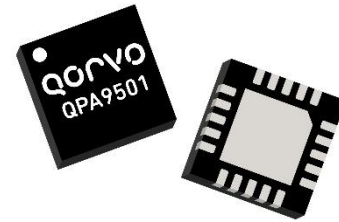


### General Description

The QPA9501 is high power amplifier module containing an internally matched 3-stage PA, compensated DC biasing circuit and output power detector. This PA module is optimized for the WiFi bands from 5.1-5.9GHz and hence well suited for LTE-U/LAA applications. It provides high gain (32 dB) and -47dBc ACLR at Pout of 22dBm with a 20MHz LTE signal without any DPD.

The QPA9501 features chipset logic compatible control voltages and buffered PA enable pin (PAEN) all of which draw very low current to facilitate ease of use and compatibility with current and future transceiver generations. With its optimized power dissipation, this amplifier module is well suited for implementation into next generation MIMO configurations and well designed to work with or without digital pre-distortion (DPD).

The QPA9501 is assembled in a small footprint 4.0 x 4.0 x 0.85 mm 20-pin QFN package.

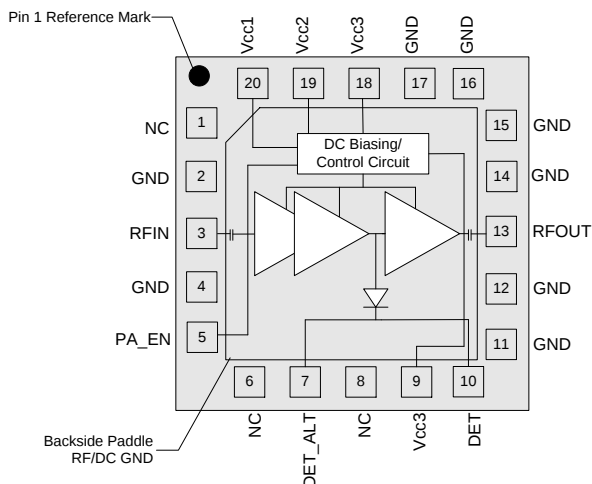


4 x 4 mm 20-pin Leadless QFN Package

### Product Features

- 4.9 GHz to 5.9 GHz Operational Bandwidth
- Fully Integrated Power Amplifier Module With Power Detector
- Internally Matched Input / Output
- -47dBc ACLR with Pout = 22dBm avg
- Temperature Compensated Bias Network
- High Gain = 32 dB
- Integrated CMOS Compatible Logic and Shutdown
- Supply Voltage: +3.3 V to +5.0 V
- Leadless 4.0 x 4.0 x 0.85 mm Pb-Free QFN Package

### Functional Block Diagram



Top View

### Applications

- 5G, Pre-5G Small Cell BTS
- LTE-U/LAA
- WiFi Access Points and Small Cells
- Telematics
- Point-to-point and Backhaul
- ISM Band

### Ordering Information

| Part No.      | Description                           |
|---------------|---------------------------------------|
| QPA9501TR13   | 2,500 pieces on a 13" reel (standard) |
| QPA9501PCB401 | Evaluation Board                      |

### Absolute Maximum Ratings

| Parameter                           | Rating        |
|-------------------------------------|---------------|
| Storage Temperature                 | -40 to 150 °C |
| RF Input Power, CW, 50 Ω, T = 25 °C | +5 dBm        |
| Device Voltage                      | +6.0 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 |
|--------------------------------------------------------|-------|-----|------|-------|
| V <sub>CC1</sub> , V <sub>CC2</sub> , V <sub>CC3</sub> | +3.15 | +5  | +5.5 | V     |
| T <sub>AMB</sub>                                       | -40   | 25  | +105 | °C    |
| T <sub>j</sub> (for >10 <sup>6</sup> hours MTTF)       |       |     | 170  | °C    |

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

### Electrical Specifications

| Parameter                             | Conditions <sup>(1)</sup>                             | Min                                                       | Typ   | Max              | Units |
|---------------------------------------|-------------------------------------------------------|-----------------------------------------------------------|-------|------------------|-------|
| Operational Freq. Range               |                                                       | 4900                                                      |       | 5900             | MHz   |
| Small Signal Gain                     | 4900 MHz                                              |                                                           | 33.6  |                  | dB    |
|                                       | 5200 MHz                                              | 30                                                        | 34    | 36               | dB    |
|                                       | 5800 MHz                                              | 29.5                                                      | 32    | 36               | dB    |
| Input Return Loss                     | 5800 MHz                                              |                                                           | 10    |                  | dB    |
| Output Return Loss                    |                                                       |                                                           | 8     |                  | dB    |
| Power Added Efficiency <sup>(2)</sup> | 4900 MHz                                              |                                                           | 6.0   |                  | %     |
|                                       | 5200 MHz                                              | 5.5                                                       | 6.2   |                  | %     |
|                                       | 5800 MHz                                              | 5.5                                                       | 6.5   |                  | %     |
| ACLR <sup>(2)</sup>                   | 4900 MHz                                              |                                                           | -46   |                  | dBc   |
|                                       | 5200 MHz                                              |                                                           | -47   | -45              | dBc   |
|                                       | 5800 MHz                                              |                                                           | -48   | -45              | dBc   |
| P1dB                                  | 4900 MHz                                              |                                                           | +31.1 |                  | dBm   |
|                                       | 5200 MHz                                              | +29.5                                                     | +31.8 |                  | dBm   |
|                                       | 5800 MHz                                              | +29.5                                                     | +33   |                  | dBm   |
| Noise Figure                          |                                                       |                                                           | 7     |                  | dB    |
| Rise/Fall Time                        |                                                       |                                                           | 0.4   | 0.8              | us    |
| PA Enable Voltage                     | Input Voltage for High State                          | +1.8                                                      | +3.0  | V <sub>CC1</sub> | V     |
|                                       | Input Voltage for Low State                           | 0                                                         |       | +0.45            |       |
| PA Enable Current                     |                                                       |                                                           |       | 100              | μA    |
| I <sub>cq</sub>                       | Total current with no RF                              | 250                                                       | 350   | 450              | mA    |
| I <sub>cc</sub>                       | Operating current with P <sub>out</sub> = 22dBm       | 450                                                       | 520   | 650              | mA    |
| TX Shut Down Current                  | PA_EN= Low, No RF                                     |                                                           | 8     |                  | μA    |
| Detector Voltage                      | No RF                                                 | +0.25                                                     | +0.35 | +0.38            | V     |
|                                       | P <sub>out</sub> = +22 dBm                            |                                                           | +0.68 |                  |       |
| Stability                             | P <sub>out</sub> = +28 dBm,<br>VSWR = 6:1, all phases | All non-harmonically related<br>outputs < -50 dBc/100 kHz |       |                  | -     |
| Thermal Resistance, θ <sub>jc</sub>   | Junction to backside paddle                           |                                                           | 17    |                  | °C/W  |

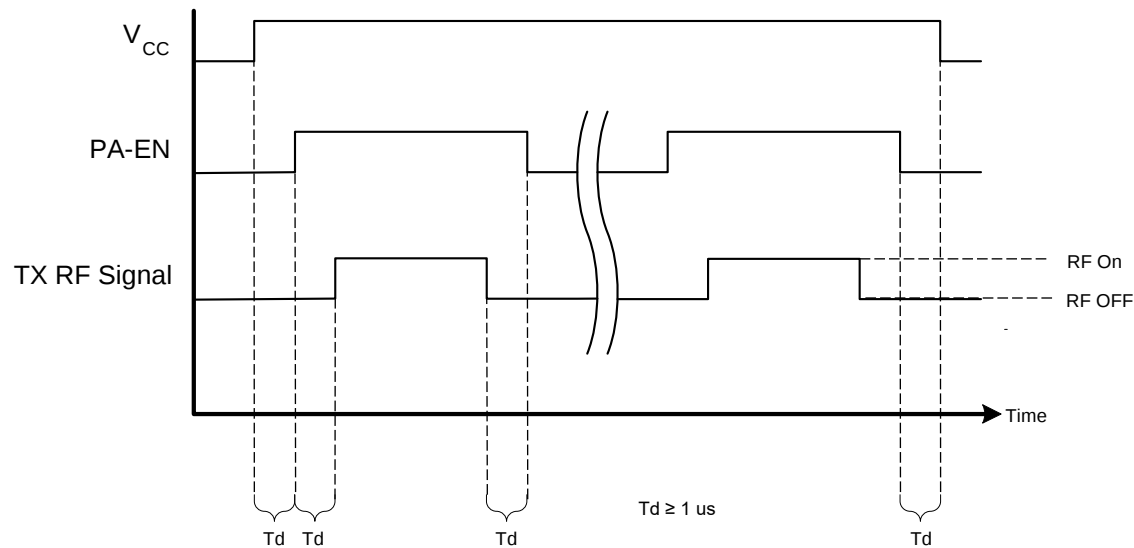
#### Notes:

- Test conditions unless otherwise noted: V<sub>CC1</sub>=V<sub>CC2</sub>=V<sub>CC3</sub> = +5.0 V, PA Enable High = 3.0 V. Temp. = +25 °C
- P<sub>out</sub> = 22dBm average, 20MHz LTE, PAR 9.5dB

## Timing Diagram

## Transmit Timing Diagram

## RF/DC Power On/Off Sequence



Notes: DC and RF signal levels per data sheet specification.

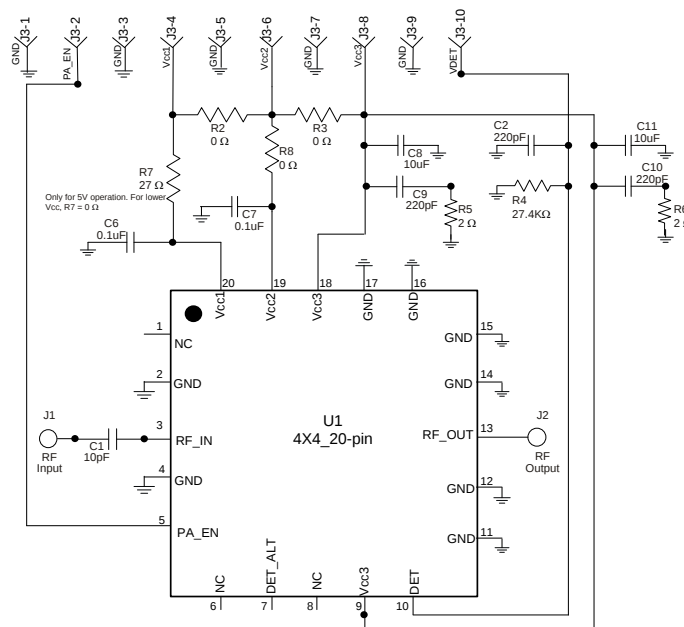
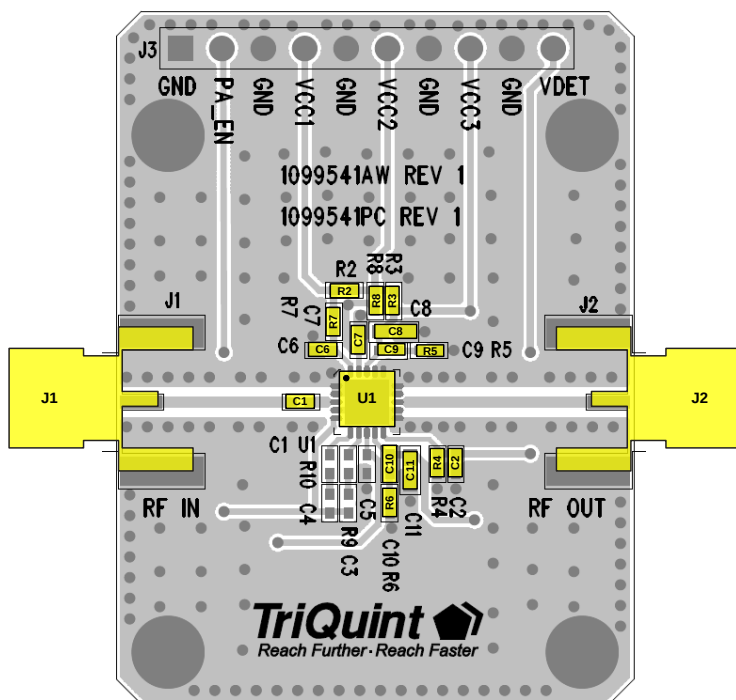
Observe the timing sequence shown in the diagram above and described below.

- Apply  $V_{CC}$  prior to turning on or pulsing PA enable.
- Turn off PA enable prior to turning off  $V_{CC}$ .
- Turn on PA enable prior to applying RF signal.
- Turn off RF signal prior to turning off PA enable.

## Logic Truth Table

| PA Mode  | PA_EN |
|----------|-------|
| Disabled | Low   |
| Enabled  | High  |

### Evaluation Board

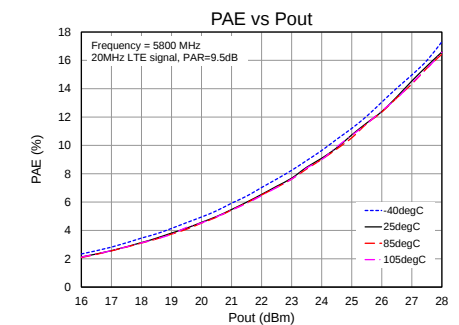
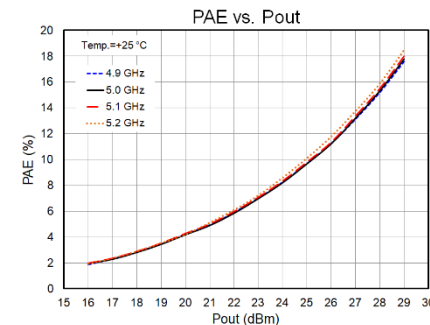
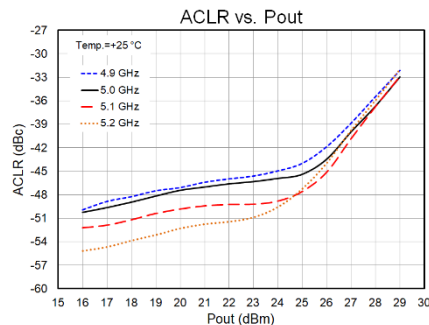
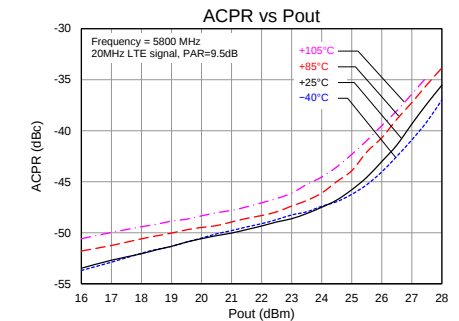
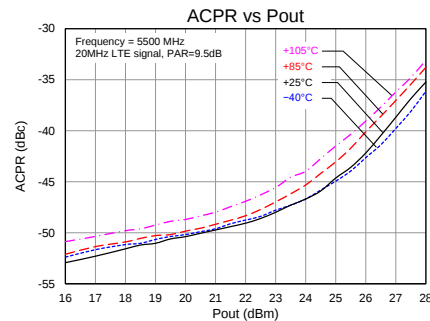
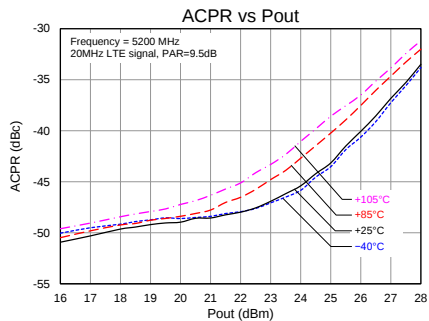
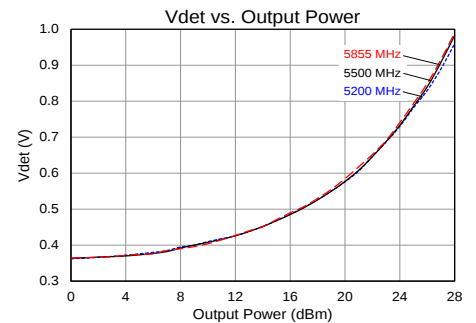
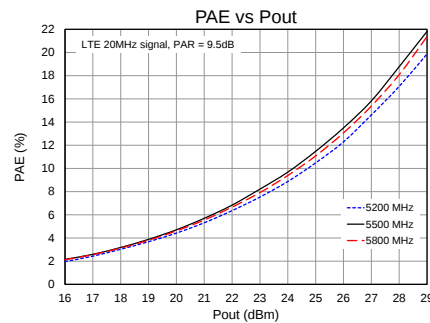
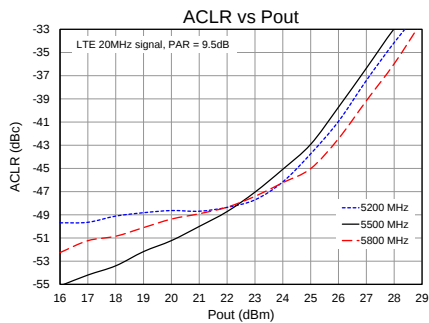
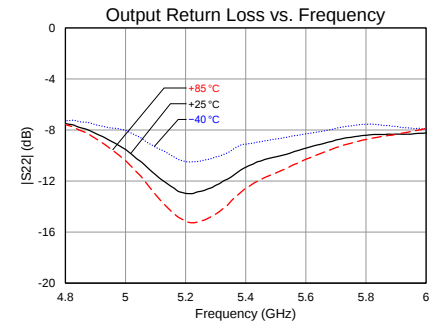
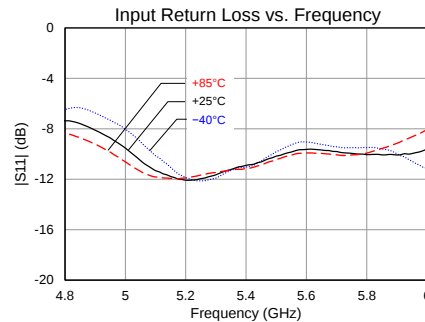
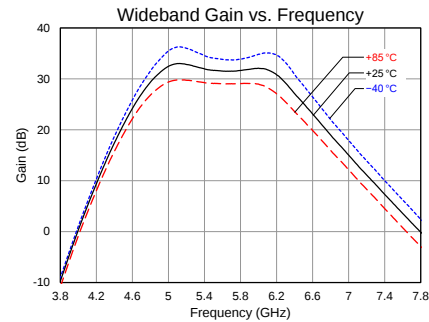


### Bill of Material – QPA9501PCB401

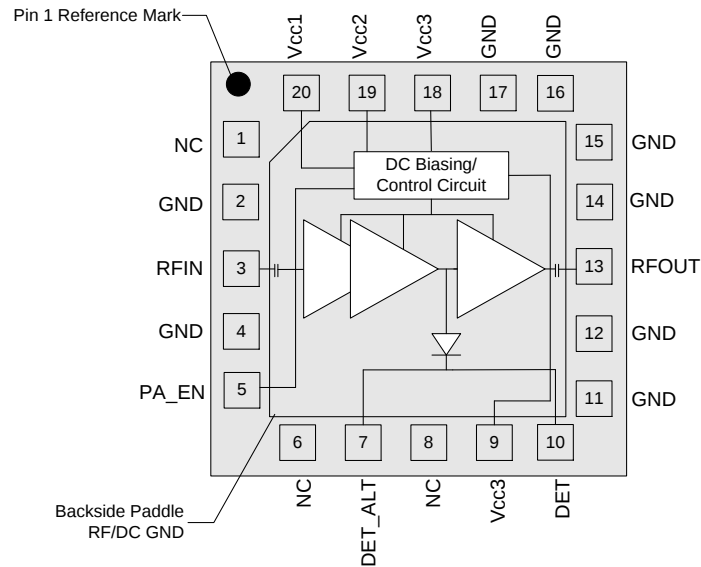
| Reference Des.        | Value            | Description                     | Manuf.  | Part Number |
|-----------------------|------------------|---------------------------------|---------|-------------|
| n/a                   | n/a              | Printed Circuit Board           | Qorvo   | 1099541     |
| U1                    | n/a              | High Power 5GHz PA              | Qorvo   | QPA9501     |
| R2, R8, R3            | 0 $\Omega$       | Resistor, Chip, 0402, 5%        | various |             |
| C1                    | 10 pF            | Capacitor, Chip, 0402, 5%       | various |             |
| C6, C7                | 0.1 uF           | Capacitor, Chip, 0402, 10%      | various |             |
| C8, C11               | 10 uF            | Capacitor, Chip, 0402, 10%      | various |             |
| C9, C10, C2           | 220 pF           | Capacitor, Chip, 0402, 10%      | various |             |
| R7 <sup>(1)</sup>     | 0 to 27 $\Omega$ | Resistor, Chip, 0402, 5%, 1/10W | various |             |
| R5, R6 <sup>(2)</sup> | 2 $\Omega$       | Resistor, Chip, 0402, 5%, 1/16W | various |             |
| R4                    | 27.4 K $\Omega$  | Resistor, Chip, 0402, 5%, 1/16W | various |             |

### Performance Plots

$V_{CC1}=V_{CC2}=V_{CC3}=+5.0\text{ V}$ ,  $PA\_EN=+3.0\text{ V}$ , Temp. =  $+25^\circ\text{C}$

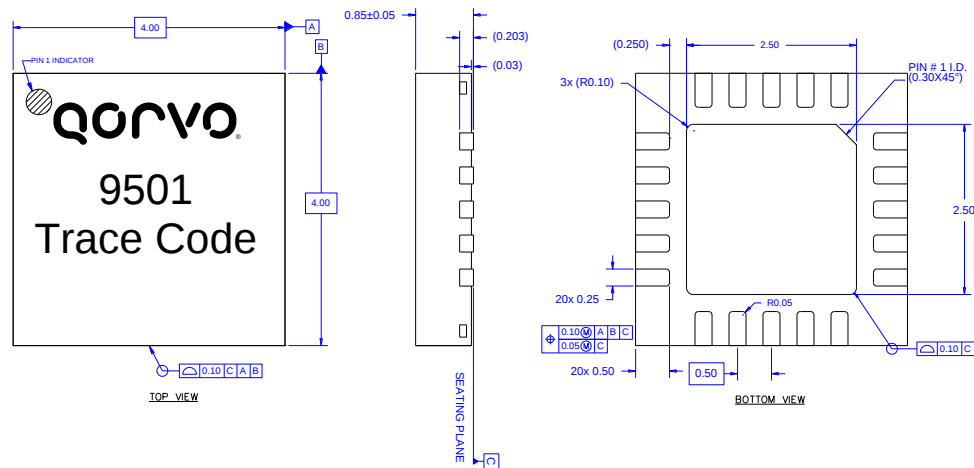


### Pin Configuration and Description



| Pin No.         | Label     | Description                                                                                                                                |
|-----------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 1               | NC        | No internal connection. This pin can be grounded or N/C on PCB.                                                                            |
| 2               | GND       | Ground                                                                                                                                     |
| 3               | RF_IN     | RF Input                                                                                                                                   |
| 4               | GND       | Ground                                                                                                                                     |
| 5               | PA_EN     | PA Enable                                                                                                                                  |
| 6               | NC        | No internal connection. This pin can be grounded or N/C on PCB.                                                                            |
| 7               | DET_ALT   | Alternate Detector Output                                                                                                                  |
| 8               | NC        | No internal connection. This pin can be grounded or N/C on PCB.                                                                            |
| 9               | VCC3      | Supply voltage for third stage PA                                                                                                          |
| 10              | DET       | Detector Output                                                                                                                            |
| 11              | GND       | Ground                                                                                                                                     |
| 12              | GND       | Ground                                                                                                                                     |
| 13              | RF_OUT    | RF Output                                                                                                                                  |
| 14              | GND       | Ground                                                                                                                                     |
| 15              | GND       | Ground                                                                                                                                     |
| 16              | GND       | Ground                                                                                                                                     |
| 17              | GND       | Ground                                                                                                                                     |
| 18              | VCC3      | Supply voltage for third stage PA                                                                                                          |
| 19              | VCC2      | Supply voltage for second stage PA                                                                                                         |
| 20              | VCC1      | Supply voltage for first stage PA                                                                                                          |
| Backside Paddle | RF/DC GND | RF/DC ground. Use recommended via pattern to minimize inductance and thermal resistance. See PCB Mounting Pattern for suggested footprint. |

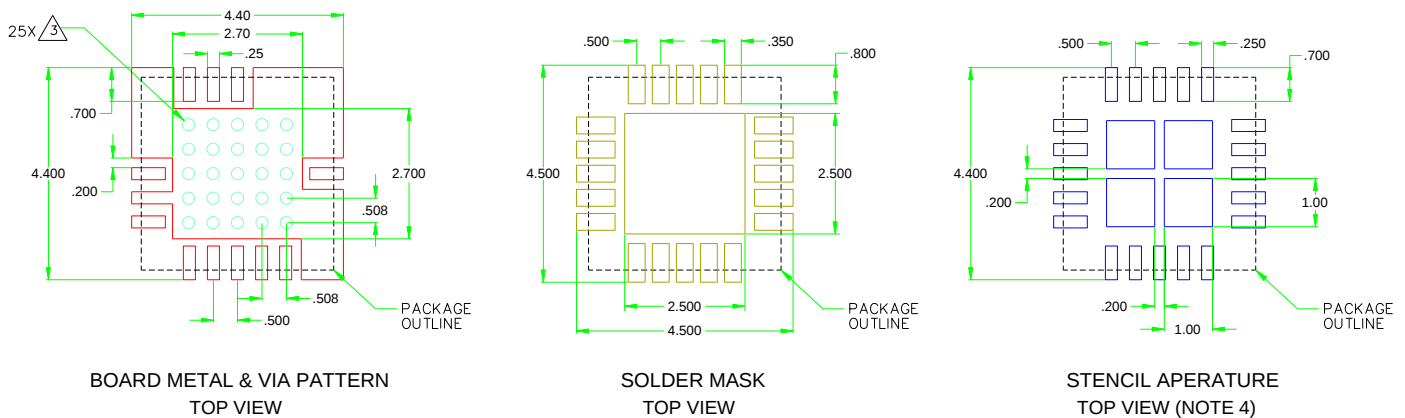
### Package Marking and Dimensions



#### Notes:

1. All dimensions are in millimeters.

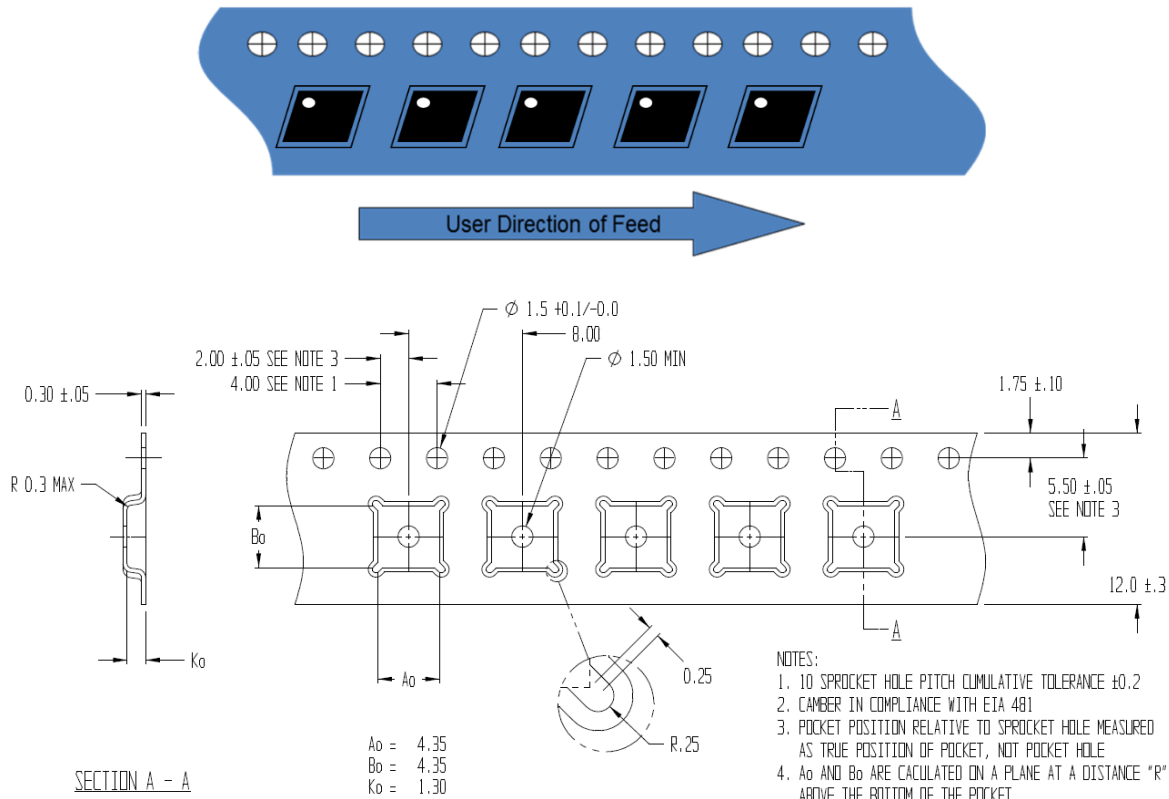
### PCB Mounting Pattern



#### Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1 oz. copper minimum for top and bottom layer metal.
3. Via holes 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 (0.01").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

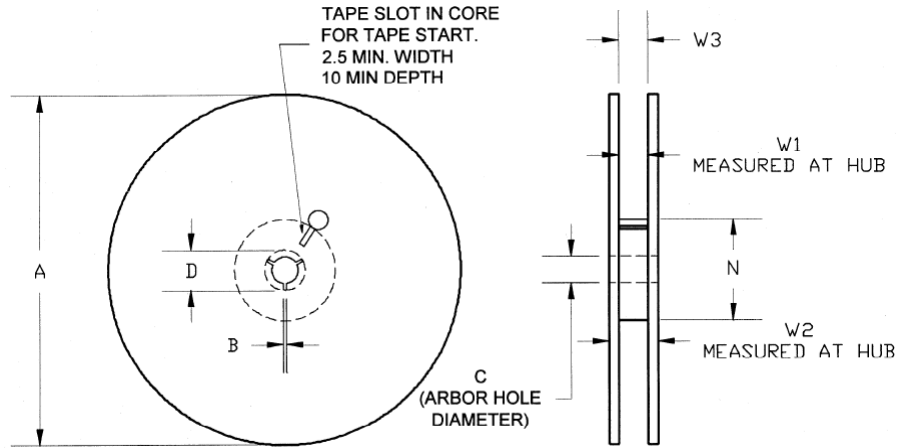
### Tape and Reel Information – Carrier and Cover Tape Dimensions



| Feature             | Measure                                  | Symbol | Size (in) | Size (mm) |
|---------------------|------------------------------------------|--------|-----------|-----------|
| Cavity              | Length                                   | A0     | 0.171     | 4.35      |
|                     | Width                                    | B0     | 0.171     | 4.35      |
|                     | Depth                                    | K0     | 0.051     | 1.30      |
|                     | 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      |

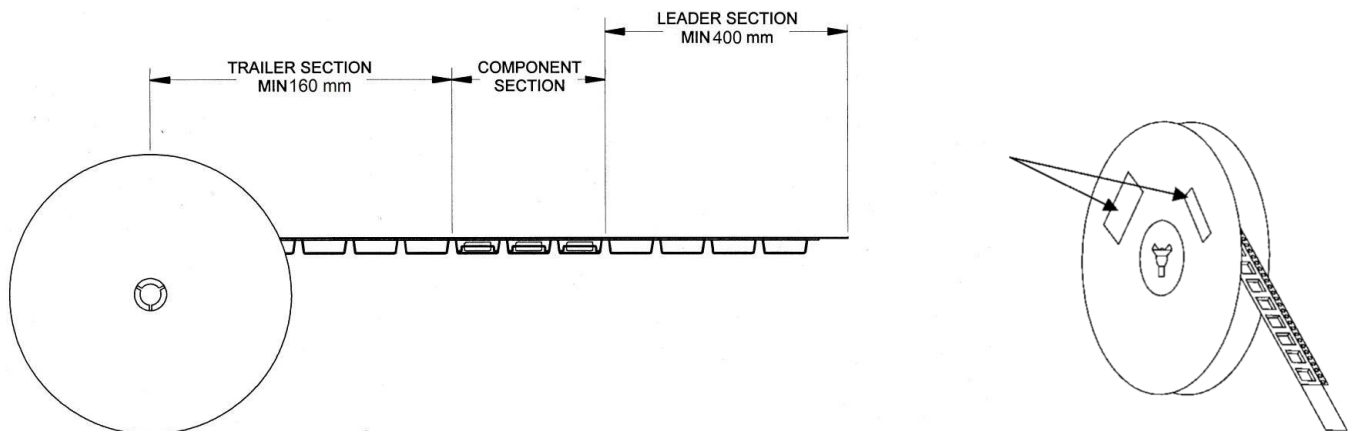
### Tape and Reel Information – Reel Dimensions

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



| Feature | Measure              | Symbol | Size (in) | Size (mm) |
|---------|----------------------|--------|-----------|-----------|
| Flange  | Diameter             | A      | 12.992    | 330.00    |
|         | Thickness            | W2     | 0.717     | 18.20     |
|         | Space Between Flange | W1     | 0.504     | 12.80     |
| Hub     | Outer Diameter       | N      | 4.016     | 102.00    |
|         | Arbor Hole Diameter  | C      | 0.512     | 13.00     |
|         | Key Slit Width       | B      | 0.079     | 2.00      |
|         | Key Slit Diameter    | D      | 0.787     | 20.00     |

### 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 1C | ESDA / JEDEC JS-001-2012 |
| ESD – Charged Device Model (CDM) | Class C3 | JEDEC JESD22-C101F       |
| 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: NiPdAu

### 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:

- 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
- Qorvo Green



### 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)

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- Конкурентоспособные цены и скидки постоянным клиентам.
- Специальные условия для постоянных клиентов.
- Подбор аналогов.
- Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.
- Приемлемые сроки поставки, возможна ускоренная поставка.
- Доставку товара в любую точку России и стран СНГ.
- Комплексную поставку.
- Работу по проектам и поставку образцов.
- Формирование склада под заказчика.
- Сертификаты соответствия на поставляемую продукцию (по желанию клиента).
- Тестирование поставляемой продукции.
- Поставку компонентов, требующих военную и космическую приемку.
- Входной контроль качества.
- Наличие сертификата ISO.

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- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
- Изготовление тестовой платы монтаж и пусконаладочные работы.



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