

Features

- Integrates Image Reject (Balanced) Mixer, LO Buffer, LO Quadrupler and RF Buffer
- 13 dB Conversion Gain
- +20 dBm Input Third Order Intercept (IIP3)
- -30 dBm (4x) LO Leakage (@ RF Port)
- 18 dBc Image Rejection
- Variable Gain with Adjustable Bias
- Lead-Free 4 mm, 24 Lead QFN Package
- RoHS[^] Compliant

Description

The MAUC-011009 is an integrated up-converter that has a typical conversion gain of 13 dB, and an image rejection of 18 dBc. The device includes a LO quadrupler, LO buffer amplifier, and RF buffer amplifier. Variable gain can be achieved by adjusting the bias, with turn-down trajectories optimized to maintain linearity and 4xLO leakage over the gain control range. The output IP3 is 32 dBm at maximum gain.

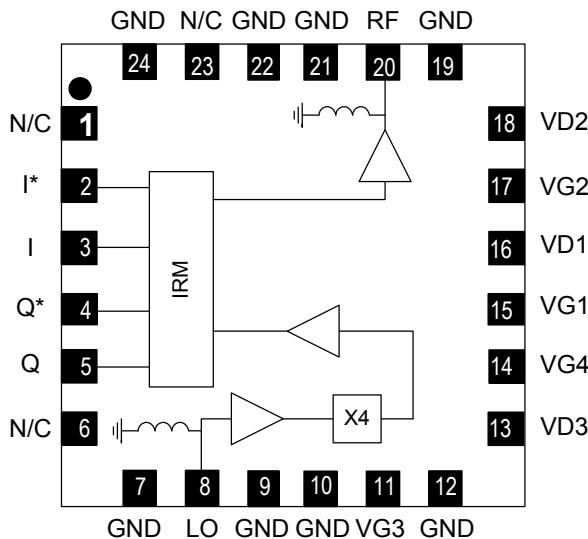
The MAUC-011009 is ideally suited for 38 GHz band point-to-point radios under both LSB and USB operation.

Each device is 100% RF tested to ensure performance compliance.

Ordering Information^{1,2}

| Part Number | Package |
|--------------------|----------------|
| MAUC-011009-TR0500 | 500 Piece Reel |
| MAUC-011009-000SMB | Sample Board |

1. Reference Application Note M513 for reel size information.
2. All sample boards include 3 loose parts.

Functional Schematic**Pin Configuration³**

| Pin No. | Function | Pin No. | Function |
|---------|----------|---------|---------------------|
| 1 | N/C | 13 | VD3 |
| 2 | I* | 14 | VG4 |
| 3 | I | 15 | VG1 |
| 4 | Q* | 16 | VD1 |
| 5 | Q | 17 | VG2 |
| 6 | N/C | 18 | VD2 |
| 7 | GND | 19 | GND |
| 8 | LO | 20 | RF |
| 9 | GND | 21 | GND |
| 10 | GND | 22 | GND |
| 11 | VG3 | 23 | N/C |
| 12 | GND | 24 | GND |
| | | 25 | Paddle ⁴ |

3. MACOM recommends connecting all N/C (no connection) package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

¹ Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

Up Converter
37 - 40 GHz

Rev. V1

Electrical Specifications⁵:LO = 0 dBm, IF = -10 dBm, T_A = +25°CV_{D1} = V_{D2} = V_{D3} = 4 V, I_{D1} = 45 mA, I_{D2} = 135 mA, I_{D3} = 200 mA

| Parameter | Units | Min. | Typ. | Max. |
|--|-------|-------|-------|--------|
| Frequency Range (RF) | GHz | 37 | — | 40 |
| Frequency Range (LO) | GHz | 8.375 | — | 10.875 |
| Frequency Range (IF) | GHz | DC | — | 3.5 |
| LO Input Power (PLO) | dBm | — | 0 | — |
| USB Conversion Gain (IF = 3.5 GHz) | dB | 9.5 | 13 | — |
| Image Rejection | dBc | — | 18 | — |
| Input IP3 (P _{IN} = -10 dBm/tone, IF = 3.5 GHz, ΔIF = 10 MHz) | dBm | — | 19 | — |
| USB Output IP3 (P _{IN} = -10 dBm/tone, IF = 3.5 GHz, ΔIF = 10 MHz) | dBm | 28 | 32 | — |
| Spurious (4xLO) [tuned - IF voltages ~ 0.2 V] | dBm | — | -30 | — |
| Spurious (1xLO) | dBm | — | -70 | — |
| RF Return Loss | dB | — | 10 | — |
| LO Return Loss | dB | — | 15 | — |
| IF Return Loss | dB | — | 15 | — |
| Current, Drain 1 (I _{D1}) | mA | — | 45 | — |
| Current, Drain 2 (I _{D2}) | mA | — | 135 | — |
| Current, Drain 3 (I _{D3}) | mA | — | 200 | — |
| Gate Voltage (V _{G4}) | V | — | -3.25 | — |
| Gate Current (I _{G4}) | mA | — | -1 | — |

5. Apply gate voltages prior to drain voltages. Adjust V_{G1}, V_{G2} and V_{G3} between -1.0 and -0.1 V to achieve specified drain current. Typical current 380 mA = 45 (I_{D1}) + 135 (I_{D2}) + 200 (I_{D3}) mA. Refer to App Note [1] for biasing details.

Absolute Maximum Ratings^{6,7}

| Parameter | Absolute Max. |
|-----------------------------------|-------------------------|
| Drain Voltage | +4.3 V |
| Gate Bias Voltage (V_G 1,2,3) | -1.5 V < V_G < +0.3 V |
| Gate Bias Voltage (V_G 4) | -4.0 V < V_G < 0 V |
| Input Power | 10 dBm |
| LO Input Power | 13 dBm |
| Storage Temperature | -55°C to +150°C |
| Operating Temperature | -40°C to +85°C |
| Junction Temperature ⁸ | +150°C |

6. Exceeding any one or combination of these limits may cause permanent damage to this device.
7. MACOM does not recommend sustained operation near these survivability limits.
8. Junction Temperature (T_J) = T_C + Θ_{JC} * (V * I)
Typical thermal resistance (Θ_{JC}) = 36°C/W.

Handling Procedures

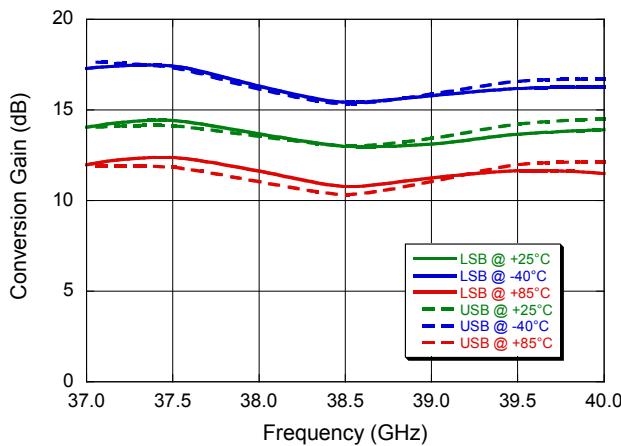
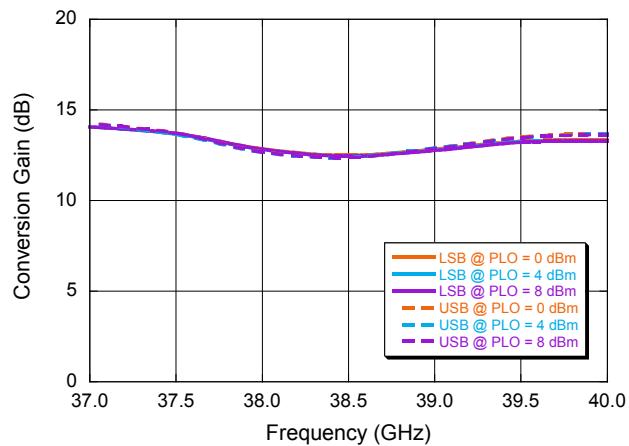
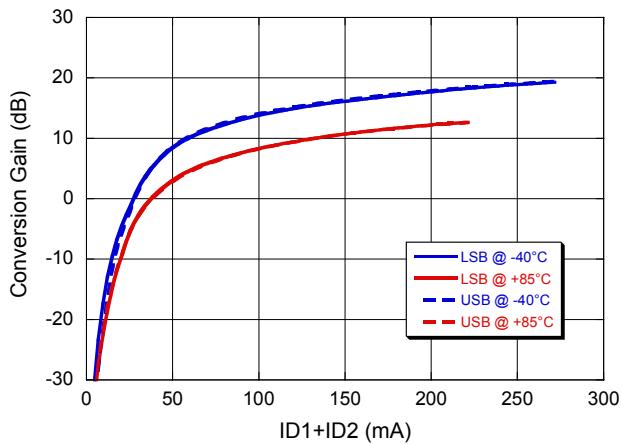
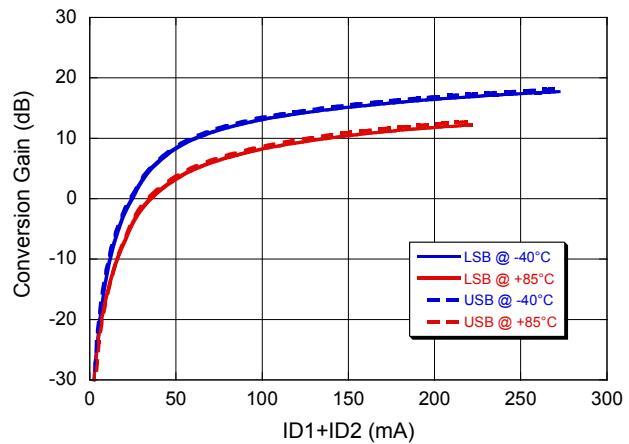
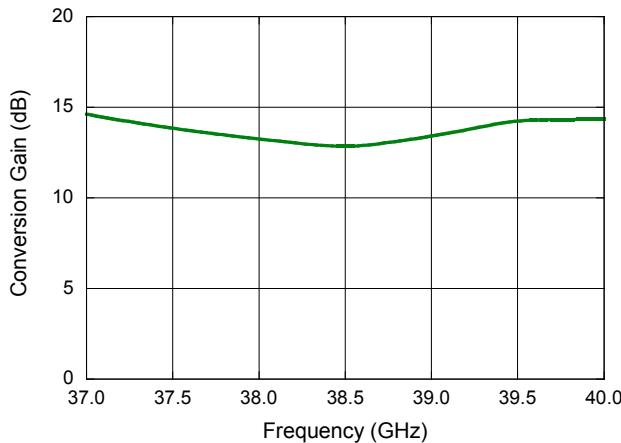
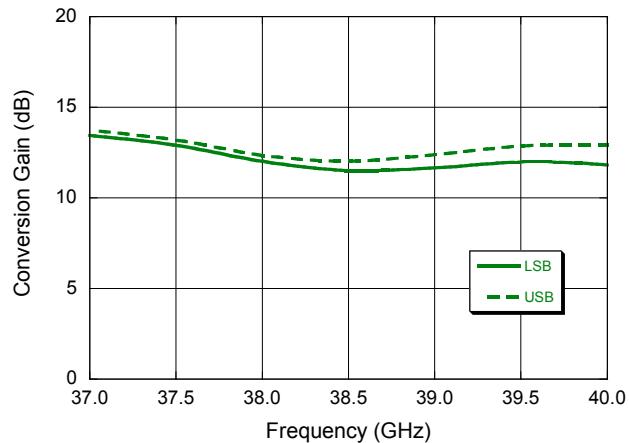
Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

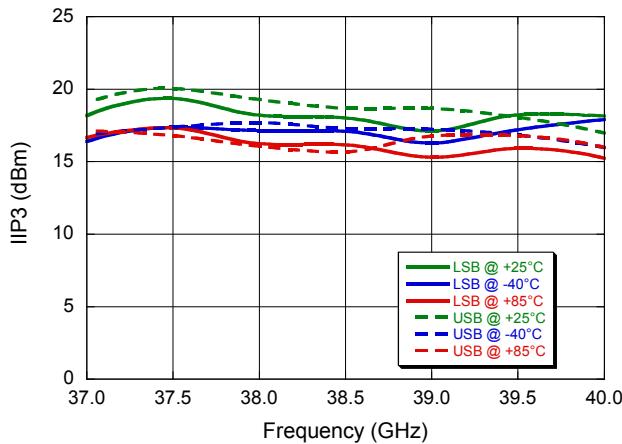
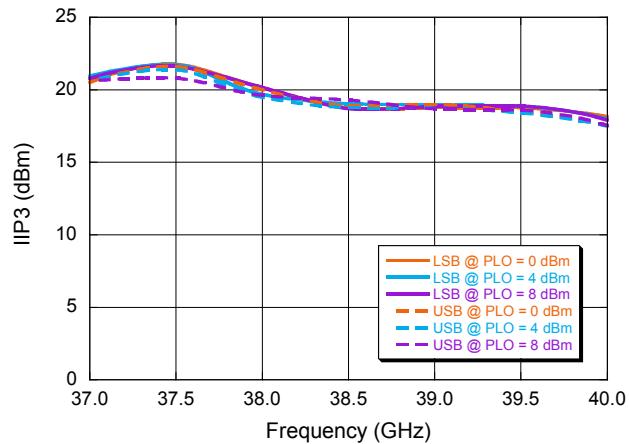
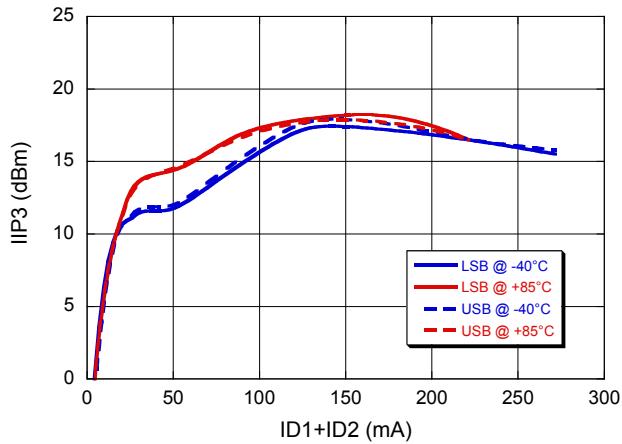
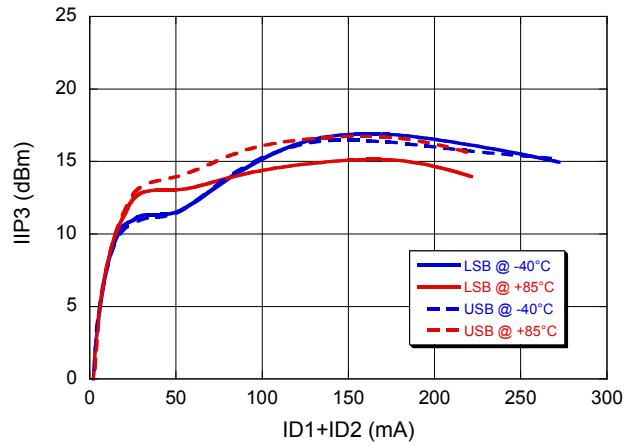
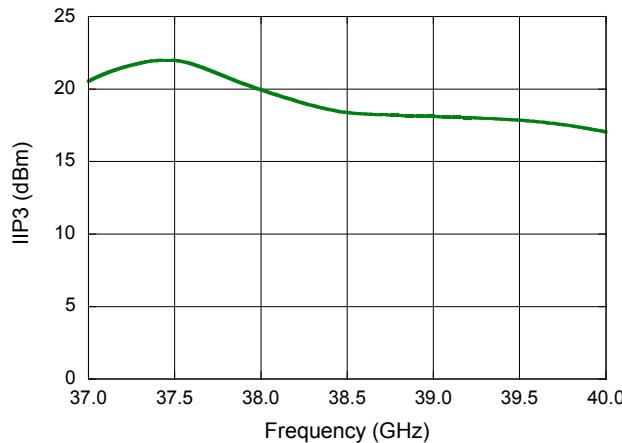
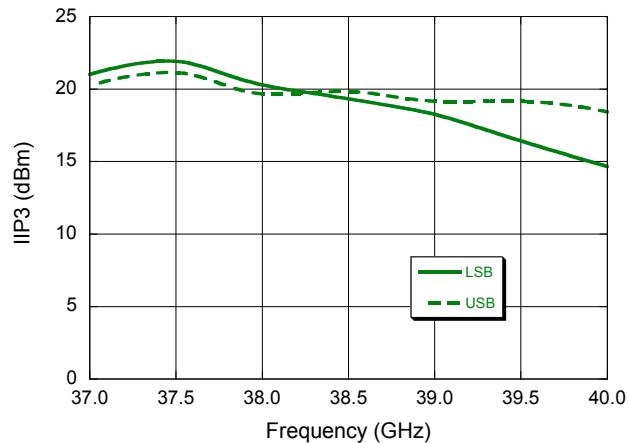
Up Converter
37 - 40 GHz

Rev. V1

Typical Performance Curves: LO = 0 dBm, IF = -10 dBm @ 2 GHz, P_{DC} = 1.52 W
Conversion Gain**Conversion Gain, LO Power swept****Conversion Gain @ 37 GHz****Conversion Gain @ 40 GHz****Conversion Gain @ IF = 21.4 MHz****Conversion Gain @ IF = 3.5 GHz**

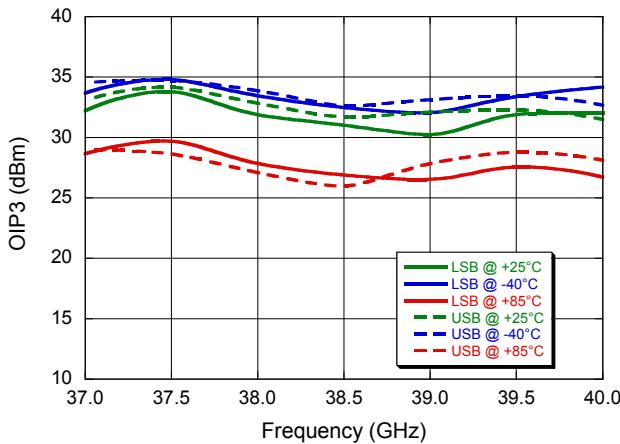
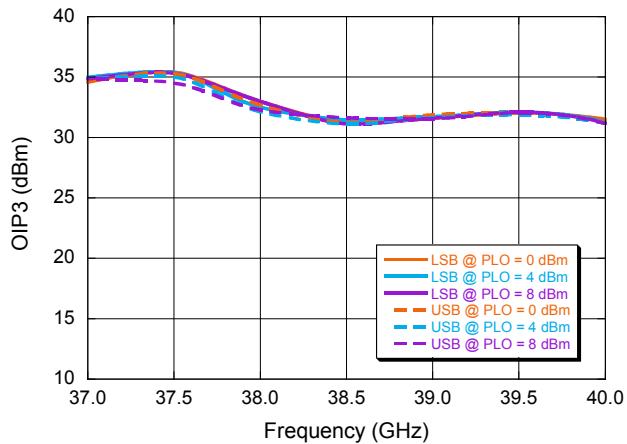
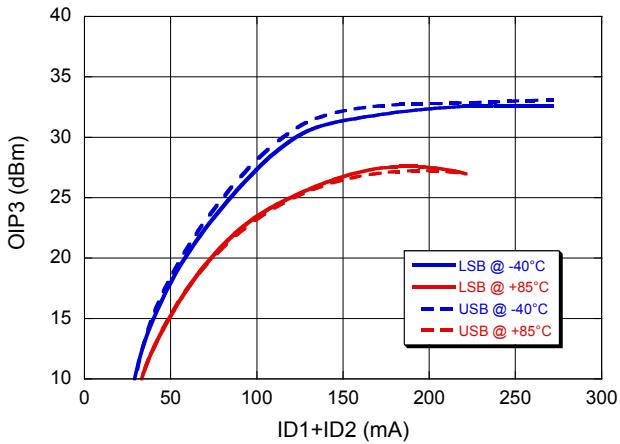
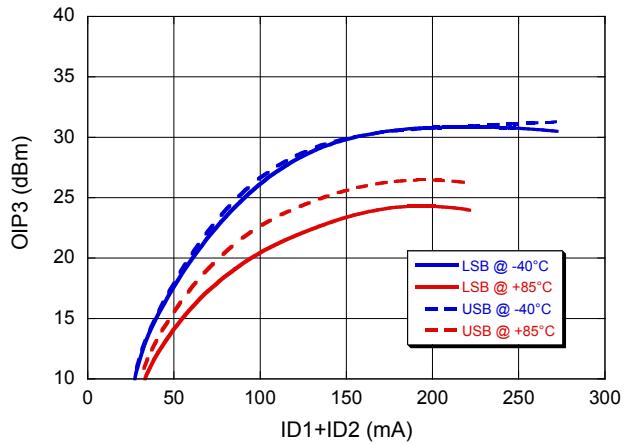
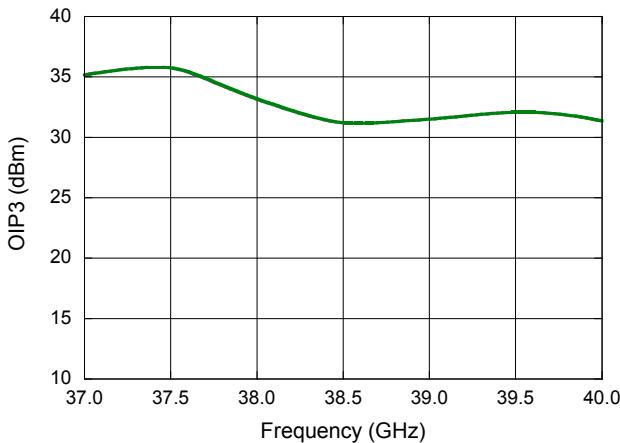
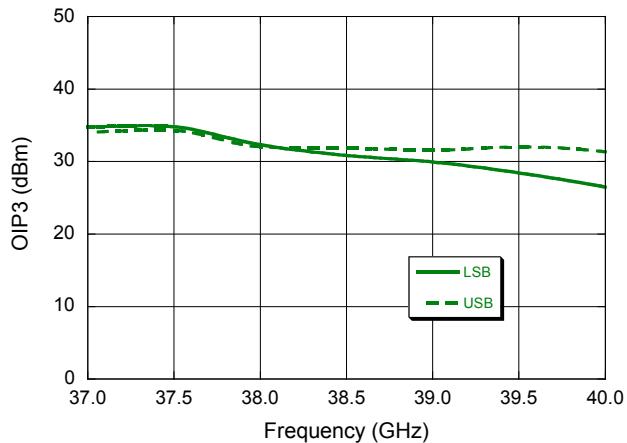
Up Converter
37 - 40 GHz

Rev. V1

Typical Performance Curves: LO = 0 dBm, IF = -10 dBm @ 2 GHz, P_{DC} = 1.52 W
Input IP3**Input IP3, LO Power swept****Input IP3 @ 37 GHz****Input IP3 @ 40 GHz****Input IP3, IF = 21.4 MHz****Input IP3, IF = 3.5 GHz**

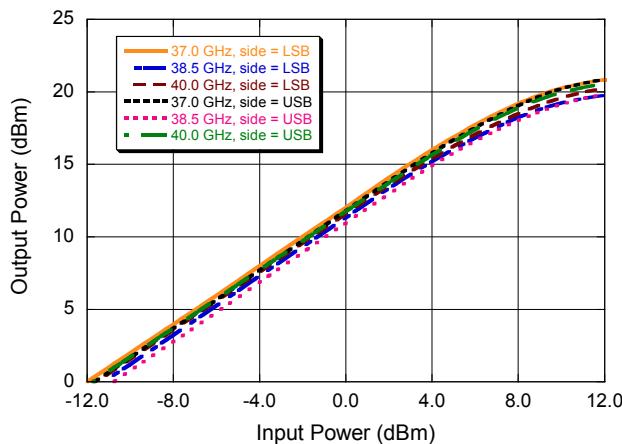
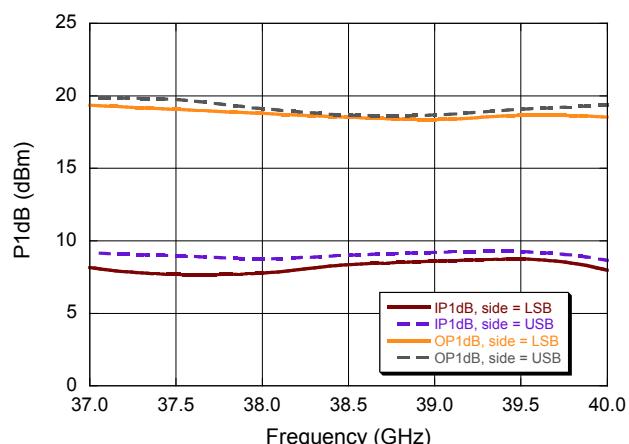
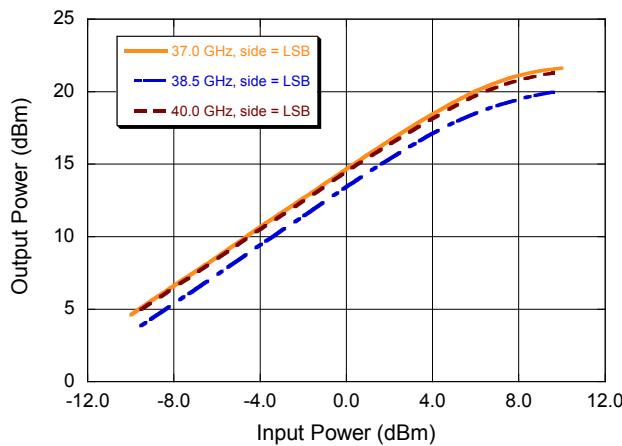
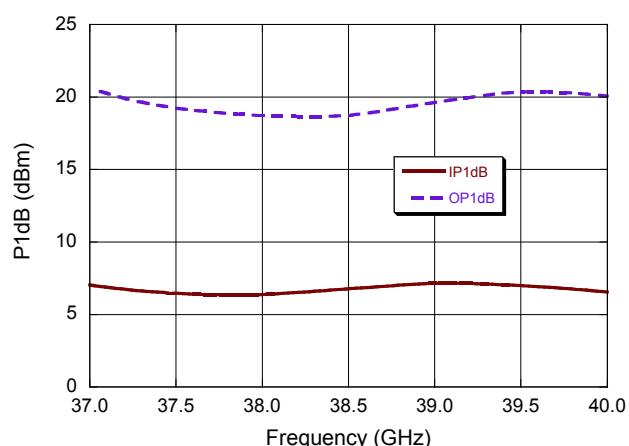
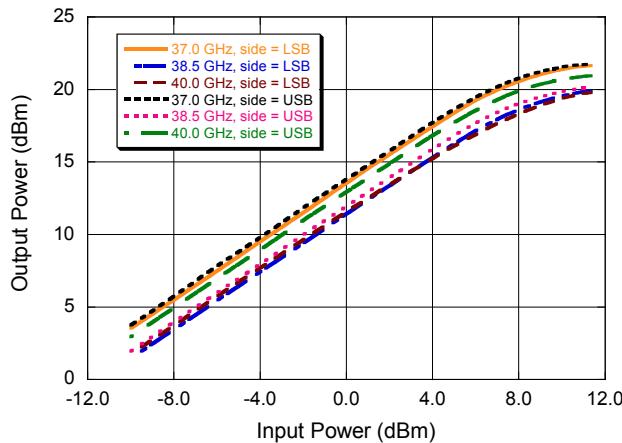
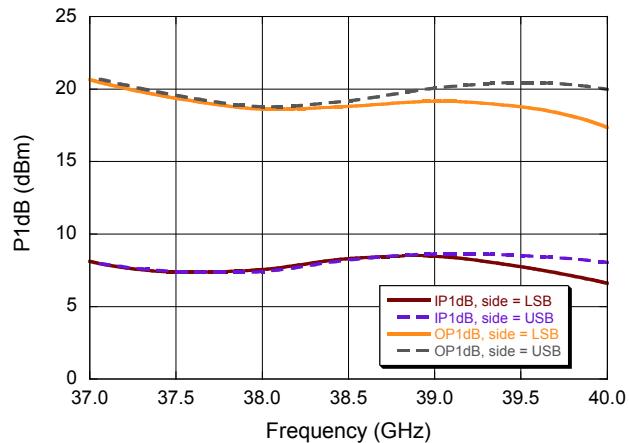
Up Converter
37 - 40 GHz

Rev. V1

Typical Performance Curves: LO = 0 dBm, IF = -10 dBm @ 2 GHz, $P_{DC} = 1.52$ W
Output IP3**Output IP3, LO Power swept****Output IP3 @ 37 GHz****Output IP3 @ 40 GHz****Output IP3, IF = 21.4 MHz****Output IP3, IF = 3.5 GHz**

Up Converter
37 - 40 GHz

Rev. V1

Typical Performance Curves: LO = 0 dBm, IF = -10 dBm @ 2 GHz, P_{DC} = 1.52 W
P_{OUT} vs. P_{IN}**P1dB, Input & Output****P_{OUT} vs. P_{IN} @ IF = 21.4 MHz****P1dB @ Input & Output, IF = 21.4 MHz****P_{OUT} vs. P_{IN} @ IF = 3.5 GHz****P1dB @ Input & Output, IF = 3.5 GHz**

Typical Performance Curves: LO = 0 dBm, IF = -10 dBm @ 2 GHz, $P_{DC} = 1.52$ W

Image Rejection

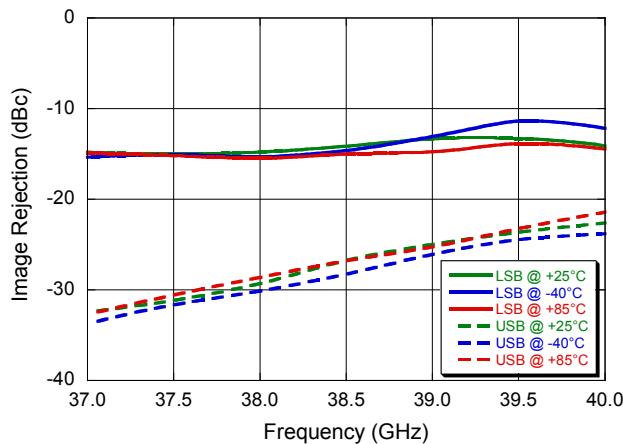


Image Rejection, LO Power swept

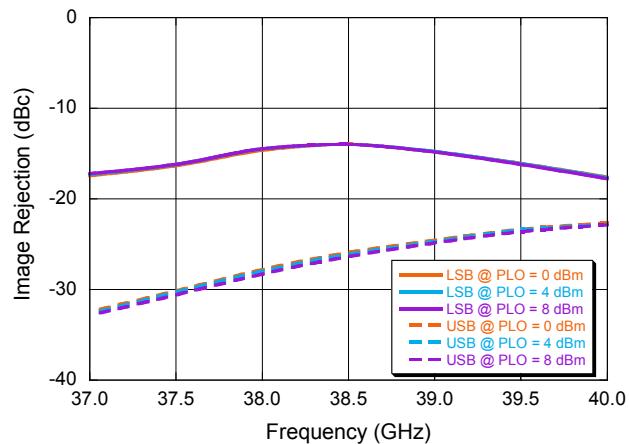


Image Rejection, IF = 21.4 MHz

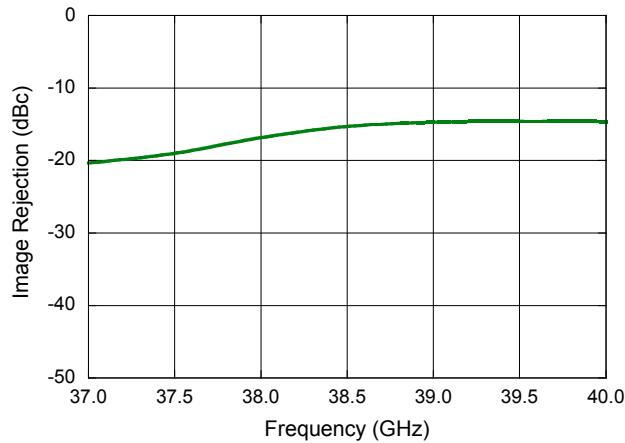
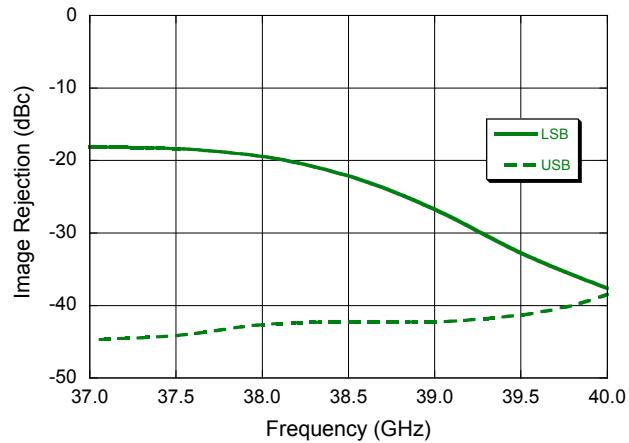


Image Rejection, IF = 3.5 GHz

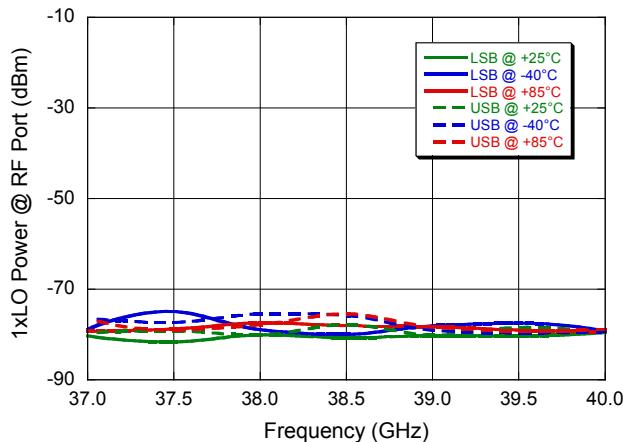


Up Converter 37 - 40 GHz

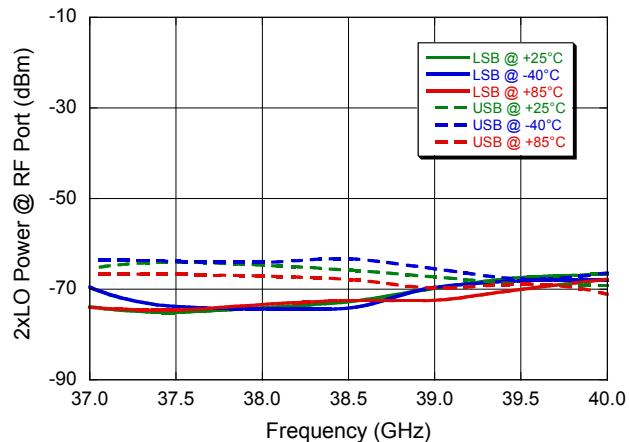
Rev. V1

Typical Performance Curves

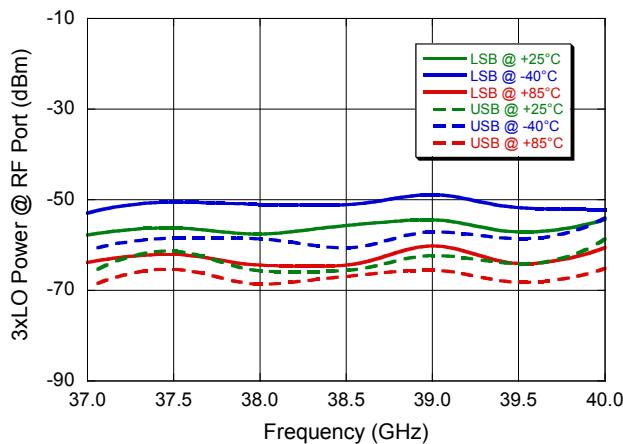
1xLO Leakage @ RF port



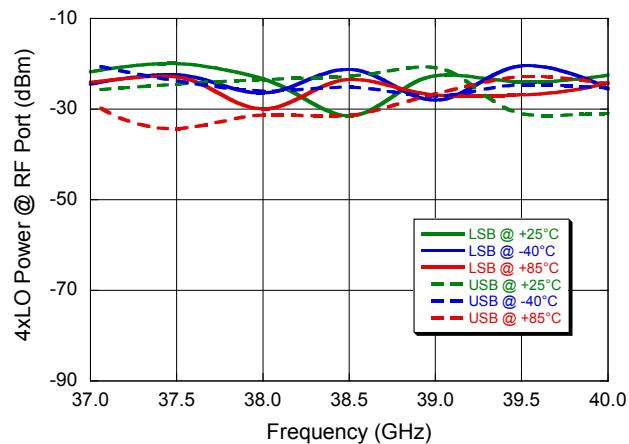
2xLO Leakage @ RF Port



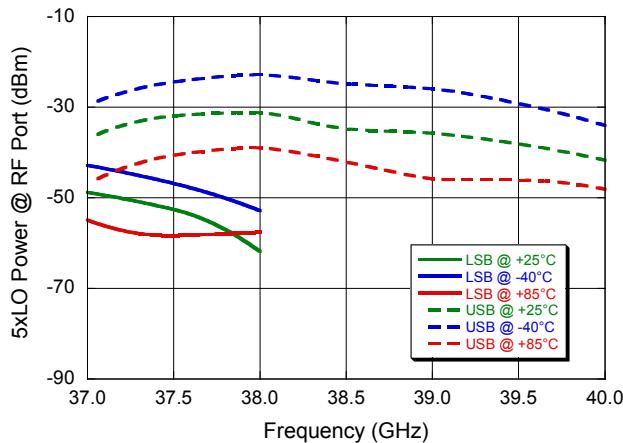
3xLO Leakage @ RF Port



4xLO Leakage @ RF Port

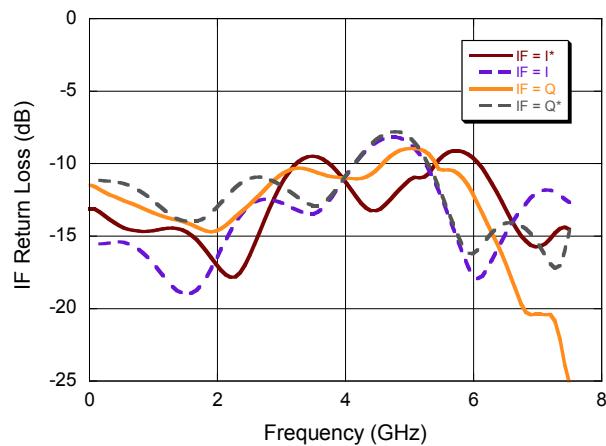


5xLO Leakage @ RF Port

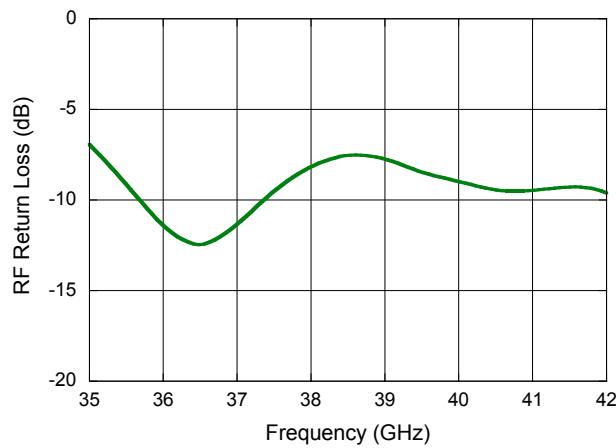


Typical Performance Curves

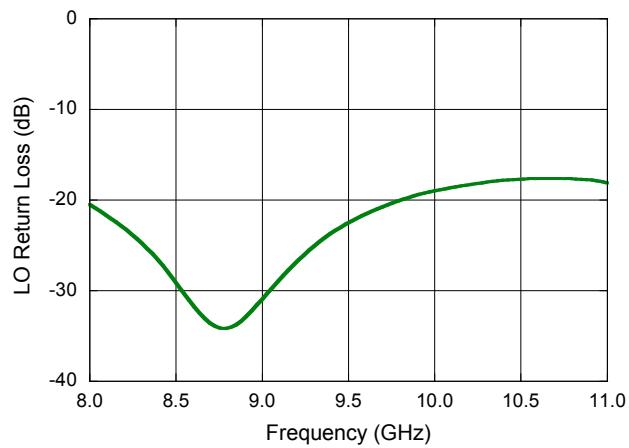
IF Return Loss



RF Return Loss



LO Return Loss

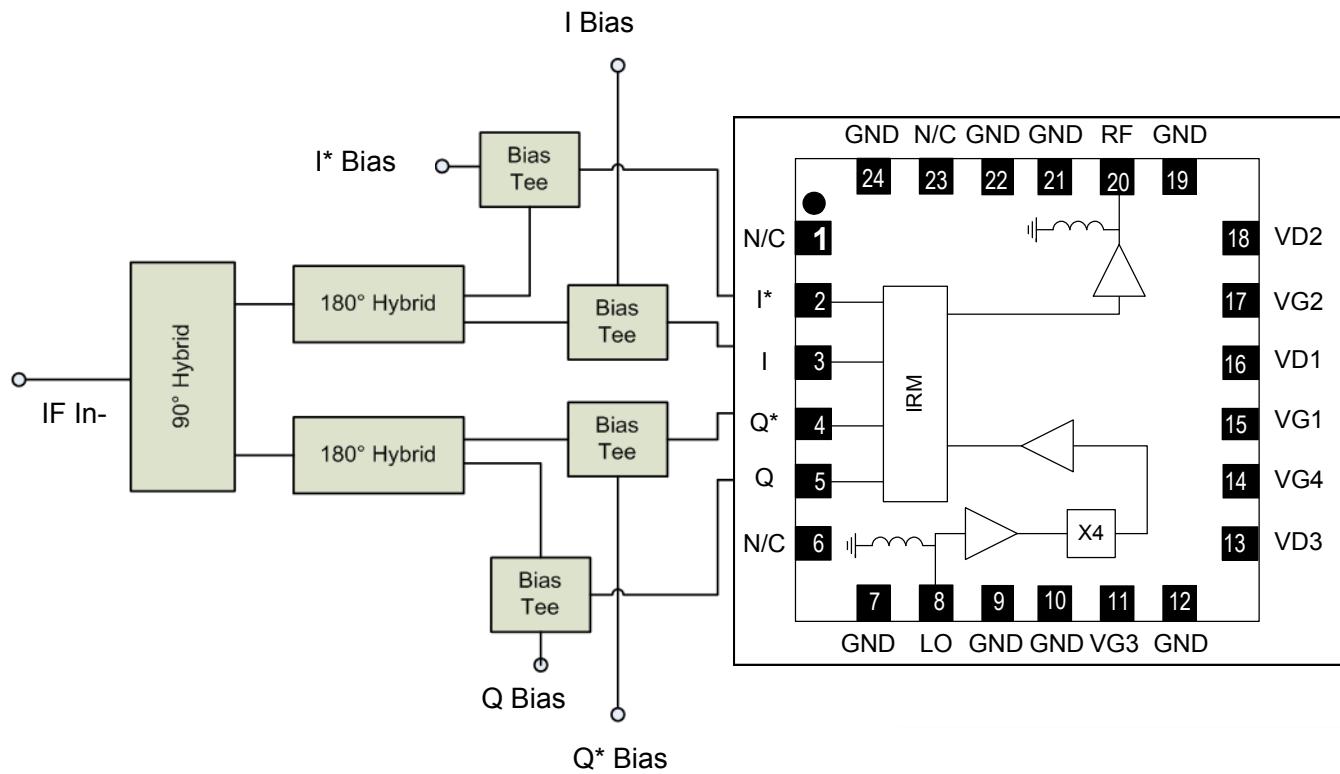


App Note [1] Biasing

MAUC-011009 is operated by biasing V_D1 , V_D2 and V_D3 at 4.0 V. The corresponding drain currents are set to 45 mA, 135 mA and 200 mA respectively. V_G4 requires a fixed voltage bias of nominally -3.25 V. It is recommended to use active bias on V_G1 , V_G2 , V_G3 to keep the currents in V_D1 , V_D2 and V_D3 constant, in order to maintain the best performance over temperature. Depending on the supply voltages available and the power dissipation constraints, the bias circuits may include a single transistor or a low power operational amplifier, with a low value resistor in series with the drain supply to sense the current. Make sure to sequence the applied voltage to ensure negative gate bias is available before applying the positive drain supply.

App Note [2] IF Inputs

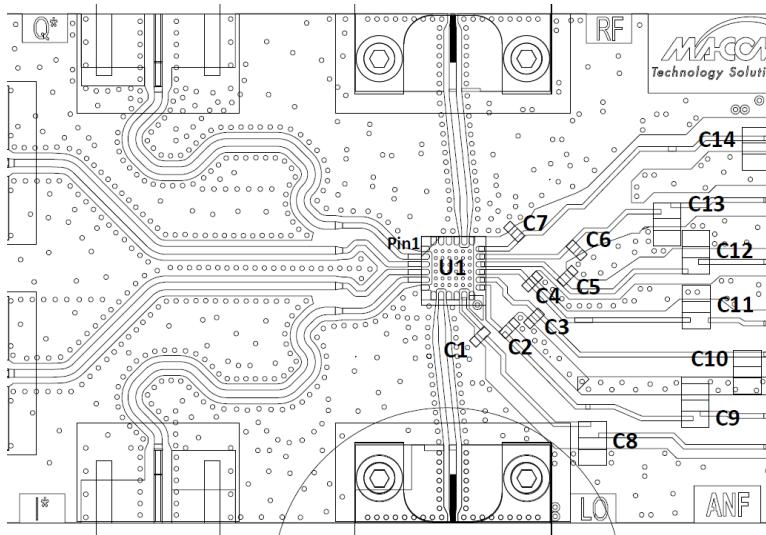
The IF input to the typical configuration is through a 90° hybrid coupler. The hybrid splits the IF input into inphase and quadrature phase components which feed into two 180° hybrid couplers splitting into 4 signals. These four signals enter the MAUC-011009 on I/I*, Q/Q* IF inputs through bias tees. For highest gain, best image rejection and highest OIP3, all the 4 IF inputs should be used. See App Note [4] for IF bias.



App Note [3] Board Layout

As shown in the recommended board layout, it is recommended to provide 100 pF decoupling capacitors as close to the bias pins as possible. Additional 10 nF and 1 μ F on each of the bias lines are recommended placed a distance further away.

Recommended Board Layout



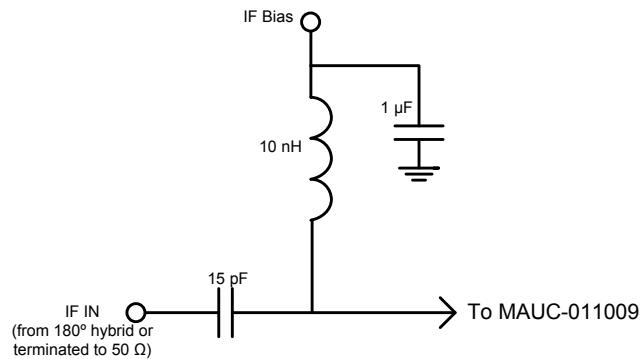
App Note [4] IF Bias

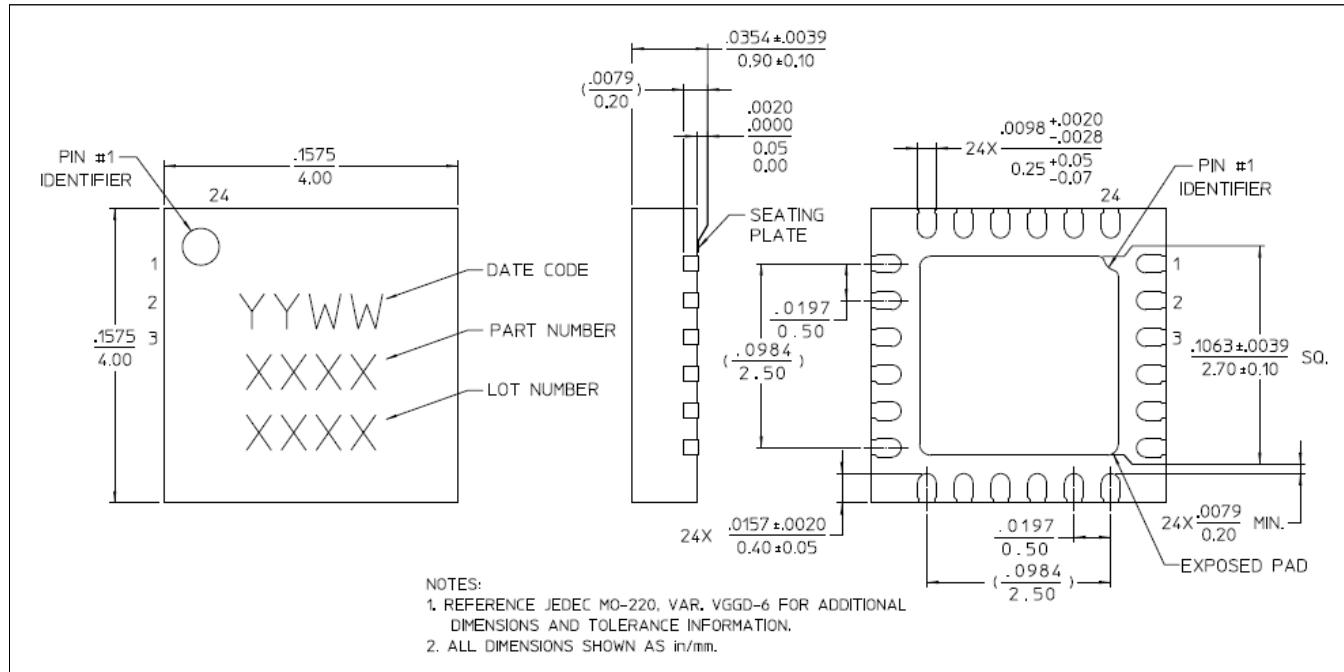
To obtain optimum 4xLO leakage performance, tuning is achieved by adjusting the DC bias on each of the IF inputs (I, Q, I*, Q*). DC bias is implemented by adding simple bias tees to each of the four IF ports (see drawing from App Note [2] for the bias tees location). The diagram below shows a typical bias tee design used.

A typical tuning arrangement is to apply a fixed 0.2 V DC bias to I, Q. The remaining two IF ports can be tuned independently between -0.5 and 1 V for minimum 4xLO leakage.

For minimum 4xLO leakage in a system, it may be necessary to correct the IF DC bias for different frequency and temperature conditions. This can be implemented by calibration and offset tables stored in memory, and used to control IF bias over all practical conditions.

Typical Configuration



Lead-Free 4 mm 24-Lead PQFN [†]

[†] Reference Application Note S2083 for lead-free solder reflow recommendations.

Meets JEDEC moisture sensitivity level 1 requirements.
Plating is NiPdAuAg over copper.

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