Power Amplifier, 0.25 W
DC - 27 GHz

MACOM®

MAAP-011324-DIE
Rev. V1

Features

- High Gain: 18.0 dB
- P1dB: 25 dBm
- P3dB: 26 dBm
- Output IP3: 35 dBm
- Bias Voltage: V_{DD} = 8 V
- Bias Current: I_{DSQ} = 220 mA
- 50 Ω Matched Input / Output
- Temperature Compensated Output Power Detector
- Die Size: 2800 x 1300 x 100 µm
- RoHS* Compliant

Applications

- Test & Measurement
- EW
- ECM
- Radar

Description

The MAAP-011324-DIE is a 0.25 W distributed power amplifier offered in bare die form. The power amplifier operates from DC to 27 GHz and provides 18 dB of linear gain and 26 dBm of output power at 3-dB compression. The device is fully matched across the band and includes a temperature compensated output power detector.

The MAAP-011324-DIE can be used as a power amplifier stage or as a driver stage in higher power applications.

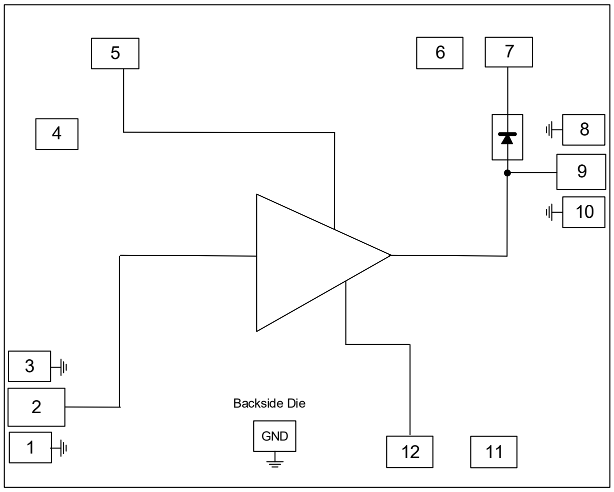
This product is fabricated using a GaAs pHEMT process which features full passivation for enhanced reliability.

Ordering Information[1,2]

Part Number	Package
MAAP-011324-DIE	DIE in Gel Pack
MAAP-011324-DIESMB	Sample Board

1. Reference Application Note M513 for reel size information.
2. Sample Board is DIE EVAL. Module.

Functional Schematic



Pin Configuration[3]

Pin #	Pin Name	Description
1,3,8,10	GND	Ground
2	RF_{IN}	RF Input
4,6,11	Not Used	Not Used
5	V_D_AUX	V_D_Auxiliary
7	DET	Power Detector
9	RF_{OUT}/V_{DD}	RF Output / Drain Voltage
12	V_G	Gate Voltage

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

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

Electrical Specifications (Measure on Bare DIE):
T_A = +25°C, V_{DD} = 8 V, I_{DSQ} = 220 mA, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	2 GHz 12 GHz 22 GHz 27 GHz	dB	17.0 17.0 17.0 —	18.5 18.0 18.0 17.5	—
P_{OUT}	P_{IN} = +10 dBm 2 GHz 12 GHz 22 GHz 27 GHz	dBm	—	27.5 26.5 24.5 21.0	—
P1dB	2 GHz 12 GHz 22 GHz 27 GHz	dBm	24.0 23.0 20.5 —	26.0 25.0 22.0 20.5	—
OIP3	P_{OUT}= +14 dBm/tone (10 MHz Tone Spacing) 2 GHz 12 GHz 22 GHz 27 GHz	dBm	—	38.0 34.5 33.5 32.5	—
PAE	P_{IN} = +10 dBm 2 GHz 12 GHz 22 GHz 27 GHz	%	—	29 24 14 6.5	—
Vdet	10 dBm P_{OUT}, 7 GHz 25 dBm P_{OUT}, 7 GHz	mV	—	150 350	—
Input Return Loss	P_{IN} = -10 dBm	dB	—	15	—
Output Return Loss	P_{IN} = -10 dBm	dB	—	15	—
I_{DD} (with RF drive)	P_{IN} = +10 dBm	mA	—	250	—
I_G	—	mA	—	4	—

Maximum Operating Ratings

Parameter	Rating
Input Power	13 dBm
Junction Temperature[4,5]	+150°C
Operating Temperature	-40°C to +85°C

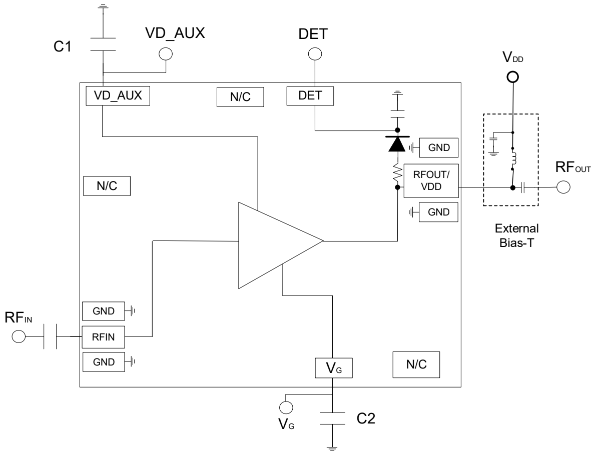
4. Operating at nominal conditions with junction temperature ≤ +150°C will ensure MTTF > 1 x 10^6 hours.
5. Junction Temperature (T_J) = T_C + $Θ_{JC}$ * ((V * I) - (P_{OUT} - P_{IN}))
   Typical thermal resistance ($Θ_{JC}$) = 10.1 °C/W.
   a) For T_C = +25°C,
   T_J = +41.7 °C @ 8 V, 235 mA, P_{OUT} = 23.6 dBm, P_{IN} = 8 dBm
   b) For T_C = +85°C,
   T_J = +102.1 °C @ 8 V, 235 mA, P_{OUT} = 22.9 dBm, P_{IN} = 8 dBm

Absolute Maximum Ratings[6,7,8]

Parameter	Absolute Maximum
Input Power	25 dBm
Drain and V_D_Aux Voltage	+10 V
Gate Voltage	-5 to 0 V
Junction Temperature[9]	+175°C
Storage Temperature	-65°C to +125°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. Junction temperature directly effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

Application Schematic



Bill of Materials[9,10,11]

Part	Value	Size	Comment
C1, C2	1 µF	0402	bypass

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

Biasing Conditions

Recommended biasing conditions are V_{DD} = 8 V, I_{DSQ} = 220 mA (controlled with V_G).

By-pass capacitor C1 for the auxiliary pad is for a low frequency operation extension (below 1 GHz).

There are 2 possible methods to bias the drain:

1. The required VDD is applied at RFOUT/VDD through the bias tee. This provides wide band performance of 100 kHz - 27 GHz (depending on the bandwidth of the bias tees).

2. The required VDD is applied at VD_AUX through a wideband conical inductor. No external bias tee is required at the RFOUT/VDD but an external DC block is required. This provides wide band performance of 100 kHz - 27 GHz (depending on the bandwidth of the bias tee).

There are 2 possible methods to bias the gate:

1. VG is applied using the VG pad (pin 12) and set using to provide the required current bias (IDSQ). No external bias tee is required at the RF input but an external DC block is required. This provides wide band performance of 100 kHz - 27 GHz (depending on the bandwidth of the bias tee). .

2. VG is applied at the RF input (pin 2) through an external bias tee on the RF input line and set to provide the required current bias (IDSQ). This provides wide band performance of 100 kHz - 27 GHz (depending on the bandwidth of the bias tees).

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 1B devices.

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 ground paddle.

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.

Operating the MAAP-011324-DIE

Turn-on

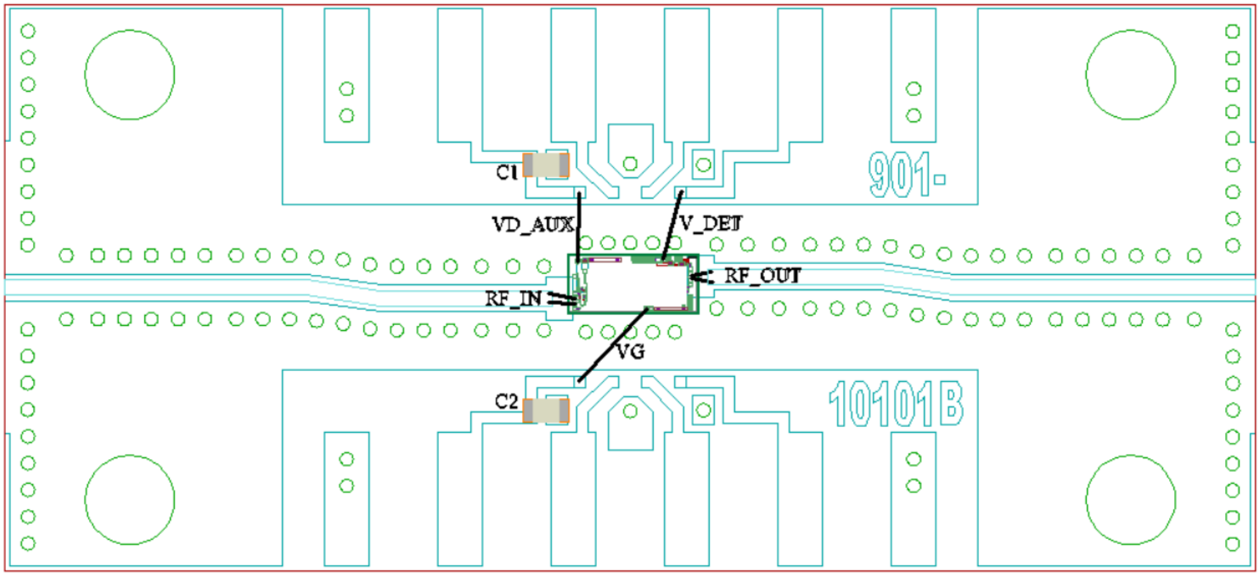
1. Apply V_{G1} (-4.5 V).
2. Increase V_{DD} to 8 V.
3. Set I_{DSQ} by adjusting V_G more positive (typically –0.53 V for I_{DSQ} = 220 mA).
4. Apply RF_{IN} signal.

Turn-off

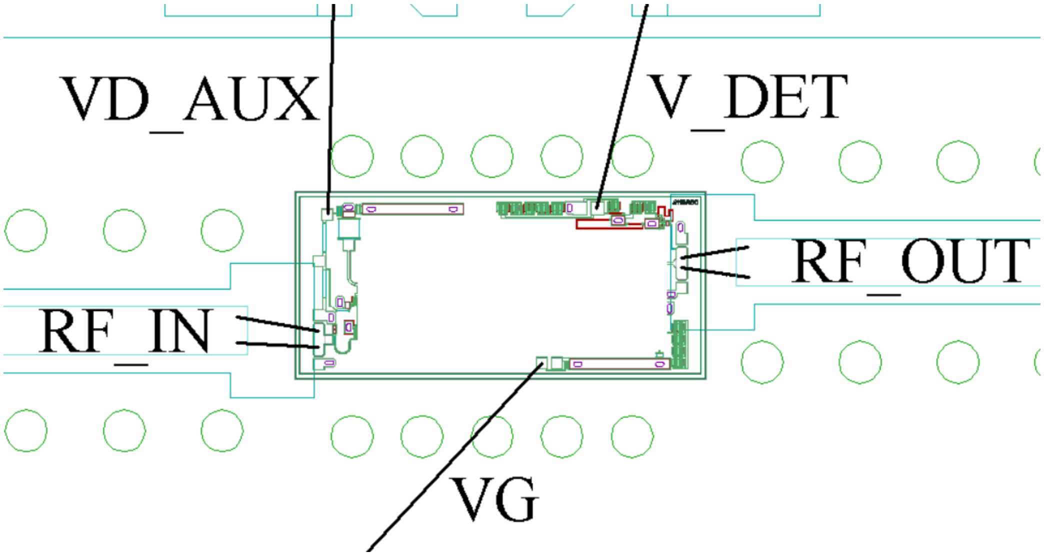
1. Remove RF_{IN} signal.
2. Decrease V_G to -4.5 V.
3. Decrease V_{DD} to 0 V.

PCB Layout:

RF input and output traces on 901-10101B board are cut such that die can fit between them with out shorting them to ground.



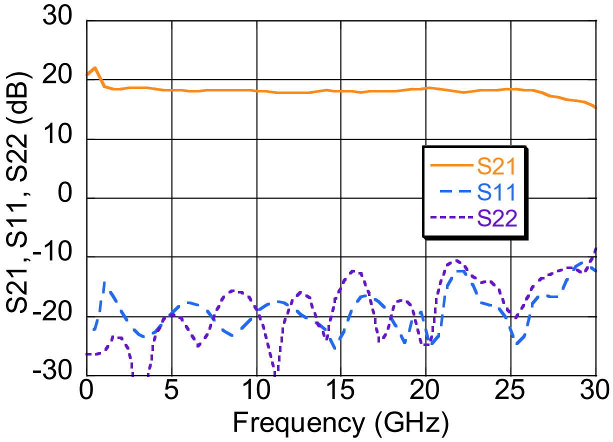
Close Up:



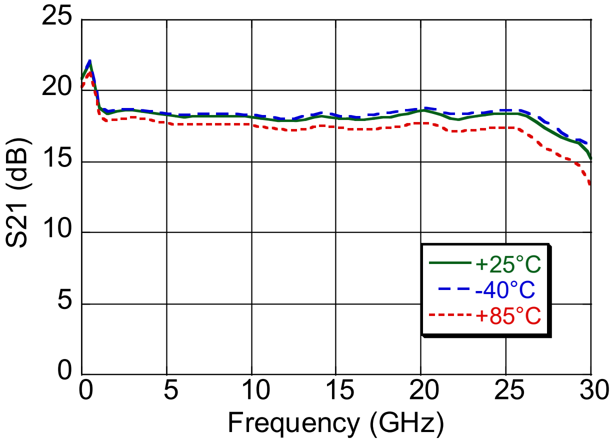
Typical Performance Curves (Measurement includes Wirebond):

V_{DD} = 8 V, I_{DSQ} = 220 mA, V_G = -0.53 V typical

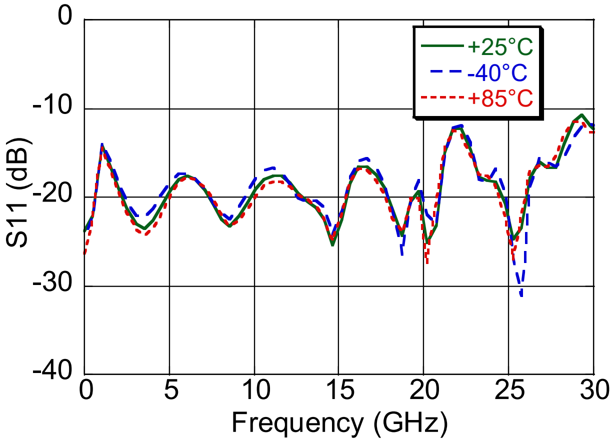
S Parameters



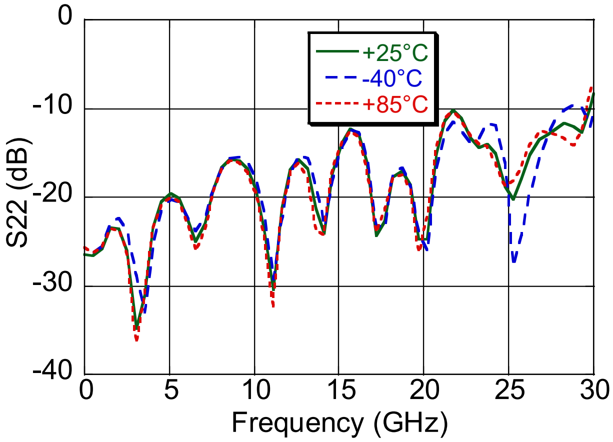
Gain



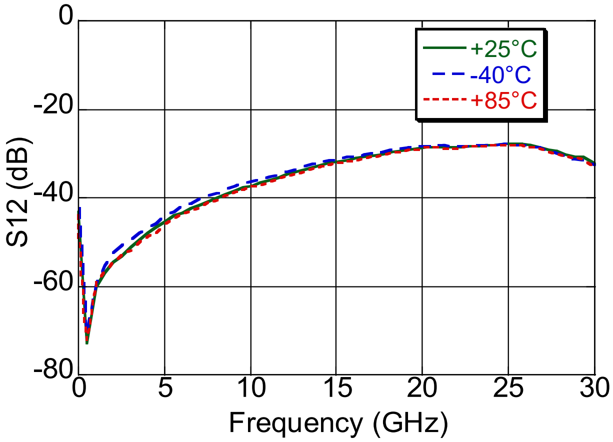
Input Return Loss



Output Return Loss



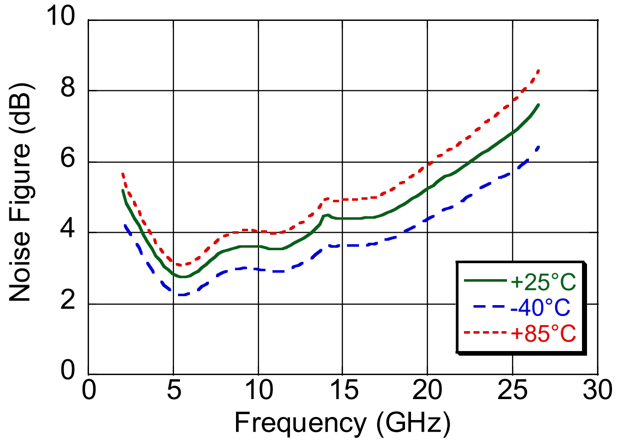
Isolation



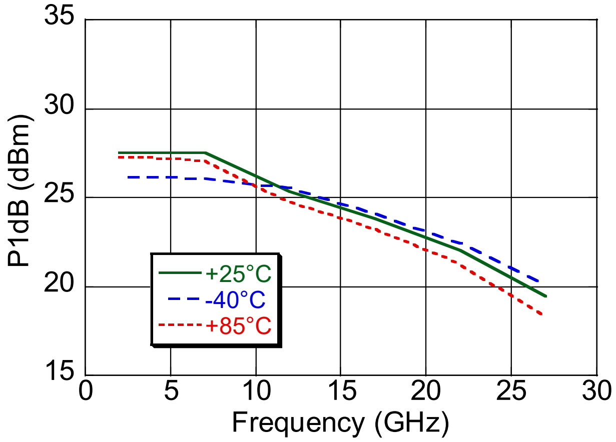
Typical Performance Curves (Measurement includes Wirebond):

V_{DD} = 8 V, I_{DSQ} = 220 mA, V_G = -0.53 V typical

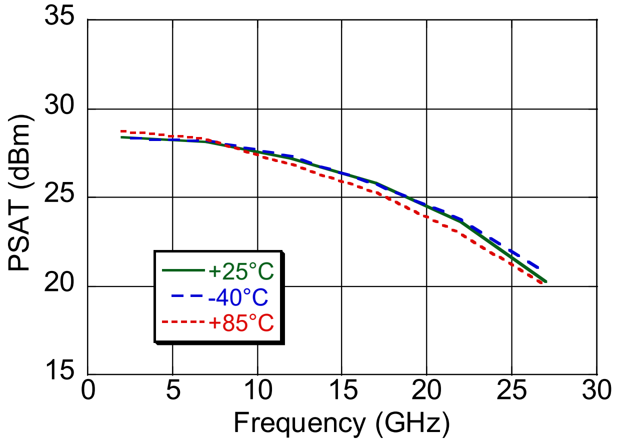
Noise Figure over Temperature



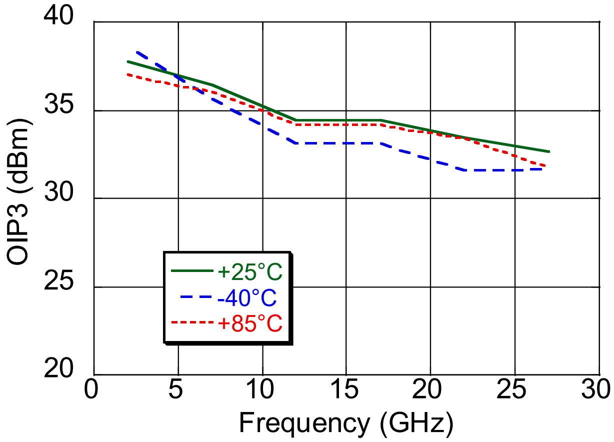
P1dB over Temperature



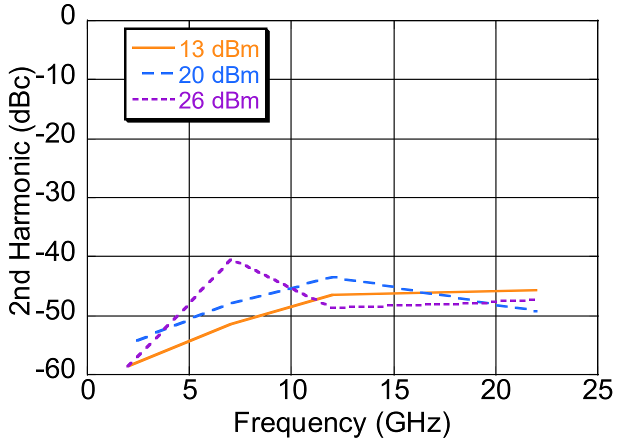
P_{SAT} over Temperature



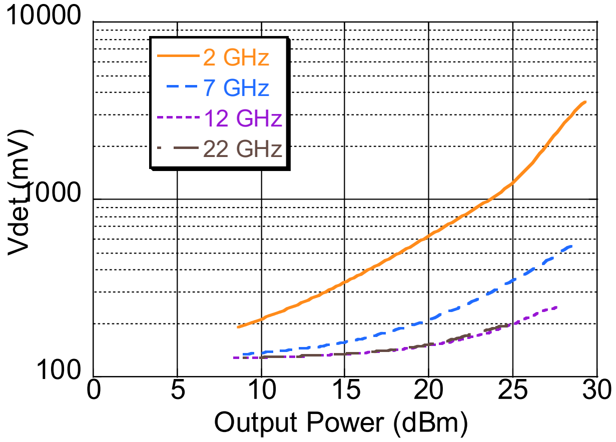
Output IP3 over Temperature @ 14 dBm per tone



2nd Harmonic



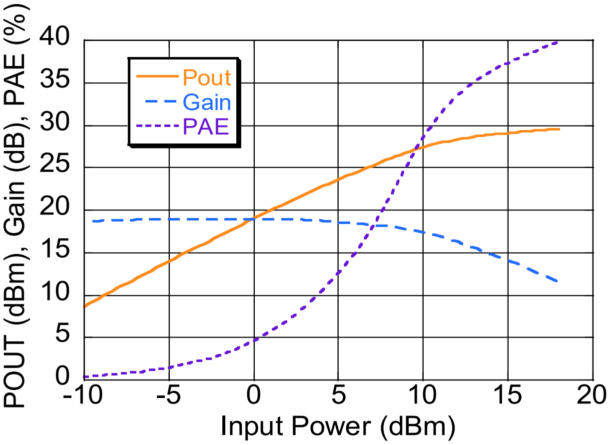
Detected Voltage



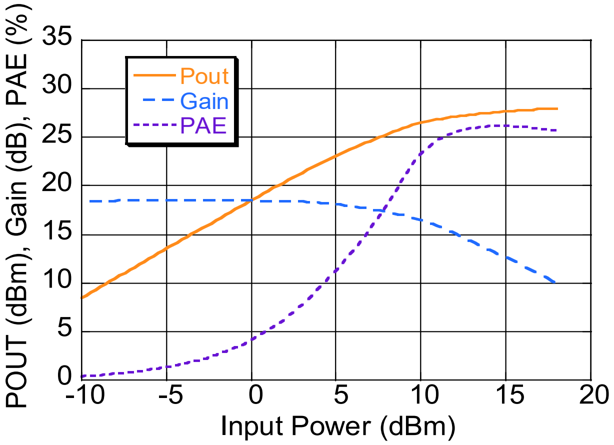
Typical Performance Curves (Measurement includes Wirebond):

V_{DD} = 8 V, I_{DSQ} = 220 mA, V_G = -0.53 V typical

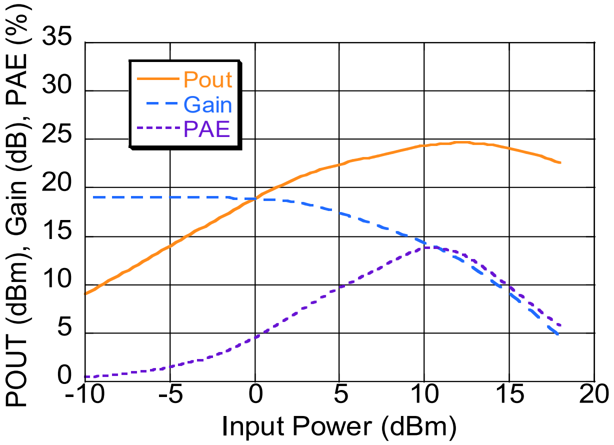
Power Compression @ 2 GHz



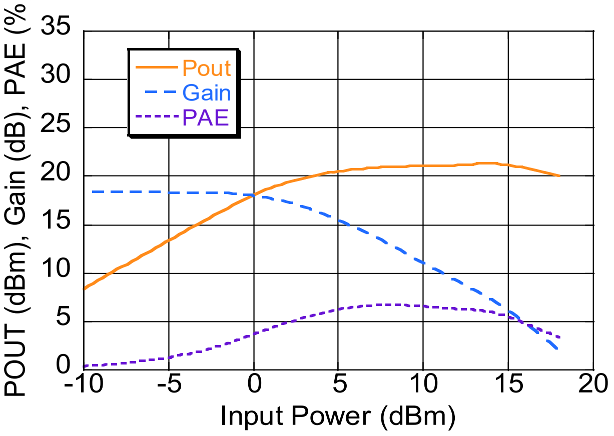
Power Compression @ 12 GHz



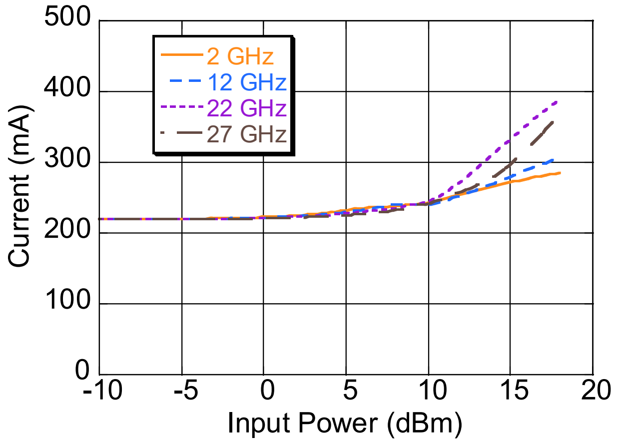
Power Compression @ 22 GHz



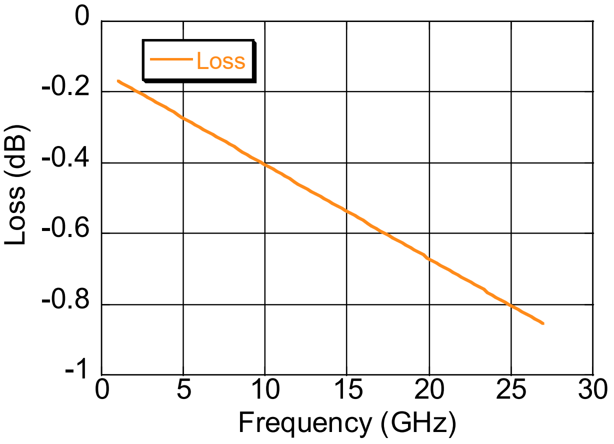
Power Compression @ 27 GHz



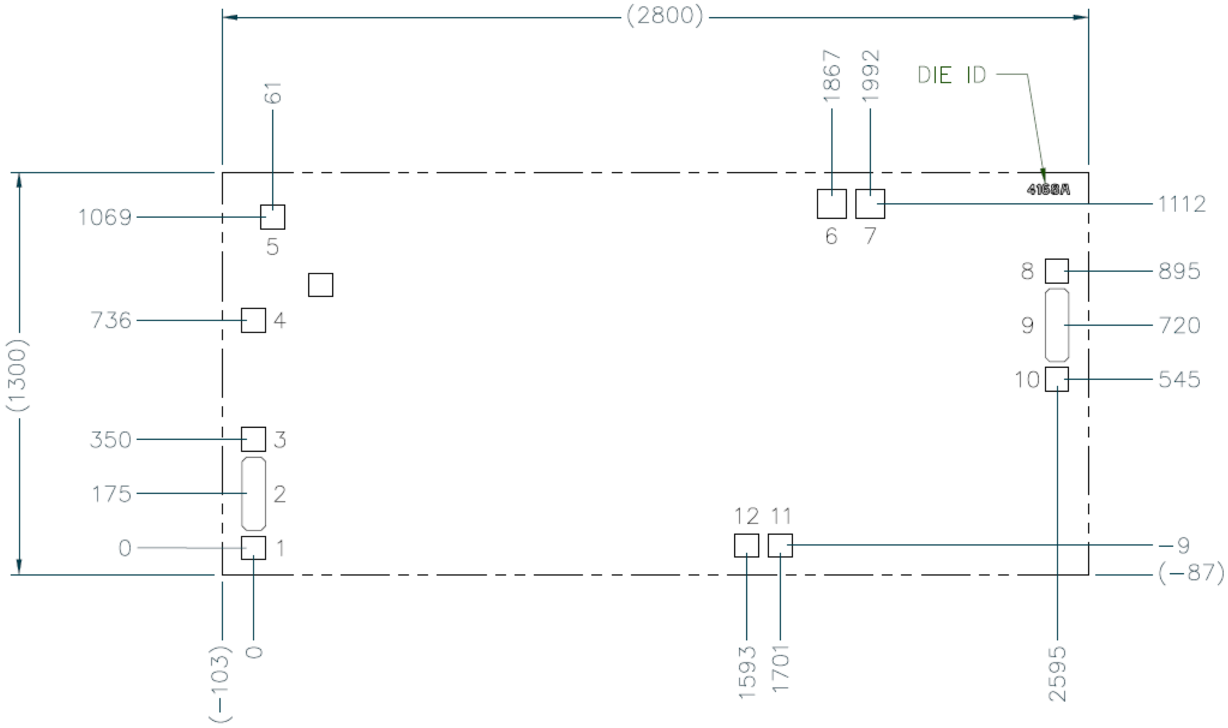
Current



Test Board Loss including Connector



Die Dimensions[12,13,14,15]



12. All units in µm, unless otherwise noted, with a tolerance of ± 5 µm.
13. Die thickness is 100 ± 10 µm.
14. Die size reflects un-cut dimensions. Laser kerf reduces die size by ~ 25 µm each dimension.
15. Bond Pad / Backside Metallization : Gold
16. The un-numbered bondpad near pads 4 and 5 is for DC probe test only.

Bond Pad Dimensions (µm)

Pad	X	Y
1,3,4,5,6,7, 8,10,11,12	76	76
2,9	76	236