

# Low Phase Noise Amplifier

## 4 - 8 GHz



MAAL-011154-DIE

Rev. V2

### Features

- Phase Noise: 165 dBc/Hz @ 10 kHz
- Gain: 15 dB
- P1dB: 20 dBm
- Bias Voltage:  $V_{CC} = +5\text{ V}$
- Bias Current:  $I_{CQ} = 85\text{ mA}$
- 50  $\Omega$  Matched Input and Output
- Positive Voltage Only
- Die Size: 2265 x 1695 x 100  $\mu\text{m}$
- RoHS\* Compliant

### Applications

- Radar
- Electronic Countermeasures
- Test and Measurement
- Microwave Communication Systems

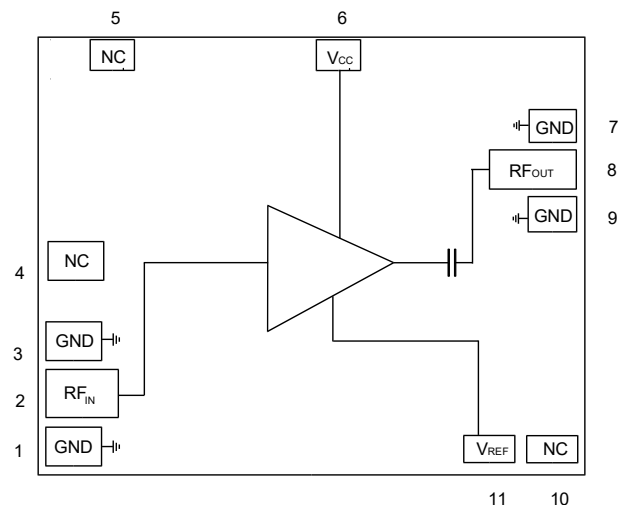
### Description

The MAAL-011154-DIE is an easy to use low phase noise amplifier chip. It operates from 4 - 8 GHz and provides 165 dBc/Hz phase noise, 15 dB gain and 20 dBm P1dB. The input and output are fully matched to 50  $\Omega$  with typical return loss >15 dB.

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

The MAAL-011154-DIE is ideally suited for Radar, Test and Measurement, EW, ECM, and Microwave Communication Systems applications.

### Functional Schematic



### Pad Configuration<sup>1</sup>

Pad #	Pad Name	Description
1,3,7,9	GND	DC + RF Ground to Backside Via
2	RF <sub>IN</sub>	RF Input
4,5,10	NC	Not Connected
6	V <sub>CC</sub>	Supply Voltage
8	RF <sub>OUT</sub>	RF Output
11	V <sub>REF</sub>	Reference Voltage

1. Backside of die must be connected to RF, DC and thermal ground.

### Ordering Information

Part Number	Package
MAAL-011154-DIE	Gel Pack

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

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### Electrical Specifications:

Freq. = 4 - 8 GHz,  $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $Z_0 = 50\ \Omega$  (Based on probed die production data)

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	$P_{IN} = -15\text{ dBm}$	dB	13.5	15.7	—
Gain Flatness	—	dB	—	$\pm 0.2$	—
Gain Variation over Temperature	—	dB/ $^{\circ}\text{C}$	—	0.011	—
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	18.5 18.5 16	20.5 20.5 18.	—
Noise Figure	—	dB	—	5.1	—
Input Return Loss	—	dB	—	17	—
Output Return Loss	—	dB	—	16	—
P1dB	6 GHz	dBm	—	20	—
P3dB	6 GHz	dBm	—	21	—
OIP3	6 GHz, -10 dBm $P_{IN}$ per tone	dBm	—	30.5	—
Phase Noise	4 GHz, P1dB 100 Hz 1 kHz 10 kHz 1 MHz	dBc/Hz	—	149 160 165 175	—
$I_{cq}$	—	mA	—	85	—

### Absolute Maximum Ratings<sup>2,3</sup>

Parameter	Absolute Maximum
Input Power	14 dBm
$V_{CC}$	6 V
$I_{CC}$	105 mA
Junction Temperature <sup>4,5</sup>	$+150^{\circ}\text{C}$
Operating Temperature	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$
Storage Temperature	$-40^{\circ}\text{C}$ to $+150^{\circ}\text{C}$

- 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.
- 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 ( $\Theta_{jc}$ ) =  $25.9\ ^{\circ}\text{C/W}$ .  
a) For  $T_C = +25^{\circ}\text{C}$ ,  
 $T_J = 41.3^{\circ}\text{C}$  @ 6 V, 105 mA  
b) For  $T_C = +85^{\circ}\text{C}$ ,  
 $T_J = 101.3^{\circ}\text{C}$  @ 6 V, 105 mA

### 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, 250 V devices.

# Low Phase Noise Amplifier

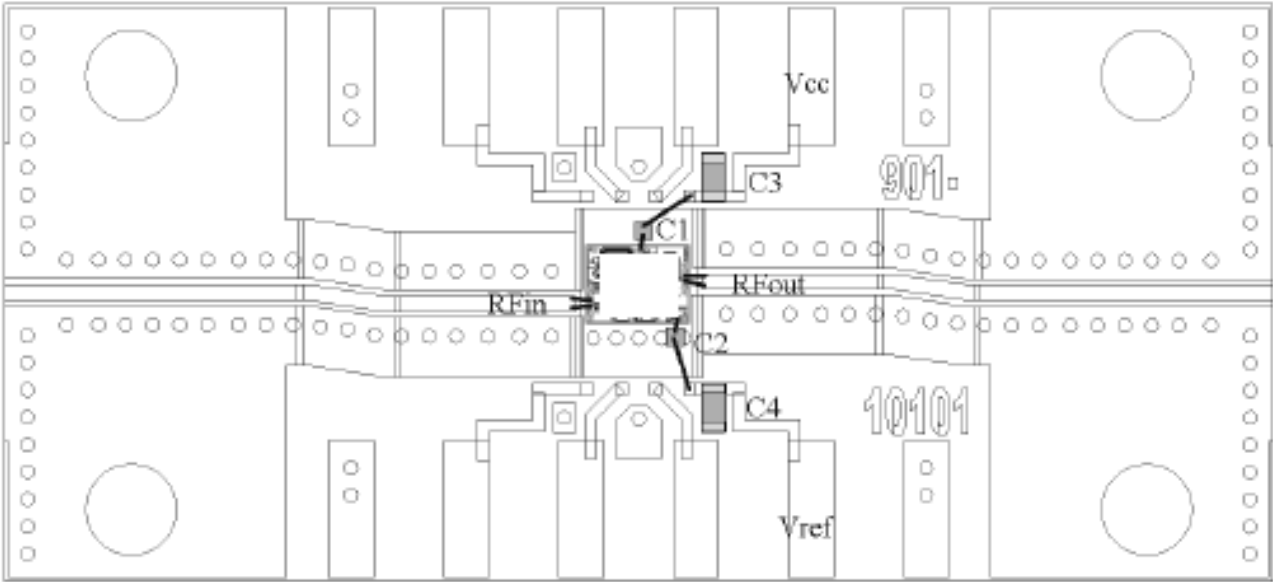
## 4 - 8 GHz



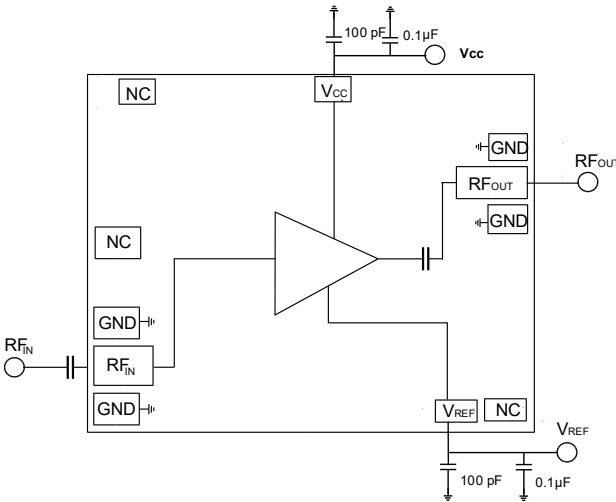
MAAL-011154-DIE

Rev. V2

### PCB Layout



### 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

### 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

### Parts List

Part	Value	Case Style	MFG	MFG Part #
C1, C2	100 pF	Single Layer	MACOM	MKVC-050100-1453
C3, C4	0.1 μF	0402	KYOCERA	04023C103KAT2A

# Low Phase Noise Amplifier

## 4 - 8 GHz

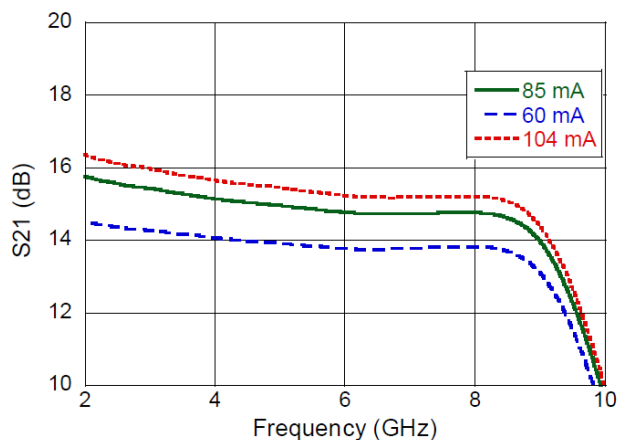


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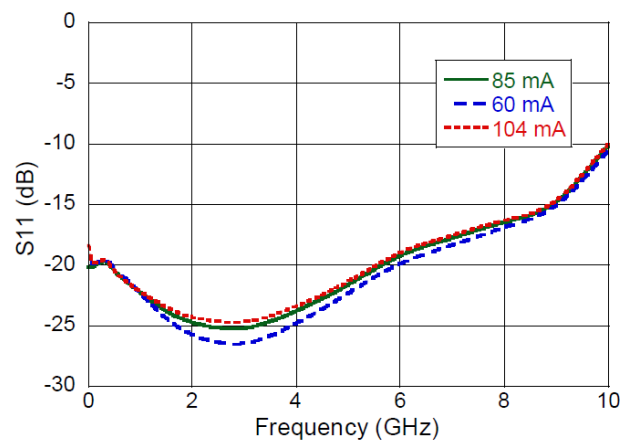
Rev. V2

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

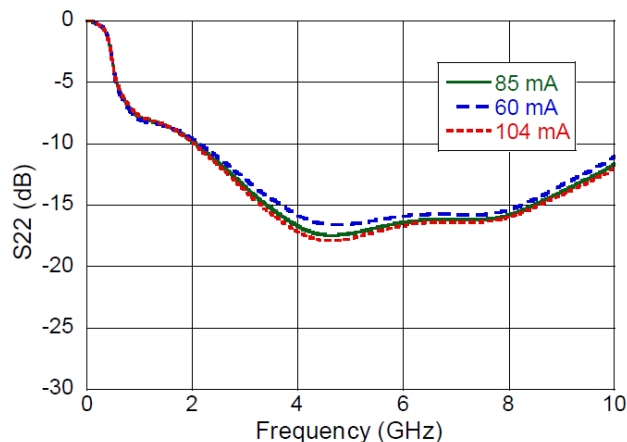
**Gain**



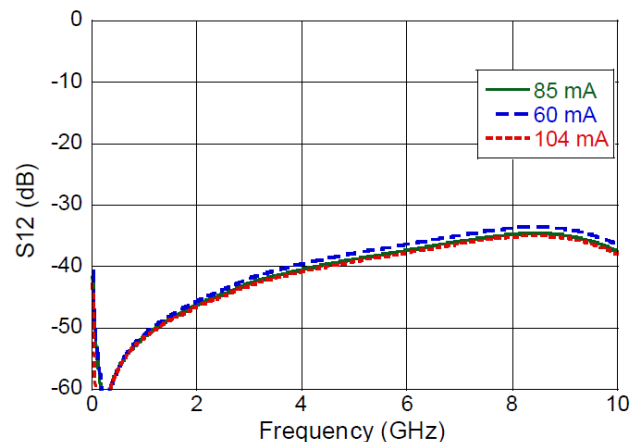
**Input Return Loss**



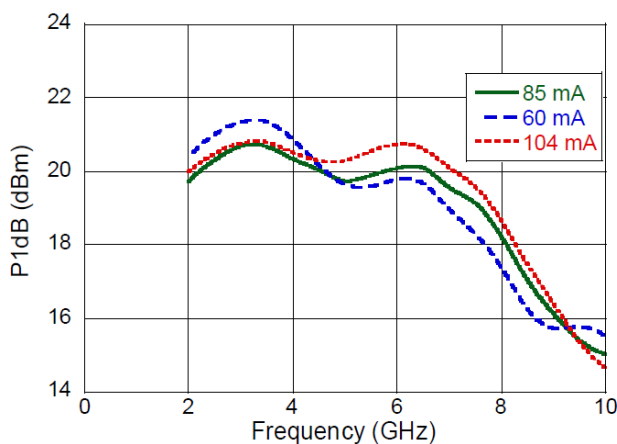
**Output Return Loss**



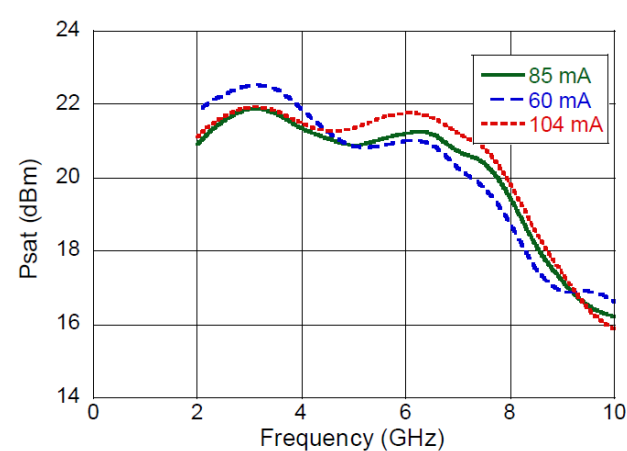
**Reverse Isolation**



**P1dB**



**$P_{SAT}$**



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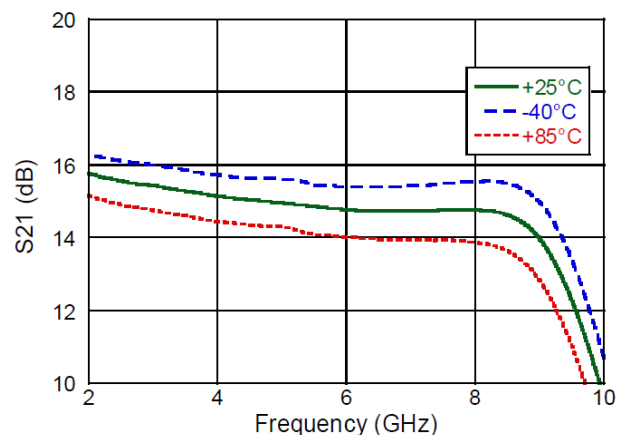


MAAL-011154-DIE

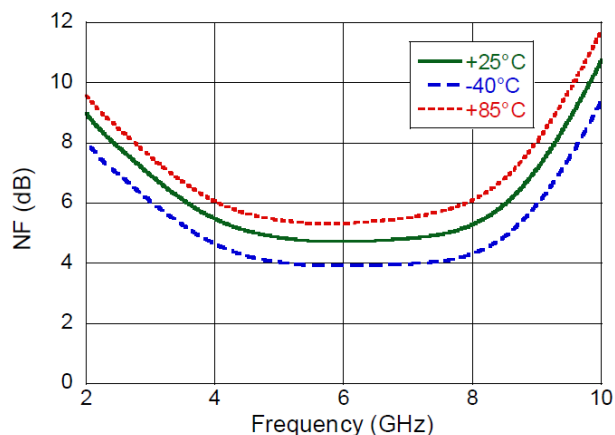
Rev. V2

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

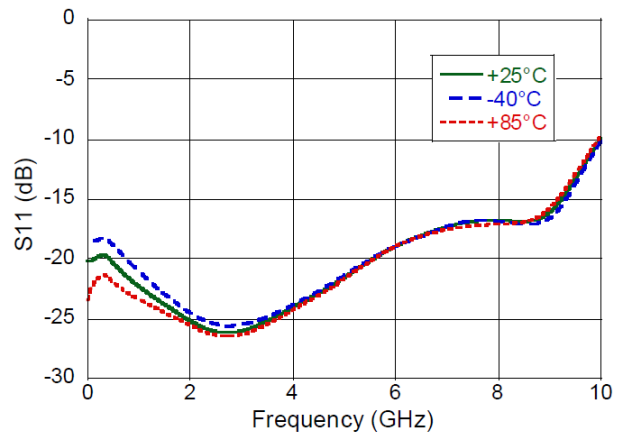
**Gain**



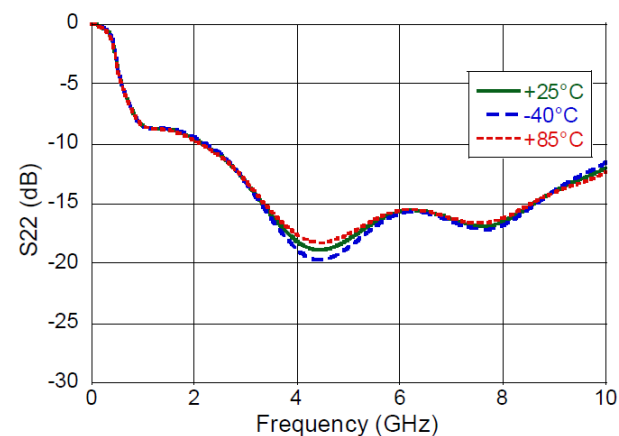
**Noise Figure**



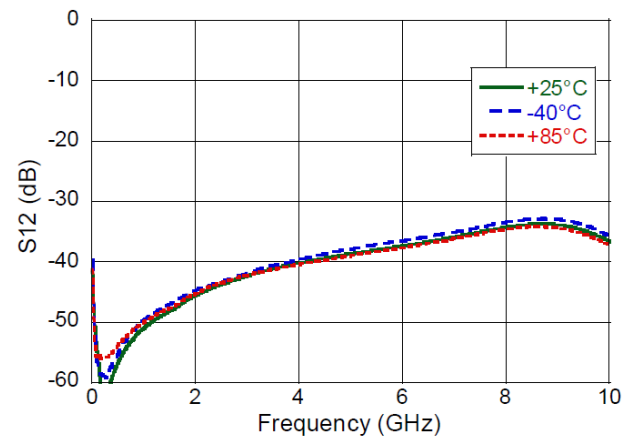
**Input Return Loss**



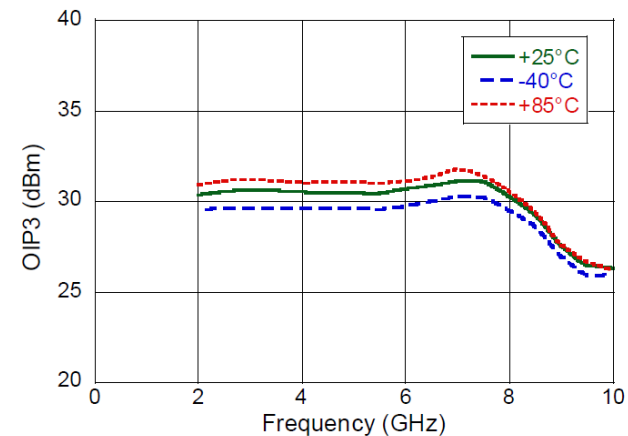
**Output Return Loss**



**Reverse Isolation**



**Output IP3**  
(10 MHz Tone Spacing,  $P_{IN} = -10\text{ dBm}$  per tone)



# Low Phase Noise Amplifier 4 - 8 GHz

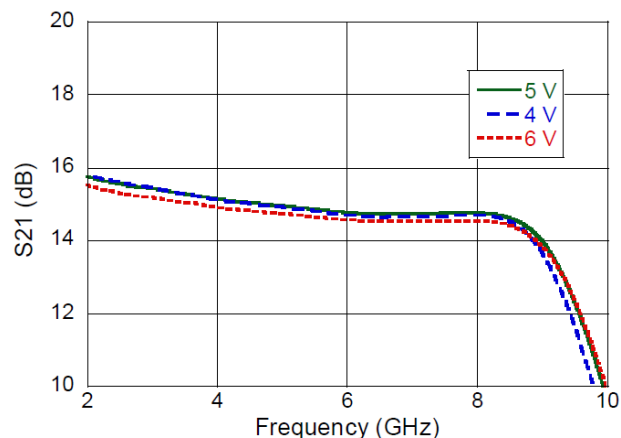


MAAL-011154-DIE

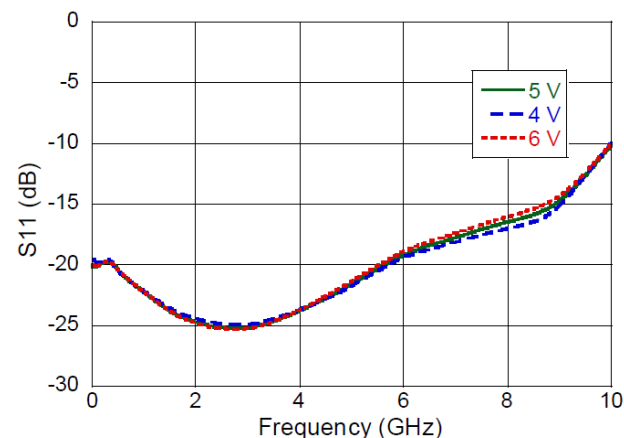
Rev. V2

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

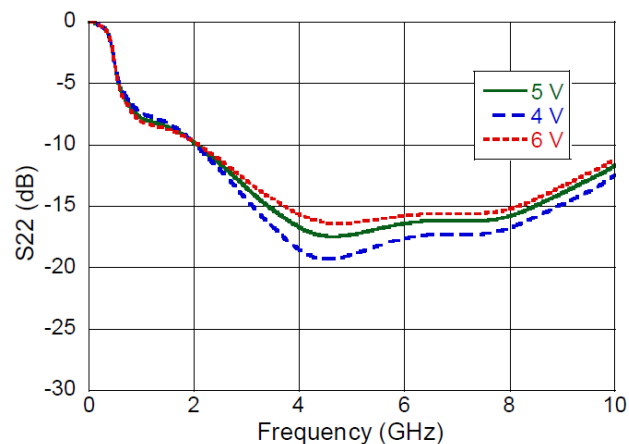
**Gain**



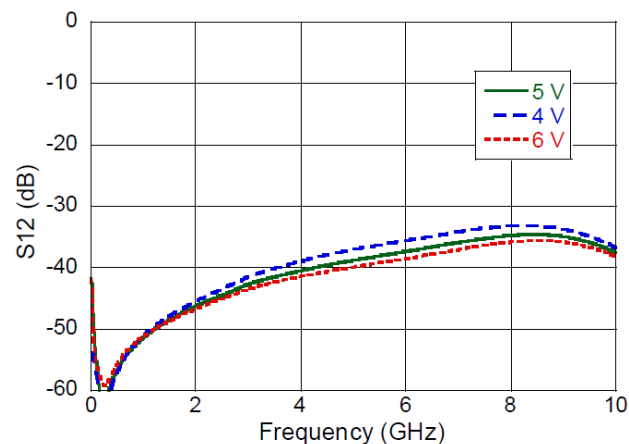
**Input Return Loss**



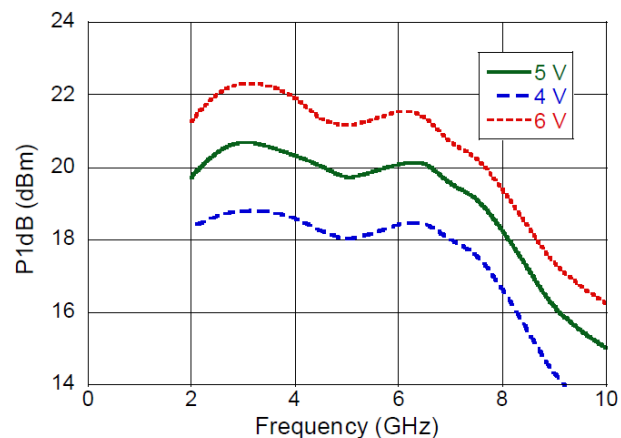
**Output Return Loss**



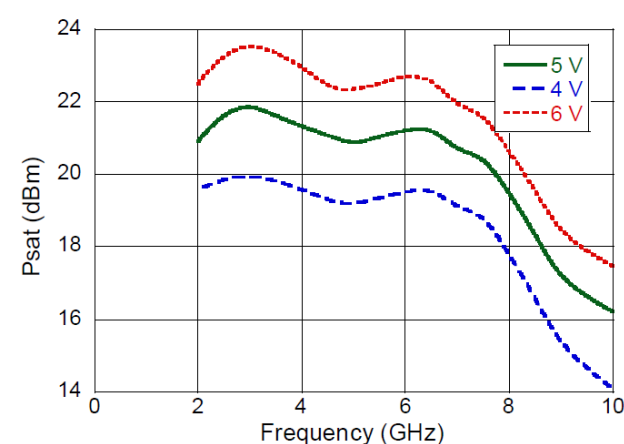
**Reverse Isolation**



**P1dB**



**$P_{SAT}$**



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## 4 - 8 GHz

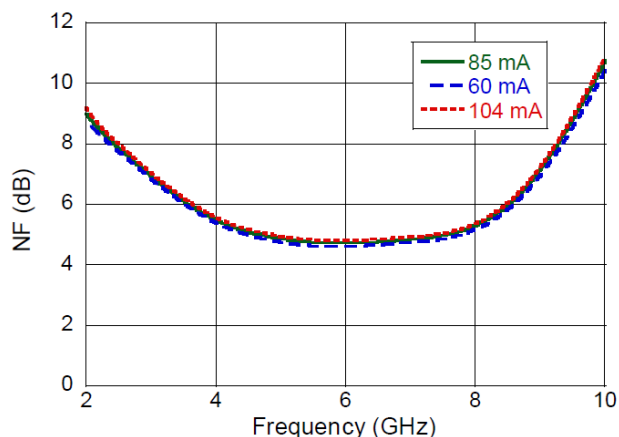


MAAL-011154-DIE

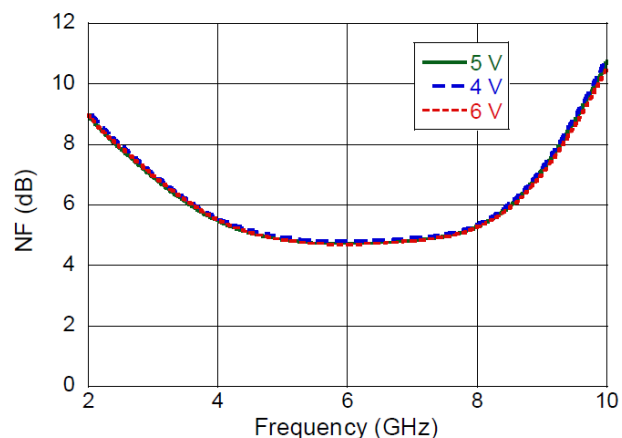
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### Typical Performance Curves: +25°C

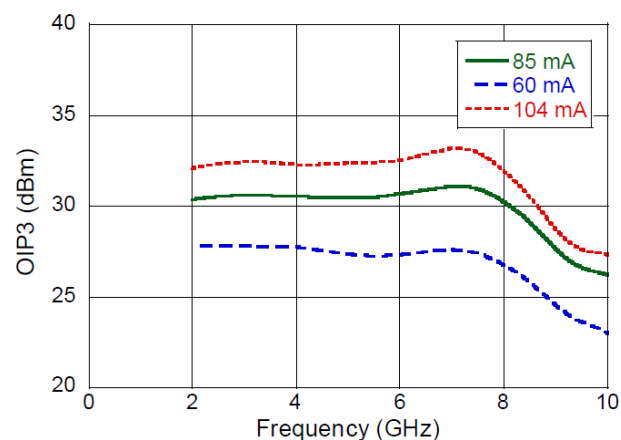
Noise Figure @ 5 V



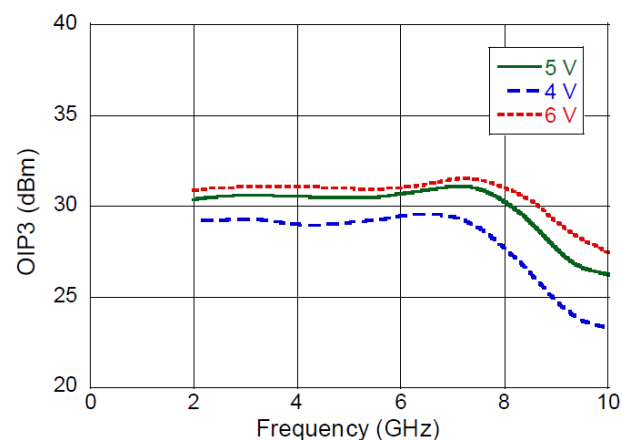
Noise Figure @ 85 mA



Output IP3 @ 5 V  
(10 MHz Tone Spacing,  $P_{IN} = -10$  dBm per tone)



Output IP3 @ 85 mA  
(10 MHz Tone Spacing,  $P_{IN} = -10$  dBm per tone)



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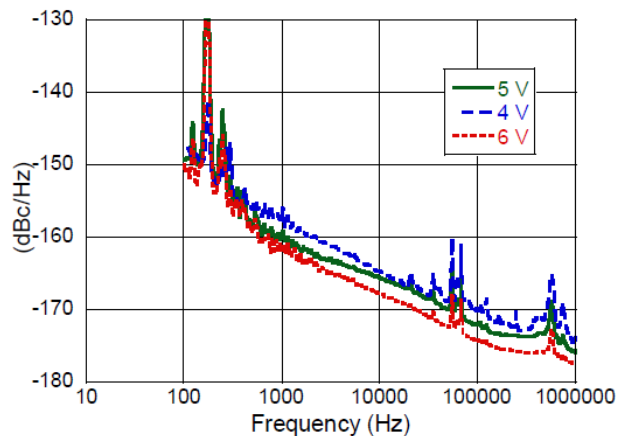


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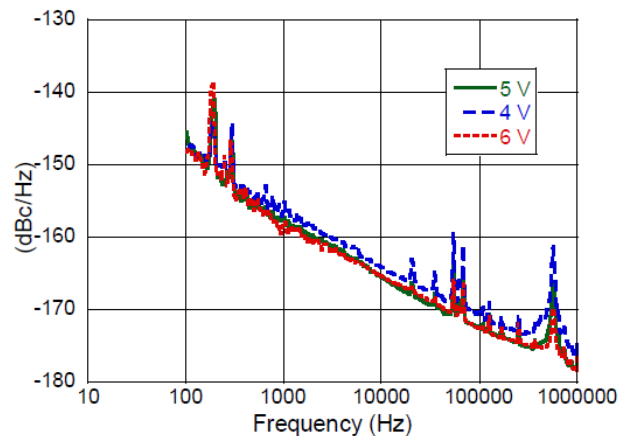
Rev. V2

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

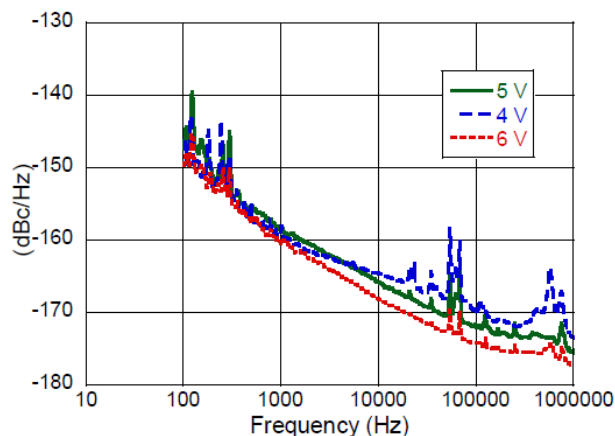
Phase Noise @ 4 GHz, P1dB



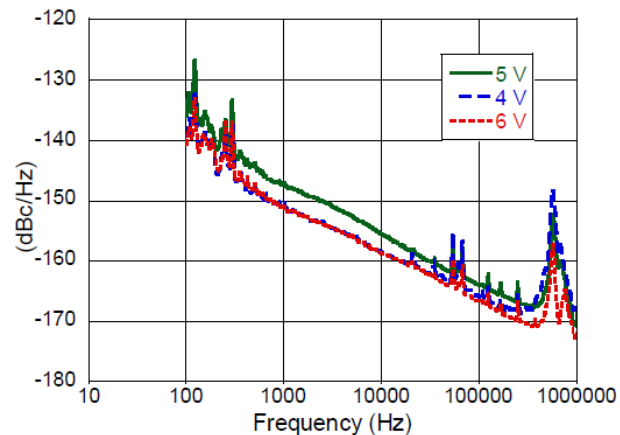
Phase Noise @ 4 GHz, P4dB



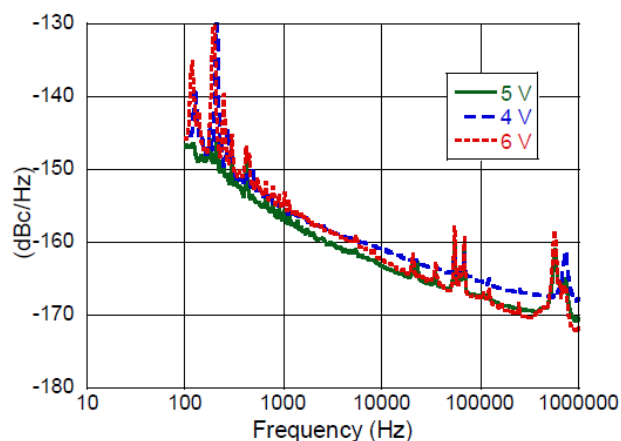
Phase Noise @ 6 GHz, P1dB



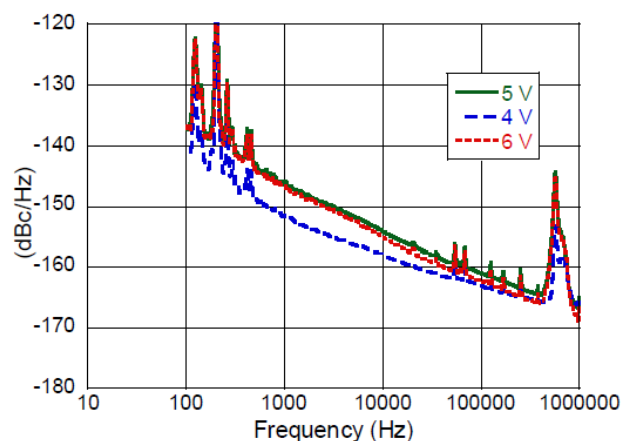
Phase Noise @ 6 GHz, P4dB



Phase Noise @ 8 GHz, P1dB

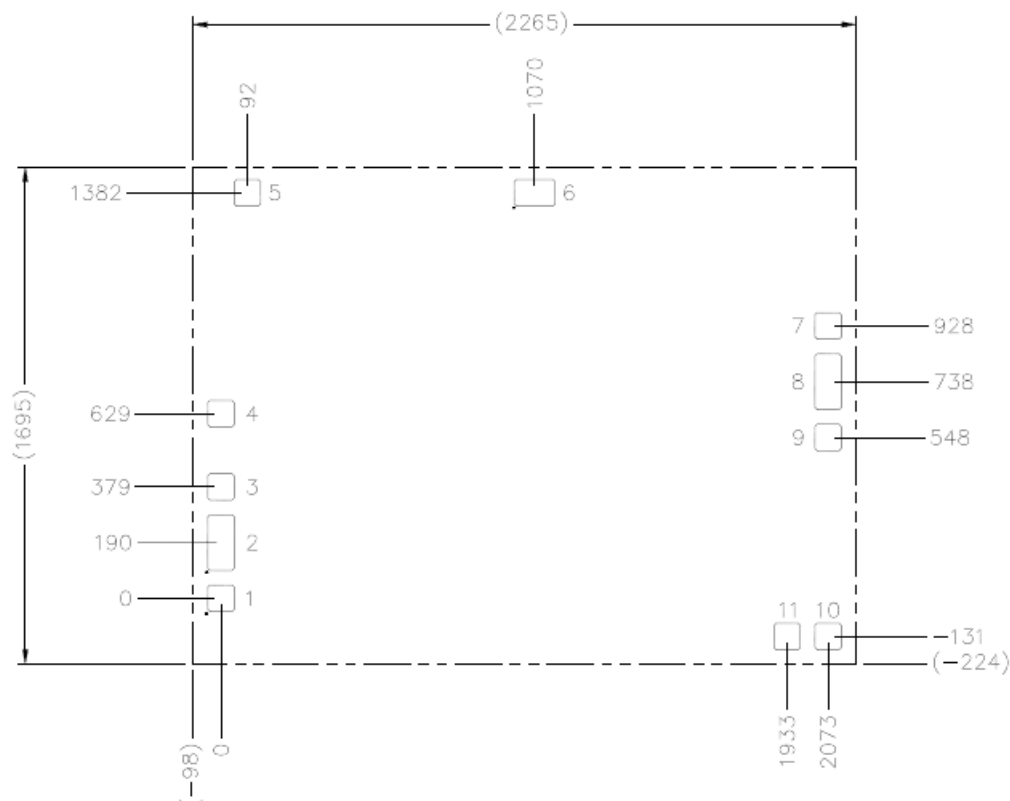


Phase Noise @ 8 GHz, P4dB





### MMIC Die Outline



### Bond Pad Detail<sup>6,7,8,9</sup>

Pad #	X	Y
1,3,4,5,7,9,10,11	100	100
2,8	100	200
6	140	100

6. All dimensions shown as microns ( $\mu\text{m}$ ) with a tolerance of  $\pm 5 \mu\text{m}$ , unless otherwise noted.
7. Die thickness is  $100 \mu\text{m} \pm 10 \mu\text{m}$ .
8. Bond pad and backside metalization: gold
9. Die size reflects cut dimensions. Saw or laser kerf reduces die size by  $\sim 25 \mu\text{m}$  each dimension.

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