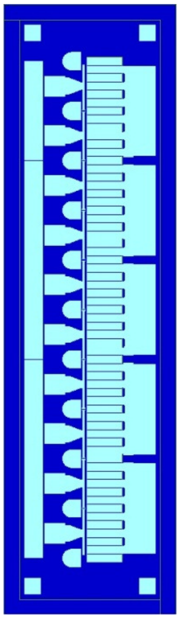
TGF2957

70 Watt Discrete Power GaN on SiC HEMT

Applications

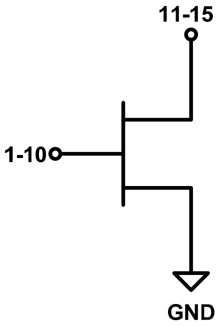
- Defense & Aerospace
- Broadband Wireless



Product Features

- Frequency Range: DC - 12 GHz
- 48.6 dBm Nominal P_{SAT} at 3 GHz
- 69.6% Maximum PAE at 3 GHz
- 19.2 dB Nominal Power Gain at 3 GHz
- Bias: V_D = 32 V, I_{DQ} = 250 mA
- Technology: TQGaN25 on SiC
- Chip Dimensions: 1.01 x 3.66 x 0.10 mm

Functional Block Diagram



General Description

The TriQuint TGF2957 is a discrete 12.6 mm GaN on SiC HEMT which operates from DC-12 GHz. The TGF2957 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 TGF2957 typically provides 48.6 dBm of saturated output power with power gain of 19.2 dB at 3 GHz. The maximum power added efficiency is 69.6 % which makes the TGF2957 appropriate for high efficiency applications.

Lead-free and RoHS compliant.

Pad Configuration

Pad No.	Symbol
1-10	V_G / RF IN
11-15	V_D / RF OUT
Backside	Source / Ground

Ordering Information

Part	ECCN	Description
TGF2957	3A001b.3.b	70 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)	7.5 A
Gate Current (I_G)	-12.6 to 21mA
Power Dissipation (P_D)	68 W
CW Input Power (P_{IN}) @ 10GHz	44.3 dBm
Channel Temperature (T_{CH})	275℃
Mounting Temperature (30 Sec.)	320℃
Storage Temperature	–65 to 150℃

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})	250 mA
Drain Current Under RF Drive (I_D)(1)	4.2 A (Typ.)
Pinch-off Gate Voltage (V_G)	–3.5 V (Typ.)
Channel Temperature (T_{CH})	225℃ (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})	250	250	250	250	250	mA
Output P3dB (P_{3dB})	48.5	48.6	48.5	48.6	48.2	dBm
PAE @ P_{3dB} (PAE_{3dB})	64.7	63.7	58.9	52.8	44.9	%
Gain @ P3dB (G_{3dB})	26.6	19.2	14.2	10.5	7.5	dB
Parallel Output Resistance (1) (R_p)	95.0	95.6	86.8	70.8	41.7	Ω·mm
Parallel Output Capacitance (1) (C_p)	-0.038	0.142	0.209	0.218	0.234	pF/mm
Load Impedance (ZL)	7.53-j0.17	7.12+j1.82	4.69+j3.21	2.90+j2.81	1.79+j1.65	Ω
Source Impedance (ZS)	1.05+j7.47	0.39+j2.44	0.45+j1.03	0.38+j0.23	0.39-j0.31	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})	250	250	250	250	250	mA
Output P3dB (P_{3dB})	47.1	47.2	47.2	47.8	48.0	dBm
PAE @ P_{3dB} (PAE_{3dB})	71.2	69.6	64.8	55.4	45.9	%
Gain @ P3dB (G_{3dB})	27.7	20.8	15.1	10.9	7.8	dB
Parallel Output Resistance (1) (R_p)	170.9	158.0	141.8	93.8	46.0	Ω·mm
Parallel Output Capacitance (1) (C_p)	0.288	0.283	0.288	0.271	0.251	pF/mm
Load Impedance (ZL)	12.4+j3.83	7.33+j6.18	3.40+j5.14	2.10+j3.35	1.67+j1.82	Ω
Source Impedance (ZS)	1.05+j7.47	0.39+j2.44	0.45+j1.03	0.38+j0.23	0.39-j0.31	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 = 50.4 W, Tbaseplate = 85℃ Pulse: 100uS, 5%	1.53	ºC/W
Channel Temperature, T_{CH}		162	℃
Median Lifetime, T_M		6.71E08	Hrs
Thermal Resistance, θ_{JC}	P_D = 50.4 W, Tbaseplate = 85℃ Pulse: 100uS, 10%	1.63	℃/W
Channel Temperature, T_{CH}		167	℃
Median Lifetime, T_M		3.94E08	Hrs
Thermal Resistance, θ_{JC}	P_D = 50.4 W, Tbaseplate = 85℃ Pulse: 100uS, 20%	1.81	ºC/W
Channel Temperature, T_{CH}		176	℃
Median Lifetime, T_M		1.53E08	Hrs
Thermal Resistance, θ_{JC}	P_D = 50.4 W, Tbaseplate = 85℃ Pulse: 100uS, 50%	2.36	ºC/W
Channel Temperature, T_{CH}		204	℃
Median Lifetime, T_M		1.09E07	Hrs

Notes:

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

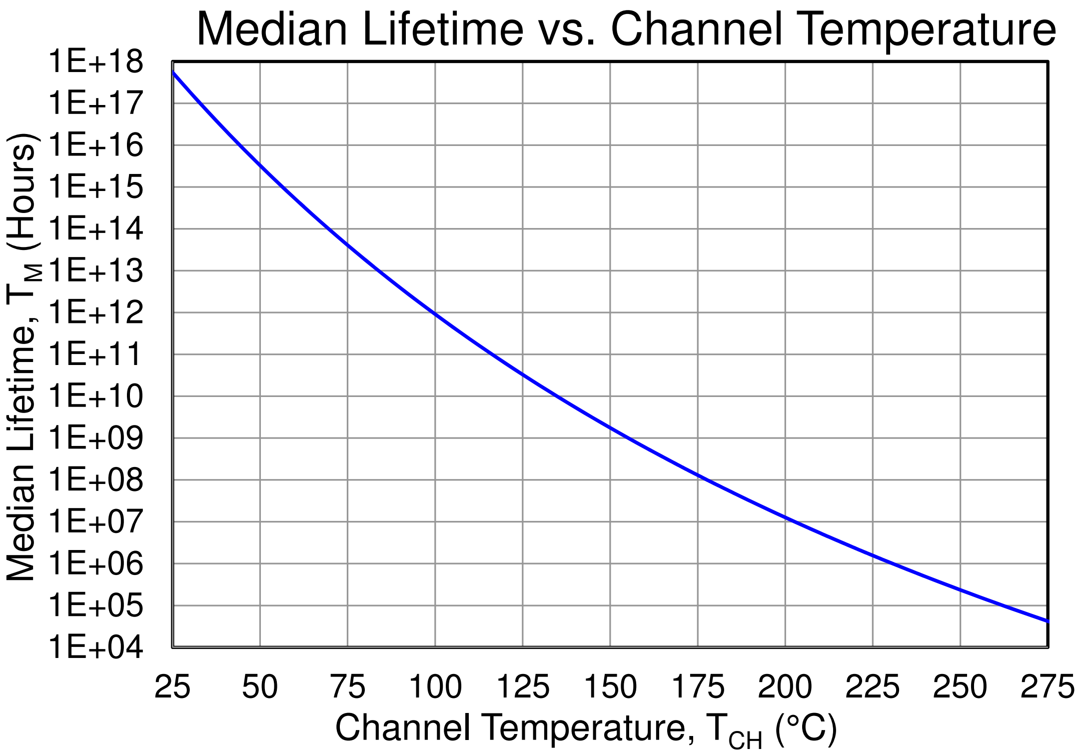
Thermal and Reliability Information - CW (1)

Parameter	Test Conditions	Value	Units
Thermal Resistance, θ_{JC}	P_D = 12.6 W, Tbaseplate = 85℃ CW	2.78	ºC/W
Channel Temperature, T_{CH}		120	℃
Median Lifetime, T_M		9.51E10	Hrs
Thermal Resistance, θ_{JC}	P_D = 25.2 W, Tbaseplate = 85℃ CW	2.98	℃/W
Channel Temperature, T_{CH}		160	℃
Median Lifetime, T_M		8.30E08	Hrs
Thermal Resistance, θ_{JC}	P_D = 37.8 W, Tbaseplate = 85℃ CW	3.23	ºC/W
Channel Temperature, T_{CH}		207	℃
Median Lifetime, T_M		8.44E06	Hrs
Thermal Resistance, θ_{JC}	P_D = 50.4 W, Tbaseplate = 85℃ CW	3.49	ºC/W
Channel Temperature, T_{CH}		261	℃
Median Lifetime, T_M		1.18E05	Hrs

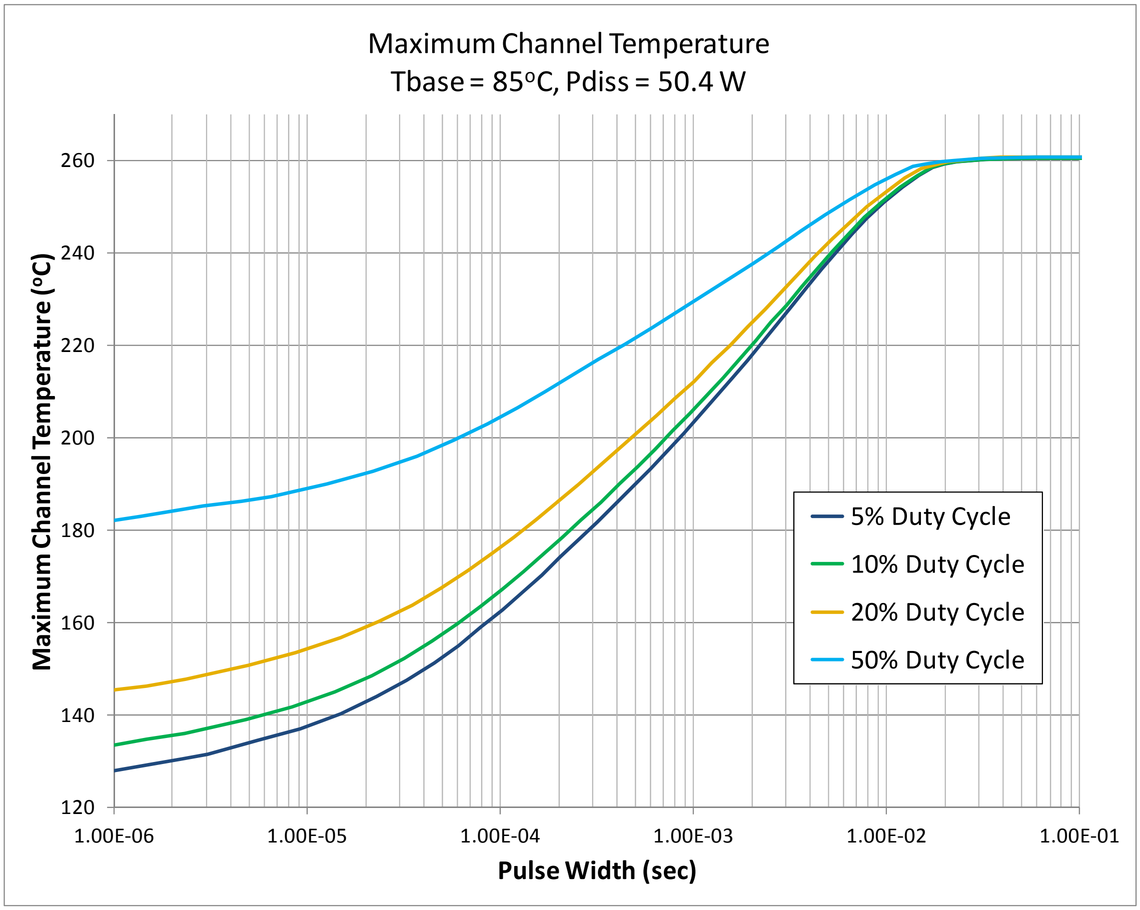
Notes:

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

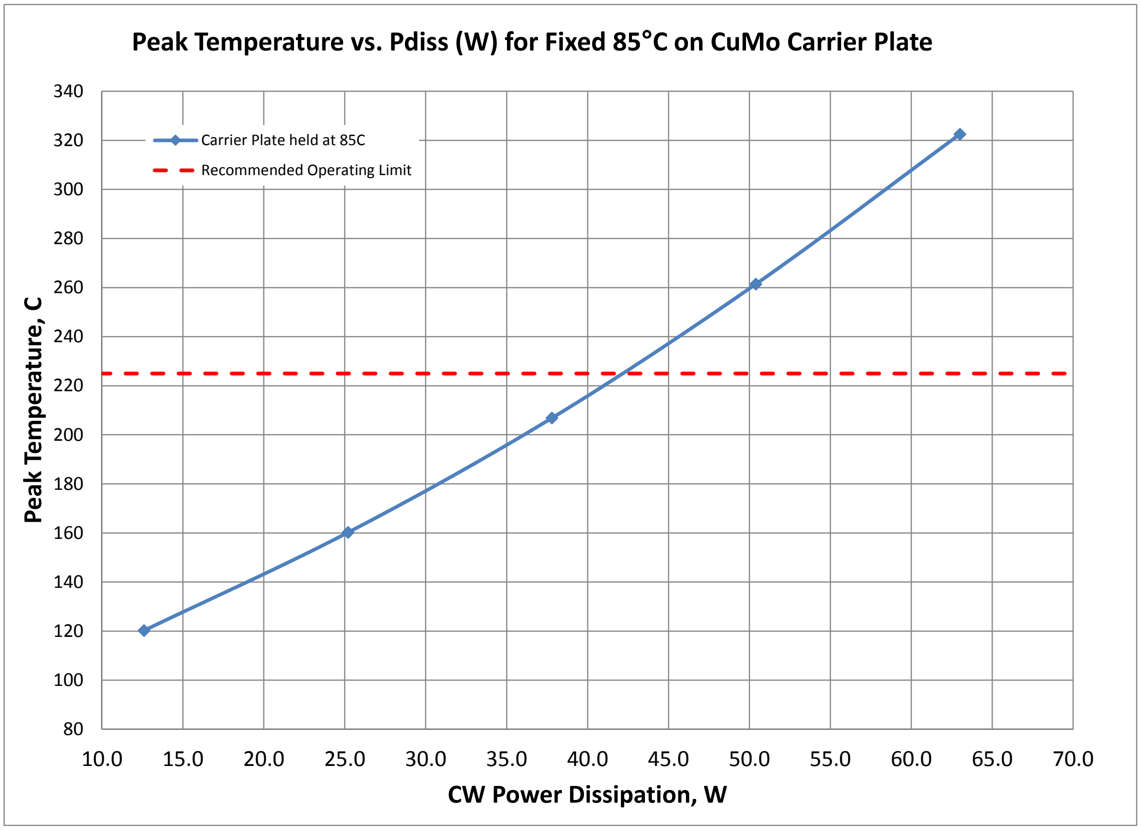
Median LifeTime



Maximum Channel Temperature - Pulsed

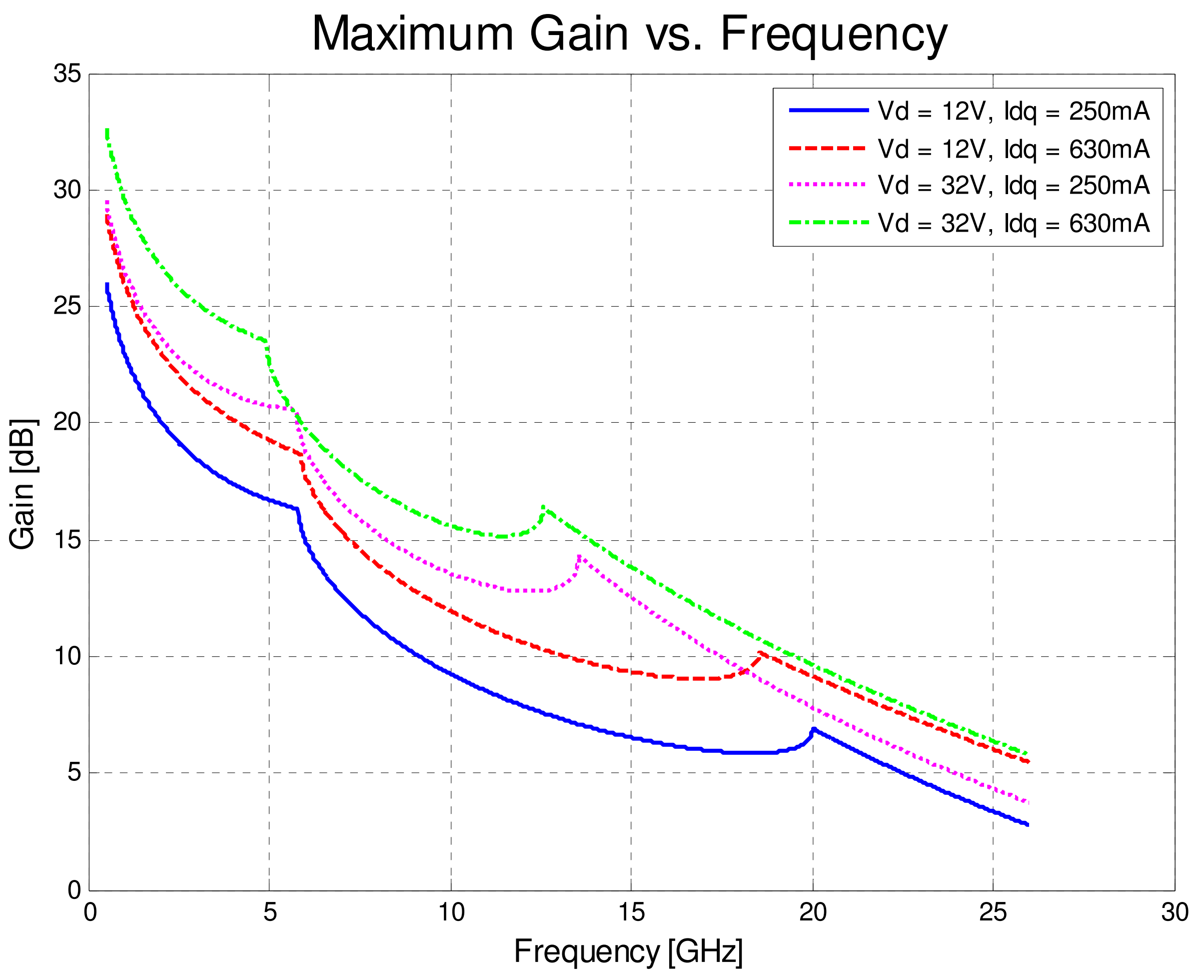


Maximum Channel Temperature - CW



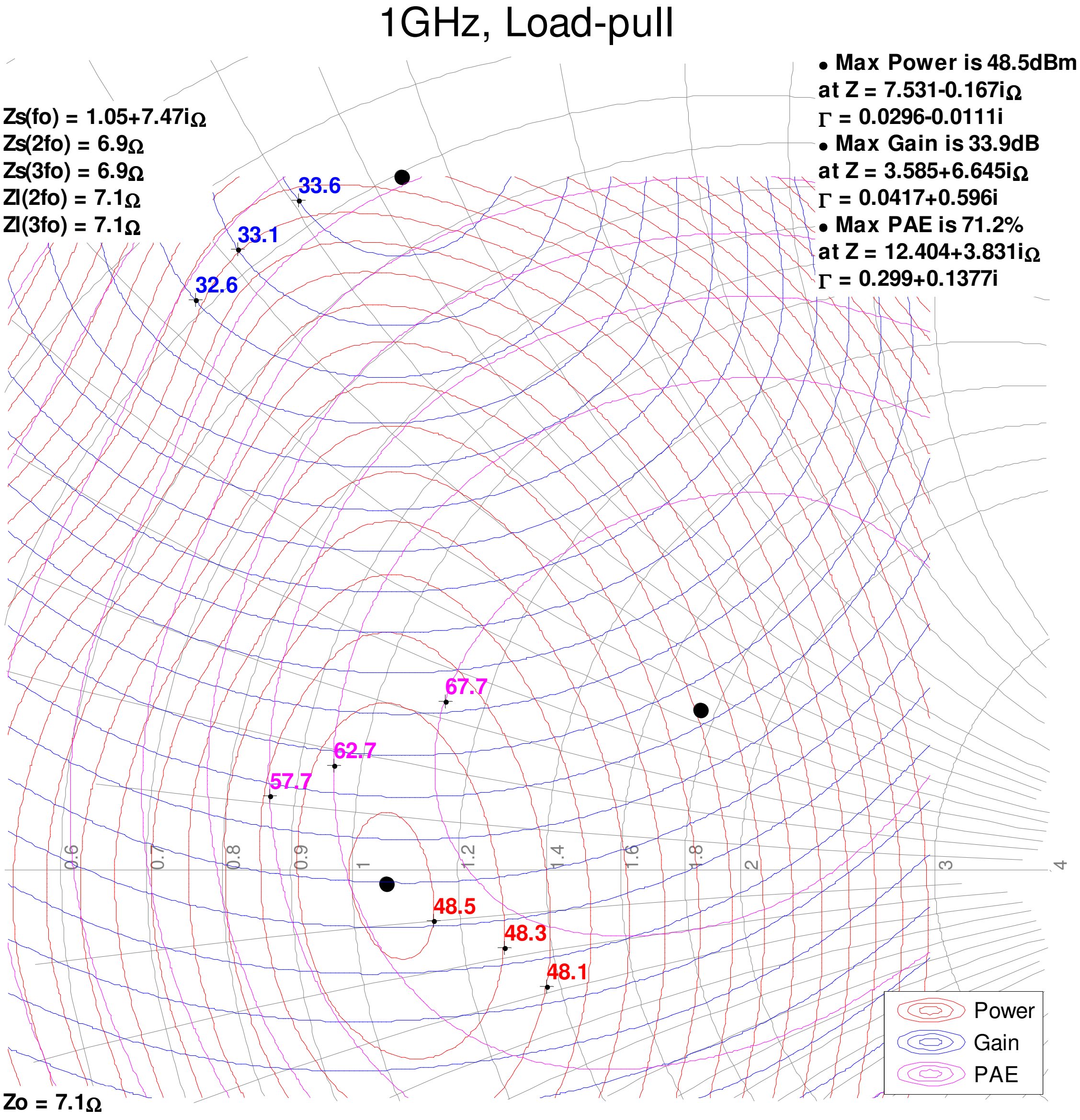
Model Maximum Gain Performance

See page 17 for reference planes.



Model Load Pull Contours

Vds = 32V, Idq = 250mA. 3dB compression referenced to peak gain.
Simulated signal: 10% pulses. Bond wires not included. See page 17 for reference planes.


1GHz, Load-pull

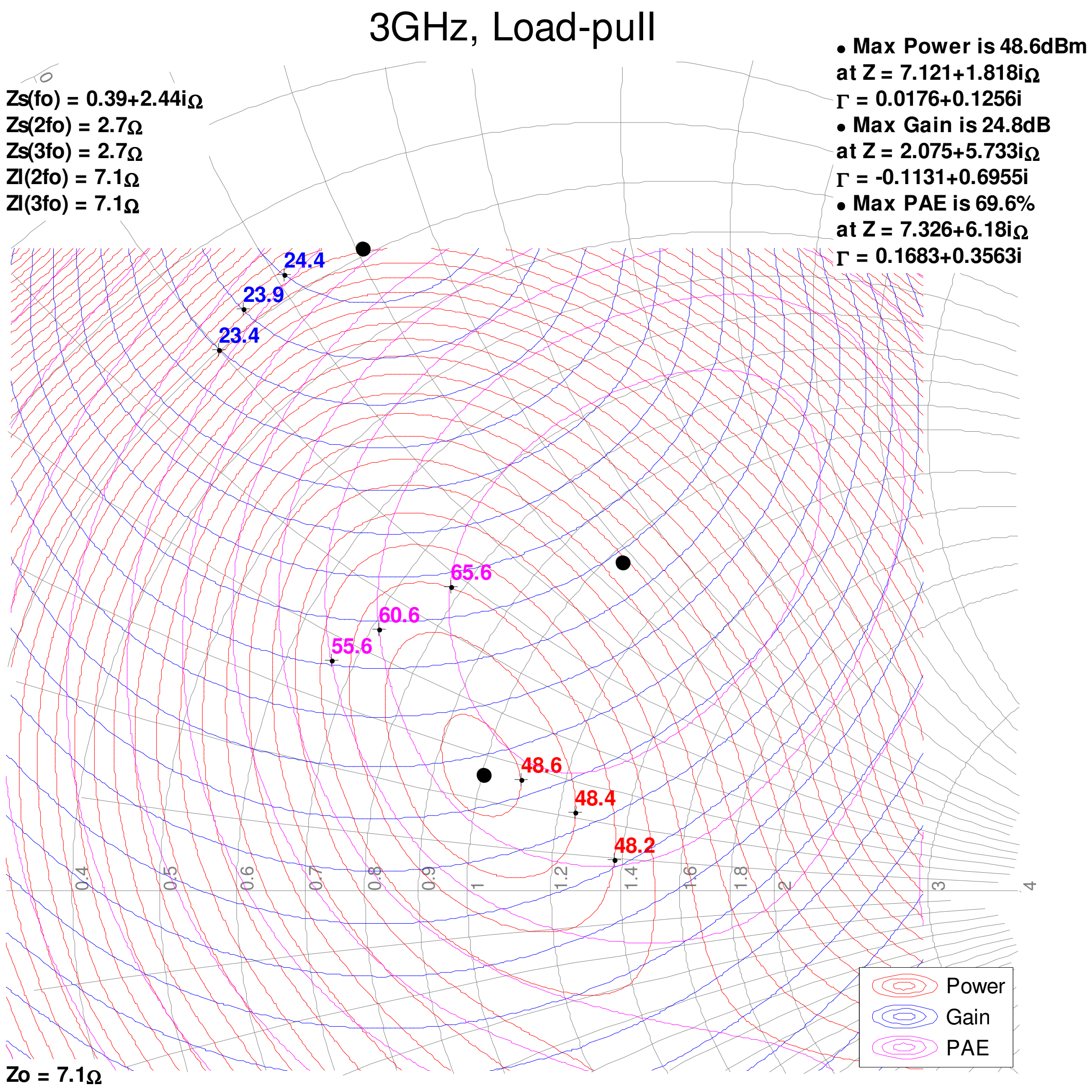
Zs(fo) = 1.05+7.47iΩ
Zs(2fo) = 6.9Ω
Zs(3fo) = 6.9Ω
Zl(2fo) = 7.1Ω
Zl(3fo) = 7.1Ω

- **Max Power is 48.5dBm**
at Z = 7.531-0.167iΩ
Γ = 0.0296-0.0111i
- **Max Gain is 33.9dB**
at Z = 3.585+6.645iΩ
Γ = 0.0417+0.596i
- **Max PAE is 71.2%**
at Z = 12.404+3.831iΩ
Γ = 0.299+0.1377i

Zo = 7.1Ω

Model Load Pull Contours

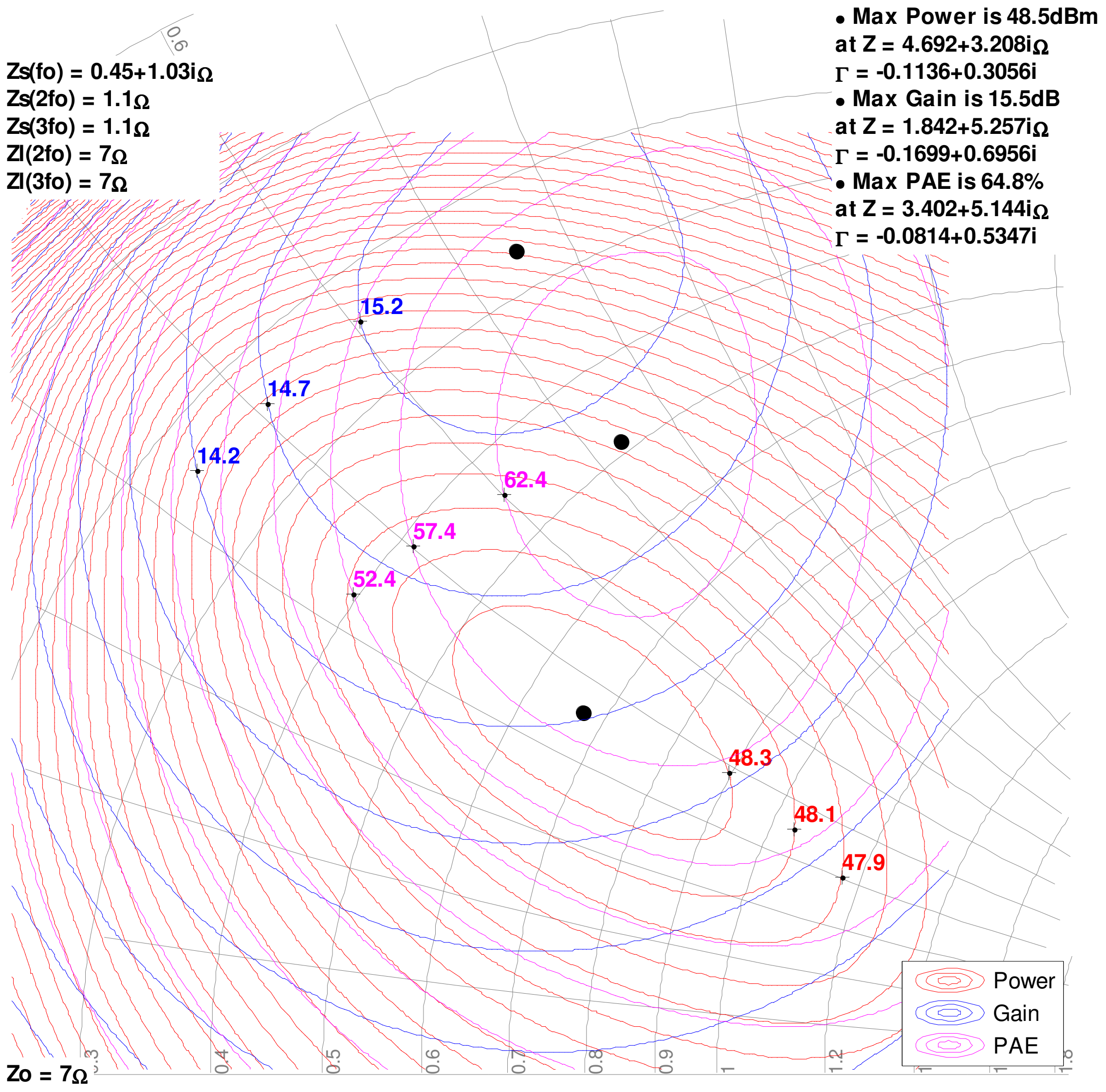
Vds = 32V, Idq = 250mA. 3dB compression referenced to peak gain.
Simulated signal: 10% pulses. Bond wires not included. See page 17 for reference planes.



Model Load Pull Contours

Vds = 32V, Idq = 250mA. 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) = 0.45+1.03iΩ
Zs(2fo) = 1.1Ω
Zs(3fo) = 1.1Ω
Zl(2fo) = 7Ω
Zl(3fo) = 7Ω

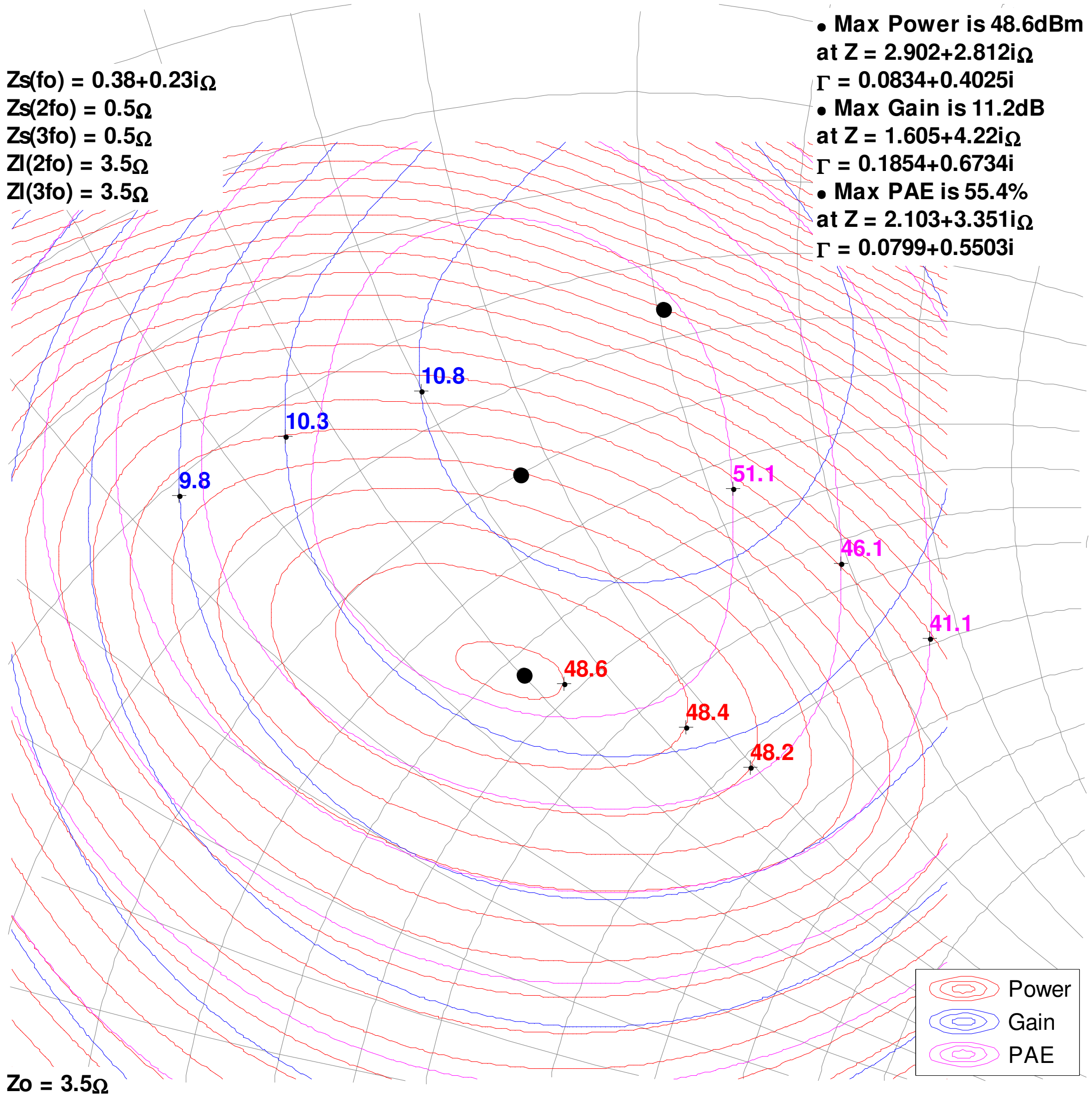
- **Max Power is 48.5dBm**
  at Z = 4.692+3.208iΩ
  Γ = -0.1136+0.3056i
- **Max Gain is 15.5dB**
  at Z = 1.842+5.257iΩ
  Γ = -0.1699+0.6956i
- **Max PAE is 64.8%**
  at Z = 3.402+5.144iΩ
  Γ = -0.0814+0.5347i

Zo = 7Ω

Model Load Pull Contours

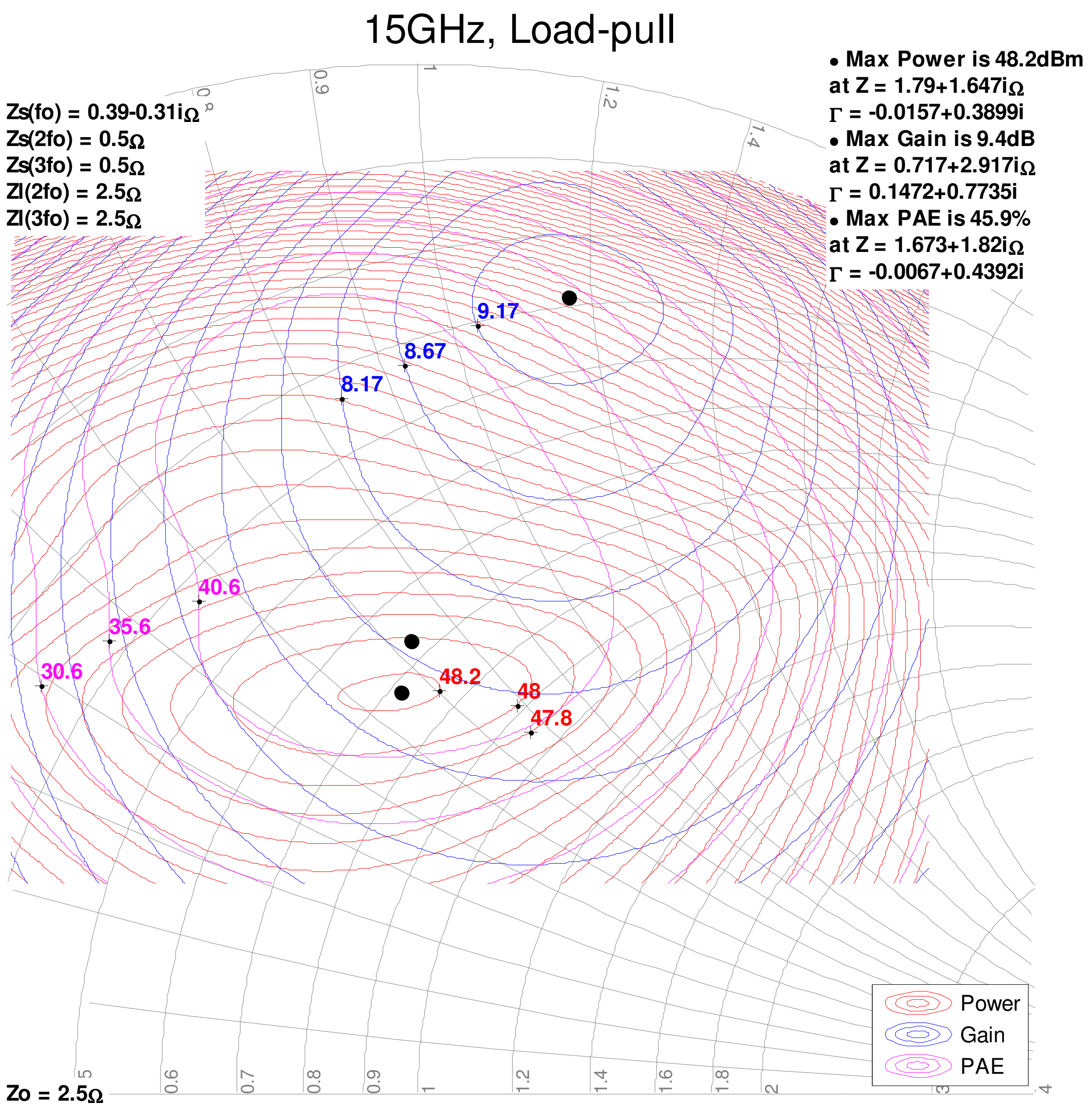
Vds = 32V, Idq = 250mA. 3dB compression referenced to peak gain.
Simulated signal: 10% pulses. Bond wires not included. See page 17 for reference planes.

10GHz, Load-pull



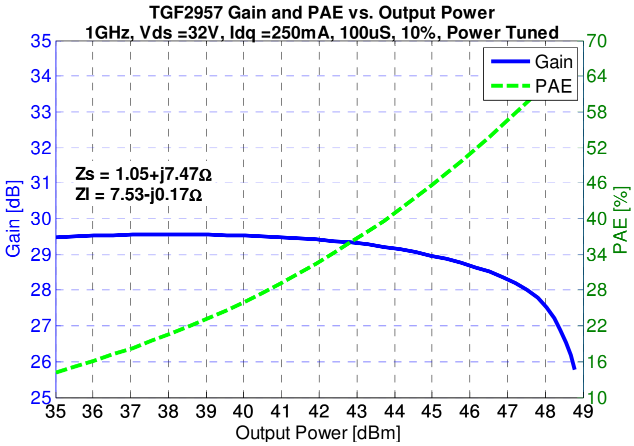
Model Load Pull Contours

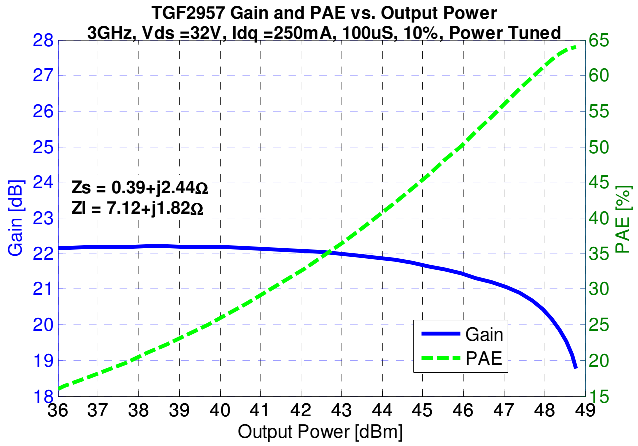
Vds = 32V, Idq = 250mA. 3dB compression referenced to peak gain.
Simulated signal: 10% pulses. Bond wires not included. See page 17 for reference planes.

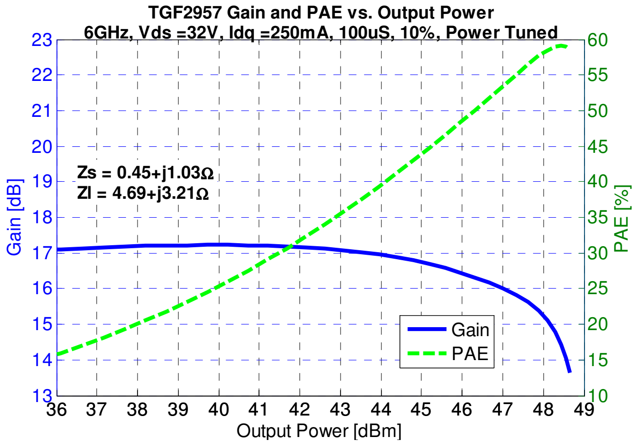


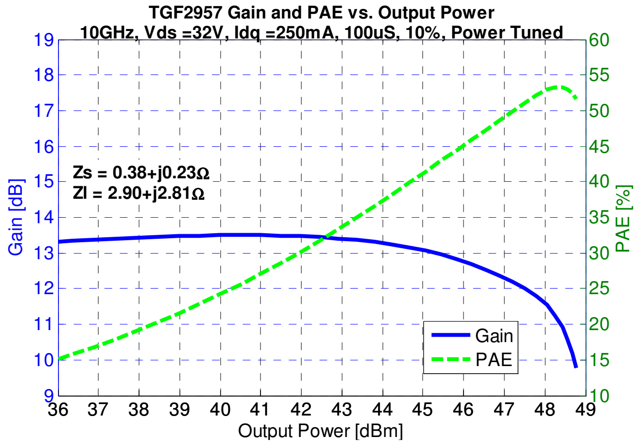
Model Power Tuned Data

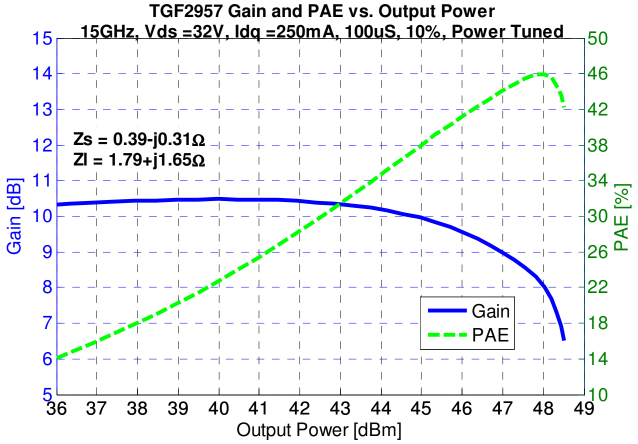
Bond wires not included. See page 17 for reference planes.





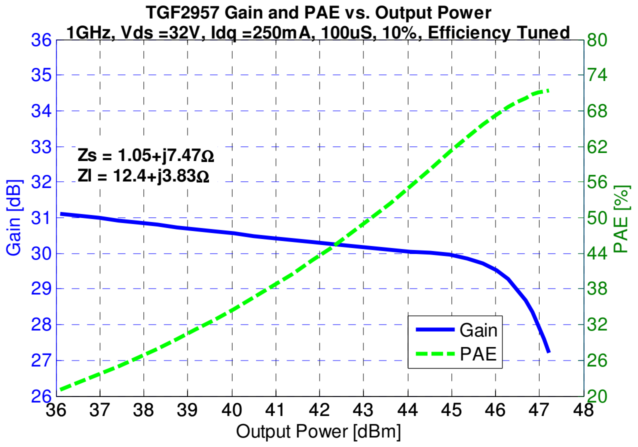


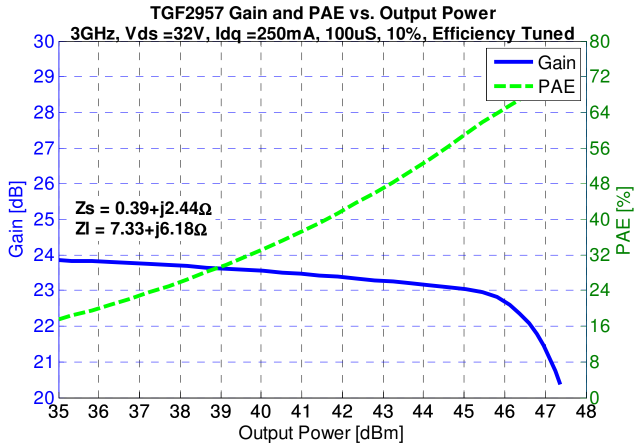


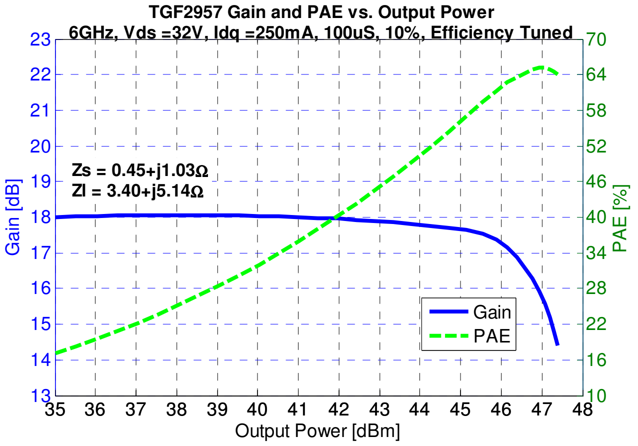


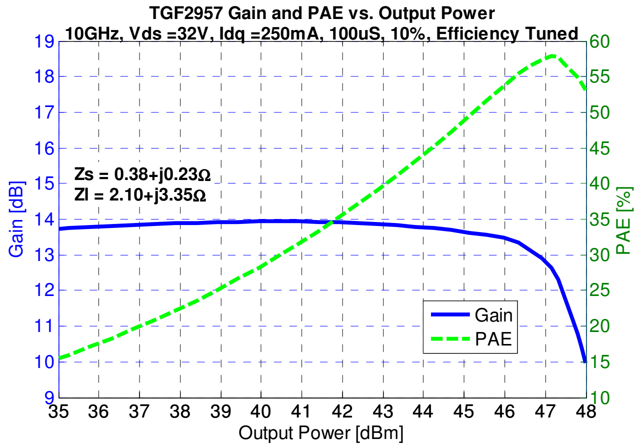
Model Efficiency Tuned Data

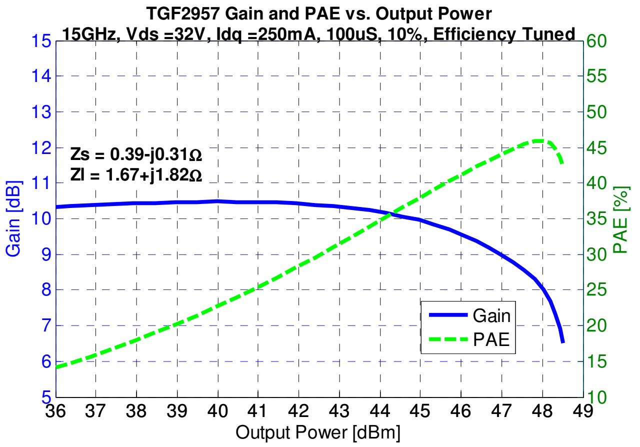
Bond wires not included.   See page 17 for reference planes.



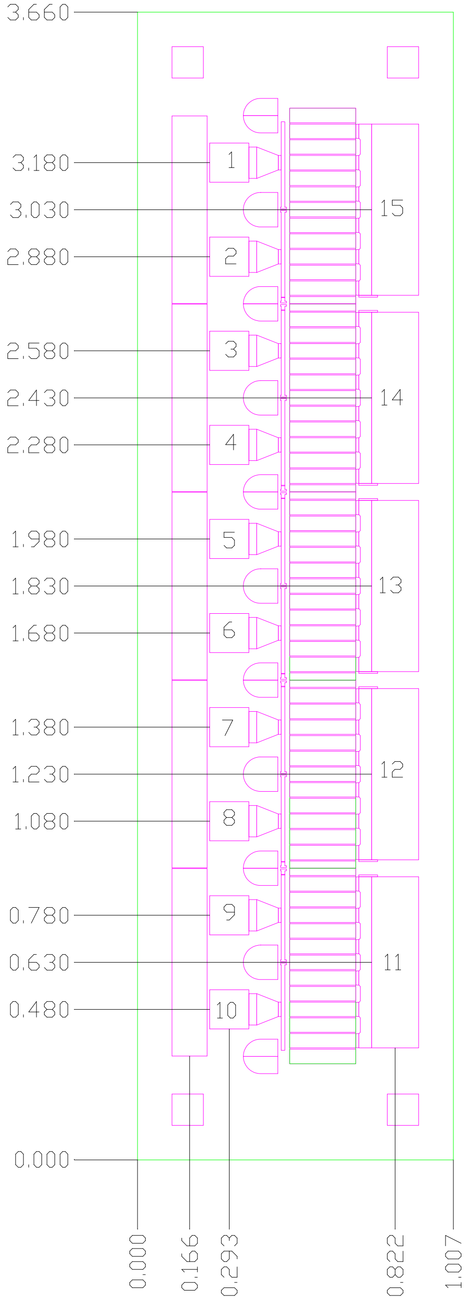








Mechanical Drawing

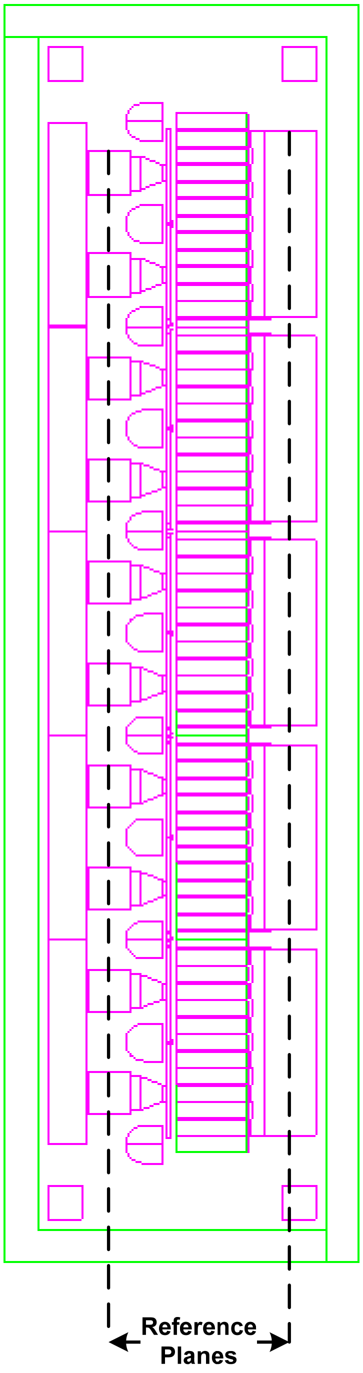


1. Units: millimeters
2. Thickness: 0.100 mm
3. Die xy size tolerance: ± 0.050 mm

Bond Pads

Pad No.	Description	Dimensions
1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Gate	0.125 x 0.125
11, 12, 13, 14, 15	Drain	0.150 x 0.546
Die Backside	Source / Ground	1.007 x 3.660

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 250 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.