Power Amplifier, 1 W
0.001 - 22 GHz

MAAP-011327-DIE
Rev. V1

Features

- Positive Gain Slope
- High Gain: 14 dB
- P1dB: 30 dBm
- P_{SAT}: 32 dBm
- Output IP3: 46.5 dBm
- Bias Voltage: V_{DD} = 10 V
- Bias Current: I_{DSQ} = 500 mA
- 50 Ω Matched Input / Output
- Temperature Compensated Output Power Detector
- 1500 x 2900 µm Die Size
- RoHS* Compliant

Applications

- Test & Measurement, EW, ECM, and Radar

Description

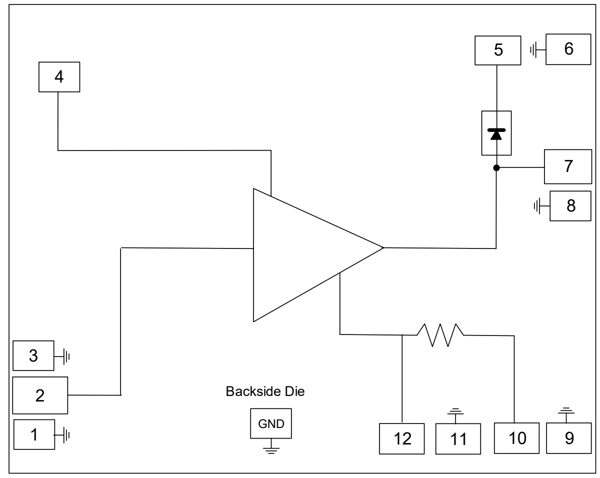
The MAAP-011327-DIE is a 1 W distributed power amplifier die. The power amplifier operates from 0.001 to 22 GHz and provides 14 dB of linear gain and 32 dBm of output power at saturation. The device is fully matched across the band and includes a temperature compensated output power detector.

The MAAP-011327-DIE can be used as a power amplifier stage or as a driver stage in higher power applications. This device is ideally suited for test and measurement, EW, ECM, and radar applications.

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 two 0.025 mm (1 mil) wire bonds of minimal length 0.31 mm (12 mils) on the RF_{IN} and RF_{OUT}/V_{DD} ports.

Functional Schematic



Pin Configuration[2]

Pin #	Pin Name	Description
1, 3, 6, 8, 9, 11	GND	Ground
2	RF_{IN}	RF Input
4	VD_AUX	VD Auxiliary
5	DET	Power Detector
7	RF_{OUT}/V_{DD}	RF Output / Drain Voltage
10	VG_AUX	VG Auxiliary
12	V_{G1}	Gate Voltage

2. Backside of die on the die bottom must be connected to RF, DC and thermal ground.

Ordering Information

Part Number	Package
MAAP-011327-DIE	Gel Pack[1]
MAAP-011327-DIESMB	Sample Board

1. Die quantity varies.

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

Electrical Specifications: T_A = +25°C, V_{DD} = 10 V, I_{DSQ} = 500 mA, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	2 GHz 10 GHz 18 GHz 22 GHz	dB	— 11.0 11.5 12.0	13.0 13.0 13.5 14.0	—
P_{SAT}	P_{IN} = +24 dBm 2 GHz 10 GHz 18 GHz 22 GHz	dBm	—	32.0 31.0 31.0 29.0	—
P1dB	2 GHz 10 GHz 18 GHz 22 GHz	dBm	— 28.5 26.5 26.0	30.0 29.5 28.0 28.0	—
OIP3	P_{OUT} = +18 dBm/tone (10 MHz Tone Spacing) 2 GHz 10 GHz 18 GHz 22 GHz	dBm	—	46.5 42.0 40.0 40.0	—
PAE	P_{IN} = +22 dBm 2 GHz 10 GHz 18 GHz 22 GHz	%	—	29.0 23.0 22.0 19.0	—
Input Return Loss	P_{IN} = -20 dBm	dB	—	15	—
Output Return Loss	P_{IN} = -20 dBm	dB	—	10	—
I_{DD} (with RF drive)	P_{IN} = +23 dBm	mA	—	600	—
I_{G1}	P_{IN} = +23 dBm	mA	—	-0.22	—

Maximum Operating Ratings

Parameter	Rating
Input Power	24 dBm
Drain Voltage	12 V
Junction Temperature[3,4]	+150°C
Operating Temperature	-40°C to +85°C

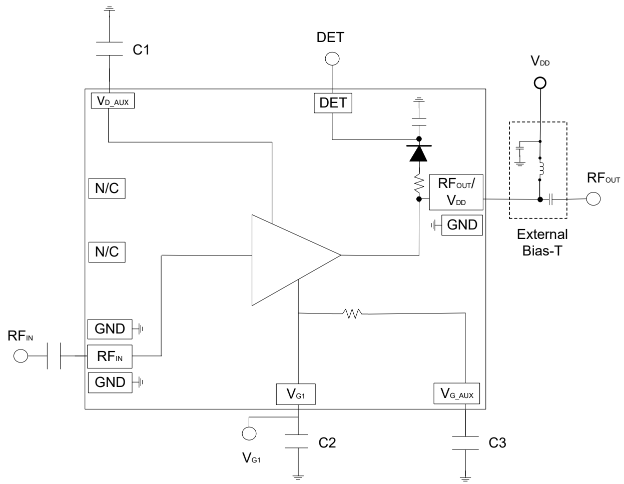
3. Operating at nominal conditions with junction temperature ≤ +150°C will ensure MTTF > 1 x 10^6 hours.
4. Junction Temperature (T_J) = T_C + Θ_{JC} * ((V * I) - (P_{OUT} - P_{IN}))
   Typical thermal resistance (Θ_{JC}) = 12.2 °C/W.
   a) For T_C = +85°C,
   T_J = +151°C @ 10 V, 0.60 A, P_{OUT} = 29 dBm, P_{IN} = 24 dBm, 22 GHz

Absolute Maximum Ratings[5,6]

Parameter	Absolute Maximum
Input Power	30 dBm
Drain Voltage	+13 V
Gate Voltage	-2 to 0 V
Junction Temperature[7]	+175°C
Storage Temperature	-65°C to +125°C

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

Application Schematic



Bill of Materials[8,9,10]

Part	Value	Size	Comment
C1 - C3	1 µF	0402	bypass

8. C1 & C2 are required for operation below 1 GHz.
9. High power external bias tee was used for measurements.
10. External DC block was used on input.

Biasing Conditions

Recommended biasing conditions are V_{DD} = 10 V, I_{DSQ} = 500 mA (controlled with V_{G1}).

V_{DD} Bias must be applied through a resonant free high inductance on the RF output line.

Bypass capacitors C1 and C2 for the auxiliary pads are for low frequency operation extension (below 1 GHz).

Mounting and Bonding Information

The DIE should be directly attached to the RF/DC ground plane; either with solder (AuSn) or a thin application of conductive epoxy. Avoid overflows.

Any connecting microstrip (50 Ω Transmission Line) substrate should be brought as close as possible to the die in order to minimize bond wire inductance. A typical spacing between die and microstrip substrate should be kept between 75 - 125 µm for best RF behavior. All bonds should be kept as short as possible. Use minimum ultrasonic energy for reliable wire bonds.

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 HBM Class 2 devices.

Airbridges

The top of the die has exposed airbridges which can be damaged if mishandled. Please take appropriate precautions when handling the die.

Recommended PCB Information

RF input and output are 50 Ω transmission lines.
Single layer 8 mil Rogers RO4008 with 1/2 oz. Cu.
Use copper filled vias under die backside ground pad.

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; however, for good thermals, it is recommended to use as many as physically possible.

Operating the MAAP-011327-DIE

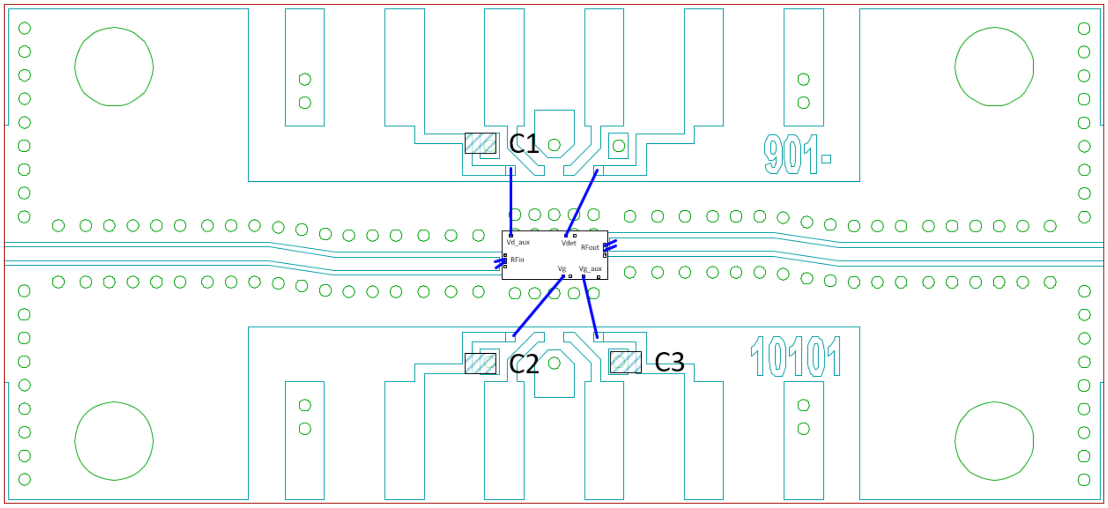
Turn-on

1. Apply V_{G1} (-1.5 V).
2. Increase V_{DD} to 10 V.
3. Set I_{DSQ} by adjusting V_{G1} more positive (typically –0.8 V for I_{DSQ} = 500 mA).
4. Apply RF_{IN} signal.

Turn-off

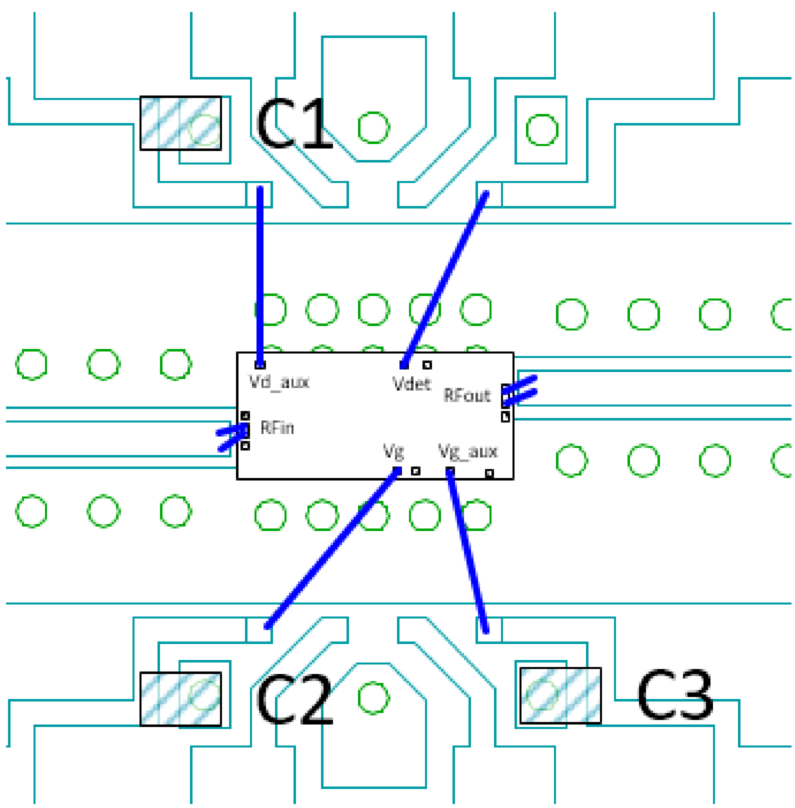
1. Remove RF_{IN} signal.
2. Decrease V_{G1} to -1.5 V.
3. Decrease V_{DD} to 0 V.

PCB Layout



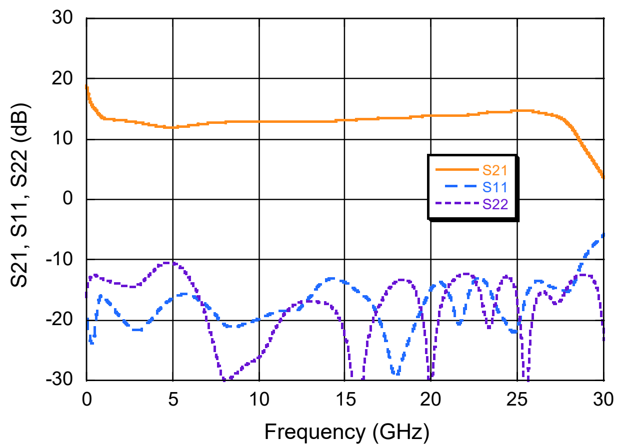
Co-Planar transmission line: Width = 340 µm, Gap = 130 µm
Copper filled vias: 300 µm diameter, 5 x 5 array under die

Die Bonding Close Up

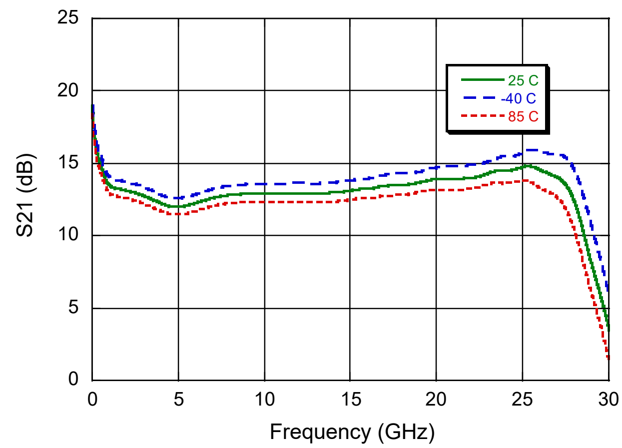


Typical Performance Curves V_{DD} = 10 V, I_{DSQ} = 500 mA, V_{G1} = -0.8 V typical

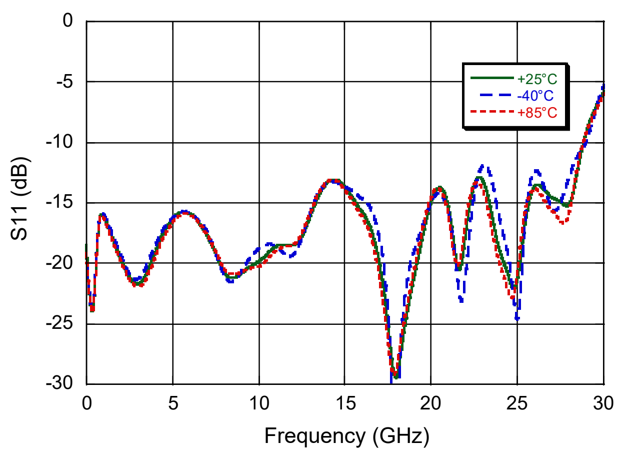
S Parameters



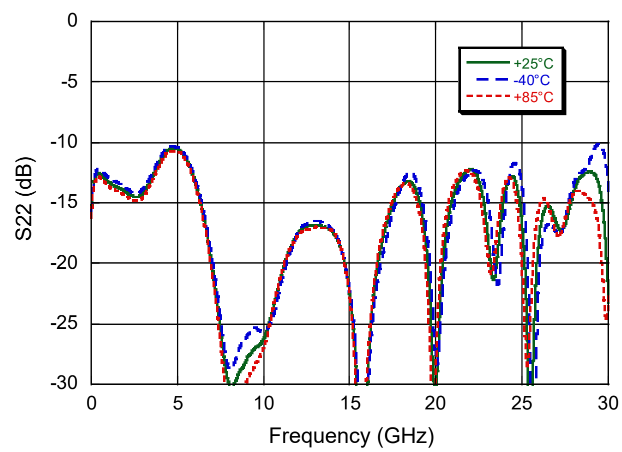
Gain



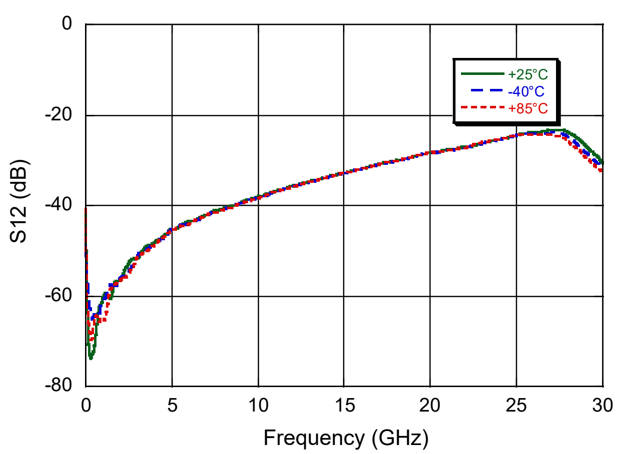
Input Return Loss



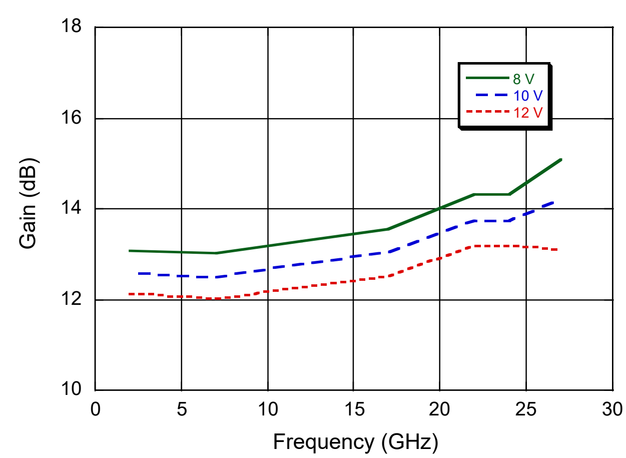
Output Return Loss



Isolation

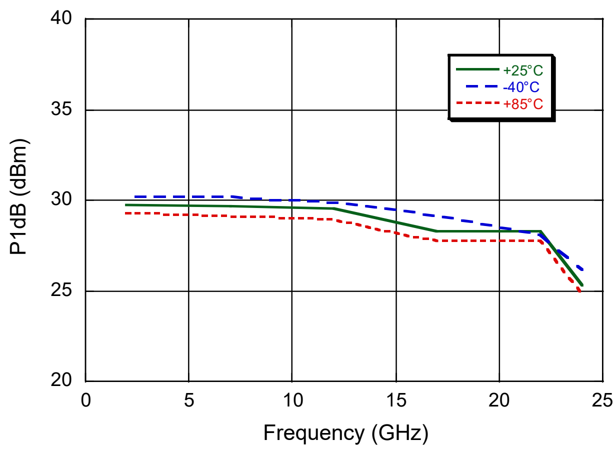


Gain over Voltage

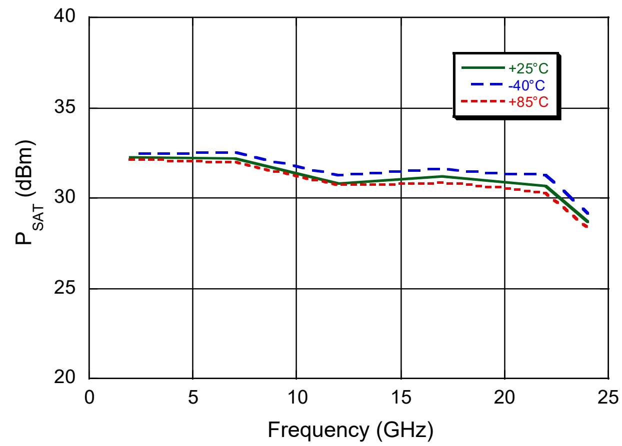


Typical Performance Curves V_{DD} = 10 V, I_{DSQ} = 500 mA, V_{G1} = -0.8 V typical

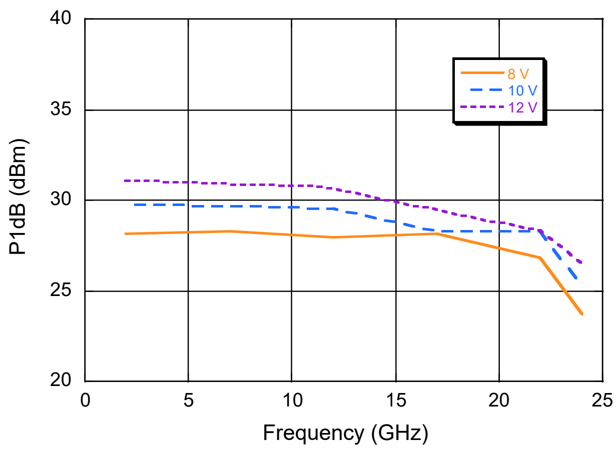
P1dB over Temperature



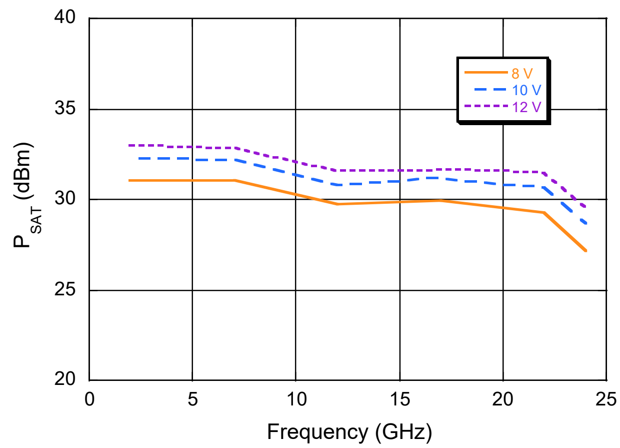
P_{SAT} over Temperature



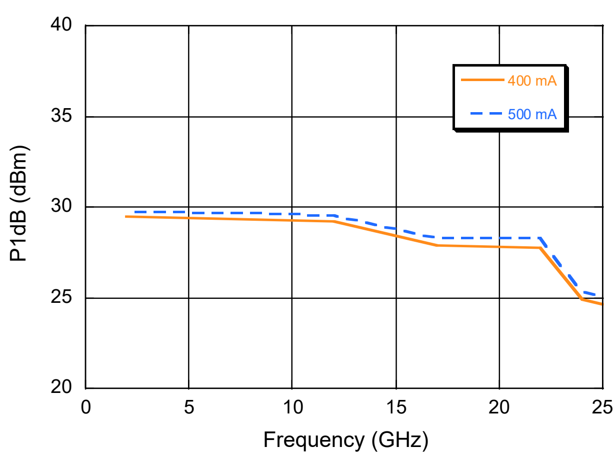
P1dB over Voltage



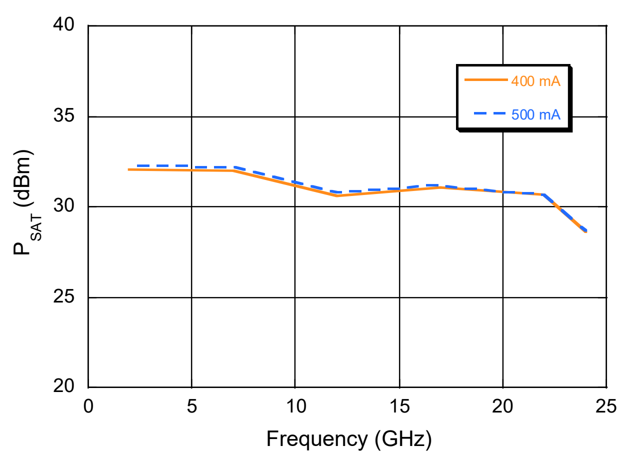
P_{SAT} over Voltage



P1dB over Current

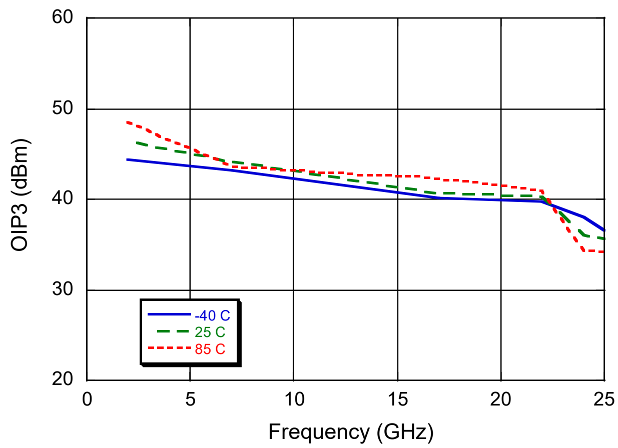


P_{SAT} over Current

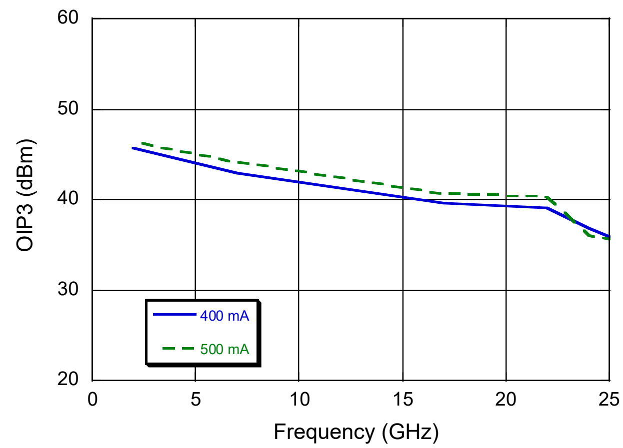


Typical Performance Curves V_{DD} = 10 V, I_{DSQ} = 500 mA, V_{G1} = -0.8 V typical

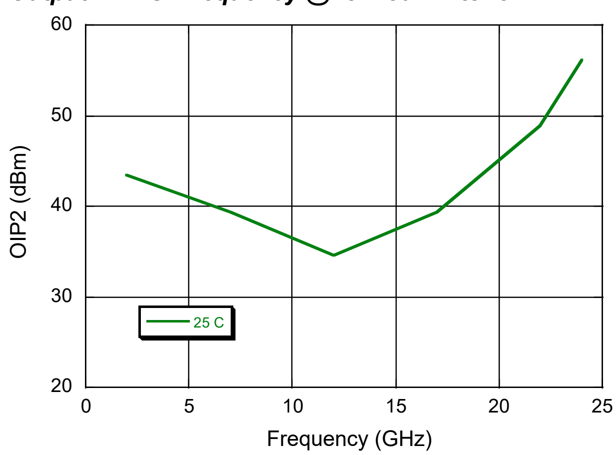
Output IP3 vs. Frequency over Temperature @Po=18dBm/tone



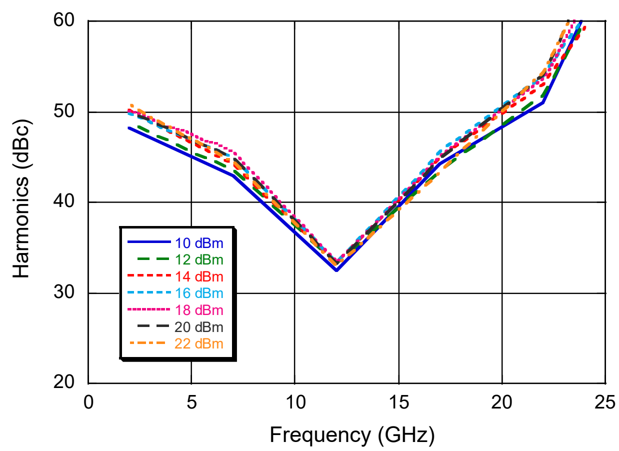
Output IP3 vs. Frequency over Drain Current @Po=18dBm/tone



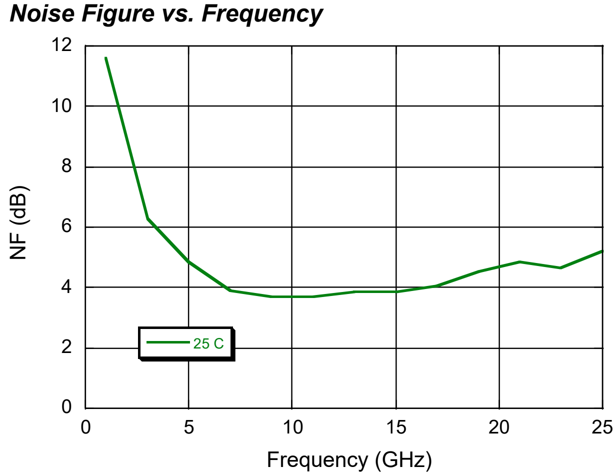
Output IP2 vs. Frequency @Po=18dBm/tone



2nd Harmonic level vs. Frequency over Output Power

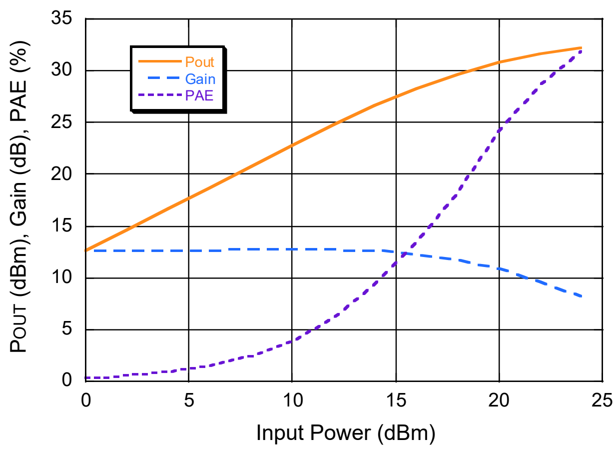


Noise Figure vs. Frequency

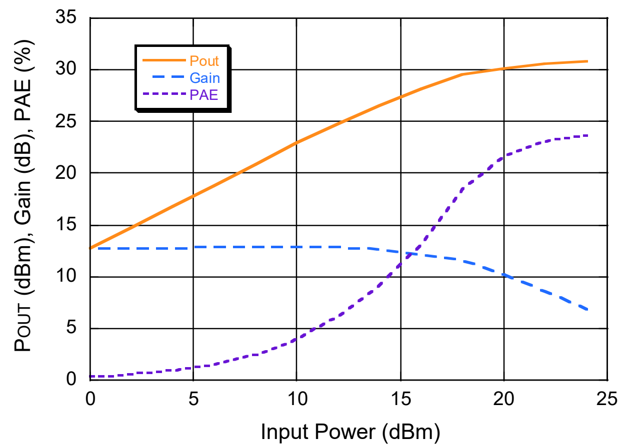


Typical Performance Curves V_{DD} = 10 V, I_{DSQ} = 500 mA, V_{G1} = -0.8 V typical

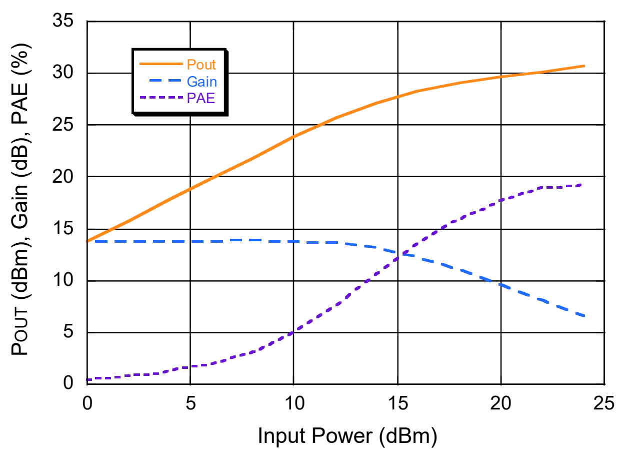
Power Compression @ 2 GHz



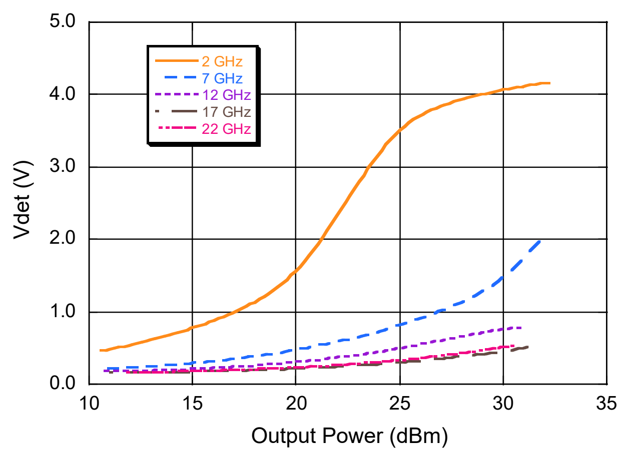
Power Compression @ 12 GHz



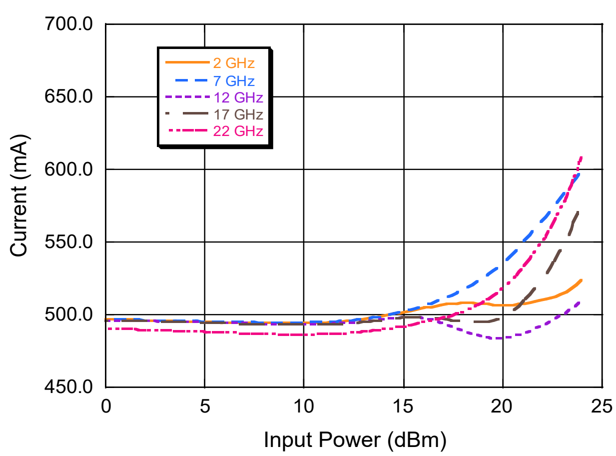
Power Compression @ 22 GHz



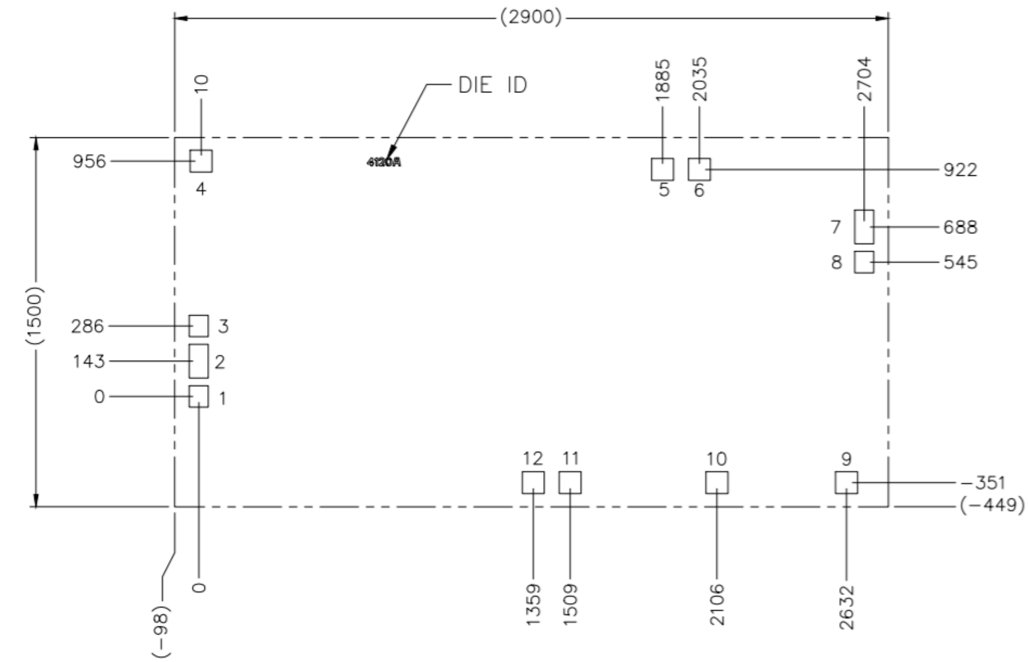
Detector Voltage vs. Power



Current



Die Dimensions[11,12,13]



11. 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.
12. Bondpad and backside metal is gold.
13. Die thickness is 100 ± 10 µm.

Bond Pad Dimensions (µm)

Pad	X	Y
1,3,8	77	87
2,7	77	137
4,5,6,9,10,11,12	89	89