QPD1004A

25W, 50V, 30 – 1400MHz, GaN Input Matched Transistor

1. Product Overview and Benefits

The QPD1004A is a 25W (P_{3dB}), 50OHM input matched discrete GaN on SiC HEMT which operates from 30MHz to 1400MHz on a 50V supply rail. 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. It is ideally suited for basestation, radar, and communications applications and can support both CW and pulsed mode of operations.

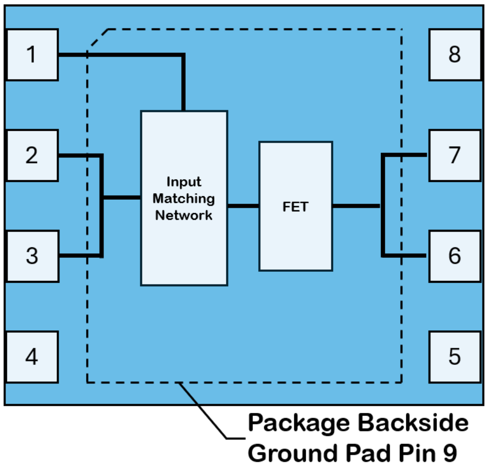
The device is housed in an industry-standard 6 x 5mm surface mount DFN package.

Lead-free and ROHS compliant

Evaluation boards are available upon request

6 x 5 x 0.85mm DFN Package

2. Functional Block Diagram



Top View

3. QPD1004AEVB Performance

Freq.(GHz)	P_{3dB}(W)	G_{3dB}(dB)	DE_{3dB}(%)
0.1	27.1	17.8	73.9
0.5	29.9	17.8	66.7
1.0	23.7	16.4	60.3

At Bottom of Baseplate Temperature of 25°C, Signal Type: CW

V_D = 50V, I_{DQ} = 50mA

See Evaluation Board – 100 – 1000MHz for more details.

4. Key Features

- Operating Voltage: 50V
- Low Thermal Resistance Package
- CW and Pulse Capable
- 6 x 5mm Package

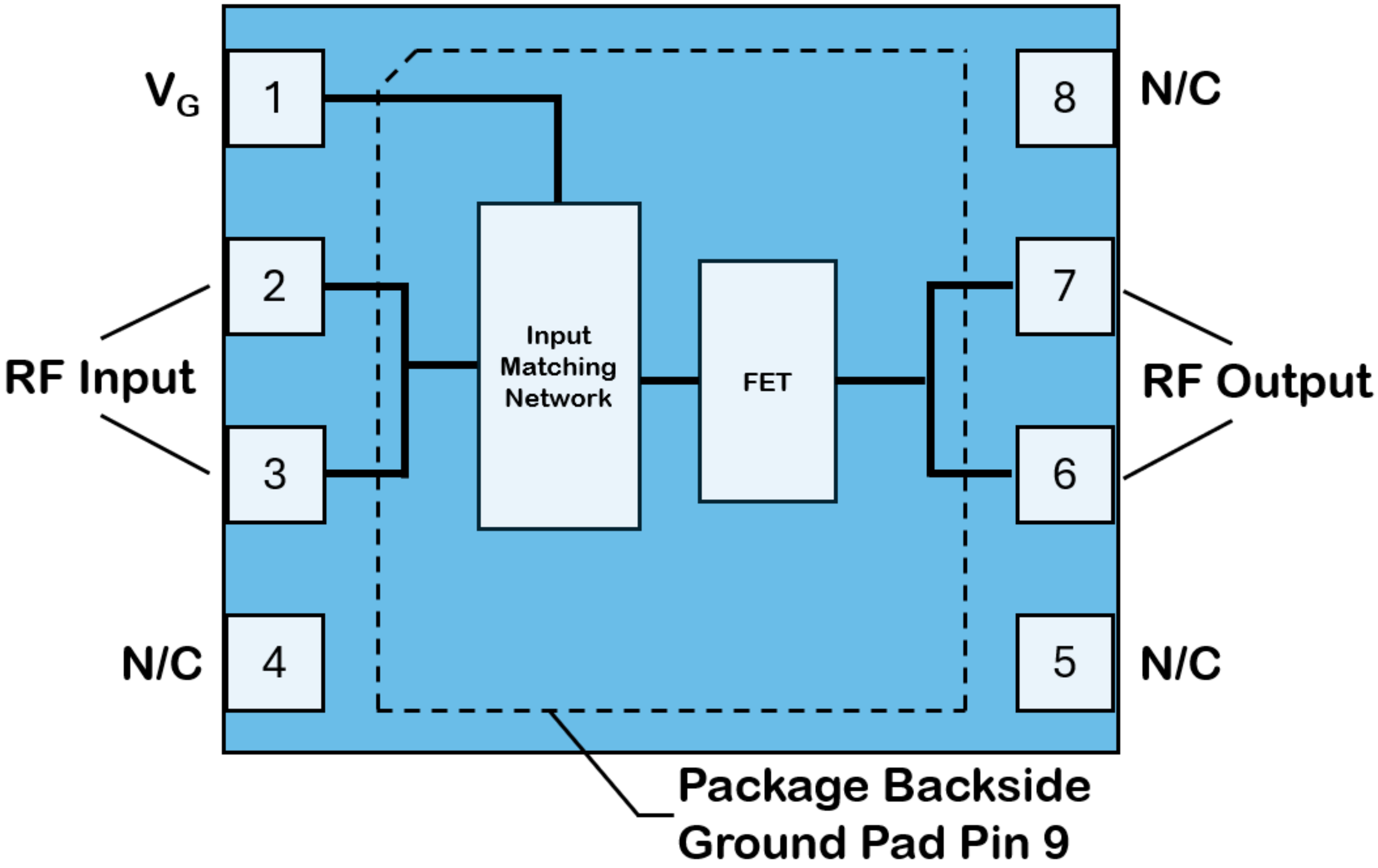
5. Applications

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

6. Ordering Information

Part Number	Description
QPD1004AS2	2 pcs. WP Sample
QPD1004ASR	100 pcs. 7” Short Reel
QPD1004ATR7	750 pcs.7” Reel
QPD1004AEVB	100 – 1000MHz Evaluation Board

7. Pin Configuration and Description

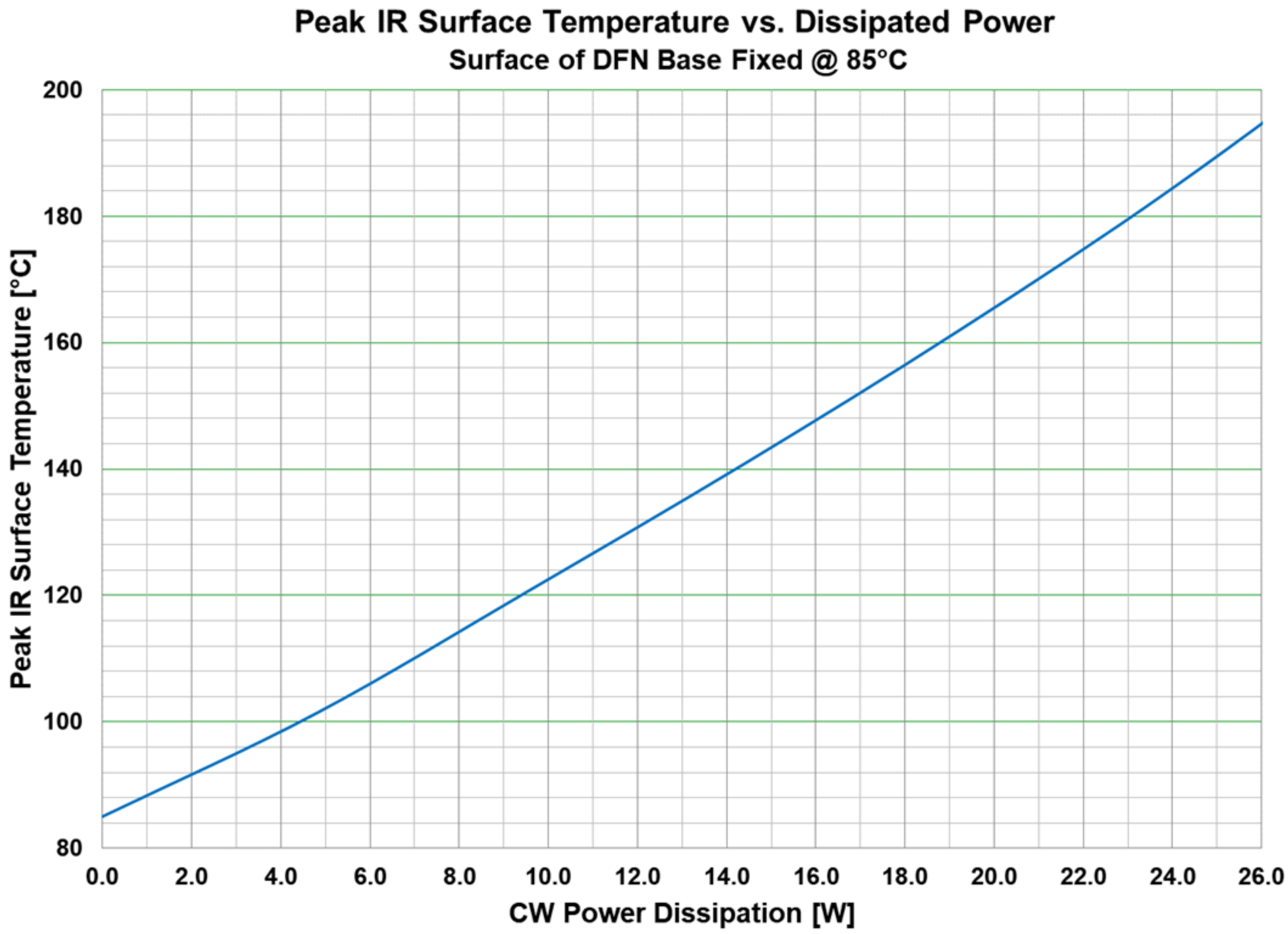


Top View

Pin Number	Label	Description
1	V_G	Gate Supply
2, 3	RF_{IN}	RF Input Port 50 OHM
6, 7	RF_{OUT}	Drain Supply, RF Output Port
9	GND	Ground Pad
4, 5, 8	N/C	No connections required. Can be used for reflow alignment.

8. Thermal and Reliability Information

8.1. Continuous Wave



Parameter	Conditions	Values	Unit
IR Thermal Resistance, θ_{JC}	85°C backside temperature	3.25	°C/W
Peak IR Surface Temperature, T_{CH}	4.0 W Pdiss, CW	98.5	°C
IR Thermal Resistance, θ_{JC}	85°C backside temperature	3.72	°C/W
Peak IR Surface Temperature, T_{CH}	9.0 W Pdiss, CW	118.5	°C
IR Thermal Resistance, θ_{JC}	85°C backside temperature	3.86	°C/W
Peak IR Surface Temperature, T_{CH}	14.0 W Pdiss, CW	139.0	°C
IR Thermal Resistance, θ_{JC}	85°C backside temperature	4.00	°C/W
Peak IR Surface Temperature, T_{CH}	19.0 W Pdiss, CW	161.0	°C
IR Thermal Resistance, θ_{JC}	85°C backside temperature	4.13	°C/W
Peak IR Surface Temperature, T_{CH}	24.0 W Pdiss, CW	184.1	°C

Please refer to the following document GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

9. Electrical Characteristics

9.1. Absolute Maximum Ratings

Parameter	Rating	Unit
Breakdown Voltage, BV_{DG}	+145	V
Gate Voltage Range, V_G	-7 to +2	V
Drain Current	3.6	A
Gate Current Range, I_G[2]	7.2	mA
Power Dissipation, CW, P_{DISS}	27.6	W
RF Input Power, CW, P_{IN}[1]	+29.7	dBm
Mounting Temperature (30 Seconds)	320	°C
Storage Temperature	-65 to +150	°C

Operation of this device outside the parameter ranges given above may cause permanent damage.

Note:

1. Continuous Wave(CW), T = 25°C, 1GHz
2. At FEA Channel Temperature of 200°C

9.2. Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Units
Operating Temperature Range	-40	+25	+85	°C
Drain Voltage Range, V_D	-	+50	+55	V
Drain Bias Current, I_{DQ}	-	50	-	mA
Gate Voltage, V_G[1]	-	-2.8	-	V
Channel Temperature (T_{CH})	-	-	+250	°C
Power Dissipation, CW (P_{DISS})[2]	-	-	25	W

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

Note:

1. To be adjusted to desired I_{DQ}
2. Back side of package at 85°C

9.3. Load Pull Performance – Power Tuned

Parameters	Typical Values				Unit
Frequency, Freq.	0.6	0.8	1.0	1.2	GHz
Linear Gain, G_{LIN}	21.0	21.2	20.1	18.4	dB
Output Power at 3dB Compression, P_{3dB}	45.7	45.9	46.0	45.7	dBm
Power Added Efficiency at 3dB Compression, PAE_{3dB}	62.4	61.5	63.5	59.5	%
Gain at 3dB Compression	18.0	18.2	17.1	15.4	dB

Note:

1. Test conditions: Pulsed Continuous Wave(Pulsed CW), Pulse Width = 100us, Duty Cycle = 10%, V_D = +50V, I_{DQ} = 50mA, Temperature = +25°C.

9.4. Load Pull Performance – Efficiency Tuned

Parameters	Typical Values				Unit
Frequency, Freq.	0.6	0.8	1.0	1.2	GHz
Linear Gain, G_{LIN}	22.6	22.0	20.8	18.8	dB
Output Power at 3dB Compression, P_{3dB}	43.5	44.8	44.9	45.0	dBm
Power Added Efficiency at 3dB Compression, PAE_{3dB}	73.7	68.6	73.2	65.0	%
Gain at 3dB Compression	19.6	19.0	17.8	15.8	dB

Note:

1. Test conditions: Pulsed Continuous Wave(Pulsed CW), Pulse Width = 100us, Duty Cycle = 10%, V_D = +50V, I_{DQ} = 50mA, Temperature = +25°C.

9.5. RF Characterization – 100 – 1000 MHz EVB Performance at 500MHz

Parameter	Min	Typ	Max	Units
Linear Gain, G_{LIN}	-	20.8	-	dB
Output Power at 3dB Compression, P_{3dB}	-	44.7	-	dBm
Drain Efficiency at 3dB Compression, DE_{3dB}	-	66.7	-	%
Gain at 3dB Compression, G_{3dB}	-	17.8	-	dB

Notes:

1. Test conditions unless otherwise noted: V_D = +50V, I_{DQ} = 50mA, Continuous Wave(CW), Bottom of Baseplate Temp = 25°C.

9.6. RF Characterization – Mismatch Ruggedness at 1000 MHz

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

Notes:

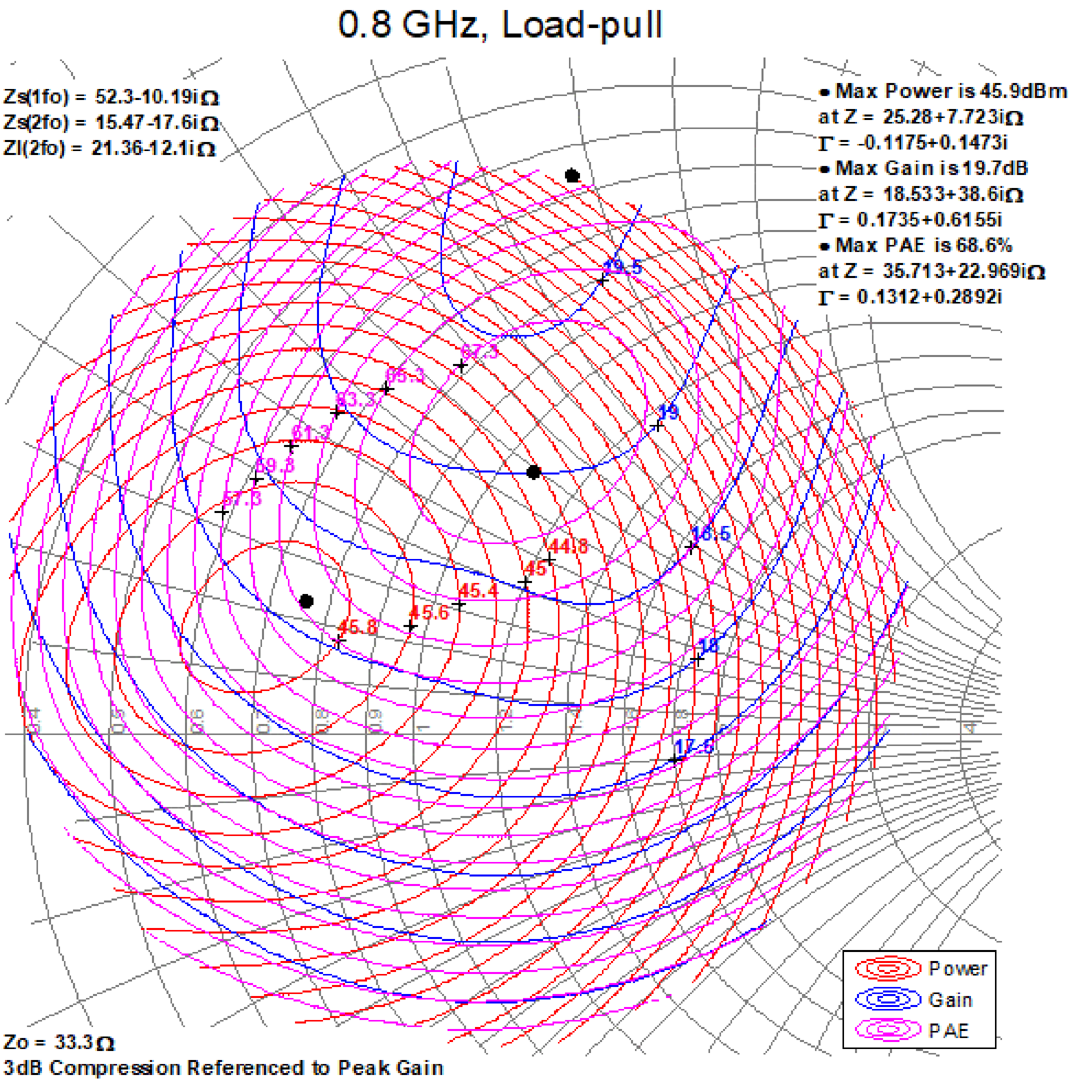
1. Test conditions unless otherwise noted: Bottom of Baseplate Temp = 25°C, V_D = 50V, I_{DQ} = 50mA, Continuous Wave(CW). Driving input power is determined at CW compression under matched condition at EVB output connector.

9.7. Load Pull Contours

9.7.1. 800MHz

Notes:

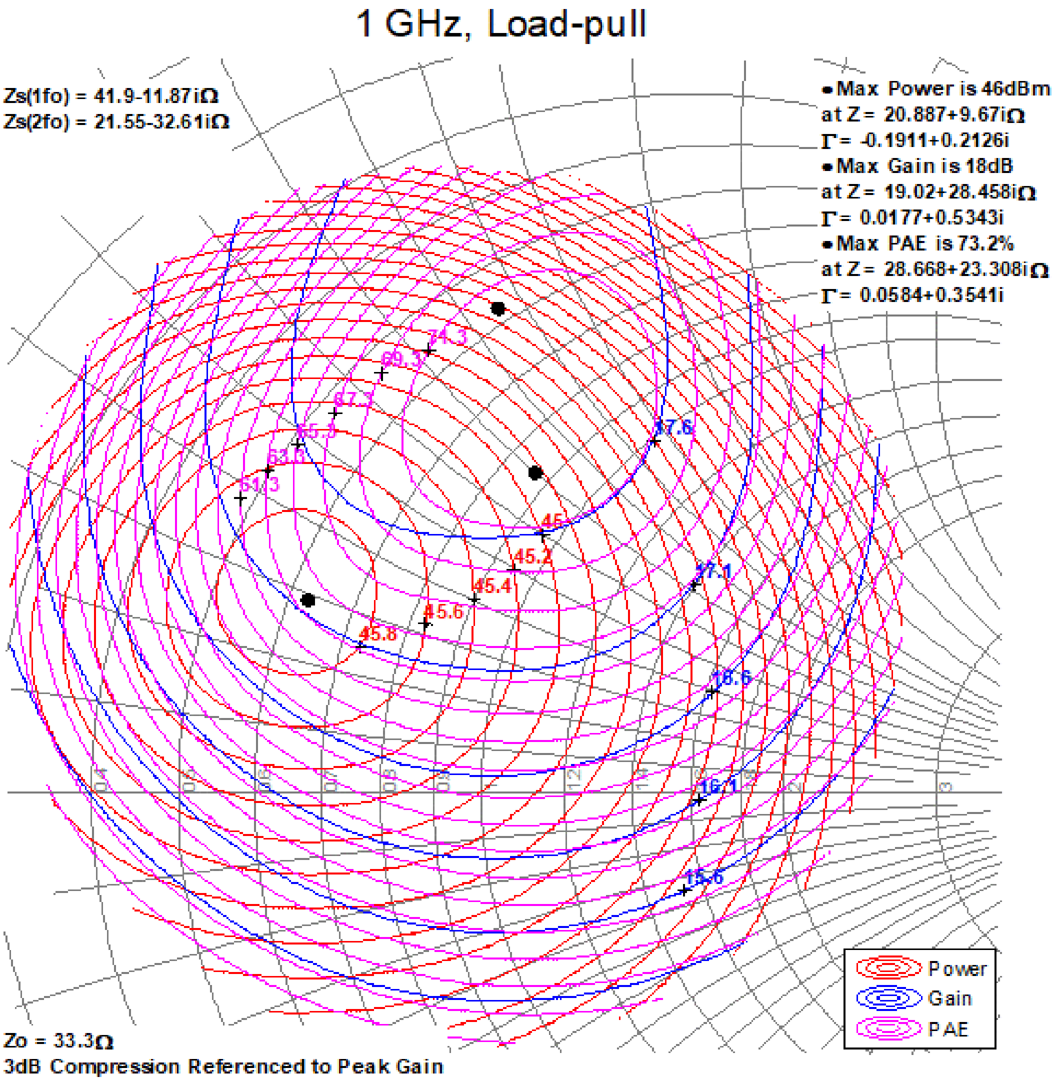
1. V_D = 50V, I_{DQ} = 50mA, Pulsed CW, Pulse Width = 100us, Duty Cycle = 10%. Performance is at 3dB compression referenced to peak gain.
2. See Recommended Package Footprint for load pull and source pull reference planes. 50OHM load pull fixtures are built with 20-mil RO4350B material.
3. NaN means the impedances are either undefined or varying in load pull system.



9.7.2. 1000MHz

Notes:

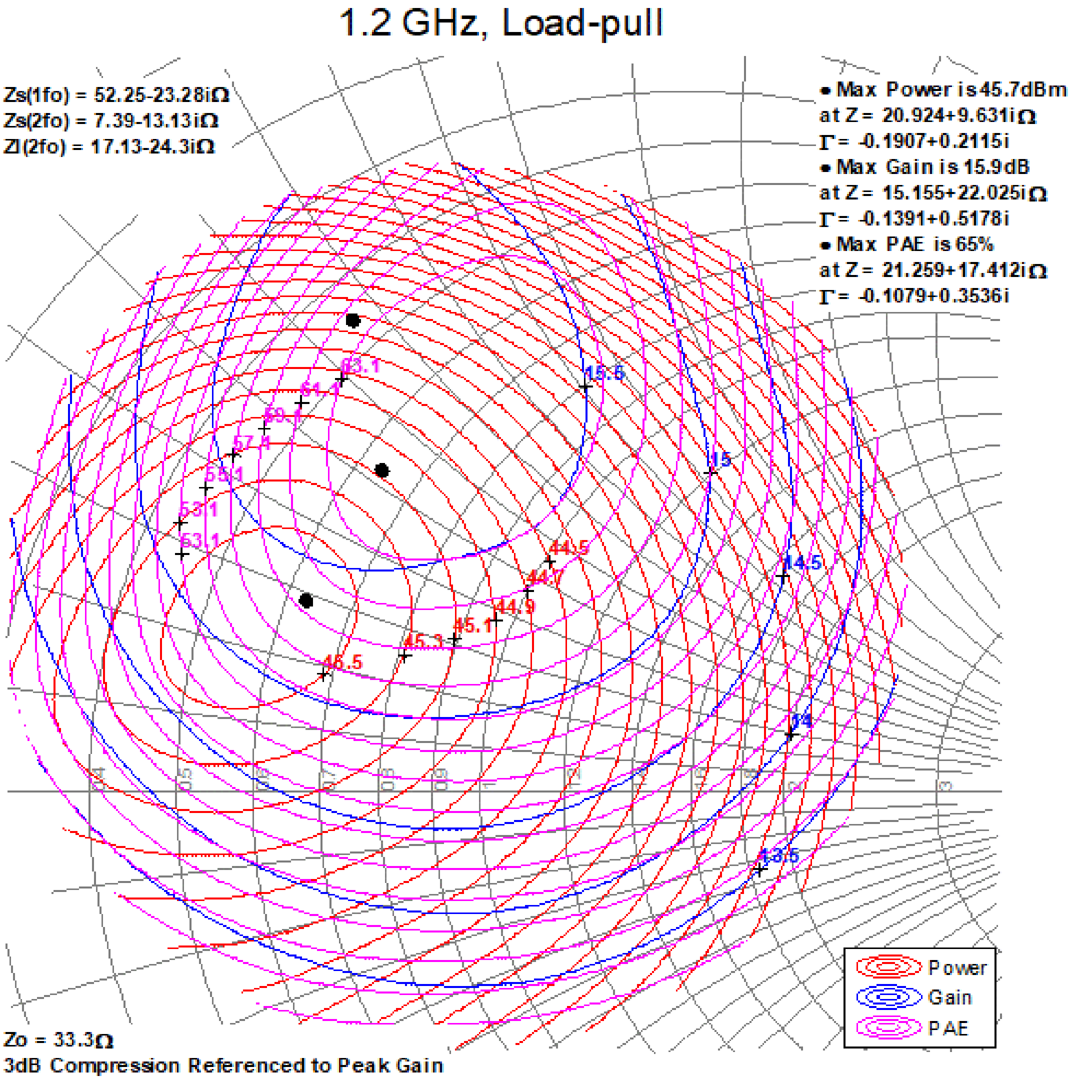
1. V_D = 50V, I_{DQ} = 50mA, Pulsed CW, Pulse Width = 100us, Duty Cycle = 10%. Performance is at 3dB compression referenced to peak gain.
2. See Recommended Package Footprint for load pull and source pull reference planes. 50OHM load pull fixtures are built with 20-mil RO4350B material.
3. NaN means the impedances are either undefined or varying in load pull system.



9.7.3. 1200MHz

Notes:

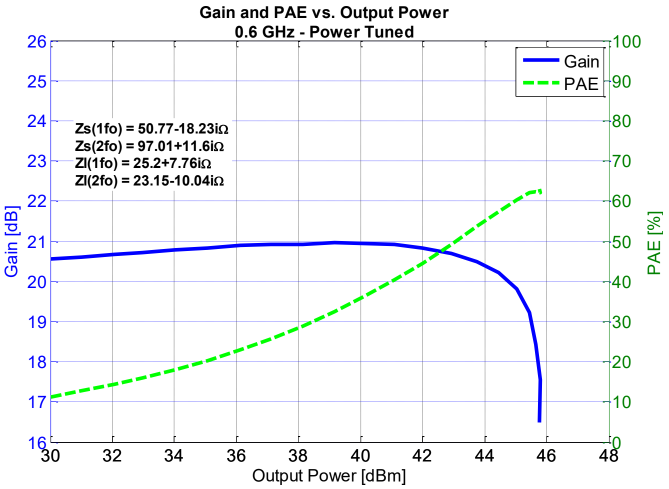
1. V_D = 50V, I_{DQ} = 50mA, Pulsed CW, Pulse Width = 100us, Duty Cycle = 10%. Performance is at 3dB compression referenced to peak gain.
2. See Recommended Package Footprint for load pull and source pull reference planes. 50OHM load pull fixtures are built with 20-mil RO4350B material.
3. NaN means the impedances are either undefined or varying in load pull system.



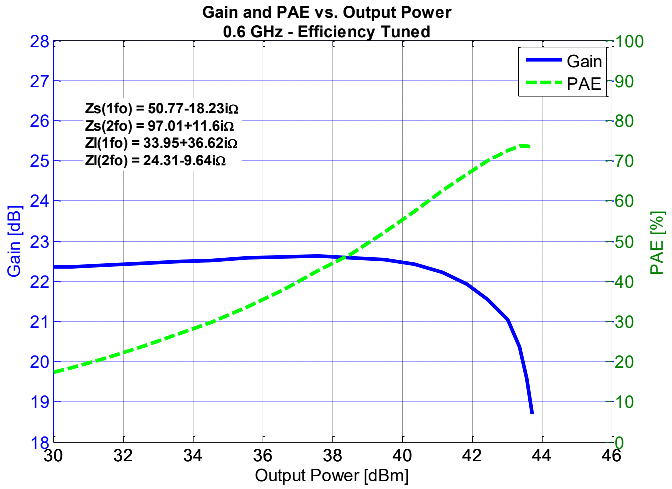
9.8. Load Pull Drive-up[1,2]

Notes:

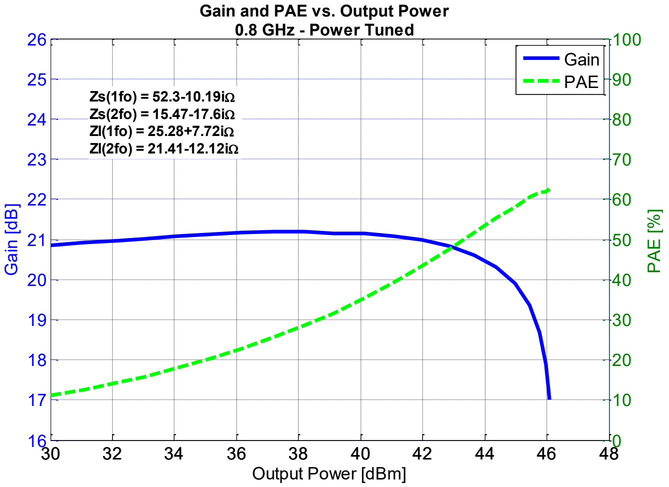
1. Pulsed CW, Pulse Width = 100us, Duty Cycle = 10%, V_D = 50V, I_{DQ} = 50mA
2. See Recommended Package Footprint for load pull and source pull reference planes where the performance was measured.


Gain and PAE vs. Output Power
0.6 GHz - Power Tuned

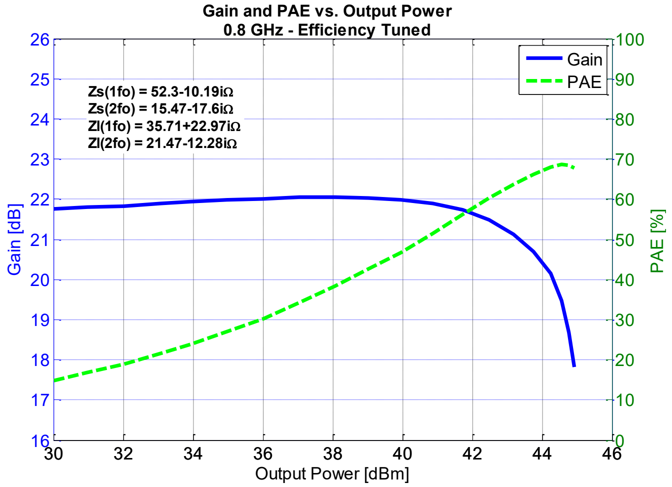
Zs(1fo) = 50.77-18.23iΩ
Zs(2fo) = 97.01+11.6iΩ
Zl(1fo) = 25.2+7.76iΩ
Zl(2fo) = 23.15-10.04iΩ


Gain and PAE vs. Output Power
0.6 GHz - Efficiency Tuned

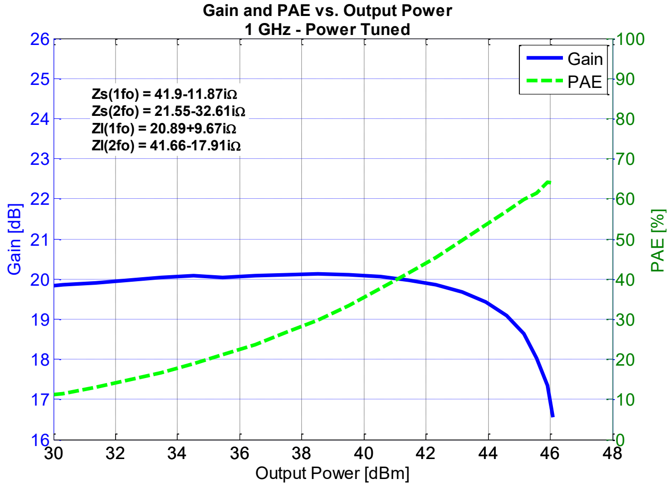
Zs(1fo) = 50.77-18.23iΩ
Zs(2fo) = 97.01+11.6iΩ
Zl(1fo) = 33.95+36.62iΩ
Zl(2fo) = 24.31-9.64iΩ


Gain and PAE vs. Output Power
0.8 GHz - Power Tuned

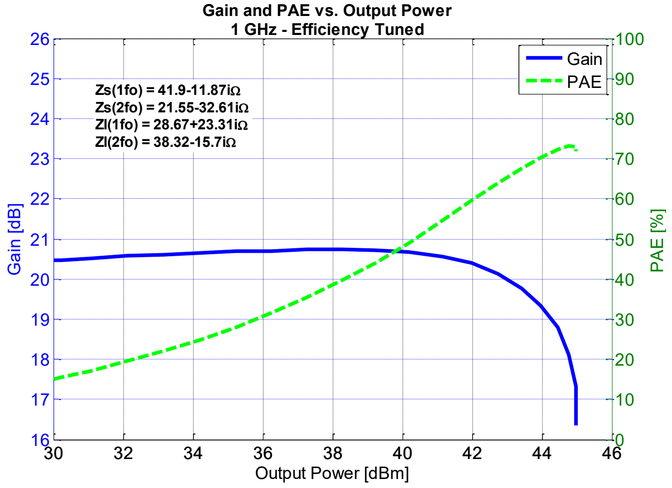
Zs(1fo) = 52.3-10.19iΩ
Zs(2fo) = 15.47-17.6iΩ
Zl(1fo) = 25.28+7.72iΩ
Zl(2fo) = 21.41-12.12iΩ


Gain and PAE vs. Output Power
0.8 GHz - Efficiency Tuned

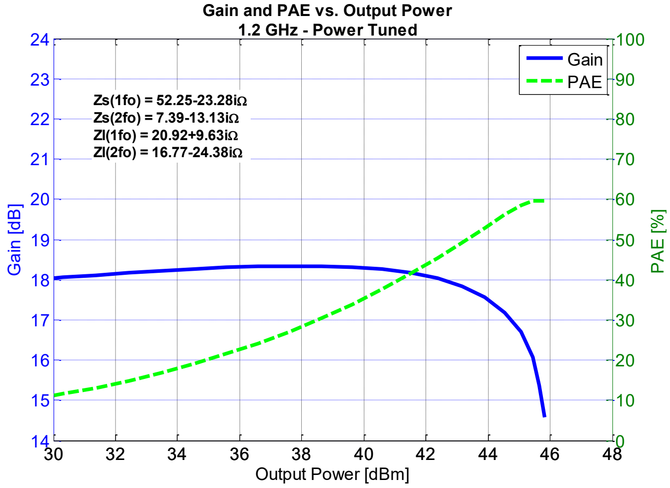
Zs(1fo) = 52.3-10.19iΩ
Zs(2fo) = 15.47-17.6iΩ
Zl(1fo) = 35.71+22.97iΩ
Zl(2fo) = 21.47-12.28iΩ


Gain and PAE vs. Output Power
1 GHz - Power Tuned

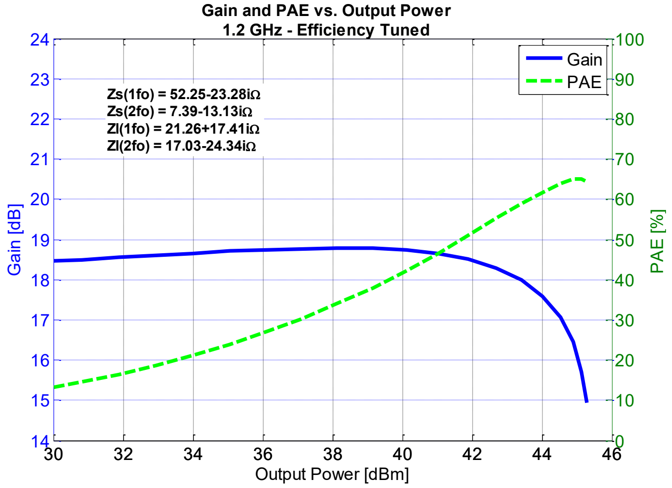
Zs(1fo) = 41.9-11.87iΩ
Zs(2fo) = 21.55-32.61iΩ
Zl(1fo) = 20.89+9.67iΩ
Zl(2fo) = 41.66-17.91iΩ


Gain and PAE vs. Output Power
1 GHz - Efficiency Tuned

Zs(1fo) = 41.9-11.87iΩ
Zs(2fo) = 21.55-32.61iΩ
Zl(1fo) = 28.67+23.31iΩ
Zl(2fo) = 38.32-15.7iΩ


Gain and PAE vs. Output Power
1.2 GHz - Power Tuned

Zs(1fo) = 52.25-23.28iΩ
Zs(2fo) = 7.39-13.13iΩ
Zl(1fo) = 20.92+9.63iΩ
Zl(2fo) = 16.77-24.38iΩ


Gain and PAE vs. Output Power
1.2 GHz - Efficiency Tuned

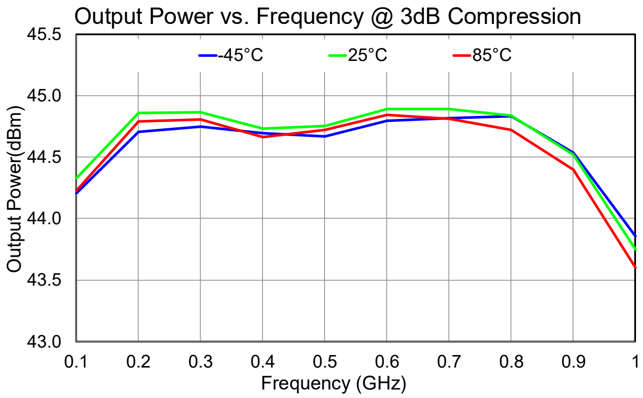
Zs(1fo) = 52.25-23.28iΩ
Zs(2fo) = 7.39-13.13iΩ
Zl(1fo) = 21.26+17.41iΩ
Zl(2fo) = 17.03-24.34iΩ

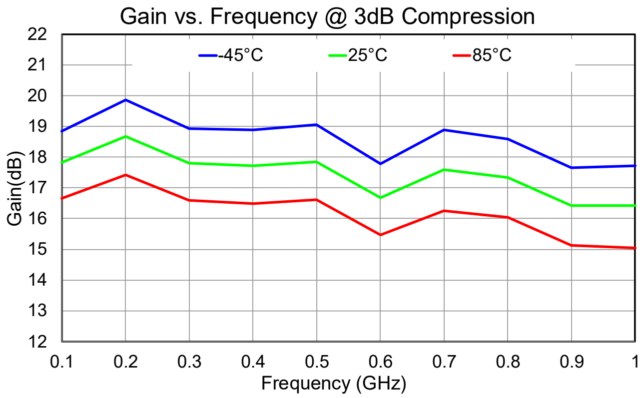
10. Evaluation Board – 100 – 1000MHz

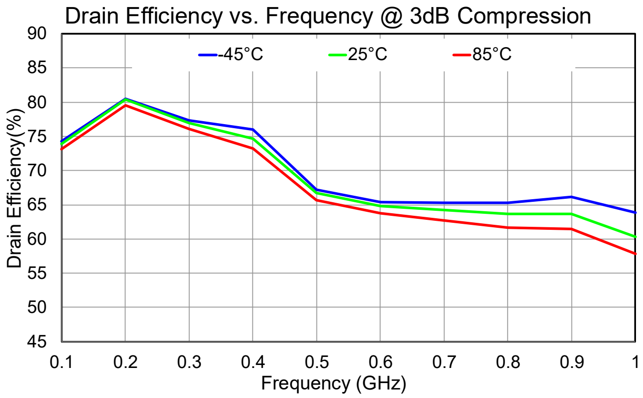
10.1.1. Power Drive-up Performance Over Temperature

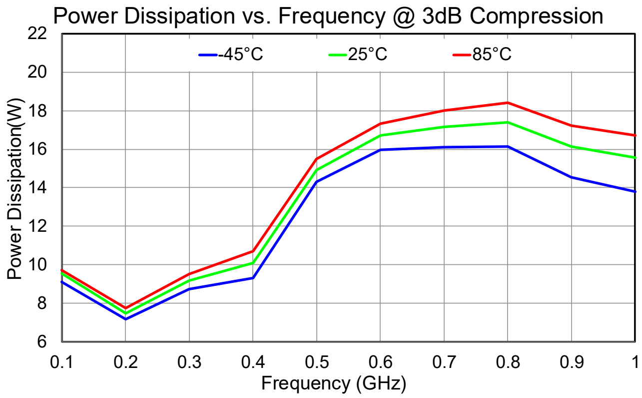
Notes:

1. V_D = 50V, I_{DQ} = 50mA, Continuous Wave(CW)


Output Power vs. Frequency @ 3dB Compression


Gain vs. Frequency @ 3dB Compression

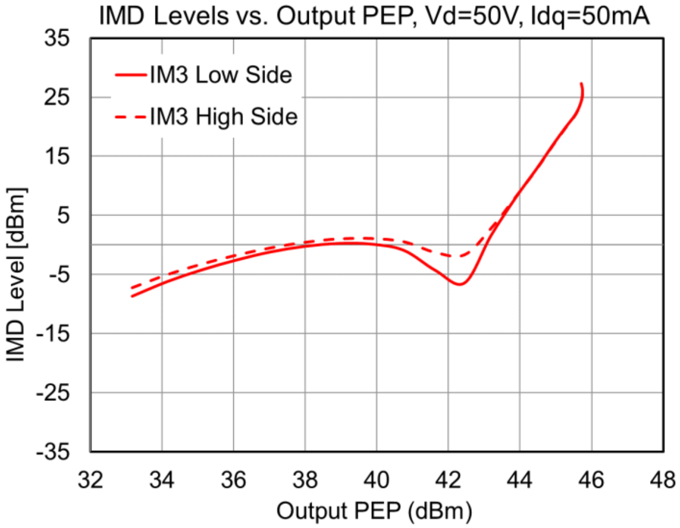

Drain Efficiency vs. Frequency @ 3dB Compression

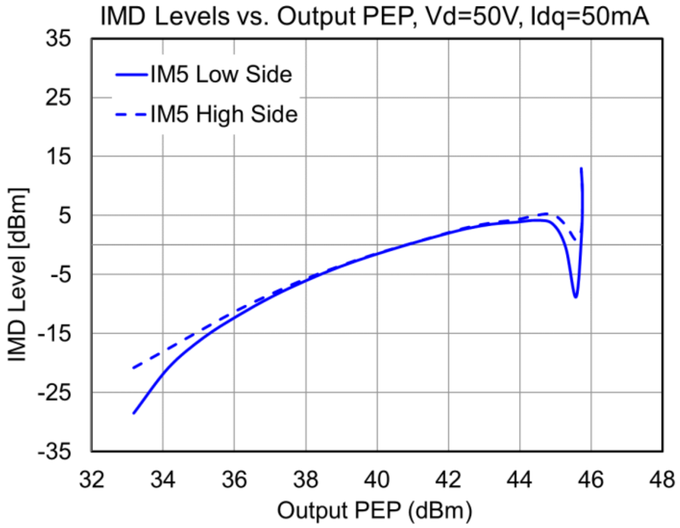

Power Dissipation vs. Frequency @ 3dB Compression

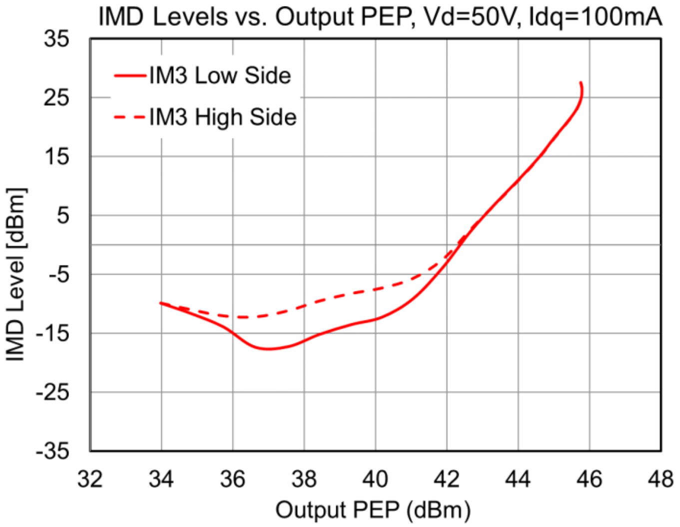
10.1.2. Two-Tone Performance at 25°C

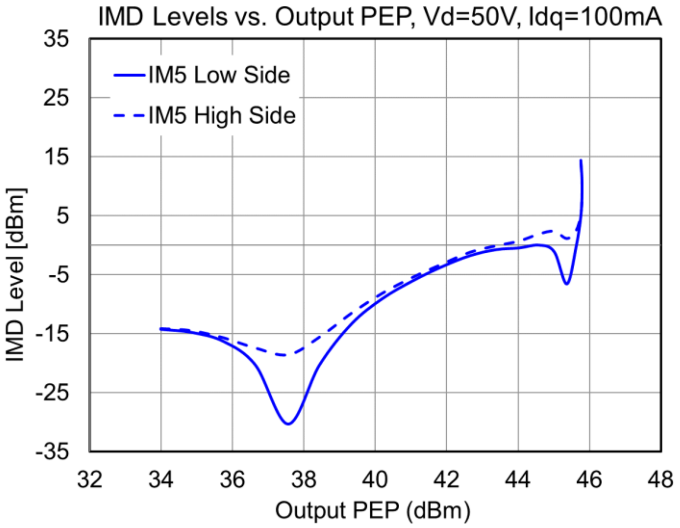
Notes:

1. Data based on QPD1004A’s predecessor: QPD1004 30 – 1000MHz Evaluation Board.
2. Center Frequency = 450MHz. Tone Separation = 1MHz.





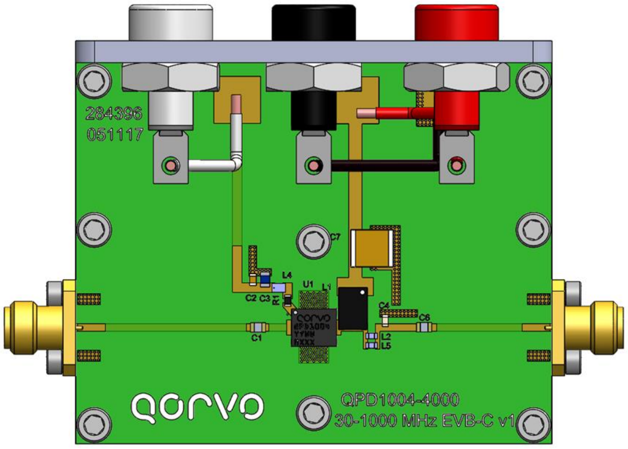




10.1.3. PCB Layout – 100 – 1000MHz

Notes:

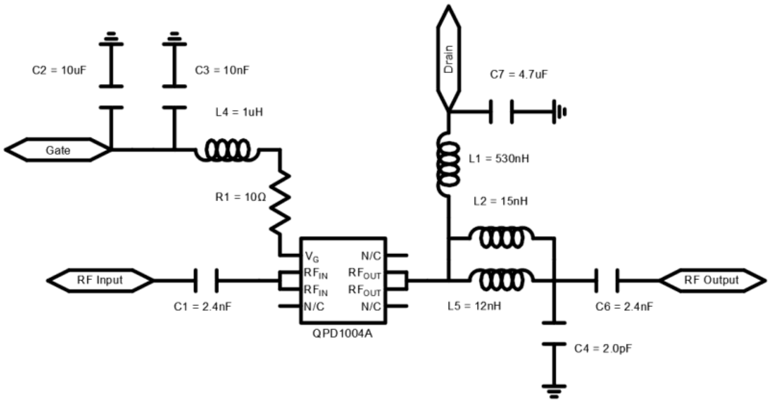
1. PCB Material: RO4350B, 20mil thickness, 2oz copper cladding. Overall EVB size is 3.98” x 3.98”.



10.1.4. Bill of Material

Reference Designator	Value	Quantity	Manufacturer	Part Number
C1, C6	2400 pF	2	DLI	C08BL242X-5UN-X0T
C3	10 nF	1	AVX	0603YC103KAT2A
C2	10 uF	1	Murata	GRM21BR71A106KE51L
C4	2.0 pF	1	ATC	600S2R0AT250X
C7	4.7 uF	1	Murata	GRM55ER72A475KA01L
L1	530 nH	1	Coilcraft	BCR-531JLB
L2	15 nH	1	Coilcraft	0603HC-15NXJLW
L4	1000 nH	1	Coilcraft	0603LS-102XGLC
L5	12 nH	1	Coilcraft	0603HP-12NXGLW
R1	10 Ohm	1	TTI Inc	CRCW060310R0JNEA

10.1.5. Circuit Schematic



11. Application Information

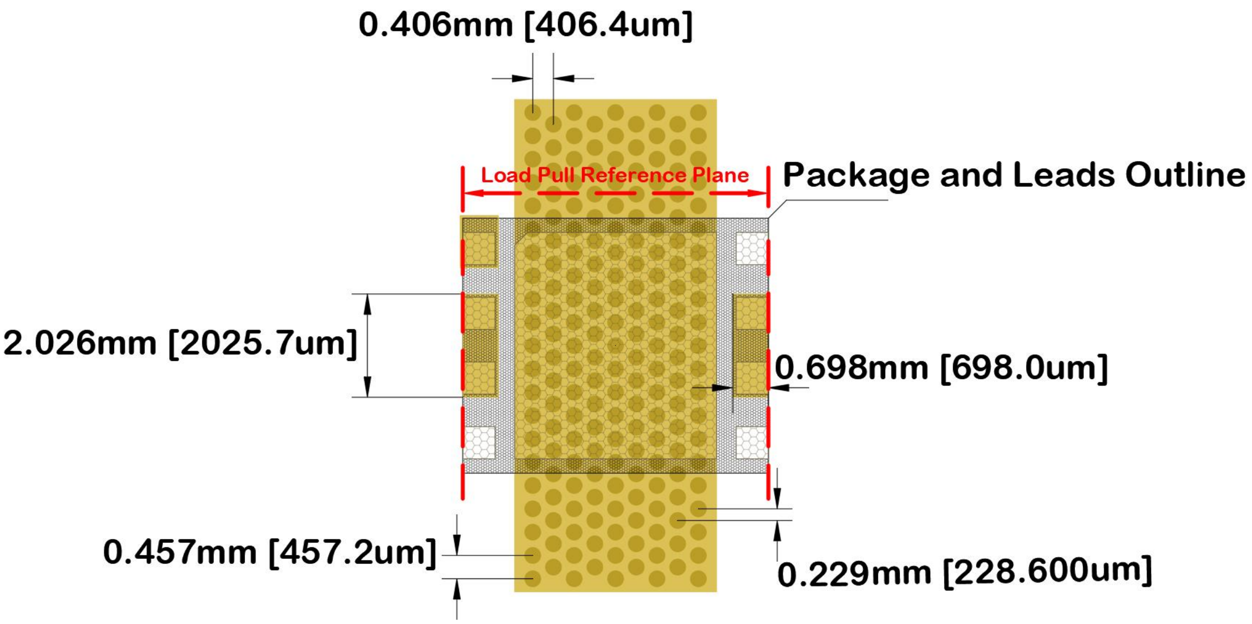
11.1. Biasing Sequence

Bias Up Sequence	Bias Down Sequence
1. Set V_G to -5V	1. Turn off RF
2. Set I_D current limit to 100mA	2. Set V_G to -5V
3. Set V_D to 50V	3. Set V_D to 0V
4. Slowly adjust V_G until I_{DQ} is set to 50mA	4. Wait until drain voltage supplying the device is discharged to 0V
5. Set I_D current limit to 1.5A	5. Turn off Drain Supply
6. Apply RF	6. Turn off Gate Supply

Note:

1. The above biasing sequence is based on typical biasing condition of VD = 50V, IDQ = 20mA

11.2. Recommended Package Footprint



Layer Stack Legend

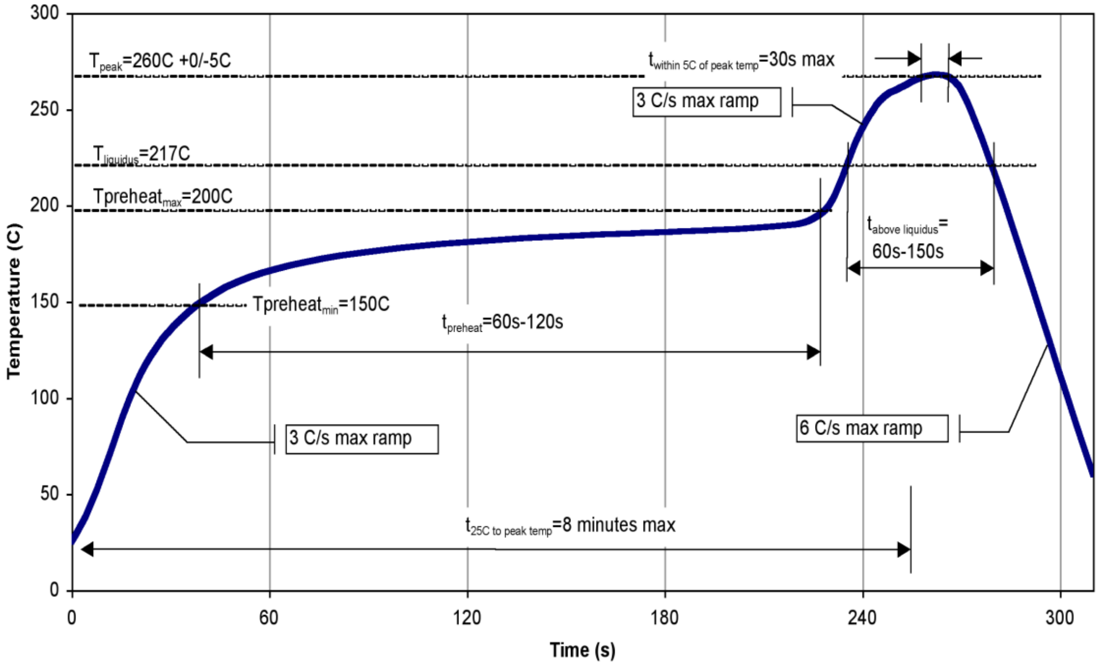
	Material	Layer	Thickness	Dielectric Material	Type
🟥		SILKSCREEN_TOP			Legend
🟩	Surface Material	SOLDERMASK_TOP	1.00mil(0.03mm)	Solder Resist	Solder Mask
▨	**Copper**	**METAL1_TOP**	**0.70mil(0.02mm)**		**Signal**
▨	*Core*		*20.00mil(0.51mm)*	*RO4350B*	*Dielectric*
▨	**Copper**	**METAL2_BOT**	**0.70mil(0.02mm)**		**Signal**

Total thickness: 22.40mil(0.57mm)

Note:

1. All vias shown in the package footprint are copper filled.

11.3. Recommended Solder Temperature Profile

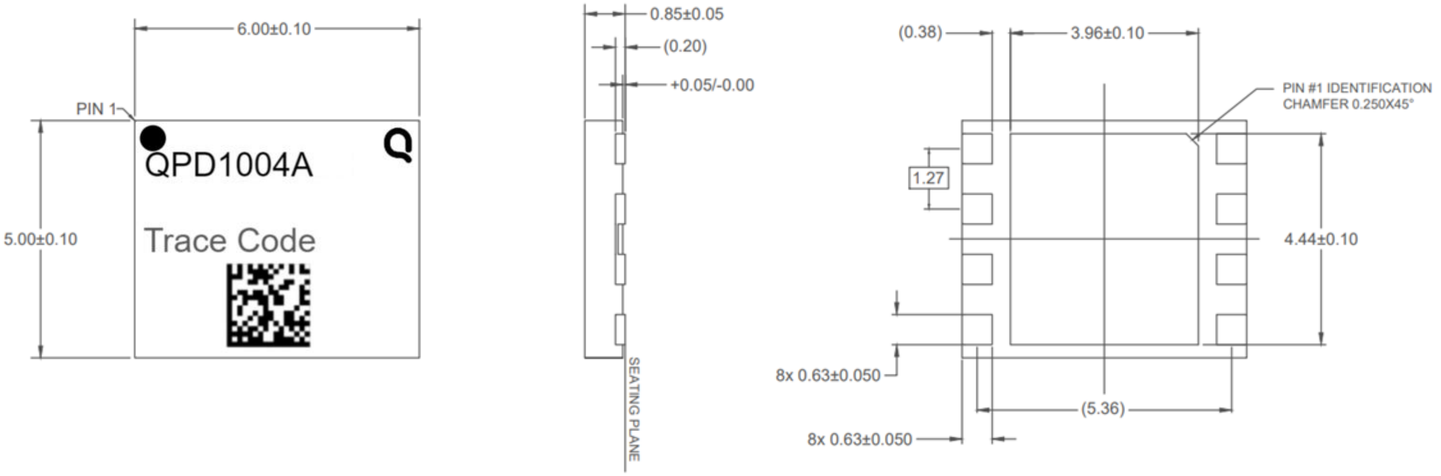


12. Packaging and Ordering Information

12.1. Device Marking and Package Dimensions

Marking: Part number – QPD1004A

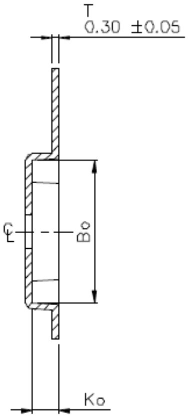
Trace code – QR Code Format



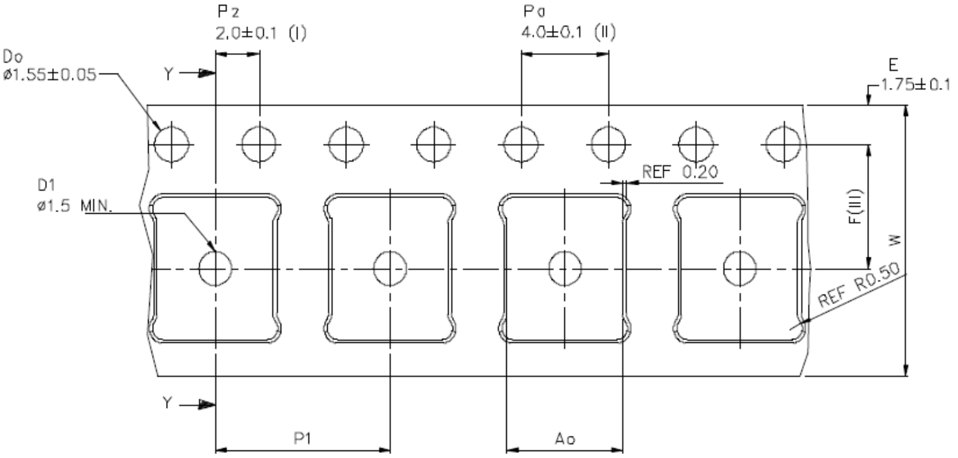
Notes:

1. Package leads are gold plated.
2. Part is mold encapsulated.
3. All units are in millimeter.

12.2. Tape and Reel Information



SECTION Y–Y



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.

13. Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	250V	ANSI/ESD/JEDEC JS-001
ESD – Charged Device Model (CDM)	1000V	ANSI/ESD/JEDEC JS-001
MSL – Moisture Sensitivity Level	Level 3	JESD J-STD-020

Caution!

ESD sensitive device

14. Solderability

Compatible with both lead-free (260 °C max. reflow temperature) and tin/lead (245 °C max. reflow temperature) soldering processes.

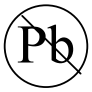
Contact Plating: NiPdAu

15. Environmental Compliance

This part is compliant with the 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
- SVHC Free
- PFOS Free



16. Revision History

Revision	Description
A	Datasheet Release

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 Notices

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