

TQM8M9075

0.05–4 GHz Digital Variable Gain Amplifier

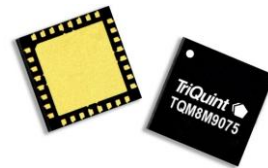


Applications

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

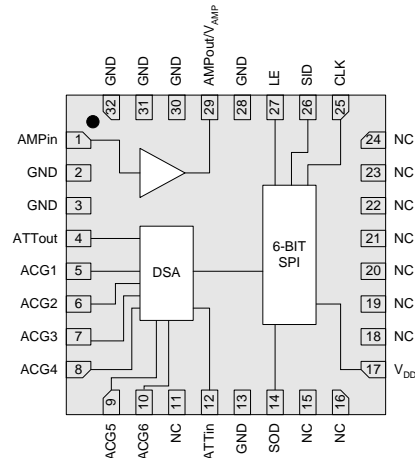
Product Features

- Integrates DSA + Amp Functionality
- 50-4000 MHz Broadband Performance
- 18 dB Gain at 2.14 GHz
- 2.9 dB Noise Figure at max gain setting
- +21 dBm P1dB
- +36.5 dBm OIP3
- +5 V Supply Voltage
- 88 mA Operating Current
- MTTF > 1000 Years



5x5mm 32-pin leadless SMT package

Functional Block Diagram



General Description

The TQM8M9075 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. This combination of performance parameters makes the DVGA ideal for receiver applications requiring gain control with high IIP3 and low noise figure.

The TQM8M9075 integrates a high performance digital step attenuator and a high linearity, broadband gain block. Both stages are internally matched to 50 Ohms and do not require any external matching components. A serial output port enables cascading with other serial controlled devices.

The TQM8M9075 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 TQM8M9075 is targeted for use in wireless infrastructure, point-to-point, or can be used for any general purpose wireless application.

Pin Configuration

| Pin # | Symbol |
|--------------------------|---------------------------|
| 1 | AMPin |
| 2, 3, 13, 28, 30, 31, 32 | GND (Ground) |
| 4 | ATTout |
| 5, 6, 7, 8, 9, 10 | ACG1-6 |
| 11, 15, 16, 18-24 | NC (No Connect) |
| 14 | SOD |
| 12 | ATTin |
| 17 | V _{DD} |
| 25 | CLK |
| 26 | SID |
| 27 | LE |
| 29 | AMPout / V _{AMP} |
| Backside Paddle | RF/DC Ground |

Ordering Information

| Part No. | Description |
|---------------|---------------------------------|
| TQM8M9075 | Digital Variable Gain Amplifier |
| TQM8M9075-PCB | 0.3-4.0 GHz Evaluation Board |

Standard T/R size = 2500 pieces on a 13" reel.

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Absolute Maximum Ratings

| Parameter | Rating |
|-----------------------------------|-------------------------|
| Storage Temperature | -65 to 150°C |
| RF Input Power, CW, 50Ω, T = 25°C | +24 dBm |
| Supply Voltage (V _{DD}) | +6 V |
| Reverse Device Voltage | -0.3 V |
| Digital Input Voltage | V _{DD} + 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 |
|--|------|-----|-------|-------|
| Supply Voltage (V _{DD}) | +3.3 | +5 | +5.25 | V |
| Supply Current (I _{DD}) | | 88 | | mA |
| Operating Temp. Range | -40 | | +85 | °C |
| T _J (for >10 ⁶ 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_{DD} = +5V, Temp. = +25°C, Configured as DSA followed by Amp

| Parameter | Conditions | Min | Typ | Max | Units |
|--|---|------------------------------------|-------|------|-------|
| Operational Frequency Range | | 50 | | 4000 | MHz |
| Test Frequency | | | 2140 | | MHz |
| Gain | | 16 | 18 | 20 | dB |
| Gain Control Range | | | 31.5 | | dB |
| Gain Accuracy | | ± (0.3 + 4% of Atten. Setting) Max | | | dB |
| Attenuation Step | | | 0.5 | | dB |
| Time _{rise / fall} | 10% / 90% RF | | 90 | | ns |
| Time _{on} , Time _{off} | 50% CTL to 10% / 90% RF | | 100 | | ns |
| Input Return Loss | | | -16 | | dB |
| Output Return Loss | | | -16.5 | | dB |
| Output P1dB | | | +20.5 | | dBm |
| Output IP3 | P _{out} =+3 dBm/tone, Δf=1 MHz | +32.5 | +36.5 | | dBm |
| Noise Figure | At max gain level | | 2.9 | | dB |
| Supply Current (I _{DD}) | | 70 | 88 | 110 | mA |
| Thermal Resistance | Channel to case | | | 41 | °C/W |

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Serial Control Interface

The TQM8M9075 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_{LESUP} | after last CLK rising edge | 10 | | ns |
| LE Pulse Width, t_{LEPW} | | 30 | | ns |
| SID set-up time, t_{SDSUP} | before CLK rising edge | 10 | | ns |
| SID hold-time, t_{SDHLD} | after CLK rising edge | 10 | | ns |
| LE Pulse Spacing t_{LE} | LE to LE pulse spacing | 630 | | ns |
| Propagation Delay t_{PLO} | 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} | | 2.4 | 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 | μA |

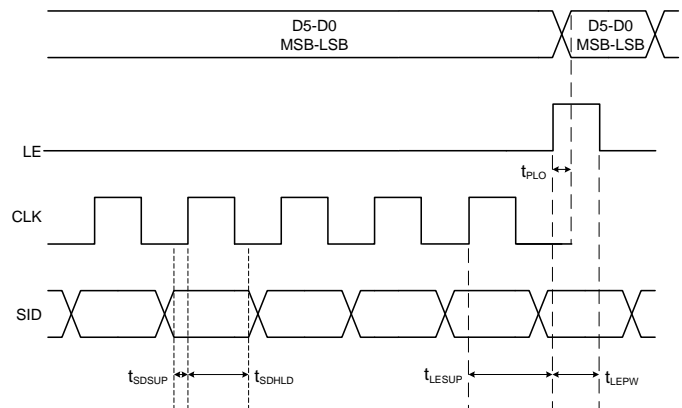
SERIN Control Logic Truth Table

| 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

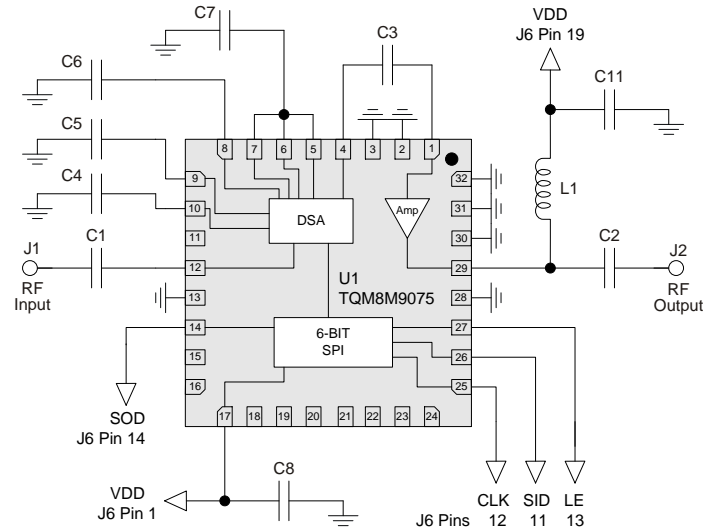
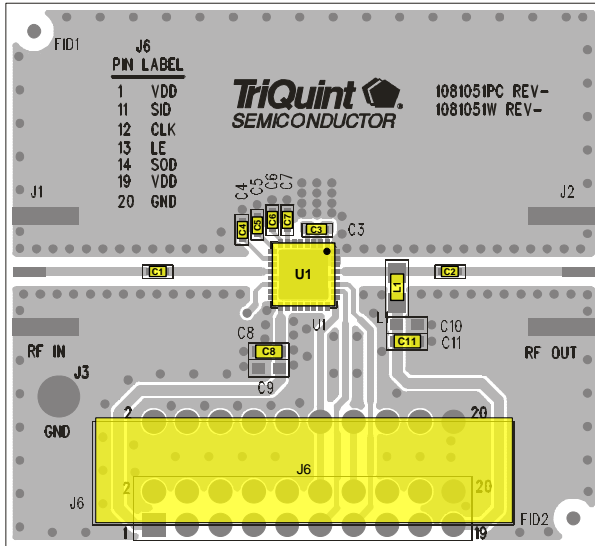


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TQM8M9075-PCB Evaluation Board



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 – TQM8M9075-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 | TQM8M9075 |
| L1 (Note 3) | 68 nH | Inductor, 0603 | Coilcraft | 0603CS-47NXJLW |
| 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.

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Typical Performance TQM8M9075-PCB

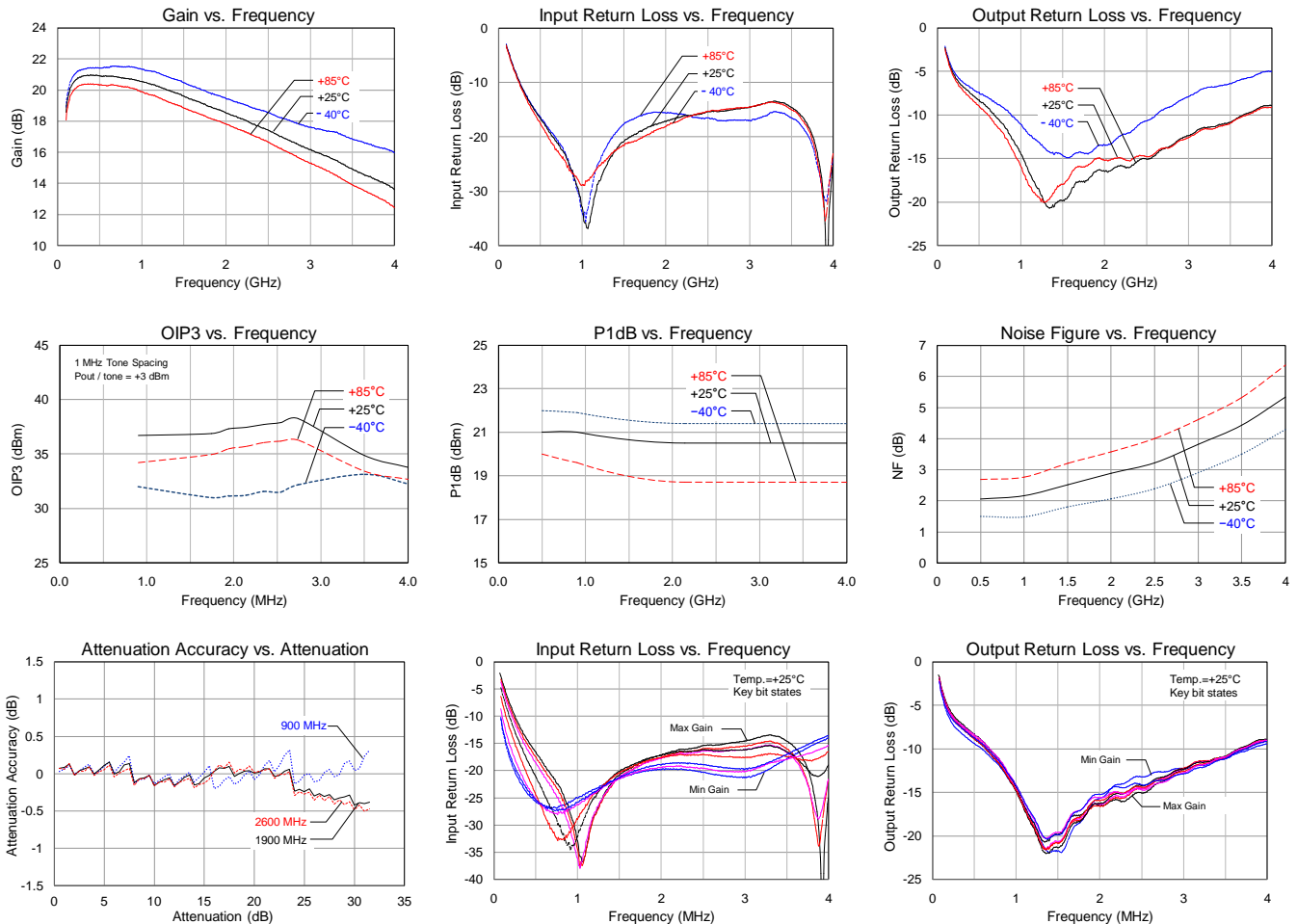
Test conditions unless otherwise noted: $V_{DD}=+5$ V, $I_{DD}=88$ mA (typ.), Temp= $+25^{\circ}\text{C}$

| Parameter | Conditions | Typical Value | | | | | | Units |
|-----------------------------|-------------------------------------|---------------|-------|-------|-------|-------|-------|-------|
| Frequency | | 500 | 900 | 2140 | 2700 | 3500 | 4000 | MHz |
| Gain | | 20.7 | 20.5 | 18.0 | 16.7 | 14.7 | 13.4 | dB |
| Input Return Loss | | 16.6 | 27.2 | 16.5 | 15.2 | 14.6 | 25.0 | dB |
| Output Return Loss | | 8.3 | 12.9 | 16.0 | 13.9 | 10.9 | 8.9 | dB |
| Output P1dB | | +21 | +21 | +20.5 | +20.1 | +19.7 | +19.0 | dBm |
| Output IP3 | Pout= +3 dBm/tone, $\Delta f=1$ MHz | +36.7 | +36.7 | +36.5 | +38.0 | +34.9 | +33.8 | dBm |
| Noise figure ⁽¹⁾ | | 1.9 | 2.0 | 2.9 | 3.3 | 4.1 | 4.9 | 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 - TQM8M9075-PCB

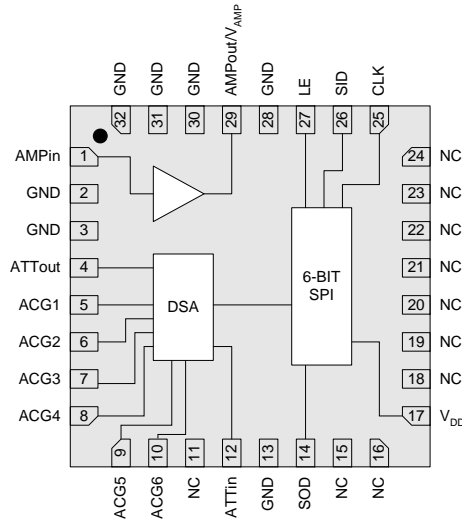


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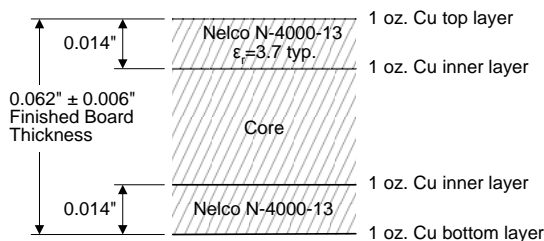
Pin Configuration and Description



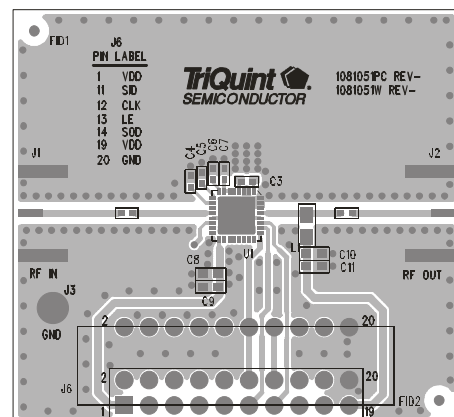
| Pin No. | Symbol | Description |
|--------------------------|-------------------|--|
| 1 | AMPin | Amp RF input. External DC block required. |
| 2, 3, 13, 28, 30, 31, 32 | GND (Ground) | DC ground |
| 11, 15, 16, 18-24 | NC (No Connect) | No electrical connection. Provide land pads for PCB mounting integrity. |
| 29 | AMPout/ V_{AMP} | 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 | Vdd | 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"



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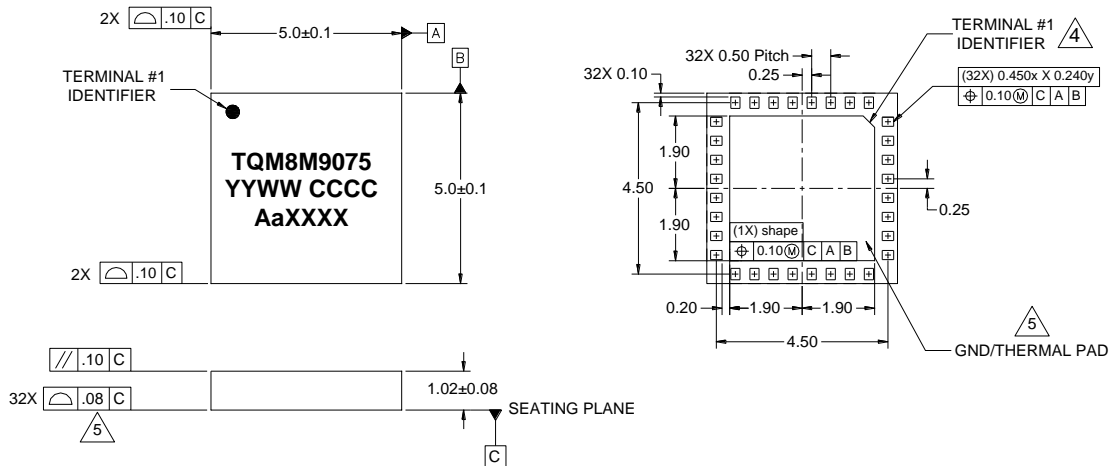
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Mechanical Information

Package Marking and Dimensions

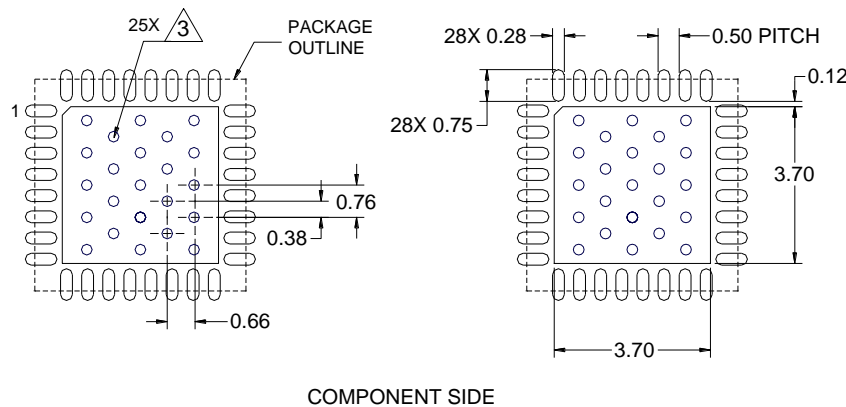
Marking: Part number – TQM8M9075
 Year, week, country code - YYWW CCCC
 Assembly Code – AaXXXX



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.

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Product Compliance Information

ESD Sensitivity Ratings



Caution! ESD-Sensitive Device

ESD Rating: Class 1A
Value: Passes ≥ 250 V to < 500 V
Test: Human Body Model (HBM)
Standard: JEDEC Standard JESD22-A114

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

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 max. reflow temperature) and tin/lead (245 °C max. reflow temperature) soldering processes.

Contact plating: Electrolytic plated Au over Ni

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 (C₁₅H₁₂Br₄O₂) Free
- PFOS Free
- SVHC Free

Contact Information

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