

### Product Overview

The QPD1017 is a 450 W ( $P_{3dB}$ ) internally matched discrete GaN on SiC HEMT which operates from 3.1 to 3.5 GHz on a 50V supply rail. The device is GaN IMFET fully matched to 50  $\Omega$  in an industry standard air cavity package and is ideally suited for military radar.

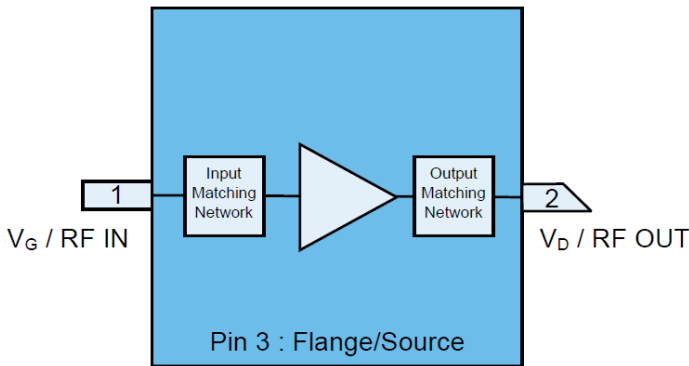
ROHS compliant.

Evaluation boards are available upon request.



17.40 x 24.00 x 4.31 mm

### Functional Block Diagram



### Key Features<sup>1</sup>

- Frequency: 3.1 to 3.5 GHz
- Output Power ( $P_{3dB}$ )<sup>1</sup>: 460 W
- Linear Gain<sup>1</sup>: 16.5 dB
- Typical  $DE_{3dB}$ <sup>1</sup>: 63%
- Typical  $PAE_{3dB}$ <sup>1</sup>: 60%
- Operating Voltage: 50 V
- Low thermal resistance package
- Pulse capable

Note 1: @ 3.3 GHz

### Applications

- Military radar
- Civilian radar
- Test instrumentation

### Ordering Information

Part No.	Description
QPD1017	3.1 – 3.5 GHz RF IMFET
QPD1017SB	3.1 – 3.5 GHz Sample
QPD1017PCB4B01	3.1 – 3.5 GHz EVB

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

Parameter	Rating	Units
Breakdown Voltage, $BV_{DG}$	+145	V
Gate Voltage Range, $V_G$	-7 to +2	V
Drain Current	20	A
Gate Current Range, $I_G$	See page 4.	mA
Power Dissipation, 10% DC 100 uS PW, $P_D$ , $T = 85^\circ\text{C}$	511	W
RF Input Power, 10% DC 100 uS PW, 3.3 GHz, $T = 25^\circ\text{C}$	+49	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.

### Recommended Operating Conditions<sup>1, 2, 3, 4</sup>

Parameter	Min	Typ	Max	Units
Operating Temp. Range	-40	+25	+85	$^\circ\text{C}$
Drain Voltage Range, $V_D$	+28	+50	+55	V
Drain Bias Current, $I_{DQ}$	-	750	-	mA
Drain Current, $I_D$	-	15	-	A
Gate Voltage, $V_G$ <sup>4</sup>	-	-2.8	-	V
Power Dissipation, Pulsed ( $P_D$ ) <sup>2, 3</sup>	-	-	476	W

Notes:

1. Electrical performance is measured under conditions noted in the electrical specifications table. Specifications are not guaranteed over all recommended operating conditions.
2. Package base at  $85^\circ\text{C}$
3. Pulse Width = 100 uS, Duty Cycle = 10%
4. To be adjusted to desired  $I_{DQ}$

### Pulsed Characterization – Load-Pull Performance – Power Tuned<sup>1</sup>

Parameters	Typical Values			Unit
	3.1	3.3	3.5	
Frequency, F	3.1	3.3	3.5	GHz
Linear Gain, $G_{LIN}$	14.8	15.7	15.5	dB
Output Power at 3dB compression point, $P_{3dB}$	57.9	57.8	57.6	dBm
Power-Added-Efficiency at 3dB compression point, $PAE_{3dB}$	57.5	56.4	54.7	%
Gain at 3dB compression point	11.8	12.7	12.5	dB

Notes:

1. Test conditions unless otherwise noted:  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ ,  $\text{Temp} = 25^\circ\text{C}$ , 100 uS PW, 10% DC

### Pulsed Characterization – Load-Pull Performance – Efficiency Tuned<sup>1</sup>

Parameters	Typical Values			Unit
	3.1	3.3	3.5	
Frequency, F	3.1	3.3	3.5	GHz
Linear Gain, $G_{LIN}$	15.8	16.8	16.8	dB
Output Power at 3dB compression point, $P_{3dB}$	56.1	56.2	55.9	dBm
Power-Added-Efficiency at 3dB compression point, $PAE_{3dB}$	68.0	66.0	65.0	%
Gain at 3dB compression point, $G_{3dB}$	12.8	13.8	13.8	dB

Notes:

1. Test conditions unless otherwise noted:  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ ,  $\text{Temp} = 25^\circ\text{C}$ , 100 uS PW, 10% DC

### RF Characterization – 3.1 – 3.5 GHz EVB Performance At 3.1 GHz<sup>1</sup>

Parameter	Min	Typ	Max	Units
Linear Gain, $G_{LIN}$	–	15.4	–	dB
Output Power at 3dB compression point, $P_{3dB}$	–	56.6	–	dBm
Power-Added Efficiency at 3dB compression point, $PAE_{3dB}$	–	57.1	–	%
Gain at 3dB compression point, $G_{3dB}$	–	12.4	–	dB

Notes:

1.  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ , Temp = 25°C, 100 uS PW, 10% DC

### RF Characterization – 3.1 – 3.5 GHz EVB Performance At 3.3 GHz<sup>1</sup>

Parameter	Min	Typ	Max	Units
Linear Gain, $G_{LIN}$	–	16.0	–	dB
Output Power at 3dB compression point, $P_{3dB}$	–	56.3	–	dBm
Power-Added Efficiency at 3dB compression point, $PAE_{3dB}$	–	54.6	–	%
Gain at 3dB compression point, $G_{3dB}$	–	13.0	–	dB

Notes:

1.  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ , Temp = 25°C, 100 uS PW, 10% DC

### RF Characterization – 3.1 – 3.5 GHz EVB Performance At 3.5 GHz<sup>1</sup>

Parameter	Min	Typ	Max	Units
Linear Gain, $G_{LIN}$	–	16.2	–	dB
Output Power at 3dB compression point, $P_{3dB}$	–	56.2	–	dBm
Power-Added Efficiency at 3dB compression point, $PAE_{3dB}$	–	54.1	–	%
Gain at 3dB compression point, $G_{3dB}$	–	13.2	–	dB

Notes:

1.  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ , Temp = 25°C, 100 uS PW, 10% DC

### RF Characterization – Mismatch Ruggedness at 3.1, 3.3 & 3.5 GHz<sup>1, 2, 3</sup>

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

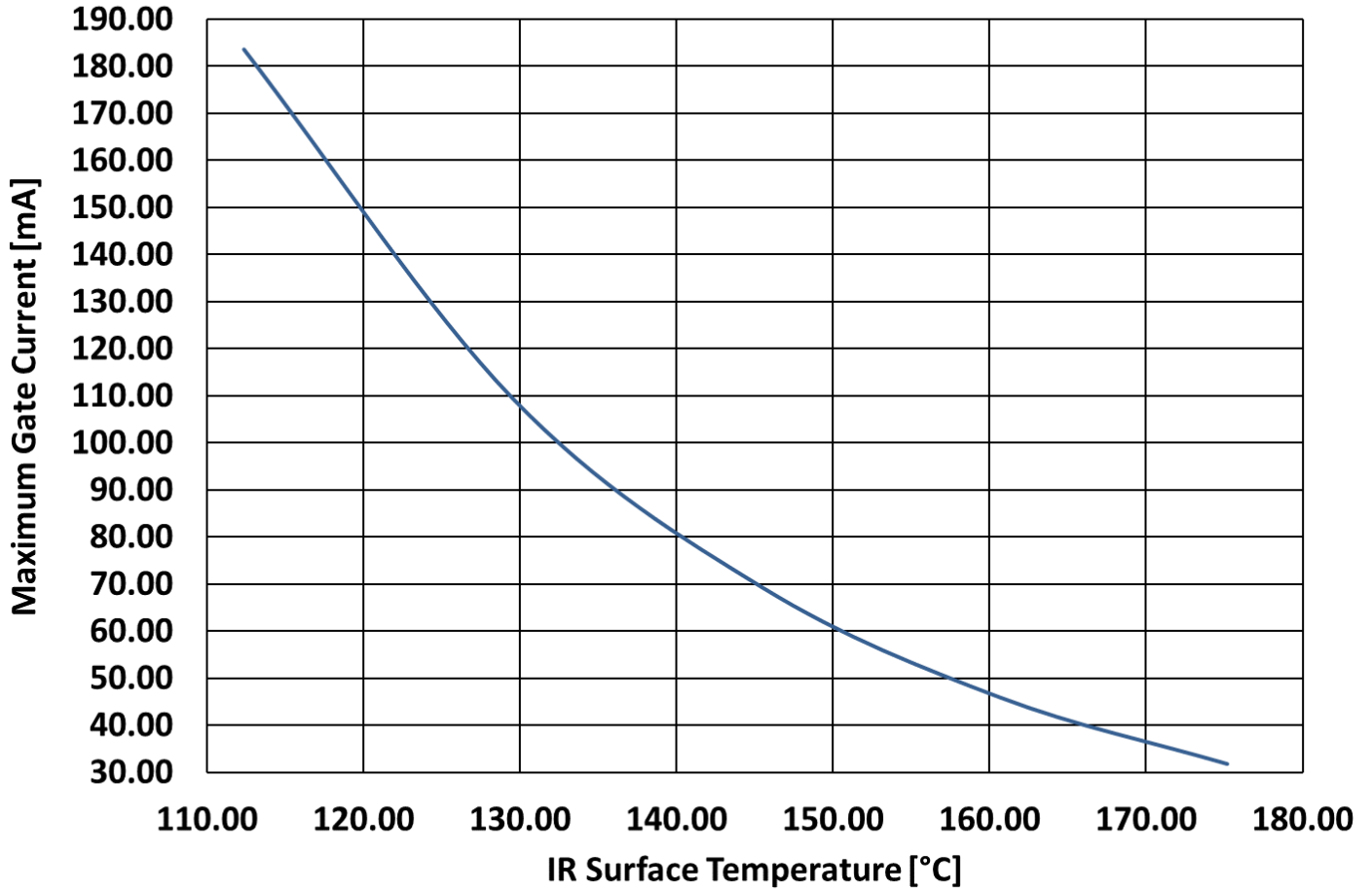
Notes:

1. Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ , 100 uS PW, 10% DC.
2. Driving input power is determined at pulsed compression under matched condition at EVB output connector.
3. No spur detected down to the noise floor of Spectrum Analyzer from 1 – 15GHz at  $T_A = -40^\circ\text{C}$ .

Maximum Gate Current

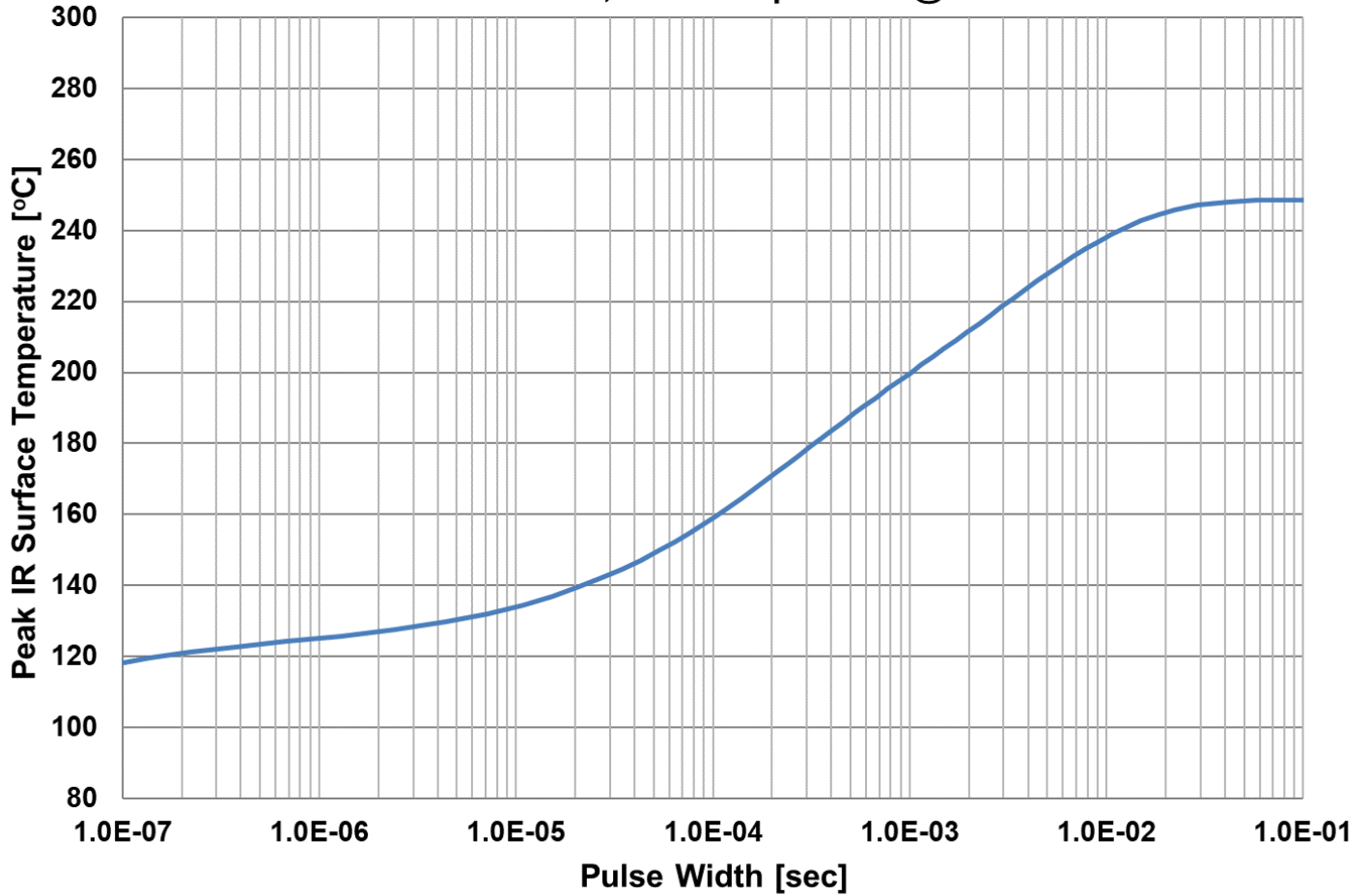
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Maximum Gate Current vs. IR Surface Temperature



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

**Peak IR Surface Temperature vs. Pulse Width**  
**P<sub>diss</sub> = 346 W, Base Temperature @ 85°C**



Parameter	Conditions	Values	Units
Thermal Resistance, IR <sup>1</sup> ( $\theta_{JC}$ )	85°C back side temperature	0.33	°C/W
Peak IR Surface Temperature <sup>1</sup> ( $T_{CH}$ )	346 W P <sub>diss</sub> , 1 mS PW, 10% DC	200	°C

Notes:

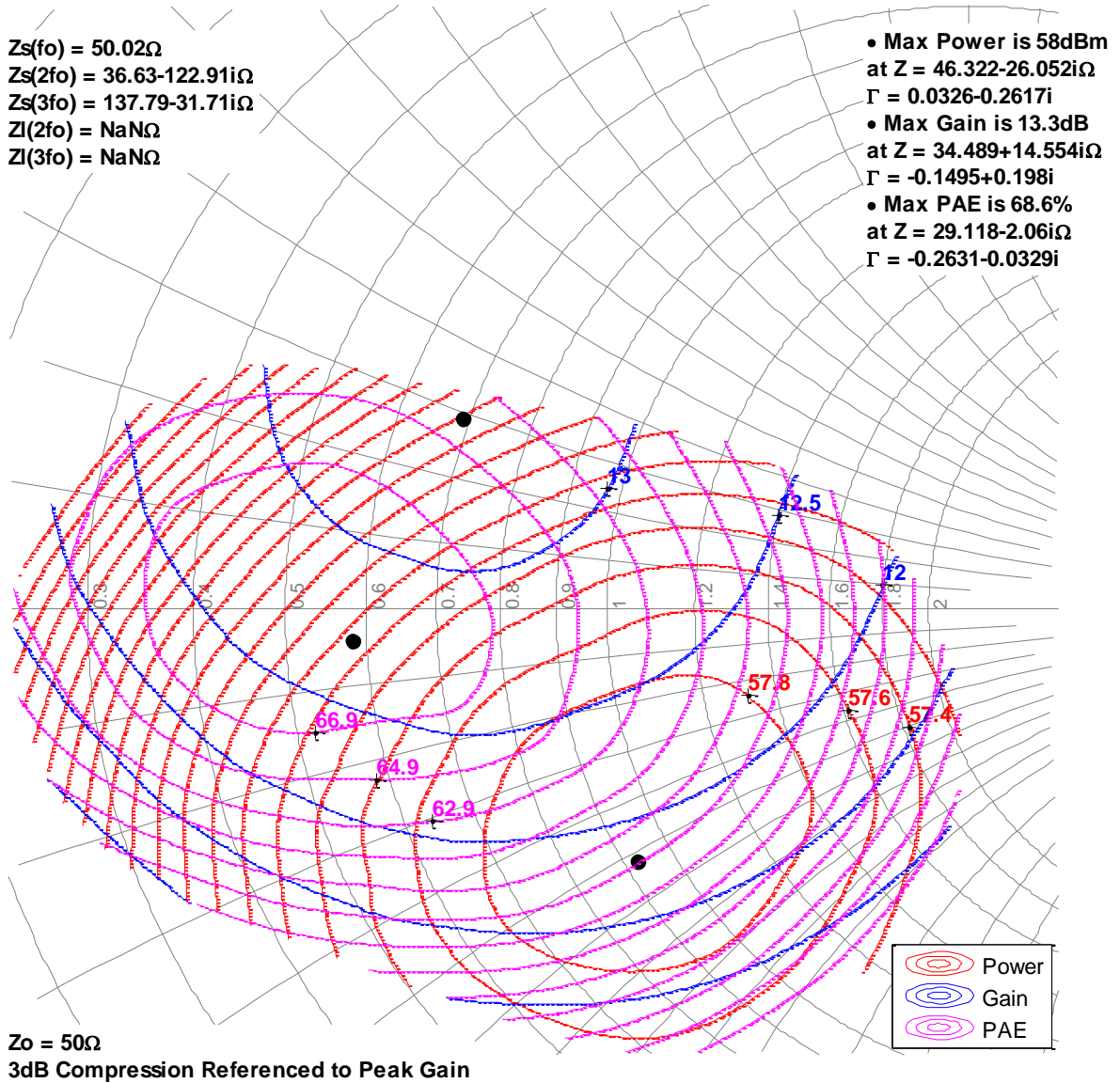
1- Refer to the following document: [GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates](#)

Load-Pull Smith Charts<sup>1, 2, 3</sup>

Notes:

1.  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ ,  $100\text{ }\mu\text{s PW}$ ,  $10\%$  DC pulsed. Performance is at 3dB gain compression referenced to peak gain.
2. See page 12 for load-pull and source-pull reference planes.  $50\text{-}\Omega$  load-pull TRL fixtures are built with  $20\text{-mil RO4350B}$  material.
3. NaN means the impedances are either undefined or varying in load-pull system.

3.1GHz, Load-pull

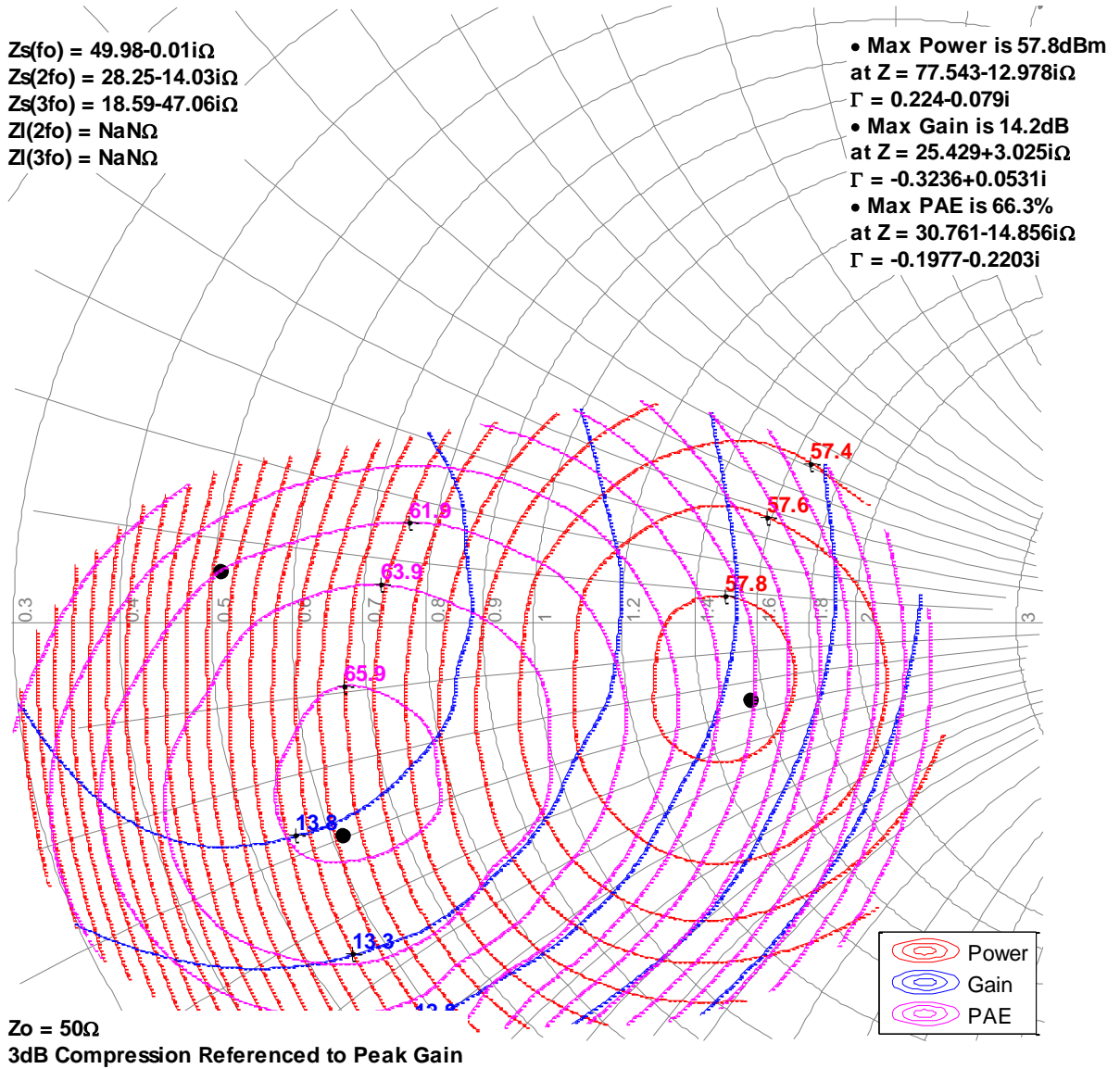


Load-Pull Smith Charts<sup>1, 2, 3</sup>

Notes:

1.  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ ,  $100\text{ }\mu\text{s PW}$ ,  $10\%$  DC pulsed. Performance is at 3dB gain compression referenced to peak gain.
2. See page 12 for load-pull and source-pull reference planes.  $50\text{-}\Omega$  load-pull TRL fixtures are built with 20-mil RO4350B material.
3. NaN means the impedances are either undefined or varying in load-pull system.

3.3GHz, Load-pull



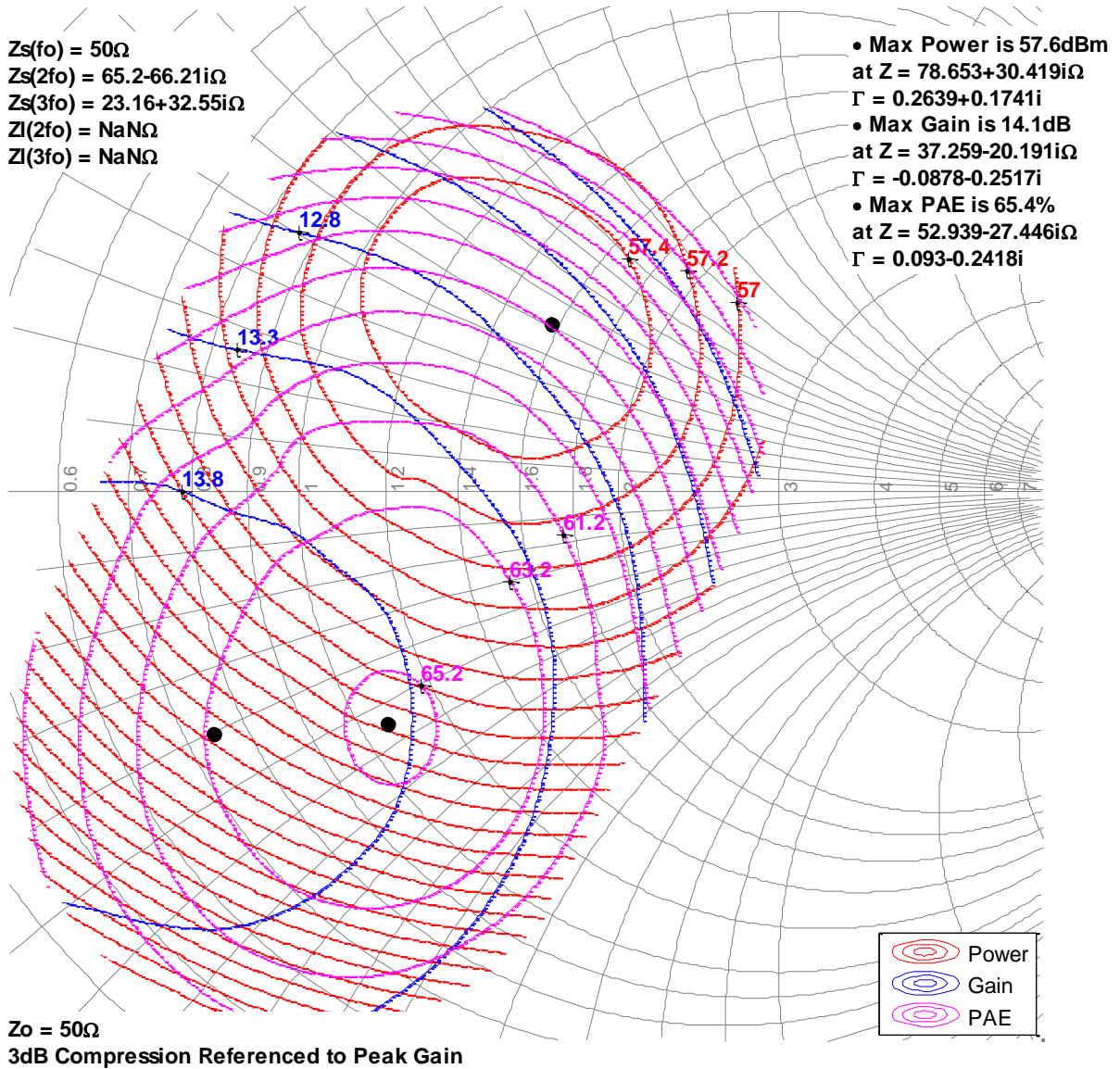


Load-Pull Smith Charts<sup>1, 2, 3</sup>

Notes:

1.  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ ,  $100\text{ }\mu\text{s PW}$ ,  $10\%$  DC pulsed. Performance is at 3dB gain compression referenced to peak gain.
2. See page 12 for load-pull and source-pull reference planes.  $50\text{-}\Omega$  load-pull TRL fixtures are built with 20-mil RO4350B material.
3. NaN means the impedances are either undefined or varying in load-pull system.

3.5GHz, Load-pull

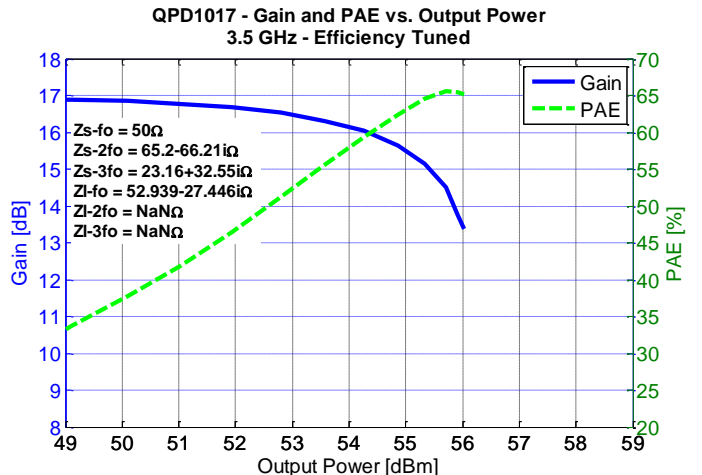
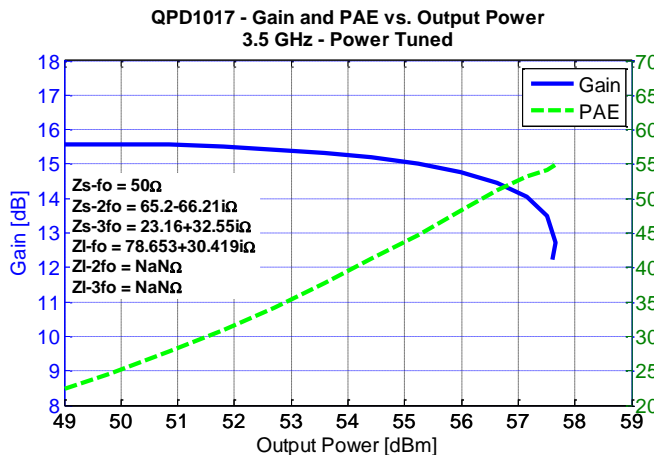
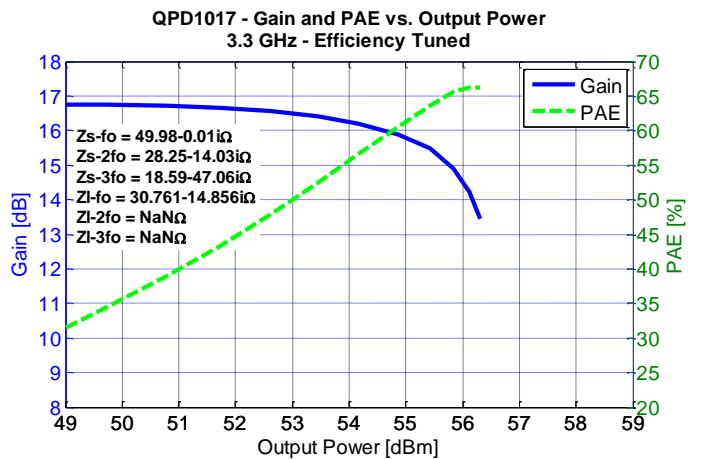
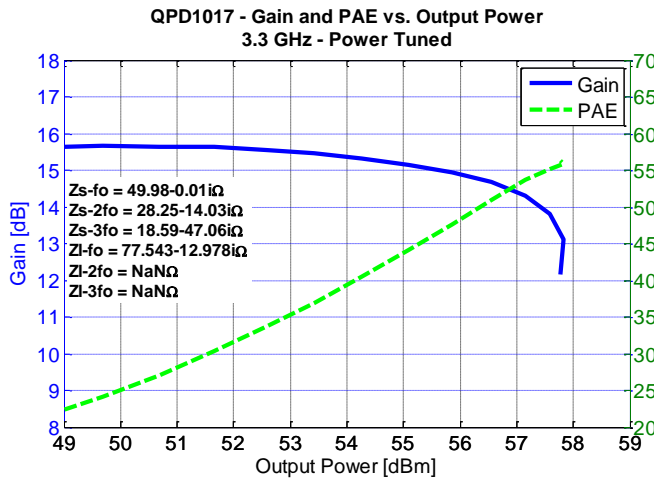
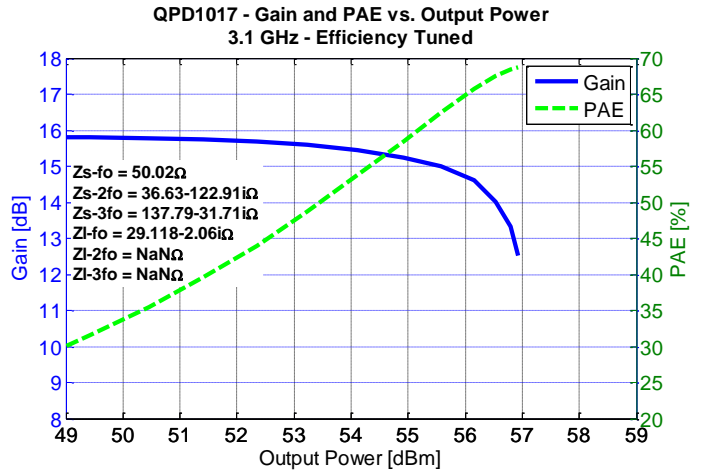
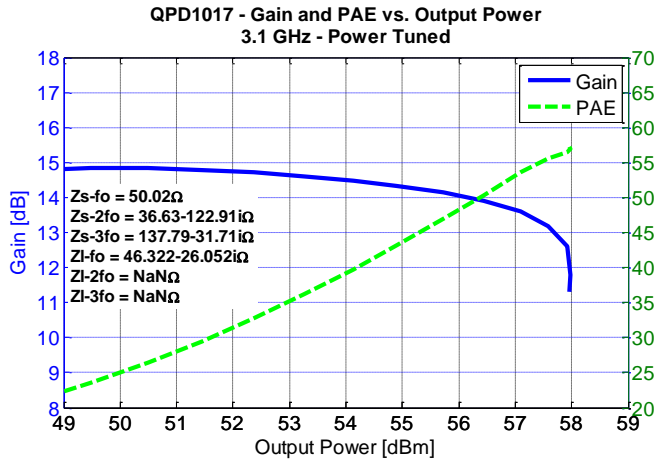




### Typical Performance – Load-Pull Drive-up<sup>1, 2</sup>

Notes:

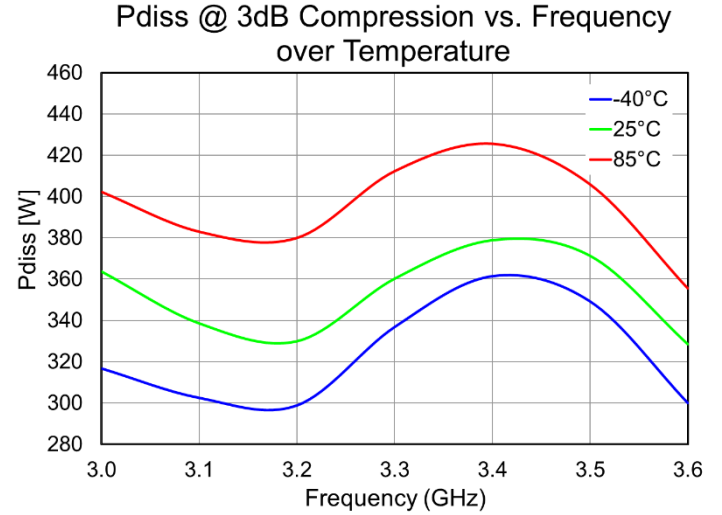
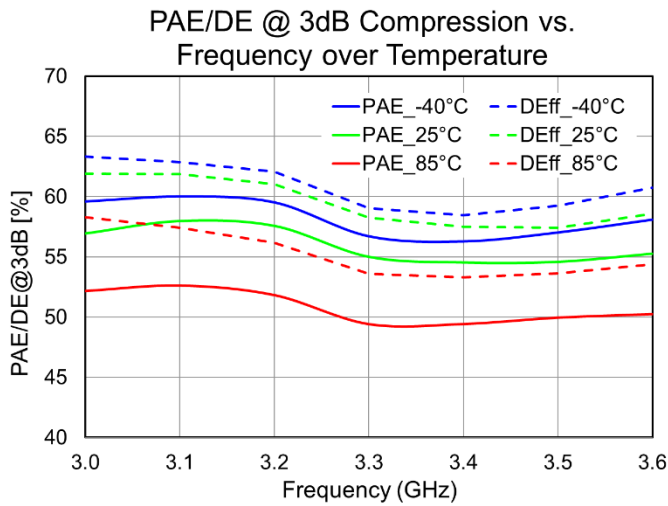
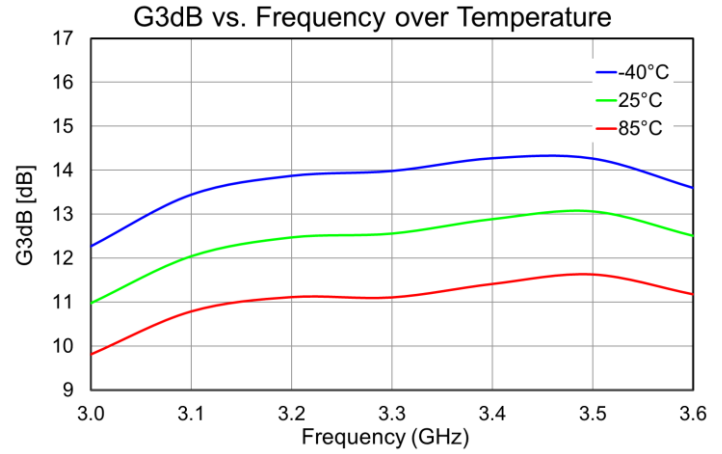
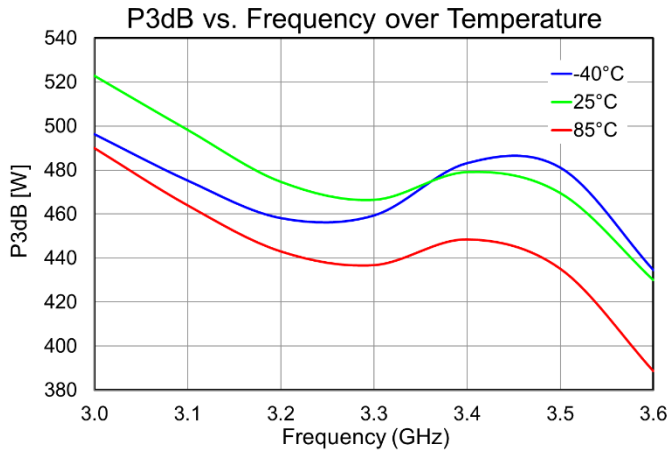
1. 100 uS PW, 10% DC pulsed signal,  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ ,  $T_A = 25^\circ\text{C}$ .
2. See page 12 for load-pull and source-pull reference planes where the performance was measured.



### Power Drive-up Performance Over Temperatures Of 3.1 – 3.5 GHz EVB<sup>1, 2</sup>

Notes:

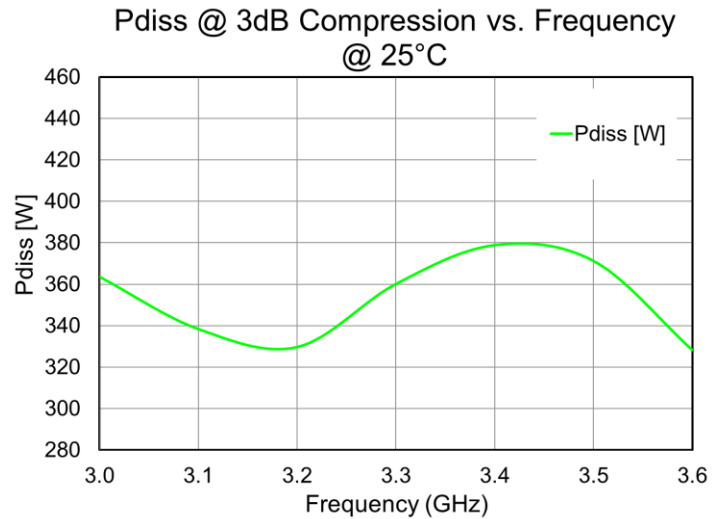
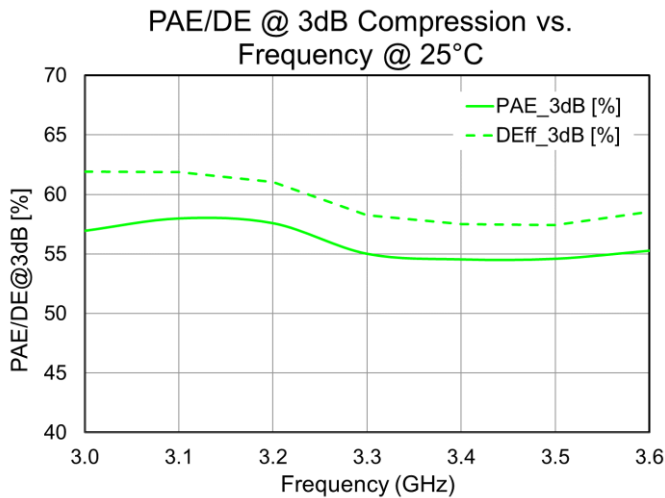
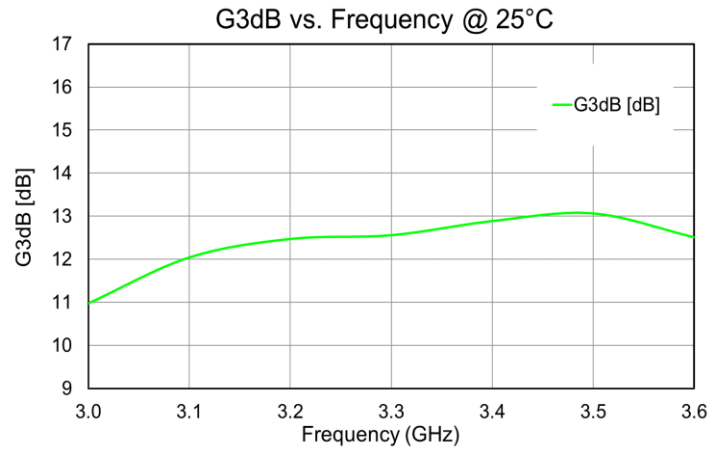
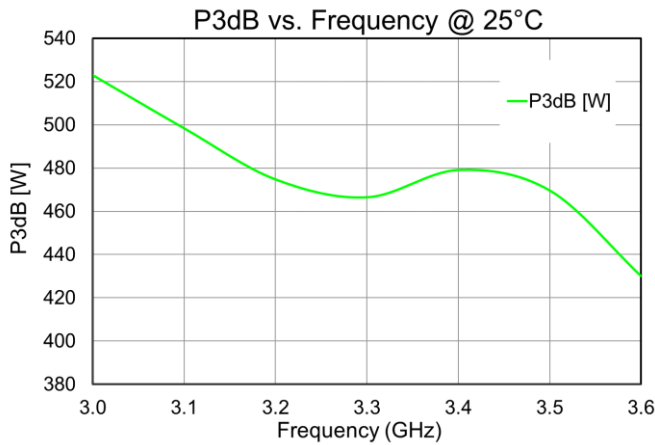
1.  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ ,  $100\text{ }\mu\text{S PW}$ ,  $10\%\text{ DC}$ .
2. Performance shown is at EVB connectors reference plane.



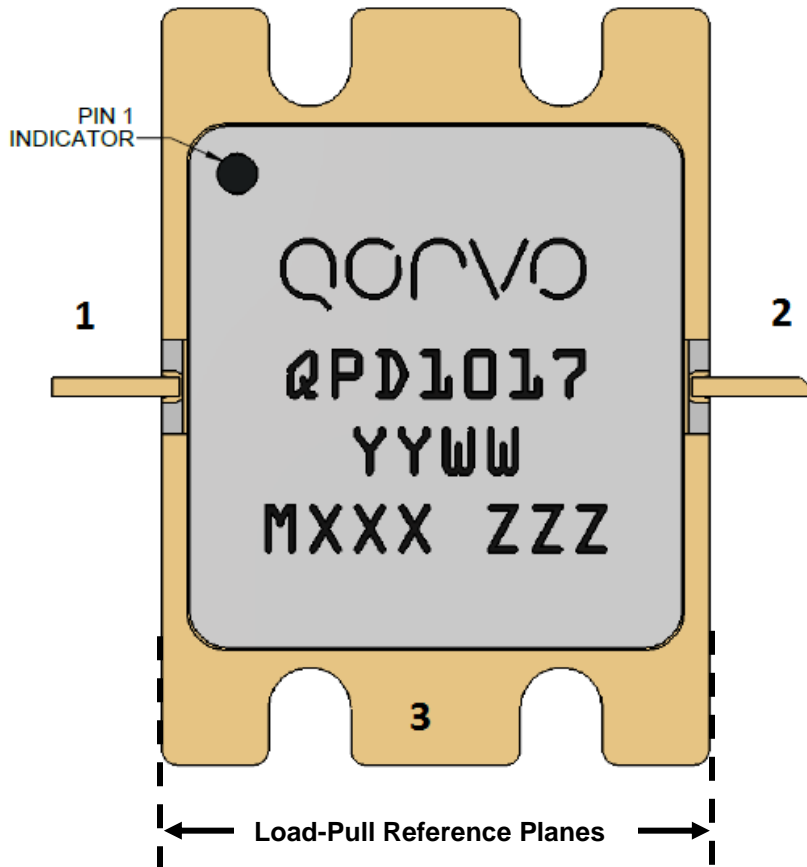
### Power Drive-up Performance At 25°C Of 3.1 – 3.5 GHz EVB<sup>1,2</sup>

Notes:

1.  $V_D = 50\text{ V}$ ,  $I_{DQ} = 750\text{ mA}$ ,  $100\text{ }\mu\text{S PW}$ ,  $10\%\text{ DC}$ ,  $T_A = 25^\circ\text{C}$ .
2. Performance shown is at EVB connectors reference plane.



**Pin Configuration, Marking and Description<sup>1</sup>**



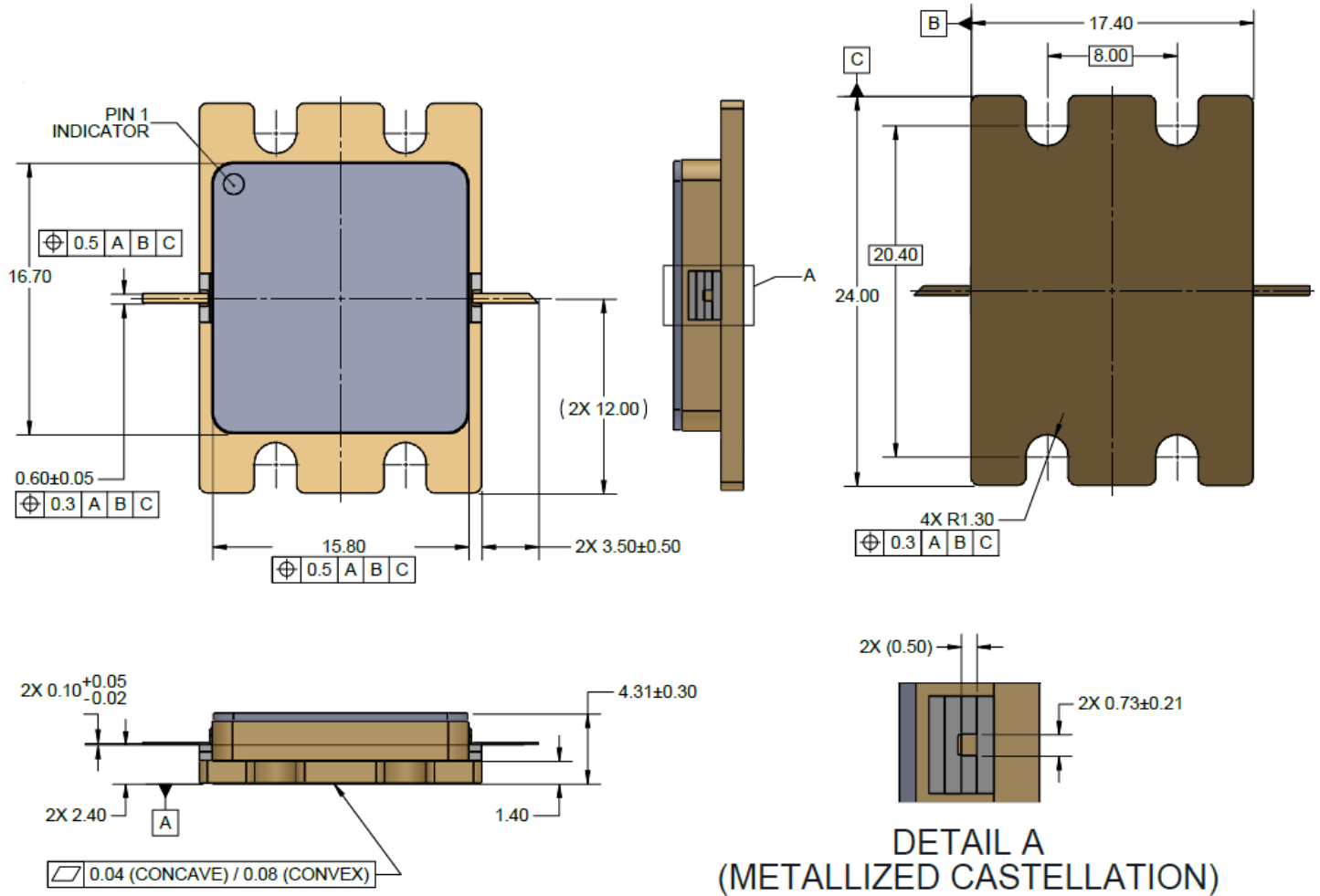
**Pin Description**

Pin	Symbol	Description
1	$V_G$ / RF IN	Gate voltage / RF Input
2	$V_D$ / RF OUT	Drain voltage / RF Output
3	GND	Package base / Ground

Notes:

- The QPD1017 will be marked with the “QPD1017” 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.

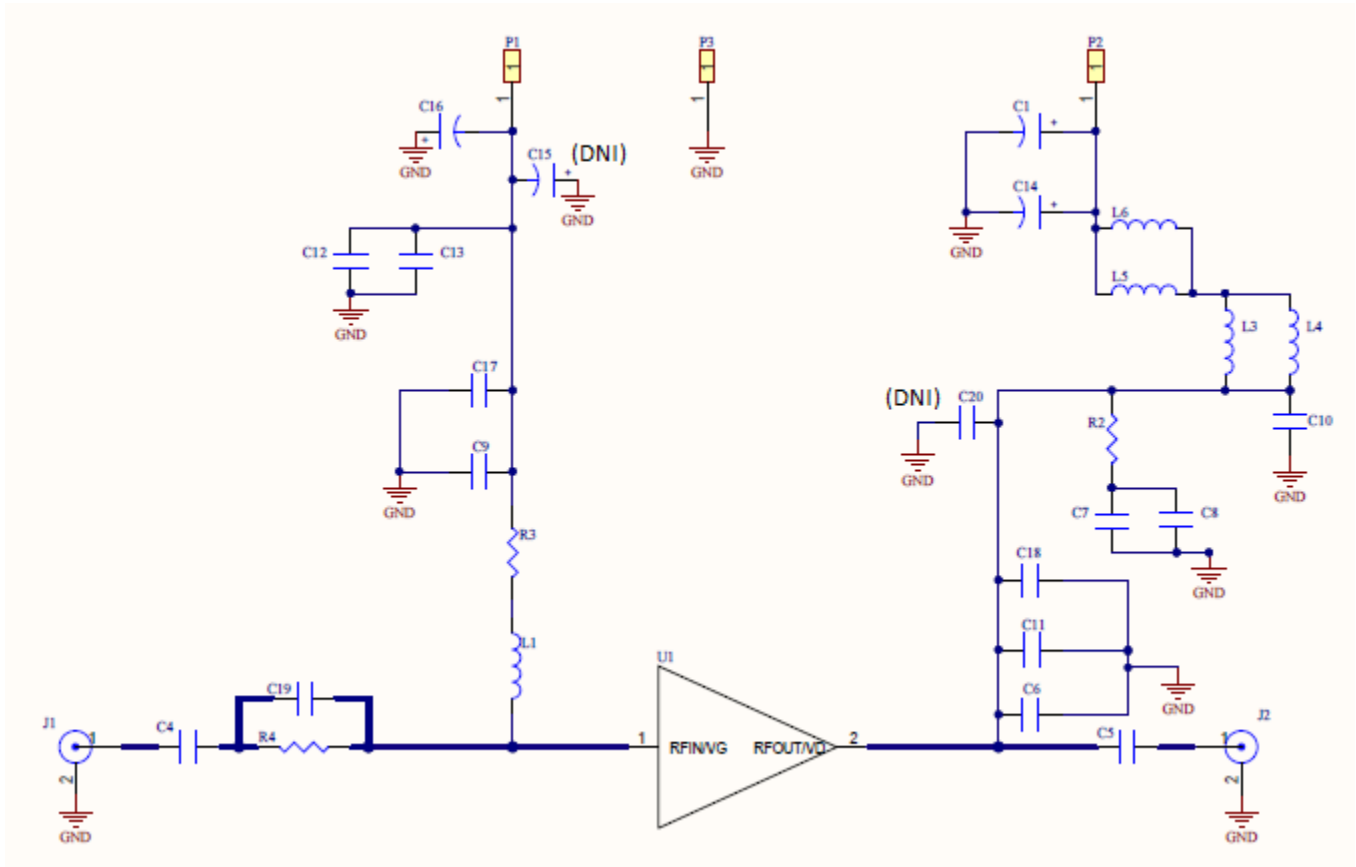
Package Dimensions<sup>1, 2, 3, 4</sup>



Notes:

1. All dimensions are in mm. otherwise noted, the tolerance is ±0.15 mm.
2. Package is an all metal design with ceramic lid and feed thru's.
3. Package is epoxy sealed.
4. For instruction to mount the part, please refer to application note "[RF565 Package Mounting, Mechanical Mounting and PCB Considerations](#)".

### Schematic – 3.1 – 3.5 GHz EVB



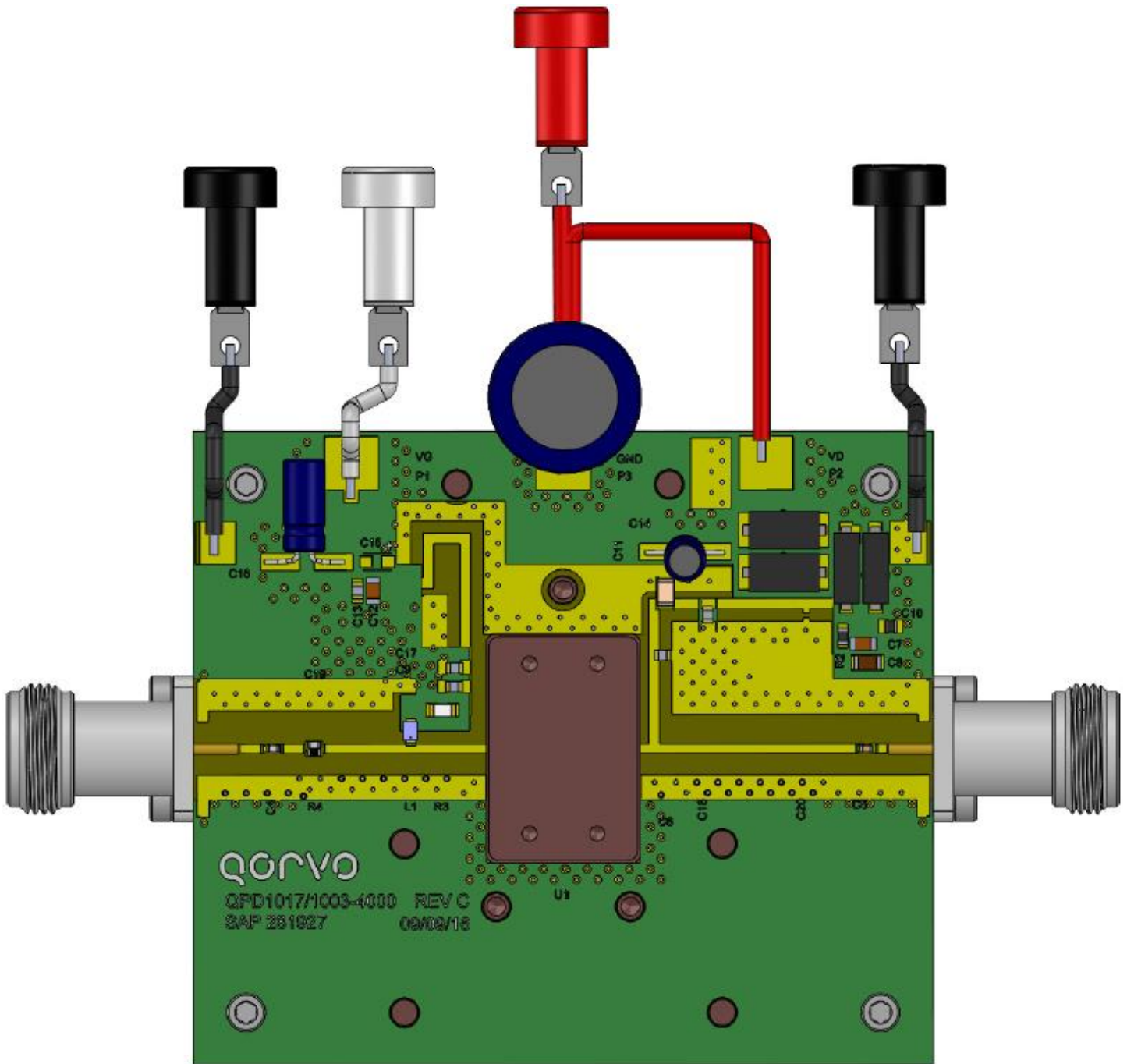
#### Bias-up Procedure

1. Set  $V_G$  to -6 V.
2. Set  $I_D$  current limit to 1000 mA.
3. Apply 50 V  $V_D$ .
4. Slowly adjust  $V_G$  until  $I_D$  is set to 750 mA.
5. Set  $I_D$  current limit to 2 A
6. Apply RF.

#### Bias-down Procedure

1. Turn off RF signal.
2. Turn off  $V_D$
3. Wait 2 seconds to allow drain capacitor to discharge
4. Turn off  $V_G$

PCB Assembly – 3.1 – 3.5 GHz EVB<sup>1</sup>



- Notes:
1. PCB Material: RO4350B, 20 mil thickness, 1 oz copper cladding



### Bill Of material – 3.1 – 3.5 GHz EVB

Ref Des	Value	Qty	Manufacturer	Part Number
C1	680 uF	1	Panasonic	EEU-FC2A681
C4, C19	10 pF	2	ATC	ATC600S100JW250XT
C5	15 pF	1	ATC	ATC600S150FT250XT
C6, C9	10 pF	2	ATC	ATC600F100BT250XT
C7, C12	10000 pF	2	Panasonic	ECJ-2VB2A103K
C8	0.1 uF	1	Panasonic	ECJ-3YB2A104K
C10	100 pF	1	ATC	ATC800A101JT250X
C11	0.1 uF	1	Murata	GRM32NR72A104KA01L
C13	0.1 uF	1	Panasonic	ECJ-2YB1H104K
C14, C16	10 uF	2	Panasonic	ECA-2AM100
C17, C18	10000 pF	2	Samsung	CL31B103KGFNNNE
R2	51 Ohm	1	Panasonic	ERJ-6GEYJ510
R3	10 Ohm	1	Panasonic	ERJ-8GEYJ100V
R4	1 kOhm	1	Vishay	CRCW06031K00FKTA
L1	22 nH	1	Coilcraft	0805HT-22NTJLB
L3, L4	75 Ohm	2	Steward	35F0121-1SR-10
L5, L6	115 Ohm	2	Steward	28F0181-1SR-10

### Recommended Solder Temperature Profile

