

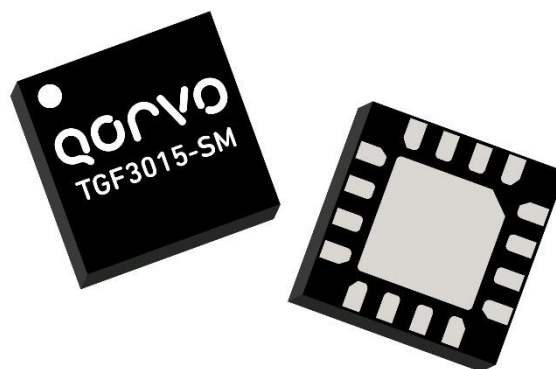
### Product Overview

The Qorvo TGF3015-SM is a 10W ( $P_{3dB}$ ), 50 $\Omega$ -input matched discrete GaN on SiC HEMT which operates from 30 MHz to 3.0 GHz. The integrated input matching network enables wideband gain and power performance, while the output can be matched on board to optimize power and efficiency for any region within the band.

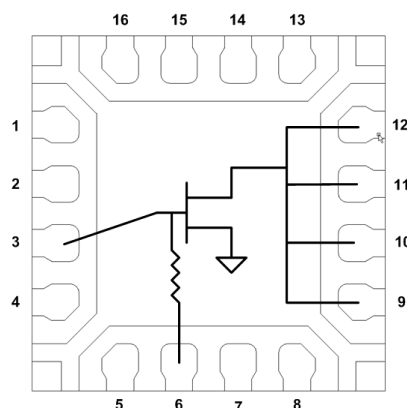
The device is housed in an industry-standard 3 x 3 mm package that saves real estate in space-constrained handheld radios.

Lead-free and ROHS compliant

Evaluation boards are available upon request.



### Functional Block Diagram



### Pin Configuration

Pin No.	Label
9 - 12	$V_D$ / RF OUT
3	$V_G$ / RF IN
6	Off-chip Shunt Cap for Low-Frequency Gain
Back side	Source

### Key Features

- Frequency: 30 MHz to 3.0 GHz
- Output Power ( $P_{3dB}$ ): 11 W at 2.4 GHz
- Linear Gain: 17.1 dB at 2.4 GHz
- Typical PAE<sub>3dB</sub>: 62.7% at 2.4 GHz
- Operating Voltage: 32 V
- Low thermal resistance package
- CW and Pulse capable
- 3 x 3 mm package

### Applications

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

### Ordering info

Part No.	Description
TGF3015-SM	QFN Packaged Part
TGF3015-SMEVB1	1 – 3 GHz EVB

## Absolute Maximum Ratings <sup>1, 2, 3</sup>

Parameter	Rating	Units
Breakdown Voltage, $BV_{DS}$	100	V
Gate Voltage Range, $V_G$	-50 to 0	V
Drain Current, $I_{D_{MAX}}$	1.5	A
Gate Current Range, $I_G$	-2.5 to 4.2	mA
Power Dissipation, Pulsed, $P_{DISS}^2$	15	W
RF Input Power, CW, $T = 25^\circ\text{C}$ ( $P_{IN}$ )	27.5	dBm
Mounting Temperature (30 Seconds)	320	$^\circ\text{C}$
Storage Temperature	-40 to +150	$^\circ\text{C}$

### Notes:

- Operation of this device outside the parameter ranges given above may cause permanent damage
- Pulsed, 100us PW, 20% DC, Package base at 85  $^\circ\text{C}$
- Pulsed, 100us PW, 20% DC,  $T = 25^\circ\text{C}$

## Recommended Operating Conditions <sup>1</sup>

Parameter	Min	Typ	Max	Units
Gate Voltage, $V_G$	–	-2.7	–	V
Drain Voltage Range, $V_D$		32		V
Drain Bias Current, $I_{DQ}$	–	50	–	mA

### Notes:

- Electrical performance is measured under conditions noted in the electrical specifications table. Specifications are not guaranteed over all recommended operating conditions

## RF Characterization – Load Pull Performance at 1.0 GHz <sup>1</sup>

Parameter	Min	Typ	Max	Units
Linear Gain, $G_{LIN}$	–	16.2	–	dB
Output Power at 3dB compression point, $P_{3dB}$	–	40.2	–	dBm
Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned, $PAE_{3dB}$	–	70.9	–	%
Gain at 3dB compression point, $G_{3dB}$	–	13.2	–	dB

### Notes:

- $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ ,  $T_A = 25^\circ\text{C}$ , Pulse Width = 100 us, Duty Cycle = 20%

## RF Characterization – Load Pull Performance at 2.0 GHz <sup>1</sup>

Parameter	Min	Typ	Max	Units
Linear Gain, $G_{LIN}$	–	16.5	–	dB
Output Power at 3dB compression point, $P_{3dB}$	–	40.6	–	dBm
Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned, $PAE_{3dB}$	–	61.7	–	%
Gain at 3dB compression point, $G_{3dB}$	–	13.5	–	dB

### Notes:

- $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ ,  $T_A = 25^\circ\text{C}$ , Pulse Width = 100 us, Duty Cycle = 20%

## RF Characterization – Load Pull Performance at 2.4 GHz <sup>1</sup>

Parameter	Min	Typ	Max	Units
Linear Gain, $G_{LIN}$	–	17.1	–	dB
Output Power at 3 dB Gain Compression, Power Tuned, $P_{3dB}$	–	40.4	–	dBm
Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned, $PAE_{3dB}$	–	62.7	–	%
Gain at 3dB compression point, Power Tuned, $G_{3dB}$	–	14.1	–	dB

Notes:

- $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ ,  $T_A = 25\text{ °C}$ , Pulse Width = 100 us, Duty Cycle = 20%

## RF Characterization – Load Pull Performance at 2.7 GHz <sup>1</sup>

Parameter	Min	Typ	Max	Units
Linear Gain, $G_{LIN}$	–	16.3	–	dB
Output Power at 3 dB Gain Compression, Power Tuned, $P_{3dB}$	–	40.5	–	dBm
Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned, $PAE_{3dB}$	–	63.7	–	%
Gain at 3dB compression point, Power Tuned, $G_{3dB}$	–	13.3	–	dB

Notes:

- $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ ,  $T_A = 25\text{ °C}$ , Pulse Width = 100 us, Duty Cycle = 20%

## RF Characterization – Load Pull Performance at 3.0 GHz <sup>1</sup>

Parameter	Min	Typ	Max	Units
Linear Gain, $G_{LIN}$	–	15.4	–	dB
Output Power at 3dB compression point, Power Tuned, $P_{3dB}$	–	40.5	–	dBm
Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned, $PAE_{3dB}$	–	58.6	–	%
Gain at 3dB compression point, Power Tuned, $G_{3dB}$	–	12.4	–	dB

Notes:

- $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ ,  $T_A = 25\text{ °C}$ , Pulse Width = 100 us, Duty Cycle = 20%

## RF Characterization – EVB Performance at 2.4 GHz <sup>1</sup>

Parameter	Min	Typ	Max	Units
Linear Gain, $G_{LIN}$	–	16.9	–	dB
Output Power at 3dB compression point, P3dB	–	40.1	–	dBm
Drain Efficiency at 3dB compression point, DEFF3dB	–	56.8	–	%
Gain at 3dB compression point, G3dB	–	13.9	–	dB
Gate Leakage $V_D = +10\text{ V}$ , $V_G = -3.7\text{ V}$	-2.8	–	–	mA

Notes:

1.  $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ ,  $T_A = 25\text{ }^\circ\text{C}$ , Pulse Width = 100 us, Duty Cycle = 20%, measured on 1.0 GHz to 3.0 GHz Evaluation Board

## RF Characterization – Mismatch Ruggedness at 3.0 GHz <sup>1, 2, 3</sup>

Symbol	Parameter	dB Compression	Typical
VSWR	Impedance Mismatch Ruggedness	3	10:1

Notes:

1. Test conditions unless otherwise noted:  $T_A = 25\text{ }^\circ\text{C}$ ,  $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$
2. Input drive power is determined at pulsed 3dB compression under matched condition at EVB output connector
3. Pulse: 100us, 20% Duty cycle

## Thermal and Reliability Information – CW <sup>1, 2</sup>

Parameter	Test Conditions	Value	Units
Thermal Resistance, IR ( $\theta_{JC}$ )	Vds = 32V, Idq = 50mA 85 °C Case	7.76	°C/W
Channel Temperature, IR ( $T_{CH}$ )	2.5 W Pdiss, CW	104.40	°C
Thermal Resistance, IR ( $\theta_{JC}$ )	Vds = 32V, Idq = 50mA 85 °C Case	8.37	°C/W
Channel Temperature, IR ( $T_{CH}$ )	5 W Pdiss, CW	126.85	°C
Thermal Resistance, IR ( $\theta_{JC}$ )	Vds = 32V, Idq = 50mA 85 °C Case	8.73	°C/W
Channel Temperature, IR ( $T_{CH}$ )	7.5 W Pdiss, CW	150.44	°C
Thermal Resistance, IR ( $\theta_{JC}$ )	Vds = 32V, Idq = 50mA 85 °C Case	9.13	°C/W
Channel Temperature, IR ( $T_{CH}$ )	10 W Pdiss, CW	176.34	°C
Thermal Resistance, IR ( $\theta_{JC}$ )	Vds = 32V, Idq = 50mA 85 °C Case	9.67	°C/W
Channel Temperature, IR ( $T_{CH}$ )	12.5 W Pdiss, CW	205.87	°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 <sup>1, 2</sup>

Parameter	Test Conditions	Value	Units
Thermal Resistance, IR ( $\theta_{JC}$ )	Vds = 32V, Idq = 50mA 85 °C Case	5.68	°C/W
Channel Temperature, IR ( $T_{CH}$ )	10 W Pdiss, 100uS PW, 20%	141.77	°C
Thermal Resistance, IR ( $\theta_{JC}$ )	Vds = 32V, Idq = 50mA 85 °C Case	5.77	°C/W
Channel Temperature, IR ( $T_{CH}$ )	12.5 W Pdiss, 100uS PW, 20%	157.08	°C
Thermal Resistance, IR ( $\theta_{JC}$ )	Vds = 32V, Idq = 50mA 85 °C Case	5.86	°C/W
Channel Temperature, IR ( $T_{CH}$ )	15 W Pdiss, 100uS PW, 20%	172.90	°C

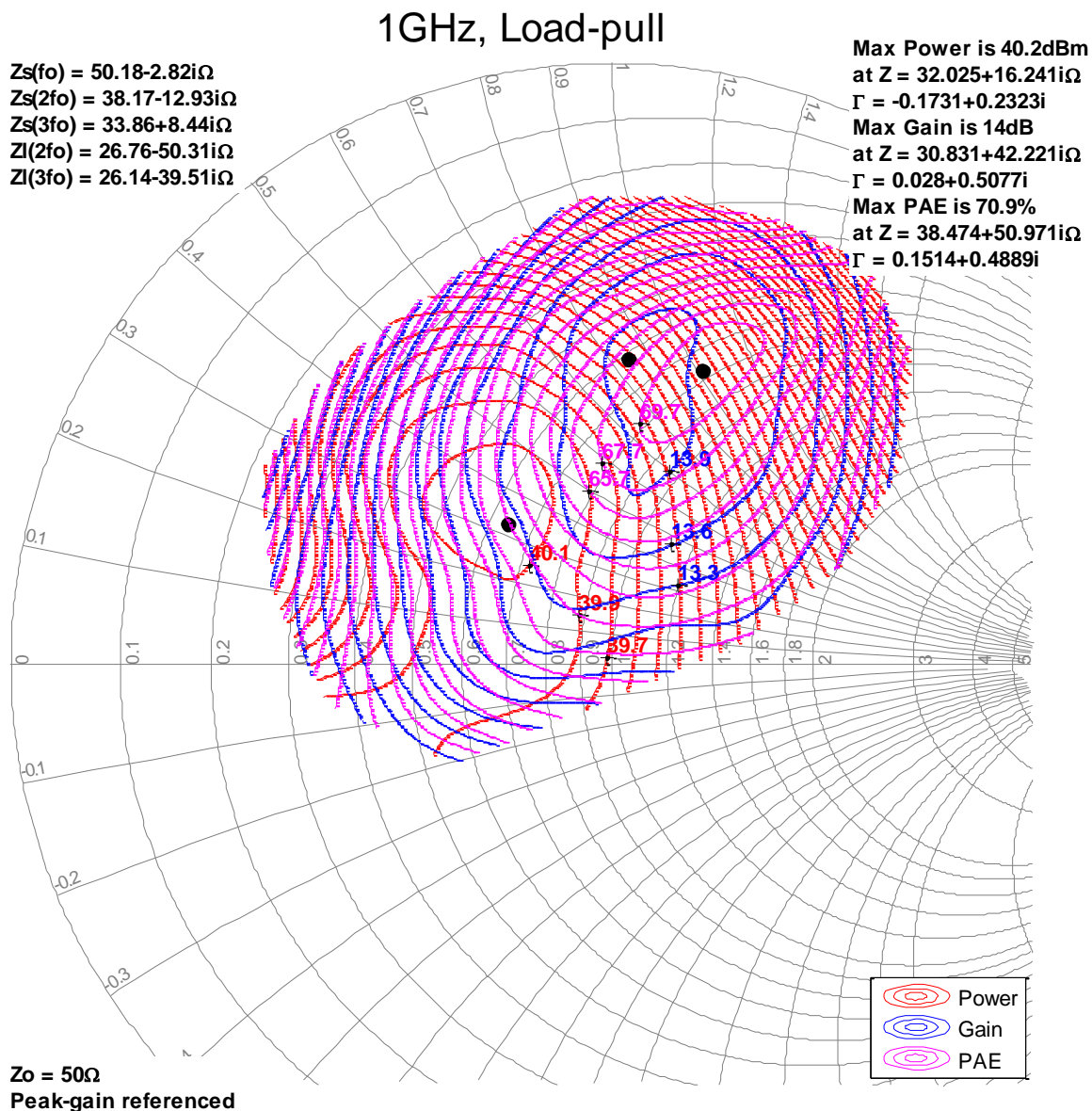
Notes:

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

## Load Pull Contours 1, 2, 3

Notes:

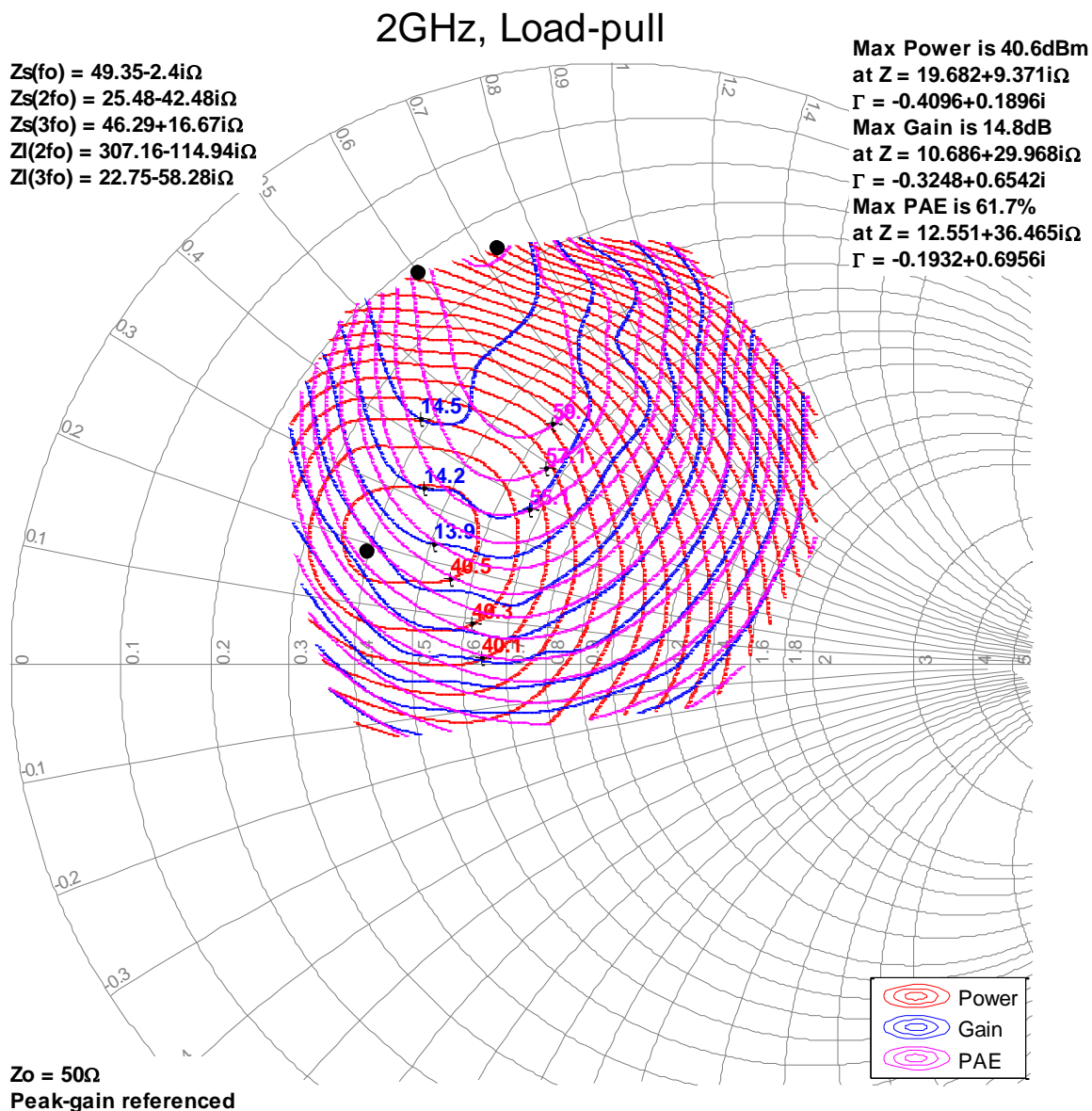
1. Test Conditions:  $V_D = 32$  V,  $I_{DQ} = 50$  mA, 100 us Pulse Width, 20% Duty Cycle.
2. 3dB Compression referenced at peak gain.
3. See "Pin Configuration and Description" for load pull and source pull reference planes.



## Load Pull Contours 1, 2, 3

Notes:

1. Test Conditions:  $V_D = 32$  V,  $I_{DQ} = 50$  mA, 100 us Pulse Width, 20% Duty Cycle.
2. 3dB Compression referenced at peak gain.
3. See "Pin Configuration and Description" for load pull and source pull reference planes.





## Load Pull Contours 1, 2, 3

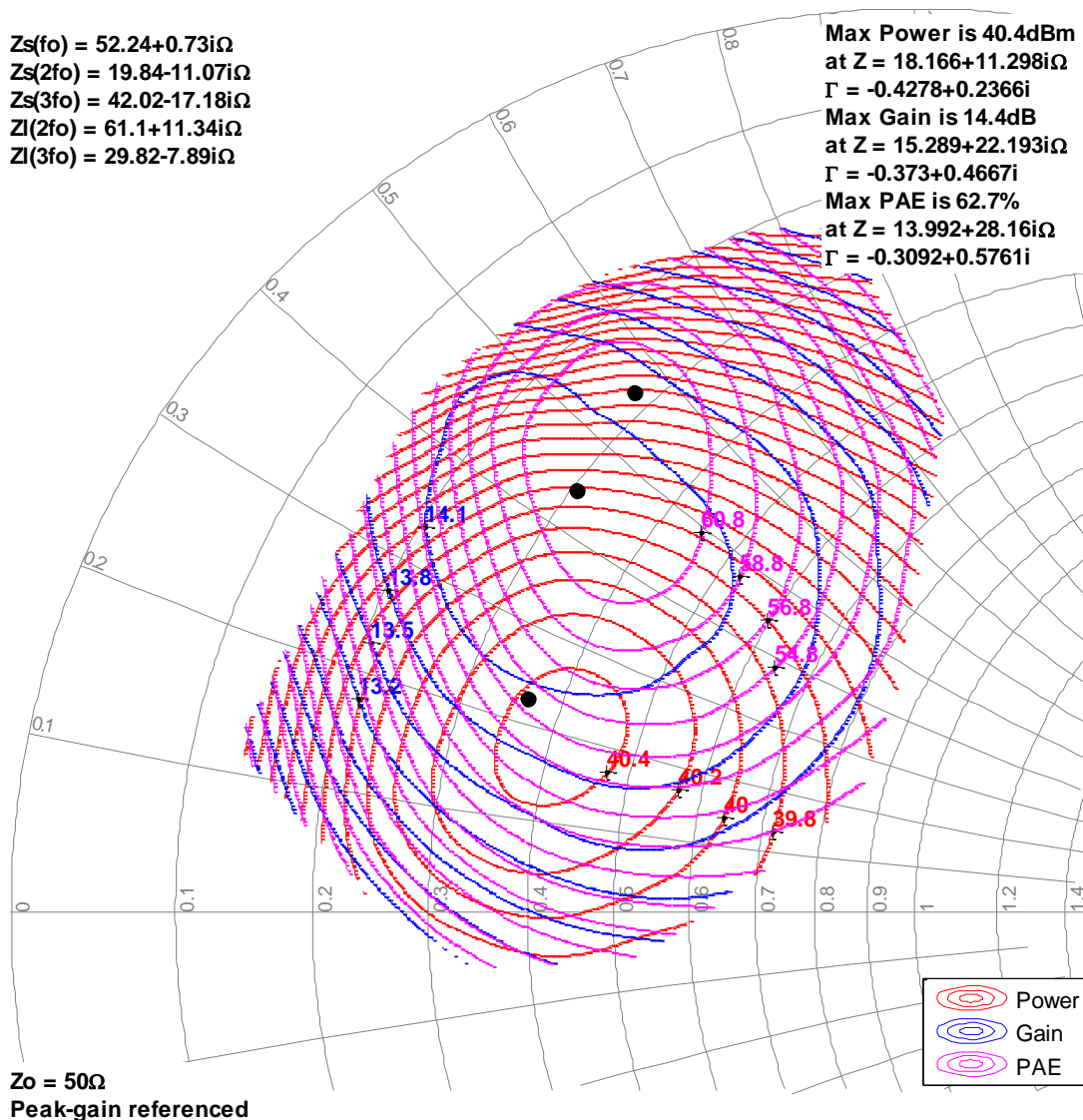
Notes:

1. Test Conditions:  $V_D = 32$  V,  $I_{DQ} = 50$  mA, 100 us Pulse Width, 20% Duty Cycle.
2. 3dB Compression referenced at peak gain.
3. See "Pin Configuration and Description" for load pull and source pull reference planes.

### 2.4GHz, Load-pull

$Z_s(f_0) = 52.24 + 0.73i\Omega$   
 $Z_s(2f_0) = 19.84 - 11.07i\Omega$   
 $Z_s(3f_0) = 42.02 - 17.18i\Omega$   
 $Z_l(2f_0) = 61.1 + 11.34i\Omega$   
 $Z_l(3f_0) = 29.82 - 7.89i\Omega$

**Max Power is 40.4dBm**  
**at  $Z = 18.166 + 11.298i\Omega$**   
 $\Gamma = -0.4278 + 0.2366i$   
**Max Gain is 14.4dB**  
**at  $Z = 15.289 + 22.193i\Omega$**   
 $\Gamma = -0.373 + 0.4667i$   
**Max PAE is 62.7%**  
**at  $Z = 13.992 + 28.16i\Omega$**   
 $\Gamma = -0.3092 + 0.5761i$





## Load Pull Contours <sup>1, 2, 3</sup>

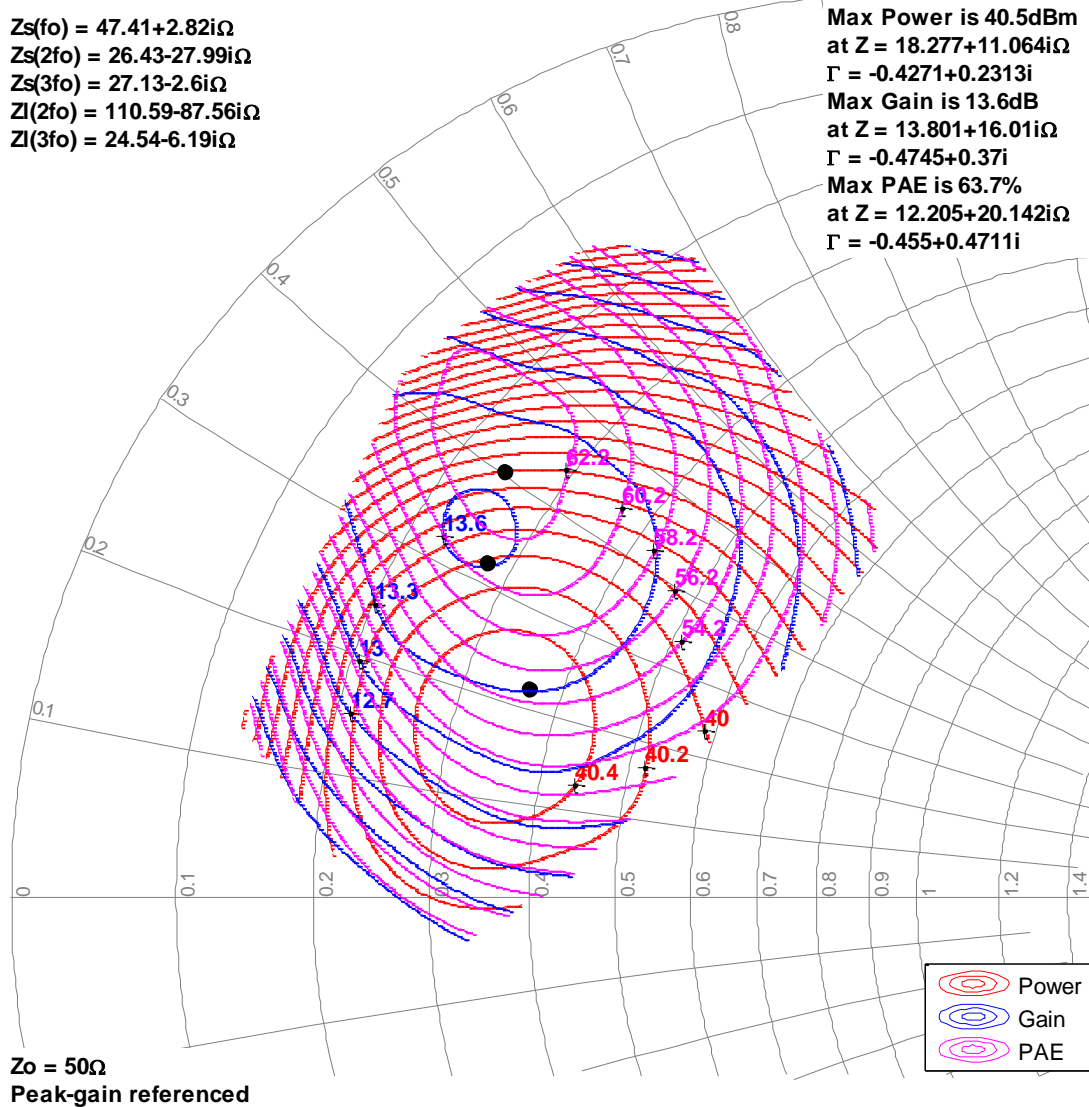
Notes:

1. Test Conditions:  $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ , 100  $\mu\text{s}$  Pulse Width, 20% Duty Cycle.
2. 3dB Compression referenced at peak gain.
3. See "Pin Configuration and Description" for load pull and source pull reference planes.

### 2.7GHz, Load-pull

$Z_s(f_0) = 47.41 + 2.82i\Omega$   
 $Z_s(2f_0) = 26.43 - 27.99i\Omega$   
 $Z_s(3f_0) = 27.13 - 2.6i\Omega$   
 $Z_l(2f_0) = 110.59 - 87.56i\Omega$   
 $Z_l(3f_0) = 24.54 - 6.19i\Omega$

**Max Power is 40.5dBm**  
**at  $Z = 18.277 + 11.064i\Omega$**   
 $\Gamma = -0.4271 + 0.2313i$   
**Max Gain is 13.6dB**  
**at  $Z = 13.801 + 16.01i\Omega$**   
 $\Gamma = -0.4745 + 0.37i$   
**Max PAE is 63.7%**  
**at  $Z = 12.205 + 20.142i\Omega$**   
 $\Gamma = -0.455 + 0.4711i$



### Load Pull Contours 1, 2, 3

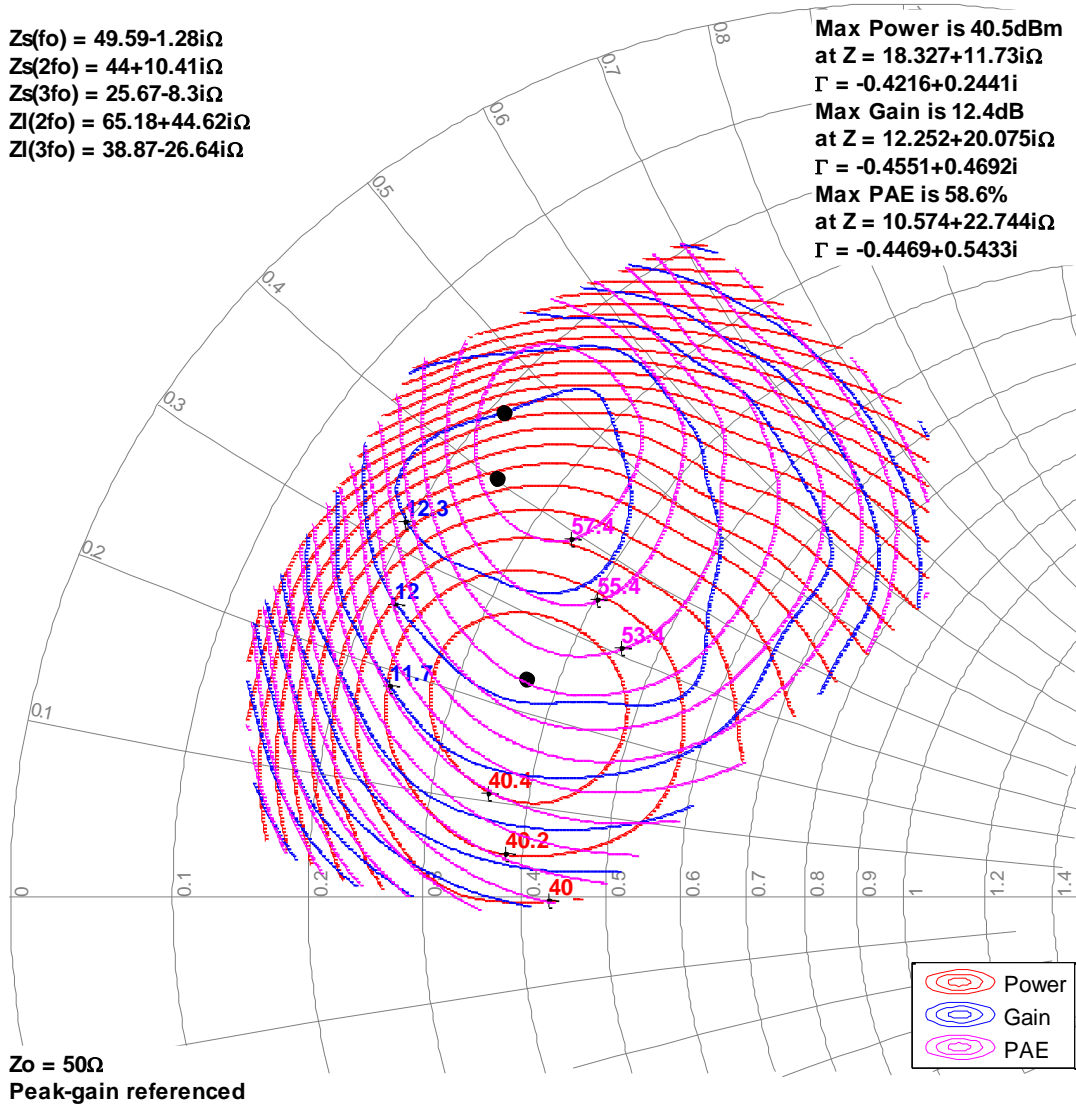
Notes:

1. Test Conditions:  $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ , 100 us Pulse Width, 20% Duty Cycle.
2. 3dB Compression referenced at peak gain.
3. See "Pin Configuration and Description" for load pull and source pull reference planes.

### 3GHz, Load-pull

$Z_s(f_0) = 49.59 - 1.28i\Omega$   
 $Z_s(2f_0) = 44 + 10.41i\Omega$   
 $Z_s(3f_0) = 25.67 - 8.3i\Omega$   
 $Z_l(2f_0) = 65.18 + 44.62i\Omega$   
 $Z_l(3f_0) = 38.87 - 26.64i\Omega$

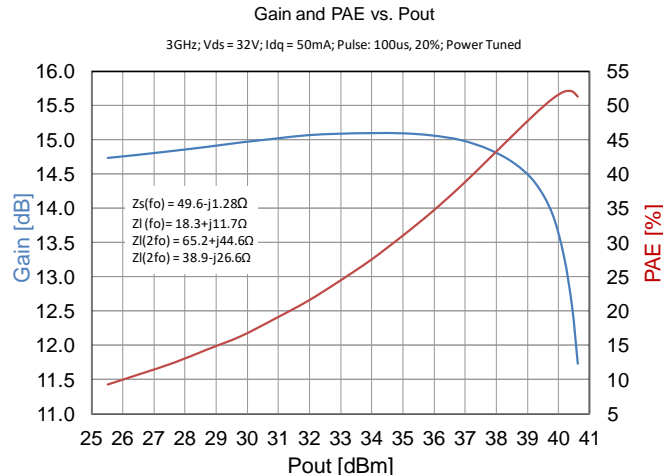
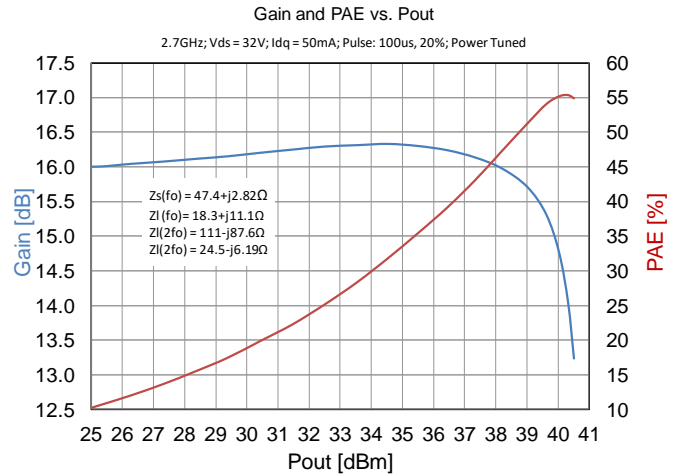
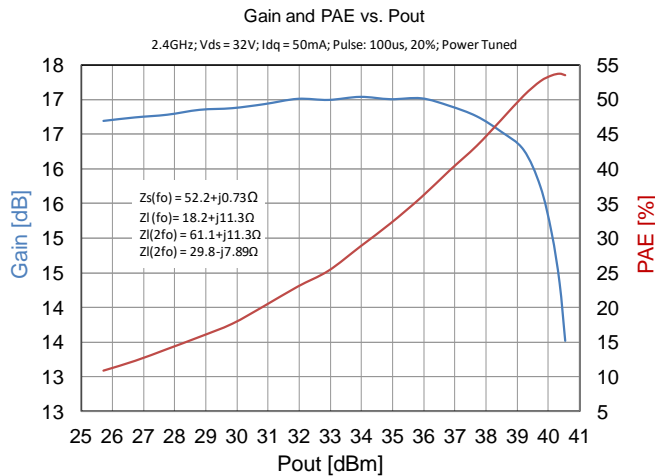
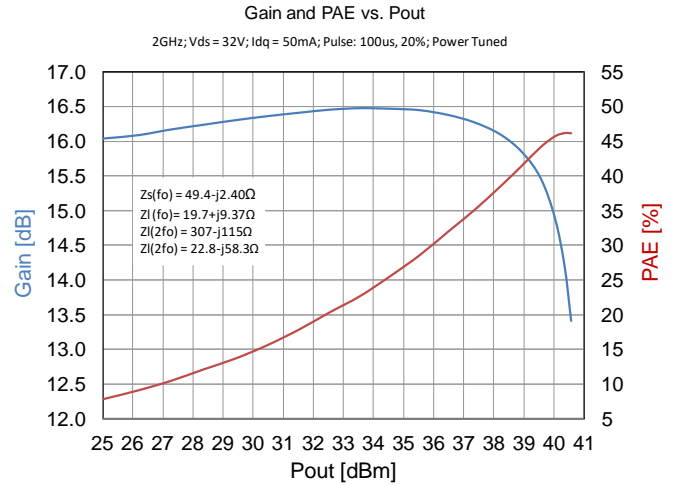
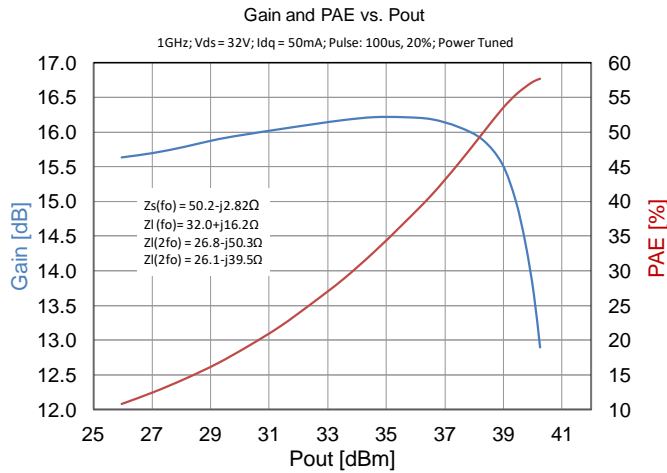
Max Power is 40.5dBm  
 at  $Z = 18.327 + 11.73i\Omega$   
 $\Gamma = -0.4216 + 0.2441i$   
 Max Gain is 12.4dB  
 at  $Z = 12.252 + 20.075i\Omega$   
 $\Gamma = -0.4551 + 0.4692i$   
 Max PAE is 58.6%  
 at  $Z = 10.574 + 22.744i\Omega$   
 $\Gamma = -0.4469 + 0.5433i$



## Typical Performance – Power Tuned 1, 2, 3

Notes:

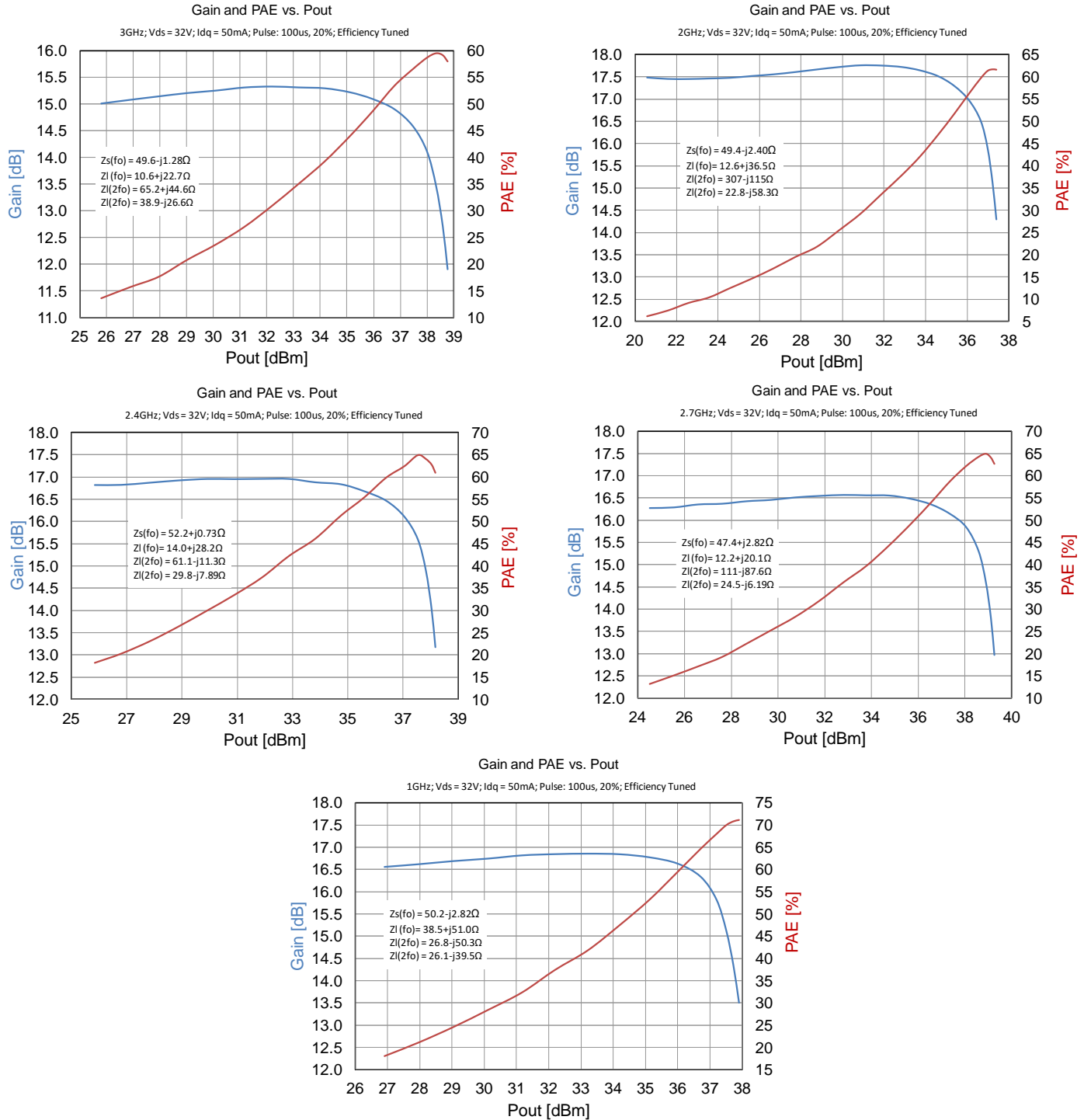
1. Test Conditions:  $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ , 100 us Pulse Width, 20% Duty Cycle.
2. The performance shown below is measured at device reference planes
3. See "Pin Configuration and Description" for load pull and source pull reference planes.



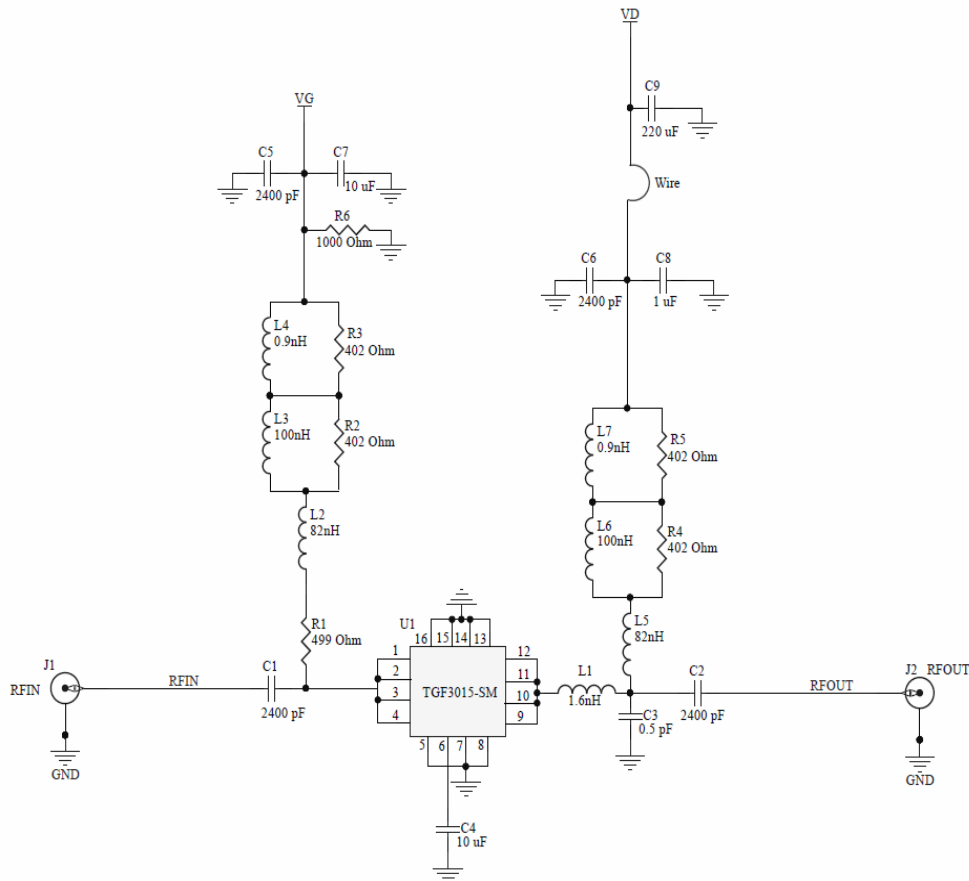
## Typical Performance – Efficiency Tuned <sup>1, 2, 3</sup>

Notes:

1. Test Conditions:  $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ , 100  $\mu\text{s}$  Pulse Width, 20% Duty Cycle.
2. The performance shown below is measured at device reference planes
3. See "Pin Configuration and Description" for load pull and source pull reference planes.



## 1 – 3 GHz Application Circuit - Schematic



### Bias-up Procedure

1. Set gate voltage ( $V_G$ ) to -5.0V
2. Set drain voltage ( $V_D$ ) to 32 V
3. Slowly increase  $V_G$  until  $I_{DQ}$  is 50 mA.
4. Apply RF signal

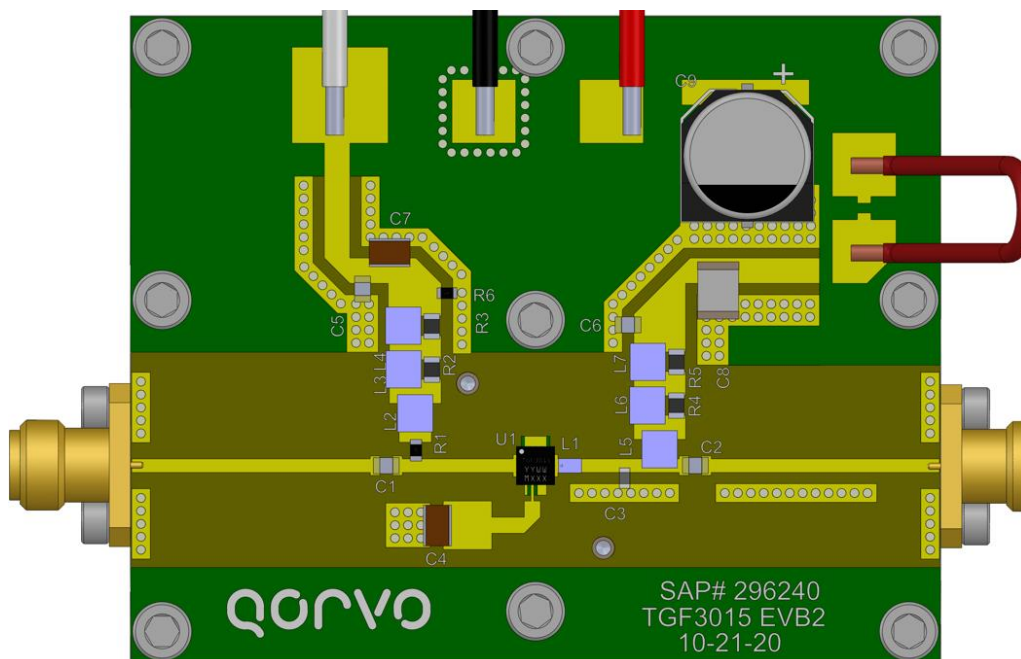
### Bias-down Procedure

1. Turn off RF signal
2. Turn off  $V_D$  and wait 1 second to allow drain capacitor dissipation
3. Turn off  $V_G$

### 1 – 3 GHz Application Circuit EVB – Layout <sup>1, 2</sup>

#### Notes:

1. PCB material is RO4350B 0.020" thick,  $\epsilon_r = 3.48$ .
2. The PCB land pattern has been developed to accommodate lead and package tolerances.



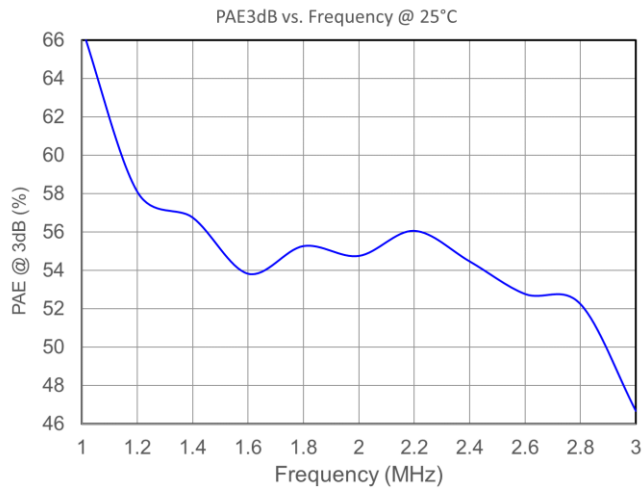
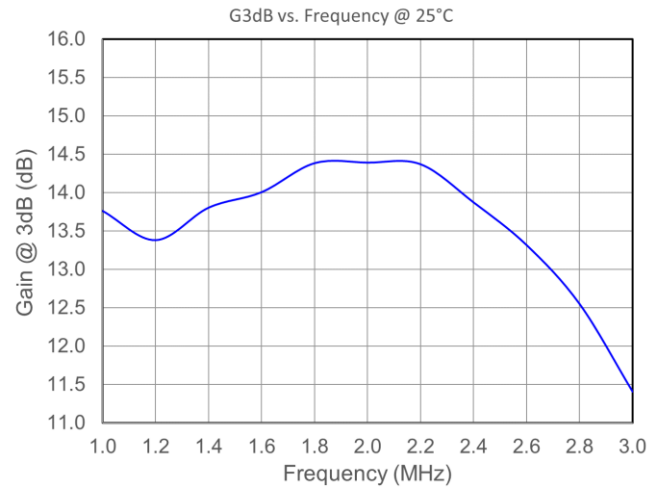
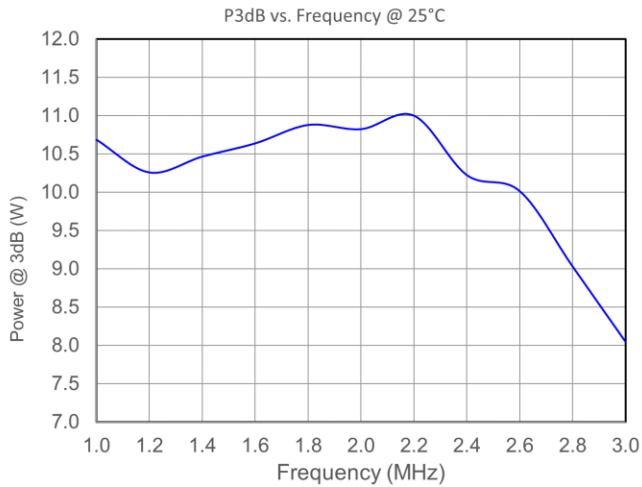
### 1 – 3 GHz Application Circuit – Bill of Material

Ref Des	Qty	Description	Mfg Name	Mfg Part #
R1	1	499 $\Omega$	Vishay Americas	CRCW0603499RFKEA
R2, R3, R4, R5	4	402 $\Omega$	Vishay Americas	CRCW0805402RFKEA
R6	1	1k $\Omega$	Vishay Americas	CRCW06031K00FKEA
C1, C2, C5, C6	4	2400pF	Dielectric Labs	C08BL242X-5UN-X0T
C3	1	0.5pF	ATC	600S005BT250XT
C4, C7	2	10uF	Murata	LLL31MR60J106ME01L
C8	1	1uF	AVX	18121C105KAT2A
C9	1	220uF	United Chemicon	EMVY500ADA221MJA0G
L1	1	1.6nH	CoilCraft	0603HC-1N6XJLU
L2, L5	2	82nH	CoilCraft	1008CS-820XGLB
L3, L6	2	100nH	CoilCraft	1008CS-101XGLB
L4, L7	2	900nH	CoilCraft	1008AF-901XJLB

## Evaluation Board Performance at 25°C <sup>1, 2</sup>

### Notes:

1. Test Conditions:  $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ , 100  $\mu\text{s}$  Pulse Width, 20% Duty Cycle.
2. Performance measured on 1.0 GHz to 3.0 GHz Evaluation Board.

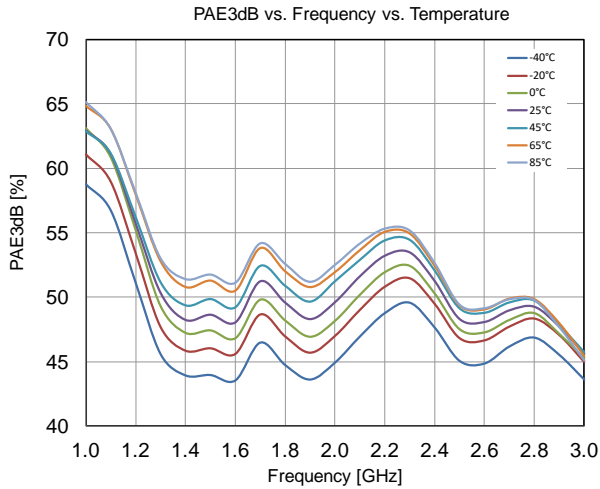
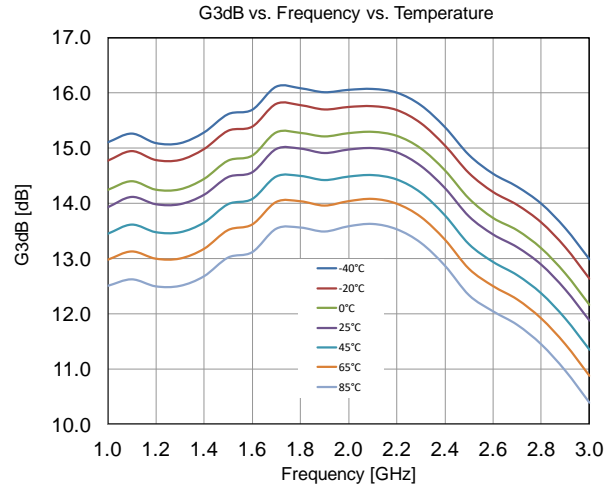
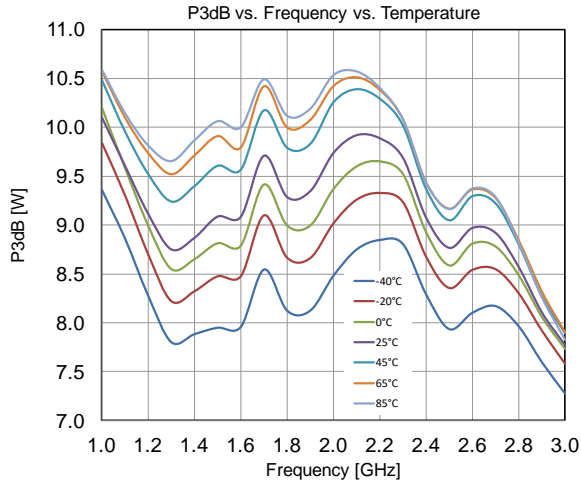




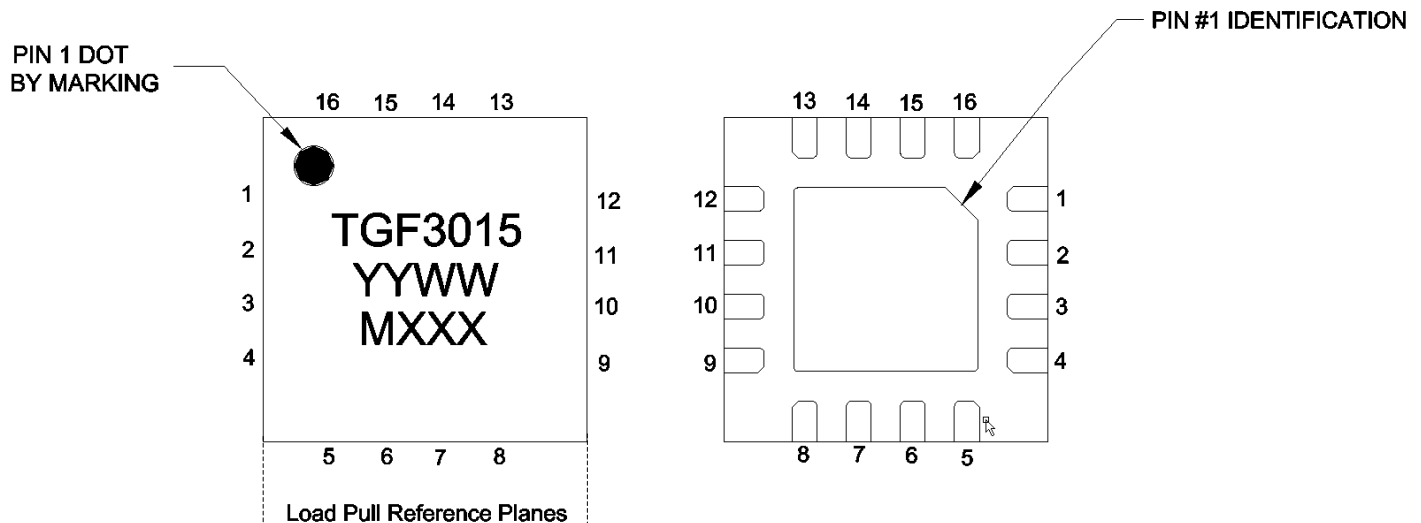
## Evaluation Board Performance Over Temperature <sup>1, 2</sup>

Notes:

1. Test Conditions:  $V_D = 32\text{ V}$ ,  $I_{DQ} = 50\text{ mA}$ , 100  $\mu\text{s}$  Pulse Width, 20% Duty Cycle.
2. Performance measured on 1.0 GHz to 3.0 GHz Evaluation Board.



## Pin Configuration and Description <sup>1, 2</sup>

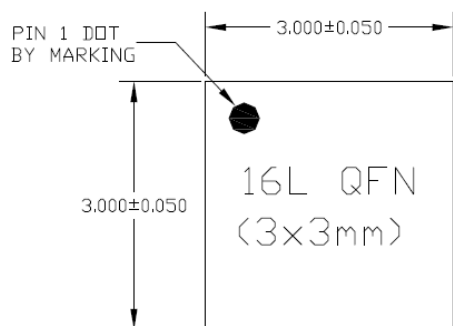


### Notes:

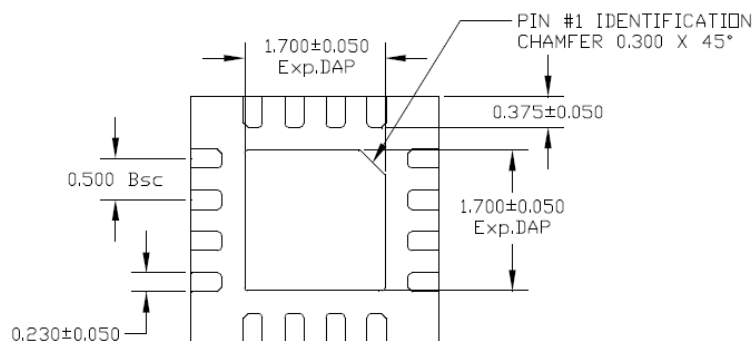
1. Thermal resistance measured to back side of package
2. The TGF3015-SM will be marked with the “TGF3015” designator and a lot code marked below the part designator. The “YY” represents the last two digits of the calendar year the part was manufactured, the “WW” is the work week of the assembly lot start, and the “MXXX” is the production lot number.

Pin	Symbol	Description
3	VG / RF IN	Gate voltage / RF Input to be matched to 50 ohms.
6	Off-chip Cap	Off-chip cap to extend low frequency gain.
9, 10, 11, 12	VD / RF OUT	Drain voltage / RF Output to be matched to 50 ohms.
Back side	Source	Source connected to ground

## Mechanical Drawing <sup>1-4</sup>

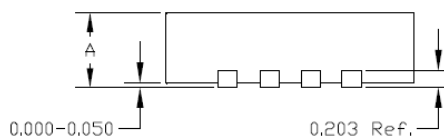


TOP VIEW



BOTTOM VIEW

A		QFN
	MAX.	0.900
	NOM.	0.850
	MIN.	0.800

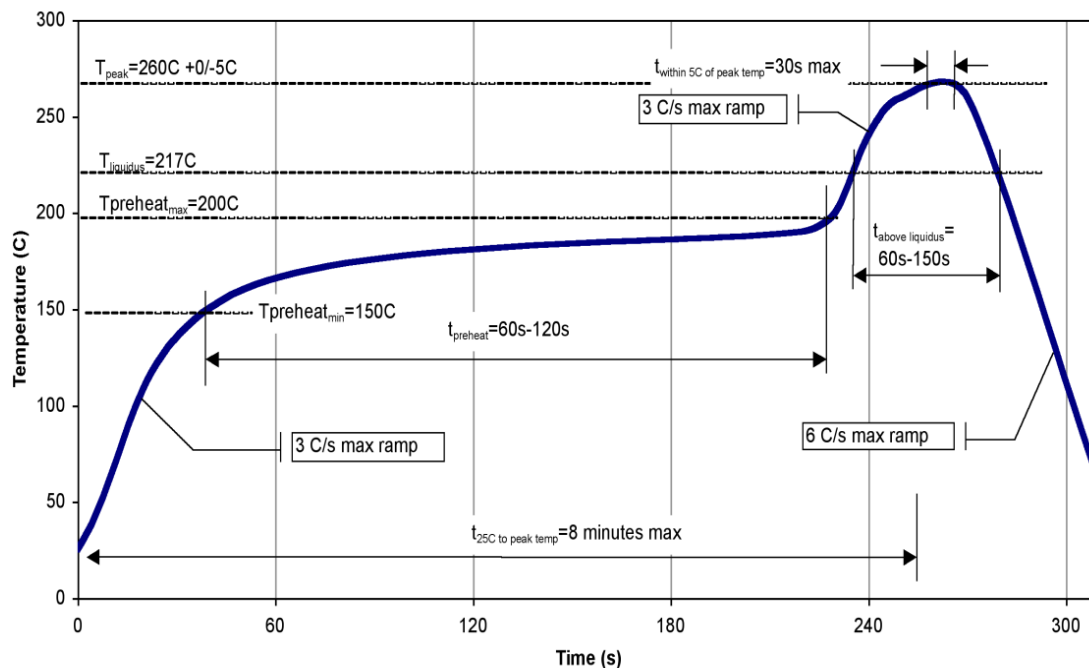


TOP VIEW

### Notes:

1. Dimension tolerance is  $\pm 0.127$  mm, unless noted otherwise.
2. This package is lead-free/RoHS-compliant.
3. The plating material on the leads is NiPdAu.
4. It is compatible with both lead-free (maximum 260 °C reflow temperature) and tin-lead (maximum 245°C reflow temperature) soldering processes

## Recommended Solder Temperature Profile



## Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1B	JEDEC JS-001
ESD – Charged Device Model (CDM)	Class C2B	JEDEC JS-002
MSL – Moisture Sensitivity Level	MSL3	JESD J-STD-020



Caution!  
ESD-Sensitive Device

## Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes.

Solder profiles available upon request.

The use of no-clean solder to avoid washing after soldering is recommended.

Contact plating: NiPdAu. Minimum Au thickness is 100micro-inches

## 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:

- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) Free
- PFOS Free
- SVHC Free
- Lead Free

## Contact Information

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

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**Tel:** 1-844-890-8163

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