

Low Phase Noise Amplifier

4 - 8 GHz



MAAL-011154-DIE

Rev. V1

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 Ω Matched Input and Output
- Positive Voltage Only
- Die Size: 2265 x 1695 x 100 μm
- 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 Ω with typical return loss >15 dB.

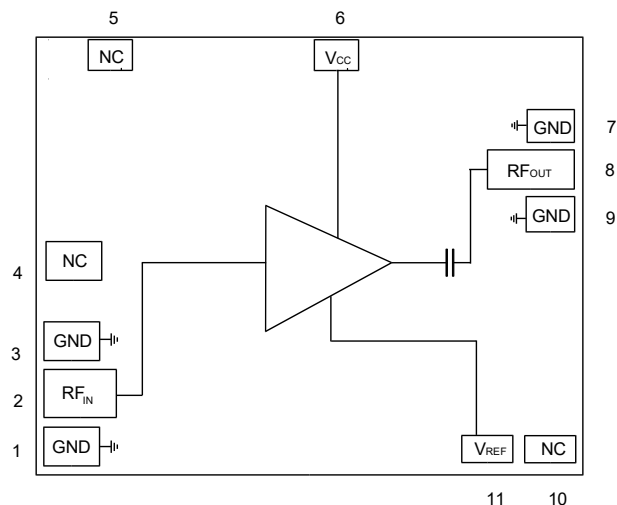
This product is fabricated using a GaAs HBT process which features full passivation for enhanced reliability.

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

Ordering Information

| Part Number | Package |
|-----------------|----------|
| MAAL-011154-DIE | Gel Pack |

Functional Schematic



Pad Configuration¹

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

1. Backside of die 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, $T_A = +25^\circ\text{C}$, $V_{CC} = 5\text{ V}$, $Z_0 = 50\ \Omega$ (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 | — | ± 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_{cc} | — | mA | — | 85 | — |

Absolute Maximum Ratings^{2,3}

| Parameter | Absolute Maximum |
|-------------------------------------|---|
| Input Power | 14 dBm |
| V_{CC} | 6 V |
| I_{cc} | 105 mA |
| Junction Temperature ^{4,5} | +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 (Θ_{jc}) = 25.9 $^\circ\text{C/W}$.
 - For $T_C = +25^\circ\text{C}$,
 $T_J = 41.3^\circ\text{C}$ @ 6 V, 105 mA
 - For $T_C = +85^\circ\text{C}$,
 $T_J = 101.3^\circ\text{C}$ @ 6 V, 105 mA

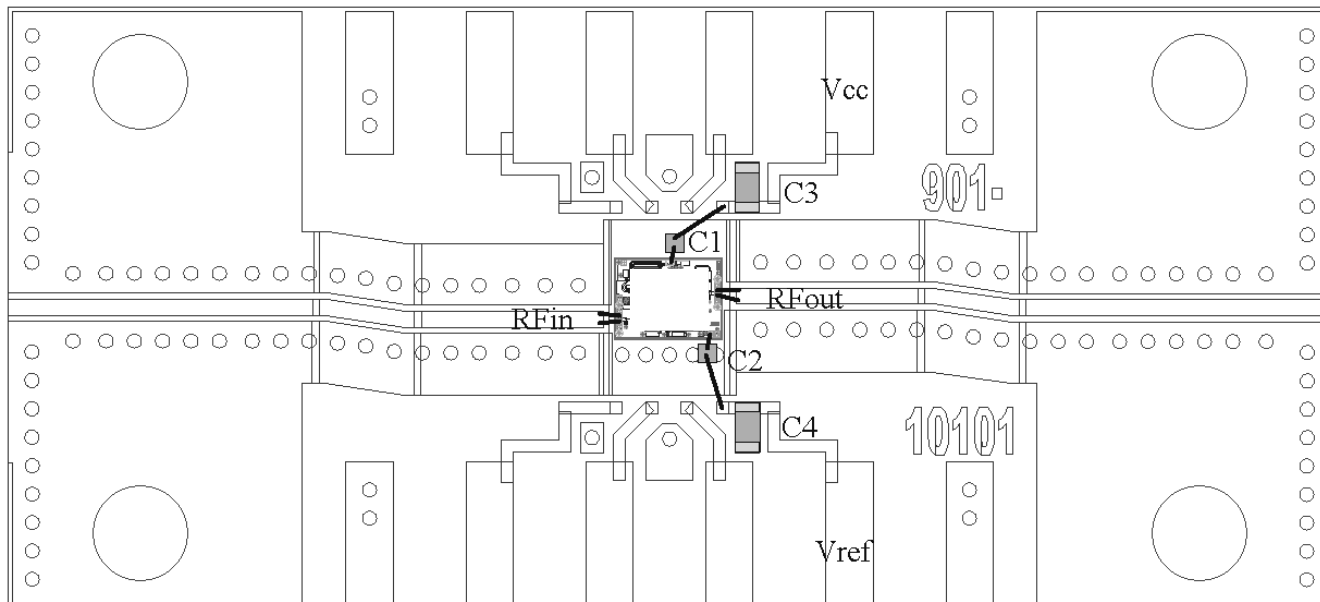
Handling Procedures

Please observe the following precautions to avoid damage:

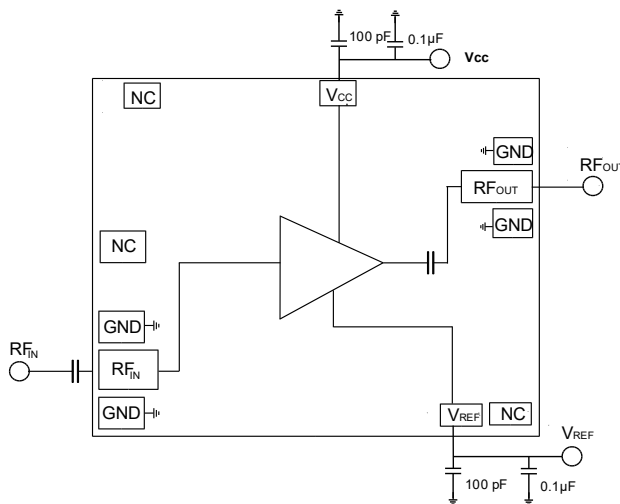
Static Sensitivity

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.

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 | MC2S100025-025 |
| C3, C4 | 0.1 μF | 0402 | KYOCERA | 04023C103KAT2A |

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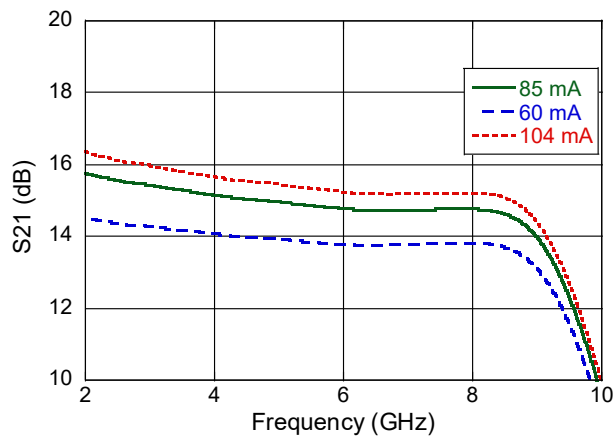


MAAL-011154-DIE

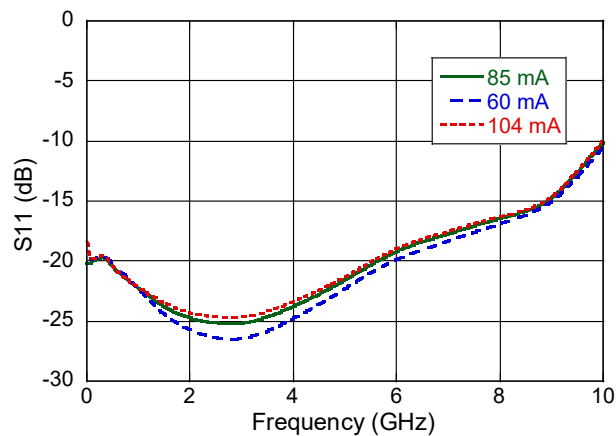
Rev. V1

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

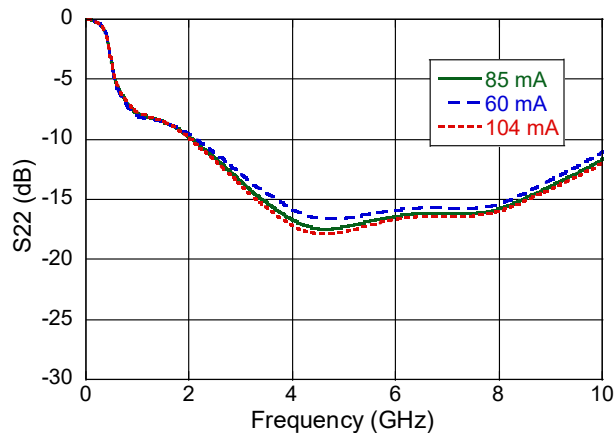
Gain



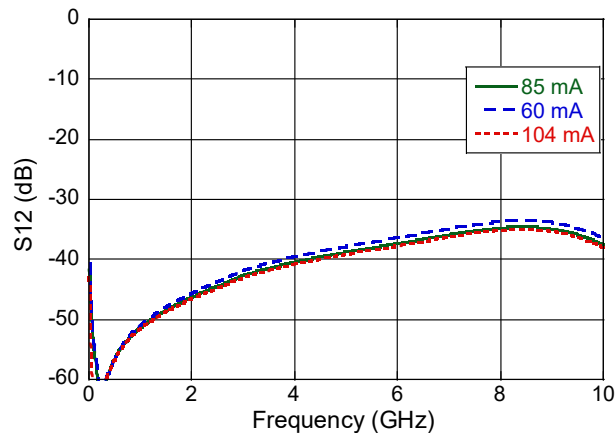
Input Return Loss



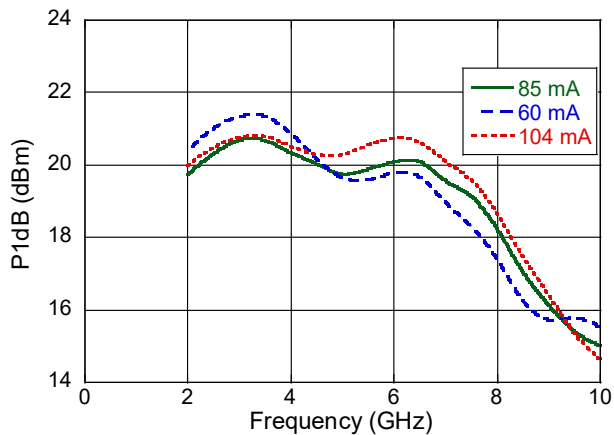
Output Return Loss



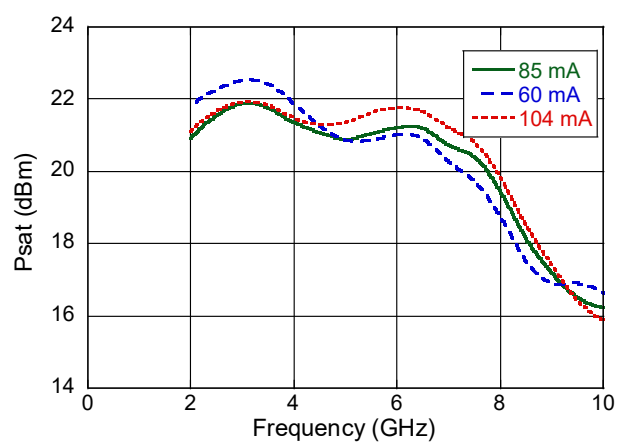
Reverse Isolation



P1dB



PSAT



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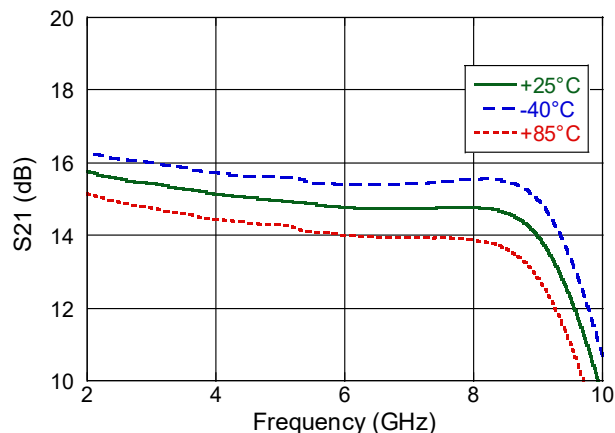


MAAL-011154-DIE

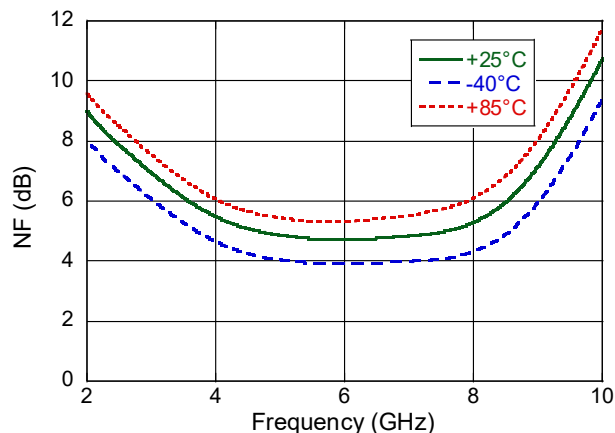
Rev. V1

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

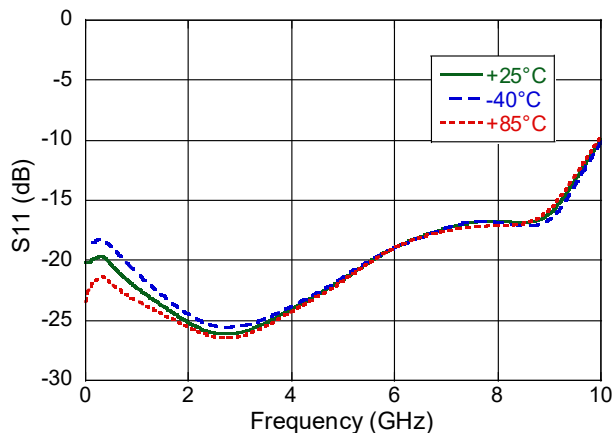
Gain



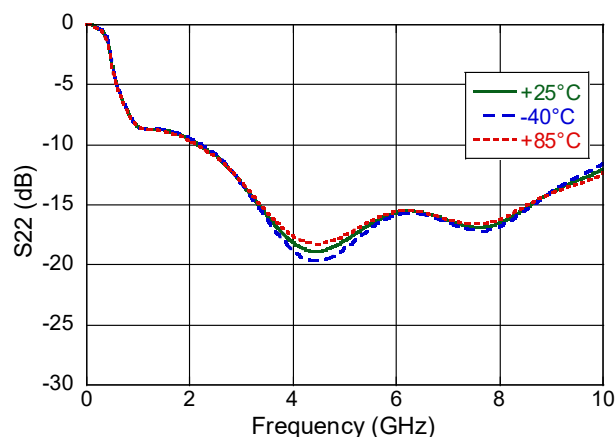
Noise Figure



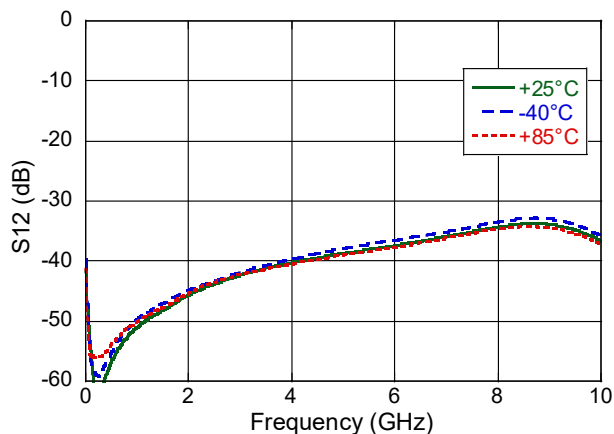
Input Return Loss



Output Return Loss

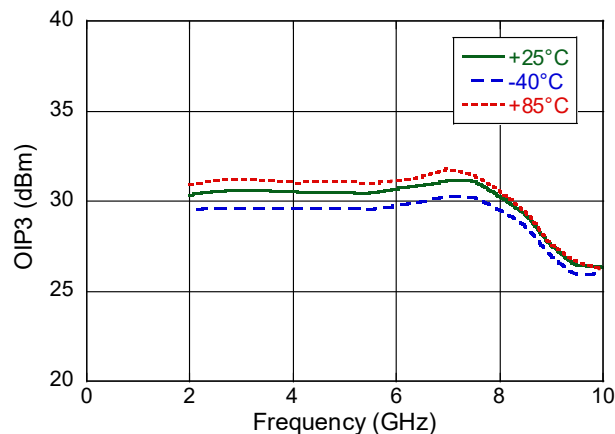


Reverse Isolation



Output IP3

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



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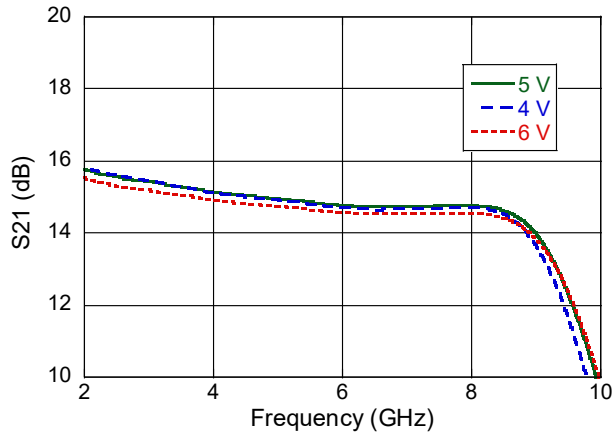


MAAL-011154-DIE

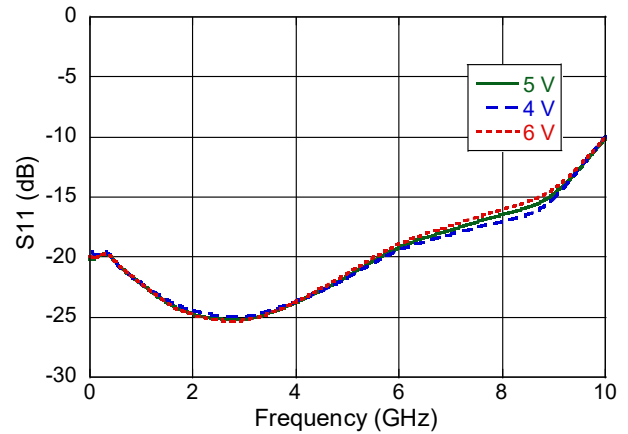
Rev. V1

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

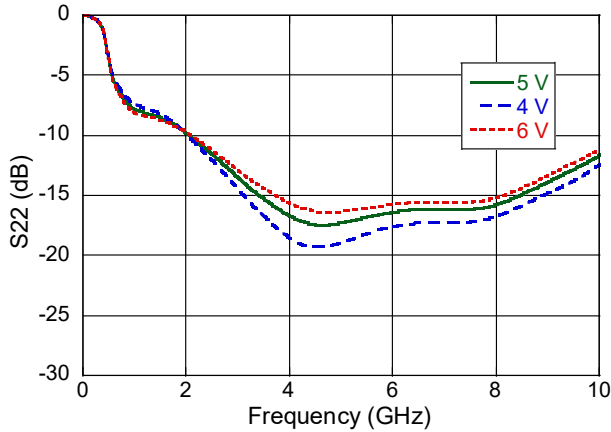
Gain



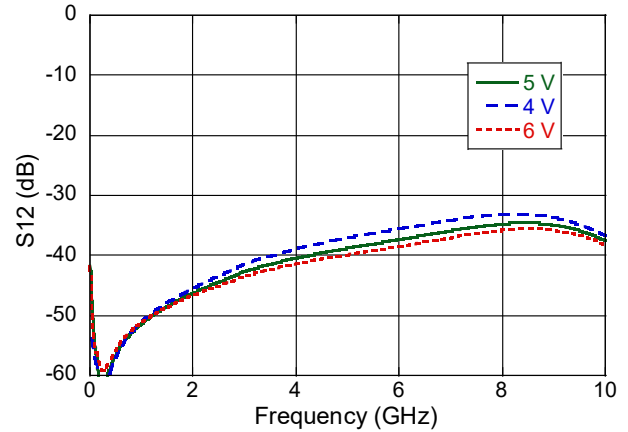
Input Return Loss



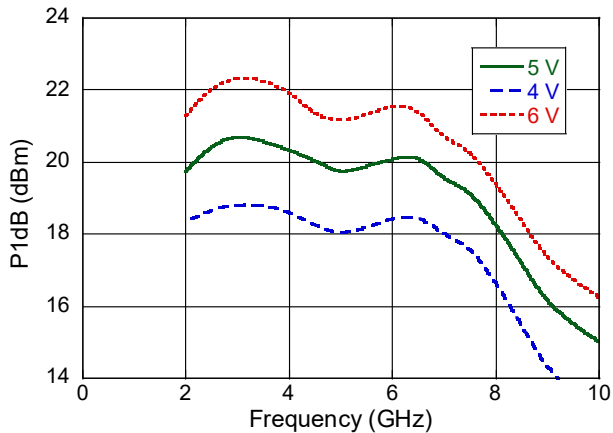
Output Return Loss



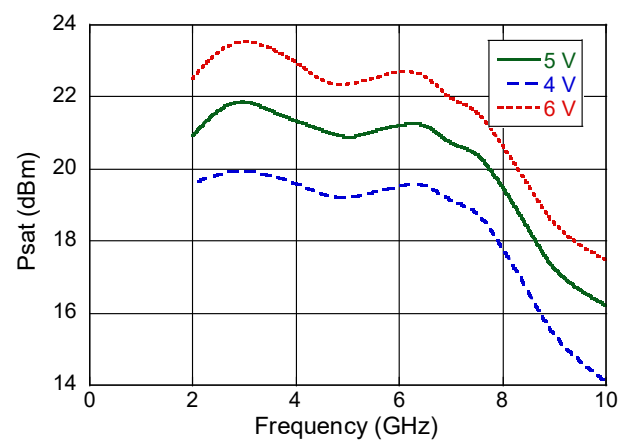
Reverse Isolation



P1dB



Psat



Low Phase Noise Amplifier 4 - 8 GHz

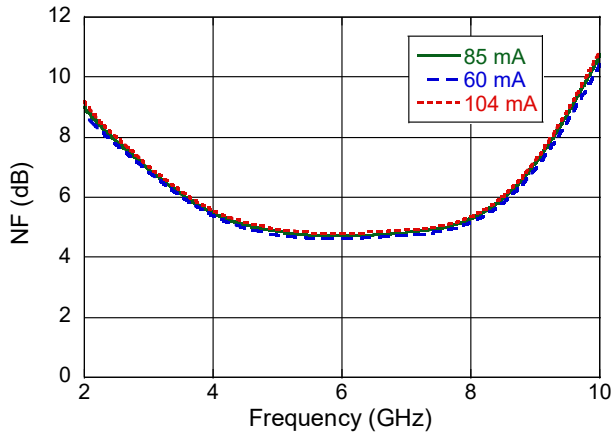


MAAL-011154-DIE

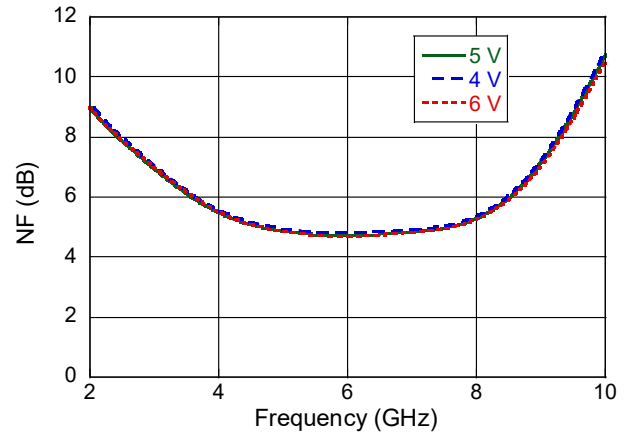
Rev. V1

Typical Performance Curves: +25°C

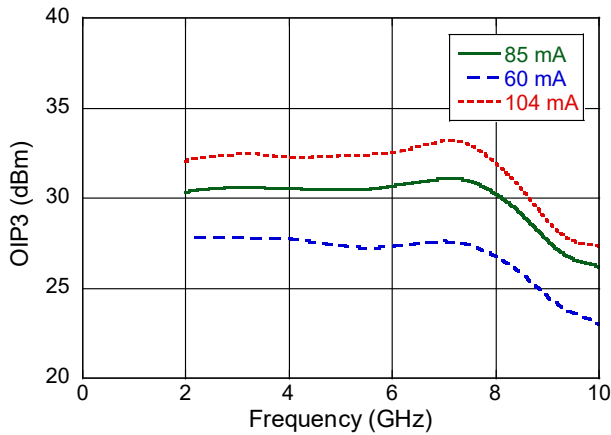
Noise Figure @ 5 V



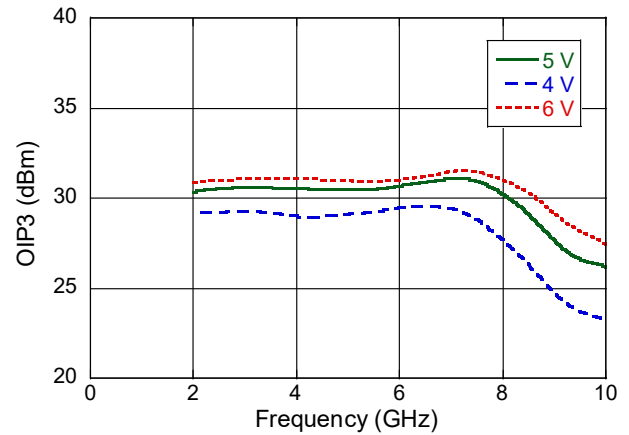
Noise Figure @ 85 mA



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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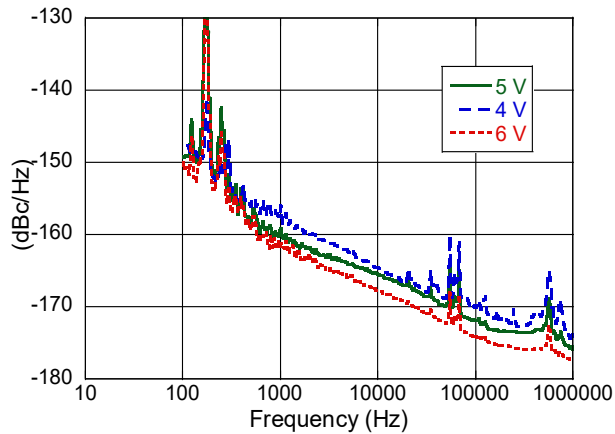


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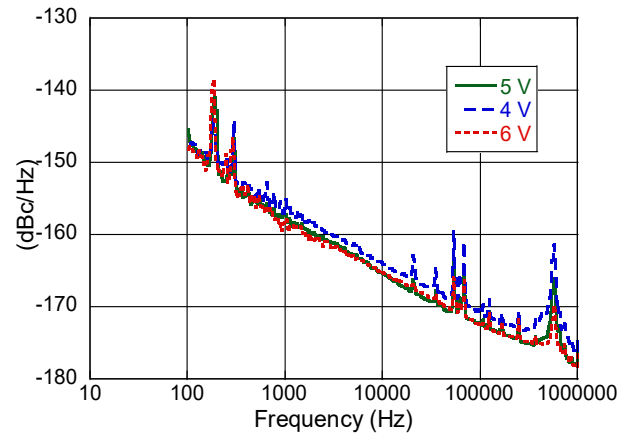
Rev. V1

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

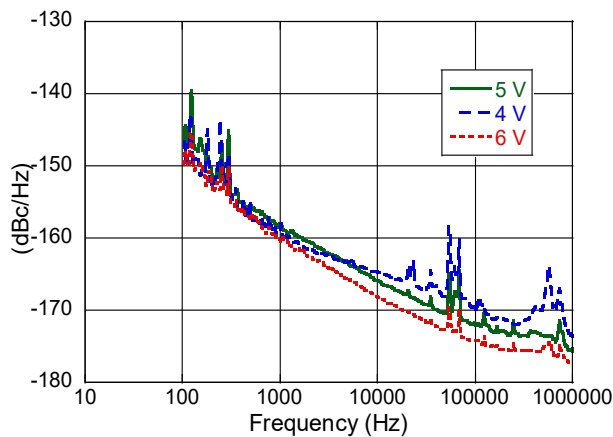
Phase Noise @ 4 GHz, P1dB



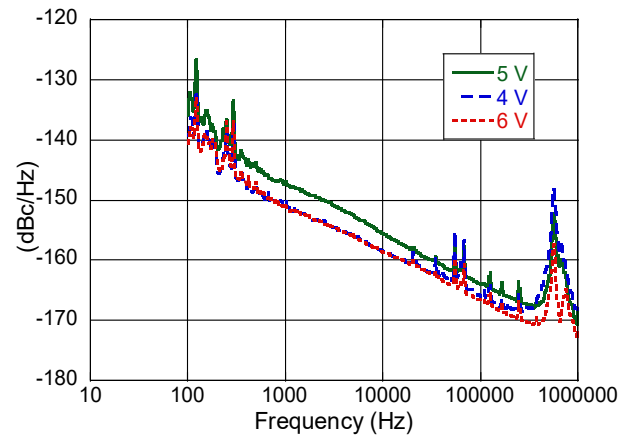
Phase Noise @ 4 GHz, P4dB



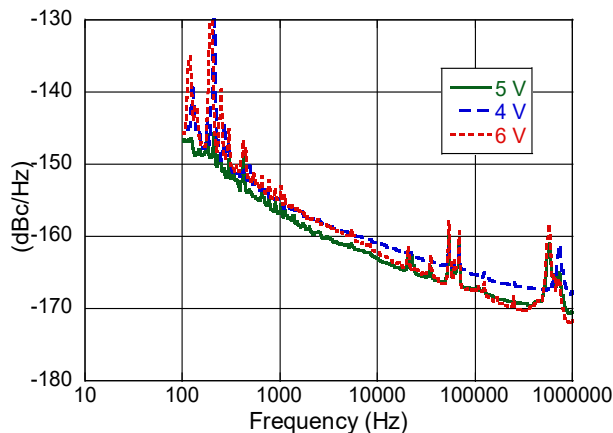
Phase Noise @ 6 GHz, P1dB



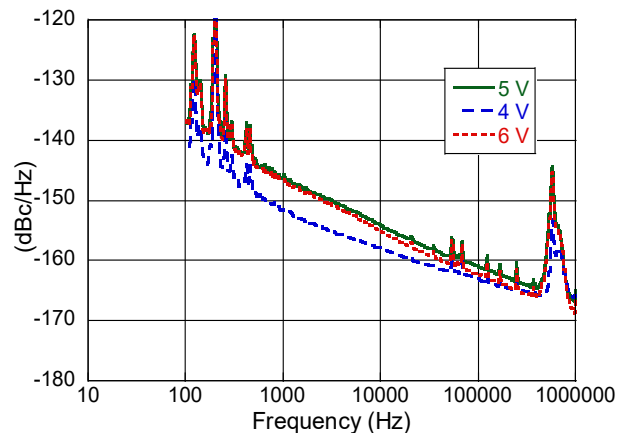
Phase Noise @ 6 GHz, P4dB



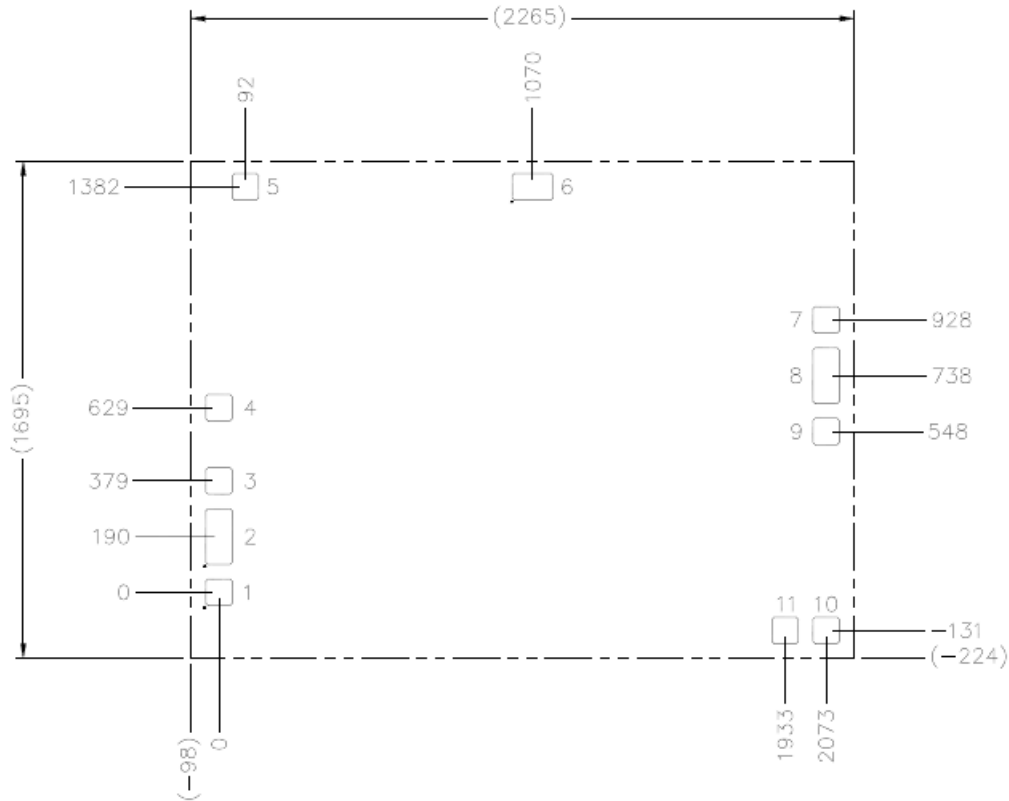
Phase Noise @ 8 GHz, P1dB



Phase Noise @ 8 GHz, P4dB



MMIC Die Outline



Bond Pad Detail^{6,7,8,9}

| 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 (μm) 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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