MAAL-011130

Broadband Low Noise Amplifier
2 - 18 GHz

Rev. V1

Features

- Gain: 21 dB @ 10 GHz
- Noise Figure: 1.4 dB @ 10 GHz
- Output P1dB: 14 dBm
- Single Voltage Bias: 3.3 V to 5 V
- Power Down Capability
- Lead-Free 2 mm 8-lead PDFN Package
- Halogen-Free "Green" Mold Compound
- RoHS* Compliant

Description

The MAAL-011130 is an easy-to-use, broadband, low noise amplifier with 19 dB typical gain from 2 to 18 GHz. The input and output are fully matched to 50 Ω with typical return loss >10 dB. Third order linearity (OIP3) is typically 23 dBm and reverse isolation is >35 dB.

Single voltage (V_{DD} from +3.3 V to +5 V) operation is achieved using an external resistor, R_B, between pin 4 and V_{DD}. The value of R_B will set the drain current. Alternatively, the application of a bias voltage (V_B) to pin 4 allows for the adjustment of drain current from 5 mA to 80 mA and provides power down capability, achieved by applying V_B <0.2 V. See biasing information on pages 3 and 4.

The MAAL-011130 is housed in a lead-free 2 mm 8–lead PDFN package compatible with standard pick and place assembly equipment.

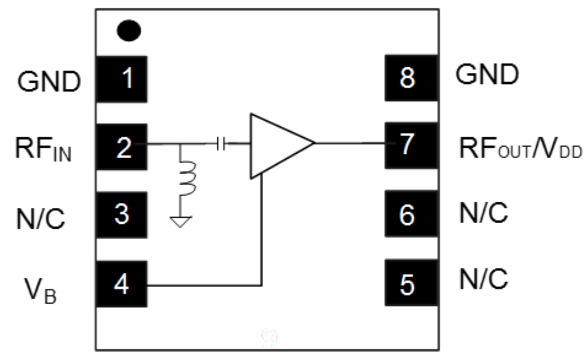
The MAAL-011130 is well suited to multiple applications such as X-Band satellite communication receivers and wideband A&D systems.

Ordering Information[1,2]

Part Number	Package
MAAL-011130	Bulk
MAAL-011130-TR3000	3000 piece reel
MAAL-011130-SMB	Sample Board

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

Functional Schematic



Pin Configuration[3,4]

Pin No.	Pin Name	Description
1	GND	DC + RF ground
2	RF_{IN}	RF input
3	N/C	No connection
4	V_B	Bias control voltage
5	N/C	No connection
6	N/C	No connection
7	RF_{OUT} / V_{DD}	RF output and V_{DD}
8	GND	DC + RF ground
	Paddle	DC + RF ground

3. MACOM recommends connecting unused package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF and DC ground.

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

Electrical Specifications: $T_A = +25°C$, $V_{DD} = 5$ V, $V_B = 0.9$ V[5], $Z_0 = 50\ \Omega$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	2 GHz 6 GHz 10 GHz 14 GHz 18 GHz	dB	19	27 23 21 19 14	—
Output P1dB	2 GHz 6 GHz 10 GHz 14 GHz 18 GHz	dBm	—	12 13 14 15 15	—
Noise Figure	2 GHz 6 GHz 10 GHz 14 GHz 18 GHz	dB	—	2.1 1.2 1.4 1.8 2.9	1.8
Output IP3	P_{IN} = -22 dBm/tone (10 MHz Tone Spacing) 2 GHz 6 GHz 10 GHz 14 GHz 18 GHz	dBm	—	18 20 24 25 24	—
Input Return Loss	P_{IN} = -20 dBm	dB	—	10	—
Output Return Loss	P_{IN} = -20 dBm	dB	—	10	—
Isolation	P_{IN} = -20 dBm	dB	—	35	—
Bias Current	—	mA	—	76	90

5. For single voltage operation, refer to typical R_B values and biasing information on pages 3 and 4.

Absolute Maximum Ratings[6,7]

Parameter	Absolute Maximum
Input Power	10 dBm
Operating Voltage	7 V
Operating Temperature	-40 °C to +85 °C
Storage Temperature	-65 °C to +150 °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 $T_J \le +150°C$ will ensure MTTF > 1×10^6 hours.
9. Junction Temperature (T_J) = T_C + Ɵjc * (V * I).
   Typical thermal resistance (Ɵjc) = 126°C/W.
   a) T_C = +25°C,
      T_J = 76°C @ 5 V, 80 mA
   b) T_C = +85°C,
      T_J = 136°C @ 5 V, 80 mA

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these Class 1A devices.

Application Information

The MAAL-011130 is designed for simple implementation with high performance. The ultra small size, fully matched, and simple bias application allows easy placement on system boards. It has a shunt inductor connected to ground on the input for ESD protection. For this reason, an input DC blocking capacitor is required if DC voltage is present on the input.

Bias Adjust Using V_B

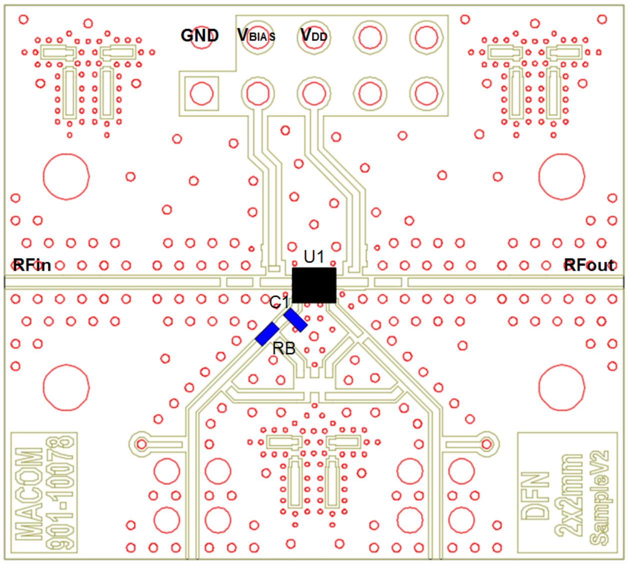
Pin 4 can be connected to a separate voltage source to achieve the desired I_{DD}. The amplifier will be powered down by applying a V_B of 0.2 V or less.

The following tables show typical total drain current ($I_{D\_TOTAL} = I_{D\_BIAS} + I_{DD}$, where I_{D_BIAS} is the current drawn by the V_B pin and I_{DD} is the drain current) versus bias voltage (V_B) values for V_{DD} voltages of 5.0 V and 3.3 V. Also shown in each case is a typical value of R_B required to set I_{DD} if using a single supply (see Single Bias Operation information on page 4).

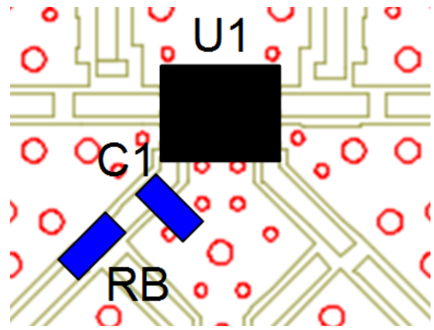
V_{DD} = 3.3 V				
V_B (V)	I_{D_TOTAL} (mA)	I_{D_BIAS} (mA)	I_{DD} (mA)	R_B (kΩ)
0.6	32.9	1.2	31.7	2.2
0.7	44.9	2.3	42.6	1.1
0.8	56.7	3.5	53.3	0.7
0.9	67.4	4.6	62.8	0.5
1.0	76.4	5.8	70.5	0.4

V_{DD} = 5 V				
V_B (V)	I_{D_TOTAL} (mA)	I_{D_BIAS} (mA)	I_{DD} (mA)	R_B (kΩ)
0.6	40	1.1	39	4.0
0.7	53	2.3	50	1.9
0.8	65	3.4	62	1.3
0.9	77	4.5	73	0.9
1.0	89	5.8	83	0.7

Sample PCB



Sample PCB layout



Single Bias Operation

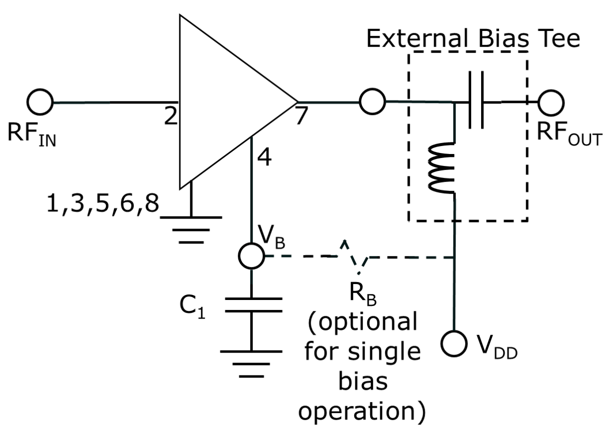
Connecting V_{DD} to pin 4 using an external resistor R_B enables single bias operation of the amplifier, where the value of external resistor R_B can be used to set the desired I_{DD}.

In this configuration, power down mode cannot be used unless a switch is included to connect V_B to ground.

Grounding

It is recommended that the total ground (common mode) inductance not exceed 0.03 nH (30 pH). This is equivalent to placing at least four 8-mil (200-µm) diameter vias under the device, assuming an 8-mil (200-µm) thick RF layer to ground.

Application Schematic

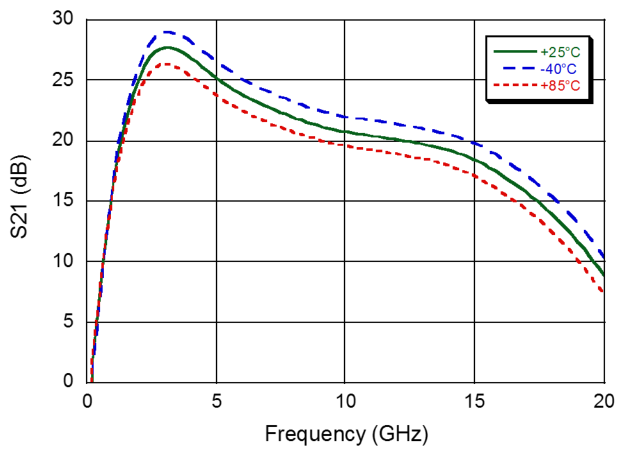


Parts List

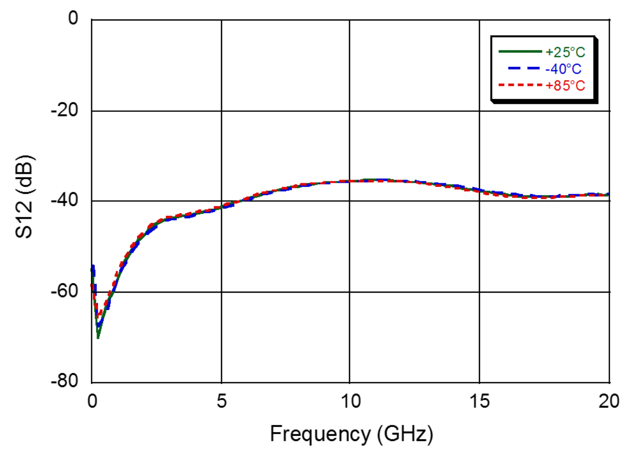
Des	Value	Size	Part Number	Purpose
C1	0.01 µF	0201	Murata GRM033R70J103KA01D	Bypass
U1	—	2 mm	MACOM MAAL-011130	LNA

Typical Performance Curves V_{DD} = 5 V, V_B = 0.9 V

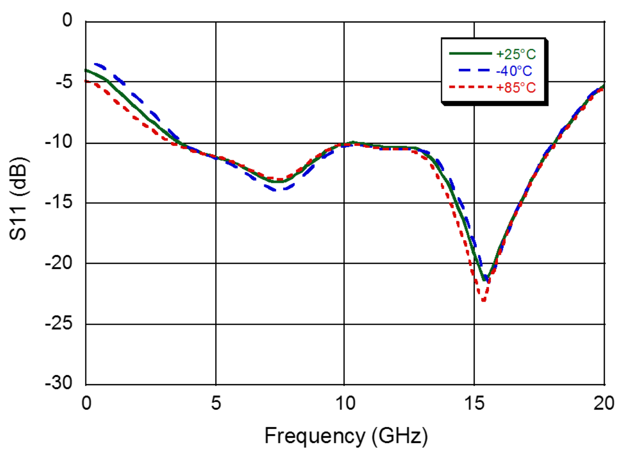
Gain



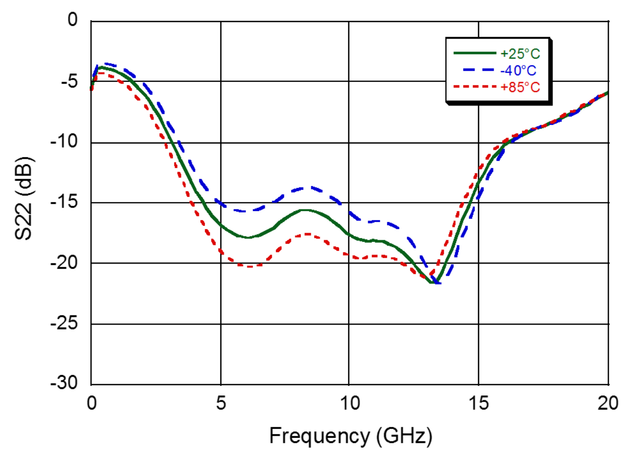
Isolation



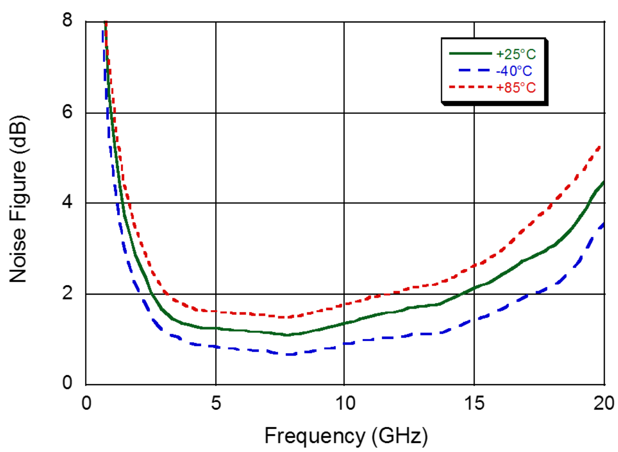
Input Return Loss



Output Return Loss

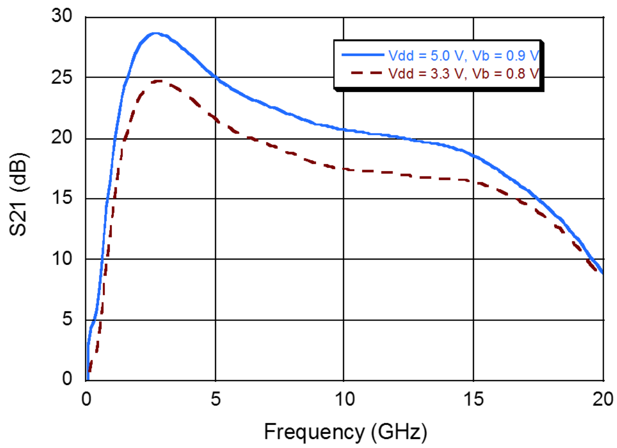


Noise Figure

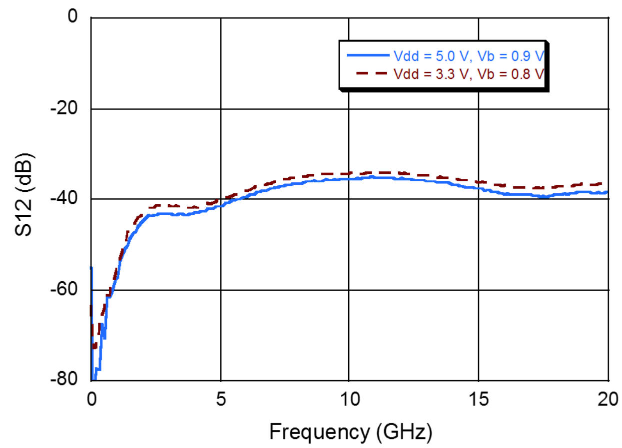


Typical Performance Curves T_A = 25°C, V_{DD} = 3.3 V & 5 V

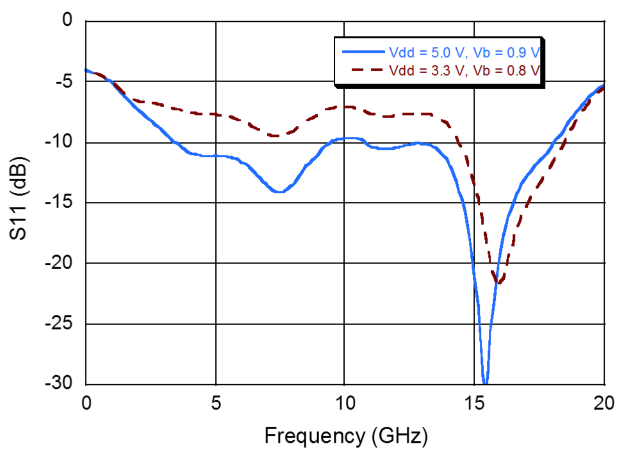
Gain



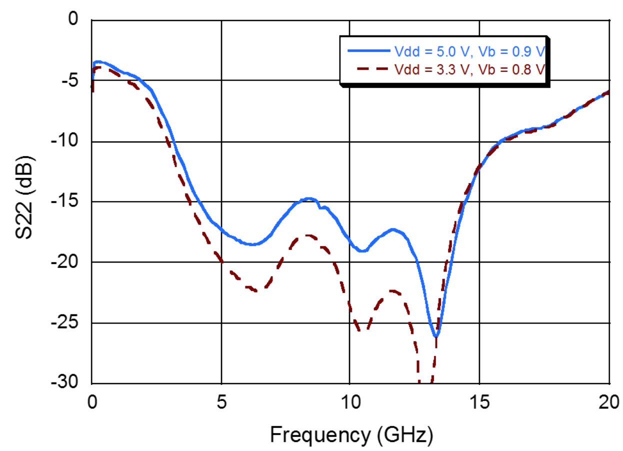
Isolation



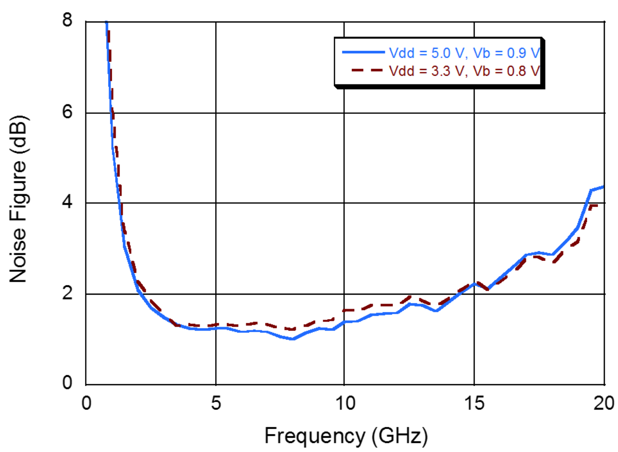
Input Return Loss



Output Return Loss

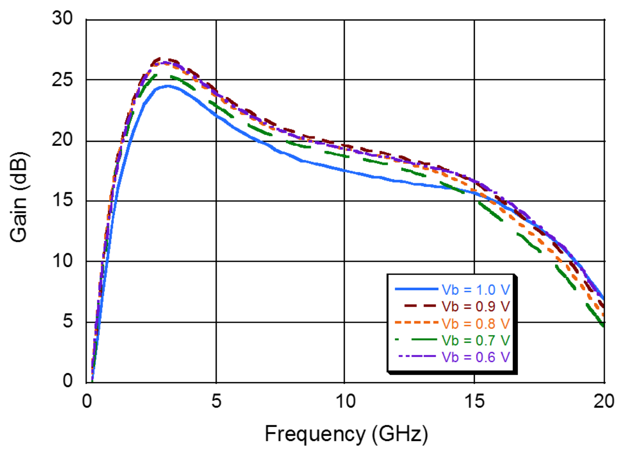


Noise Figure

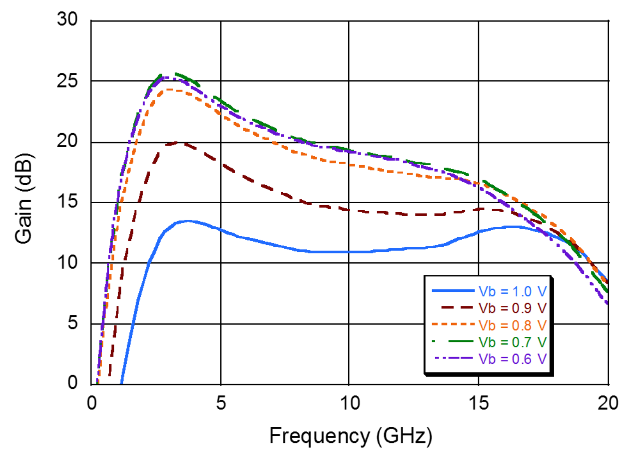


Typical Performance Curves T_A = 25°C, V_{DD} = 5 V & 3.3 V

Gain vs. V_B for V_{DD} = 5 V

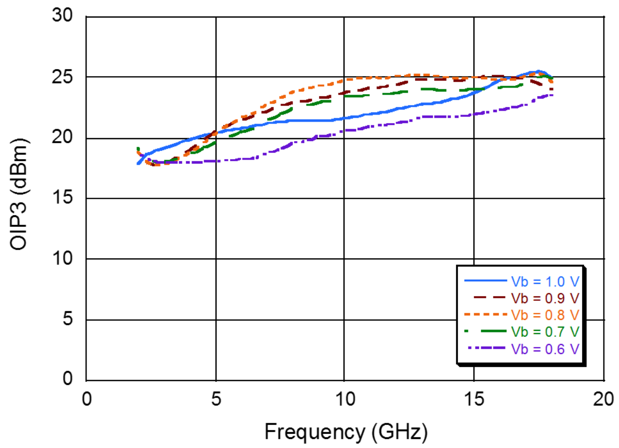


Gain vs. V_B for V_{DD} = 3.3 V

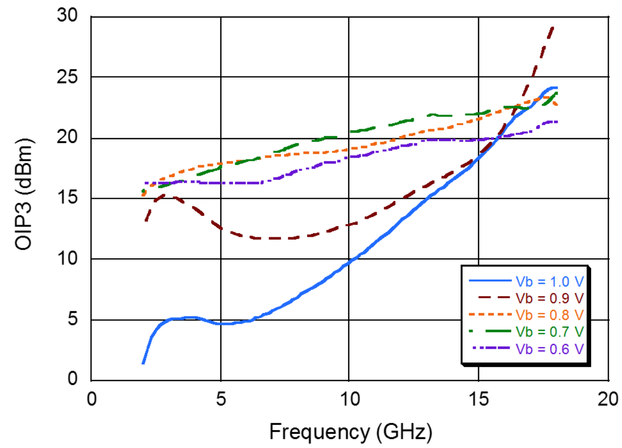


Typical Output IP3 Curves V_{DD} = 5 V and 3.3 V

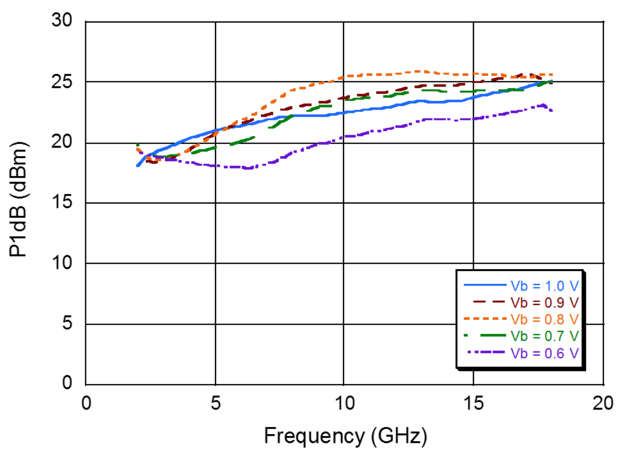
Output IP3 @ T_A = 25°C, V_{DD} = 5 V



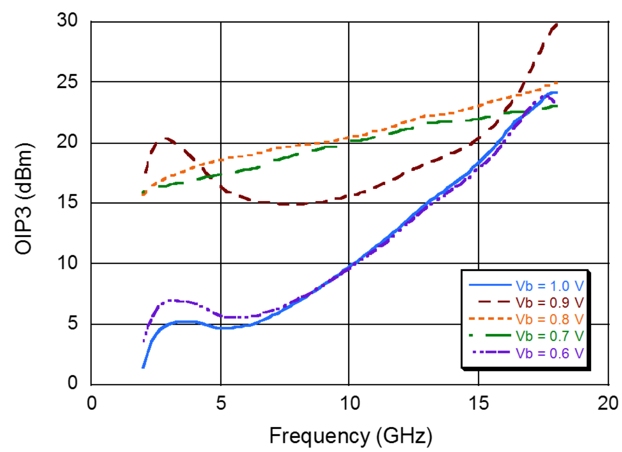
Output IP3 @ T_A = 25°C, V_{DD} = 3.3 V



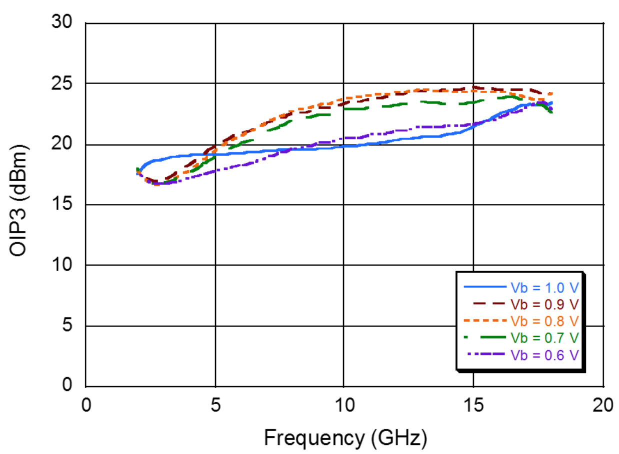
Output IP3 @ T_A = -40°C, V_{DD} = 5 V



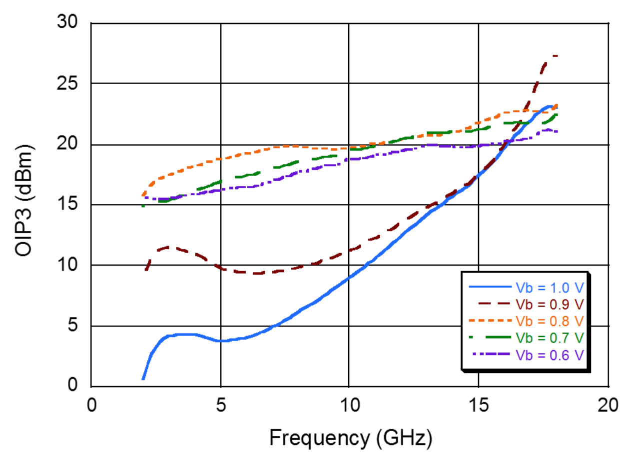
Output IP3 @ T_A = -40°C, V_{DD} = 3.3 V



Output IP3 @ T_A = 85°C, V_{DD} = 5 V

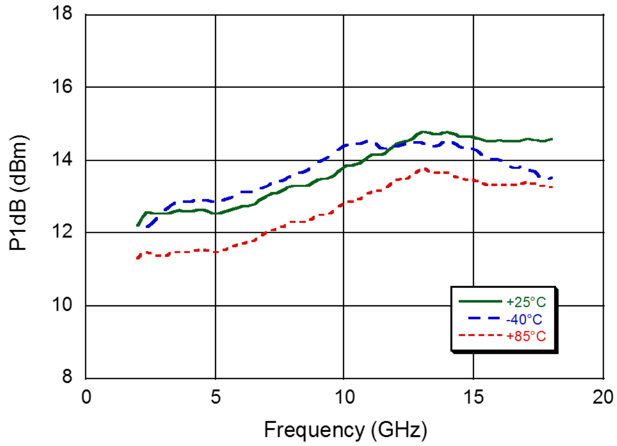


Output IP3 @ T_A = 85°C, V_{DD} = 3.3 V

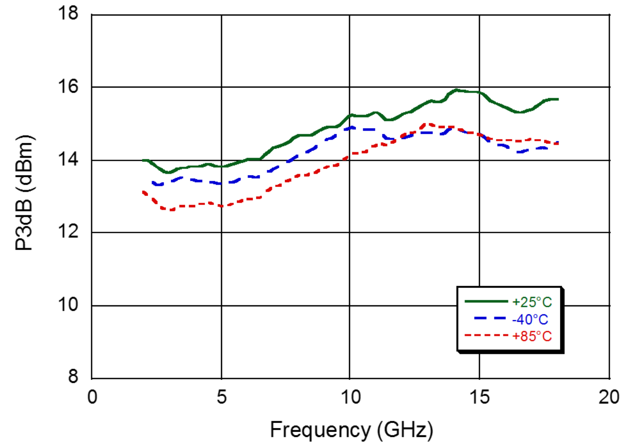


Typical P1dB and P3dB Curves V_{DD} = 5 V

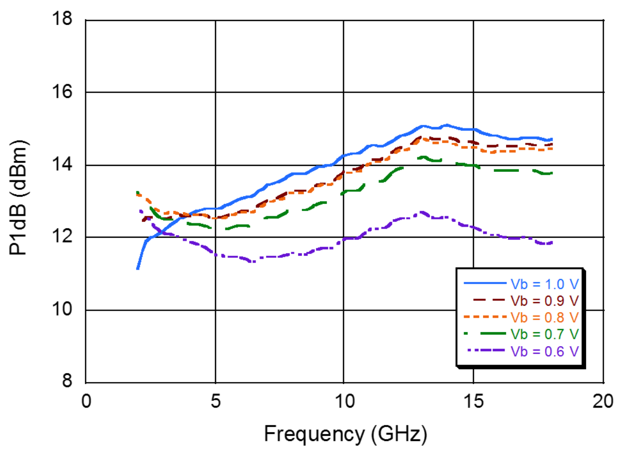
P1dB @ V_{DD} = 5 V, V_B = 0.9 V



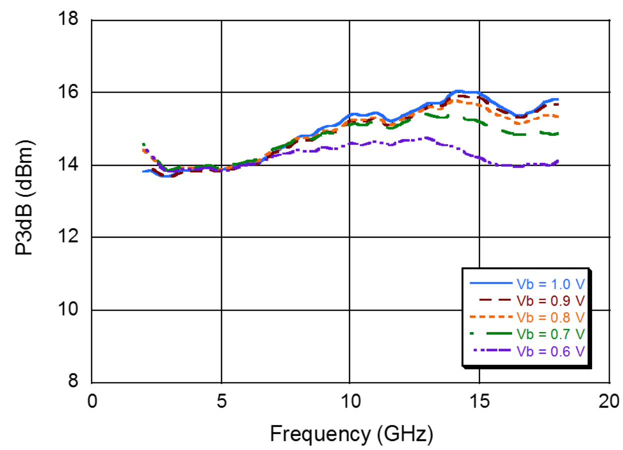
P3dB @ V_{DD} = 5 V, V_B = 0.9 V



P1dB @ T_A = 25°C, V_{DD} = 5 V

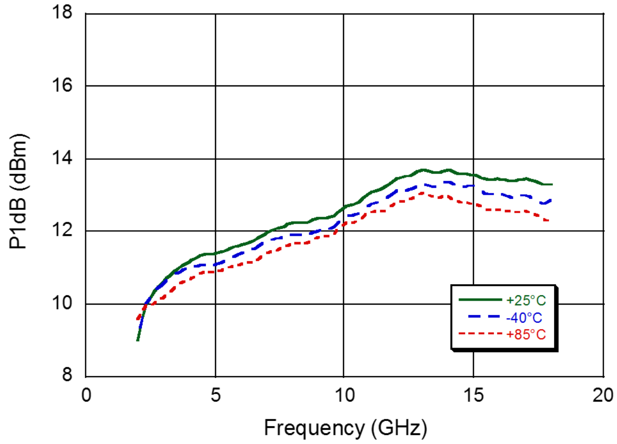


P3dB @ T_A = 25°C, V_{DD} = 5 V

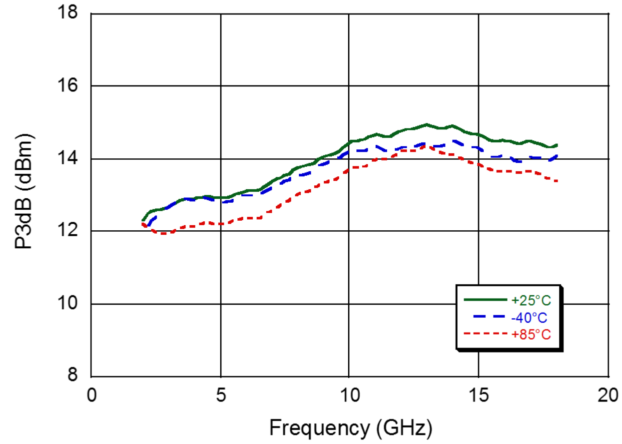


Typical P1dB and P3dB Curves V_{DD} = 3.3 V

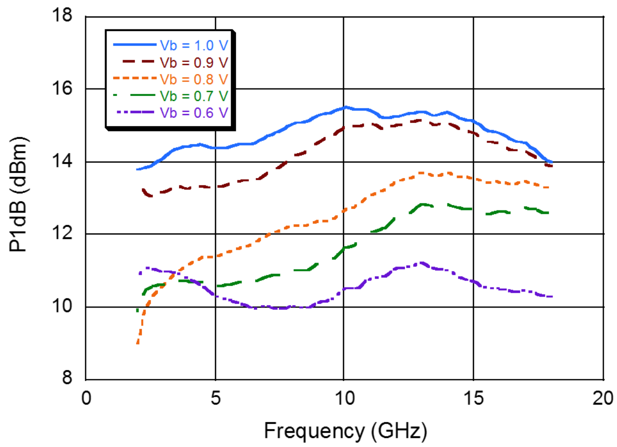
P1dB @ V_{DD} = 3.3 V, V_B = 0.8 V



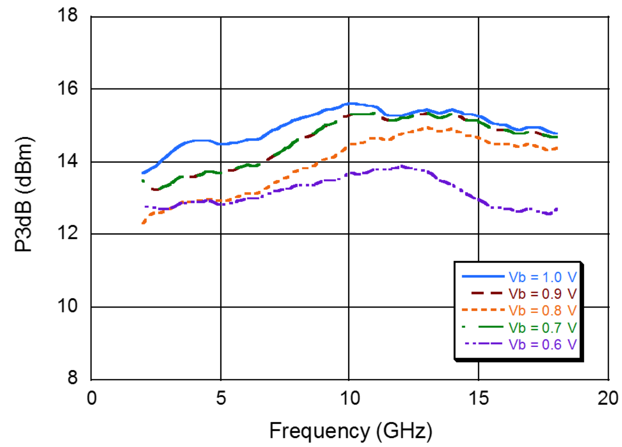
P3dB @ V_{DD} = 3.3 V, V_B = 0.8 V



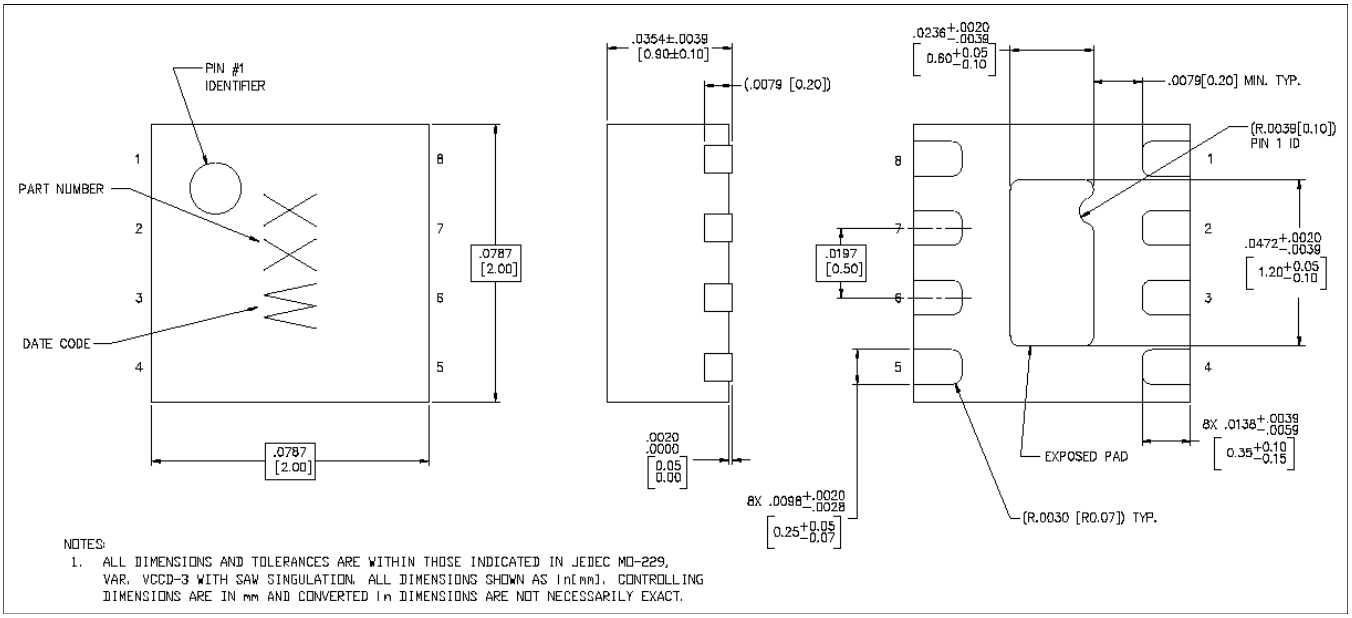
P1dB @ T_A = 25°C, V_{DD} = 3.3 V



P3dB @ T_A = 25°C, V_{DD} = 3.3 V



Lead-Free 2 mm 8-Lead PDFN†



† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is 100% matte tin over copper.