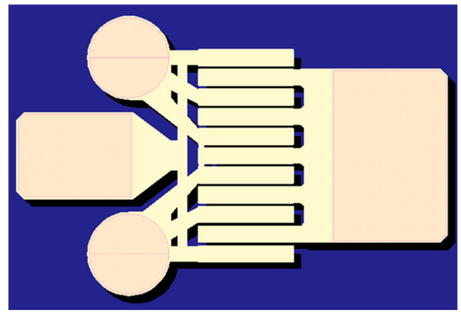
Applications

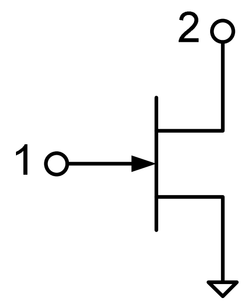
- Defense & Aerospace
- Broadband Wireless



Product Features

- Frequency Range: DC - 18 GHz
- 38 dBm Nominal P_{SAT} at 3 GHz
- 71.6% Maximum PAE
- 18 dB Nominal Power Gain at 3 GHz
- Bias: V_D = 12 - 32 V, I_{DQ} = 25 - 125 mA
- Technology: TQGaN25 on SiC
- Chip Dimensions: 0.82 x 0.66 x 0.10 mm

Functional Block Diagram



General Description

The TriQuint TGF2023-2-01 is a discrete 1.25 mm GaN on SiC HEMT which operates from DC-18 GHz. The TGF2023-2-01 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 TGF2023-2-01 typically provides 37.7 dBm of saturated output power with power gain of 20.7 dB at 3 GHz. The maximum power added efficiency is 71.6 % which makes the TGF2023-2-01 appropriate for high efficiency applications.

Lead-free and RoHS compliant

Pad Configuration

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

Ordering Information

Part	ECCN	Description
TGF2023-2-01	EAR99	6 Watt GaN HEMT

Absolute Maximum Ratings

Parameter	Value
Breakdown Voltage (BV_{DG})	100 V
Drain Voltage (V_D)	40 V
Gate Voltage Range (V_G)	–50 to 0 V
Drain Current (I_D)	1.25 A
Gate Current (I_G)	–1.25 to 3.5 mA
Power Dissipation (P_D)	See graph on pg.3.
CW Input Power (P_{IN})	+31 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)	12 – 32 V
Drain Quiescent Current (I_{DQ})	62.5 mA
Drain Current Under RF Drive (I_D)	400 mA (Typ.)
Gate Voltage (V_G)	–3.0 V (Typ.)
Channel Temperature (T_{CH})	225 °C (Max.)

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

RF Characterization – Optimum Power Tune

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 125 mA, measured on a 1.25 mm GaN/SiC unit cell. Bond wires not included.

Parameter	Typical Value					Units
Frequency (F)	3	6	8.45	10	14	GHz
Saturated Output Power (P_{SAT})	38.0	37.1	37.3	36.6	36.1	dBm
Power Added Efficiency (PAE)	58.8	58.4	54.4	53.6	44.4	%
Power Gain (Gain)	18.0	15.1	11.2	10.6	7.2	dB
Parallel Resistance (1) (R_P)	59.5	72.1	57.7	59.8	57.9	Ω·mm
Parallel Capacitance (1) (C_P)	0.42	0.29	0.33	0.33	0.33	pF/mm
Load Reflection Coefficient (2) (Γ_L)	0.23∠109°	0.35∠99.5°	0.47∠122°	0.54∠125°	0.66∠133°	--

Notes:
1. Large signal equivalent output network (normalized).
2. Characteristic Impedance (Zo) = 50 Ω.

RF Characterization – Optimum Efficiency Tune

Test conditions unless otherwise noted: V_D = 28 V, I_{DQ} = 125 mA, measured on a 1.25 mm GaN/SiC unit cell. Bond wires not included.

Parameter	Typical Value					Units
Frequency (F)	3	6	8.45	10	14	GHz
Saturated Output Power (P_{SAT})	36.6	36.4	36.4	36.3	35.8	dBm
Power Added Efficiency (PAE)	69	65.5	59.2	57.1	45.7	%
Power Gain (Gain)	16.7	14.4	10.4	10.3	6.9	dB
Parallel Resistance (1) (R_P)	148	120	98.3	91.2	67.5	Ω·mm
Parallel Capacitance (1) (C_P)	0.11	0.35	0.39	0.39	0.37	pF/mm
Load Reflection Coefficient (2) (Γ_L)	0.41∠18°	0.55∠88°	0.65∠113°	0.68∠120°	0.73∠134°	--

Notes:
1. Large signal equivalent output network (normalized).
2. Characteristic Impedance (Zo) = 50 Ω.

RF Characterization – Optimum Power Tune

Test conditions unless otherwise noted: Bond wires included. Measured data provided by Modelithics.

Parameter	Typical Value					Units
Frequency (F)	3	3	3	10	18	GHz
Drain Voltage (V_D)	12	28	28	28	28	V
Bias Current (I_{DQ})	62.5	25	62.5	62.5	62.5	mA
Input Power (P_{in})	15	17	17	27	31	dBm
Output Power (P_{out})	34.1	37.7	37.7	37.2	36.7	dBm
Power Added Efficiency (PAE)	60.8	61.4	61.1	59.8	42.4	%
Power Gain (Gain)	19.1	20.7	20.7	10.2	5.7	dB
Parallel Resistance (1) (R_p)	35.0	65.4	64.6	27.5	39.4	Ω·mm
Parallel Capacitance (1) (C_p)	1.21	0.34	0.32	0.71	–2.10	pF/mm
Load Reflection Coefficient (2) (Γ_L)	0.52∠146°	0.20∠95°	0.19∠96°	0.45∠161°	0.71∠–147°	--

Notes:
1. Large signal equivalent output network (normalized) (see figure, pg. 6).
2. Characteristic Impedance (Zo) = 50 Ω.

RF Characterization – Optimum Efficiency Tune

Test conditions unless otherwise noted: Bond wires included. Measured data provided by Modelithics.

Parameter	Typical Value					Units
Frequency (F)	3	3	3	10	18	GHz
Drain Voltage (V_D)	12	28	28	28	28	V
Bias Current (I_{DQ})	62.5	25	62.5	62.5	62.5	mA
Input Power (P_{in})	15	17	17	27	31	
Output P3dB (P_{3dB})	32.4	36.2	36.9	36.7	36.7	dBm
PAE @ P_{3dB} (PAE_{3dB})	71.6	66.8	65.2	65.6	42.4	%
Gain @ P3dB (G_{3dB})	17.4	19.2	19.9	9.7	5.7	dB
Parallel Resistance(2) (R_p)	64.0	129	105	34.1	39.4	Ω·mm
Parallel Capacitance(2) (C_p)	0.80	0.53	0.46	1.43	–2.10	pF/mm
Load Reflection Coefficient(3) (Γ_L)	0.43∠114°	0.50∠73°	0.40∠72°	0.57∠147°	0.71∠–147°	--

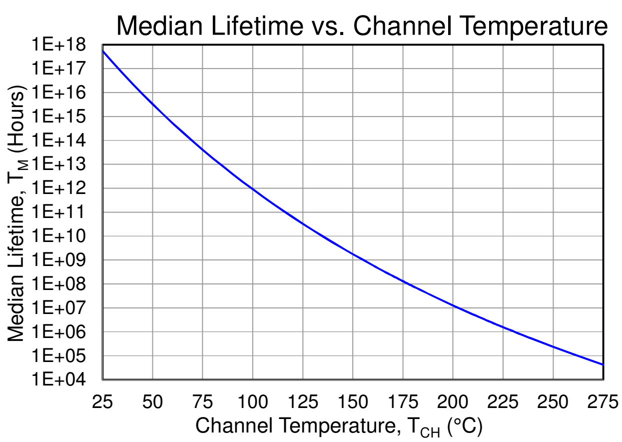
Notes:
1. Large signal equivalent output network (normalized) (see figure, pg. 6).
2. Characteristic Impedance (Zo) = 50 Ω.

Thermal and Reliability Information [1]

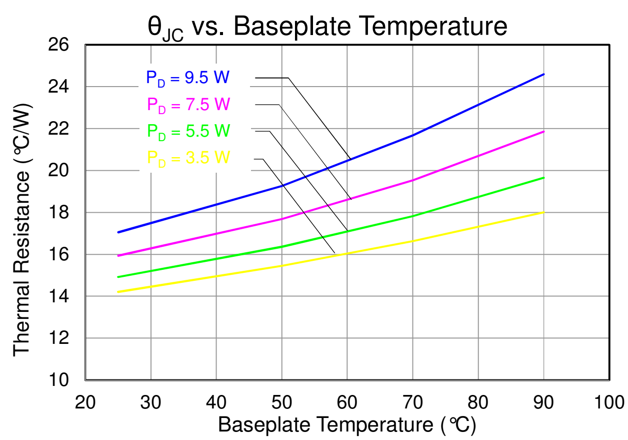
Parameter	Test Conditions	Value	Units
Thermal Resistance, θ_{JC} (No RF Drive)	V_D = 28 V, I_D = 125 mA, P_D = 3.5 W, Tbaseplate = 70°C	16.63	ºC/W
Channel Temperature, T_{CH} (No RF Drive)		128	°C
Median Lifetime, T_M (No RF Drive)		2.27 x 10^10	Hrs
Thermal Resistance, θ_{JC} (Under RF Drive)	V_D = 28 V, I_D = 379 mA, P_{OUT} = 38.1 dBm, P_D = 4.2 W, Tbaseplate = 70°C	16.95	°C/W
Channel Temperature, T_{CH} (Under RF Drive)		141	°C
Median Lifetime, T_M (Under RF Drive)		4.84 x 10^9	Hrs

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

Median Lifetime

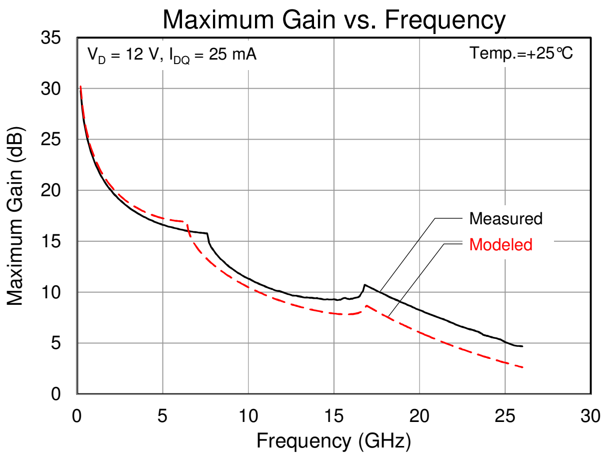


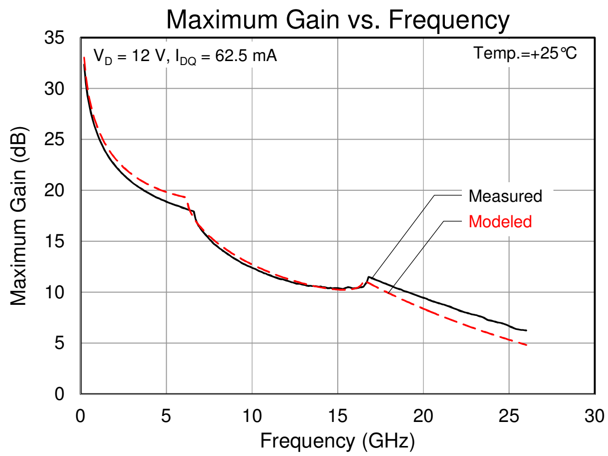
Thermal Resistance

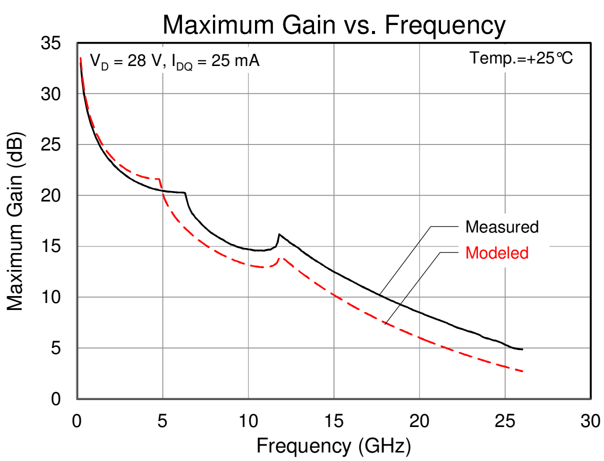


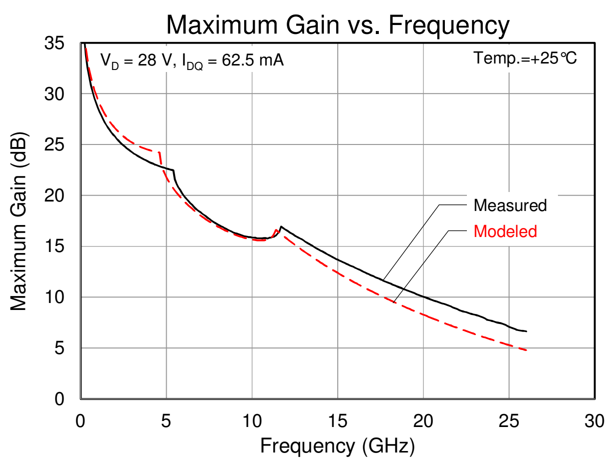
Maximum Gain Performance

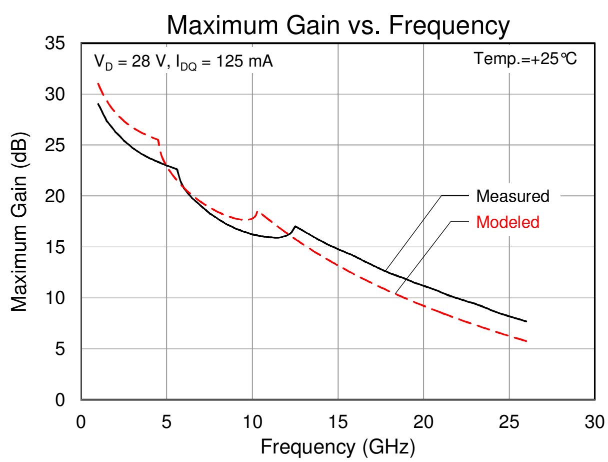
Modelithics provided measured data at 25mA and 62.5mA bias currents.







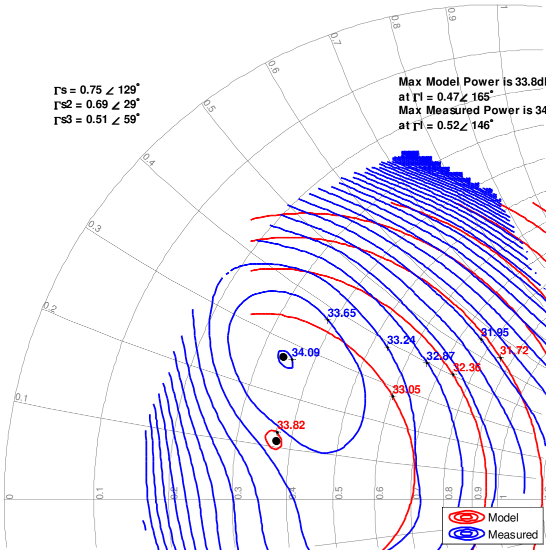




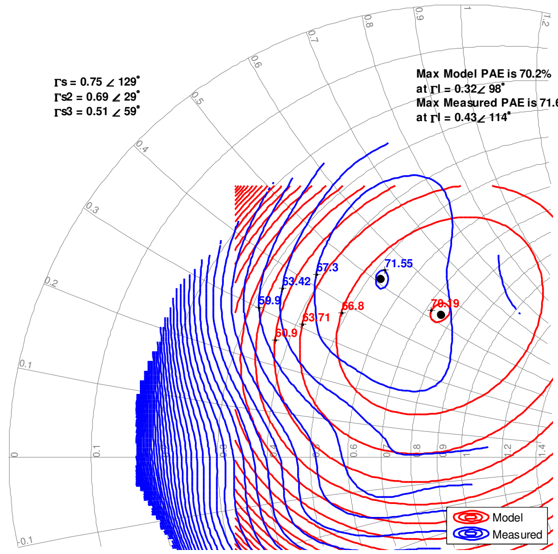
Load Pull Contours

Load pull signal: 10%, 100 µS pulses. Bond wires included. Measured data provided by Modelithics.

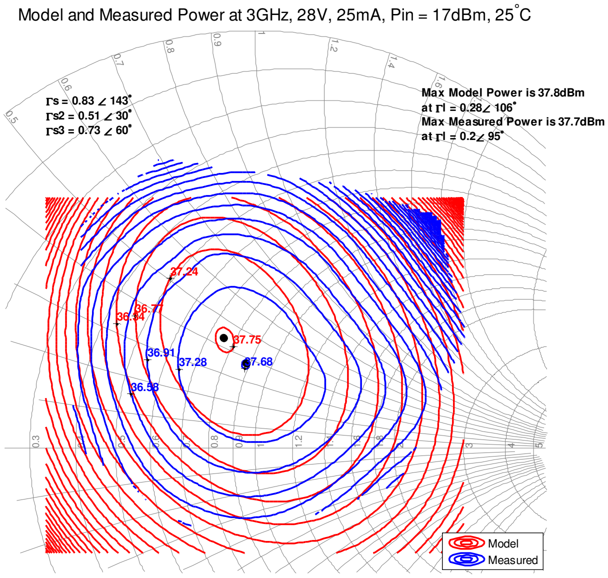
Load Pull
Model and Measured Power at 3GHz, 12V, 62.5mA, Pin = 15dBm, 25°C



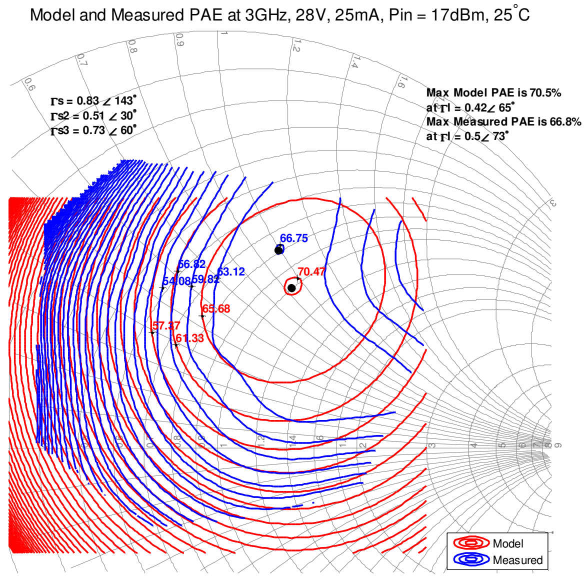
Load Pull
Model and Measured PAE at 3GHz, 12V, 62.5mA, Pin = 15dBm, 25°C



Load Pull
Model and Measured Power at 3GHz, 28V, 25mA, Pin = 17dBm, 25°C



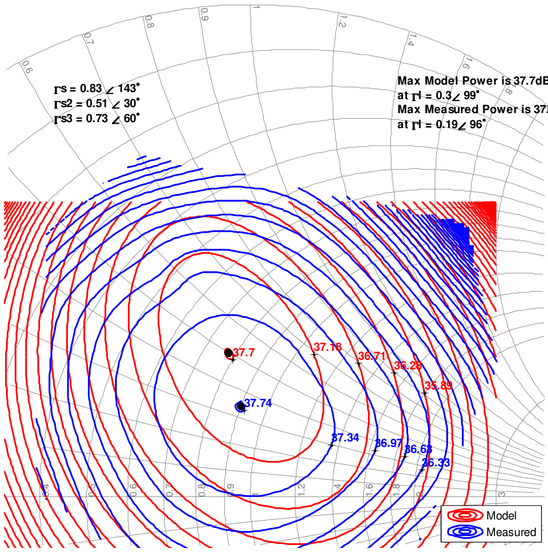
Load Pull
Model and Measured PAE at 3GHz, 28V, 25mA, Pin = 17dBm, 25°C



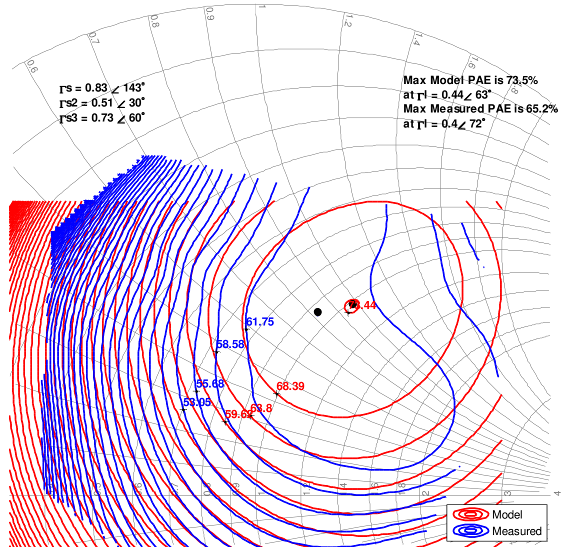
Load Pull Contours

Load pull signal: 10%, 100 µS pulses. Bond wires included. Measured data provided by Modelithics.

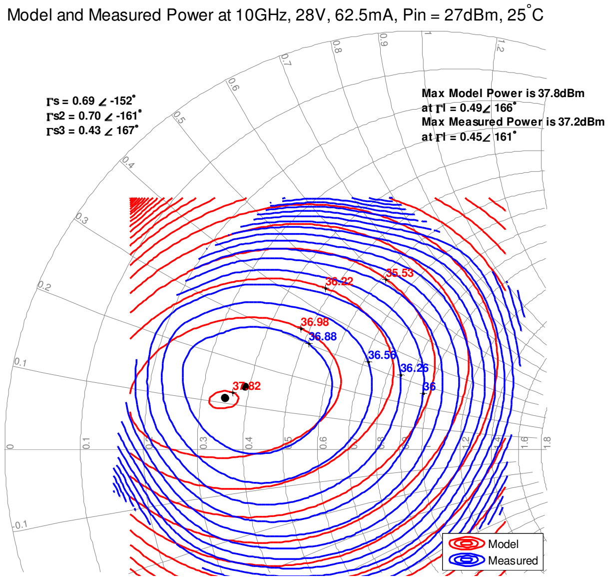
Load Pull
Model and Measured Power at 3GHz, 28V, 62.5mA, Pin = 17dBm, 25°C



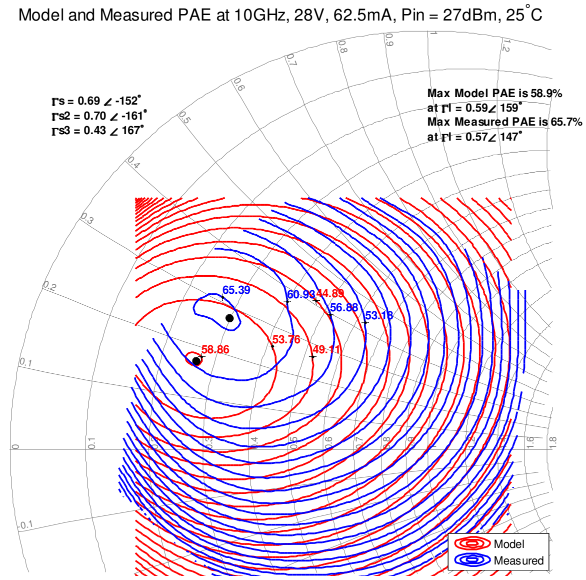
Load Pull
Model and Measured PAE at 3GHz, 28V, 62.5mA, Pin = 17dBm, 25°C



Load Pull
Model and Measured Power at 10GHz, 28V, 62.5mA, Pin = 27dBm, 25°C



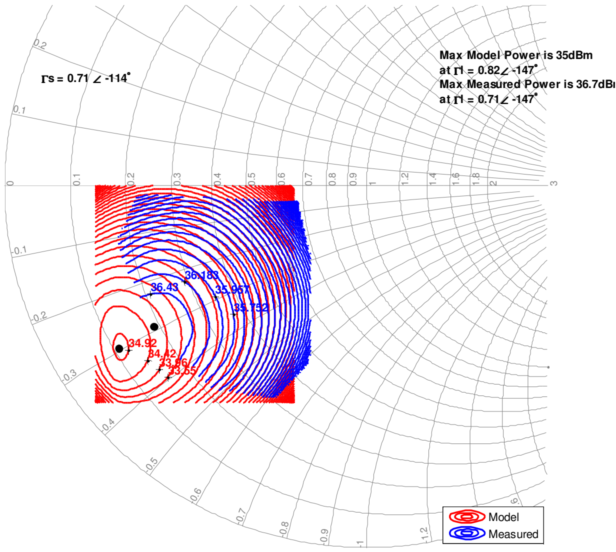
Load Pull
Model and Measured PAE at 10GHz, 28V, 62.5mA, Pin = 27dBm, 25°C



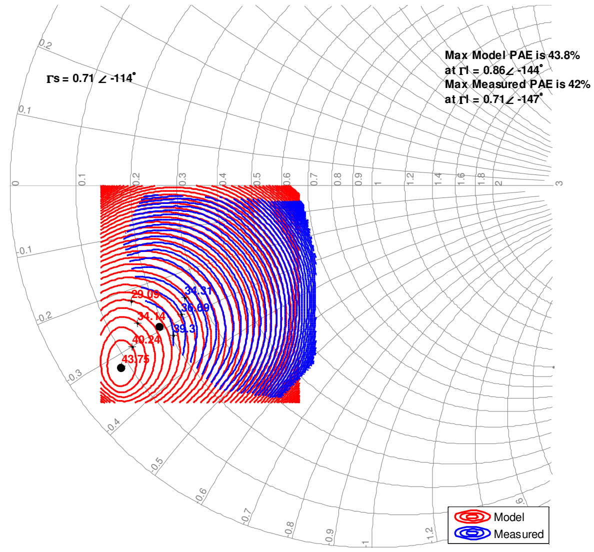
Load Pull Contours

Load pull signal: 10%, 100 µS pulses. Bond wires included. Measured data provided by Modelithics.

Load Pull
Model and Measured Power at 18GHz, 28V, 62.5mA, Pin = 31dBm, 25°C



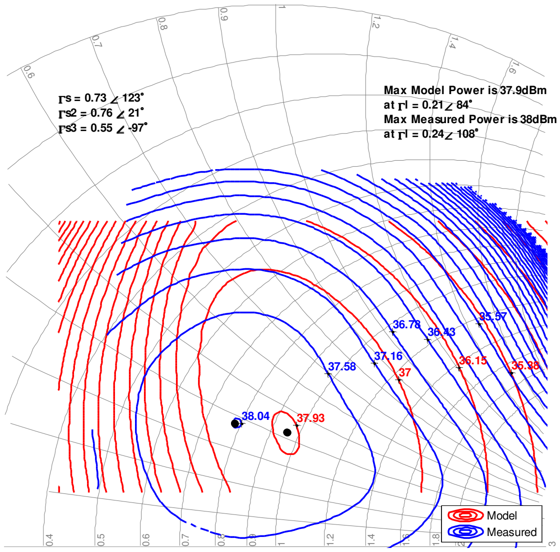
Load Pull
Model and Measured PAE at 18GHz, 28V, 62.5mA, Pin = 31dBm, 25°C



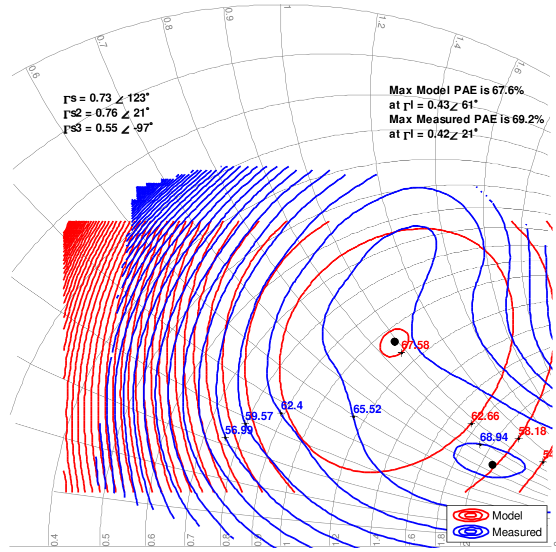
Load Pull Contours

Load pull signal: 10%, 100 µS pulses. Bond wires not included.

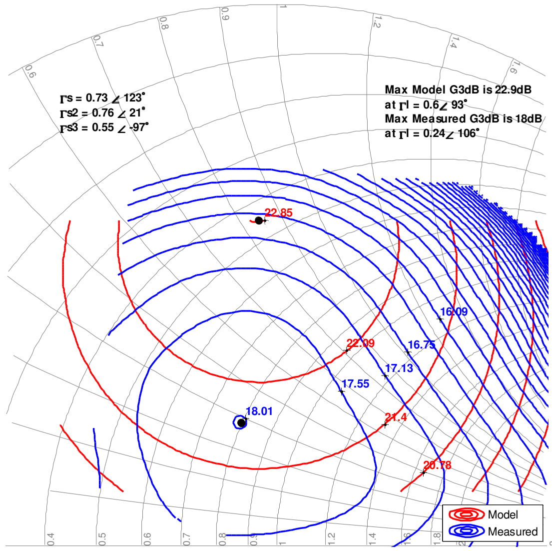
Load Pull
Model and Measured Power at 3GHz, 28V, 125mA, P3dB, 25˚C



Load Pull
Model and Measured PAE at 3GHz, 28V, 125mA, P3dB, 25˚C



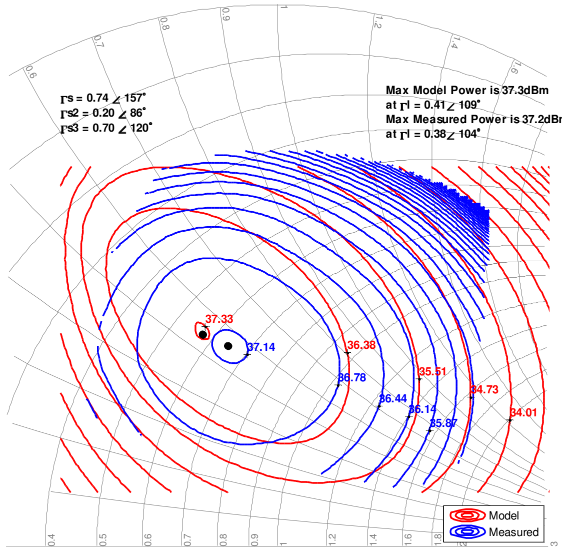
Load Pull
Model and Measured P3dB Gain at 3GHz, 28V, 125mA, P3dB, 25˚C



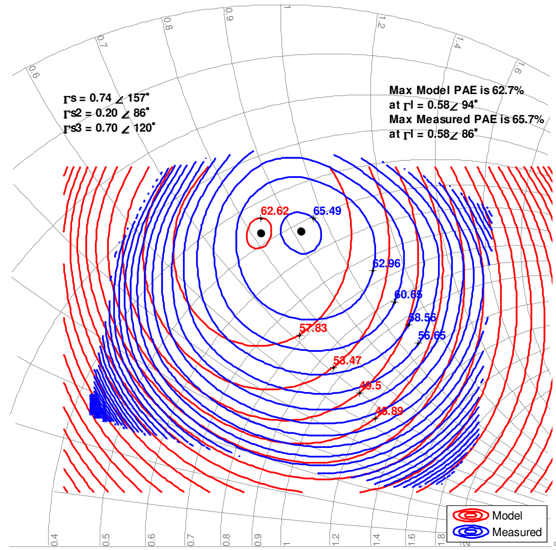
Load Pull Contours

Load pull signal: 10%, 100 µS pulses. Bond wires not included.

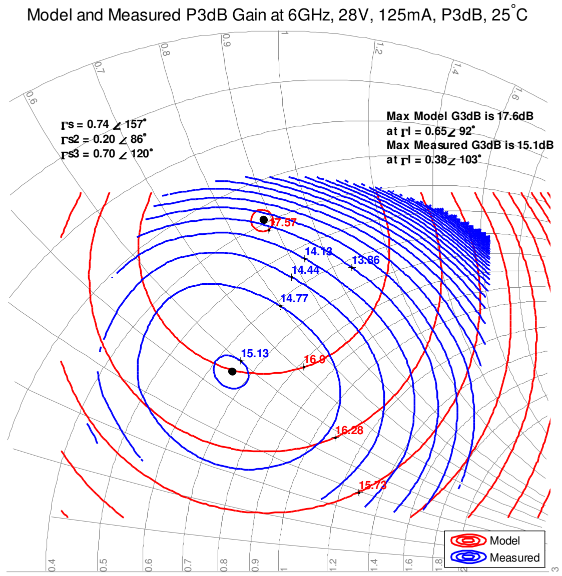
Load Pull
Model and Measured Power at 6GHz, 28V, 125mA, P3dB, 25°C



Load Pull
Model and Measured PAE at 6GHz, 28V, 125mA, P3dB, 25°C



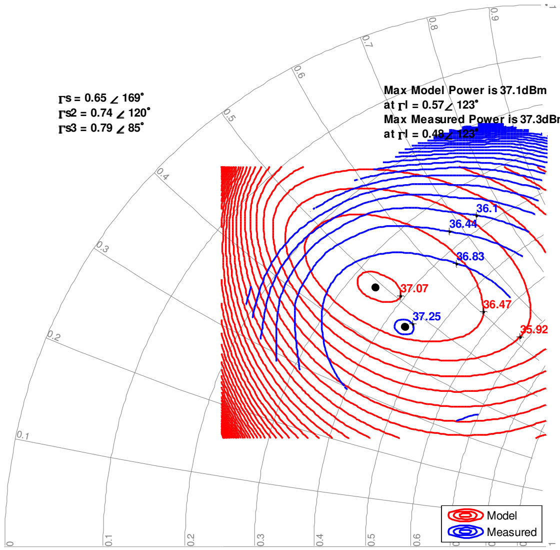
Load Pull
Model and Measured P3dB Gain at 6GHz, 28V, 125mA, P3dB, 25°C



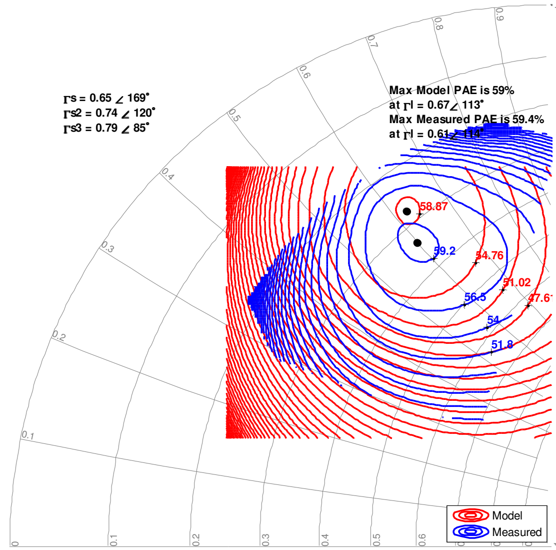
Load Pull Contours

Load pull signal: 10%, 100 µS pulses. Bond wires not included.

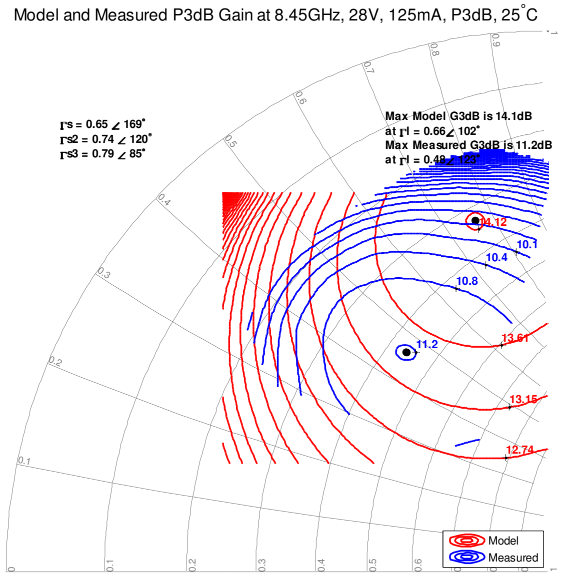
Load Pull
Model and Measured Power at 8.45GHz, 28V, 125mA, P3dB, 25°C



Load Pull
Model and Measured PAE at 8.45GHz, 28V, 125mA, P3dB, 25°C

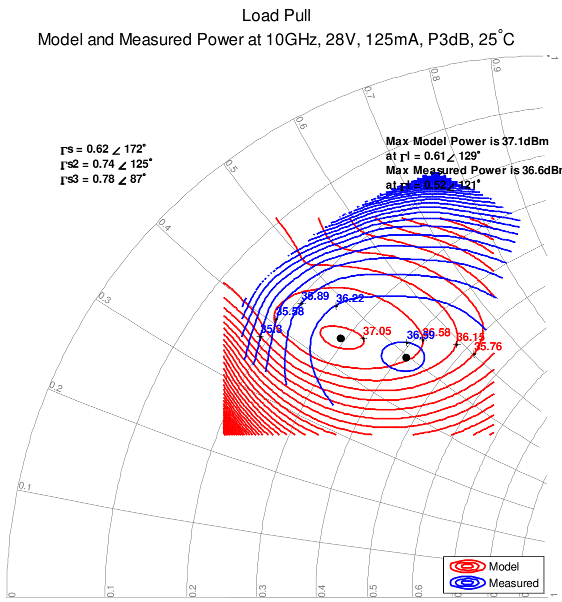


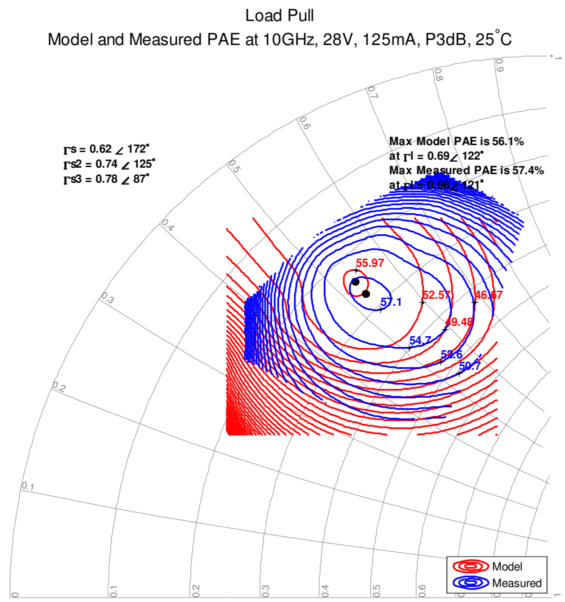
Load Pull
Model and Measured P3dB Gain at 8.45GHz, 28V, 125mA, P3dB, 25°C

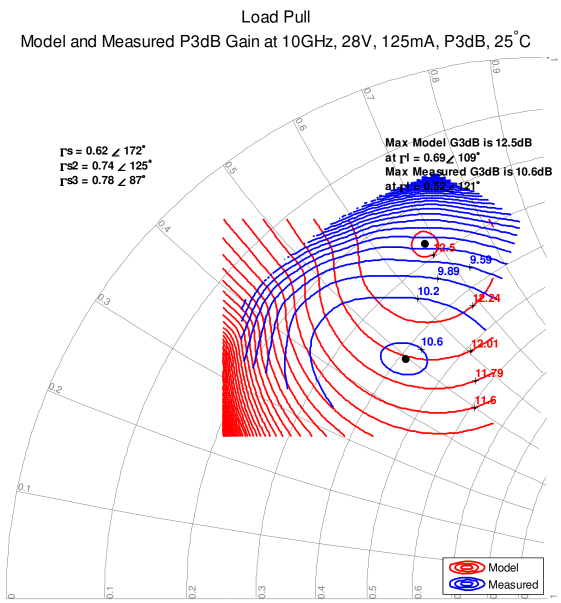


Load Pull Contours

Load pull signal: 10%, 100 μS pulses. Bond wires included.



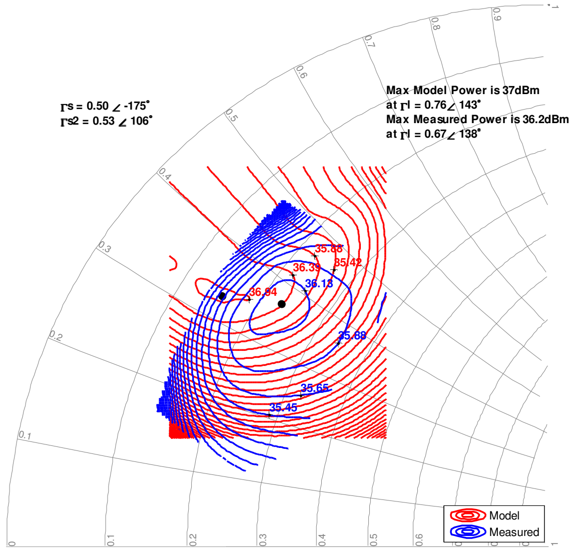




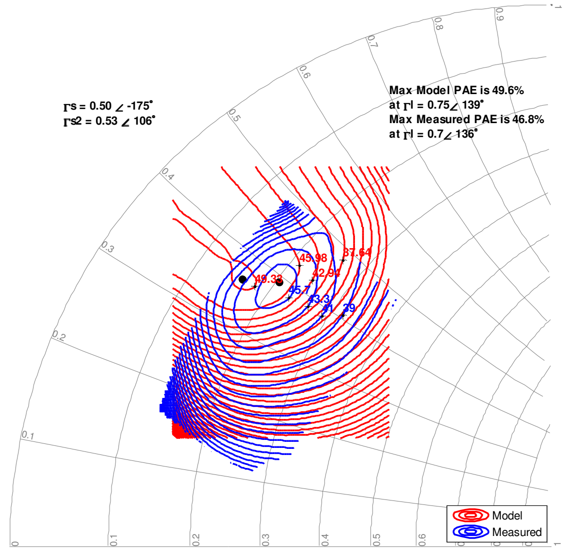
Load Pull Contours

Load pull signal: 10%, 100 µS pulses. Bond wires included.

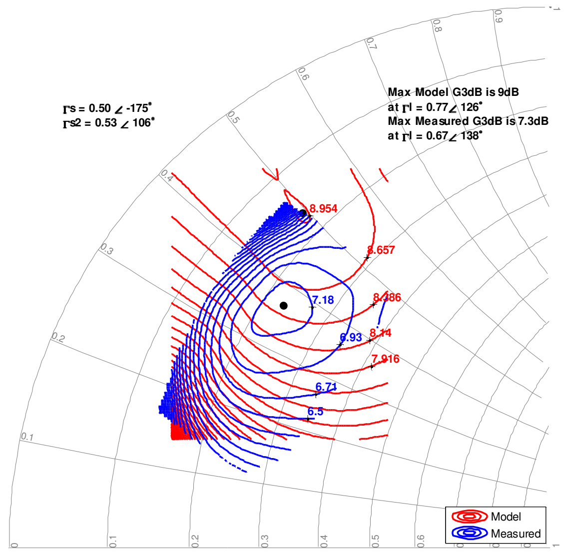
Load Pull
Model and Measured Power at 14GHz, 28V, 125mA, P3dB, 25°C



Load Pull
Model and Measured PAE at 14GHz, 28V, 125mA, P3dB, 25°C

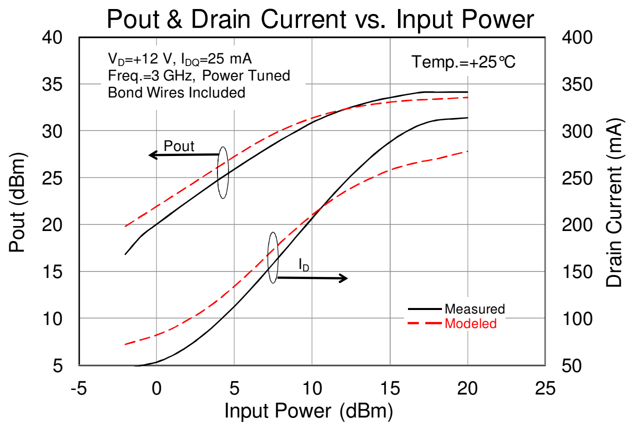


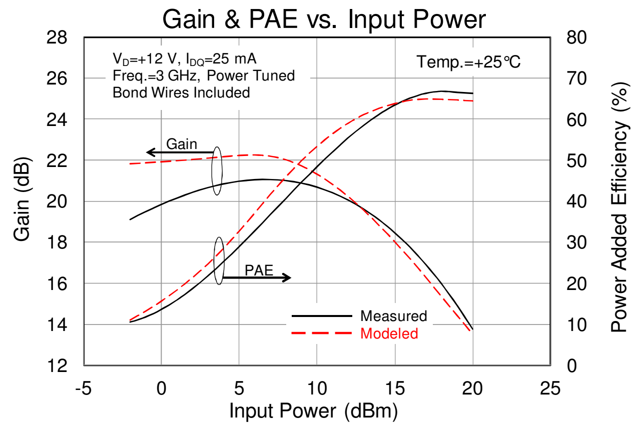
Load Pull
Model and Measured P3dB Gain at 14GHz, 28V, 125mA, P3dB, 25°C



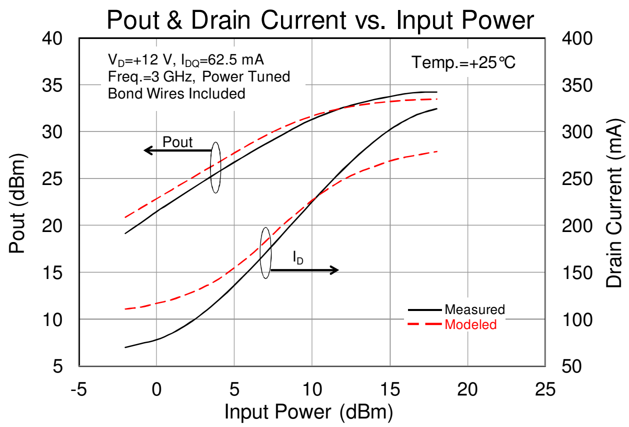
Power Tuned Data

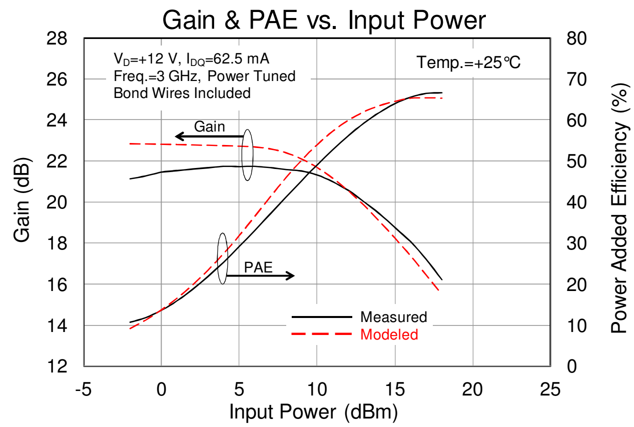
Modelithics provided measured data at 25mA and 62.5mA bias currents.



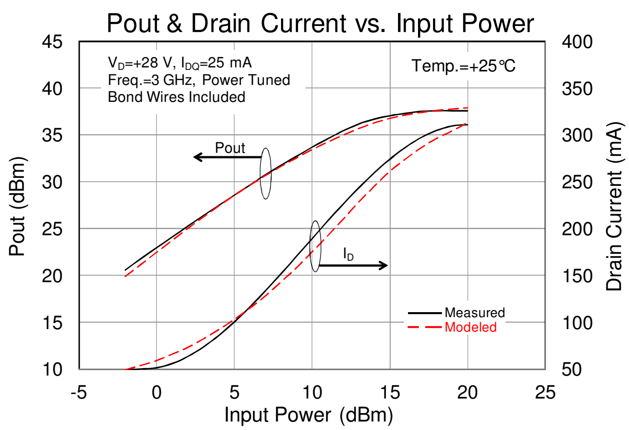


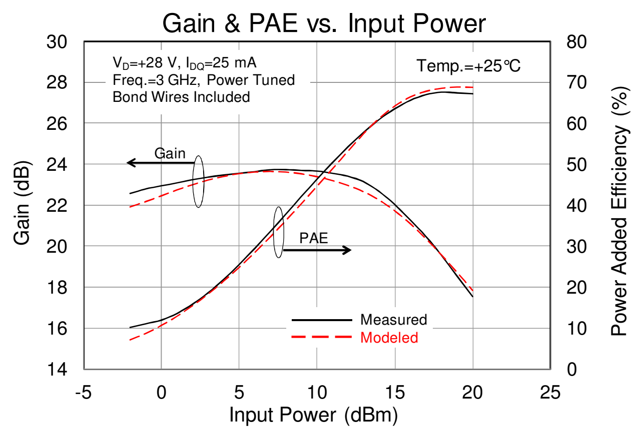
Source Γ: fo: 0.75∠129°, 2fo: 0.69∠29°, 3fo: 0.51∠59°
Load Γ: fo: 0.36∠144°, 2fo: 0.33∠60°, 3fo: 0.12∠148°





Source Γ: fo: 0.75∠129°, 2fo: 0.69∠29°, 3fo: 0.51∠59°
Load Γ: fo: 0.36∠144°, 2fo: 0.33∠60°, 3fo: 0.12∠148°

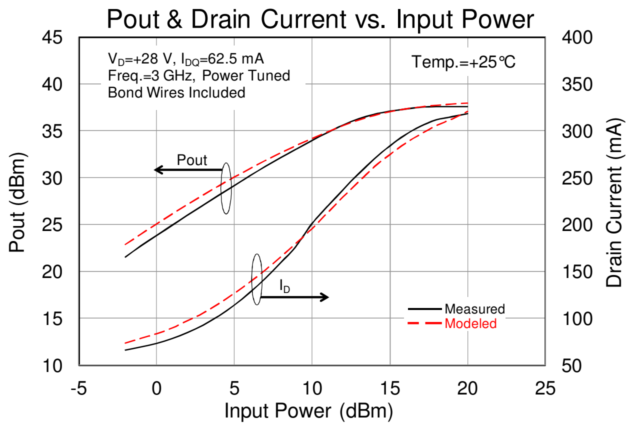


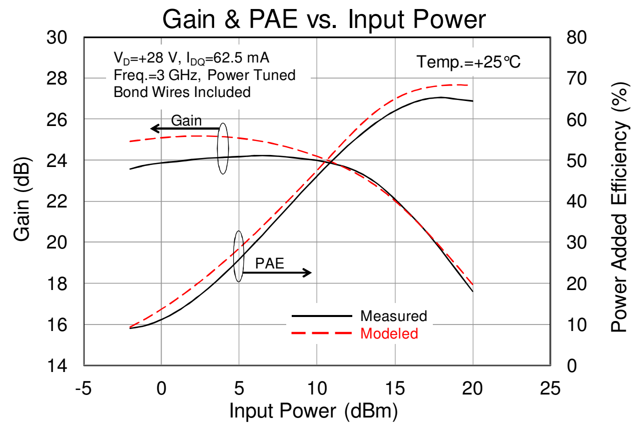


Source Γ: fo: 0.83∠142°, 2fo: 0.51∠30°, 3fo: 0.73∠60°
Load Γ: fo: 0.29∠82°, 2fo: 0.41∠–137°, 3fo: 0.27∠44°

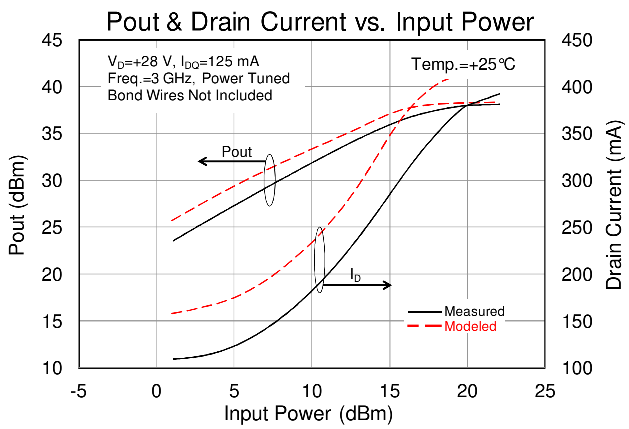
Power Tuned Data

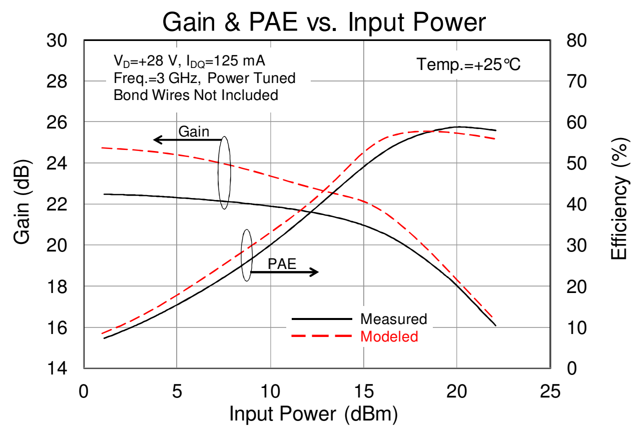
Modelithics provided measured data at 25mA and 62.5mA bias currents.



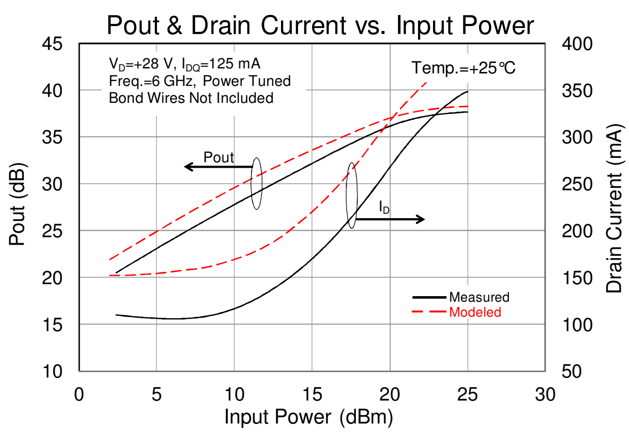


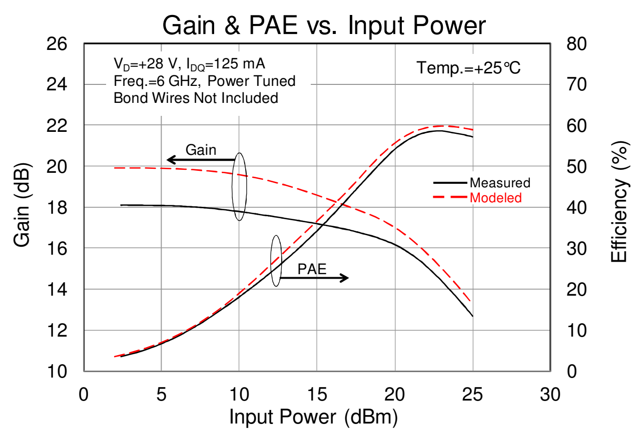
Source Γ: fo: 0.83∠142°, 2fo: 0.51∠30°, 3fo: 0.73∠60°
Load Γ: fo: 0.29∠82°, 2fo: 0.41∠−137°, 3fo: 0.27∠44°





Source Γ: fo: 0.73∠123°, 2fo: 0.76∠21°, 3fo: 0.55∠−97°
Load Γ: fo: 0.23∠−109°, 2fo: 0.01∠-51°, 3fo: 0.26∠77°

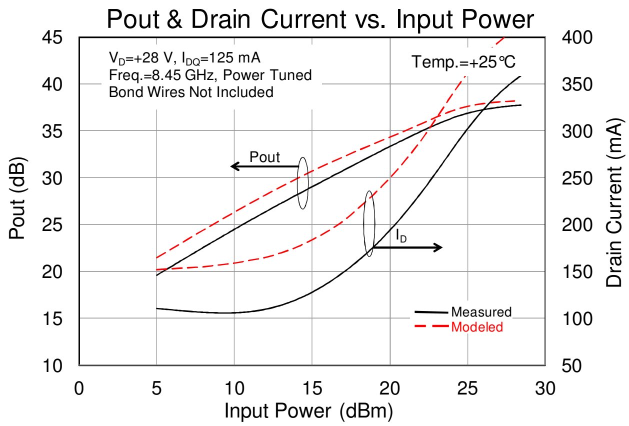


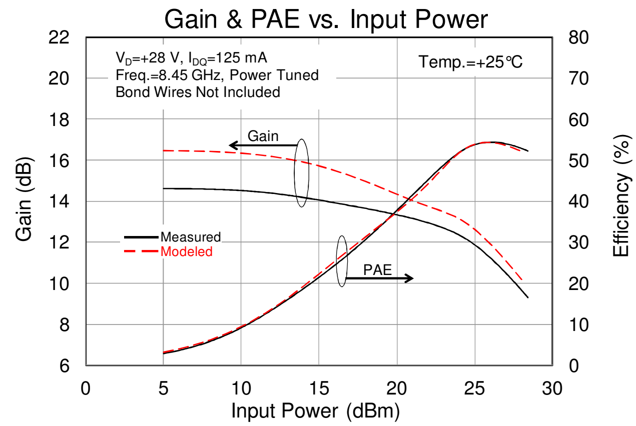


Source Γ: fo: 0.74∠157°, 2fo: 0.20∠86°, 3fo: 0.70∠120°
Load Γ: fo: 0.35∠100°, 2fo: 0.22∠74°, 3fo: 0.35∠17°

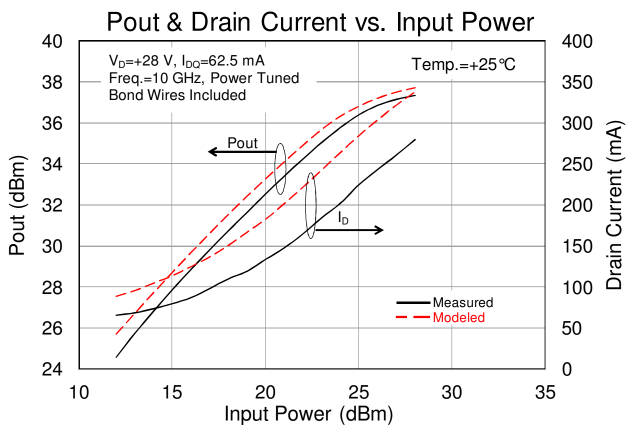
Power Tuned Data

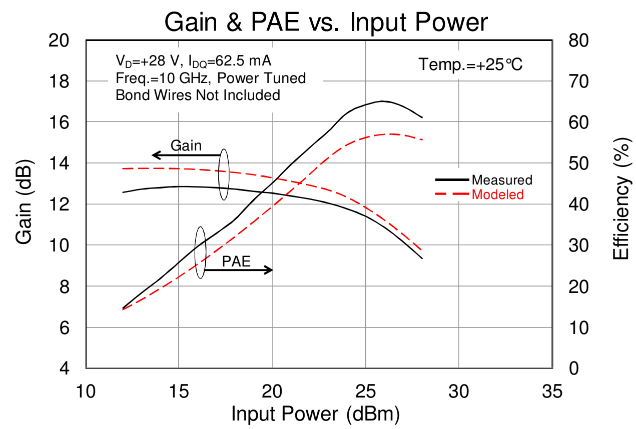
Modelithics provided measured data at 25mA and 62.5mA bias currents.



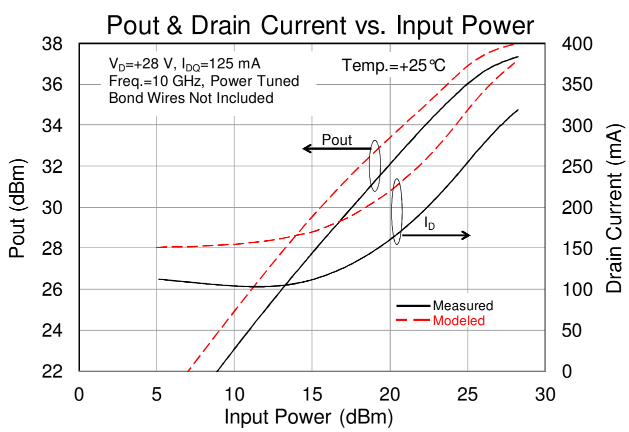


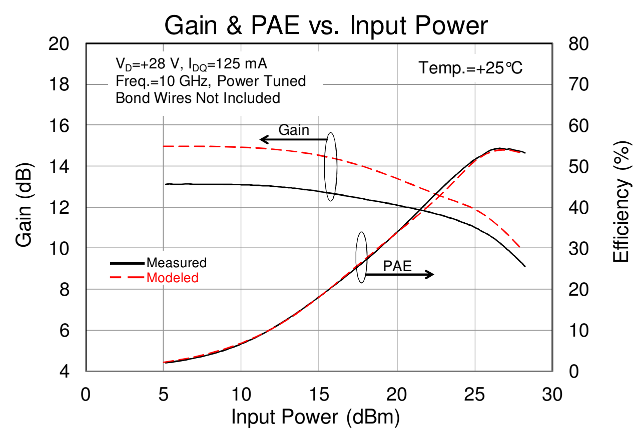
Source Γ: fo: 0.65∠169°, 2fo: 0.74∠120°, 3fo: 0.79∠85°
Load Γ: fo: 0.47∠122°, 2fo: 0.69∠69°, 3fo: 0.61∠19°





Source Γ: fo: 0.68∠–152°, 2fo: 0.70∠–161°, 3fo: 0.43∠167°
Load Γ: fo: 0.49∠153°, 2fo: 0.46∠31°, 3fo: 0.20∠–94°

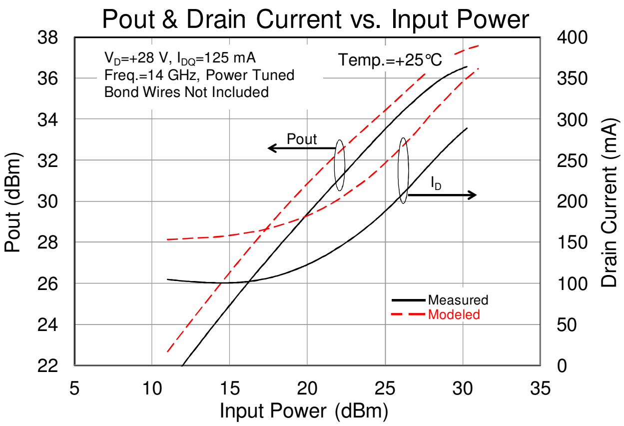


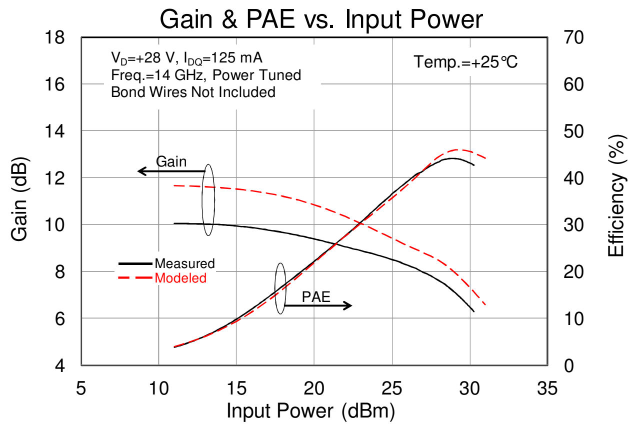


Source Γ: fo: 0.62∠172°, 2fo: 0.74∠125°, 3fo: 0.89∠62°
Load Γ: fo: 0.54∠125°, 2fo: 0.65∠39°, 3fo: 0.41∠–4.0°

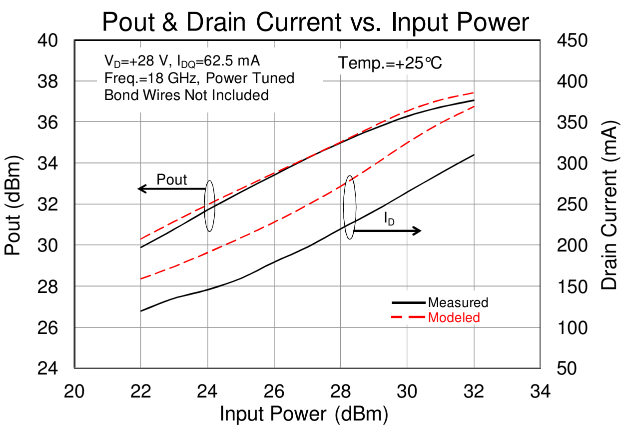
Power Tuned Data

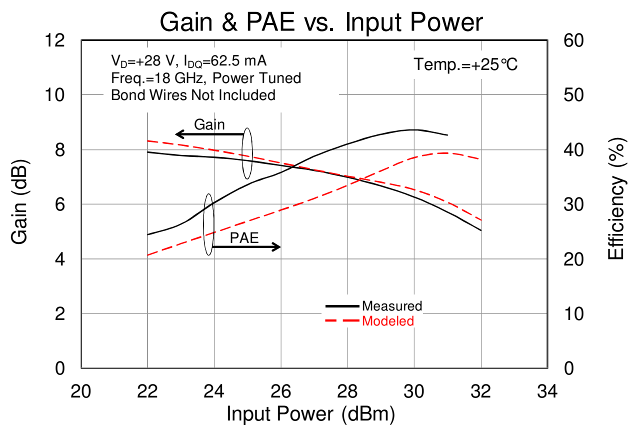
Modelithics provided measured data at 25mA and 62.5mA bias currents.





Source Γ: fo: 0.50∠−175°, 2fo: 0.53∠106°
Load Γ: fo: 0.66∠134°, 2fo: 0.82∠67°

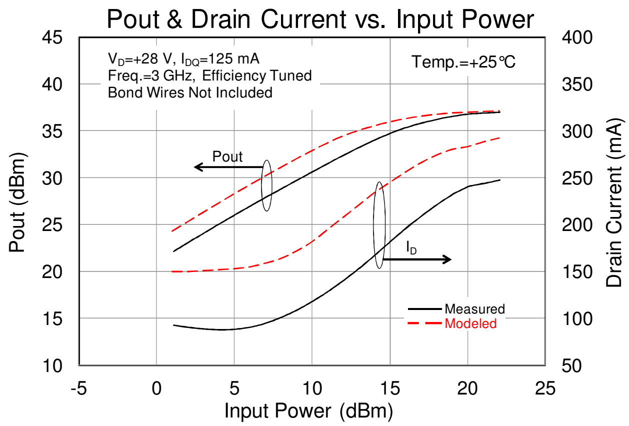


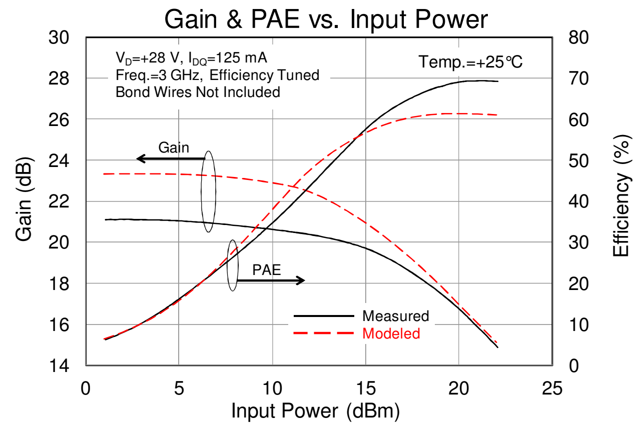


Source Γ: fo: 0.72∠−114°
Load Γ: fo: 0.71∠−147°

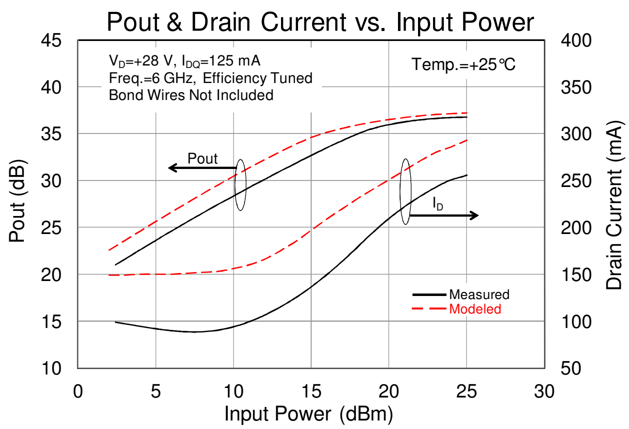
Efficiency Tuned Data

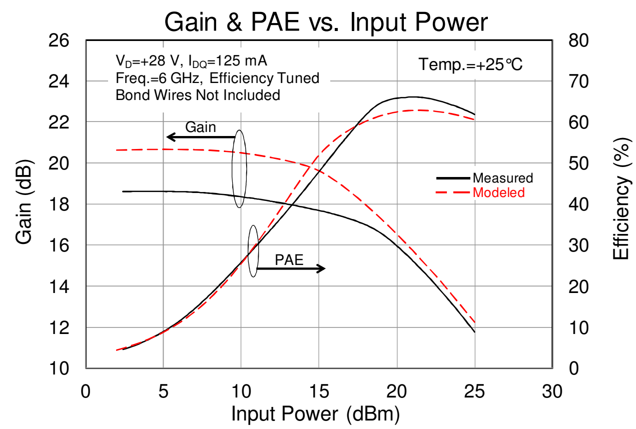
Modelithics provided measured data at 25mA and 62.5mA bias currents.



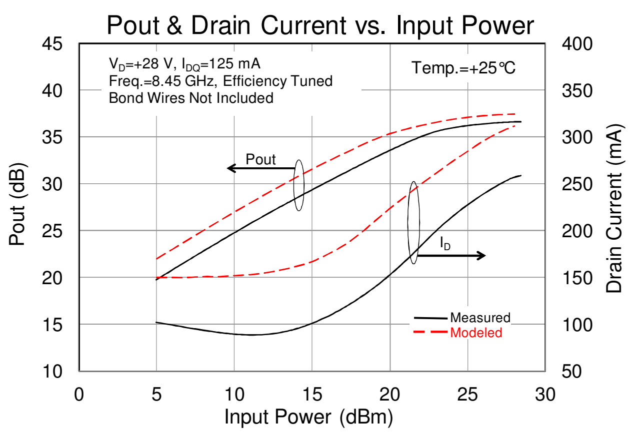


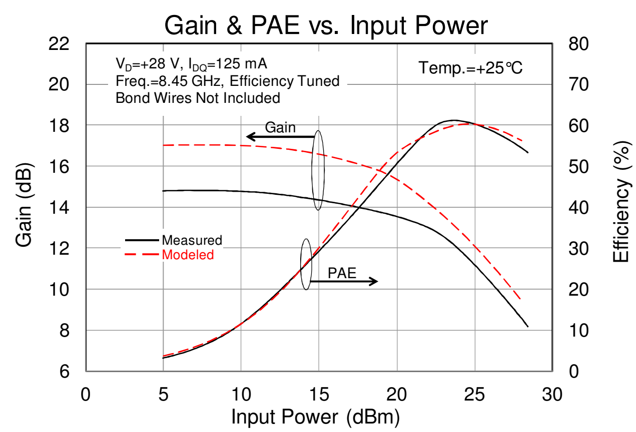
Source Γ: fo: 0.73∠123°, 2fo: 0.76∠21°, 3fo: 0.55∠–97°
Load Γ: fo: 0.41∠18°, 2fo: 0.62∠104°, 3fo: 0.35∠–160°





Source Γ: fo: 0.74∠157°, 2fo: 0.20∠86°, 3fo: 0.70∠120°
Load Γ: fo: 0.55∠88°, 2fo: 0.20∠74°, 3fo: 0.30∠–42°

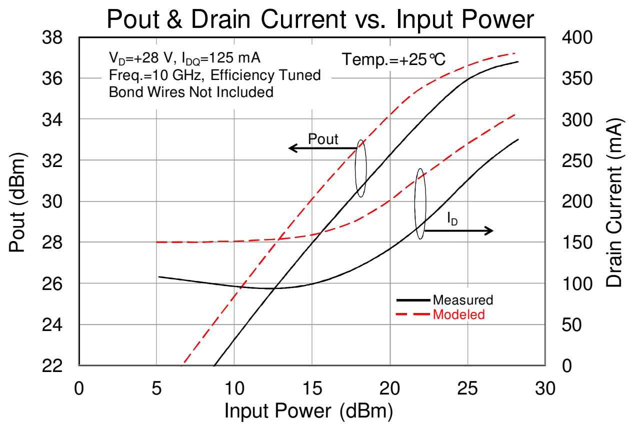


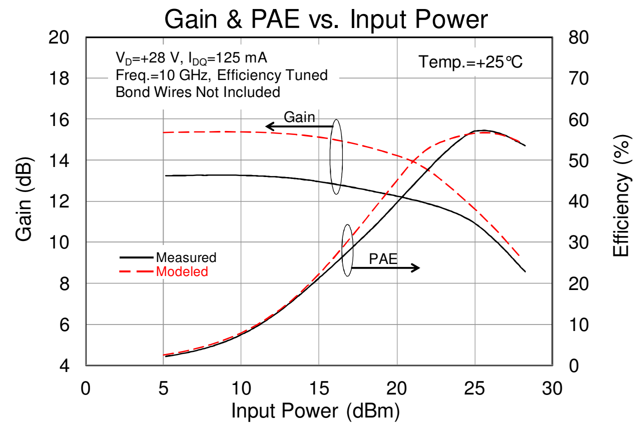


Source Γ: fo: 0.65∠169°, 2fo: 0.74∠120°, 3fo: 0.79∠85°
Load Γ: fo: 0.65∠113°, 2fo: 0.78∠50°, 3fo: 0.57∠–22°

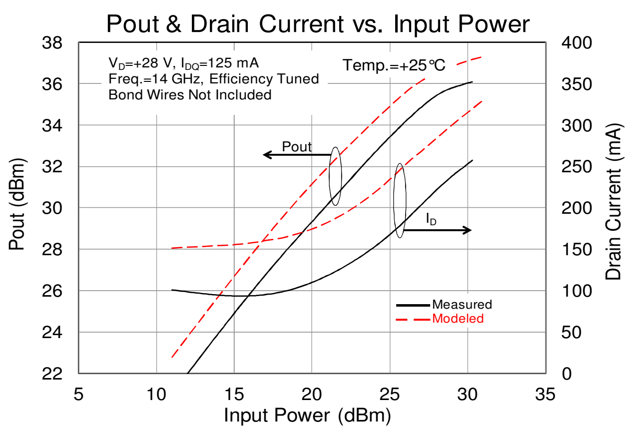
Efficiency Tuned Data

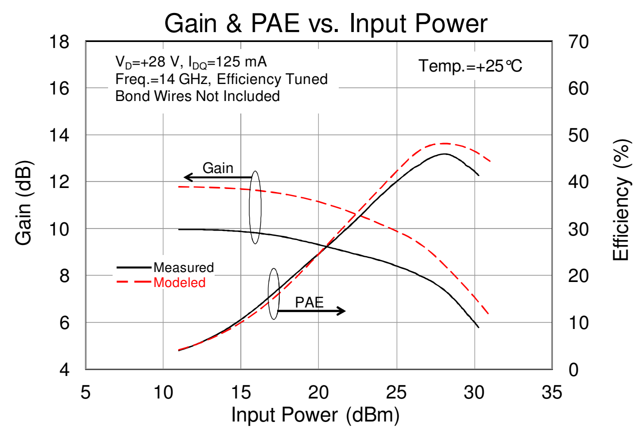
Modelithics provided measured data at 25mA and 62.5mA bias currents.





Source Γ: fo: 0.62∠172°, 2fo: 0.74∠125°, 3fo: 0.89∠62°
Load Γ: fo: 0.68∠120°, 2fo: 0.69∠34°, 3fo: 0.41∠–17°



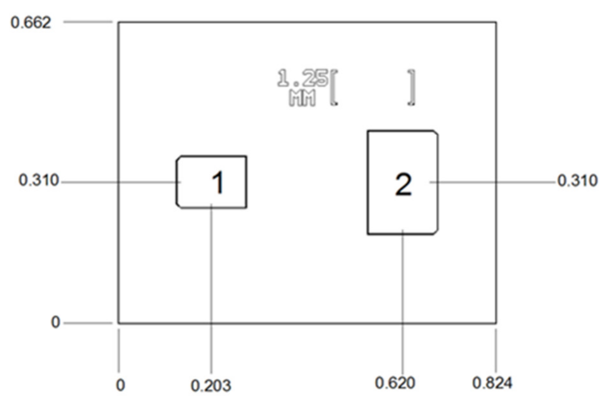


Source Γ: fo: 0.50∠–175°, 2fo: 0.53∠106°
Load Γ: fo: 0.73∠134°, 2fo: 0.84∠71°

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.

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	Gate	0.154 x 0.115
2	Drain	0.154 x 0.230
Die Backside	Source / Ground	0.662 x 0.824

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 28 V.
3. Adjust V_G more positive until quiescent I_D is 125 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.

Product Compliance Information

ESD Sensitivity Ratings

Caution! ESD-Sensitive Device

ESD Rating: TBD
Value: TBD
Test: TBD
Standard: TBD

Solderability

Compatible with gold/tin (320℃ maximum reflow temperature) soldering processes.

RoHs Compliance

This part is compliant with EU 2002/95/EC RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment).

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free

Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations, and information about TriQuint:

Web: www.triquint.com **Tel:** +1.972.994.8465
Email: info-sales@triquint.com **Fax:** +1.972.994.8504

For technical questions and application information: **Email:** info-products@triquint.com

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