

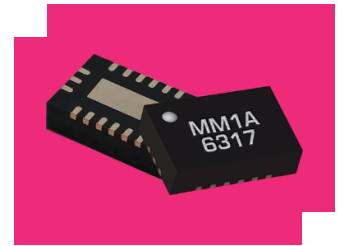
MM1A-1040HPSM-2

Double Balanced Mixer/LO Amplifier

DEVICE OVERVIEW

General Description

The MM1A-1040HPSM is a versatile, robust, and broadband double balanced mixer with an integrated broadband LO driver amplifier. The MM1A-1040HPSM 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 +3dBm while retaining exceptional conversion loss and linearity.



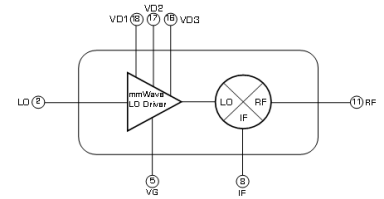
Features

- RF/LO response: 10GHz - 40GHz
- IF response: DC – 12GHz
- Conversion Loss: 8 dB
- Minimum LO drive: +3 dBm

Applications

- Test and Measurement Equipment
- SATCOM
- 5G
- Radar

Functional Block Diagram



Part Ordering Options

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
MM1A-1040HPSM-2	Double Balanced Mixer/LO Amplifier	QFN	REACH RoHS	Released	EAR99
EVB-MM1A-1040HP	Evaluation Board, 10-40 GHz Double Balanced Mixer/LO Amplifier	EVB	REACH RoHS	Released	EAR99

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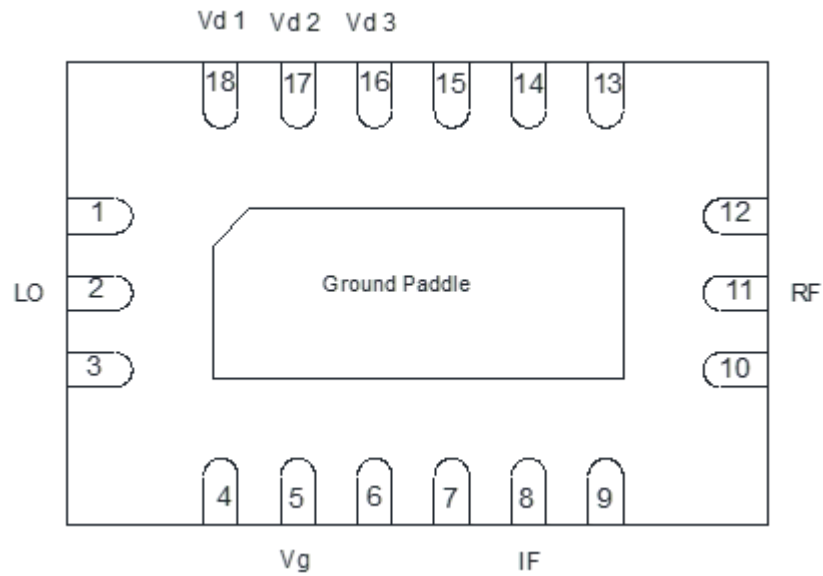
Revision History

Revision Code	Revision Date	Comment
-	2022-09-01	Datasheet Initial Release
A	2022-10-01	New RF-LO & IF-LO Isolation Plots
B	2024-09-11	Updated Recommended Power Supply Voltage

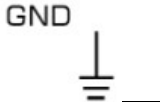
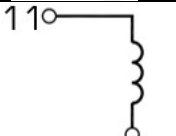
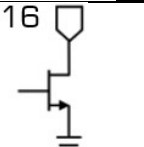
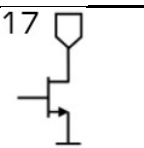
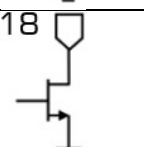
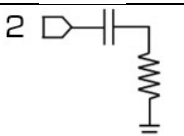
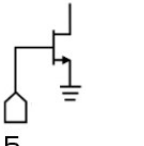
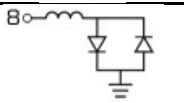
Port Configuration and Functions

Port Diagram

A top-down x-ray view of the MM1A-1040HPSM's PSM Package outline drawing is shown below. The MM1A-1040HPSM has the input and output ports given in Port Functions.



Port Functions

Port	Function	Description	Equivalent Circuit for Package
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.	
Pin 11	RF	Pin 11 is DC open and AC matched to 50 Ohms from 10 to 40 GHz. Blocking capacitor is optional.	
Pin 16	Positive DC Supply Vd3	Pins 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 Vd2	Pins 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 Vd1	Pins 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.	
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.	

Specifications

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	Unit
DC Voltage on VD	4.5	V
DC Voltage on VG	-2	V
LO Power Handling	20	dBm
Maximum Operating Temperature	85	°C
Maximum Storage Temperature	150	°C
Max Junction Temperature for MTTF > 1E6 hours	175	°C
Minimum Operating Temperature	-40	°C
Minimum Storage Temperature	-65	°C
Positive Drain Supply Current with RF Input (Id)	450	mA
RF Power Handling	25	dBm
θ_{JC} , Junction to Case Thermal Resistance	94	°C/W

Package Information

Parameter	Details	Rating
Dimensions	-	3 x 4.6 mm
Moisture Sensitivity Level	-	MSL 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.

Parameter	Min	Nominal	Max	Unit
LO Input Power	3	6	9	dBm
Positive DC Voltage (Vd3)	2.5	3	-	V
Gate Bias DC Voltage (Vg)	-0.6	-0.5	-0.4	V
Positive DC Voltage (Vd1)	2.5	3	4	V
Positive DC Voltage (Vd2)	2.5	3	4	V
Quiescent Current Consumption	-	180	-	mA
Saturated Current Consumption	-	240	350	mA
Ambient Temperature	-40	25	85	°C

Sequencing Requirements

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

Electrical Specifications

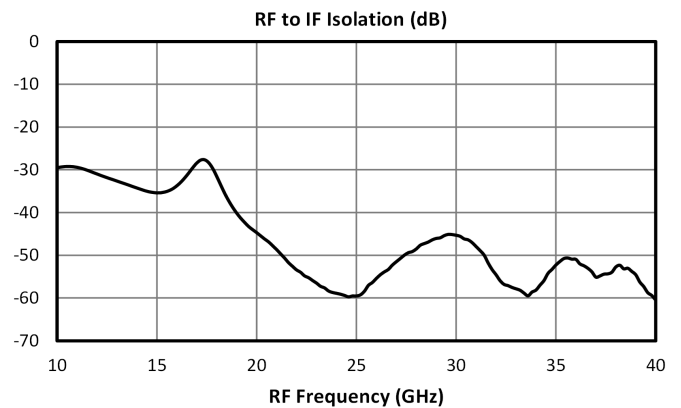
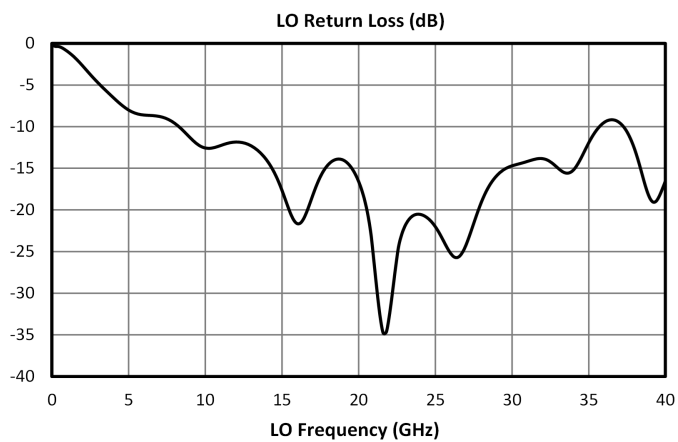
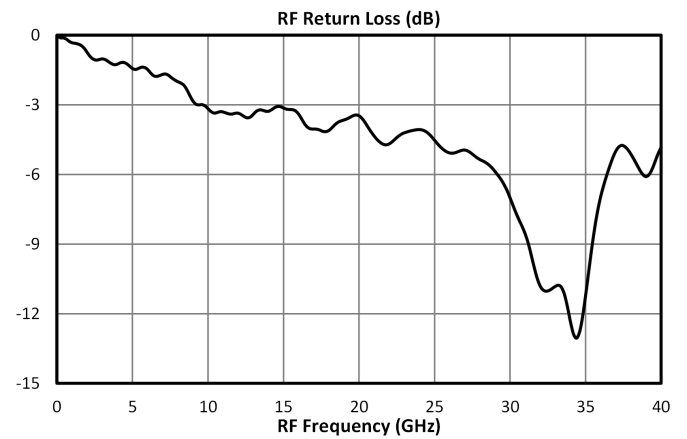
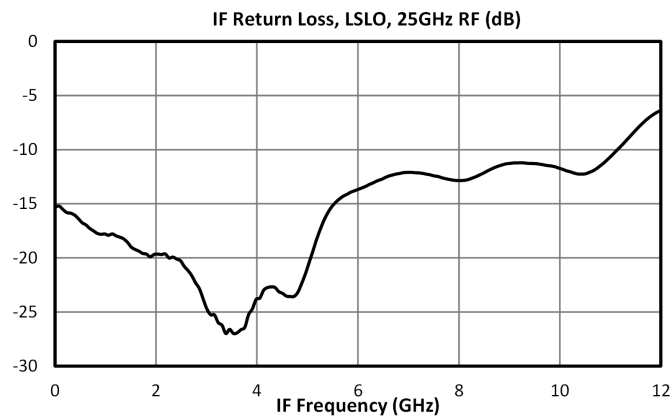
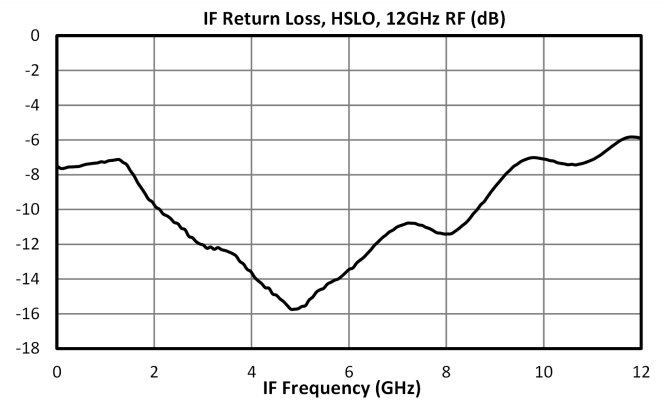
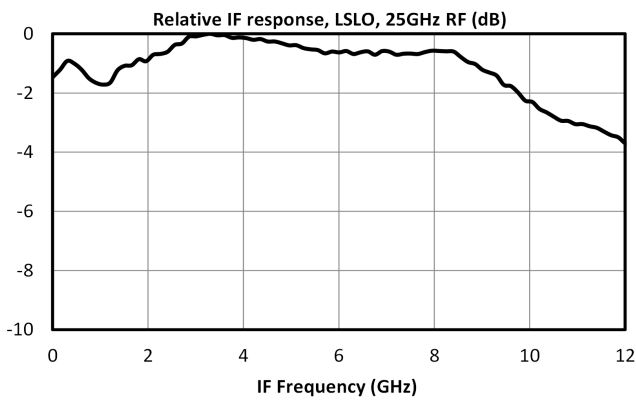
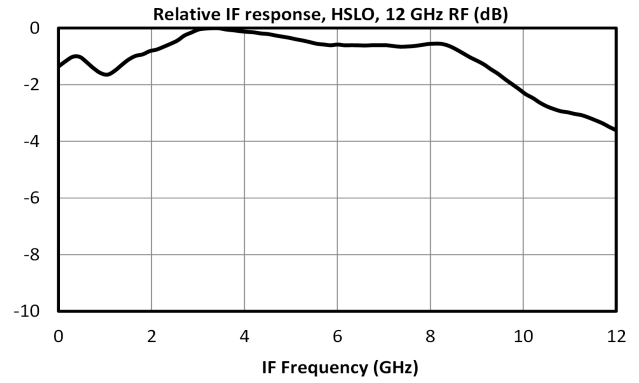
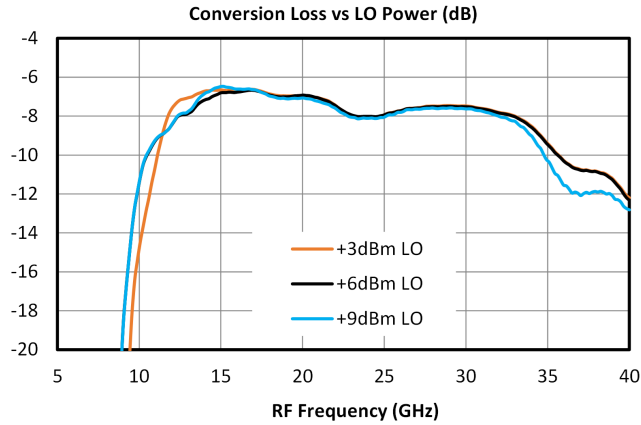
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +6dBm LO input to the integrated LO driver amp biased at +3Vd1/+3Vd2/+3Vd3/-0.5Vg unless otherwise specified.

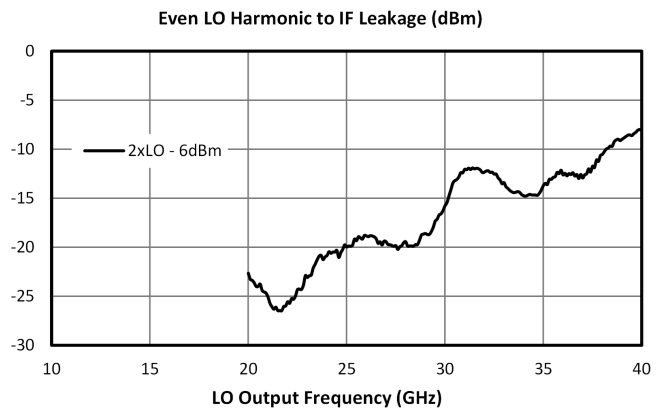
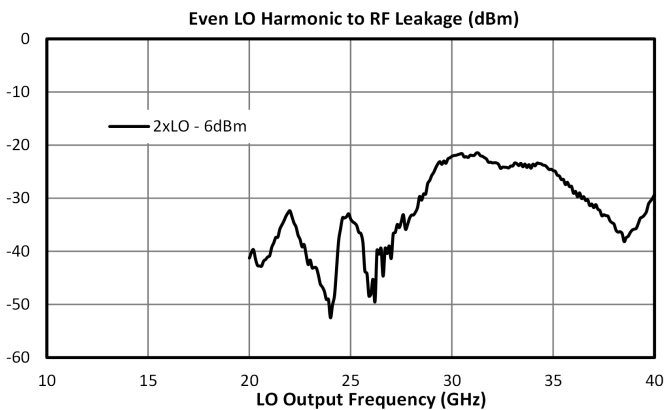
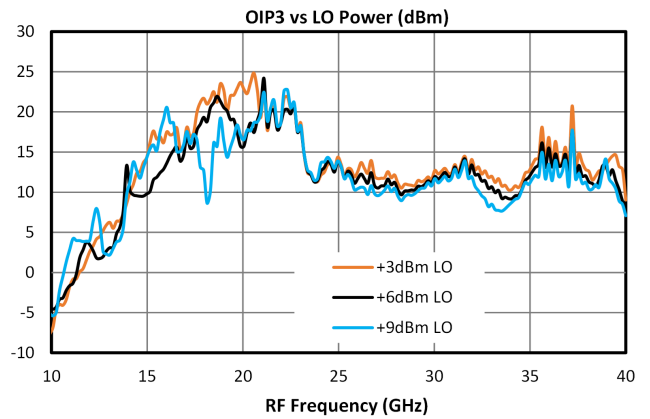
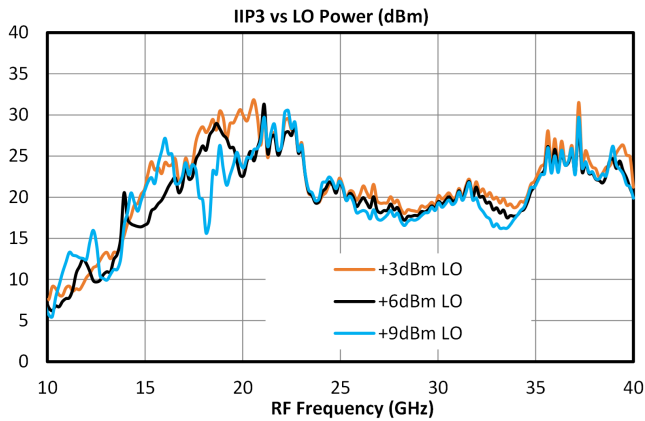
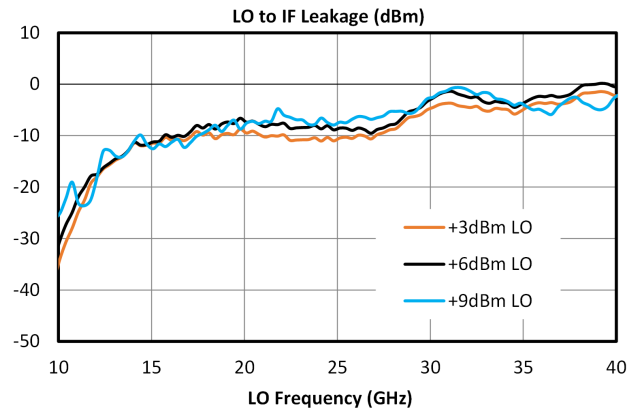
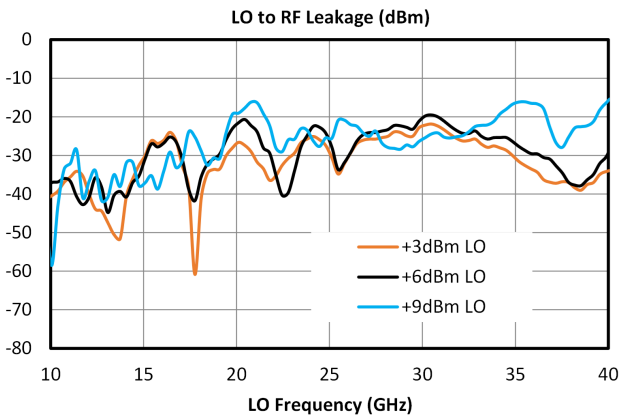
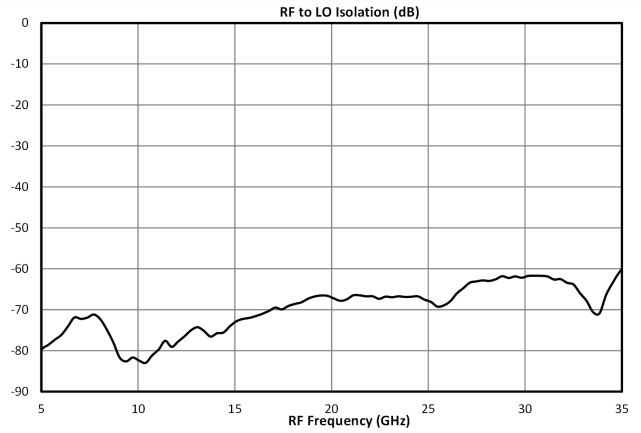
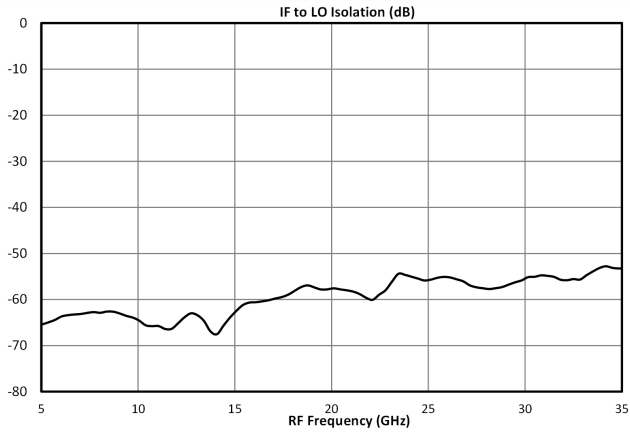
Parameter	Test Conditions	Min	Typ	Max	Unit
Conversion Loss ¹	RF/LO = 10 - 40 GHz I = 0.2 - 12 GHz	-	9	14	dB
Conversion Loss ²	RF/LO = 10 - 40 GHz I = DC - 0.2 GHz	-	8	-	dB
IF Frequency Range	-	0	-	12	GHz
Input 1 dB Gain Compression Point (P1dB)	-	-	11	-	dBm
Input IP3	RF/LO = 10 - 40 GHz	-	23	-	dBm
LO Frequency Range	-	10	-	40	GHz
Noise Figure ³	RF/LO = 10 - 40 GHz I = DC - 0.2 GHz	-	10	-	dB
RF Frequency Range	-	10	-	40	GHz
RF to IF Isolation	RF/LO = 10 - 40 GHz	-	44	-	dB

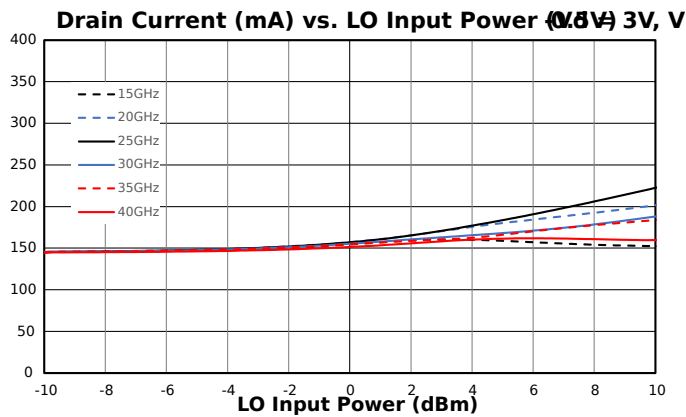
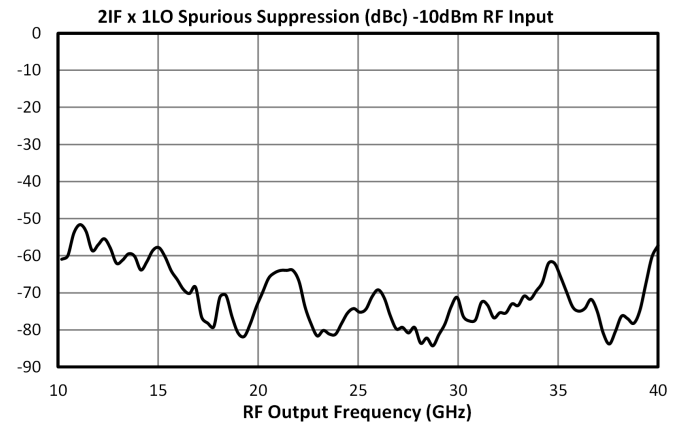
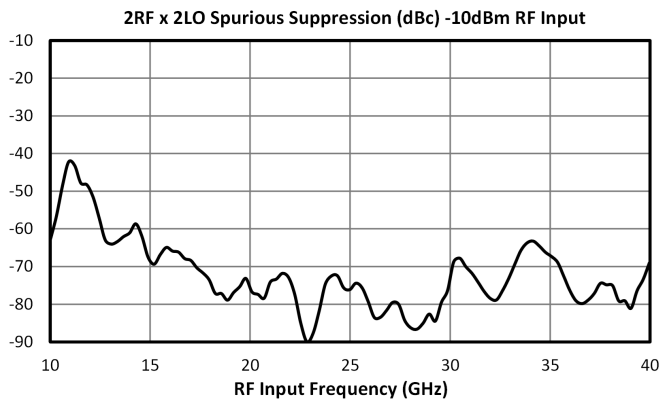
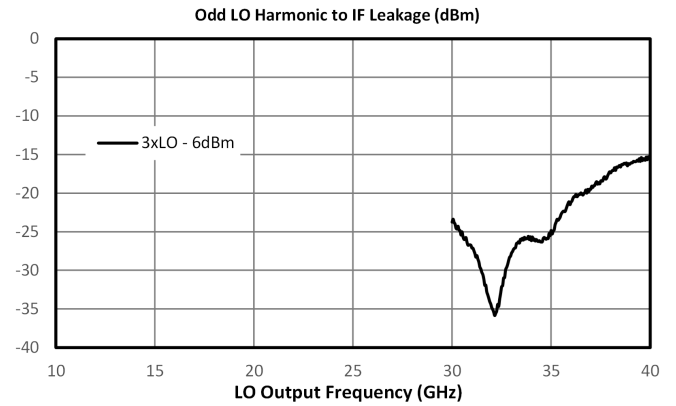
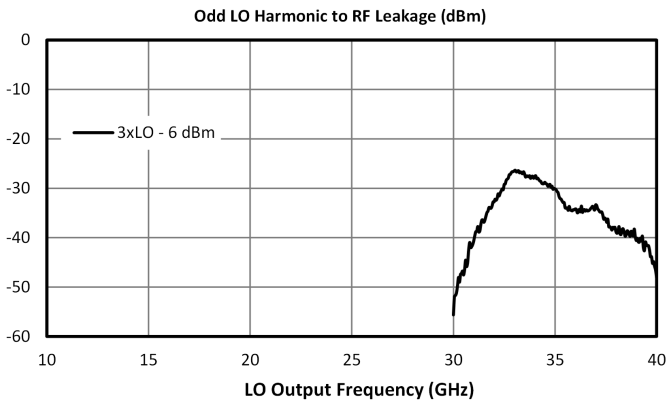
[1][2] Measured as a down converter to a fixed 91 MHz IF.

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

Typical Performance Plots







Spur Table

Typical Spurious Performance: Down-Conversion

Typical spurious data is provided by selecting RF and LO frequencies ($\pm m \cdot \text{LO} \pm n \cdot \text{RF}$) 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 $2\text{RF} \times 2\text{LO}$ spur is 63 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is $(2-1) \times (-10 \text{ dB})$ lower, or 73 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	38	Reference	21	16	36	N/A
2xRF	72	60	63	60	62	60
3xRF	88	40	78	70	75	67
4xRF	N/A	N/A	104	105	105	109
5xRF	N/A	N/A	107	124	117	120

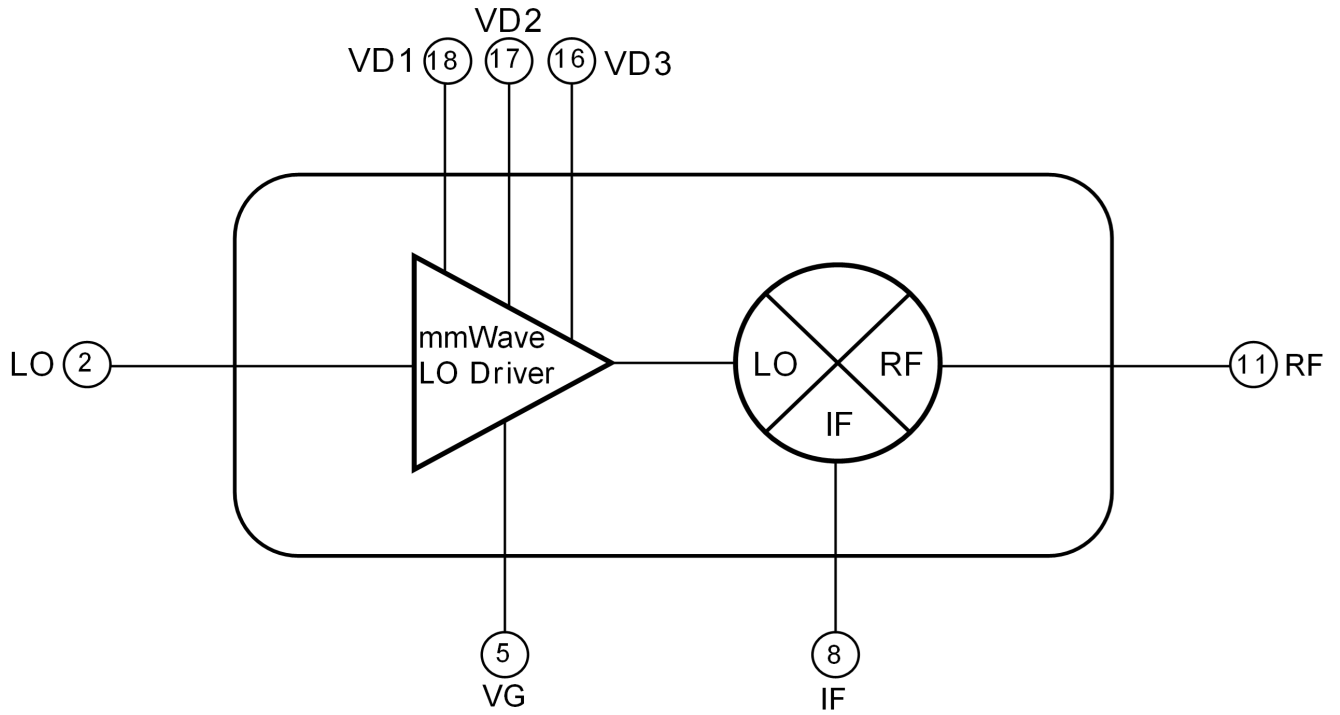
Typical Spurious Performance: Up-Conversion

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. 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	31	Reference	16	16	21	29
2xIF	66	64	58	54	48	54
3xIF	82	70	65	53	55	59
4xIF	111	103	97	90	92	88
5xIF	128	119	113	102	110	102

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.

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.

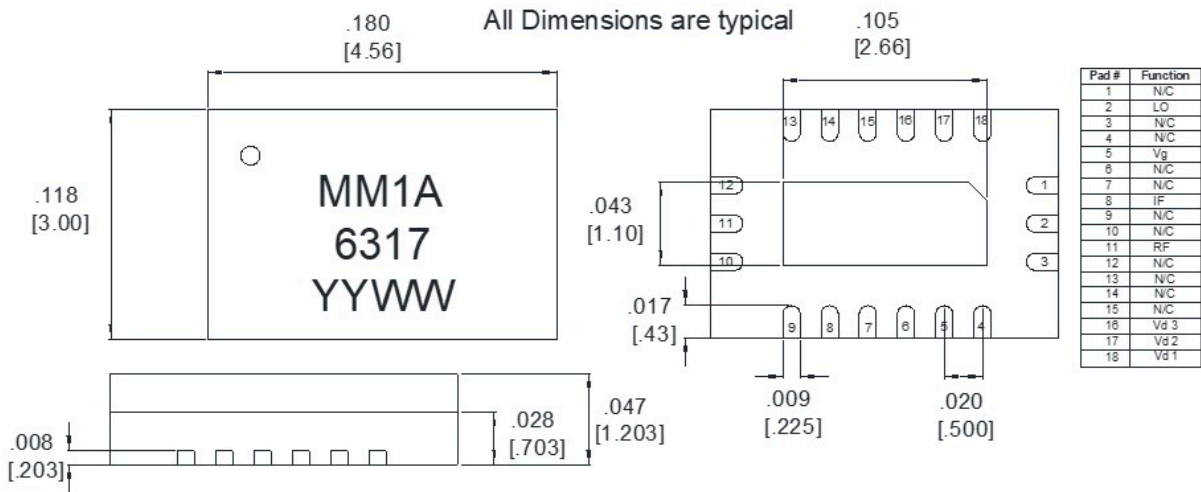
Filtering and Matching- Filtering is generally desired for spurious and image removal on the output port of the mixer. Reflective filters can cause out of band signals to reflect back into the mixer and cause conversion loss ripple, erroneous spurs, and other undesired behaviors. To eliminate these problems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

Mechanical Data

Outline Drawing

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



1. Substrate material is LCP.

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

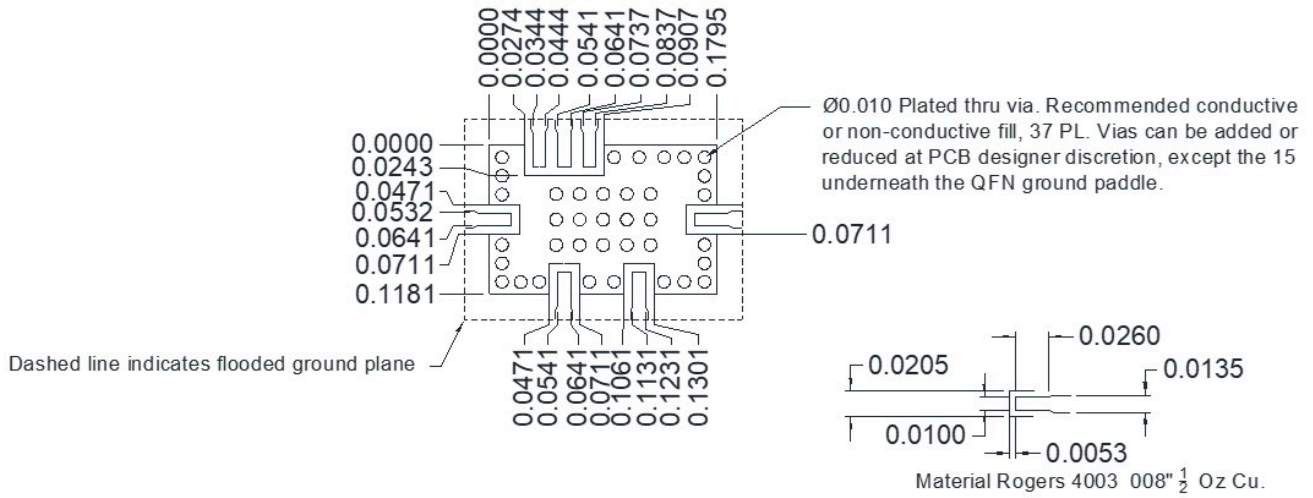
0.08 - 0.15 microns Palladium

0.5 - 2.0 microns Nickel.

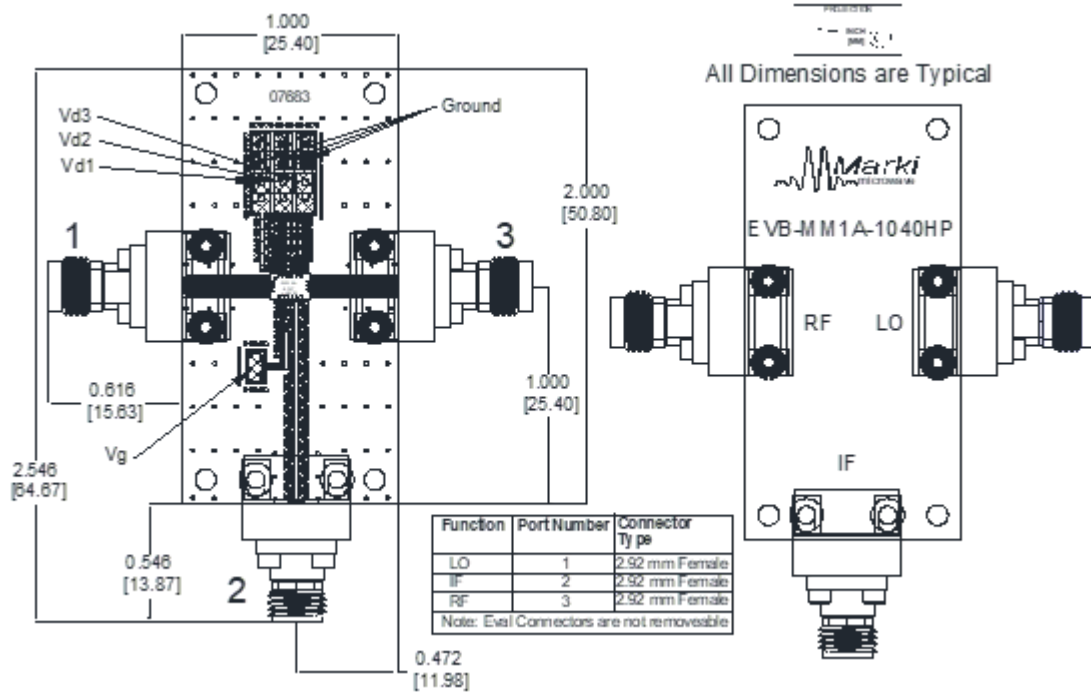
3. All unconnected pins should be connected to PCB RF ground.

Footprint Image

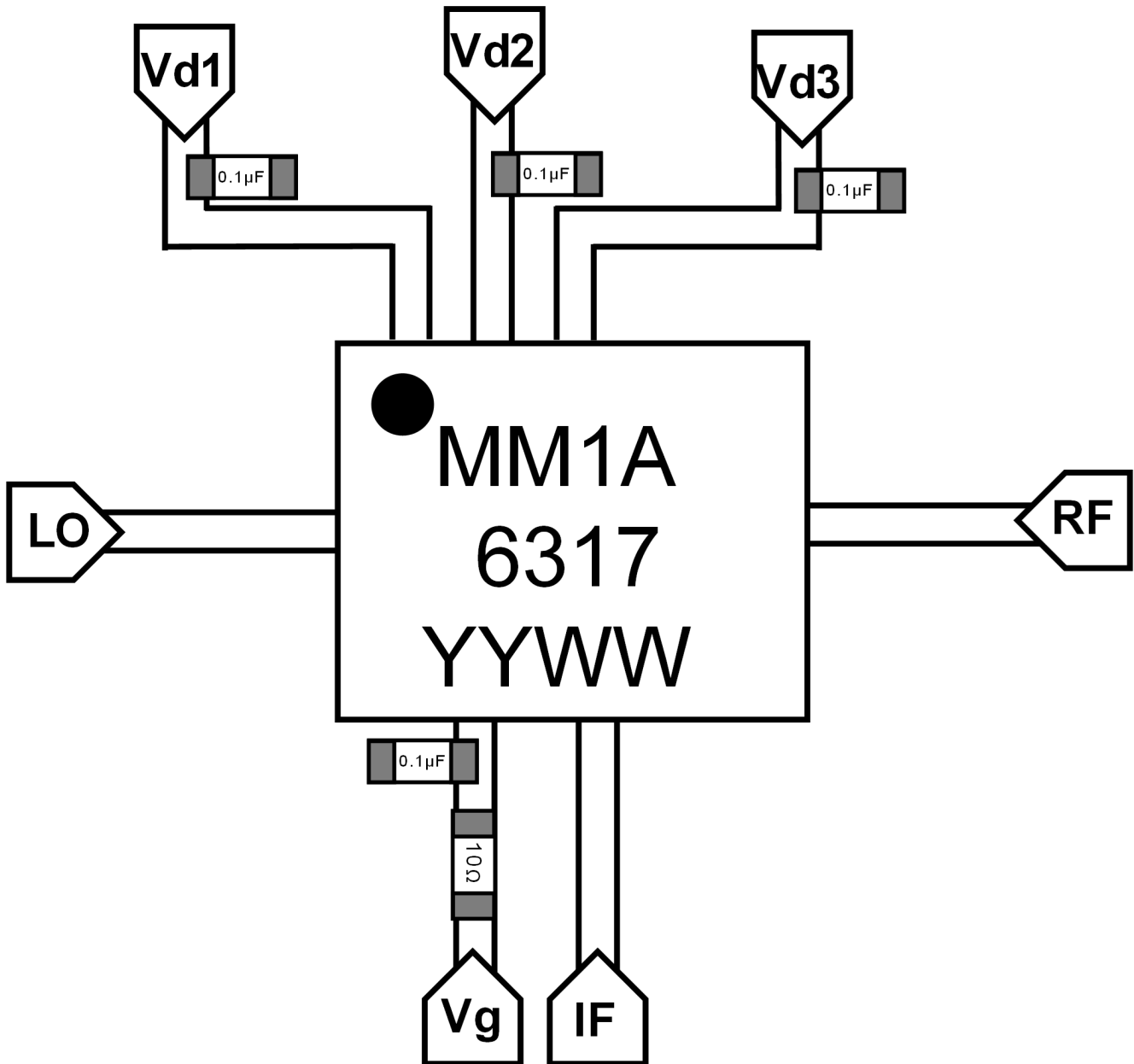
Download: [Footprint Drawing](#)



Evaluation Board - Outline Drawing



Evaluation Board - Application Circuit



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