

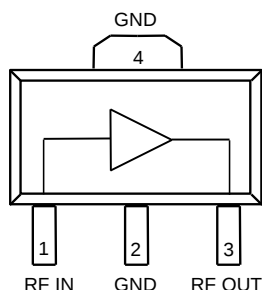
### Product Description

The TQP3M9028 is a cascadable, high linearity gain block amplifier in a low-cost surface-mount package. At 1.9 GHz, the amplifier typically provides 14.7 dB gain, +40 dBm OIP3, and 1.8 dB Noise Figure while only drawing 85 mA current. The device is housed in a leadfree/green/RoHS-compliant industry-standard SOT-89 package.

The TQP3M9028 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 TQP3M9028 covers the 50-4000 MHz frequency band and is targeted for wireless infrastructure or other applications requiring high linearity and/or low noise figure.

### Functional Block Diagram



SOT-89 Package

### Product Features

- 50-4000 MHz
- Flat gain ( $14.7 \pm 0.3$  dB) from 0.5 – 3.5 GHz
- +40 dBm Output IP3
- 1.8 dB Noise Figure @ 1900 MHz
- No RF components needed; 50 Ohm Gain Block
- Unconditionally Stable
- +5V Single Supply, 85 mA Current
- SOT-89 Package

### Applications

- Repeaters
- Mobile Infrastructure
- Defense / Aerospace
- LTE / WCDMA / CDMA
- General Purpose Wireless
- IF Amplifier, RF Driver Amplifier

### Ordering Information

| Part No.         | Description                   |
|------------------|-------------------------------|
| TQP3M9028        | High Linearity LNA Gain Block |
| TQP3M9028-PCB_IF | 50-500 MHz Evaluation Board   |
| TQP3M9028-PCB_RF | 0.5-4 GHz Evaluation Board    |

Standard T/R size = 1000 pieces on a 7" reel

## Absolute Maximum Ratings

| Parameter                         | Rating        |
|-----------------------------------|---------------|
| Storage Temperature               | -65 to +150°C |
| RF Input Power, CW, 50 Ω, T=25 °C | +23 dBm       |
| Device Voltage (V <sub>DD</sub> ) | +7 V          |
| Reverse Supply Voltage            | -0.3 V        |

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability.

## Recommended Operating Conditions

| Parameter                                      | Min   | Typ  | Max   | Units |
|------------------------------------------------|-------|------|-------|-------|
| Device Voltage (V <sub>DD</sub> )              | +4.75 | +5.0 | +5.25 | V     |
| T <sub>CASE</sub>                              | -40   |      | +105  | °C    |
| T <sub>j</sub> for >10 <sup>6</sup> hours MTTF |       |      | +190  | °C    |

Electrical specifications are measured under bias, signal and temperature conditions as specified. Specifications are not guaranteed over all recommended operating conditions.

## Electrical Specifications

| Parameter                           | Conditions                               | Min   | Typ   | Max  | Units  |
|-------------------------------------|------------------------------------------|-------|-------|------|--------|
| Operational Frequency Range         |                                          | 50    |       | 4000 | MHz    |
| Test Frequency                      |                                          |       | 1900  |      | MHz    |
| Gain                                |                                          | 13    | 14.5  | 16   | dB     |
| Input Return Loss                   |                                          |       | 18    |      | dB     |
| Output Return Loss                  |                                          |       | 19    |      | dB     |
| Output P1dB                         |                                          |       | +20.7 |      | dBm    |
| Output IP3                          | P <sub>out</sub> =+4 dBm/tone, Δf= 1 MHz | +36.0 | +40   |      | dBm    |
| Noise Figure                        |                                          |       | 1.8   |      | dB     |
| Device Current, I <sub>DD</sub>     |                                          |       | 85    | 100  | mA     |
| Thermal Resistance, θ <sub>Jc</sub> | Junction to backside paddle              |       | 36.6  |      | °C / W |

### Notes:

1. Test conditions unless otherwise noted: V<sub>DD</sub>= +5V, Temp= +25°C, 50Ω system

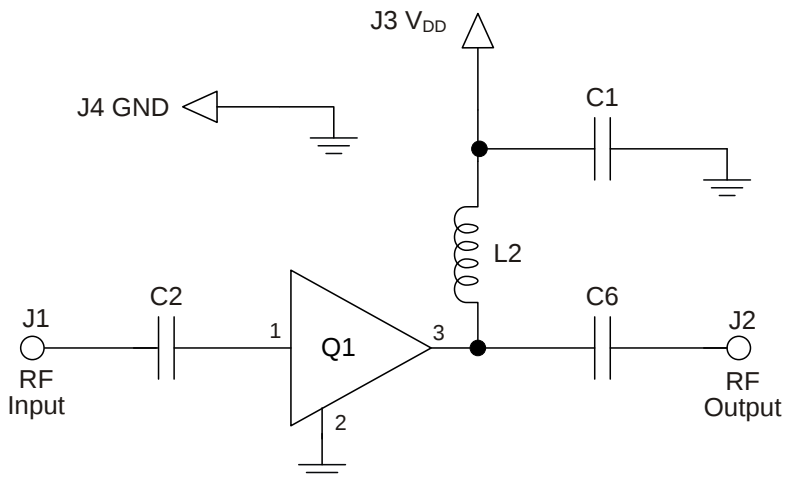
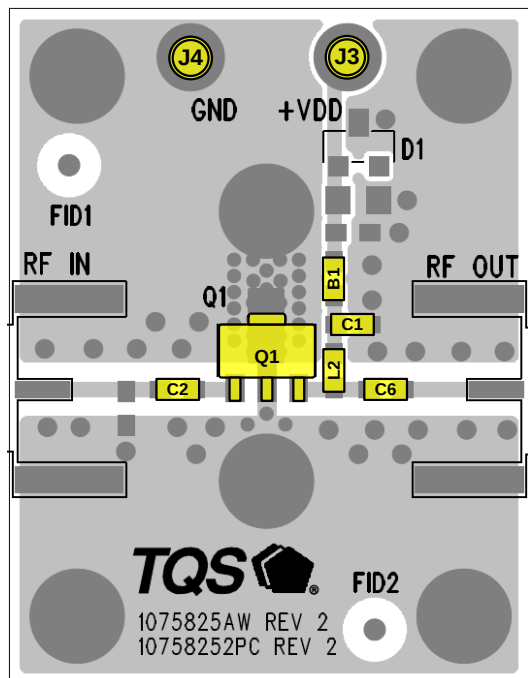
## S-Parameters

| Freq (GHz) | S11 (dB) | S11 (ang) | S21 (dB) | S21 (ang) | S12 (dB) | S12 (ang) | S22 (dB) | S22 (ang) |
|------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|
| 0.05       | -17.781  | -79.977   | 16.426   | 168.24    | -19.626  | 4.3045    | -19.220  | -103.67   |
| 0.1        | -20.687  | -111.11   | 15.710   | 165.75    | -19.125  | -0.3832   | -19.244  | -133.67   |
| 0.2        | -23.728  | -139.82   | 15.333   | 161.88    | -18.801  | -5.7231   | -19.718  | -156.97   |
| 0.4        | -26.055  | -167.83   | 15.114   | 150.42    | -19.148  | -15.433   | -20.556  | 179.38    |
| 0.6        | -27.432  | -174.22   | 15.068   | 138.49    | -19.086  | -24.010   | -22.047  | 170.39    |
| 0.8        | -28.336  | 175.58    | 14.970   | 124.69    | -19.086  | -32.722   | -22.058  | 163.66    |
| 1.0        | -28.090  | 168.62    | 14.889   | 112.00    | -19.259  | -42.486   | -23.024  | 152.72    |
| 1.2        | -27.851  | 173.63    | 14.837   | 98.392    | -19.196  | -50.978   | -24.702  | 147.54    |
| 1.4        | -27.744  | -176.1    | 14.787   | 85.391    | -19.461  | -59.544   | -27.618  | 150.45    |
| 1.6        | -25.498  | -170.21   | 14.785   | 71.784    | -19.643  | -67.665   | -30.371  | 178.07    |
| 1.8        | -23.299  | -171.85   | 14.681   | 58.795    | -19.718  | -76.829   | -30.117  | -137.55   |
| 2.0        | -21.873  | -177.68   | 14.742   | 45.335    | -19.786  | -86.241   | -24.898  | -137.73   |
| 2.2        | -19.991  | 174.69    | 14.585   | 31.380    | -20.202  | -94.784   | -21.473  | -136.81   |
| 2.4        | -18.395  | 168.24    | 14.660   | 17.730    | -20.964  | -105.89   | -18.570  | -137.28   |
| 2.6        | -16.954  | 156.32    | 14.540   | 3.3697    | -20.584  | -113.76   | -16.815  | -144.20   |
| 2.8        | -15.635  | 143.92    | 14.468   | -10.871   | -21.081  | -123.83   | -15.001  | -146.29   |
| 3.0        | -14.526  | 132.69    | 14.390   | -25.665   | -21.170  | -134.66   | -13.630  | -160.04   |
| 3.2        | -13.585  | 121.19    | 14.321   | -40.604   | -21.463  | -143.32   | -12.590  | -169.39   |
| 3.4        | -13.396  | 109.54    | 14.295   | -55.994   | -21.608  | -153.10   | -11.447  | -179.44   |
| 3.6        | -13.267  | 95.204    | 14.103   | -71.813   | -22.114  | -164.82   | -10.288  | 168.78    |
| 3.8        | -13.490  | 73.954    | 14.022   | -88.474   | -22.248  | -174.45   | -9.8699  | 161.57    |
| 4.0        | -13.580  | 51.354    | 13.694   | -105.82   | -22.604  | 175.38    | -9.6061  | 156.49    |

Notes:

1. Test Conditions:  $V_{DD}=+5$  V (typ.),  $I_{DD}=85$  mA (typ.),  $T=+25$  °C, unmatched 50 ohm system, calibrated to device leads

## TQP3M9028-PCB\_RF Evaluation Board (500–4000 MHz)



### Notes:

1. See PC Board Layout, page 8 for more information.
2. Components shown on the silkscreen but not on the schematic are not used.
3. B1 (0  $\Omega$  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 – TQP369180-PCB

| Reference Des. | Value        | Description                   | Manuf.    | Part Number   |
|----------------|--------------|-------------------------------|-----------|---------------|
| n/a            | n/a          | Printed Circuit Board         | Qorvo     | 1075825       |
| Q1             | n/a          | High Linearity LNA Gain Block | Qorvo     | TQP3M9028     |
| C2, C6         | 100 pF       | CAP, 0603, 5%, 100V, NPO/COG  | various   |               |
| C1             | 0.01 $\mu$ F | CAP, 0603, 5%, 50V, X7R       | various   |               |
| L2             | 68 nH        | IND, 0603, 5%                 | CoilCraft | 0603CS-68NXJL |
| B1             | 0 $\Omega$   | RES, 0603                     | various   |               |
| L1, D1, C3, C4 | DNP          | n/a                           | n/a       | n/a           |

Note: Performances can be optimized at frequency of interest by using recommended component values shown in the table below. Inductors are wirewound Coilcraft.

## Component Values for Specific Frequencies

| 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 – TQP3M9028-PCB\_RF

Test conditions unless otherwise noted:  $V_{DD} = +5V$ ,  $I_{DD} = 85$  mA (typ.), Temp = +25°C

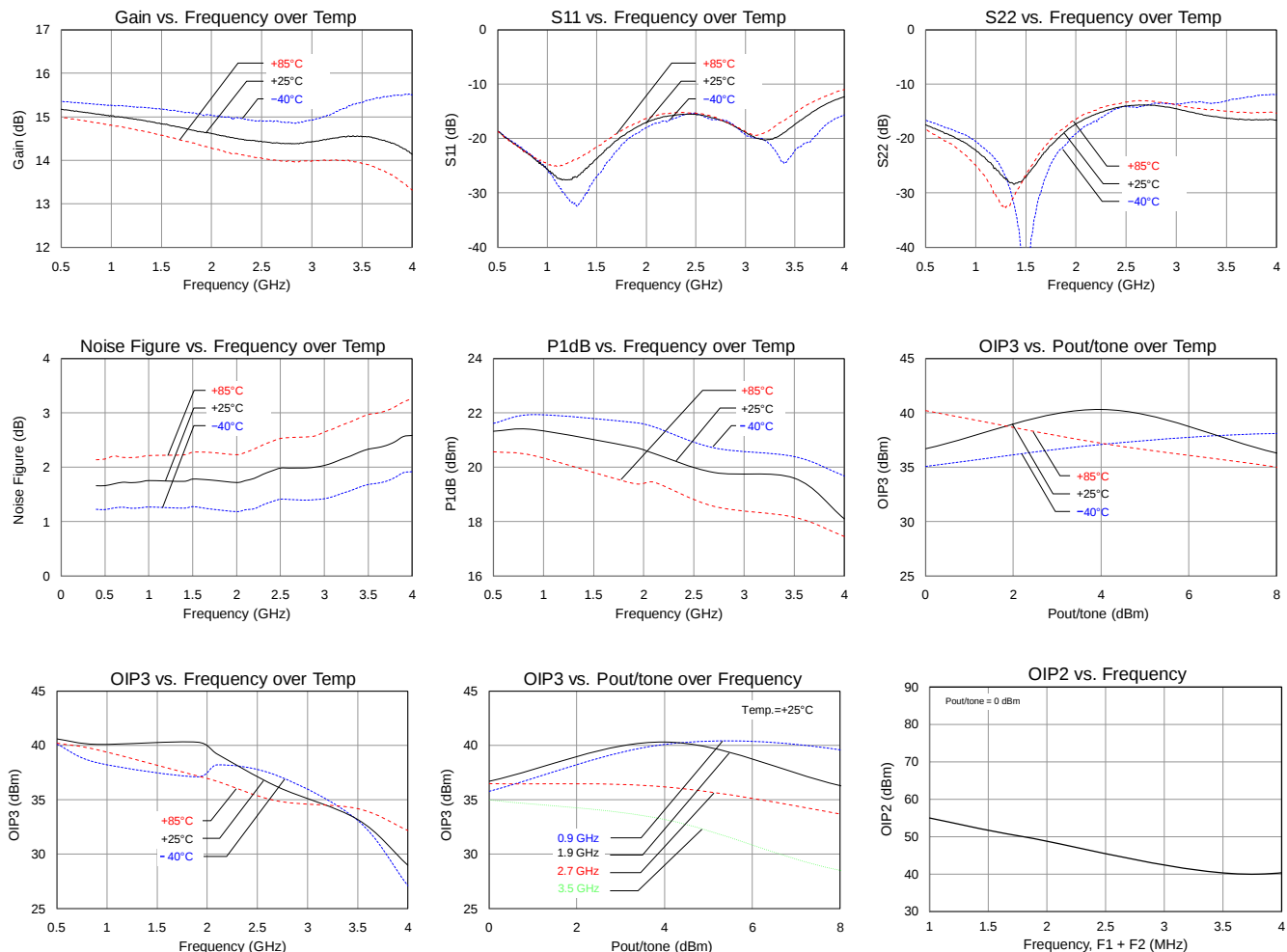
| Parameter                   | Typical Value |       |       |       |       |       | Units |
|-----------------------------|---------------|-------|-------|-------|-------|-------|-------|
| Frequency                   | 500           | 900   | 1900  | 2700  | 3500  | 4000  | MHz   |
| Gain                        | 15.2          | 15.1  | 14.7  | 14.4  | 14.6  | 14.2  | dB    |
| Input Return Loss           | 19            | 24    | 18    | 16    | 17    | 12    | dB    |
| Output Return Loss          | 17.5          | 21    | 19    | 14    | 16    | 16.5  | dB    |
| Output P1dB                 | +21.3         | +21.4 | +20.7 | +19.8 | +19.6 | +18.1 | dBm   |
| OIP3 <sup>(1)</sup>         | +40.6         | +40.1 | +40.3 | +36.2 | +33.2 | +29   | dBm   |
| Noise figure <sup>(2)</sup> | 1.6           | 1.7   | 1.8   | 2.0   | 2.3   | 2.6   | dB    |

Notes:

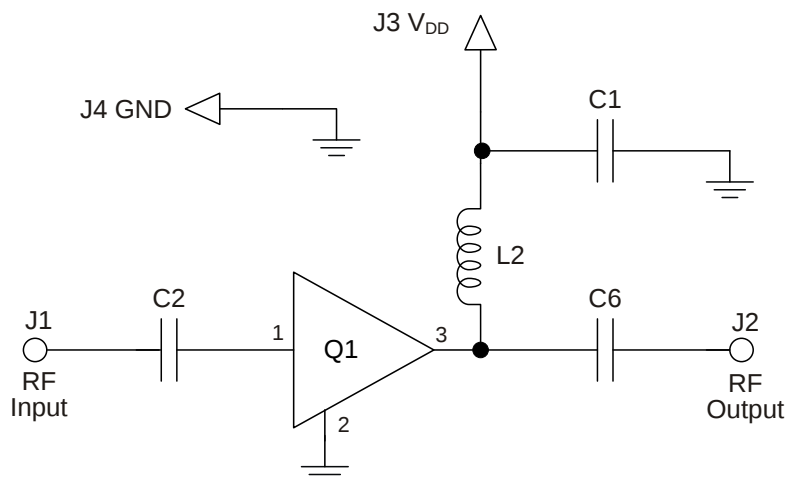
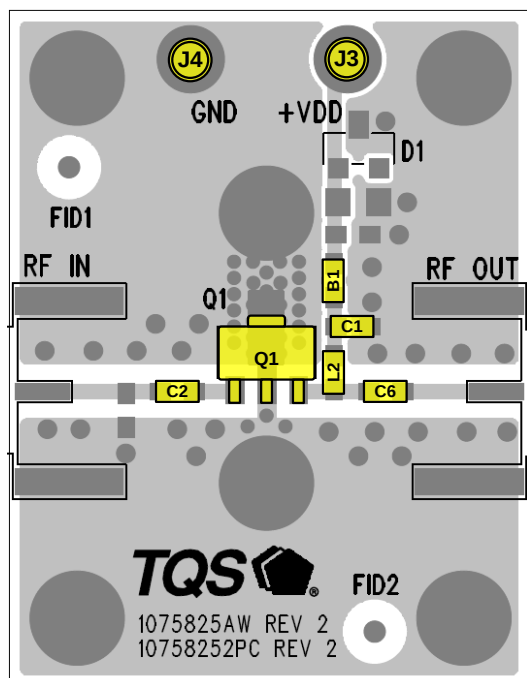
- OIP3 measured with two tones at an output power of +4 dBm / tone separated by 1 MHz.
- Noise figure data shown in the table above is de-embedded from the eval board loss.

### Performance Plots – TQP3M9028-PCB\_RF

Test conditions unless otherwise noted:  $V_{DD} = +5V$ ,  $I_{DD} = 85$  mA (typ.), Temp = +25°C



## TQP3M9028-PCB\_IF Evaluation Board (50–500 MHz)



### Notes:

1. See PC Board Layout, page 8 for more information.
2. Components shown on the silkscreen but not on the schematic are not used.
3. B1 (0  $\Omega$  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 – TQP3M9028-PCB\_IF

| Reference Des. | Value        | Description                   | Manuf.    | Part Number   |
|----------------|--------------|-------------------------------|-----------|---------------|
| n/a            | n/a          | Printed Circuit Board         | Qorvo     | 1075825       |
| Q1             | n/a          | High Linearity LNA Gain Block | Qorvo     | TQP3M9028     |
| C2, C6         | 1000 pF      | CAP, 0603, 5%, 50V, X7R       | various   |               |
| C1             | 0.01 $\mu$ F | CAP, 0603, 5%, 50V, X7R       | various   |               |
| L2             | 330 nH       | IND, 0603, 5%                 | CoilCraft | 0603CS-R33XJL |
| B1             | 0 $\Omega$   | RES, 0603                     | various   |               |
| L1, D1, C3, C4 | DNP          | n/a                           | n/a       | n/a           |

### Typical Performance – TQP3M9028-PCB\_IF

Test conditions unless otherwise noted:  $V_{DD} = +5V$ ,  $I_{DD} = 85$  mA (typ.), Temp = +25°C

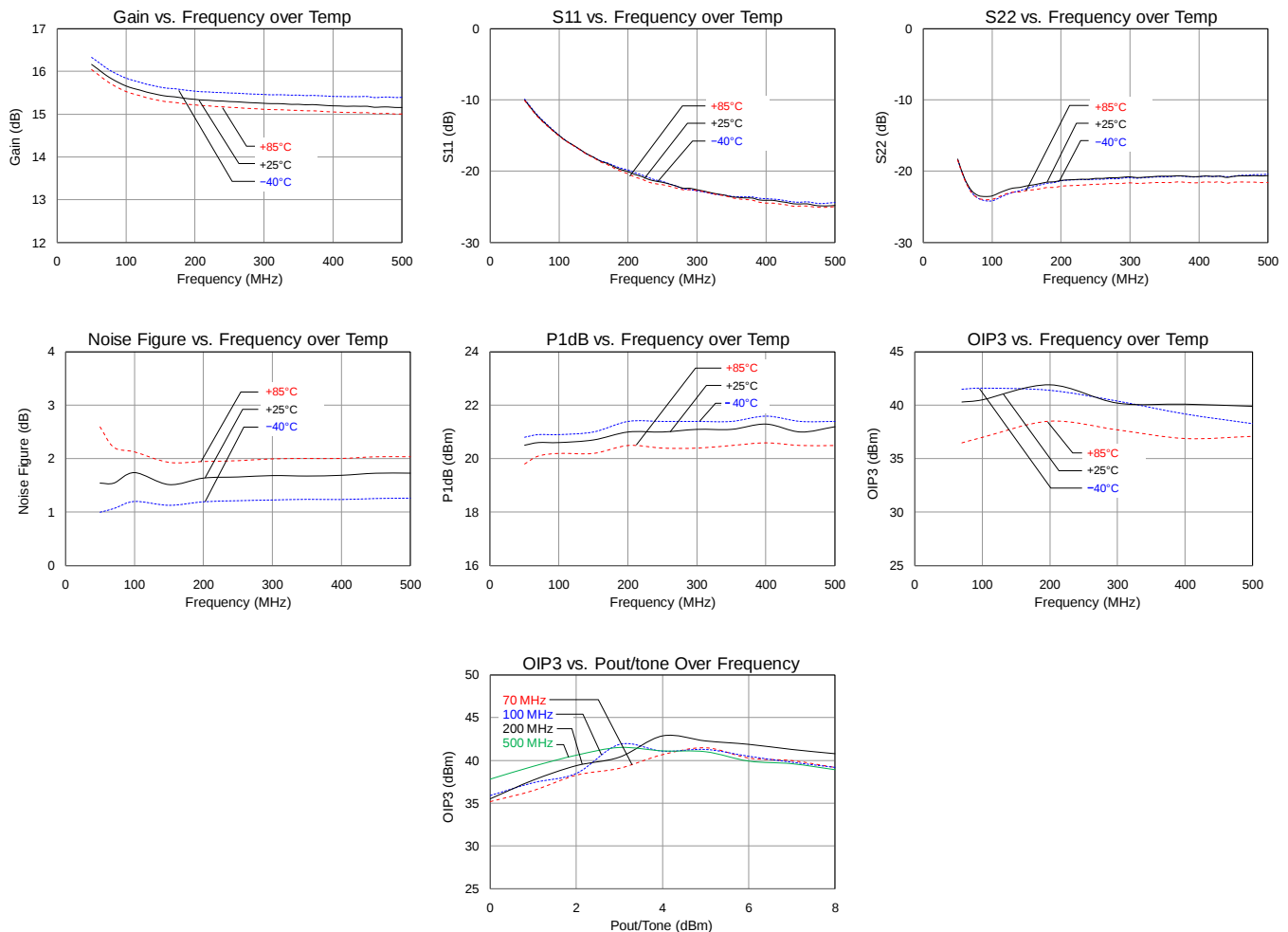
| Parameter                   | Conditions                             | Typical Values |       |       |       | Units |
|-----------------------------|----------------------------------------|----------------|-------|-------|-------|-------|
| Frequency                   |                                        | 70             | 100   | 200   | 500   | MHz   |
| Gain                        |                                        | 15.8           | 15.5  | 15.3  | 15.2  | dB    |
| Input Return Loss           |                                        | 13             | 15    | 20    | 25    | dB    |
| Output Return Loss          |                                        | 23             | 23    | 22    | 20.5  | dB    |
| Output P1dB                 |                                        | +20.6          | +20.6 | +21.0 | +21.2 | dBm   |
| OIP3                        | Pout = +6 dBm/tone, $\Delta f = 1$ MHz | +40.3          | +40.5 | +41.9 | +39.9 | dBm   |
| Noise figure <sup>(1)</sup> |                                        | 1.7            | 1.7   | 1.7   | 1.7   | dB    |

Notes:

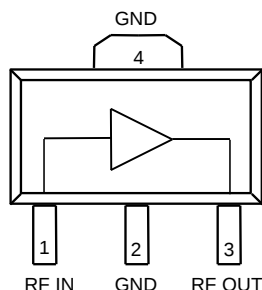
- Noise figure data shown in the table above is de-embedded from the eval board loss.

### Performance Plots – TQP3M9028-PCB\_IF

Test conditions unless otherwise noted:  $V_{DD} = +5V$ ,  $I_{DD} = 85$  mA (typ.), Temp = +25°C



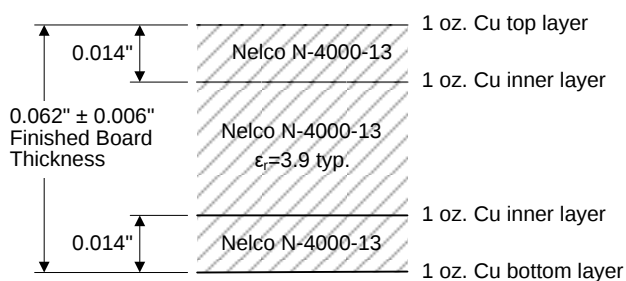
## Pin Configuration and Description



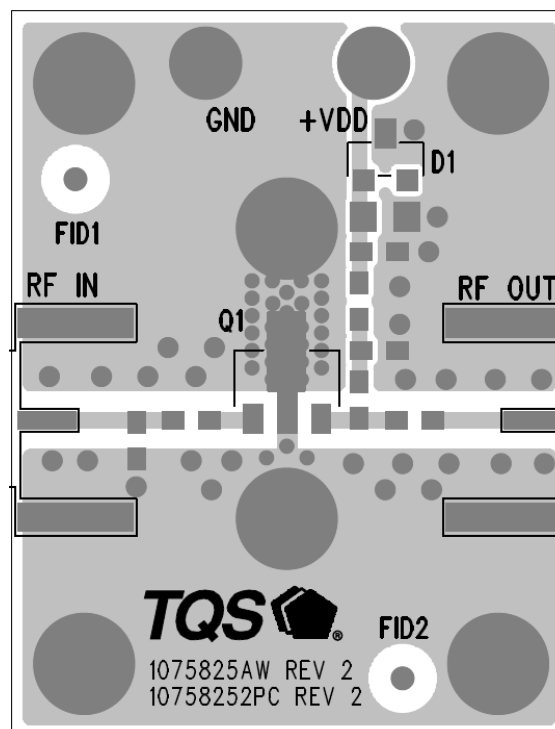
| Pin No. | Label            | Description                                                                  |
|---------|------------------|------------------------------------------------------------------------------|
| 1       | RF IN            | RF Input, matched to 50 ohms. External DC Block is required.                 |
| 3       | RF OUT / DC Bias | Output, matched to 50 ohms, External DC Block is required and supply voltage |
| 2, 4    | Ground           | RF/DC Ground Connection                                                      |

## Application Information

### Qorvo PCB 1075825 Material and Stack-up

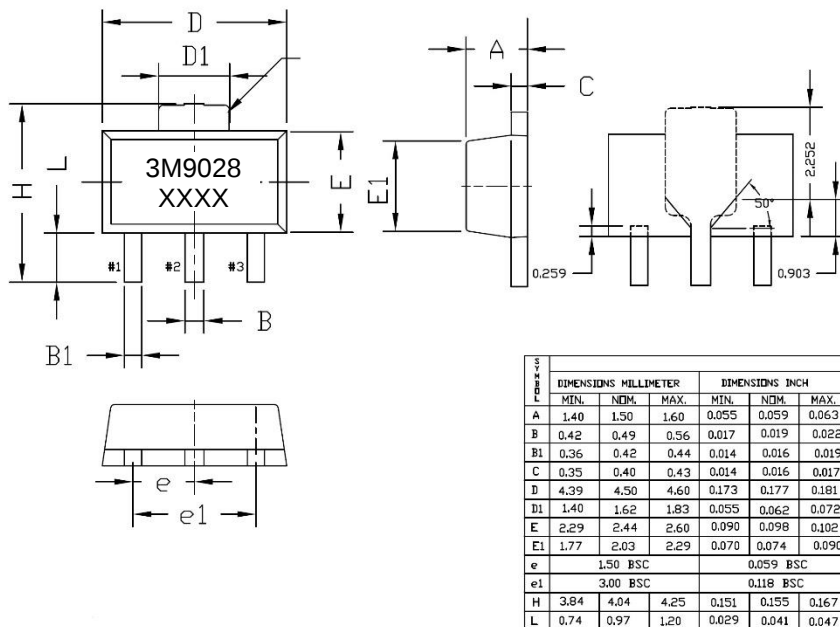


50 ohm line dimensions: width = 0.029", spacing = 0.035"



## Package Marking and Dimensions

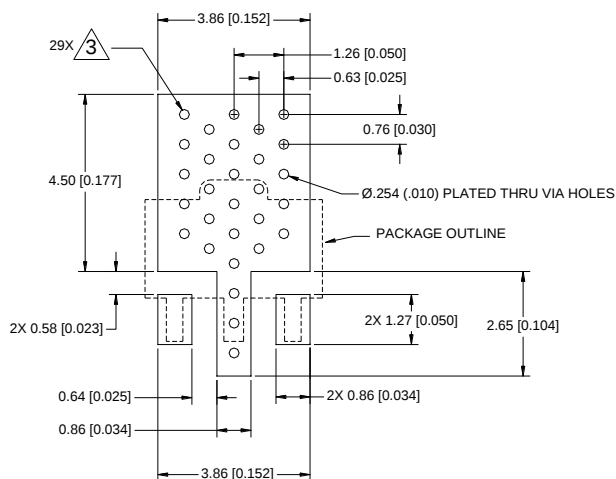
Marking: Part number – 3M9028  
Lot code – XXXX



### Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Dimension and tolerance formats conform to ASME Y14.4M-1994.
3. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.

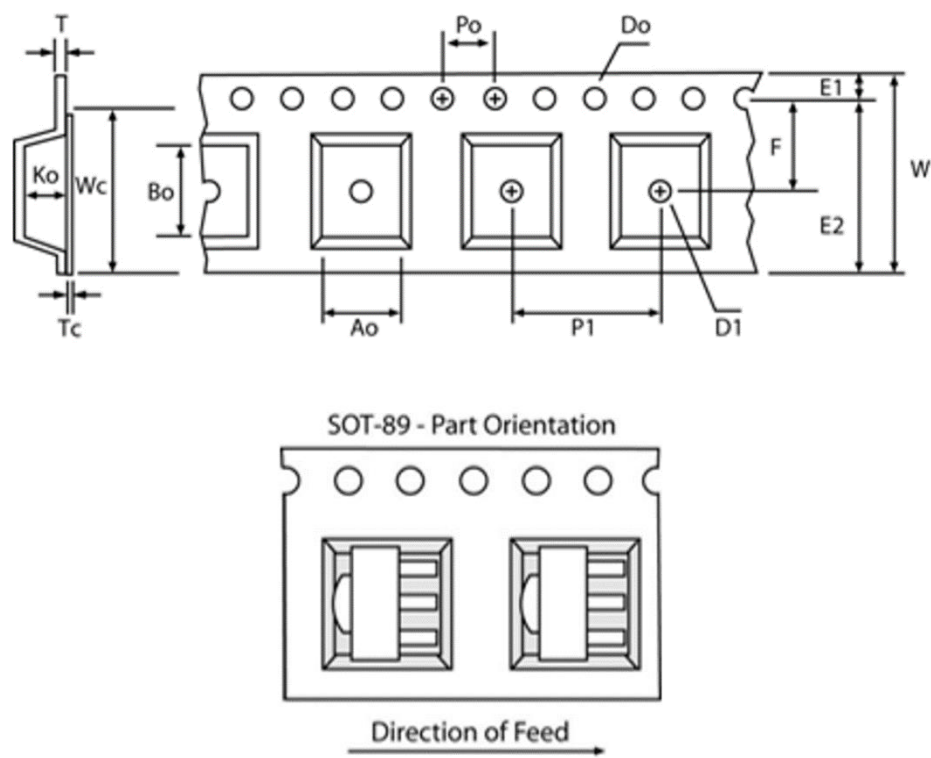
## PCB Mounting Pattern



### NOTES:

1. All dimensions are in millimeters[inches]. 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 0.25mm (0.01").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

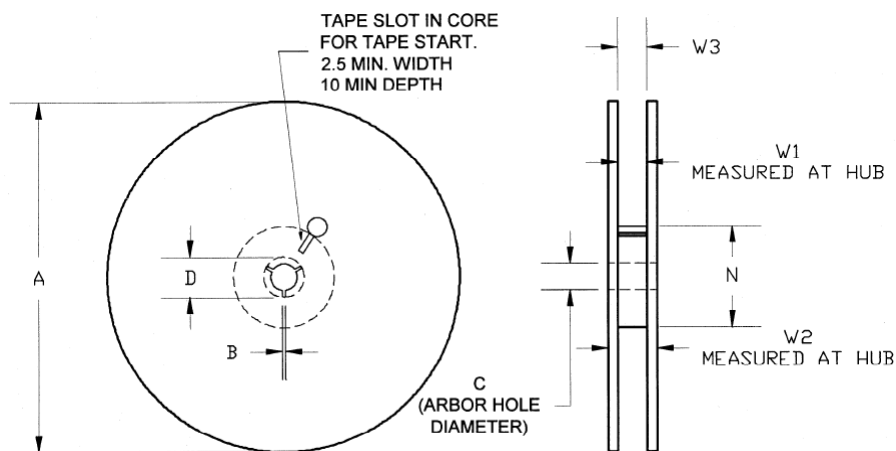
Tape and Reel Information – Carrier and Cover Tape Dimensions



| Feature             | Measure                                  | Symbol | Size (in) | Size (mm) |
|---------------------|------------------------------------------|--------|-----------|-----------|
| Cavity              | Length                                   | A0     | 0.181     | 4.60      |
|                     | Width                                    | B0     | 0.193     | 4.90      |
|                     | Depth                                    | K0     | 0.075     | 1.90      |
|                     | Pitch                                    | P1     | 0.315     | 8.00      |
| Centerline Distance | Cavity to Perforation - Length Direction | P2     | 0.079     | 2.00      |
|                     | Cavity to Perforation - Width Direction  | F      | 0.217     | 5.50      |
| Cover Tape          | Width                                    | C      | 0.362     | 9.20      |
| Carrier Tape        | Width                                    | W      | 0.472     | 12.0      |

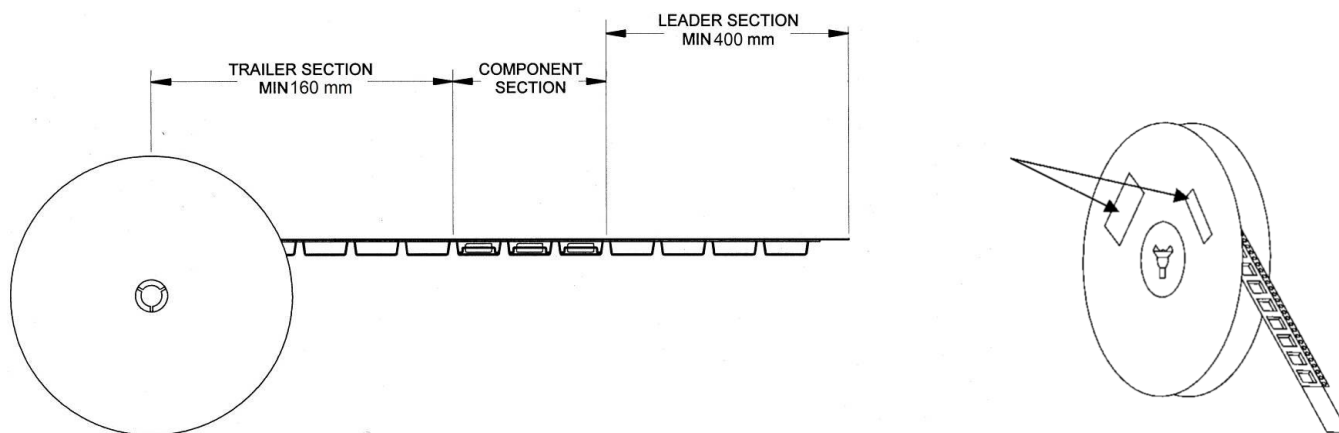
## Tape and Reel Information – Reel Dimensions

Standard T/R size = 1,000 pieces on a 7" reel.



| Feature | Measure              | Symbol | Size (in) | Size (mm) |
|---------|----------------------|--------|-----------|-----------|
| Flange  | Diameter             | A      | 6.969     | 170.0     |
|         | Thickness            | W2     | 0.717     | 18.2      |
|         | Space Between Flange | W1     | 0.504     | 12.8      |
| Hub     | Outer Diameter       | N      | 2.283     | 58.0      |
|         | Arbor Hole Diameter  | C      | 0.512     | 13.0      |
|         | Key Slit Width       | B      | 0.079     | 2.0       |
|         | Key Slit Diameter    | D      | 0.787     | 20.0      |

## Tape and Reel Information – Tape Length and Label Placement



### Notes:

1. Empty part cavities at the trailing and leading ends are sealed with cover tape. See EIA 481-1-A.
2. Labels are placed on the flange opposite the sprockets in the carrier tape.

## Handling Precautions

| Parameter                        | Rating   | Standard                   |
|----------------------------------|----------|----------------------------|
| ESD – Human Body Model (HBM)     | Class 1A | JEDEC Standard JESD22-A114 |
| ESD – Charged Device Model (CDM) | Class C3 | JEDEC Standard JESD22-C101 |
| MSL – Moisture Sensitivity Level | Level 1  | IPC/JEDEC J-STD-020        |



Caution!  
ESD-Sensitive Device

## Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes.  
Solder profiles available upon request.

Contact plating: Matte Tin

## RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) Free
- PFOS Free
- SVHC Free



## Contact Information

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

**Web:** [www.qorvo.com](http://www.qorvo.com)

**Tel:** 1-844-890-8163

**Email:** [customer.support@qorvo.com](mailto:customer.support@qorvo.com)

For technical questions and application information:

**Email:** [appsupport@qorvo.com](mailto:appsupport@qorvo.com)

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