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

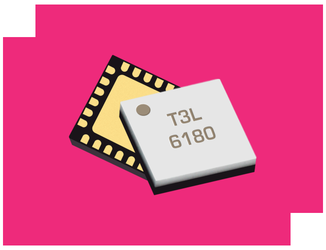
MT3D-0113LSM-2

GaAs MMIC T3 Mixer with Differential IF

DEVICE OVERVIEW

General Description

MT3D-0113LSM is a GaAs MMIC triple balanced mixer with high dynamic range and low conversion loss. This mixer belongs to the T3 family which offers high IP3, P1dB, and broad operating bandwidths for applications in the S, C and X bands. The MT3D-0113LSM 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 MT3D-0113LSM is available in a 4x4 mm¬2 QFN package.



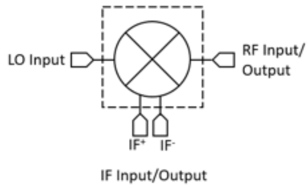
Features

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

Applications

- Test and Measurement Equipment
- S/C/X band radar

Functional Block Diagram



Part Ordering Options

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
MT3D-0113LSM-2	GaAs MMIC T3 Mixer with Differential IF	QFN	REACH RoHS	Released	EAR99

Table Of Contents

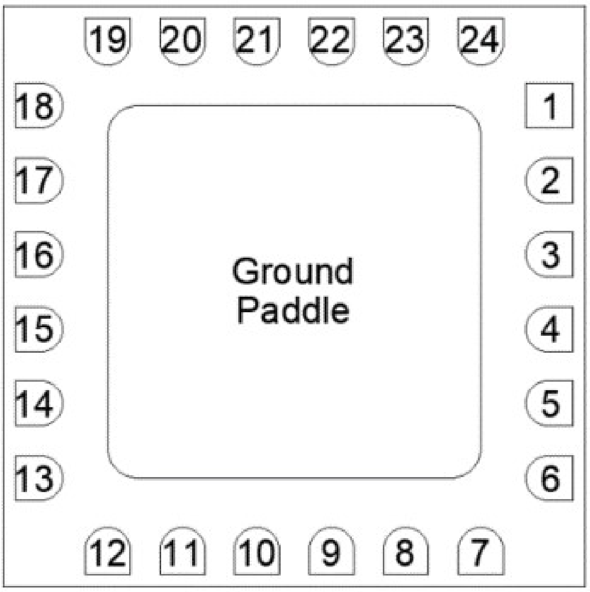
Revision History

Revision Code	Revision Date	Comment
-	2021-08-01	Datasheet Initial Release
A	2022-10-01	Spurs, Harmonic Isolations, and EVB part number added.

Port Configuration and Functions

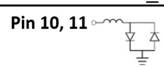
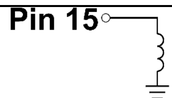
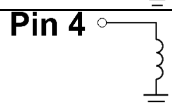
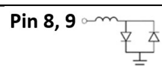
Port Diagram

A bottom-up view of the MT3D-0113LSM's SM package outline drawing is shown below. The MT3D-0113LSM has the input and output ports given in Port Functions. The MT3D-0113LSM can be used in either an up or down conversion. Configuration A/B refer to the same part number (MT3D-0113LSM) 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. Refer to section 4.1 for explanation of Configuration A and B operation.



Port Functions

Configuration A

Port	Function	Description	Equivalent Circuit for Package
GND	Ground	SM package ground path is provided through the ground paddle.	 GND
Pin 10 and 11	IF N1 and N2	Pins 10 and 11 are DC coupled to the diodes. Blocking capacitors are required. Pins 8 and 9 should be DC blocked and connected prior to balun.	 Pin 10, 11
Pin 15	RF	Pin 15 is DC short for the SM package.	 Pin 15
Pin 4	LO	Pin 4 is DC short for the SM package.	 Pin 4
Pin 8 and 9	IF P1 and P2	Pins 8 and 9 are DC coupled to the diodes. Blocking capacitors are required. Pins 8 and 9 should be DC blocked and connected prior to balun.	 Pin 8, 9

MT3D-0113LSM-2

GaAs MMIC T3 Mixer with Differential IF

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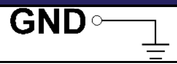
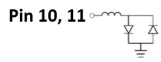
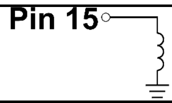
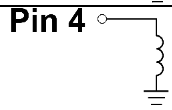
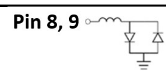
Configuration B

Port	Function	Description	Equivalent Circuit for Package
GND	Ground	SM package ground path is provided through the ground paddle.	
Pin 10 and 11	IF N1 and N2	Pins 10 and 11 are DC coupled to the diodes. Blocking capacitors are required. Pins 8 and 9 should be DC blocked and connected prior to balun.	
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 8 and 9	IF P1 and P2	Pins 8 and 9 are DC coupled to the diodes. Blocking capacitors are required. Pins 8 and 9 should be DC blocked and connected prior to balun.	

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
Minimum Operating Temperature	-40	°C
Minimum Storage Temperature	-40	°C
Minimum Storage Temperature	125	°C
Pin 8, 9, 10, 11 DC Current	0	mA
Power Handling, at any Port	30	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	11	17	25	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.

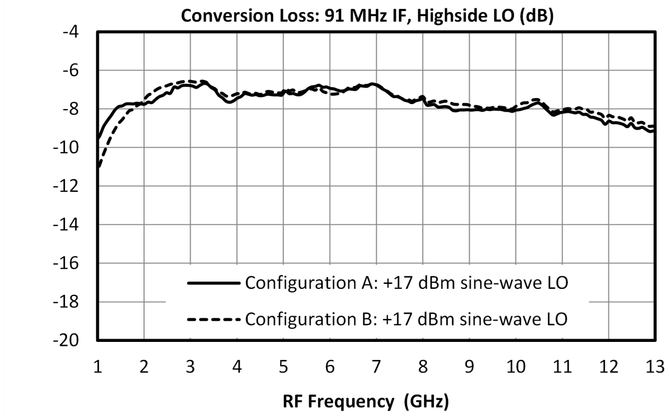
Electrical Specifications

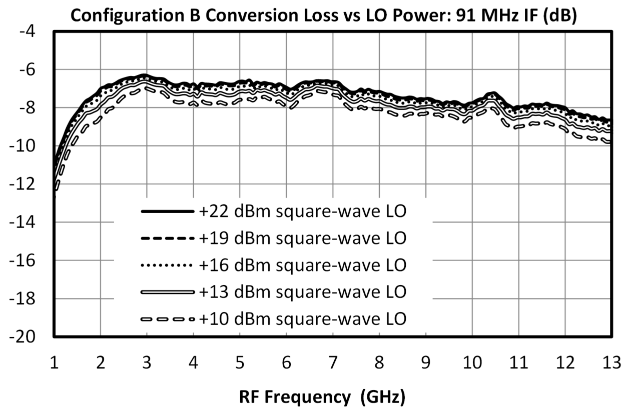
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for the connectorized EVAL package mixer† used with a +17 dBm sine wave LO. Typical IP3 data shown for a +19 dBm square wave LO. Min and Max limits apply only to our connectorized units and are guaranteed at TA=+25°C.

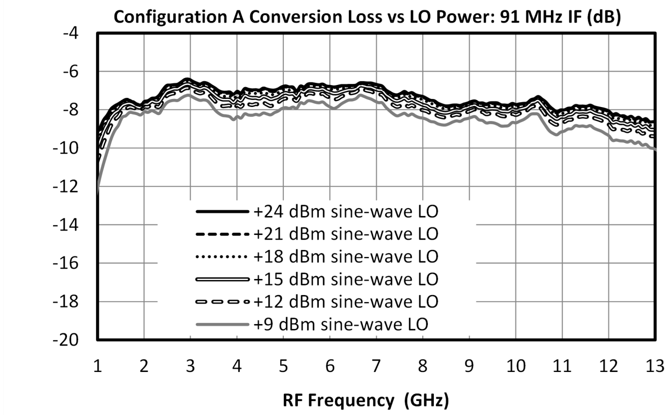
Parameter	Port Configuration	Test Conditions	Min	Typ	Max	Unit
Conversion Loss [1]	A	RF/LO = 1.5 - 13 GHz I = 91 MHz	-	7.5	-	dB
Input IP3 [2]	A	RF/LO = 1.5 - 13 GHz I = 91 MHz	-	27	-	dBm
Isolation, LO to IF	A	IF/LO = 1.5 - 13 GHz	-	43	-	dB
Isolation, LO to RF	A	RF/LO = 1.5 - 13 GHz	-	43	-	dB
Isolation, RF to IF	A	RF/IF = 1.5 - 13 GHz	-	42	-	dB
Noise Figure [3]	A	RF/LO = 1.5 - 13 GHz I = 91 MHz	-	7.5	-	dB
Conversion Loss [4]	B	RF/LO = 1.5 - 13 GHz I = 91 MHz	-	7.5	-	dB
Input IP3 [5]	B	RF/LO = 1.5 - 13 GHz I = 91 MHz	-	27	-	dBm
Isolation, LO to IF	B	IF/LO = 1.5 - 13 GHz	-	42	-	dB
Isolation, LO to RF	B	RF/LO = 1.5 - 13 GHz	-	37	-	dB
Isolation, RF to IF	B	RF/IF = 1.5 - 13 GHz	-	43	-	dB
Noise Figure [6]	B	RF/LO = 1.5 - 13 GHz I = 91 MHz	-	7.5	-	dB
IF Frequency Range [7]	-	-	-	-	-	GHz
LO Frequency Range	-	-	1.5	-	13	GHz
RF Frequency Range	-	-	1.5	-	13	GHz

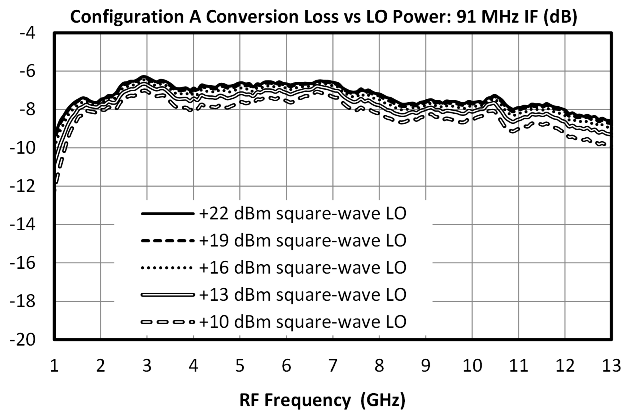
[1][4] Measured as a down converter to a fixed 91 MHz IF. Unless otherwise stated, frequency conversion done using a highside LO.
[2][5] IP3 depends on LO drive condition. Reported table value is measured with a square wave LO formed using 2x ADM1-0026PA in series with +10 dBm input into the first stage. LO Power reported in plots is of the fundamental tone only. Square wave LO power in plots is stepped down using broadband DC-40 GHz attenuators.
[3][6] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.
[7] IF range max value is determined by off-chip balun. Contact support@markimicrowave.com for details.

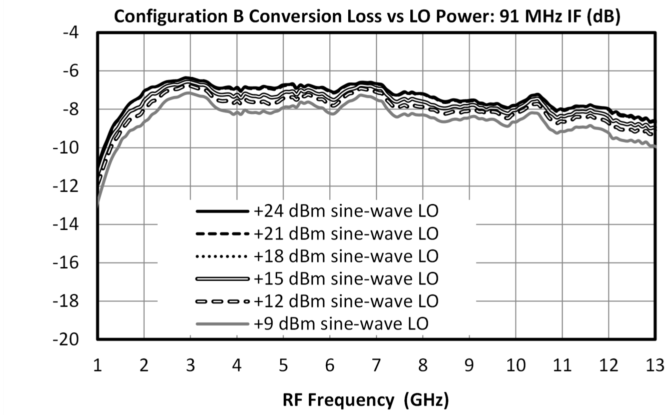
Typical Performance Plots

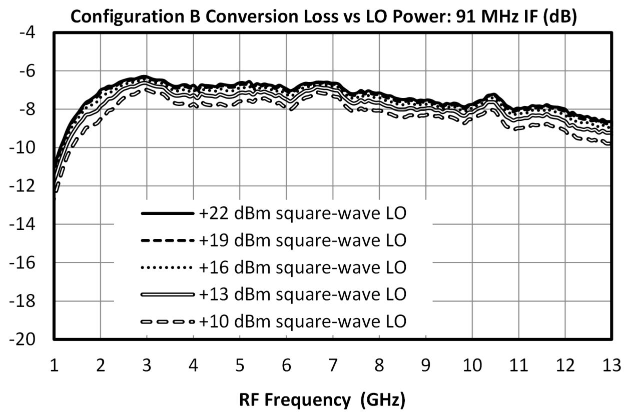


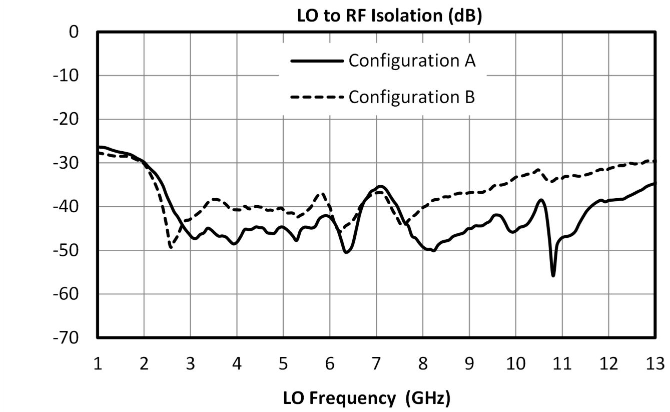


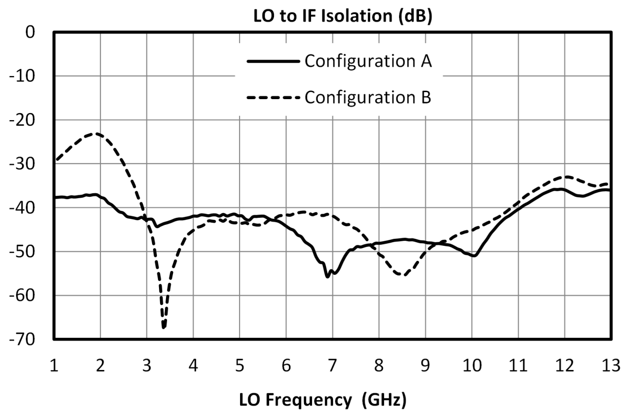


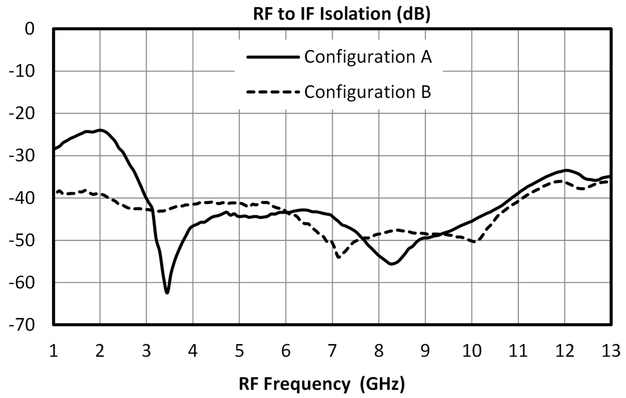


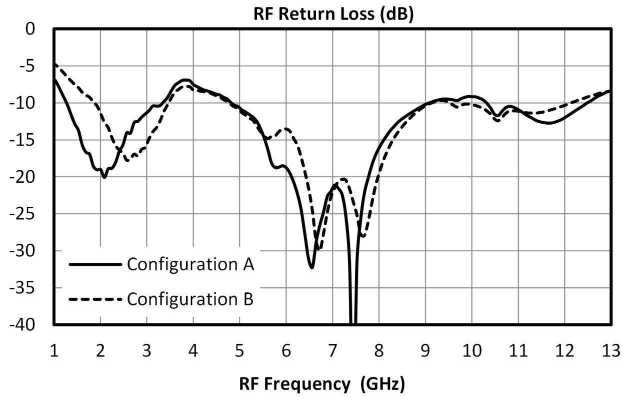


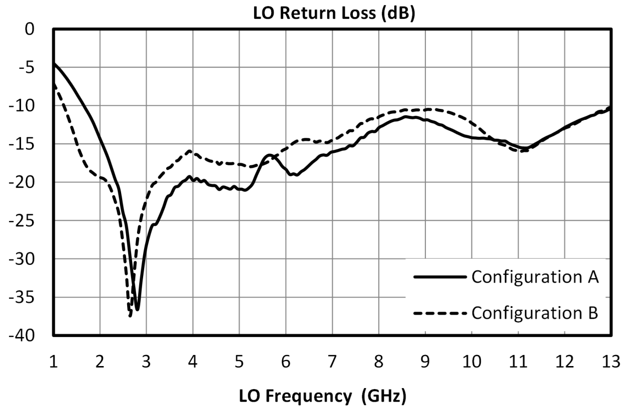


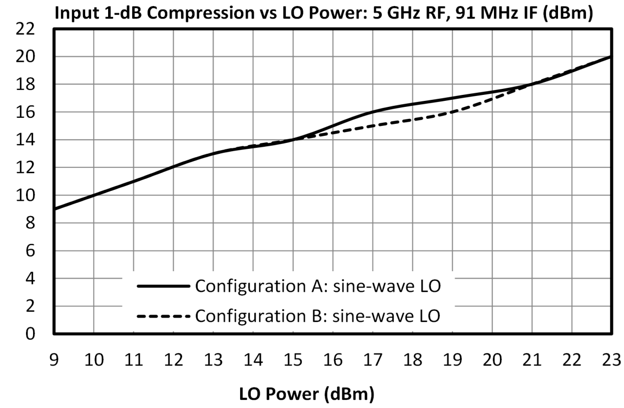


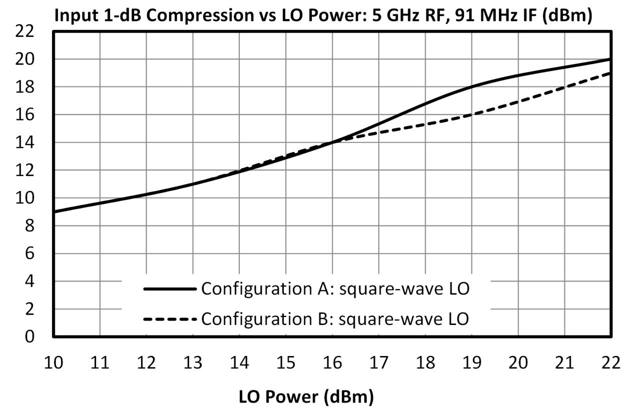


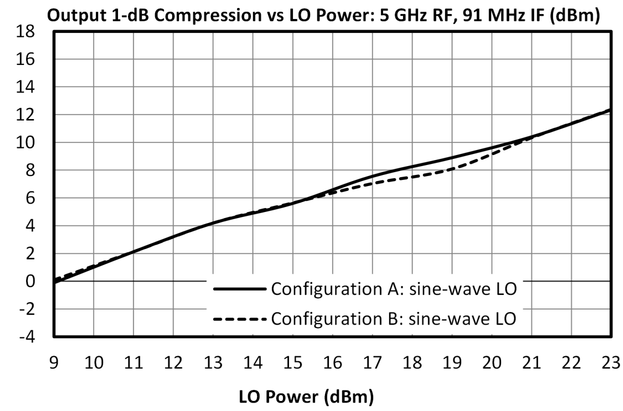

RF to IF Isolation (dB)
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
1 2 3 4 5 6 7 8 9 10 11 12 13
RF Frequency (GHz)

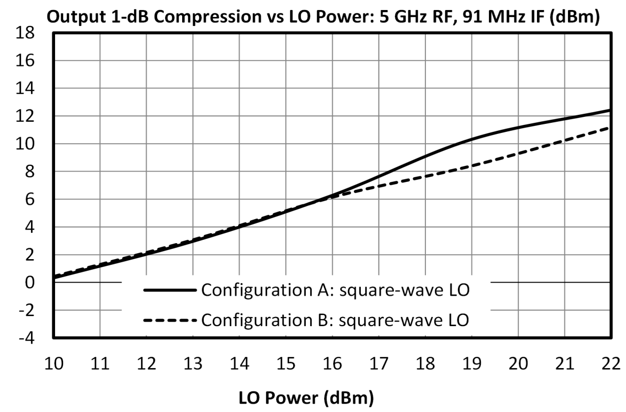

RF Return Loss (dB)
Configuration A
Configuration B
0
-5
-10
-15
-20
-25
-30
-35
-40
1 2 3 4 5 6 7 8 9 10 11 12 13
RF Frequency (GHz)


LO Return Loss (dB)
Configuration A
Configuration B
0
-5
-10
-15
-20
-25
-30
-35
-40
1 2 3 4 5 6 7 8 9 10 11 12 13
LO Frequency (GHz)

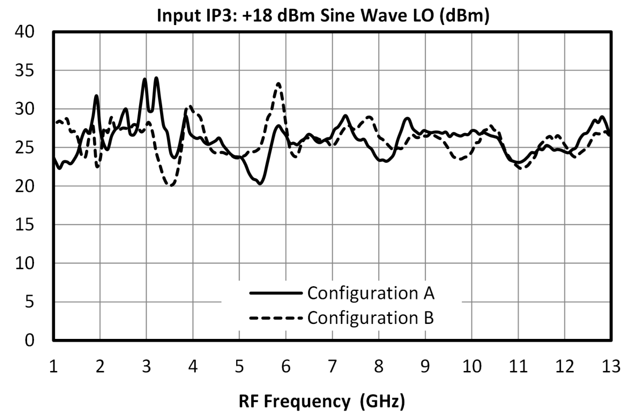

Input 1-dB Compression vs LO Power: 5 GHz RF, 91 MHz IF (dBm)
Configuration A: sine-wave LO
Configuration B: sine-wave LO
22
20
18
16
14
12
10
8
6
4
2
0
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
LO Power (dBm)

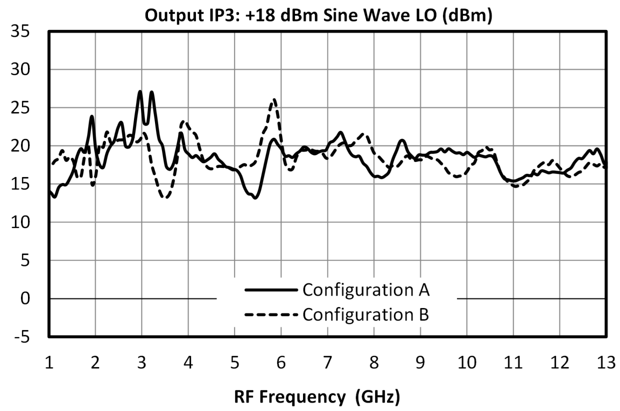

Input 1-dB Compression vs LO Power: 5 GHz RF, 91 MHz IF (dBm)
Configuration A: square-wave LO
Configuration B: square-wave LO
22
20
18
16
14
12
10
8
6
4
2
0
10 11 12 13 14 15 16 17 18 19 20 21 22
LO Power (dBm)

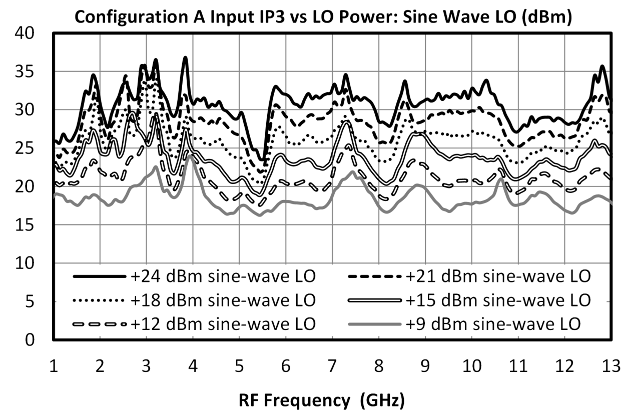

Output 1-dB Compression vs LO Power: 5 GHz RF, 91 MHz IF (dBm)
Configuration A: sine-wave LO
Configuration B: sine-wave LO
18
16
14
12
10
8
6
4
2
0
-2
-4
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
LO Power (dBm)

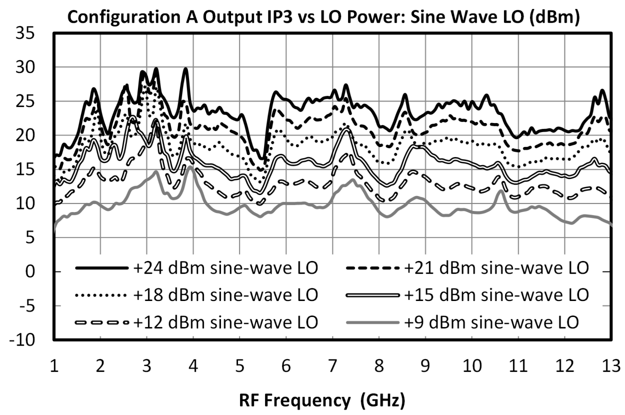

Output 1-dB Compression vs LO Power: 5 GHz RF, 91 MHz IF (dBm)
Configuration A: square-wave LO
Configuration B: square-wave LO
18
16
14
12
10
8
6
4
2
0
-2
-4
10 11 12 13 14 15 16 17 18 19 20 21 22
LO Power (dBm)

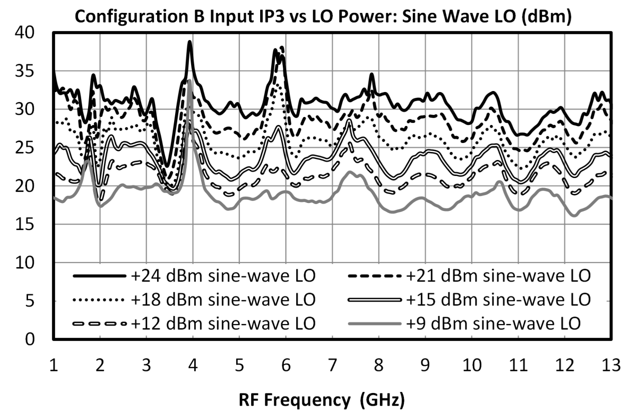
Typical Performance Plots: IP3, Sine Wave LO

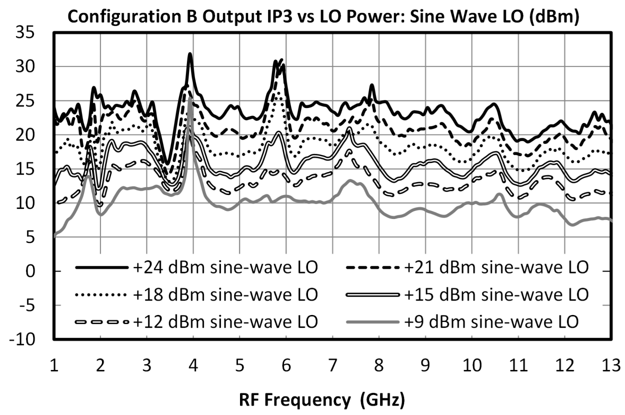




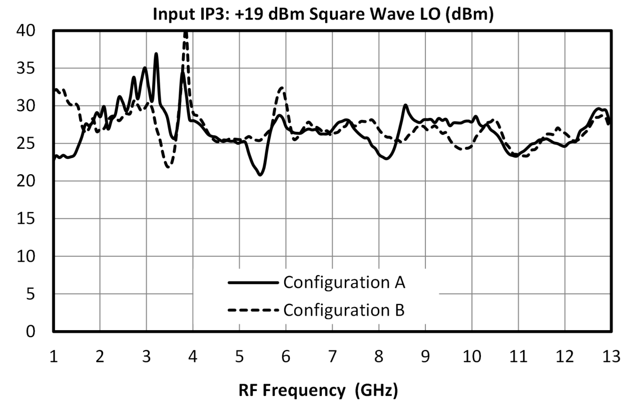


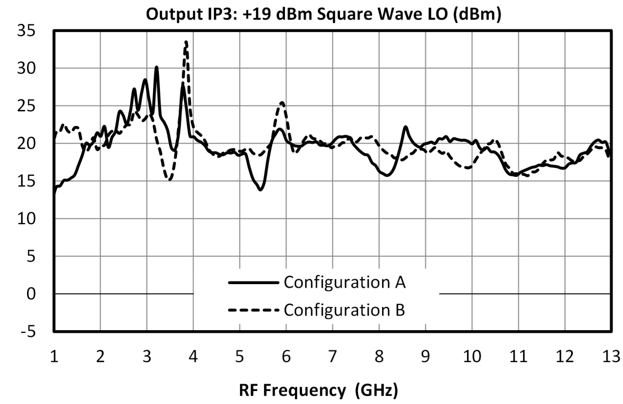


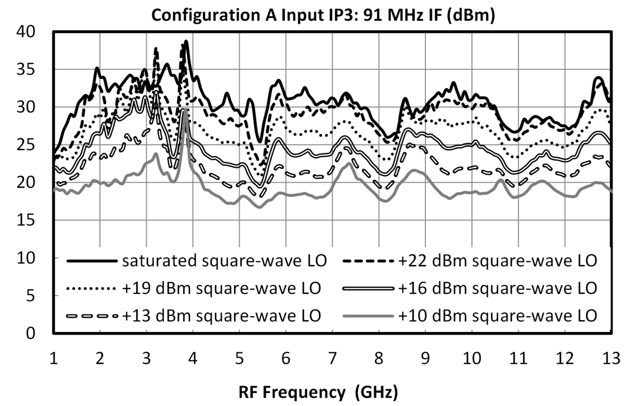


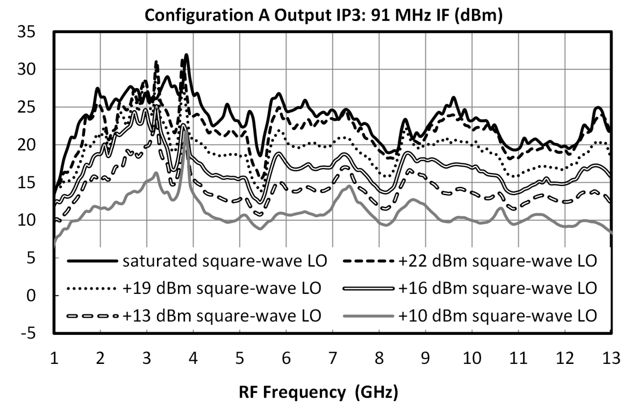


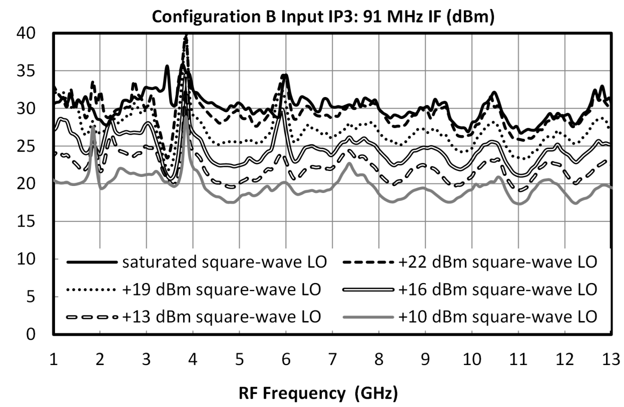
Typical Performance Plots: IP3, Square Wave LO

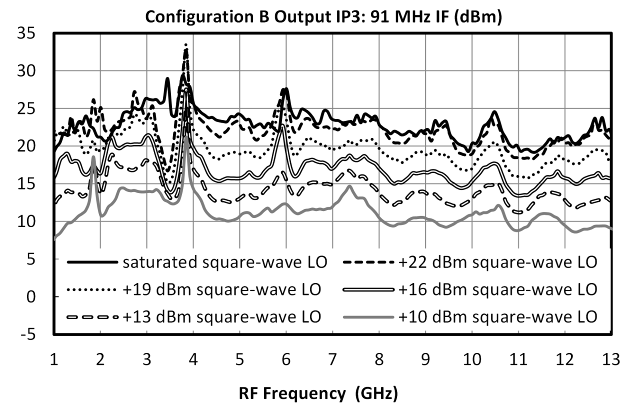






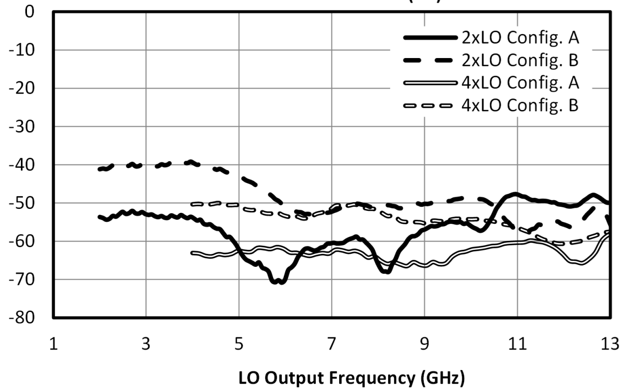




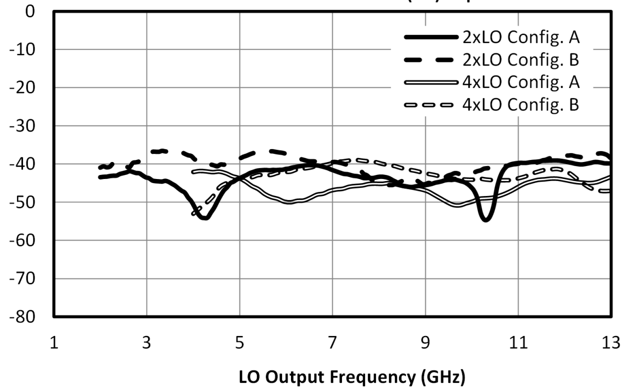


Typical Performance Plots: Harmonic Isolations

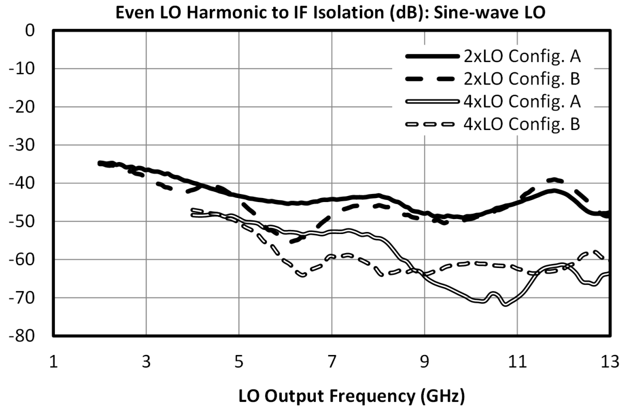
Even LO Harmonic to RF Isolation (dB): Sine-wave LO



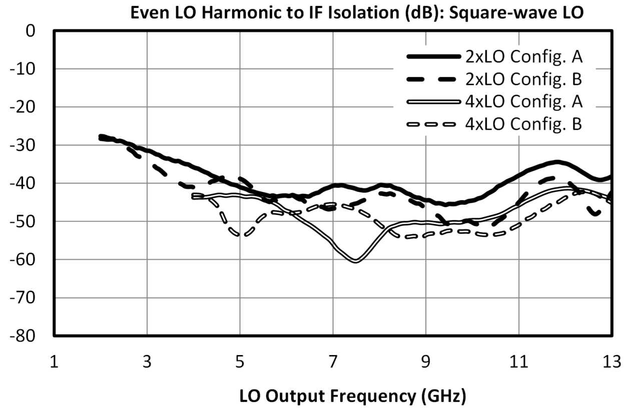
Even LO Harmonic to RF Isolation (dB): Square-wave LO



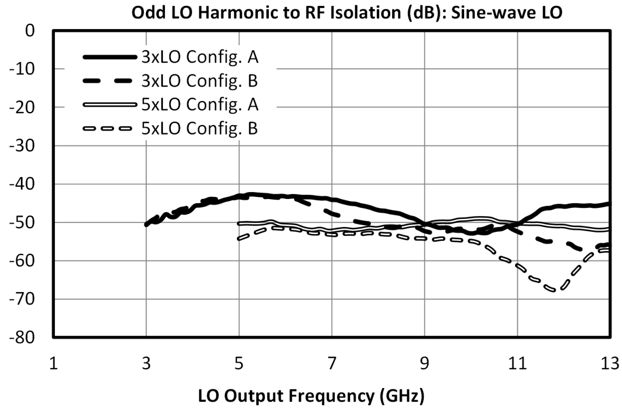
Even LO Harmonic to IF Isolation (dB): Sine-wave LO



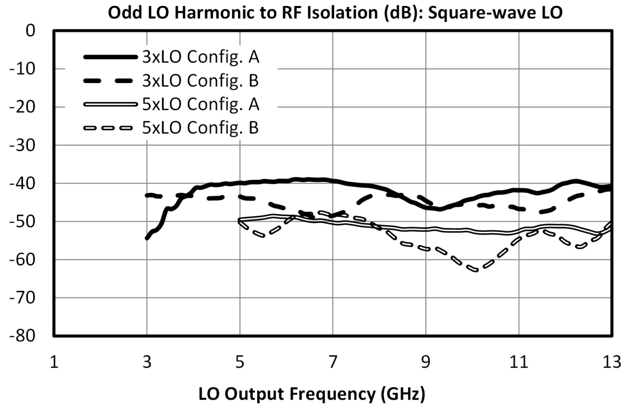
Even LO Harmonic to IF Isolation (dB): Square-wave LO



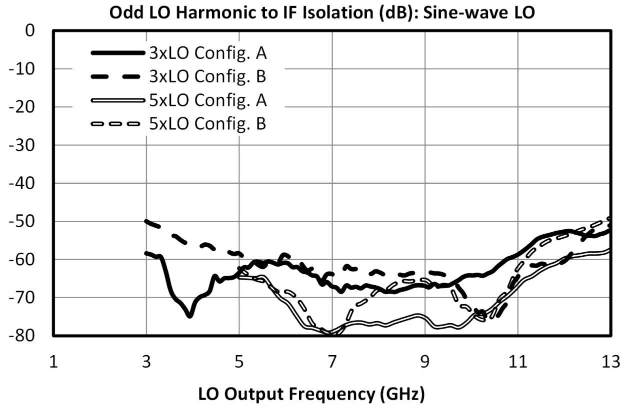
Odd LO Harmonic to RF Isolation (dB): Sine-wave LO



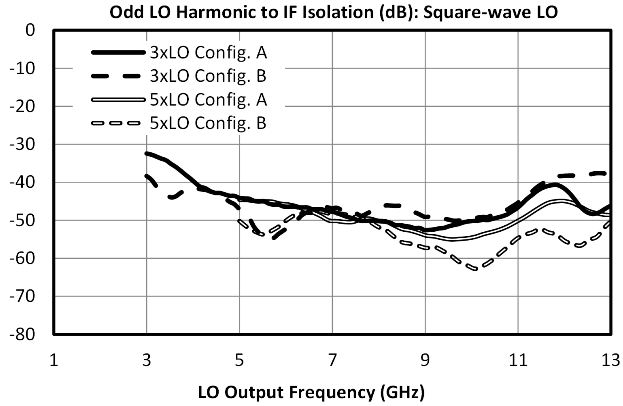
Odd LO Harmonic to RF Isolation (dB): Square-wave LO

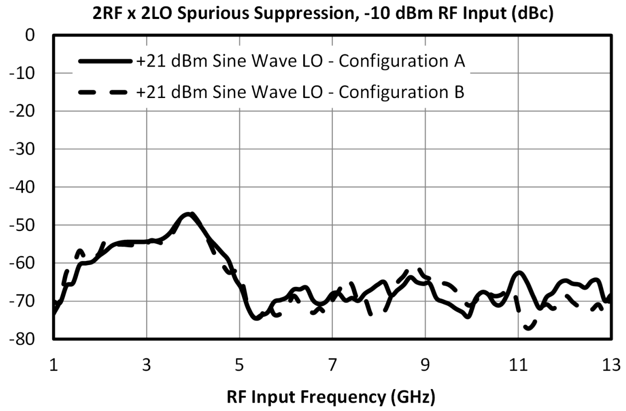


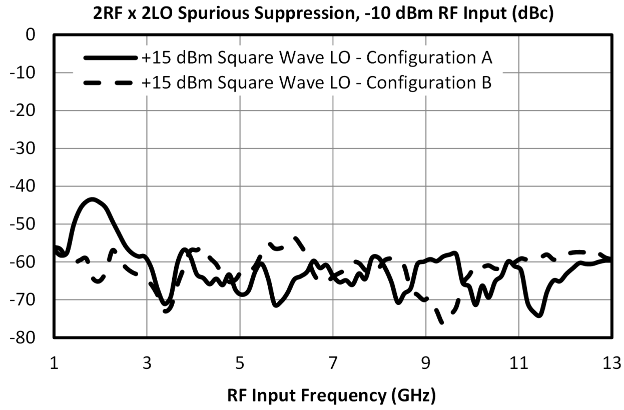
Odd LO Harmonic to IF Isolation (dB): Sine-wave LO

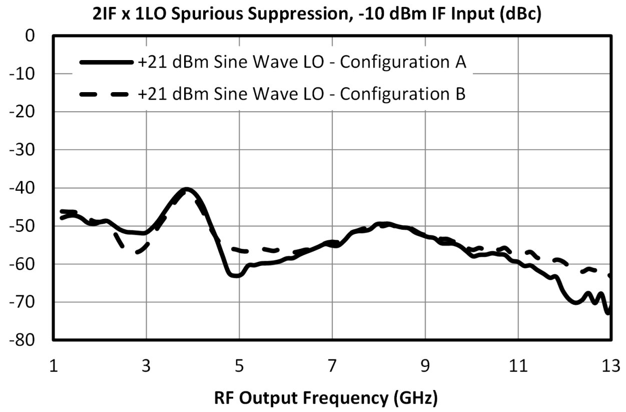


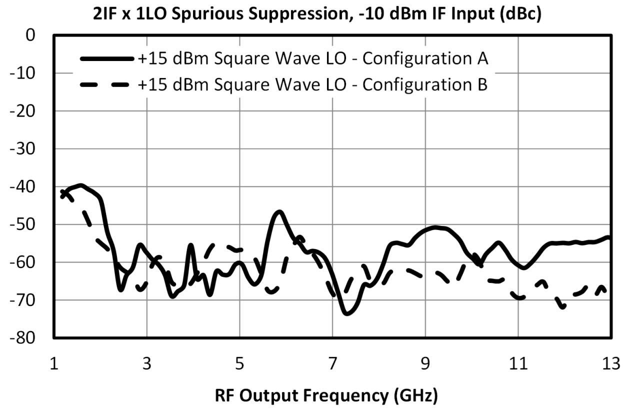
Odd LO Harmonic to IF Isolation (dB): Square-wave LO




2RF x 2LO Spurious Suppression, -10 dBm RF Input (dBc)
+21 dBm Sine Wave LO - Configuration A
+21 dBm Sine Wave LO - Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
1
3
5
7
9
11
13
RF Input Frequency (GHz)


2RF x 2LO Spurious Suppression, -10 dBm RF Input (dBc)
+15 dBm Square Wave LO - Configuration A
+15 dBm Square Wave LO - Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
1
3
5
7
9
11
13
RF Input Frequency (GHz)


2IF x 1LO Spurious Suppression, -10 dBm IF Input (dBc)
+21 dBm Sine Wave LO - Configuration A
+21 dBm Sine Wave LO - Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
1
3
5
7
9
11
13
RF Output Frequency (GHz)


2IF x 1LO Spurious Suppression, -10 dBm IF Input (dBc)
+15 dBm Square Wave LO - Configuration A
+15 dBm Square Wave LO - Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
1
3
5
7
9
11
13
RF Output Frequency (GHz)

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 64 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 74 dBc. Data is shown for the frequency plan in Typical Performance.

Typical Down-conversion spurious suppression sine wave (dBc): Config A (B)

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	22 (30)	Reference	40 (44)	13 (13)	42 (48)	23 (22)
2xRF	58 (63)	67 (65)	64 (64)	70 (69)	62 (65)	70 (67)
3xRF	98 (98)	76 (77)	93 (94)	82 (82)	97 (100)	81 (80)
4xRF	120 (125)	115 (114)	111 (110)	119 (113)	116 (109)	117 (118)
5xRF	130 (112)	125 (126)	131 (129)	126 (130)	128 (131)	128 (128)

Typical Down-conversion spurious suppression square wave (dBc): Config A (B)

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	31 (24)	Reference	13 (13)	17 (16)	15 (14)	24 (22)
2xRF	59 (68)	59 (58)	59 (61)	58 (59)	58 (61)	57 (58)
3xRF	91 (91)	69 (72)	72 (75)	67 (72)	70 (75)	71 (74)
4xRF	104 (109)	103 (103)	97 (102)	96 (97)	93 (99)	90 (96)
5xRF	121 (126)	122 (120)	115 (117)	108 (113)	106 (115)	106 (113)

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 Typical Performance.

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

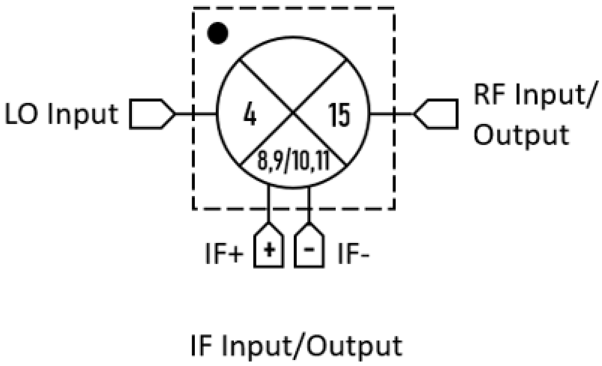
-10 dBm IF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	31 (33)	Reference	42 (42)	13 (13)	46 (48)	25 (23)
2xIF	70 (69)	60 (59)	68 (64)	58 (60)	65 (58)	54 (56)
3xIF	98 (98)	73 (76)	88 (90)	69 (70)	80 (89)	65 (69)
4xIF	114 (100)	108 (109)	107 (106)	104 (99)	101 (99)	93 (94)
5xIF	128 (125)	124 (124)	122 (125)	114 (115)	120 (123)	107 (110)

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

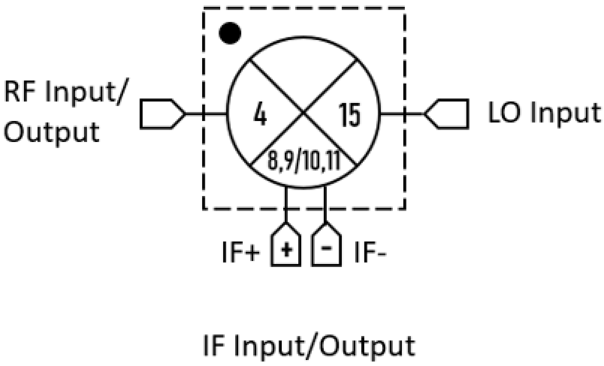
-10 dBm IF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	31 (24)	Reference	13 (13)	17 (16)	15 (14)	24 (22)
2xIF	59 (68)	59 (58)	59 (61)	58 (59)	58 (61)	57 (58)
3xIF	92 (98)	69 (72)	72 (75)	67 (72)	70 (75)	71 (74)
4xIF	104 (109)	103 (103)	97 (102)	96 (97)	93 (97)	90 (96)
5xIF	120 (126)	122 (120)	115 (117)	108 (113)	106 (115)	106 (113)

Application Information

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.

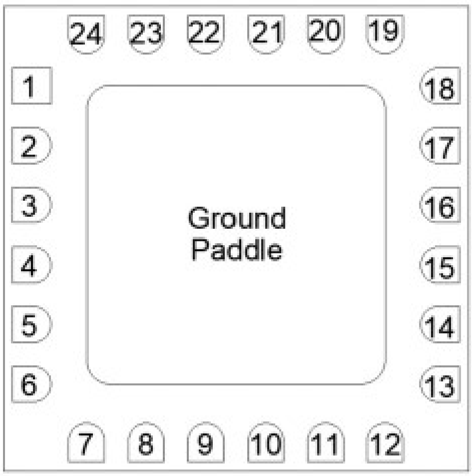


Configuration A



Configuration B

Application Circuit



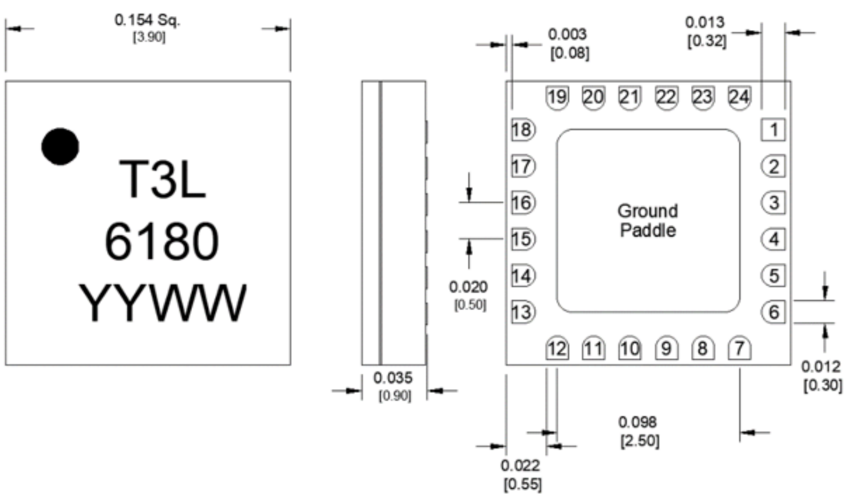
Application Circuit Description

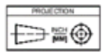
A top-down view of the MT3D-0113LSM's SM package outline drawing is shown in Configuration A. Pins 8 and 9 should be DC blocked and connected prior to balun. Pins 10 and 11 should be DC blocked and connected prior to balun.

Mechanical Data

Outline Drawing

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





Pad #	Configuration A Function	Configuration B Function
1	N/C	N/C
2	N/C	N/C
3	N/C	N/C
4	LO	RF
5	N/C	N/C
6	N/C	N/C
7	N/C	N/C
8	IFP1	IFP1
9	IFP2	IFP2
10	IFN1	IFN1
11	IFN2	IFN2
12	N/C	N/C
13	N/C	N/C
14	N/C	N/C
15	RF	LO
16	N/C	N/C
17	N/C	N/C
18	N/C	N/C
19	N/C	N/C
20	N/C	N/C
21	N/C	N/C
22	N/C	N/C
23	N/C	N/C
24	N/C	N/C

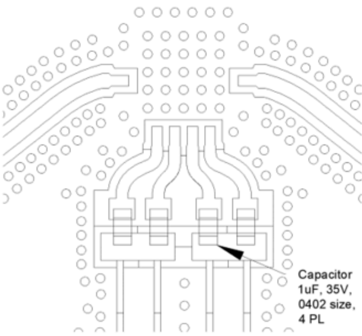
1. Substrate material is ceramic.
2. I/O Leads and Ground Paddle plating is (from base to finish):

Ni:	8.89um MAX	1.27um MIN
Pd:	0.17um MAX	0.07um MIN
Au	0.254um MAX	0.03um MIN

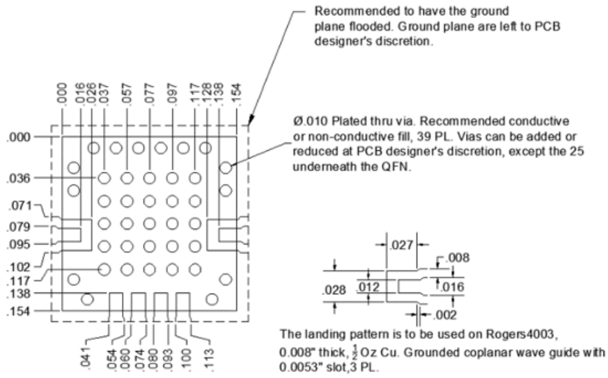
3. All unconnected pads should be connected to PCB RF ground.

Footprint Image

Download : Footprint Drawing



Footprint detailing IF traces with DC blocking capacitors prior to balun



Detailed view of landing pattern for QFN

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