Features

- Wide Frequency Range: 20 - 45 GHz
- High Gain: 19 dB
- P1dB: 28.5 dBm
- P3dB: 30 dBm
- Bare Die
- RoHS* Compliant

Applications

- ISM/MM

Description

The MAAM-011291-DIE is a 4-stage, 1 W power amplifier MMIC die. This power amplifier operates from 20 to 45 GHz and provides 19 dB of linear gain, 1 W at P3dB compression, and 15% efficiency at P3dB while biased at 5 V.

This device can be used as a power amplifier ideally suited for 5G systems and test and measurement applications in the 20 to 45 GHz range.

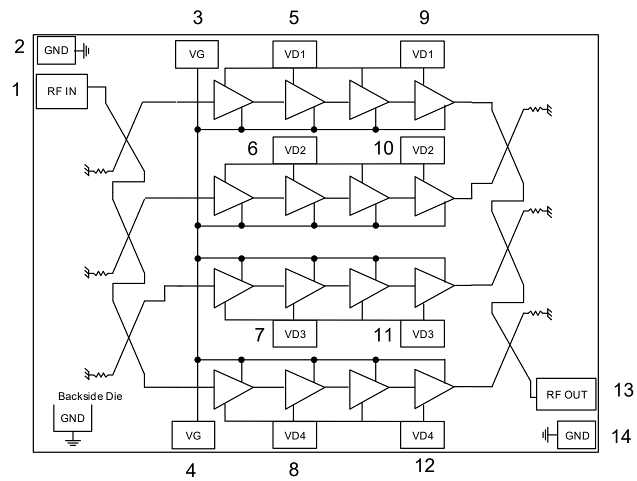
This product is fabricated using a GaAs pHEMT process which features full passivation for enhanced reliability.

All data is taken with the chip connected via three 1 mil diameter gold bond wires that are each approximately 350 µm long.

Ordering Information

Part Number	Package
MAAM-011291-DIE	Bare Die

Functional Schematic



Bond Pad Configuration[1]

Pad #	Pad Name	Description
1	RF IN	RF Input
2, 14	GND	Ground
3, 4	VG	Gate Voltage
5, 9	VD1	Drain Voltage 1
6, 10	VD2	Drain Voltage 2
7, 11	VD3	Drain Voltage 3
8, 12	VD4	Drain Voltage 4
13	RF OUT	RF Output

1. Backside of die must be connected to RF, DC and thermal ground.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

Electrical Specifications: Freq. = 20 - 45 GHz, T_A = +25°C, V_D = 5 V, I_{DSQ} = 1 A, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	P_{IN} = -10 dBm 20 GHz 30 GHz 39 GHz 45 GHz	dB	18.0 15.5 19.0 —	19.5 17.5 21.0 17.7	—
Input Return loss	—	dB	—	12	—
Output Return Loss	—	dB	—	12	—
P1dB	20 GHz 30 GHz 39 GHz 45 GHz	dBm	27 — 28 —	28 29 29 28	—
P3dB	20 GHz 30 GHz 39 GHz 45 GHz	dBm	—	30	—
OIP3	P_{OUT}/Tone = 14 dBm, Δf = 2 MHz	dBm	—	35	—
Drain Current	P3dB, 39 GHz	mA	—	1450	1800
Power Added Efficiency	P3dB, 39 GHz	%	—	15	—

Maximum Operating Ratings

Parameter	Rating
Input Power	P_{IN} ≤ 3dB Compression
Drain Voltage	4 to 6 V
Junction Temperature[2,3]	+160°C
Operating Temperature	-40°C to +85°C

2. Operating at nominal conditions with junction temperature ≤ +160°C will ensure MTTF > 1 x 10^6 hours.
3. Junction Temperature (T_J) = T_C + $Θ_{JC}$ * [(V * I) - (P_{OUT} - P_{IN})]. Typical thermal resistance ($Θ_{JC}$) = 5.1°C/W
   a) For T_C = +25°C
      T_J = 60.1°C @ 5 V, 1604 mA,
      P_{OUT} = 30.8 dBm, P_{IN} = 18 dBm
   b) For T_C = +85°C
      T_J = 115.1°C @ 5 V, 1341 mA,
      P_{OUT} = 29.3 dBm, P_{IN} = 17.6 dBm

Absolute Maximum Ratings[4,5]

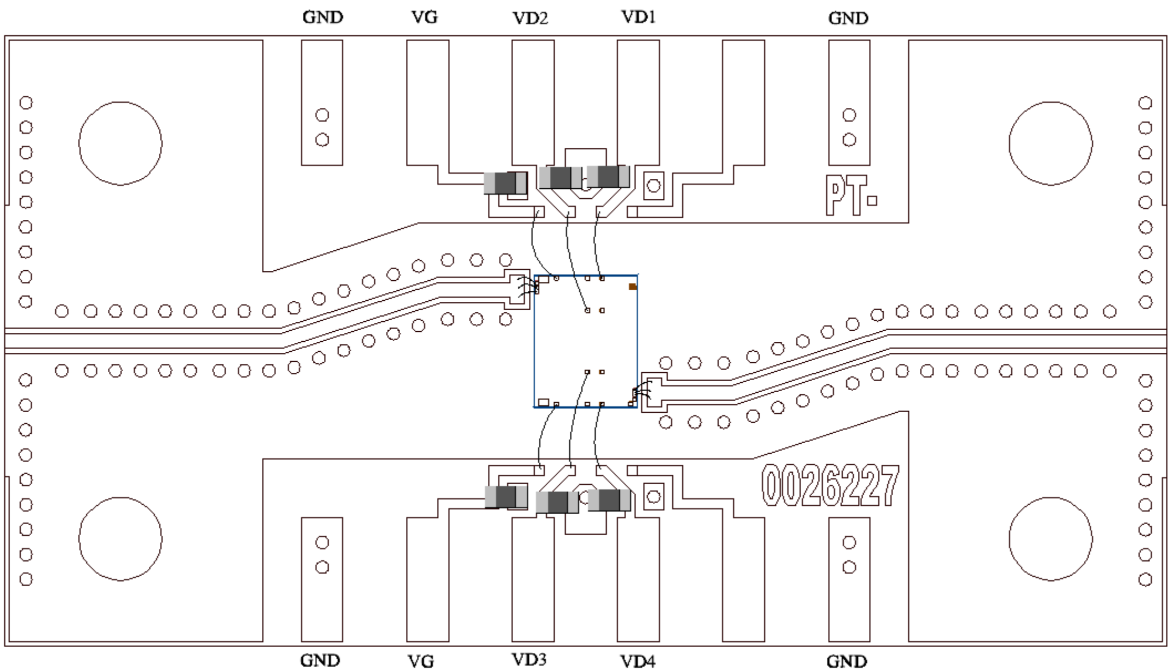
Parameter	Absolute Maximum
Input Power	23 dBm
Drain Voltage	6.5 V
Gate Voltage	-3 to 0 V
Junction Temperature[6]	+175°C
Storage Temperature	-65°C to +125°C

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Junction temperature directly effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

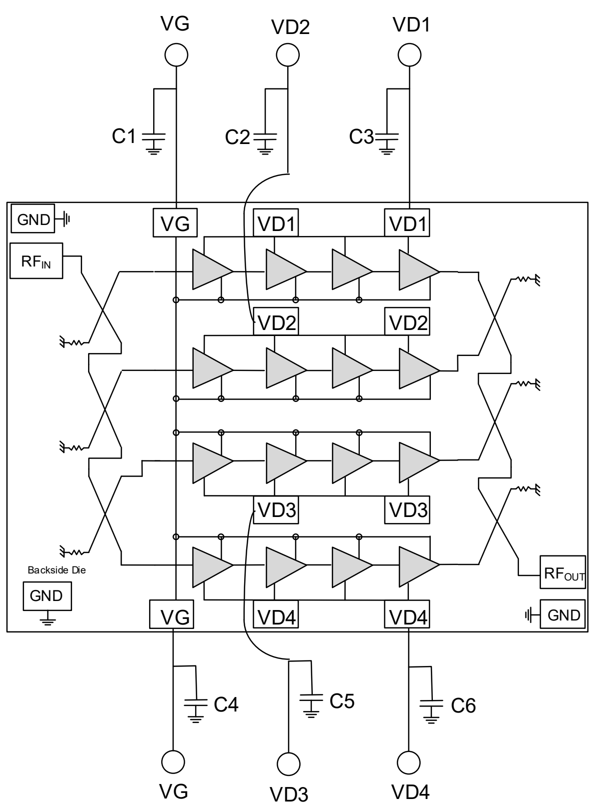
Handling Procedures
Please observe the following precautions to avoid damage:

Static Sensitivity
These electronics devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these 300 V HBM Class 1A devices.

Sample Board Layout



Application Schematic



Parts List

Part	Value	Case Style
C1 - C6	1 µF	0402

Sample Board Loss

Refer to the plot on page 9 for sample board loss.

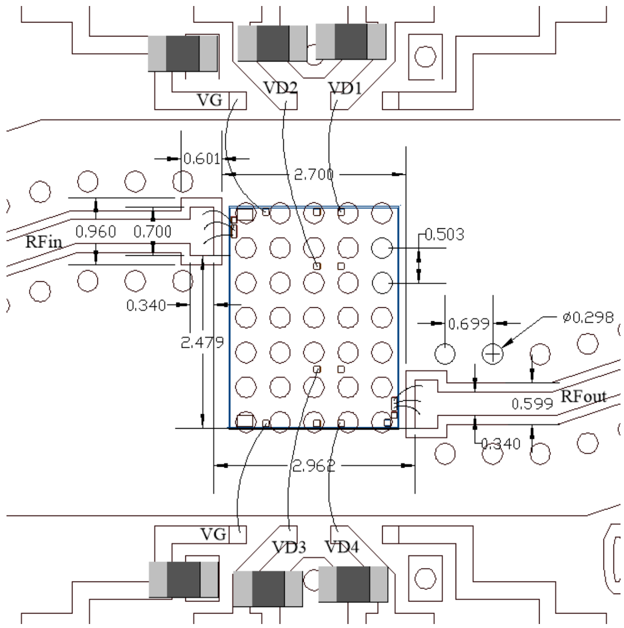
Sample Board Material Specifications

Top Layer: 1/2 oz Copper Cladding, 0.0175 mm thickness
Dielectric Layer: Rogers RO4003C 0.203 mm thickness
Bottom Layer: 1/2 oz Copper Cladding, 0.0175 mm thickness
Finished overall thickness: 0.238 mm

Recommended Bonding Diagram and PCB Details:

For optimum performance, RF input and output transmission lines require open stubs on the application board for bonding wire inductance compensation. The physical length for the 1 mil diameter gold wire is approximately 350 µm each for the three wire connection.

Use copper filled and plated over vias for the thermal, DC and RF ground vias.



Units are in mm.

Biasing Conditions

Recommended biasing conditions are V_D = 5 V, I_{DQ} = 1000 mA (controlled with V_G). The drain bias voltage range is 4 to 6 V, and the quiescent drain current biasing range is 800 to 1200 mA.

V_G pads 3 and 4 are internally connected; therefore, interconnection is not required. Muting can be accomplished by setting the V_G to the pinched off voltage (V_G = -2 V).

V_D bias must be applied to V_{D1} through V_{D4}. V_{D1} through V_{D4} supplies are not connected internally.

Operating the MAAM-011291-DIE

Turn-on

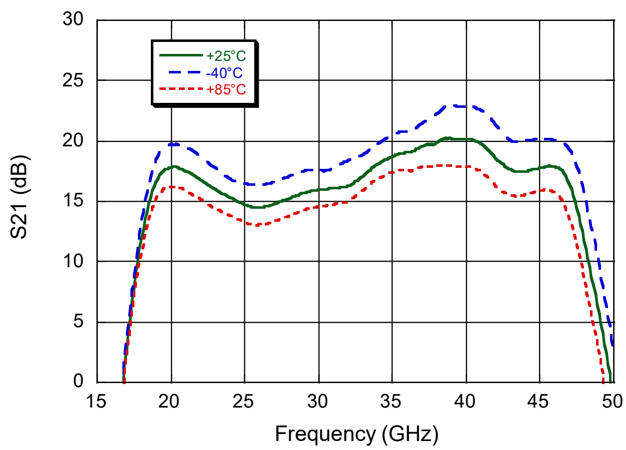
1. Apply V_G (-2 V).
2. Apply V_D (5.0 V typical).
3. Set I_{DQ} by adjusting V_G more positive (typically -0.9 to -1.0 V for I_{DQ} = 1 A).
4. Apply RF_{IN} signal.

Turn-off

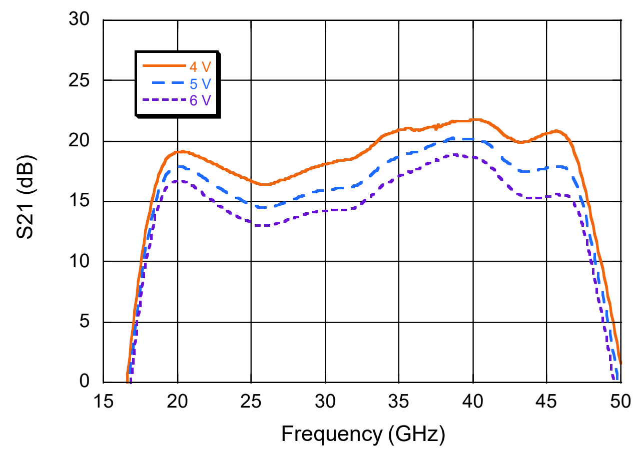
1. Remove RF_{IN} signal.
2. Decrease V_G to -2 V.
3. Decrease V_D to 0 V.

Typical Performance Curves: V_D = 5 V, I_{DSQ} = 1000 mA

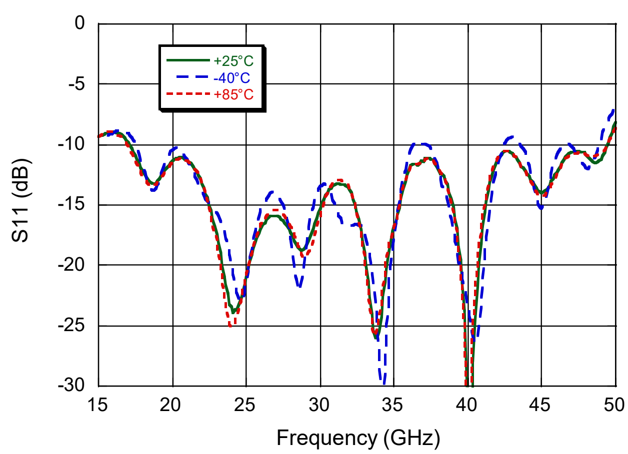
Small Signal Gain vs. Frequency



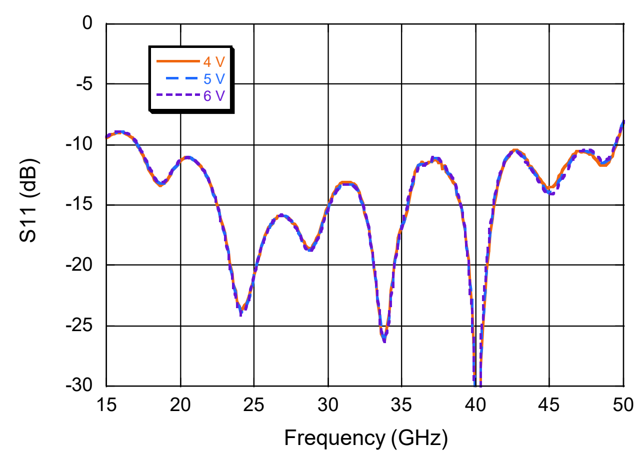
Small Signal Gain vs. Frequency



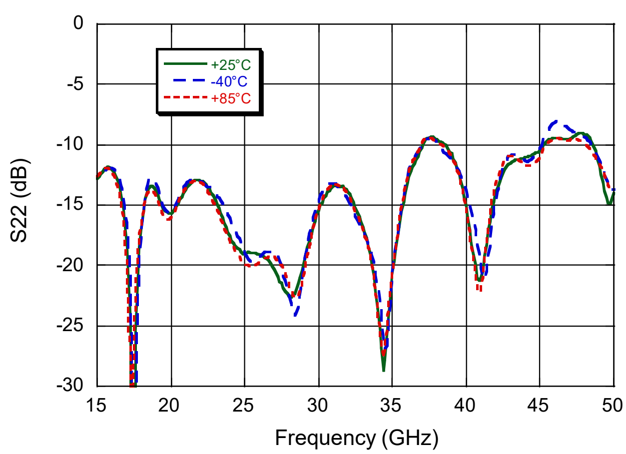
Input Return Loss vs. Frequency



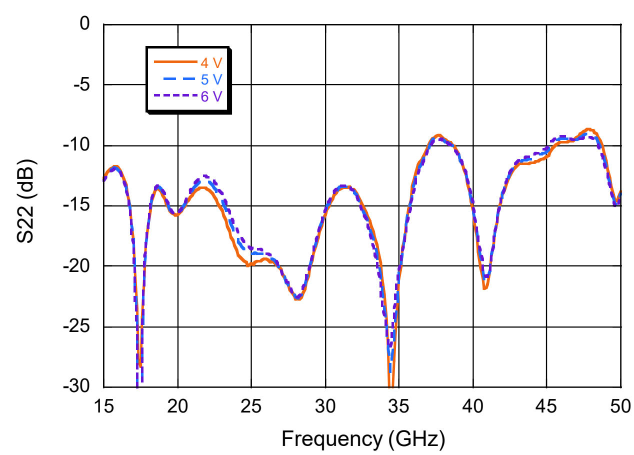
Input Return Loss vs. Frequency



Output Return Loss vs. Frequency

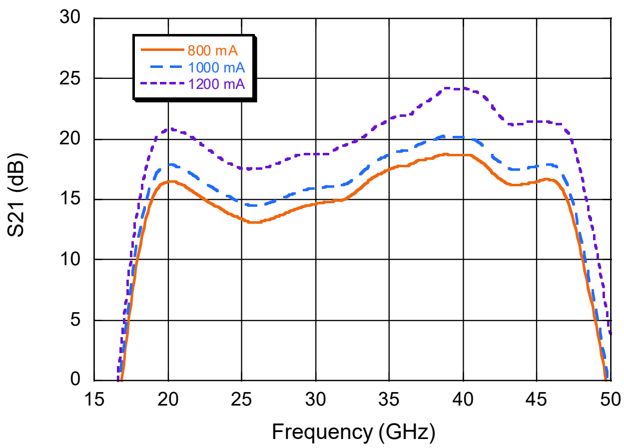


Output Return Loss vs. Frequency

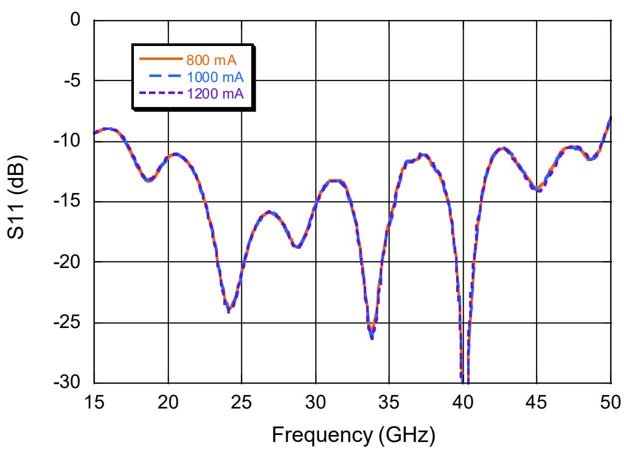


Typical Performance Curves: V_D = 5 V

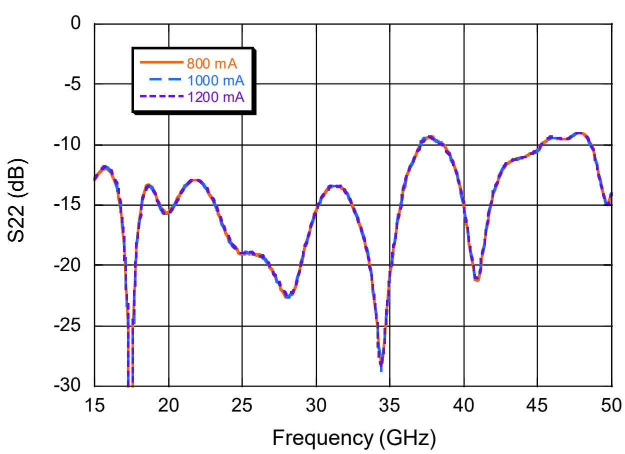
Small Signal Gain vs. Frequency



Input Return Loss vs. Frequency

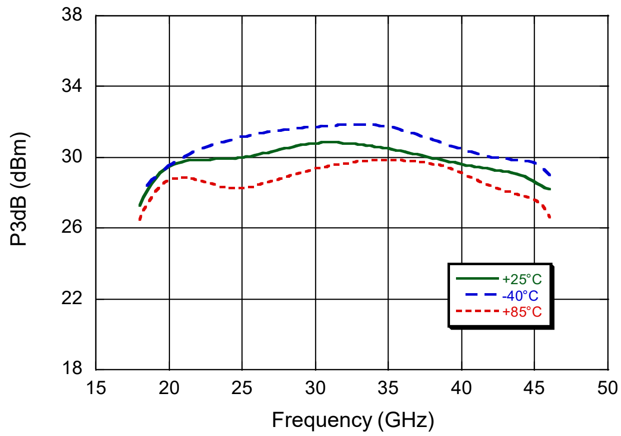


Output Return Loss vs. Frequency

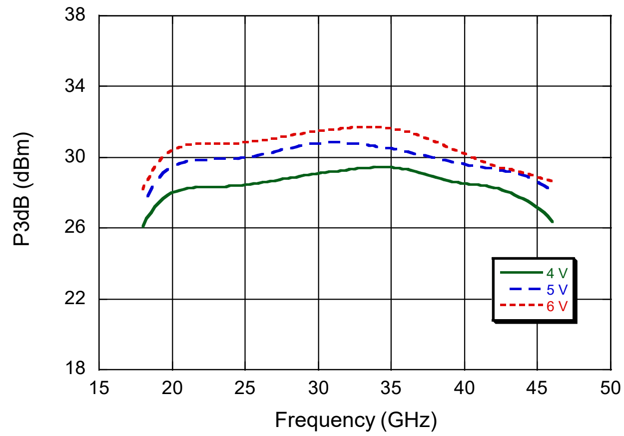


Typical Performance Curves: V_D = 5 V, I_{DSQ} = 1000 mA

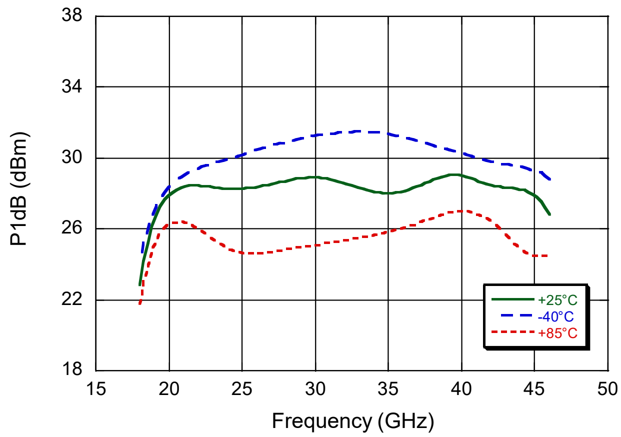
P3dB vs. Frequency



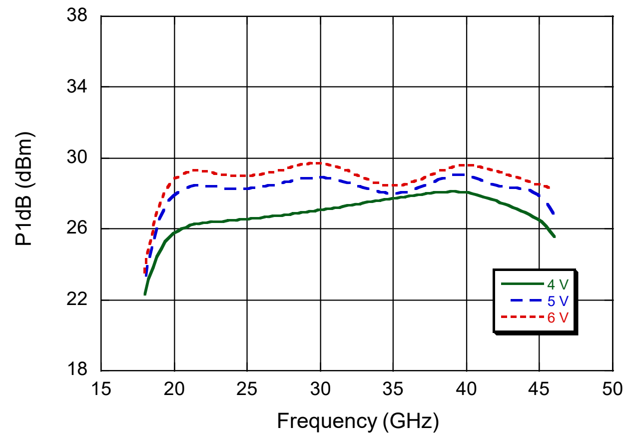
P3dB vs. Frequency



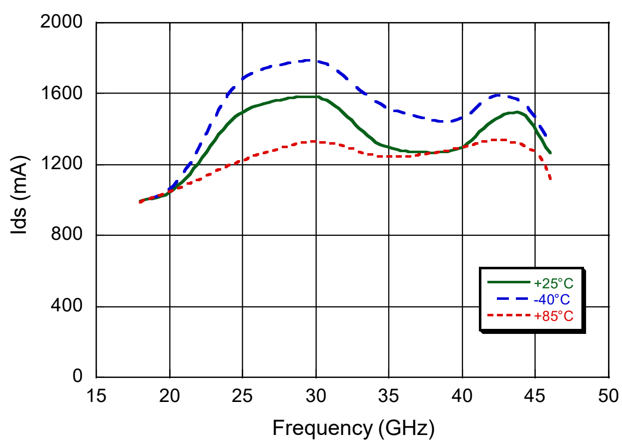
P1dB vs. Frequency



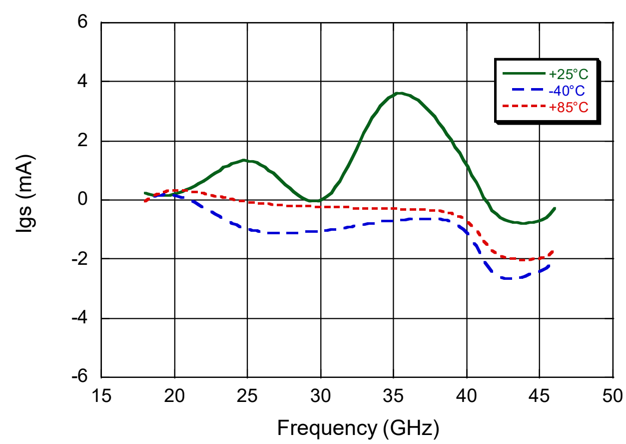
P1dB vs. Frequency



Ids vs. Frequency @ P3dB

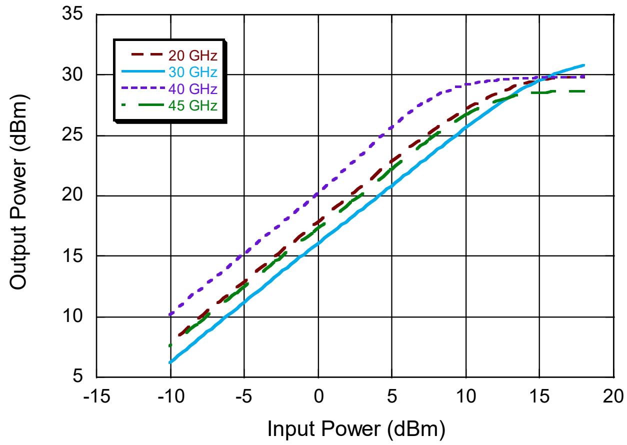


Igs vs. Frequency @ P3dB

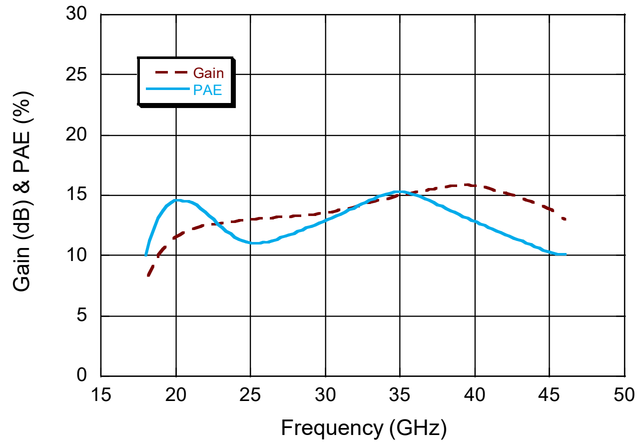


Typical Performance Curves: V_D = 5 V, I_{DSQ} = 1000 mA

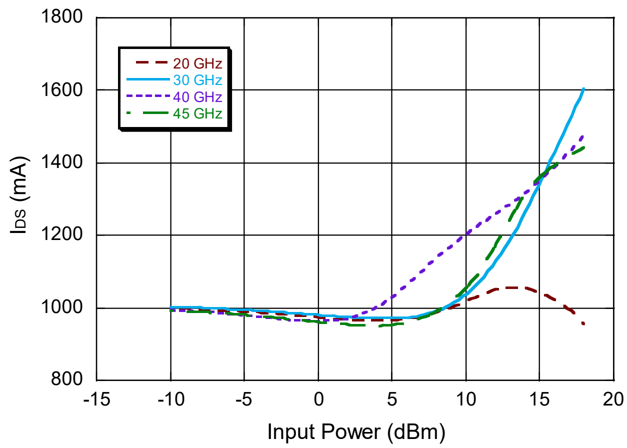
Output Power vs. Input Power



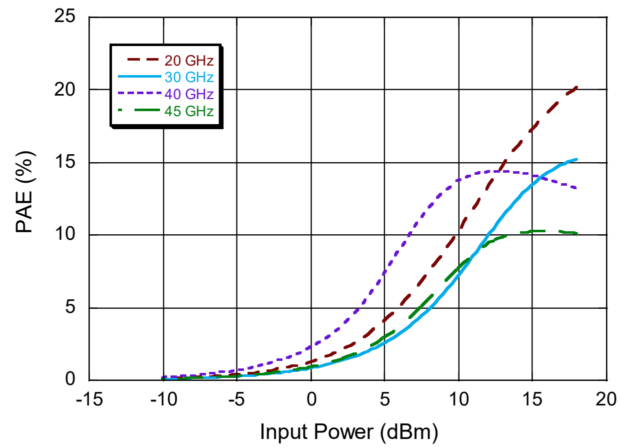
Gain and PAE @ P3dB vs. Frequency



Drain Current vs. Input Power

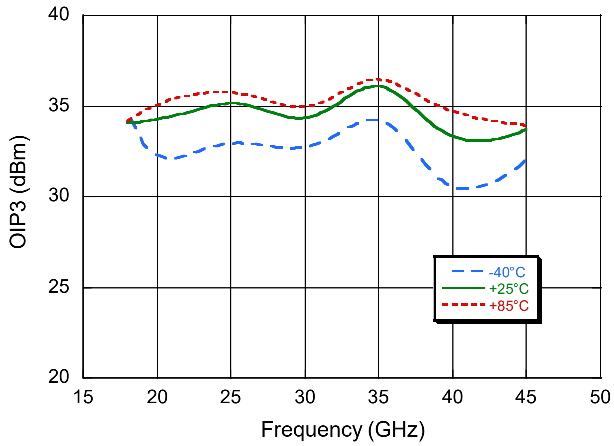


PAE vs. Input Power

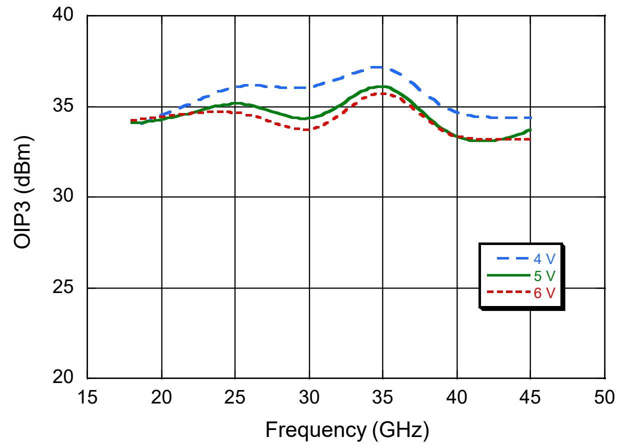


Typical Performance Curves: V_D = 5 V, I_{DSQ} = 1000 mA

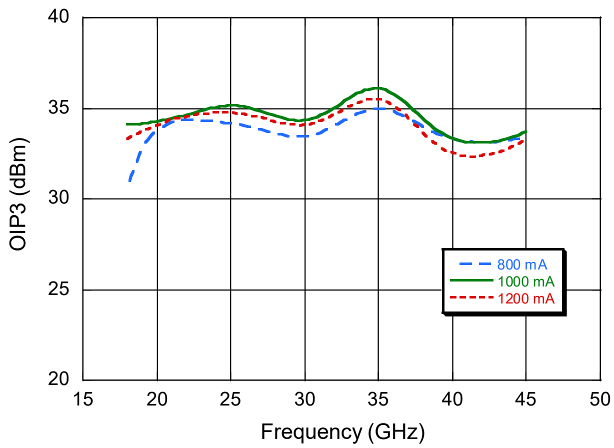
Output IP3 vs. Frequency @ Pout = 14 dBm / Tone



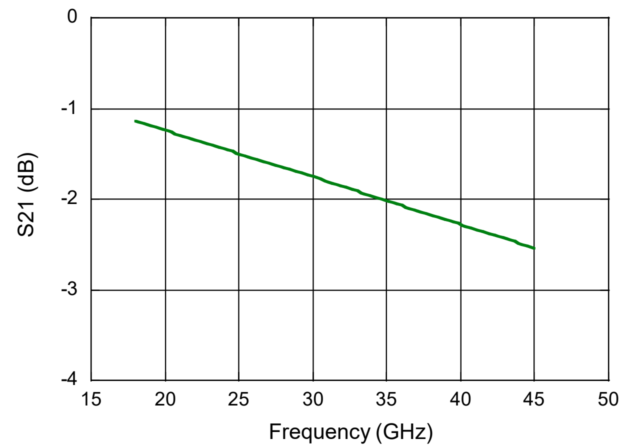
Output IP3 vs. Frequency @ Pout = 14 dBm / Tone



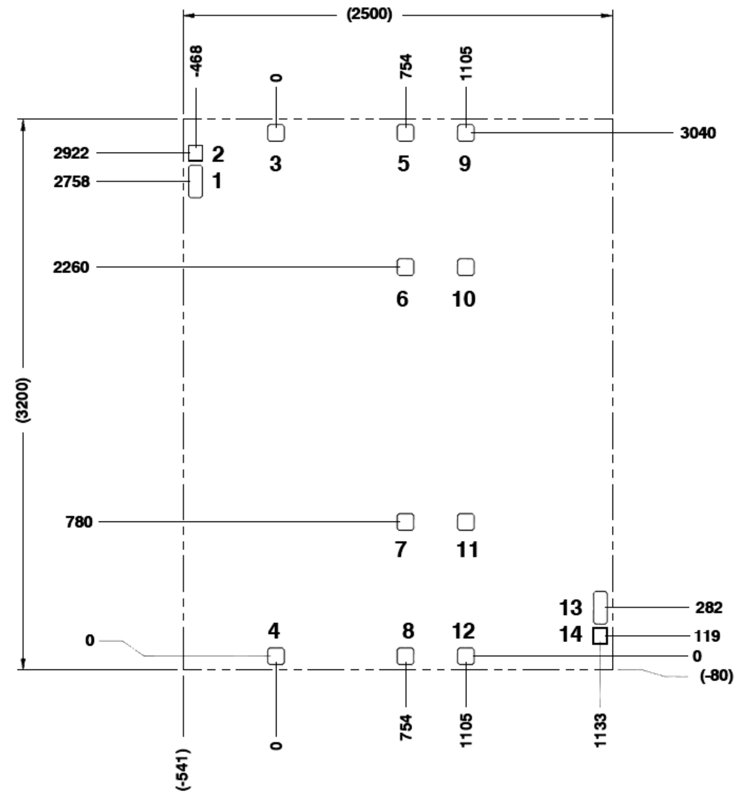
Output IP3 vs. Frequency @ Pout = 14 dBm / Tone



Sample Board Loss
Includes Two 2.4 mm Connectors



Die Dimensions



Units are in microns with a tolerance of ±5 µm, except for die exterior dimensions which are street-center-to-street-center – nominal saw or laser kerf ~ 25 µm tolerance each dimension. Pad and backside metal is gold.
Die thickness is 100 ± 10 µm.

Pad Dimensions (µm)

Pad #	X	Y
1, 13	76	186
2, 14	76	86
3—12	93	93