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Sales & Customer Support: sales@markimicrowave.com
Tech Support: support@markimicrowave.com

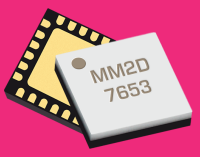
MM2D-0528SCSM-2

GaAs MMIC Differential IF Triple Balanced Mixer

DEVICE OVERVIEW

General Description

MM2D-0528SCSM is a GaAs MMIC triple balanced mixer with high dynamic range and low conversion loss. This mixer offers broad operating bandwidths for applications in the C through Ka bands. The MM2D-0528SCSM has on-chip baluns for the LO and RF ports, while offering differential ports on the IF for flexible operation with an external balun or differential interface. The MM2D-0528SCSM is available in a 4x4 mm QFN package.



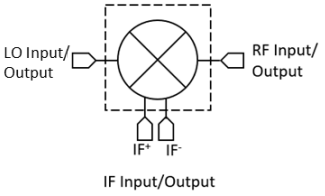
Features

- High LO to RF isolation
- Broad, overlapping RF/LO & IF bands
- Differential IF port

Applications

- Test and Measurement Equipment
- C through Ka band radar

Functional Block Diagram



Part Ordering Options

Part Number	Description	Package	Packing Size	Green Status	Product Lifecycle	Export Classification
MM2D-0528SCSM-2	GaAs MMIC Differential IF Triple Balanced Mixer	QFN	-	REACH RoHS	Released	EAR99
EVB-MM2D-0528SC	Evaluation Board, GaAs MMIC 5-28 GHz Differential IF Triple Balanced Mixer	EVB	-	REACH RoHS	Released	EAR99
MM2D-0528S-2-TR	Tape and Reel, GaAs MMIC Differential IF Triple Balanced Mixer	QFN	13"	REACH RoHS	Released	EAR99

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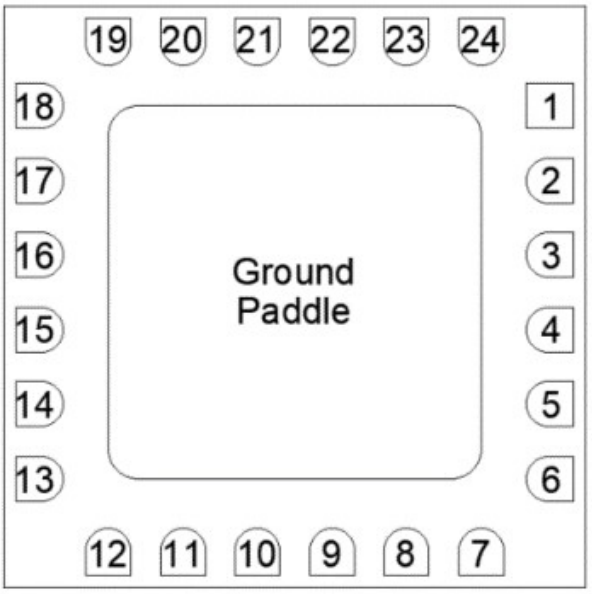
Revision History

Revision Code	Revision Date	Comment
-	2022-11-01	Datasheet Initial Release

Port Configuration and Functions

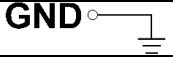
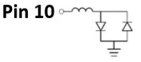
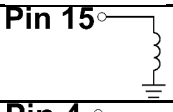
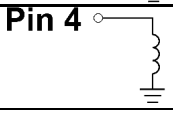
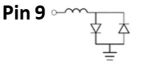
Port Diagram

A bottom-up view of the MM2D-0528SCSM's SM package outline drawing is shown below. The MM2D-0528SCSM has the input and output ports given in Port Functions. The MM2D-0528SCSM can be used in either an up or down conversion. Configuration A/B refer to the same part number (MM2D-0528SCSM) used in one of two different ways for optimal spurious performance. For configuration A, input the LO into pin 4, use pin 15 for the RF. For configuration B, input the LO into pin 4, use pin 15 for the RF.

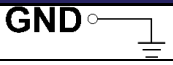
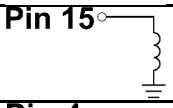
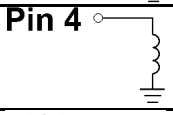
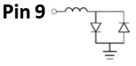


Port Functions

Configuration A

Port	Function	Description	DC Equivalent Circuit
GND	Ground	SM package ground path is provided through the ground paddle.	
Pin 10	IF-1	Pins 10 is DC coupled to the diodes.	
Pin 15	RF	Pin 15 is DC short for the SM package.	
Pin 4	LO	Pin 4 is DC short for the SM package.	
Pin 9	IF-2	Pin 9 is DC coupled to the diodes.	

Configuration B

Port	Function	Description	DC Equivalent Circuit
GND	Ground	SM package ground path is provided through the ground paddle.	
Pin 10	IF-1	Pins 10 is DC coupled to the diodes.	
Pin 15	LO	Pin 15 is DC short for the SM package.	
Pin 4	RF	Pin 4 is DC short for the SM package.	
Pin 9	IF-2	Pin 9 is DC coupled to the diodes.	

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	-40	°C
Minimum Storage Temperature	-40	°C
Pin 10 DC Current	15	mA
Pin 15 DC Current	20	mA
Pin 4 DC Current	20	mA
Pin 9 DC Current	15	mA
Power Handling, at any Port	33	dBm

Package Information

Parameter	Details	Rating
ESD	250 to < 500 Volts	HBM Class 1A
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
Ambient Temperature	-40	25	100	°C
LO Input Power	23	28	30	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.

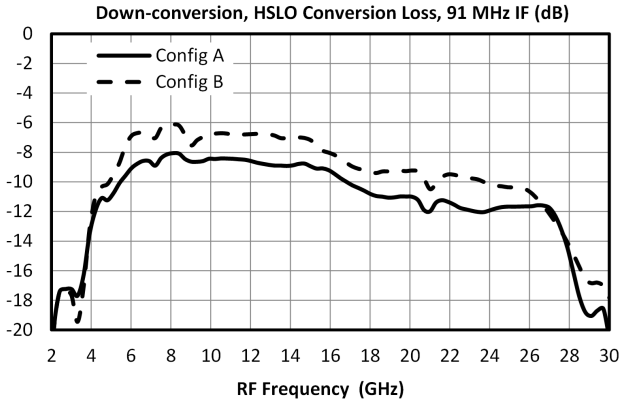
Electrical Specifications

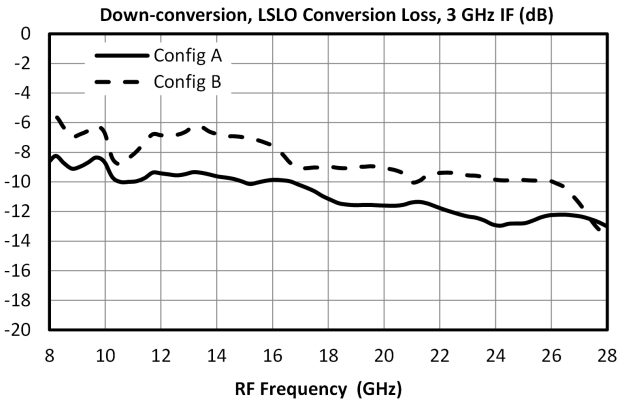
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for the connectorized EVAL package mixer† used with a typical +28dBm sine wave LO. Min and Max limits apply only to our connectorized units and are guaranteed at TA=+25°C.

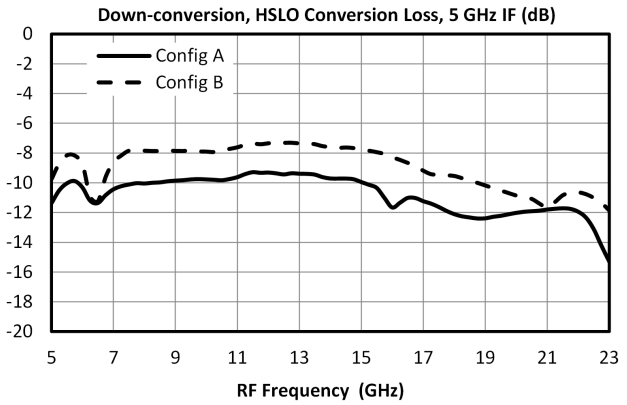
Parameter	Port Configuration	Test Conditions	Min	Typ	Max	Unit
Conversion Loss [1]	A	RF/LO = 5 - 28 GHz I = 0.2 – 12 GHz	-	12	-	dB
Conversion Loss [2]	A	RF/LO = 5 - 28 GHz I = DC – 0.2 GHz	-	10	-	dB
Input IP3	A	RF/LO = 5 - 28 GHz I = DC – 0.2 GHz	-	31	-	dBm
Isolation, LO to IF	A	IF/LO = 5 - 28 GHz	-	40	-	dB
Isolation, LO to RF	A	RF/LO = 5 - 28 GHz	-	36	-	dB
Isolation, RF to IF	A	RF/IF = 5 - 28 GHz	-	41	-	dB
Noise Figure [3]	A	RF/LO = 5 - 28 GHz I = DC – 0.2 GHz	-	10	-	dB
Conversion Loss [4]	B	RF/LO = 5 - 28 GHz I = 0.2 – 12 GHz	-	10	-	dB
Conversion Loss [5]	B	RF/LO = 5 - 28 GHz I = DC – 0.2 GHz	-	9	-	dB
Input IP3	B	RF/LO = 5 - 28 GHz I = DC – 0.2 GHz	-	28	-	dBm
Isolation, LO to IF	B	IF/LO = 5 - 28 GHz	-	44	-	dB
Isolation, LO to RF	B	RF/LO = 5 - 28 GHz	-	42	-	dB
Isolation, RF to IF	B	RF/IF = 5 - 28 GHz	-	37	-	dB
Noise Figure [6]	B	RF/LO = 5 - 28 GHz I = DC – 0.2 GHz	-	9	-	dB
IF Frequency Range	-	-	5	-	12	GHz
Input 1 dB Gain Compression Point (P1dB)	-	-	-	19	-	dBm
LO Frequency Range	-	-	5	-	28	GHz
RF Frequency Range	-	-	5	-	28	GHz

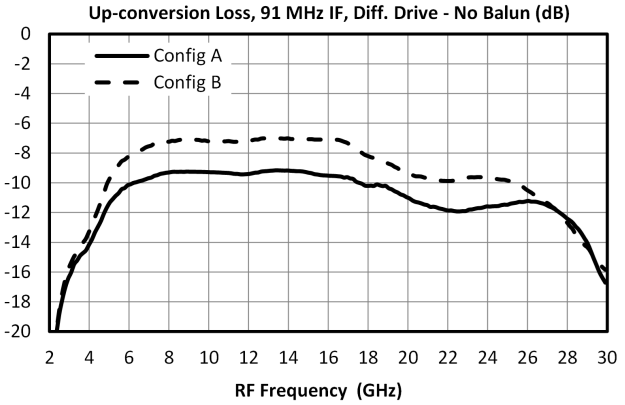
[1][2][4][5] Measured as a down converter to a fixed 91 MHz IF. Unless otherwise stated, frequency conversion done using a highside LO.
[3][6] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

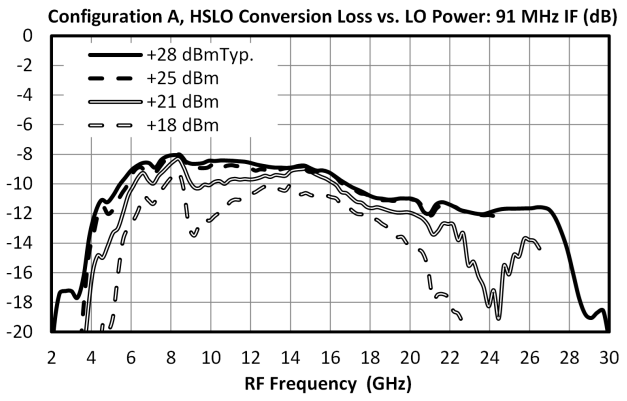
Typical Performance: Conversion Loss

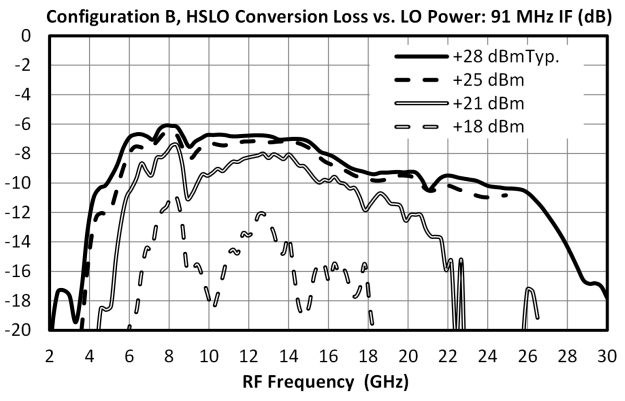






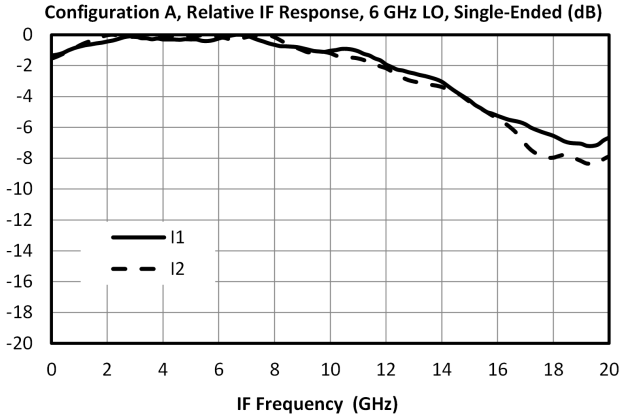




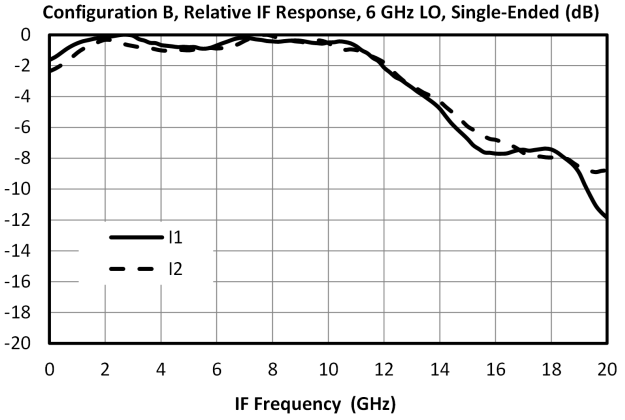


Typical Performance: IF Response

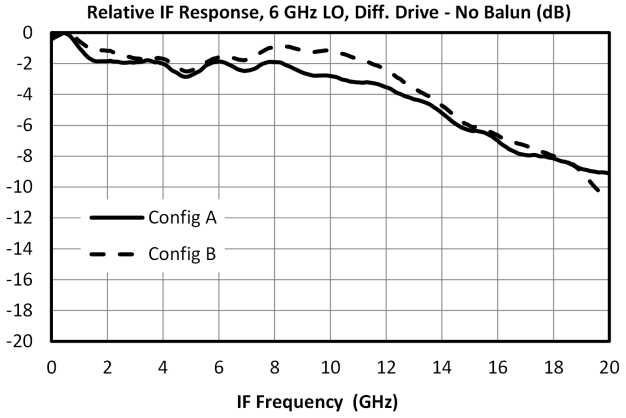
Configuration A, Relative IF Response, 6 GHz LO, Single-Ended (dB)



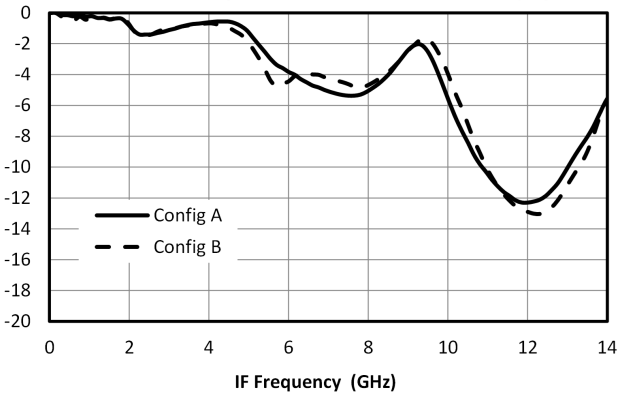
Configuration B, Relative IF Response, 6 GHz LO, Single-Ended (dB)



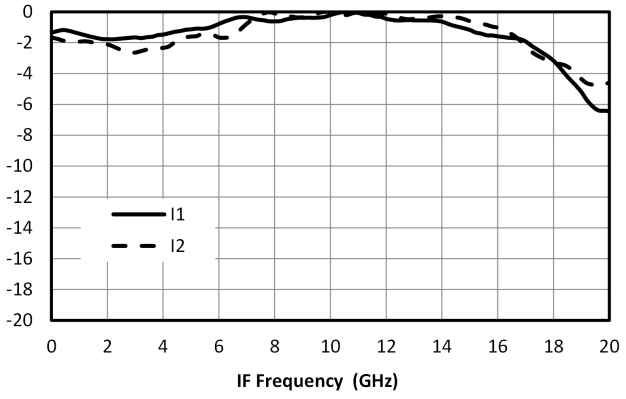
Relative IF Response, 6 GHz LO, Diff. Drive - No Balun (dB)



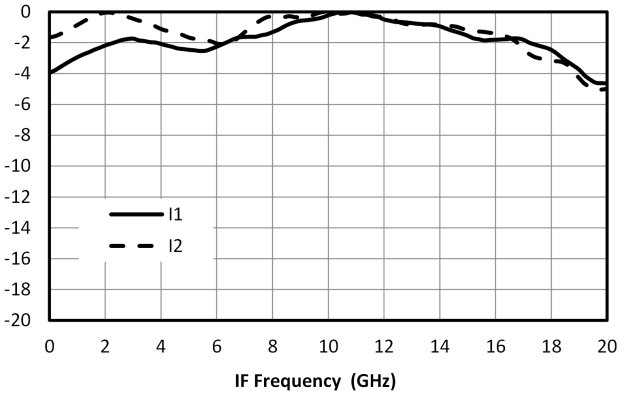
Relative IF Response, 6 GHz RF, Balun-Combined (dB)



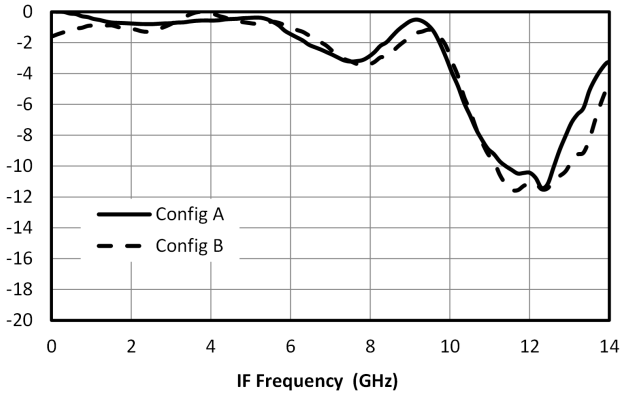
Configuration A, Relative IF Response, 27 GHz LO, Single-Ended (dB)



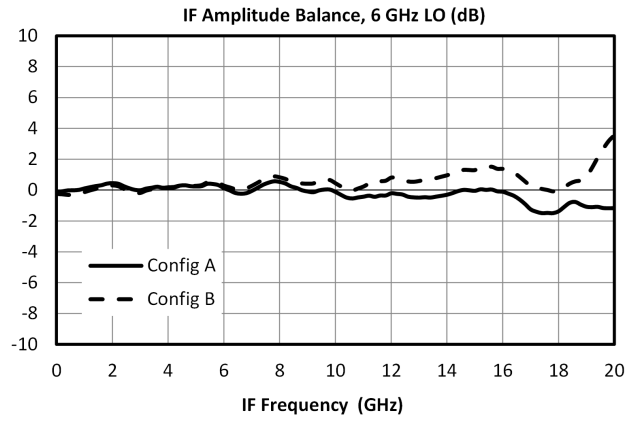
Configuration B, Relative IF Response, 27 GHz LO, Single-Ended (dB)

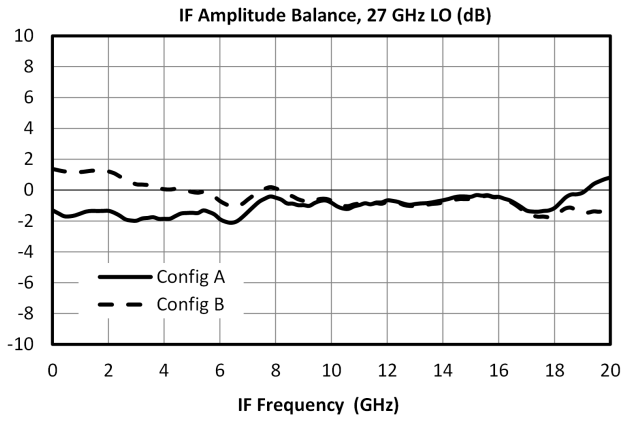


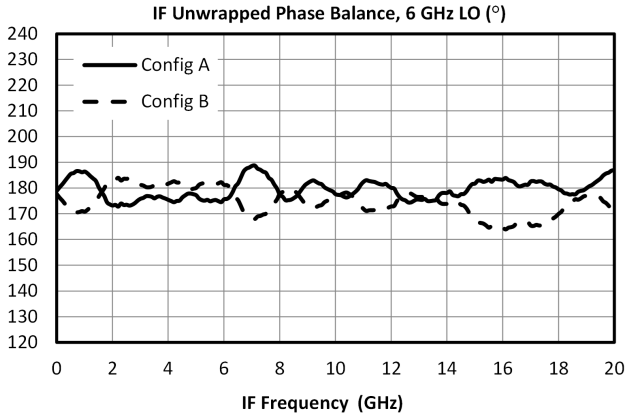
Relative IF Response, 27 GHz RF, Balun-Combined (dB)

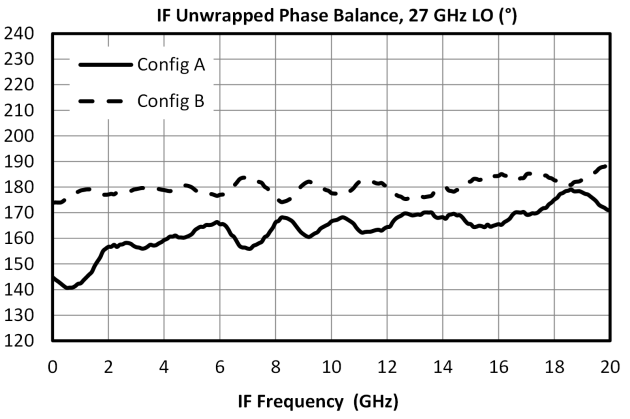


Typical Performance: IF Amplitude and Phase Balance



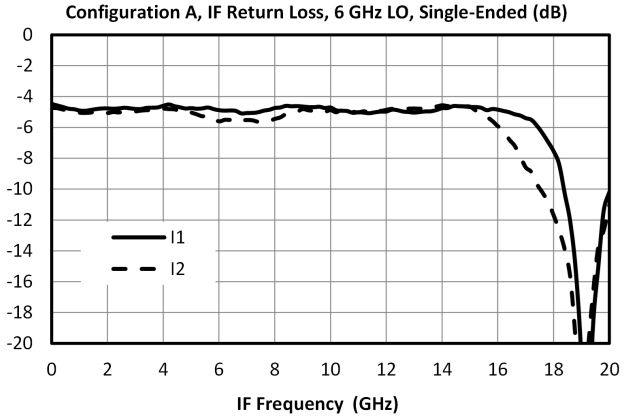




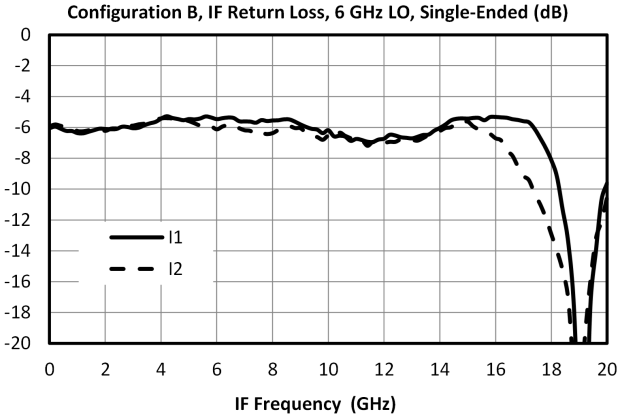


Typical Performance: Return Loss

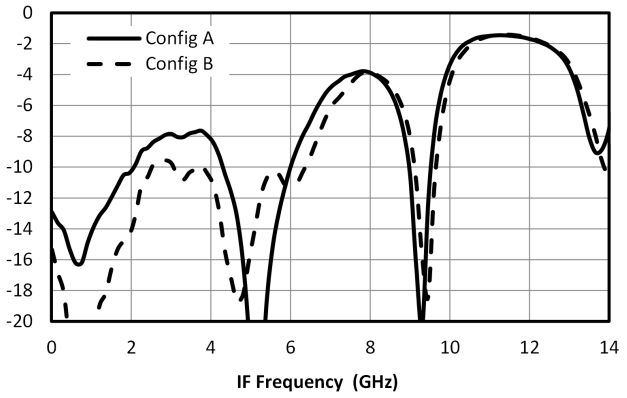
Configuration A, IF Return Loss, 6 GHz LO, Single-Ended (dB)



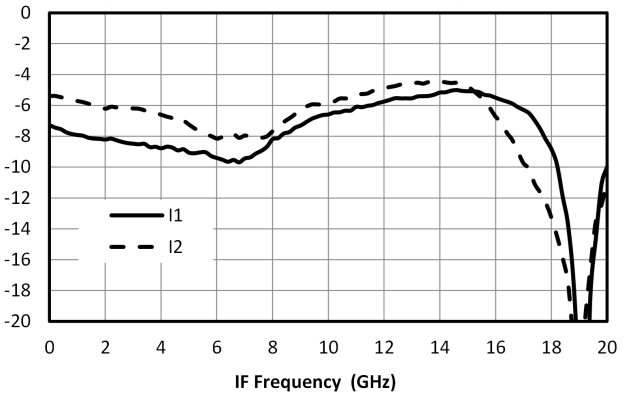
Configuration B, IF Return Loss, 6 GHz LO, Single-Ended (dB)



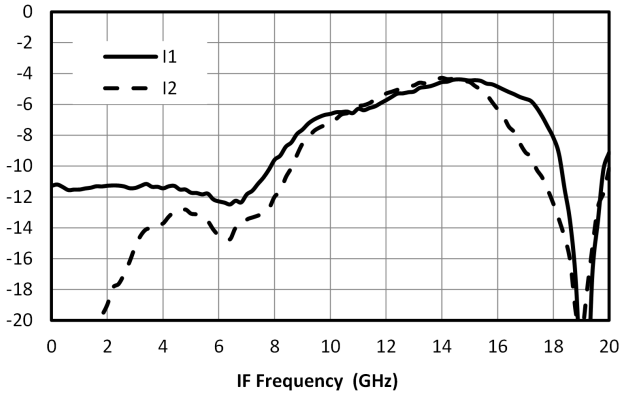
IF Return Loss, 6 GHz RF, Balun-Combined (dB)



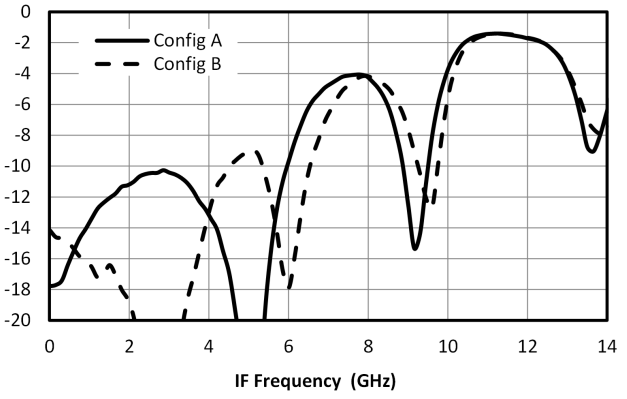
Configuration A, IF Return Loss, 27 GHz LO, Single-Ended (dB)



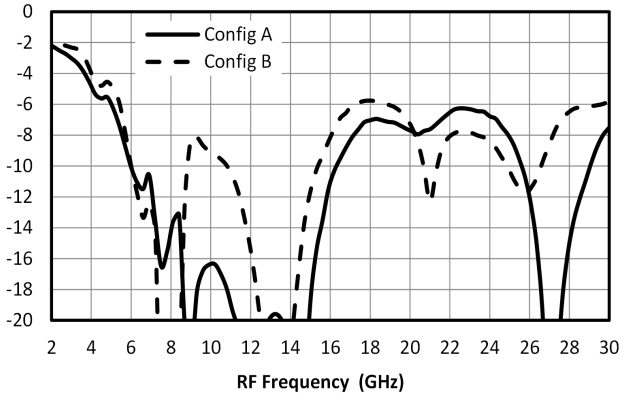
Configuration B, IF Return Loss, 27 GHz LO, Single-Ended (dB)



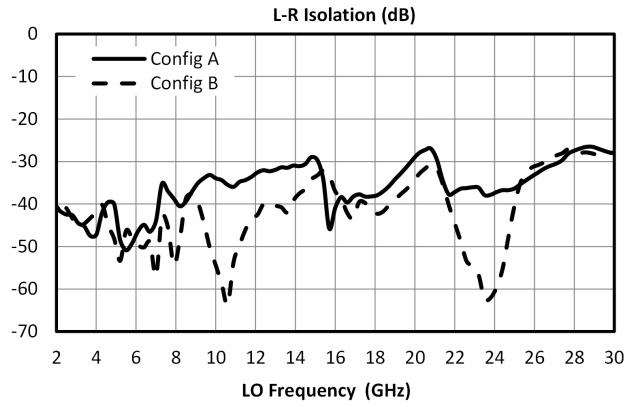
IF Return Loss, 27 GHz RF, Balun-Combined (dB)

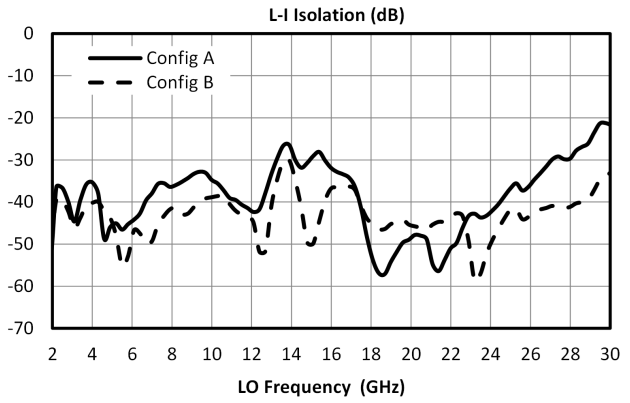


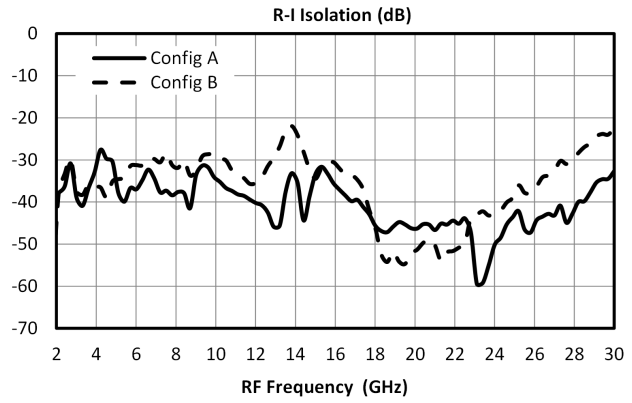
RF Return Loss (dB)



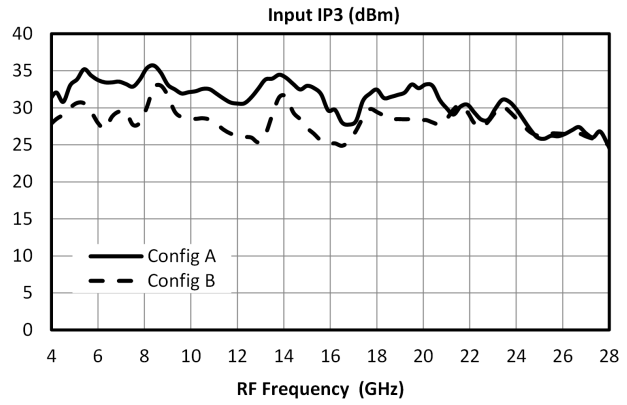
Typical Performance: Isolations

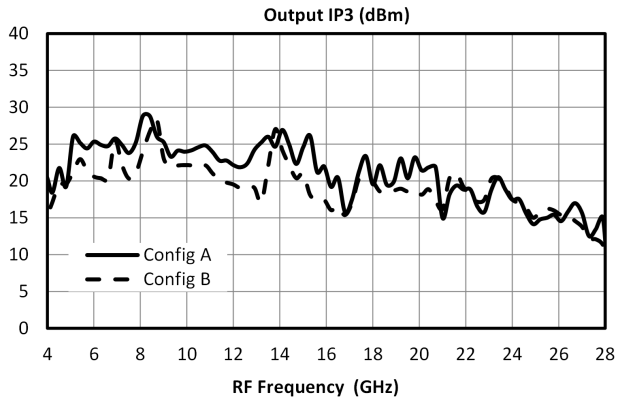


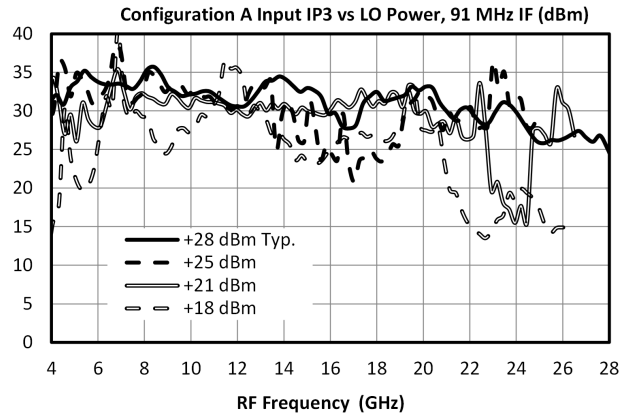


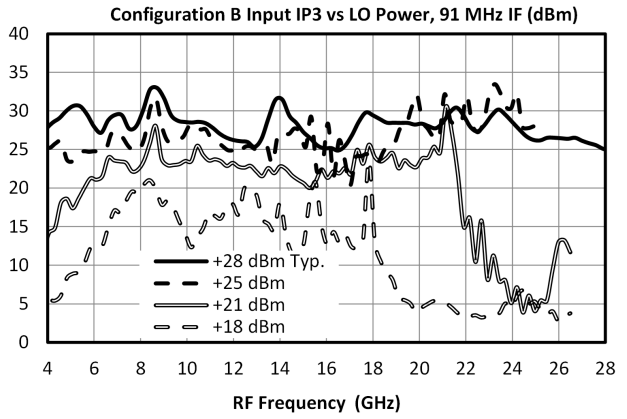


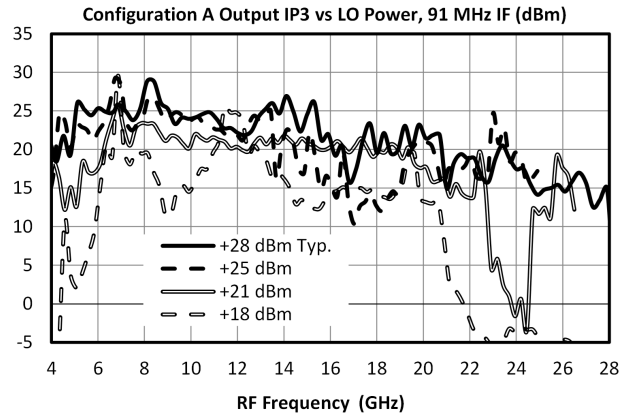
Typical Performance: IP3

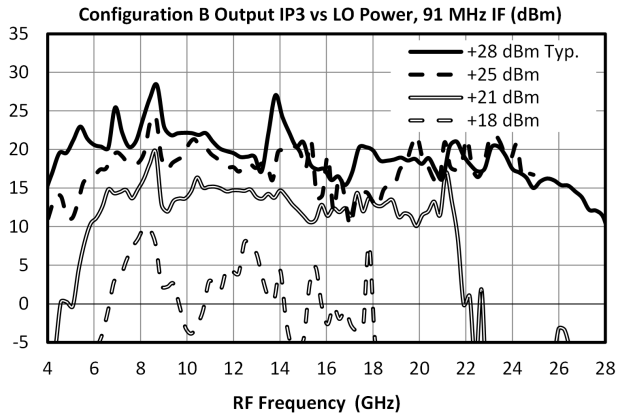




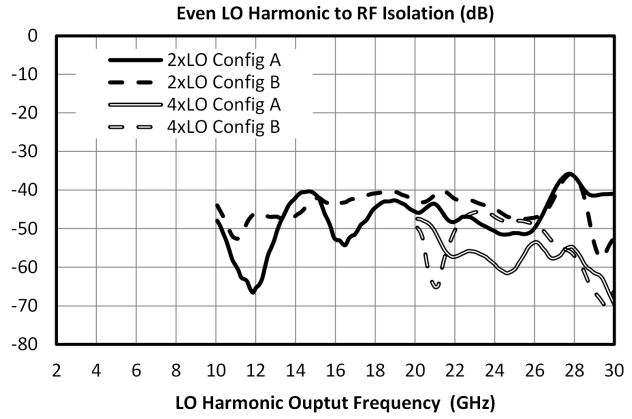


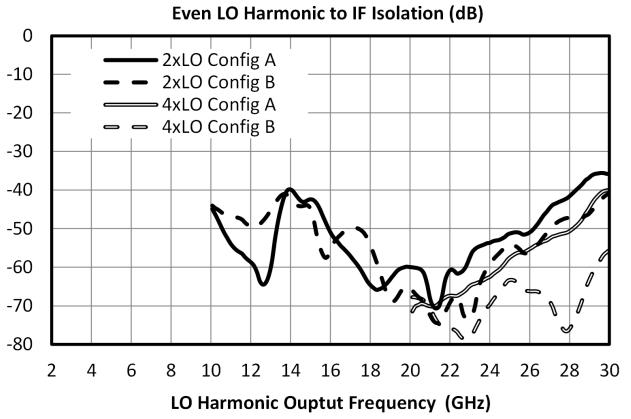


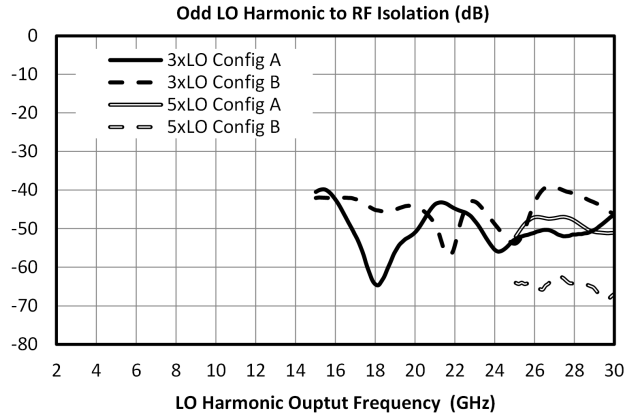


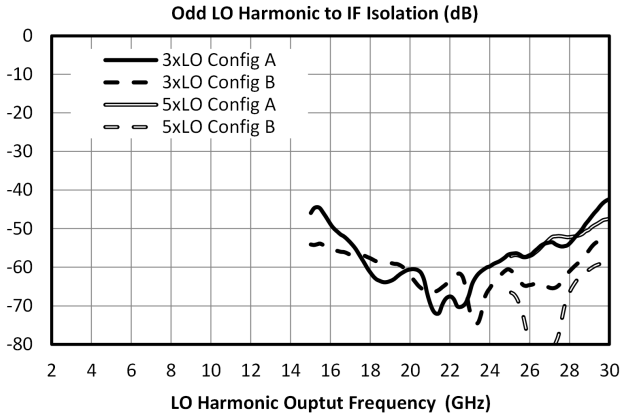


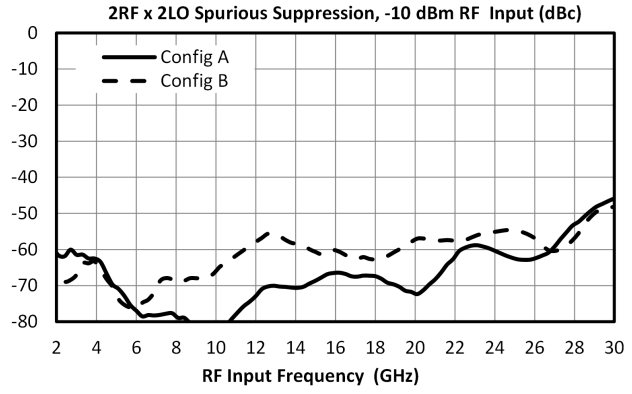
Typical Performance: Harmonic Isolation and Spurious Suppression

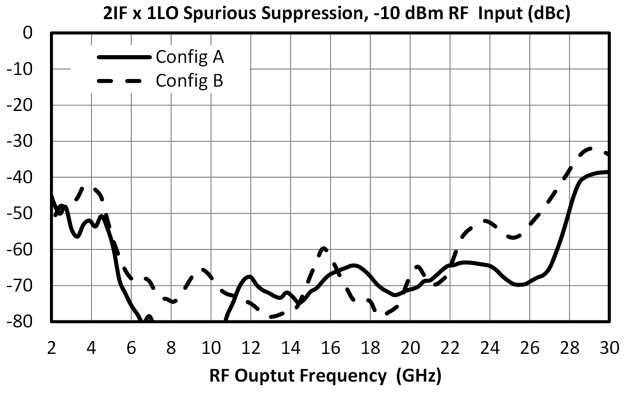












Spur Table

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 68 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 78 dBc. Data is shown for the frequency plan in 3.6 Typical Performance. mLOx0RF plots can be found in Section 3.6.5. 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	32 (30)	Reference	25 (21)	11 (12)	27 (24)	17 (26)
2xRF	84 (75)	70 (60)	68 (61)	75 (65)	77 (65)	78 (76)
3xRF	N/A	92 (84)	108 (94)	100 (90)	107 (94)	99 (91)
4xRF	N/A	132 (130)	140 (126)	145 (129)	144 (129)	145 (130)
5xRF	N/A	159 (163)	167 (158)	167 (156)	167 (157)	168 (158)

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.

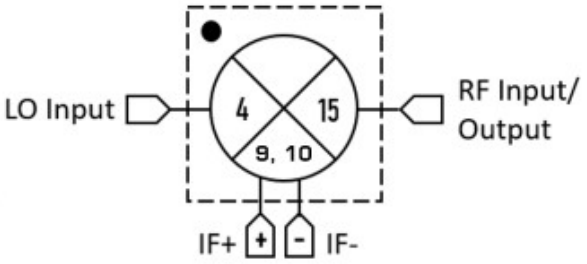
Typical Up-conversion spurious suppression (dBc): Config A (B)

-10 dBm IF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	28 (29)	Reference	29 (25)	10 (10)	24 (26)	17 (19)
2xIF	73 (78)	69 (64)	71 (68)	67 (63)	63 (63)	57 (58)
3xIF	104 (106)	93 (84)	98 (91)	87 (80)	86 (82)	78 (75)
4xIF	140 (134)	136 (128)	137 (131)	128 (123)	123 (116)	108 (106)
5xIF	153 (159)	164 (150)	161 (157)	152 (147)	146 (141)	129 (132)

Application Information

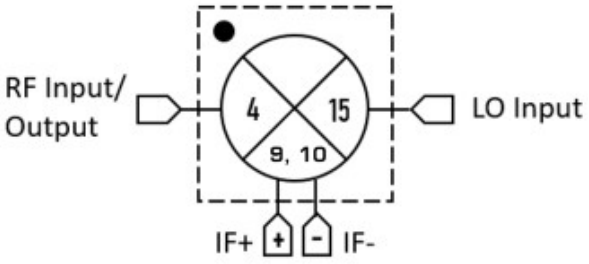
Configuration A/B

Configuration A and Configuration B refer to the same part number used in one of two different ways to optimize spurious performance while balancing other parameters such as conversion loss, LO drive, and isolation. Experimentation or simulation is required to determine which configuration results in optimal spurious suppression for a given application.



IF Input/Output

Configuration A



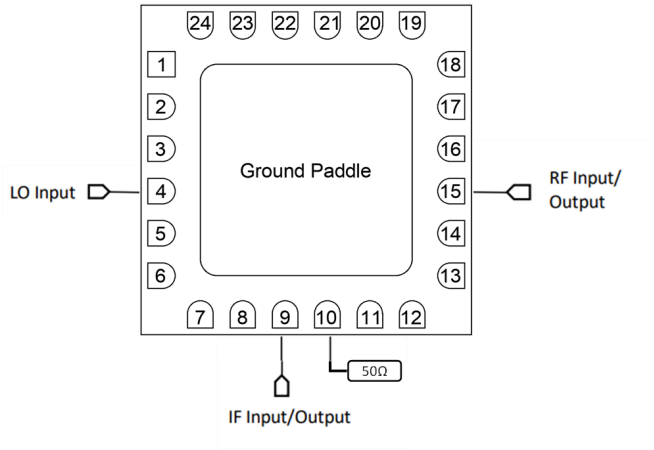
IF Input/Output

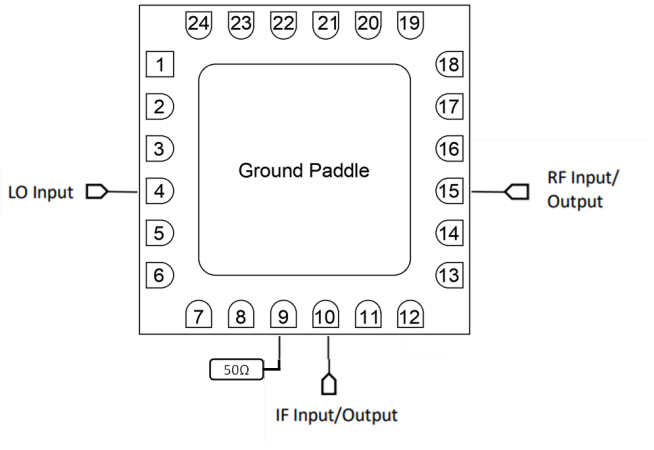
Configuration B

Single Ended and Differential Usage

Single Ended IF Use Case

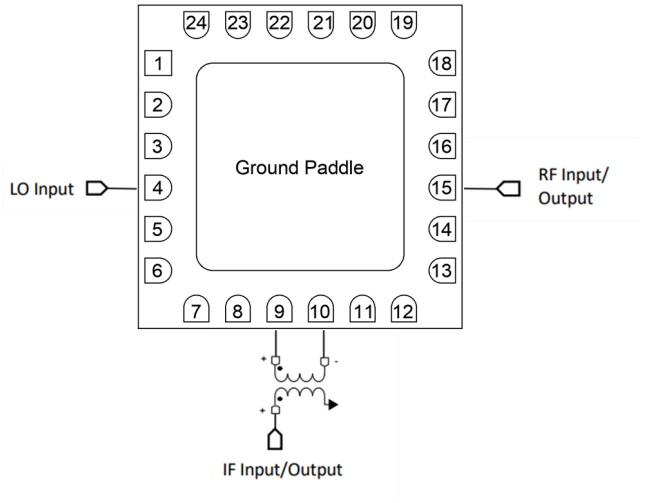
When using this mixer with a single ended IF, the unused IF port should be terminated with a 50Ω load. This is how all plots in section 3.6 which are titled “Single Ended” are taken. In this configuration, there is no balance on the IF port and thus there is an expected degradation in isolations and spurious suppression from the specs listed in table 3.5 Electrical Specifications. A top-down view of the MM2D-0528SCSM’s SM package outline drawing is shown below in Configuration A configured for use with a single ended IF.

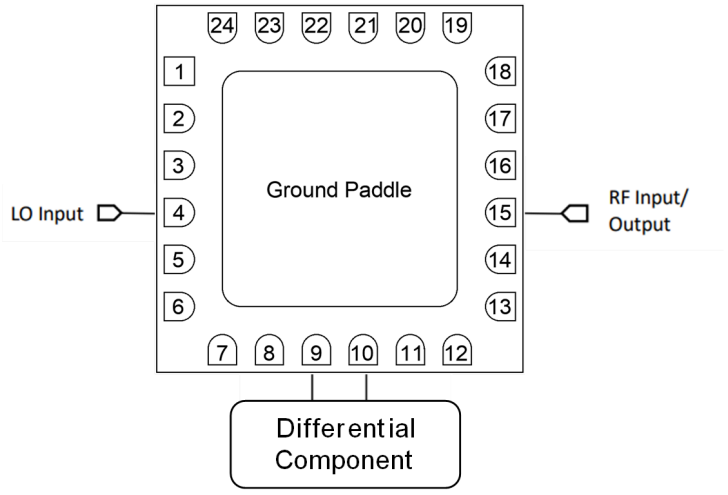




Differential IF Use Case

The MM2D-0528SCSM can also be used with the IF port driving, or being driven by, a differential signal. This has the benefit of balance on the IF port compared to the single ended use case which allows for greater suppression of spurs and greater isolation between ports. The degree to which the balance improves these specs is dependent on the common mode rejection of the differential circuit attached to the mixer's IF ports. This is how the data was collected for plots in section 3.6 titled "Diff Drive" and the plots which are measured with our off-chip balun. A top-down view of the MM2D-0528SCSM's SM package outline drawing is shown below in Configuration A configured for use in differential applications.

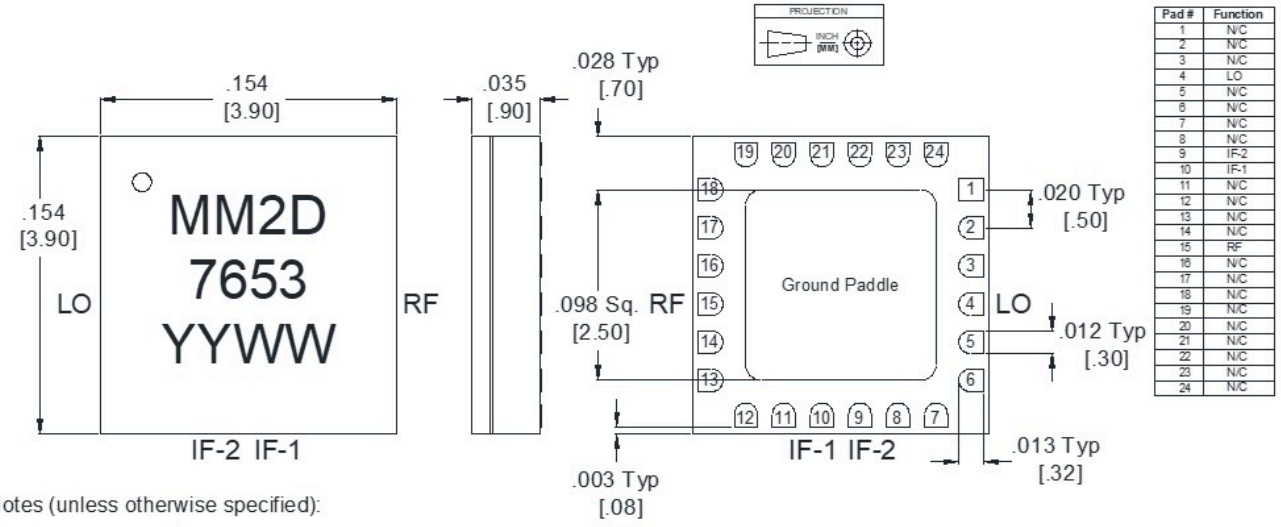




Mechanical Data

Outline Drawing

Download : Outline 2D Drawing | Outline 3D Drawing | Outline 3D STP



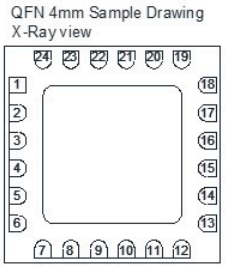
Pad #	Function
1	N/C
2	N/C
3	N/C
4	LO
5	N/C
6	N/C
7	N/C
8	N/C
9	IF-2
10	IF-1
11	N/C
12	N/C
13	N/C
14	N/C
15	RF
16	N/C
17	N/C
18	N/C
19	N/C
20	N/C
21	N/C
22	N/C
23	N/C
24	N/C

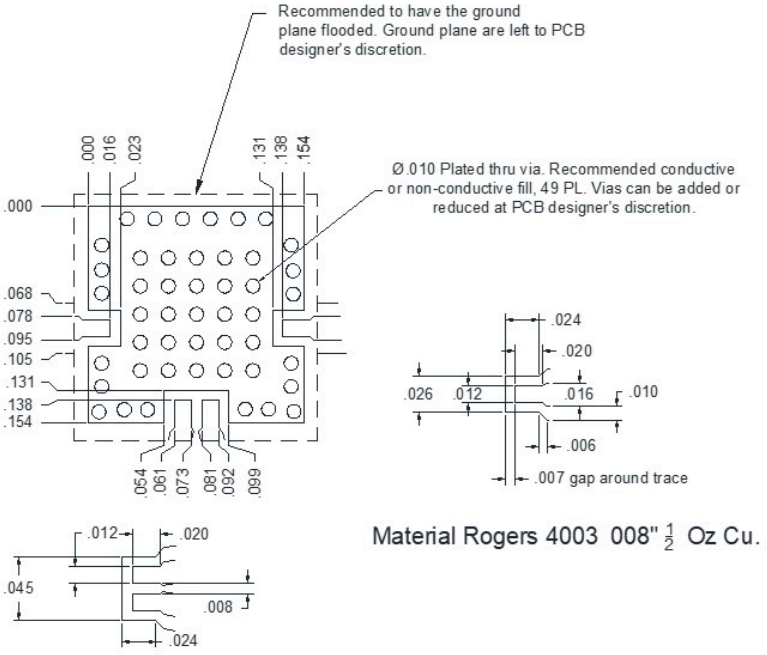
Notes (unless otherwise specified):

1. Substrate material is Ceramic.
2. All unconnected pads should be connected to PCB RF ground.
3. ENEPIG Plating\Finish:
   Ni: 8.89µ Max 1.27µ Min, 350µin Max 50µin Min
   Pd: 0.17µ Max 0.07µ Min, 6.69µin Max 2.76µin Min
   Au: 0.254µ Max 0.03µ Min, 10.0µin Max 1.81µin Min

Footprint Image

Download : Footprint Drawing

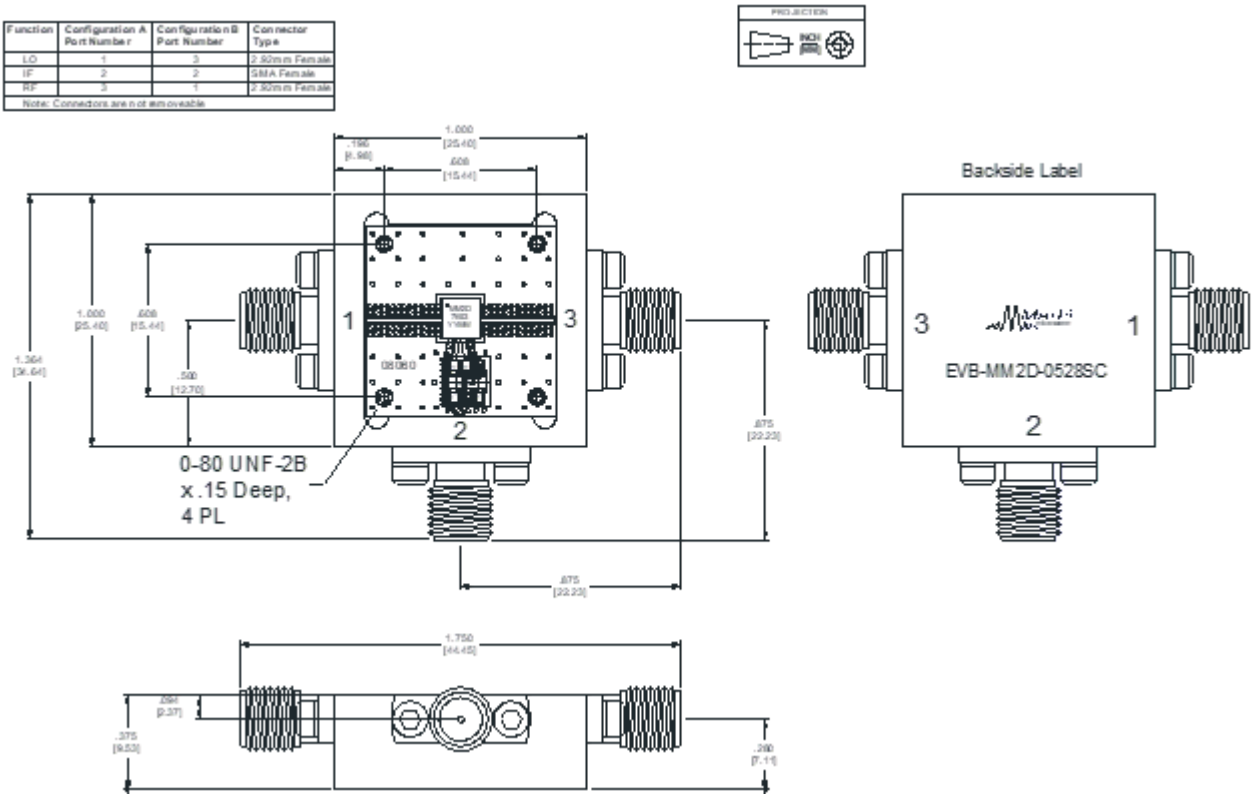




Evaluation Board - Outline Drawing

Function	Configuration A Port Number	Configuration B Port Number	Connector Type
LO	1	3	2.92mm Female
IF	2	2	SMA Female
RF	3	1	2.92mm Female

Note: Connectors are not removable



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