

### Applications

- Wireless Infrastructure
- Fixed Wireless
- Microwave and Satellite Radio
- General Purpose Wireless

### Product Features

- Integrates DSA + Amp Functionality
- 50 – 4000 MHz Broadband Performance
- 19.3 dB Gain at 2.14 GHz
- 2.9 dB Noise Figure at Maximum Gain Setting
- +21.5 dBm P1dB
- +38.5 dBm OIP3
- +5 V Supply Voltage
- 125 mA Operating Current
- MTTF > 1000 Years

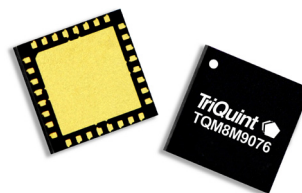
### General Description

The TQM8M9076 is a digitally controlled variable gain amplifier (DVGA) with a broadband frequency range of 50 to 4000 MHz. The DVGA features high linearity and low noise while providing digital variable gain with a 31.5 dB of range in 0.5 dB steps through a 6-bit serial mode control interface.

The TQM8M9076 integrates a high performance digital step attenuator followed by a high linearity, broadband gain block. The input and output of the individual stages are accessible with external pins to allow for optimization of performance at any sub-band across the DVGA's 0.05 to 4.0 GHz operating frequency range.

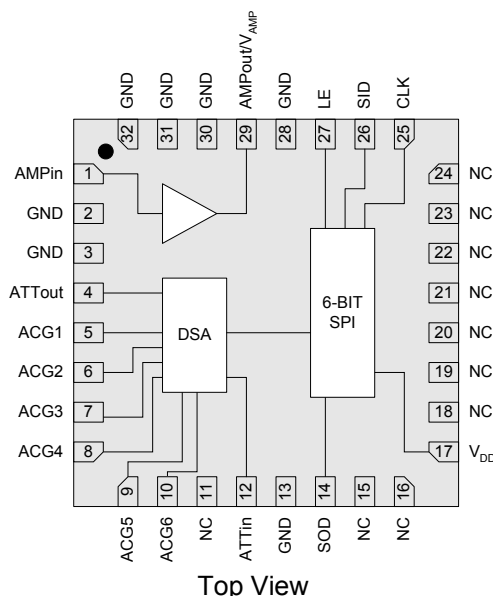
The TQM8M9076 is packaged in a RoHS-compliant, compact 5x5 mm surface-mount leadless package. Superior thermal design allows the product to have a minimum MTTF rating of 1000 years at a mounting temperature of +85 °C.

The TQM8M9076 is targeted for use in wireless infrastructure, point-to-point, or can be used for any general purpose wireless application.



32 Pin 5 x 5 mm Leadless SMT Package

### Functional Block Diagram



### Pin Configuration

| Pin No.             | Label        | Pin No. | Label                     |
|---------------------|--------------|---------|---------------------------|
| 1                   | Ampin        | 17      | V <sub>DD</sub>           |
| 4                   | ATTout       | 25      | CLK                       |
| 5, 6, 7, 8, 9, 10   | ACG1 – 6     | 26      | SID                       |
| 14                  | SOD          | 27      | LE                        |
| 12                  | ATTin        | 29      | Ampout / V <sub>AMP</sub> |
| 11, 15, 16, 18–24   | NC           |         |                           |
| 2, 3, 13, 28, 30–32 | GND          |         |                           |
| Backside Paddle     | Ground RF/DC |         |                           |

### Ordering Information

| Part No.                                      | Description                     |
|-----------------------------------------------|---------------------------------|
| TQM8M9076                                     | Digital Variable Gain Amplifier |
| TQM8M9076-PCB                                 | 0.3 – 4.0 GHz Evaluation Board  |
| Standard T/R size = 2500 pieces on a 13" reel |                                 |

### Absolute Maximum Ratings

| Parameter                          | Rating                 |
|------------------------------------|------------------------|
| Storage Temperature                | -65 to 150 °C          |
| RF Input Power, CW, 50Ω, T = 25 °C | +24 dBm                |
| Supply Voltage (V <sub>DD</sub> )  | +6 V                   |
| Digital Input Voltage              | V <sub>DD</sub> +0.5 V |

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

### Recommended Operating Conditions

| Parameter                                         | Min   | Typ | Max   | Units |
|---------------------------------------------------|-------|-----|-------|-------|
| V <sub>DD</sub>                                   | +4.75 | +5  | +5.25 | V     |
| I <sub>DD</sub>                                   |       | 125 |       | mA    |
| Operating Temp. Range                             | -40   |     | +85   | °C    |
| T <sub>ch</sub> (for >10 <sup>6</sup> hours 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: V<sub>DD</sub>=+5 V, Temp.=+25 °C

| Parameter                                | Conditions                   | Min                                | Typical | Max  | Units |
|------------------------------------------|------------------------------|------------------------------------|---------|------|-------|
| Operational Frequency Range              |                              | 50                                 |         | 4000 | MHz   |
| Test Frequency                           |                              |                                    | 2140    |      | MHz   |
| Gain                                     |                              | 18.0                               | 19.5    |      | dB    |
| Gain Control Range                       |                              |                                    | 31.5    |      | dB    |
| Gain Accuracy                            |                              | ± (0.3 + 4% of Atten. Setting) Max |         |      | dB    |
| Attenuation Step                         |                              |                                    | 0.5     |      | dB    |
| Time <sub>rise / fall</sub>              | 10% / 90% RF                 |                                    | 90      |      | ns    |
| Time <sub>on</sub> , Time <sub>off</sub> | 50% CTL to 10% / 90% RF      |                                    | 100     |      | ns    |
| Input Return Loss                        |                              |                                    | 13      |      | dB    |
| Output Return Loss                       |                              |                                    | 10      |      | dB    |
| Output P1dB                              |                              |                                    | +22     |      | dBm   |
| Output IP3                               | Pout=+3 dBm / tone, Δf=1 MHz | +35                                | +38.5   |      | dBm   |
| Noise Figure                             | At max gain level            |                                    | 2.9     |      | dB    |
| Supply Current                           |                              |                                    | 125     | 150  | mA    |
| Thermal Resistance                       | Channel to case              |                                    |         | 38   | °C/W  |

### Serial Control Interface

The TQM8M9076 has a CMOS SPI™ input compatible serial interface. This serial control interface converts the serial data input stream to parallel output word. The input is 3-wire (CLK, LE and SID) SPI™ input compatible. At power up, the serial control interface resets the DSA to the minimum gain state. The 6-bit SID (Serial Input Data) word is loaded into the register on rising edge of the CLK, MSB first. When LE is high, CLK is internally disabled.

### Serial Control Timing Characteristics (Test conditions: $V_{DD} = +5\text{ V}$ , Temp.=25°C)

| Parameter                           | Condition                   | Min | Max | Units |
|-------------------------------------|-----------------------------|-----|-----|-------|
| Clock Frequency                     | 50% Duty Cycle              |     | 10  | MHz   |
| LE Setup Time, $t_{LE\text{SUP}}$   | after last CLK rising edge  | 10  |     | ns    |
| LE Pulse Width, $t_{LE\text{PW}}$   |                             | 30  |     | ns    |
| SID set-up time, $t_{SD\text{SUP}}$ | before CLK rising edge      | 10  |     | ns    |
| SID hold-time, $t_{SD\text{HLD}}$   | after CLK rising edge       | 10  |     | ns    |
| LE Pulse Spacing $t_{LE}$           | LE to LE pulse spacing      | 630 |     | ns    |
| Propagation Delay $t_{P\text{LO}}$  | LE to Parallel output valid |     | 30  | ns    |

### Serial Control DC Logic Characteristics (Test conditions: $V_{DD} = +5\text{ V}$ , Temp.=25 °C)

| Parameter                           | Condition               | Min | Max      | Units         |
|-------------------------------------|-------------------------|-----|----------|---------------|
| Input Low State Voltage, $V_{IL}$   |                         | 0   | 0.8      | V             |
| Input High State Voltage, $V_{IH}$  |                         | 2.1 | $V_{DD}$ | V             |
| Output High State Voltage, $V_{OH}$ | On SOD pin              | 2.0 | $V_{DD}$ | V             |
| Output Low State Voltage, $V_{OL}$  | On SOD pin              | 0   | 0.8      | V             |
| Input Current, $I_{IH} / I_{IL}$    | On SID, LE and CLK pins | -10 | +10      | $\mu\text{A}$ |

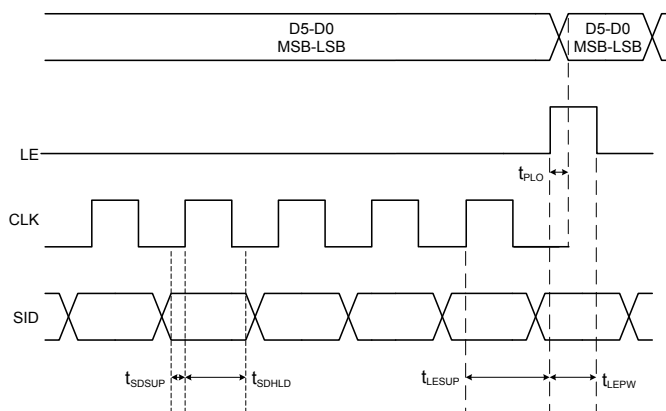
### SERIN Control Logic Truth Table

| 6-Bit Control Word |    |    |     |    |    | Gain Relative to Maximum Gain |
|--------------------|----|----|-----|----|----|-------------------------------|
| MSB                |    |    | LSB |    |    |                               |
| D5                 | D4 | D3 | D2  | D1 | D0 |                               |
| 1                  | 1  | 1  | 1   | 1  | 1  | Maximum Gain                  |
| 1                  | 1  | 1  | 1   | 1  | 0  | −0.5 dB                       |
| 1                  | 1  | 1  | 1   | 0  | 1  | −1 dB                         |
| 1                  | 1  | 1  | 0   | 1  | 1  | −2 dB                         |
| 1                  | 1  | 0  | 1   | 1  | 1  | −4 dB                         |
| 1                  | 0  | 1  | 1   | 1  | 1  | −8 dB                         |
| 0                  | 1  | 1  | 1   | 1  | 1  | −16 dB                        |
| 0                  | 0  | 0  | 0   | 0  | 0  | −31.5 dB                      |

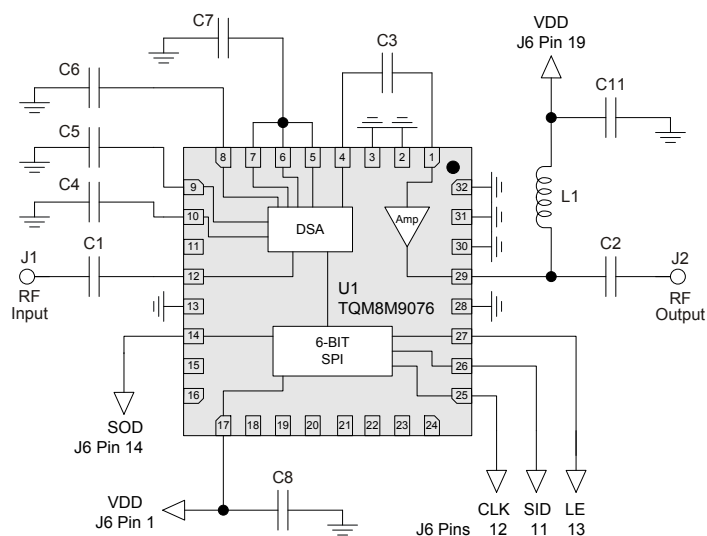
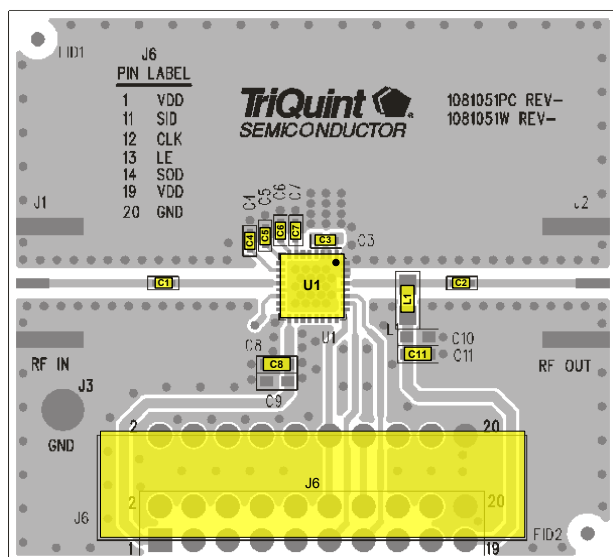
Any combination of the possible 64 states will provide a reduction in gain of approximately the sum of the bits selected.

### Timing Diagram

CLK is internally disabled when LE is high



**TQM8M9076-PCB Evaluation Board**



**Notes:**

1. See Evaluation Board PCB Information section for material and stack-up.
2. C4, C5, C6 and C7 may be removed for operation above 700 MHz.

**Bill of Material – TQM8M9076-PCB**

| Reference Des. | Value   | Description               | Manuf.   | Part Number |
|----------------|---------|---------------------------|----------|-------------|
| N/A            | N/A     | Printed Circuit Board     | TriQuint | 1081051     |
| U1             | N/A     | Digital Variable Gain Amp | TriQuint | TQM8M9076   |
| L1 (Note 3)    | 68 nH   | Inductor, 0603            | various  |             |
| C1, C2, C3     | 68 pF   | Capacitor, 0402           | various  |             |
| C4, C5, C6, C7 | 330 pF  | Capacitor, 0402           | various  |             |
| C8             | 1000 pF | Capacitor, 0603           | various  |             |
| C11            | 0.01 uF | Capacitor, 0603           | various  |             |

**Notes:**

1. For IF applications (<300 MHz) increase L1 to 330 nH.

### Typical Performance - TQM8M9076-PCB

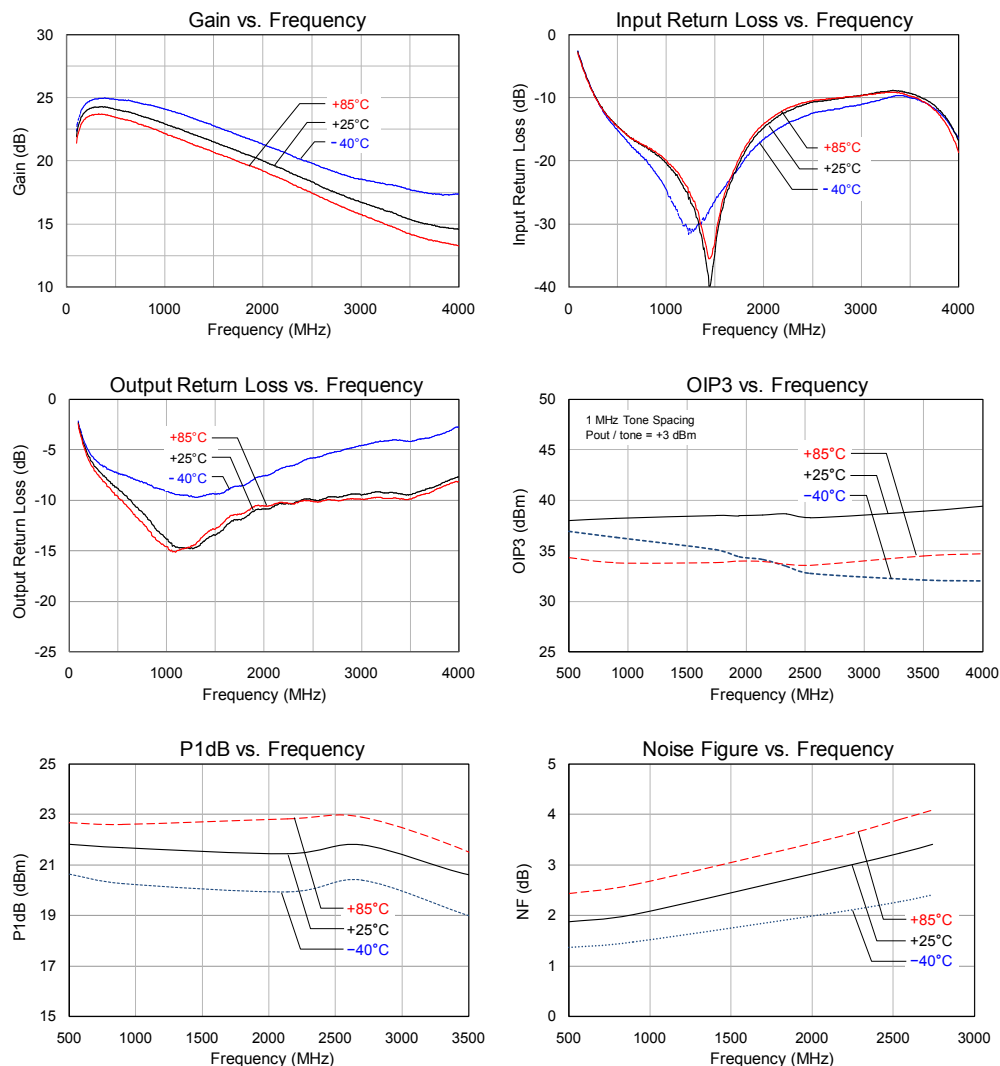
Test conditions unless otherwise noted:  $V_{DD}=+5\text{ V}$ ,  $I_{DD}=88\text{ mA}$  (typ.), Temp= $+25\text{ }^{\circ}\text{C}$

| Parameter                   | Conditions                                 | Typical Value |       |       |       |       | Units |
|-----------------------------|--------------------------------------------|---------------|-------|-------|-------|-------|-------|
| Frequency                   |                                            | 500           | 900   | 2140  | 2600  | 3500  | MHz   |
| Gain                        |                                            | 24.1          | 23.2  | 19.5  | 17.6  | 15.3  | dB    |
| Input Return Loss           |                                            | 15            | 19    | 13    | 11    | 9     | dB    |
| Output Return Loss          |                                            | 9             | 13    | 10    | 10    | 9     | dB    |
| Output P1dB                 |                                            | +21.8         | +21.7 | +21.5 | +21.5 | +20.6 | dBm   |
| Output IP3                  | Pout= +3 dBm/tone, $\Delta f=1\text{ MHz}$ | +38.0         | +38.2 | +38.5 | +38.5 | +38.9 | dBm   |
| Noise figure <sup>(1)</sup> |                                            | 1.9           | 2.0   | 2.9   | 3.2   | 3.4   | dB    |

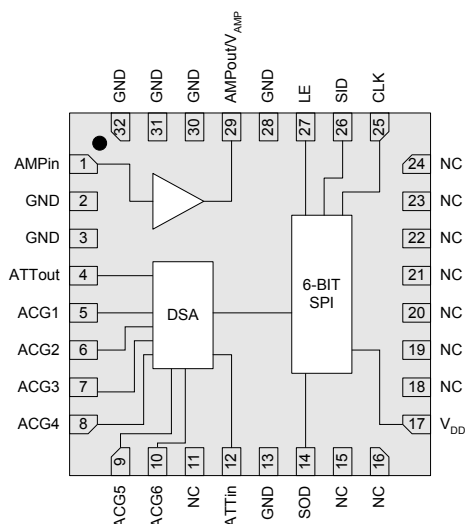
Notes:

- Gain values reflect de embedding of 0.4 dB eval board RF I/O line losses that would not be present in target applications.
- NF values reflect de-embedding of eval board RF I/O line losses that would not be present in target applications.
- Unless otherwise stated, performance plots shown below for DVGA maximum gain state.

### Performance Plots - TQM8M9076-PCB



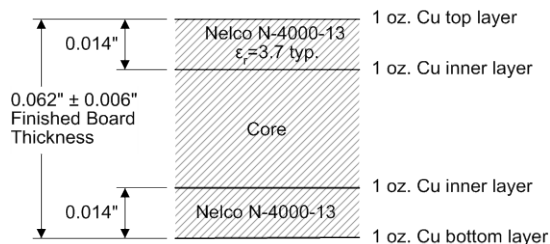
## Pin Configuration and Description



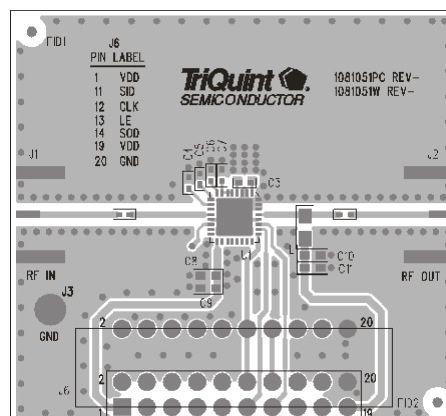
| Pin No.                  | Label                   | Description                                                                                                          |
|--------------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------|
| 1                        | AMPin                   | Amp RF input. External DC block required.                                                                            |
| 2, 3, 13, 28, 30, 31, 32 | GND                     | DC ground                                                                                                            |
| 11, 15, 16, 18 – 24      | NC                      | No electrical connection. Provide land pads for PCB mounting integrity.                                              |
| 29                       | AMPout/V <sub>AMP</sub> | Amp RF output / DC supply. External DC block and bias choke required.                                                |
| 12                       | ATTin                   | DSA Input                                                                                                            |
| 4                        | ATTout                  | DSA Output                                                                                                           |
| 5, 6, 7, 8, 9, 10        | ACG1-6                  | Place external capacitor to Ground for applications below 700 MHz.                                                   |
| 14                       | SOD                     | Serial Output Data                                                                                                   |
| 17                       | V <sub>DD</sub>         | DC supply into SPI and DSA                                                                                           |
| 25                       | CLK                     | Serial Clock                                                                                                         |
| 26                       | SID                     | Serial Input Data                                                                                                    |
| 27                       | LE                      | Latch Enable                                                                                                         |
| Backside Paddle          | RF/DC GND               | RF/DC ground. Use recommended via pattern and ensure good solder attach for best thermal and electrical performance. |

## Evaluation Board PCB Information

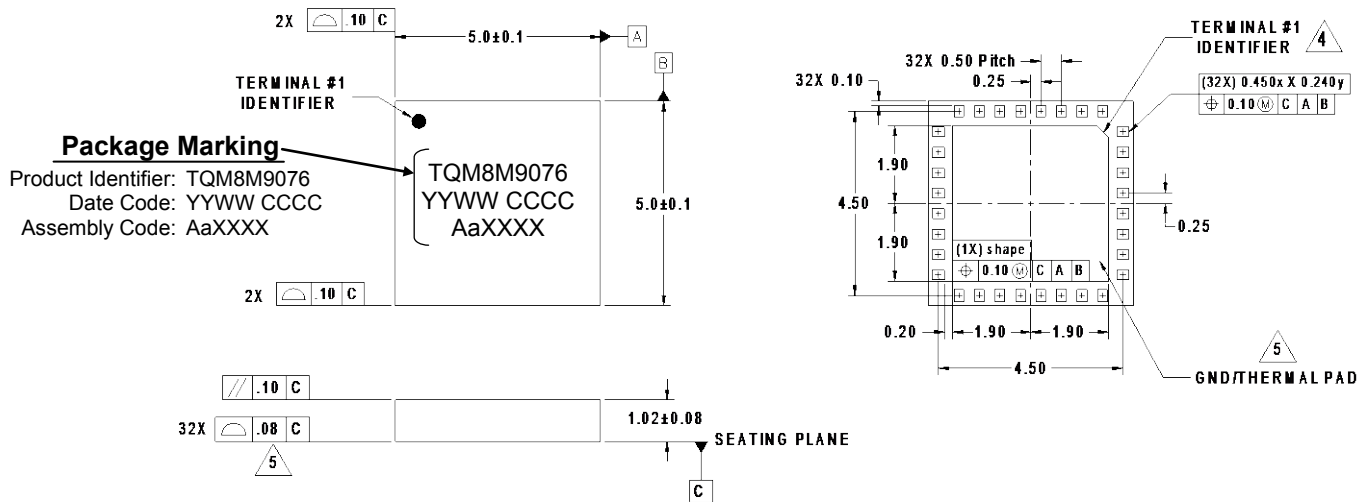
## TriQuint PCB 1081051 Material and Stack-up



50 ohm line dimensions: width = .026", spacing = .032"



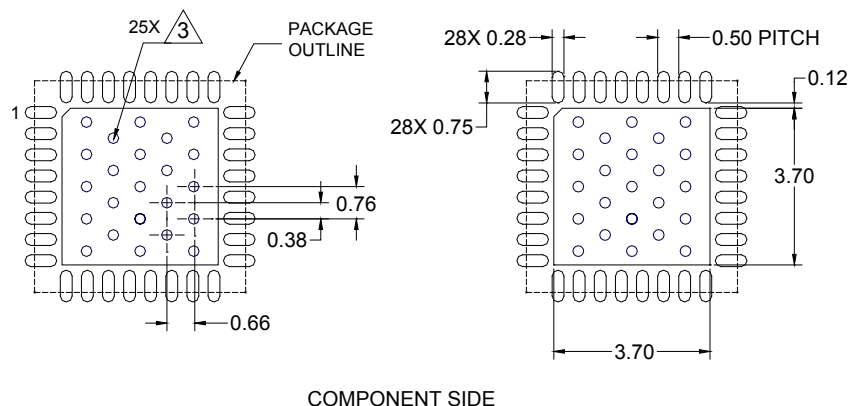
### Package Marking and Dimensions



#### Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Except where noted, this part outline conforms to JEDEC standard MO-220, Issue E (Variation VGGC) for thermally enhanced plastic very thin fine pitch quad flat no lead package (QFN).
3. Dimension and tolerance formats conform to ASME Y14.4M-1994.
4. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.

### PCB Mounting Pattern



#### Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1 oz. copper minimum for top and bottom layer metal.
3. Vias are required under the backside paddle of this device for proper RF/DC grounding and thermal dissipation. We recommend a 0.35mm (#80/.0135") diameter bit for drilling via holes and a final plated thru diameter of 0.25 mm (0.10").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

## Product Compliance Information

### ESD Sensitivity Ratings



Caution! ESD-Sensitive Device

ESD Rating: Class 1A  
Value:  $\geq 250$  V to  $< 500$  V  
Test: Human Body Model (HBM)  
Standard: ESDA/JEDEC Standard JS-001-2012

ESD Rating: Class C3  
Value:  $\geq 1000$  V  
Test: Charged Device Model (CDM)  
Standard: JEDEC Standard JESD22-C101F

### MSL Rating

MSL Rating: Level 3  
Test: 260 °C convection reflow  
Standard: JEDEC Standard IPC/JEDEC J-STD-020

### Solderability

Compatible with both lead-free (260 °C maximum reflow temperature) and tin/lead (245 °C maximum reflow temperature) soldering processes.

Contact plating: NiPdAu

### 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

## Contact Information

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

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