TGF3020-SM

4 – 6 GHz, 32 V, 5 W GaN RF Input-Matched Transistor

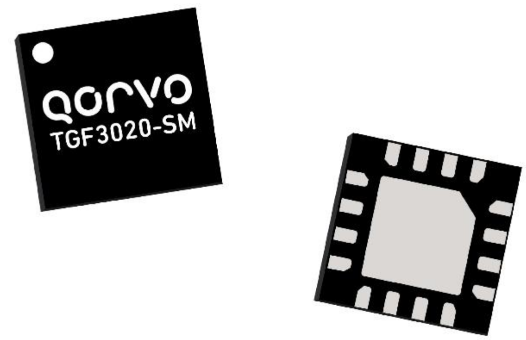
Product Overview

The Qorvo TGF3020-SM is a 5W (P_{3dB}), 50 Ω -input matched discrete GaN on SiC HEMT which operates from 4.0 to 6.0GHz. 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.

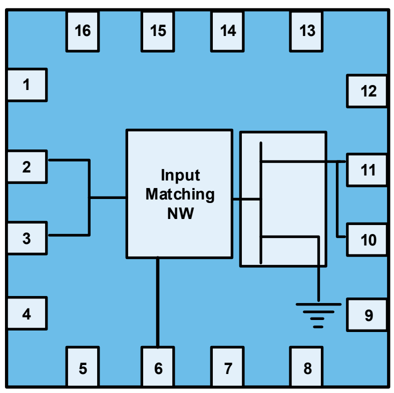
Lead-free and ROHS compliant.

Evaluation boards are available upon request.



3 x 3mm QFN package

Functional Block Diagram



Key Features

- Frequency: 4 to 6 GHz
- Output Power (P_{3dB})[1]: 6.8 W
- Linear Gain[1]: 13 dB
- Typical PAE_{3dB}[1]: 60%
- Operating Voltage: 32 V
- CW and Pulse capable

  Note 1: @ 5 GHz Load Pull

TGF3020-SMEVB01 Performance

Freq.(GHz)	P_{3dB}(W)	G_{3dB}(dB)	DE_{3dB}(%)
5.3	5.5	8.8	51.9
5.4	5.7	8.7	53.1
5.5	5.6	8.9	52.9
5.6	5.3	9.1	52.4
5.7	5.2	9.2	52.5
5.8	5.0	9.0	51.1
5.9	4.9	8.9	50.3

Pulse Width = 100uS, Duty Cycle = 20%,
V_D = +32 V, I_{DQ} = 25 mA, 25°C Base Temperature

Applications

- Telemetry
- C-band radar
- Communications
- Test instrumentation
- Wideband amplifiers
- 5.8GHz ISM

TGF3020-SMEVB02 Performance

Freq.(GHz)	P_{3dB}(W)	G_{3dB}(dB)	DE_{3dB}(%)
4.0	4.9	9.0	52.1
4.4	5.5	8.9	51.2
4.8	5.7	8.9	52.8
5.2	5.4	9.4	57.0
5.6	4.6	9.2	52.8
6.0	3.8	8.5	43.4

Pulse Width = 100uS, Duty Cycle = 20%
V_D = +32 V, I_{DQ} = 25 mA, 25°C Base Temperature

Ordering Information

Part No.	Description
TGF3020-SM	QFN Packaged Part
TGF3020-SMEVB01	5.3 – 5.9 GHz EVB
TGF3020-SMEVB02	4 – 6 GHz EVB

Absolute Maximum Ratings[1]

Parameter	Rating	Units
Breakdown Voltage, BV_{DG}	+100	V
Gate Voltage Range, V_G	−7 to +2	V
Drain Current, I_{DMAX}	0.6	A
Power Dissipation, P_{DISS}[2]	10.4	W
RF Input Power, CW, T = 25 °C	+30	dBm
Storage Temperature	−65 to +150	°C

Notes:

1. Operation of this device outside the parameter ranges given above may cause permanent damage.
2. Pulsed 100uS PW, 20% DC

Recommended Operating Conditions[1]

Parameter	Min	Typ	Max	Units
Operating Temp. Range	−40	+25	+85	°C
Drain Voltage Range, V_D	+12	+32	+40	V
Drain Bias Current, I_{DQ}		25		mA
Drain Current, I_D[4]	–	0.25	–	A
Gate Voltage, V_G[3]	–	−2.8	–	V
Power Dissipation (P_D)[2,4]	–	–	7.6	W
Power Dissipation (P_D), CW[2]	–	–	6.2	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 base at 85 °C
3. To be adjusted to desired I_{DQ}
4. Pulsed, 100uS PW, 20% DC

Measured Load Pull Performance – Power Tuned[1, 2]

Parameter	Typical Values				Units
Frequency, F	4	4.4	5	5.5	GHz
Drain Voltage, V_D	32	32	32	32	V
Drain Bias Current, I_{DQ}	25	25	25	25	mA
Output Power at 3dB compression, P_{3dB}	38.4	38.3	38.3	38.2	dBm
Power Added Efficiency at 3dB compression, PAE_{3dB}	50.1	50.4	49.5	53.0	%
Gain at 3dB compression, G_{3dB}	9.6	9.7	9.7	10.3	dB

Notes:

1. Pulsed, 100 uS Pulse Width, 20% Duty Cycle
2. Load-pull characteristic Impedance, Zo = 50 Ω.

Measured Load Pull Performance – Efficiency Tuned[1, 2]

Parameter	Typical Values				Units
Frequency, F	2.7	2.9	3.1	3.3	GHz
Drain Voltage, V_D	32	32	32	32	V
Drain Bias Current, I_{DQ}	25	25	25	25	mA
Output Power at 3dB compression, P_{3dB}	37.6	36.8	37.1	36.8	dBm
Power Added Efficiency at 3dB compression, PAE_{3dB}	60.1	61.5	59.6	59	%
Gain at 3dB compression, G_{3dB}	10.3	10.3	10.1	10.7	dB

Notes:

1. Pulsed, 100 uS Pulse Width, 20% Duty Cycle
2. Load-pull characteristic Impedance, Zo = 50 Ω.

RF Characterization 5.3 – 5.9 GHz EVB – 5.4 GHz Performance[1]

Parameter	Min	Typ	Max	Units
Linear Gain, G_{LIN}	–	11.7	–	dB
Output Power at 3dB compression point, P3dB	–	5.7	–	W
Drain Efficiency at 3dB compression point, DEFF3dB	–	53.1	–	%
Gain at 3dB compression point, G3dB	–	8.7	–	dB

Notes:
1. V_D = +32 V, I_{DQ} = 25 mA, Temp = +25 °C, Pulse Width = 100 uS, Duty Cycle = 20%

RF Characterization 4 – 6 GHz EVB – 4.7 GHz Performance[1]

Parameter	Min	Typ	Max	Units
Linear Gain, G_{LIN}	–	11.8	–	dB
Output Power at 3dB compression point, P3dB	–	5.6	–	W
Drain Efficiency at 3dB compression point, DEFF3dB	–	51.7	–	%
Gain at 3dB compression point, G3dB	–	8.8	–	dB

Notes:
1. V_D = +32 V, I_{DQ} = 25 mA, Temp = +25 °C, Pulse Width = 100 uS, Duty Cycle = 20%

RF Characterization – Mismatch Ruggedness at 5.3 GHz and 5.9 GHz

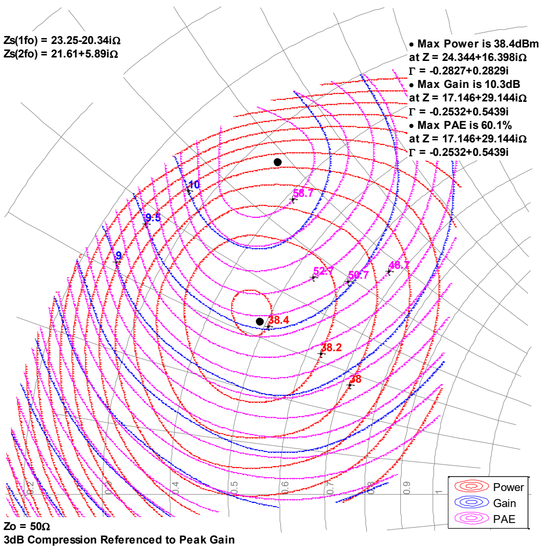
Symbol	Parameter	dB Compression	Typical
VSWR	Impedance Mismatch Ruggedness	3	10:1

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

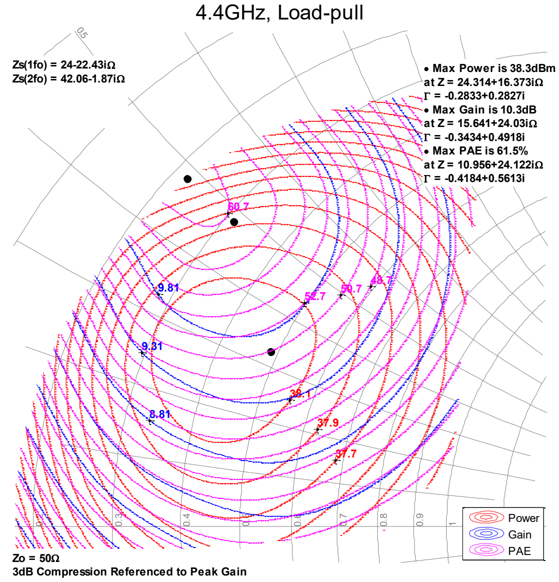
Measured Load-Pull Smith Charts[1, 2]

Notes:
1. Test Conditions: V_D = 32 V, I_{DQ} = 25 mA, 100 uS Pulse Width, 20% Duty Cycle

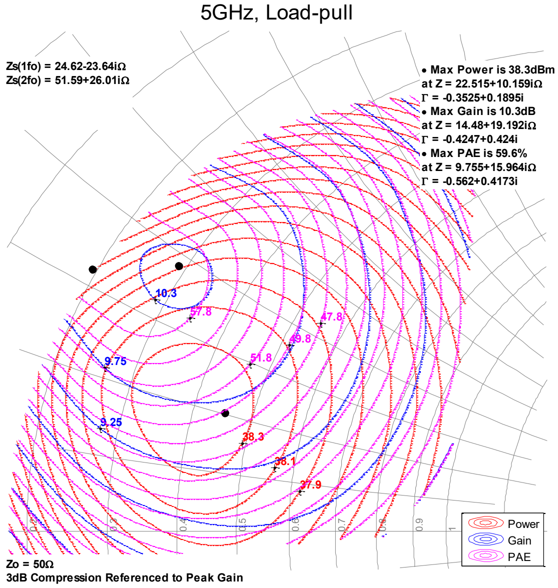
4GHz, Load-pull



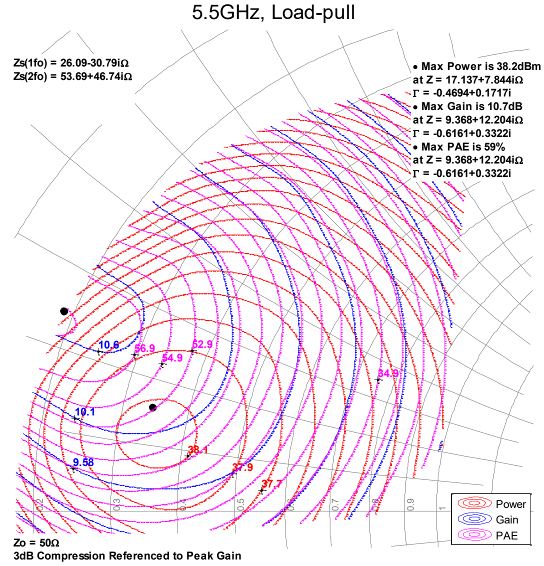
4.4GHz, Load-pull



5GHz, Load-pull

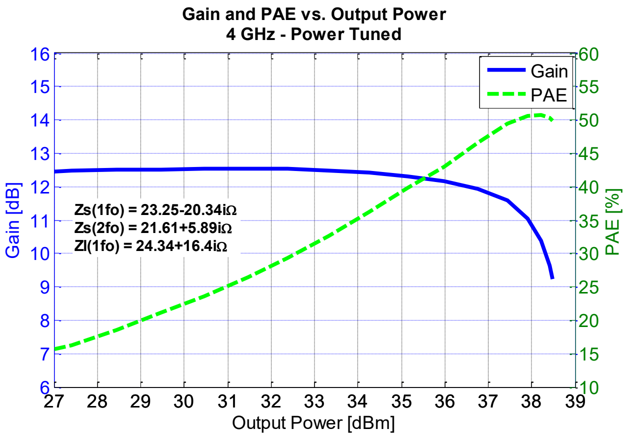


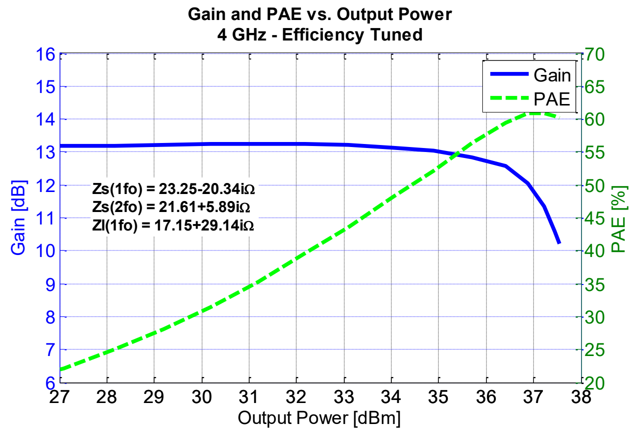
5.5GHz, Load-pull

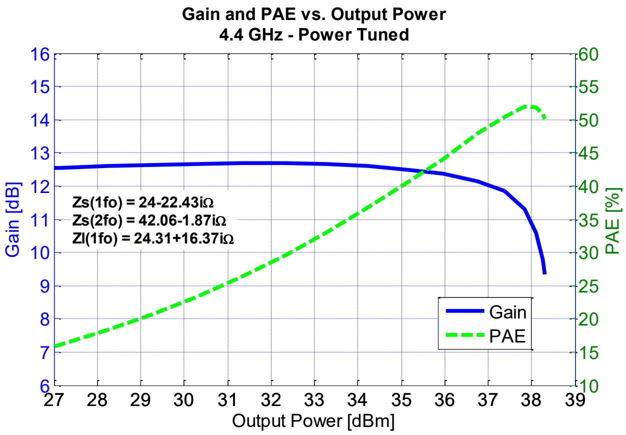


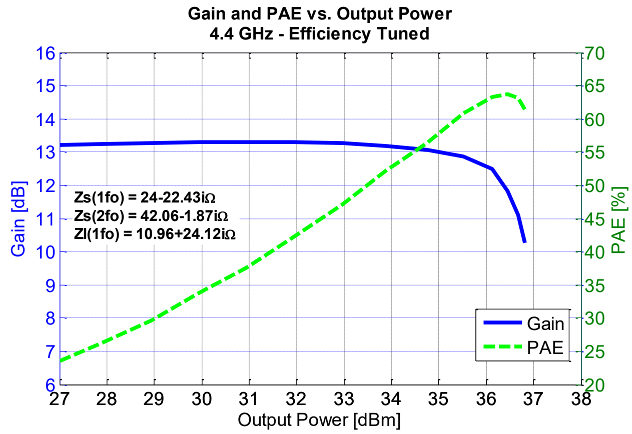
Typical Measured Performance – Load-Pull Drive-up[1, 2]

Notes:
1. Pulsed signal with 100uS pulse width and 20% duty cycle



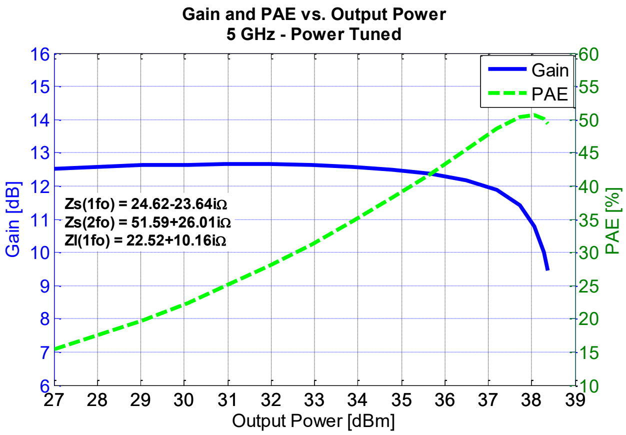


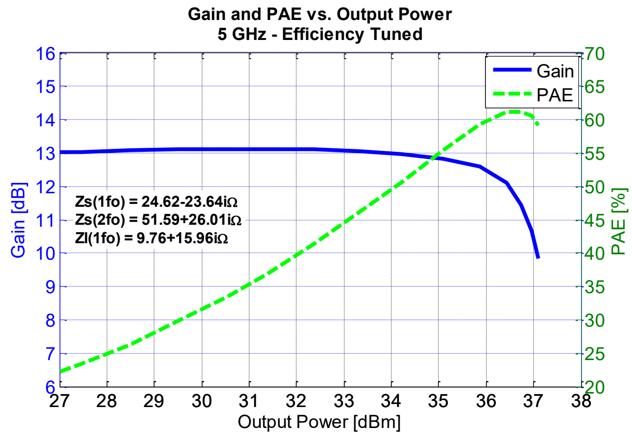


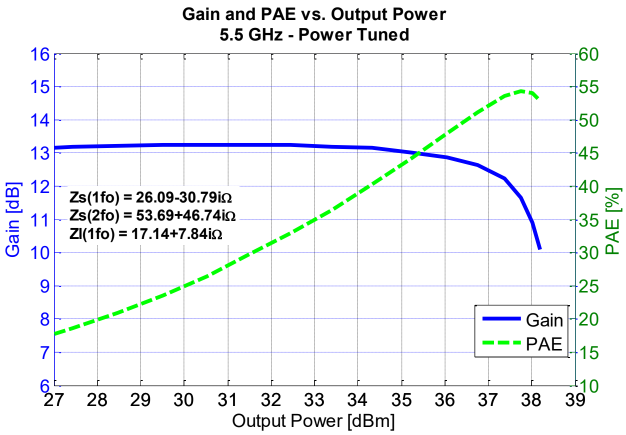


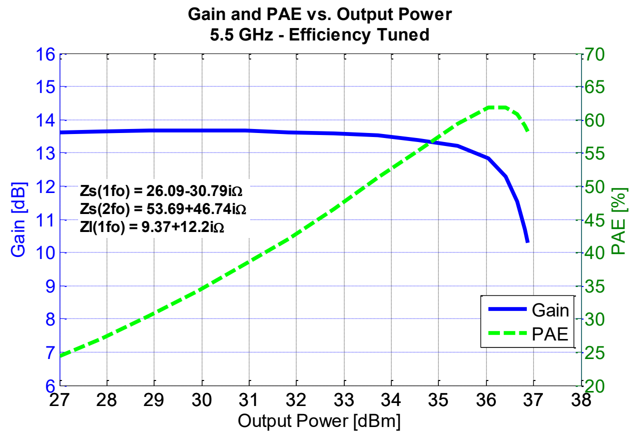
Typical Measured Performance – Load-Pull Drive-up[1, 2]

Notes:
1. Pulsed signal with 100uS pulse width and 20% duty cycle



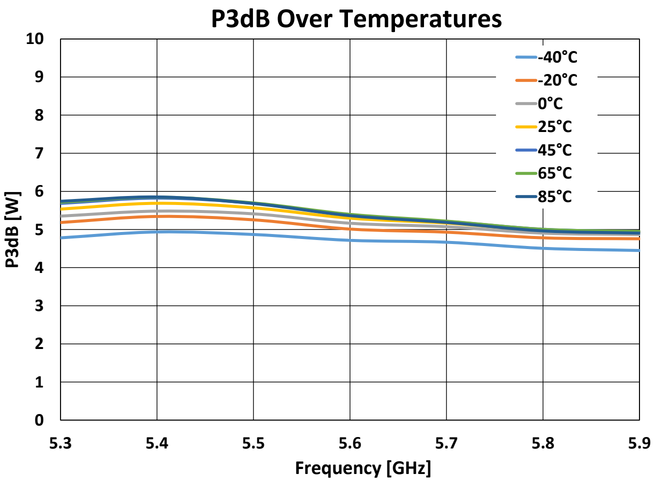


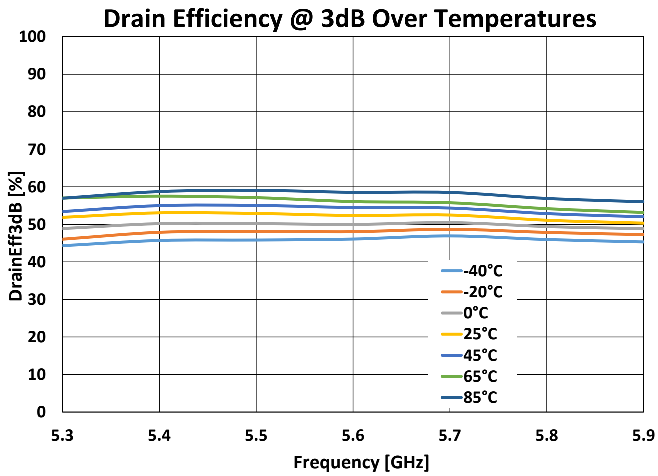


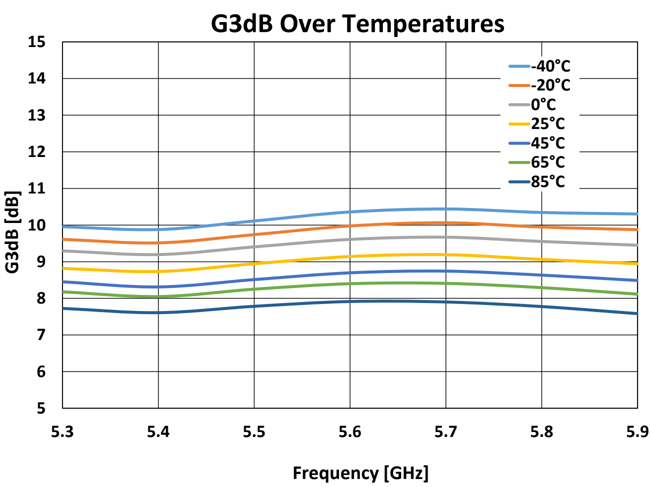


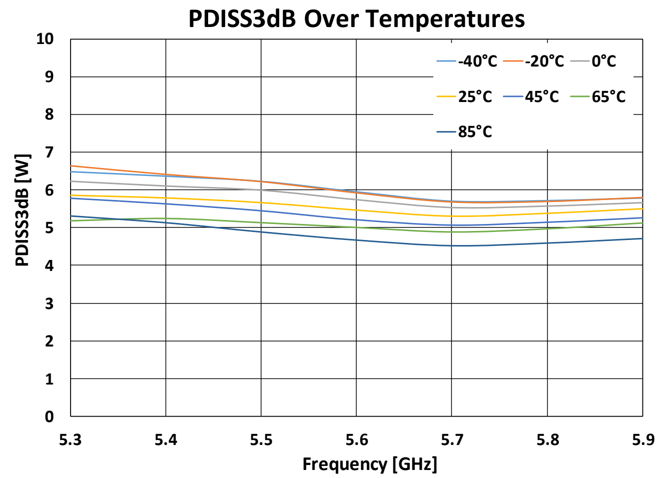
Power Driveup Performance Over Temperatures Of 5.3 – 5.9 GHz EVB[1, 2]

Notes:
1. Test Conditions: V_D = 32 V, I_{DQ} = 25 mA, 20 uS Pulse Width, 20% Duty Cycle
2. The dissipation power limit is conservative because it is specified at DUT only without accounting for the loss of the output matching network.



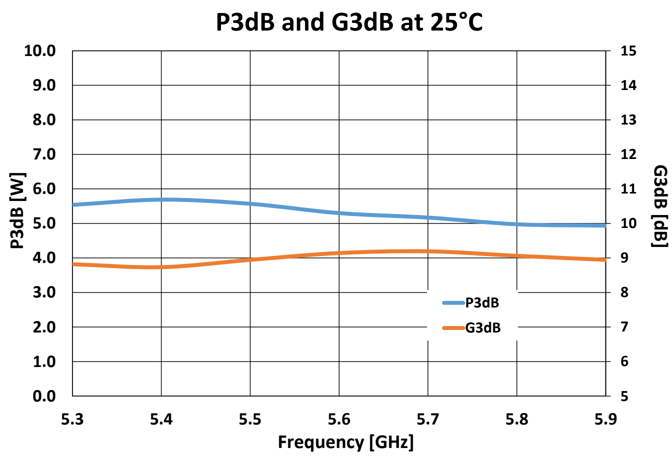


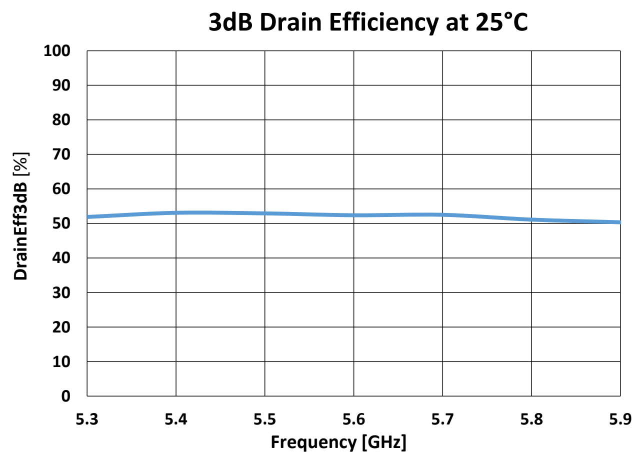


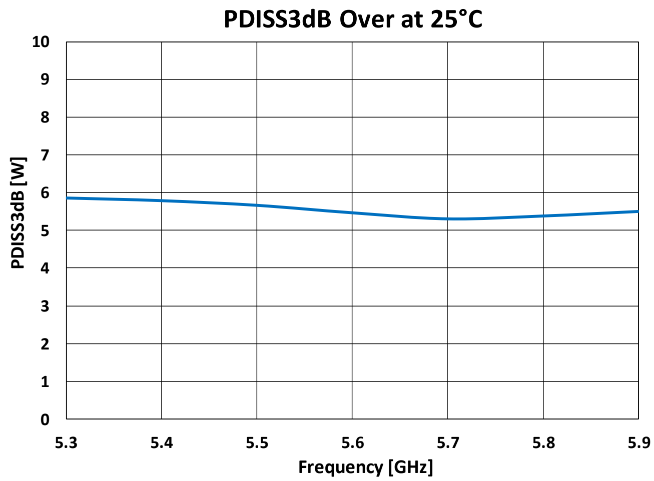


Power Driveup Performance At 25°C Of 5.3 – 5.9 GHz EVB[1, 2]

Notes:
1. Test Conditions: V_D = 32 V, I_{DQ} = 25 mA, 20 uS Pulse Width, 20% Duty Cycle
2. The dissipation power limit is conservative because it is specified at DUT only without accounting for the loss of the output matching network..

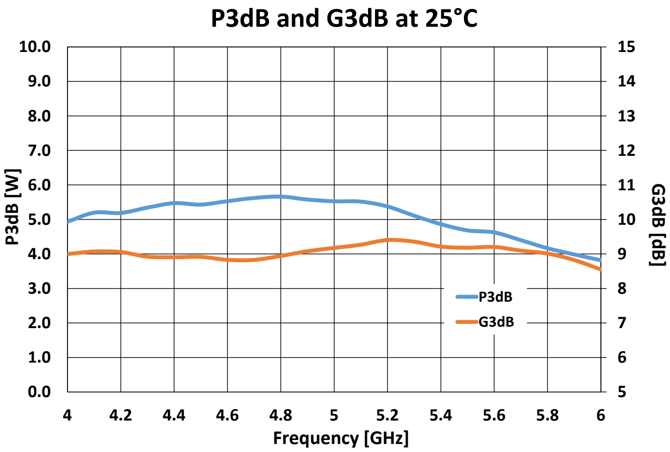


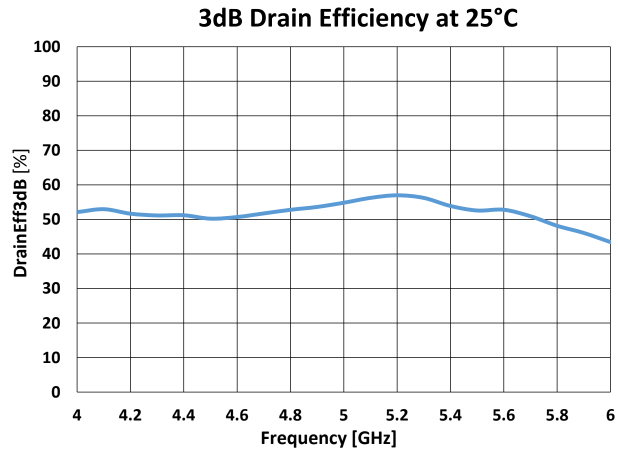


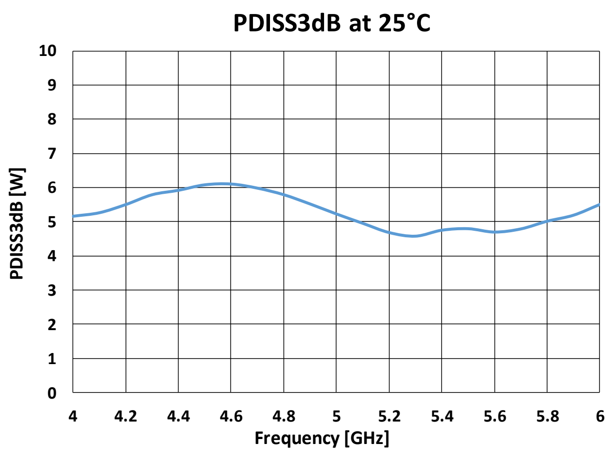


Power Driveup Performance At 25°C Of 4 – 6 GHz EVB[1, 2]

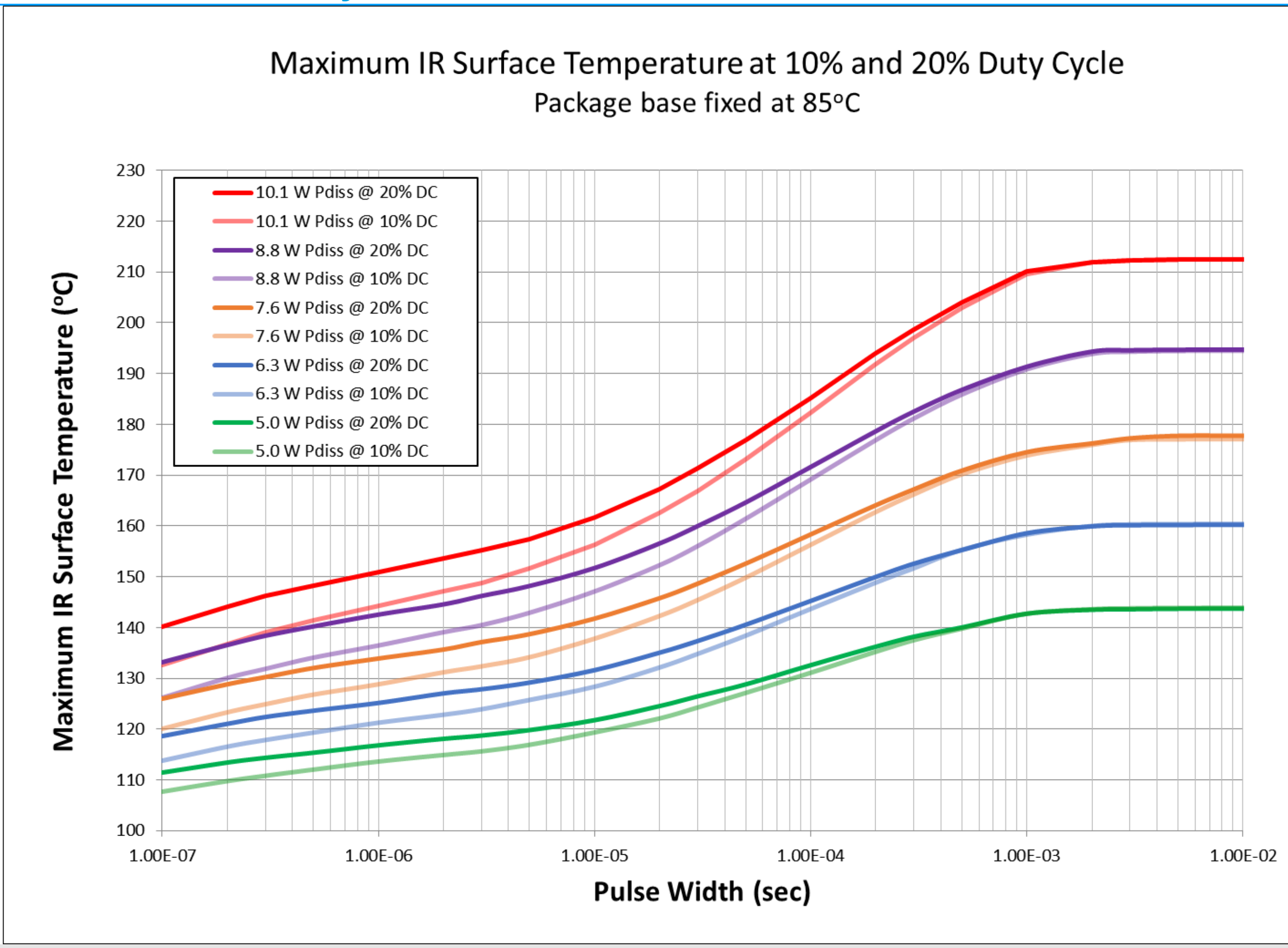
Notes:
1. Test Conditions: V_D = 32 V, I_{DQ} = 25 mA, 100 uS Pulse Width, 20% Duty Cycle
2. The dissipation power limit is conservative because it is specified at DUT only without accounting for the loss of the output matching network..







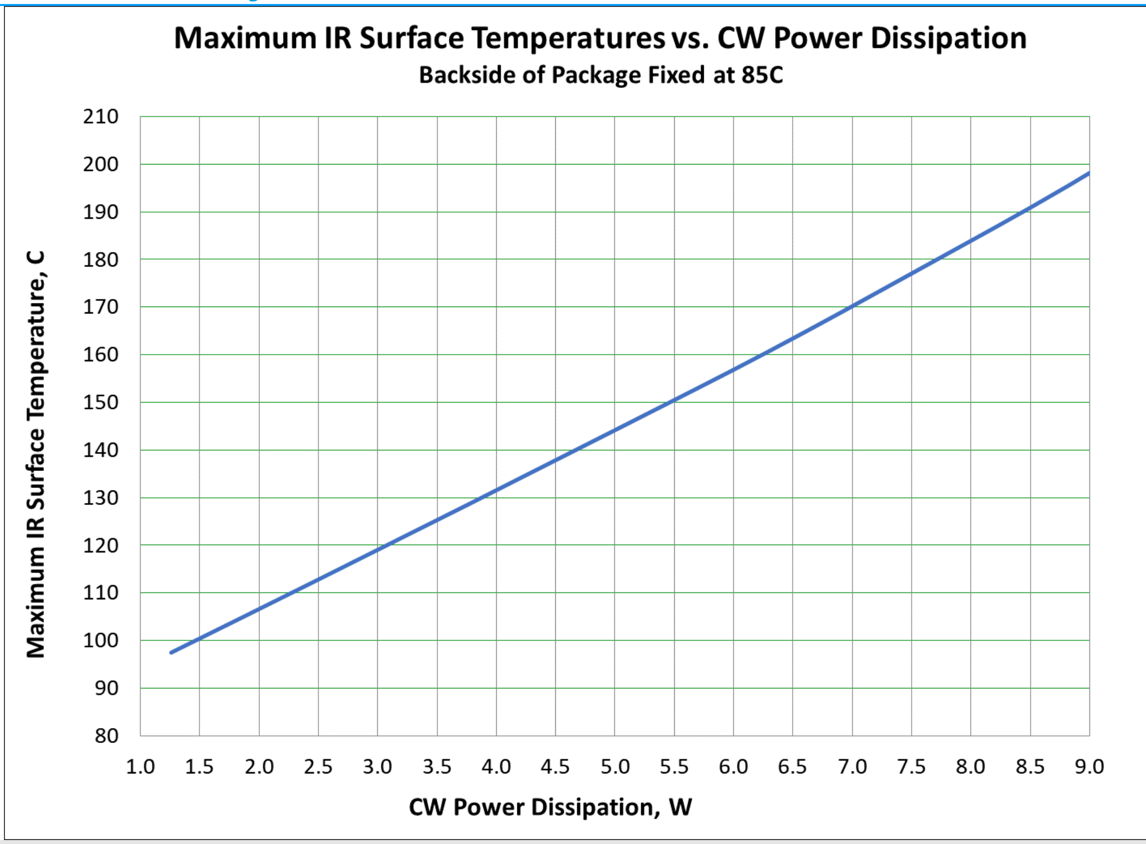
Thermal and Reliability Information – Pulsed[1]



Parameter	Conditions	Values	Units
Thermal Resistance, Maximum IR Surface Temperature at Dissipated Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 185°C, P_{DISS} = 10.1 W, 100 uS PW, 20% DC	9.9	°C/W
Thermal Resistance, Maximum IR Surface Temperature at Dissipated Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 172°C, P_{DISS} = 8.8 W, 100 uS PW, 20% DC	9.9	°C/W
Thermal Resistance, Maximum IR Surface Temperature at Dissipated Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 158°C, P_{DISS} = 7.6 W, 100 uS PW, 20% DC	9.6	°C/W
Thermal Resistance, Maximum IR Surface Temperature at Dissipated Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 145°C, P_{DISS} = 6.3 W, 100 uS PW, 20% DC	9.5	°C/W
Thermal Resistance, Maximum IR Surface Temperature at Dissipated Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 133°C, P_{DISS} = 5.0 W, 100 uS PW, 20% DC	9.6	°C/W

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

Thermal and Reliability Information – CW[1]

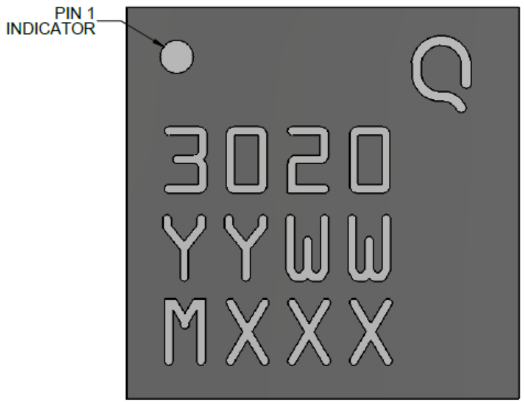


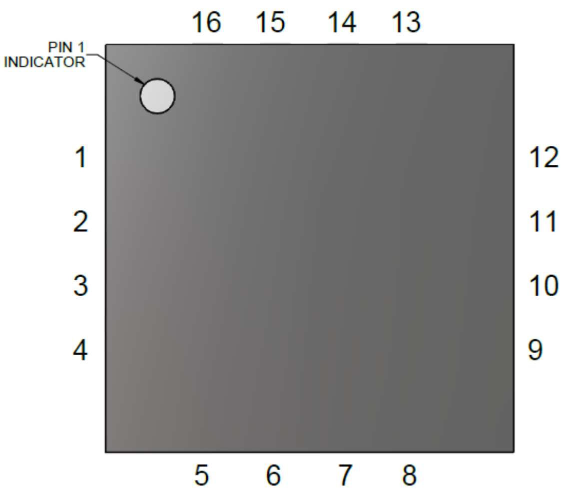
Parameter	Conditions	Values	Units
Thermal Resistance, Maximum IR Surface Temperature at Average Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 113°C, P_{DISS} = 2.52 W	11.1	°C/W
Thermal Resistance, Maximum IR Surface Temperature at Average Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 129°C, P_{DISS} = 3.78 W	11.6	°C/W
Thermal Resistance, Maximum IR Surface Temperature at Average Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 145°C, P_{DISS} = 5.04 W	11.9	°C/W
Thermal Resistance, Maximum IR Surface Temperature at Average Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 161°C, P_{DISS} = 6.30 W	12.1	°C/W
Thermal Resistance, Maximum IR Surface Temperature at Average Power (θ_{JC})	T_{CASE} = +85°C, T_{CH} = 178°C, P_{DISS} = 7.56 W	12.3	°C/W

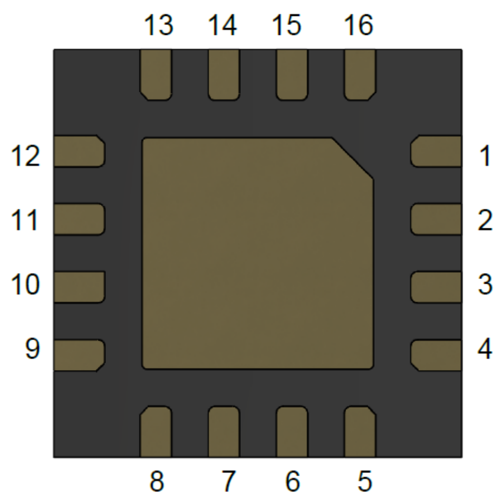
Notes:
1. Thermal resistance is measured to package backside.
2. Refer to the following document: GaN Device Channel Temperature, Thermal Resistance, and Reliability Estimates

Marking Diagram and Pin Description[1]

The TGF3020-SM will be marked with the “3020” 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 batch ID number.





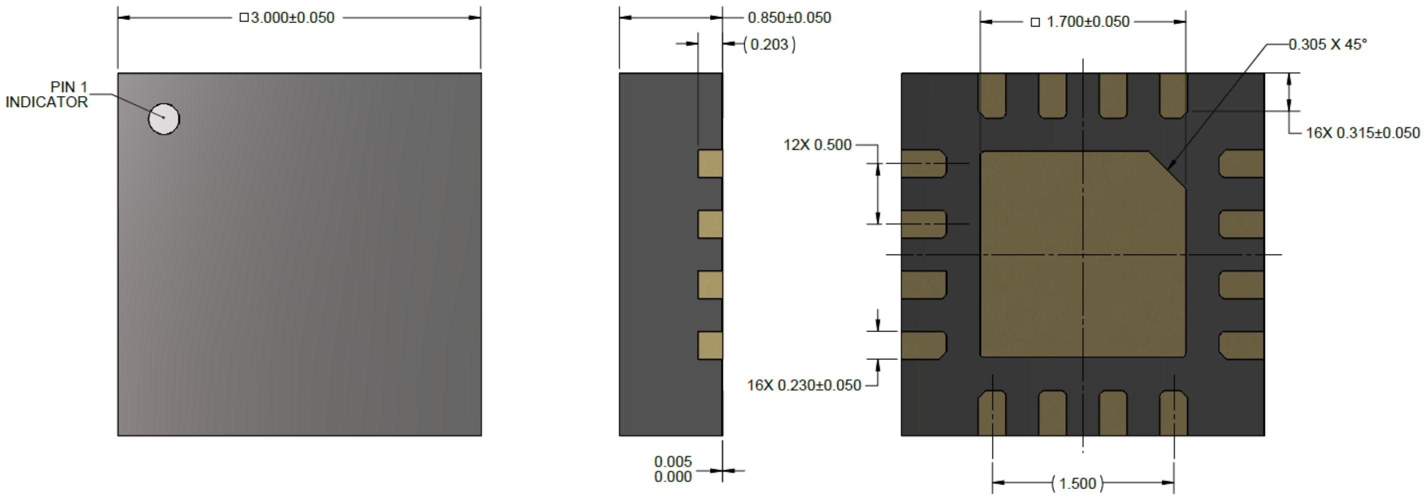


PIN ASSIGNMENT TABLE			
PIN NO.	DEFINITION	PIN NO.	DEFINITION
1	N/C	10	RF OUT
2	RF IN	11	RF OUT
3	RF IN	12	N/C
4	N/C	13	N/C
5	N/C	14	N/C
6	N/C	15	N/C
7	N/C	16	N/C
8	N/C	17	N/C
9	N/C		

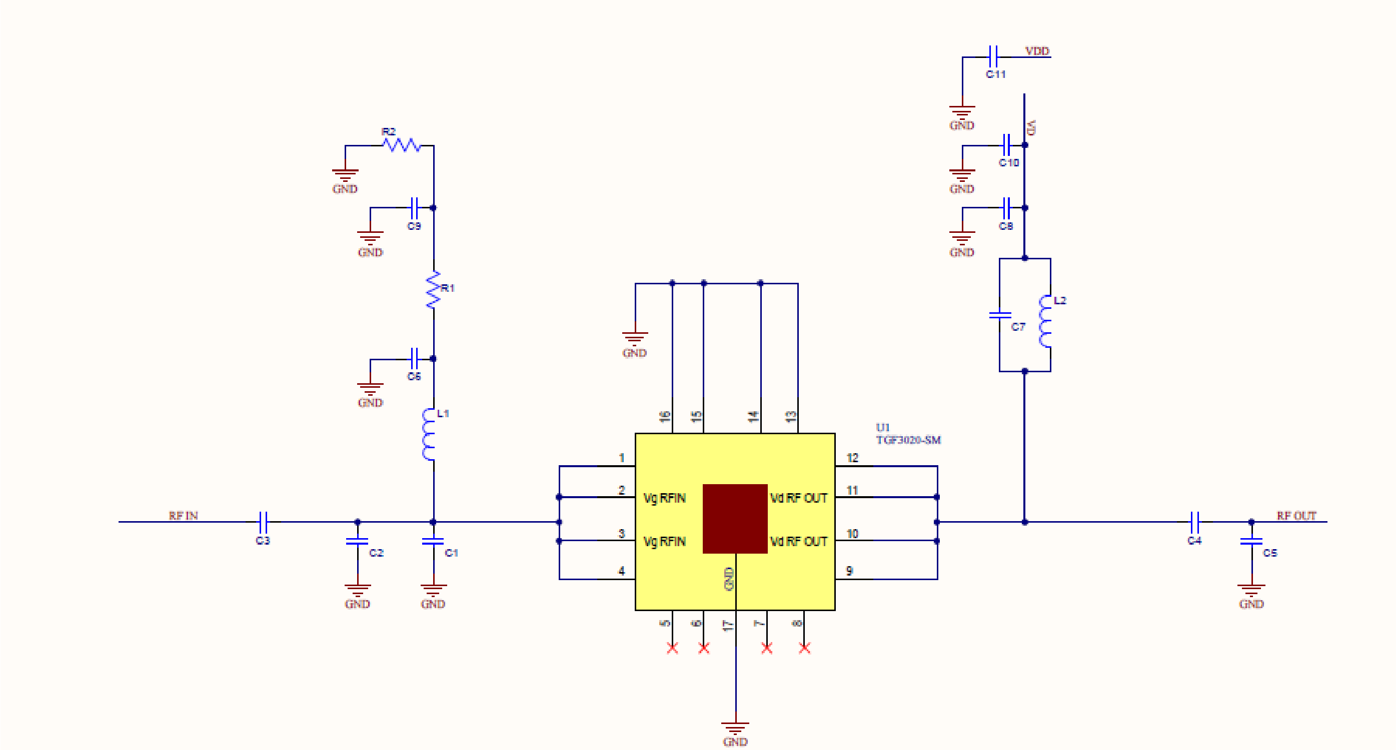
Mechanical Drawing[1,2]

Notes: Unless otherwise specified, all dimensions are shown in mm and tolerances are +/-0.100 mm.
1. Package exposed metallization is gold plated.
2. Part is overmold encapsulated.

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.



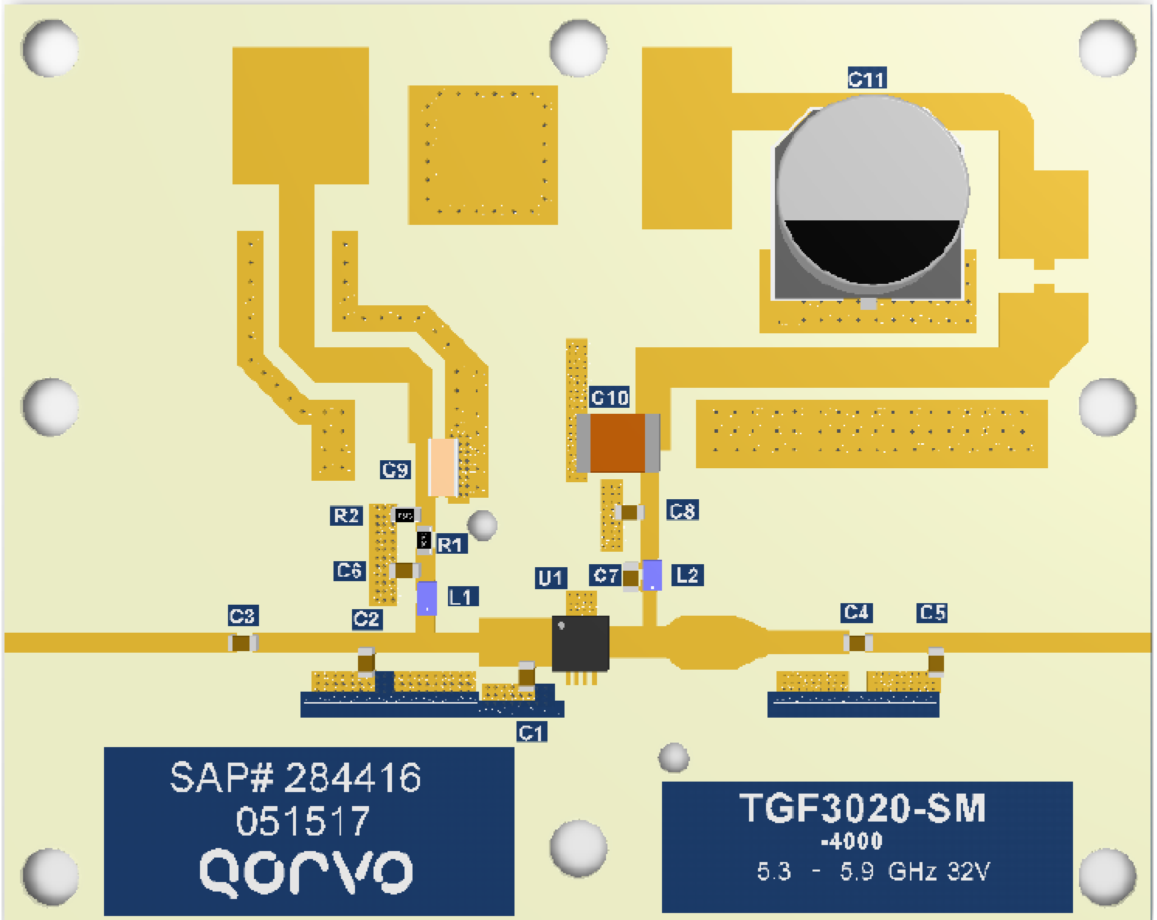
5.3 – 5.9 GHz Application Circuit - Schematic



Bias-up Procedure	Bias-down Procedure
1. Set V_G to -3.5 V.	1. Turn off RF signal.
2. Set I_D current limit to 30 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 25 mA.	4. Turn off V_G
5. Set I_D current limit to 0.3 A (Pulsed operation.)	
6. Apply RF.	

5.3 – 5.9 GHz Application Circuit - Layout

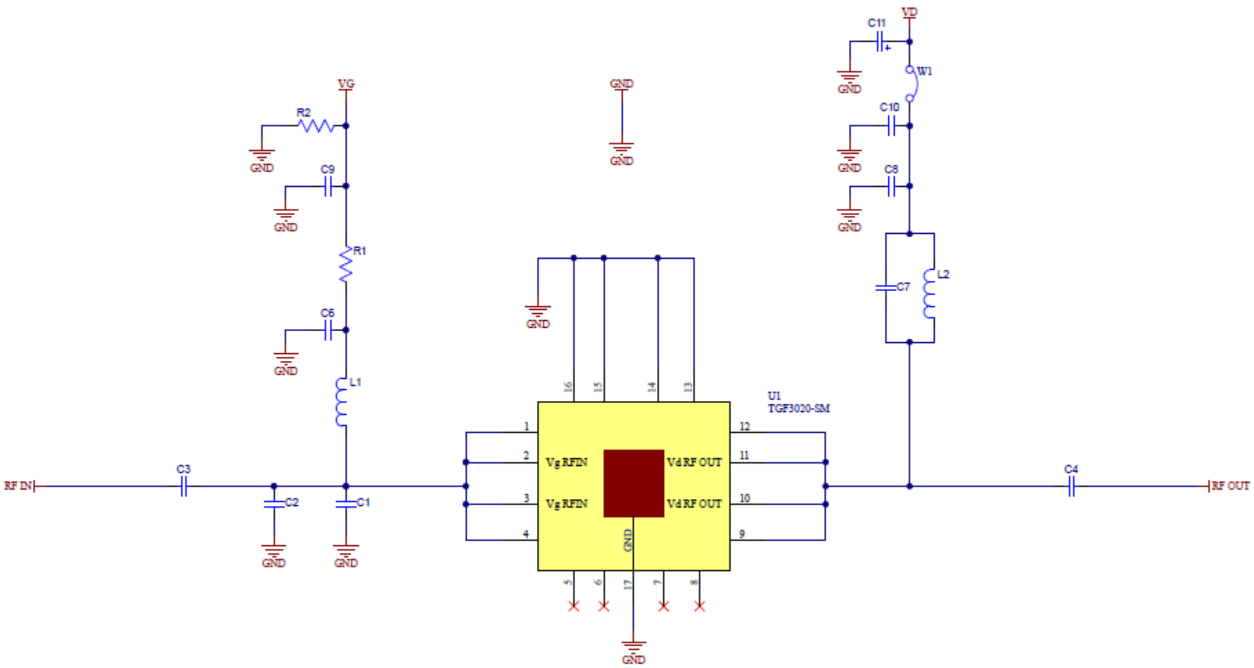
Board material is RO4350B 0.020" thickness with 1oz copper cladding. Overall EVB size is 2" x 2.5".



5.3 – 5.9 GHz Application Circuit - Bill of Materials

Reference Design	Value	Qty	Manufacturer	Part Number
R1	10 Ω	1	Vishay	CRCW060310R0JNTA
R2	1 kΩ	1	Vishay	CRCW06031K00JNTA
C1, C5	0.2 pF	2	Kyocera AVX	600S0R2AT250XT
C2	0.3 pF	1	Passive Plus	0603N0R3AW251X
C3, C4	5.1 pF	2	Kyocera AVX	600S5R1BT250X
C6, C7, C8	3.3 pF	3	Kyocera AVX	600S3R3BT250XT
C9	10 uF	1	Murata	LLL31MR60J106ME01L
C10	1 uF	1	Kyocera AVX	18121C105KAT2A
C11	220 uF	1	United Chemicon	EMVY500ADA221MJA0G
L1	3.9nH	1	CoilCraft	0603CS-3N9XJRW
L2	2.2nH	1	CoilCraft	0603CS-2N2XJEW

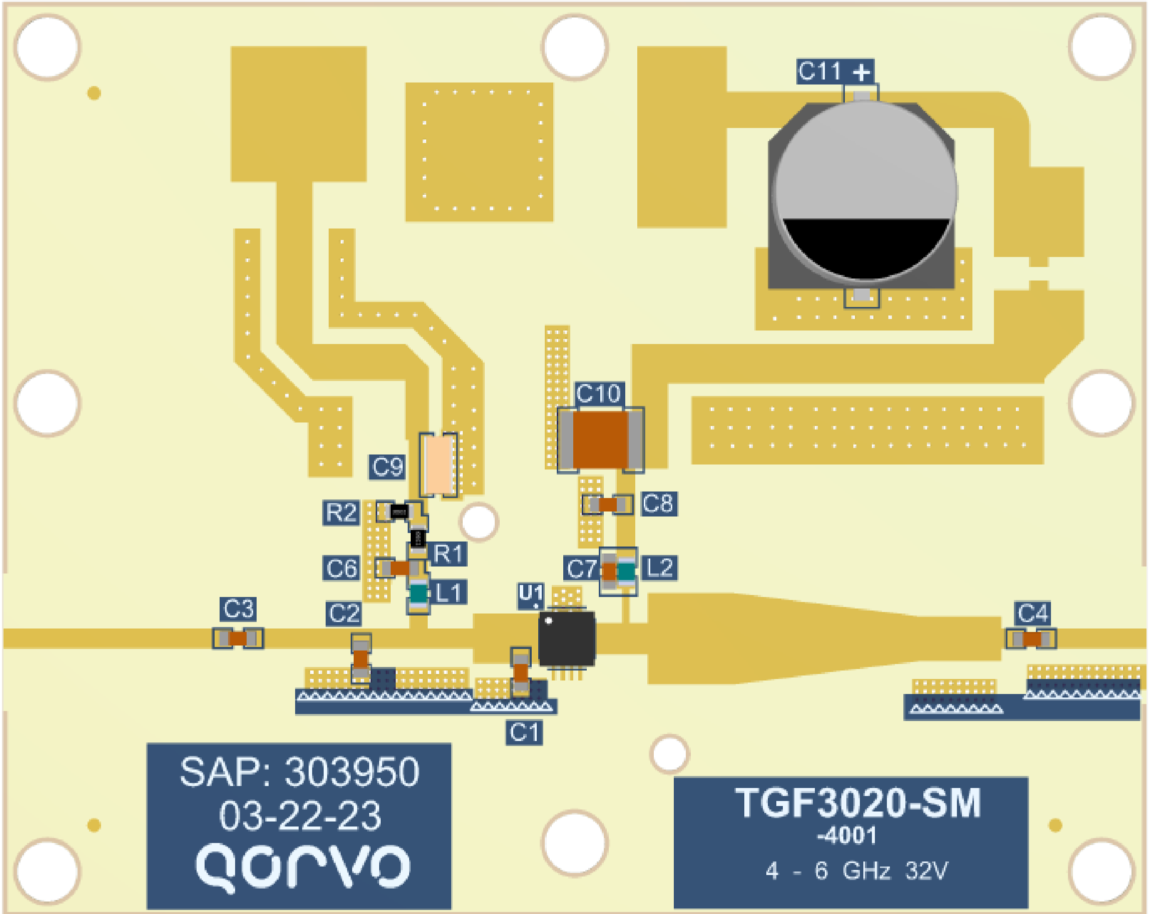
4 – 6 GHz Application Circuit - Schematic



Bias-up Procedure	Bias-down Procedure
2. Set V_G to -4 V.	3. Turn off RF signal.
4. Set I_D current limit to 30 mA.	4. Turn off V_D
5. Apply 32 V V_D.	5. Wait 2 seconds to allow drain capacitor to discharge.
6. Slowly adjust V_G until I_D is set to 25 mA.	7. Turn off V_G
8. Set I_D current limit to 0.3 A (Pulsed operation.)	
9. Apply RF.	

4 – 6 GHz Application Circuit - Layout

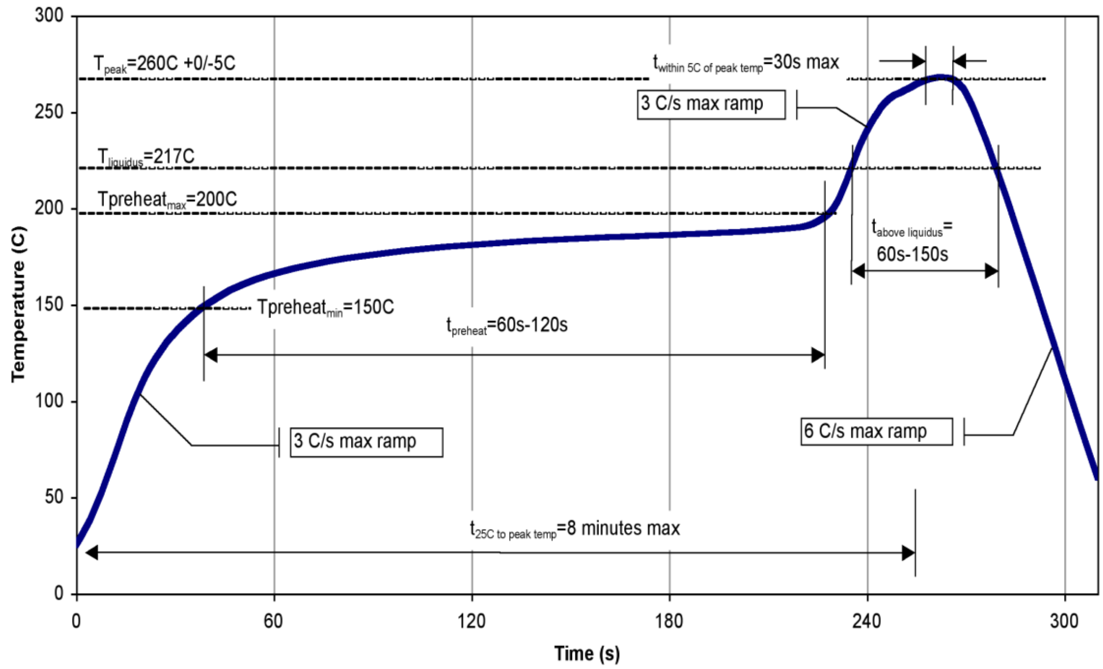
Board material is RO4350B 0.020” thickness with 1oz copper cladding. Overall EVB size is 2” x 2.5”.



4 – 6 GHz Application Circuit - Bill of Materials

Reference Design	Value	Qty	Manufacturer	Part Number
R1	10 Ω	1	Vishay	CRCW060310R0JNTA
R2	1 kΩ	1	Vishay	CRCW06031K00JNTA
C1	0.2 pF	1	Kyocera AVX	600S0R2AT250XT
C2	0.3 pF	1	Passive Plus	0603N0R3AW251X
C3	5.1 pF	1	Kyocera AVX	600S5R1BT250X
C4	10 pF	1	Kyocera AVX	600S100JT250XT
C6, C7, C8	3.3 pF	3	Kyocera AVX	600S3R3BT250XT
C9	10 uF	1	TDK	C1632X5R0J106M130AC
C10	1 uF	1	Kyocera AVX	18121C105KAT2A
C11	220 uF	1	United Chemicon	EMVY500ADA221MJA0G
L1	3.9nH	1	CoilCraft	0603CS-3N9XJRW
L2	1.8nH	1	CoilCraft	0603CS-1N8XJRW

Recommended Solder Temperature Profile



Handling Precautions

Parameter	Rating	Standard
ESD – Human Body Model (HBM)	Class 1A (250V)	ESDA / JEDEC JS-001-2012
ESD – Charged Device Model (CDM)	Class C3 (1000V)	JEDEC JESD22-C101F
MSL – Moisture Sensitivity Level	Level 3	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.

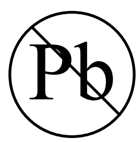
Contact plating: NiPdAu

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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