TGF3021-SM

30 W, 32 V, 0.03 to 4 GHz, GaN RF Transistor

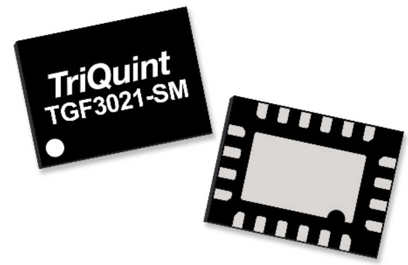
Product Overview

The TGF3021-SM is a 30 W (P_{1dB}) discrete GaN on SiC HEMT which operates from 0.03 to 4.0 GHz. The device is constructed with proven TQGaN25 processes, 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

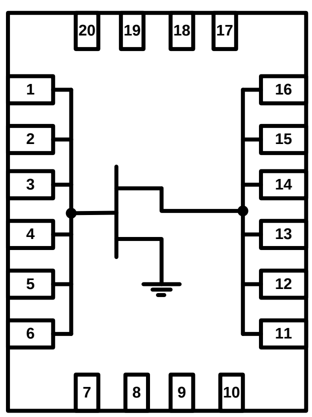
Evaluation boards are available upon request.



Key Features

- Frequency: 0.03 to 4.0 GHz
- Output Power (P_{1dB}): 36.0 W at 2 GHz
- Linear Gain: 19.3 dB at 2 GHz
- Typical PAE_{1dB}: 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



Applications

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

Pad Configuration

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

Ordering Information

Part Number	Description
TGF3021-SM	QFN Packaged Part
TGF3021-SM-EVB1	0.05 – 0.55 GHz EVB

Absolute Maximum Ratings

Parameter	Rating
Drain to Gate Voltage (V_{DG})	100 V
Gate Voltage Range (V_G)	−7 to 2 V
Drain Current (I_D)	5.8 A
Gate Current (I_G)	−7.5 to 16.8 mA
CW RF Input Power (P_{IN})	See page 9.
Storage Temperature	−40 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	Value	Units
Drain Voltage Range (V_D)	32 (Typ.)	V
Drain Quiescent Current (I_{DQ})	65	mA
Peak Drain Current (I_D)	1800 (Typ.)	mA
Gate Voltage (V_G)	−2.7 (Typ.)	V

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

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	2.0 GHz		19.3		dB
		2.5 GHz		17.3		
		3.0 GHz		15.9		
		3.5 GHz		14.9		
P_{3dB}	Output Power at 3 dB Gain Compression, Power Tuned	2.0 GHz		45.6		dBm
		2.5 GHz		45.6		
		3.0 GHz		45.4		
		3.5 GHz		45.4		
PAE_{3dB}	Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned	2.0 GHz		72.7		%
		2.5 GHz		64.4		
		3.0 GHz		62.9		
		3.5 GHz		61.5		
G_{3dB}	Gain at 3 dB Compression, Power Tuned	2.0 GHz		16.3		dB
		2.5 GHz		14.3		
		3.0 GHz		12.9		
		3.5 GHz		11.9		

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		22.8		dB
P_{1dB}	Output Power at 1 dB Gain Compression		25.5		W
PAE_{1dB}	Power-Added Efficiency at 1 dB Gain Compression		63.6		%
G_{1dB}	Gain at 1 dB Compression		21.8		dB
Gate Leakage	V_D = +10 V, V_G = −3.7 V	-8.3			mA

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	Test Conditions	Value	Units
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 11.3 W, Tbaseplate = 85°C	3.2	ºC/W
Channel Temperature, T_{CH}		121	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 15.1 W, Tbaseplate = 85°C	3.3	°C/W
Channel Temperature, T_{CH}		126	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 18.9 W, Tbaseplate = 85°C	3.3	ºC/W
Channel Temperature, T_{CH}		148	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 22.7 W, Tbaseplate = 85°C	3.4	ºC/W
Channel Temperature, T_{CH}		162	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 30.2 W, Tbaseplate = 85°C	3.6	ºC/W
Channel Temperature, T_{CH}		194	°C

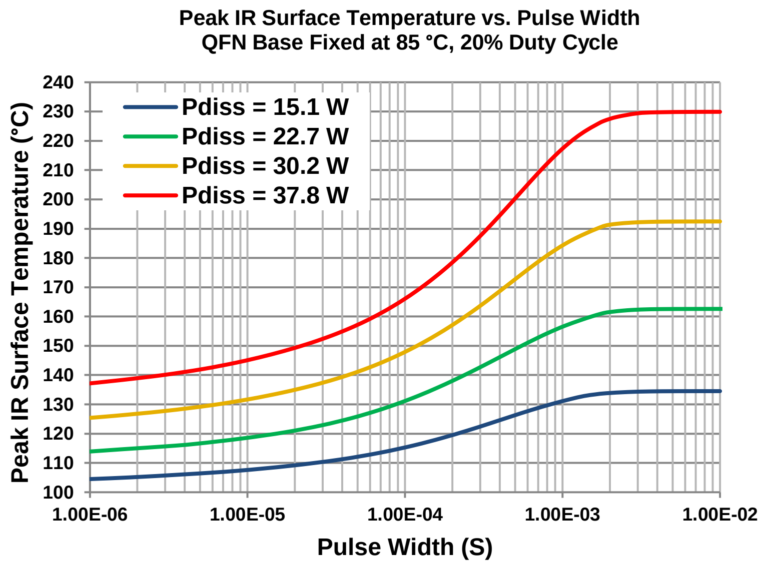
Notes:
1. Thermal resistance measured to bottom of package.
2. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

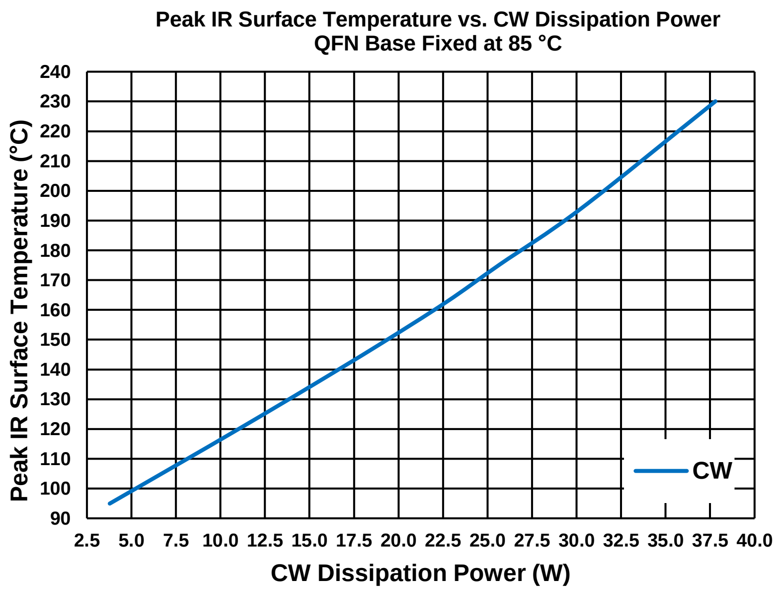
Thermal and Reliability Information - Pulsed (1)

Parameter	Test Conditions	Value	Units
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 15.1 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 5%	2.0	ºC/W
Channel Temperature, T_{CH}		115	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 22.7 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 10%	2.0	°C/W
Channel Temperature, T_{CH}		131	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 30.2 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 20%	2.1	ºC/W
Channel Temperature, T_{CH}		148	°C
Thermal Resistance, Peak IR Surface Temperature at Average Power (θ_{JC})	P_{DISS} = 37.8 W, Tbaseplate = 85°C Pulse Width = 100 uS Duty Cycle = 20%	2.1	ºC/W
Channel Temperature, T_{CH}		166	°C

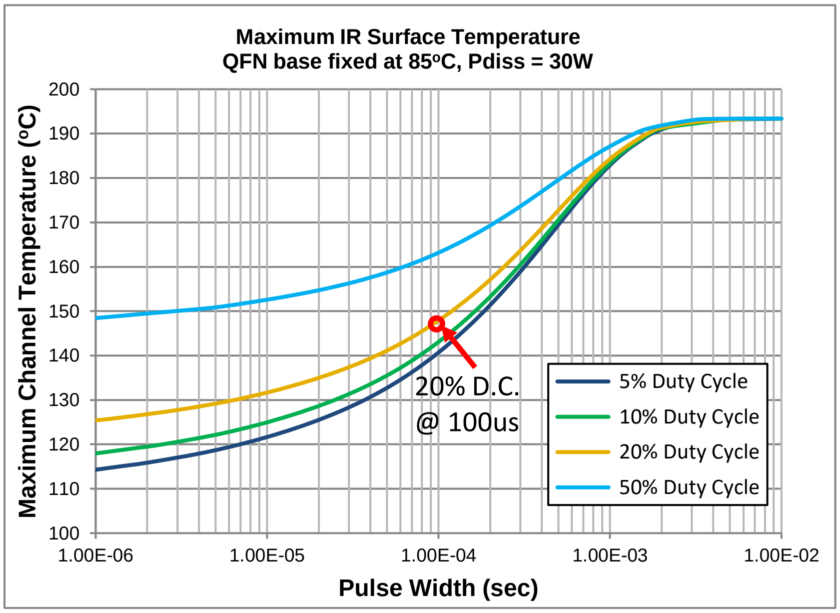
Notes:
1. Thermal resistance measured to bottom of package.
2. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

Maximum Channel Temperature

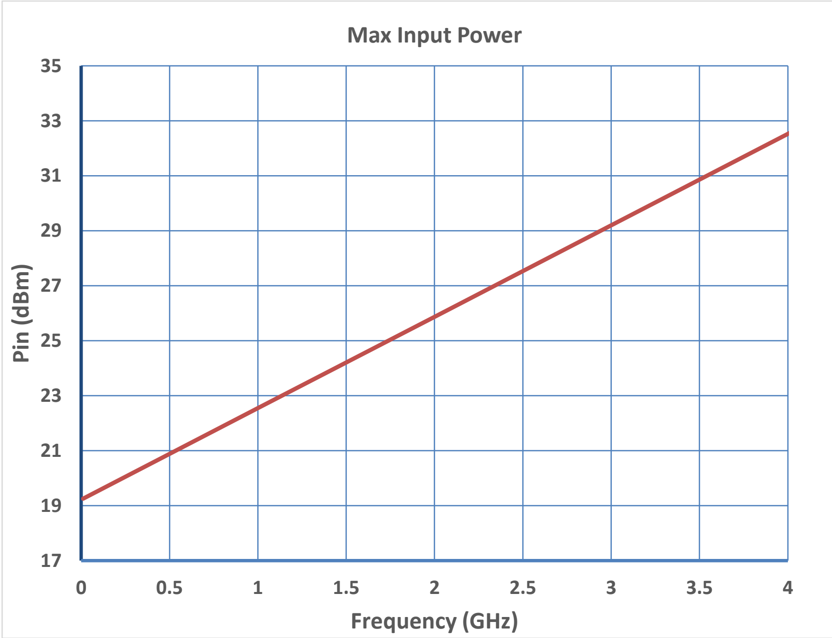




Maximum Channel Temperature



Maximum Input Power [1]

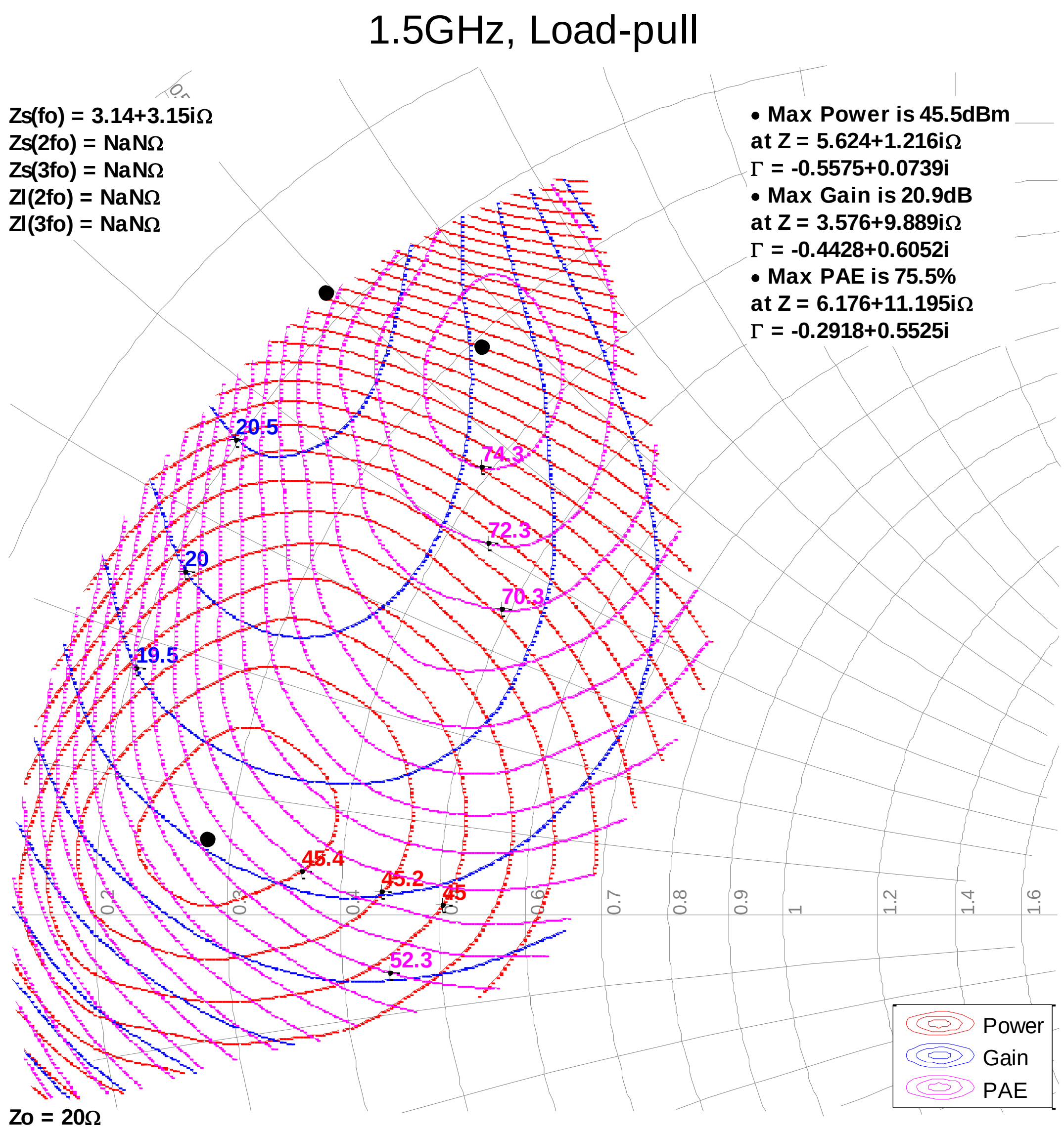


(1) Values are estimated at 25 °C and CW condition.

Model Load Pull Contours – 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.



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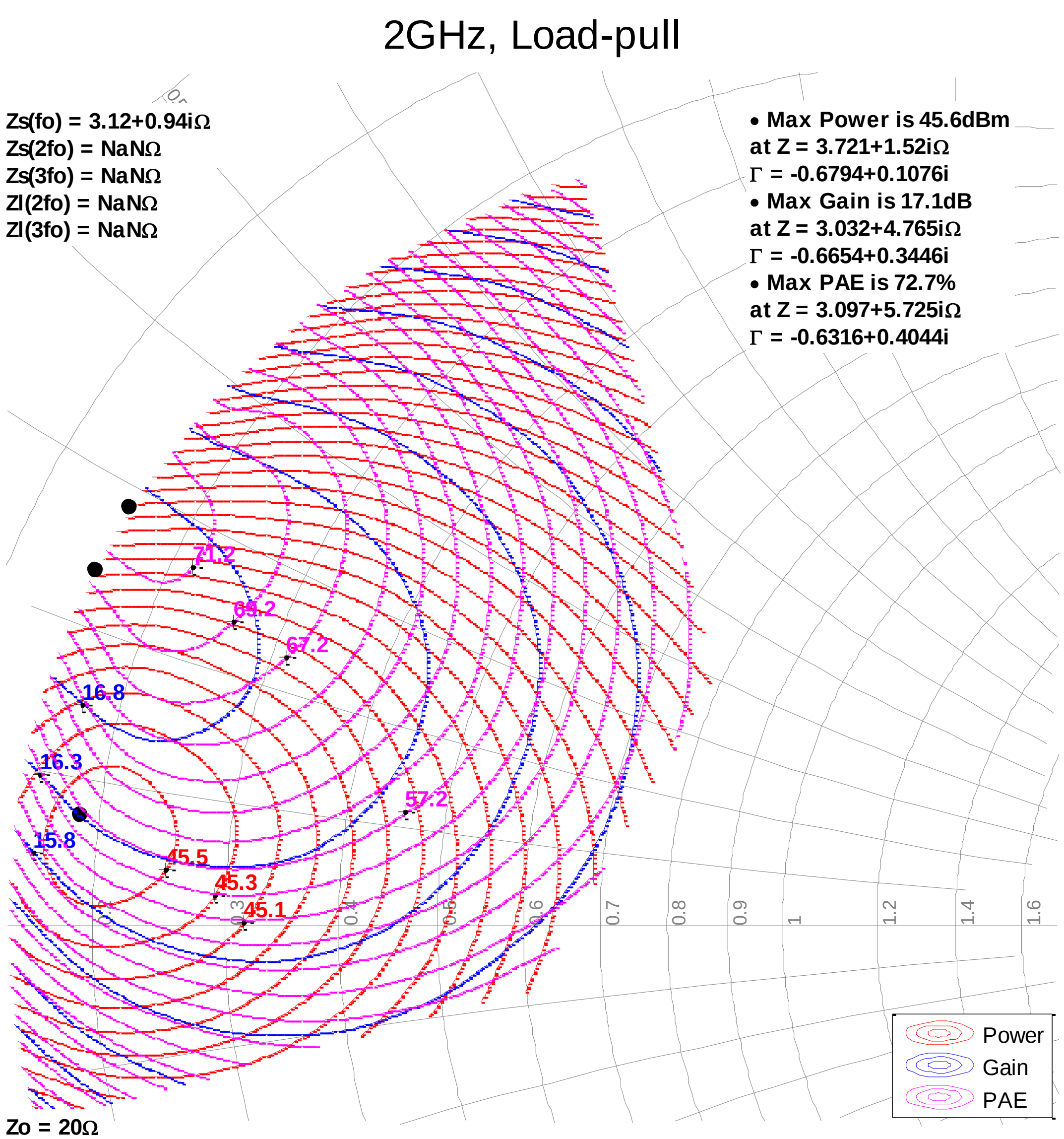
2. See page 28 for load pull and source pull reference planes.
3. NaN means the impedances are undefined in load-pull system.



Model Load Pull Contours – Pulsed [1,2,3]

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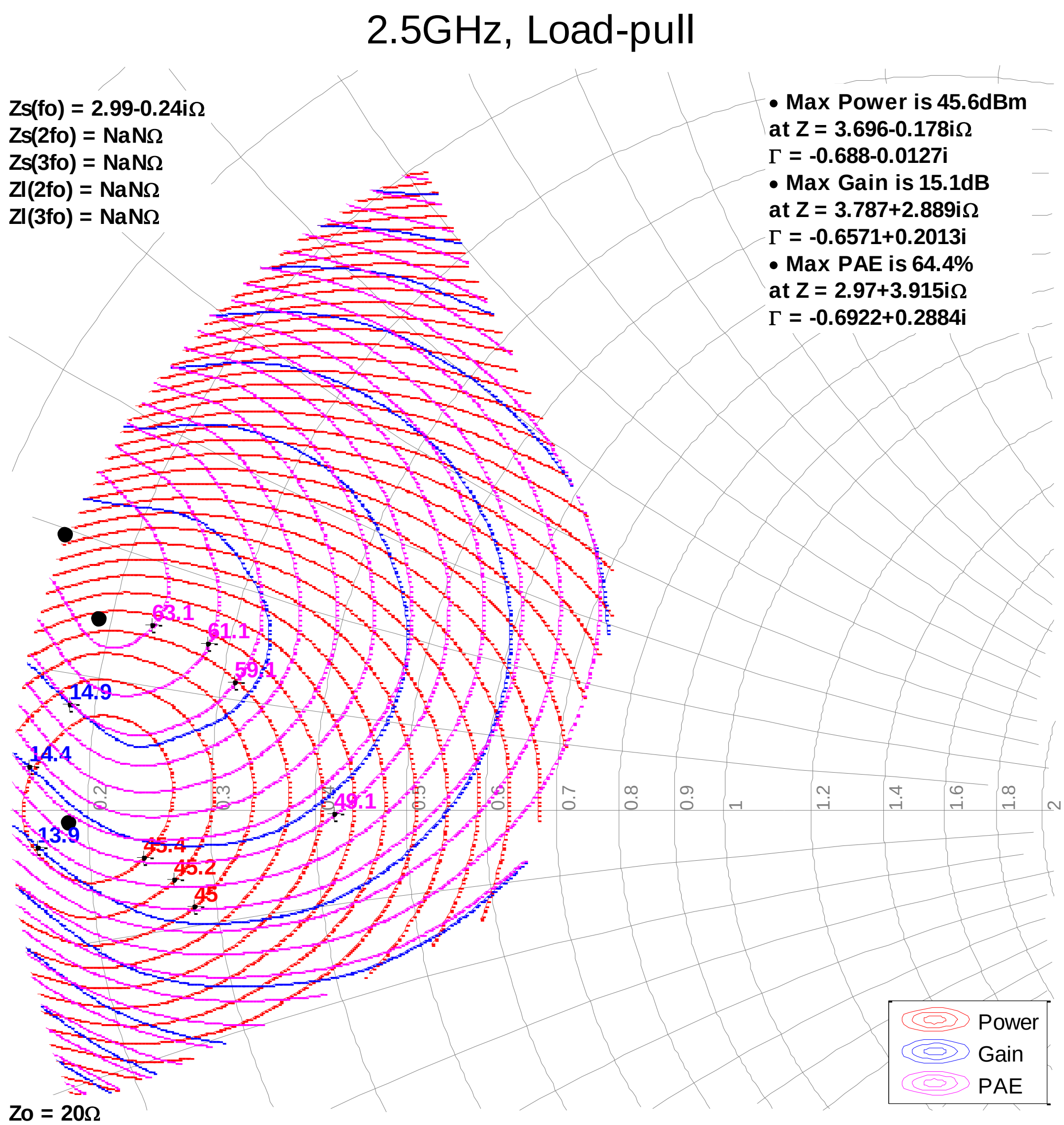

Model Load Pull Contours – Pulsed (1,2,3)

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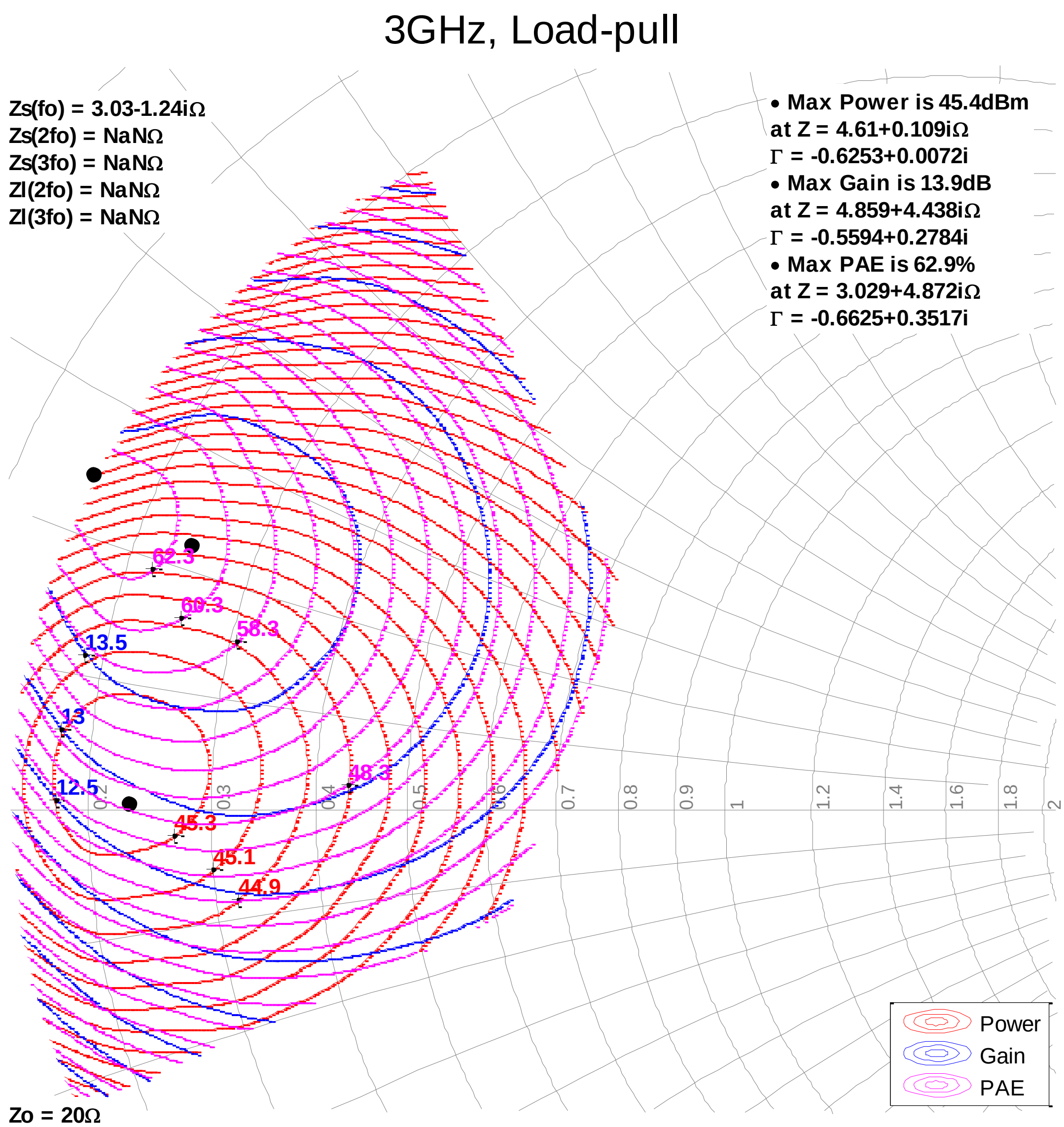
2. See page 28 for load pull and source pull reference planes.
3. NaN means the impedances are undefined in load-pull system.



Model Load Pull Contours – 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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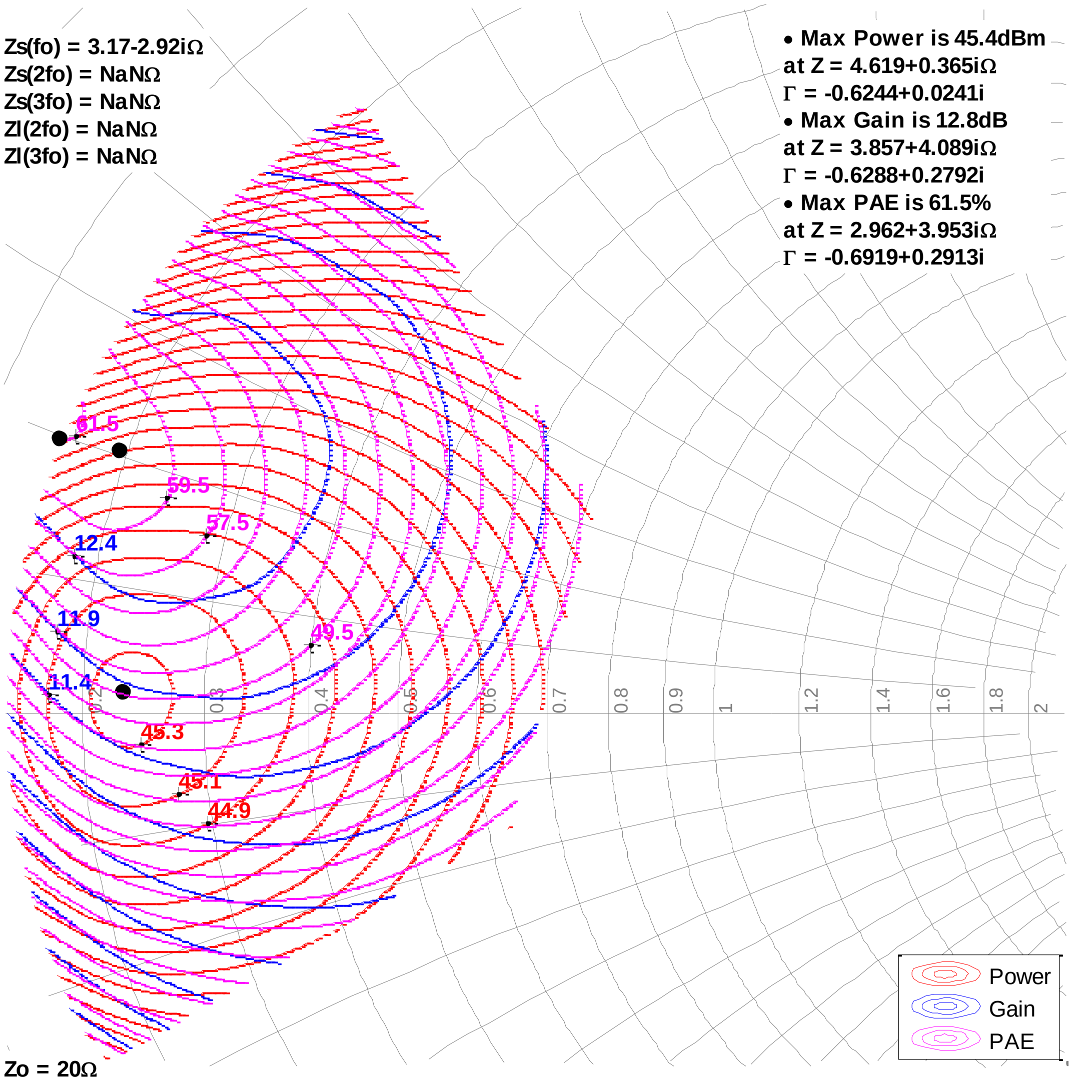
2. See page 28 for load pull and source pull reference planes.
3. NaN means the impedances are undefined in load-pull system.

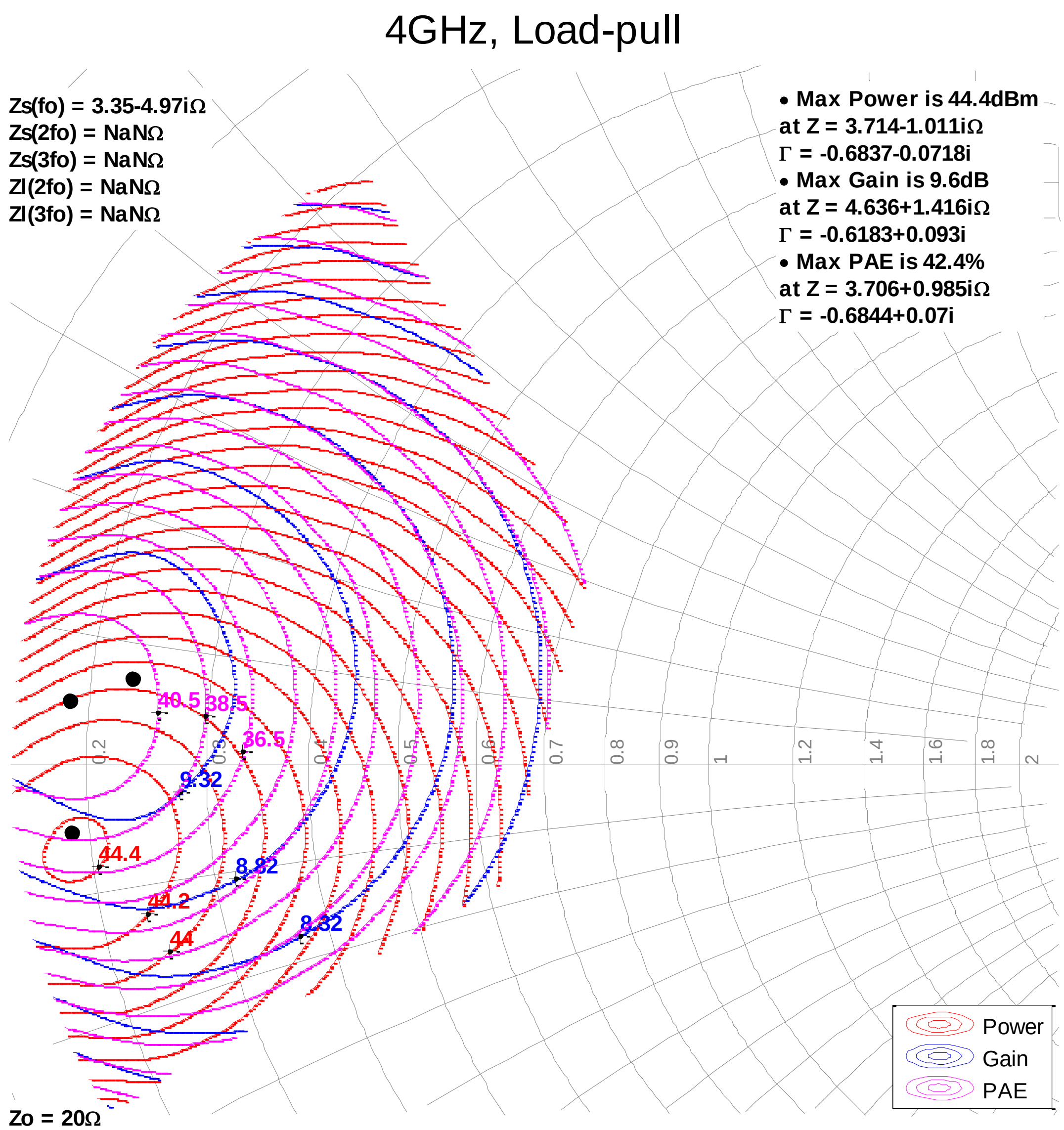
3.5GHz, Load-pull



Model Load Pull Contours – 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.

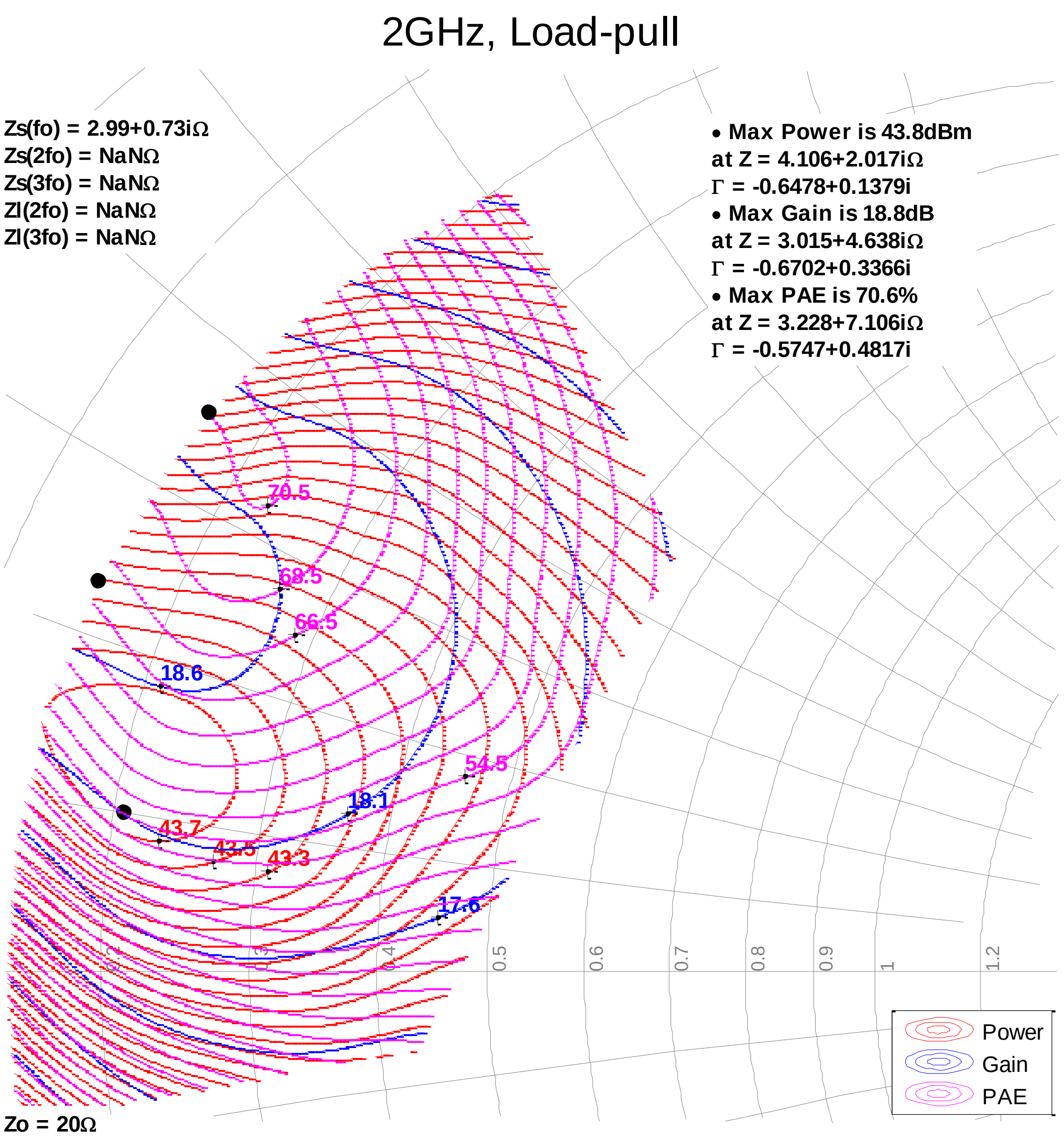
Notes:
1. 32 V, 65 mA, Pulsed signal with 100 uS pulse width and 20% duty cycle. 3 dB compression referenced to peak gain.
2. See page 28 for load pull and source pull reference planes.
3. NaN means the impedances are undefined in load-pull system.



Model Load Pull Contours – CW (4, 5, 6)

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., CW, 1 dB compression referenced to peak gain.
5. See page 28 for load pull and source pull reference planes.
6. NaN means the impedances are undefined in load-pull system.

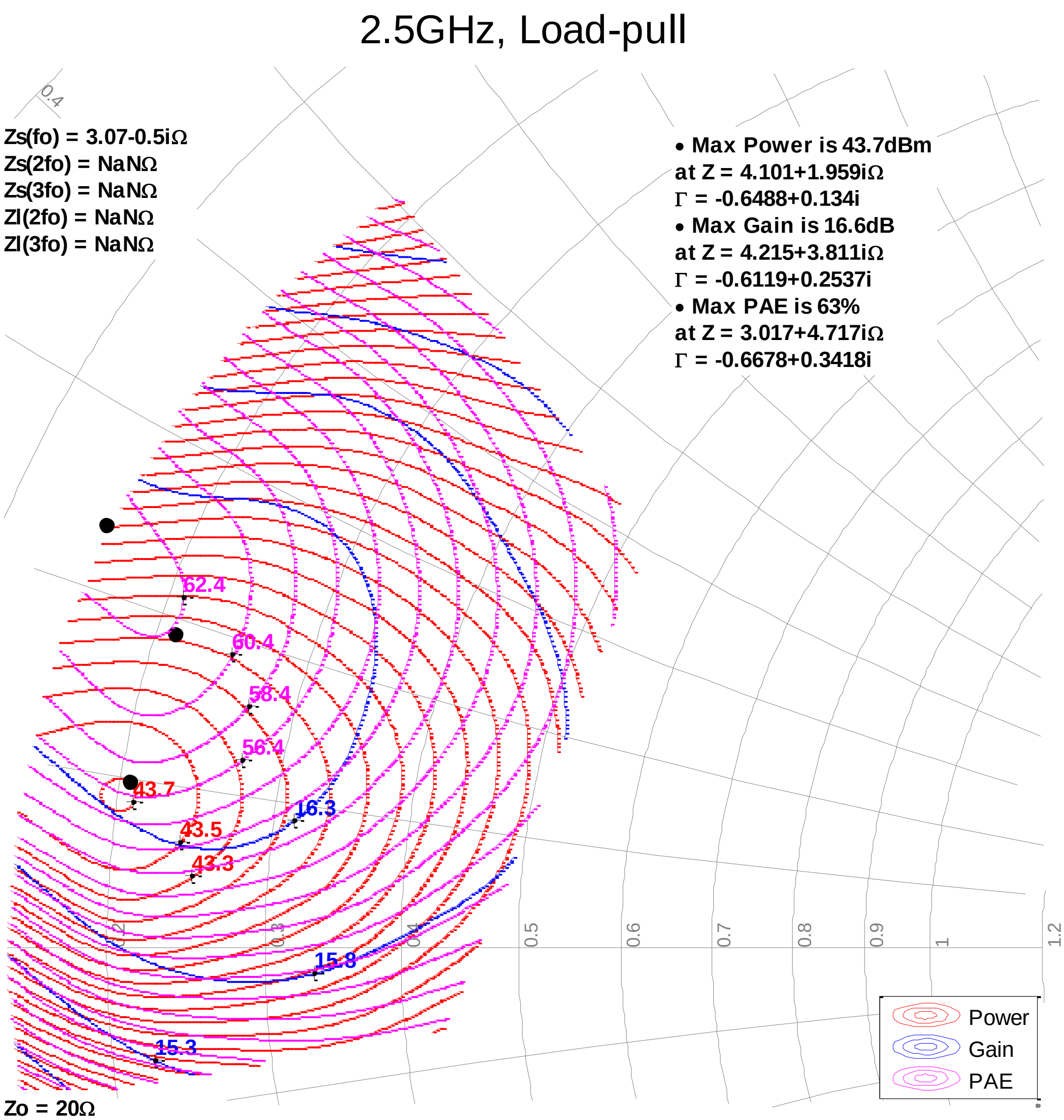


Model Load Pull Contours – CW (4, 5, 6)

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., CW, 1 dB compression referenced to peak gain.
5. See page 28 for load pull and source pull reference planes.
6. NaN means the impedances are undefined in load-pull system.



Model Load Pull Contours – CW (4, 5, 6)

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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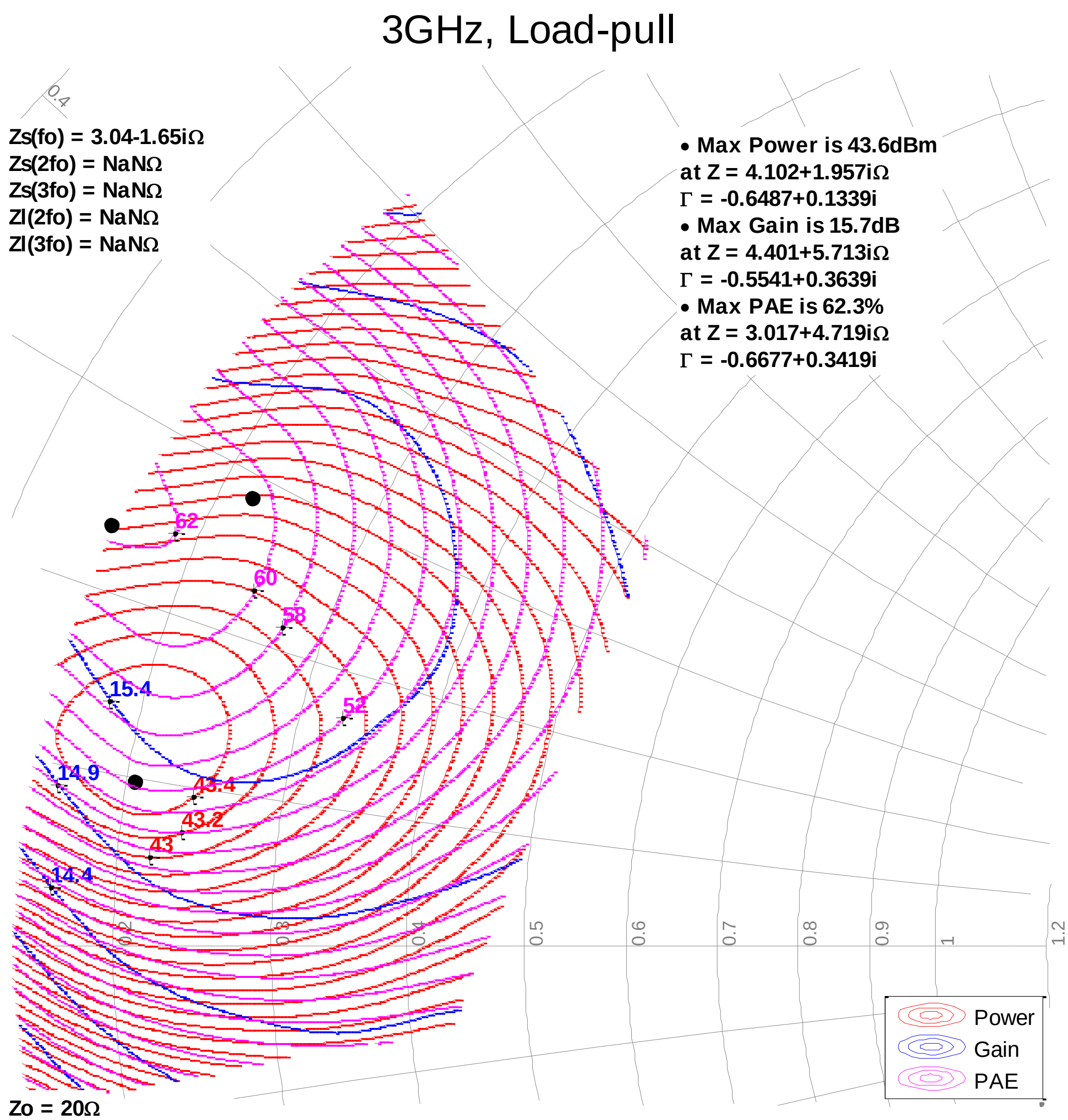

Model Load Pull Contours – CW (4, 5, 6)

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Notes:
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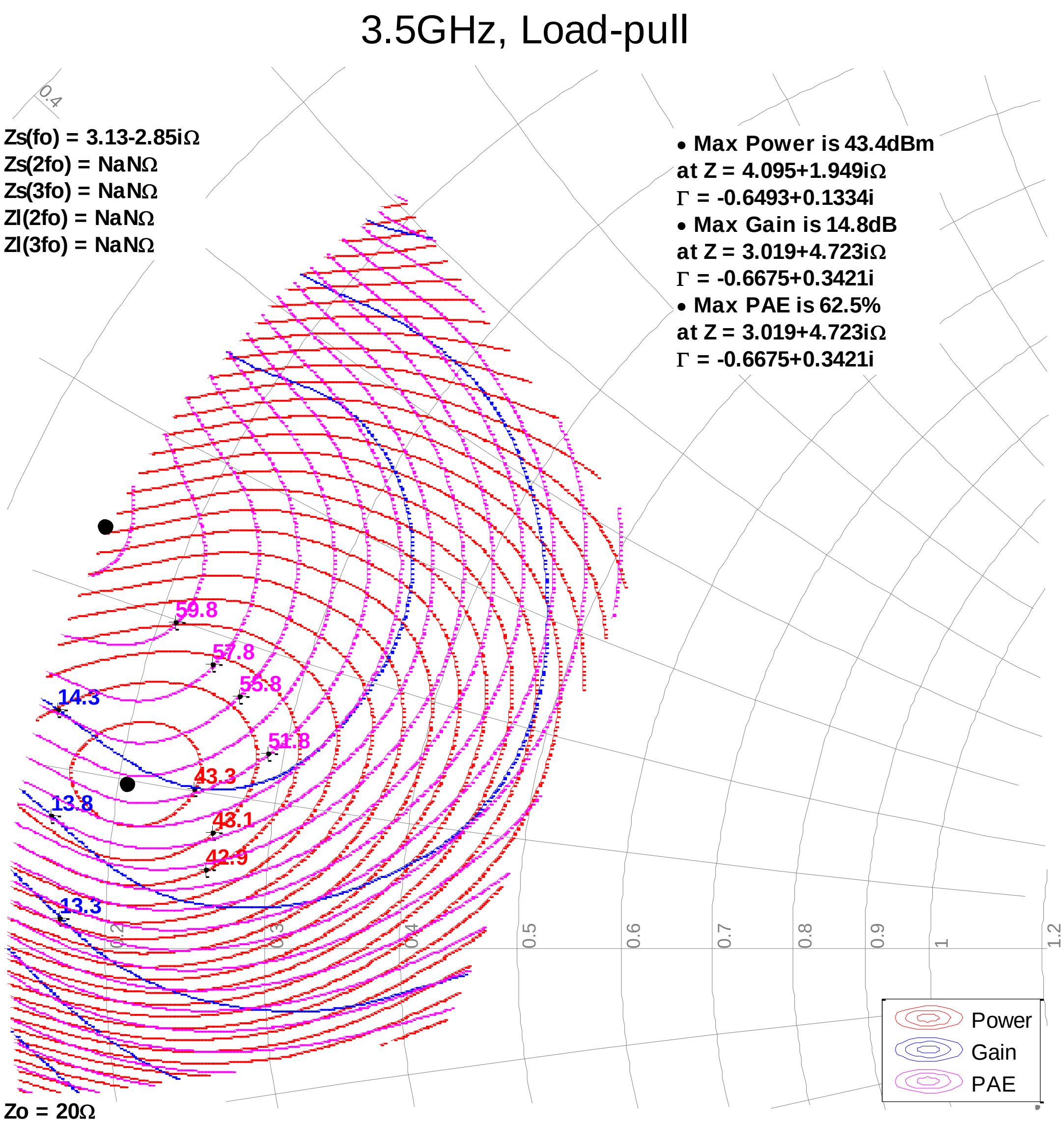
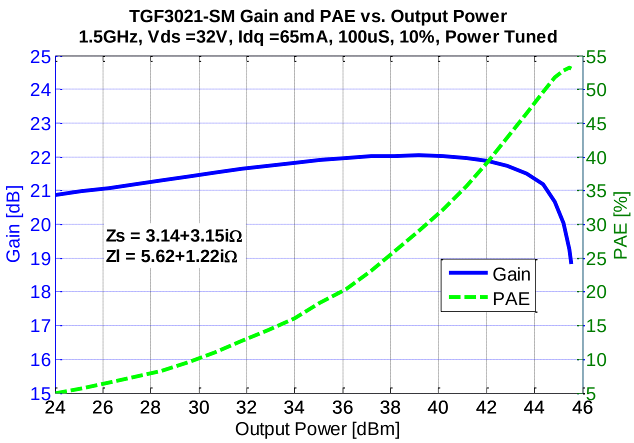
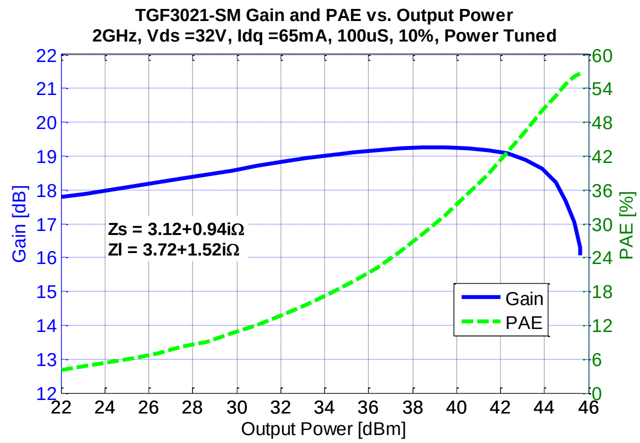
5. See page 28 for load pull and source pull reference planes.
6. NaN means the impedances are undefined in load-pull system.

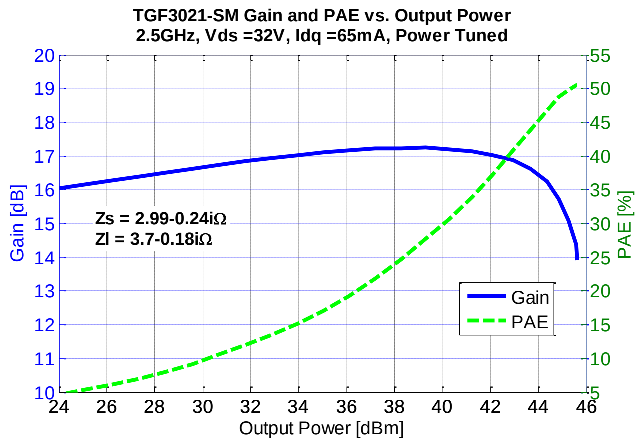


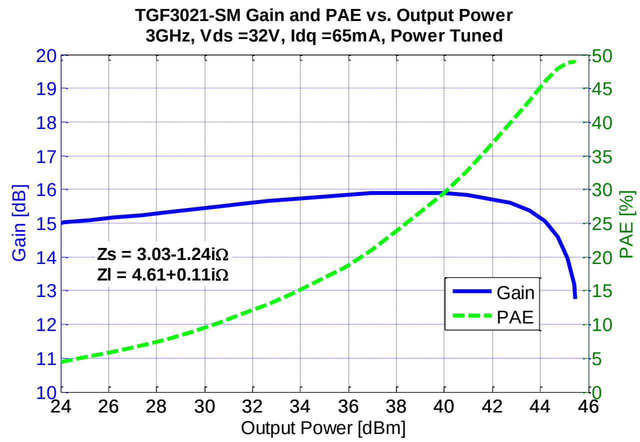
Typical Pulsed Performance – Power Tuned [1,2]

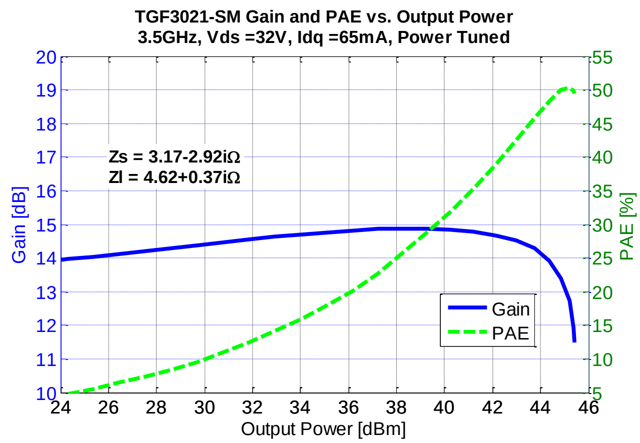
Notes:
1. Pulsed signal with 100 uS pulse width and 20% duty cycle
2. See page 28 for load pull and source pull reference planes where the performance was measured.

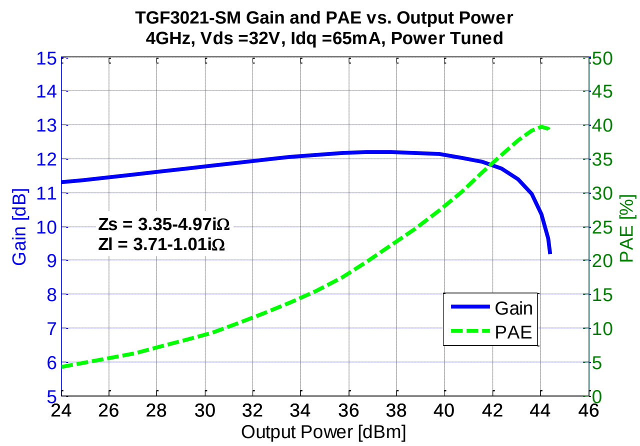






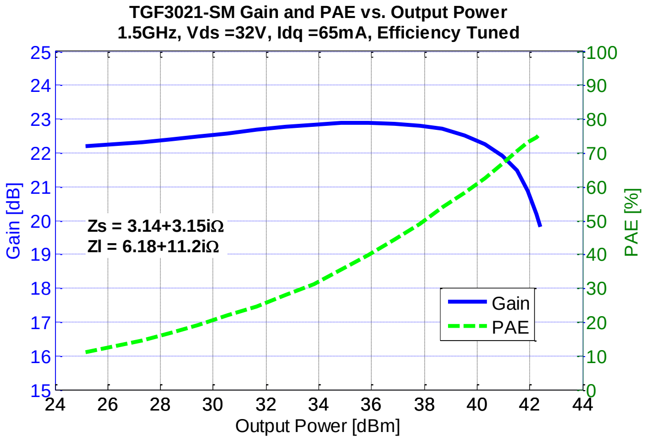


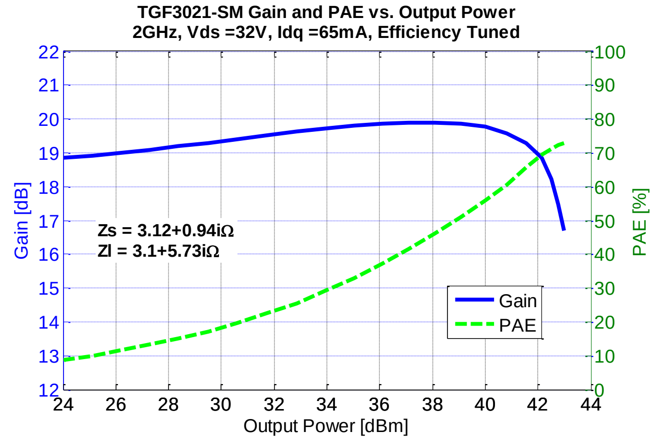


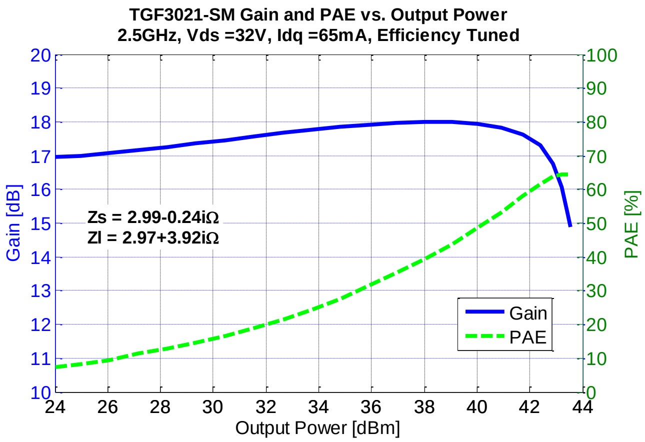


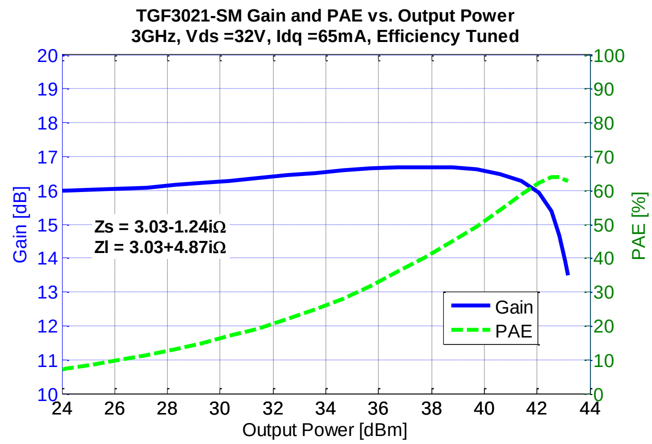
Typical Pulsed Performance – Efficiency Tuned [1,2]

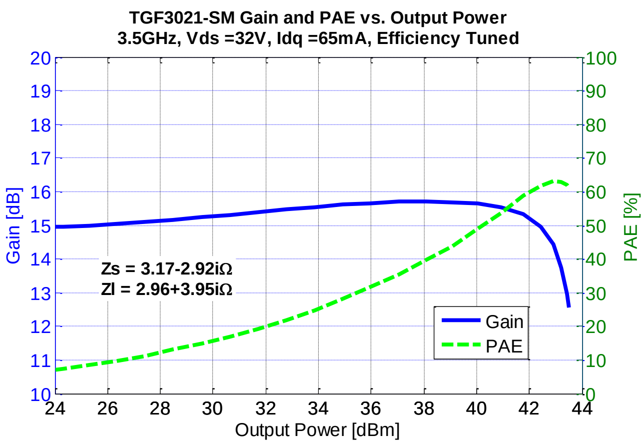
Notes:
1. Pulsed signal with 100 uS pulse width and 20% duty cycle
2. See page 28 for load pull and source pull reference planes where the performance was measured.

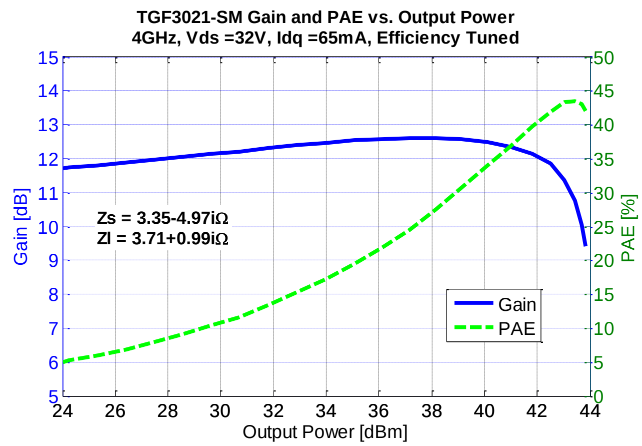






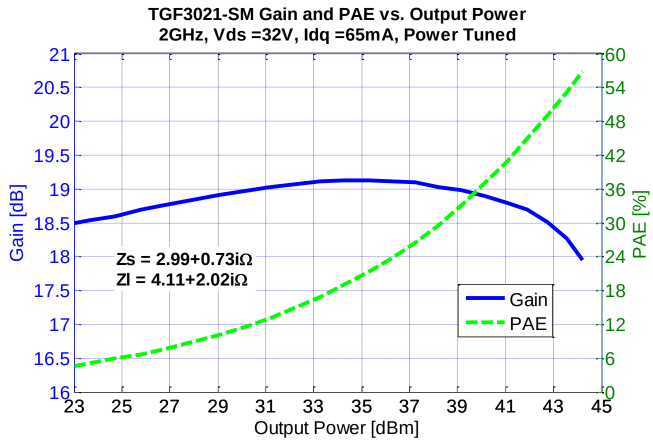


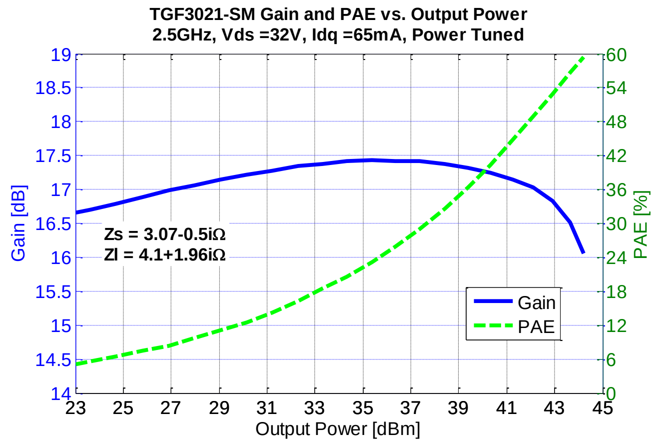


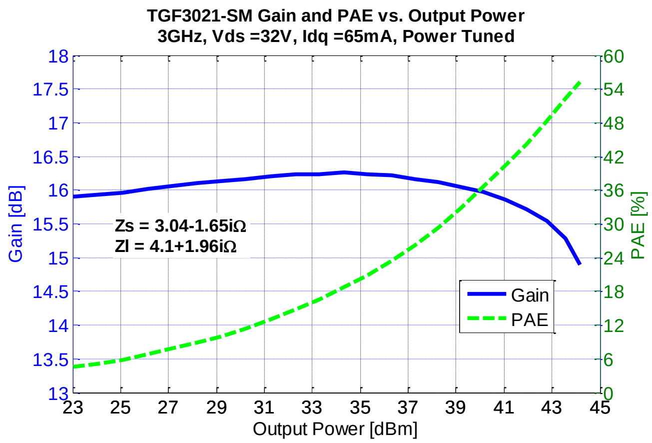


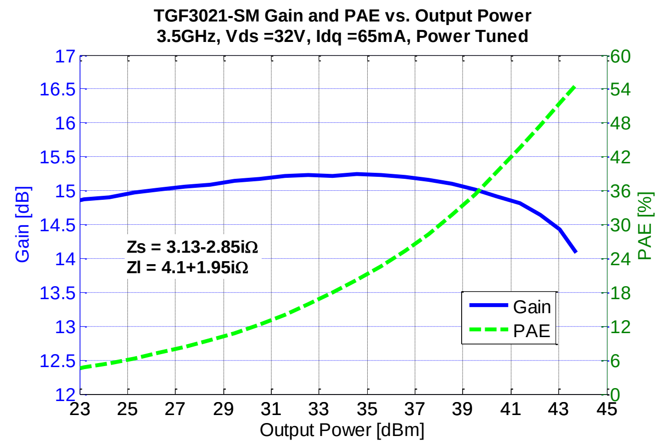
Typical CW Performance – Power Tuned [1, 2]

Notes:
1. CW signal
2. See page 28 for load pull and source pull reference planes where the performance was measured.



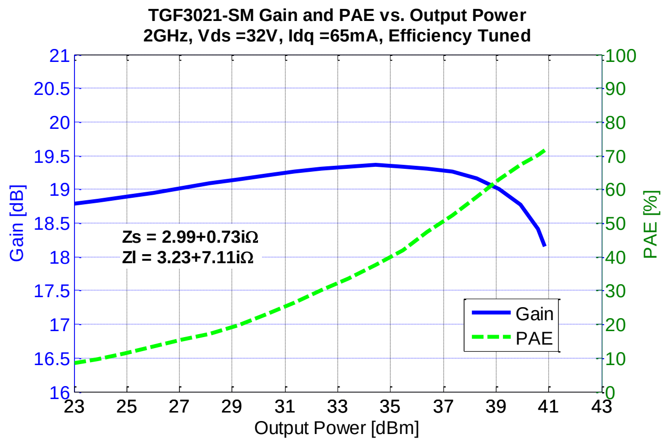


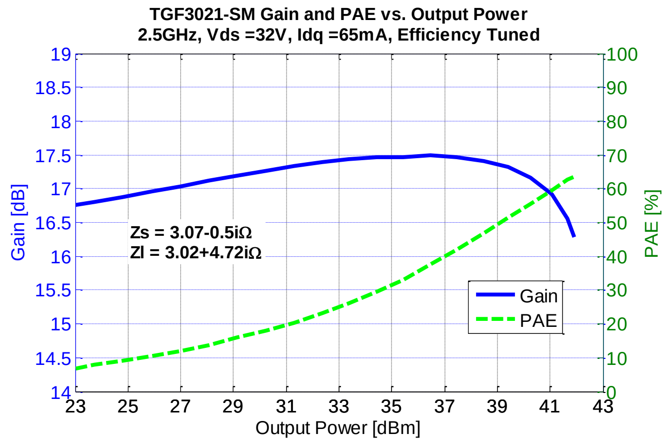


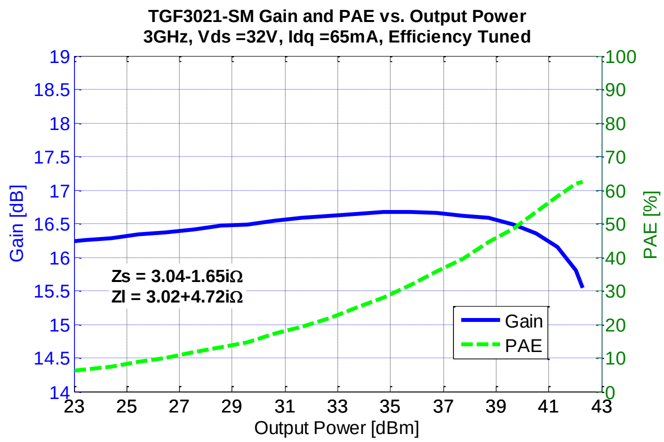


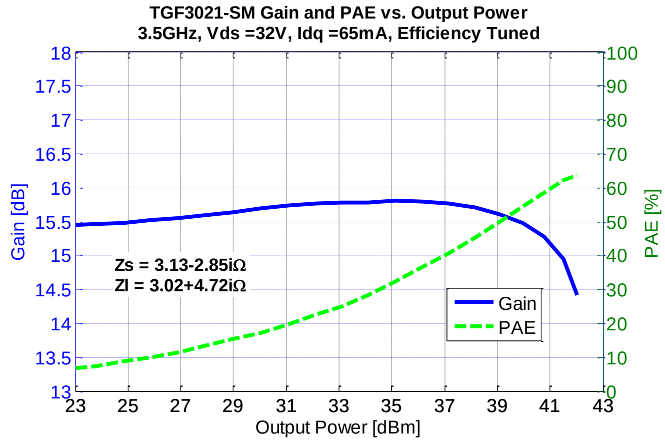
Typical CW Performance – Efficiency Tuned (1, 2)

Notes:
1. CW signal
2. See page 28 for load pull and source pull reference planes where the performance was measured.





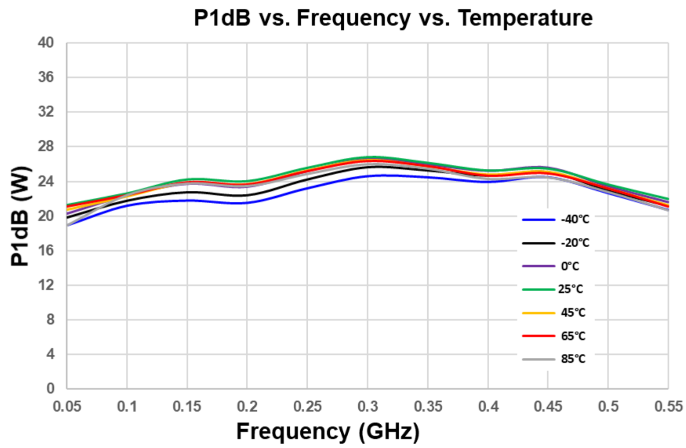


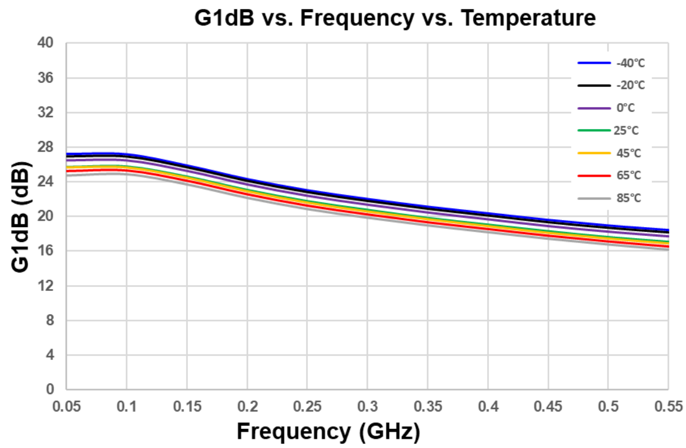


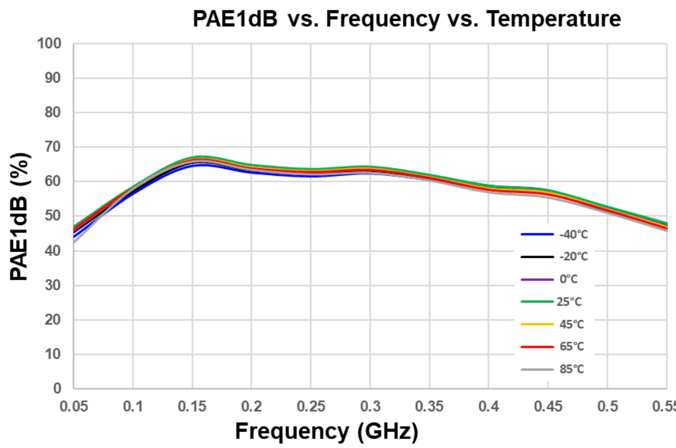
0.05 – 0.55 GHz EVB Performance Over Temperature (1, 2, 3)

Notes:

1. Performance measured on Qorvo's 0.05 – 0.55 GHz Evaluation Board
2. Test Conditions: V_{DS} = 32 V, I_{DQ} = 65 mA
3. Test Signal: CW



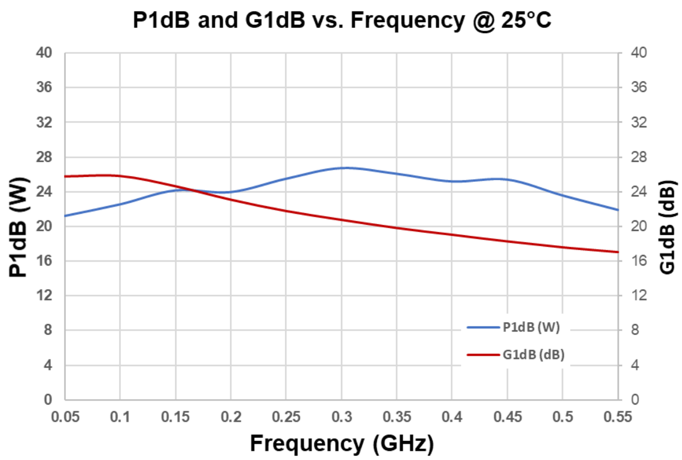


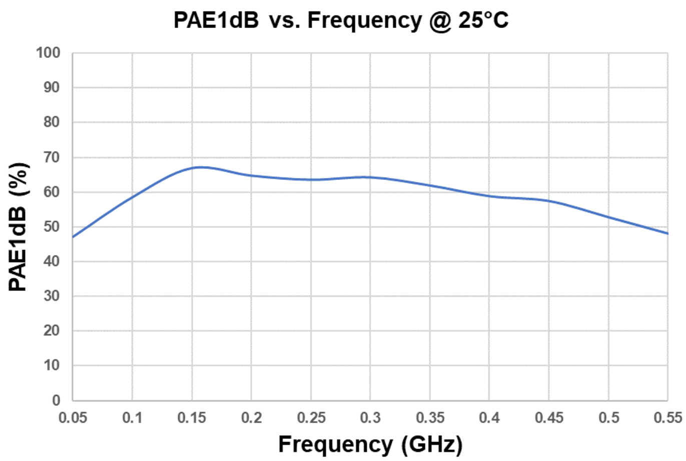


0.05 – 0.55 GHz EVB Performance At 25°C (1, 2, 3)

Notes:

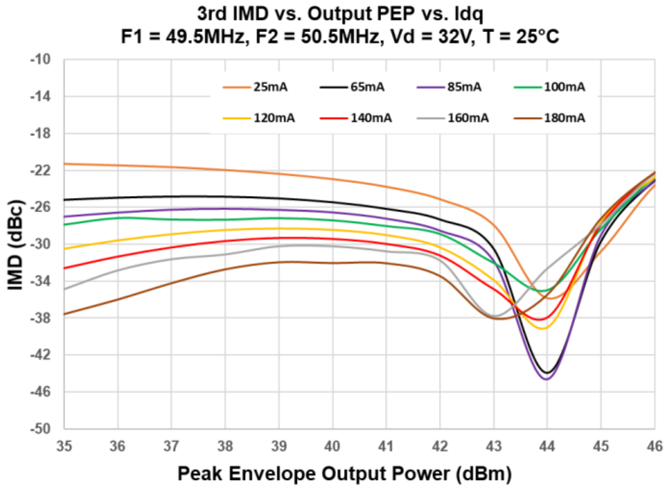
1. Performance measured on Qorvo's 0.05 – 0.55 GHz Evaluation Board
2. Test Conditions: V_{DS} = 32 V, I_{DQ} = 65 mA
3. Test Signal: CW

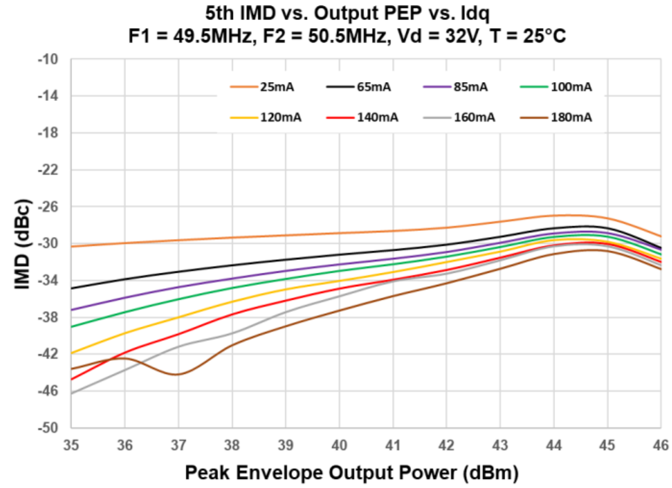


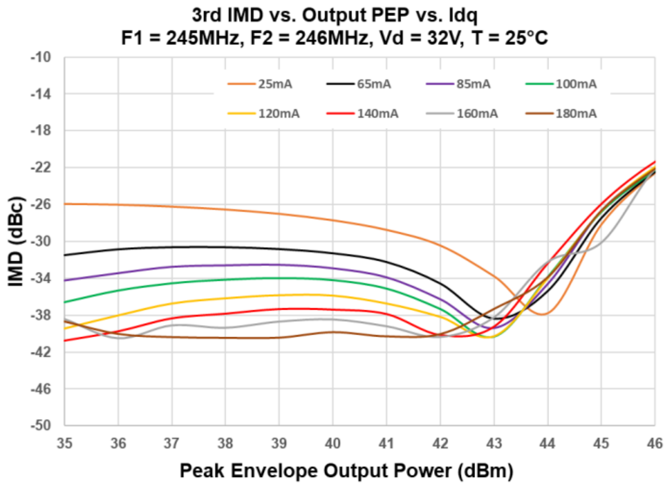


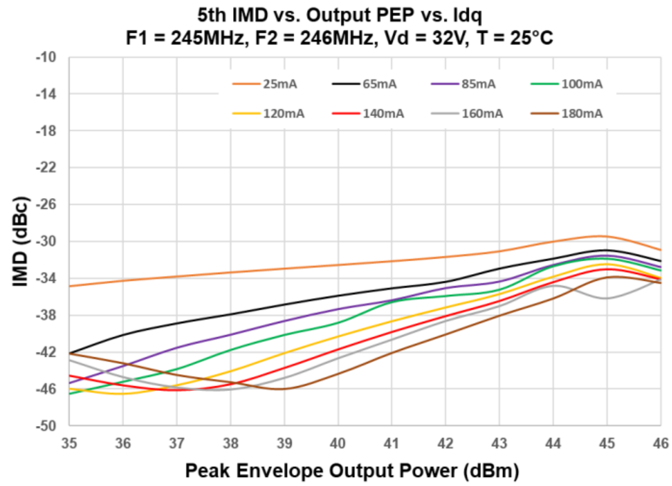
0.05 – 0.55 GHz EVB Performance - Two-Tone Measurements (1)

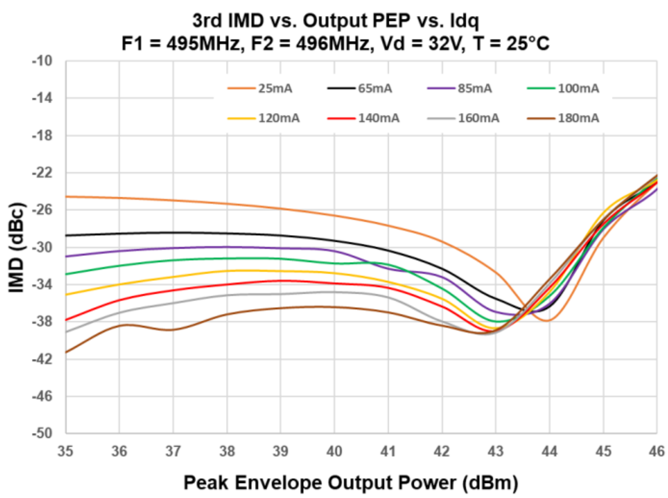
(1) Intermodulation Modulation Distortion products (IMD) are referenced to Output Peak Envelope Power (PEP), which is 6 dB above single-tone output power. Center frequency = 50 MHz, 245.5 MHz, 495.5 MHz, Tone Separation = 1 MHz, Temp = 25 °C.

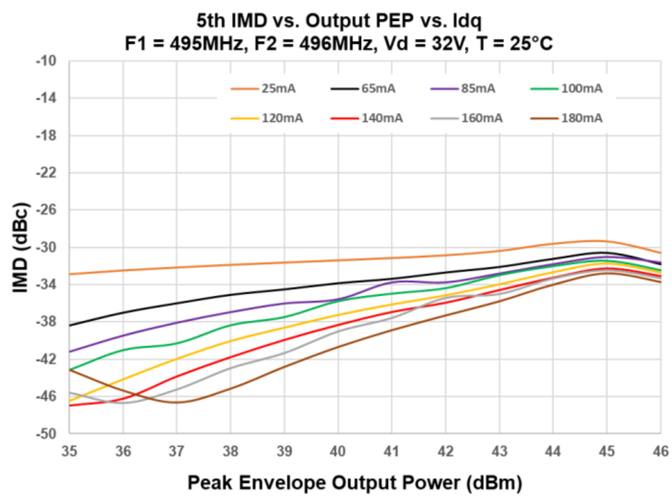




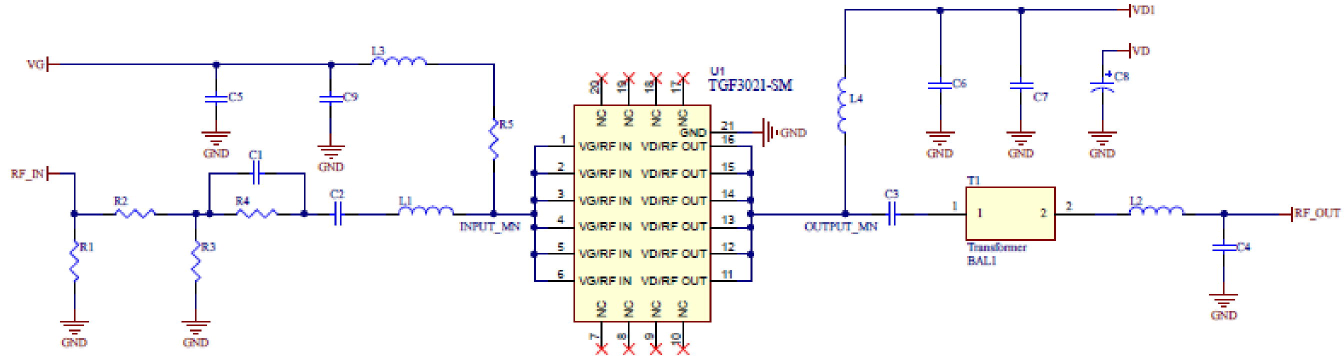








0.05 – 0.55 GHz EVB Schematic



Bias-up Procedure

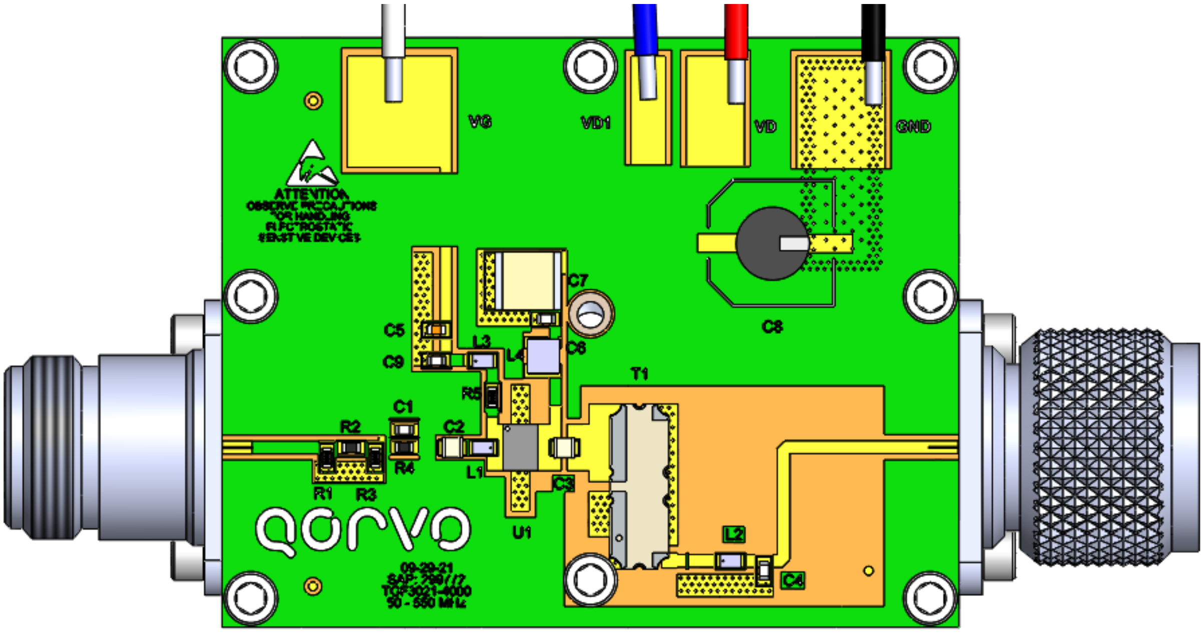
1. V_G set to -5 V.
2. V_D set to 32 V.
3. Adjust V_G more positive until quiescent I_D is 65 mA.
4. Apply RF signal.

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.

0.05 – 0.55 GHz EVB Layout

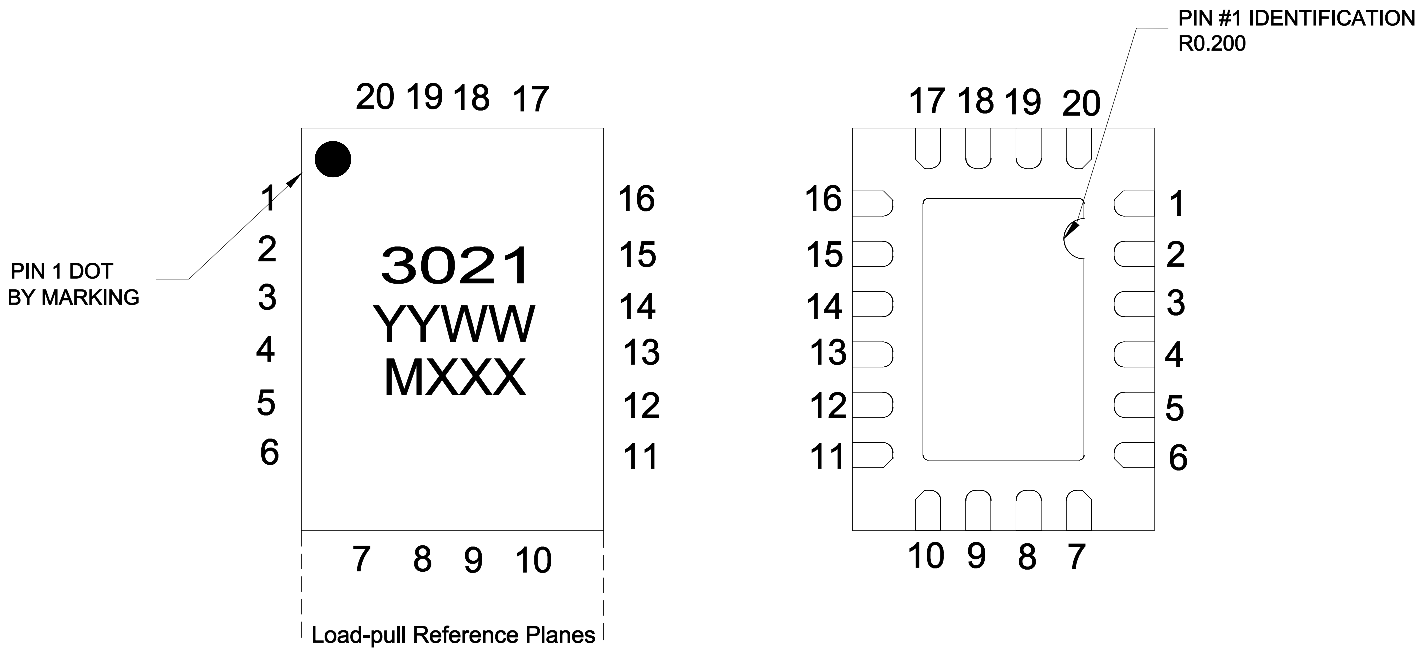
Top RF layer is 0.020” thick Rogers RO4350B, ε_r = 3.48. The pad pattern shown has been developed and tested for optimized assembly at Qorvo Semiconductor. The PCB land pattern has been developed to accommodate lead and package tolerances.



0.05 – 0.55 GHz EVB Bill of Materials

Reference Design	Value	Qty	Manufacturer	Part Number
R1, R3	430 Ω	2	Any	Generic 0603
R2	11 Ω	1	Any	Generic 0603
R4	24 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	1.5 pF	1	ATC	600S1R5AT250XT
C5	10 uF	1	Murata	GRM188R60J6ME47D
C6, C9	82 pF	1	ATC	600S820FT250XT
C7	10 uF	1	TDK	C5750X7R1H106K320KB
C8	220 uF	1	United Chemi-Con	EMVE500ADA221MJA0G
L1	10 nH	1	Coilcraft	0603HC-10NXJE
L2	6.8 nH	1	Coilcraft	0603HC-6N8XJE
L3	1000 nH	1	Coilcraft	0603LS-102XJ
L4	1100 nH	1	Coilcraft	1008AF-112XJ
T1	Transformer	1	Anaren	XT0010E15012S

Pin Layout



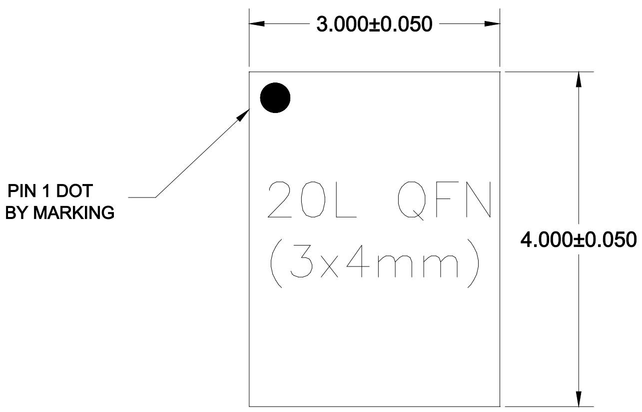
Pin Description

Pin	Symbol	Description
1 - 6	V_G / RF IN	Gate voltage / RF Input to be matched to 50 ohms; see EVB Layout on page 27 as an example.
11 - 16	V_D / RF OUT	Drain voltage / RF Output to be matched to 50 ohms; see EVB Layout on page 27 as an example.
7 – 10, 17 - 20	NC	Not connected
Back side	Source	Source connected to ground

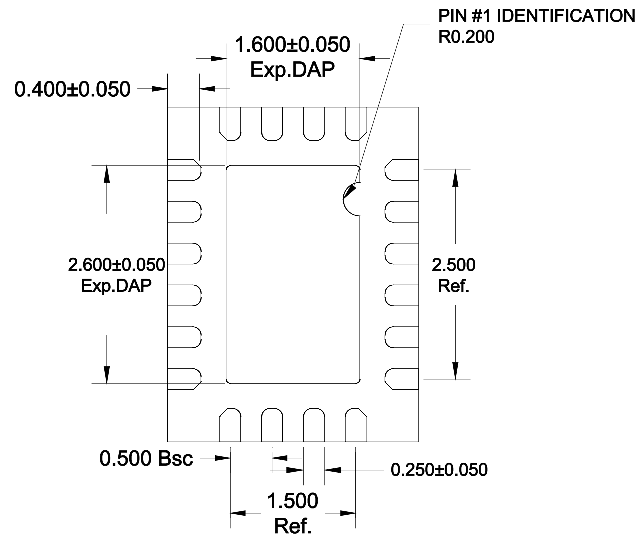
Notes:
Thermal resistance measured to back side of package
The TGF3021-SM will be marked with the “3021” designator and a lot code marked below the part designator The “YY” represents the last two digits of the calendar year the part was manufactured, the “WW” is the work week of the assembly lot start,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

Mechanical Information

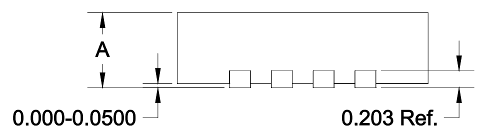
All dimensions are in millimeters.



TOP VIEW



BOTTOM VIEW



SIDE VIEW

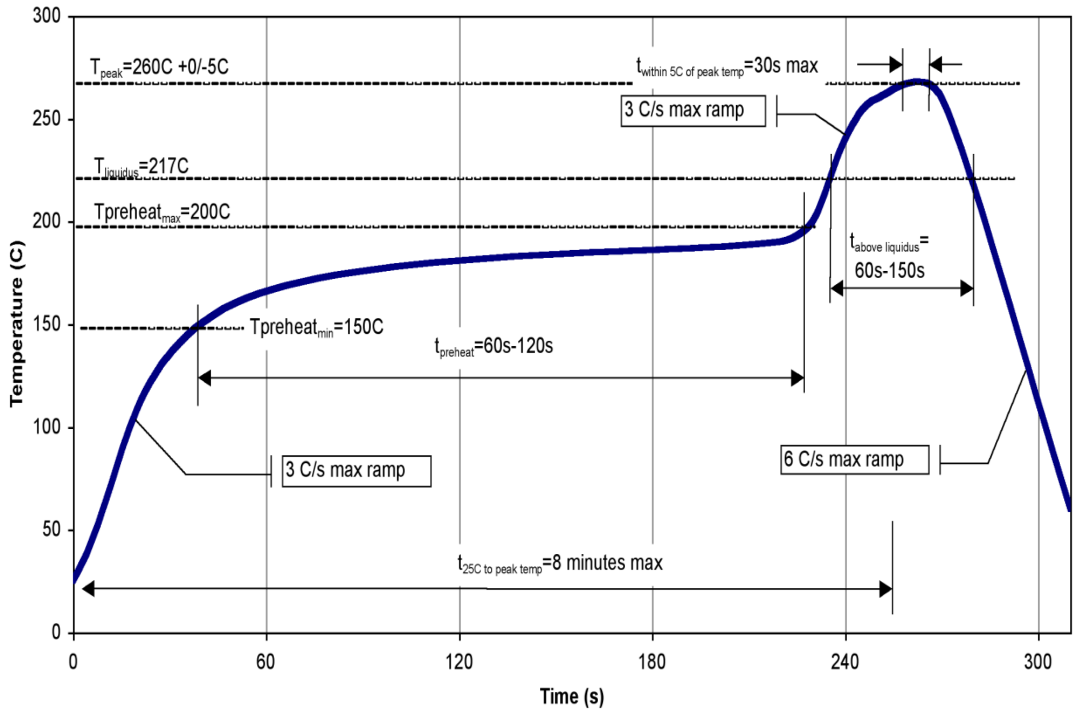
		QFN
A	MAX.	0.900
	NOM.	0.850
	MIN.	0.800

Note:

Unless otherwise noted, all dimension tolerances are +/-0.127 mm.

This package is lead-free/RoHS-compliant. The plating material on the leads is NiPdAu. It is compatible with both lead-free (maximum 260 °C reflow temperature) and tin-lead (maximum 245°C reflow temperature) soldering processes.

Recommended Soldering Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1B (600V)	JEDEC Standard JESD22-A114
ESD – Charged Device Model (CDM)	Class C3 (1000V)	ANSI/ESDA/JEDEC Standard JS-002
MSL – Moisture Sensitivity Level	MSL3	IPC/JEDEC Standard J-STD-020

Caution!
ESD-Sensitive Device

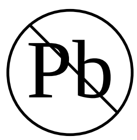
Solderability

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

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 ($C_{15}H_{12}Br_{4}0_{2}$) 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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