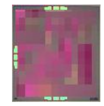
GaAs MMIC High Dynamic Range Mixer **MT3L-0113H**

1. Device Overview



Die

Module

1.1 General Description

MT3L-0113H 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, P_{1dB}, and broad operating bandwidths for applications in the S, C and X bands. MT3L-0113H is the monolithic cousin of the MT3-0113HCQG and sister of the MT3H-0113HCH targeted towards lower IF applications in a small footprint. The MT3L-0113H is available as both wire bondable die and a connectorized module.

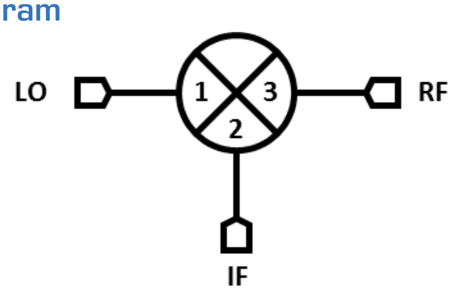
1.2 Features

- Low IF band
- Broad, overlapping RF/LO & IF bands
- High >+30 dBm IP3

1.3 Applications

- Test and measurement equipment
- S/C/X band radar

1.4 Functional Block Diagram



1.5 Part Ordering Options[1]

Part Number	Description	Package	Green Status	Product Lifecycle	Export Classification
MT3L-0113HCH-2	Wire bondable die	CH	**RoHS**	Active	EAR99
MT3L-0113HS	Connectorized module	S		Active	EAR99

[1] Refer to our website for a list of definitions for terminology presented in this table.

Table of Contents

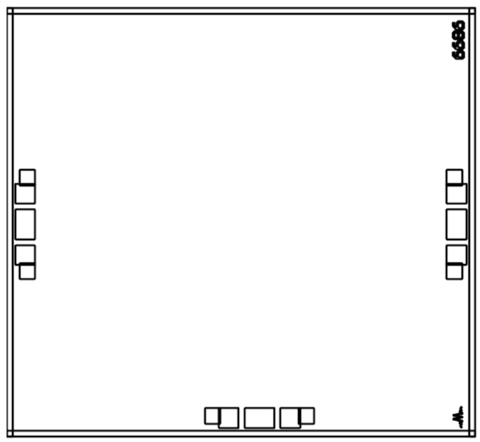
Revision History

Revision Code	Revision Date	Comment
-	January 2019	Datasheet Initial Release

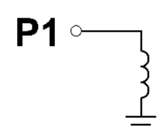
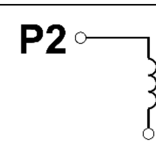
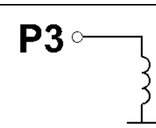
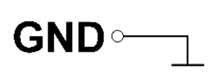
2. Port Configurations and Functions

2.1 Port Diagram

A top-down view of the MT3L-0113H's CH package outline drawing is shown below. The MT3L-0113H has the input and output ports given in Port Functions. The MT3L-0113H 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.



2.2 Port Functions

Port	Function	Description	Equivalent Circuit for Package
Port 1	LO (Configuration A) RF (Configuration B)	Port 1 is DC short for the CH and S packages.	
Port 2	IF	Port 2 is DC openfor the CH and S package.	
Port 3	RF (Configuration A) LO (Configuration B)	Port 3 is DC short for the CH and S packages.	
GND	Ground	CH package ground path is provided through the substrate and ground bond pads. S package ground provided through metal housing and outer coax conductor.	

3. Specifications

3.1 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	Units
Port 1 DC Current	150	mA
Port 2 DC Current	150	mA
Power Handling, at any Port	+33	dBm
Operating Temperature	-55 to +100	°C
Storage Temperature	-65 to +125	ºC

3.2 Package Information

Parameter	Details	Rating
ESD	Human Body Model (HBM), per MIL-STD-750, Method 1020	1 A
Weight	S Package	10 g

3.3 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.

	Min	Nominal	Max	Units
T_A, Ambient Temperature	-55	+25	+100	°C
LO Input Power	+15		+25	dBm

3.4 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.

3.5 Electrical Specifications

The electrical specifications apply at T_A=+25°C in a 50Ω system. Typical data shown is for the connectorized S package mixer used with a +20 dBm sine wave LO. Specifications shown for configuration A (B).

Min and Max limits apply only to our connectorized units and are guaranteed at T_A=+25°C. All bare die are 100% DC tested and visually inspected.

Parameter	Test Conditions	Min	Typical	Max	Units
RF (Port 3) Frequency Range		1.5		13	GHz
LO (Port 1) Frequency Range		1.5		13	GHz
I (Port 2) Frequency Range		0.25		5	GHz
Conversion Loss (CL)[2]	RF/LO = 1.5 - 13 GHz I = 0.75 GHz		8.5 (10)	11.5 (13)	dB
	RF/LO = 1.5 - 13 GHz I = 0.25- 0.75 GHz		10.5 (11)		dB
	RF/LO = 1.5 - 13 GHz I = 0.75- 5 GHz		9.5 (11)		dB
Noise Figure (NF)[3]	RF/LO = 1.5 - 13 GHz I = 0.75 GHz		8.5		dB
Isolation – LO to RF	RF/LO = 1.5 - 13 GHz		43		dB
Isolation – LO to IF	IF/LO = 1.5 - 13 GHz		41		dB
Isolation – RF to IF	RF/IF = 1.5 - 13 GHz		39		dB
Input IP3 (IIP3)[4]	RF/LO = 1.5 - 13 GHz I = 0.75 GHz		+31 (+31)		dBm
Input 1 dB Gain Compression Point (P1dB)[5]			+20 (+20)		dBm

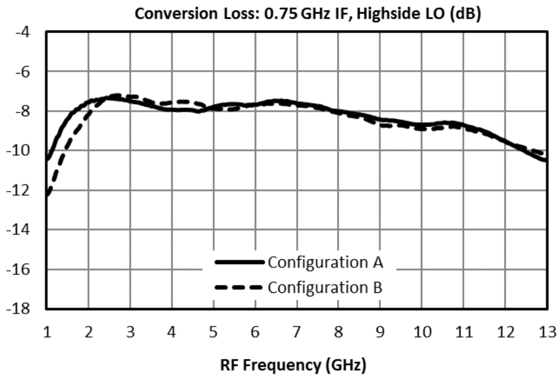
[2] Measured as a down converter to a fixed 750 MHz IF. Unless otherwise stated, frequency conversion done using a highside LO.

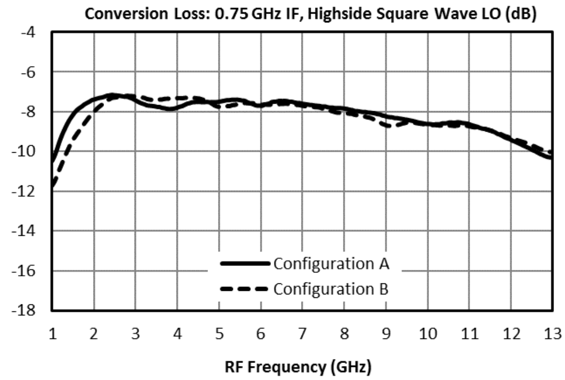
[3] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

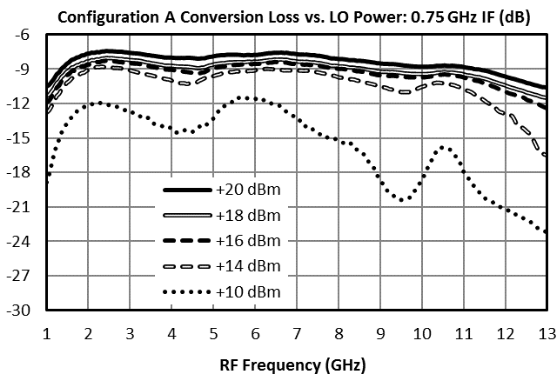
[4] IP3 depends on LO drive condition. Reported table value is measured with a square wave LO formed using 2x ADM1-0026PA in series with +10 dBm input into the first stage. LO Power reported in plots is of the fundamental tone only. Square wave LO power in plots is stepped down using broadband DC-40 GHz attenuators.

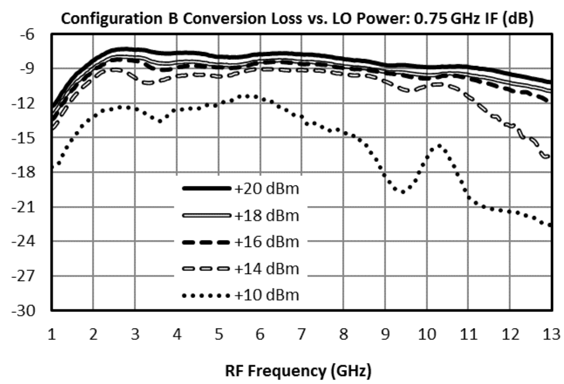
[5] P1dB is measured using a +23 dBm square wave LO.

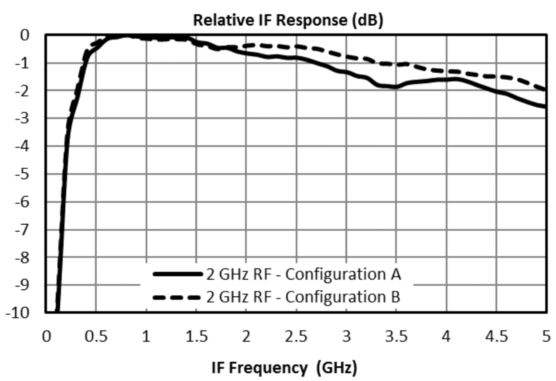
3.6 Typical Performance Plots

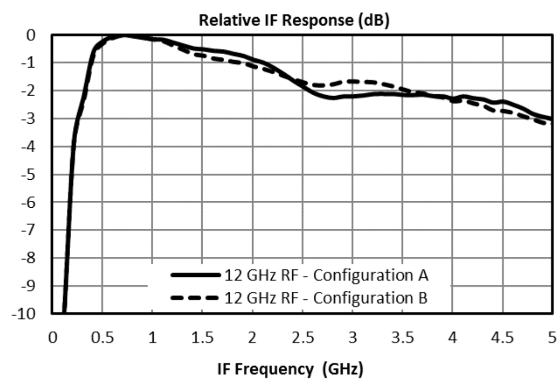


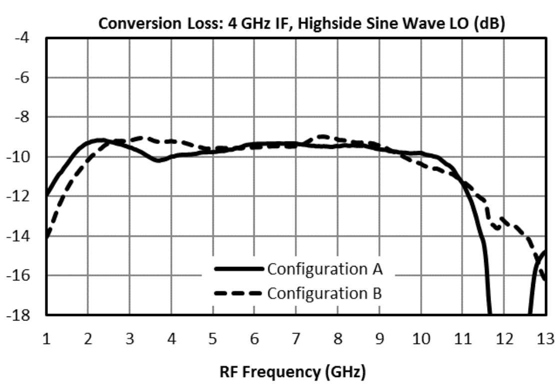


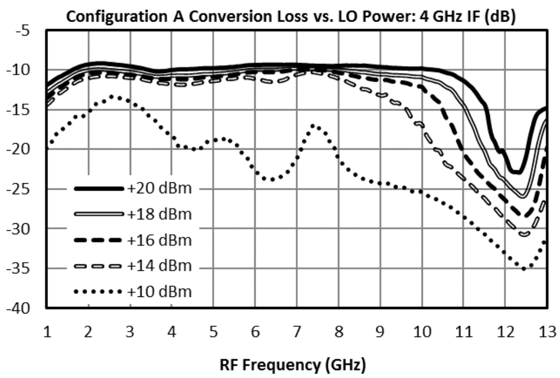


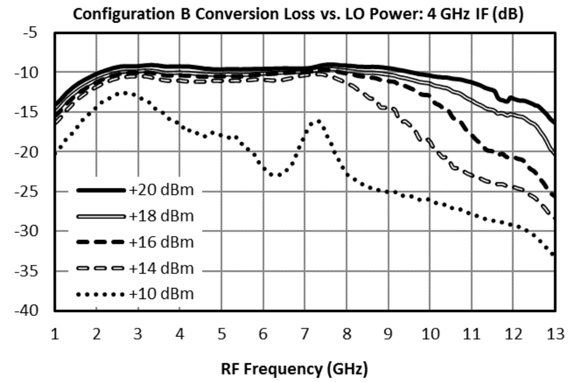


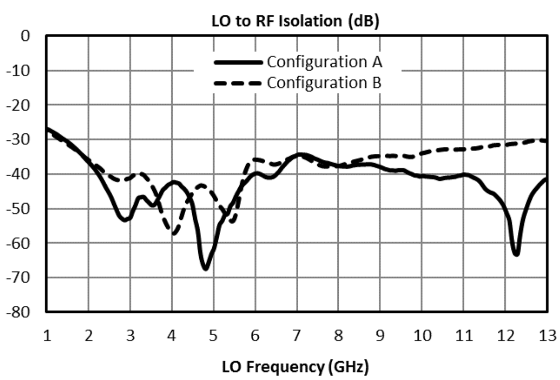


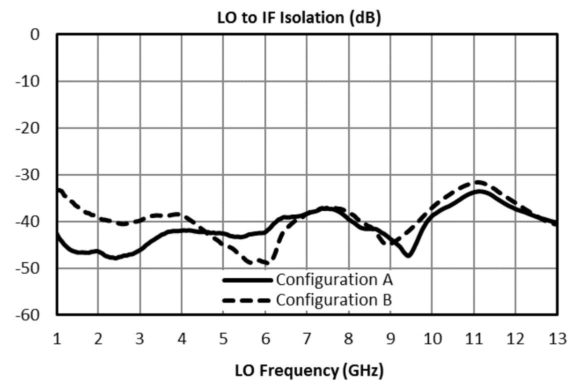


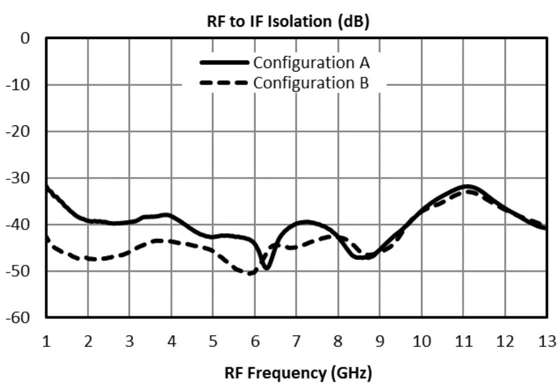


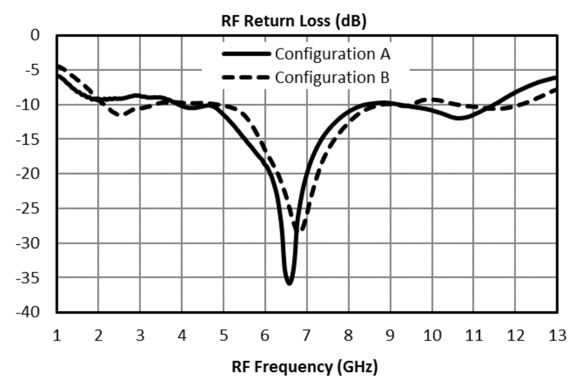

Configuration A Conversion Loss vs. LO Power: 4 GHz IF (dB)
+20 dBm
+18 dBm
+16 dBm
+14 dBm
+10 dBm
RF Frequency (GHz)

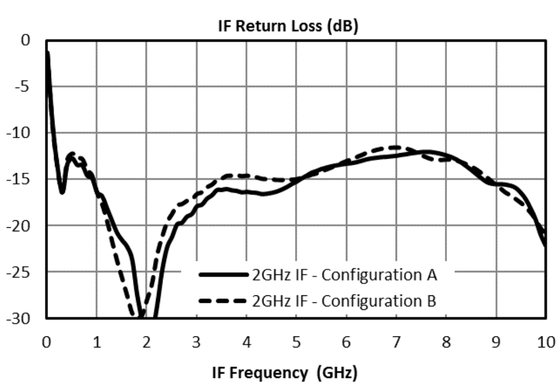

Configuration B Conversion Loss vs. LO Power: 4 GHz IF (dB)
+20 dBm
+18 dBm
+16 dBm
+14 dBm
+10 dBm
RF Frequency (GHz)

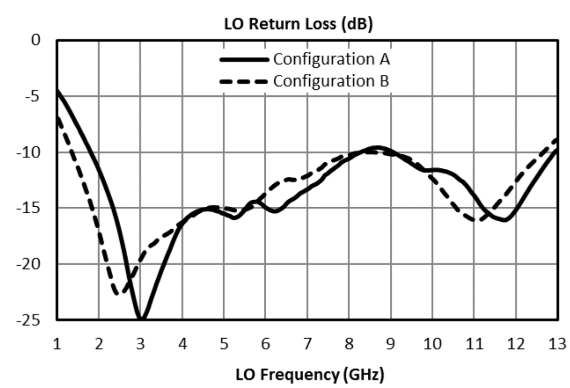

LO to RF Isolation (dB)
Configuration A
Configuration B
LO Frequency (GHz)


LO to IF Isolation (dB)
Configuration A
Configuration B
LO Frequency (GHz)

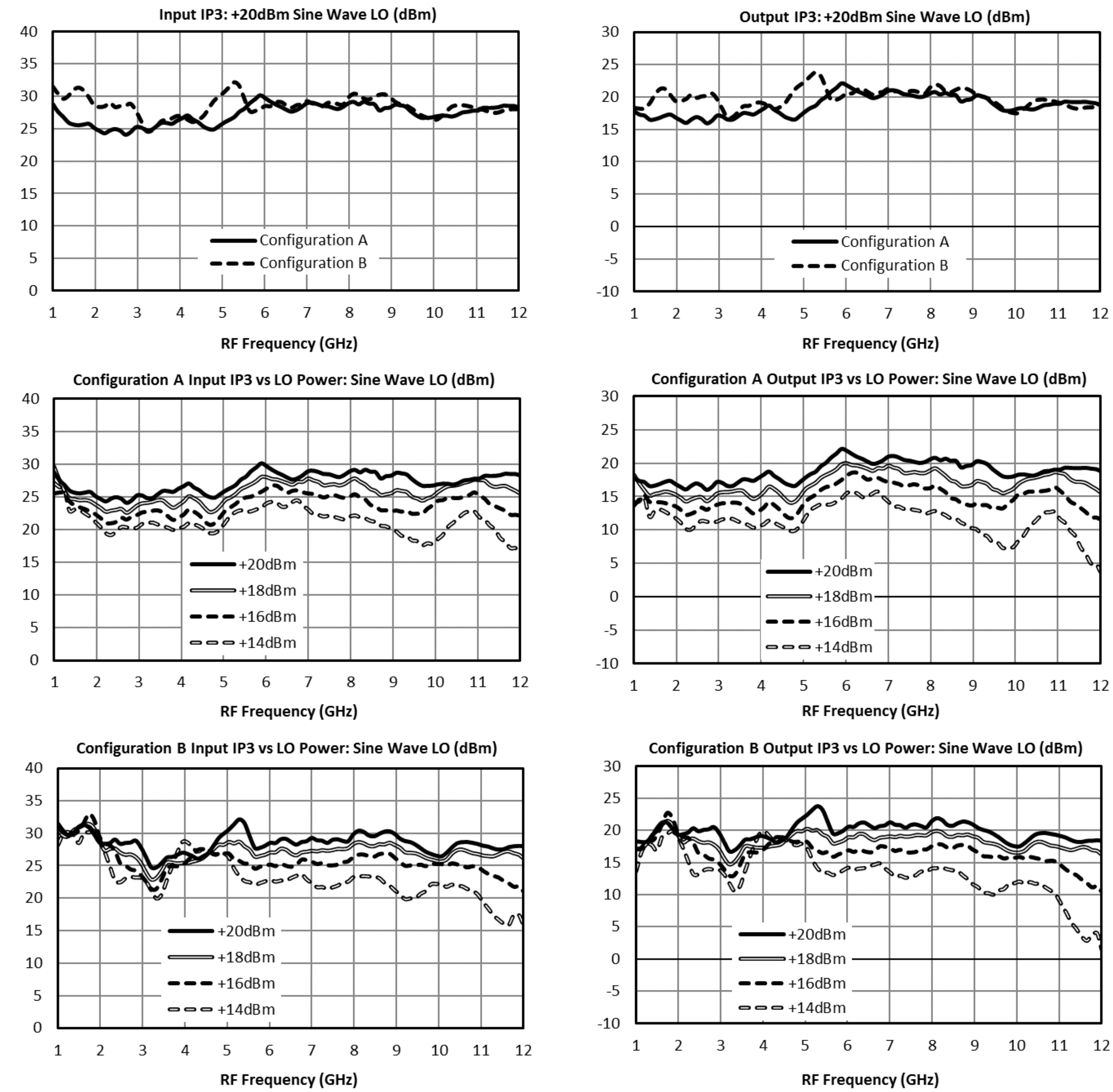

RF to IF Isolation (dB)
Configuration A
Configuration B
RF Frequency (GHz)


RF Return Loss (dB)
Configuration A
Configuration B
RF Frequency (GHz)

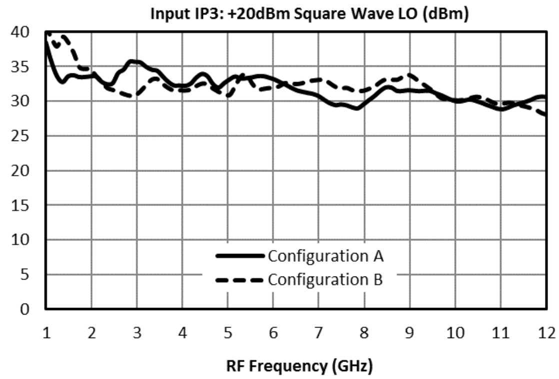

IF Return Loss (dB)
2GHz IF - Configuration A
2GHz IF - Configuration B
IF Frequency (GHz)

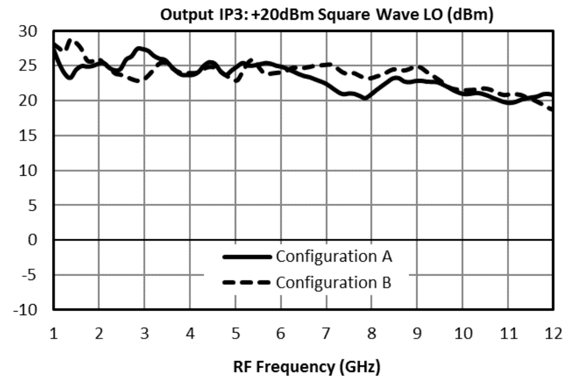

LO Return Loss (dB)
Configuration A
Configuration B
LO Frequency (GHz)

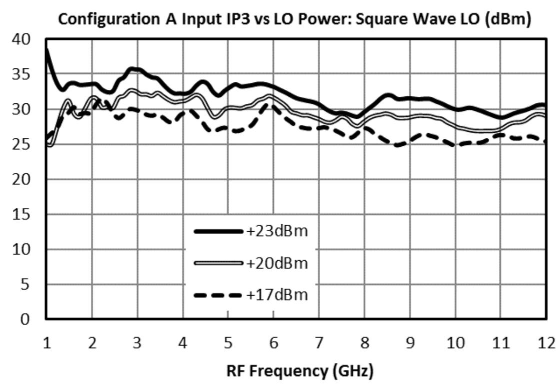
3.6.1 Typical Performance Plots: IP3, Sine Wave LO

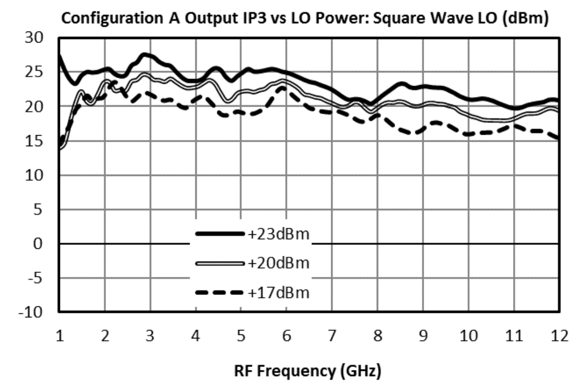


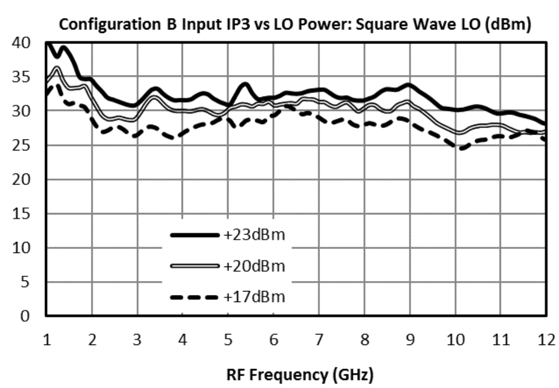
3.6.1 Typical Performance Plots: IP3, Square Wave LO

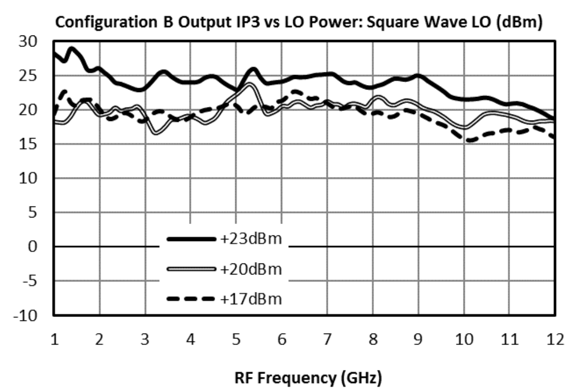




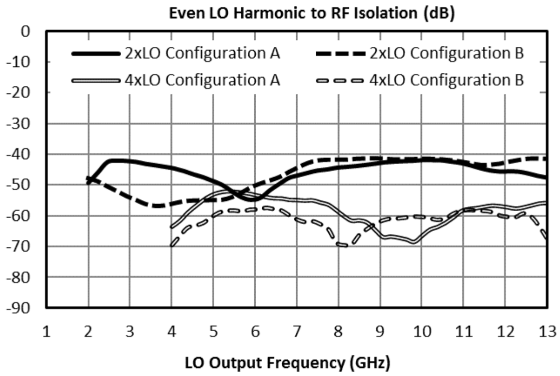


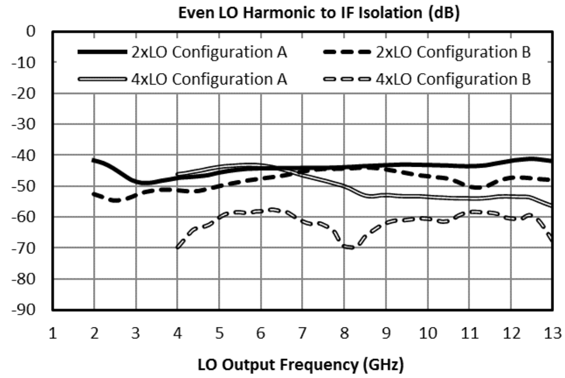


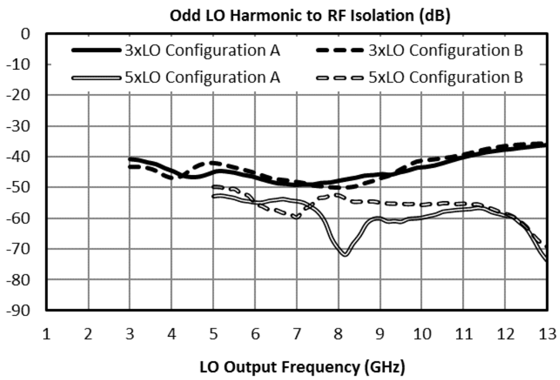


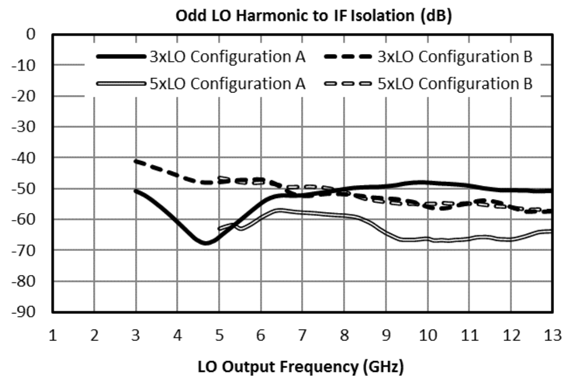


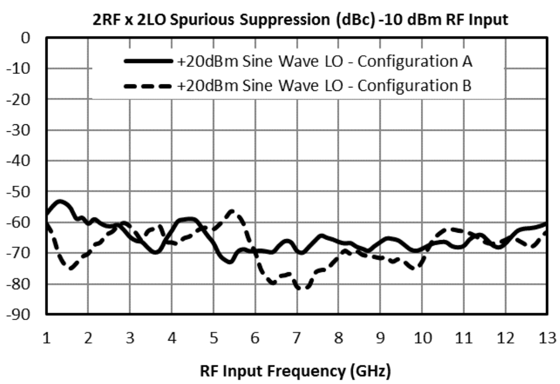
3.6.2 Typical Performance Plots: LO Harmonic Isolation

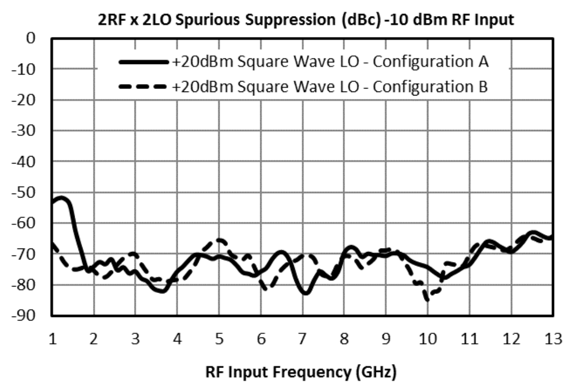


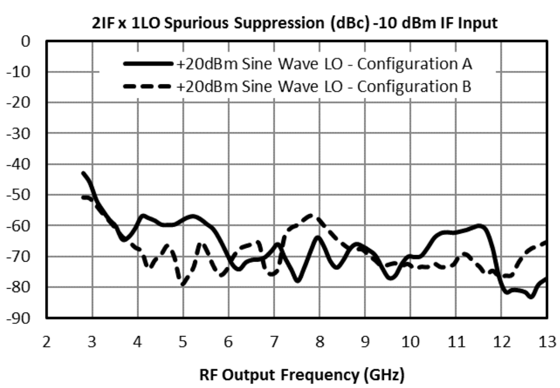


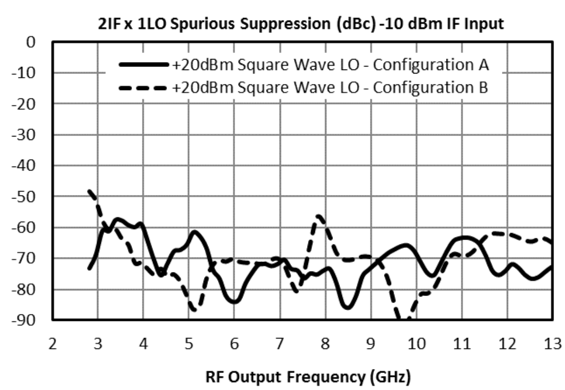












3.6.3 Typical Spurious Performance: Down-Conversion

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 63 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 73 dBc.

Typical Down-conversion spurious suppression (dBc): Config A (B), Sine Wave LO

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	30 (35)	Reference	42 (41)	18 (18)	35 (41)	21 (23)
2xRF	62 (62)	67 (66)	63 (66)	68 (63)	56 (58)	69 (64)
3xRF	111 (110)	82 (87)	98 (102)	80 (81)	101 (100)	138 (138)
4xRF	129 (128)	145 (145)	124 (127)	128 (129)	123 (123)	131 (129)
5xRF	165 (172)	147 (154)	159 (161)	148 (149)	159 (161)	145 (145)

Typical Down-conversion spurious suppression (dBc): Config A (B), Square Wave LO

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	29 (35)	Reference	37 (39)	13 (13)	37 (37)	18 (19)
2xRF	69 (62)	68 (69)	69 (70)	73 (71)	61 (64)	70 (73)
3xRF	109 (114)	94 (94)	106 (110)	91 (91)	107 (110)	137 (138)
4xRF	137 (141)	145 (145)	133 (137)	140 (140)	133 (137)	138 (137)
5xRF	173 (174)	158 (163)	167 (170)	162 (163)	171 (167)	161 (162)

3.6.4 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 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.

Typical Up-conversion spurious suppression (dBc): Config A (B), Sine Wave LO

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	23 (30)	Reference	42 (41)	19 (17)	39 (43)	22 (21)
2xIF	71 (63)	64 (67)	60 (57)	57 (59)	63 (59)	52 (57)
3xIF	102 (101)	85 (85)	100 (99)	85 (81)	94 (100)	81 (79)
4xIF	135 (131)	127 (128)	127 (123)	122 (120)	124 (121)	115 (117)
5xIF	163 (153)	150 (156)	161 (157)	151 (149)	155 (154)	144 (146)

Typical Up-conversion spurious suppression (dBc): Config A (B), Square Wave LO

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	23 (30)	Reference	37 (36)	13 (13)	37 (37)	18 (19)
2xIF	71 (63)	64 (67)	58 (59)	73 (71)	61 (64)	70 (73)
3xIF	102 (101)	89 (90)	105 (110)	91 (91)	107 (110)	137 (138)
4xIF	135 (131)	127 (128)	130 (133)	140 (140)	133 (137)	138 (137)
5xIF	163 (153)	150 (156)	172 (174)	162 (163)	171 (167)	161 (162)

4. Die Mounting Recommendations

4.1 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.

4.2 Handling Precautions

General Handling

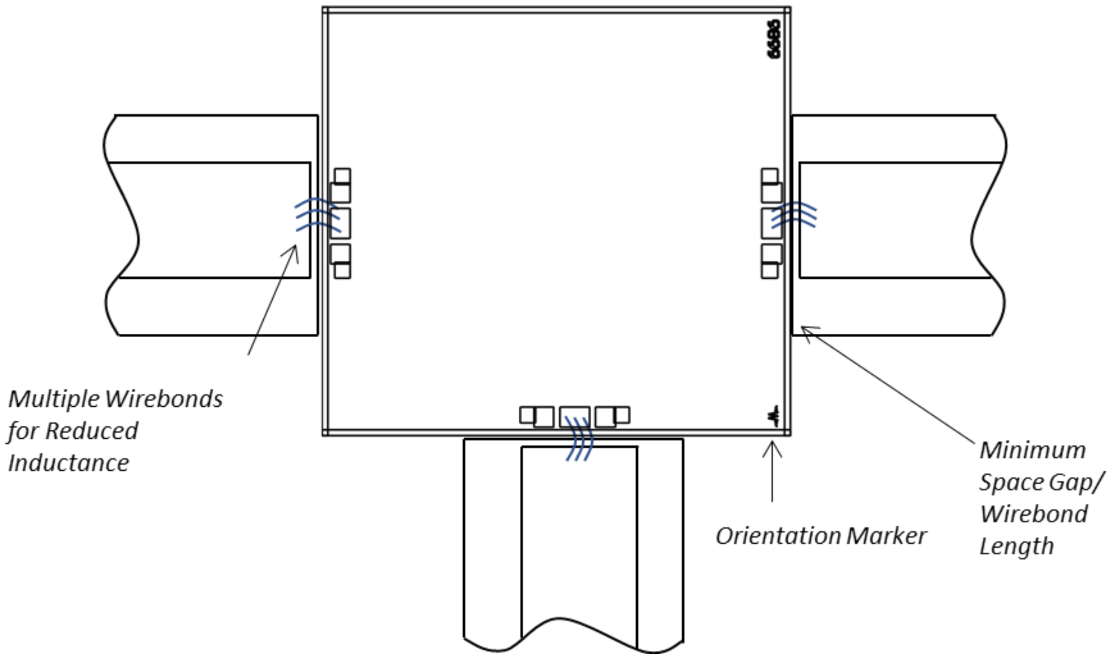
Chips should be handled with care using tweezers or a vacuum collet. Users should take precautions to protect chips from direct human contact that can deposit contaminants, like perspiration and skin oils on any of the chip's surfaces.

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.

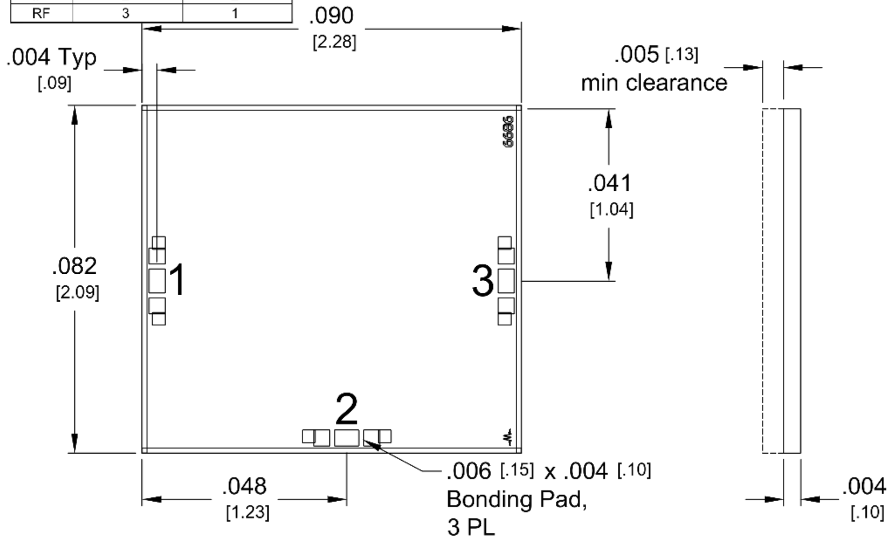
4.3 Bonding Diagram



5. Mechanical Data

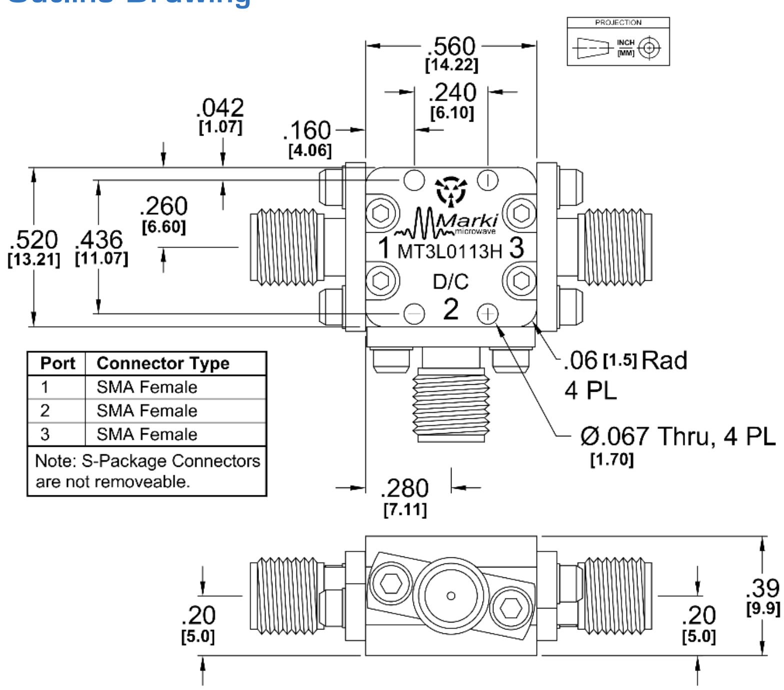
5.1 CH Package Outline Drawing

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



1. CH Substrate material is 0.004 in thick GaAs.
2. I/O trace finish is 4.2 microns Au. Ground plane finish is 5 microns Au.

5.2 S Package Outline Drawing



Port	Connector Type
1	SMA Female
2	SMA Female
3	SMA Female

Note: S-Package Connectors are not removeable.