

Wideband Distributed Amplifier

100 kHz - 67.5 GHz



MAAM-011238-DIE

Rev. V4

Features

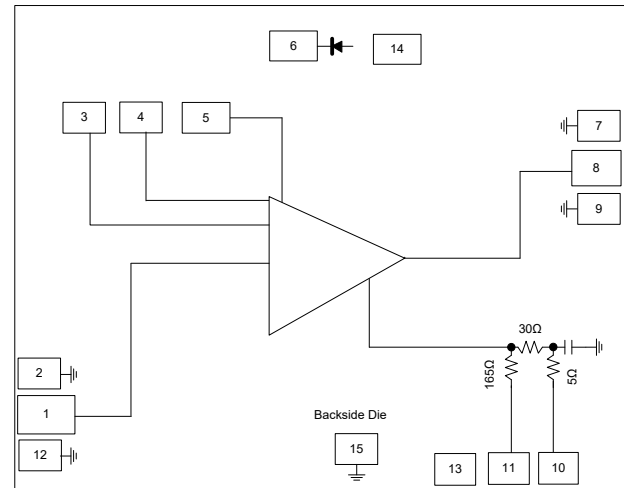
- Gain: 14 dB @ 6 V, 30 GHz
- P1dB: 18 dBm @ 6 V, 30 GHz
- P3dB: 20 dBm @ 6 V, 30 GHz
- Integrated Power Detector
- Gain Control with Only Positive Bias Voltages
- 50 Ω Input and Output Match
- Bias Voltage: $V_{DD} = 4 - 6$ V
- Bias Current: $I_{DSQ} = 125 - 150$ mA
- Die size: 2.1 x 1.05 mm
- RoHS* Compliant

Description

MAAM-011238-DIE is an easy-to-use, wideband amplifier that operates from 100 kHz to 67.5 GHz. The amplifier provides 14 dB gain, 4.5 dB noise figure and 20 dBm of P3dB output power @ 30 GHz. It is matched to 50 Ω with typical return loss better than 12 dB. The amplifier requires only positive bias voltages and would typically be operated at 6 V and 135 mA.

MAAM-011238-DIE is suitable for a wide range of applications in instrumentation and communication systems.

Functional Schematic



Pad Configuration¹

| Pin # | Pin Name | Description |
|-----------------|-------------------|--------------------------------|
| 1 | RF _{IN} | RF Input / Gate Voltage |
| 2, 7, 9, 12, 15 | GND | DC & RF Ground to Backside Via |
| 3 | V _{G2} | Gate Voltage 2 |
| 4 | V _{DD} | Drain Voltage |
| 5 | V _{DAUX} | Auxiliary Drain Voltage |
| 6 | V _{DET} | Detector Voltage |
| 8 | RF _{OUT} | RF Output / Drain Voltage |
| 10 | V _{GAUX} | Auxiliary Gate Voltage |
| 11 | V _{G1} | Gate Voltage 1 |
| 13, 14 | NC | Not Connected |

1. The backside of the die must be connected to RF, DC and thermal ground.

Ordering Information

| Part Number | Package |
|-----------------|----------------|
| MAAM-011238-DIE | Die in Gel Pak |

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

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Electrical Specifications: $T_C = +25^\circ\text{C}$, $V_D = 6\text{ V}$, $Z_0 = 50\ \Omega$

| Parameter | Test Conditions | Units | Min. | Typ. | Max. |
|--------------------|-----------------|-------|------|------|------|
| Gain | 0.0001 - 10 GHz | dB | 14 | 15.9 | — |
| | 10 - 20 GHz | | 13.8 | 15.5 | |
| | 20 - 30 GHz | | 13.3 | 15.0 | |
| | 30 - 40 GHz | | 12.5 | 14.0 | |
| | 40 - 50 GHz | | 11.5 | 13.0 | |
| | 50 - 60 GHz | | — | 11.5 | |
| | 60 - 67.5 GHz | | — | 7.0 | |
| Noise Figure | 2.8 - 10 GHz | dB | — | 6.0 | — |
| | 10 - 20 GHz | | | 4.1 | |
| | 20 - 30 GHz | | | 4.7 | |
| | 30 - 40 GHz | | | 6.0 | |
| | 40 - 50 GHz | | | 9.0 | |
| Input Return Loss | 0.0001 - 10 GHz | dB | — | 18.0 | — |
| | 10 - 20 GHz | | | 17.0 | |
| | 20 - 30 GHz | | | 17.0 | |
| | 30 - 40 GHz | | | 16.6 | |
| | 40 - 67.5 GHz | | | 15.0 | |
| Output Return Loss | 0.0001 - 10 GHz | dB | — | 17.0 | — |
| | 10 - 20 GHz | | | 15.0 | |
| | 20 - 30 GHz | | | 13.0 | |
| | 30 - 40 GHz | | | 13.5 | |
| | 40 - 67.5 GHz | | | 12.0 | |
| P1dB | 40 GHz | dBm | 15 | 17.6 | — |
| P3dB | 0.0001 - 10 GHz | dBm | — | 22.0 | — |
| | 10 - 20 GHz | | | 21.0 | |
| | 20 - 30 GHz | | | 20.0 | |
| | 30 - 40 GHz | | | 19.0 | |
| | 40 - 50 GHz | | | 18.0 | |
| | 50 - 60 GHz | | | 16.0 | |
| | 60 - 67.5 GHz | | | 14.0 | |
| Output IP3 | 0.0001 - 10 GHz | dBm | — | 29.0 | — |
| | 10 - 20 GHz | | | 28.0 | |
| | 20 - 30 GHz | | | 27.0 | |
| | 30 - 40 GHz | | | 26.5 | |
| | 40 - 50 GHz | | | 25.0 | |
| | 50 - 60 GHz | | | 22.0 | |
| | 60 - 67.5 GHz | | | 16.0 | |
| Drain Current | Quiescent Bias | mA | — | 135 | — |

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Electrical Specifications: $T_C = +25^\circ\text{C}$, $V_D = 5\text{ V}$, $Z_0 = 50\ \Omega$

| Parameter | Test Conditions | Units | Min. | Typ. | Max. |
|--------------------|-----------------|-------|------|------|------|
| Gain | 0.0001 - 10 GHz | dB | — | 16.5 | — |
| | 10 - 20 GHz | | | 16.0 | |
| | 20 - 30 GHz | | | 16.0 | |
| | 30 - 40 GHz | | | 16.0 | |
| | 40 - 50 GHz | | | 16.0 | |
| | 50 - 60 GHz | | | 15.0 | |
| | 60 - 67.5 GHz | | | 12.0 | |
| Noise Figure | 2.8 - 10 GHz | dB | — | 6.0 | — |
| | 10 - 20 GHz | | | 4.1 | |
| | 20 - 30 GHz | | | 4.7 | |
| | 30 - 40 GHz | | | 6.0 | |
| | 40 - 50 GHz | | | 9.0 | |
| Input Return Loss | 0.0001 - 10 GHz | dB | — | 18.0 | — |
| | 10 - 20 GHz | | | 17.0 | |
| | 20 - 30 GHz | | | 17.0 | |
| | 30 - 40 GHz | | | 16.6 | |
| | 40 - 67.5 GHz | | | 15.0 | |
| Output Return Loss | 0.0001 - 10 GHz | dB | — | 17.0 | — |
| | 10 - 20 GHz | | | 15.0 | |
| | 20 - 30 GHz | | | 13.0 | |
| | 30 - 40 GHz | | | 13.5 | |
| | 40 - 67.5 GHz | | | 12.0 | |
| P1dB | 0.0001 - 10 GHz | dBm | — | 18.0 | — |
| | 10 - 20 GHz | | | 17.6 | |
| | 20 - 30 GHz | | | 17.0 | |
| | 30 - 40 GHz | | | 17.5 | |
| | 40 - 50 GHz | | | 15.5 | |
| | 50 - 60 GHz | | | 15.0 | |
| | 60 - 67.5 GHz | | | 14.0 | |
| P3dB | 0.0001 - 10 GHz | dBm | — | 21.5 | — |
| | 10 - 20 GHz | | | 21.0 | |
| | 20 - 30 GHz | | | 19.5 | |
| | 30 - 40 GHz | | | 18.5 | |
| | 40 - 50 GHz | | | 17.5 | |
| | 50 - 60 GHz | | | 17.0 | |
| | 60 - 67.5 GHz | | | 16.0 | |
| Output IP3 | 0.0001 - 10 GHz | dBm | — | 25.0 | — |
| | 10 - 20 GHz | | | 26.0 | |
| | 20 - 30 GHz | | | 25.5 | |
| | 30 - 40 GHz | | | 25.5 | |
| | 40 - 50 GHz | | | 24.0 | |
| | 50 - 60 GHz | | | 22.5 | |
| | 60 - 67.5 GHz | | | 17.0 | |
| Drain Current | Quiescent bias | mA | — | 150 | — |

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Absolute Maximum Ratings^{3,4}

| Parameter | Absolute Maximum |
|-------------------------------------|------------------|
| Input Power | 16 dBm |
| Drain Supply Voltage | 8 V |
| Junction Temperature ^{5,6} | +150°C |
| Operating Temperature | -40°C to +85°C |
| Storage Temperature | -65°C to +150°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) = $T_A + \theta_{JC} * ((V * I) - (P_{\text{OUT}} - P_{\text{IN}}))$
Typical thermal resistance (θ_{JC}) = 22.1 °C/W.
For $T_A = +85^\circ\text{C}$,
 $T_J = +103^\circ\text{C}$ at $V = 6\text{ V}$, $I = 0.135\text{ A}$

Operating Conditions

One of the recommended biasing conditions is $V_{\text{DD}} = 6\text{ V}$, $I_{\text{DSQ}} = 135\text{ mA}$. (I_{DSQ} is set by adjusting V_{G1} after correctly setting V_{DD} . (Refer to turn on sequence.)

There are 3 possible bias methods:

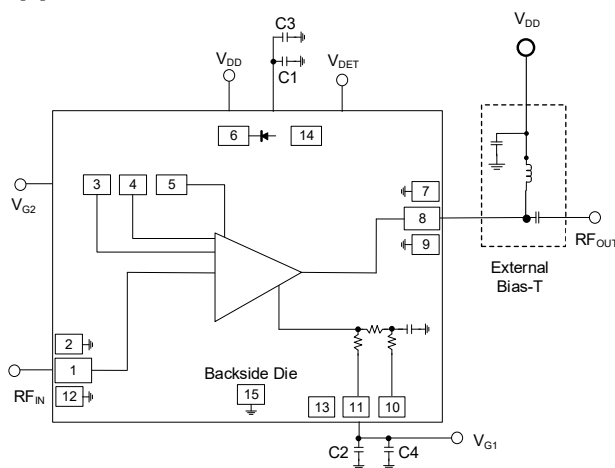
- The use of an external DC block on the input and a bias tee. The required V_{DD} is applied at $\text{RF}_{\text{OUT}}/V_{\text{DD}}$ through the bias tee and V_{G} is set to provide the required current bias (I_{DSQ}). This provides wide band performance of 40 MHz - 67.5 GHz. (depending on the bandwidth of the bias tee)
- The direct application of drain voltage to V_{DD} using a wideband conical. No external bias tee is required. However DC blocking is required on both the RF_{IN} and RF_{OUT} . Using this method provides for an operational frequency of 40 MHz - 67.5 GHz.
- For compatibility with systems requiring $V_{\text{G1}} > 3\text{ V}$ V_{GAUX} can be grounded. Note that this configuration will cause I_{G1} to be 21 mA (instead of 0.65 V @ 1 mA).

For low frequency extension, the addition of 2 bypass capacitors on V_{G1} and V_{DAUX} of 1200 pF and 10 μF will improve the frequency of operation down to 100 kHz. These capacitors should be positioned as close to the device as possible.

Dynamic gain control is available when operating in the linear gain region through the application of 0 to 1.6 V to V_{G2} .

The evaluation board is configured with bias option 1. Bypass capacitors on V_{G1} and V_{AUX} are also included for operation down to 100 kHz. Data in this datasheet was measured using option 1.

Application Schematic



Component List

| Part | Value | Size | Part Number |
|--------|------------------|--------|--------------------------|
| C1, C2 | 1200 pF | 25 mil | TECDIA SKT03C122V12A6 |
| C3, C4 | 10 μF | 0603 | any |

Operating the MAAM-011238-DIE

Turn-on

- Apply V_{G1} to 0 V.
- Apply V_{DD} to 6 V.
- Set I_{DSQ} by adjusting V_{G1} more positive. (typically 0.65 V for $I_{\text{DSQ}} = 135\text{ mA}$).
- Apply RF_{IN} signal.

Turn-off

- Remove RF_{IN} signal.
- Decrease V_{G1} to 0 V.
- Decrease V_{DD} to 0 V.

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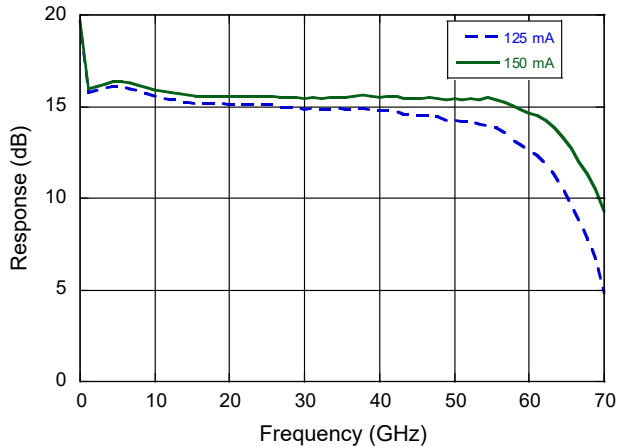


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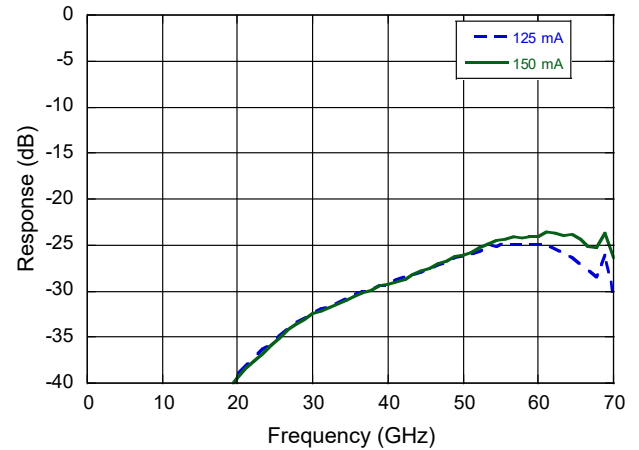
Rev. V4

Typical Performance Curves: $V_D = 6\text{ V}$, $T_A = +25^\circ\text{C}$

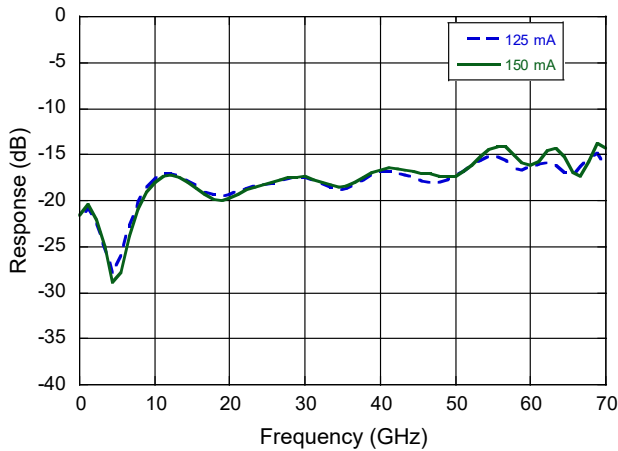
Gain



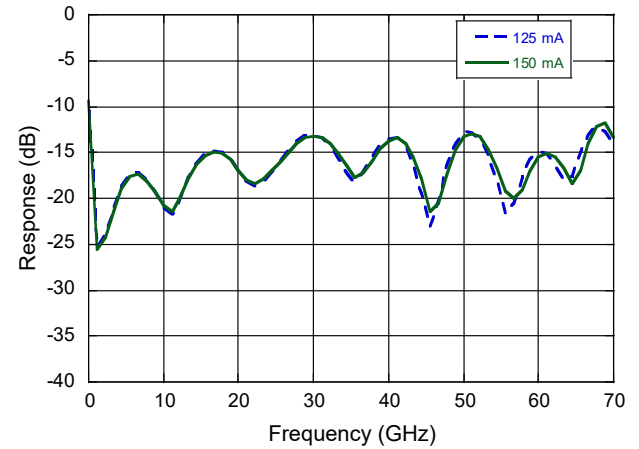
Reverse Isolation



Input Return Loss



Output Return Loss



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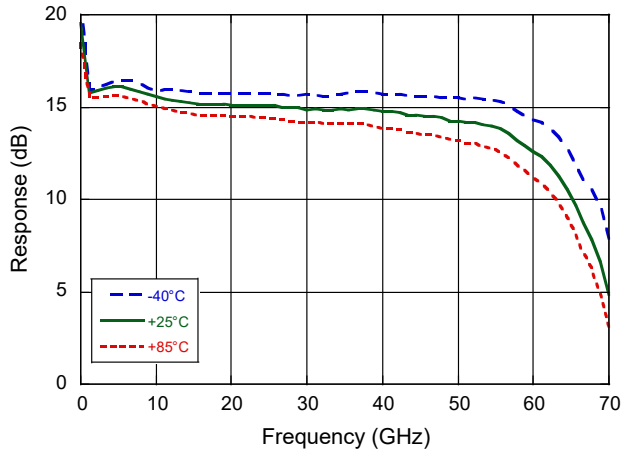


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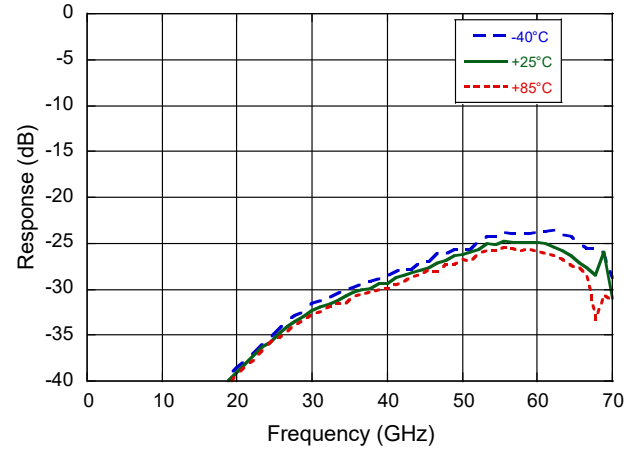
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Typical Performance Curves: $V_D = 6\text{ V}$, $I_D = 125\text{ mA}$

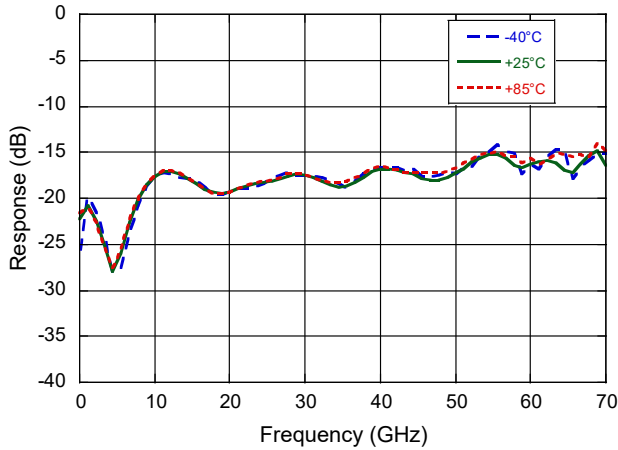
Gain



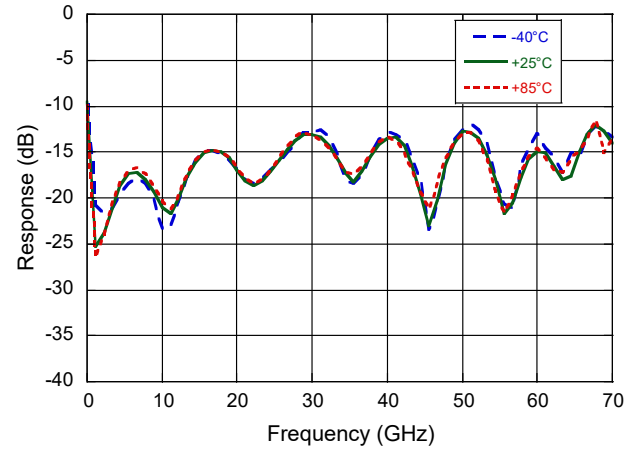
Reverse Isolation



Input Return Loss



Output Return Loss



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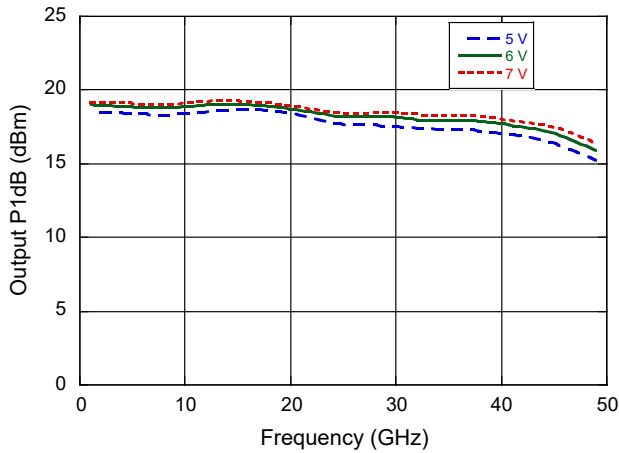


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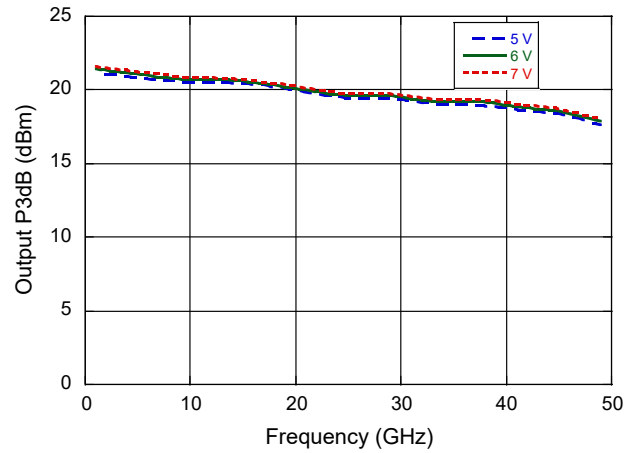
Rev. V4

Typical Performance Curves: $V_D = 6\text{ V}$, $I_D = 135\text{ mA}$, $T_A = +25^\circ\text{C}$

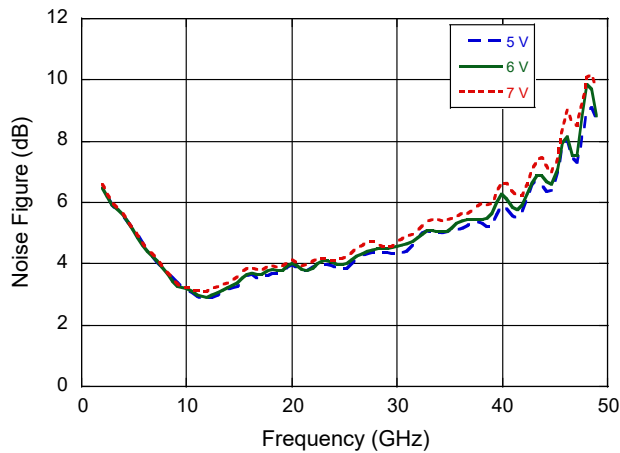
Output P1dB



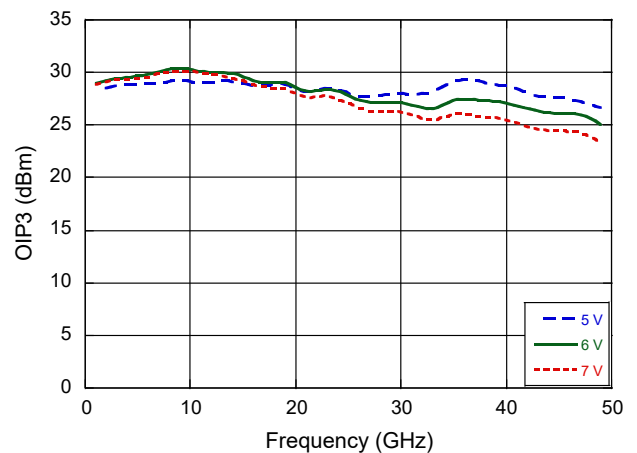
Output P3dB



Noise Figure at $T_A = 25^\circ\text{C}$



OIP3 at $T_A = 25^\circ\text{C}$



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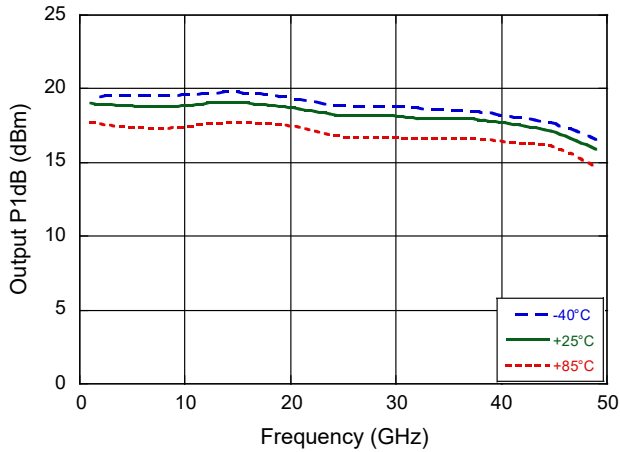


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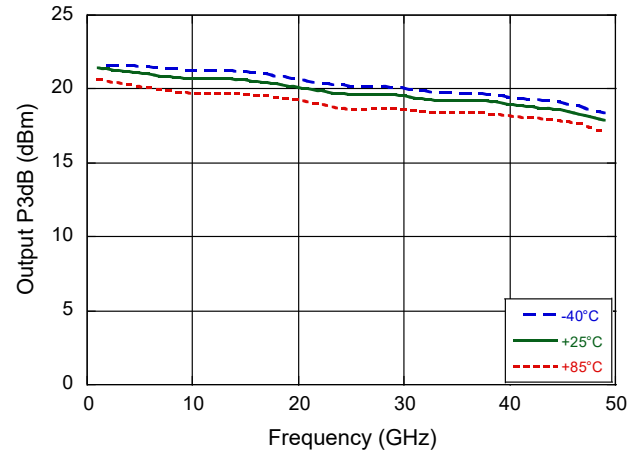
Rev. V4

Typical Performance Curves: $V_D = 6\text{ V}$, $I_D = 135\text{ mA}$

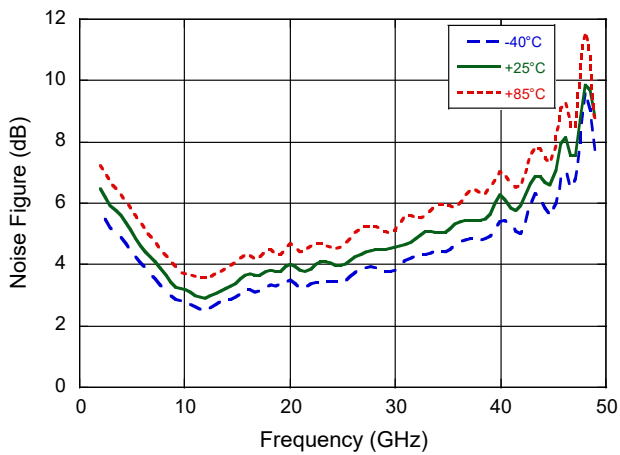
Output P1dB



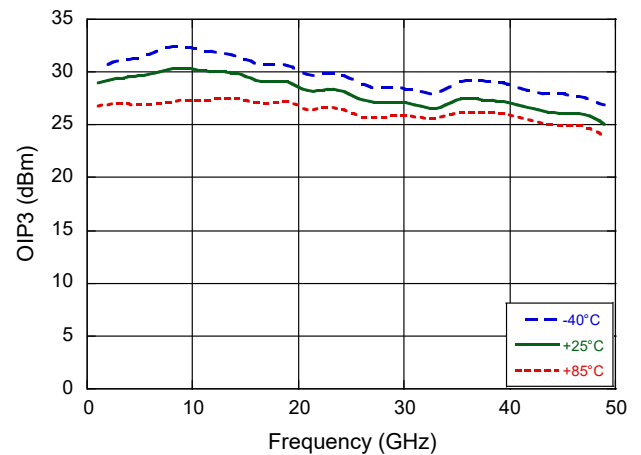
Output P3dB



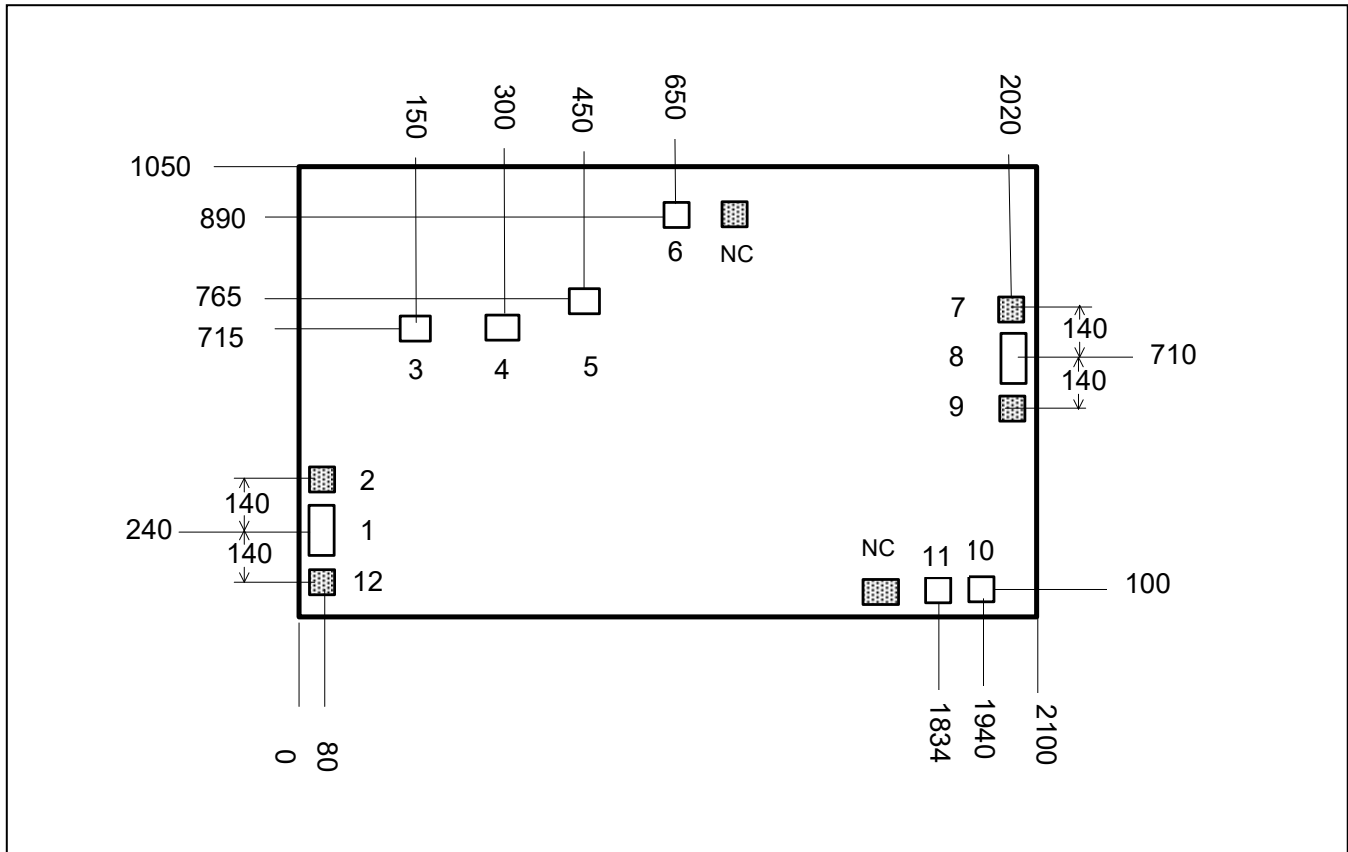
Noise Figure



OIP3



Die Dimensions^{7,8}



Bond Pad Detail

| Pin # | Size (x) | Size (y) |
|------------------|----------|----------|
| 1 | 99 | 155 |
| 2, 6, 10, 11, 12 | 69 | 69 |
| 3, 4, 5 | 69 | 89 |
| 7, 9 | 89 | 69 |
| 8 | 69 | 168 |

- 7. All dimensions shown as microns (μm) with a tolerance of $\pm 5 \mu\text{m}$, unless otherwise noted.
- 8. Die thickness is $100 \mu\text{m} \pm 10 \mu\text{m}$.

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 1C devices.

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