

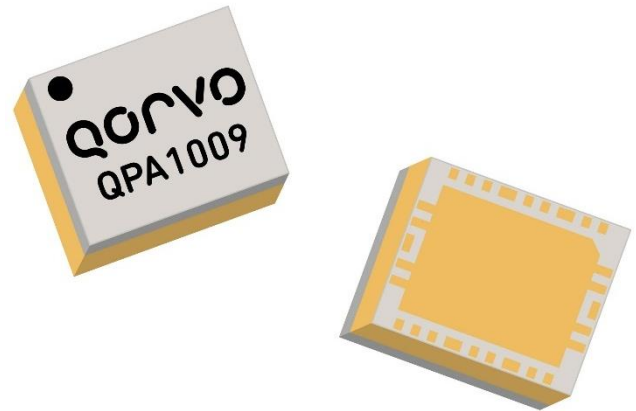
Product Overview

Qorvo's QPA1009 is a laminate packaged wide band power amplifier MMIC fabricated on Qorvo's production 0.15 um GaN on SiC process (QGaN15). Covering 10.7 – 12.7 GHz, the QPA1009 provides greater than 16 Watts (42 dBm) of saturated output power and 16 dB of large-signal gain while achieving 33% power-added efficiency.

The QPA1009 RF ports have DC blocking capacitors and are matched to 50 ohms. The QPA1009 RF input port is DC coupled to ground for optimum ESD performance.

The QPA1009 is packaged in a 6.0 x 5.0 mm laminate package. The QPA1009 can support a wide range of operating conditions, including CW operation, making it well-suited for both commercial and military systems.

Lead-free and RoHS compliant.

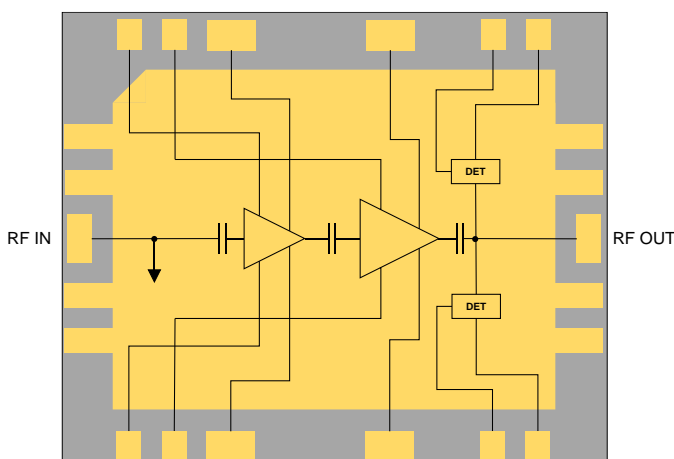


Key Features

- Frequency Range: 10.7 – 12.7 GHz
- P_{SAT} :43 dBm ($P_{IN} = 27$ dBm)
- PAE: 33% ($P_{IN} = 27$ dBm)
- Power Gain: 16 dB ($P_{IN} = 27$ dBm)
- Small Signal Gain: 21 dB
- Bias: $V_D = 20$ V, $I_{DQ} = 300$ mA
- Package Dimensions: 6.00 x 5.00 x 1.76 mm

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

Functional Block Diagram



Top View

Applications

- Satellite Communications
- Radar
- Point to Point Communications

Ordering Information

| Part No. | Description |
|------------|-------------------------------------|
| QPA1009 | 10.7 – 12.7 GHz GaN Power Amplifier |
| QPA1009EVB | Evaluation Board for QPA1009 |
| QPA1009TR7 | QPA1009 on 250 piece reel |

Absolute Maximum Ratings

| Parameter | Value / Range |
|---|------------------|
| Drain Voltage (V_D) | 29.5 V |
| Gate Voltage Range (V_G) | -4 V to 0 V |
| Drain Current (I_{D1}/I_{D2}) (T=85 °C) | 0.42 / 4.0 A |
| Gate Current (I_G) | See plot page 11 |
| P_{DISS} (under drive), 85 °C | 59.5 W |
| Input Power, 50 Ω , $V_D=20$ V, $I_{DQ}=300$ mA, CW, 85 °C | 31 dBm |
| Input Power, 3:1 VSWR, $V_D=20$ V, $I_{DQ}=300$ mA, CW, 85 °C | 31 dBm |
| Soldering Temperature | 260 °C |
| Storage Temperature | -55 to +125 °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 | Unit |
|----------------------------|-----|-----|-----|------|
| Drain Voltage (V_D) | | 20 | | V |
| Drain Current (I_{DQ}) | | 300 | 600 | mA |
| Operating Temperature | -40 | 25 | 85 | °C |

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

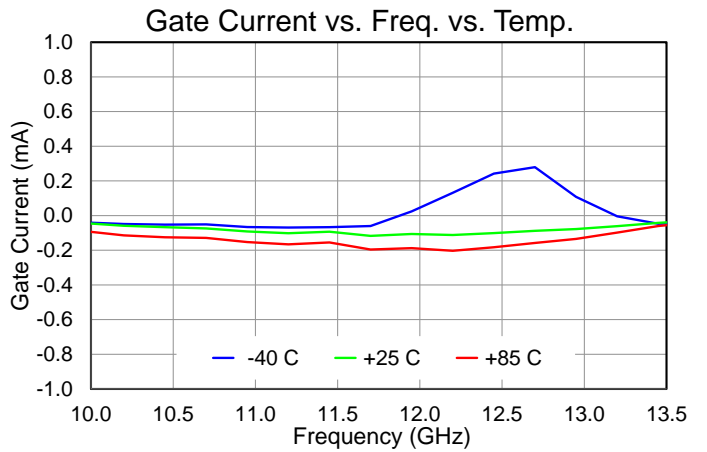
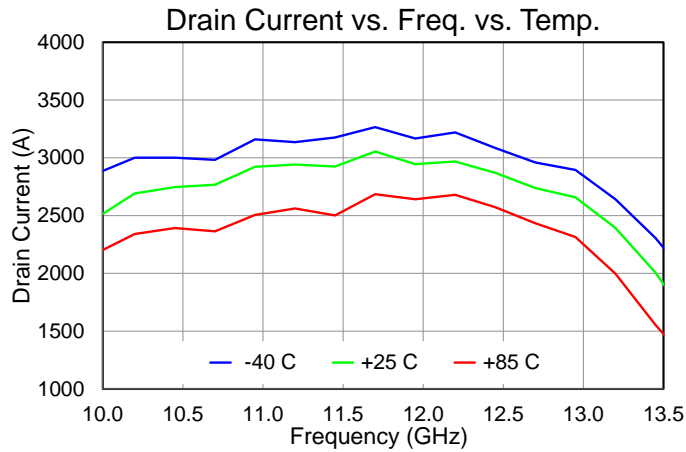
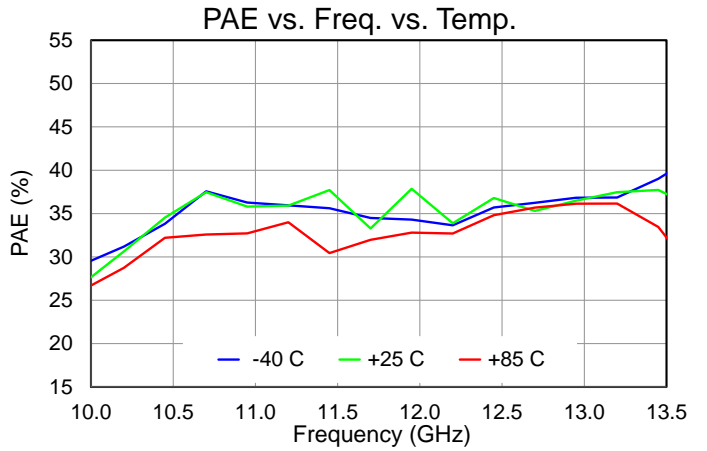
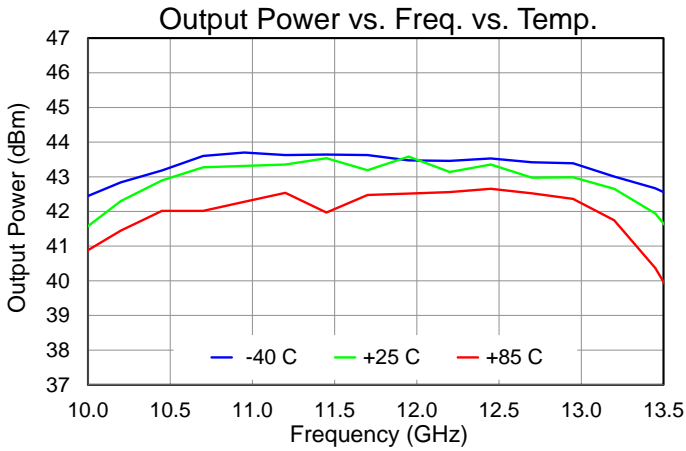
Electrical Specifications

| Parameter | | Min | Typ | Max | Units |
|---|----------|-------|--------|------|-------|
| Operational Frequency | | 10.7 | | 12.7 | GHz |
| Output Power (P _{IN} =27 dBm) | 10.7 GHz | | 43.3 | | dBm |
| | 11.7 GHz | | 43.2 | | dBm |
| | 12.7 GHz | | 43.0 | | dBm |
| PAE (P _{IN} =27 dBm) | 10.7 GHz | | 37.5 | | % |
| | 11.7 GHz | | 33.3 | | % |
| | 12.7 GHz | | 35.3 | | % |
| Small Signal Gain | 10.7 GHz | | 21.4 | | dB |
| | 11.7 GHz | | 21.9 | | dB |
| | 12.7 GHz | | 21.6 | | dB |
| Input Return Loss | 10.7 GHz | | 18 | | dB |
| | 11.7 GHz | | 15 | | dB |
| | 12.7 GHz | | 15 | | dB |
| Output Return Loss | 10.7 GHz | | 5 | | dB |
| | 11.7 GHz | | 6 | | dB |
| | 12.7 GHz | | 10 | | dB |
| 2 ND Harmonic Level (P _{IN} =27 dBm) | 10.7 GHz | | -31 | | dBc |
| | 11.7 GHz | | -36 | | dBc |
| | 12.7 GHz | | -39 | | dBc |
| Third Order IM Distortion (P _{OUT} /Tone = 34 dBm, 50 MHz tone spacing) | 10.7 GHz | | -24 | | dBc |
| | 11.7 GHz | | -32 | | dBc |
| | 12.7 GHz | | -32 | | dBc |
| P _{OUT} Temp. Coeff. (85 °C to -40 °C, P _{IN} = 27 dBm) | | | -0.009 | | dB/°C |
| Sm. Sig. Gain Temp. Coefficient (85 °C to -40 °C) | | | -0.068 | | dB/°C |
| Gate Leakage Current (V _D = +10 V, V _G = -3.7 V) | | -13.2 | | | mA |

Test conditions, unless otherwise noted: T = 25 °C, V_D = 20 V, I_{DQ} = 300 mA

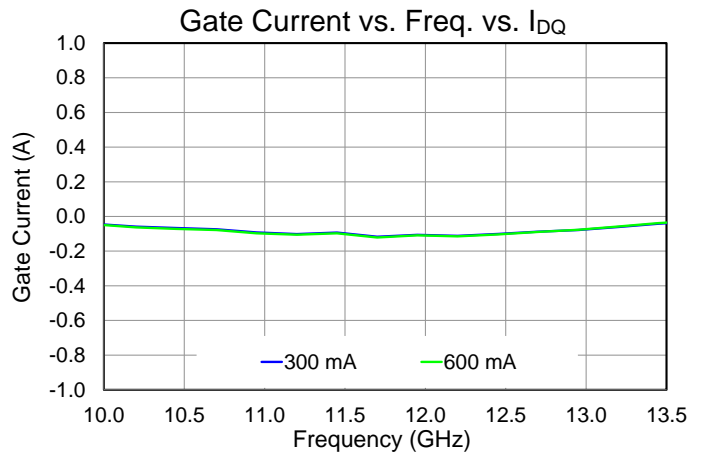
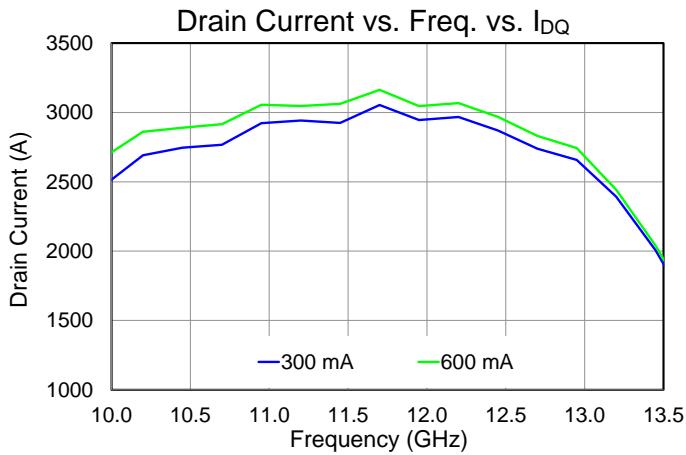
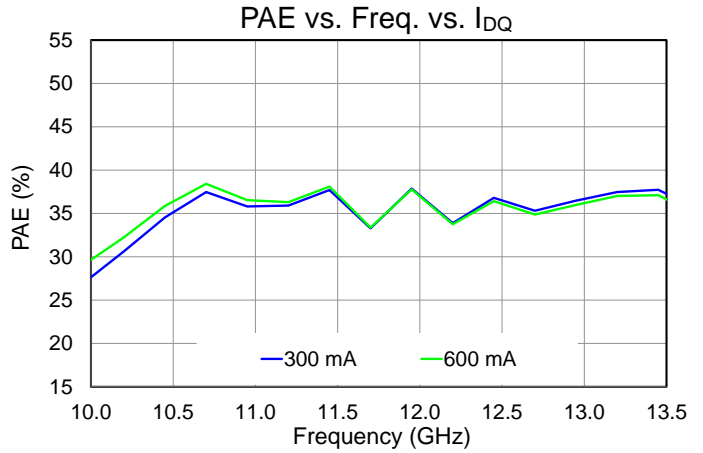
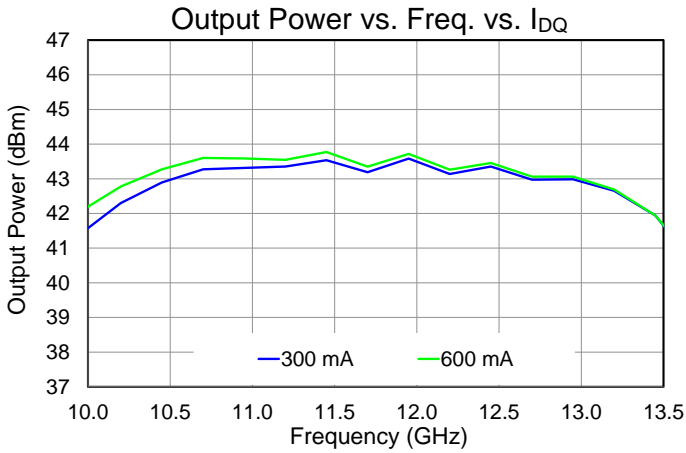
Performance Plots – Large Signal

Test conditions, unless otherwise noted: $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $T = +25\text{ }^\circ\text{C}$, $P_{IN} = 27\text{ dBm}$, CW



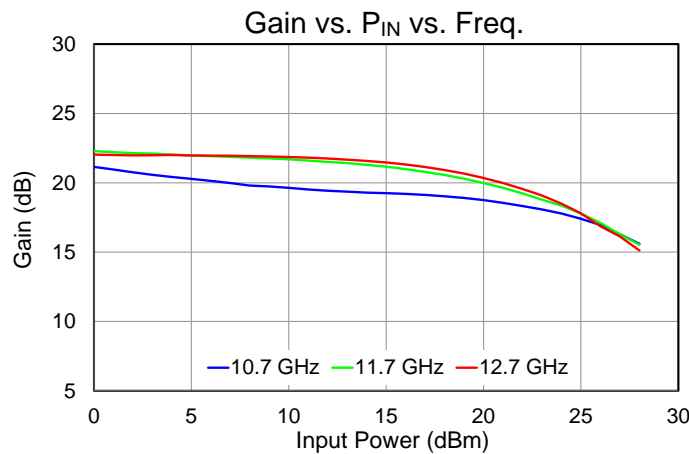
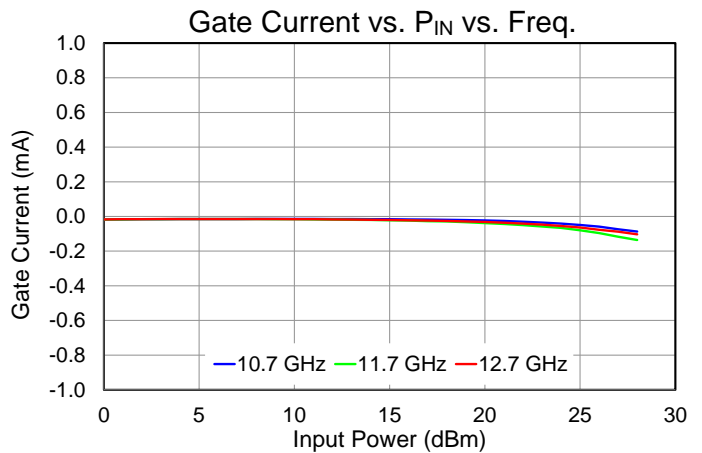
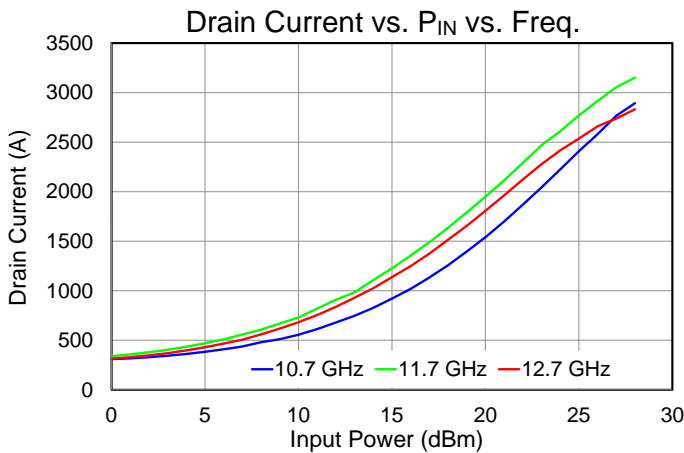
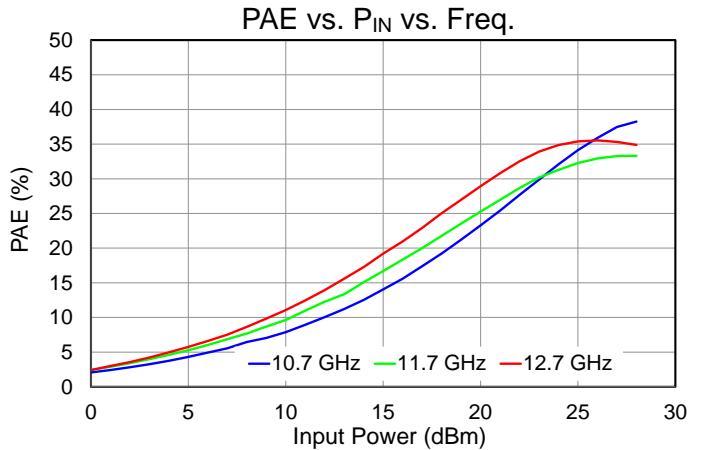
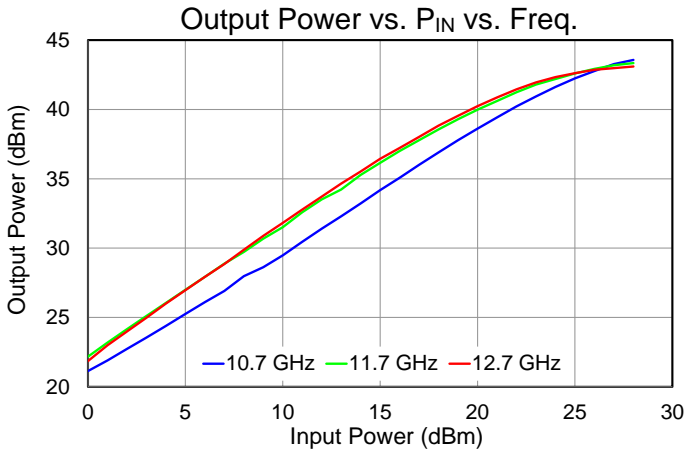
Performance Plots – Large Signal

Test conditions, unless otherwise noted: $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $T = +25\text{ }^\circ\text{C}$, $P_{IN} = 27\text{ dBm}$, CW



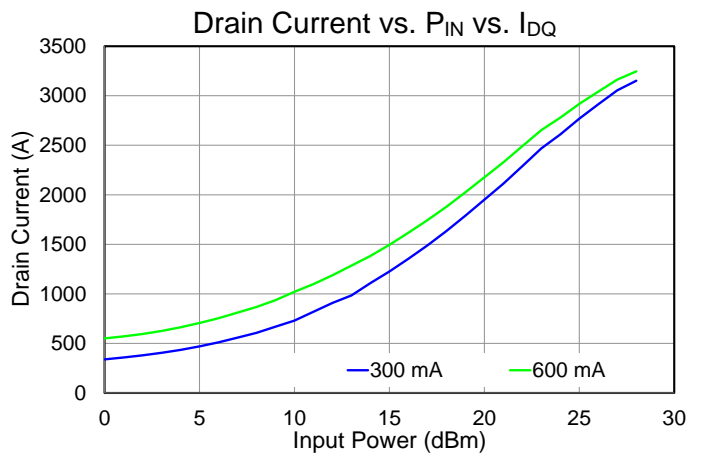
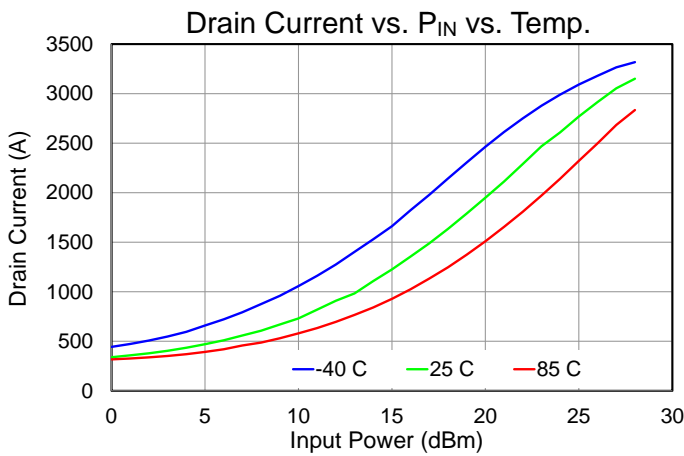
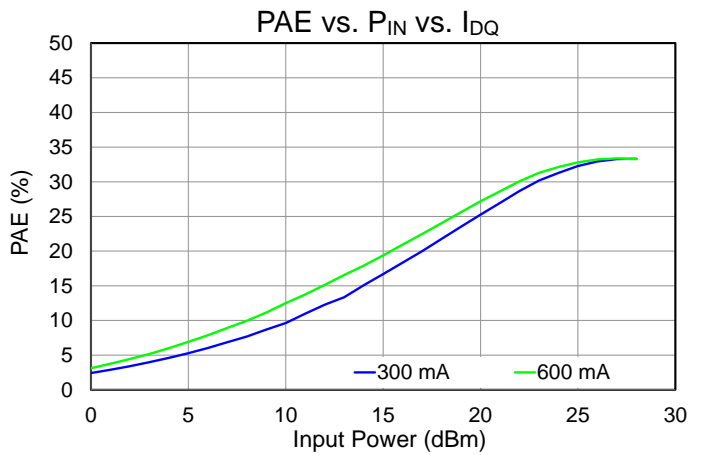
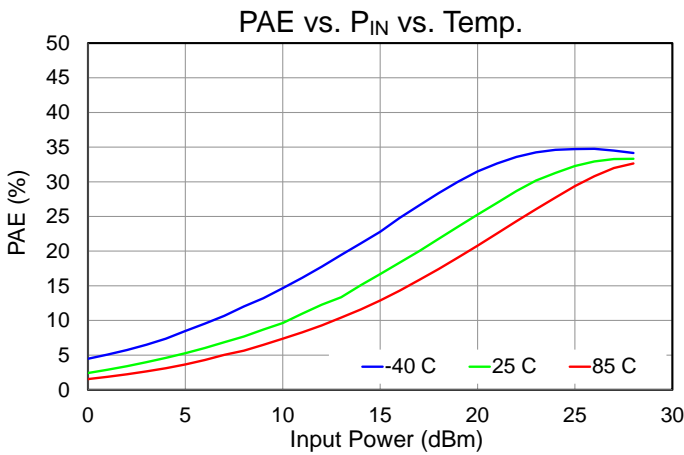
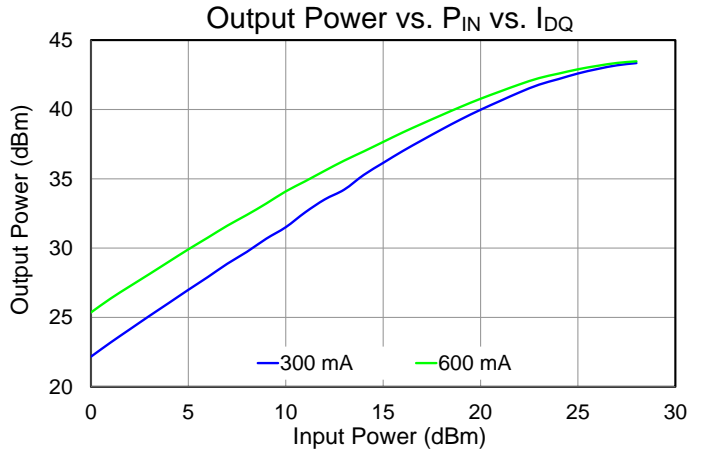
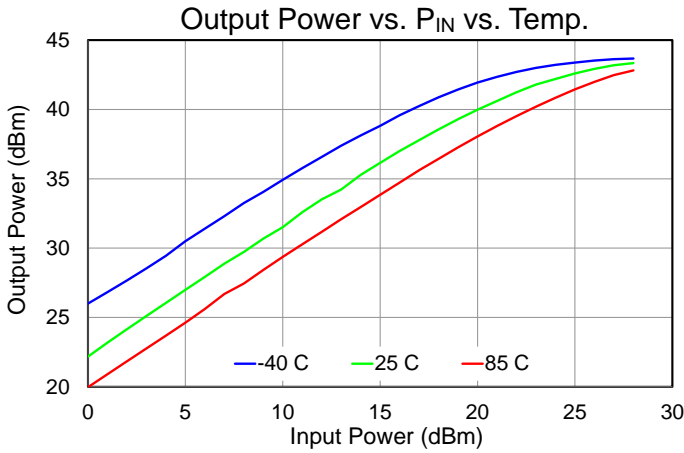
Performance Plots – Large Signal

Test conditions, unless otherwise noted: $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $T = +25\text{ }^\circ\text{C}$, CW



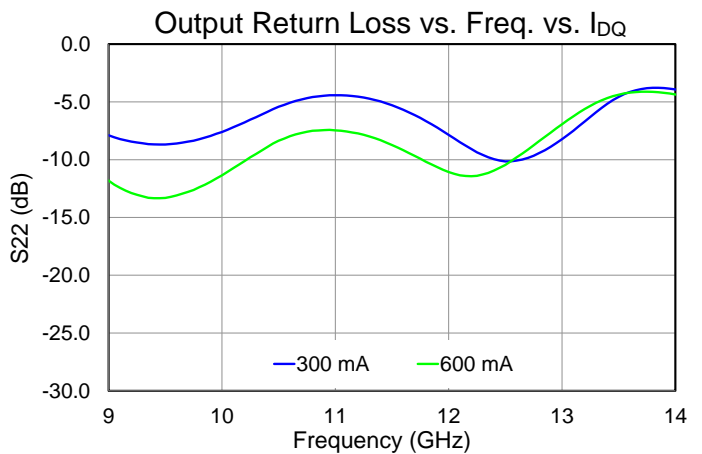
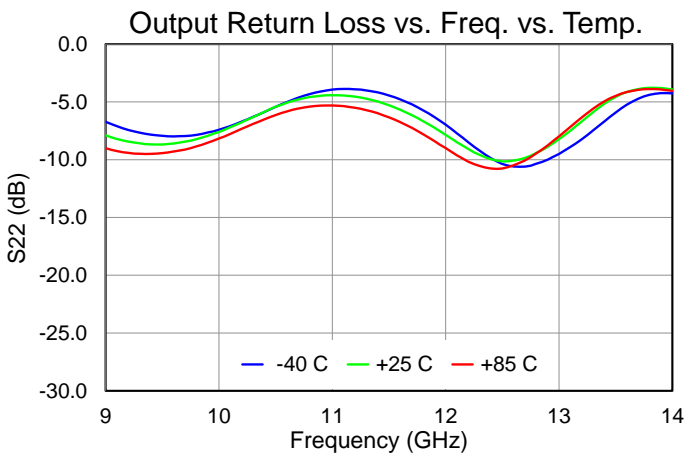
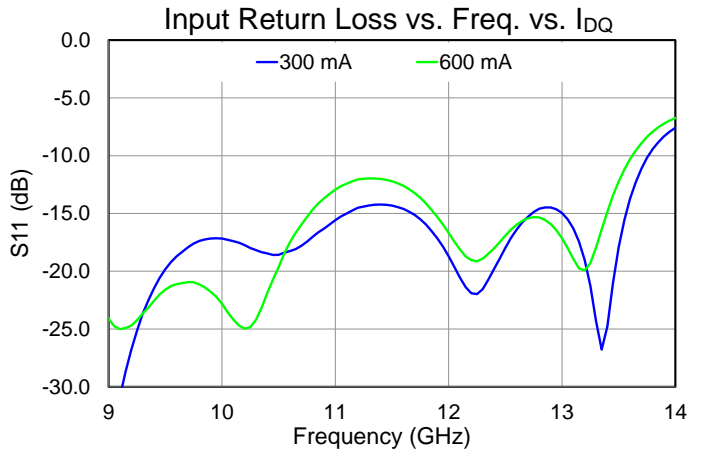
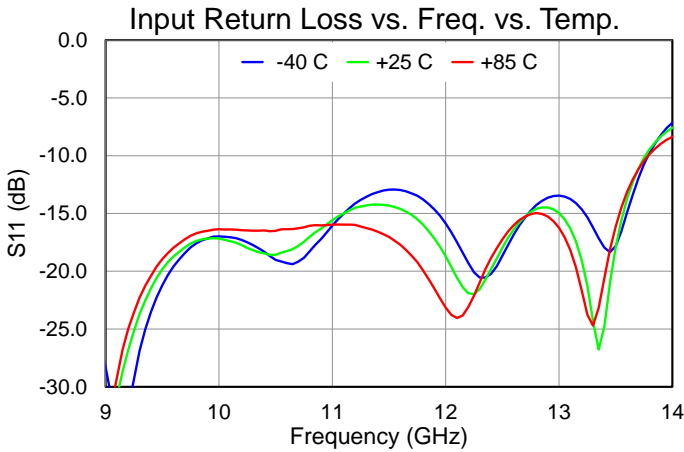
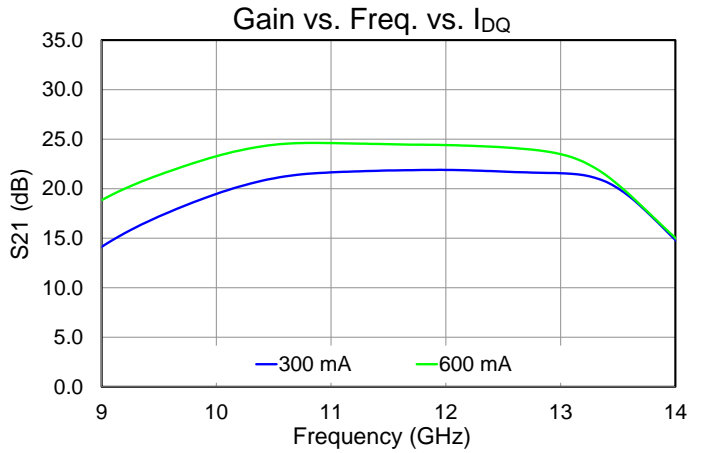
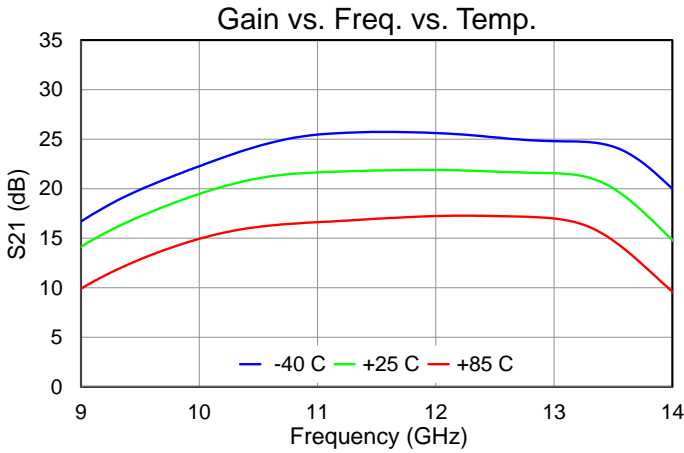
Performance Plots – Large Signal

Test conditions, unless otherwise noted: $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $T = +25\text{ }^\circ\text{C}$, Freq. = 11.7 GHz, CW



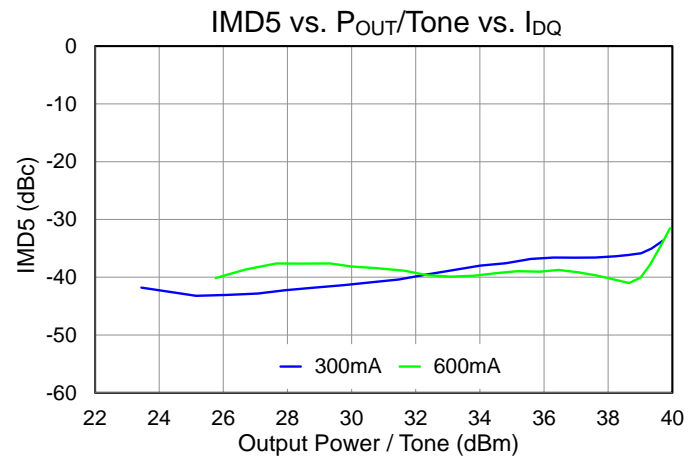
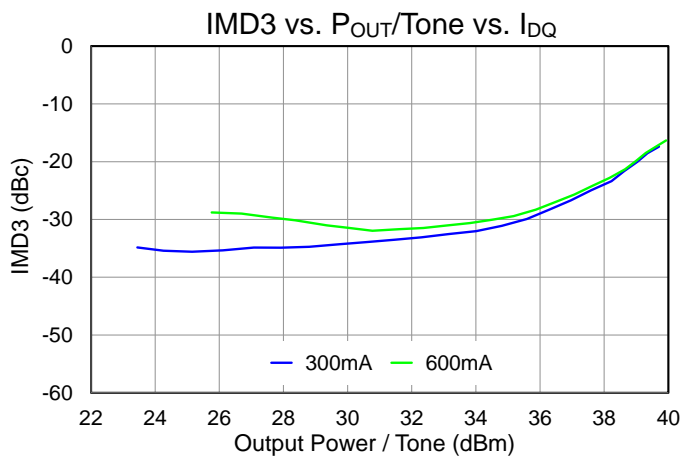
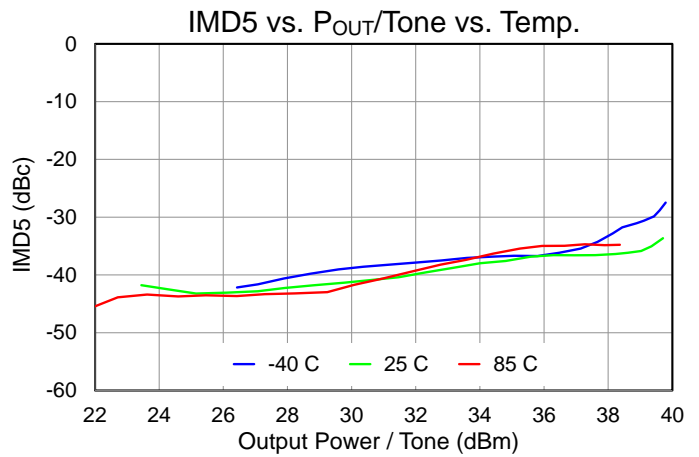
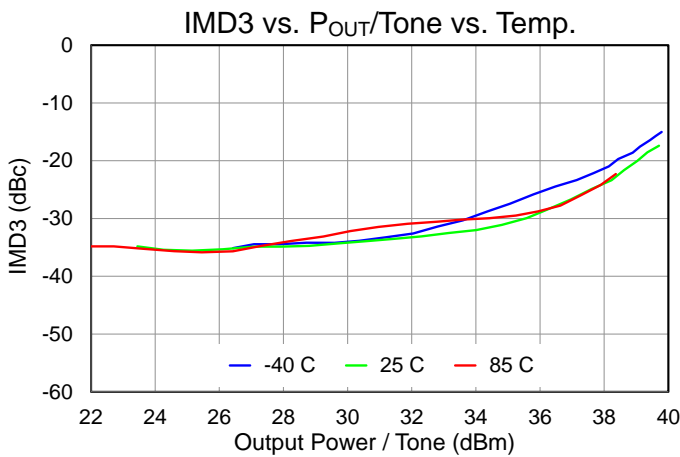
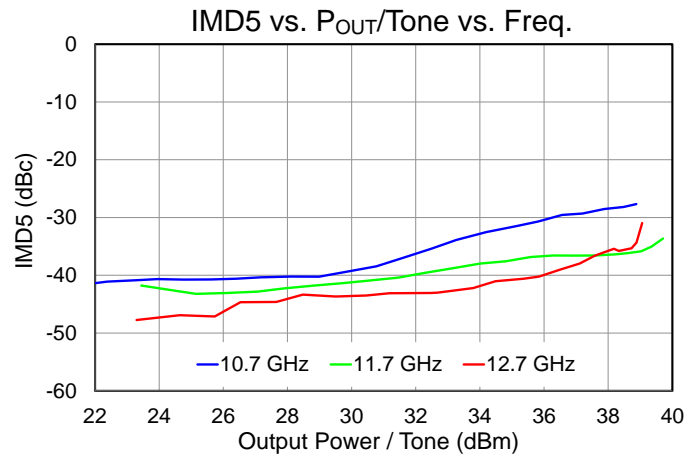
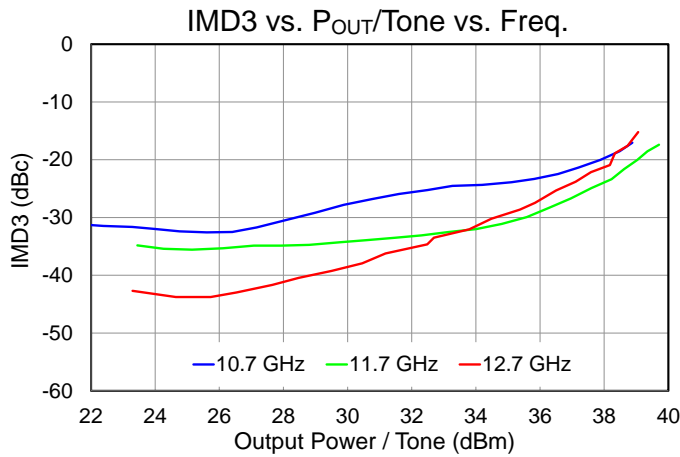
Performance Plots – Small Signal

Test conditions, unless otherwise noted: $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $T = +25\text{ }^\circ\text{C}$, CW



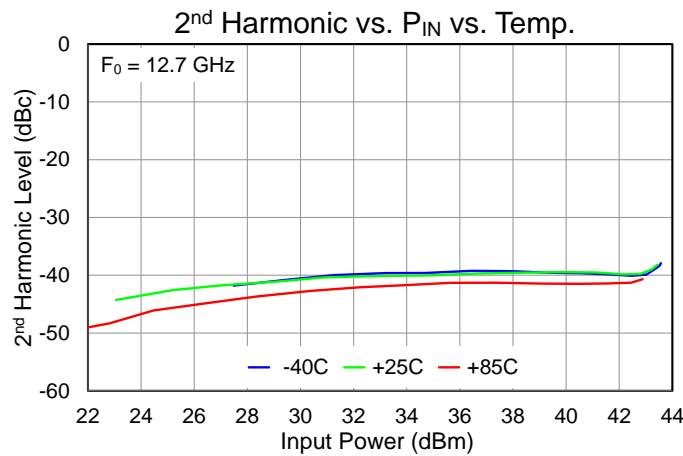
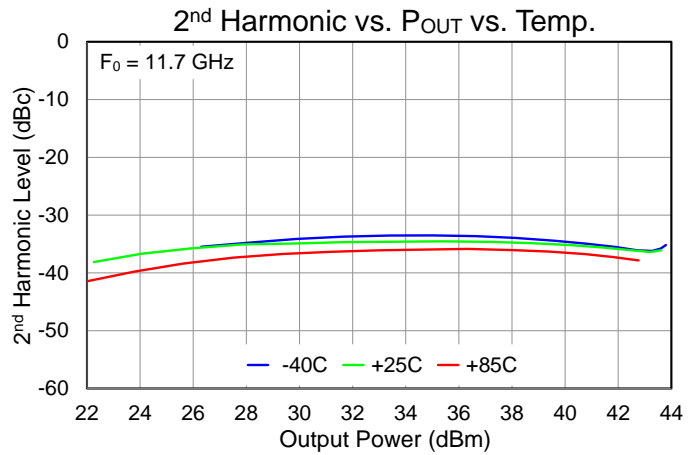
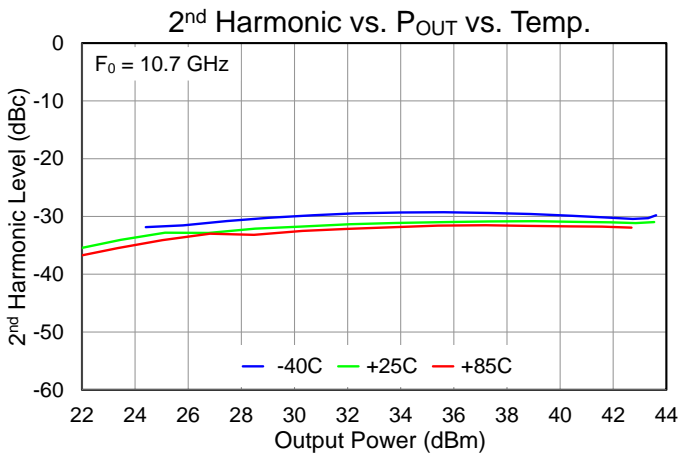
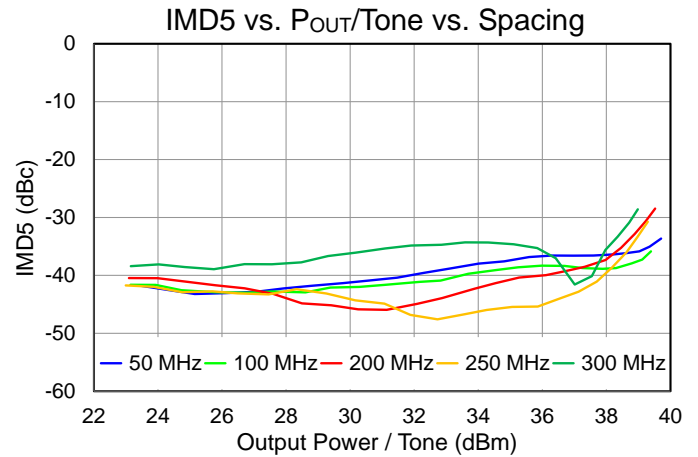
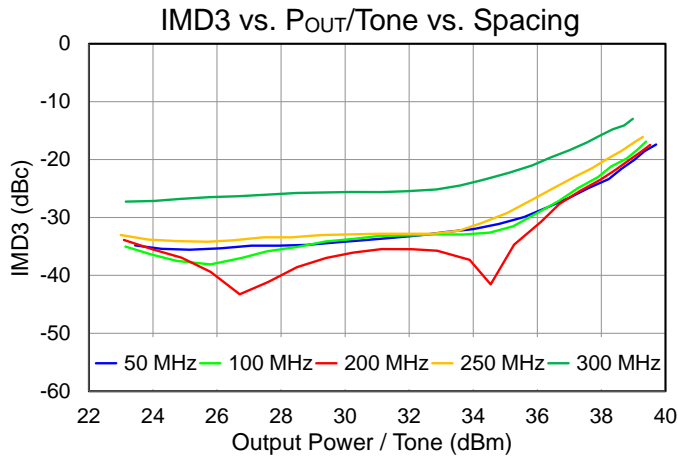
Performance Plots – Linearity

Test conditions, unless otherwise noted: $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $T = +25\text{ }^\circ\text{C}$, CW, $F_c = 11.7\text{ GHz}$, Tone Spacing = 50 MHz



Performance Plots – Linearity, Harmonics

Test conditions, unless otherwise noted: $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $T = +25\text{ }^\circ\text{C}$, CW, $F_c = 11.7\text{ GHz}$, Tone Spacing = 50 MHz



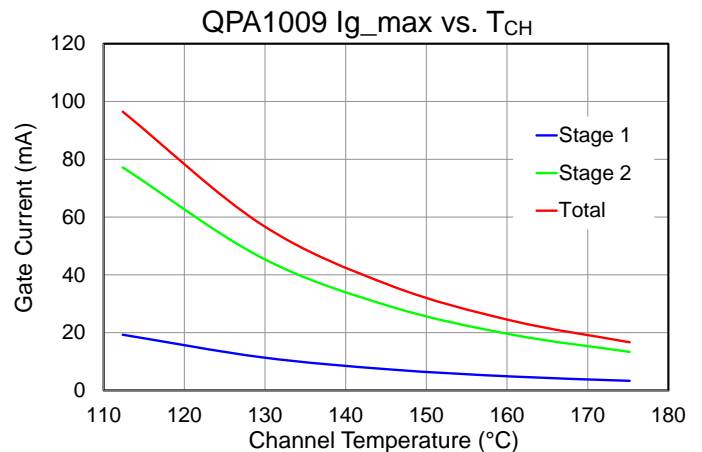
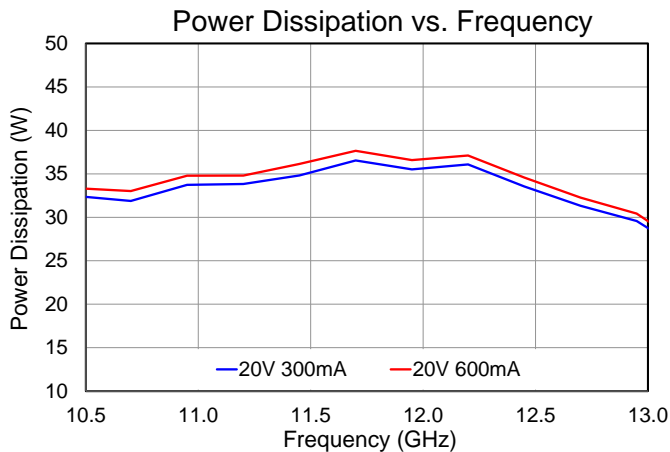
Thermal and Reliability Information

| Parameter | Test Conditions | Value | Units |
|--|--|-------|-----------------------------|
| Thermal Resistance (θ_{JC}) ⁽¹⁾ | $T_{base} = 85\text{ }^{\circ}\text{C}$, $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $P_{DISS} = 6.0\text{ W}$ (Quiescent; no RF drive) | 0.818 | $^{\circ}\text{C}/\text{W}$ |
| Channel Temperature, T_{CH} (Quiescent) ⁽²⁾ | | 89.9 | $^{\circ}\text{C}$ |
| Thermal Resistance (θ_{JC}) ⁽¹⁾ | $T_{base} = 85\text{ }^{\circ}\text{C}$, $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $\text{Freq} = 11.7\text{ GHz}$, $I_{D_Drive} = 2684\text{ mA}$, $P_{IN} = 27\text{ dBm}$, $P_{OUT} = 42.5\text{ dBm}$, $P_{DISS} = 36.1\text{ W}$ | 1.270 | $^{\circ}\text{C}/\text{W}$ |
| Channel Temperature, T_{CH} (w/ RF drive) ⁽²⁾ | | 130.8 | $^{\circ}\text{C}$ |

Notes:

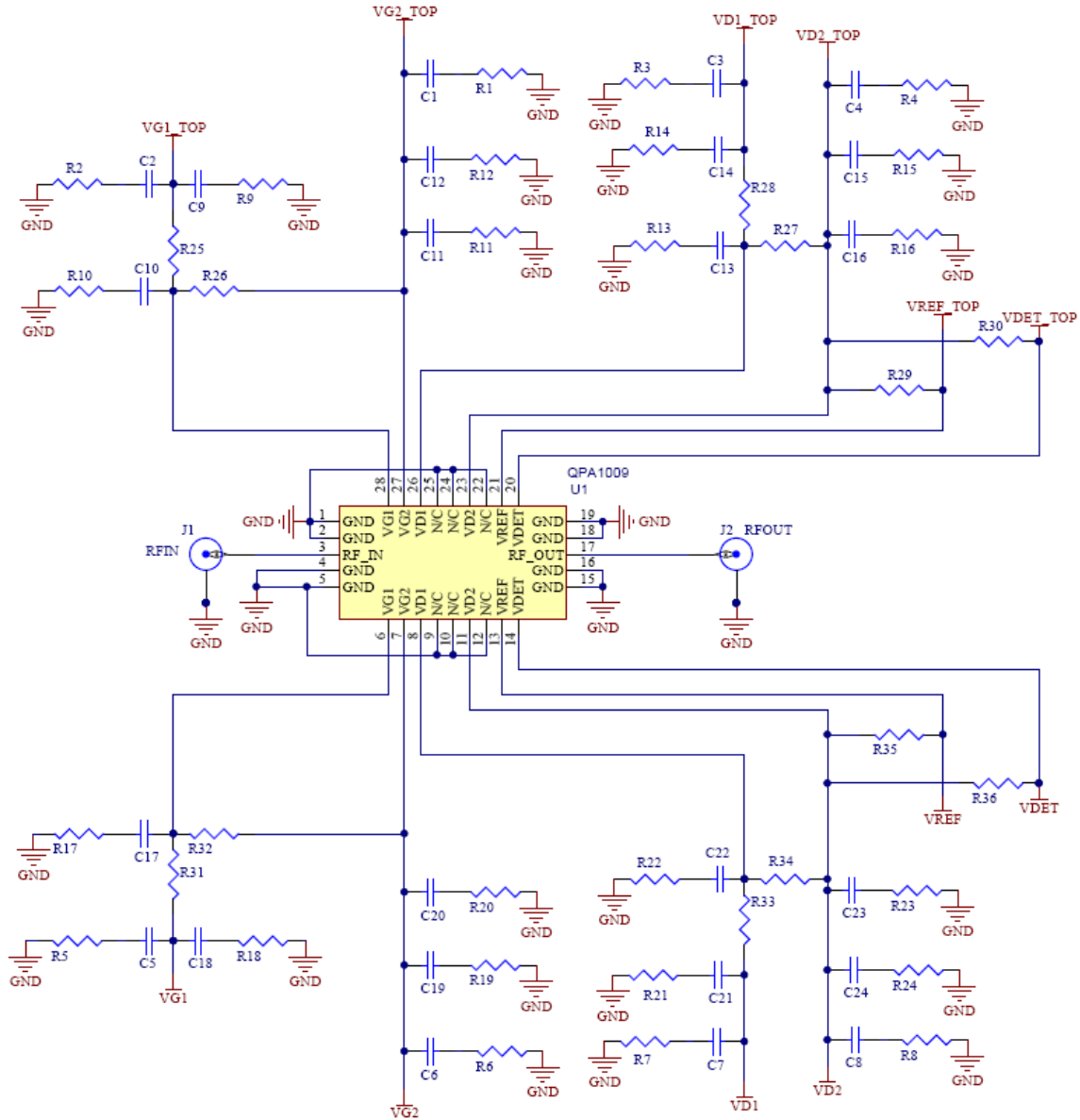
- Thermal resistance determined to the back of package, T_{base} (85 $^{\circ}\text{C}$)
- T_{CH} values are IR Scan equivalent temperatures. Refer to the following document: [GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates](#)

Dissipated Power and Maximum Gate Current



Test conditions, unless otherwise noted: $V_D = 20\text{ V}$, $I_{DQ} = 300\text{ mA}$, $T = +25\text{ }^{\circ}\text{C}$, $P_{IN} = 27\text{ dBm}$

Applications Information



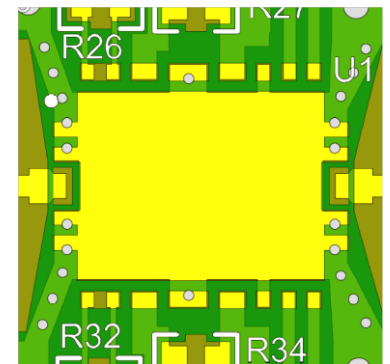
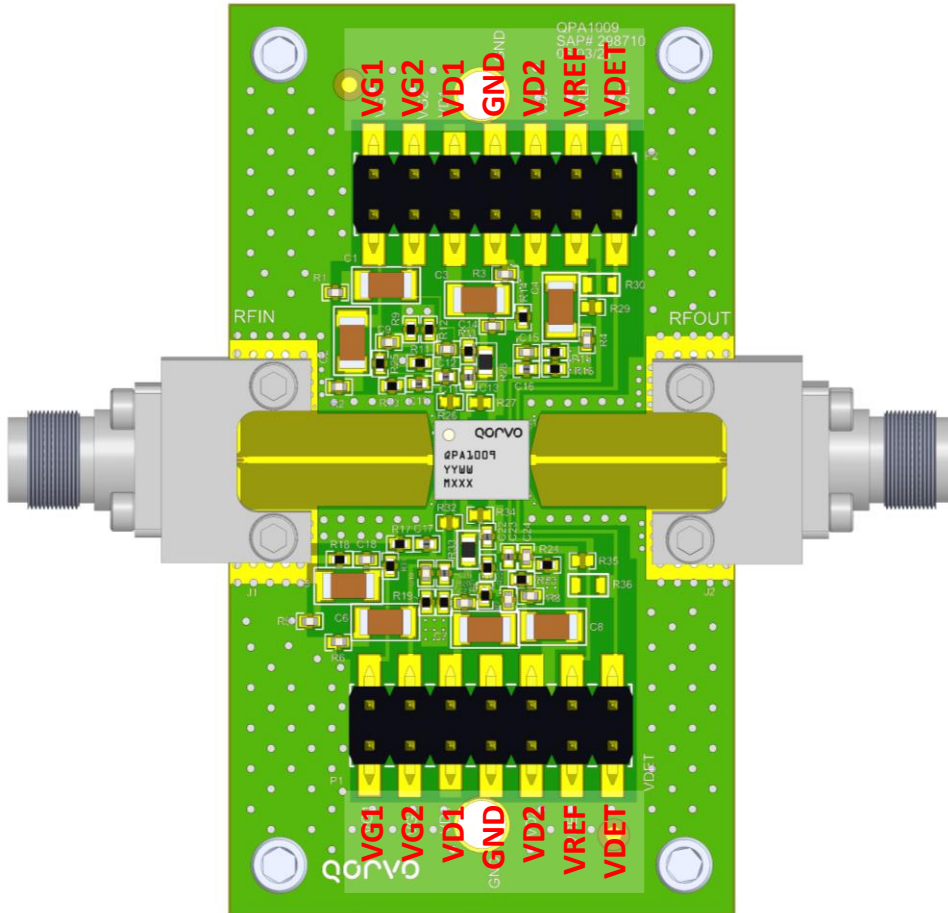
Bias-Up Procedure

- Turn on V_G supply and set $V_G = -4V$, I_G limit to 20 mA
- Turn on V_D supply and set $V_D = 0V$, I_D limit to 3750 mA
- Adjust V_D to 20 V
- Adjust V_G to obtain desired I_{DQ} (300 mA)

Bias-Down Procedure

- Set $V_G = -4 V$
- Set $V_D = 0 V$
- Turn off V_D Supply
- Turn off V_G Supply

Evaluation Board (EVB) Layout Assembly

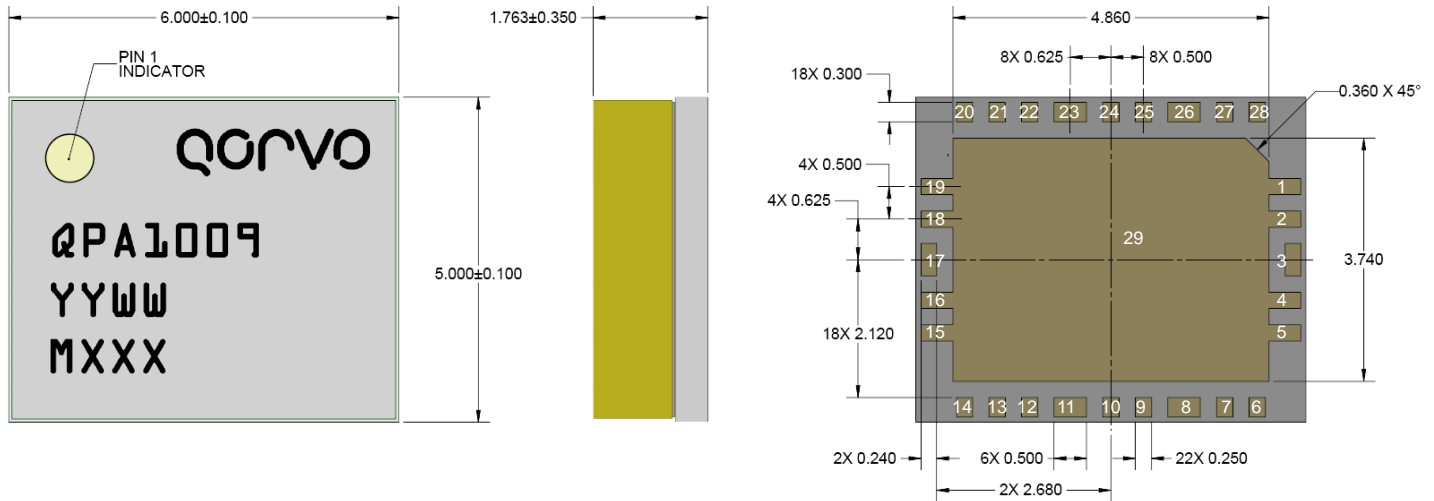


Package removed to show mounting location

Bill of Materials

| Reference Des. | Value | Description | Manuf. | Part No. |
|---|---------|---|---------------------|------------|
| C1, C2, C3, C4, C5, C6, C7, C8 | 10 uF | CAP, 10uF, 20%, 50V, 20%, X5R, 1206 | Various | |
| C9, C12, C14, C15, C18, C19, C21, C24 | 0.01 uF | CAP, 0.01uF, 10%, 50V, X7R, 0402 | Various | |
| C10, C11, C13, C16, C17, C20, C22, C23 | 1 nF | CAP, 1nF, 10%, 50V, X7R, 0402 | Various | |
| R1, R2, R3, R4, R5, R6, R7, R8 | 5.1 Ω | RES, 5.1 OHM, 1%, 1/10W, 0402 | Various | |
| R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R31 | 0 Ω | RES, 0 OHM, 1/10W, 0402 | Various | |
| R28, R33 | 0 Ω | RES, 0 OHM, 0603 | Various | |
| J1, J2 | 2.92 mm | CONN, 2.92, END, F, PIN .005, DIEL .029 | Southwest Microwave | 1092-01A-5 |

Mechanical Information



Material:

1. Package Lid: FR4
2. All package leads are gold plated
3. The part is epoxy sealed

Tolerances:

- .XX = ± .25
- .XXX = ± .100
- .XXXX = ± .0245

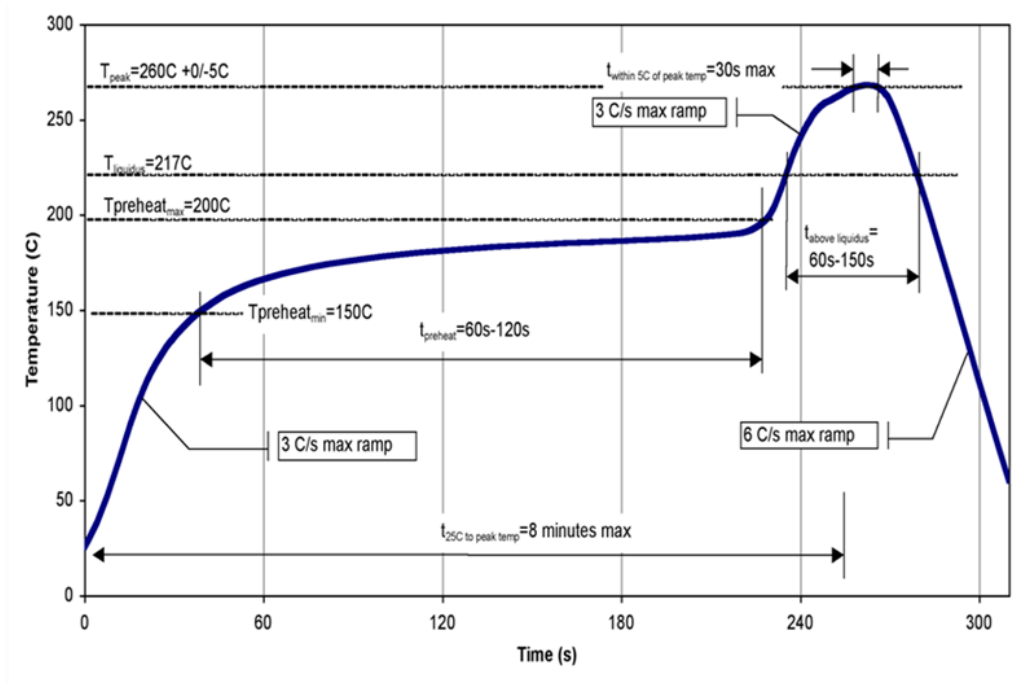
Unless otherwise specified, dimensions are in mm

Bond Pad Description

| Pad No. | Symbol | Description |
|--------------------------------|--------|--|
| 1, 2, 4, 5, 15, 16, 18, 19, 29 | GND | Ground |
| 9, 10, 12, 22, 24, 25 | NC | No internal connection; may be connected to PCB ground |
| 3 | RF IN | RF input. 50 ohms. DC blocked |
| 6, 28 | VG1 | First stage gate voltage |
| 7, 27 | VG2 | Second stage gate voltage |
| 8, 26 | VD1 | First stage drain voltage |
| 11, 23 | VD2 | Second stage drain voltage |
| 13, 21 | VREF | Reference voltage for detector |
| 14, 20 | VDET | Detector voltage |
| 17 | RF OUT | RF output. 50 Ohms. DC blocked |

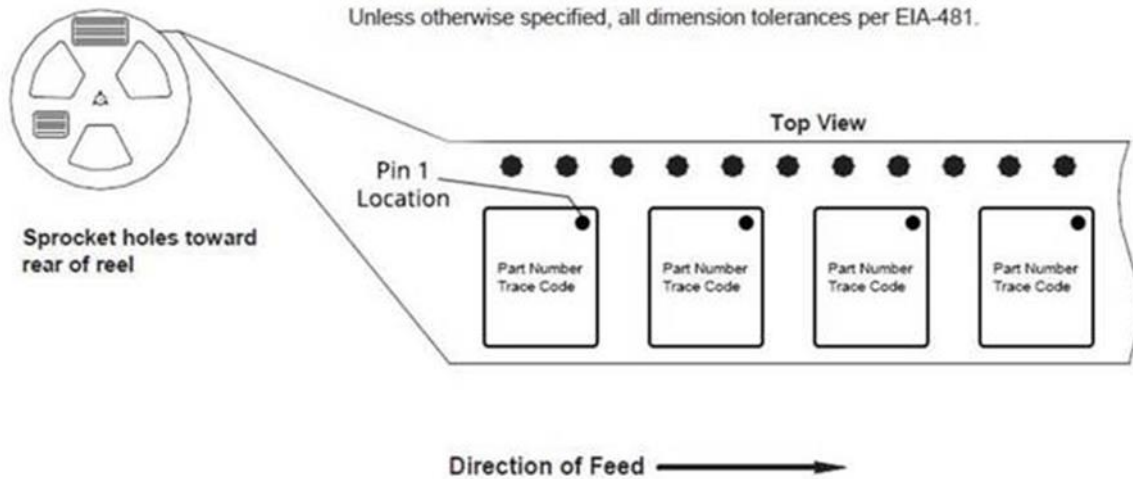
Assembly Notes

- Compatible with lead-free soldering processes with 260°C peak reflow temperature.
- All package leads are gold plated
- Solder rework is not recommended



Tape and Reel Information – Carrier and Cover Tape Dimensions

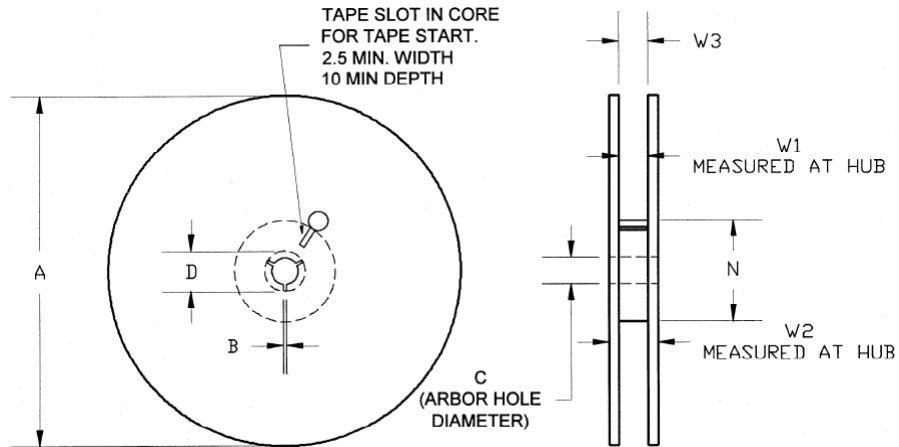
Tape and reel specifications for this part are also available on the Qorvo website.
Standard T/R size = 250 pieces on a 7" reel.



| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---------------------|--|--------|-----------|-----------|
| Cavity | Length | A0 | 0.209 | 5.3 |
| | Width | B0 | 0.248 | 6.3 |
| | Depth | K0 | 0.083 | 2.1 |
| | Pitch | P1 | 0.315 | 8.0 |
| Centerline Distance | Cavity to Perforation - Length Direction | P2 | 0.079 | 2.0 |
| | Cavity to Perforation - Width Direction | F | 0.217 | 5.5 |
| Cover Tape | Width | C | 0.362 | 9.2 |
| Carrier Tape | Width | W | 0.472 | 12.0 |

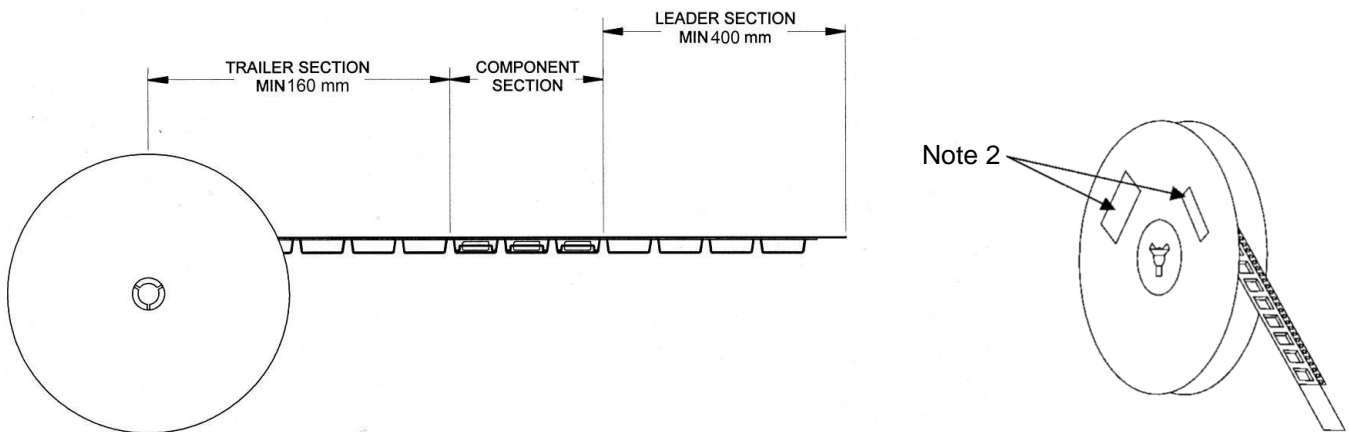
Tape and Reel Information – Reel Dimensions

Packaging reels are used to prevent damage to devices during shipping and storage, loaded carrier tape is typically wound onto a plastic take-up reel. The reel size is 7" diameter. The reels are made from high-impact injection-molded polystyrene (HIPS), which offers mechanical and ESD protection to packaged devices.



| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---------|----------------------|--------|-----------|-----------|
| Flange | Diameter | A | 6.969 | 177.0 |
| | Thickness | W2 | 0.724 | 18.4 |
| | Space Between Flange | W1 | 0.488 | 12.4 |
| Hub | Outer Diameter | N | 2.283 | 58.0 |
| | Arbor Hole Diameter | C | 0.512 | 13.0 |
| | Key Slit Width | B | 0.079 | 2.0 |
| | Key Slit Diameter | D | 0.795 | 20.2 |

Tape and Reel Information – Tape Length and Label Placement



Notes:

1. Empty part cavities at the trailing and leading ends are sealed with cover tape. See EIA 481.
2. Labels are placed on the flange opposite the sprockets in the carrier tape.