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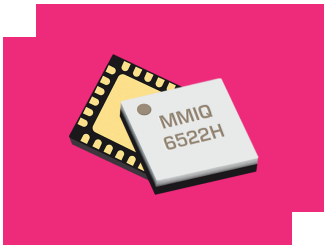
# MMIQ-0416HSM-2

## Passive GaAs MMIC IQ Mixer

## DEVICE OVERVIEW

### General Description

MMIQ-0416HSM is a high linearity, passive GaAs MMIC IQ mixer. This is an ultra-broadband mixer spanning 4 to 16 GHz on the RF and LO ports with an IF from DC to 6 GHz. Up to 40 dB of image rejection is available due to the excellent phase and amplitude balance of its on-chip LO quadrature hybrid. The MMIQ 0416HSM is available in a 4x4 mm QFN package. Evaluation boards are available.



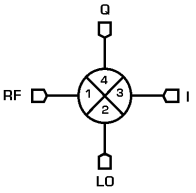

### Features

N/A

### Applications

- Single Sideband and Image Rejection Mixing
- IQ Modulation / Demodulation
- Band Shifting
- Vector Amplitude Modulation

### Functional Block Diagram




### Part Ordering Options

| Part Number | Description | Package | Green Status | Product Lifecycle | Export Classification |
|---|---|---|---|---|---|
| EVAL-MMIQ-0416H | Evaluation Board, Passive GaAs MMIC 4 - 16 GHz IQ Mixer | - | RoHS | Released | EAR99 |
| MMIQ-0416HSM-2 | Passive GaAs MMIC IQ Mixer | QFN | RoHS<br>RoHS | Released | EAR99 |

## Table Of Contents



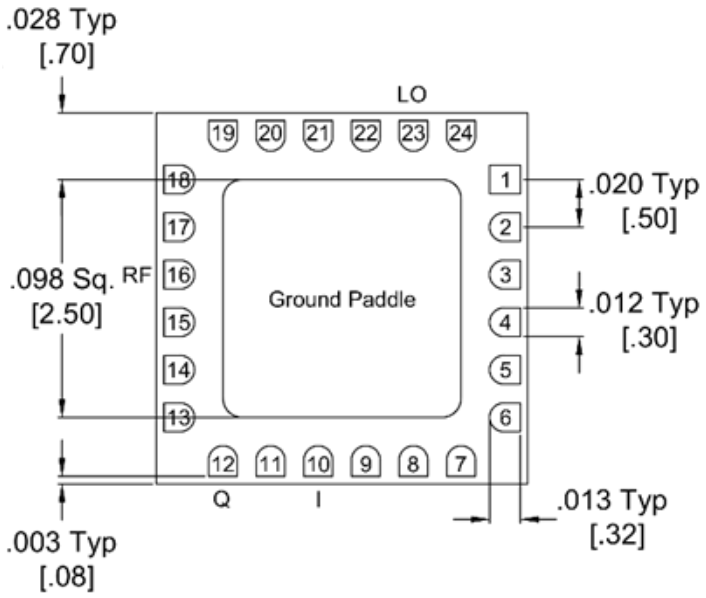
## Revision History

| Revision Code | Revision Date | Comment |
|---|---|---|
| - | 2019-03-01 | Datasheet Initial Release |
| A | 2019-08-01 | Changed I/Q Max Current Rating |
| B | 2019-10-01 | Updated Max Power Handling Spec |

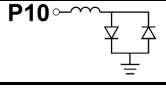
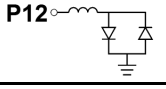
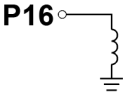
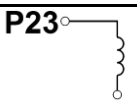
## Port Configuration and Functions

### Port Diagram

A bottom-up view of the MMIQ-0416H's SM package outline drawing is shown below. The mixer may be operated as either a downconverter or an upconverter. Use of the RF or IF as the input or output port will depend on the application.




## Port Functions

| Port | Function | Description | Equivalent Circuit for Package |
|---|---|---|---|
| Pin 10 | I Input / Output | Pin 10 is diode coupled and AC matched to 50Ω over the specified I port frequency range. |   |
| Pin 12 | Q Input / Output | Pin 12 is diode coupled and AC matched to 50Ω over the specified Q port frequency range. |   |
| Pin 16 | RF Input / Output | Pin 16 is DC short and AC matched to 50Ω over the specified RF frequency range. |   |
| Pin 23 | LO Input | Pin 23 is DC open and AC matched to 50Ω over the specified LO frequency range. |   |

## 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 |
| Pin 10 DC Current | 30 | mA |
| Pin 12 DC Current | 30 | mA |
| Power Handling, at any Port | 26 | dBm |

### Package Information

| Parameter | Details | Rating |
|---|---|---|
| ESD | 250 to < 500 Volts | HBM Class 1A |
| Dimensions | - | 4x4 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 | 13 | 20 | 22 | dBm |
| Ambient Temperature | -55 | 25 | 100 | °C |
| RF/IF Input Power | - | - | 11 | dBm |

## 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

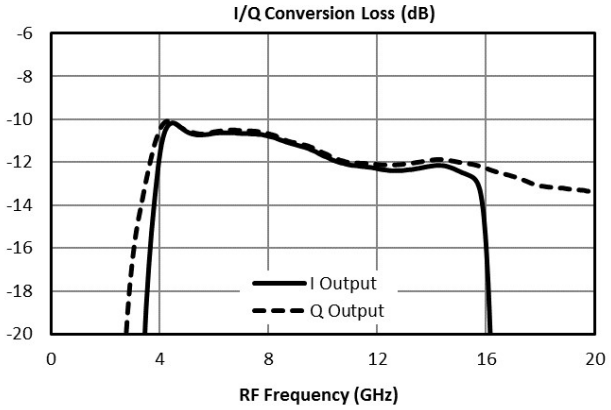
The electrical specifications apply at TA=+25°C in a 50Ω system. Typical data shown is for a down conversion application with a +20 dBm sine wave LO input. Min and Max limits apply only to our connectorized units and are guaranteed at TA=+25°C. All bare die are 100% DC tested and visually inspected.

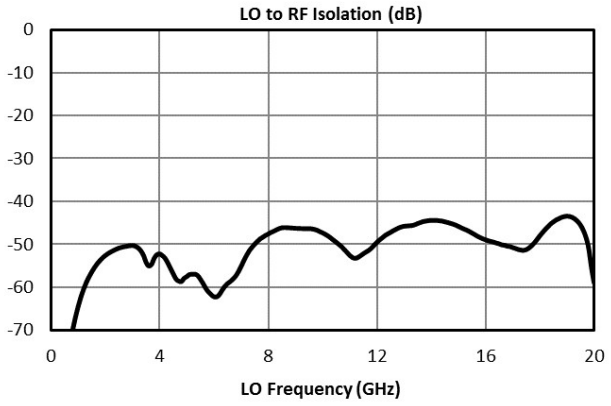
| Parameter | Test Conditions | Minimum Frequency (GHz) | Maximum Frequency (GHz) | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| RF Frequency Range | - | - | - | 4 | - | 16 | GHz |
| LO Frequency Range | - | - | - | 4 | - | 16 | GHz |
| Conversion Loss [1] | RF/LO = 4 - 15 GHz<br>I = 0.2 - 6 GHz | 4 | 15 | - | 14 | - | dB |
| Conversion Loss [2] | RF/LO = 4 - 15 GHz<br>I = DC - 0.2 GHz | 4 | 15 | - | 11.7 | 15 | dB |
| Conversion Loss [3] | RF/LO = 4 - 15 GHz<br>Q = 0.2 - 6 GHz | 4 | 15 | - | 14 | - | dB |
| Conversion Loss [4] | RF/LO = 4 - 15 GHz<br>Q = DC - 0.2 GHz | 4 | 15 | - | 11.4 | 15 | dB |
| Noise Figure [5] | RF/LO = 4 - 16 GHz<br>I = DC – 0.2 GHz | 4 | 16 | - | 12 | - | dB |
| Noise Figure [6] | RF/LO = 4 - 16 GHz<br>Q = DC – 0.2 GHz | 4 | 16 | - | 12 | - | dB |
| Image Rejection [7] | RF/LO = 4 - 16 GHz<br>I+Q = DC – 0.2 GHz | 4 | 16 | - | 31 | - | dBc |
| Input IP3 [8] | RF/LO = 4 - 6 GHz<br>I = DC – 0.2 GHz | 4 | 6 | - | 25 | - | dBm |
| Balance [9] | - | - | - | - | 0.5 | - | dB |
| Phase Balance | - | - | - | - | 2 | - | ° |
| IF Frequency Range | - | - | - | 0 | - | 6 | GHz |
| Input 1 dB Gain Compression Point, I | - | - | - | - | 10 | - | dBm |
| Input 1 dB Gain Compression Point, Q | - | - | - | - | 11 | - | dBm |
| Q (Port 4) Frequency Range | - | - | - | 0 | - | 6 | GHz |
| Isolation, LO to IF | IF/LO = 4 - 16 GHz | 4 | 16 | - | 39 | - | dB |
| Isolation, LO to RF | RF/LO = 4 - 16 GHz | 4 | 16 | - | 51 | - | dB |
| Isolation, RF to IF | RF/IF = 4 - 16 GHz | 4 | 16 | - | 31 | - | dB |

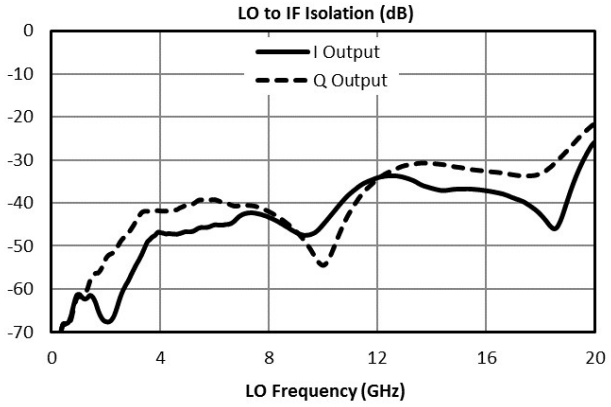
[1][2][3][4] Measured as an I/Q down converter (i.e., I and Q powers are not combined)
[5][6] Mixer Noise Figure typically measures within 0.5 dB of conversion loss for IF frequencies greater than 5 MHz.
[7] Image Rejection and Single sideband performance plots are defined by the upper sideband (USB) or lower sideband (LSB) with respect to the LO signal. Plots are defined by which sideband is selected by the external IF quadrature hybrid.
[8] Typical IIP3 is measured with I and Q ports combined with an external quadrature hybrid coupler in a down conversion.
[9] Amplitude and phase balance measured in a down conversion.

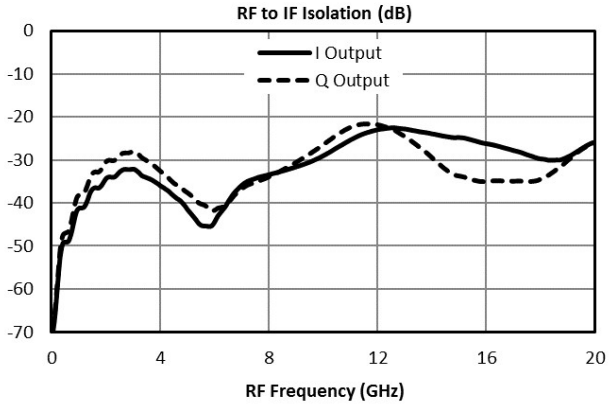
## Typical Performance Plots

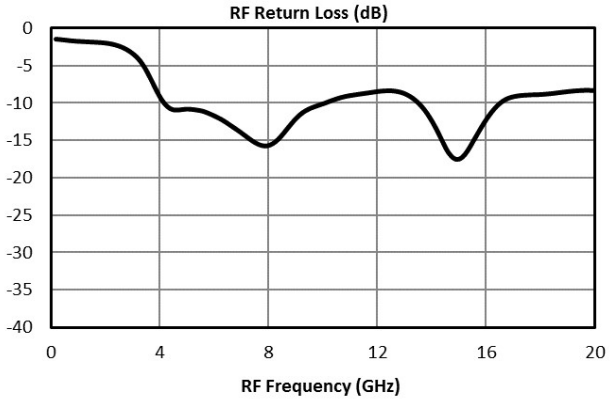
I output means that the IF output signal is measured at the I port of the mixer and the Q port is loaded. Q output means the IF output signal is measured at the Q port of the mixer while the I port is loaded.

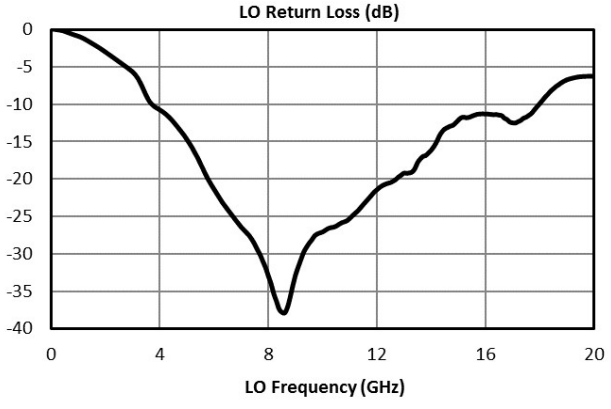


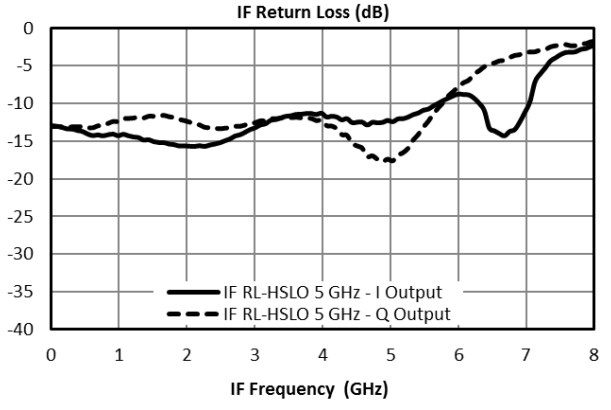



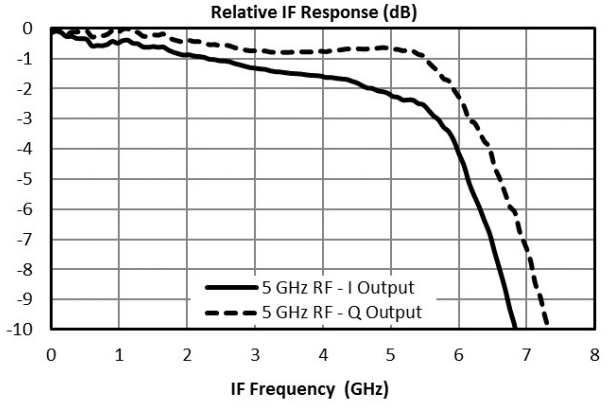



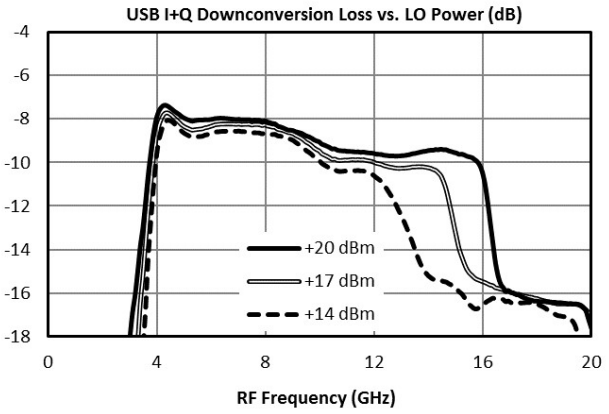



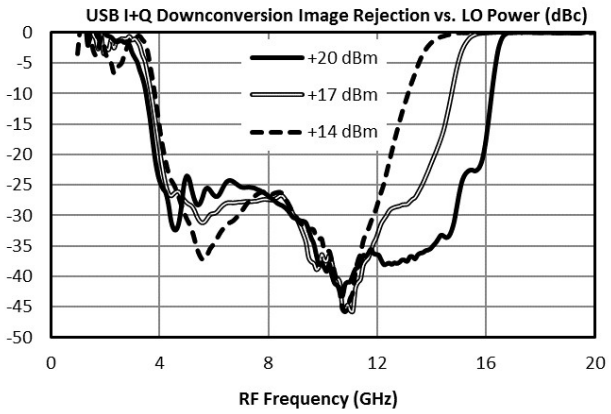



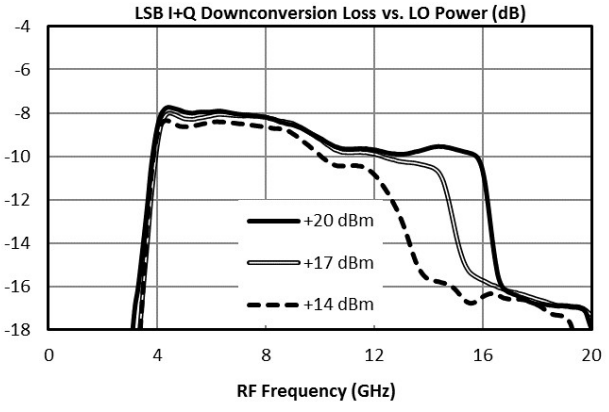



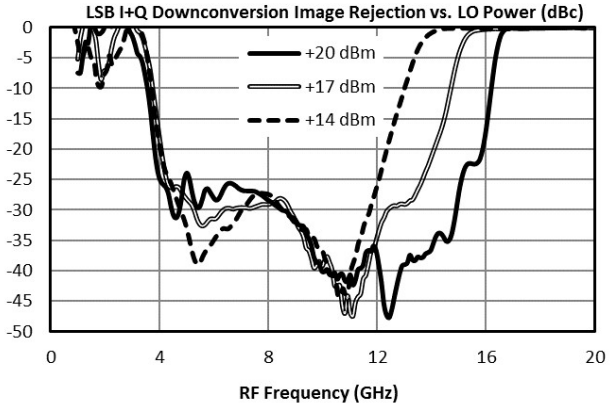



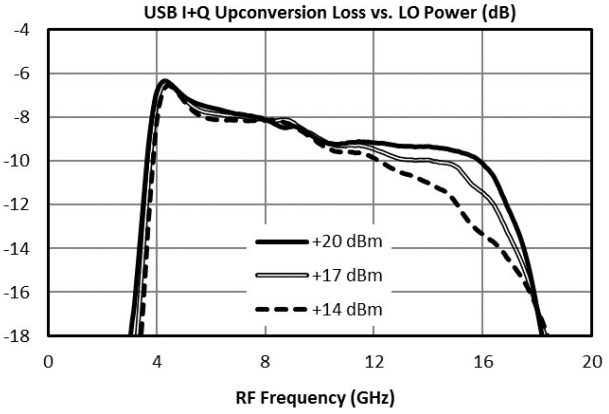



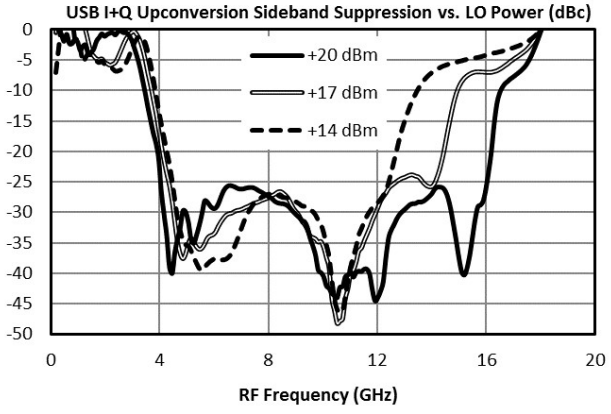


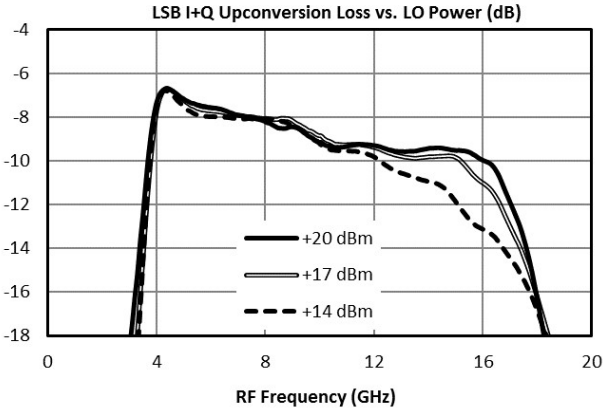



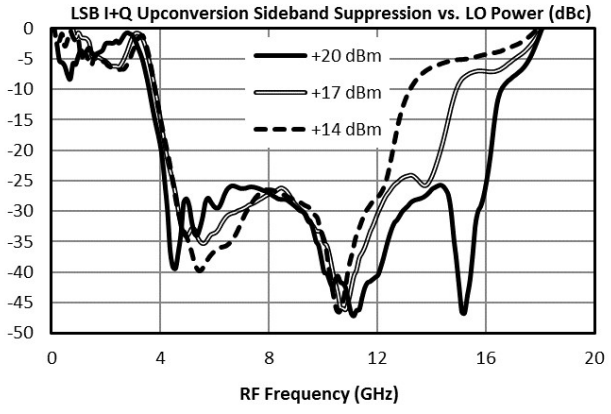



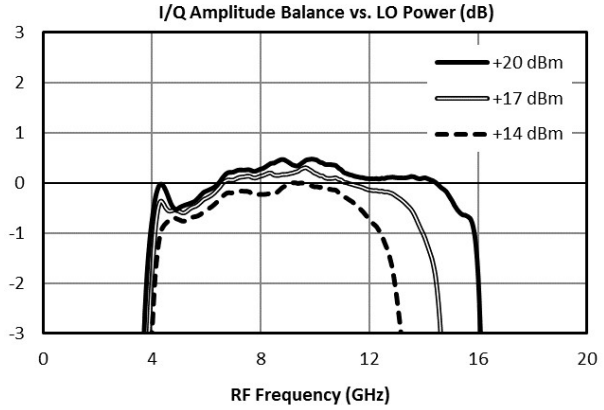



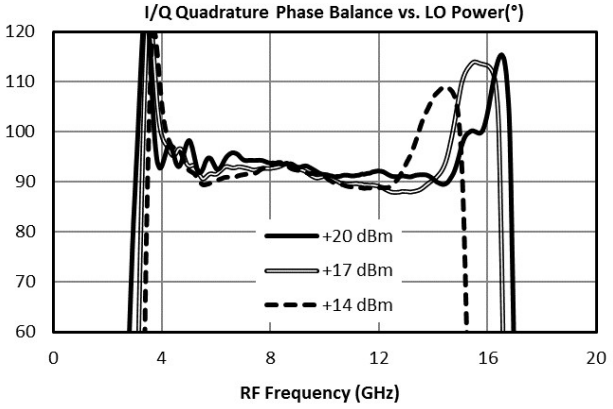



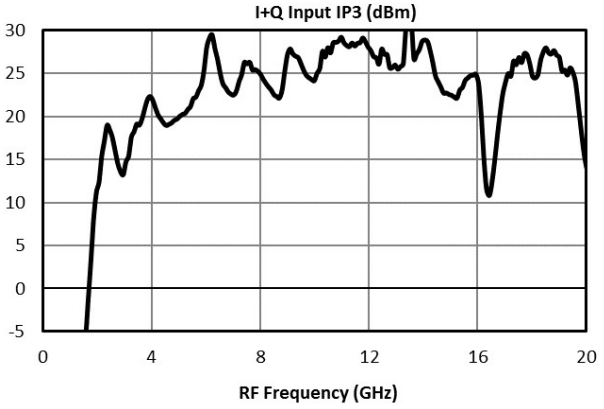
I/Q Amplitude Balance vs. LO Power (dB)



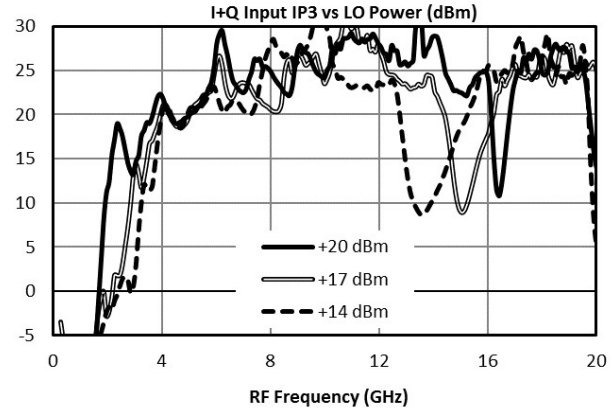

I/Q Quadrature Phase Balance vs. LO Power(°)



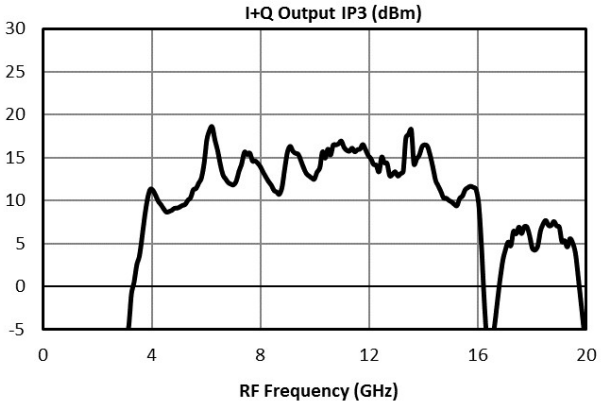

I+Q Input IP3 (dBm)



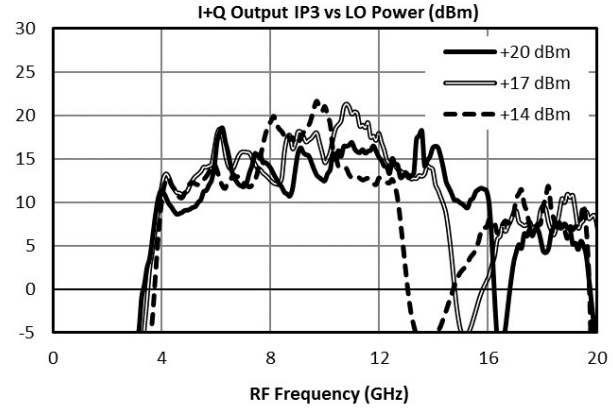

I+Q Input IP3 vs LO Power (dBm)



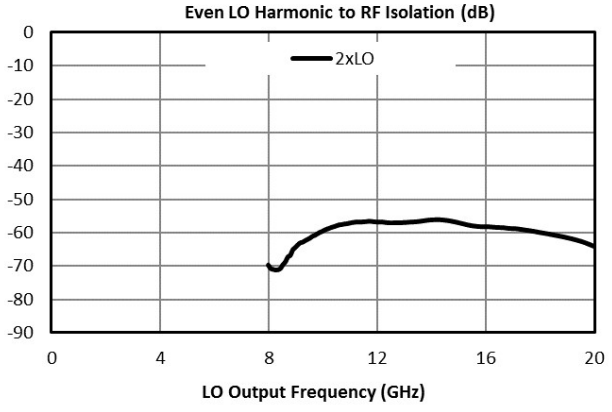

I+Q Output IP3 (dBm)



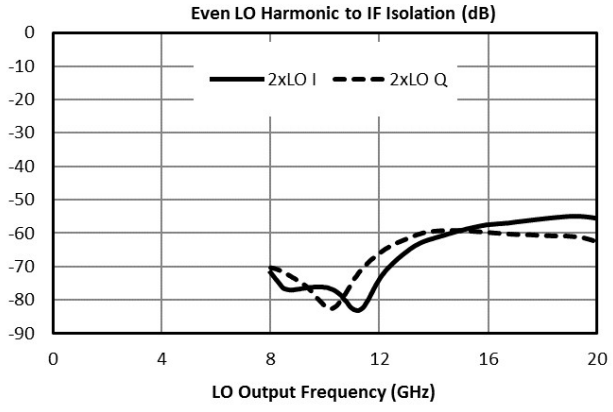

I+Q Output IP3 vs LO Power (dBm)

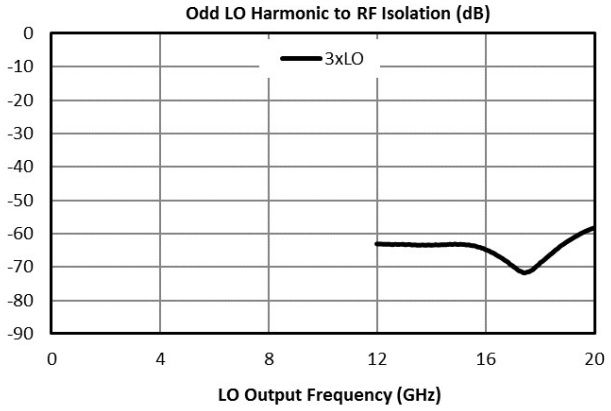


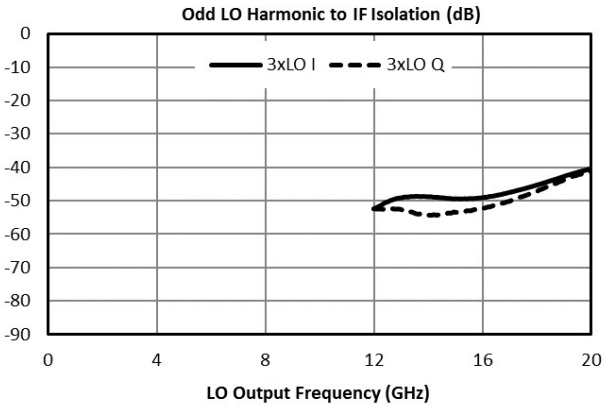

Even LO Harmonic to RF Isolation (dB)




Even LO Harmonic to IF Isolation (dB)





## Spur Table

## 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 73 dBc for a -10 dBm input, so a -20 dBm RF input creates a spur that is (2-1) x (-10 dB) lower, or 83 dBc.

**Typical Down-conversion spurious suppression (dBc): I Port (Q Port)**

| -10 dBm RF Input | 0xLO | 1xLO | 2xLO | 3xLO | 4xLO | 5xLO |
|---|---|---|---|---|---|---|
| 0xRF | - | 41 (39) | 70 (68) | 49 (52) | N/A | N/A |
| 1xRF | 31 (31) | Reference | 30 (35) | 16 (11) | N/A | N/A |
| 2xRF | 72 (66) | 53 (59) | 73 (70) | 64 (63) | 64 (66) | 63 (56) |
| 3xRF | 99 (97) | 63 (72) | 93 (95) | 82 (85) | 95 (89) | 85 (82) |
| 4xRF | N/A | N/A | 120 (124) | 116 (121) | 124 (122) | 119 (117) |
| 5xRF | N/A | N/A | 137 (143) | 138 (140) | 138 (141) | 138 (140) |

## Typical Spurious Performance: Up-Conversion

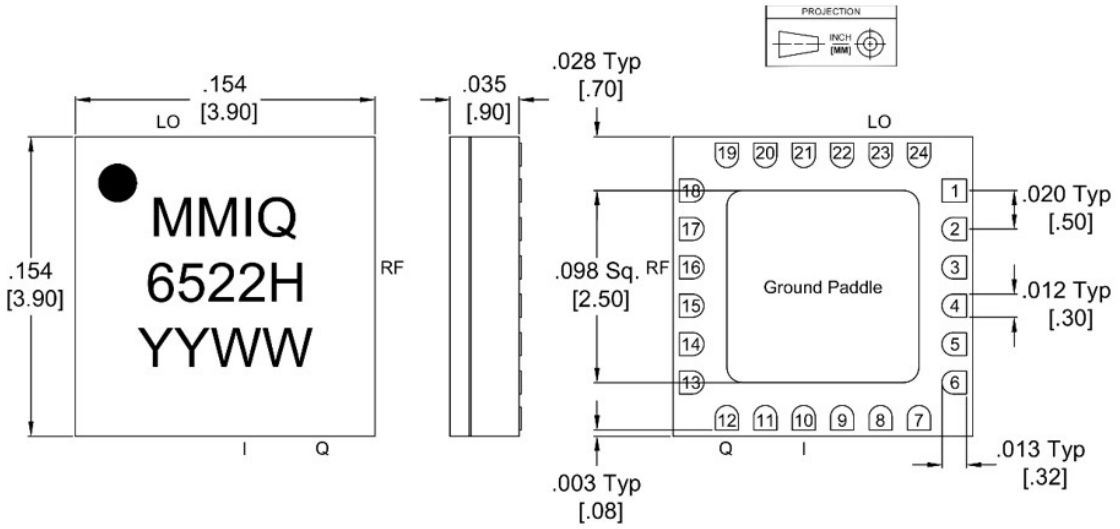
Typical spurious data is taken by mixing an input within the IF band, with LO frequencies(± m*LO ± n*IF), to create a spurious output within the RF output band. The mixer is swept across the full spurious output band and the mean is calculated. The numbers shown in the table below are for a -10 dBm IF 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 73 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 83 dBc.

**Typical Up-conversion spurious suppression (dBc): I Port (Q Port)**

| -10 dBm RF Input | 0xLO | 1xLO | 2xLO | 3xLO | 4xLO | 5xLO |
|---|---|---|---|---|---|---|
| 0xIF | - | 22 (22) | 59 (59) | 65 (65) | N/A | N/A |
| 1xIF | 31 (31) | Reference | 39 (32) | 13 (13) | N/A | N/A |
| 2xIF | 82 (82) | 73 (67) | 58 (58) | 79 (75) | N/A | N/A |
| 3xIF | 105 (106) | 71 (68) | 87 (76) | 70 (74) | N/A | N/A |
| 4xIF | 113 (113) | 117 (118) | 100 (106) | 126 (121) | N/A | N/A |
| 5xIF | 137 (136) | 118 (119) | 133 (133) | 118 (124) | N/A | N/A |

## Mechanical Data

## Outline Drawing



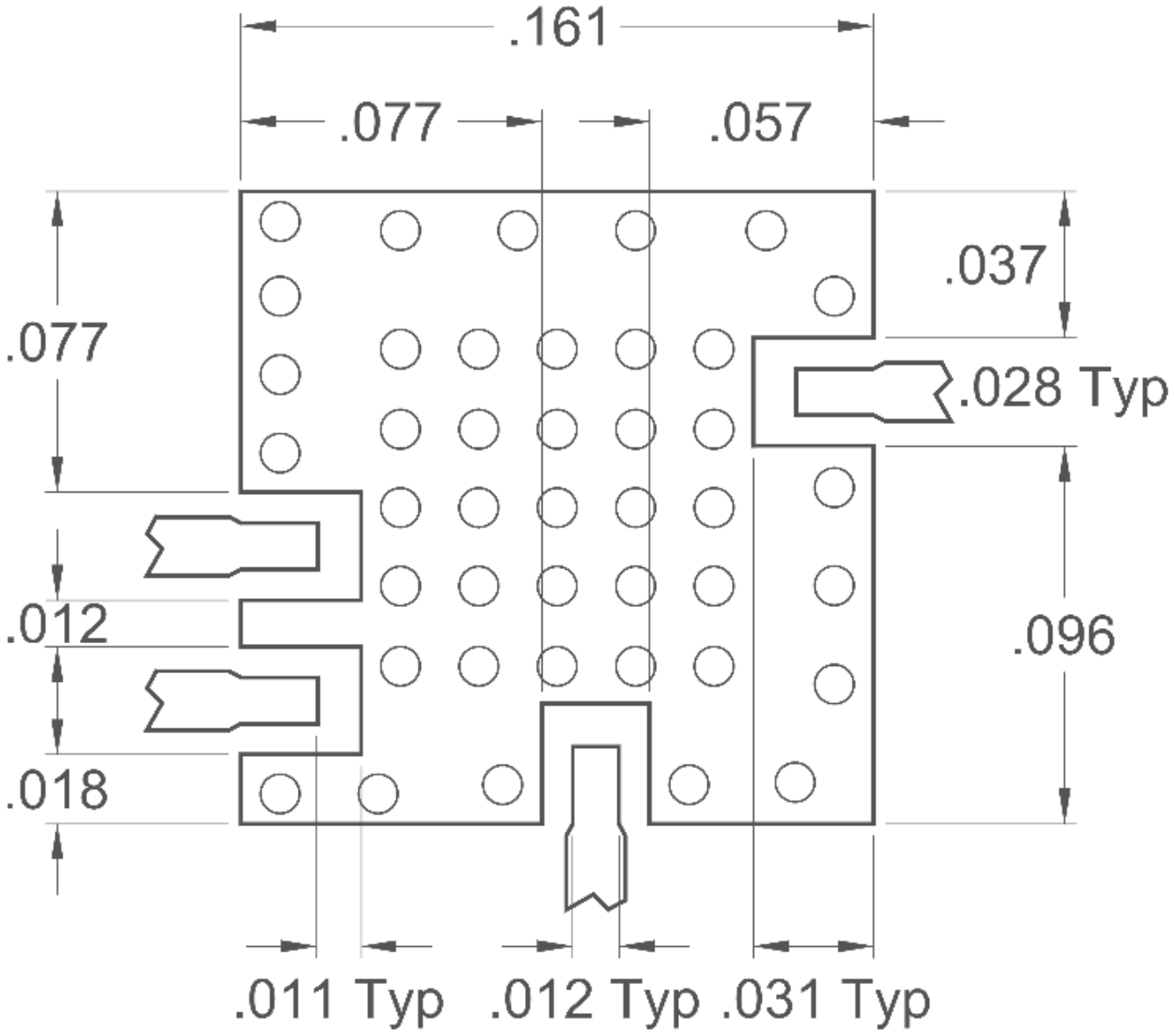

| Pad # | Function |
|---|---|
| 1 | N/C |
| 2 | N/C |
| 3 | N/C |
| 4 | N/C |
| 5 | N/C |
| 6 | N/C |
| 7 | N/C |
| 8 | N/C |
| 9 | N/C |
| 10 | IF-I |
| 11 | N/C |
| 12 | IF-Q |
| 13 | N/C |
| 14 | N/C |
| 15 | N/C |
| 16 | RF |
| 17 | N/C |
| 18 | N/C |
| 19 | N/C |
| 20 | N/C |
| 21 | N/C |
| 22 | N/C |
| 23 | LO |
| 24 | N/C |

1. Substrate material is ceramic.
2. I/O Leads and Ground Paddle plating is (from base to finish):

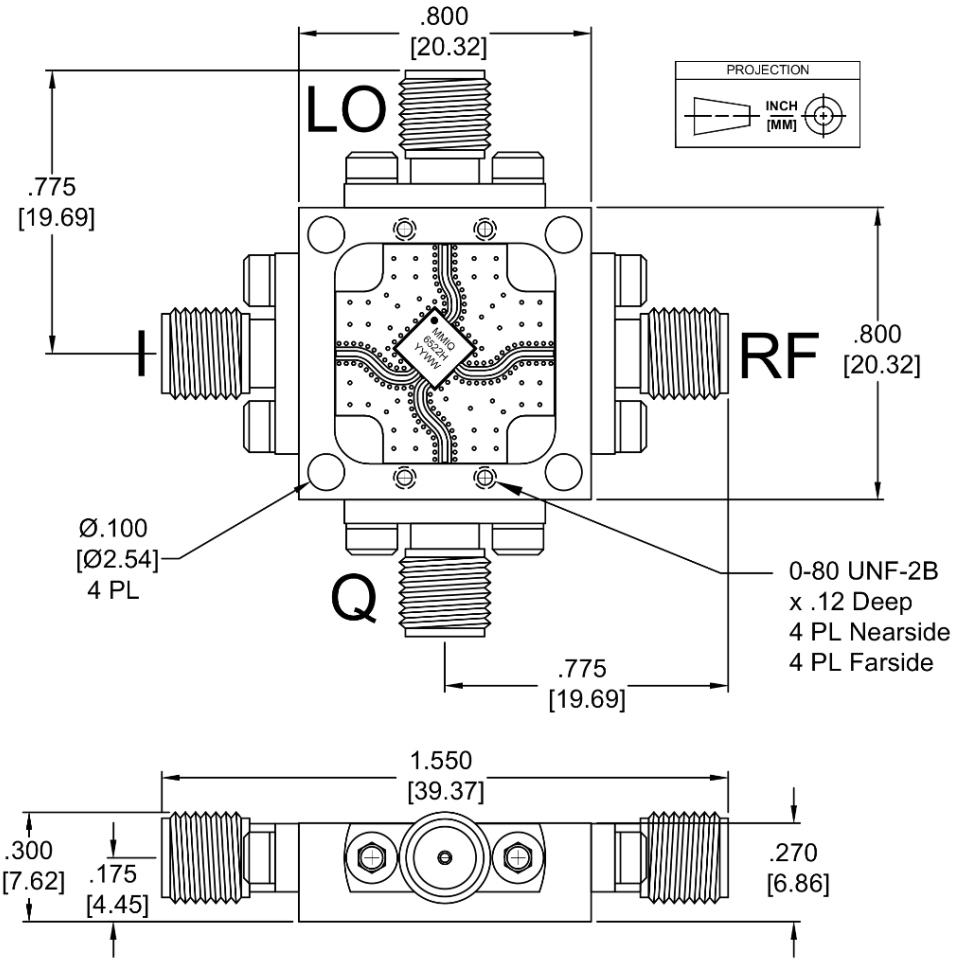
| | | |
|---|---|---|
| Ni: | 8.89um MAX | 1.27um MIN |
| Pd: | 0.17um MAX | 0.07um MIN |
| Au | 0.254um MAX | 0.03um MIN |

3. All unconnected pads should be connected to PCB RF ground.

## Footprint Image



| Port | Connector Type |
|---|---|
| LO | SMA Female |
| RF | SMA Female |
| I/Q | SMA Female |
| Note: Eval Connectors are not removeable. | |



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