QPD1003

500 W, 50 V, 1.2 – 1.4 GHz, GaN RF IMFET

Product Overview

The QPD1003 is a 500W (P_{3dB}) internally matched discrete GaN on SiC HEMT which operates from 1.2 to 1.4 GHz and a 50V supply rail. The device is GaN IMFET fully matched to 50 Ω in an industry standard air cavity package and is ideally suited for military and civilian radar. The device can support pulsed and linear operations.

ROHS compliant.

Evaluation boards are available upon request.

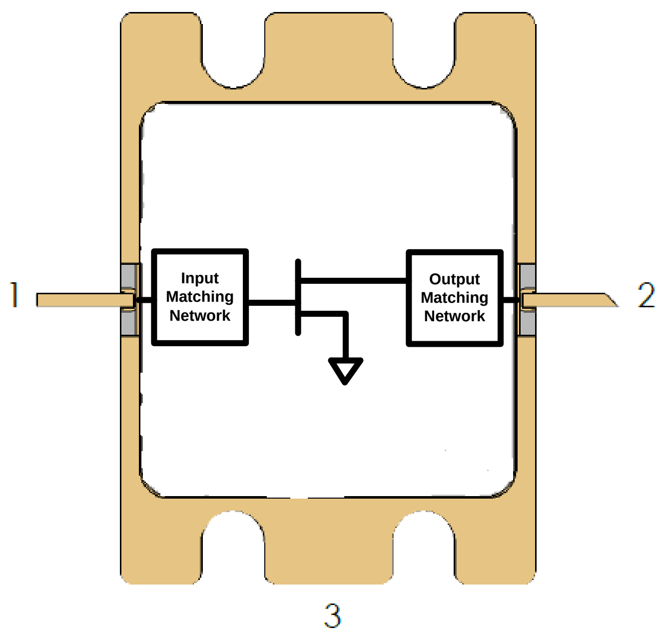
17.40 x 24.0 x 4.31 mm

Key Features

- Frequency: 1.2 to 1.4 GHz
- Output Power (P_{3dB})[1]: 540 W
- Linear Gain[1]: 19.9 dB
- Typical PAE_{3dB}[1]: 66.7%
- Operating Voltage: 50 V
- Low thermal resistance package
- Pulse capable

Notes:
1. @ 1.3 GHz

Functional Block Diagram



Applications

- Military Radar
- Civilian Radar

Ordering Information

Part Number	Description
1131389	1.2 – 1.4 GHz RF IMFET
1131532	1.2 – 1.4 GHz EVB

Absolute Maximum Ratings[1]

Parameter	Rating	Units
Breakdown Voltage (BV_{DG})	+145	V
Gate Voltage (V_G)	-7 to +2	V
Drain Current (I_D)	20	A
Power Dissipation (P_D)[2]	410	W
RF Input Power (RF_{IN})[2,3]	+42	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 CW: Duty Cycle = 10%, Pulse Width = 1 ms
3. Frequency at 1.3 GHz, T = 25 °C

Recommended Operating Conditions[1]

Parameter	Min	TYP	Max	Units
Operating Temperature	-40	+25	+85	°C
Drain Voltage (V_D)	+28	+50	+55	V
Drain Bias Current (I_{DQ})	-	750	-	mA
Drain Current (I_D)	-	15	-	A
Gate Voltage (V_G)[3]	-	-2.8	-	V
Power Dissipation (P_D)[2]	-	-	370	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. Pulsed CW: Pulse Width = 1 ms, Duty Cycle = 10 Package base at 85°C
3. To be adjusted to desired I_{DQ}

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

Parameters	Typical Values			Units
Frequency	1.2	1.3	1.4	GHz
Linear Gain (G_{LIN})	19	19.9	18.6	dB
Output Power at 3dB Compression (P_{3dB})	57.3	57.3	57	dBm
Power-Added-Efficiency at 3dB Compression (PAE_{3dB})	55.1	57.6	56.9	%
Gain at 3dB Compression (G_{3dB})	16	16.9	15.6	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 1 ms, Duty Cycle = 10%

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

Parameters	Typical Values			Units
Frequency	1.2	1.3	1.4	GHz
Linear Gain (G_{LIN})	20.3	20.6	19.4	dB
Output Power at 3dB Compression (P_{3dB})	55.4	55.6	55.3	dBm
Power-Added-Efficiency at 3dB Compression (PAE_{3dB})	70.3	66.7	67.4	%
Gain at 3dB Compression (G_{3dB})	17.3	17.6	16.4	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 1 ms, Duty Cycle = 10%

RF Characterization – 1.2 – 1.4 GHz EVB Performance at 1.2 GHz[1]

Parameters	Typical Values			Units
Linear Gain (G_{LIN})	-	18.6	-	dB
Output Power at 3dB Compression (P_{3dB})	-	57.1	-	dBm
Power-Added-Efficiency at 3dB Compression (PAE_{3dB})	-	57.7	-	%
Gain at 3dB Compression (G_{3dB})	-	15.6	-	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, CW

RF Characterization – 1.2 – 1.4 GHz EVB Performance at 1.3 GHz[1]

Parameters	Typical Values			Units
Linear Gain (G_{LIN})	-	19.8	-	dB
Output Power at 3dB Compression (P_{3dB})	-	56.6	-	dBm
Power-Added-Efficiency at 3dB Compression (PAE_{3dB})	-	62.0	-	%
Gain at 3dB Compression (G_{3dB})	-	16.8	-	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, CW

RF Characterization – 1.2 – 1.4 GHz EVB Performance at 1.4 GHz[1]

Parameters	Typical Values			Units
Linear Gain (G_{LIN})	-	18.5	-	dB
Output Power at 3dB Compression (P_{3dB})	-	56.4	-	dBm
Power-Added-Efficiency at 3dB Compression (PAE_{3dB})	-	59.2	-	%
Gain at 3dB Compression (G_{3dB})	-	15.5	-	dB

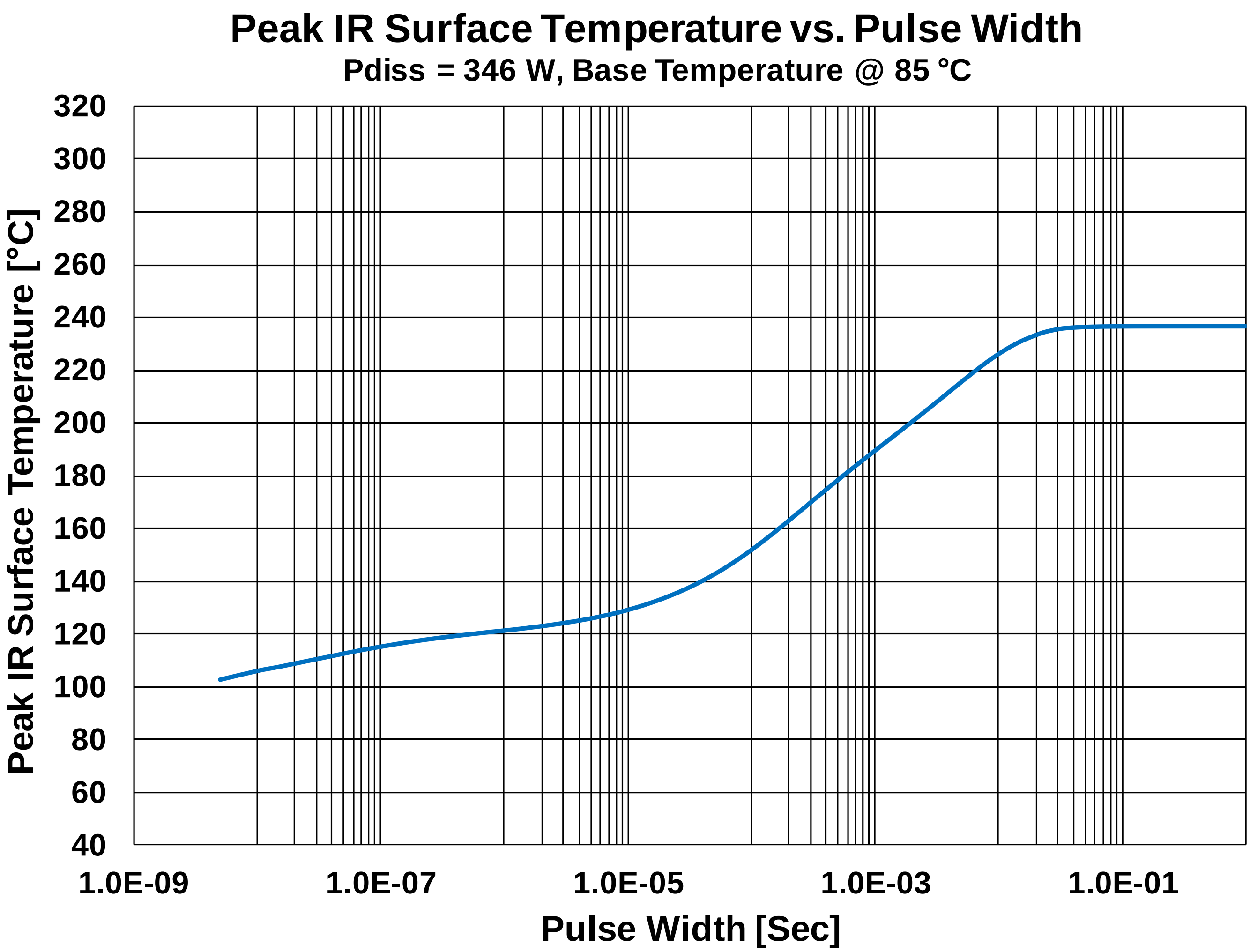
Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, CW

RF Characterization – Mismatch Ruggedness at 1.3 GHz[1]

Symbol	Parameter	dB Compression	Typical
VSWR	Impedance Mismatch Ruggedness	3	5:1

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 1 ms, Duty Cycle = 10%
2. Driving input power is determined at pulsed compression under matched condition at EVB output connector.

Thermal and Reliability Information – Pulsed



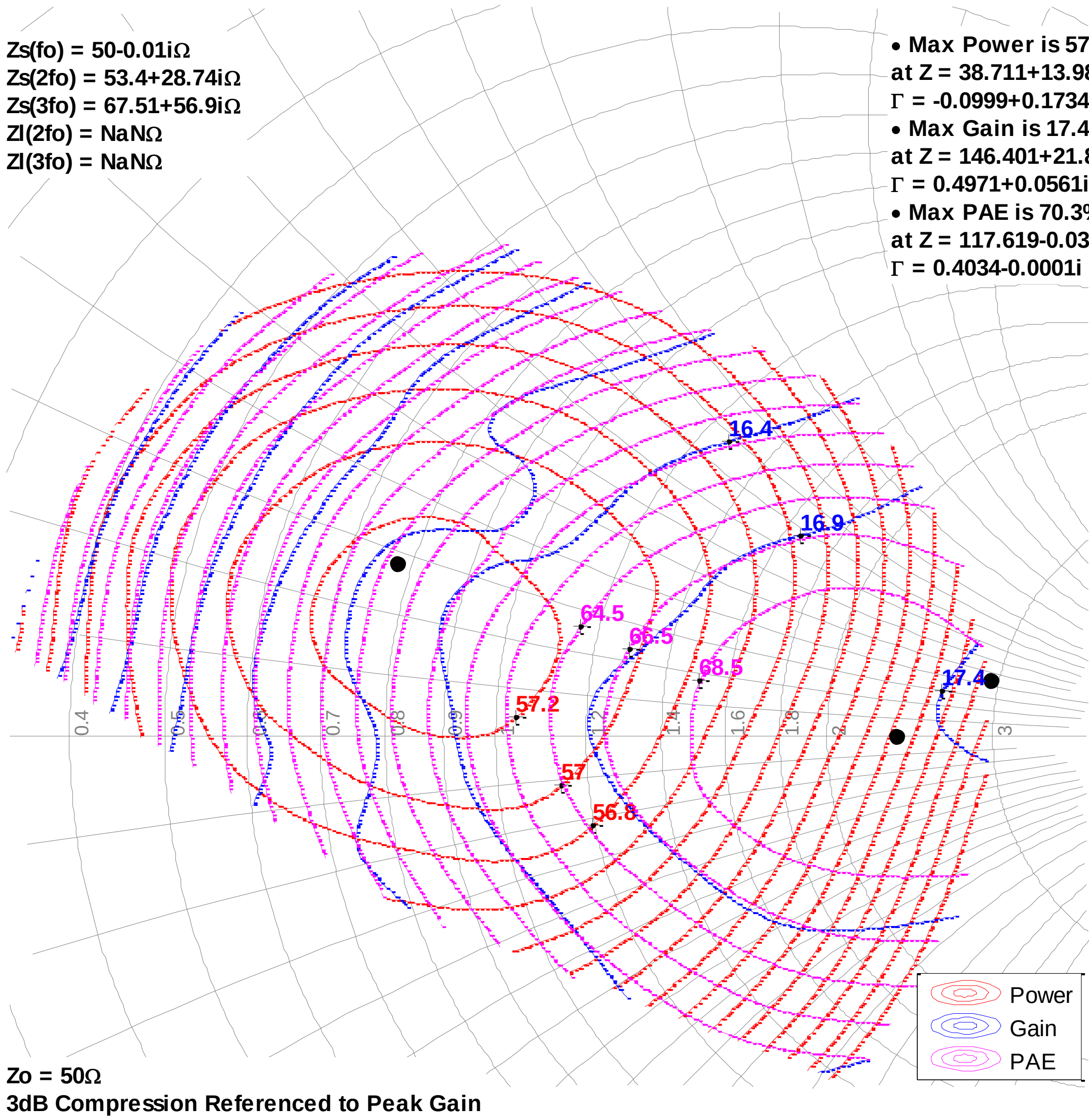
Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	0.3	°C/W
Peak IR Surface Temperature[1] (T_{CH})	346 W P_D, Pulse Width = 1 ms, Duty Cycle = 10%	189	°C

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

Load Pull Contours[1, 2, 3]

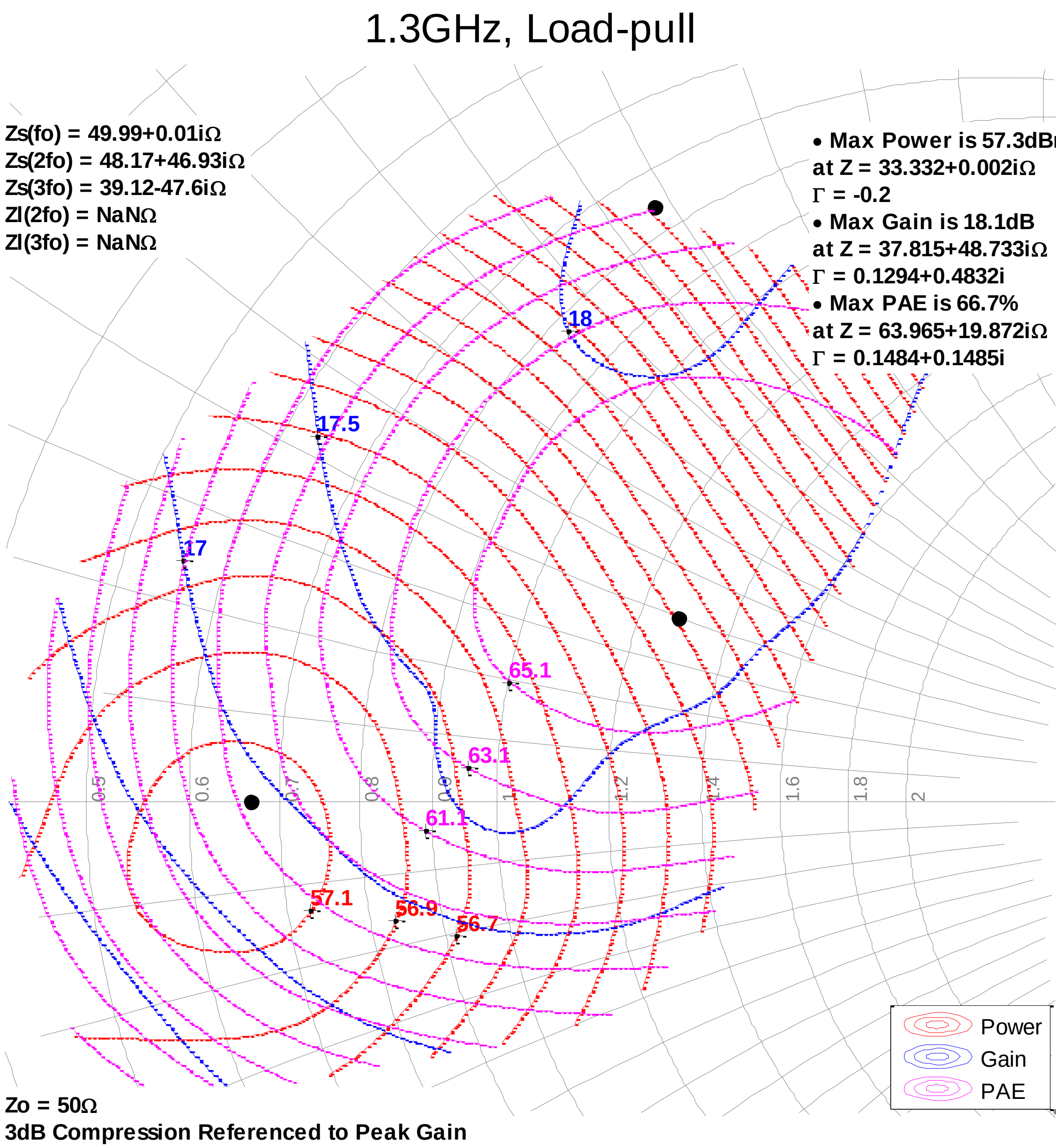
Notes:
1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 1 ms. Duty Cycle = 10%. Performance is at 3dB gain compression referenced to peak gain.
2. See page 11 for load-pull and source-pull reference planes. 50 Ω load-pull TRL fixtures are built with 20 mils RO4350B material.
3. NaN means the impedance are either undefined or varying in load-pull system.

1.2GHz, Load-pull



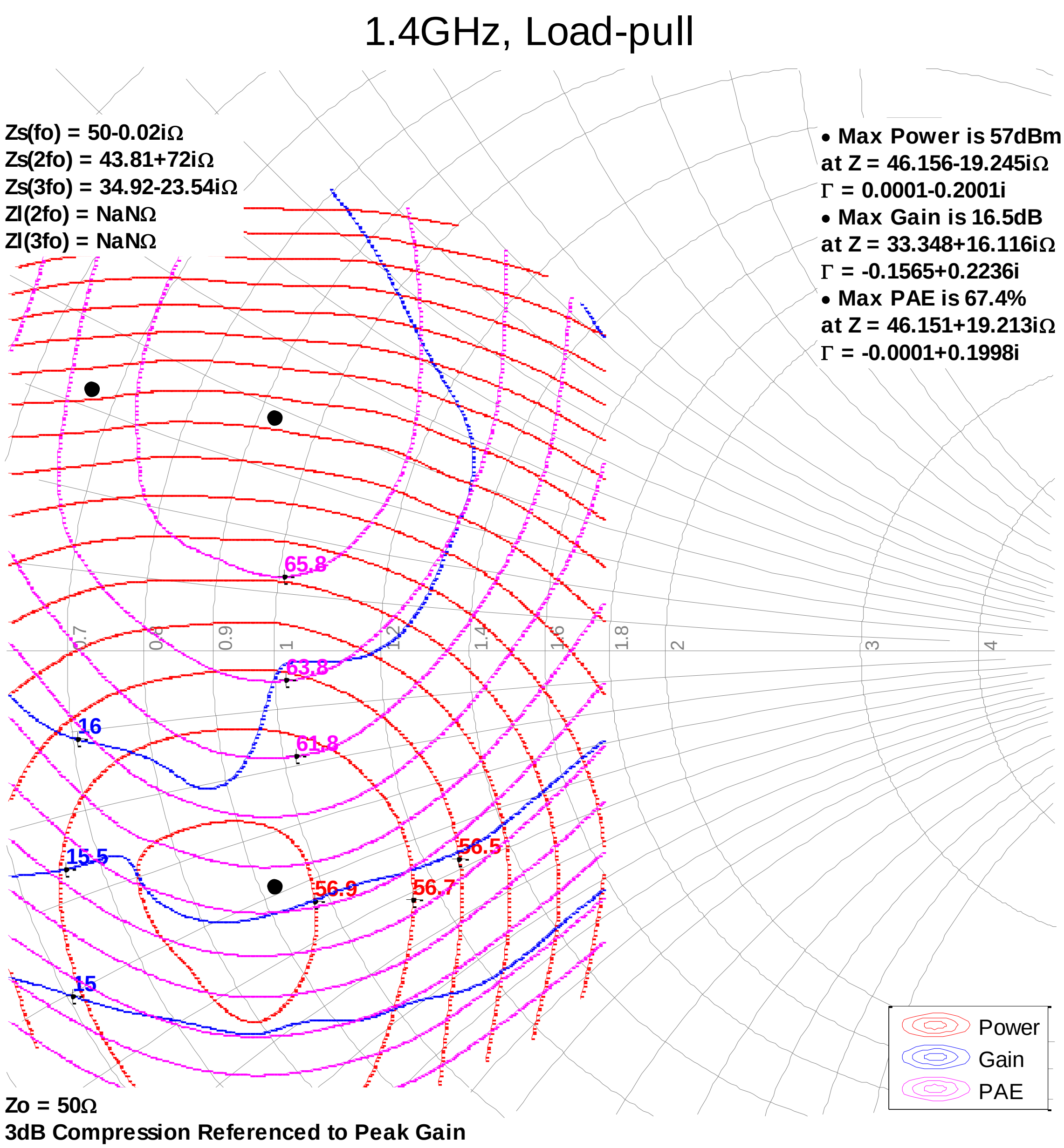
Load Pull Contours[1, 2, 3]

Notes:
1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 1 ms. Duty Cycle = 10%. Performance is at 3dB gain compression referenced to peak gain.
2. See page 11 for load-pull and source-pull reference planes. 50 Ω load-pull TRL fixtures are built with 20 mils RO4350B material.
3. NaN means the impedance are either undefined or varying in load-pull system.



Load Pull Contours[1, 2, 3]

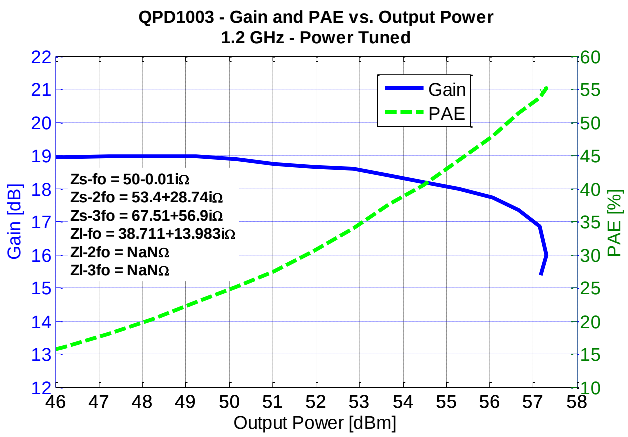
Notes:
1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 1 ms. Duty Cycle = 10%. Performance is at 3dB gain compression referenced to peak gain.
2. See page 11 for load-pull and source-pull reference planes. 50 Ω load-pull TRL fixtures are built with 20 mils RO4350B material.
3. NaN means the impedance are either undefined or varying in load-pull system.

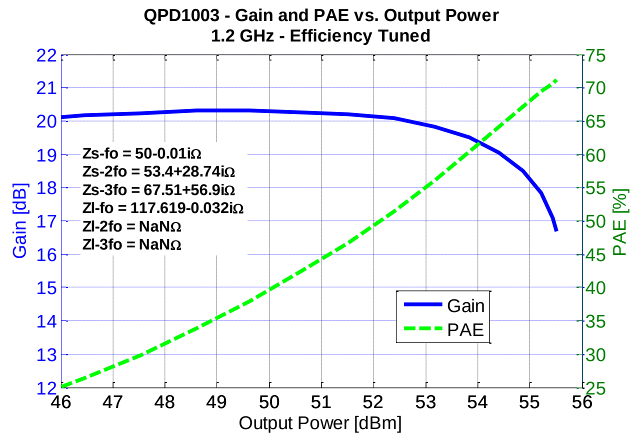


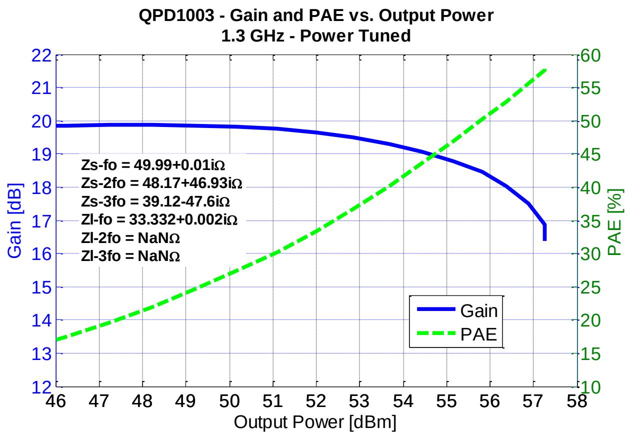
Typical Performance – Load-Pull Drive-up[1, 2]

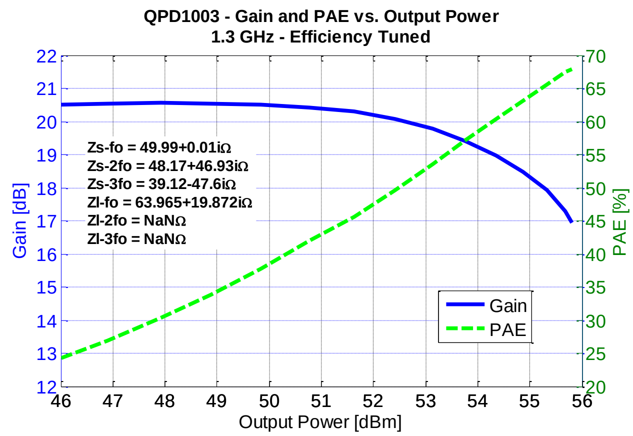
Notes:

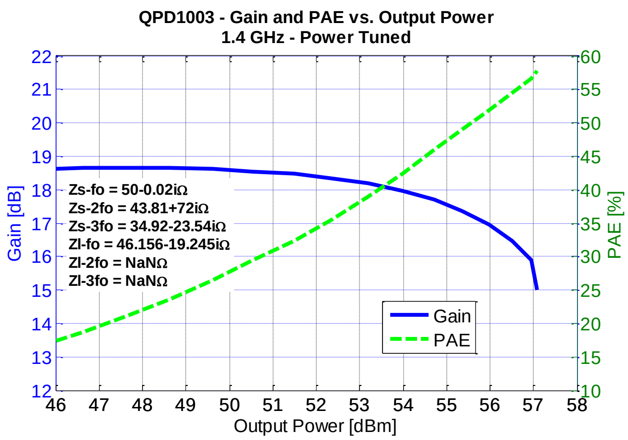
1. Pulse Width = 1 ms, Duty Cycle = 10%, V_D = 50 V, I_{DQ} = 750 mA
2. See page 11 for load-pull and source-pull reference planes where the performance was measured.

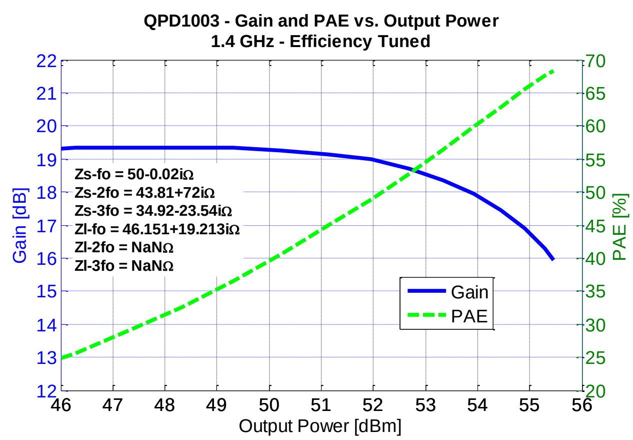








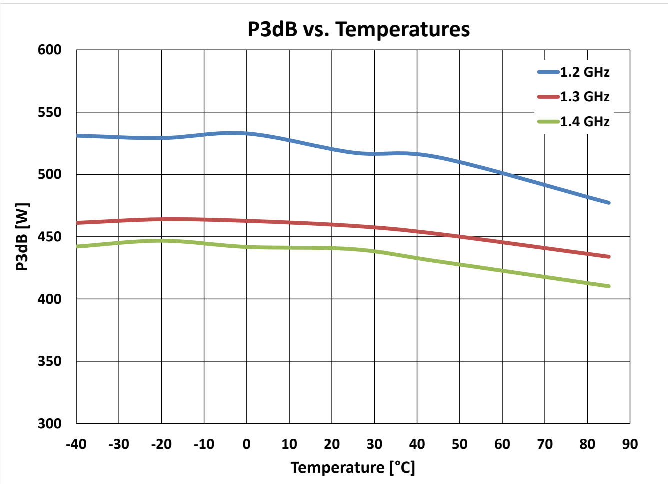


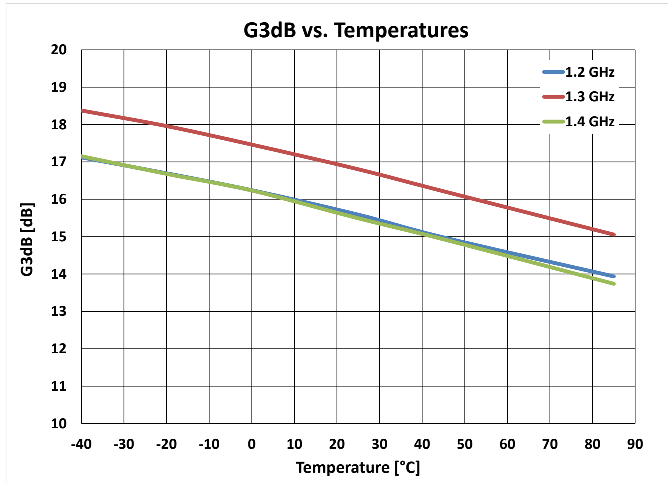


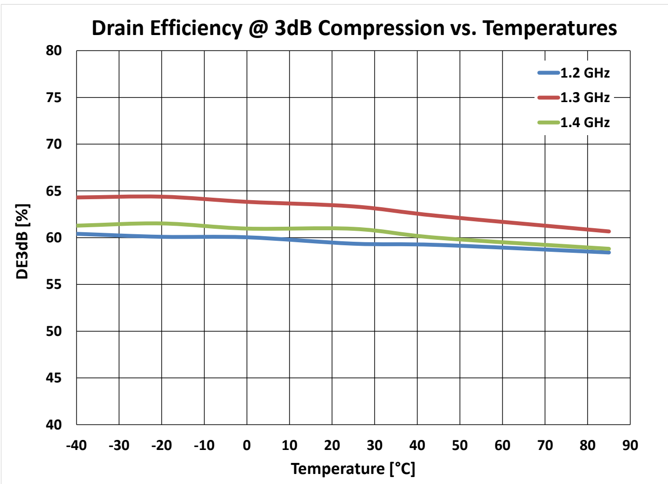
Power Drive-Up Performance Over Temperatures of 1.2 – 1.4 GHz EVB[1]

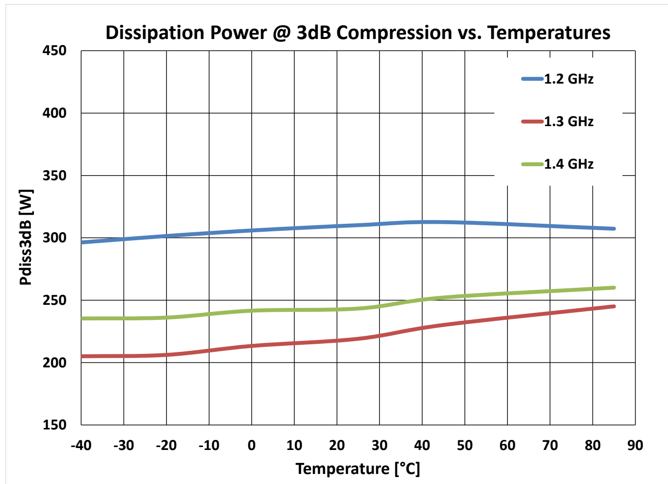
Notes:

1. Pulse Width = 1 ms, Duty Cycle = 10%, V_D = 50 V, I_{DQ} = 750 mA



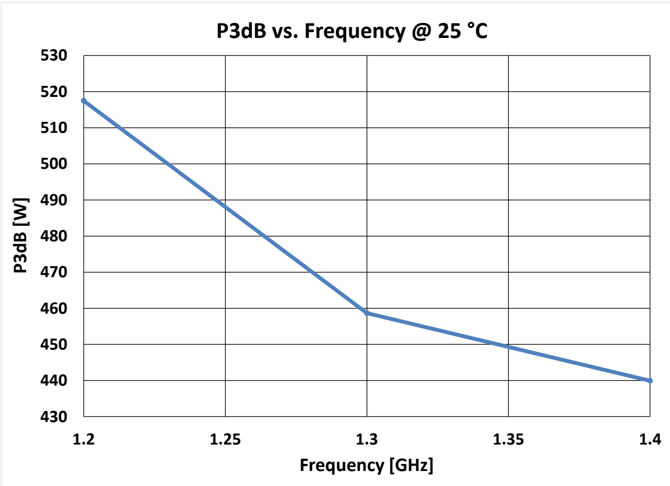


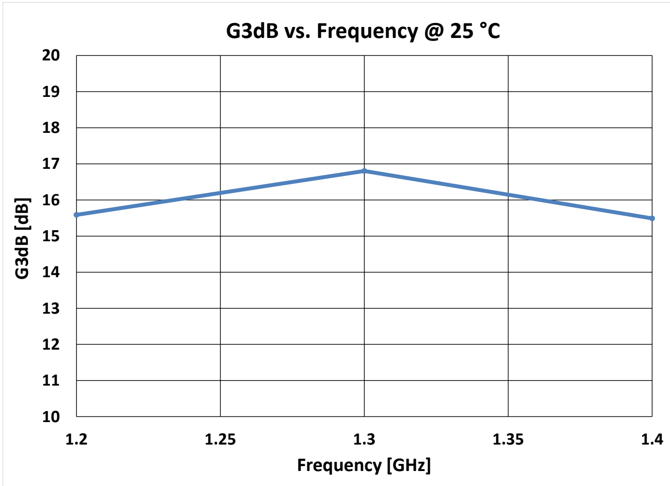


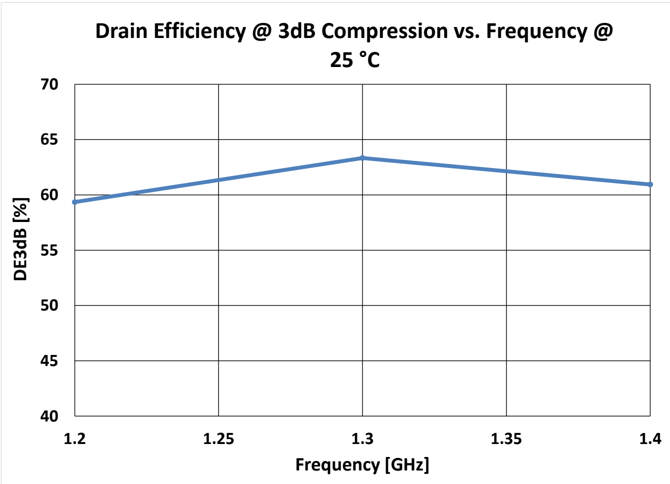


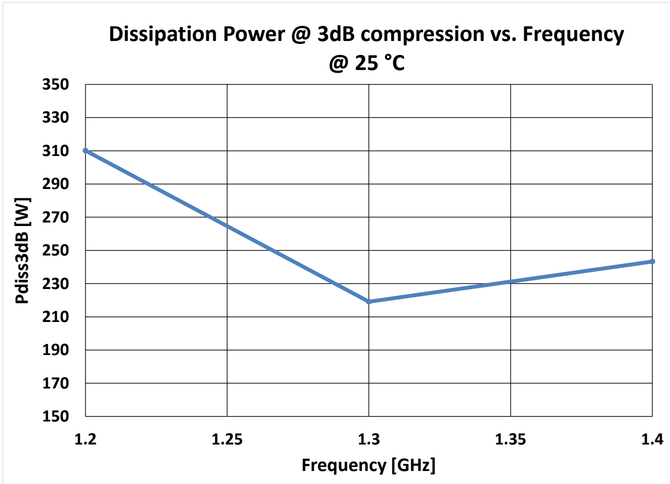
Power Drive-Up Performance at 25 C of 1.2 – 1.4 GHz EVB[1]

Notes:
1. Pulse Width = 1 ms, Duty Cycle = 10%, V_D = 50 V, I_{DQ} = 750 mA

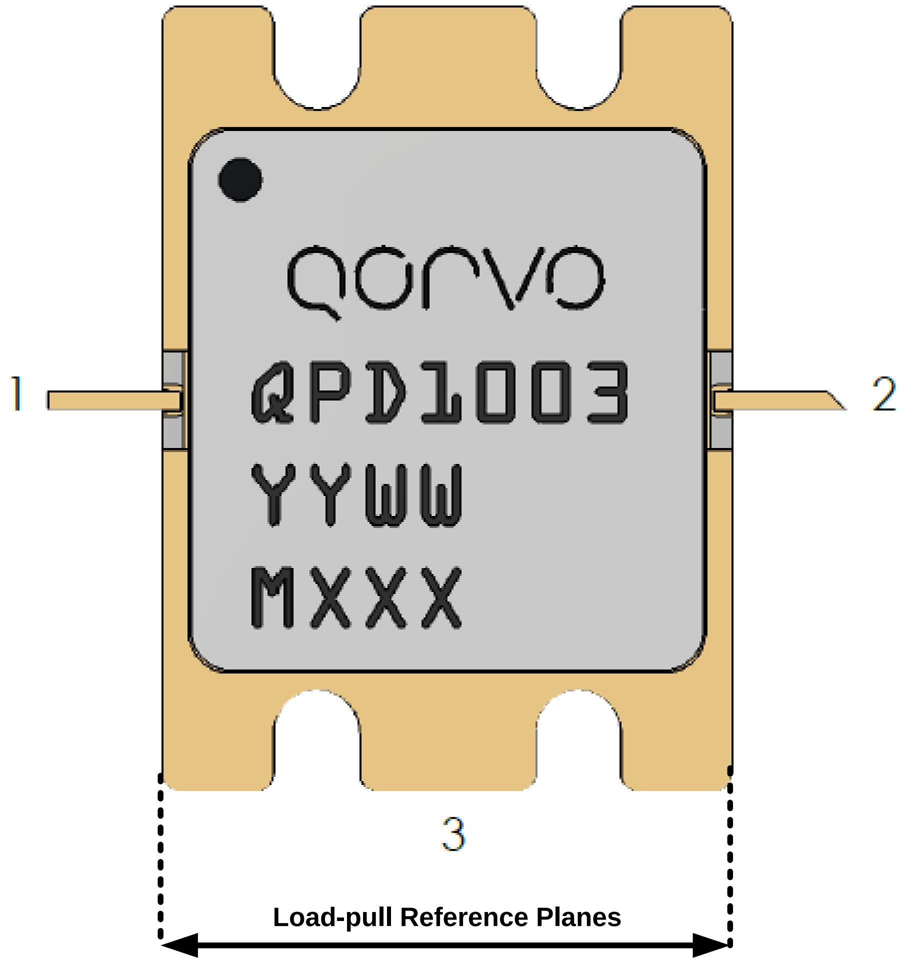








Pin Configuration and Package Marking[1]



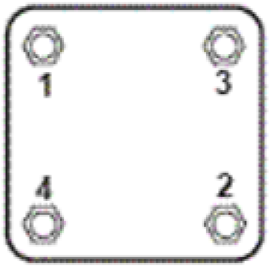
Pin	Symbol	Description
1	V_G / RF_{IN}	Gate Voltage / RF Input
2	V_D / RF_{OUT}	Drain Voltage / RF Output
3	GND	Package base/ Ground

Notes:

1. The QPD1003 will be marked with the "1003" 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.

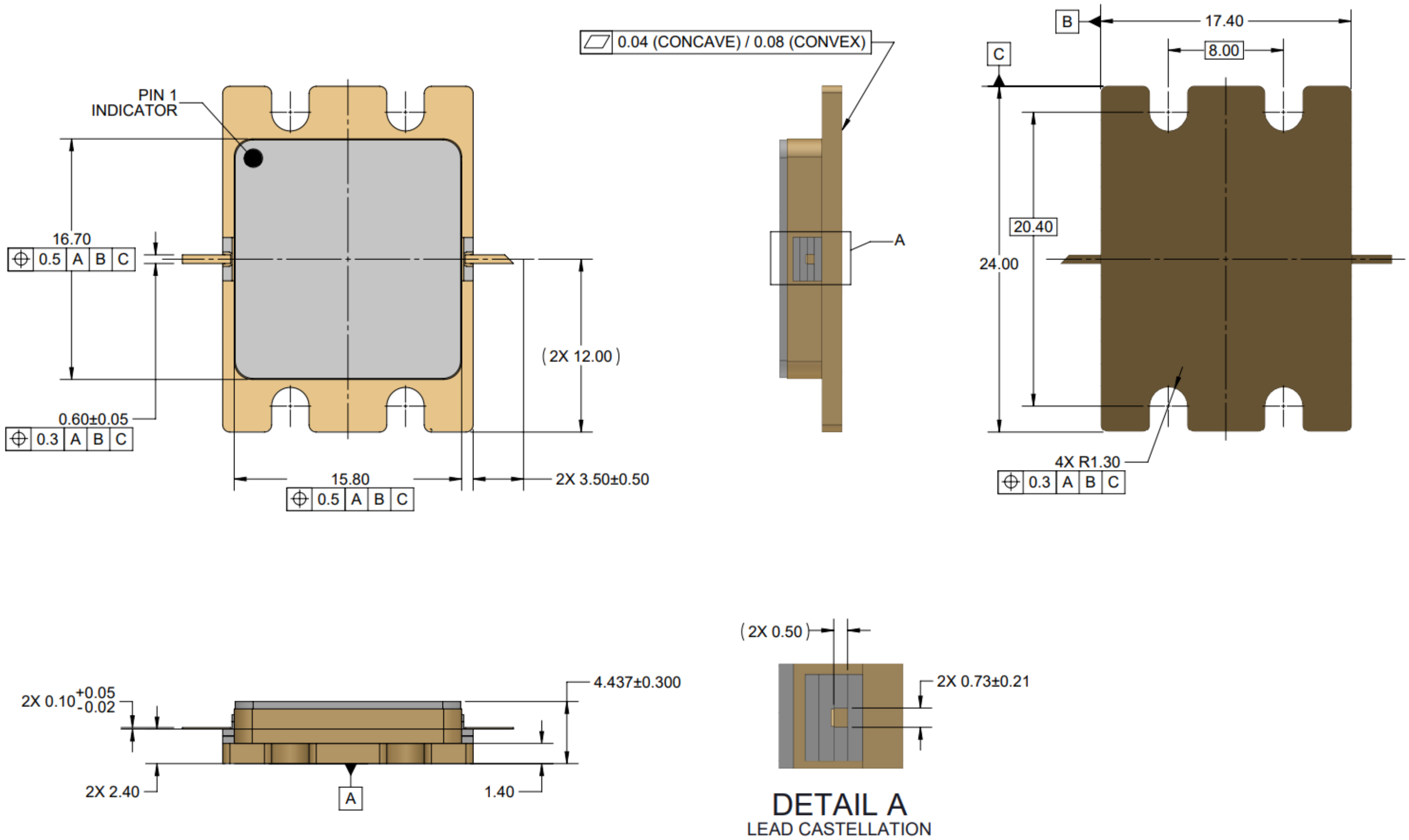
Assembly Notes

1. Carefully clean the PC board and package leads with alcohol. Allow it to dry fully.
2. To improve the thermal and RF performance, Qorvo recommends attaching a heat sink to the bottom of the PCB and apply thermal compound (Arctic Silver 5 recommended or 4 mil indium shim between the heat sink and the package.
3. (The following is for *information only*. There are many variables in a second level assembly that Qorvo does not control, so Qorvo does not recommend an absolute torque value.) Use screws to attach the component to the heat sink. A suggested torque value is 16 in-oz. for a 0-80 screw. Start with screws finger tight, then torque to 8 in-oz., then torque to final value. Use the following tightening pattern.



4. Apply no-flux solder to each pin of the QPD1003. The component leads should be manually soldered, and the package cannot be subjected to conventional reflow processes. The use of no-clean solder to avoid washing after soldering is recommended.

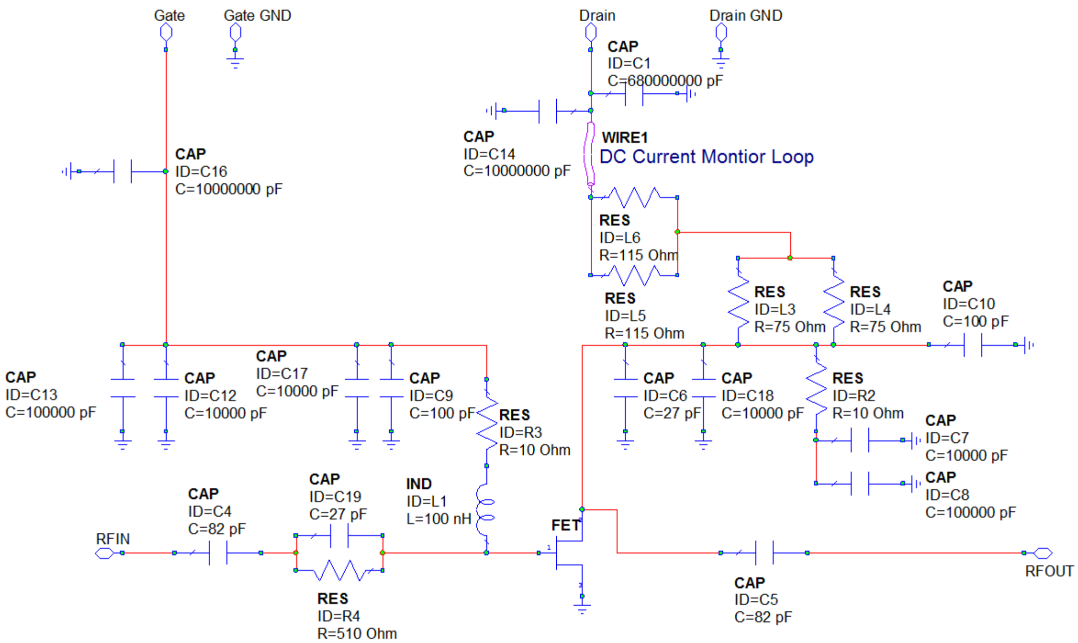
Package Dimensions[1, 2, 3, 4, 5]



Notes:

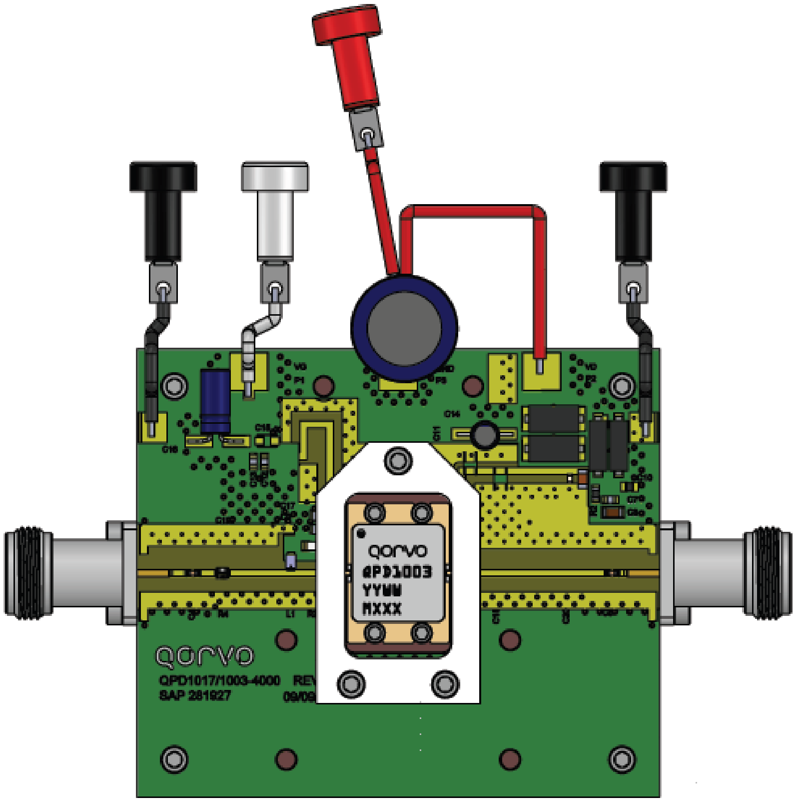
1. All dimensions are in mm. Unless otherwise noted, the tolerance is ±0.15 mm.
2. Package is an all metal design with ceramic lid and feed thru's.
3. Package is Ni/Au plated.
4. Package is epoxy sealed.
5. For instruction to mount the part, please refer to application note "RF565 Package Mounting, Mechanical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

Schematic – 1.2 – 1.4 GHz EVB



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 800 mA.	2. Turn off V_D.
3. Set V_D to 50 V.	3. Wait 2 seconds to allow drain capacitor to discharge
4. Slowly adjust V_G until I_D is set to 750 mA.	4. Turn off V_G
5. Set I_D current limit to 2 A.	
6. Apply RF.	

1.2 – 1.4 GHz EVB[1]



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

Bill of Material – 1.2 – 1.4 GHz EVB

Ref Des	Value	Qty	Manufacturer	Part Number
C1	680 uF	1	Panasonic	EEU-FC2A681
C4, C5	82 pF	2	ATC	ATC600S820JT250XT
C9	1000 pF	1	Samsung	CL31B102KGFNFNE
C6, C19	27 pF	2	ATC	600S270JT250XT
C7, C12	10000 pF	2	Panasonic	ECJ-2VB2A103K
C8	0.1 uF	1	Panasonic	ECJ-3YB2A104K
C10	100 pF	1	ATC	ATC800A101JT250X
C13	0.1 uF	1	Kemet	C0805C104K5RACTU
C14, C16	10 uF	2	Panasonic	ECA-2AM100
C17, C18	10000 pF	2	Samsung	CL31B103KGFNFNE
R2	51 Ω	1	Panasonic	ERJ-6GEYJ510
R3	10 Ω	1	Panasonic	ERJ-8GEYJ100V
R4	510 Ω	1	Panasonic	ERJ-6GEYJ511
L1	100 nH	1	Coilcraft	0603LS-101XJLB
L3, L4	N/A	1	STEWARD, INC.	35F0121-1SR-10
L5, L6	N/A	1	STEWARD, INC.	28F0181-1SR-10

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1B (950 V)	ESDA / JEDEC JS-001-2012
ESD – Charged Device Model (CDM)	Class C3 (1000 V)	JEDEC JESD22-C101F
MSL – Moisture Sensitivity Level	MSL3	IPC/JEDEC J-STD-020

Caution!
ESD-Sensitive Device

Solderability

The component leads should be manually soldered, and the package cannot be subjected to conventional reflow processes. Soldering of the component leads is compatible with the latest version of J-STD-020, lead-free solder, 260 °C. The use of no-clean solder to avoid washing after soldering is recommended.

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

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

Important Notice