

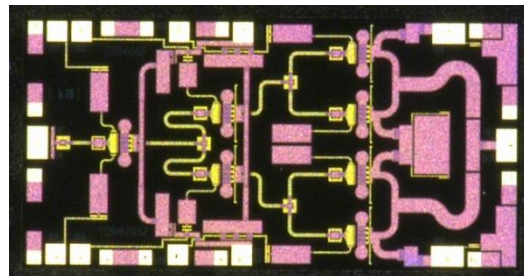
### Product Description

Qorvo's TGA2594 is a Ka-band power amplifier fabricated on Qorvo's 0.15  $\mu\text{m}$  GaN on SiC process. Operating from 27 to 31 GHz, it achieves 5W saturated output power with an efficiency of 28 % PAE, and 23 dB small signal gain. Along with excellent linear characteristics, the TGA2594 is ideally suited to support both commercial and defense related satellite communications.

To simplify system integration, the TGA2594 is fully matched to 50 ohms with integrated DC blocking caps on both I/O ports.

The TGA2594 is 100 % DC and RF tested on-wafer to ensure compliance to electrical specifications.

Lead-free and RoHS compliant.

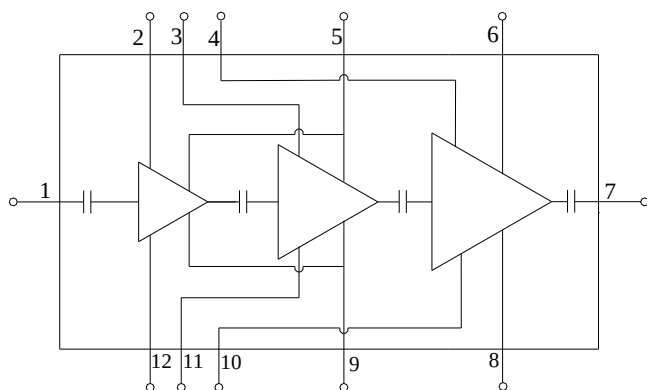


### Product Features

- Frequency Range: 27 to 31 GHz
- $P_{OUT}$ : 36.5 dBm ( $P_{IN} = 18$  dBm), CW
- PAE: 28 % ( $P_{IN} = 18$  dBm), CW
- Small Signal Gain: 23 dB
- Return Loss: 10 dB
- IM3 @ 25 dBm/tone: -35 dBc
- IM5 @ 25 dBm/tone: -45 dBc
- Bias:  $V_D = +20$  V,  $I_{DQ} = 140$  mA,  $V_G \approx -2.5$  V Typical
- Chip Dimensions: 3.24 x 1.74 x 0.10 mm

*Performance is typical across frequency. Please reference electrical specification table and data plots for more details.*

### Functional Block Diagram



### Applications

- Satellite Communications

### Ordering Information

| Part No.   | Description                       |
|------------|-----------------------------------|
| TGA2594    | 27 – 31GHz 5W GaN Power Amplifier |
| TGA2594S2  | Samples (2 pcs. pack)             |
| TGA2594EVB | Evaluation Board for TGA2594      |



# TGA2594

## 27 – 31 GHz 5 W GaN Power Amplifier

### Absolute Maximum Ratings

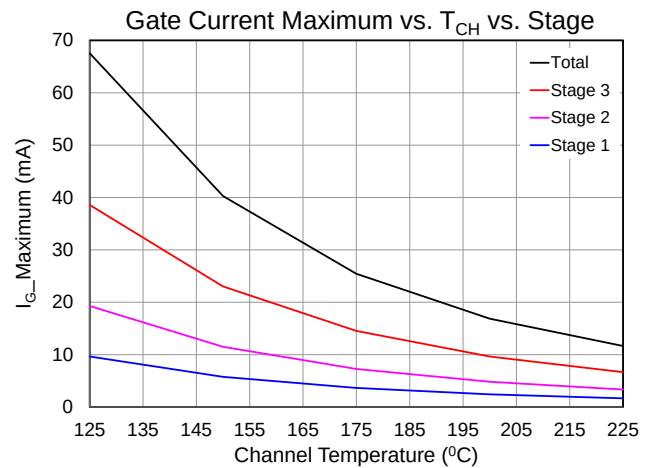
| Parameter                                                                      | Value / Range |
|--------------------------------------------------------------------------------|---------------|
| Drain Voltage ( $V_D$ )                                                        | 29.5          |
| Gate Voltage Range ( $V_G$ )                                                   | -5 to 0 V     |
| Drain Current ( $I_D$ )                                                        | 1.4 A         |
| Gate Current ( $I_G$ )                                                         | See chart     |
| Power Dissipation ( $P_{DISS}$ ), CW, 85°C                                     | 22 W          |
| Input Power ( $P_{IN}$ ), CW, 50 $\Omega$ , $V_D=22$ V, $I_{DQ}=280$ mA, 85 °C | 30 dBm        |
| Input Power ( $P_{IN}$ ), CW, 10:1 VSWR, $V_D=22$ V, $I_{DQ}=280$ mA, 25 °C    | 25 dBm        |
| Channel Temperature ( $T_{CH}$ )                                               | 275 °C        |
| Mounting Temperature (30 seconds)                                              | 320 °C        |
| Storage Temperature                                                            | -40 to 150 °C |

Operation of this device outside the parameter ranges given above may cause permanent damage. These are stress ratings only, and functional operation of the device at these conditions is not implied.

### Recommended Operating Conditions

| Parameter                             | Min               | Typ | Max | Units |
|---------------------------------------|-------------------|-----|-----|-------|
| Drain Voltage ( $V_D$ )               |                   | +20 |     | V     |
| Drain Current, Quiescent ( $I_{DQ}$ ) |                   | 140 |     | mA    |
| Drain Current, RF ( $I_{D\_Drive}$ )  | See charts page 6 |     |     | mA    |
| Gate Voltage Typ. Range ( $V_G$ )     | -2 to -3          |     |     | V     |
| Operating Temp. Range                 | -40               | +25 | +85 | °C    |

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



### Electrical Specifications

| Parameter                                     | Conditions <sup>(1) (2)</sup>                                                  | Min  | Typ   | Max | Units  |
|-----------------------------------------------|--------------------------------------------------------------------------------|------|-------|-----|--------|
| Operational Frequency Range                   |                                                                                | 27   |       | 31  | GHz    |
| Output Power at Saturation, $P_{SAT}$         | $P_{IN} = +18$ dBm                                                             | 34.6 | 36.5  |     | dBm    |
| Power Added Efficiency, PAE                   | $P_{IN} = +18$ dBm                                                             |      | 28    |     | %      |
| Small Signal Gain, S21                        |                                                                                |      | 23    |     | dB     |
| Input Return Loss, IRL                        |                                                                                |      | 10    |     | dB     |
| Output Return Loss, ORL                       |                                                                                |      | 8     |     | dB     |
| 3 <sup>RD</sup> Intermodulation Products, IM3 | $P_{OUT/TONE} = +25$ dBm, Tone Spacing = 1 MHz                                 |      | -35   |     | dBc    |
| 5 <sup>th</sup> Intermodulation Products, IM5 | $P_{OUT/TONE} = +25$ dBm, Tone Spacing = 1 MHz                                 |      | -45   |     | dBc    |
| $P_{SAT}$ Temperature Coefficient             | $T_{DIFF} = +25^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ ; $P_{IN} = +22$ dBm |      | -0.01 |     | dBm/°C |
| S21 Temperature Coefficient                   | $T_{DIFF} = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$                      |      | -0.09 |     | dB/°C  |

#### Notes:

- Test conditions unless otherwise noted: CW,  $V_D = +20$  V,  $I_{DQ} = 140$  mA,  $V_G = -2.5$  V +/- 0.5 V typical,  $T_{BASE} = +25^{\circ}\text{C}$ ,  $Z_0 = 50 \Omega$
- $T_{BASE}$  is back side of carrier plate



# TGA2594

## 27 – 31 GHz 5 W GaN Power Amplifier

### Thermal and Reliability Information

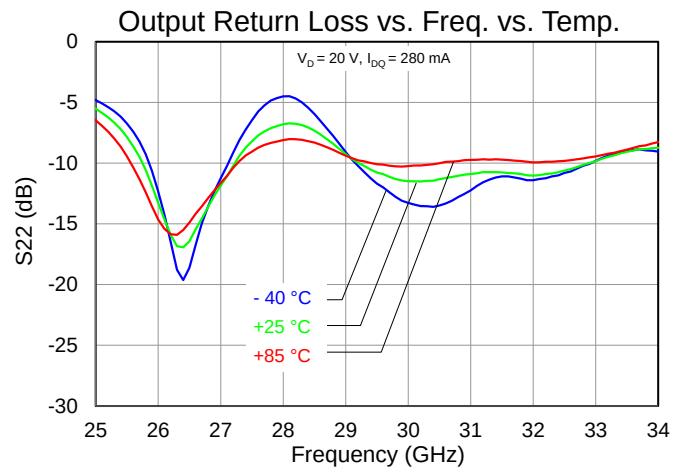
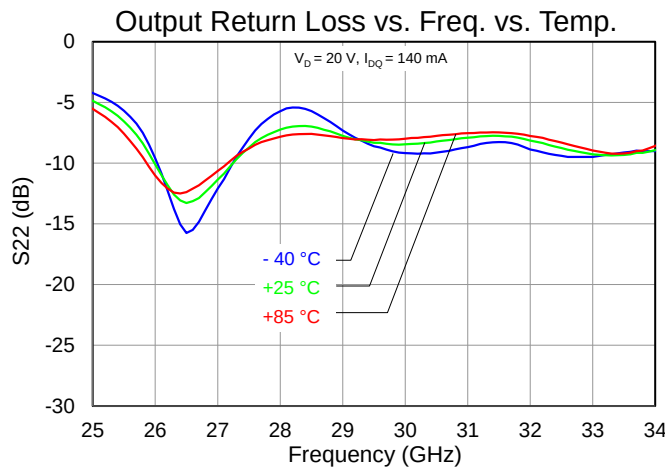
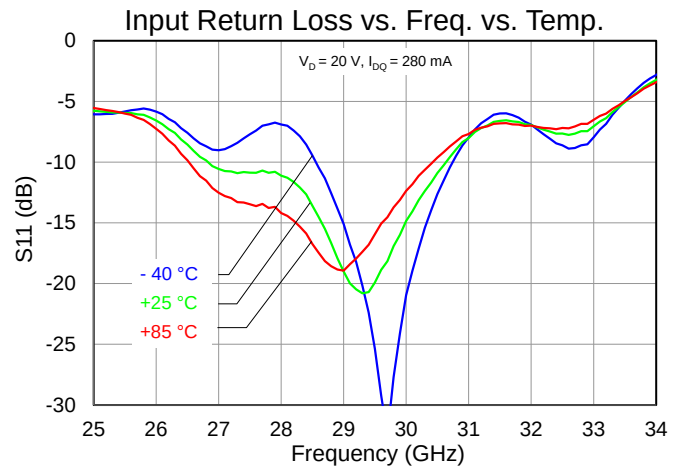
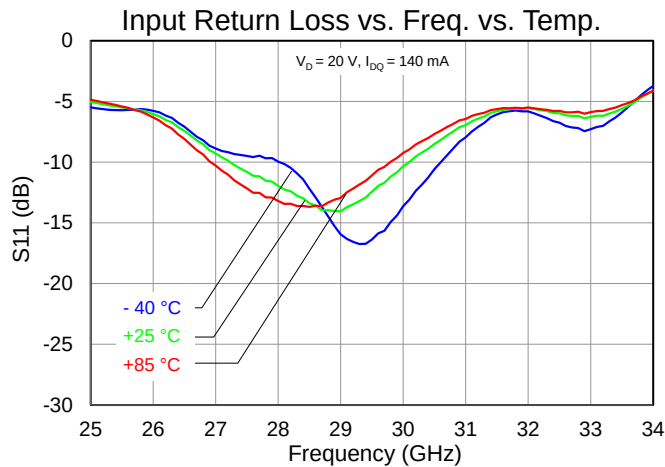
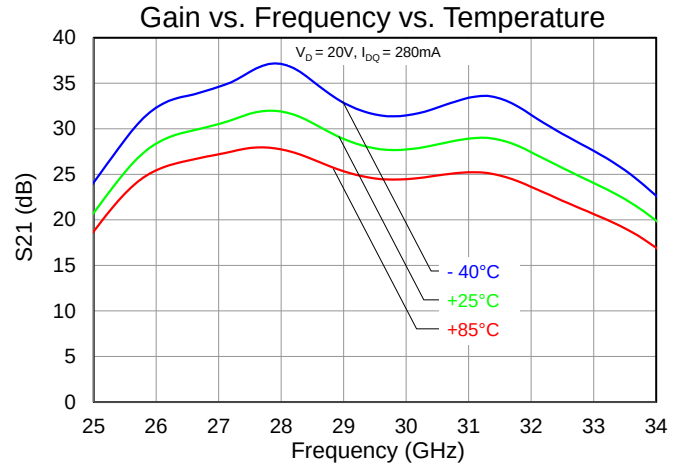
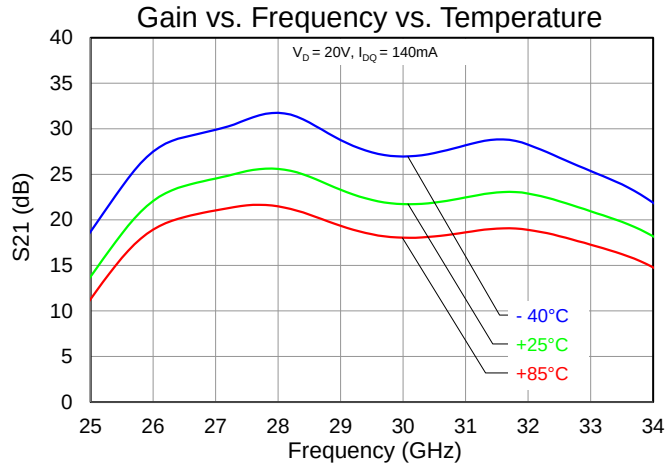
| Parameter                                       | Test Conditions                                                                                     | Value | Units                |
|-------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------|----------------------|
| Thermal Resistance ( $\theta_{JC}$ )            | For $I_{DQ} = 140$ mA:<br>$T_{BASE} = 85^{\circ}\text{C}$ , $V_D = +20$ V, $I_{D\_Drive} = 870$ mA, | 5.64  | $^{\circ}\text{C/W}$ |
| Channel Temperature ( $T_{CH}$ ) under RF Drive | Frequency = 28 GHz, $P_{IN} = 18$ dBm,<br>$P_{OUT} = 36.2$ dBm, $P_{DISS} = 13.3$ W                 | 160   | $^{\circ}\text{C}$   |

#### Notes:

1. Thermal resistance measured to back of carrier plate. MMIC mounted on 20 mils CuMo carrier using 1.5 mil 80/20 AuSn.
2. Channel temperature indicated is an IR scan equivalent temperature. Thermal resistance is calculated using this value. Additional information can be found in the Qorvo Applications Note "GaN Device TCHMAX Theta-JC and Reliability Estimates," located here <https://www.qorvo.com/products/d/da006480>

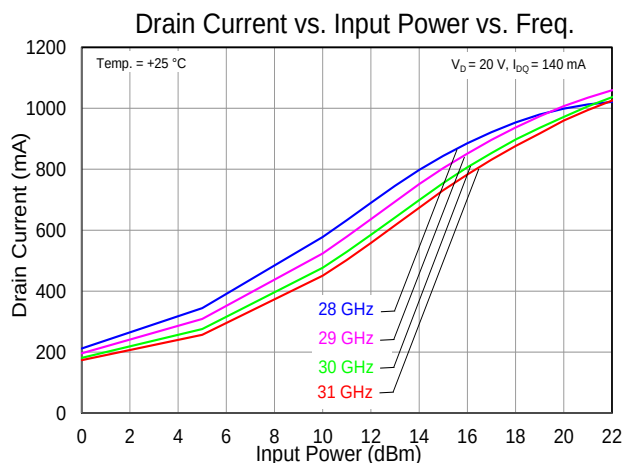
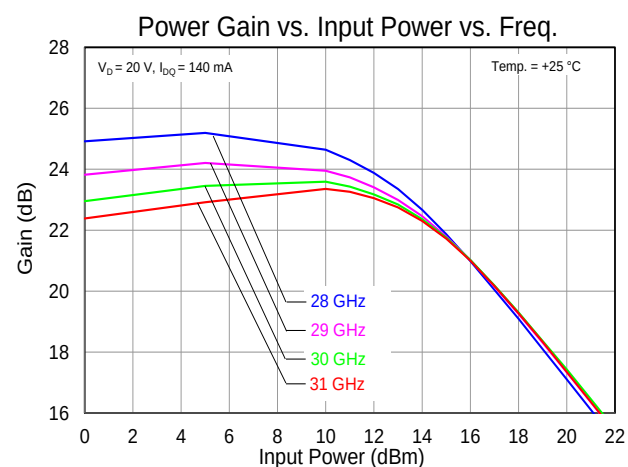
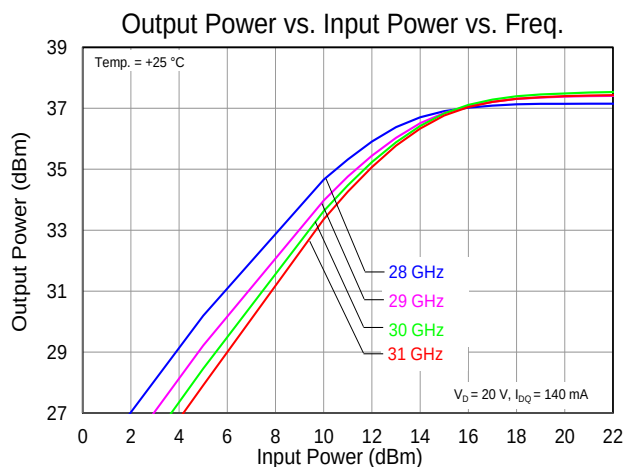
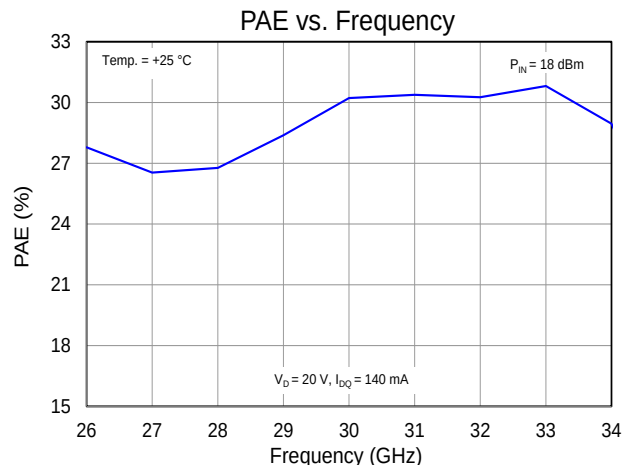
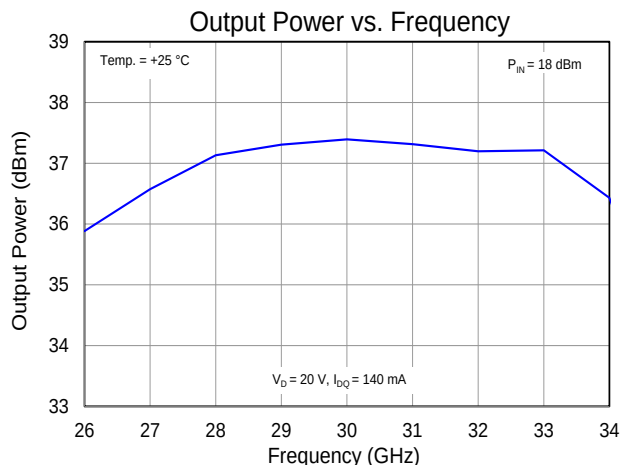
### Typical Performance – Small Signal

Test conditions unless otherwise noted: CW,  $V_D = +20$  V,  $I_{DQ} = 140$  mA and 280 mA,  $T_{BASE} = +25$  °C



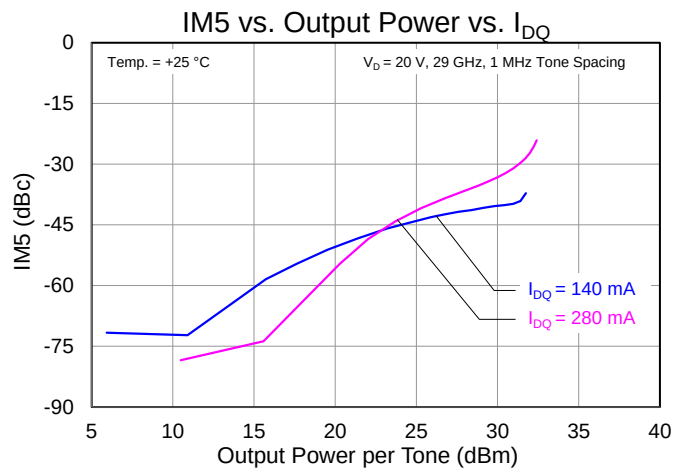
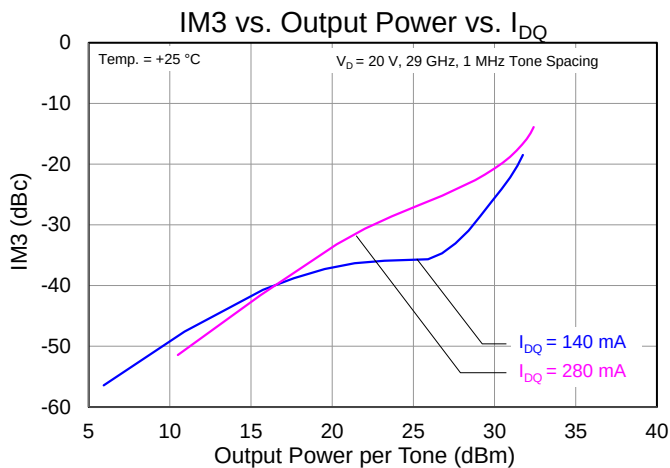
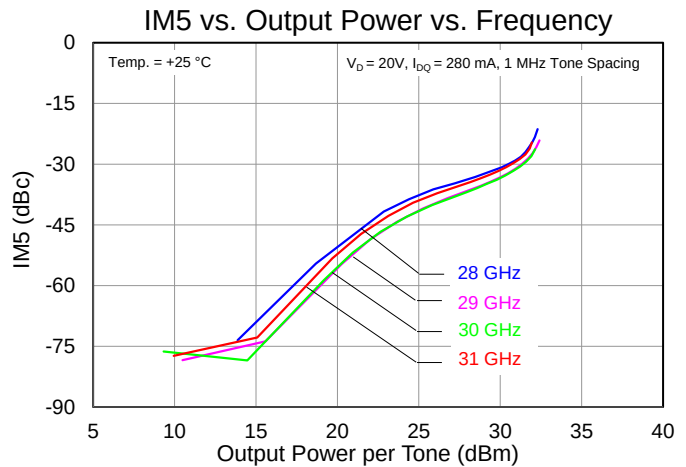
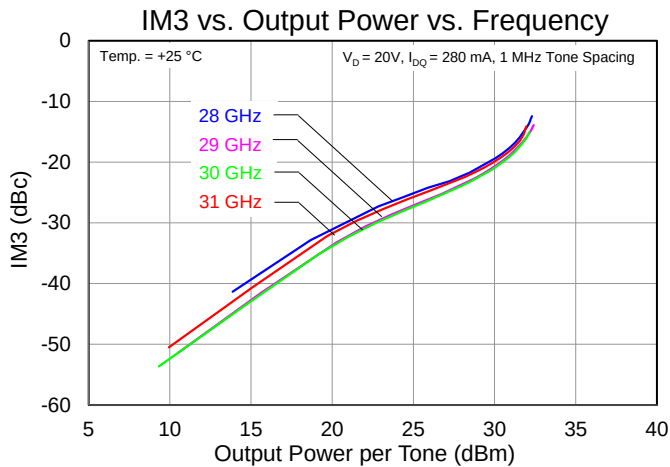
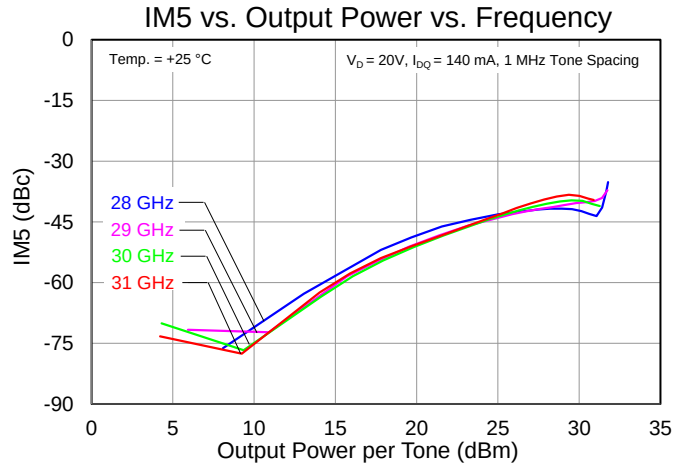
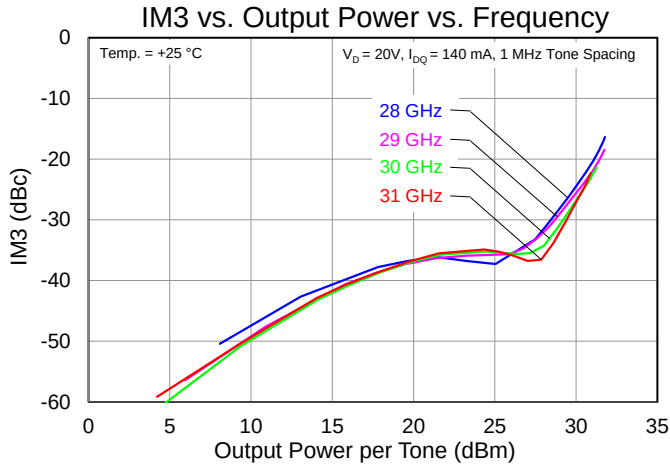
### Typical Performance – Large Signal

Test conditions unless otherwise noted: CW,  $V_D = +20$  V,  $I_{DQ} = 140$  mA,  $T_{BASE} = +25$  °C



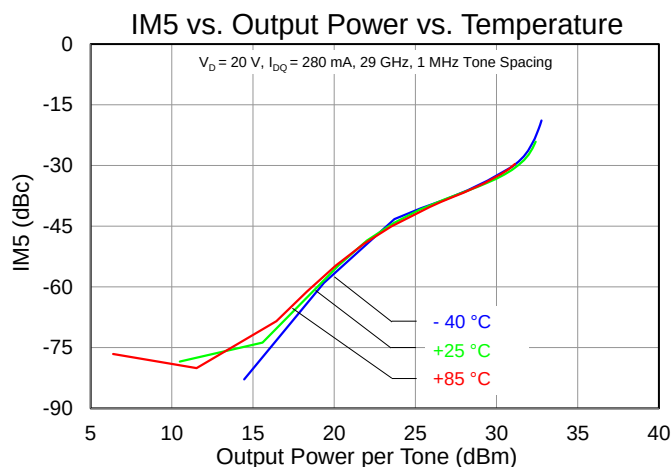
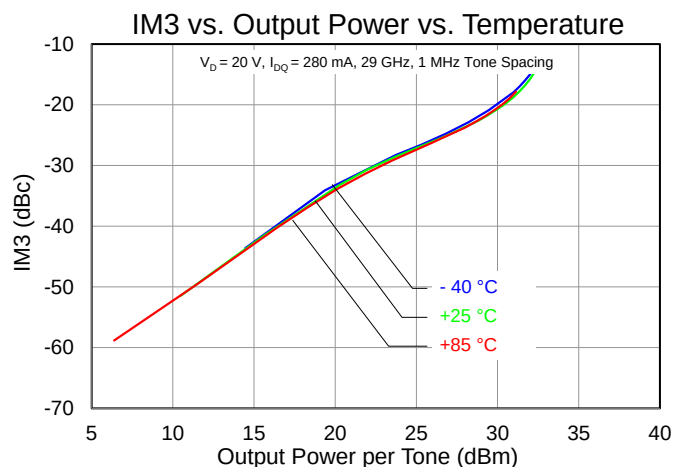
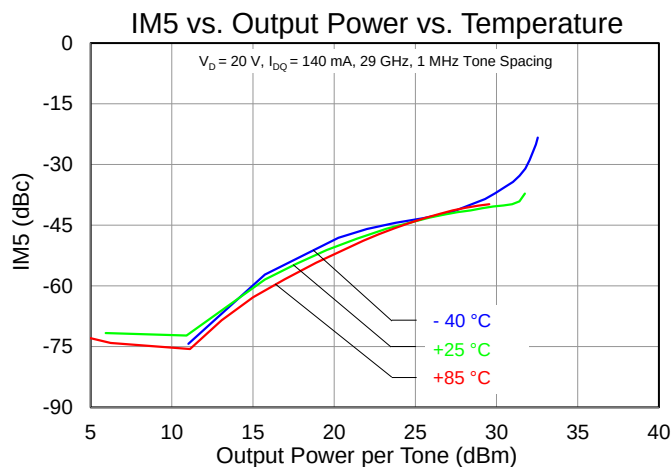
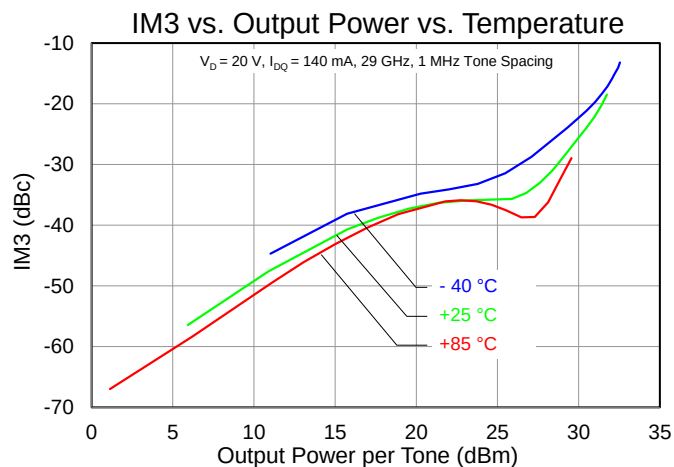
### Typical Performance – Linearity

Test conditions unless otherwise noted: CW,  $V_D = +20$  V,  $I_{DQ} = 140$  mA, Tone Spacing = 1 MHz,  $T_{BASE} = +25$  °C

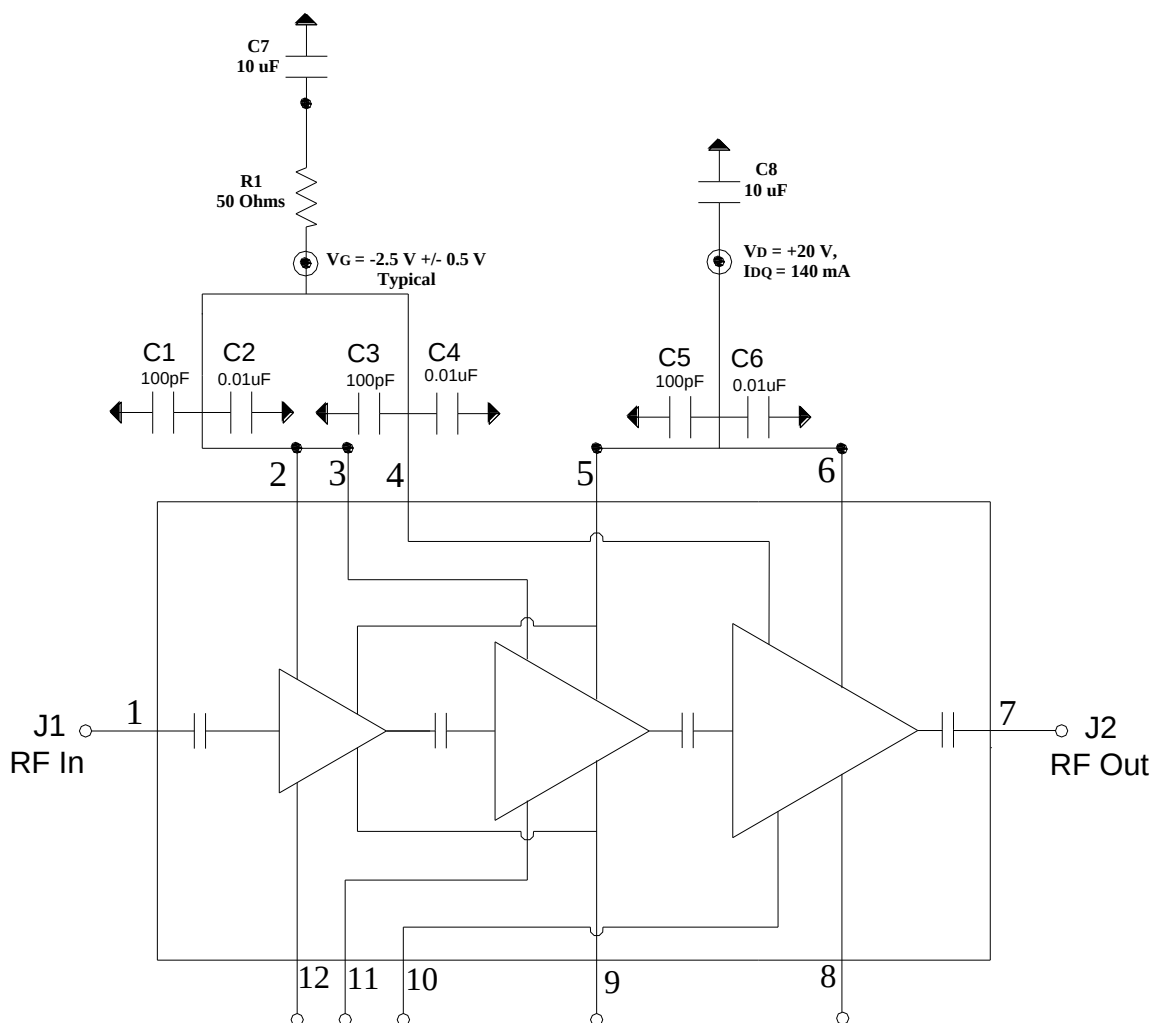


### Typical Performance – Linearity (cont.)

Test conditions unless otherwise noted: CW,  $V_D = +20$  V,  $I_{DQ} = 140$  mA, Tone Spacing = 1 MHz,  $T_{BASE} = +25$  °C



### Application Circuit



### Bias Up Procedure

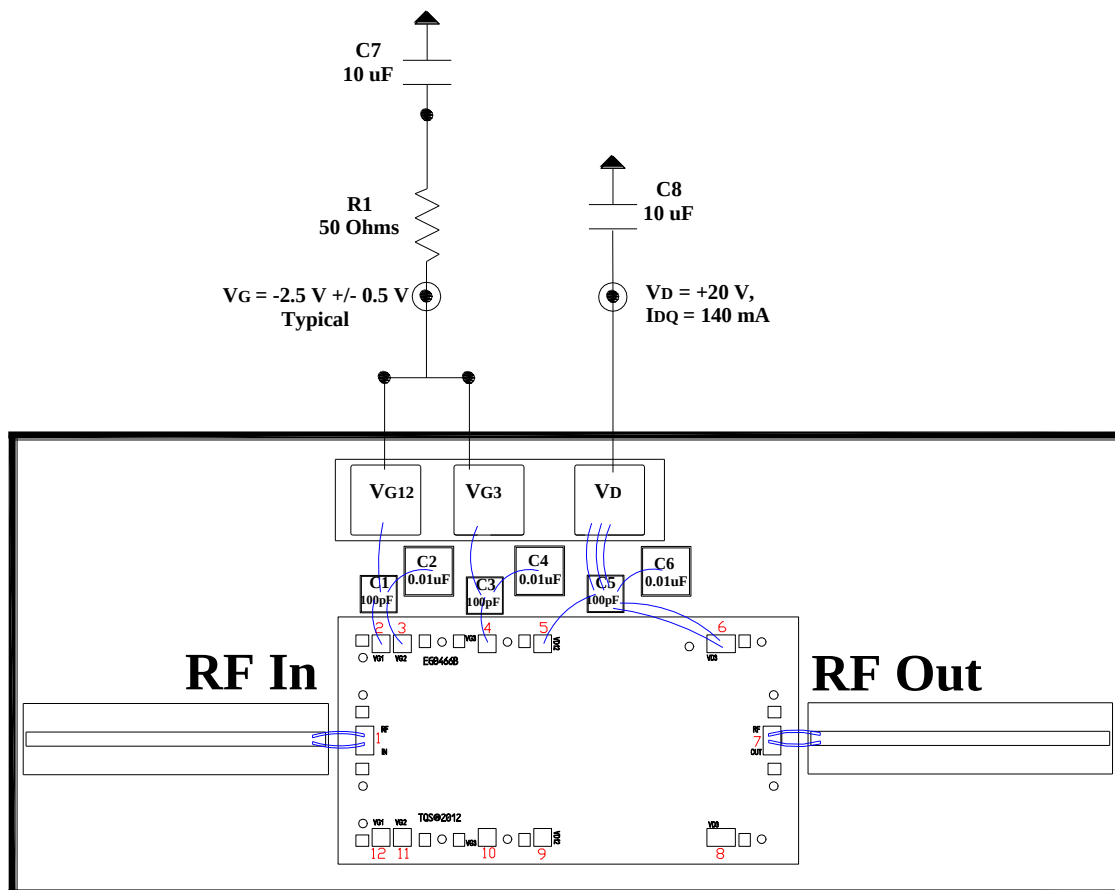
1. Set  $I_D$  limit to 1.2 A,  $I_G$  limit to 10 mA
2. Apply -5 V to  $V_G$  (Combine all  $V_G$ 's together)
3. Apply +20 V to  $V_D$  (Combine all  $V_D$ 's together)
4. Adjust  $V_G$  until  $I_{DQ} = 140$  mA ( $V_G \sim -2.5$  V +/- Typ.)
5. Apply RF supply

### Bias Down Procedure

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

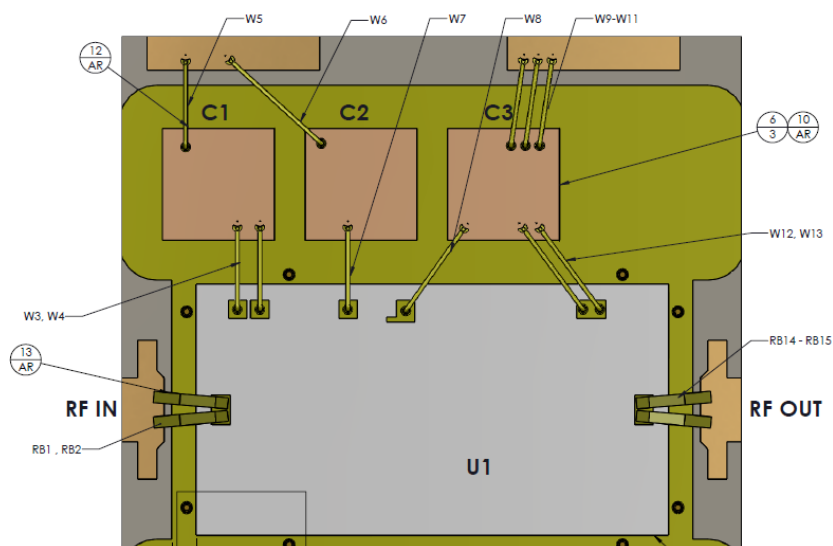


## Assembly Drawing

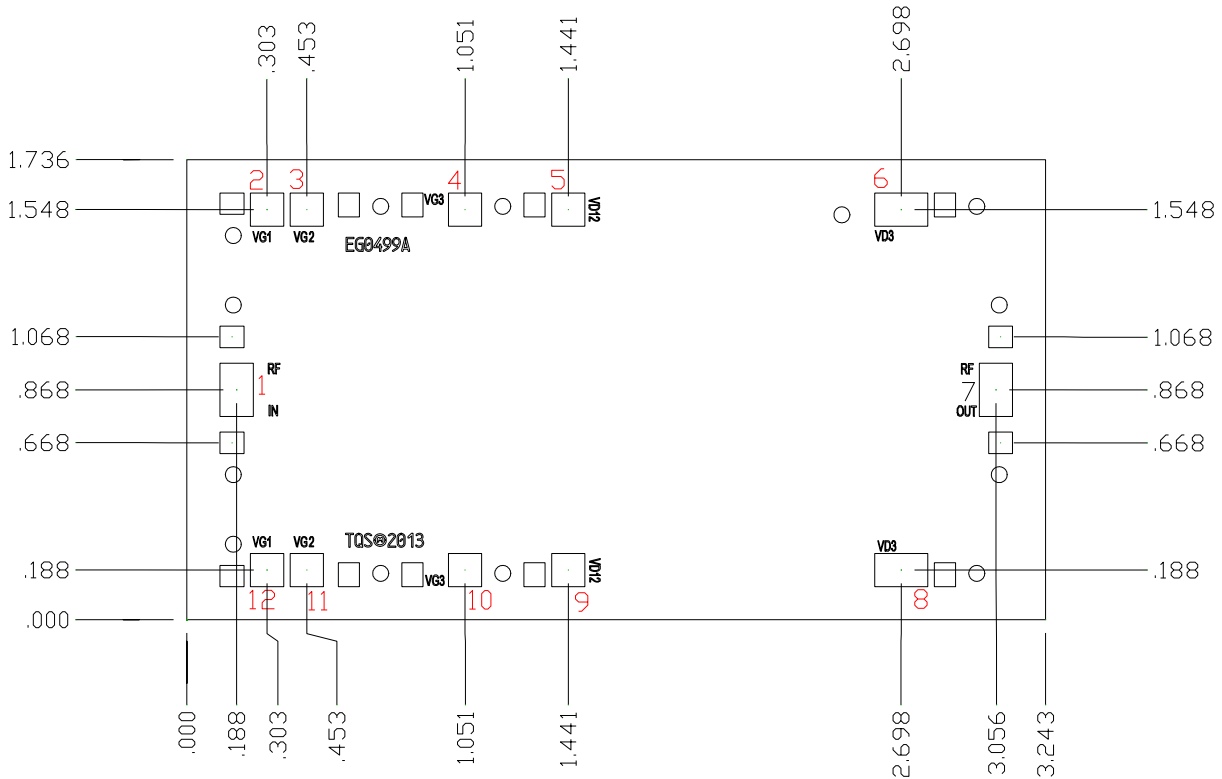


Notes: Minimize RF wirebond lengths to achieve optimum return loss. Options in order of preference are:

1. Short w = 5mil ribbon bonds
2. Multiple short wedge or chisel bonds
3. Multiple ball bonds



### Mechanical Drawing



Unit: millimeters  
 Thickness: 0.10  
 Die x, y size tolerance: +/- 0.050  
 Chip edge to bond pad dimensions are shown to center of pad  
 Ground is backside of die

### Bond Pad Description

| Pad No. | Symbol           | Pad Size      | Description                                                                                                                |
|---------|------------------|---------------|----------------------------------------------------------------------------------------------------------------------------|
| 1       | RF In            | 0.125 x 0.200 | Input; matched to 50 $\Omega$ ; DC blocked.                                                                                |
| 2, 12   | V <sub>G1</sub>  | 0.125 x 0.125 | Gate voltage, V <sub>G1</sub> top and bottom. Bias network is required; see Application Circuit on page 8 as an example.   |
| 3, 11   | V <sub>G2</sub>  | 0.125 x 0.125 | Gate voltage, V <sub>G2</sub> top and bottom. Bias network is required; see Application Circuit on page 8 as an example.   |
| 4, 10   | V <sub>G3</sub>  | 0.125 x 0.125 | Gate voltage, V <sub>G1</sub> top and bottom. Bias network is required; see Application Circuit on page 8 as an example.   |
| 5, 9    | V <sub>D12</sub> | 0.125 x 0.125 | Drain voltage, V <sub>D12</sub> top and bottom. Bias network is required; see Application Circuit on page 8 as an example. |
| 6, 8    | V <sub>D3</sub>  | 0.200 x 0.125 | Drain voltage, V <sub>D3</sub> top and bottom. Bias network is required; see Application Circuit on page 8 as an example.  |
| 7       | RF Out           | 0.125 x 0.200 | Output; matched to 50 $\Omega$ ; DC blocked.                                                                               |

### 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.

Reflow process assembly notes:

- Use AuSn (80/20) solder and limit exposure to temperatures above 300 °C to 3–4 minutes, maximum.
- 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 ultrasonic are critical parameters.
- Aluminum wire should not be used.
- Devices with small pad sizes should be bonded with 0.0007-inch wire.

### Handling Precautions

| Parameter                        | Rating | Standard              |
|----------------------------------|--------|-----------------------|
| ESD – Human Body Model (HBM)     | 1A     | ANSI/ESD/JEDEC JS-001 |
| ESD – Charged Device Model (CDM) | C3     | ANSI/ESD/JEDEC JS-002 |



Caution!  
ESD-Sensitive Device

### Solderability

Use only AuSn (80/20) solder, and limit exposure to temperatures above 300 °C to 3–4 minutes, maximum.

### RoHS Compliance

This product is compliant with the 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:

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

Tel: 1-844-890-8163

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

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