Double Balanced Mixer/LO Amplifier **MM1A-0832HPSM**

1. Device Overview

QFN

1.1 General Description

The MM1A-0832HPSM is a versatile, robust, and broadband double balanced mixer with an integrated broadband LO driver amplifier. The MM1A-0832HPSM is ideal for applications with wide bandwidths and operation at mmWave frequencies. The integrated LO driver amplifier allows for operation with LO powers as low as -6 dBm while retaining exceptional conversion loss and linearity.

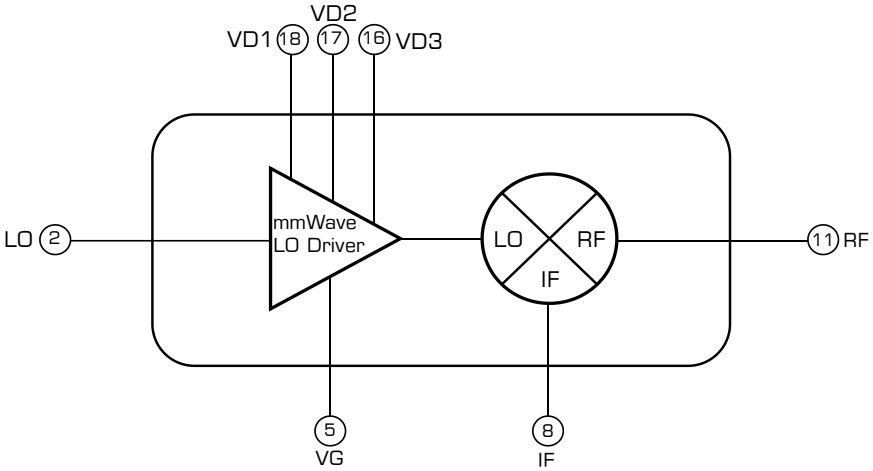
1.2 Features

Parameter	Typical
RF/LO response	8GHz - 32GHz
IF response	DC – 12GHz
Conversion Loss	9 dB
Minimum LO drive	-6 dBm

1.3 Applications

- Test and measurement equipment
- SATCOM
- Radar
- 5G

1.4 Functional Block Diagram



1.5 Part Ordering Options[1]

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
MM1A-0832HPSM-2	3.0 x 4.6 mm QFN	PSM	**RoHS**	Active	EAR99
EVB-MM1A-0832HP	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

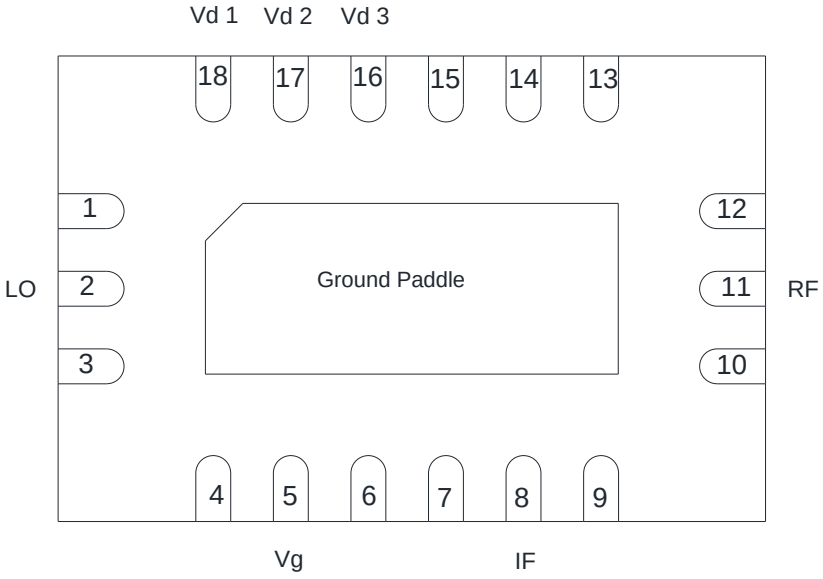
Revision History

Revision Code	Revision Date	Comment
-	September 2022	Datasheet Initial Release
A	October 2022	New RF-LO & IF-LO Isolation Plots

2. Port Configurations and Functions

2.1 Port Diagram

A top-down x-ray view of the MM1A-0832HPSM's PSM Package outline drawing is shown below. The MM1A-0832HPSM has the input and output ports given in Port Functions.



2.2 Sequencing Requirement

Turn-on Procedure:

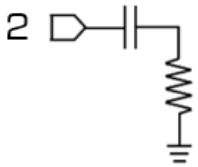
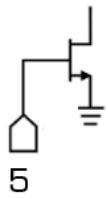
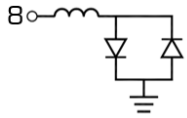
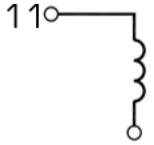
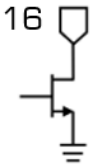
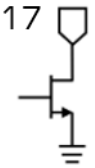
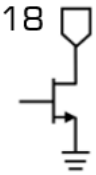
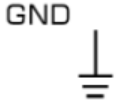
1. Apply Vg (Pin 5)
2. Apply Vd (Pin 16, Pin 17, Pin 18)

Turn-off Procedure:

1. Turn off Vd (Pin 16, Pin 17, Pin 18)
2. Turn off Vg (Pin 5)

Note: LO power can be injected at any moment in the bias sequencing procedure

2.3 Port Functions

Port	Function	Description	Equivalent Circuit for Package
Pin 2	LO	Pin 2 is the input of the integrated LO driver amplifier and is matched to 50 ohms. It is internally DC blocked.	
Pin 5	Negative DC Supply Vg	Pin 5 requires -0.4V to -0.6V of DC voltage. This must be turned on before turning on the positive supply voltage to Pin 5.	
Pin 8	IF	Pin 8 is DC coupled to the diodes. Blocking capacitor is optional.	
Pin 11	RF	Pin 11 is DC open and AC matched to 50 Ohms from 8 to 32 GHz. Blocking capacitor is optional.	
Pin 16	Positive DC Supply Vd_3	Pin 16 provides +2.5V to +4V DC voltage to the amplifier's third stage. Negative voltage must be supplied to Pin 5 before turning on the positive supply voltage.	
Pin 17	Positive DC Supply Vd_2	Pin 17 provides +2.5V to +4V DC voltage to the amplifier's second stage. Negative voltage must be supplied to Pin 5 before turning on the positive supply voltage.	
Pin 18	Positive DC Supply Vd_1	Pin 18 provides +2.5V to +4V DC voltage to the amplifier's first stage. Negative voltage must be supplied to Pin 5 before turning on the positive supply voltage.	
GND	Ground	Ground paddle and non-connected pins must be connected to a DC/RF ground potential with high thermal and electrical conductivity, and low inductance.	

3. Specifications

3.1 Absolute Maximum Ratings

The Absolute Maximum Ratings indicate limits beyond which damage may occur to the device. All limits are individual and should not be met in parallel, doing so will degrade the lifetime of the device. If these limits are exceeded, the device may be inoperable or have a reduced lifetime.

Parameter	Maximum Rating	Units
DC Voltage on VD	4.5	V
DC Voltage on VG	-2	V
Positive Drain Supply Current with RF Input (Id)	450	mA
RF Power Handling	+25	dBm
LO Power Handling	+20	dBm
Operating Temperature	-40 to +85	°C
Storage Temperature	-65 to +125	°C
Max Junction Temperature for MTTF> 1E6 hours	175	°C
θJC, Junction to Case Thermal Resistance	94	°C/W

3.2 Package Information

Parameter	Details	Rating
Weight	EVB package	39.8 g

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	-40	+25	+85	°C
LO Input Power	-6	+6	+6	dBm
Positive DC Voltage (Vd)	+2.5	+3	+4	V
Gate Bias DC Voltage (Vg)	-0.6	-0.5	-0.4	V
Saturated Current Consumption		250	330	mA
Quiescent Current Consumption		170		mA

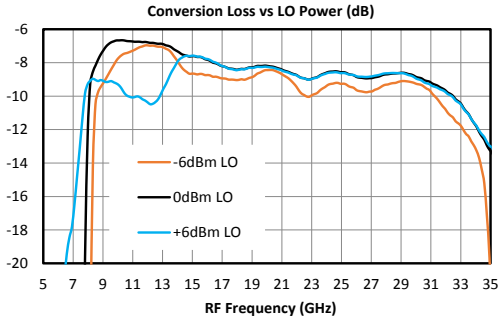
3.5 Electrical Specifications

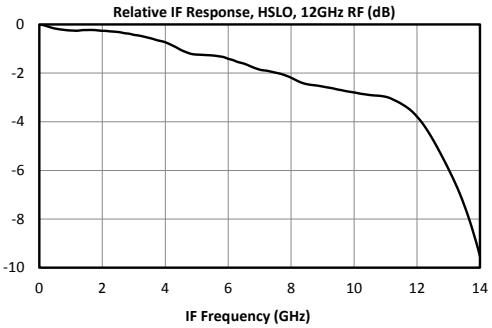
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +6dBm LO input to the integrated LO driver amp biased at +3Vd$_1$/+3Vd$_2$/+3Vd$_3$/-0.5Vg unless otherwise specified.

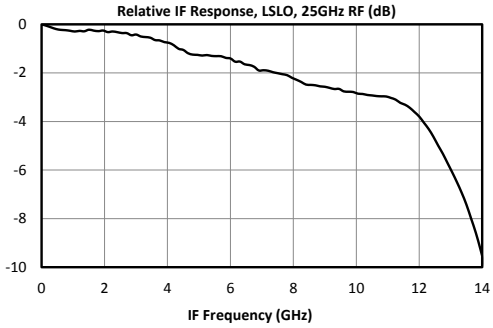
Parameter		Test Conditions	Min	Typical	Max	Units
RF (Pin 11) Frequency Range			8		32	GHz
LO (Pin 2) Frequency Range			8		32	
I (Pin 7) Frequency Range			0		12	
Conversion Loss (CL)[2]		RF/LO = 8 - 32 GHz I = DC – 0.2 GHz		9		dB
		RF/LO = 8 - 32 GHz I = 0.2 – 12 GHz		11	14	
Noise Figure (NF)[3]		RF/LO = 8 - 32 GHz I = DC – 0.2 GHz		9		dB
RF to IF Isolation		RF/LO = 8 - 32 GHz		39		dB
LO Leakage	LO to IF	RF/LO = 8 - 32 GHz		See Plots		dBm
	LO to RF	RF/LO = 8 - 32 GHz		See Plots		
Input IP3 (IIP3)		RF/LO = 8 - 32 GHz I = DC - 2 GHz		+24		dBm
Input 1 dB Gain Compression Point (P1dB)				+9		dBm

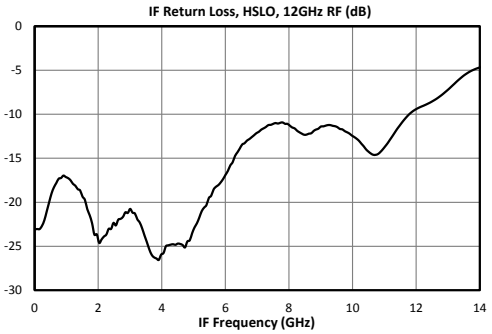
[2] Measured as a down converter to a fixed 91 MHz IF.
[3] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

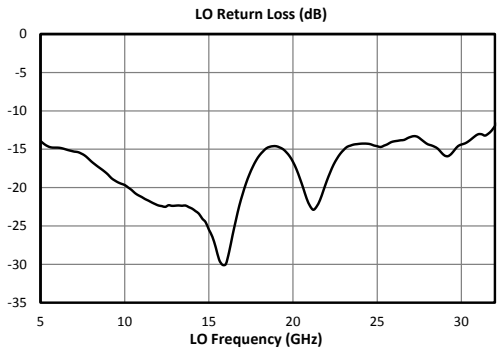
3.6 Typical Performance Plots

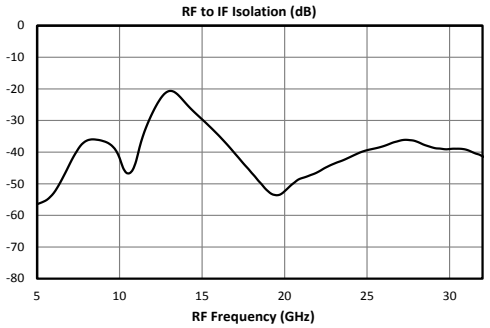


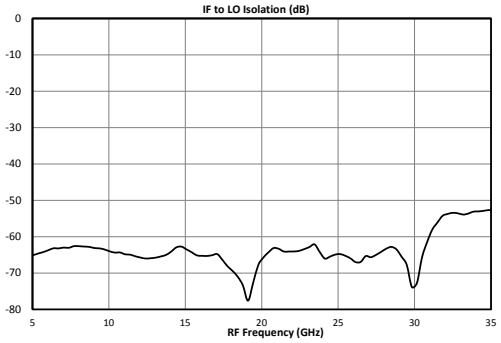


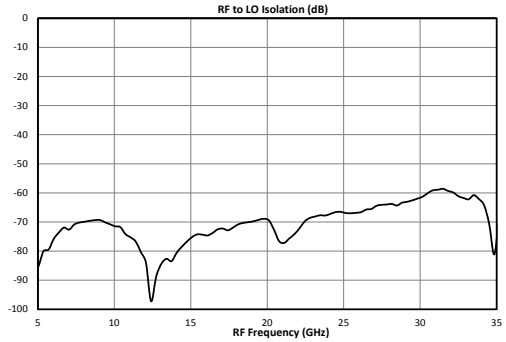


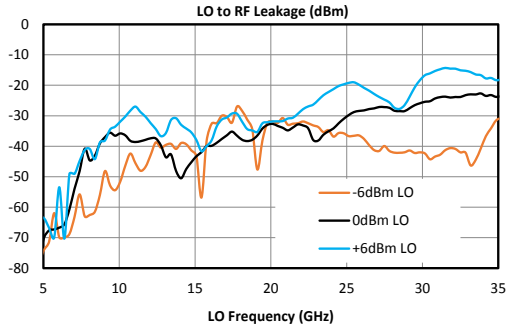


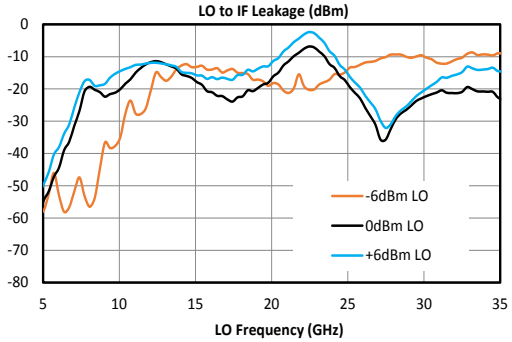


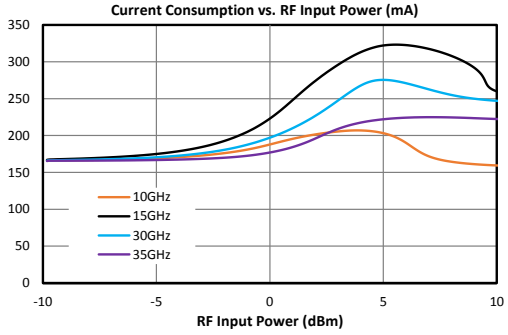


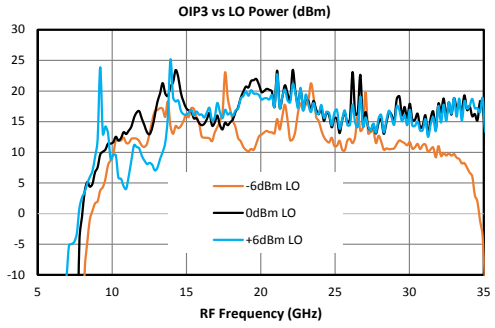


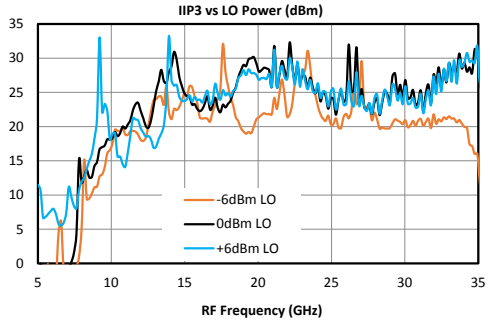


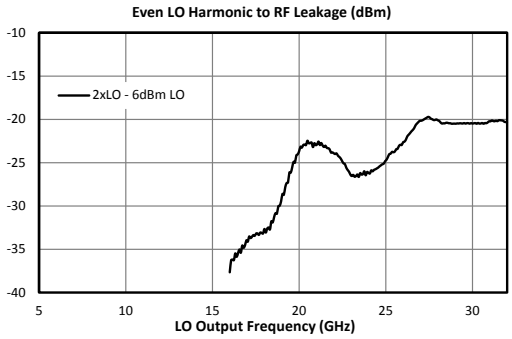


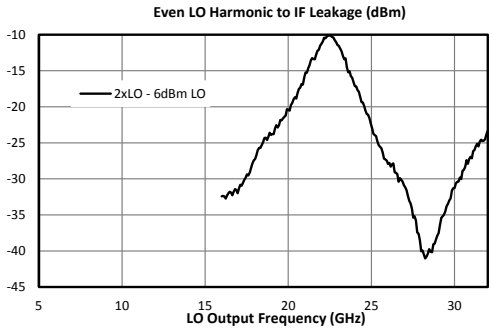


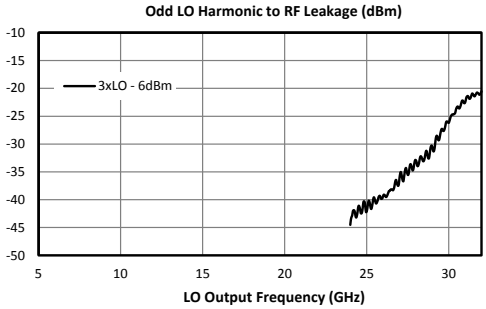


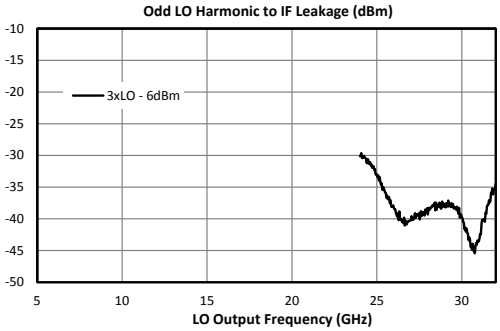


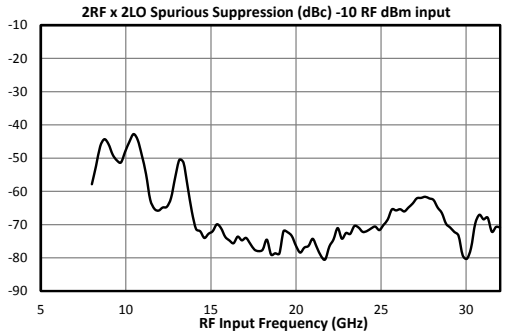


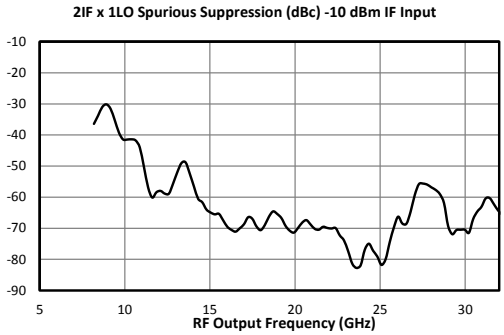












3.6.1 Typical Spurious Performance: Down-Conversion

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 65 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 75 dBc. Data is shown for the frequency plan in 3.6 Typical Performance.

Typical Down-conversion spurious suppression (dBc)

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	29	Reference	10	14	27	N/A
2xRF	86	65	65	63	60	58
3xRF	104	53	84	80	83	74
4xRF	N/A	N/A	113	113	111	114
5xRF	N/A	N/A	110	132	134	134

3.6.2 Typical Spurious Performance: Up-Conversion

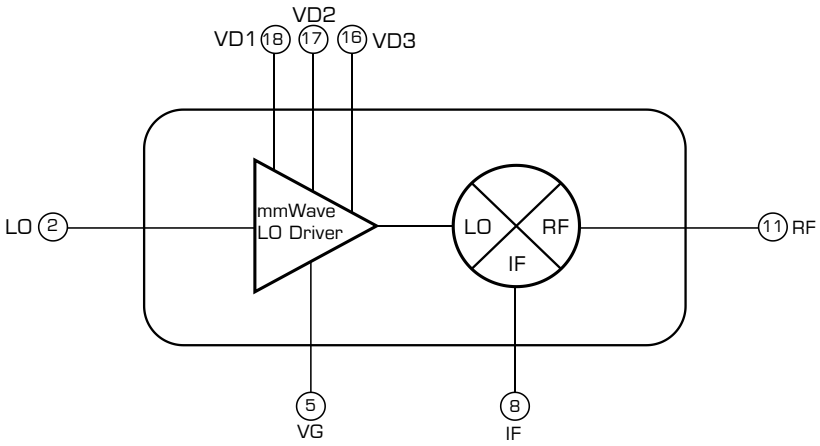
Typical spurious data is taken by mixing an input within the IF band, with LO frequencies (± m*LO ± n*IF), to create a spurious output within the RF output band. The mixer is swept across the full spurious output band and the mean is calculated. The numbers shown in the table below are for a -10 dBm 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 63 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 73 dBc. Data is shown for the frequency plan in 3.6 Typical Performance.

Typical Up-conversion spurious suppression (dBc)

-10 dBm IF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	32	Reference	11	11	15	15
2xIF	71	63	56	48	47	46
3xIF	88	70	62	61	56	57
4xIF	119	106	94	89	86	86
5xIF	143	124	111	111	109	105

4. Operation

4.1 Application Circuit Block Diagram



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.

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.

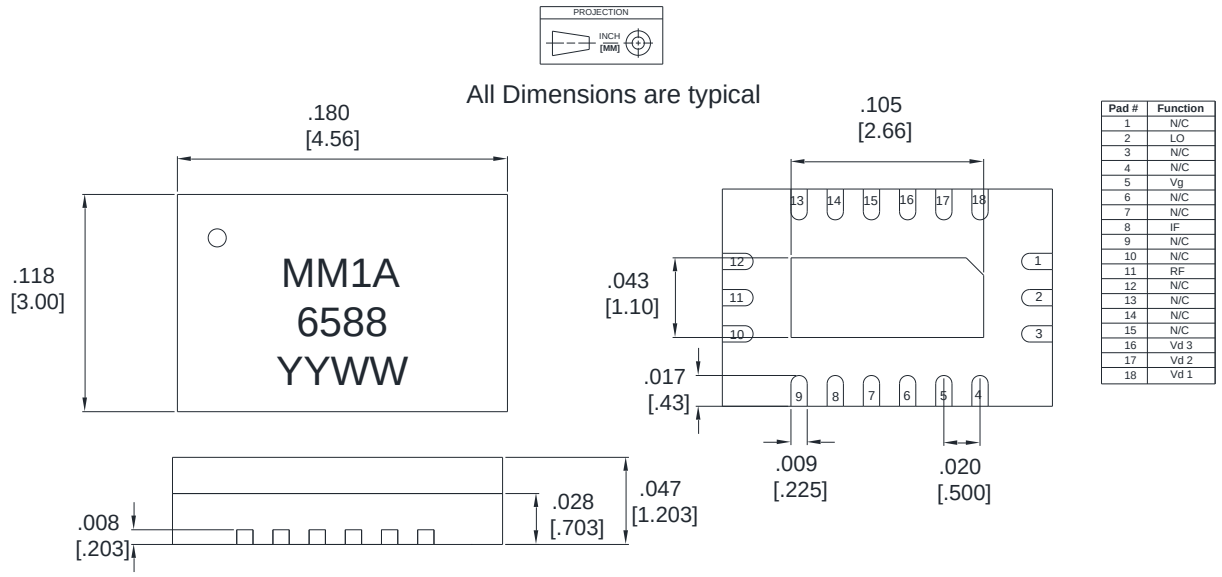
LO Port – The noise floor of the LO input signal should be less than the value of the noise floor plus isolation of the mixer, or a filter is recommended to prevent reduction in dynamic range. An integrated LO amplifier is included, allowing for superior performance with LO power below the typical recommended drive level.

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.

5. Mechanical Data

5.1 PSM Package Outline Drawing



Pad #	Function
1	N/C
2	LO
3	N/C
4	N/C
5	Vg
6	N/C
7	N/C
8	IF
9	N/C
10	N/C
11	RF
12	N/C
13	N/C
14	N/C
15	N/C
16	Vd 3
17	Vd 2
18	Vd 1

1. Substrate material is LCP.

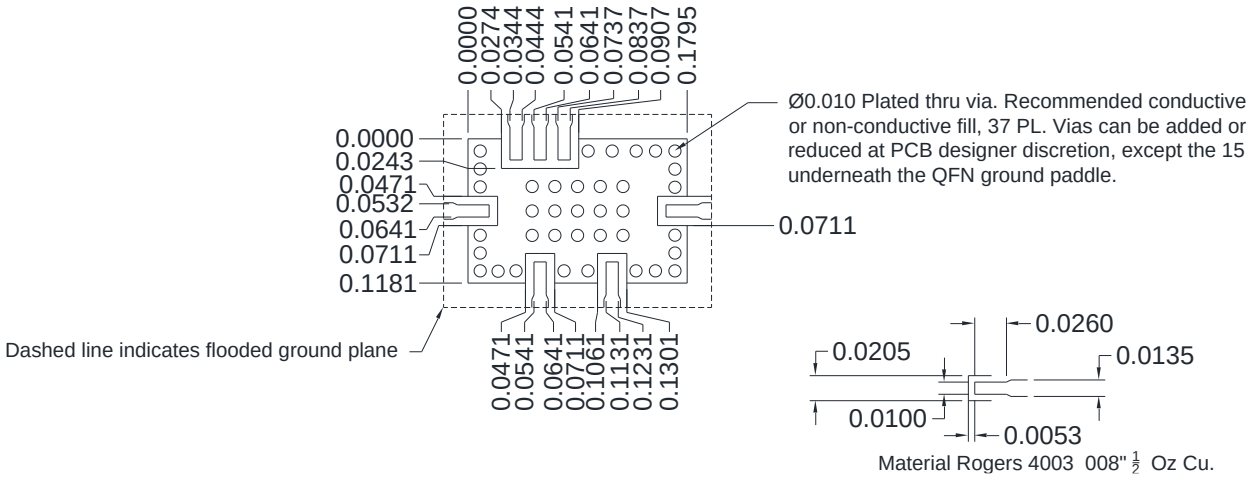
2. I/O Leads and Die Paddle are: 0.003 microns Gold (MIN)

   0.08 - 0.15 microns Palladium

   0.5 - 2.0 microns Nickel.

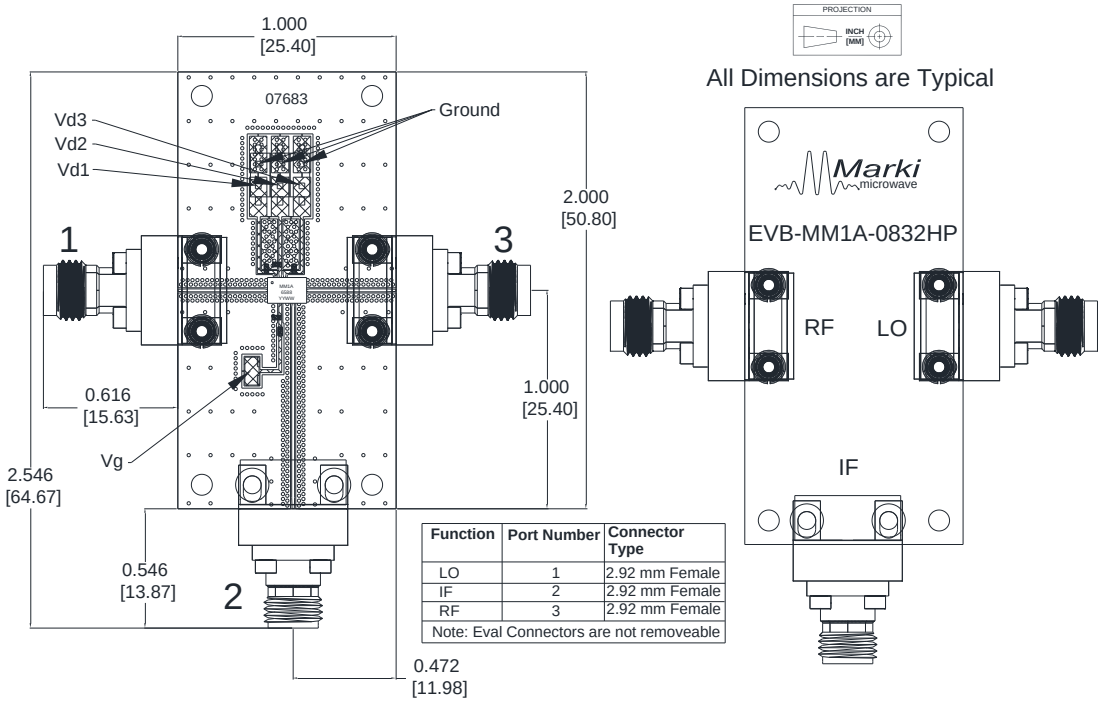
3. All unconnected pins should be connected to PCB RF ground.

5.2 PSM Package Footprint



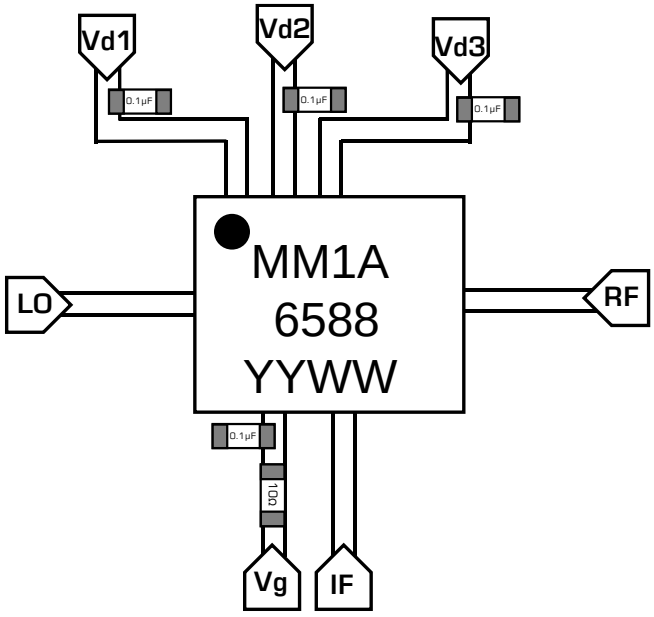
QFN-Package Surface-Mount Landing Pattern
Click here for a DXF of the above layout.
Click here for leaded solder reflow. Click here for lead-free solder reflow.

5.3 Evaluation Board Outline Drawing



Function	Port Number	Connector Type
LO	1	2.92 mm Female
IF	2	2.92 mm Female
RF	3	2.92 mm Female
Note: Eval Connectors are not removeable		

5.4 Evaluation Board Application Circuit



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