

## Ultra Low Phase Noise Amplifier 2 - 18 GHz

Rev. V1

### Features

- Wideband Performance
- Noise Figure: 3.5 dB @ 10 GHz
- Phase Noise: -165 dBc/Hz @ 100 kHz Offset
- Bias Voltage: 5 V
- Bias Current: 60 mA
- 50 Ω Matched Input / Output
- Positive Voltage Only
- Lead-Free 5 mm 32-lead PQFN Package
- RoHS\* Compliant

### Description

The MAAL-011151 is an easy to use, wideband low noise distributed amplifier in a lead-free 5 mm 32-lead PQFN package. It operates from 2 to 18 GHz and provides 15 dB of linear gain, 19 dBm of P1dB, and 3.5 dB of noise figure at 10 GHz. The input and output are fully matched to 50 Ω with typical return loss >10 dB.

The RF input and RF output ports are DC blocked. Amplifier control is available through the use of a control circuit.

This product is fabricated using a low phase noise HBT process which features full passivation for enhanced reliability.

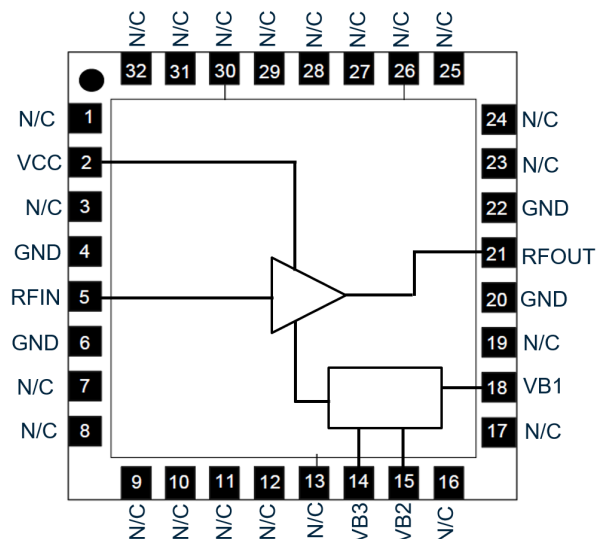
The MAAL-011151 can be used as a low noise amplifier stage for signal generation applications. This device is ideally suited for Test and Measurement, EW, ECM, and Radar applications where ultra low phase noise and drive power is required.

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

Part Number	Package
MAAL-011151-TR0100	100 piece reel
MAAL-011151-001SMB	Sample Board

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

### Functional Schematic



### Pin Configuration

Pin #	Pin Name	Description
1,3,7-13,16, 17,19,23-32	N/C	No Connection
2	VCC	Collector Voltage
4,6,20,22	GND	Ground
5	RFIN	RF Input
14	VB3	Bias Voltage 3
15	VB2	Bias Voltage 2
18	VB1	Bias Voltage 1
21	RFOUT	RF Output
Paddle <sup>3</sup>	GND	Ground

3. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

<sup>1</sup> \* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

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Electrical Specifications:  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = V_{CT}^4 = 5\text{ V}$ ,  $Z_0 = 50\ \Omega$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	$P_{IN} = -15\text{ dBm}$ 2 GHz 10 GHz 18 GHz	dB	15.0 14.0 13.5	16 15 15	—
Output P3dB <sup>5</sup>	2 GHz 10 GHz 18 GHz	dBm	—	22 20 16	—
Output Power	$P_{IN} = +5.7\text{ dBm}$ , 2 GHz $P_{IN} = +3.0\text{ dBm}$ , 10 GHz $P_{IN} = -4.0\text{ dBm}$ , 18 GHz	dBm	18.0 15.0 9.0	20 19 13	—
Input Return Loss	$P_{IN} = -15\text{ dBm}$	dB	—	10	—
Output Return Loss	$P_{IN} = -15\text{ dBm}$	dB	—	10	—
Noise Figure	2 GHz 10 GHz 18 GHz	dB	—	7.0 3.5 8.0	—
Isolation	$P_{IN} = -15\text{ dBm}$ 2 GHz 10 GHz 18 GHz	dB	—	48 42 33	—
Phase Noise	$P_{IN} = +3\text{ dBm}$ , 12 GHz 100 Hz 1 kHz 10 kHz 100 kHz	dBc/Hz	—	-143 -149 -158 -165	—
ICQ	—	mA	—	60	—
ICT <sup>4</sup>	Total current into R1, R2	mA	—	2	—

4. Reference detailed bias conditions on page 3.

5. MACOM does not recommend sustained operation at power levels above 3 dB compression.

### Maximum Operating Conditions

Parameter	Rating
Input Power	$P_{IN} < 3\text{ dB}$ Compression Point
ICQ	90 mA
Junction Temperature <sup>6,7</sup>	130°C
Operating Temperature	-40°C to +85°C

6. Operating at nominal conditions with junction temperature  $\leq 130^\circ\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours.

7. Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{JC} * ((V * I) - (P_{OUT} - P_{IN}))$ .  
Typical thermal resistance ( $\Theta_{JC}$ ) = 120°C/W.

a) For  $T_C = +25^\circ\text{C}$

$T_J = +72^\circ\text{C}$  @ 5 V, 98 mA,  $P_{OUT} = 20\text{ dBm}$ ,  $P_{IN} = 4.5\text{ dBm}$

b) For  $T_C = +85^\circ\text{C}$

$T_J = 129^\circ\text{C}$  @ 5 V, 88 mA,  $P_{OUT} = 19\text{ dBm}$ ,  $P_{IN} = 4.5\text{ dBm}$

### Absolute Maximum Ratings<sup>8,9</sup>

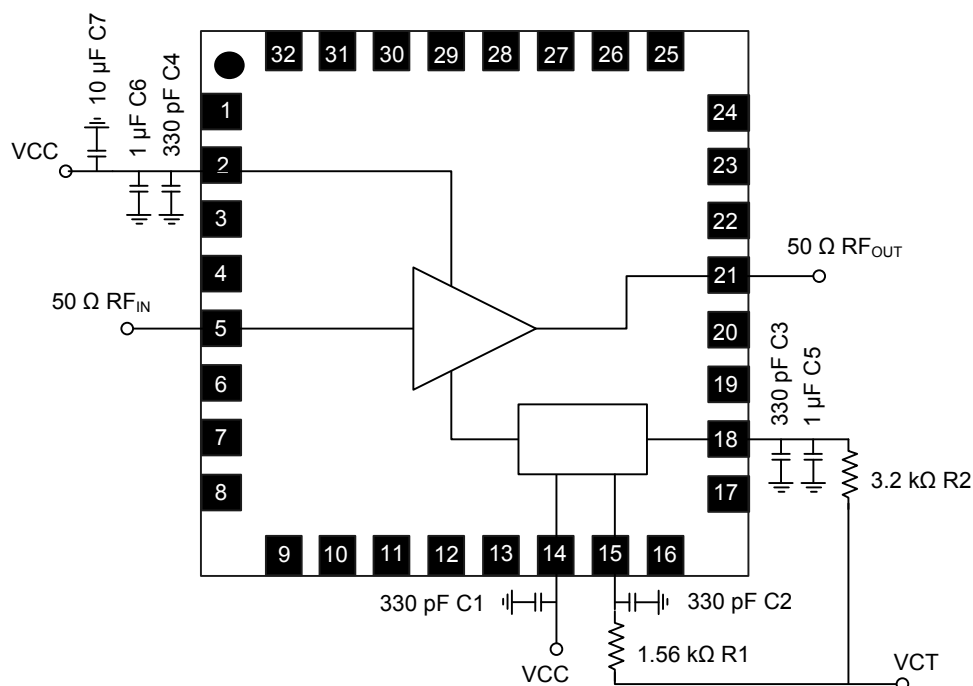
Parameter	Absolute Maximum
Input Power	12 dBm
ICQ	120 mA
VCC, VB1, VB2, VB3	6 V
VB1, VB2, VB3, Current	5 mA
Junction Temperature <sup>10</sup>	150°C
Storage Temperature	-65°C to +125°C

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

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

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

### Application Schematic



### Operating Conditions

Recommended biasing conditions are  $V_{CC} = 5\text{ V}$  applied to pin 14 (VB3) and pin 2 (VCC). Apply amplifier control (VCT) through the offset resistors (R1, R2) to pin 15 (VB2) and pin 18 (VB1) according to the application schematic shown. Setting  $V_{CT} = 5\text{ V}$  will turn on the amplifier ( $I_{CQ} \sim 60\text{ mA}$  from  $V_{CC} = 5\text{ V}$ ). Setting  $V_{CT} = 0\text{ V}$  will turn off the amplifier. VB1 and VB2 will draw  $< 2\text{ mA}$  ( $I_{CT}$ ) from  $V_{CT} = 5\text{ V}$ . All DC supplies need to be low noise to prevent degradation of the amplifier phase noise.

### Parts List

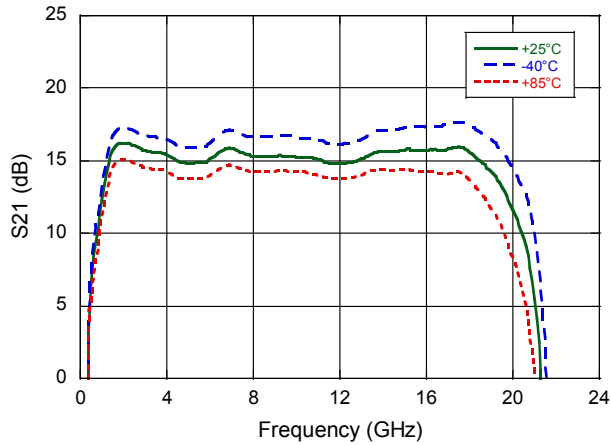
Part #	Value	Case Style
C1 - C4	330 pF	Single Layer
C5, C6	1 $\mu\text{F}$	0402
C7	10 $\mu\text{F}$	1210
R1	1.56 k $\Omega$	Thin film
R2	3.2 k $\Omega$	Thin film

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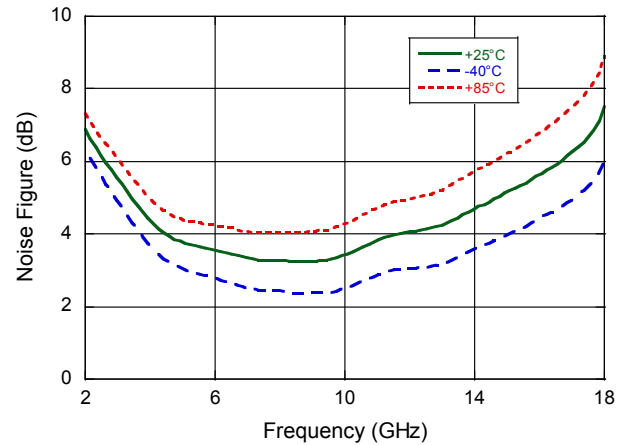
Rev. V1

Typical Performance Curves: 5 V, ICQ = 60 mA

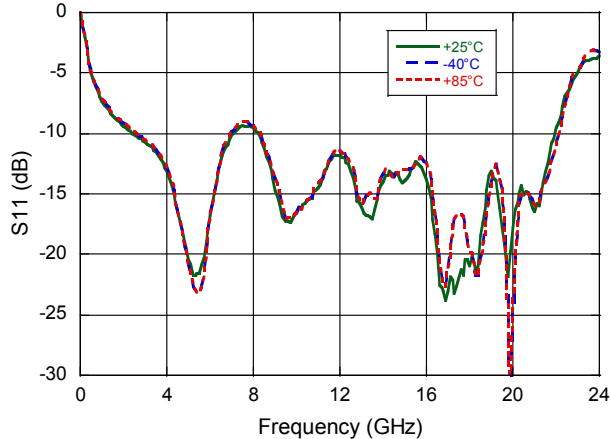
**Gain**



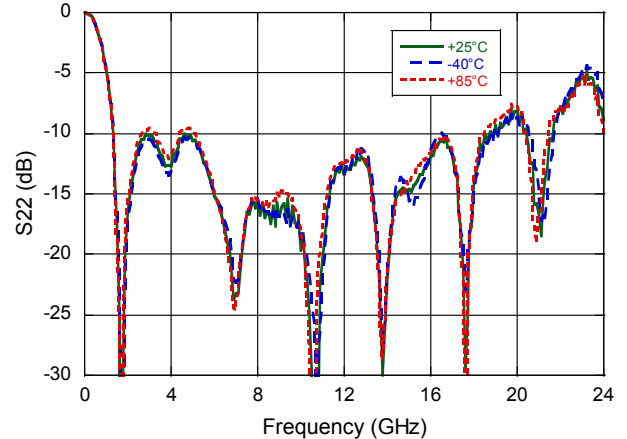
**Noise Figure**



**Input Return Loss**



**Output Return Loss**

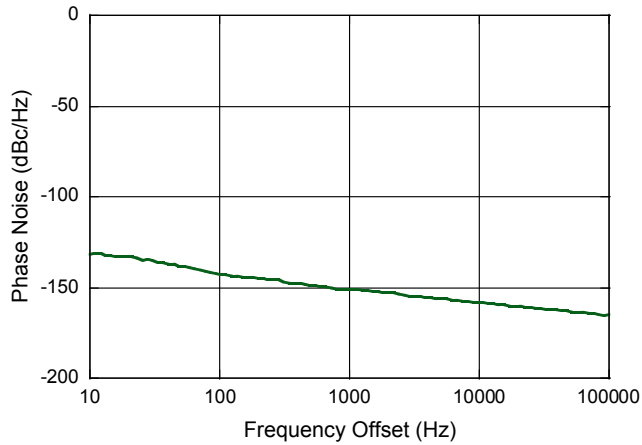


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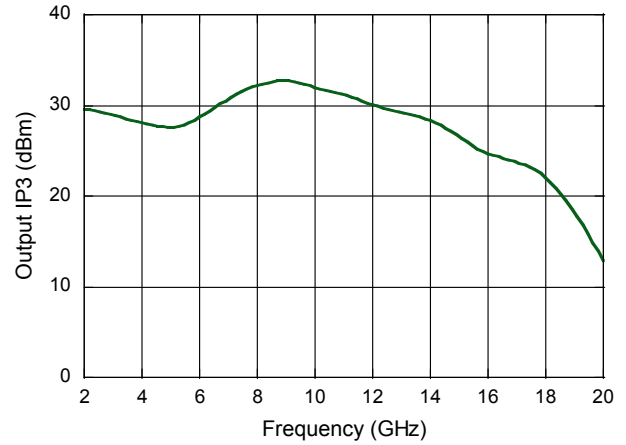
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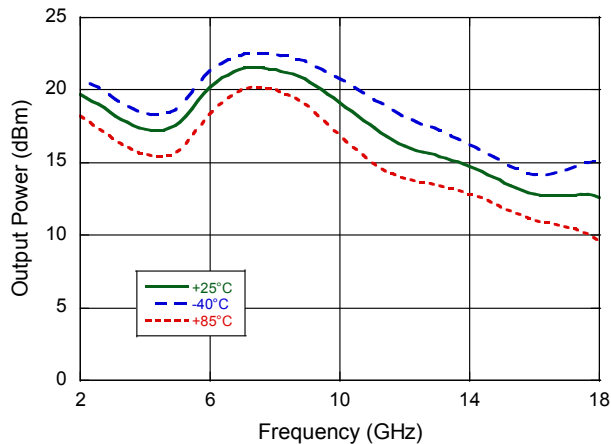
Phase Noise @ +25°C, 12 GHz



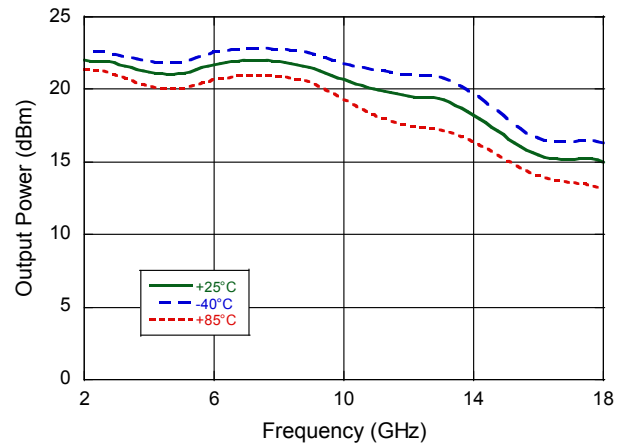
Output IP3 @ +25°C



Output Power @ P1dB



Output Power @ P3dB



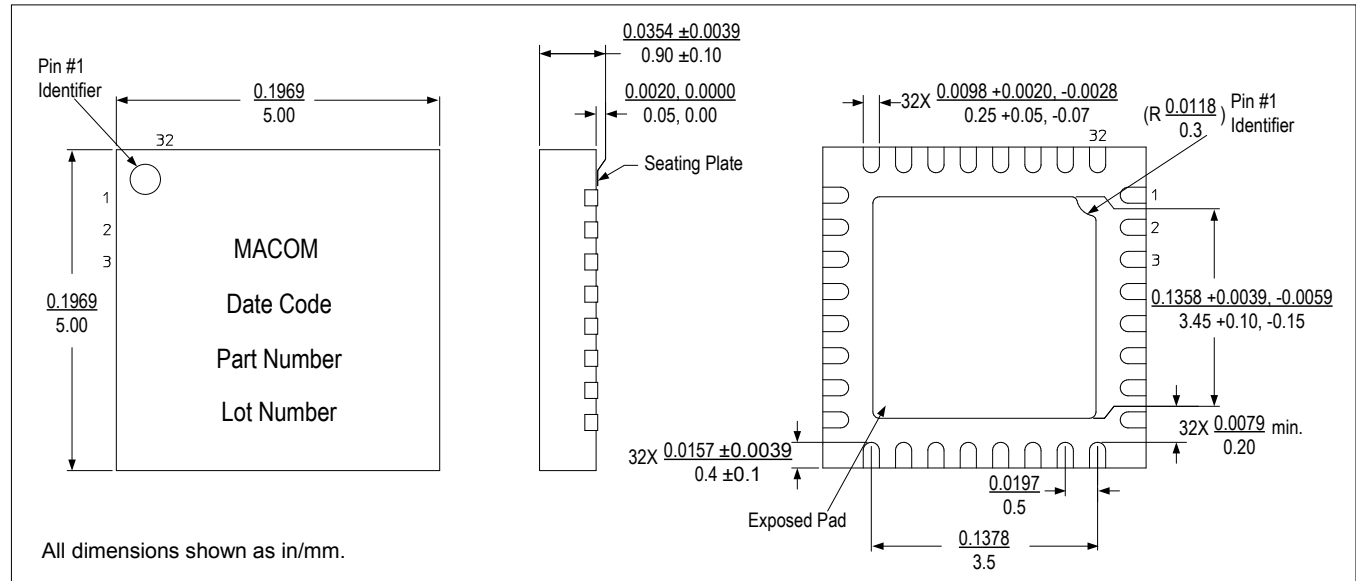
## Handling Procedures

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.

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



<sup>†</sup> Reference Application Note S2083 for lead-free solder reflow recommendations.  
 Meets JEDEC moisture sensitivity level 1 requirements.  
 Plating is NiPdAuAg.

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