# QPD1008L

## 125W, 50V, DC – 3.2 GHz, GaN RF Transistor

## General Description

The QPD1008L is a 125 W ($P_{3dB}$) wideband unmatched discrete GaN on SiC HEMT which operates from DC to 3.2 GHz with a 50V supply rail. The device is in an industry standard air cavity package and is ideally suited for military and civilian radar, land mobile and military radio communications, avionics, and test instrumentation. The device can support pulsed, CW, and linear operation.

Lead-free and ROHS compliant

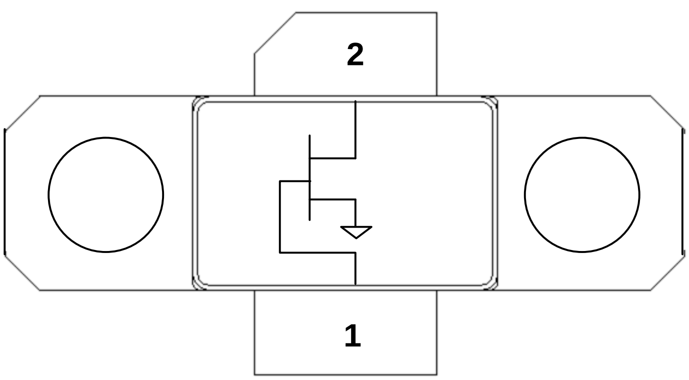
Evaluation boards are available upon request.


## Product Features

- Frequency: DC to 3.2 GHz
- Output Power ($P_{3dB}$)[1]: 162 W
- Linear Gain[1]: 17.5 dB
- Typical $DEFF_{3dB}$[1]: 74%
- Operating Voltage: 50 V
- Low thermal resistance package
- CW and Pulse capable

Note: 1 @ 2 GHz

## Functional Block Diagram




## Applications

- Military radar
- Civilian radar
- Land mobile and military radio communications
- Test instrumentation
- Wideband or narrowband amplifiers
- Jammers
- Avionics

| Part No. | Description |
| --- | --- |
| QPD1008L | DC – 3.2 GHz RF Transistor |
| QPD1008LPCB4B01 | 0.96 – 1.215 GHz EVB |
| QPD1008LEVB2 | 1.1 – 1.5 GHz EVB |

## Absolute Maximum Ratings

| Parameter | Rating |
|---|---|
| Drain to Gate Voltage ($V_{DG}$) | 145 V |
| Gate Voltage Range ($V_G$) | −7 to +2 V |
| RF Input Power, CW, 50 Ω, T = 25 °C | 40 dB |
| Power Dissipation $P_{DISS}$ | See graph on page 5 |
| Storage Temperature | −65 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 | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Drain Voltage ($V_D$) | +12 | +48 | +55 | V |
| Carrier Gate Voltage ($V_G$) | | −2.8 | | V |
| Carrier Quiescent Current ($I_{DQ1}$) | | 260 | | mA |
| Operating Temperature Range | −40 | +25 | +85 | °C |

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

Note:

1. To be adjusted to desired $I_{DQ}$

## Electrical Characterization

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Gate Leakage | $V_D$ = +10 V, $V_G$ = −3.8 V | −23.1 | | | mA |

## Pulsed Characterization – Load-Pull Performance – Power Tuned[1]

| Parameters | Typical Values | | | Unit |
|---|---|---|---|---|
| Frequency, F | 1 | 2 | 3 | GHz |
| Linear Gain, $G_{LIN}$ | 22.5 | 17.5 | 14.1 | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | 52.0 | 52.1 | 51.9 | dBm |
| Drain Efficiency at 3dB compression point, $DEFF_{3dB}$ | 63.4 | 62.1 | 59.2 | % |
| Gain at 3dB compression point | 19.5 | 14.4 | 11.1 | dB |

Notes:
1. Test conditions unless otherwise noted: $V_D$ = +50 V, $I_D$ = 260 mA, Temp = +25 °C

## Pulsed Characterization – Load-Pull Performance – Efficiency Tuned[1]

| Parameters | Typical Values | | | Unit |
|---|---|---|---|---|
| Frequency | 1 | 2 | 3 | GHz |
| Linear Gain, $G_{LIN}$ | 23.5 | 18.6 | 15.2 | dB |
| Output Power at 3dB compression point, $P_{3dB}$ | 48.2 | 50.2 | 51.0 | dBm |
| Drain Efficiency at 3dB compression point, $DEFF_{3dB}$ | 76.2 | 74.6 | 69.7 | % |
| Gain at 3dB compression point, G3dB | 20.5 | 15.6 | 12.2 | dB |

Notes:
1. Test conditions unless otherwise noted: $V_D$ = +50 V, $I_{DQ}$ = 260 mA, Temp = +25 °C

## RF Characterization – EVB1 Performance at 1.09 GHz[1]

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Linear Gain, $G_{LIN}$ | – | 20 | – | dB |
| Output Power at 3dB compression point, P3dB | – | 51.2 | – | dBm |
| Drain Efficiency at 3dB compression point, DEFF3dB | – | 73.5 | – | % |
| Gain at 3dB compression point, G3dB | – | 17 | – | dB |

Notes:
1. $V_D$ = +50 V, $I_{DQ}$ = 260 mA, Temp = +25 °C, Pulse Width = 128 uS, Duty Cycle = 10%

## RF Characterization – Mismatch Ruggedness at 1.09 GHz

| Symbol | Parameter | dB Compression | Typical |
|---|---|---|---|
| VSWR | Impedance Mismatch Ruggedness | 3 | 10:1 |

Test conditions unless otherwise noted: $T_A$ = 25 °C, $V_D$ = 50 V, $I_{DQ}$ = 260 mA
Driving input power is determined at pulsed 3dB compression under matched condition at EVB output connector.

## Thermal and Reliability Information - CW (1)

| Parameter | Test Conditions | Value | Units |
|---|---|---|---|
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 21 W, Tbaseplate = 85°C | 1.24 | ºC/W |
| Channel Temperature, $T_{CH}$ | | 111 | °C |
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 42 W, Tbaseplate = 85°C | 1.33 | °C/W |
| Channel Temperature, $T_{CH}$ | | 141 | °C |
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 63 W, Tbaseplate = 85°C | 1.41 | ºC/W |
| Channel Temperature, $T_{CH}$ | | 174 | °C |
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 84 W, Tbaseplate = 85°C | 1.51 | ºC/W |
| Channel Temperature, $T_{CH}$ | | 212 | °C |
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 105 W, Tbaseplate = 85°C | 1.6 | ºC/W |
| Channel Temperature, $T_{CH}$ | | 253 | °C |

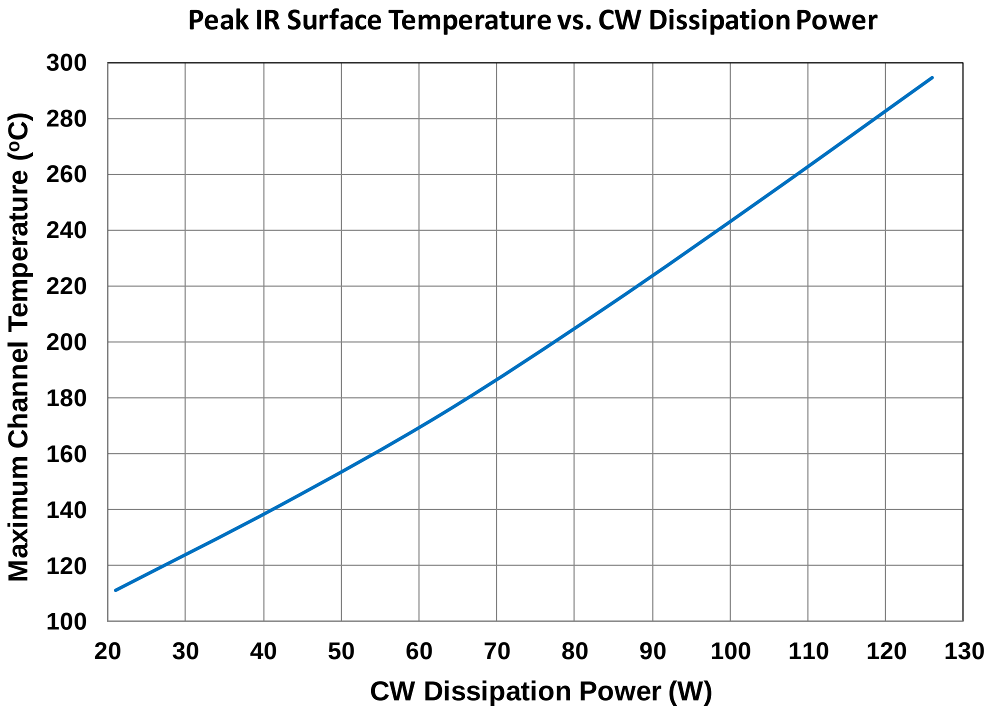
Notes:
1. Thermal resistance measured to bottom of package.
2. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

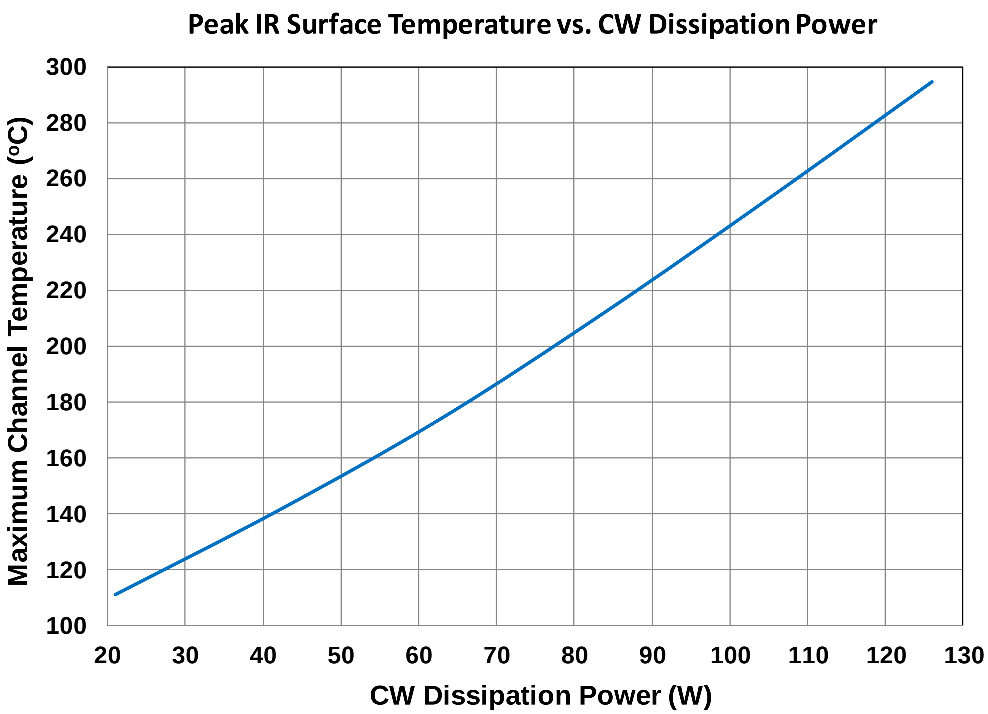
## Thermal and Reliability Information - Pulsed (1)

| Parameter | Test Conditions | Value | Units |
|---|---|---|---|
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 42 W, Tbaseplate = 85°C<br>Pulse Width = 128 uS<br>Duty Cycle = 10% | 0.74 | ºC/W |
| Channel Temperature, $T_{CH}$ | | 116 | °C |
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 63 W, Tbaseplate = 85°C<br>Pulse Width = 128 uS<br>Duty Cycle = 10% | 0.76 | °C/W |
| Channel Temperature, $T_{CH}$ | | 133 | °C |
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 84 W, Tbaseplate = 85°C<br>Pulse Width = 128 uS<br>Duty Cycle = 10% | 0.77 | °C/W |
| Channel Temperature, $T_{CH}$ | | 150 | °C |
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 105 W, Tbaseplate = 85°C<br>Pulse Width = 128 uS<br>Duty Cycle = 10% | 0.80 | ºC/W |
| Channel Temperature, $T_{CH}$ | | 169 | °C |
| Thermal Resistance, Peak IR Surface Temperature at Average Power ($\theta_{JC}$) | $P_{DISS}$ = 126 W, Tbaseplate = 85°C<br>Pulse Width = 128 uS<br>Duty Cycle = 10% | 0.82 | ºC/W |
| Channel Temperature, $T_{CH}$ | | 188 | °C |

Notes:
1. Thermal resistance measured to bottom of package.
2. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

## Maximum Channel Temperature



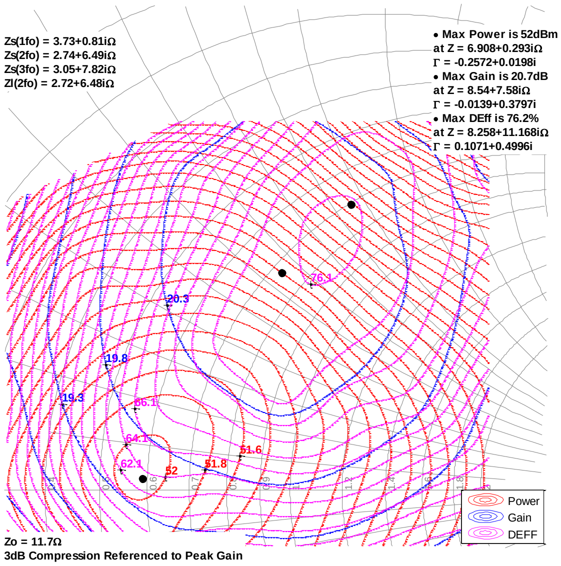



## Load-Pull Smith Charts[1, 2]

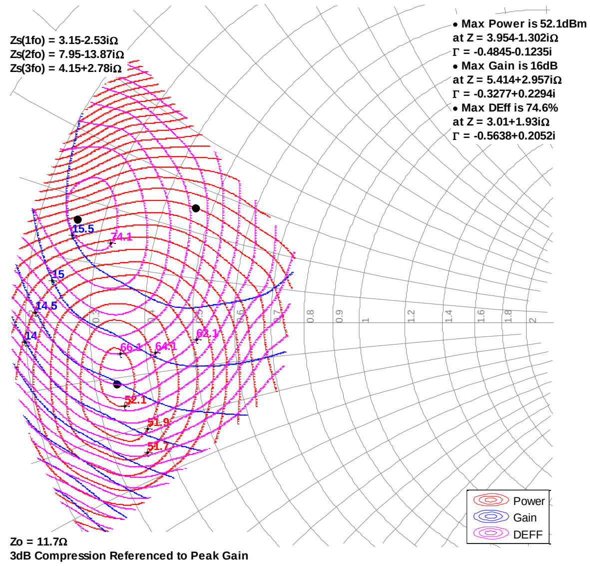
Notes:

1. 50 V, 260 mA, Pulsed signal with 128 uS pulse width and 10 % duty cycle.
2. See page 13 for load-pull and source-pull reference planes. 11.7-Ω load-pull TRL fixtures are built with 32-mil RO4360G2 material.

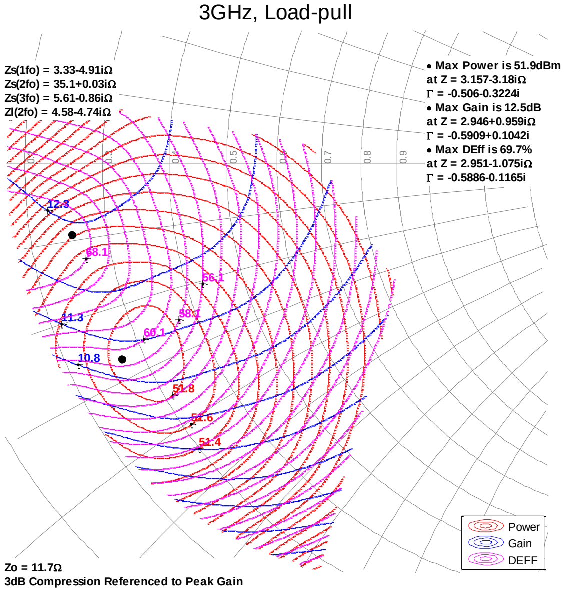
1GHz, Load-pull




2GHz, Load-pull



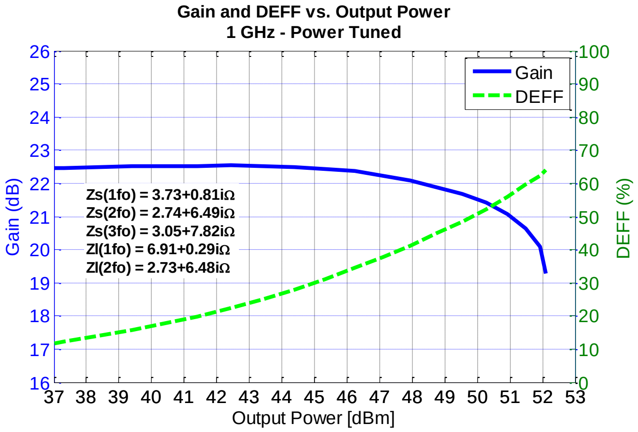

3GHz, Load-pull

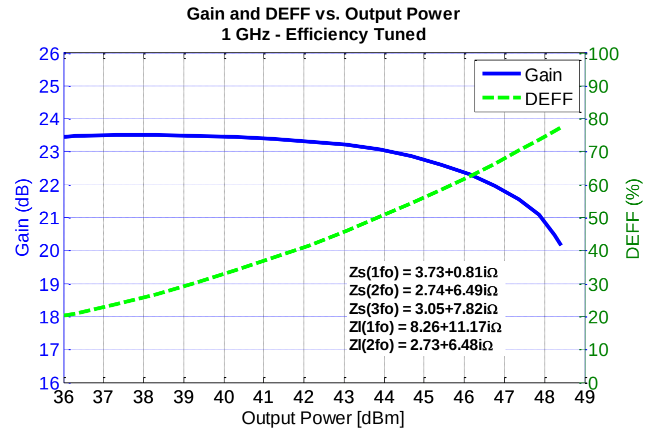


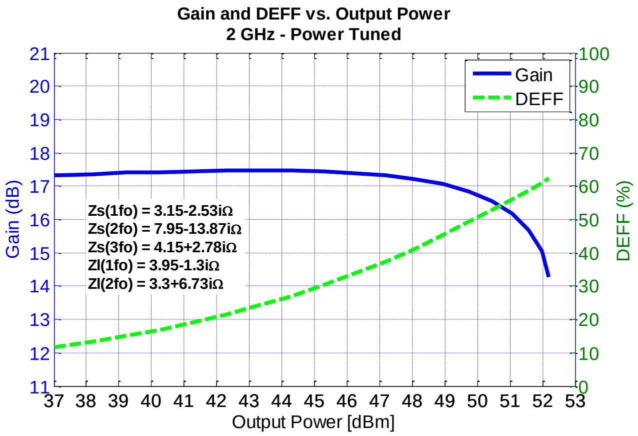
## Typical Performance – Load-Pull Drive-up

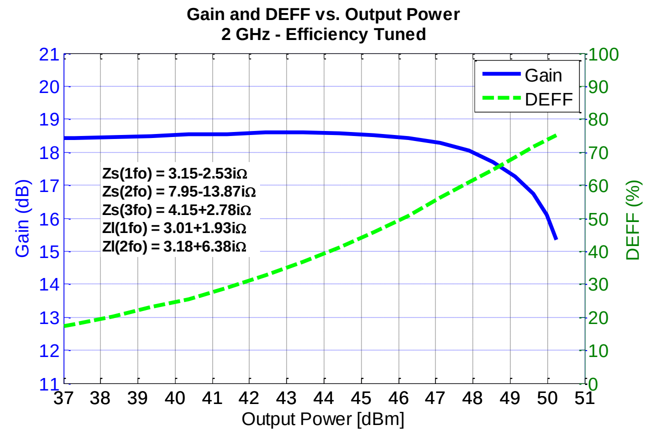
Notes:

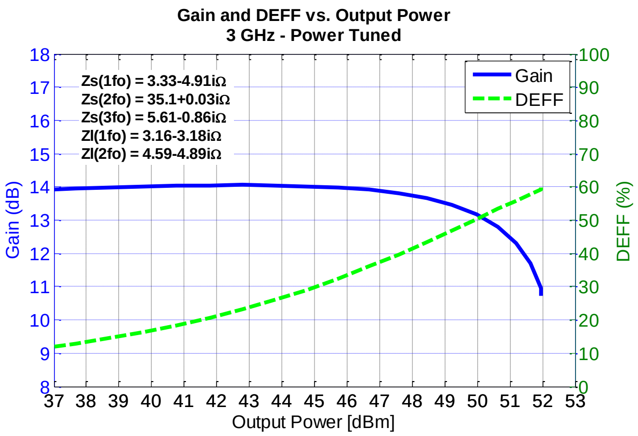
1. Pulsed signal with 128 uS pulse width and 10 % duty cycle, Vd = 50 V, $I_{DQ}$ = 260 mA.
2. See page 13 for load-pull and source-pull reference planes where the performance was measured.

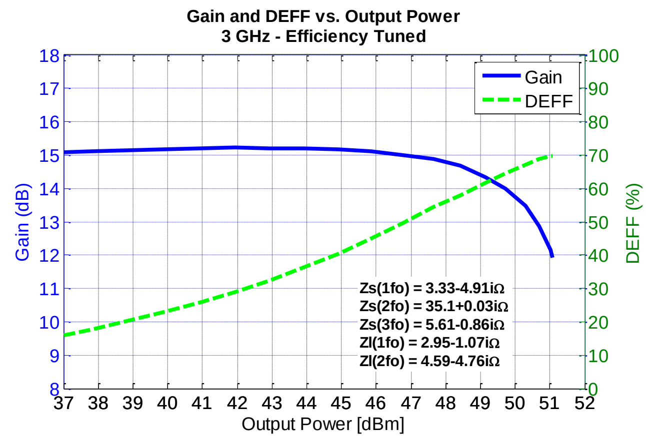


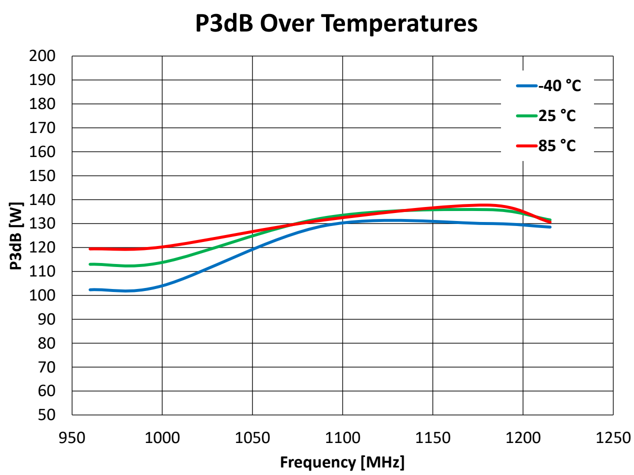



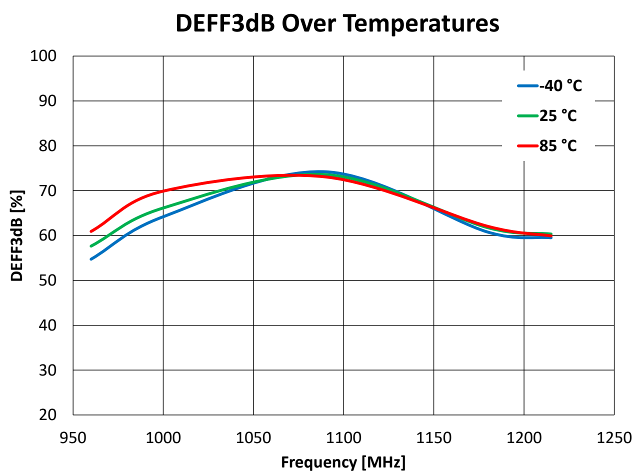



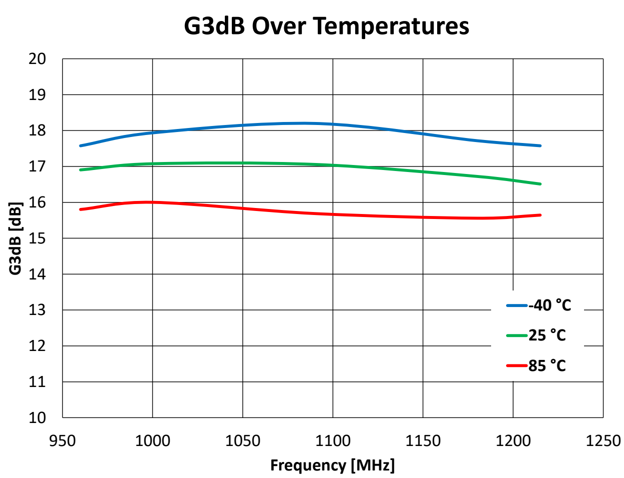
## Power Driveup Performance Over Temperatures Of 0.96 – 1.215 GHz EVB[1]

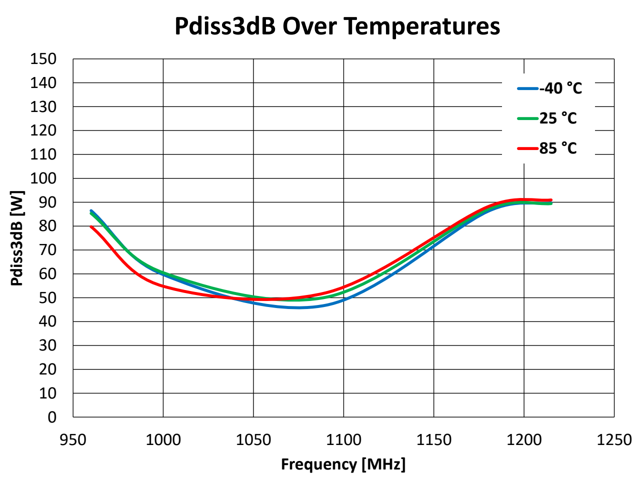
Notes:

1. Pulsed signal with 128 uS pulse width and 10 % duty cycle, Vd = 50 V, $I_{DQ}$ = 260 mA.



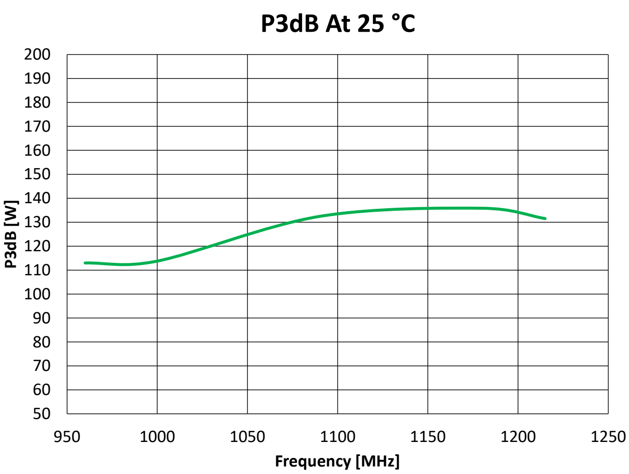



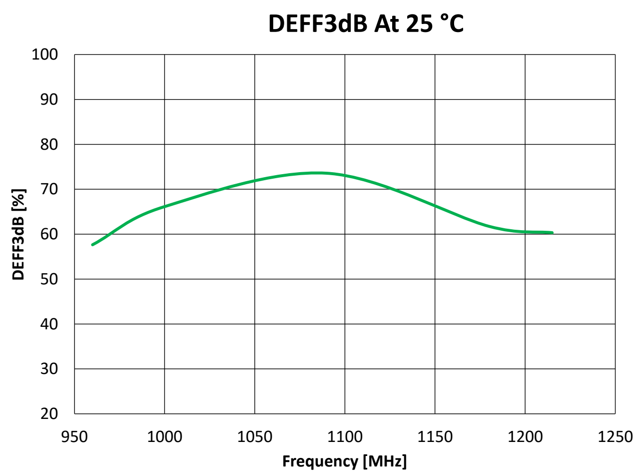



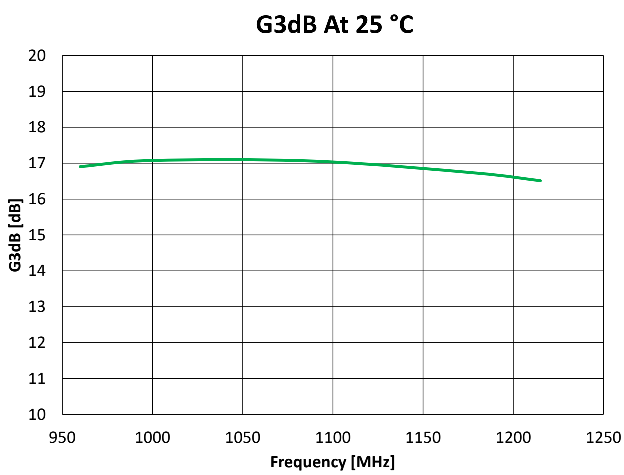
## Typical Performance – 0.96 – 1.215 GHz EVB at 25 °C [1]

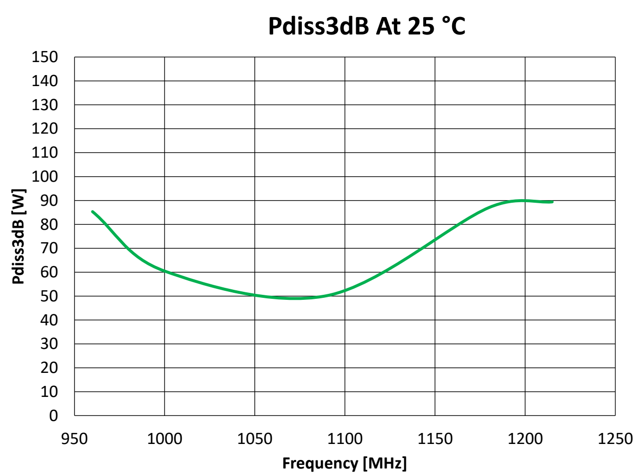
Notes:

1. Pulsed signal with 128 uS pulse width and 10 % duty cycle, Vd = 50 V, $I_{DQ}$ = 260 mA



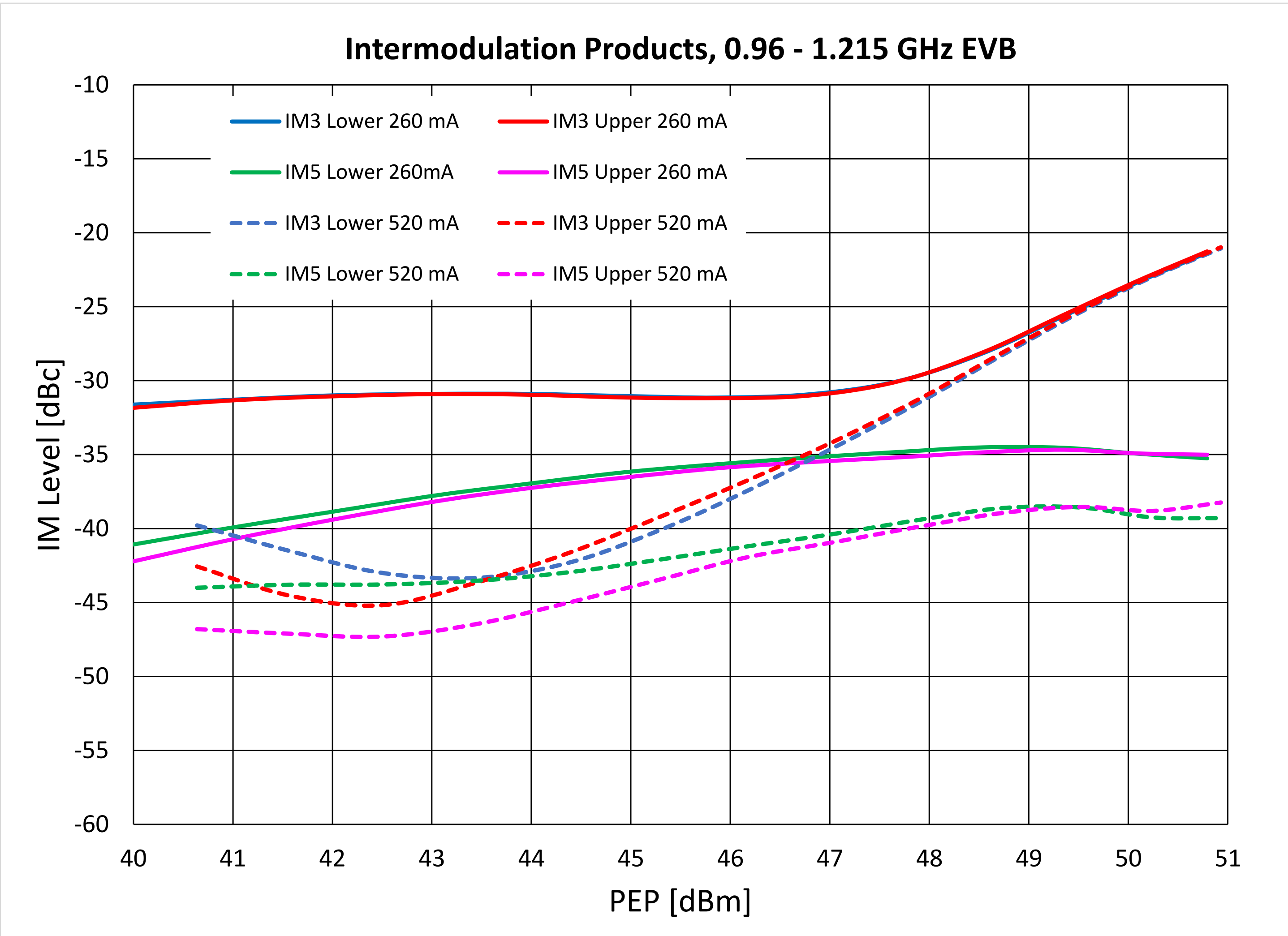



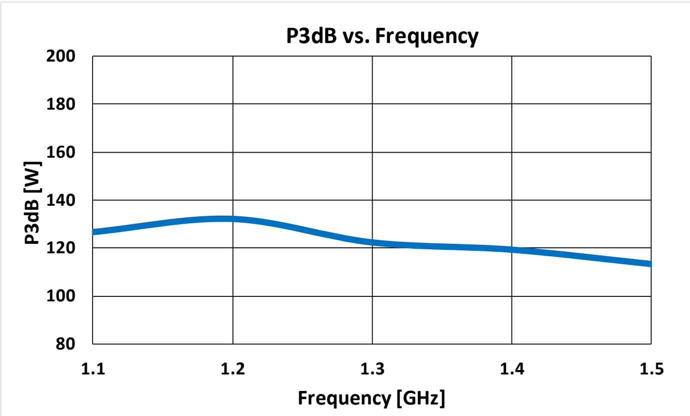
## Typical 2-Tone Performance – 0.96 – 1.215 GHz EVB at 25 °C [1]

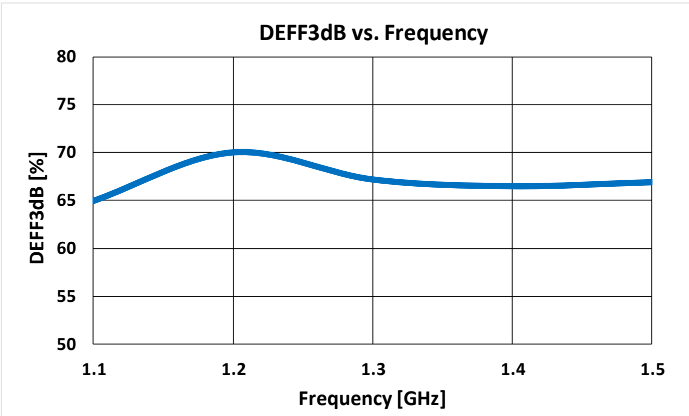
Notes:
1. Center Frequency = 1.095 GHz, Tone Spacing = 10 MHz, $I_{DQ}$ = 260 mA and 520 mA.

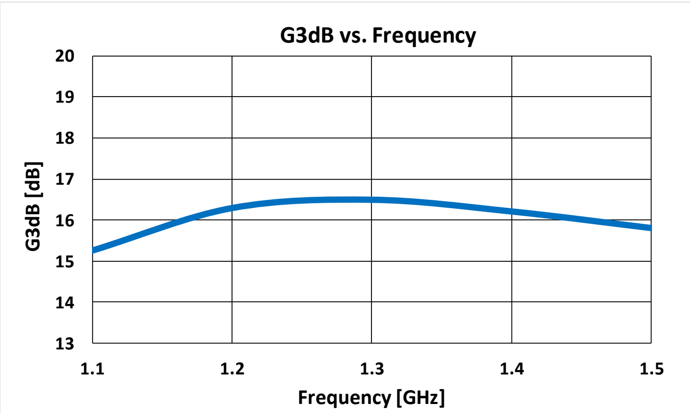


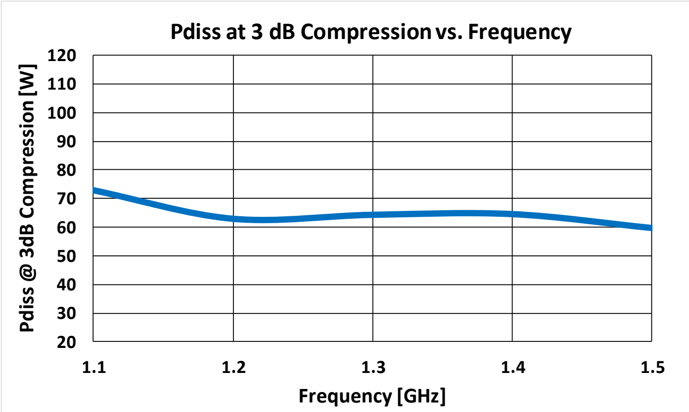
## Typical Performance – 1.1 – 1.5 GHz EVB at 25 °C [1]

Notes:
1. Pulsed signal with 128 uS pulse width and 10 % duty cycle, Vd = 50 V, $I_{DQ}$ = 260 mA.

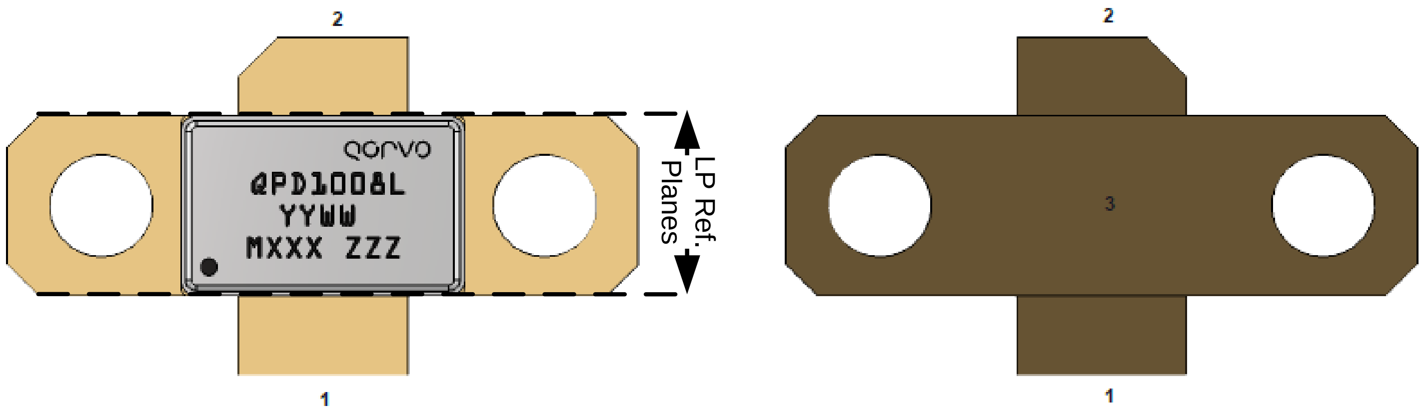


## Pin Layout[1]

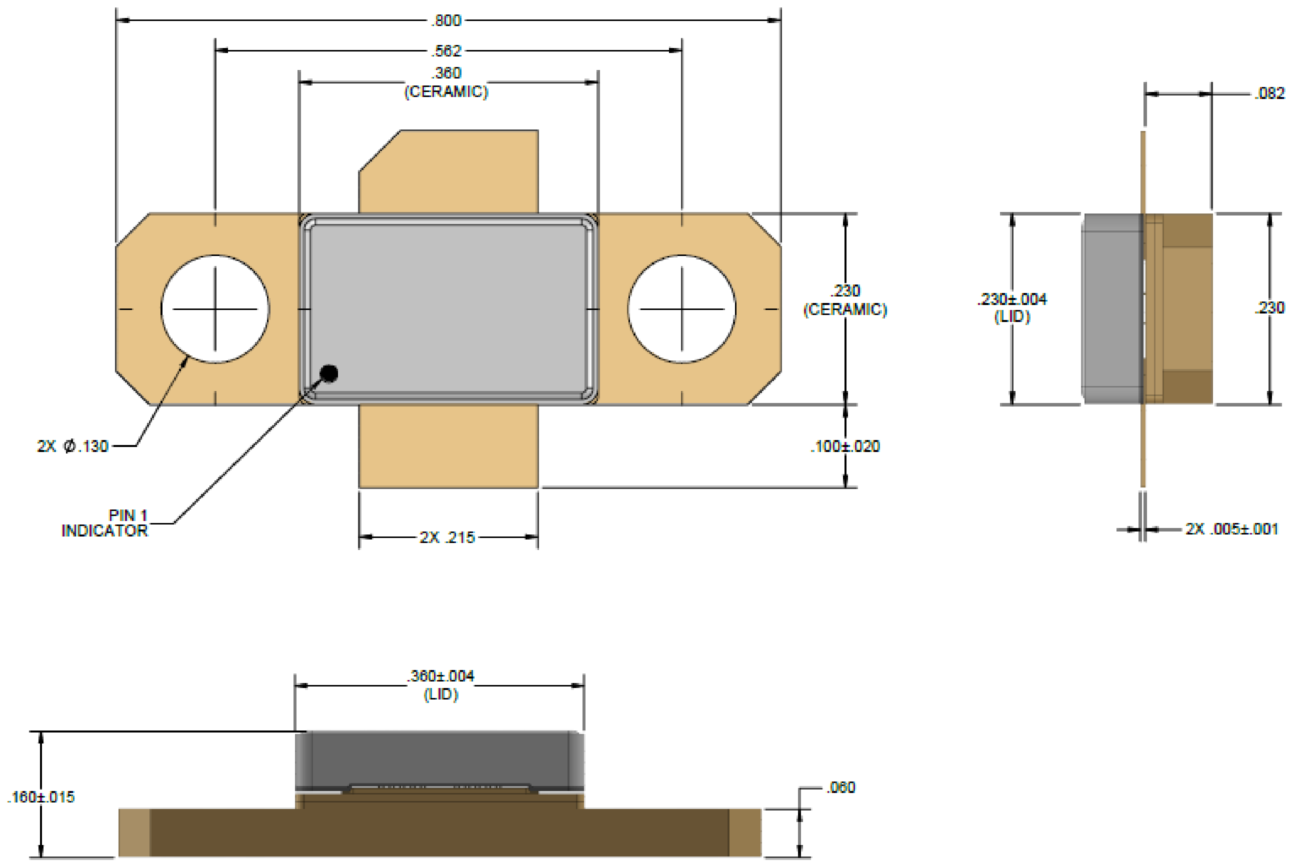



Notes:
1. The QPD1008L will be marked with the "QPD1008L" designator and a lot code marked below the part designator. The "YY" represents the last two digits of the calendar year the part was manufactured, the "WW" is the work week of the assembly lot start, the "MXXX" is the production lot number, and the "ZZZ" is an auto-generated serial number.

## Pin Description

| Pin | Symbol | Description |
|---|---|---|
| 1 | VG / RF IN | Gate voltage / RF Input |
| 2 | VD / RF OUT | Drain voltage / RF Output |
| 3 | Flange | Source to be connected to ground |

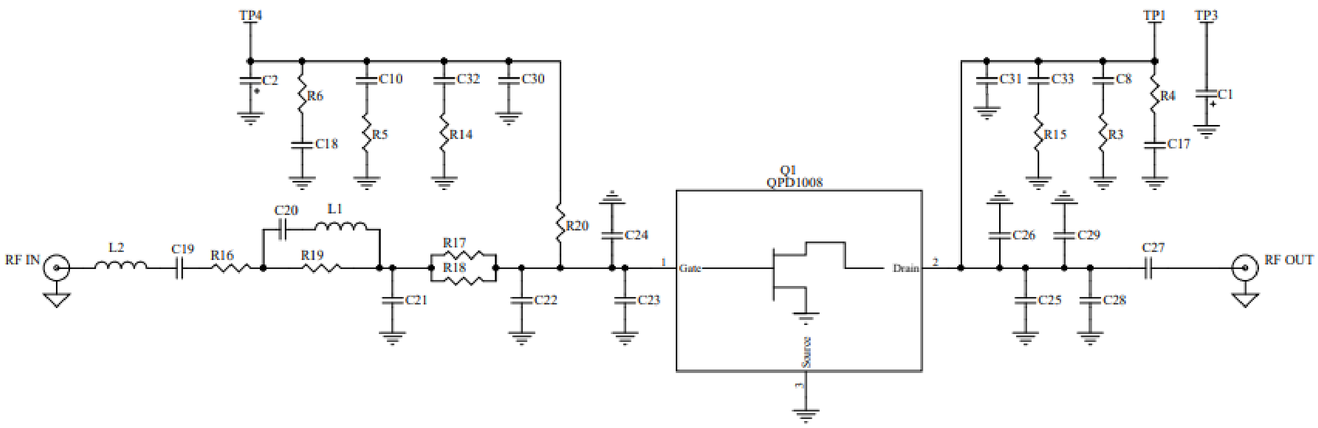
## Mechanical Drawing[1]




Note 1:

1. All dimensions are in inches. Angles are in degrees.
2. Dimension tolerance is ± 0.005 inches, unless otherwise noted.
3. Material:
   Package Base: Ceramic / Metal
   Package Lid: Ceramic
4. Package exposed metallization is gold plated.
5. Part is epoxy sealed.
6. Part meets industry NI360 footprint.
7. Body dimensions do not include epoxy runout which can be up to 0.020 inches per side.

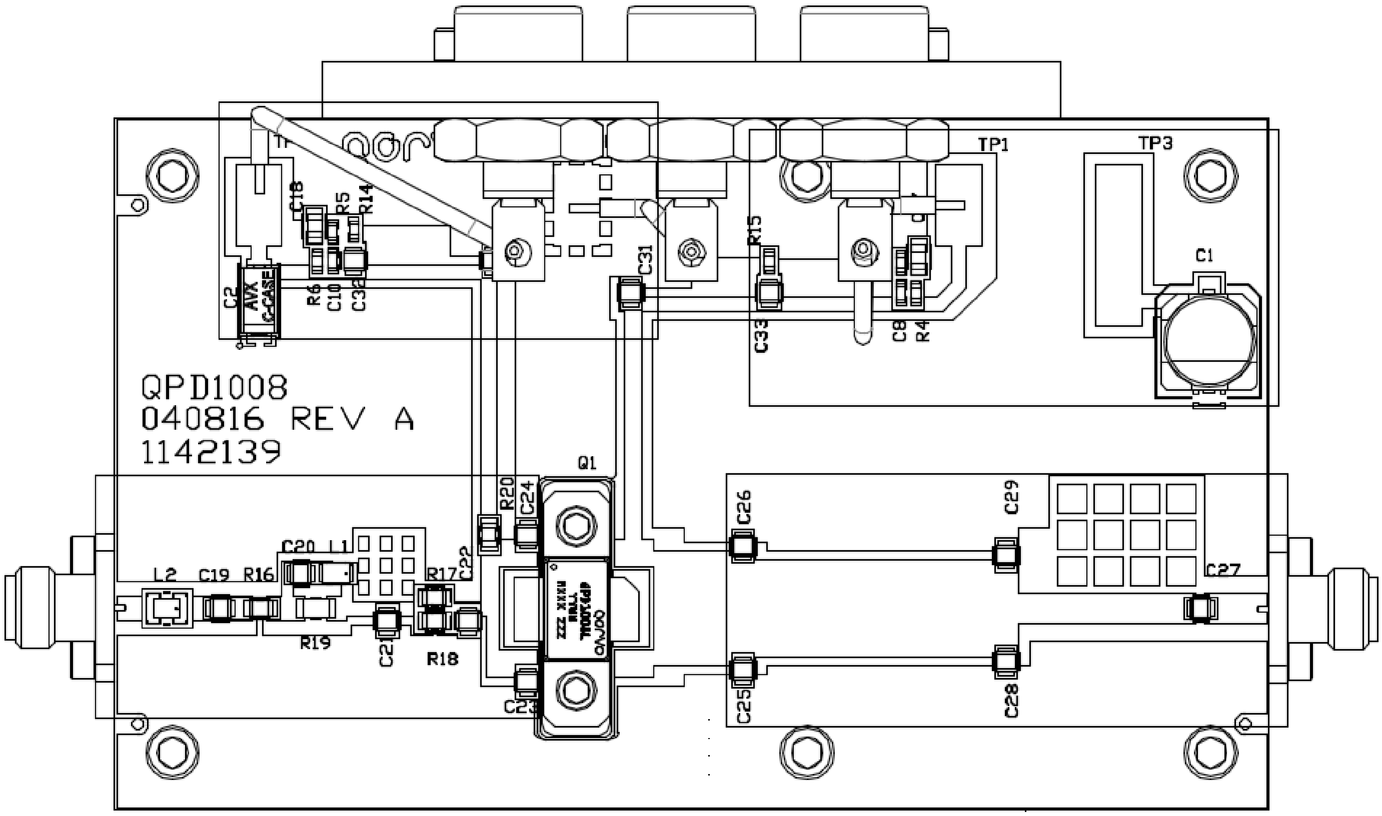
## 0.96 – 1.215 GHz Application Circuit - Schematic




| Bias-up Procedure | Bias-down Procedure |
|---|---|
| 1. Set $V_G$ to -4 V. | 1. Turn off RF signal. |
| 2. Set $I_D$ current limit to 300 mA. | 2. Turn off $V_D$ |
| 3. Apply 50 V $V_D$. | 3. Wait 2 seconds to allow drain capacitor to discharge |
| 4. Slowly adjust $V_G$ until $I_D$ is set to 260 mA. | 4. Turn off $V_G$ |
| 5. Set $I_D$ current limit to 0.6 A (Pulsed operation) | |
| 6. Apply RF. | |

## 0.96 – 1.215 GHz Application Circuit - Layout

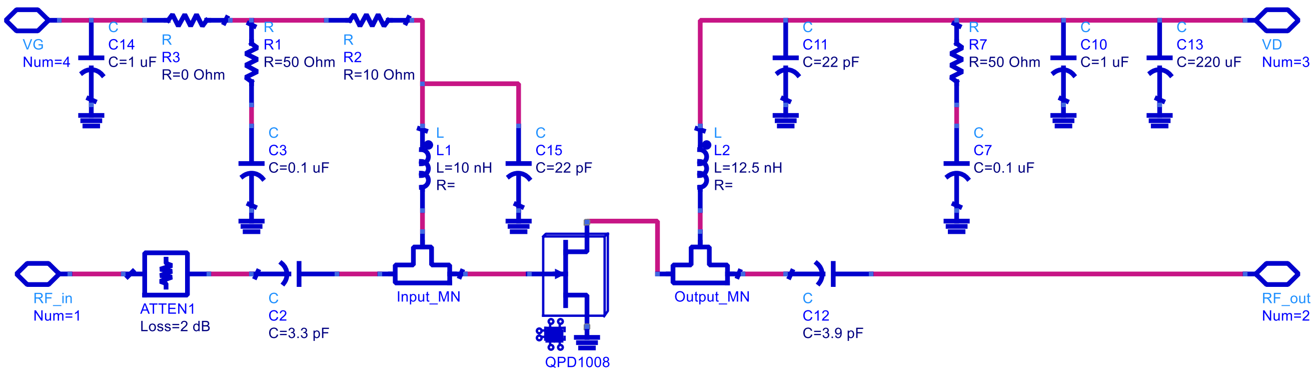
Board material is RO4360G2 0.032” thickness with 1oz copper cladding.



## 0.96 – 1.215 GHz Application Circuit - Bill Of material

| Ref Des | Value | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| C8, 10 | 1 nF | X7R 100V 5% 0603 Capacitor | AVX | 06031C102JAT2A |
| C17 - 18 | 100 nF | X7R 100V 5% 0805 Capacitor | AVX | 08051C104JAT2A |
| C28 - 29 | 2 pF | RF NPO 250VDC ± 0.1 pF Capacitor | AVX | 800A2R0BT250XT |
| C23 – 24 | 2.4 pF | RF NPO 250VDC ± 0.1 pF Capacitor | AVX | 800A2R4BT250XT |
| C20 | 3.0 pF | RF NPO 250VDC ± 0.1 pF Capacitor | AVX | 800A3R0BT250X |
| C21 | 4.7pF | RF NPO 250VDC ± 0.1 pF Capacitor | AVX | 800A4R7BT250XT |
| C25, 26 | 6.2 pF | RF NPO 250VDC ± 0.1 pF Capacitor | Passive Plus | 0505C6R2BW301X |
| C22 | 13 pF | RF NPO 250VDC 1% Capacitor | AVX | 800A100FT250X |
| C19, 27, 30, 31 | 56 pF | RF NPO 250VDC 1% Capacitor | Passive Plus | 0505C560FW151X |
| C32, 33 | 100 pF | RF NPO 250VDC 1% Capacitor | Passive Plus | 0505C101FW151X |
| C1 | 33 uF | RF NPO 250VDC 1% Capacitor | Panasonic | 63SXV33M |
| C2 | 10 uF | RF NPO 250VDC 1% Capacitor | AVX | TPSC106KR0500 |
| J1 - 2 | | SMA Panel Mount 4-hole Jack | Gigalane | PSF-S00-000 |
| L1 | 5.6 nH | 0805 5% Inductor | Coilcraft | 0805CS-050XJE |
| L2 | 4.1 nH | 0805 5% Inductor | Coilcraft | 1008HQ-4N1X-LB |
| R4, 6 | 1 Ohm | 0603 Thick Film Resistor | ANY | |
| R5 | 3.3 Ohm | 0603 Thick Film Resistor | ANY | |
| R14, 15 | 5.1 Ohm | 0603 Thick Film Resistor | ANY | |
| R16 | 4.0 Ohm | 0805CS High Power Thick Film Resistor | | ND3-0805CS4R00J |
| R3 | 33 Ohm | 0603 Thick Film Resistor | ANY | |
| R20 | 3.9 Ohm | 0805 Thick Film Resistor | ANY | |
| R17, 18 | 7 Ohm | 0805CS High Power Thick Film Resistor | IMS | ND3-0805CS7R00J |
| R19 | 510 Ohm | 1206 Thick Film Resistor | ANY | |

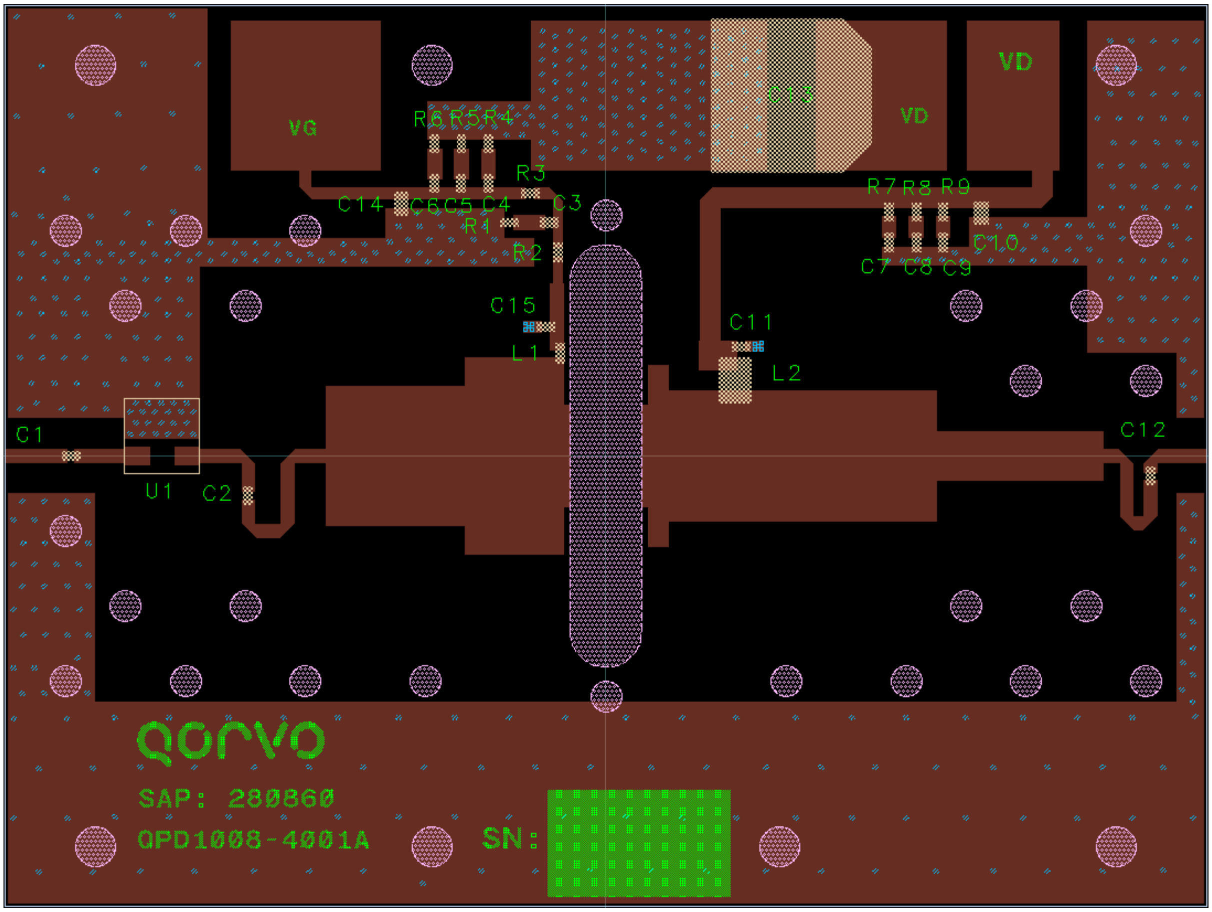
## 1.1 – 1.5 GHz Application Circuit - Schematic




| Bias-up Procedure | Bias-down Procedure |
|---|---|
| 2. Set $V_G$ to -4 V. | 3. Turn off RF signal. |
| 4. Set $I_D$ current limit to 300 mA. | 4. Turn off $V_D$ |
| 5. Apply 50 V $V_D$. | 5. Wait 2 seconds to allow drain capacitor to discharge |
| 6. Slowly adjust $V_G$ until $I_D$ is set to 260 mA. | 7. Turn off $V_G$ |
| 8. Set $I_D$ current limit to 0.6 A (Pulsed operation) | |
| 9. Apply RF. | |

## 1.1 – 1.5 GHz Application Circuit - Layout

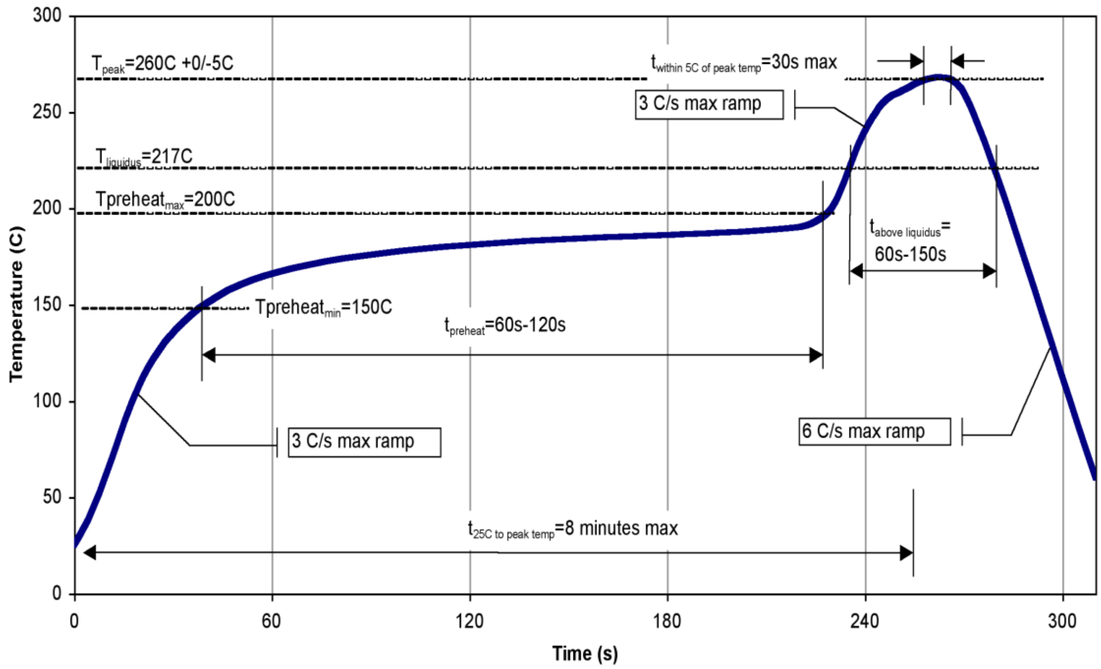
Board material is RO4360G2 0.032" thickness with 1oz copper cladding.  EVB dimension is 3" x 4".




## 1.1 – 1.5 GHz Application Circuit - Bill Of material

| Ref Des | Value | Quantity | Part Number | Manufacturer |
|---|---|---|---|---|
| C1 | 100 pF | 1 | 0603G101J201S | Capax |
| C2 | 3.3 pF | 1 | 600S3R3AT250XT | ATC |
| C12 | 3.9 pF | 1 | 600S3R9AT250XT | ATC |
| C11, C15 | 22 pF | 2 | 600S220FT250XT | ATC |
| C3, C7 | 0.1 uF | 2 | GRM188R72A104KA35D | Murata |
| C10, C14 | 1 uF | 2 | C2012X7S2A105M125AB | TDK |
| C13 | 100 uF, 63 V | 1 | EEETG1J101UP | Panasonic |
| R1, R7 | 50 Ohm | 2 | CRCW060350R0FKEA-ND | Vishay |
| R2 | 10 Ohm | 1 | CRCW060310R0JNEA | Vishay |
| L1 | 10 nH | 1 | 0603CS-10NXJEW | Coilcraft |
| L2 | 12.5 nH | 1 | A04TJLC | Coilcraft |
| U1 | 2dB Atten. | 1 | RFP-250250-4AA2-1 | Anaren |

## Recommended Solder Temperature Profile



## Handling Precautions

| Parameter | Rating | Standard |
|---|---|---|
| ESD – Human Body Model (HBM) | Class 1A | ANSI/ESD/JEDEC JS-001 |
| ESD – Charged Device Model (CDM) | Class C3 | ANSI/ESD/JEDEC JS-002 |
| MSL – Moisture Sensitivity Level | MSL3 | IPC/JEDEC J-STD-020 |

Caution!
ESD-Sensitive Device

## Solderability

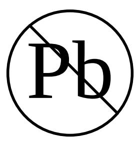
Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes.
Solder profiles available upon request.

Contact plating: NiAu. Au thickness is 60 microinches minimum.

## 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 ($C_{15}H_{12}Br_{4}0_{2}$) 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**

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