TGF2023-2-01

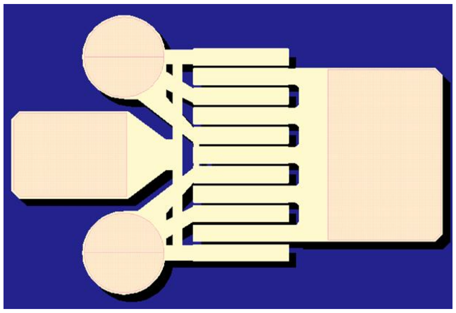
6 W, 32 V, DC to 18 GHz, Discrete Power GaN on SiC HEMT

Product Overview

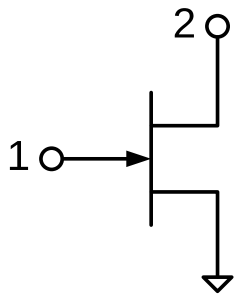
The Qorvo TGF2023-2-01 is a discrete 1.25 mm GaN on SiC HEMT which operates from DC-18 GHz. The TGF2023-2-01 is designed using Qorvo's proven QGaN25 production process. This process features advanced field plate techniques to optimize microwave power and efficiency at high drain bias operating conditions.

The TGF2023-2-01 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



Functional Block Diagram



Key Features

- Frequency Range: DC - 18 GHz
- Output Power (P_{3dB})[1]: 38 dBm
- Maximum PAE[1]: 71.6%
- Linear Gain[1]: 18 dB
- 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

Note 1: @ 3 GHz

Applications

- Defense & Aerospace
- Broadband Wireless

Pad Configuration

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

Ordering Information

Part Number	Description
TGF2023-2-01	6 Watt GaN HEMT

Absolute Maximum Ratings

Parameter	Rating
Drain to Gate Voltage (V_{DG})	100 V
Drain Voltage (V_D)	40 V
Gate Voltage Range (V_G)	−7 to 2 V
Drain Current (I_D)	1.438 A
Gate Current (I_G)	−1.25 to 3.5 mA
Power Dissipation, CW (P_D)	See graph on pg.4.
CW Input Power (P_{IN})	+31 dBm
Storage Temperature	−65 to 150°C

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
Drain Voltage Range (V_D)	+12	+28	+40	V
Drain Quiescent Current (I_{DQ})	–	62.5	–	mA
Gate Voltage, V_G[1]	−3.7	−2.8	−2.3	V
Gate Leakage: V_D = +10 V, V_G = −3.7 V	−1.25	–	–	mA

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

Note:

1. To be adjusted to desired I_{DQ}

RF Characterization – Model Optimum Power Tune

Test conditions unless otherwise noted: T = 25°C, Pulse (10% Duty Cycle, 100 µs Width).

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})	25	62.5	25	62.5	25	62.5	25	62.5	mA
Output P3dB (P_{3dB})	38	37.8	38.1	38.0	38.1	38.0	38.1	38.0	dBm
Drain Eff. @ P_{3dB} (DE_{3dB})	60.2	59.1	57.7	57.3	55.4	55.6	53	53.3	%
Gain @ P3dB (G_{3dB})	20	20.8	14.6	15.4	12.2	13	10.4	11.2	dB
Parallel Resistance (1) (R_p)	65.2	65.1	63.1	62.7	59.3	59.7	56.1	55.8	Ω·mm
Parallel Capacitance (1) (C_p)	0.318	0.312	0.324	0.321	0.341	0.343	0.328	0.330	pF/mm
Load Reflection Coefficient (2) (Γ_L)	0.19∠94°	0.19∠95°	0.36∠110°	0.35∠110°	0.46∠120°	0.47∠120°	0.52∠126°	0.52∠127°	--

Notes:

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

RF Characterization – Model Optimum Efficiency Tune

Test conditions unless otherwise noted: T = 25°C, Pulse (10% Duty Cycle, 100 µs Width).

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})	25	62.5	25	62.5	25	62.5	25	62.5	mA
Output P3dB (P_{3dB})	36.8	36.7	37.0	37.0	37	37.1	37.1	37.1	dBm
Drain Eff. @ P_{3dB} (DE_{3dB})	65.6	64.3	63.3	62.5	60.5	60.1	57.3	57.4	%
Gain @ P3dB (G_{3dB})	21.6	22.4	15.9	16.6	13.3	14.1	11.4	12.2	dB
Parallel Resistance (1) (R_p)	110	112	104	100	99.8	94.4	88.9	85.9	Ω·mm
Parallel Capacitance (1) (C_p)	0.398	0.384	0.394	0.390	0.394	0.390	0.384	0.386	pF/mm
Load Reflection Coefficient (2) (Γ_L)	0.39∠64°	0.39∠62°	0.55∠97°	0.53∠97°	0.63∠110°	0.62∠111°	0.68∠120°	0.67∠121°	--

Notes:

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

Thermal and Reliability Information - CW (1)

Parameter	Test Conditions	Value	Units
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 1.25 W, Tbaseplate = 85°C	12.7	ºC/W
Channel Temperature, T_{CH}		101	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 2.5 W, Tbaseplate = 85°C	14.1	°C/W
Channel Temperature, T_{CH}		120	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 3.75 W, Tbaseplate = 85°C	14.7	ºC/W
Channel Temperature, T_{CH}		140	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 5.00 W, Tbaseplate = 85°C	15.2	ºC/W
Channel Temperature, T_{CH}		161	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 6.25 W, Tbaseplate = 85°C	15.9	ºC/W
Channel Temperature, T_{CH}		184	°C

Notes:

1. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

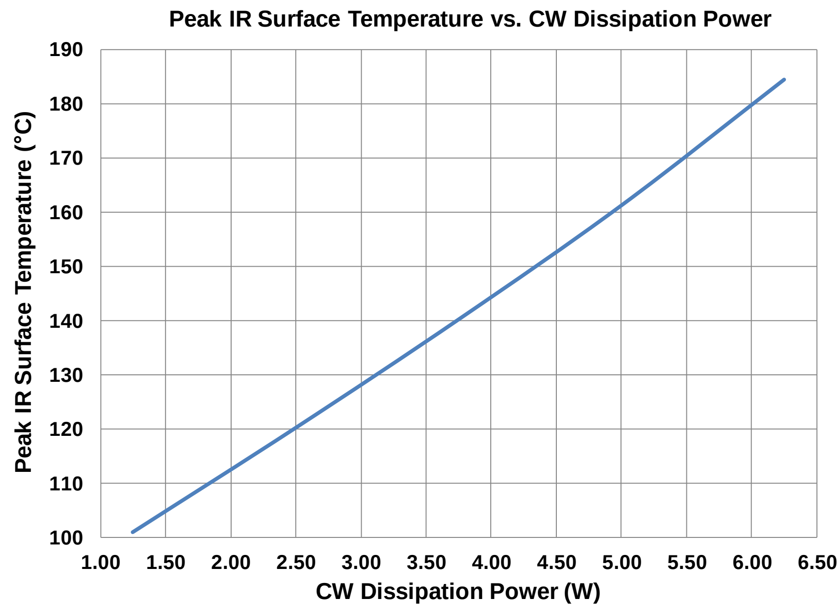
Thermal and Reliability Information - Pulsed (1)

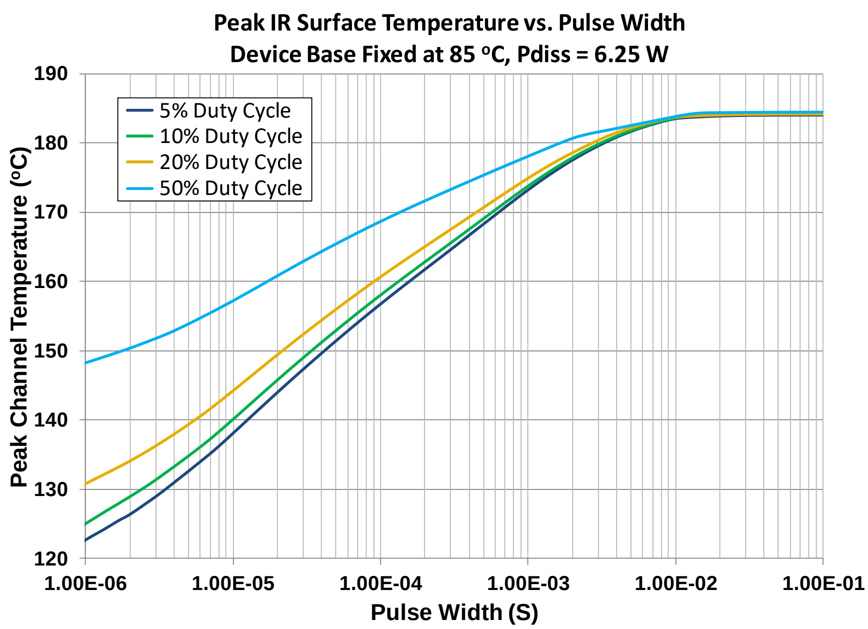
Parameter	Test Conditions	Value	Units
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 6.25 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 5%	11.5	ºC/W
Channel Temperature, T_{CH}		157	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 6.25 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 10%	11.7	°C/W
Channel Temperature, T_{CH}		158	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 6.25 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 20%	12.1	ºC/W
Channel Temperature, T_{CH}		161	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 6.25 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 50%	13.8	ºC/W
Channel Temperature, T_{CH}		171	°C

Notes:

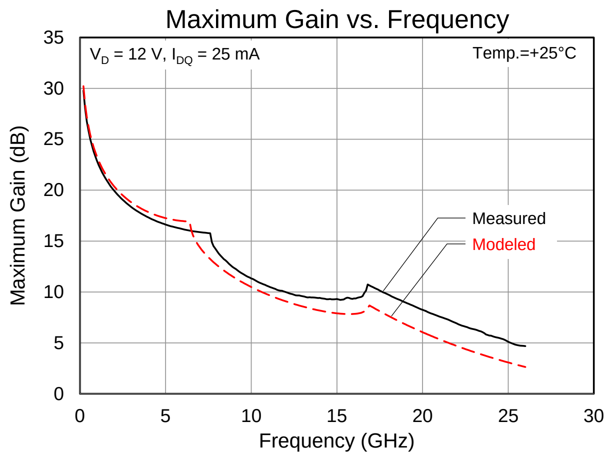
1. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

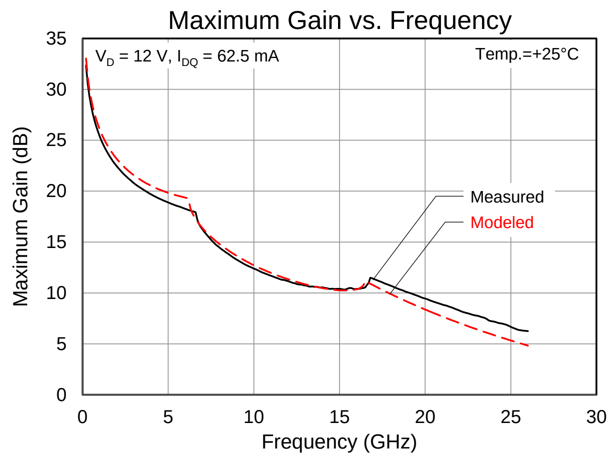
Maximum Channel Temperature

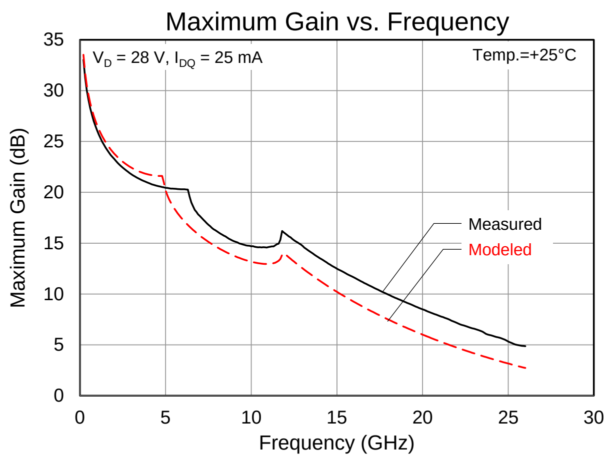


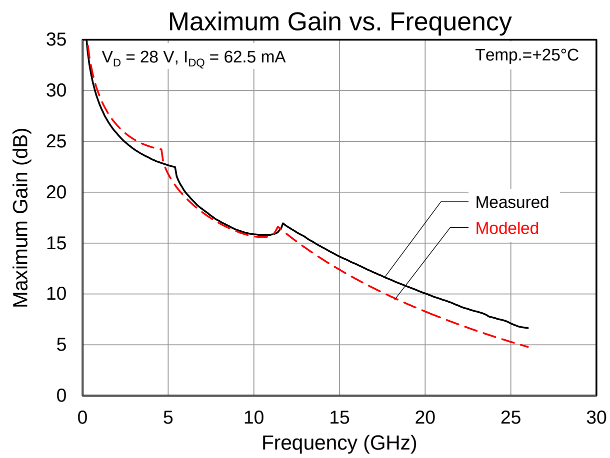


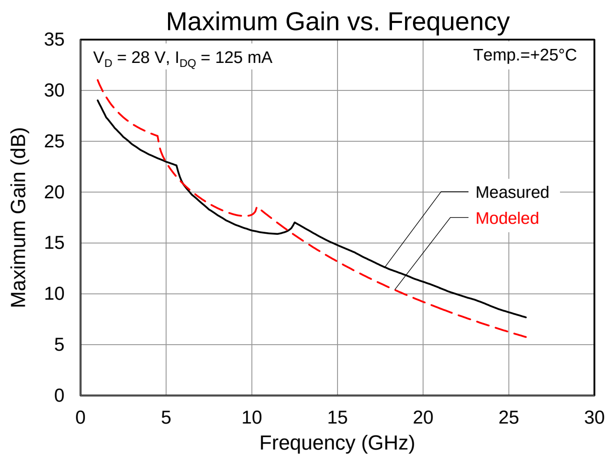
Model Maximum Gain Performance







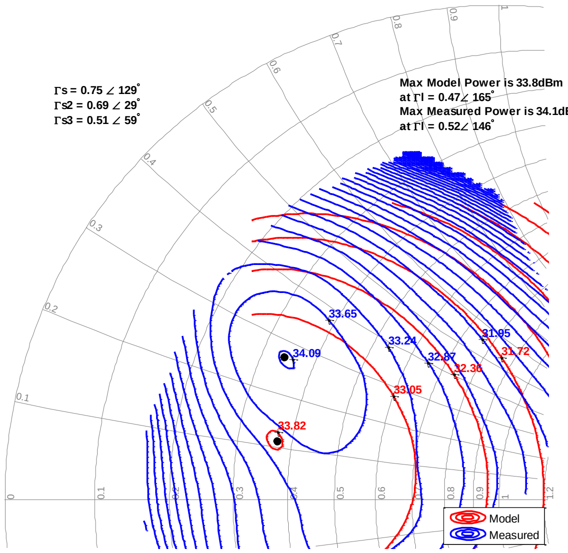




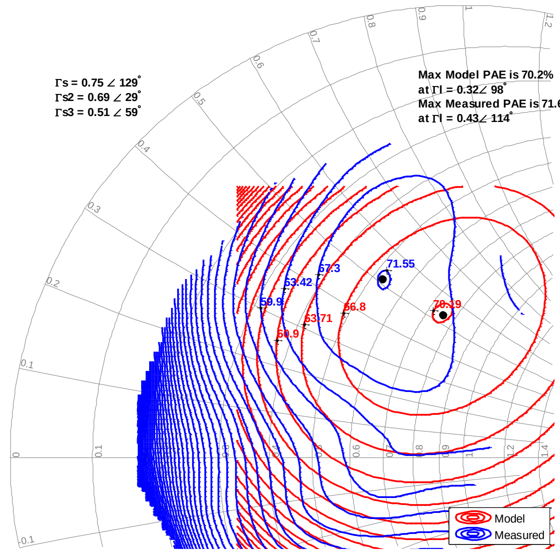
Model Load Pull Contours

Load pull signal: Pulse (10% Duty Cycle, 100 μs Width). Bond wires included. Measured data provided by Modelithics.

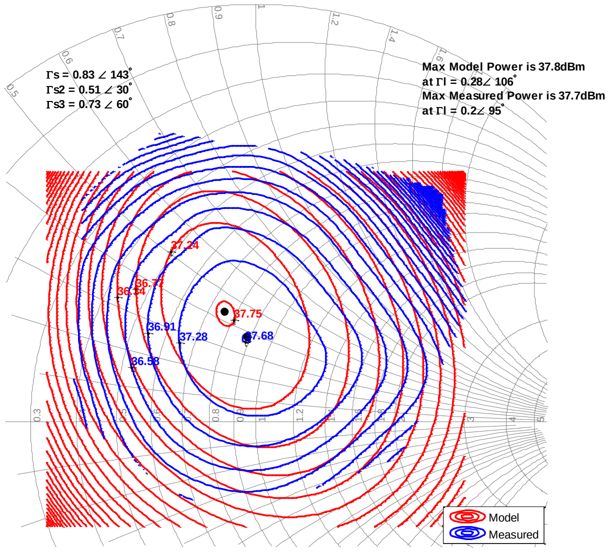
Load Pull
Model and Measured Power at 3GHz, 12V, 62.5mA, Pin = 15dBm, 25°C



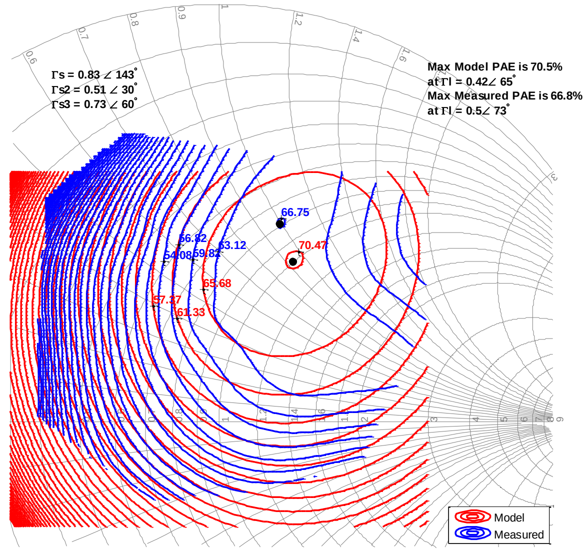
Load Pull
Model and Measured PAE at 3GHz, 12V, 62.5mA, Pin = 15dBm, 25°C



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



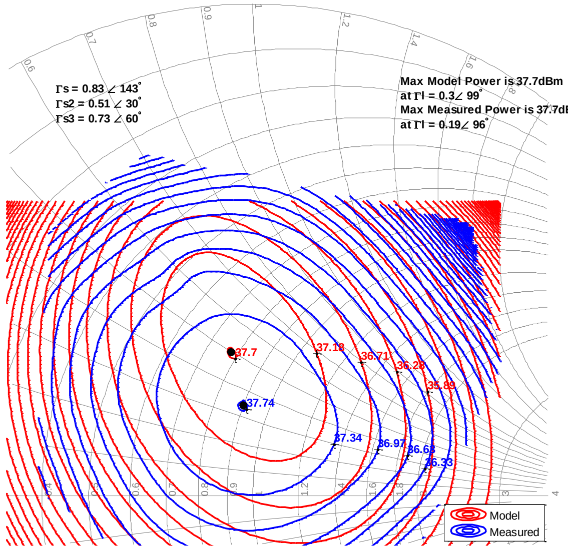
Load Pull
Model and Measured PAE at 3GHz, 28V, 25mA, Pin = 17dBm, 25°C



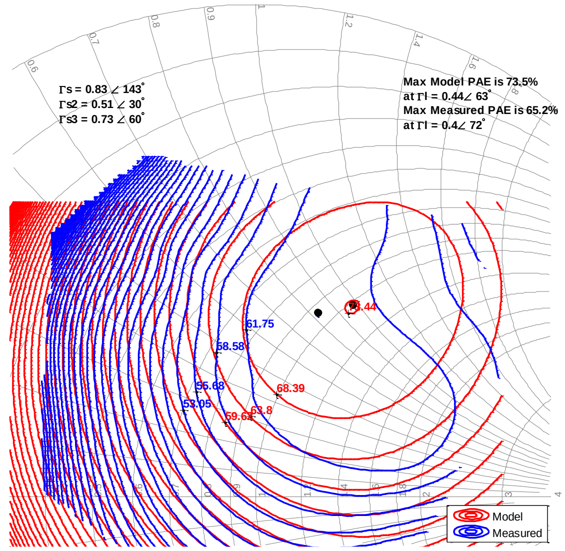
Model Load Pull Contours

Load pull signal: Pulse (10% Duty Cycle, 100 µs Width). Bond wires included. Measured data provided by Modelithics.

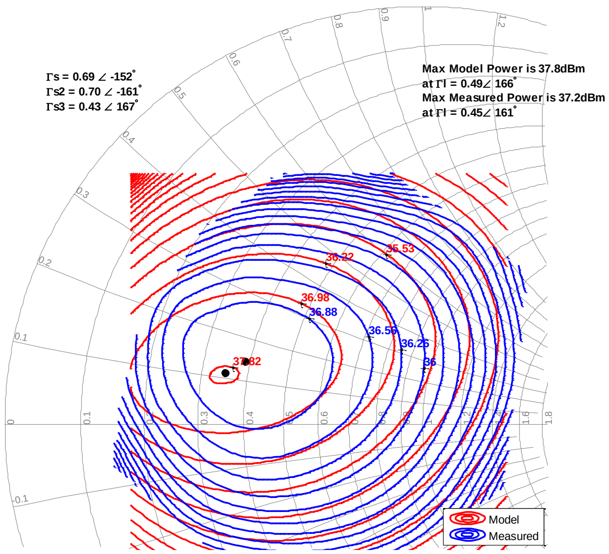
Load Pull
Model and Measured Power at 3GHz, 28V, 62.5mA, Pin = 17dBm, 25°C



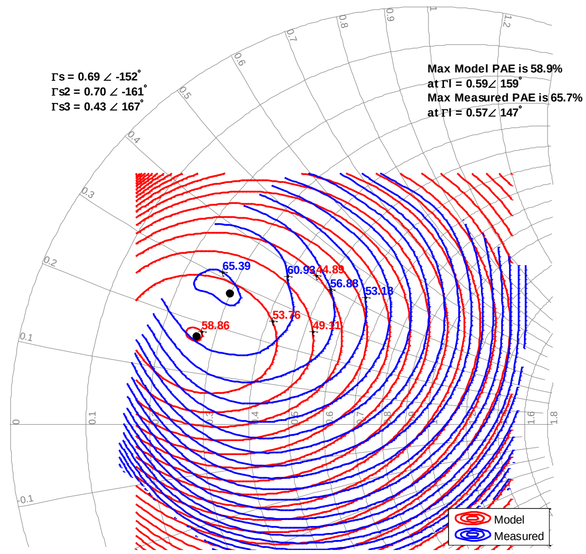
Load Pull
Model and Measured PAE at 3GHz, 28V, 62.5mA, Pin = 17dBm, 25°C



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

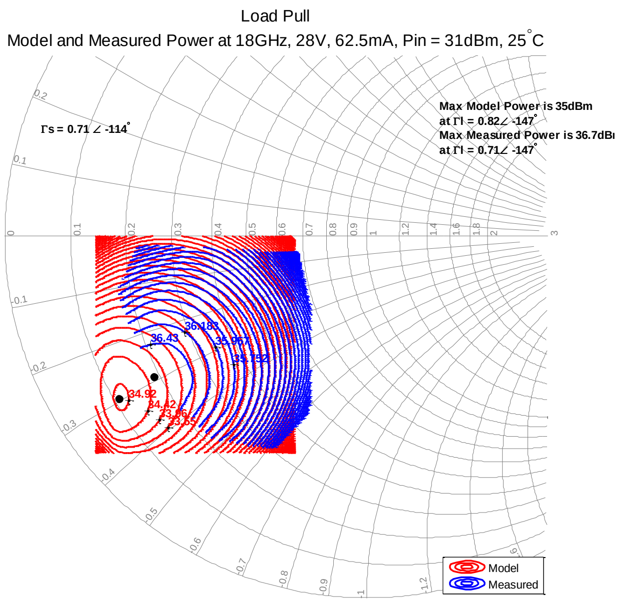


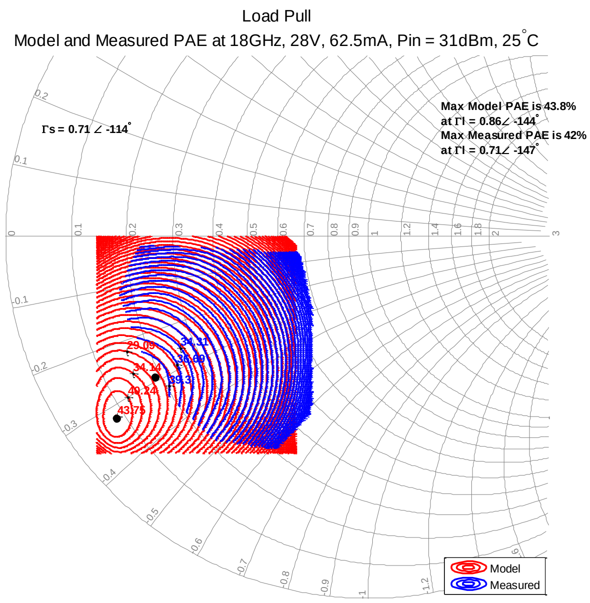
Load Pull
Model and Measured PAE at 10GHz, 28V, 62.5mA, Pin = 27dBm, 25°C



Model Load Pull Contours

Load pull signal: Pulse (10% Duty Cycle, 100 µs Width). Bond wires included. Measured data provided by Modelithics.

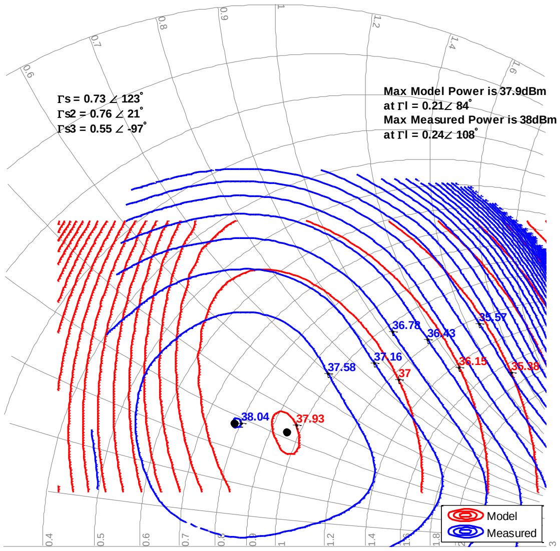




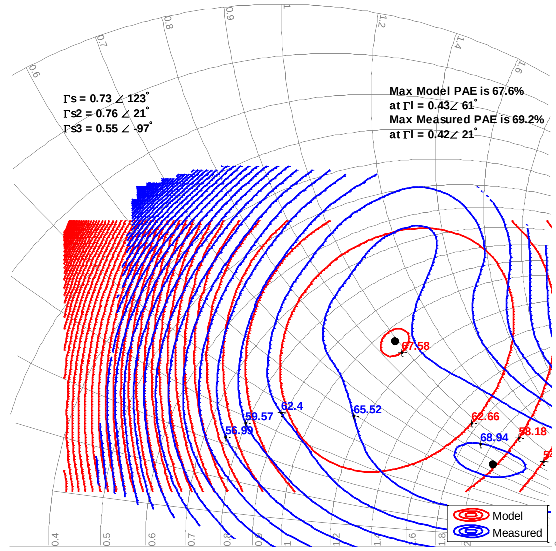
Model Load Pull Contours

Load pull signal: Pulse (10% Duty Cycle, 100 µs Width). Bond wires included.

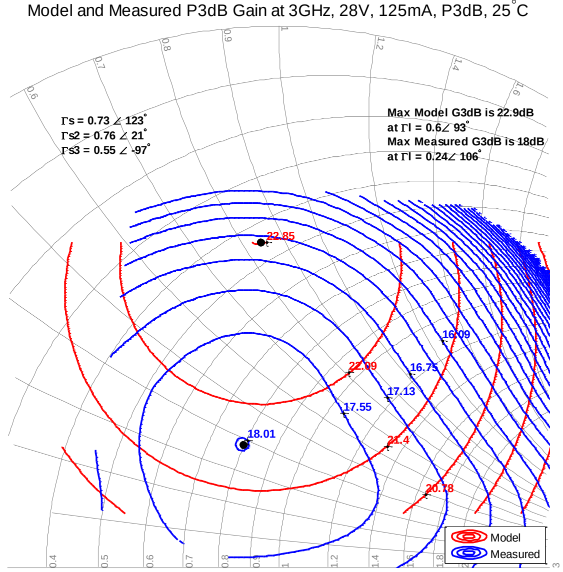
Load Pull
Model and Measured Power at 3GHz, 28V, 125mA, P3dB, 25°C



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



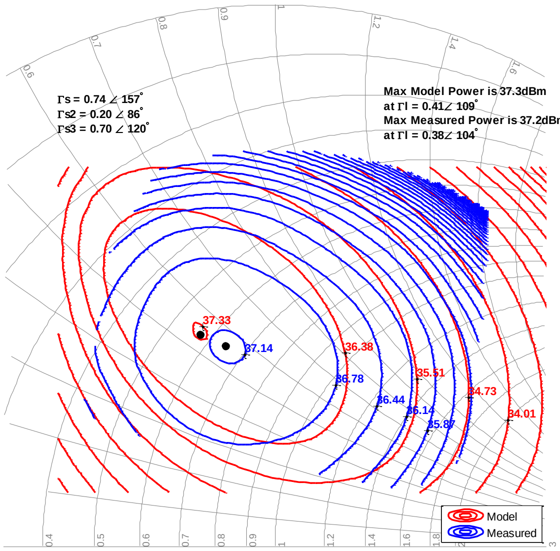
Load Pull
Model and Measured P3dB Gain at 3GHz, 28V, 125mA, P3dB, 25°C



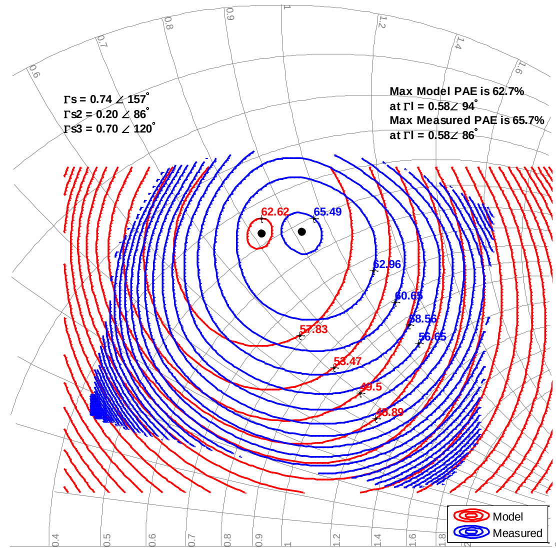
Model Load Pull Contours

Load pull signal: Pulse (10% Duty Cycle, 100 µs Width). Bond wires included.

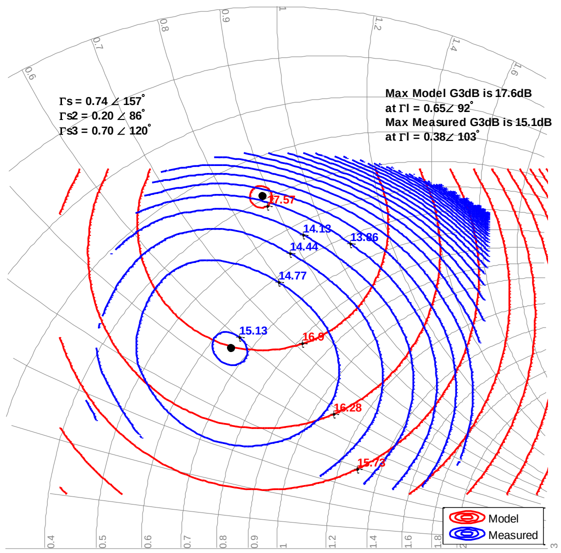
Load Pull
Model and Measured Power at 6GHz, 28V, 125mA, P3dB, 25°C



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



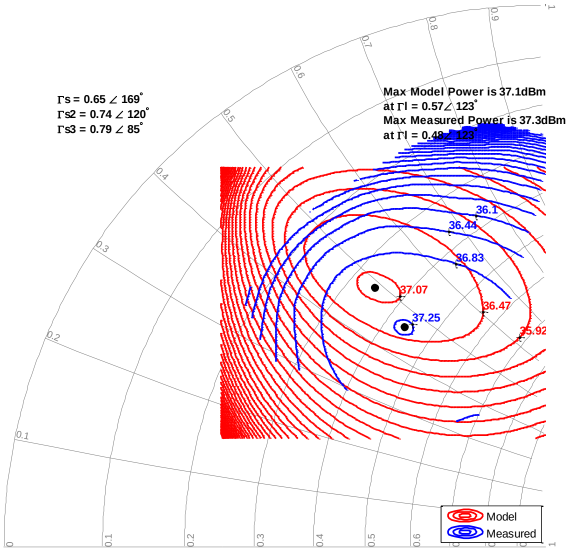
Load Pull
Model and Measured P3dB Gain at 6GHz, 28V, 125mA, P3dB, 25°C



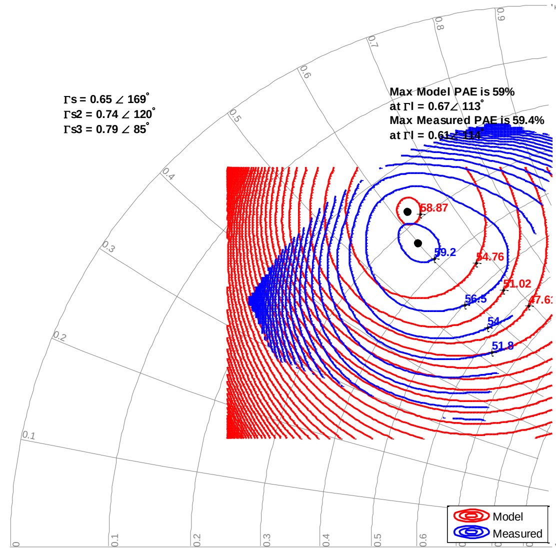
Model Load Pull Contours

Load pull signal: Pulse (10% Duty Cycle, 100 µs Width). Bond wires included.

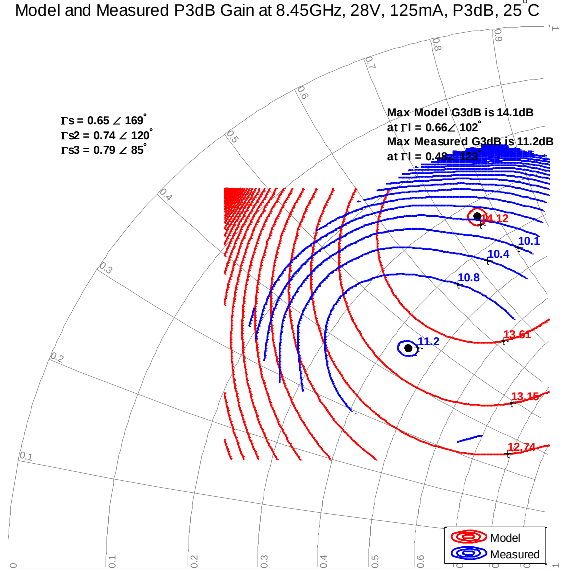
Load Pull
Model and Measured Power at 8.45GHz, 28V, 125mA, P3dB, 25°C



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

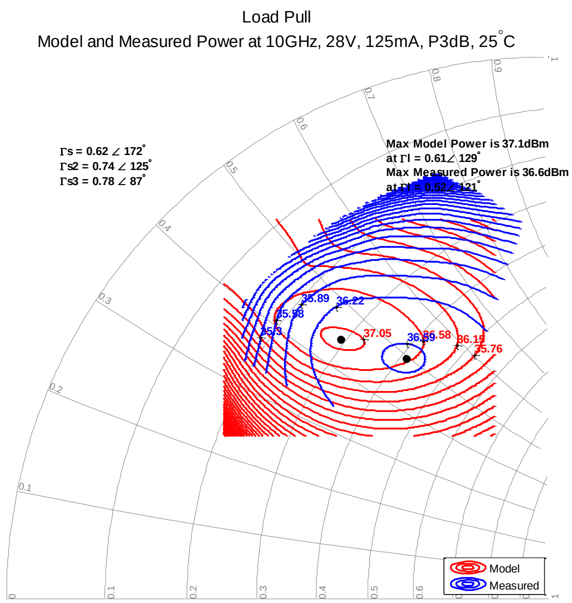


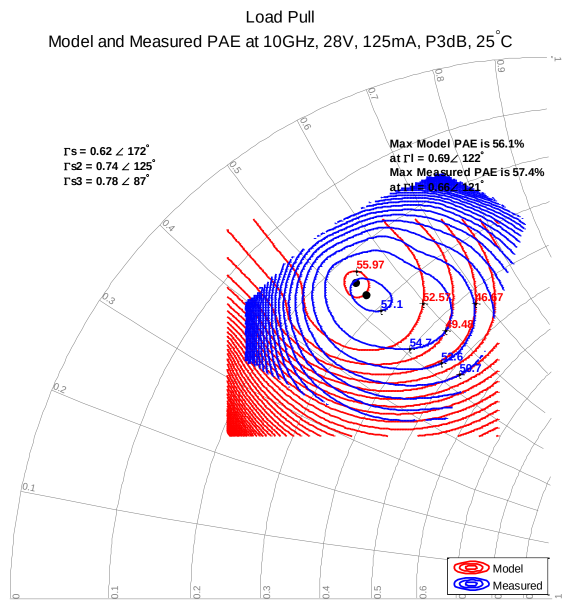
Load Pull
Model and Measured P3dB Gain at 8.45GHz, 28V, 125mA, P3dB, 25°C

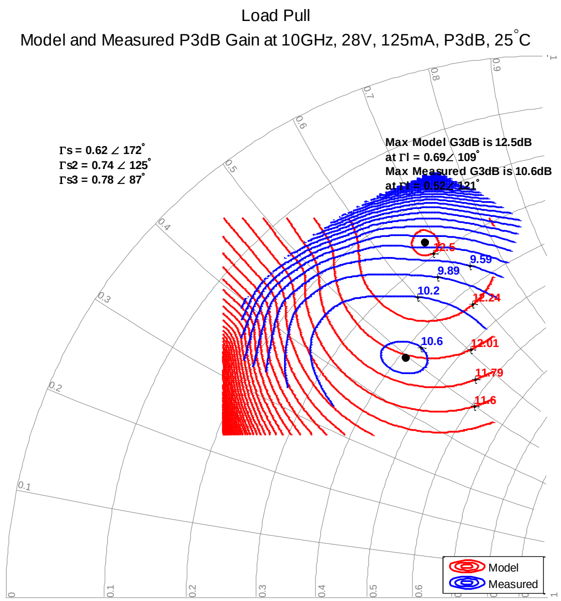


Model Load Pull Contours

Load pull signal: Pulse (10% Duty Cycle, 100 μs Width). Bond wires included.



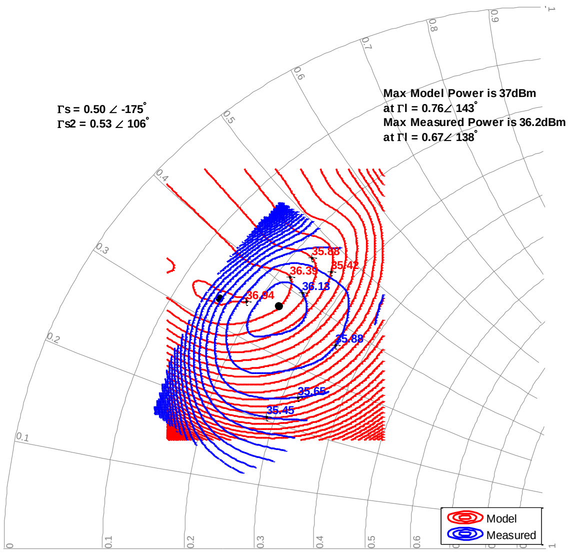




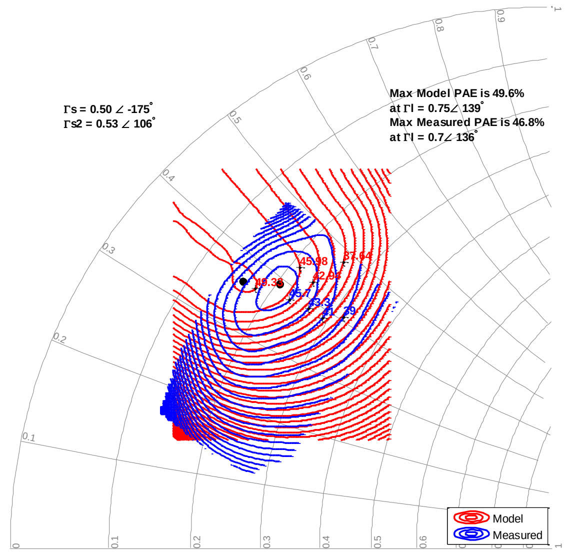
Model Load Pull Contours

Load pull signal: Pulse (10% Duty Cycle, 100 µs Width). Bond wires included.

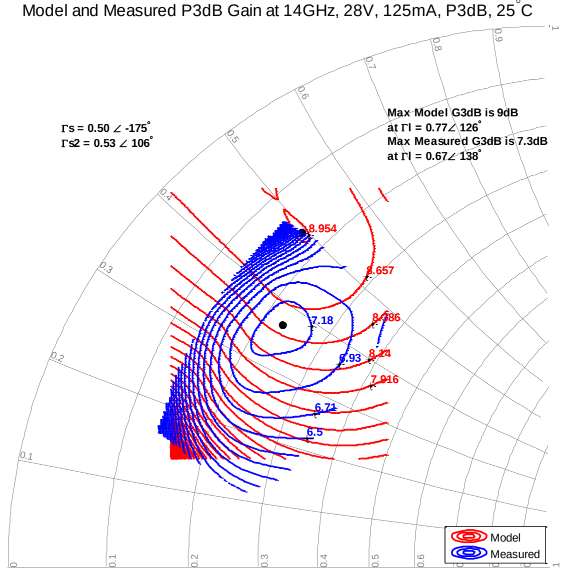
Load Pull
Model and Measured Power at 14GHz, 28V, 125mA, P3dB, 25°C



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

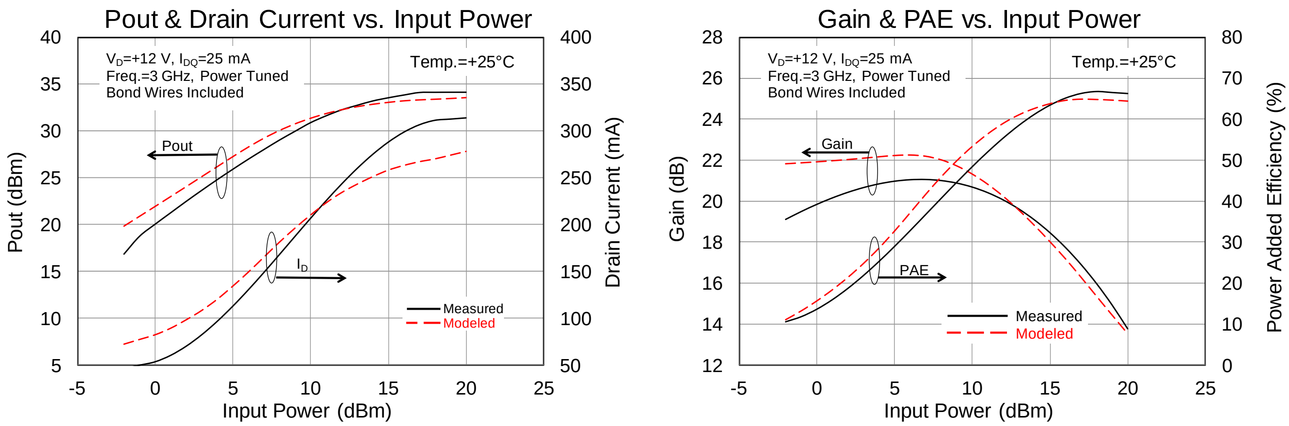


Load Pull
Model and Measured P3dB Gain at 14GHz, 28V, 125mA, P3dB, 25°C

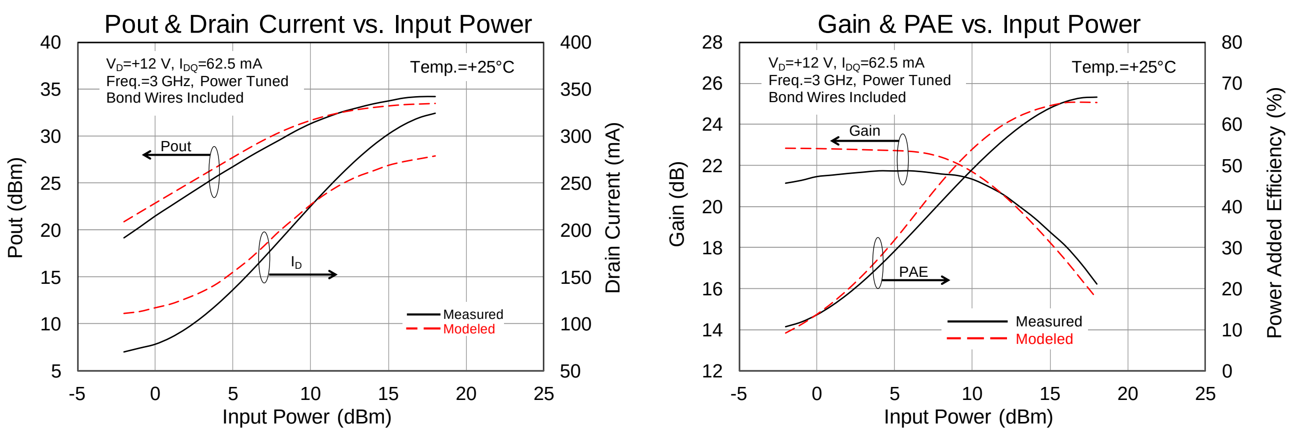


Measured Power Tuned Data

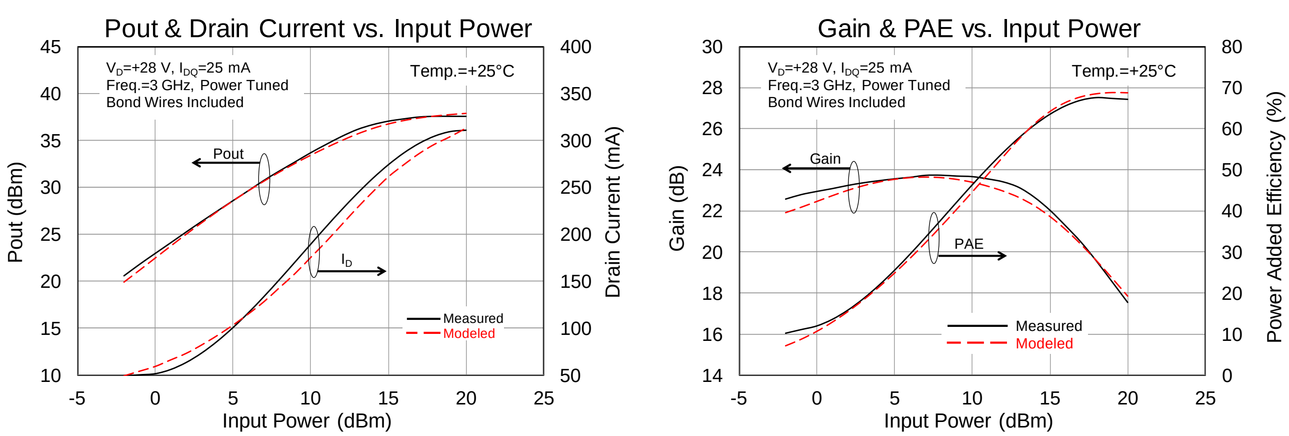
Modelithics provided measured data at 25mA and 62.5mA bias currents.



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°



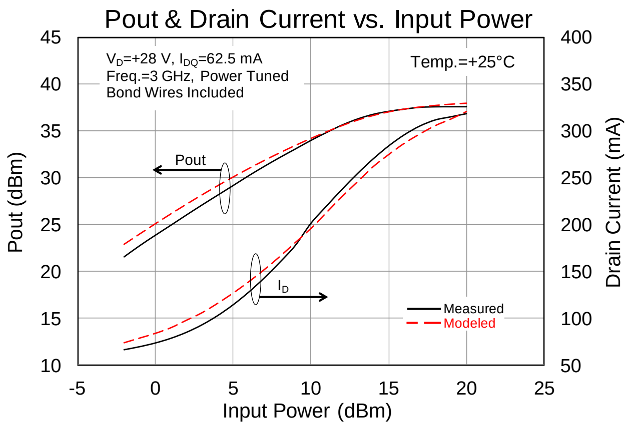
Source Γ: fo: 0.75∠129°, 2fo: 0.69∠29°, 3fo: 0.51∠59°
Load Γ: fo: 0.36∠144°, 2fo: 0.33∠60°, 3fo: 0.12∠148°

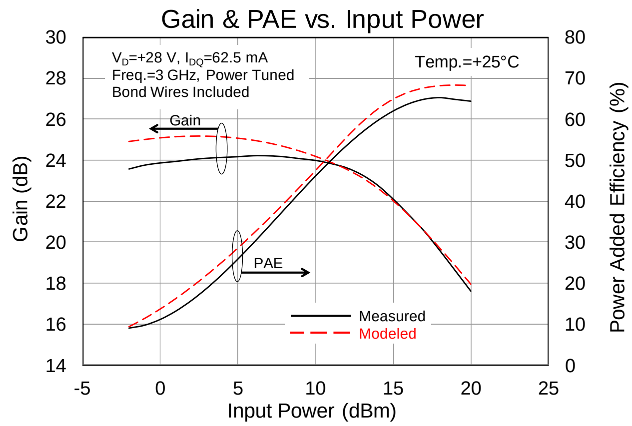


Source Γ: fo: 0.83∠142°, 2fo: 0.51∠30°, 3fo: 0.73∠60°
Load Γ: fo: 0.29∠82°, 2fo: 0.41∠−137°, 3fo: 0.27∠44°

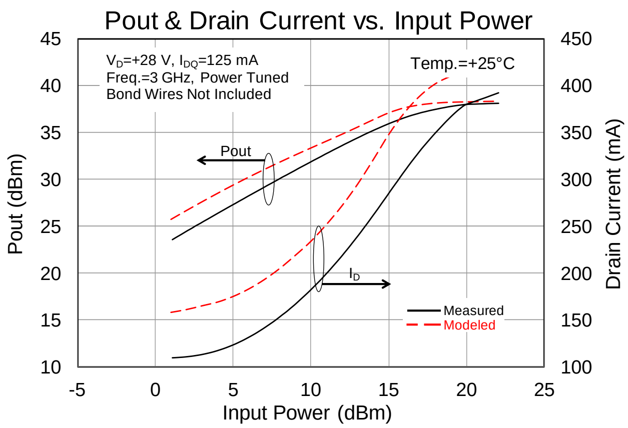
Measured Power Tuned Data

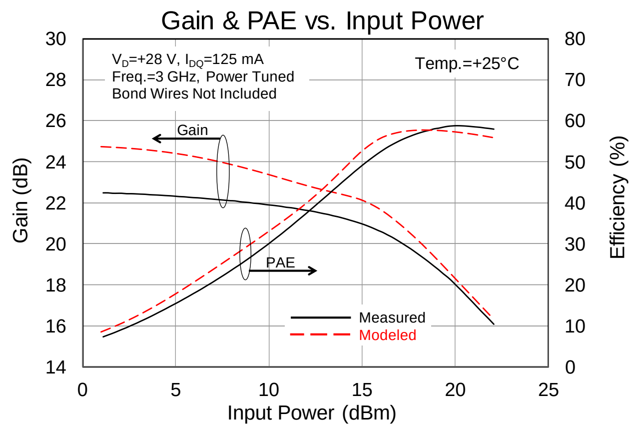
Modelithics provided measured data at 25mA and 62.5mA bias currents.



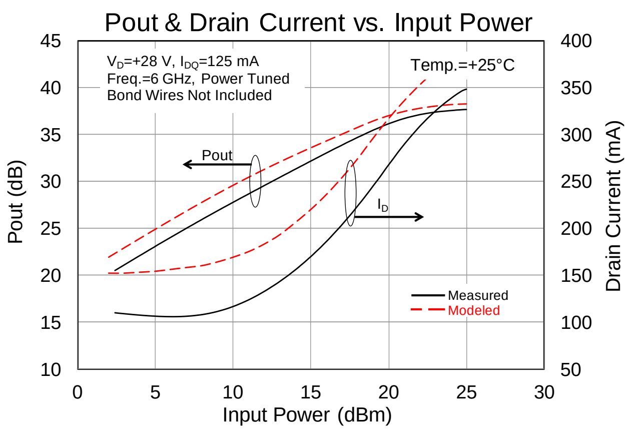


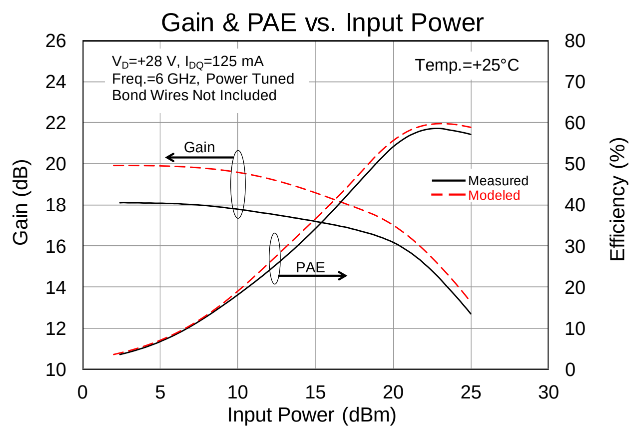
Source Γ: fo: 0.83∠142°, 2fo: 0.51∠30°, 3fo: 0.73∠60°
Load Γ: fo: 0.29∠82°, 2fo: 0.41∠−137°, 3fo: 0.27∠44°





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°

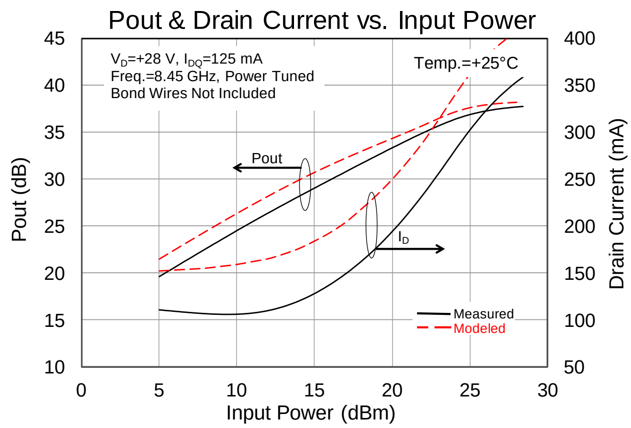


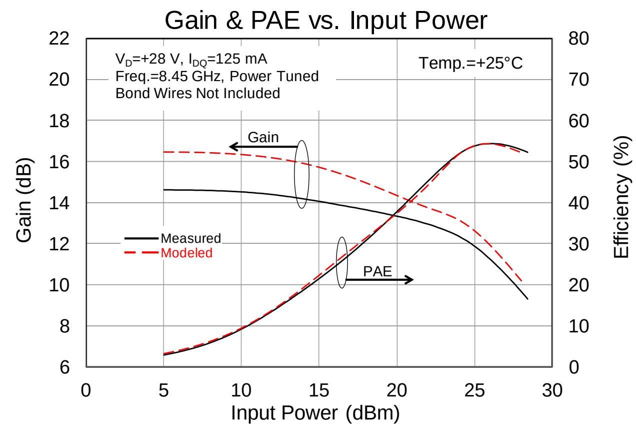


Source Γ: fo: 0.74∠157°, 2fo: 0.20∠86°, 3fo: 0.70∠120°
Load Γ: fo: 0.35∠100°, 2fo: 0.22∠74°, 3fo: 0.35∠17°

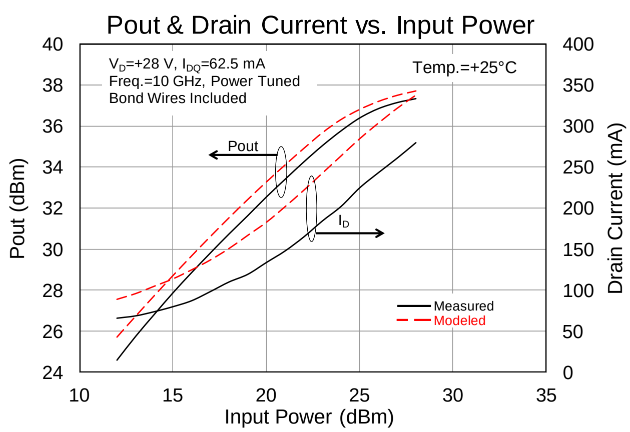
Measured Power Tuned Data

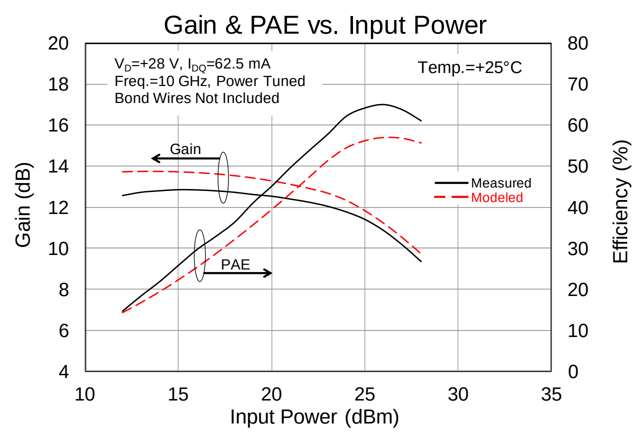
Modelithics provided measured data at 25mA and 62.5mA bias currents.



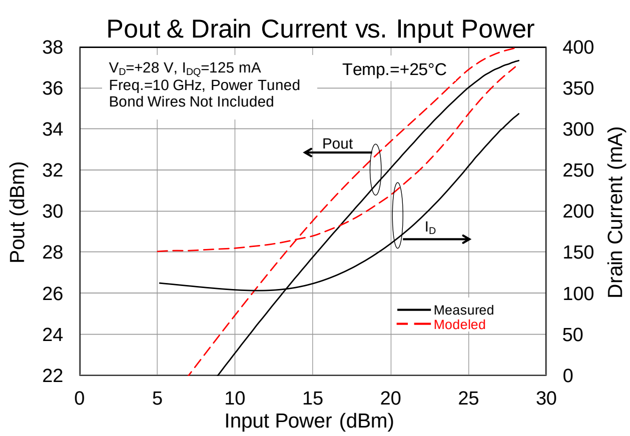


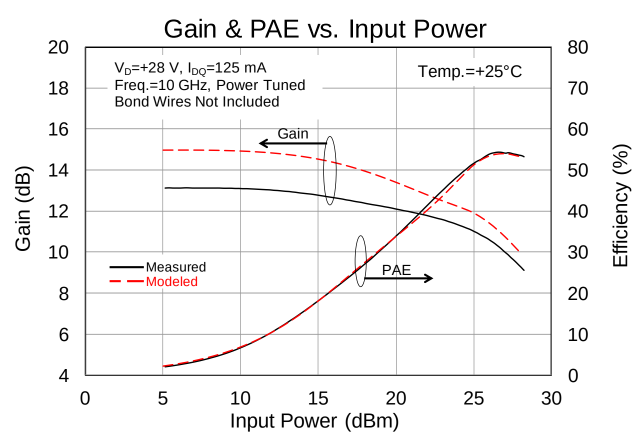
Source Γ: fo: 0.65∠169°, 2fo: 0.74∠120°, 3fo: 0.79∠85°
Load Γ: fo: 0.47∠122°, 2fo: 0.69∠69°, 3fo: 0.61∠19°





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°

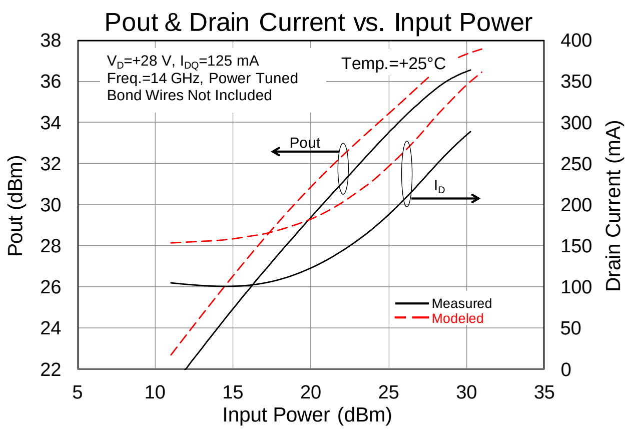


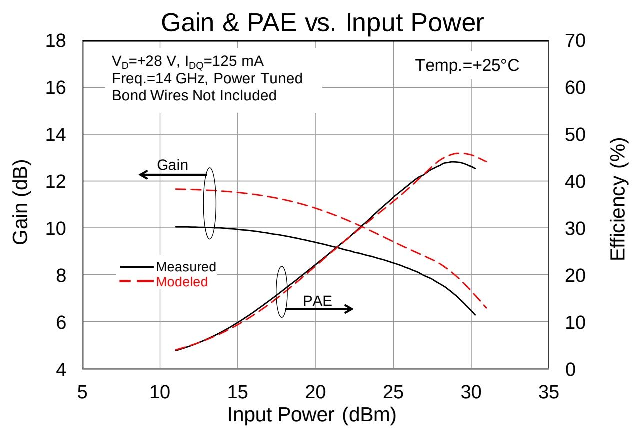


Source Γ: fo: 0.62∠172°, 2fo: 0.74∠125°, 3fo: 0.89∠62°
Load Γ: fo: 0.54∠125°, 2fo: 0.65∠39°, 3fo: 0.41∠−4.0°

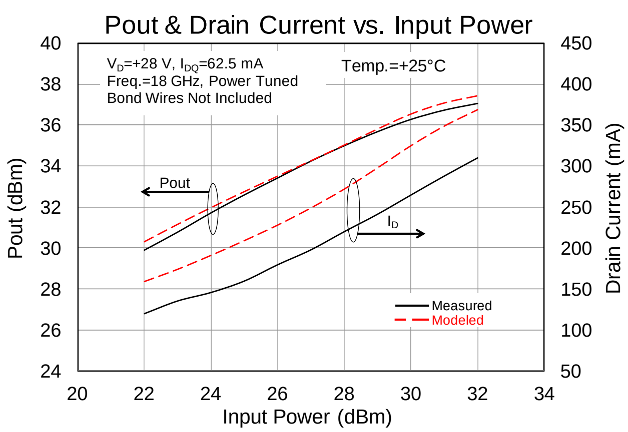
Measured Power Tuned Data

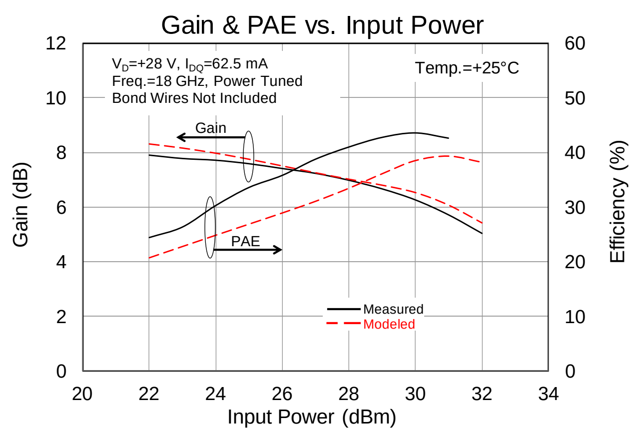
Modelithics provided measured data at 25mA and 62.5mA bias currents.





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

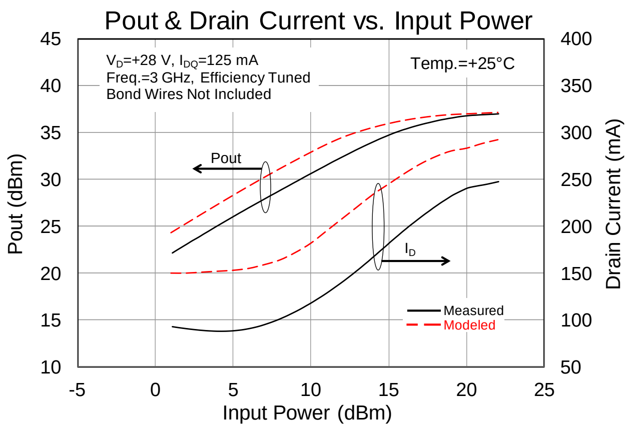


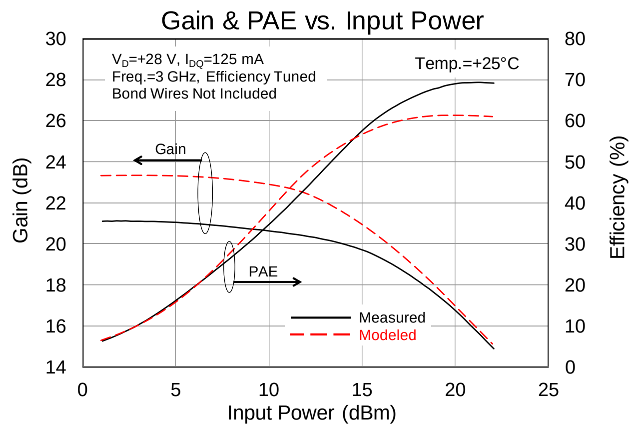


Source Γ: fo: 0.72∠−114°
Load Γ: fo: 0.71∠−147°

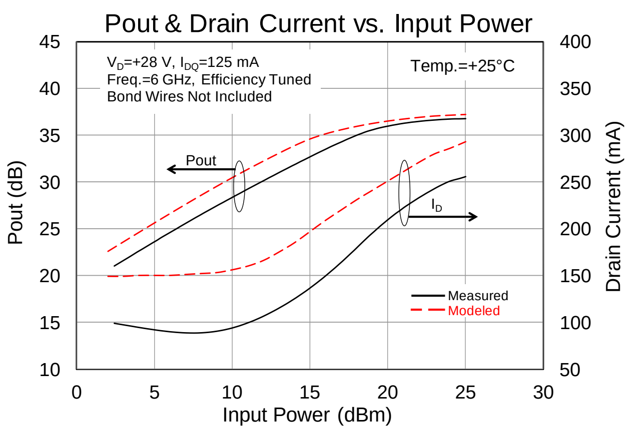
Measured Efficiency Tuned Data

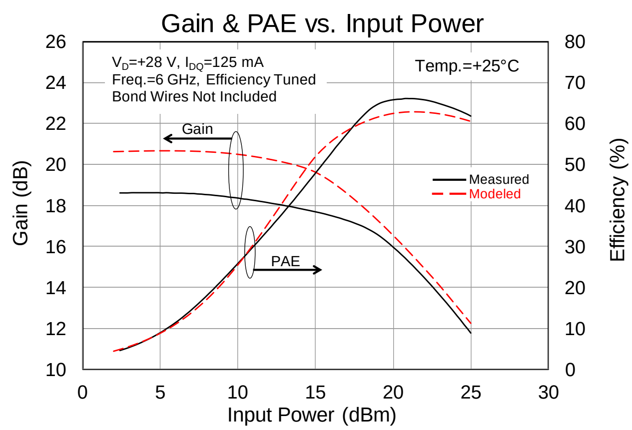
Modelithics provided measured data at 25mA and 62.5mA bias currents.



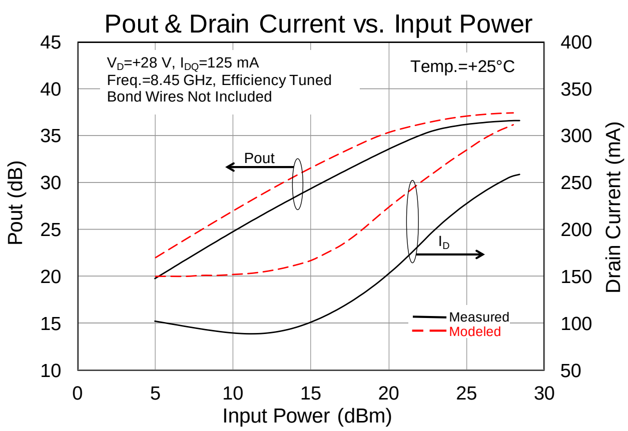


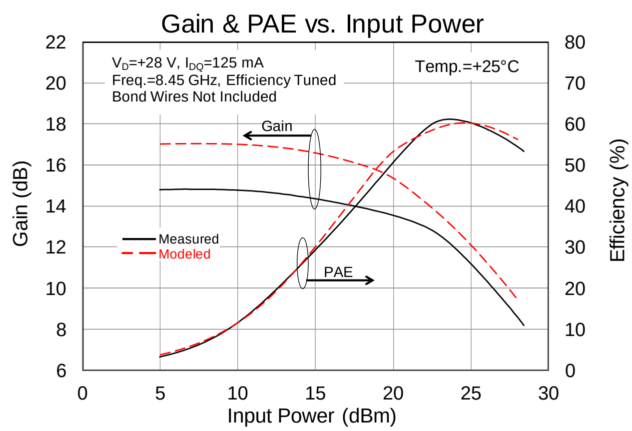
Source Γ: fo: 0.73∠123°, 2fo: 0.76∠21°, 3fo: 0.55∠−97°
Load Γ: fo: 0.41∠18°, 2fo: 0.62∠104°, 3fo: 0.35∠−160°





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°

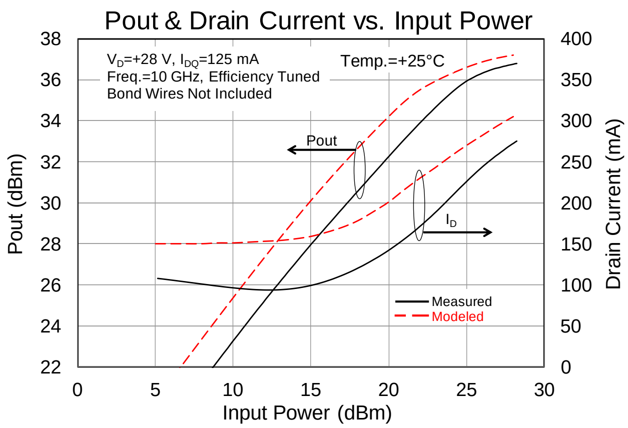


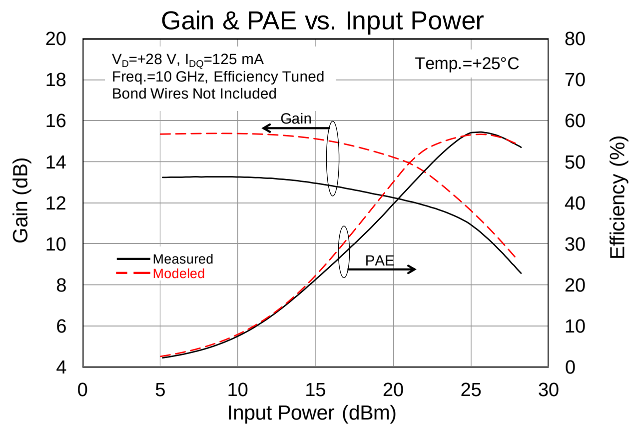


Source Γ: fo: 0.65∠169°, 2fo: 0.74∠120°, 3fo: 0.79∠85°
Load Γ: fo: 0.65∠113°, 2fo: 0.78∠50°, 3fo: 0.57∠−22°

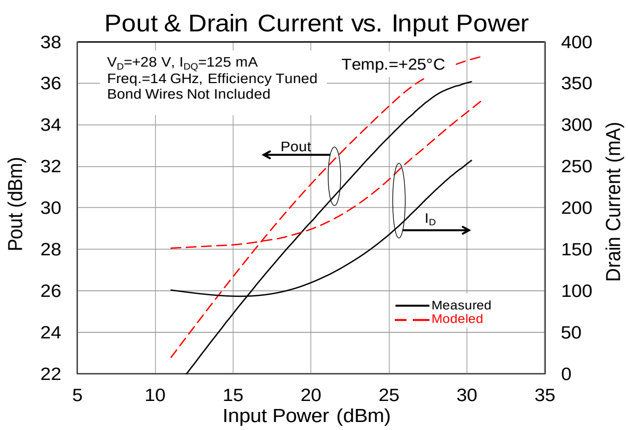
Measured Efficiency Tuned Data

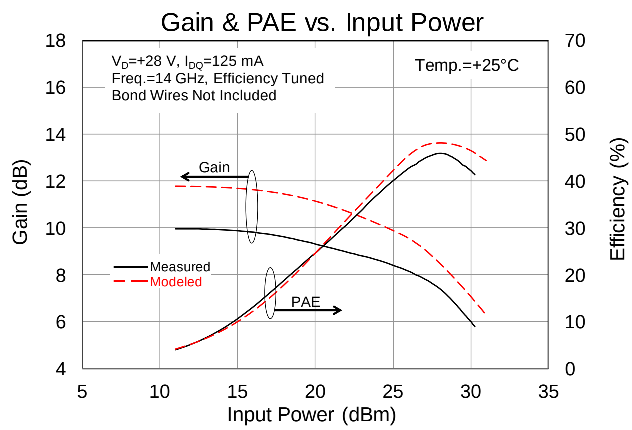
Modelithics provided measured data at 25mA and 62.5mA bias currents.





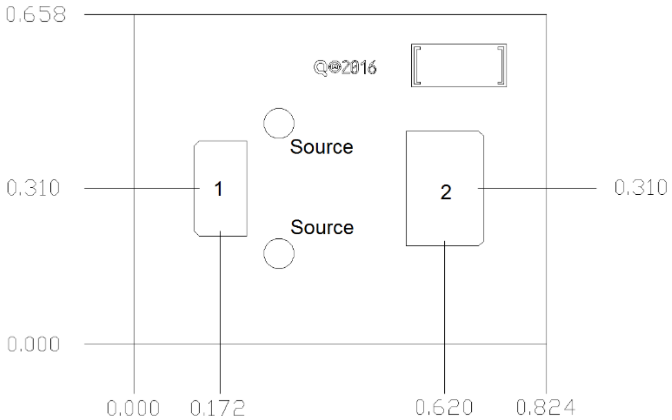
Source Γ: fo: 0.62∠172°, 2fo: 0.74∠125°, 3fo: 0.89∠62°
Load Γ: fo: 0.68∠120°, 2fo: 0.69∠34°, 3fo: 0.41∠−17°





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

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

Model

A model is available for download from Modelithics (at http://www.modelithics.com/mvp/Triquint&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.

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 Procedure

Bias-Up Procedure	Bias-Down Procedure
1. Set V_G to –5 V.	1. Turn off RF signal.
2. Apply +28 V to V_D.	2. Turn off V_D.
3. Slowly adjust V_G until I_D is set to 125 mA.	3. Wait two (2) seconds to allow drain capacitor to discharge.
4. Apply RF.	4. Turn off V_G.

Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	TBD	ANSI/ESDA/JEDEC Standard JS-001
ESD – Charged Device Model (CDM)	N/A	ANSI/ESDA/JEDEC Standard JS-002
MSL – Moisture Sensitivity Level	N/A	IPC/JEDEC Standard J-STD-020

Caution!
ESD-Sensitive Device

Solderability

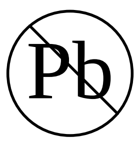
Compatible with gold/tin (320°C maximum reflow temperature) soldering processes.

RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_40_2$) Free
- PFOS Free
- SVHC Free



Contact Information

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

Web: www.qorvo.com **Tel: 1-844-890-8163**

Email: customer.support@qorvo.com

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