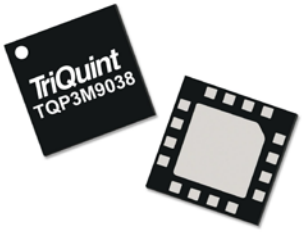
# TQP3M9038

## *High Linearity LNA Gain Block*

## Applications

- Repeaters
- Mobile Infrastructure
- Defense/Aerospace
- LTE / WCDMA / EDGE / CDMA
- General Purpose Wireless
- IF amplifier, RF driver amplifier

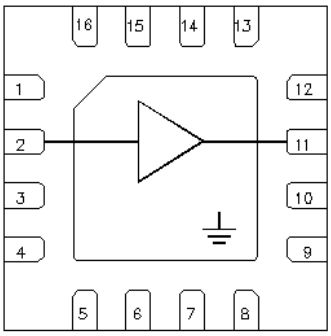



3x3 mm 16-lead QFN Package

## Product Features

- 50-4000 MHz
- Flat gain (14.7 ± 0.3 dB) from 0.5 – 3.5 GHz
- +40 dBm Output IP3
- 2 dB Noise Figure @ 1.9 GHz
- No RF component needed; 50 Ω gain block
- Unconditionally stable
- +5V Single Supply, 85 mA Current
- 3x3mm 16-lead QFN plastic package

## Functional Block Diagram




## General Description

The TQP3M9038 is a cascadable, high linearity gain block amplifier in a low-cost surface-mount package. At 1.9 GHz, the amplifier typically provides 15 dB gain, +40 dBm OIP3, and 2 dB Noise Figure while only drawing 85 mA current. The device is housed in a lead-free/green /RoHS-compliant QFN Package.

The TQP3M9038 has the benefit of having excellent gain flatness across a broad range of frequencies. The low noise figure and high linearity performance allows the device to be used in both receiver and transmitter chains for high performance systems. The amplifier is internally matched using a high performance E-pHEMT process and only requires an external RF choke and blocking/bypass capacitors for operation from a single +5V supply. The internal active bias circuit also enables stable operation over bias and temperature variations.

The TQP3M9038 covers the 0.05-4 GHz frequency band and is targeted for wireless infrastructure or other applications requiring high linearity and/or low noise figure.

## Pin Configuration

| Pin # | Symbol |
|---|---|
| 2 | RF IN |
| 11 | RF OUT/BIAS |
| All other pins | N/C or GND |
| Backside paddle | GND |

## Ordering Information

| Part No. | Description |
|---|---|
| TQP3M9038 | High Linearity LNA Gain Block |
| TQP3M9038-PCB_IF | TQP3M9038 EVB 0.05-0.5 GHz |
| TQP3M9038-PCB_RF | TQP3M9038 EVB 0.5-4 GHz |

Standard T/R size = 2500 pieces on a 7” reel.

## Specifications

### Absolute Maximum Ratings

| Parameter | Rating |
|---|---|
| Storage Temperature | -65 to +150 °C |
| Device Voltage, $V_{dd}$ | +7 |
| RF Input Power, CW,50 Ω,T = 25°C | +23 dBm |
| Reverse Device Voltage | -0.3V |

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

### Recommended Operating Conditions

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| $V_{dd}$ | +4.75 | +5 | +5.25 | V |
| $T_{case}$ | -40 | | 85 | °C |
| $T_{ch}$ (for>$10^6$ hrs MTTF) | | | 190 | °C |

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

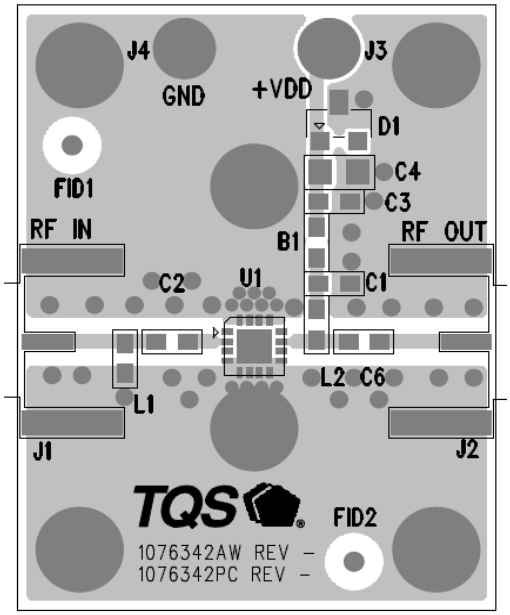
### Electrical Specifications

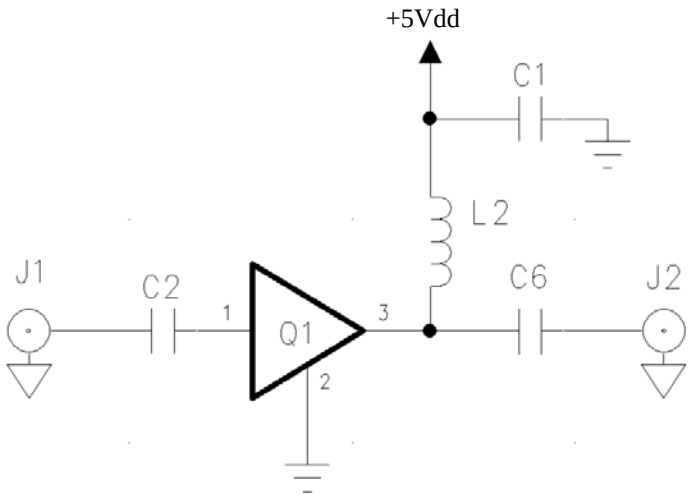
Test conditions unless otherwise noted: +25°C, +5V Vsupply, 50 Ω system.

| Parameter | Conditions | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Operational Frequency Range | | 50 | | 4000 | MHz |
| Test Frequency | | | 1900 | | MHz |
| Gain | | 13 | 14.9 | 16 | dB |
| Input Return Loss | | | 21 | | dB |
| Output Return Loss | | | 23 | | dB |
| Output P1dB | | | +21.6 | | dBm |
| Output IP3 | See Note 1 | +35.5 | +39.5 | | dBm |
| Noise Figure | | | 2 | | dB |
| Vdd | | | +5 | | V |
| Current, Idd | | | 85 | 100 | mA |
| Thermal Resistance (channel to case) $\theta_{jc}$ | | | 36.6 | | °C/W |

Notes
1. OIP3 measured with two tones at an output power of +4 dBm / tone separated by 1 MHz. The suppression on the largest IM3 product is used to calculate the OIP3 using 2:1 rule.

## Application Circuit Configuration




Notes:
1. See PC Board Layout, page 9 for more information.
2. Components shown on the silkscreen but not on the schematic are not used.
3. B1 (0 Ω jumper) may be replaced with copper trace in the target application layout.
4. The recommended component values are dependent upon the frequency of operation.
5. All components are of 0603 size unless stated on the schematic.

## Bill of Material

| Reference Designation | Frequency (MHz) | |
|---|---|---|
| | TQP3M9038-PCB_IF | TQP3M9038-PCB_RF |
| | 50 - 500 | 500 - 4000 |
| Q1 | TQP3M9038 | |
| C2, C6 | 1000 pF | 100 pF |
| C1 | 0.01 uF | 0.01 uF |
| L2 | 330 nH | 68 nH |
| L1, D1, C3, C4 | Do Not Place | |
| B1 | 0 Ω | |

Notes:
6. Performances can be optimized at frequency of interest by using recommended component values shown in the table below.

| Reference Designation | Frequency (MHz) | | | |
|---|---|---|---|---|
| | 500 | 2000 | 2500 | 3500 |
| C2, C6 | 100 pF | 22 pF | 22 pF | 22 pF |
| L2 | 82 nH | 22 nH | 18 nH | 15 nH |

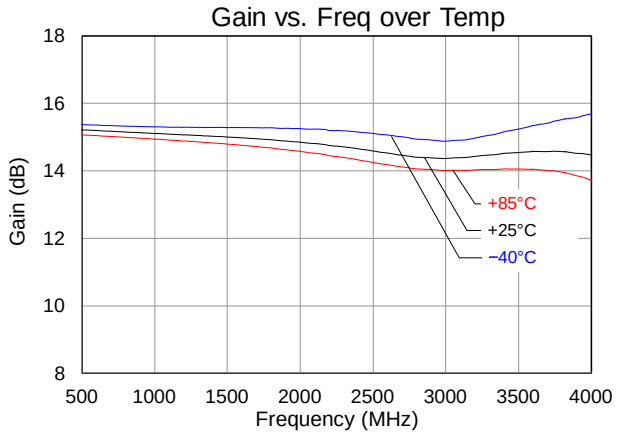
## Typical Performance 500-4000 MHz

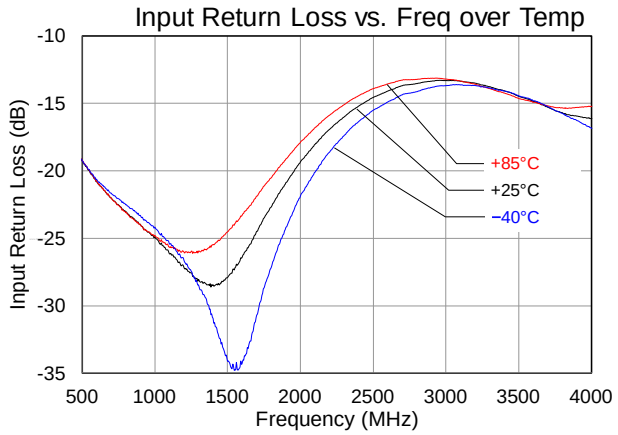
Test conditions unless otherwise noted: +25ºC, +5V, 85 mA, 50 Ω system. The data shown below is measured on TQP3M9038-PCB_RF.

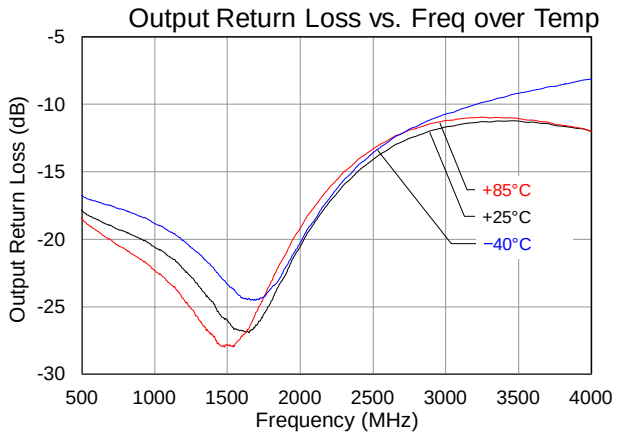
| Frequency | MHz | 500 | 900 | 1900 | 2700 | 3500 | 4000 |
|---|---|---|---|---|---|---|---|
| Gain | dB | 15.2 | 15.1 | 14.9 | 14.5 | 14.5 | 14.5 |
| Input Return Loss | dB | -19.2 | -24.0 | -20.9 | -13.7 | -14.5 | -16.1 |
| Output Return Loss | dB | -17.9 | -20.0 | -22.6 | -12.8 | -11.3 | -12.0 |
| Output P1dB | dBm | +21.7 | +21.9 | +21.6 | +20.6 | +19.8 | +18.5 |
| OIP3 [1] | dBm | +41.1 | +41.4 | +41.2 | +38.0 | +35.3 | +32.3 |
| Noise Figure [2] | dB | 1.7 | 1.8 | 1.9 | 2.2 | 2.8 | 3.0 |

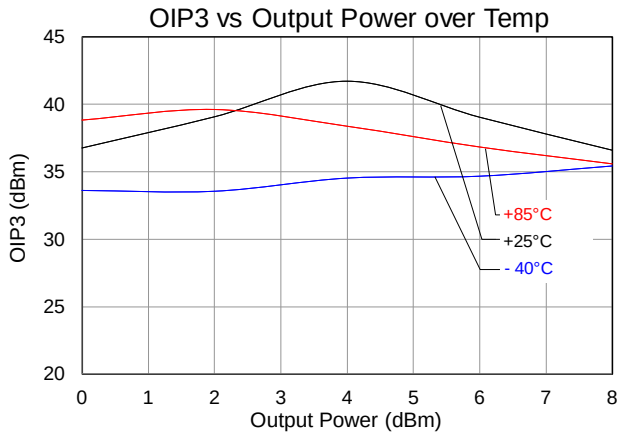
Notes:
1. OIP3 measured with two tones at an output power of +4 dBm / tone separated by 1 MHz. The suppression on the largest IM3 product is used to calculate the OIP3 using 2:1 rule.
2. Noise figure data shown in the table above is measured on evaluation board which includes board losses of 0.1dB @ 2 GHz.

## RF Performance Plots



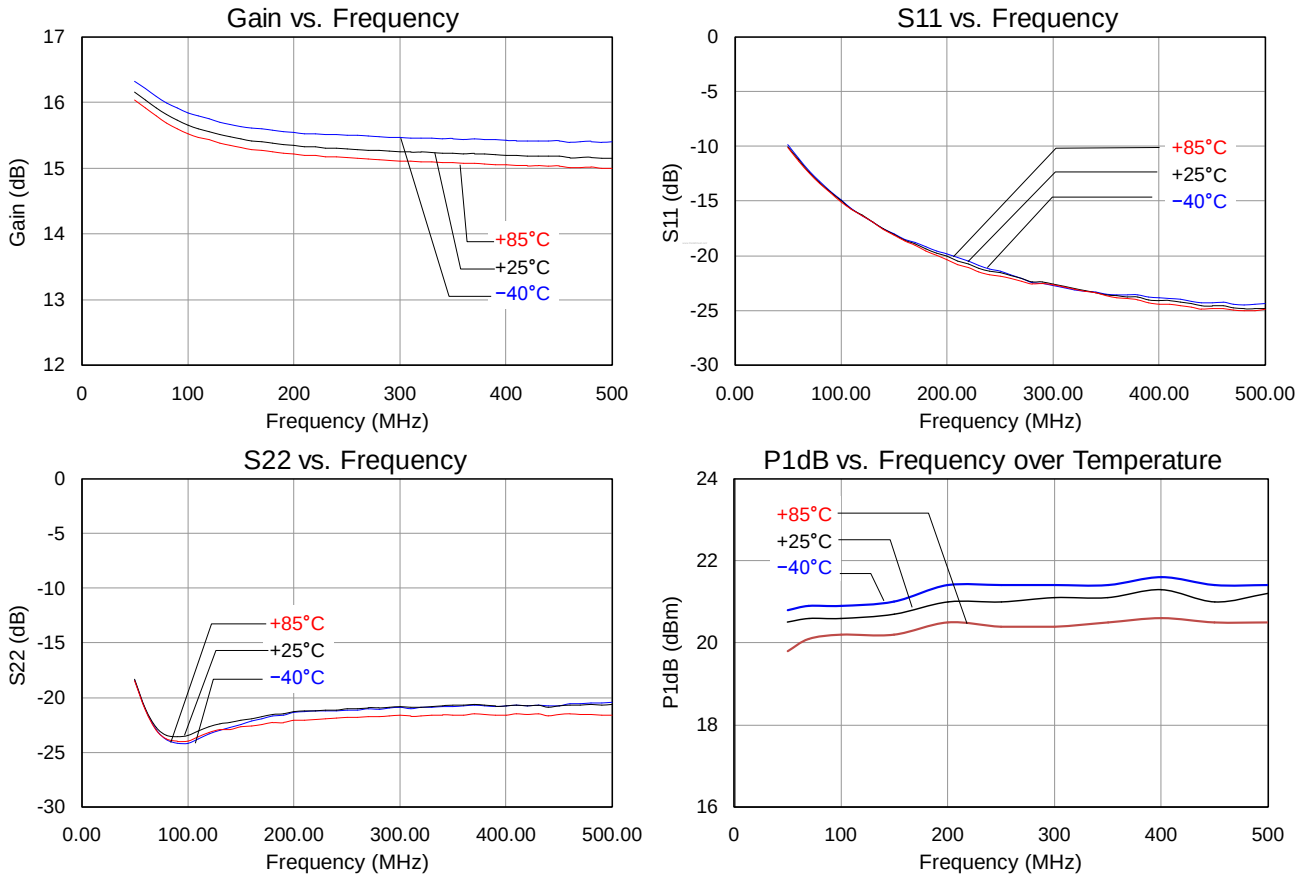
## Typical Performance 50-500 MHz

Test conditions unless otherwise noted: +25ºC, +5V, 85 mA, 50 Ω system. The data shown below is measured on TQP3M9038-PCB_IF.

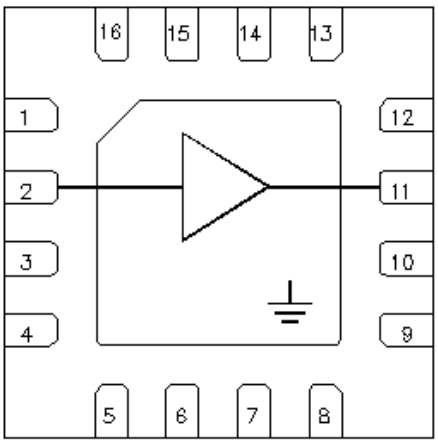
| Frequency | MHz | 70 | 100 | 200 | 500 |
|---|---|---|---|---|---|
| Gain | dB | 15.9 | 15.7 | 15.4 | 15.2 |
| Input Return Loss | dB | -12.3 | -15.0 | -20.4 | -26.4 |
| Output Return Loss | dB | -23.0 | -24.5 | -22.4 | -21.4 |
| Output P1dB | dBm | +20.9 | 21.0 | 21.0 | 21.3 |
| OIP3 [1] | dBm | +39.5 | +39.7 | +40.7 | +40.0 |
| Noise Figure [2] | dB | 1.65 | 1.75 | 1.75 | 1.70 |

Notes:
1. OIP3 measured with two tones at an output power of +6 dBm / tone separated by 1 MHz. The suppression on the largest IM3 product is used to calculate the OIP3 using 2:1 rule.
2. Noise figure data shown in the table above is measured on evaluation board which includes board losses of 0.1 dB @ 2 GHz.

## IF Performance Plots



## Pin Configuration and Description



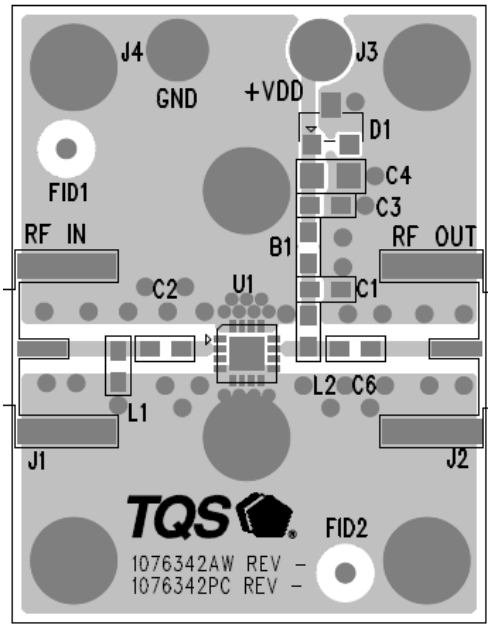

| Pin | Symbol | Description |
|---|---|---|
| 2 | RF IN | Input, matched to 50 ohms. External DC Block is required. |
| 11 | RF OUT/BIAS | Output, matched to 50 ohms. External DC Block is required and supply voltage. |
| All other pins | N/C or GND | These pins are not connected internally but are recommended to be grounded on the PCB for optimal isolation. |
| Backside paddle | GND | Backside Paddle. Multiple vias should be employed to minimize inductance and thermal resistance; see page 7 for suggested footprint. |

## PCB Information

### PC Board Layout

Top RF layer is .014" NELCO N4000-13, $\epsilon_r$ = 3.9, 4 total layers (0.062" thick) for mechanical rigidity. Metal layers are 1-oz copper. 50 ohm Microstrip line details: width = .029", spacing = .035".

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. Since surface mount processes vary from company to company, careful process development is recommended.

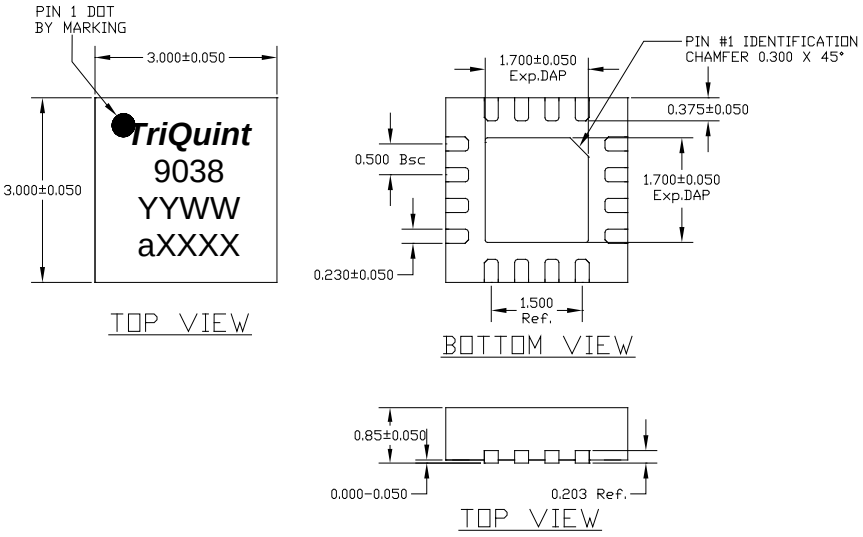


## Mechanical Information

### Package Information and Dimensions

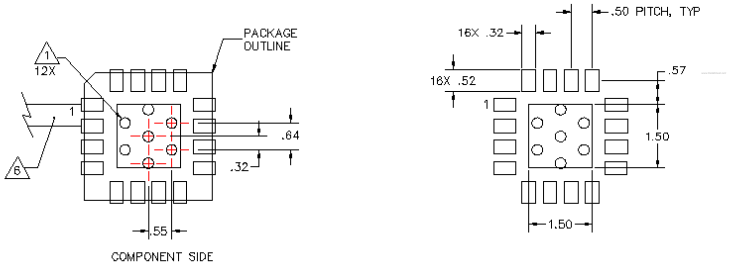
This package is lead-free/RoHS-compliant. The plating material on the leads is annealed matte tin.

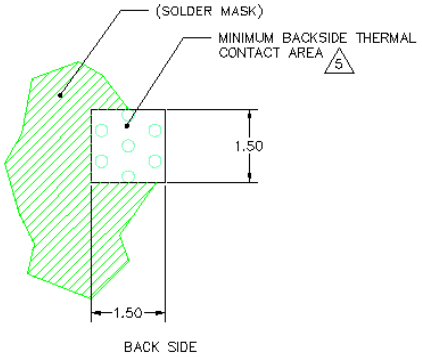
The component will be marked with an "9038" designator with an alphanumeric lot code on the top surface of package.




### Mounting Configuration

All dimensions are in millimeters (inches). Angles are in degrees.




NOTES:

1. GROUND/THERMAL VIAS ARE CRITICAL FOR THE PROPER PERFORMANCE OF THIS DEVICE. VIAS SHOULD USE A .35mm (#80/.0135") DIAMETER DRILL AND HAVE A FINAL, PLATED THRU DIAMETER OF .25mm (.010").
2. ADD AS MUCH COPPER AS POSSIBLE TO INNER AND OUTER LAYERS NEAR THE PART TO ENSURE OPTIMAL THERMAL PERFORMANCE.
3. TO ENSURE RELIABLE OPERATION, DEVICE GROUND PADDLE-TO-GROUND PAD SOLDER JOINT IS CRITICAL.
4. ADD MOUNTING SCREWS NEAR THE PART TO FASTEN THE BOARD TO A HEATSINK. ENSURE THAT THE GROUND/THERMAL VIA REGION CONTACTS THE HEATSINK.
5. DO NOT PUT SOLDER MASK ON THE BACK SIDE OF THE PC BOARD IN THE REGION WHERE THE BOARD CONTACTS THE HEATSINK.
6. RF TRACE WIDTH DEPENDS UPON THE PC BOARD MATERIAL AND CONSTRUCTION.
7. USE 1 OZ. COPPER MINIMUM.
8. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.

Notes:

1. Ground / thermal vias are critical for the proper performance of this device. Vias should use a .35mm (#80 / .0135") diameter drill and have a final plated thru diameter of .25 mm (.010").
2. Add as much copper as possible to inner and outer layers near the part to ensure optimal thermal performance.

## Product Compliance Information

### ESD Information

**Caution! ESD-Sensitive Device**

| | |
|---|---|
| ESD Rating: | Class 1A |
| Value: | 250 V |
| Test: | Human Body Model (HBM) |
| Standard: | JEDEC Standard JESD22-A114 |

| | |
|---|---|
| ESD Rating: | Class IV |
| Value: | 1000 V |
| Test: | Charged Device Model (CDM) |
| Standard: | JEDEC Standard JESD22-C101 |

### MSL Rating

The part is rated Moisture Sensitivity Level 1 at 260°C per JEDEC standard IPC/JEDEC J-STD-020.

### Solderability

Compatible with the latest version of J-STD-020, Lead free solder, 260°

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 ($C_{15}H_{12}Br_40_2$) 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:** +1.503.615.9000
**Email:** info-sales@tqs.com **Fax:** +1.503.615.8902

For technical questions and application information:

**Email:** sjcapplications.engineering@tqs.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.