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Tech Support: support@markimicrowave.com

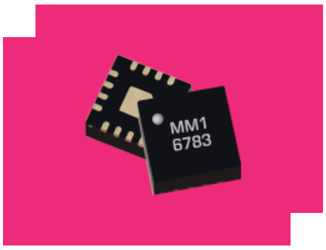
MM1-0222HSM-2

GaAs MMIC Double Balanced Mixer

DEVICE OVERVIEW

General Description

The MM1-0222HSM is a GaAs MMIC double balanced mixer that features excellent conversion loss, superior isolations and spurious performance across a broad bandwidth. MM1-0222HSM works well as both an up and down converter through Ku band and beyond. The MM1-0222HSM is recommend for moderate power applications that demand high linearity. If a lower LO drive is required, the MM1-0222LSM offers similar specs in the same surface mount package. The MM1-0222HSM is available in a 3x3 mm QFN package. Evaluation boards are also available.



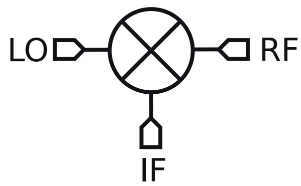
Features

RF/LO response: 2GHz - 22GHz
IF response: DC – 3.5 GHz
Conversion Loss: 7.5 dB
LO to RF Isolation: 50dB

Applications

- Test and Measurement Equipment
- SATCOM
- Radar
- Electronic warfare equipment

Functional Block Diagram



Part Ordering Options

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
MM1-0222HSM-2	GaAs MMIC Double Balanced Mixer	QFN	REACH RoHS	Released	EAR99
EVAL-MM1-0222H	Evaluation Board, GaAs MMIC Double Balanced Mixer	EVAL	REACH RoHS	Released	EAR99

Table Of Contents

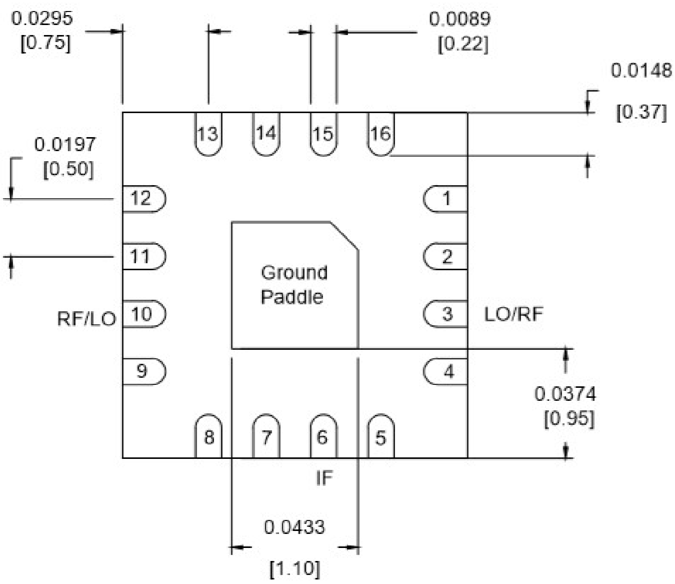
Revision History

Revision Code	Revision Date	Comment
-	2019-09-01	Datasheet Initial Release
A	2020-01-01	Max DC current added; Updated landing pattern
B	2020-03-01	Power Handling Updated
C	2022-03-01	Conversion Loss vs LO Power Plot updated

Port Configuration and Functions

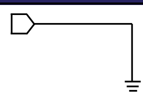
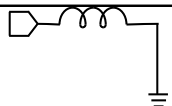
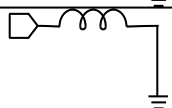
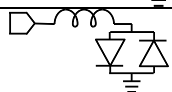
Port Diagram

A bottom-up view of the MM1-0222HSM's SM package outline drawing is shown below. The MM1-0222HSM has the input and output ports given in Port Functions. The MM1-0222HSM can be used in either an up or down conversion. For configuration A, input the LO into pin 3, use pin 10 for the RF, and port 6 for the IF. For configuration B, input the LO into pin 10, use pin 3 for the RF, and pin 6 for the IF.

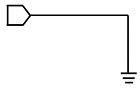
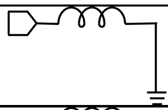
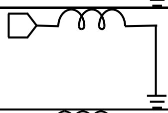
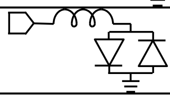


Port Functions

Configuration A

Port	Function	Description	DC Equivalent Circuit
GND	Ground	SM package ground path is provided through the ground paddle.	
Pin 10	RF	Pin 10 is DC short and AC matched to 50 Ohms from 2 to 22 GHz. Blocking capacitor is optional.	
Pin 3	LO	Pin 3 is DC short and AC matched to 50 Ohms from 2 to 22 GHz. Blocking capacitor is optional.	
Pin 6	IF	Pin 6 is DC coupled to the diodes. Blocking capacitor is optional.	

Configuration B

Port	Function	Description	DC Equivalent Circuit
GND	Ground	SM package ground path is provided through the ground paddle.	
Pin 10	LO	Pin 10 is DC short and AC matched to 50 Ohms from 2 to 22 GHz. Blocking capacitor is optional.	
Pin 3	RF	Pin 3 is DC short and AC matched to 50 Ohms from 2 to 22 GHz. Blocking capacitor is optional.	
Pin 6	IF	Pin 6 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 10 DC Current	30	mA
Pin 3 DC Current	30	mA
Pin 6 DC Current	30	mA
Power Handling, at any Port	30	dBm

Package Information

Parameter	Details	Rating
ESD	250 to < 500 Volts	HBM Class 1A
Dimensions	-	3 x 3 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
Ambient Temperature	-55	25	100	°C
LO Input Power	12	-	20	dBm

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.

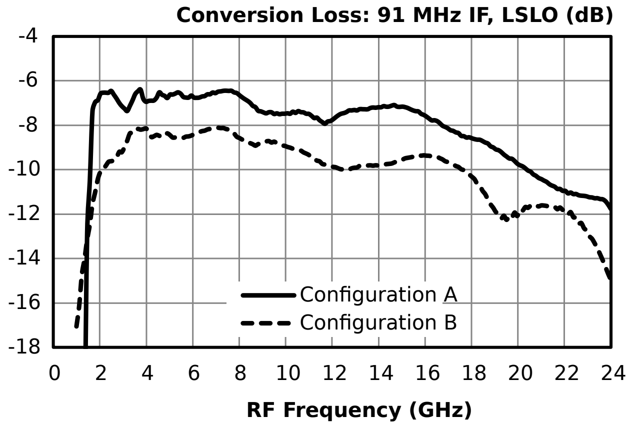
Electrical Specifications

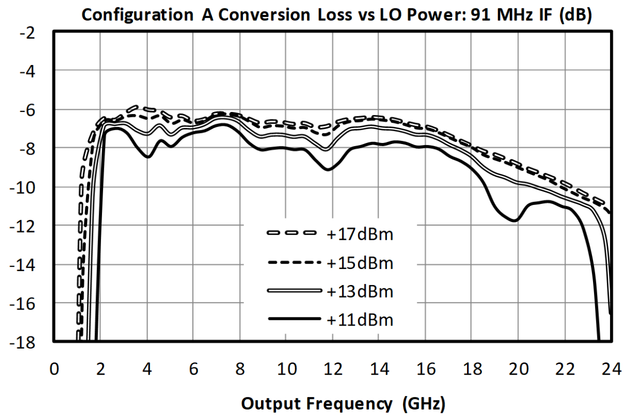
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +15dBm sine wave LO input. Specifications shown for configuration A (B).

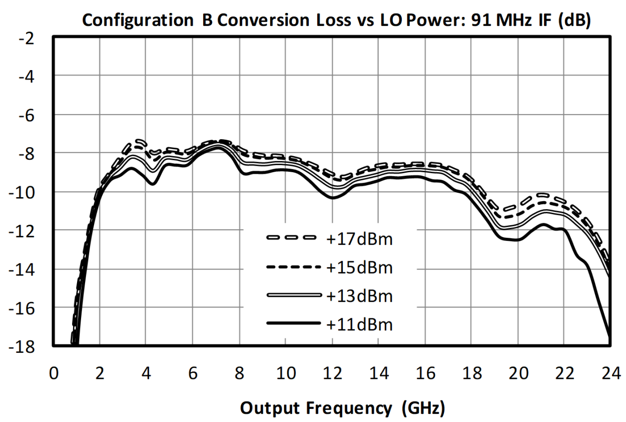
Parameter	Port Configuration	Test Conditions	Min	Typ	Max	Unit
Conversion Loss [1]	A	RF/LO = 2 - 22 GHz I = DC - 0.2 GHz	-	7.5	11.5	dB
Input IP3	A	RF/LO = 2 - 22 GHz I = DC - 0.2 GHz	-	20	-	dBm
Input P1dB	A	-	-	9	-	dBm
Conversion Loss [2]	B	RF/LO = 2 - 22 GHz I = DC - 0.2 GHz	-	9	12	dB
Input IP3	B	RF/LO = 2 - 22 GHz I = DC - 0.2 GHz	-	23	-	dBm
Input P1dB	B	-	-	11	-	dBm
IF Frequency Range	-	-	0	-	3.5	GHz
LO Frequency Range	-	-	2	-	22	GHz
LO-IF Isolation	-	IF/LO = 2 - 22 GHz	-	27	-	dB
LO-RF Isolation	-	RF/LO = 2 - 22 GHz	-	50	-	dB
Noise Figure [3]	-	RF/LO = 2 - 22 GHz I = DC - 0.2 GHz	-	7.5	-	dB
RF Frequency Range	-	-	2	-	22	GHz
RF-IF Isolation	-	RF/IF = 2 - 22 GHz	-	30	-	dB

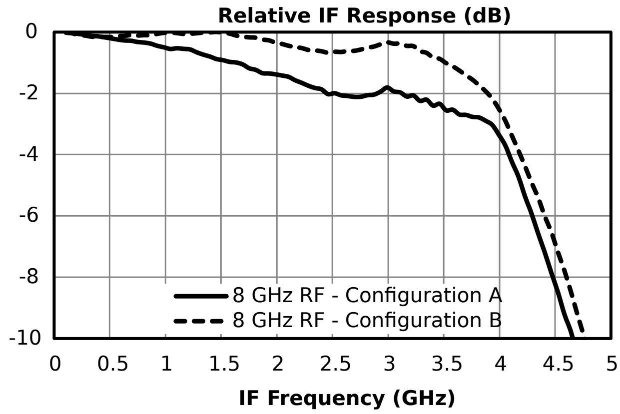
[1][2] Measured as a down converter to a fixed 91MHz IF.
[3] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

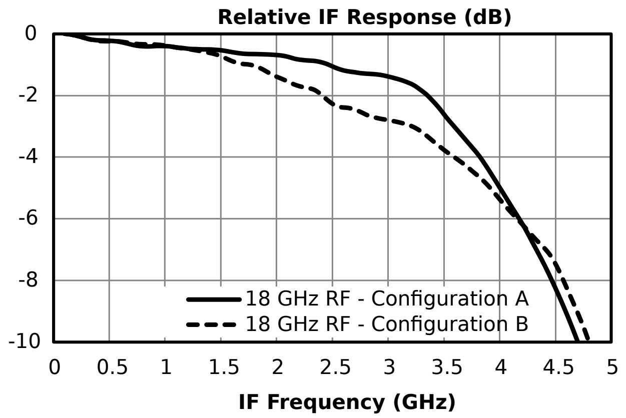
Typical Performance Plots

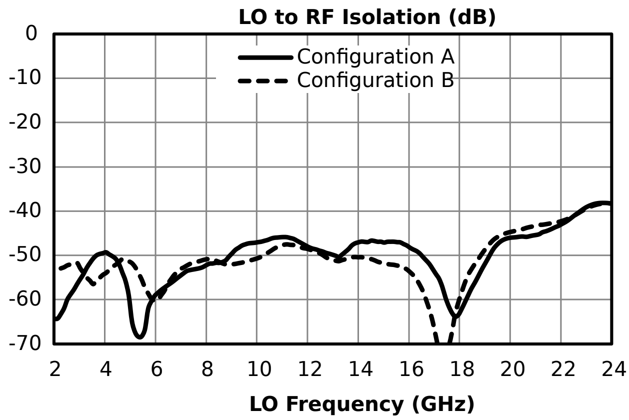


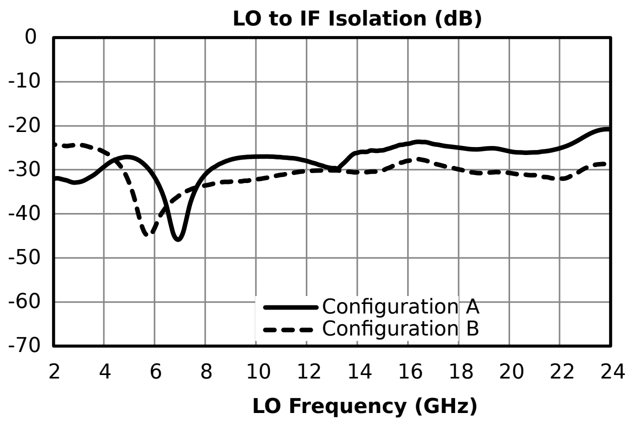


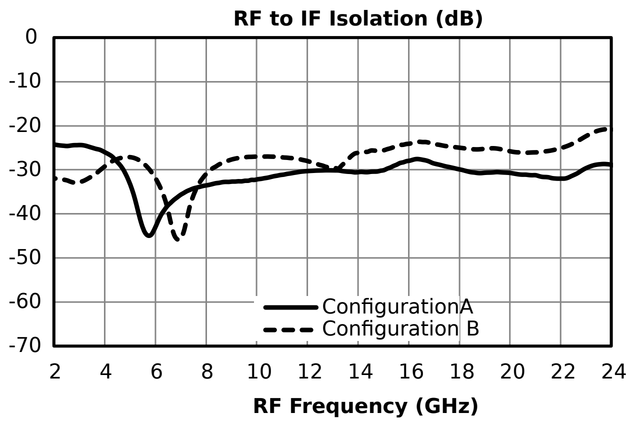


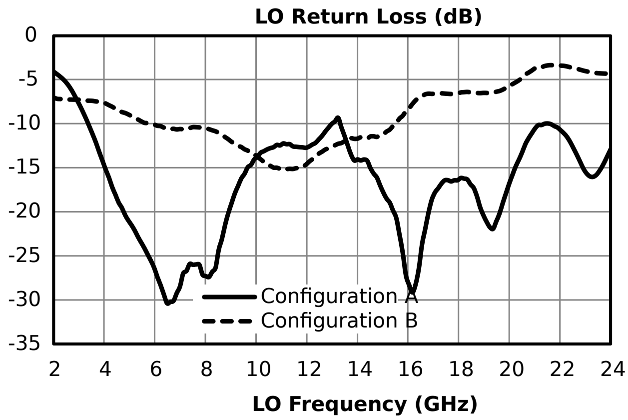


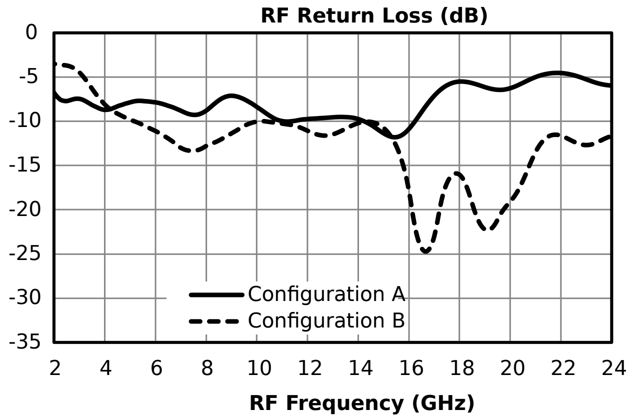


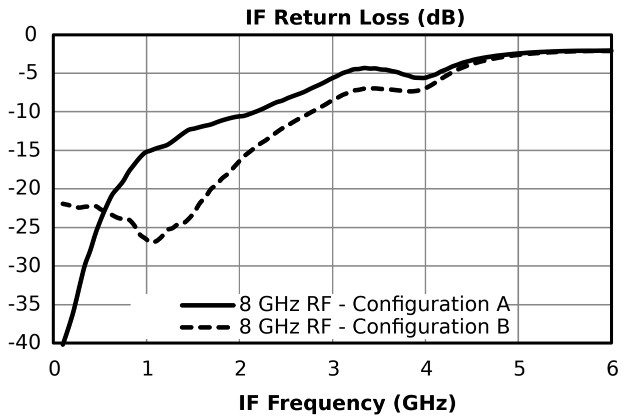


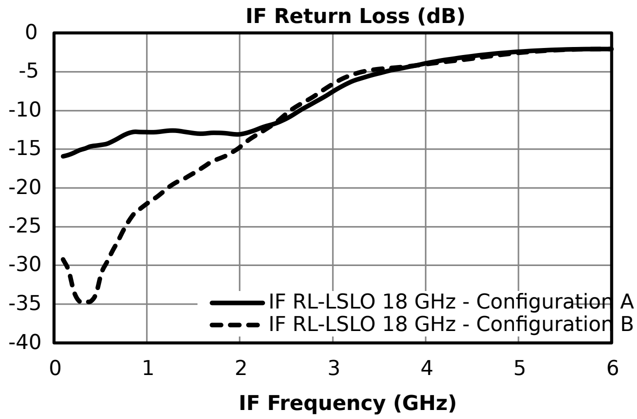




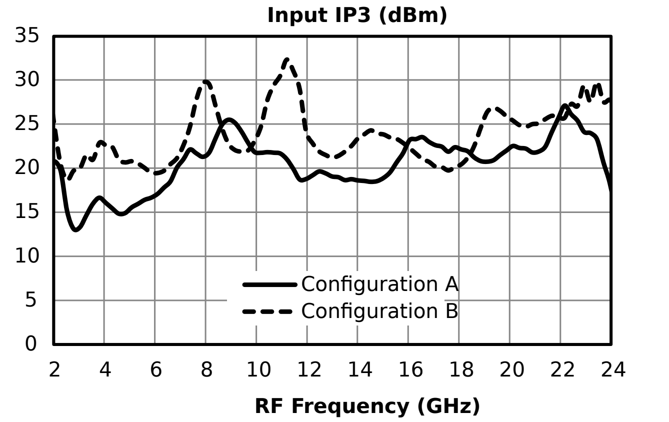

LO Return Loss (dB)
0
-5
-10
-15
-20
-25
-30
-35
2
4
6
8
10
12
14
16
18
20
22
24
LO Frequency (GHz)
Configuration A
Configuration B

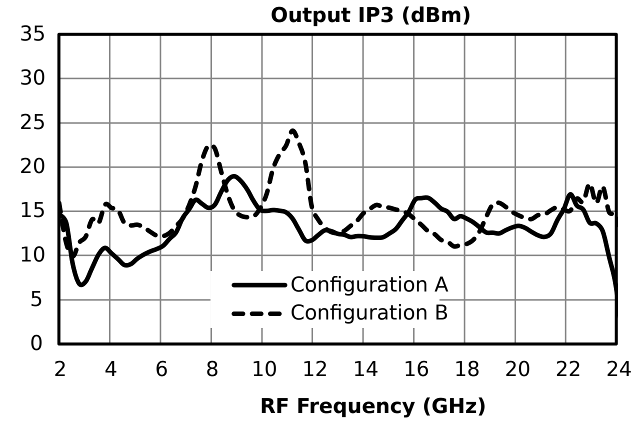

RF Return Loss (dB)
0
-5
-10
-15
-20
-25
-30
-35
2
4
6
8
10
12
14
16
18
20
22
24
RF Frequency (GHz)
Configuration A
Configuration B

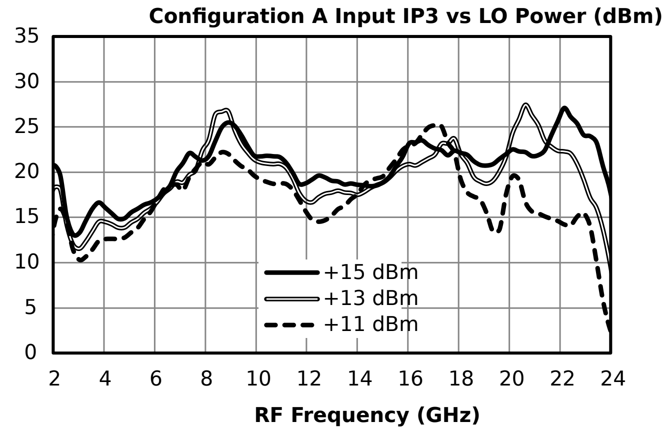

IF Return Loss (dB)
0
-5
-10
-15
-20
-25
-30
-35
-40
0
1
2
3
4
5
6
IF Frequency (GHz)
8 GHz RF - Configuration A
8 GHz RF - Configuration B

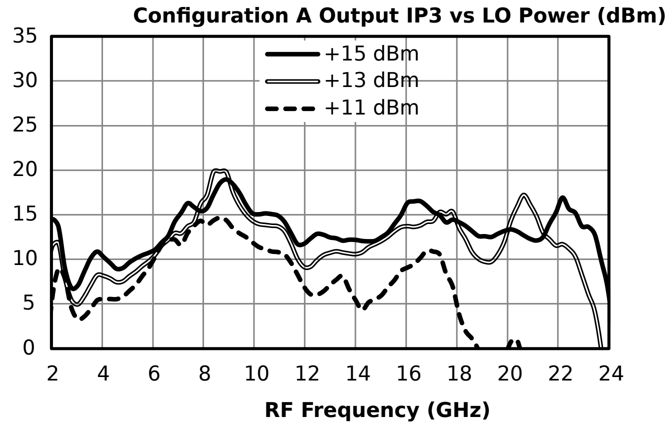

IF Return Loss (dB)
0
-5
-10
-15
-20
-25
-30
-35
-40
0
1
2
3
4
5
6
IF Frequency (GHz)
IF RL-LSLO 18 GHz - Configuration A
IF RL-LSLO 18 GHz - Configuration B

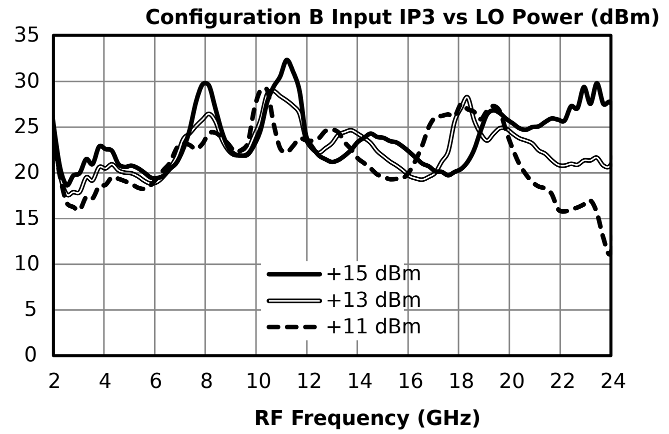
Typical Performance Plots: IP3

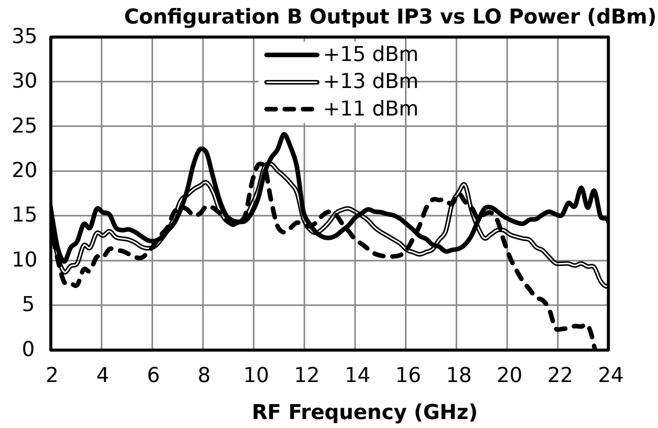




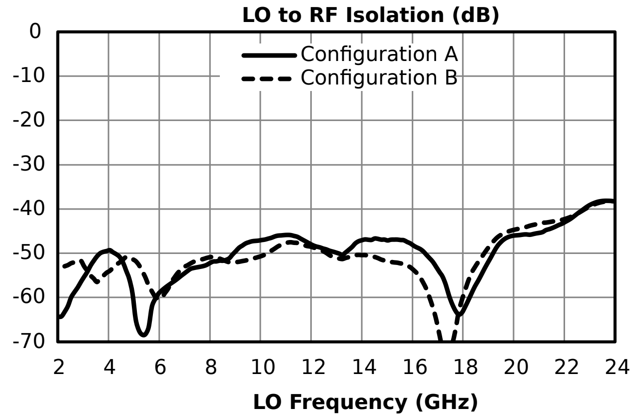


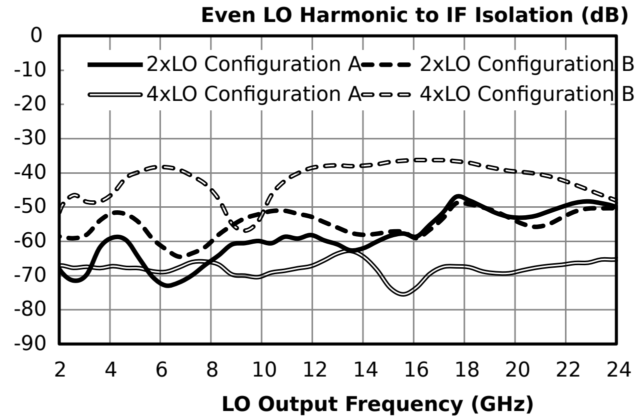


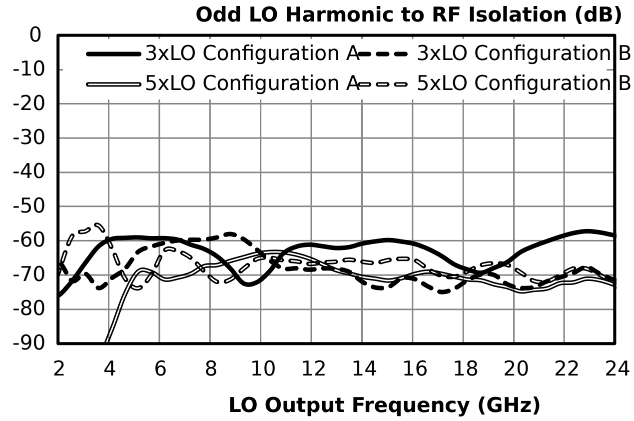


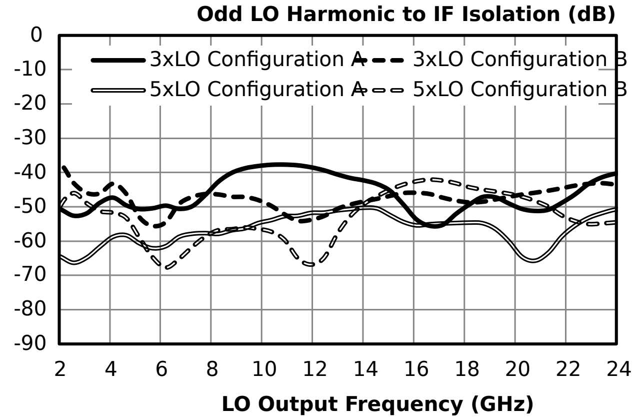


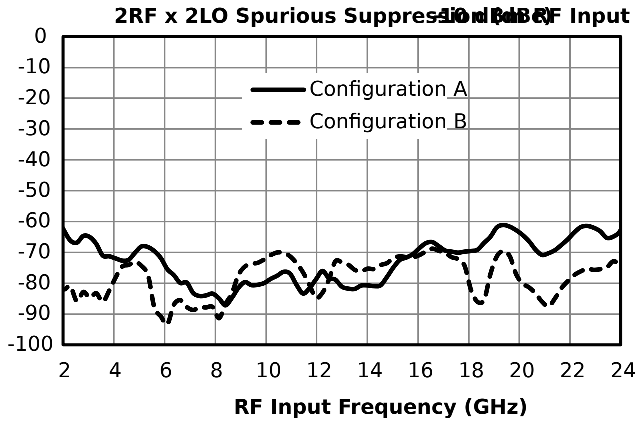
Typical Performance Plots: LO Harmonic Isolation

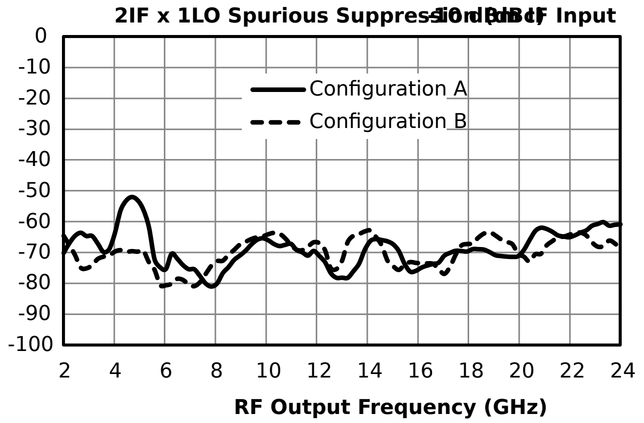












Spur Table

Typical Spurious Performance: Down-Conversion

Typical spurious data is provided by selecting RF and LO frequencies (± 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 69 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 79 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 (16)	Reference	29 (34)	13 (12)	38 (39)	24 (16)
2xRF	66 (74)	51 (50)	69 (79)	59 (57)	70 (74)	59 (54)
3xRF	80 (94)	71 (81)	86 (105)	79 (90)	89 (101)	77 (86)
4xRF	121 (134)	119 (123)	122 (132)	177 (122)	126 (132)	119 (122)
5xRF	137 (149)	132 (143)	135 (150)	130 (144)	138 (150)	130 (146)

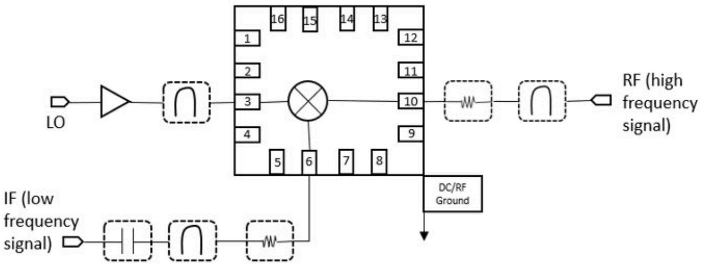
Typical Spurious Performance: Up-Conversion

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 69 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 79 dBc. Data is shown for the frequency plan in 3.6 Typical Performance.

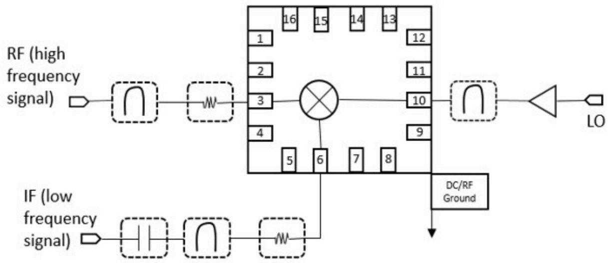
Typical Up-conversion spurious suppression (dBc): Config A (B)

-10 dBm IF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	27 (18)	Reference	49 (56)	47 (50)	57 (59)	63 (62)
2xIF	57 (62)	69 (70)	59 (51)	63 (71)	48 (45)	66 (68)
3xIF	120 (96)	76 (78)	86 (94)	68 (73)	84 (89)	69 (71)
4xIF	130 (128)	123 (128)	115 (111)	118 (126)	104 (103)	114 (119)
5xIF	151 (156)	126 (129)	135 (147)	115 (124)	126 (139)	108 (118)

Application Circuit



Configuration A



Configuration B

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.

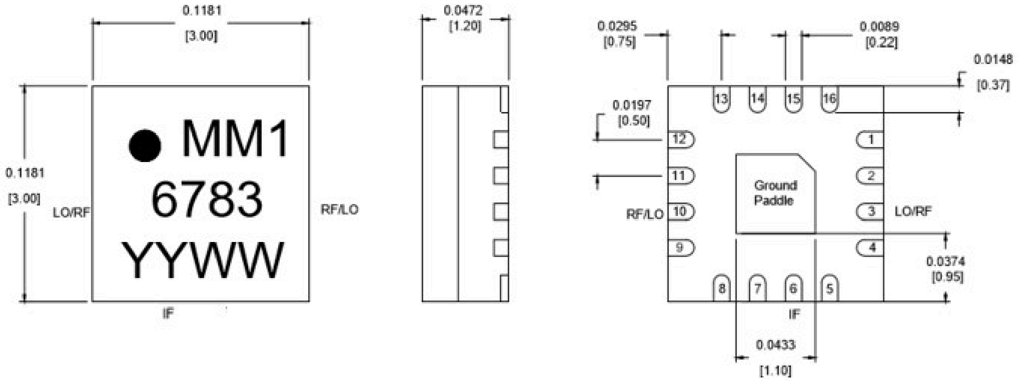
RF Ground – The ground paddle of the QFN should be connected to a low noise RF ground with very low electrical resistance for high frequency operation.

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



Pin #	Config A	Config B
1	N/C	N/C
2	N/C	N/C
3	LO	RF
4	N/C	N/C
5	N/C	N/C
6	IF	IF
7	N/C	N/C
8	N/C	N/C
9	N/C	N/C
10	RF	LO
11	N/C	N/C
12	N/C	N/C
13	N/C	N/C
14	N/C	N/C
15	N/C	N/C
16	N/C	N/C

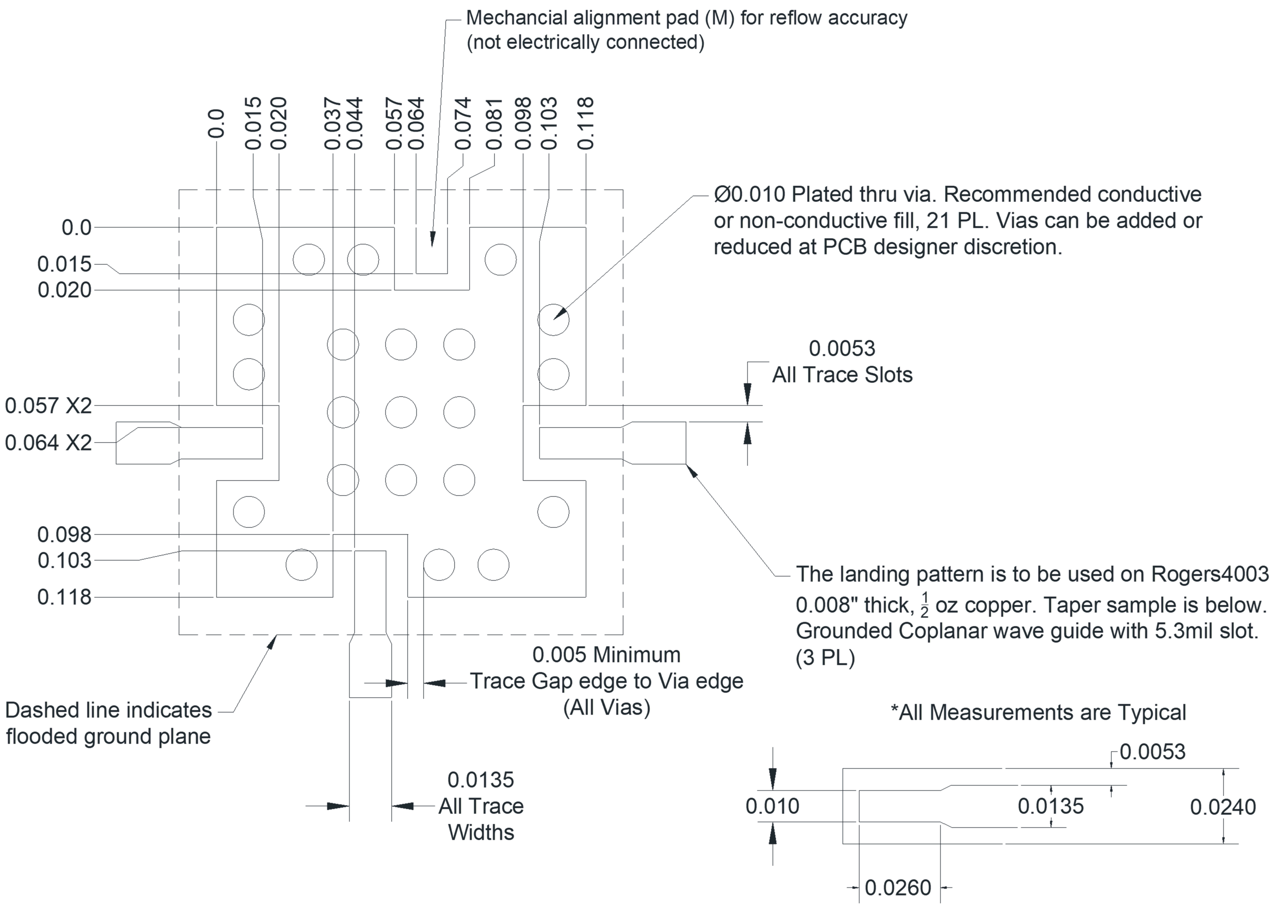
1. Substrate material is LCP.
2. I/O Leads and Ground Paddle plating is (from base to finish):

Ni:	0.5um MIN
Pd:	0.02um MIN
Au	0.05um MAX

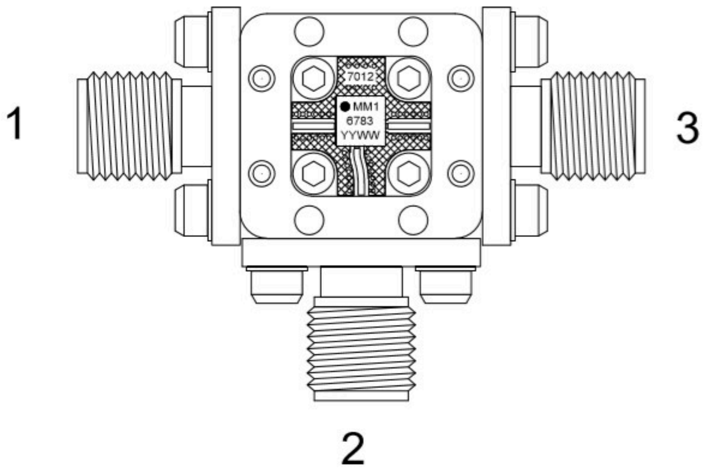
3. All unconnected pads should be connected to PCB RF ground.

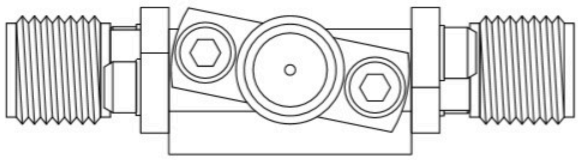
Footprint Image

Download : Footprint Drawing



Evaluation Board - Outline Drawing





Function	Configuration A Port Number	Configuration B Port Number	Connector Type
LO	1	3	SMA Female
IF	2	2	SMA Female
RF	3	1	SMA Female
Note: Eval Connectors are not removeable			

DISCLAIMER