

Rev. V3

### **Features**

High Gain: 18 dB P1dB: 25.5 dBm P3dB: 27 dBm

Output IP3: 34.5 dBm Bias Voltage: V<sub>DD</sub> = 8 V Bias Current: I<sub>DSQ</sub> = 220 mA 50 Ω Matched Input / Output

Temperature Compensated Output Power Detector

Lead-Free 5 mm 32-lead AQFN Package

RoHS\* Compliant

### **Applications**

- Test & Measurement
- EW, ECM, and Radar

### **Description**

The MAAP-011324 is a 0.25 W distributed power amplifier offered in a lead-free 5 mm 32-lead AQFN package. The power amplifier operates from DC to 27 GHz and provides 18 dB of linear gain and 27 dBm of output power at 3-dB compression. The device is fully matched across the band and includes a temperature compensated output power detector.

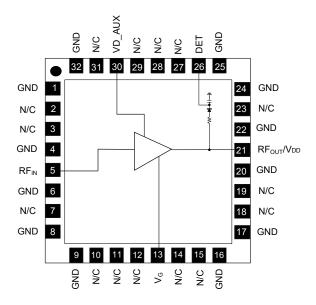
The MAAP-011324 can be used as a power amplifier stage or as a driver stage in higher power applications.

# Ordering Information<sup>1</sup>

Part Number	Package
MAAP-011324-TR0500	500 piece reel
MAAP-011324-TR1000	1000 piece reel
MAAP-011324-SMB	Sample Board

1. Reference Application Note M513 for reel size information.

### **Functional Schematic**



# Pin Configuration<sup>2,3</sup>

Pin #	Pin Name	Description
1, 4, 6, 8, 9, 16, 17, 20, 22, 24, 25, 32	GND	Ground
2, 3, 7, 10 - 12, 14, 15, 18, 19, 23, 27 - 29, 31	N/C	No Connection
5	RFIN	RF Input
13	VG	Gate Voltage
21	RFout/ Vdd	RF Output / Drain Voltage
26	DET	Power Detector
30	VD_AUX	VD_Auxiliary

- 2. MACOM recommends connecting all no connection pins to
- ground.
  The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

<sup>\*</sup> Restrictions on Hazardous Substances, compliant to current RoHS EU directive.



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# Electrical Specifications: $T_A = +25$ °C, $V_{DD} = 8$ V, $I_{DSQ} = 220$ mA, $Z_0 = 50$ $\Omega$

Parameter	Test Conditions		Min.	Тур.	Max.
Gain	2 GHz 12 GHz 22 GHz 27 GHz		17.0 16.5 17.0	18.5 18.0 18.5 17.5	_
P <sub>OUT</sub>	P <sub>IN</sub> = +10 dBm 2 GHz 12 GHz 22 GHz 27 GHz		_	28.5 27.0 23.5 20.5	_
P1dB	2 GHz 12 GHz 22 GHz 27 GHz		24.0 22.5 19.5 —	26.0 24.0 21.5 19.5	_
OIP3	P <sub>out</sub> = +13 dBm/tone (10 MHz Tone Spacing) 2 GHz 12 GHz 22 GHz 27 GHz		_	37.5 34.5 32.5 28.5	_
PAE	P <sub>IN</sub> = +10 dBm 2 GHz 12 GHz 22 GHz 27 GHz		_	26.5 22.5 13.0 6.0	_
Input Return Loss	P <sub>IN</sub> = -10 dBm	dB	_	15	_
Output Return Loss	P <sub>IN</sub> = -10 dBm		_	15	_
I <sub>DD</sub> (with RF drive)	P <sub>IN</sub> = +10 dBm		_	250	_
I <sub>G</sub>	-		_	4	_

# **Maximum Operating Ratings**

Parameter	Rating
Input Power	13 dBm
Junction Temperature <sup>4,5</sup>	+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<sup>6</sup> hours.
- 5. Junction Temperature ( $T_J$ ) =  $T_C$  +  $\Theta_{JC}$  \* ((V \* I) ( $P_{OUT}$   $P_{IN}$ )) Typical thermal resistance ( $\Theta_{JC}$ ) = 10.8 °C/W. a) For  $T_C$  = +25°C,
  - $T_{\rm J}^{\prime}$  = +43.3 °C @ 8 V, 239 mA,  $P_{\rm OUT}$  = 23.4 dBm,  $P_{\rm IN}$  = 8 dBm b) For  $T_{\rm C}$  = +85°C,
  - $T_J$  = +103.6 °C @ 8 V, 239 mA,  $P_{OUT}$  = 23 dBm,  $P_{IN}$  = 8 dBm

# **Absolute Maximum Ratings**<sup>6,7</sup>

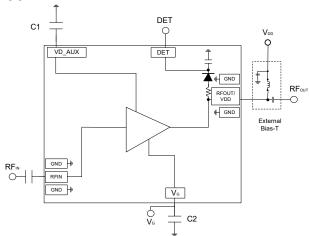
Parameter	Absolute Maximum	
Input Power	25 dBm	
Drain-Voltage	+10 V	
Gate Voltage	-5 to 0 V	
Junction Temperature <sup>8</sup>	+175°C	
Storage Temperature	-65°C to +125°C	

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



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### **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  $V_{DD} = 8 \text{ V}$ ,  $I_{DSO} = 220 \text{ mA}$  (controlled with  $V_{G}$ ).

By-pass capacitor C1 for the auxiliary pad is for a low frequency operation extension (below 1 GHz). This provides wide band performance of 100 kHz - 27 GHz (depending on the bandwidth of the bias tees).

To bias the drain:

1. The required  $V_{DD}$  is applied at  $RF_{OUT}/V_{DD}$  through the bias tee.

There are 2 possible methods to bias the gate:

- V<sub>G</sub> is applied using the V<sub>G</sub> pad (pin 13) and set using to provide the required current bias (I<sub>DSQ</sub>).
   No external bias tee is required at the RF input but an external DC block is required.
- 2. V<sub>G</sub> is applied at the RF input (pin 5) through an external bias tee on the RF input line and set to provide the required current bias (I<sub>DSQ</sub>).

# Operating the MAAP-011324 Turn ON

- 1. Apply V<sub>G1</sub> (-4.5 V).
- 2. Increase V<sub>DD</sub> 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<sub>IN</sub> signal.

### **Turn OFF**

- 1. Remove RF<sub>IN</sub> signal.
- 2. Decrease V<sub>G</sub> to -4.5 V.
- 3. Decrease  $V_{DD}$  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 1B devices.

### **Recommended PCB Information**

RF input and output are 50  $\Omega$  transmission lines. Single layer 8 mil Rogers RO4008 with 1/2 oz. Cu. Use copper filled vias under ground paddle.

### Grounding

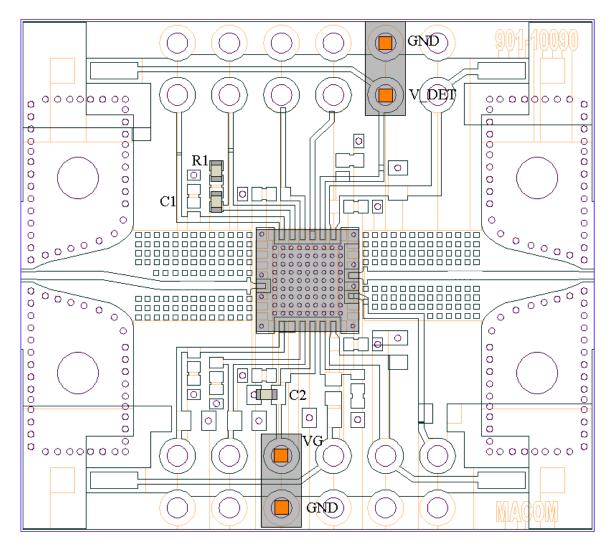
It is recommended that the total ground (common mode) inductance not exceed 0.03 nH (30 pH). This is equivalent to placing at least four 8-mil (200-µm) diameter vias under the device, assuming an 8-mil (200-µm) thick RF layer to ground.



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### Sample Board Layout

R1 is a zero ohm resistor and vias underneath package need to be solid copper filled and plated over. Do not use copper paste for vias. The MACOM sample board uses 81 vias underneath the IC. Gerber files are available upon request.



# Sample Board Material Specifications

Top Layer: 1/2 oz Copper Cladding, 0.017 mm thickness Dielectric Layer: Rogers RO4003C 0.203 mm thickness Bottom Layer: 1/2 oz Copper Cladding, 0.017 mm thickness



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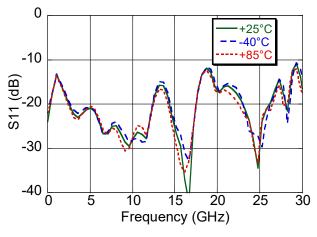
# Typical Performance Curves $V_{DD}$ = 8 V, $I_{DSQ}$ = 220 mA, $V_{G}$ = -0.53 V typical

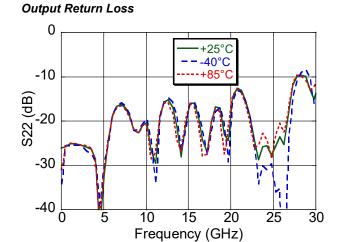
# S Parameters 30 20 20 70 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 10 80 1

Frequency (GHz)

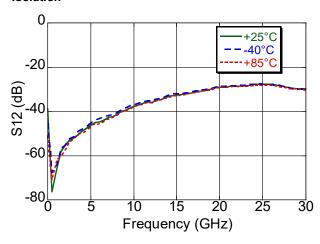
### Gain 25 20 S21 (dB) 15 10 +25°C -40°C 5 +85°C 0 15 25 5 10 20 30 Frequency (GHz)

### Input Return Loss





### Isolation

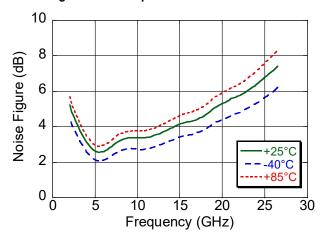




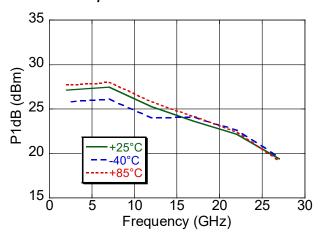
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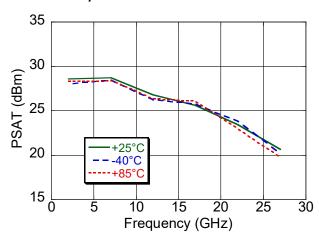
### Noise Figure over Temperature



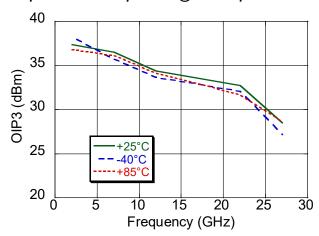
### P1dB over Temperature



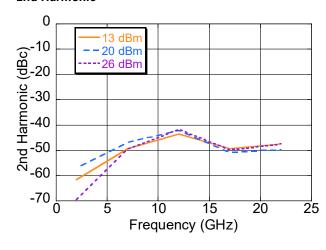
### **P**<sub>SAT</sub> over Temperature



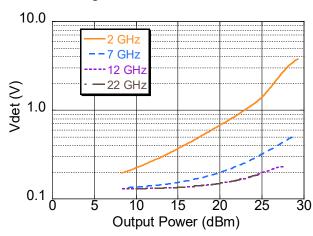
### Output IP3 over Temperature @ 14 dBm per tone



### 2nd Harmonic



### **Detected Voltage**



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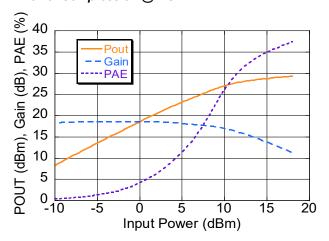
Visit <a href="https://www.macom.com">www.macom.com</a> for additional data sheets and product information.



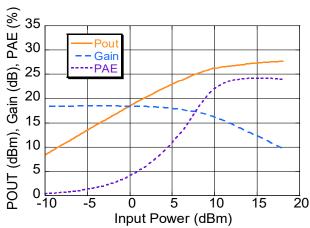
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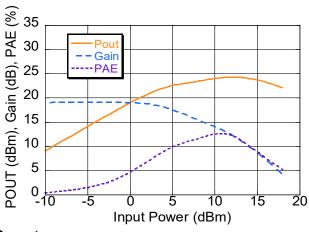
### Power Compression @ 2 GHz



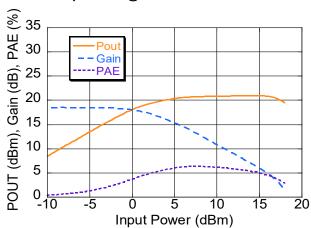
### Power Compression @ 12 GHz



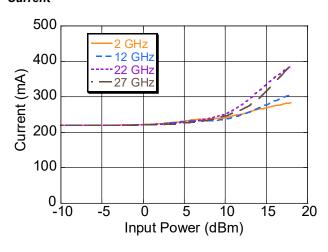
### Power Compression @ 22 GHz



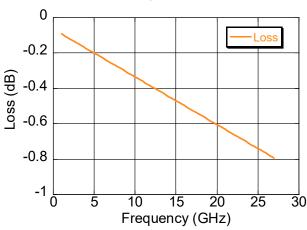
### Power Compression @ 27 GHz



### Current



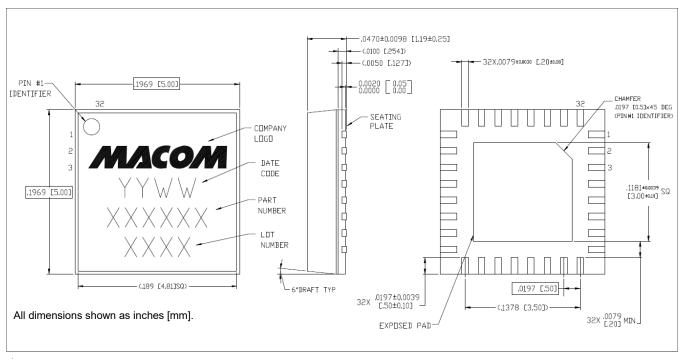
Test Board Loss including Connector





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# Lead-Free 5 mm 32-lead AQFN Package<sup>†</sup>



<sup>&</sup>lt;sup>†</sup> Reference Application Note S2083 for lead-free solder reflow recommendations. Meets JEDEC moisture sensitivity level 3 requirements. Plating is NiPdAu.

# Power Amplifier, 0.25 W DC - 27 GHz



MAAP-011324

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