QPD1000

15W, 28V, 0.03 – 1.215 GHz, GaN RF Input-Matched Transistor

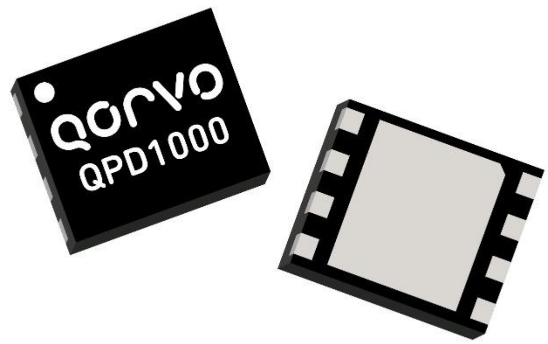
Product Overview

The Qorvo QPD1000 is a 15W (P_{3dB}), 50Ω-input matched discrete GaN on SiC HEMT which operates from 30MHz to 1.215 GHz. The integrated input matching network enables wideband gain and power performance, while the output can be matched on board to optimize power and efficiency for any region within the band.

The device is housed in a 5 x 6 mm leadless SMT package that saves real estate of already space-constrained handheld radios.

Lead-free and ROHS compliant

Evaluation boards are available upon request.



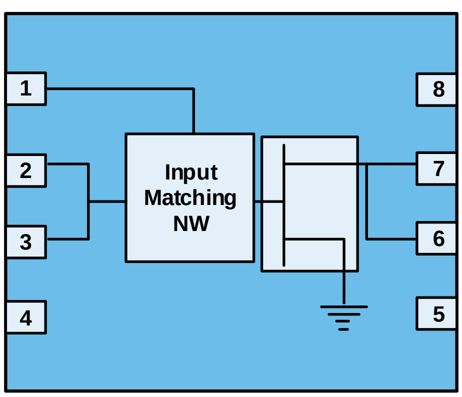
5 x 6 x 1.09 mm QFN

Key Features

- Frequency: 30 MHz to 1.215 GHz
- Output Power (P_{3dB})[1]: 24 W
- Linear Gain[1]: 19 dB
- Typical PAE_{3dB}[1]: 78 %
- Operating Voltage: 28 V
- Low thermal resistance package
- CW and Pulse capable
- 5 x 6 mm package

Note 1: @ 1 GHz

Functional Block Diagram



Applications

- Military radar
- Civilian radar
- Land mobile and military radio communications
- Test instrumentation
- Wideband or narrowband amplifiers
- Jammers

Ordering info

Part No.	Description
QPD1000	0.03 – 1.215 GHz RF Transistor
QPD1000PCB4B01	0.05 – 1.00 GHz EVB
QPD1000PCB4B02	0.20 – 1.20 GHz EVB

Absolute Maximum Ratings[1]

Parameter	Rating	Units
Breakdown Voltage, BV_{DG}	+100	V
Gate Voltage Range, V_G	−7 to +2	V
Drain Current	3	A
Power Dissipation, CW, P_{DISS}	32.4	W
RF Input Power, CW, 1 GHz, T = 25 °C	+30	dBm
Storage Temperature	−65 to +150	°C

Notes:

1. Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

Recommended Operating Conditions[1]

Parameter	Min	Typ	Max	Units
Operating Temp. Range	−40	+25	+85	°C
Drain Voltage Range, V_D	+12	+28	+32	V
Drain Bias Current, I_{DQ}	–	50	–	mA
Gate Voltage, V_G[2]	−4	−2.8	−1	V

Notes:

1. Electrical performance is measured under conditions noted in the electrical specifications table. Specifications are not guaranteed over all recommended operating conditions.
2. To be adjusted to desired I_{DQ}

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

Parameters	Typical Values				Unit
Frequency, F	0.6	0.8	1.0	1.2	GHz
Linear Gain, G_{LIN}	19.9	20.0	19.0	17.2	dB
Output Power at 3dB compression point, P_{3dB}	43.7	43.8	43.8	43.8	dBm
Power-Added-Efficiency at 3dB compression point, PAE_{3dB}	62.4	56.5	61.6	59.5	%
Gain at 3dB compression point	16.9	17.0	16.0	14.2	dB

Notes:

1. Test conditions unless otherwise noted: V_D = +28 V, I_{DQ} = 50 mA, Temp = +25 °C

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

Parameters	Typical Values				Unit
Frequency, F	0.6	0.8	1.0	1.2	GHz
Linear Gain, G_{LIN}	20.4	20.9	19.3	17.1	dB
Output Power at 3dB compression point, P_{3dB}	41.9	41.5	41.1	41.0	dBm
Power-Added-Efficiency at 3dB compression point, PAE_{3dB}	72.4	74.6	78.2	71.1	%
Gain at 3dB compression point, G_{3dB}	17.4	17.9	16.3	14.1	dB

Notes:

1. Test conditions unless otherwise noted: V_D = +28 V, I_{DQ} = 50 mA, Temp = +25 °C

RF Characterization – 0.05 – 1.00 GHz EVB Performance At 0.152 GHz[1]

Parameter	Min	Typ	Max	Units
Output Power at 25 dBm Input Power	40	41.2	–	dBm
Drain Efficiency at 25 dBm Input Power	72	87.8	–	%
Gain at 25 dBm Input Power	14.5	16.2	–	dB

Notes:
1. V_D = +28 V, I_{DQ} = 50 mA, Temp = +25 °C, CW

RF Characterization – 0.05 – 1.00 GHz EVB Performance At 0.5 GHz[1]

Parameter	Min	Typ	Max	Units
Output Power at 25 dBm Input Power	40.5	41.8	–	dBm
Drain Efficiency at 25 dBm Input Power	52	57.6	–	%
Gain at 25 dBm Input Power	15	16.8	–	dB
Gate Leakage: V_D = +10 V, V_G = −3.7 V	−7.92	–	–	mA

Notes:
1. V_D = +28 V, I_{DQ} = 50 mA, Temp = +25 °C, CW

RF Characterization – 0.05 – 1.00 GHz EVB Performance At 0.9 GHz[1]

Parameter	Min	Typ	Max	Units
Output Power at 25 dBm Input Power	40.8	42.4	–	dBm
Drain Efficiency at 25 dBm Input Power	57	66.2	–	%
Gain at 25 dBm Input Power	15.5	17.4	–	dB

Notes:
1. V_D = +28 V, I_{DQ} = 50 mA, Temp = +25 °C, CW

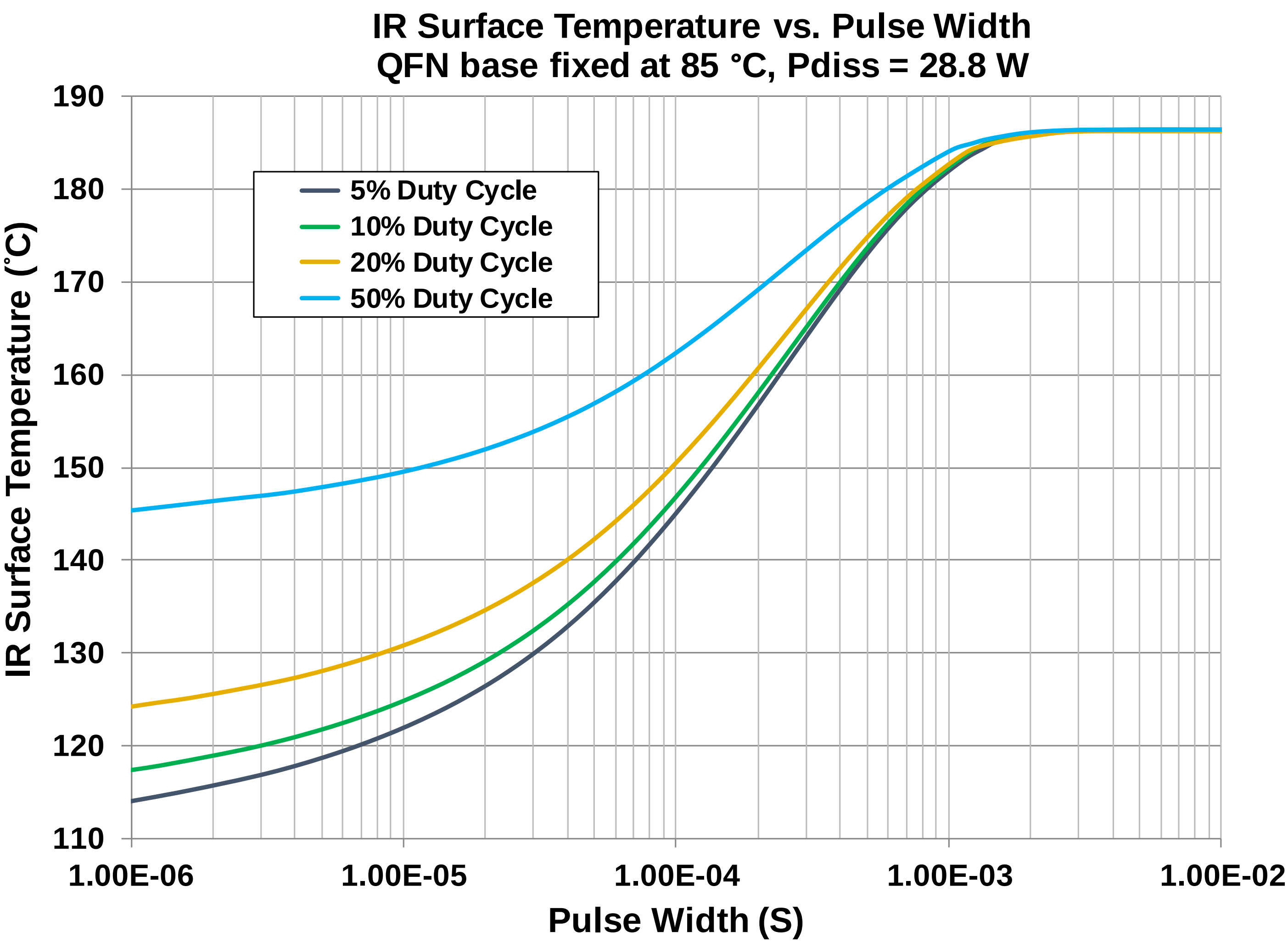
RF Characterization – Mismatch Ruggedness at 1 GHz[1]

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

Notes:
1. Test conditions unless otherwise noted: T_A = 25 °C, V_D = 28 V, I_{DQ} = 50 mA, CW

Driving input power is determined at CW compression under matched condition at EVB output connector.

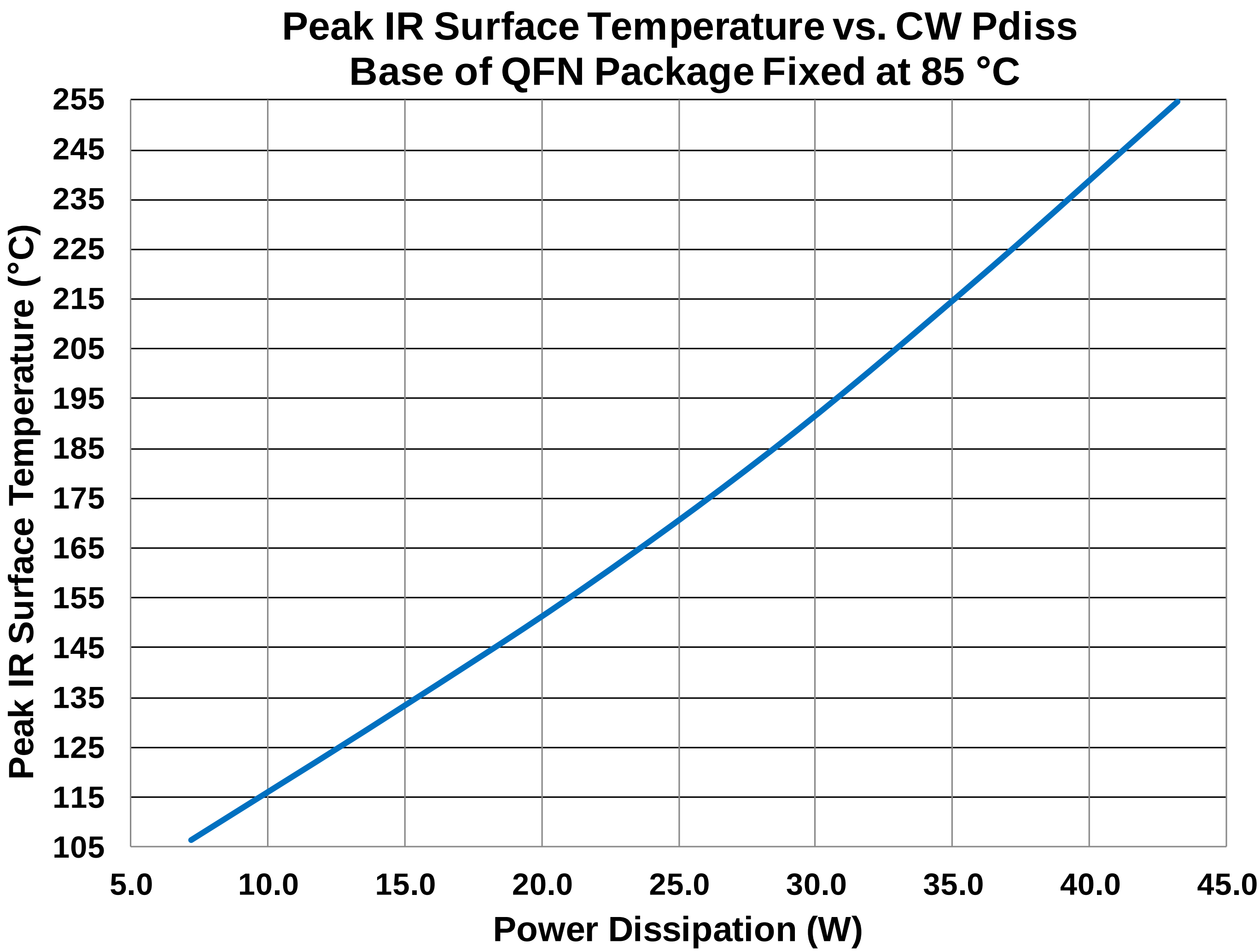
Thermal and Reliability Information – Pulsed



Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	2.08	°C/W
Peak IR Surface Temperature[1] (T_{CH})	28.8 W Pdiss, 100 uS PW, 5% DC	145	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	2.15	°C/W
Peak IR Surface Temperature[1] (T_{CH})	28.8 W Pdiss, 100 uS PW, 10% DC	147	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	2.26	°C/W
Peak IR Surface Temperature[1] (T_{CH})	28.8 W Pdiss, 100 uS PW, 20% DC	150	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	2.67	°C/W
Peak IR Surface Temperature[1] (T_{CH})	28.8 W Pdiss, 100 uS PW, 50% DC	162	°C

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

Thermal and Reliability Information – CW



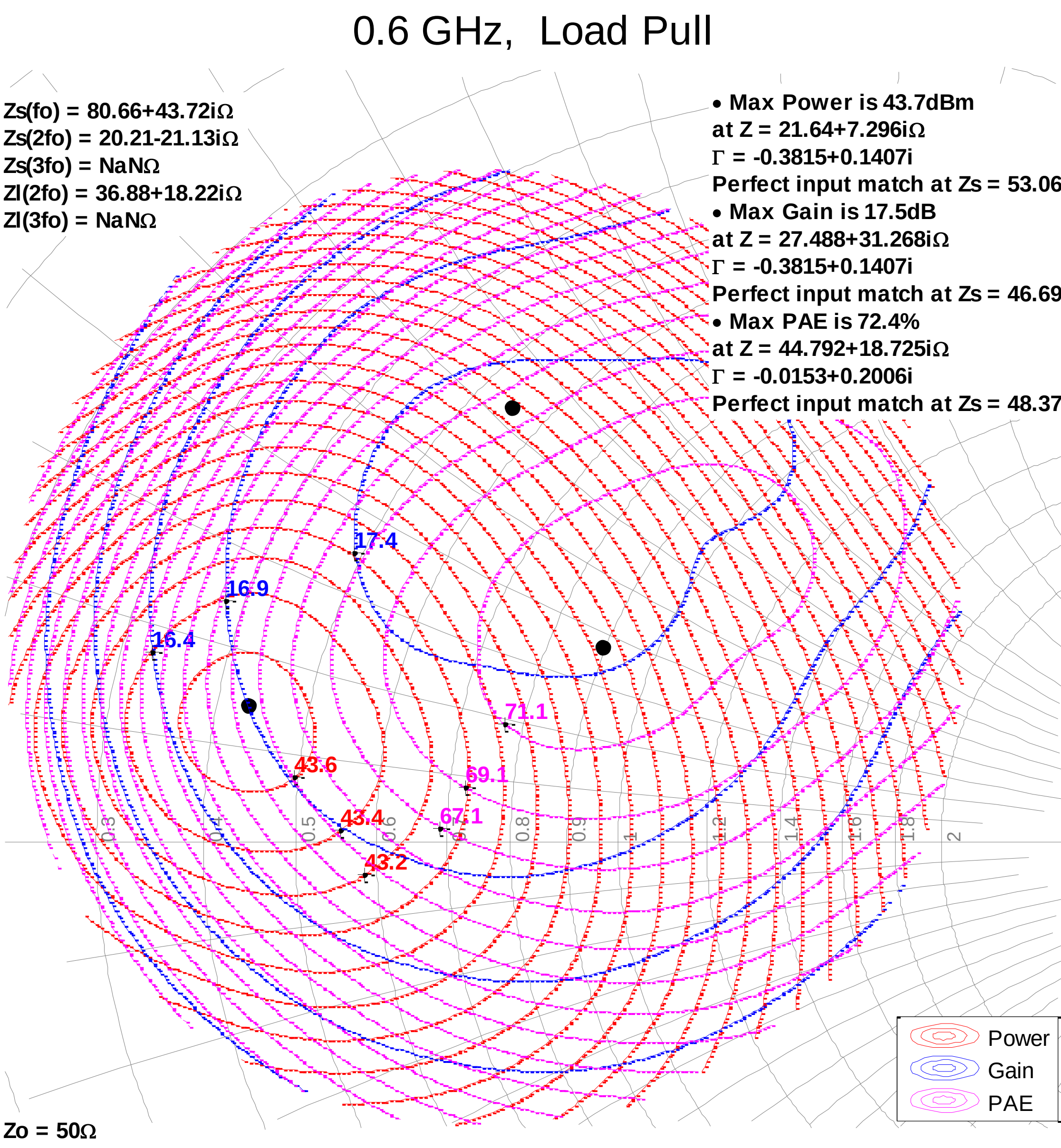
Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	2.92	°C/W
Peak IR Surface Temperature[1] (T_{CH})	7.2 W Pdiss, CW	106	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	3.19	°C/W
Peak IR Surface Temperature[1] (T_{CH})	14.4 W Pdiss, CW	131	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	3.33	°C/W
Peak IR Surface Temperature[1] (T_{CH})	21.6 W Pdiss, CW	157	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	3.51	°C/W
Peak IR Surface Temperature[1] (T_{CH})	28.8 W Pdiss, CW	186	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	3.72	°C/W
Peak IR Surface Temperature[1] (T_{CH})	36 W Pdiss, CW	219	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C back side temperature	3.94	°C/W
Peak IR Surface Temperature[1] (T_{CH})	43.2 W Pdiss, CW	255	°C

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

Load-Pull Smith Charts[1, 2, 3]

Notes:

1. V_D = 28 V, I_{DQ} = 50 mA, 100 uS PW, 10% DC pulsed. Performance is at 3dB gain compression referenced to peak gain.
2. See page 17 for load-pull and source-pull reference planes. 50-Ω 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.



Load-Pull Smith Charts[1, 2, 3]

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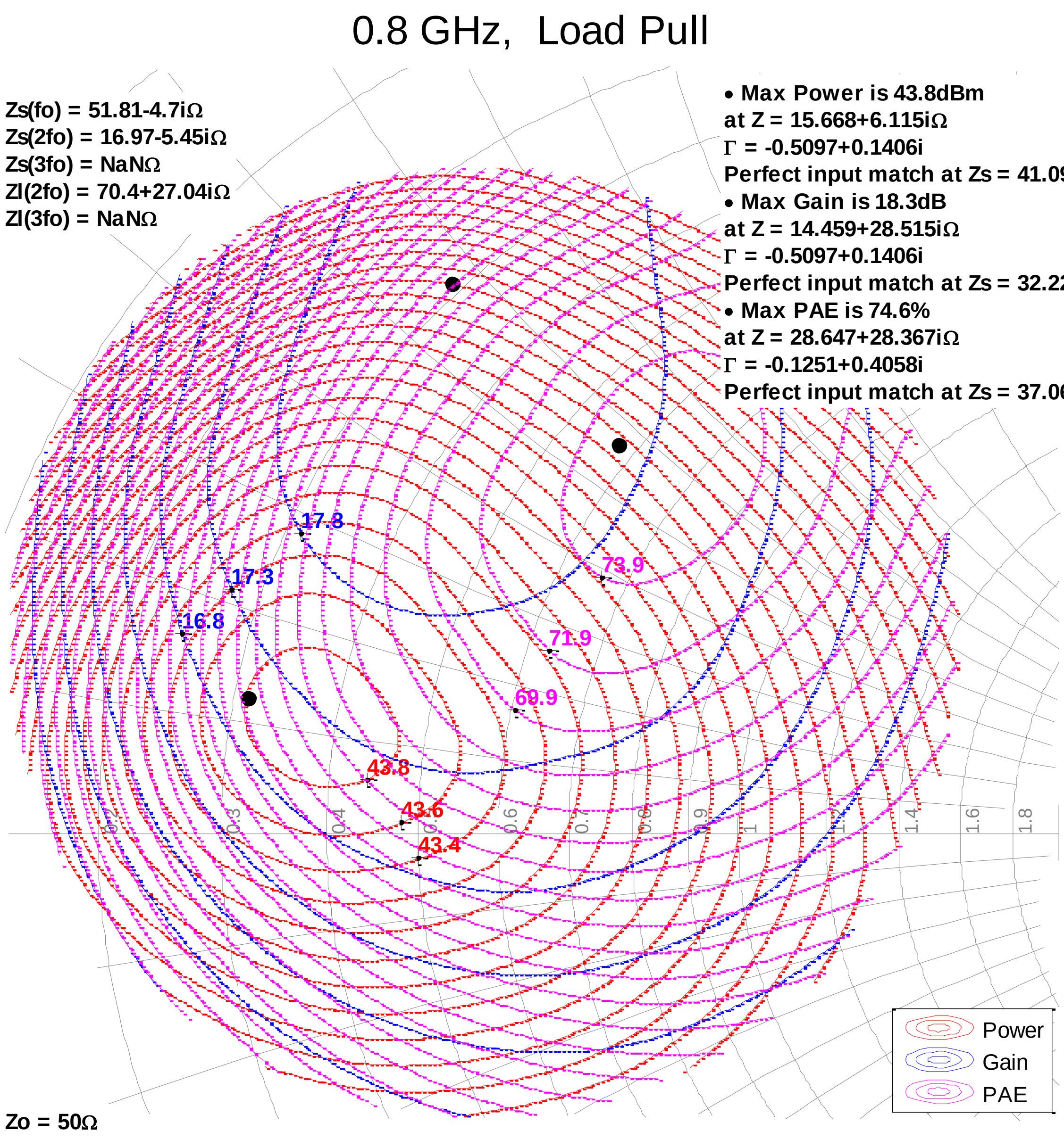

Load-Pull Smith Charts[1, 2, 3]

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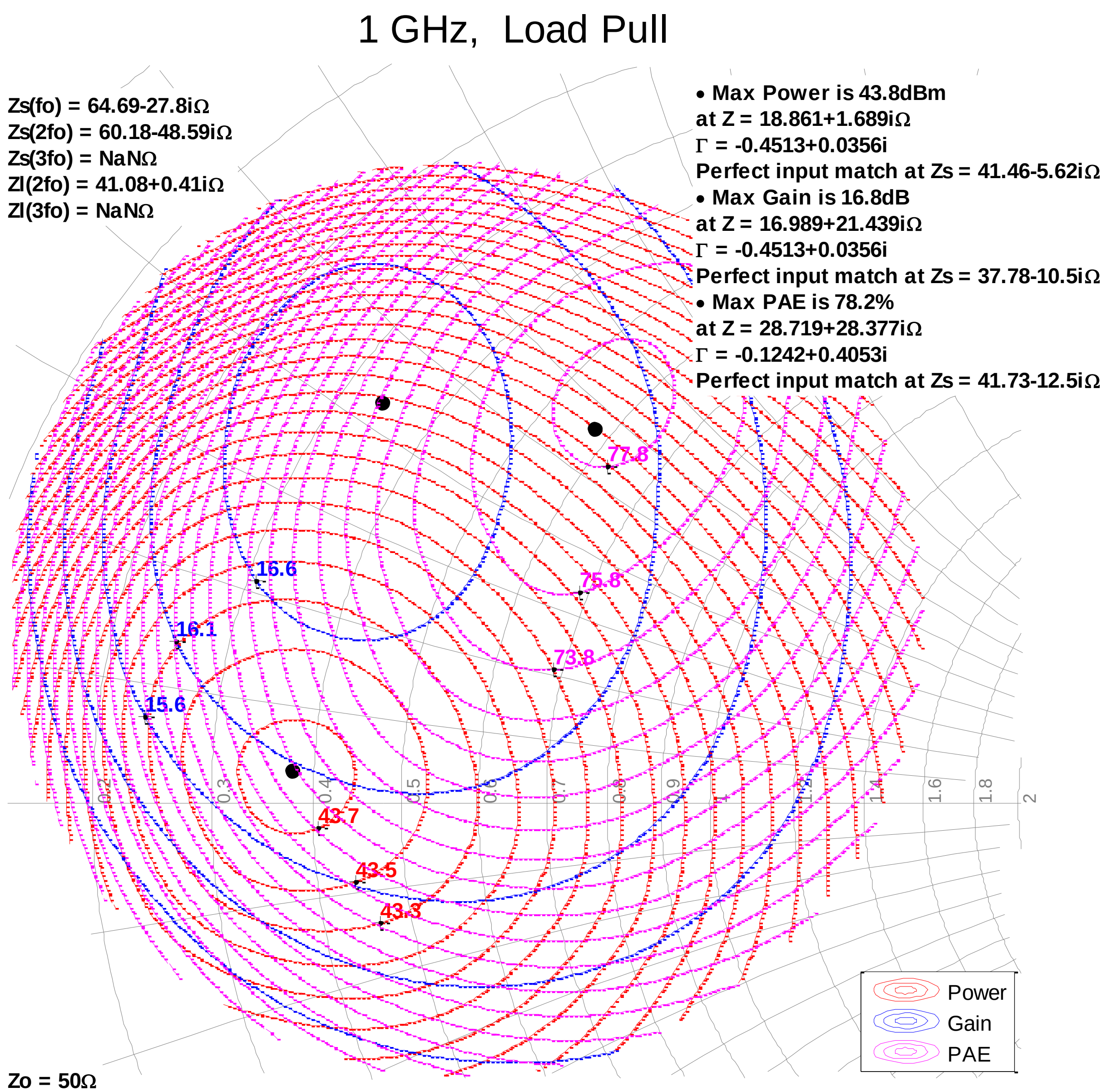

Load-Pull Smith Charts[1, 2, 3]

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1. V_D = 28 V, I_{DQ} = 50 mA, 100 uS PW, 10% DC pulsed. Performance is at 3dB gain compression referenced to peak gain.
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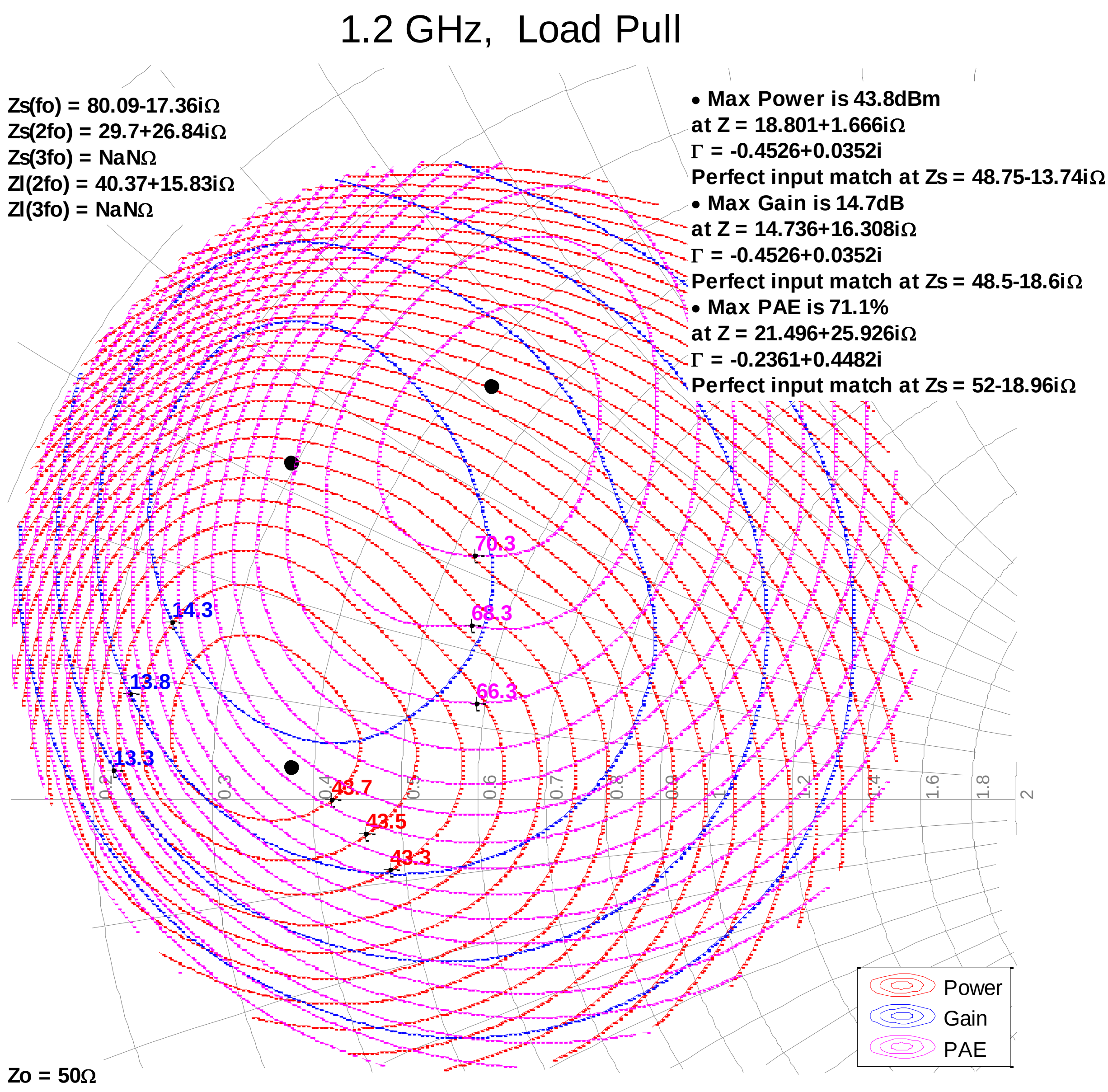
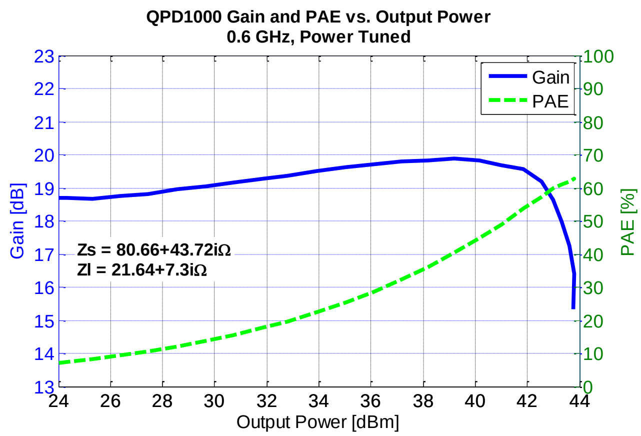
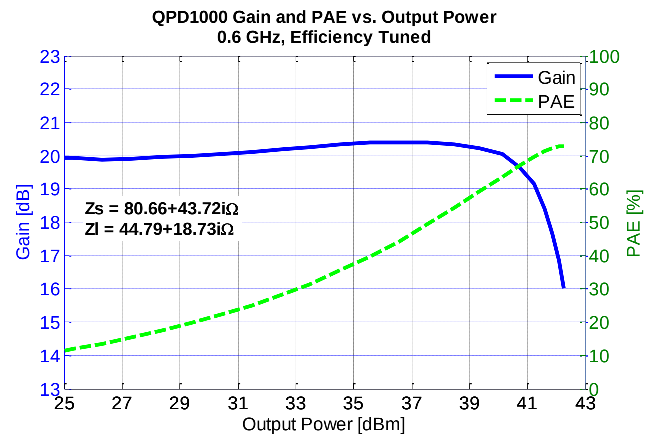


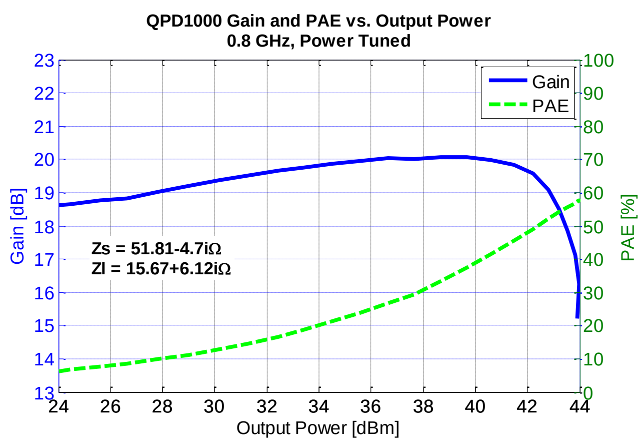
Typical Performance – Load-Pull Drive-up[1, 2]

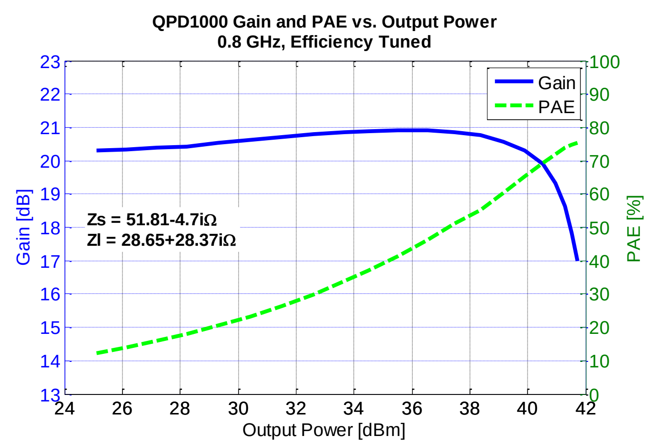
Notes:

1. 100 uS PW, 10% DC pulsed signal, V_D = 28 V, I_{DQ} = 50 mA
2. See page 17 for load-pull and source-pull reference planes where the performance was measured.









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

Notes:

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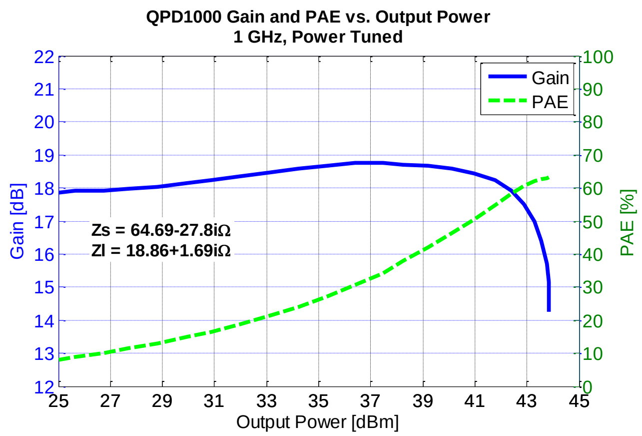
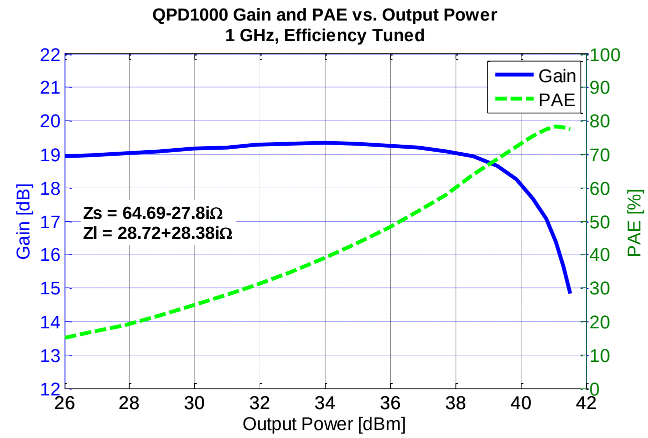
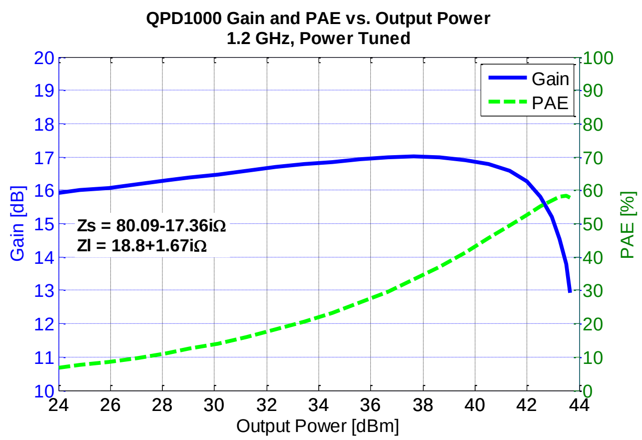
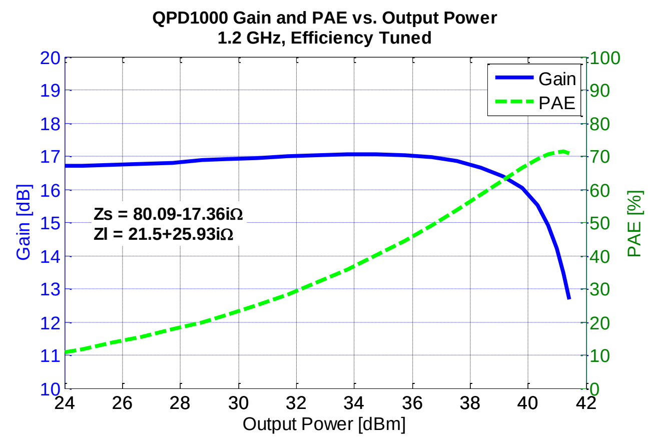




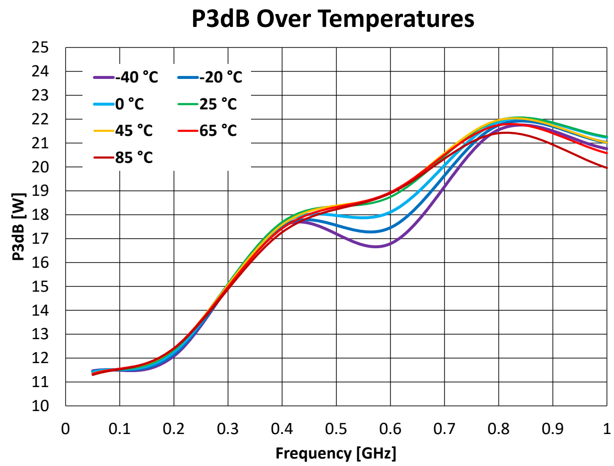


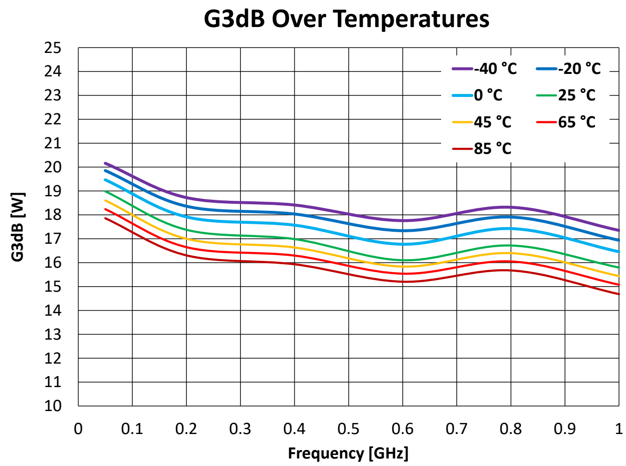


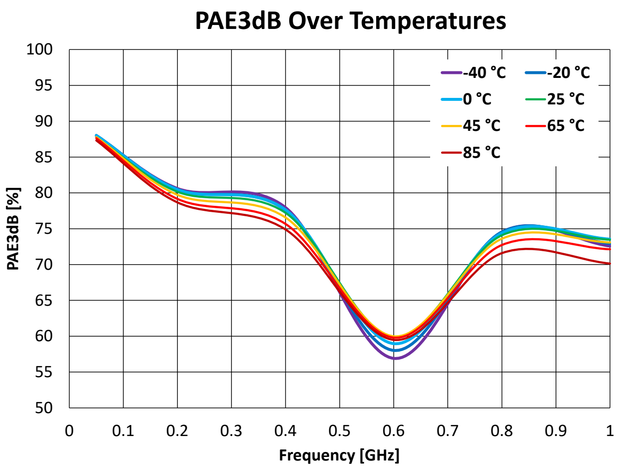
Power Drive-up Performance Over Temperatures Of 0.05 – 1.00 GHz EVB[1]

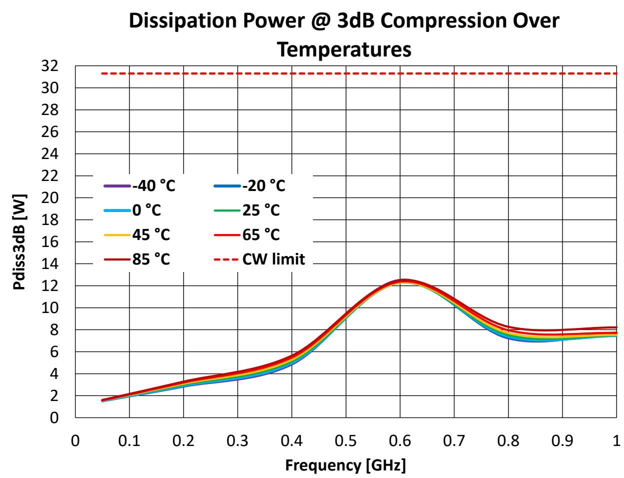
Notes:

1. V_D = 28 V, I_{DQ} = 50 mA, CW





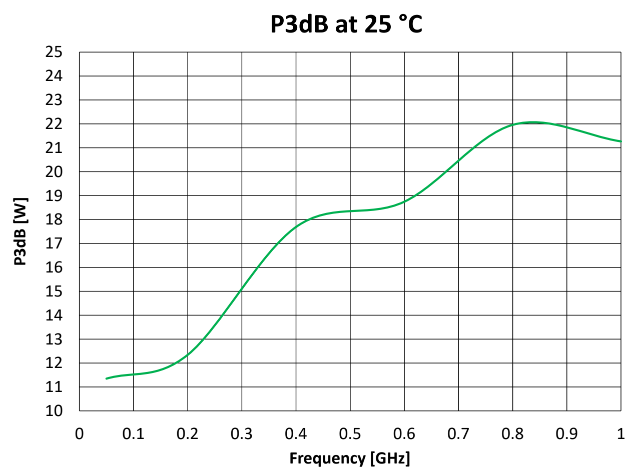


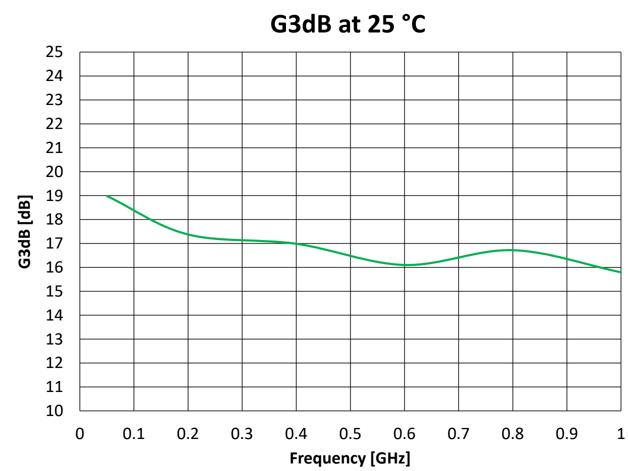


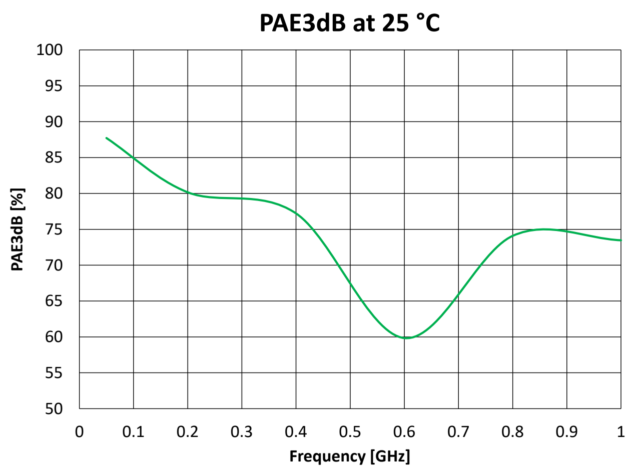
Power Drive-up Performance At 25 °C Of 0.05 – 1.00 GHz EVB[1]

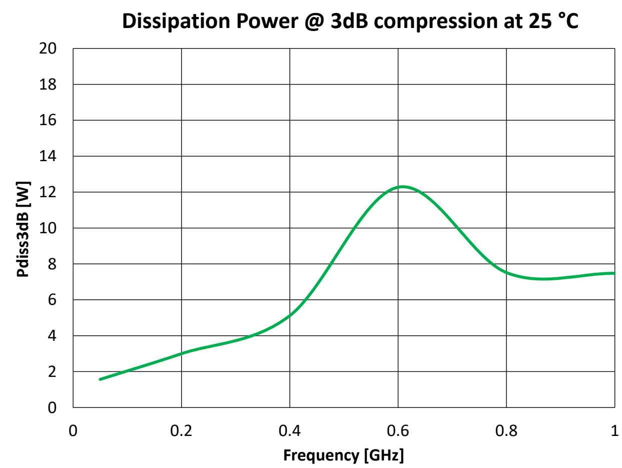
Notes:

1. V_D = 28 V, I_{DQ} = 50 mA, CW

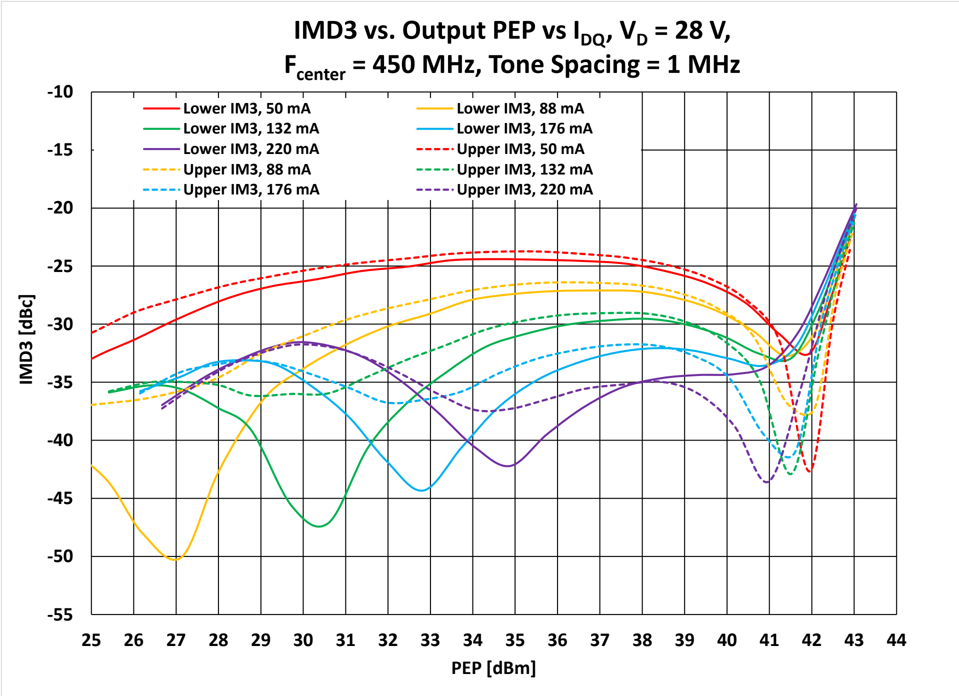


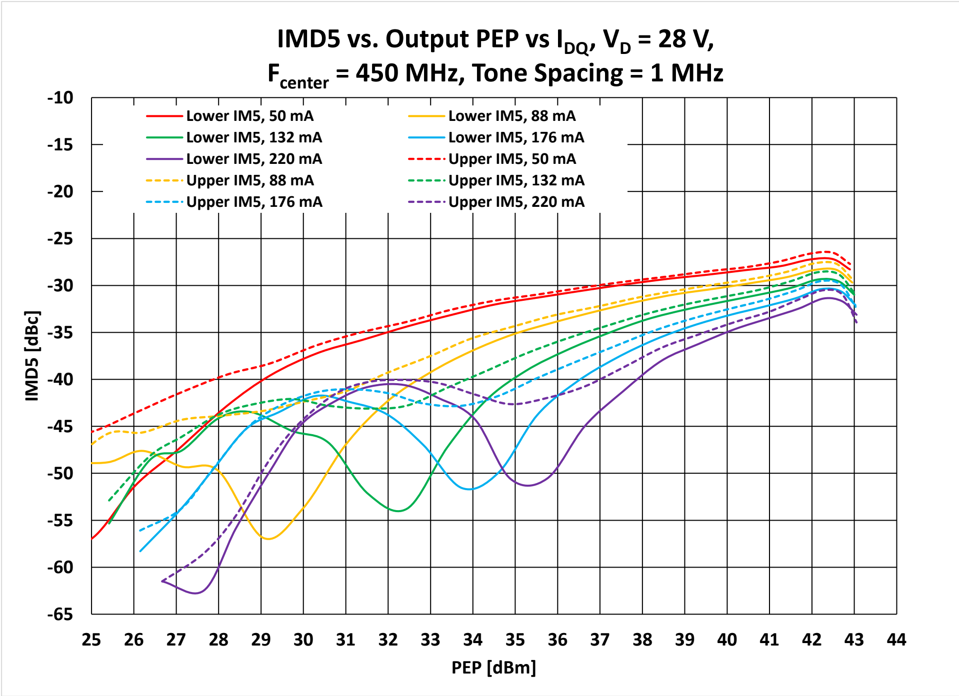




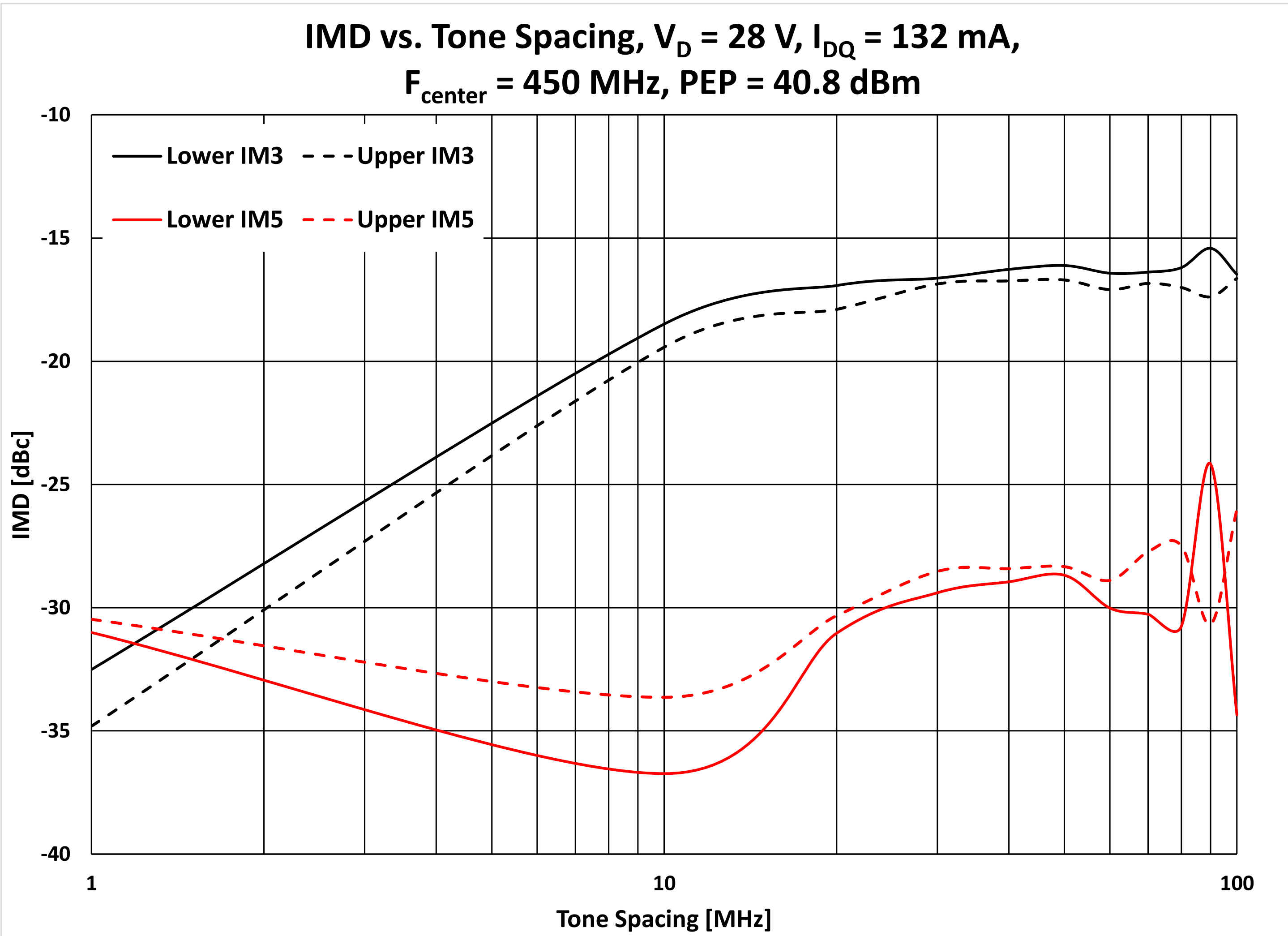


Two-Tone Performance At 25 °C Of 0.05 – 1.00 GHz EVB





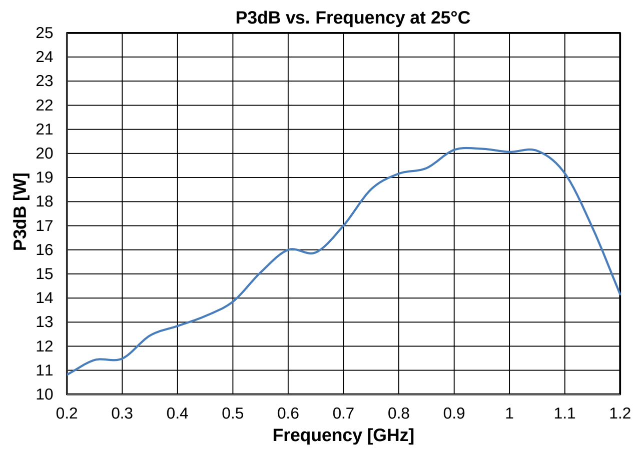
Two-Tone Performance At 25 °C Of 0.05 – 1.00 GHz EVB

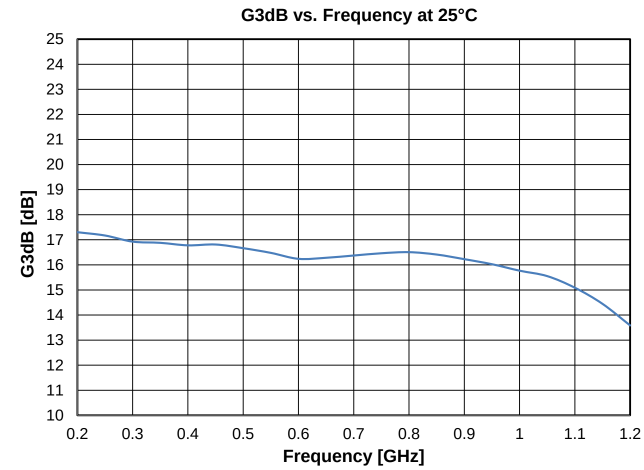


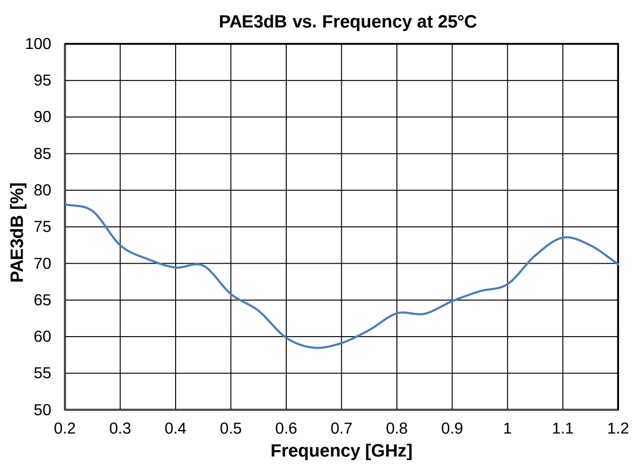
Power Drive-up Performance At 25 °C Of 0.2 – 1.20 GHz EVB[1]

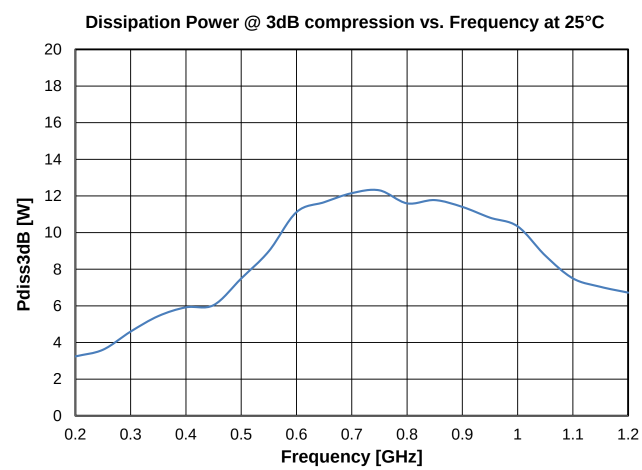
Notes:

1. V_D = 28 V, I_{DQ} = 50 mA, CW

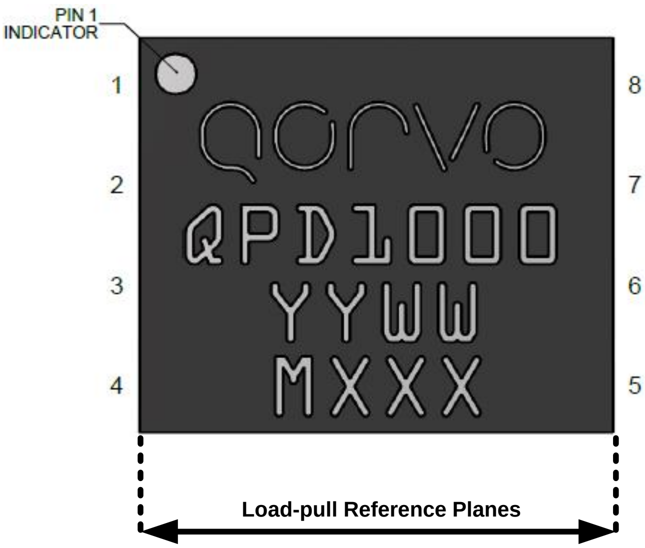


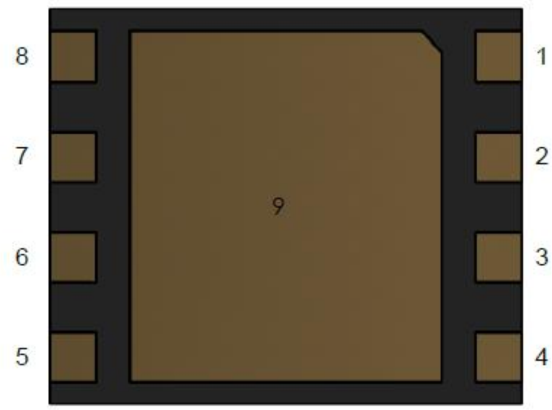






Pin Configuration and Description [1]





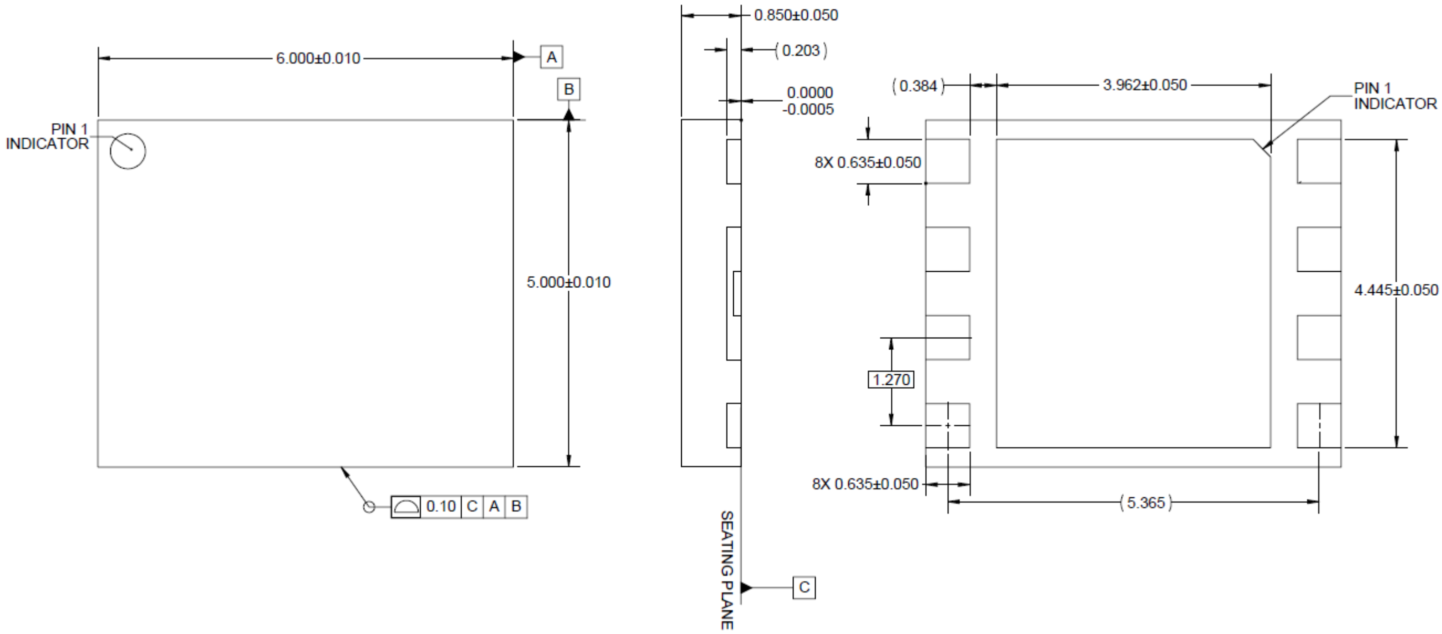
Notes:

1. The QPD1000 will be marked with the “1000” 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.

Pin Description

Pin	Symbol	Description
2, 3	RF IN	Gate voltage / RF Input
6, 7	V_D / RF OUT	Drain voltage / RF Output
1	V_{GQ}	Gate bias supply
4, 5, 8	N/C	Not connected
9	Source	Source to be connected to ground

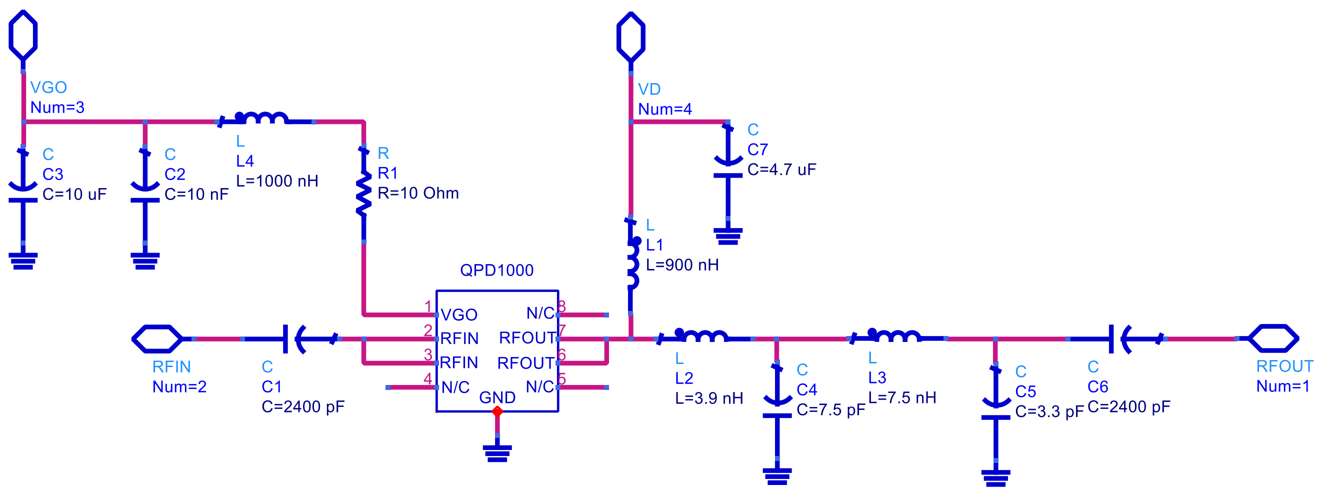
Package Marking and Dimensions[1, 2, 3]



Notes:

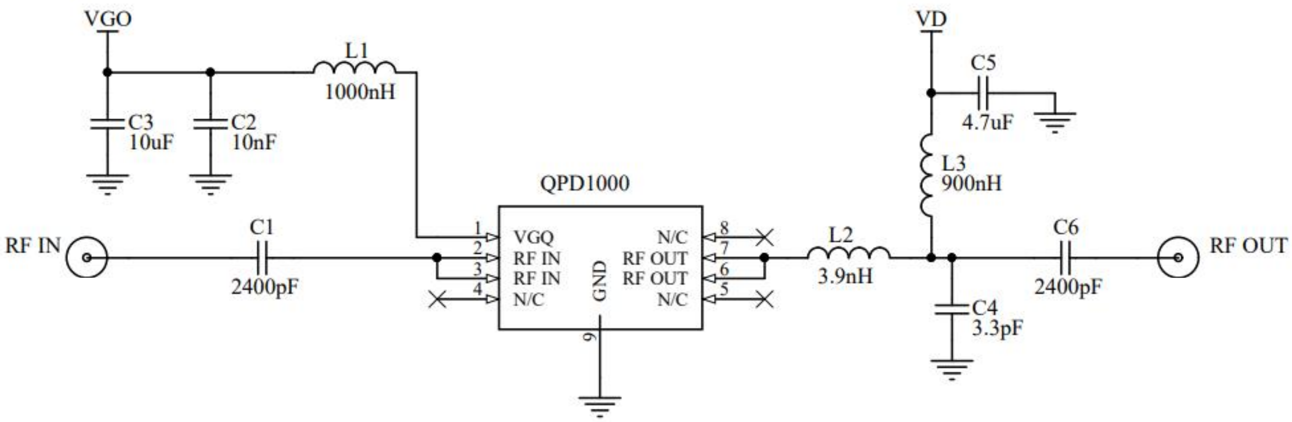
1. All dimensions are in mm. Otherwise noted, the tolerance is ±0.1 mm.
2. Package leads are gold plated.
3. Part is mold encapsulated.

Schematic - 0.05 – 1.00 GHz EVB



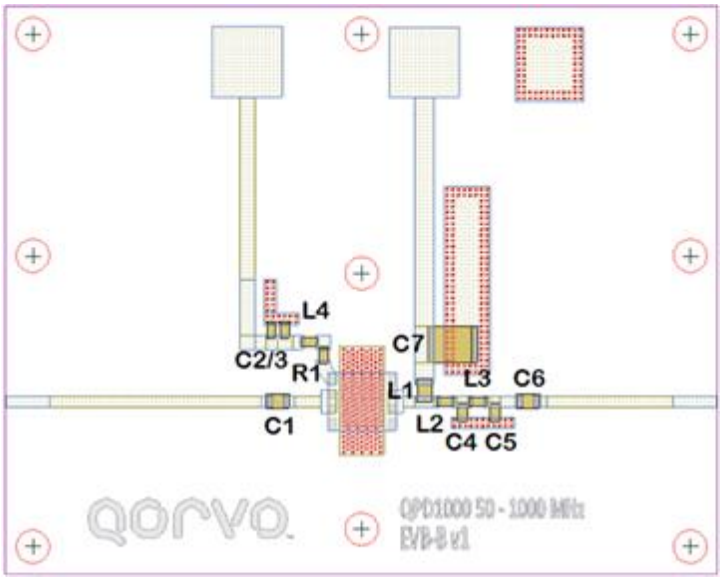
Bias-up Procedure	Bias-down Procedure
1. Set V_G to -4 V.	1. Turn off RF signal.
2. Set I_D current limit to 60 mA.	2. Turn off V_D
3. Apply 28 V V_D.	3. Wait 2 seconds to allow drain capacitor to discharge
4. Slowly adjust V_G until I_D is set to 50 mA.	4. Turn off V_G
5. Set I_D current limit to 2 A	
6. Apply RF.	

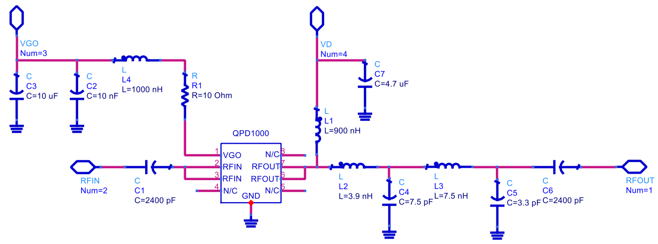
Schematic - 0.20 – 1.20 GHz EVB



Bias-up Procedure	Bias-down Procedure
2. Set V_G to -4 V.	3. Turn off RF signal.
4. Set I_D current limit to 60 mA.	4. Turn off V_D
5. Apply 28 V V_D.	5. Wait 2 seconds to allow drain capacitor to discharge
6. Slowly adjust V_G until I_D is set to 50 mA.	7. Turn off V_G
8. Set I_D current limit to 2 A	
9. Apply RF.	

0.05 – 1.00 GHz Reference Design





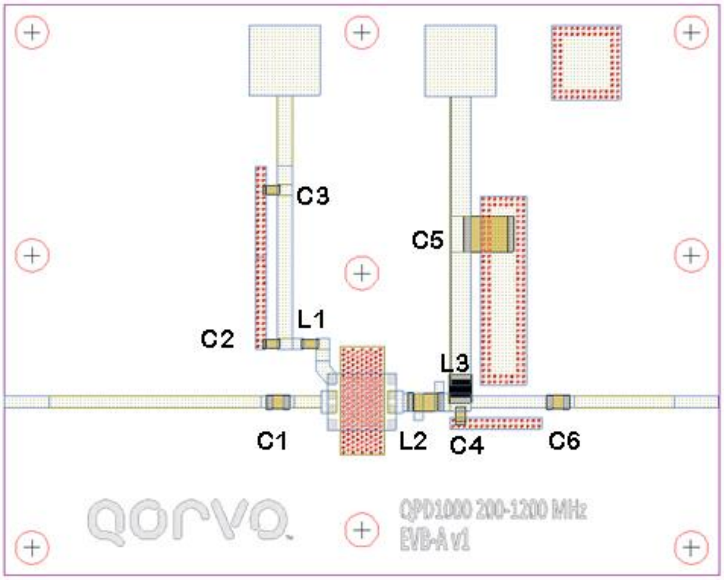
Notes:

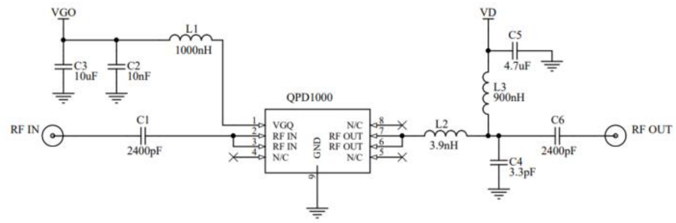
1. PCB Material: RO4350B, 20 mil thickness, 1 oz copper cladding

Bill Of material - 0.05 – 1.00 GHz EVB

Ref Des	Value	Qty	Manufacturer	Part Number
R1	10 Ω	1	Vishay	CRCW060310R0JNEA
C2	10 nF	1	AVX	0603YC103KAT2A
C3	10 uF	1	Murata	GRM21BR71A106KE51L
C4	7.5 pF	1	ATC	600S7R5BT250XT
C1, C6	2400 pF	2	Dielectric Labs	C08BL242X-5UN-X0T
C5	3.3 pF	1	ATC	600S3R3BT250XT
C7	4.7 uF	1	Murata	GRM55ER72A475KA01L
L1	900 nH	1	Coilcraft	1008AF-901XJLC
L2	3.9 nH	1	Coilcraft	0603HC-3N9XGLW
L3	7.5 nH	1	Coilcraft	0603HC-7N5XGLW
L4	1000 nH	1	Coilcraft	0603LS-102XGLC

0.20 – 1.20 GHz Reference Design





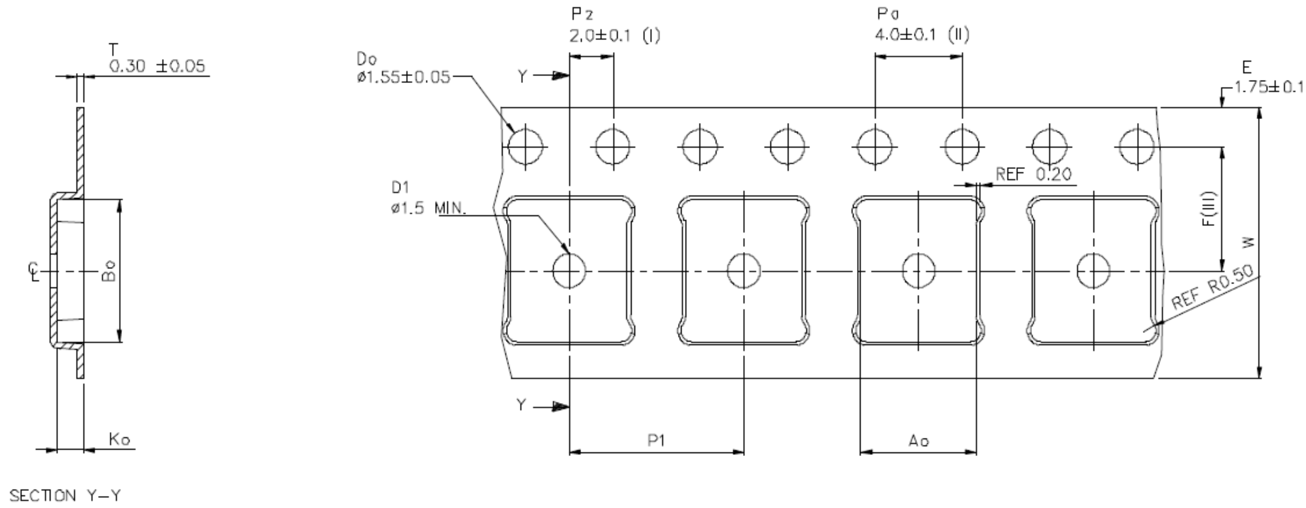
Notes:

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

Bill Of material - 0.2 – 1.20 GHz EVB

Ref Des	Value	Qty	Manufacturer	Part Number
C2	10 nF	1	AVX	0603YC103KAT2A
C3	10 uF	1	Murata	GRM21BR71A106KE51L
C4	3.3 pF	1	ATC	600S3R3AT250XT
C1, C6	2400 pF	2	Dielectric Labs	C08BL242X-5UN-X0T
C5	4.7 uF	1	Murata	GRM55ER72A475KA01L
L2	3.9 nH	1	Coilcraft	0603HC-3N9XGLW
L3	900 nH	1	Coilcraft	1008AF-901XJLC
L1	1000 nH	1	Coilcraft	0603LS-102XGLC

Tape and Reel Information

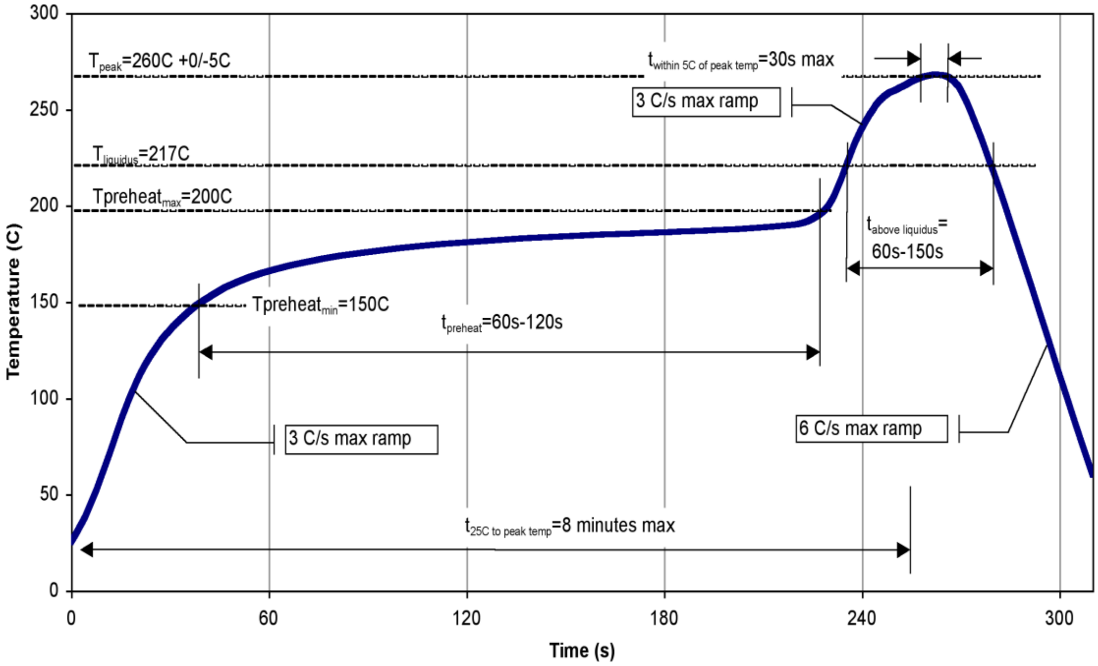


Ao	5.30 +/− 0.1
Bo	6.30 +/− 0.1
Ko	1.20 +/− 0.1
F	5.50 +/− 0.1
P1	8.00 +/− 0.1
W	12.00 +/− 0.3

(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

Recommended Solder Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1A, 250 V	ANSI/ESD/JEDEC JS-001
ESD – Charged Device Model (CDM)	Class C2B, 750 V	ANSI/ESD/JEDEC JS-002
MSL – Moisture Sensitivity Level	MSL3	JESD J-STD-020

Caution!
ESD-Sensitive Device

Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes.
Solder profiles available upon request.

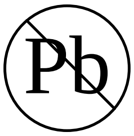
Contact plating: NiPdAu

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:

- Lead Free
- 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, and information about Qorvo:

Web: **www.qorvo.com** **Tel:** **+1.844.890.8163**
Email: **customer.support@qorvo.com**

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