



# QPA2609D

7 – 14 GHz Low Noise Amplifier

## Product Overview

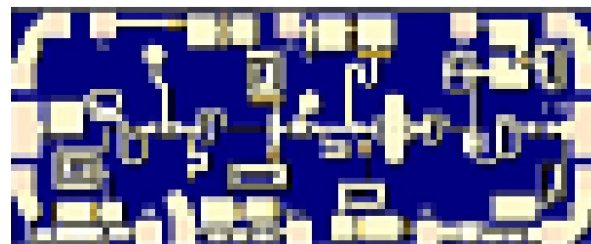
Qorvo's QPA2609D is a high-performance, low noise MMIC amplifier fabricated on Qorvo's production 90 nm pHEMT process (QPHT09). Covering 7 – 14 GHz, the QPA2609D provides 27 dB small signal gain and 1.1 dB noise figure. With a compact size of 2.4 x 1 mm, the amplifier can deliver 20dBm of saturated power with P1dB of 18 dBm. In addition, the device can provide low IMD3 level of -50 dBc at Pout = 0 dBm/tone.

The QPA2609D is matched to 50 ohms with integrated DC blocking caps on both I/O ports for easy handling and simple system integration.

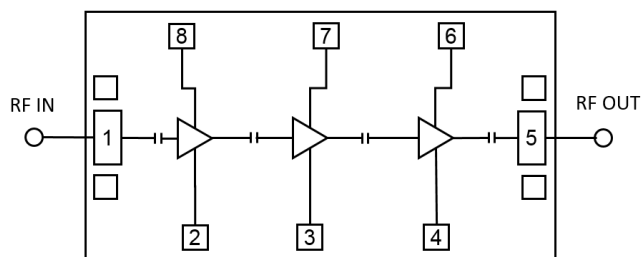
The high performance of the QPA2609D makes it ideal for satellite and point to point communication systems.

Lead-free and RoHS compliant.

Evaluation boards are available upon request.



## Functional Block Diagram



## Key Features

- Frequency Range: 7 – 14 GHz
- Noise Figure: 1.1 dB (typical)
- Small Signal Gain: 27 dB (typical)
- P1dB: 18 dBm (typical)
- IMD3: -50 dBc (typical) (Pout=0 dBm/tone)
- Bias: VD = 3.5 V, IDQ = 120 mA, VG = -0.46 V (typical)
- Die Dimensions: 2.40 x 1.00 x 0.10 mm

## Applications

- Satellite Communications
- Point-to-Point Communications
- Radar

## Ordering Information

| Part No.     | ECCN  | Description                    |
|--------------|-------|--------------------------------|
| QPA2609D     | EAR99 | 7 – 14 GHz Low Noise Amplifier |
| QPA2609D_EVB | EAR99 | QPA2609D Evaluation Board      |

## Absolute Maximum Ratings

| Parameter                                        | Rating         |
|--------------------------------------------------|----------------|
| Drain Voltage ( $V_D$ )                          | 4.5 V          |
| Drain Current ( $I_{D1}/I_{D2}/I_{D3}$ )         | 96/115/192 mA  |
| Gate Voltage Range ( $V_G$ )                     | –1.5 V to 0 V  |
| Gate Current ( $I_{G1}/I_{G2}/I_{G3}$ at 125 °C) | 5.0/5.0/6.6 mA |
| RF Input Power (50 $\Omega$ , 85 °C)             | 20 dBm         |
| Channel Temperature, $T_{CH}$                    | 175 °C         |
| Mounting Temperature (30 seconds)                | 260 °C         |
| Storage Temperature                              | –55 to 150 °C  |

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

## Recommended Operating Conditions

| Parameter                                       | Typ          | Units |
|-------------------------------------------------|--------------|-------|
| Drain Voltage                                   | 3.5 V        | V     |
| Drain Current (quiescent, $I_{DQ}$ )            | 120 mA       | mA    |
| Drain Current ( $I_D$ , Low noise / $P_{SAT}$ ) | 120 / 175 mA | mA    |
| Gate Voltage (typical)                          | –0.46 V      | V     |
| Operating Temperature Range                     | –40 to 85    | °C    |

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

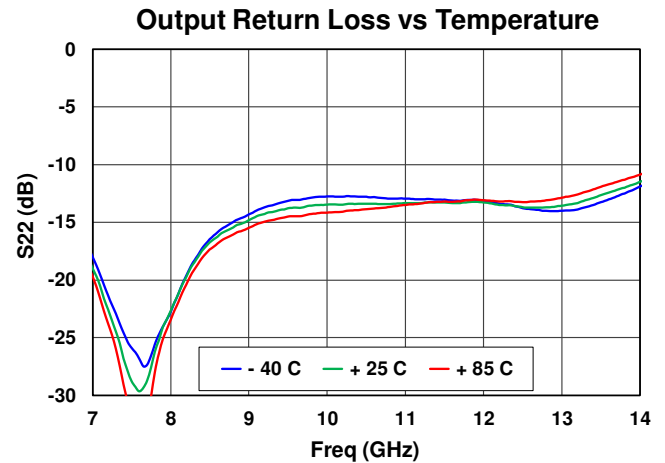
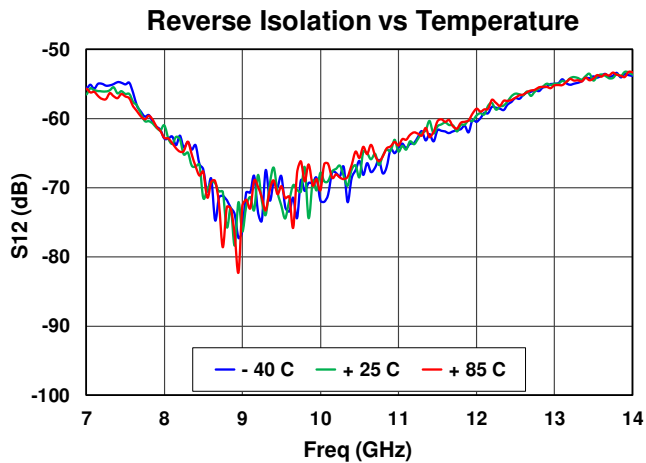
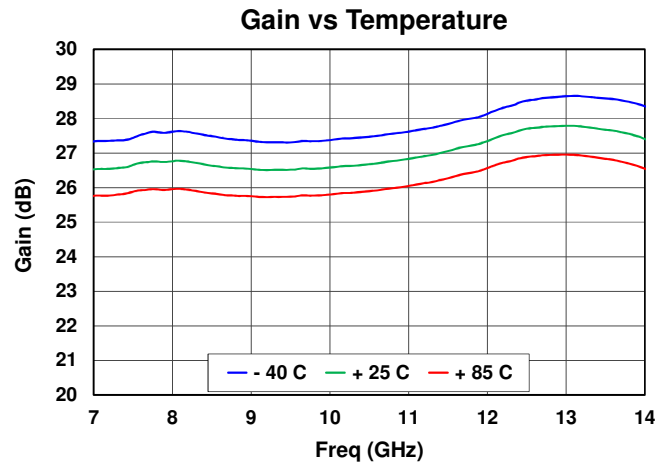
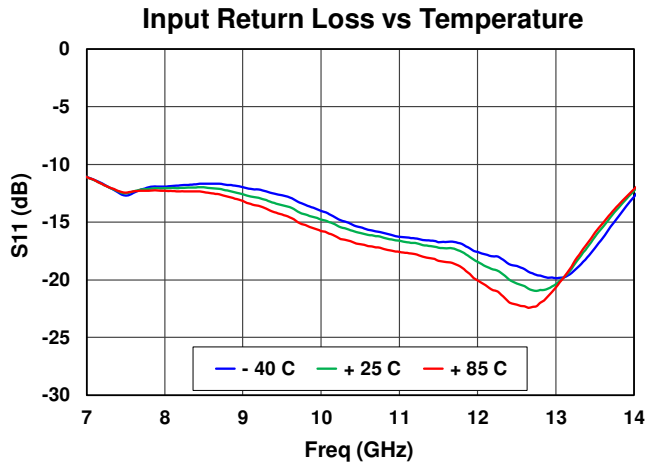
## Electrical Specifications

Test conditions unless otherwise noted:  $V_D = +3.5V$ ,  $I_{DQ} = 120$  mA, Temp. = +25 °C. Data de-embedded to MMIC bond wires.

| Parameter                                                               | Min | Typ    | Max | Units |
|-------------------------------------------------------------------------|-----|--------|-----|-------|
| Operating Frequency                                                     | 7   |        | 14  | GHz   |
| Small Signal Gain                                                       |     | 27     |     | dB    |
| Noise Figure                                                            |     | 1.1    |     | dB    |
| 1-dB Compression Point                                                  |     | 18     |     | dBm   |
| Input Return Loss                                                       |     | 14.0   |     | dB    |
| Output Return Loss                                                      |     | 13.0   |     | dB    |
| 3 <sup>RD</sup> Order Intermodulation Level ( $P_{OUT} = 0$ dBm / Tone) |     | –50    |     | dBc   |
| Output TOI ( $P_{out} = 0$ dBm / tone)                                  |     | 25.0   |     | dBm   |
| Gain (S21) Temperature Coefficient                                      |     | –0.013 |     | dB/°C |

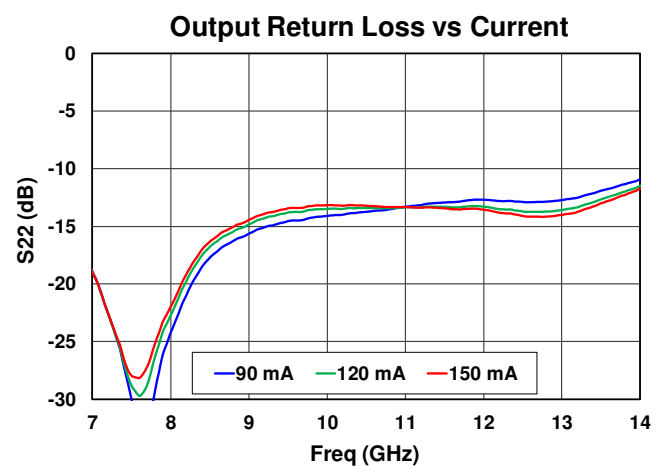
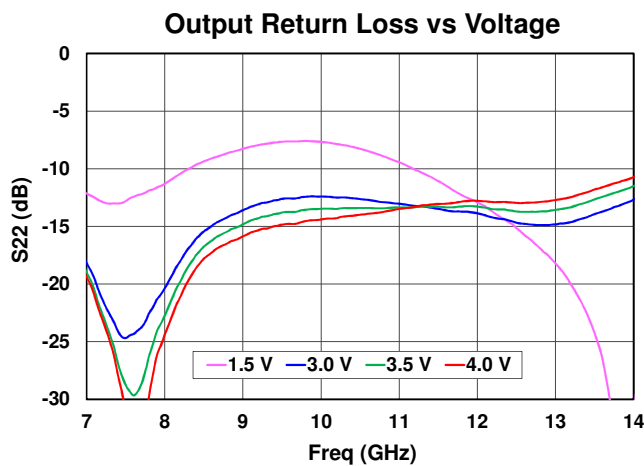
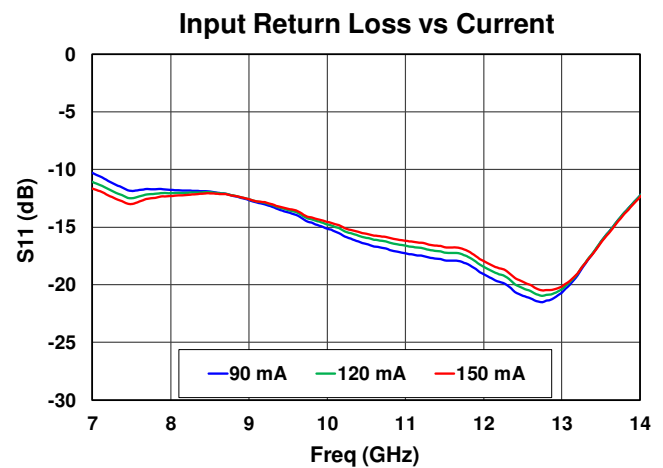
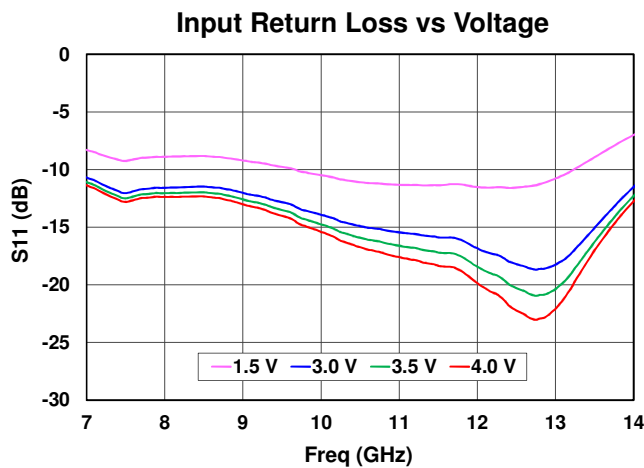
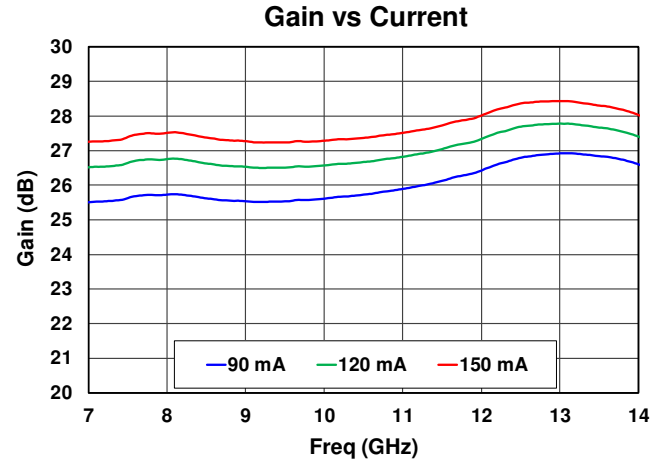
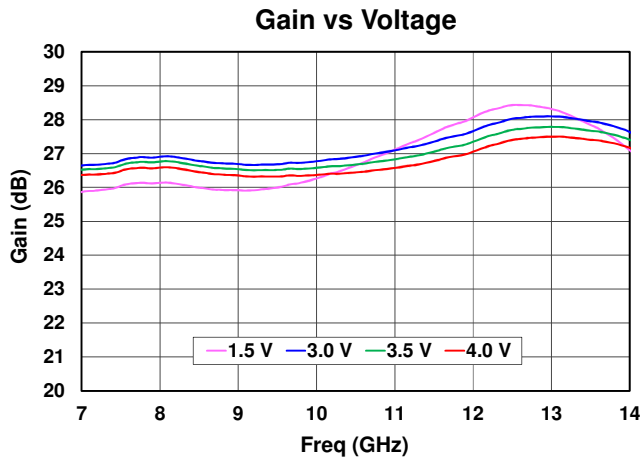
## Performance Plots – Small Signal

Test conditions unless otherwise noted:  $V_D = +3.5V$ ,  $I_{DQ} = 120\text{ mA}$ , Temp. =  $+25\text{ }^{\circ}\text{C}$ . Data de-embedded to MMIC bond wires.



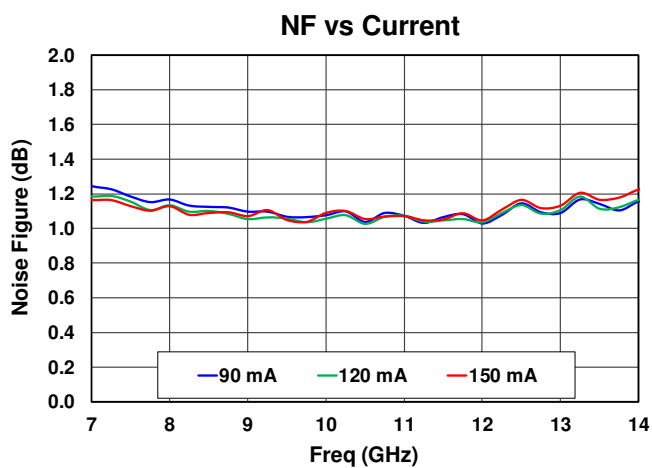
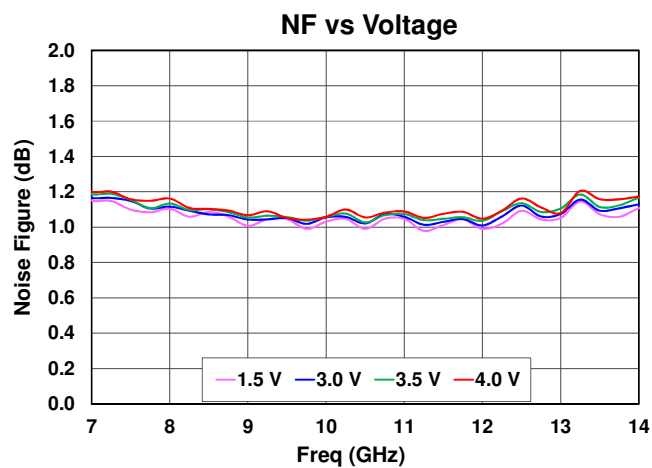
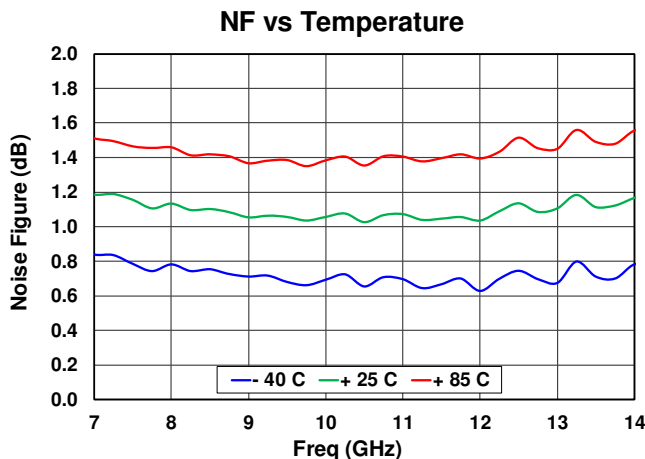
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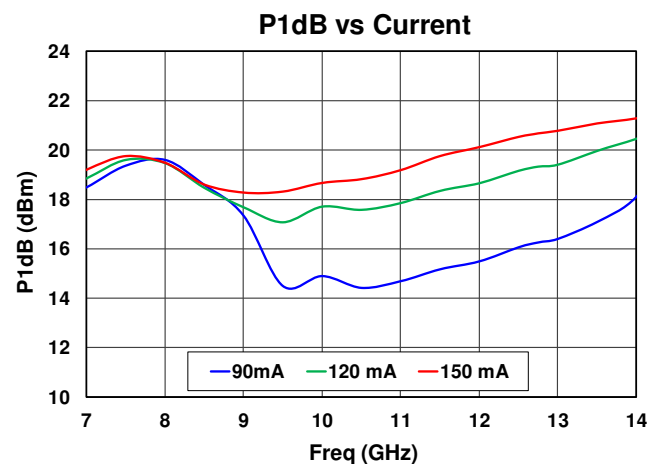
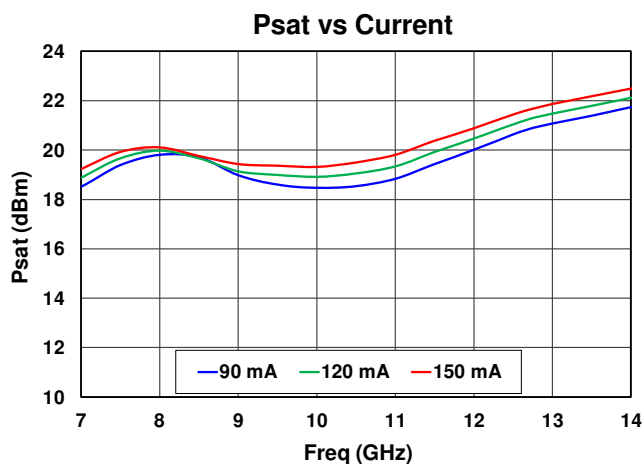
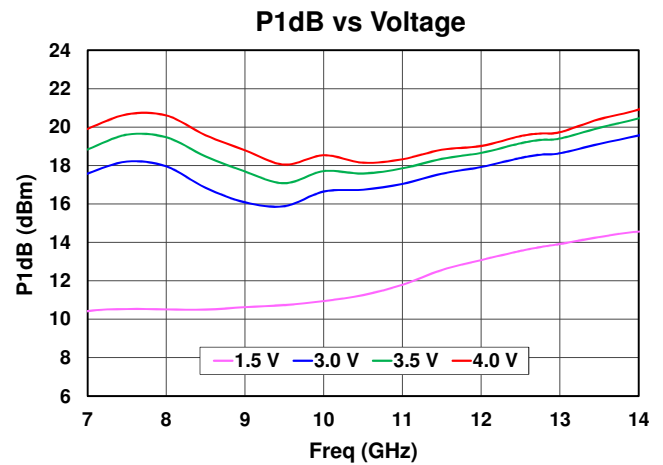
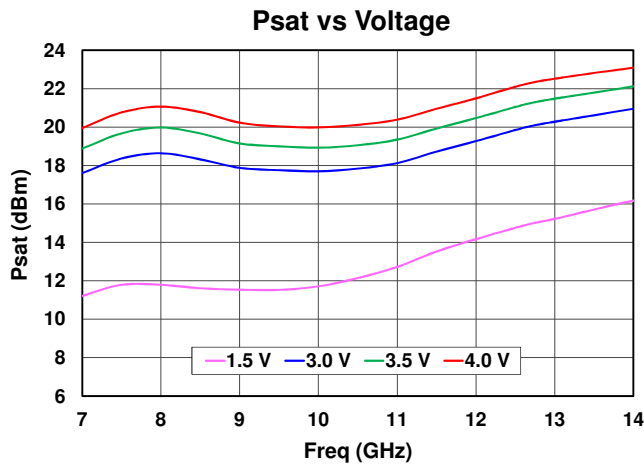
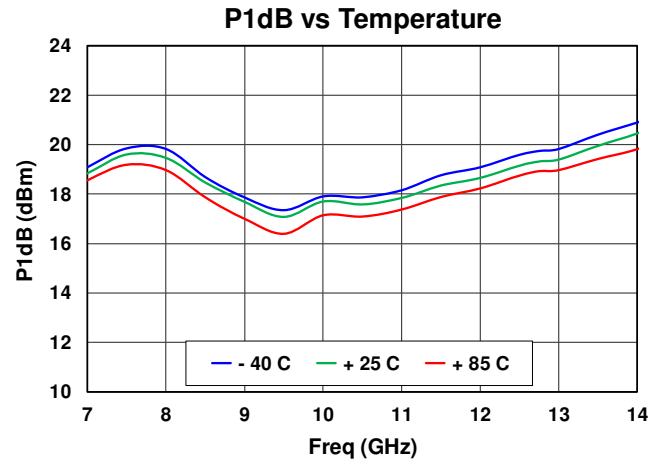
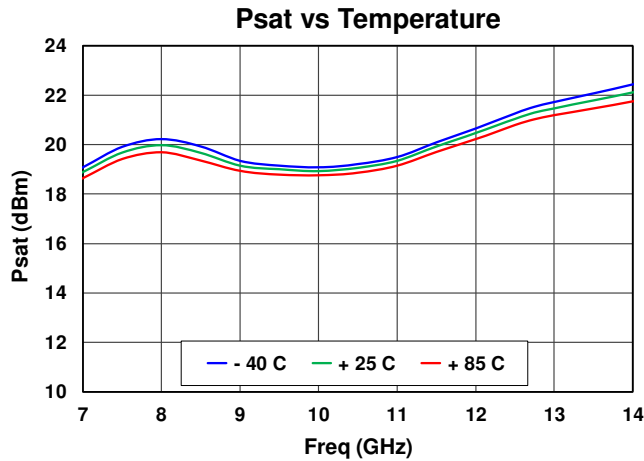
## Performance Plots – Noise Figure

Test conditions unless otherwise noted:  $V_D = +3.5V$ ,  $I_{DQ} = 120\text{ mA}$ , Temp. =  $+25\text{ }^{\circ}\text{C}$ . Data de-embedded to MMIC bond wires.



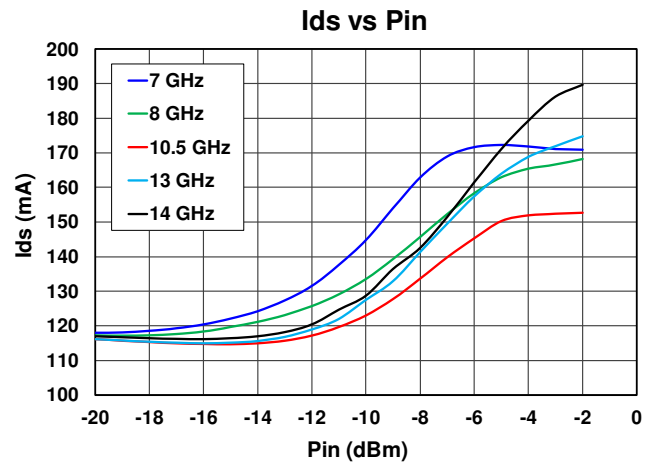
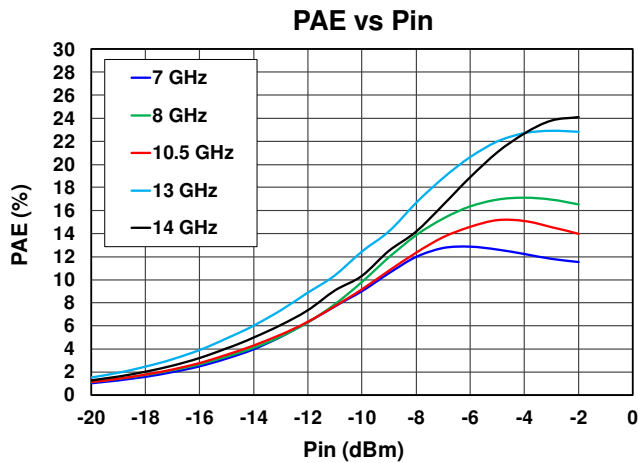
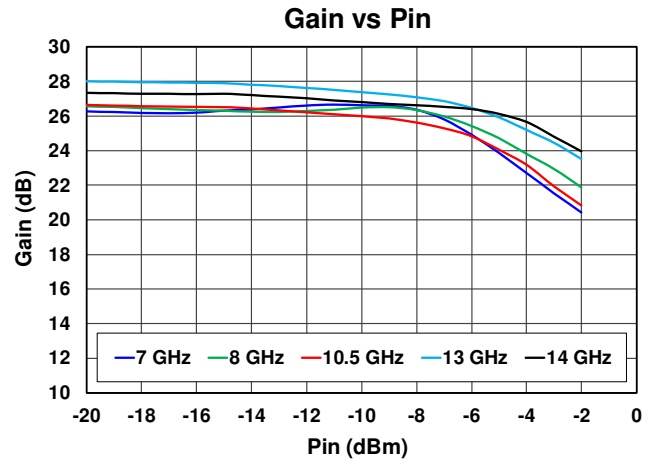
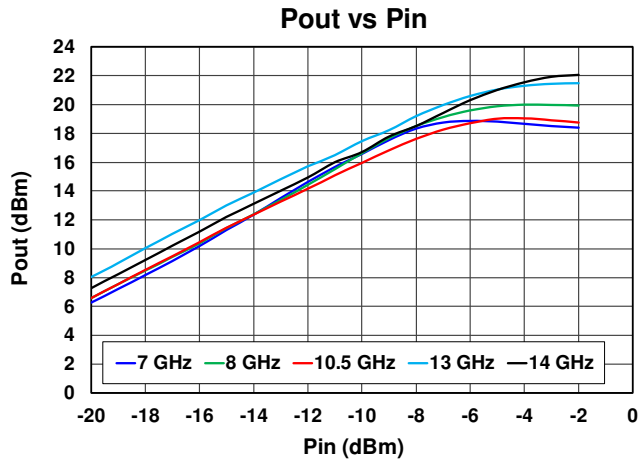
## Performance Plots – Large Signal

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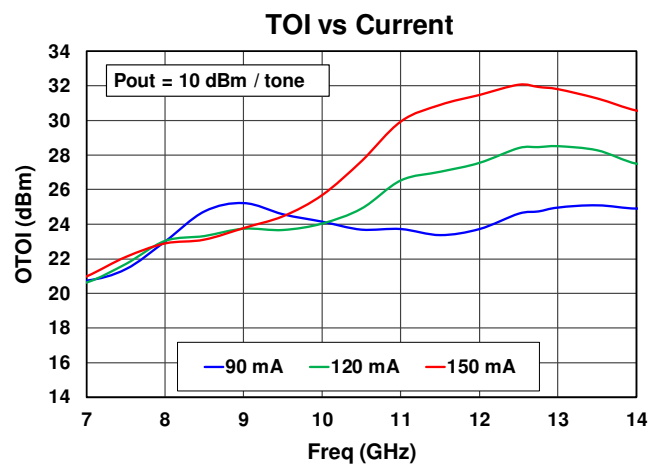
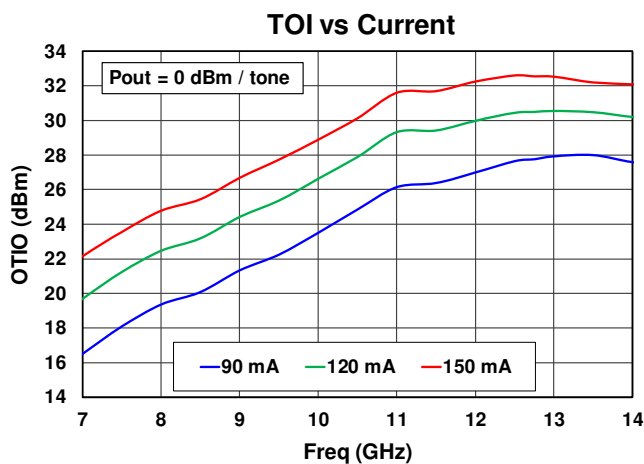
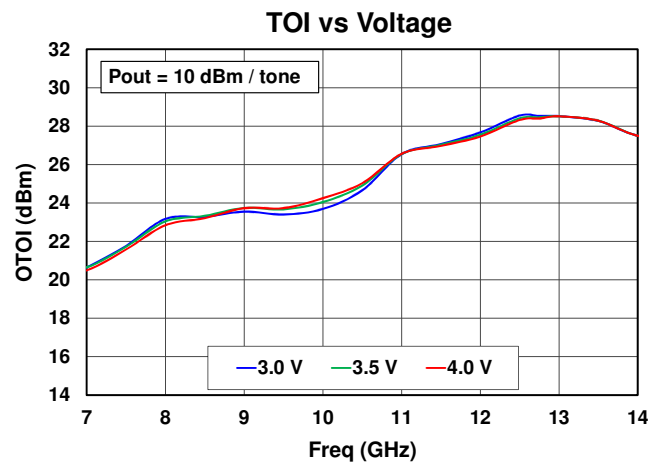
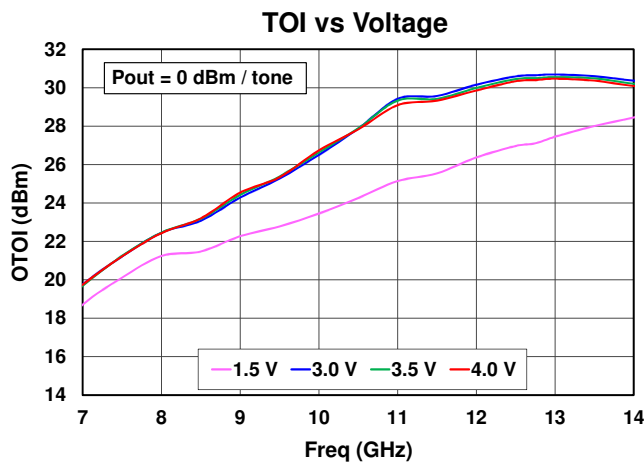
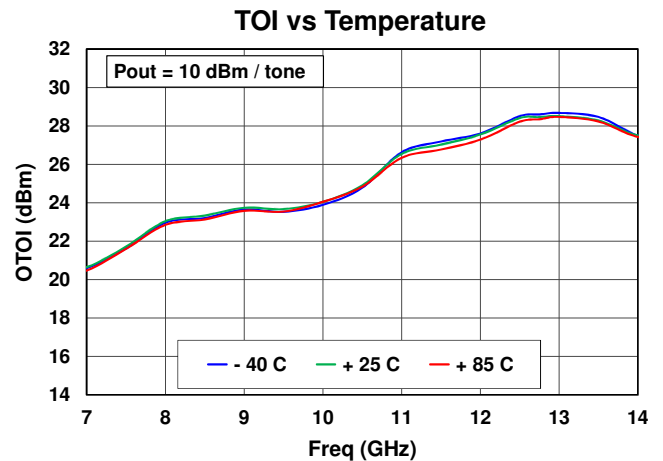
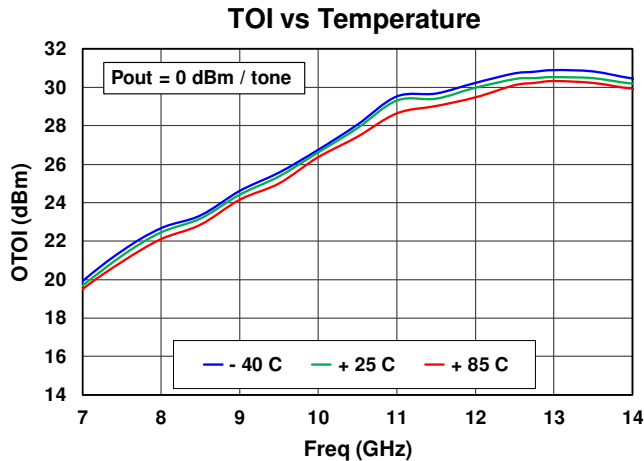
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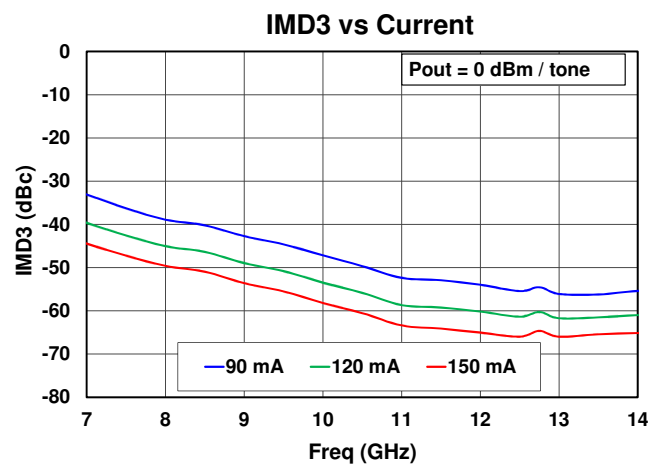
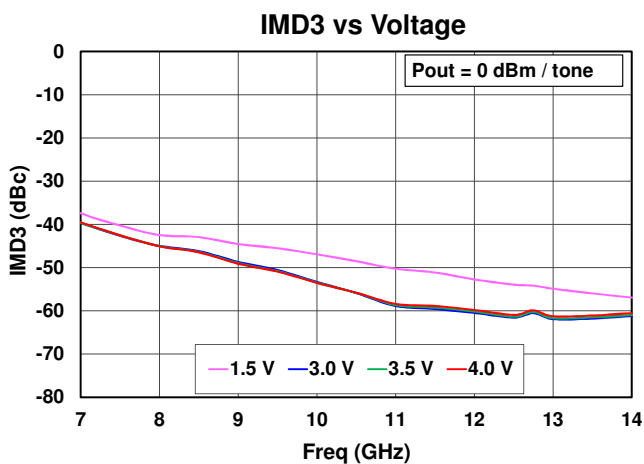
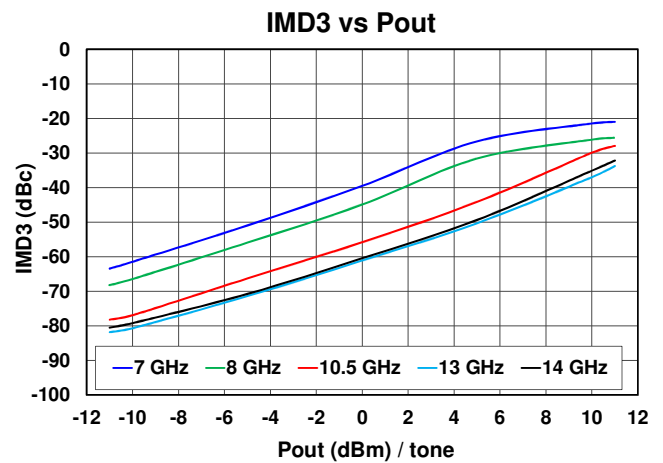
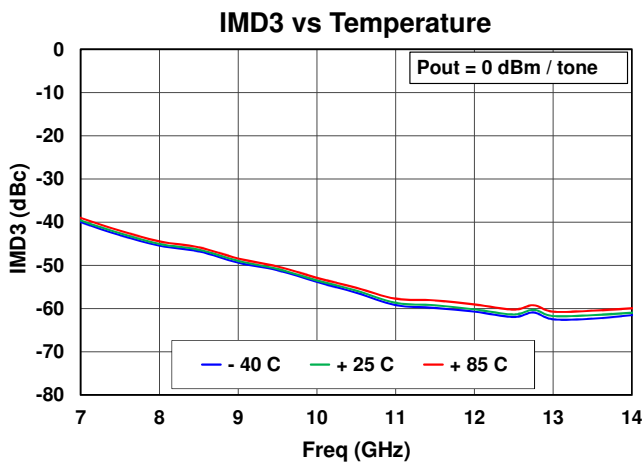
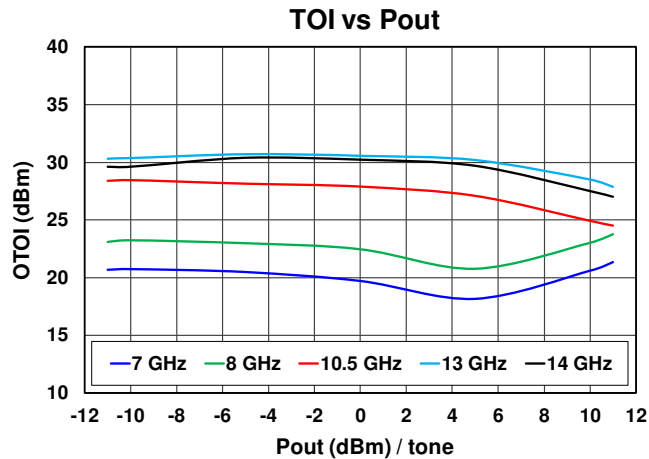
## Performance Plots – Linearity

Test conditions unless otherwise noted:  $V_D = +3.5\text{V}$ ,  $I_{DQ} = 120\text{ mA}$ ,  $\Delta f = 11\text{ MHz}$ ,  $25\text{ }^\circ\text{C}$ . Data de-embedded to MMIC bond wires.



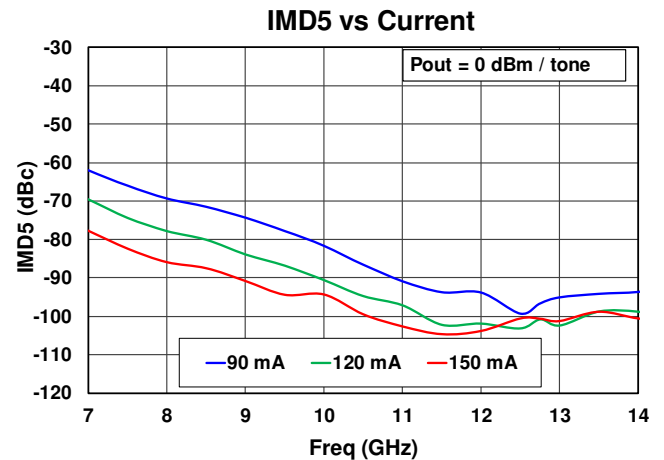
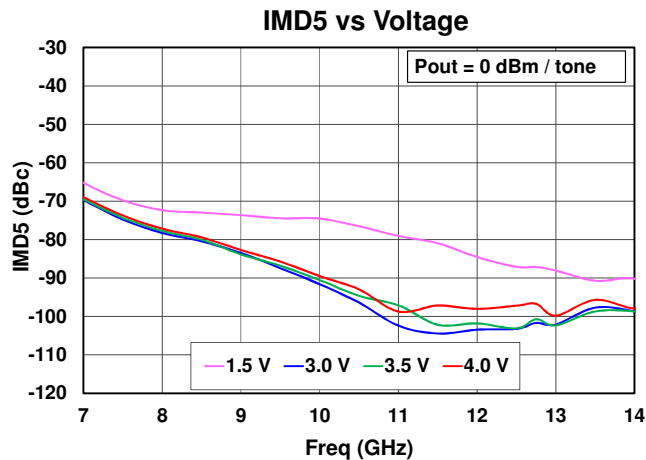
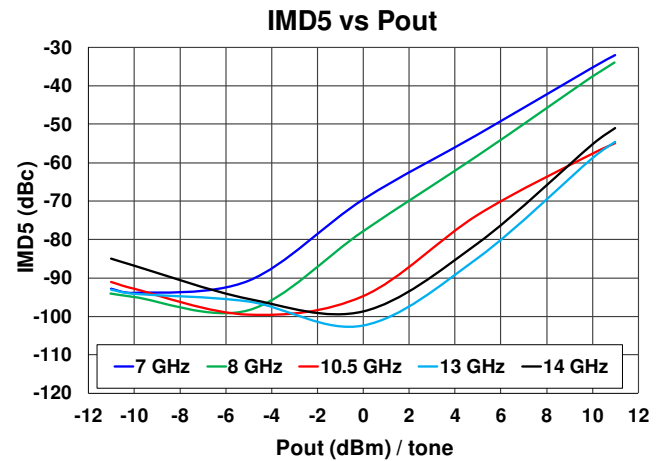
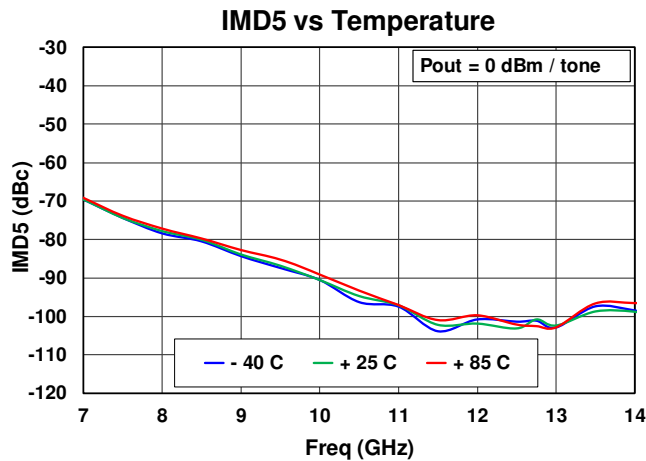
## Performance Plots – Linearity

Test conditions unless otherwise noted:  $V_D = +3.5V$ ,  $I_{DQ} = 120\text{ mA}$ ,  $\Delta f = 11\text{ MHz}$ ,  $25\text{ }^{\circ}\text{C}$ . Data de-embedded to MMIC bond wires.

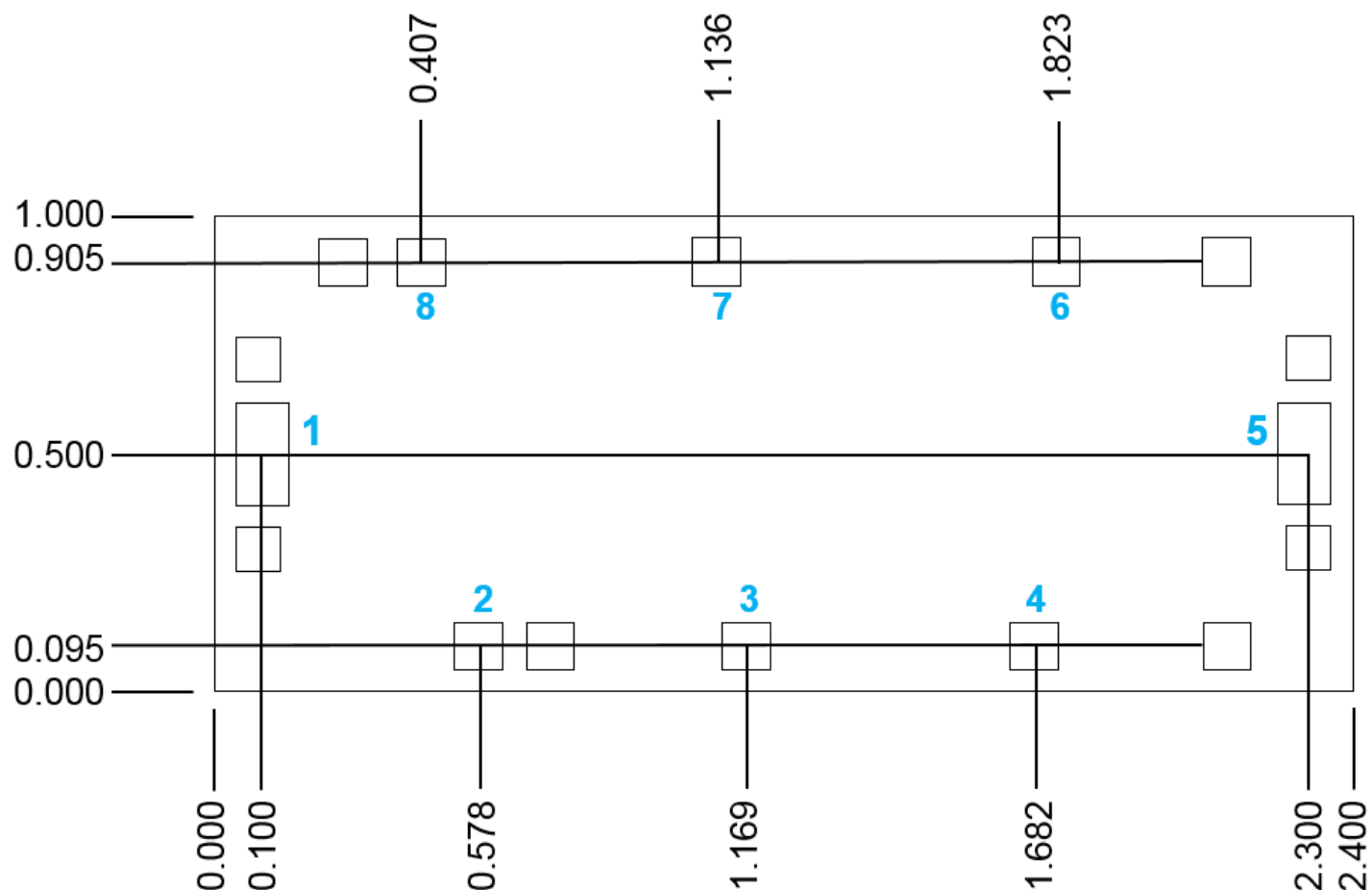


## Performance Plots – Linearity

Test conditions unless otherwise noted:  $V_D = +3.5V$ ,  $I_{DQ} = 120$  mA,  $\Delta f = 11$  MHz, 25 °C. Data de-embedded to MMIC bond wires.



## Mechanical Drawing and Bond Pad Description



Dimensions in mm

| Pad No. | Label     | Description                                                              |
|---------|-----------|--------------------------------------------------------------------------|
| 1       | RF Input  | Matched to 50 ohms, DC blocked                                           |
| 2       | VG1       | Gate Voltage; bias network is required (VG can be tied together at PCB)  |
| 3       | VG2       | Gate Voltage; bias network is required (VG can be tied together at PCB)  |
| 4       | VG3       | Gate Voltage; bias network is required (VG can be tied together at PCB)  |
| 5       | RF Output | Matched to 50 ohms, DC blocked                                           |
| 6       | VD3       | Drain Voltage; bias network is required (VD can be tied together at PCB) |
| 7       | VD2       | Drain Voltage; bias network is required (VD can be tied together at PCB) |
| 8       | VD1       | Drain Voltage; bias network is required (VD can be tied together at PCB) |

## Assembly Notes

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### **Component placement and adhesive attachment assembly notes:**

- Vacuum pencils and/or vacuum collets are the preferred method of pick up.
- Air bridges must be avoided during placement.
- The force impact is critical during auto placement.
- Organic attachment (i.e., conductive epoxy) can be used in low-power applications.
- Curing should be done in a convection oven; proper exhaust is a safety concern.

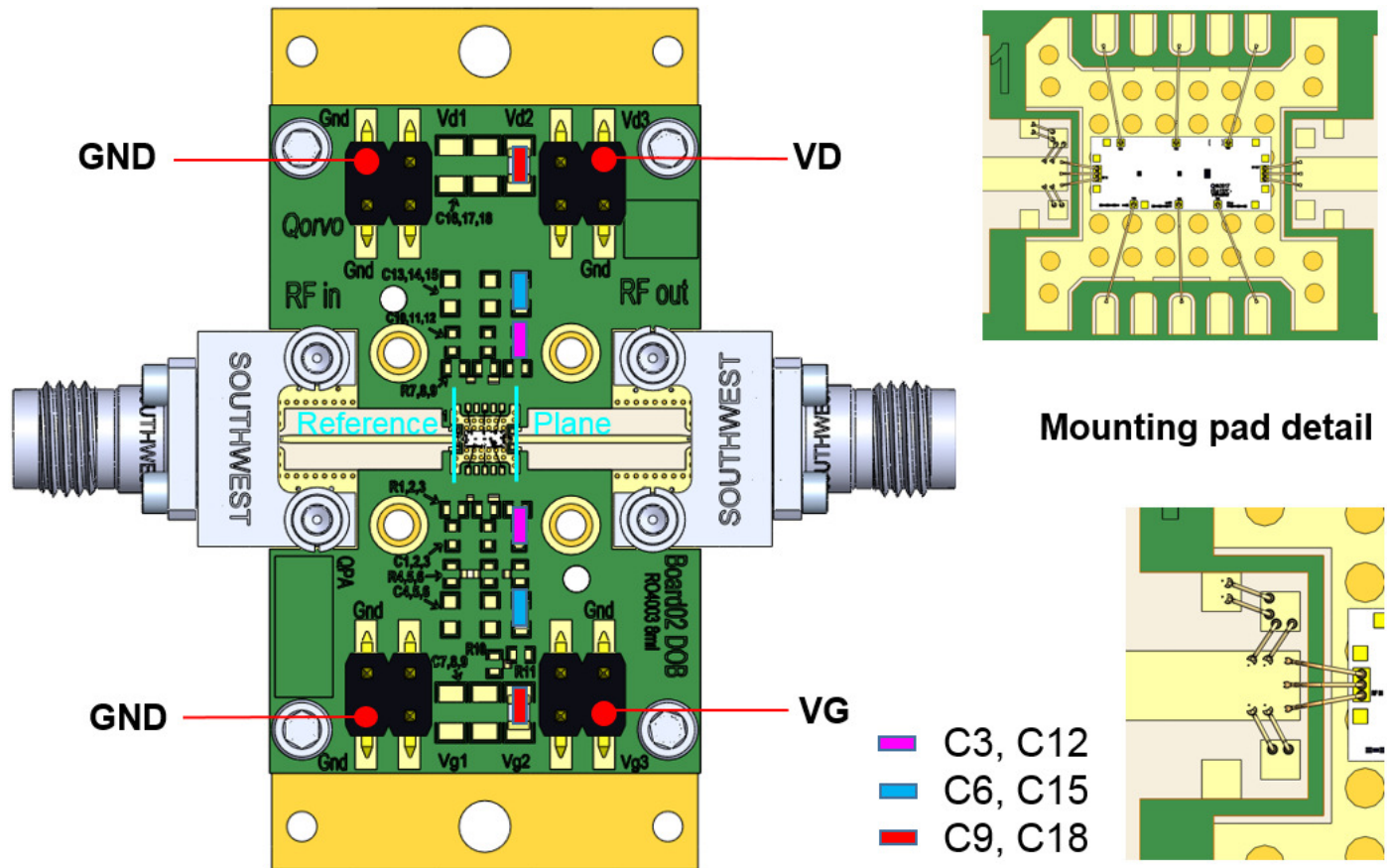
### **Reflow process assembly notes:**

- Use AuSn (80/20) solder and limit exposure to temperatures above 300°C to 3-4 minutes, maximum.
- Conductive epoxy die attach is recommended for PCB mounting.
- Bonding pads plating: Au.
- An alloy station or conveyor furnace with reducing atmosphere should be used.
- Do not use any kind of flux.
- Coefficient of thermal expansion matching is critical for long-term reliability.
- Devices must be stored in a dry nitrogen atmosphere.

### **Interconnect process assembly notes:**

- Thermosonic ball bonding is the preferred interconnect technique.
- Force, time, and ultrasonics are critical parameters.
- Aluminum wire should not be used.
- Devices with small pad sizes should be bonded with 0.0007-inch wire.

## Evaluation Board and BOM

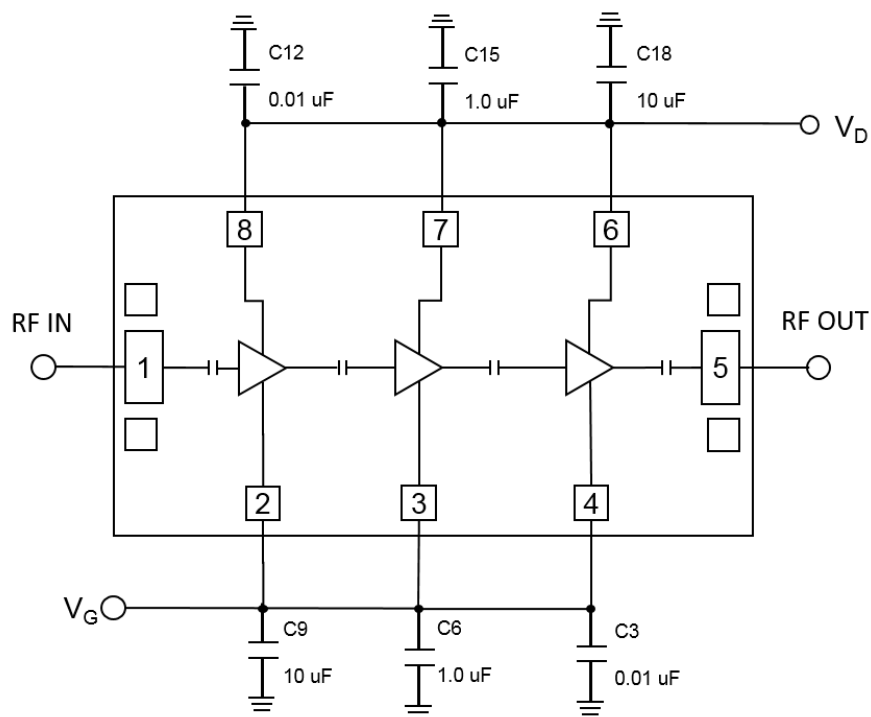


RF Layer is 0.008" thick Rogers Corp. RO4003C ( $\epsilon_r = 3.35$ ). Metal layers are 0.5 oz. copper. The microstrip line at the connector interface is optimized for the Southwest Microwave end launch connector 1092-01A-5. PCB level tuning at input side is recommended for optimal performance.

## Bill of Material – Evaluation Board

| Ref. Des.     | Value   | Description                            | Manuf.              | Part Number |
|---------------|---------|----------------------------------------|---------------------|-------------|
| C3, C12       | 0.01 uF | CAP 0.01UF +/-10% 50V 0402 X7R ROHS    | Various             |             |
| C6, C15       | 1.0 uF  | CAP 1.0UF +/-10% 16V 0603 X7R ROHS     | Various             |             |
| C9, C18       | 10 uF   | CAP CER 10UF 10V X7R 10% 0805 TDK ROHS | Various             |             |
| RF IN, RF OUT | 2.92 mm | 2.92 MM END LAUNCH CONNECTOR           | Southwest Microwave | 1092-01A-5  |

## Application Circuit and Biasing Sequence



### Notes:

1. Can use separate gate and drain for individual stage controls.

### Bias-up Procedure

1. Set  $I_D$  limit to 220 mA,  $I_G$  limit to 10 mA
2. Set  $V_G$  to  $-1.5$  V
3. Set  $V_D$  to  $+3.5$  V
4. Adjust  $V_G$  more positive until  $I_{DQ} = 120$  mA  
( $V_G \approx -0.46$  V Typical)
5. Apply RF signal

### Bias-down Procedure

1. Turn off RF signal
2. Reduce  $V_G$  to  $-1.5$  V. Ensure  $I_{DQ} \approx 0$  mA
3. Set  $V_D$  to 0V
4. Turn off  $V_D$  supply
5. Turn off  $V_G$  supply

## Thermal and Reliability Information

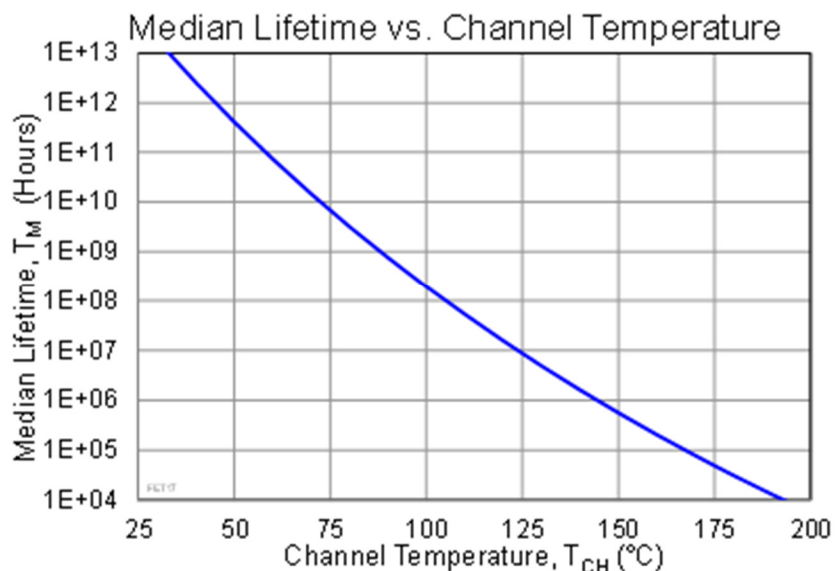
| Parameter                                           | Test Conditions                                                                                                                                   | Value  | Units                |
|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------------------|
| Thermal Resistance ( $\theta_{JC}$ ) <sup>(1)</sup> | $T_{base} = 85^{\circ}\text{C}$ , $V_D = 3.5\text{ V}$ , $I_{DQ} = 120\text{ mA}$<br>Quiescent/Small Signal operation, $P_{DISS} = 0.42\text{ W}$ | 65.0   | $^{\circ}\text{C/W}$ |
| Channel Temperature, $T_{CH}$ (Under RF)            |                                                                                                                                                   | 112.3  | $^{\circ}\text{C}$   |
| Median Lifetime ( $T_M$ )                           |                                                                                                                                                   | 4.0E07 | Hrs                  |

### Notes:

1. Die mounted to 40 mil CuMo carrier plate with AuSn eutectic. Thermal resistance measured at back of carrier plate.

## Median Lifetime

Test Conditions:  $V_D = +4\text{ V}$   
Failure Criteria is 10% reduction in  $I_{D\_MAX}$



## Handling Precautions

| Parameter                    | Rating | Standard                 |
|------------------------------|--------|--------------------------|
| ESD – Human Body Model (HBM) | 1A     | ESDA / JEDEC JS-001-2012 |



Caution!  
ESD-Sensitive Device

## RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) Free
- PFOS Free
- SVHC Free

## Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

**Tel:** 1-844-890-8163

**Web:** [www.qorvo.com](http://www.qorvo.com)

**Email:** [customer.support@qorvo.com](mailto:customer.support@qorvo.com)

For technical questions and application information: **Email:** [appsupport@qorvo.com](mailto:appsupport@qorvo.com)

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