

Product Overview

The QPA9421 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 QPA9421 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 QPA9421 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 QPA9421 is available in a 7 x 7 mm surface mount package.

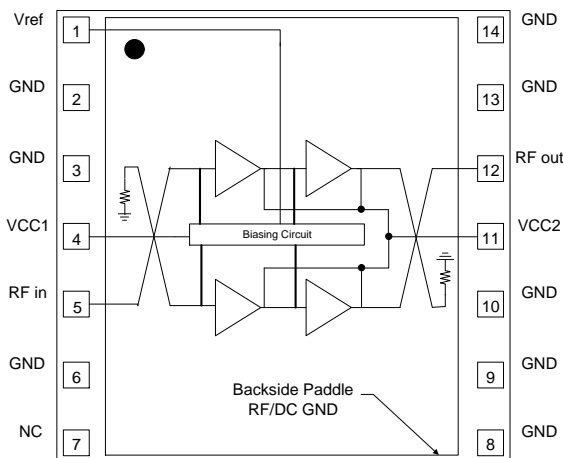


7 mm x 7 mm Leadless SMT Package

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 $P_{avg} = +27$ dBm
- 30 dB Gain
- 14% 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 |
|---------------|----------------------------------|
| QPA9421TR13 | 2500 pieces on a 13" reel |
| QPA9421EVB-01 | 2.11 – 2.17 GHz Evaluation board |

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 |
| T _j 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 |
| T _j 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

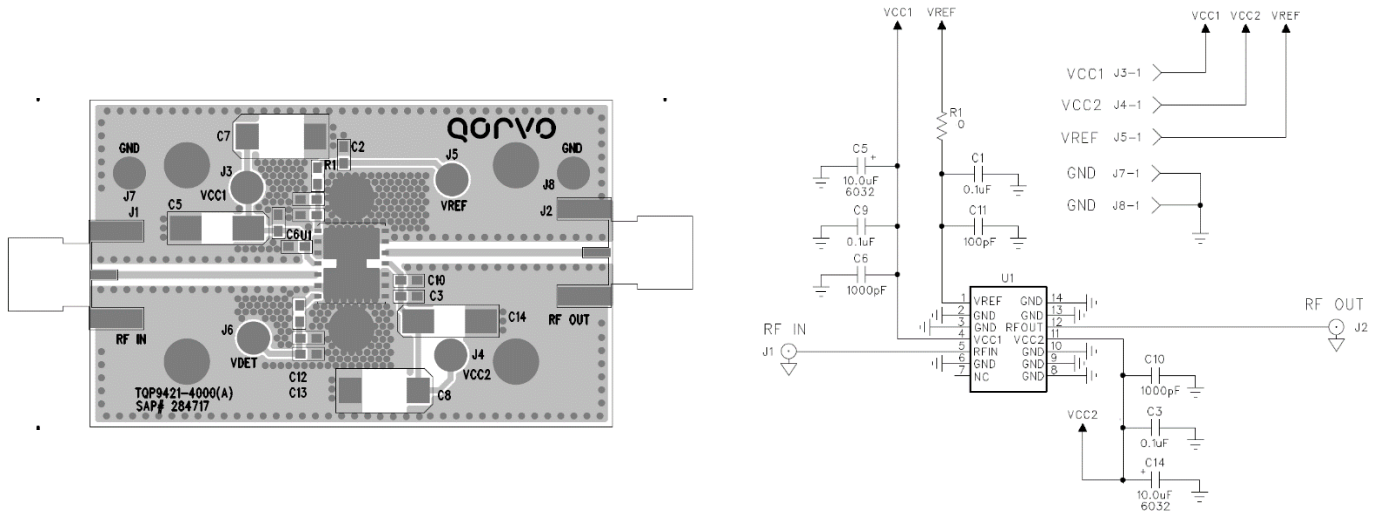
Test conditions unless otherwise noted: V_{CC1} = V_{CC2} = +4.5V, V_{ref} = +2.85V, Temp = +25°C

| Parameter | Conditions | Min | Typ | Max | Units |
|--------------------------------------|--|------|-------|------|-------|
| Operational Frequency Range | | 2110 | | 2170 | MHz |
| Test Frequency | | | 2140 | | MHz |
| Gain | | 27 | 29.6 | 33 | dB |
| Input Return Loss | CW, Small Signal | 15 | 21 | | dB |
| Output Return Loss | | 15 | 25 | | dB |
| P1dB | CW | | +35.5 | | dBm |
| ACLR | P _{OUT} +27 dBm, 20 MHz LTE E-TM1.1, 9.5 dB PAR | | -50 | -47 | dBc |
| | P _{OUT} +27 dBm, 20 MHz x 2 LTE E-TM1.1, 9.5dB PAR | | -46 | | dBc |
| | P _{OUT} +27 dBm, 15 MHz LTE E-TM1.1, 9.5dB PAR | | -50 | | dBc |
| | P _{OUT} +27 dBm, 10 MHz LTE E-TM1.1, 9.5dB PAR | | -49 | | dBc |
| | P _{OUT} +27 dBm, 5 MHz LTE E-TM1.1, 9.5dB PAR | | -49 | | dBc |
| Power Added Efficiency | P _{OUT} +27 dBm, 20 MHz LTE E-TM1.1, 9.5 dB PAR | 13 | 14 | | % |
| Quiescent Current, I _{CC1} | V _{CC1} + V _{CC2} | 330 | 420 | 510 | mA |
| Leakage Current on V _{CC} | 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} | P _{OUT} +27 dBm, 20 MHz LTE E-TM1.1, 9.5 dB PAR | | 680 | 920 | mA |
| Wake Up Time | 50% of control signal to 90% of the RF output | | 715 | | ns |
| Power Down Time | 50% of control signal to 10% of the RF output | | 1370 | | ns |
| Spurious Output Level | P _{OUT} ≤ +27dBm, In & Out of band load VSWR ≤ 10:1 | | -60 | | dBc |
| VSWR survivability | No permanent degradation or failure | 10:1 | | | - |
| Harmonics | 2F ₀ (P _{OUT} +27 dBm), CW signal | | -39 | -33 | dBc |
| | 3F ₀ (P _{OUT} +27 dBm), CW signal | | -48 | -37 | dBc |
| | 4F ₀ (P _{OUT} +27 dBm), CW signal | | -64 | -37 | dBc |
| Thermal Resistance, θ _{jc} | Module (junction to case) | | | 18.5 | °C/W |

Notes:

- V_{CC1} draws very little current and provides the bias voltage to the current mirror circuit along with V_{ref} to set the bias point for the whole amplifier.
- Control signal applied to V_{ref} Pin, 0 to 2.85V

QPA9421 Application Circuit Schematic and Layout



Bill of Material - QPA9421EVb-01

| Ref Designation | Value | Description | Manufacture | Part Number |
|-----------------|---------|---------------------------------------|-------------|-------------|
| - | - | Printed Circuit Board | Qorvo | |
| U1 | - | Amplifier, High Linearity 0.5 W Power | Qorvo | QPA9421 |
| R1 | 0 Ω | Resistor, Chip, 0603, 5% | various | |
| C1 | 0.01 µF | Capacitor, Chip, 0603, 5% | various | |
| C11 | 100 pF | Capacitor, Chip, 0603, 5% | various | |
| C3, C9 | 0.1 µF | Capacitor, Chip, 0603, 5% | various | |
| C5, C14 | 10 µF | Capacitor, Chip, 6032, 10%, Tantalum | various | |
| C6, C10 | 1000 pF | Capacitor, Chip, 0603, 5%, NPO/C0G | various | |

QPA9421EVb-01 Typical Performances

Test conditions unless otherwise noted: $V_{CC1} = V_{CC2} = +4.5V$, $V_{ref} = +2.85V$, $P_{out} 27dBm$, 2140MHz, Signal PAR 9.5dB, Temp= +25 °C

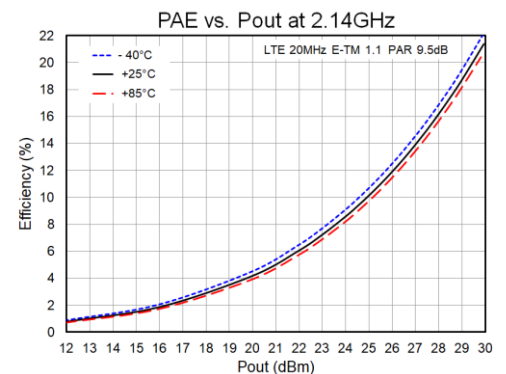
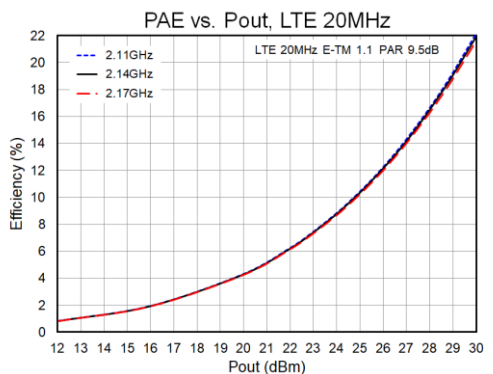
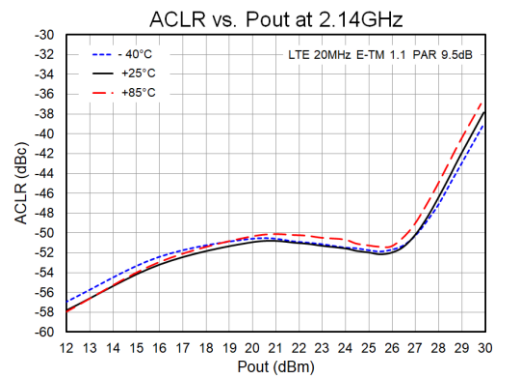
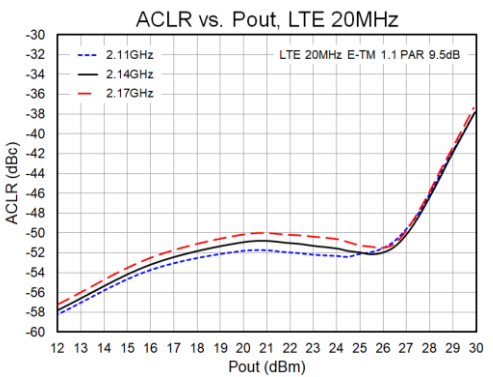
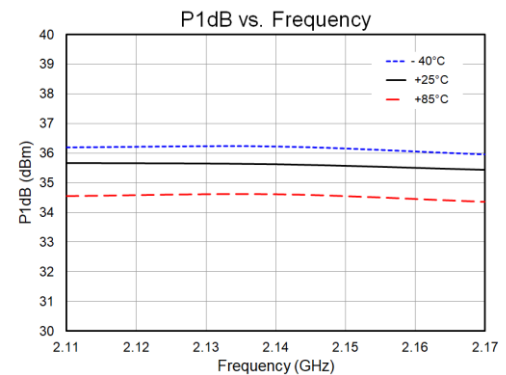
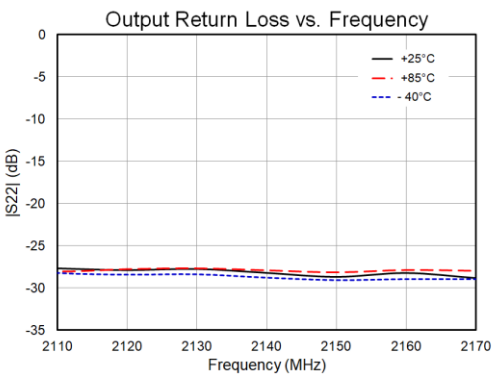
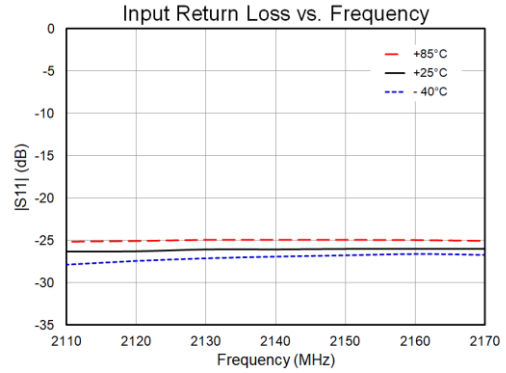
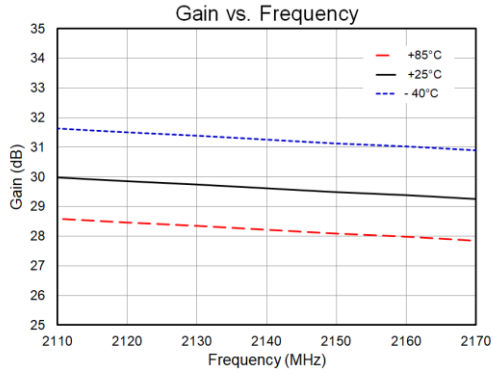
| LTE Signal BW | 5MHz | 10MHz | 15MHz | 20MHz | 20MHz x 2 | Units |
|---------------|-------|-------|-------|-------|-----------|-------|
| ACLR1-Low | -49.9 | -49.3 | -50.2 | -50.0 | -46.5 | dBc |
| ACLR1-high | -49.9 | -50.3 | -50.5 | -50.7 | -48.1 | dBc |

| Parameter | Conditions | -40°C | +25°C | +85°C | Units |
|-----------|---|-------|-------|-------|-------|
| Gain | | 30.9 | 29.0 | 27.6 | dB |
| ACLR | $P_{OUT} = +27 dBm$, 20 MHz LTE E-TM1.1, 9.5dB PAR | -50.3 | -50.0 | -49.2 | dBc |
| PAE | | 14.5 | 14.1 | 13.3 | % |
| P1dB | CW | +35.8 | +35.5 | +34.3 | dBm |

Test Frequency = 2140MHz

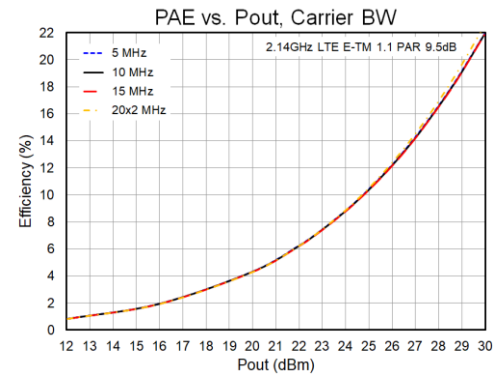
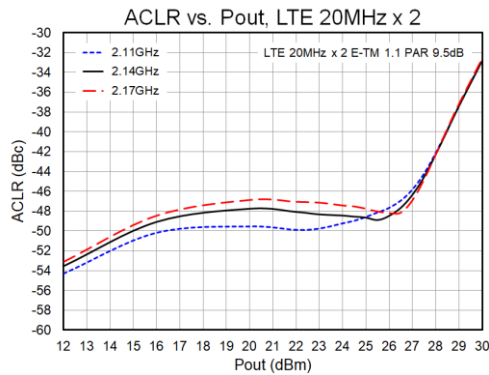
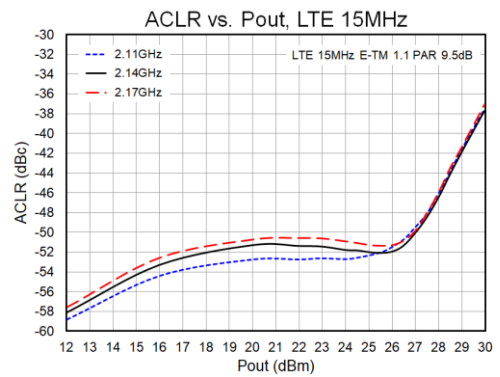
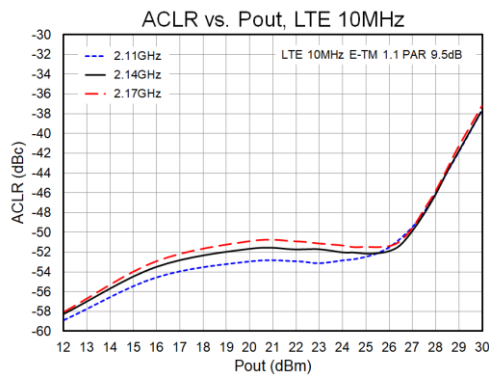
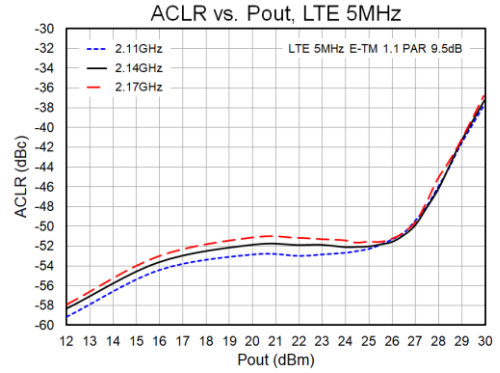
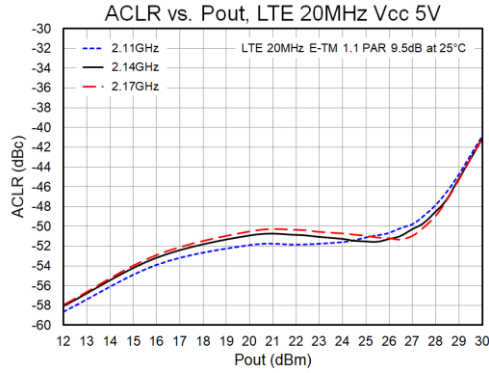
Performance Plots

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

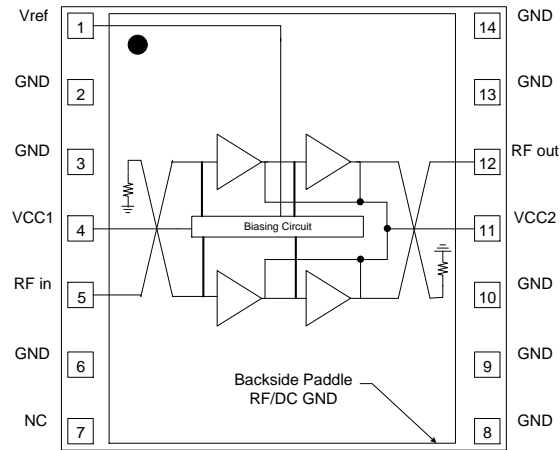


Performance Plots (continue)

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



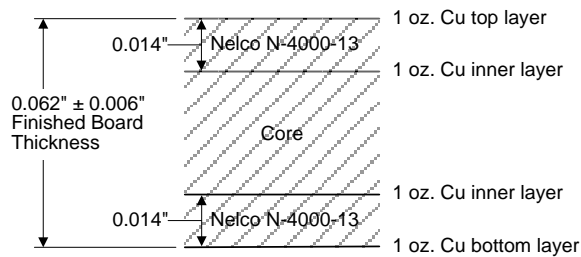
Pin Configuration and Description



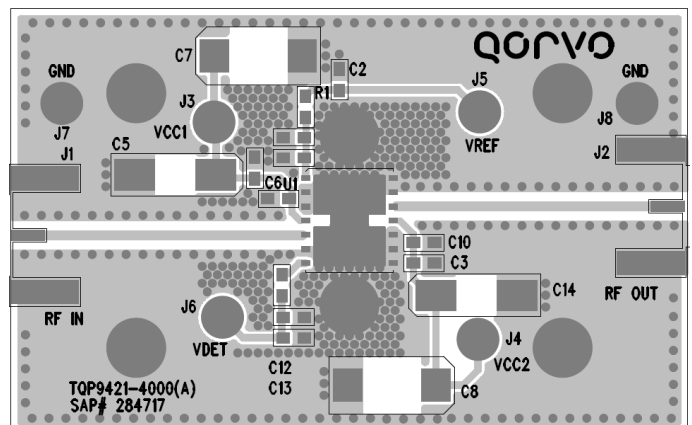
| Pin No. | Label | Description |
|---------------------------|-----------|---|
| 1 | Vref | Provides reference voltage for internal active biasing circuit |
| 2, 3, 6, 8, 9, 10, 13, 14 | GND | RF and DC ground. |
| 4 | VCC1 | Bias voltage for current mirror in combination with Vref to set the bias point. |
| 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 284717 Material and Stack-up



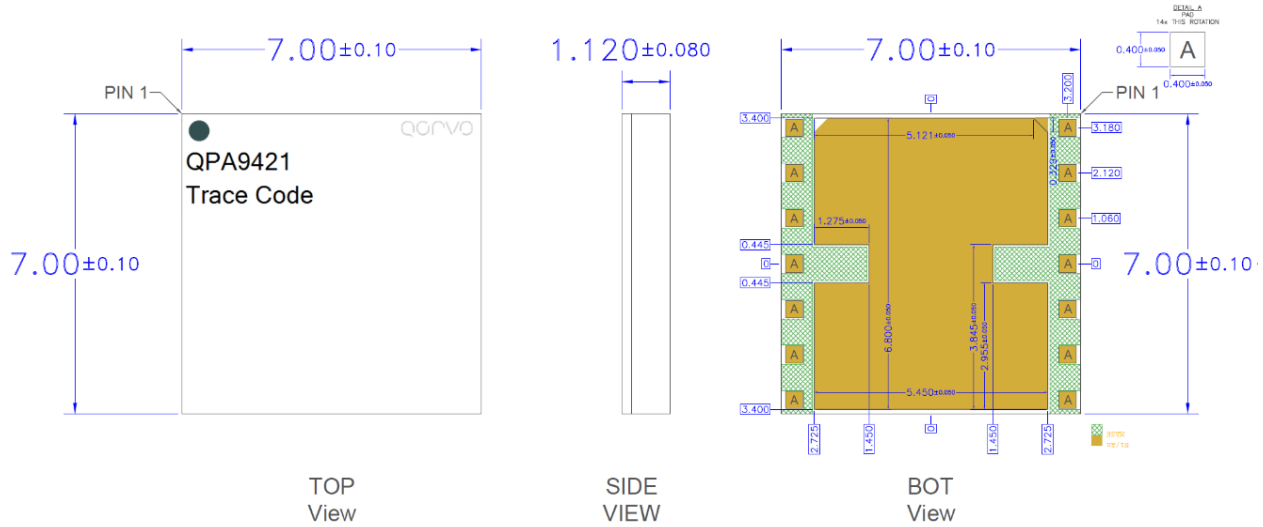
50 ohm line dimensions: width = .028"
spacing = .028".



Mechanical Information

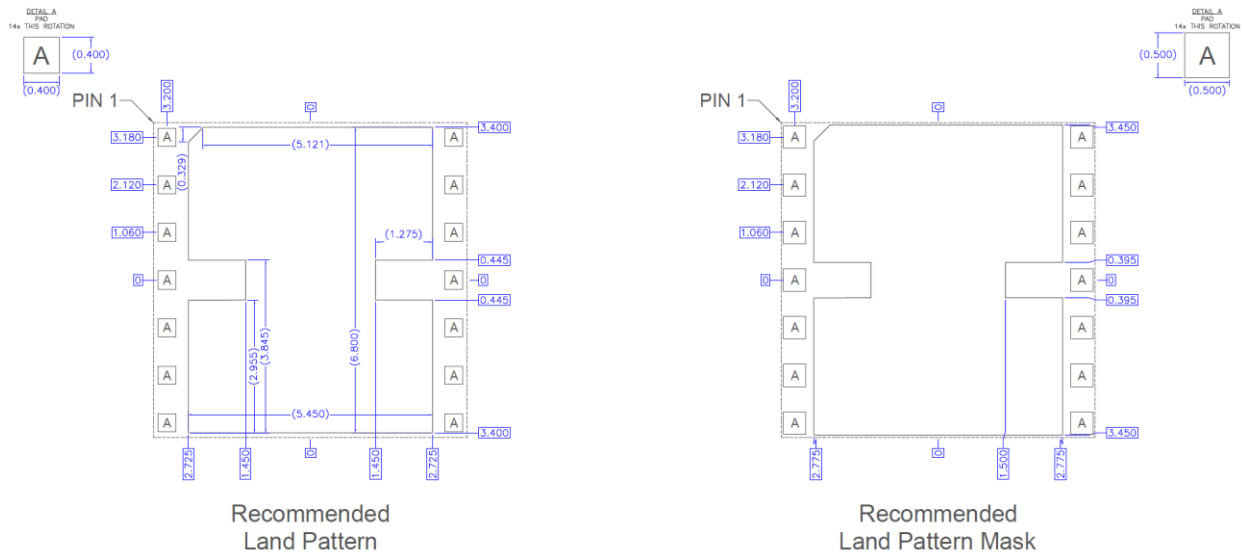
Package Marking and Dimensions

Marking: Part number – QPA9421
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.

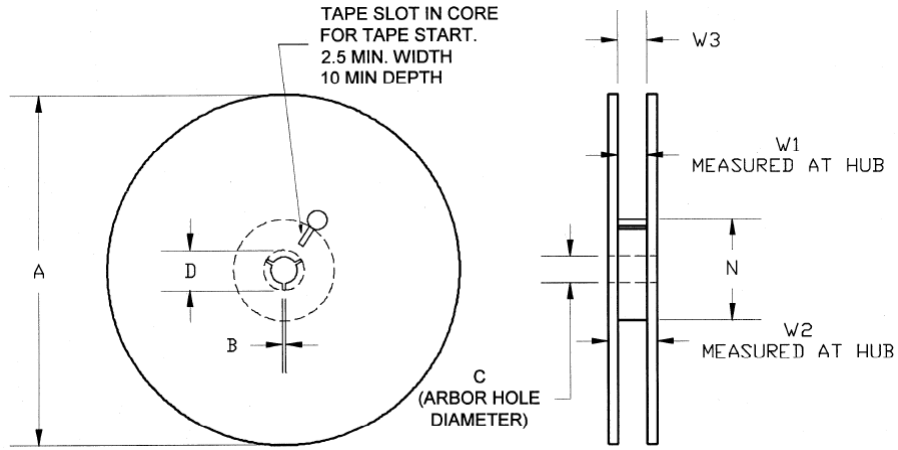
PCB Mounting Pattern



- 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 via holes are critical for the proper performance of this device. Via holes 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.

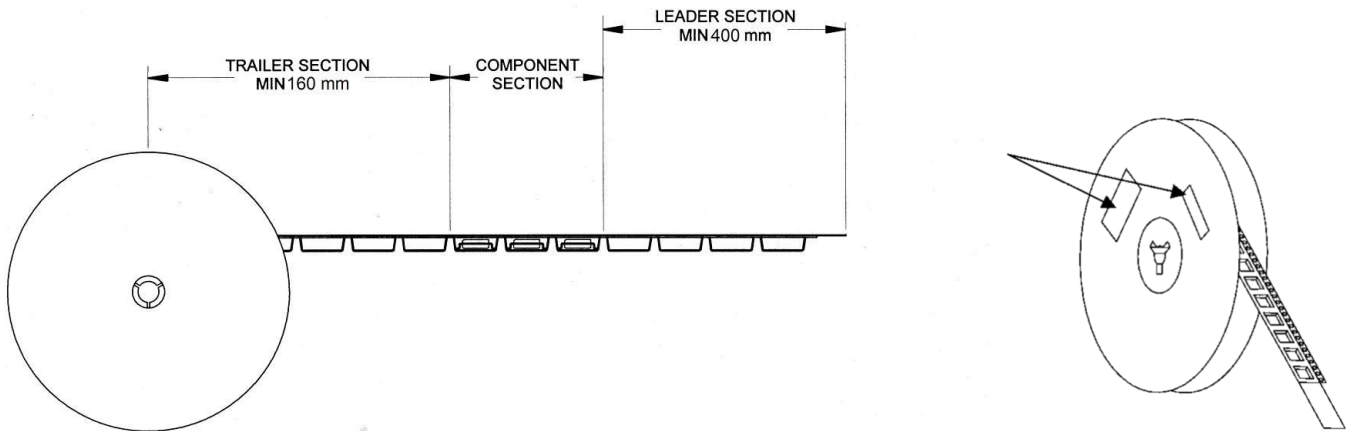
Tape and Reel Information – Reel Dimensions (13”)

Standard T/R size = 2,500 pieces on a 13” reel.



| Feature | Measure | Symbol | Size (in) | Size (mm) |
|---------|----------------------|--------|-----------|-----------|
| Flange | Diameter | A | 12.992 | 330.0 |
| | Thickness | W2 | 0.874 | 22.2 |
| | Space Between Flange | W1 | 0.661 | 16.8 |
| Hub | Outer Diameter | N | 4.016 | 102.0 |
| | 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 | 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 (*Plating thickness: Ni 5.0±30µm, Au 0.10µm minimum*)

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 (C₁₅H₁₂Br₄O₂) 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

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