

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.

Ordering Information

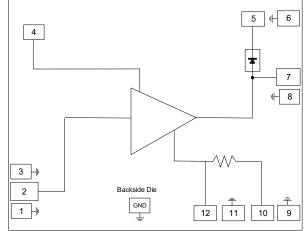
Part Number	Package
MAAP-011327-DIE	Gel Pack ¹
MAAP-011327-DIESMB	Sample Board

1. Die quantity varies.

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

Functional Schematic



Pin Configuration²

Pin #	Pin Name	Description	
1, 3, 6, 8, 9, 11	GND	Ground	
2	RFIN	RF Input	
4	VD_AUX	VD Auxiliary	
5	DET	Power Detector	
7	RFout/Vdd	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.

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

Electrical Specifications: $T_A = +25^{\circ}C$, $V_{DD} = 10 V$, $I_{DSQ} = 500 mA$, $Z_0 = 50 \Omega$

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 $\leq +150^{\circ}$ C will ensure MTTF > 1 x 10⁶ hours.
- 4. Junction Temperature $(T_J) = T_C + \Theta_{JC} * ((V * I) (P_{OUT} P_{IN}))$ Typical thermal resistance $(\Theta_{JC}) = 12.2 \text{ °C/W}.$

a) For $T_c = +85^{\circ}C$,

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 $T_{\rm J}$ = +151°C @ 10 V, 0.60 A, $P_{\rm OUT}$ = 29 dBm, $P_{\rm IN}$ = 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.

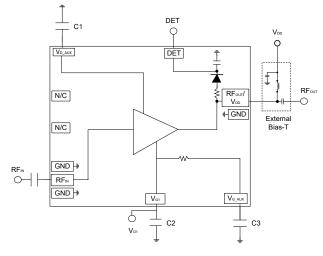
 Junction temperature directly effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

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^{6.} MACOM does not recommend sustained operation near these survivability limits.



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.

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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 μ m) diameter vias under the device, assuming an 8 mil (200 μ m) 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.
- 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.

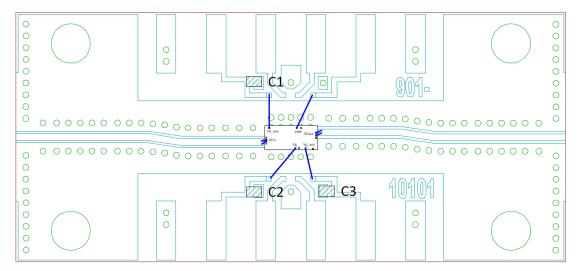
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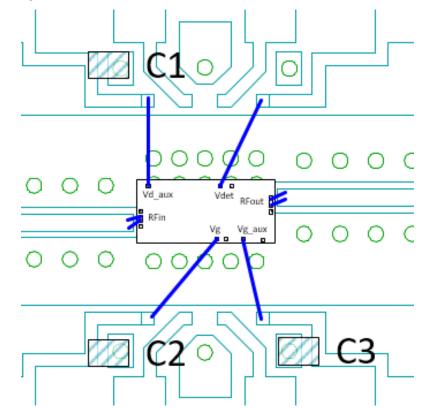
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PCB Layout



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

Die Bonding Close Up



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25 0

-40 0

25

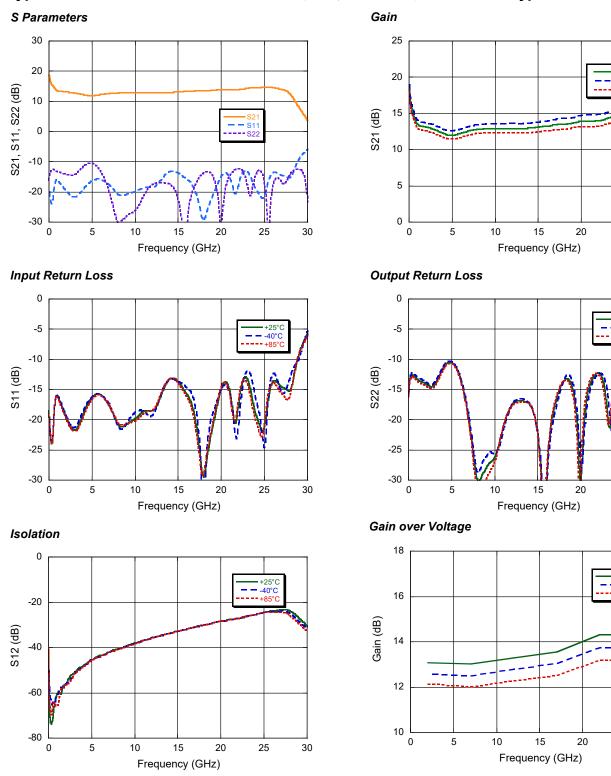
+25°C

-40°C

25

30

30



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

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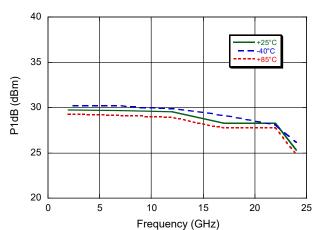
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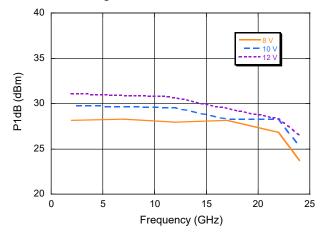


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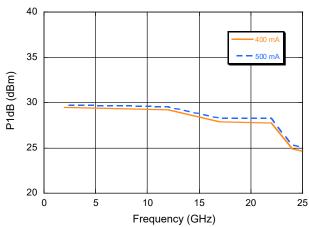
P1dB over Temperature

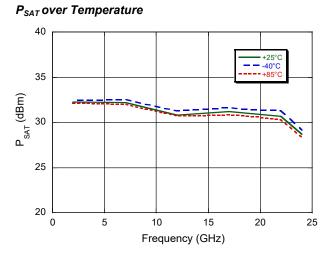


P1dB over Voltage

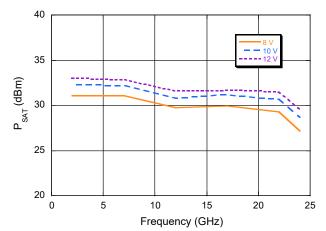


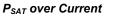
P1dB over Current

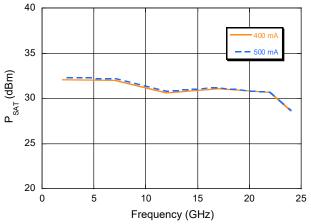




P_{SAT} over Voltage







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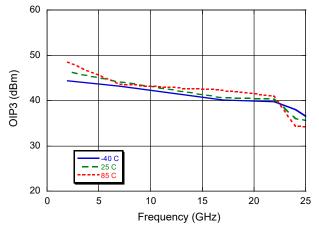
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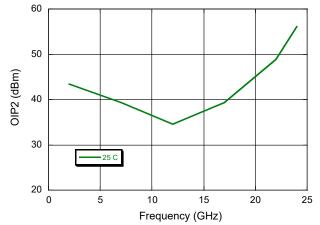


Typical Performance Curves V_{DD} = 10 V, I_{DSQ} = 500 mA, V_{G1} = -0.8 V typical

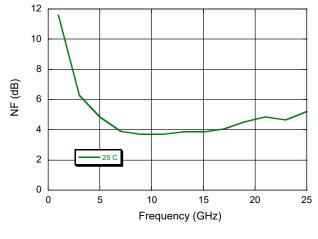
Output IP3 vs. Frequency over Temperature @Po=18dBm/tone



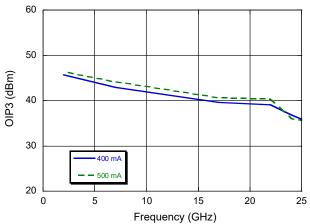
Output IP2 vs. Frequency @Po=18dBm/tone



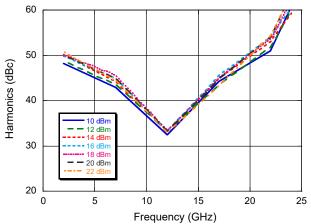
Noise Figure vs. Frequency



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



2nd Harmonic level vs. Frequency over Output Power

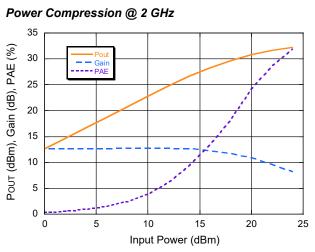


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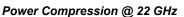
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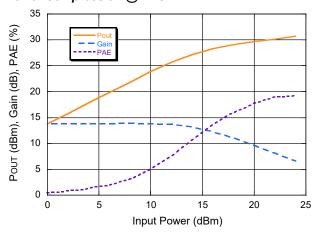


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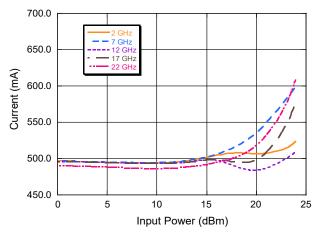


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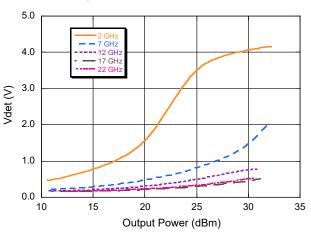


Current





35 Pour (dBm), Gain (dB), PAE (%) 30 25 20 15 10 5 0 0 10 20 25 5 15 Input Power (dBm)



Detector Voltage vs. Power

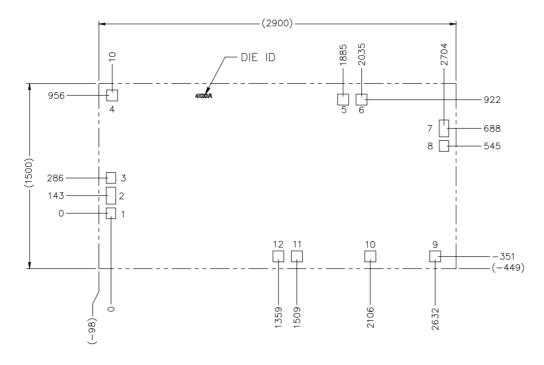
Power Compression @ 12 GHz

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Die Dimensions^{11,12,13}



- 11. Units are in microns with a tolerance of $\pm 5 \mu m$, 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 $100 \pm 10 \ \mu m$.

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

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