# QPD1016L

**DC – 1.7 GHz, 50 V, 500 W GaN RF Transistor**

## Product Overview

The Qorvo QPD1016L is a 500 W ($P_{3dB}$) pre-matched discrete GaN on SiC HEMT which operates from DC to 1.7 GHz and 50 V supply. The device is in an industry standard air cavity package and is ideally suited for IFF, avionics, military and civilian radar, and test instrumentation. The device can support pulsed and linear operations.

ROHS compliant.

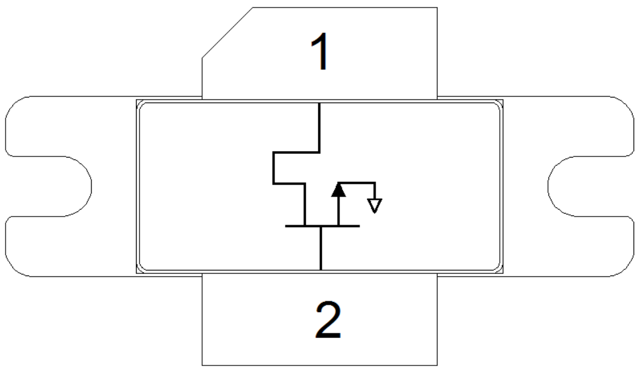
Evaluation boards are available upon request.


NI-780 Package

## Key Features

- Frequency: DC to 1.7 GHz
- Output Power ($P_{3dB}$): 537 W
- Linear Gain: 18 dB
- Typical Drain Efficiency at 3 dB compresion: 67%
- Operating Voltage: 50 V
- CW and Pulse capable

## Functional Block Diagram




## Applications

- IFF
- Avionics
- Military and civilian radar
- Test instrumentation

## Ordering info

| Part No. | Description |
|---|---|
| QPD1016L | DC – 1.7 GHz, 50 V, 500 W GaN RF Transistor |
| QPD1016LS1 | Sample bag – 1 piece |
| QPD1016LS2 | Sample bag – 2 piece |
| QPD1016LEVB01 | 1.2 – 1.4 GHz EVB |

## Absolute Maximum Ratings[1,2]

| Parameter | Rating | Units |
|---|---|---|
| Breakdown Voltage, $BV_{DG}$ | +145 | V |
| Gate Voltage Range, $V_G$ | -7 to +2 | V |
| Drain Current, $I_{DMAX}$ | 70 | A |
| Gate Current Range, $I_G$ | See page 17 | mA |
| Power Dissipation, $P_{DISS}$ | 714[2] | W |
| RF Input Power, Pulse, 1.3 GHz, T = 25 °C[2] | +45.5 | dBm |
| Mounting Temperature (30 Seconds) | 320 | °C |
| Storage Temperature | −65 to +150 | °C |

Notes:
1. Operation of this device outside the parameter ranges given above may cause permanent damage.
2. Pulsed 300 uS PW, 10% DC

## Recommended Operating Conditions[1]

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Drain Voltage Range, $V_D$ | | 50 | | V |
| Drain Bias Current, $I_{DQ}$ | | 1000 | | mA |
| Gate Voltage, $V_G$ | – | −2.8 | – | V |

Notes:
1. Electrical performance is measured under conditions noted in the electrical specifications table. Specifications are not guaranteed over all recommended operating conditions.

## Measured Load Pull Performance – Power Tuned [1,2]

| Parameter | Typical Values | | | | | | Units |
|---|---|---|---|---|---|---|---|
| Frequency, F | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.7 | GHz |
| Drain Voltage, $V_D$ | 50 | 50 | 50 | 50 | 50 | 50 | V |
| Drain Bias Current, $I_{DQ}$ | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | mA |
| Output Power at 3dB compression, $P_{3dB}$ | 58.8 | 58.6 | 58.3 | 58 | 57.6 | 58 | dBm |
| Power Added Efficiency at 3dB compression, $PAE_{3dB}$ | 71.7 | 69.2 | 72.2 | 76.1 | 69.9 | 71.2 | % |
| Gain at 3dB compression, $G_{3dB}$ | 21.0 | 20.6 | 20.9 | 21.7 | 21.0 | 20.6 | dB |

Notes:
1. Pulsed, 300 uS Pulse Width, 10% Duty Cycle
2. Characteristic Impedance, Zo = 3 Ω.

## Measured Load Pull Performance – Efficiency Tuned [1,2]

| Parameter | Typical Values | | | | | | Units |
|---|---|---|---|---|---|---|---|
| Frequency, F | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.7 | GHz |
| Drain Voltage, $V_D$ | 50 | 50 | 50 | 50 | 50 | 50 | V |
| Drain Bias Current, $I_{DQ}$ | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | mA |
| Output Power at 3dB compression, $P_{3dB}$ | 57.6 | 57.1 | 56.4 | 57.3 | 56.1 | 56.7 | dBm |
| Power Added Efficiency at 3dB compression, $PAE_{3dB}$ | 79.2 | 78.3 | 77.4 | 77.8 | 71.2 | 73.5 | % |
| Gain at 3dB compression, $G_{3dB}$ | 22.2 | 22.1 | 22.2 | 22.3 | 21.7 | 21.7 | dB |

Notes:
1. Pulsed, 300 uS Pulse Width, 10% Duty Cycle
2. Characteristic Impedance, Zo = 3 Ω.

## 1.2 – 1.4 GHz EVB 1.3 GHz Performance [1,2]

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Linear Gain, $G_{LIN}$ | – | 18.0 | – | dB |
| Output Power at 3dB compression point, P3dB | – | 57.3 | – | dBm |
| Drain Efficiency at 3dB compression point, DEFF3dB | – | 67.3 | – | % |
| Gain at 3dB compression point, G3dB | – | 15.0 | – | dB |
| Gate Leakage ($V_D$ = 10V , $V_G$ = -3.3V ) | -40 | | | mA |

Notes:
1. $V_D$ = +50 V, $I_{DQ}$ = 1000 mA, Temp = +25 °C, Pulse Width = 300 uS, Duty Cycle = 10%
2. Performance at 1.3 GHz in a 1.2 to 1.4 GHz Evaluation Board

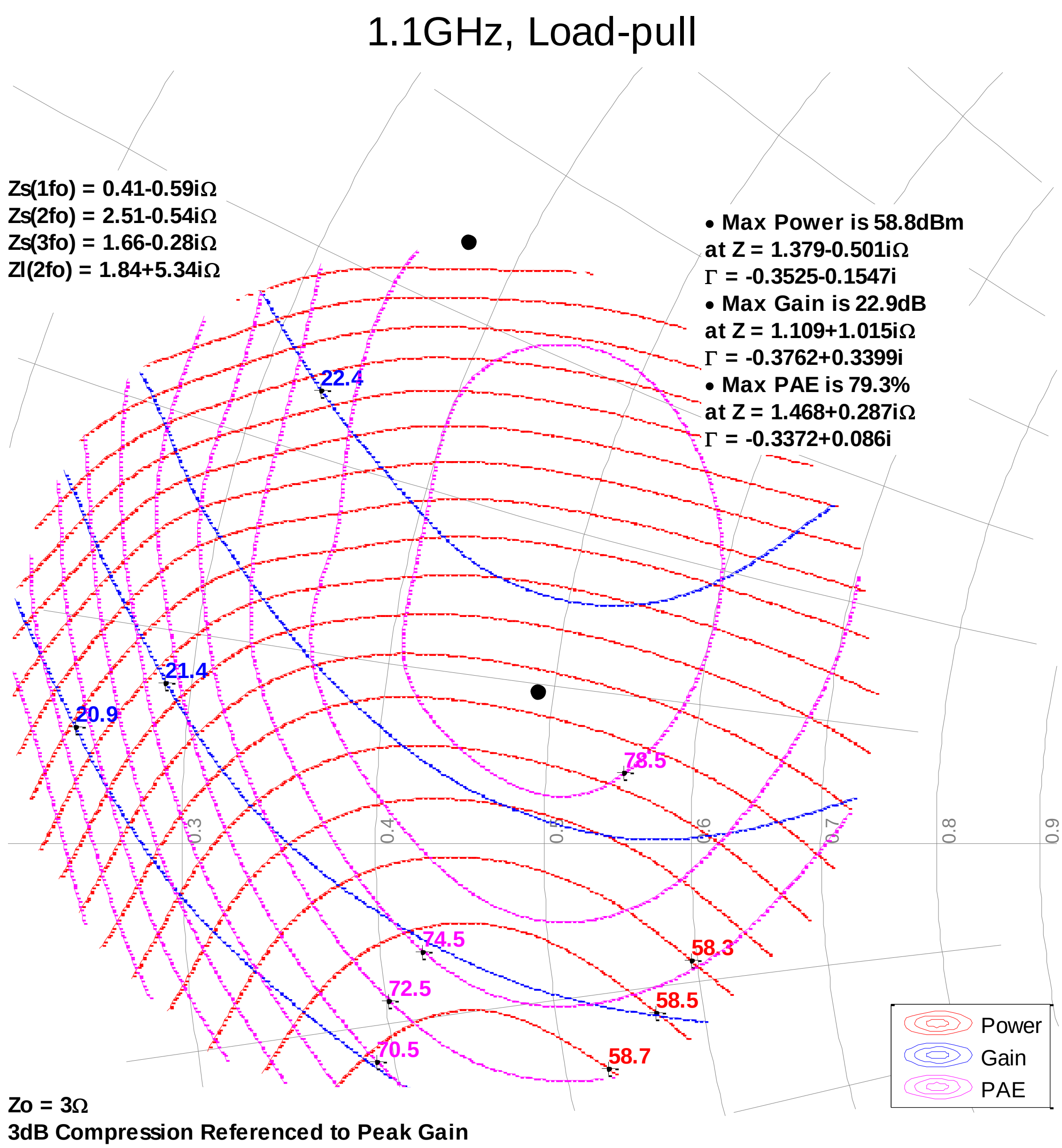
## RF Characterization – Mismatch Ruggedness at 1.3 GHz [1, 2]

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

Notes:
1. Test conditions unless otherwise noted: $T_A$ = 25 °C, $V_D$ = 50 V, $I_{DQ}$ = 1000 mA
2. Input drive power is determined at pulsed 3dB compression under matched condition at EVB output connector.

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

Notes:
1. Test Conditions: $V_D$ = 50 V, $I_{DQ}$ = 1000 mA, 300 uS Pulse Width, 10% Duty Cycle
2. See *"Pin Configuration and Description"* for load pull and source pull reference planes.



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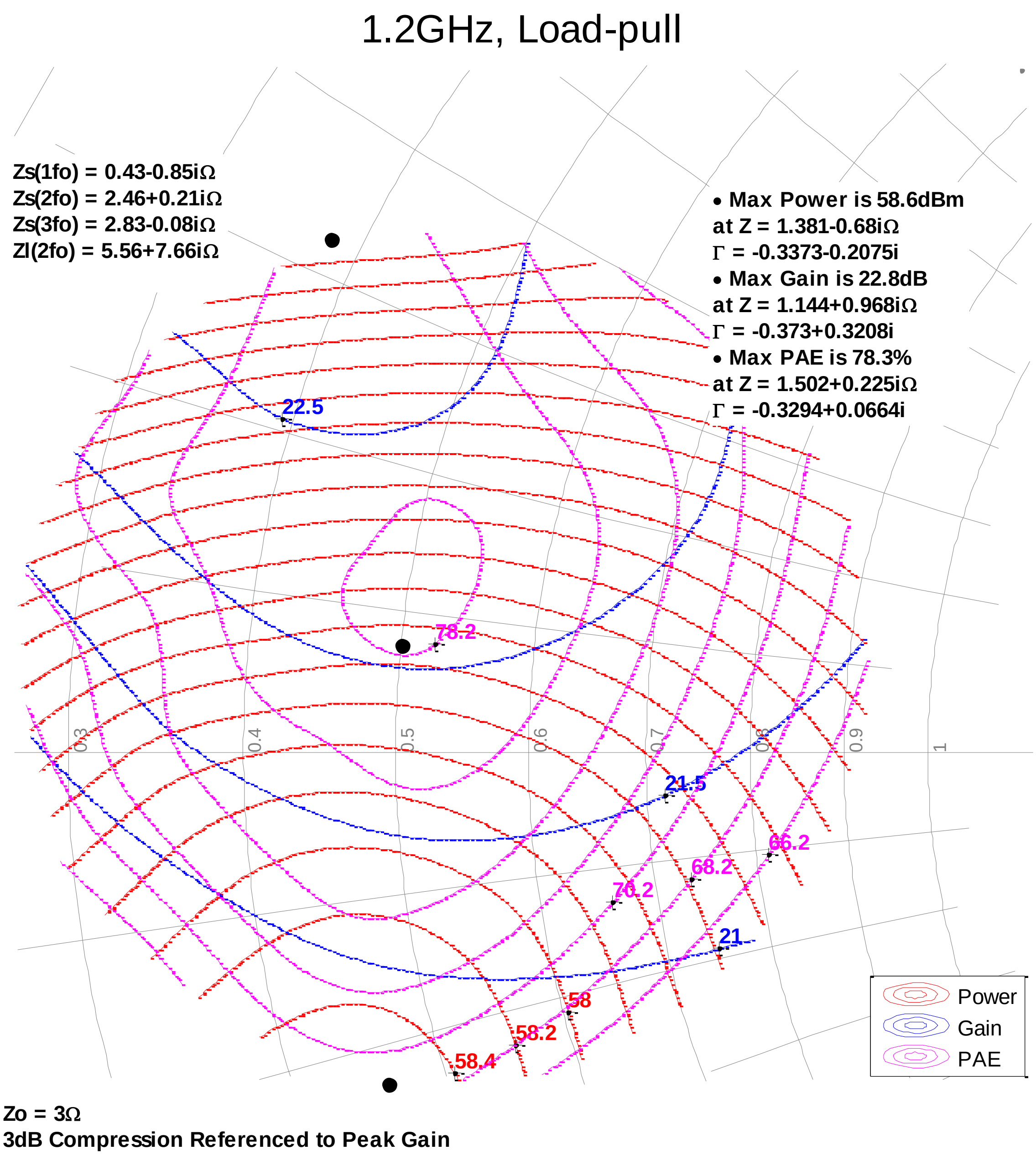

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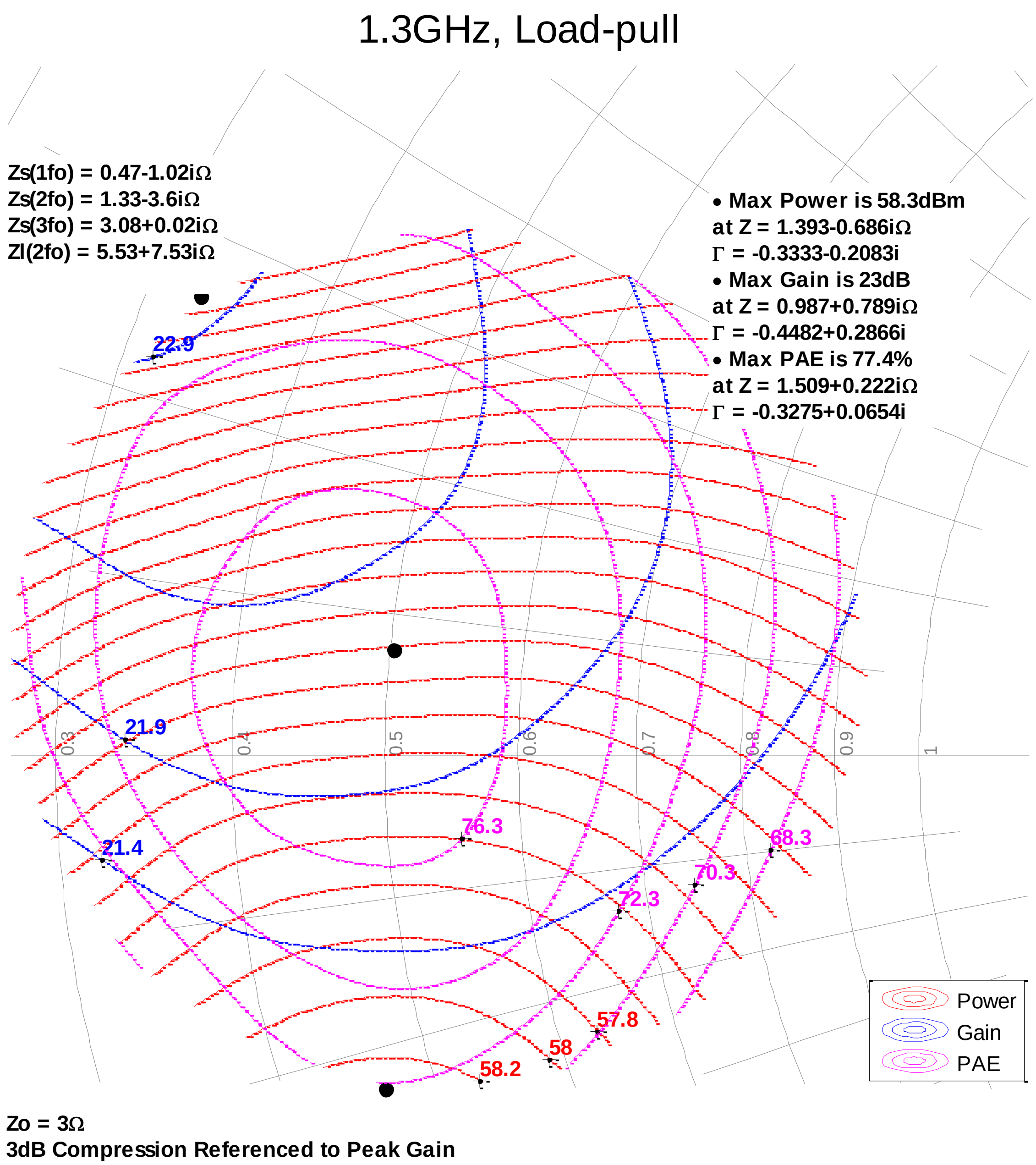

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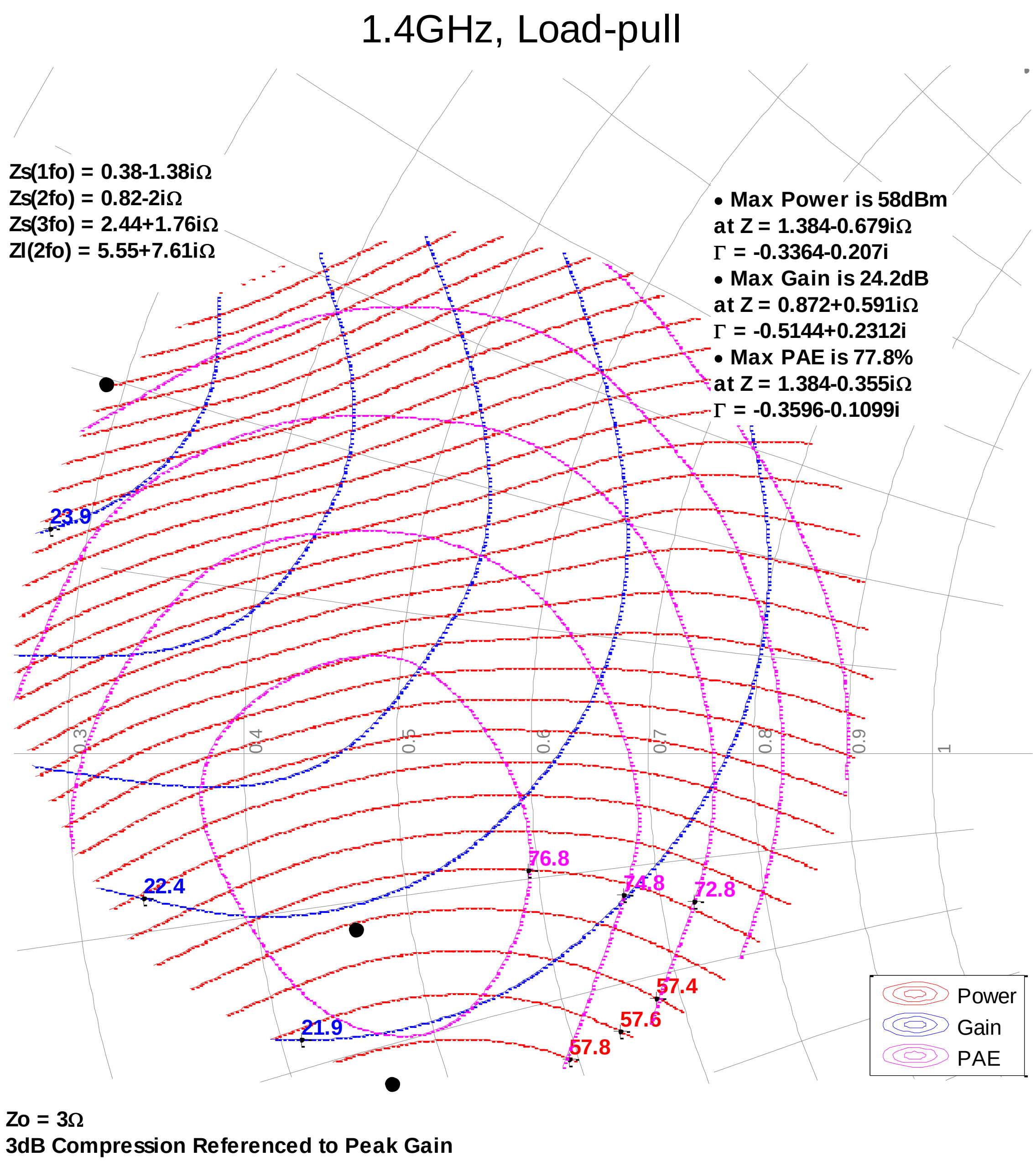

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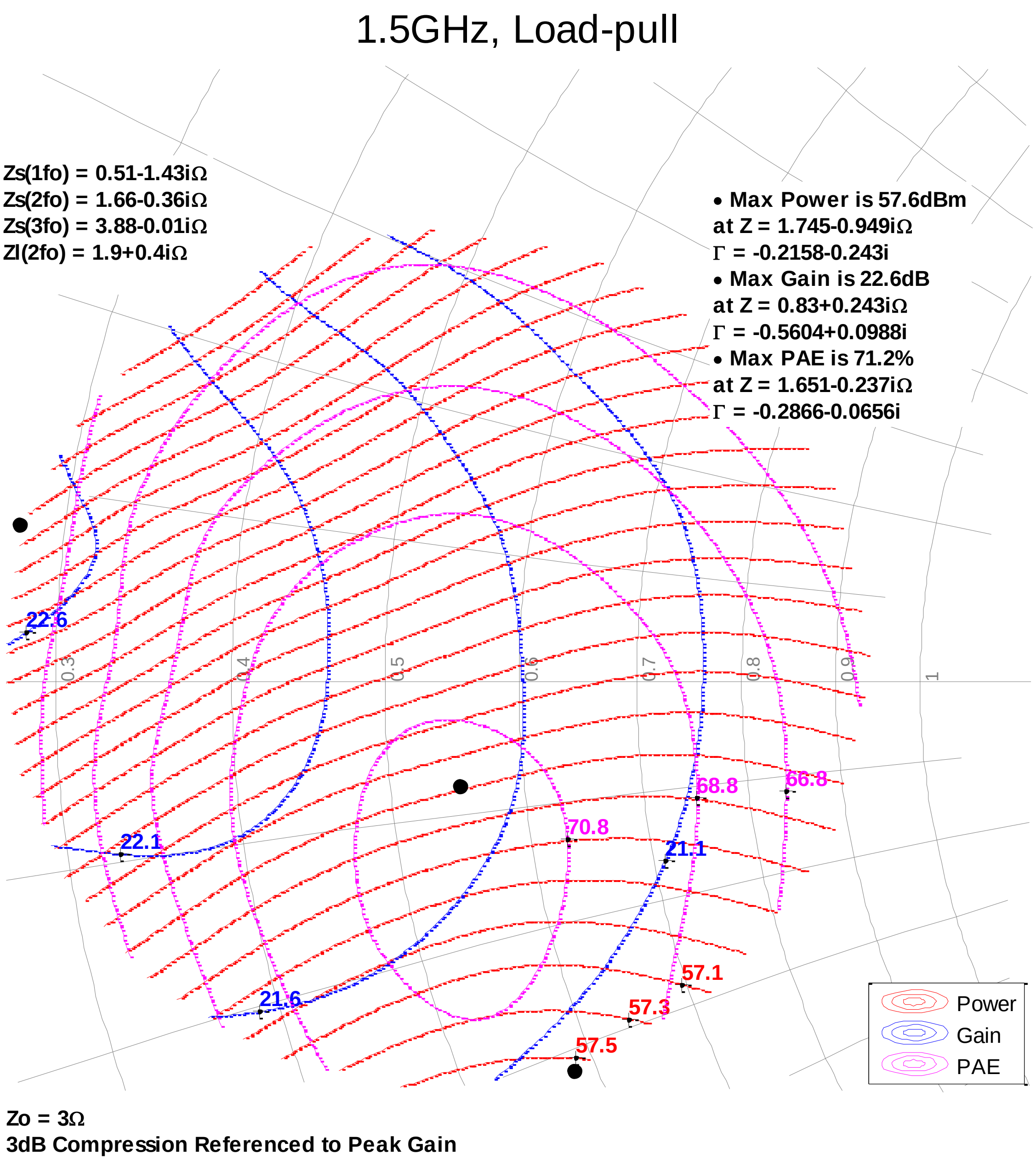

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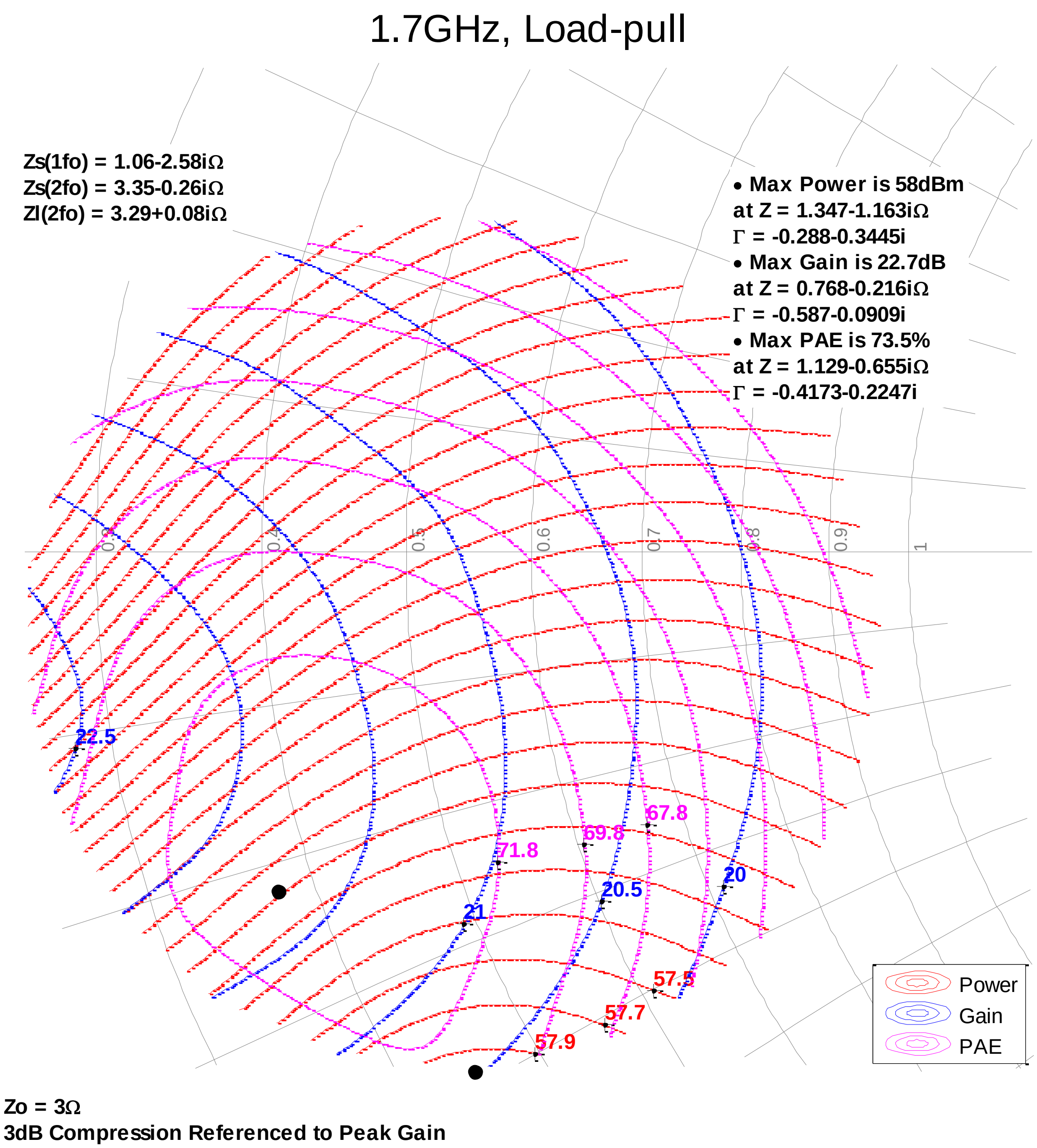

## Typical Measured Performance – Load-Pull Drive-up[1, 2]

Notes:
1. Test Conditions: $V_D$ = 50 V, $I_{DQ}$ = 1000 mA, 300 uS Pulse Width, 10% Duty Cycle
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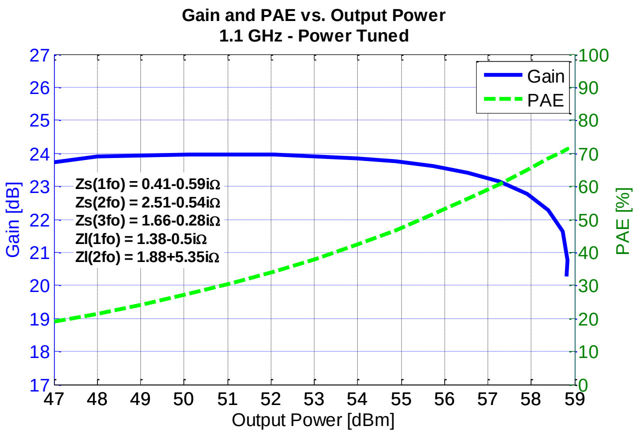


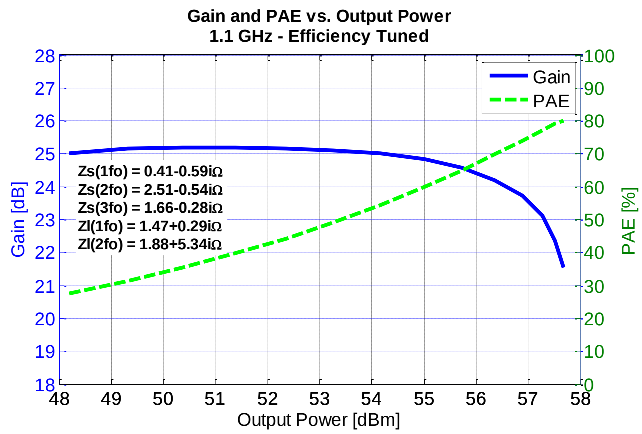


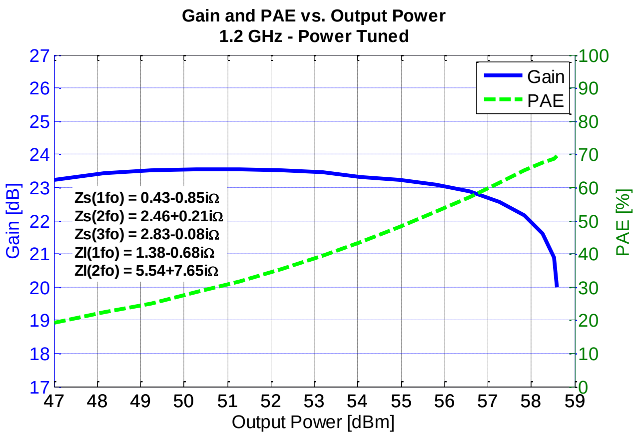


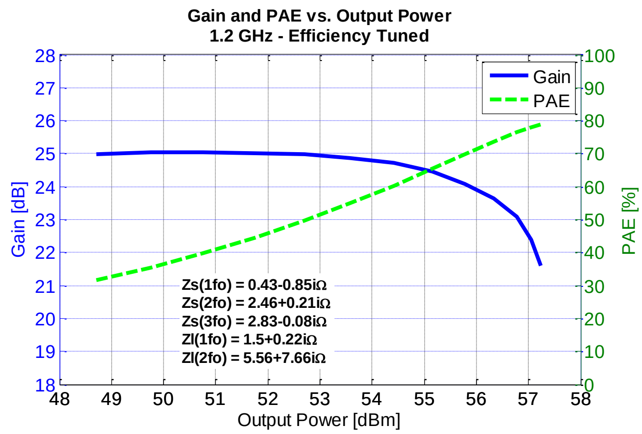

## Typical Measured Performance – Load-Pull Drive-up[1, 2]

Notes:

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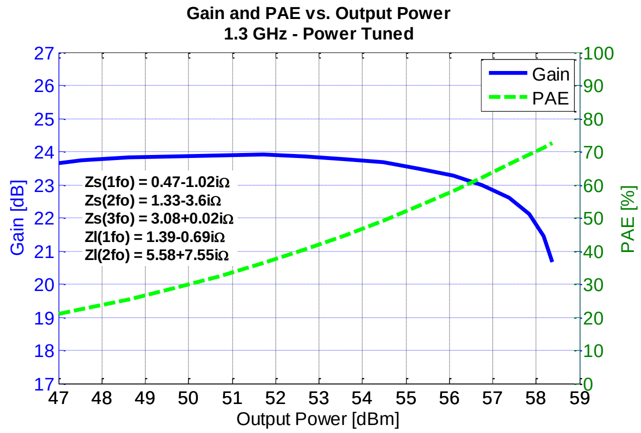
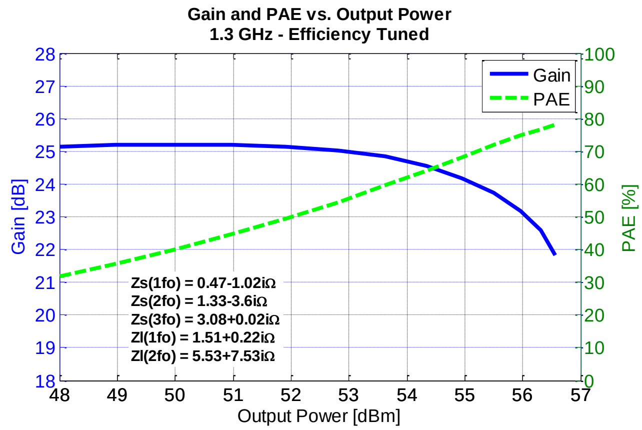
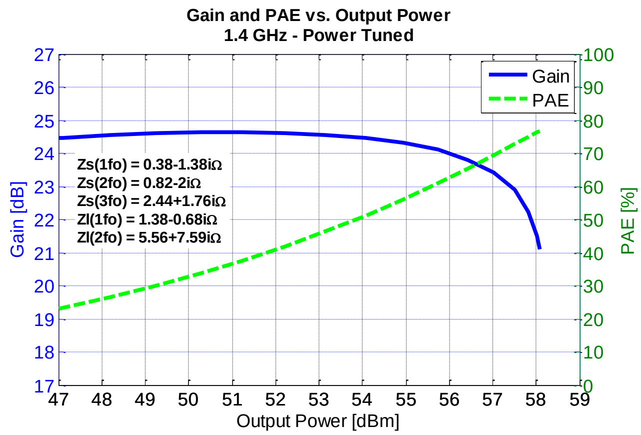
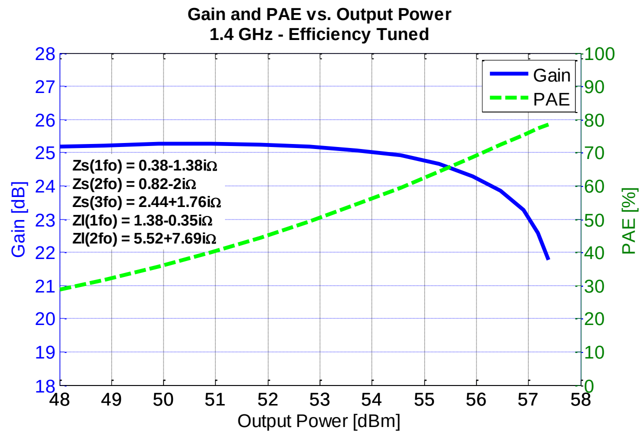
2. See *"Pin Configuration and Description"* for load pull and source pull reference planes.



## Typical Measured Performance – Load-Pull Drive-up[1, 2]

Notes:

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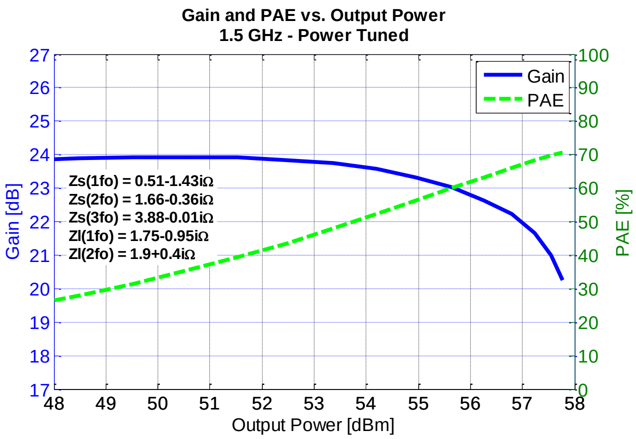
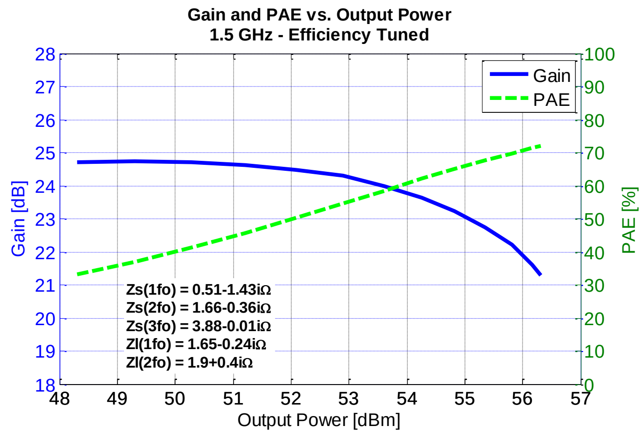
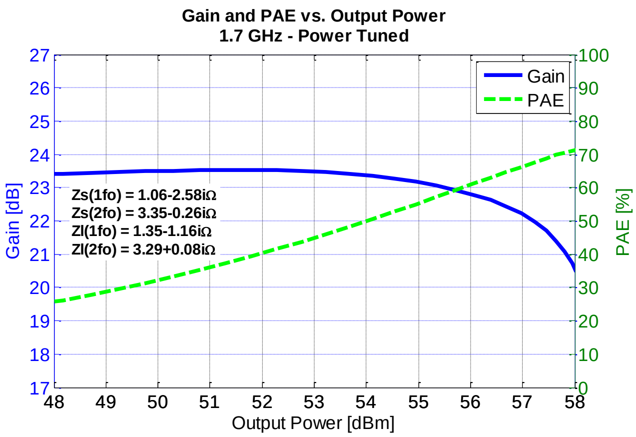
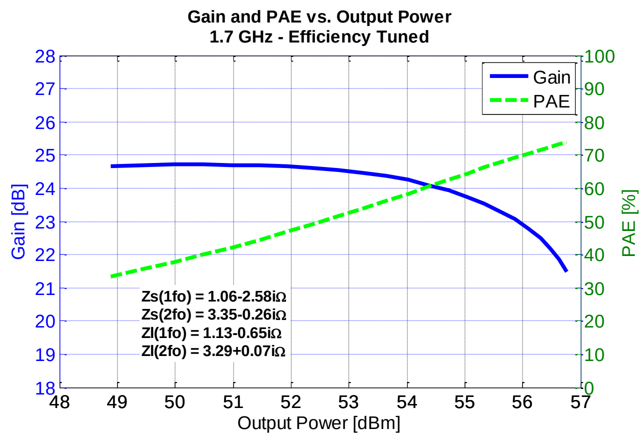


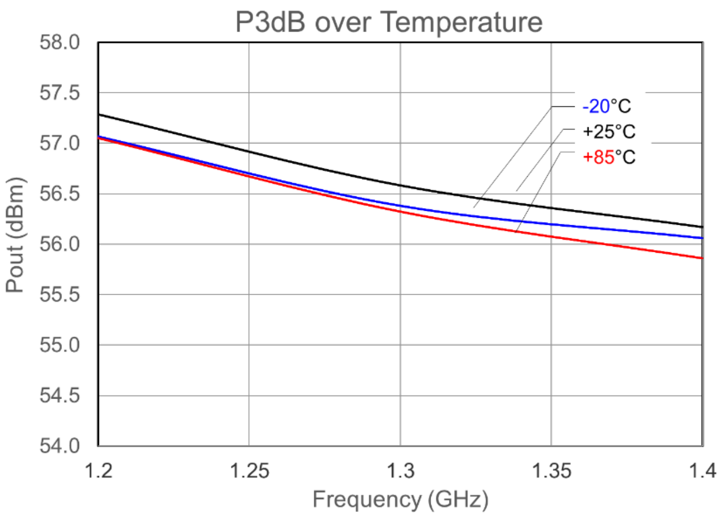



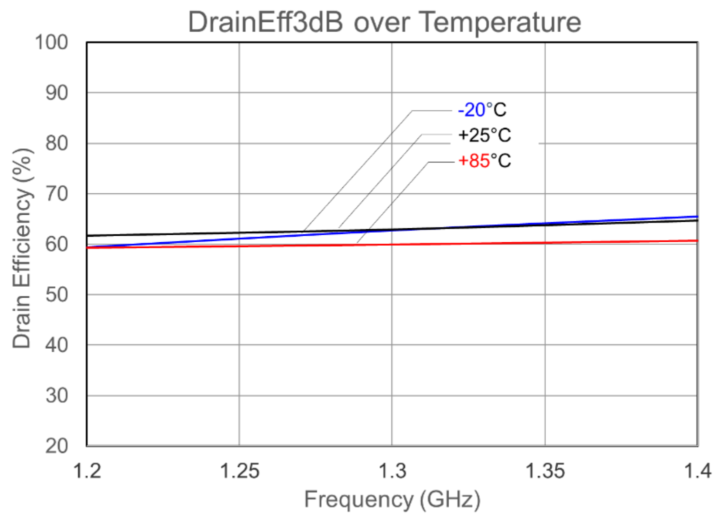



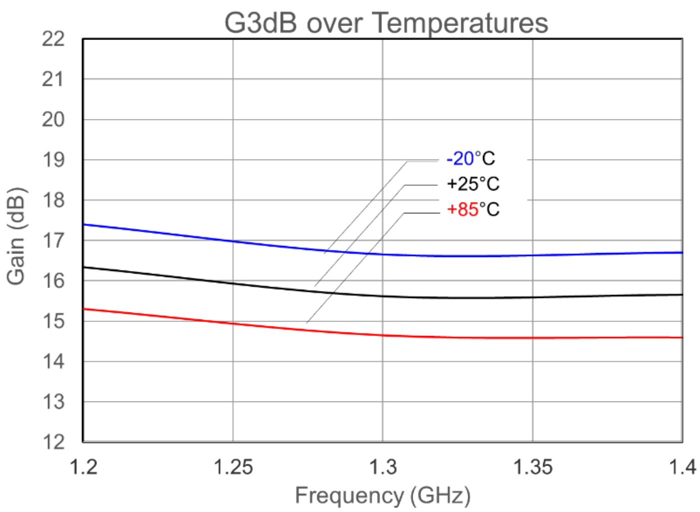
## Power Driveup Performance Over Temperatures Of 1.2 – 1.4 GHz EVB [1]

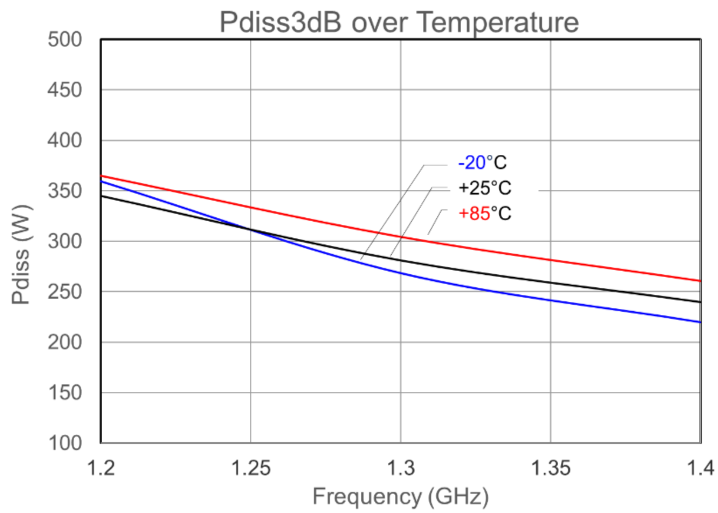
Notes:

1. Test Conditions: $V_D$ = 50 V, $I_{DQ}$ = 1000 mA, 300 uS Pulse Width, 10% Duty Cycle



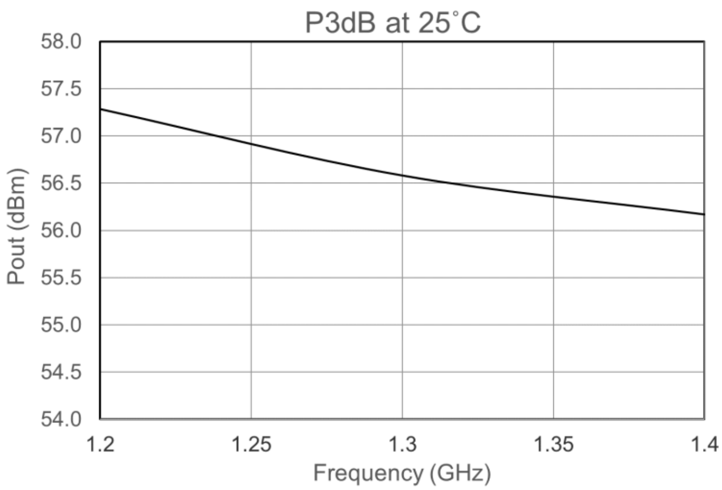



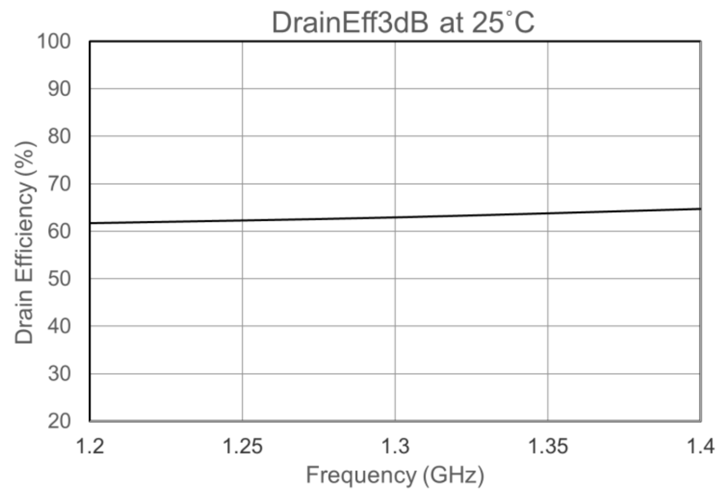



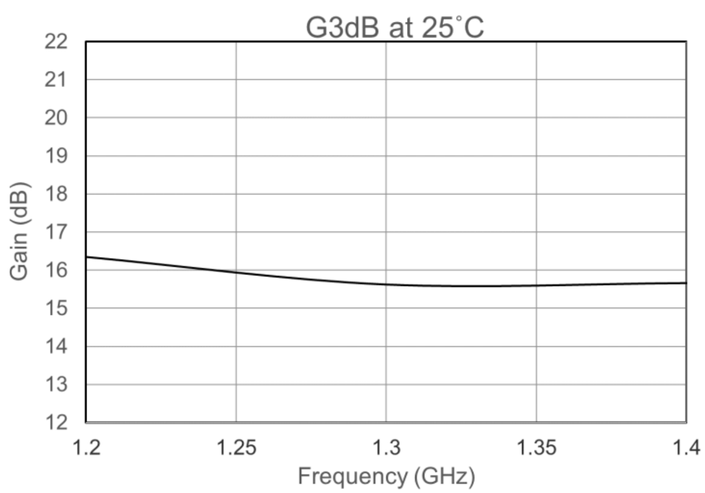



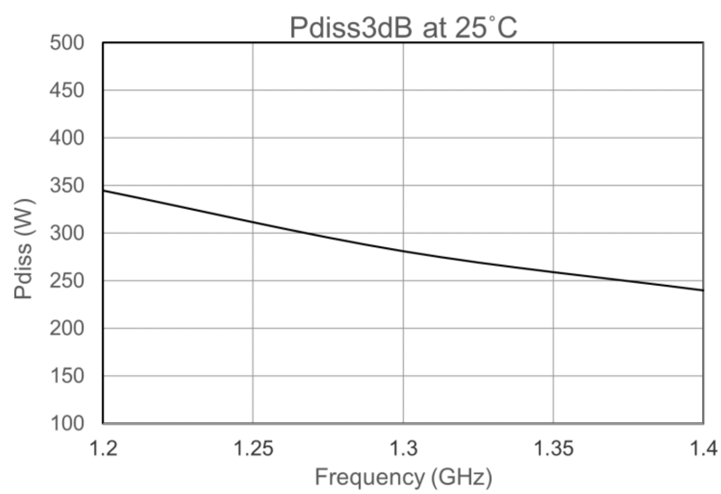
## Power Driveup Performance At 25°C Of 1.2 – 1.4 GHz EVB [1]

Notes:
1. Test Conditions: $V_D$ = 50 V, $I_{DQ}$ = 1000 mA, 300 uS Pulse Width, 10% Duty Cycle

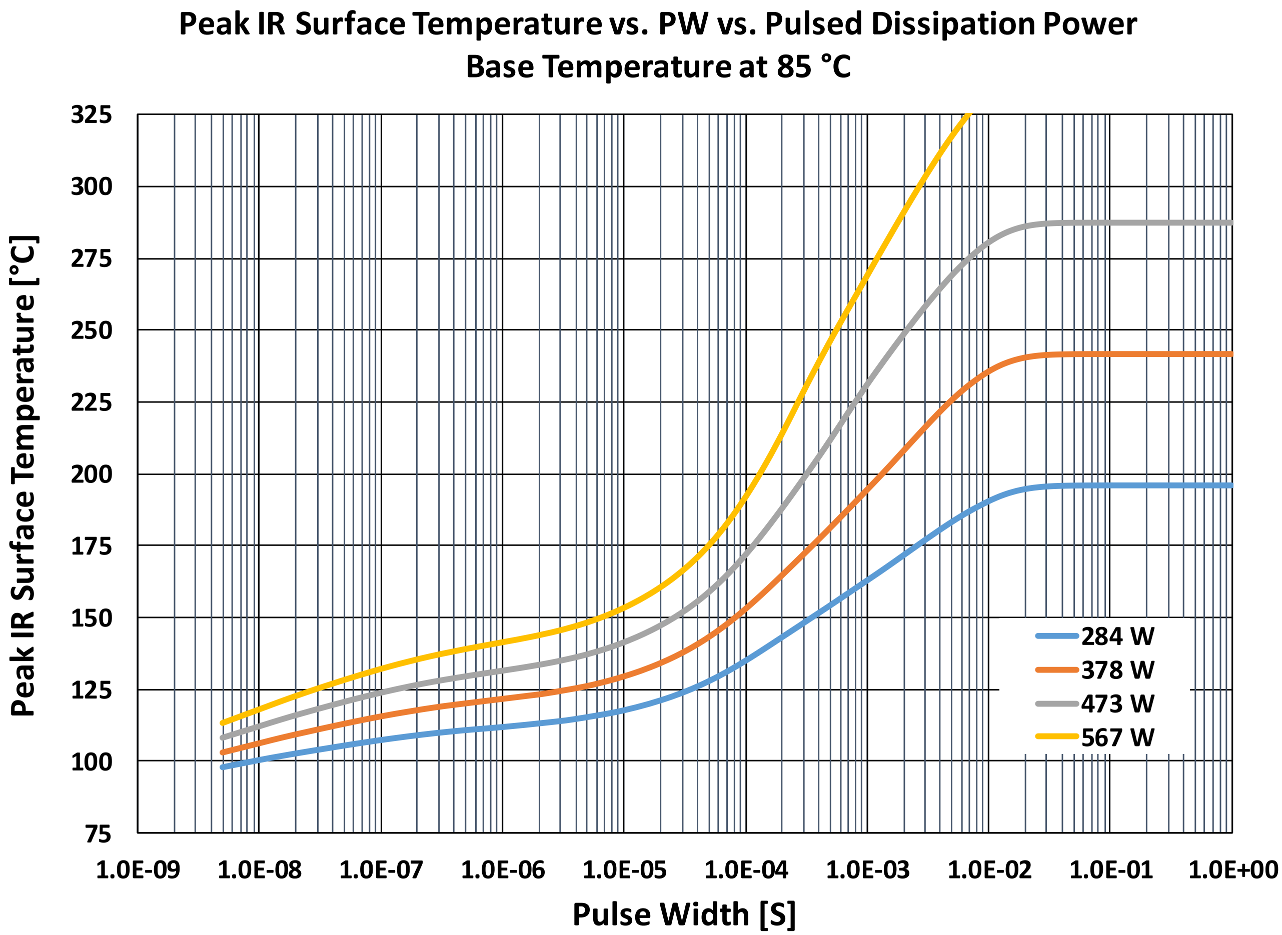


## Thermal and Reliability Information – Pulsed [1]

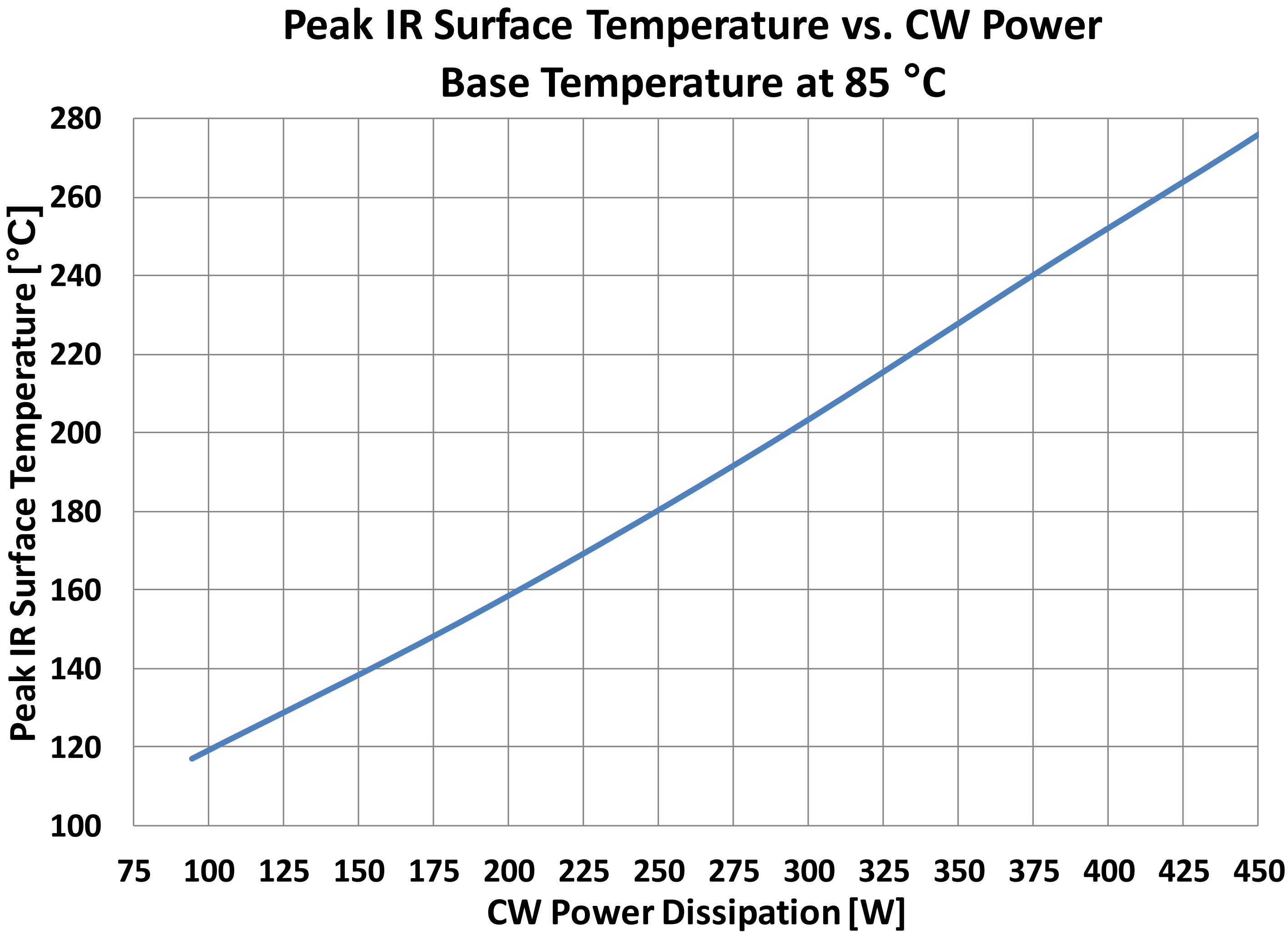



| Parameter[1] | Conditions | Values | Units |
|---|---|---|---|
| Thermal Resistance, IR ($\theta_{JC}$) | 85 °C Case<br>284 W Pdiss, 300 uS PW, 10% DC | 0.22 | °C/W |
| Peak Channel Temperature, IR ($T_{CH}$) | | 148 | °C |
| Thermal Resistance, IR ($\theta_{JC}$) | 85 °C Case<br>378 W Pdiss, 300 uS PW, 10% DC | 0.23 | °C/W |
| Peak Channel Temperature, IR ($T_{CH}$) | | 172 | °C |
| Thermal Resistance, IR ($\theta_{JC}$) | 85 °C Case<br>473 W Pdiss, 300 uS PW, 10% DC | 0.24 | °C/W |
| Peak Channel Temperature, IR ($T_{CH}$) | | 198 | °C |
| Thermal Resistance, IR ($\theta_{JC}$) | 85 °C Case<br>567 W Pdiss, 300 uS PW, 10% DC | 0.25 | °C/W |
| Peak Channel Temperature, IR ($T_{CH}$) | | 228 | °C |

Notes:

1. Refer to the following document GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

## Thermal and Reliability Information – CW [1]

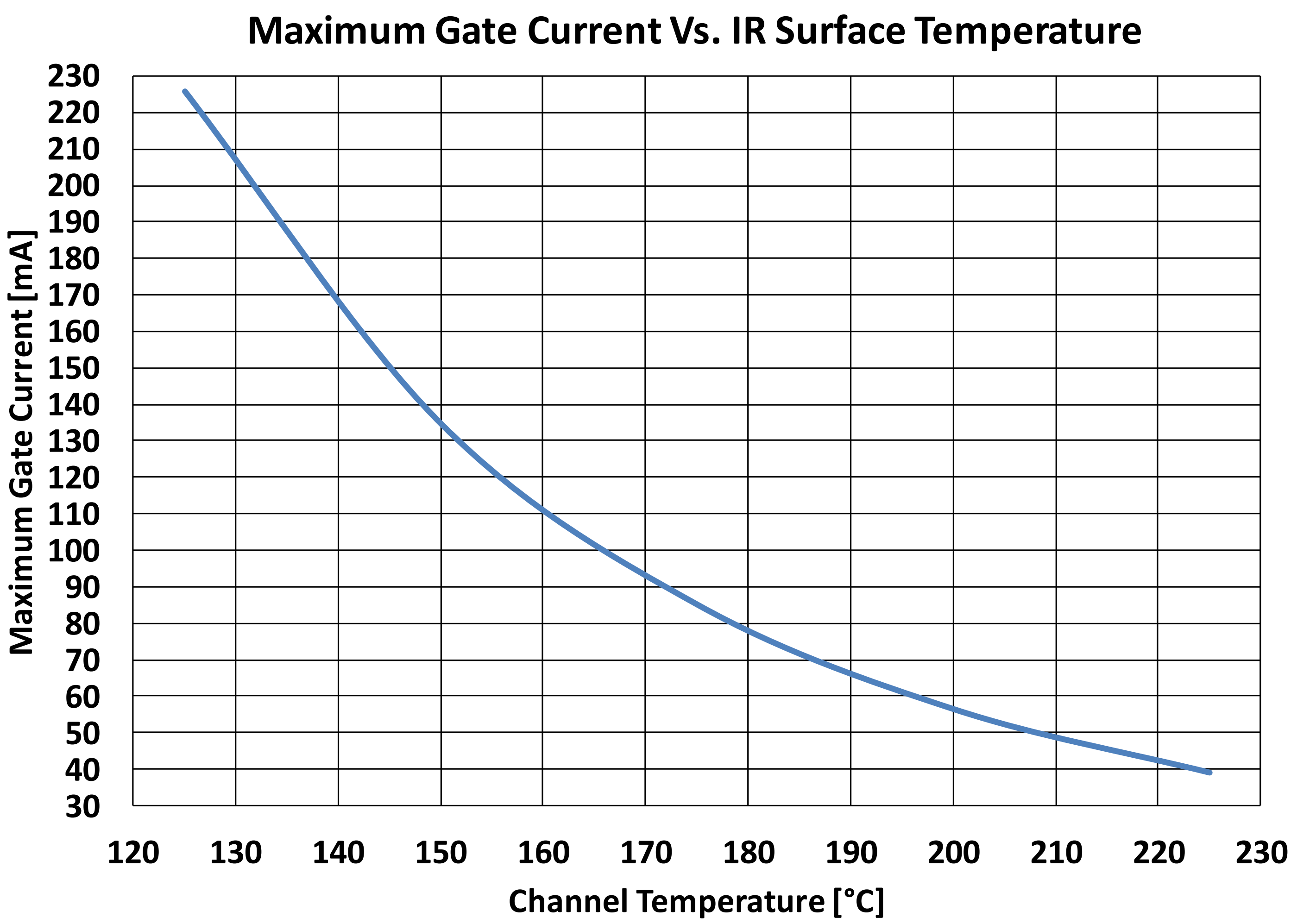



| Parameter[1] | Conditions | Values | Units |
|---|---|---|---|
| Thermal Resistance, IR ($\theta_{JC}$) | 85 °C Case<br>94.5 W Pdiss, CW | 0.34 | °C/W |
| Peak Channel Temperature, IR ($T_{CH}$) | | 117 | °C |
| Thermal Resistance, IR ($\theta_{JC}$) | 85 °C Case<br>189 W Pdiss, CW | 0.37 | °C/W |
| Peak Channel Temperature, IR ($T_{CH}$) | | 154 | °C |
| Thermal Resistance, IR ($\theta_{JC}$) | 85 °C Case<br>284 W Pdiss, CW | 0.39 | °C/W |
| Peak Channel Temperature, IR ($T_{CH}$) | | 196 | °C |
| Thermal Resistance, IR ($\theta_{JC}$) | 85 °C Case<br>378 W Pdiss, CW | 0.42 | °C/W |
| Peak Channel Temperature, IR ($T_{CH}$) | | 242 | °C |

Notes:

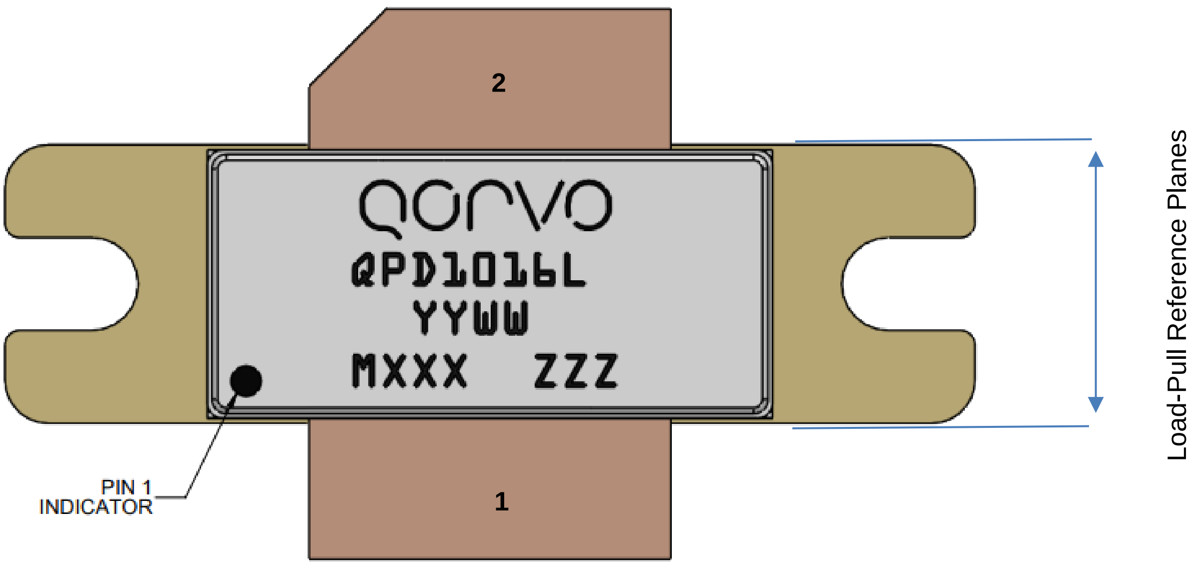
1. Refer to the following document GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

## Maximum Gate Current



## Pin Configuration and Description[1]

Note 1: The QPD1016L will be marked with the “QPD1016L” 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.

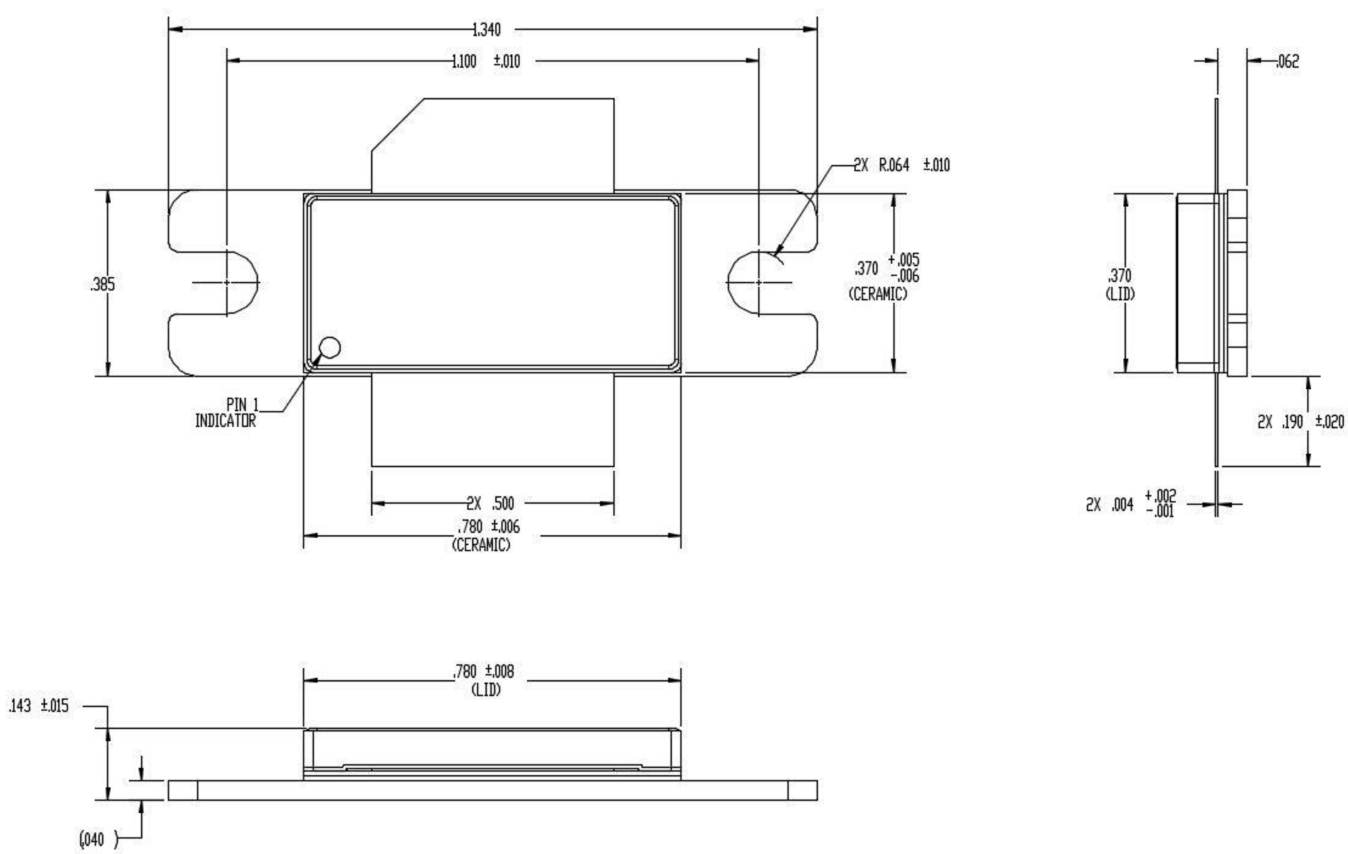



| Pin | Symbol | Description |
|---|---|---|
| 1 | RF IN / $V_G$ | Gate |
| 2 | RF OUT / $V_D$ | Drain |
| 3 | Source | Source / Ground / Backside of part |

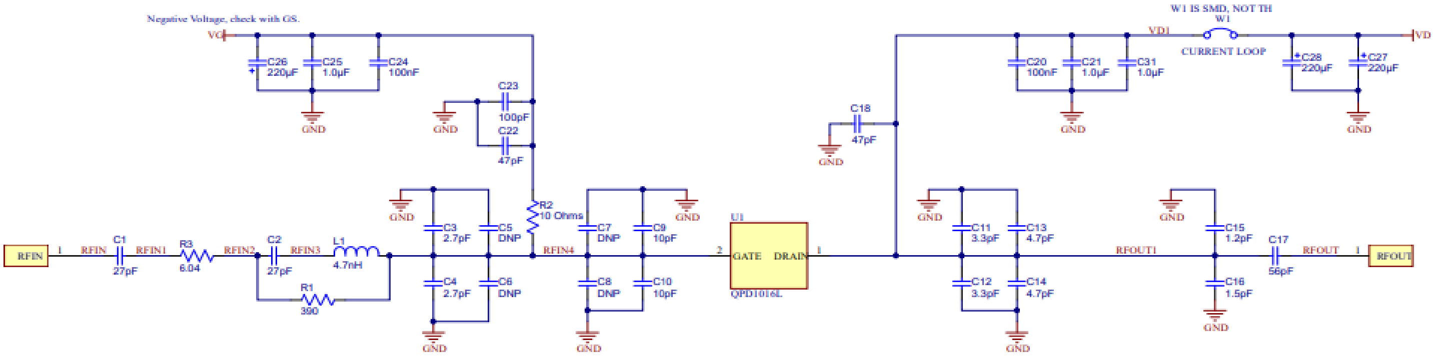
## Mechanical Drawing[1]

[1]Notes:

1. Dimension tolerances are ± 0.005 inches for lengths and 0.5° for angles.
2. Material:
   Package base: Ceramic/Metal
   Package lid: Ceramic
3. Package exposed metallization is gold plated.
4. Part is epoxy sealed.
5. Part meets industry NI780 footprint.
6. Body dimensions do not include lid shift or epoxy run out which can be up to 20 mils per side.



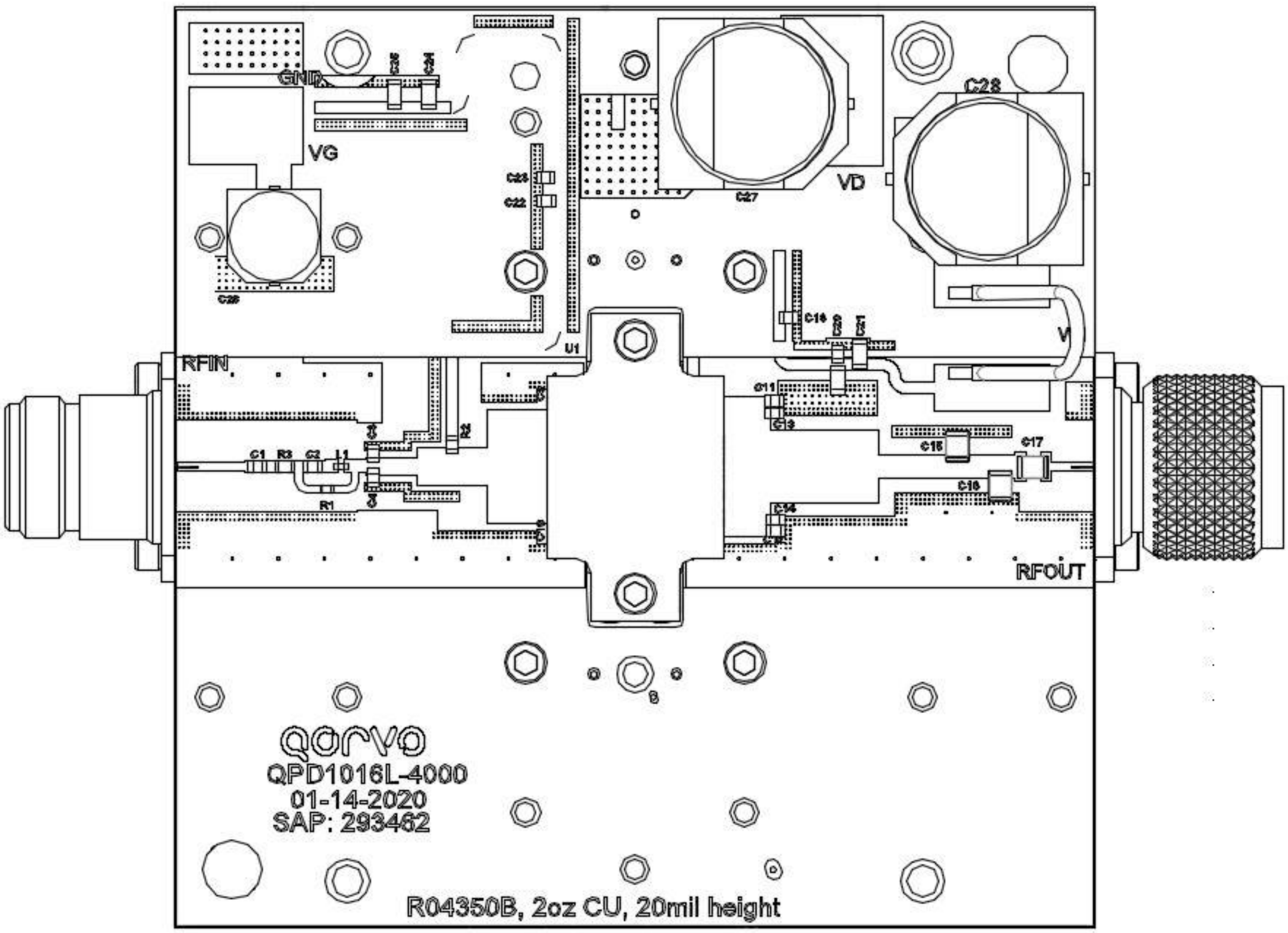
## 1.2 – 1.4 GHz Application Circuit - Schematic




| 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 1100 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 1000 mA. | 4. Turn off $V_G$ |
| 5. Set $I_D$ current limit to 7 A (Pulsed operation) | |
| 6. Apply RF. | |

## 1.2 – 1.4 GHz Application Circuit - Layout

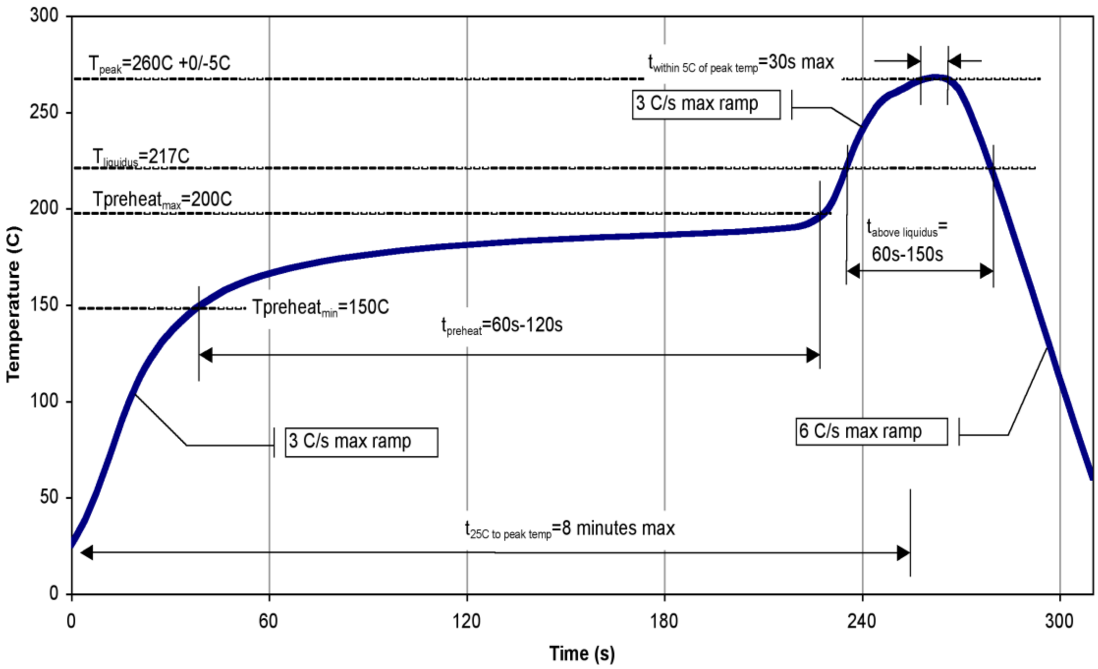
Board material is RO4350B 0.020" thickness with 2oz copper cladding. Overall EVB size is 3.98" x 3.98".



## 1.2 – 1.4 GHz Application Circuit - Bill Of Material

| Description | Ref. Des. | Manufacturer | Part Number |
|---|---|---|---|
| Capacitor 27pF, 250v, 1% NPO 0805 600F | C1, C2 | American Technical Ceramics | 600F270FT250XT |
| Capacitor 2.7 pF, 250V, 0805, 600F | C3, C4 | American Technical Ceramics | 600F2R7BT250XT |
| Capacitor 10 pF, 600F-Series | C9, C10 | American Technical Ceramics | 600F100CT |
| Capacitor 3.3 pF, 600F-Series | C11, C12 | American Technical Ceramics | 600F3R3CT |
| Capacitor 4.7 pF, 600F-Series | C13, C14 | American Technical Ceramics | 600F4R7CT |
| Capacitor 1.2 pF, 2%, 500v, COG 800B | C15 | American Technical Ceramics | 800B1R2CT500X |
| Capacitor 1.5 pF, 2%, 500v, COG 800B | C16 | American Technical Ceramics | 800B1R5CT500X |
| Capacitor 56 pF, 2%, 500v, COG 800B | C17 | American Technical Ceramics | 800B560JT500X |
| Capacitor 47 pF, 5%, 250V, 0805, 600F | C18, C22 | American Technical Ceramics | 600F470JT250XT |
| Capacitor 100 pF, 600F-Series | C20, C23 | American Technical Ceramics | 600F101JT |
| Capacitor, 100nF, 10%, 100V X7R1206 | C19, C24 | N/A | N/A |
| Capacitor, 1uF, 20%, 100V X7R1206 | C21, C25 | Murata | GRM32ER72A105MA01L |
| Capacitor 220 uF, 20%, 100V, SMD Electrolytic | C27, C28 | Nichicon | UUJ2A221MNQ1MS |
| Capacitor 220 uF, 20%, 50V, SMD Electrolytic | C26 | Panasonic | EMVY500ADA221MJA0G |
| Resistor, 390 Ohm, 1%, 1/10W, 0805 | R1 | Rohm Electronics | MCR03EZPFX6200 |
| Resistor, 10 Ohm, 1%, 1/10W, 0805 | R2 | Panasonic | ERJ-6ENF10R0V |
| Resistor, 6.04ohm, 1%, 1/10W, 0805 | R3 | Panasonic | RC0805FR-076R04L |

## Recommended Solder Temperature Profile



## Handling Precautions

| Parameter | Rating | Standard |
| --- | --- | --- |
| ESD – Human Body Model (HBM) | Class 1B (500V) | ANSI/ESD/JEDEC JS-001 |
| ESD – Charged Device Model (CDM) | Class C3 (1000V) | 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.

Package lead plating is 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:

- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free
- Lead Free

## Contact Information

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

**Web:** www.qorvo.com **Tel: 1-844-890-8163**

**Email:** customer.support@qorvo.com

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