

GaAs MMIC Double Balanced Mixer

MM1-0212H

1. Device Overview

1.1 General Description

MM1-0212H is a GaAs MMIC double balanced mixer that is optimized for low frequency applications. MM1-0212H is a low frequency S band mixer that works well as both an up and down converter to through X band. This mixer offers low conversion loss and high LO to RF isolations at moderate LO powers. The sister MM1-0212S is recommended for applications which demand higher linearity. The MM1-0212L is recommended for low power applications. The MM1-0212H is available as both wire bondable die and as connectorized modules.



Die



Module

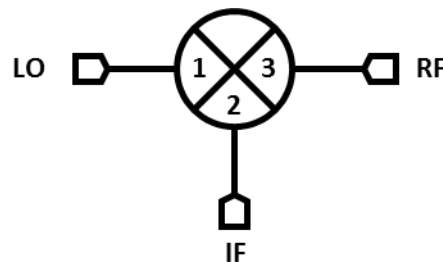
1.2 Features

- High LO to RF isolation
- Low cost X band mixer

1.3 Applications

- Test and measurement equipment

1.4 Functional Block Diagram



1.5 Part Ordering Options¹

| Part Number | Description | Package | Green Status | Product Lifecycle | Export Classification |
|---------------|----------------------|---------|--------------|-------------------|-----------------------|
| MM1-0212HCH-2 | Wire bondable die | CH | RoHS | Active | EAR99 |
| MM1-0212HS | Connectorized module | S | | Active | EAR99 |

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

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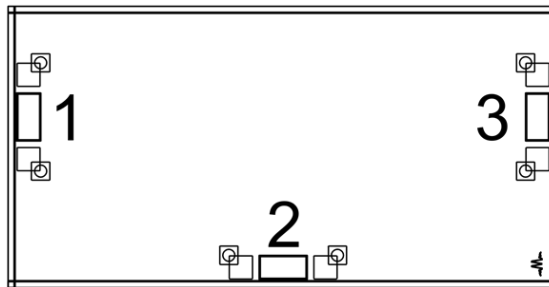
Revision History

| Revision Code | Revision Date | Comment |
|---------------|---------------|--|
| - | January 2018 | Datasheet Initial Release |
| A | January 2019 | Added max power/current spec, ESD rating |

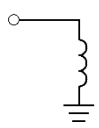
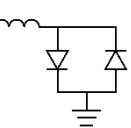
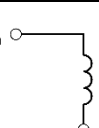
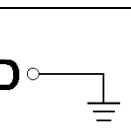
2. Port Configurations and Functions

2.1 Port Diagram

A top-down view of the MM1-0212H's CH package outline drawing is shown below. The MM1-0212H has the input and output ports given in Port Functions. The MM1-0212H 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. | P1  |
| Port 2 | IF | Port 2 is diode connected for the CH and S package. | P2  |
| Port 3 | RF (Configuration A) LO (Configuration B) | Port 3 is DC open for the CH and S packages. | P3  |
| 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. | GND  |

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 | 30 | mA |
| Port 2 DC Current | 30 | mA |
| Power Handling, at any Port | +30 | dBm |
| Operating Temperature | -55 to +100 | °C |
| Storage Temperature | -65 to +125 | °C |

3.2 Package Information

| Parameter | Details | Rating |
|-----------|--|--------|
| ESD | Human Body Model (HBM), per MIL-STD-750, Method 1020 | 1A |
| 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 | +13 | | +17 | 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 $T_A=+25^{\circ}\text{C}$ in a 50Ω system. Typical data shown is for the connectorized S package mixer used in the forward direction with a +15 dBm sine wave input. Specifications shown for configuration A (B).

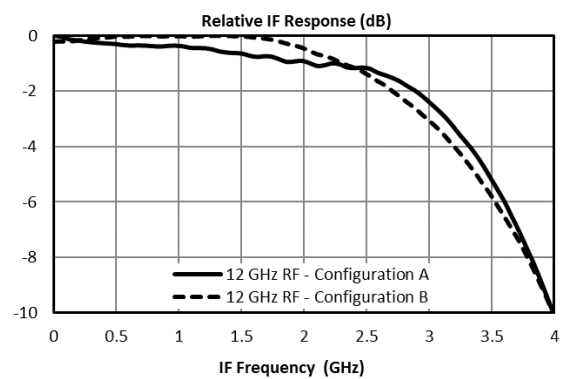
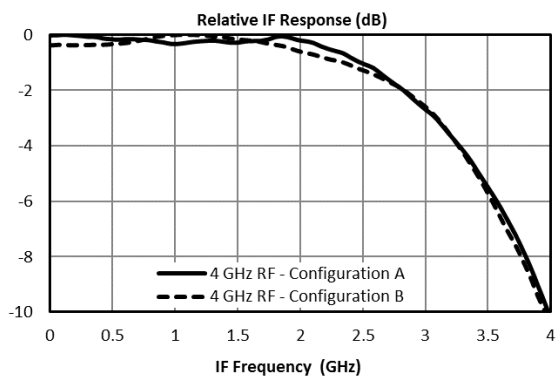
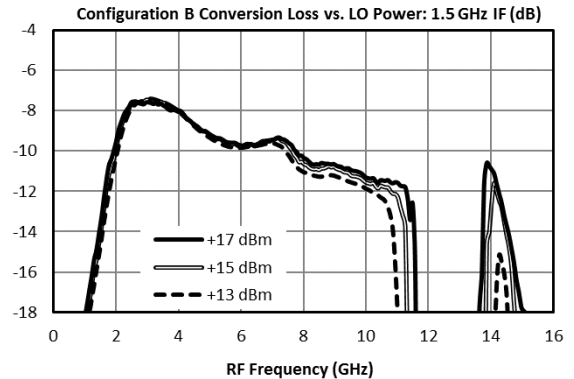
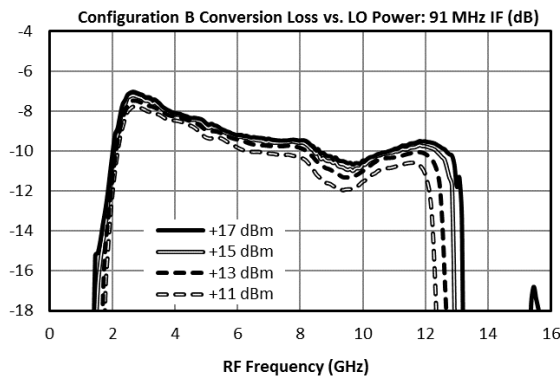
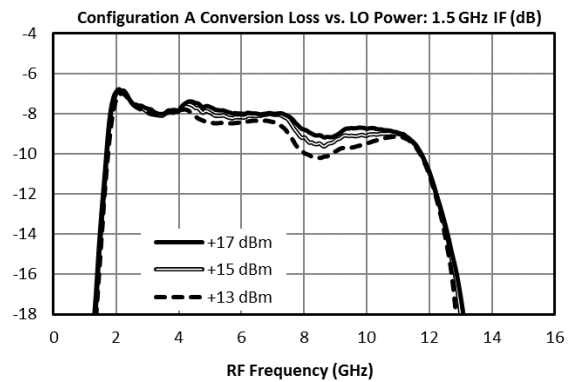
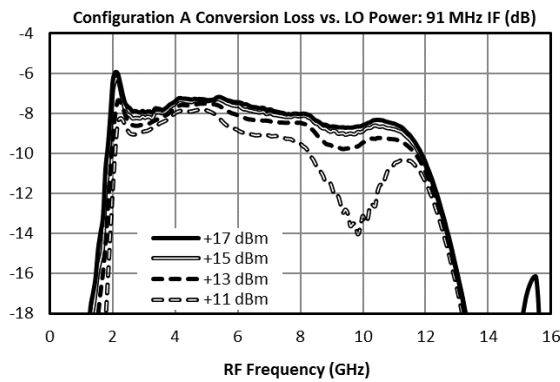
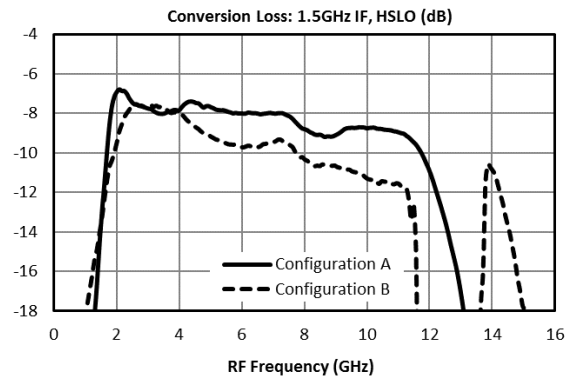
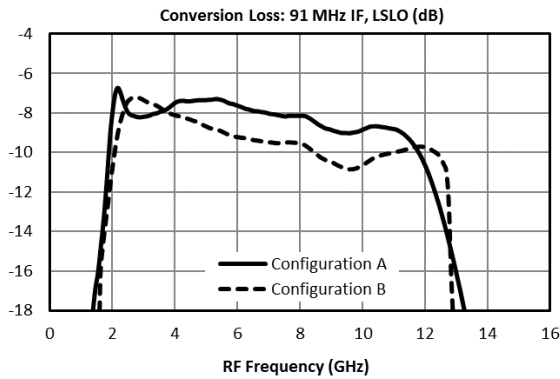
Min and Max limits apply only to our connectorized units and are guaranteed at $T_A=+25^{\circ}\text{C}$. All bare die are 100% DC tested and visually inspected.

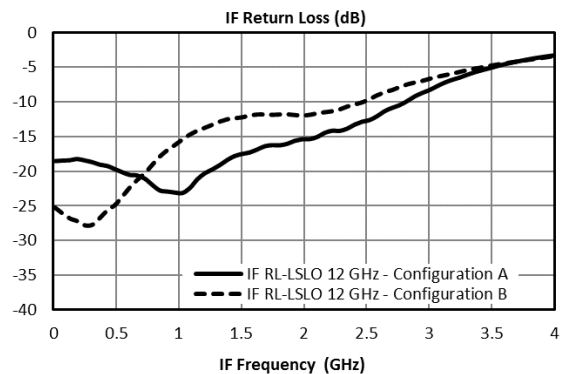
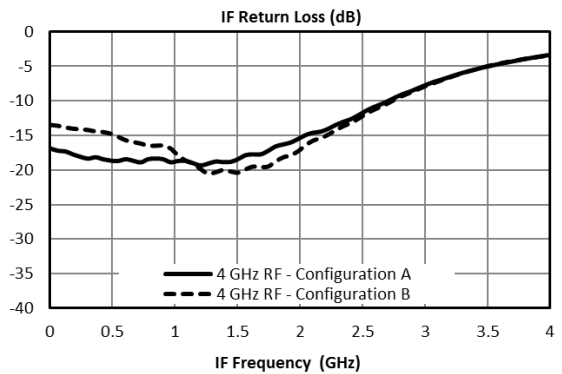
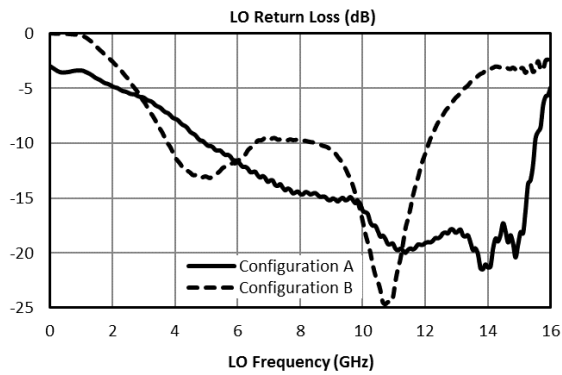
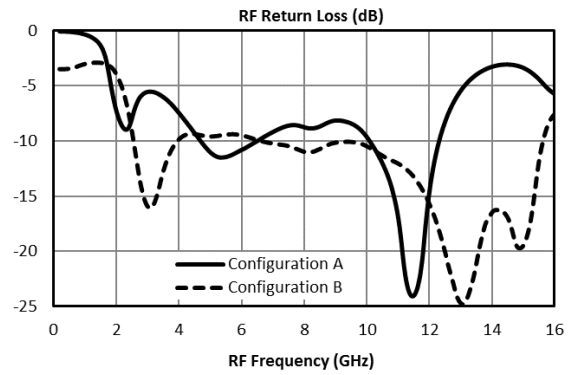
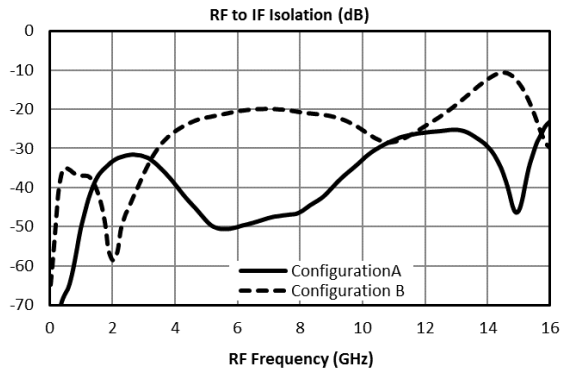
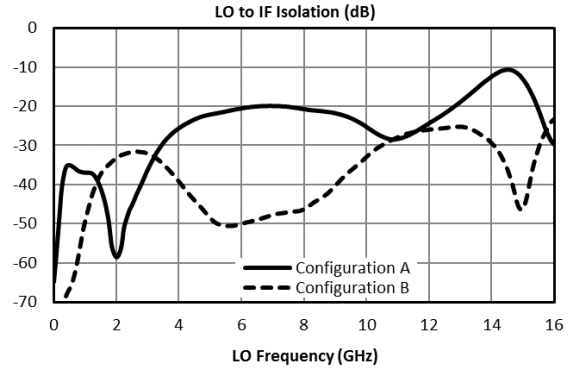
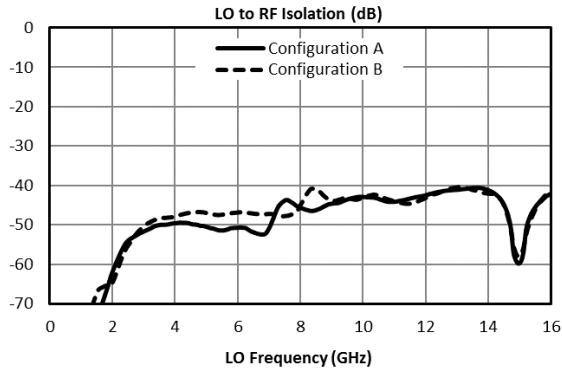
| Parameter | | Test Conditions | Min | Typical | Max | Units |
|--|----------|--|-----|--------------|--------------|-------|
| RF (Port 3) Frequency Range | | | 2 | | 12 | GHz |
| LO (Port 1) Frequency Range | | | 2 | | 12 | |
| I (Port 2) Frequency Range | | | 0 | | 3 | |
| Conversion Loss (CL) ² | | RF/LO = 2 - 12 GHz I = DC - 0.2 GHz | | 8.5 (10) | 11.5 (13) | dB |
| | | RF/LO = 2 - 12 GHz I = 0.2 - 3 GHz | | 9.5 (11) | | |
| Noise Figure (NF) ³ | | RF/LO = 2 - 12 GHz I = DC - 0.2 GHz | | 9 | | dB |
| Isolation | LO to RF | RF/LO = 2 - 12 GHz | | 47 | | dB |
| | LO to IF | IF/LO = 2 - 12 GHz | | 49 | | |
| | RF to IF | RF/IF = 2 - 12 GHz | | 39 | | |
| Input IP3 (IIP3) | | RF/LO = 2 - 12 GHz I = DC - 0.2 GHz | | +23 (+20) | | dBm |
| Input 1 dB Gain Compression Point (P1dB) | | | | +12 (+14) | | dBm |

² Measured as a down converter to a fixed 91MHz IF.

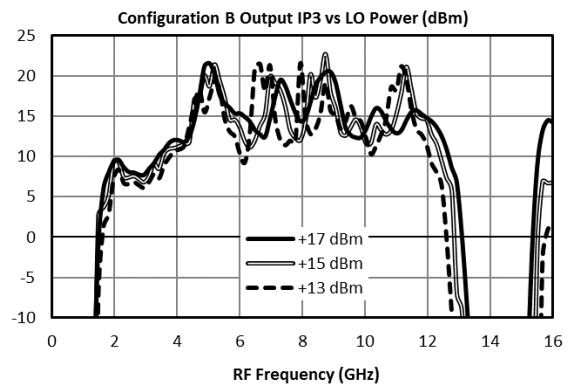
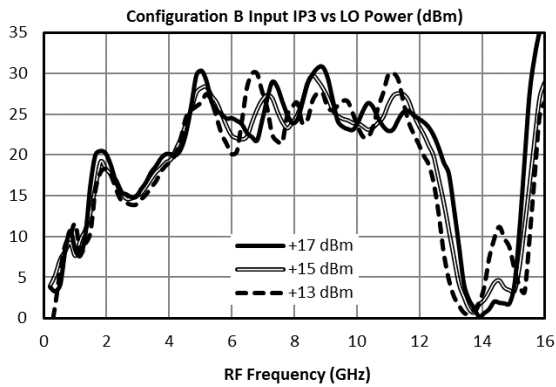
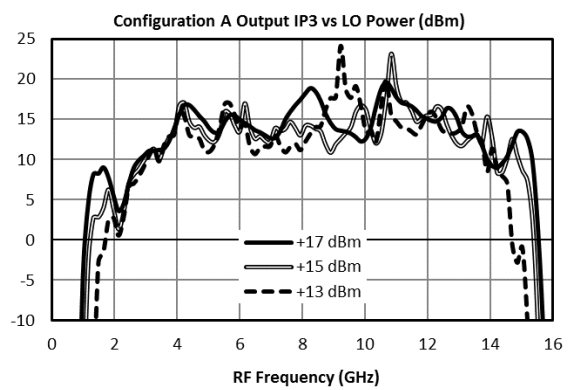
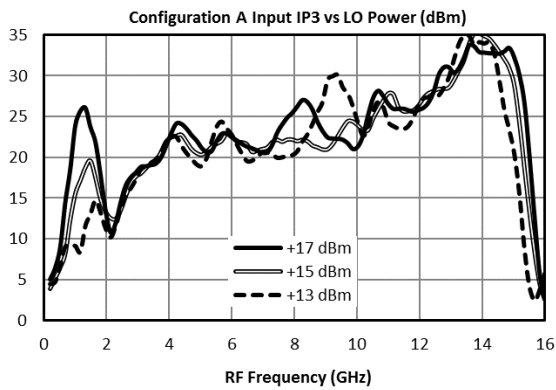
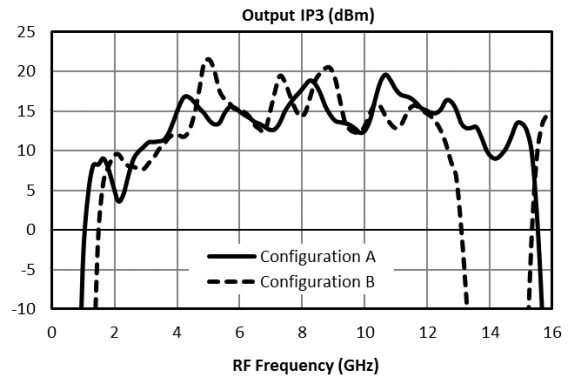
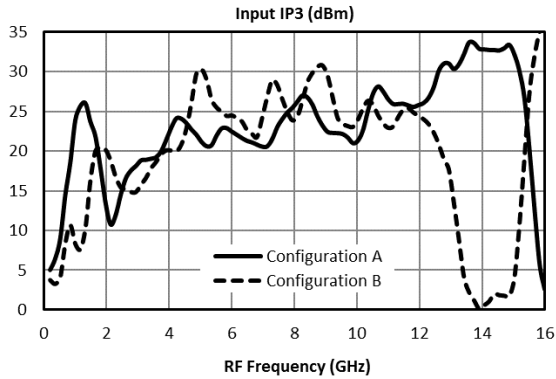
³ Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

3.6 Typical Performance Plots

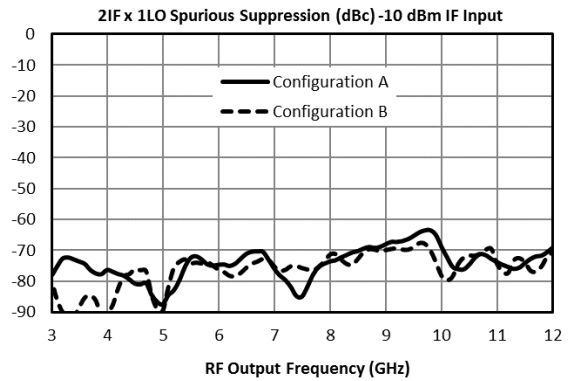
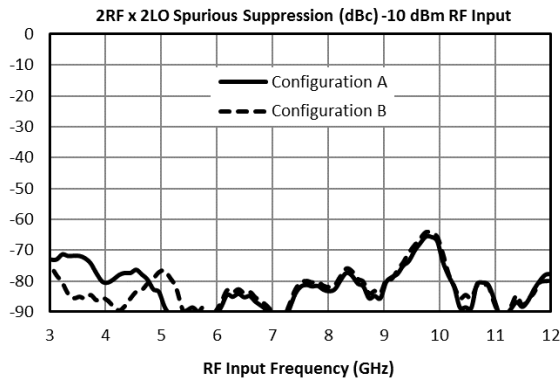
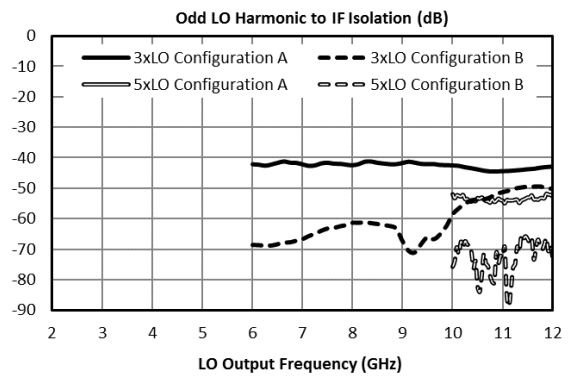
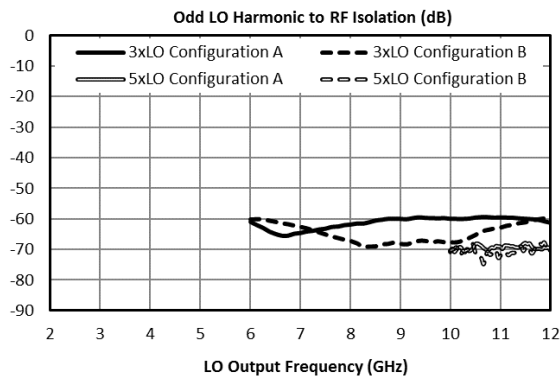
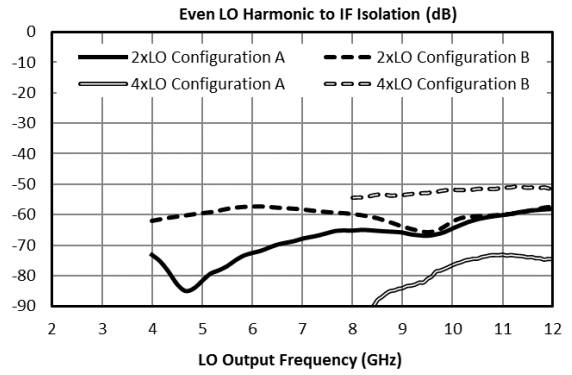
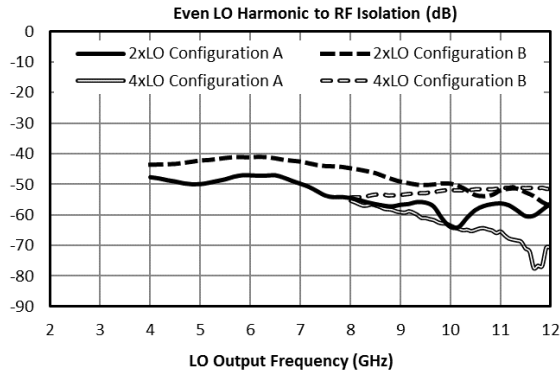




3.6.1 Typical Performance Plots: IP3



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 ($\pm m \cdot \text{LO} \pm n \cdot \text{RF}$) 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 $2\text{RF} \times 2\text{LO}$ spur is 81 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is $(2-1) \times (-10 \text{ dB})$ lower, or 91 dBc. Data is shown for the frequency plan in 3.6 Typical Performance. $m\text{LO} \times n\text{RF}$ plots can be found in section 3.6.2 Typical Performance Plots: LO Harmonic Isolation. $0\text{LO} \times 1\text{RF}$ 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 |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| 0xRF | - | 48 (47) | 54 (47) | 61 (65) | 64 (52) | 69 (71) |
| 1xRF | 30 (15) | Reference | 33 (32) | 11 (13) | 43 (40) | 24 (27) |
| 2xRF | 72 (71) | 56 (57) | 81 (82) | 68 (65) | 70 (74) | 73 (66) |
| 3xRF | 93 (84) | 61 (62) | 89 (94) | 77 (77) | 90 (92) | 68 (71) |
| 4xRF | 125 (130) | 104 (110) | 114 (118) | 115 (116) | 126 (130) | 113 (116) |
| 5xRF | 139 (149) | 120 (122) | 127 (132) | 116 (121) | 136 (143) | 123 (129) |

3.6.4 Typical Spurious Performance: Up-Conversion

Typical spurious data is taken by mixing an input within the IF band, with LO frequencies ($\pm m \cdot \text{LO} \pm n \cdot \text{IF}$), 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 $2\text{IF} \times 1\text{LO}$ spur is typically 74 dBc for a -10 dBm input with a sine-wave LO, so a -20 dBm IF input creates a spur that is $(2-1) \times (-10 \text{ dB})$ lower, or 84 dBc. Data is shown for the frequency plan in 3.6 Typical Performance.

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

| -10 dBm RF Input | 0xLO | 1xLO | 2xLO | 3xLO | 4xLO | 5xLO |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| 0xIF | - | 79 (80) | 68 (60) | 43 (61) | 79 (73) | 53 (73) |
| 1xIF | 27 (19) | Reference | 34 (34) | 11 (12) | 43 (38) | 32 (25) |
| 2xIF | 55 (70) | 74 (76) | 59 (56) | 79 (79) | 65 (58) | 79 (76) |
| 3xIF | 92 (83) | 73 (71) | 82 (83) | 64 (66) | 86 (87) | 72 (70) |
| 4xIF | 119 (120) | 125 (126) | 115 (111) | 120 (123) | 109 (106) | 120 (120) |
| 5xIF | 139 (139) | 114 (114) | 130 (132) | 105 (107) | 129 (125) | 111 (105) |

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

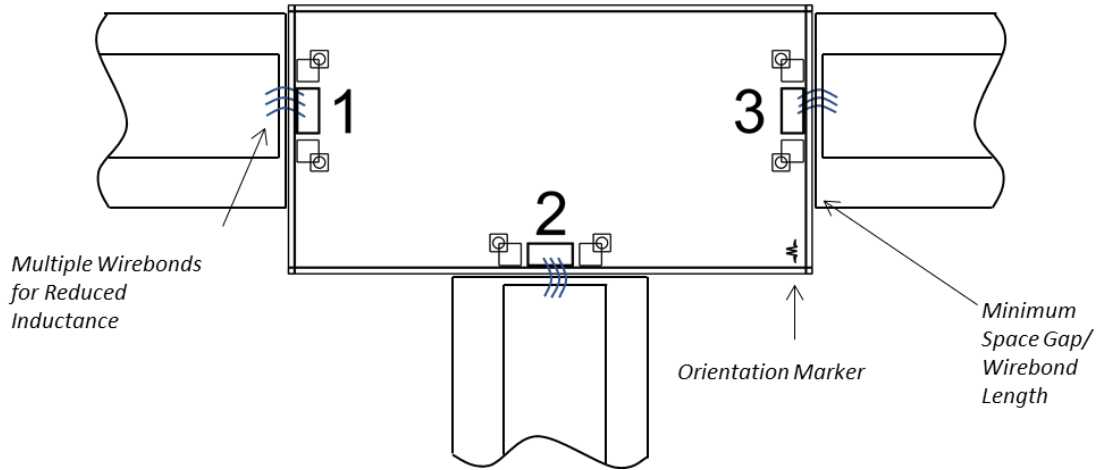
Chips should be handled with care using tweezers or a vacuum collet. Users should take precautions to protect chips from direct human contact that can deposit contaminants, like perspiration and skin oils on any of the chip's surfaces.

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.

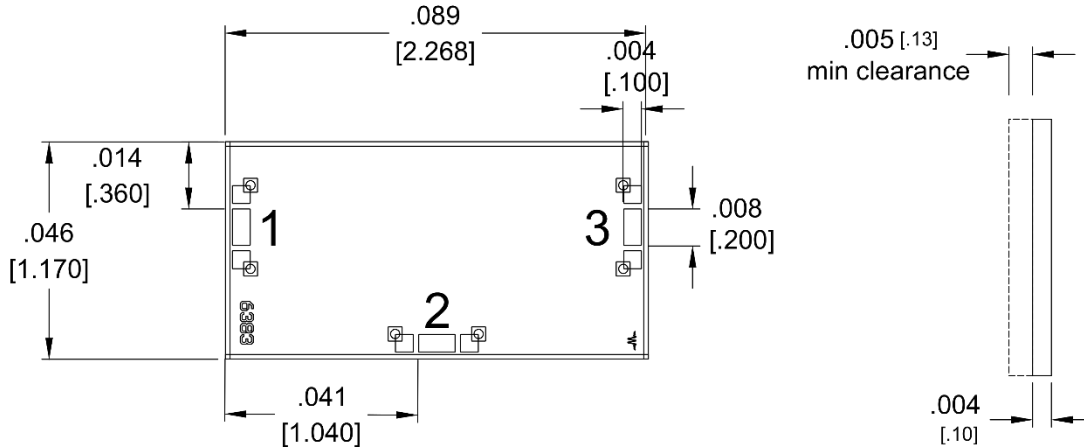
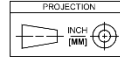
4.3 Bonding Diagram



5. Mechanical Data

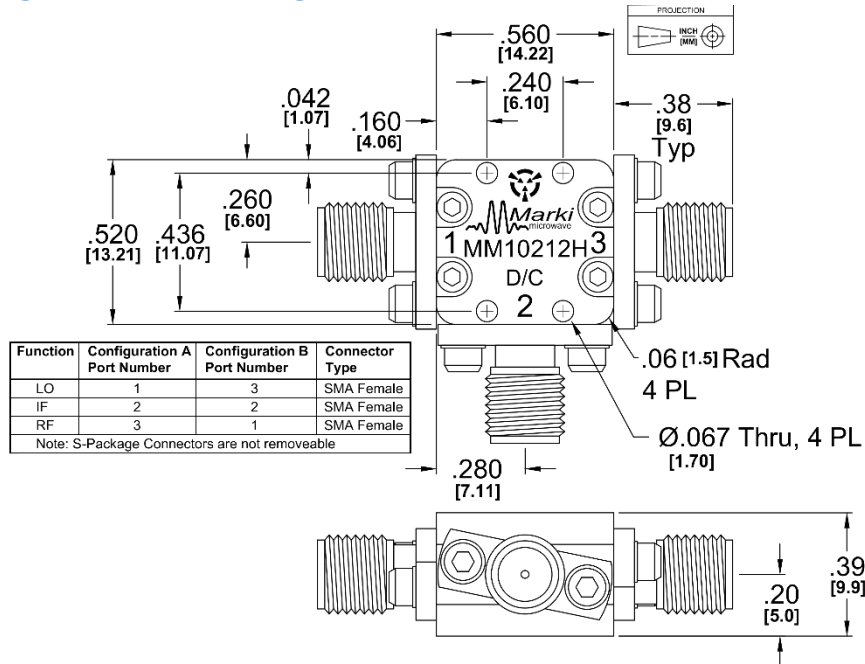
5.1 CH Package Outline Drawing

| 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



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