

GaAs MMIC Double Balanced Mixer

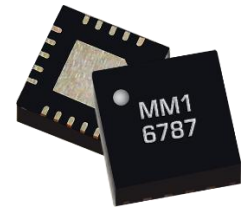
MM1-1453LSM

1. Device Overview

1.1 General Description

The MM1-1453LSM is a GaAs MMIC double balanced mixer that features excellent conversion loss, superior isolations and spurious performance across a broad bandwidth.

MM1-1453LSM works well as both an up and down converter and is recommend for low power applications that demand high linearity. If a higher LO drive is required, the MM1-1453HSM offers similar specifications in the same surface mount package. The MM1-1453LSM is available in a 4x4 mm QFN package. Evaluation boards are also available. The AMM-6702SM is recommended as the ideal LO driver for the MM1-1453LSM and for a complete list of recommended LO driver amps for all mixers and IQ mixers, see [here](#).



QFN

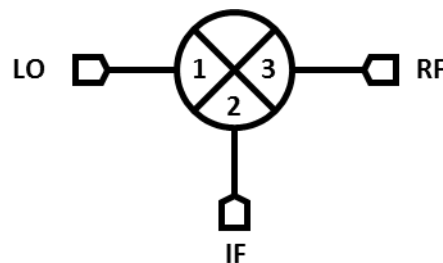
1.2 Features

| Parameter | Typical |
|--------------------|---------------|
| RF/LO response | 14GHz - 53GHz |
| IF response | DC – 22 GHz |
| Conversion Loss | 8 dB |
| LO to RF Isolation | 56 dB |

1.3 Applications

- Test and measurement equipment
- SATCOM
- Radar
- mmWave Tuner Mixer

1.4 Functional Block Diagram



1.5 Part Ordering Options¹

| Part Number | Description | Package | Green Status | Product Lifecycle | Export Classification |
|----------------|----------------------------------|---------|--------------|-------------------|-----------------------|
| MM1-1453LSM-2 | 4x4 mm QFN | SM | RoHS | Active | EAR99 |
| EVAL-MM1-1453L | Connectorized Evaluation Fixture | Eval | | Active | EAR99 |

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

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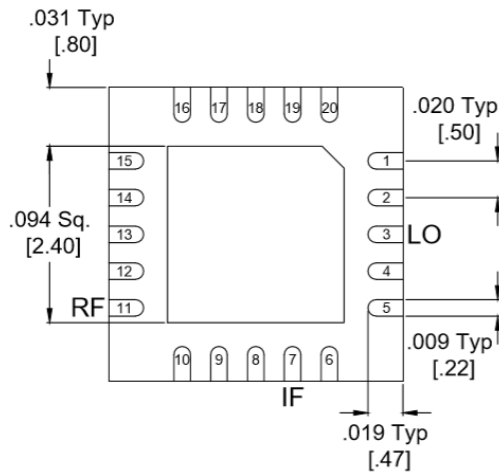
Revision History

| Revision Code | Revision Date | Comment |
|---------------|---------------|---------------------------|
| - | August 2020 | Datasheet Initial Release |

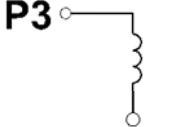
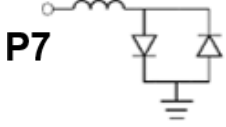
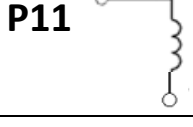
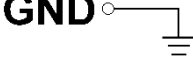
2. Port Configurations and Functions

2.1 Port Diagram

A bottom-up view of the MM1-1453LSM's SM package outline drawing is shown below. The MM1-1453LSM has the input and output ports given in Port Functions. The MM1-1453LSM can be used in either an up or down conversion. For configuration A, input the LO into pin 3, use pin 11 for the RF, and pin 7 for the IF. For configuration B, input the LO into pin 11, use pin 3 for the RF, and pin 7 for the IF.



2.2 Port Functions

| Port | Function | Description | Equivalent Circuit for Package |
|--------|--|--|---|
| Pin 3 | LO (Configuration A) RF (Configuration B) | Pin 3 is DC open and AC matched to 50 Ohms from 14 to 53 GHz. |  |
| Pin 7 | IF | Pin 7 is DC coupled to the diodes. Blocking capacitor is optional. |  |
| Pin 11 | RF (Configuration A) LO (Configuration B) | Pin 11 is DC open and AC matched to 50 Ohms from 14 to 53 GHz. |  |
| GND | Ground | SM package ground path is provided through the ground paddle. |  |

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 |
|-----------------------------|----------------|-------|
| Pin 3 DC Current | N/A | mA |
| Pin 7 DC Current | 30 | mA |
| Pin 11 DC Current | N/A | 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 | EVAL package | 33.5 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 | +7 | | +15 | 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

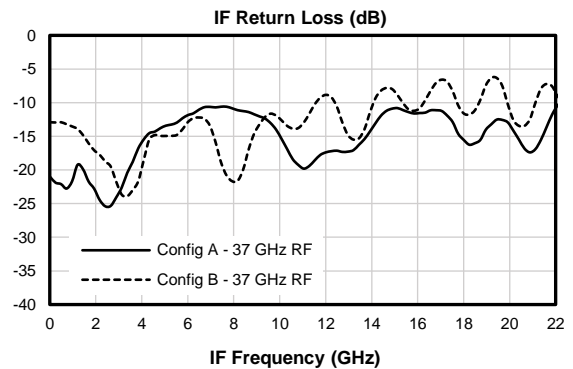
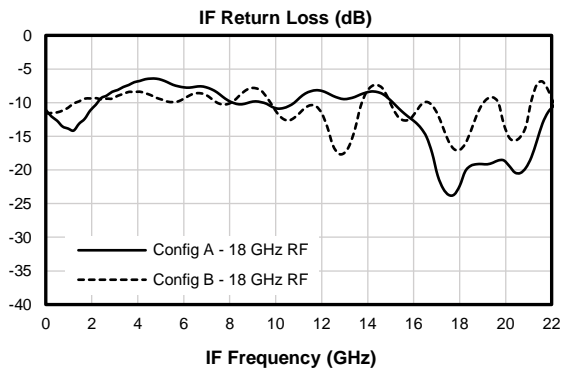
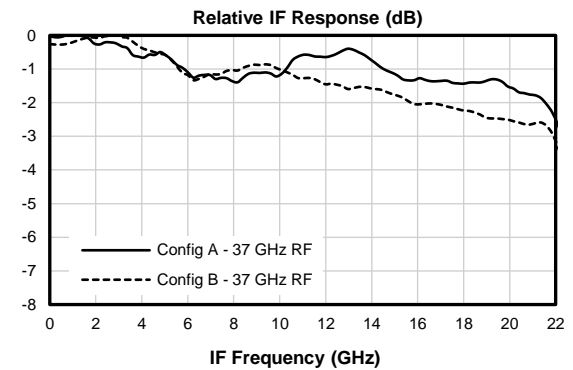
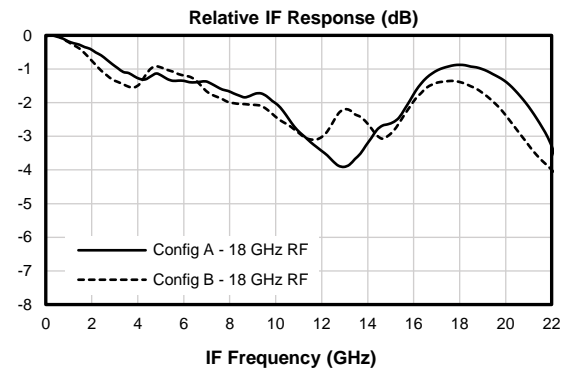
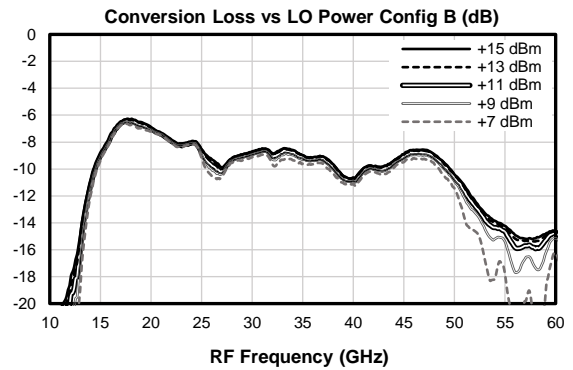
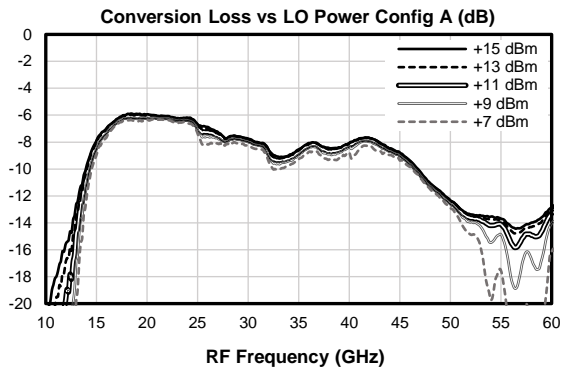
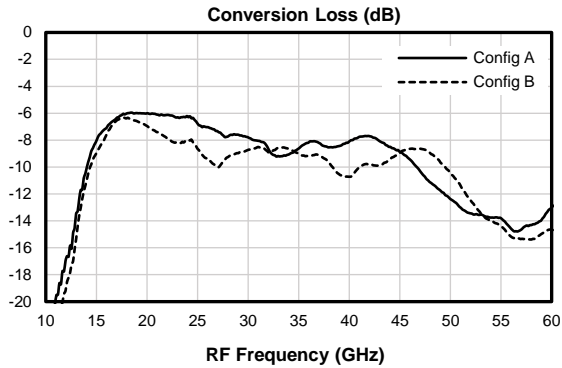
The electrical specifications apply at $T_A = +25^\circ\text{C}$ in a 50Ω system. Typical data shown is for a down conversion application with a +13dBm sine wave LO input. Specifications shown for configuration A (B).

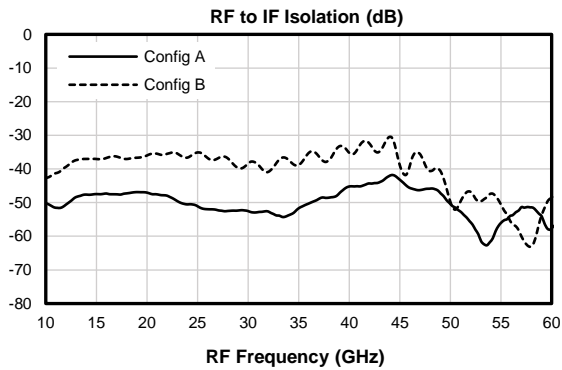
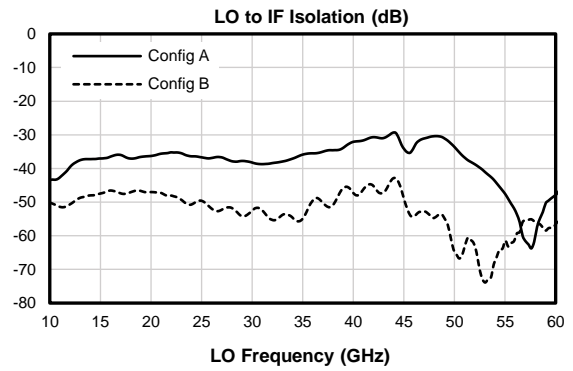
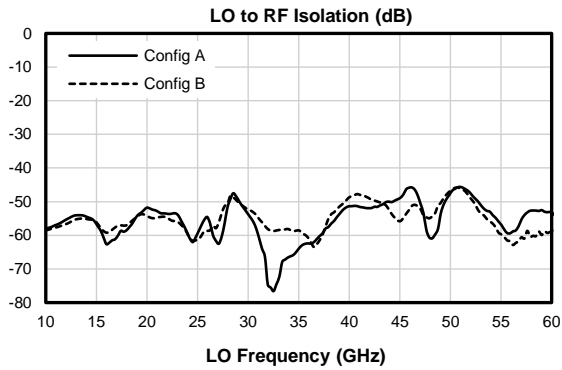
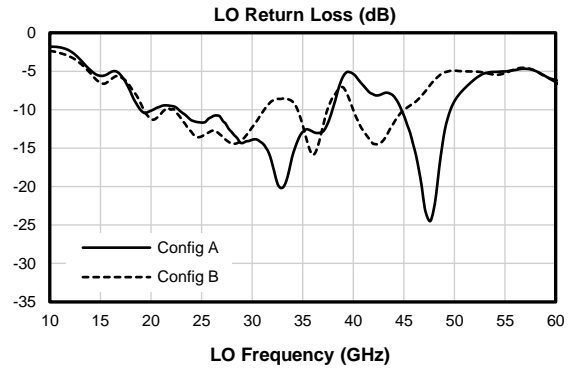
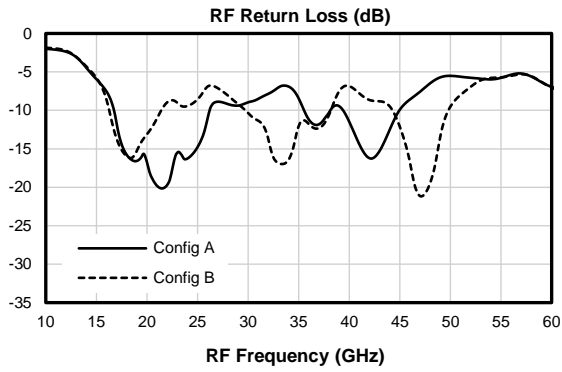
| Parameter | | Test Conditions | Min | Typical | Max | Units |
|--|----------|------------------------------------|-----|--------------|------------|-------|
| RF (Pin 11) Frequency Range | | | 14 | | 53 | GHz |
| LO (Pin 3) Frequency Range | | | 14 | | 53 | |
| I (Pin 7) Frequency Range | | | 0 | | 22 | |
| Conversion Loss (CL) ² | | RF/LO = 14 - 50 GHz IF = 91 MHz | | 8 (9) | 12 (11) | dB |
| | | RF/LO = 50 - 53 GHz IF = 91 MHz | | 13 (12) | 14 (13) | |
| Noise Figure (NF) ³ | | RF/LO = 14 - 53 GHz IF = 91 MHz | | 8 | | dB |
| Isolation | LO to RF | RF/LO = 14 - 53 GHz | | 56 (54) | | dB |
| | LO to IF | IF/LO = 14 - 53 GHz | | 35 (51) | | |
| | RF to IF | RF/IF = 14 - 53 GHz | | 49 (38) | | |
| Input IP3 (IIP3) | | RF/LO = 14 - 53 GHz IF = 91 MHz | | +13 (+16) | | dBm |
| Input 1 dB Gain Compression Point (P1dB) | | | | +2 (+3) | | dBm |

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

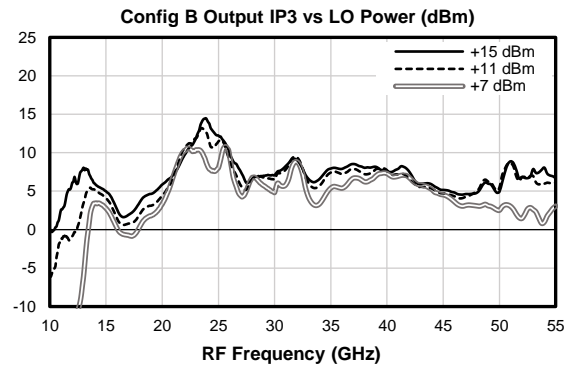
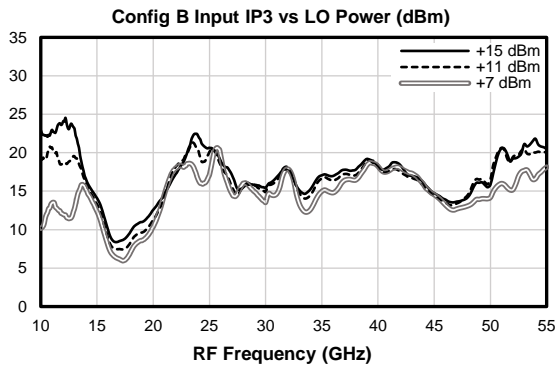
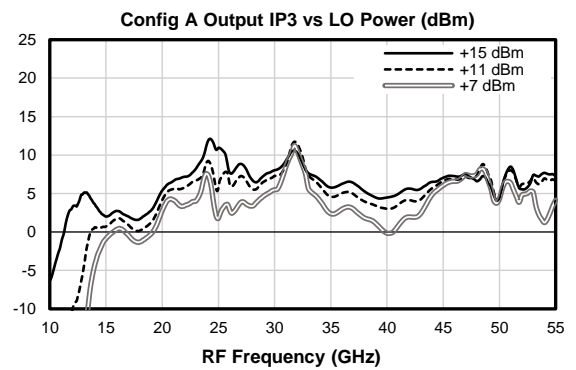
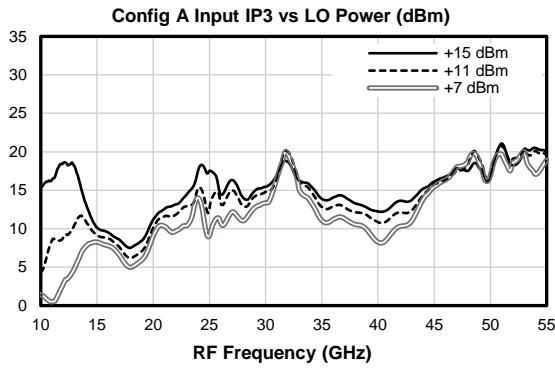
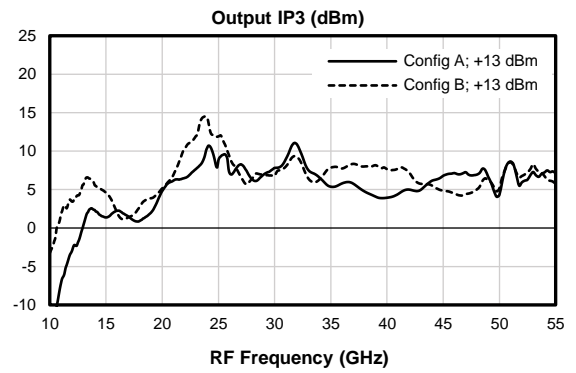
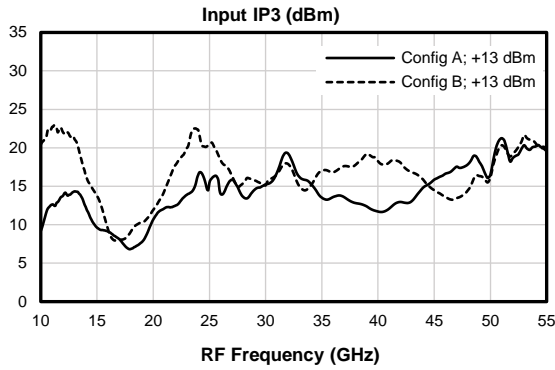
³ Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.

3.6 Typical Performance Plots

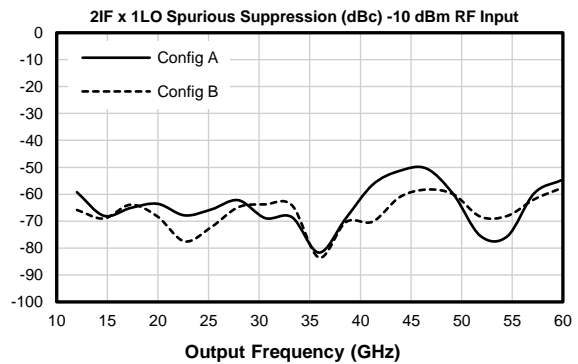
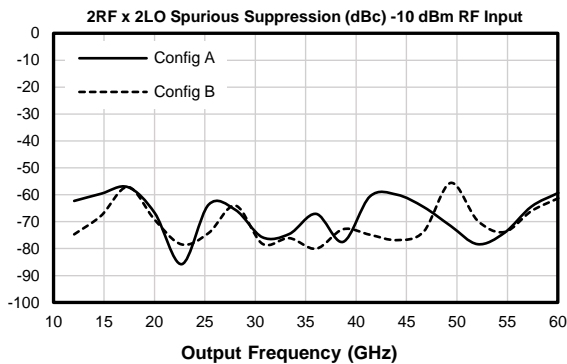
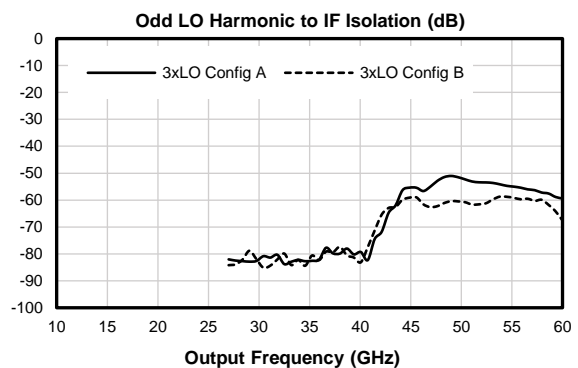
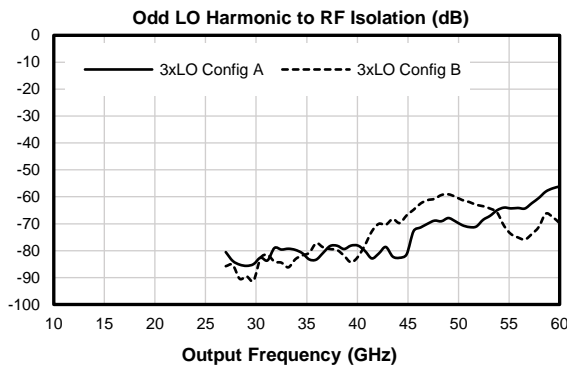
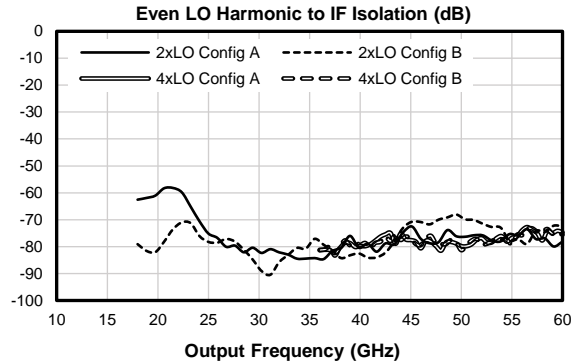
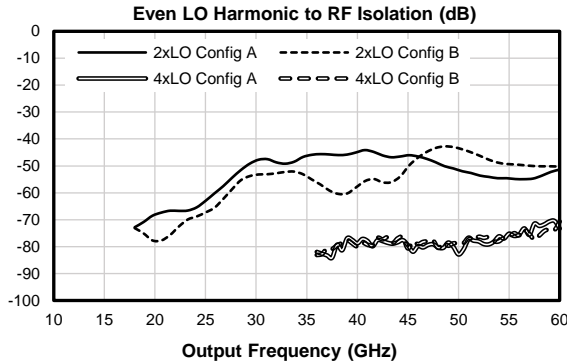




3.6.1 Typical Performance Plots: IP3



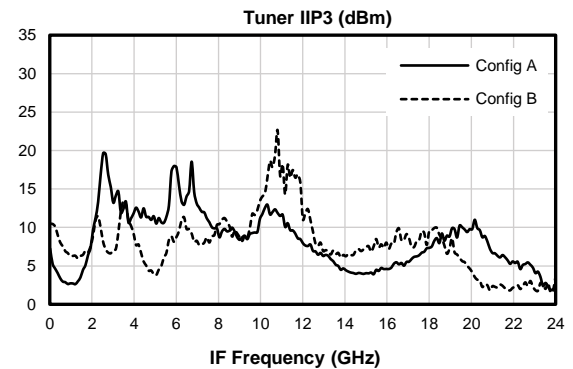
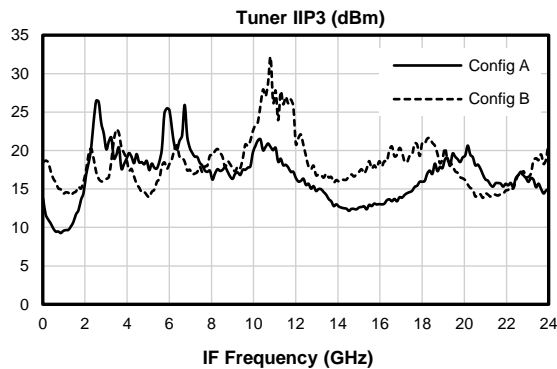
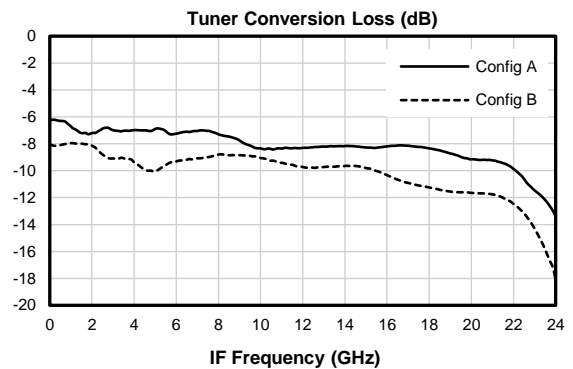
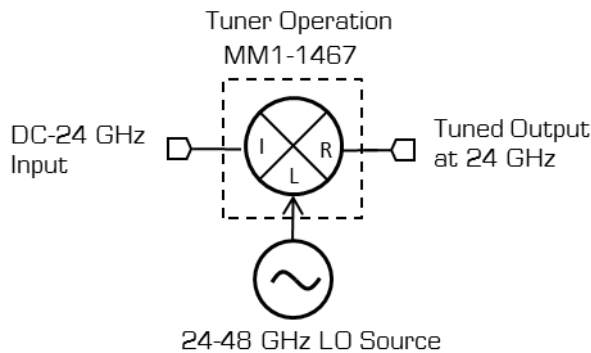
3.6.2 Typical Performance Plots: LO Harmonic Isolation



3.6.3 Typical Spurious Performance: Tuner Mixer

Tuner mixer performance plots are taken with the following test conditions and frequency plan:

| Parameter | Start | Nominal | Stop | Units |
|---------------------|-------|---------|------|-------|
| IF Input Frequency | 0 | | 24 | GHz |
| IF Input Power | | -10 | | dBm |
| LO Input Frequency | 24 | | 48 | GHz |
| LO Input Power | | +13 | | dBm |
| RF Output Frequency | | 24 | | GHz |



3.6.4 Typical Spurious Performance: Down-Conversion

Typical spurious data is provided by selecting RF and LO frequencies ($\pm m \cdot LO \pm n \cdot RF$) 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 $2RF \times 2LO$ spur is 68 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 78 dBc. Data is shown for the frequency plan in 3.6 Typical Performance. $mLO \times nRF$ plots can be found in section 3.6.2 Typical Performance Plots: LO Harmonic Isolation. $0LO \times 1RF$ 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 | 39 (27) | Reference | 44 (35) | 16 (14) | 46 (32) | N/A |
| 2xRF | 89 (90) | 52 (63) | 68 (71) | 57 (61) | 70 (72) | 62 (67) |
| 3xRF | 90 (86) | 54 (57) | 85 (80) | 62 (64) | 85 (79) | 61 (62) |
| 4xRF | 124 (124) | 92 (112) | 93 (104) | 95 (102) | 106 (110) | 100 (104) |
| 5xRF | N/A | 110 (130) | 110 (102) | 101 (107) | 121 (116) | 105 (110) |

3.6.5 Typical Spurious Performance: Up-Conversion

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

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

| -10 dBm IF Input | 0xLO | 1xLO | 2xLO | 3xLO | 4xLO | 5xLO |
|------------------|---------|-----------|-----------|----------|----------|----------|
| 1xIF | 39 (27) | Reference | 44 (36) | 15 (13) | 51 (34) | N/A |
| 2xIF | 63 (64) | 64 (67) | 56 (57) | 73 (68) | 63 (63) | 82 (78) |
| 3xIF | 82 (79) | 53 (57) | 81 (73) | 49 (47) | 81 (66) | 59 (62) |
| 4xIF | 98 (96) | 102 (104) | 94 (95) | 100 (99) | 94 (92) | 103 (99) |
| 5xIF | 98 (98) | 91 (97) | 128 (121) | 78 (79) | 105 (99) | 102 (79) |

4. Operation

4.1 Ports Operation

IF Port – Used as input on an upconversion, output on downconversion, or LO port in a band shifting application. Signals should be connected by 50 ohm microstrip or coplanar traces to well matched broadband 50 ohm sources and loads. Blocking capacitor is recommended if DC voltage is present on the line.

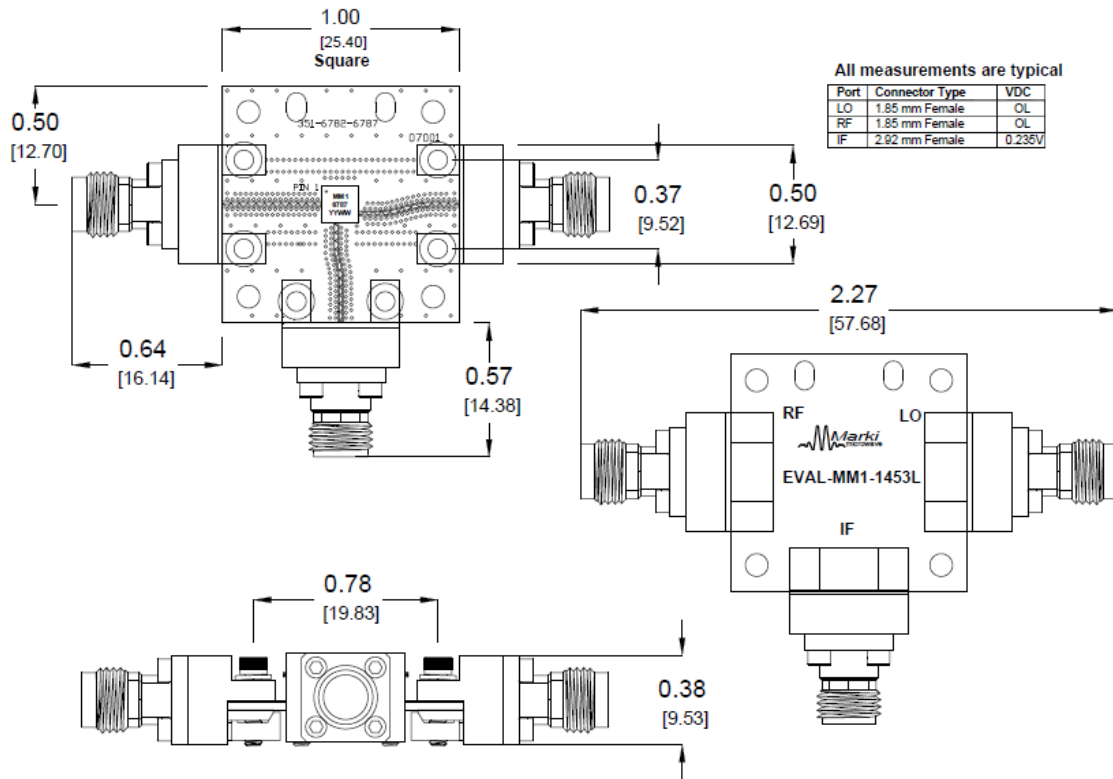
RF Port – Used as input on a downconversion, output on upconversion, or output in a band shifting application. Signals should be connected by 50 ohm microstrip or coplanar traces to well matched broadband 50 ohm sources and loads.

Filtering and Matching- Filtering is generally desired for spurious and image removal on the output port of the mixer. Reflective filters can cause out of band signals to reflect back into the mixer and cause conversion loss ripple, erroneous spurs, and other undesired behaviors. To eliminate these problems it is recommended that the filters be placed as close to the output port as possible. If undesired behavior is still observed, a diplexer with one port terminated or a 1-3 dB attenuator may reduce this problem.

RF Ground – The ground paddle of the QFN should be connected to a low noise RF ground with very low electrical resistance for high frequency operation.

LO Port – The noise floor of the LO input signal should be less than the value of the noise floor plus isolation of the mixer, or a filter is recommended to prevent reduction in dynamic range. An LO amplifier is required if the LO power is below the recommended drive level. It is important to use an amplifier with a broadband 50 ohm match such that it does not reflect spurious signals back into the mixer or other system circuitry.

5.3 Evaluation Board Outline Drawing



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