QPD1010

10W, 50V, DC – 4 GHz, GaN RF Transistor

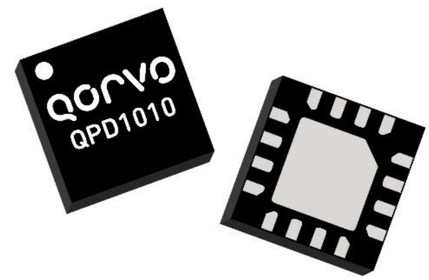
General Description

The Qorvo QPD1010 is a 10 W (P_{3dB}) discrete GaN on SiC HEMT which operates from DC to 4 GHz. The device is constructed with Qorvo's proven QGaN25HV process, which features advanced field plate techniques to optimize power and efficiency at high drain bias operating conditions. This optimization can potentially lower system costs in terms of fewer amplifier line-ups and lower thermal management costs.

The device is housed in an industry-standard 3 x 3 mm surface mount QFN package.

Lead-free and ROHS compliant

Evaluation boards are available upon request.



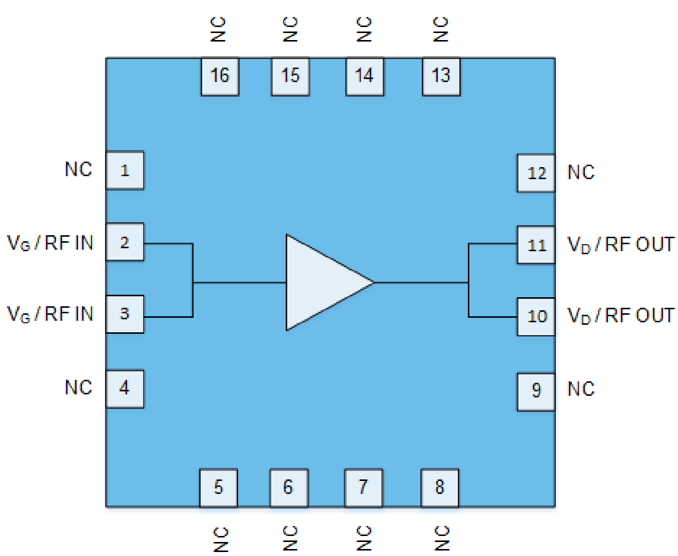
16 Pin QFN (3 x 3 x 0.85 mm)

Product Features

- Frequency: DC to 4 GHz
- Output Power (P_{3dB}): 11 W[1]
- Linear Gain: 24.7 dB[1]
- Typical $DEFF_{3dB}$: 71%[1]
- Operating Voltage: 50 V
- Low thermal resistance package
- CW and Pulse capable
- 3 x 3 mm package

Note 1: @ 2 GHz (Loadpull)

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
QPD1010	DC – 4 GHz RF Transistor
QPD1010PCB1B01	0.96 – 1.215 GHz EVB
QPD1010EVB02	2.7 – 3.5 GHz EVB

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Absolute Maximum Ratings[1]

Parameter	Rating	Units
Breakdown Voltage, BV_{DG}	+145	V
Gate Voltage Range, V_G	-7 to +2	V
Maximum Drain Current, I_{DMAX}	1.46	A
Gate Current Range, I_G	See page 4.	mA
Power Dissipation, CW, P_{DISS}	12.8	W
RF Input Power at 2 GHz, CW, 50 Ω, T = 25 °C	+24	dBm
Mounting Temperature (30 Seconds)	320	°C
Storage Temperature	−40 to +150	°C

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

Recommended Operating Conditions[1]

Parameter	Min	Typ	Max	Units
Operating Temp. Range	−40	+25	+85	°C
Drain Voltage Range, V_D	+12	+50	+60	V
Drain Bias Current, I_{DQ}	–	18	–	mA
Drain Current, I_D	–	400	–	mA
Gate Voltage, V_G[4]	–	−2.8	–	V
Power Dissipation, CW (P_D)[2]	–	–	11.4	W
Power Dissipation, Pulsed (P_D)[2, 3]	–	–	13.5	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. Back plane of package at 85 °C
3. Pulse Width = 128 uS, Duty Cycle = 10%
4. To be adjusted to desired I_{DQ}

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Pulsed Characterization – Load Pull Performance – Power Tuned

Parameters	Typical Values					Unit
Frequency, F	1	2	3	3.5	4	GHz
Linear Gain, G_{LIN}	26.4	24.7	21.4	20.7	19.8	dB
Output Power at 3dB compression point, P_{3dB}	40.9	40.4	41	40.7	40.4	dBm
Drain Efficiency at 3dB compression point, $DEFF_{3dB}$	69.4	63.2	64.7	59.5	53.9	%
Gain at 3dB compression point	23.4	21.7	18.4	17.7	16.8	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 18 mA, Temp = +25 °C

Pulsed Characterization – Load Pull Performance – Efficiency Tuned

Parameters	Typical Values					Unit
Frequency	1	2	3	3.5	4	GHz
Linear Gain, G_{LIN}	27.1	25.3	22.3	21.3	20.1	dB
Output Power at 3dB compression point, P_{3dB}	39.7	38.6	39.7	39.1	39.8	dBm
Drain Efficiency at 3dB compression point, $DEFF_{3dB}$	80.5	71.0	74.1	65.1	57.8	%
Gain at 3dB compression point, G_{3dB}	24.1	22.3	19.3	18.3	17.1	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 18 mA, Temp = +25 °C

RF Characterization – 0.96 – 1.215 GHz EVB Performance At 1.09 GHz[1]

Parameter	Min	Typ	Max	Units
Linear Gain, G_{LIN}	–	19.3	–	dB
Output Power at 3dB compression point, P_{3dB}	–	40.5	–	dBm
Drain Efficiency at 3dB compression point, $DEFF_{3dB}$	–	65.7	–	%
Gain at 3dB compression point, G_{3dB}	–	16.3	–	dB

Notes:
1. V_D = +50 V, I_{DQ} = 18 mA, Temp = +25 °C, Pulse Width = 128 uS, Duty Cycle = 10%

RF Characterization – Mismatch Ruggedness at 1.1 GHz

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

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 50 V, I_{DQ} = 18 mA
Driving input power is determined at pulsed compression under matched condition at EVB output connector.

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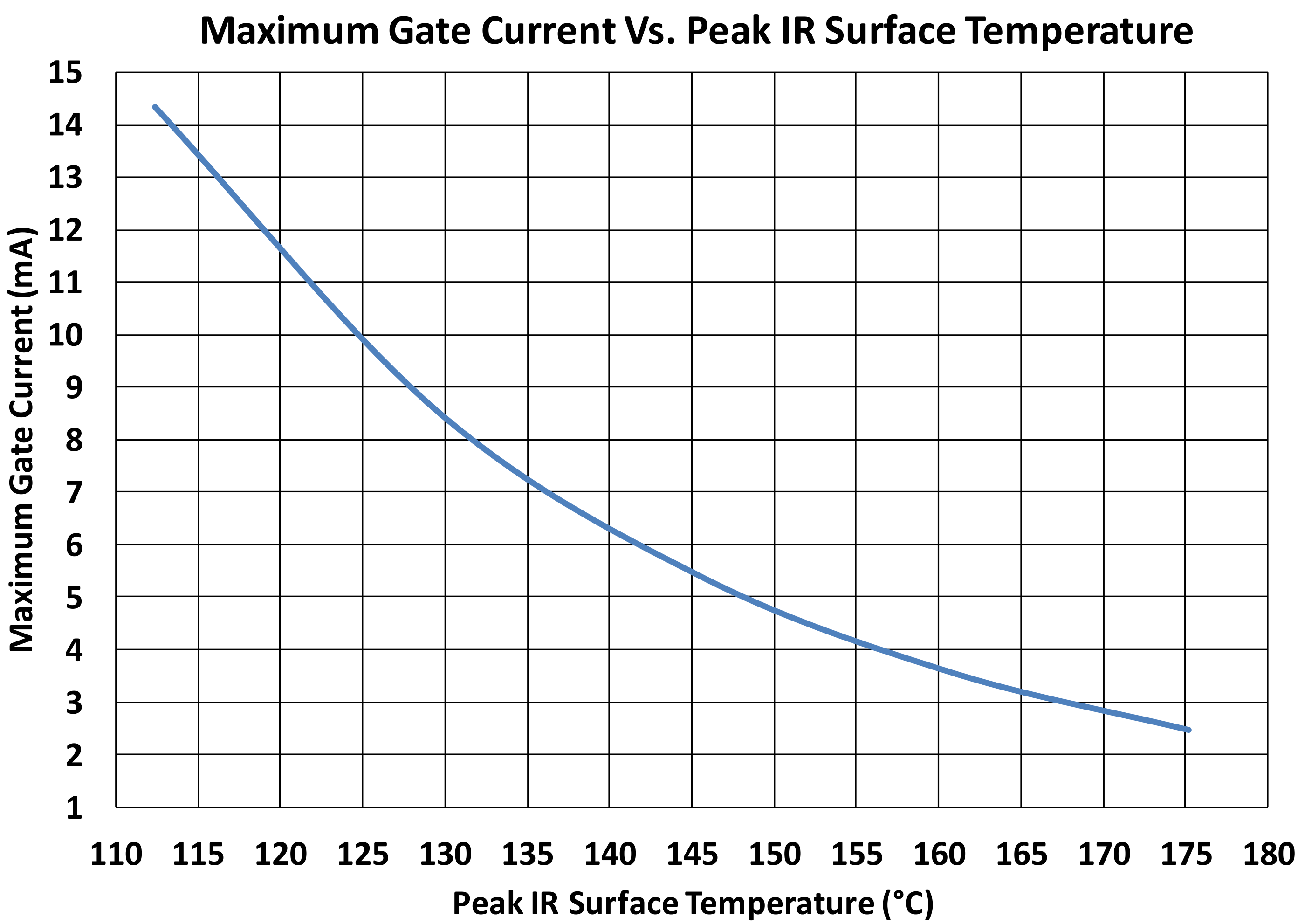
Maximum Gate Current



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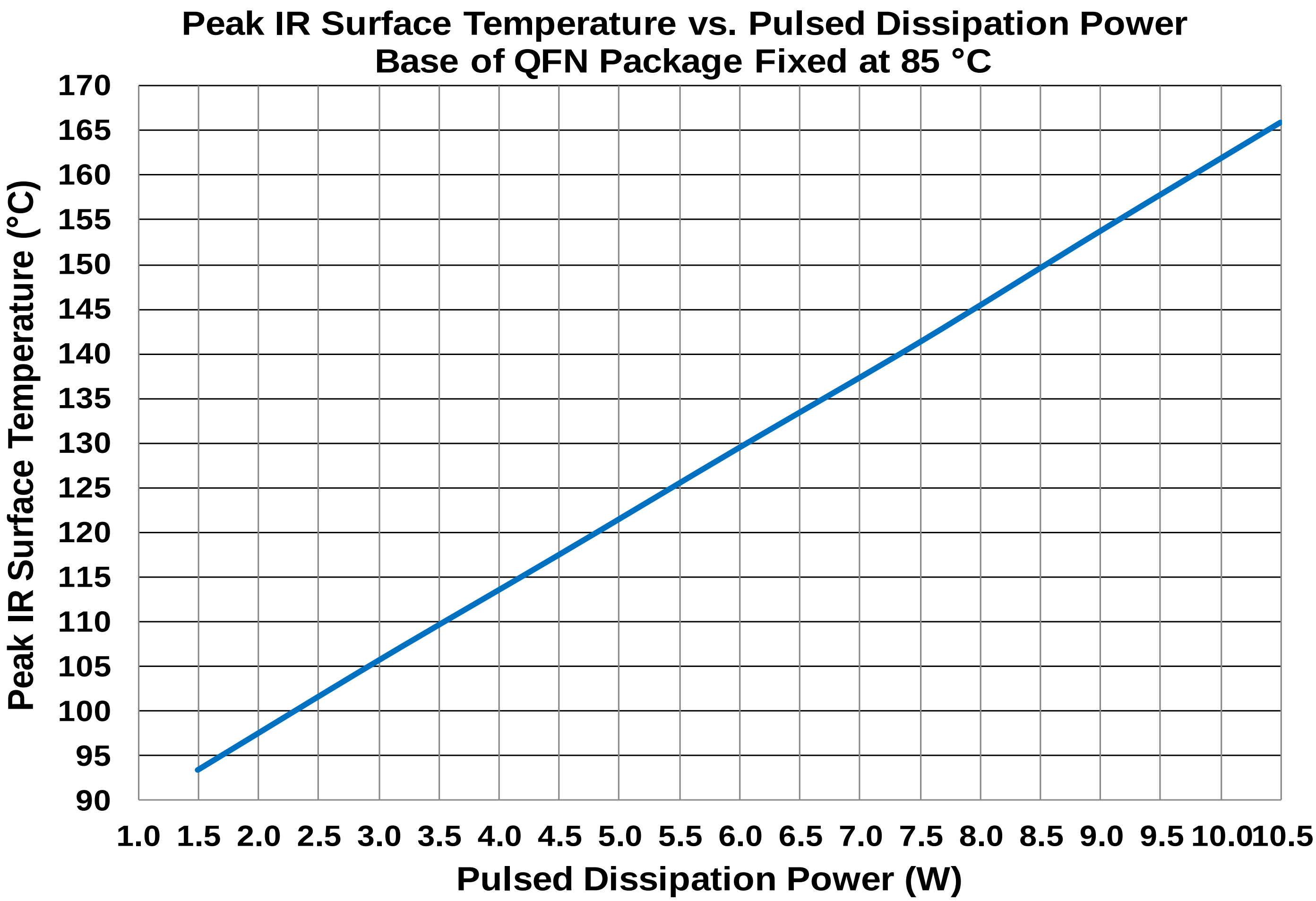
Thermal and Reliability Information - Pulsed



Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	6.89	°C/W
Peak IR Surface Temperature[1] (T_{CH})	3 W Pdiss, 128 uS, 10%	106	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	7.22	°C/W
Peak IR Surface Temperature[1] (T_{CH})	4.5 W Pdiss, 128 uS, 10%	118	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	7.42	°C/W
Peak IR Surface Temperature[1] (T_{CH})	6 W Pdiss, 128 uS, 10%	130	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	7.51	°C/W
Peak IR Surface Temperature[1] (T_{CH})	7.5 W Pdiss, 128 uS, 10%	141	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	7.64	°C/W
Peak IR Surface Temperature[1] (T_{CH})	9 W Pdiss, 128 uS, 10%	154	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	7.71	°C/W
Peak IR Surface Temperature[1] (T_{CH})	10.5 W Pdiss, 128 uS, 10%	166	°C

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

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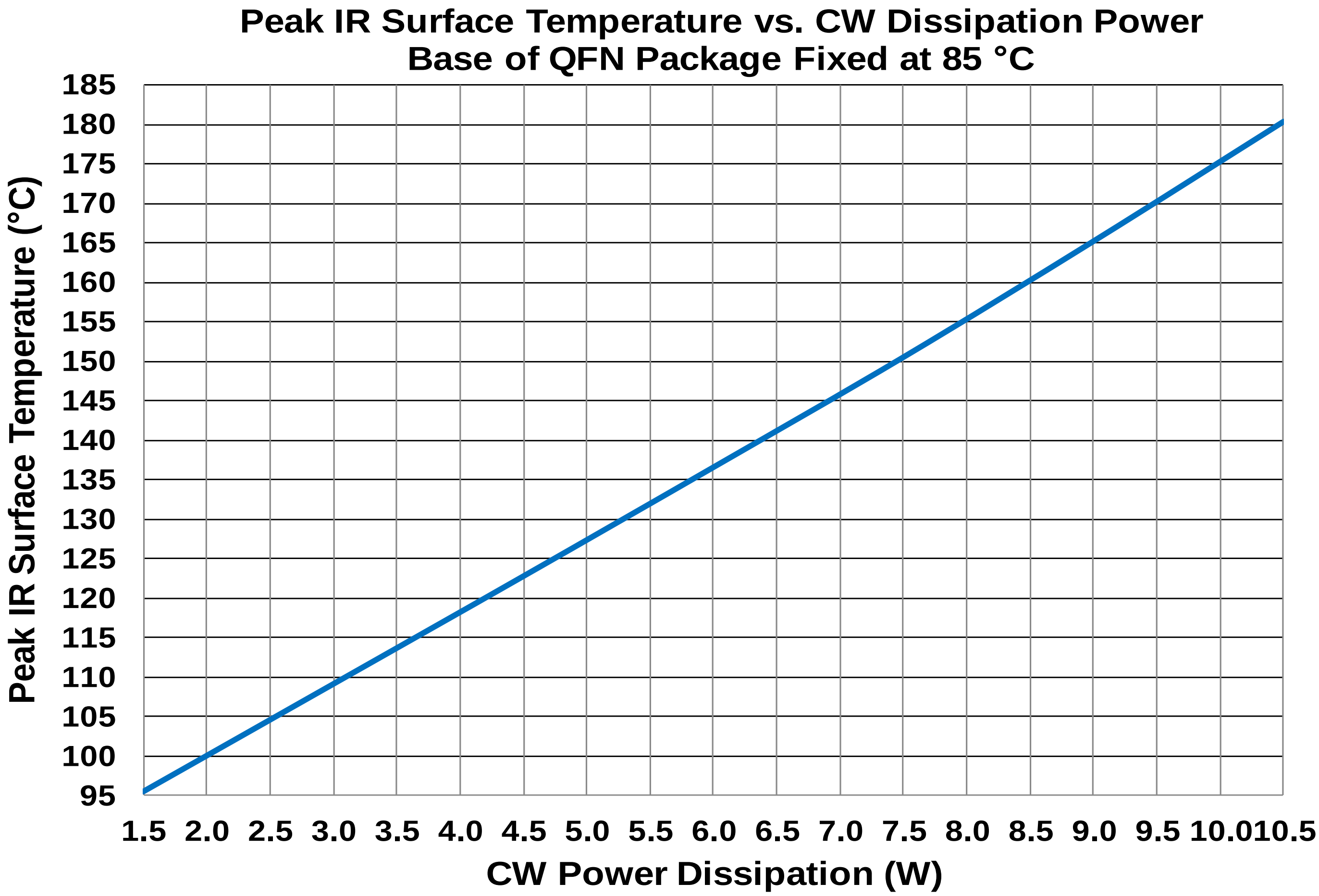
Thermal and Reliability Information - CW



Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 3 W Pdiss, CW	8.06	°C/W
Peak IR Surface Temperature[1] (T_{CH})		109	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 4.5 W Pdiss, CW	8.41	°C/W
Peak IR Surface Temperature[1] (T_{CH})		123	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 6.0 W Pdiss, CW	8.61	°C/W
Peak IR Surface Temperature[1] (T_{CH})		137	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 7.5 W Pdiss, CW	8.75	°C/W
Peak IR Surface Temperature[1] (T_{CH})		151	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 9.0 W Pdiss, CW	8.93	°C/W
Peak IR Surface Temperature[1] (T_{CH})		165	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 10.5 W Pdiss, CW	9.09	°C/W
Peak IR Surface Temperature[1] (T_{CH})		181	°C

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

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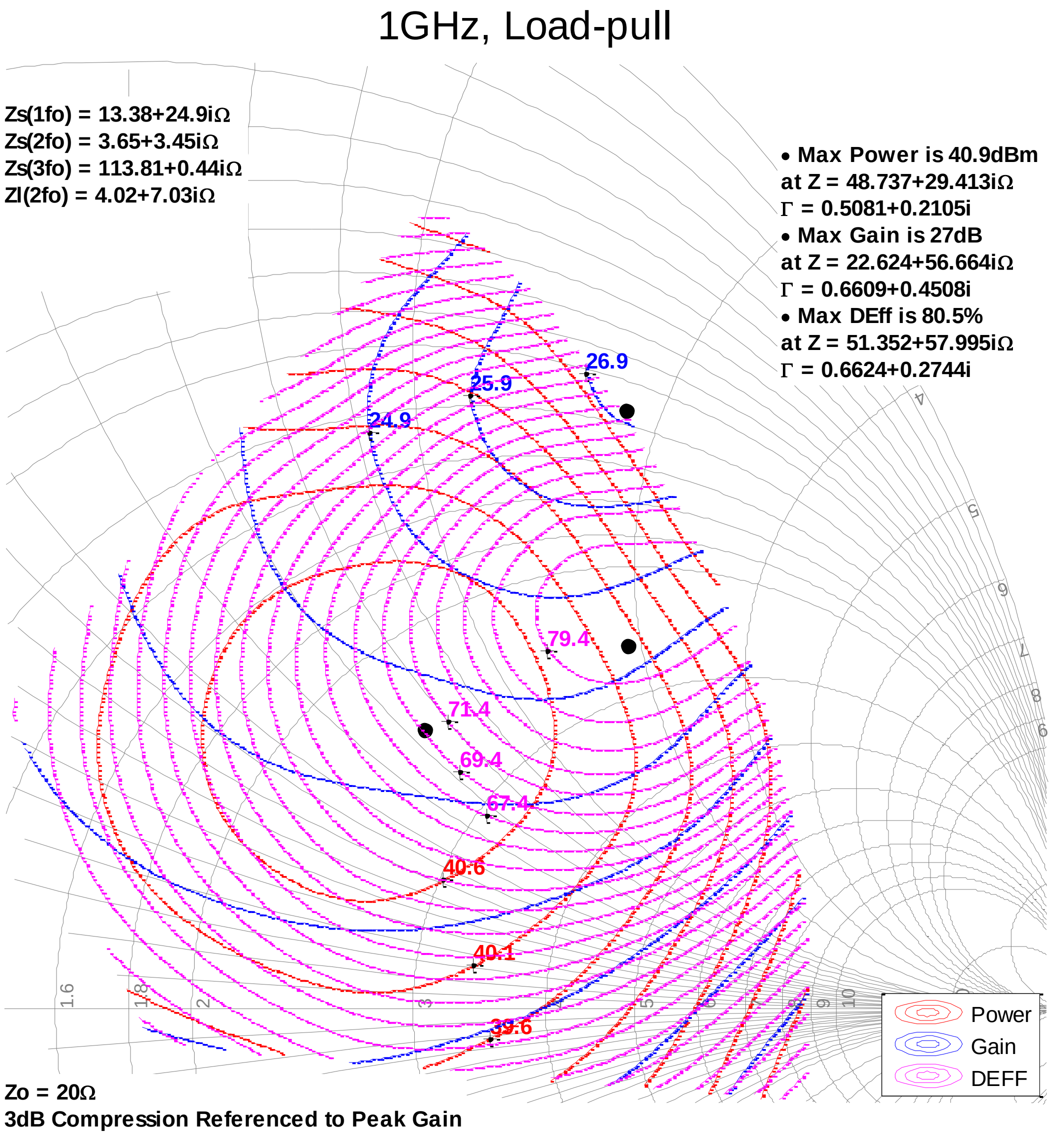
Load Pull Smith Charts[1, 2]

Notes:
1. Vd = 50 V, I_{DQ} = 18 mA, Pulsed signal with 128 uS pulse width and 10 % duty cycle. Performance is at indicated input power.
2. See page 18 for load pull and source pull reference planes. 20-Ω load pull TRL fixtures are built with 20-mil RO4350B material.



Load Pull Smith Charts[1, 2]

Notes:

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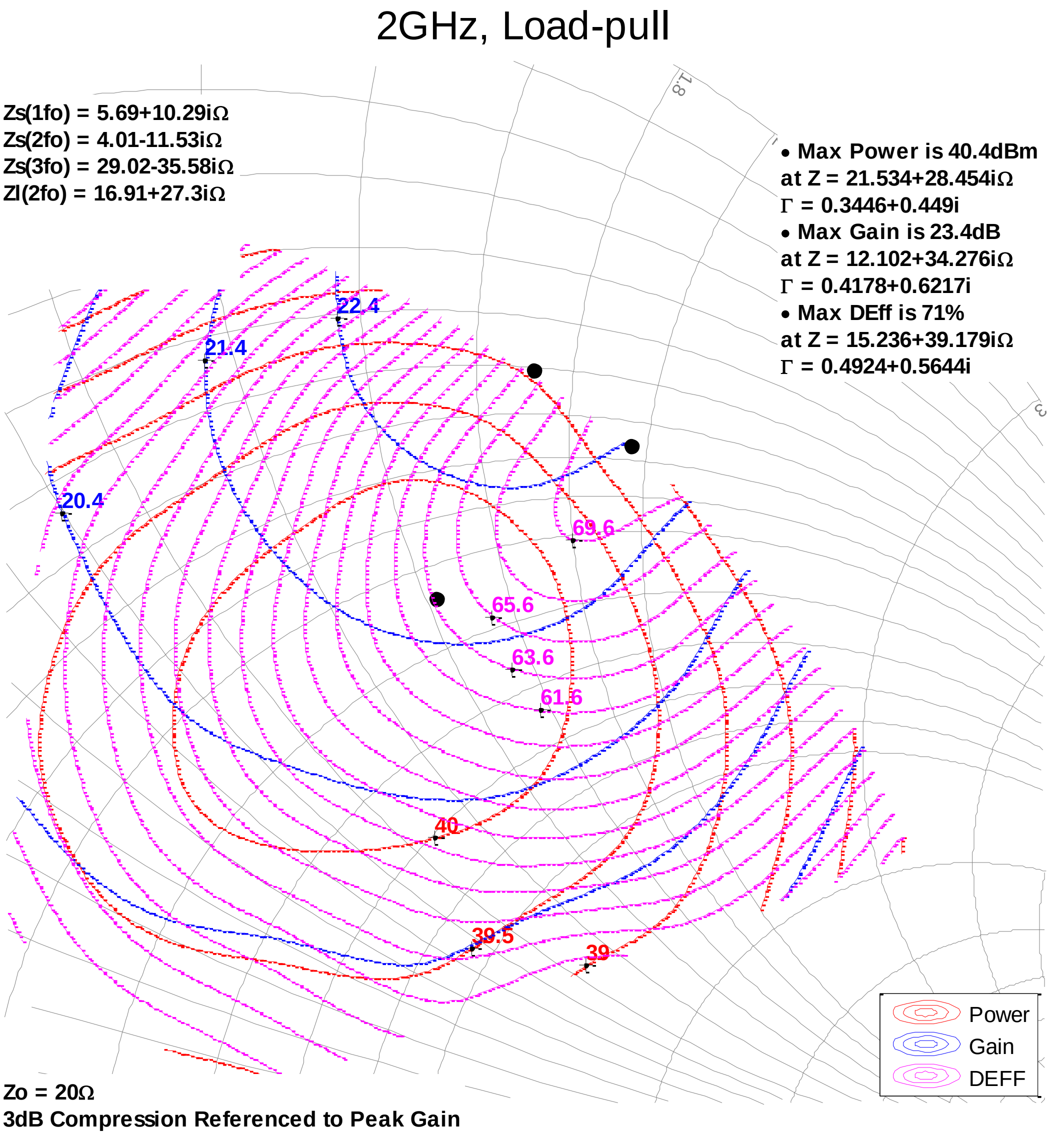

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Load Pull Smith Charts[1, 2]

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1. Vd = 50 V, I_{DQ} = 18 mA, Pulsed signal with 128 uS pulse width and 10 % duty cycle. Performance is at indicated input power.
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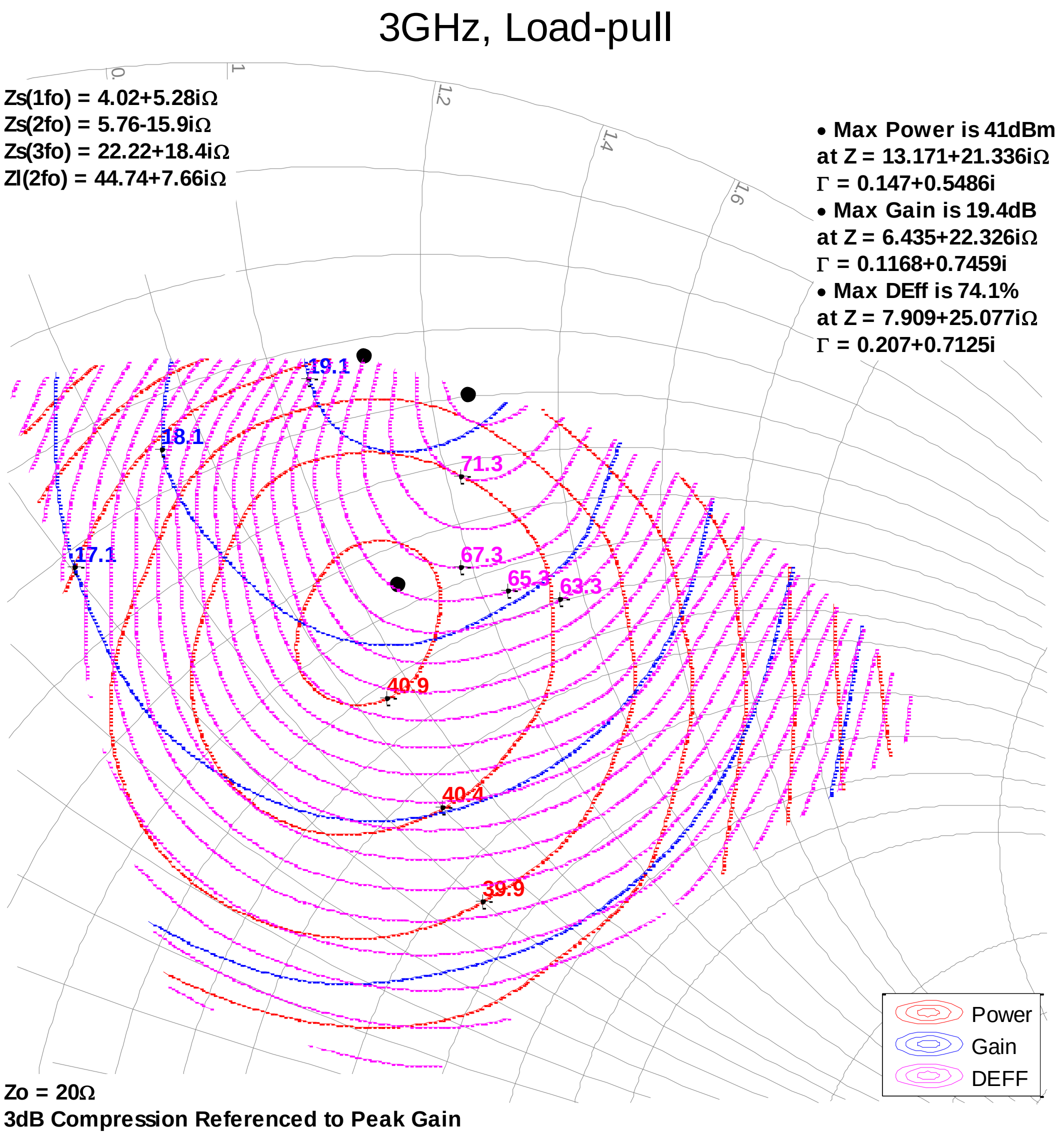

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Load Pull Smith Charts[1, 2]

Notes:

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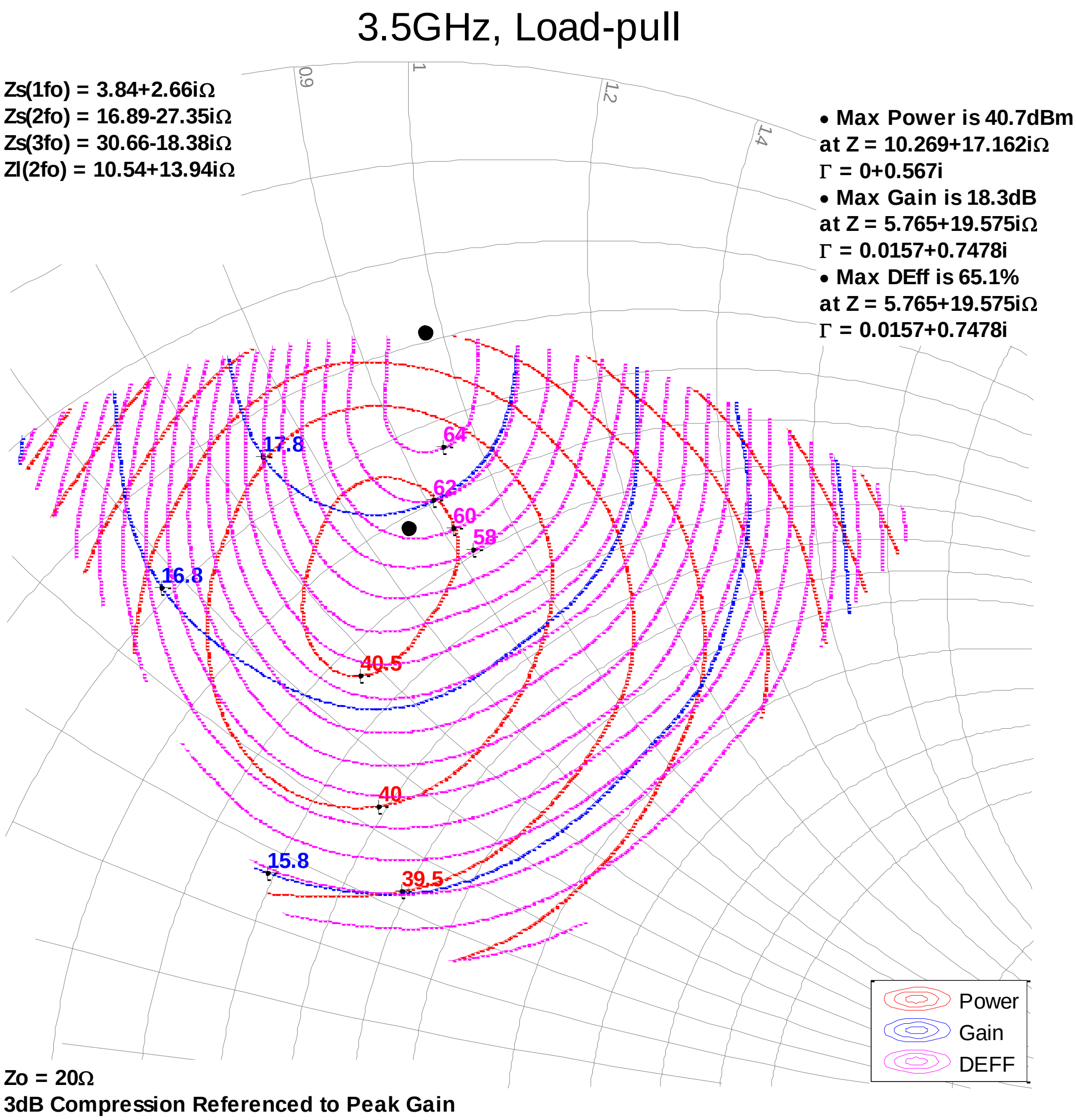

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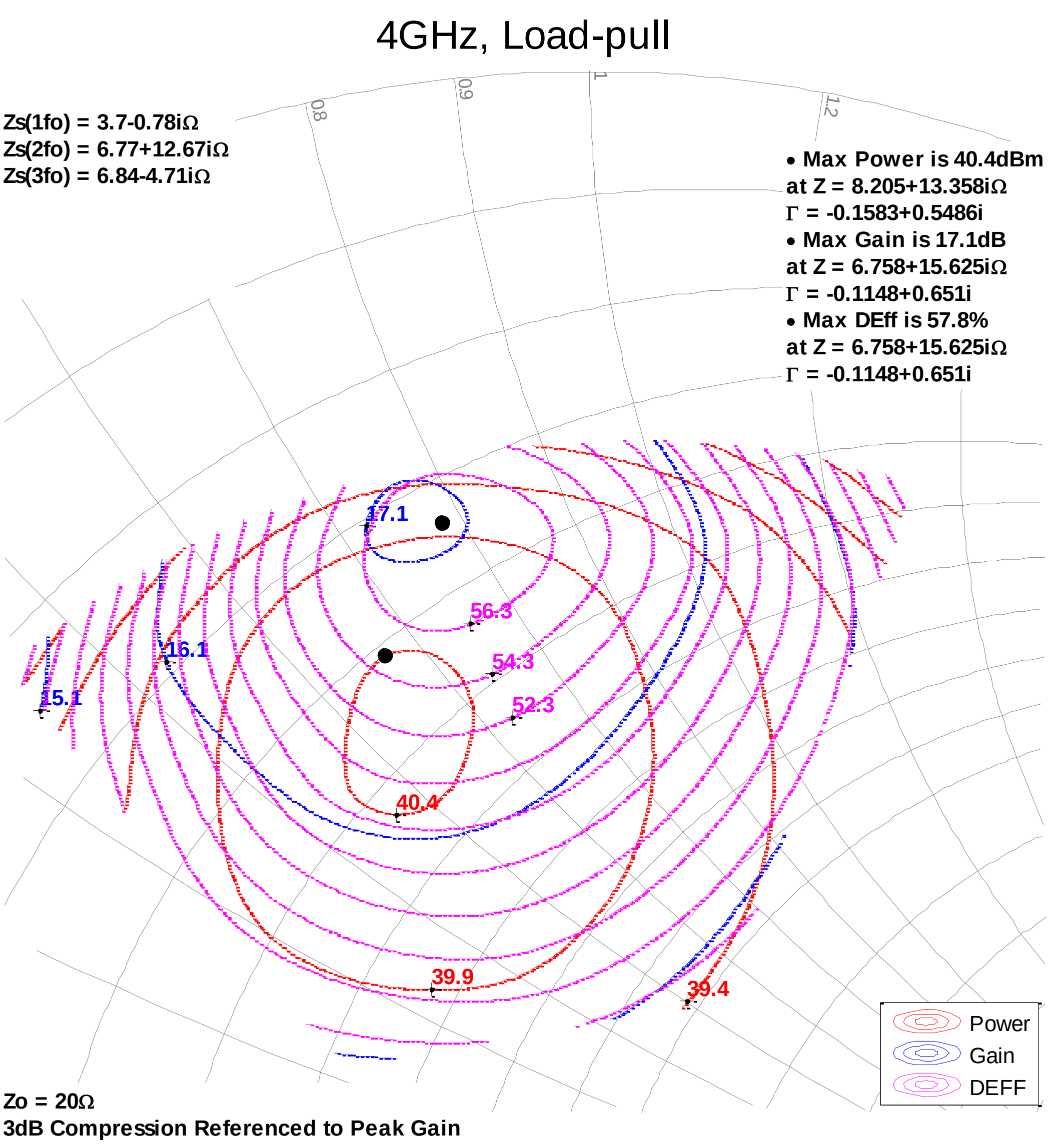
Load Pull Smith Charts[1, 2]

Notes:
1. Vd = 50 V, I_{DQ} = 18 mA, Pulsed signal with 128 uS pulse width and 10 % duty cycle. Performance is at indicated input power.
2. See page 18 for load pull and source pull reference planes. 20-Ω load pull TRL fixtures are built with 20-mil RO4350B material.



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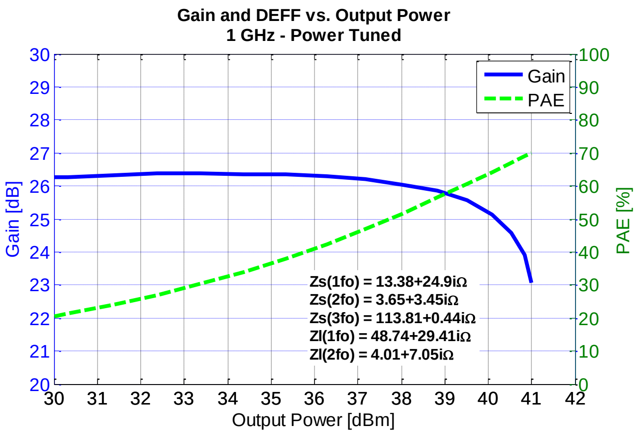
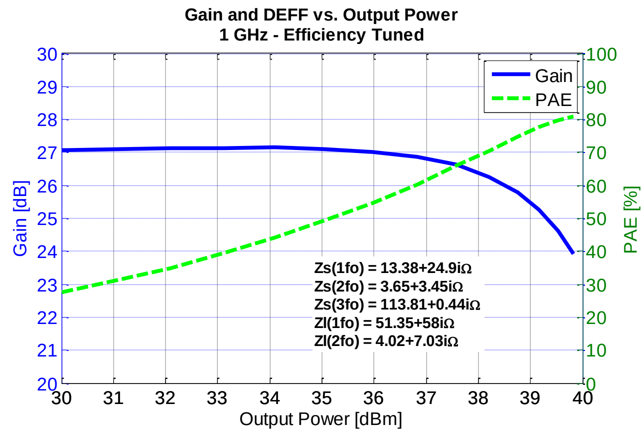
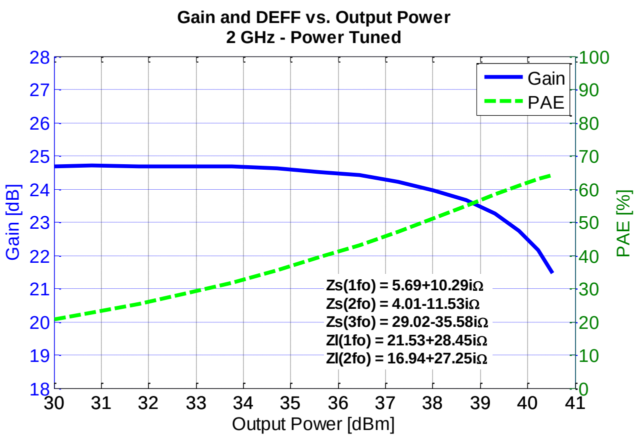
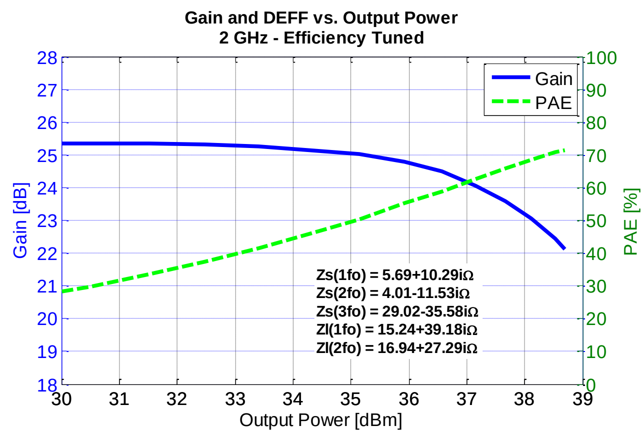
Typical Performance – Load Pull Drive-up [1, 2]

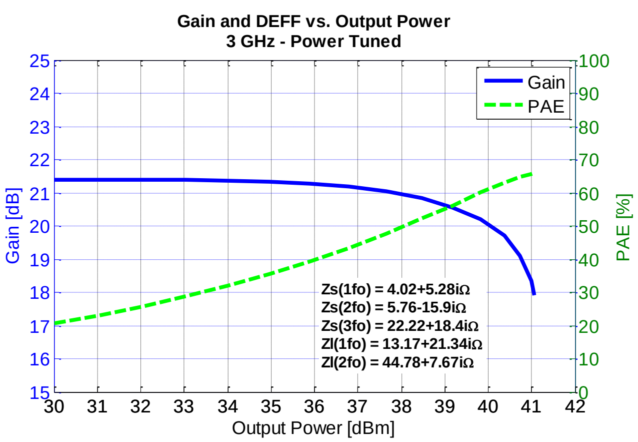
Notes:
1. Pulsed signal with 128 uS pulse width and 10 % duty cycle, Vd = 50 V, I_{DQ} = 18 mA
2. See page 18 for load pull and source pull reference planes where the performance was measured.

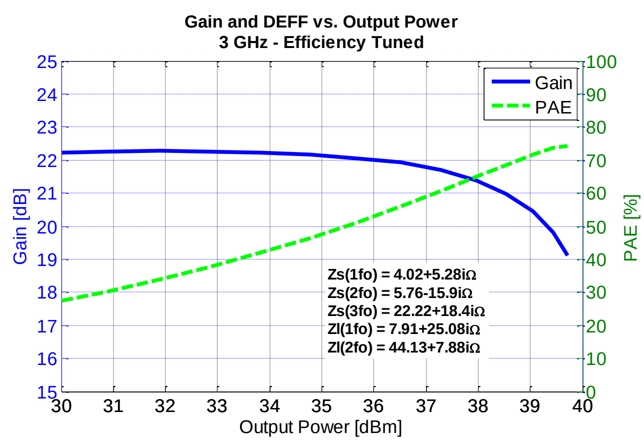












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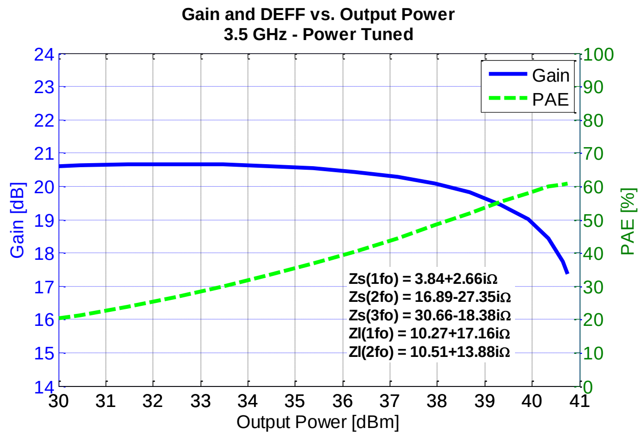
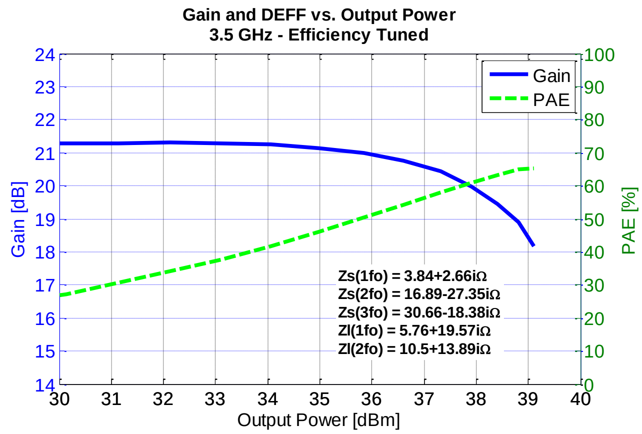
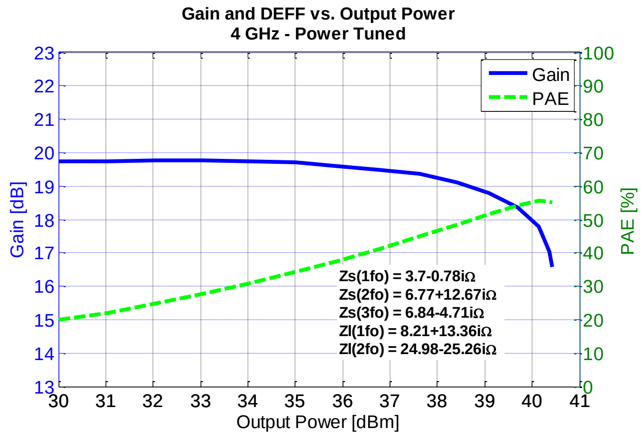
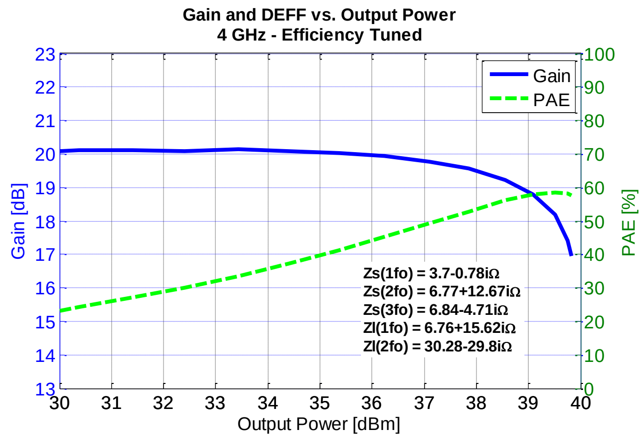
Typical Performance – Load Pull Drive-up [1, 2]

Notes:
1. Pulsed signal with 128 uS pulse width and 10 % duty cycle, Vd = 50 V, I_{DQ} = 18 mA
2. See page 18 for load pull and source pull reference planes where the performance was measured.









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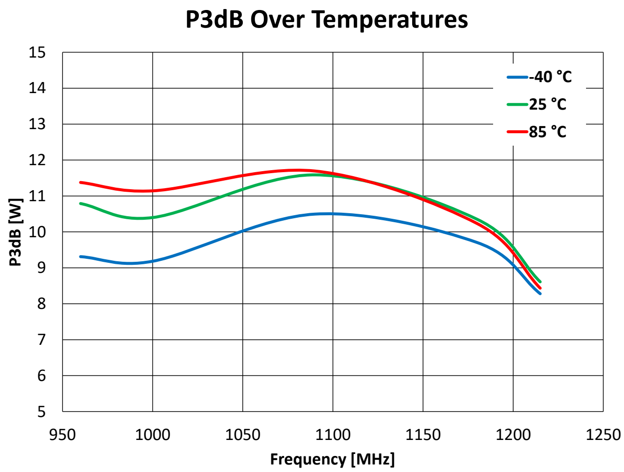
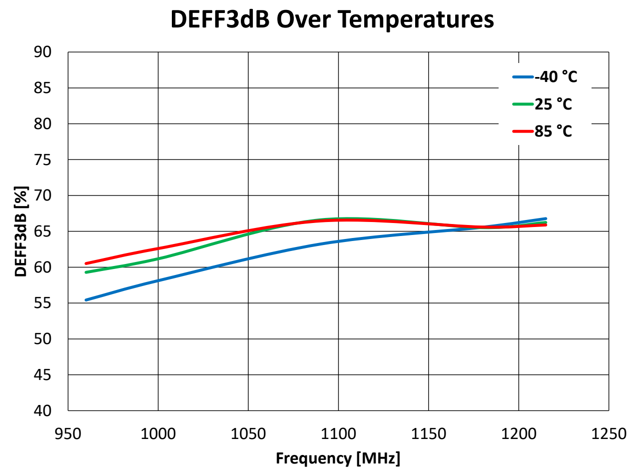
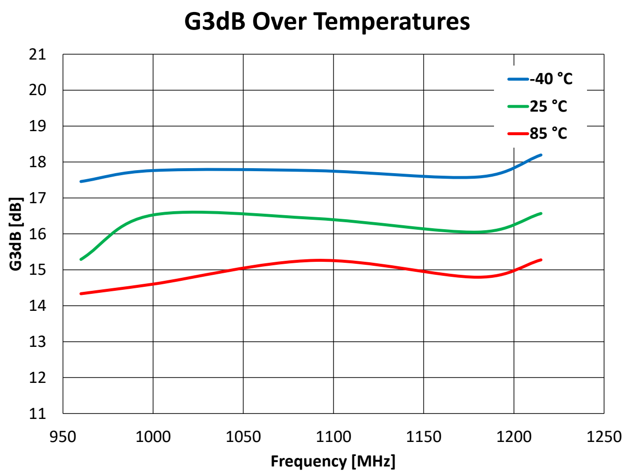
Power Driveup Performance Over Temperatures Of 0.96 – 1.2 GHz EVB[1]

[1] Vd = 50 V, I_{DQ} = 18 mA, Pulse Width = 128 uS, Duty Cycle = 10 %







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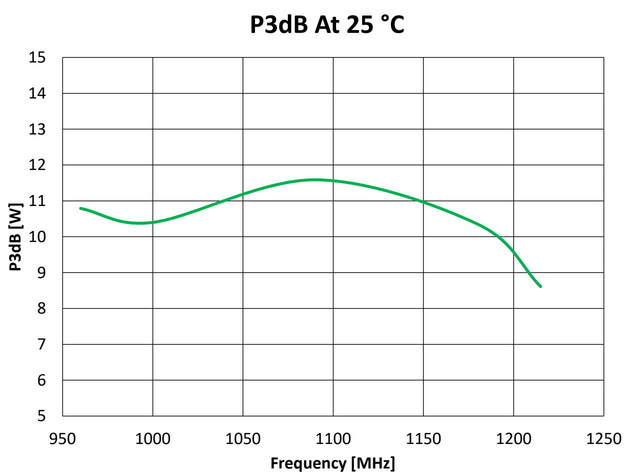
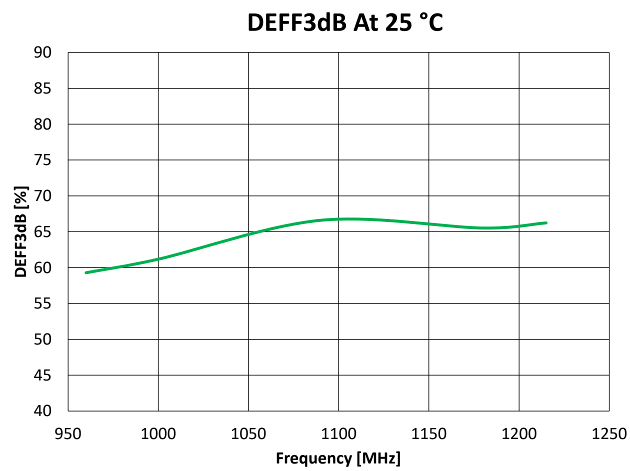
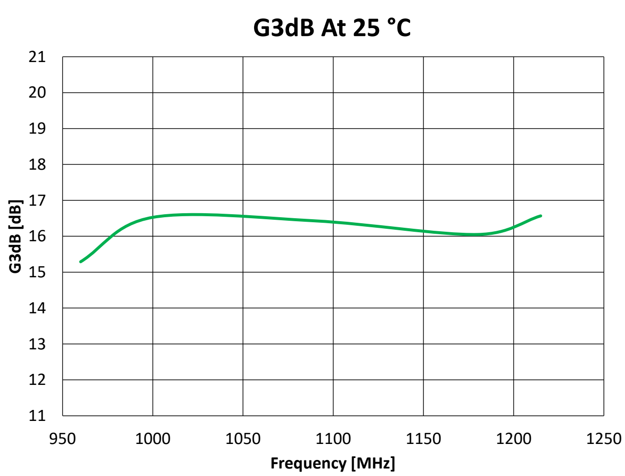
Power Driveup Performance At 25 °C Of 0.96 – 1.2 GHz EVB[1]

[1] Vd = 50 V, I_{DQ} = 18 mA, Pulse Width = 128 uS, Duty Cycle = 10 %







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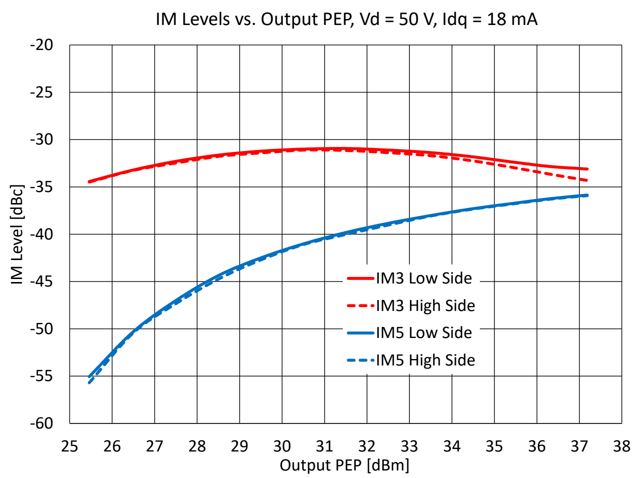
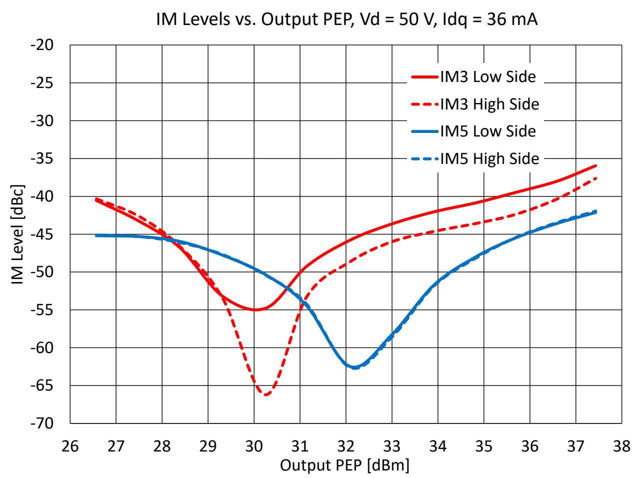
Two-Tone Performance At 25 °C Of 0.96 – 1.2 GHz EVB[1]

[1] Center Frequency = 1.09 GHz, Tone Separation = 1 MHz





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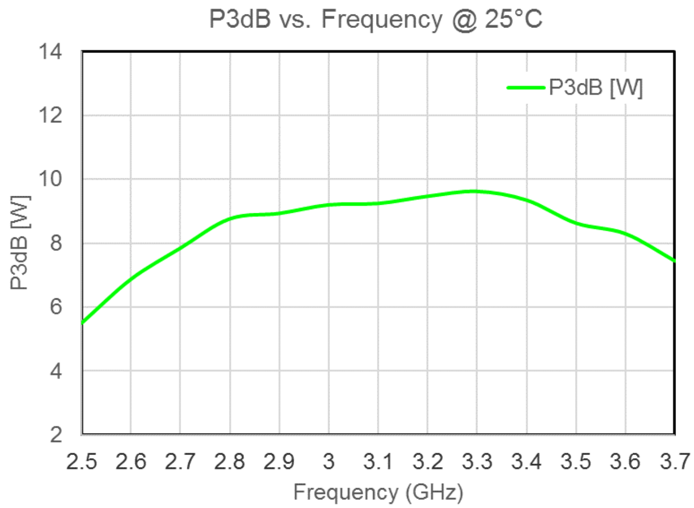
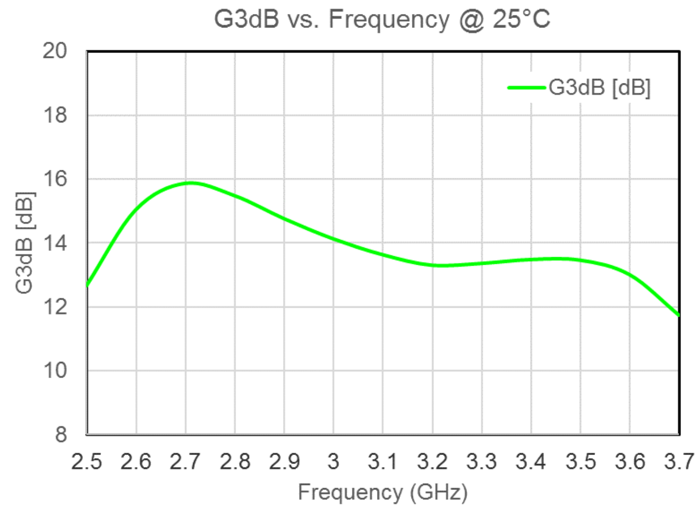
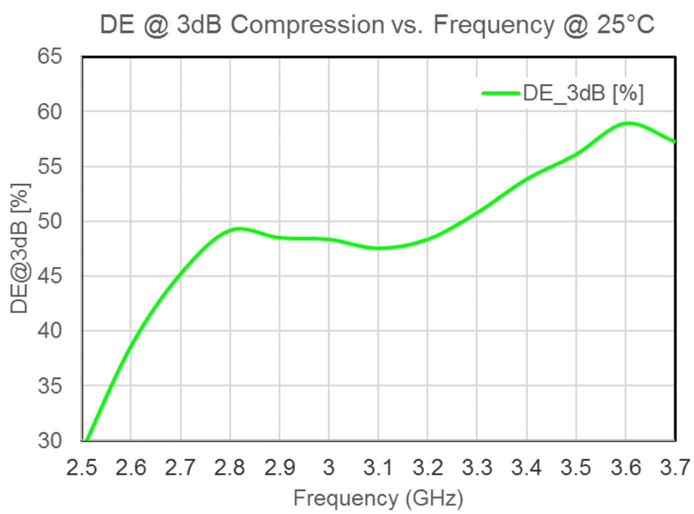
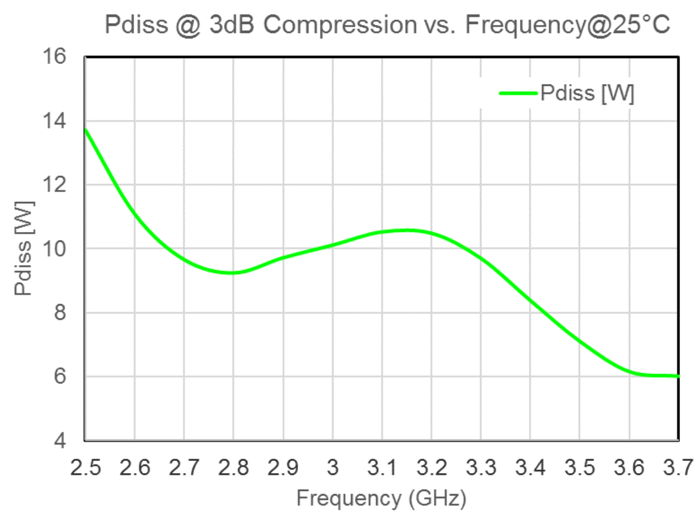
Power Driveup Performance At 25 °C Of 2.7 – 3.5 GHz EVB[1]

[1] Vd = 50 V, I_{DQ} = 18 mA, Pulse Width = 128 uS, Duty Cycle = 10 %









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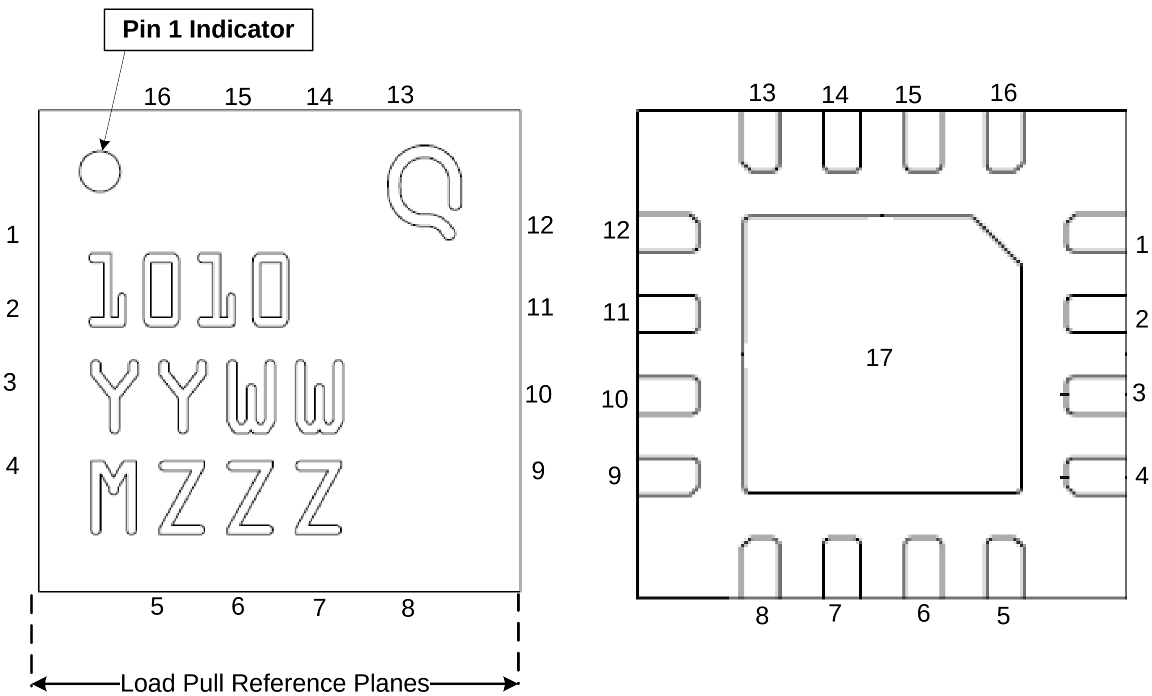
Pin Layout [1]



Notes:

1. The QPD1010 will be marked with the “1010” 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, and the “ZZZ” is an auto-generated serial number.

Pin Description

Pin	Symbol	Description
2, 3	VG / RF IN	Gate voltage / RF Input
10, 11	VD / RF OUT	Drain voltage / RF Output
1, 4, 5 – 9, 12 - 16	NC	Not Connected
17	Back Plane	Source to be connected to ground

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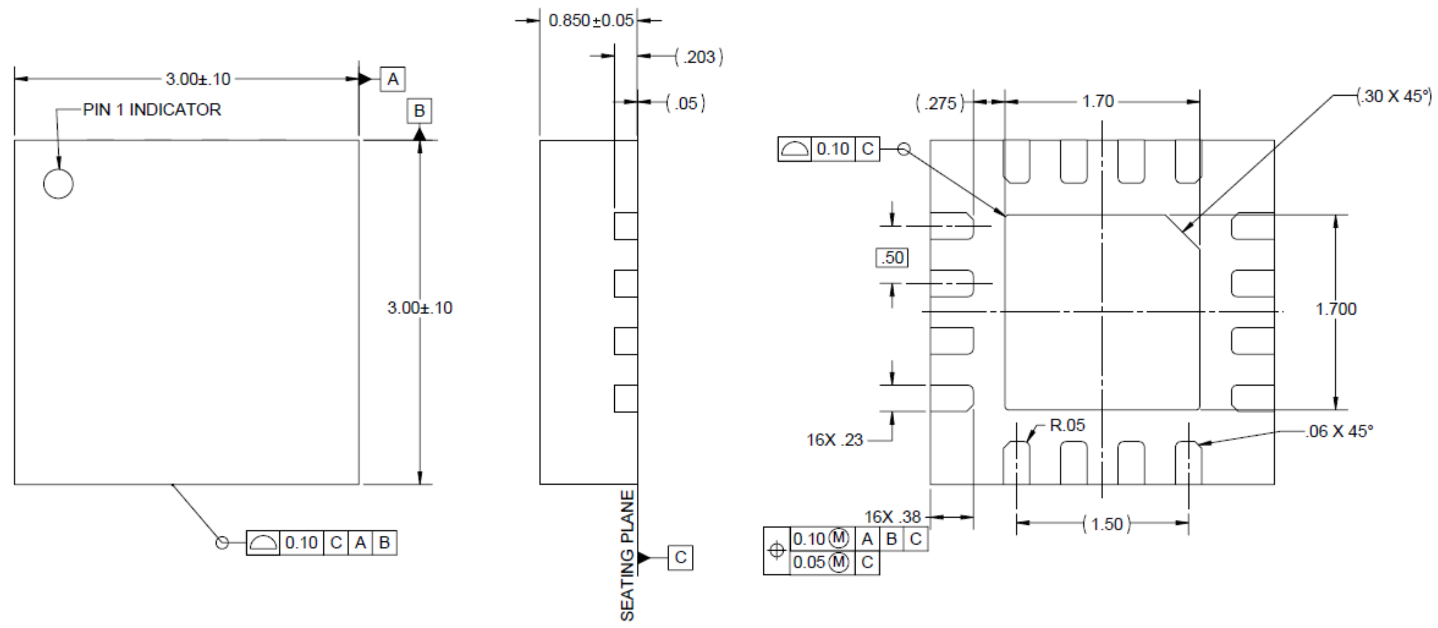
Mechanical Drawing [1, 2, 3]



Notes:

1. All dimensions are in mm. Tolerance is ±0.050 mm, otherwise noted.
2. Package leads are gold plated.
3. Part is mold encapsulated.

Bias-up Procedure	Bias-down Procedure
1. Set V_G to -4 V.	1. Turn off RF signal.
2. Set ID current limit to 30 mA.	2. Turn off VD
3. Apply 50 V VD.	3. Wait 2 seconds to allow drain capacitor to discharge
4. Slowly adjust VG until ID is set to 26 mA.	4. Turn off VG
5. Set ID current limit to 1 A	
6. Apply RF.	

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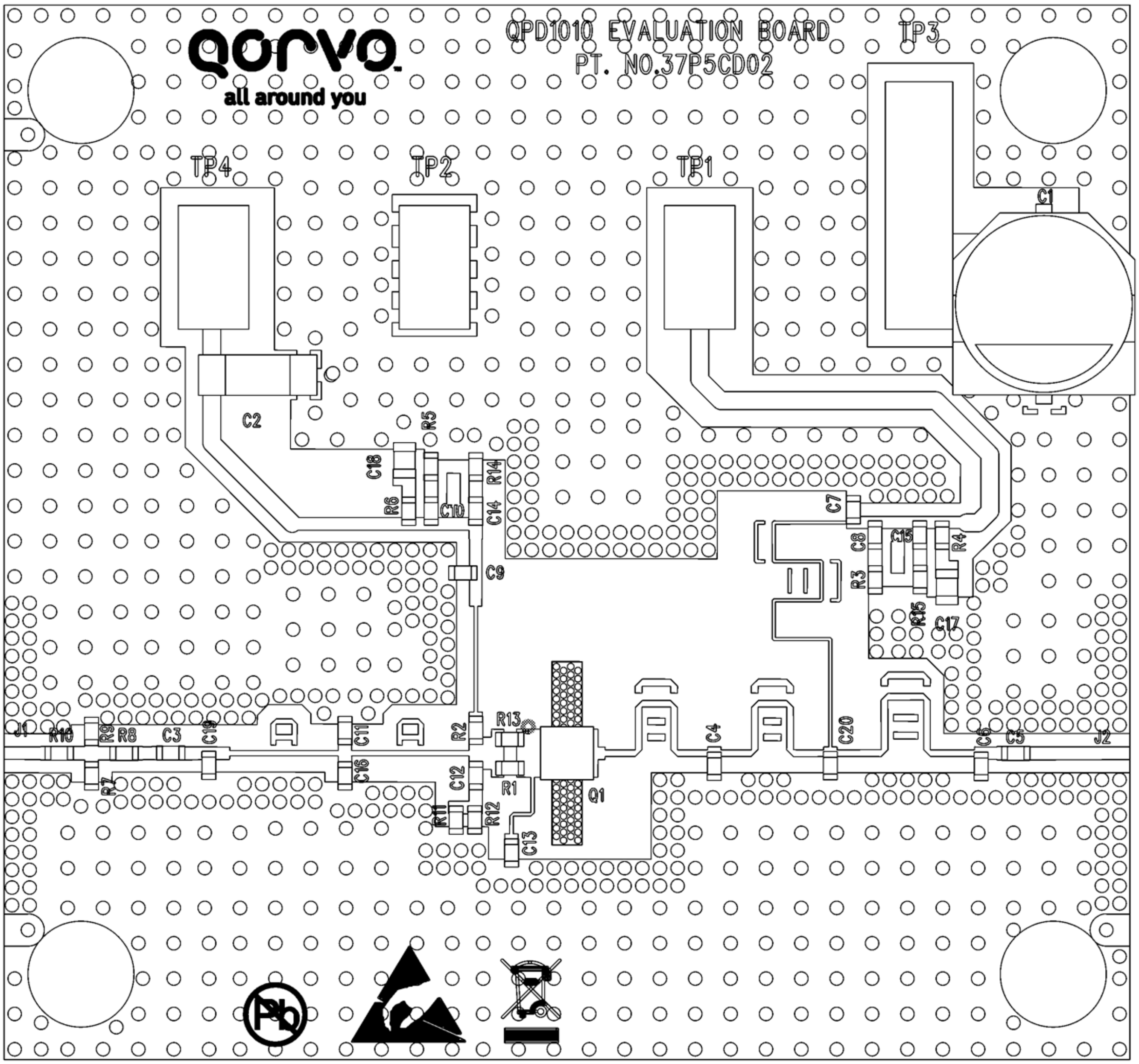
PCB Layout – 0.96 – 1.215 GHz EVB

Board material is RO4360G2 0.020” thickness with 1 oz copper cladding.



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Bill Of material – 0.96 – 1.215 GHz EVB

Ref Des	Value	Description	Manufacturer	Part Number
C14, 15	82 pF	C0G 100V 5% 0603 Capacitor	AVX	06031A820JAT2A
C8 - 10	1 nF	X7R 100V 5% 0603 Capacitor	AVX	06031C102JAT2A
C17 - 18	100 nF	X7R 100V 5% 0805 Capacitor	AVX	08051C104JAT2A
C4	0.5 pF	RF NPO 250VDC ± 0.05 pF Capacitor	ATC	ATC600S0R5AT250X
C13	1.0 pF	RF NPO 250VDC ± 0.05 pF Capacitor	ATC	ATC600S1R0AT250X
C6	3.3 pF	RF NPO 250VDC ± 0.05 pF Capacitor	ATC	ATC600S3R3AT250X
C16, 19	6.2 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	ATC600S6R2BT250X
C11, 20	6.8 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	ATC600S6R8BT250X
C3, 5, 7, 9, 12	56 pF	RF NPO 250VDC 1% Capacitor	ATC	ATC600S5650FT250X
C1	33 uF	80V SVP Capacitor	Panasonic	EEEFK1K330P
C2	10 uF	16V Tantalum Capacitor	AVX	TPSC106KR0500
J1 - 2		SMA Panel Mount 4-hole Jack	Gigalane	PSF-S00-000
R4, 6	1 Ohm	0603 1% Thick Film Resistor	ANY	
R2, 8, 10	5.1 Ohm	0603 1% Thick Film Resistor	ANY	
R1, 13, 14, 15	7.5 Ohm	0603 1% Thick Film Resistor	ANY	
R3, 5	33 Ohm	0603 1% Thick Film Resistor	ANY	
R11, 12	240 Ohm	0603 1% Thick Film Resistor	ANY	
R7, 9	430 Ohm	0603 1% Thick Film Resistor	ANY	

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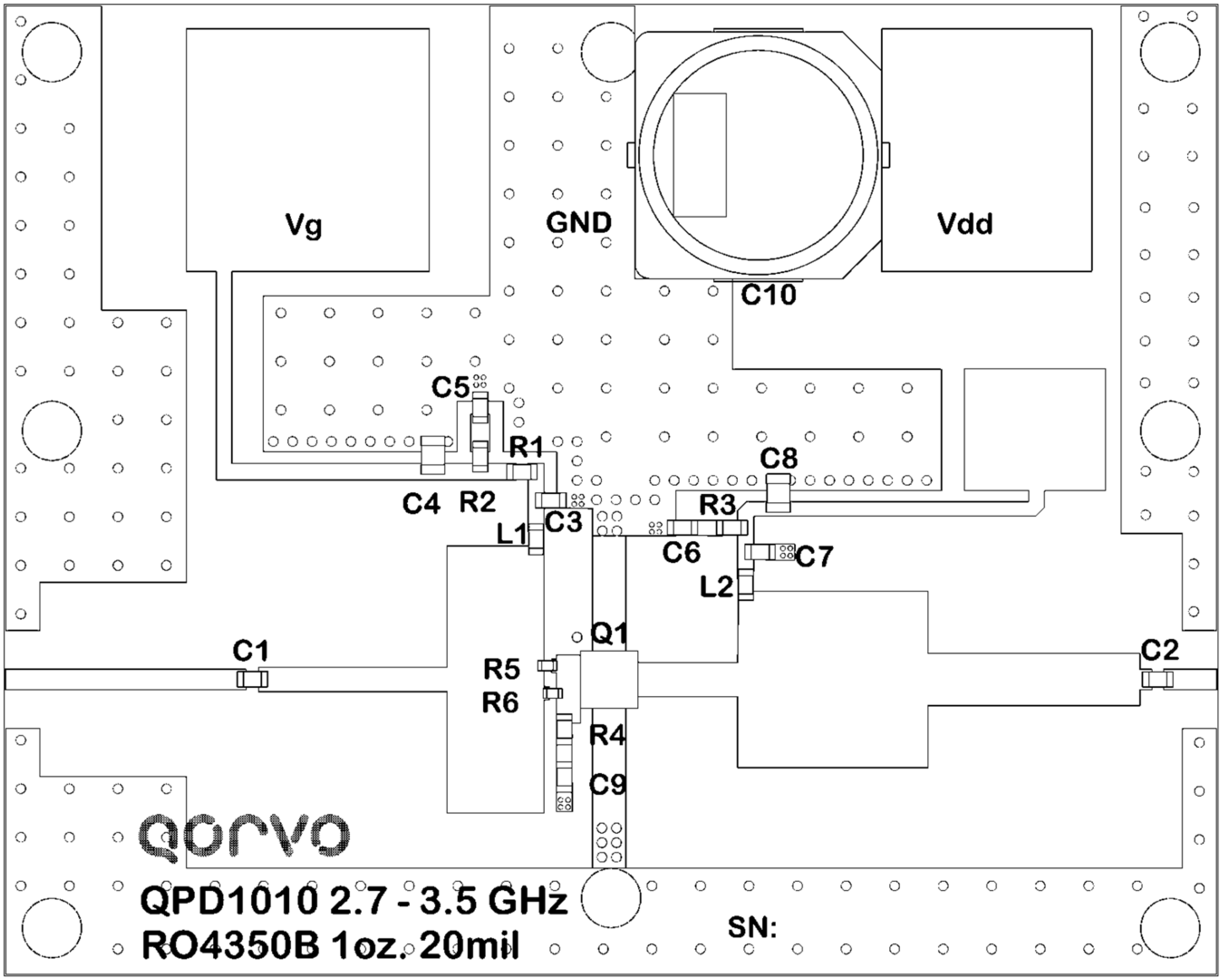
PCB Layout – 2.7 – 3.5 GHz EVB

Board material is RO4350B, 0.020” thickness with 1oz copper cladding.



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Bill Of material – 2.7 – 3.5 GHz EVB

Ref Des	Value	Description	Manufacturer	Part Number
C3, C7	2.2 pF	CAP 2.2pF+/-0.1pF 250V 0603	ATC	600S2R2BT250T
C1	0.6 pF	CAP 0.6pF+/-0.05pF 250V 0603	ATC	600S0R6AT250XT
C2	1.2 pF	CAP 1.2pF+/-0.1pF 250V 0603	ATC	600S1R2BT250XT
C5, C6	100 pF	CAP 100pF 5% 250V 0603	ATC	600S101JT250XT
C10	100 uF	CAP 100uF 20% 100V ALUM 12.5mmSQ	BC Components	MAL215099907E3
C4, C8	1.0 uF	CAP 1uF 20% 100V X7S 0805	TDK	C2012X7S2A105M125AB
C9	1000 pF	CAP 1000pF 5% 50V NPO 0603	Murata	GRM1885C1H102JA01D
R1	10 Ohm	RES 10Ohm 5% 0.1W 0603	KOA Speer	RK73B1JTTD100J
R2, R3	51.1 Ohm	RES 51.1Ohm 5% 0.1W 0603	Cal-Chip Electronics	RM06F51R1CT
R4	33 Ohm	RES 33Ohm 5% 0.1W 0603	KOA Speer	RK73B1JTTD330J
R5, R6	5.1 Ohm	RES 5.1Ohm 1% 0.1W 0402	Kamaya	RMC1/16SK5R10FTH
J1 - 2	-	SMA Panel Mount 4-hole Jack	Gigalane	PSF-S00-000
L1	5.1 nH	IND 5.1nH 5% W/W 0603	Coilcraft	0603CS-5N1XJBC
L2	8.2 nH	IND 8.2nH 5% W/W 0603	Coilcraft	0603HP-8N2XJLW

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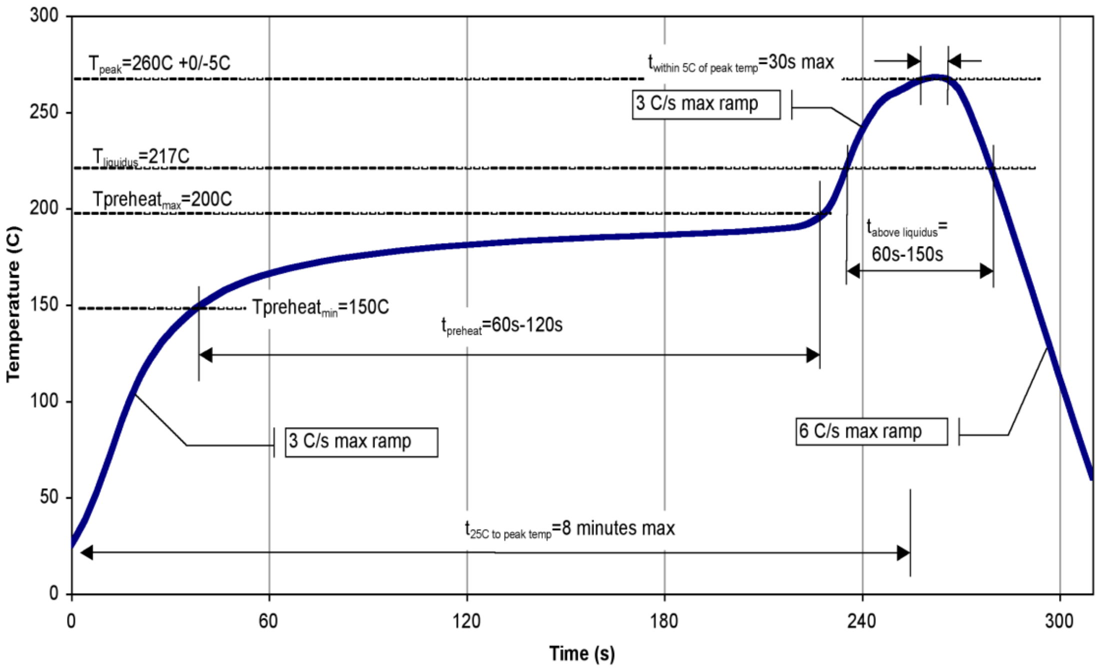
Recommended Solder Temperature Profile



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