QPD0030

45 W, 48 V, DC – 4 GHz, GaN RF Power Transistor

General Description

The QPD0030 is a 45 W (P3dB) unmatched discrete GaN on SiC HEMT which operates from DC to 4GHz on a +48 V supply rail. It is ideally suited for basestation, radar and communications applications and can support both CW and pulsed mode of operations.

The QPD0030 can be used in Doherty architecture for the final stage of a base station power amplifier for small cell, microcell, and active antenna systems. The QPD0030 can also be used as a driver in a macrocell base station power amplifier.

The device is housed in an industry-standard 4x3 mm surface mount QFN package.

Lead-free and ROHS compliant.

Evaluation boards are available upon request.

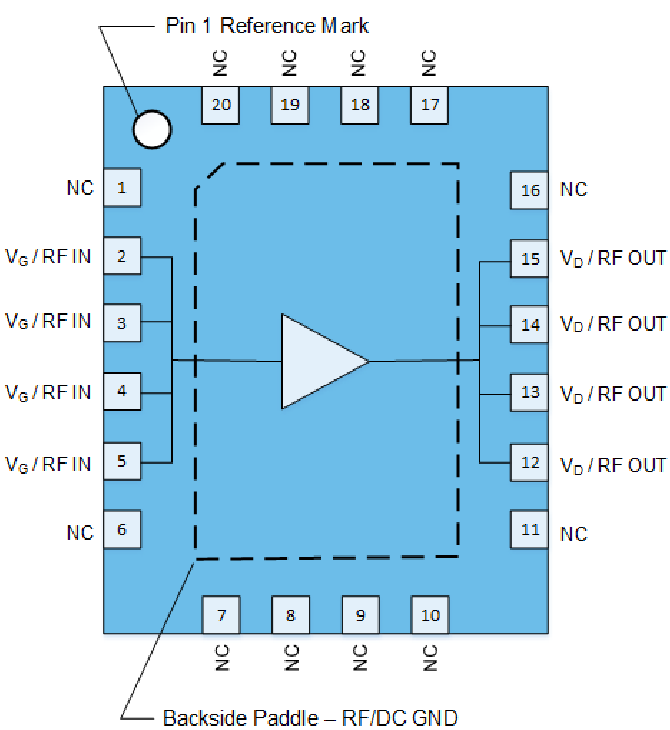
20 Pin 4x3 mm QFN Package

Product Features

- Frequency: DC to 4 GHz
- Output Power (P_{3dB}): 49 W [1]
- Linear Gain: 22.3 dB [1]
- Typical PAE_{3dB}: 71.5% [1]
- Operating Voltage: +48 V
- Low Thermal Resistance Package
- CW and Pulse Capable

Note 1: @ 2.2 GHz (Loadpull)

Functional Block Diagram



Applications

- Active Antenna Systems
- Macrocell Base Station Driver
- Small Cell Final Stage
- Land Mobile and Military Radio Communications
- Test Instrumentation
- Wideband or Narrowband Amplifiers

Ordering Information

Part No.	Description
1132528	45 W, DC – 4 GHz Transistor
QPD0030EVB01	1.2 – 1.4 GHz EVB
QPD0030EVB02	1.8 – 2.2 GHz EVB

Absolute Maximum Ratings

Parameter	Rating	Units
Breakdown Voltage, BV_{DG}	165	V
Gate Voltage Range, V_G	-7 to +2	V
Drain Voltage, V_D	+55	V
Drain Current, I_D	6	A
Gate Current Range, I_G	See page 5.	mA
Power Dissipation, CW, P_{DISS} (2)	33.4	W
RF Input Power	33	dBm
Channel Temperature, T_{CH}	+275	°C
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. Back plane of package at +85°C.

Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
Operating Temp. Range	–40	+25	+85	°C
Drain Voltage Range, V_D	–	+48	–	V
Drain Bias Current, I_{DQ}	–	85	–	mA
Drain Current, I_D	–	2	–	A
Gate Voltage, V_G (2)	–	–2.8	–	V
Channel Temperature, T_{CH}	–	–	+250	°C
Power Dissipation, CW, P_{DISS} (3)	–	–	30.0	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. To be adjusted to desired I_{DQ}.
3. Back plane of package at +85°C.

Pulsed Characterization – Load Pull Performance – Power Tuned

Parameters	Typical Values					Unit
Frequency, F	1.8	2.0	2.2	2.5	2.7	GHz
Linear Gain, G_{LIN}	24.5	24.0	22.3	21.2	21.0	dB
Output Power at 3dB Compression Point, P_{3dB}	46.9	46.5	46.9	46.8	47.0	dBm
Power-Added-Efficiency at 3dB Compression Point, PAE_{3dB}	60.0	61.4	56.4	58.5	60.1	%
Gain at 3 dB Compression Point, G_{3dB}	21.5	21.0	19.3	18.2	18.0	dB

Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 85 mA, Temp = +25 °C

Pulsed Characterization – Load Pull Performance – Efficiency Tuned

Parameters	Typical Values					Unit
Frequency, F	1.8	2.0	2.2	2.5	2.7	GHz
Linear Gain, G_{LIN}	26.8	25.7	25.0	23.0	22.8	dB
Output Power at 3dB Compression Point, P_{3dB}	45.3	45.3	45.2	45.2	45.0	dBm
Power-Added-Efficiency at 3dB Compression Point, PAE_{3dB}	72.3	70.1	71.5	70.7	72.5	%
Gain at 3 dB Compression Point, G_{3dB}	23.8	22.7	22.0	20.0	19.8	dB

Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 85 mA, T = +25 °C

RF Characterization – Mismatch Ruggedness at 2.2 GHz

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

Notes:
1. Test conditions unless otherwise noted: T = +25 °C, V_D = +48 V, I_{DQ} = 85 mA
2. Driving input power is determined at CW compression under matched condition at EVB output connector.

RF Characterization – 1.2 – 1.4 GHz EVB Performance

Parameters	Conditions	Typical Values			Unit
Frequency, F		1.2	1.3	1.4	GHz
Linear Gain, G_{LIN}		19.5	19.9	19.2	dB
Output Power, P_{3dB}	3 dB Compression Point	46.2	45.6	45.7	dBm
Power-Added Efficiency, PAE_{3dB}	P_{3dB}	66.5	74.2	62.7	%
Gain, G_{3dB}	P_{3dB}	16.5	16.9	16.2	dB

Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 90 mA, Pulse CW (10% duty cycle, 1 ms period), T = +25°C

RF Characterization – 1.8 – 2.2 GHz EVB Performance

Parameters	Conditions	Typical Values			Unit
Frequency, F		1.8	2.0	2.2	GHz
Linear Gain, G_{LIN}	P_{OUT} = 34 dBm	21.3	20.8	21.3	dB
Output Power, P_{3dB}	3 dB Compression Point	46.3	45.7	45.6	dBm
Power-Added Efficiency, PAE_{3dB}	P_{3dB}	69.0	60.5	58.6	%
Gain, G_{3dB}	P_{3dB}	18.3	17.8	18.3	dB

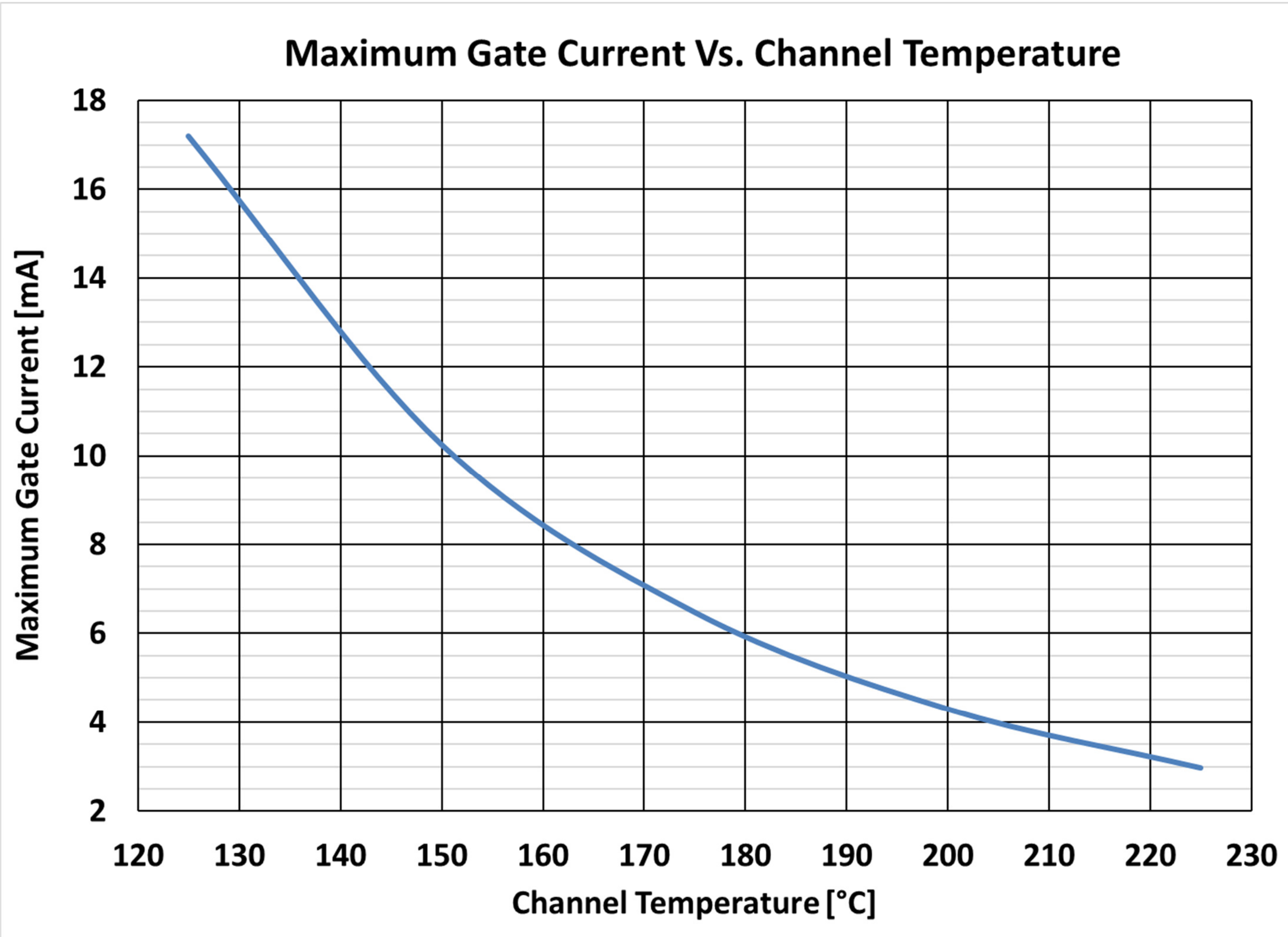
Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 85 mA, Pulse CW (10% duty cycle, 1 ms period), T = +25°C

RF Characterization – Performance at 2.0 GHz

Parameters	Conditions	Min	Typical	Max	Unit
Linear Gain, G_{LIN}	P_{OUT} = 34 dBm	18.4	20.2	–	dB
Output Power, P_{3dB}	3 dB Compression Point	43.9	45.2	–	dBm
Power-Added Efficiency, PAE_{3dB}	P_{3dB}	46.0	57.5	–	%
Gain, G_{3dB}	P_{3dB}	14.6	16.3	–	dB

Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 85 mA, Pulse CW (10% duty cycle, 1 ms period), T = +25°C, Frequency = 2005 MHz on 1.8 – 2.2 GHz EVB.

Maximum Gate Current

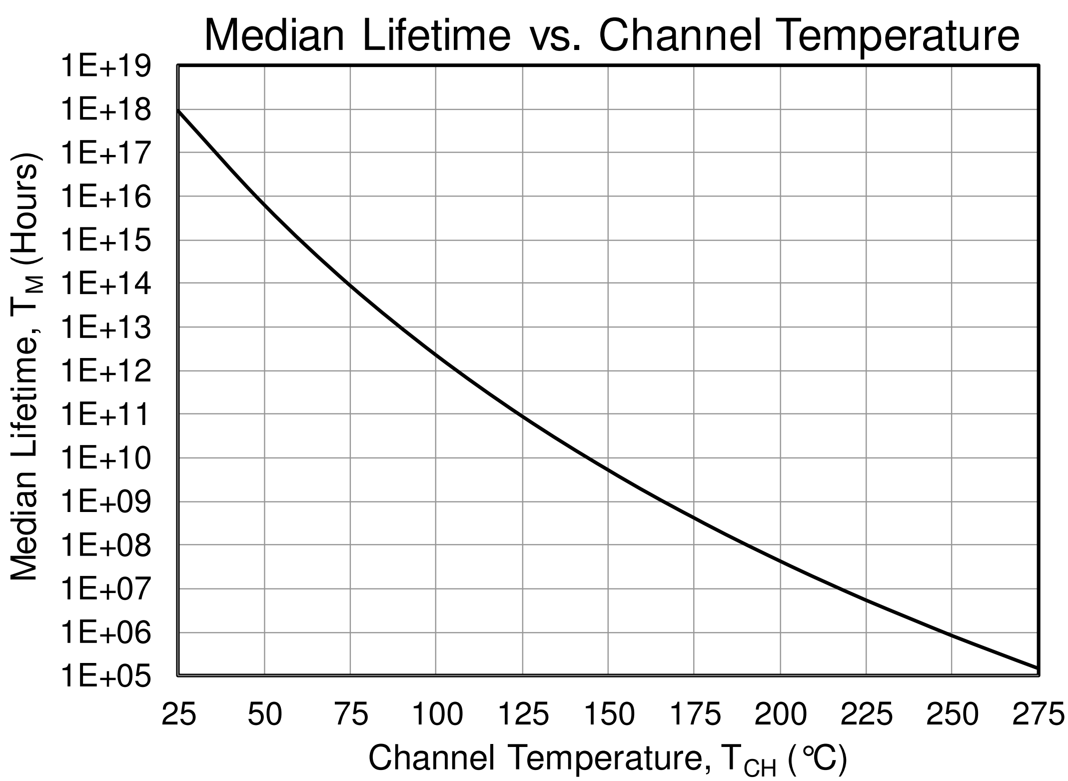


Thermal and Reliability Information

Parameter	Conditions	Values	Units
Thermal Resistance, FEA (θ_{JC}) (1) (3)	CW T_{CASE} = +85°C, P_{OUT} = 2.1 W, P_{DISS} = 9.6 W	4.4	°C/W
Channel Temperature, FEA (T_{CH}) (1)		127	°C
Median Lifetime (T_M) (1)		7.0E10	Hrs
Thermal Resistance, IR (θ_{JC}) (2) (3)		3.0	°C/W
Channel Temperature, IR (T_{CH}) (2)		114	°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.

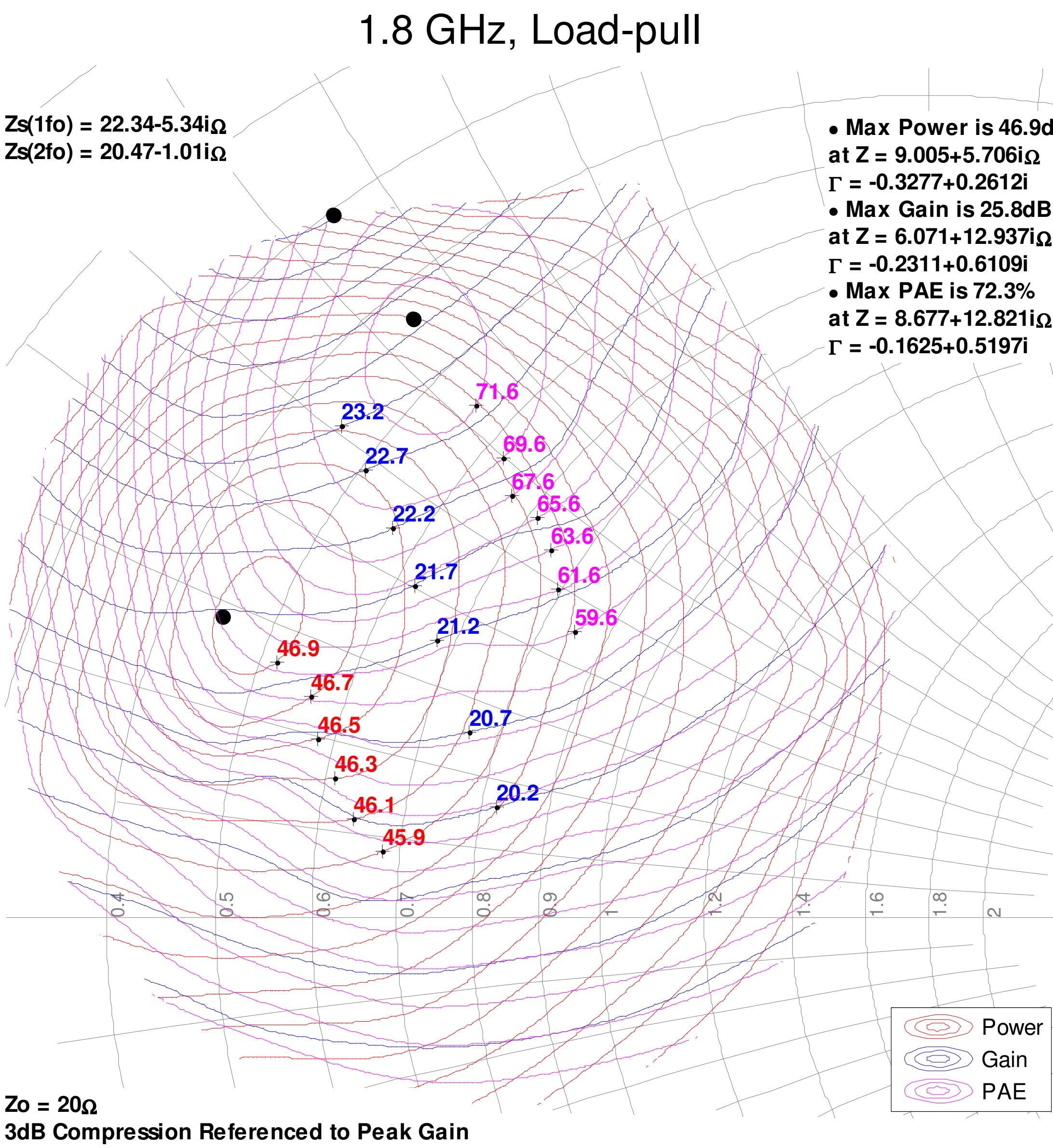
Median Lifetime



Note: For pulsed signals, average lifetime is average lifetime at maximum channel temperature divided by duty cycle.

Load Pull Smith Chart – 1.8 GHz

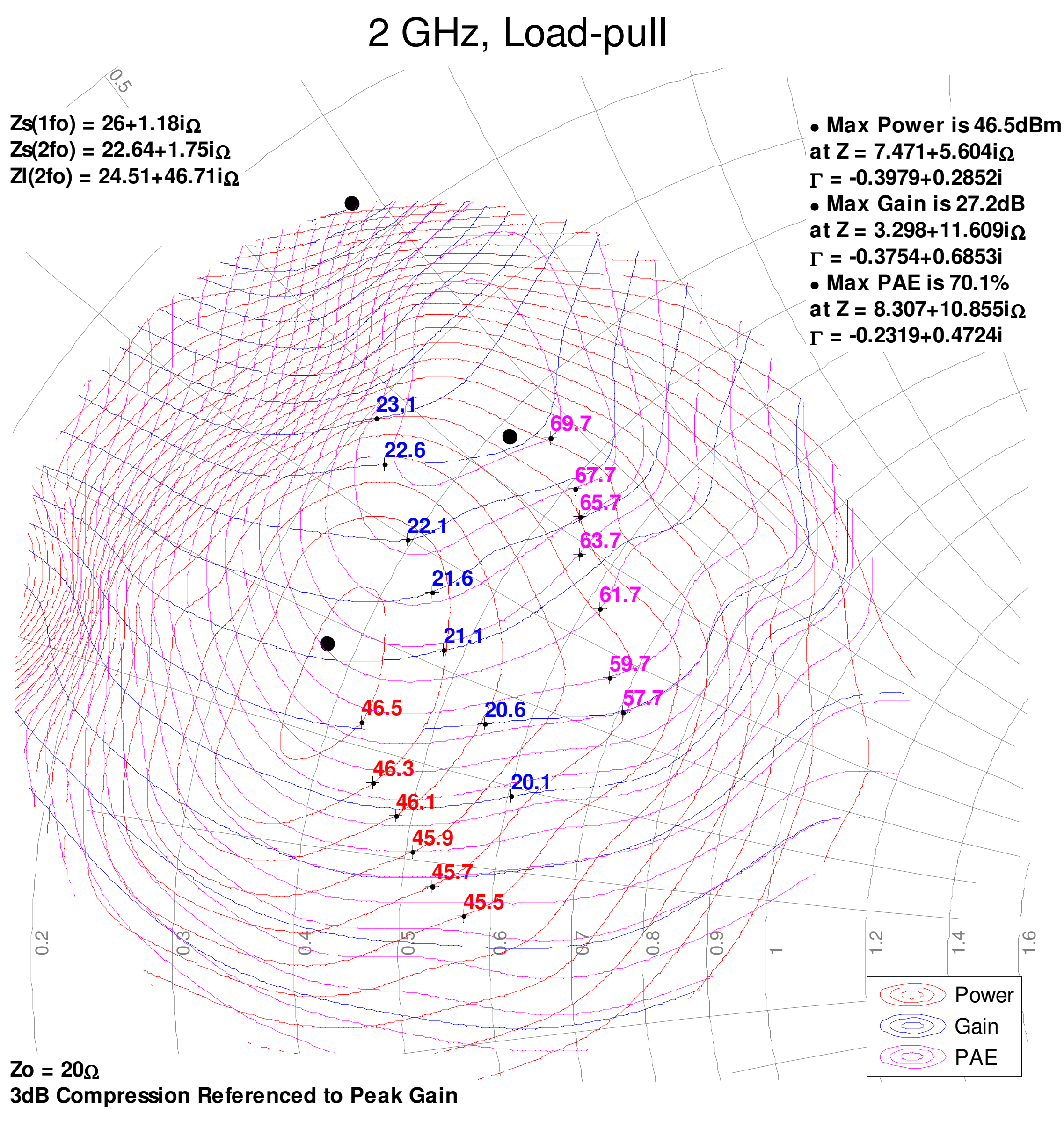
Notes:
1. V_D = +48 V, I_{DQ} = 85 mA, Pulse CW (10% duty cycle, 1 ms period), T = +25°C
2. See page 16 for load pull and source pull reference planes.



Load Pull Smith Chart – 2.0 GHz

Notes:

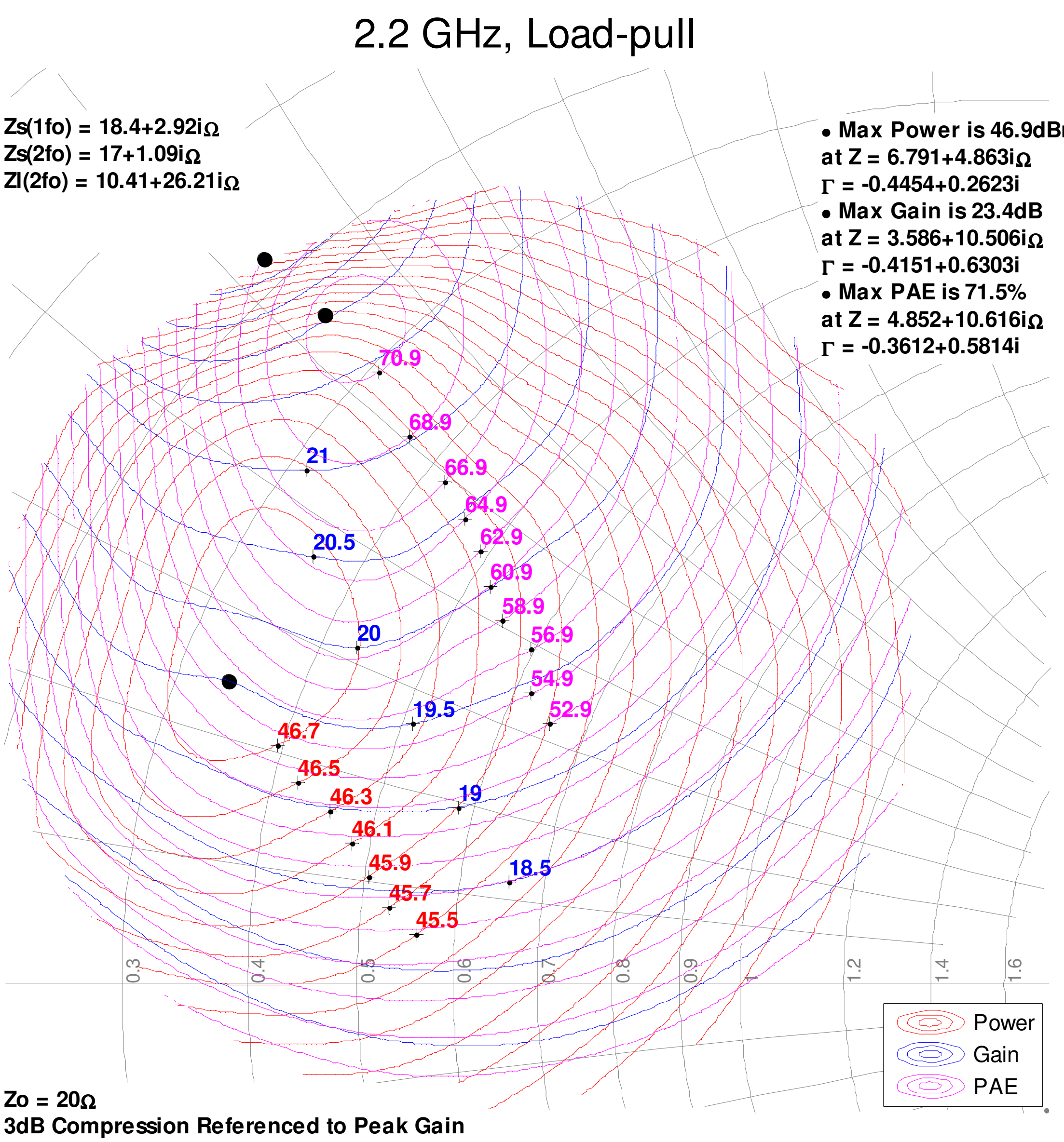
1. V_D = +48 V, I_{DQ} = 85 mA, Pulse CW (10% duty cycle, 1 ms period) , T = +25°C
2. See page 16 for load pull and source pull reference planes.



Load Pull Smith Chart – 2.2 GHz

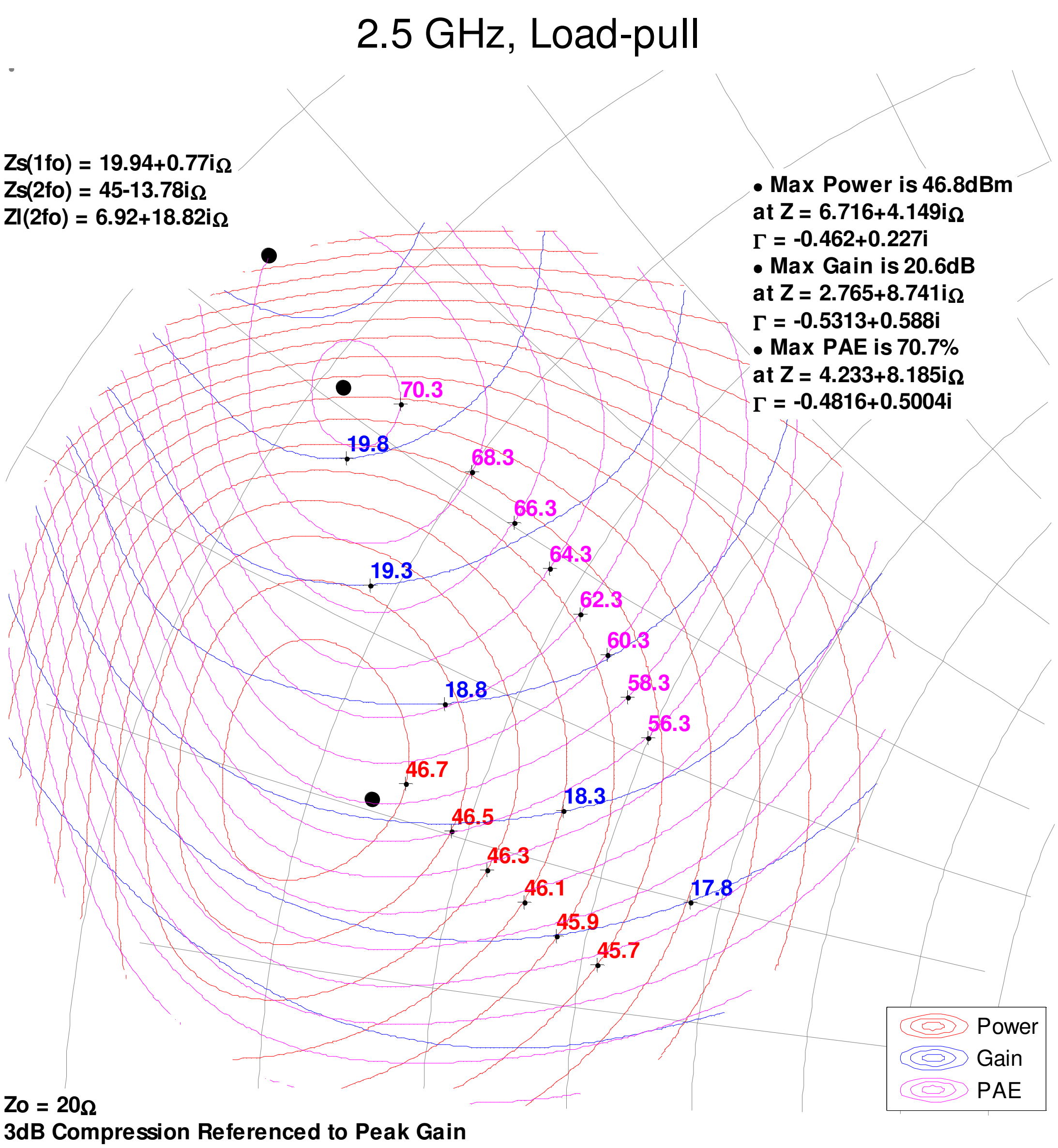
Notes:

1. V_D = +48 V, I_{DQ} = 85 mA, Pulse CW (10% duty cycle, 1 ms period), T = +25°C
2. See page 16 for load pull and source pull reference planes.



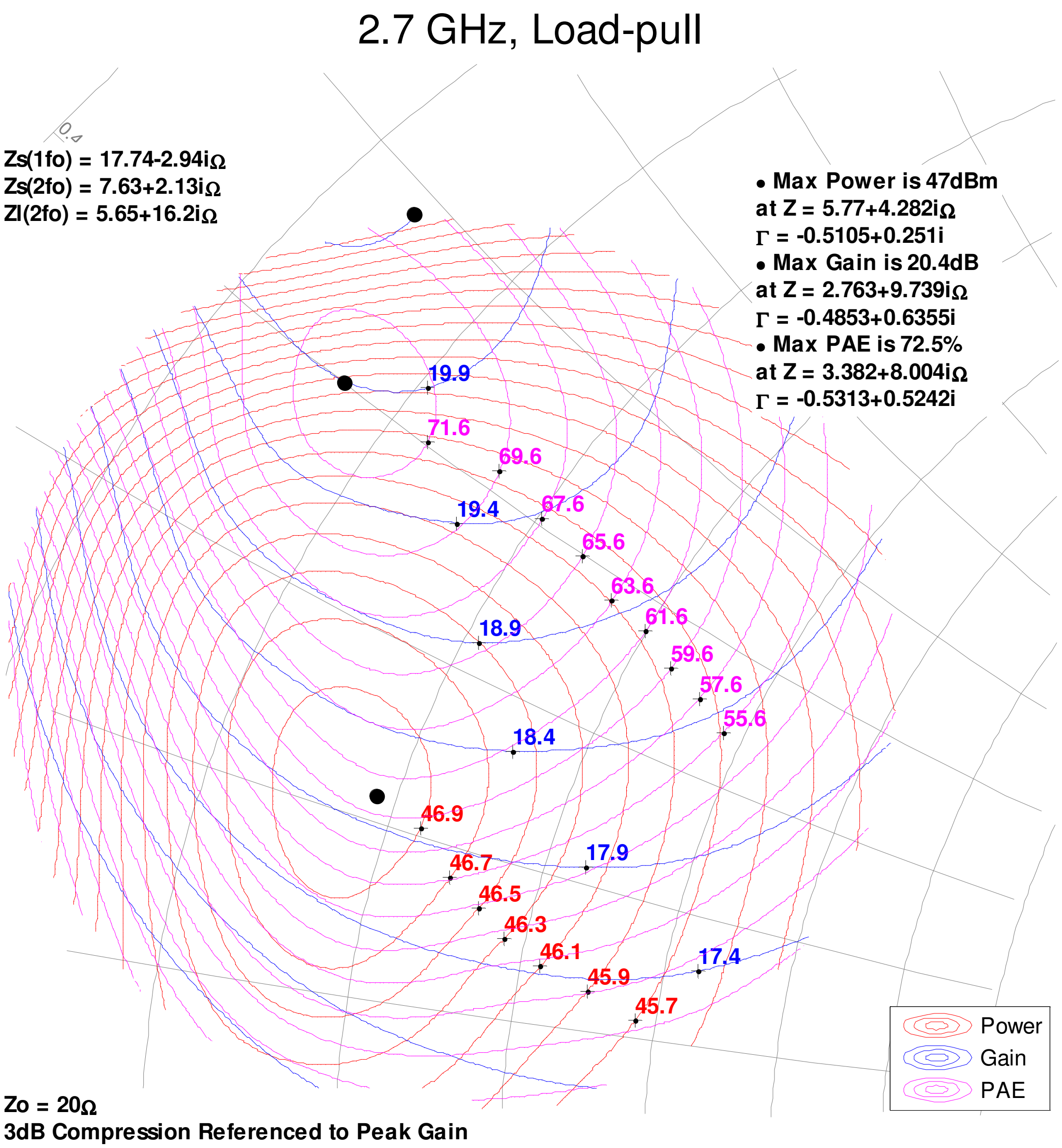
Load Pull Smith Chart – 2.5 GHz

Notes:
1. V_D = +48 V, I_{DQ} = 85 mA, Pulse CW (10% duty cycle, 1 ms period), T = +25 °C
2. See page 16 for load pull and source pull reference planes.



Load Pull Smith Chart – 2.7 GHz

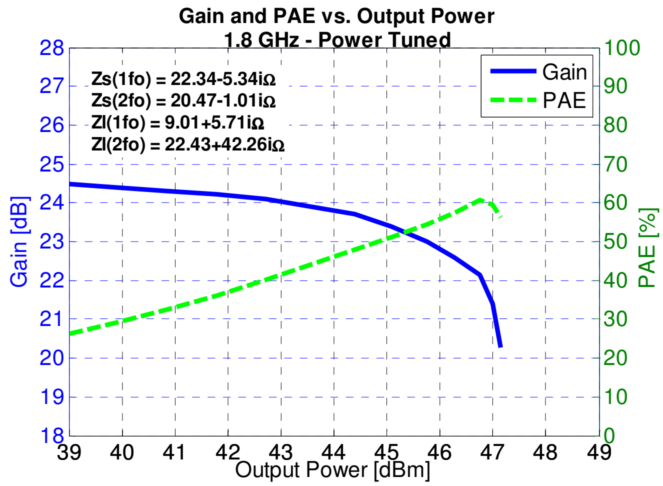
Notes:
1. V_D = +48 V, I_{DQ} = 85 mA, Pulse CW (10% duty cycle, 1 ms period), T = +25℃
2. See page 16 for load pull and source pull reference planes.

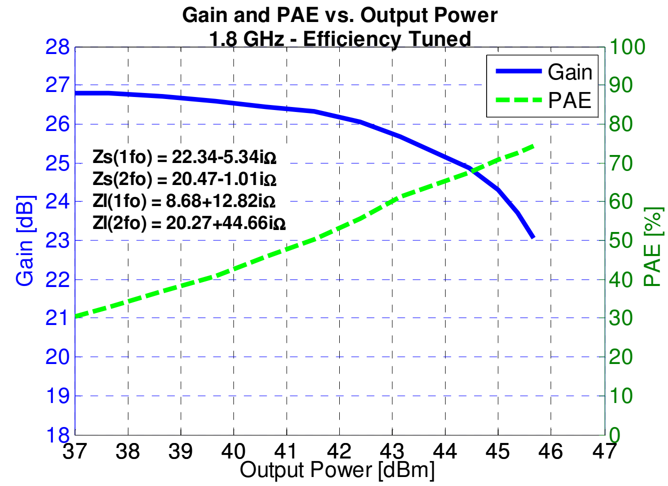


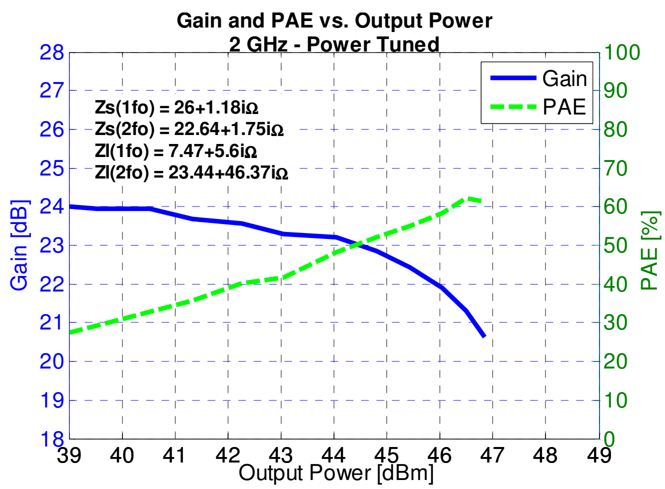
Typical Performance – Load Pull Drive-Up

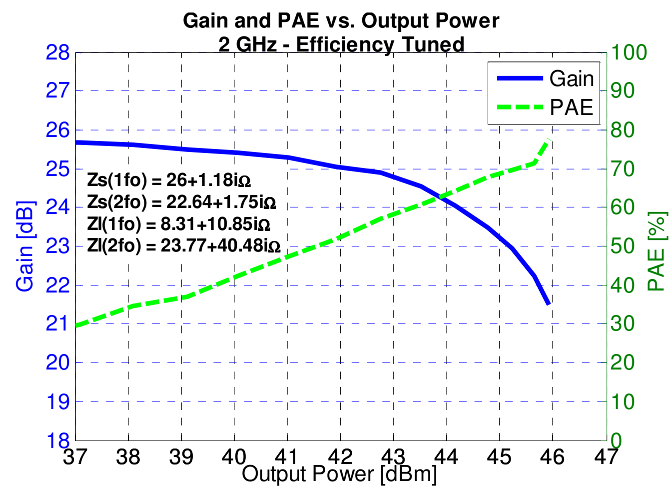
Notes:

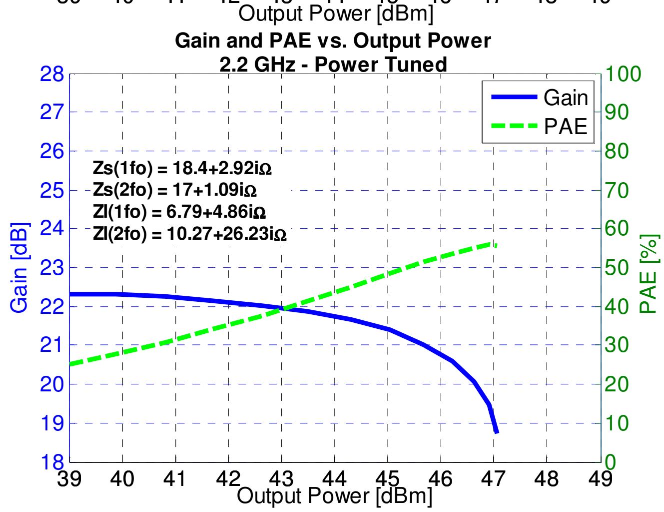
1. V_D = +48 V, I_{DQ} = 85 mA, Pulse CW (10% duty cycle, 1 ms period), T = +25 °C
2. See page 16 for load pull and source pull reference planes where the performance was measured.

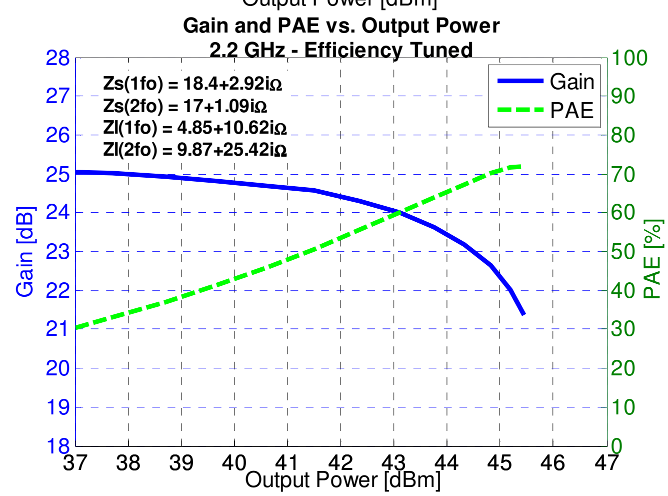








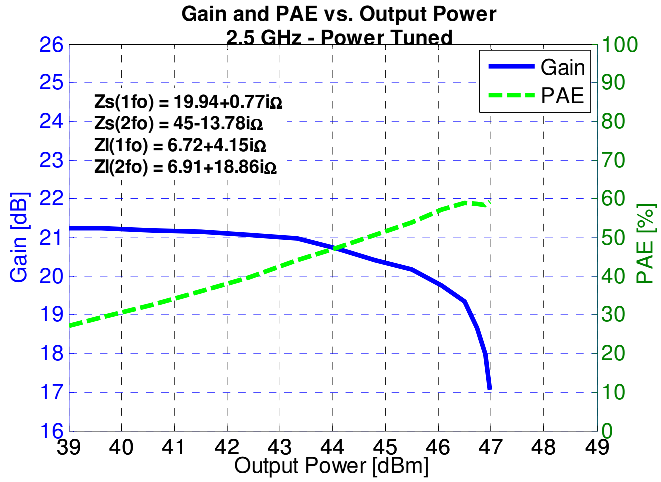


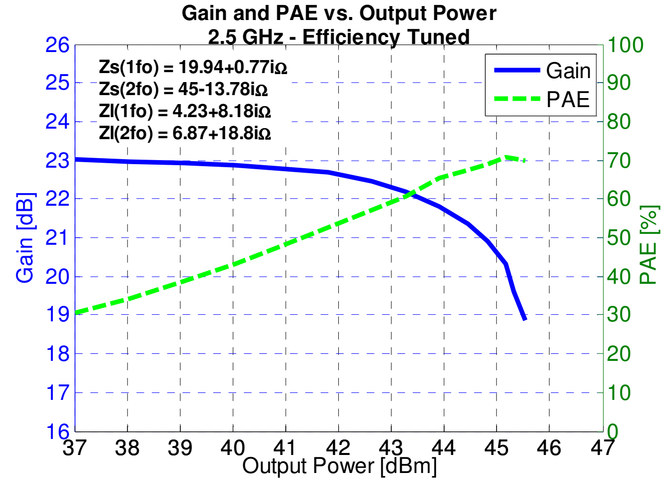


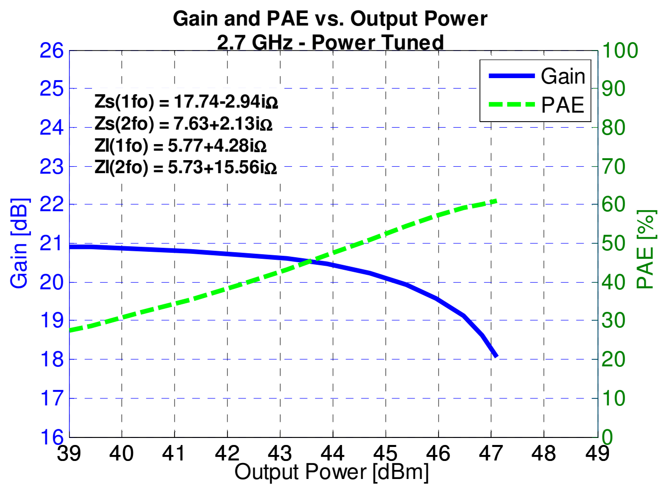
Typical Performance – Load Pull Drive-Up

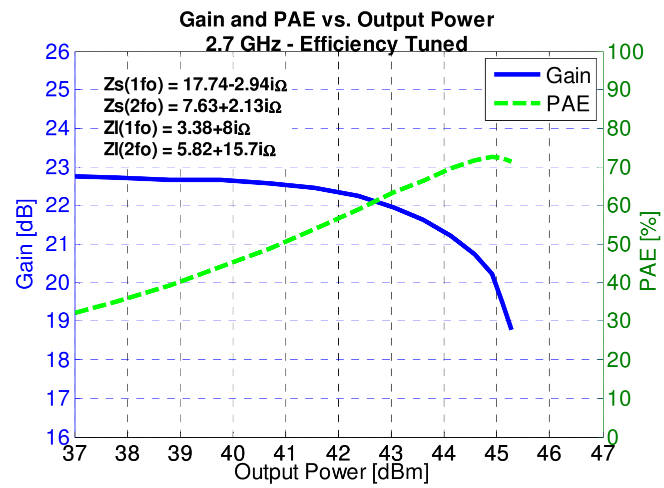
Notes:

1. V_D = +48 V, I_{DQ} = 85 mA, Pulse CW (10% duty cycle, 1 ms period), T = +25 °C
2. See page 16 for load pull and source pull reference planes where the performance was measured.



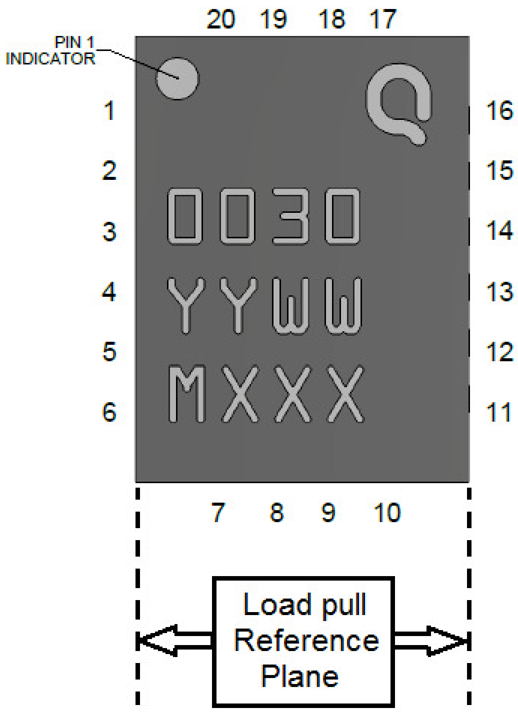


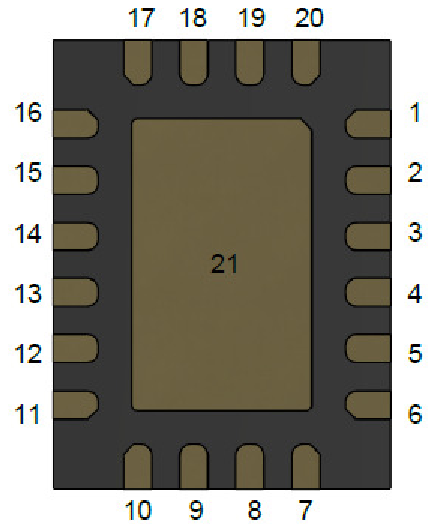




Package Marking and Pin Configuration

Marking: Qorvo Logo
Part Number and Package Version – 0030
Date Code – YYWW
Production Lot Number - MXXX

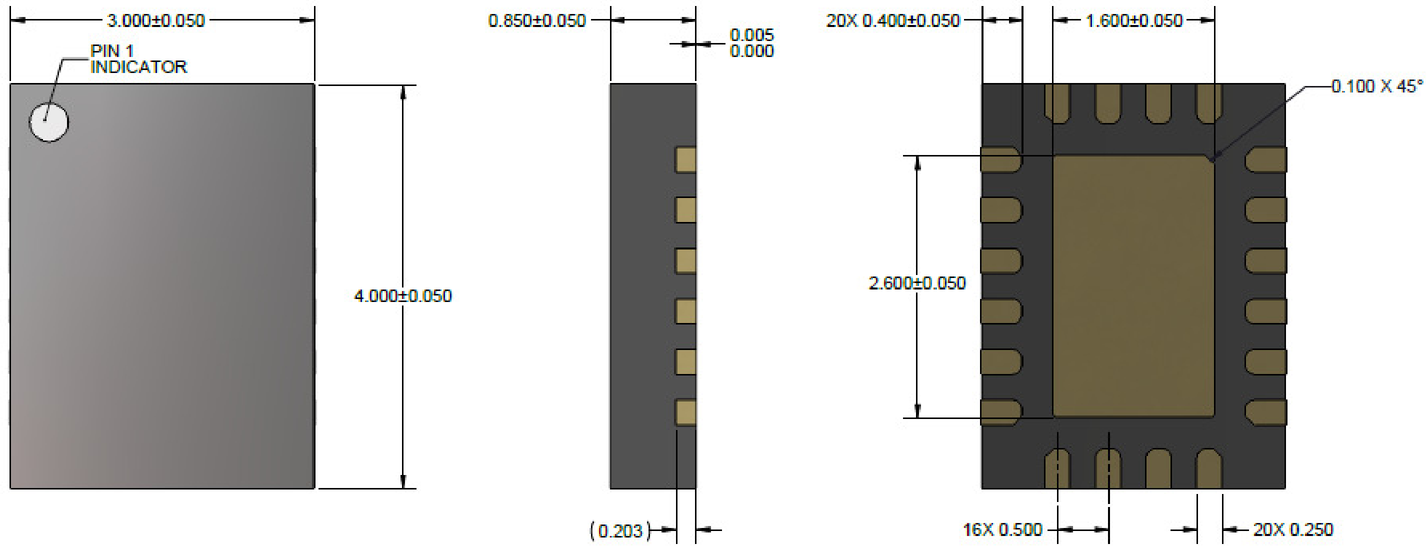




Pin Description

Pin Number	Symbol	Description
1	NC	Not Connected
2, 3, 4, 5	RF IN / VG	RF Input / Gate voltage
6, 7, 8, 9, 10, 11	NC	Not Connected
12, 13, 14, 15	RF OUT / VD	RF Output / Drain voltage
16, 17, 18, 19, 20	NC	Not Connected
21	GND	Source to be connected to ground

Package Dimensions



Note: All dimensions are in mm, otherwise noted. Tolerance is ±0.050 mm.

Bias Procedure

Bias-Up Procedure

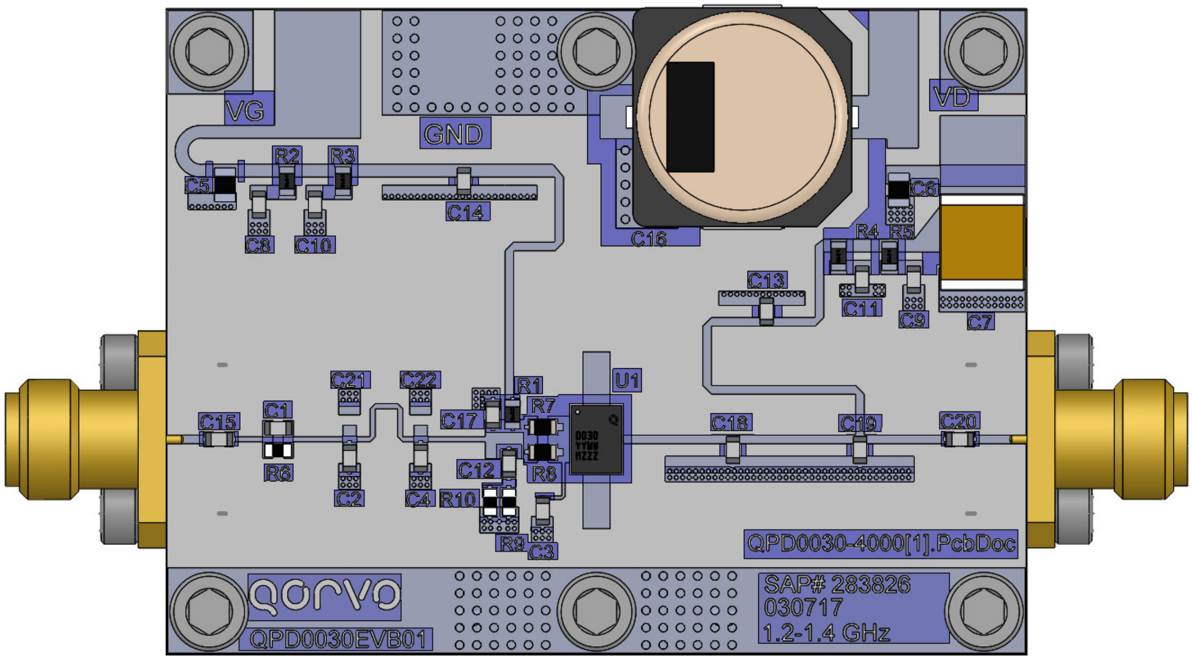
1. Set V_G to –4 V.
2. Set I_D current limit to 200 mA.
3. Apply +48 V V_D.
4. Slowly adjust V_G until I_D is set to 85 mA.
5. Set I_D current limit to 2 A.
6. Apply RF.

Bias-Down Procedure

1. Turn off RF signal.
2. Turn off V_D.
3. Wait two (2) seconds to allow drain capacitor to discharge.
4. Turn off V_G.

PCB Layout for 1.2 – 1.4 GHz EVB

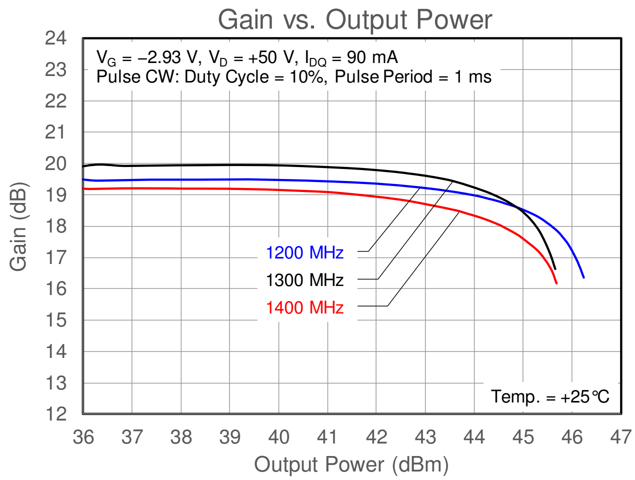
Note: PCB Material is RO6010, 25 mil thick substrate, 1 oz. copper each side.

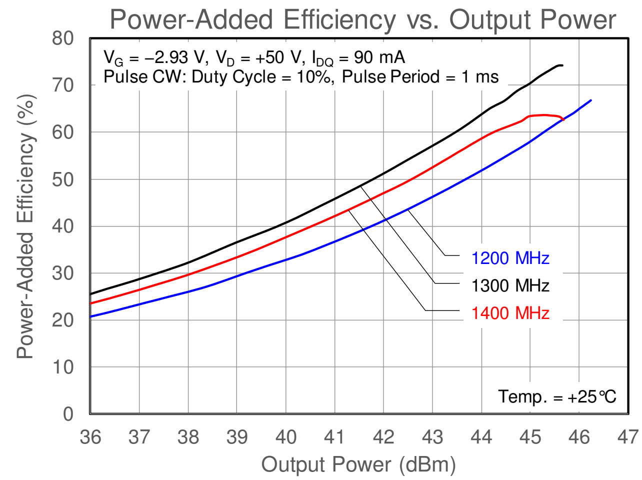


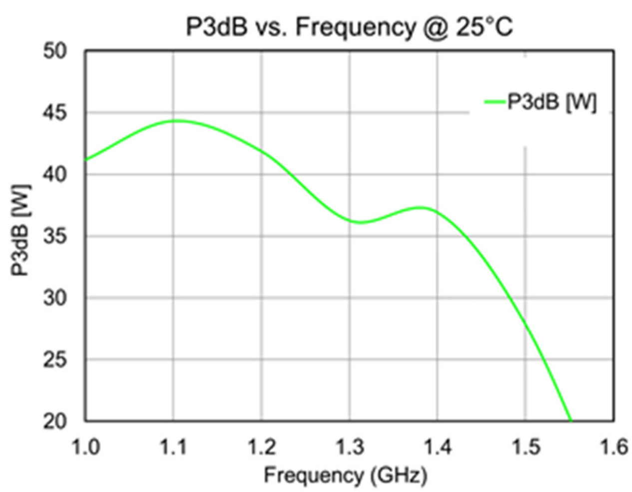
Bill of Materials for 1.2 – 1.4 GHz EVB

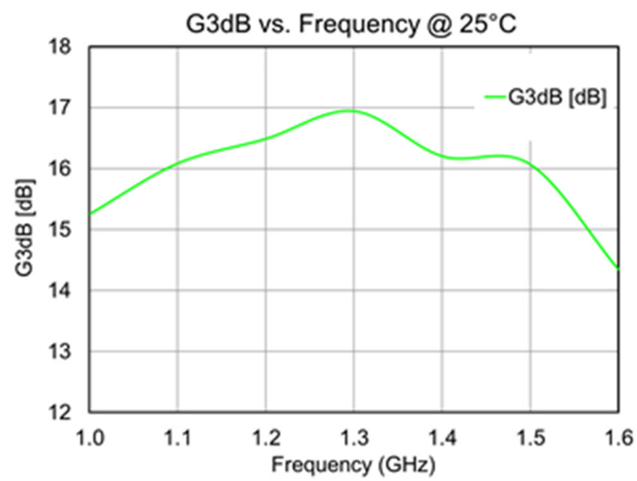
Ref Des	Value	Description	Manufacturer	Part Number
C1	10 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S100JT250XT
C2,C3	1.0 pF	RF NPO 250VDC ± 0.05 pF Capacitor	ATC	600S1R0AT250XT
C4	4.7 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	600S4R7BT250XT
C5,C6	0.1uF	X7R 100V 10% 0805 Capacitor	TDK	C2012X7R2A104K
C7	10 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,C15	15 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S150JT250XT
C16	100 uF	ALUM 100V 20% 12.5mm SQ	BC Components	MAL215099907E3
C17	7.5 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	600S7R5BT250XT
C18	8.2 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	600S8R2BT250XT
C19	3.3 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	600S3R3BT250XT
C20	5.6 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	600S5R6BW250XT
R1,R2,R3,R4,R5	10 Ohm	0603 5% Thick Film Resistor	KOA Speer	RK73B1JTTD100J
R6	100 Ohm	0603 1% Thick Film Resistor	Panasonic	ERJ-3EKF1000
R7,R8	5.1 Ohm	0603 1% Thick Film Resistor	Samsung	RC1608F5R1CS
R9,R10	240 Ohm	0603 1% Thick Film Resistor	Samsung	RC1608F241CS

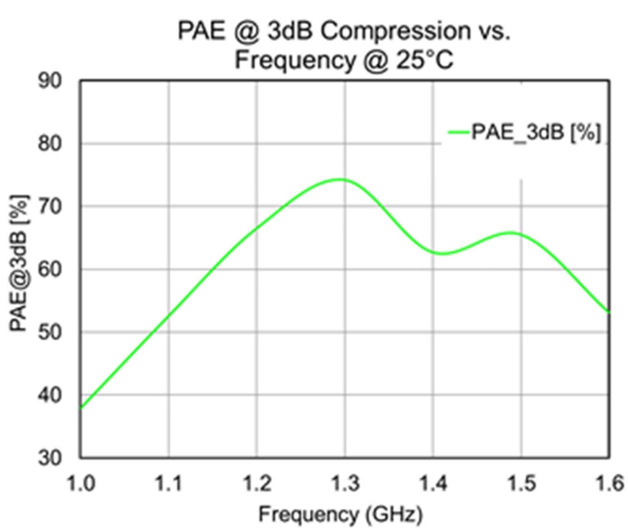
Performance Plots of 1.2 – 1.4 GHz EVB

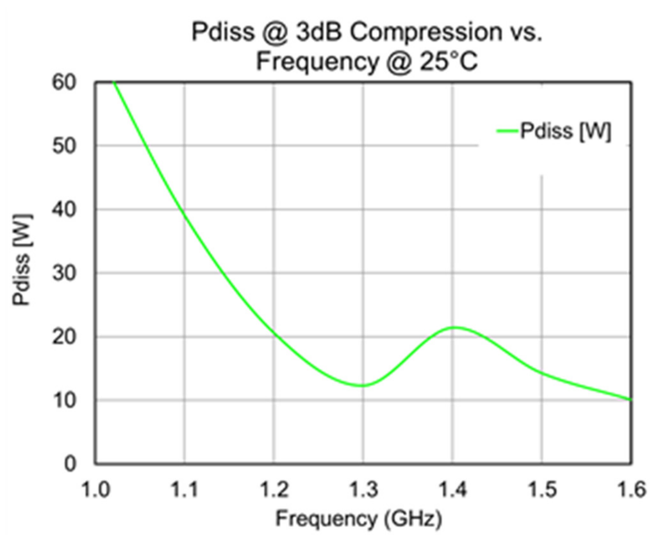








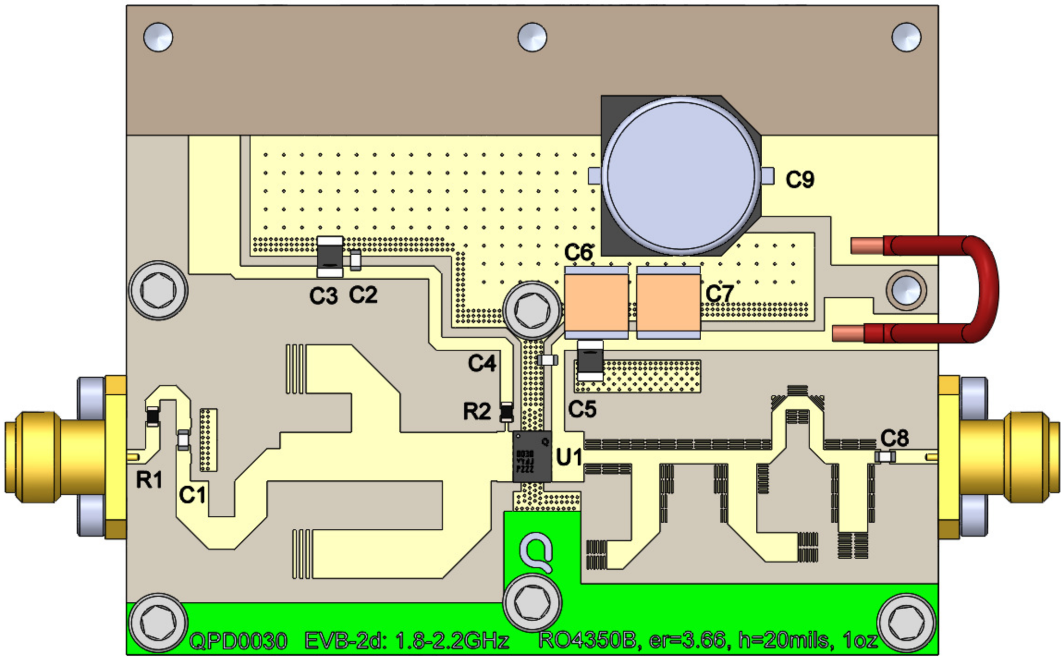




Test conditions unless otherwise noted: Pulse CW (10% duty cycle, 1 ms period), V_G = −2.93 V, V_D = +50 V, I_{DQ} = 90 mA, T = +25℃

PCB Layout for 1.8 – 2.2 GHz EVB

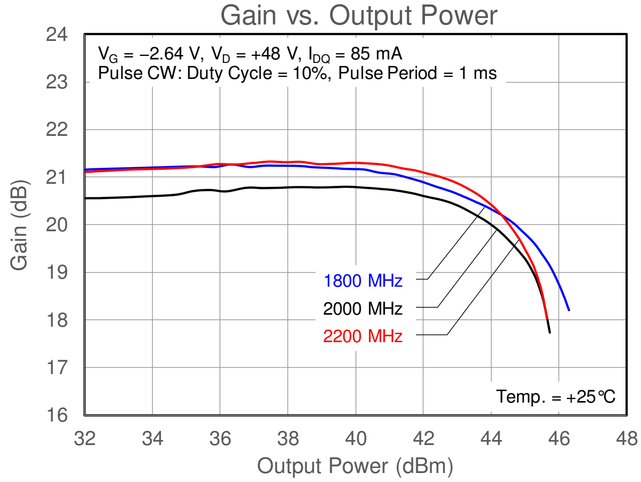
Note: PCB Material is RO4350B, 20 mil thick substrate, 1 oz. copper each side.

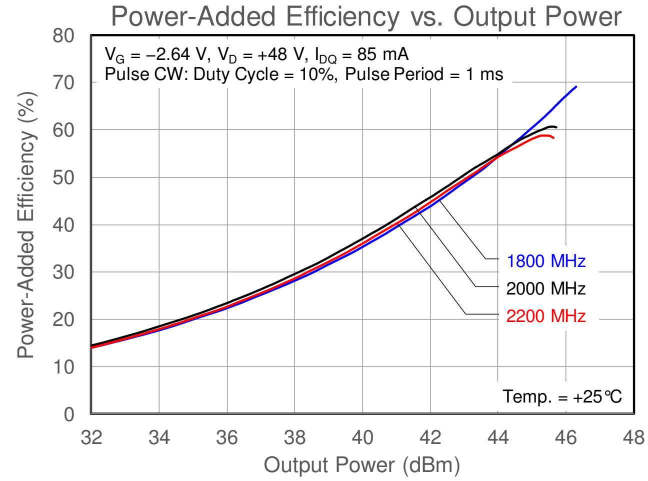


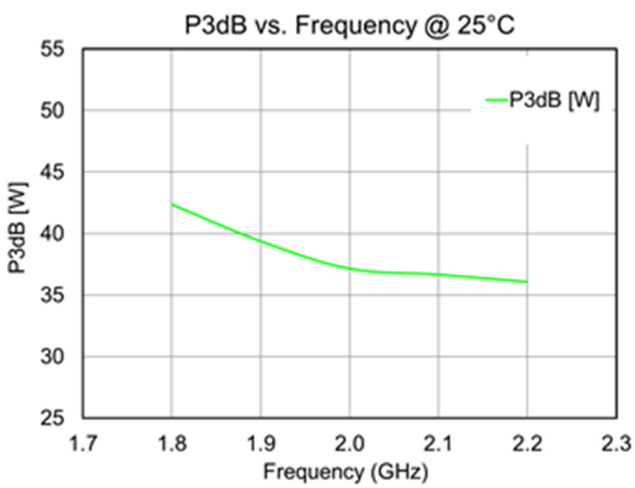
Bill of Materials for 1.8 – 2.2 GHz EVB

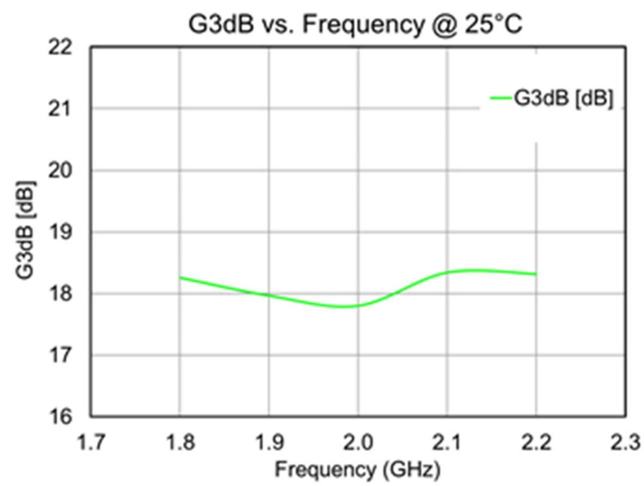
Ref Des	Value	Description	Manufacturer	Part Number
C1	6.8 pF	RF NPO 250VDC ± 0.25 pF Capacitor	ATC	600S6R8CT250XT
C2,C4	15 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S150JT250XT
C3	4.7 uF	X7R 50V 10% 1206 Capacitor	Kemet	C1206C475K5RACTU
C5	1000 pF	X7R 630V 10% 1206 Capacitor	Murata	GRM31BR72J102KW01L
C6,C7	10 uF	X7S 100V 20% 2220 Capacitor	TDK	C5750X7S2A106M230KB
C8	20 pF	RF NPO 250VDC ± 5% Capacitor	ATC	600S200JT250XT
C9	100 uF	100V Electrolytic 20% 12.5mm SQ	Vishay	MAL215099907E3
R1	5.1 Ohm	0603 5% Thick Film Resistor	Vishay	CRCW06035R10JNEA
R2	10 Ohm	0603 5% Thick Film Resistor	Vishay	CRCW060310R0JNEA
J1 – J2	–	SMA Panel Mount 4-hole Jack	Gigalane	PSF-S00-000

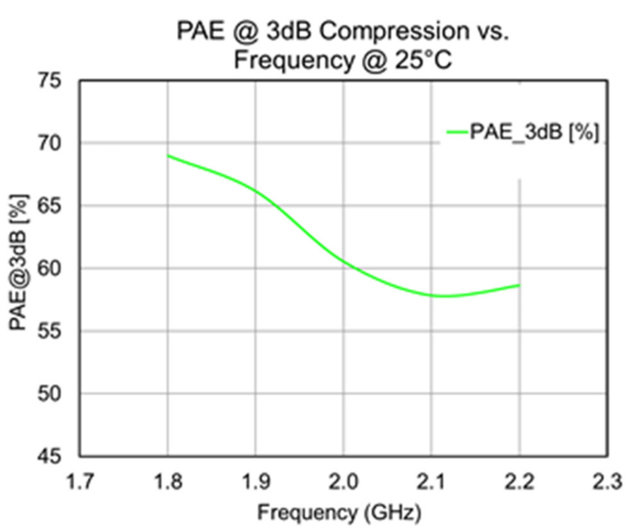
Performance Plots of 1.8 – 2.2 GHz EVB

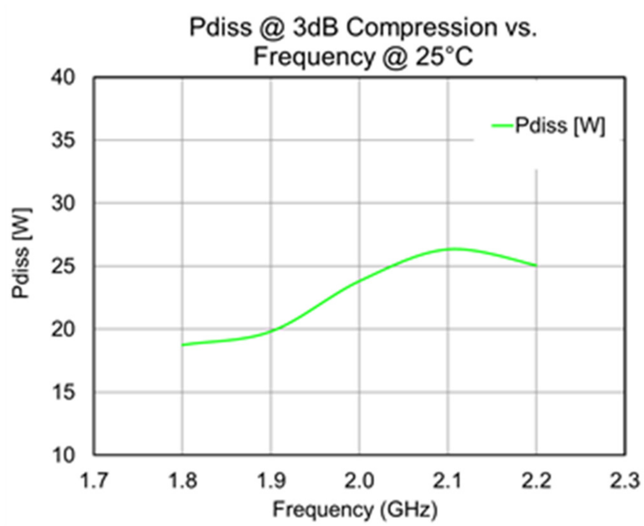






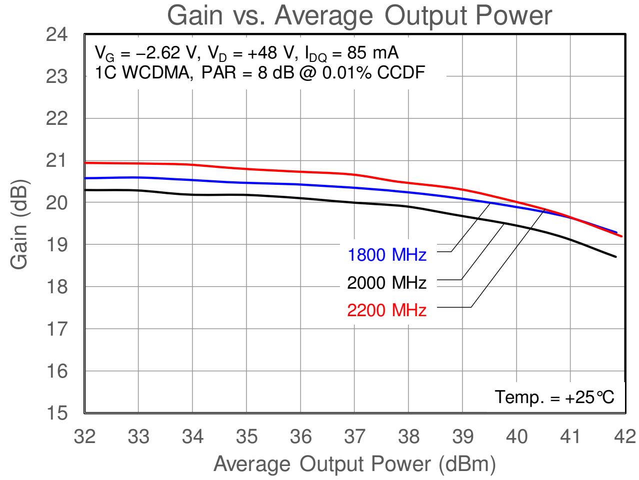


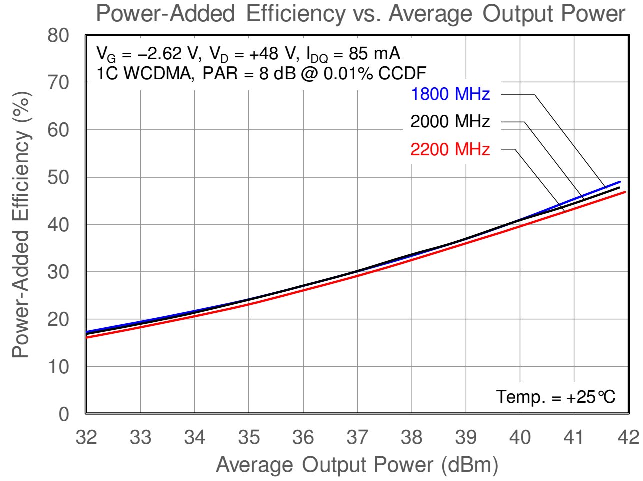


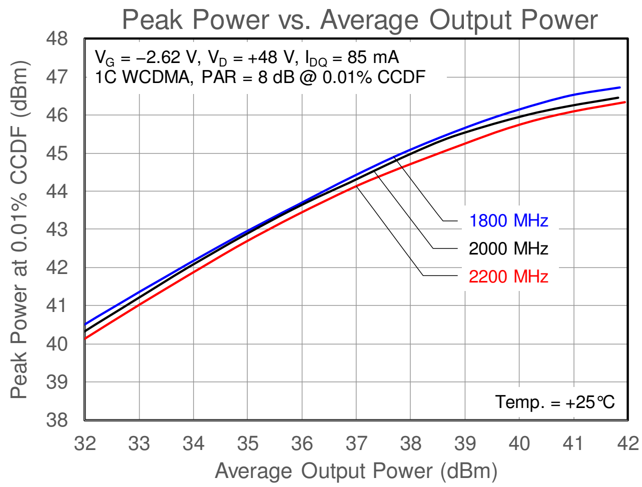


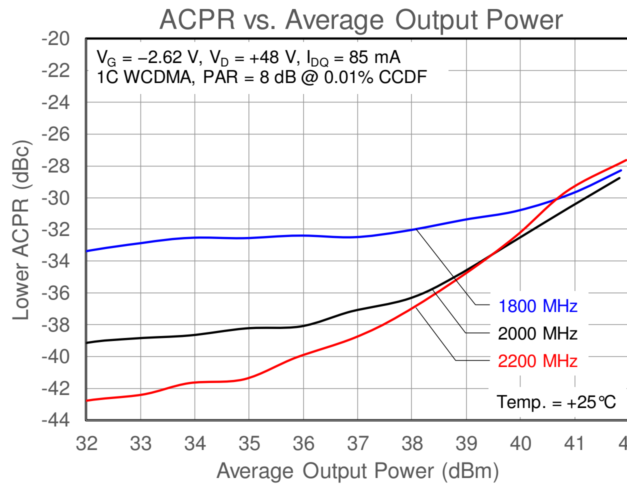
Test conditions unless otherwise noted: Pulse CW (10% duty cycle, 1 ms period), V_G = –2.64 V, V_D = +48 V, I_{DQ} = 85 mA, T = +25°C

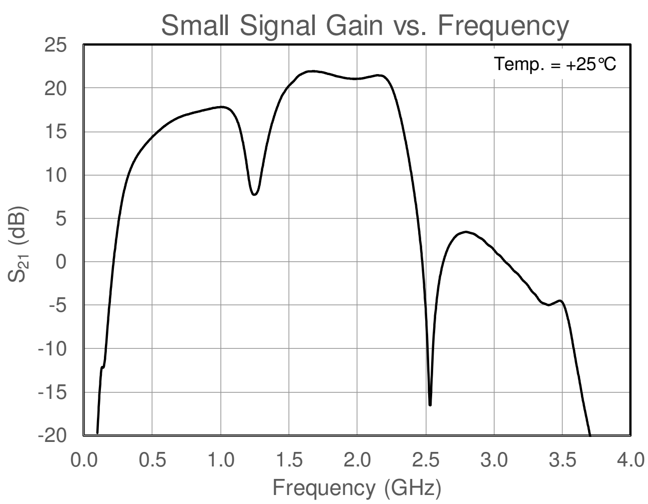
Performance Plots of 1.8 – 2.2 GHz EVB

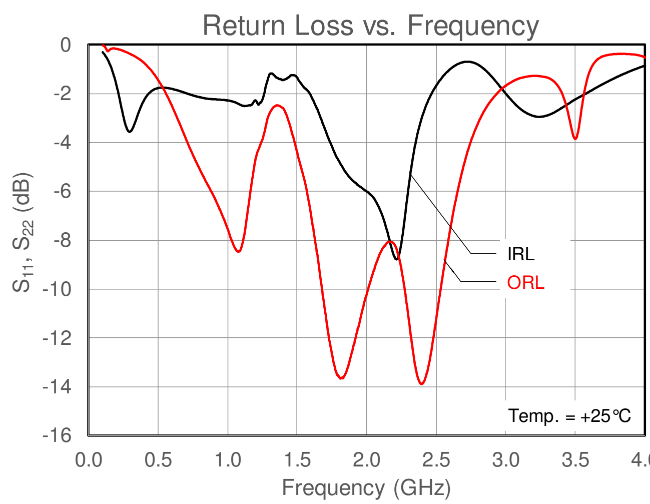












Test conditions unless otherwise noted: V_D = +48 V, I_{DQ} = 85 mA, T = +25°C

Recommended Solder Temperature Profile