Features

- Integrates Image Reject (Balanced) Mixer, LO Buffer, LO Quadrupler and RF Buffer
- 13 dB Conversion Gain
- 3.8 dB Noise Figure
- 2 dBm Input Third Order Intercept (IIP3)
- 30 dBm Average Two-Tones Input Second Order Intercept (IIP2)
- 25 dBm Input Second Order Intercept (IIP2 IF/2)
- 25 dBc Image Rejection
- 12 dB RF and 15 dB LO Return Loss
- Lead-Free 4 mm, 24 Lead QFN Package
- RoHS^ Compliant

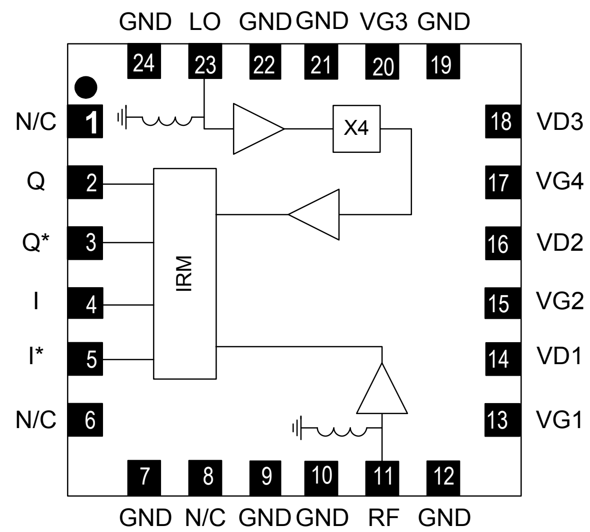
Description

The MADC-011010 is an integrated LSB/USB receiver that has a noise figure of 3.8 dB and a typical conversion gain of 13 dB. The device integrates a four stage LNA followed by an image rejection mixer, and includes an integrated LO quadrupler and buffer amplifier within a 4 mm QFN package. The I/Q and complementary I*/Q* mixer outputs are provided, and two external 180° hybrids and one external 90° hybrid are required to complete the image rejection function.

The MADC-011010 is ideally suited for 38 GHz band point to point radios.

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

Functional Schematic



Ordering Information[1,2]

Part Number	Package
MADC-011010-TR0500	500 Piece Reel
MADC-011010-001SMB	Sample Evaluation board

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

Pin Configuration[3]

Pin No.	Function	Pin No.	Function
1	N/C	13	V_G1
2	Q	14	V_D1
3	Q*	15	V_G2
4	I	16	V_D2
5	I*	17	V_G4
6	N/C	18	V_D3
7	GND	19	GND
8	N/C	20	V_G3
9	GND	21	GND
10	GND	22	GND
11	RF	23	LO
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.

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

Electrical Specifications[5]:
LO = 4 dBm, T_A = +25°C
$V_D1 = V_D2 = V_D3 = 3$ V, $I_D1 = 30$ mA, $I_D2 = 100$ mA, $I_D3 = 150$ 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	—	4	—
USB Conversion Gain (IF = 2 GHz)	dB	10	13	—
USB Noise Figure (IF = 2 GHz)	dB	—	3.8	5
Image Rejection	dBc	—	25	—
Input IP3	dBm	—	2	—
Input IP2 (IF/2)	dBm	—	25	—
Average Two-Tones Input IP2 (ZIF)	dBm	—	30	—
RF Return Loss	dB	—	12	—
LO Return Loss	dB	—	15	—
IF Return Loss	dB	—	15	—
Current, Drain 1 (I_D1)	mA	—	30	—
Current, Drain 2 (I_D2)	mA	—	100	—
Current, Drain 3 (I_D3)	mA	—	150	—
Gate Voltage (V_G4)	V	—	-2.5	—
Drain Voltage on each IF port	V	—	0.3	—

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 280 mA = 30 (I_D1) + 100 (I_D2) + 150 (I_D3) mA. Refer to App Note [1] for biasing details.

Absolute Maximum Ratings[6,7]

Parameter	Absolute Maximum
Drain Voltage	+4.3 V
Gate Bias Voltage (V_G1,2,3)	-1.5 V < V_G < +0.3 V
Gate Bias Voltage (V_G4)	-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[8,9]	+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. Operating at nominal conditions with $T_J \leq +150°C$ will ensure MTTF > 1 x 10^6 hours.
9. Junction Temperature (T_J) = T_C + Ɵjc * (V * I)
   Typical thermal resistance (Ɵjc) = 44°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.

Biasing Quickstart

Turn ON:

Step 1: Turn on the fixed voltage on VG4 first.
Step 2: Turn on VG1, VG2 and VG3 at approximately -1.0V .
Step 3: Turn on IF voltages at the fixed voltage.
Step 4: Turn on VD1, VD2 and VD3 at the fixed voltages, and adjust corresponding VG to get the required current levels.

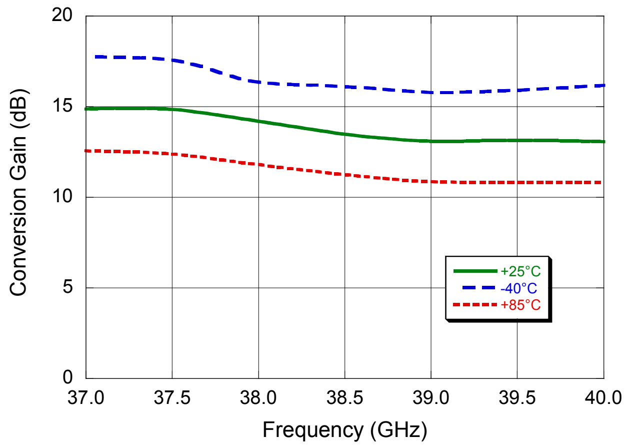
Turn OFF:

*Reverse steps indicated in **Turn ON** sequence*

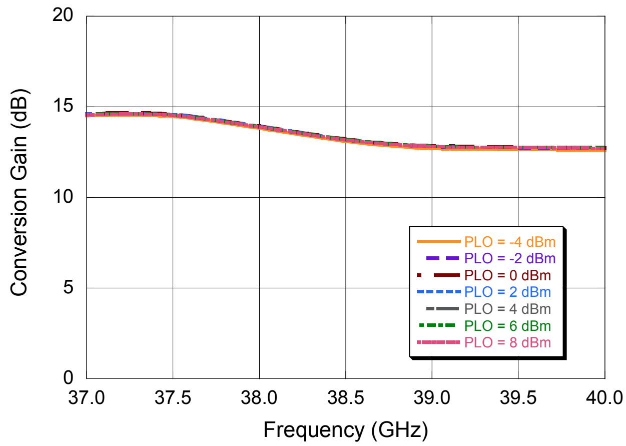
For further details please see App Note [1]

Typical Performance Curves: LO = 4 dBm, RF = -20 dBm @ 50 MHz IF, P_{DC} = 0.84 W

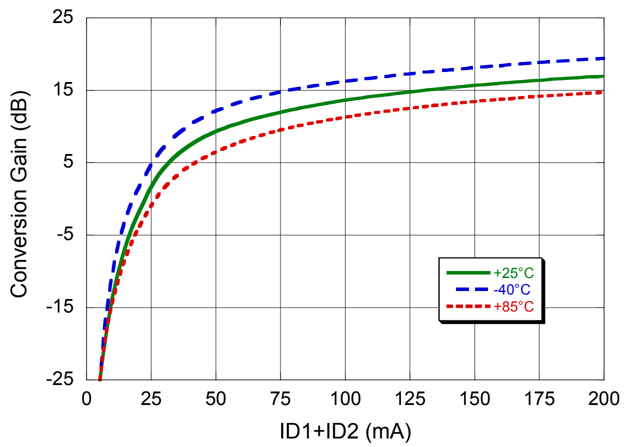
Conversion Gain



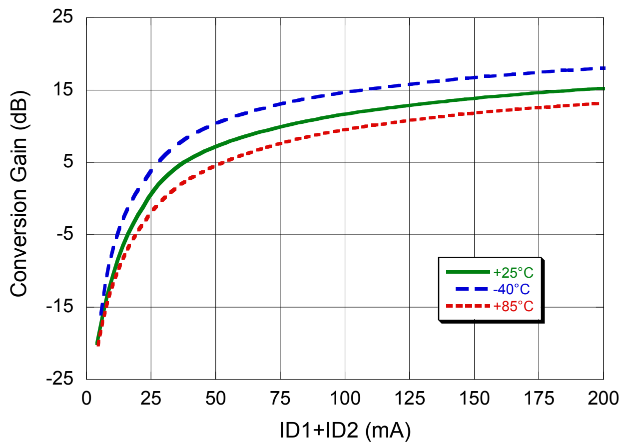
Conversion Gain, LO Power swept



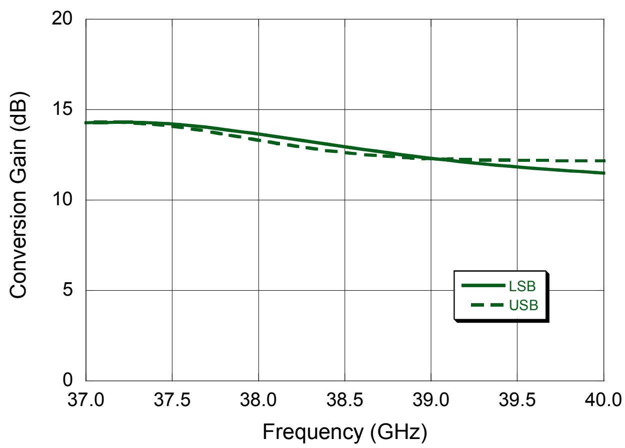
Conversion Gain @ 37 GHz



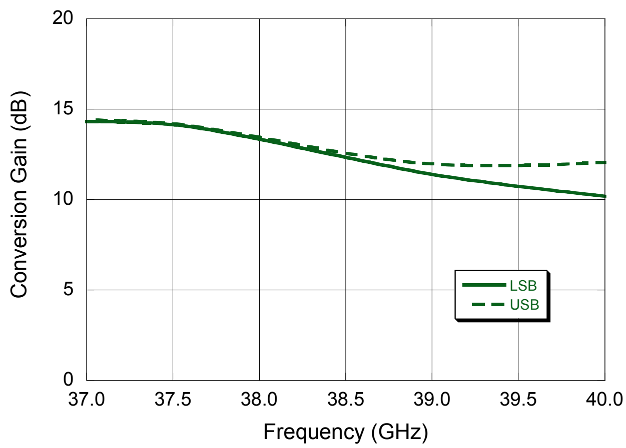
Conversion Gain @ 40 GHz



Conversion Gain, IF = 2 GHz

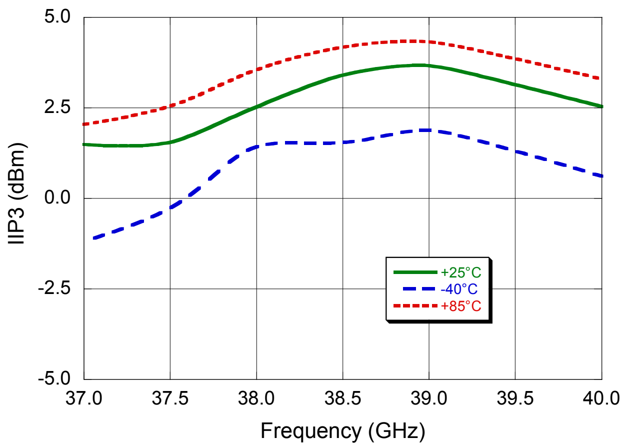


Conversion Gain, IF = 3.5 GHz

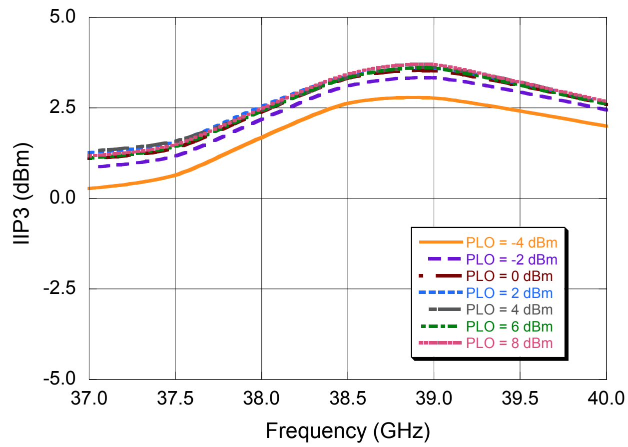


Typical Performance Curves: LO = 4 dBm, RF = -20 dBm @ 50 MHz IF, P_{DC} = 0.84 W

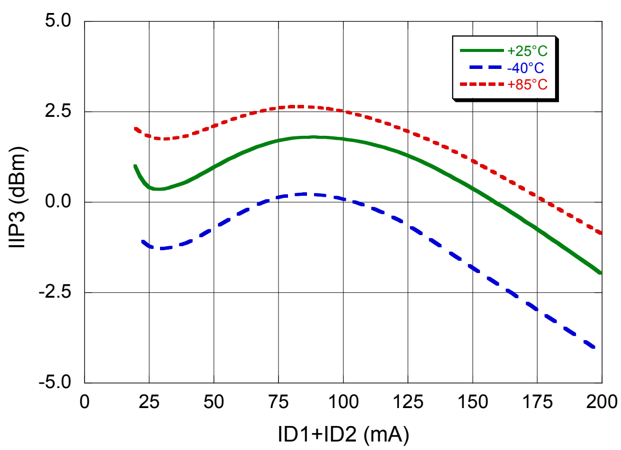
Input IP3



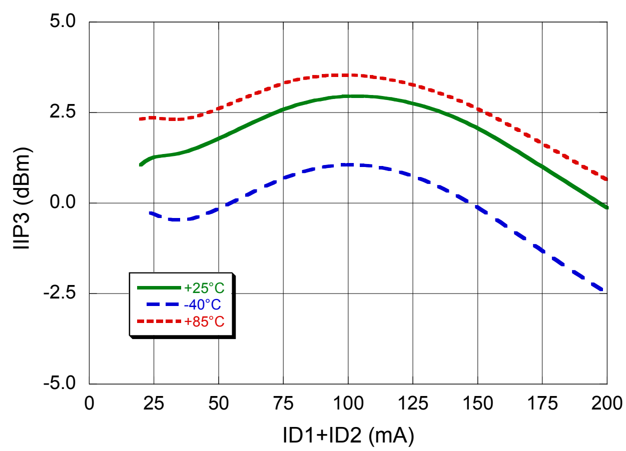
Input IP3, LO Power swept



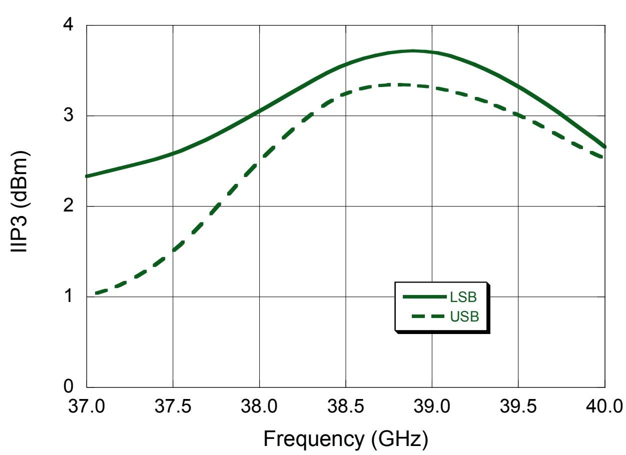
Input IP3 @ 37 GHz



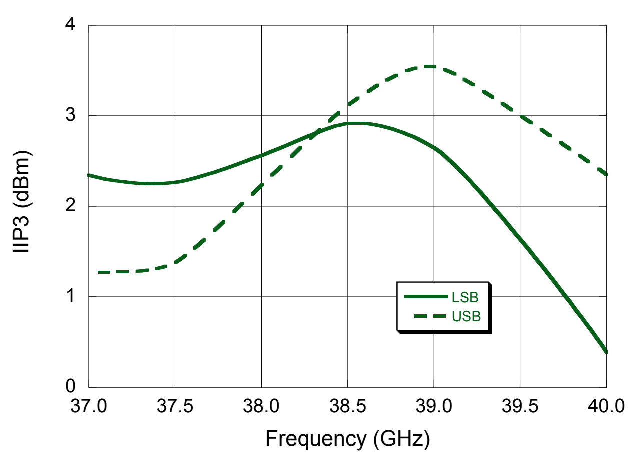
Input IP3 @ 40 GHz



Input IP3, IF = 2 GHz

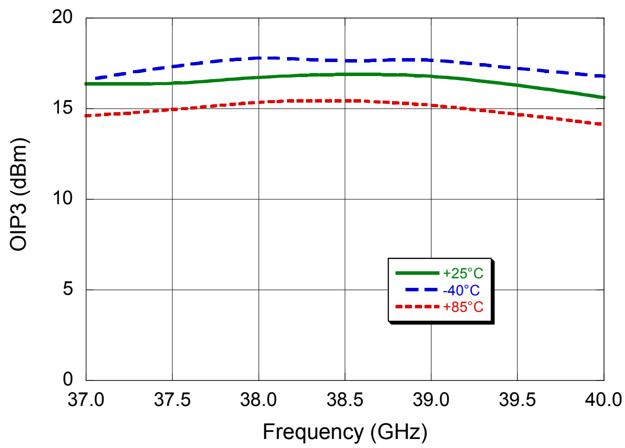


Input IP3, IF = 3.5 GHz

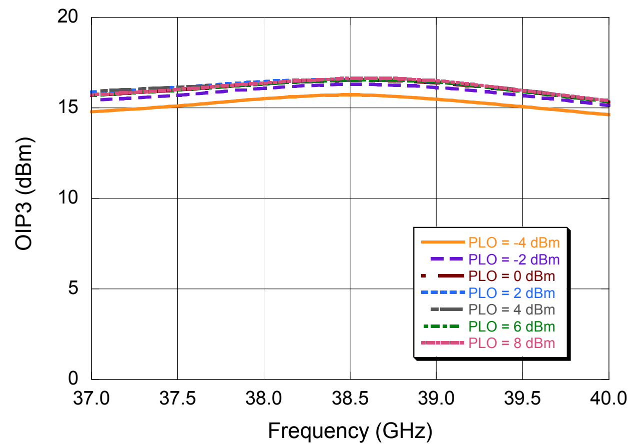


Typical Performance Curves: LO = 4 dBm, RF = -20 dBm @ 50 MHz IF, P_{DC} = 0.84 W

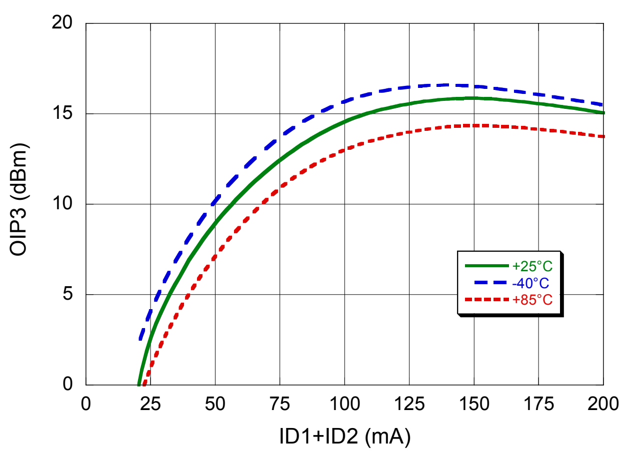
Output IP3



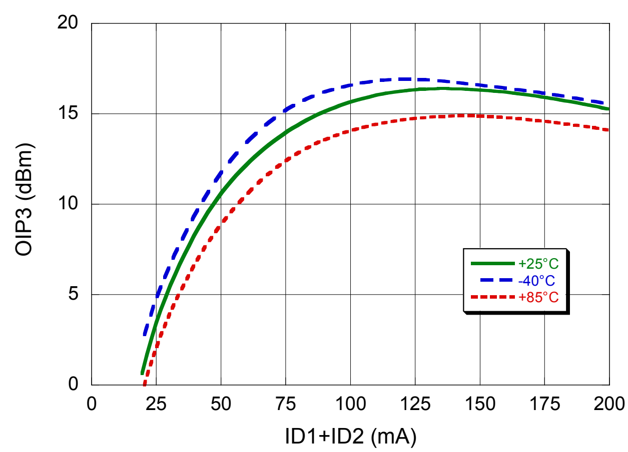
Output IP3, LO Power swept



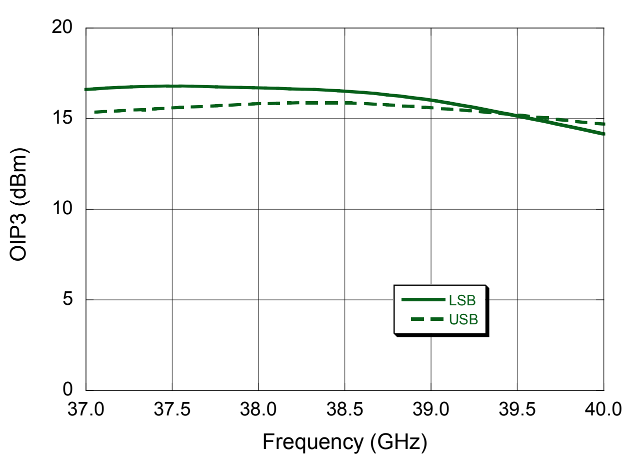
Output IP3 @ 37 GHz



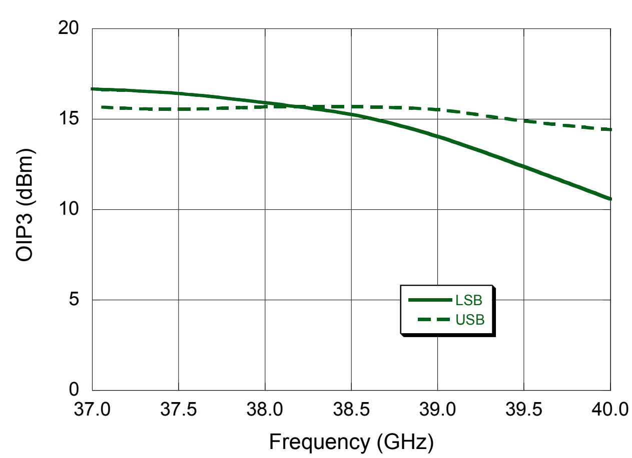
Output IP3 @ 40 GHz



Output IP3, IF = 2 GHz

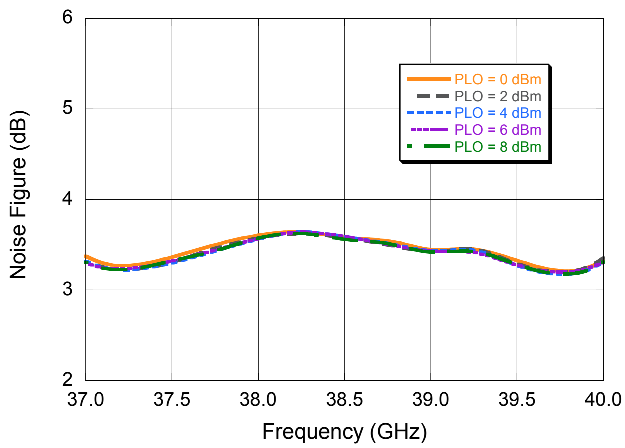


Output IP3, IF = 3.5 GHz

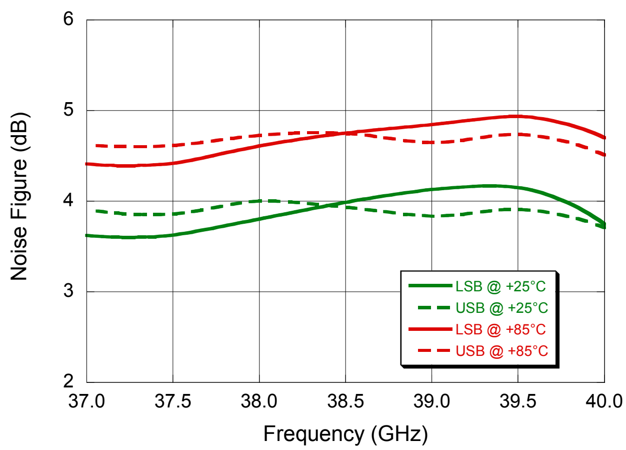


Typical Performance Curves: LO = 4 dBm, IF = 150 MHz, P_{DC} = 0.84 W

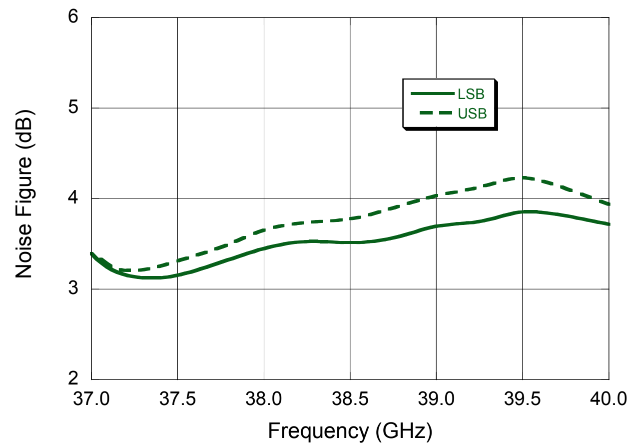
Noise Figure, LO Power swept



Noise Figure, IF = 2 GHz

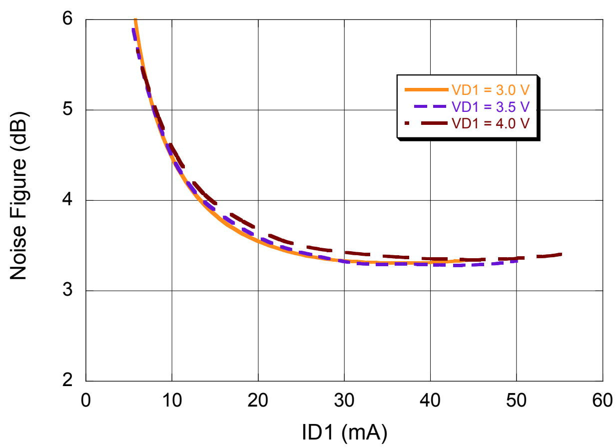


Noise Figure, IF = 3.5 GHz

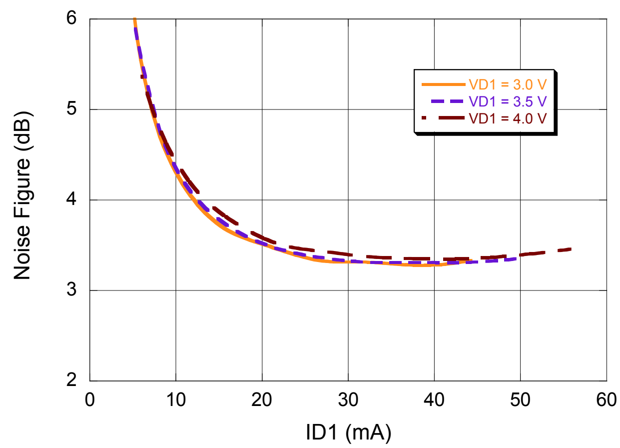


Typical Performance Curves: LO = 4 dBm, IF = 150 MHz, P_{DC} = 0.84 W

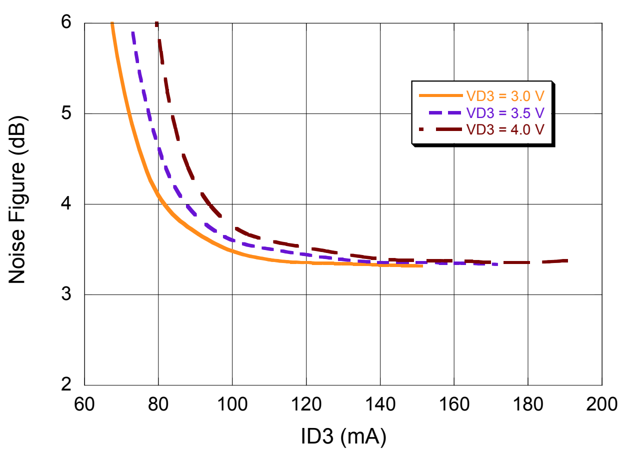
Noise Figure @ 37 GHz



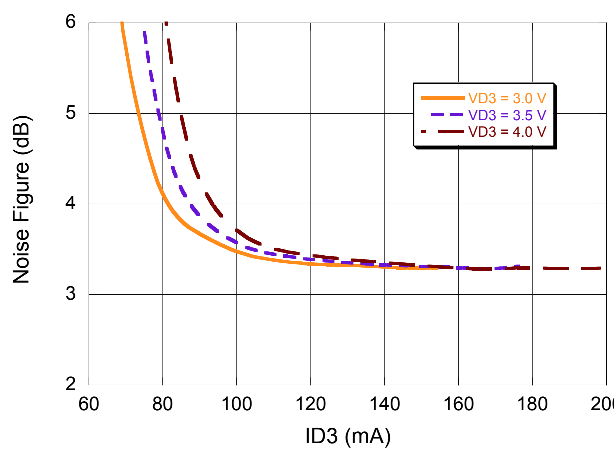
Noise Figure @ 40 GHz



Noise Figure @ 37 GHz



Noise Figure @ 40 GHz



Typical Performance Curves: LO = 4 dBm, RF = -20 dBm @ 50 MHz IF, P_{DC} = 0.84 W

Image Rejection

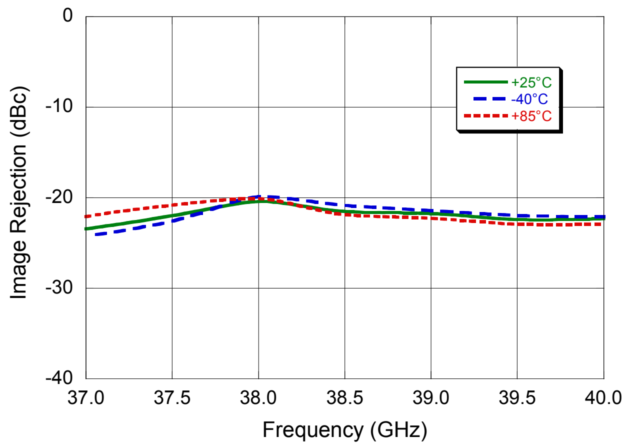


Image Rejection, LO Power swept

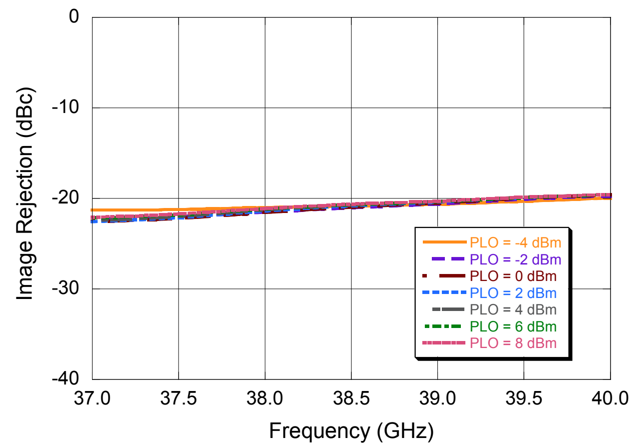


Image Rejection, IF = 2 GHz

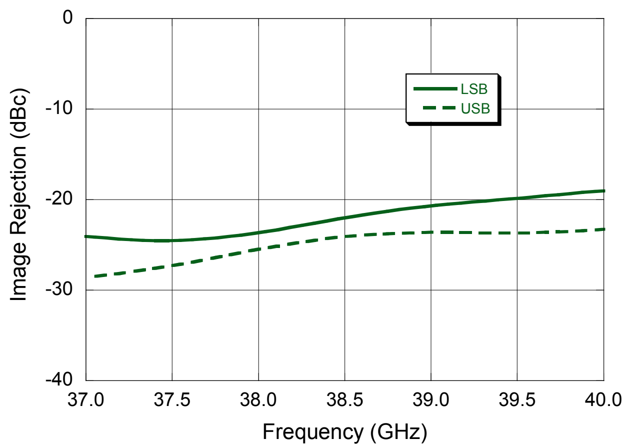
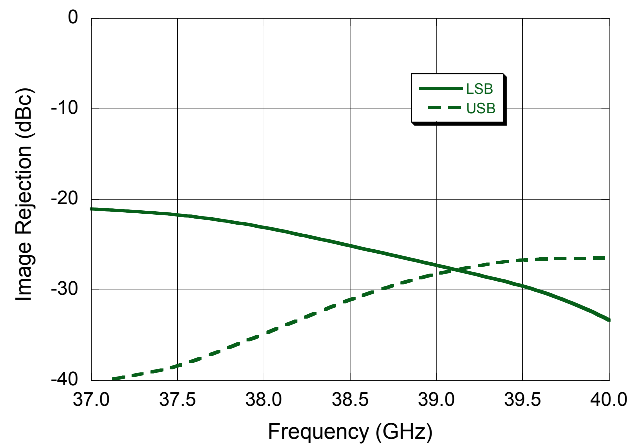
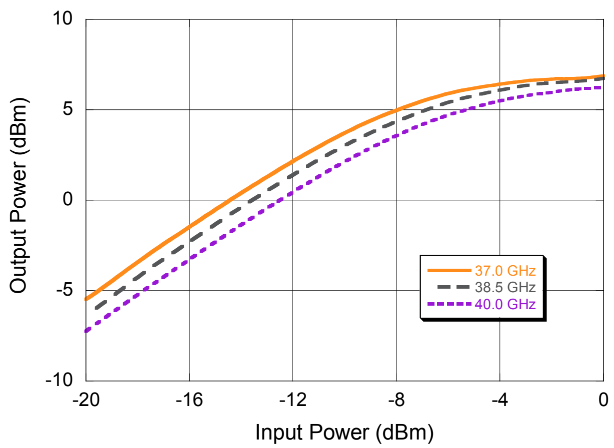


Image Rejection, IF = 3.5 GHz

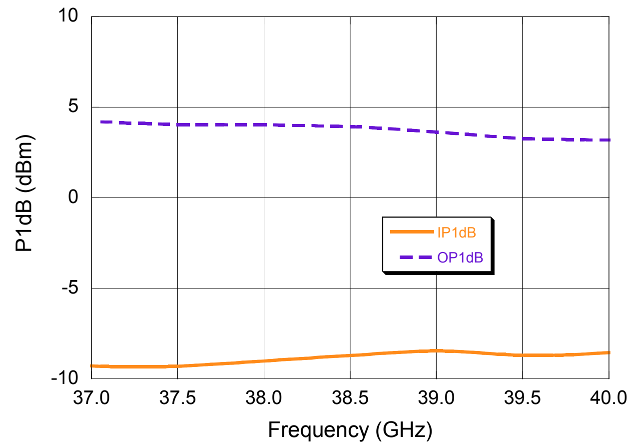


Typical Performance Curves: LO = 4 dBm, RF = -20 dBm @ 50 MHz IF, P_{DC} = 0.84 W

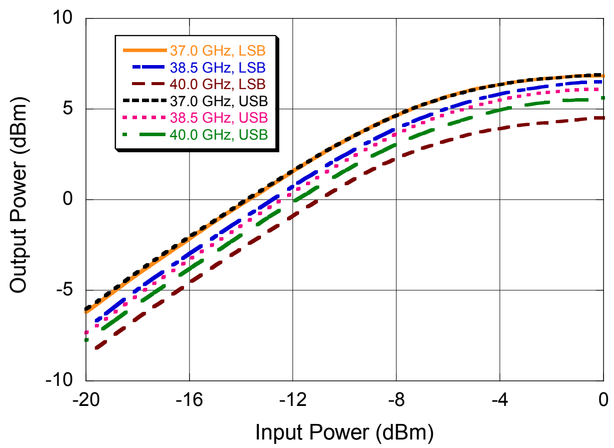
P_{OUT} vs. P_{IN}



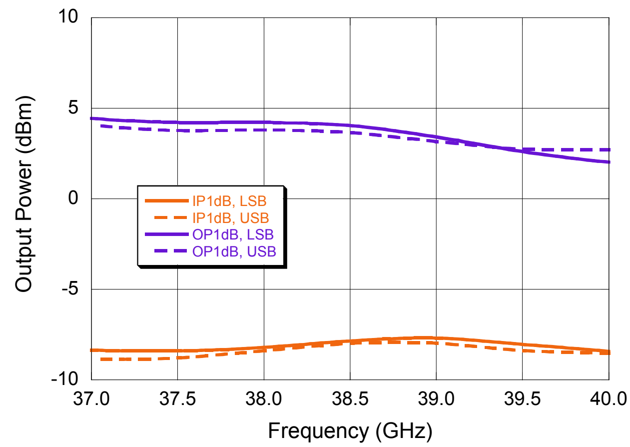
P1dB, Input & Output



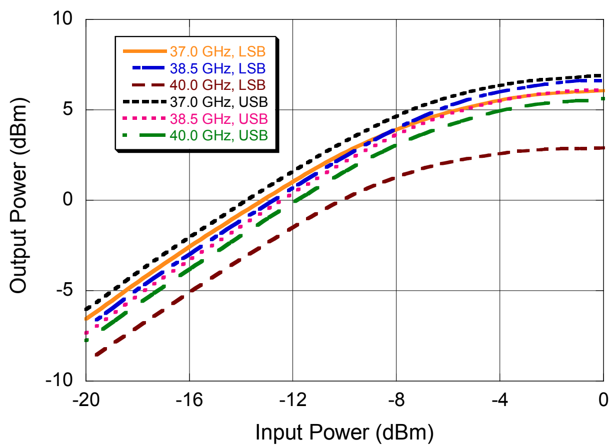
P_{OUT} vs. P_{IN}, IF = 2 GHz



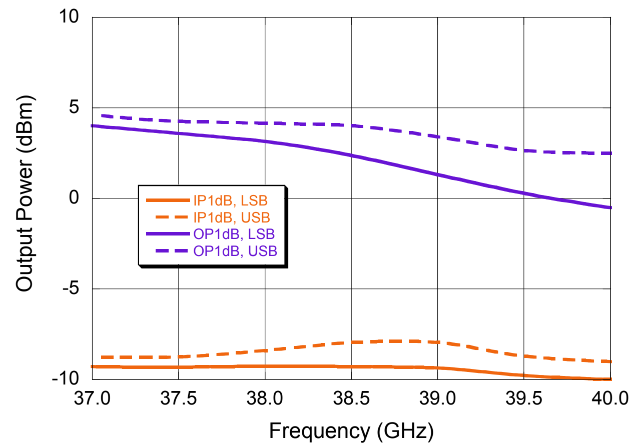
P1dB, Input & Output, IF = 2 GHz



P_{OUT} vs. P_{IN}, IF = 3.5 GHz

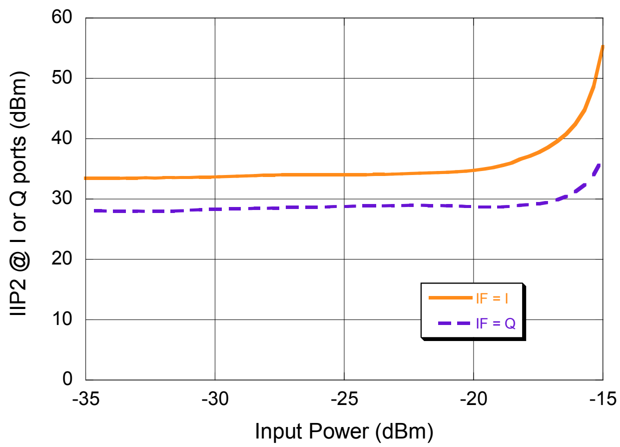


P1dB, Input & Output, IF = 3.5 GHz

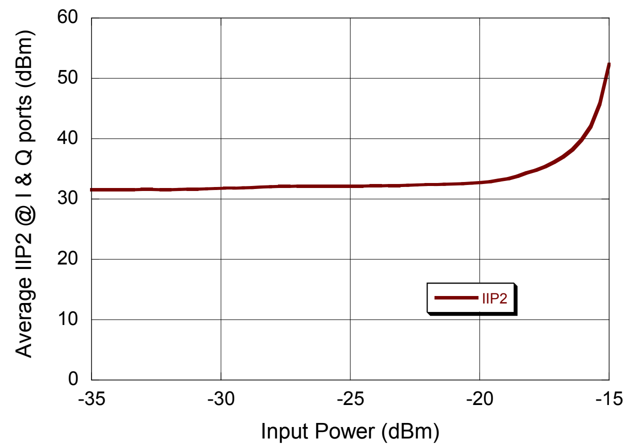


Typical Performance Curves: LO = 4 dBm, IF1 = 41 MHz, IF2 = 53 MHz, P_{DC} = 0.84 W

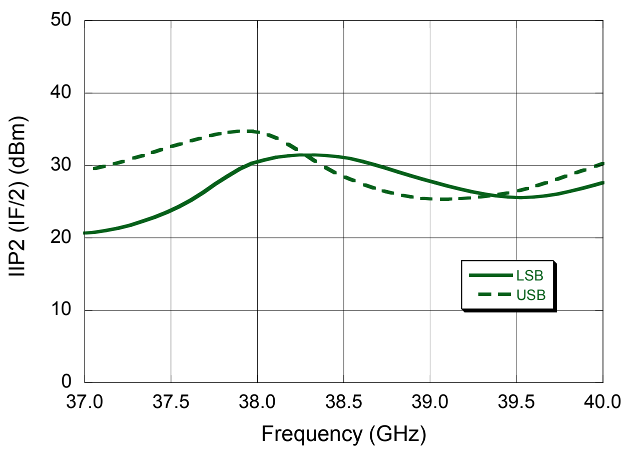
Two-Tones Input IP2 @ I - I* Ports or Q - Q* Ports



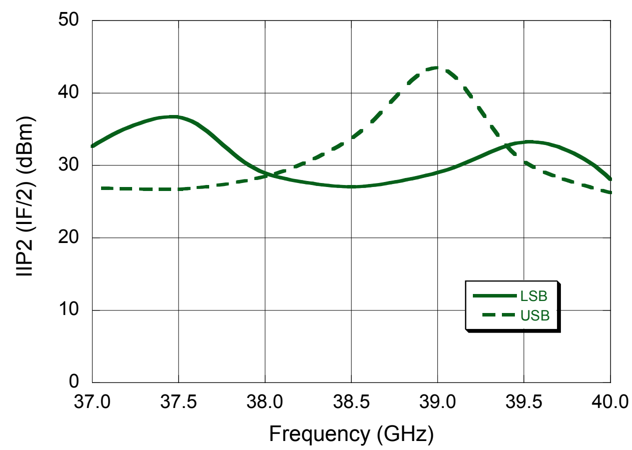
Average Two-Tones IIP2 @ I - I* Ports or Q - Q* Ports



Input IP2 (IF/2), IF = 2 GHz

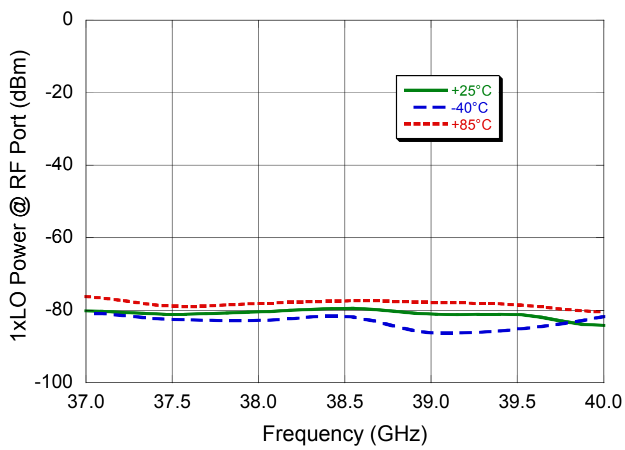


Input IP2 (IF/2), IF = 3.5 GHz

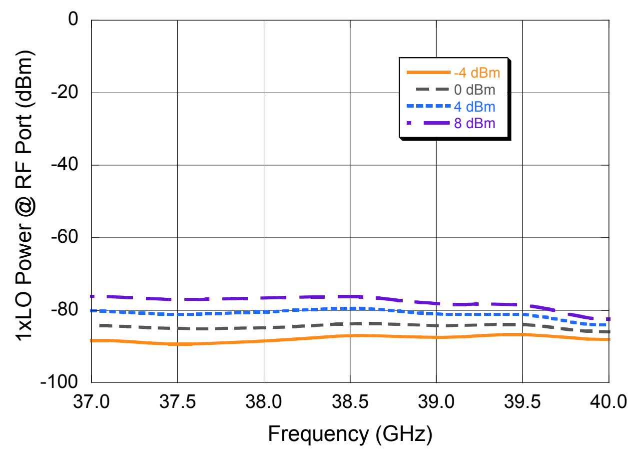


Typical Performance Curves: LO = 4 dBm, P_{DC} = 0.84 W

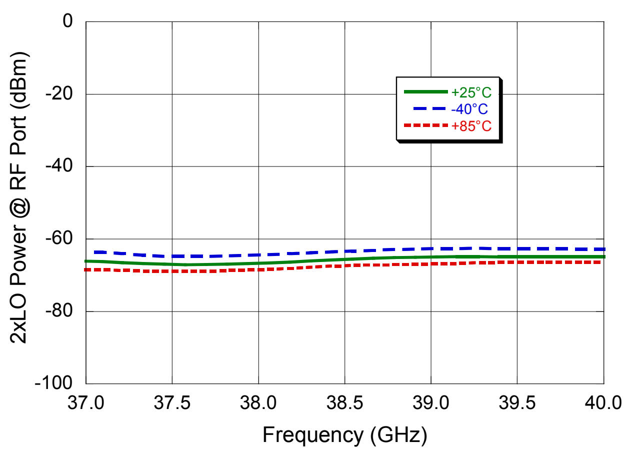
1xLO Leakage @ RF Port



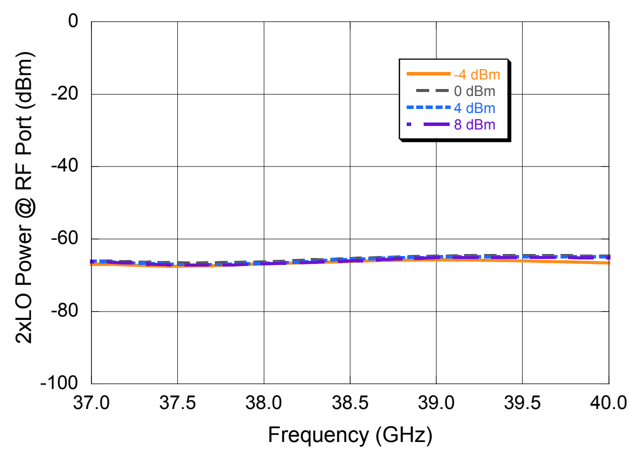
1xLO Leakage @ RF Port, LO Power swept



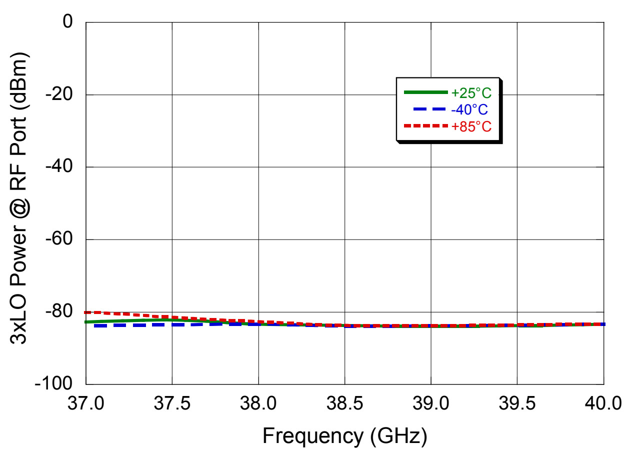
2xLO Leakage @ RF Port



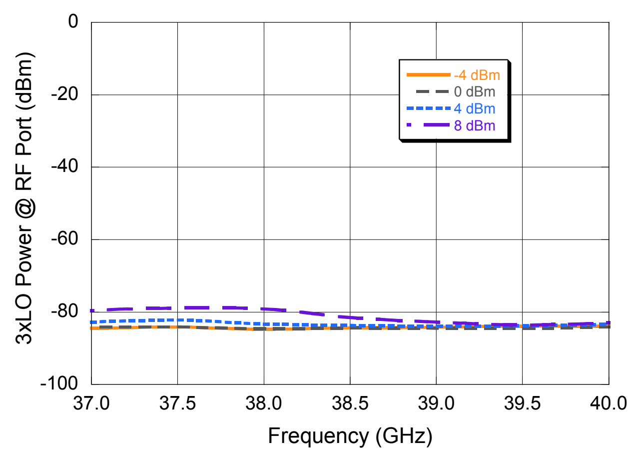
2xLO Leakage @ RF Port, LO Power swept



3xLO Leakage @ RF Port

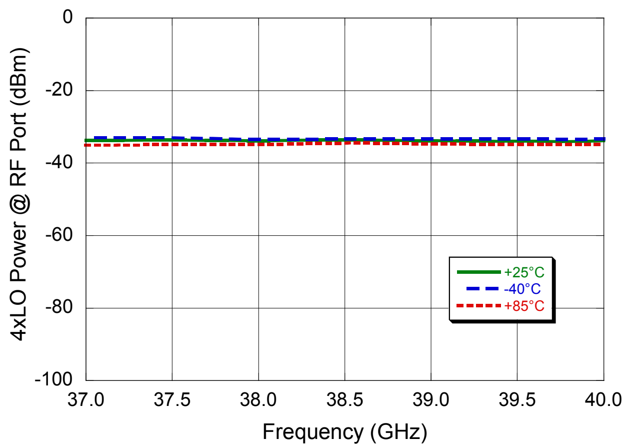


3xLO Leakage @ RF Port, LO Power swept

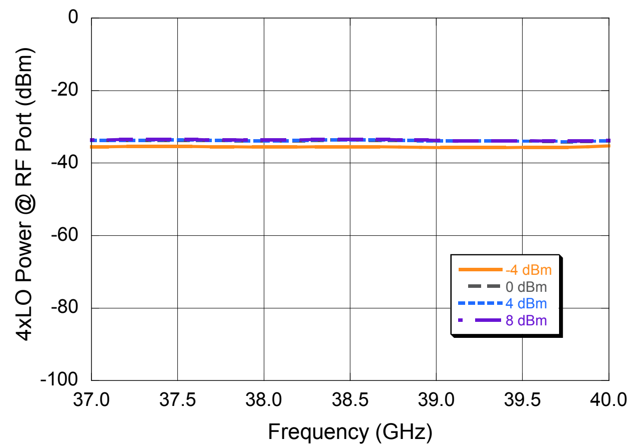


Typical Performance Curves: LO = 4 dBm, P_{DC} = 0.84 W

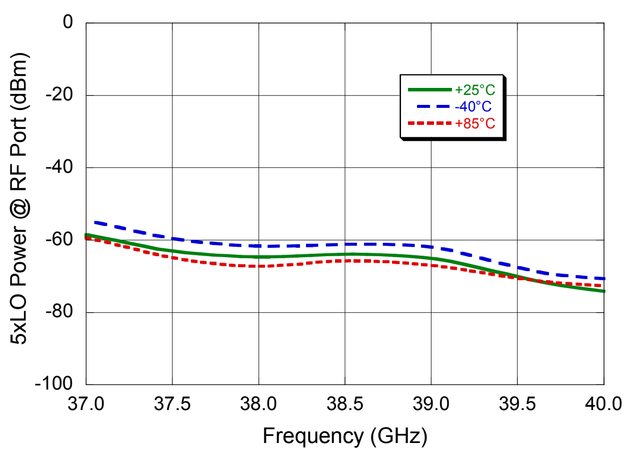
4xLO Leakage @ RF Port



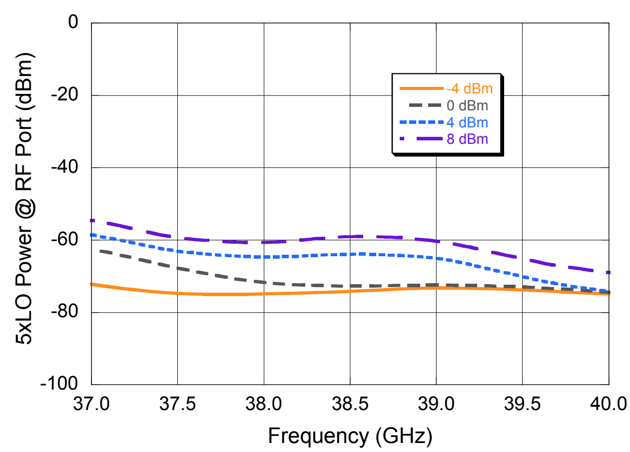
4xLO Leakage @ RF Port, LO Power swept



5xLO Leakage @ RF Port

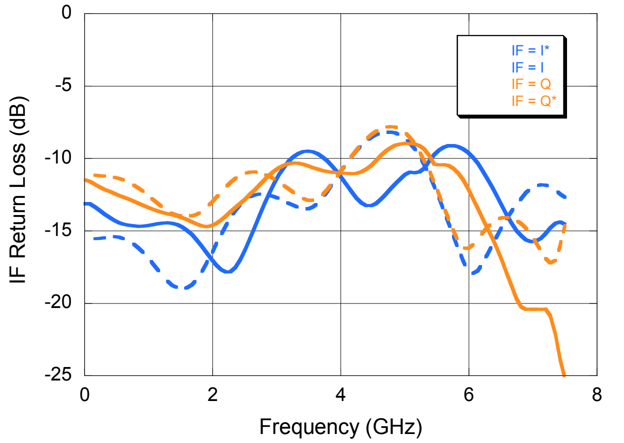


5xLO Leakage @ RF Port, LO Power swept

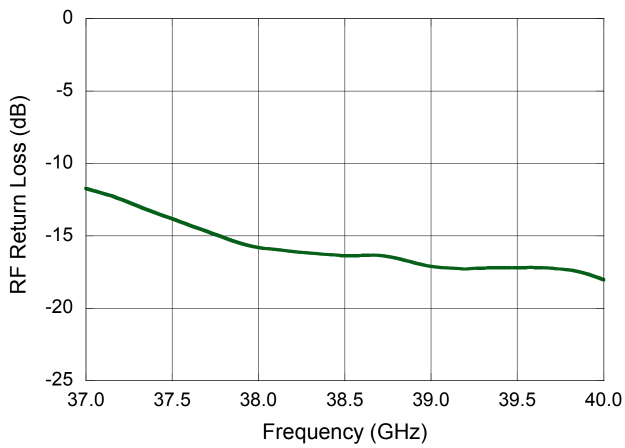


Typical Performance Curves:

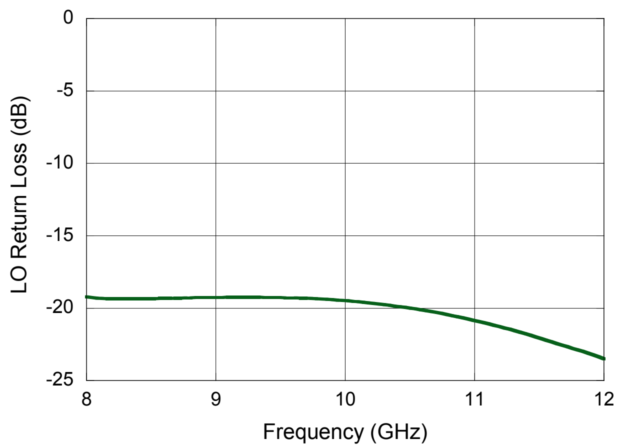
IF Return Loss



RF Return Loss



LO Return Loss

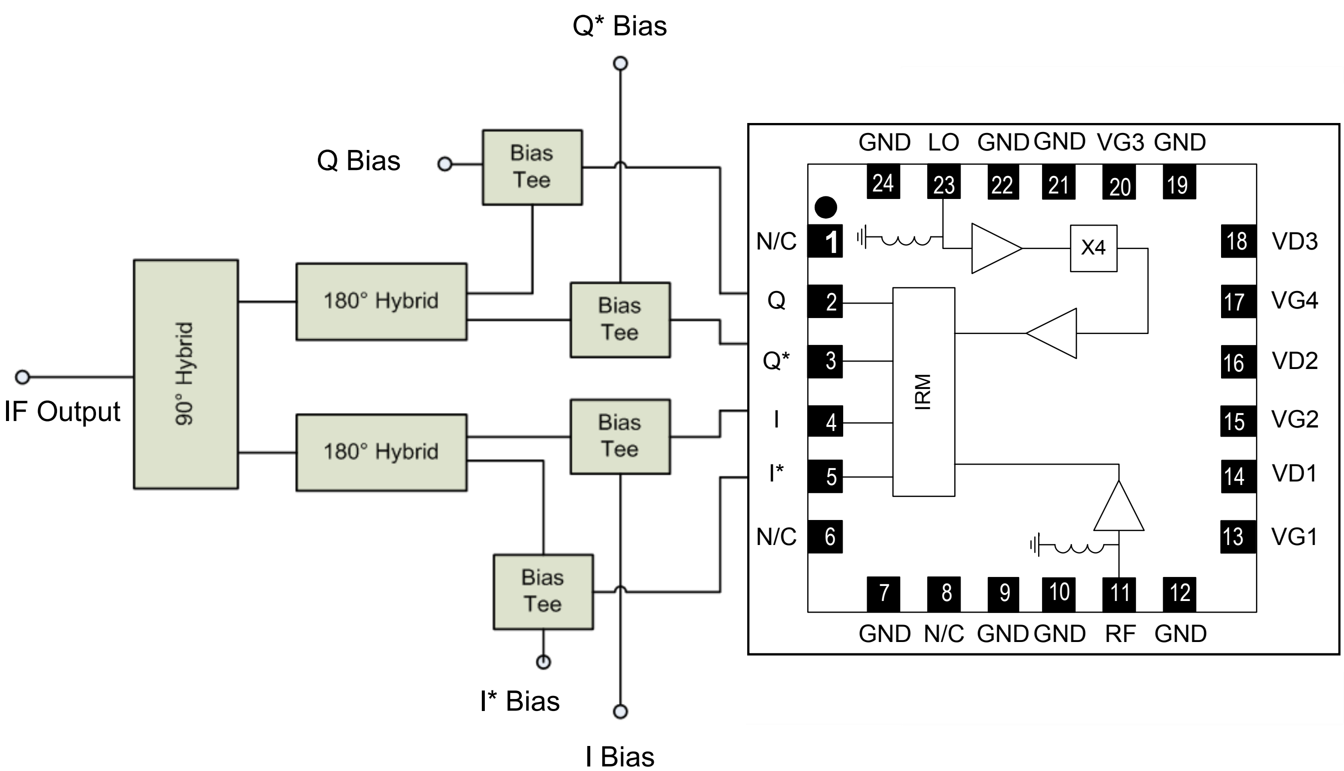


App Note [1] Biasing

MADC-011010 is operated by biasing V_D1, V_D2 and V_D3 at +3.0 V. The corresponding drain currents are set to 30 mA, 100 mA and 150 mA respectively. V_G4 requires a fixed voltage bias of nominally -2.5 V and all IF to be biased at +0.3 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 Outputs

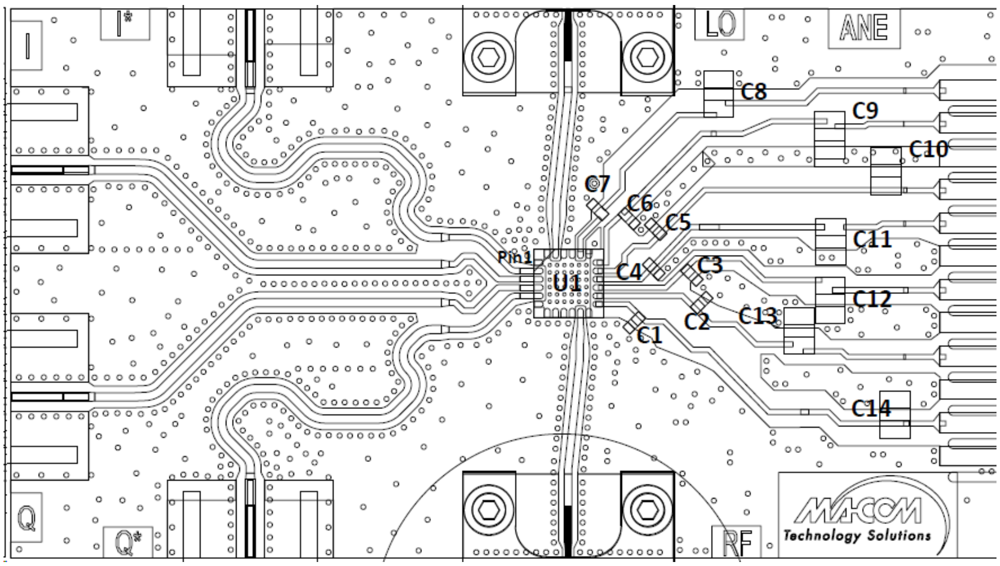
For highest gain, best image rejection and lowest noise figure all 4 IF ports should be used. I/I* and Q/Q* will be combined through two 180° hybrid couplers generating inphase and quadrature phase components. Inphase and quadrature signals then need to be combined through 90° hybrid combiner to create IF output. 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 μF on each of the bias lines are recommended placed a distance further away.

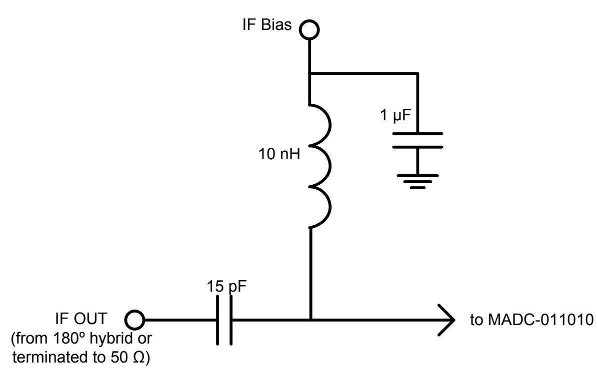
Recommended Board Layout



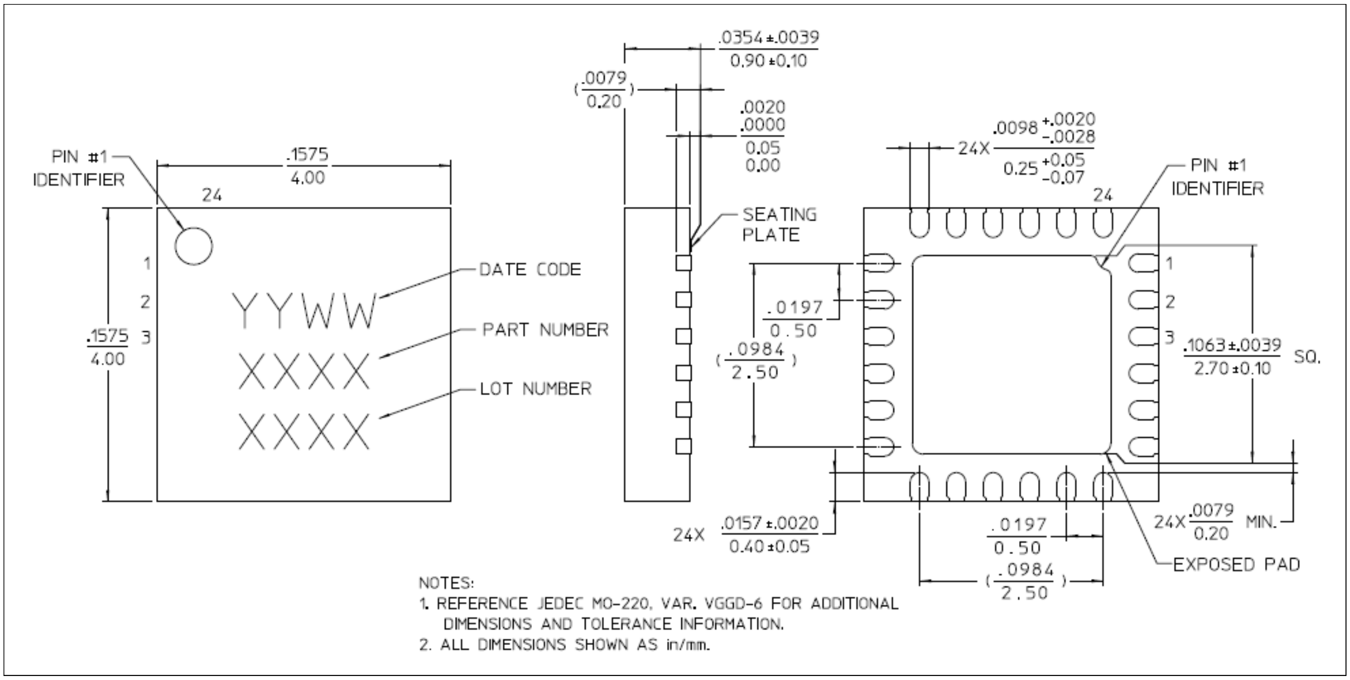
App Note [4] IF Bias

To obtain optimum OIP3 performance, it is required to apply DC bias of + 0.3 V on each of the IF inputs (I, Q, I*, Q*). This can be 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. Before applying a

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.