QPD1019

500 W, 50 V, 2.9 – 3.3 GHz, GaN RF IMFET

Product Overview

The QPD1019 is a 500W (P_{3dB}) internally matched discrete GaN on SiC HEMT which operates from 2.9 to 3.3 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 radar.

ROHS compliant.

Evaluation boards are available upon request.

17.40 x 24.00 x 4.437 mm

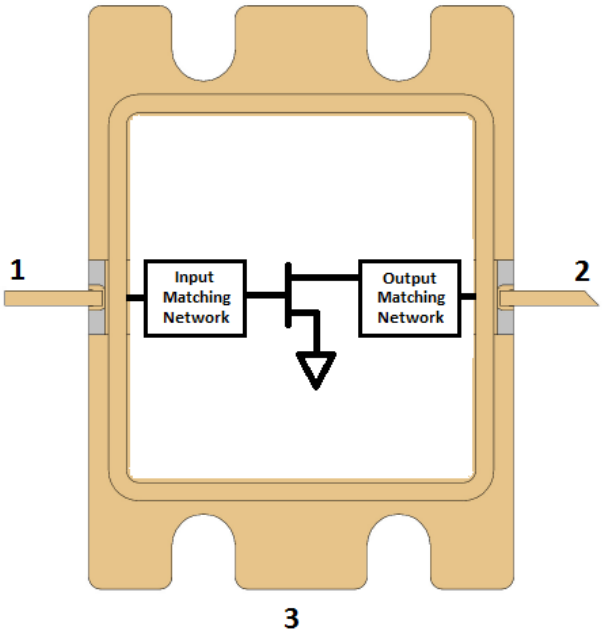
Key Features

- Frequency: 2.9 to 3.3 GHz
- Output Power (P_{3dB})[1]: 590 W
- Linear Gain[1]: 15.5 dB
- Typical DE_{3dB}[1]: 69%
- Operating Voltage: 50 V
- Low thermal resistance package
- Pulse capable

Notes:

1. @ 3.1 GHz

Functional Block Diagram



Applications

- Military Radar
- Civilian Radar
- Test Instrumentation

Ordering Information

Part Number	Description
QPD1019	Waffle Pack of 18 QPD1019
QPD1019EVB01	2.9 – 3.3 GHz EVB

Absolute Maximum Ratings[1]

Parameter	Rating	Units
Breakdown Voltage (BV_{DG})	+150	V
Gate Voltage (V_G)	-7 to +2	V
Drain Current (I_D)	20	A
Power Dissipation (P_D)[2]	522	W
RF Input Power (RF_{IN})[3]	+49	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: Pulse Width = 100 us, Duty Cycle = 10% @ 85 °C
3. Pulsed CW: Pulse Width = 100 us, Duty Cycle = 10% @ 3.1 GHz, 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]	-	-	469	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 = 100 us, 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	2.9	3.1	3.3	GHz
Linear Gain (G_{LIN})	15.5	15.5	15.8	dB
Output Power at 3dB Compression (P_{3dB})	57.7	57.7	57.5	dBm
Power-Added-Efficiency at 3dB Compression (PAE_{3dB})	62.3	60.5	60.0	%
Gain at 3dB Compression (G_{3dB})	12.5	13.5	12.8	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 100 us, Duty Cycle = 10%

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

Parameters	Typical Values			Units
Frequency	2.9	3.3	3.3	GHz
Linear Gain (G_{LIN})	16.1	17.5	16.7	dB
Output Power at 3dB Compression (P_{3dB})	56.4	55.9	56.1	dBm
Power-Added-Efficiency at 3dB Compression (PAE_{3dB})	69.5	69.3	66.0	%
Gain at 3dB Compression (G_{3dB})	13.1	14.5	13.7	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 100 us, Duty Cycle = 10%

RF Characterization – 2.9 – 3.3 GHz EVB Performance at 2.9 GHz[1]

Parameters		Typical Values		Units
Linear Gain (G_{LIN})	-	15.5	-	dB
Output Power at 3dB Compression (P_{3dB})	-	57.0	-	dBm
Drain Efficiency at 3dB Compression (DE_{3dB})	-	65.8	-	%
Gain at 3dB Compression (G_{3dB})	-	12.5	-	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 100 us, Duty Cycle = 10%

RF Characterization – 2.9 – 3.3 GHz EVB Performance at 3.1 GHz[1]

Parameters		Typical Values		Units
Linear Gain (G_{LIN})	-	16.3	-	dB
Output Power at 3dB Compression (P_{3dB})	-	57.0	-	dBm
Drain Efficiency at 3dB Compression (DE_{3dB})	-	62.3	-	%
Gain at 3dB Compression (G_{3dB})	-	13.3	-	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 100 us, Duty Cycle = 10%

RF Characterization – 2.9 – 3.3 GHz EVB Performance at 3.3 GHz[1]

Parameters		Typical Values		Units
Linear Gain (G_{LIN})	-	16.3	-	dB
Output Power at 3dB Compression (P_{3dB})	-	56.4	-	dBm
Drain Efficiency at 3dB Compression (DE_{3dB})	-	65.1	-	%
Gain at 3dB Compression (G_{3dB})	-	13.3	-	dB

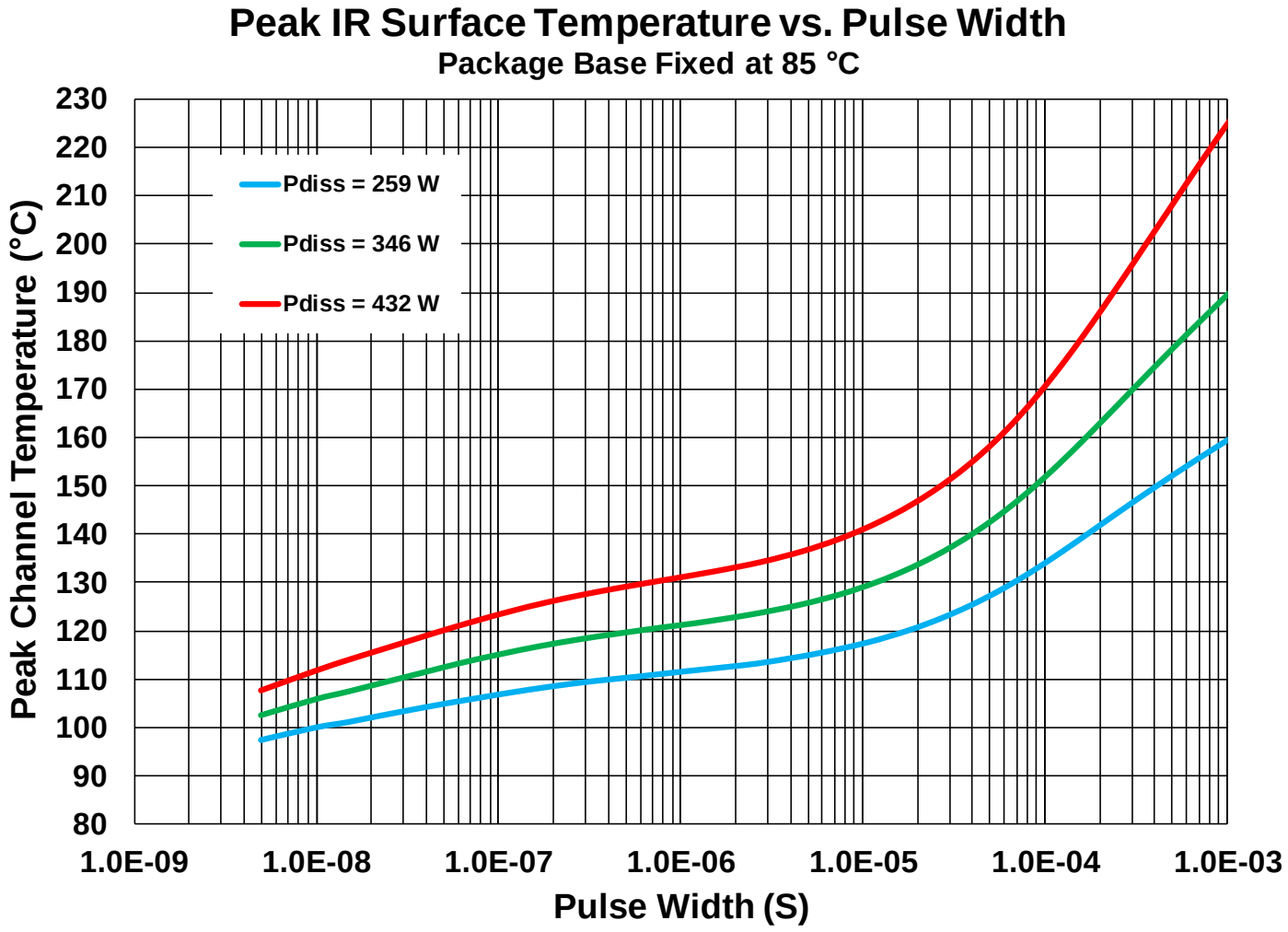
Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 100 us, Duty Cycle = 10%

RF Characterization – Mismatch Ruggedness at 2.9, 3.1, and 3.3 GHz[1, 2, 3]

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

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 100 us, Duty Cycle = 10%
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 0.01 – 8 GHz at T_A = -40 °C

Thermal and Reliability Information – Pulsed



Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	0.19	°C/W
Peak IR Surface Temperature[1] (T_{CH})	256 W P_D, Pulse Width = 100 us, Duty Cycle = 10%	134	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	0.19	°C/W
Peak IR Surface Temperature[1] (T_{CH})	346 W P_D, Pulse Width = 100 us, Duty Cycle = 10%	152	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	0.20	°C/W
Peak IR Surface Temperature[1] (T_{CH})	432 W P_D, Pulse Width = 100 us, Duty Cycle = 10%	170	°C

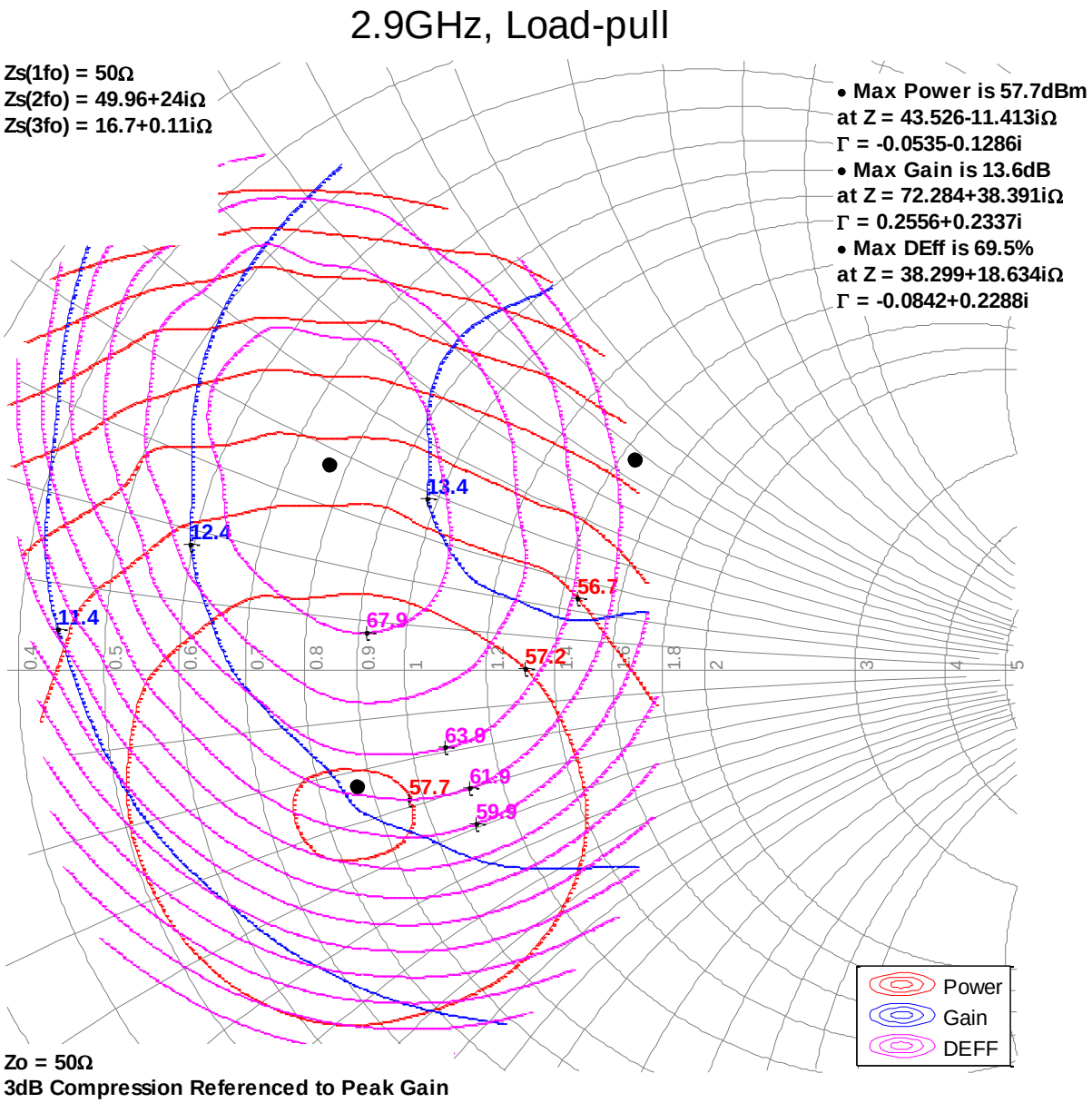
Notes:

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

Load Pull Contours[1, 2]

Notes:

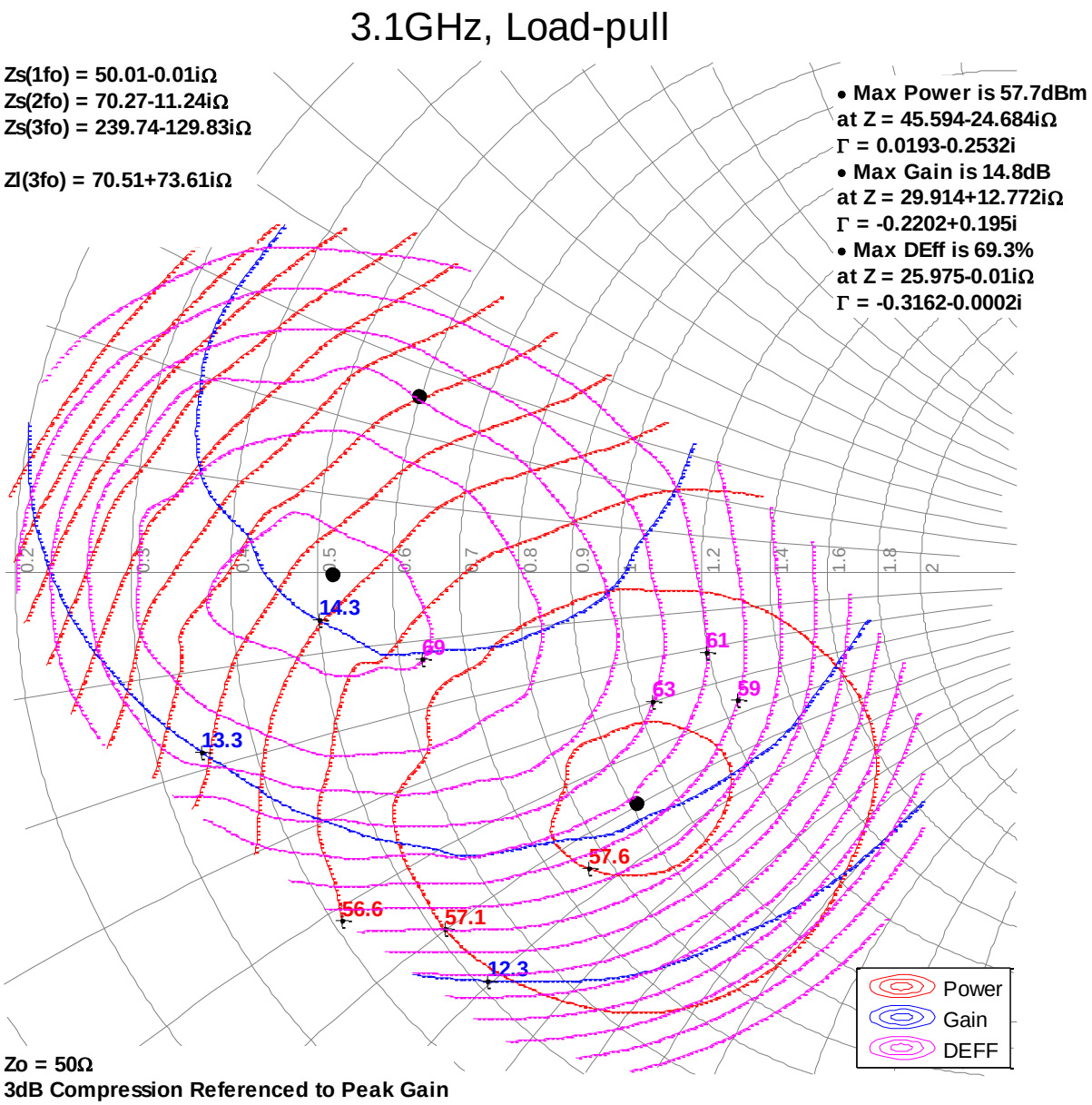
1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 100 us. Duty Cycle = 10%. Performance is at 3 dB gain compression referenced to peak gain.
2. See page 12 for load-pull and source-pull reference planes. 50 Ω load-pull TRL fixtures are built with 20 mils RO4350B material.



Load Pull Contours[1, 2]

Notes:

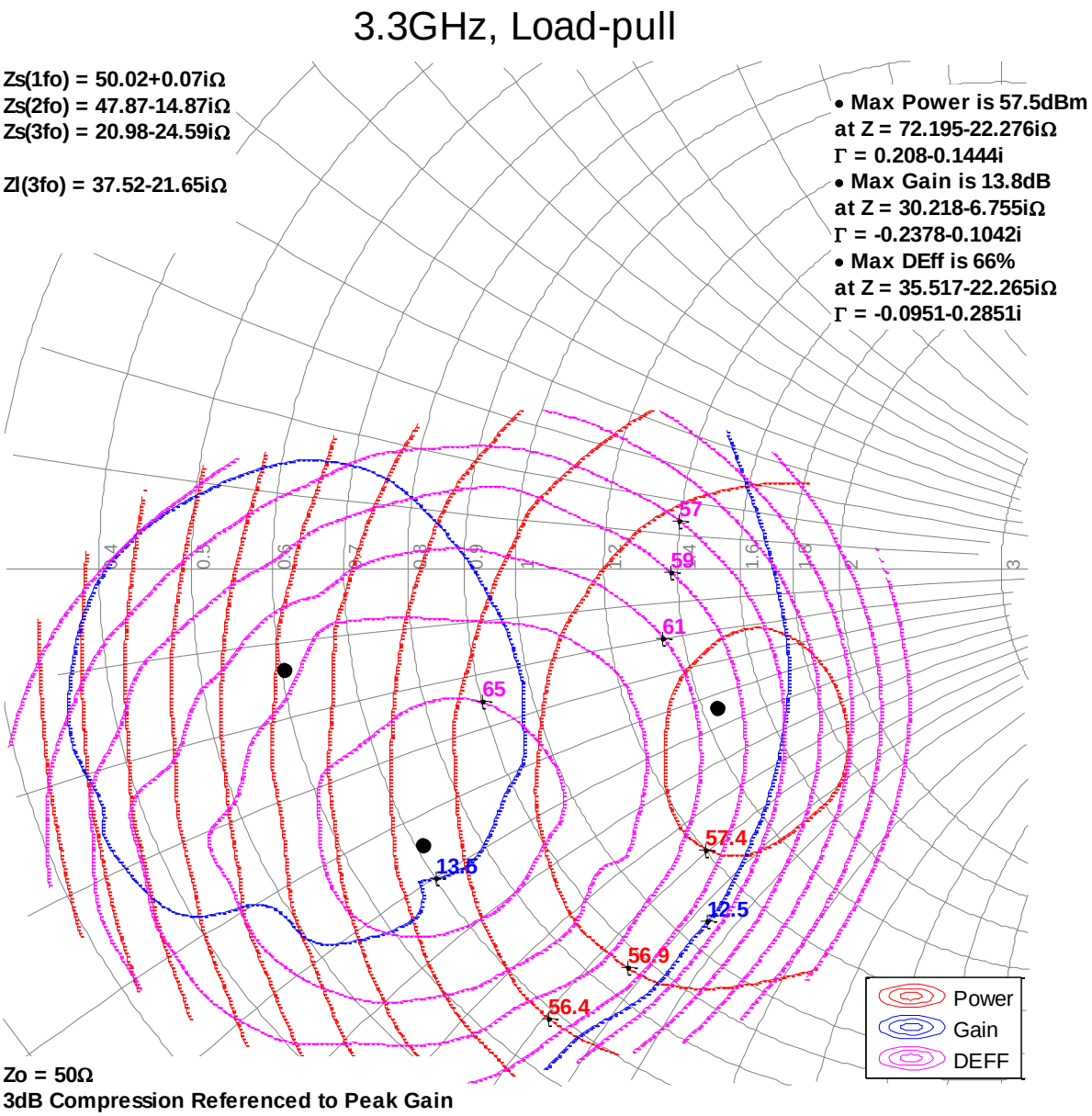
1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 100 us. Duty Cycle = 10%. Performance is at 3 dB gain compression referenced to peak gain.
2. See page 12 for load-pull and source-pull reference planes. 50 Ω load-pull TRL fixtures are built with 20 mils RO4350B material.



Load Pull Contours[1, 2]

Notes:

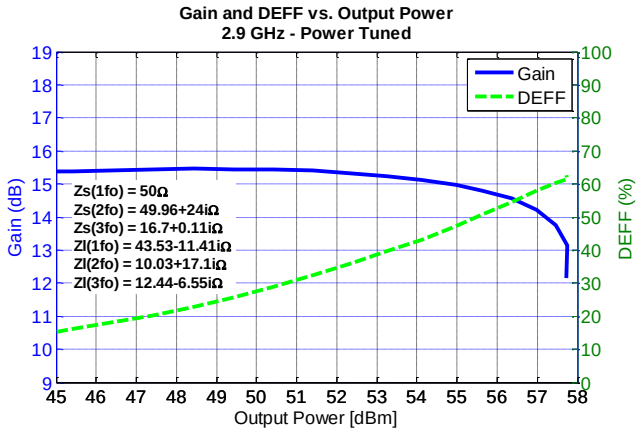
1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 100 us. Duty Cycle = 10%. Performance is at 3 dB gain compression referenced to peak gain.
2. See page 12 for load-pull and source-pull reference planes. 50 Ω load-pull TRL fixtures are built with 20 mils RO4350B material.

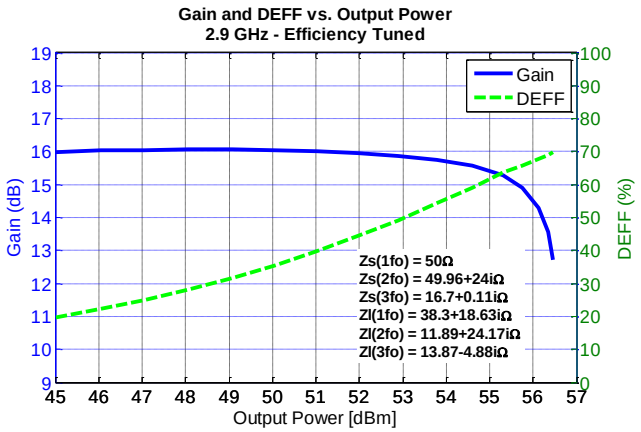


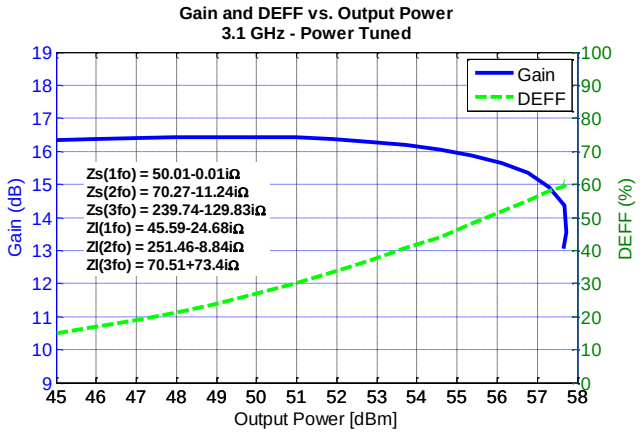
Typical Performance – Load-Pull Drive-up[1, 2]

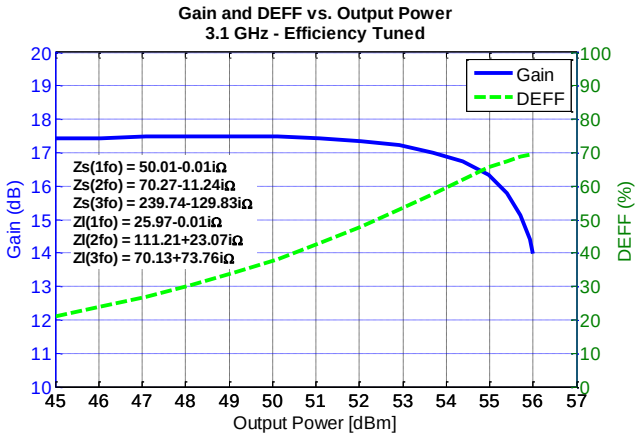
Notes:

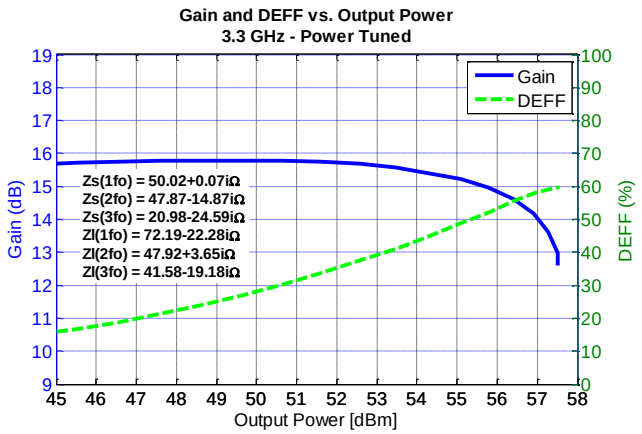
1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 100 us, Duty Cycle = 10%, T_A = 25 °C
2. See page 12 for load-pull and source-pull reference planes where the performance was measured.

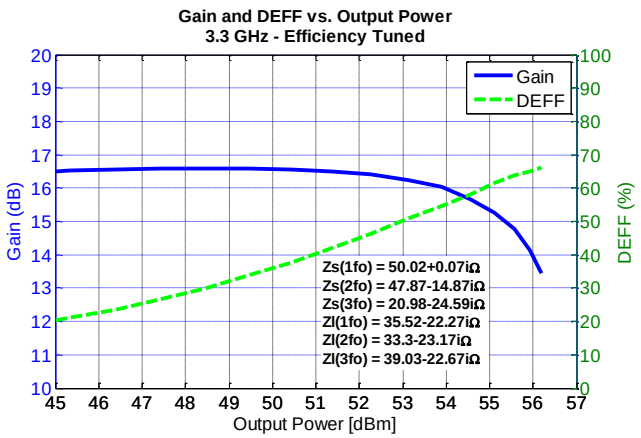








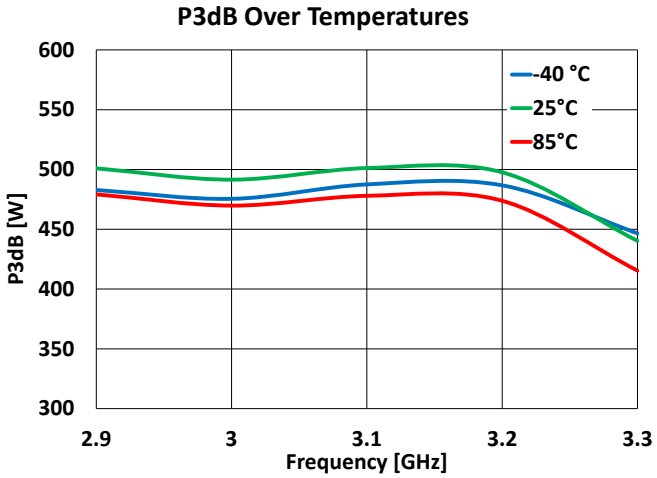


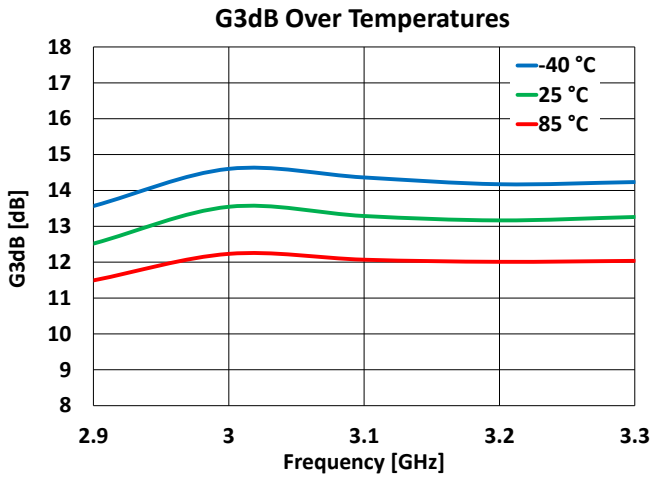


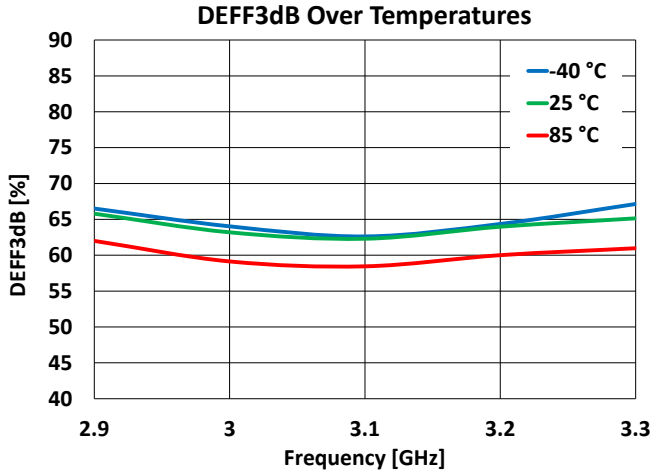
Power Drive-Up Performance Over Temperatures of 2.9 – 3.3 GHz EVB[1, 2]

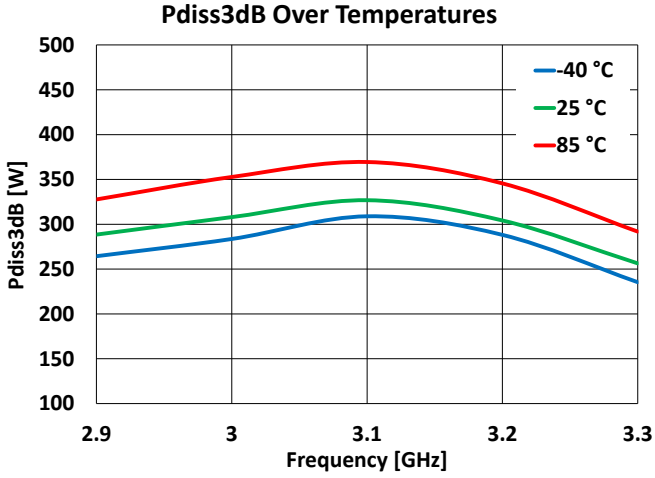
Notes:

1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 100 us, Duty Cycle = 10%
2. Performance shown is at EVB connectors reference plane.





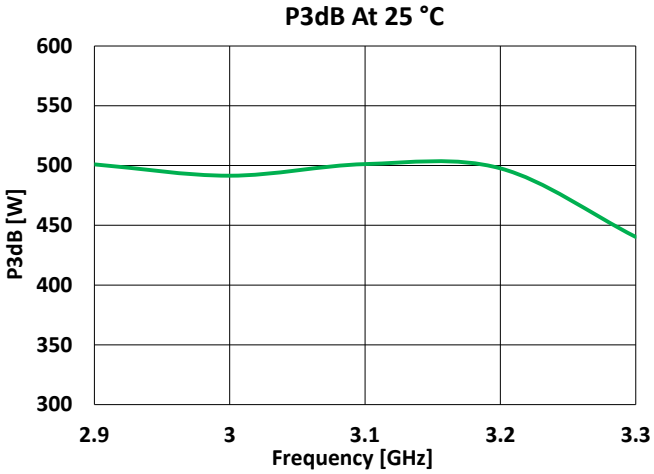


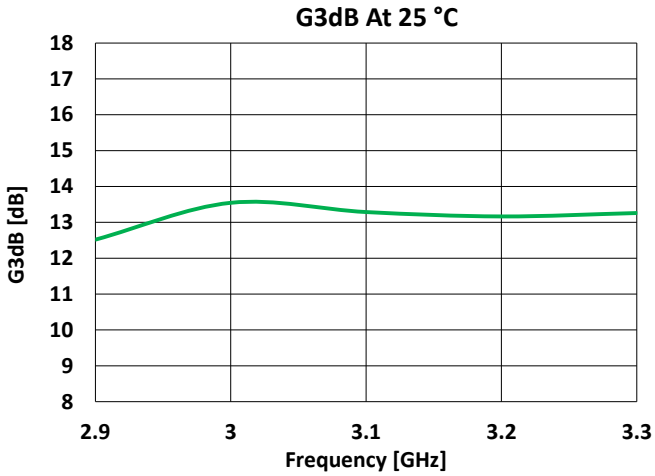


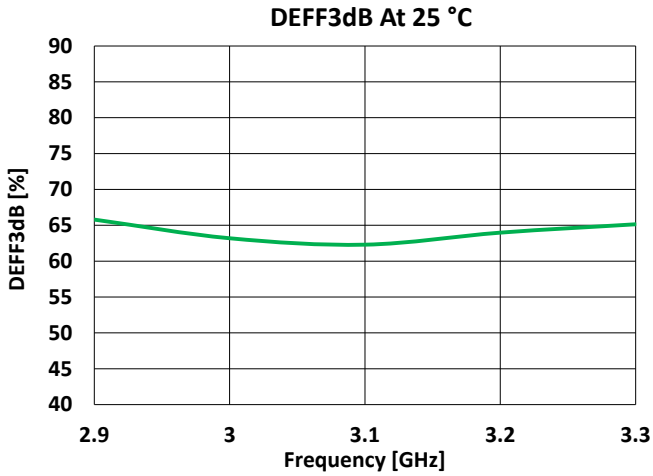
Power Drive-Up Performance at 25 °C of 2.9 – 3.3 GHz EVB[1]

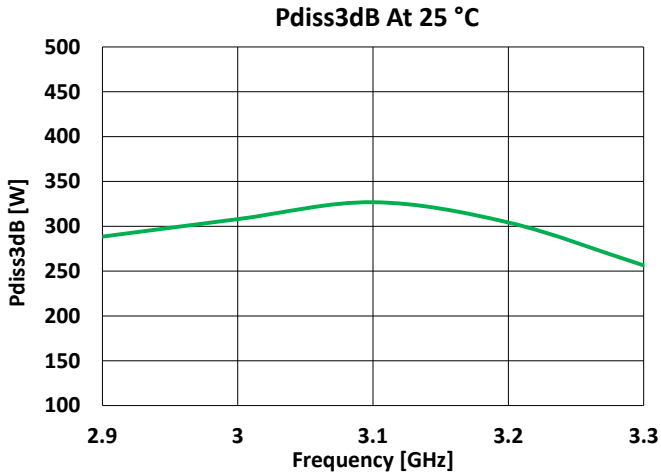
Notes:

1. Pulse Width = 100 us, Duty Cycle = 10%, V_D = 50 V, I_{DQ} = 750 mA, T_A = 25 °C
2. Performance shown is at EVB connectors reference plane.





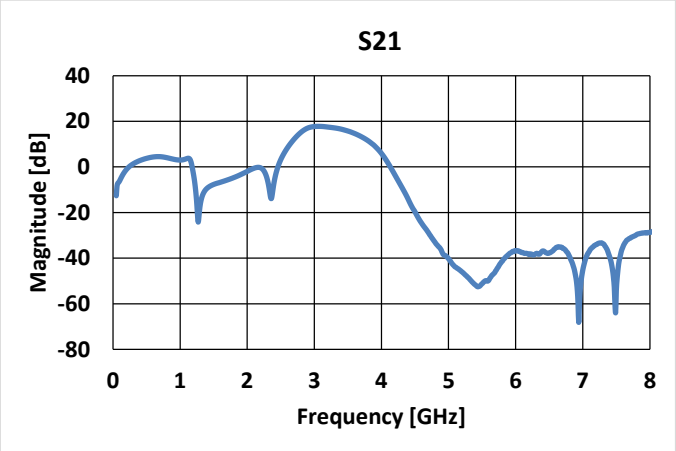


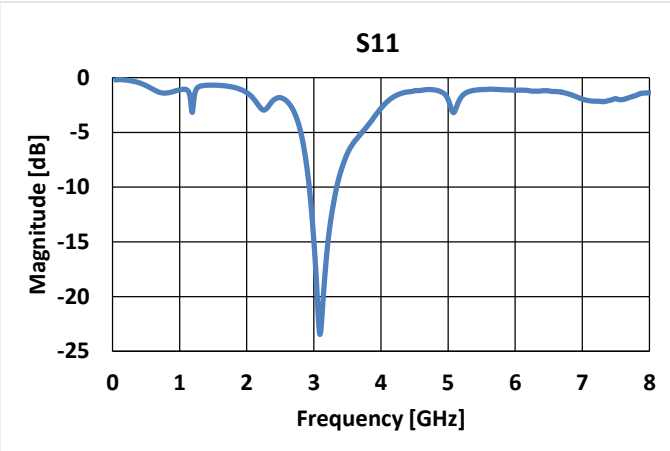


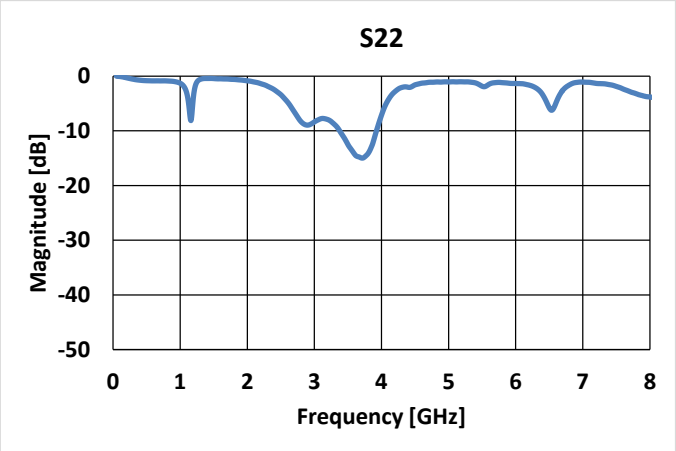
S-Parameters at -40 °C of 2.9 – 3.3 GHz EVB[1, 2]

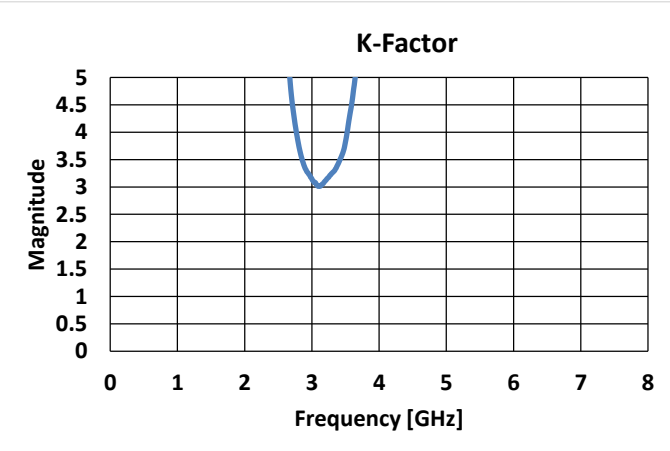
Notes:

1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 100 us, Duty Cycle = 10%, T_A = -40 °C
2. Performance shown is at EVB connectors reference plane.

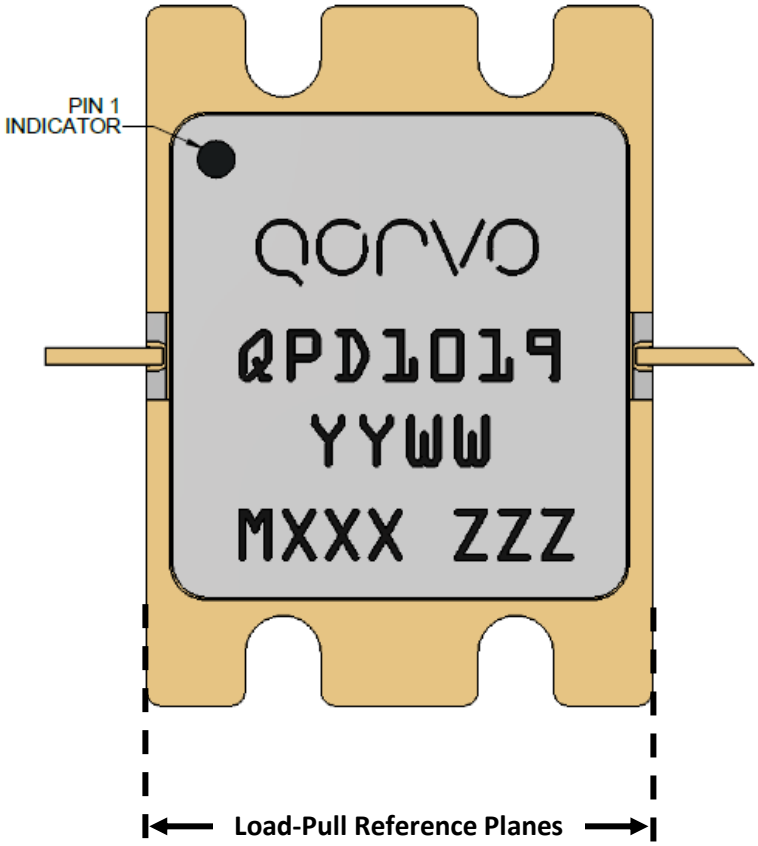








Pin Configuration and Package Marking[1]



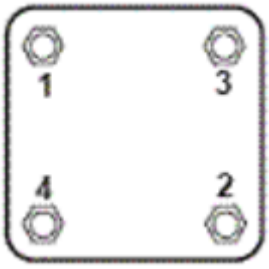
Pin	Symbol	Description
1	V_G / RF_{IN}	Gate Voltage / RF Input
2	V_D / RF_{OUT}	Drain Voltage / RF Output
3	GND	Package base / Ground

Notes:

1. The QPD1019 will be marked with the “QPD1019” 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. “ZZZ” is the unique serial number.

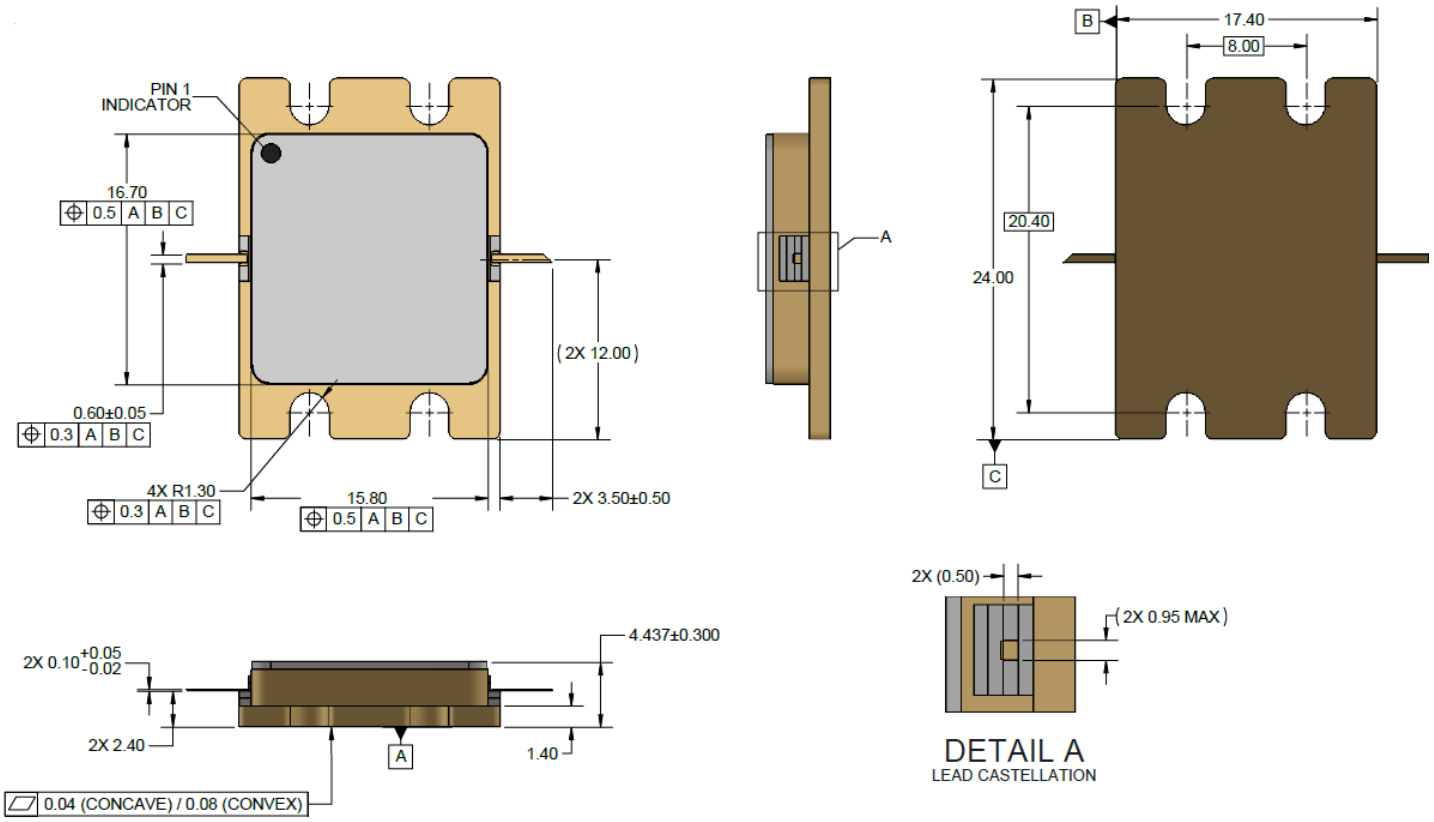
Assembly Notes

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 QPD1019. 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.

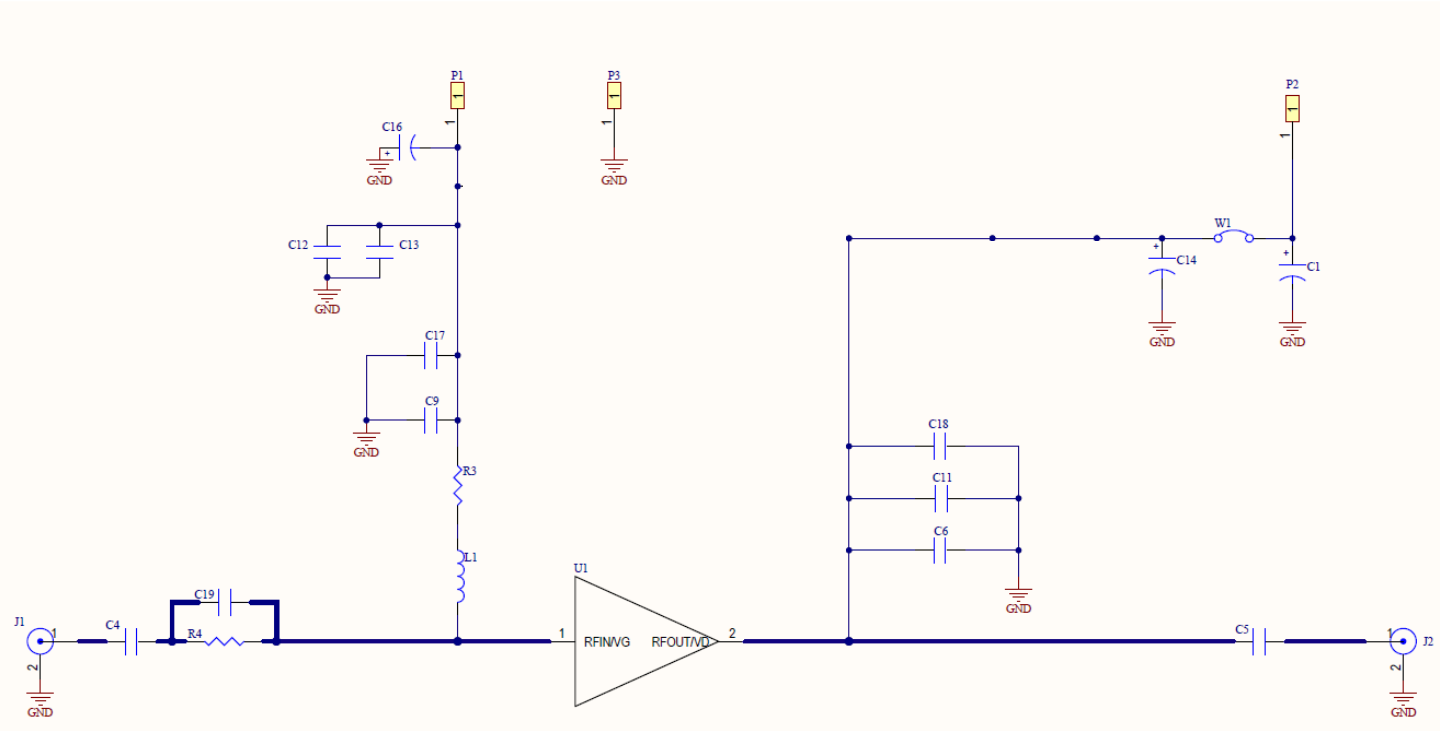
Package Dimensions[1, 2, 3, 4, 5]



Notes:

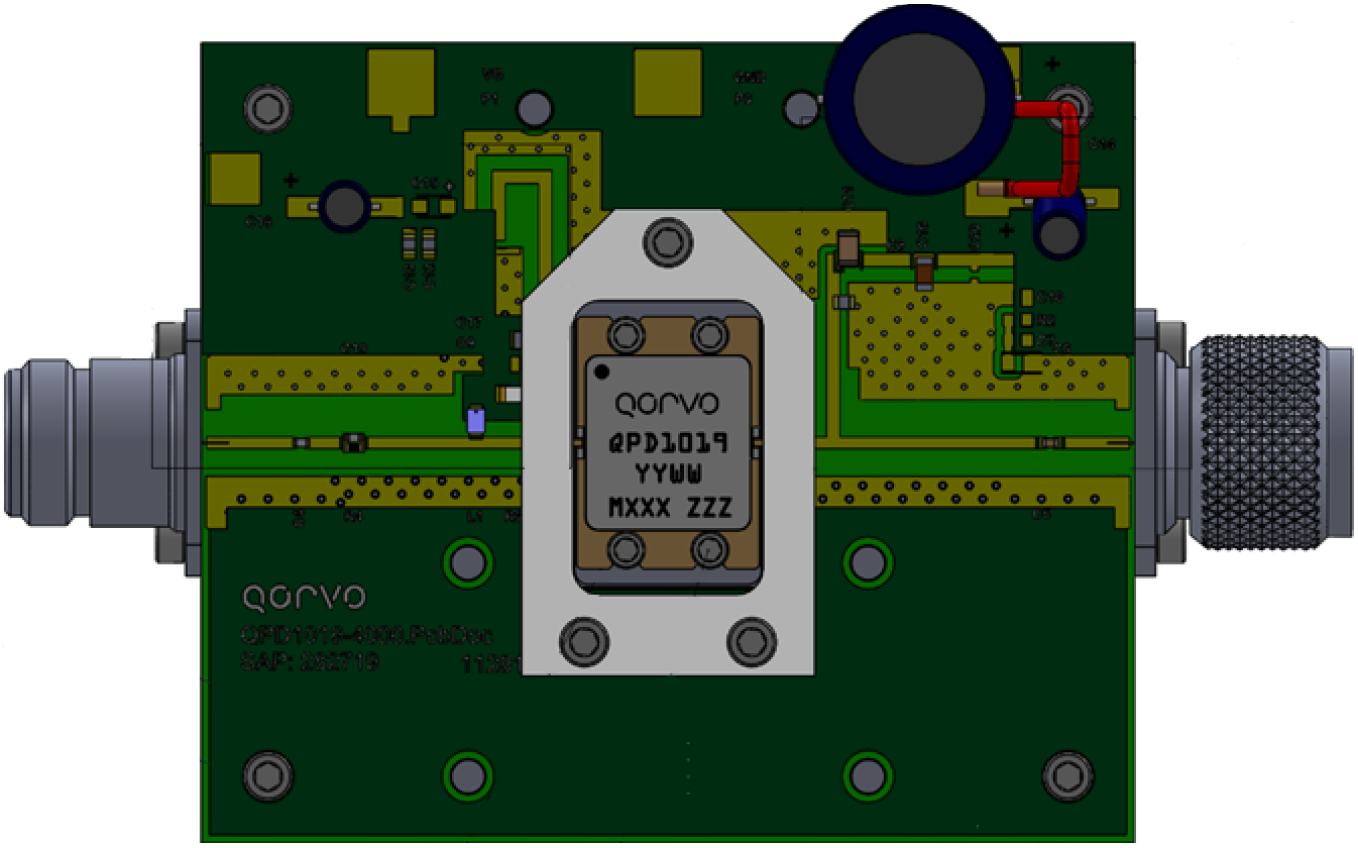
1. All dimensions are in mm. Unless otherwise noted, the tolerance is ±0.15mm.
2. Package is an all metal design with ceramic lid and feed thru's.
3. Package is Ni/Au plated.
4. Package is epoxy sealed.
5. For instruction to mount the part, please refer to application note "RF565 Package Mounting, Mechanical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

Schematic – 2.9 – 3.3 GHz EVB



Bias-up Procedure	Bias-down Procedure
1. Set V_G to -6 V	1. Turn off RF signal.
2. Set I_D current limit to 1 A.	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.	

2.9 – 3.3 GHz EVB[1]



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

Bill of Material – 2.9 – 3.3 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
C12	10000 pF	1	Panasonic	ECJ-2VB2A103K
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
R3	10 Ohm	1	Panasonic	ERJ-8GEYJ100V
R4	1 kOhm	1	Vishay	CRCW06031K00FKTA
L1	22 nH	1	Coilcraft	0805HT-22NTJLB

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1C (1800V)	ESDA / JEDEC JS-001-2012
ESD – Charged Device Model (CDM)	Class C3 (1000V)	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:

- 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

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