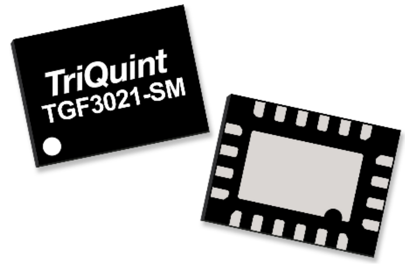
Applications

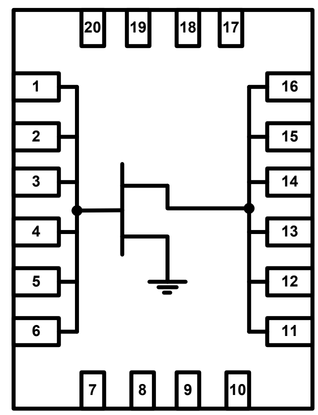
- Military radar
- Civilian radar
- Land mobile and military radio communications
- Test instrumentation
- Wideband and narrowband amplifiers
- Jammers



Product Features

- Frequency: 0.03 to 4.0 GHz
- Output Power (P_{3dB}): 36.0 W at 2 GHz
- Linear Gain: 19.3 dB at 2 GHz
- Typical PAE_{3dB}: 72.7% at 2 GHz
- Operating Voltage: 32 V
- Low thermal resistance package
- CW and Pulse capable
- 3 x 4 mm package

Functional Block Diagram



General Description

The TriQuint TGF3021-SM is a 30 W (P_{3dB}) discrete GaN on SiC HEMT which operates from 0.03 to 4.0 GHz. The device is constructed with TriQuint's proven TQGaN25 process, which features advanced field plate techniques to optimize power and efficiency at high drain bias operating conditions. This optimization can potentially lower system costs in terms of fewer amplifier line-ups and lower thermal management costs.

The device is housed in an industry-standard 3 x 4 mm surface mount QFN package.

Lead-free and ROHS compliant

Evaluation boards are available upon request.

Pin Configuration

Pin No.	Label
11 - 16	V_D / RF OUT
1 - 6	V_G / RF IN
7 – 10, 20 - 17	NC
Back side	Source

Ordering Information

Part	ECCN	Description
TGF3021-SM	EAR99	QFN Packaged Part
TGF3021-SM-EVB1	EAR99	0.03 – 0.512 GHz EVB

Absolute Maximum Ratings

Parameter	Value
Breakdown Voltage (BV_{DG})	100 V min.
Gate Voltage Range (V_G)	-10 to 0 V
Drain Current (I_D)	5.8 A
Gate Current (I_G)	-7.5 to 16.8 mA
Power Dissipation (P_D)	32.3 W
RF Input Power, CW, T = 25°C (P_{IN})	See page 10.
Channel Temperature (T_{CH})	275 °C
Storage Temperature	-40 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 (V_D)	32 V (Typ.)
Drain Quiescent Current (I_{DQ})	65 mA (Typ.)
Peak Drain Current (I_D)	1800 mA (Typ.)
Gate Voltage (V_G)	-2.7 V (Typ.)
Channel Temperature (T_{CH})	225 °C (Max)
Power Dissipation, CW (P_D)[2]	25.7 W (Max)
Power Dissipation, Pulse (P_D)[3]	41.5 W (Max)

[1] Electrical specifications are measured at specified test conditions.

Specifications are not guaranteed over all recommended operating conditions.

[2] Package at 85 °C

[3] 100uS Pulse Width, 20 % Duty Cycle, package at 85 °C

Pulsed RF Characterization – Load Pull Performance

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 65 mA, Pulse: 100uS Pulse Width, 20 % Duty Cycle

Symbol	Parameter	Freq	Min	Typical	Max	Units
G_{LIN}	Linear Gain, Power Tuned	1.5 GHz		22.1		dB
		2.0 GHz		19.3		
		2.5 GHz		17.3		
		3.0 GHz		15.9		
		3.5 GHz		14.9		
		4.0 GHz		12.2		
P_{3dB}	Output Power at 3 dB Gain Compression, Power Tuned	1.5 GHz		45.5		dBm
		2.0 GHz		45.6		
		2.5 GHz		45.6		
		3.0 GHz		45.4		
		3.5 GHz		45.4		
		4.0 GHz		44.4		
PAE_{3dB}	Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned	1.5 GHz		75.5		%
		2.0 GHz		72.7		
		2.5 GHz		64.4		
		3.0 GHz		62.9		
		3.5 GHz		61.5		
		4.0 GHz		42.4		
G_{3dB}	Gain at 3 dB Compression, Power Tuned	1.5 GHz		19.1		dB
		2.0 GHz		16.3		
		2.5 GHz		14.3		
		3.0 GHz		12.9		
		3.5 GHz		11.9		
		4.0 GHz		9.2		

CW RF Characterization – Load Pull Performance

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 65 mA

Symbol	Parameter	Freq	Min	Typical	Max	Units
G_{LIN}	Linear Gain, Power Tuned	2.0 GHz		19.1		dB
		2.5 GHz		17.4		
		3.0 GHz		16.3		
		3.5 GHz		15.3		
P_{1dB}	Output Power at 1 dB Gain Compression, Power Tuned	2.0 GHz		43.8		dBm
		2.5 GHz		43.7		
		3.0 GHz		43.6		
		3.5 GHz		43.4		
PAE_{1dB}	Power-Added Efficiency at 1 dB Gain Compression, Efficiency Tuned	2.0 GHz		70.6		%
		2.5 GHz		63		
		3.0 GHz		62.3		
		3.5 GHz		62.5		
G_{1dB}	Gain at 1 dB Compression, Power Tuned	2.0 GHz		18.1		dB
		2.5 GHz		16.4		
		3.0 GHz		15.3		
		3.5 GHz		14.3		

RF Characterization – 0.05 – 0.55 GHz EVB Performance at 0.25 GHz

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 65 mA, Signal: CW

Symbol	Parameter	Min	Typical	Max	Units
G_{LIN}	Linear Gain		21.8		dB
P_{1dB}	Output Power at 1 dB Gain Compression		25.7		W
PAE_{1dB}	Power-Added Efficiency at 3 dB Gain Compression		52.4		%
G_{1dB}	Gain at 3 dB Compression		20.8		dB

RF Characterization – Test Performance at 2.6 GHz

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 60 mA, Signal: 100uS Pulse Width, 20% Duty Cycle

Symbol	Parameter	Min	Typical	Max	Units
P_{3dB}	Output Power at 1 dB Gain Compression		21.4		W
DrE_{3dB}	Drain Efficiency at 3 dB Gain Compression		65		%
G_{3dB}	Gain at 3 dB Compression		14.3		dB

RF Characterization – Mismatch Ruggedness at 512 MHz

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 65 mA
Driving input power is determined at pulsed compression under matched condition at EVB output connector.

Symbol	Parameter	dB Compression	Typical
VSWR	Impedance Mismatch Ruggedness	1	10:1

Thermal and Reliability Information - CW [1]

Parameter	Simulated Conditions	Value	Units
Thermal Resistance (θ_{JC})	85 ℃ Case 11.3 W Pdiss, CW	4.69	ºC/W
Channel Temperature (T_{CH})		138	℃
Median Lifetime (T_M)		1.02E10	Hrs
Thermal Resistance (θ_{JC})	85 ℃ Case 15.1 W Pdiss, CW	4.83	ºC/W
Channel Temperature (T_{CH})		158	℃
Median Lifetime (T_M)		1.03E9	Hrs
Thermal Resistance (θ_{JC})	85 ℃ Case 18.9 W Pdiss, CW	4.97	ºC/W
Channel Temperature (T_{CH})		179	℃
Median Lifetime (T_M)		1.15E8	Hrs
Thermal Resistance (θ_{JC})	85 ℃ Case 22.7 W Pdiss, CW	5.20	ºC/W
Channel Temperature (T_{CH})		203	℃
Median Lifetime (T_M)		1.19E7	Hrs
Thermal Resistance (θ_{JC})	85 ℃ Case 30.2 W Pdiss, CW	5.73	ºC/W
Channel Temperature (T_{CH})		258	℃
Median Lifetime (T_M)		1.38E5	Hrs

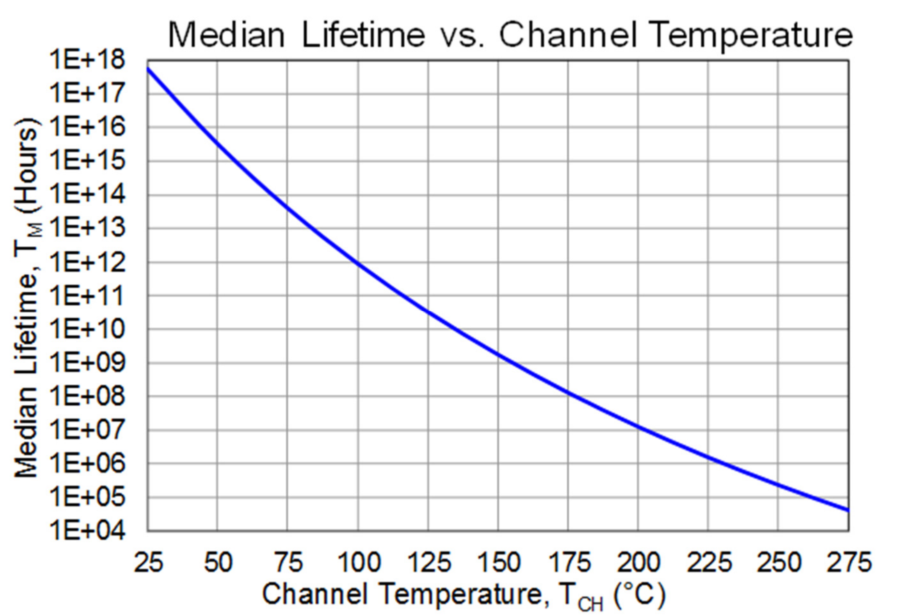
Notes:
1. Thermal resistance measured to bottom of package.

Thermal and Reliability Information - Pulsed [1]

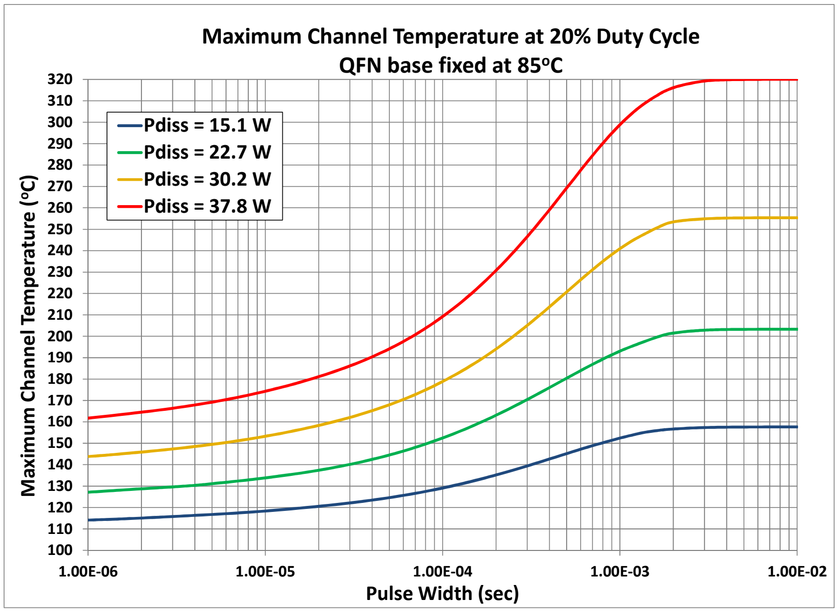
Parameter	Simulated Conditions	Value	Units
Thermal Resistance (θ_{JC})	85 ℃ Case 15.1 W Pdiss, 100uS PW, 20%	2.91	ºC/W
Channel Temperature (T_{CH})		129	℃
Median Lifetime (T_M)		2.98E10	Hrs
Thermal Resistance (θ_{JC})	85 ℃ Case 22.7 W Pdiss, 100uS PW, 20%	2.97	ºC/W
Channel Temperature (T_{CH})		152.5	℃
Median Lifetime (T_M)		1.85E9	Hrs
Thermal Resistance (θ_{JC})	85 ℃ Case 30.2 W Pdiss, 100uS PW, 20%	3.13	ºC/W
Channel Temperature (T_{CH})		179.5	℃
Median Lifetime (T_M)		1.44E9	Hrs
Thermal Resistance (θ_{JC})	85 ℃ Case 37.8 W Pdiss, 100uS PW, 20%	3.28	ºC/W
Channel Temperature (T_{CH})		209	℃
Median Lifetime (T_M)		7.11E6	Hrs

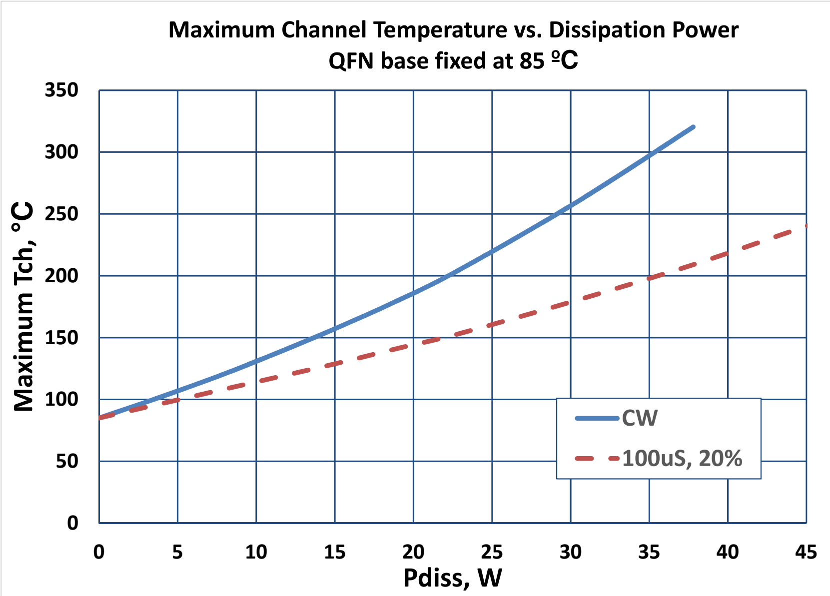
Notes:
1. Thermal resistance measured to bottom of package.

Median Lifetime

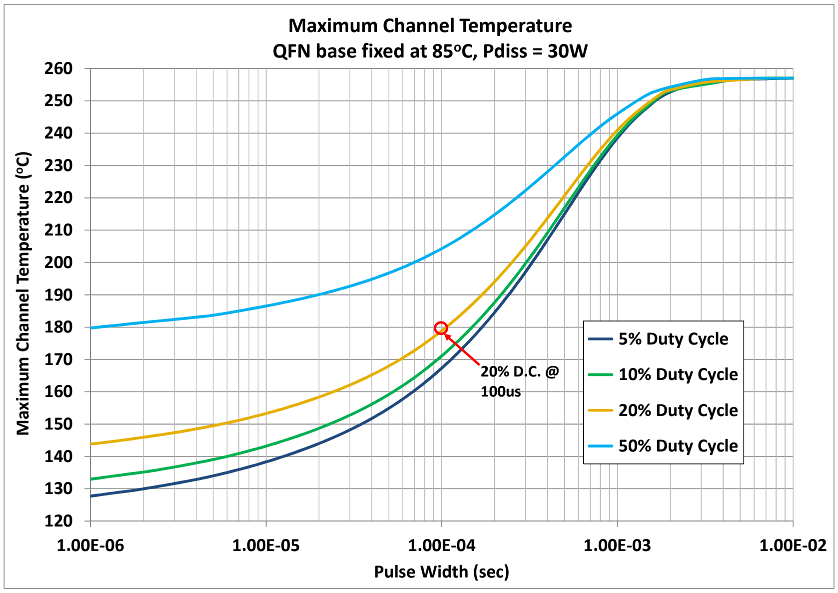


Maximum Channel Temperature

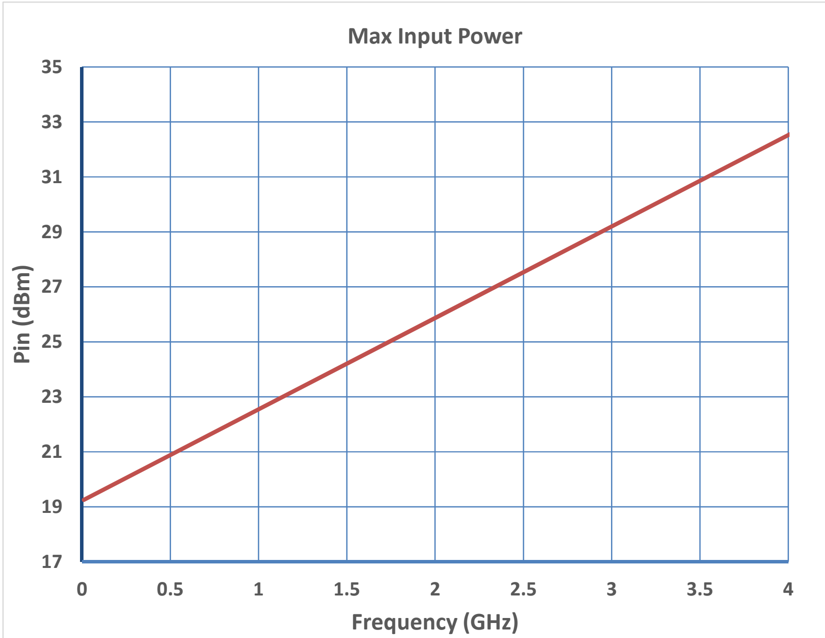




Maximum Channel Temperature



Maximum Input Power [1]



(1) Values are estimated at 25 °C and CW condition.

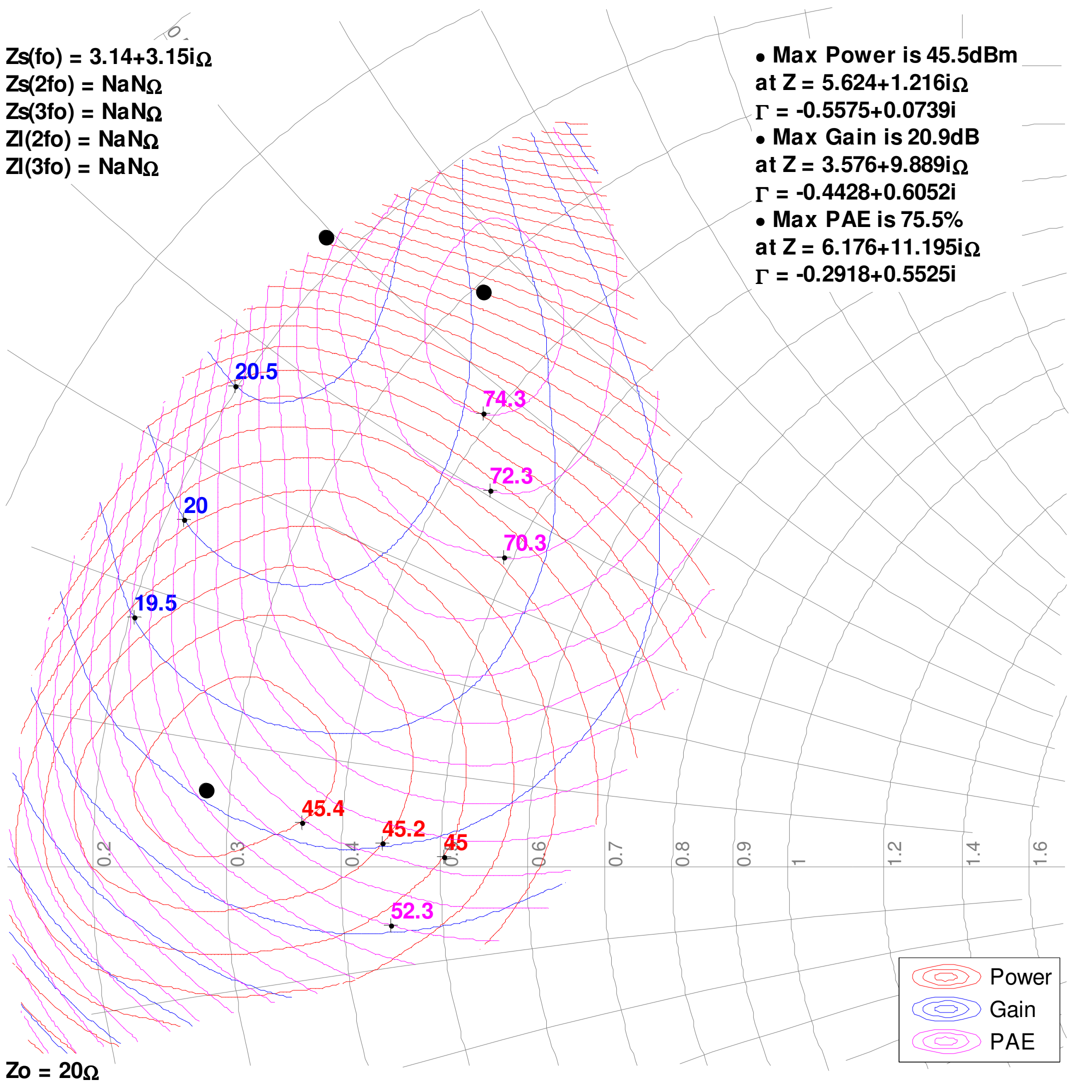
Load Pull Smith Charts - Pulsed (1, 2, 3)

RF performance that the device typically exhibits when placed in the specified impedance environment. The impedances are not the impedances of the device, they are the impedances presented to the device via an RF circuit or load-pull system. The impedances listed follow an optimized trajectory to maintain high power and high efficiency.

Notes:

1. 32 V, 65 mA, Pulsed signal with 100 uS pulse width and 20 % duty cycle. 3 dB compression referenced to peak gain.
2. See page 30 for load pull and source pull reference planes.
3. NaN means the impedances are undefined in load-pull system.

1.5GHz, Load-pull



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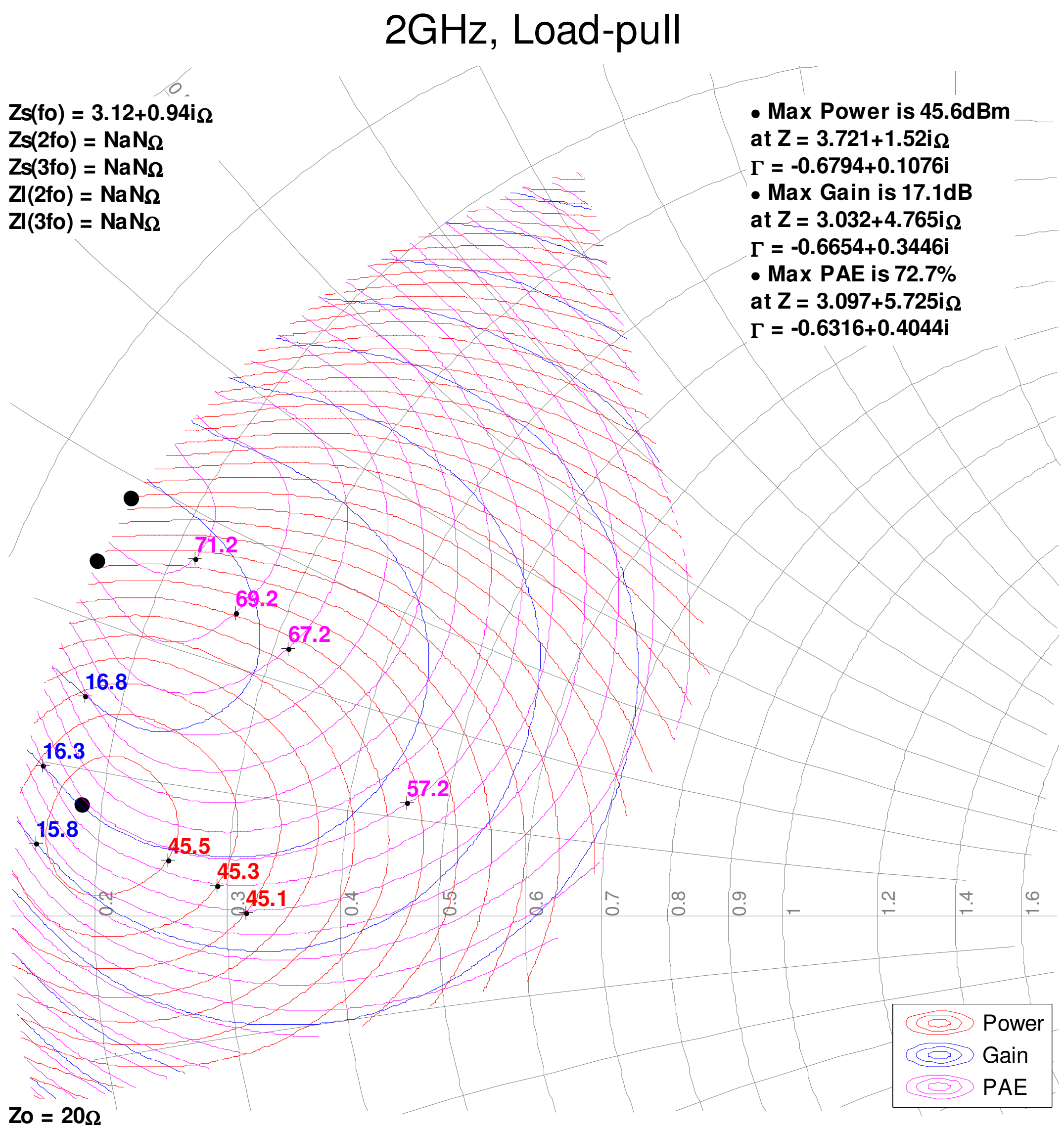

Load Pull Smith Charts - Pulsed (1, 2, 3)

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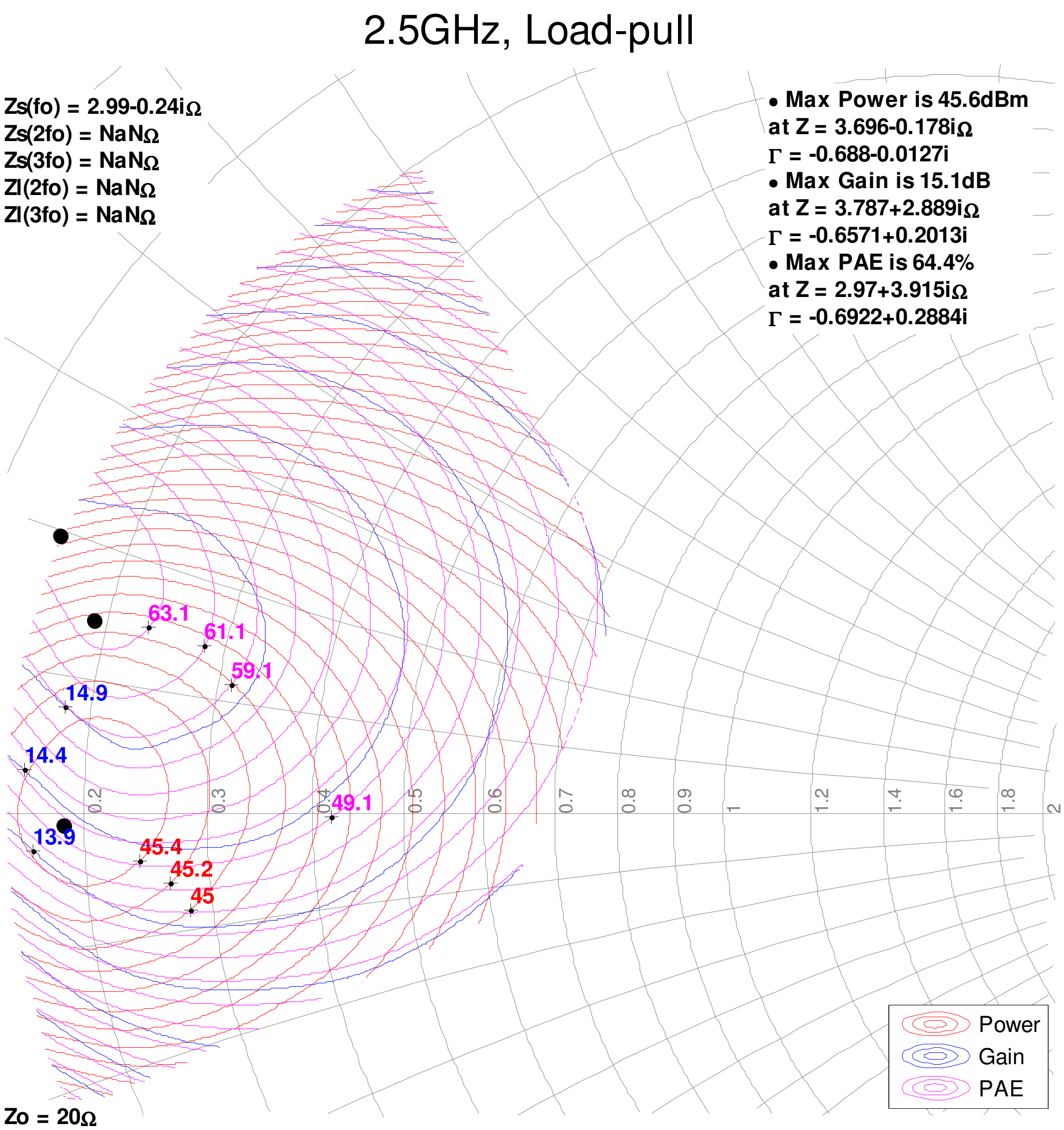

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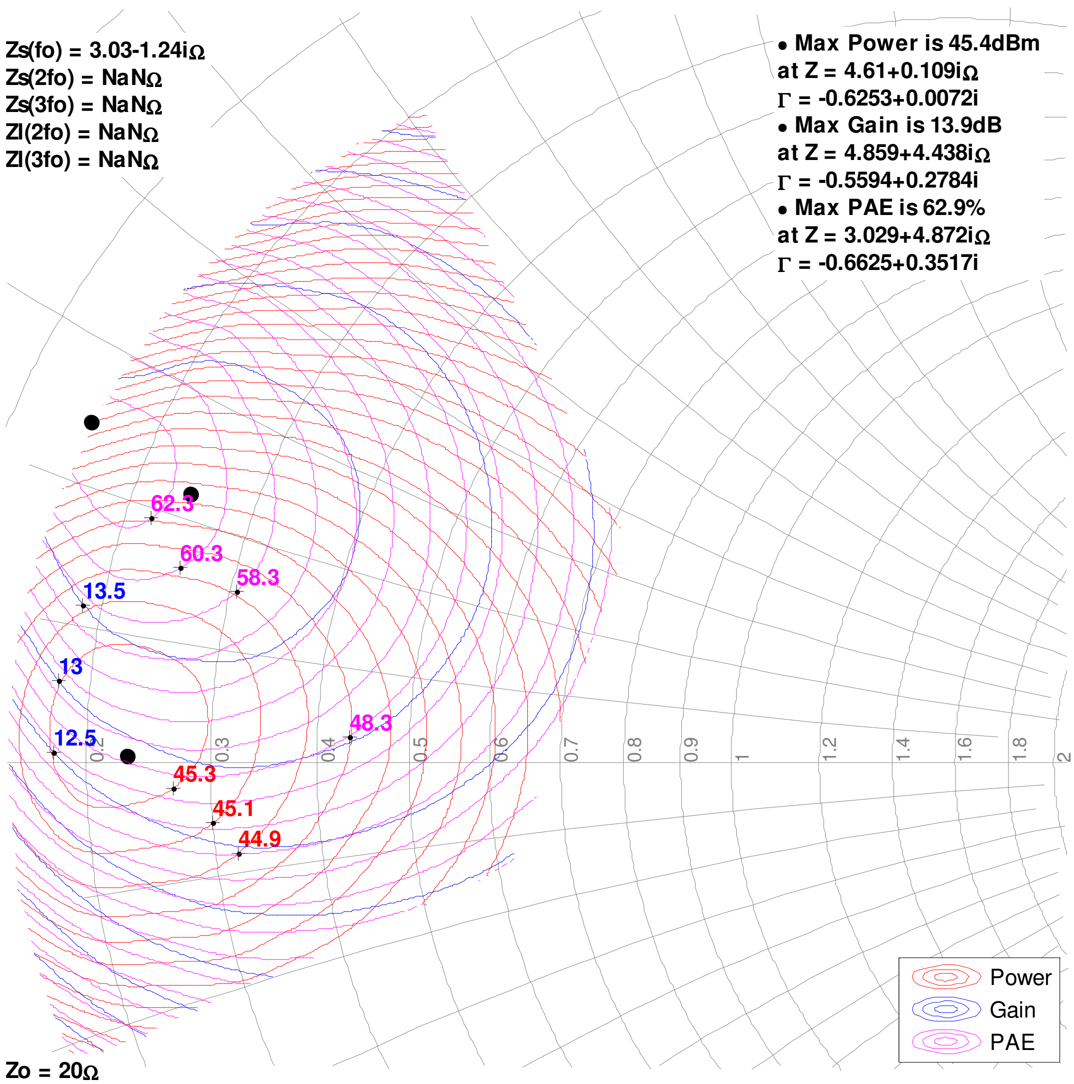

Load Pull Smith Charts - Pulsed (1, 2, 3)

RF performance that the device typically exhibits when placed in the specified impedance environment. The impedances are not the impedances of the device, they are the impedances presented to the device via an RF circuit or load-pull system. The impedances listed follow an optimized trajectory to maintain high power and high efficiency.

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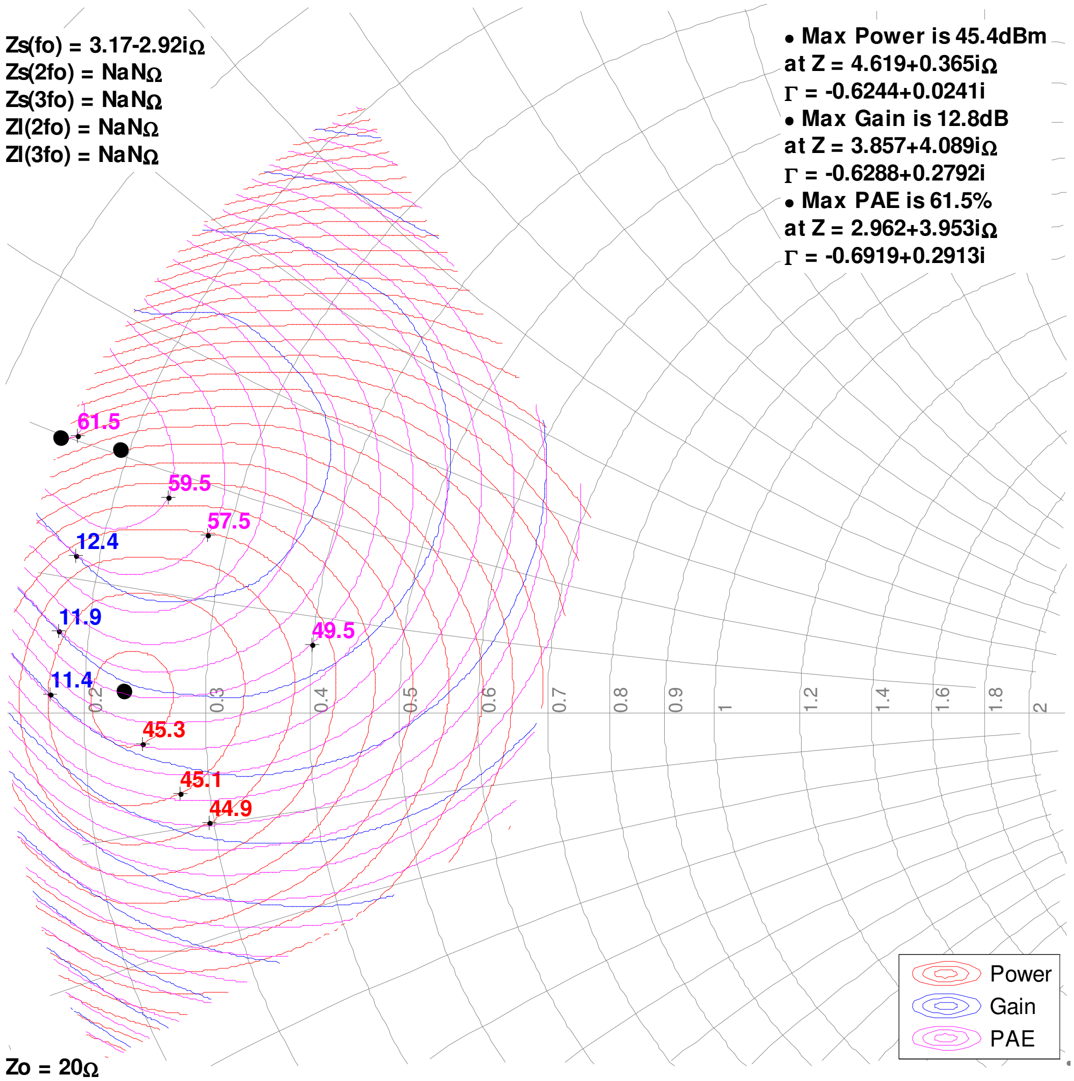
2. See page 30 for load pull and source pull reference planes.
3. NaN means the impedances are undefined in load-pull system.

3.5GHz, Load-pull



Load Pull Smith Charts - Pulsed (1, 2, 3)

RF performance that the device typically exhibits when placed in the specified impedance environment. The impedances are not the impedances of the device, they are the impedances presented to the device via an RF circuit or load-pull system. The impedances listed follow an optimized trajectory to maintain high power and high efficiency.

Notes:

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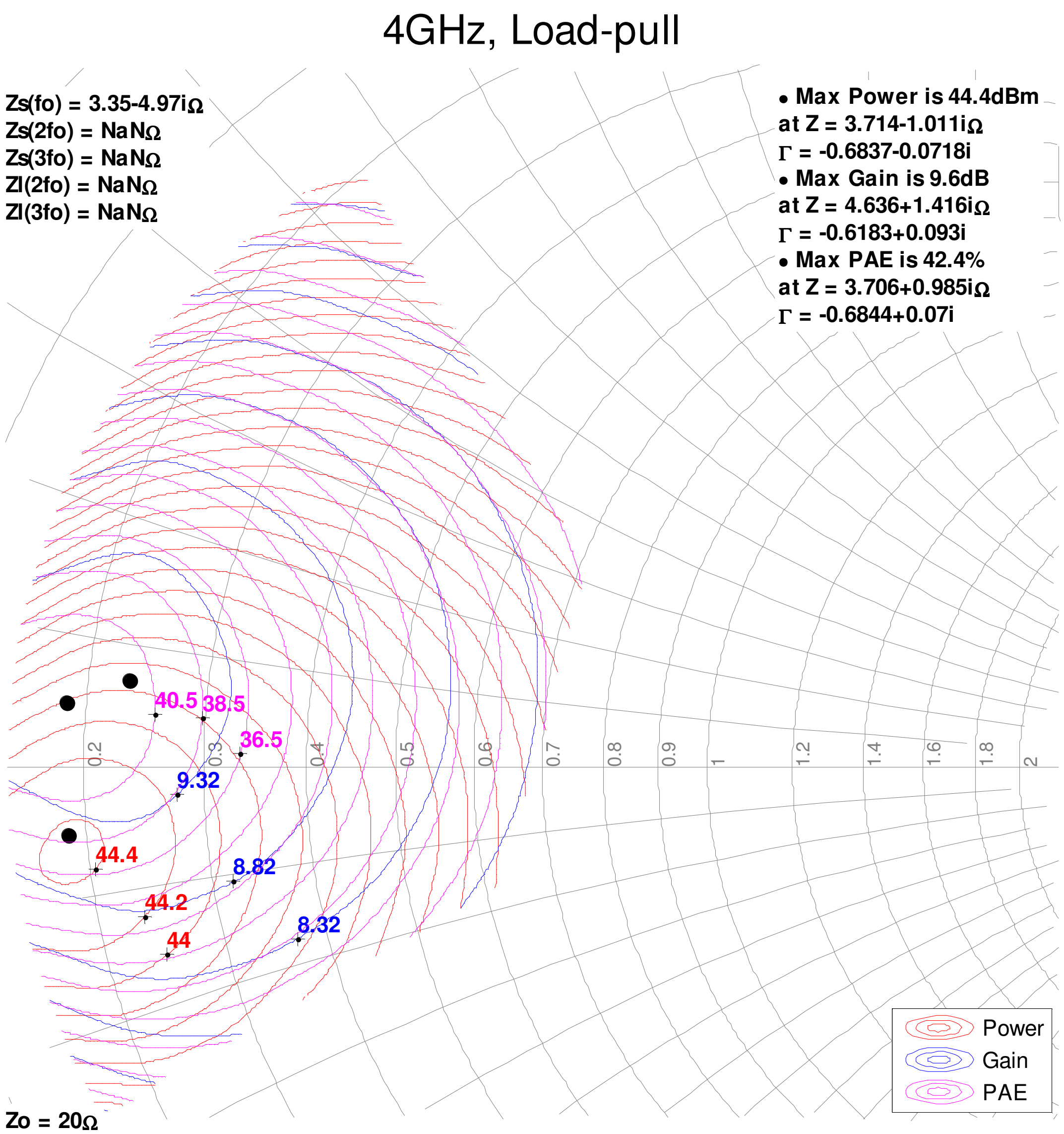
2. See page 30 for load pull and source pull reference planes.
3. NaN means the impedances are undefined in load-pull system.



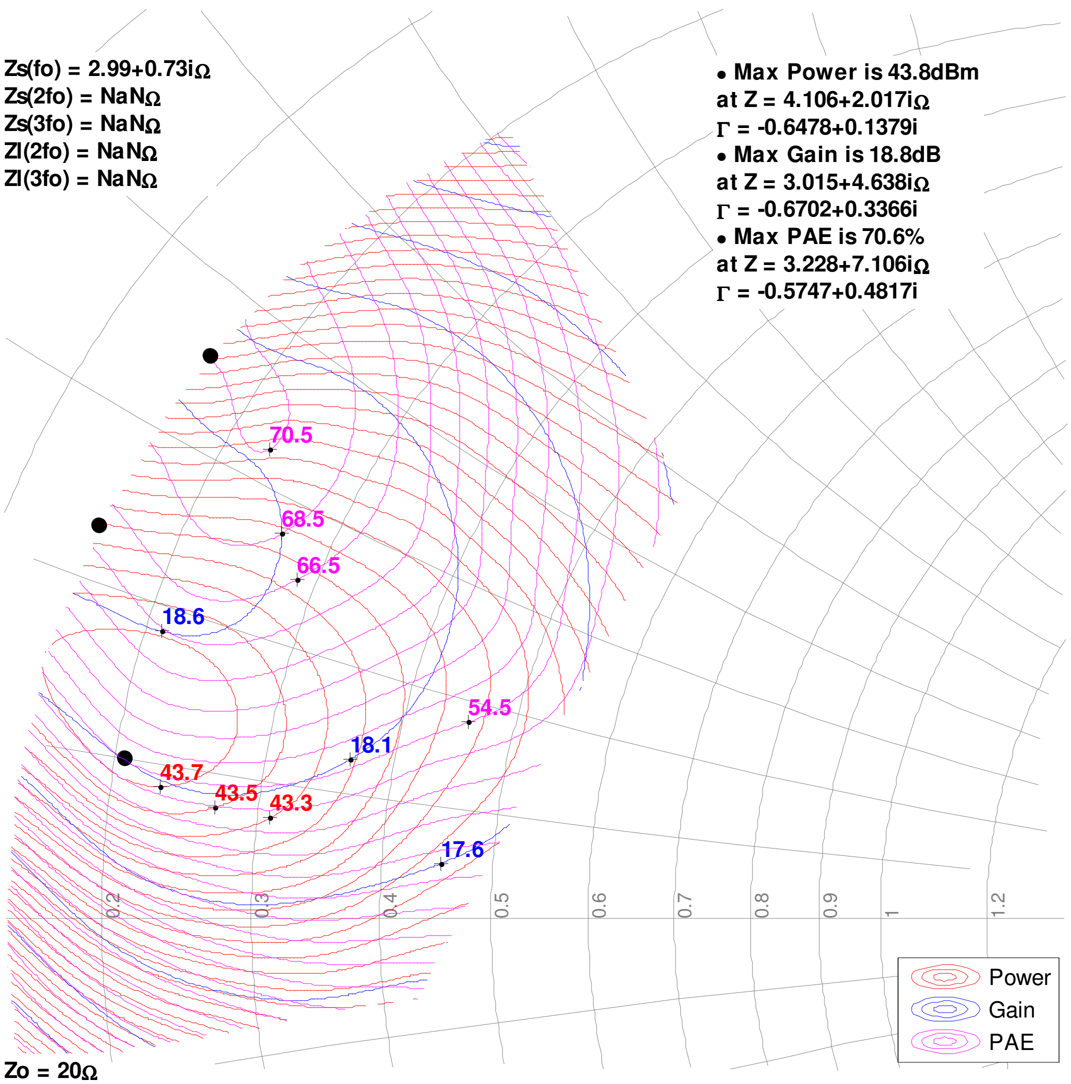
Load Pull Smith Charts - CW (1, 2, 3)

RF performance that the device typically exhibits when placed in the specified impedance environment. The impedances are not the impedances of the device, they are the impedances presented to the device via an RF circuit or load-pull system. The impedances listed follow an optimized trajectory to maintain high power and high efficiency.

Notes:

4. 32 V, 65 mA. 1 dB compression referenced to peak gain.
5. See page 30 for load pull and source pull reference planes.
6. NaN means the impedances are undefined in load-pull system.

2GHz, Load-pull



Load Pull Smith Charts - CW (1, 2, 3)

RF performance that the device typically exhibits when placed in the specified impedance environment. The impedances are not the impedances of the device, they are the impedances presented to the device via an RF circuit or load-pull system. The impedances listed follow an optimized trajectory to maintain high power and high efficiency.

Notes:

4. 32 V, 65 mA. 1 dB compression referenced to peak gain.
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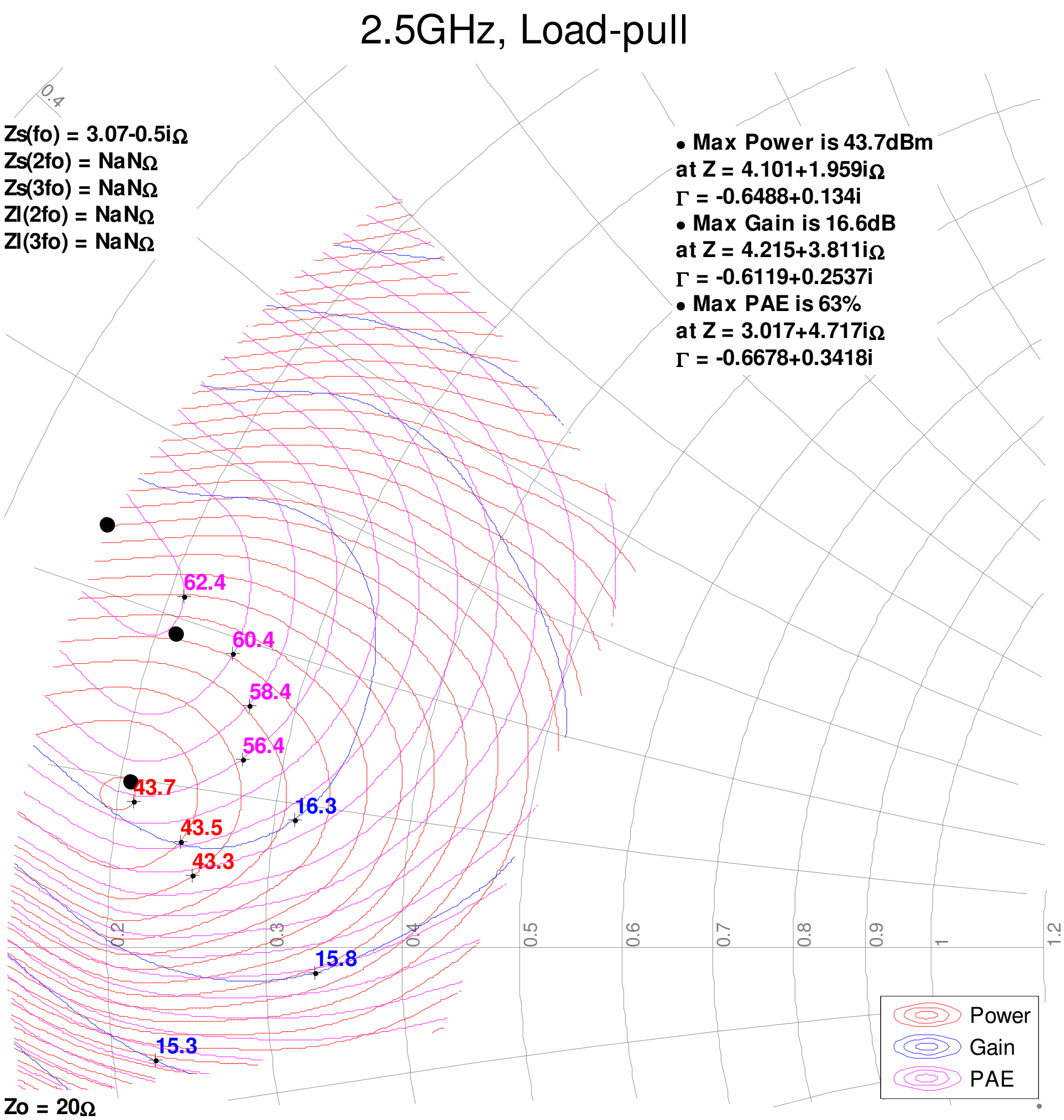
6. NaN means the impedances are undefined in load-pull system.



Load Pull Smith Charts - CW (1, 2, 3)

RF performance that the device typically exhibits when placed in the specified impedance environment. The impedances are not the impedances of the device, they are the impedances presented to the device via an RF circuit or load-pull system. The impedances listed follow an optimized trajectory to maintain high power and high efficiency.

Notes:

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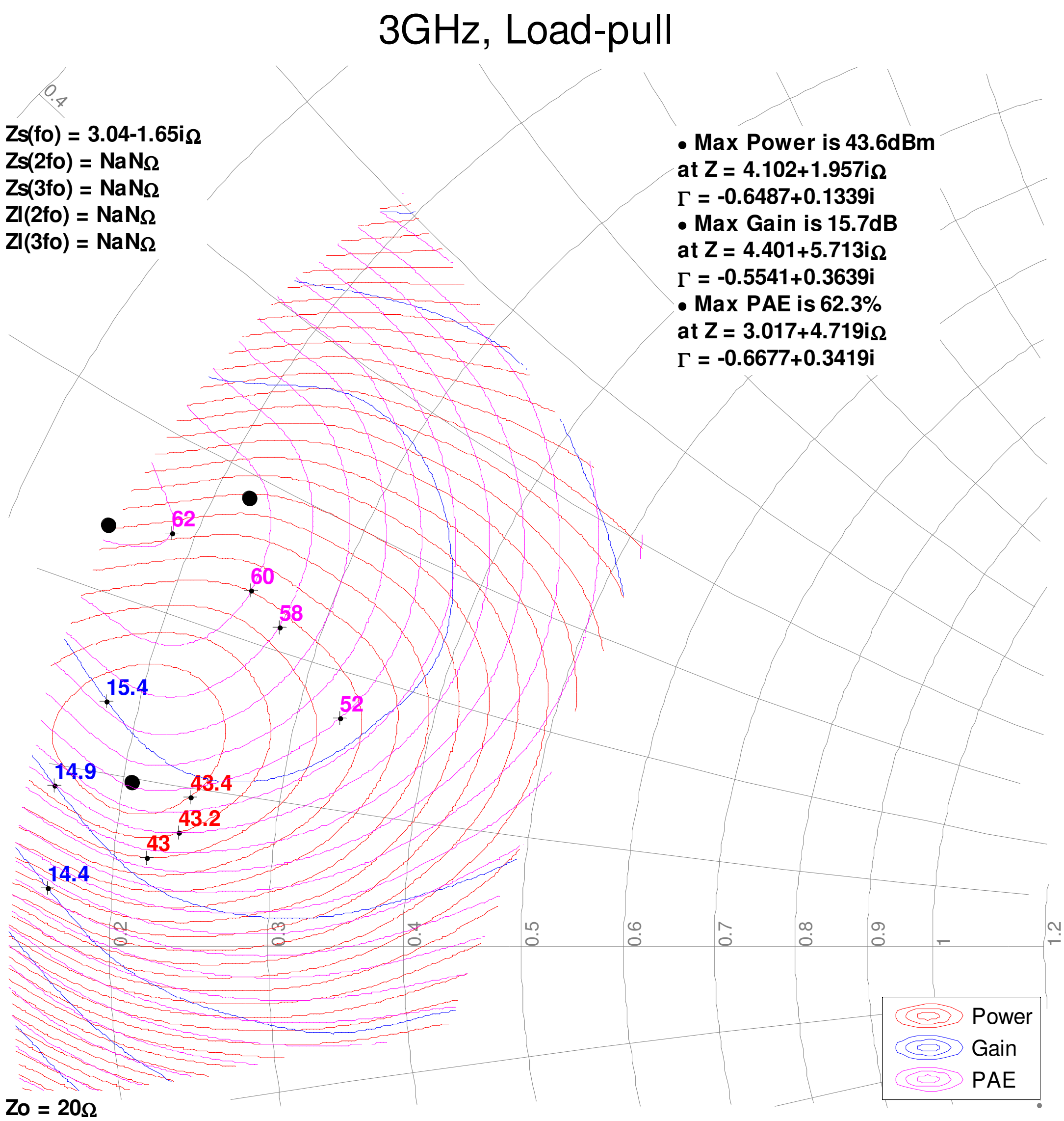

Load Pull Smith Charts - CW (1, 2, 3)

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Notes:

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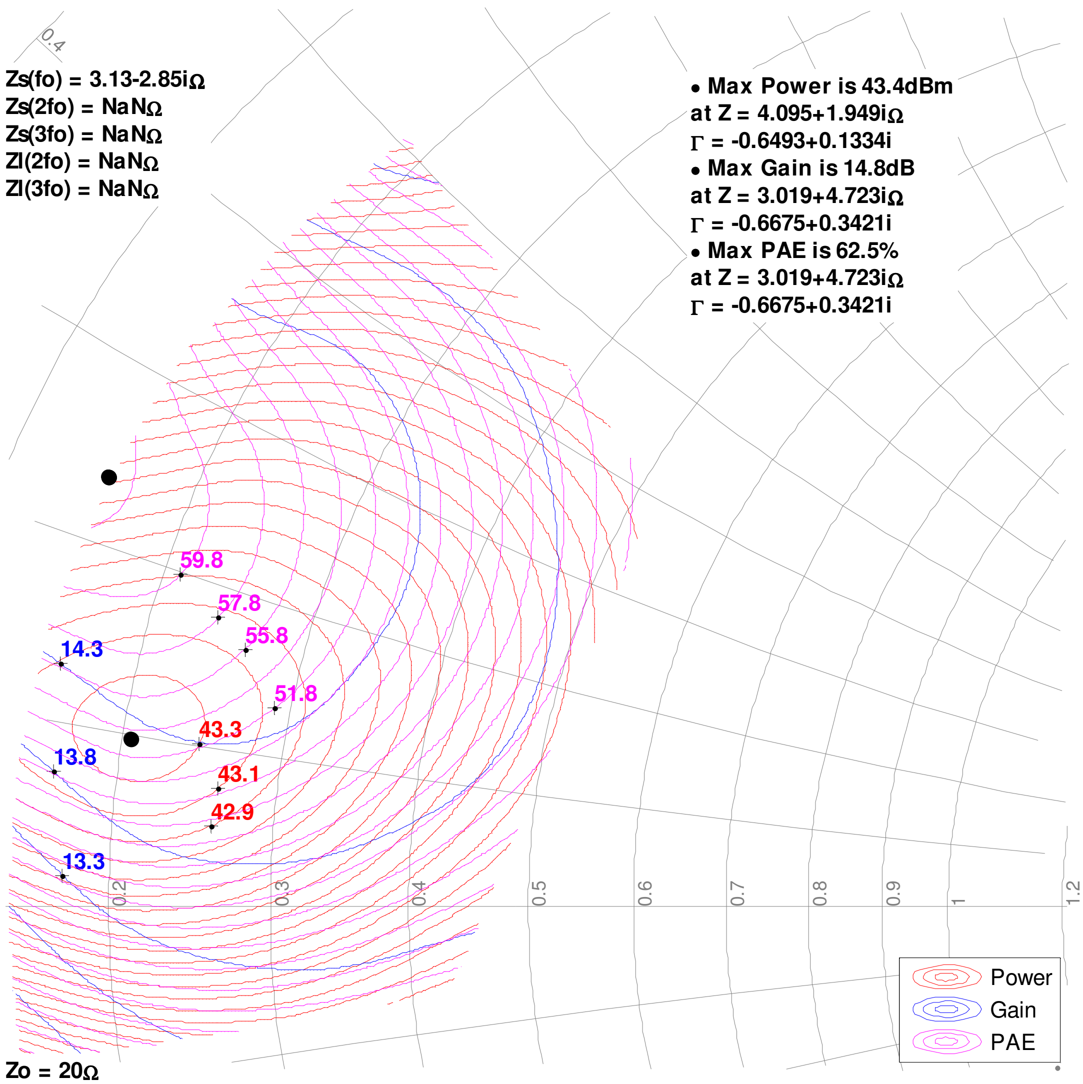
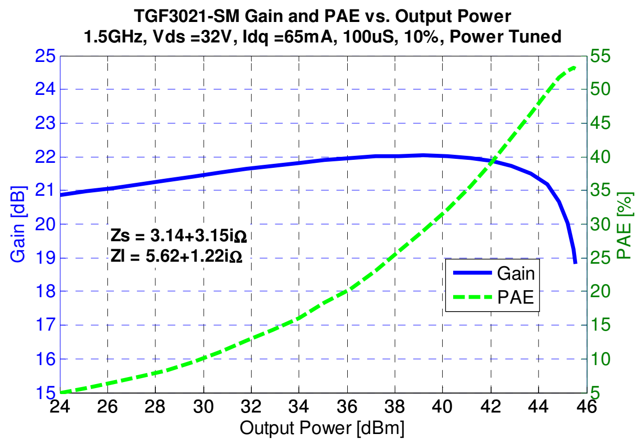
5. See page 30 for load pull and source pull reference planes.
6. NaN means the impedances are undefined in load-pull system.

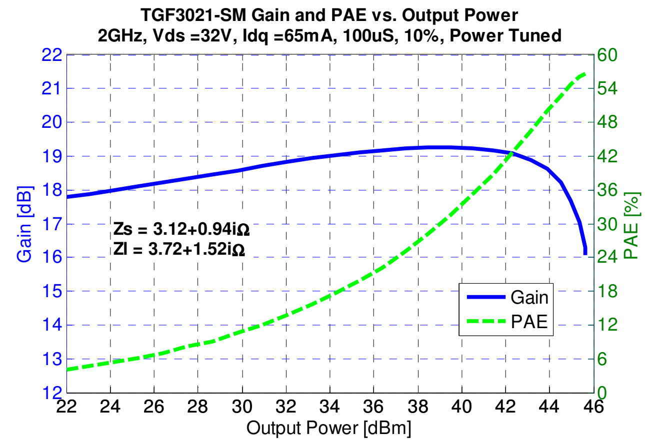
3.5GHz, Load-pull

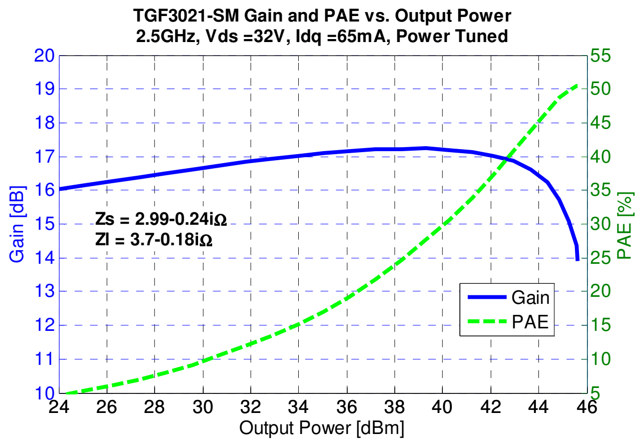


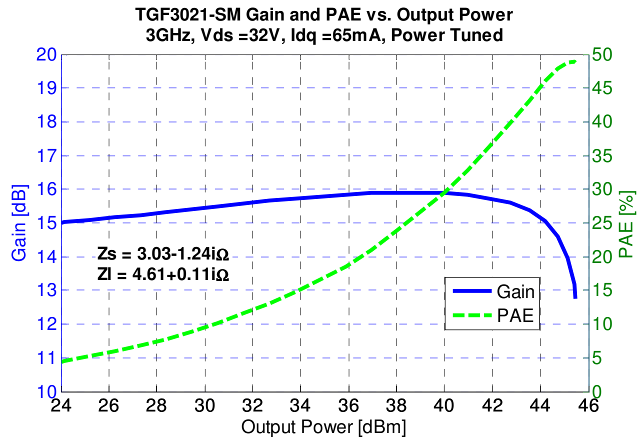
Typical Pulsed Performance – Power Tuned(1,2,3)

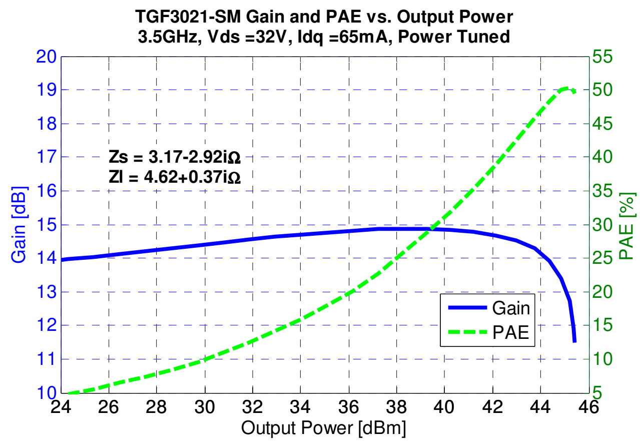
Notes:
1. Pulsed signal with 100 uS pulse width and 20 % duty cycle
2. See page 20 for load pull and source pull reference planes where the performance was measured.

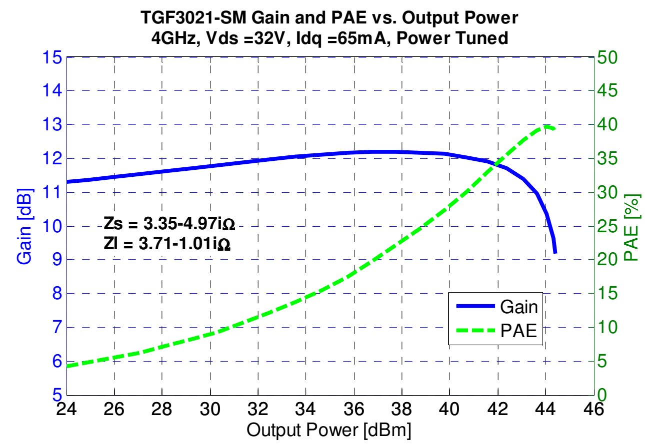






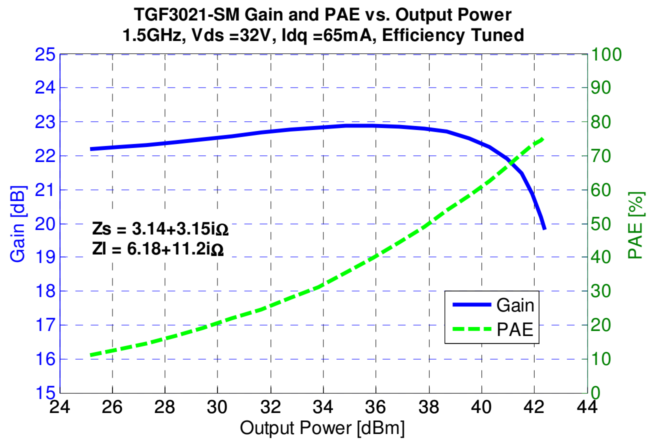


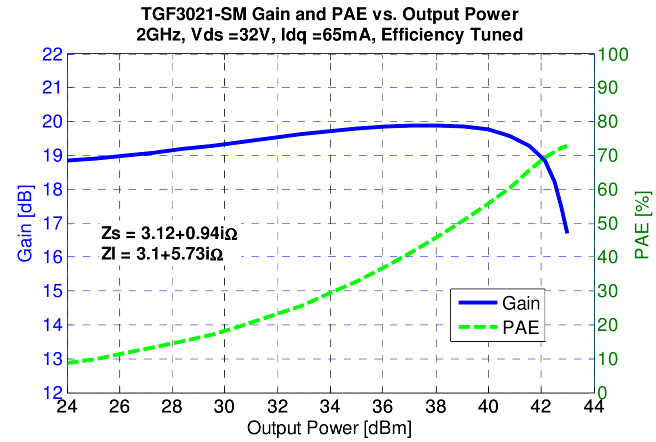


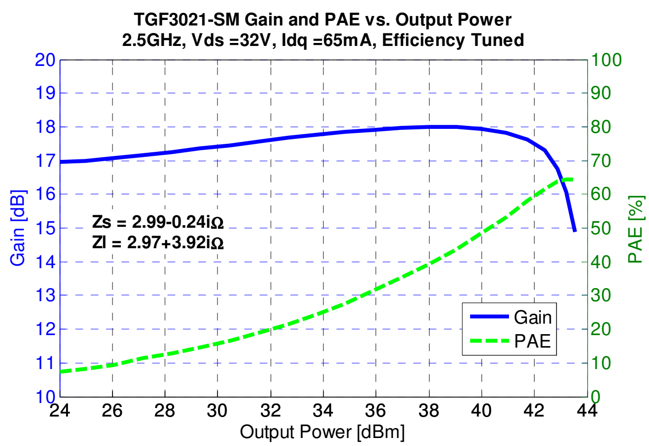


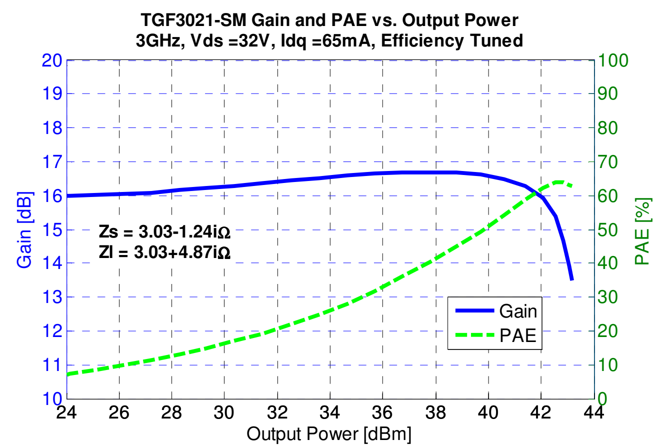
Typical Pulsed Performance – Efficiency Tuned[1,2,3]

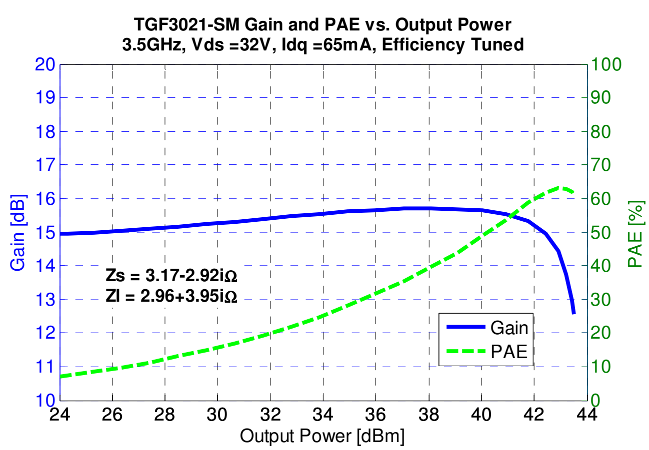
Notes:
1. Pulsed signal with 100 uS pulse width and 20 % duty cycle
2. See page 20 for load pull and source pull reference planes where the performance was measured.

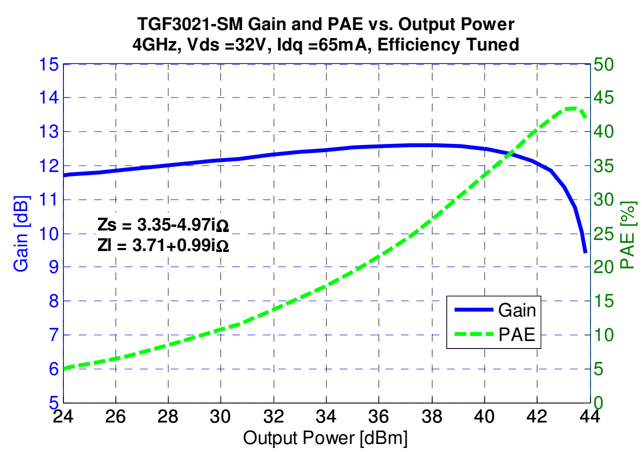






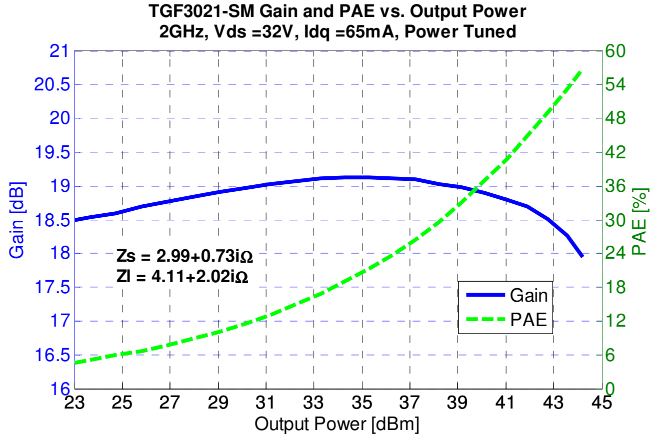


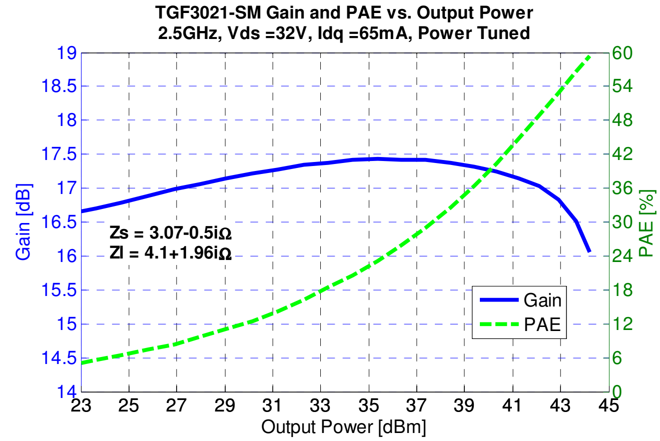


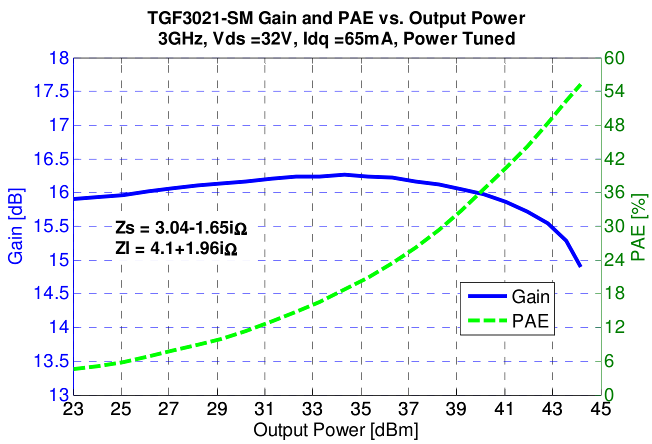


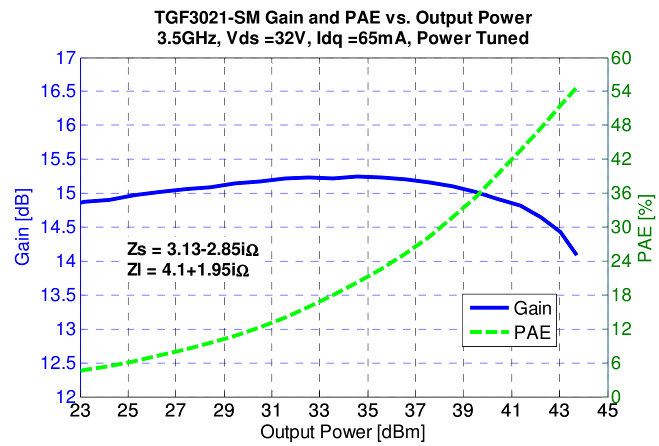
Typical CW Performance – Power Tuned[1,2,3]

Notes:
3. Pulsed signal with 100 uS pulse width and 20 % duty cycle
4. See page 20 for load pull and source pull reference planes where the performance was measured.





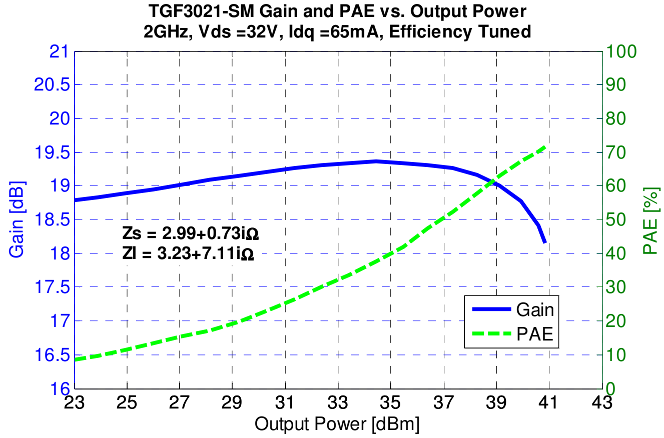


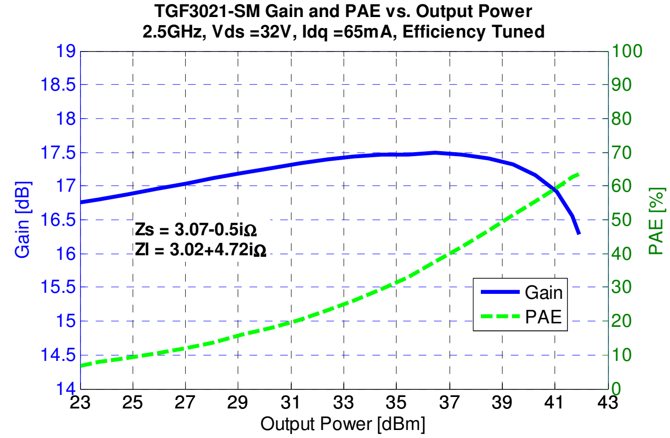


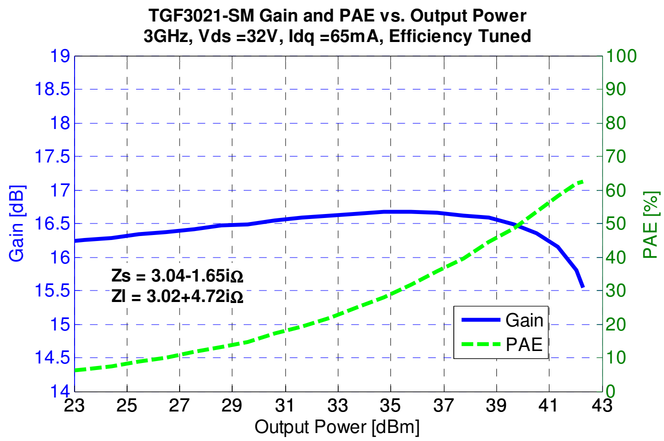
Typical CW Performance – Efficiency Tuned(1,2,3)

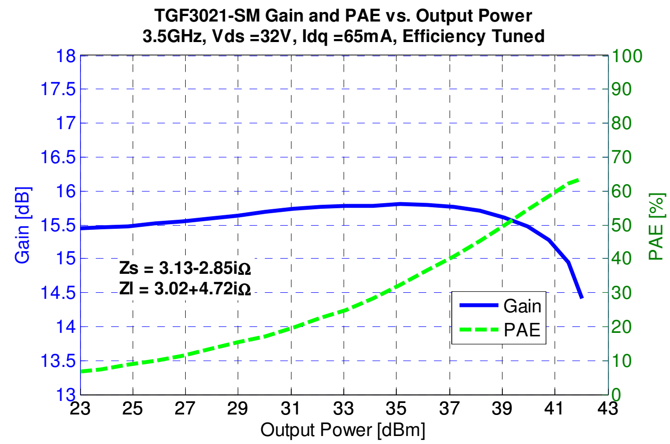
Notes:

1. Pulsed signal with 100uS pulse width and 20% duty cycle
2. See page 20 for load pull and source pull reference planes where the performance was measured.



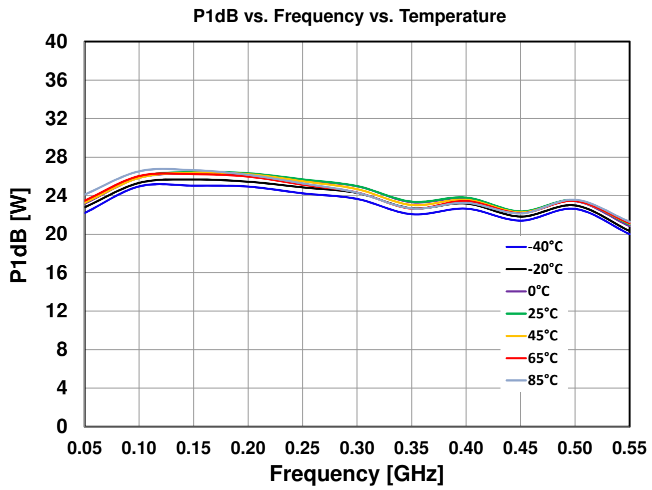


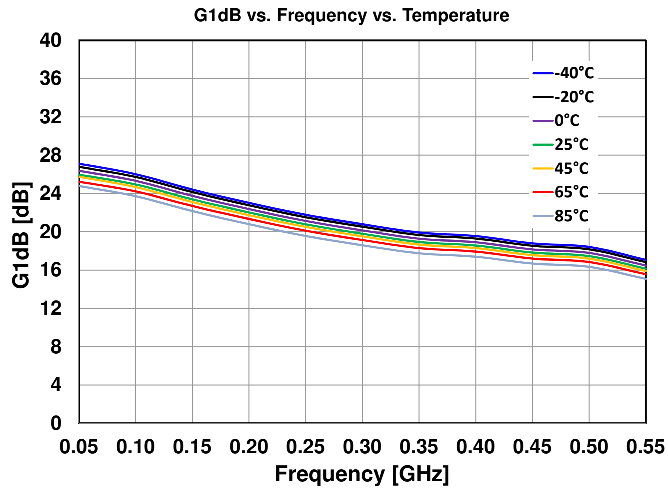


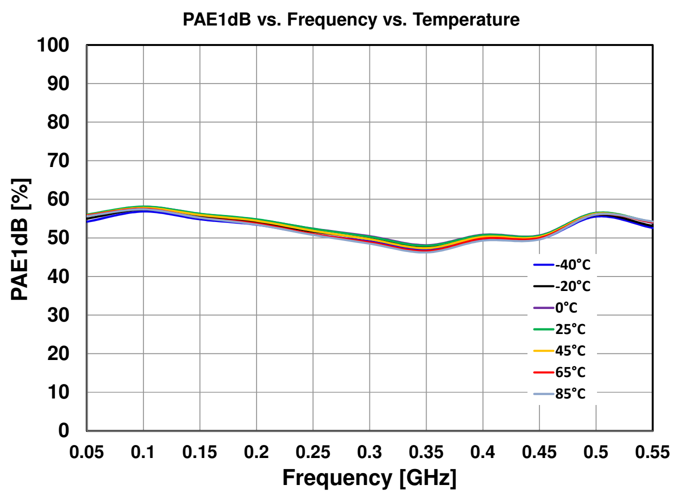


0.03 – 0.512 GHz Evaluation Board Performance Over Temperature (1, 2)

Performance measured on TriQuint's 0.03 GHz to 0.512 GHz Evaluation Board





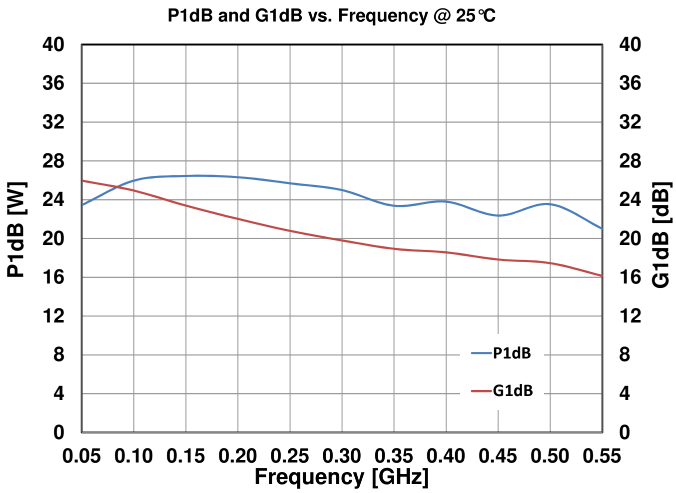


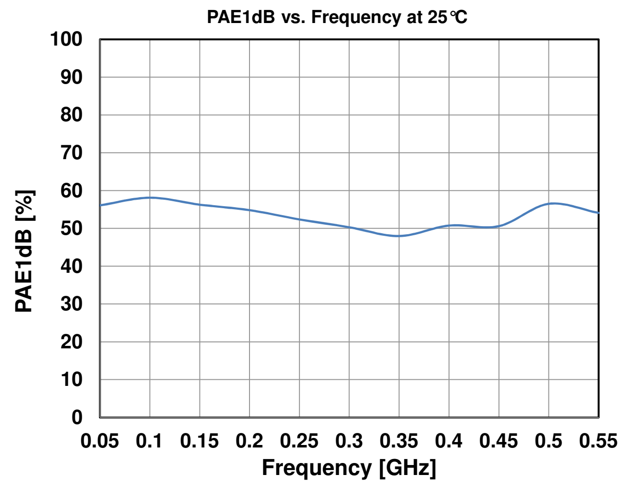
Notes:

1. Test Conditions: V_{DS} = 32 V, I_{DQ} = 65 mA
2. Test Signal: CW

0.03 – 0.512 GHz Evaluation Board Performance At 25°C(1, 2)

Performance measured on TriQuint's 0.03 GHz to 0.512 GHz Evaluation Board

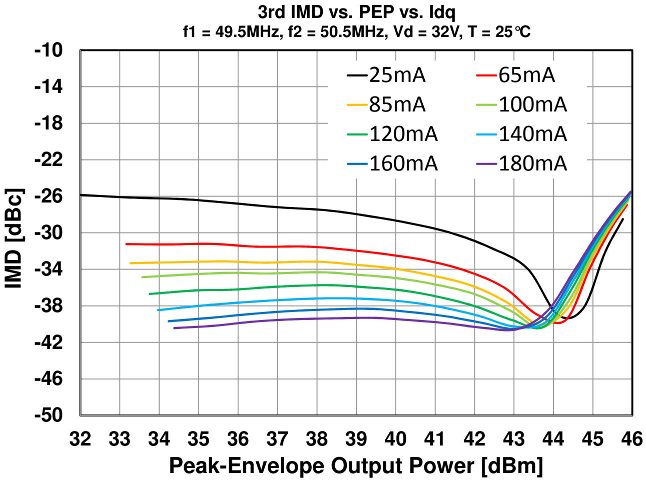


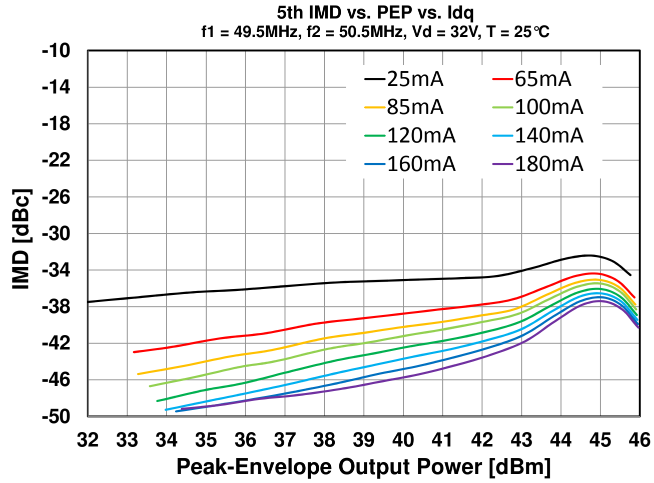


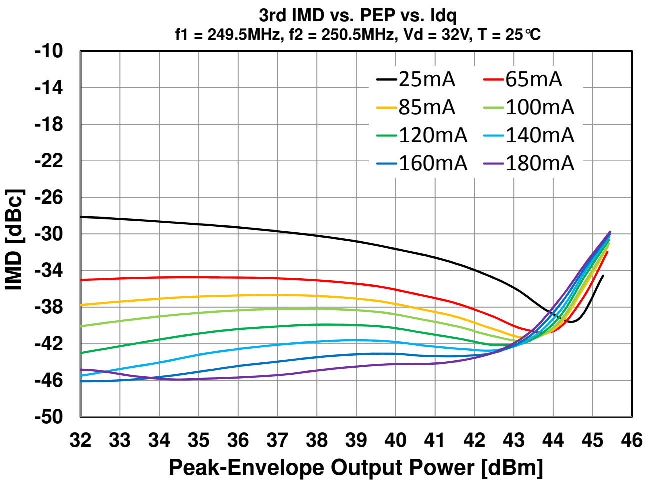
Notes:
1. Test Conditions: V_{DS} = 32 V, I_{DQ} = 65 mA
2. Test signal: CW

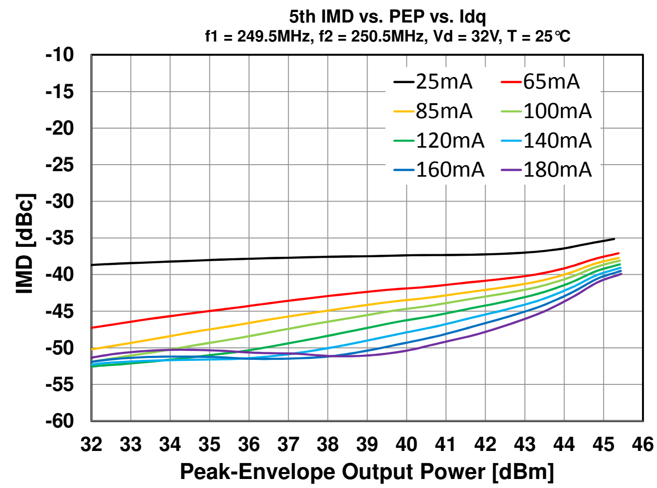
0.03 – 0.512 GHz Evaluation Board Performance - Two-Tone Measurements[1]

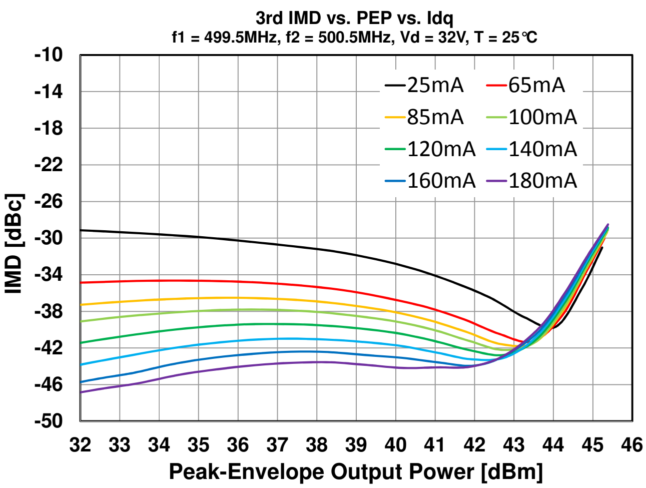
[1] The Intermode Modulation Distortion products (IMD) are referenced to peak-envelope output power, which is 6 dB above single-tone output power.

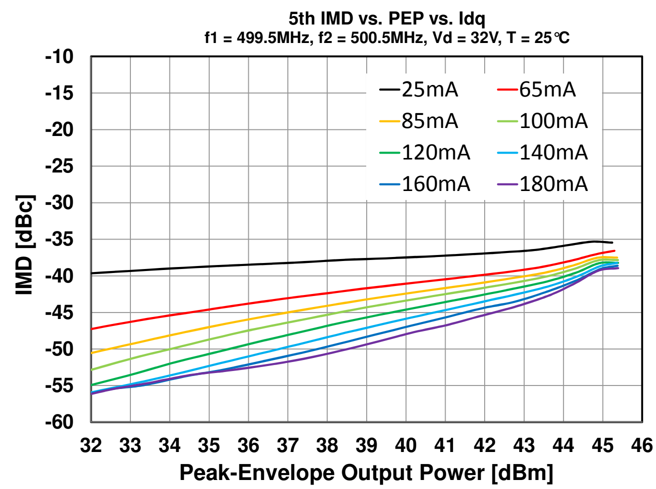




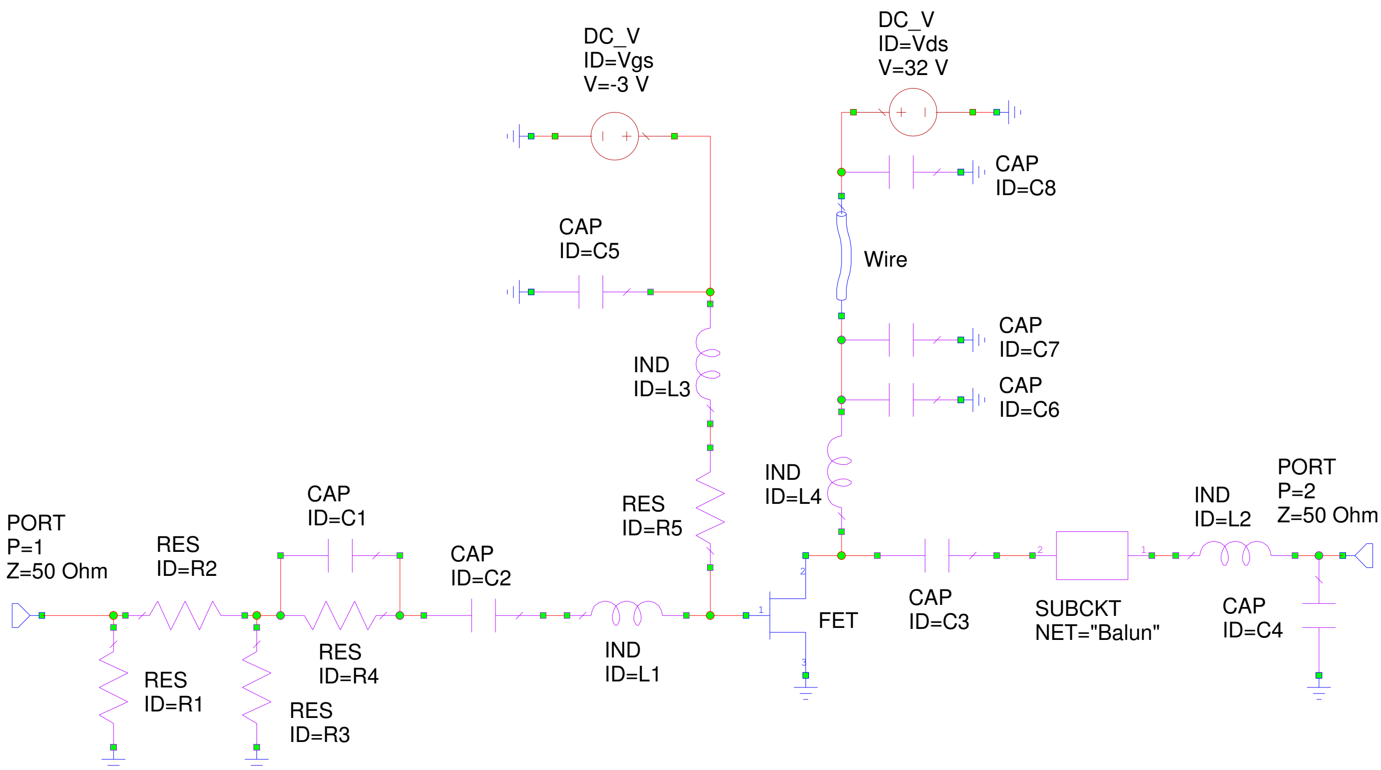








0.03 – 0.512 GHz Application Circuit



Bias-up Procedure

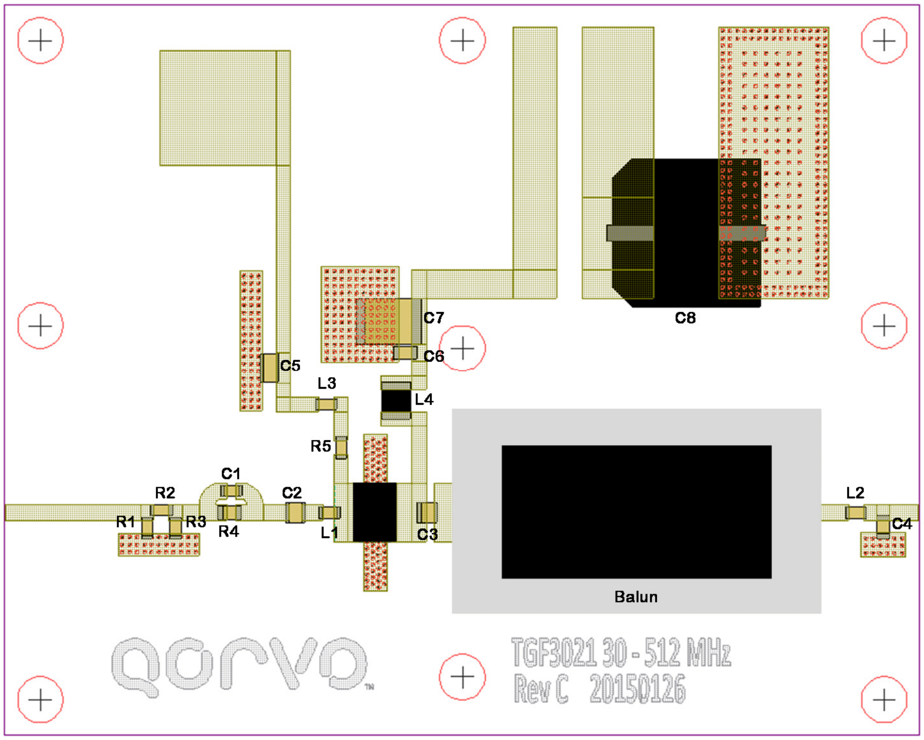
1. V_G set to -5 V.
2. V_D set to 32 V.
3. Adjust V_G more positive until quiescent I_D is 65 mA.
4. Apply RF signal.

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.

0.03 – 0.512 GHz Evaluation Board Layout

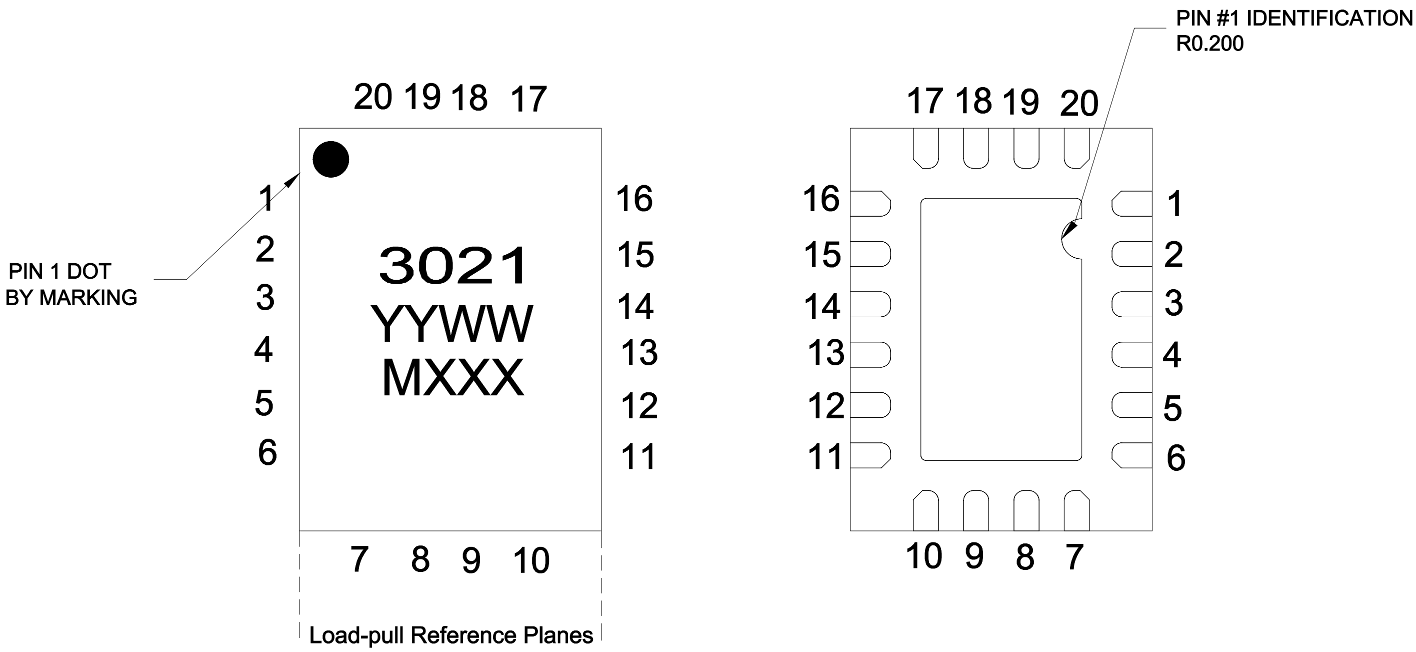
Top RF layer is 0.020" thick Rogers RO4350B, ε_r = 3.48. The pad pattern shown has been developed and tested for optimized assembly at TriQuint Semiconductor. The PCB land pattern has been developed to accommodate lead and package tolerances.



0.03 – 3 GHz EVB Bill of Materials

Reference Design	Value	Qty	Manufacturer	Part Number
R1, R3	432 Ω	2	Any	Generic 0603
R2	11.3 Ω	1	Any	Generic 0603
R4	23.7 Ω	1	Any	Generic 0603
R5	10 Ω	1	Any	Generic 0603
C1	15 pF	1	ATC	600S150AT250XT
C2, C3	820 pF	2	ATC	700A821JW050XT
C4	2.7 pF	1	ATC	600S2R7AT250XT
C5	10 uF	1	Murata	GRM188R60J6ME47D
C6	82 pF	1	ATC	600S820FT250XT
C7	10 uF	1	TDK	C5750X7R1H106K320KB
C8	220 uF	1	Nichicon	UWT1H221ML1GS
L1	15 nH	1	Coilcraft	0603HC-15NX
L2	10 nH	1	Coilcraft	0603HC-10NX
L3	1200 nH	1	Coilcraft	0603LS-122X
L4	1100 nH	1	Coilcraft	108AF-112X
Balun	NA	1	Anaren	XMT0310B5012

Pin Layout



Pin Description

Pin	Symbol	Description
11 - 16	V_D / RF OUT	Drain voltage / RF Output to be matched to 50 ohms; see EVB Layout on page 19 as an example.
1 - 6	V_G / RF IN	Gate voltage / RF Input to be matched to 50 ohms; see EVB Layout on page 19 as an example.
7 – 10, 17 - 20	NC	Not connected
Back side	Source	Source connected to ground

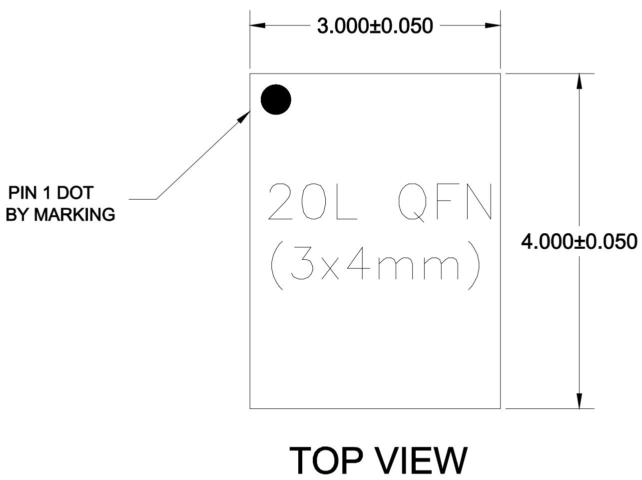
Notes:

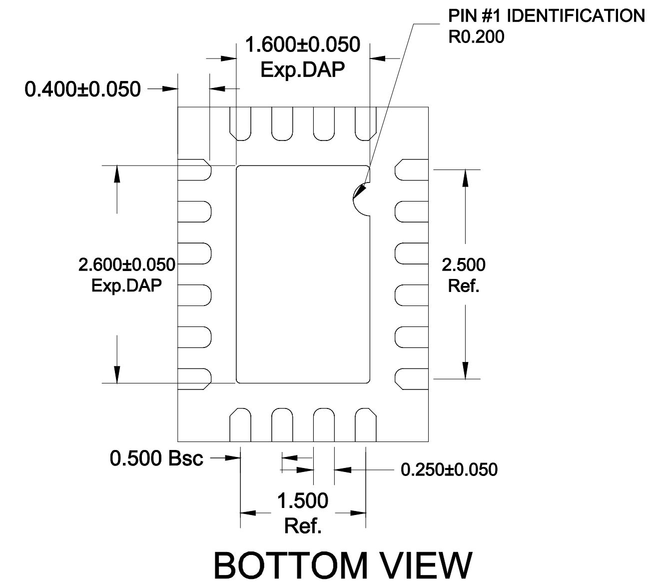
Thermal resistance measured to back side of package

The TGF3021-SM will be marked with the “3021” designator and a lot code marked below the part designator The “YY” represents the last two digits of the calendar year the part was manufactured, the “WW” is the work week of the assembly lot start, and the “MXXX” is the production lot number.

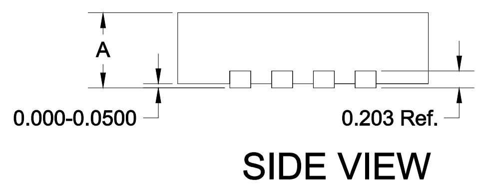
Mechanical Information

All dimensions are in milimeters.





		QFN
A	MAX.	0.900
	NOM.	0.850
	MIN.	0.800



Note:
Unless otherwise noted, all dimention tolerances are +/-0.127 mm.
This package is lead-free/RoHS-compliant. The plating material on the leads is NiAu. It is compatible with both lead-free (maximum 260 ℃ reflow temperature) and tin-lead (maximum 245℃ reflow temperature) soldering processes.

Product Compliance Information

ESD Sensitivity Ratings

Caution! ESD-Sensitive Device

ESD Rating: Class 1B
Value: Passes 600 V min.
Test: Human Body Model (HBM)
Standard: JEDEC Standard JESD22-A114

MSL Rating

The part is rated Moisture Sensitivity Level 3 at 260℃ per JEDEC standard IPC/JEDEC J-STD-020.

ECCN

US Department of Commerce EAR99

Solderability

Compatible with the latest version of J-STD-020, Lead free solder, 260 ℃

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

Recommended Soldering Temperature Profile