QPD1006

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

Product Overview

The QPD1006 is a 450 W (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 CW operations.

ROHS compliant.

Evaluation boards are available upon request.

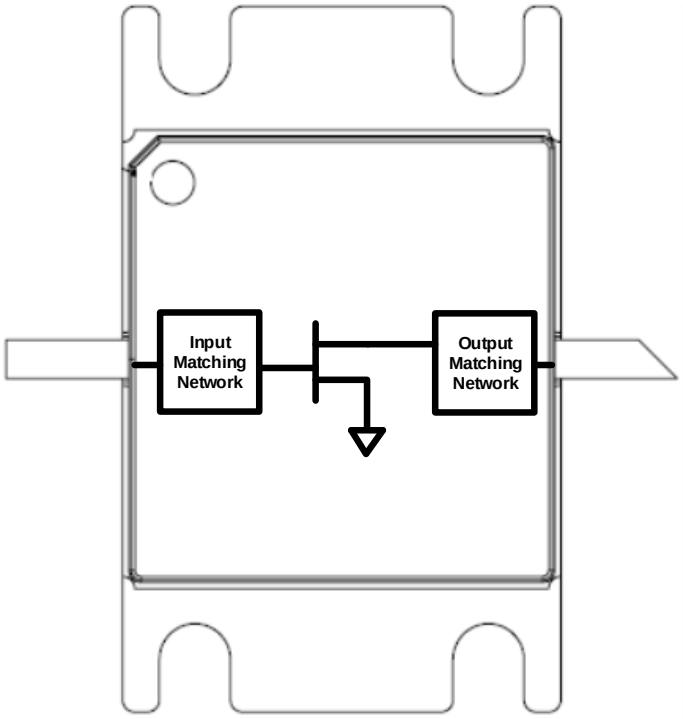
18.19 x 29.24 x 4.49 mm

Key Features

- Frequency: 1.2 to 1.4 GHz
- Output Power (P_{3dB})[1]: 313 W (CW), 468 W (Pulsed)
- Linear Gain[1]: 17.5 dB (CW), 17.8 dB (Pulsed)
- Typical DE_{3dB}[1]: 55% (CW), 62.2% (Pulsed)
- Operating Voltage: 45 V (CW), 50 V (Pulsed)
- Low thermal resistance package
- Pulse capable

Notes:
1. @ 1.3 GHz, 25 °C

Functional Block Diagram



Applications

- Military Radar
- Civilian Radar

Ordering Information

Part Number	Description
QPD1006	1.2 – 1.4 GHz RF IMFET
QPD1006EVB4	1.2 – 1.4 GHz Evaluation Board

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)	60	A
Power Dissipation (P_D)[2]	496	W
RF Input Power (RF_{IN})[2,3]	+46	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 = 1 ms, Duty Cycle = 10%
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)	-	14	-	A
Gate Voltage (V_G)[4]	-	-2.7	-	V
Power Dissipation (P_D)[2]	-	-	445	W
Power Dissipation (P_D)[3]	-	-	299	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 = 300 us, Duty Cycle = 30% Package base at 85°C
3. CW: Package base at 85°C
4. To be adjusted to desired I_{DQ}

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

Parameters	Min	Typical	Max	Units
Frequency	-	17.5	-	GHz
Output Power at 3dB Compression (P_{3dB})	-	55.4	-	dBm
Drain Efficiency at 3dB Compression (PAE_{3dB})	-	56.2	-	%
Gain at 3dB Compression (G_{3dB})	-	14.5	-	dB

Notes:

1. Test conditions unless otherwise noted: V_D = +45 V, I_{DQ} = 750 mA, T_A = +25 °C

RF Characterization – EVB CW Performance at 1.3 GHz[1]

Parameters	Min	Typical	Max	Units
Frequency	-	17.3	-	GHz
Output Power at 3dB Compression (P_{3dB})	-	54.9	-	dBm
Drain Efficiency at 3dB Compression (PAE_{3dB})	-	54.6	-	%
Gain at 3dB Compression (G_{3dB})	-	14.3	-	dB

Notes:

1. Test conditions unless otherwise noted: V_D = +45 V, I_{DQ} = 750 mA, T_A = +25 °C

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

Parameters	Min	Typical	Max	Units
Frequency	-	17.5	-	GHz
Output Power at 3dB Compression (P_{3dB})	-	54.7	-	dBm
Drain Efficiency at 3dB Compression (PAE_{3dB})	-	49.4	-	%
Gain at 3dB Compression (G_{3dB})	-	14.5	-	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +45 V, I_{DQ} = 750 mA, T_A = +25 °C

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

Parameters	Min	Typical	Max	Units
Frequency	-	17.8	-	GHz
Output Power at 3dB Compression (P_{3dB})	-	57.1	-	dBm
Drain Efficiency at 3dB Compression (PAE_{3dB})	-	62.8	-	%
Gain at 3dB Compression (G_{3dB})	-	14.8	-	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 300 us, Duty Cycle = 30%

RF Characterization – EVB Pulsed Performance at 1.3 GHz[1]

Parameters	Min	Typical	Max	Units
Frequency	-	17.8	-	GHz
Output Power at 3dB Compression (P_{3dB})	-	56.7	-	dBm
Drain Efficiency at 3dB Compression (PAE_{3dB})	-	62.0	-	%
Gain at 3dB Compression (G_{3dB})	-	14.8	-	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 300 us, Duty Cycle = 30%

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

Parameters	Min	Typical	Max	Units
Frequency	-	17.8	-	GHz
Output Power at 3dB Compression (P_{3dB})	-	57.1	-	dBm
Drain Efficiency at 3dB Compression (PAE_{3dB})	-	59.6	-	%
Gain at 3dB Compression (G_{3dB})	-	14.8	-	dB

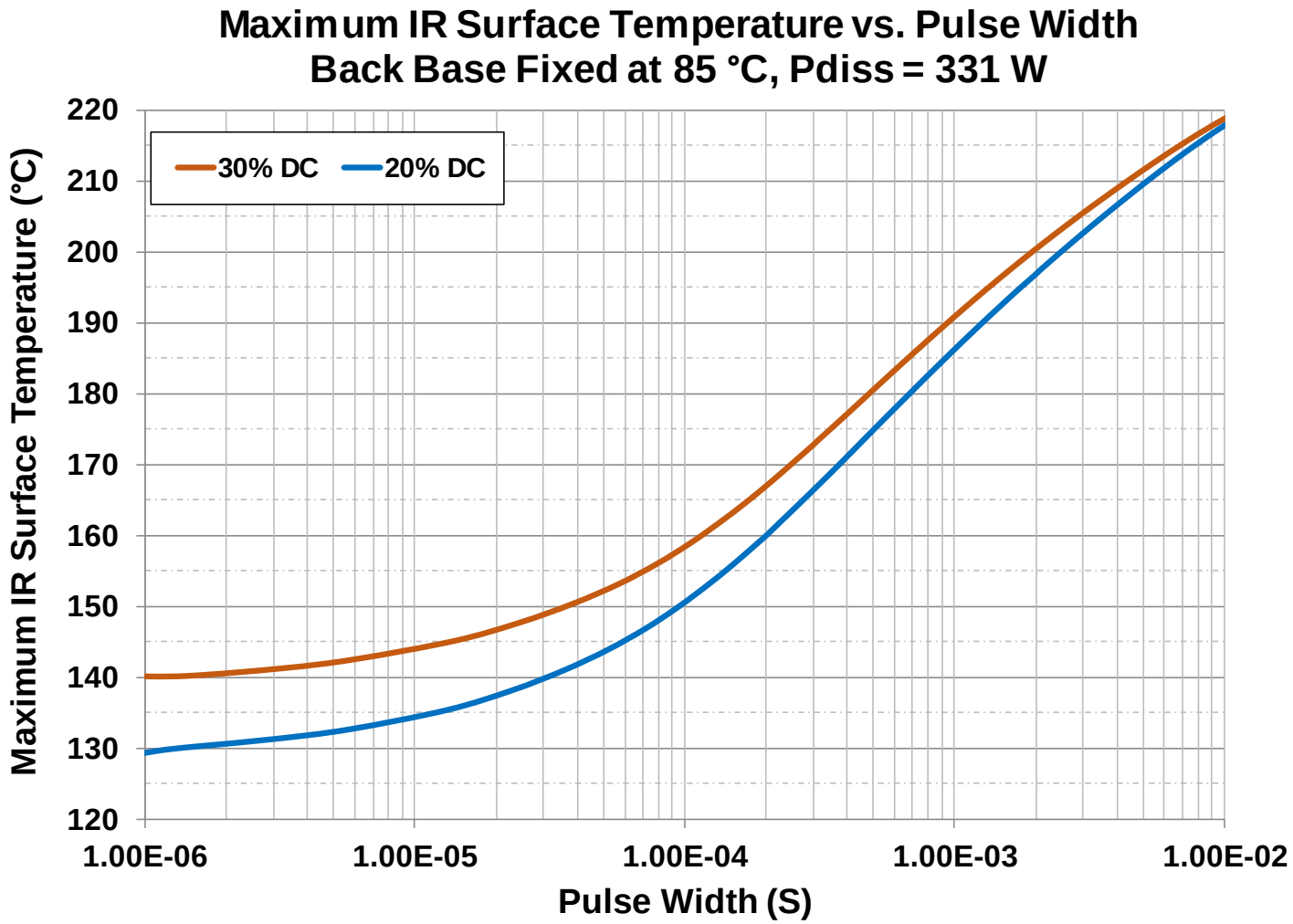
Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 750 mA, T_A = +25 °C, Pulse Width = 300 us, Duty Cycle = 30%

RF Characterization – Mismatch Ruggedness at 1.3 GHz[1]

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.

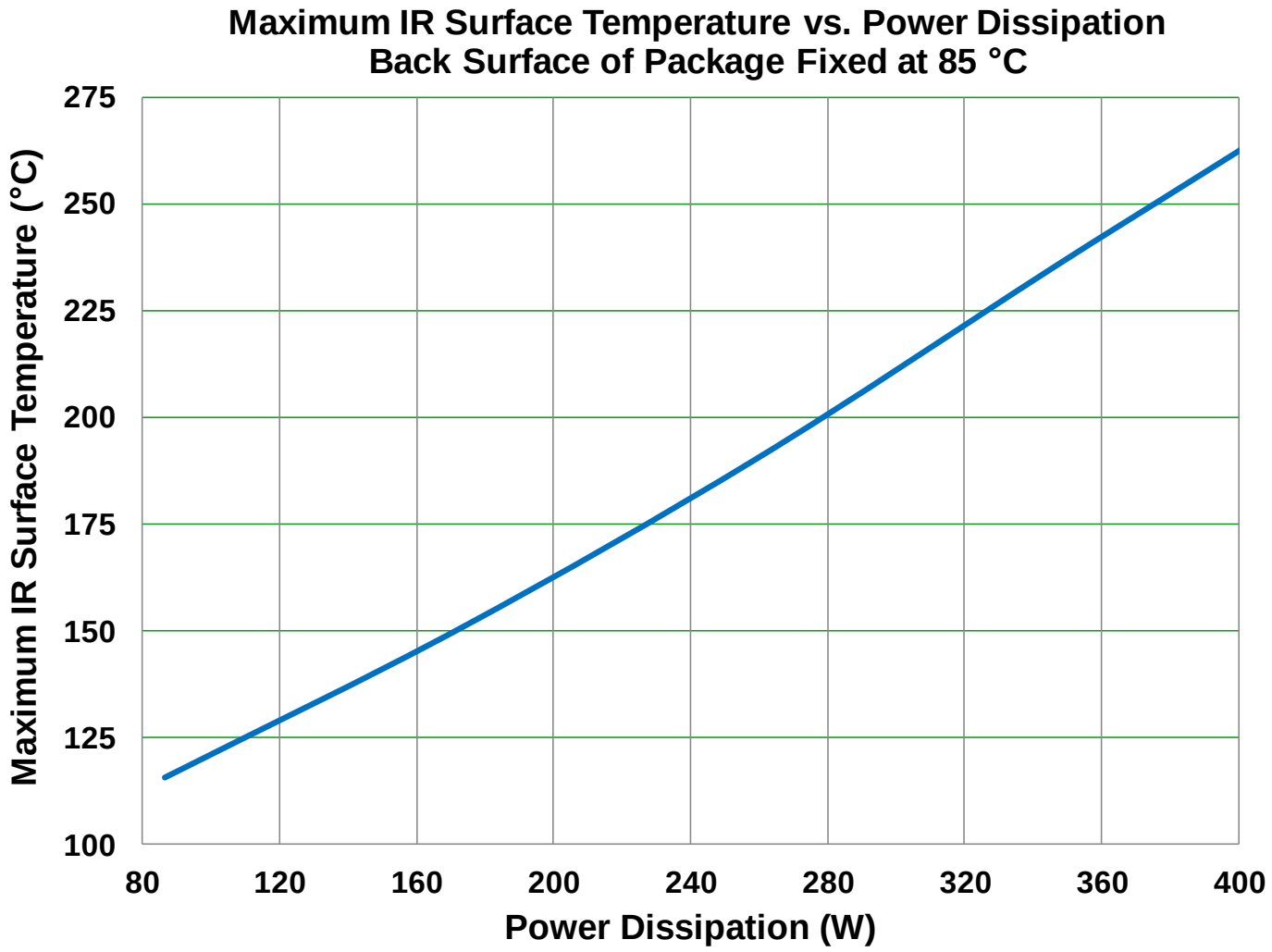
Thermal and Reliability Information – Pulsed



Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	0.23	°C/W
Peak IR Surface Temperature[1] (T_{CH})	331 W P_D, Pulse Width = 200 us, Duty Cycle = 20%	160	°C
Thermal Resistance, IR[1], (θ_{JC})	85 °C back side temperature	0.27	°C/W
Peak IR Surface Temperature[1] (T_{CH})	331 W P_D, Pulse Width = 300 us, Duty Cycle = 30%	173	°C

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

Thermal and Reliability Information – CW



Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	0.35	°C/W
Peak IR Surface Temperature[1] (T_{CH})	86.4 W P_D, CW	116	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	0.38	°C/W
Peak IR Surface Temperature[1] (T_{CH})	177.8 W P_D, CW	151	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	0.41	°C/W
Peak IR Surface Temperature[1] (T_{CH})	259.2 W P_D, CW	190	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	0.43	°C/W
Peak IR Surface Temperature[1] (T_{CH})	345.6 W P_D, CW	235	°C

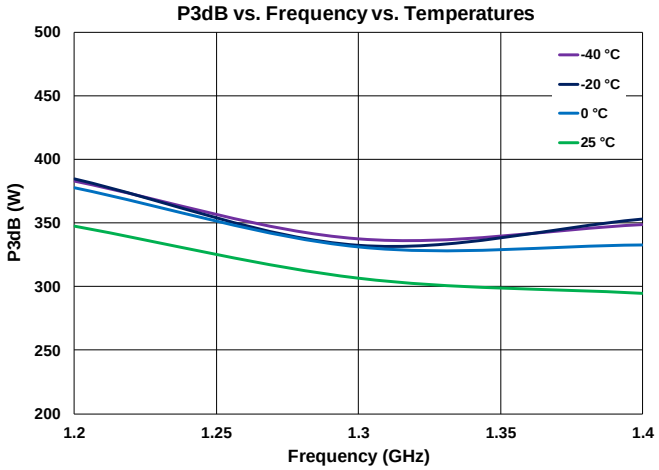
Notes:

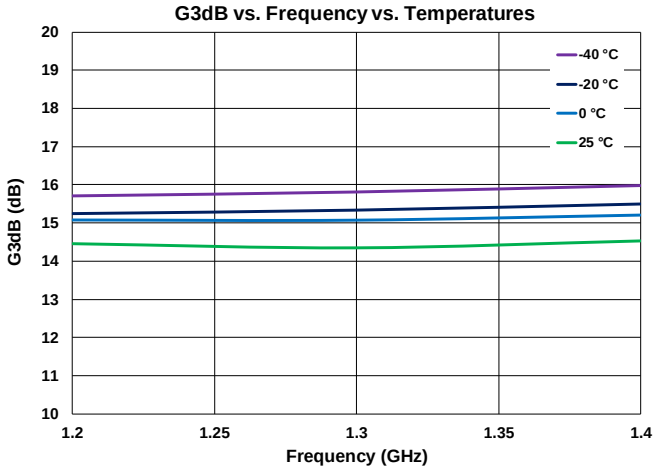
1. Refer to the following document GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

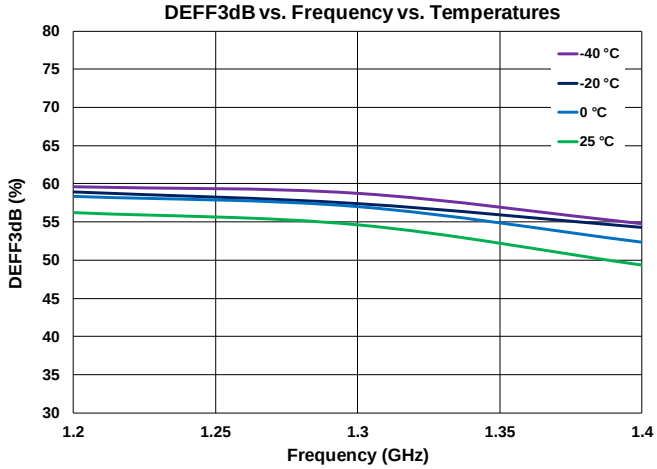
CW Power Drive-up Performance Over Temperatures of 1.2 – 1.4 GHz EVB[1]

Notes:

1. V_D = 45 V, I_{DQ} = 750 mA



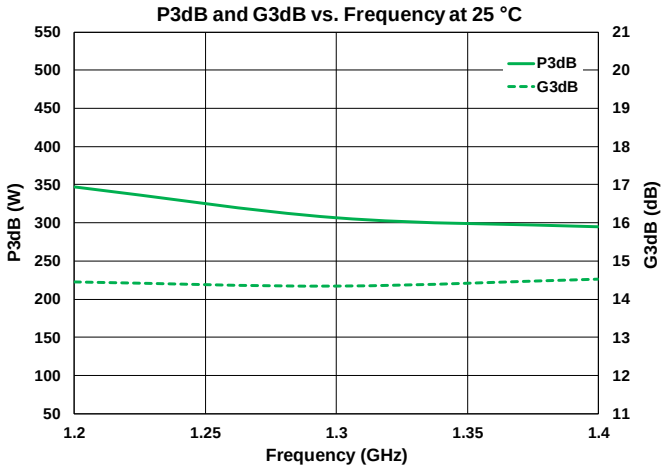


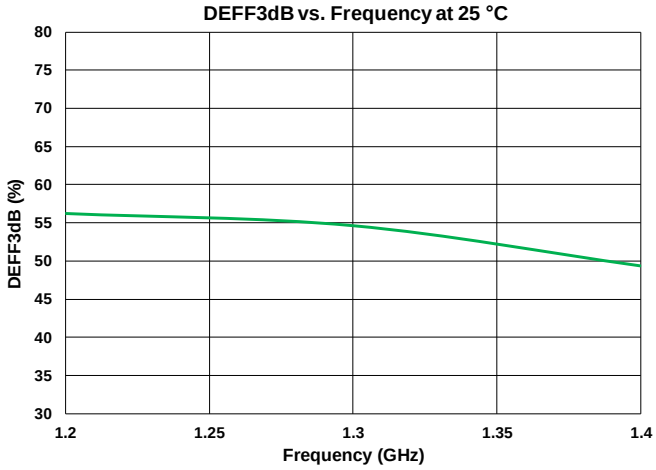


CW Power Drive-up Performance at 25 C of 1.2 – 1.4 GHz EVB[1]

Notes:

1. V_D = 45 V, I_{DQ} = 750 mA

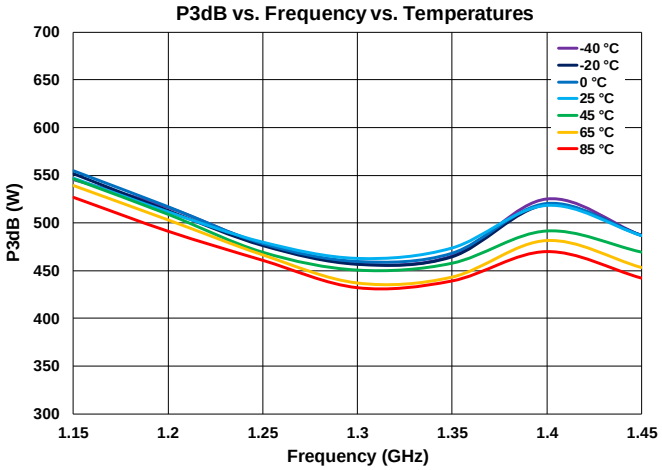


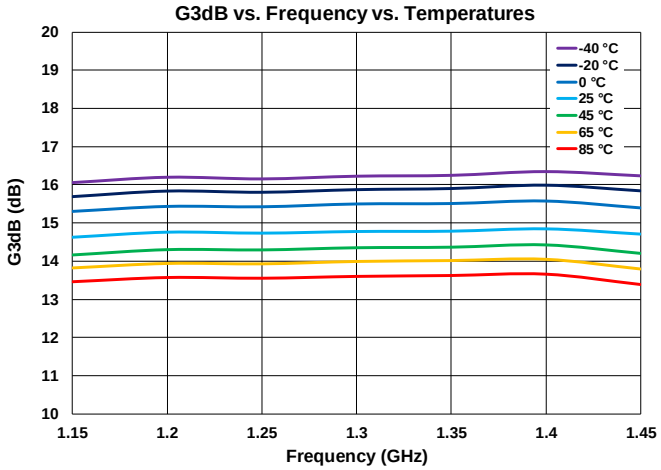


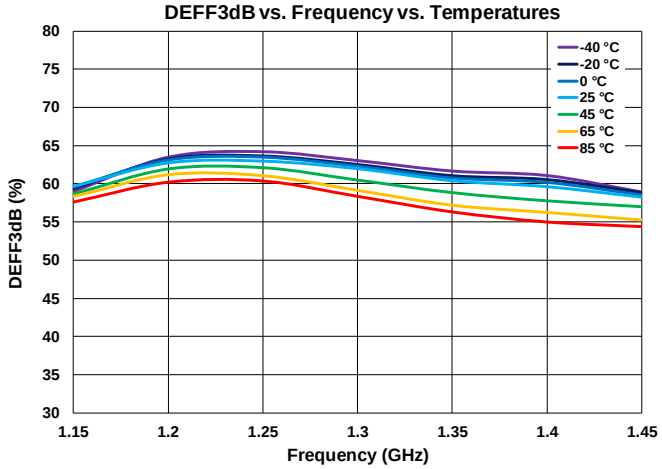
Pulsed Power Drive-up Performance Over Temperature of 1.2 – 1.4 GHz EVB[1]

Notes:

1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 300 us, Duty Cycle = 30%



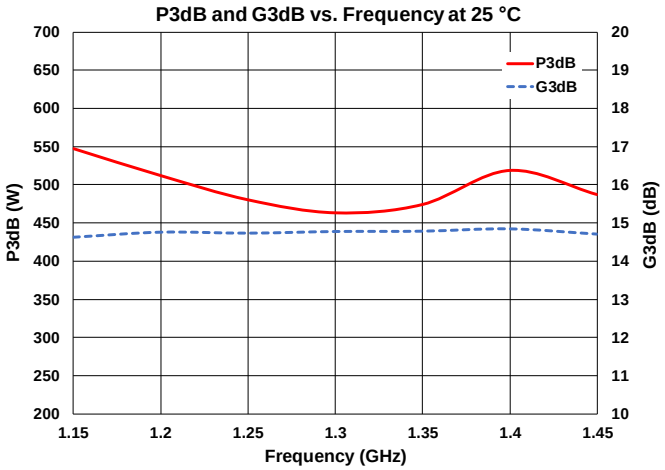


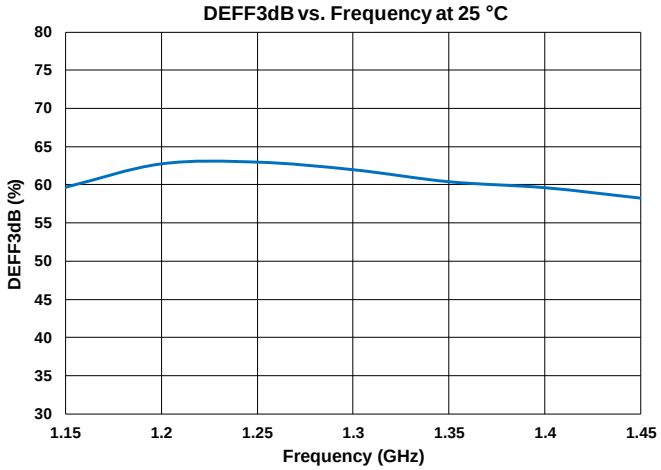


Pulsed Power Drive-Up Performance at 25 °C of 1.2 – 1.4 GHz EVB[1]

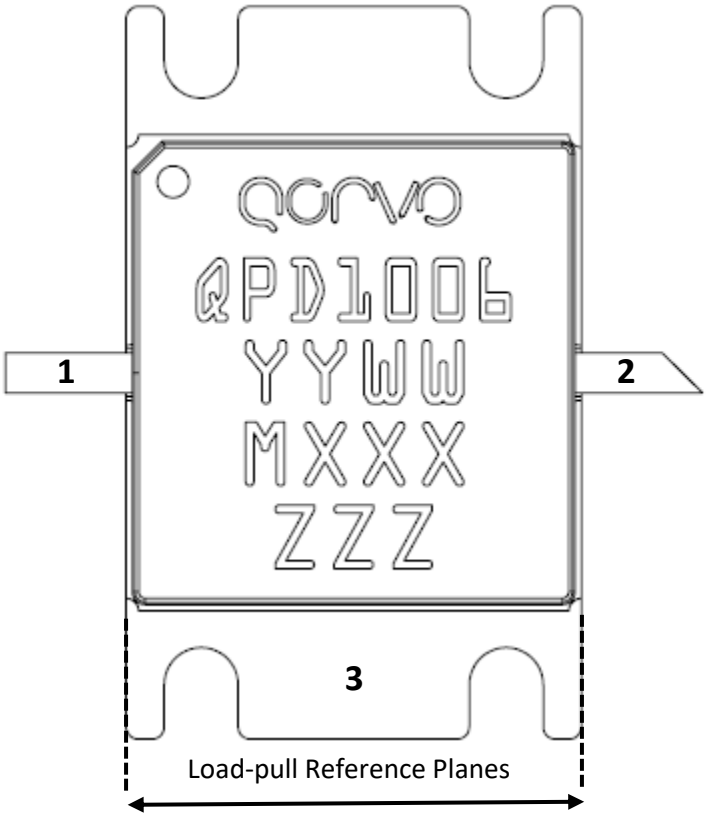
Notes:

1. V_D = 50 V, I_{DQ} = 750 mA, Pulse Width = 300 us, Duty Cycle = 30%





Pin Configuration and Package Marking[1]



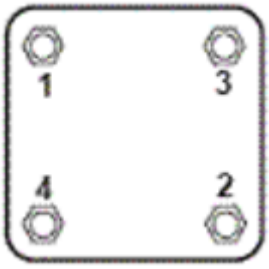
Pin	Symbol	Description
1	V_G / RF_{IN}	Gate Voltage / RF Input
2	V_D / RF_{OUT}	Drain Voltage / RF Output
3	GND	Package base/ Ground

Notes:

1. The QPD1006 will be marked with the “QPD1006” 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.

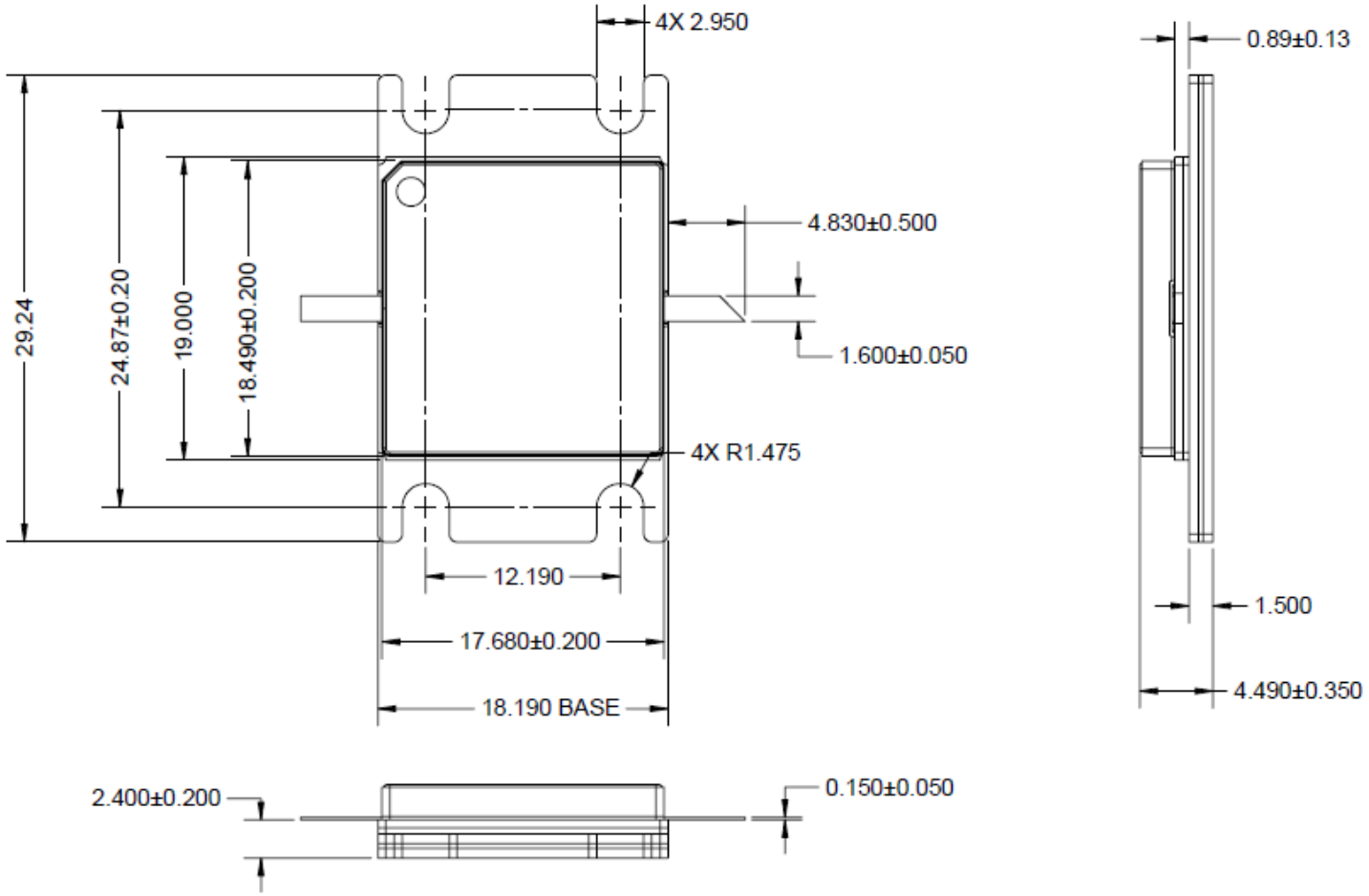
Assembly Notes

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 QPD1006. 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.

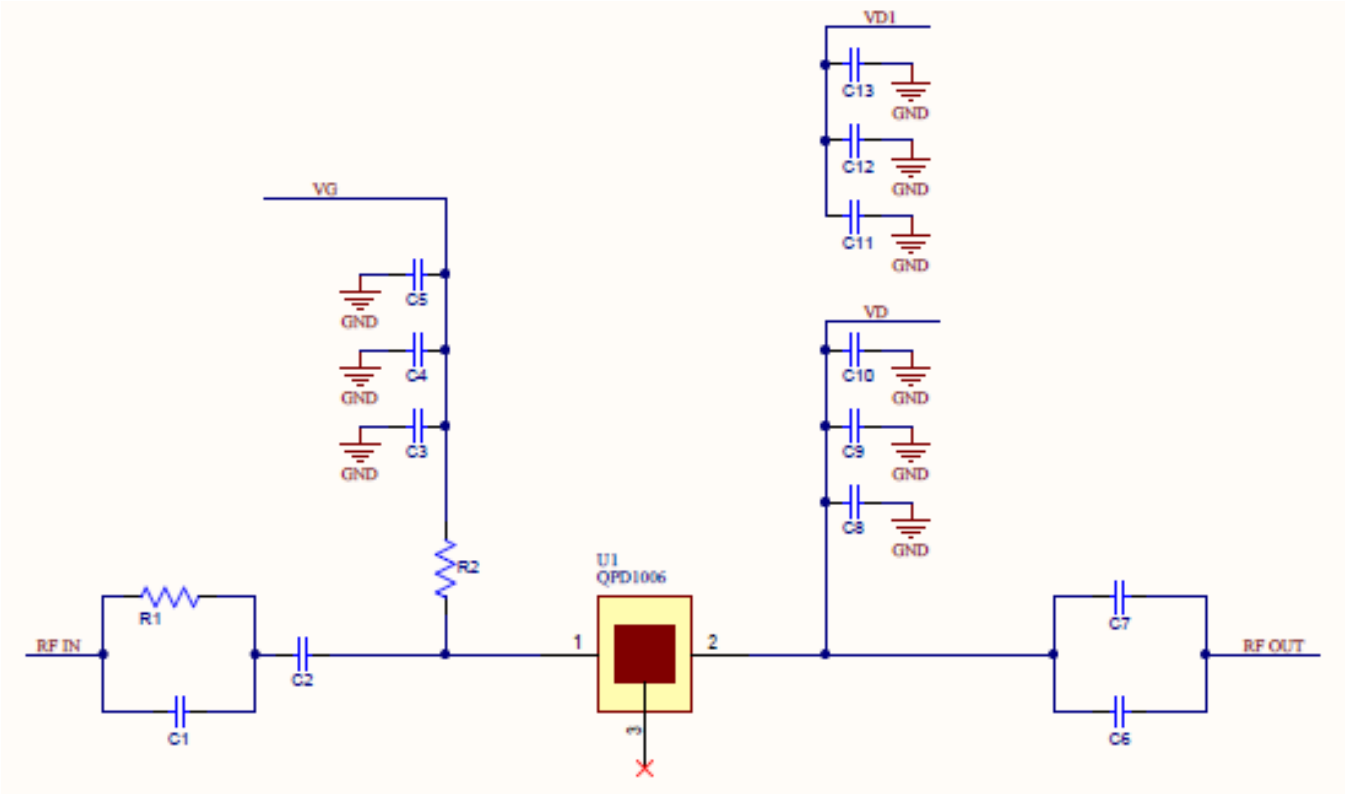
Package Dimensions[1, 2, 3, 4, 5, 6]



Notes:

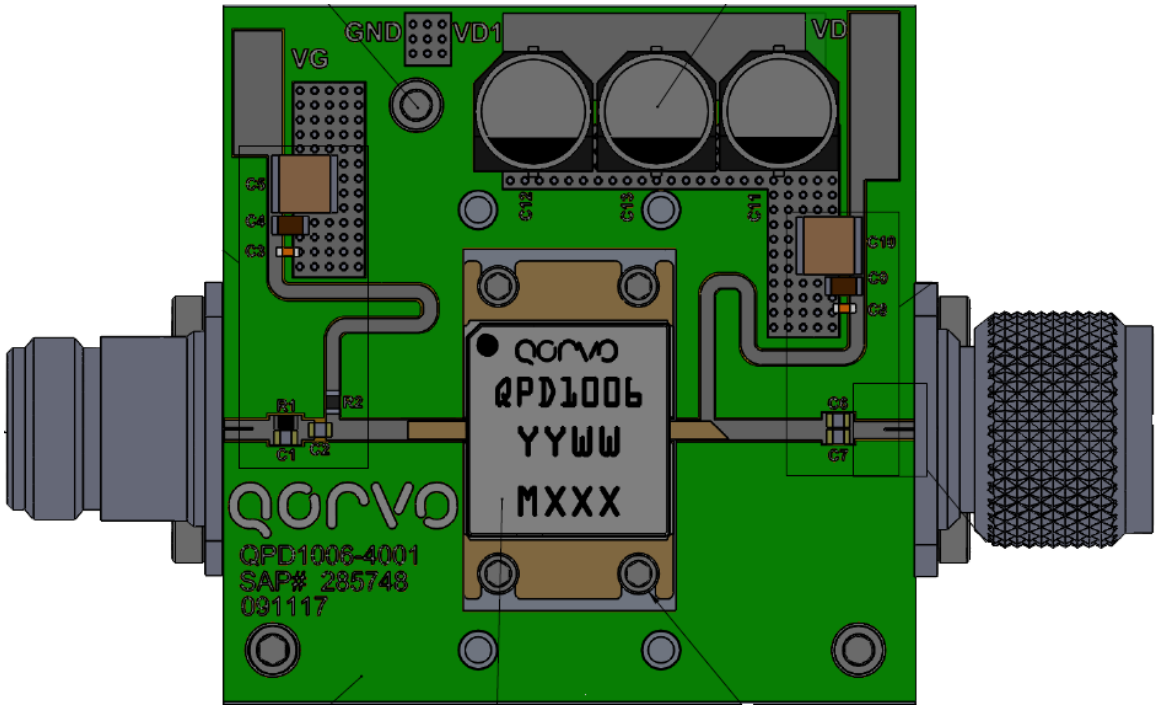
1. All dimensions are in mm. Unless otherwise noted, the tolerance is +/- 0.15mm.
2. For instruction to mount the part, please refer to application note "RF565 Package Mounting, Mechanical Mounting and PCD Considerations."
3. Material:
   Package Base: Metal
   Package Lid: Ceramic
4. Package exposed metallization is gold plated.
5. Part is epoxy sealed.
6. Body dimensions do not include lid shift or epoxy run out which can be up to 0.5 mm per side.

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 7 A.	
6. Apply RF.	

1.2 – 1.4 GHz EVB[1, 2]



Notes:

1. PCB Material: TACONIC RF35-TC, 30 mil thickness
2. For good pulsed operation, an additional 3300 uF, 100 V electrolytic capacitor is required on the drain supply line.

Bill of Material – 1.2 – 1.4 GHz EVB

Ref Des	Value	Qty	Manufacturer	Part Number
C1, C2, C6, C7	33 pF	4	ATC	600F330JT250XT
C4, C9	0.1 uF	2	TDK	C3216X7R2A104K160AA
C3, C8	240 pF	2	AVX	UQCFVA241JAT2A\500
C11, C12, C13	220 uF	3	United Chemicon	EMVY500ADA221MJA03
C5, C10	10 uF	2	TDK	C5750X7S2A106M230KB
R1	100 Ohm	1	Kamaya, Inc	RMC1/10-101JTP
R2	10 Ohm	1	Vishay	CRCW080510R0JNTA

Handling Precautions

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

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Email: customer.support@qorvo.com

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