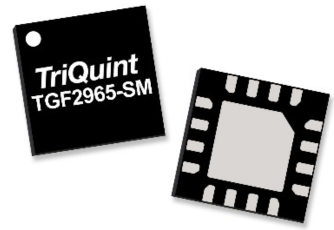
TGF2965-SM

5W, 32V, 0.03 – 3 GHz, GaN RF Input-Matched Transistor

Applications

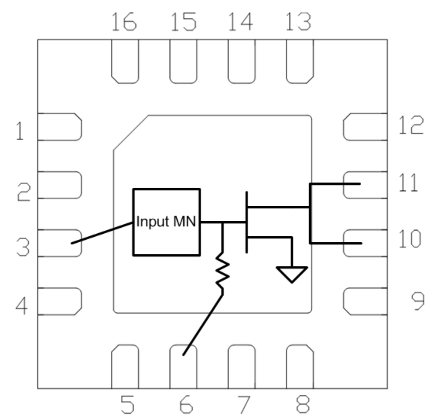
- Military radar
- Civilian radar
- Land mobile and military radio communications
- Test instrumentation
- Wideband and narrowband amplifiers
- Jammers



Product Features

- Frequency: 0.03 to 3.0 GHz
- Output Power (P_{3dB}): 6.0 W at 2 GHz
- Linear Gain: 18 dB at 2 GHz
- Typical PAE_{3dB}: 63% at 2 GHz
- Operating Voltage: 32 V
- Low thermal resistance package
- CW and Pulse capable
- 3 x 3 mm package

Functional Block Diagram



General Description

The TriQuint TGF2965-SM is a 6W (P_{3dB}), 50Ω-input matched discrete GaN on SiC HEMT which operates from 0.03 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 surface mount QFN package.

Lead-free and ROHS compliant

Evaluation boards are available upon request.

Pin Configuration

Pin No.	Label
10 - 11	V_D / RF OUT
3	V_G / RF IN
6	Off-chip shunt cap for low frequency gain
Back side	Source

Ordering Information

Part	ECCN	Description
TGF2965-SM	EAR99	QFN Packaged Part
TGF2965-SM-EVB1	EAR99	0.03 – 3.0 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)	0.6 A
Gate Current (I_G)	-1.25 to 2.1 mA
Power Dissipation (P_D)	7.5 W
RF Input Power, CW, T = 25 °C (P_{IN})	30 dBm
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[1]	Value
Drain Voltage (V_D)	32 V (Typ.)
Drain Quiescent Current (I_{DQ})	25 mA (Typ.)
Peak Drain Current (I_D)	326 mA (Typ.)
Gate Voltage (V_G)	-2.7 V (Typ.)
Channel Temperature (T_{CH})	225 °C (Max)
Power Dissipation, CW (P_D)	7.05 W (Max)
Power Dissipation, Pulse (P_D)[2]	9.1 W (Max)

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

[2] 100uS Pulse Width, 20% Duty Cycle

RF Characterization – Load Pull Performance at 1.0 GHz

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 30 mA, Pulse: 100uS Pulse Width, 20% Duty Cycle

Symbol	Parameter	Min	Typical	Max	Units
G_{LIN}	Linear Gain, Power Tuned		17.3		dB
P_{3dB}	Output Power at 3 dB Gain Compression, Power Tuned		37.8		dBm
PAE_{3dB}	Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned		73.9		%
G_{3dB}	Gain at 3 dB Compression, Power Tuned		14.3		dB

RF Characterization – Load Pull Performance at 1.5 GHz

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 30 mA, Pulse: 100uS Pulse Width, 20% Duty Cycle

Symbol	Parameter	Min	Typical	Max	Units
G_{LIN}	Linear Gain, Power Tuned		17.4		dB
P_{3dB}	Output Power at 3 dB Gain Compression, Power Tuned		37.7		dBm
PAE_{3dB}	Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned		61.1		%
G_{3dB}	Gain at 3 dB Compression, Power Tuned		14.4		dB

RF Characterization – Load Pull Performance at 2.0 GHz

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 30 mA, Pulse: 100uS Pulse Width, 20% Duty Cycle

Symbol	Parameter	Min	Typical	Max	Units
G_{LIN}	Linear Gain, Power Tuned		18.2		dB
P_{3dB}	Output Power at 3 dB Gain Compression, Power Tuned		37.8		dBm
PAE_{3dB}	Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned		62.9		%
G_{3dB}	Gain at 3 dB Compression, Power Tuned		15.2		dB

RF Characterization – Load Pull Performance at 2.5 GHz

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 30 mA, Pulse: 100uS Pulse Width, 20% Duty Cycle

Symbol	Parameter	Min	Typical	Max	Units
G_{LIN}	Linear Gain, Power Tuned		17.8		dB
P_{3dB}	Output Power at 3 dB Gain Compression, Power Tuned		38.1		dBm
PAE_{3dB}	Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned		63.5		%
G_{3dB}	Gain at 3 dB Compression, Power Tuned		14.8		dB

RF Characterization – Load Pull Performance at 3.0 GHz

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 30 mA, Pulse: 100uS Pulse Width, 20% Duty Cycle

Symbol	Parameter	Min	Typical	Max	Units
G_{LIN}	Linear Gain, Power Tuned		16.9		dB
P_{3dB}	Output Power at 3 dB Gain Compression, Power Tuned		38.3		dBm
PAE_{3dB}	Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned		68.7		%
G_{3dB}	Gain at 3 dB Compression, Power Tuned		13.9		dB

RF Characterization – 0.03 – 3 GHz EVB Performance at 2.5 GHz - Pulsed

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 30 mA, Pulse: 100uS Pulse Width, 20% Duty Cycle

Symbol	Parameter	Min	Typical	Max	Units
G_{LIN}	Linear Gain		17.1		dB
P_{3dB}	Output Power at 3 dB Gain Compression		5.0		W
DE_{3dB}	Drain Efficiency at 3 dB Gain Compression		50.6		%
G_{3dB}	Gain at 3 dB Compression		14.1		dB

RF Characterization – Mismatch Ruggedness at 1, 2 and 3 GHz

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 30 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	3	10:1
VSWR	Impedance Mismatch Ruggedness	8	2:1

Thermal and Reliability Information - CW [1]

Parameter	Test Conditions	Value	Units
Thermal Resistance ($θ_{JC}$)	85 °C Case 1.26 W Pdiss, CW	17.5	ºC/W
Channel Temperature (T_{CH})		107	°C
Median Lifetime (T_M)		5.56E11	Hrs
Thermal Resistance ($θ_{JC}$)	85 °C Case 2.52 W Pdiss, CW	17.9	ºC/W
Channel Temperature (T_{CH})		130	°C
Median Lifetime (T_M)		2.65E10	Hrs
Thermal Resistance ($θ_{JC}$)	85 °C Case 3.78 W Pdiss, CW	18.8	ºC/W
Channel Temperature (T_{CH})		156	°C
Median Lifetime (T_M)		1.27E9	Hrs
Thermal Resistance ($θ_{JC}$)	85 °C Case 5.04 W Pdiss, CW	19.8	ºC/W
Channel Temperature (T_{CH})		185	°C
Median Lifetime (T_M)		6.46E7	Hrs
Thermal Resistance ($θ_{JC}$)	85 °C Case 6.30 W Pdiss, CW	21.1	ºC/W
Channel Temperature (T_{CH})		218	°C
Median Lifetime (T_M)		3.28E6	Hrs

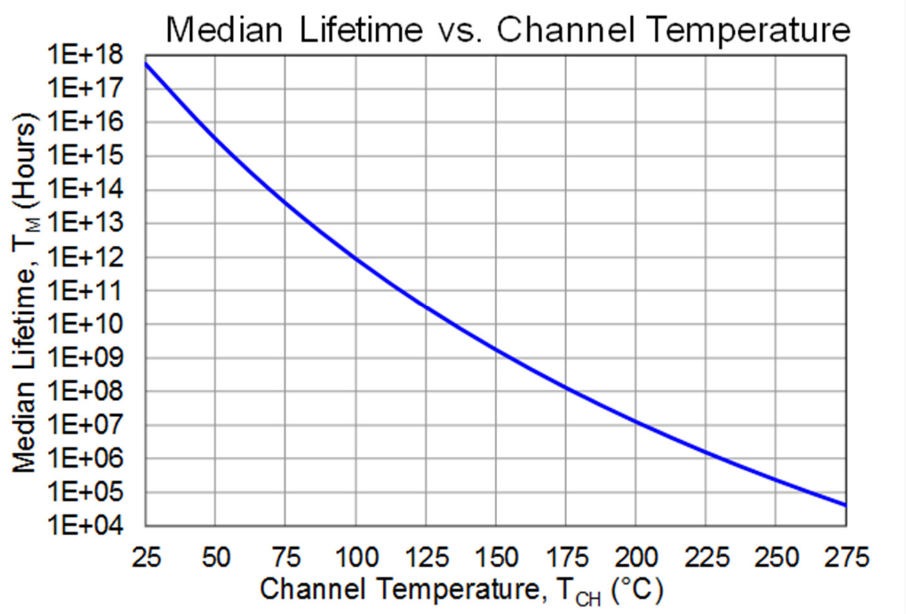
Notes:
1. Thermal resistance measured to bottom of package.

Thermal and Reliability Information - Pulsed [1]

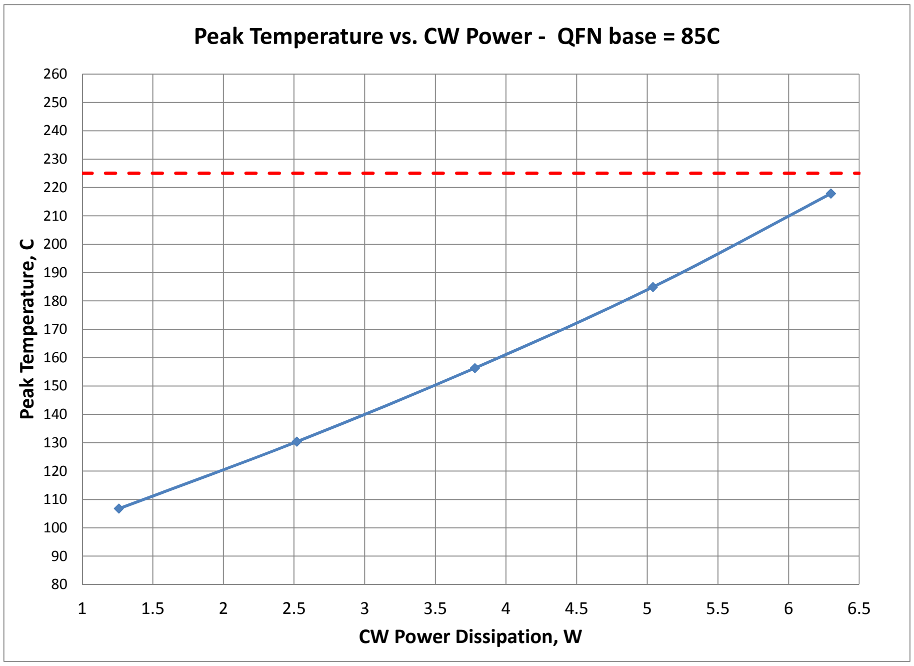
Parameter	Test Conditions	Value	Units
Thermal Resistance ($θ_{JC}$)	85 °C Case 7.6 W Pdiss, 100uS PW, 5%	15.0	ºC/W
Channel Temperature (T_{CH})		199	°C
Median Lifetime (T_M)		1.69E7	Hrs
Thermal Resistance ($θ_{JC}$)	85 °C Case 7.6 W Pdiss, 100uS PW, 10%	15.4	ºC/W
Channel Temperature (T_{CH})		202	°C
Median Lifetime (T_M)		1.30E7	Hrs
Thermal Resistance ($θ_{JC}$)	85 °C Case 7.6 W Pdiss, 100uS PW, 20%	16.1	ºC/W
Channel Temperature (T_{CH})		207	°C
Median Lifetime (T_M)		8.44E6	Hrs
Thermal Resistance ($θ_{JC}$)	85 °C Case 7.6 W Pdiss, 100uS PW, 50%	18.0	ºC/W
Channel Temperature (T_{CH})		222	°C
Median Lifetime (T_M)		2.33E6	Hrs

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

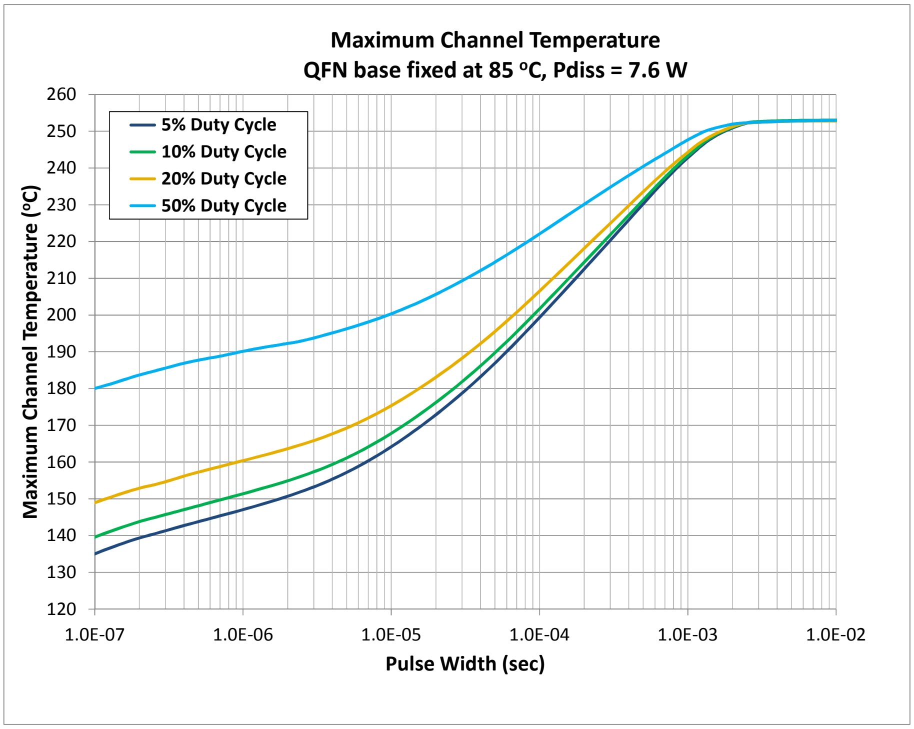
Median Lifetime



Maximum Channel Temperature - CW



Maximum Channel Temperature - Pulsed

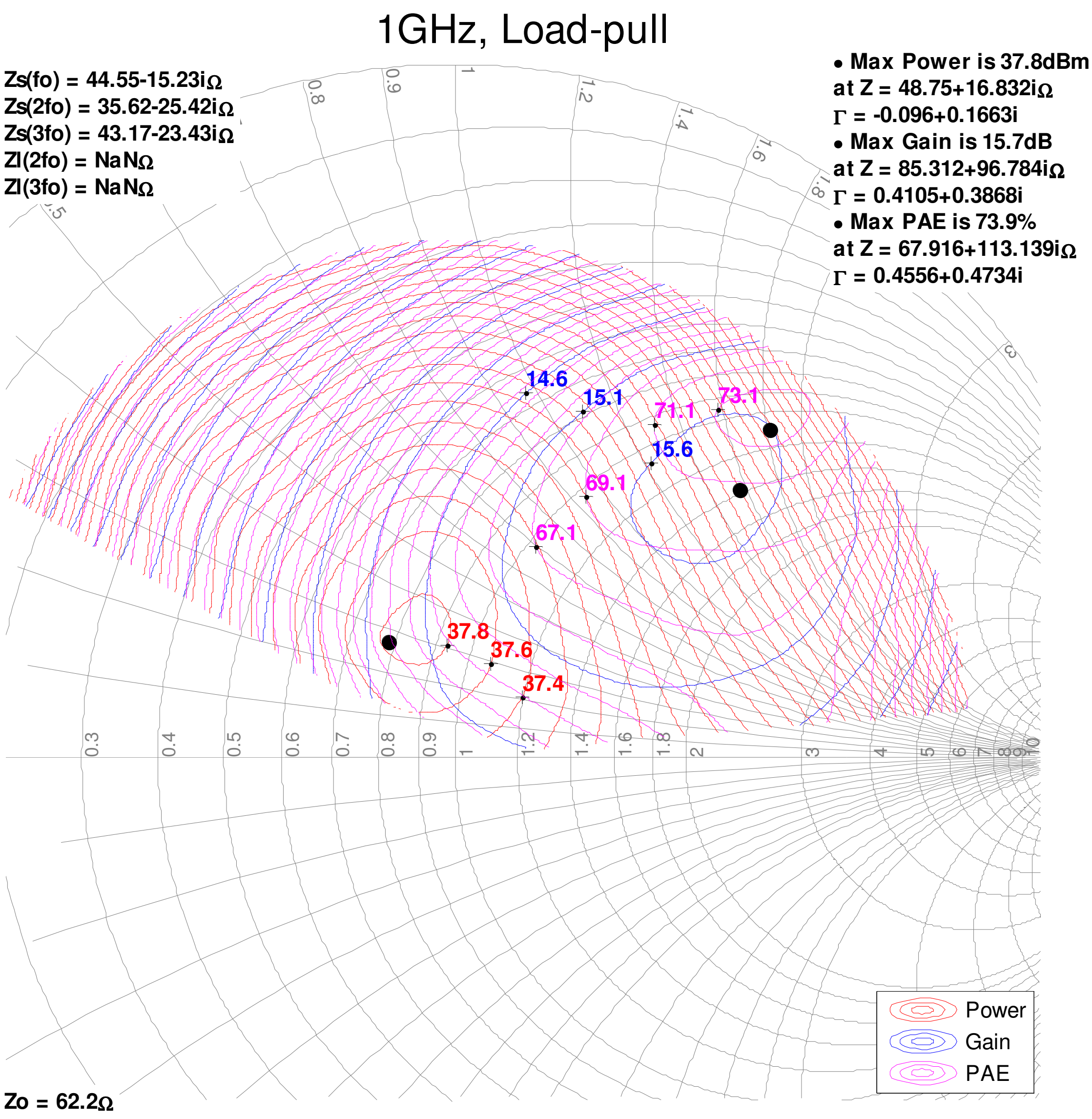


Load Pull Smith Charts [1, 2, 3]

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



Load Pull Smith Charts (1, 2, 3)

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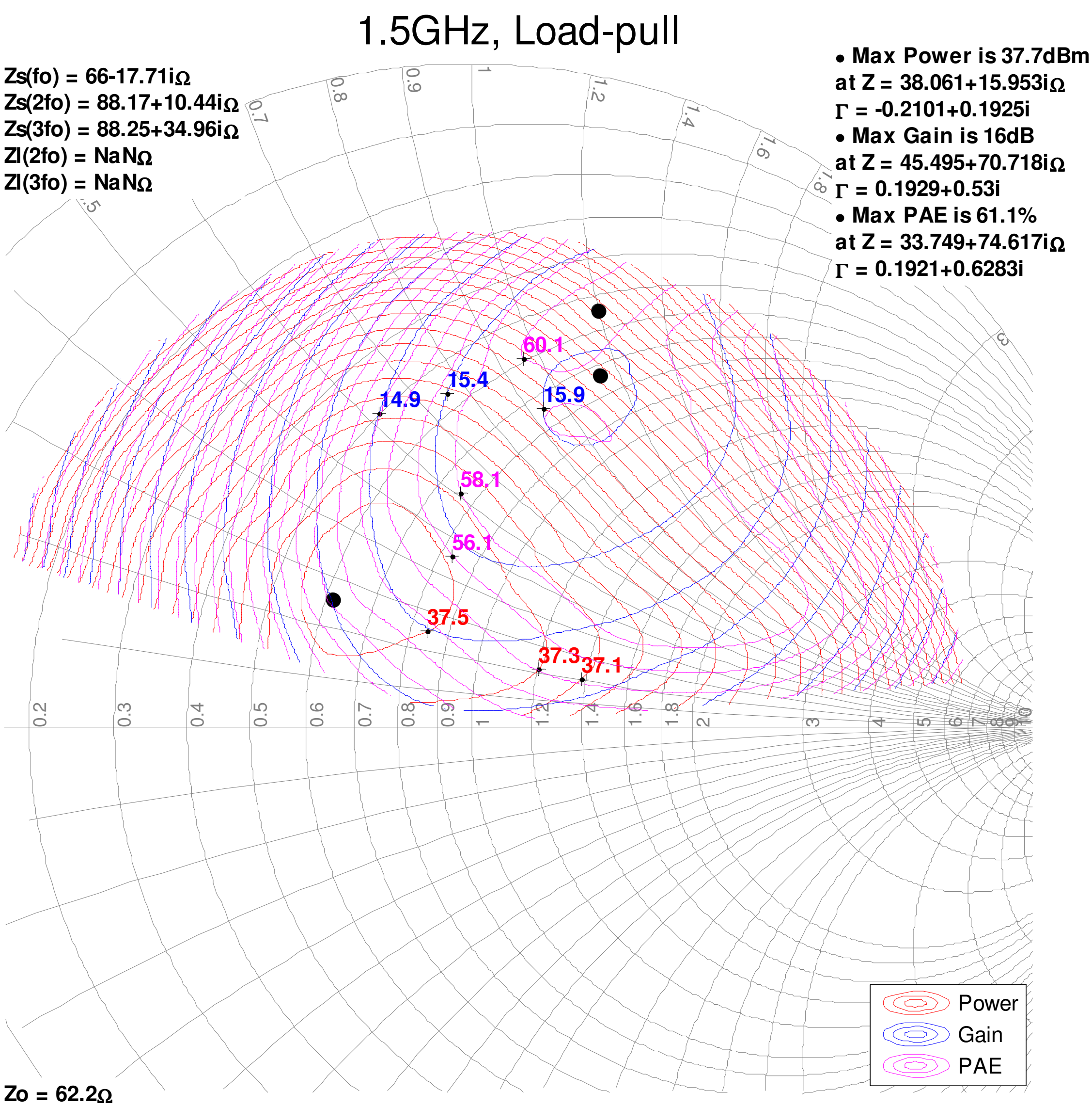

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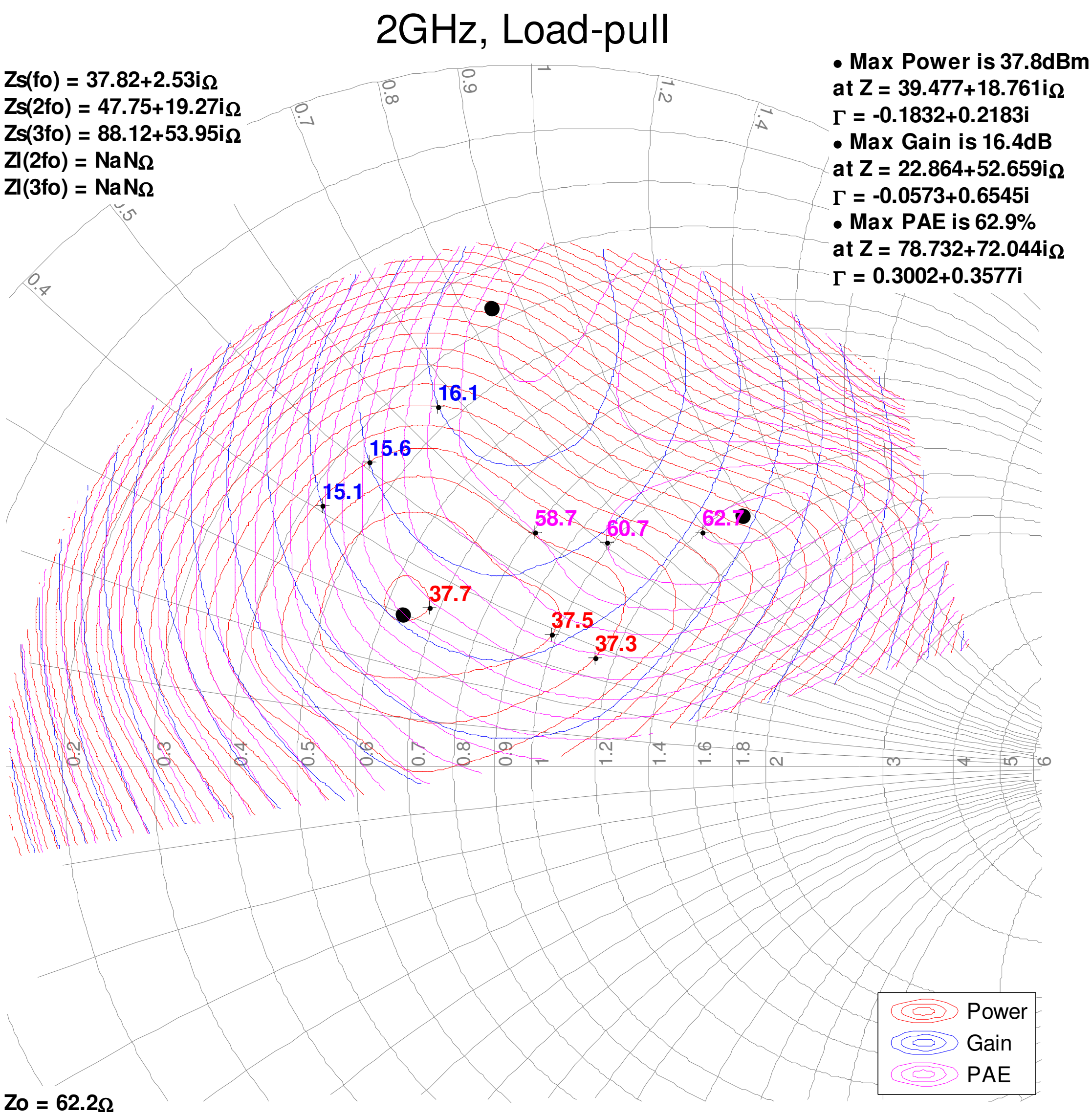

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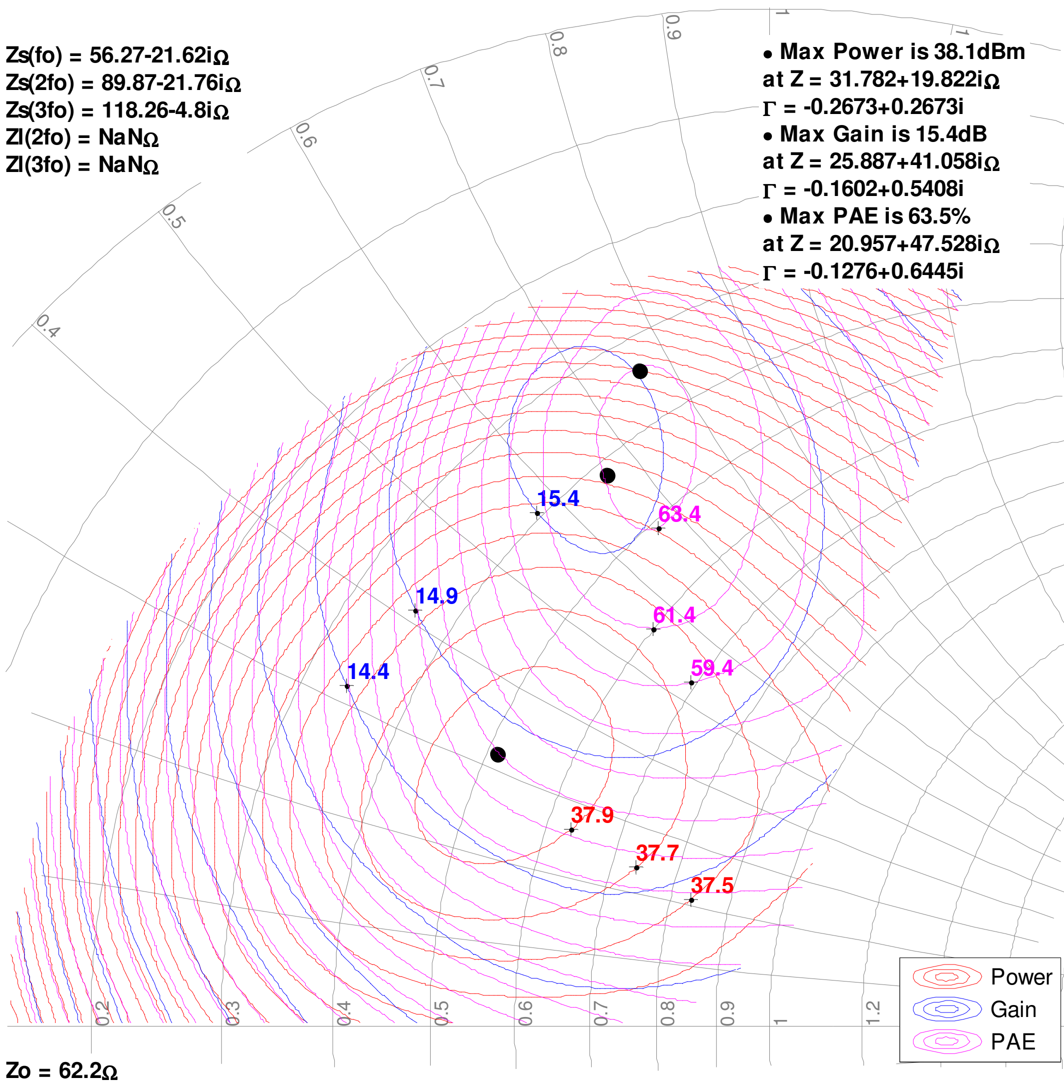

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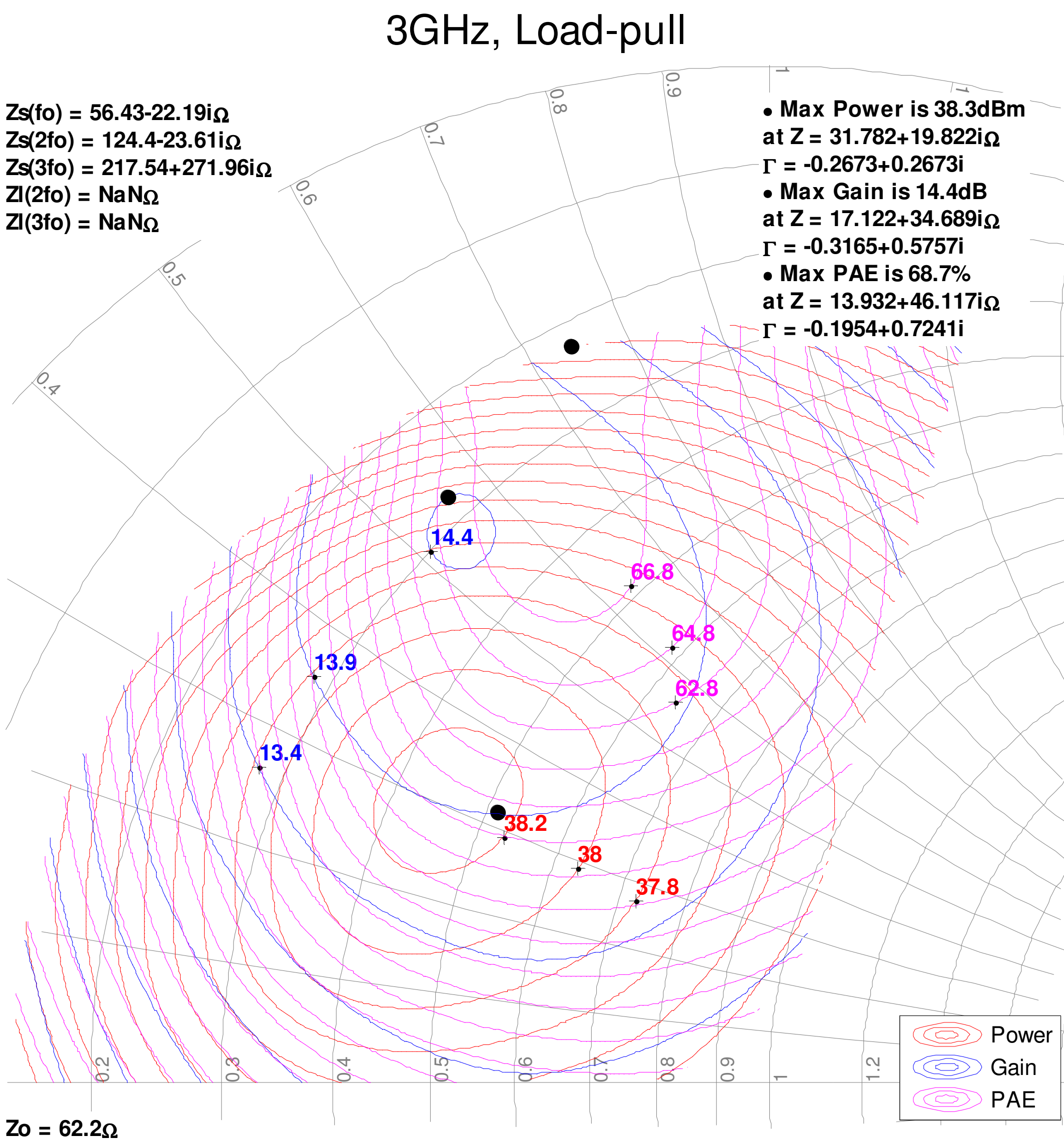
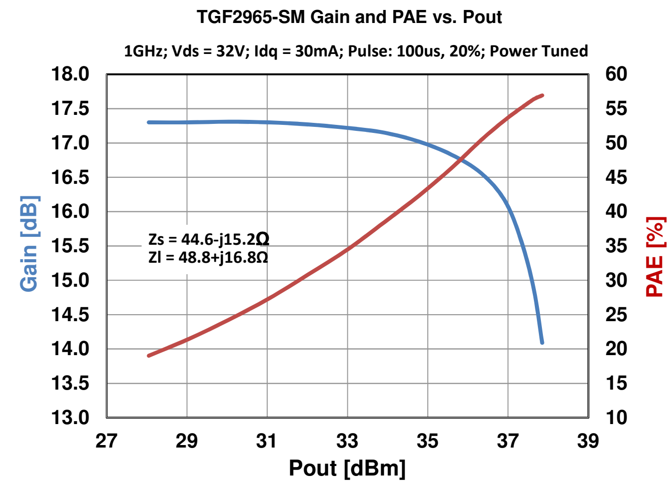
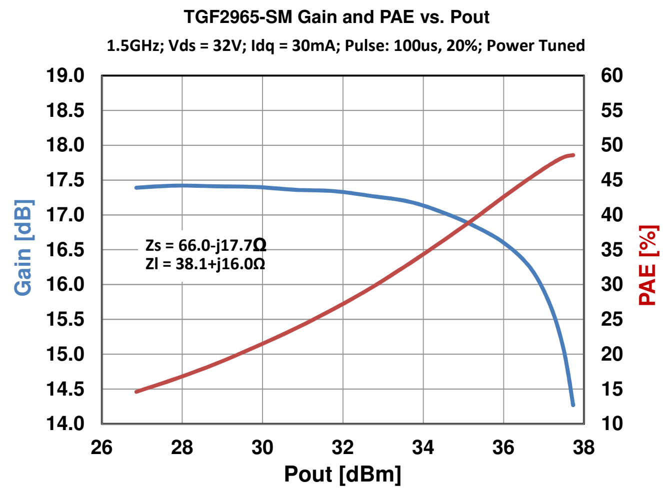
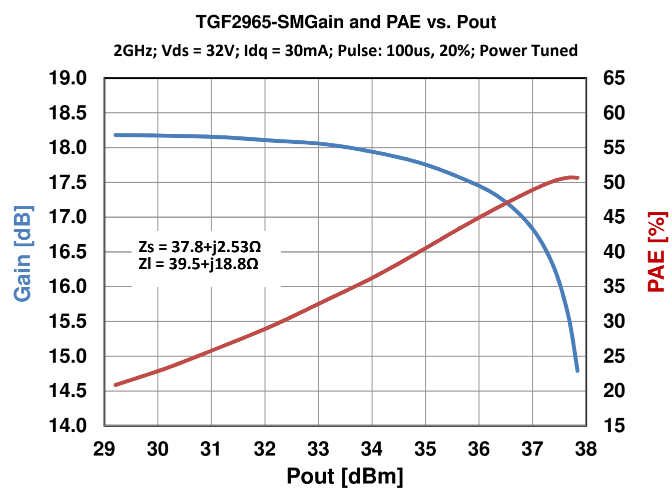


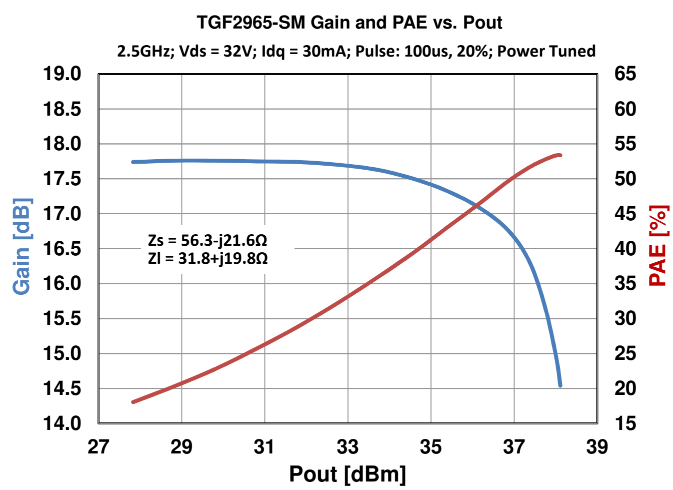
Typical Performance – Power Tuned[1,2]

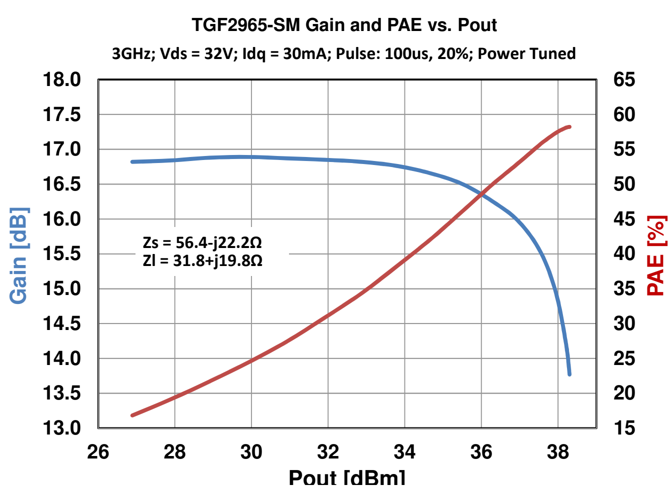
Notes:
1. Pulsed signal with 100uS pulse width and 20% duty cycle
2. See page 20 for load pull and source pull reference planes where the performance was measured.







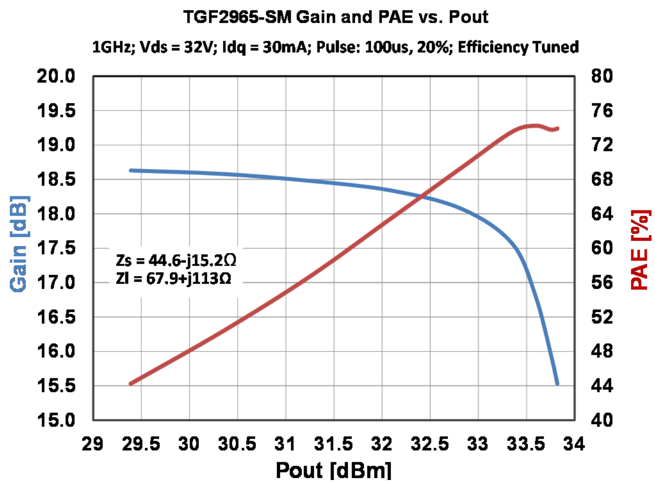


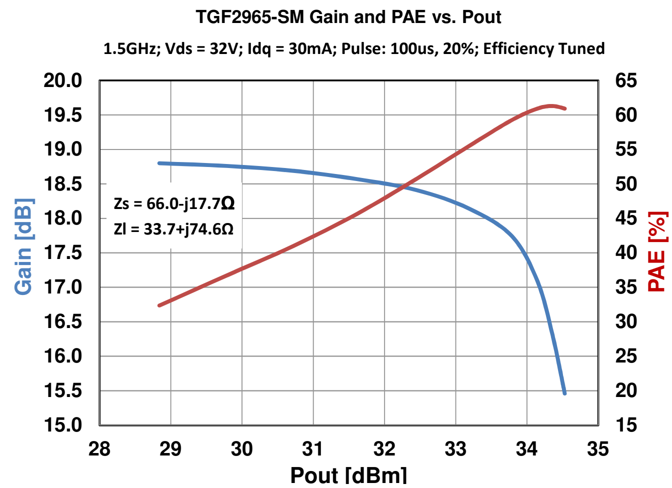


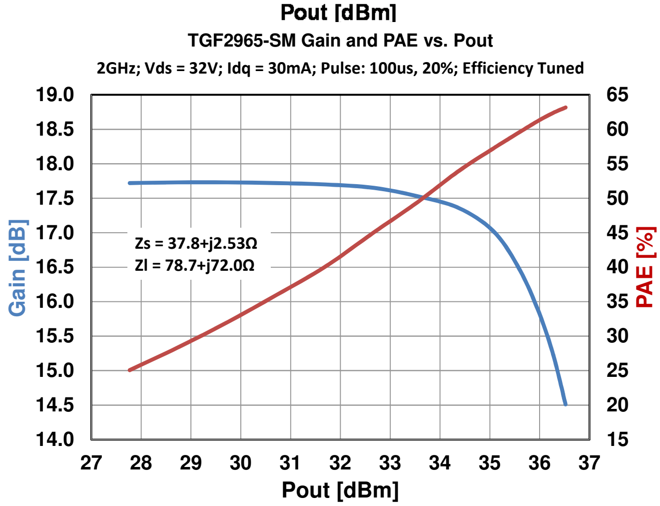
Typical Performance – Efficiency Tuned[1,2]

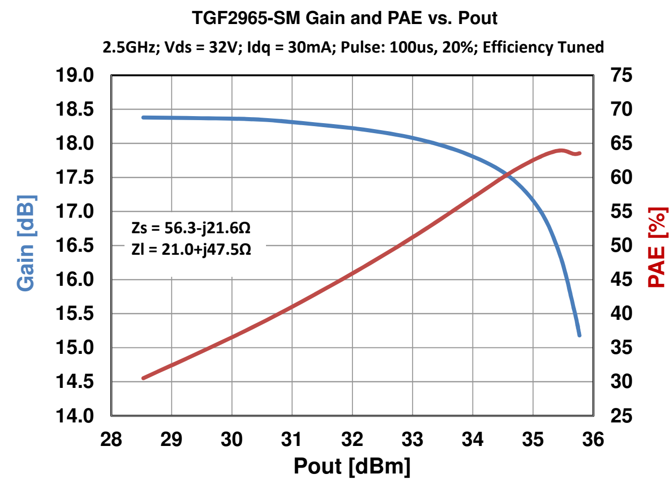
Notes:

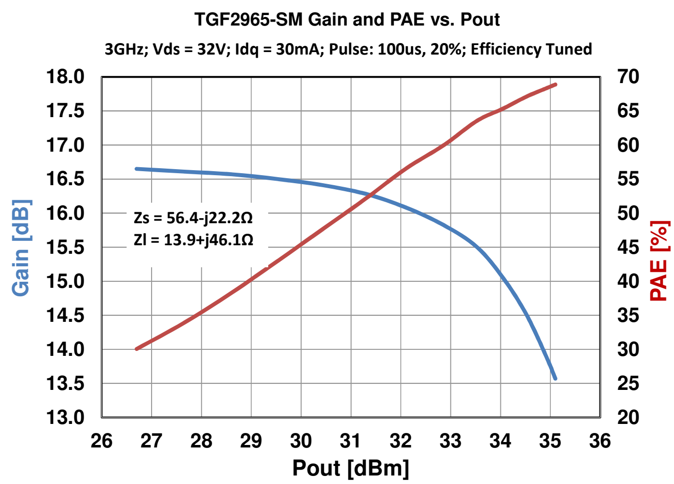
1. Pulsed signal with 100uS pulse width and 20% duty cycle
2. See page 20 for load pull and source pull reference planes where the performance was measured.





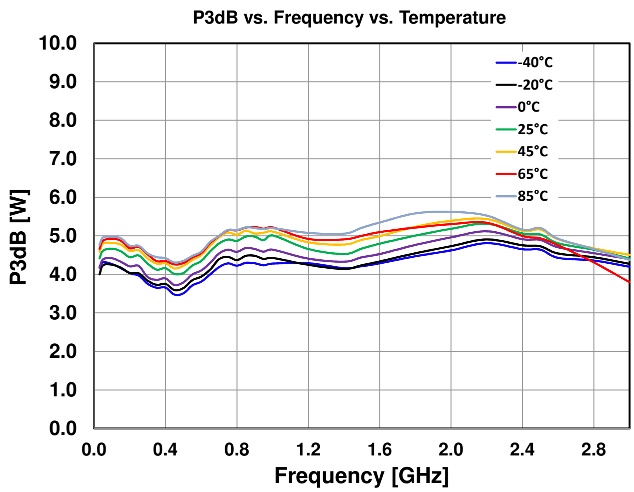


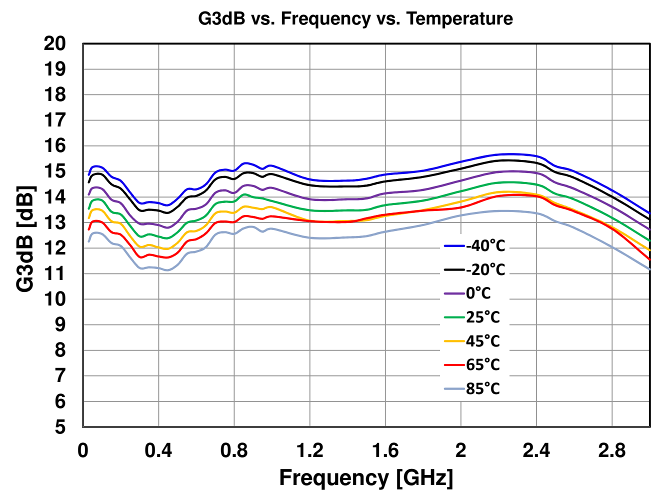


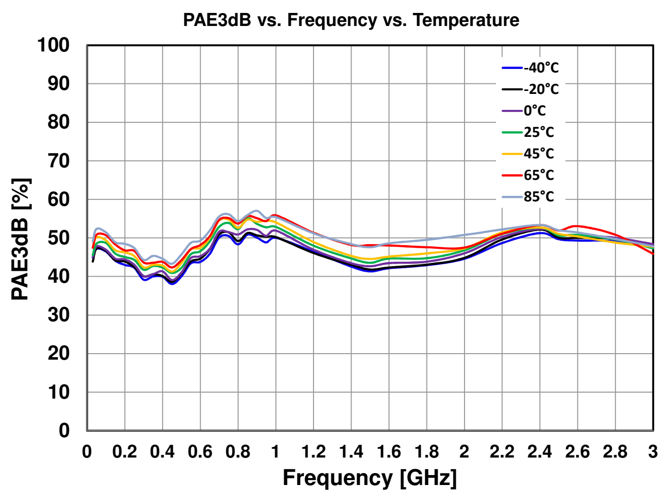


0.03 – 3 GHz Evaluation Board Performance Over Temperature (1, 2)

Performance measured on TriQuint's 0.03 GHz to 3 GHz Evaluation Board





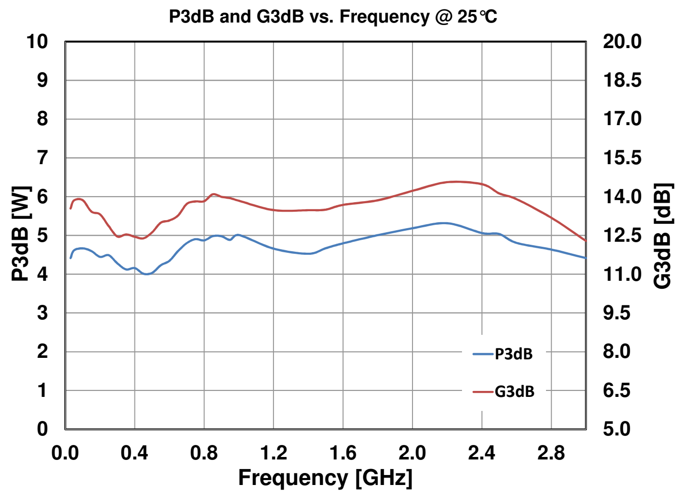


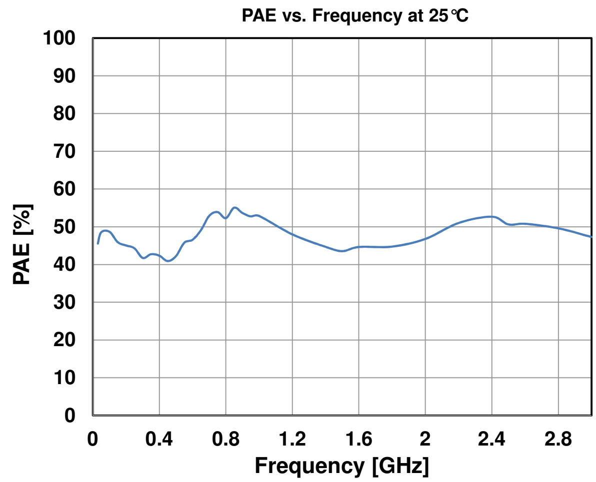
Notes:

1. Test Conditions: V_{DS} = 32 V, I_{DQ} = 30 mA
2. Test Signal: Pulse Width = 100 µs, Duty Cycle = 20%

0.03 – 3 GHz Evaluation Board Performance At 25°C(1, 2) - Pulsed

Performance measured on TriQuint's 0.03 GHz to 3 GHz Evaluation Board



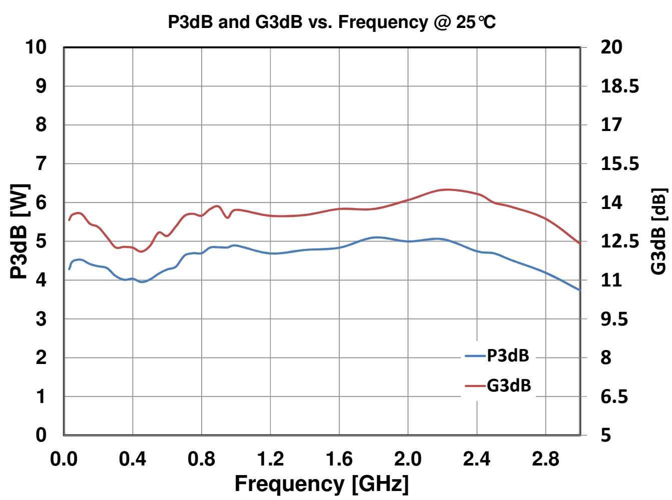


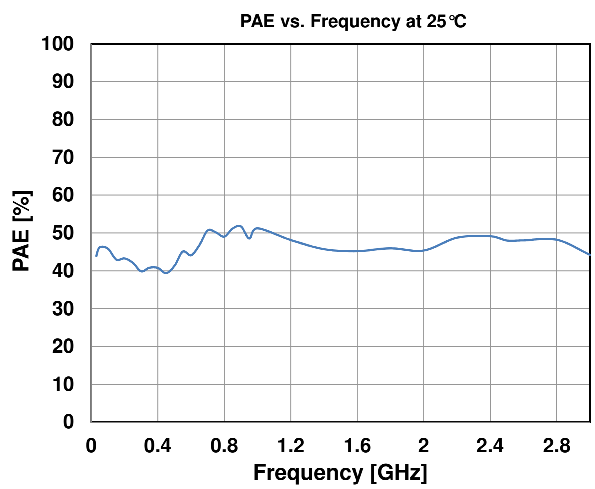
Notes:

1. Test Conditions: V_{DS} = 32 V, I_{DQ} = 30 mA, 25°C
2. Test Signal: Pulse Width = 100 µs, Duty Cycle = 20 %

0.03 – 3 GHz Evaluation Board Performance At 25°C(1) - CW

Performance measured on TriQuint's 0.03 GHz to 3 GHz Evaluation Board





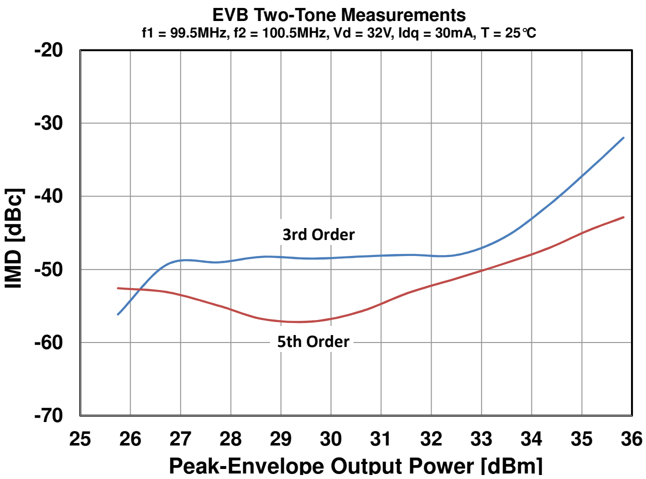
Notes:

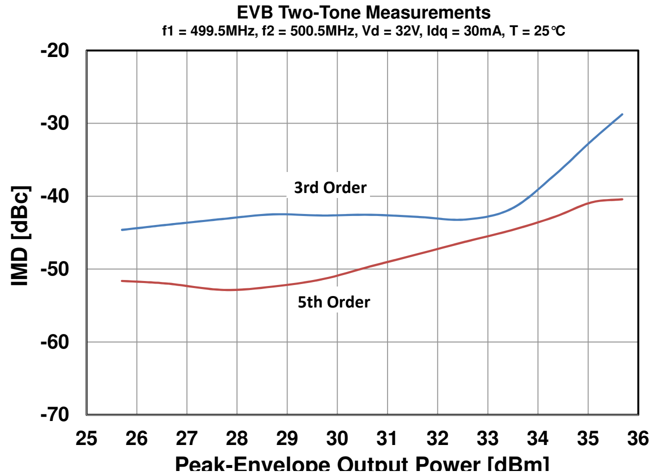
1. Test Conditions: V_{DS} = 32 V, I_{DQ} = 30 mA, 25°C

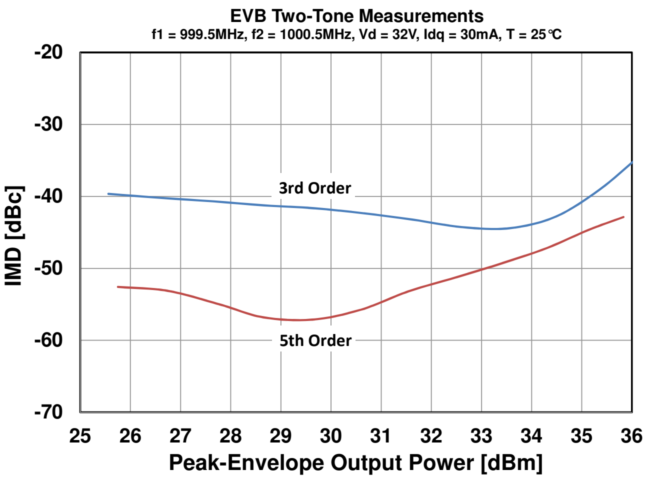
0.03 – 3 GHz Evaluation Board Performance - Two-Tone Measurements(1)

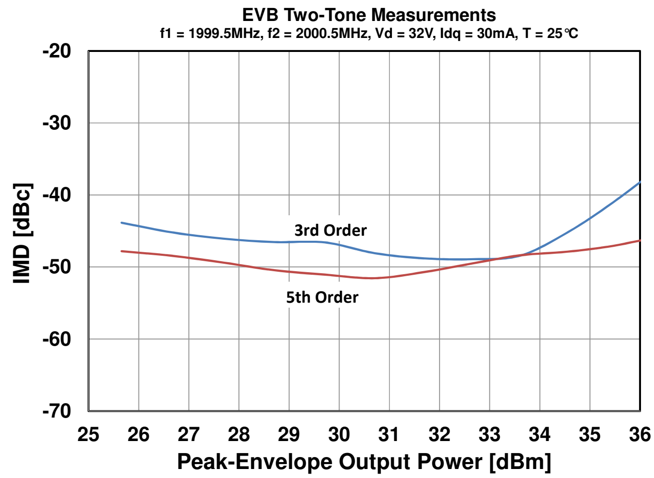
Notes:

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









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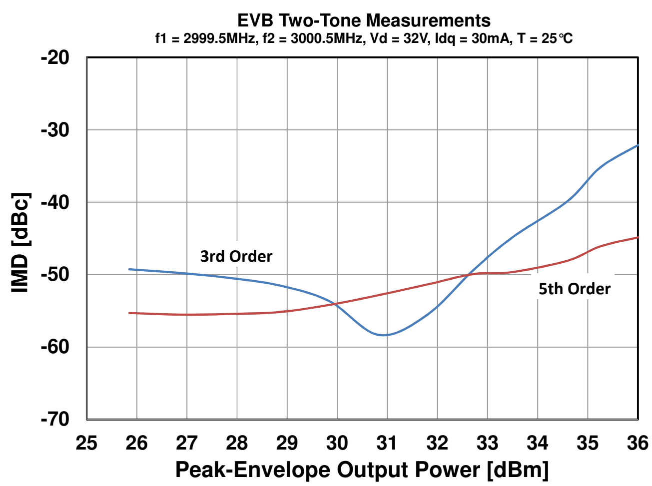
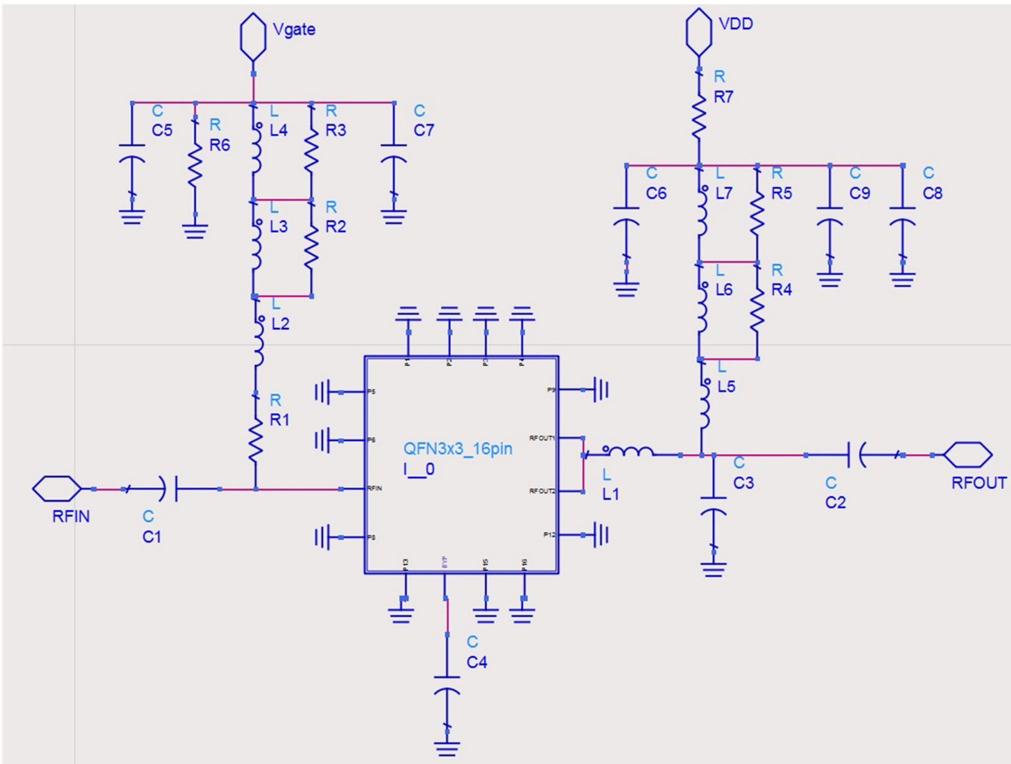


0.03 – 3 GHz Application Circuit



Bias-up Procedure

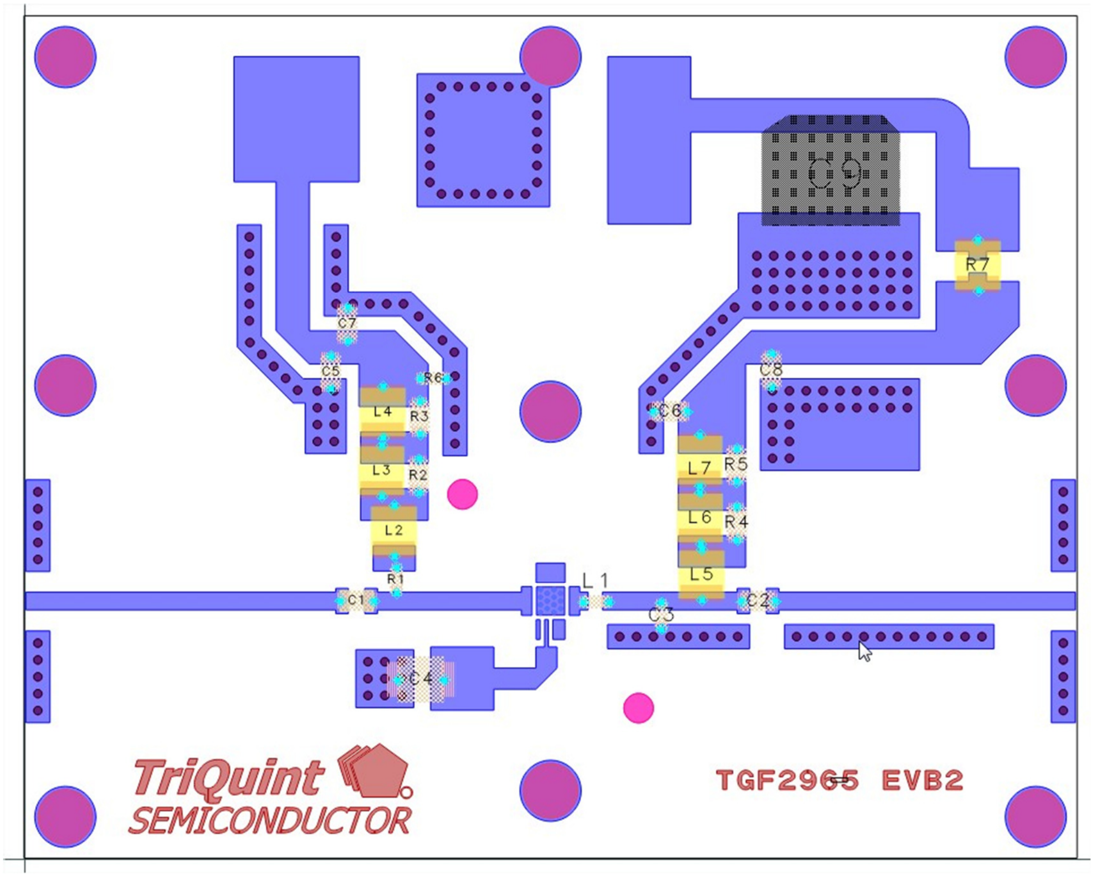
1. V_G set to -5 V.
2. V_D set to 32 V.
3. Adjust V_G more positive until quiescent I_D is 30 mA.
4. Apply RF signal.

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 – 3GHz Evaluation Board Layout

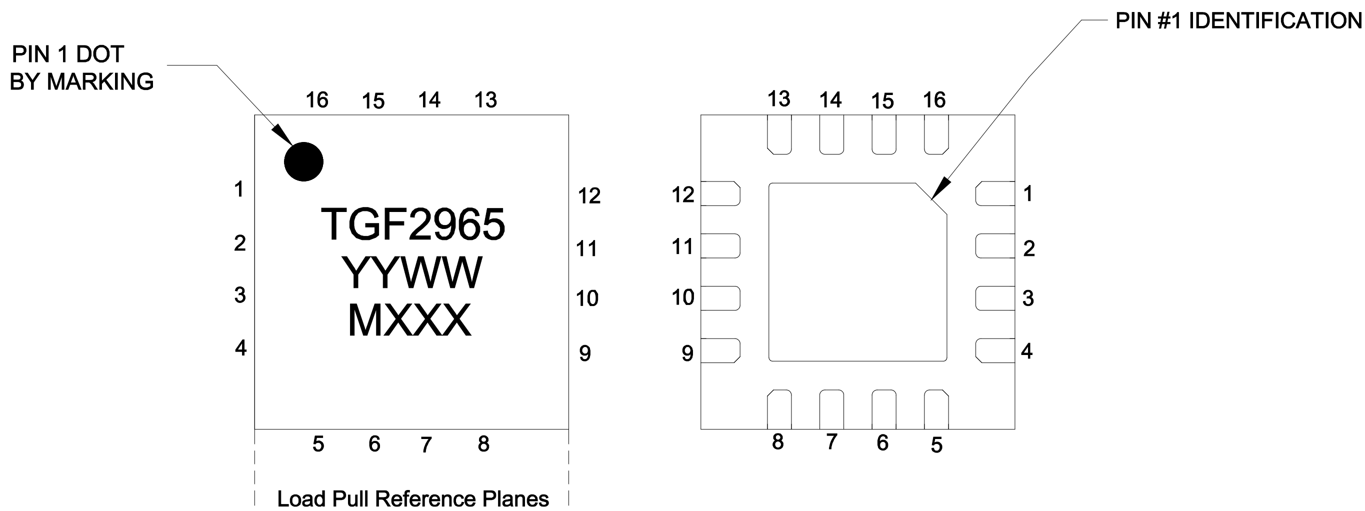
Top RF layer is 0.020" thick Rogers RO4350B, ε_r = 3.48. The pad pattern shown has been developed and tested for optimized assembly at TriQuint Semiconductor. The PCB land pattern has been developed to accommodate lead and package tolerances.



0.03 – 3 GHz EVB Bill of Materials

Reference Design	Value	Qty	Manufacturer	Part Number
C1, C2, C5, C6	2400 pF	4	DLI	C08BL102X-1UN-X0T
C3	0.2 pF	1	Murata	GRM1555C1HR20BZ01
C4, C7	10 uF	2	TDK	C1632X5R0J106M130AC
C8	1 uF	1	AVX	18121C105KAT2A
C9	220 uF	1	United Chemicon	EMVY500ADA221MJA0G
L1	2 nH	1	CoilCraft	0603HC-2N0XJLU
L2, L5	82 nH	2	CoilCraft	1008CS-820XGLB
L3, L6	100 nH	2	CoilCraft	1008CS-101XGLB
L4, L7	900 nH	2	CoilCraft	1008AF-901XJLB
R1	499 Ω	1	Venkel	CR0603-10W-4990FT
R2, R3, R4, R5	400 Ω	4	Venkel	CR0805-8W-4020FT
R6	1 kΩ	1	Venkel	CR0603-10W-1001FT
R7	0 Ω	DNP		

Pin Layout



Pin Description

Pin	Symbol	Description
10, 11	V_D / RF OUT	Drain voltage / RF Output to be matched to 50 ohms; see EVB Layout on page 19 as an example.
3	V_G / RF IN	Gate voltage / RF Input to be matched to 50 ohms; see EVB Layout on page 19 as an example.
6	Off-chip Cap	Off-chip capacitor to extend low-frequency gain
Back side	Source	Source connected to ground

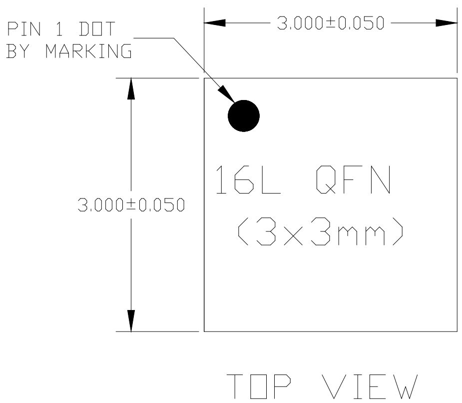
Notes:

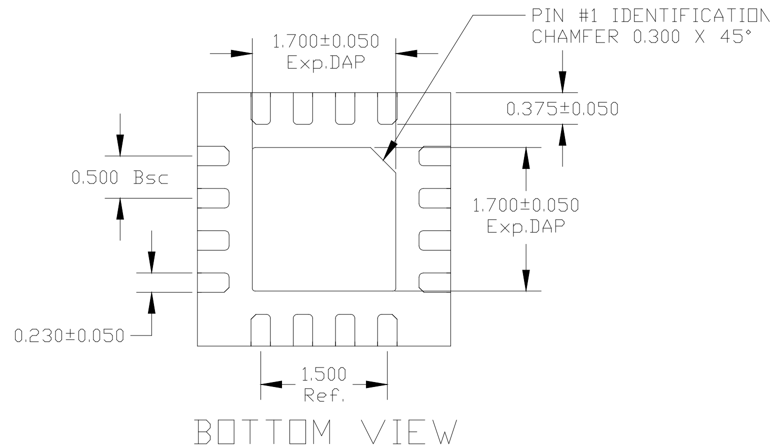
Thermal resistance measured to back side of package

The TGF2965-SM will be marked with the “TGF2965” 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.

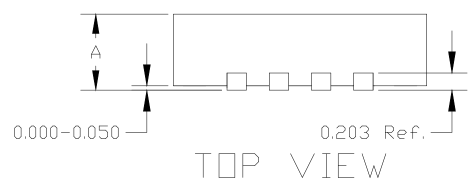
Mechanical Information

All dimensions are in milimeters.





		SLP
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 °C reflow temperature) and tin-lead (maximum 245°C reflow temperature) soldering processes.

Product Compliance Information

ESD Sensitivity Ratings

Caution! ESD-Sensitive Device

ESD Rating:	Class 1B
Value:	Passes ≥ 950 V to < 1000V max.
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° C

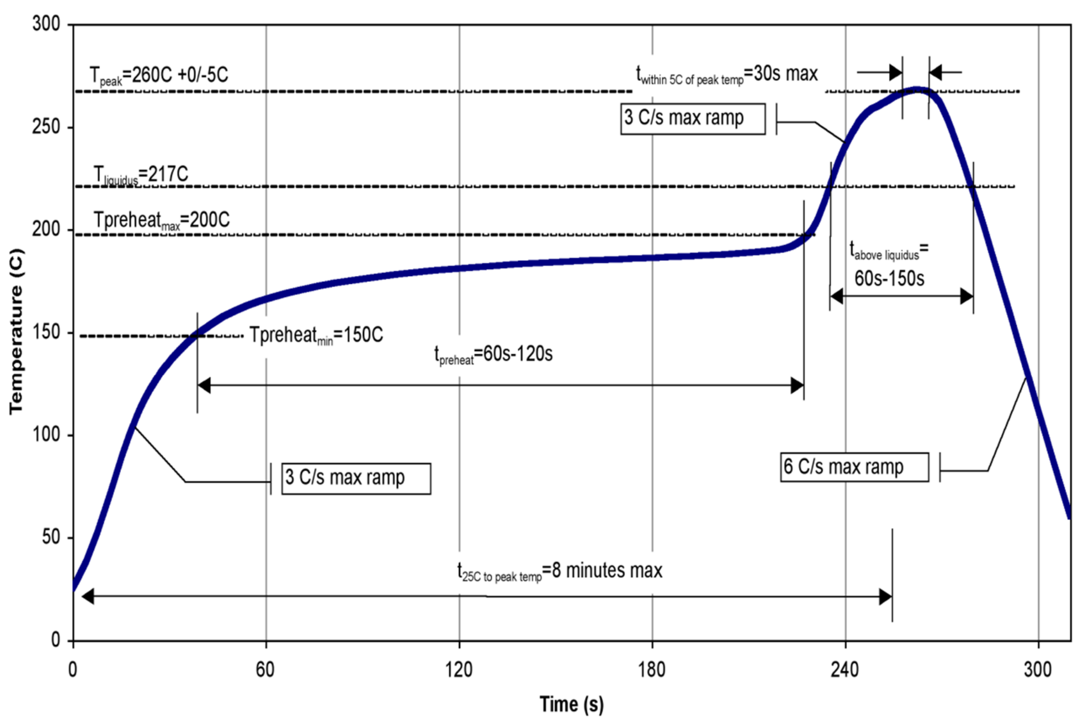
RoHs Compliance

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



Contact Information

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