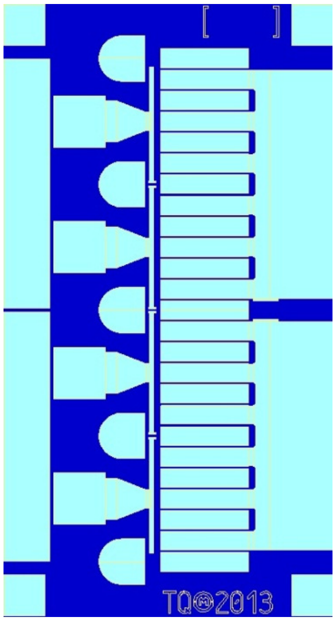
TGF2954

27 Watt Discrete Power GaN on SiC HEMT

Applications

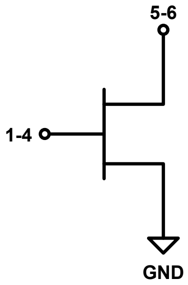
- Marine radar
- Satellite communications
- Point to point communications
- Military communications
- Broadband amplifiers
- High efficiency amplifiers



Product Features

- Frequency Range: DC - 12 GHz
- 44.5 dBm Nominal P_{SAT} at 3 GHz
- 71.6% Maximum PAE at 3 GHz
- 19.6 dB Nominal Power Gain at 3 GHz
- Bias: V_D = 32 V, I_{DQ} = 100 mA
- Technology: TQGaN25 on SiC
- Chip Dimensions: 1.01 x 1.68 x 0.10 mm

Functional Block Diagram



General Description

The TriQuint TGF2954 is a discrete 5.04 mm GaN on SiC HEMT which operates from DC-12 GHz. The TGF2954 is designed using TriQuint's proven TQGaN25 production process. This process features advanced field plate techniques to optimize microwave power and efficiency at high drain bias operating conditions.

The TGF2954 typically provides 44.5 dBm of saturated output power with power gain of 19.5 dB at 3 GHz. The maximum power added efficiency is 71.5 % which makes the TGF2954 appropriate for high efficiency applications.

Lead-free and RoHS compliant.

Pad Configuration

Pad No.	Symbol
1-4	V_G / RF IN
5-6	V_D / RF OUT
Backside	Source / Ground

Ordering Information

Part	ECCN	Description
TGF2954	3A001b.3.b	27 Watt GaN HEMT

Absolute Maximum Ratings

Parameter	Value
Drain to Gate Voltage (V_{DG})	100 V
Drain Voltage (V_D)	40 V
Gate Voltage Range (V_G)	-10 to 0 V
Drain Current (I_D)	3 A
Gate Current (I_G)	-5.04 to 8.4 mA
CW Power Dissipation (P_D) @ 10GHz	34.5 W
CW Input Power (P_{IN}) @ 10GHz	37 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

Parameter	Value
Drain Voltage Range (V_D)	32 V
Drain Quiescent Current (I_{DQ})	100 mA
Drain Current Under RF Drive (I_D)(1)	1.7 A
Pinch-off Gate Voltage (V_G)	–3.5 V (Typ.)
Channel Temperature (T_{CH})	225°C (Max.)

(1) 10% pulses at 3GHz, Power Tuned

RF Characterization – Model Optimum Power Tune

Simulation conditions unless otherwise noted: T = 25°C, Bond wires not included, Pulse: 100uS PW, 10%. See page 17 for reference planes.

Parameter	Typical Value					Units
Frequency (F)	1	3	6	10	15	GHz
Drain Voltage (V_D)	32	32	32	32	32	V
Bias Current (I_{DQ})	50	50	50	50	50	mA
Output P3dB (P_{3dB})	44.5	44.5	44.5	44.3	44.2	dBm
PAE @ P_{3dB} (PAE_{3dB})	64.5	64.6	57.9	52.1	44.6	%
Gain @ P3dB (G_{3dB})	26.8	19.6	14.6	10.8	7.5	dB
Parallel Output Resistance (1) (R_p)	95.7	94.3	86.8	67.2	36.5	Ω·mm
Parallel Output Capacitance (1) (C_p)	-0.036	0.168	0.180	0.222	0.263	pF/mm
Load Impedance (ZL)	19.0-j0.41	17.2+j5.12	12.8+j7.52	7.09+j6.65	3.98+j3.60	Ω
Source Impedance (ZS)	2.49+j18.3	1.31+j6.14	1.05+j2.41	0.96+j0.60	0.92-j0.71	Ω

Notes:
1. Large signal equivalent output network (normalized).

RF Characterization – Model Optimum Efficiency Tune

Simulation conditions unless otherwise noted: T = 25°C, Bond wires not included, Pulse: 100uS PW, 10%. See page 17 for reference planes.

Parameter	Typical Value					Units
Frequency (F)	1	3	6	10	15	GHz
Drain Voltage (V_D)	32	32	32	32	32	V
Bias Current (I_{DQ})	50	50	50	50	50	mA
Output P3dB (P_{3dB})	43.2	43.0	43.0	43.7	43.3	dBm
PAE @ P_{3dB} (PAE_{3dB})	70.4	71.6	65.5	55.5	48.0	%
Gain @ P3dB (G_{3dB})	28.1	21.0	15.7	11.2	8.4	dB
Parallel Output Resistance (1) (R_p)	162.4	166.7	151.4	89.8	55.5	Ω·mm
Parallel Output Capacitance (1) (C_p)	0.285	0.295	0.290	0.275	0.317	pF/mm
Load Impedance (ZL)	29.7+j8.65	17.8+j16.5	8.06+j13.3	5.22+j8.11	2.94+j4.87	Ω
Source Impedance (ZS)	2.49+j18.3	1.31+j6.14	1.05+j2.41	0.96+j0.60	0.92-j0.71	Ω

Notes:
1. Large signal equivalent output network (normalized).

Thermal and Reliability Information - Pulsed(1)

Parameter	**Test Conditions**	**Value**	**Units**
Thermal Resistance, θ_{JC}	P_D = 25.2 W, Tbaseplate = 85℃ Pulse: 100uS, 5%	3.94	ºC/W
Channel Temperature, T_{CH}		184	℃
Median Lifetime, T_M		6.84E07	Hrs
Thermal Resistance, θ_{JC}	P_D = 25.2 W, Tbaseplate = 85℃ Pulse: 100uS, 10%	4.04	℃/W
Channel Temperature, T_{CH}		187	℃
Median Lifetime, T_M		5.39E07	Hrs
Thermal Resistance, θ_{JC}	P_D = 25.2 W, Tbaseplate = 85℃ Pulse: 100uS, 20%	4.26	ºC/W
Channel Temperature, T_{CH}		192	℃
Median Lifetime, T_M		3.18E07	Hrs
Thermal Resistance, θ_{JC}	P_D = 25.2 W, Tbaseplate = 85℃ Pulse: 100uS, 50%	4.93	ºC/W
Channel Temperature, T_{CH}		209	℃
Median Lifetime, T_M		6.99E06	Hrs

Notes:

1. Assumes eutectic attach using 1mil thick 80/20 AuSn mounted to a 10 mil CuMo Carrier Plate.

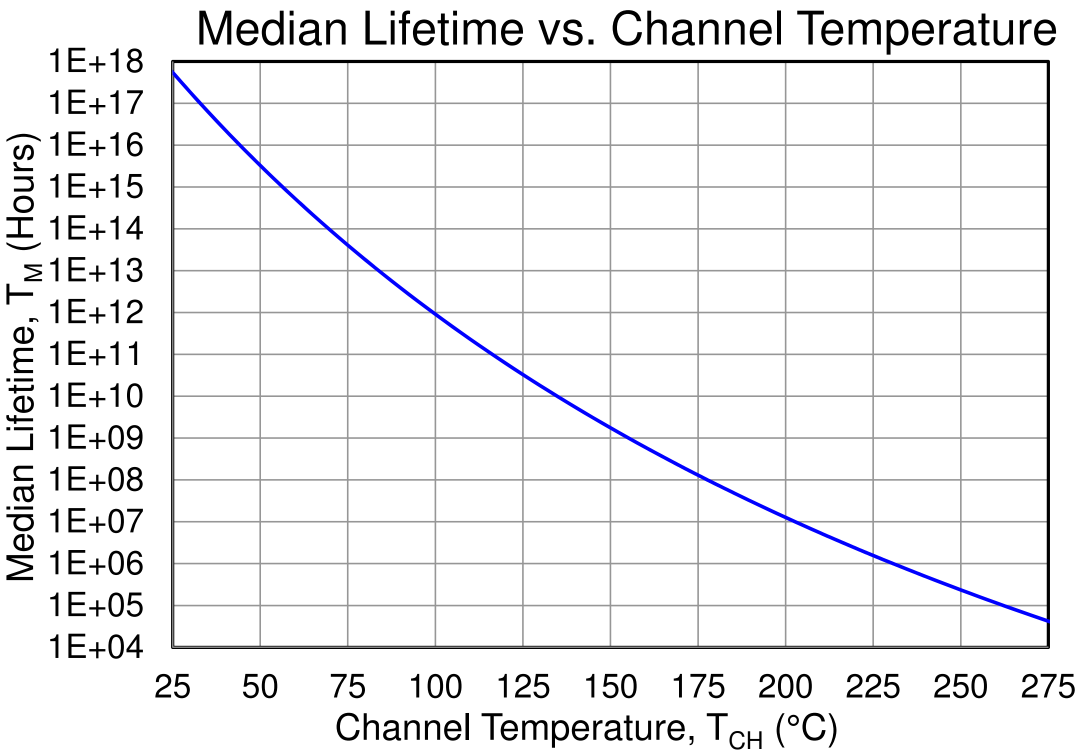
Thermal and Reliability Information - CW(1)

Parameter	**Test Conditions**	**Value**	**Units**
Thermal Resistance, θ_{JC}	P_D = 10.08 W, Tbaseplate = 85℃ CW	5.16	ºC/W
Channel Temperature, T_{CH}		137	℃
Median Lifetime, T_M		1.14E10	Hrs
Thermal Resistance, θ_{JC}	P_D = 15.12 W, Tbaseplate = 85℃ CW	5.49	℃/W
Channel Temperature, T_{CH}		168	℃
Median Lifetime, T_M		3.54E08	Hrs
Thermal Resistance, θ_{JC}	P_D = 20.16 W, Tbaseplate = 85℃ CW	5.85	ºC/W
Channel Temperature, T_{CH}		203	℃
Median Lifetime, T_M		1.19E07	Hrs
Thermal Resistance, θ_{JC}	P_D = 25.2 W, Tbaseplate = 85℃ CW	6.27	ºC/W
Channel Temperature, T_{CH}		243	℃
Median Lifetime, T_M		4.43E05	Hrs

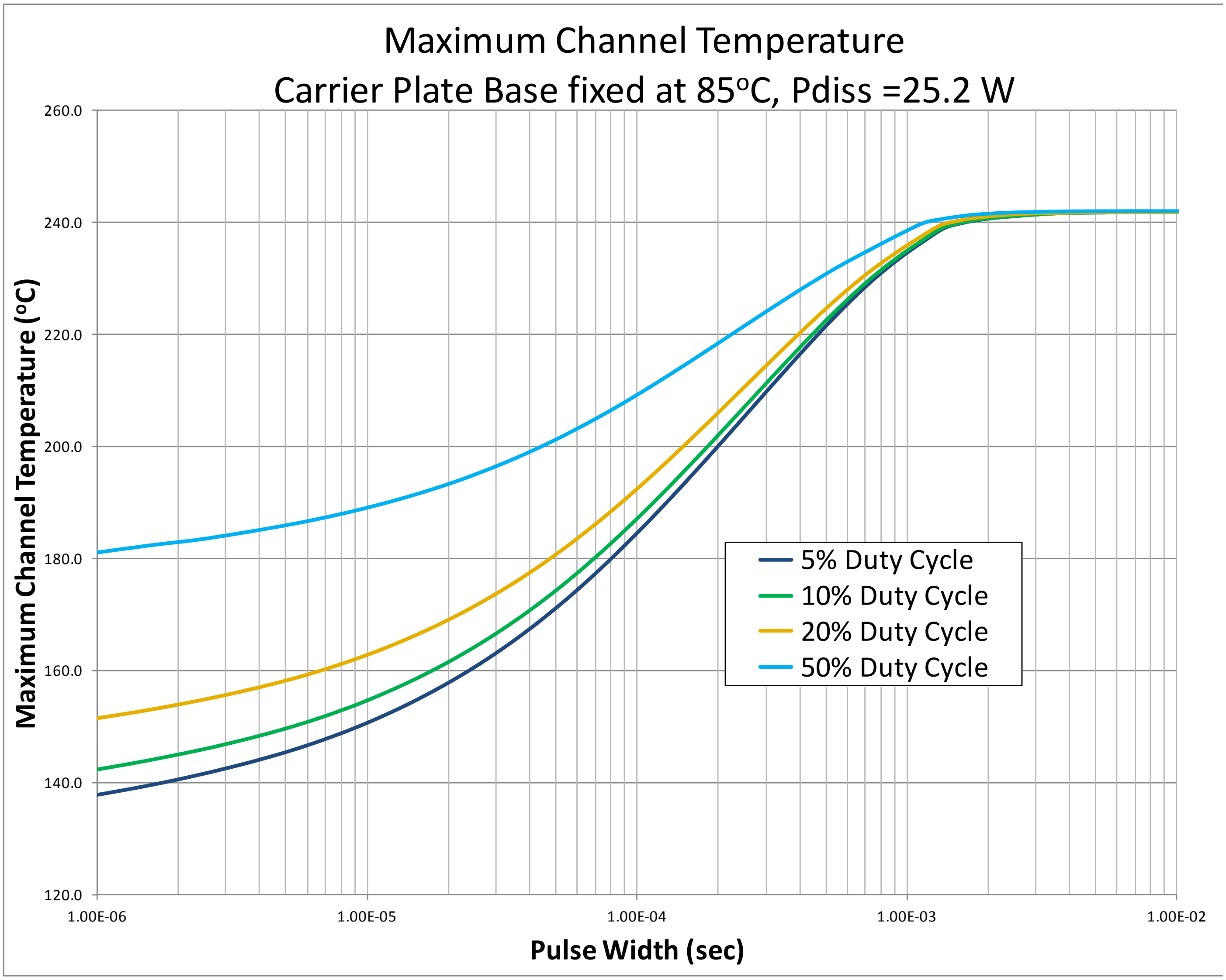
Notes:

1. Assumes eutectic attach using 1mil thick 80/20 AuSn mounted to a 10 mil CuMo Carrier Plate.

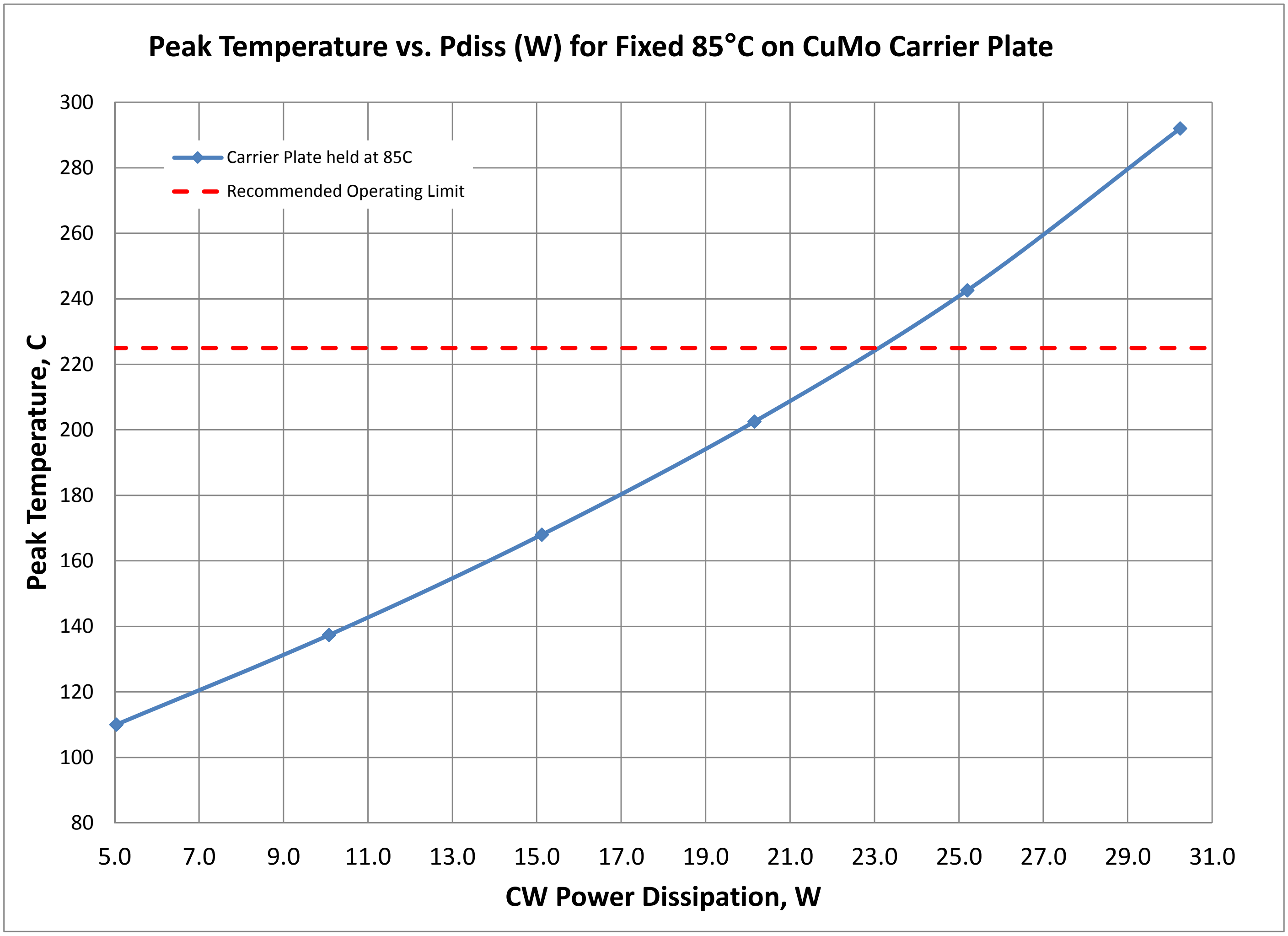
Median LifeTime



Maximum Channel Temperature - Pulsed

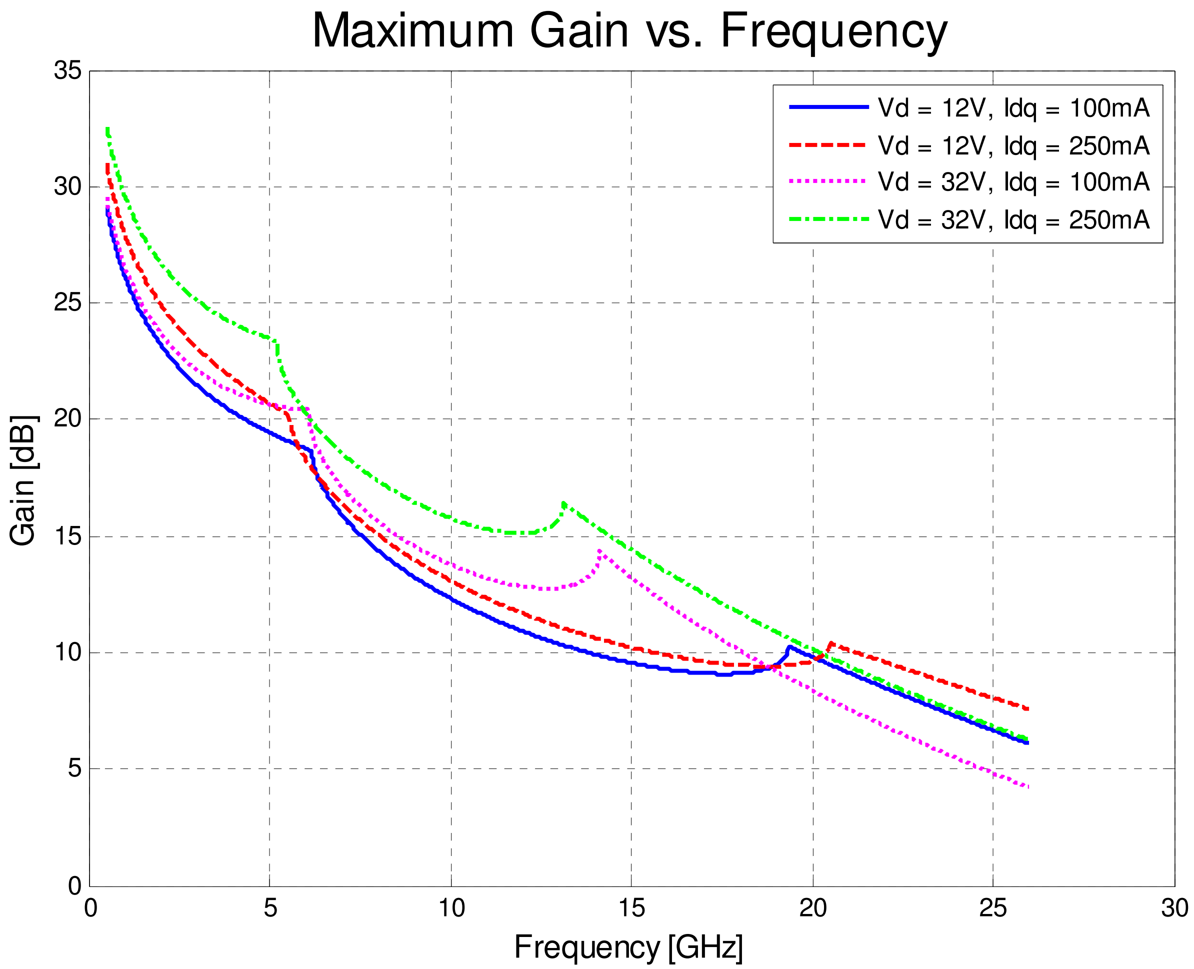


Maximum Channel Temperature - CW



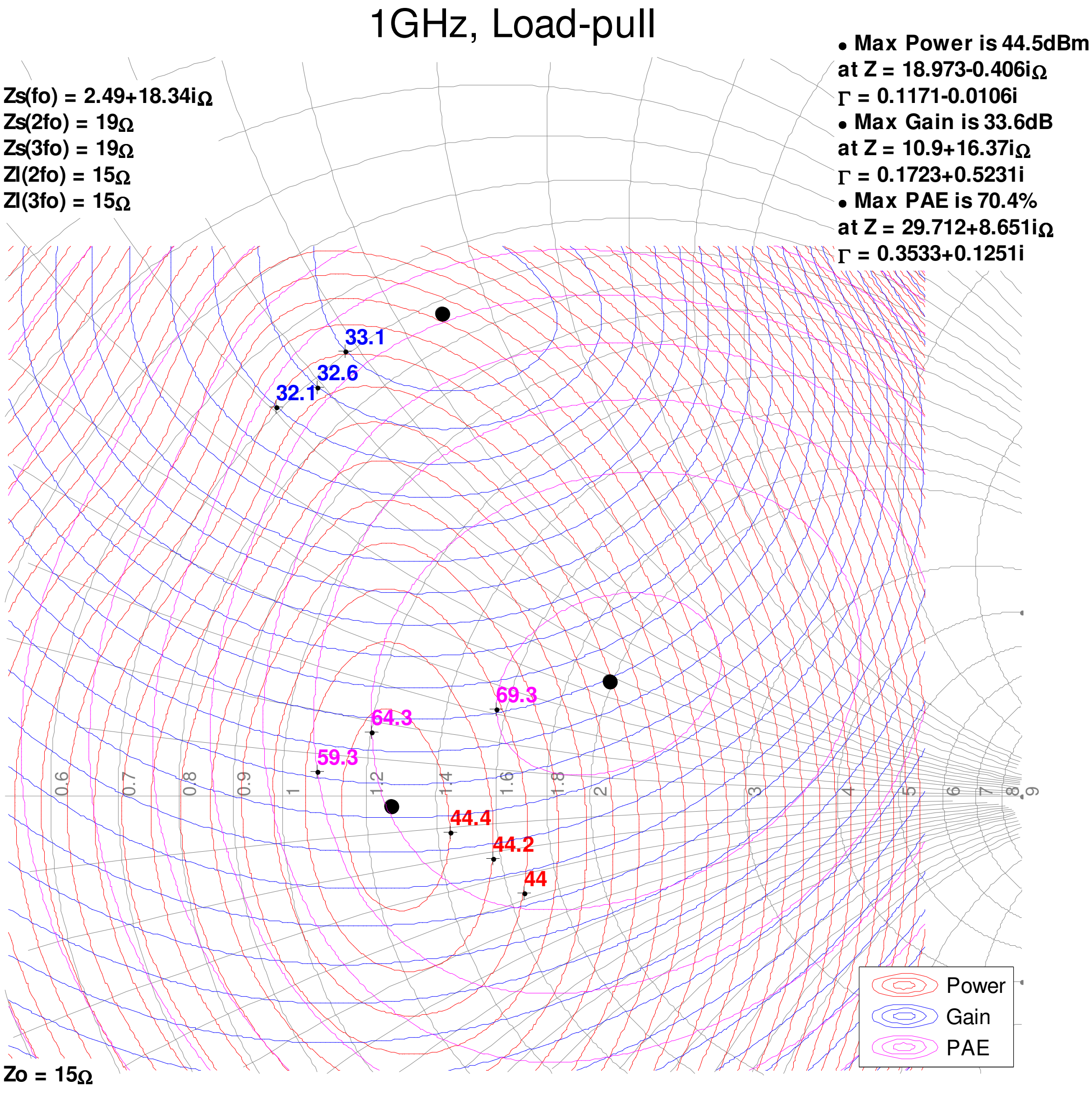
Model Maximum Gain Performance

Bond wires not included. See page 17 for reference planes.



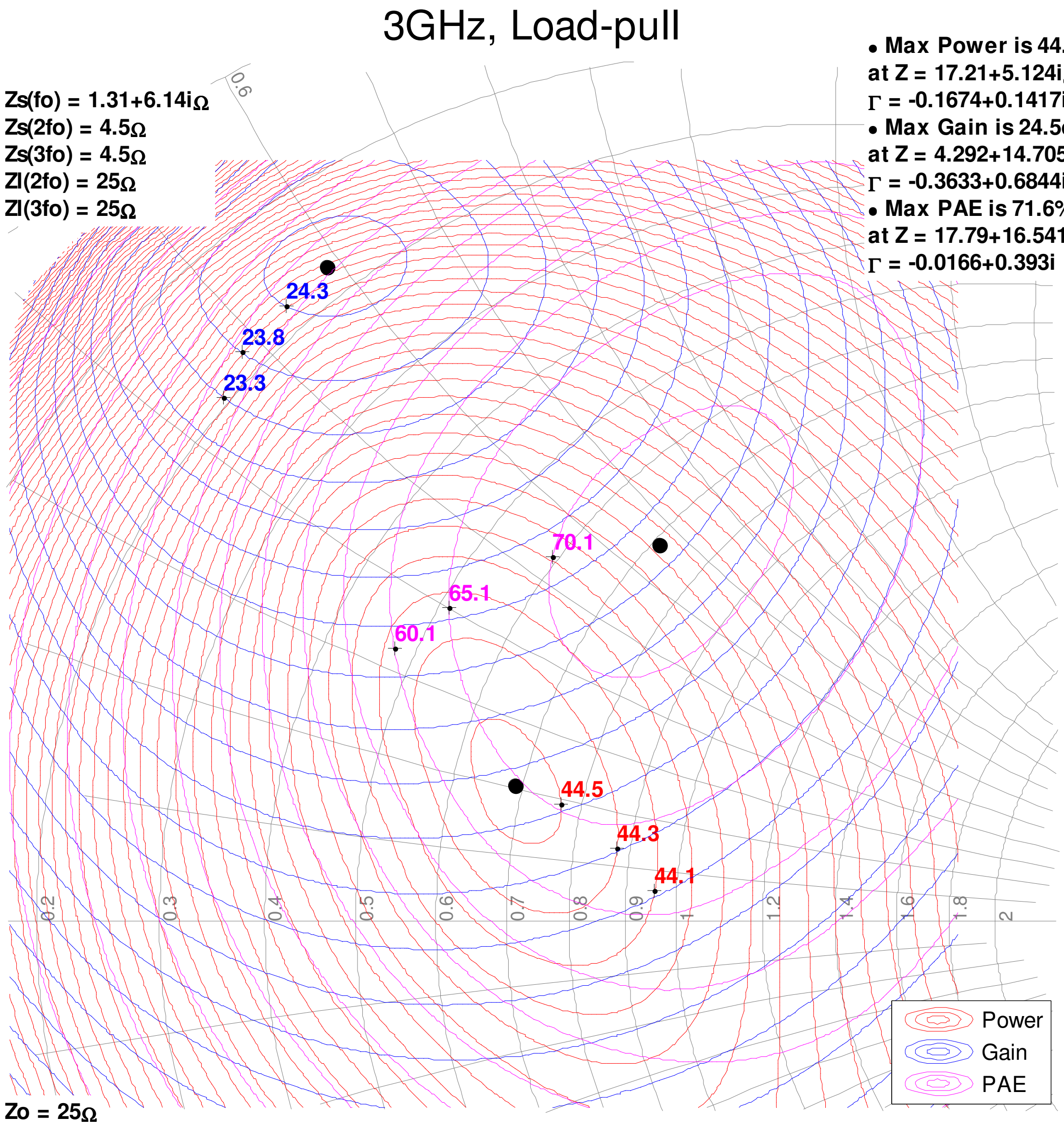
Model Load Pull Contours

Vds = 32V, Idq = 100mA. 3dB compression referenced to peak gain.
Simulated signal: 10% pulses. Bond wires not included. See page 17 for reference planes.



Model Load Pull Contours

Vds = 32V, Idq = 100mA. 3dB compression referenced to peak gain.
Simulated signal: 10% pulses. Bond wires not included. See page 17 for reference planes.



3GHz, Load-pull

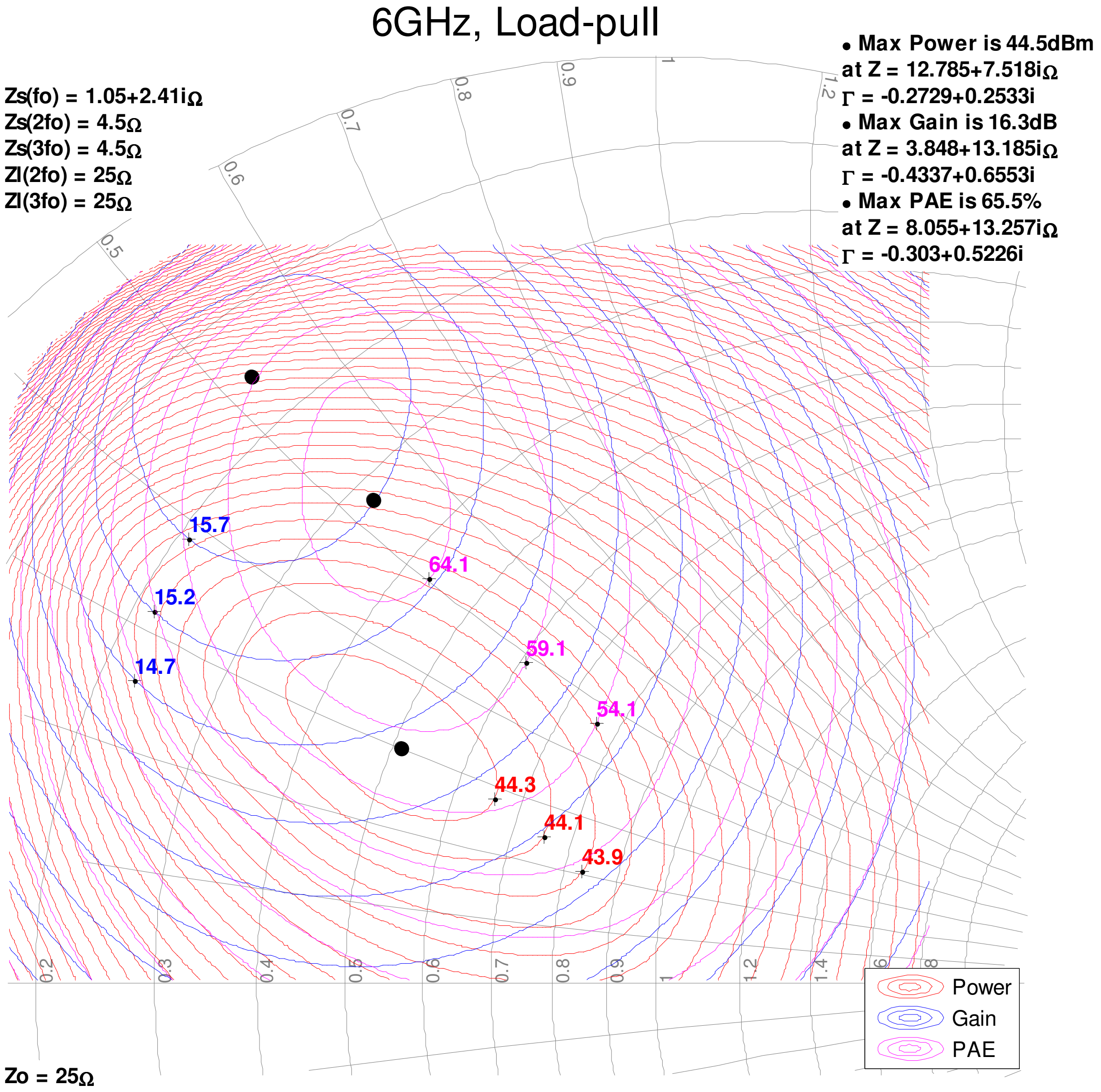
Zs(fo) = 1.31+6.14iΩ
Zs(2fo) = 4.5Ω
Zs(3fo) = 4.5Ω
Zl(2fo) = 25Ω
Zl(3fo) = 25Ω

- **Max Power is 44.5dBm**
at Z = 17.21+5.124iΩ
Γ = -0.1674+0.1417i
- **Max Gain is 24.5dB**
at Z = 4.292+14.705iΩ
Γ = -0.3633+0.6844i
- **Max PAE is 71.6%**
at Z = 17.79+16.541iΩ
Γ = -0.0166+0.393i

Zo = 25Ω

Model Load Pull Contours

Vds = 32V, Idq = 100mA. 3dB compression referenced to peak gain.
Simulated signal: 10% pulses. Bond wires not included. See page 17 for reference planes.



6GHz, Load-pull

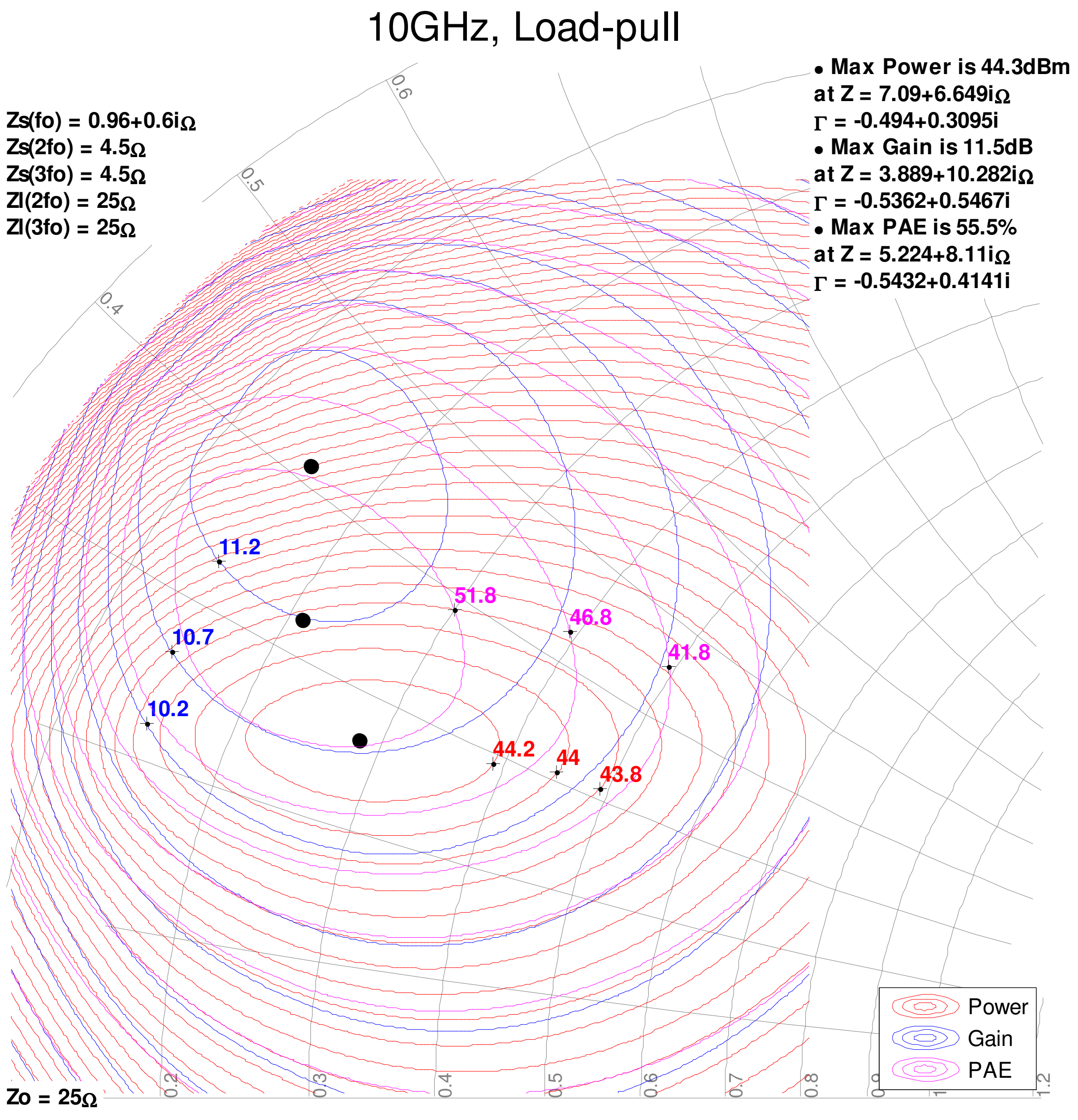
Zs(fo) = 1.05+2.41iΩ
Zs(2fo) = 4.5Ω
Zs(3fo) = 4.5Ω
Zl(2fo) = 25Ω
Zl(3fo) = 25Ω

- **Max Power is 44.5dBm at Z = 12.785+7.518iΩ Γ = -0.2729+0.2533i**
- **Max Gain is 16.3dB at Z = 3.848+13.185iΩ Γ = -0.4337+0.6553i**
- **Max PAE is 65.5% at Z = 8.055+13.257iΩ Γ = -0.303+0.5226i**

Zo = 25Ω

Model Load Pull Contours

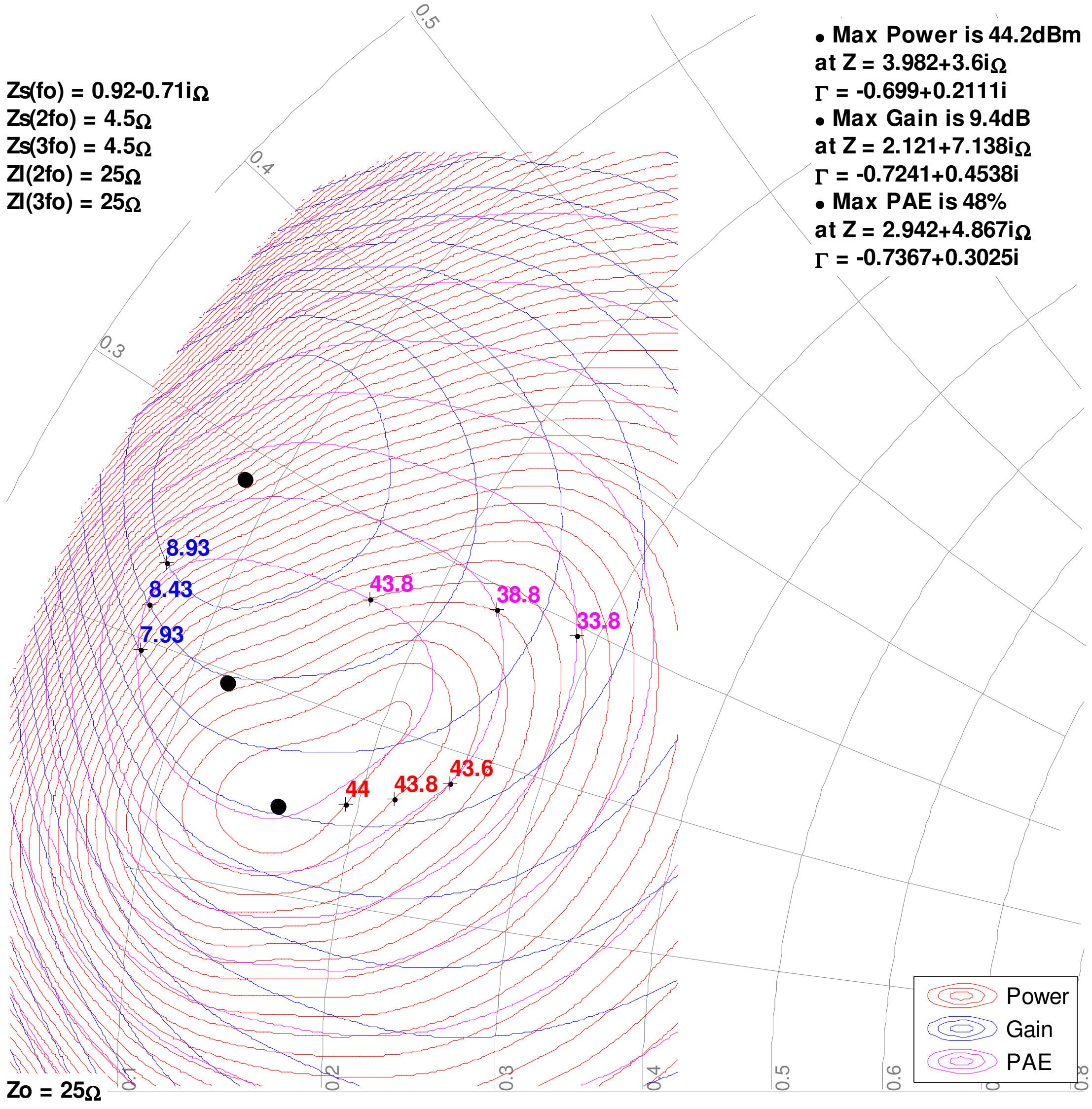
Vds = 32V, Idq = 100mA. 3dB compression referenced to peak gain.
Simulated signal: 10% pulses. Bond wires not included. See page 17 for reference planes.



Model Load Pull Contours

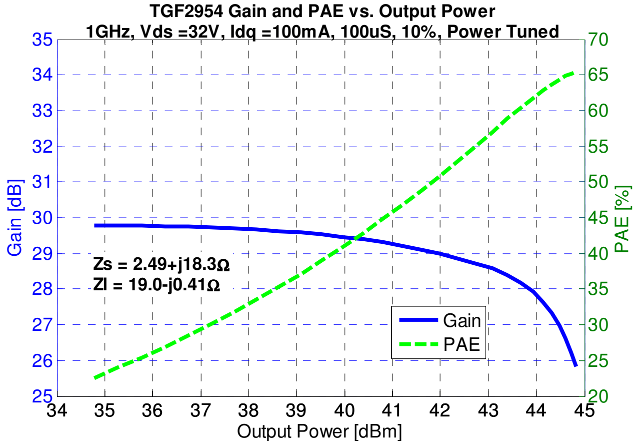
Vds = 32V, Idq = 100mA. 3dB compression referenced to peak gain.
Simulated signal: 10% pulses. Bond wires not included. See page 17 for reference planes.

15GHz, Load-pull



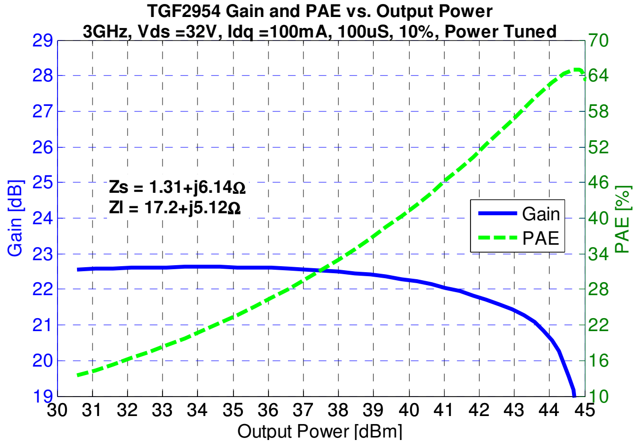
Model Power Tuned Data

Bond wires not included. See page 17 for reference planes.



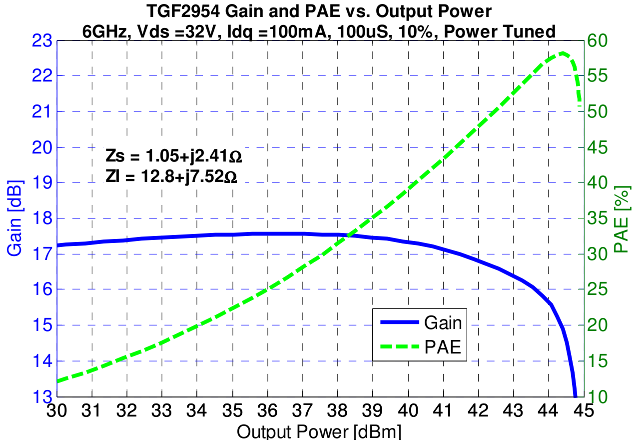
TGF2954 Gain and PAE vs. Output Power
1GHz, Vds =32V, Idq =100mA, 100uS, 10%, Power Tuned

Zs = 2.49+j18.3Ω
Zl = 19.0-j0.41Ω



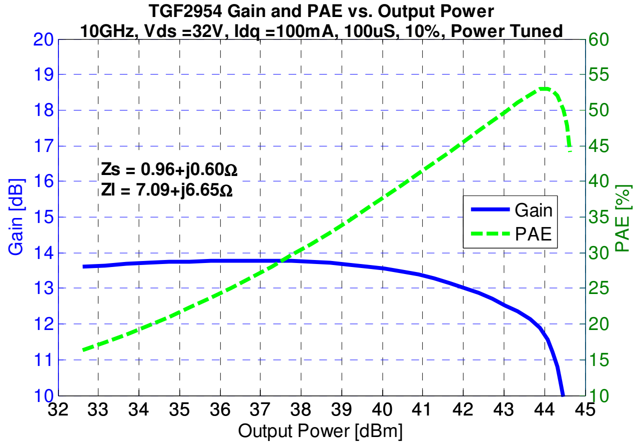
TGF2954 Gain and PAE vs. Output Power
3GHz, Vds =32V, Idq =100mA, 100uS, 10%, Power Tuned

Zs = 1.31+j6.14Ω
Zl = 17.2+j5.12Ω



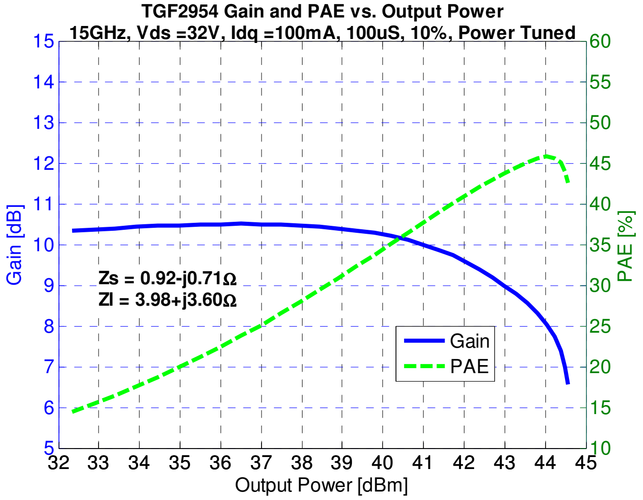
TGF2954 Gain and PAE vs. Output Power
6GHz, Vds =32V, Idq =100mA, 100uS, 10%, Power Tuned

Zs = 1.05+j2.41Ω
Zl = 12.8+j7.52Ω



TGF2954 Gain and PAE vs. Output Power
10GHz, Vds =32V, Idq =100mA, 100uS, 10%, Power Tuned

Zs = 0.96+j0.60Ω
Zl = 7.09+j6.65Ω

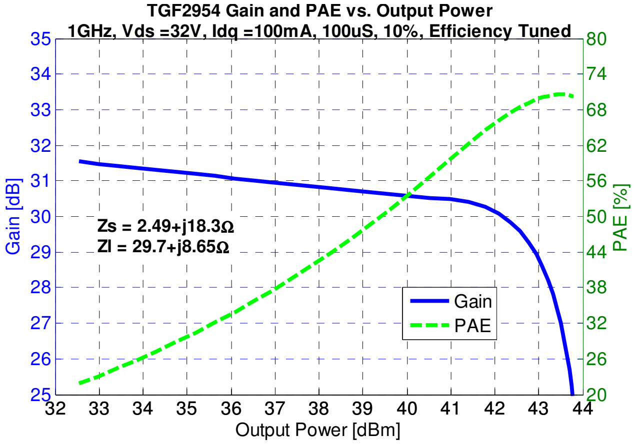


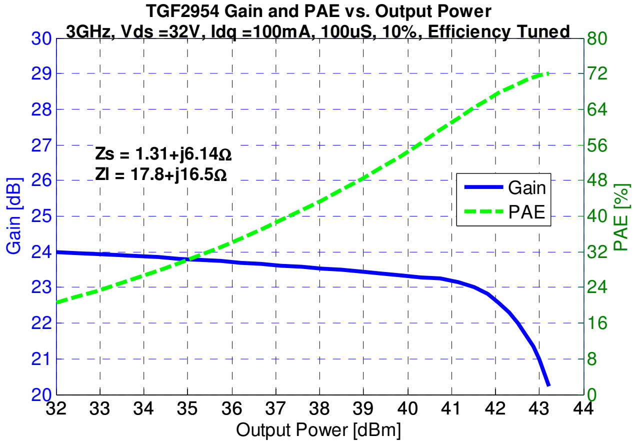
TGF2954 Gain and PAE vs. Output Power
15GHz, Vds =32V, Idq =100mA, 100uS, 10%, Power Tuned

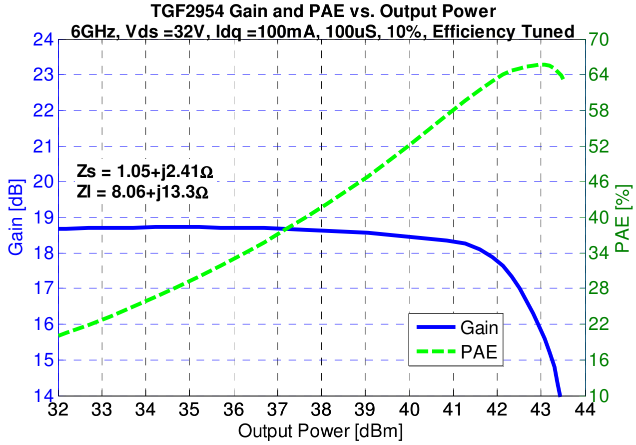
Zs = 0.92-j0.71Ω
Zl = 3.98+j3.60Ω

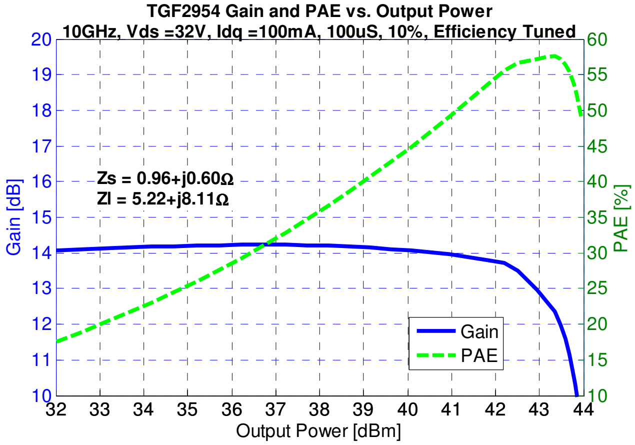
Model Efficiency Tuned Data

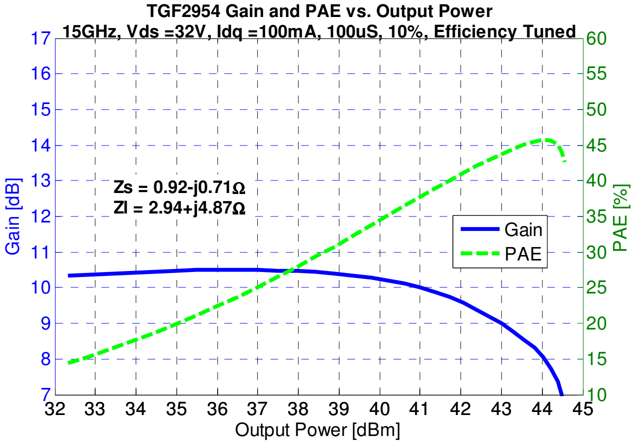
Bond wires not included. See page 17 for reference planes.



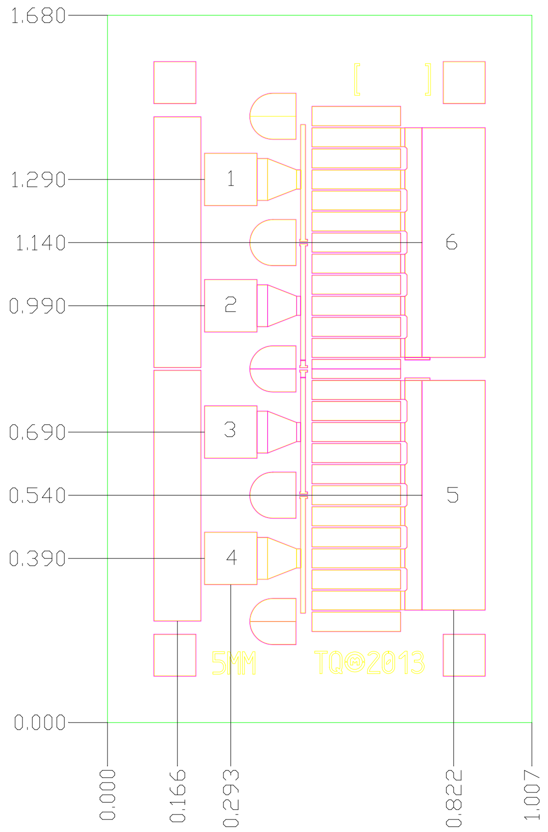








Mechanical Drawing

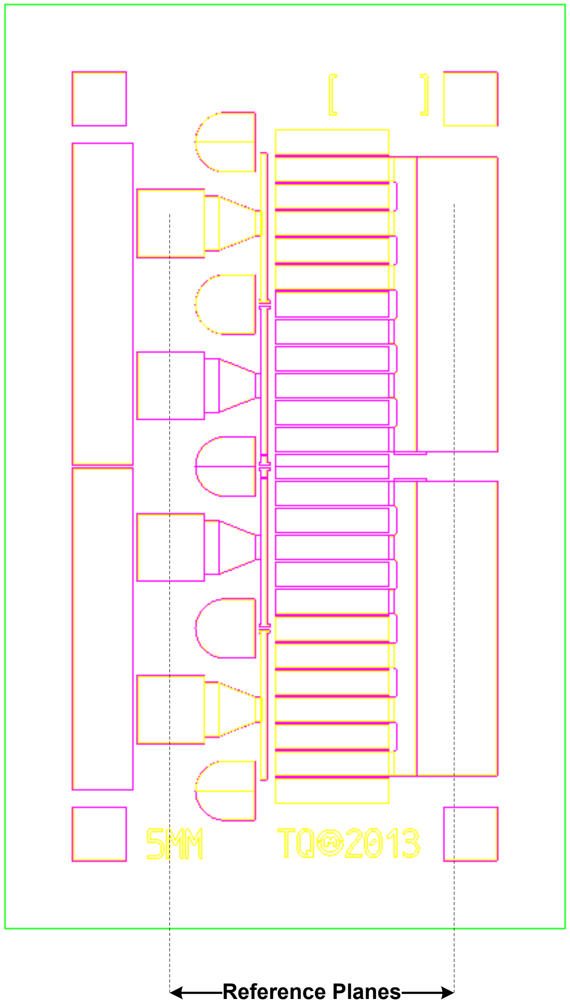


1. Units: millimeters
2. Thickness: 0.100 mm
3. Die xy size tolerance: ± 0.050 mm

Bond Pads

Pad No.	Description	Dimensions
1, 2, 3, 4	Gate	0.125 x 0.125
5, 6	Drain	0.150 x 0.546
Die Backside	Source / Ground	1.007 x 1.680

Reference Planes



Model

A model is available for download from Modelithics (at http://www.modelithics.com/mvp/Triquint&tab=3) by approved TriQuint 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.

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. V_G set to -5 V.
2. V_D set to 32 V.
3. Adjust V_G more positive until quiescent I_D is 100 mA.
4. 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.