TriQuint

# TGA2958

***13 to 18 GHz 2W GaN Driver Amplifier***

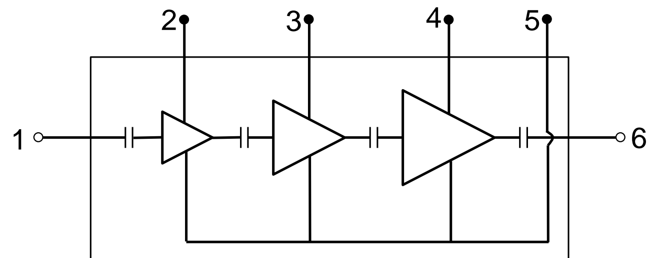
## Applications

- Satellite Communications
- Data Links
- Radar
- General Purpose

## Product Features

- Frequency Range: 13 - 18 GHz
- Psat: > 33 dBm at $P_{IN}$ = 12 dBm
- PAE: > 25 % at Pin = 12 dBm
- Small Signal Gain: > 25 dB
- Input Return Loss: > 7 dB
- Output Return Loss: > 8 dB
- Bias: $V_D$ = 20 V, $I_{DQ}$ = 70 mA, $V_G$ = -2.7 V Typical
- Chip Dimensions: 1.25 x 2.14 x 0.10 mm
- Performance under CW operation

## Functional Block Diagram




## General Description

TriQuint's TGA2958 is a driver amplifier fabricated on TriQuint's TQGaN15 GaN on SiC process. The TGA2958 operates from 13 – 18 GHz and achieves 2 W of saturated output power with > 21 dB of large signal gain and at least 25% power-added efficiency .

The TGA2958 is an ideal choice to drive TriQuint's high performing Ku-band GaN HPA's allowing the user to operate the driver and HPA off similar voltage rails.

Fully matched to 50 ohms with integrated DC blocking capacitors on both I/O ports, the TGA2958 is ideally suited for a variety of military and commercial radar and communications applications.

Lead free and RoHS compliant.

Evaluation Boards are available upon request.

## Pad Configuration

| Pad No. | Symbol |
|---|---|
| 1 | $RF_{IN}$ |
| 2 | $V_{G1}$ |
| 3 | $V_{G2}$ |
| 4 | $V_{G3}$ |
| 5 | $V_D$ |
| 6 | $RF_{OUT}$ |

## Ordering Information

| Part | ECCN | Description |
|---|---|---|
| TGA2958 | EAR99 | 13 - 18 GHz 2W GaN Driver Amplifier |



***© 2014 TriQuint***

## Absolute Maximum Ratings

| Parameter | Value |
|---|---|
| Drain Voltage ($V_D$) | 23 V |
| Gate Voltage Range ($V_G$) | -5 to 0 V |
| Drain Current – common drain<br>- 1st Stage ($I_{D1}$)<br>- 2nd Stage ($I_{D2}$)<br>- 3rd Stage ($I_{D3}$) | 576 mA<br>72 mA<br>192 mA<br>384 mA |
| Gate Current at Tch = 200 °C:<br>- 1st Stage ($I_{G1}$)<br>- 2nd Stage ($I_{G2}$)<br>- 3rd Stage ($I_{G3}$) | <br>-0.2 to 1.2 mA<br>-0.4 to 2.4 mA<br>-0.8 to 2.4 mA |
| Power Dissipation ($P_{DISS}$), 85°C | 13 W |
| Input Power ($P_{IN}$), CW, 50 Ω, $V_D$ = 22 V, $I_{DQ}$ = 70 mA, 85 °C | 27 dBm |
| Input Power ($P_{IN}$), CW, VSWR 3:1, $V_D$ = 22 V, $I_{DQ}$ = 70 mA, 85 °C | 20 dBm |
| Channel Temperature ($T_{CH}$) | 275 °C |
| Mounting Temperature (30 Seconds) | 320 °C |
| Storage Temperature | -55 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 ($V_D$) CW | 20 V |
| Drain Current ($I_{DQ}$) | 70 mA |
| Drain Current Under RF Drive ($I_{D_DRIVE}$) | See plots p. 7 |
| Gate Voltage ($V_G$) | −2.7 V (Typ.) |
| Gate Current Under RF Drive ($I_{G_DRIVE}$) | See plots p. 7 |
| Temperature ($T_{BASE}$) | -40 to 85 °C |

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

## Electrical Specifications

Test conditions unless otherwise noted: 25 °C, $V_D$ = 20 V, $I_{DQ}$ = 70 mA, $V_G$ = −2.7 V Typ, CW.

| Parameter | Min | Typical | Max | Units |
|---|---|---|---|---|
| Operational Frequency Range | 13 | | 18 | GHz |
| Small Signal Gain | | > 25 | | dB |
| Input Return Loss | | > 7 | | dB |
| Output Return Loss | | > 8 | | dB |
| Output Power at Pin = 12 dBm | | > 33 | | dBm |
| Power Added Efficiency at Pin = 12 dBm | | > 25 | | % |
| Large Signal Gain at Pin = 12 dBm | | > 21 | | dB |
| IM3 (Pout/tone = 24 dBm, 1 MHz spacing) | | -27 | | dBc |
| IM5 (Pout/tone = 24 dBm, 1 MHz spacing) | | -33 | | dBc |
| Small Signal Gain Temperature Coefficient | | -0.07 | | dB/°C |
| Output Power Temperature Coefficient<br>- at Pin = 0 dBm<br>- at Pin = 12 dBm | | <br>-0.06<br>-0.01 | | dBm/°C |
| Recommended Operating Voltage | | 20 | 22 | V |


© 2014 TriQuint

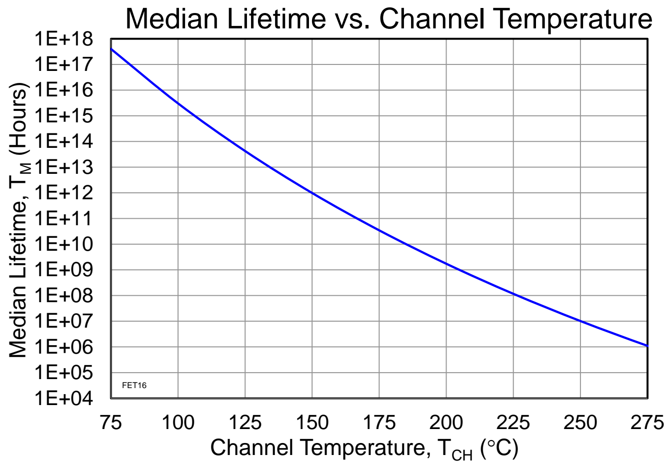
## Thermal and Reliability Information

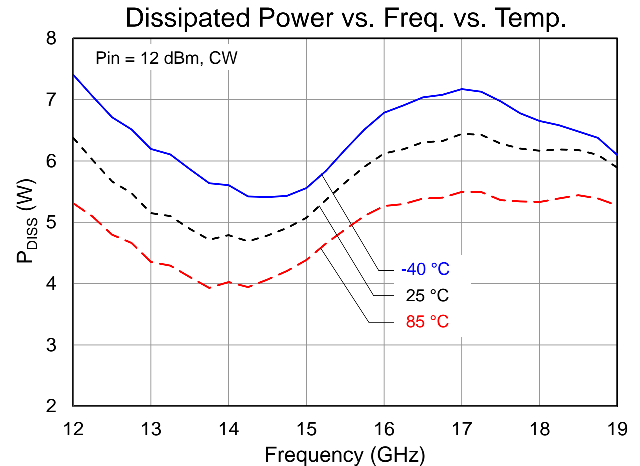
| Parameter | Test Conditions | Value | Units |
|---|---|---|---|
| Thermal Resistance ($\theta_{JC}$) [(1)] | $T_{BASE}$ = 85°C, $V_D$ = 20 V (CW) At $I_{DQ}$ = 70 mA, $P_{DISS}$ = 1.4 W | 12.9 | °C/W |
| Channel Temperature ($T_{CH}$) (Quiescent) | | 103 | °C |
| Median Lifetime ($T_M$) | | 1.8 x 10^15 | Hrs |
| Thermal Resistance ($\theta_{JC}$) [(1)] | $T_{BASE}$ = 85°C, $V_D$ = 20 V (CW) At Freq = 17 GHz, $I_{DQ}$ = 70 mA, $P_{OUT}$ = 27 dBm, $P_{DISS}$ = 3.2 W | 15.6 | °C/W |
| Channel Temperature ($T_{CH}$) (Under RF drive) | | 135 | °C |
| Median Lifetime ($T_M$) | | 8.3 x 10^12 | Hrs |
| Thermal Resistance ($\theta_{JC}$) [(1)] | $T_{BASE}$ = 85°C, $V_D$ = 20 V (CW) At Freq = 17 GHz, $I_{DQ}$ = 70 mA, $P_{OUT}$ = 33.5 dBm, $P_{DISS}$ = 7.9 W | 14.8 | °C/W |
| Channel Temperature ($T_{CH}$) (Under RF drive) | | 202 | °C |
| Median Lifetime ($T_M$) | | 1.2 x 10^09 | Hrs |

Notes:

1. Thermal resistance measured to back of carrier plate. MMIC mounted on a 40 mil CuMo carrier using 1.5 mil 80/20 AuSn.

Test Conditions: $V_D$ = 22 V; Failure Criteria = 10% reduction in $I_{D_MAX}$



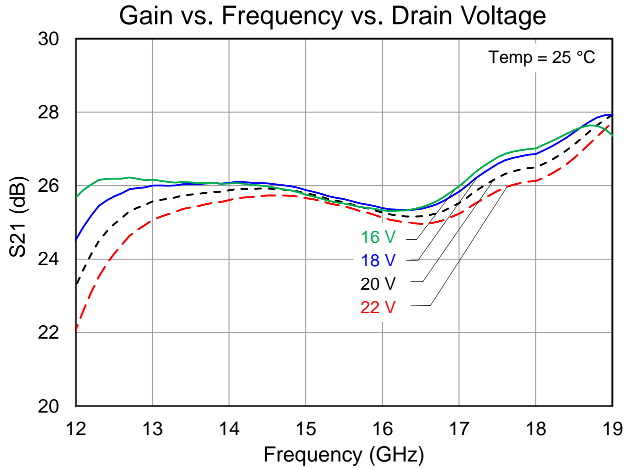



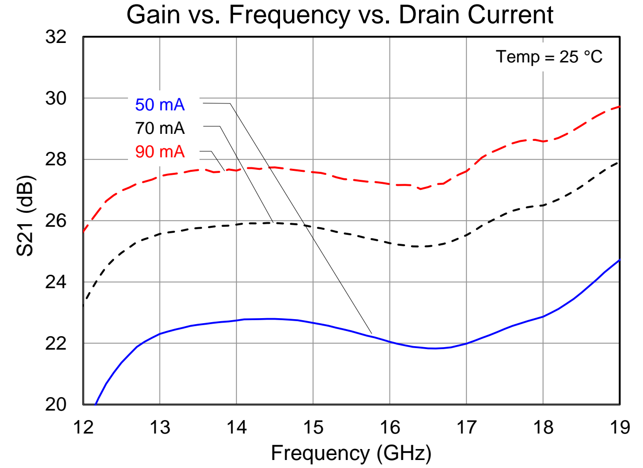


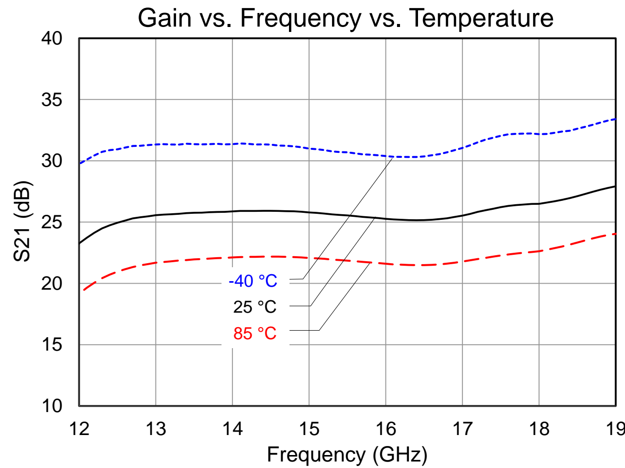
© 2014 TriQuint

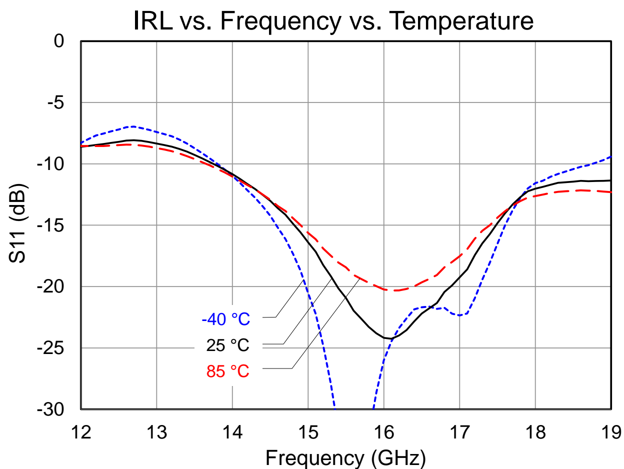
## Typical Performance: Small Signal

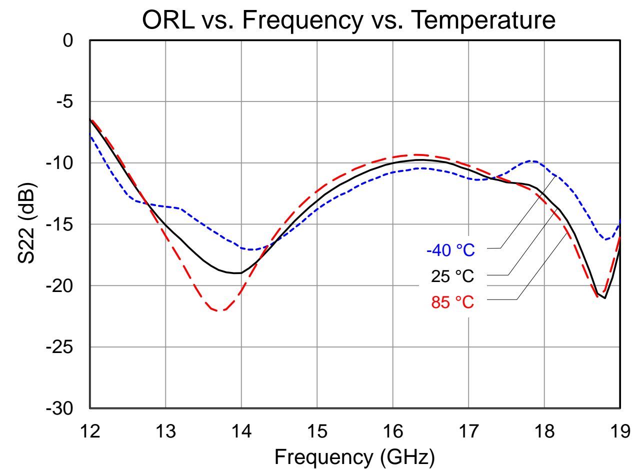
Conditions unless otherwise specified: $V_D$ = 20 V, $I_{DQ}$ = 70 mA, $V_G$ = −2.7 V Typ, CW.



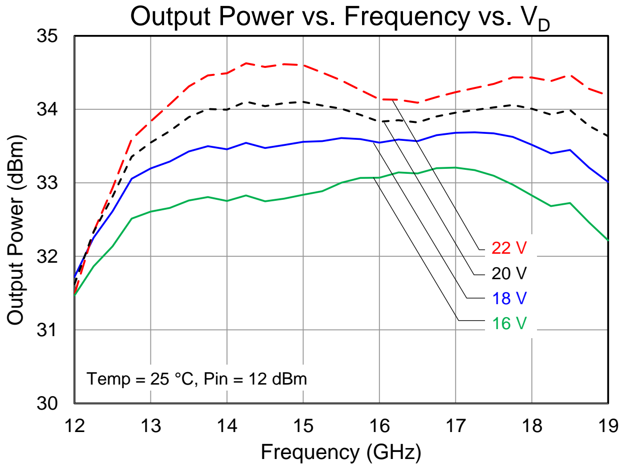



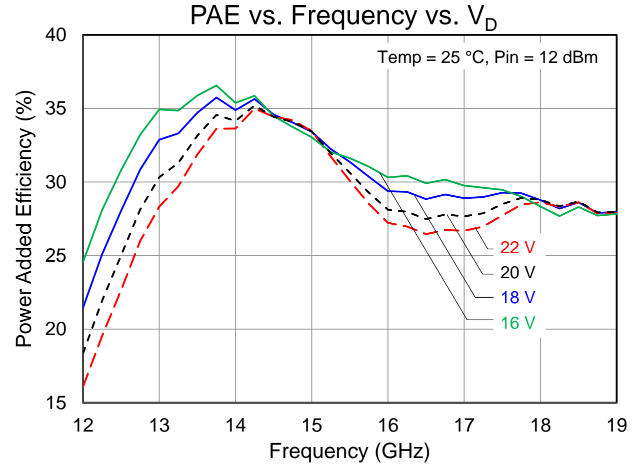


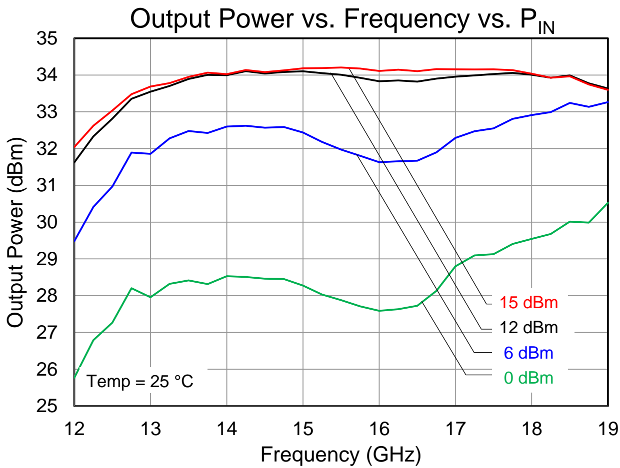

**© 2014 TriQuint**

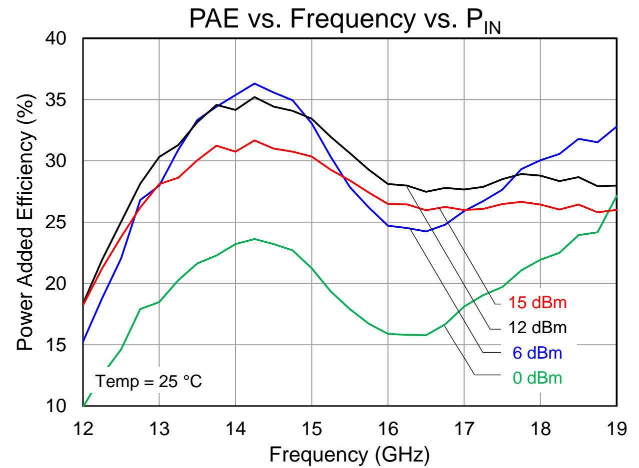
## Typical Performance: Large Signal

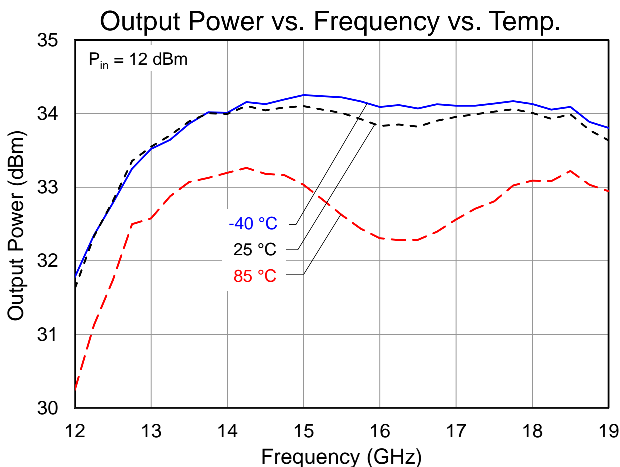
Conditions unless otherwise specified: $V_D$ = 20 V, $I_{DQ}$ = 70 mA, $V_G$ = −2.7 V Typ, CW .

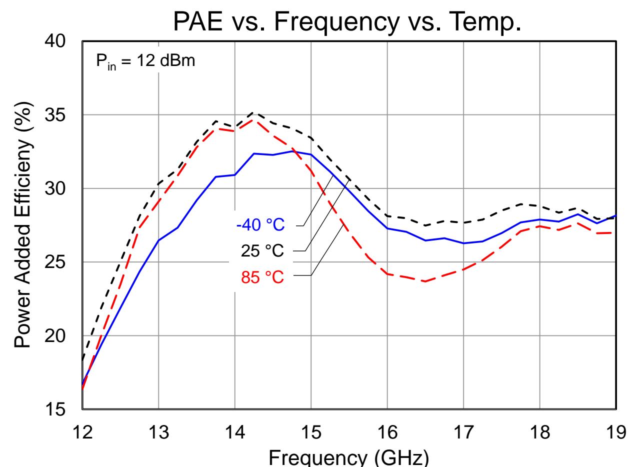


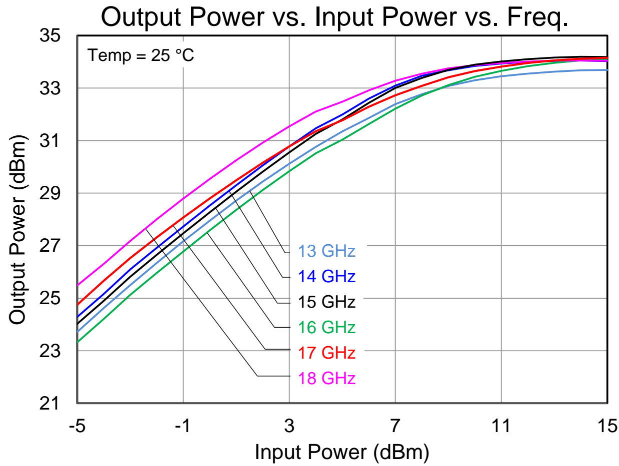



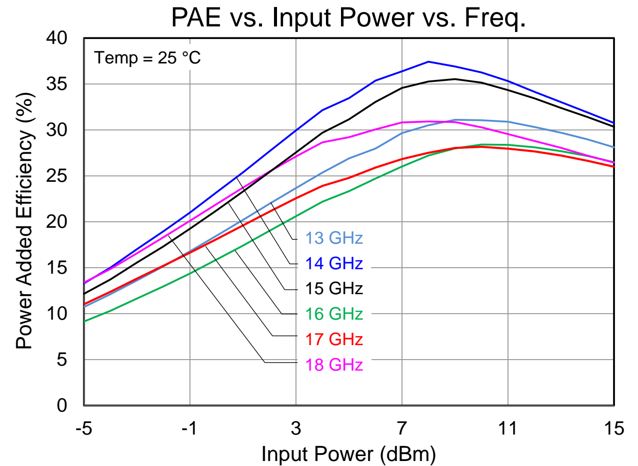


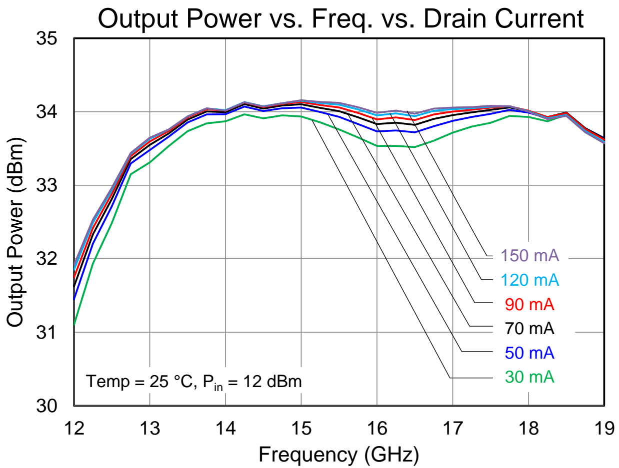
**© 2014 TriQuint**
Disclaimer: Subject to change without notice
**www.triquint.com**

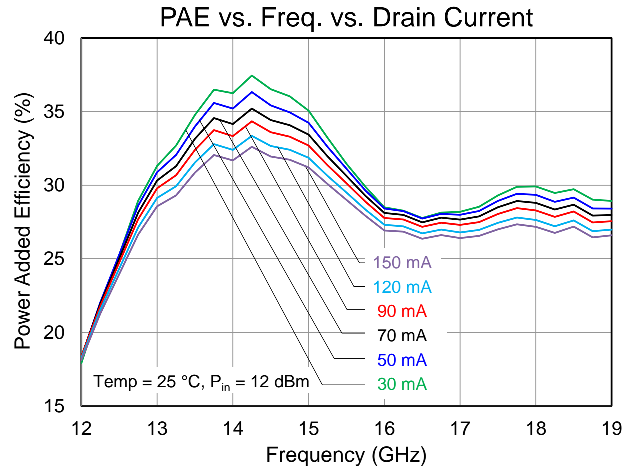
## Typical Performance: Large Signal

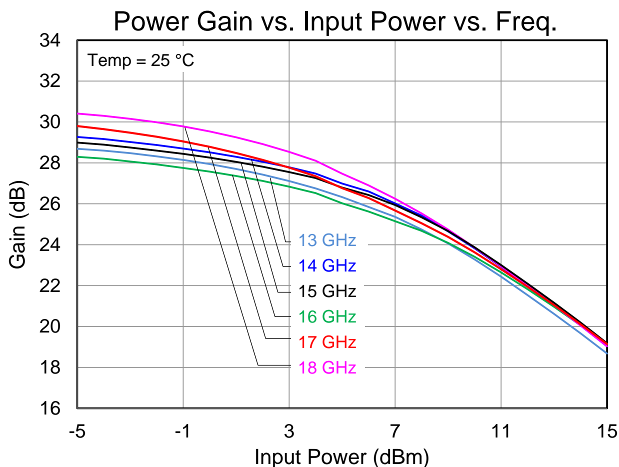
Conditions unless otherwise specified: $V_D$ = 20 V, $I_{DQ}$ = 70 mA, $V_G$ = −2.7 V Typ, CW .

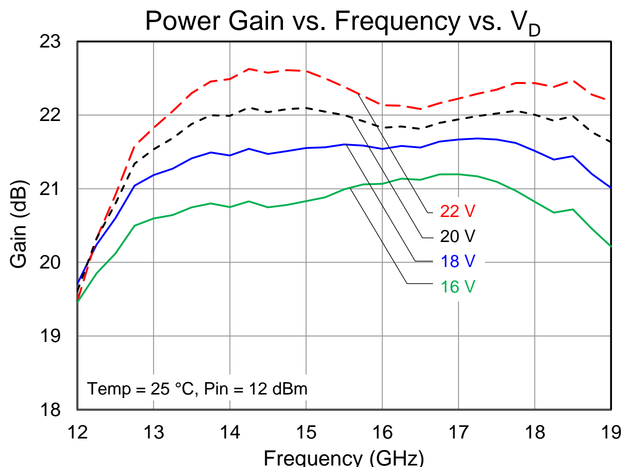


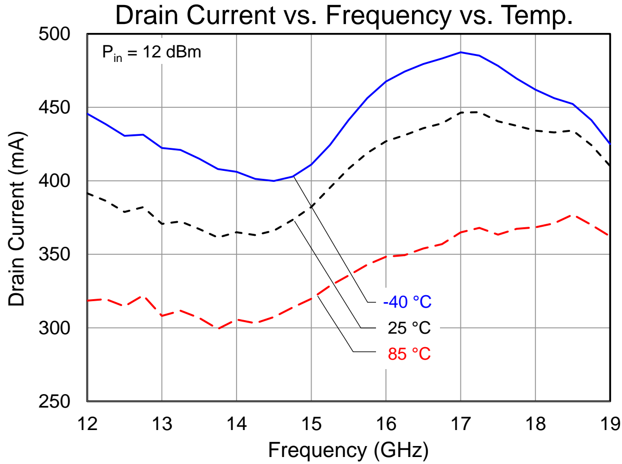


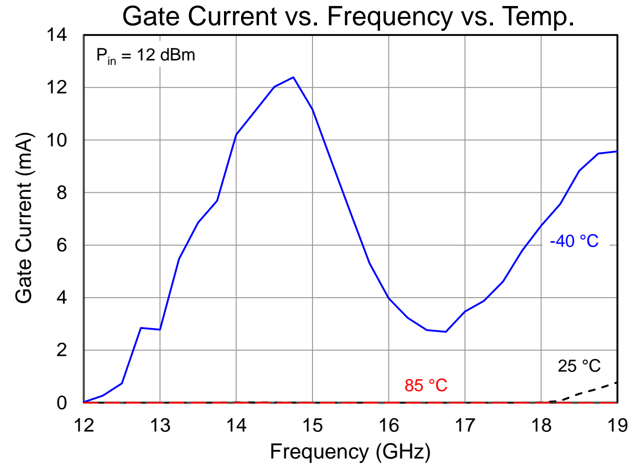
*© 2014 TriQuint*

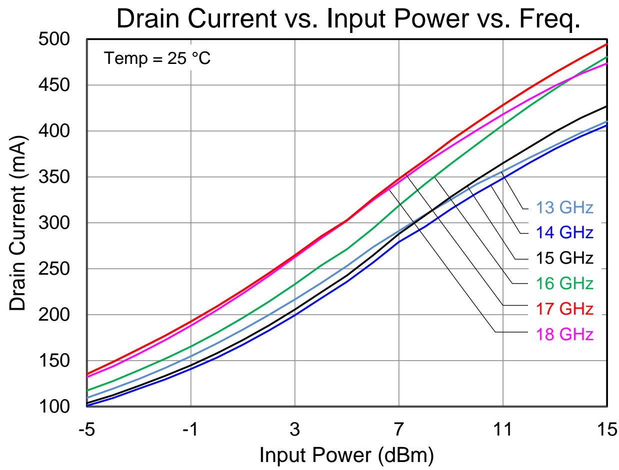
Disclaimer: Subject to change without notice

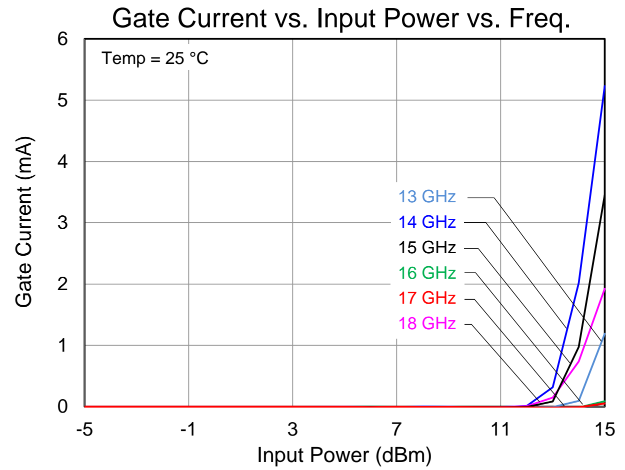
## Typical Performance: Large Signal

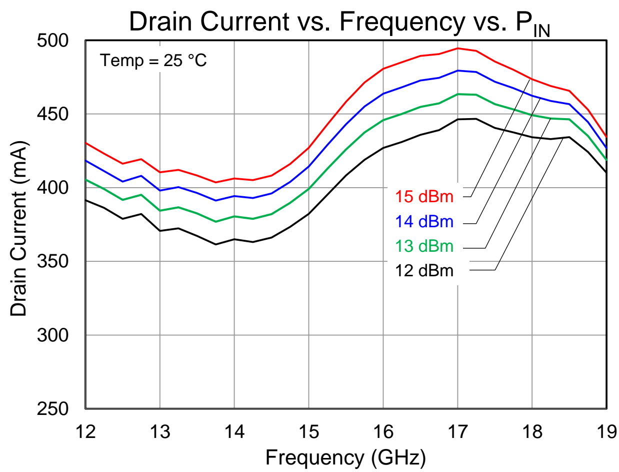
Conditions unless otherwise specified: $V_D$ = 20 V, $I_{DQ}$ = 70 mA, $V_G$ = −2.7 V Typ, CW.

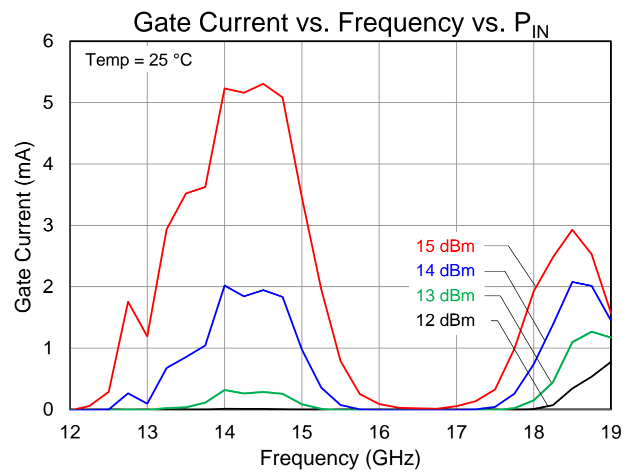


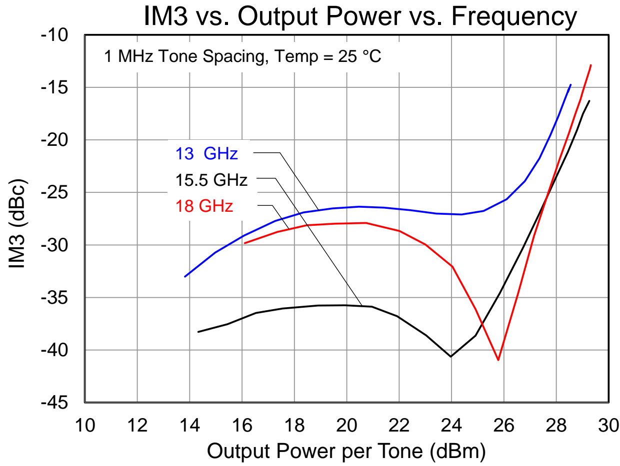



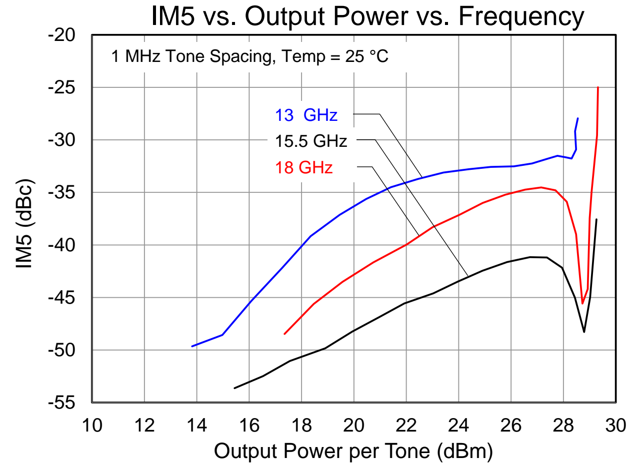


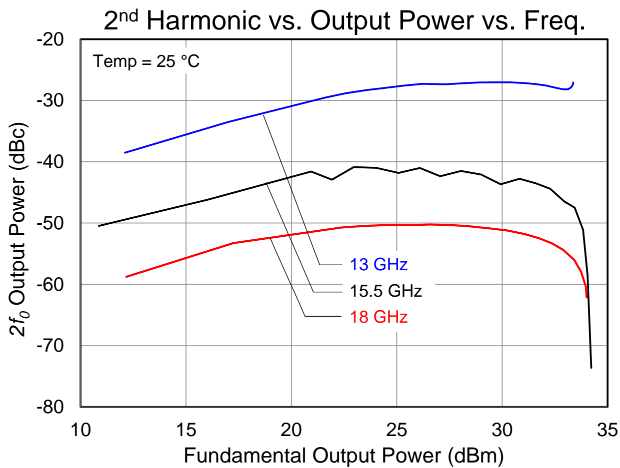
© 2014 TriQuint

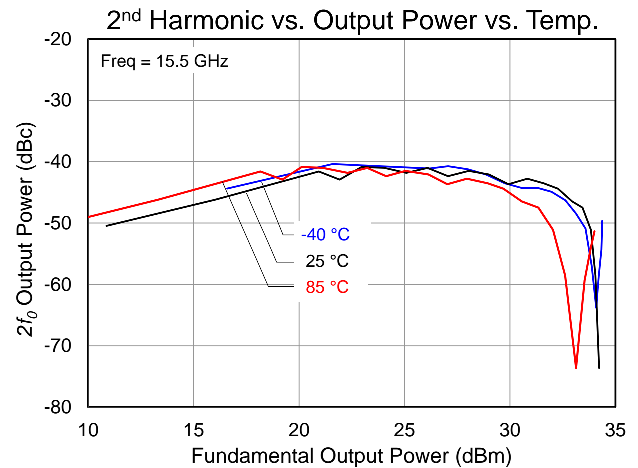
## Typical Performance: Linearity

Conditions unless otherwise specified: $V_D$ = 20 V, $I_{DQ}$ = 70 mA, $V_G$ = −2.7 V Typ, CW .



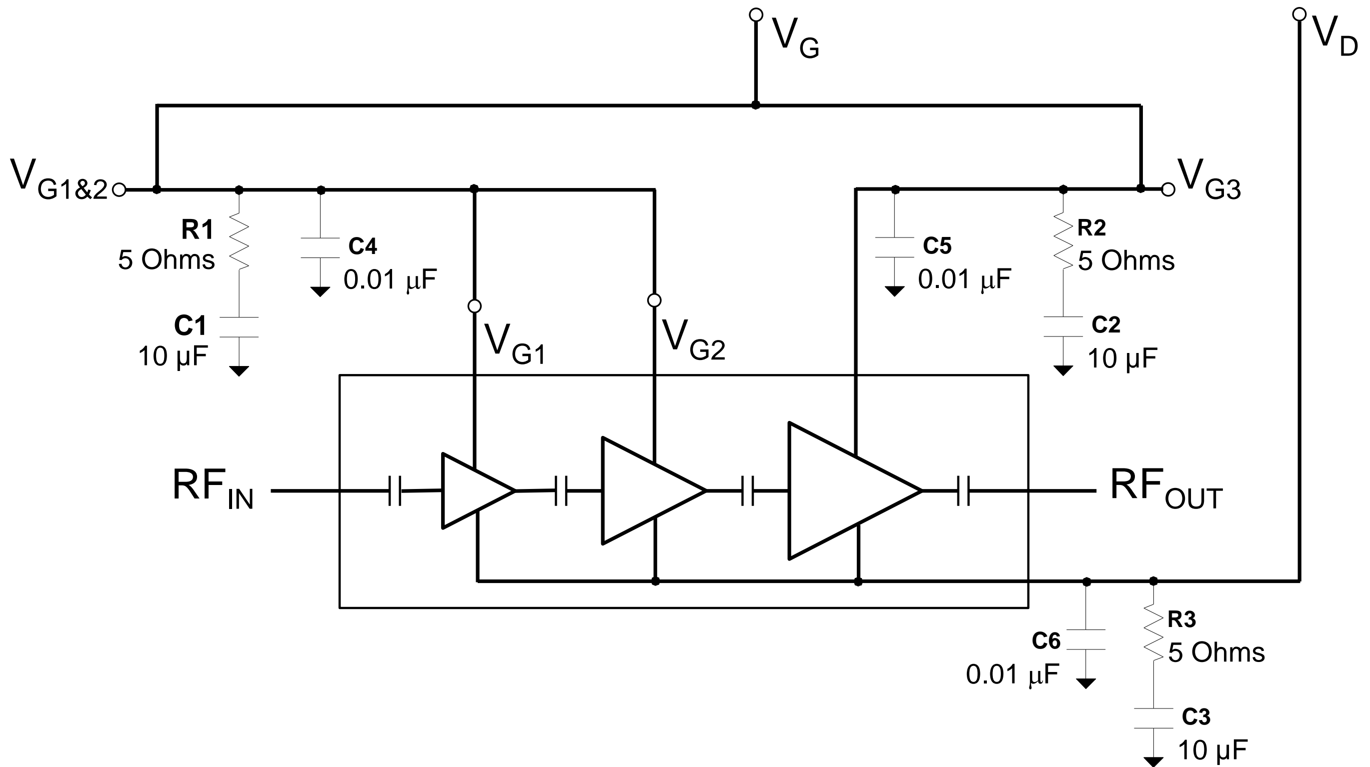





**© 2014 TriQuint**
Disclaimer: Subject to change without notice
**www.triquint.com**

## Application Circuit




## Bias-up Procedure

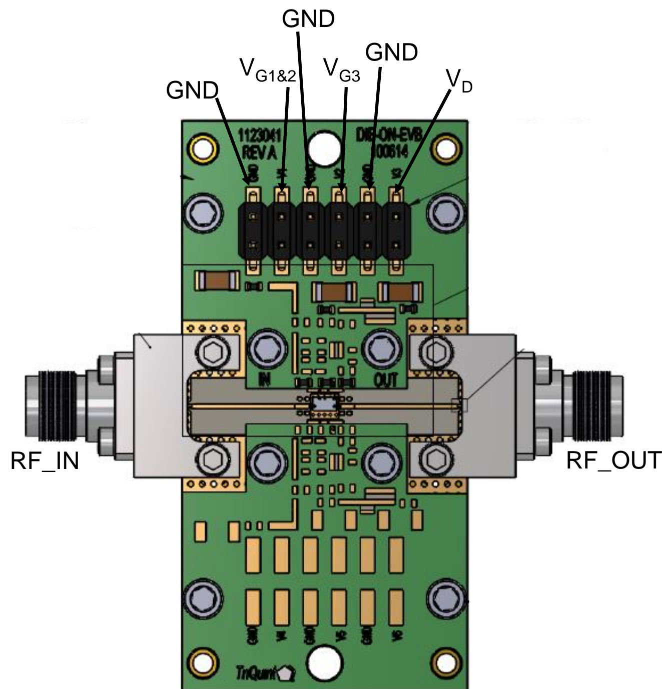
1. Set $I_D$ limit to 500 mA, $I_G$ limit to 13 mA
2. Apply −5 V to $V_G$
3. Apply +20 V to $V_D$; ensure $I_{DQ}$ is approx. 0 mA
4. Adjust $V_G$ until $I_{DQ}$ = 70 mA ($V_G$ ~ −2.7 V Typ.).
5. Turn on RF signal generator

## Bias-down Procedure

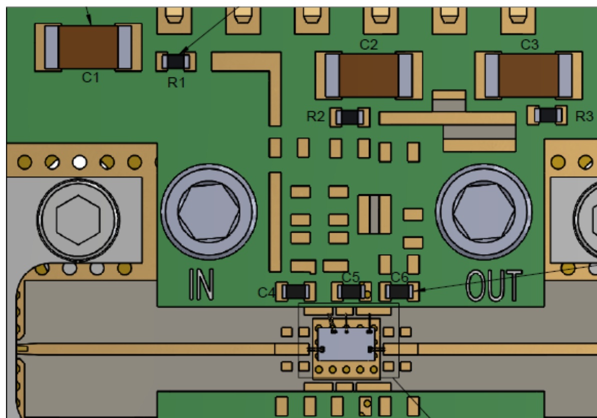
1. Turn off RF signal generator
2. Reduce $V_G$ to −5 V; ensure $I_{DQ}$ is approx. 0 mA
3. Set $V_D$ to 0 V
4. Turn off $V_D$ supply
5. Turn off $V_G$ supply

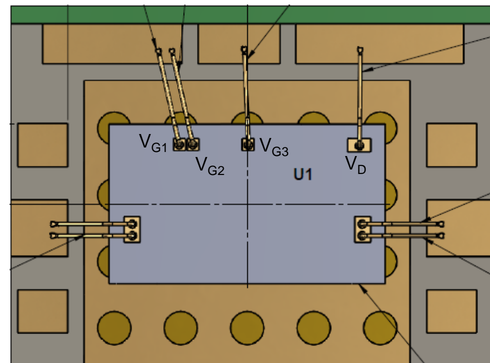

© 2014 TriQuint

## Assembly Drawing




MMIC bonding detail:



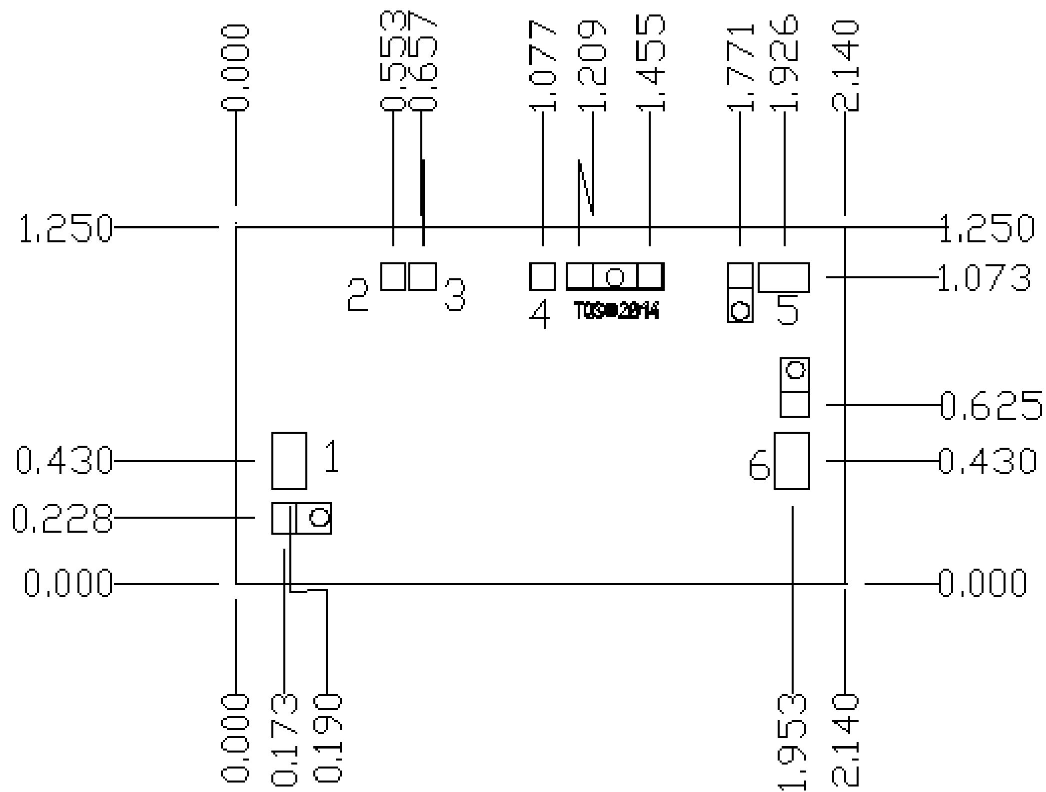




## Bill of Material

| Reference Des. | Value | Description | Manuf. | Part Number |
|---|---|---|---|---|
| C1, C2, C3 | 10 µF | Cap, 1206, 50V, 20%, X5R | Various | |
| C4, C5, C6 | 0.01 µF | Cap, 0402, 50V, 10%, X7R | Various | |
| R1, R2, R3 | 5.1 Ohms | Res, 0402, 5% | Various | |


© 2014 TriQuint

## Mechanical Information




Units: millimeters
Thickness: 0.10
Die x,y size tolerance: ± 0.050

## Pad Description

| Pad No. | Symbol | Description |
|---|---|---|
| 1 | $RF_{IN}$ | Input; matched to 50 Ω; DC blocked |
| 2 | $V_{G1}$ (1), (2) | Gate Voltage; Bias network is required; see recommended Application Information on page 9. |
| 3 | $V_{G2}$ (1), (2) | Gate Voltage; Bias network is required; see recommended Application Information on page 9. |
| 4 | $V_{G3}$ (2) | Gate Voltage; Bias network is required; see recommended Application Information on page 9. |
| 5 | $V_D$ | Drain voltage; Bias network is required; see recommended Application Information page 9. |
| 6 | $RF_{OUT}$ | Output; matched to 50 Ω; DC blocked |

Notes:
1. Pads 2 & 3 are tied together off-chip.
2. Pads 2,3, & 4 may be tied together for biasing

Ground is backside of die


© 2014 TriQuint

## Assembly Notes

Component placement and adhesive attachment assembly notes:

- Vacuum pencils and/or vacuum collets are the preferred method of pick up.
- Air bridges must be avoided during placement.
- The force impact is critical during auto placement.
- Organic attachment (i.e. epoxy) can be used in low-power applications.
- Curing should be done in a convection oven; proper exhaust is a safety concern.

Reflow process assembly notes:

- Use AuSn (80/20) solder and limit exposure to temperatures above 300°C to 3-4 minutes, maximum.
- An alloy station or conveyor furnace with reducing atmosphere should be used.
- Do not use any kind of flux.
- Coefficient of thermal expansion matching is critical for long-term reliability.
- Devices must be stored in a dry nitrogen atmosphere.

Interconnect process assembly notes:

- Thermosonic ball bonding is the preferred interconnect technique.
- Force, time, and ultrasonic are critical parameters.
- Aluminum wire should not be used.
- Devices with small pad sizes should be bonded with 0.0007-inch wire.


**© 2014 TriQuint**

## Product Compliance Information

### ESD Sensitivity Ratings

Caution! ESD-Sensitive Device

ESD Rating: TBD
Value: TBD
Test: Human Body Model (HBM)
Standard: JEDEC Standard JESD22-A114

### ECCN

US Department of Commerce: EAR99

### Solderability

Use AuSn (80/20) solder and limit exposure to temperatures above 300°C to 3-4 minutes, maximum.

### 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 ($C_{15}H_{12}Br_{4}0_{2}$) Free
- PFOS Free
- SVHC Free

## 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**