QPD1013

150W, 65V, DC – 2.7 GHz, GaN RF Transistor

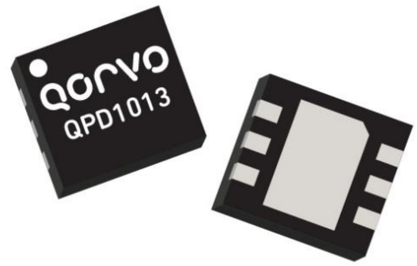
General Description

The Qorvo QPD1013 is a 150 W (P_{3dB}) discrete GaN on SiC HEMT which operates from DC to 2.7 GHz. This is a single stage unmatched power amplifier transistor in an over-molded plastic package. The high power and wide bandwidth of the QPD1013 makes it suitable for many different applications from DC to 2.7 GHz.

The device is housed in an industry-standard 7.2 x 6.6 mm surface mount DFN package.

Lead-free and ROHS compliant

Evaluation boards are available upon request.



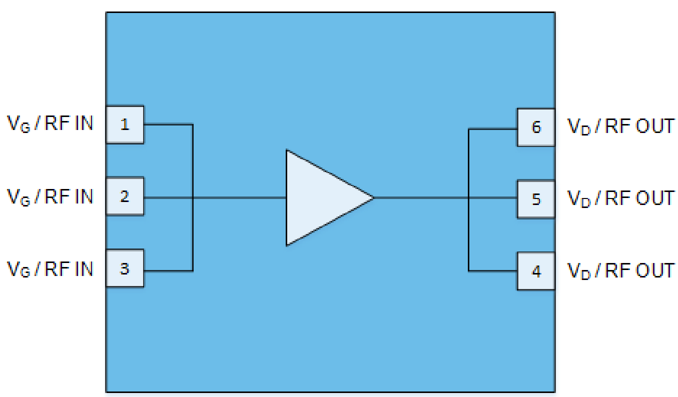
6 Pin DFN (7.2 x 6.6 x 0.9 mm)

Product Features

- Frequency: DC to 2.7 GHz
- Output Power (P_{3dB}): 178 W[1]
- Linear Gain: 21.8 dB[1]
- Typical PAE_{3dB}: 64.8 %[1]
- Operating Voltage: 65 V
- Low thermal resistance package
- CW and Pulse capable
- 7.2 x 6.6 mm package

Note 1: @ 1.8 GHz (Loadpull)

Functional Block Diagram



Applications

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

Ordering info

Part No.	ECCN	Description
QPD1013S2	EAR99	2 Piece Sample Bag
QPD1013SQ	EAR99	25 Piece Sample Bag
QPD1013SR	EAR99	100 Piece 7" Reel
QPD1013EVB01	EAR99	1.2 – 1.9 GHz EVB

Absolute Maximum Ratings[2]

Parameter	Rating	Units
Breakdown Voltage, BV_{DG}	225	V
Gate Voltage Range, V_G	-8 to +2	V
Drain Current, I_D	9	A
Gate Current Range, I_G[1]	19.2	mA
Power Dissipation, CW, P_{DISS}	74	W
RF Input Power at 1.6 GHz, CW, 50 Ω, T = 25 °C	+39	dBm
Channel Temperature, T_{CH}	275	°C
Mounting Temperature (30 Seconds)	320	°C
Storage Temperature	−65 to +150	°C

Notes:
1. At Channel temperature of 200°C.
2. 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	–	+65	+70	V
Drain Bias Current, I_{DQ}	–	240	–	mA
Drain Current, I_D	–	1.7	–	A
Gate Voltage, V_G[4]	–	−2.8	–	V
Channel Temperature (T_{CH})	–	–	250	°C
Power Dissipation, CW (P_D)[2]	–	–	67.0	W
Power Dissipation, Pulsed (P_D)[2, 3]	–	–	120.0	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. Back plane of package at 85 °C
3. Pulse Width = 100 us, Duty Cycle = 10%
4. To be adjusted to desired I_{DQ}

Pulsed Characterization – Load Pull Performance – Power Tuned – 65 V[1]

Parameters	Typical Values					Unit
Frequency, F	1.2	1.5	1.8	2.3	2.7	GHz
Linear Gain, G_{LIN}	23.7	22.3	20.3	18.1	15.2	dB
Output Power at 3dB compression point, P_{3dB}	52.7	52.5	52.5	52.3	52.1	dBm
Power-Added-Efficiency at 3dB compression point, PAE_{3dB}	61.5	58.1	53.7	51.1	43.2	%
Gain at 3dB compression point	20.7	19.3	17.3	15.1	12.2	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +65 V, I_{DQ} = 240 mA, Temp = +25 °C

Pulsed Characterization – Load Pull Performance – Efficiency Tuned – 65 V[1]

Parameters	Typical Values					Unit
Frequency	1.2	1.5	1.8	2.3	2.7	GHz
Linear Gain, G_{LIN}	25.3	23.7	21.8	19.3	16.8	dB
Output Power at 3dB compression point, P_{3dB}	50.6	50.2	51.1	51.1	50.9	dBm
Power-Added-Efficiency at 3dB compression point, PAE_{3dB}	70.9	69.4	64.8	57.5	52.3	%
Gain at 3dB compression point	22.3	20.7	18.8	16.3	13.8	dB

Notes:
1- Test conditions unless otherwise noted: V_D = +65 V, I_{DQ} = 240 mA, Temp = +25 °C

Pulsed Characterization – Load Pull Performance – Power Tuned – 50 V[1]

Parameters	Typical Values				Unit
Frequency, F	1.2	1.5	1.8	2.7	GHz
Linear Gain, G_{LIN}	22.5	21.9	19.7	15.2	dB
Output Power at 3dB compression point, P_{3dB}	51.5	51.5	51.6	51.4	dBm
Power-Added-Efficiency at 3dB compression point, PAE_{3dB}	62.8	56.8	50.5	50.9	%
Gain at 3dB compression point	19.5	18.9	16.7	12.2	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 240 mA, Temp = +25 °C

Pulsed Characterization – Load Pull Performance – Efficiency Tuned – 50 V[1]

Parameters	Typical Values				Unit
Frequency, F	1.2	1.5	1.8	2.7	GHz
Linear Gain, G_{LIN}	23.7	23.3	21.0	16.2	dB
Output Power at 3dB compression point, P_{3dB}	49.9	50.4	49.6	50.8	dBm
Power-Added-Efficiency at 3dB compression point, PAE_{3dB}	73.1	67.7	64.6	58.1	%
Gain at 3dB compression point	20.7	20.3	18.0	13.2	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +50 V, I_{DQ} = 240 mA, Temp = +25 °C

RF Characterization – 1.2 – 1.9 GHz EVB Performance At 1.6 GHz[1]

Parameter	Min	Typ	Max	Units
Linear Gain, G_{LIN}	–	16.6	–	dB
Output Power at 3dB compression point, P_{3dB}	–	51.9	–	dBm
Drain Efficiency at 3dB compression point, $DEFF_{3dB}$	–	55.3	–	%
Gain at 3dB compression point, G_{3dB}	–	13.6	–	dB

Notes:

1. V_D = +65 V, I_{DQ} = 240 mA, Temp = +25 °C, Pulse Width = 100 us, Duty Cycle = 10%

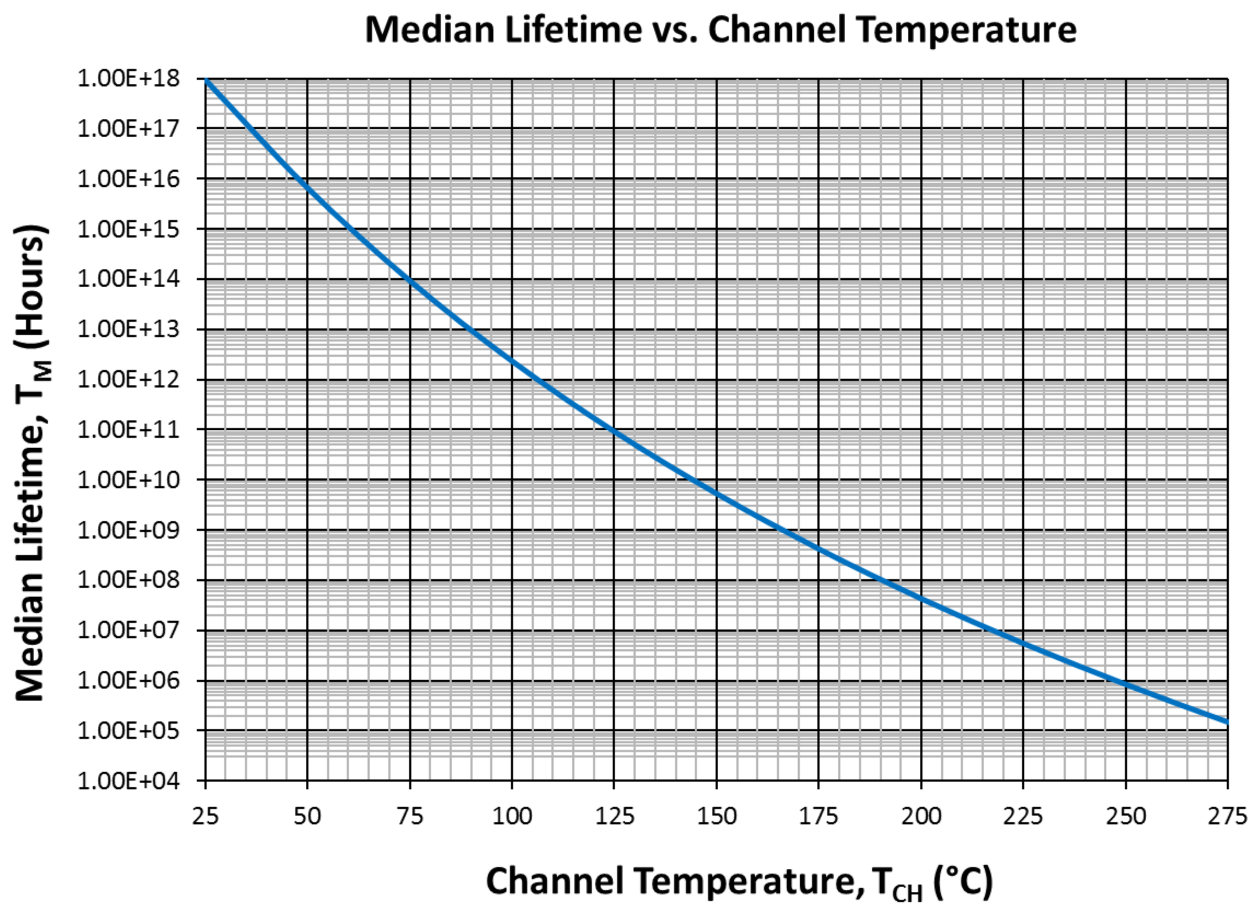
RF Characterization – Mismatch Ruggedness at 1.6 GHz[1,2]

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

Notes:

1- Test conditions unless otherwise noted: T_A = 25 °C, V_D = 65 V, I_{DQ} = 240 mA
2- Driving input power is determined at pulsed compression under matched condition at EVB output connector.

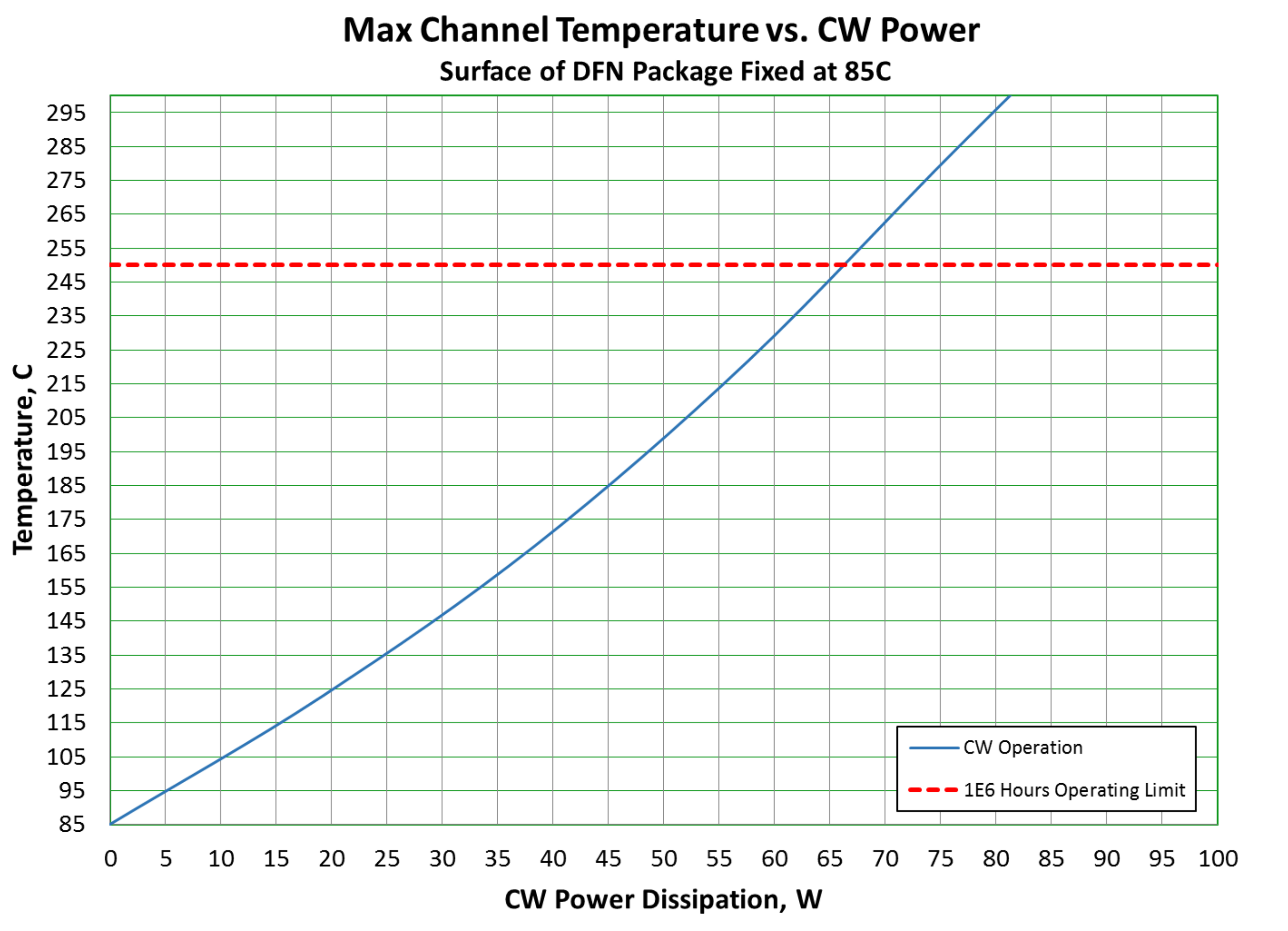
Median Lifetime[1]



Notes:

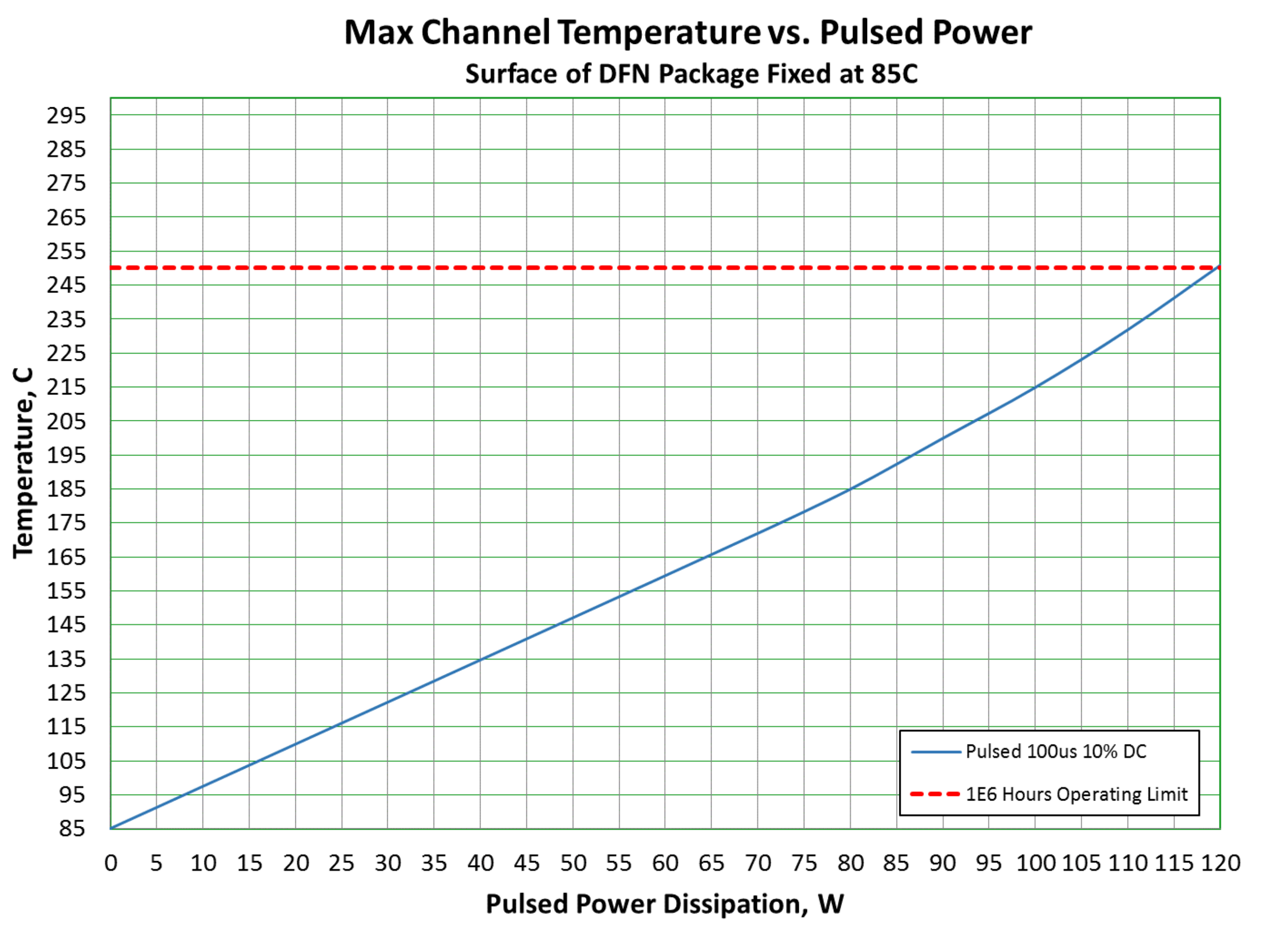
1- For pulsed signals, average lifetime is average lifetime at maximum channel temperature divided by duty cycle.

Thermal and Reliability Information - CW



Parameter	Conditions	Values	Units
Thermal Resistance (θ_{JC})	85 °C Case 19.2 W Pdiss, CW	2.0	°C/W
Maximum Channel Temperature (T_{CH})		124	°C
Median Lifetime (T_M)		9.0E10	Hrs
Thermal Resistance (θ_{JC})	85 °C Case 38.4 W Pdiss, CW	2.2	°C/W
Maximum Channel Temperature (T_{CH})		168	°C
Median Lifetime (T_M)		7.0E8	Hrs
Thermal Resistance (θ_{JC})	85 °C Case 57.6 W Pdiss, CW	2.4	°C/W
Maximum Channel Temperature (T_{CH})		222	°C
Median Lifetime (T_M)		7.0E6	Hrs
Thermal Resistance (θ_{JC})	85 °C Case 76.8 W Pdiss, CW	2.6	°C/W
Maximum Channel Temperature (T_{CH})		285	°C
Median Lifetime (T_M)		7.0E4	Hrs

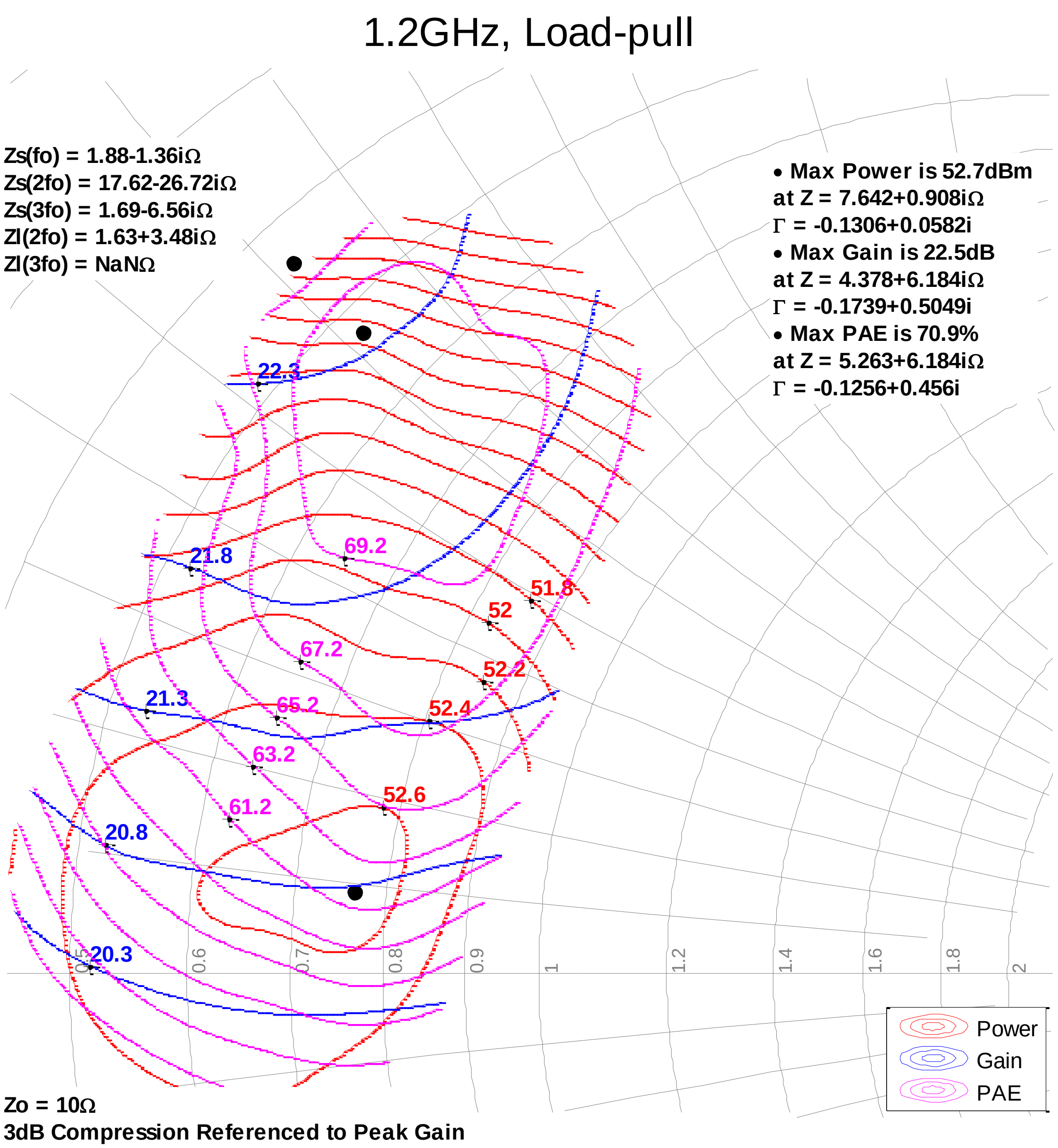
Thermal and Reliability Information - Pulsed



Parameter	Conditions	Values	Units
Thermal Resistance (θ_{JC})	85 °C Case 90 W Pdiss, Pulsed 100us 10% DC	2.0	°C/W
Maximum Channel Temperature (T_{CH})		200	°C
Median Lifetime (T_M)		4.0E8	Hrs
Thermal Resistance (θ_{JC})	85 °C Case 100 W Pdiss, Pulsed 100us 10% DC	1.7	°C/W
Maximum Channel Temperature (T_{CH})		215	°C
Median Lifetime (T_M)		1.0E8	Hrs
Thermal Resistance (θ_{JC})	85 °C Case 110 W Pdiss, Pulsed 100us 10% DC	1.5	°C/W
Maximum Channel Temperature (T_{CH})		232	°C
Median Lifetime (T_M)		3.0E7	Hrs
Thermal Resistance (θ_{JC})	85 °C Case 120 W Pdiss, Pulsed 100us 10% DC	1.4	°C/W
Maximum Channel Temperature (T_{CH})		251	°C
Median Lifetime (T_M)		8.0E6	Hrs

Load Pull Smith Charts[1, 2]

Notes:
1. Vd = 65 V, I_{DQ} = 240 mA, Pulsed signal with 100 us pulse width and 10 % duty cycle.
2. See page 20 for load pull and source pull reference planes.



Load Pull Smith Charts[1, 2]

Notes:
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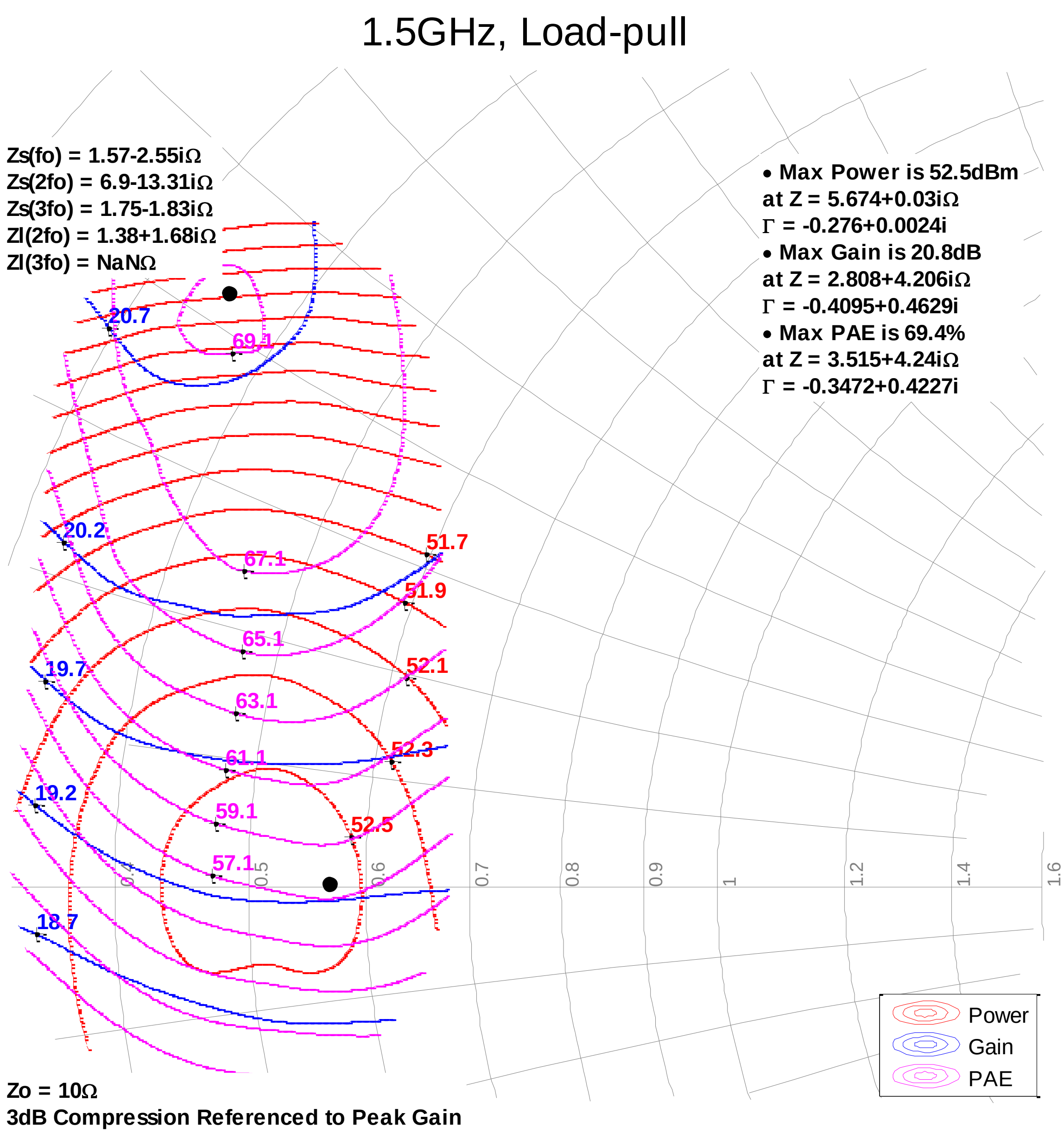
2. See page 20 for load pull and source pull reference planes.



Load Pull Smith Charts[1, 2]

Notes:

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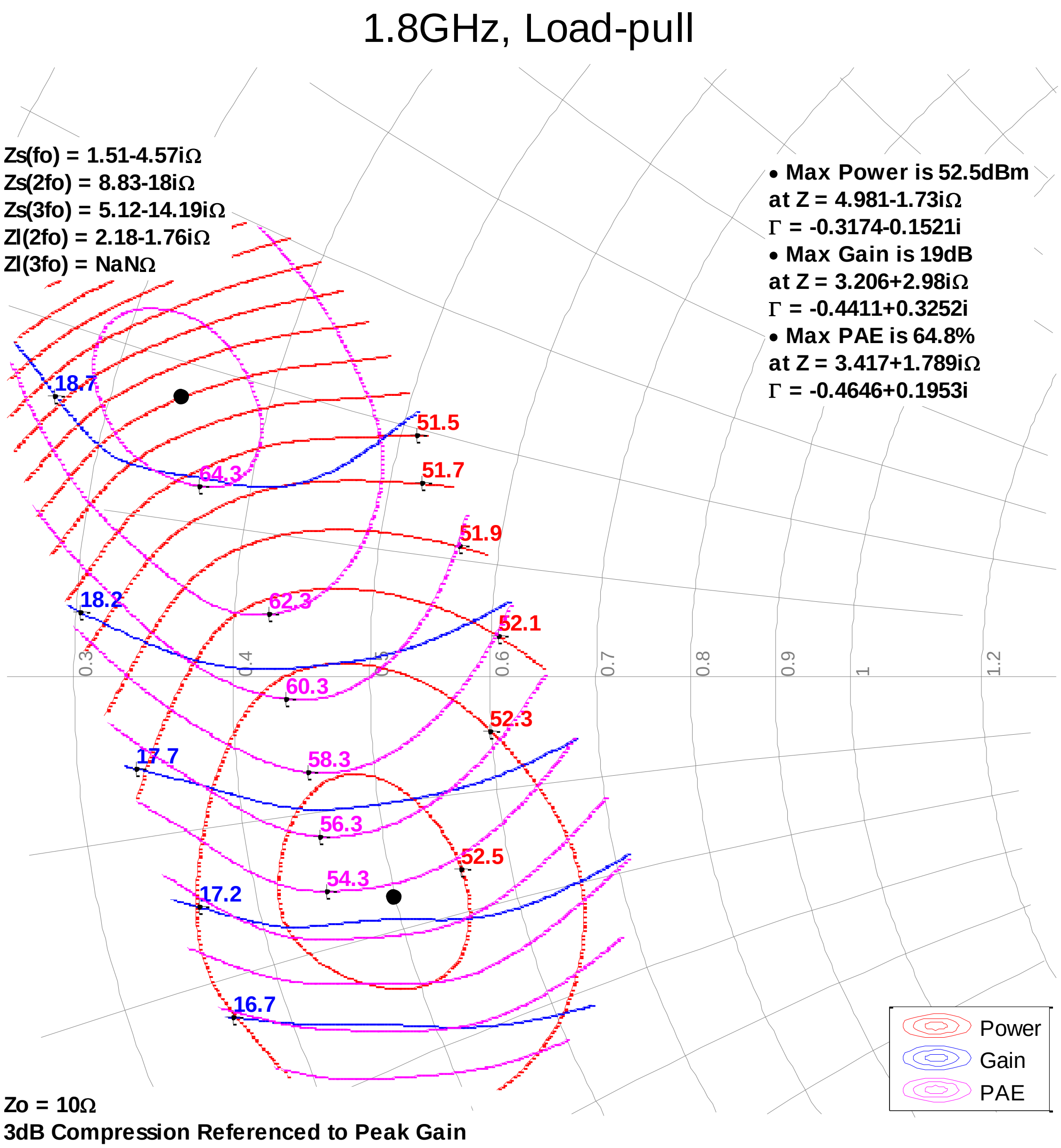

Load Pull Smith Charts[1, 2]

Notes:
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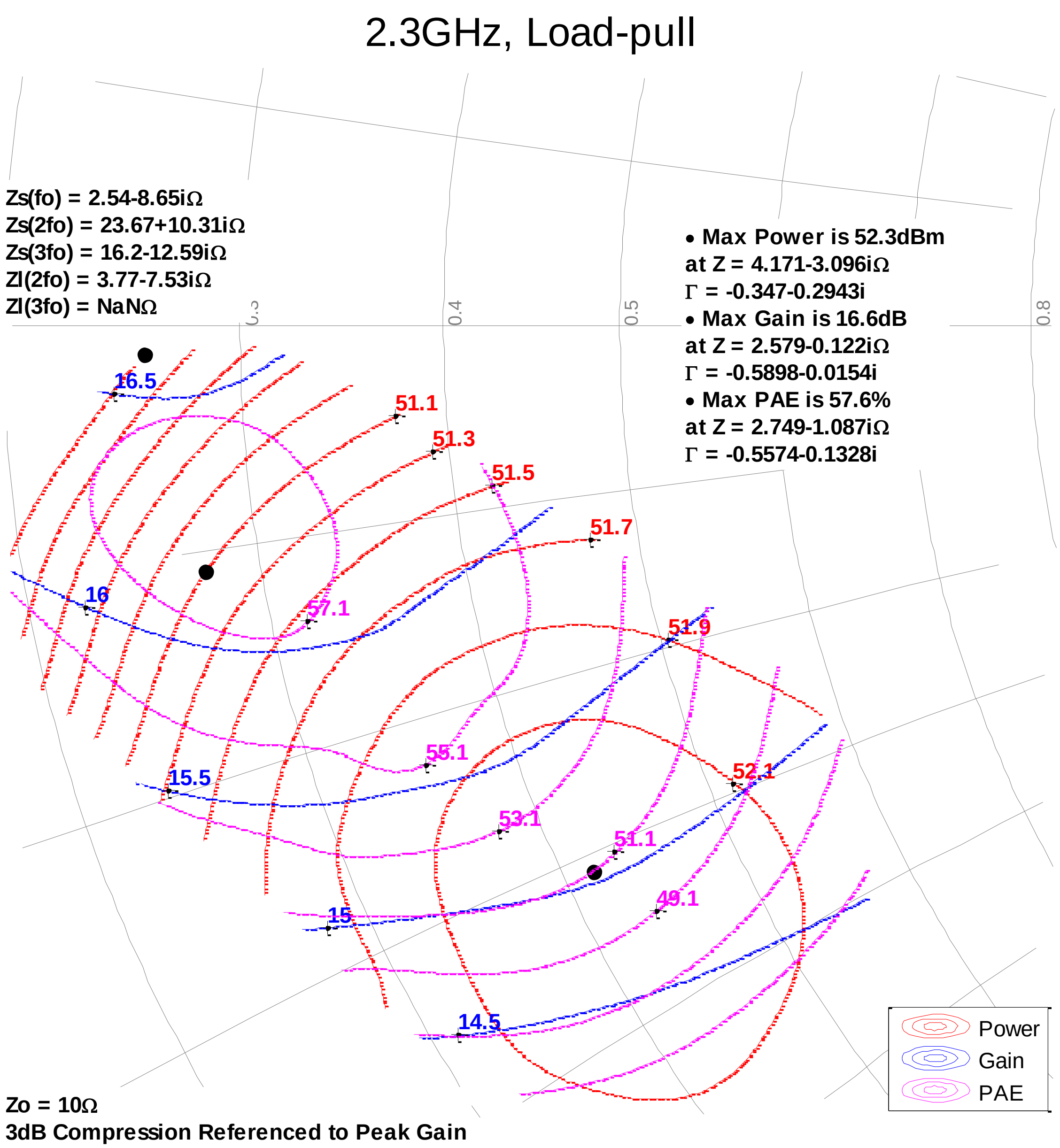

Load Pull Smith Charts[1, 2]

Notes:

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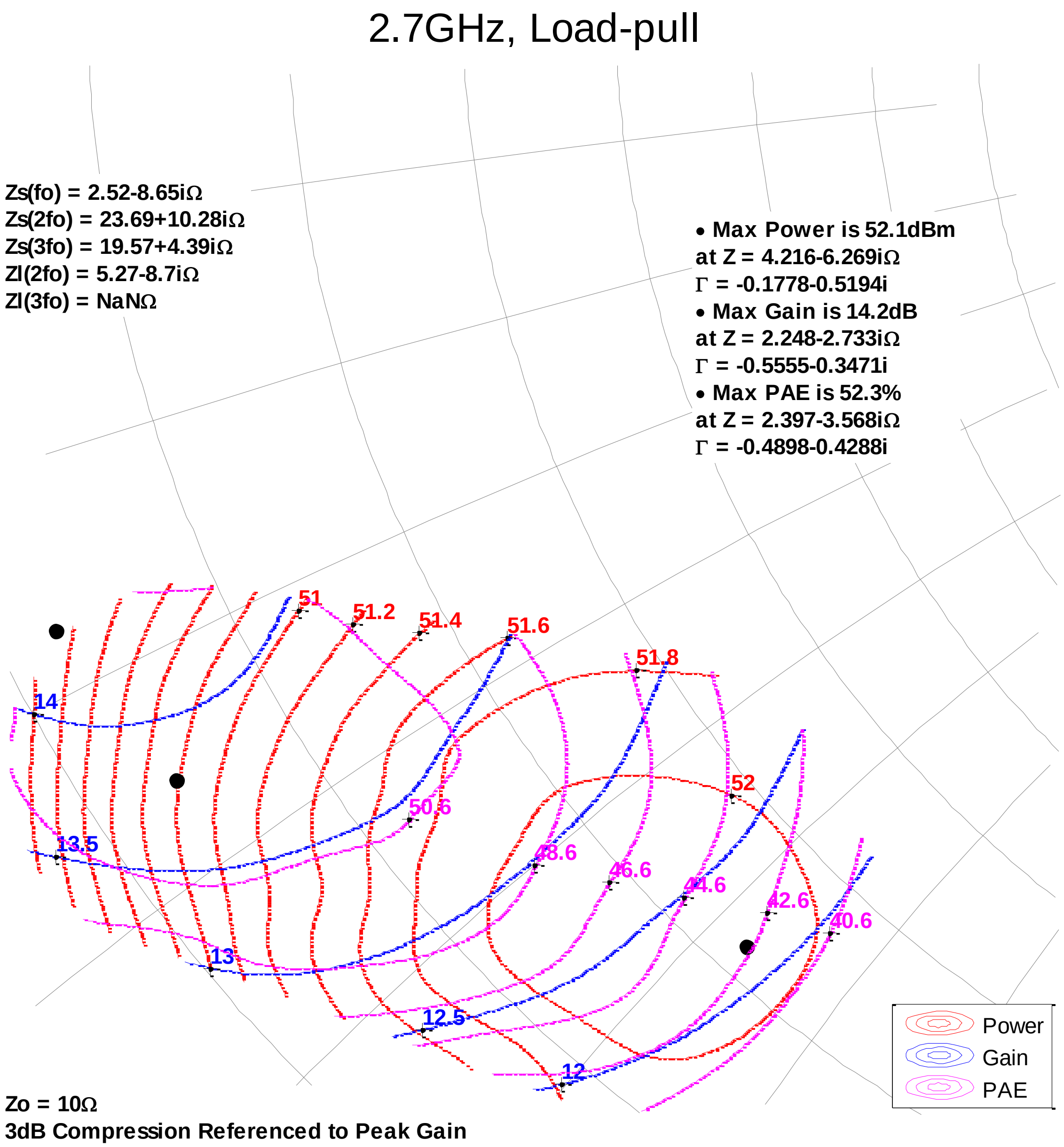
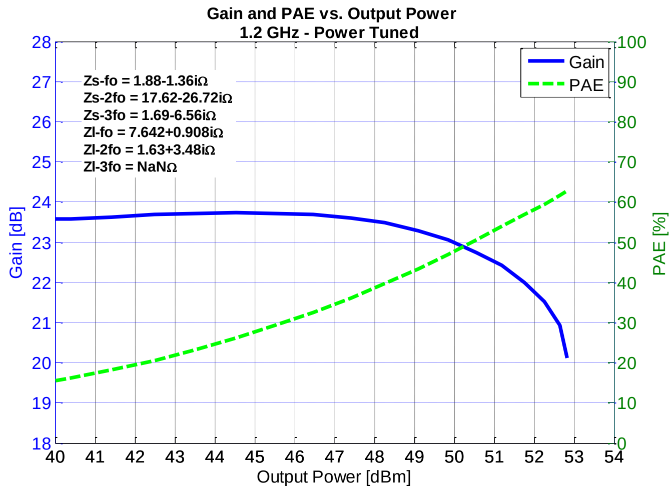
2. See page 20 for load pull and source pull reference planes.

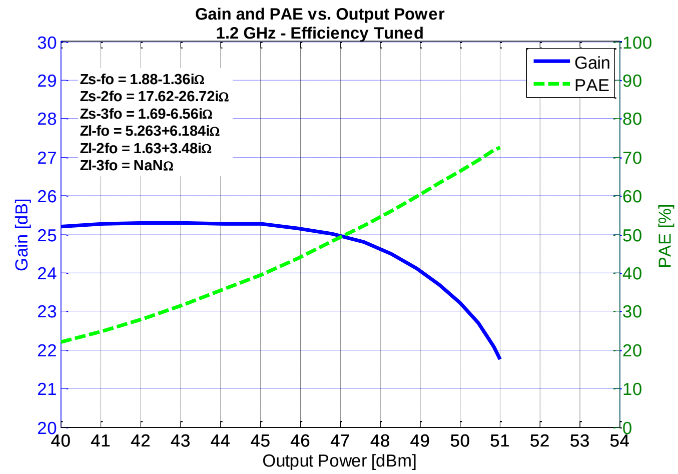


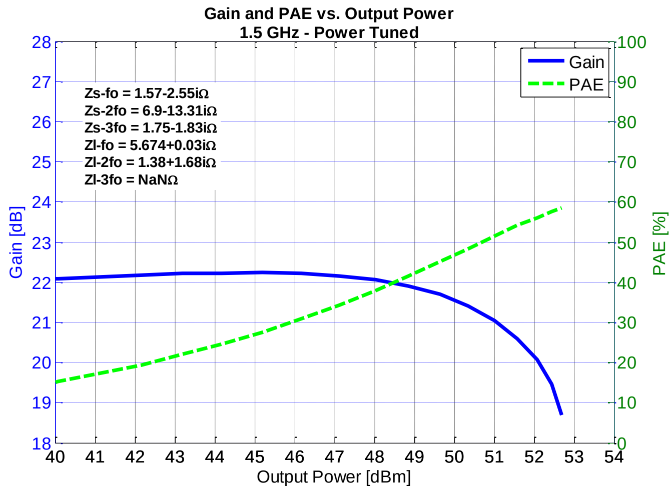
Typical Performance – Load Pull Drive-up

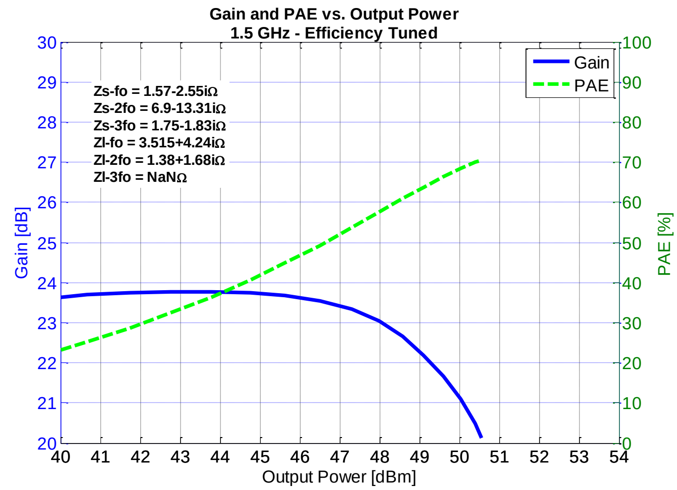
Notes:

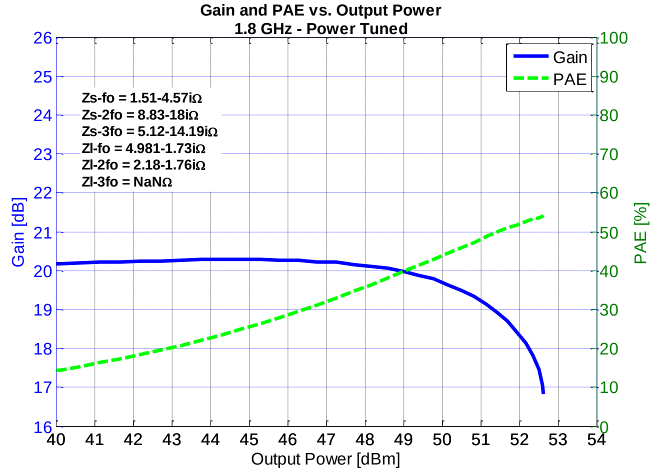
1. Pulsed signal with 100 us pulse width and 10 % duty cycle, Vd = 65 V, I_{DQ} = 240 mA
2. See page 20 for load pull and source pull reference planes where the performance was measured.

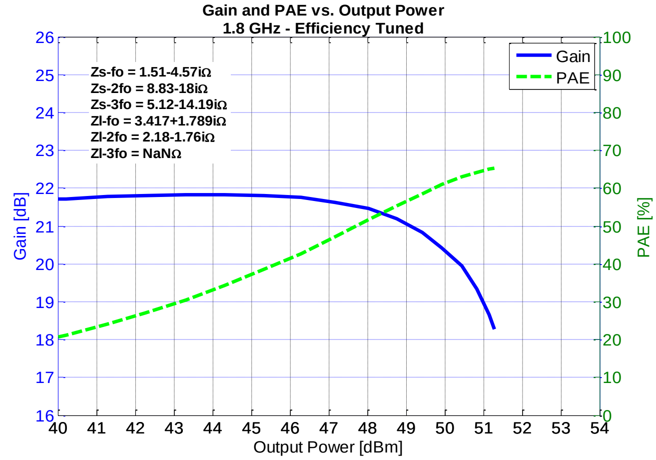








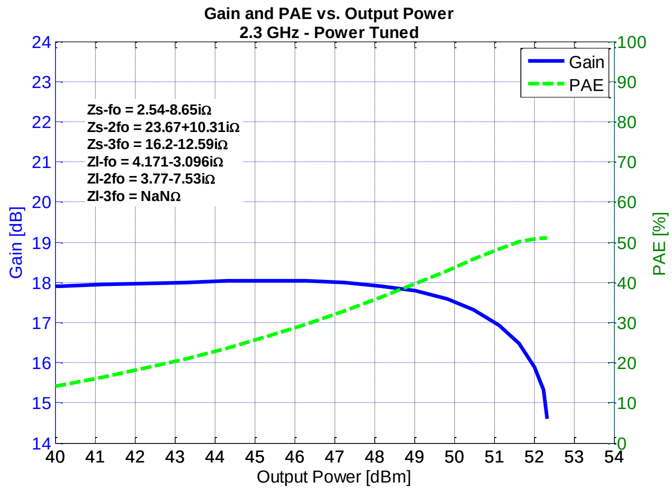


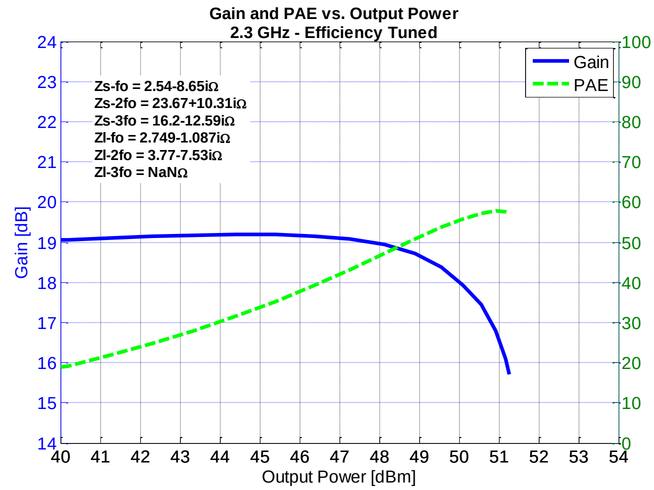


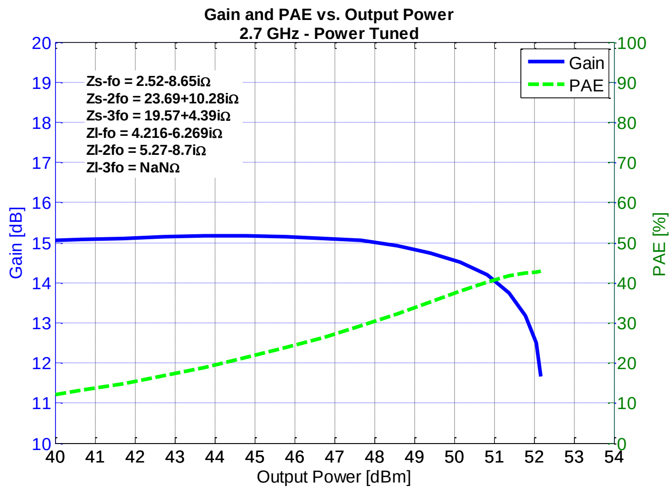
Typical Performance – Load Pull Drive-up

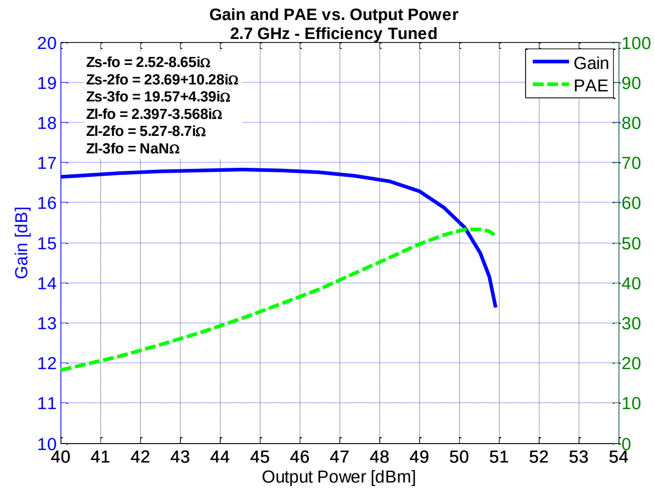
Notes:

1. Pulsed signal with 100 us pulse width and 10 % duty cycle, Vd = 65 V, I_{DQ} = 240 mA
2. See page 20 for load pull and source pull reference planes where the performance was measured.



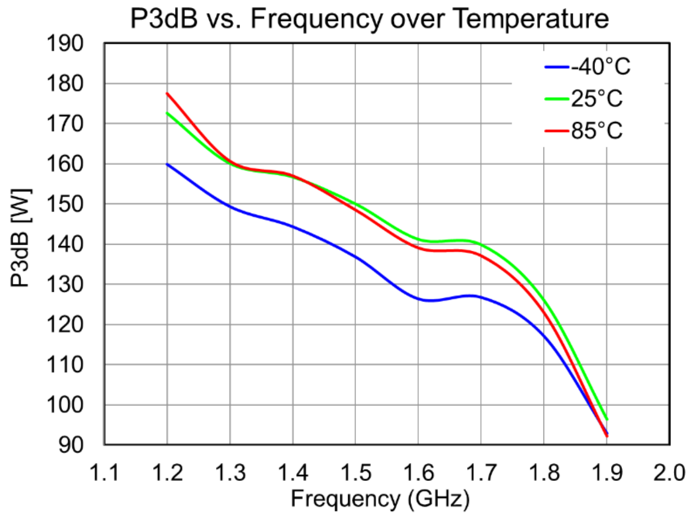


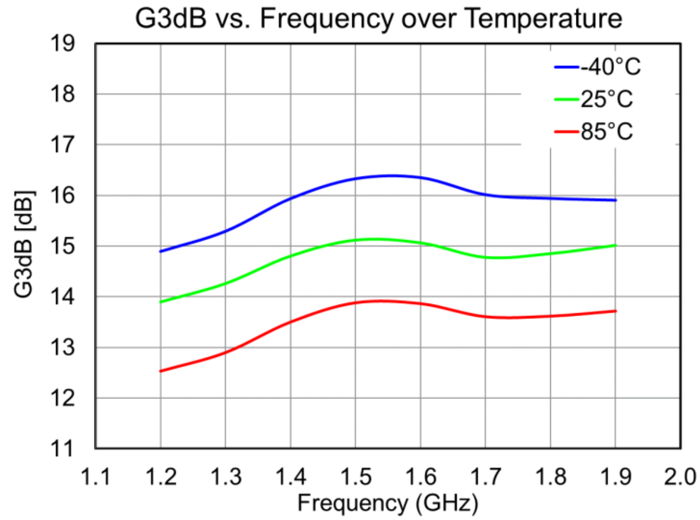


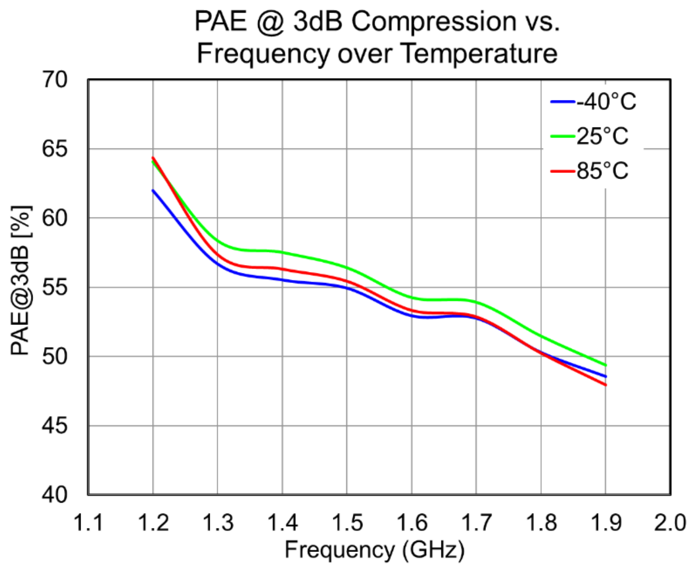


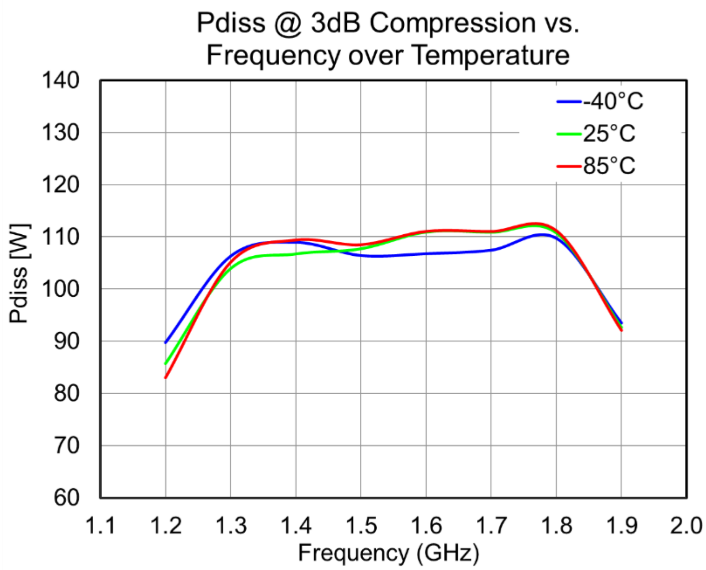
Power Driveup Performance Over Temperatures of 1.2 – 1.9 GHz EVB – 65 V[1]

Notes:
1- Vd = 65 V, I_{DQ} = 240 mA, Pulse Width = 100 us, Duty Cycle = 10 %





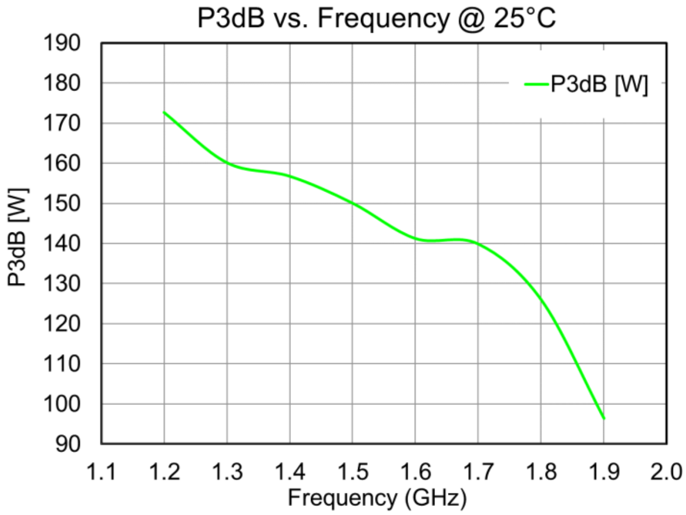


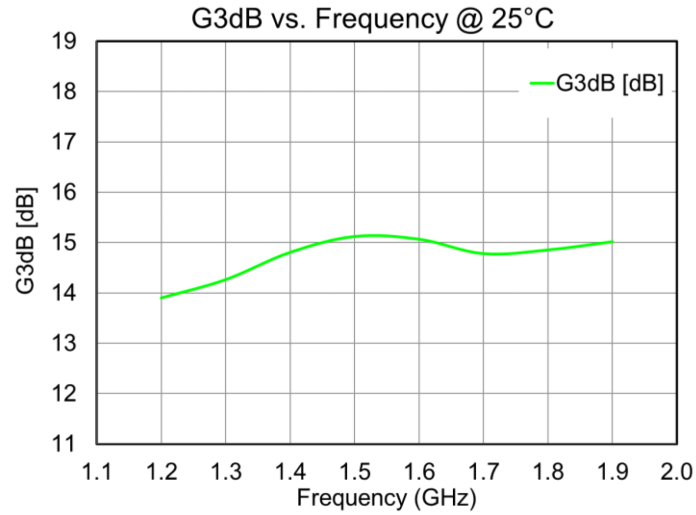


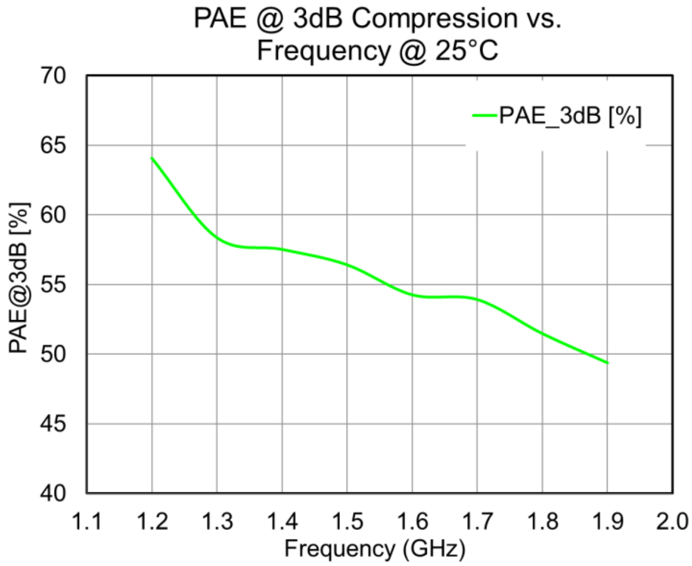
Power Driveup Performance at 25 °C of 1.2 – 1.9 GHz EVB – 65 V[1]

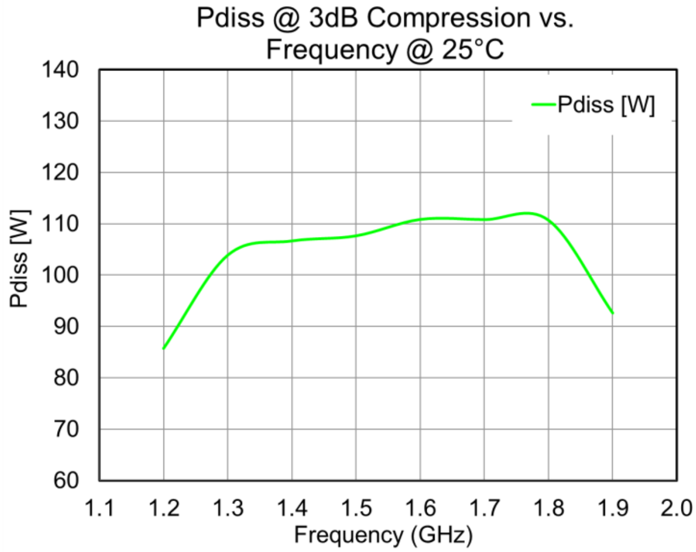
Notes:

1- Vd = 65 V, I_{DQ} = 240 mA, Pulse Width = 100 us, Duty Cycle = 10 %



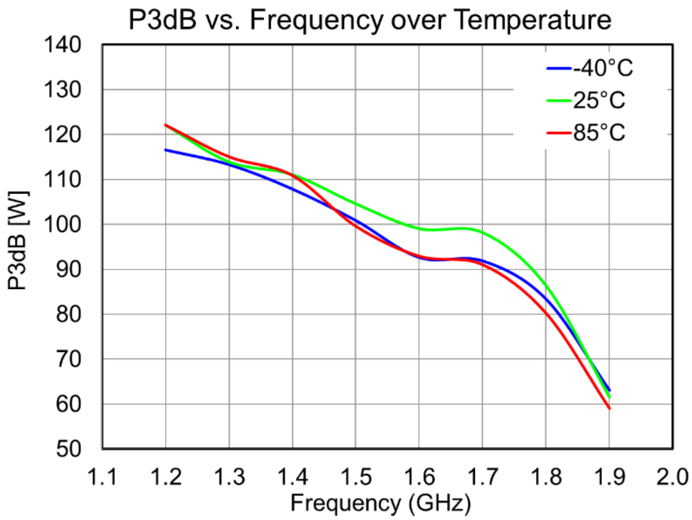


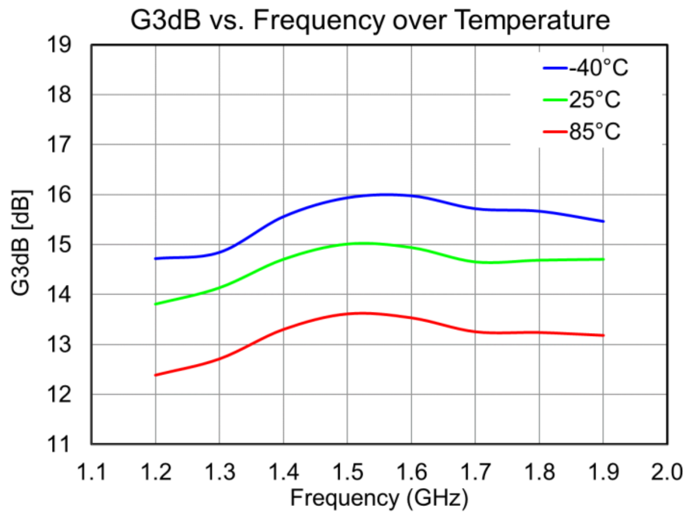


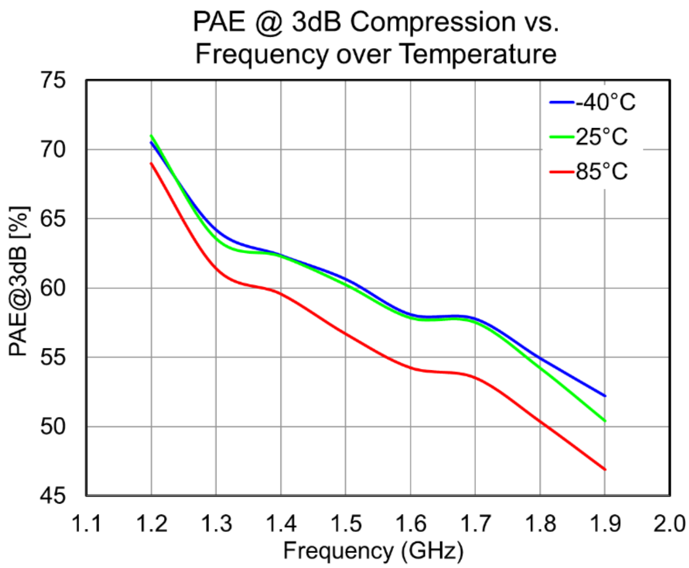


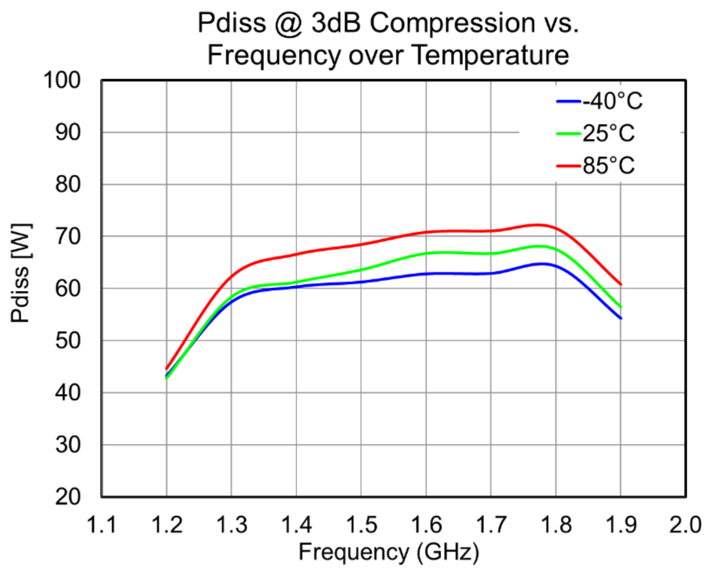
Power Driveup Performance Over Temperatures of 1.2 – 1.9 GHz EVB – 50 V[1]

Notes:
1- Vd = 50 V, I_{DQ} = 240 mA, Pulse Width = 100 us, Duty Cycle = 10 %





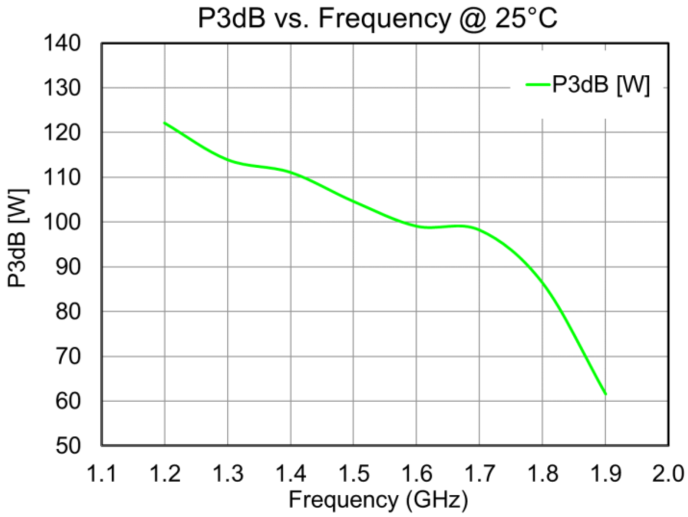


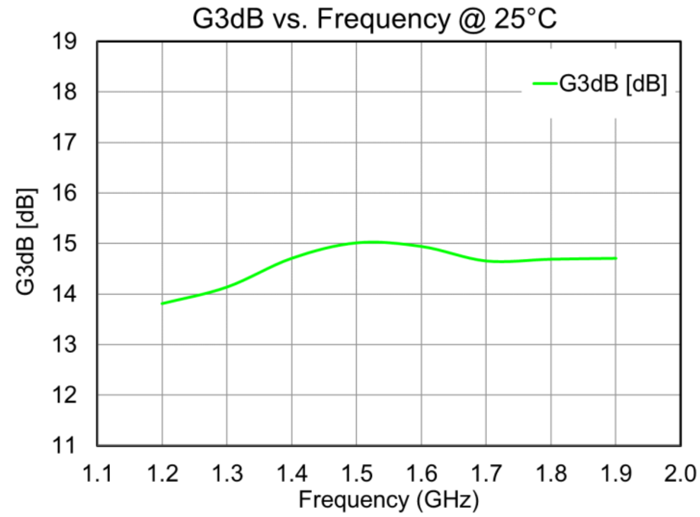


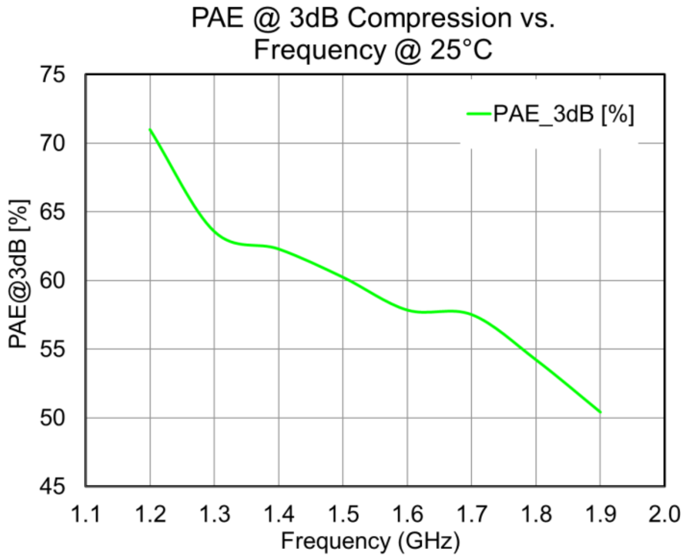
Power Driveup Performance at 25 °C of 1.2 – 1.9 GHz EVB – 50 V[1]

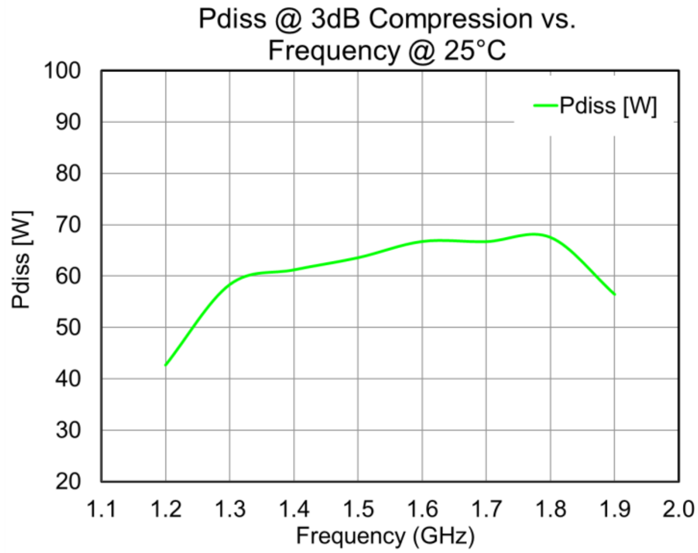
Notes:

1- Vd = 50 V, I_{DQ} = 240 mA, Pulse Width = 100 us, Duty Cycle = 10 %





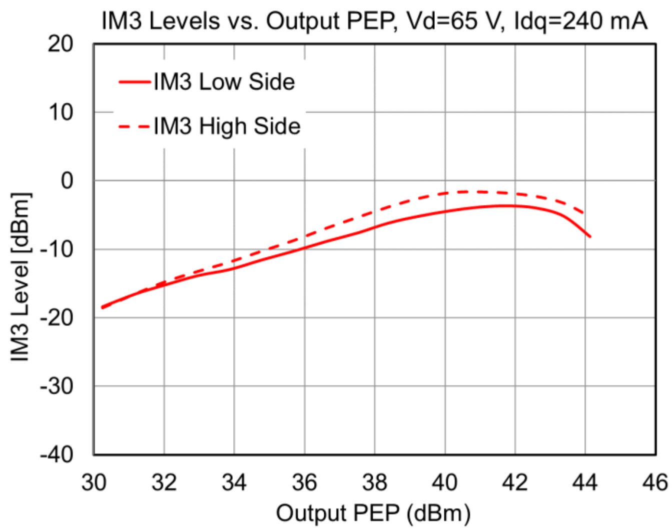


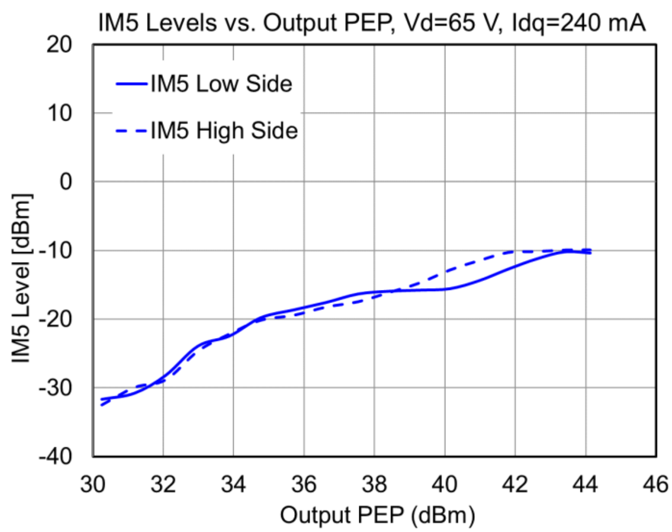


Two-Tone Performance at 25 °C of 1.2 – 1.9 GHz EVB[1]

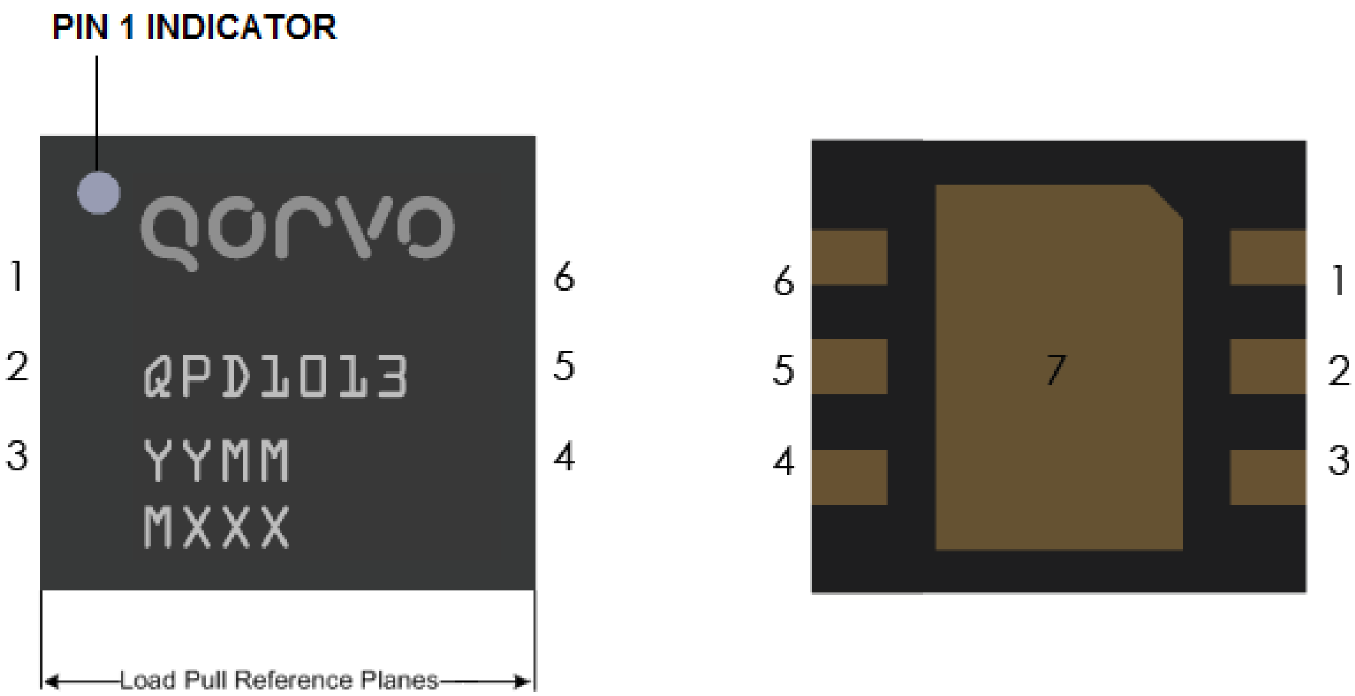
Notes:

1- Center Frequency = 1.5 GHz. Tone Seperation = 1 MHz.





Pin Layout [1]



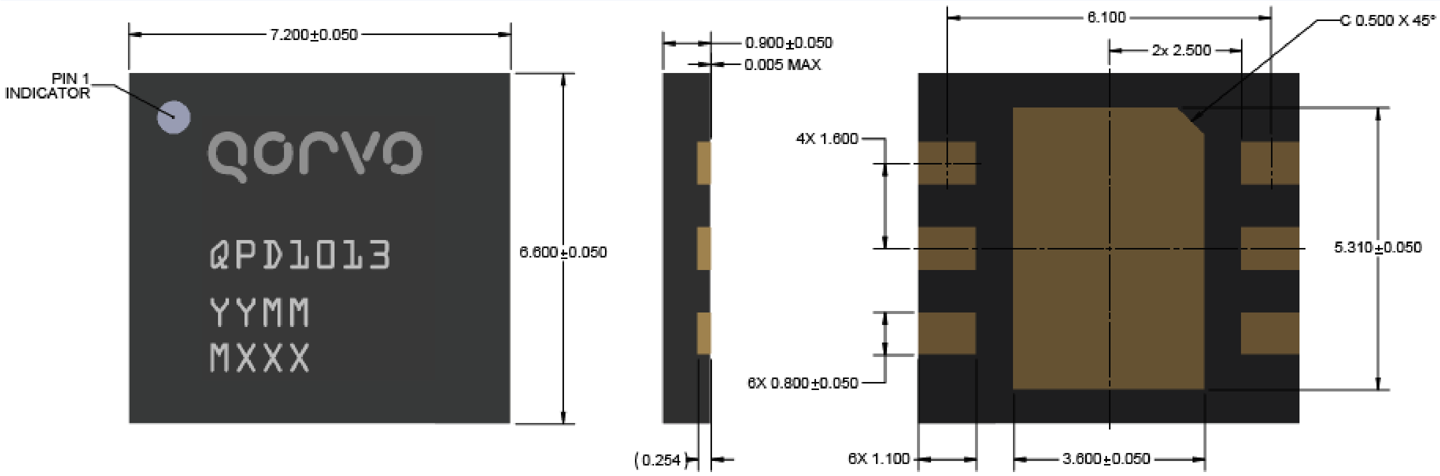
Notes:

1. The QPD1013 will be marked with the “QPD1013” 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 “MM” is the work week of the assembly lot start, the “MXXX” is the batch ID.

Pin Description

Pin	Symbol	Description
1 – 3	VG / RF IN	Gate voltage / RF Input
4 – 6	VD / RF OUT	Drain voltage / RF Output
7	Back Plane	Source to be connected to ground

Mechanical Drawing



Notes:

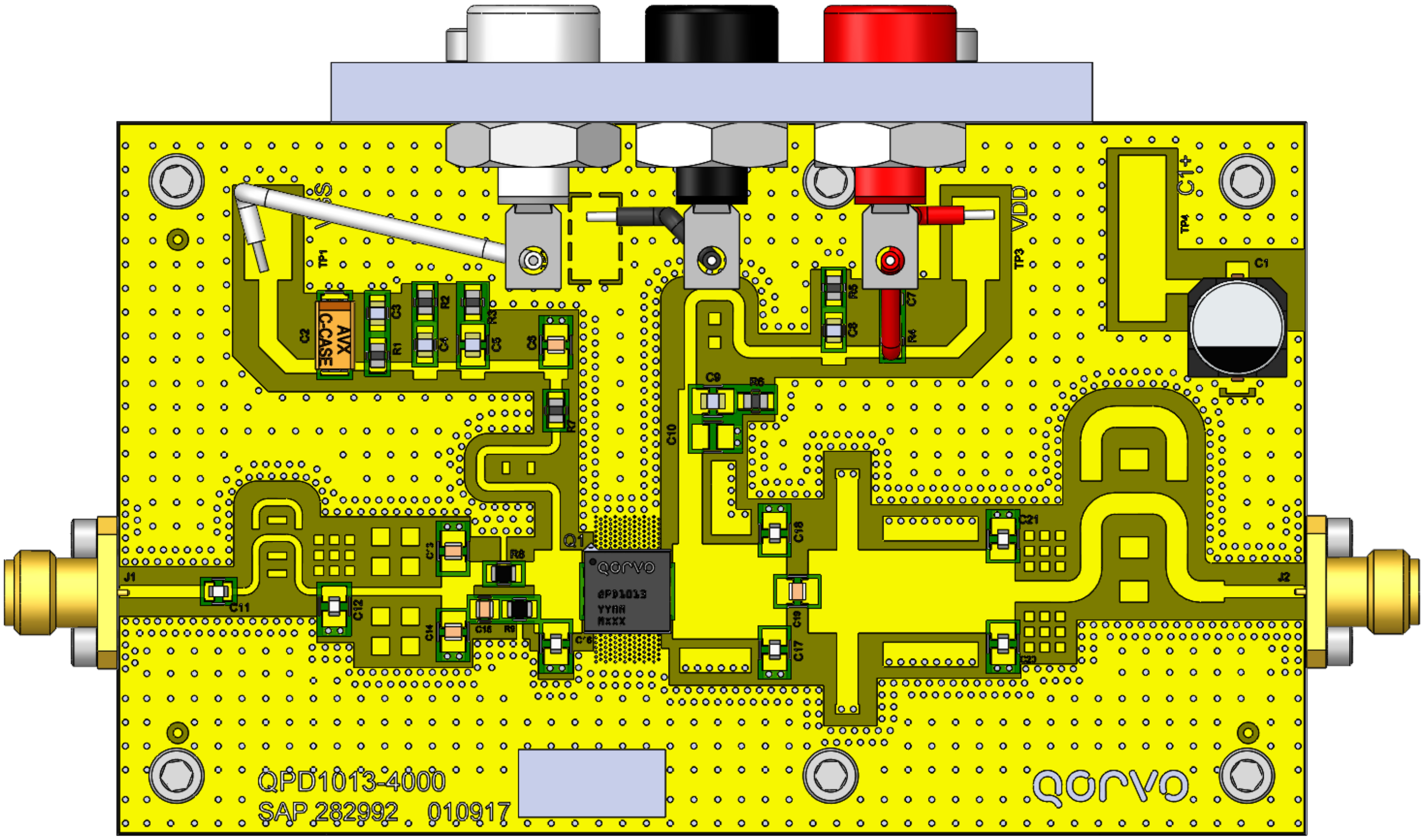
1- All dimensions are in mm, otherwise noted. Tolerance is ±0.050 mm.

Bias-up Procedure	Bias-down Procedure
1. Set V_G to -4 V.	1. Turn off RF signal.
2. Set ID current limit to 500 mA.	2. Turn off VD
3. Apply 65 V VD.	3. Wait 2 seconds to allow drain capacitor to discharge
4. Slowly adjust VG until ID is set to 240 mA.	4. Turn off VG
5. Set ID current limit to 3 A	
6. Apply RF.	

PCB Layout – 1.2 – 1.9 GHz EVB[1]

Notes:

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



Bill Of material – 1.2 – 1.9 GHz EVB

Ref Des	Value	Description	Manufacturer	Part Number
C4, C8	1.0 nF	X7R 100V 5% 0805 Capacitor	AVX	08051C102JAT2A
C3, C7	10.0 nF	X7R 100V 5% 0805 Capacitor	AVX	08051C103JAT2A
C20 – C21	1.5 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	ATC600S1R5BT250XT
C13 – C14	1.2 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	ATC800A1R2BT250XT
C12	2.0 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	ATC600S2R0BT250XT
C16	3.6 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	ATC600S3R6BT250XT
C17 – C18	3.9 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	ATC600S3R9BT250XT
C11	4.7 pF	RF NPO 250VDC ± 0.1 pF Capacitor	ATC	ATC600S4R7BT250XT
C15, C19	12.0 pF	RF C0G 250VDC 5% Capacitor	ATC	ATC800A120JT250XT
C6	22.0 pF	RF C0G 250VDC 5% Capacitor	ATC	ATC800A220JT250XT
C5, C9	100 pF	RF C0G 250VDC 5% Capacitor	ATC	ATC600F101JT250XT
C1	33 uF	80V 20% SVP Capacitor	Panasonic	EEEFK1K330P
C2	10 uF	16V 10% Tantalum Capacitor	AVX	TPSC106KR0500
J1 - 2	–	SMA Panel Mount 4-hole Jack	Gigalane	PSF-S00-000
R7	3.0 Ohm	0805 1% Thick Film Resistor	ANY	–
R1 – R6	5.1 Ohm	0805 1% Thick Film Resistor	ANY	–
R8	3.0 Ohm	0805 16W 5% Thick Film Resistor	IMS	NGC-0805CS3R00J
R9	5.0 Ohm	0805 16W 5% Thick Film Resistor	IMS	NGC-0805CS5R00J

Recommended Solder Temperature Profile