Features

- High Gain: 22 dB
- P1dB: 24 dBm
- P_{SAT}: 24.5 dBm
- Output IP3: 33 dBm
- Bias Voltage: V_{DD} = 5 V
- Bias Current: I_{DSQ} = 375 mA
- 50 Ω Matched Input / Output
- Temperature Compensated Output Power Detector
- Die Size: 2500 x 851 x 100 µm
- RoHS* Compliant

Applications

- Test & Measurement
- 5G FR2, EW, ECM
- Radar

Description

The MAAP-011377-DIE is a 0.25 W distributed power amplifier offered in die form. The power amplifier operates from 20 to 55 GHz and provides 22 dB of linear gain and 24.5 dBm of saturated output power. The device is fully matched across the band and includes a temperature compensated output power detector.

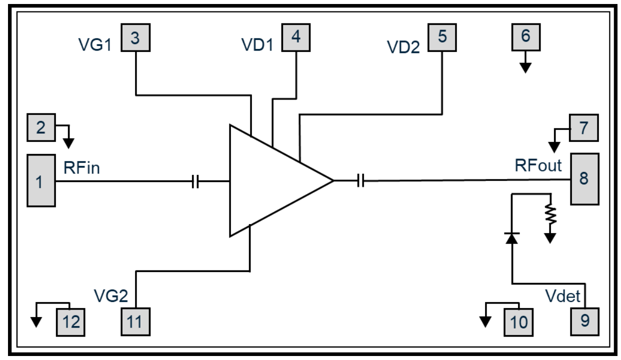
The MAAP-011377-DIE can be used as a power amplifier stage or as a driver stage in higher power applications. This device is ideally suited for test and measurement, 5G FR2, EW, ECM, and radar applications.

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

Ordering Information

Part Number	Package
MAAP-011377-DIE	Bare Die

Functional Schematic



Bond Pad Configuration[1]

Pad #	Pad Name	Description
1	RFIN	RF Input
2,6,7,10,12	GND	Ground
3	VG1	Gate Voltage 1
4	VD1	Drain Voltage 1
5	VD2	Drain Voltage 2
8	RFOUT	RF Output
9	V_{DET}	Power Detector
11	VG2	Gate Voltage 2

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: T_A = +25°C, V_D = 5 V, I_{DSQ} = 375 mA, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	P_{IN} = -10 dBm 20.0 GHz 30.0 GHz 40.0 GHz 48.5 GHz 55.0 GHz	dB	18.5 — 19.5 19.5 —	21.0 20.0 23.0 23.0 21.0	—
Input Return loss	—	dB	—	10	—
Output Return Loss	—	dB	—	10	—
P1dB	20.0 GHz 30.0 GHz 40.0 GHz 48.5 GHz 55.0 GHz	dBm	22.5 — 23.75 22.0 —	23.5 24.0 25.0 24.0 19.0	—
P_{SAT}	20.0 GHz 30.0 GHz 40.0 GHz 48.5 GHz 55.0 GHz	dBm	—	24.5 24.5 24.5 25.0 21.0	—
OIP3	P_{OUT}/Tone = 14 dBm, Δf = 2 MHz	dBm	—	33	—
Drain Current	P_{SAT}, 40 GHz	mA	—	450	—
Power Added Efficiency	P_{SAT}, 40 GHz	%	—	10	—

Maximum Operating Ratings

Parameter	Rating
Input Power	10 dBm
Drain Voltage	5.5 V
Junction Temperature[2,3]	+160°C
Operating Temperature	-40°C to +85°C

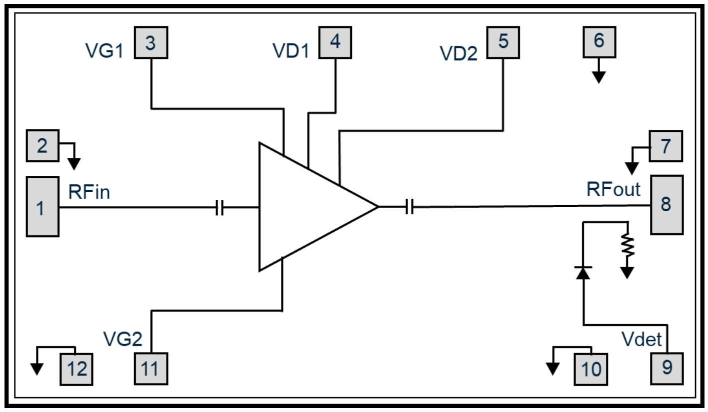
2. Operating at nominal conditions with junction temperature ≤ +160°C will ensure MTTF > 1 x 10^6 hours.
3. Junction Temperature (T_J) = T_C + $Θ_{JC}$ * [(V * I) - (P_{OUT} - P_{IN})]. Typical thermal resistance ($Θ_{JC}$) = 13°C/W
   a) For T_C = +25°C at the backside of the die
      T_J = 49°C @ 5 V, 425 mA,
      P_{OUT} = 24.5 dBm, P_{IN} = 5 dBm
   b) For T_C = +85°C at the backside of the die
      T_J = 110°C @ 5 V, 425 mA,
      P_{OUT} = 23 dBm, P_{IN} = 5 dBm

Absolute Maximum Ratings[4,5]

Parameter	Absolute Maximum
Input Power	17 dBm
Drain Voltage	6.5 V
Gate Voltage	-3 to 0 V
Junction Temperature[6]	+175°C
Storage Temperature	-65°C to +125°C

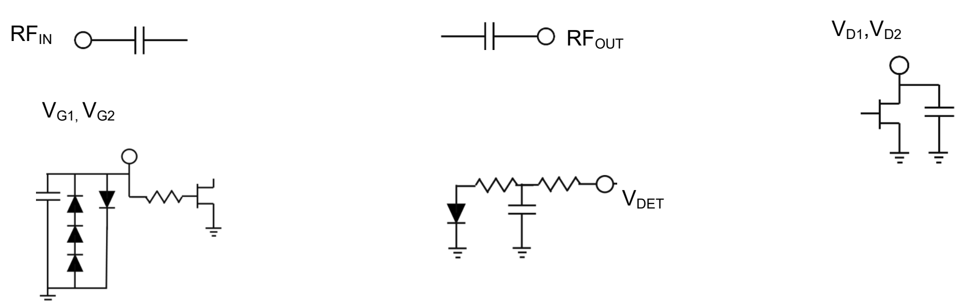
4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.
6. Junction temperature directly effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

Pin Configuration and Functional Descriptions



Pin #	Pin Name	Description
1	RF_{IN}	RF Signal Input. This pad is matched to 50 Ω and is AC coupled.
2,6,7,10,12	GND	These pads are grounded on the MMIC.
3,11	V_{G1},V_{G2}	Power amplifier gate controls. Adjust V_G from –2 V to 0 V to achieve the desired quiescent current. External bypass capacitors are required as described in the applications schematic. There is an internal connection between pads 3 & 11 and so only one pin needs to be externally connected to the gate voltage.
4	V_{D1}	Drain bias 1 for the amplifier. External bypass capacitors are required as described in the applications schematic. There is no internal connection between pads 4 and 5 and so both of the pins need to be externally connected to the drain supply.
5	V_{D2}	Drain bias 2 for the amplifier. External bypass capacitors are required as described in the applications schematic. There is no internal connection between pads 4 and 5 and so both of the pins need to be externally connected to the drain supply.
8	RF_{OUT}	RF Signal Output. This pad is matched to 50 Ω and is AC coupled
9	V_{DET}	Power detector output voltage. There is an internal 5kΩ resistor on this pin.

Interface Schematics

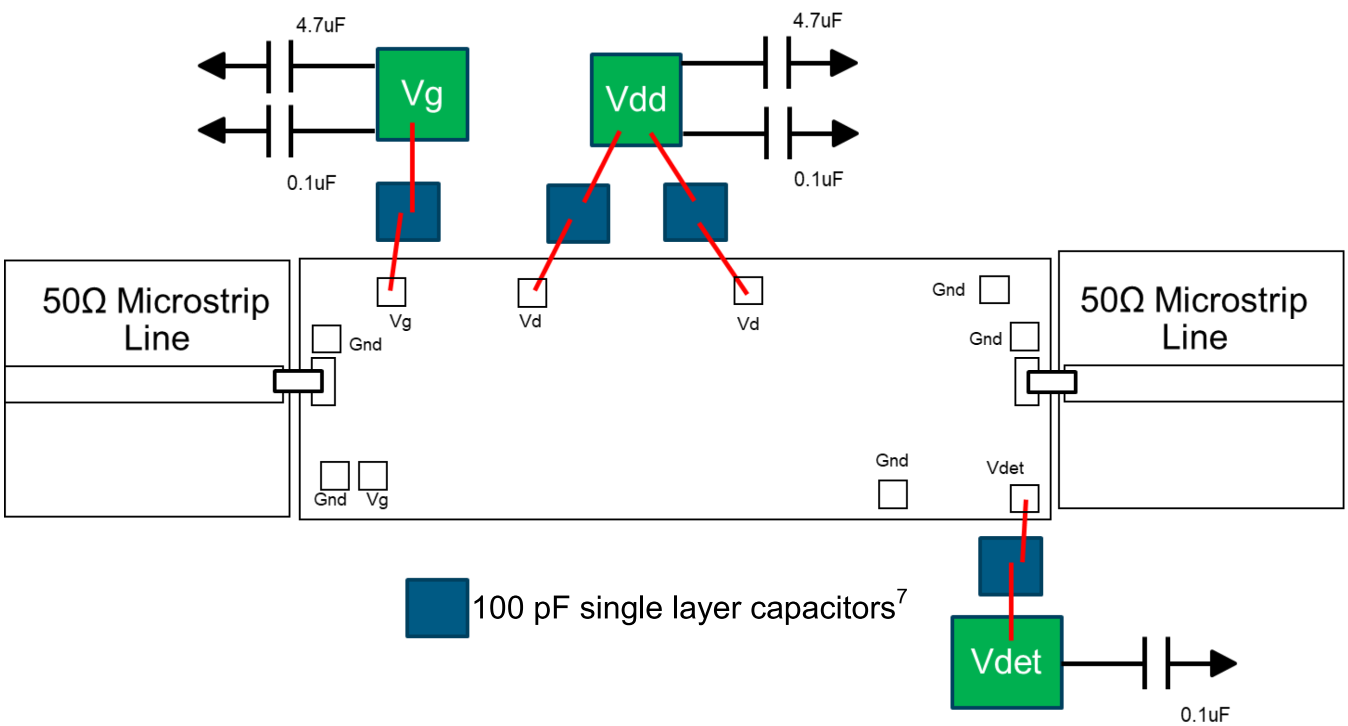


Recommended Bonding Diagram and Application Details:

For optimum performance, RF input and output transmission lines require either 3 mil gold ribbon (wedge bond) or 3 x 1 mil diameter gold wire bonds. The gap between the MMIC and the RF input and output lines should be a nominal 3mil.

In the configuration shown below 100 pF chip capacitors are used as part of the drain supply bypassing network. These chip capacitors are to be placed as close to the die as practically possible. The larger 0.1 μF capacitor could be implemented using an SMT component on a PCB instead of a chip cap: in this case, proximity to the MMIC die is less important. The circuit is not sensitive to the positioning of the 4.7 μF capacitors however these should be on the same PCB as the rest of the biasing components.

The capacitors on the detector output are optional: values will depend on the required response time of the detector output. There is an internal series 5 kΩ resistor on this pin.



7. For the 100 pF single layer capacitors use MACOM MKVC-050100-1453.

Biasing Conditions

Recommended biasing conditions are V_D = 5 V, I_{DQ} = 375 mA (controlled with V_G). The drain bias voltage range is 4 to 5.5 V, and the quiescent drain current biasing range is 325 to 425 mA.

Operating the MAAP-011377-DIE

Turn-on

1. Apply V_G (-2 V).
2. Apply V_D (5 V typical).
3. Set I_{DQ} by adjusting V_G more positive (typically -0.9 to -1.0 V for I_{DQ} = 375 mA).
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.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

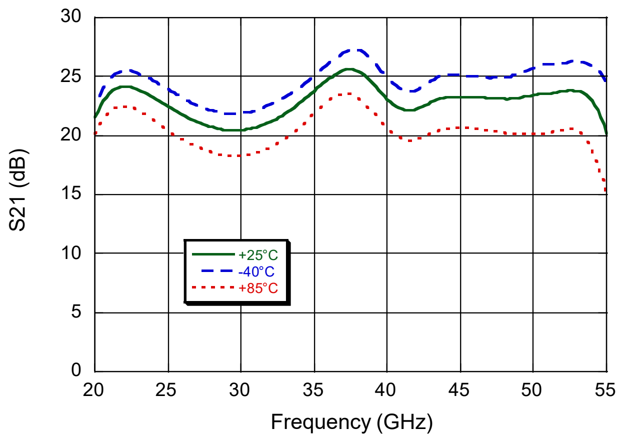
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1A devices.

Handling the Die

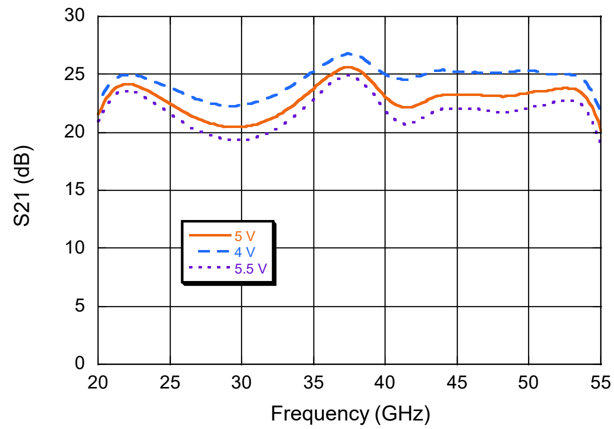
This MMIC has fragile exposed airbridges on its surface and must be handled on the edges only using a vacuum collet or suitable tweezers. Do not touch the surface of the chip with a vacuum collet, tweezers, or fingers.

Typical Performance Curves: V_D = 5 V, I_{DSQ} = 375 mA

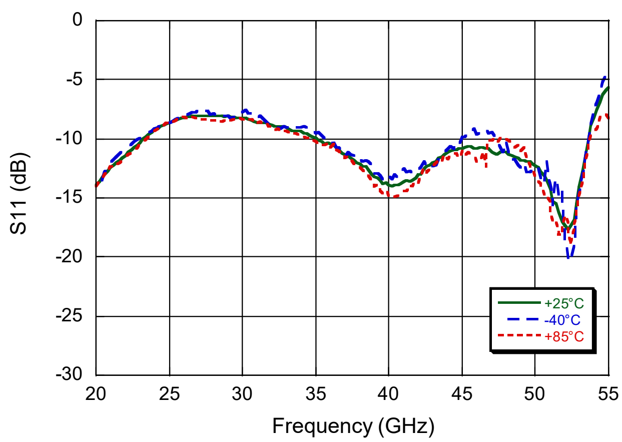
Small Signal Gain vs. Frequency



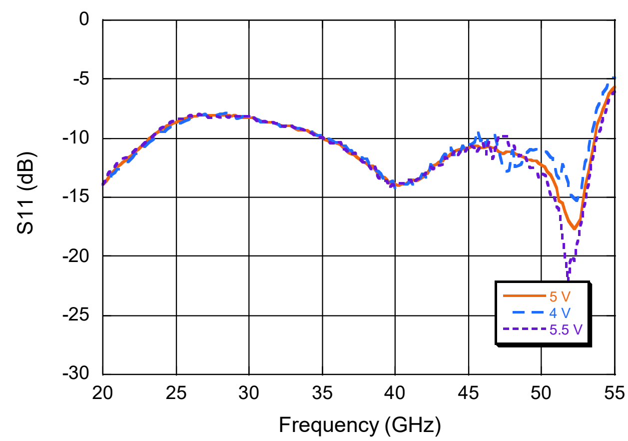
Small Signal Gain vs. Frequency



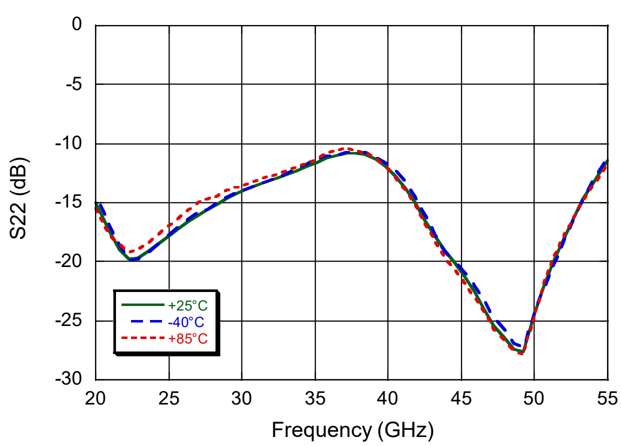
Input Return Loss vs. Frequency



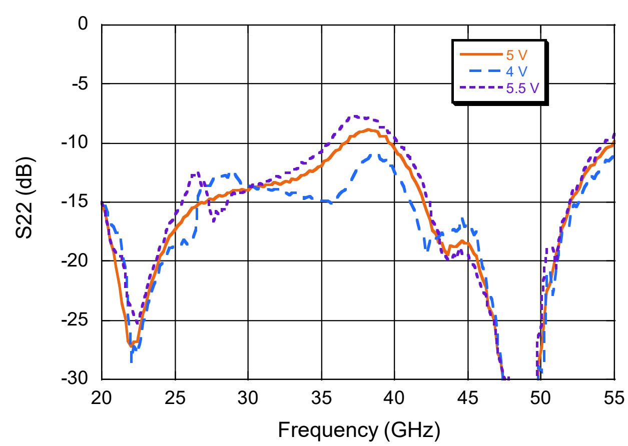
Input Return Loss vs. Frequency



Output Return Loss vs. Frequency

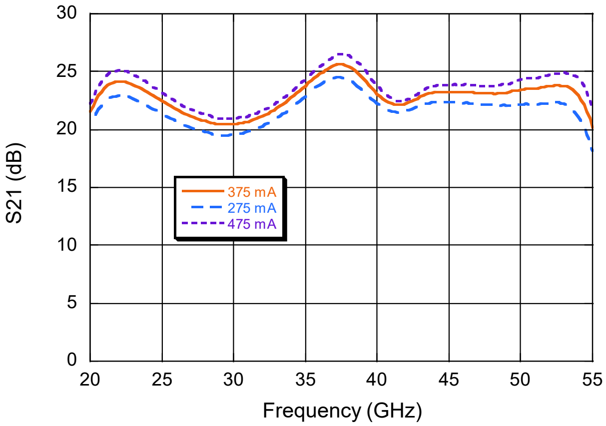


Output Return Loss vs. Frequency

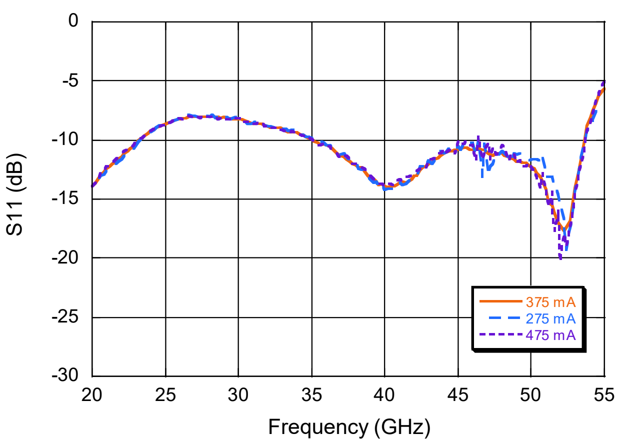


Typical Performance Curves: V_D = 5 V

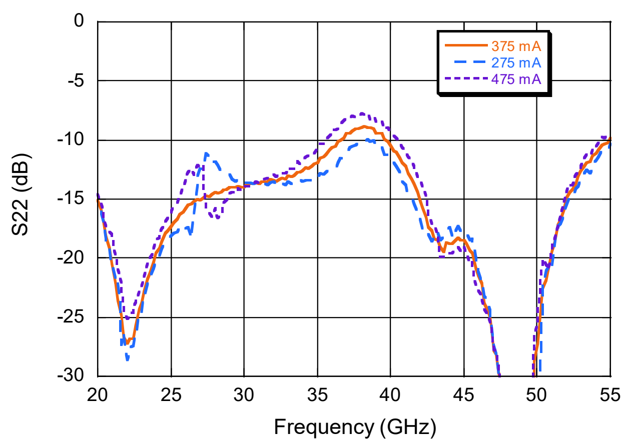
Small Signal Gain vs. Frequency



Input Return Loss vs. Frequency



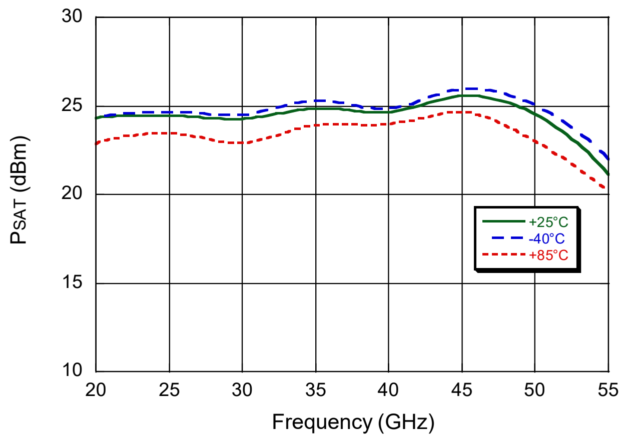
Output Return Loss vs. Frequency



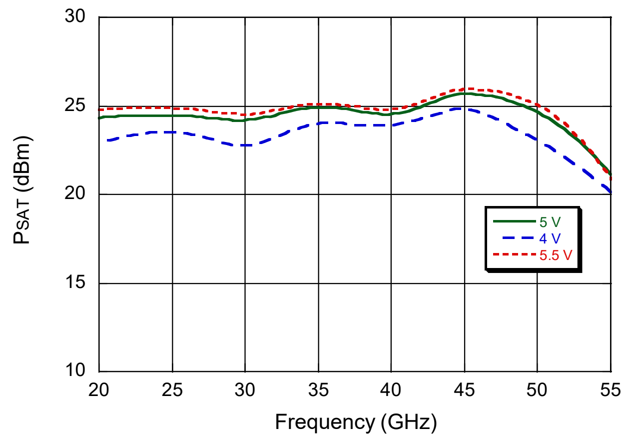
Typical Performance Curves: V_D = 5 V, I_{DSQ} = 375 mA

P

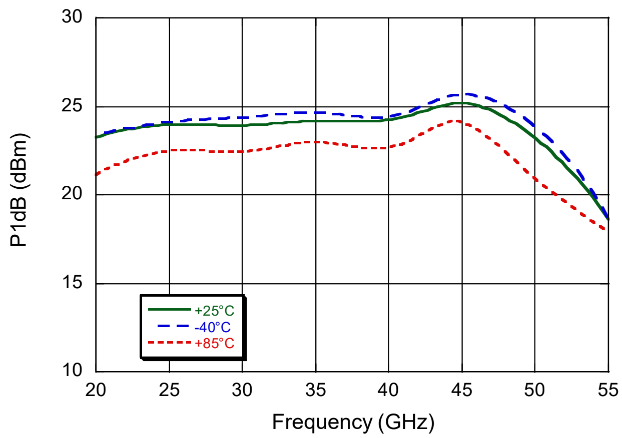
P_{SAT} vs. Frequency



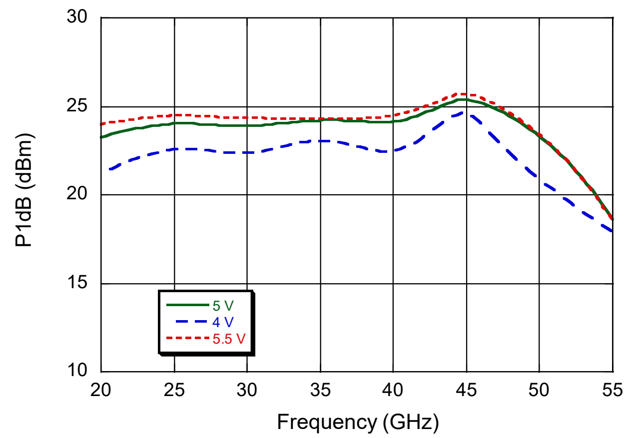
P_{SAT} vs. Frequency



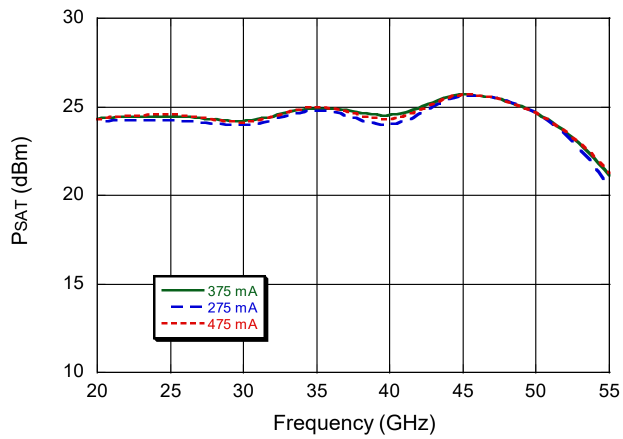
P1dB vs. Frequency



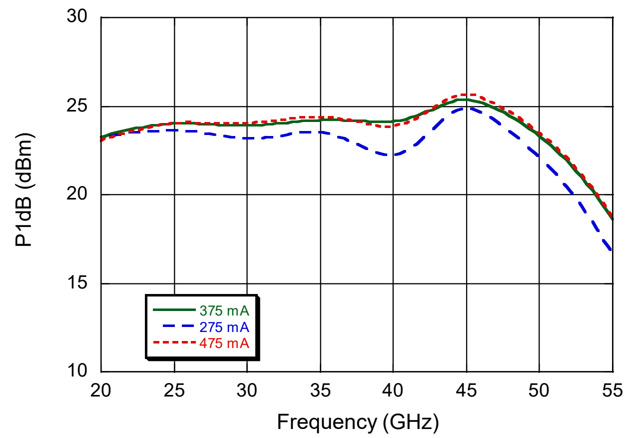
P1dB vs. Frequency



P_{SAT} vs. Frequency

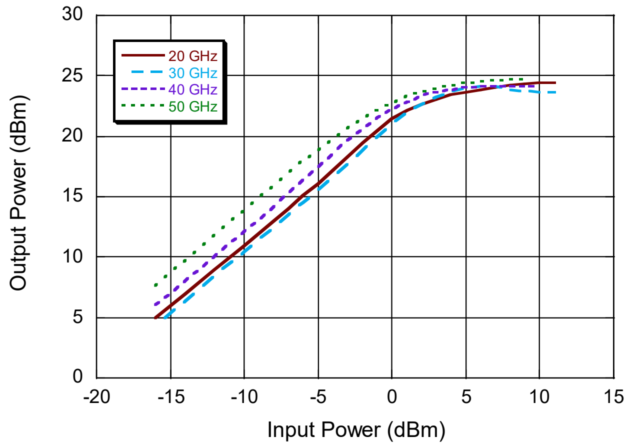


P1dB vs. Frequency

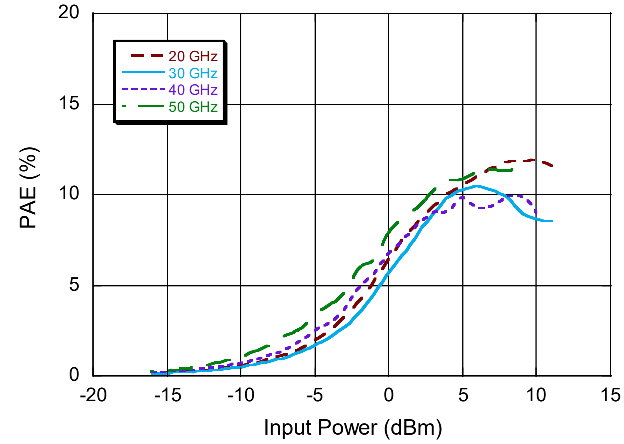


Typical Performance Curves: V_D = 5 V, I_{DSQ} = 375 mA

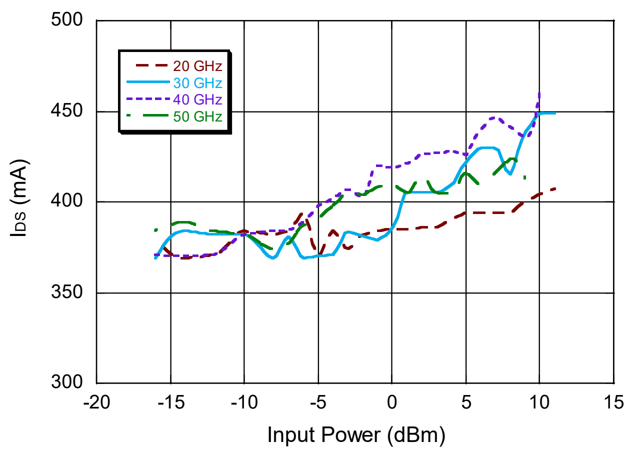
Output Power vs. Input Power



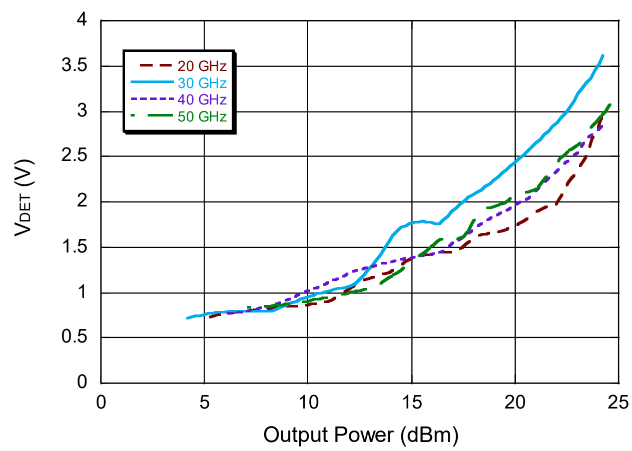
PAE vs. Input Power



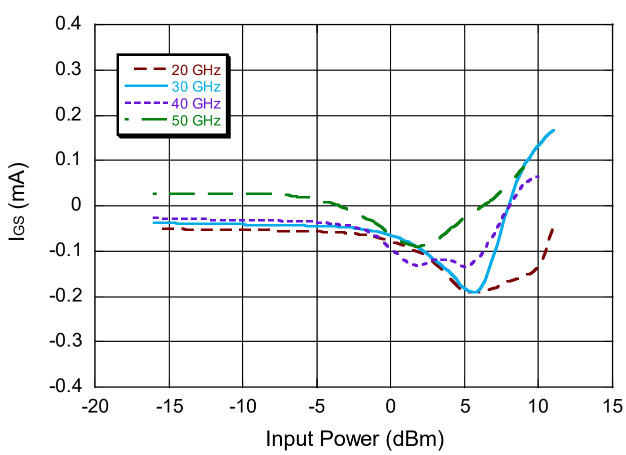
Drain Current vs. Input Power



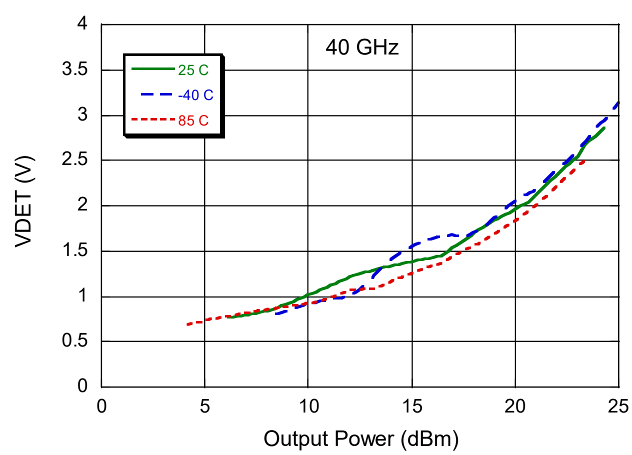
Detector Voltage vs. Output Power



Gate Current vs. Input Power

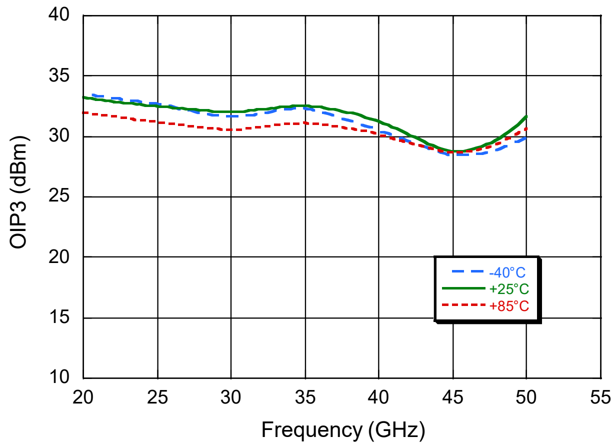


Detector Voltage vs. Output Power and Temperature

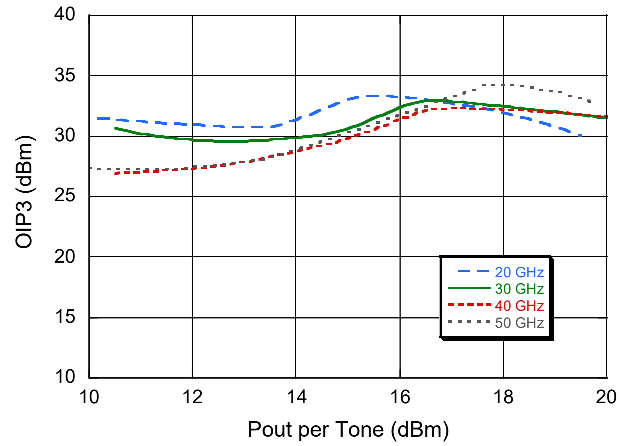


Typical Performance Curves: V_D = 5 V, I_{DSQ} = 375 mA

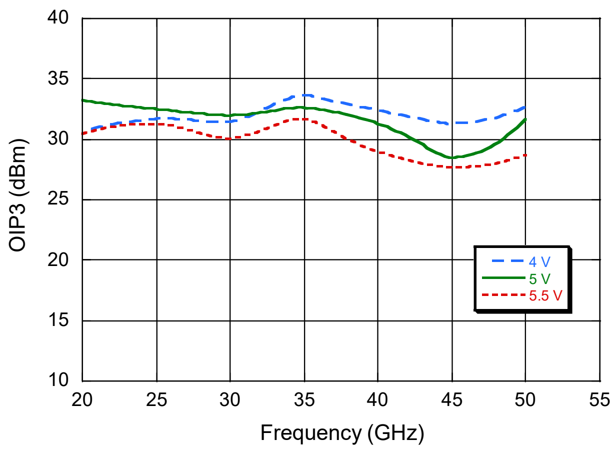
Output IP3 vs. Frequency @ Pout = 16 dBm / Tone



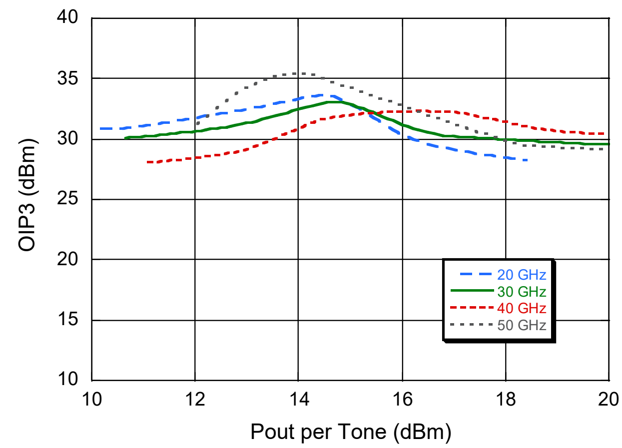
Output IP3 vs. Frequency and Pout per Tone
Vd = 5 V



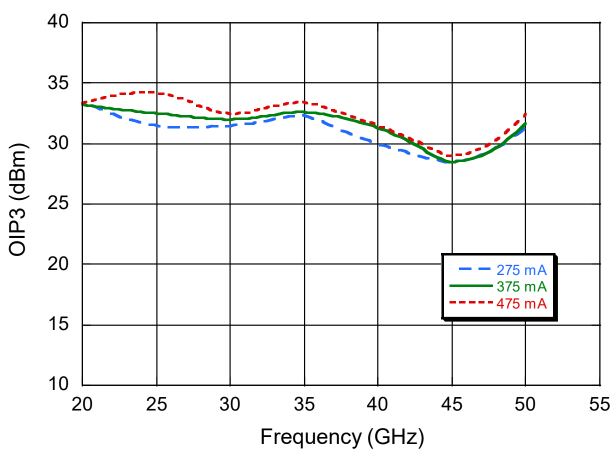
Output IP3 vs. Frequency @ Pout = 16 dBm / Tone



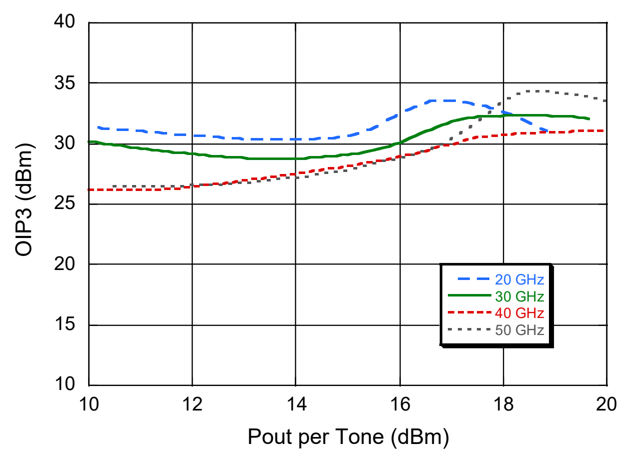
Output IP3 vs. Frequency and Pout per Tone
Vd = 4 V



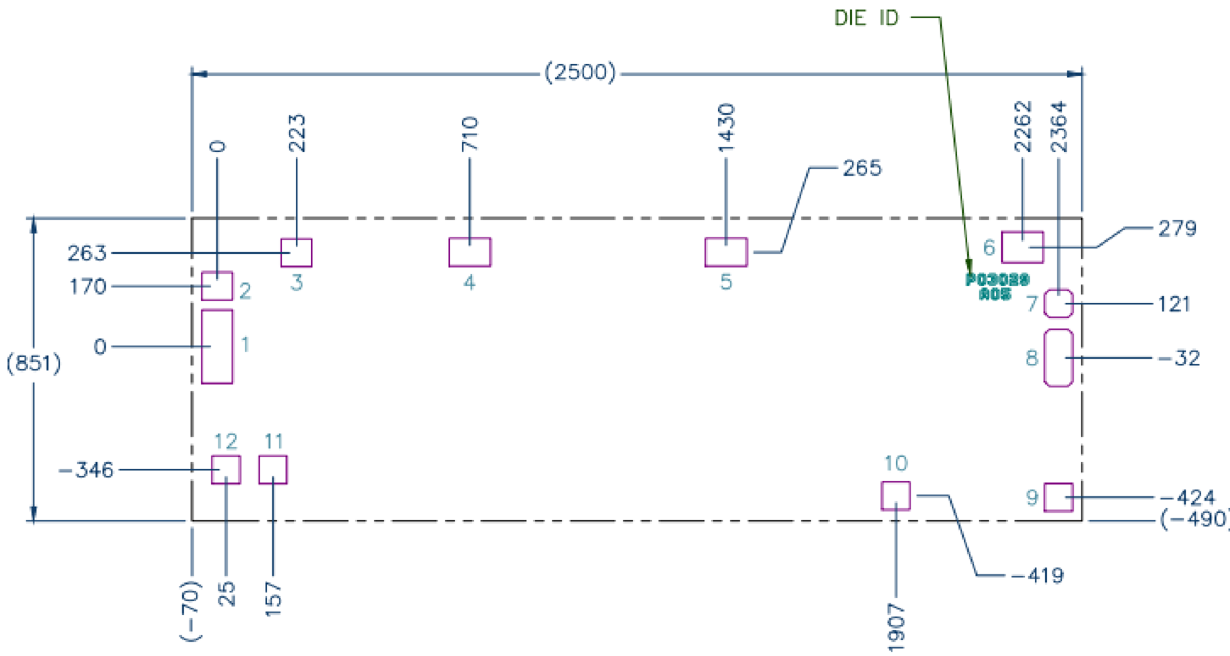
Output IP3 vs. Frequency @ Pout = 16 dBm / Tone



Output IP3 vs. Frequency and Pout per Tone
Vd = 5.5 V



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	86	206
2,3	86	78
4,5,6	116	78
7	78	78
8	78	160
9,10,11,12	78	78