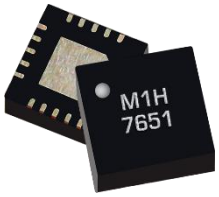
GaAs MMIC Double Balanced Mixer **MM1-0115HPSM**

1. Device Overview



QFN

1.1 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. For a list of recommended LO driver amps for all mixers and IQ mixers, see here.

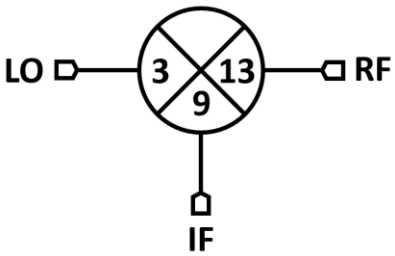
1.2 Features

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

1.3 Applications

- Test and measurement equipment
- SATCOM
- Radar
- Electronic Warfare

1.4 Functional Block Diagram



1.5 Part Ordering Options[1]

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
MM1-0115HPSM-2	4x4 mm QFN	PSM	**RoHS**	Active	EAR99
EVB-MM1-0115HP	Connectorized Evaluation Fixture	EVB		Active	EAR99

[1] Refer to our website for a list of definitions for terminology presented in this table.

Table of Contents

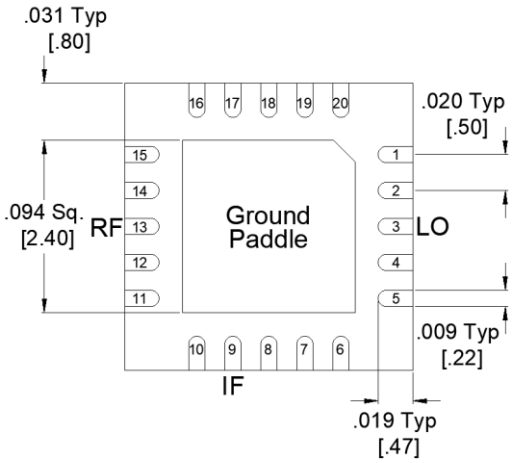
Revision History

Revision Code	Revision Date	Comment
-	October 2022	Datasheet Initial Release

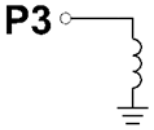
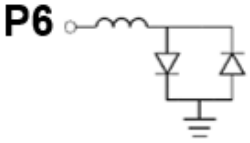
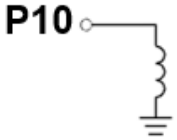
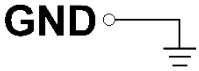
2. Port Configurations and Functions

2.1 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.



2.2 Port Functions

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

3. Specifications

3.1 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	Units
Pin 3 DC Current	30	mA
Pin 9 DC Current	30	mA
Pin 13 DC Current	30	mA
Power Handling, at any Port	+33	dBm
Operating Temperature	-55 to +100	°C
Storage Temperature	-65 to +125	°C

3.2 Package Information

Parameter	Details	Rating
ESD	Human Body Model (HBM), per MIL-STD-750, Method 1020	1A
Weight	PSM package	42 mg

3.3 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.

	Min	Nominal	Max	Units
T_A, Ambient Temperature	-55	+25	+100	°C
LO Input Power	+13	+17	+21	dBm

3.4 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.

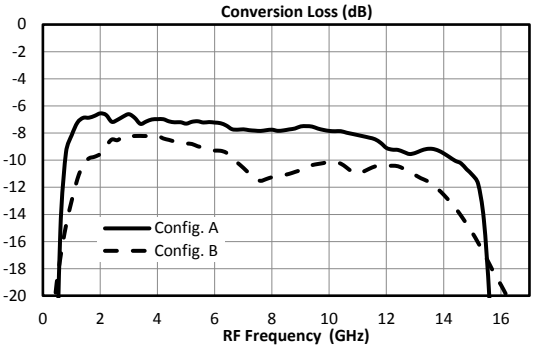
3.5 Electrical Specifications

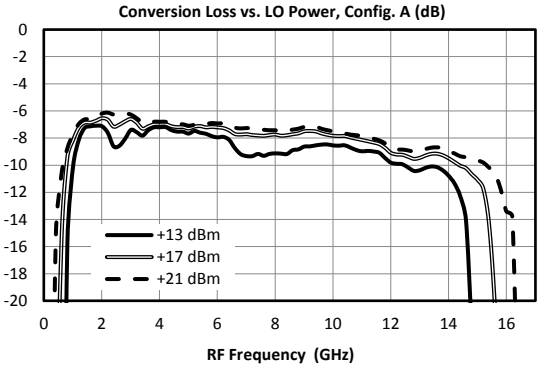
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +17dBm sine wave LO input. Specifications shown for configuration A (B).

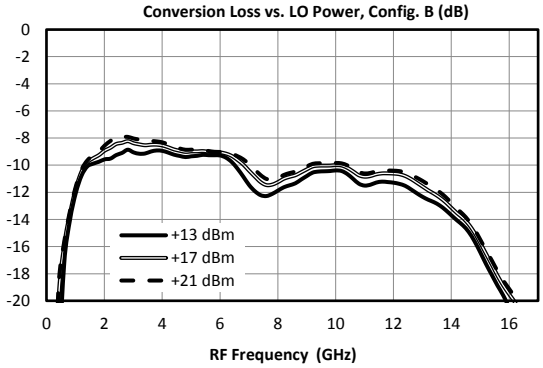
Parameter		Test Conditions	Min	Typical	Max	Units
RF (Pin 13) Frequency Range			1		15	GHz
LO (Pin 3) Frequency Range			1		15	
I (Pin 9) Frequency Range			0		2.5	
Conversion Loss (CL)[2]		RF/LO = 1 - 15 GHz I = DC - 0.2 GHz		8.0 (10.5)	14.0 (18.5)	dB
		RF/LO = 1 - 15 GHz I = 0.2 – 2.5 GHz		9 (11.5)		
Noise Figure (NF)[3]		RF/LO = 1 - 15 GHz I = DC - 0.2 GHz		8 (10.5)		dB
Isolation	LO to RF	RF/LO = 1 - 15 GHz		52 (54)		dB
	LO to IF	IF/LO = 1 - 15 GHz		23 (32)		
	RF to IF	RF/IF = 1 - 15 GHz		34 (23)		
Input IP3 (IIP3)		RF/LO = 1 - 15 GHz I = DC - 0.2 GHz		+21 (+24)		dBm
Input 1 dB Gain Compression Point (P1dB)				+10 (+13)		dBm

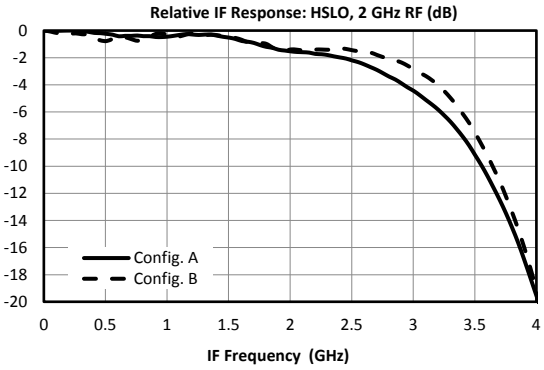
[2] Measured as a down converter to a fixed 91MHz IF.
[3] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

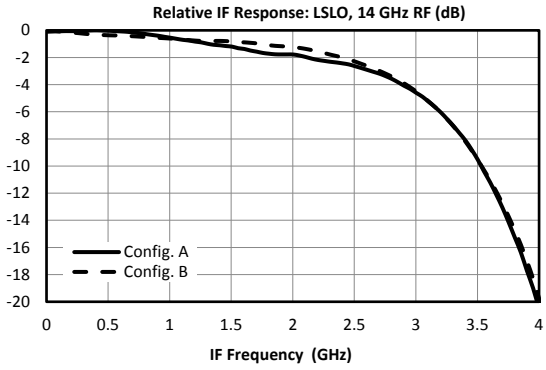
3.6 Typical Performance Plots

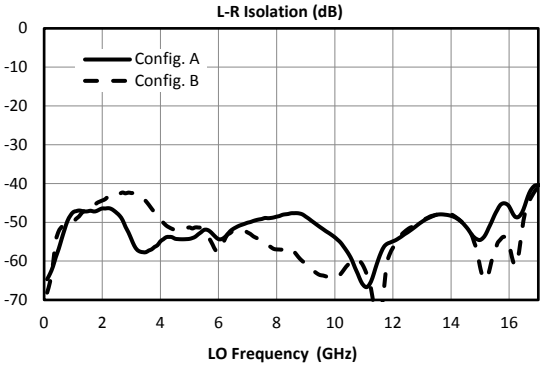


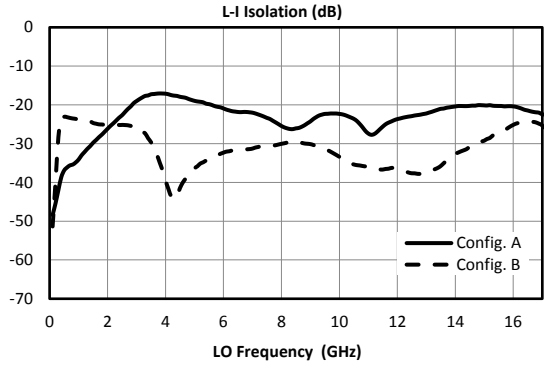


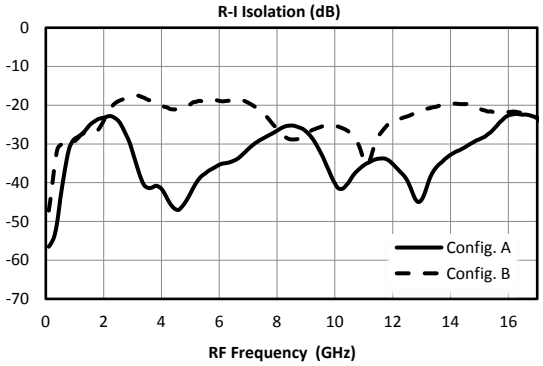


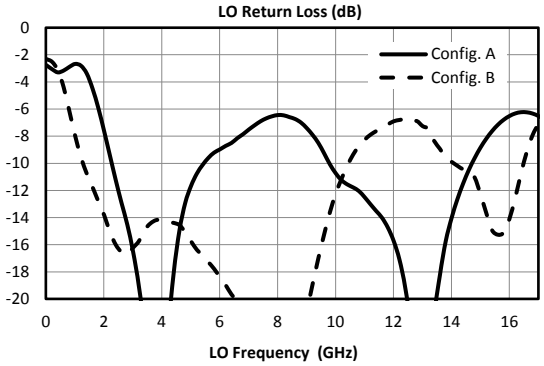


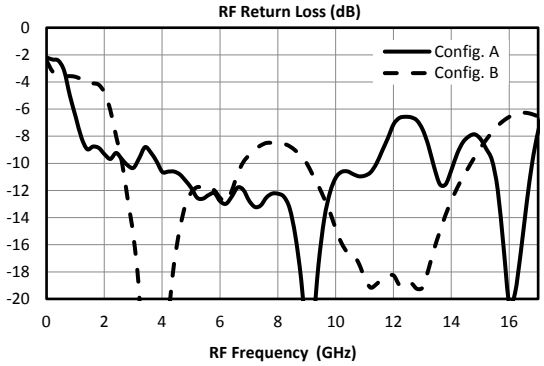


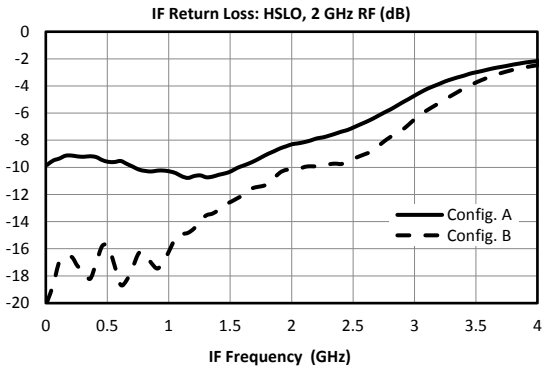


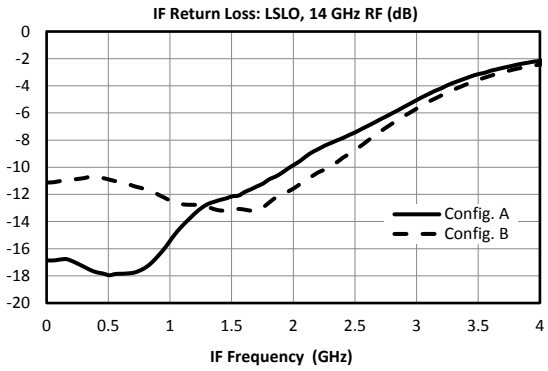




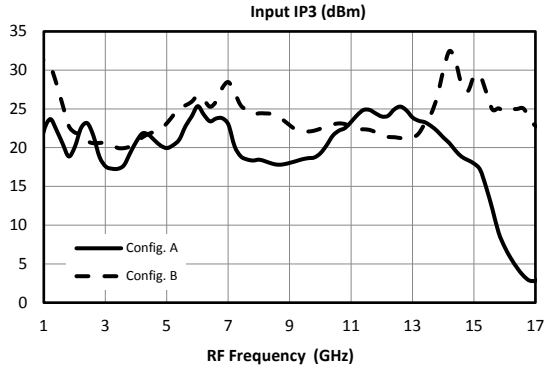


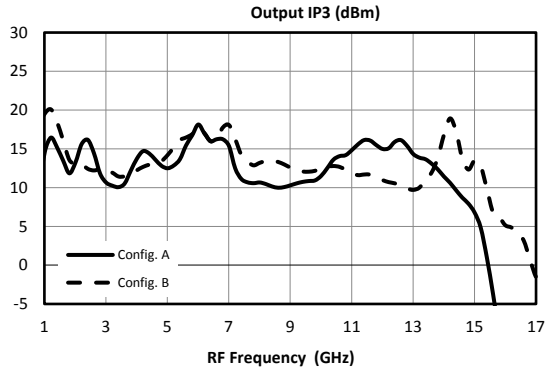


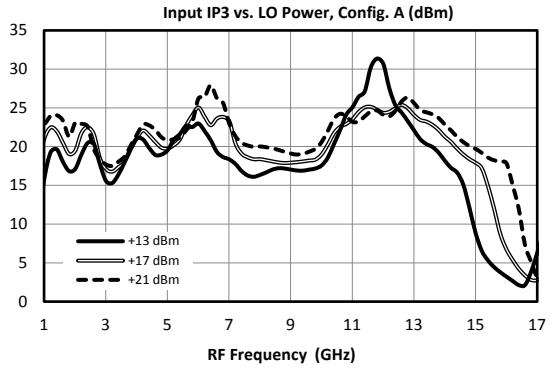


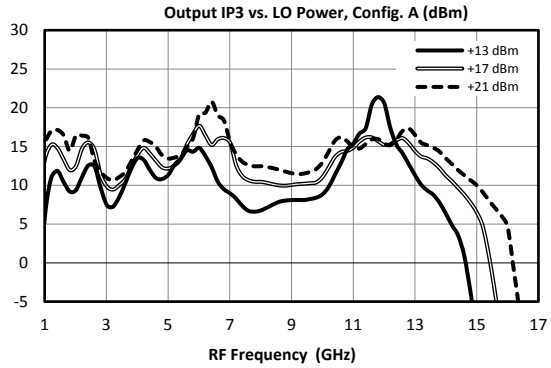


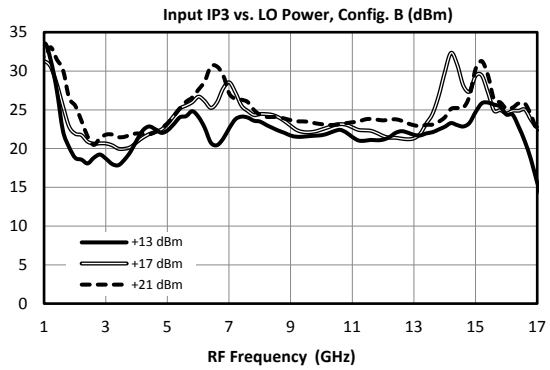
3.6.1 Typical Performance Plots: IP3

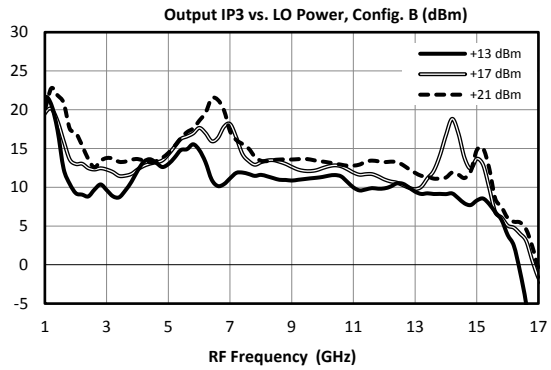




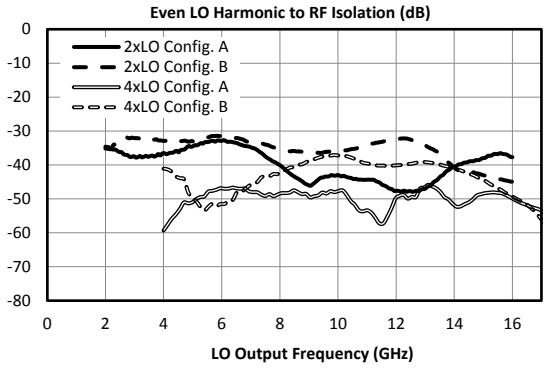


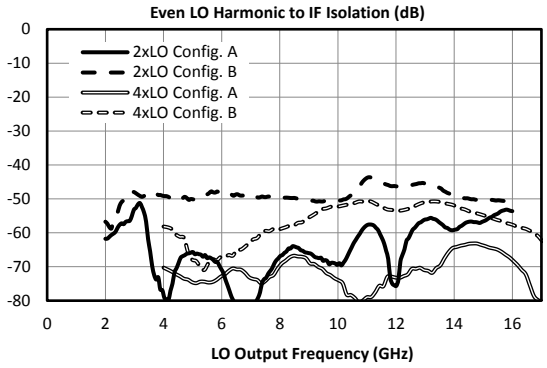


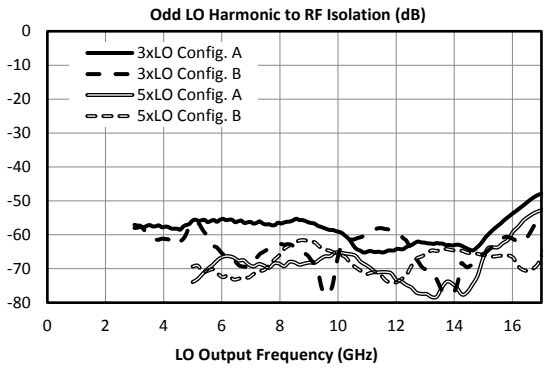


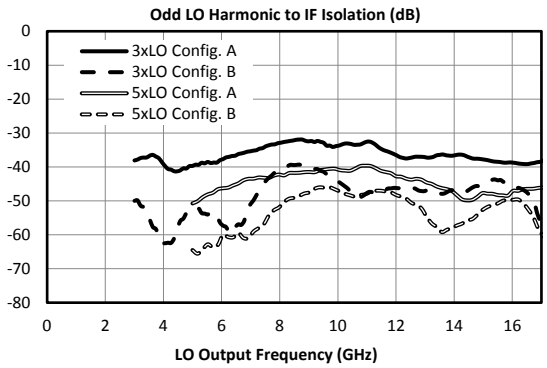


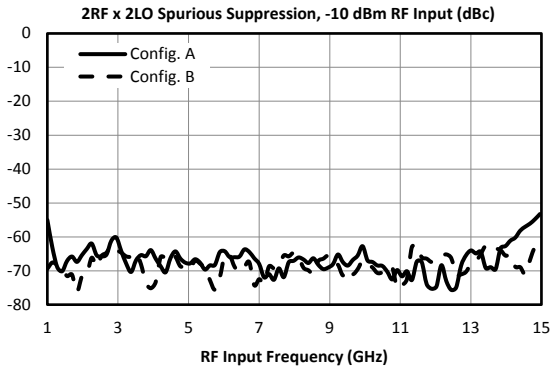
3.6.2 Typical Performance Plots: LO Harmonic Isolation

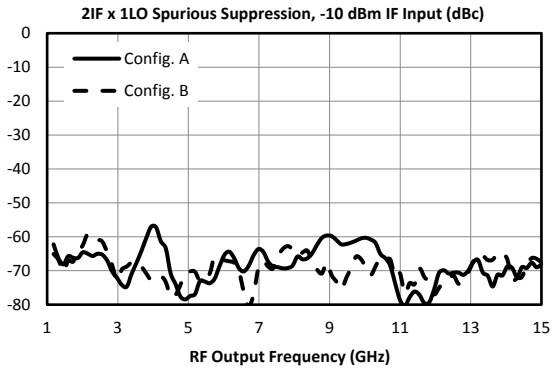












3.6.3 Typical Spurious Performance: Down-Conversion

Typical spurious data is provided by selecting RF and LO frequencies (± m*LO ± n*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. mLOxORF plots can be found in section 3.6.2 Typical Performance Plots: LO Harmonic Isolation. OLOx1RF 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)

3.6.4 Typical Spurious Performance: Up-Conversion

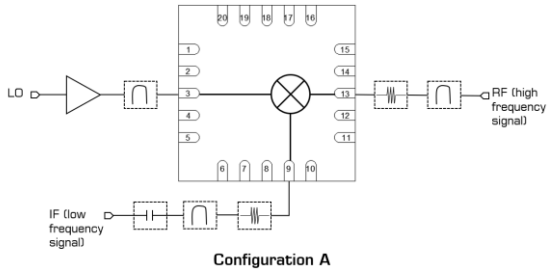
Typical spurious data is taken by mixing an input within the IF band, with LO frequencies (± m*LO ± n*IF), to create a spurious output within the RF output band. The mixer is swept across the full spurious output band and the mean is calculated. The numbers shown in the table below are for a -10 dBm 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)

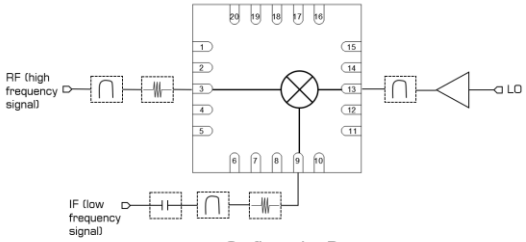
-10 dBm IF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	20 (12)	Reference	27 (31)	12 (10)	34 (42)	21 (18)
2xIF	53 (55)	73 (72)	60 (58)	68 (73)	54 (53)	66 (68)
3xIF	87 (98)	73 (71)	77 (84)	63 (65)	78 (82)	62 (63)
4xIF	94 (107)	113 (116)	98 (96)	105 (111)	87 (92)	100 (105)
5xIF	115 (133)	110 (113)	120 (127)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

4. Operation

4.1 Application Circuit



Configuration A



Configuration B

4.2 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.

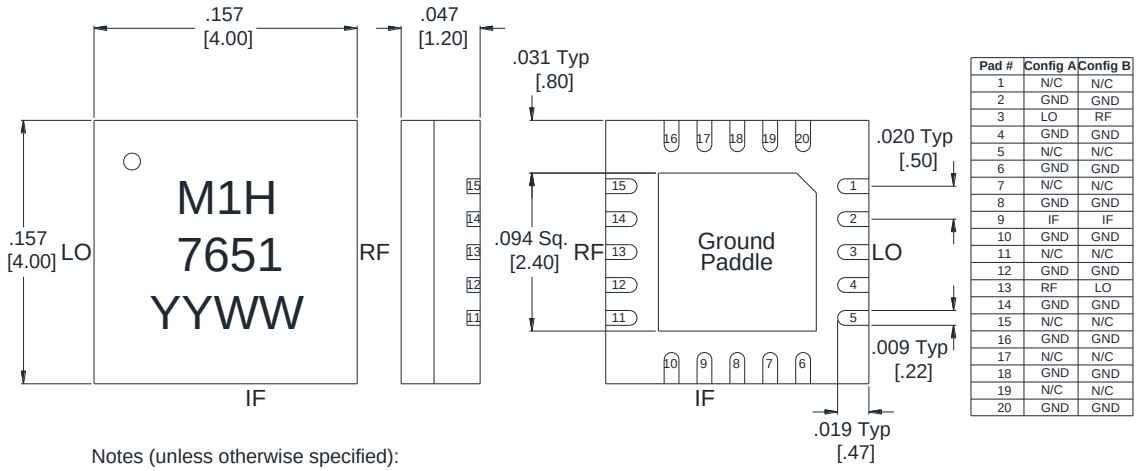
Filtering and Matching- Filtering is generally desired for spurious and image removal on the output port of the mixer. Reflective filters can cause out of band signals to reflect back into the mixer and cause conversion loss ripple, erroneous spurs, and other undesired behaviors. To eliminate these problems 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.

5. Mechanical Data

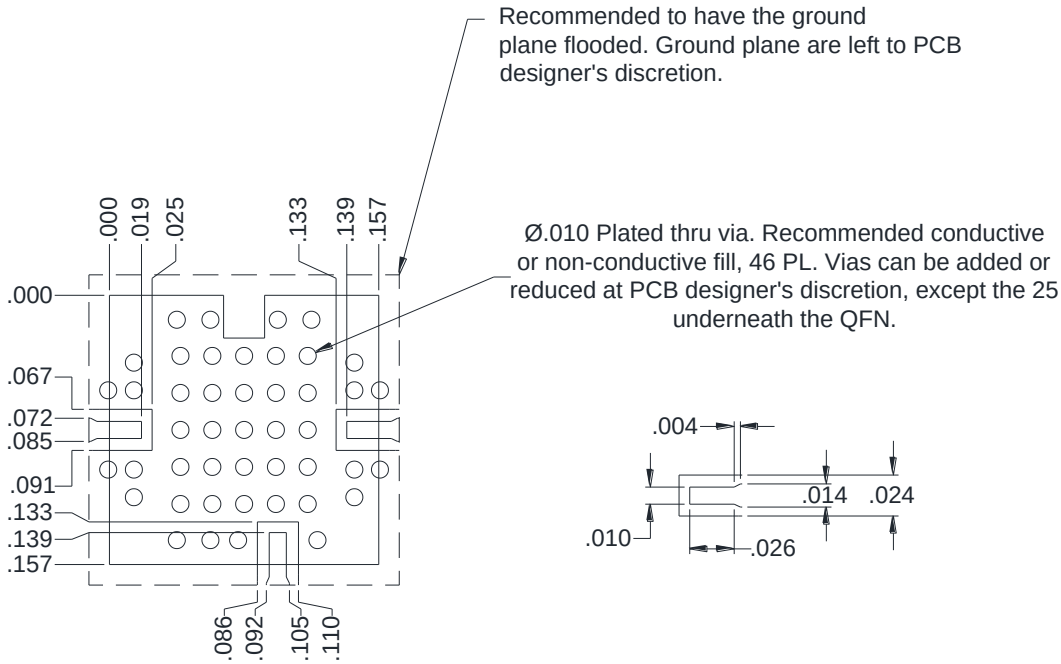
5.1 PSM Package Outline Drawing



Pad #	Config A	Config B
1	N/C	N/C
2	GND	GND
3	LO	RF
4	GND	GND
5	N/C	N/C
6	GND	GND
7	N/C	N/C
8	GND	GND
9	IF	IF
10	GND	GND
11	N/C	N/C
12	GND	GND
13	RF	LO
14	GND	GND
15	N/C	N/C
16	GND	GND
17	N/C	N/C
18	GND	GND
19	N/C	N/C
20	GND	GND

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.

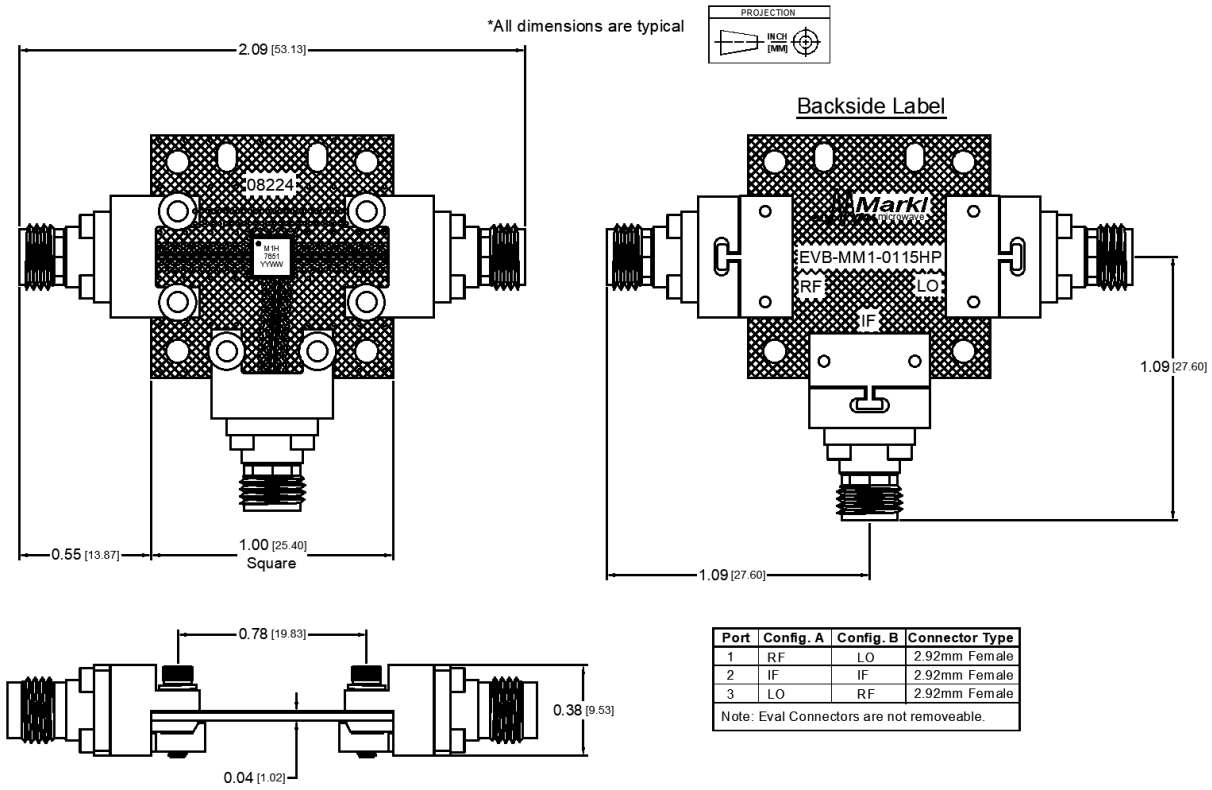
5.2 PSM Package Footprint



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

QFN-Package Surface-Mount Landing Pattern
Click here for a DXF of the above layout.
Click here for leaded solder reflow. Click here for lead-free solder reflow.

5.3 Evaluation Board Outline Drawing



Port	Config. A	Config. B	Connector Type
1	RF	LO	2.92mm Female
2	IF	IF	2.92mm Female
3	LO	RF	2.92mm Female
Note: Eval Connectors are not removeable.			