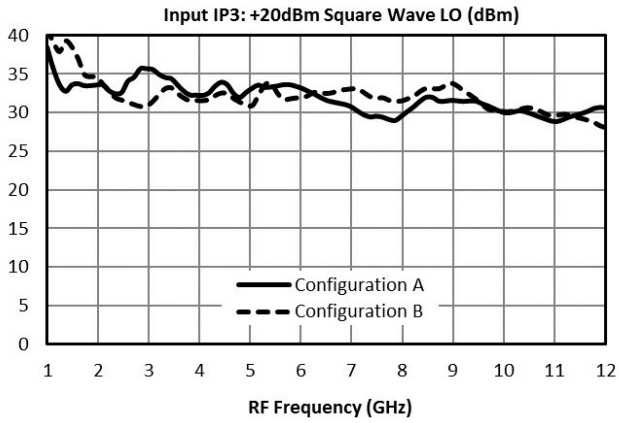




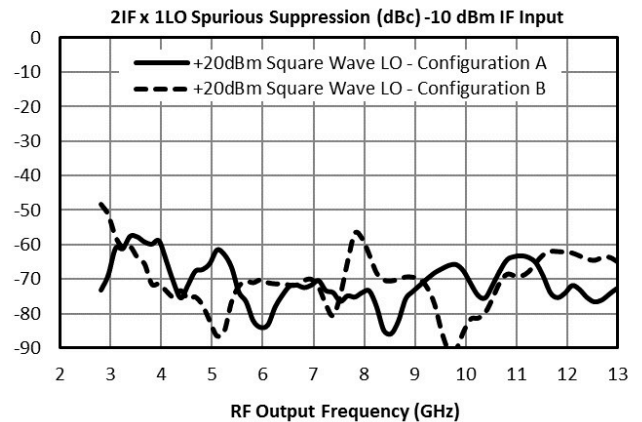
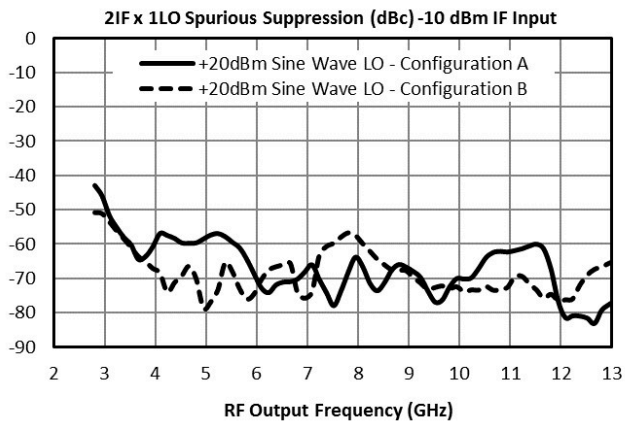
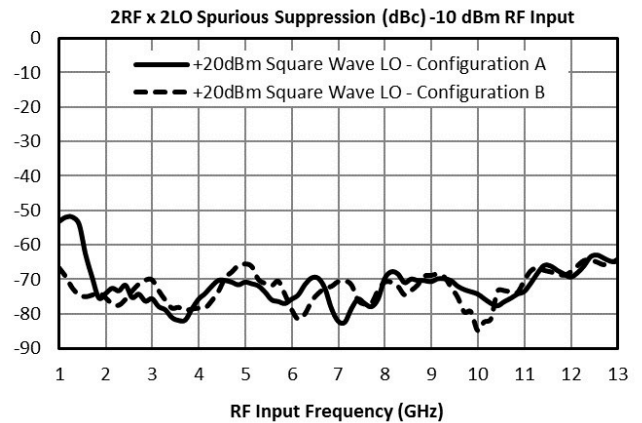
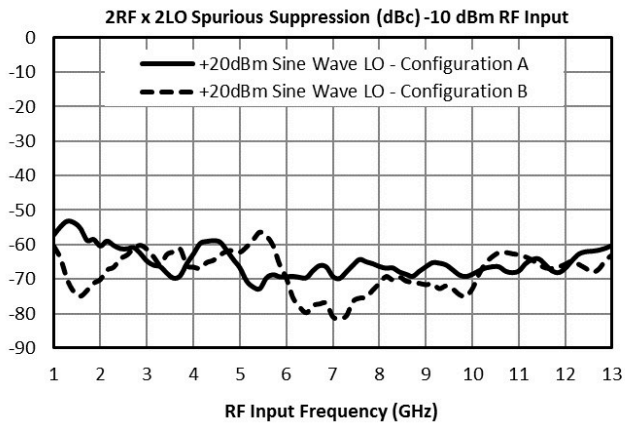
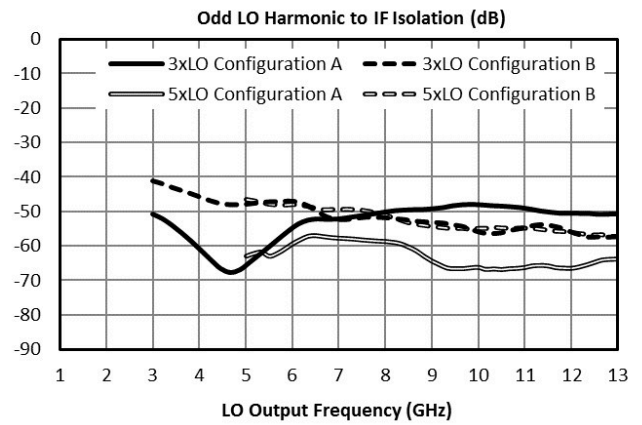
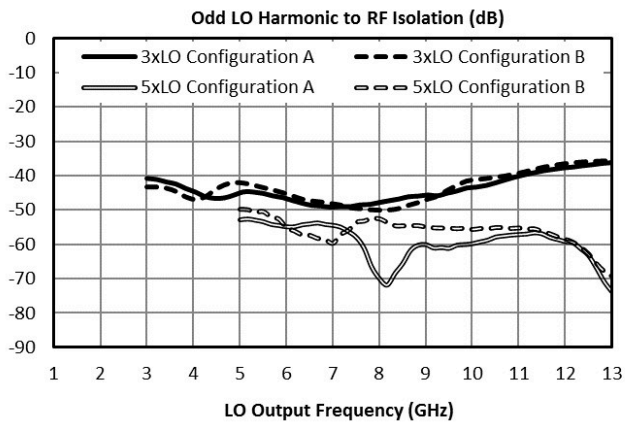
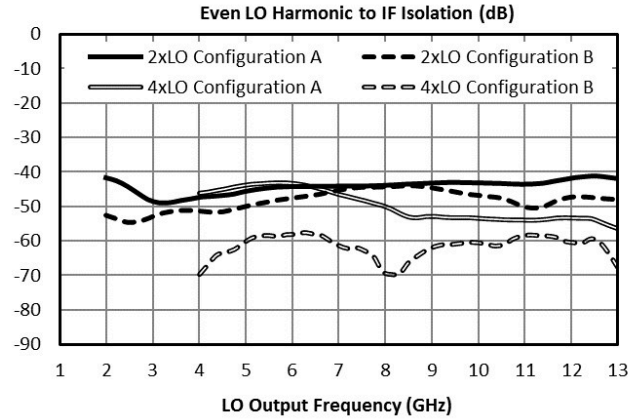
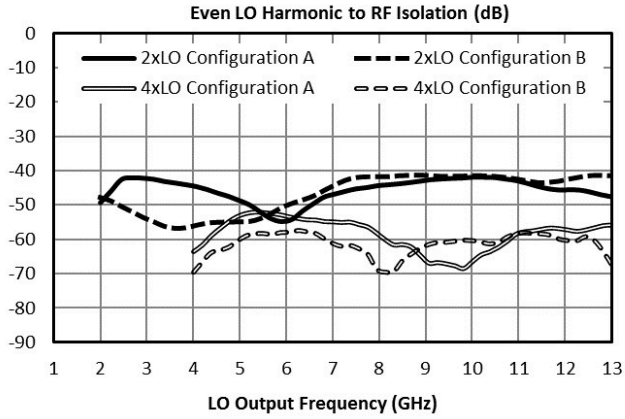
**Typical Performance Plots: IP3, Sine Wave LO**



**Typical Performance Plots: IP3, Square Wave LO**

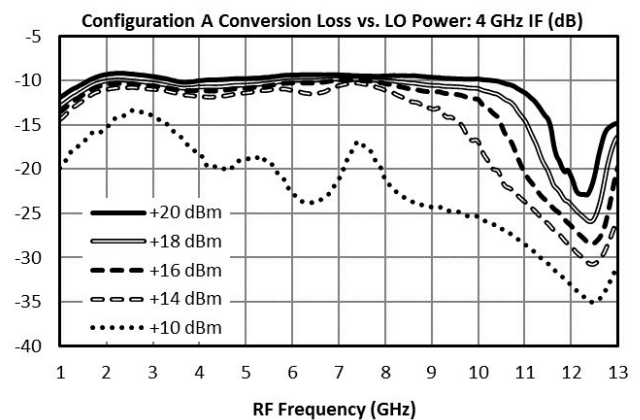
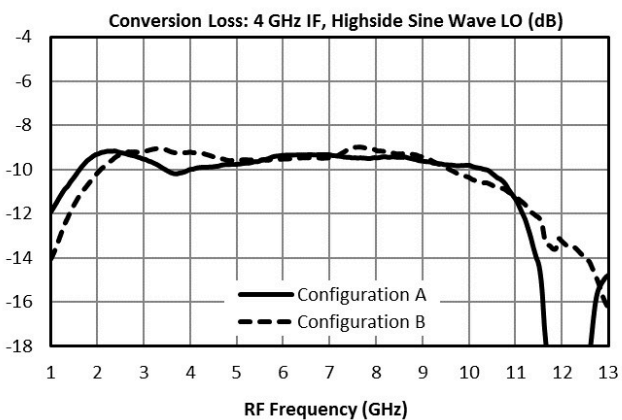
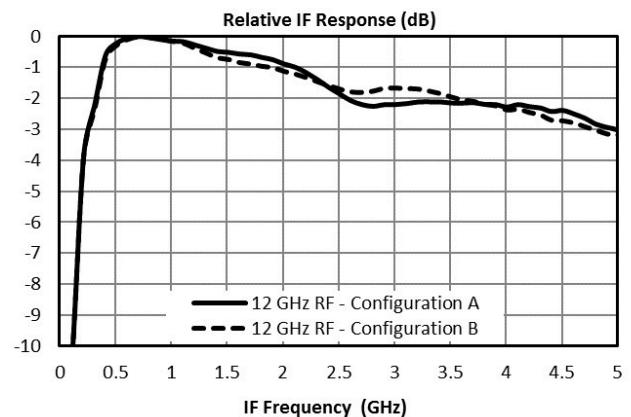
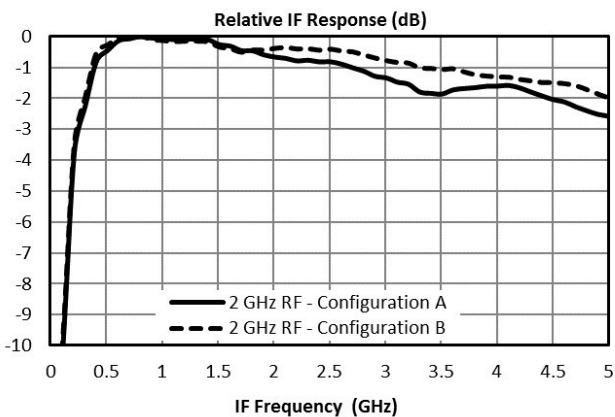
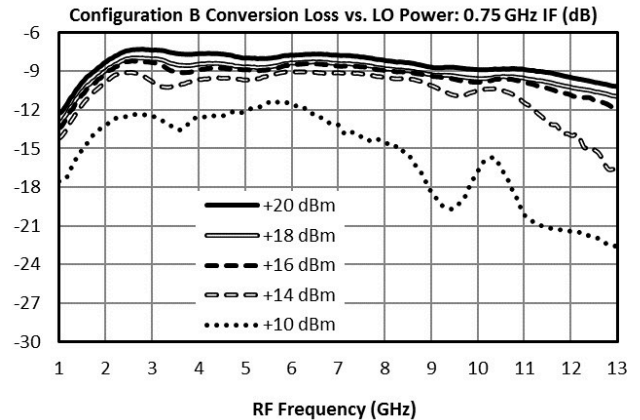
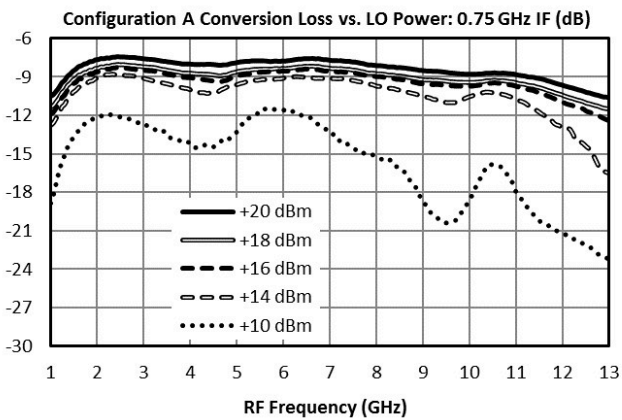
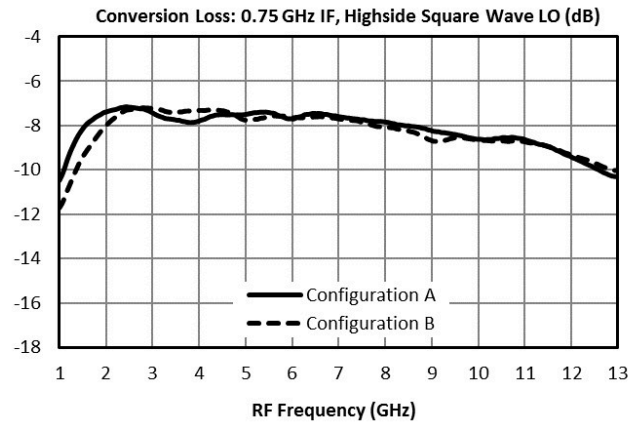
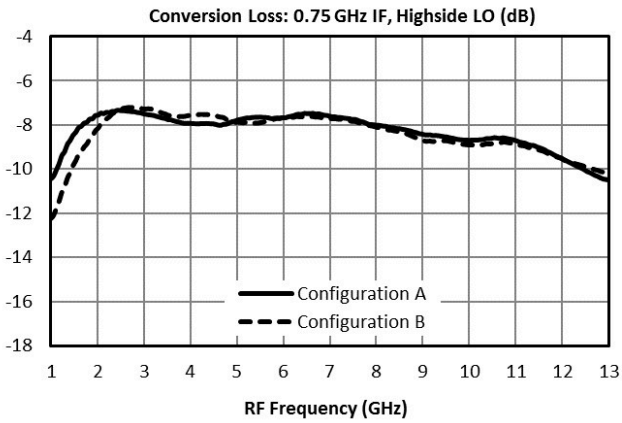


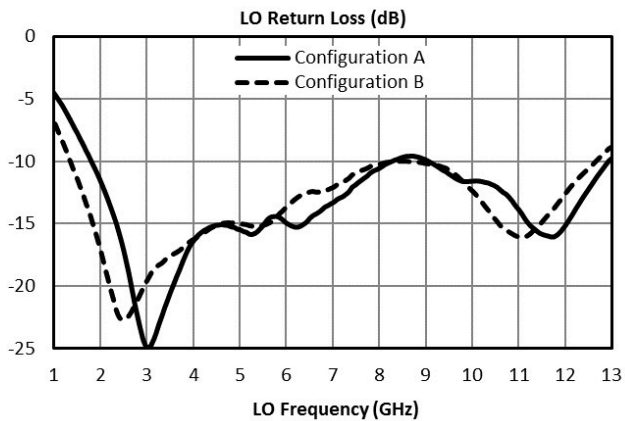
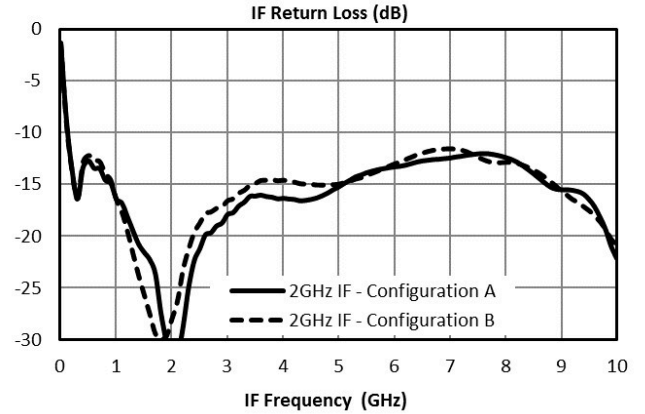
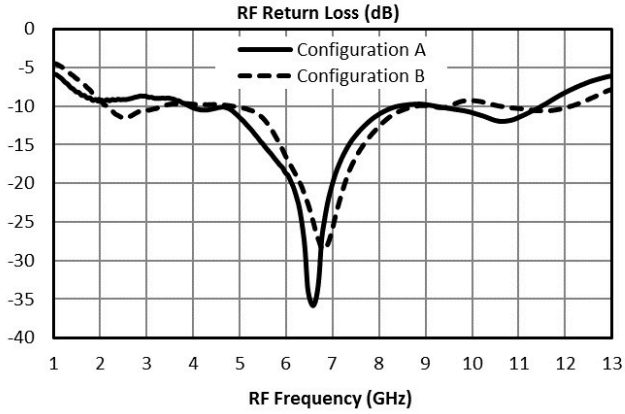
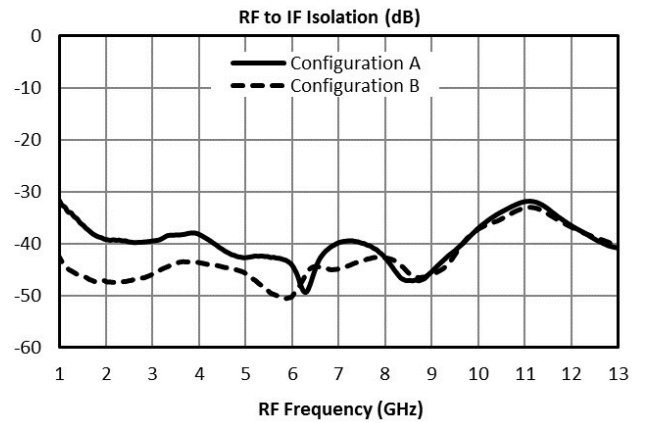
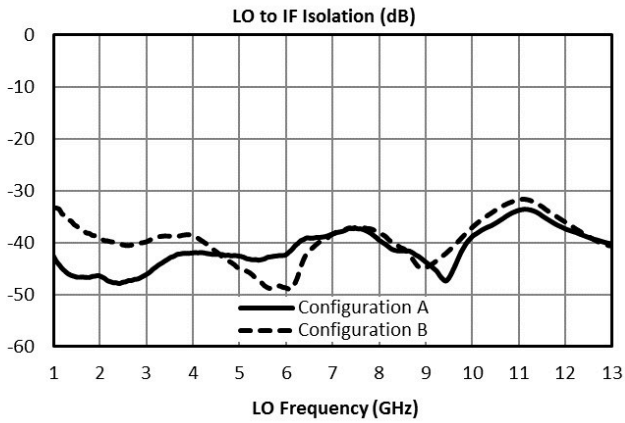
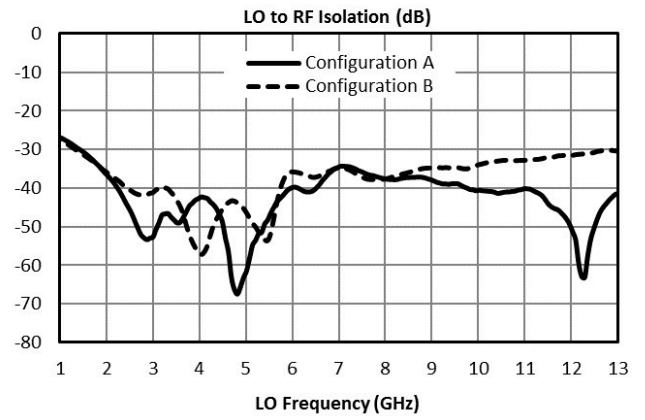
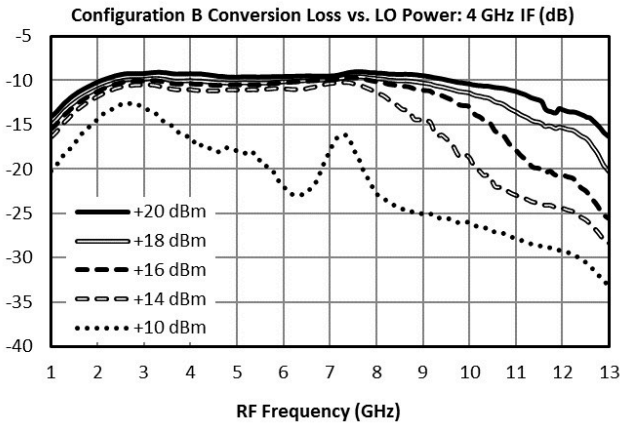
**Typical Performance Plots: LO Harmonic Isolation**



**MT3L-0113HS - Typical Performance Plots**

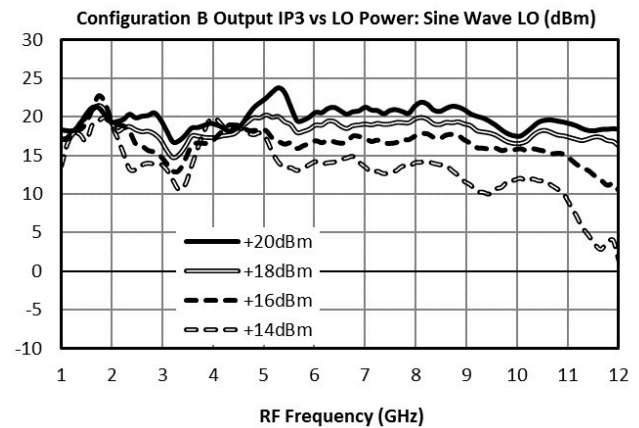
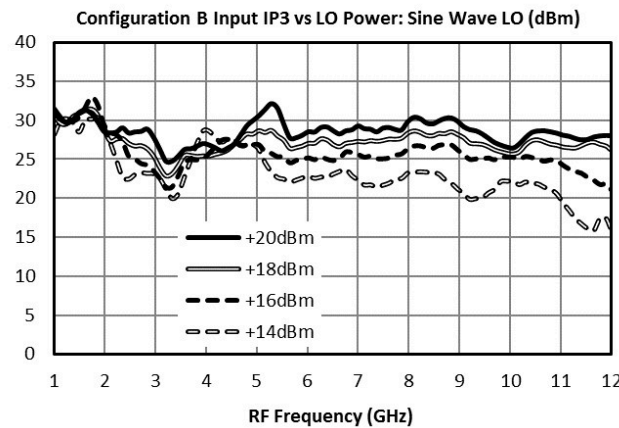
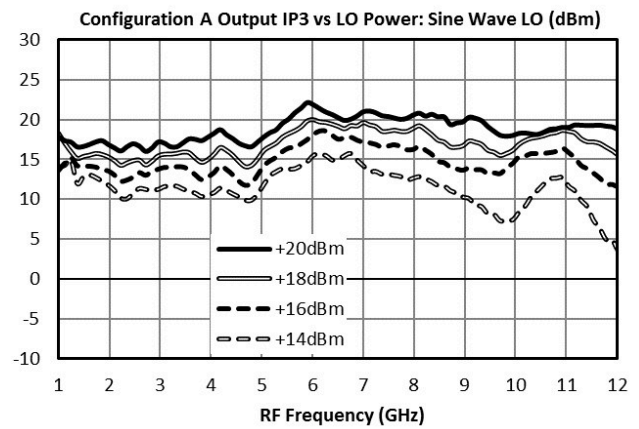
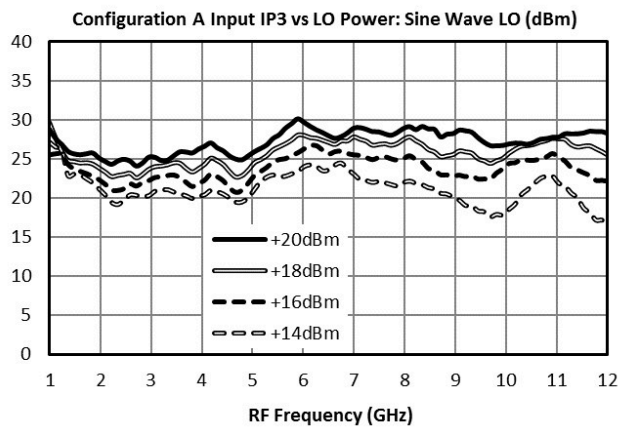
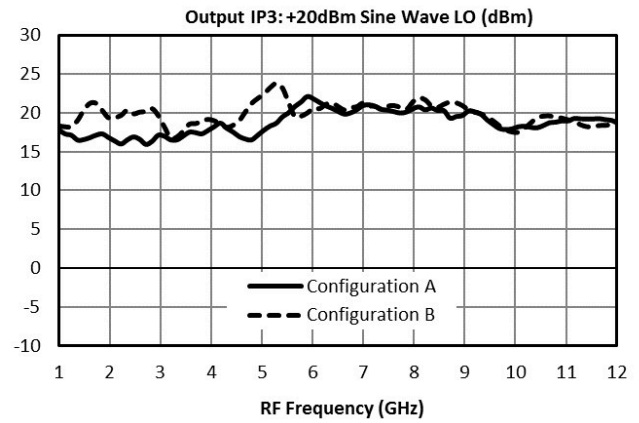
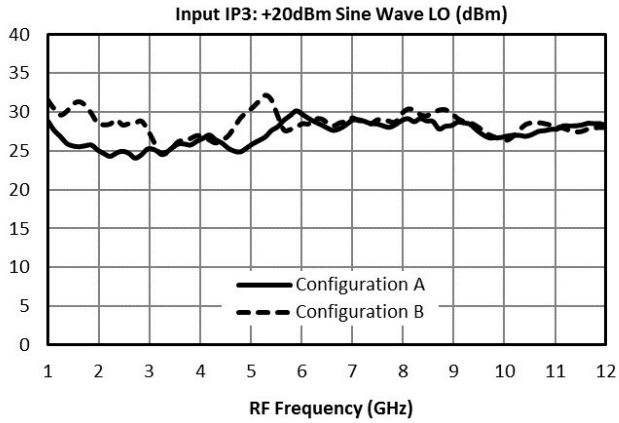
Performance plots for the connectorized module are shown for measurements where directly probed measurements of the die are unavailable. Note that the following measurements include losses from connectors and microstrip traces.





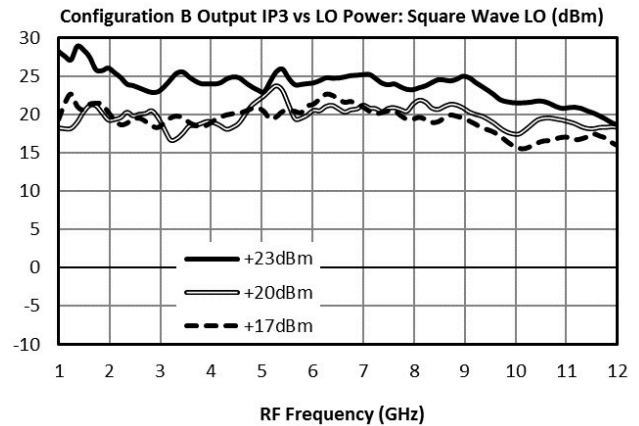
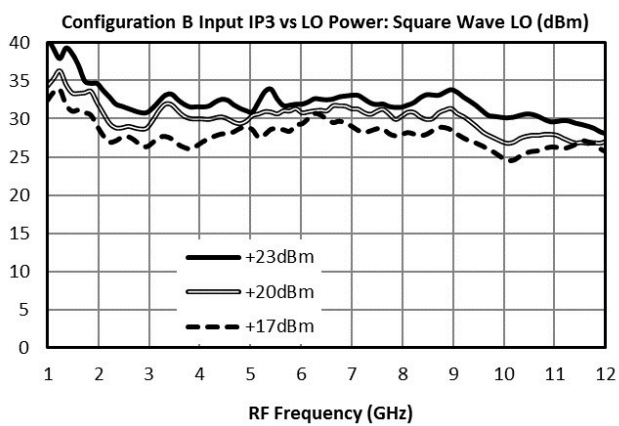
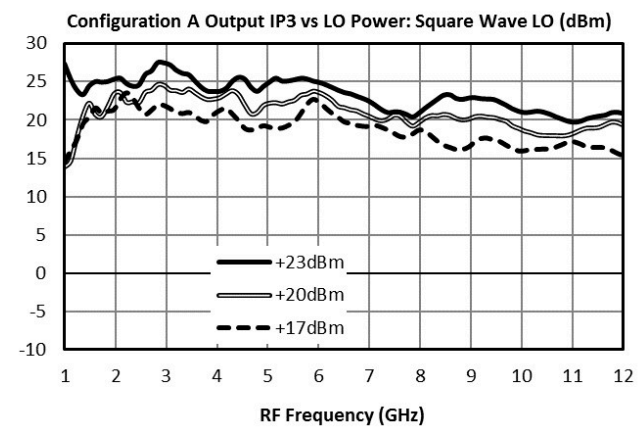
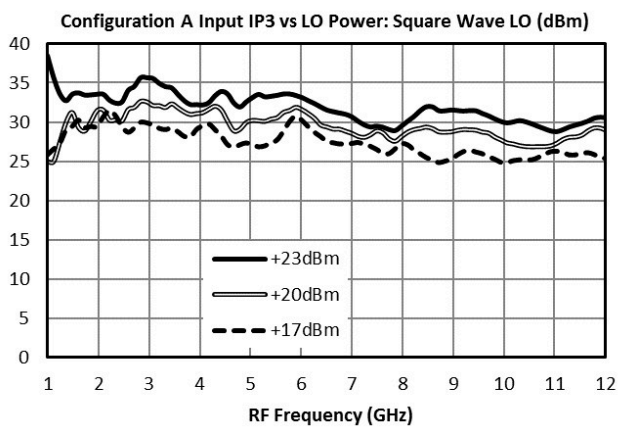
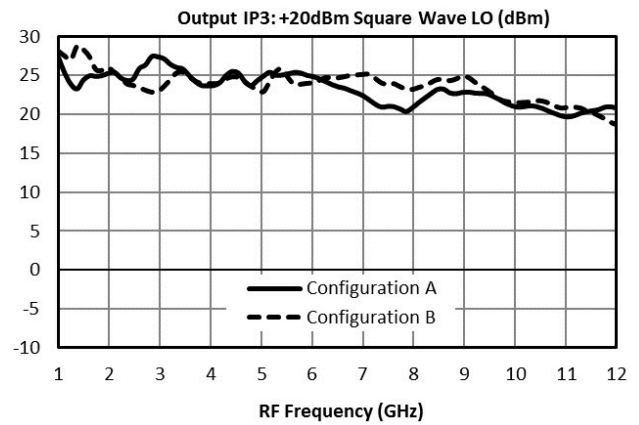
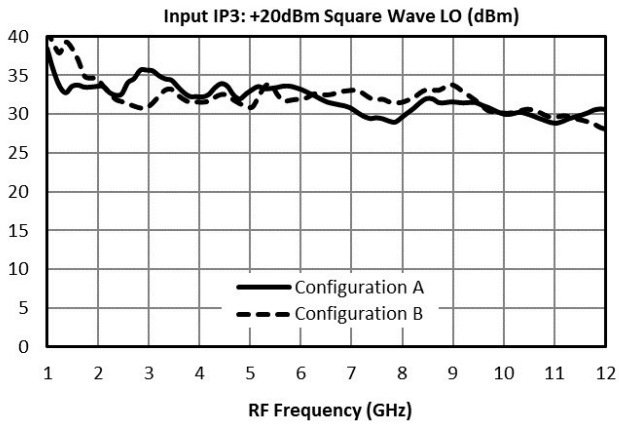
**MT3L-0113HS - Typical Performance Plots: IP3, Sine Wave LO**

Performance plots for the connectorized module are shown for measurements where directly probed measurements of the die are unavailable. Note that the following measurements include losses from connectors and microstrip traces.



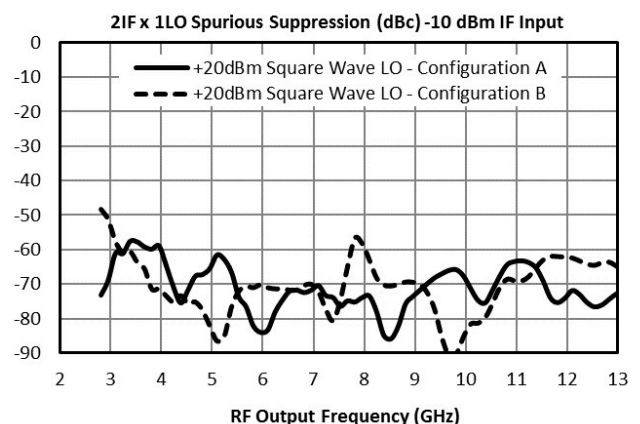
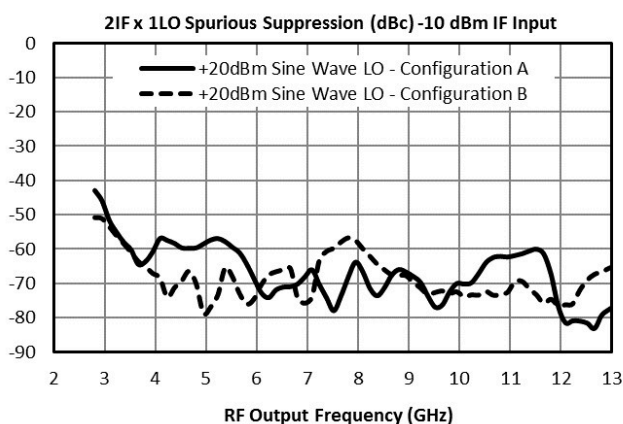
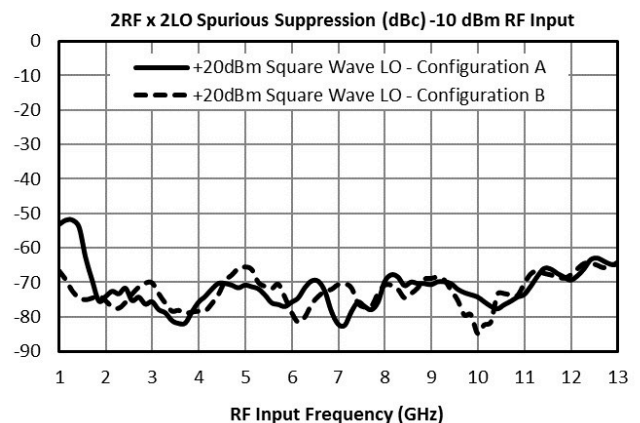
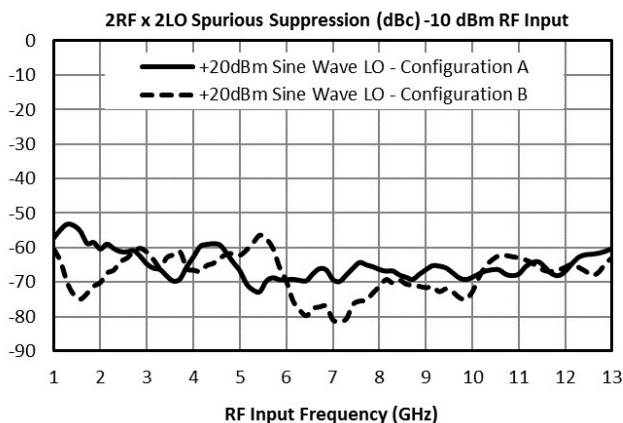
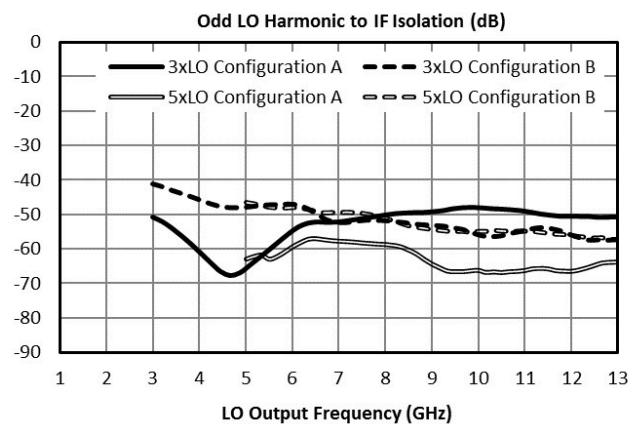
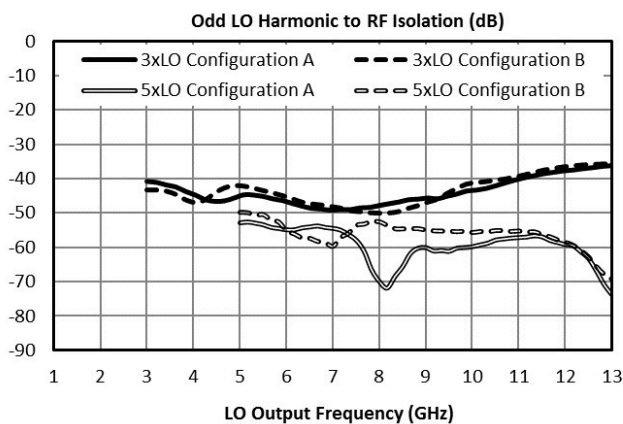
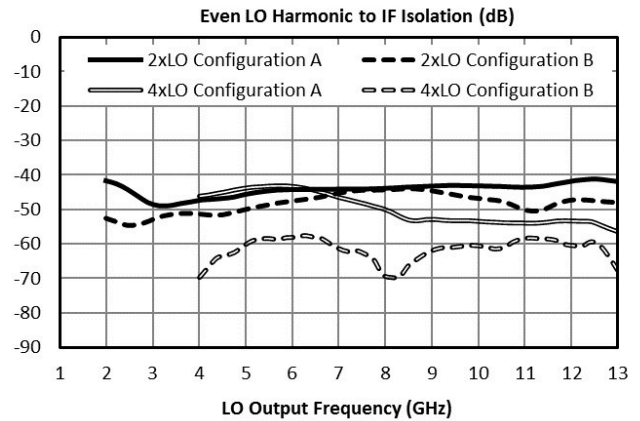
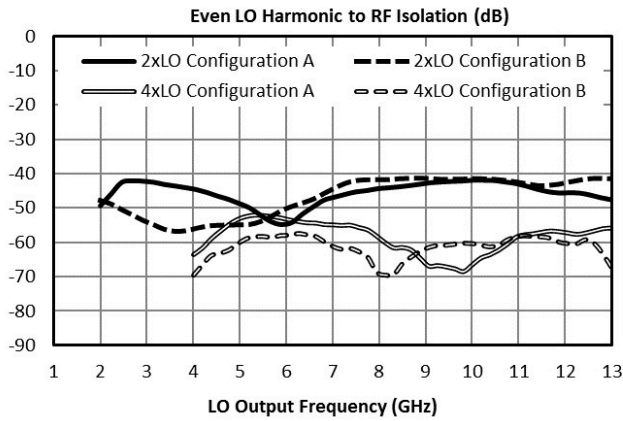
**MT3L-0113HS - Typical Performance Plots: IP3, Square Wave LO**

Performance plots for the connectorized module are shown for measurements where directly probed measurements of the die are unavailable. Note that the following measurements include losses from connectors and microstrip traces.



**MT3L-0113HS - Typical Performance Plots: LO Harmonic Isolation**

Performance plots for the connectorized module are shown for measurements where directly probed measurements of the die are unavailable. Note that the following measurements include losses from connectors and microstrip traces.



**Spur Table**

**Typical Spurious Performance: Down-Conversion**

Typical spurious data is provided by selecting RF and LO frequencies ( $\pm m \cdot LO \pm n \cdot RF$ ) within the RF/LO bands, to create a spurious output within the IF band. The mixer is swept across the full spurious band and the mean is calculated. The numbers shown in the table below are for a -10 dBm RF input. Spurious suppression is scaled for different RF power levels by (n-1), where “n” is the RF spur order. For example, the 2RF x 2LO spur is 63 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 73 dBc.

**Typical Down-conversion spurious suppression (dBc): Config A (B), Sine Wave LO**

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	30 (35)	Reference	42 (41)	18 (18)	35 (41)	21 (23)
2xRF	62 (62)	67 (66)	63 (66)	68 (63)	56 (58)	69 (64)
3xRF	111 (110)	82 (87)	98 (102)	80 (81)	101 (100)	138 (138)
4xRF	129 (128)	145 (145)	124 (127)	128 (129)	123 (123)	131 (129)
5xRF	165 (172)	147 (154)	159 (161)	148 (149)	159 (161)	145 (145)

**Typical Down-conversion spurious suppression (dBc): Config A (B), Square Wave LO**

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	29 (35)	Reference	37 (39)	13 (13)	37 (37)	18 (19)
2xRF	69 (62)	68 (69)	69 (70)	73 (71)	61 (64)	70 (73)
3xRF	109 (114)	94 (94)	106 (110)	91 (91)	107 (110)	137 (138)
4xRF	137 (141)	145 (145)	133 (137)	140 (140)	133 (137)	138 (137)
5xRF	173 (174)	158 (163)	167 (170)	162 (163)	171 (167)	161 (162)

**Typical Spurious Performance: Up-Conversion**

Typical spurious data is taken by mixing an input within the IF band, with LO frequencies ( $\pm m \cdot LO \pm n \cdot IF$ ), to create a spurious output within the RF output band. The mixer is swept across the full spurious output band and the mean is calculated. The numbers shown in the table below are for a -10 dBm IF input. Spurious suppression is scaled for different IF input power levels by (n-1), where “n” is the IF spur order. For example, the 2IFx1LO spur is typically 64 dBc for a -10 dBm input with a sine-wave LO, so a -20 dBm IF input creates a spur that is (2-1) x (-10 dB) lower, or 74 dBc.

**Typical Up-conversion spurious suppression (dBc): Config A (B), Sine Wave LO**

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	23 (30)	Reference	42 (41)	19 (17)	39 (43)	22 (21)
2xIF	71 (63)	64 (67)	60 (57)	57 (59)	63 (59)	52 (57)
3xIF	102 (101)	85 (85)	100 (99)	85 (81)	94 (100)	81 (79)
4xIF	135 (131)	127 (128)	127 (123)	122 (120)	124 (121)	115 (117)
5xIF	163 (153)	150 (156)	161 (157)	151 (149)	155 (154)	144 (146)

**Typical Up-conversion spurious suppression (dBc): Config A (B), Square Wave LO**

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	23 (30)	Reference	37 (36)	13 (13)	37 (37)	18 (19)
2xIF	71 (63)	64 (67)	58 (59)	73 (71)	61 (64)	70 (73)
3xIF	102 (101)	89 (90)	105 (110)	91 (91)	107 (110)	137 (138)
4xIF	135 (131)	127 (128)	130 (133)	140 (140)	133 (137)	138 (137)
5xIF	163 (153)	150 (156)	172 (174)	162 (163)	171 (167)	161 (162)

## Die Mounting Recommendations

### Mounting and Bonding Recommendations

Marki MMICs should be attached directly to a ground plane with conductive epoxy. The ground plane electrical impedance should be as low as practically possible. This will prevent resonances and permit the best possible electrical performance. Datasheet performance is only guaranteed in an environment with a low electrical impedance ground.

**Mounting** - To epoxy the chip, apply a minimum amount of conductive epoxy to the mounting surface so that a thin epoxy fillet is observed around the perimeter of the chip. Cure epoxy according to manufacturer instructions.

**Wire Bonding** - Ball or wedge bond with 0.025 mm (1 mil) diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150 °C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Use the minimum level of ultrasonic energy to achieve reliable wirebonds. Wirebonds should be started on the chip and terminated on the package or substrate. All bonds should be as short as possible <0.31 mm (12 mils).

**Circuit Considerations** – 50 Ω transmission lines should be used for all high frequency connections in and out of the chip. Wirebonds should be kept as short as possible, with multiple wirebonds recommended for higher frequency connections to reduce parasitic inductance. In circumstances where the chip more than .001” thinner than the substrate, a heat spreading spacer tab is optional to further reduce bondwire length and parasitic inductance.

### **Mounting and Bonding Recommendations**

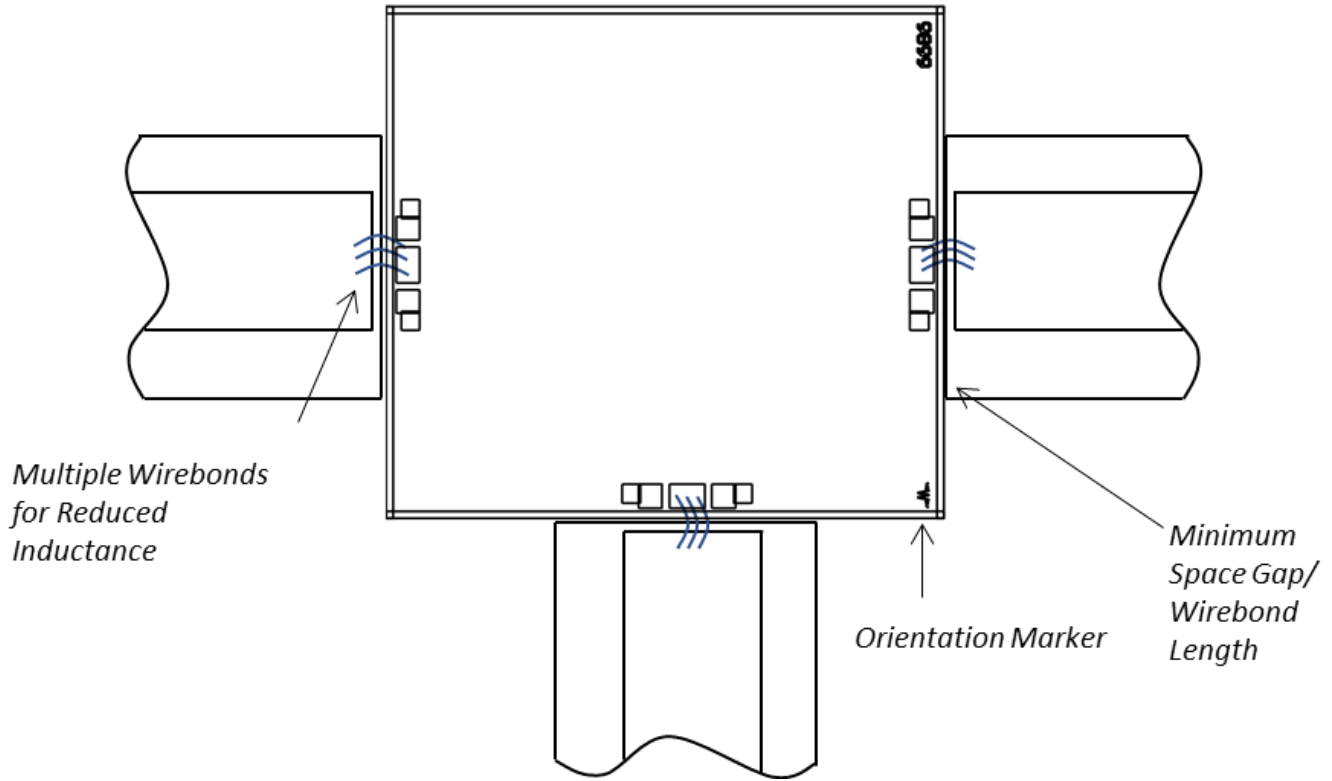
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**Bonding Diagram**





**DISCLAIMER**

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