

### Product Description:

The TQM7138 is a 3V, 2 stage SiGe HBT Power Amplifier Module designed for use in mobile phones. Its extremely small 4x4mm package makes it ideal for today's extremely small data enabled phones. Its RF performance meets the requirements for products designed to IS-95/98 standards. The TQM7138 provides the capability to be operated in one, two, or continuous quiescent current modes. In digital quiescent current mode operation, the TQM7138 is controlled from the base-band processor using a CMOS compatible  $I_{CQ}$  voltage control voltage. Overall current consumption of the device is minimized by selecting the lowest  $I_{CQ}$  state available for each power output level. RF input and output matching is included within the module; therefore, minimal external circuitry is required.

The TQM7138 gives excellent RF performance with low current consumption resulting in longer talk times in portable applications. The small 4mm square surface mount package is ideal for new generation small and light phones.

### Electrical Specifications:

| Parameter                           | Min | Typ  | Max | Units |
|-------------------------------------|-----|------|-----|-------|
| Frequency                           | 824 |      | 849 | MHz   |
| CDMA mode $P_{out}^1$               |     | 28   |     | dBm   |
| CDMA Mode Efficiency <sup>1</sup>   |     | 35   |     | %     |
| AMPS Mode Output Power <sup>2</sup> |     | 31.5 |     | dBm   |
| AMPS Mode Efficiency <sup>2</sup>   |     | 51   |     | %     |

Note 1: Test Conditions CDMA Mode:  $V_{CC1}=3.4VDC$ ,  $V_{CC2}=3.4VDC$ ,  $V_{REF}=3.00VDC$ ,  $V_{CTRL}=0.0VDC$ ,  $T_C=25^\circ C$ ,  $P_{out}=28.0dBm$

Note 2: Test Conditions AMPS Mode:  $V_{CC1}=3.4VDC$ ,  $V_{CC2}=3.4VDC$ ,  $V_{REF}=3.00VDC$ ,  $V_{CTRL}=0.0VDC$ ,  $T_C=25^\circ C$ ,  $P_{out}=31.5dBm$

For additional information and latest specifications, see our website: [www.triquint.com](http://www.triquint.com)

## TQM7138

### DATA SHEET

## 3V HBT SiGe CDMA 4x4mm POWER AMPLIFIER MODULE

### Features

- Analog continuous bias capability with excellent linearity over 1.9 to 3.0VDC and temperature stability over  $-30^\circ C$  to  $85^\circ C$
- Excellent PAE
- Small 10 pin 4x4mm module
- 1xRTT Compatible
- Industry compatible digital quiescent current state control
- Analog continuous bias capability
- CMOS compatible logic input
- Excellent Rx band noise performance
- Internally matched input and output
- Full ESD Protection
- Low leakage current

### Applications

- Cellular Band CDMA IS-95/98 based mobile phones.
- Single-Mode, Dual Mode, and Tri Mode CDMA/AMPS phones

# TQM7138 - Preliminary Data Sheet

## Absolute Maximum Ratings

| Symbol              | Parameter  | Absolute Maximum Value | Units |
|---------------------|--|------------------------|-------|
| $V_{CC1}, V_{CC2}$  | Power Supply Voltage, no RF Applied  | -0.5 to 6.0            | VDC   |
|                     | RF Applied   | -0.5 to 5.0            |       |
| $V_{REF}, V_{CTRL}$ | Bias reference voltages ( $V_{REF}$ ) and bias control voltage ( $V_{CTRL}$ ). | -0.5 to 5.0            | VDC   |
| $P_{DISS}$          | Power Dissipation  | 2.5                    | W     |
| $T_C$               | Case Temperature, Survival   | -40 to +100            | °C    |
| $T_{STG}$           | Storage Temperature  | -40 to +150            | °C    |
| $RF_{IN}$           | DC Grounded RF input, 50ohm RF impedance                                       | 0 to 0V                | VDC   |
| $RF_{OUT}$          | DC Blocked RF output, 50 ohm RF impedance                                      | -20V to 20V            | VDC   |

Note: The part may not survive all maximums applied simultaneously.

## CDMA Mode Electrical Characteristics<sup>1,2,3</sup>

| Parameter                              | Conditions   | Min. | Typ/Nom   | Max. | Units |
|--|--|------|-----------|------|-------|
| RF Frequency                           |  | 824  |           | 849  | MHz   |
| $P_{out}, I_{CQ-hi}$                   | $V_{CTRL} = low$   |      | 28        |      | dBm   |
| Large Signal Gain, $I_{CQ-hi}$         | $P_{out} = 28dBm, V_{CTRL} = low$  |      | 30        |      | dB    |
| Large Signal Gain, $I_{CQ-low}$        | $P_{out} = 16dBm, V_{CTRL} = high$   |      | 28        |      | dB    |
| Gain Variation vs. Temp.               | -30 to 85 °C, $P_{out}=28dBm$  |      | +0.7/-1.6 |      | dB    |
| Quiescent Current, $I_{CQ-hi}$         | $V_{CTRL} = low$   |      | 120       |      | mA    |
| Quiescent Current, $I_{CQ-low}$        | $V_{CTRL} = low$   |      | 69        |      | mA    |
| $I_{CC}$                               | $P_{out} = 28dBm, V_{CTRL} = low$  |      | 525       |      | mA    |
| Power Added Efficiency                 | $P_{out} = 28dBm, V_{CTRL} = low$  |      | 35        |      | %     |
| Adjacent Channel Power (ACP)           | $P_{out} = 28dBm, V_{CTRL} = low, IS-95 Standard$  |      | -49       |      | dBc   |
| Adjacent Channel Power (ACP-1xRTT)     | $P_{out}=27.5dBm, V_{CTRL} = low, IS-98 Standard, 4.5 dB Peak to Average Ratio, CCDF=1%$ |      | -49       |      | dBc   |
| Alternate Channel Power (ALT)          | $P_{out} = 28dBm, V_{CTRL} = low, IS-95 Standard$  |      | -57       |      | dBc   |
| Alternate Channel Power (ALT-1xRTT)    | $P_{out}=27.5dBm, V_{CTRL} = low, IS-98 Standard, 4.5 dB Peak to Average Ratio, CCDF=1%$ |      | -57       |      | dBc   |
| Output Power Low -Power $I_{CQ}$ state | $ACPR = -51dBc, V_{CTRL} = high, IS-95 Standard$   |      | 16        |      | dBm   |

### CDMA Mode Electrical Characteristics<sup>1,2,3</sup> (cont'd)

|  |  |      |      |      |        |
|--|--|------|------|------|--------|
| Noise Power in Rx band                         | P <sub>out</sub> =28dBm, V <sub>CTRL</sub> = low, IS-95 Standard                   | -138 |      |      | dBm/Hz |
| Input VSWR                                     | Both I <sub>CQ</sub> -hi & I <sub>CQ</sub> -low                                    | 2:1  |      |      |        |
| Second Harmonic                                | P <sub>out</sub> =+28dBm, V <sub>CTRL</sub> = low, IS-95 Standard                  | -38  |      |      | dBc    |
| Third Harmonic                                 | P <sub>out</sub> =+28dBm, V <sub>CTRL</sub> = low, IS-95 Standard                  | -48  |      |      | dBc    |
| Recommended Supply Voltage                     |  | 3.2  | 3.4  | 4.2  | VDC    |
| Reference Voltage                              |  | 2.9  | 3.00 | 3.1  | VDC    |
| V <sub>REF</sub> Current, I <sub>CQ</sub> -hi  | Hi-Power Mode, V <sub>CTRL</sub> = high  | 7    |      |      | mA     |
| V <sub>REF</sub> Current, I <sub>CQ</sub> -low | Low-Power Mode, V <sub>CTRL</sub> = low  | 4    |      |      | mA     |
| Leakage Current                                | V <sub>CTRL</sub> = low, V <sub>REF</sub> =0VDC                                    | 10   |      |      | μA     |
| Logic Current (V <sub>CTRL</sub> )             |  |      |      | 100  | μA     |
| Logic Voltage (V <sub>CTRL</sub> )             | High   | 1.7  | 2.0  |      | VDC    |
|  | Low  | 0    | 0.25 | 0.5  | VDC    |
| Recommended Operating Temperature              |  | -30  |      | +85C |        |
| Ruggedness                                     | No Damage, P <sub>out</sub> =+28dBm, V <sub>CTRL</sub> = low, IS-95 Standard       |      |      | 10:1 |        |
| Stability                                      | No Oscillations, P <sub>out</sub> =+28dBm, V <sub>CTRL</sub> = low, IS-95 Standard |      |      | 10:1 |        |

Note 1: Test Conditions: V<sub>CC1</sub>=3.4VDC, V<sub>CC2</sub>=3.4VDC, V<sub>REF</sub>=3.00VDC, V<sub>CTRL</sub>=0.0VDC, RF=836 MHz, T<sub>C</sub> = 25 °C unless otherwise specified.

Note 2: Min./Max. limits are at +25 °C case temperature unless otherwise specified.

Note 3: TriQuint Test Board.

### AMPS Mode Electrical Characteristics<sup>1,2,3</sup>

| Parameter                    | Conditions   | Min. | Typ/Nom | Max. | Units  |
|------------------------------|--|------|---------|------|--------|
| RF Frequency                 |  | 824  |         | 849  | MHz    |
| P <sub>out</sub> , Saturated |  |      | 31.5    |      | dBm    |
| Large Signal Gain            | P <sub>out</sub> = 31.5 dBm                        |      | 28      |      | dB     |
| Power Added Efficiency       | P <sub>out</sub> = 31.5 dBm                        |      | 51      |      | %      |
| Receive Band Noise Power     | BW=30KHz, f=Tx+45MHz                               |      | -137    |      | dBm/Hz |
| Input VSWR                   | All Operating P <sub>out</sub> and V <sub>cc</sub> |      | 2:1     |      |        |
| 2 <sup>nd</sup> Harmonic     | P <sub>out</sub> = 31.5 dBm                        |      | -34     |      | dBc    |
| 3 <sup>rd</sup> Harmonic     | P <sub>out</sub> = 31.5 dBm                        |      | -49     |      | dBc    |
| I <sub>cc</sub>              | P <sub>out</sub> = 31.5 dBm                        |      | 812     |      | mA     |

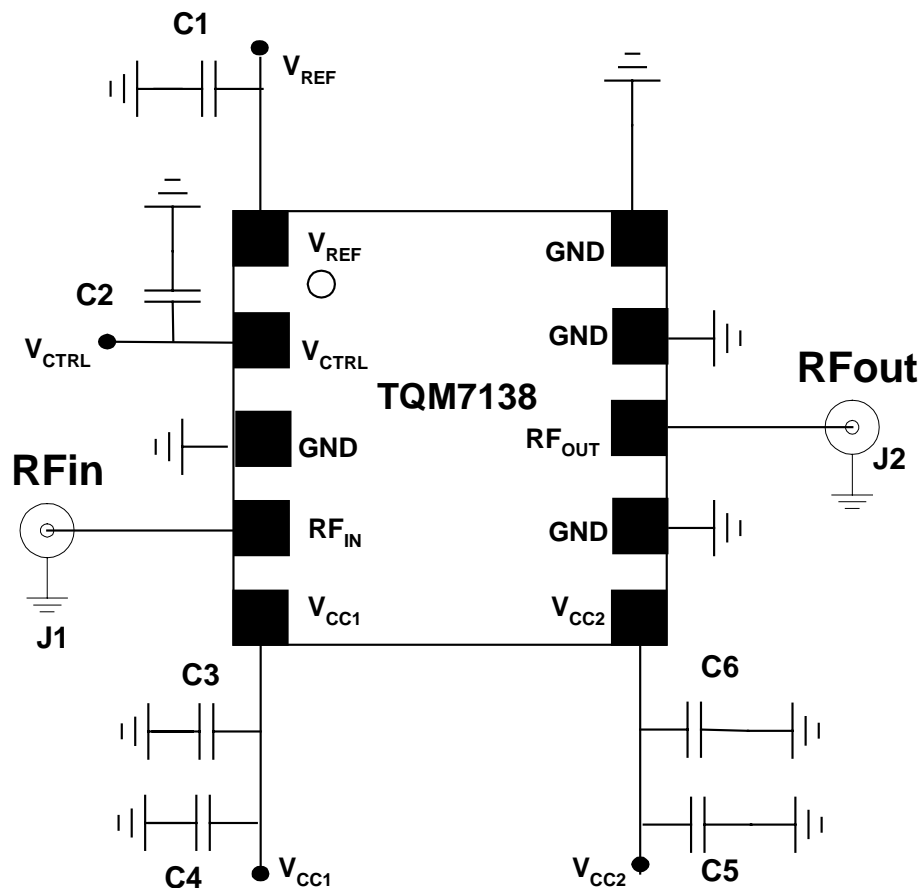
Note 1: Test Conditions: V<sub>CC1</sub>=3.4VDC, V<sub>CC2</sub>=3.4VDC, V<sub>REF</sub>=3.00, V<sub>CTRL</sub>=0.0VDC, RF=836MHz, T<sub>C</sub> = 25 °C unless otherwise specified.

Note 2: Min./Max. limits are at +25 °C case temperature unless otherwise specified.

Note 3: TriQuint Test Board.

TQM7138 - Preliminary  
Data Sheet

Application/Test Circuit:



US Cellular Band, 824 – 849 MHz

Bill of Material for TQM7138 Power Amplifier Module Application/Test Circuit\*

| Component              | Reference Designator | Part Number | Value, Cellular Band | Size            |
|------------------------|----------------------|-------------|----------------------|-----------------|
| Power Amplifier Module |                      | TQM7138     |                      | 8pin/6mm square |
| RF Connector           | J1, J2               |             |                      |                 |
| Capacitor              | C1, C2, C3, C6       |             | 0.1µF                | 0402            |
| Capacitor              | C4, C5               |             | 10µF                 | 1210            |

\*May vary due to printed circuit board layout and material

### Product Description:

The TQM7138 is a two stage SiGe HBT power amplifier module in a cascade configuration intended for use in CDMA Cellular band handsets.

### Operation

The operation modes of the TQM7138 are determined based on the setting of  $V_{CNTRL}$  and  $V_{REF}$ . The truth table below defines the operating mode. Also, if the TQM7138 will be used in continuous bias mode  $V_{CNTRL}$  must be connected on the circuit board to ground.

| Operating Mode  | $V_{CNTRL1}$ | $V_{REF}$      |
|-----------------|--------------|----------------|
| High Power      | Low          | >2.7VDC        |
| Low-Power       | High         | >2.7VDC        |
| Continuous Bias | Low          | ~1.9 to 3.0VDC |
| Off             | Low          | 0VDC           |

### Application

The applications circuit for the TQM7138 is very simple since most of the critical components are included inside the module. There are several important considerations when using the module in a phone design.

First of all, it is important that the source impedance of the  $V_{CC}$  power supply be very low. This is because the high current demand during the modulation peaks of the CDMA waveform can introduce voltage ripple at the symbol rate that will introduce additional inter-modulation distortion or Adjacent Channel Power distortion at the output of the power amplifier. If the power amplifier has a quiescent current of 100 mA and a peak current demand in excess of 1 amp, it is possible to see 900 mA change in the current required from  $V_{CC}$  as the modulated signal moves from one extreme to the other. If the power supply source

impedance were 1 ohm, the resulting voltage ripple would be 0.9 volts which would cause the amplifier to fail its ACP requirements. Generally, the power supply source impedance should be kept as low as possible, preferably below 0.1 ohms total. Most battery technologies used in cellular telephones will support a low source impedance, but it may be necessary to supplement this in some designs with an low ESR capacitor. Ceramic or tantalum capacitors of approximately 10 micro-farads work well for this requirement.

The application circuit includes 0.1  $\mu$ F capacitors at each of the PA control lines and  $V_{CC}$  lines to ensure proper RF bypassing. Depending on the phone board layout and circuit bypassing in other areas of the phone, some of these components may not be necessary. There are a number of VCO signals and IF signals used in a given phone design, so it is important to protect the PA module from interfering signals and to limit any interference coming from the PA itself. Care should be taken when removing any of the RF bypassing components.

One final area of concern is with excessive bypassing. If too large a value of bypassing capacitor is used on any of the control lines, it could reduce the frequency response of that control line to the point where a specification failure could occur. Please be sure that the logic lines and regulated supply lines driving the power amplifier control lines are adequate to supply peak current requirements of the bypassing capacitors chosen on the control lines.

#### One Bias State Operation

The TQM7138 can be operated using one bias state. If this mode is selected,  $V_{CNTRL}$  should be connected to ground.

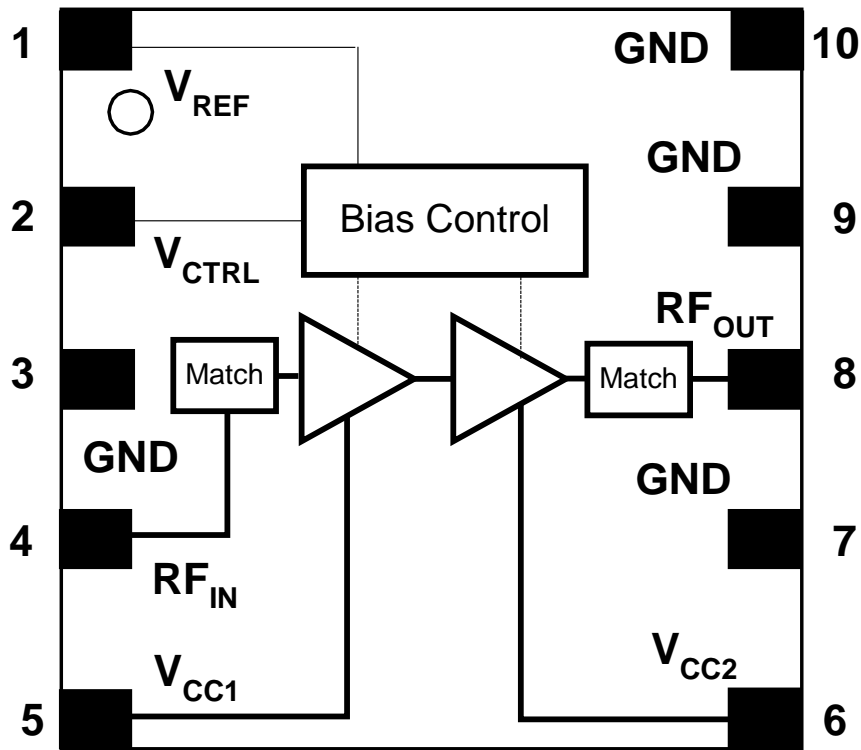
#### Continuous Bias-State Operation

The TQM7138 can be operated in continuous bias mode in which the  $V_{REF}$  voltage is varied from ~1.9V to 3.0V to set the PAM quiescent current as appropriate for the desired output power level. In this mode,  $V_{CNTRL}$  should be connected to ground on the phone board. Specific application circuit information for this mode is available upon request.

# TQM7138 - Preliminary

## Data Sheet

### Package Pinout:

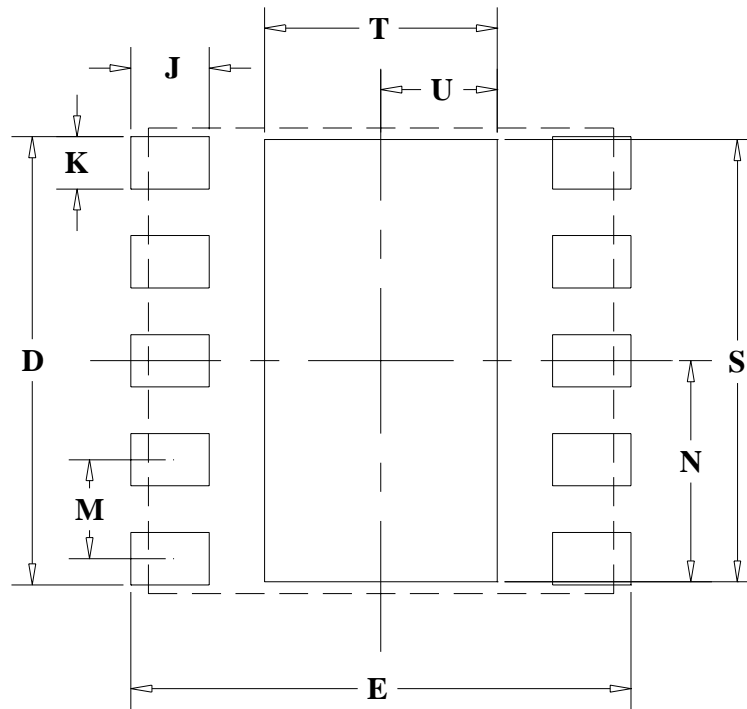


### Pin Descriptions:

| Pin Name          | Pin #       | Description and Usage (Equivalent Circuit)  |
|-------------------|-------------|---|
| GND               | Paddle      | Device Ground and Heat Sink. Needs good thermal path to remove heat.  |
| V <sub>REF</sub>  | 1           | Regulated supply for setting bias. Vref is set to 0VDC to power-off the TQM7138   |
| V <sub>CTRL</sub> | 2           | CMOS compatible logic level to set bias level   |
| RF <sub>IN</sub>  | 4           | RF input. The RF circuit is DC ground. 50 Ohm RF impedance. <div> </div> |
| V <sub>CC1</sub>  | 5           | Collector supply for input stage.   |
| V <sub>CC2</sub>  | 6           | Collector supply for output stage.  |
| RF <sub>OUT</sub> | 8           | RF output. The RF circuit is DC blocked internally. 50 ohm RF impedance.  |
| GND               | 3, 7, 9, 10 | Ground  |

TriQuint recommends use of several via holes to the backside ground under the Paddle.

*Recommended PC board layout to Accept 10 Pin Module Package:*



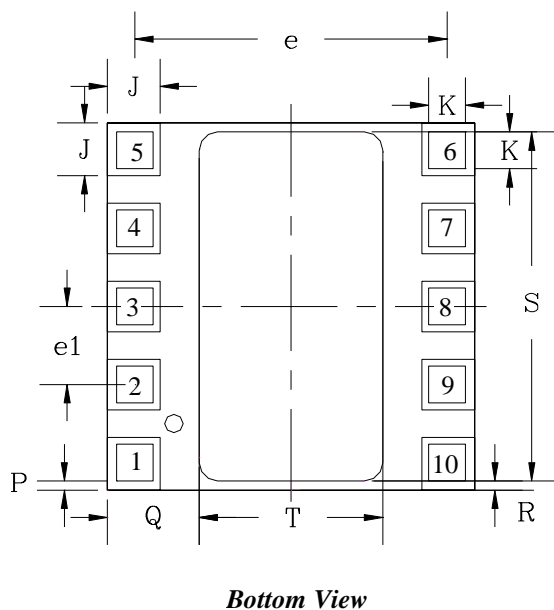
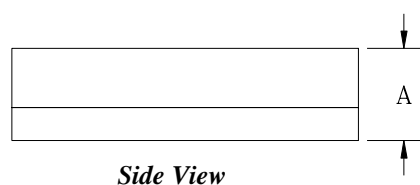
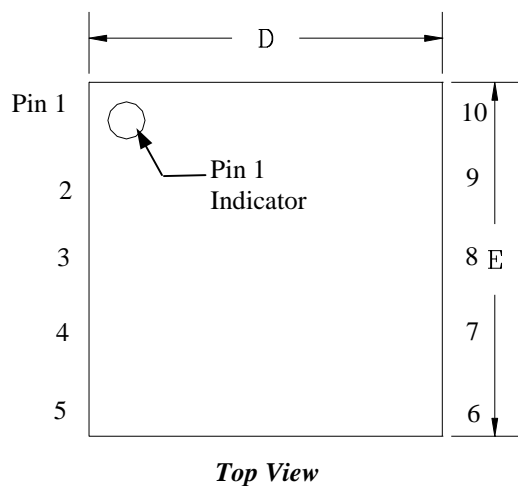
| DIMENSION | MM   |
|-----------|------|
| <b>D</b>  | 3.85 |
| <b>E</b>  | 4.30 |
| <b>J</b>  | 0.68 |
| <b>K</b>  | 0.45 |
| <b>M</b>  | 0.85 |
| <b>N</b>  | 1.90 |
| <b>S</b>  | 3.80 |
| <b>T</b>  | 2.00 |
| <b>U</b>  | 1.00 |

**Notes:**

- 1 Only ground signal traces are allowed directly under the package
- 2 Primary dimensions are in millimeters alternate dimensions are in inches.

# TQM7138 - Preliminary Data Sheet

Package Type: 10 Pin Plastic Module Package





*Package Type: 10 Pin Plastic Module Package (cont'd)*

| DESIGNATION | DESCRIPTION   | DIMENSION         |
|-------------|---|-------------------|
| A           | OVERALL HEIGHT  | 1.06 +/-0.09 mm   |
| D           | PACKAGE LENGTH  | 4.0 +/-0.1 mm     |
| E           | PACKAGE WIDTH   | 4.0 +/-0.1 mm     |
| J           | SOLDER MASK OPENING LENGTH AND WIDTH                      | 0.575 +/-0.075 mm |
| K           | METAL PAD LENGTH AND WIDTH                                | 0.40 +/-0.05 mm   |
| P           | DISTANCE BETWEEN METAL PAD AND PACKAGE EDGE               | 0.10 +/-0.025 mm  |
| T           | GND SOLDER MASK OPENING WIDTH                             | 2.00 +/-0.05 mm   |
| S           | GND SOLDER MASK OPENING LENGTH                            | 3.80 +/-0.05 mm   |
| R           | DISTANCE BETWEEN GND SOLDER MASK OPENING AND PACKAGE EDGE | 0.10 +/-0.1 mm    |
| Q           | DISTANCE BETWEEN GND SOLDER MASK OPENING AND PACKAGE EDGE | 1.00 +/-0.1 mm    |
| e           | TERMINAL PITCH FOR TERMINAL 1-10, 2-9, 3-8, 4-7 AND 5-6   | 3.400 mm          |
| e1          | TERMINAL PITCH FOR TERMINAL 1-2-3-4-5 AND 6-7-8-9-10      | 0.850 mm          |

Notes:

**1. GND SOLDER MASK OPENING IS NOT CENTERED ON THE PACKAGE**

*Additional Information*

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

Web: [www.triquint.com](http://www.triquint.com) Tel: (503) 615-9000  
Email: [info\\_wireless@tqs.com](mailto:info_wireless@tqs.com) Fax: (503) 615-8902

For technical questions and additional information on specific applications:

Email: [info\\_wireless@tqs.com](mailto:info_wireless@tqs.com)

The information provided herein is believed to be reliable; TriQuint assumes no liability for inaccuracies or omissions. TriQuint assumes no responsibility for the use of this information, and all such information shall be entirely at the user's own risk. Prices and specifications are subject to change without notice. No patent rights or licenses to any of the circuits described herein are implied or granted to any third party.

TriQuint does not authorize or warrant any TriQuint product for use in life-support devices and/or systems.

Copyright © 2002 TriQuint Semiconductor, Inc. All rights reserved.

Revision 0.1, September 6, 2002



For additional information and latest specifications, see our website: [www.triquint.com](http://www.triquint.com)