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

MM1-1140HCH-1

GaAs Double-Balanced Mixer

DEVICE OVERVIEW

General Description

The MM1-1140H is a passive double balanced MMIC mixer. It features excellent conversion loss, superior isolations and spurious performance across a broad bandwidth, in a highly miniaturized form factor. Accurate, nonlinear simulation models are available for Microwave Office® through the Marki Microwave PDK. The MM1-1140H is available as a wire bondable chip or in a connectorized package. The MM1-1140H is a superior alternative to Marki Microwave carrier and packaged M1 and M9 mixers.

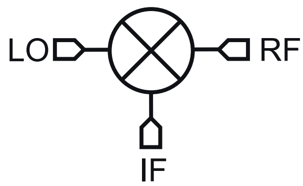
Features

- Compact Chip Style Package (0.054" x 0.046"x0.004")
- CAD Optimized for Superior Isolation and Spurious Response
- Broadband Performance
- Excellent Unit-to-Unit Repeatability
- Fully nonlinear software models available with Marki PDK for Microwave Office
- RoHS Compliant

Applications

N/A

Functional Block Diagram



Part Ordering Options

Part Number	Description	Package	Connectors	Green Status	Product Lifecycle	Export Classification
MM1-1140HS	GaAs Double-Balanced Mixer	S	Standard	REACH RoHS	Released	EAR99
MM1-1140HCH-1	GaAs Double-Balanced Mixer	CH	-	REACH RoHS	Released	EAR99
MM1-1140HCH-2	GaAs Double-Balanced Mixer	CH	-	REACH RoHS	Released	EAR99

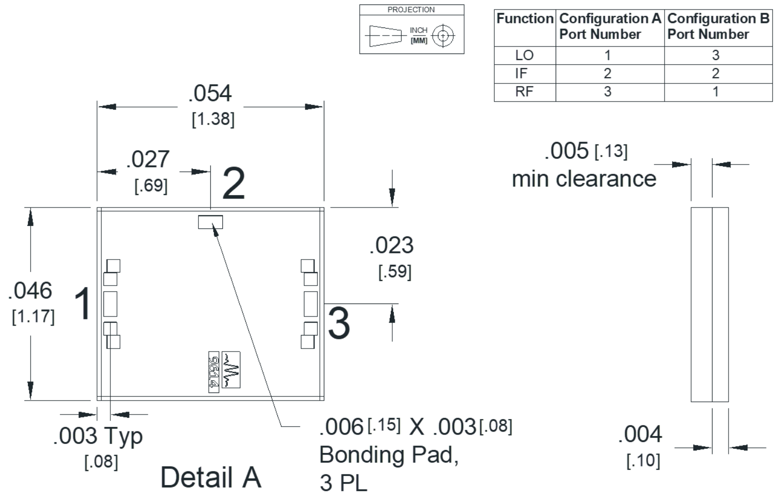
Table Of Contents

Revision History

Revision Code	Revision Date	Comment
-	2024-02-08	Initial Release

Port Configuration and Functions

Port Diagram

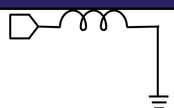
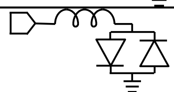


Notes:

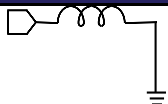
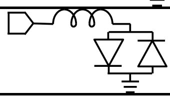
1. CH substrate is .004 in Thick GaAs.
2. I/O traces finish is 4 microns Au. Ground plane finish is 5 microns Au.

Port Functions

Configuration A

Port	Function	Description	Equivalent Circuit for Package
Port 1	LO	Port 1 is DC short to ground and AC matched to 50 Ohms from 11 to 40 GHz. Blocking capacitor is optional.	
Port 2	IF	Port 2 is DC coupled to the diodes. Blocking capacitor is optional.	
Port 3	RF	Port 3 is DC open and AC matched to 50 Ohms from 11 to 40 GHz. Blocking capacitor is optional.	

Configuration B

Port	Function	Description	Equivalent Circuit for Package
Port 1	RF	Port 1 is DC short to ground and AC matched to 50 Ohms from 11 to 40 GHz. Blocking capacitor is optional.	
Port 2	IF	Port 2 is DC coupled to the diodes. Blocking capacitor is optional.	
Port 3	LO	Port 3 is DC open and AC matched to 50 Ohms from 11 to 40 GHz. Blocking capacitor is optional.	

Specifications

Absolute Maximum Ratings

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	15	mA
Port 2 DC Current	24	mA
RF Power Handling (RF+LO), 100°C	21	dBm
RF Power Handling (RF+LO), 25°C	25	dBm

Package Information

Parameter	Details	Rating
Dimensions	-	1.38 x 1.17 mm

Recommended Operating Conditions

Parameter	Min	Nominal	Max	Unit
LO Input Power	12	-	20	-

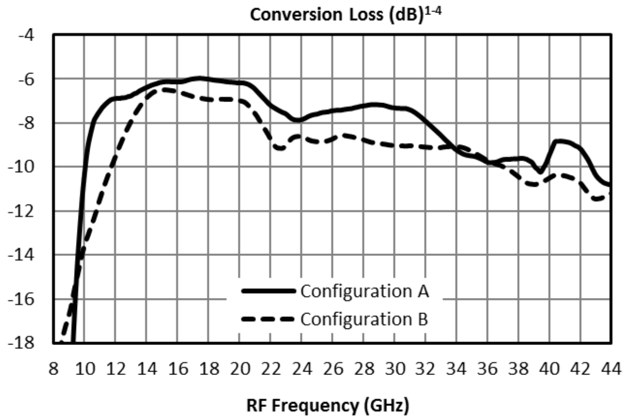
Electrical Specifications

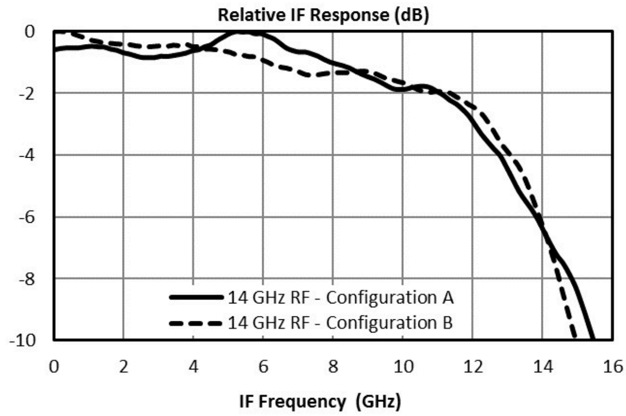
Specifications guaranteed from -55 to +100°C, measured in a 50Ω system. All bare die are 100% DC tested and 100% visual inspected. RF testing is performed on a sample basis to verify conformance to datasheet guaranteed specifications. onsult factory for more information.

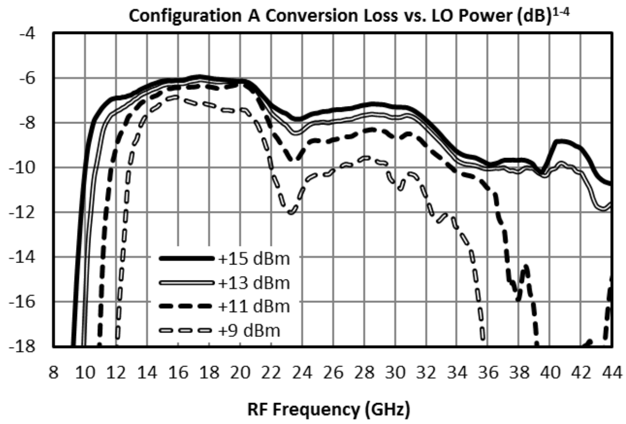
Parameter	Port Configuration	Test Conditions	Min	Typ	Max	Unit
Conversion Loss	A	LO/RF=11-40 GHz IF=DC-12 GHz LO drive level=15dBm	-	8	14	dB
IF Frequency Range	A	-	0	-	12	GHz
Input 1 dB Compression	A	LO/RF=11-40 GHz IF=DC-12 GHz LO drive level=13-20dBm	-	9	-	dBm
Input IP3	A	LO/RF=11-40 GHz IF=DC-12 GHz LO drive level=13-20dBm	-	21	-	dBm
Isolation, LO to RF	A	-	-	47	-	dB
LO Frequency Range	A	-	11	-	40	GHz
RF Frequency Range	A	-	11	-	40	GHz
Conversion Loss	B	LO/RF=11-40 GHz IF=DC-12 GHz LO drive level=15dBm	-	9	16	dB
Input 1 dB Compression	B	LO/RF=11-40 GHz IF=DC-12 GHz LO drive level=12-17dBm	-	9	-	dBm
Input IP3	B	LO/RF=11-40 GHz IF=DC-12 GHz LO drive level=12-17dBm	-	23	-	dBm

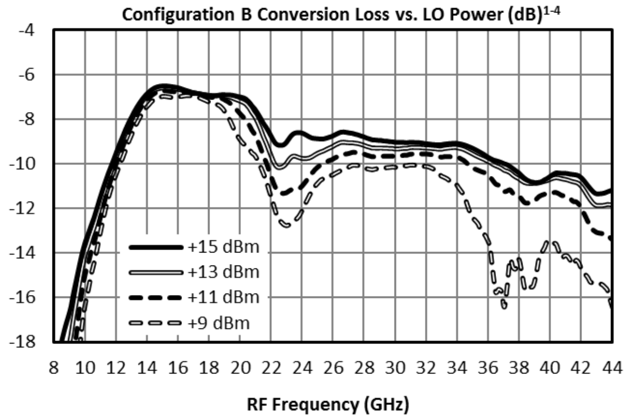
www.markimicrowave.com

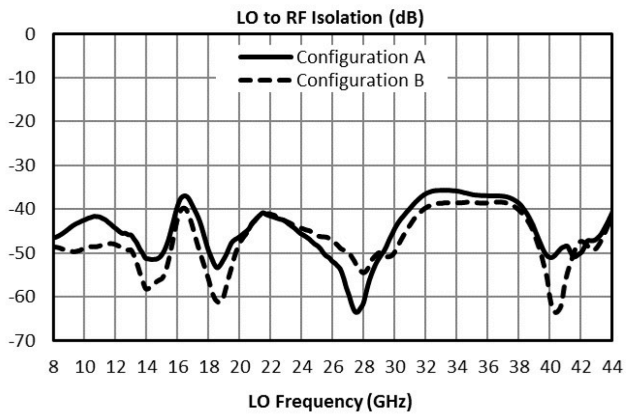
Typical Performance

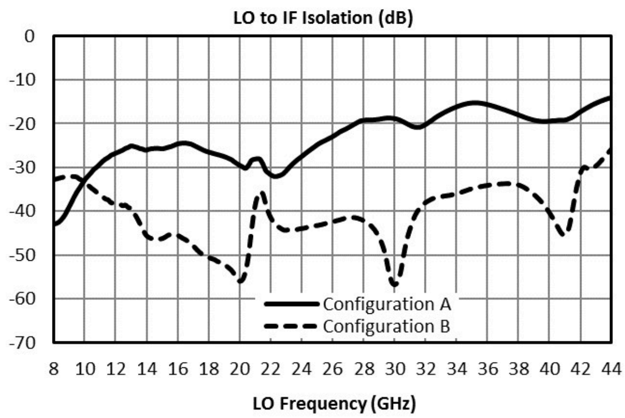


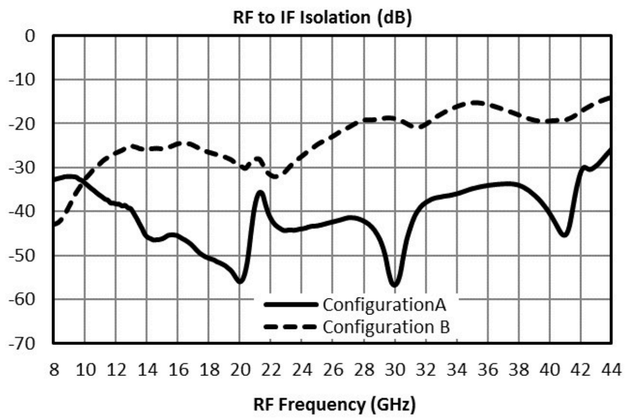


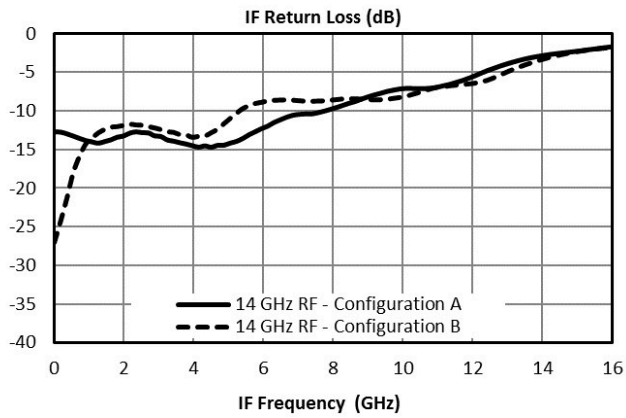


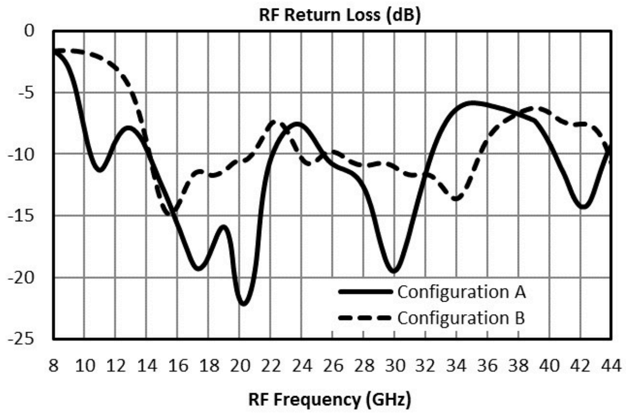


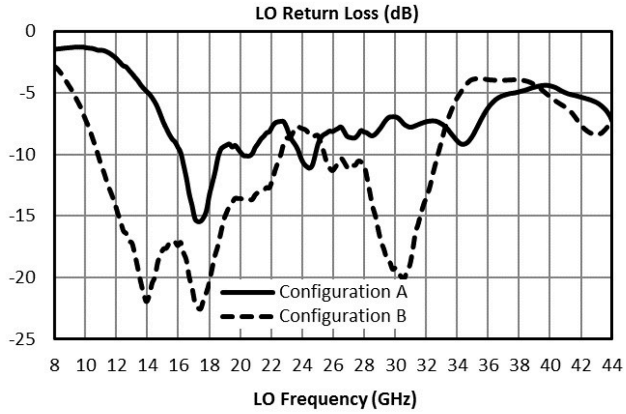


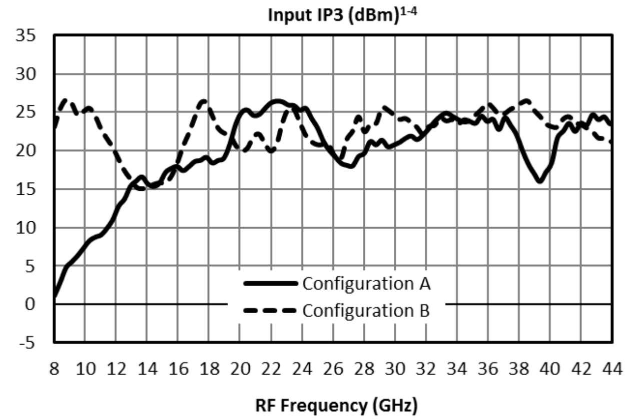


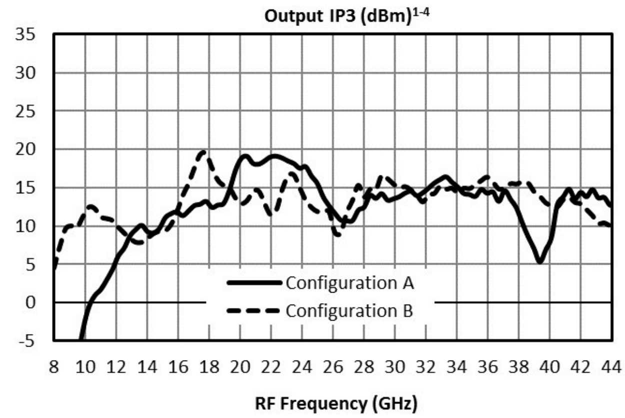


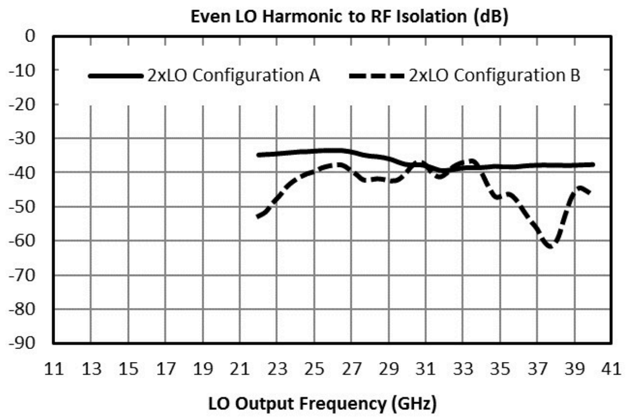


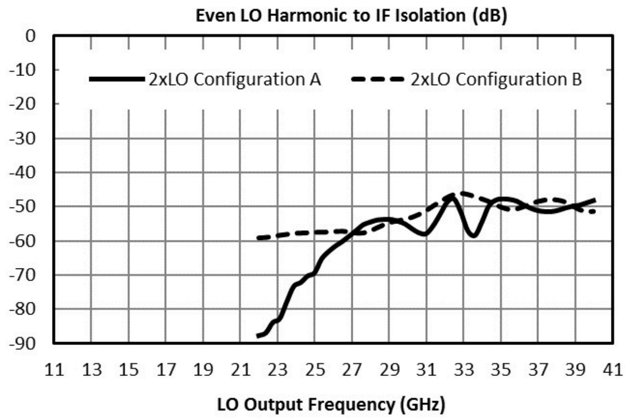

RF Return Loss (dB)
0
-5
-10
-15
-20
-25
8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
Configuration A
Configuration B
RF Frequency (GHz)

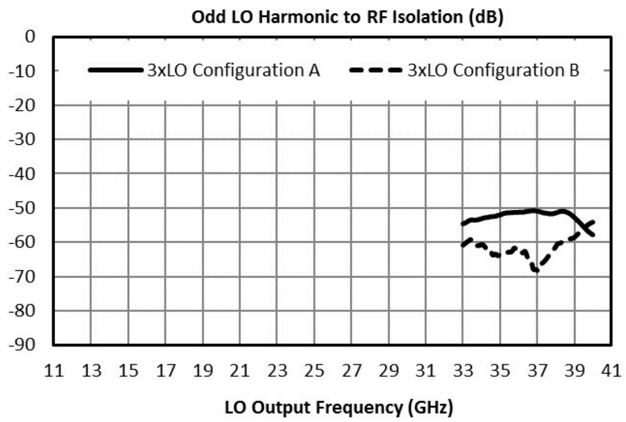

LO Return Loss (dB)
0
-5
-10
-15
-20
-25
8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
Configuration A
Configuration B
LO Frequency (GHz)

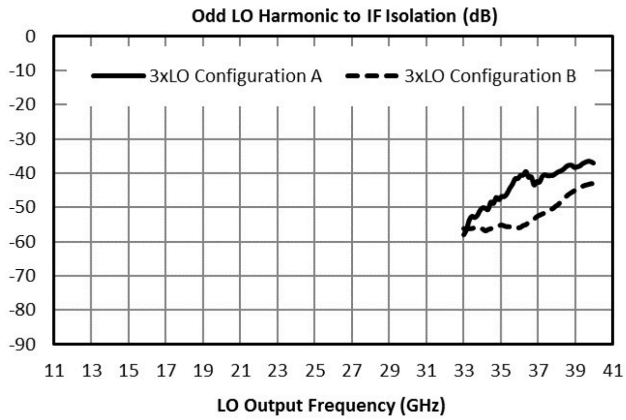

Input IP3 (dBm)1-4
35
30
25
20
15
10
5
0
-5
8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
Configuration A
Configuration B
RF Frequency (GHz)

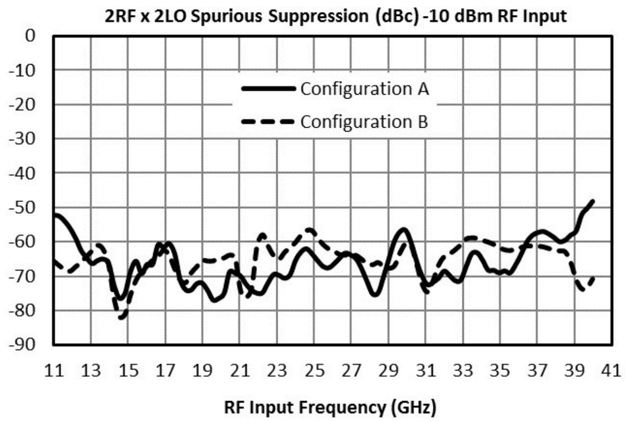

Output IP3 (dBm)1-4
35
30
25
20
15
10
5
0
-5
8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
Configuration A
Configuration B
RF Frequency (GHz)

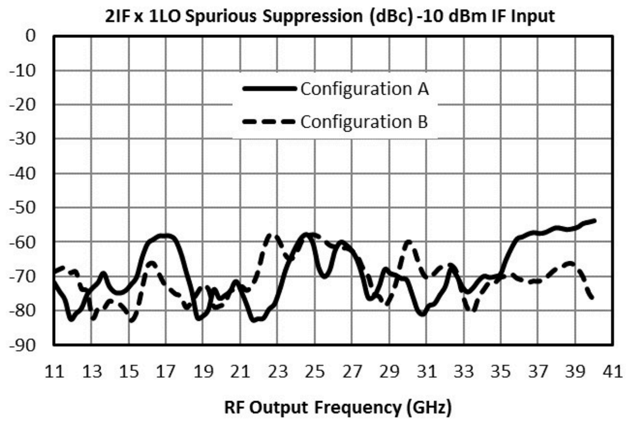

Even LO Harmonic to RF Isolation (dB)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
2xLO Configuration A
2xLO Configuration B
LO Output Frequency (GHz)


Even LO Harmonic to IF Isolation (dB)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
2xLO Configuration A
2xLO Configuration B
LO Output Frequency (GHz)


Odd LO Harmonic to RF Isolation (dB)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
3xLO Configuration A
3xLO Configuration B
LO Output Frequency (GHz)

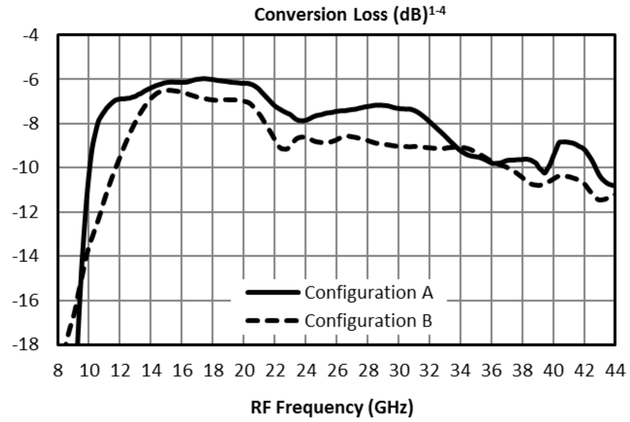

Odd LO Harmonic to IF Isolation (dB)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
3xLO Configuration A
3xLO Configuration B
LO Output Frequency (GHz)

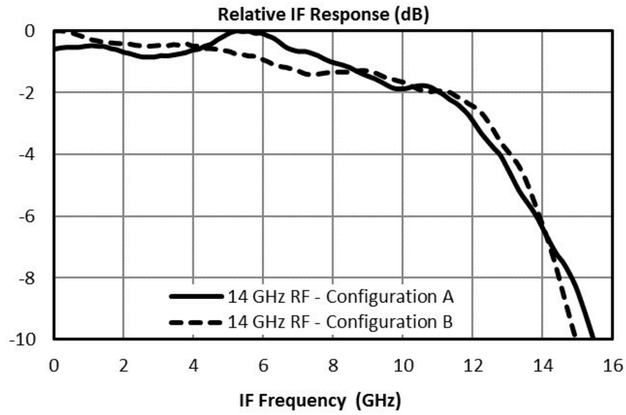

2RF x 2LO Spurious Suppression (dBc) -10 dBm RF Input
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
RF Input Frequency (GHz)

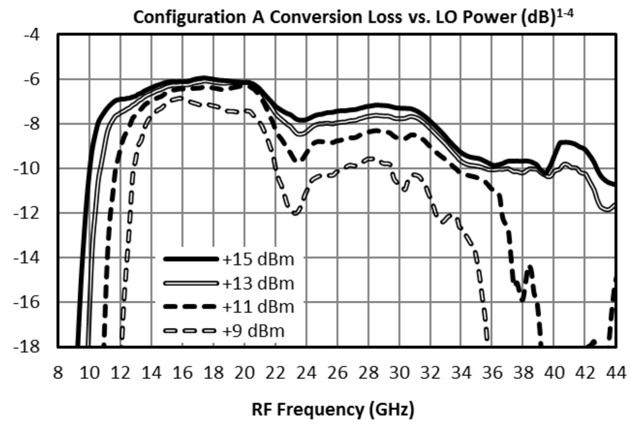

2IF x 1LO Spurious Suppression (dBc) -10 dBm IF Input
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
RF Output Frequency (GHz)

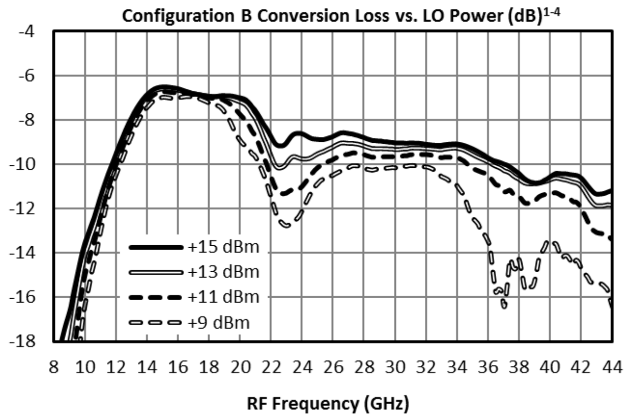
MM1-1140HS - Typical Performance Plots

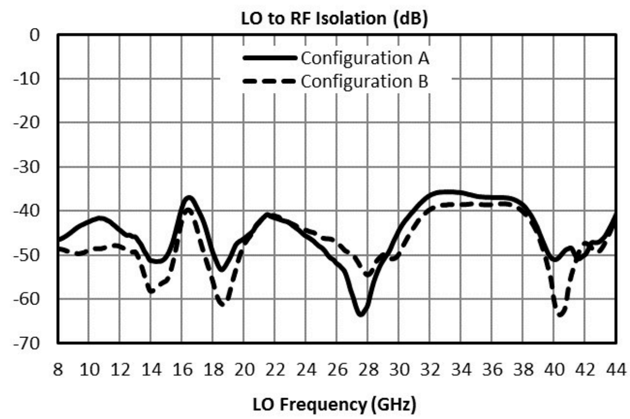
Performance plots for the connectorized module are shown for measurements where directly probed measurements of the die are unavailable. Note that the following measurements include losses from connectors and microstrip traces.

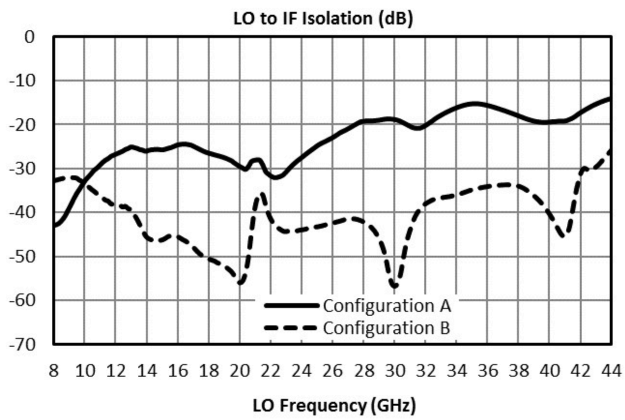


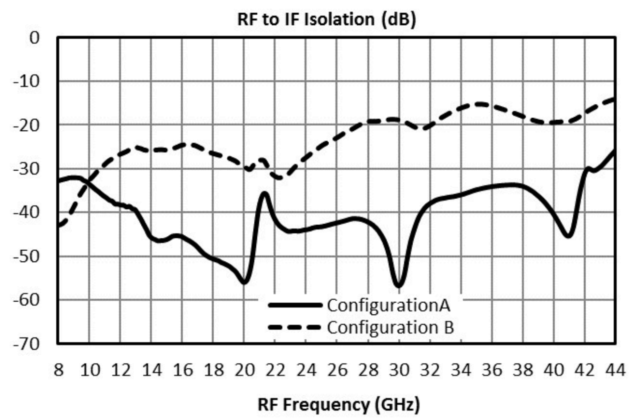


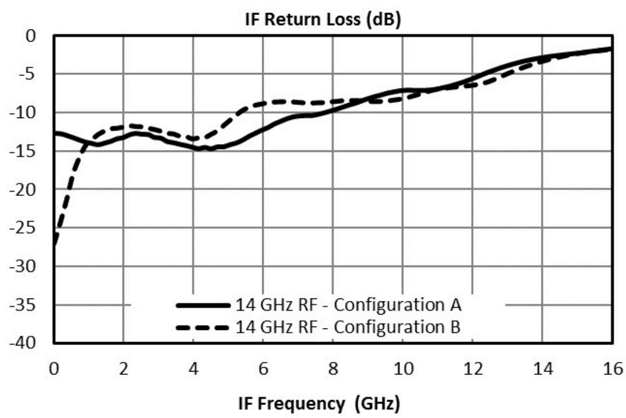




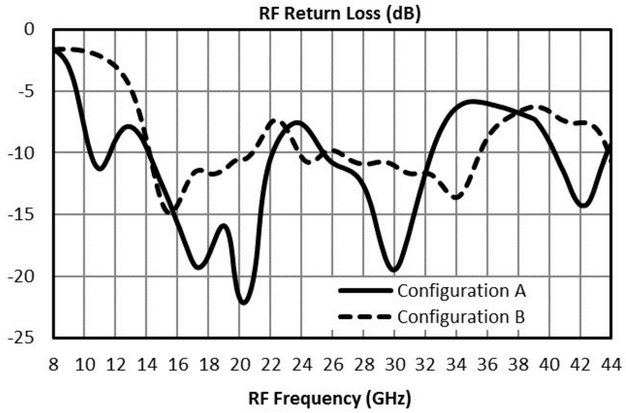




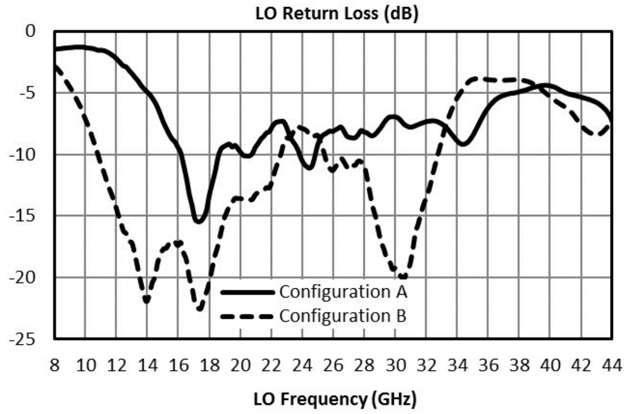




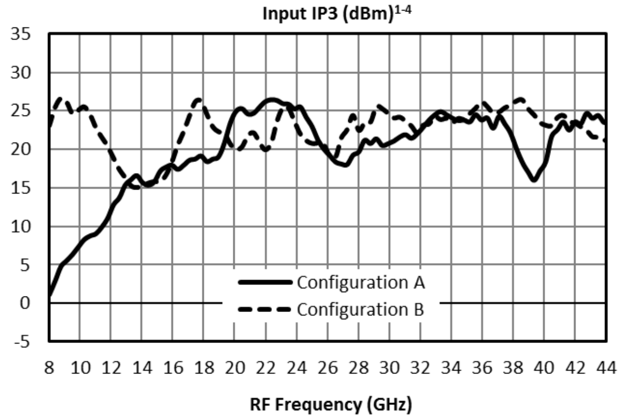
RF Return Loss (dB)



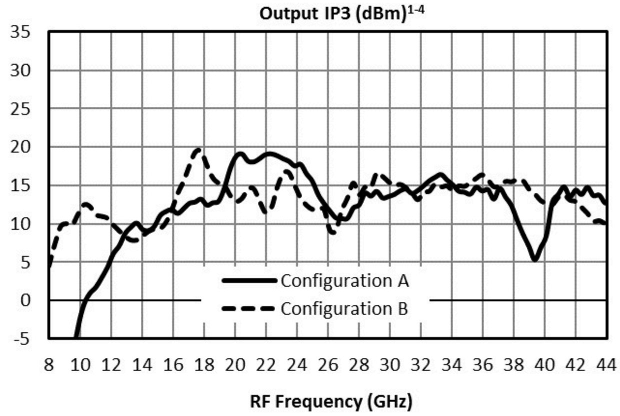
LO Return Loss (dB)



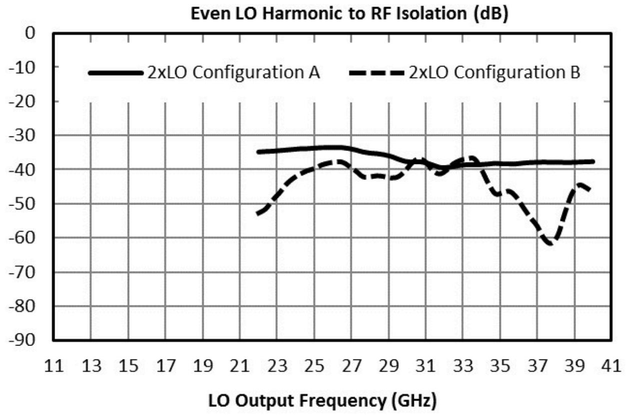
Input IP3 (dBm)[1-4]



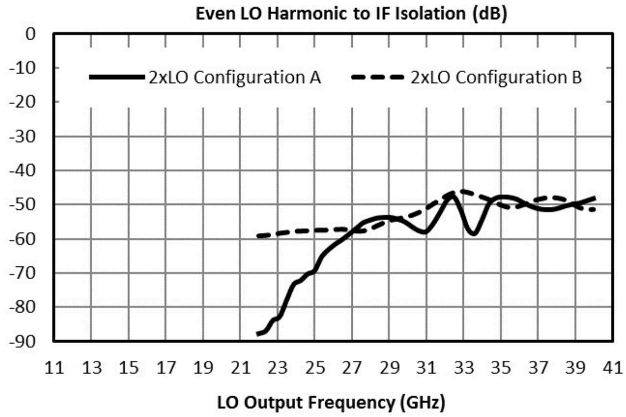
Output IP3 (dBm)[1-4]



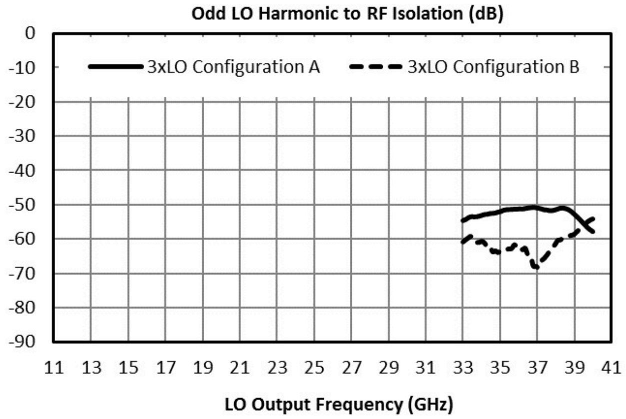
Even LO Harmonic to RF Isolation (dB)



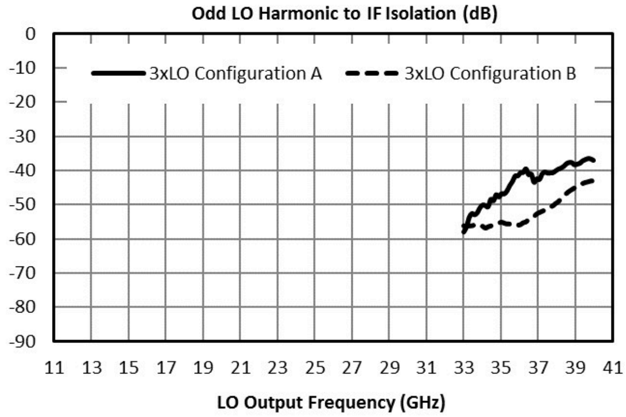
Even LO Harmonic to IF Isolation (dB)

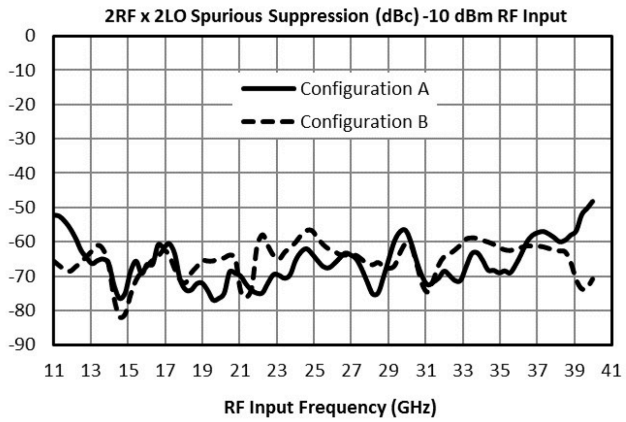


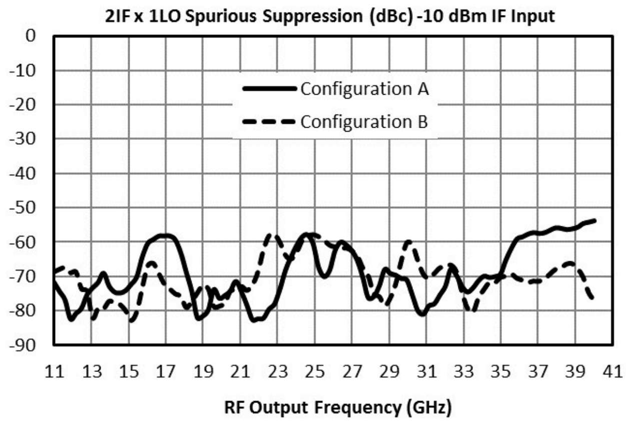
Odd LO Harmonic to RF Isolation (dB)



Odd LO Harmonic to IF Isolation (dB)




2RF x 2LO Spurious Suppression (dBc) -10 dBm RF Input
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
RF Input Frequency (GHz)


2IF x 1LO Spurious Suppression (dBc) -10 dBm IF Input
Configuration A
Configuration B
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
RF Output Frequency (GHz)

Spur Table

Downconversion Spurious Suppression

Spurious data is taken by selecting RF and LO frequencies (+mLO+nRF) within the RF/LO bands, to create a spurious output within the IF output 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 2RFx2LO spur is 66 dBc for the A configuration for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) dB lower, or 76 dBc.

Typical Downconversion Spurious Suppression (dBc): A Configuration (B Configuration) [4]

-10 dBm RF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xRF	34 (15)	Reference	33 (36)	15 (11)	37 (34)	N/A
2xRF	73 (71)	53 (57)	66 (65)	62 (56)	62 (69)	61 (56)
3xRF	85 (79)	57 (68)	78 (83)	69 (71)	77 (87)	63 (69)
4xRF	N/A	88 (116)	102 (105)	101 (101)	108 (111)	105 (104)
5xRF	N/A	106 (124)	111 (123)	115 (124)	117 (128)	114 (118)

Upconversion Spurious Suppression

Spurious data is taken by mixing an input within the IF band, with LO frequencies (+mLO+nIF), 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 the A configuration for a -10 dBm input, so a -20 dBm IF input creates a spur that is (2-1) x (-10 dB) dB lower, or 79 dBc.

Typical Upconversion Spurious Suppression (dBc): A Configuration (B Configuration) [4]

-10 dBm IF Input	0xLO	1xLO	2xLO	3xLO	4xLO	5xLO
1xIF	33 (20)	Reference	42 (38)	15 (10)	36 (35)	19 (26)
2xIF	60 (64)	69 (70)	59 (57)	63 (64)	55 (54)	62 (70)
3xIF	93 (91)	70 (64)	79 (81)	67 (62)	74 (83)	63 (70)
4xIF	114 (106)	104 (103)	101 (95)	108 (103)	100 (91)	97 (110)
5xIF	125 (122)	113 (108)	118 (119)	117 (111)	115 (117)	98 (107)

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 and the epoxy should have high thermal conductivity. 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. MMICs with high power dissipation, particularly those with high DC power requirements, also require a thermally conductive ground plane with a thermally conductive epoxy attachment.

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 ohm 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.

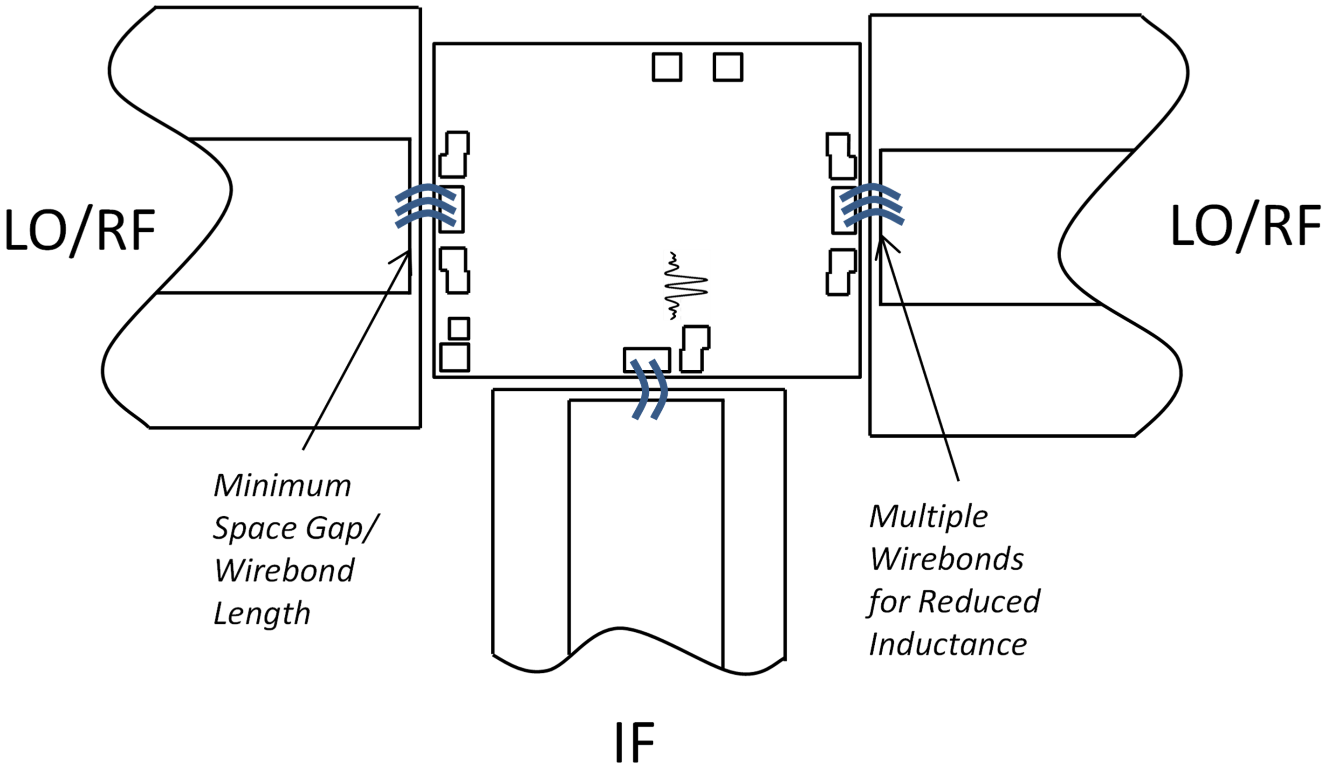
Handling Precautions

General Handling: Chips should be handled with a vacuum collet when possible, or with sharp tweezers using well trained personnel. The surface of the chip is fragile and should not be contacted if possible.

Static Sensitivity: GaAs MMIC devices are subject to static discharge, 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



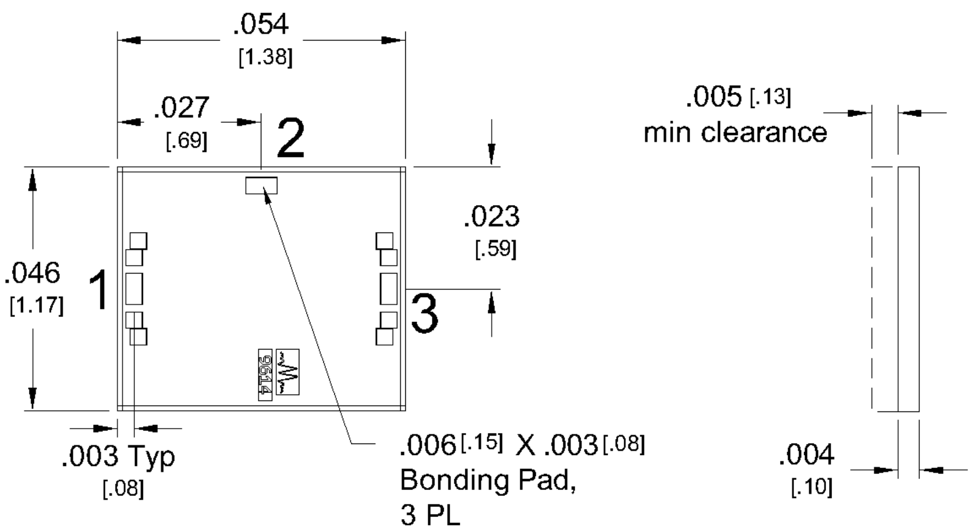
Mechanical Data

Outline Drawing

Download : Outline 2D Drawing

PROJECTION	REVISIONS			
INCH [MM]	REV.	DESCRIPTION	DATE	APPROVALS
	A	ECN 24096 remove gel-pak info.	10/17/24	AT

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



Notes:

1. CH substrate is .004 in Thick GaAs.
2. I/O traces finish is 4 microns Au. Ground plane finish is 5 microns Au.

Proprietary: This document was originated by and is the property of Marki Microwave. Unauthorized disclosure is prohibited.

.XX± .01 ±
.XXX± .002

MATERIAL: 210-09614-R70

FINISH:

DO NOT SCALE DRAWING

NOTES:

DRAWN BY: OG DATE: 2/6/2024

Marki microwave www.markimicrowave.com

Outline
MMIC Mixer

SIZE: A CAGE CODE: 0UC32 DWG. NO.: MM1-1140HCH-1

SCALE 40/1 SHEET 1 OF 1

Notes

1. Mixer Conversion Loss Plot IF frequency is 91 MHz.
2. Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.
3. Conversion Loss typically degrades less than 0.5 dB at +100°C and improves less than 0.5 dB at -55°C.
4. Unless otherwise specified, data is taken with +15 dBm LO drive.
5. Specifications are subject to change without notice. Contact Marki Microwave for the most recent specifications and data sheets.
6. Catalog mixer circuits are continually improved. Configuration control requires custom mixer model numbers and specifications.