

### 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.

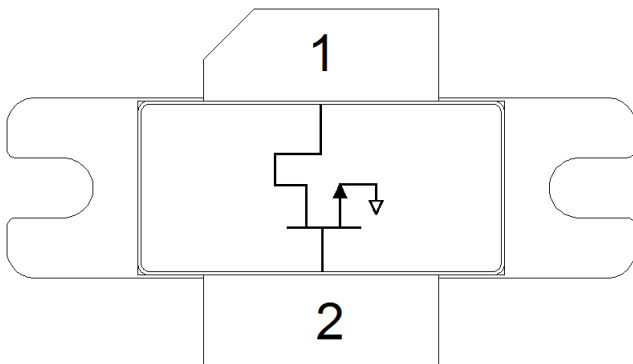
ROHS compliant.

Evaluation boards are available upon request.



NI-780 Package

### Functional Block Diagram



### Key Features

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

### 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



# QPD1016L

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

## Absolute Maximum Ratings<sup>1,2</sup>

Parameter	Rating	Units
Breakdown Voltage, $V_{BDG}$	+145	V
Gate Voltage Range, $V_G$	-7 to +2	V
Drain Current, $I_{D_{MAX}}$	70	A
Gate Current Range, $I_G$	See page 17	mA
Power Dissipation, $P_{DISS}$	714 <sup>2</sup>	W
RF Input Power, Pulse, 1.3 GHz, $T = 25\text{ }^\circ\text{C}^2$	+45.5	dBm
Mounting Temperature (30 Seconds)	320	$^\circ\text{C}$
Storage Temperature	-65 to +150	$^\circ\text{C}$

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<sup>1</sup>

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<sup>1,2</sup>

Parameter	Typical Values						Units
	1.1	1.2	1.3	1.4	1.5	1.7	
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,  $Z_0 = 3\ \Omega$ .

## Measured Load Pull Performance – Efficiency Tuned<sup>1,2</sup>

Parameter	Typical Values						Units
	1.1	1.2	1.3	1.4	1.5	1.7	
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,  $Z_0 = 3\ \Omega$ .

### 1.2 – 1.4 GHz EVB 1.3 GHz Performance <sup>1,2</sup>

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.  $V_D = +50V$ ,  $I_{DQ} = 1000mA$ , 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 <sup>1,2</sup>

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

Notes:

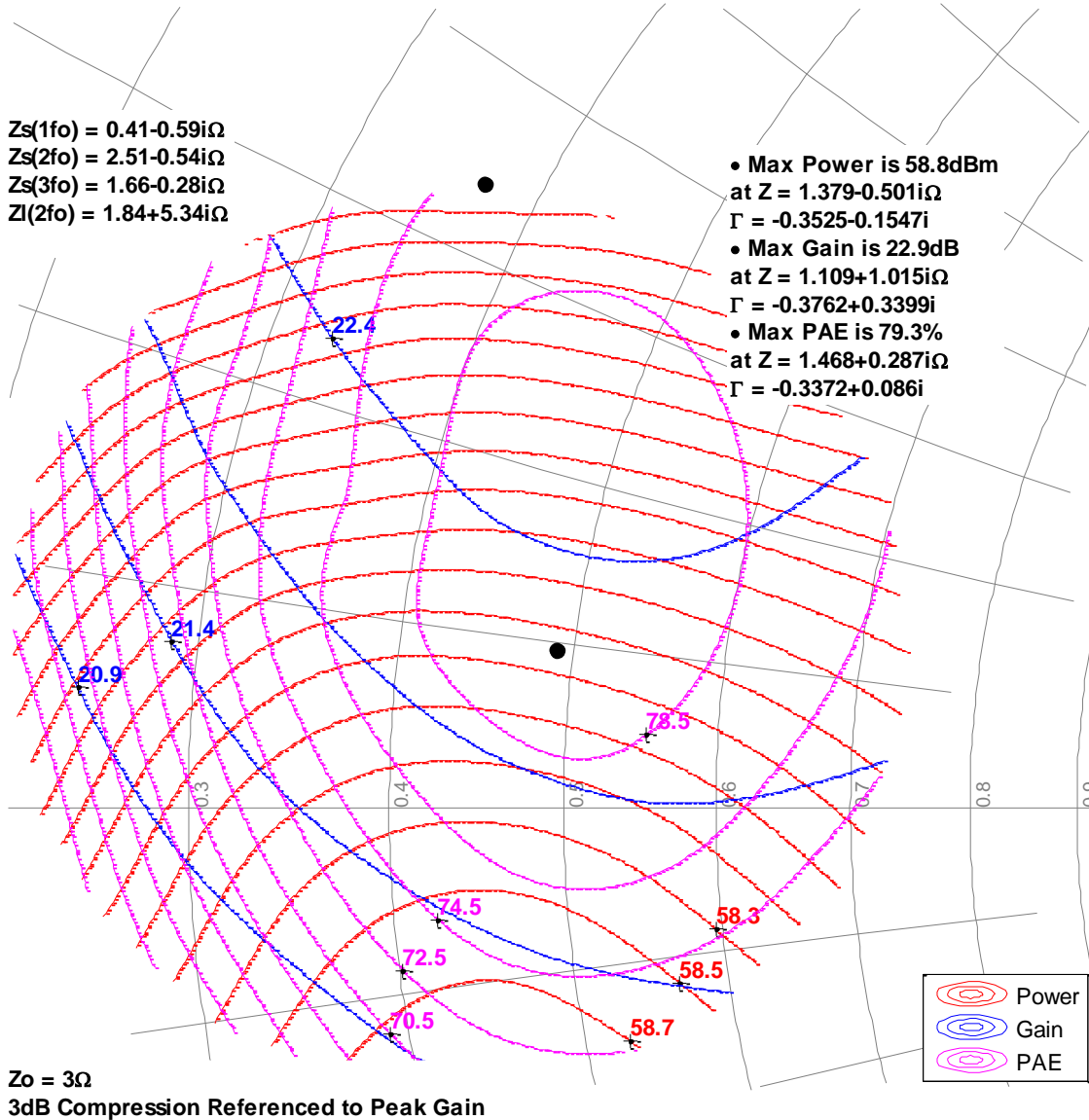
1. Test conditions unless otherwise noted:  $T_A = 25\text{ °C}$ ,  $V_D = 50V$ ,  $I_{DQ} = 1000mA$
2. Input drive power is determined at pulsed 3dB compression under matched condition at EVB output connector.

Measured Load-Pull Smith Charts<sup>1,2</sup>

Notes:

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

1.1GHz, Load-pull

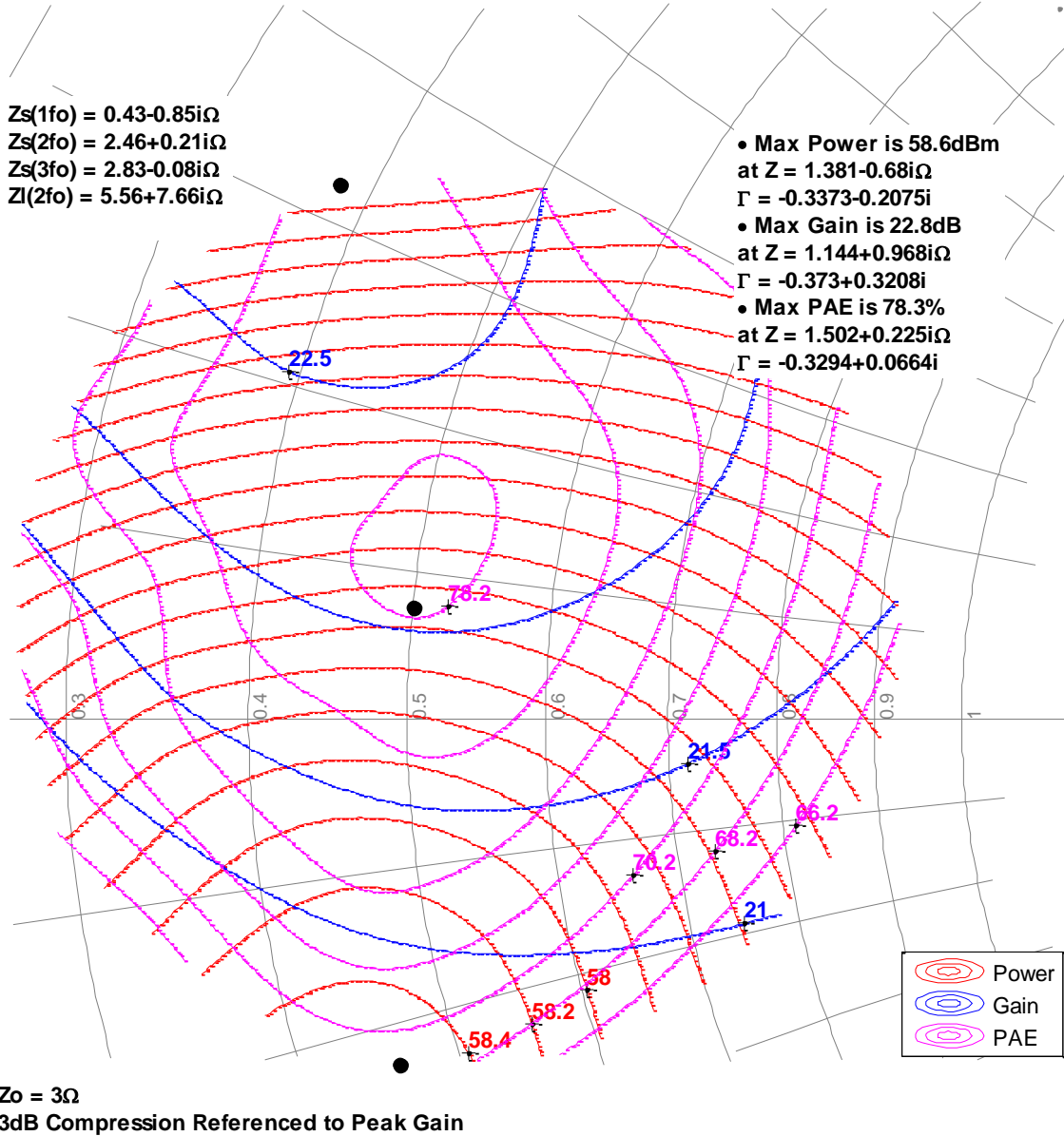


Measured Load-Pull Smith Charts<sup>1, 2</sup>

Notes:

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

1.2GHz, Load-pull

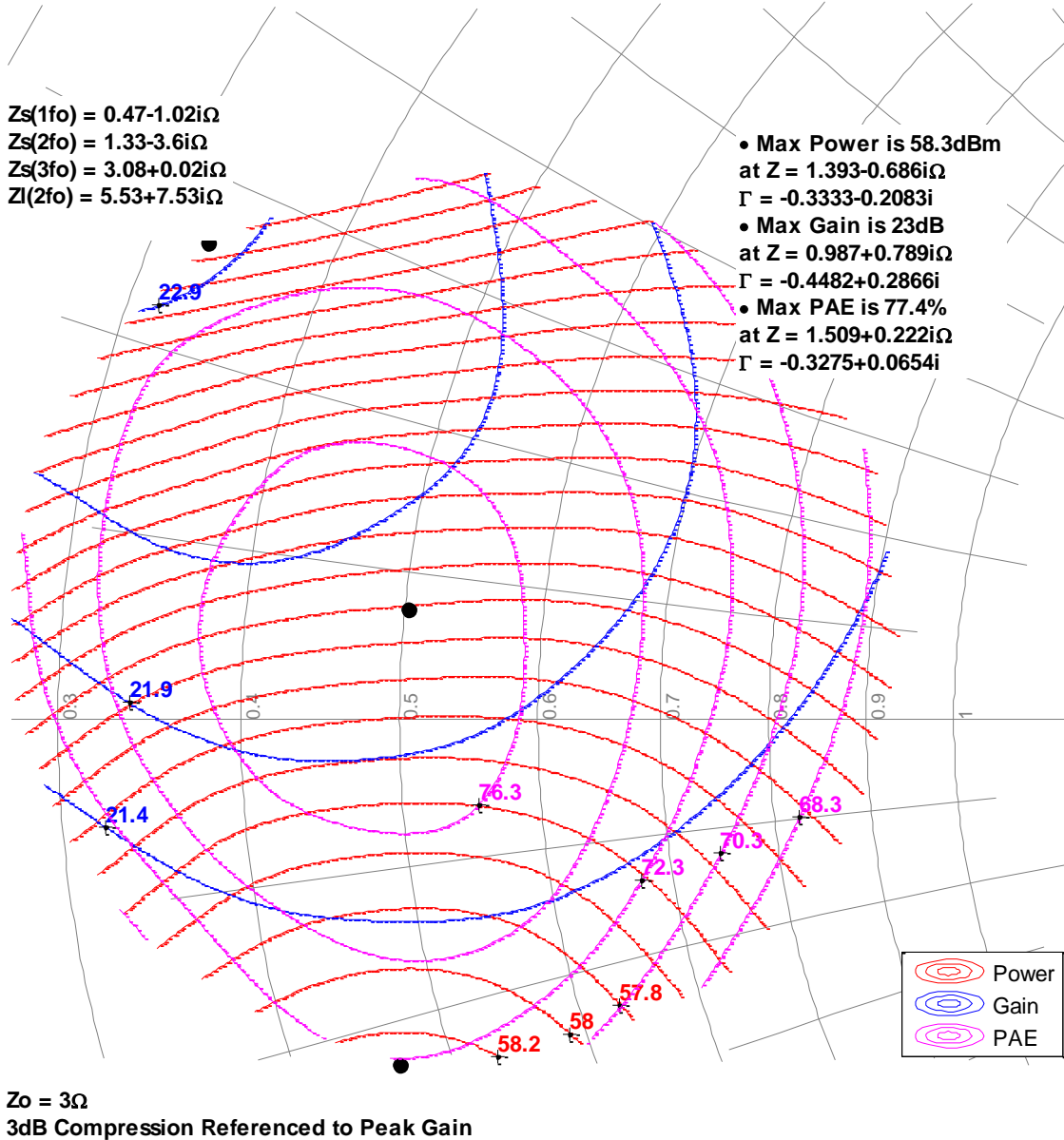


Measured Load-Pull Smith Charts<sup>1, 2</sup>

Notes:

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

1.3GHz, Load-pull

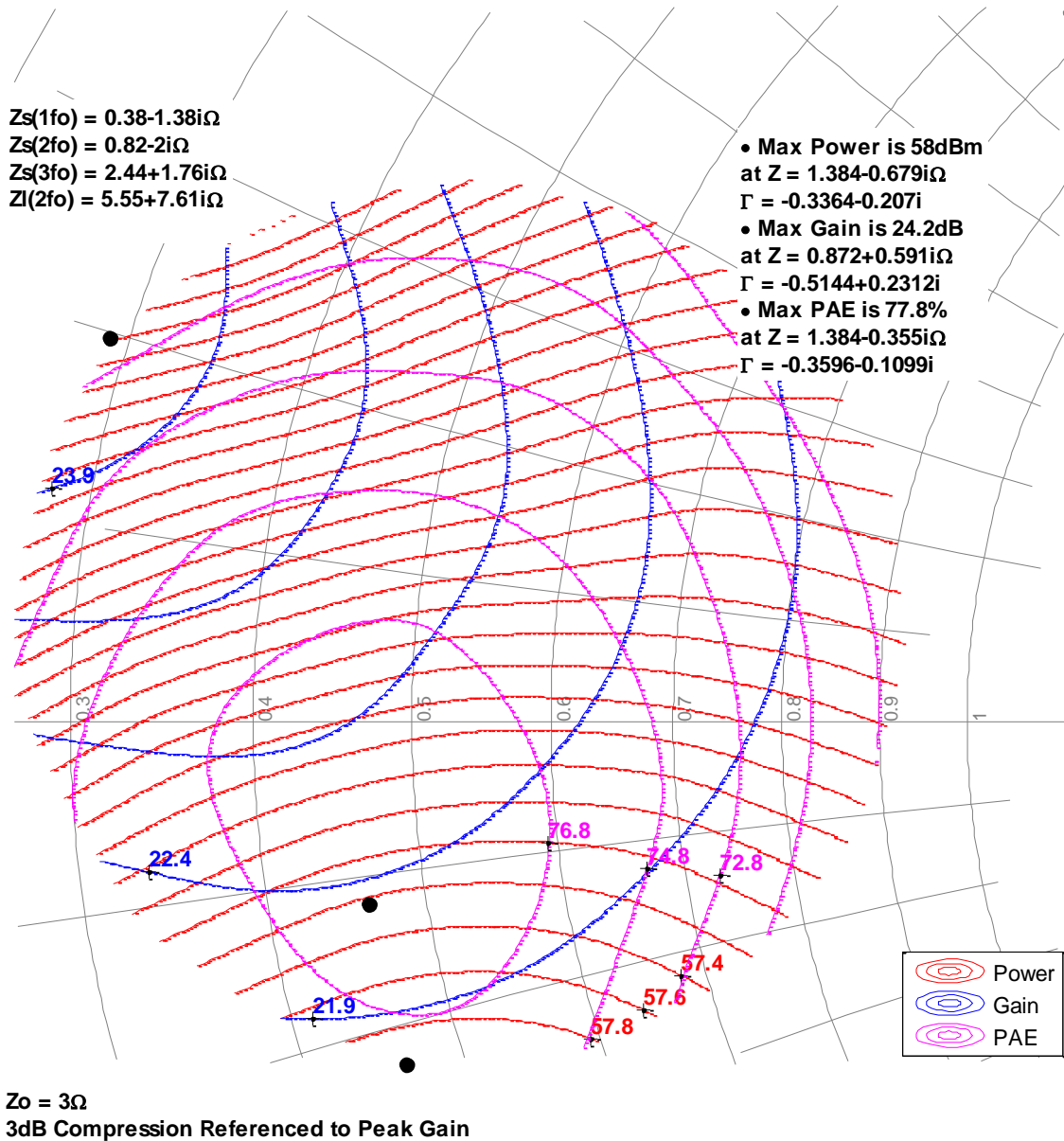


Measured Load-Pull Smith Charts<sup>1,2</sup>

Notes:

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

1.4GHz, Load-pull

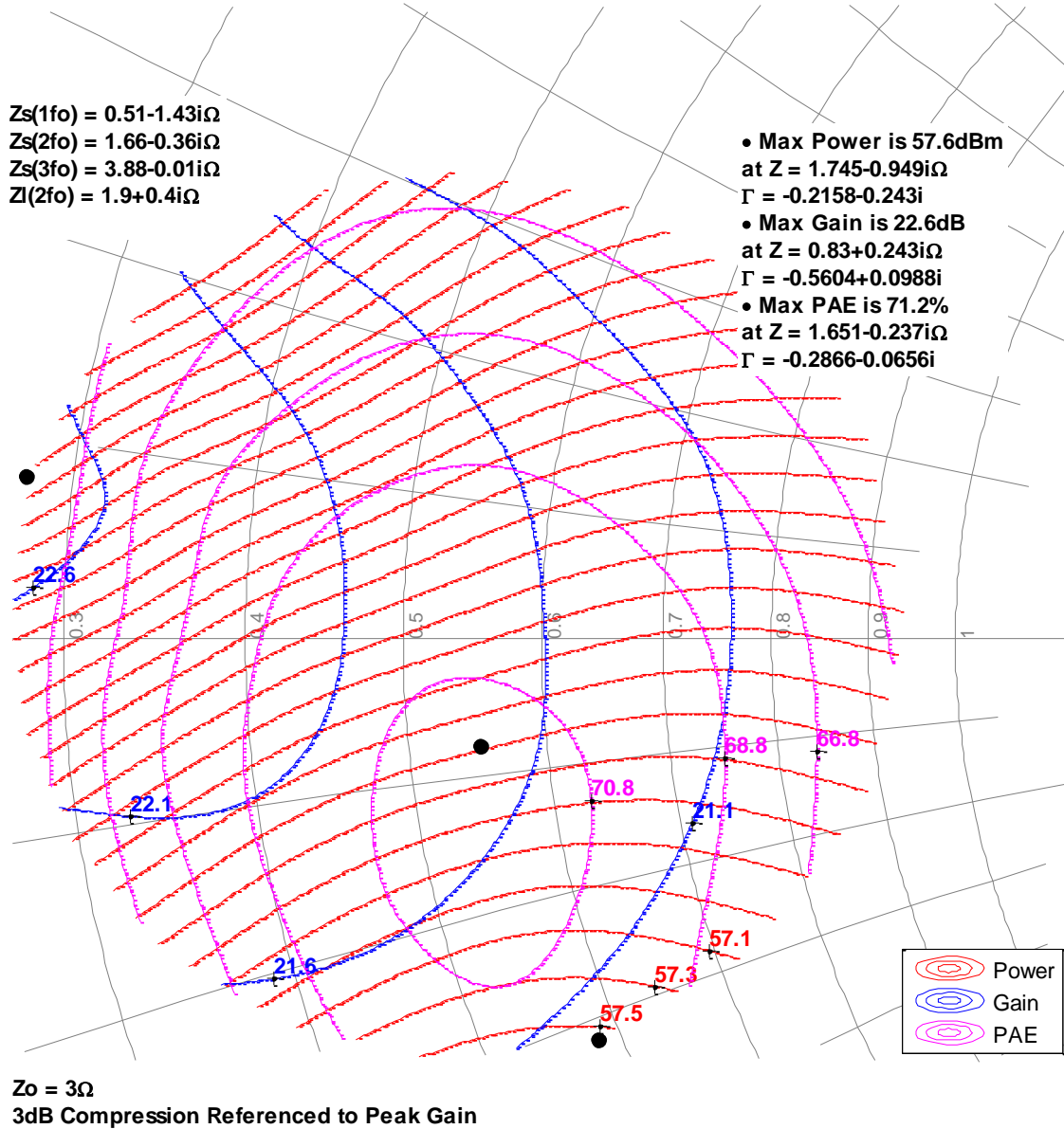


Measured Load-Pull Smith Charts<sup>1, 2</sup>

Notes:

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

1.5GHz, Load-pull



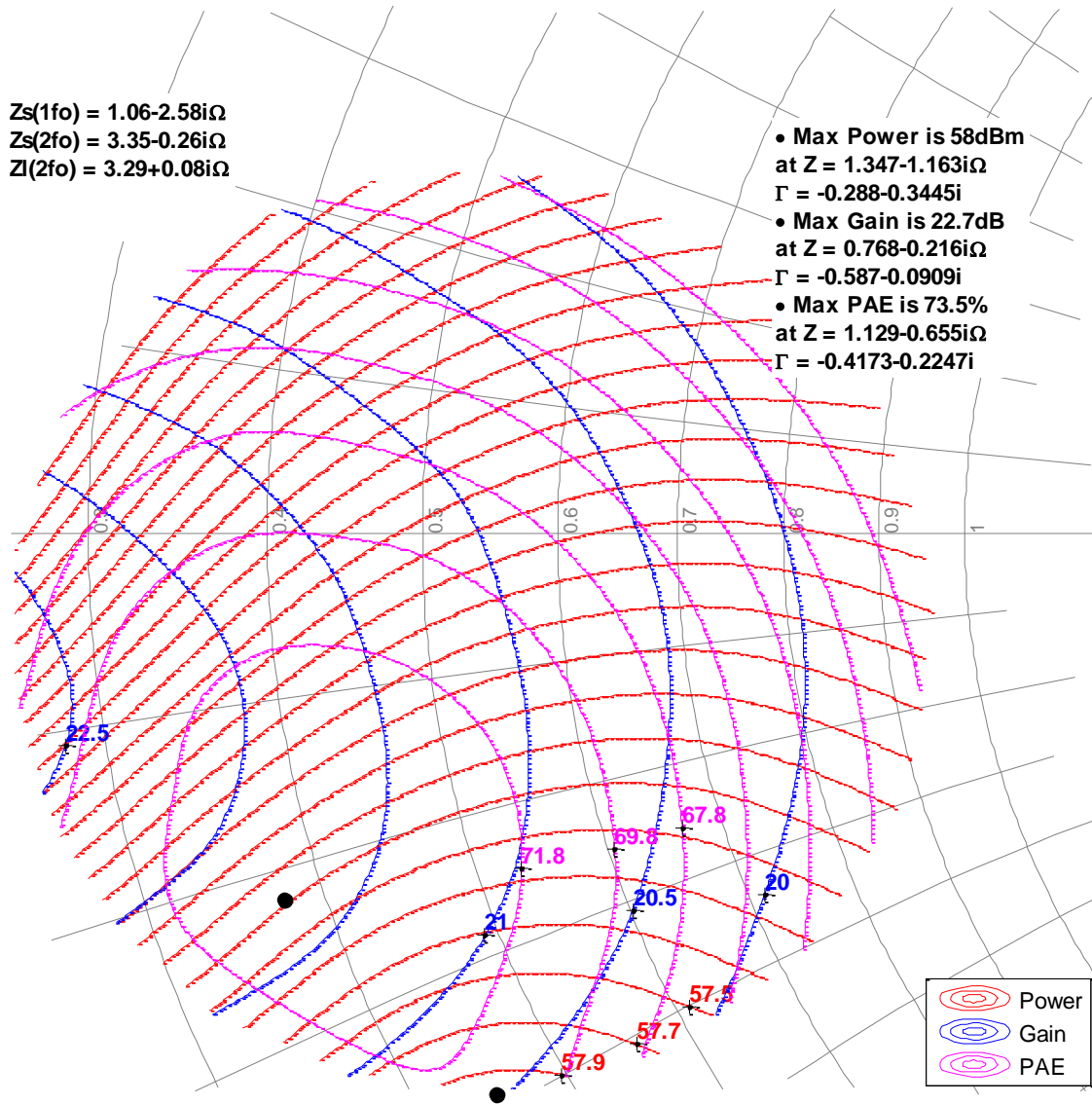


Measured Load-Pull Smith Charts<sup>1, 2</sup>

Notes:

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

1.7GHz, Load-pull

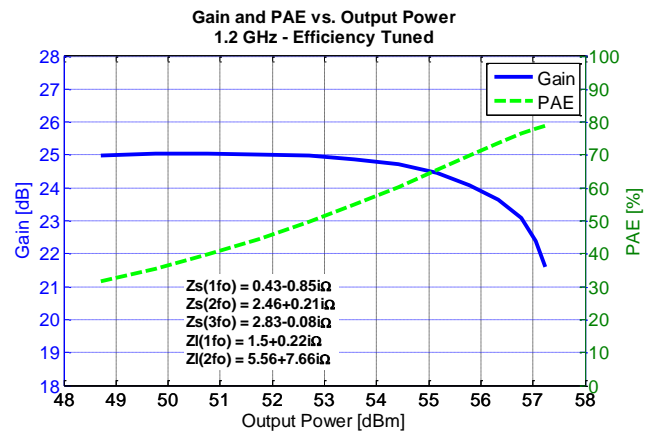
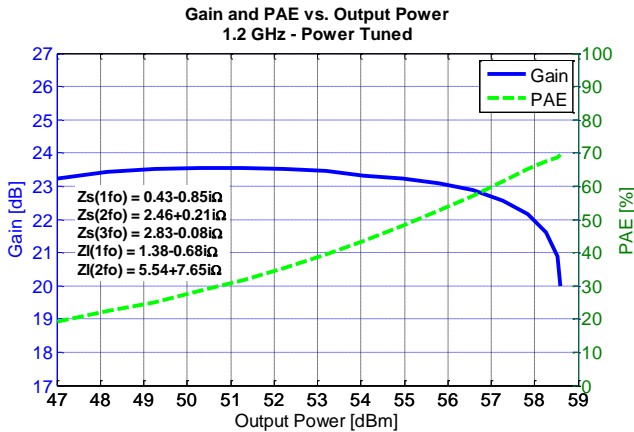
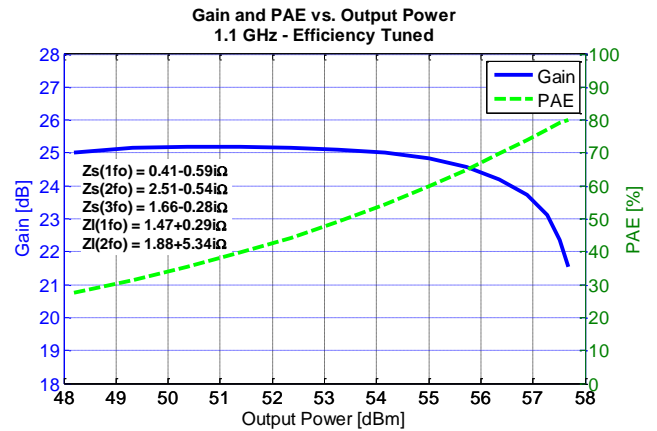
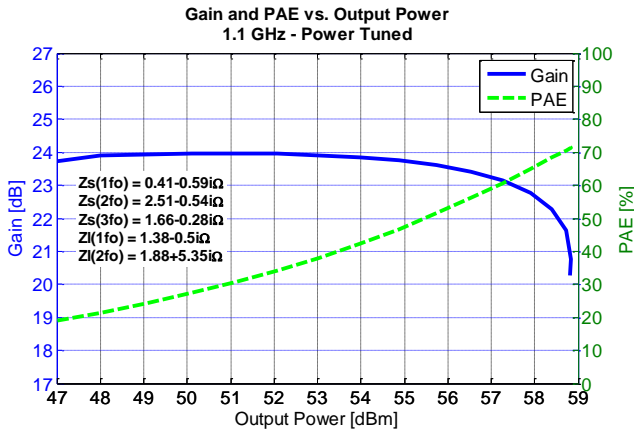


$Z_o = 3\Omega$   
 3dB Compression Referenced to Peak Gain

### Typical Measured Performance – Load-Pull Drive-up<sup>1, 2</sup>

Notes:

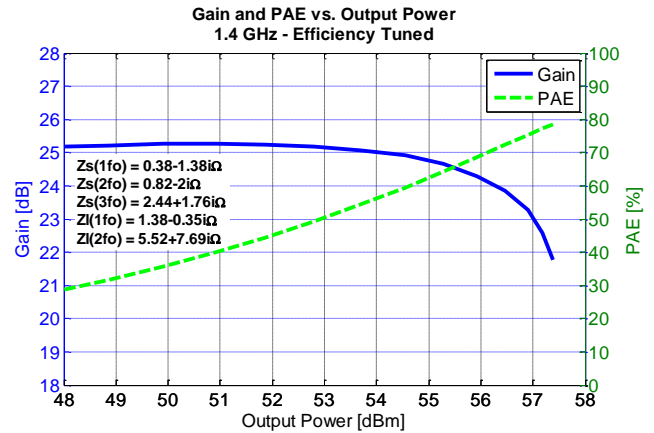
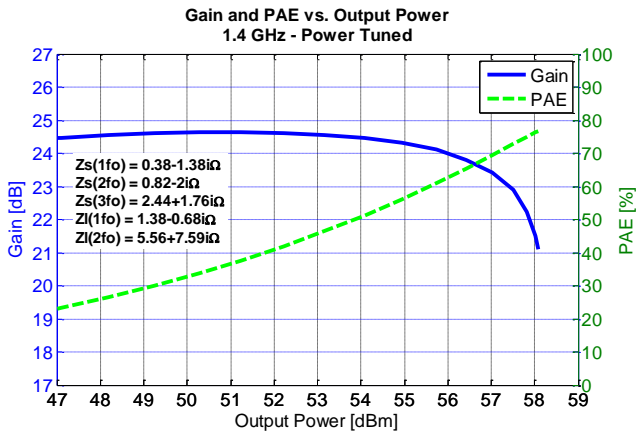
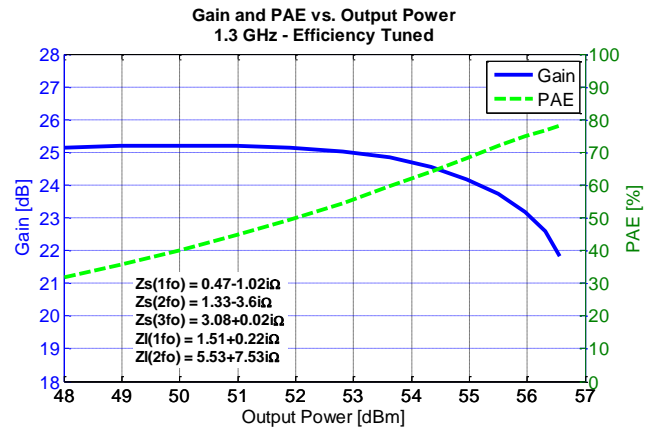
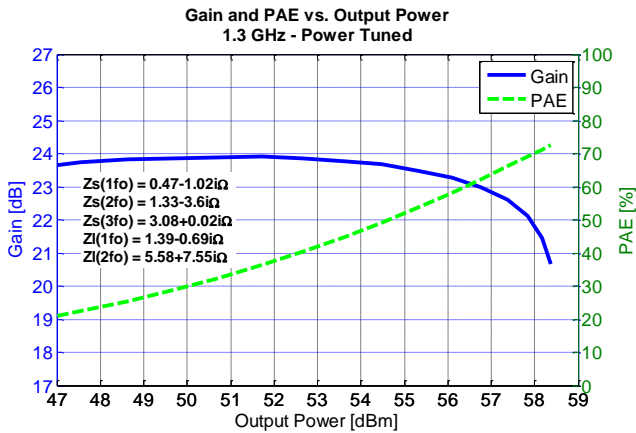
1. Test Conditions:  $V_D = 50\text{ V}$ ,  $I_{DQ} = 1000\text{ mA}$ , 300  $\mu\text{s}$  Pulse Width, 10% Duty Cycle
2. See "Pin Configuration and Description" for load pull and source pull reference planes.



### Typical Measured Performance – Load-Pull Drive-up<sup>1, 2</sup>

Notes:

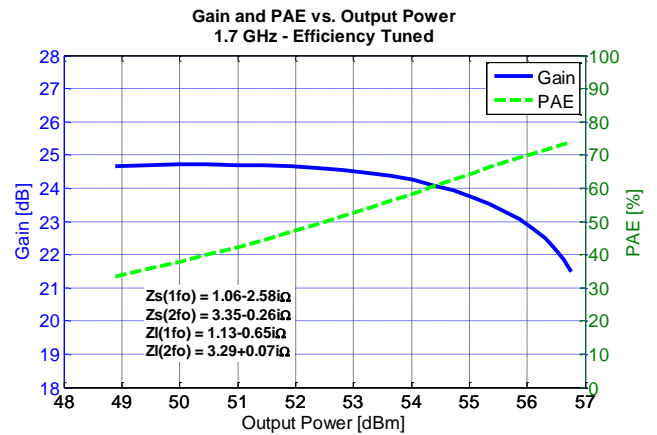
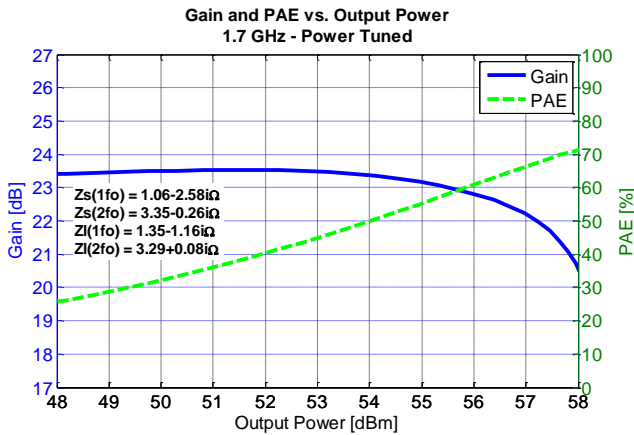
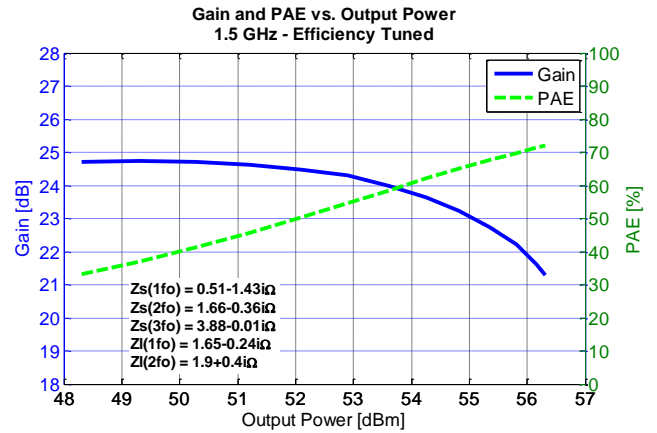
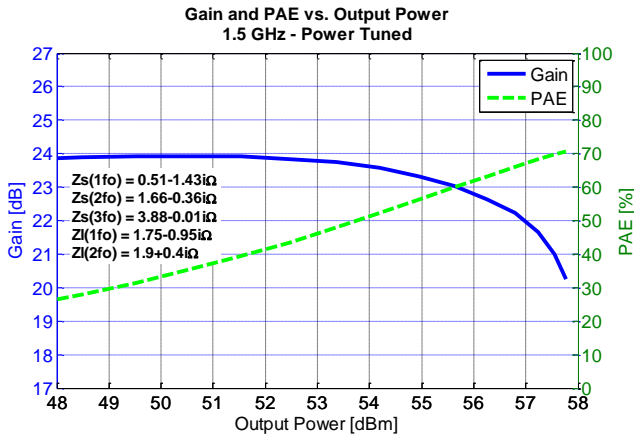
1. Test Conditions:  $V_D = 50\text{ V}$ ,  $I_{DQ} = 1000\text{ mA}$ , 300  $\mu\text{s}$  Pulse Width, 10% Duty Cycle
2. See "Pin Configuration and Description" for load pull and source pull reference planes.



### Typical Measured Performance – Load-Pull Drive-up<sup>1, 2</sup>

Notes:

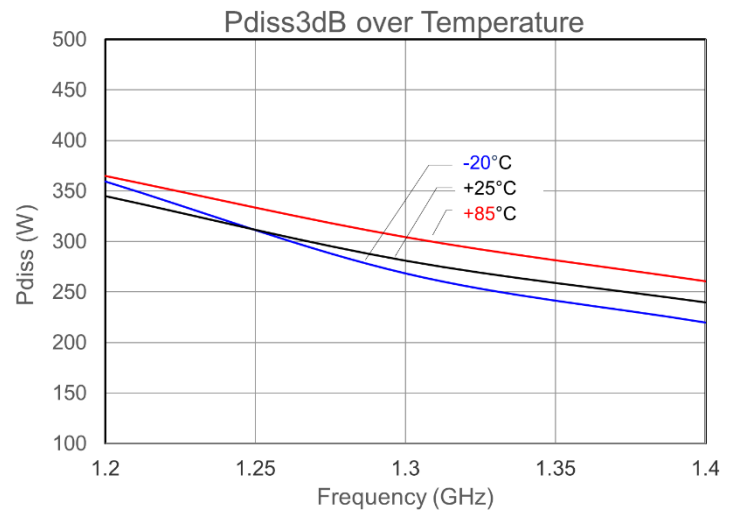
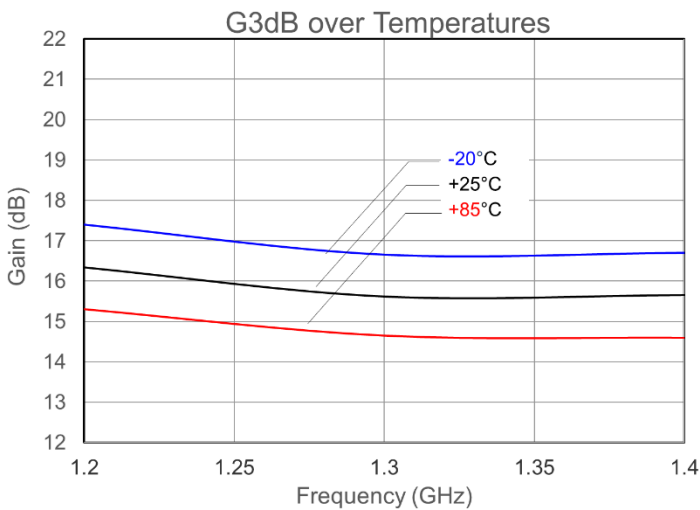
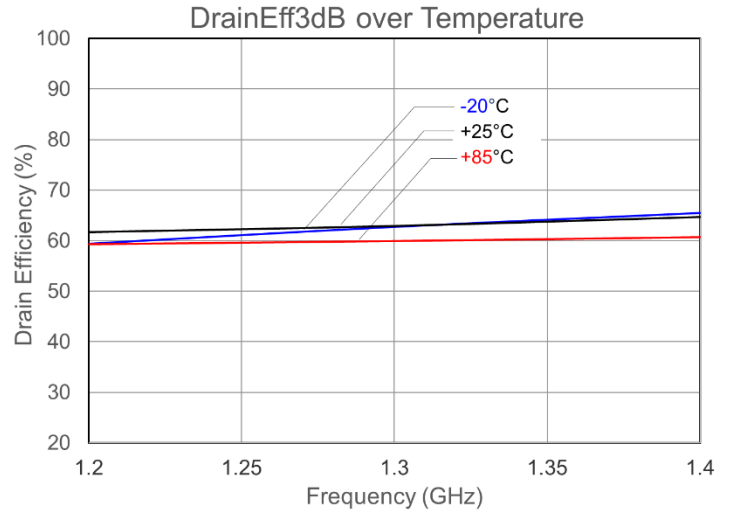
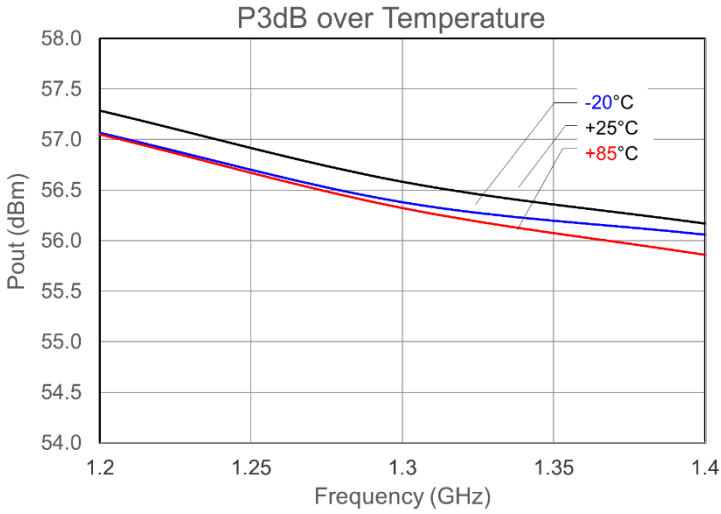
1. Test Conditions:  $V_D = 50\text{ V}$ ,  $I_{DQ} = 1000\text{ mA}$ , 300  $\mu\text{s}$  Pulse Width, 10% Duty Cycle
2. See "Pin Configuration and Description" for load pull and source pull reference planes..



### Power Driveup Performance Over Temperatures Of 1.2 – 1.4 GHz EVB <sup>1</sup>

Notes:

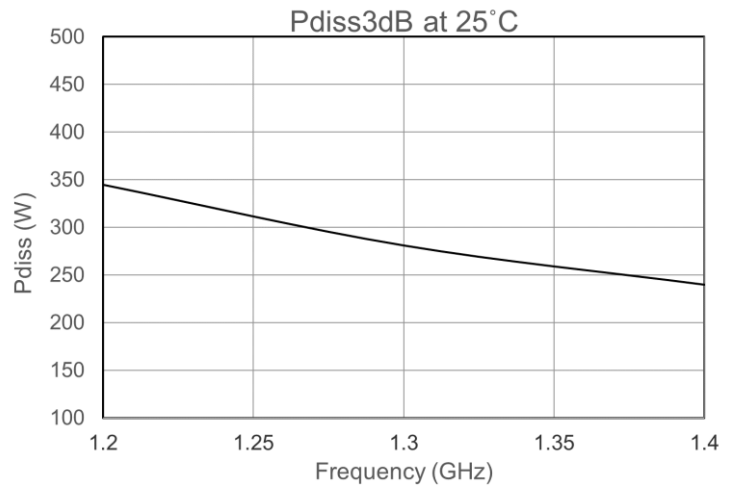
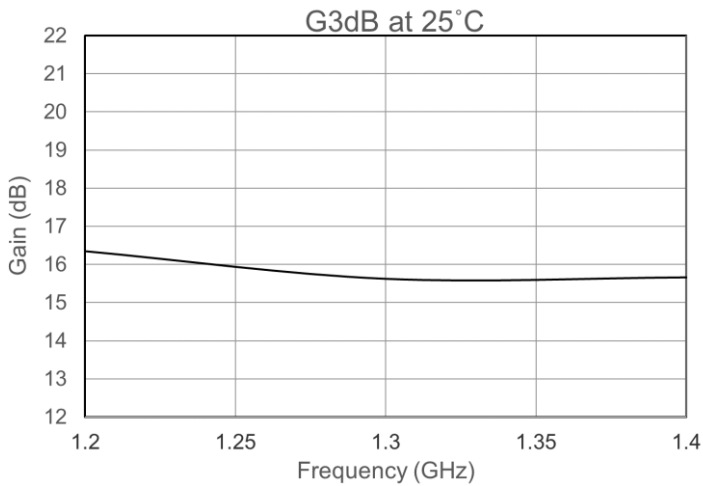
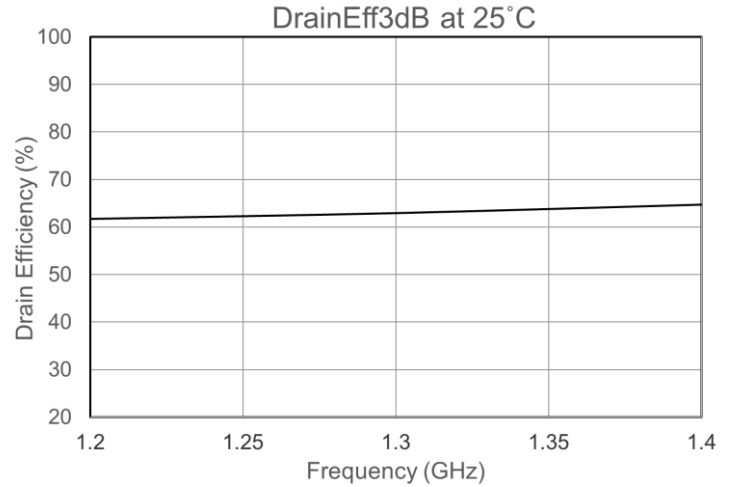
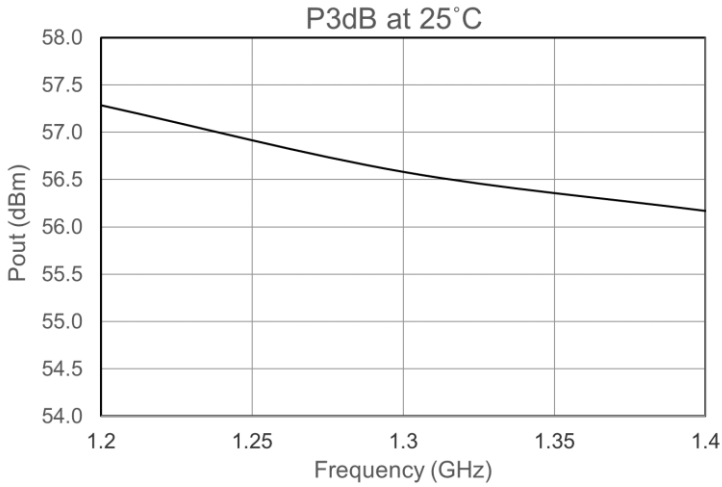
1. Test Conditions:  $V_D = 50\text{ V}$ ,  $I_{DQ} = 1000\text{ mA}$ , 300  $\mu\text{s}$  Pulse Width, 10% Duty Cycle



### Power Driveup Performance At 25°C Of 1.2 – 1.4 GHz EVB <sup>1</sup>

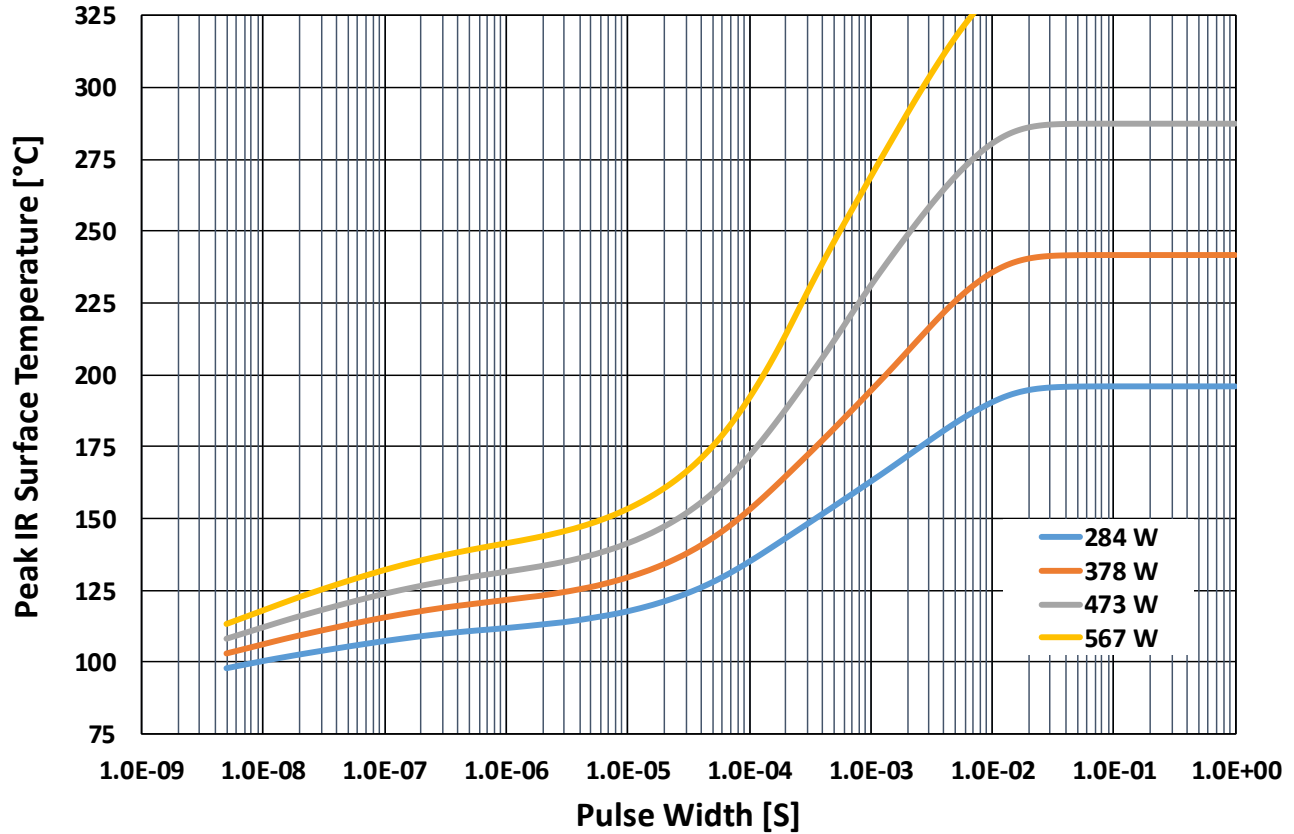
Notes:

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



## Thermal and Reliability Information – Pulsed <sup>1</sup>

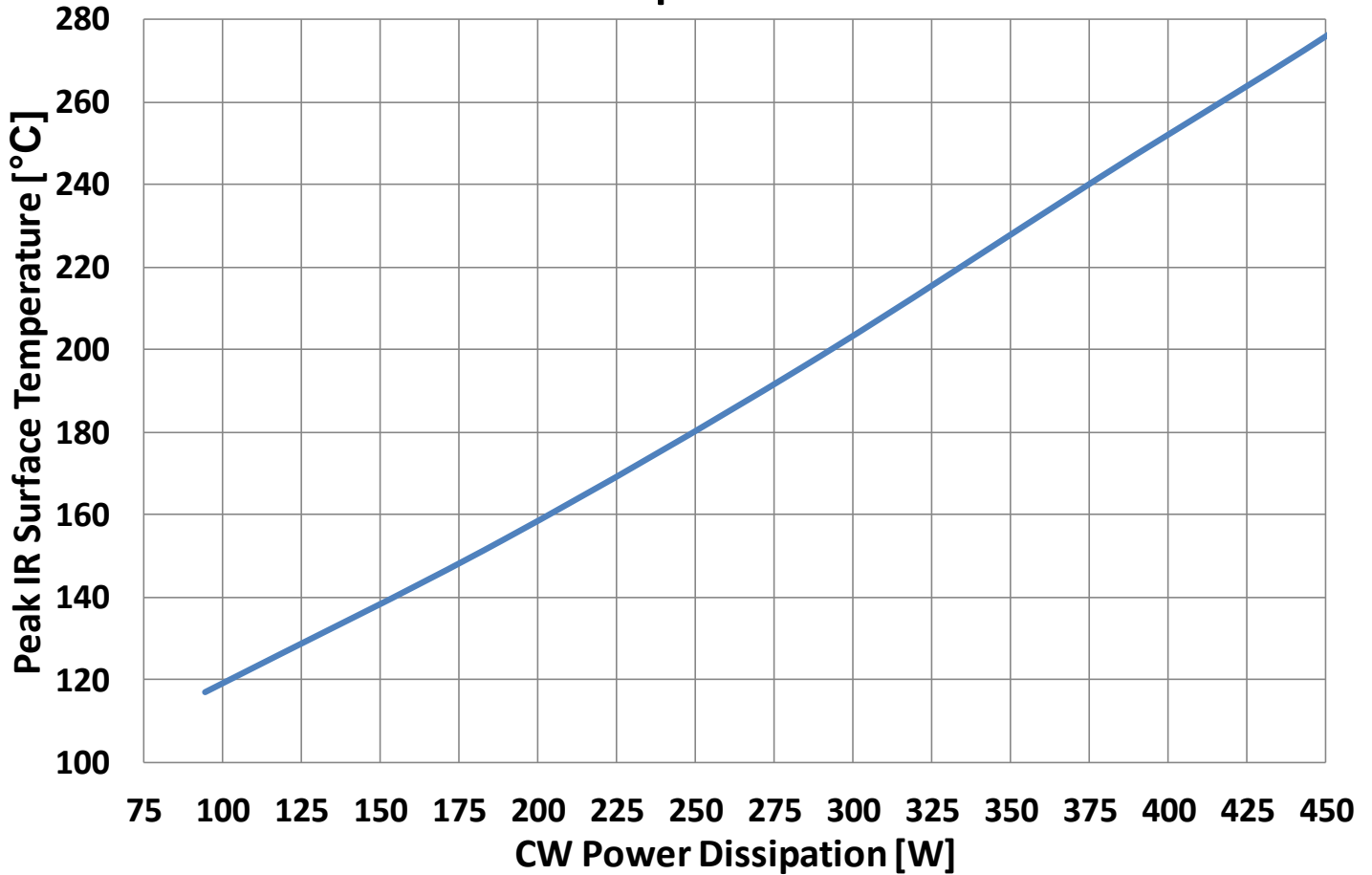
Peak IR Surface Temperature vs. PW vs. Pulsed Dissipation Power  
Base Temperature at 85 °C



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

Notes:

1. Refer to the following document [GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates](#)

**Thermal and Reliability Information – CW <sup>1</sup>**
**Peak IR Surface Temperature vs. CW Power  
Base Temperature at 85 °C**


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

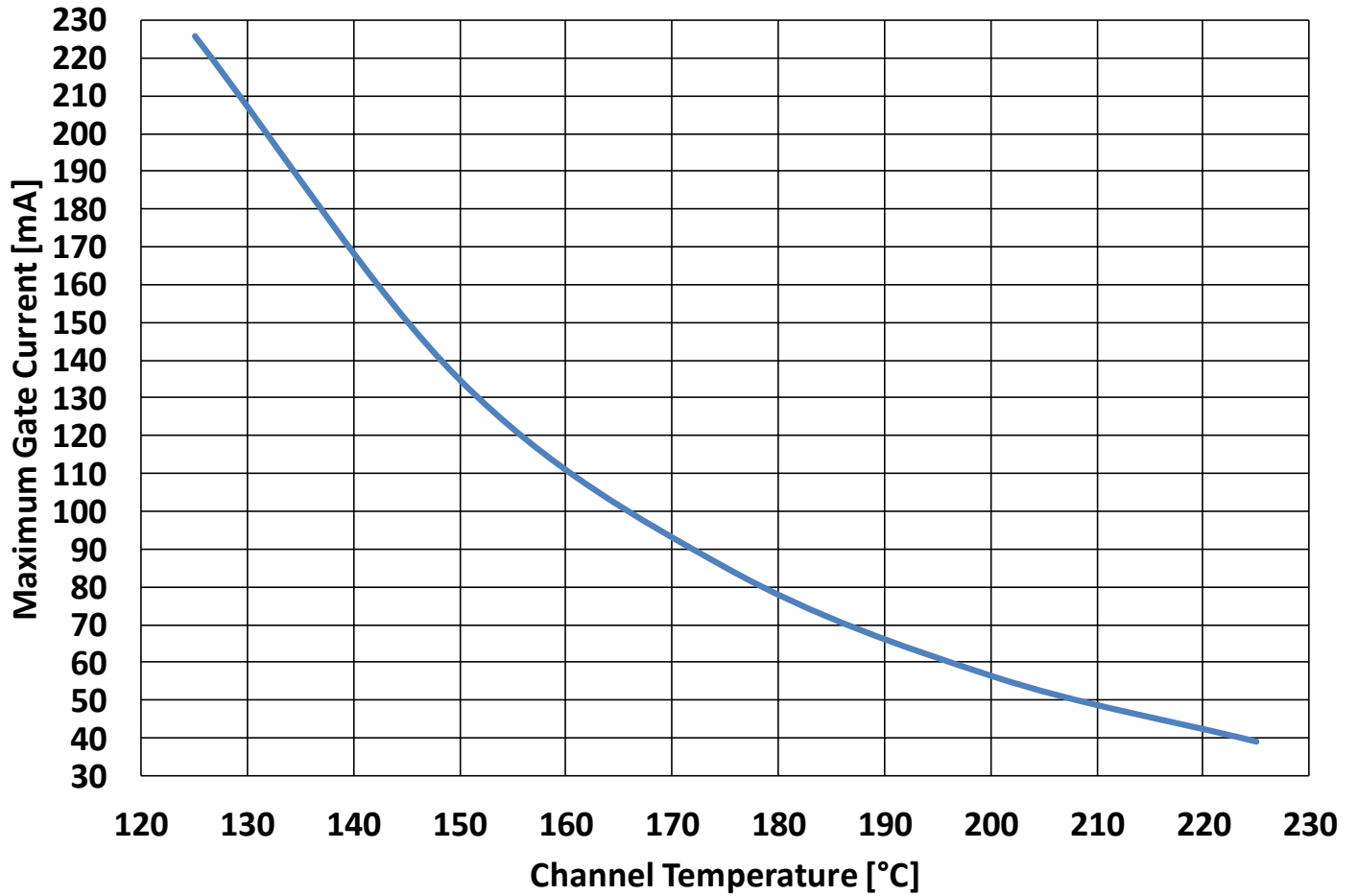
**Notes:**

1. Refer to the following document [GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates](#)



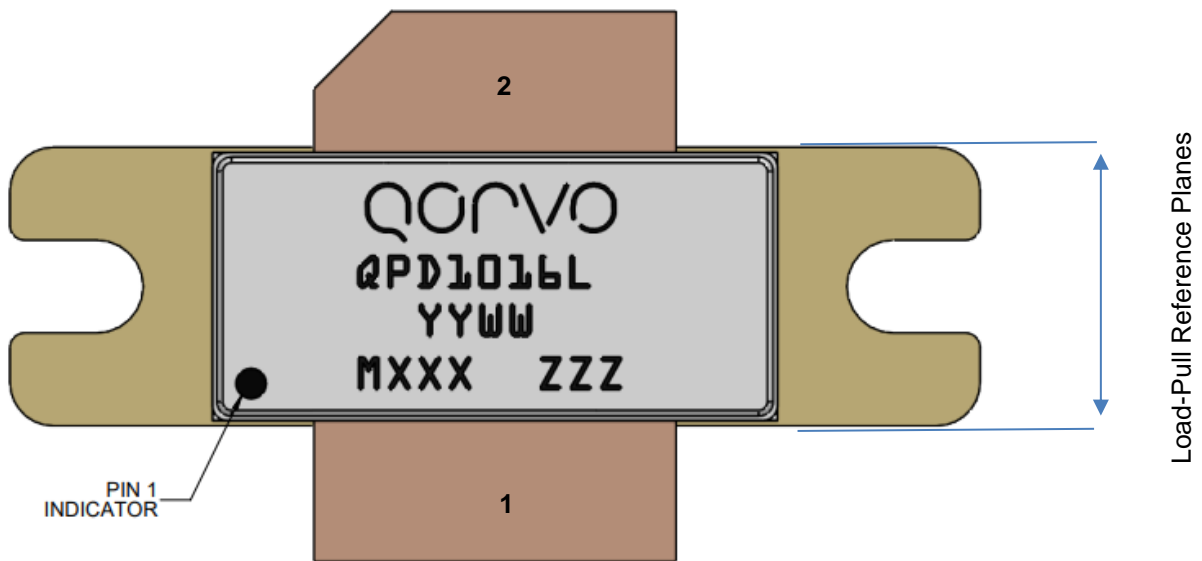
Maximum Gate Current

Maximum Gate Current Vs. IR Surface Temperature



## Pin Configuration and Description<sup>1</sup>

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.

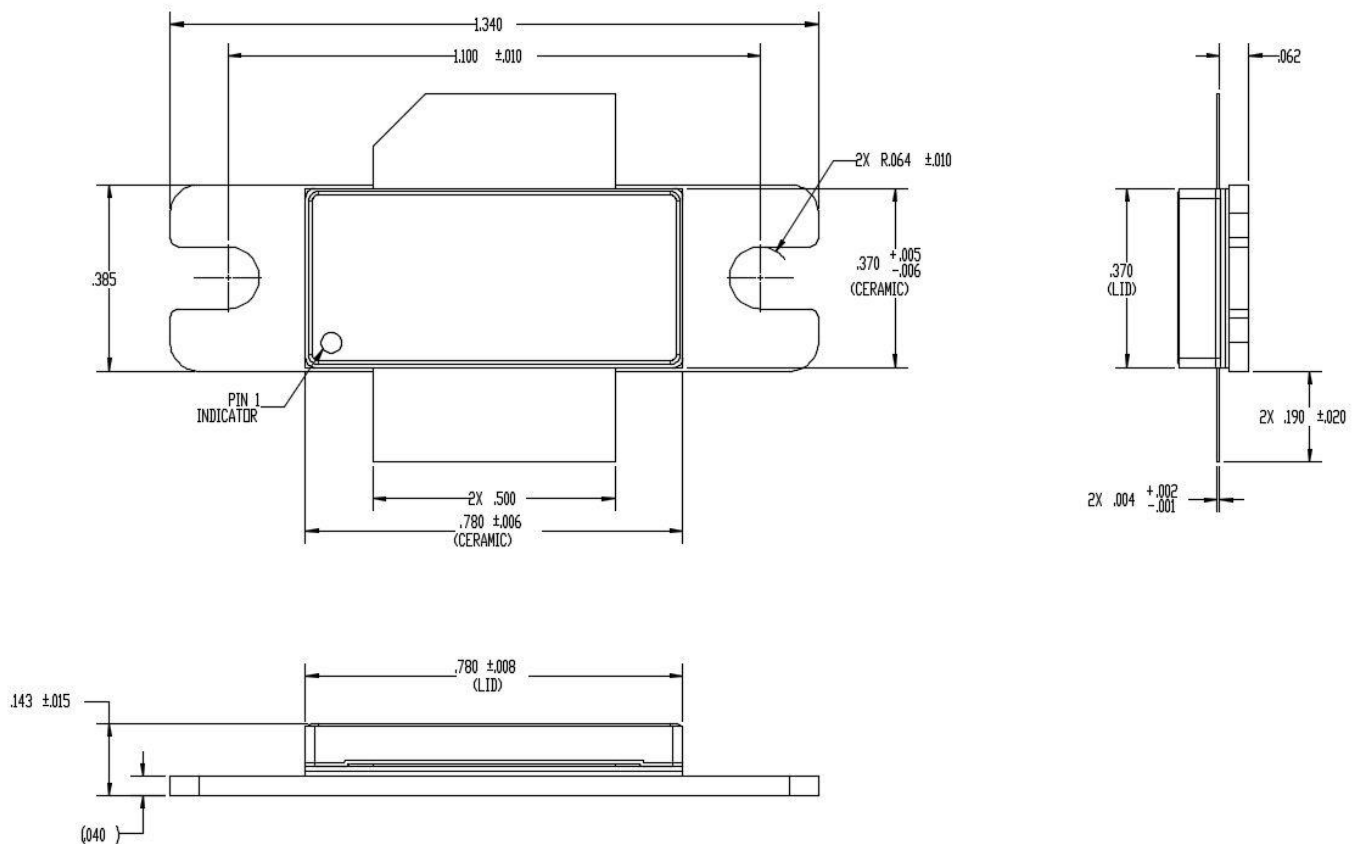


Pin	Symbol	Description
1	RF IN / $V_G$	Gate
2	RF OUT / $V_D$	Drain
3	Source	Source / Ground / Backside of part

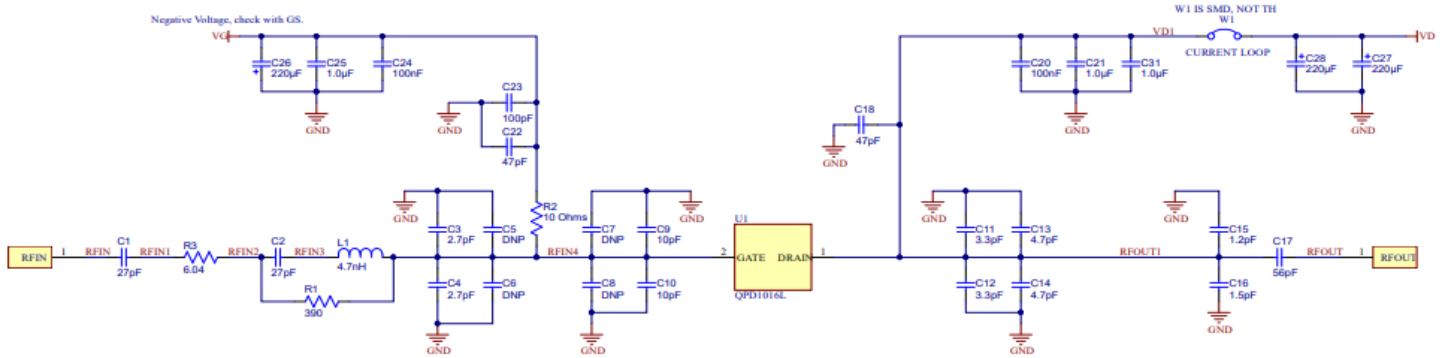
### Mechanical Drawing<sup>1</sup>

<sup>1</sup>Notes:

1. Dimension tolerances are  $\pm 0.005$  inches for lengths and  $0.5^\circ$  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.



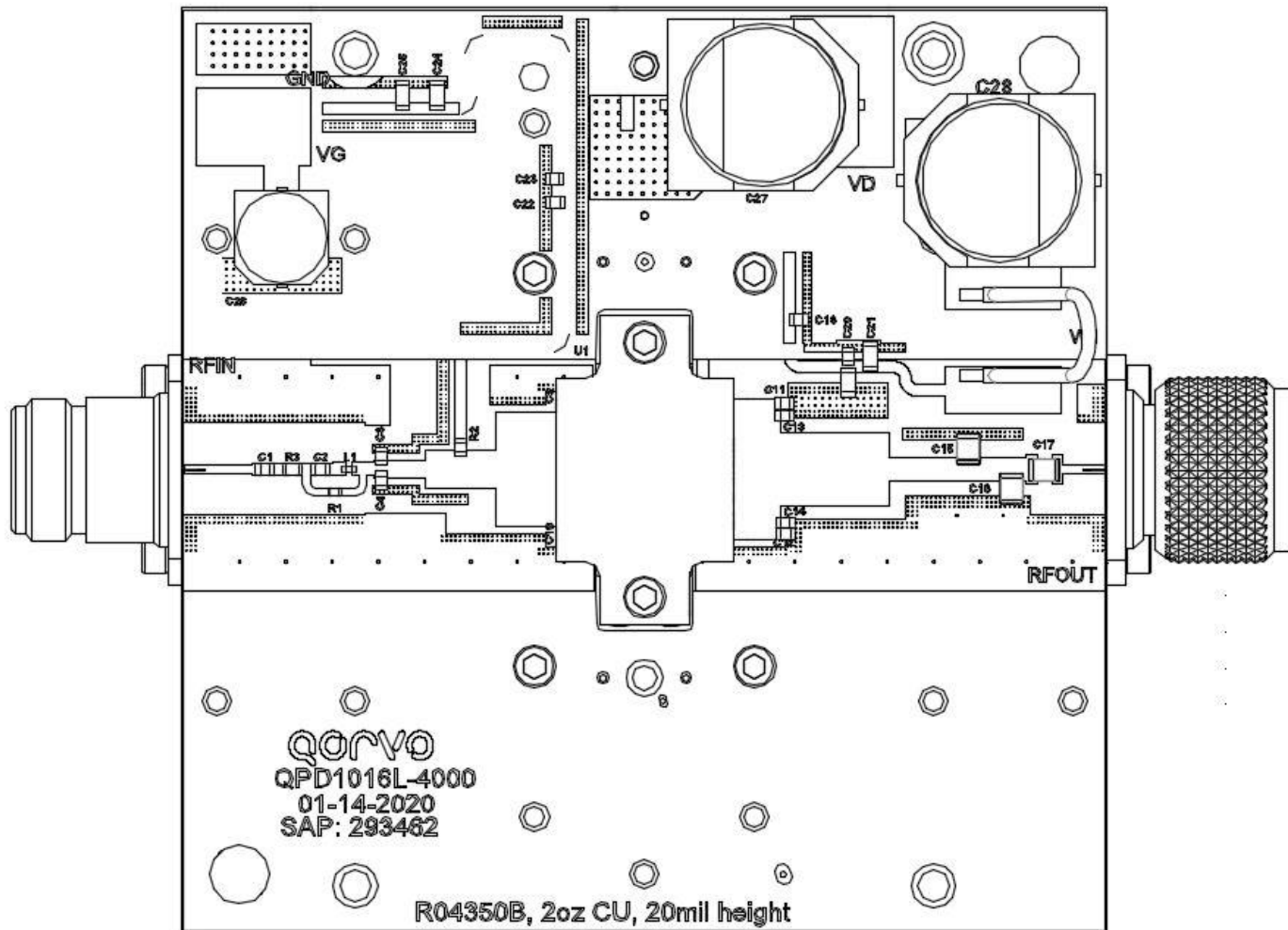
### 1.2 – 1.4 GHz Application Circuit - Schematic



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	UUJ2A221MNPQ1MS
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

