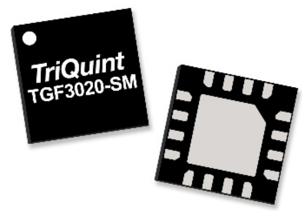
## Applications

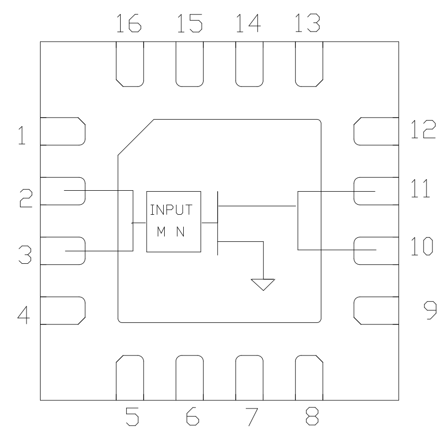
- Telemetry
- C-band radar
- Communications
- Test instrumentation
- Wideband amplifiers
- 5.8GHz ISM




## Product Features

- Frequency: 4.0 to 6.0 GHz
- Output Power ($P_{3dB}$): 6.8 W at 5 GHz
- Linear Gain: 12.7 dB at 5 GHz
- Typical $PAE_{3dB}$: 59.6% at 5 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 TGF3020-SM is a 5W ($P_{3dB}$), 50Ω-input matched discrete GaN on SiC HEMT which operates from 4.0 to 6.0 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 |
| 2 - 3 | $V_G$ / RF IN |
| Back side | Source |

## Ordering Information

| Part | ECCN | Description |
|---|---|---|
| TGF3020-SM | EAR99 | QFN Packaged Part |
| TGF3020-SM-EVB1 | EAR99 | 5.3 – 5.9 GHz EVB |
| TGF3020-SM-EVB2 | EAR99 | 4 – 6 GHz EVB |


***© 2014 TriQuint***

## Absolute Maximum Ratings

| Parameter | Value |
|---|---|
| Breakdown Voltage ($BV_{DG}$) | 100 V min. |
| Gate Voltage Range ($V_G$) | -50 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 4.0 GHz

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

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $G_{LIN}$ | Linear Gain, Power Tuned | | 12.6 | | dB |
| $P_{3dB}$ | Output Power at 3 dB Gain Compression, Power Tuned | | 38.4 | | dBm |
| $PAE_{3dB}$ | Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned | | 60.1 | | % |
| $G_{3dB}$ | Gain at 3 dB Compression, Power Tuned | | 9.6 | | dB |

## RF Characterization – Load Pull Performance at 4.4 GHz

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

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $G_{LIN}$ | Linear Gain, Power Tuned | | 12.7 | | 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 | | 61.5 | | % |
| $G_{3dB}$ | Gain at 3 dB Compression, Power Tuned | | 9.7 | | dB |


*© 2014 TriQuint*

## RF Characterization – Load Pull Performance at 5 GHz

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

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $G_{LIN}$ | Linear Gain, Power Tuned | | 12.7 | | 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 | | 59.6 | | % |
| $G_{3dB}$ | Gain at 3 dB Compression, Power Tuned | | 9.7 | | dB |

## RF Characterization – Load Pull Performance at 5.5 GHz

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

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $G_{LIN}$ | Linear Gain, Power Tuned | | 13.3 | | dB |
| $P_{3dB}$ | Output Power at 3 dB Gain Compression, Power Tuned | | 38.2 | | dBm |
| $PAE_{3dB}$ | Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned | | 59.0 | | % |
| $G_{3dB}$ | Gain at 3 dB Compression, Power Tuned | | 10.3 | | dB |


*© 2014 TriQuint*

## RF Characterization – 5.3 – 5.9 GHz EVB Performance at 5.4 GHz

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

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $G_{LIN}$ | Linear Gain | | 11.7 | | dB |
| $P_{3dB}$ | Output Power at 3 dB Gain Compression | | 5.7 | | W |
| $DE_{3dB}$ | Drain Efficiency at 3 dB Gain Compression | | 53.1 | | % |
| $G_{3dB}$ | Gain at 3 dB Compression | | 8.7 | | dB |

## RF Characterization – 4 – 6 GHz EVB Performance at 4.7 GHz

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

| Symbol | Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| $G_{LIN}$ | Linear Gain | | 11.8 | | dB |
| $P_{3dB}$ | Output Power at 3 dB Gain Compression | | 5.6 | | W |
| $DE_{3dB}$ | Drain Efficiency at 3 dB Gain Compression | | 51.7 | | % |
| $G_{3dB}$ | Gain at 3 dB Compression | | 8.8 | | dB |

## RF Characterization – Mismatch Ruggedness at 5.3 and 5.9 GHz

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

| Symbol | Parameter | Typical |
|---|---|---|
| VSWR | Impedance Mismatch Ruggedness | 10:1 |



*© 2014 TriQuint*

## Thermal and Reliability Information - CW [1]

| Parameter | Test Conditions | Value | Units |
|---|---|---|---|
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>1.26 W Pdiss, CW | 17.5 | ºC/W |
| Channel Temperature ($T_{CH}$) | | 107 | °C |
| Median Lifetime ($T_M$) | | 5.56E11 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>2.52 W Pdiss, CW | 17.9 | ºC/W |
| Channel Temperature ($T_{CH}$) | | 130 | °C |
| Median Lifetime ($T_M$) | | 2.65E10 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>3.78 W Pdiss, CW | 18.8 | ºC/W |
| Channel Temperature ($T_{CH}$) | | 156 | °C |
| Median Lifetime ($T_M$) | | 1.27E9 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>5.04 W Pdiss, CW | 19.8 | ºC/W |
| Channel Temperature ($T_{CH}$) | | 185 | °C |
| Median Lifetime ($T_M$) | | 6.46E7 | Hrs |
| Thermal Resistance ($\theta_{JC}$) | 85 °C Case<br>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 ($\theta_{JC}$) | 85 °C Case<br>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 ($\theta_{JC}$) | 85 °C Case<br>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 ($\theta_{JC}$) | 85 °C Case<br>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 ($\theta_{JC}$) | 85 °C Case<br>7.6 W Pdiss, 100uS PW, 50% | 18.0 | ºC/W |
| Channel Temperature ($T_{CH}$) | | 222 | °C |
| Median Lifetime ($T_M$) | | 2.33E6 | Hrs |

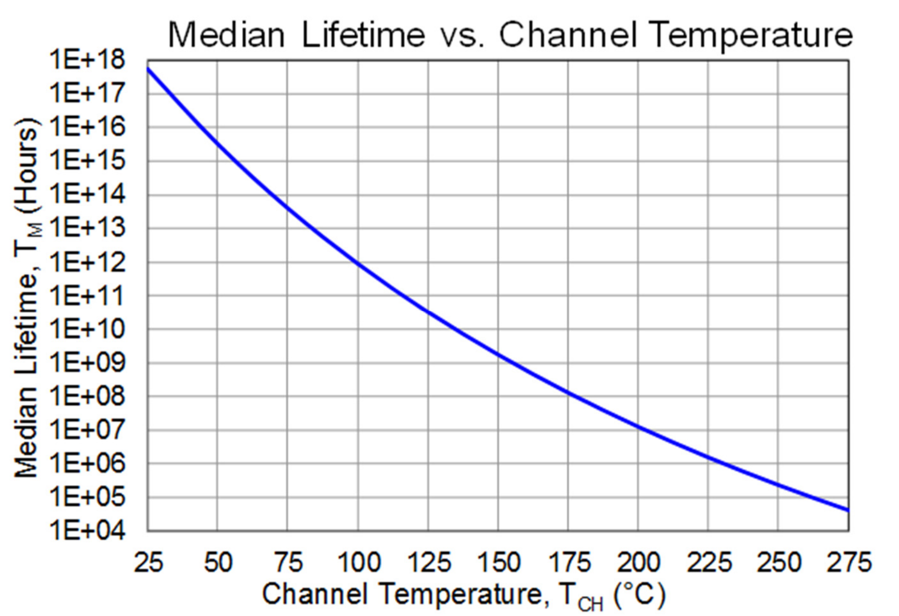
Notes:

1. Thermal resistance measured to bottom of package.

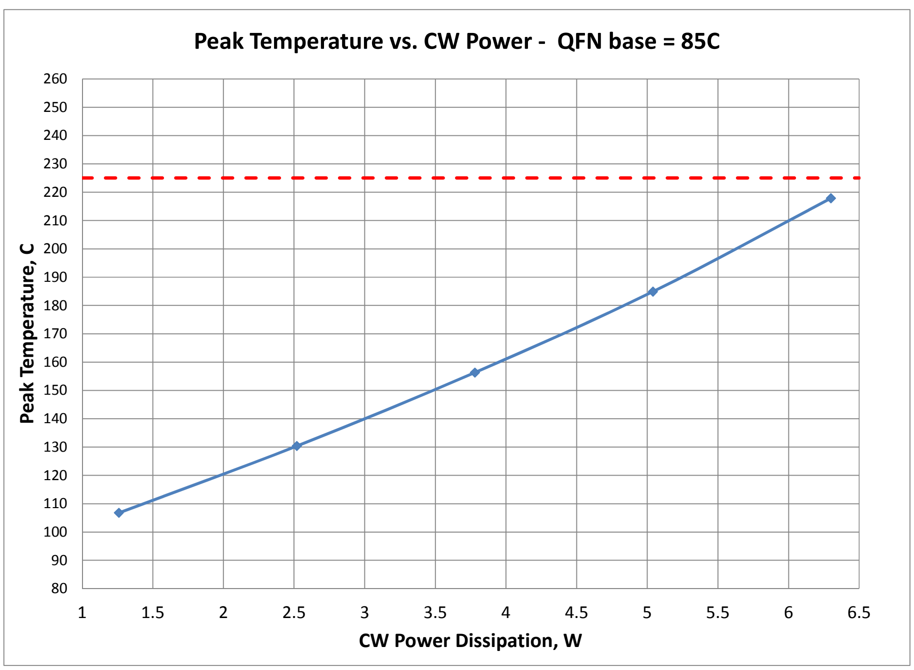


*© 2014 TriQuint*

## Median Lifetime



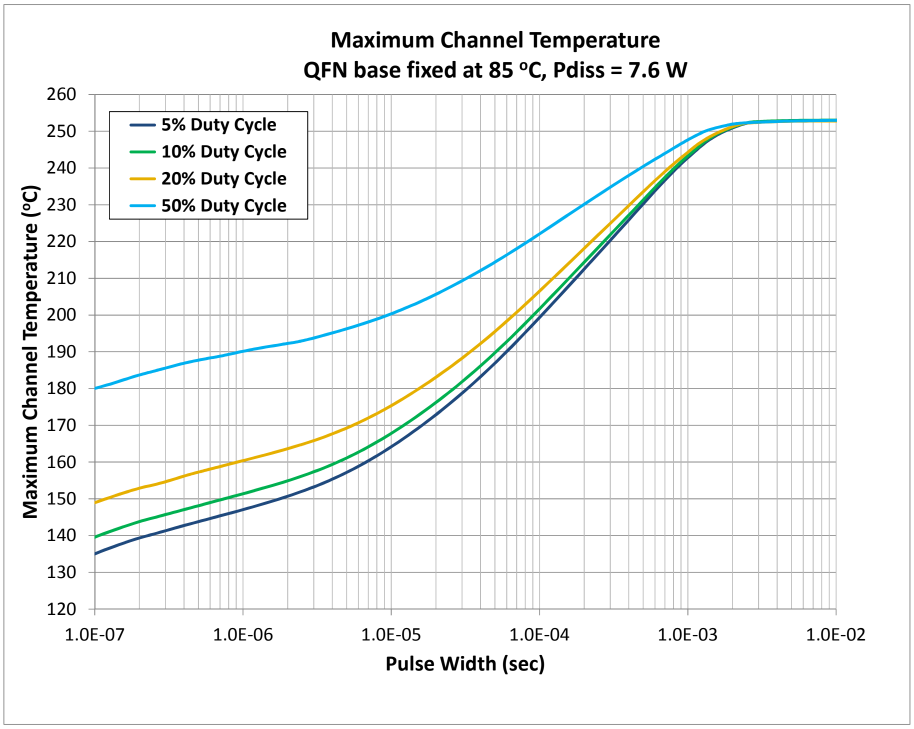

## Maximum Channel Temperature - CW





*© 2014 TriQuint*

## Maximum Channel Temperature - Pulsed





*© 2014 TriQuint*

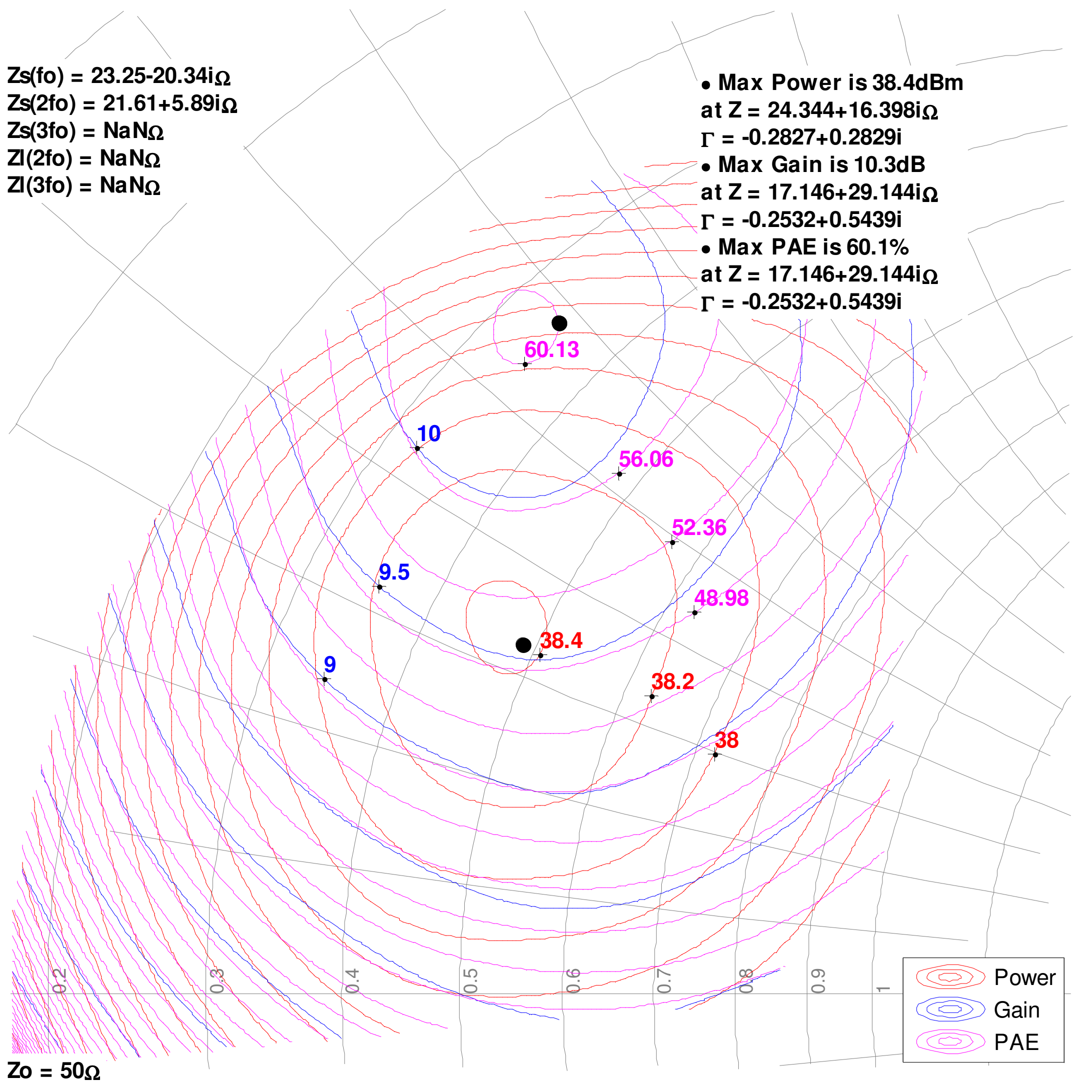
## Load Pull Smith Charts (1, 2, 3)

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, 25mA, 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.

4GHz, Load-pull





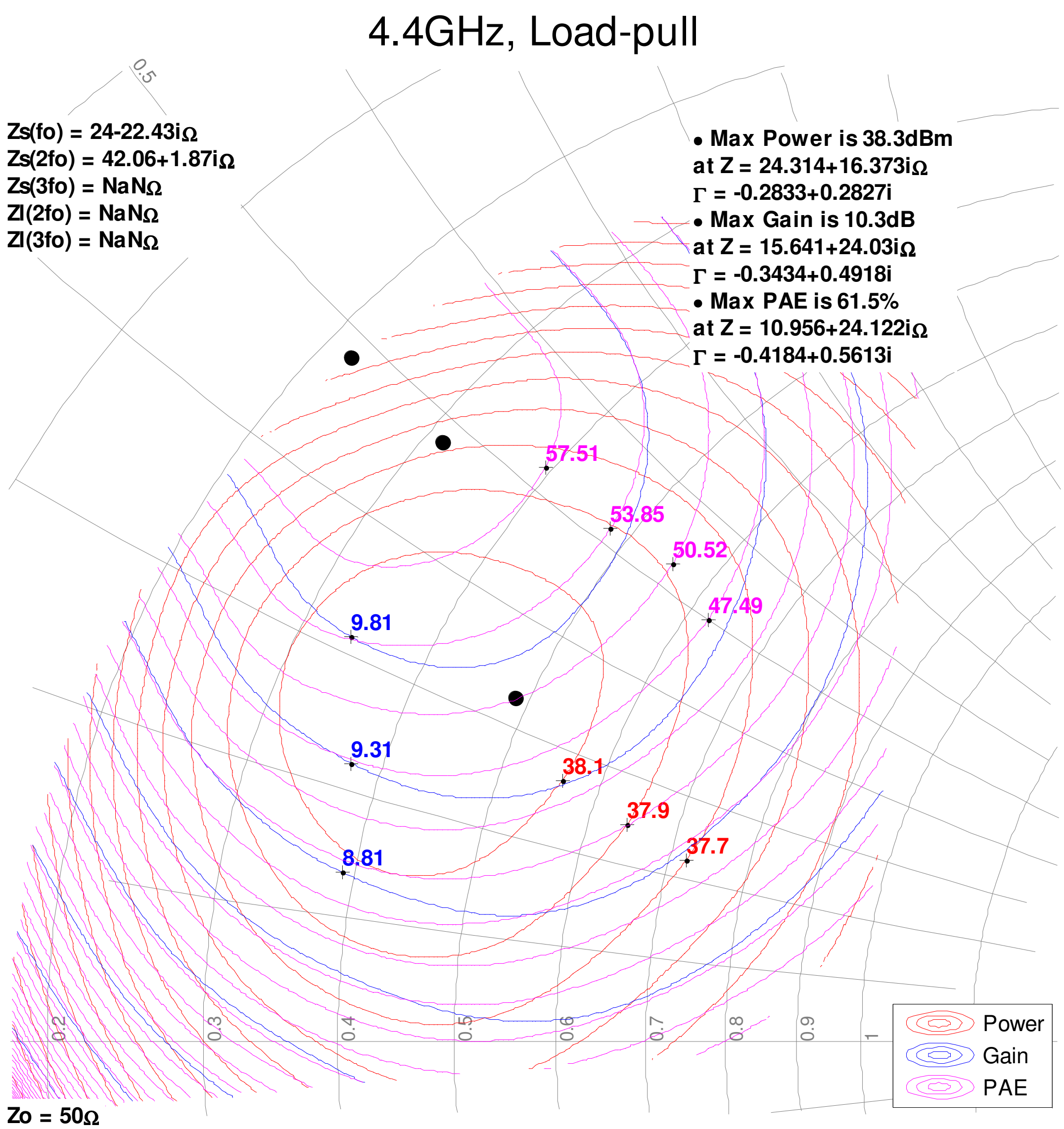
© 2014 TriQuint

## 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, 25mA, 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.





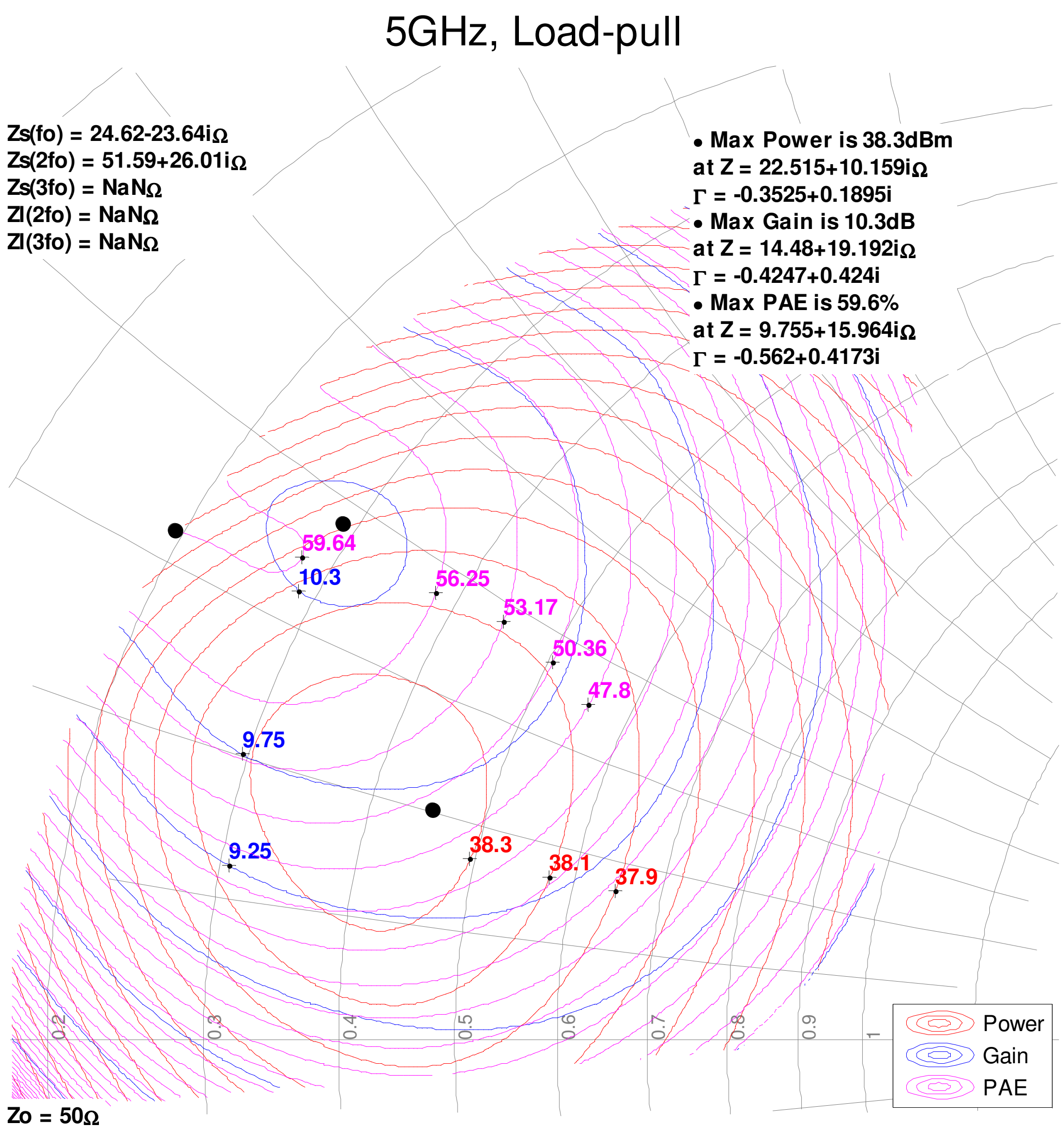
© 2014 TriQuint

## 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, 25mA, 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.





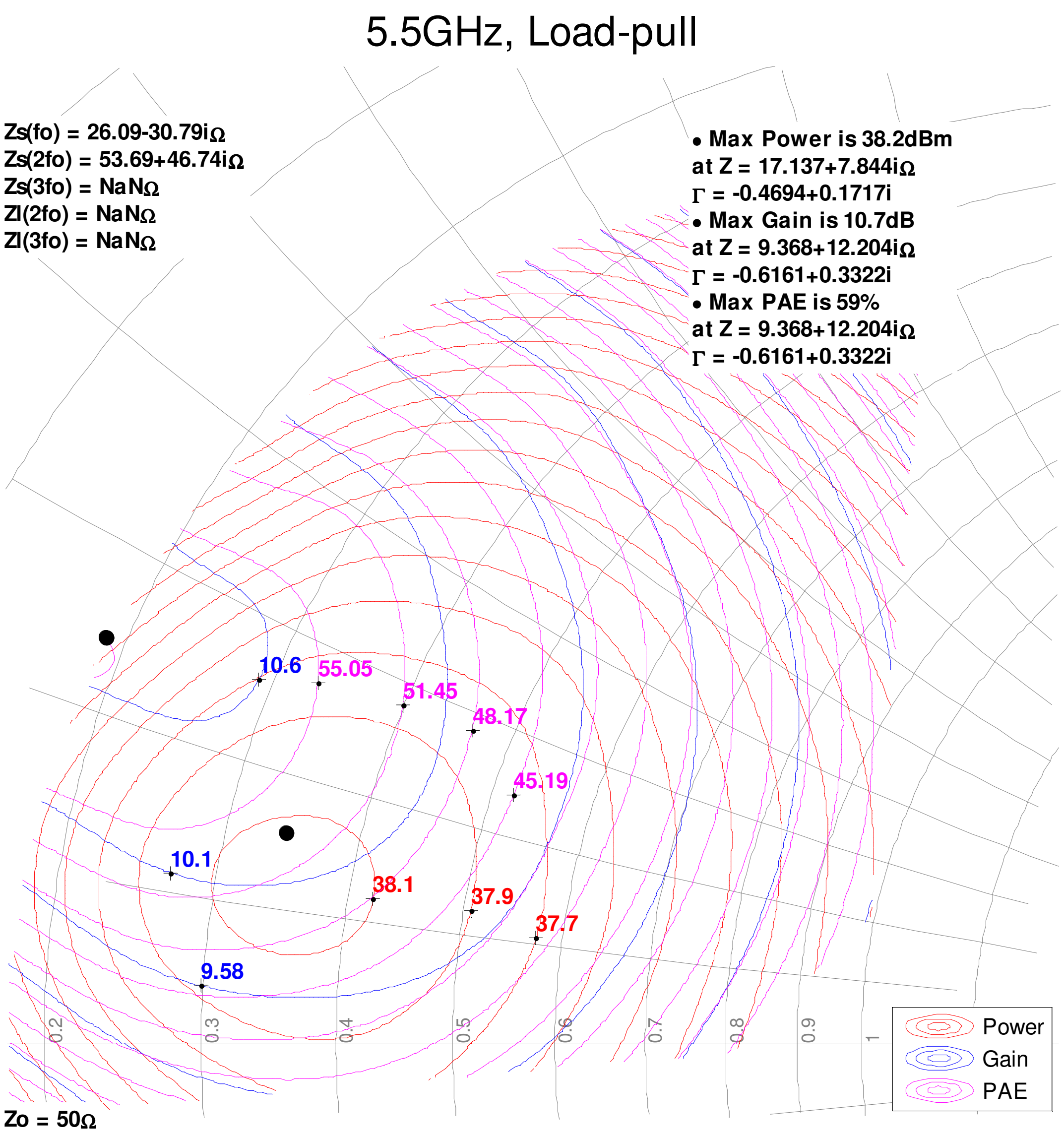
© 2014 TriQuint

## 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, 25mA, 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.



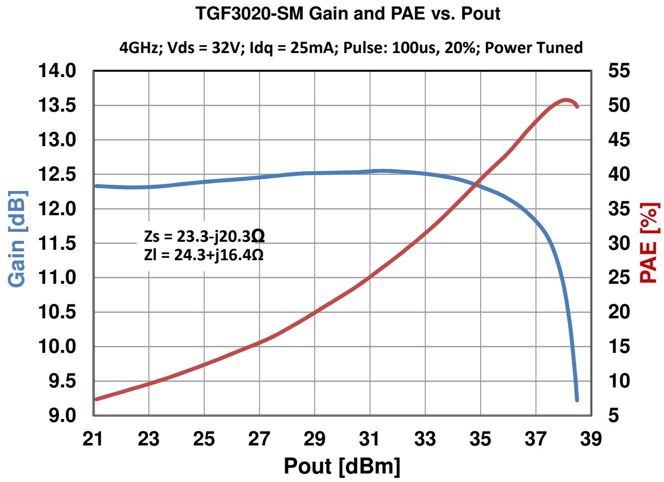


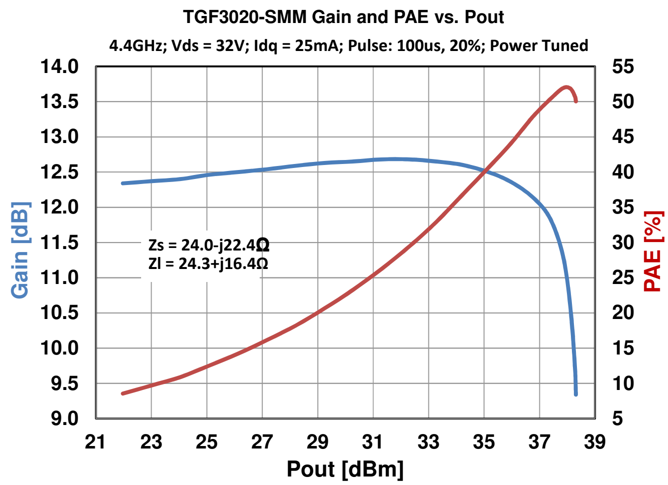
*© 2014 TriQuint*

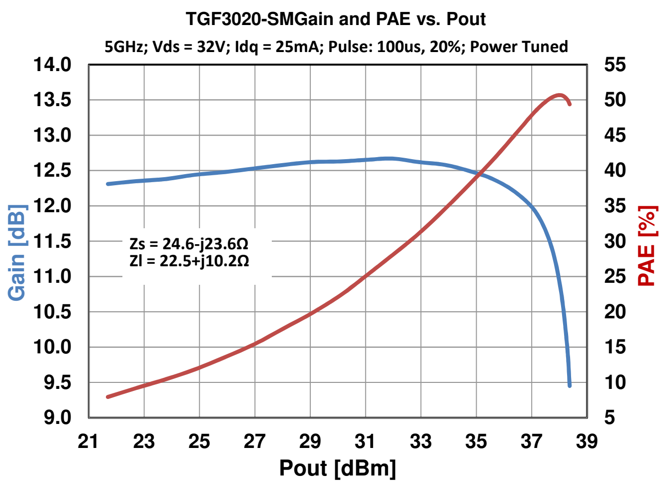
## Typical Performance – Power Tuned(1,2,3)

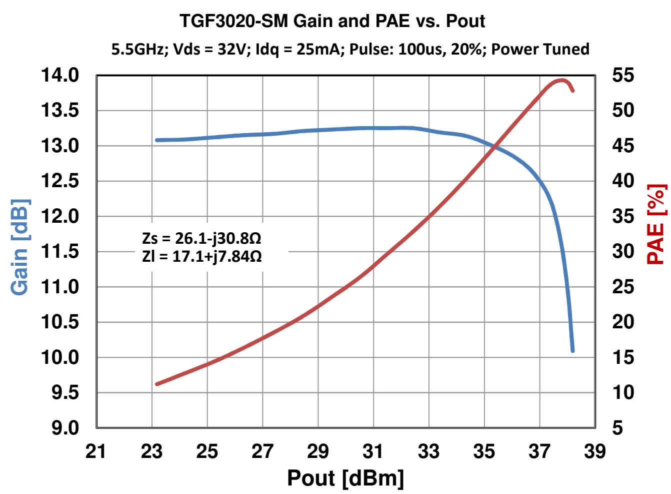
Notes:

1. Pulsed signal with 100uS pulse width and 20% duty cycle
2. See page 20 for load pull and source pull reference planes.
3. Performance is measured at device reference planes.



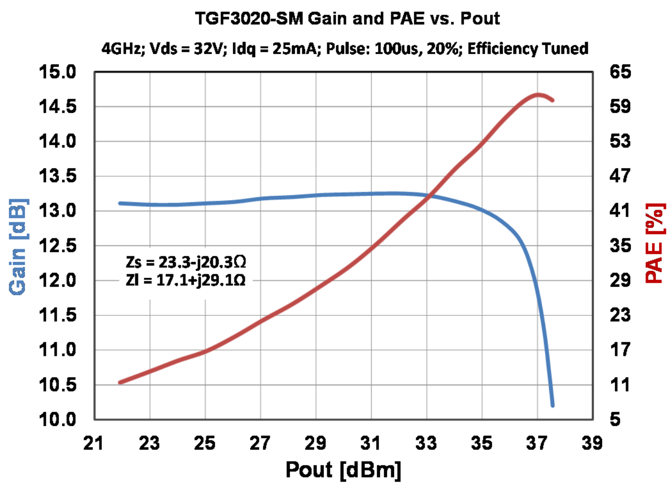



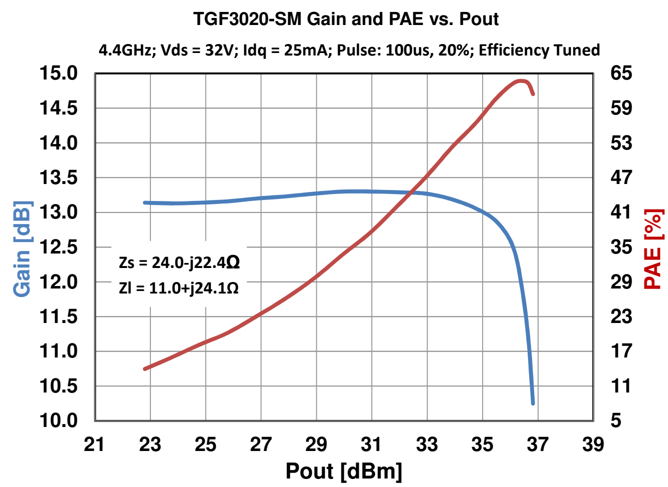


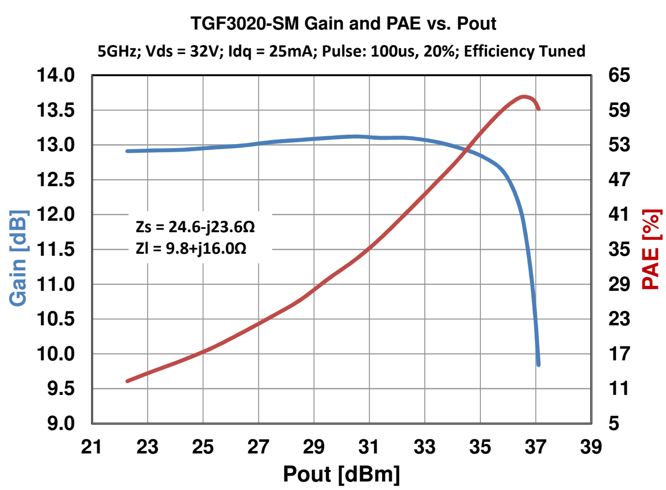
*© 2014 TriQuint*

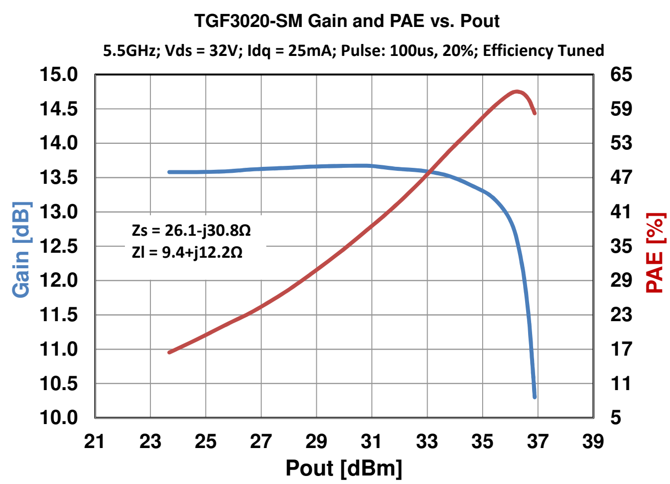
## Typical Performance – Efficiency Tuned(1,2,3)

Notes:
1. Pulsed signal with 100uS pulse width and 20% duty cycle
2. See page 20 for load pull and source pull reference planes.
3. Performance is measured at device reference planes.



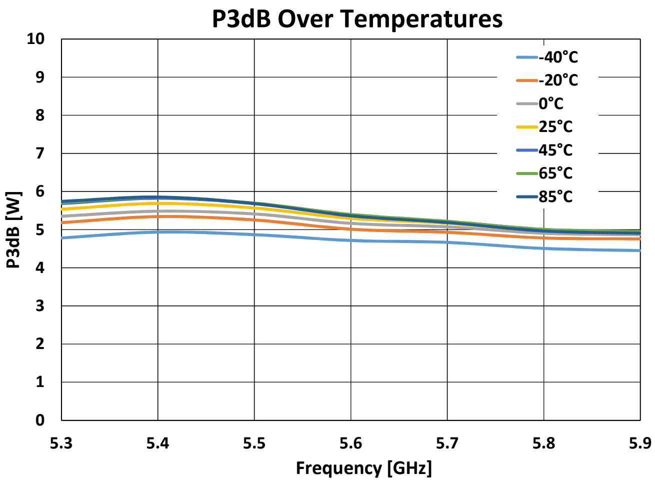



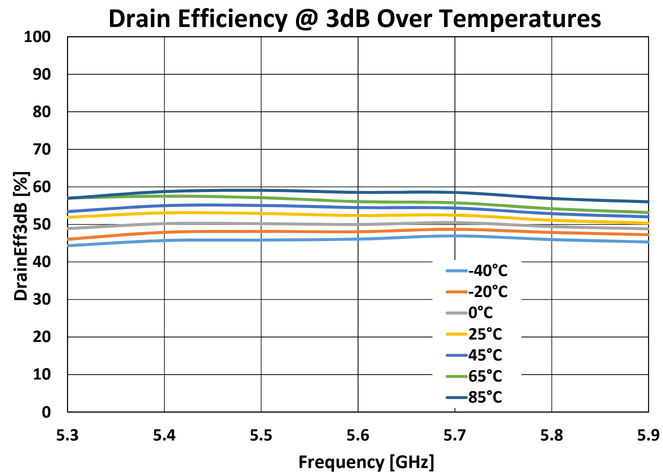


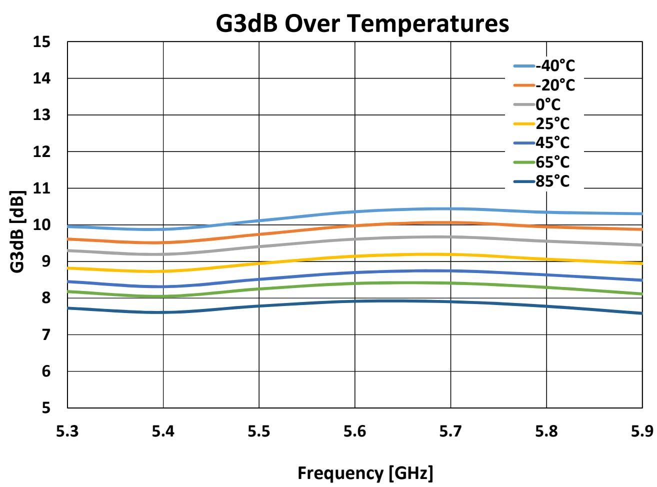
*© 2014 TriQuint*

## 5.3 – 5.9 GHz Evaluation Board Performance Over Temperature [1, 2]

Performance measured on TriQuint's 5.3 GHz to 5.9 GHz Evaluation Board



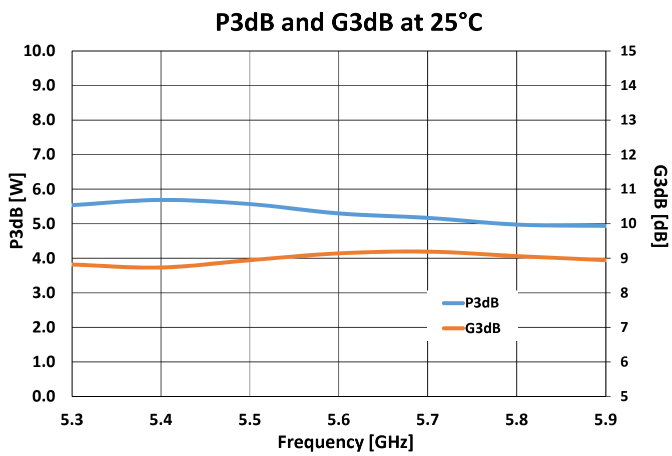



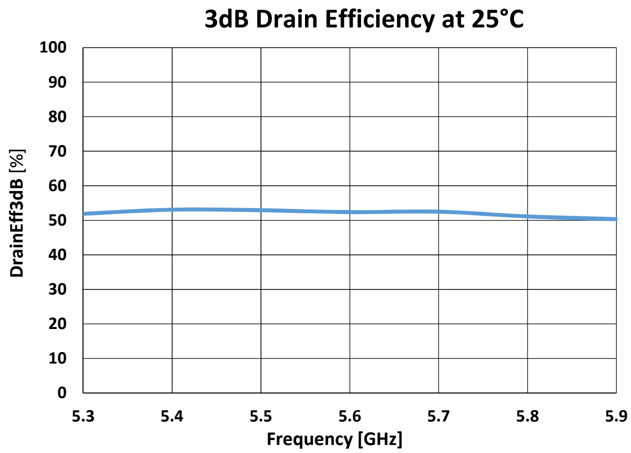

Notes:
1. Test Conditions: $V_{DS}$ = 32 V, $I_{DQ}$ = 25 mA
2. Test Signal: Pulse Width = 100 µs, Duty Cycle = 20%


© 2014 TriQuint

## 5.3 – 5.9 GHz Evaluation Board Performance At 25°C(1, 2)

Performance measured on TriQuint's 5.3 GHz to 5.9 GHz Evaluation Board



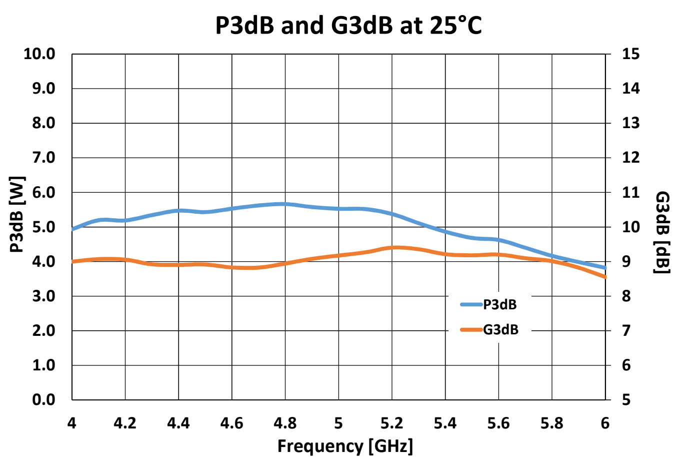



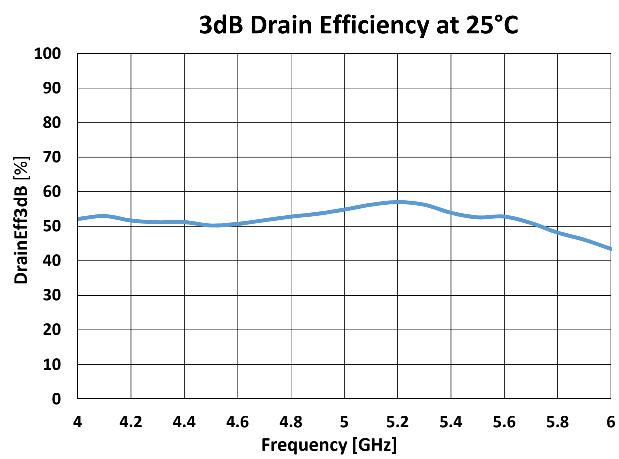

Notes:

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

## 4 – 6 GHz Evaluation Board Performance At 25°C(1, 2)

Performance measured on TriQuint's 5.3 GHz to 5.9 GHz Evaluation Board



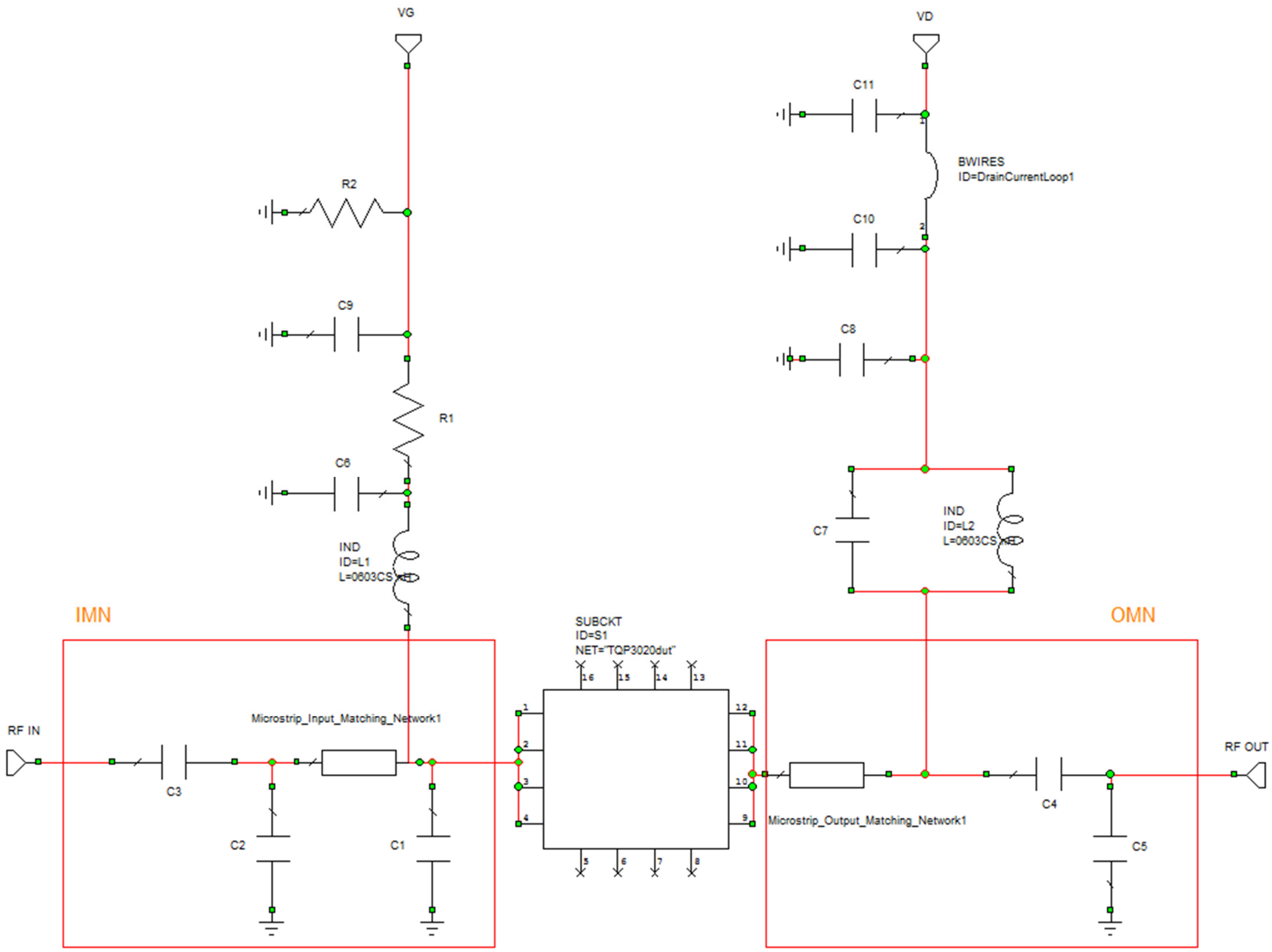




Notes:

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


*© 2014 TriQuint*

## 5.3 – 5.9 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 25 mA.
4. Apply RF signal.

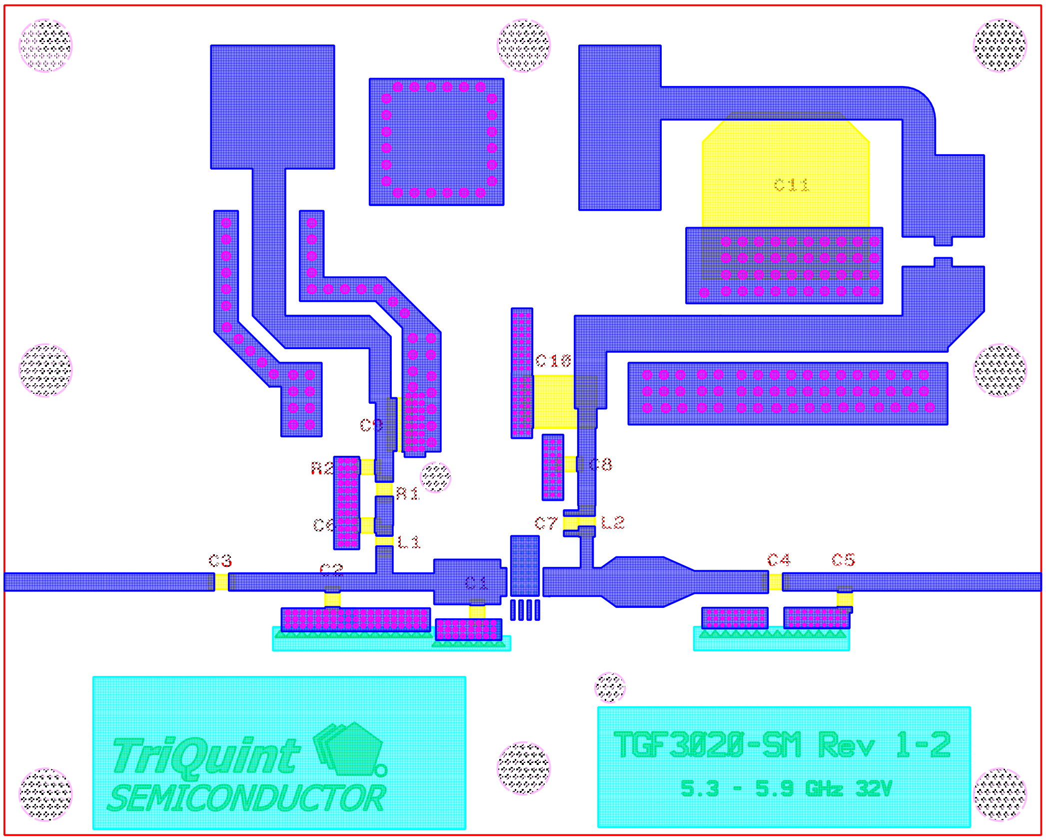
## Bias-down Procedure

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


*© 2014 TriQuint*

## 5.3 – 5.9GHz Evaluation Board Layout

Top RF layer is 0.020" thick Rogers RO4350B, $\varepsilon_r$ = 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.

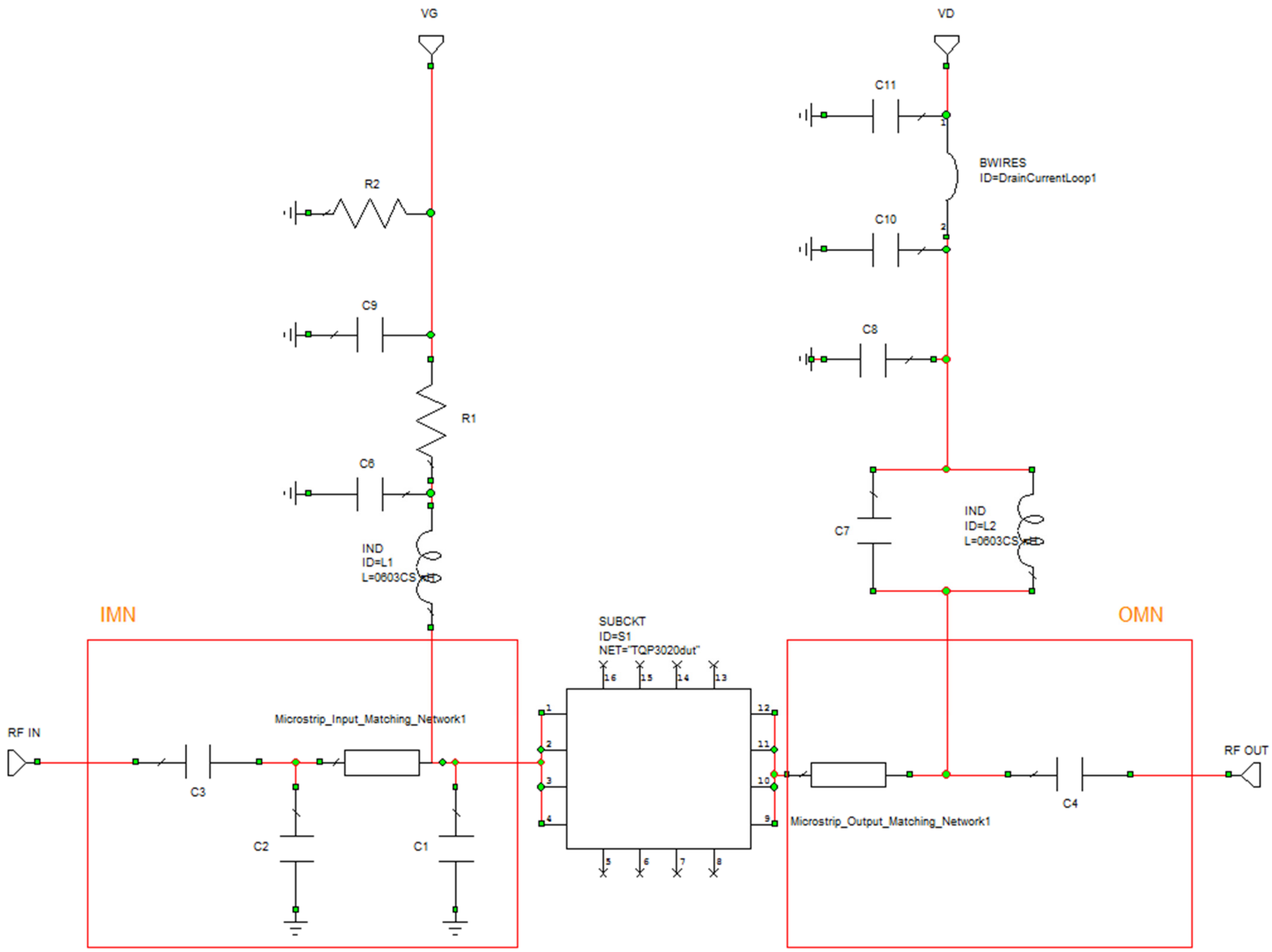



## 5.3 – 5.9 GHz EVB Bill of Materials

| Reference Design | Value | Qty | Manufacturer | Part Number |
|---|---|---|---|---|
| R1 | 10 Ω | 1 | | Generic 0603 |
| R2 | 1 kΩ | 1 | | Generic 0603 |
| C1, C5 | 0.2 pF | 2 | ATC | 600S0R2BT250XT |
| C2 | 0.3 pF | 1 | ATC | 600S0R3BT250XT |
| C3, C4 | 5.1 pF | 2 | ATC | 600S5R1BT250XT |
| C6, C7, C8 | 3.3 pF | 3 | ATC | 600S3R3BT250XT |
| C11 | 220 uF | 1 | United Chemicon | EMVY500ADA221MJA0G |
| C9 | 10 uF | 1 | TDK | C1632X5R0J106M130AC |
| C10 | 1 uF | 1 | AVX | 18121C105KAT2A |
| L1 | 3.9nH | 1 | CoilCraft | 0603CS-3N9X_E |
| L2 | 2.2nH | 1 | CoilCraft | 0603CS-2N2X_E |


© 2014 TriQuint
www.triquint.com

## 4 – 6 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 25 mA.
4. Apply RF signal.

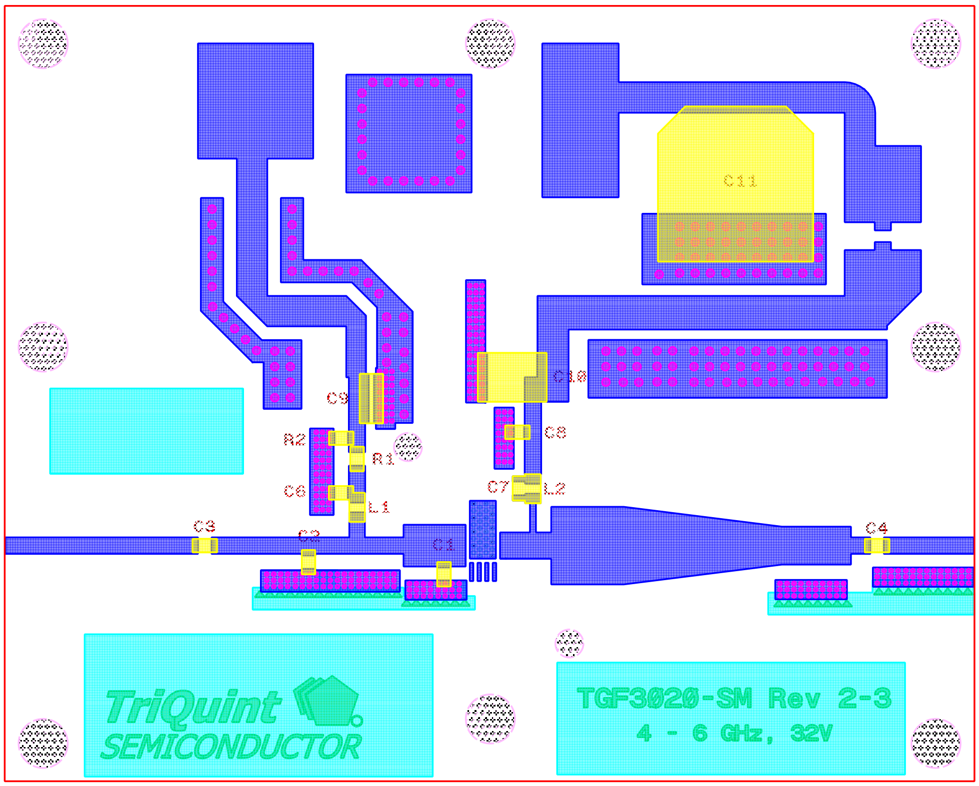
## Bias-down Procedure

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


*© 2014 TriQuint*

## 4 – 6 GHz Evaluation Board Layout

Top RF layer is 0.020” thick Rogers RO4350B, $\varepsilon_r$ = 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.

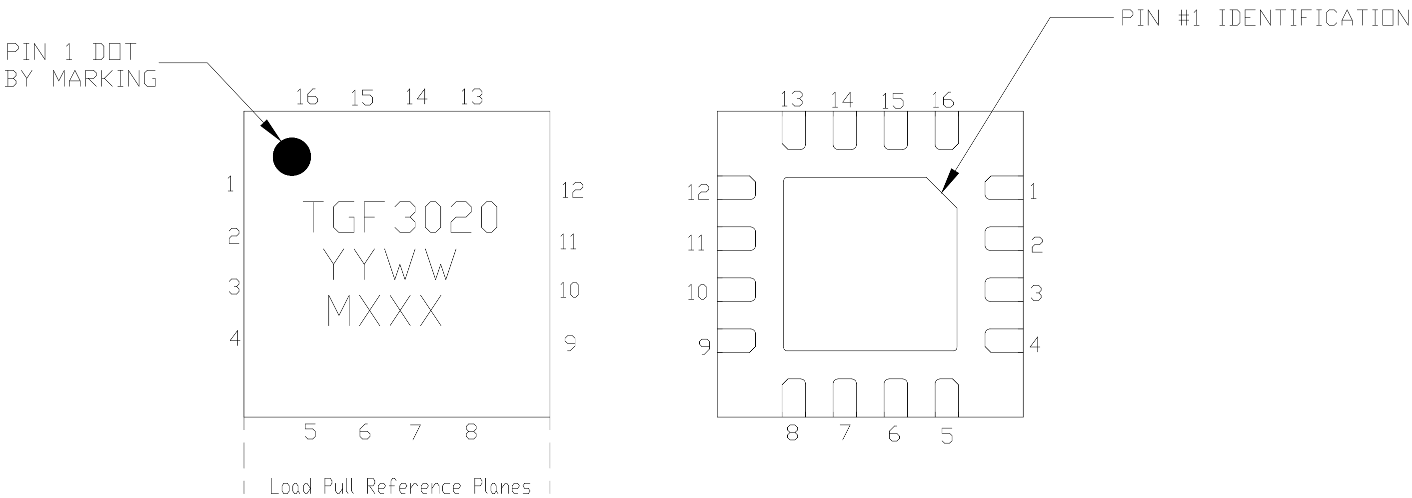



## 4 – 6 GHz EVB Bill of Materials

| Reference Design | Value | Qty | Manufacturer | Part Number |
|---|---|---|---|---|
| R1 | 10 Ω | 1 | | Generic 0603 |
| R2 | 1 kΩ | 1 | | Generic 0603 |
| C1 | 0.2 pF | 1 | ATC | 600S0R2BT250XT |
| C2 | 0.3 pF | 1 | ATC | 600S0R3BT250XT |
| C3 | 5.1 pF | 1 | ATC | 600S5R1BT250XT |
| C4 | 10 pF | 1 | ATC | 600S100BT250XT |
| C6, C7, C8 | 3.3 pF | 3 | ATC | 600S3R3BT250XT |
| C11 | 220 uF | 1 | United Chemicon | EMVY500ADA221MJA0G |
| C9 | 10 uF | 1 | TDK | C1632X5R0J106M130AC |
| C10 | 1 uF | 1 | AVX | 18121C105KAT2A |
| L1 | 3.9nH | 1 | CoilCraft | 0603CS-3N9X_E |
| L2 | 1.8nH | 1 | CoilCraft | 0603CS-1N8X_E |


*© 2014 TriQuint*

## 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 17 as an example. |
| 2, 3 | $V_G$ / RF IN | Gate voltage / RF Input to be matched to 50 ohms; see EVB Layout on page 17 as an example. |
| Back side | Source | Source connected to ground |

Notes:

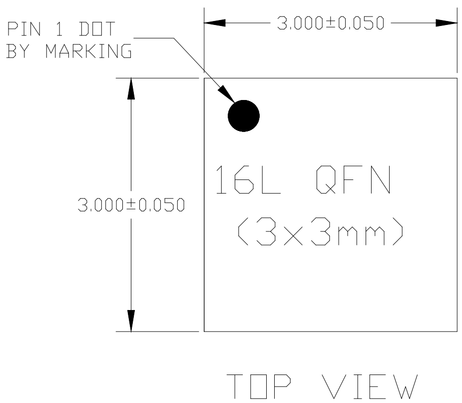
Thermal resistance measured to back side of package

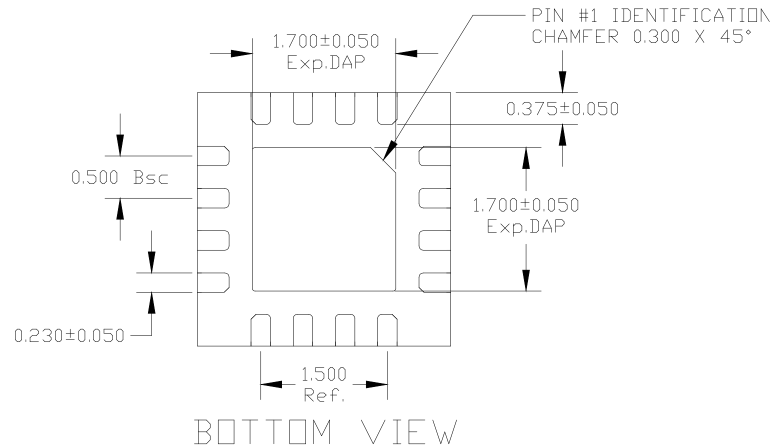
The TGF3020-SM will be marked with the "TGF3020" designator and a lot code marked below the part designator The "YY" represents the last two digits of the calendar year the part was manufactured, the "WW" is the work week of the assembly lot start, and the "MXXX" is the production lot number.


© 2014 TriQuint

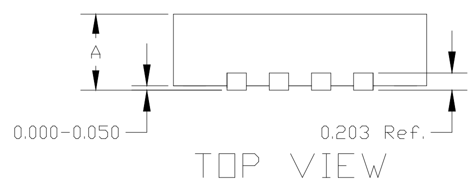
## Mechanical Information

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 ℃ reflow temperature) and tin-lead (maximum 245℃ reflow temperature) soldering processes.


*© 2014 TriQuint*

## Product Compliance Information

### ESD Sensitivity Ratings

Caution! ESD-Sensitive Device

ESD Rating: TBD
Value: Passes ≥ TBD V min.
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

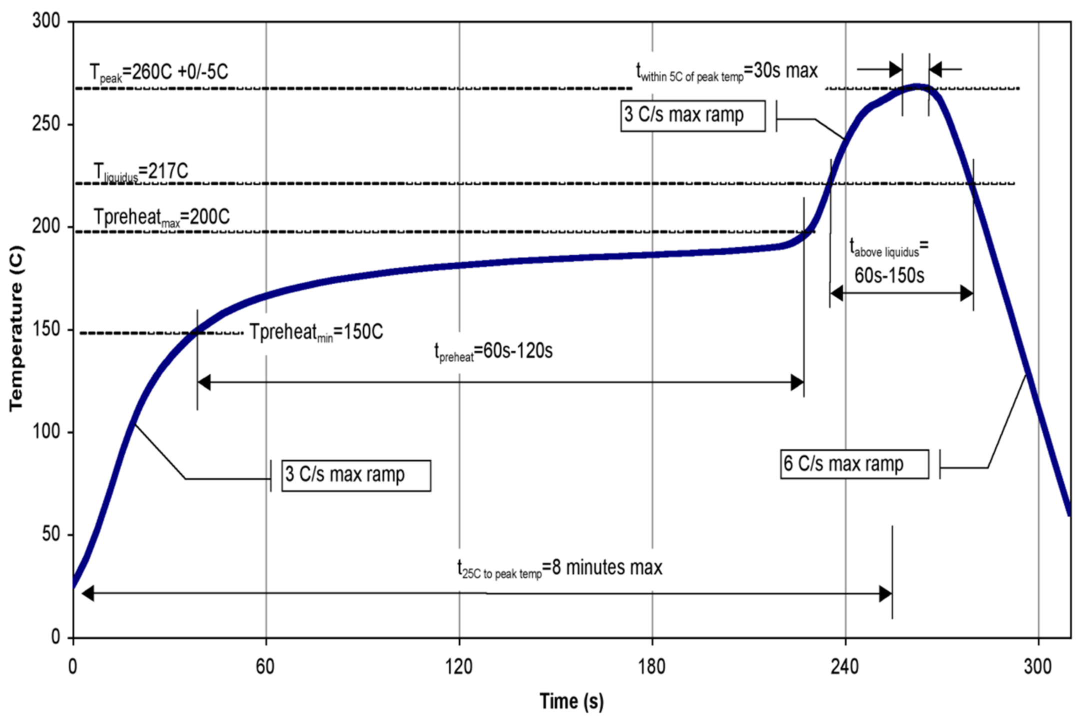
### RoHs Compliance

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





© 2014 TriQuint

## Contact Information

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

**Web:** www.triquint.com **Tel:** +1.972.994.8465
**Email:** info-sales@triquint.com **Fax:** +1.972.994.8504

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

## Important Notice

The information contained herein is believed to be reliable. TriQuint makes no warranties regarding the information contained herein. TriQuint assumes no responsibility or liability whatsoever for any of the information contained herein. TriQuint assumes no responsibility or liability whatsoever for the use of the information contained herein. The information contained herein is provided "AS IS, WHERE IS" and with all faults, and the entire risk associated with such information is entirely with the user. All information contained herein is subject to change without notice. Customers should obtain and verify the latest relevant information before placing orders for TriQuint products. The information contained herein or any use of such information does not grant, explicitly or implicitly, to any party any patent rights, licenses, or any other intellectual property rights, whether with regard to such information itself or anything described by such information.

TriQuint products are not warranted or authorized for use as critical components in medical, life-saving, or life-sustaining applications, or other applications where a failure would reasonably be expected to cause severe personal injury or death.


*© 2014 TriQuint*