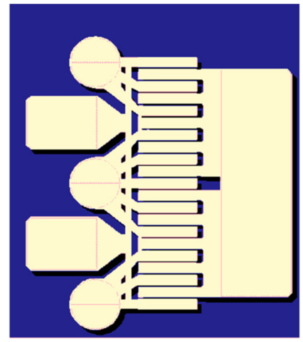
Applications

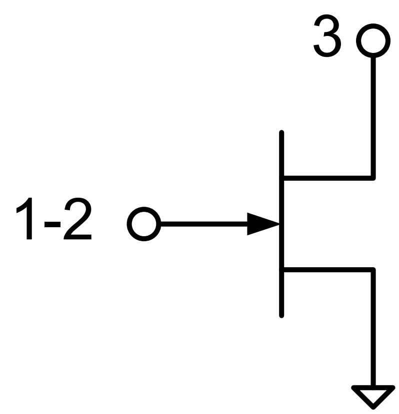
- Defense & Aerospace
- Broadband Wireless



Product Features

- Frequency Range: DC - 18 GHz
- 41.2 dBm Nominal P_{SAT} at 6 GHz
- 63.4% Maximum PAE at 6 GHz
- 18 dB Linear Gain at 6 GHz
- Bias: V_D = 12 - 32 V, I_{DQ} = 50 - 125 mA
- Technology: QGaN25 on SiC
- Chip Dimensions: 0.82 x 0.92 x 0.10 mm

Functional Block Diagram



General Description

The Qorvo TGF2023-2-02 is a discrete 2.5 mm GaN on SiC HEMT which operates from DC-18 GHz. The TGF2023-2-02 is designed using Qorvo's proven QGaN25 production process. This process features advanced field plate techniques to optimize microwave power and efficiency at high drain bias operating conditions.

The TGF2023-2-02 typically provides 41.2 dBm of saturated output power with power gain of 14.9 dB at 6GHz. The maximum power added efficiency is 63.4 % which makes the TGF2023-2-02 appropriate for high efficiency applications.

Lead-free and RoHS compliant

Pad Configuration

Pad No.	Symbol
1-2	V_G / RF IN
3	V_D / RF OUT
Backside	Source / Ground

Ordering Information

Part	ECCN	Description
TGF2023-2-02	EAR99	12 Watt GaN HEMT

Absolute Maximum Ratings

Parameter	Value
Drain to Gate Voltage (V_{DG})	100 V
Gate Voltage Range (V_G)	−10 to 0 V
Drain Current (I_D)	2.5 A
Gate Current (I_G)	−2.5 to 7 mA
Power Dissipation (P_D)	See graph on pg.5.
CW Input Power (P_{IN})	+34 dBm
Channel Temperature (T_{CH})	275 °C
Mounting Temperature (30 Sec.)	320 °C
Storage Temperature	−65 to 150 °C

Operation of this device outside the parameter ranges given above may cause permanent damage. These are stress ratings only, and functional operation of the device at these conditions is not implied.

Recommended Operating Conditions[1]

Parameter	Value
Drain Voltage Range (V_D)	12 – 40 V
Drain Quiescent Current (I_{DQ})	125 mA
Drain Current Under RF Drive (I_D)	750 mA (Typ.)
Gate Voltage (V_G)	−3.0 V (Typ.)
Channel Temperature (T_{CH})	225 °C (Max.)
Dissipation Power. CW (P_D)[3]	8.2 W
Dissipation Power, Pulsed (P_D)[2,3]	11 W

1. Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.
2. 684 uS Pulse Width, 10% Duty Cycle
3. Carrier plate temperature is at 85°C.

RF Characterization – Optimum Power Tune

Test conditions unless otherwise noted: T = 25°C.

Parameter	Typical Value								Units
Frequency (F)	3		6		8		10		GHz
Drain Voltage (V_D)	28	28	28	28	28	28	28	28	V
Bias Current (I_{DQ})	50	125	50	125	50	125	50	125	mA
Output P3dB (P_{3dB})	41.1	41	41.3	41.2	41.3	41.2	41.3	41.2	dBm
PAE @ P_{3dB} (PAE_{3dB})	60.9	60.1	59.1	59.0	57.2	57.0	55	55.4	%
Gain @ P3dB (G_{3dB})	19.4	20.3	14.1	14.9	11.8	12.5	10.0	10.8	dB
Parallel Resistance (1) (R_p)	63.7	63.6	61.3	62.1	58.7	58.3	54.7	54.4	Ω·mm
Parallel Capacitance (1) (C_p)	0.287	0.275	0.315	0.313	0.316	0.317	0.328	0.329	pF/mm
Load Reflection Coefficient (2) (Γ_L)	0.445∠18°	0.44∠17°	0.46∠39°	0.46∠38°	0.47∠50°	0.47∠50°	0.48∠63°	0.48∠63°	--

Notes:
1. Large signal equivalent output network (normalized).
2. Characteristic Impedance (Zo) = 10 Ω.

RF Characterization – Optimum Efficiency Tune

Test conditions unless otherwise noted: T = 25°C.

Parameter	Typical Value								Units
Frequency (F)	3		6		8		10		GHz
Drain Voltage (V_D)	28	28	28	28	28	28	28	28	V
Bias Current (I_{DQ})	50	125	50	125	50	125	50	125	mA
Output P3dB (P_{3dB})	39.7	39.8	40.1	40.2	40.1	40.2	40.4	40.3	dBm
PAE @ P_{3dB} (PAE_{3dB})	66.2	65	64.2	63.4	62.2	61.8	59.5	59.7	%
Gain @ P3dB (G_{3dB})	20.9	21.7	15.4	16.1	13.2	13.5	11.1	11.7	dB
Parallel Resistance (1) (R_p)	111	108	101	97.1	96.4	91.6	83.4	83	Ω·mm
Parallel Capacitance (1) (C_p)	0.357	0.350	0.368	0.365	0.376	0.376	0.373	0.381	pF/mm
Load Reflection Coefficient (2) (Γ_L)	0.64∠20°	0.63∠20°	0.64∠40°	0.63∠40°	0.65∠53°	0.64∠53°	0.64∠64°	0.64∠65°	--

Notes:
1. Large signal equivalent output network (normalized).
2. Characteristic Impedance (Zo) = 10 Ω.

Thermal and Reliability - CW (1)

Parameter	Test Conditions	Value	Units
Thermal Resistance, θ_{JC}	P_D = 2.5 W, Tbaseplate = 85°C	12.0	°C/W
Channel Temperature, T_{CH}		115	°C
Median Lifetime, T_M		1.9E11	Hrs
Thermal Resistance, θ_{JC}	P_D = 5.0 W, Tbaseplate = 85°C	13.0	°C/W
Channel Temperature, T_{CH}		150	°C
Median Lifetime, T_M		2.4E9	Hrs
Thermal Resistance, θ_{JC}	P_D = 7.5 W, Tbaseplate = 85°C	14.0	°C/W
Channel Temperature, T_{CH}		190	°C
Median Lifetime, T_M		4.0E7	Hrs
Thermal Resistance, θ_{JC}	P_D = 10.0 W, Tbaseplate = 85°C	15.4	°C/W
Channel Temperature, T_{CH}		239	°C
Median Lifetime, T_M		6.1E5	Hrs
Thermal Resistance, θ_{JC}	P_D = 12.5 W, Tbaseplate = 85°C	17.1	°C/W
Channel Temperature, T_{CH}		299	°C
Median Lifetime, T_M		9.0E3	Hrs

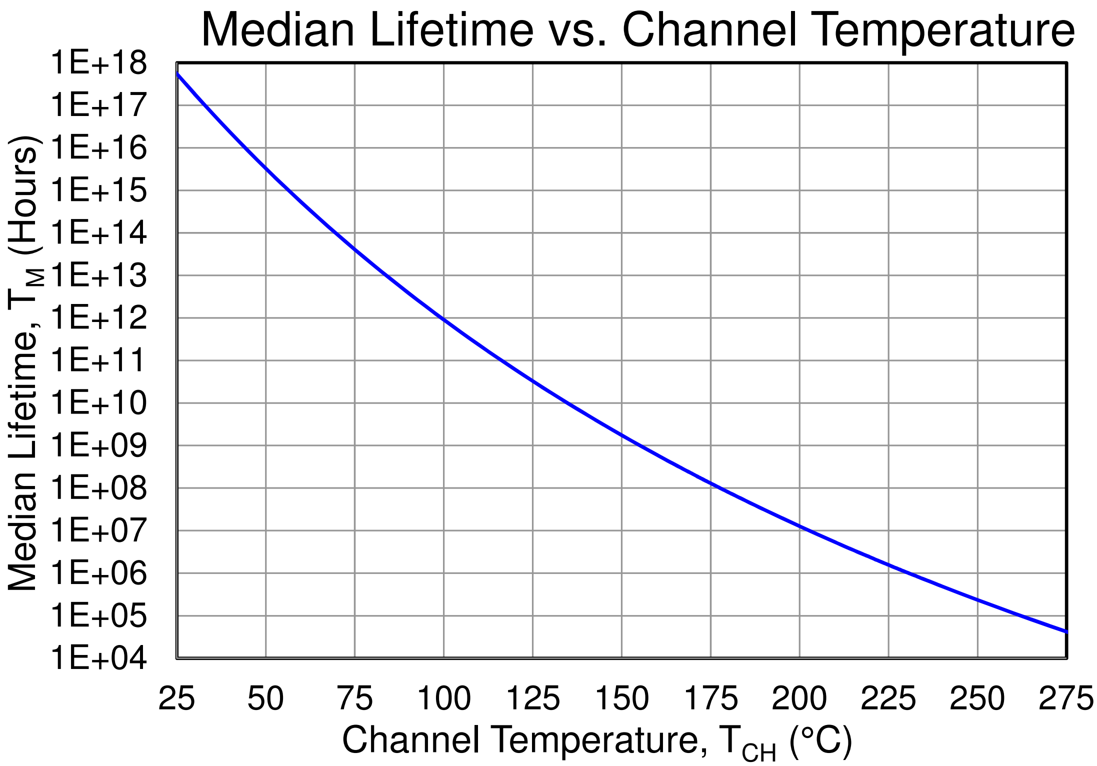
Notes:
1. Assumes eutectic attach using 1.5 mil thick 80/20 AuSn mounted to a 10 mm x 10 mm x 40 mil CuMo Carrier Plate.

Thermal and Reliability - Pulsed (1)

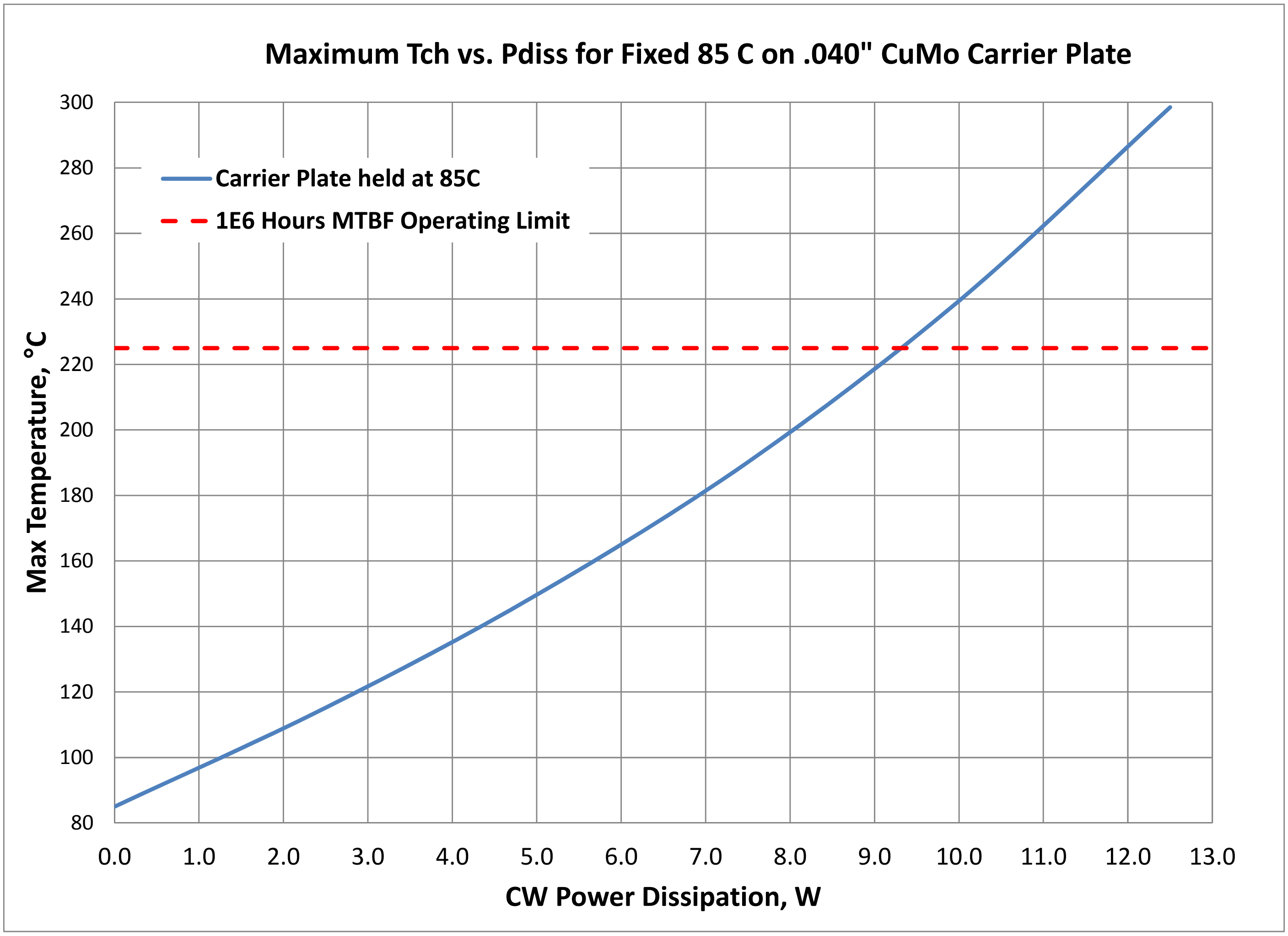
Parameter	Test Conditions	Value	Units
Thermal Resistance, θ_{JC}	P_D = 11 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 5%	9.5	°C/W
Channel Temperature, T_{CH}		190	°C
Median Lifetime, T_M		8.0E8	Hrs
Thermal Resistance, θ_{JC}	P_D = 11 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 10%	9.8	°C/W
Channel Temperature, T_{CH}		193	°C
Median Lifetime, T_M		3.0E8	Hrs
Thermal Resistance, θ_{JC}	P_D = 11 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 20%	10.4	°C/W
Channel Temperature, T_{CH}		199	°C
Median Lifetime, T_M		8.5E7	Hrs
Thermal Resistance, θ_{JC}	P_D = 11 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 50%	12.4	°C/W
Channel Temperature, T_{CH}		221	°C
Median Lifetime, T_M		5.1E6	Hrs

Notes:
1. Assumes eutectic attach using 1.5 mil thick 80/20 AuSn mounted to a 10 mm x 10 mm x 40 mil CuMo Carrier Plate.

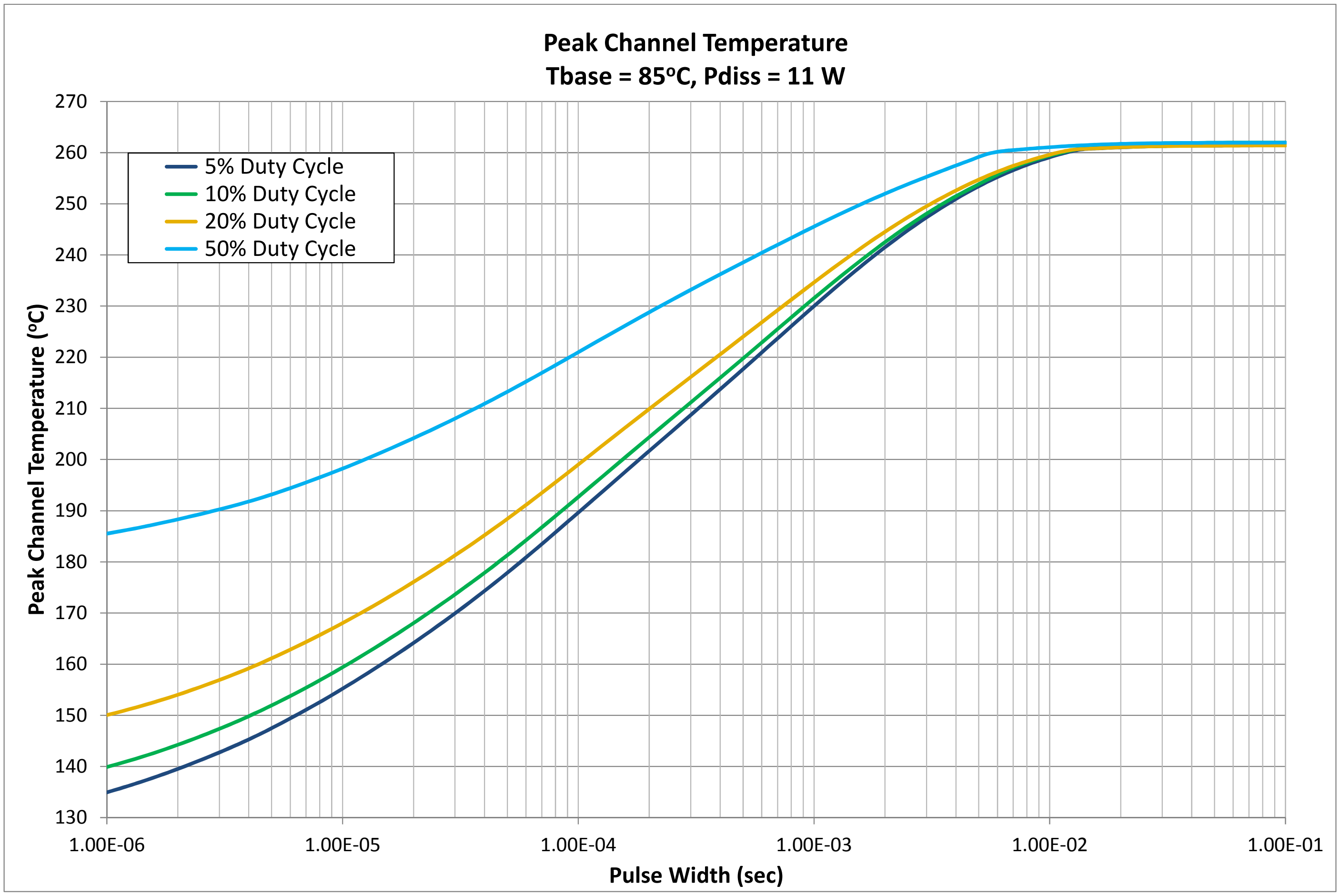
Median Lifetime



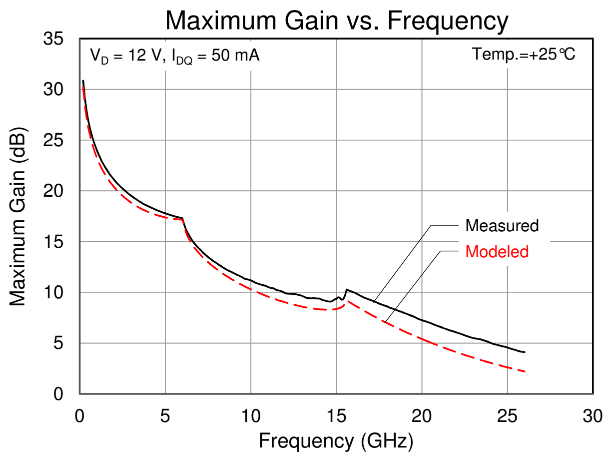
Maximum Channel Temperature - CW

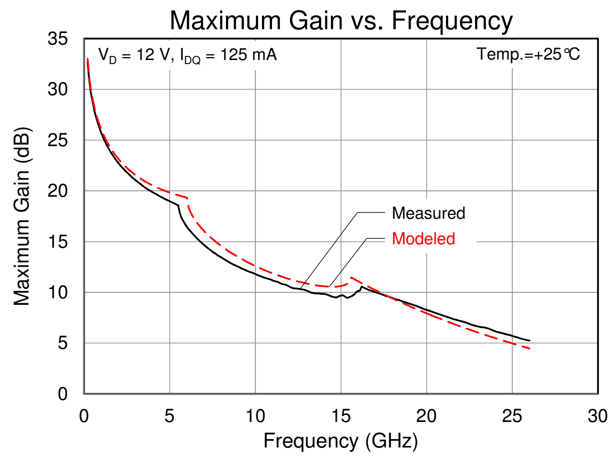


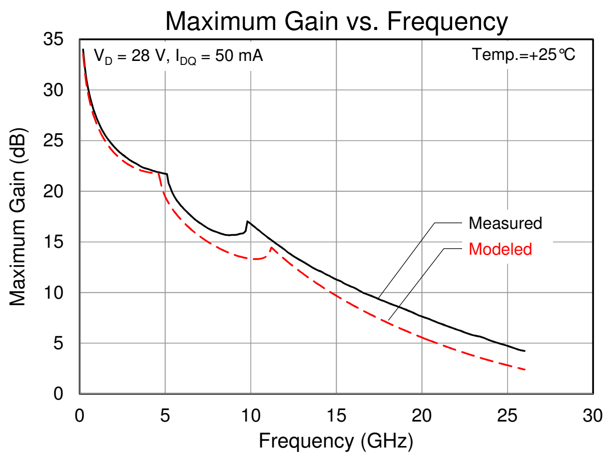
Peak Channel Temperature - Pulsed

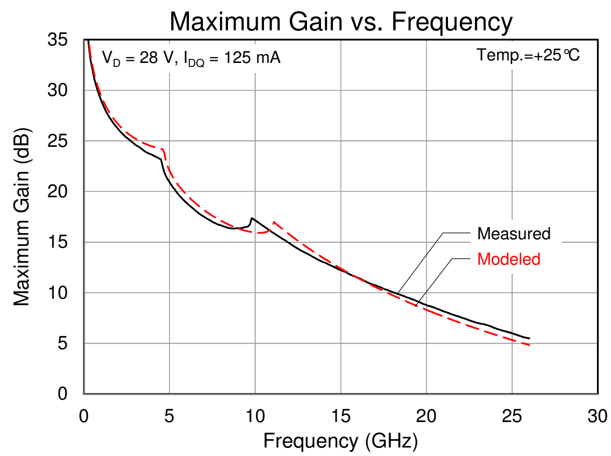


Measured Maximum Gain





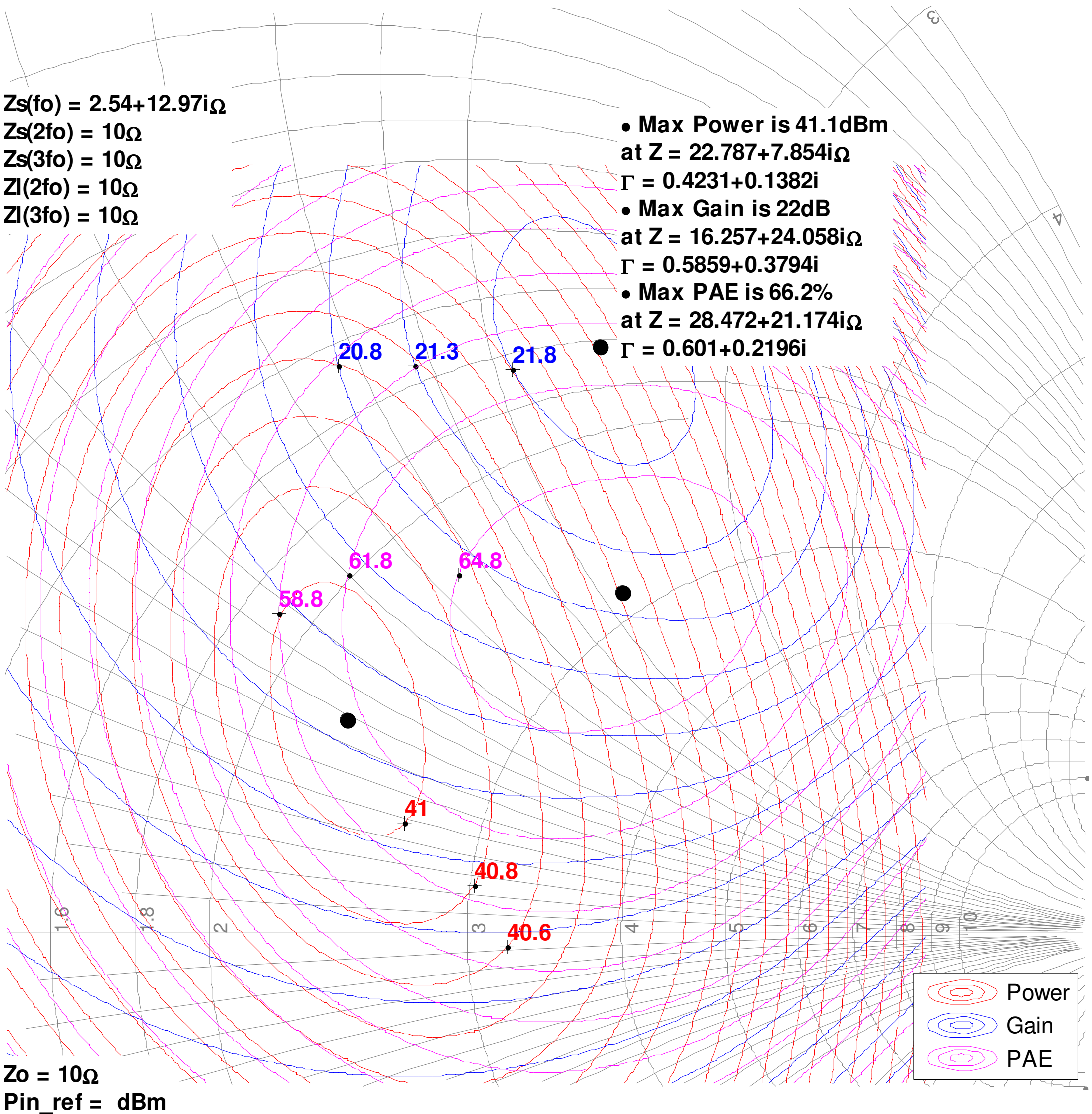




Model Load Pull Contours

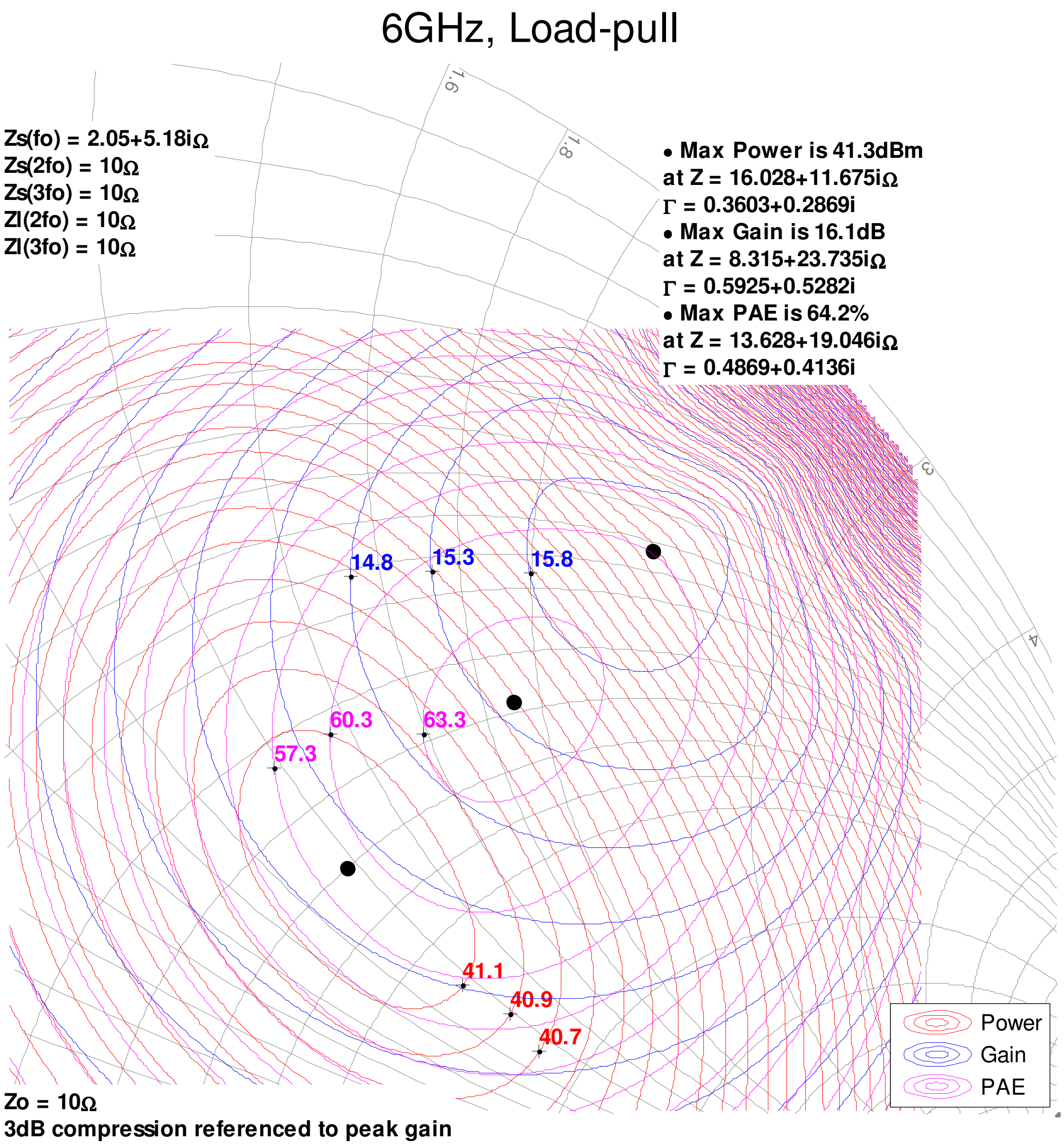
Simulated signal: 10% pulses
Vd = 28 V, Idq = 50 mA

3GHz, Load-pull



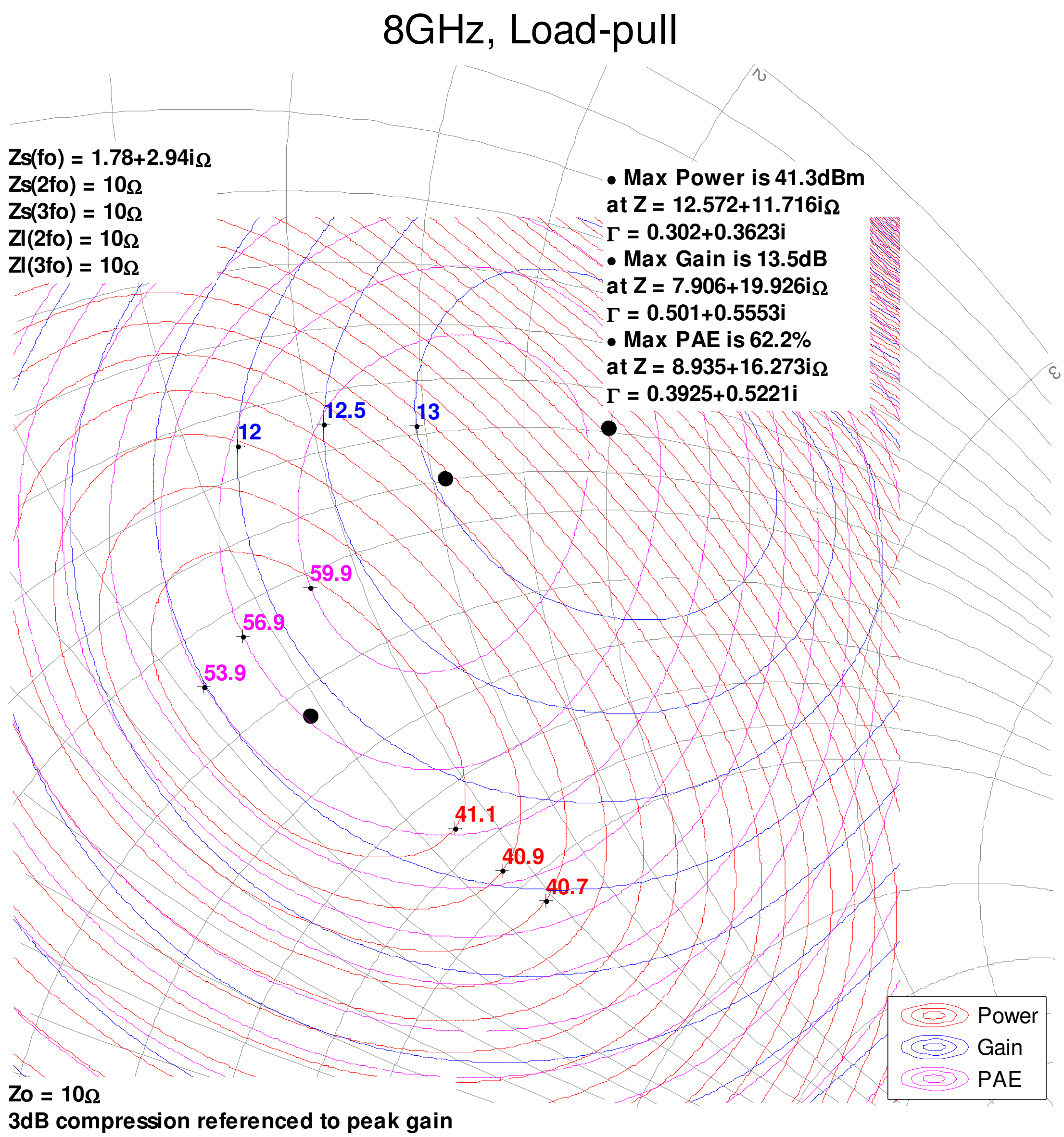
Model Load Pull Contours

Simulated signal: 10% pulses
Vd = 28 V, Idq = 50 mA



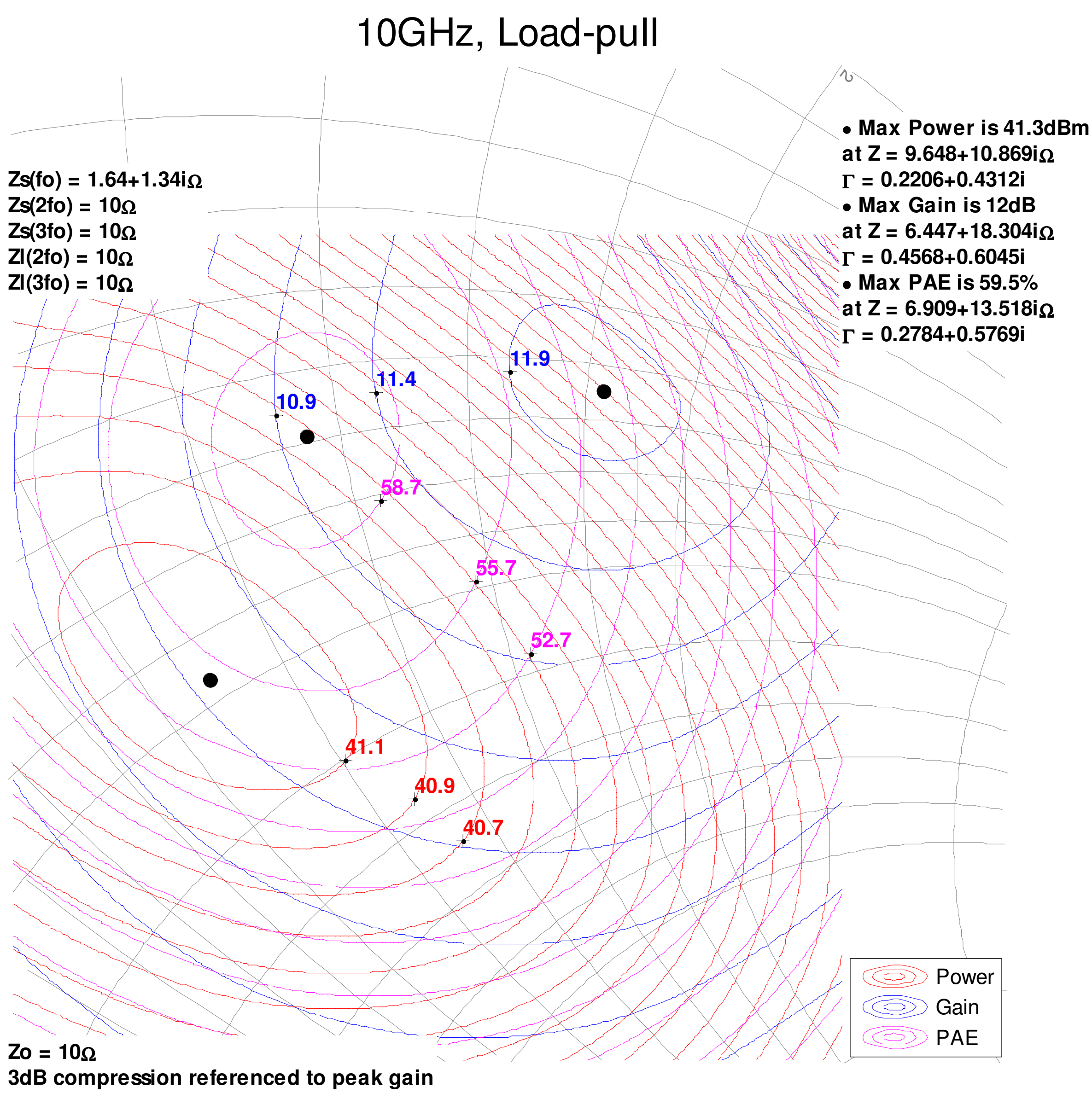
Model Load Pull Contours

Simulated signal: 10% pulses
Vd = 28 V, Idq = 50 mA



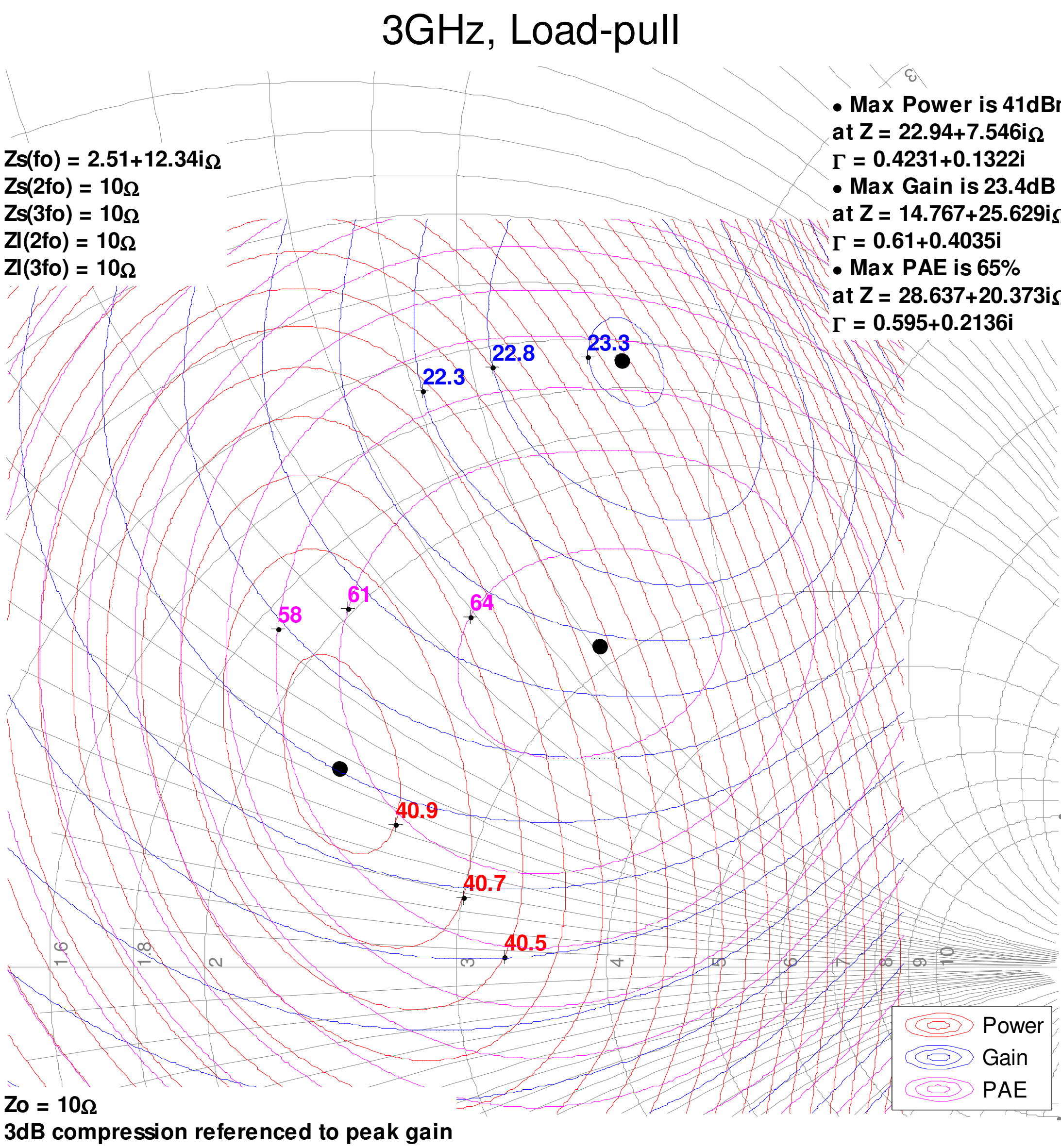
Load Pull Contours

Simulated signal: 10% pulses
Vd = 28 V, Idq = 50 mA



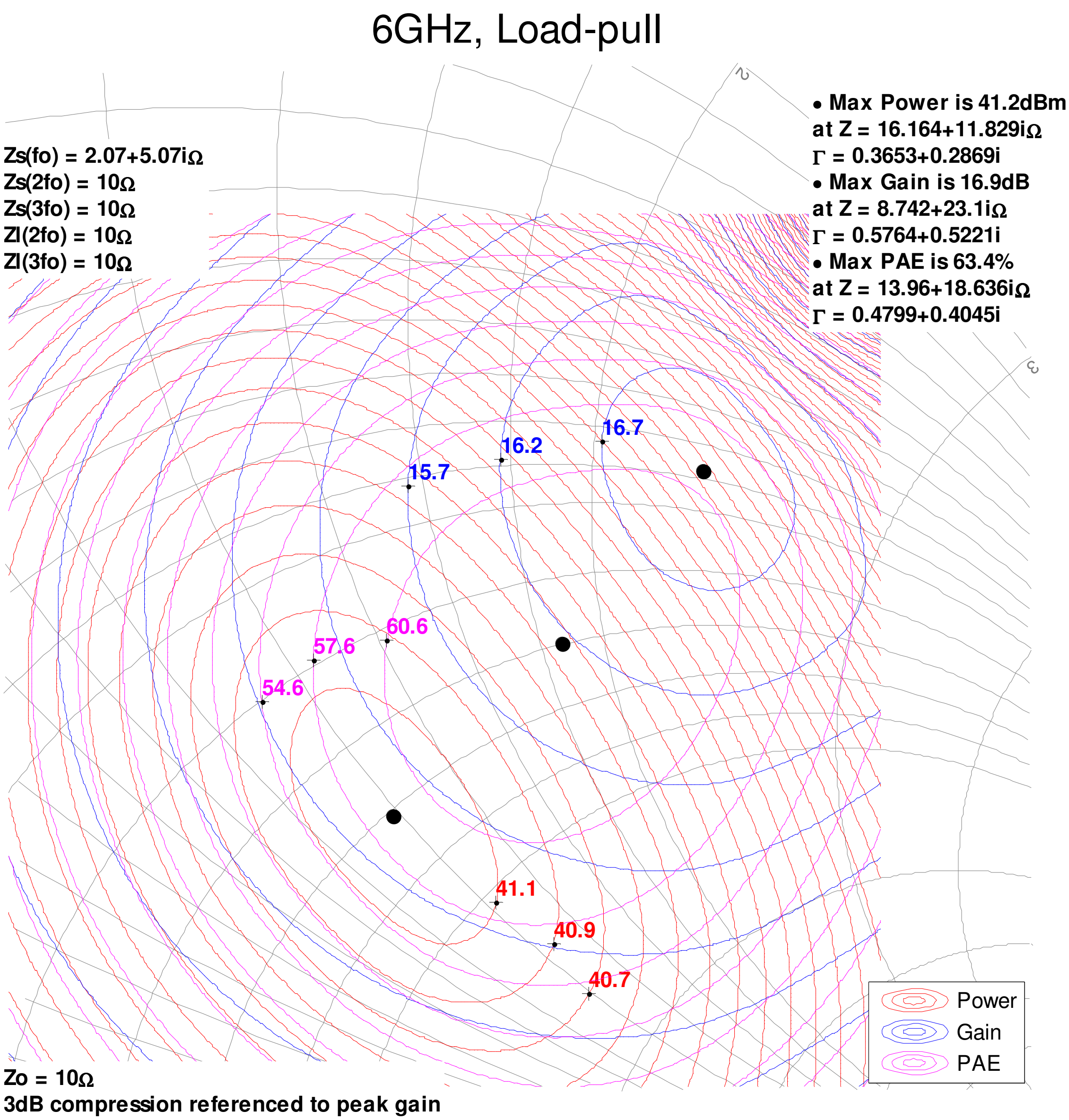
Load Pull Contours

Simulated signal: 10% pulses
Vd = 28 V, Idq = 125 mA



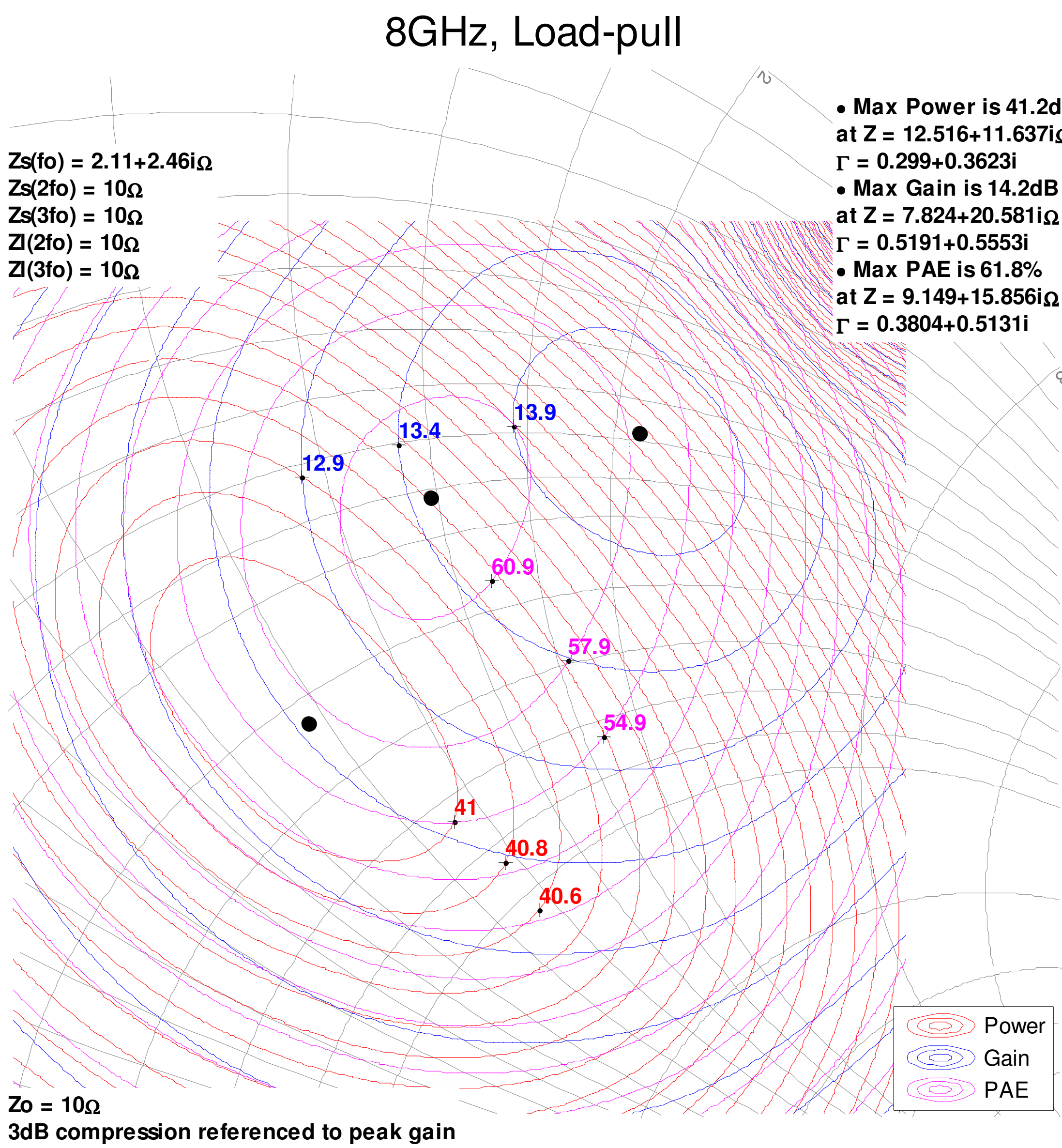
Load Pull Contours

Simulated signal: 10% pulses
Vd = 28 V, Idq = 125 mA



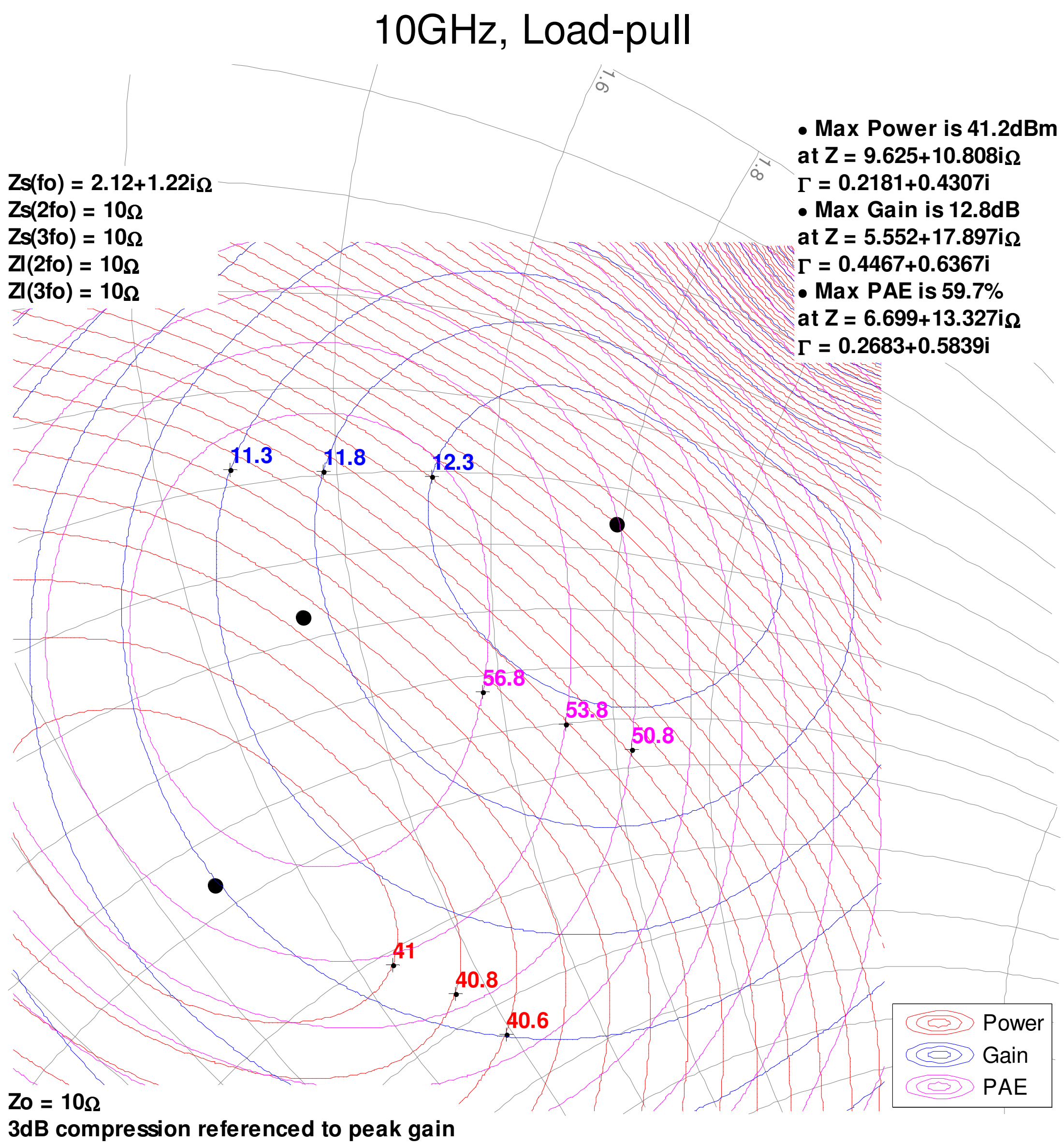
Load Pull Contours

Simulated signal: 10% pulses
Vd = 28 V, Idq = 125 mA

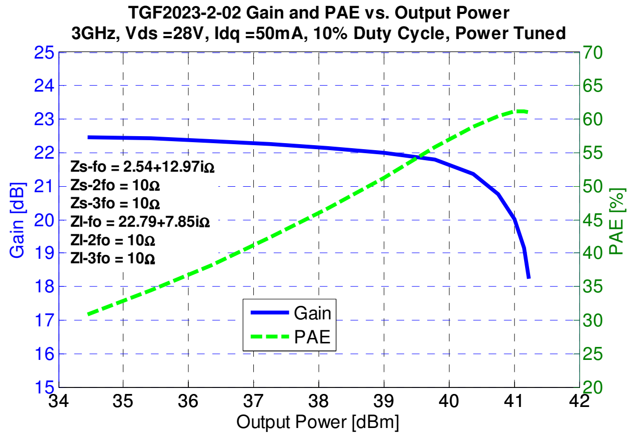


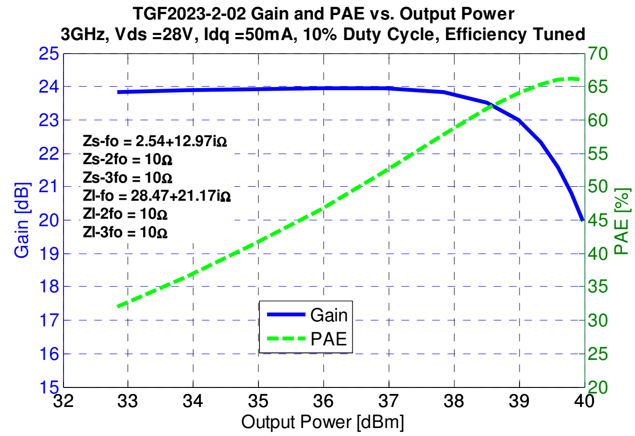
Load Pull Contours

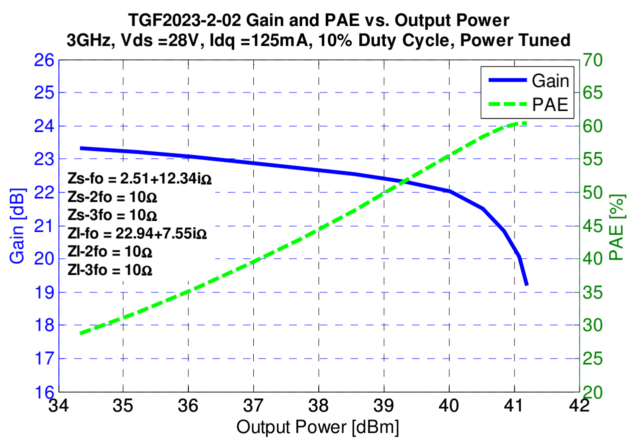
Simulated signal: 10% pulses
Vd = 28 V, Idq = 125 mA

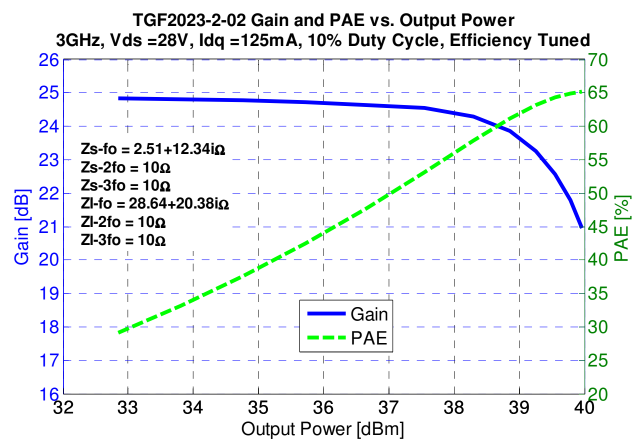


Model Drive-up Data – 3 GHz

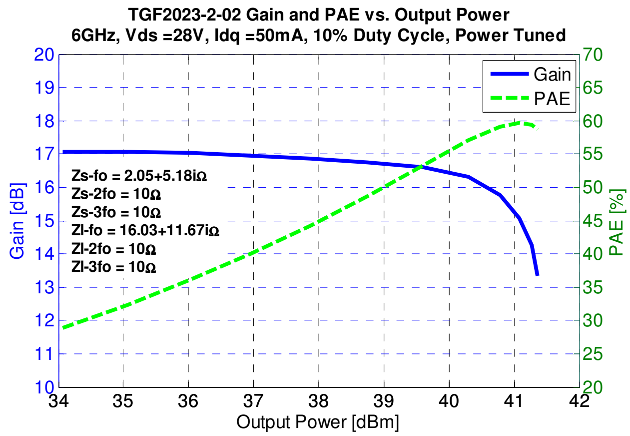


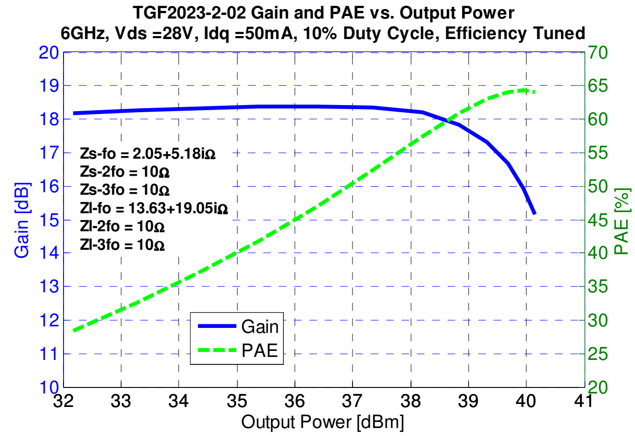


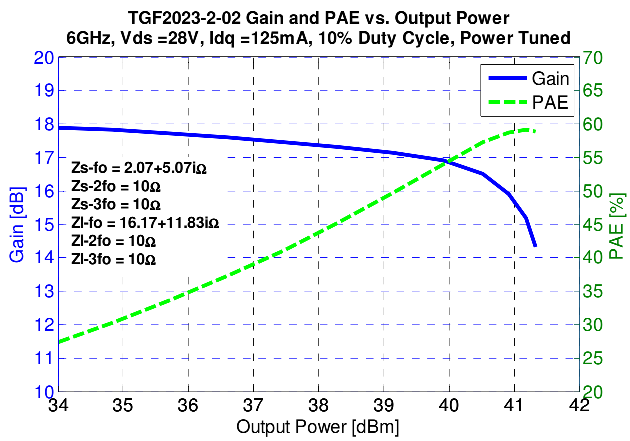


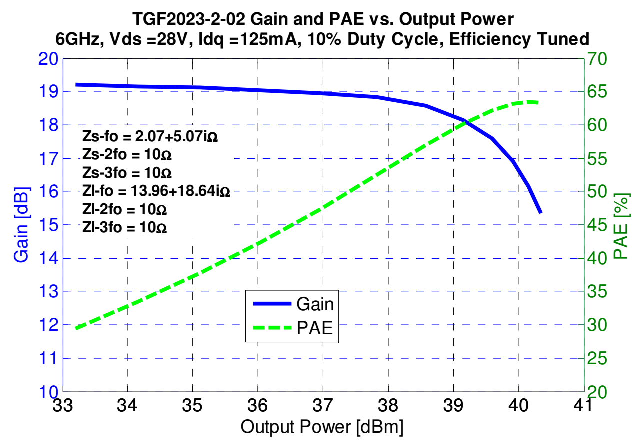


Model Drive-up Data – 6 GHz

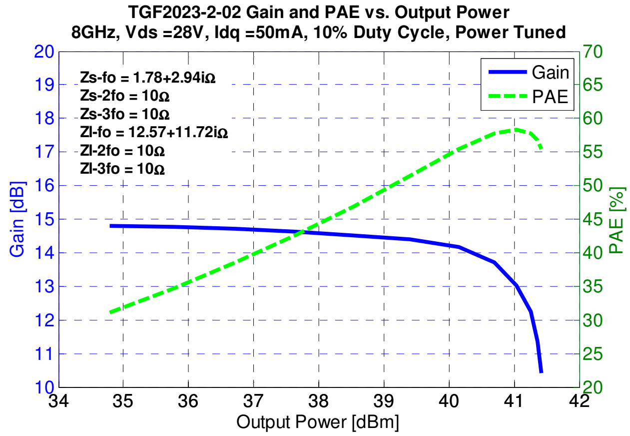


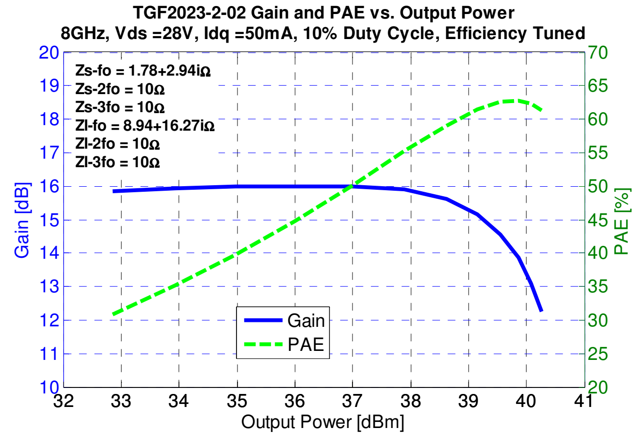


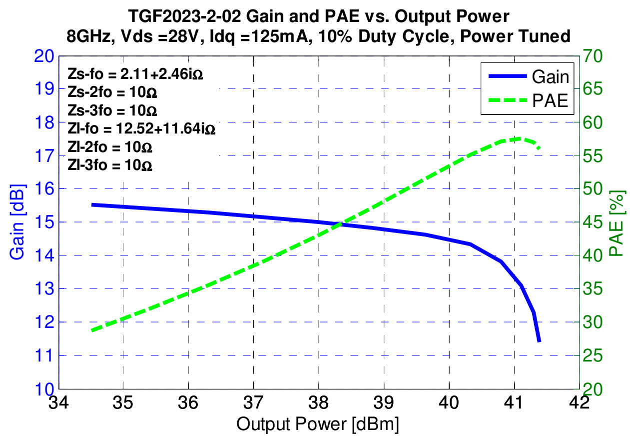


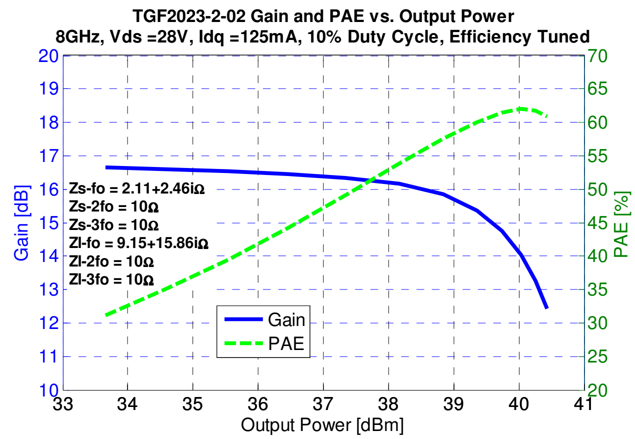


Model Drive-up Data – 8 GHz

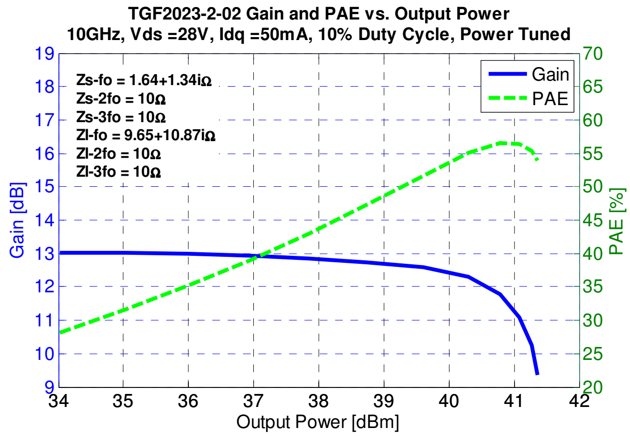


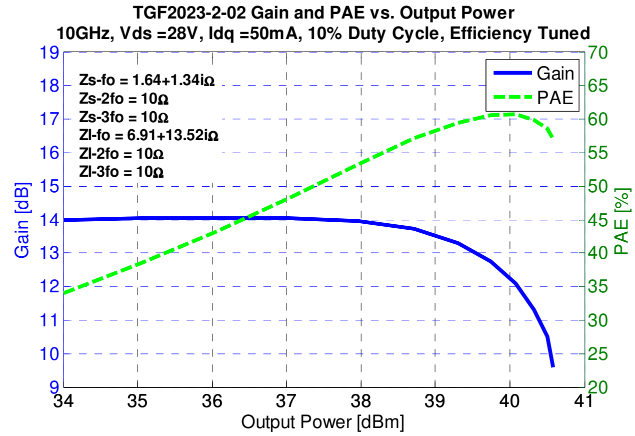


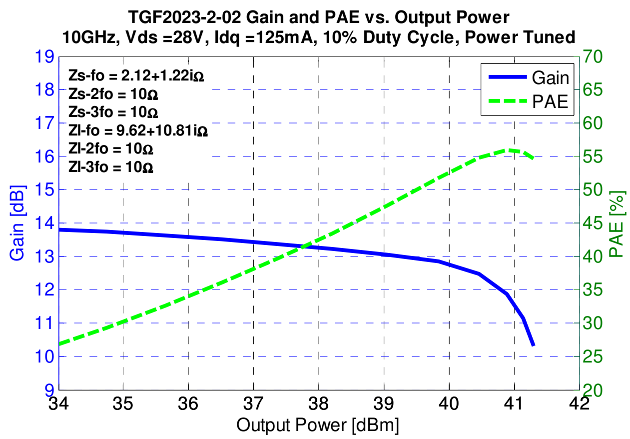


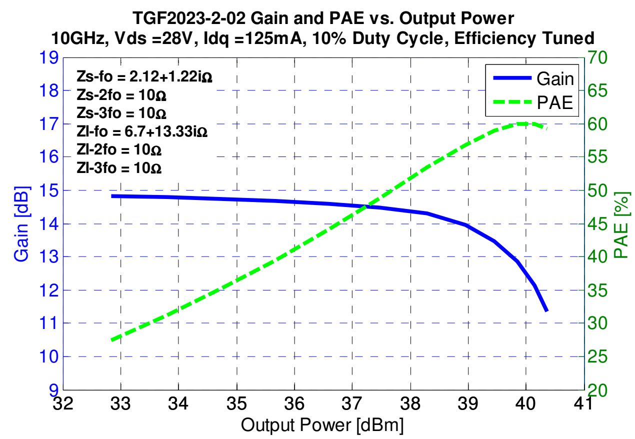


Model Drive-up Data – 10 GHz





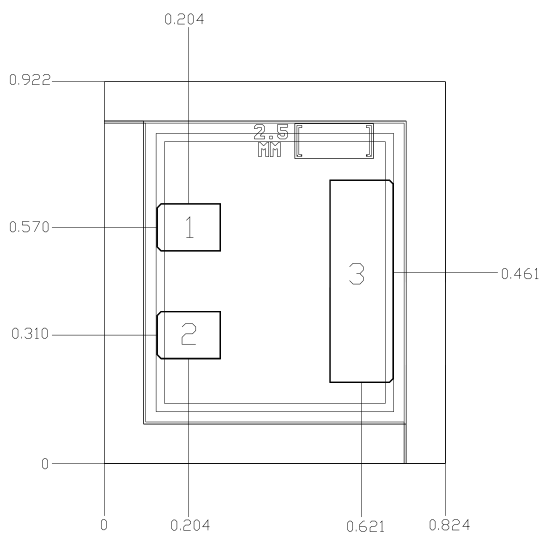




Model

A non-linear model is available for download from Modelithics (at http://www.modelithics.com/mvp/Qorvo&tab=3) by approved Qorvo customers. The model is compatible with the industry's most popular design software including Agilent ADS and National Instruments/AWR applications. Once on the Modelithics web page, the user will need to register for a free license before being granted the download.

Mechanical Drawing



Notes:

1. Units: millimeters
2. Thickness: 0.100 mm
3. Die x,y size tolerance: +/- 0.050 mm

Bond Pads

Pad No.	Description	Dimensions
1-2	Gate	0.154 x 0.115
3	Drain	0.154 x 0.490
Die Backside	Source / Ground	0.824 x 0.922

Assembly Notes

Component placement and adhesive attachment assembly notes:

- Vacuum pencils and/or vacuum collets are the preferred method of pick up.
- Air bridges must be avoided during placement.
- The force impact is critical during auto placement.
- Organic attachment (i.e. epoxy) not recommended.

Reflow process assembly notes:

- Use AuSn (80/20) solder and limit exposure to temperatures above 300°C to 3-4 minutes, maximum.
- An alloy station or conveyor furnace with reducing atmosphere should be used.
- Do not use any kind of flux.
- Coefficient of thermal expansion matching is critical for long-term reliability.
- Devices must be stored in a dry nitrogen atmosphere.

Interconnect process assembly notes:

- Ball bonding is the preferred interconnect technique, except where noted on the assembly diagram.
- Force, time, and ultrasonics are critical bonding parameters.
- Aluminum wire should not be used.
- Devices with small pad sizes should be bonded with 0.0007-inch wire.

Disclaimer

GaN/SiC devices are susceptible to damage from Electrostatic Discharge. Proper precautions should be observed during handling, assembly and test.

Bias-up Procedure

1. Set V_G to –5 V.
2. Set I_D limit to 140 mA.
3. Set V_D to 28 V.
4. Adjust V_G more positive until quiescent I_D is 125 mA.
5. Set I_D limit to 1 A.
6. Apply RF signal.

Bias-down Procedure

1. Turn off RF signal.
2. Turn off V_D and wait 1 second to allow drain capacitor dissipation.
3. Turn off V_G.