QPD0060

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

Product Description

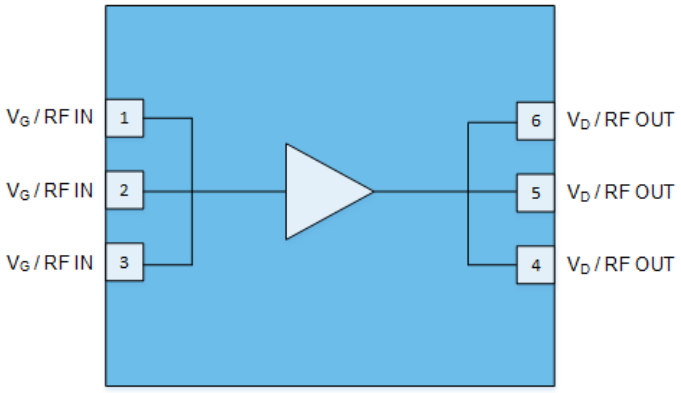
The QPD0060 is a wide band over-molded DFN discrete power amplifier. The device is a single stage unmatched power amplifier transistor.

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 3.6 GHz. QPD0060 can deliver P_{SAT} of 90 W at +48 V operation.

Lead-free and ROHS compliant.

Functional Block Diagram



6 Pin 7.2 x 6.6 mm DFN Package

Product Features

- Operating Frequency Range: DC to 3.6 GHz
- Operating Drain Voltage: +48 V
- Maximum Output Power (P_{SAT}): 95 W
- Maximum Drain Efficiency: 73.6%
- Efficiency-Tuned P3dB Gain: 22.9 dB
- Surface Mount Plastic Package

Applications

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

Ordering Information

Part No.	ECCN	Description
QPD0060TR7	EAR99	7” Reel with 250 pieces
QPD0060PCB4B01	EAR99	1.8 – 2.2 GHz Eval Board
QPD0060EVB01	EAR99	762–944 MHz Eval Board
QPD0060EVB02	EAR99	136–944 MHz Eval Board

Absolute Maximum Ratings

Parameter	Range / Value	Units
Gate Voltage (V_G)	−10	V
Drain Voltage (V_D)	+55	V
Maximum RF Input Power	38	dBm
VSWR Mismatch, P1dB Pulse (20 % duty cycle, 100 µs width), T = 25 °C	10:1	–
Storage Temperature	−65 to +150	°C

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

Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
Operating Temperature	−40	–	–	°C
Gate Voltage (V_G)	–	−2.7	–	V
Drain Voltage (V_D)	–	48	–	V
Quiescent Current (I_{DQ})	–	150	–	mA
T_{CH} for >10^6 hours MTTF	–	–	225	°C

Electrical performance is measured under conditions noted in the electrical specifications table. Specifications are not guaranteed over all recommended operating conditions.

Electrical Specifications

Parameter	Conditions	Min	Typ	Max	Units
Frequency Range		1800	–	3800	MHz
Quiescent Current		–	150	–	mA
Gain	P3dB	–	16.2	–	dB
P3dB		–	49.4	–	dBm
Drain Efficiency	P3dB	–	65.1	–	%

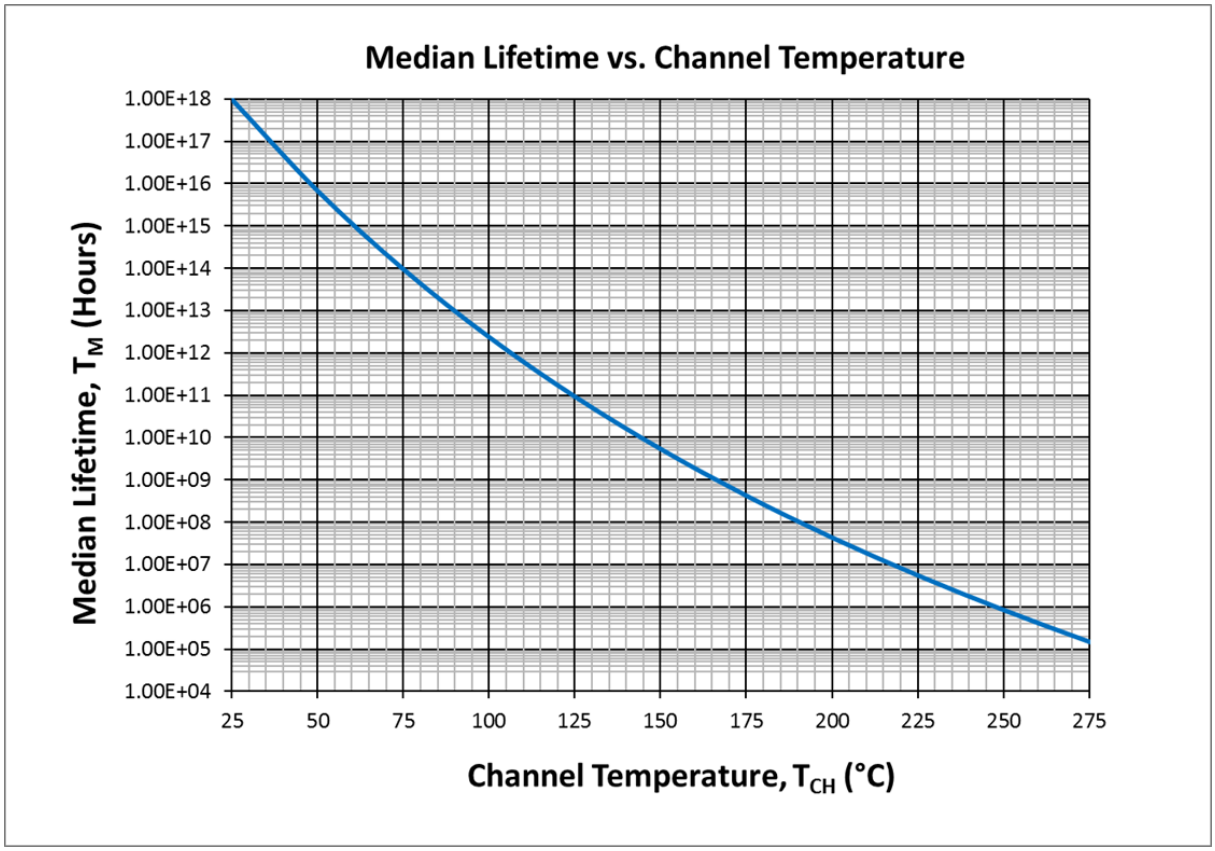
Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = 25°C, Pulsed (10% duty cycle, 100 µs width), on a Class AB single-ended EVB tuned for 1.8-2.2 GHz

Thermal and Reliability Information

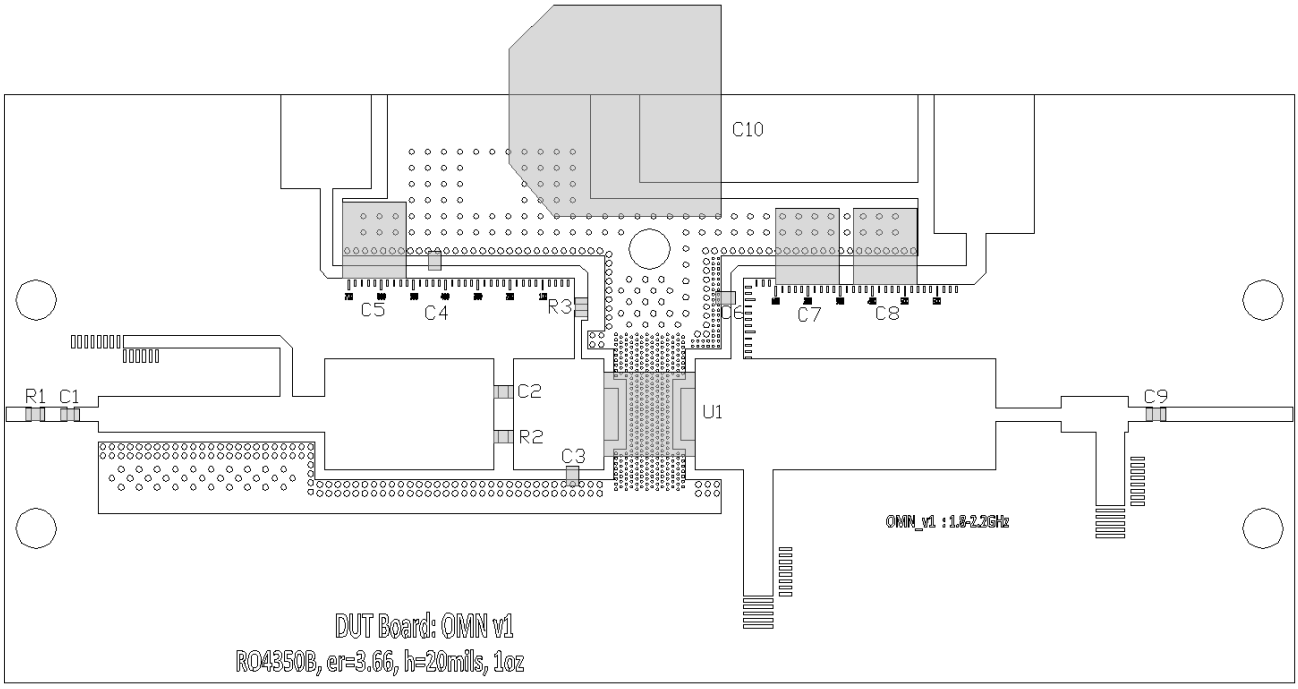
Parameter	Test Conditions	Value	Units
Thermal Resistance, FEA (θ_{JC}) (1) (3)	105 °C Case 12.6 W Pdiss, CW	2.8	°C/W
Channel Temperature, FEA (T_{CH}) (1)		140	°C
Median Lifetime (T_M) (1)		2.0E10	Hrs
Thermal Resistance, IR (θ_{JC}) (2) (3)		1.4 (2)	°C/W
Channel Temperature, IR (T_{CH}) (2)		123 (2)	°C
Thermal Resistance, FEA (θ_{JC}) (1) (3)	105 °C Case 25.2 W Pdiss, CW	3.0	°C/W
Channel Temperature, FEA (T_{CH}) (1)		181	°C
Median Lifetime (T_M) (1)		2.0E8	Hrs
Thermal Resistance, IR (θ_{JC}) (2) (3)		1.7 (2)	°C/W
Channel Temperature, IR (T_{CH}) (2)		149 (2)	°C
Thermal Resistance, FEA (θ_{JC}) (1) (3)	105 °C Case 37.8 W Pdiss, CW	3.3	°C/W
Channel Temperature, FEA (T_{CH}) (1)		230	°C
Median Lifetime (T_M) (1)		4.0E6	Hrs
Thermal Resistance, IR (θ_{JC}) (2) (3)		1.9 (2)	°C/W
Channel Temperature, IR (T_{CH}) (2)		178 (2)	°C

Notes:
1. Finite Element Analysis (FEA) thermal values shall be used to determine performance and reliability. Unless otherwise noted, all thermal references are FEA.
2. Infrared (IR) thermal values are for reference only and can not be used to determine performance or reliability.
3. Thermal resistance measured to backside of package.

Median Lifetime



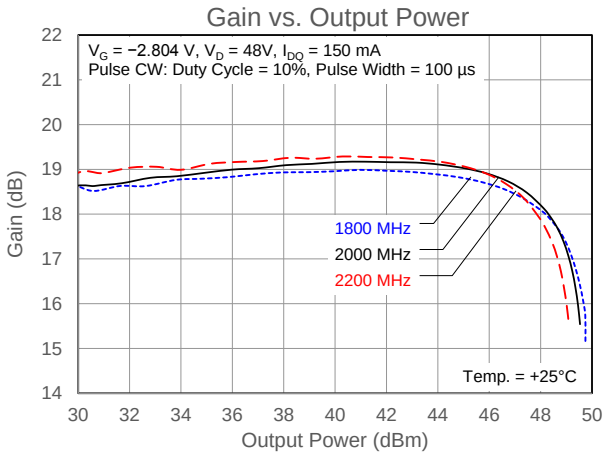
QPD0060PCB4B01 1.8 – 2.2 GHz Evaluation Board Layout

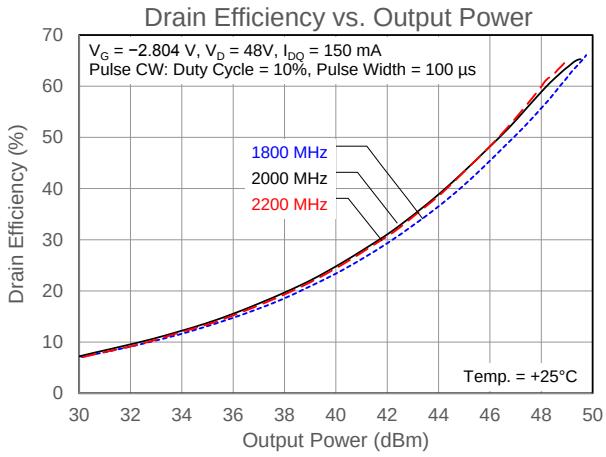


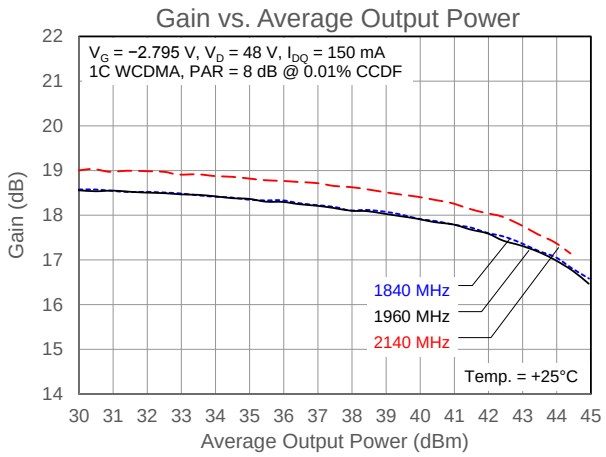
Bill of Materials – QPD0060PCB4B01 1.8 – 2.2 GHz Evaluation Board

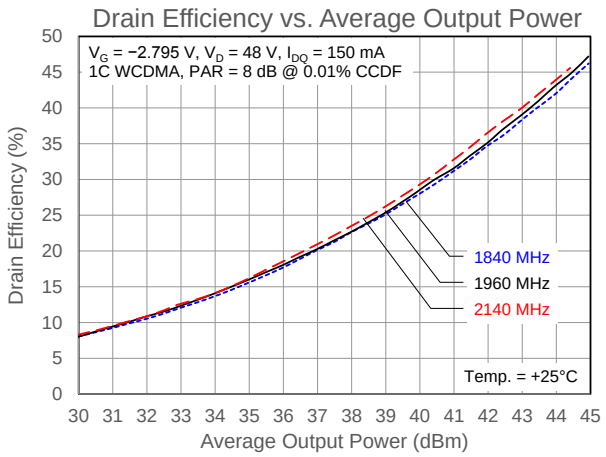
Reference Des.	Value	Description	Manuf.	Part No.
C1	1.6 pF	Capacitor, ±0.05 pF, 250 V, HI-Q, 0603	ATC	600S1R6AT250XT
C2, C3	3.0 pF	Capacitor, ±0.1 pF, 250 V, HI-Q, 0603	ATC	600S3R0BT250XT
C4, C6, C9	20 pF	Capacitor, 1%, 250 V, HI-Q, 0603	ATC	600S200FT250XT
C5, C7, C8	10 µF	Capacitor, 20%, 100 V, X7S, 2220	TDK	C5750X7S2A106M230KB
C10	100 µF	Capacitor, 20%, 100 V, AL ELEC, RAD, SMD	Panasonic	EEV-TG2A101M
R1	3.0 Ω	Resistor, 5%, 0.1 W, 0603	various	–
R2	220 Ω	Resistor, 5%, 0.1 W, 0603, Lead Free	KOA Speer	RK73B1JTTD221J
R3	10 Ω	Resistor, 0603, ROHS	Kamaya	RMC1/16K10R0FTP
U1	–	100 W GaN RF Transistor	Qorvo	QPD0060

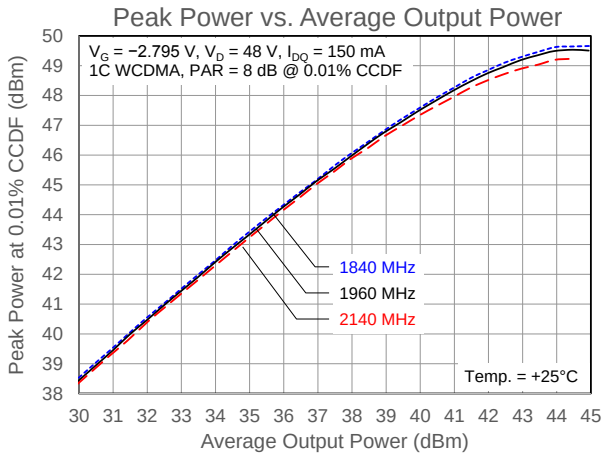
Performance Plots

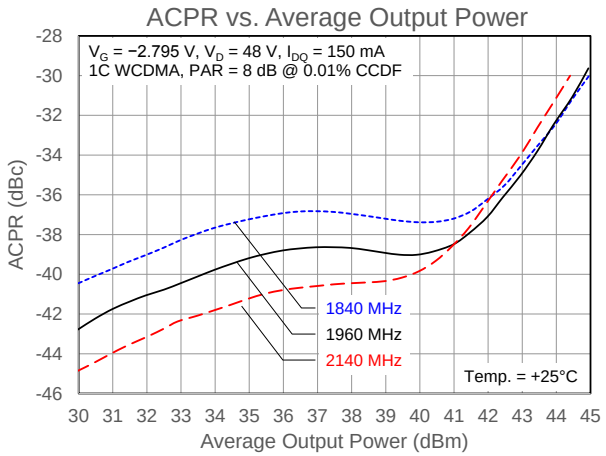






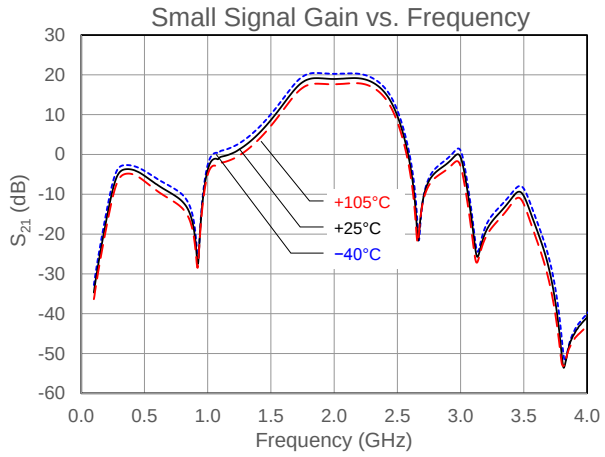


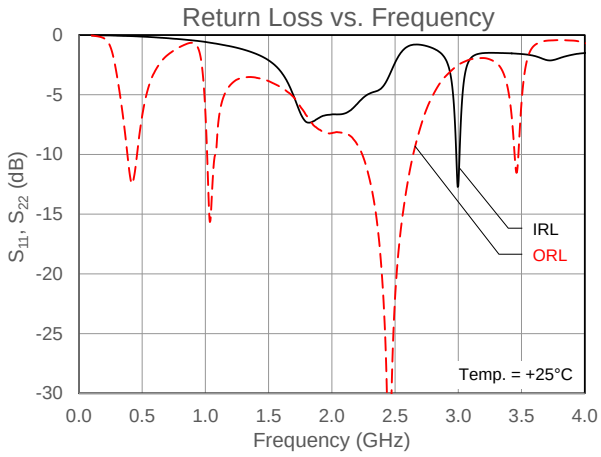


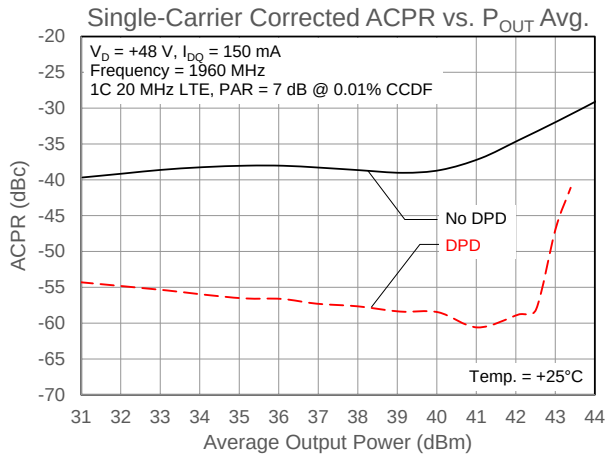


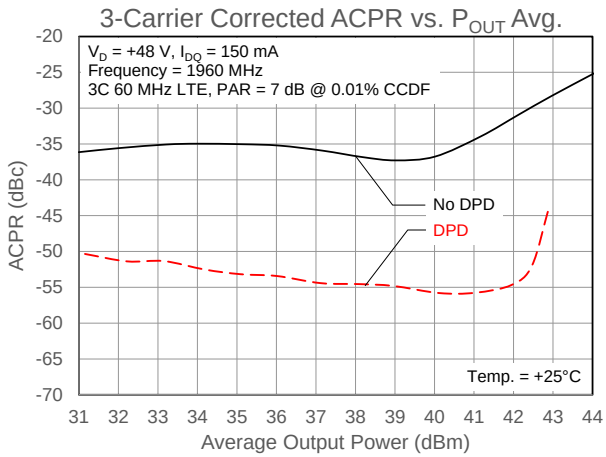
Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = 25°C, on a Class AB single-ended EVB tuned for 1.8-2.2 GHz

Performance Plots







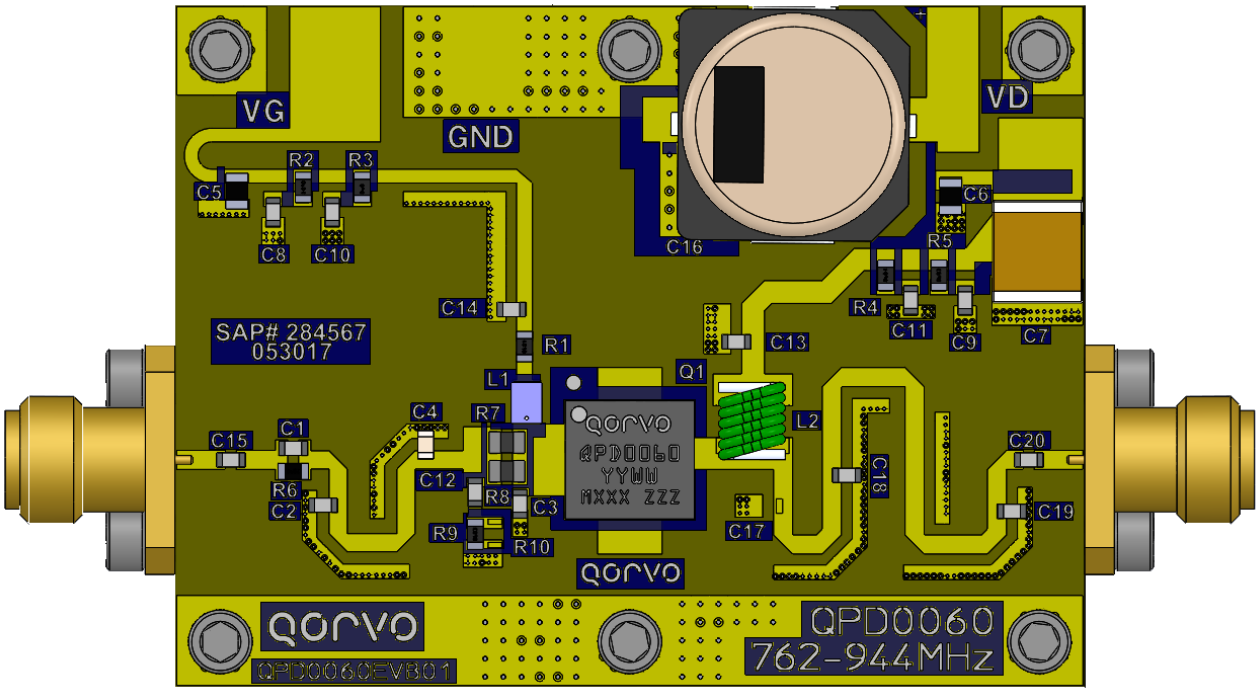


Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = 25°C, on a Class AB single-ended EVB tuned for 1.8-2.2 GHz

PCB Layout – 762 – 944 MHz EVB[1]

Notes:

1. PCB Material is RO4350B, 20 mil thick substrate, 1 oz. copper each side.



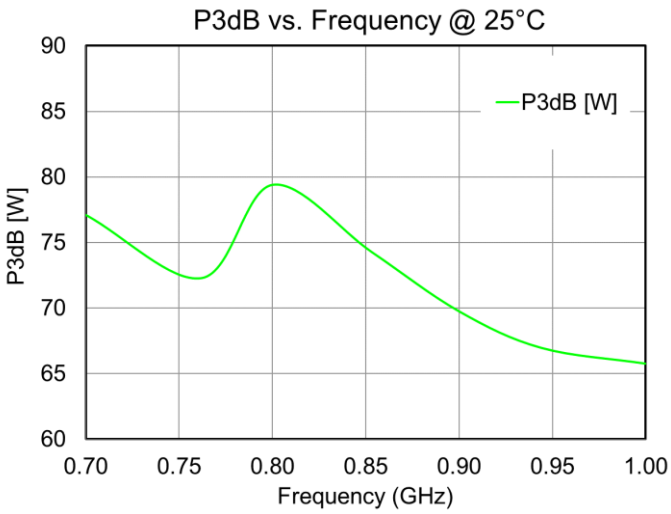
Bill Of material – 762 – 944 MHz EVB

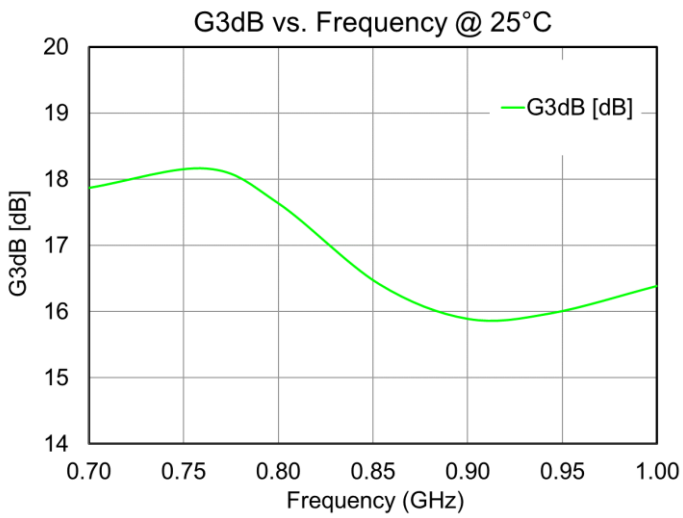
Ref Des	Value	Description	Manufacturer	Part Number
C1,C2,C15,C18	8.2 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	600S8R2BT250XT
C3,C19	3.3 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	600S3R3BT250XT
C4	22 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S220JT250XT
C5,C6	1.0 uF	X7S 100V 10% 0805 Capacitor	TDK	CGA4J3X7S2A105K
C7	10 uF	X7S 100V 10% 2220 Capacitor	TDK	C5750X7S2A106K230KB
C8,C9	0.1 uF	X7R 100V 10% 0603 Capacitor	Murata	GRM188R72A104KA35D
C10,C11,C12	100 pF	RF C0G 250VDC ± 5% Capacitor	TDK	C1608C0G2E101JT080AA
C13,C14	15 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S150JT250XT
C16	100 uF	ALUM 100V 20% 12.5mm SQ	BC Components	MAL215099907E3
C20	47 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S470JT250XT
L1	68 nH	Inductor 68nH 10% 0805 W/W	Coilcraft	0805CS-680XK
L2	47nH	Inductor 47nH 5% 1515	Coilcraft	1515SQ-47NJ
R1,R2,R3,R4,R5	10 Ohm	0603 5% Thick Film Resistor	KOA Speer	RK73B1JTTD100J
R6	1000 Ohm	0603 1% Thick Film Resistor	Cal-Chip	RM06F1001CT
R7,R8	5.1 Ohm	0805 1% Thick Film Resistor	Vishay	CRCW08055R10FKEA
R9	120 Ohm	0603 1% Thick Film Resistor	KOA Speer	RK73B1JTTD121J

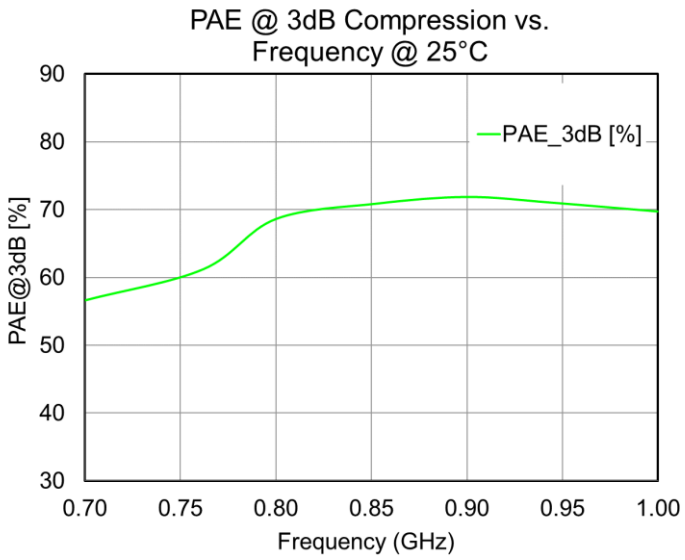
Power Drive-up Performance Plots of 762 – 944 MHz EVB[1]

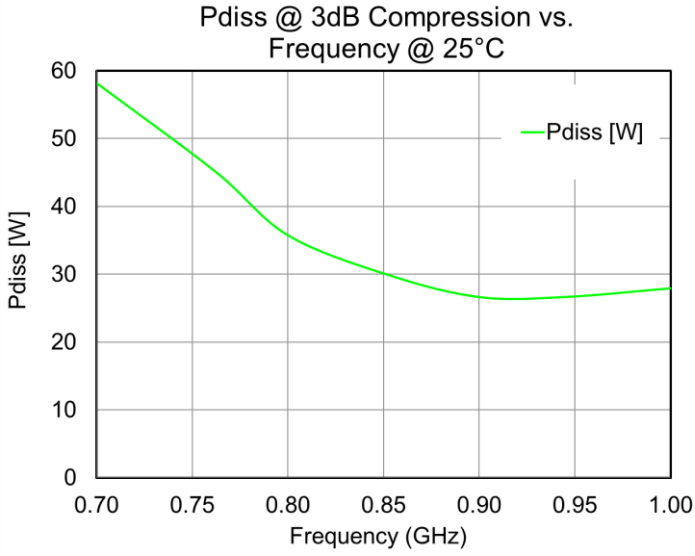
Notes:

1- Vd = 50 V, I_{DQ} = 150 mA, Pulsed signal 100us 10% Duty Cycle, Temp = 25°C.





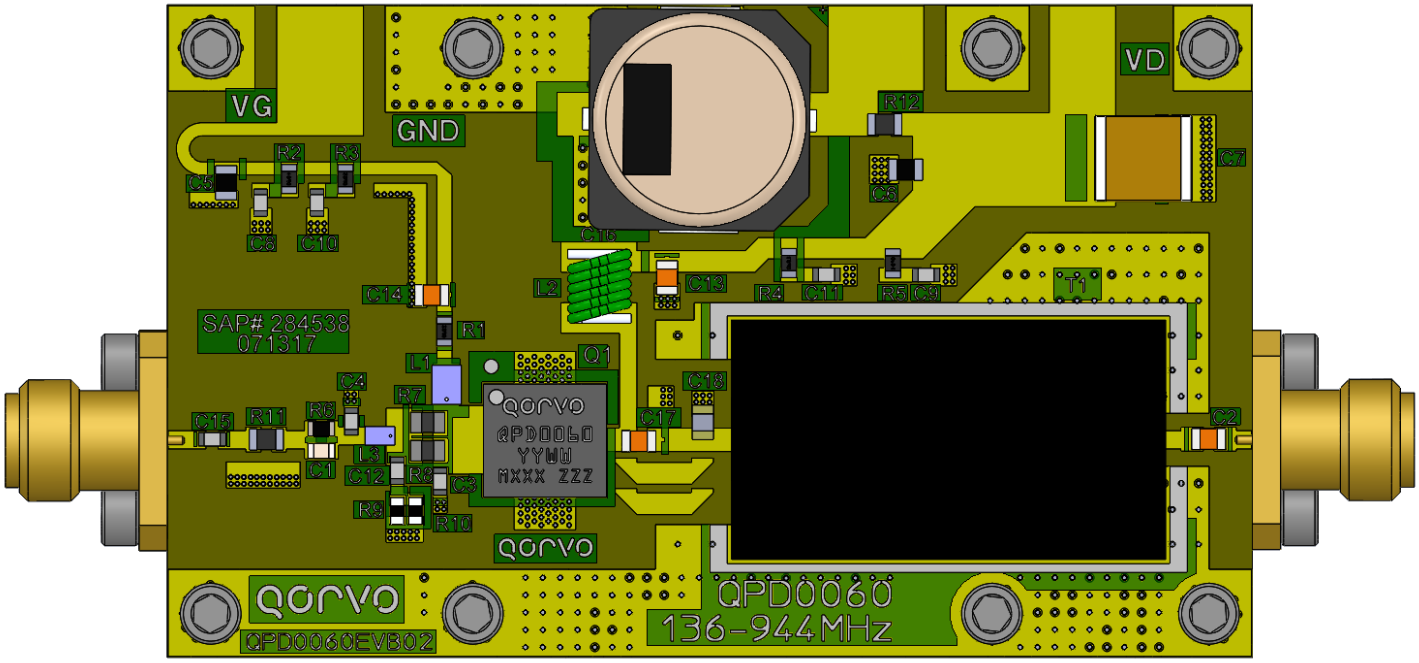




PCB Layout – 136 – 944 MHz EVB[1]

Notes:

1. PCB Material is RO4350B, 20 mil thick substrate, 1 oz. copper each side.



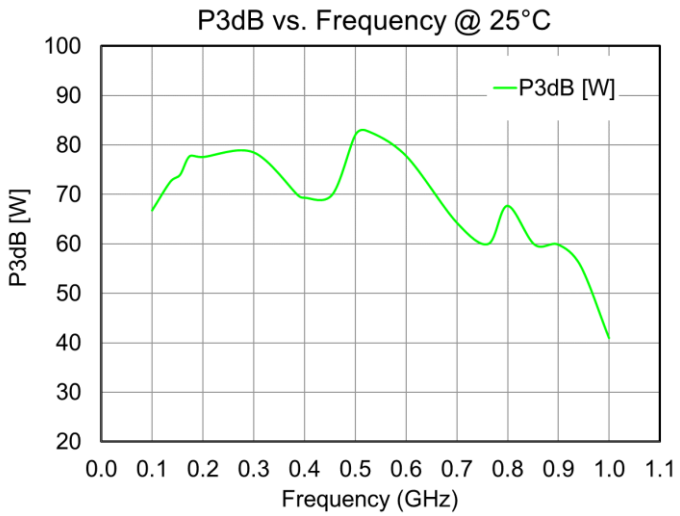
Bill Of material – 136 – 944 MHz EVB

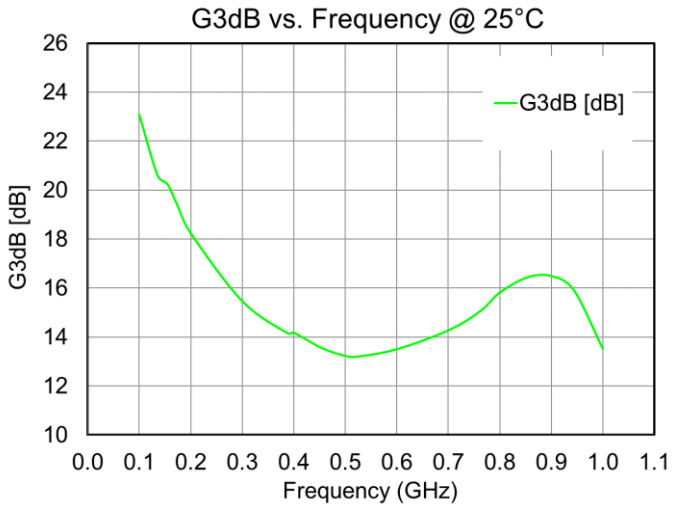
Ref Des	Value	Description	Manufacturer	Part Number
C1	22 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S220JT250XT
C2,C13,C14,C17	240 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600F241JT250XT
C3	3.3 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	600S3R3BT250XT
C4	8.2 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S8R2JT250XT
C5,C6	1.0 uF	X7S 100V 10% 0805 Capacitor	TDK	CGA4J3X7S2A105K
C7	10 uF	X7S 100V 10% 2220 Capacitor	TDK	C5750X7S2A106K230KB
C8,C9	0.1 uF	X7R 100V 10% 0603 Capacitor	Murata	GRM188R72A104KA35D
C10,C11,C12,C15	100 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S101JT250XT
C16	100 uF	ALUM 100V 20% 12.5mm SQ	BC Components	MAL215099907E3
C18	6.8 pF	RF C0G 250VDC ± 0.1 pF Capacitor	ATC	600F6R8BT250XT
L1	68 nH	Inductor 68nH 10% 0805 W/W	Coilcraft	0805CS-680XK
L2	82 nH	Inductor 82nH 5% 1515	Coilcraft	1515SQ-82NJ
L3	1.8 nH	Inductor 1.8nH 5% 0603	Coilcraft	0603HP-1N8XJ
R1,R2,R3,R4,R5	10 Ohm	0603 5% Thick Film Resistor	KOA Speer	RK73B1JTTD100J
R6	27 Ohm	0603 5% Thick Film Resistor	Panasonic	ERJ-3GEYJ270
R7,R8	5.1 Ohm	0805 1% Thick Film Resistor	Vishay	CRCW08055R10FKEA
R9,R10	240 Ohm	0603 1% Thick Film Resistor	Samsung	RC1608F241CS
R11	10 Ohm	0805 5% Thick Film Resistor	KOA Speer	RK73B2ALTD100J
T1	12.5 Ohm	Impedance Transformer 50-12.5Ohm	Anaren	XMT0310B5012

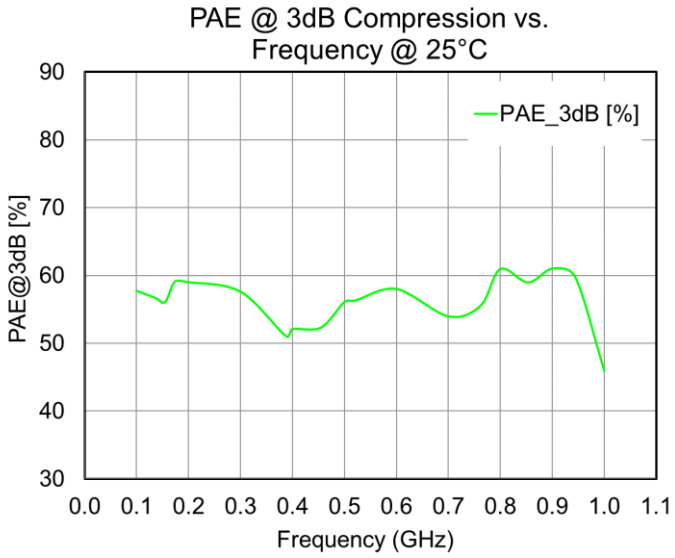
Power Drive-up Performance Plots of 136 – 944 MHz EVB[1]

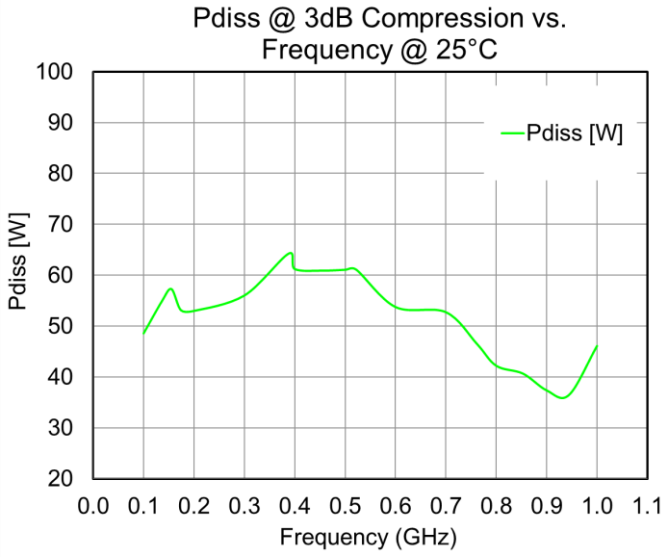
Notes:

1- Vd = 50 V, I_{DQ} = 150 mA, Pulsed signal 100us 10% Duty Cycle, Temp = 25°C.









RF Characterization – Power-Tuned Load Pull Performance

Frequency (MHz)	Source Impedance	Load Impedance	Gain @ P3dB (dB)	P3dB (dBm)	Drain Efficiency (%)
1800	7.62 + j0.37	6.03 + j0.84	21.3	49.7	59.1
2000	9.99 + j4.10	5.37 – j0.33	20.3	49.8	57.8
2200	8.66 + j0.82	6.05 + j0.08	19.8	49.7	63.0

Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = 25°C, Pulsed (10% duty cycle, 100 µs width) on a Class AB single-ended EVB tuned for 1.8-2.2 GHz

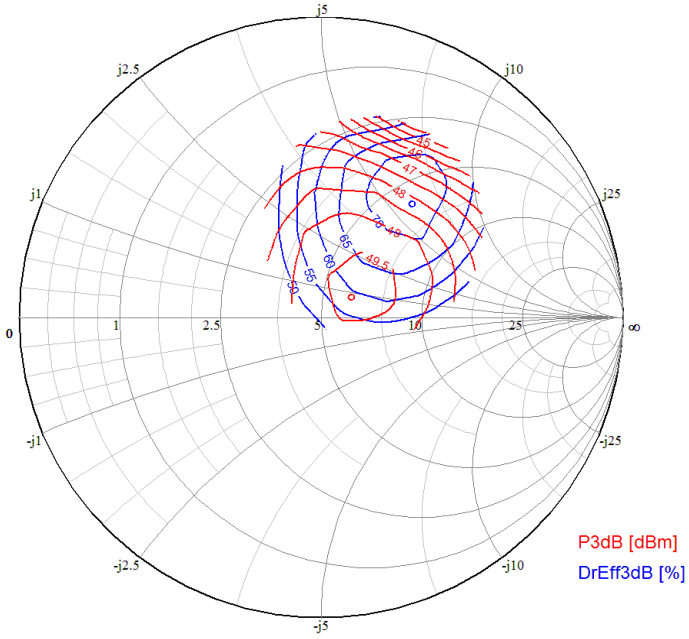
RF Characterization – Efficiency-Tuned Load Pull Performance

Frequency (MHz)	Source Impedance	Load Impedance	Gain @ P3dB (dB)	P3dB (dBm)	Drain Efficiency (%)
1800	7.62 + j0.37	6.08 + j5.97	23.1	48.3	72.6
2000	9.99 + j4.10	3.98 + j4.40	22.9	47.9	73.6
2200	8.66 + j0.82	3.30 + j3.51	22.0	47.4	72.4

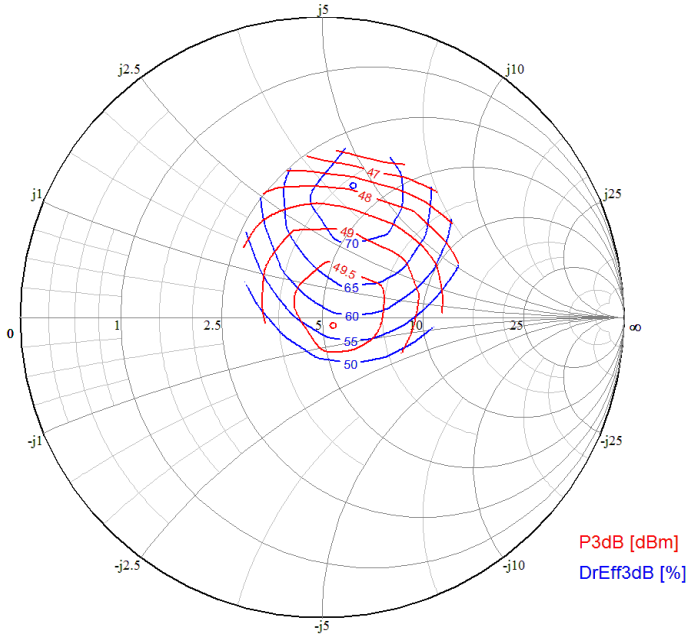
Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = 25°C, Pulsed (10% duty cycle, 100 µs width) on a Class AB single-ended EVB tuned for 1.8-2.2 GHz

Load Pull Plots

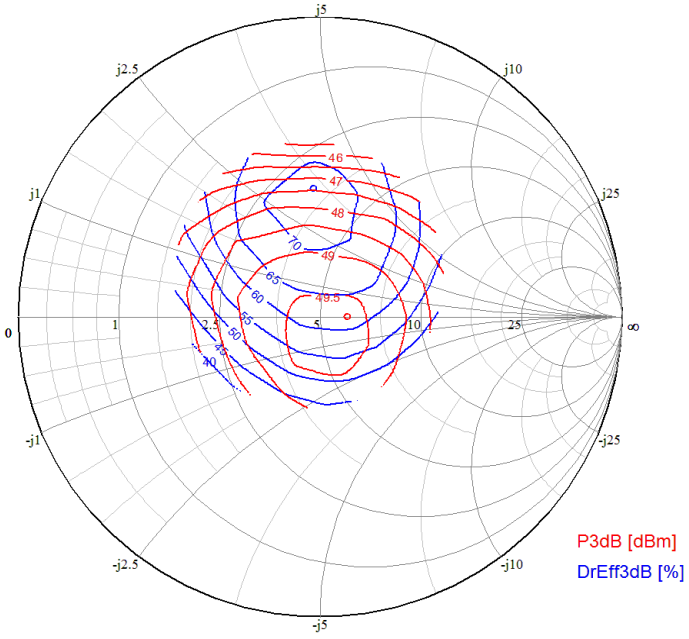
Load Pull at 1.8 GHz



Load Pull at 2 GHz

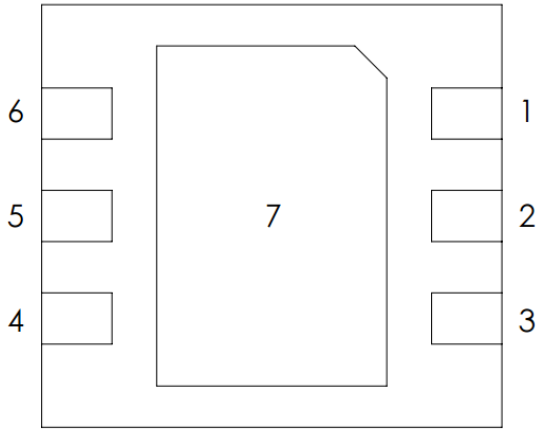


Load Pull at 2.2 GHz



Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 150 mA, T = 25°C, Pulsed (10% duty cycle, 100 µs width) on a Class AB single-ended EVB tuned for 1.8-2.2 GHz

Pin Configuration and Description

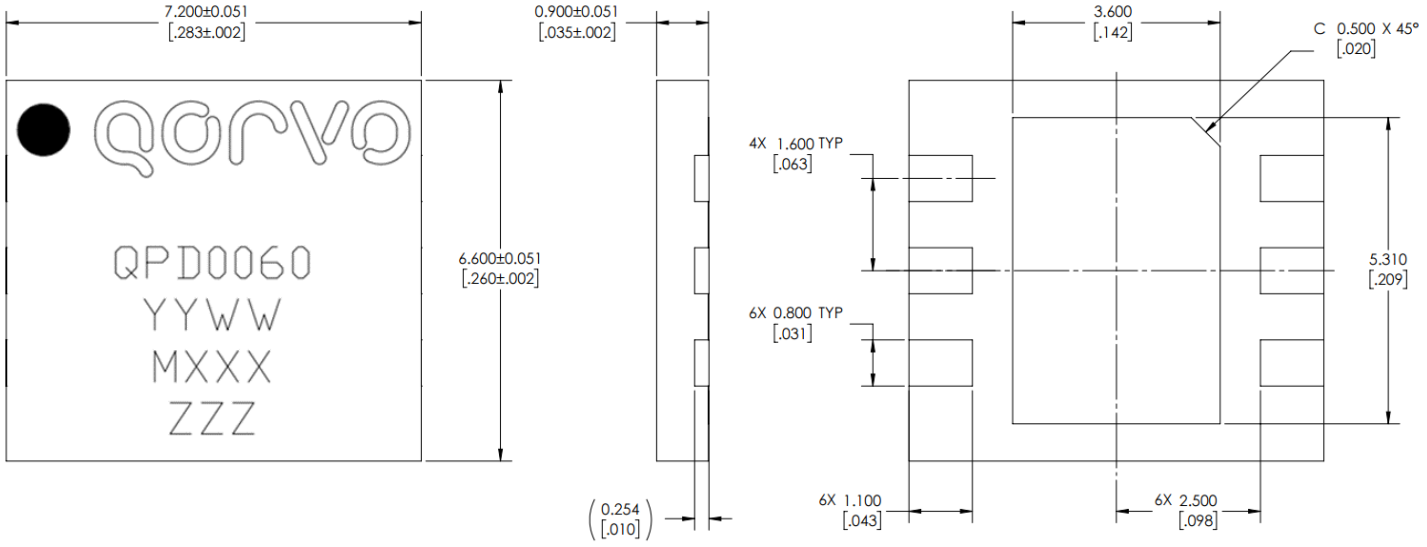


BOTTOM VIEW

Pin No.	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

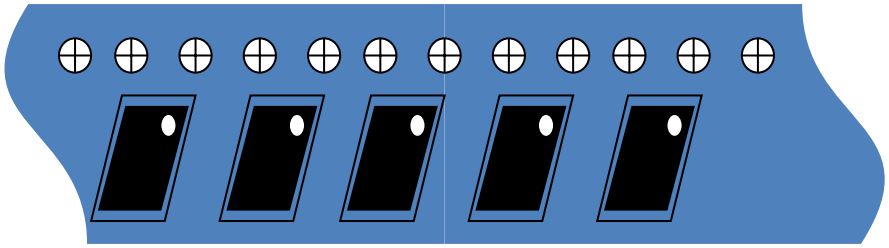
Package Marking and Dimensions

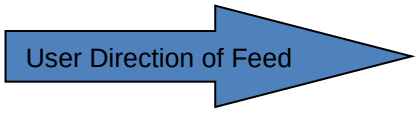
Marking: Qorvo Logo
Part Number and Package Version – QPD0060
Date Code – YYWW
Production Lot Number – MXXX
Serial Number – ZZZ

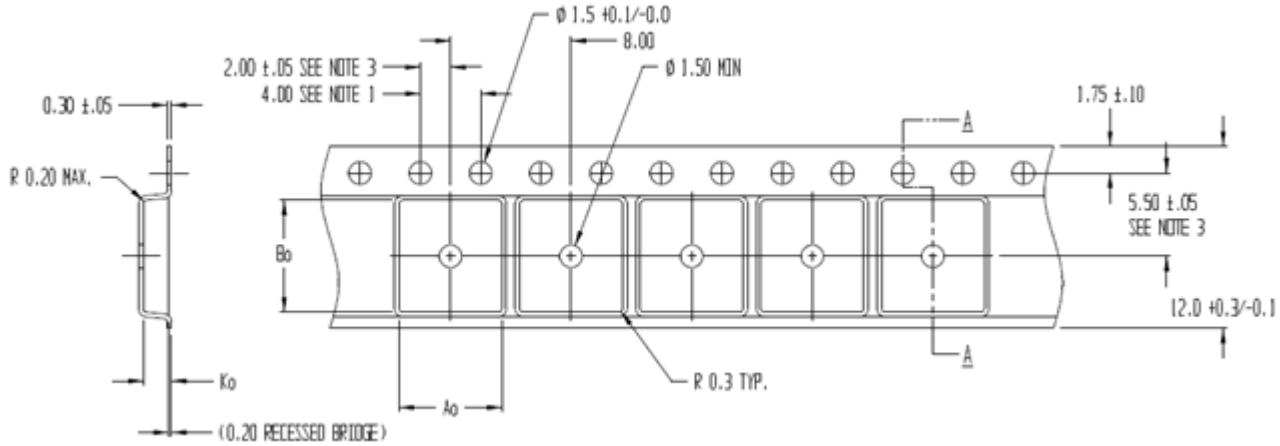


Notes:
1. All dimensions are in mm. Angles are in degrees.
2. Exposed metallization is NiAu plated.

Tape and Reel Information – Carrier and Cover Tape Dimensions



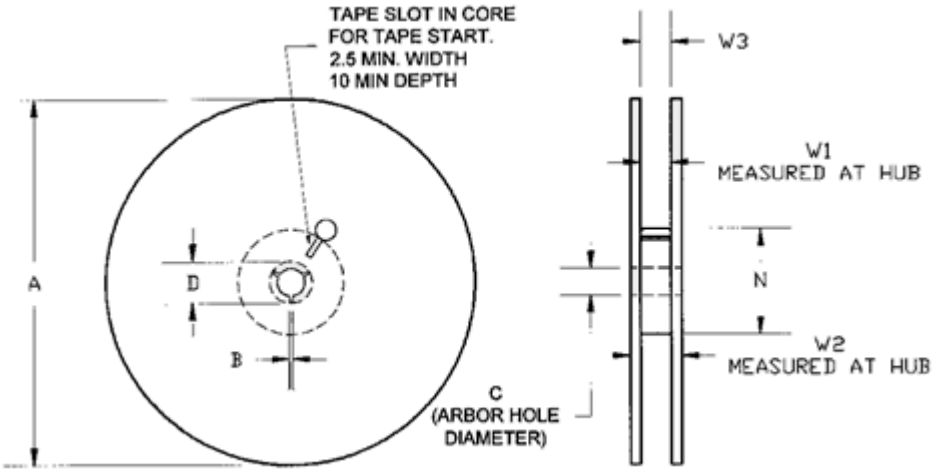




Feature	Measure	Symbol	Size (in)	Size (mm)
Cavity	Length	A0	0.269	6.83
	Width	B0	0.292	7.42
	Depth	K0	0.074	1.88
	Pitch	P1	0.315	8.0
Centerline Distance	Cavity to Perforation – Length Direction	P2	0.079	2.00
	Cavity to Perforation – Width Direction	F	0.217	5.5
Cover Tape	Width	C	0.472	12.0
Carrier Tape	Width	W	0.362	9.2

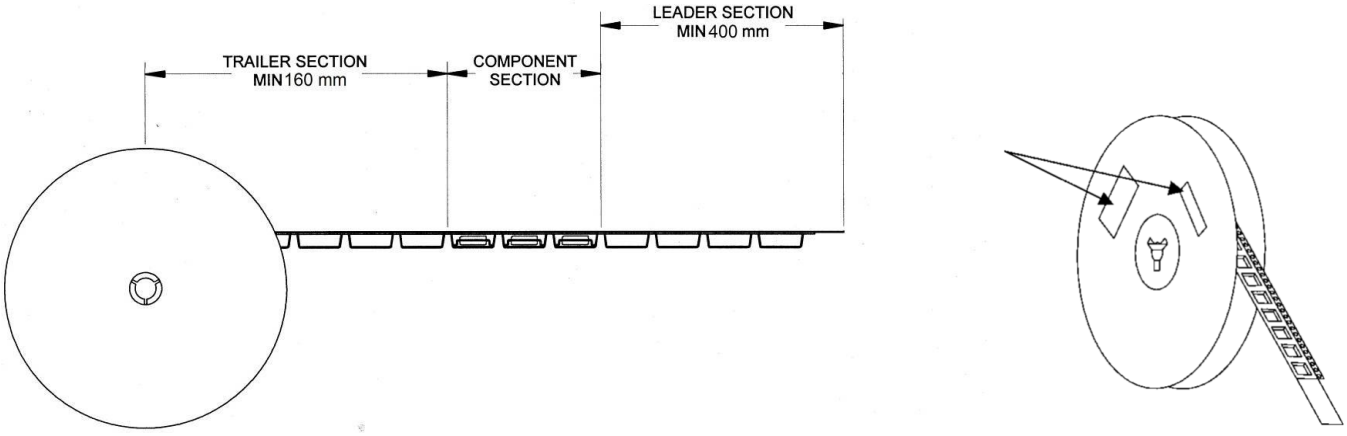
Tape and Reel Information – Reel Dimensions

Standard T/R size = 250 pieces on a 7” reel.



Feature	Measure	Symbol	Size (in)	Size (mm)
Flange	Diameter	A	6.969	177.0
	Thickness	W2	0.717	18.2
	Space Between Flange	W1	0.504	12.8
Hub	Outer Diameter	N	2.283	58.0
	Arbor Hole Diameter	C	0.512	13.0
	Key Slit Width	B	0.079	2.0
	Key Slit Diameter	D	0.787	20.0

Tape and Reel Information – Tape Length and Label Placement



Notes:
1. Empty part cavities at the trailing and leading ends are sealed with cover tape. See EIA 481-1-A.
2. Labels are placed on the flange opposite the sprockets in the carrier tape.