

## CATV Return Path Differential Amplifier 5 - 300 MHz

Rev. V1

### Features

- 21.2 dB Gain
- 5.0 V Bias
- 3.1 dB Noise Figure
- External Bias Current Control
- Low Distortion
- Wide Bandwidth for DOCSIS 3.1
- Lead-Free 3 mm 16-Lead PQFN Package
- RoHS\* Compliant and 260°C Reflow Compatible

### Description

The MAAM-011185 is a balanced GaAs MMIC amplifier assembled in a lead-free 3 mm 16-lead PQFN plastic package.

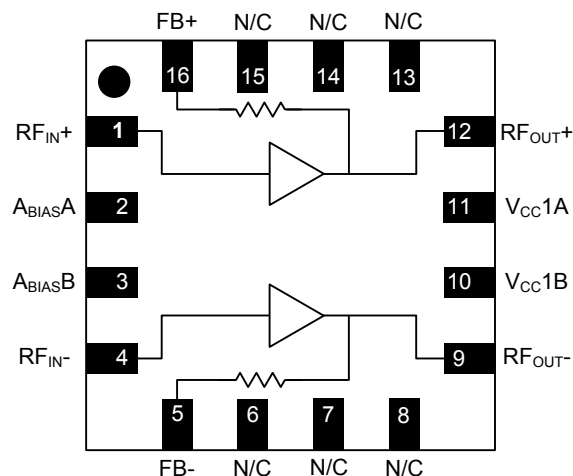
The amplifier is ideally suited for use in CATV return path applications, including DOCSIS 3.1 systems: it offers low distortion and low noise figure with high gain. It typically provides 3.1 dB noise figure, 21.2 dB gain, and 30 dB MER up to 57 dBmV per channel for 16-Channel 64 QAM signaling while drawing 290 mA DC current @ 5 V bias.

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

| Part Number        | Package         |
|--------------------|-----------------|
| MAAM-011185-TR1000 | 1000 piece reel |
| MAAM-011185-TR3000 | 3000 piece reel |
| MAAM-011185-001SMB | Sample Board    |

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.

### Functional Schematic



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

| Pin No. | Pin Name            | Description             |
|---------|---------------------|-------------------------|
| 1       | RF <sub>IN+</sub>   | RF Input +              |
| 2       | A <sub>BIAS</sub> A | Active Bias A           |
| 3       | A <sub>BIAS</sub> B | Active Bias B           |
| 4       | RF <sub>IN-</sub>   | RF Input -              |
| 5       | FB-                 | Feedback -              |
| 6       | N/C                 | No Connection           |
| 7       | N/C                 | No Connection           |
| 8       | N/C                 | No Connection           |
| 9       | RF <sub>OUT-</sub>  | RF Output (DC Bias) -   |
| 10      | V <sub>CC</sub> 1B  | V <sub>CC</sub> Bias 1B |
| 11      | V <sub>CC</sub> 1A  | V <sub>CC</sub> Bias 1A |
| 12      | RF <sub>OUT+</sub>  | RF Output (DC Bias) +   |
| 13      | N/C                 | No Connection           |
| 14      | N/C                 | No Connection           |
| 15      | N/C                 | No Connection           |
| 16      | FB+                 | Feedback +              |
| 17      | Pad <sup>4</sup>    | RF and DC Ground        |

3. All pins listed as 'No Connection' should be grounded.
4. The exposed pad centered on the package bottom must be connected to RF and DC ground.

\* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

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**Electrical Specifications<sup>5</sup>:  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $I_{CC} = 290\text{ mA}$ ,  $Z_0 = 75\ \Omega$**

| Parameter                          | Test Conditions   | Units            | Min.              | Typ.                 | Max.              |
|------------------------------------|---|------------------|-------------------|----------------------|-------------------|
| Gain                               | $P_{IN} = -10\text{ dBm}$ , 100 MHz<br>$P_{IN} = -10\text{ dBm}$ , 205 MHz<br>$P_{IN} = -10\text{ dBm}$ , 250 MHz   | dB               | 20.5<br>20.5<br>— | 21.5<br>21.2<br>21.0 | 22.5<br>22.5<br>— |
| Input Return Loss                  | 5 - 300 MHz   | dB               | —                 | 21                   | —                 |
| Output Return Loss                 | 5 - 300 MHz   | dB               | —                 | 21                   | —                 |
| Reverse Isolation                  | 5 - 300 MHz   | dB               | —                 | 25                   | —                 |
| Noise Figure                       | 5 - 205 MHz<br>205 - 300 MHz  | dB               | —                 | 3.1<br>3.3           | —                 |
| P1dB                               | $I_{CC} = 290\text{ mA}$ , 5 - 300 MHz<br>$I_{CC} = 320\text{ mA}$ , 5 - 300 MHz  | dBm              | —                 | 27.0<br>27.3         | —                 |
| OIP3                               | 12 dBm $P_{OUT}$ per tone, 6 MHz spacing,<br>$I_{CC} = 290\text{ mA}$ , 5 - 300 MHz<br>$I_{CC} = 320\text{ mA}$ , 5 - 300 MHz   | dBm              | —                 | 43<br>45             | —                 |
| OIP2                               | 12 dBm $P_{OUT}$ per tone, 6 MHz spacing,<br>$I_{CC} = 290\text{ mA}$ , 5 - 205 MHz<br>$I_{CC} = 320\text{ mA}$ , 5 - 205 MHz<br>$I_{CC} = 290\text{ mA}$ , 205 - 300 MHz<br>$I_{CC} = 320\text{ mA}$ , 205 - 300 MHz | dBm              | —                 | 80<br>82<br>76<br>78 | —                 |
| $P_{OUT}$ @ 30 dB MER <sup>5</sup> | 16 Channels,<br>$I_{CC} = 290\text{ mA}$ , 5 - 205 MHz<br>$I_{CC} = 320\text{ mA}$ , 5 - 205 MHz  | dBmV/<br>Channel | 55.5<br>—         | 57.0<br>58.0         | —                 |
| $I_{CC}$ <sup>6</sup>              | $R2 = 1.33\text{ k}\Omega$  | mA               | —                 | 290                  | 320               |

5. Modulation Error Ratio, 64 QAM 5.12 MS/s. See 'Typical Performance Curves' on page 5 of this datasheet for an example MER vs. output power relationship.

6. Data corresponds to the typical application circuit and component values shown on page 3 of this datasheet. Parameters shown at nominal  $I_{CC} = 290\text{ mA}$  unless otherwise noted.  $I_{CC}$  is the total DC current draw from the  $V_{CC}$  supply. As shown on page 3, it is distributed to pins 9 and 12 by balun T2 and pins 10 and 11 directly. Resistor R2 determines the DC voltage of  $A_{BIAS/A/B}$  and thereby  $I_{CC}$  at approximately  $0.25\text{ mA}/\Omega$ . See page 5 for a typical  $I_{CC}$  vs. R2 relationship assuming  $V_{CC} = 5\text{ V}$ .

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

| Parameter                            | Absolute Maximum |
|--------------------------------------|------------------|
| Input Power                          | 11 dBm           |
| $V_{CC}$                             | 6 V              |
| Junction Temperature <sup>9,10</sup> | +150°C           |
| Operating Temperature                | -40°C to +85°C   |
| Storage Temperature                  | -65°C to +125°C  |

7. Exceeding any one or a combination of these limits may cause permanent damage to this device.

8. MACOM does not recommend sustained operation near these survivability limits.

9. Operating at nominal conditions with  $T_J \leq 150^\circ\text{C}$  will ensure  $MTTF > 1 \times 10^6$  hours.

10. Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{jc} * (V * I)$   
Typical thermal resistance ( $\Theta_{jc}$ ) = 15° C/W.

a) For  $T_C = +25^\circ\text{C}$ ,  $T_J = 47^\circ\text{C}$  @ 5 V, 290 mA

b) For  $T_C = +85^\circ\text{C}$ ,  $T_J = 107^\circ\text{C}$  @ 5 V, 290 mA

### Handling Procedures

Please observe the following precautions to avoid damage:

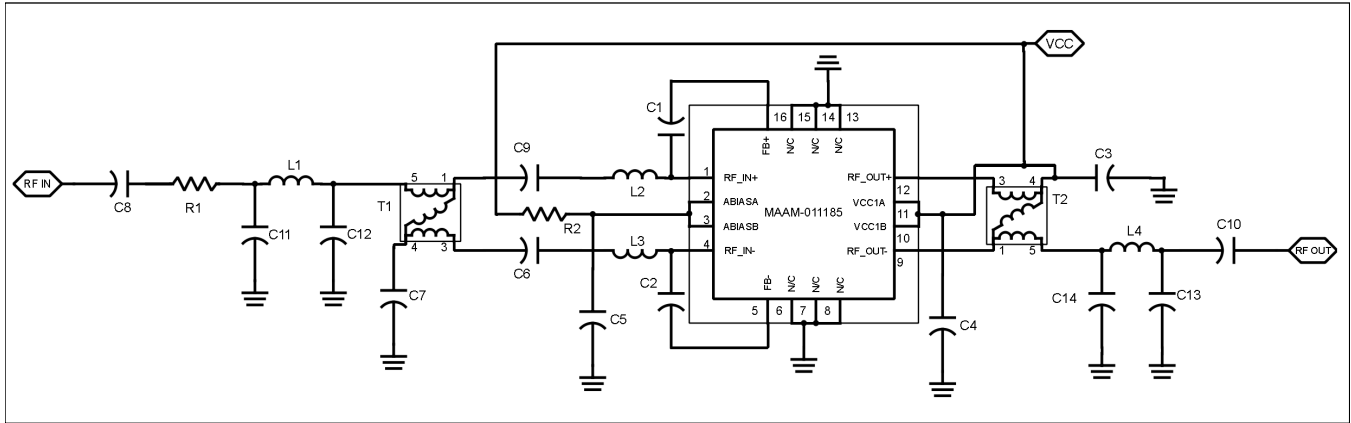
### Static Sensitivity

Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

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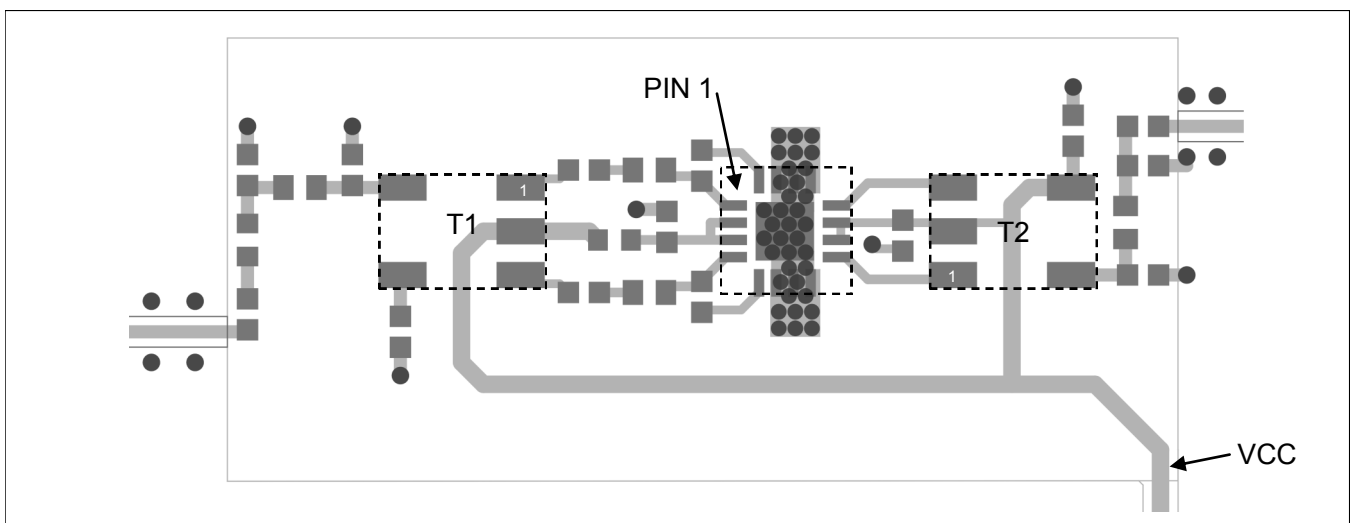
### Typical Application Circuit: Schematic



### Typical Application Circuit: Component Values

| Component | Value                                |
|-----------|--------------------------------------|
| C1 - C9   | 100 nF                               |
| C10       | 1500 pF                              |
| C11, C13  | 2.0 pF                               |
| C12       | 2.5 pF                               |
| C14       | 1.0 pF                               |
| R1        | 2 $\Omega$                           |
| R2        | 1.33 k $\Omega$                      |
| L1        | 22 nH                                |
| L2, L3    | 3.3 nH                               |
| L4        | 6.2 nH                               |
| T1, T2    | MABA-007748-CT1160 1:1 Balun (MACOM) |

### Sample Board Layout



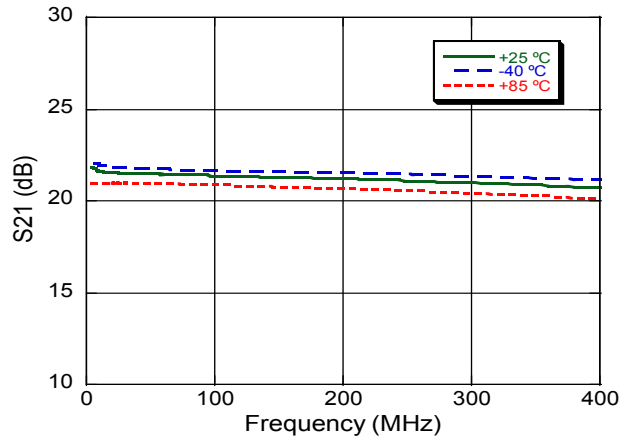
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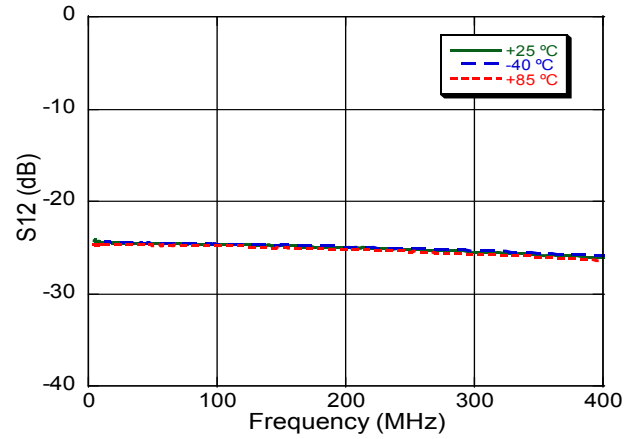
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## Typical Performance Curves: Small-Signal

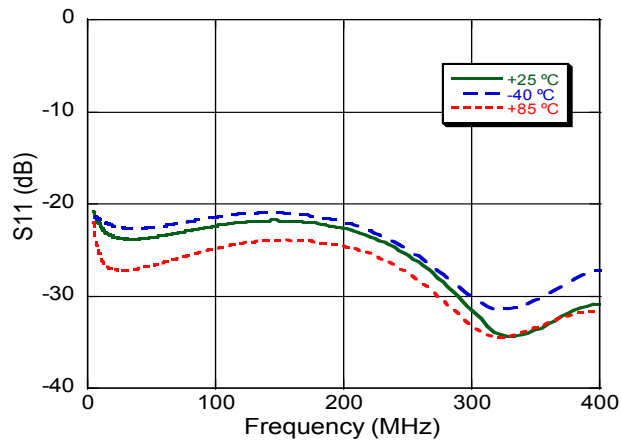
**Gain**



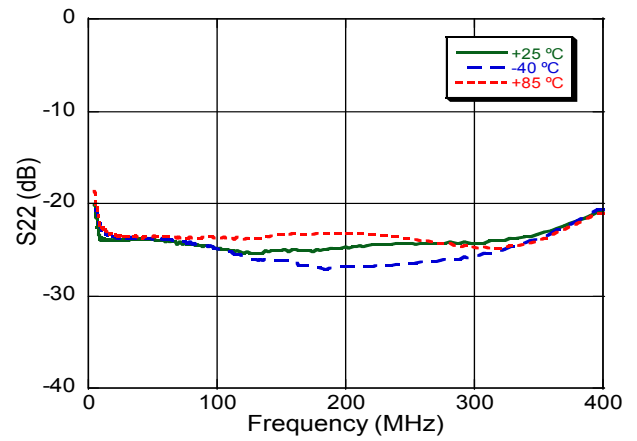
**Reverse Isolation**



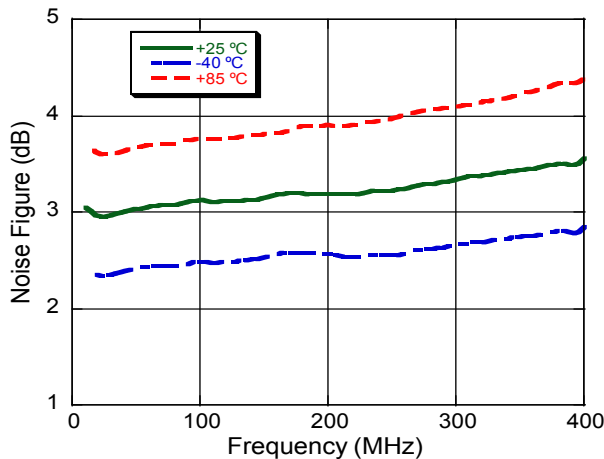
**Input Return Loss**



**Output Return Loss**



**Noise Figure**

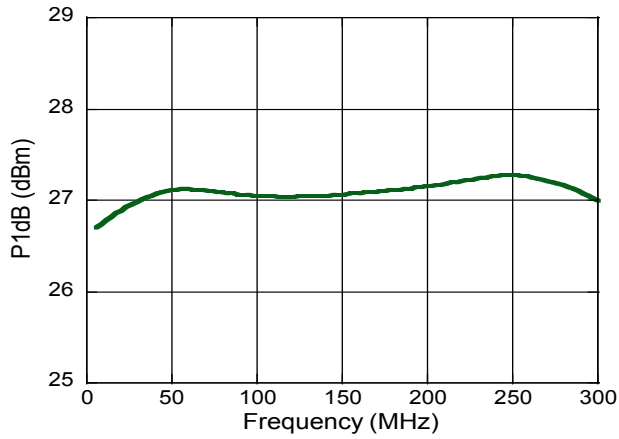


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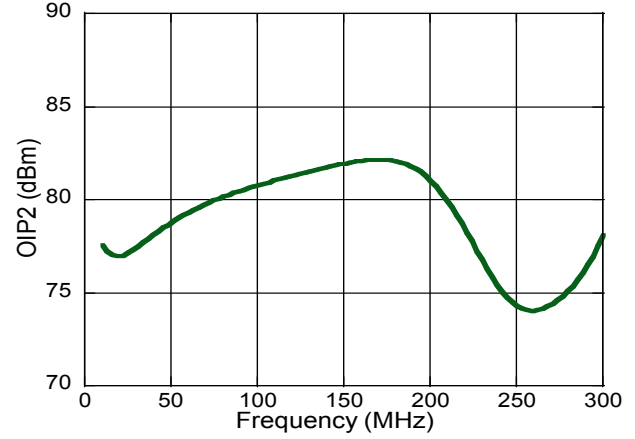
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### Typical Performance Curves: Large Signal

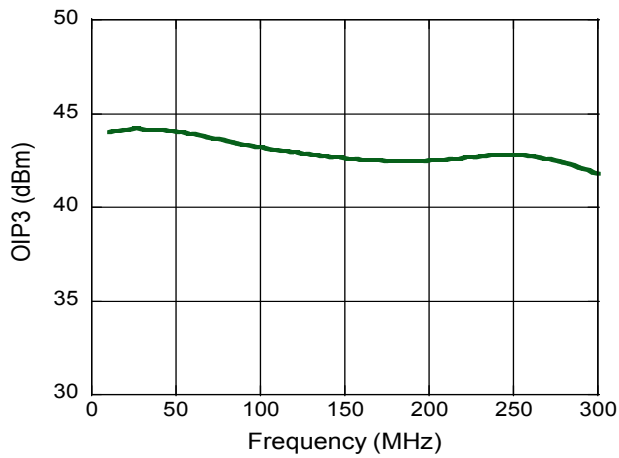
**P1dB**



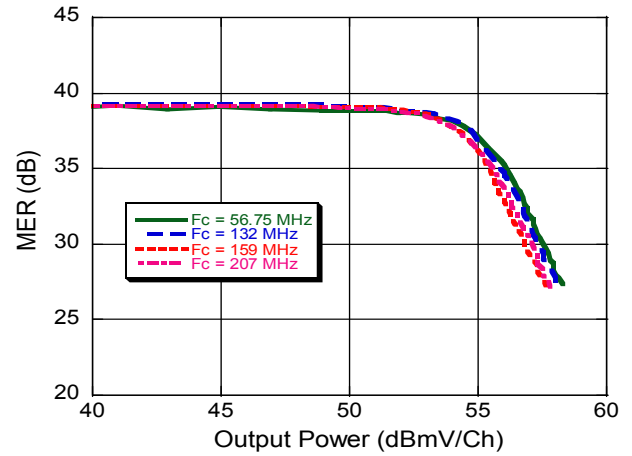
**OIP2 @ 12 dBm P<sub>OUT</sub>**



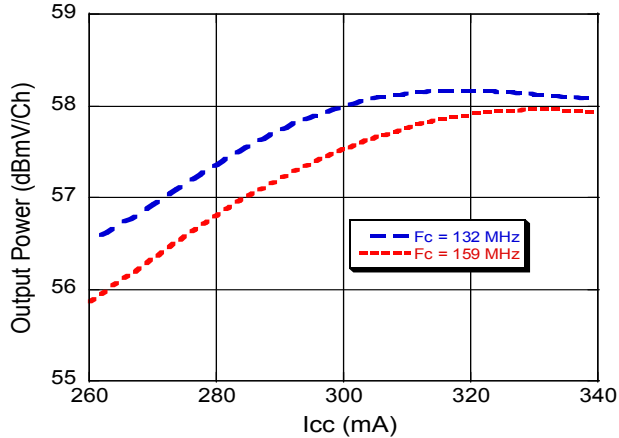
**OIP3 @ 12 dBm P<sub>OUT</sub>**



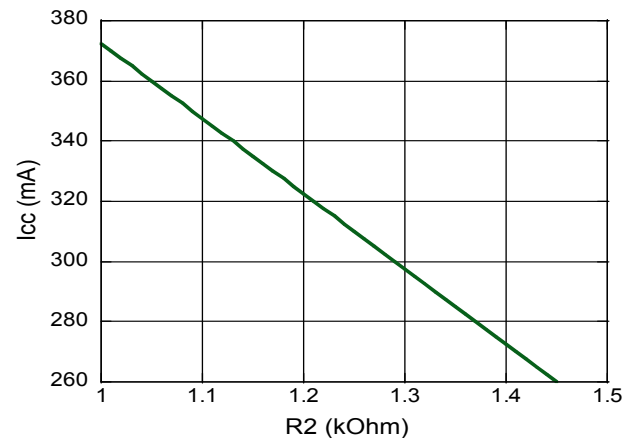
**Modulation Error Ratio (64 QAM, 16 Channel)<sup>11</sup>**



**Output Power at 30 dB MER vs. I<sub>CC</sub><sup>11</sup>**



**I<sub>CC</sub> vs. Resistor R2 at V<sub>CC</sub> = 5 V**

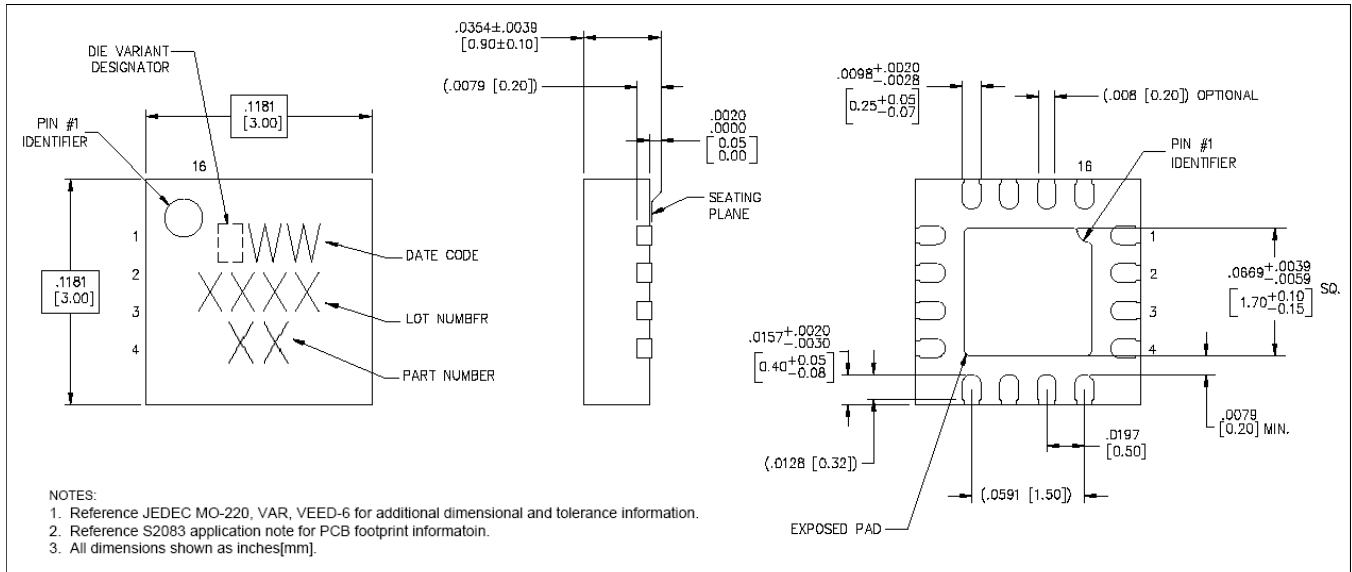


<sup>11</sup>F<sub>C</sub> is the center frequency of the measured channel, which is the 9<sup>th</sup> of 16 consecutive 64-QAM channels.

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### Lead-Free 3 mm 16-Lead PQFN<sup>†</sup>



<sup>†</sup> Reference Application Note S2083 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensitivity 1 requirements.  
Plating is 100% matte tin plating over copper.



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