# TQP9421

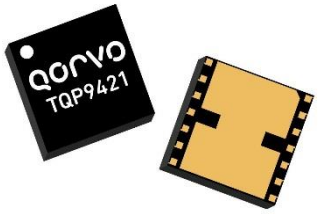
## High Linearity 0.5 W Small Cell PA

## Product Overview

The TQP9421 is a high-linearity two-stage power amplifier in a low-cost surface-mount package with on-chip bias control and temperature control circuits, suitable for small cell base station applications.

The TQP9421 provides 30 dB gain and +27 dBm linear power over the 2.11 – 2.17 GHz frequency range. This amplifier is able to achieve −50 dBc ACLR at +27 dBm output power using 20 MHz LTE signal.

The TQP9421 integrates two high performance amplifier stages onto a module to allow for a compact system design and requires very few external components for operation. The amplifier is bias adjustable allowing the amplifier's power consumption to be optimized. The TQP9421 is available in a 7 x 7 mm surface mount package.

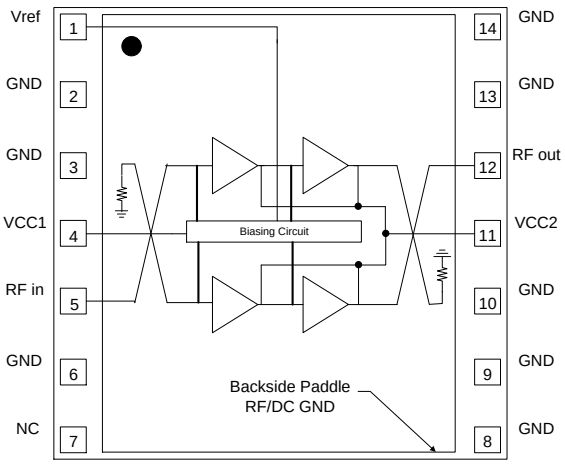



7 mm x 7 mm leadless SMT Package

## Key Features

- 2.11 – 2.17 GHz Frequency Range
- Fully integrated, 2 Stage Power Amplifier
- Internally Matched 50 Ω Input/Output
- −50 dBc ACLR at Pavg = +27 dBm
- 30 dB Gain
- 14.5% PAE at +27 dBm
- 420 mA Quiescent Current
- On-chip Control Bias and Temp. Comp Circuit

## Functional Block Diagram




Top View

## Applications

- Small Cell / Picocell
- Enterprise Femtocell
- Customer Premises Equipment (CPE)
- Data Cards and Terminals
- Distributed Antenna Systems (DAS)
- Booster Amps, Repeaters

## Ordering Information

| Part No. | Description |
|---|---|
| TQP9421 | High Linearity 0.5 W Small Cell PA |
| TQP9421-PCB | 2.11 – 2.17 GHz Evaluation board |

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

## Absolute Maximum Ratings

| Parameter | Rating |
|---|---|
| Storage Temperature | −55 to +150 °C |
| Supply Voltage ($V_{CC}$) | +6 V |
| $V_{ref}$ | +3.5 V |
| RF Input Power, CW, 50Ω, T=25˚C | +13 dBm |
| Tj at $T_{CASE}$ = 125°C | +205°C |

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

## Recommended Operating Conditions

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| $V_{CC1}$, $V_{cc2}$ | +3.6 | +4.5 | +5.25 | V |
| $V_{ref}$ | +2.75 | +2.85 | +2.95 | V |
| $T_{CASE}$ | −40 | | +85 | °C |
| Tj at $T_{CASE}$ max | | | +165 | °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: $V_{CC1}$ = $V_{CC2}$ = +4.5 V, Vref = +2.85 V, Temp= +25 °C

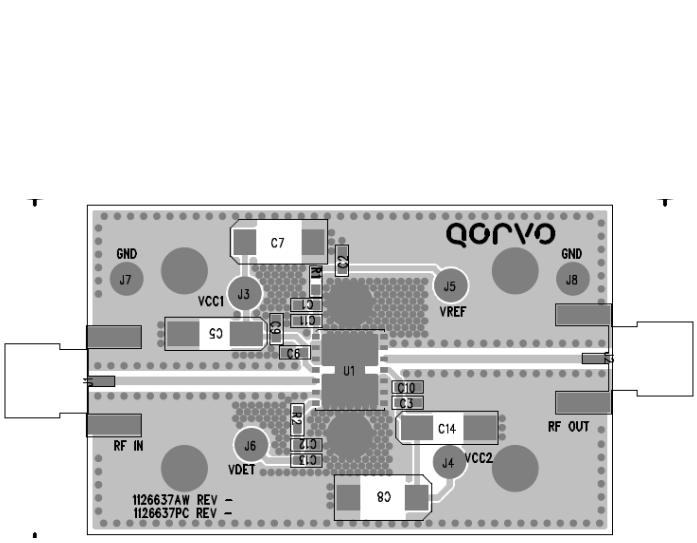
| Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Operational Frequency Range | | 2110 | | 2170 | MHz |
| Test Frequency | | | 2140 | | MHz |
| Gain | | 27 | 30 | 33 | dB |
| Input Return Loss | | 15 | 20 | | dB |
| Output Return Loss | | 15 | 25 | | dB |
| P1dB | | | +35.5 | | dBm |
| ACLR | $P_{OUT}$ = +27 dBm, 20 MHz LTE E-TM1.1, 9.5 dB PAR | | −50 | -47 | dBc |
| ACLR | $P_{OUT}$ = +27 dBm, 2X20 MHz LTE E-TM1.1, 9.5dB PAR | | -42 | | dBc |
| ACLR | $P_{OUT}$ = +27 dBm, 15 MHz LTE E-TM1.1, 9.5dB PAR | | -50 | | dBc |
| ACLR | $P_{OUT}$ = +27 dBm, 10 MHz LTE E-TM1.1, 9.5dB PAR | | -51 | | dBc |
| ACLR | $P_{OUT}$ = +27 dBm, 5 MHz LTE E-TM1.1, 9.5dB PAR | | -50 | | dBc |
| Power Added Efficiency | $P_{OUT}$ = +27 dBm, 20 MHz LTE E-TM1.1, 9.5 dB PAR | 13 | 14.5 | | % |
| Quiescent Current, $I_{CQ}$[1] | $V_{CC1}$ + $V_{CC2}$ | 330 | 420 | 510 | mA |
| Leakage Current | $V_{CC}$ = +4.5V, $V_{ref}$ = 0V | | 3 | 10 | µA |
| Reference Current , $I_{ref}$ | Temp = -40°C to +85°C, $V_{ref}$ = +2.85V | | 13 | 19.5 | mA |
| Operational Current, $I_{CC}$ | Pout = +27 dBm | | 680 | 920 | mA |
| Switching Speed | Rise time (10%-90%) | | 715 | | ns |
| | Fall time (90%-10%) | | 1370 | | ns |
| Spurious Output Level | Pout ≤ +27dBm, In & Out of band load VSWR ≤ 10:1 | | -60 | | dBc |
| VSWR survivability | No permanent degradation or failure | 10:1 | | | - |
| Harmonics | $2F_0$ (Pout = 27 dBm), CW signal | | -38 | -33 | dBc |
| | $3F_0$ (Pout = 27 dBm), CW signal | | -42 | -37 | dBc |
| | $4F_0$ (Pout = 27 dBm), CW signal | | -42 | -37 | dBc |
| Thermal Resistance, $\theta_{jc}$ | Module (junction to case) | | | 18.5 | °C/W |

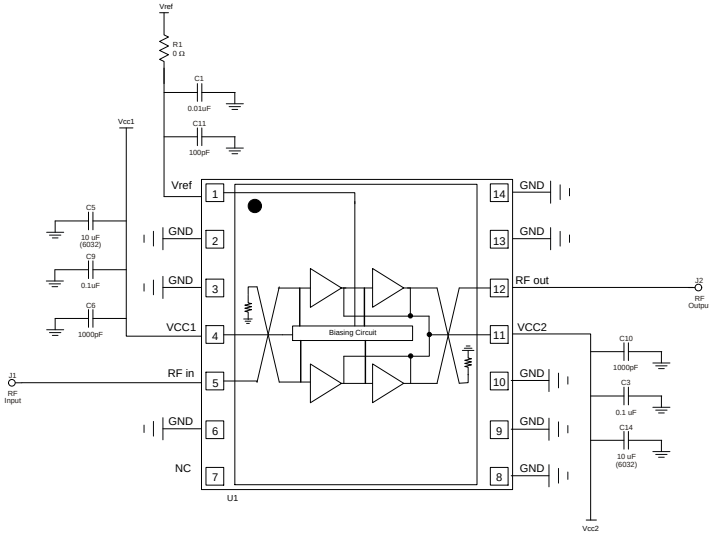
Notes:
1. Current through Vcc1 does not vary with power. Vcc1 provides the bias voltage to the current mirror circuit along with Vref to set the bias point for the whole amplifier.

| Parameter | Conditions | -40°C | +25°C | +85°C | Units |
|---|---|---|---|---|---|
| Gain | Small Signal | 31.5 | 30 | 28.7 | dB |
| ACLR | $P_{OUT}$ = +27 dBm, 20 MHz LTE E-TM1.1, 9.5dB PAR | -50 | -51 | -49.5 | dBc |
| PAE | $P_{OUT}$ = +27 dBm, 20 MHz LTE E-TM1.1, 9.5dB PAR | 15.5 | 14.5 | 13.5 | % |
| P1dB | | +36.1 | +35.5 | +34.2 | dBm |

Test Frequency = 2140MHz

## TQP9421 Application Circuit Schematic and Layout




## Bill of Material - TQP9421 Evaluation Board

| Ref Des | Value | Description | Manuf. | Part Number |
|---|---|---|---|---|
| n/a | n/a | Printed Circuit Board | Qorvo | |
| U1 | n/a | High Linearity 0.5 W Power Amplifier | Qorvo | TQP9421 |
| R1 | 0 Ω | Resistor, Chip, 0603, 5% | various | |
| C1 | 0.01 uF | Capacitor, Chip, 0603, 5% | various | |
| C11 | 100 pF | Capacitor, Chip, 0603, 5% | various | |
| C3, C9 | 0.1 uF | Capacitor, Chip, 0603, 5% | various | |
| C5, C14 | 10 uF | Capacitor , Chip, 6032, 10%, Tantalum | various | |
| C6, C10 | 1000 pF | Capacitor , Chip, 0603, NPO/COG, 5% | various | |

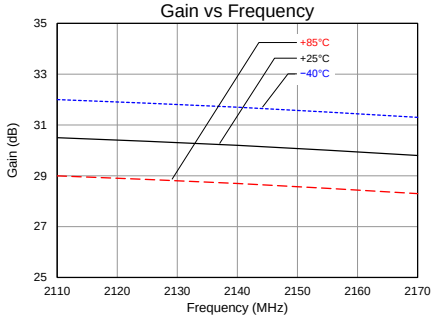
## Vcc1=Vcc2=4.5V, Pout=27dBm, Signal PAR=9.5dB

| LTE signal BW | 5MHz | 10MHz | 15MHz | 20MHz | 2X20MHz | Units |
|---|---|---|---|---|---|---|
| ACLR1-Low | -50.6 | -50.7 | -50.3 | -50.9 | -41.8 | dBc |
| ACLR1-high | -50.4 | -50.6 | -50.9 | -50.8 | -42.4 | dBc |

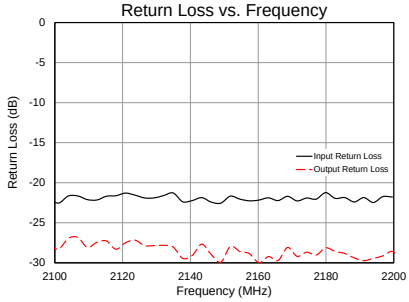
## Performance Plots

Test conditions unless otherwise noted: $V_{CC1}$ = $V_{CC2}$ = +4.5V, Vref = +2.85 V, LTE signal PAR = 9.5dB, Temp.= +25 °C

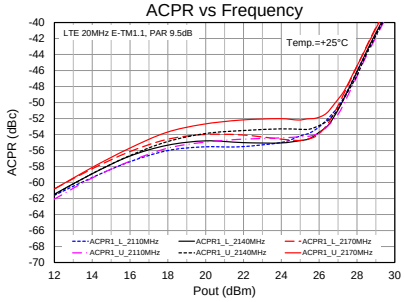
Gain vs Frequency



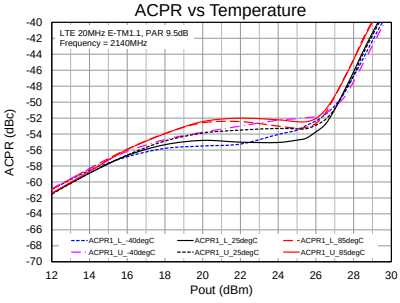

Return Loss vs. Frequency



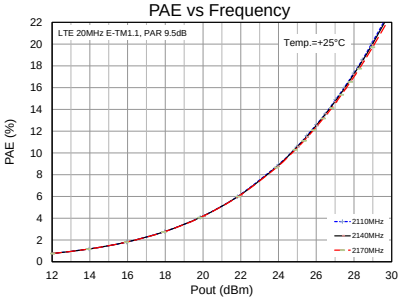

ACPR vs Frequency



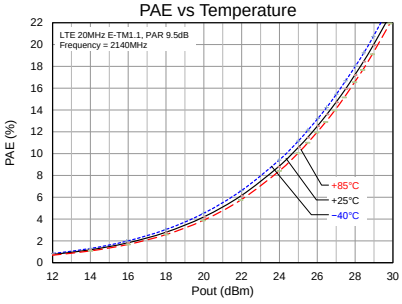

ACPR vs Temperature



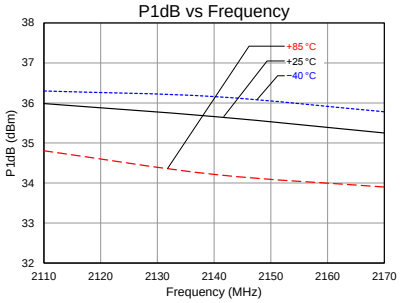

PAE vs Frequency



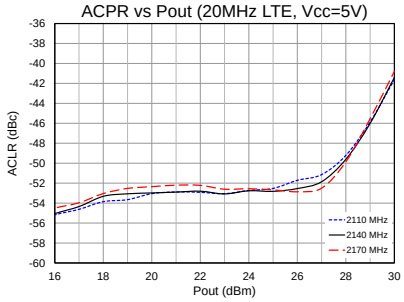

PAE vs Temperature



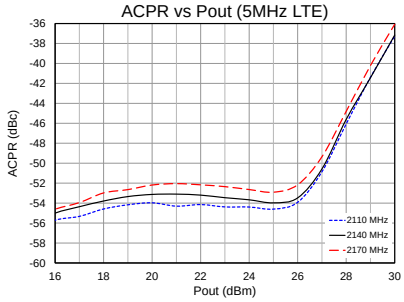

P1dB vs Frequency



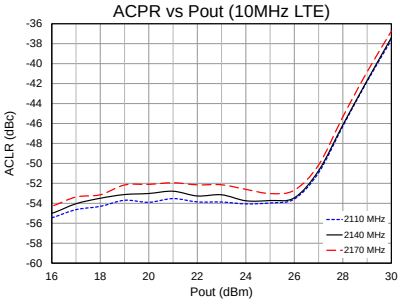

ACPR vs Pout (20MHz LTE, Vcc=5V)



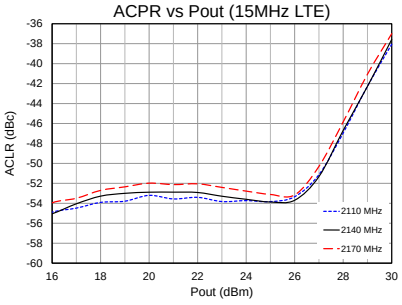

ACPR vs Pout (5MHz LTE)



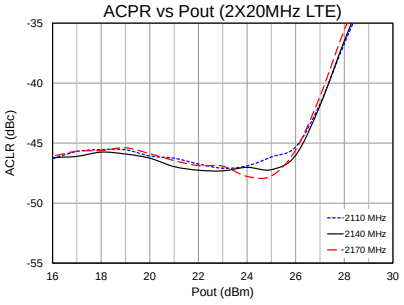

ACPR vs Pout (10MHz LTE)



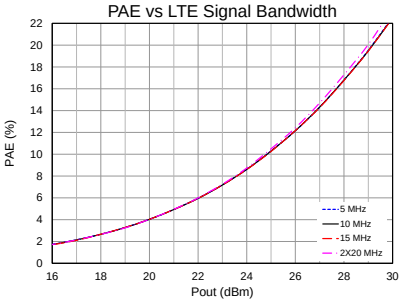

ACPR vs Pout (15MHz LTE)



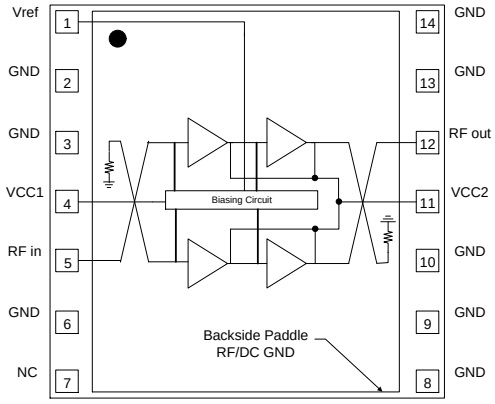

ACPR vs Pout (2X20MHz LTE)




PAE vs LTE Signal Bandwidth



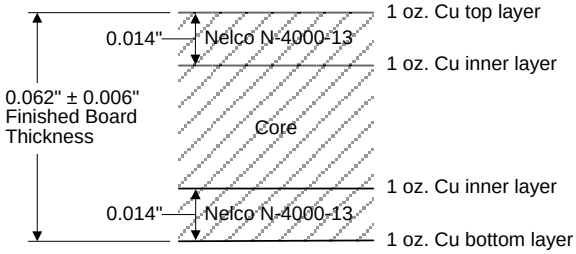
## Pin Configuration and Description



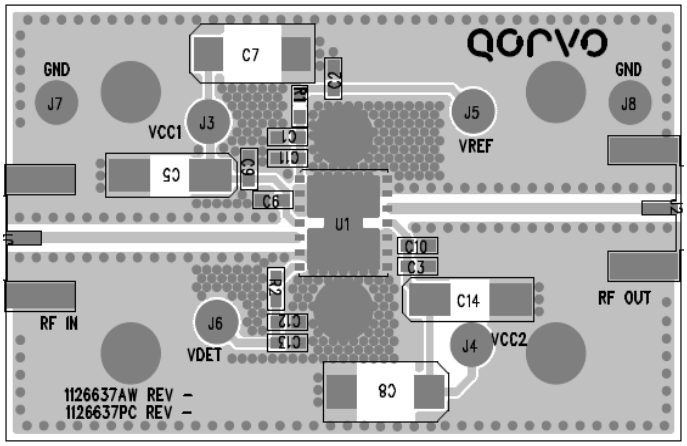

| Pin No. | Label | Description |
|---|---|---|
| 1 | Vref | Provides reference voltage for internal active biasing circuit |
| 2, 3, 6, 8, 9, 10, 13, 14 | GND | RF and DC ground. |
| 4 | VCC1 | Bias voltage for current mirror in combination with Vref to set the bias point. |
| 5 | RFin | RF input pin. The DC is internally blocked at this pin. |
| 7 | NC | No internal connection. Can be left open or grounded for mounting integrity. |
| 11 | VCC2 | Supply to all stages. |
| 12 | RFout | RF output pin. The DC is internally blocked at this pin. |
| Backside Paddle | RF/DC GND | RF/DC ground. See PCB Mounting Pattern for suggested footprint. |

## Evaluation Board PCB Information

Qorvo PCB 1126637 Material and Stack-up



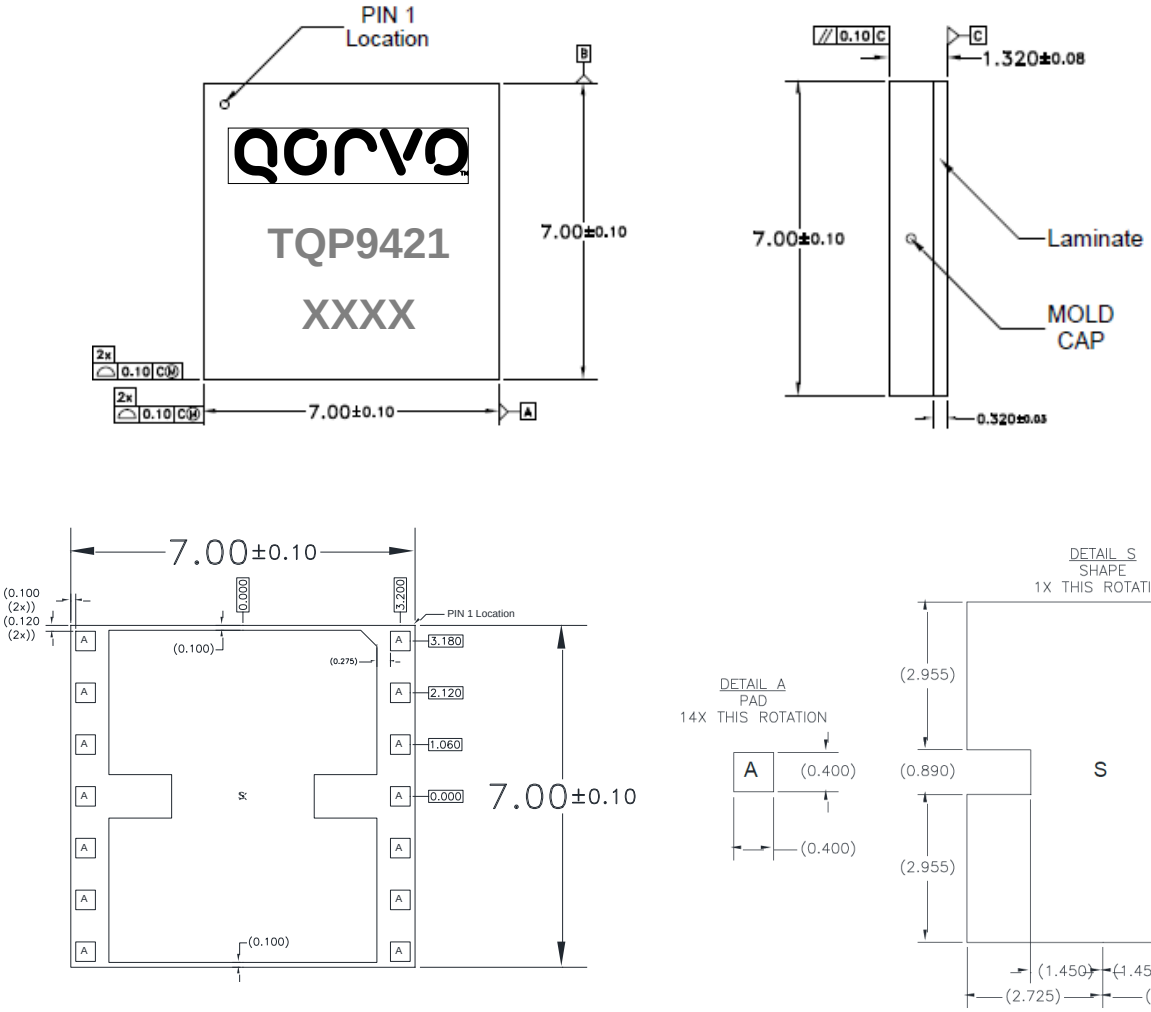

50 ohm line dimensions: width = .028”
spacing = .028”.



## Mechanical Information

### Package Marking and Dimensions

Marking: Part number – TQP9421
Trace code – XXXX

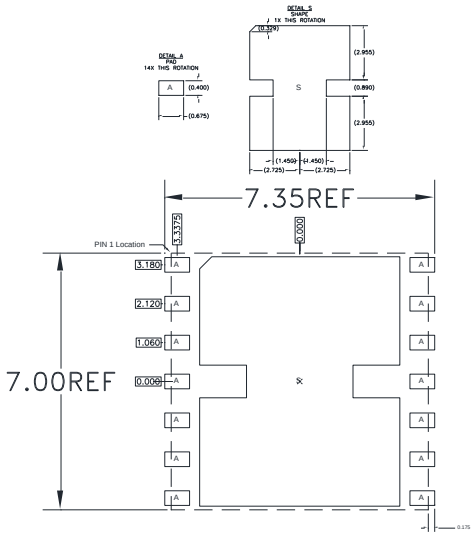



Notes:

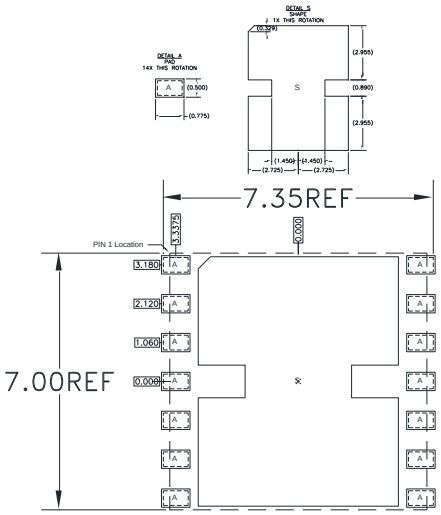
1. All dimensions are in millimeters. Angles are in degrees.
2. Dimension and tolerance formats conform to ASME Y14.4M-1994.
3. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.

## PCB Mounting Pattern

Recommend PCB land-pad pattern metallization (Top View)




RECOMMENDED
LAND PATTERN




RECOMMENDED
LAND PATTERN MASK

Notes:

1. A heat sink underneath the area of the PCB for the mounted device is strictly required for proper thermal operation. Damage to the device can occur without the use of one.
2. 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”).
3. Add as much copper as possible to inner and outer layers near the part to ensure optimal thermal performance.

## Handling Precautions

| Parameter | Rating | Standard |
|---|---|---|
| ESD – Human Body Model (HBM) | Class 2 | ESDA / JEDEC JS-001-2012 |
| ESD – Charged Device Model (CDM) | Class C3 | JEDEC JESD22-C101F |
| MSL – Moisture Sensitivity Level | Level 3 | 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: Electrolytic plated Au over Ni

## RoHS Compliance

This part is compliant with the 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:

- Product uses RoHS Exemption 7c-I to meet RoHS Compliance requirements.
- 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:

**Web:** www.qorvo.com

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

**Email:** customer.support@qorvo.com

For technical questions and application information:

**Email:** appsupport@qorvo.com

## Important Notice

The information contained herein is believed to be reliable; however, Qorvo makes no warranties regarding the information contained herein and assumes no responsibility or liability whatsoever for the use of the information contained herein. All information contained herein is subject to change without notice. Customers should obtain and verify the latest relevant information before placing orders for Qorvo 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. **THIS INFORMATION DOES NOT CONSTITUTE A WARRANTY WITH RESPECT TO THE PRODUCTS DESCRIBED HEREIN, AND QORVO HEREBY DISCLAIMS ANY AND ALL WARRANTIES WITH RESPECT TO SUCH PRODUCTS WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

Without limiting the generality of the foregoing, Qorvo 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.

# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Qorvo:
TQP9421