T1G4004532-FL

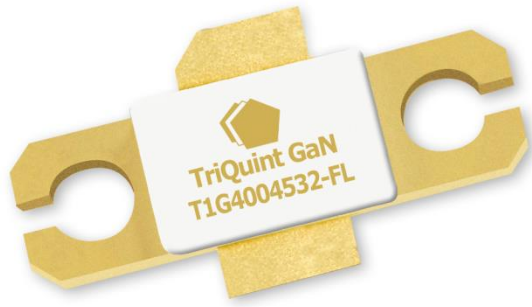
45W, 32V, DC – 3.5 GHz, GaN RF Transistor

General Description

The Qorvo T1G4004532-FL is a 45W (P_{3dB}) discrete GaN on SiC HEMT which operates from DC to 3.5 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.

Lead-free and ROHS compliant

Evaluation boards are available upon request.

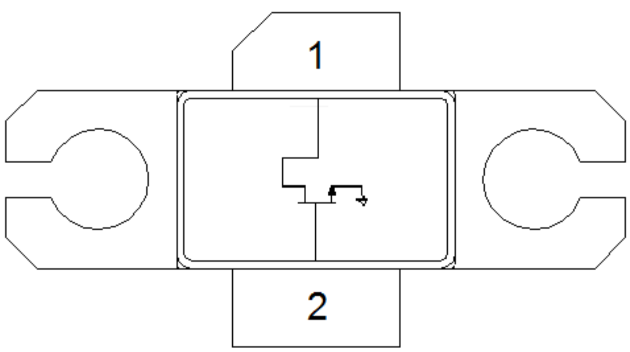


Product Features

- Frequency: DC to 3.5 GHz
- Output Power (P_{3dB})[1]: 78 W
- Linear Gain[1]: 20 dB
- Typical $DEFF_{3dB}$[1]: 73%
- Operating Voltage: 32 V
- Low thermal resistance package
- CW and Pulse capable

  Note: 1 @ 3 GHz

Functional Block Diagram



Applications

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

Part No.	Description
T1G4004532-FL	DC – 3.5 GHz RF Transistor
T1G4004532FLEVB01	2.7 – 3.5 GHz EVB

Absolute Maximum Ratings[1]

Parameter	Rating	Units
Breakdown Voltage, BV_D	+100	V
Gate Voltage Range, V_G	-7 to +2	V
Drain Current, I_{DMAX}	14.5	A
Gate Current Range, I_G	See page 4.	mA
Power Dissipation, CW, P_{DISS}, Base Temperature = 85 °C	61	W
RF Input Power, CW, 50 Ω, T = 25 °C	+41	dBm
Mounting Temperature (30 Seconds)	320	°C
Storage Temperature	−40 to +150	°C

Notes:

1. . Operation of this device outside the parameter ranges given above may cause permanent damage.

Recommended Operating Conditions[1]

Parameter	Min	Typ	Max	Units
Operating Temperature Range	−40	+25	+85	°C
Drain Voltage Range, V_D	+12	+32	+40	V
Drain Current, I_D[3]	–	2.5	–	A
Drain Bias Current, I_{DQ}	–	220	–	mA
Gate Voltage, V_G[4]	–	−2.9	–	V
Power Dissipation, CW (P_D)[2]	–	–	44	W
Power Dissipation, Pulsed (P_D)[2, 3]	–	–	68	W

Notes:

1. Electrical performance is measured under conditions noted in the electrical specifications table. Specifications are not guaranteed over all recommended operating conditions.
2. Package at 85 °C.
3. Drain current at P3dB, Pulse Width = 100 uS, Duty Cycle = 20%.
4. To be adjusted for desired I_{DQ}

Pulsed Characterization – Load-Pull Performance – Power Tuned[1]

Parameters	Typical Values				Unit
Frequency, F	1	2	3	3.5	GHz
Linear Gain, G_{LIN}	21.2	15.5	17.5	17.8	dB
Output Power at 3dB compression point, P_{3dB}	48.0	49.0	48.9	48.9	dBm
Drain Efficiency at 3dB compression point, $DEFF_{3dB}$	65.5	56.9	61.0	56.6	%
Gain at 3dB compression point	18.2	12.4	14.5	14.8	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +32 V, I_D = 220 mA, Temp = +25 °C

Pulsed Characterization – Load-Pull Performance – Efficiency Tuned[1]

Parameters	Typical Values				Unit
Frequency	1	2	3	3.5	GHz
Linear Gain, G_{LIN}	20.8	16.2	20.9	17.7	dB
Output Power at 3dB compression point, P_{3dB}	44.7	47.1	45.8	47.8	dBm
Drain Efficiency at 3dB compression point, $DEFF_{3dB}$	76.8	72.7	72.9	67.1	%
Gain at 3dB compression point, G3dB	17.8	13.2	17.9	14.7	dB

Notes:
1. Test conditions unless otherwise noted: V_D = +32 V, I_{DQ} = 220 mA, Temp = +25 °C

RF Characterization – EVB1 Performance at 3.3 GHz[1]

Parameter	Min	Typ	Max	Units
Linear Gain, G_{LIN}	–	19.5	–	dB
Output Power at 3dB compression point, P3dB	–	44.0	–	W
Drain Efficiency at 3dB compression point, DEFF3dB	–	52.0	–	%
Gain at 3dB compression point, G3dB	–	16.5	–	dB

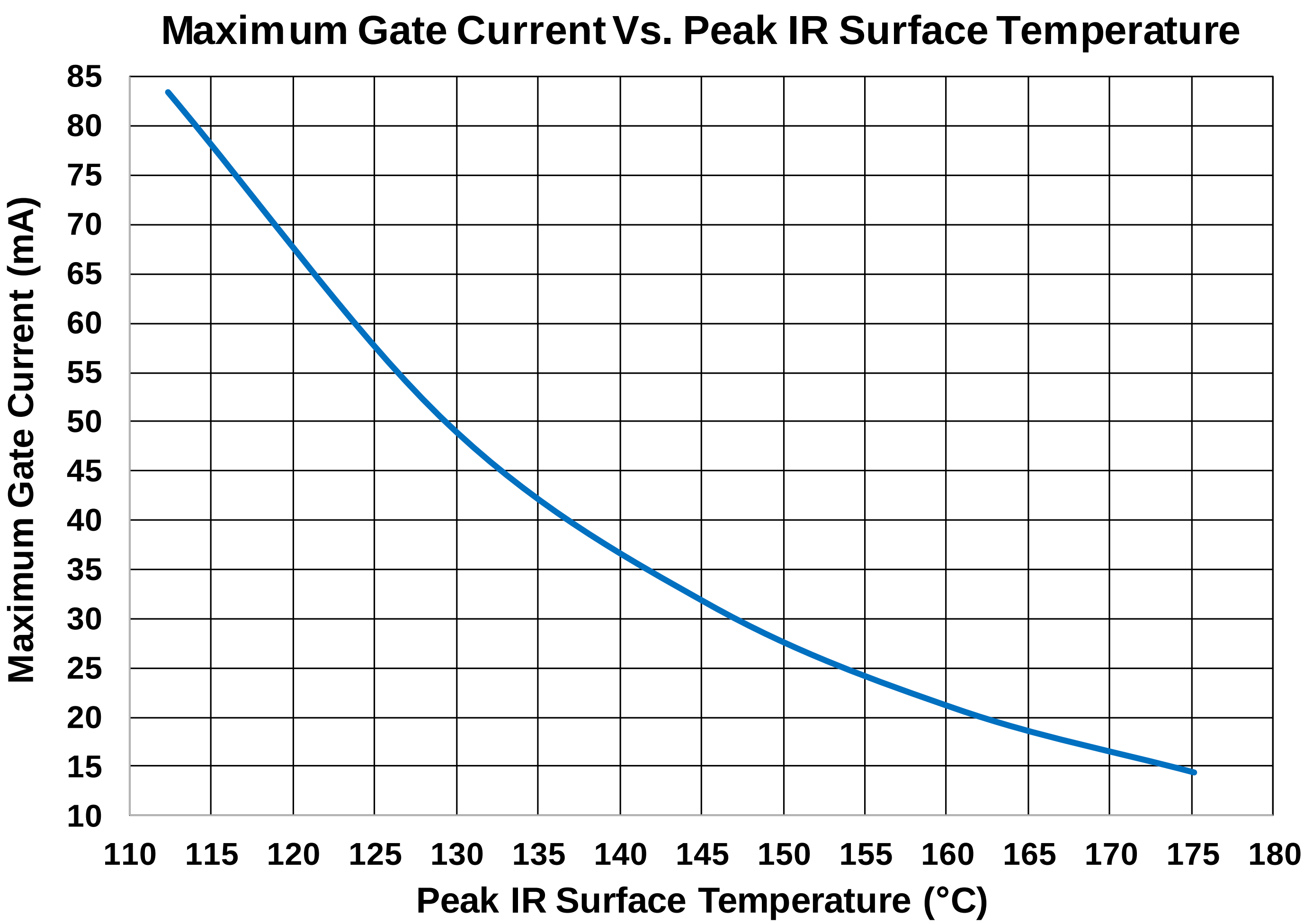
Notes:
1. V_D = +50 V, I_{DQ} = 220 mA, Temp = +25 °C, Pulse Width = 100 uS, Duty Cycle = 20%

RF Characterization – Mismatch Ruggedness at 3.5 GHz

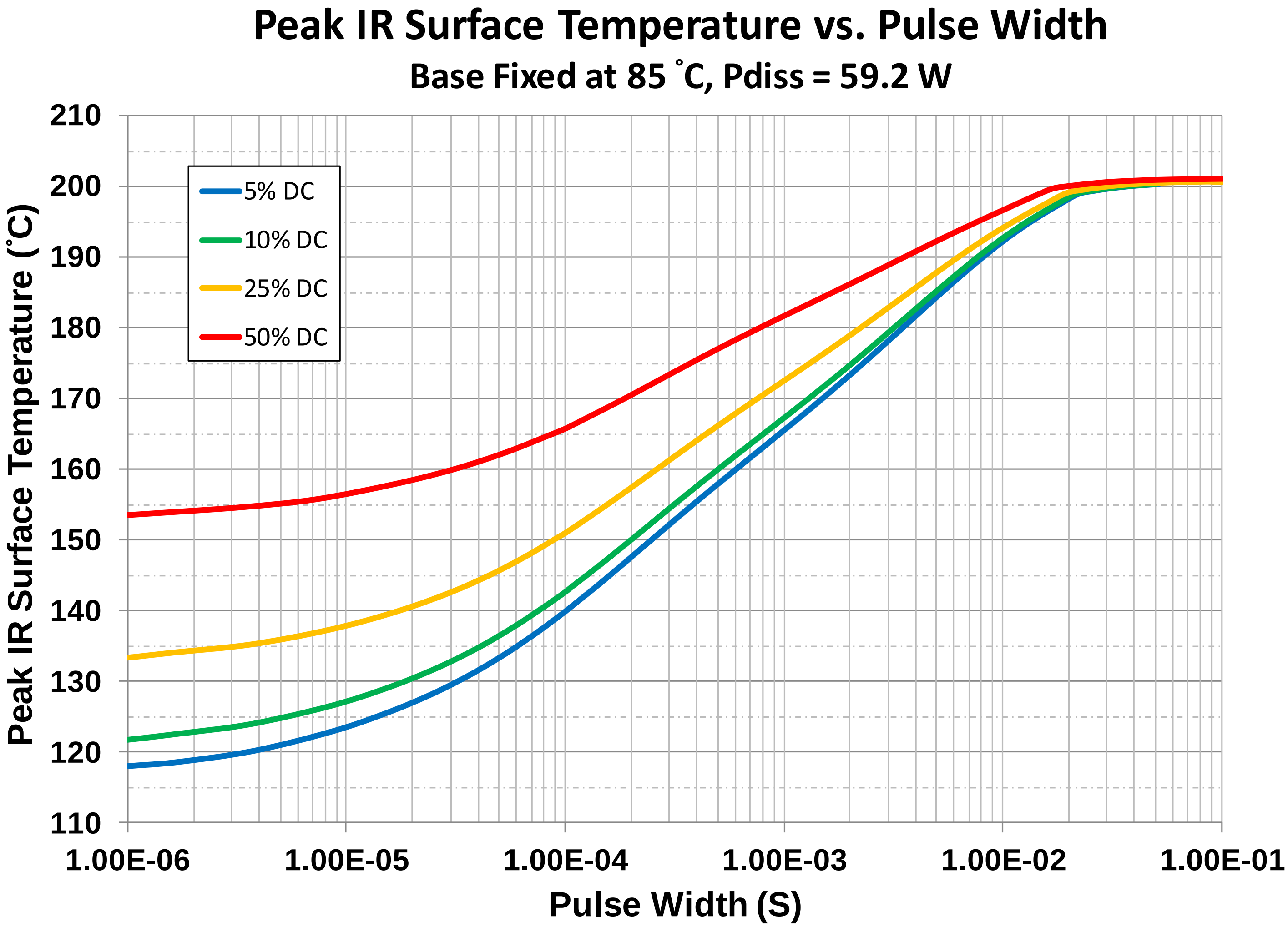
Symbol	Parameter	dB Compression	Typical
VSWR	Impedance Mismatch Ruggedness	3	10:1

Test conditions unless otherwise noted: T_A = 25 °C, V_D = 32 V, I_{DQ} = 220 mA
Driving input power is determined at pulsed 3dB compression under matched condition at EVB output connector.

Maximum Gate Current



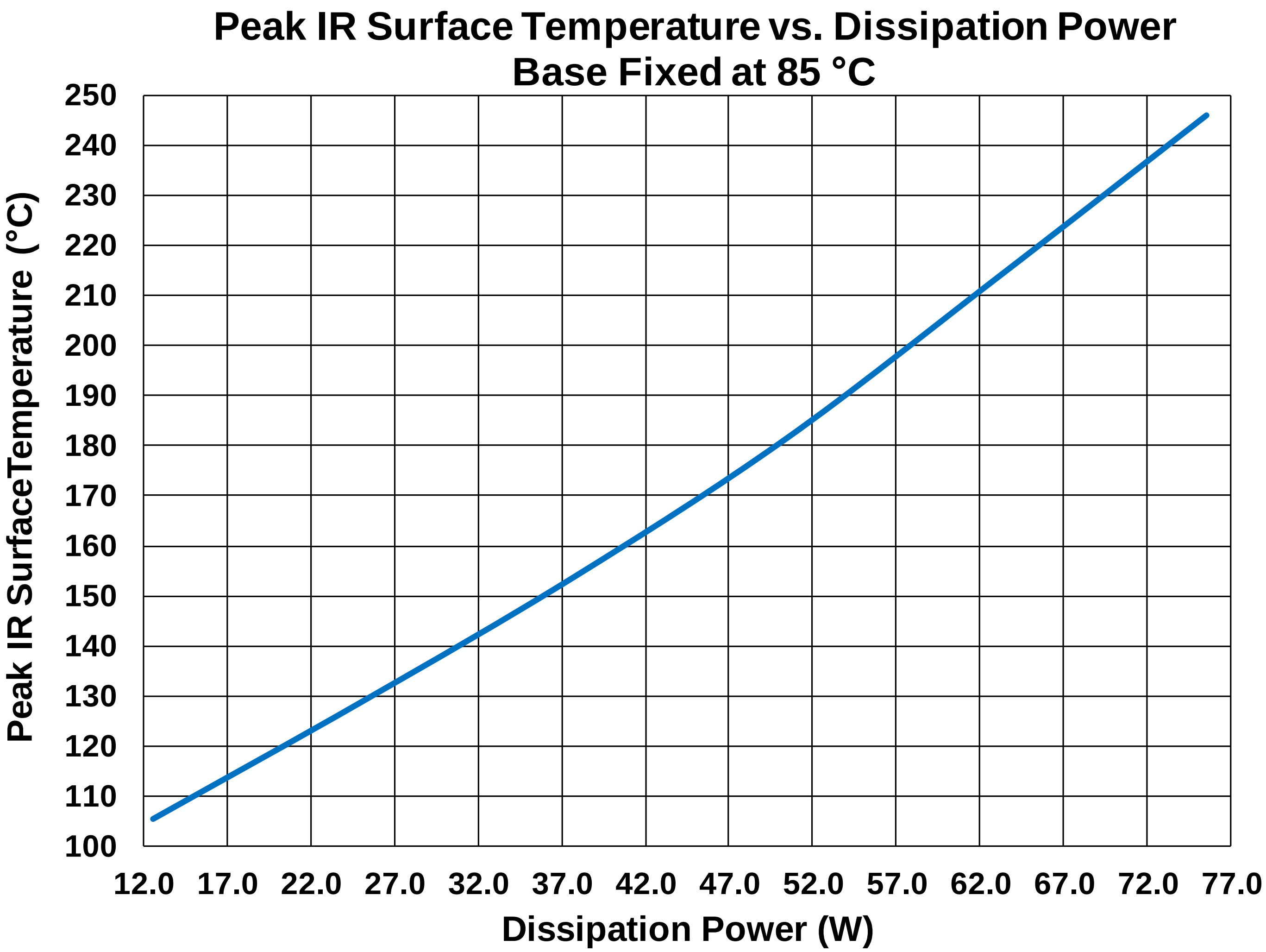
Thermal and Reliability Information – Pulsed



Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	0.93	°C/W
Peak IR Surface Temperature[1] (T_{CH})	59.2 W Pdiss, 100 uS PW, 5% DC	140	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	0.98	°C/W
Peak IR Surface Temperature[1] (T_{CH})	59.2 W Pdiss, 100 uS PW, 10% DC	143	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	1.11	°C/W
Peak IR Surface Temperature[1] (T_{CH})	59.2 W Pdiss, 100 uS PW, 25% DC	151	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case	1.37	°C/W
Peak IR Surface Temperature[1] (T_{CH})	59.2 W Pdiss, 100 uS PW, 50% DC	166	°C

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

Thermal and Reliability Information – CW



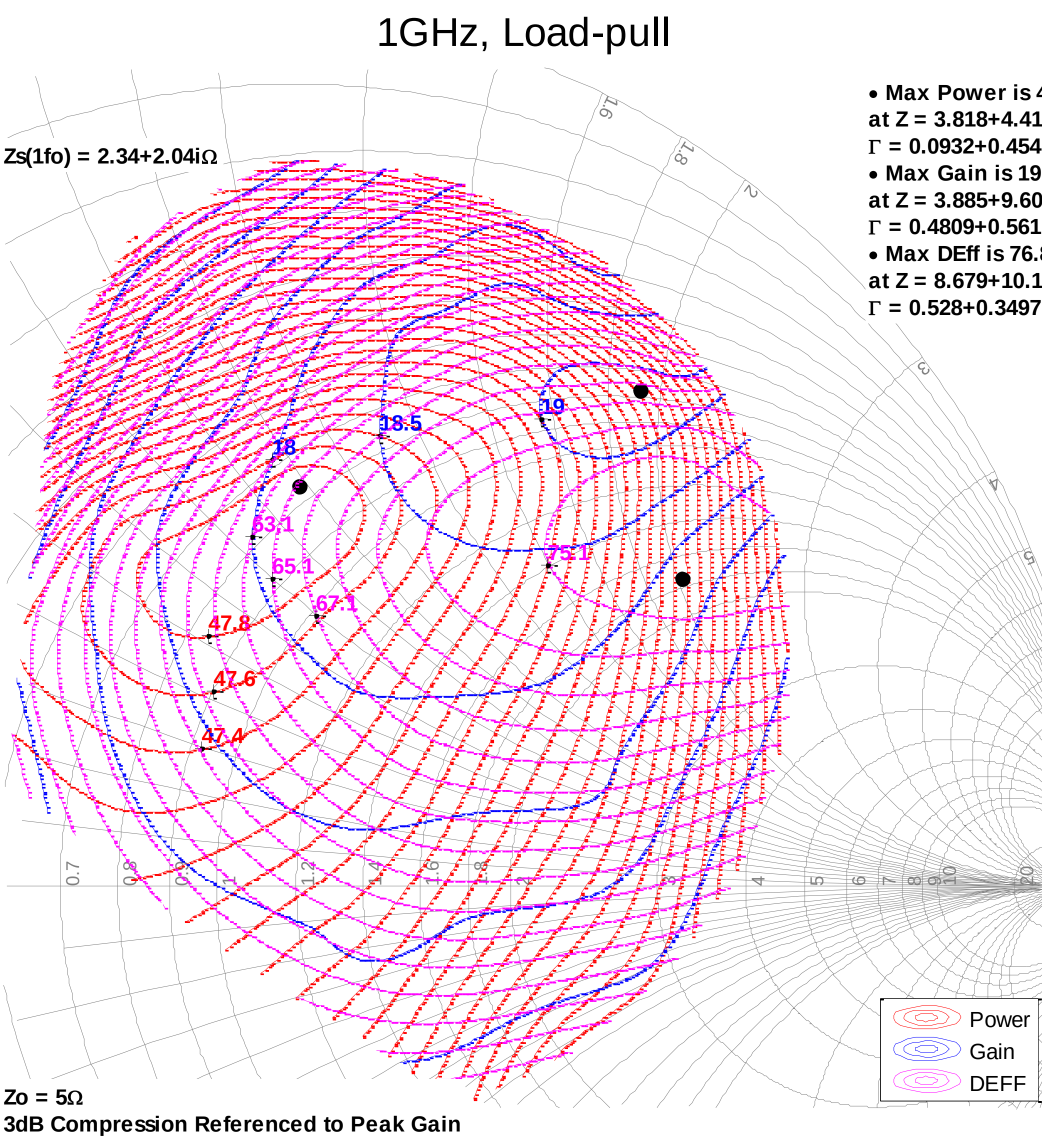
Parameter	Conditions	Values	Units
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 12.6 W Pdiss, CW	1.59	°C/W
Peak IR Surface Temperature[1] (T_{CH})		105	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 25.2 W Pdiss, CW	1.75	°C/W
Peak IR Surface Temperature[1] (T_{CH})		129	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 37.8 W Pdiss, CW	1.83	°C/W
Peak IR Surface Temperature[1] (T_{CH})		154	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 50.4 W Pdiss, CW	1.90	°C/W
Peak IR Surface Temperature[1] (T_{CH})		181	°C
Thermal Resistance, IR[1] (θ_{JC})	85 °C Case 63 W Pdiss, CW	2.03	°C/W
Peak IR Surface Temperature[1] (T_{CH})		213	°C

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

Load-Pull Smith Charts[1, 2]

Notes:

1. 50 V, 260 mA, Pulsed signal with 128 uS pulse width and 10 % duty cycle.
2. See page 15 for load-pull and source-pull reference planes.

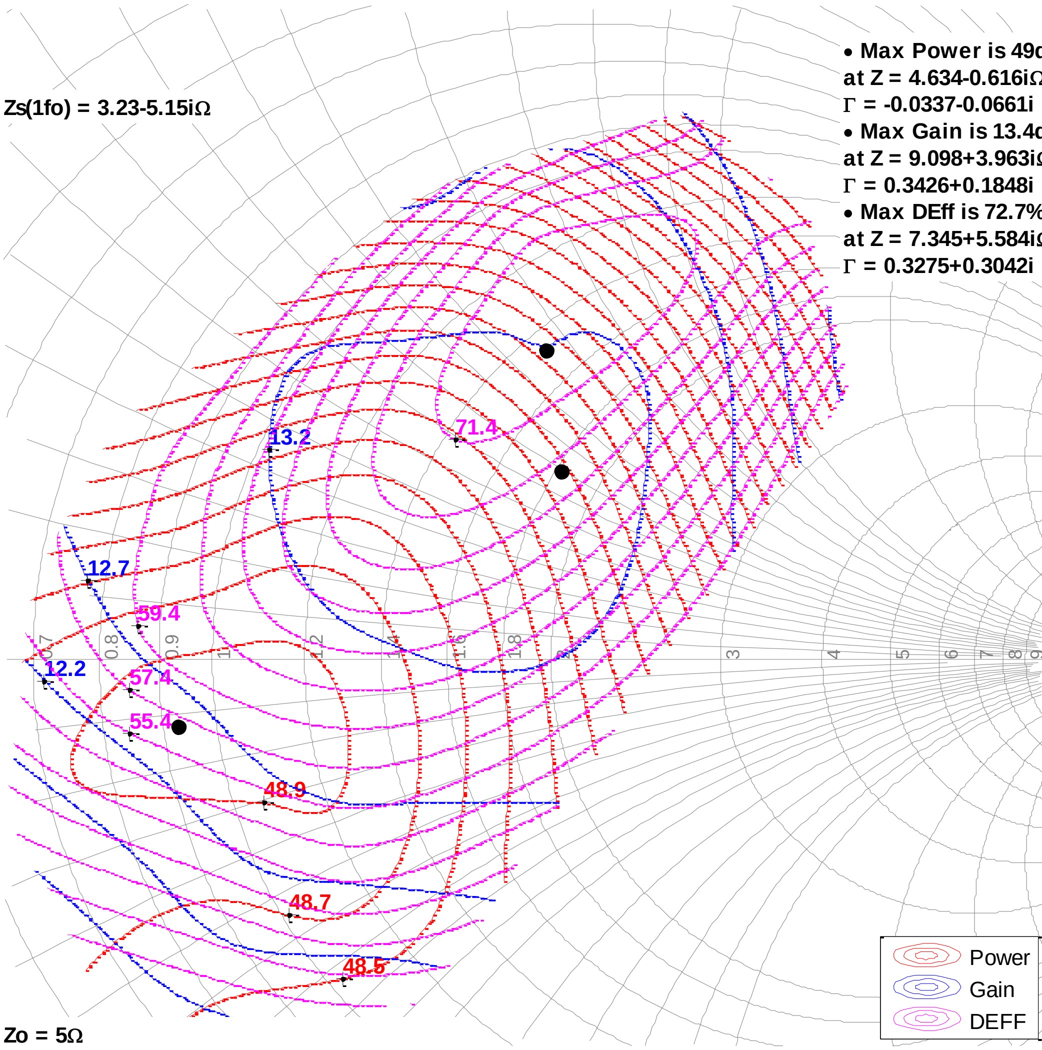


Load-Pull Smith Charts[1, 2, 3]

Notes:

1. 32 V, 220 mA, Pulsed signal with 100 uS pulse width and 20 % duty cycle.
2. See page 15 for load-pull and source-pull reference planes.

2GHz, Load-pull



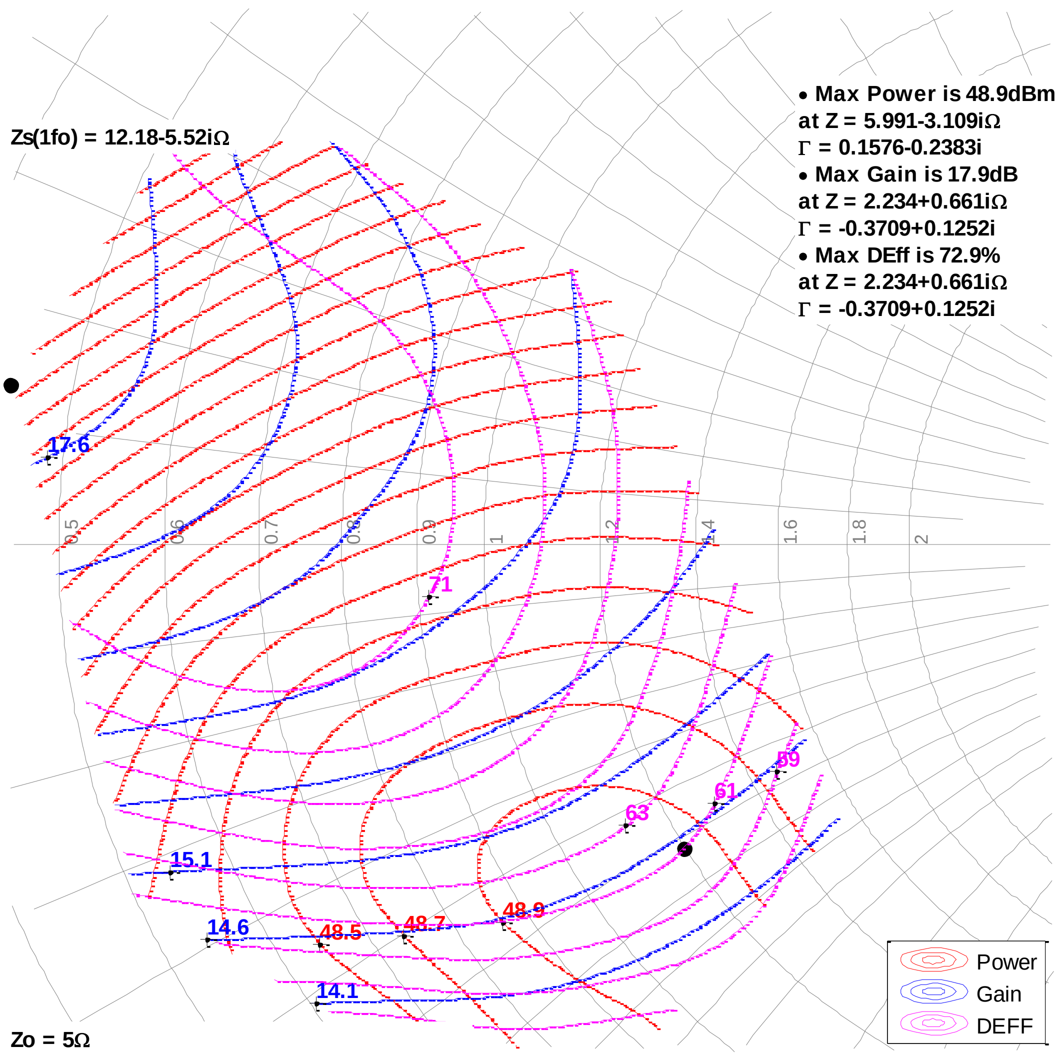
Zo = 5Ω
3dB Compression Referenced to Peak Gain

Load-Pull Smith Charts[1, 2, 3]

Notes:

3. 32 V, 220 mA, Pulsed signal with 100 uS pulse width and 20 % duty cycle.
4. See page 15 for load-pull and source-pull reference planes.

3GHz, Load-pull

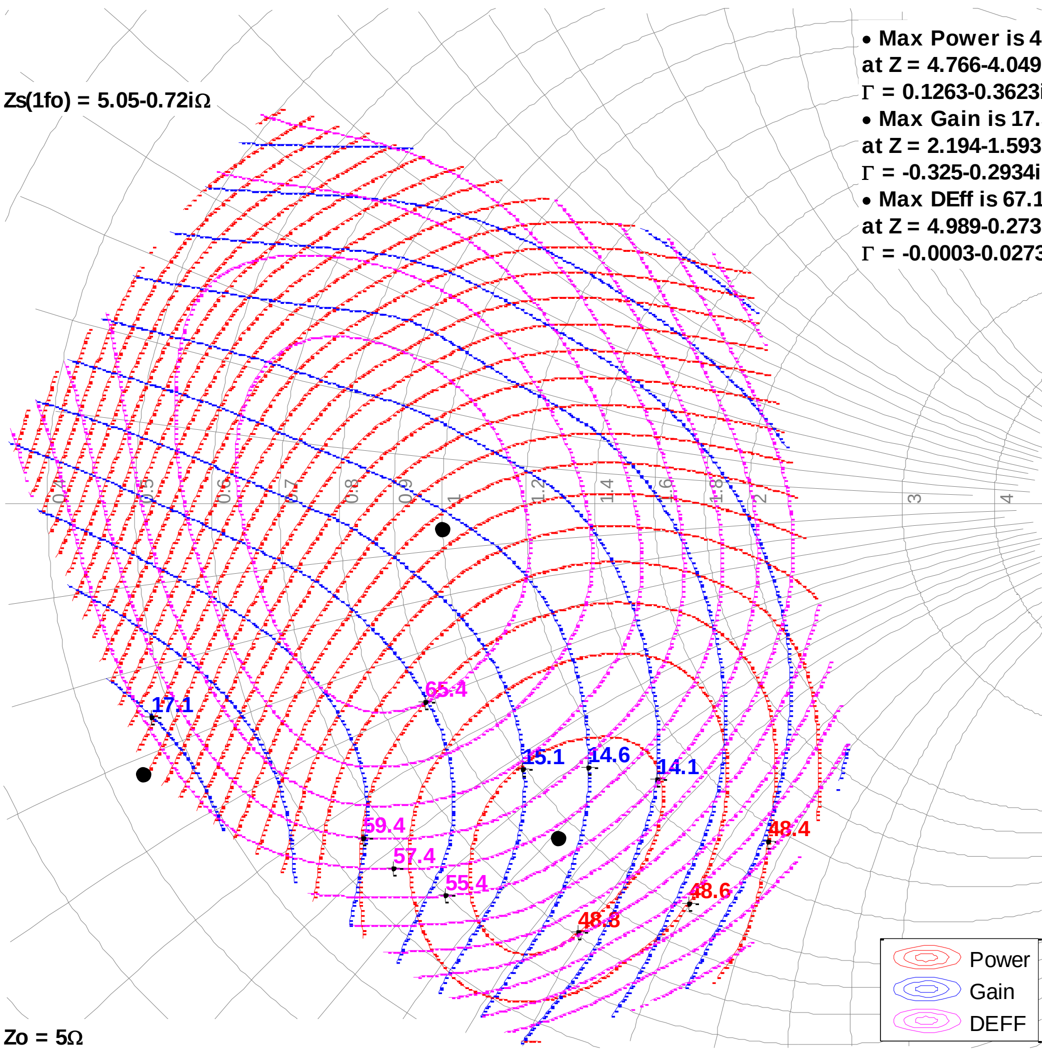


Zo = 5Ω
3dB Compression Referenced to Peak Gain

Load-Pull Smith Charts[1, 2, 3]

Notes:
1. 50 V, 260 mA, Pulsed signal with 100 uS pulse width and 20 % duty cycle.
2. See page 15 for load-pull and source-pull reference planes.

3.5GHz, Load-pull

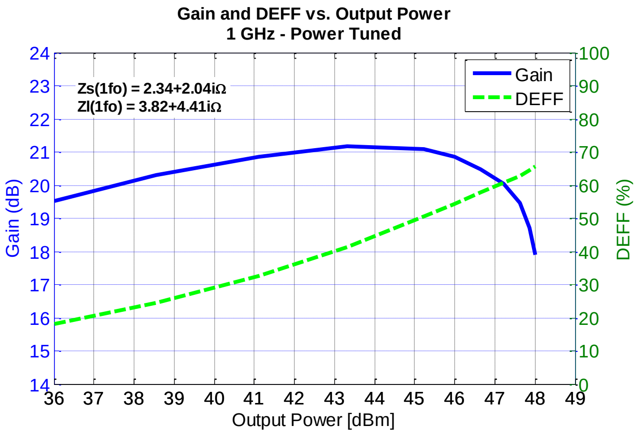


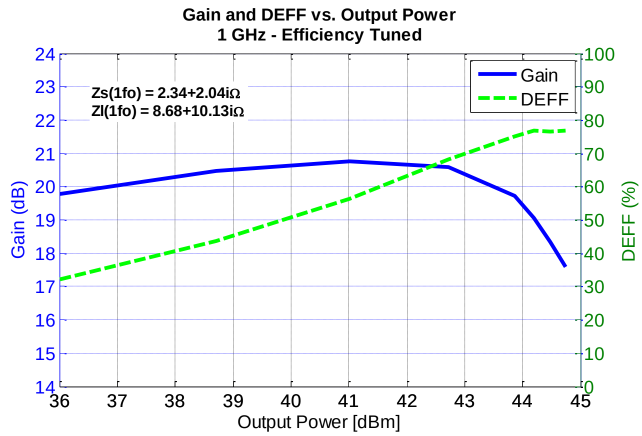
Zo = 5Ω
3dB Compression Referenced to Peak Gain

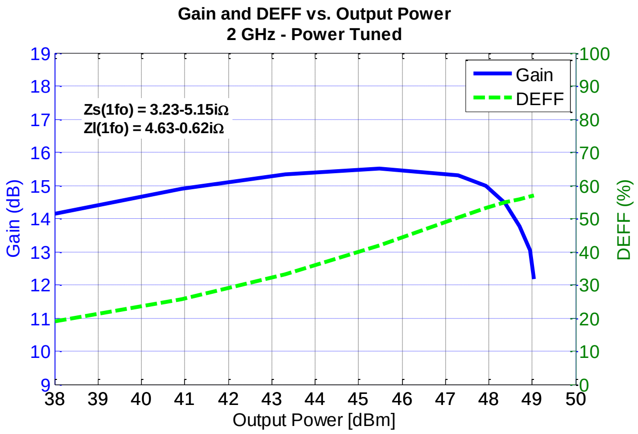
Typical Performance – Load-Pull Drive-up

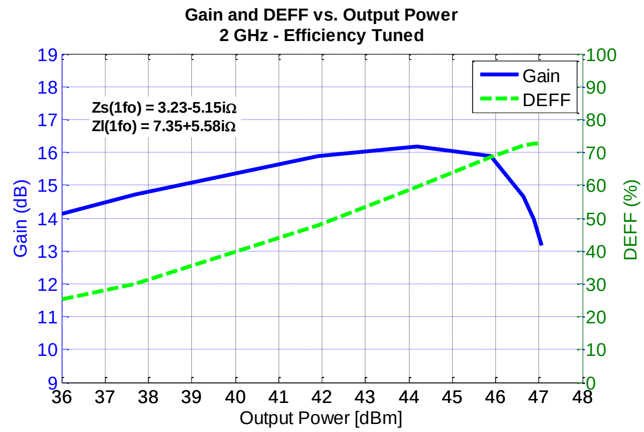
Notes:

1. Pulsed signal with 100 uS pulse width and 10 % duty cycle, Vd = 32 V, I_{DQ} = 220 mA.
2. See page 15 for load-pull and source-pull reference planes where the performance was measured.



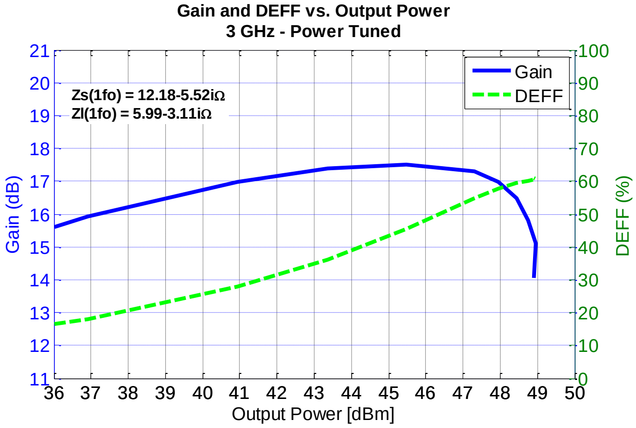


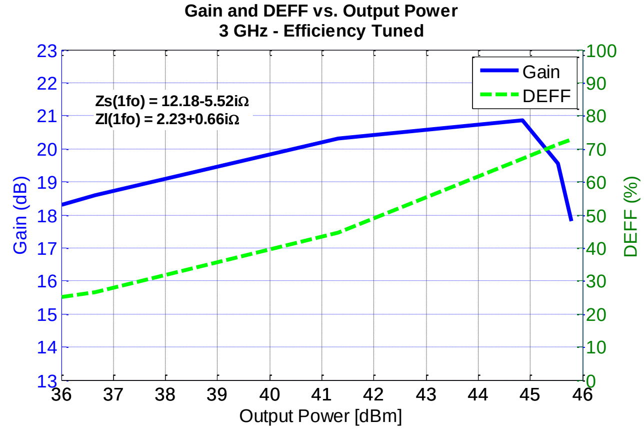


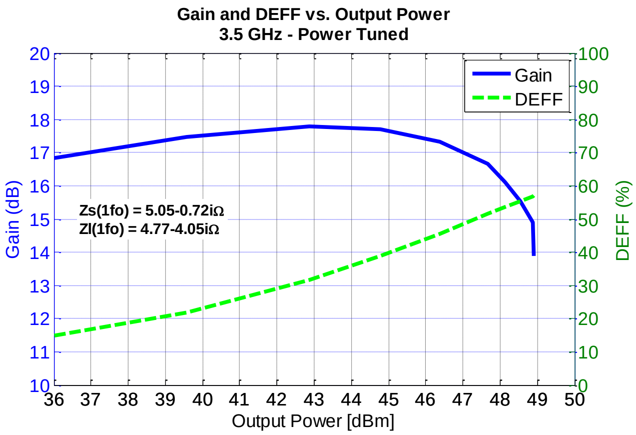


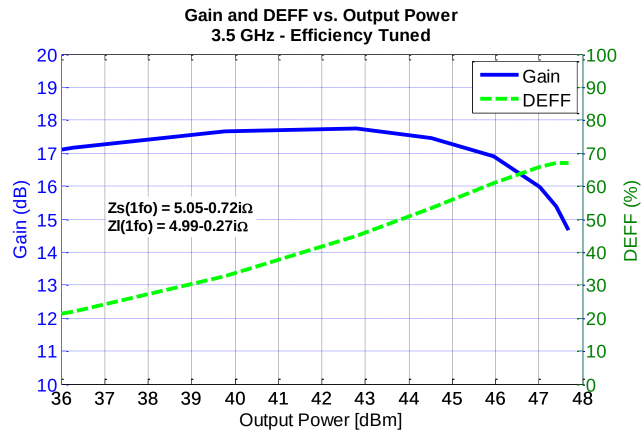
Typical Performance – Load-Pull Drive-up

Notes:
3. Pulsed signal with 100 uS pulse width and 10 % duty cycle, Vd = 32 V, I_{DQ} = 220 mA.
4. See page 15 for load-pull and source-pull reference planes where the performance was measured.





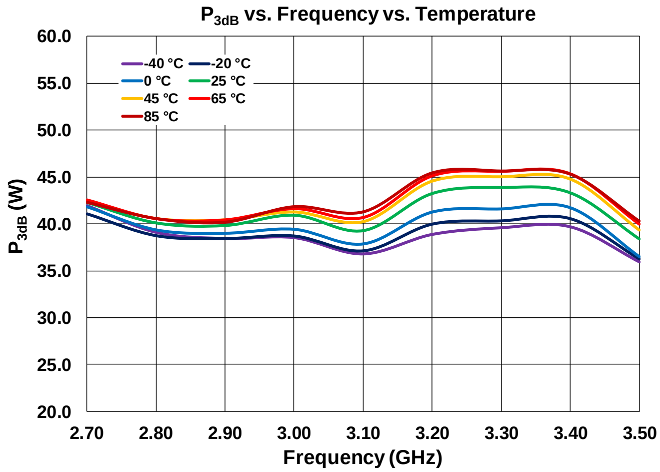


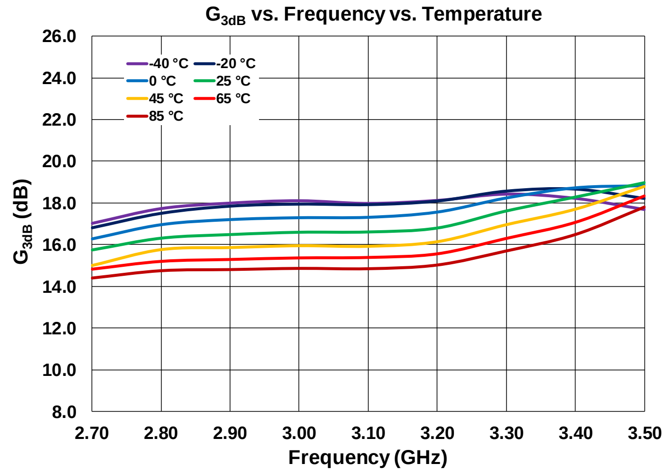


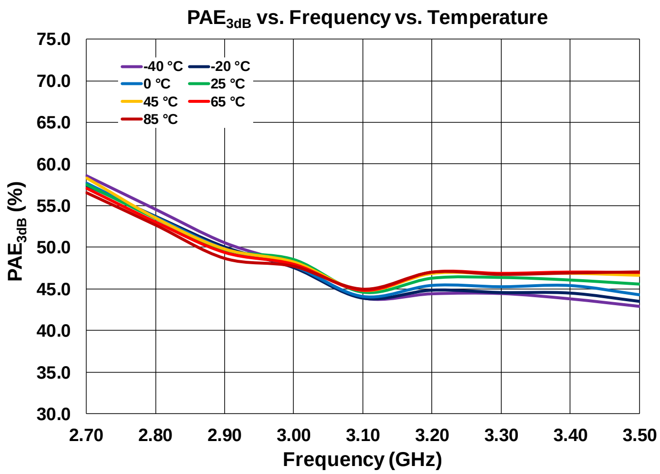
Power Driveup Performance Over Temperatures Of 2.7 – 3.5 GHz EVB[1]

Notes:

1. Pulsed signal with 100 uS pulse width and 20 % duty cycle, Vd = 32 V, I_{DQ} = 220 mA.

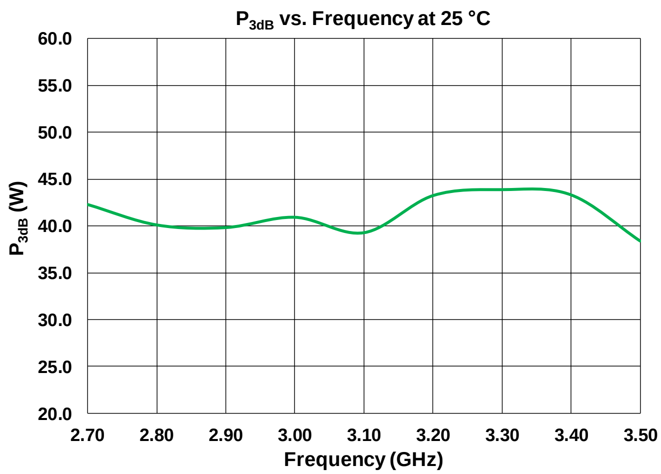


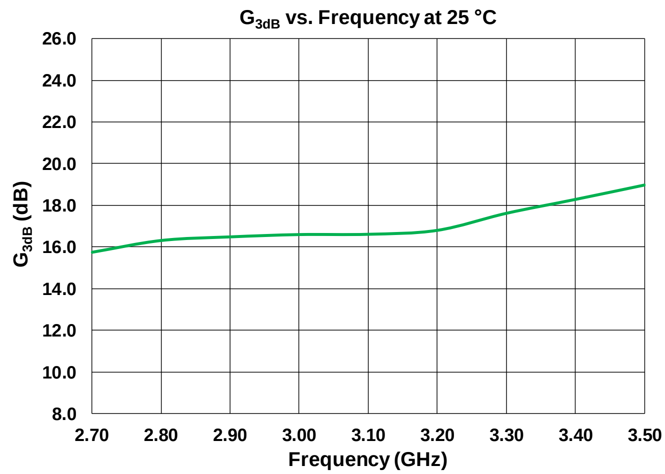


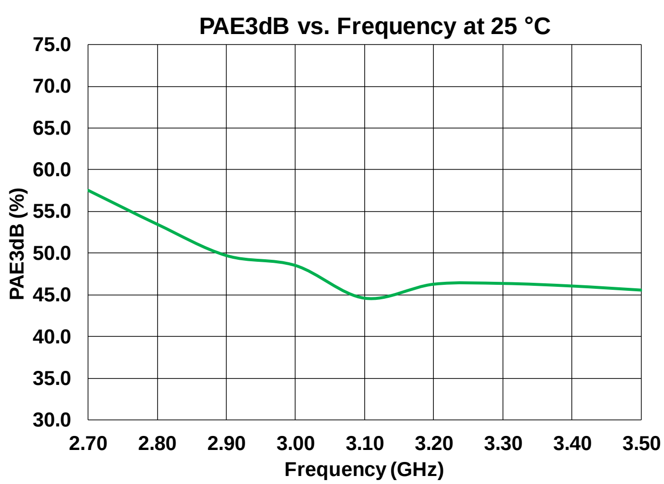


Typical Performance – 2.7 – 3.5 GHz EVB at 25 °C [1]

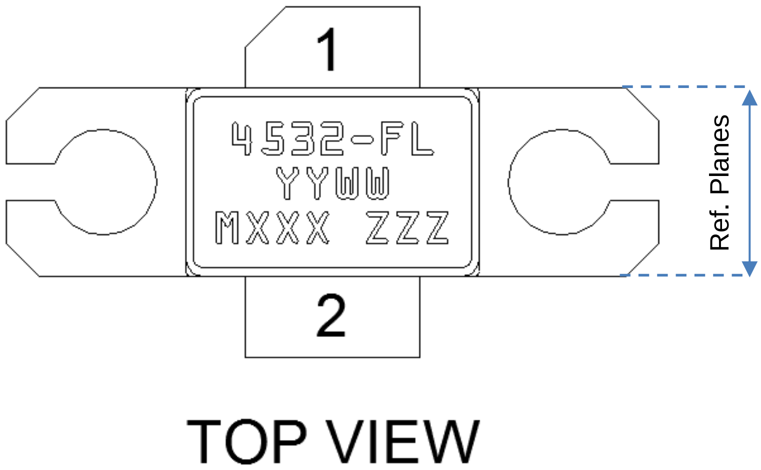
Notes:
1. Pulsed signal with 100 uS pulse width and 20 % duty cycle, Vd = 32 V, I_{DQ} = 220 mA







Pin Layout[1]



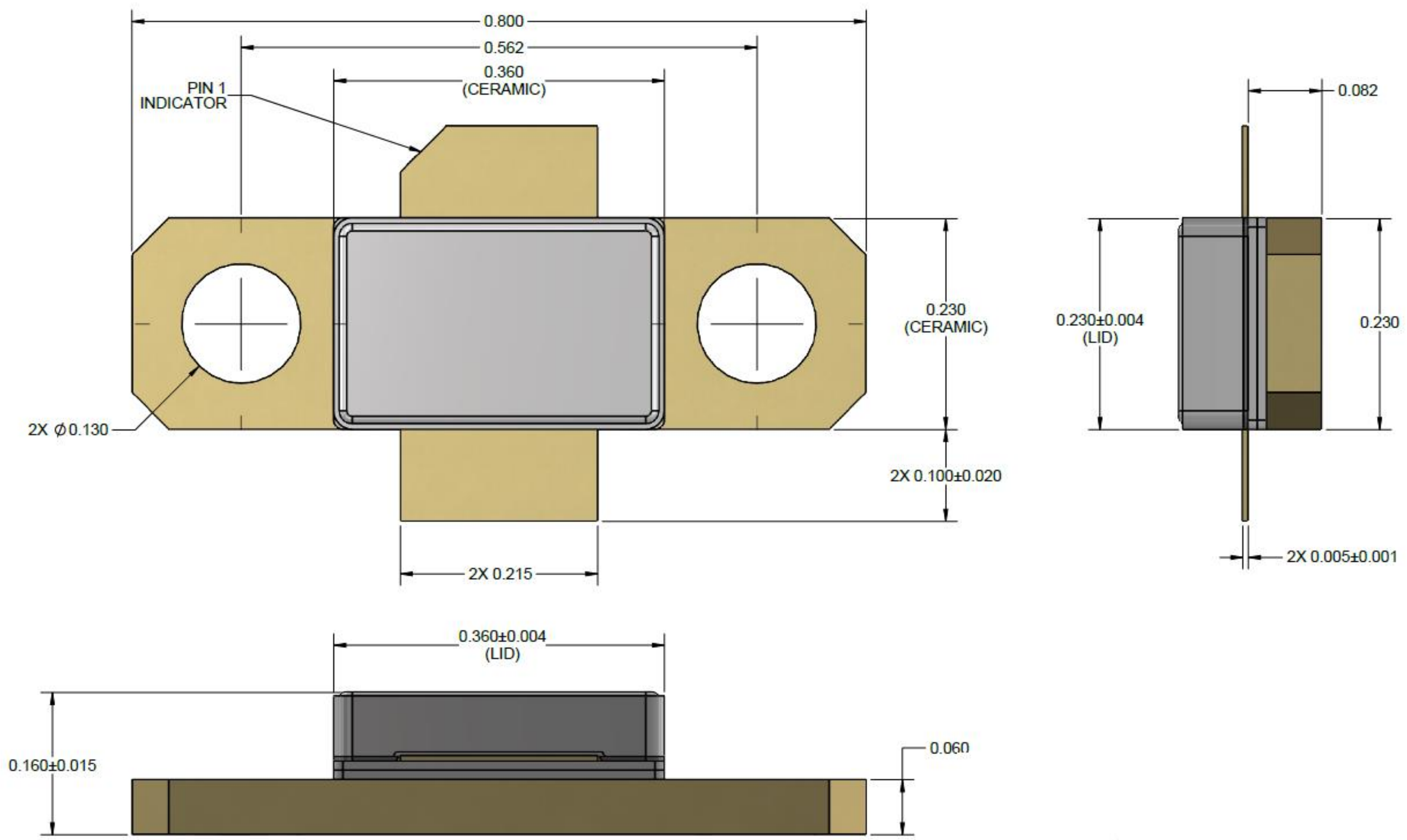
Notes:

1. The T1G4004532-FL will be marked with the "4532-FL" 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, the "MXXX" is the production lot number, and the "ZZZ" is an auto-generated serial number.

Pin Description

Pin	Symbol	Description
1	VG / RF IN	Gate voltage / RF Input
2	VD / RF OUT	Drain voltage / RF Output
3	Flange	Source to be connected to ground

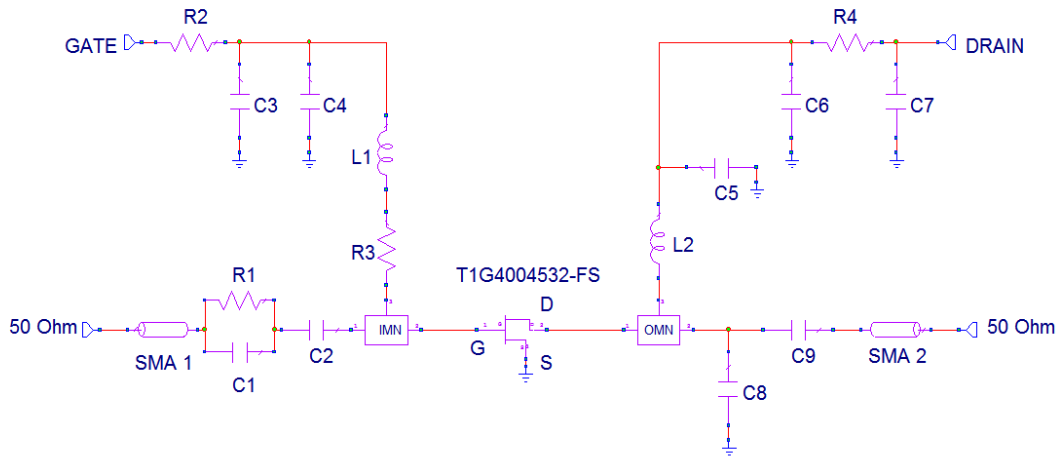
Mechanical Drawing[1]



Note 1:

1. All dimensions are in inches. Angles are in degrees.
2. Dimension tolerance is ± 0.005 inches, unless otherwise noted.
3. Material:
   Package Base: Ceramic / Metal
   Package Lid: Ceramic
4. Package exposed metallization is gold plated.
5. Part is epoxy sealed.
6. Part meets industry NI360 footprint.
7. Body dimensions do not include epoxy runout which can be up to 0.020 inches per side.

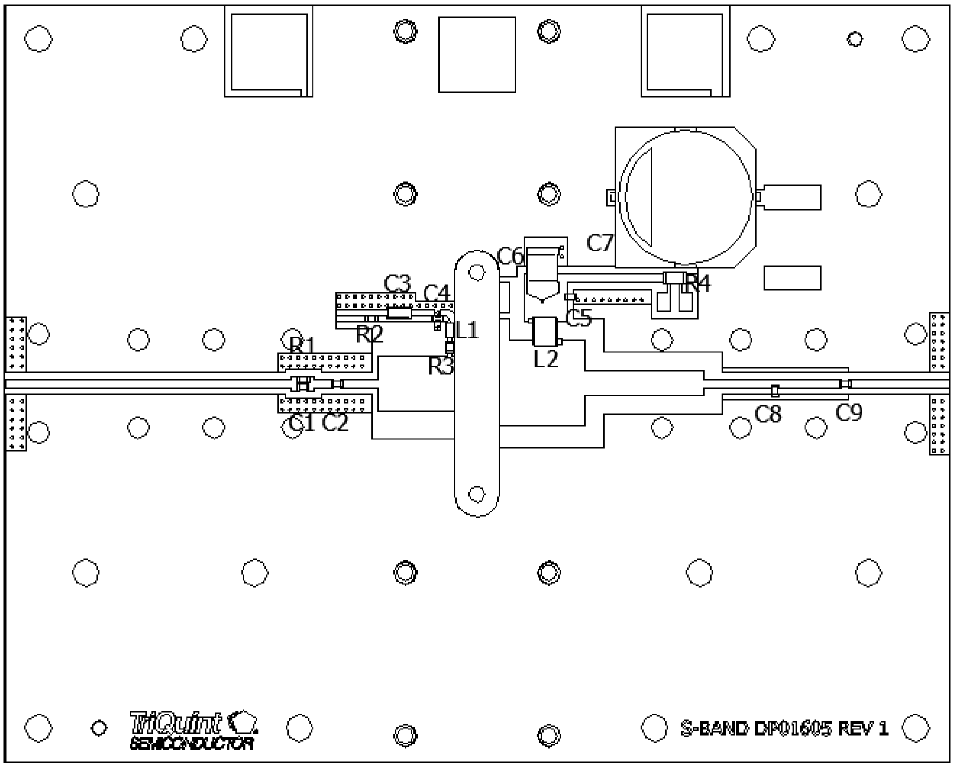
2.7 – 3.5 GHz Application Circuit - Schematic



Bias-up Procedure	Bias-down Procedure
1. Set V_G to -4 V.	1. Turn off RF signal.
2. Set I_D current limit to 250 mA.	2. Turn off V_D
3. Apply 32 V V_D.	3. Wait 2 seconds to allow drain capacitor to discharge
4. Slowly adjust V_G until I_D is set to 220 mA.	4. Turn off V_G
5. Set I_D current limit to 0.7 A (Pulsed operation)	
6. Apply RF.	

2.7 – 3.5 GHz Application Circuit – Layout[1]

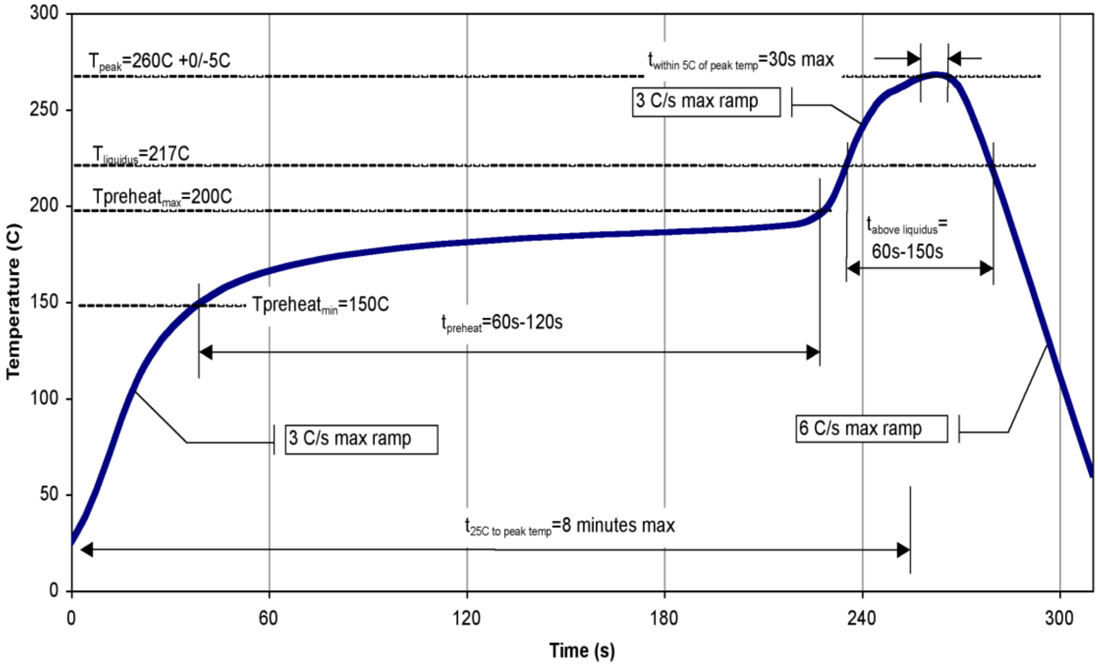
Note 1: Board material is RO4350B 0.032” thickness with 1oz copper cladding.



2.7 – 3.5 GHz Application Circuit - Bill Of material

Ref Des	Value	Qty	Manufacturer	Part Number
C1, C2, C9	5.6 pF	3	ATC	600S5R6AW250T
C3	10 uF	1	TDK	C1632X5R0J106M
C4	1.0 uF	1	Murata	NFM18PS105R0J3
C5	100 pF	1	ATC	600S100AW250T
C6	10 uF	1	Vishay Sprague	595D106X9035D2T
C7	220 uF	1	AFK	AFK227M2AR44B
C8	0.7 pF	1	ATC	600S0R7AW250T
L1	3.6 nH	1	Coilcraft	0603HC-3N6XJL
L2	6.6 nH	1	Coilcraft	GA3093-ALB
R1	100 Ohms	1	Vishay Dale	CRCW0603100RFKEC
R2, R3	10 Ohms	2	Vishay Dale	CRCW060310R0FKEA
R4	0.01 Ohms	1	Panasonic	ERJ-8BWJR010V

Recommended Solder Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1A ≥ 400 V	ANSI/ESD/JEDEC JS-001
ESD – Charged Device Model (CDM)	Class C3 ≥ 1000 V	ANSI/ESD/JEDEC JS-002
MSL – Moisture Sensitivity Level	MSL3	IPC/JEDEC 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.

Contact plating: NiAu. Au thickness is 60 microinches minimum.

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 ($C_{15}H_{12}Br_4O_2$) Free
- PFOS Free
- SVHC Free

Pb

Contact Information

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

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Email: customer.support@tqs.com

For technical questions and application information: **Email:** info-products@qorvo.com

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