Sales: 408-778-9952 | General: 408-778-4200 | Fax: 408-778-4300
Sales & Customer Support: sales@markimicrowave.com
Tech Support: support@markimicrowave.com
General Support: info@markimicrowave.com

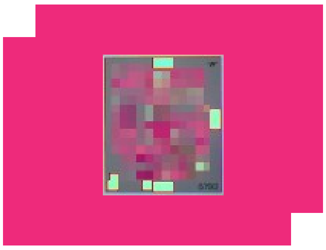
MM1-0330TCH-2

GaAs MMIC Double Balanced Mixer

DEVICE OVERVIEW

General Description

MM1-0330T is a GaAs MMIC double balanced mixer that features excellent conversion loss, superior isolations, and spurious performance across a broad bandwidth. The MM1-0330T works well as both an up and down converter through the K band and beyond. The MM1-0330T is recommended for frequency conversion applications that require high linearity. It is available as both wire bondable die and as a connectorized module.



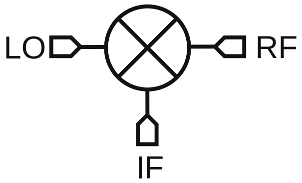
Features

- High LO to RF isolation
- Up or down conversion
- Broadband, high linearity frequency conversion

Applications

- Test and Measurement Equipment
- SATCOM
- Electronic Warfare
- Radar

Functional Block Diagram



Part Ordering Options

Part Number	Description	Package	Packing Size	Green Status	Product Lifecycle	Export Classification
MM1-0330TCH-2	GaAs MMIC Double Balanced Mixer	CH	-	RoHS RoHS	Released	EAR99
MM1-0330TS	GaAs MMIC Double Balanced Mixer	S	-	RoHS	Released	EAR99

Table Of Contents

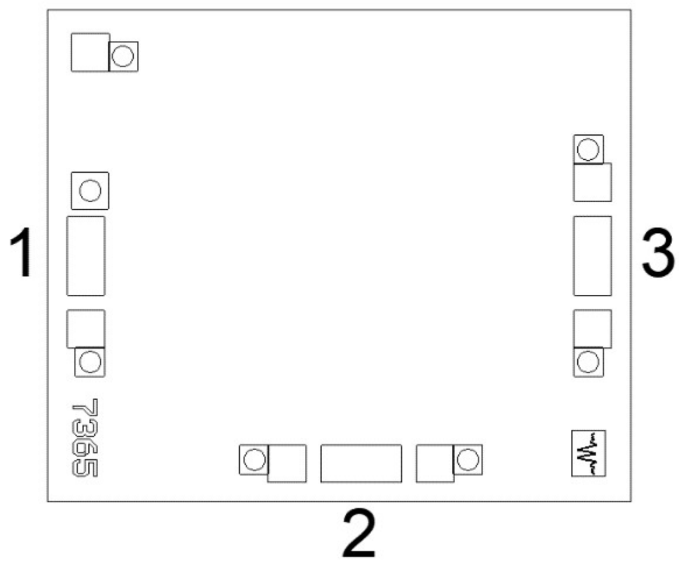
Revision History

Revision Code	Revision Date	Comment
-	2021-09-01	Datasheet Initial Release
A	2022-10-01	CL and IP3 at 1W LO Drive

Port Configuration and Functions

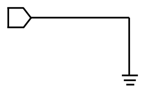
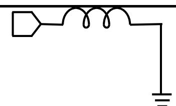
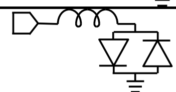
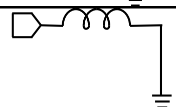
Port Diagram

A top-down view of the MM1-0330T's CH package outline drawing is shown below. The MM1-0330T has the input and output ports given in Port Functions. The MM1-0330T can be used in either an up or down conversion. For configuration A, input the LO into port 1, use port 3 for the RF, and port 2 for the IF. For configuration B, input the LO into port 3, use port 1 for the RF, and port 2 for the IF.

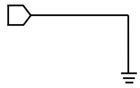
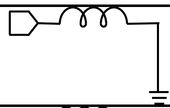
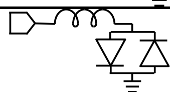
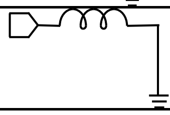


Port Functions

Configuration A

Port	Function	Description	Equivalent Circuit for Package
GND	Ground	CH package ground path is provided through the substrate and ground bond pads.	
Port 1	LO	Port 1 is DC short for the CH and S packages.	
Port 2	IF	Port 2 is diode connected for the CH and S package.	
Port 3	RF	Port 3 is DC short for the CH and S packages.	

Configuration B

Port	Function	Description	Equivalent Circuit for Package
GND	Ground	CH package ground path is provided through the substrate and ground bond pads.	
Port 1	RF	Port 1 is DC short for the CH and S packages.	
Port 2	IF	Port 2 is diode connected for the CH and S package.	
Port 3	LO	Port 3 is DC short for the CH and S packages.	

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
Port 1 DC Current	30	mA
Port 2 DC Current	30	mA
Port 3 DC Current	30	mA
Power Handling, at any Port	33	dBm

Package Information

Parameter	Details	Rating
ESD	250 to < 500 Volts	HBM Class 1A
Dimensions	-	1.38 x 1.17 mm

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	20	-	27	dBm
Ambient Temperature	-55	25	100	°C

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

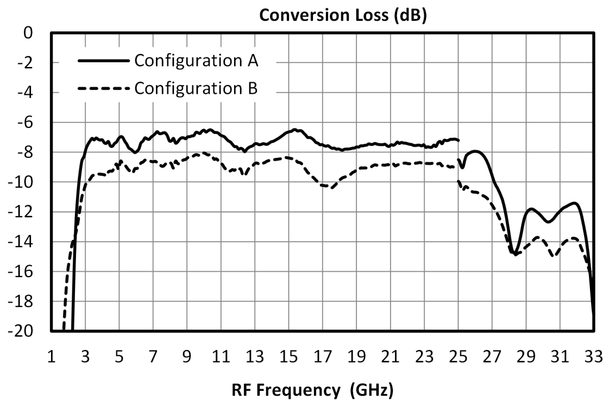
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for the connectorized S package mixer used in the forward direction with a +23 dBm sine wave input using an ADM3-0022PA-H up to 25GHz and a saturated AMM-6702UC above 25GHz . Min and Max limits apply only to our connectorized units and are guaranteed at TA=+25°C. All bare die are 100% DC tested and visually inspected.

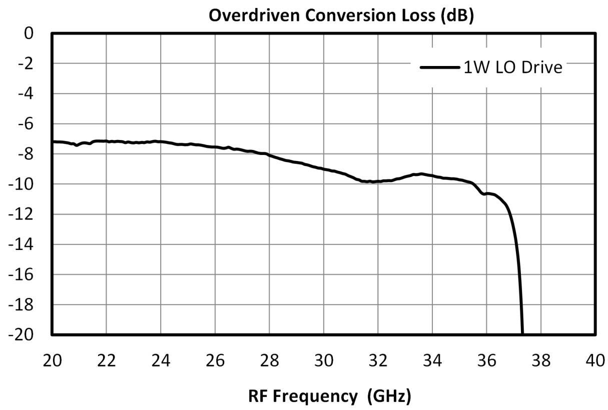
Parameter	Port Configuration	Test Conditions	Min	Typ	Max	Unit
RF Frequency Range	-	-	3	-	30	GHz
LO Frequency Range	-	-	3	-	30	GHz
Conversion Loss [1]	A	RF/LO = 3 – 30 GHz I = 0.2 – 5 GHz	-	9	-	dB
Conversion Loss [2]	A	RF/LO = 3 - 30 GHz I = DC - 0.2 GHz	-	7	15	dB
Conversion Loss [3]	B	RF/LO = 3 – 30 GHz I = 0.2 – 5 GHz	-	11	-	dB
Conversion Loss [4]	B	RF/LO = 3 - 30 GHz I = DC - 0.2 GHz	-	9	15	dB
Noise Figure [5]	-	RF/LO = 3 - 30 GHz I = DC - 0.2 GHz	-	7.5	-	dB
Isolation, LO to RF	-	RF/LO = 3 - 30 GHz	-	50	-	dB
Isolation, LO to IF	-	IF/LO = 3 - 30 GHz	-	40	-	dB
Isolation, RF to IF	-	RF/IF = 3 - 30 GHz	-	40	-	dB
Input IP3	A	RF/LO = 3 - 30 GHz I = DC - 0.2 GHz	-	32	-	dBm
Input IP3	B	RF/LO = 3 - 30 GHz I = DC - 0.2 GHz	-	32	-	dBm
Input 1 dB Gain Compression Point (P1dB)	A	-	-	15	-	dBm
Input 1 dB Gain Compression Point (P1dB)	B	-	-	15	-	dBm
IF Frequency Range	-	-	0	-	5	GHz

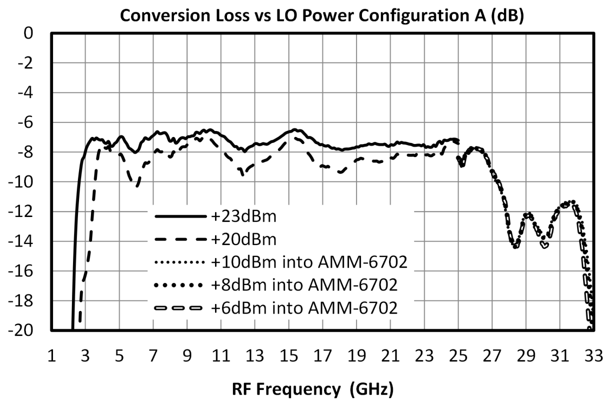
[1][2][3][4] Measured as a down converter to a fixed 91MHz IF.
[5] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

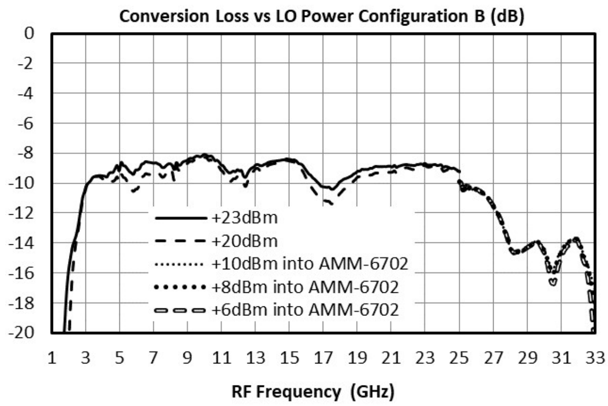
Discontinuity in measurements at 25GHz is due to the two LO driver amplifiers used. When the LO is above 25GHz, the LO power drops below the typical +23dBm.

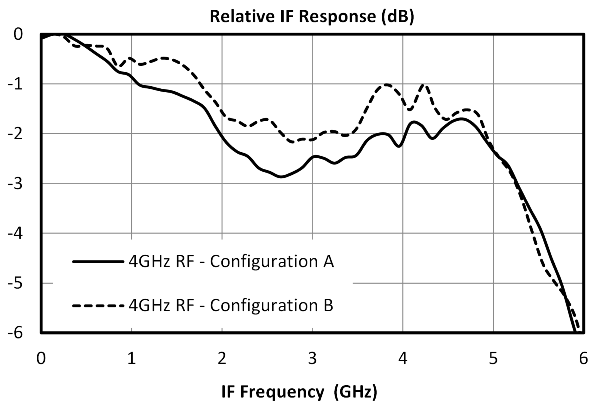
Typical Performance Plots

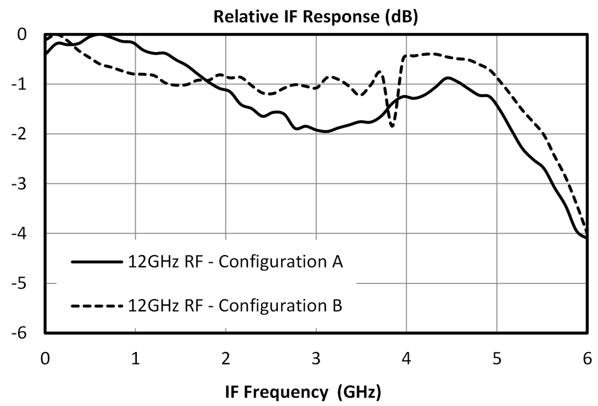


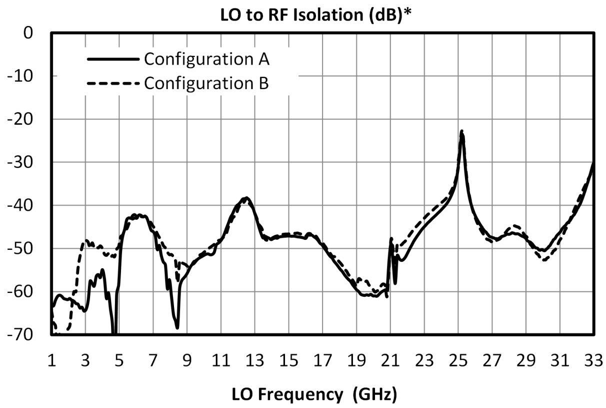


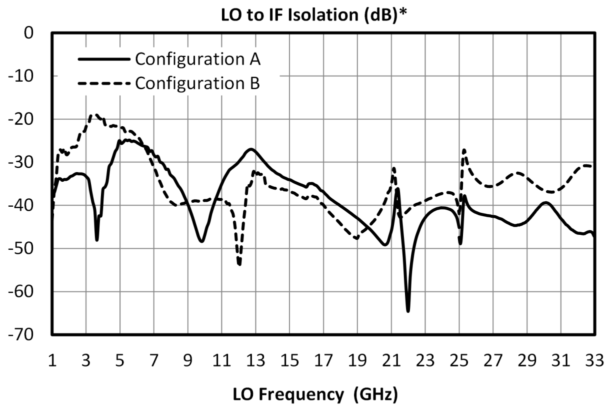


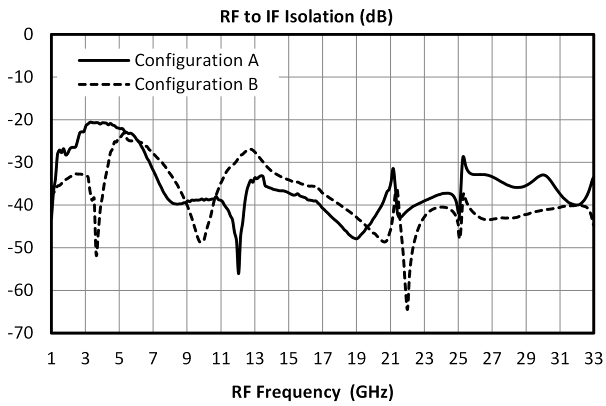


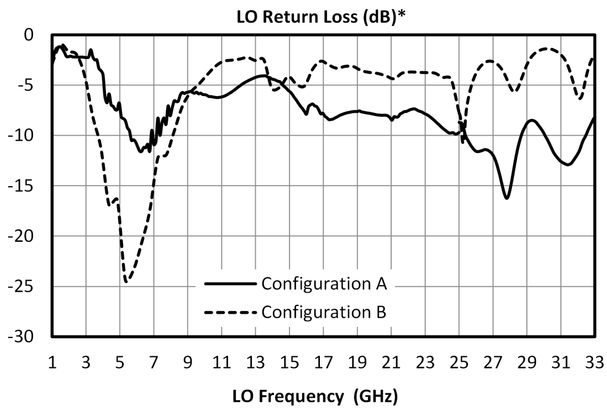


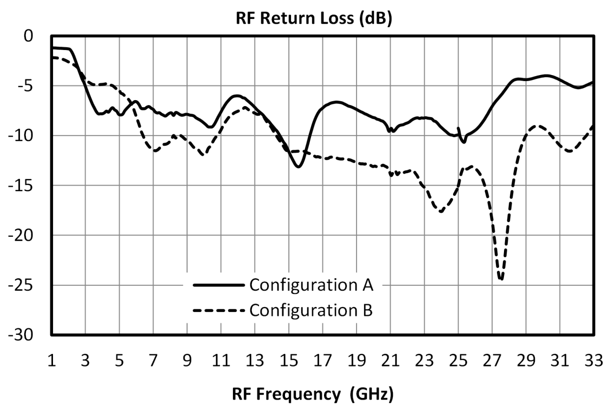


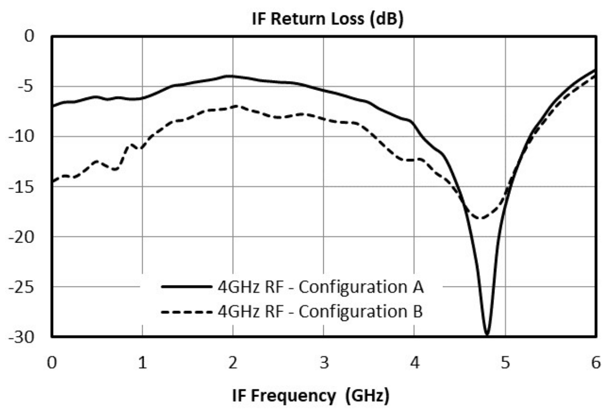

LO to RF Isolation (dB)*
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
LO Frequency (GHz)

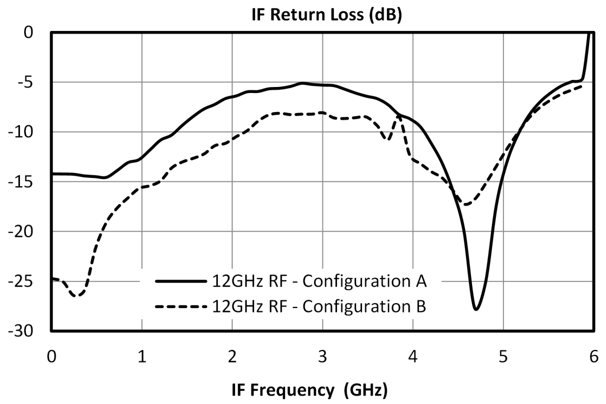

LO to IF Isolation (dB)*
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
LO Frequency (GHz)


RF to IF Isolation (dB)
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
RF Frequency (GHz)

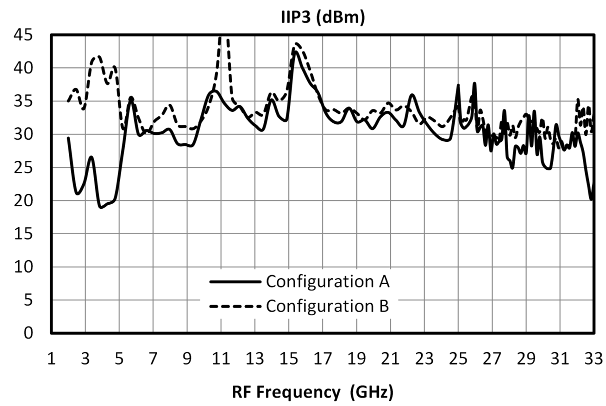

LO Return Loss (dB)*
Configuration A
Configuration B
0
-5
-10
-15
-20
-25
-30
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
LO Frequency (GHz)

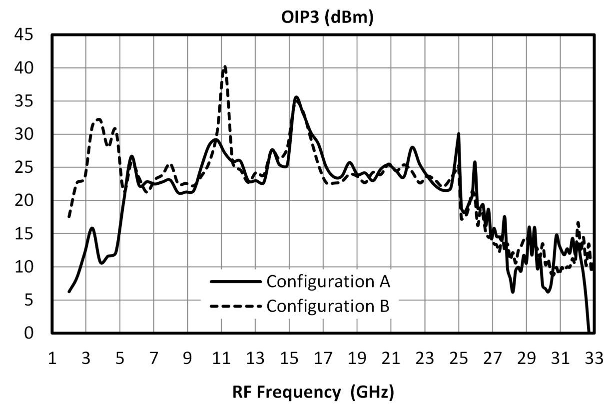

RF Return Loss (dB)
Configuration A
Configuration B
0
-5
-10
-15
-20
-25
-30
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
RF Frequency (GHz)

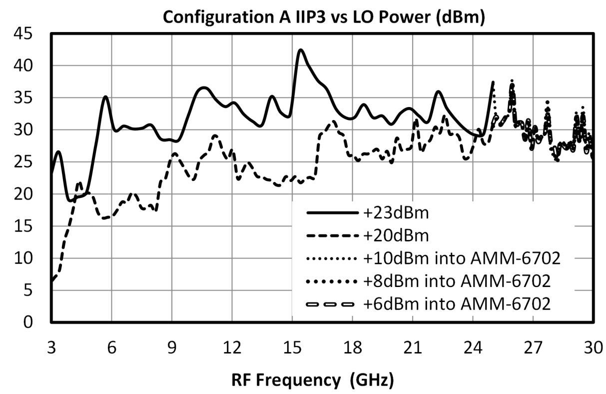

IF Return Loss (dB)
4GHz RF - Configuration A
4GHz RF - Configuration B
0
-5
-10
-15
-20
-25
-30
0 1 2 3 4 5 6
IF Frequency (GHz)

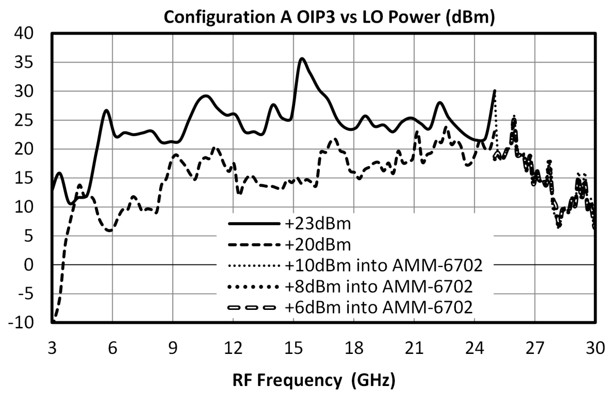


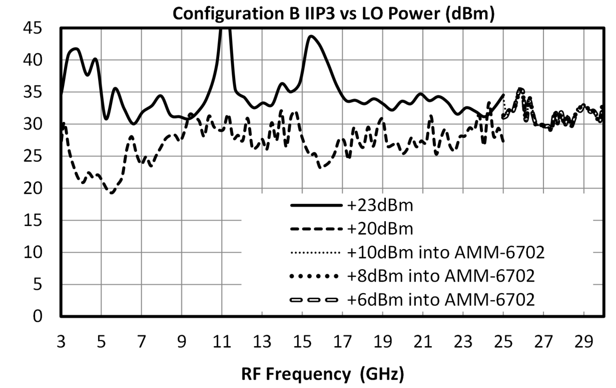
Typical Performance Plots: IP3

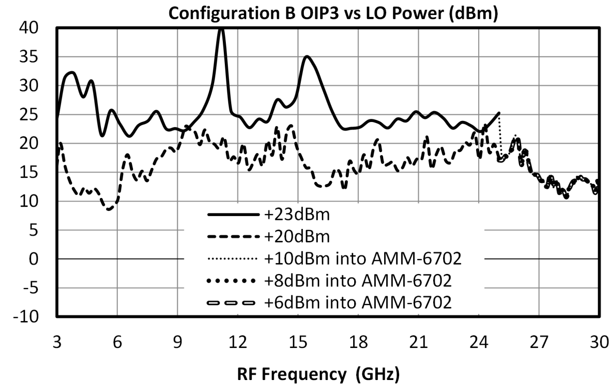


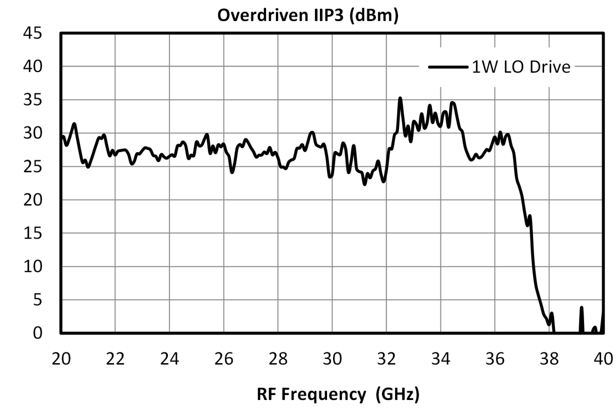


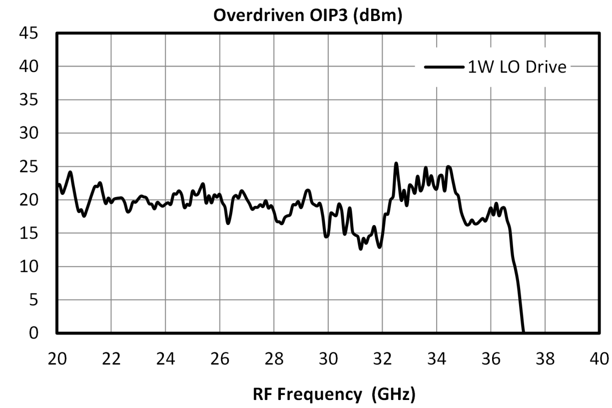




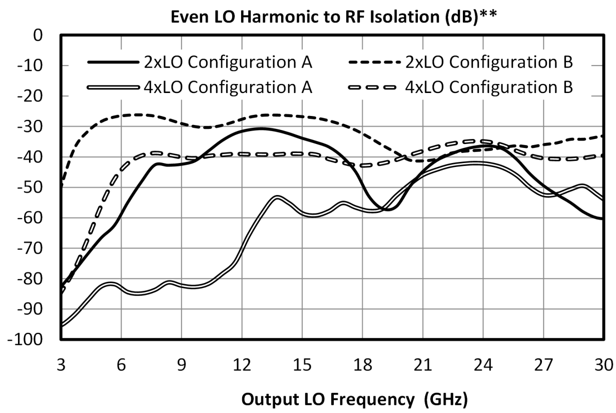


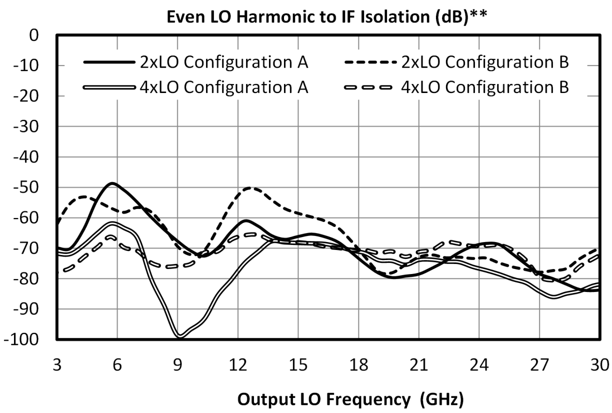


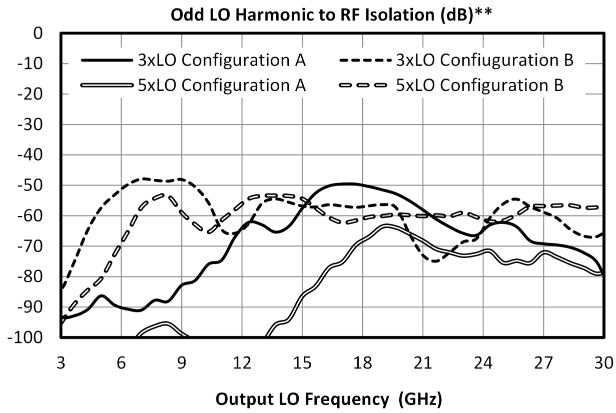


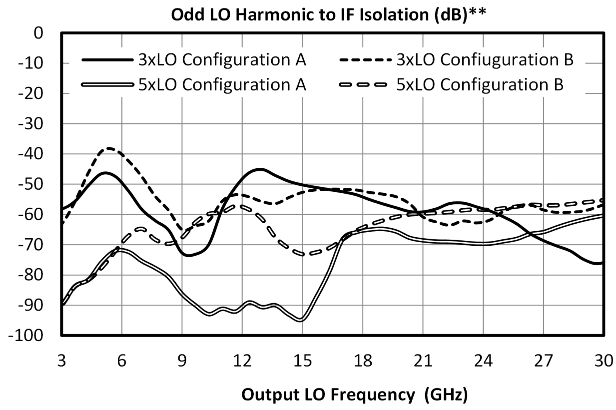


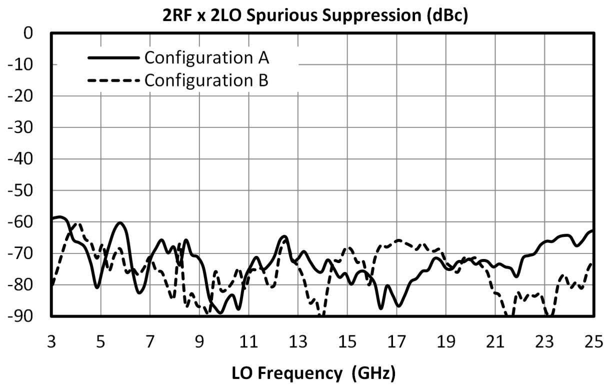
Typical Performance Plots: LO Harmonic Isolation

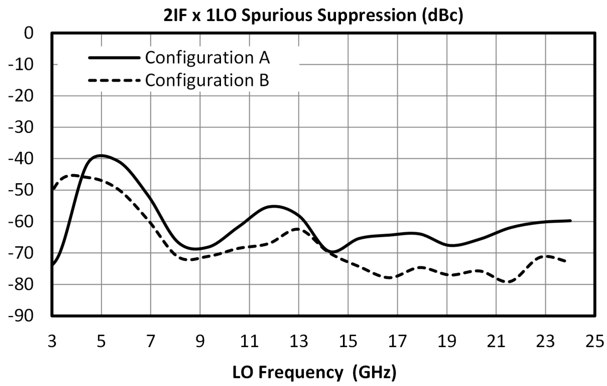





Odd LO Harmonic to RF Isolation (dB)**
3xLO Configuration A
3xLO Confiuguration B
5xLO Configuration A
5xLO Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
3
6
9
12
15
18
21
24
27
30
Output LO Frequency (GHz)


Odd LO Harmonic to IF Isolation (dB)**
3xLO Configuration A
3xLO Confiuguration B
5xLO Configuration A
5xLO Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
3
6
9
12
15
18
21
24
27
30
Output LO Frequency (GHz)


2RF x 2LO Spurious Suppression (dBc)
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
3
5
7
9
11
13
15
17
19
21
23
25
LO Frequency (GHz)


2IF x 1LO Spurious Suppression (dBc)
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
3
5
7
9
11
13
15
17
19
21
23
25
LO Frequency (GHz)

Spur Table

Typical Spurious Performance: Down-Conversion

Typical spurious data is provided by selecting RF and LO frequencies (± m*LO ± n*RF) up to 25GHz. 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 75 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 85 dBc. Data is shown for the frequency plan in 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	29 (27)	Reference	22 (30)	10 (8)	22 (29)	26 (21)
2xRF	90 (91)	69 (61)	75 (75)	64 (65)	70 (75)	59 (59)
3xRF	111 (113)	82 (89)	91 (100)	83 (88)	87 (98)	79 (87)
4xRF	127 (122)	117 (115)	117 (114)	116 (114)	116 (113)	113 (114)
5xRF	161 (158)	150 (149)	147 (149)	141 (146)	144 (149)	142 (145)

Typical Spurious Performance: Down-Conversion

Typical spurious data is provided by selecting RF and LO frequencies (± m*LO ± n*RF) up to 25GHz. 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 75 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 85 dBc. Data is shown for the frequency plan in 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 Up-conversion spurious suppression (dBc): Config A (B)

-10 dBm IF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	15 (25)	Reference	62 (68)	74 (78)	77 (84)	77 (88)
2xIF	65 (61)	65 (67)	66 (55)	67 (62)	67 (54)	74 (62)
3xIF	97 (97)	81 (85)	81 (88)	72 (69)	74 (85)	69 (69)
4xIF	120 (129)	119 (119)	114 (110)	109 (110)	112 (103)	110 (100)
5xIF	139 (142)	137 (140)	136 (140)	121 (126)	124 (135)	118 (120)

Die Mounting Recommendations

Mounting and Bonding Recommendations

Marki MMICs should be attached directly to a ground plane with conductive epoxy. The ground plane electrical impedance should be as low as practically possible. This will prevent resonances and permit the best possible electrical performance. Datasheet performance is only guaranteed in an environment with a low electrical impedance ground.

Mounting - To epoxy the chip, apply a minimum amount of conductive epoxy to the mounting surface so that a thin epoxy fillet is observed around the perimeter of the chip. Cure epoxy according to manufacturer instructions.

Wire Bonding - Ball or wedge bond with 0.025 mm (1 mil) diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150 °C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Use the minimum level of ultrasonic energy to achieve reliable wirebonds. Wirebonds should be started on the chip and terminated on the package or substrate. All bonds should be as short as possible <0.31 mm (12 mils).

Circuit Considerations – 50 Ω transmission lines should be used for all high frequency connections in and out of the chip. Wirebonds should be kept as short as possible, with multiple wirebonds recommended for higher frequency connections to reduce parasitic inductance. In circumstances where the chip more than .001” thinner than the substrate, a heat spreading spacer tab is optional to further reduce bondwire length and parasitic inductance.

Handling Precautions

General Handling

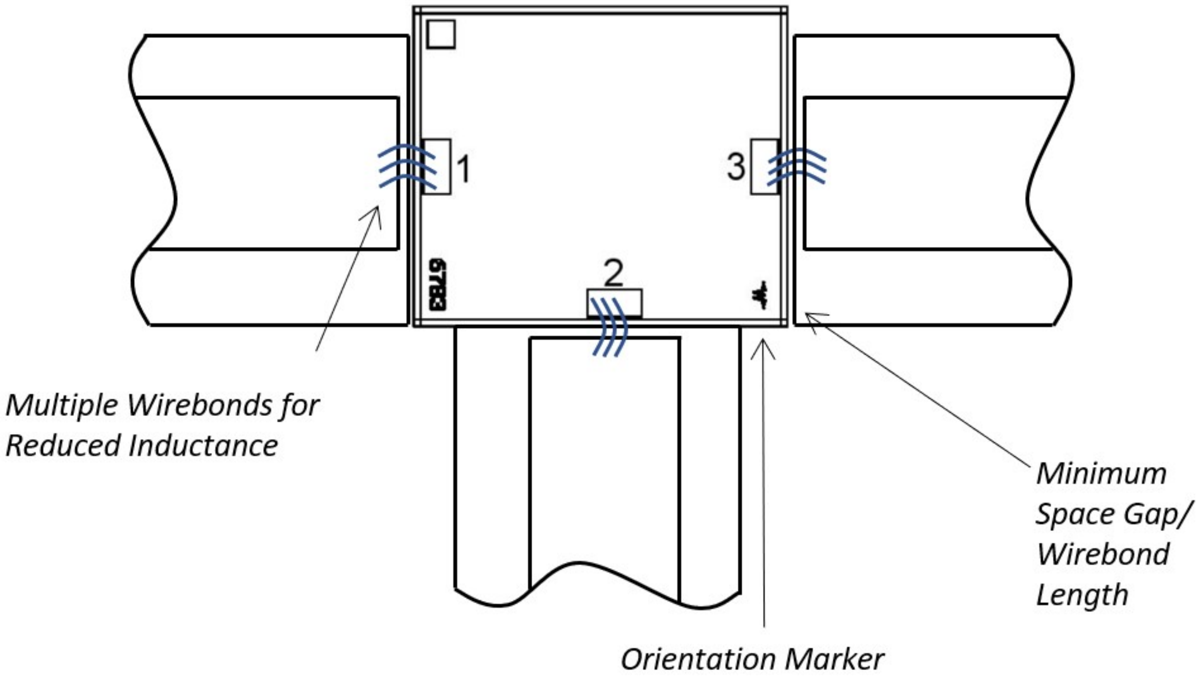
Chips should be handled with care using tweezers or a vacuum collet. Users should take precautions to protect chips from direct human contact that can deposit contaminants, like perspiration and skin oils on any of the chip's surfaces.

Static Sensitivity

GaAs MMIC devices are sensitive to ESD and should be handled, assembled, tested, and transported only in static protected environments.

Cleaning and Storage: Do not attempt to clean the chip with a liquid cleaning system or expose the bare chips to liquid. Once the ESD sensitive bags the chips are stored in are opened, chips should be stored in a dry nitrogen atmosphere.

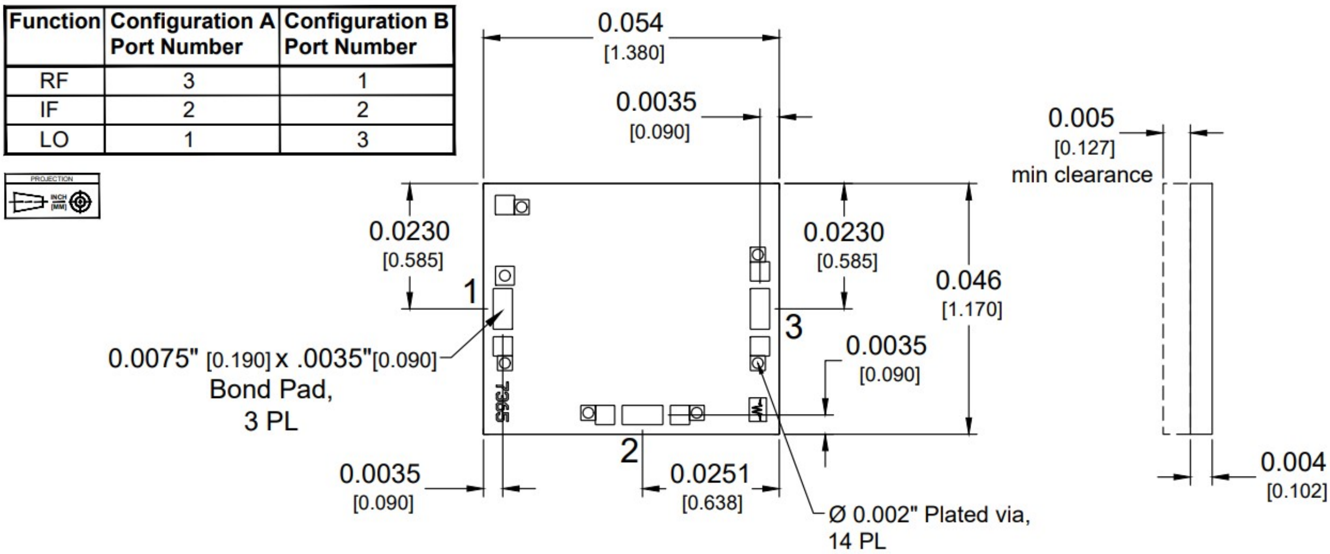
Bonding Diagram



Mechanical Data

Outline Drawing

Function	Configuration A Port Number	Configuration B Port Number
RF	3	1
IF	2	2
LO	1	3



Notes:

1. CH substrate is .004 in Thick GaAs.
2. I/O traces plane finish is 4 microns Au. Ground plane finish is 5 microns Au.
3. Tolerance for X, Y dimensions is ± 0.002 in.
   Tolerance for Z dimension is ± 0.0005 in.
   Tolerance for pad location is ± 0.0001 in.

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