QPD0060

90 W, 48 V, DC to 3.6 GHz, GaN RF Power Transistor

Product Overview

The QPD0060 is a wide band plastic overmolded DFN discrete power amplifier. The device is a single stage unmatched power amplifier transistor. The QPD0060 can be used in Doherty architecture for the final stage of a base station amplifier for small cell, microcell, and active antenna systems. The QPD0060 can also be used as a driver in a macrocell base station power amplifier. The wide bandwidth of the QPD0060 makes it suitable for many different applications from DC to 2.7 GHz.
Lead-free and RoHS compliant.

6 Pin 7.2 x 6.6 mm DFN Package

QPD0060EVB02 CW Performance

Freq.(MHz)	P_{3dB}(W)	G_{3dB}(dB)	DE_{3dB}(%)
136	77.2	18.3	61.9
350	66.0	14.3	56.8
500	63.2	13.0	55.2
750	59.0	15.2	58.8
900	59.6	16.4	61.0

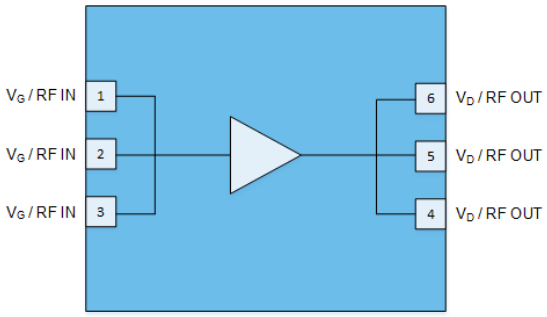
CW Signal, V_D = +50 V, I_{DQ} = 150 mA, 25°C, PCB is soldered to a copper baseplate for CW operation.

QPD0060EVB03 Pulsed Performance

Freq.(GHz)	P_{3dB}(W)	G_{3dB}(dB)	DE_{3dB}(%)
2.9	89.4	12.2	53.5
3.0	88.3	12.8	58.1
3.1	79.6	13.1	62.5
3.2	66.2	12.8	64.0
3.3	55.1	12.2	60.3

Pulse Signal: Pulse Width = 2ms, Duty Cycle = 20%, V_D = +48 V, I_{DQ} = 150 mA, 25°C

Functional Block Diagram



Key Features

- Frequency Range: DC to 3.6 GHz
- Drain Voltage: +48 V
- Maximum Output Power (P_{SAT}): 89.1 W (1)
- Maximum Drain Efficiency: 74.7% (1)
- Efficiency-Tuned P3dB Gain: 21.5 dB (1)
- Surface Mount Plastic Package
- CW and Pulse capable

Note 1: Load pull performance at 2.1 GHz.

Applications

- W-CDMA / LTE
- Macrocell Base Station Driver
- Microcell Base Station
- Small Cell Final Stage
- Active Antenna
- General Purpose Applications

Ordering Information

Part Number	Description
QPD0060SR	Short Reel – 100 Pieces
QPD0060TR7	7” Reel – 500 pieces
QPD0060PCB4B01	1.8 – 2.2 GHz Evaluation Board
QPD0060EVB01	762 – 944 MHz Evaluation Board
QPD0060EVB02	136 – 944 MHz Evaluation Board
QPD0060EVB03	2.9 – 3.3 GHz Evaluation Board

Absolute Maximum Ratings

Parameter	Rating
Breakdown Voltage (BV_{DG})	+165 V
Gate Voltage Range (V_G)	−7 to +2 V
Drain Voltage (V_D)	+55 V
Peak RF Input Power	38 dBm
Channel Temperature	225 °C
Storage Temperature	-65 to 150 °C
VSWR Mismatch, P1dB Pulse (20% Duty Cycle, 100 µs Width), T = +25°C	10:1

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

Parameter	Min	Typ	Max	Units
Gate Voltage (V_G)		−2.7		V
Drain Voltage (V_D)		+48		V
Quiescent Drain Current (I_{DQ})		150		mA
Operating Temperature Range	-40		85	°C

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

Electrical Specifications

Parameter	Conditions	Min	Typ	Max	Units
Operational Frequency Range		1800	2000	2200	MHz
Drain Voltage (V_D)			+48		V
Quiescent Drain Current (I_{DQ})			150		mA
Gain	3 dB Compression	14.7	16.4		dB
Power (P_{SAT})	3 dB Compression	48.1	49.8		dBm
Drain Efficiency	3 dB Compression	60.0	69.2		%

Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = +25°C, Pulse signal (100 µs Width, 10% Duty Cycle) at 2010-2200 MHz on a Class AB single-ended reference design fixture tuned for 1.8-2.2 GHz.

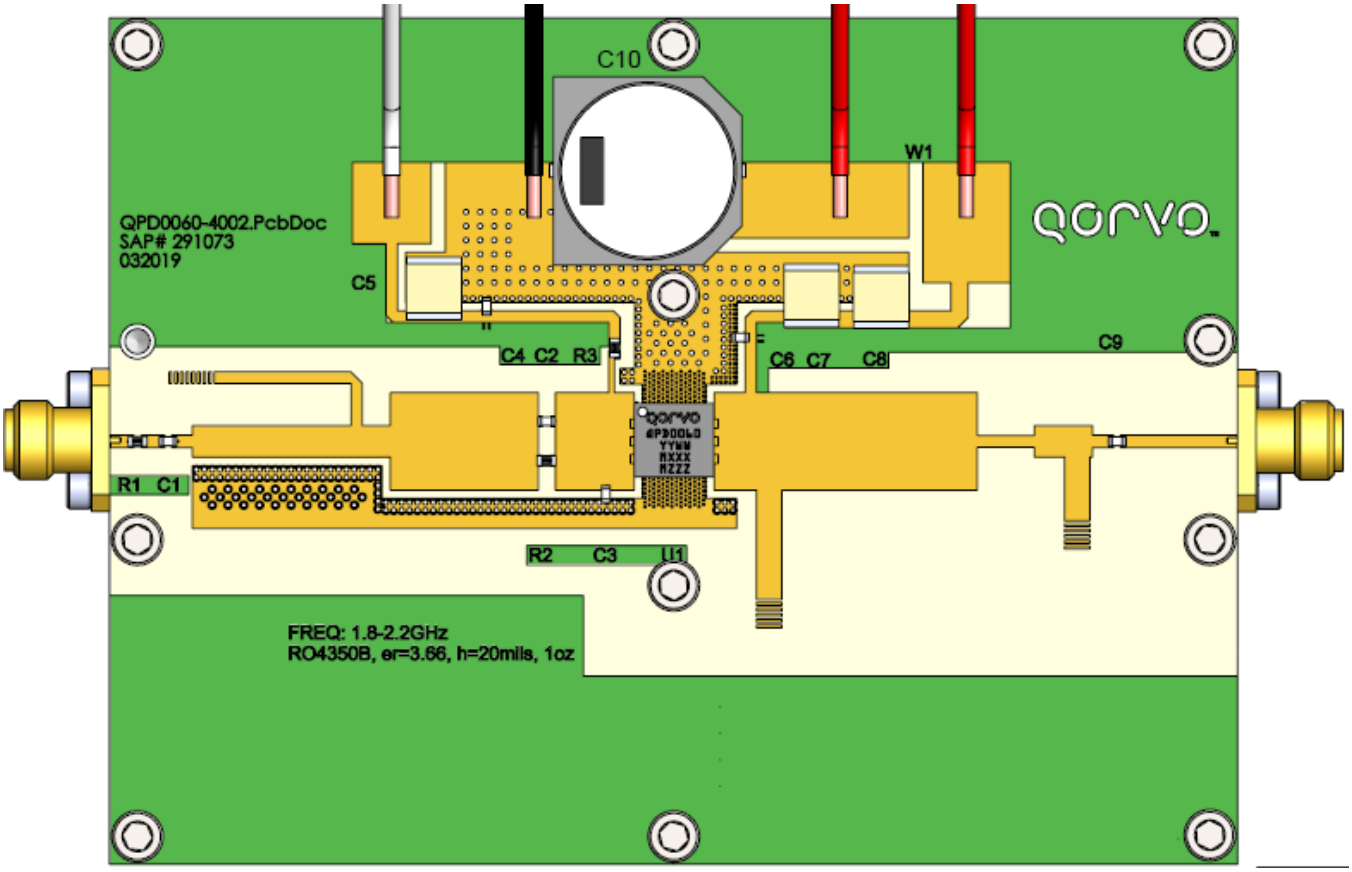
Thermal Information

Parameter	Conditions	Values	Units
Doherty Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC}) (1) (2)	T_{CASE} = +105°C, T_{CH} = 121°C CW: P_{DISS} = 11.9 W, P_{OUT} = 17.9 W	1.3	°C/W
Device Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	T_{CASE} = +105°C, T_{CH} = 142°C CW: P_{DISS} = 21.4 W, P_{OUT} = 5 W	1.7	°C/W

Notes:

1. Based on expected carrier amplifier efficiency of Doherty.
2. P_{OUT} assumes 20% peaking amplifier contribution of total average Doherty rated power.
3. Thermal resistance is measured to package backside.
4. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

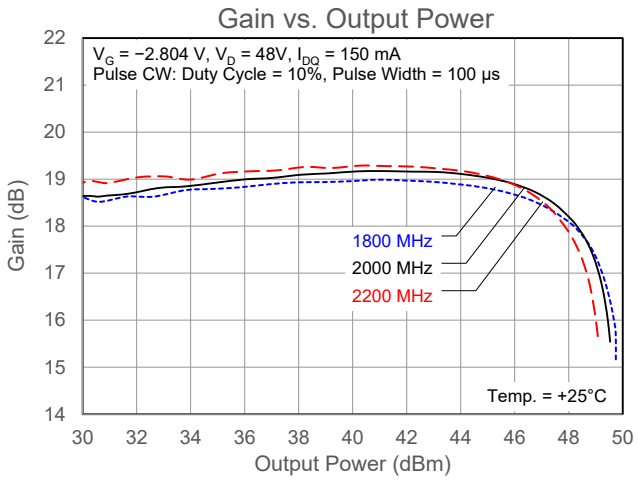
QPD0060PCB4B01 Layout – 1800 – 2200 MHz Reference Design

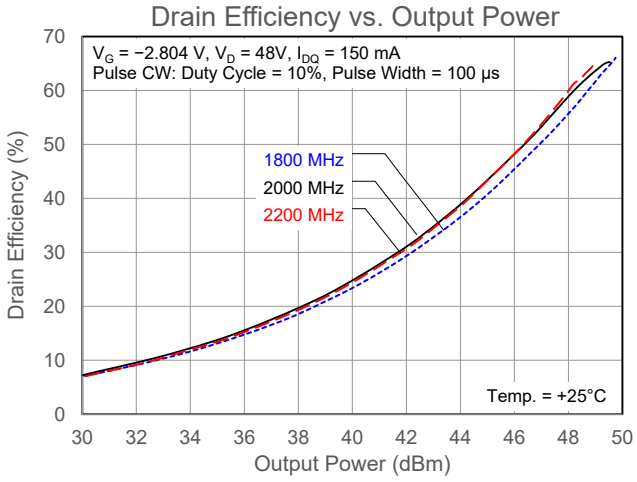


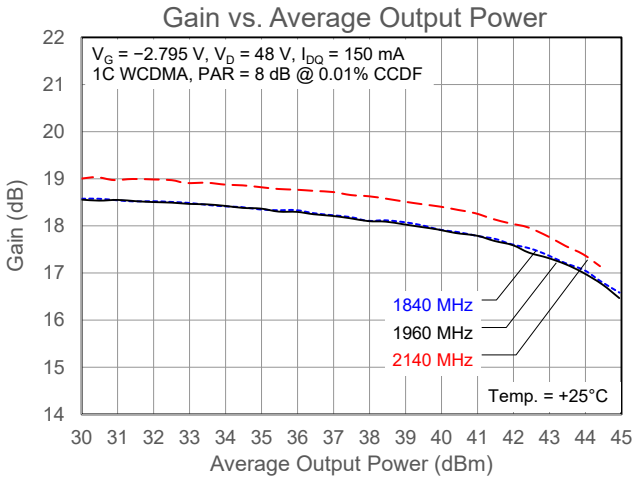
QPD0060PCB4B01 Bill of Materials

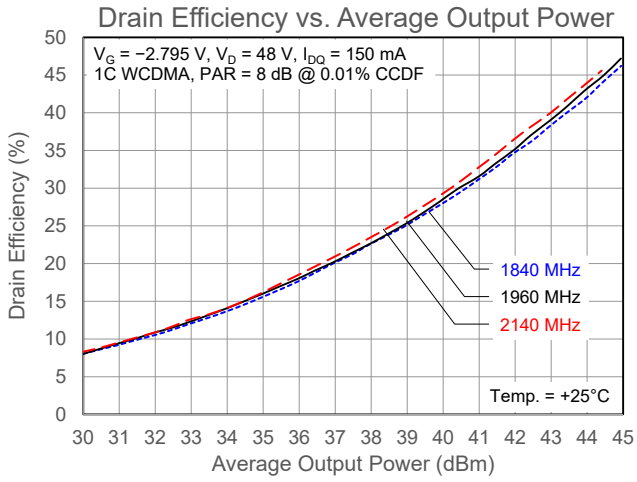
Reference Des.	Value	Description	Manufacturer	Part Number
C1	1.6 pF	Capacitor, 1.6 pF, ±0.05 pF, 250 V, HI-Q, 0603	ATC	600S1R6AT250XT
C2, C3	3 pF	Capacitor, 3.0 pF, ±0.1 pF, 250 V, HI-Q, 0603	ATC	600S3R0BT250XT
C4, C6, C9	20 pF	Capacitor, 20 pF, ±1%, 250 V, HI-Q, 0603	ATC	600S200FT250XT
C5, C7, C8	10 µF	Capacitor, 10 µF, ±20%, 100 V, X7S, 2220	TDK	C5750X7S2A106M230KB
C10	100 µF	Capacitor, 100 µF, ±20%, 100 V, Electrolytic	Panasonic	EEV-TG2A101M
R1	3 Ω	Resistor, 3 Ω, ±5%, 0.1 W, 0603	Vishay	CRCW06033R00FKEAC
R2	220 Ω	Resistor, 220 Ω, ±5%, 0.1 W, 0603, Lead Free	KOA Speer	RK73B1JTTD221J
R3	10 Ω	Resistor, 10 Ω, 0603, RoHS	Kamaya	RMC1/16K10R0FTP

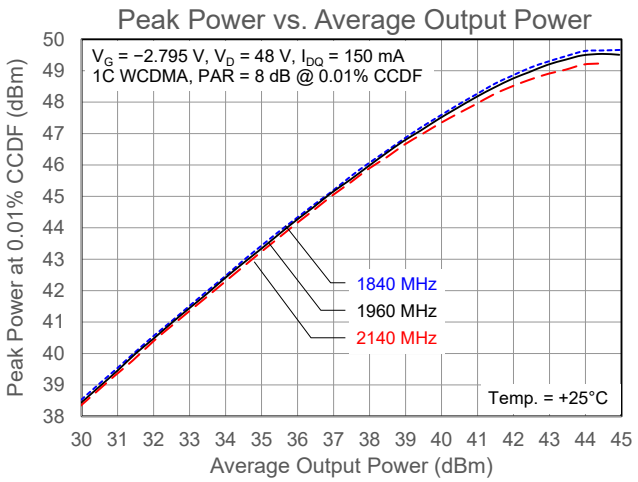
QPD0060PCB4B01 – 1800 – 2200 MHz Pulsed Performance Plots

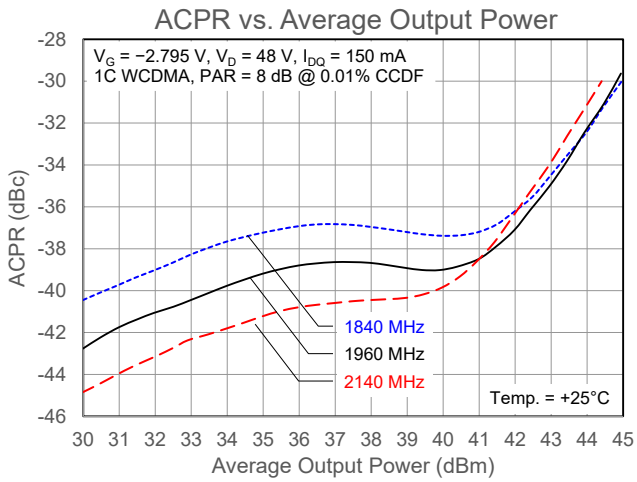






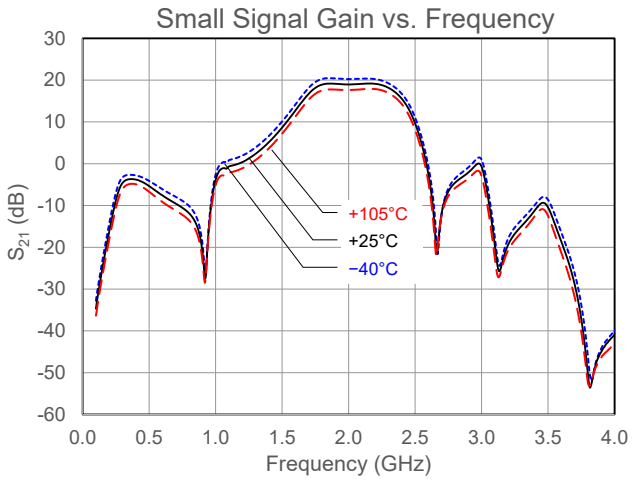


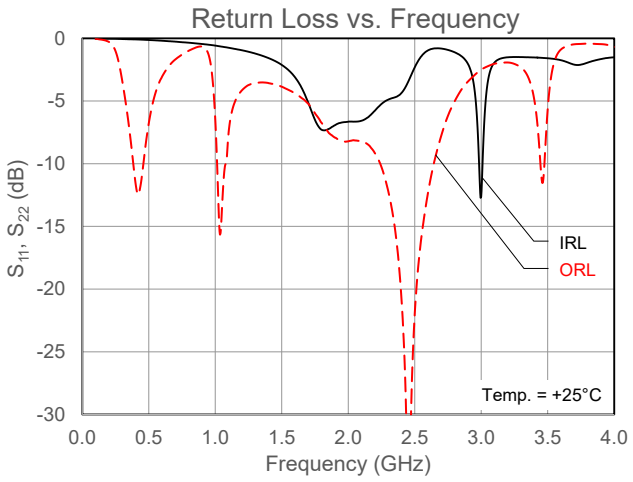


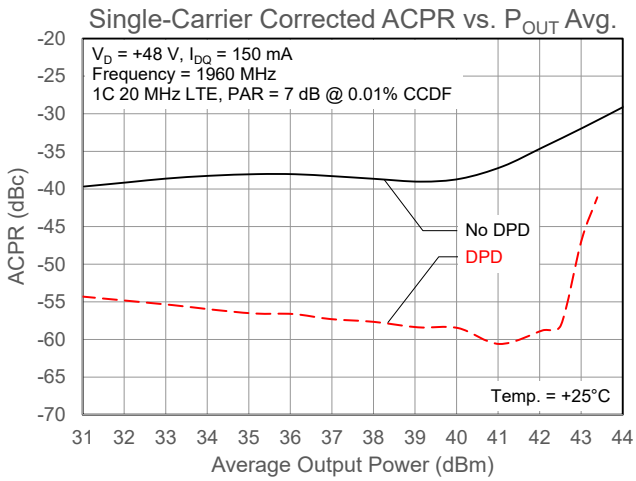


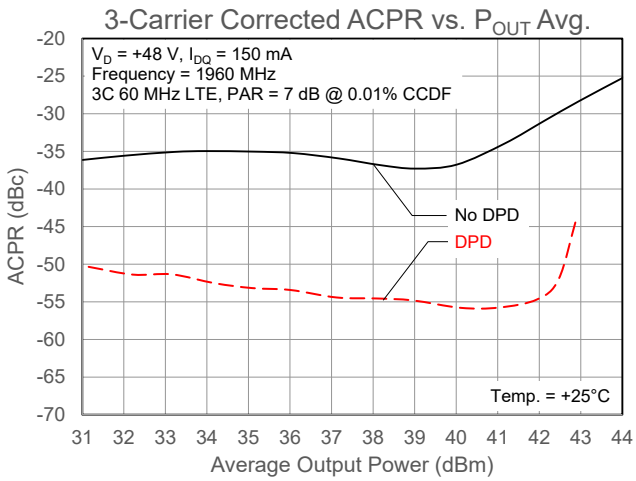
Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = +25°C, on a 1.8 – 2.2 GHz reference design fixture.

QPD0060PCB4B01 S-Parameters and ACPR Performance Plots



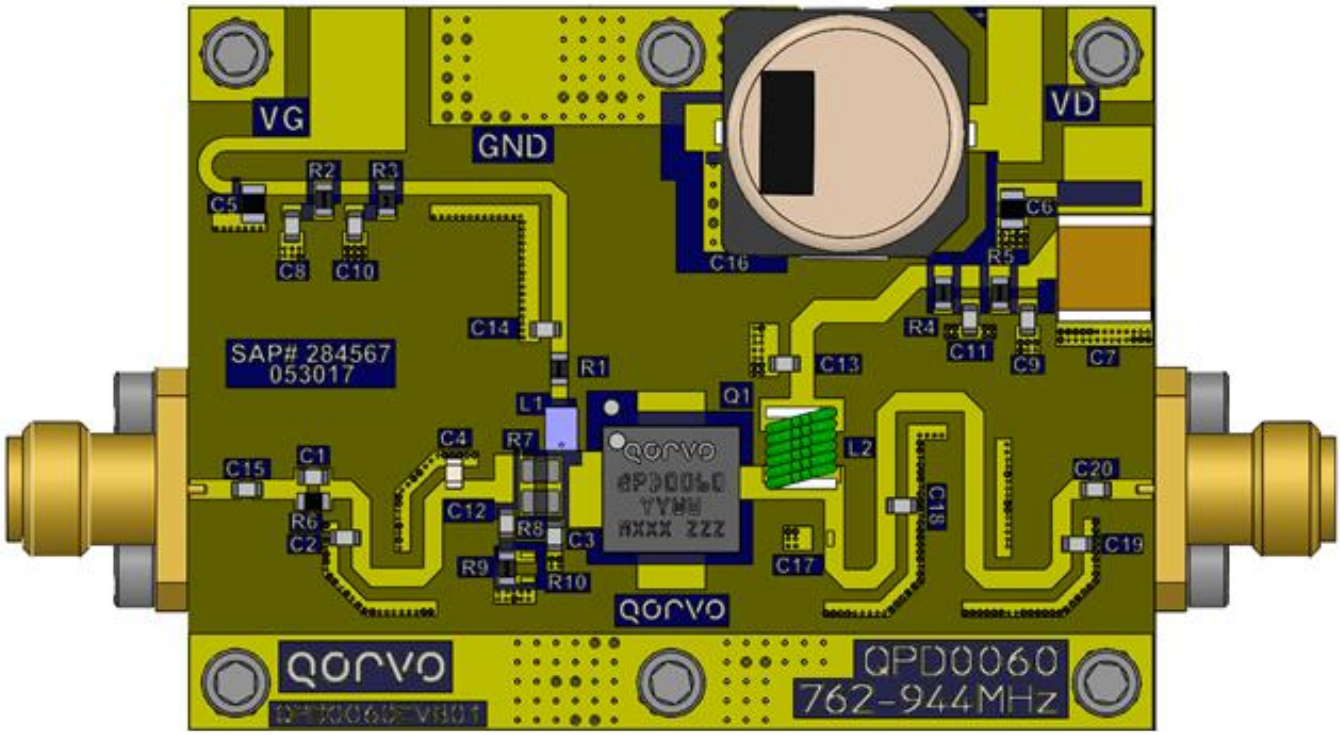






Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = +25°C, on a 1.8 – 2.2 GHz reference design fixture.

QPD0060EVB01 Layout – 762 – 944 MHz Reference Design

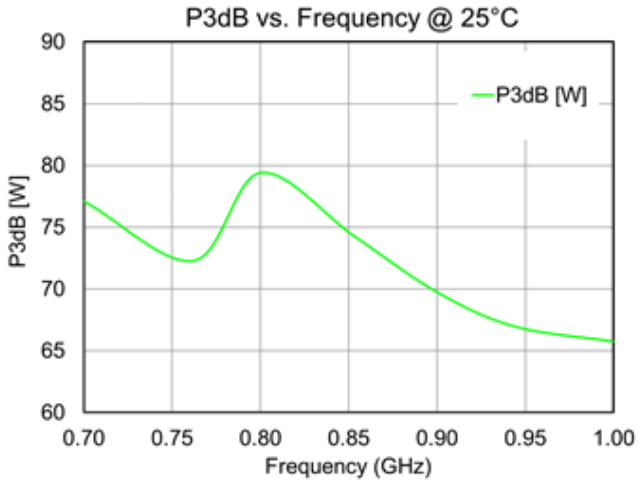


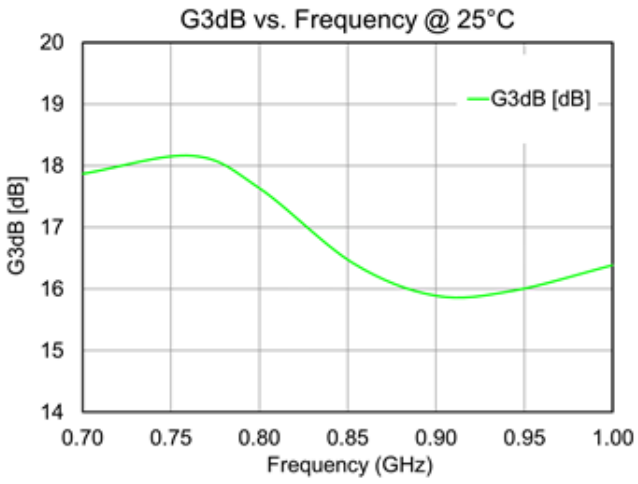
Note: PCB material is RO4350B, 20 mil thick substrate, 1 oz. copper each side.

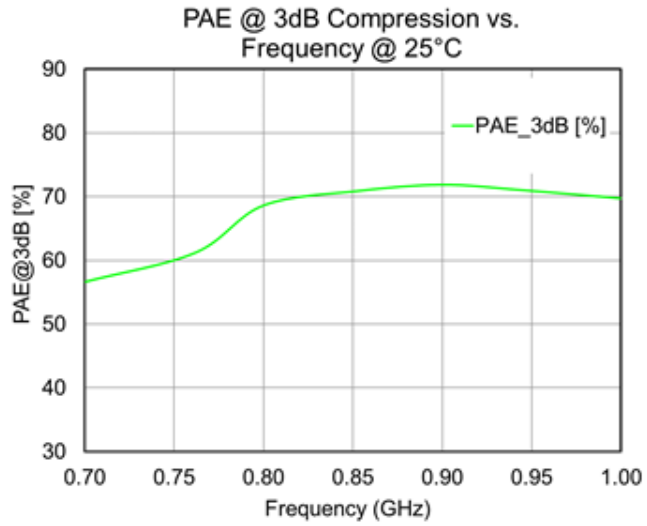
QPD0060EVB01 Bill of Materials

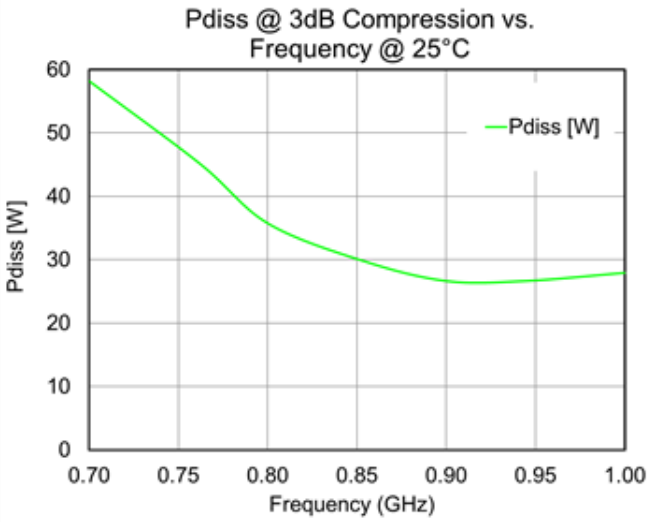
Reference Des.	Value	Description	Manufacturer	Part Number
C1, C2, C15, C18	8.2 pF	Capacitor, 8.2 pF, ±0.1 pF, 250 V, RF NPO	AVX	600S8R2BT250XT
C3, C19	3.3 pF	Capacitor, 3.3 pF, ±0.1 pF, 250 V, RF NPO	AVX	600S3R3BT250XT
C4	22 pF	Capacitor, 22 pF, ±5%, 250 V, RF NPO	AVX	600S220JT250XT
C5, C6	1 µF	Capacitor, 1 µF, ±10%, 100 V, X7S, 0805	TDK	CGA4J3X7S2A105K
C7	10 µF	Capacitor, 10 µF, ±10%, 100 V, X7S, 2220	TDK	C5750X7S2A106K230KB
C8, C9	0.1 µF	Capacitor, 0.1 µF, ±10%, 100 V, X7R, 0603	Murata	GRM188R72A104KA35D
C10, C11, C12	100 pF	Capacitor, 100 pF, ±5%, 250 V, RF C0G	TDK	C1608C0G2E101JT080AA
C13, C14	15 pF	Capacitor, 15 pF, ±5%, 250 V, RF NPO	AVX	600S150JT250XT
C16	100 µF	Capacitor, 100 µF, ±20%, 100 V, ALUM, 12.5x12.5 mm	BC Components	MAL215099907E3
C20	47 pF	Capacitor, 47 pF, ±5%, 250 V, RF NPO	AVX	600S470JT250XT
L1	68 nH	Inductor, 68 nH, ±10%, 0805 W/W	Coilcraft	0805CS-680XK
L2	47 nH	Inductor, 47 nH, ±5%, 1515	Coilcraft	1515SQ-47NJ
R1, R2, R3, R4, R5	10 Ω	Resistor, 10 Ω, ±5%, 0603, Thick Film	KOA Speer	RK73B1JTTD100J
R6	1 kΩ	Resistor, 1000 Ω, ±1%, 0603, Thick Film	Cal-Chip	RM06F1001CT
R7, R8	5.1 Ω	Resistor, 5.1 Ω, ±1%, 0805, Thick Film	Vishay	CRCW08055R10FKEA
R9	120 Ω	0603 1% Thick Film Resistor	KOA Speer	RK73B1JTTD121J

QPD0060EVB01 – 762 – 944 MHz Pulsed Performance Plots



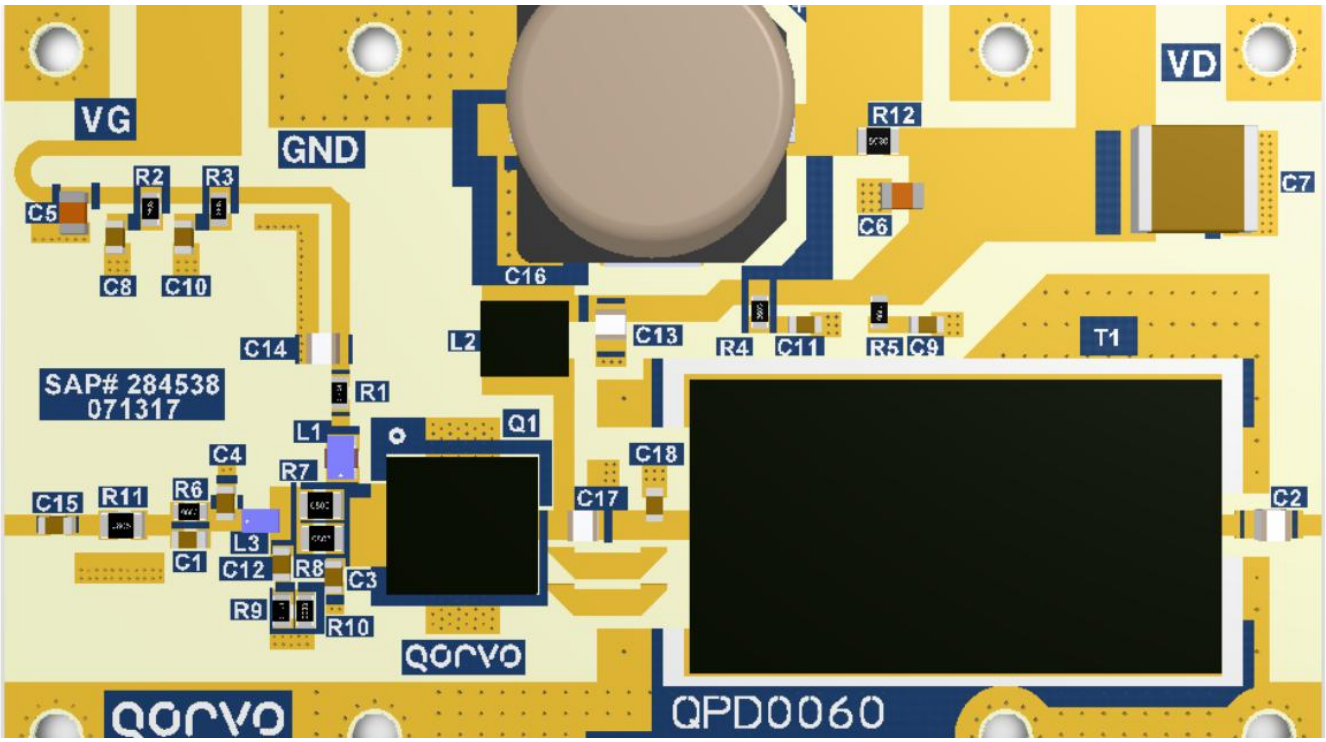






Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 150 mA, T = +25°C, Pulsed (100 µs Width, 10% Duty Cycle) on a 762 – 944 MHz reference design fixture.

QPD0060EVB02 Layout – 136 – 944 MHz Reference Design

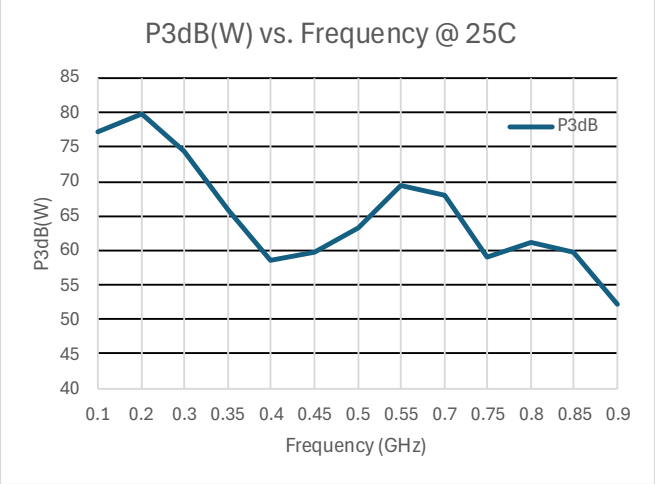


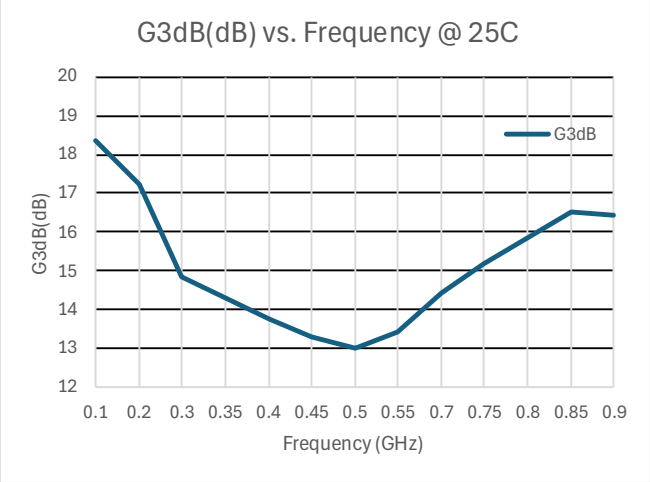
Note: PCB material is RO4350B, 20 mil thick substrate, 1 oz. copper each side. PCB is soldered to a copper baseplate for CW application.

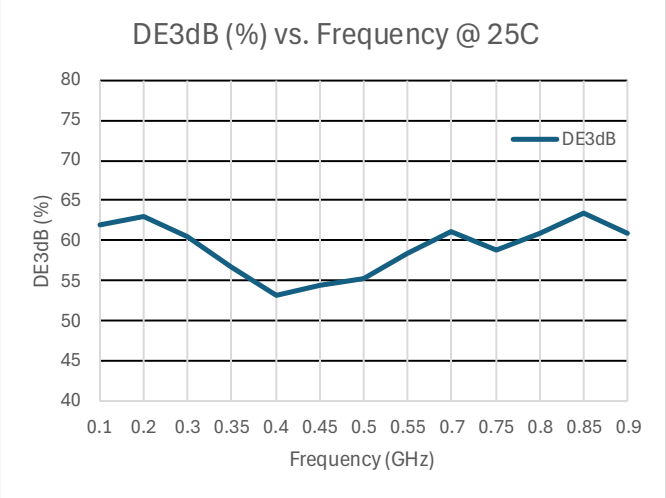
QPD0060EVB02 Bill of Materials

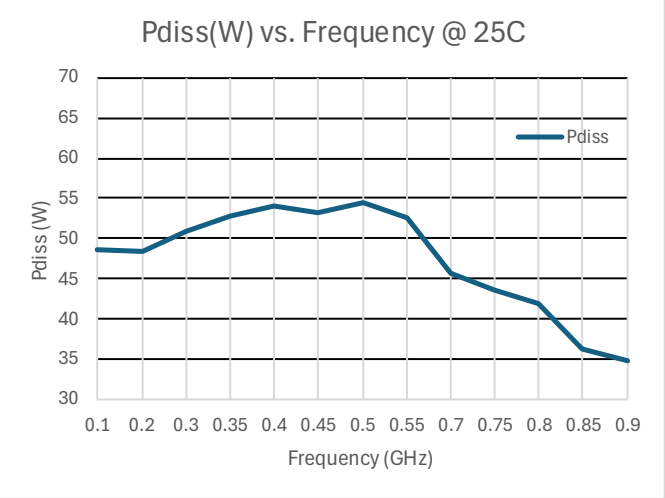
Reference Des.	Value	Description	Manufacturer	Part Number
C1	22 pF	Capacitor, 22 pF, ±5%, 250 V, RF NPO	AVX	600S220JT250XT
C3	3.3 pF	Capacitor, 3.3 pF, ±0.1 pF, 250 V, RF NPO	AVX	600S3R3BT250XT
C4	8.2 pF	Capacitor, 8.2 pF, ±0.1 pF 250 V, RF NPO	AVX	600S8R2BT250XT
C5, C6	1 µF	Capacitor, 1 µF, ±10%, 100 V, X7S, 0805	TDK	CGA4J3X7S2A105K125AB
C7	10 µF	Capacitor, 10 µF, ±10%, 100 V, X7S, 2220	TDK	C5750X7S2A106K230KB
C8, C9	0.1 µF	Capacitor, 0.1 µF, ±10%, 100 V, X7R, 0603	Murata	GRM188R72A104KA35D
C10, C11, C12, C15	100 pF	Capacitor, 100 pF, ±5%, 250 V, RF C0G	AVX	600S101JT250XT
C2, C13, C14, C17	240 pF	Capacitor, 240 pF, ±5%, 250 V, RF NPO	AVX	600F241JT250XT
C16	100 µF	Capacitor, 100 µF, ±20%, 100 V, ALUM, 12.5x12.5 mm	BC Components	MAL215099907E3
C18	6.8 pF	Capacitor, 6.8 pF, ±0.1 pF, 250 V, RF NPO	AVX	600F6R8BT250XT
T1	-	Balun Transformer, 50-12.5 Ohm	TTM Anaren	XMT0310B5012
L1	68 nH	Inductor, 68 nH, ±10%, 0805 W/W	Coilcraft	0805CS-680XK
L2	82 nH	Inductor, 82 nH, ±5%, 1515SQ	Coilcraft	1515SQ-82NJEC
L3	1.8 nH	Inductor, 1.8 nH, ±5%, 0603	Coilcraft	0603HP-1N8XJLW
R1, R2, R3, R4, R5	10 Ω	Resistor, 10 Ω, 5%, 0603, Thick Film	KOA Speer	RK73B1JTTD100J
R6	27 Ω	Resistor, 27 Ω, 5%, 0603, Thick Film	Panasonic	ERJ-3GEYJ270V
R7, R8	5.1 Ω	Resistor, 5.1 Ω, 1%, 0805, Thick Film	Vishay	CRCW08055R10FKEA
R9, R10	240 Ω	Resistor, 240 Ω, 1%, 0603, Thick Film	Samsung	RC1608F241CS
R11	10 Ω	Resistor, 10 Ω, 5%, 0805, Thick Film	Panasonic	ERJ-P06J100V
R12	0 Ω	Resistor, 0 Ω, 0805, Thick Film	Kamaya	RMC1/10JPTP

QPD0060EVB02 – 136 – 944 MHz CW Performance Plots



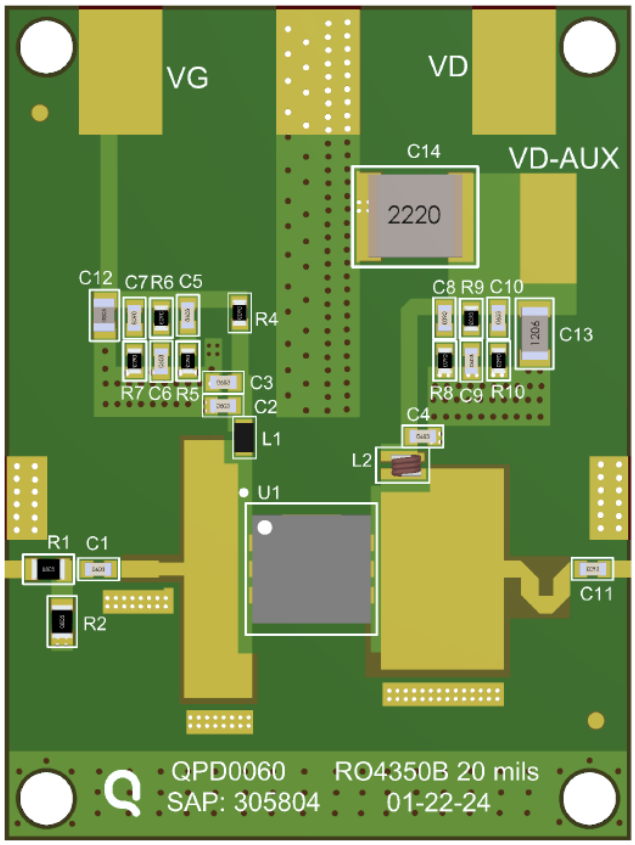






Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 150 mA, T = +25°C, CW on a 136 – 944 MHz reference design fixture. PCB is soldered to a copper baseplate for optimum power dissipation in CW operation.

QPD0060EVB03 Layout – 2.9 – 3.3 GHz Reference Design

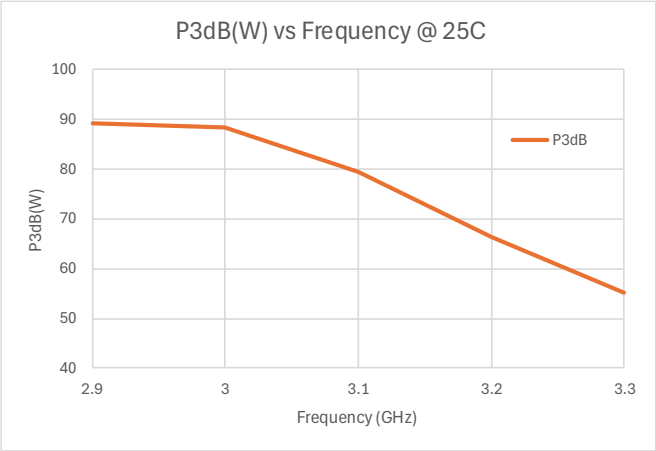


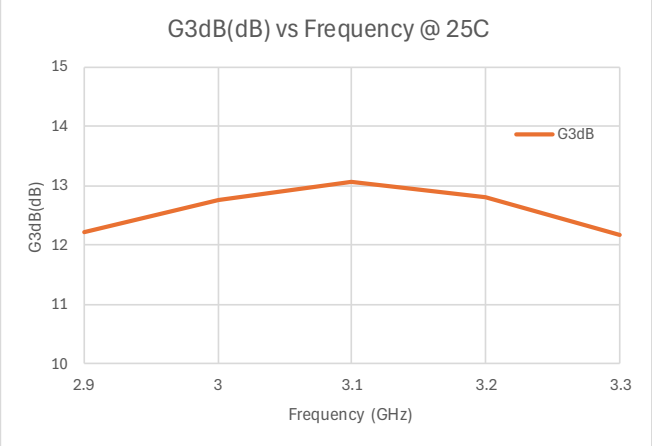
Note: PCB material is RO4350B, 20 mil thick substrate, 1 oz. copper each side.

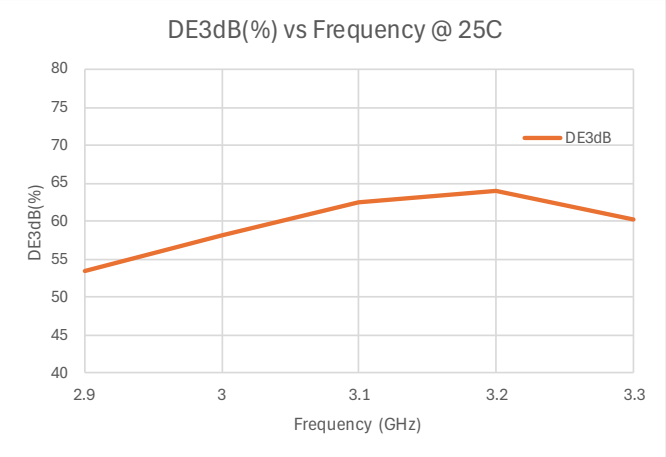
QPD0060EVB03 Bill of Materials

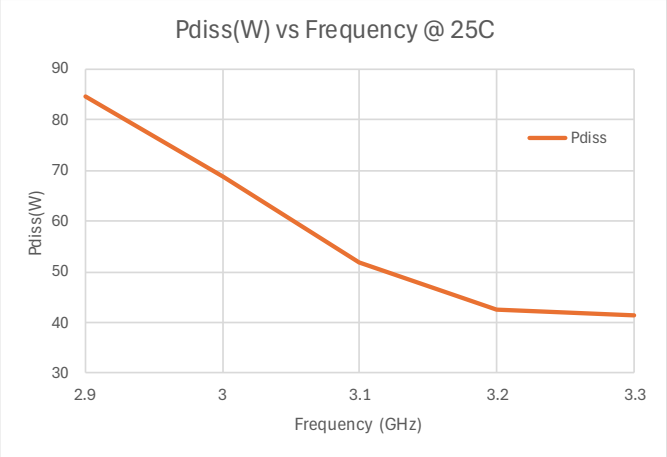
Reference Des.	Value	Description	Manufacturer	Part Number
C1	10 pF	Capacitor, 10 pF, ±5%, 250 V, 0603	AVX	600S100JT250XT
C2, C4	5.6 pF	Capacitor, 5.6 pF, ±0.1 pF, 250 V, 0603	AVX	600S5R6BT250XT
C5, C8	100 pF	Capacitor, 100 pF, ±5%, 250 V, 0603	AVX	600S101JT250XT
C6, C9	0.01 µF	Capacitor, 0.01 µF, ±10%, 100 V, X7R, 0603	CAPAX	0603X103K101S
C7	0.1 µF	Capacitor, 0.1 µF, 10%, 100 V, X7R, 0805	TDK	C2012X7R2A104K125AA
C11	0.8 pF	Capacitor, 0.8 pF, ±0.05 pF, 250 V, 0603	AVX	600S0R8AT250XT
C12	1 µF	Capacitor, 1 µF, 10%, 50 V, X7R, 0805	Kemet	C0805C105K5RACTU
C13	1 µF	Capacitor, 1 µF , 10%, 100 V, X7R, 1206	Murata	GRM31CR72A105KA01L
C14	10 µF	Capacitor, 10 µF, 20%, 100 V, X7R, 2220	AVX	22201C106MAT2A
L1	11 nH	Inductor, 11 nH, 5%, 0603 W/W	Coilcraft	0603CS-11NXJLW
L2	6.2 nH	Inductor, 6.2 nH, 5%, 0805 W/W	Coilcraft	0805HQ-6N2XJLC
R1	0 Ω	Resistor, 0 Ω, 1/2W, 0805	Vishay	CRCW08050000Z0EAHP
R4	10 Ω	Resistor, 10 Ω, 1%, 1/3W, 0603	Vishay	CRCW060310R0FKEAHP
R5, R6, R7, R8, R9	33 Ω	Resistor, 33 Ω, 1%, 1/3W, 0603	Vishay	CRCW060333R0FKEAHP

QPD0060EVB03 – 2.9 – 3.3 GHz Pulsed Performance Plots









Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 150 mA, T = +25°C, Pulsed (20% Duty Cycle, 2 ms Width) on a 2.9 – 3.3 GHz reference design fixture.

Load Pull Power-Matched Performance

Frequency (MHz)	Source Impedance (Ω)	Load Impedance (Ω)	P3dB (dBm)	Drain Efficiency (%)	G3dB (dB)
1800	2.0 – j6.0	5.7 + j1.4	49.2	61.2	19.9
1900	2.1 – j6.9	5.5 + j0.7	49.2	62.0	19.7
2100	2.9 – j10.3	6.4 + j1.0	49.5	65.7	19.6
2200	4.2 – j13.5	5.0 + j.01	49.5	65.9	18.7
2600	8.9 + j13.3	4.8 + j0.0	49.0	63.0	18.2
3500	2.1 – j9.1	3.4 – j5.8	49.7	57.7	13.4

Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = +25°C, Pulse (100 µs Width, 10% Duty Cycle).

Load Pull Efficiency-Matched Performance

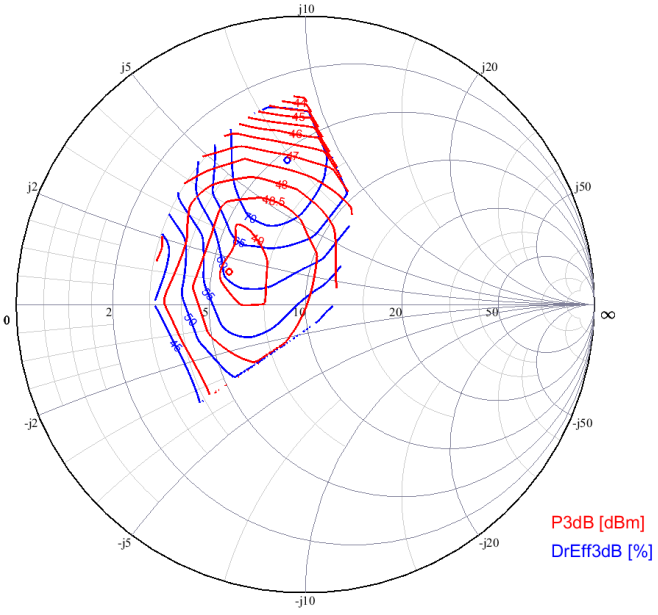
Frequency (MHz)	Source Impedance (Ω)	Load Impedance (Ω)	P3dB (dBm)	Drain Efficiency (%)	G3dB (dB)
1800	2.0 – j6.0	5.4 + j7.3	47.2	74.9	21.9
1900	2.1 – j6.9	5.1 + j5.7	47.7	75.8	22.0
2100	2.9 – j10.3	4.7 + j3.5	48.5	74.7	21.5
2200	4.2 – j13.5	4.7 + j3.5	48.4	73.9	20.9
2600	8.9 + j13.3	3.1 + 2.6	46.6	68.3	20.0
3500	2.1 – j9.1	2.0 – j3.6	48.0	68.2	15.0

Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = +25°C, Pulse (100 µs Width, 10% Duty Cycle).

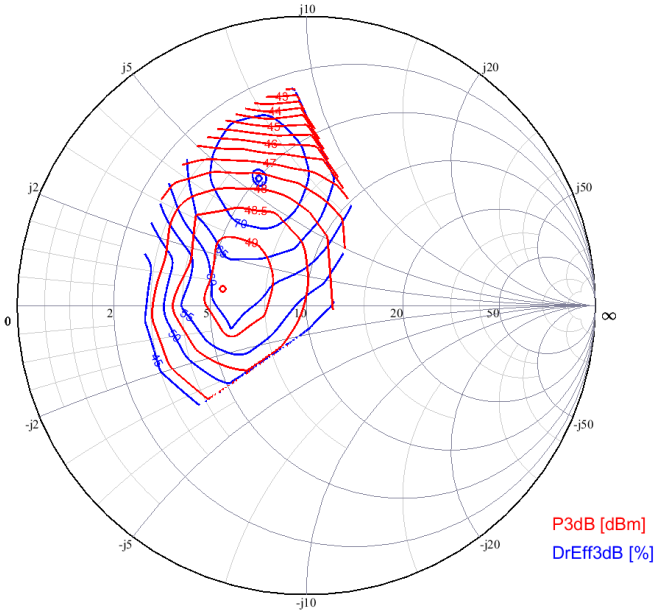
Load Pull Contours

Test Conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = +25°C, Pulse (100 µs Width, 10% Duty Cycle).

Load Pull at 1.8 GHz



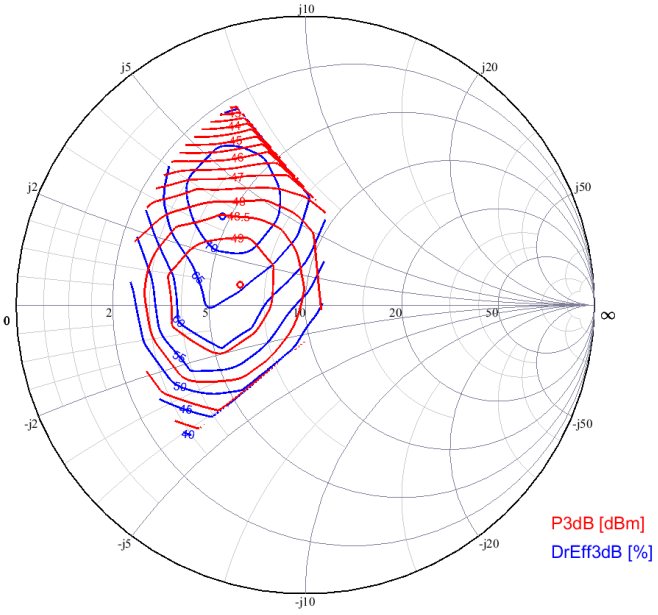
Load Pull at 1.9 GHz



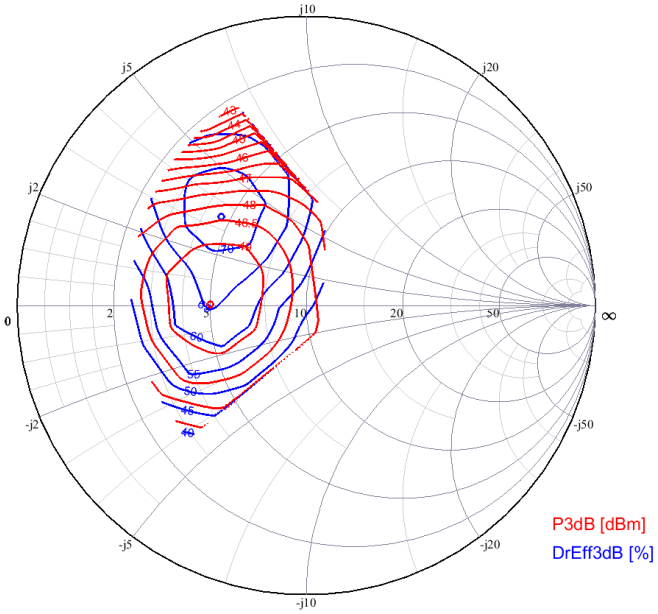
Load Pull Contours

Test Conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = +25°C, Pulse (100 µs Width, 10% Duty Cycle).

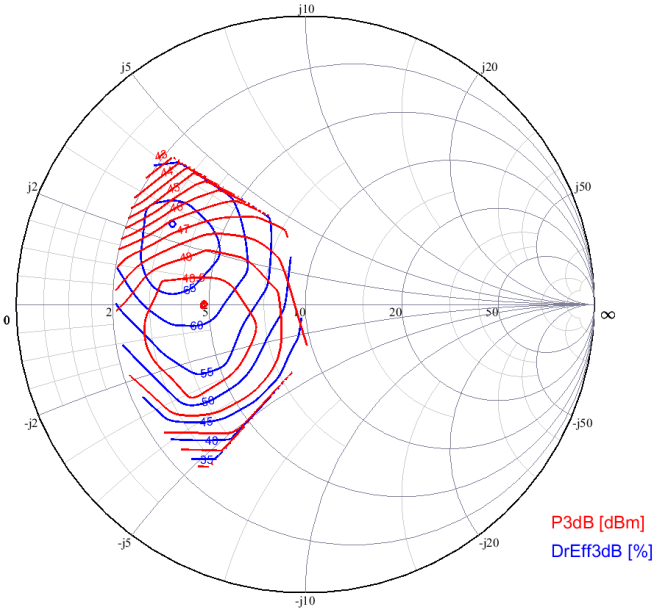
Load Pull at 2.1 GHz



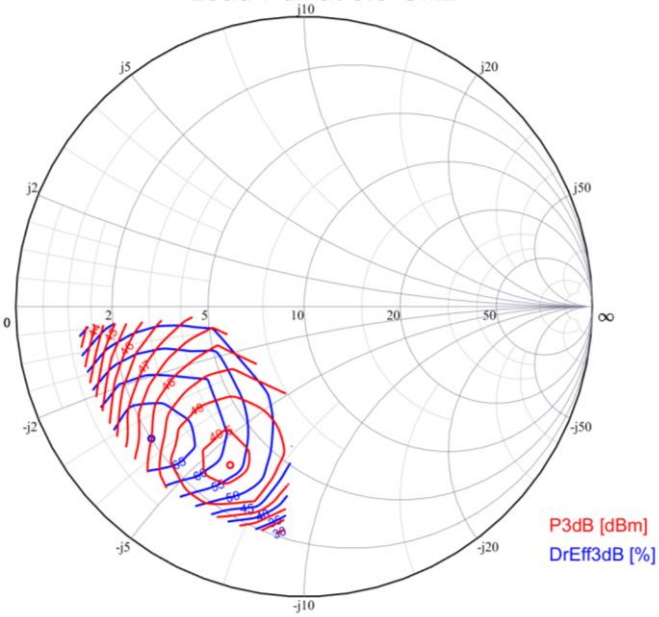
Load Pull at 2.2 GHz



Load Pull at 2.6 GHz

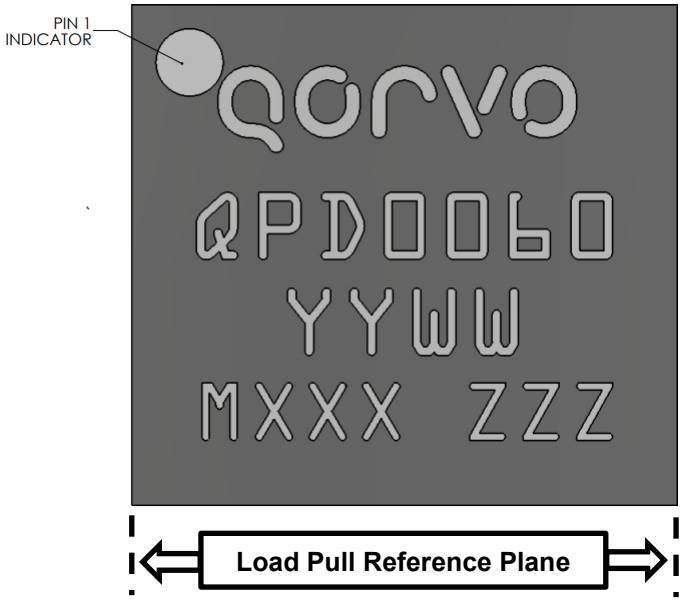


Load Pull at 3.5 GHz

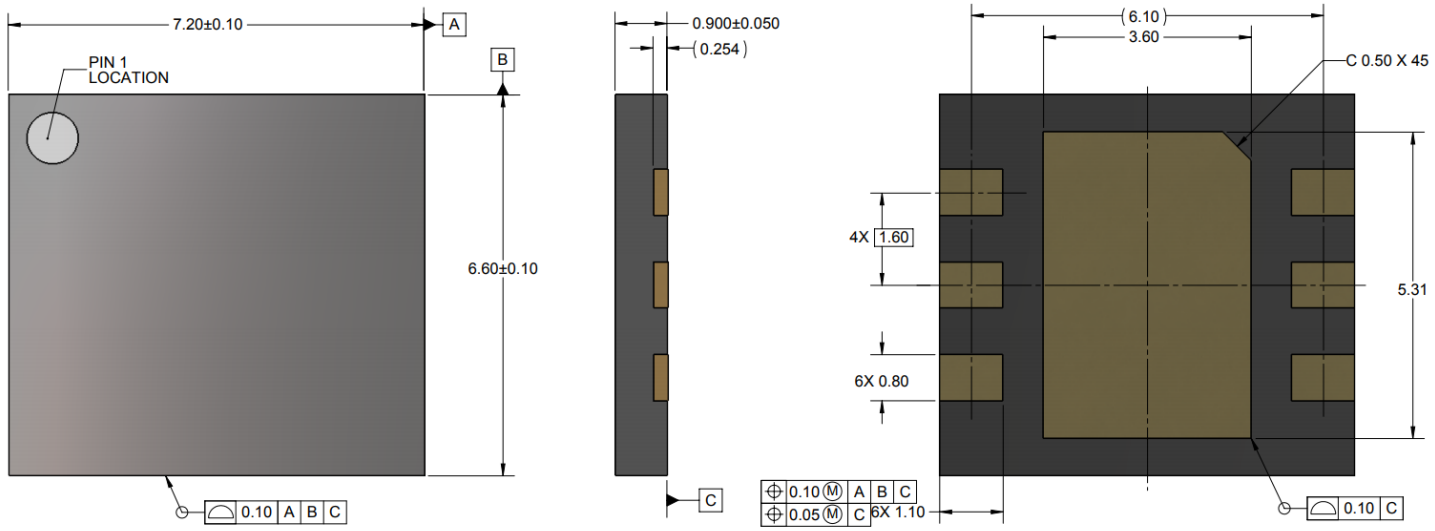


Package Markings

Marking: Qorvo Logo
Part Number – QPD0060
Date Code – YYWW
Lot Code – MXXX
Serial Number – ZZZ

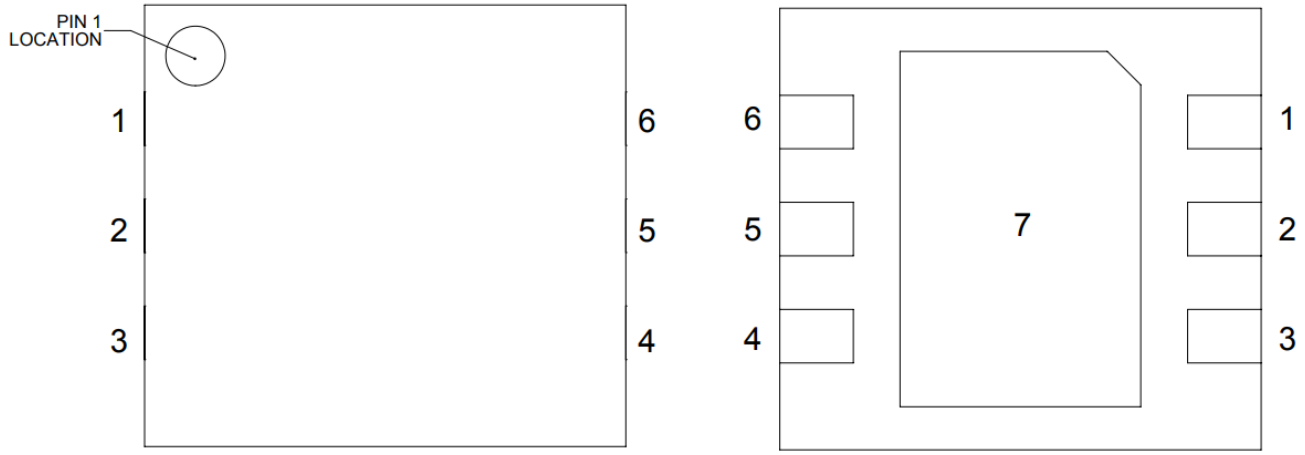


Package Dimensions



Notes:
1. Dimensions are in millimeters [inches]. Angles are in degrees.
2. Part is overmold encapsulated.
3. Contact plating is NiPdAu. Au thickness is 0.00254 to 0.01501 µm.
4. General tolerance is ±0.25.

Pin Configuration and Description

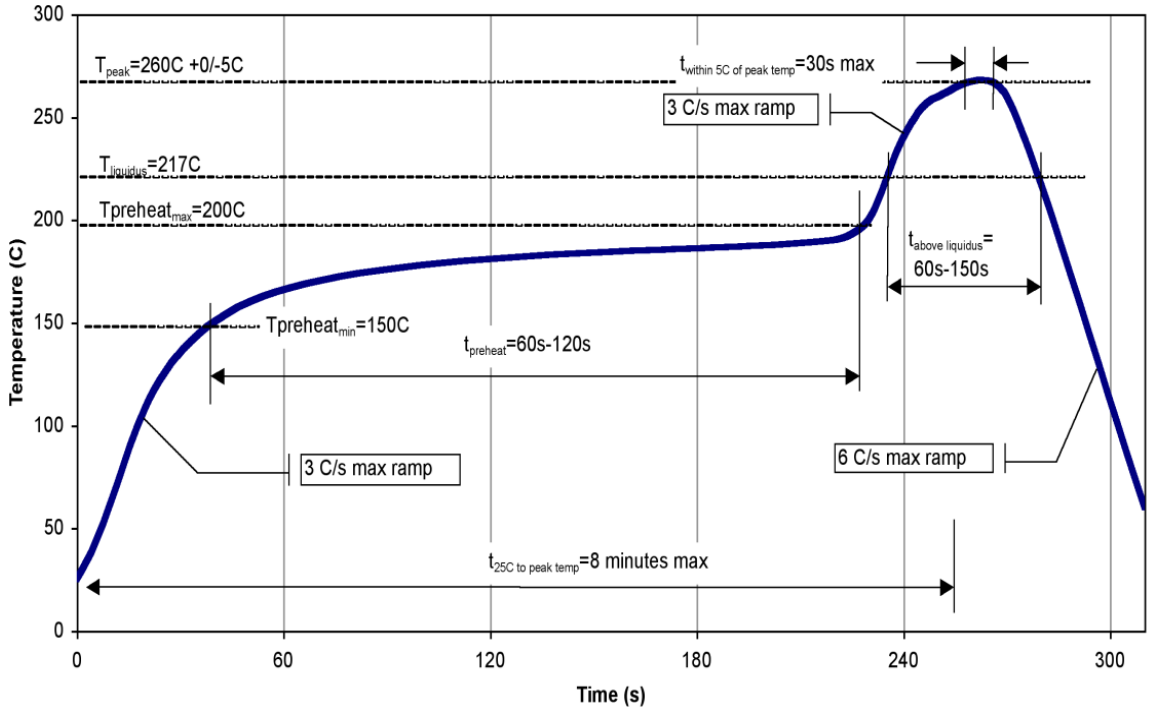


Pin Number	Label	Description
1, 2, 3	RF IN, V_G	RF Input, Gate Bias
4, 5, 6	RF OUT, V_D	RF Output, Drain Bias
7 (Backside Paddle)	RF/DC GND	RF/DC Ground

Bias Procedure

Bias On	Bias Off
1. Turn ON V_G to –4 V.	1. Turn OFF RF.
2. Turn ON V_D to +48 V.	2. Set V_G to −5 V.
3. Slowly adjust V_G until I_D is set to 130 mA. (Typically, V_G = −2.7 V.)	3. Turn OFF V_D.
	4. Wait two (2) seconds to allow drain capacitor to discharge.
5. Turn ON RF.	5. Turn OFF V_G.

Recommended Solder Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1A	ANSI/ESDA/JEDEC Standard JS-001
ESD – Charged Device Model (CDM)	Class C3	ANSI/ESDA/JEDEC Standard JS-002
MSL – Moisture Sensitivity Level	Level 3	IPC/JEDEC Standard J-STD-020

Caution!
ESD-Sensitive Device

Solderability

Compatible with lead-free (260°C max. reflow temp.) soldering processes.

Package lead plating is NiPdAu. Au thickness is 0.00254 to 0.01501 µm.

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:

Web: www.qorvo.com **Tel: 1-844-890-8163**

Email: customer.support@qorvo.com

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