

## Applications

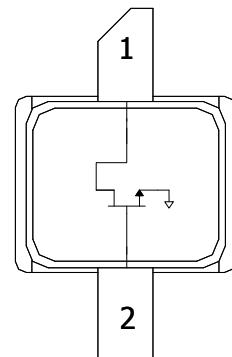
- Military radar
- Civilian radar
- Professional and military radio communications
- Test instrumentation
- Wideband or narrowband amplifiers
- Jammers



## Product Features

- Frequency: DC to 6 GHz
- Output Power ( $P_{3dB}$ ): 17 W at 3.3 GHz
- Linear Gain: >15 dB at 3.3 GHz
- Operating Voltage: 28 V
- Low thermal resistance package

## Functional Block Diagram



## General Description

The TriQuint T2G6001528-SG is a 15W ( $P_{3dB}$ ) discrete GaN on SiC HEMT which operates from DC to 6.0 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.

## Pin Configuration

| Pin No. | Label          |
|---------|----------------|
| 1       | $V_D$ / RF OUT |
| 2       | $V_G$ / RF IN  |
| Flange  | Source         |

## Ordering Information

| Part               | ECCN  | Description                       |
|--------------------|-------|-----------------------------------|
| T2G6001528-SG      | EAR99 | Packaged part<br>Flangeless       |
| T2G6001528-SG-EVB1 | EAR99 | 3.1 – 3.5 GHz<br>Evaluation Board |

## Absolute Maximum Ratings

| Parameter  | Value         |
|--|---------------|
| Breakdown Voltage ( $BV_{DG}$ )                            | 100 V         |
| Gate Voltage Range ( $V_G$ )                               | -7 to 0 V     |
| Drain Current ( $I_D$ )                                    | 5 A           |
| Gate Current ( $I_G$ )                                     | -5 to 14 mA   |
| Power Dissipation ( $P_D$ )                                | 28 W          |
| RF Input Power, CW,<br>$T = 25^\circ\text{C}$ ( $P_{IN}$ ) | 36 dBm        |
| Channel Temperature ( $T_{CH}$ )                           | 275 °C        |
| Mounting Temperature<br>(30 Seconds)                       | 320 °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                            | Value          |
|--------------------------------------|----------------|
| Drain Voltage ( $V_D$ )              | 28 V (Typ.)    |
| Drain Quiescent Current ( $I_{DQ}$ ) | 100 mA (Typ.)  |
| Peak Drain Current ( $I_D$ )         | 1400 mA (Typ.) |
| Gate Voltage ( $V_G$ )               | -3.2 V (Typ.)  |
| Channel Temperature ( $T_{CH}$ )     | 225 °C (Max)   |
| Power Dissipation, CW ( $P_D$ )      | 20.9 W (Max)   |
| Power Dissipation, Pulse ( $P_D$ )   | 22.5 W (Max)   |

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

## RF Characterization – Load Pull Performance at 1.0 GHz

Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ , Pulse: 100uS Pulse Width, 20% Duty Cycle

| Symbol      | Parameter   | Min | Typical | Max | Units |
|-------------|---|-----|---------|-----|-------|
| $G_{LIN}$   | Linear Gain, Power Tuned  |     | 24      |     | dB    |
| $P_{3dB}$   | Output Power at 3 dB Gain Compression, Power Tuned                |     | 18      |     | W     |
| $PAE_{3dB}$ | Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned |     | 76.9    |     | %     |
| $G_{3dB}$   | Gain at 3 dB Compression, Power Tuned                             |     | 21      |     | dB    |

## RF Characterization – Load Pull Performance at 2.0 GHz

Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ , Pulse: 100uS Pulse Width, 20% Duty Cycle

| Symbol      | Parameter   | Min | Typical | Max | Units |
|-------------|---|-----|---------|-----|-------|
| $G_{LIN}$   | Linear Gain, Power Tuned  |     | 18.5    |     | dB    |
| $P_{3dB}$   | Output Power at 3 dB Gain Compression, Power Tuned                |     | 18.6    |     | W     |
| $PAE_{3dB}$ | Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned |     | 61.5    |     | %     |
| $G_{3dB}$   | Gain at 3 dB Compression, Power Tuned                             |     | 15.5    |     | dB    |

## RF Characterization – Load Pull Performance at 3.0 GHz

Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ , Pulse: 100uS Pulse Width, 20% Duty Cycle

| Symbol                    | Parameter   | Min | Typical | Max | Units |
|---------------------------|---|-----|---------|-----|-------|
| $G_{\text{LIN}}$          | Linear Gain, Power Tuned  |     | 15.1    |     | dB    |
| $P_{3\text{dB}}$          | Output Power at 3 dB Gain Compression, Power Tuned                |     | 19.5    |     | W     |
| $\text{PAE}_{3\text{dB}}$ | Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned |     | 64.1    |     | %     |
| $G_{3\text{dB}}$          | Gain at 3 dB Compression, Power Tuned                             |     | 12.1    |     | dB    |

## RF Characterization – Load Pull Performance at 4.0 GHz

Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ , Pulse: 100uS Pulse Width, 20% Duty Cycle

| Symbol                    | Parameter   | Min | Typical | Max | Units |
|---------------------------|---|-----|---------|-----|-------|
| $G_{\text{LIN}}$          | Linear Gain, Power Tuned  |     | 12.6    |     | dB    |
| $P_{3\text{dB}}$          | Output Power at 3 dB Gain Compression, Power Tuned                |     | 19.6    |     | W     |
| $\text{PAE}_{3\text{dB}}$ | Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned |     | 63.8    |     | %     |
| $G_{3\text{dB}}$          | Gain at 3 dB Compression, Power Tuned                             |     | 9.6     |     | dB    |

## RF Characterization – Load Pull Performance at 5.0 GHz

Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ , Pulse: 100uS Pulse Width, 20% Duty Cycle

| Symbol                    | Parameter   | Min | Typical | Max | Units |
|---------------------------|---|-----|---------|-----|-------|
| $G_{\text{LIN}}$          | Linear Gain, Power Tuned  |     | 13.3    |     | dB    |
| $P_{3\text{dB}}$          | Output Power at 3 dB Gain Compression, Power Tuned                |     | 20      |     | W     |
| $\text{PAE}_{3\text{dB}}$ | Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned |     | 60.8    |     | %     |
| $G_{3\text{dB}}$          | Gain at 3 dB Compression, Power Tuned                             |     | 10.3    |     | dB    |

## RF Characterization – Load Pull Performance at 6.0 GHz

Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ , Pulse: 100uS Pulse Width, 20% Duty Cycle

| Symbol                    | Parameter   | Min | Typical | Max | Units |
|---------------------------|---|-----|---------|-----|-------|
| $G_{\text{LIN}}$          | Linear Gain, Power Tuned  |     | 11.6    |     | dB    |
| $P_{3\text{dB}}$          | Output Power at 3 dB Gain Compression, Power Tuned                |     | 20      |     | W     |
| $\text{PAE}_{3\text{dB}}$ | Power-Added Efficiency at 3 dB Gain Compression, Efficiency Tuned |     | 60.7    |     | %     |
| $G_{3\text{dB}}$          | Gain at 3 dB Compression, Power Tuned                             |     | 8.6     |     | dB    |

## RF Characterization – EVB Performance at 3.3 GHz

Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$ , Pulse: 100uS Pulse Width, 20% Duty Cycle

| Symbol            | Parameter                                 | Min  | Typical | Max | Units |
|-------------------|---|------|---------|-----|-------|
| $G_{\text{LIN}}$  | Linear Gain                               | 14.5 | 15.5    |     | dB    |
| $P_{3\text{dB}}$  | Output Power at 3 dB Gain Compression     | 15.5 | 17      |     | W     |
| $DE_{3\text{dB}}$ | Drain Efficiency at 3 dB Gain Compression | 68   | 72      |     | %     |
| $G_{3\text{dB}}$  | Gain at 3 dB Compression                  | 11.5 | 12.5    |     | dB    |

## RF Characterization – Narrow Band Performance at 3.30 GHz

Test conditions unless otherwise noted:  $T_A = 25^\circ\text{C}$ ,  $V_D = 28\text{ V}$ ,  $I_{DQ} = 100\text{ mA}$

Driving input power is determined at 1dB compression at EVB output connector.

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

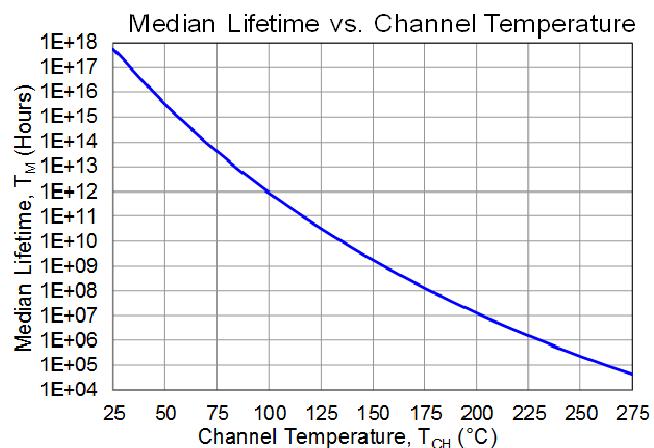
## Thermal and Reliability Information

| Parameter                            | Test Conditions  | Value | Units |
|--------------------------------------|------------------|-------|-------|
| Thermal Resistance ( $\theta_{JC}$ ) | DC at 85 °C Case | 6.7   | °C/W  |
| Channel Temperature ( $T_{CH}$ )     |                  | 225   | °C    |

Notes:

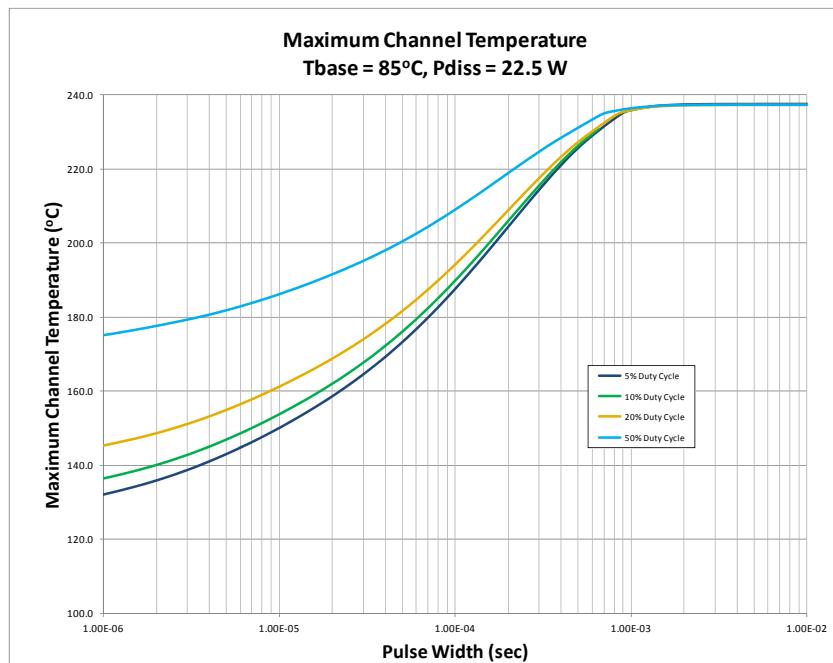
Thermal resistance measured to bottom of package, CW.

## Median Lifetime



## Maximum Channel Temperature

$T_{BASE} = 85^\circ\text{C}$ ,  $P_{diss} = 22.5\text{W}$

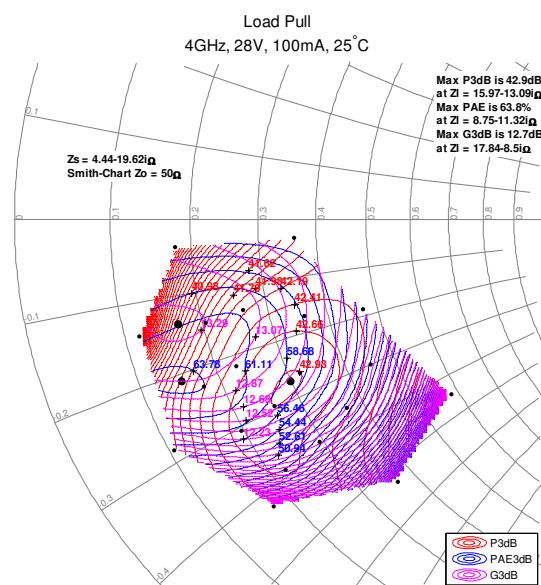
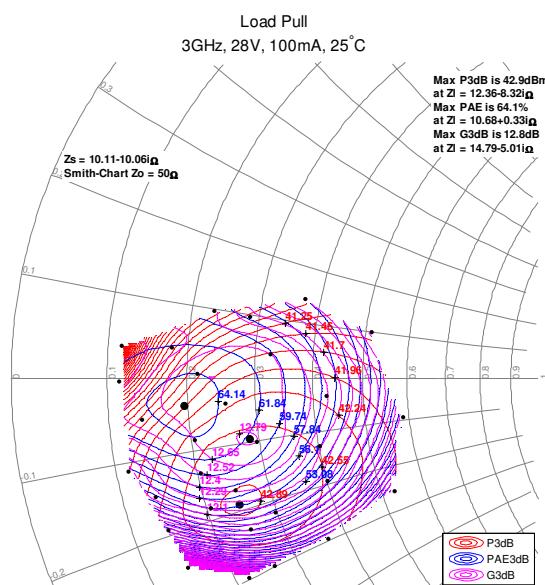
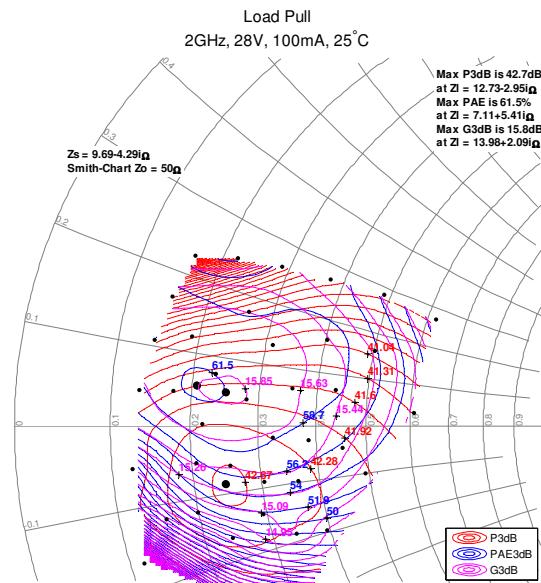
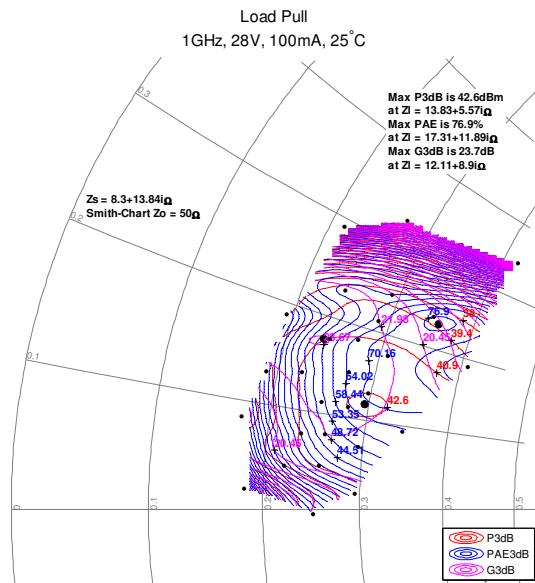


## Load Pull Smith Charts (1, 2)

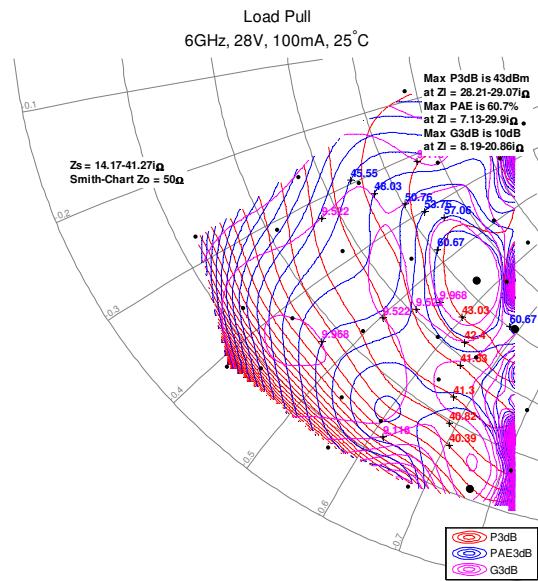
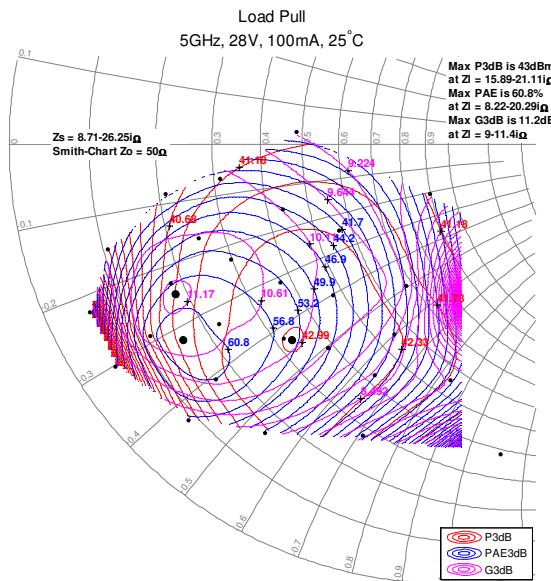
RF performance that the device typically exhibits when placed in the specified impedance environment. The impedances are not the impedances of the device, they are the impedances presented to the device via an RF circuit or load-pull system. The impedances listed follow an optimized trajectory to maintain high power and high efficiency.

Notes:

1. 28V, 100mA, Pulsed signal with 100uS pulse width and 20% duty cycle
2. See page 15 for load pull and source pull reference planes.



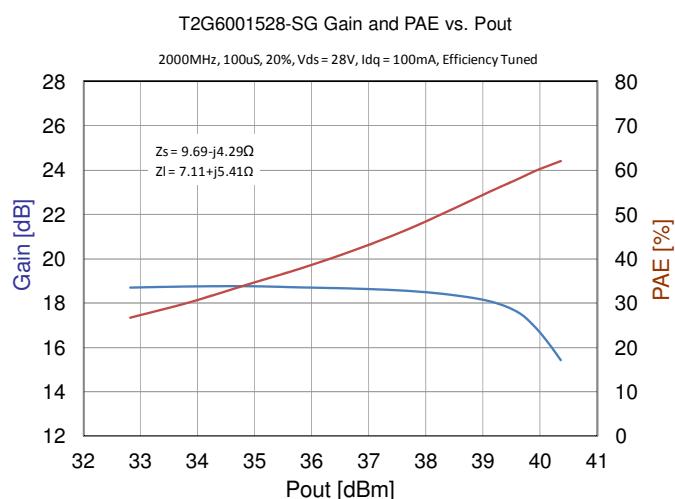
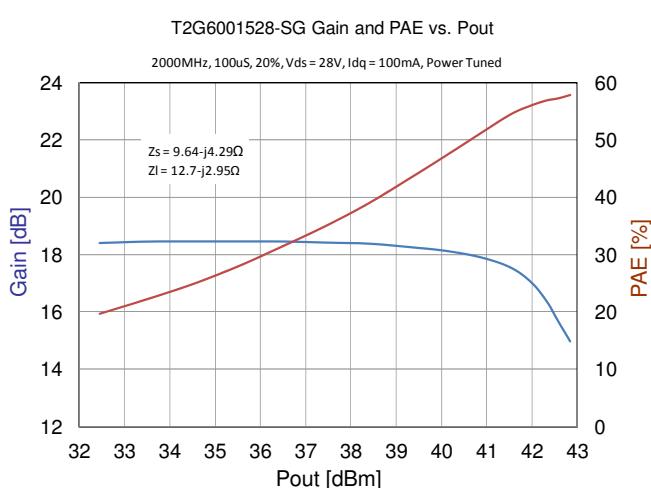
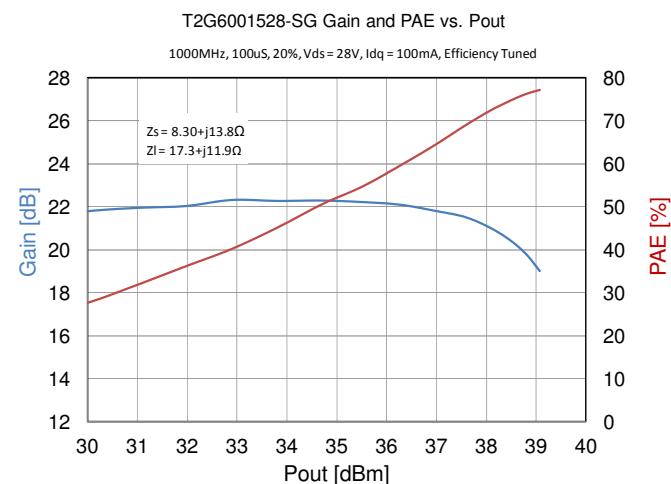
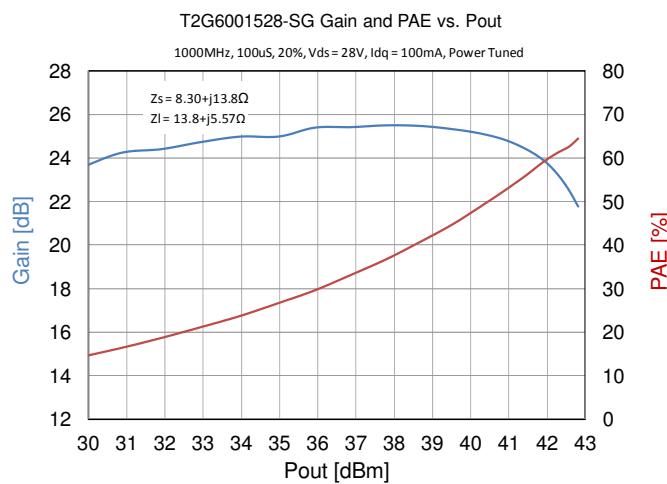
## Load Pull Smith Charts <sup>(1, 2)</sup>



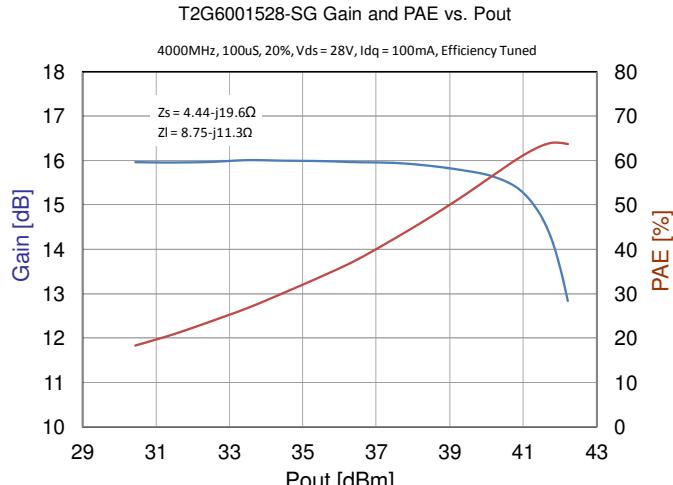
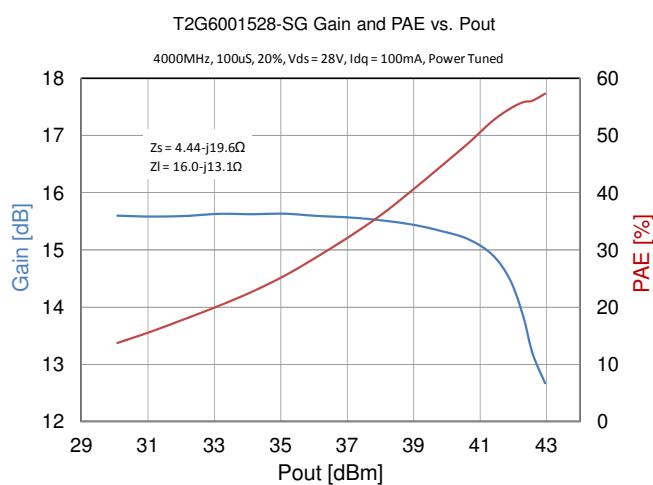
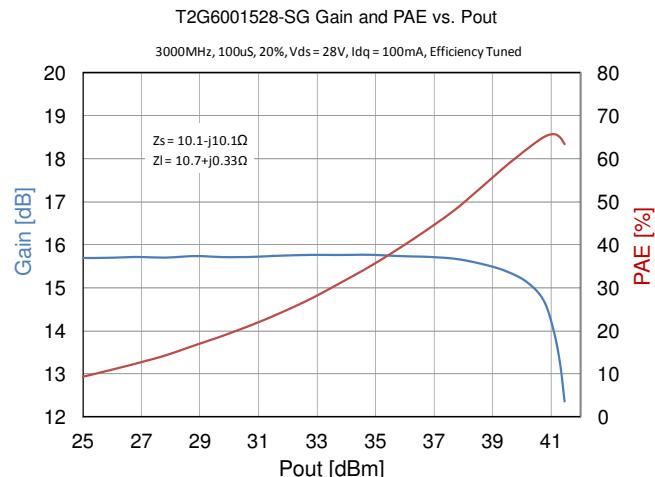
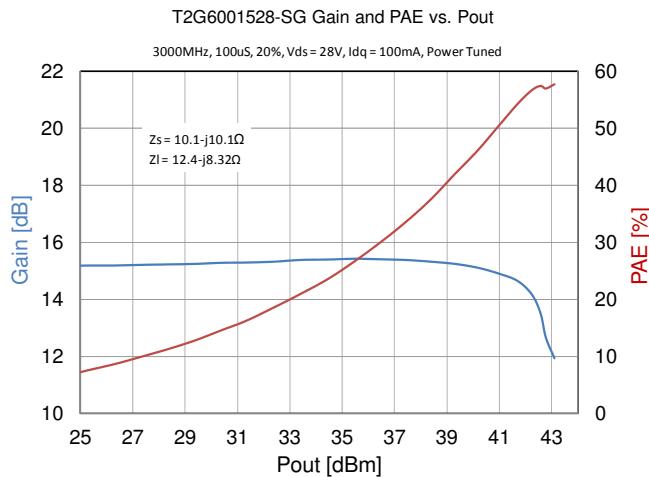
## Typical Performance<sup>(1,2,3)</sup>

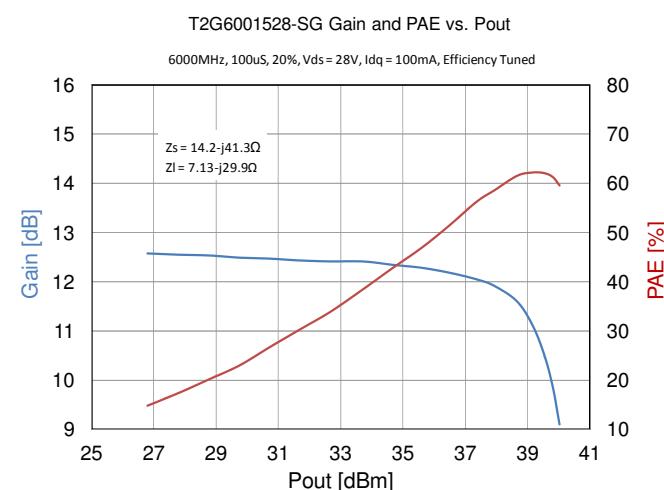
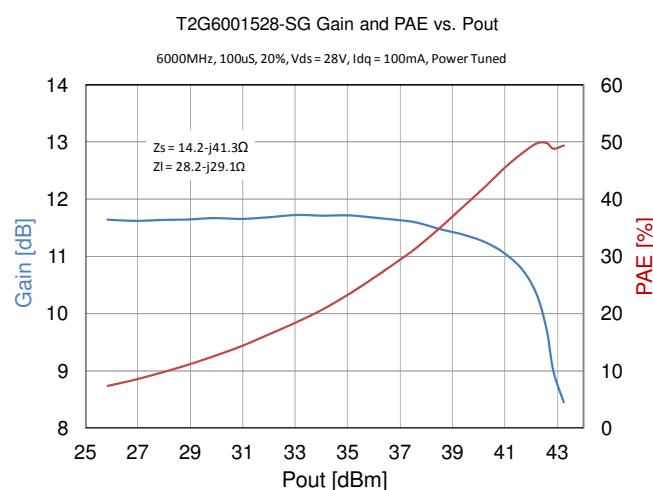
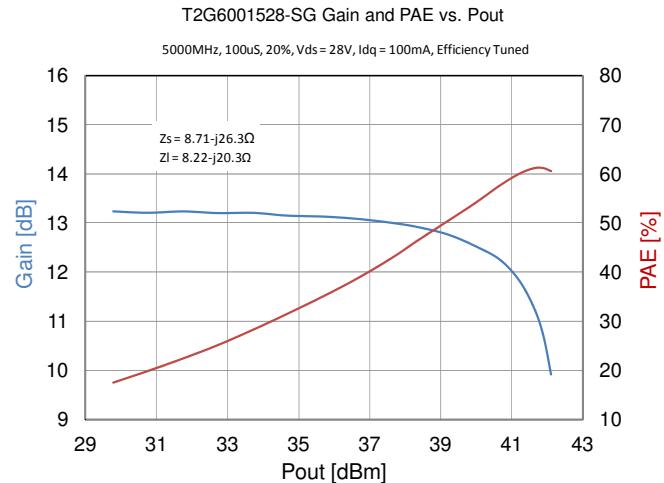
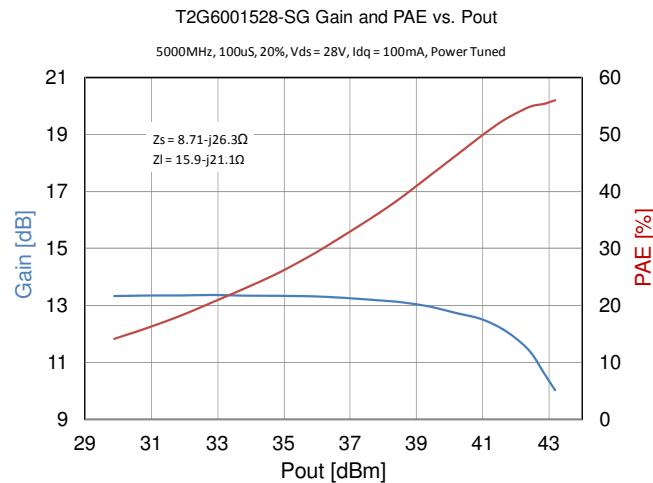
### Notes:

1. Pulsed signal with 100uS pulse width and 20% duty cycle
2. See page 15 for load pull and source pull reference planes.
3. Performance is measured at device reference planes.



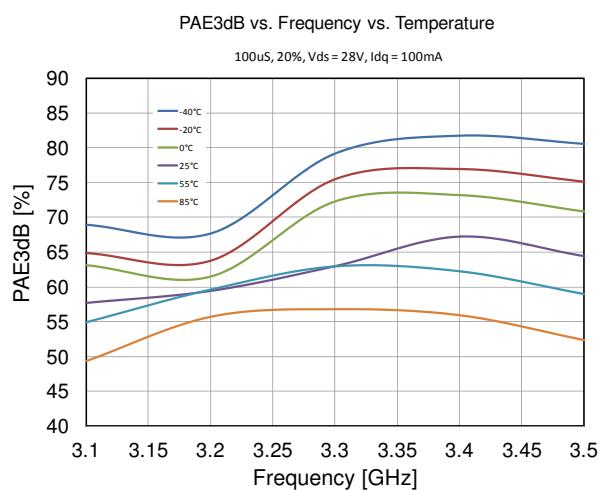
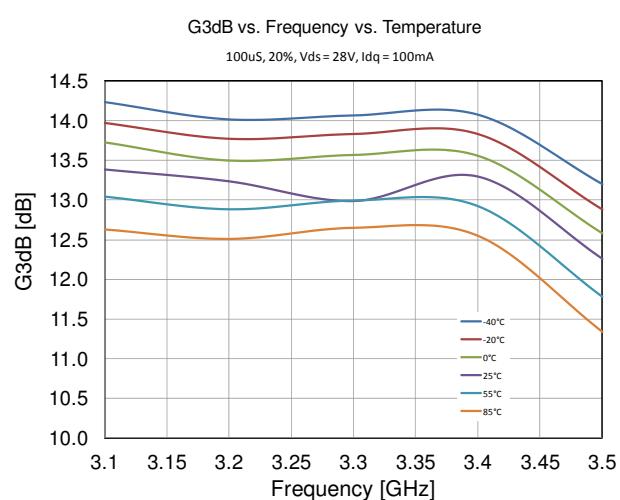
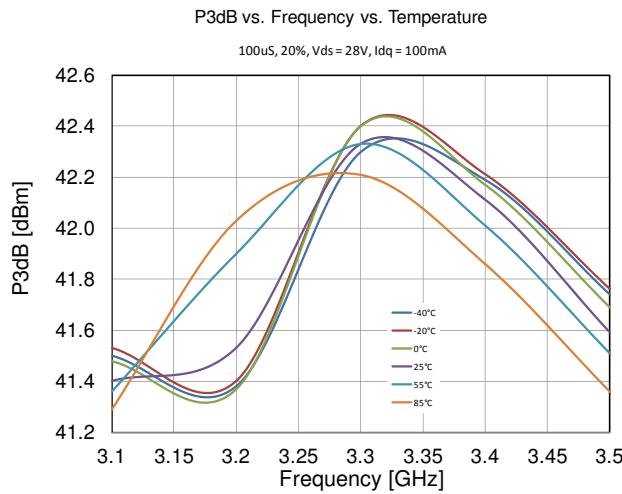
**Typical Performance<sup>(1,2,3)</sup>**



**Typical Performance<sup>(1,2,3)</sup>**


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

Performance measured on TriQuint's 3.1 GHz to 3.5 GHz Evaluation Board



### Notes:

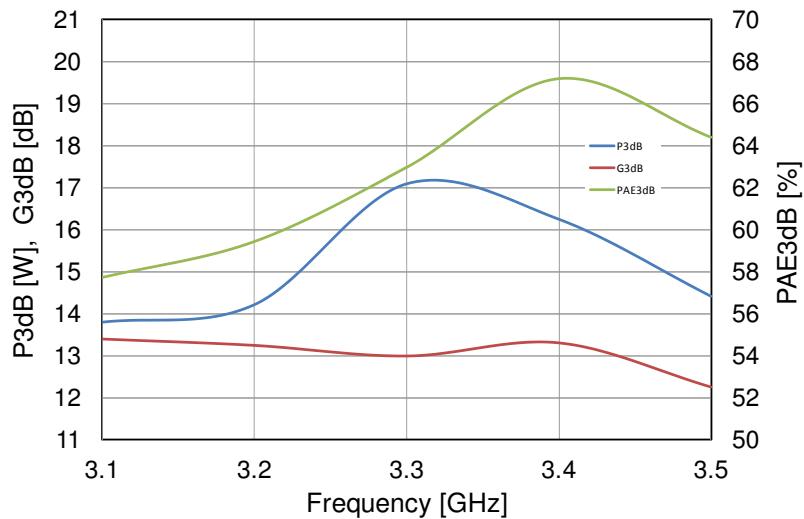
1. Test Conditions: V<sub>DS</sub> = 28 V, I<sub>DQ</sub> = 100 mA
2. Test Signal: Pulse Width = 100  $\mu$ s, Duty Cycle = 20%

**Evaluation Board Performance At 25°C<sup>(1, 2)</sup>**

Performance measured on TriQuint's 3.1 GHz to 3.5 GHz Evaluation Board

P3dB, G3dB, PAE3dB vs. Frequency at 25°C

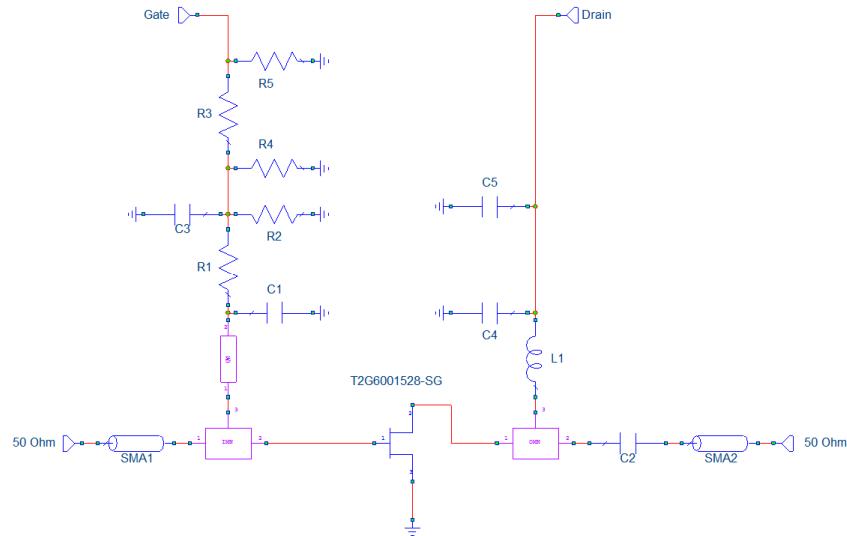
100uS, 20%, Vds = 28V, Idq = 100mA



**Notes:**

1. Test Conditions:  $V_{DS} = 28$  V,  $I_{DQ} = 100$  mA, 25°C
2. Test Signal: Pulse Width = 100  $\mu$ s, Duty Cycle = 20 %

## Application Circuit



## Bias-up Procedure

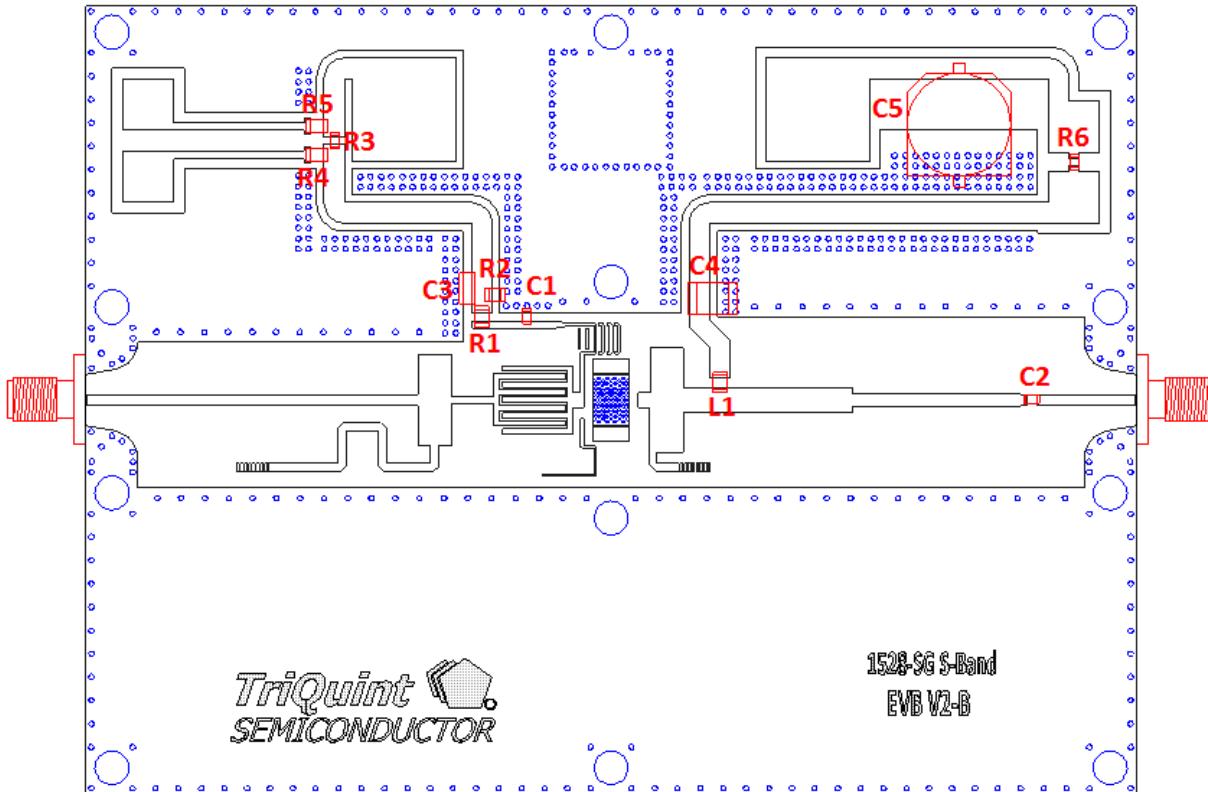
- Set gate voltage ( $V_G$ ) to -5.0V
- Set drain voltage ( $V_D$ ) to 28 V
- Slowly increase  $V_G$  until quiescent  $I_D$  is 100 mA.
- Apply RF signal

## Bias-down Procedure

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

## Evaluation Board Layout

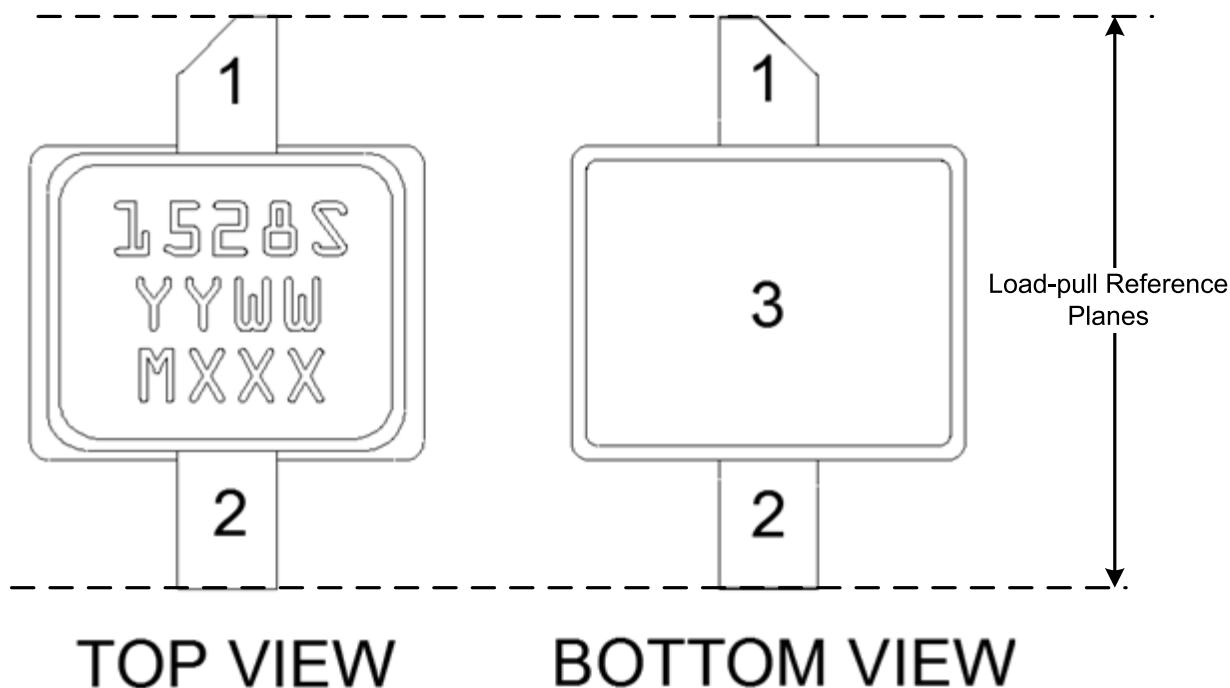
Top RF layer is 0.020" thick Rogers RO4350B,  $\epsilon_r = 3.48$ . The pad pattern shown has been developed and tested for optimized assembly at TriQuint Semiconductor. The PCB land pattern has been developed to accommodate lead and package tolerances.



## Bill of Materials

| Reference Design | Value  | Qty | Manufacturer | Part Number         |
|------------------|--------|-----|--------------|---------------------|
| C1, C2           | 18 pF  | 2   | ATC          | 600S1802BT250XT     |
| C3               | 10 uF  | 1   | TDK          | C1632X5ROJ106M130AC |
| C4               | 1.0 uF | 1   | AVX          | 18121C105KAT2A      |
| C5               | 220 uF | 1   | Nichicon     | UWT1H221MNL1GS      |
| R1, R3           | 10 Ω   | 2   | Panasonic    | ERJ-3EKF10R0V       |
| R2               | 1kΩ    | 1   | Panasonic    | ERJ-6ENF1001V       |
| R4, R5           |        |     |              | Do Not Place        |
| R6               |        |     |              | Do Not Place        |
| L1               | 22 nH  | 1   | Coilcraft    | 0805CS-220X_L_      |

## Pin Layout



**TOP VIEW**

**BOTTOM VIEW**

## Pin Description

| Pin | Symbol         | Description  |
|-----|----------------|--|
| 1   | $V_D$ / RF OUT | Drain voltage / RF Output to be matched to 50 ohms; see EVB Layout on page 14 as an example. |
| 2   | $V_G$ / RF IN  | Gate voltage / RF Input to be matched to 50 ohms; see EVB Layout on page 14 as an example.   |
| 3   | Flange         | Source connected to ground; see EVB Layout on page 14 as an example.                         |

Notes:

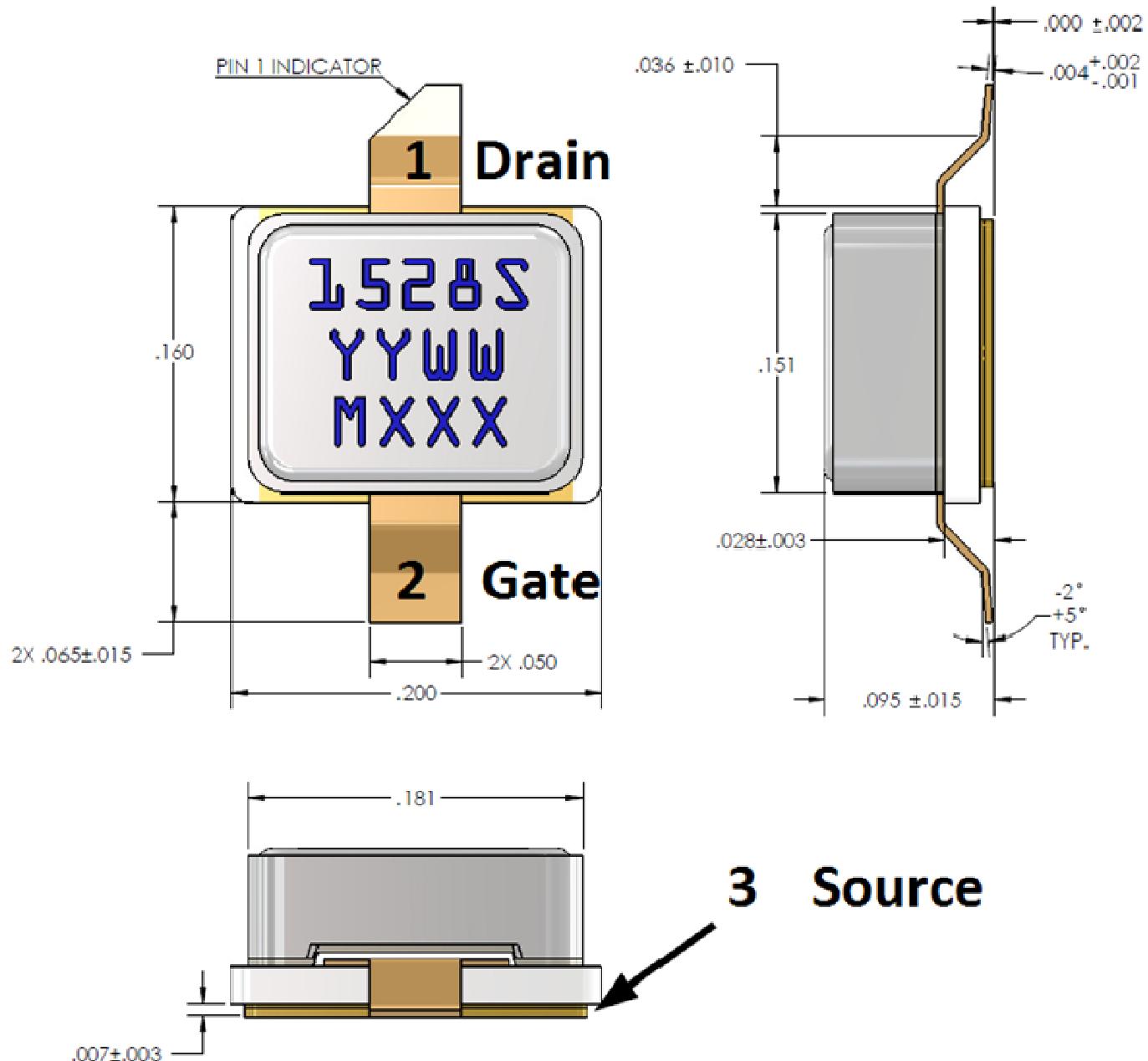
Thermal resistance measured to back side of package

Note:

The T2G6001528-SG will be marked with the "1528S" 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 inches.



**Note:**

Unless otherwise noted, all dimension tolerances are +/-0.005.

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 1A  
 Value: Passes  $\geq 400$  V min.  
 Test: Human Body Model (HBM)  
 Standard: JEDEC Standard JESD22-A114

### MSL Rating

Level 3 at  $+260^{\circ}\text{C}$  convection reflow  
 The part is rated Moisture Sensitivity Level 3 at  $260^{\circ}\text{C}$  per  
 JEDEC standard IPC/JEDEC J-STD-020.

### Solderability

Compatible with the latest version of J-STD-020, Lead free solder,  $260^{\circ}\text{C}$

### 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).

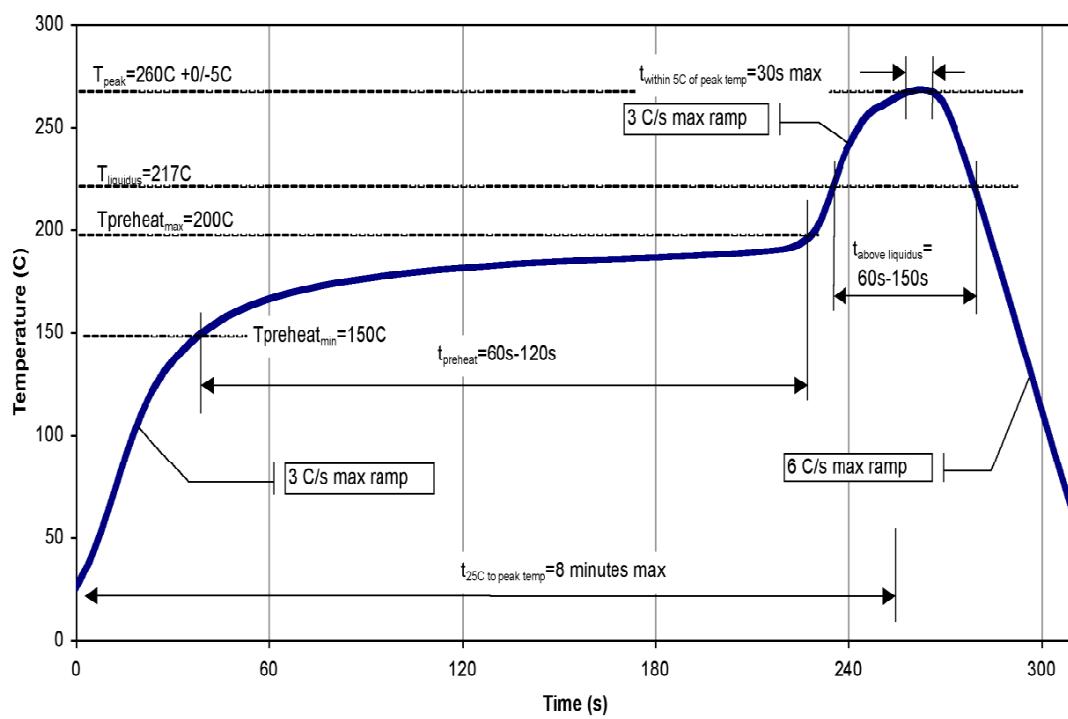
This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ( $\text{C}_{15}\text{H}_{12}\text{Br}_4\text{O}_2$ ) Free
- PFOS Free
- SVHC Free

### ECCN

US Department of Commerce EAR99

## Recommended Soldering Temperature Profile



## Contact Information

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

Web: [www.triquint.com](http://www.triquint.com)  
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Fax: +1.972.994.8504

For technical questions and application information: Email: [info-products@triquint.com](mailto:info-products@triquint.com)

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