

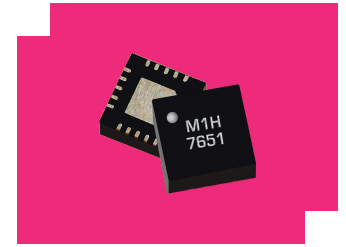
MM1-0115HPSM-2

GaAs MMIC Double Balanced Mixer

DEVICE OVERVIEW

General Description

The MM1-0115HPSM is a GaAs MMIC double balanced mixer that features excellent conversion loss, superior isolations and spurious performance across a broad bandwidth. MM1-0115HPSM works well as both an up and down converter through Ku band. The MM1-0115HPSM is recommend for moderate power applications that demand high linearity. The MM1-0115HPSM is available in a 4x4 mm QFN package. Evaluation boards are also available.



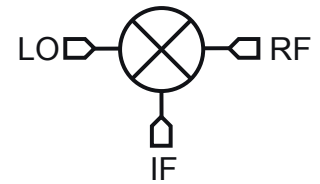
Features

RF/LO response: 1GHz - 15GHz
 IF response: DC – 2.5 GHz
 Conversion Loss: 8.0dB
 LO to RF Isolation: 52dB

Applications

- Test and Measurement Equipment
- SATCOM
- Radar
- Electronic Warfare

Functional Block Diagram



Part Ordering Options

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
MM1-0115HPSM-2	GaAs MMIC Double Balanced Mixer	QFN	REACH RoHS	Released	EAR99
EVB-MM1-0115HP	Evaluation Board, GaAs MMIC Double Balanced Mixer	EVB	REACH RoHS	Released	EAR99

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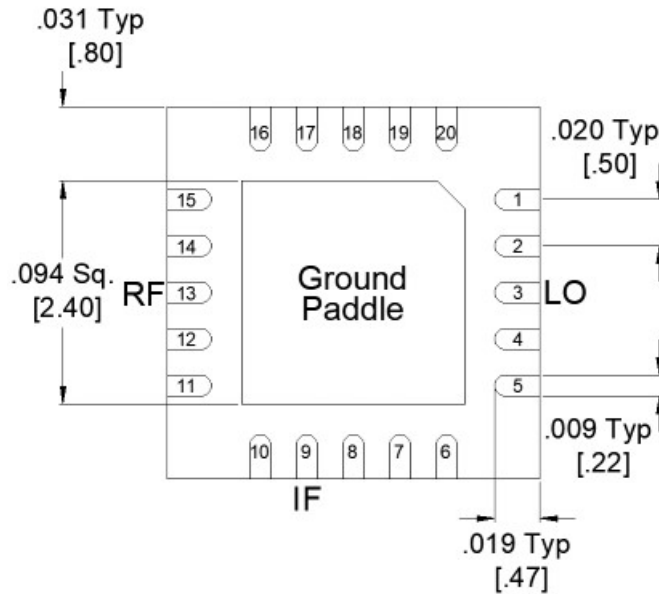
Revision History

Revision Code	Revision Date	Comment
-	2022-10-01	Datasheet Initial Release

Port Configuration and Functions


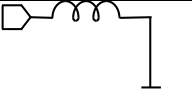
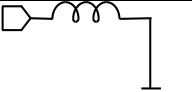
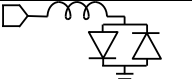
Port Diagram

A bottom-up view of the MM1-0115HPSM's PSM package outline drawing is shown below. The MM1-0115HPSM has the input and output ports given in Port Functions. The MM1-0115HPSM can be used in either an up or down conversion. For configuration A, input the LO into pin 3, use pin 13 for the RF, and port 9 for the IF. For configuration B, input the LO into pin 13, use pin 3 for the RF, and pin 9 for the IF.

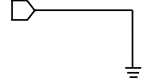
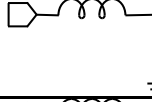

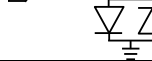


Port Functions

Configuration A

Port	Function	Description	Equivalent Circuit for Package
GND	Ground	SM package ground path is provided through the ground paddle.	
Pin 13	RF	Pin 13 is DC short and AC matched to 50 Ohms from 1 to 15 GHz. Blocking capacitor is optional.	
Pin 3	LO	Pin 3 is DC short and AC matched to 50 Ohms from 1 to 15 GHz. Blocking capacitor is optional.	
Pin 9	IF	Pin 9 is DC coupled to the diodes. Blocking capacitor is optional.	

Configuration B

Port	Function	Description	Equivalent Circuit for Package
GND	Ground	SM package ground path is provided through the ground paddle.	
Pin 13	LO	Pin 13 is DC short and AC matched to 50 Ohms from 1 to 15 GHz. Blocking capacitor is optional.	
Pin 3	RF	Pin 3 is DC short and AC matched to 50 Ohms from 1 to 15 GHz. Blocking capacitor is optional.	
Pin 9	IF	Pin 9 is DC coupled to the diodes. Blocking capacitor is optional.	

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
Pin 13 DC Current	30	mA
Pin 3 DC Current	30	mA
Pin 9 DC Current	30	mA
Power Handling, at any Port	33	dBm

Package Information

Parameter	Details	Rating
ESD	250 to < 500 Volts	HBM Class 1A
Weight	Package name: QFN	0.042g
Dimensions	-	4 x 4 mm
Moisture Sensitivity Level	-	MSL 1

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	13	17	21	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

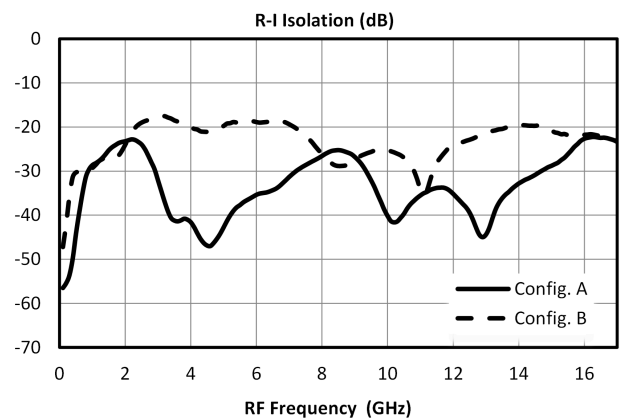
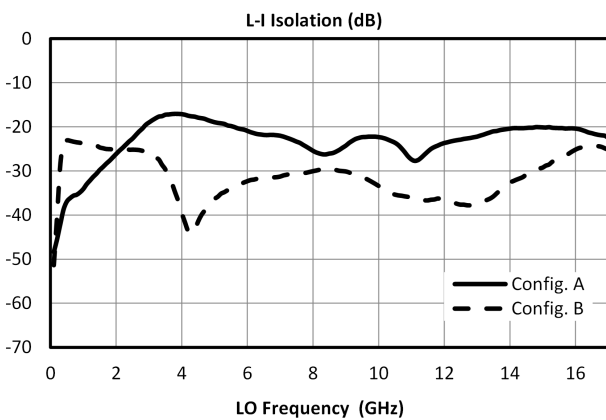
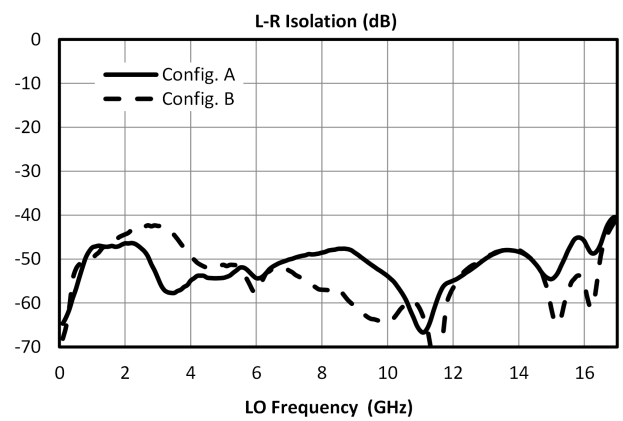
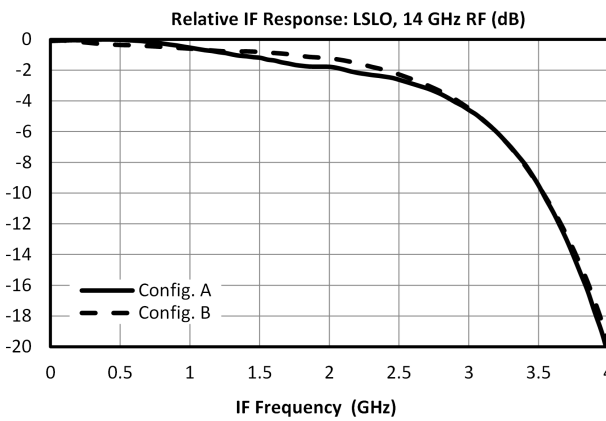
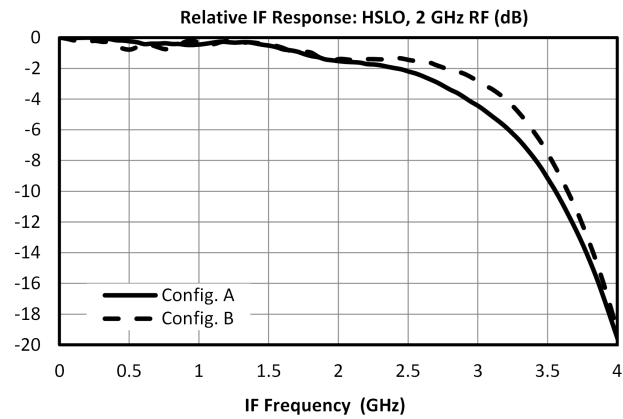
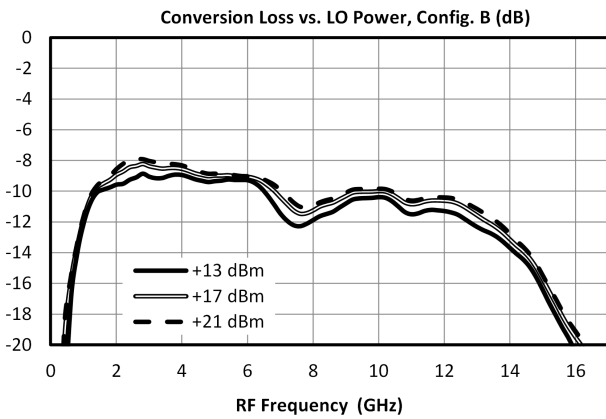
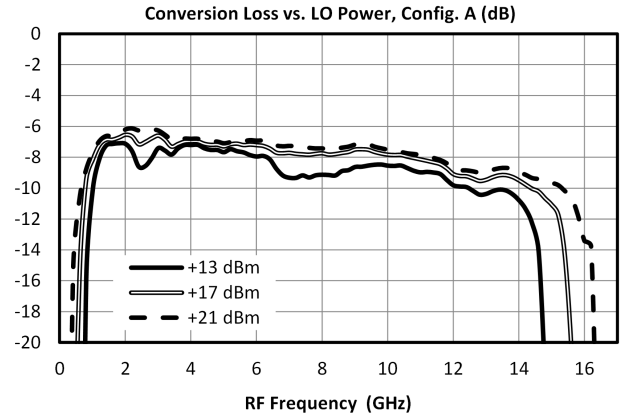
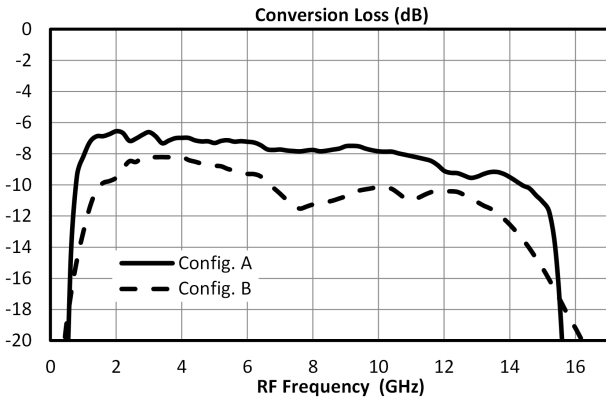
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +17dBm sine wave LO input.

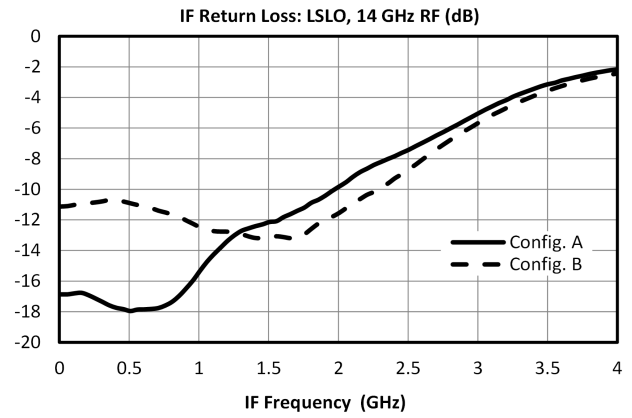
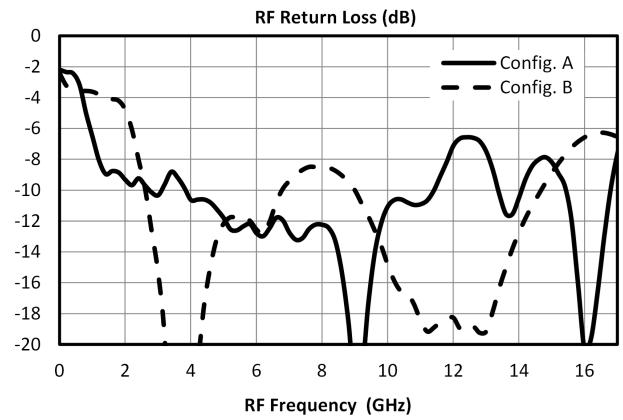
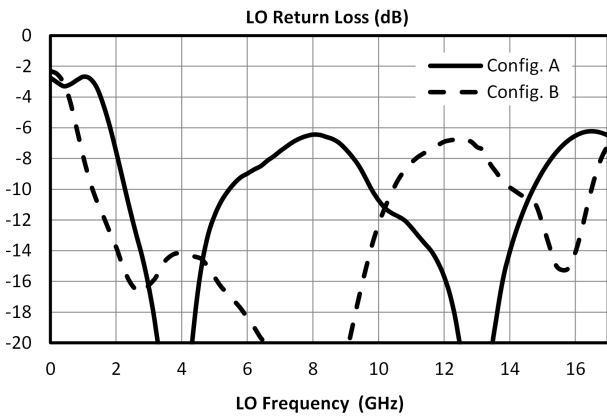
Parameter	Port Configuration	Test Conditions	Min	Typ	Max	Unit
Conversion Loss ¹	A	RF/LO = 1 - 15 GHz I = 0.2 - 2.5 GHz	-	9	-	dB
Conversion Loss ²	A	RF/LO = 1 - 15 GHz I = DC - 0.2 GHz	-	8	14	dB
Input 1 dB Gain Compression Point (P1dB)	A	-	-	10	-	dBm
Input IP3	A	RF/LO = 1 - 15 GHz I = DC - 0.2 GHz	-	21	-	dBm
Isolation, LO to IF	A	IF/LO = 1 - 15 GHz	-	23	-	dB
Isolation, LO to RF	A	RF/LO = 1 - 15 GHz	-	52	-	dB
Isolation, RF to IF	A	RF/IF = 1 - 15 GHz	-	34	-	dB
Noise Figure ³	A	RF/LO = 1 - 15 GHz I = DC - 0.2 GHz	-	8	-	dB
Conversion Loss ⁴	B	RF/LO = 1 - 15 GHz I = 0.2 - 2.5 GHz	-	11.5	-	dB
Conversion Loss ⁵	B	RF/LO = 1 - 15 GHz I = DC - 0.2 GHz	-	10.5	18.5	dB
Input 1 dB Gain Compression Point (P1dB)	B	-	-	13	-	dBm
Input IP3	B	RF/LO = 1 - 15 GHz I = DC - 0.2 GHz	-	24	-	dBm
Isolation, LO to IF	B	IF/LO = 1 - 15 GHz	-	32	-	dB
Isolation, LO to RF	B	RF/LO = 1 - 15 GHz	-	54	-	dB
Isolation, RF to IF	B	RF/IF = 1 - 15 GHz	-	23	-	dB
Noise Figure ⁶	B	RF/LO = 1 - 15 GHz I = DC - 0.2 GHz	-	10.5	-	dB
IF Frequency Range	-	-	0	-	2.5	GHz
LO Frequency Range	-	-	1	-	15	GHz
RF Frequency Range	-	-	1	-	15	GHz

[1][2][4][5] Measured as a down converter to a fixed 91MHz IF.

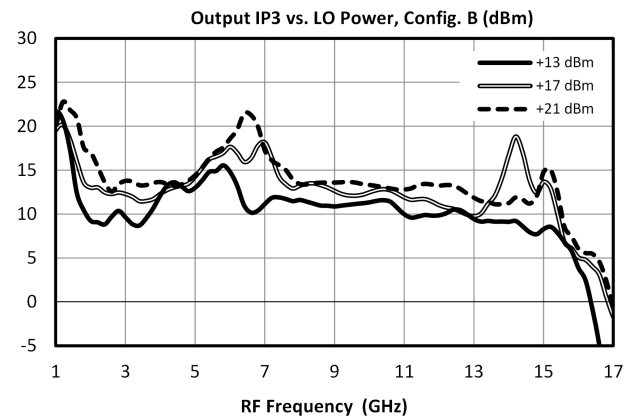
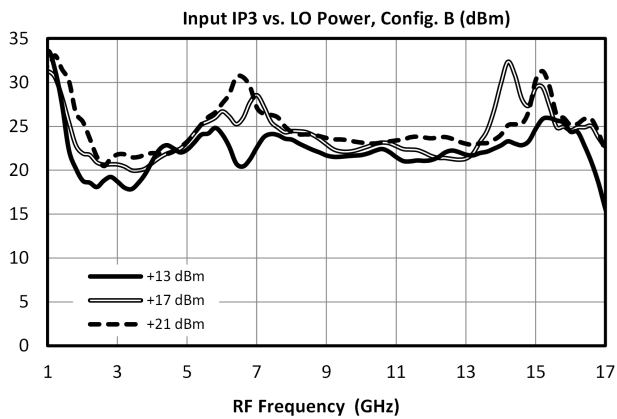
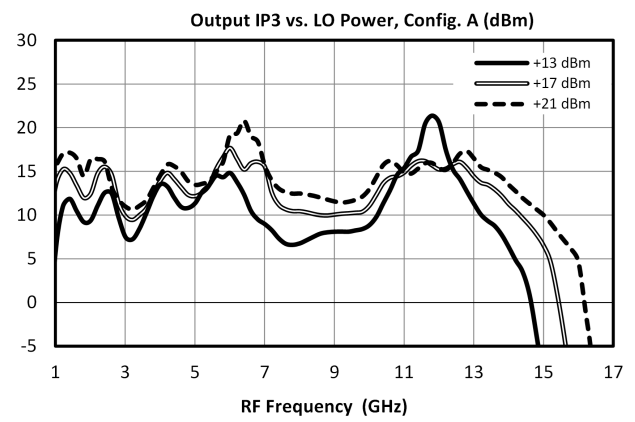
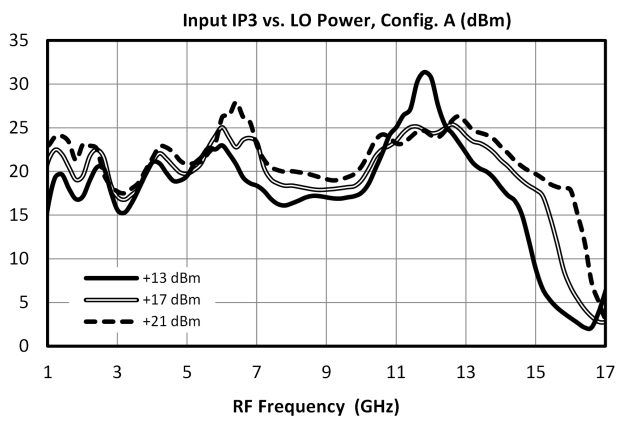
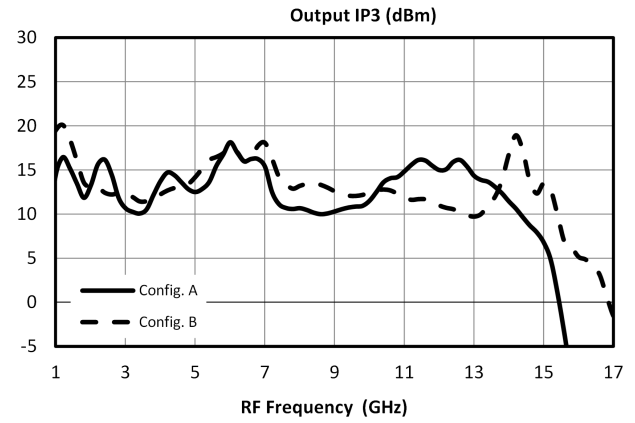
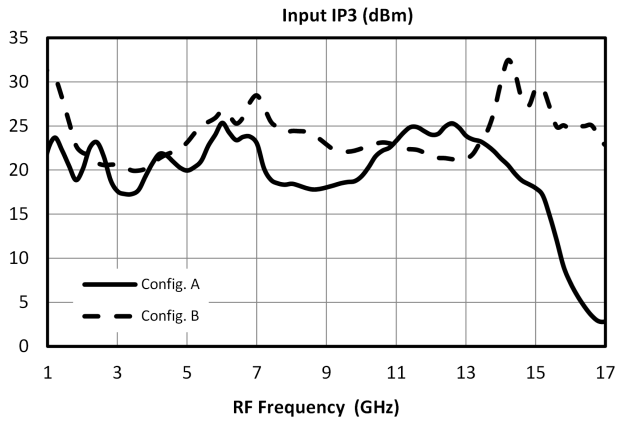
[3][6] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

Typical Performance Plots

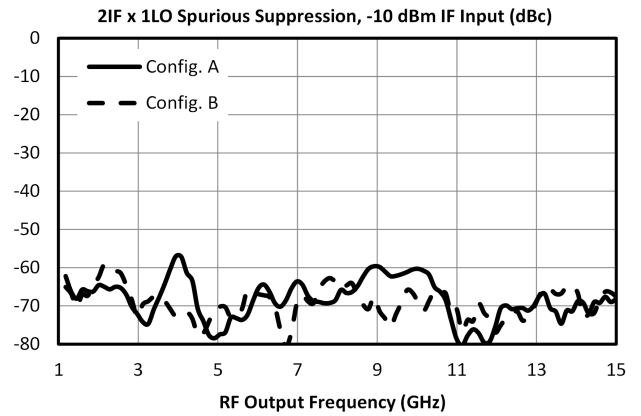
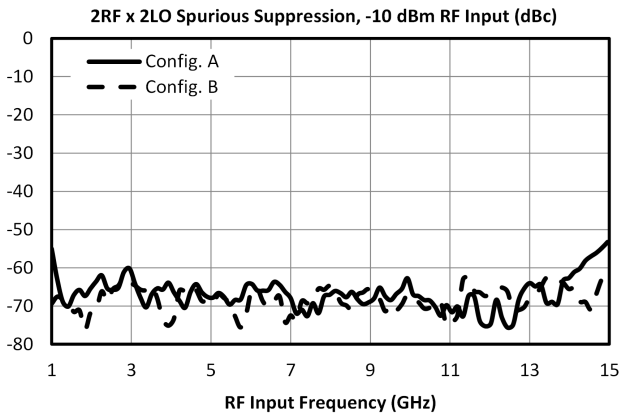
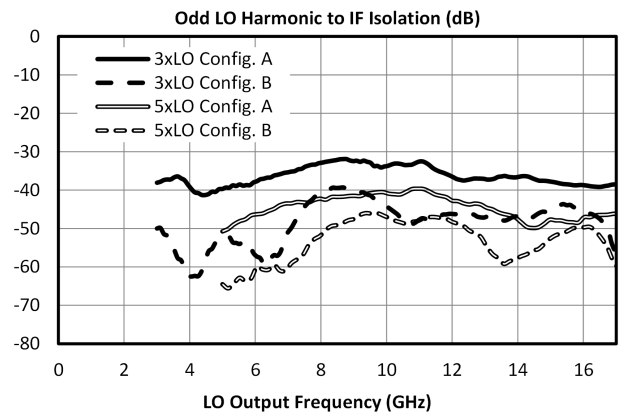
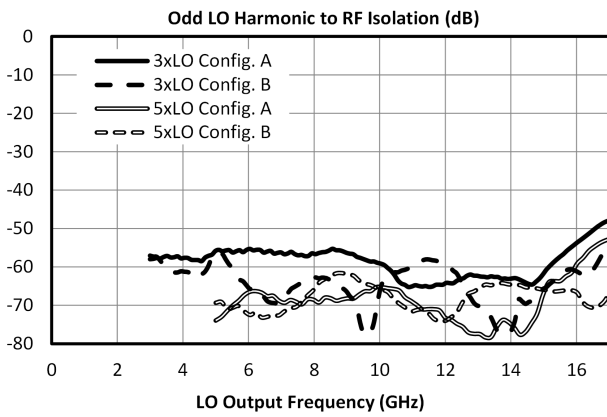
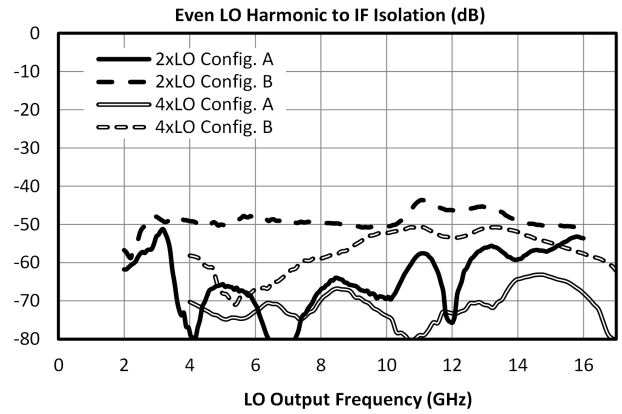
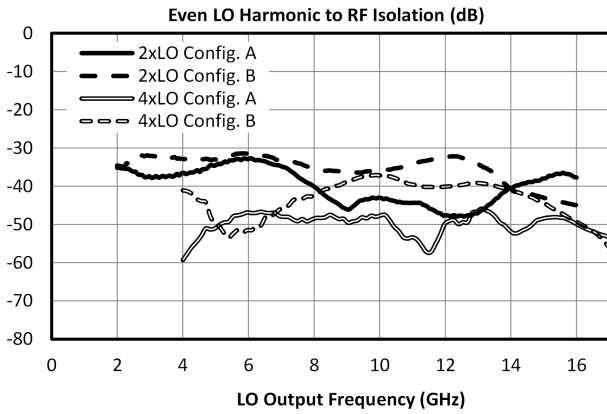




Typical Performance Plots: IP3



Typical Performance Plots: LO Harmonic Isolation



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 72 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 82 dBc. Data is shown for the frequency plan in 3.6 Typical Performance. mLOx0RF plots can be found in section 3.6.2 Typical Performance Plots: LO Harmonic Isolation. 0LOx1RF plot is identical to the plot of LO-RF isolation.

Typical Down-conversion spurious suppression (dBc): Config A (B)

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	20 (12)	Reference	26 (31)	12 (11)	36 (42)	20 (19)
2xRF	72 (77)	53 (55)	72 (78)	55 (60)	72 (77)	59 (58)
3xRF	85 (85)	61 (69)	76 (92)	74 (72)	80 (78)	66 (79)
4xRF	N/A	98 (110)	110 (116)	101 (108)	109 (105)	100 (110)
5xRF	N/A	111 (123)	119 (129)	115 (123)	120 (128)	118 (126)

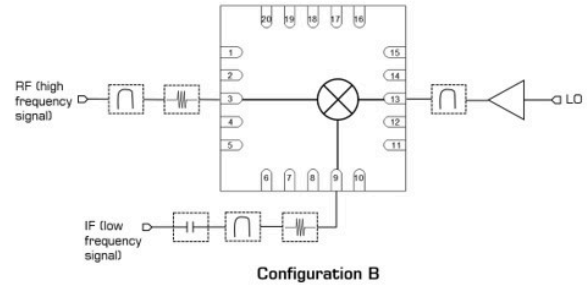
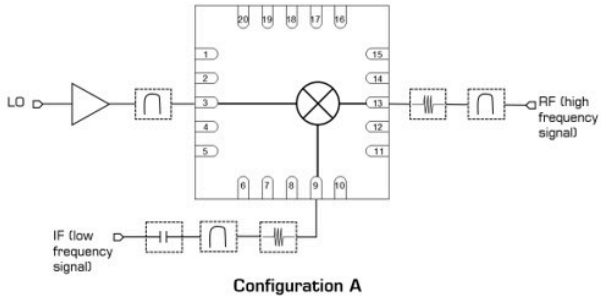
Typical Spurious Performance: Up-Conversion

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 73 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 83 dBc. Data is shown for the frequency plan in 3.6 Typical Performance.

Typical Up-conversion spurious suppression (dBc): Config A (B)

-10 dBm IF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	20 (12)	Reference	27 (31)	12 (10)	34 (42)	21 (18)
2xIF	53 (55)	73 (72)	60 (58)	68 (73)	54 (53)	66 (68)
3xIF	87 (98)	73 (71)	77 (84)	63 (65)	78 (82)	62 (63)
4xIF	94 (107)	113 (116)	98 (96)	105 (111)	87 (92)	100 (105)
5xIF	115 (133)	110 (113)	120 (127)	104 (108)	111 (121)	96 (103)

Application Circuit



Application Circuit Description

Ports Operation

IF Port – Used as input on an upconversion, output on downconversion, or LO port in a band shifting application. Signals should be connected by 50 ohm microstrip or coplanar traces to well matched broadband 50 ohm sources and loads. Blocking capacitor is recommended if DC voltage is present on the line.

RF Port – Used as input on a downconversion, output on upconversion, or output in a band shifting application. Signals should be connected by 50 ohm microstrip or coplanar traces to well matched broadband 50 ohm sources and loads.

Filtering and Matching- Filtering is generally desired for spurious and image removal on the output port of the mixer. Reflective filters can cause out of band signals to reflect back into the mixer and cause conversion loss ripple, erroneous spurs, and other undesired behaviors. To eliminate these problems it is recommend that the filters be placed as close to the output port as possible. If undesired behavior is still observed, a diplexer with one port terminated or a 1-3 dB attenuator may reduce this problem.

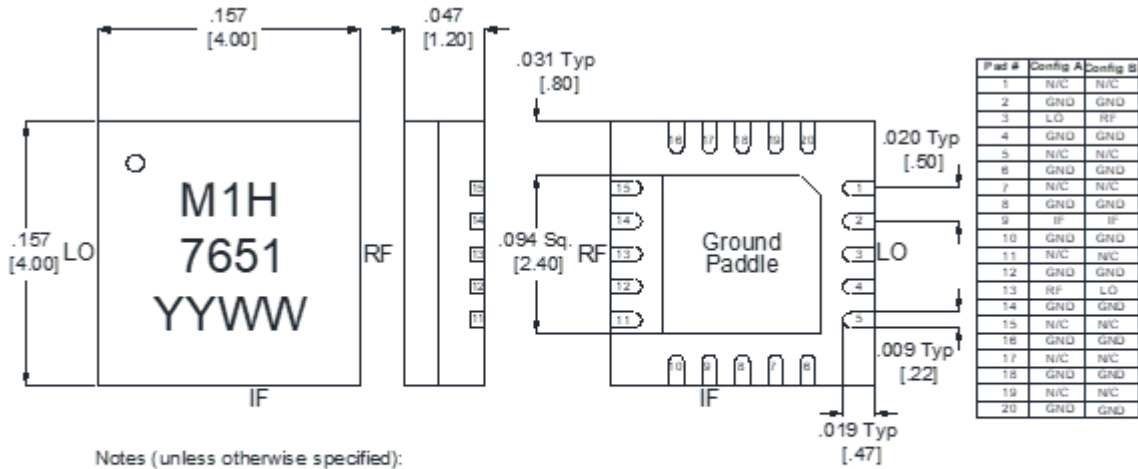
RF Ground – The ground paddle of the QFN should be connected to a low noise RF ground with very low electrical resistance for high frequency operation.

LO Port – The noise floor of the LO input signal should be less than the value of the noise floor plus isolation of the mixer, or a filter is recommended to prevent reduction in dynamic range. An LO amplifier is required if the LO power is below the recommended drive level. It is important to use an amplifier with a broadband 50 ohm match such that it does not reflect spurious signals back into the mixer or other system circuitry.

Mechanical Data

Outline Drawing

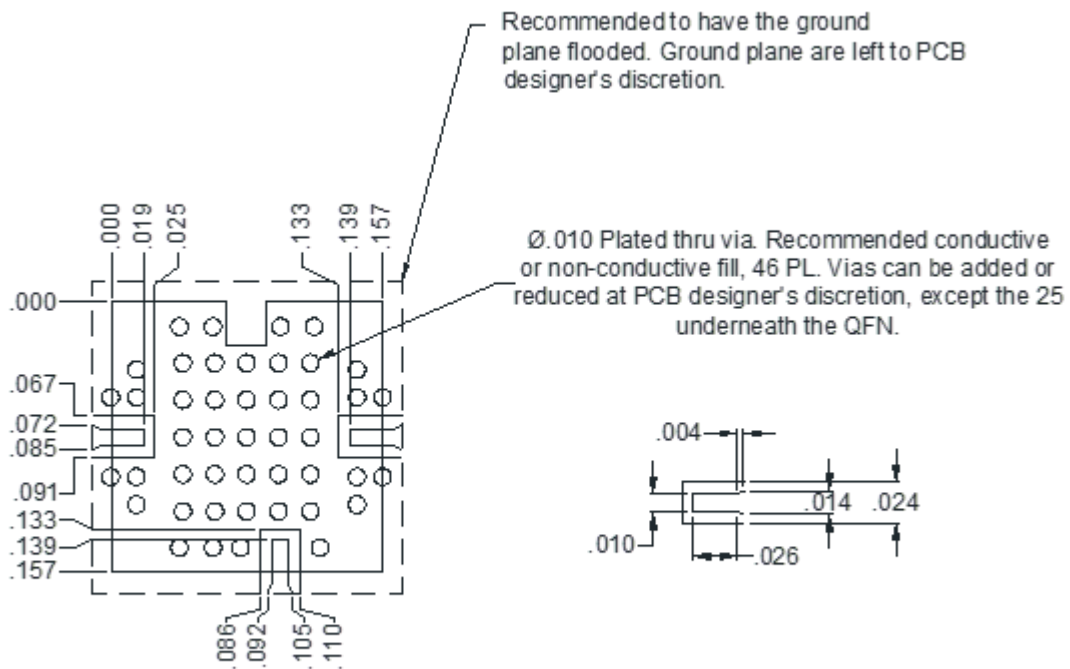
Download : [Outline 2D Drawing](#) | [Outline 3D Drawing](#) | [Outline 3D STP](#)



- Notes (unless otherwise specified):
1. Substrate material is LCP.
 2. I/O Leads and QFN Paddle are:
0.008 - 0.05 microns Gold, over
0.08 - 0.15 microns Palladium, over
0.5 - 2.0 microns Nickel
 3. Ground all unconnected pins to PCB RF ground.

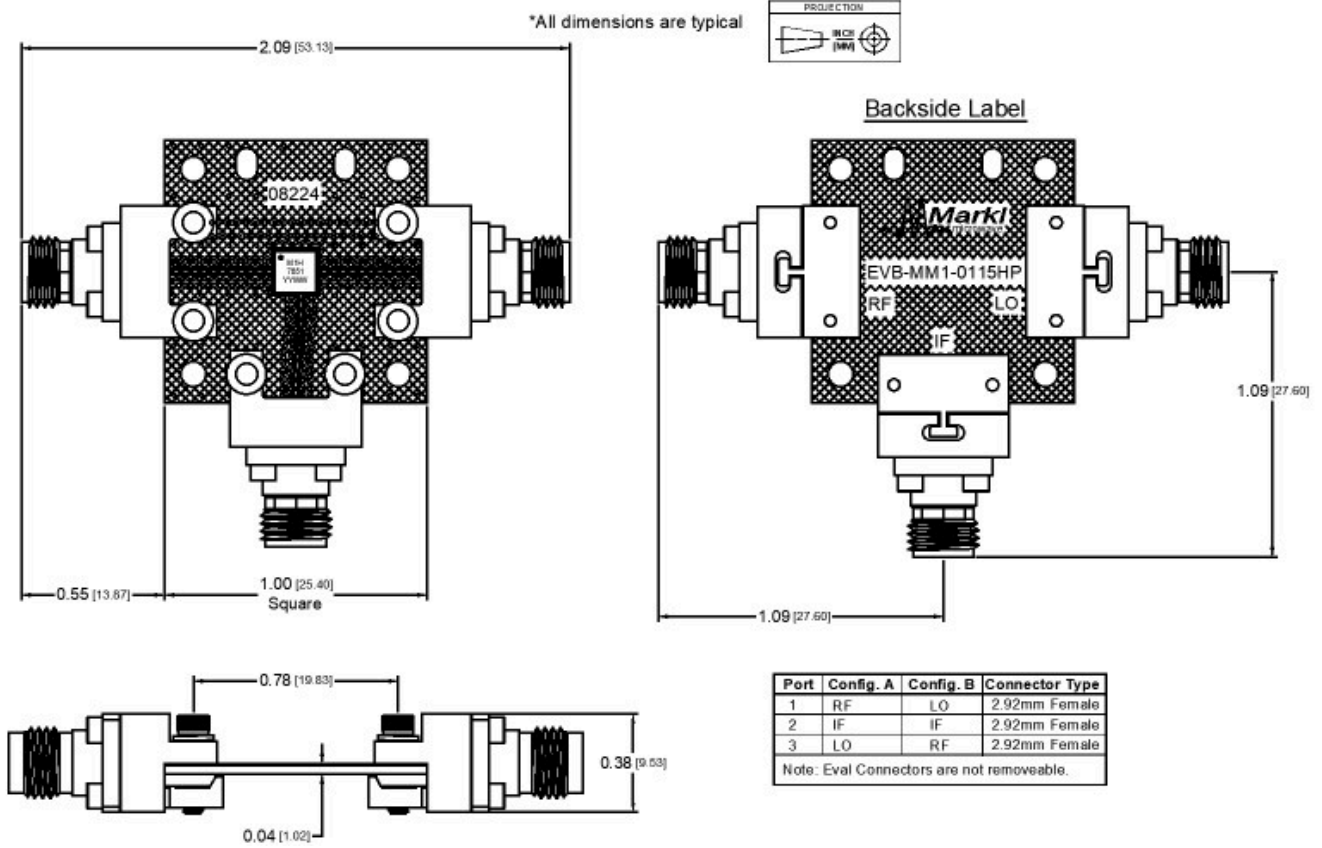
Footprint Image

Download : [Footprint Drawing](#)



The landing pattern is to be used on Rogers 4003, 0.008" thick, ½ Oz Cu.

Evaluation Board - Outline Drawing



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