

### Features

- Ultra Wideband Performance
- Noise Figure: 1.4 dB @ 8 GHz
- High Gain: 17.5 dB @ 8 GHz
- Output IP3: 27.5 dBm @ 8 GHz
- Bias Voltage:  $V_{DD} = 5 - 6 V$
- Bias Current:  $I_{DSQ} = 60 - 100 mA$
- 50  $\Omega$  Matched Input / Output
- Positive Voltage Only
- Lead-Free 5 mm 32-lead AQFN Package
- RoHS\* Compliant

### Applications

- Test & Measurement, EW, ECM, and Radar

### Description

The MAAL-011141 is an easy to use, wideband low noise distributed amplifier die. It operates from DC to 28 GHz and provides 17.5 dB of linear gain, 16 dBm of P1dB and 1.4 dB of noise figure at 8 GHz. The input and output are fully matched to 50  $\Omega$  with typical return loss >15 dB.

This amplifier employs an active termination circuit to achieve a lower noise figure at the lower end of the frequency range than is possible using traditional resistive termination techniques.

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

The MAAL-011141 can be used as a low noise 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.

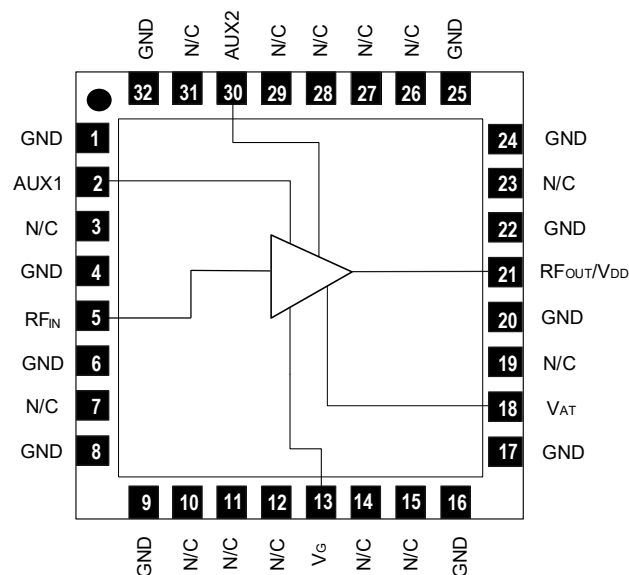
### Ordering Information<sup>1,2</sup>

| Part Number        | Package        |
|--------------------|----------------|
| MAAL-011141-TR0500 | 500 piece reel |
| MAAL-011141-001SMB | Sample Board   |

1. Reference Application Note M513 for reel size information.
2. All sample boards include 3 loose parts.

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

### Functional Schematic



### Pin Configuration<sup>3,4</sup>

| Pin #                                      | Pin Name                            | Description                |
|--|-------------------------------------|----------------------------|
| 2  | AUX1                                | Auxiliary Drain Voltage 1  |
| 5  | RF <sub>IN</sub>                    | RF Input                   |
| 13   | V <sub>G</sub>                      | Gate Voltage               |
| 18   | V <sub>AT</sub>                     | Active Termination Voltage |
| 21   | RF <sub>OUT</sub> / V <sub>DD</sub> | RF Output / Drain Voltage  |
| 30   | AUX2                                | Auxiliary Drain Voltage 2  |
| 1, 4, 6, 8, 9, 16, 17, 20, 22, 24, 25, 32  | GND                                 | Ground                     |
| 3, 7, 10 - 12, 14, 15, 19, 23, 26 - 29, 31 | N/C                                 | No Connection              |

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

Electrical Specifications:  $T_A = +25^\circ\text{C}$ ,  $V_{DD} = 6\text{ V}$ ,  $I_{DSQ} = 75\text{ mA}$ ,  $V_{AT} = 5\text{ V}$ ,  $Z_0 = 50\ \Omega$

| Parameter          | Test Conditions   | Units | Min.                        | Typ.                                 | Max.                      |
|--------------------|---|-------|-----------------------------|--------------------------------------|---------------------------|
| Gain               | $P_{IN} = -20\text{ dBm}$<br>2.0 GHz<br>8.0 GHz<br>12.0 GHz<br>18.0 GHz<br>26.5 GHz                             | dB    | 16.0<br>—<br>15.0<br>—<br>— | 18.0<br>17.5<br>17.5<br>17.5<br>17.5 | —                         |
| Output P1dB        | 2.0 GHz<br>8.0 GHz<br>12.0 GHz<br>18.0 GHz<br>26.5 GHz  | dBm   | —                           | 17.0<br>16.0<br>15.5<br>15.5<br>12.0 | —                         |
| OIP3               | $P_{IN} = -20\text{ dBm}$ / tone, 10 MHz Tone Spacing<br>2.0 GHz<br>8.0 GHz<br>12.0 GHz<br>18.0 GHz<br>26.5 GHz | dBm   | —                           | 29.5<br>27.5<br>26.0<br>25.0<br>22.5 | —                         |
| Input Return Loss  | $P_{IN} = -20\text{ dBm}$   | dB    | —                           | 15                                   | —                         |
| Output Return Loss | $P_{IN} = -20\text{ dBm}$   | dB    | —                           | 15                                   | —                         |
| Noise Figure       | 2.0 GHz<br>8.0 GHz<br>12.0 GHz<br>18.0 GHz<br>26.5 GHz  | dB    | —                           | 2.7<br>1.4<br>1.5<br>2.2<br>3.4      | 3.5<br>—<br>2.2<br>—<br>— |
| Isolation          | $P_{IN} = -20\text{ dBm}$<br>2.0 GHz<br>8.0 GHz<br>12.0 GHz<br>18.0 GHz<br>26.5 GHz                             | dB    | —                           | 55<br>40<br>37<br>35<br>33           | —                         |
| $V_G$              | Adjusted to set $I_{DSQ} = 75\text{ mA}$  | V     | —                           | 0.7                                  | —                         |
| $I_{AT}$           | $V_{AT} = 5\text{ V}$   | mA    | —                           | 10                                   | —                         |

### Operating Conditions

Recommended biasing conditions are  $V_{DD} = 6\text{ V}$ ,  $I_{DSQ} = 75\text{ mA}$ . Bias of 5 V must be applied to  $V_{AT}$  pin.  $I_{DSQ}$  is set by adjusting  $V_G$  after setting  $V_{DD}$  and  $V_{AT}$ . The drain bias voltage range,  $V_{DD}$ , is 5 to 6 V, and the quiescent drain current biasing is 60 to 100 mA. To maintain the best performance MACOM recommends using an active bias circuit for constant  $I_{DD}$ .

There are three possible bias methods:

1. The use of an external bias tee where the required  $V_{DD}$  is applied at  $RF_{OUT}/V_{DD}$  and  $V_G$  is set to provide a current bias ( $I_{DSQ}$ ) of 60 to 100 mA. This provides wide band performance of DC - 28 GHz. (depending on the bandwidth of the bias tee).
2. The direct application of  $V_{DD}$  to AUX1. Using this method provides for an operational frequency of 2 - 28 GHz. However, a voltage drop across an internal 17  $\Omega$  resistance and a 1.5  $\Omega$  typical series DC inductor resistance must be accounted for. For example, with  $I_{DSQ} = 75\text{ mA}$ , 7.4 V must be applied at AUX1 for a  $V_{DD}$  of 6 V.
3. The direct application of  $V_{DD}$  to AUX2. Using this method provides for an operational frequency of DC - 28 GHz. However, a voltage drop across series 17  $\Omega$  and 32  $\Omega$  resistors must be accounted for. For example, with  $I_{DSQ} = 75\text{ mA}$ , 9.67 V must be applied at AUX2 for a  $V_{DD}$  of 6 V.

In all cases DC blocking is required on the RF input. Additionally options 2 and 3 require DC blocking on the RF output line. It should also be noted that when using the internal bias circuit (option 2 or 3)  $I_{DSQ}$  is limited to a maximum of 80 mA.

Regardless of bias method used, a bypass capacitor of 0.1  $\mu\text{F}$  should be connected to AUX2. This provides for increased device stability margins and improved gain flatness below 2 GHz when required. When using bias method 2, an 82 nH series inductor combined with a 0.1  $\mu\text{F}$  shunt capacitor and 220  $\Omega$  resistor is recommended. This increases gain flatness below 2 GHz.

The available evaluation board is configured for bias option 3 using AUX2 for the supply of  $V_{DD}$ .

### Maximum Operating Conditions

| Parameter                         | Operating Maximum                           |
|-----------------------------------|---|
| Input Power <sup>5</sup>          | $P_{IN} \leq 1\text{ dB compression level}$ |
| Junction Temperature <sup>6</sup> | +150°C                                      |
| Operating Temperature             | -40°C to +85°C                              |

5. MACOM does not recommend sustained operation at power levels above 1 dB gain compression.
6. Operating at nominal conditions with junction temperature  $\leq +150^\circ\text{C}$  will ensure MTTF  $> 1 \times 10^6$  hours.

### Absolute Maximum Ratings<sup>7,8</sup>

| Parameter                         | Absolute Maximum |
|-----------------------------------|------------------|
| Input Power                       | 18 dBm           |
| Drain Voltage                     | 7 V              |
| Gate Voltage                      | 0.9 V            |
| Active Termination Voltage        | 6 V              |
| AUX1 Current                      | 80 mA            |
| AUX2 Current                      | 80 mA            |
| Junction Temperature <sup>9</sup> | +175°C           |
| Storage Temperature               | -65°C to +125°C  |

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

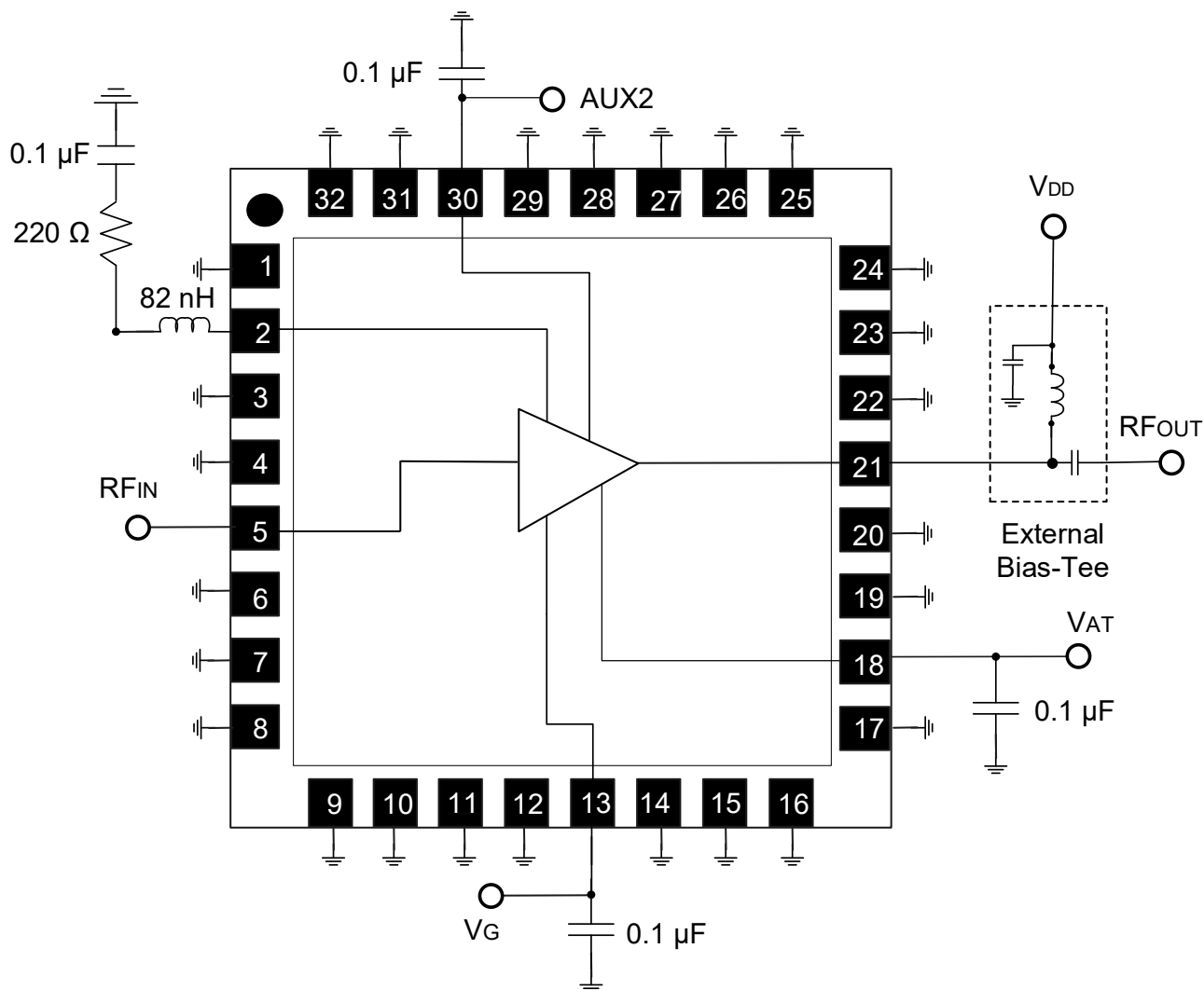
### Handling Procedures

Please observe the following precautions to avoid damage:

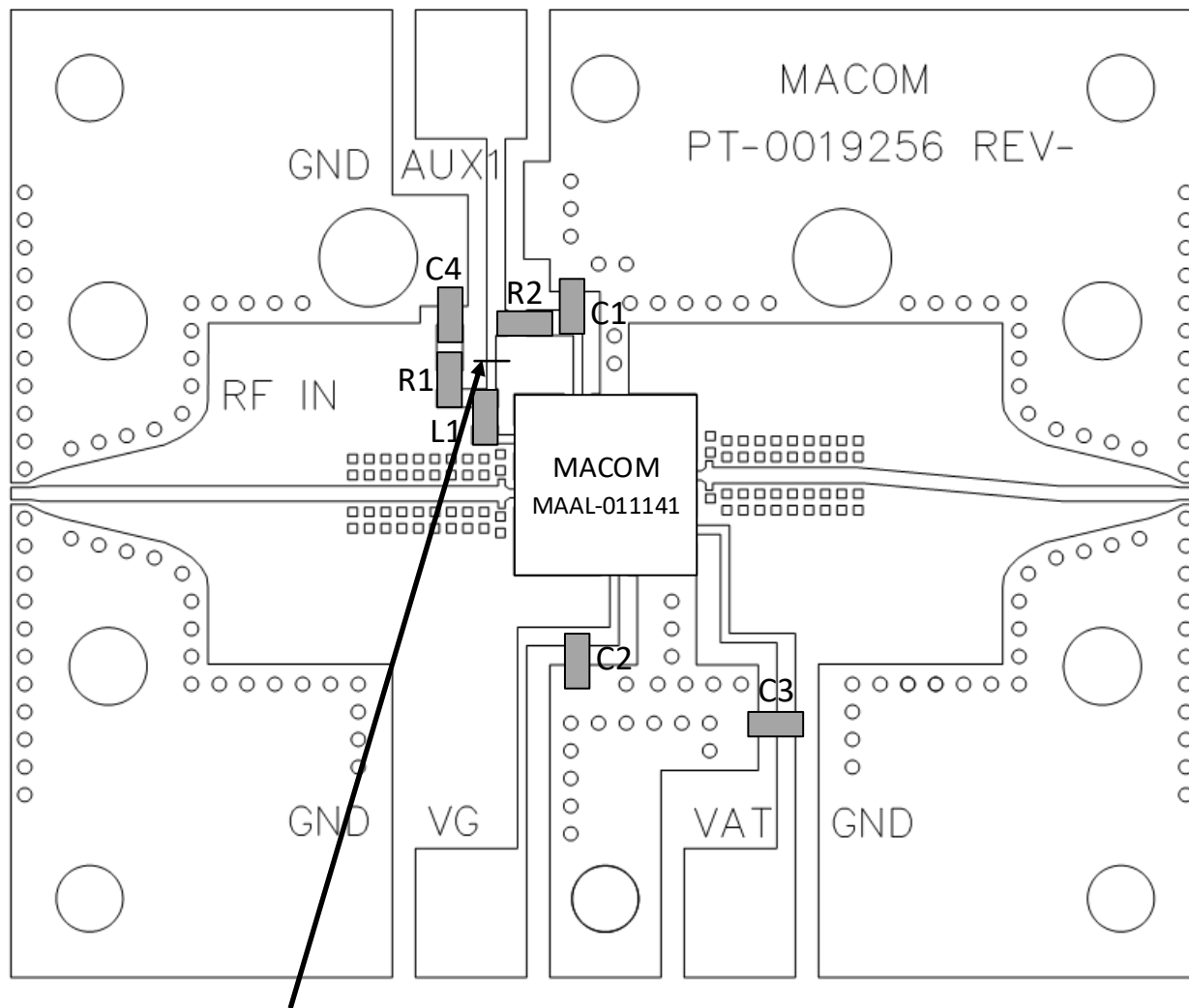
### Static Sensitivity

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.

Application Schematic



Applications Section: Sample board layout for bias option 3 using AUX2



Cut trace for AUX2 operation

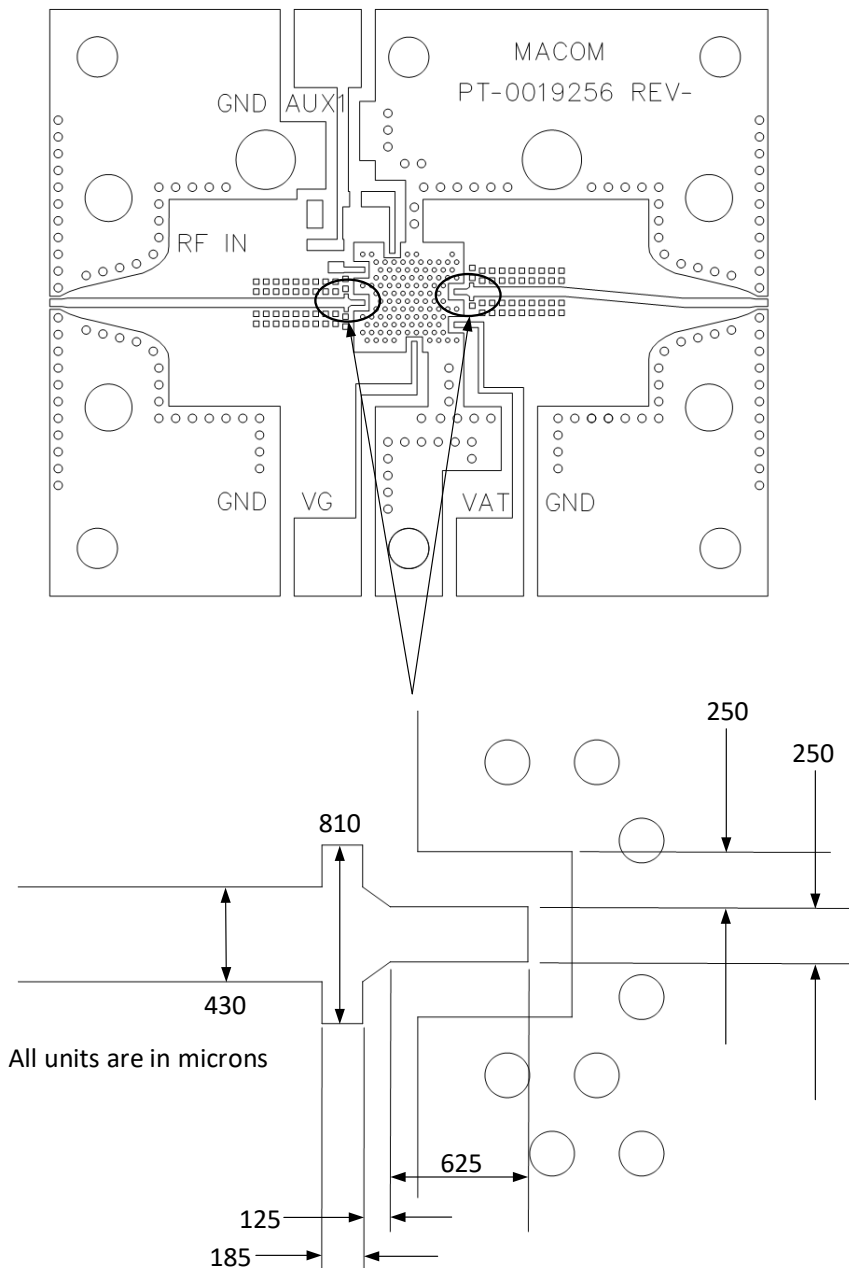
Parts List

| Part    | Value        | Case Style |
|---------|--------------|------------|
| C1 - C4 | 0.1 $\mu$ F  | 0402       |
| R1      | 220 $\Omega$ | 0402       |
| R2      | 0 $\Omega$   | 0402       |
| L1      | 82 nH        | 0402       |

Evaluation PCB 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  
Finished overall thickness: 0.237 mm

Sample Board Layout: Input and Output Tuning<sup>10</sup>



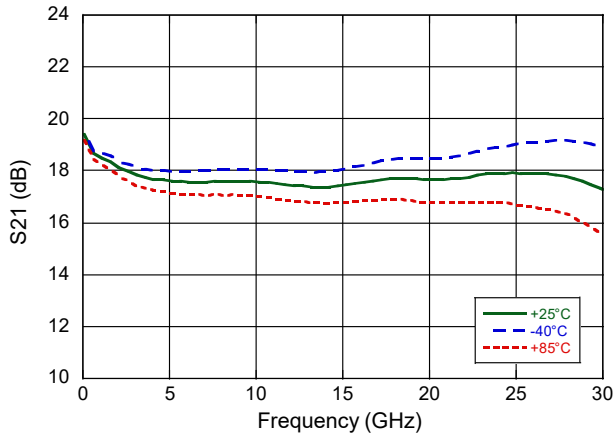
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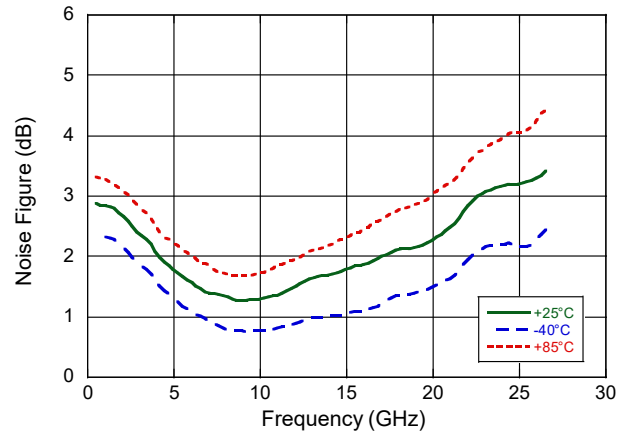
10. Input and output use the same tuning.

Typical Performance Curves:  $V_{DD} = 6\text{ V}$ ,  $I_{DSQ} = 75\text{ mA}$ ,  $V_{AT} = 5\text{ V}$

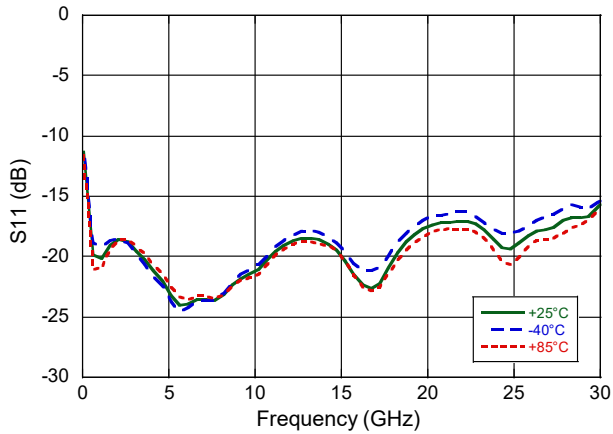
Gain



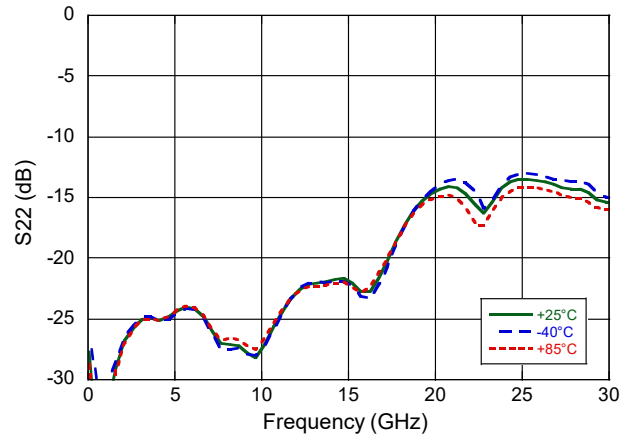
Noise Figure



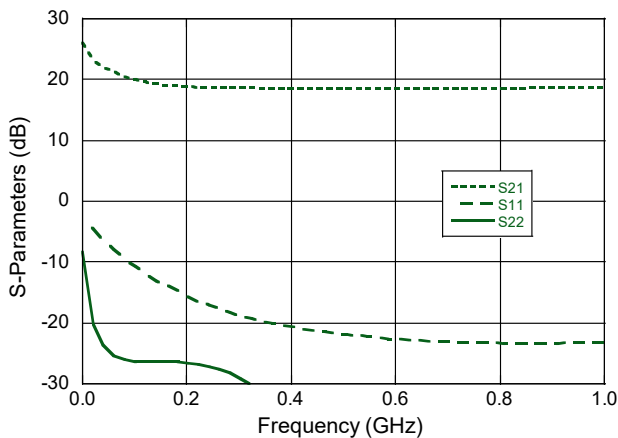
Input Return loss



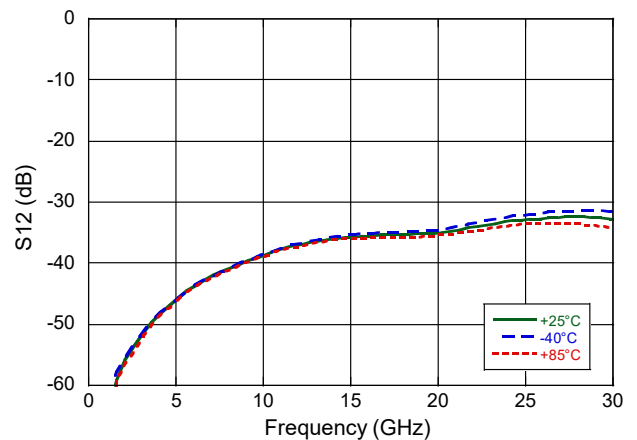
Output Return Loss



Low Frequency S-Parameters

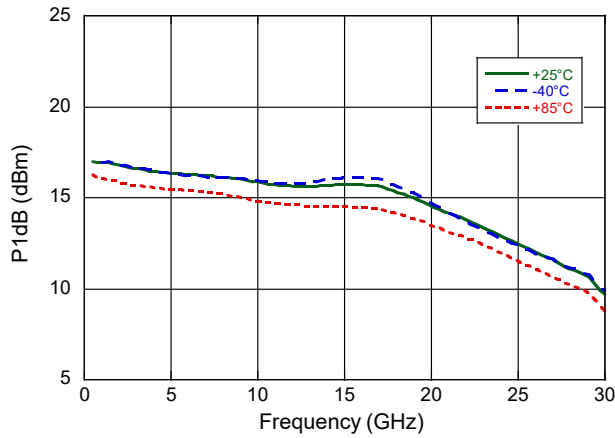


Reverse Isolation

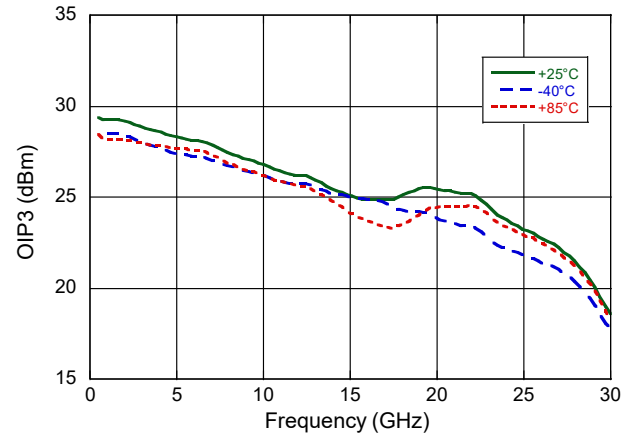


Typical Performance Curves:  $V_{DD} = 6\text{ V}$ ,  $I_{DSQ} = 75\text{ mA}$ ,  $V_{AT} = 5\text{ V}$

Output P1dB

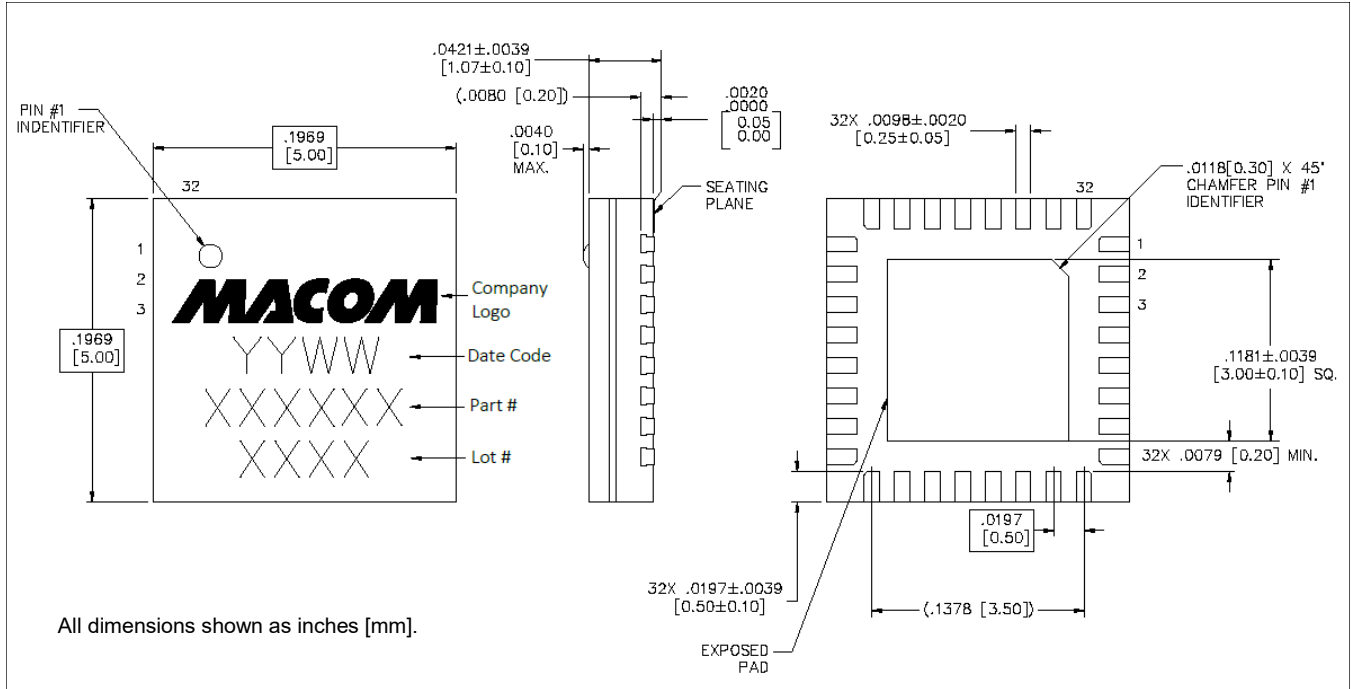


Output IP3 (10 MHz tone spacing)





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



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

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