

# Ultra Low Phase Noise Amplifier

## 4 - 8 GHz



MAAL-011154

Rev. V2

### Features

- Wideband Performance
- Phase Noise: -165 dBc/Hz @ 10 kHz Offset
- Noise Figure: 5 dB @ 5 GHz
- Bias Voltage: 5 V
- Bias Current: 85 mA
- 50  $\Omega$  Matched Input / Output
- Positive Voltage Only
- Lead-Free 4 mm 16-lead PQFN Package
- RoHS\* Compliant

### Applications

- Test & Measurement, EW, ECM, and Radar

### Description

The MAAL-011154 is an easy to use, wideband ultra low phase noise distributed amplifier in a lead-free 4 mm 16-lead PQFN package. It operates from 4 to 8 GHz and provides -165 dBc/Hz phase noise, 15.4 dB of linear gain, 19 dBm of P1dB, and 5 dB of noise figure. The input and output are fully matched to 50  $\Omega$  with typical return loss of 15 dB.

The RF output port is 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.

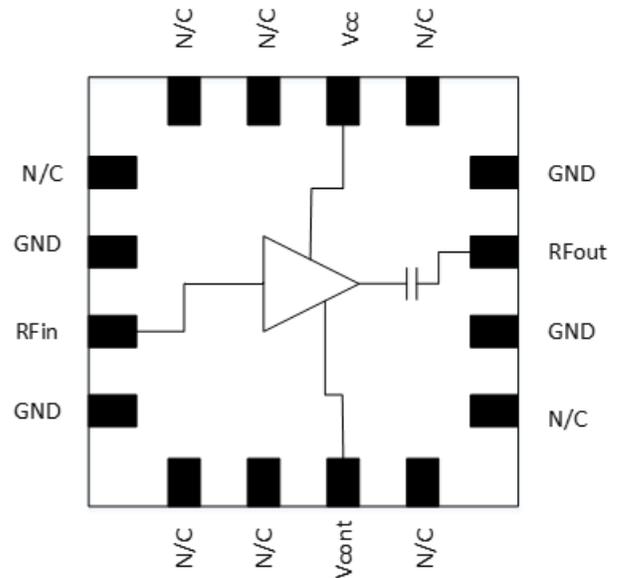
The MAAL-011154 can be used as a low noise amplifier stage for signal generation applications. This device is ideally suited for applications where ultra low phase noise and drive power is required.

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

Part Number	Package
MAAL-011154-TR0100	100 piece reel
MAAL-011154-SMB	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
1,5,6,8,9,13,15,16	N/C <sup>3</sup>	No Connection
2,4,10,12	GND	Ground
3	RF <sub>IN</sub>	RF Input
7	V <sub>CONT</sub>	Control Voltage
11	RF <sub>OUT</sub>	RF Output
14	V <sub>CC</sub>	Collector Voltage
Paddle <sup>4</sup>	GND	Ground

3. MACOM recommends connecting unused package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

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

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Electrical Specifications: Freq. = 4 - 8 GHz,  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = +5\text{ V}$ ,  $Z_0 = 50\ \Omega$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	$P_{IN} = -15\text{ dBm}$	dB	12.5	15.7	—
Gain Flatness	—	dB	—	$\pm 0.2$	—
Gain Variation over Temperature	—	dB/ $^\circ\text{C}$	—	0.009	—
Output Power	$P_{IN} = 5.4\text{ dBm}$ , 4 GHz $P_{IN} = 5.4\text{ dBm}$ , 6 GHz $P_{IN} = 3.0\text{ dBm}$ , 8 GHz	dBm	17.5 17.5 15.0	20.5 20.5 18.0	—
Noise Figure	—	dB	—	5	—
Input Return Loss	—	dB	—	15	—
Output Return Loss	—	dB	—	15	—
P1dB	—	dBm	—	19	—
P3dB	—	dBm	—	22	—
OIP3	—	dBm	—	30	—
Phase Noise @ 100 Hz	4 GHz, P1dB, 100 Hz 1 KHz 10 KHz 1 MHz	dBc/Hz	—	148 160 165 175	—
Icq	—	mA	—	85	—

### Maximum Operating Conditions

Parameter	Maximum
$P_{IN}$	12 dBm
$V_{CC}$	6 V
Icq	105 mA
Junction Temperature <sup>5,6</sup>	+130 $^\circ\text{C}$
Operating Temperature	-40 $^\circ\text{C}$ to +85 $^\circ\text{C}$
Storage Temperature	-40 $^\circ\text{C}$ to +150 $^\circ\text{C}$

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

Parameter	Absolute Maximum
$P_{IN}$	20 dBm
$V_{CC}$	6.5 V
Icq	170 mA
Junction Temperature <sup>5,6</sup>	+150 $^\circ\text{C}$
Operating Temperature	-40 $^\circ\text{C}$ to +85 $^\circ\text{C}$
Storage Temperature	-40 $^\circ\text{C}$ to +150 $^\circ\text{C}$

### 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.

- Operating at nominal conditions with  $T_J \leq +150^\circ\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours.
- Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{jc} * (V * I)$   
Typical thermal resistance ( $\Theta_{jc}$ ) = 24.0 $^\circ\text{C}/\text{W}$ .  
a) For  $T_C = +25^\circ\text{C}$ ,  
 $T_J = 40.1^\circ\text{C}$  @ 6 V, 105 mA  
b) For  $T_C = +85^\circ\text{C}$ ,  
 $T_J = 100.1^\circ\text{C}$  @ 6 V, 105 mA
- 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.

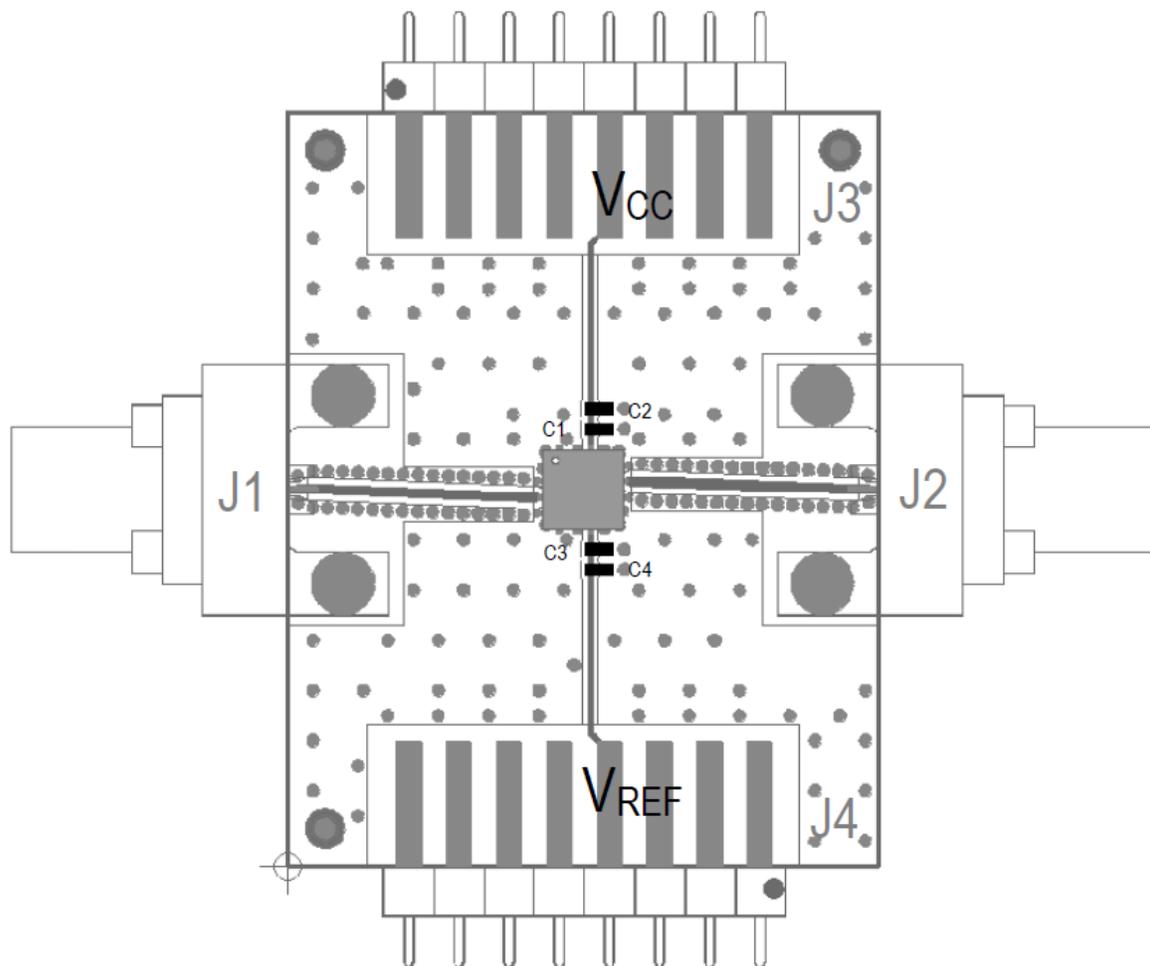
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DC-0025094

PCB Layout



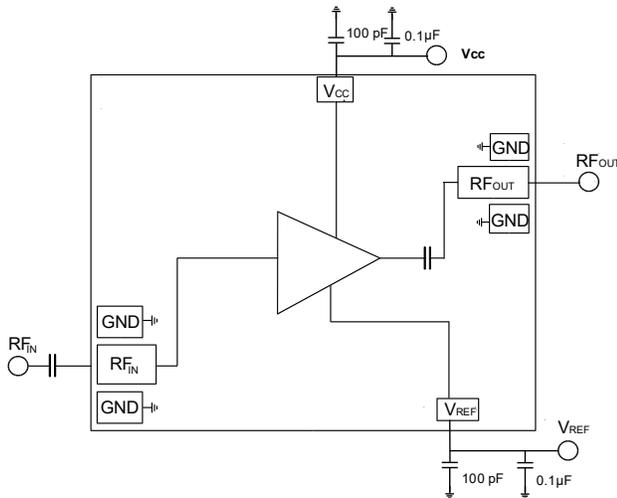
Parts List

Part	Value	Case Style
C1,C3	100 pF	0402
C2,C4	0.1 $\mu$ F	0402

Evaluation PCB Specifications

Top Layer: 1 oz Copper Cladding, 0.034 mm thickness  
 Dielectric Layer: Rogers RO4350B 0.245 mm thickness  
 Bottom Layer: 1 oz Copper Cladding, 0.034 mm thickness  
 Finished overall thickness: 0.313 mm

## Application Schematic



## Operation

The technology is HBT; so, the turn-on and turn-off procedure is fairly simple.

To turn-on simply:

1. Apply +5 V to  $V_{CC}$
2. Starting at 0 V, adjust  $V_{REF}$  for target  $I_{CC}$

To turn-off:

1. Set  $V_{REF}$  to 0 V
2. Set  $V_{CC}$  to 0 V

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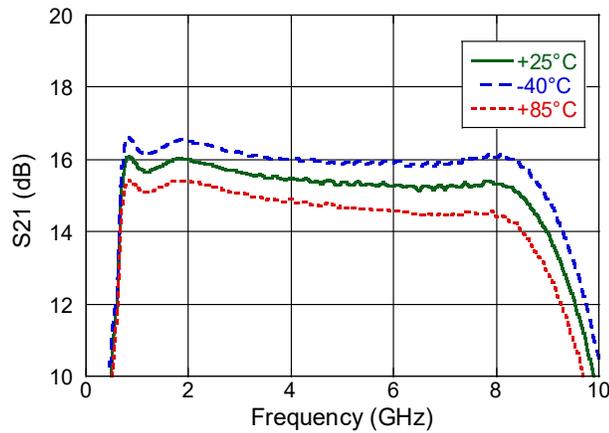


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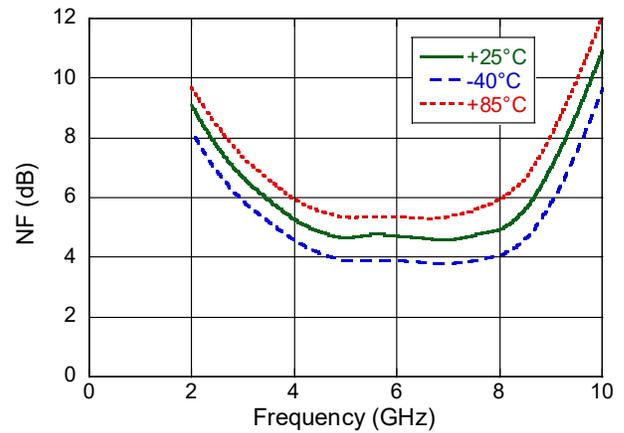
Rev. V2

Typical Performance Curves:  $V_{CC} = 5\text{ V}$ ,  $I_{CC} = 85\text{ mA}$

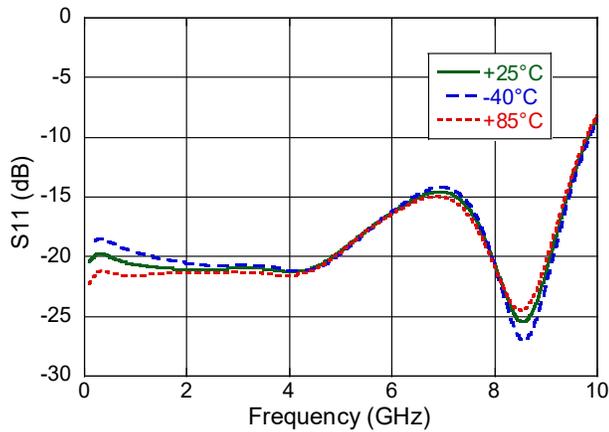
**Gain**



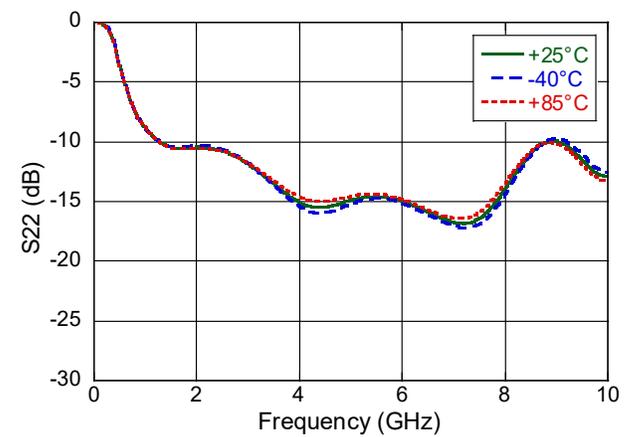
**Noise Figure**



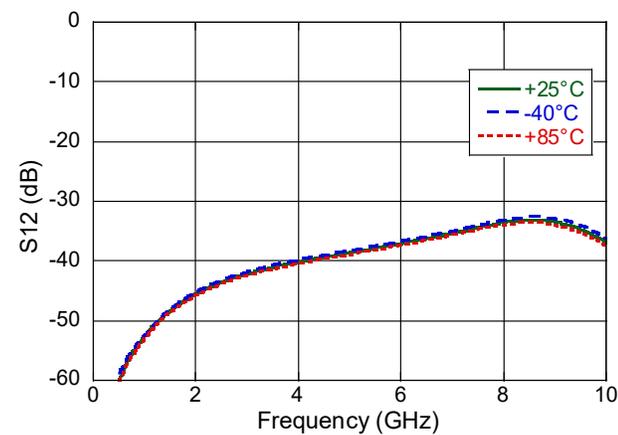
**Input Return Loss**



**Output Return Loss**

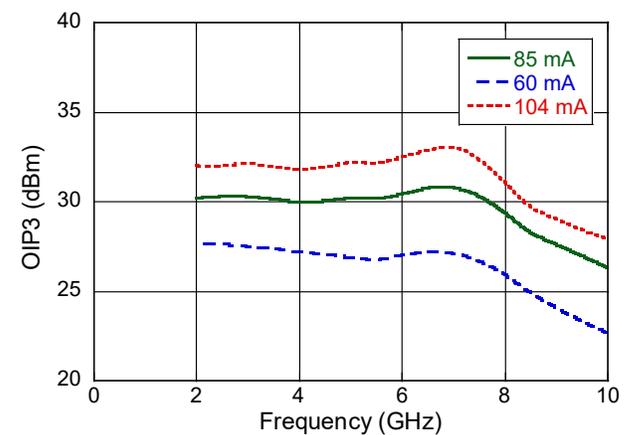


**Reverse Isolation**



**Output IP3**

(10 MHz Tone Spacing,  $P_{IN} = -10\text{ dBm}$  per tone)



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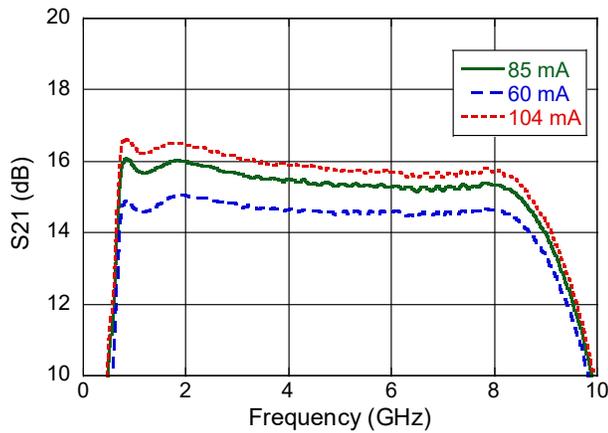


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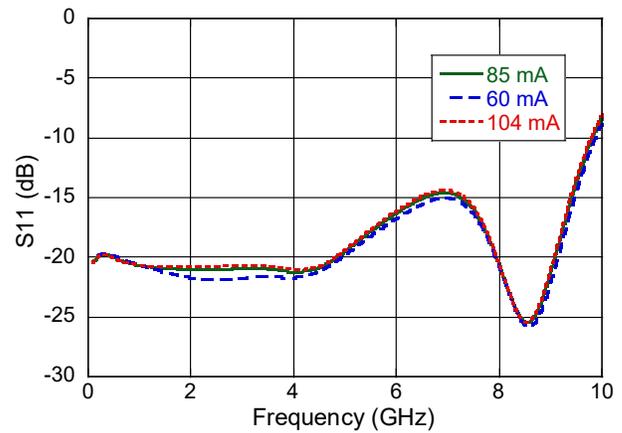
Rev. V2

Typical Performance Curves:  $V_{CC} = 5\text{ V}$ ,  $25^\circ\text{C}$

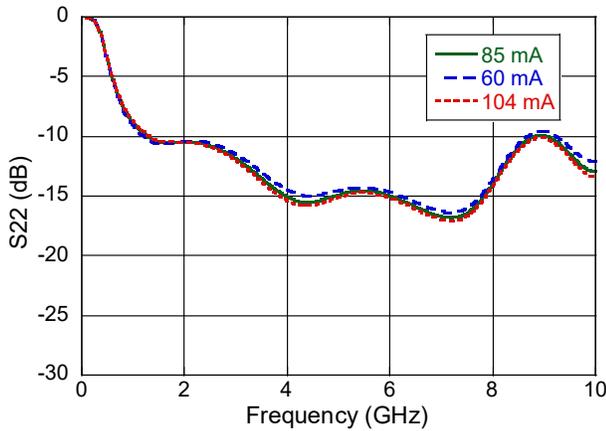
**Gain**



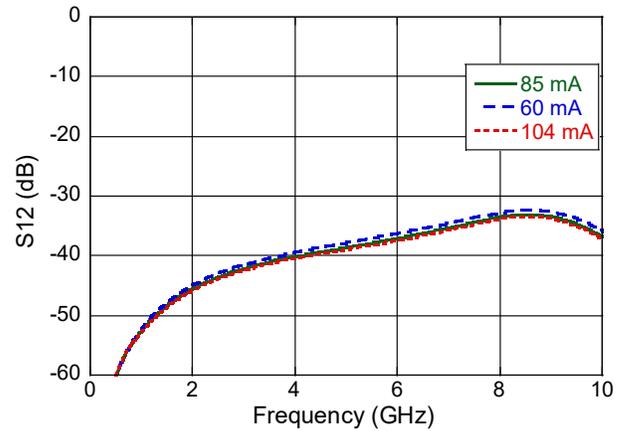
**Input Return Loss**



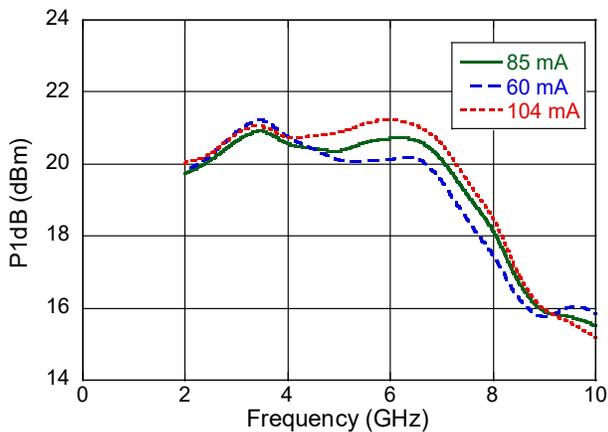
**Output Return Loss**



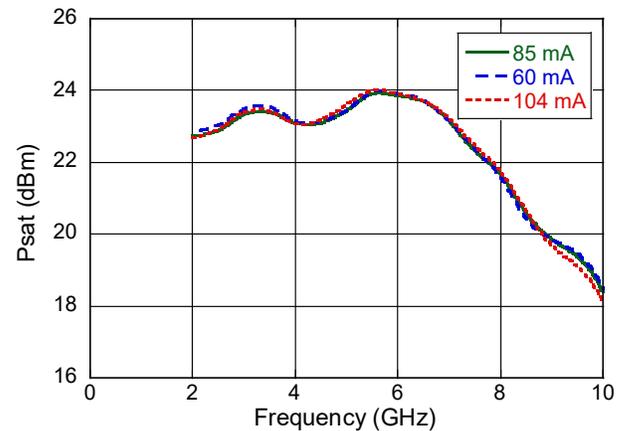
**Reverse Isolation**



**P1dB**



**Psat**



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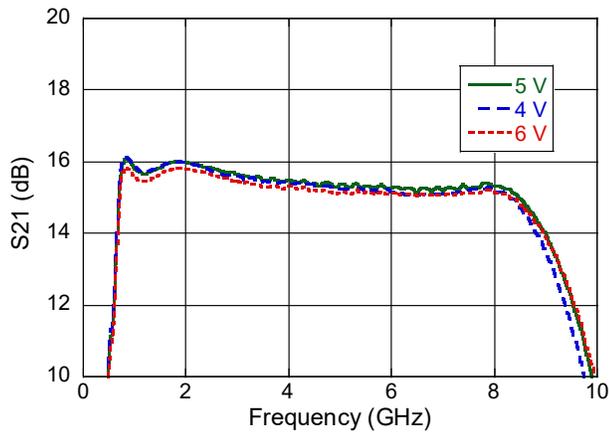


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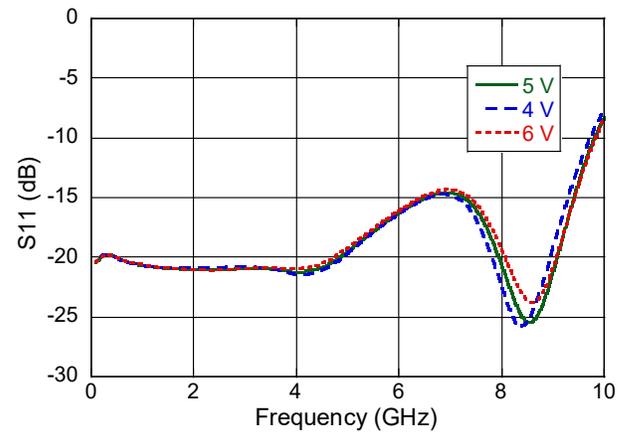
Rev. V2

Typical Performance Curves:  $I_{CC} = 85 \text{ mA}$ ,  $25^\circ\text{C}$

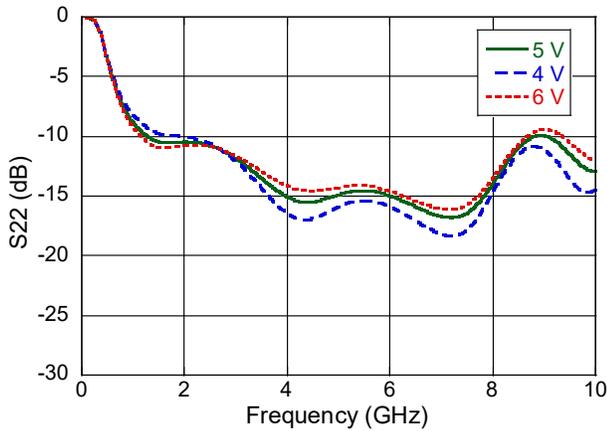
**Gain**



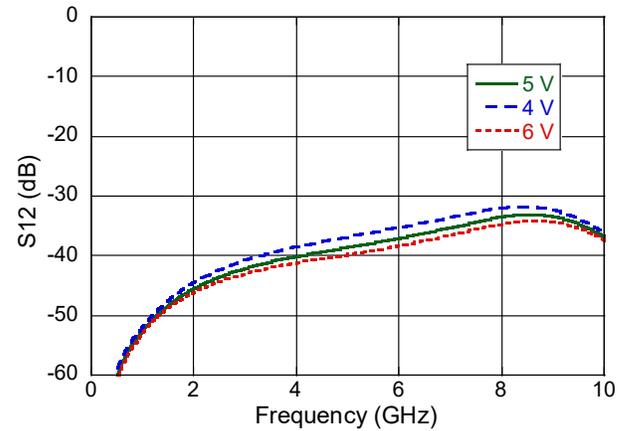
**Input Return Loss**



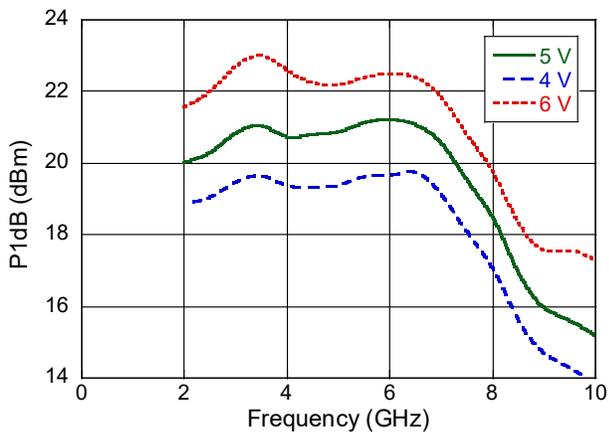
**Output Return Loss**



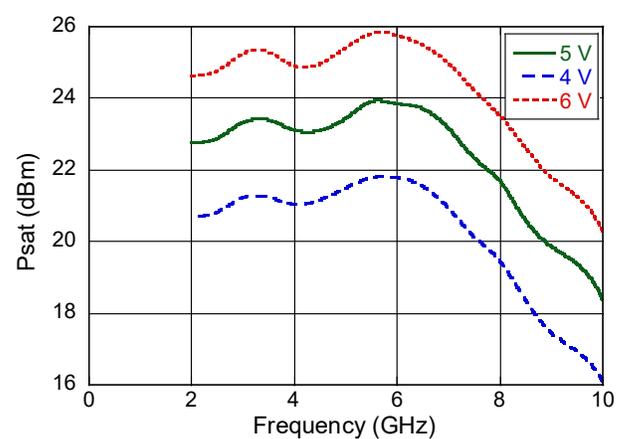
**Reverse Isolation**



**P1dB**



**Psat**



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## 4 - 8 GHz

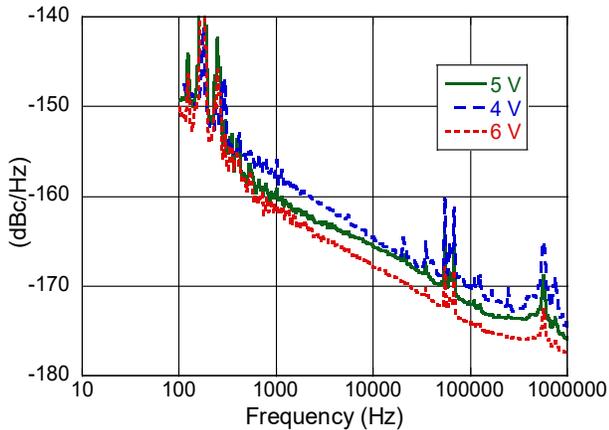


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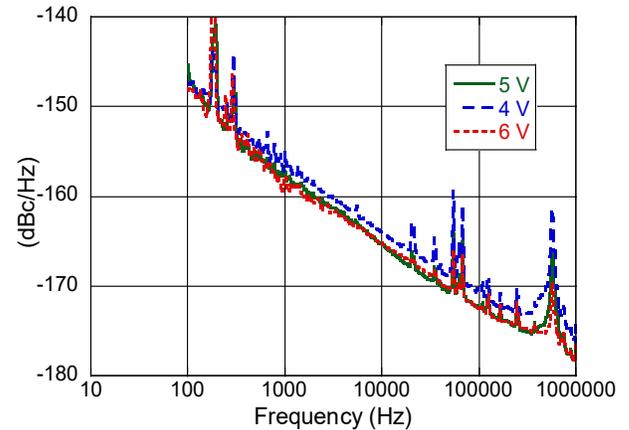
Rev. V2

### Typical Performance Curves: $I_{CC} = 85 \text{ mA}$ , $25^\circ\text{C}$

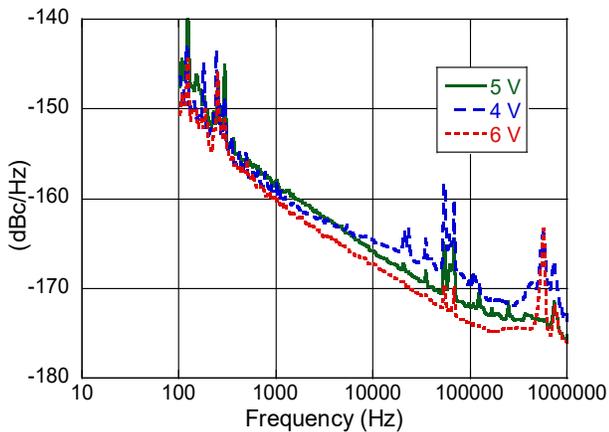
Phase Noise @ 4 GHz, P1dB



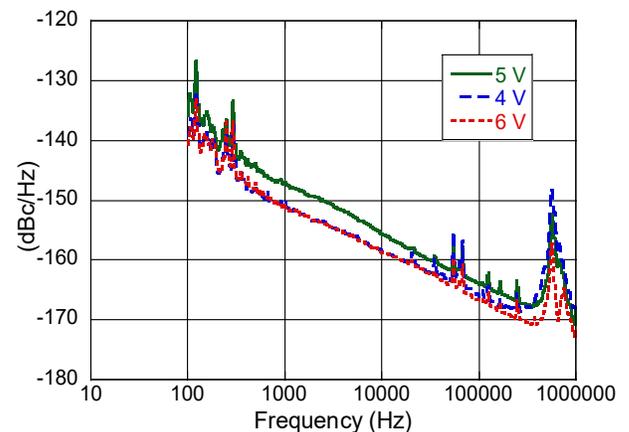
Phase Noise @ 4 GHz, P4dB



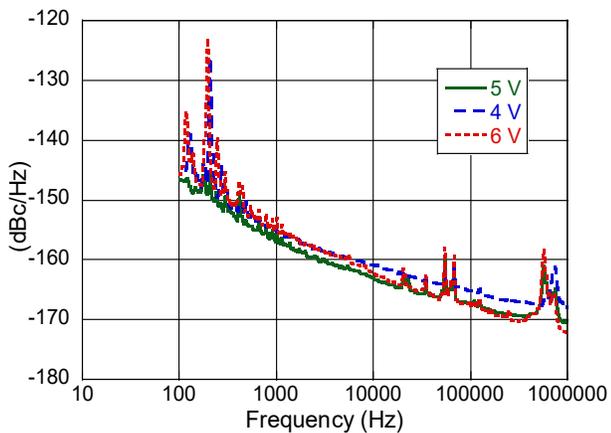
Phase Noise @ 6 GHz, P1dB



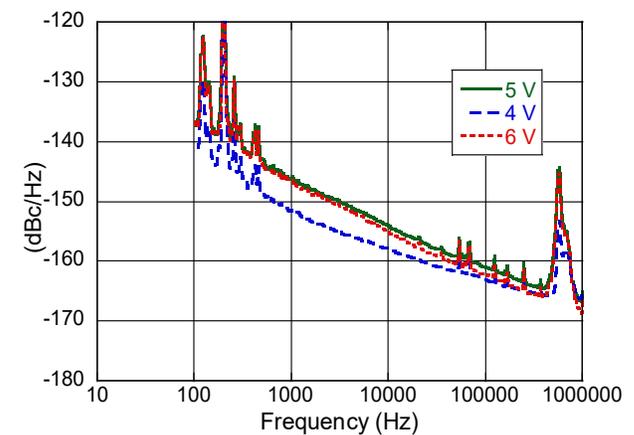
Phase Noise @ 6 GHz, P4dB



Phase Noise @ 8 GHz, P1dB



Phase Noise @ 8 GHz, P4dB



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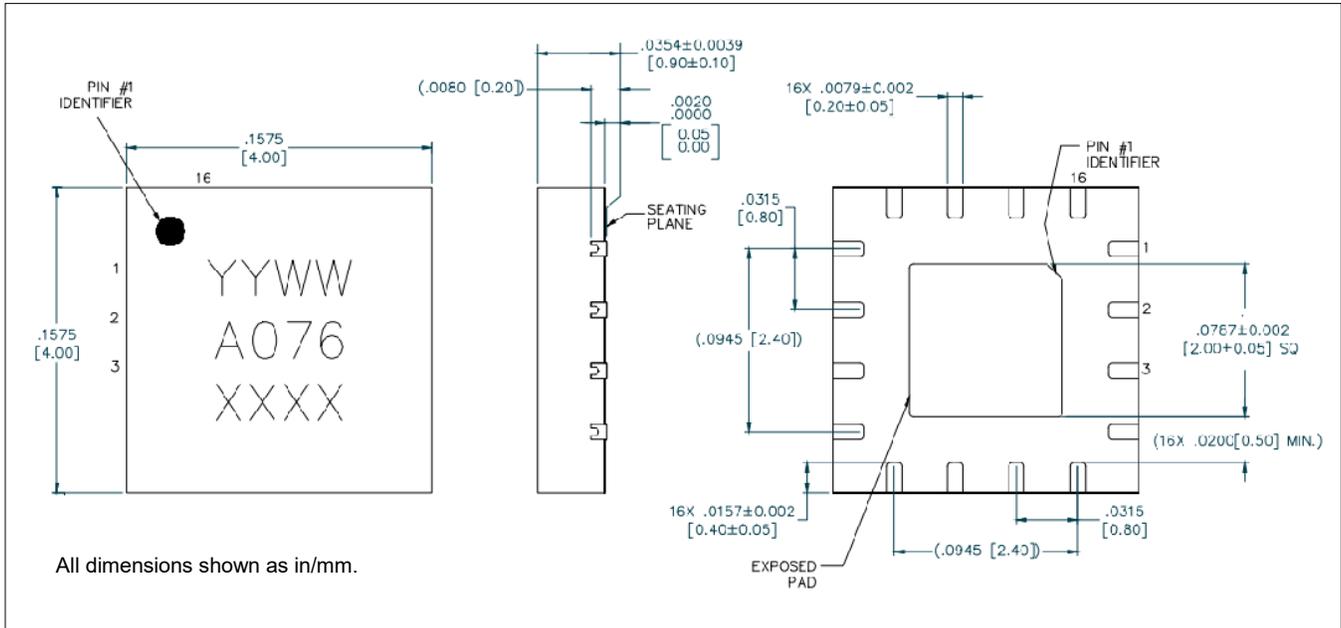
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### Lead-Free 4 mm 16-Lead PQFN Package



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

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