

### Product Overview

The Qorvo® QPB9324 is a highly integrated front-end module targeted for TDD macro or picocell base stations. The LNA switch module integrates RF functional blocks such as a pin-diode based high power switch capable of handling up to 52 W with an LTE signal (8 dB PAR) along with two LNA stages. Further integration is also implemented where the pin diode driver and dc-dc converter circuits are implemented inside the module to enable only the need for an external 5 V power supply. The control voltage for the switch and gain control. mode is with 3.3 V logic.

The QPB9324 can be utilized across the 3.4-3.6 GHz range to provide 1.2 dB noise figure for operation in the receive mode and 0.5 dB insertion loss in the transmit mode. The LNAs utilize Qorvo’s high performance E-pHEMT process while the switch allows for power levels up to 330 W peak power to be routed to an external load termination.

The QPB9324 is packaged in a RoHS-compliant, compact 8x8 mm surface-mount leadless package. The switch LNA module is targeted for wireless infrastructure applications configured for TDD-based architectures.

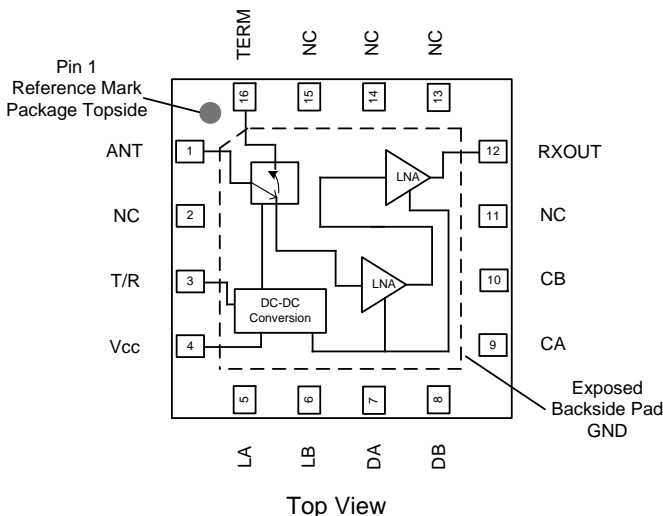


16 Pin 8 mm x 8 mm leadless SMT Package

### Key Features

- 3.4-3.6 GHz frequency range
- Integrates a high-power switch, two LNA stages, pin diode driver circuits, and dc converter
- Ideal for TDD systems with an isolator
- Only requires a 5 V supply with 3.3 V logic control
- Max RF Input power: 52 W Pavg (8 dB PAR)
- 33.8 dB gain
- 1.2 dB noise figure
- -0.6 dBm IIP3 (Rx mode)
- 0.5 dB Insertion Loss (Tx mode)
- Compact package size, 8x8 mm

### Functional Block Diagram



### Applications

- Wireless Infrastructure
- Macro or picocell base stations
- TDD-based architectures

### Ordering Information

| Part No.    | Description            |
|-------------|------------------------|
| QPB9324TR13 | 2500 pcs on a 13" reel |
| QPB9324EVB  | Evaluation board       |

## Absolute Maximum Ratings

| Parameter  | Rating        |
|--|---------------|
| Storage Temperature  | -50 to 150 °C |
| Operating Temperature  | +115 °C       |
| V <sub>CC</sub>  | +6 V          |
| RF at ANT (Tx Mode), 10sec. <sup>(1)</sup>                   | +47.2 dBm     |
| RF at ANT (Tx Mode), Indefinitely <sup>(1)</sup>             | +44.2 dBm     |
| RF at ANT (Rx Mode), Indefinitely <sup>(1)</sup>             | +20 dBm       |
| RF at ANT (Rx Mode), WCDMA PAR=10dB <sup>(2)</sup>           | +26 dBm       |
| RF at ANT (Rx Mode), CW <sup>(2)</sup>                       | +29 dBm       |
| RF at ANT (Rx Mode), 1 μs pulse 1% duty cycle <sup>(3)</sup> | +31.5 dBm     |

Notes:

1. LTE 1ch, 8 dB PAR, 88% duty cycle, 10.4 μs repetition time, T<sub>CASE</sub> = +100 °C
2. 12 hours, T<sub>CASE</sub> = +25 °C
3. 2 hour x 2 cycles, T<sub>CASE</sub> = +60 °C & then 2 hour x 3 cycles, T<sub>CASE</sub> = +75 °C

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

## Recommended Operating Conditions

| Parameter   | Min   | Typ | Max   | Units |
|---|-------|-----|-------|-------|
| V <sub>CC</sub>   | +4.75 | +5  | +5.25 | V     |
| T/R Logic Low Voltage   | 0     |     | 0.8   | V     |
| T/R Logic High Voltage  | 2.0   |     | 3.6   | V     |
| T <sub>CASE</sub>   | -40   |     | +105  | °C    |
| T <sub>j</sub> for >10 <sup>6</sup> hours MTTF <sup>(1)</sup> |       |     | +190  | °C    |

Notes:

1. For RX Mode operation

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

## Electrical Specifications

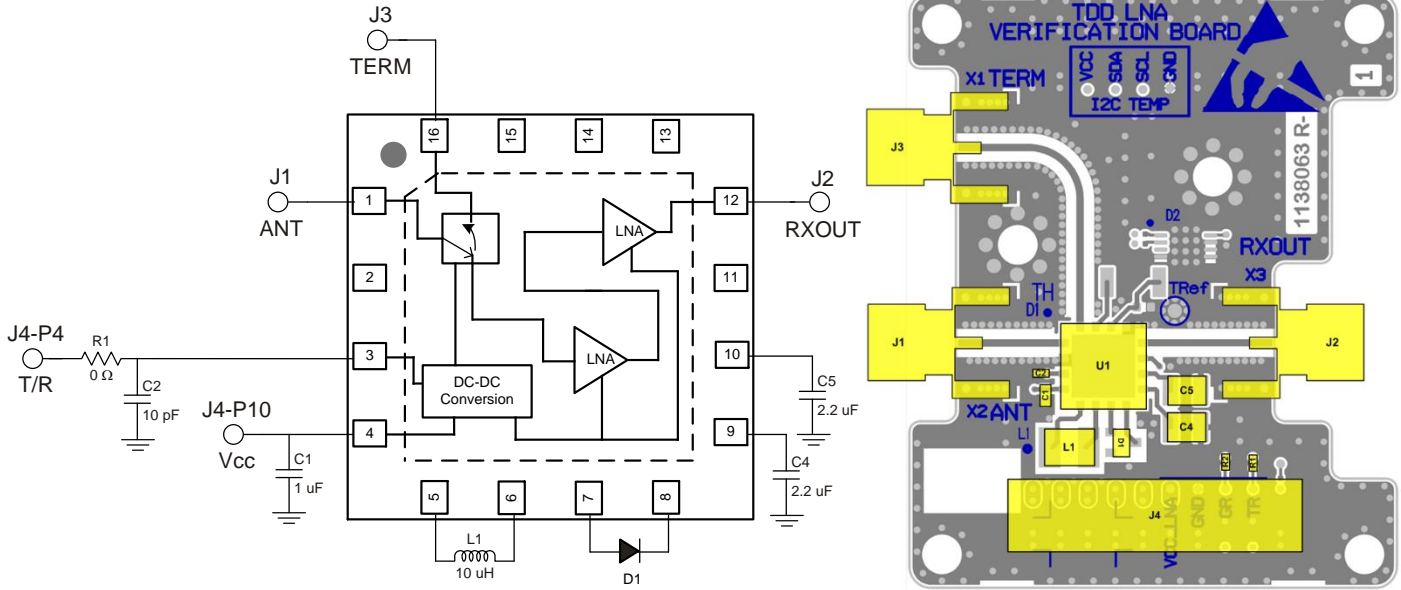
Test conditions unless otherwise noted: V<sub>CC</sub> = +5.0 V, Temp. = +25 °C, 50 Ω system

| Parameter                                | Conditions   | Min  | Typ   | Max  | Units |
|--|--|------|-------|------|-------|
| Operational Frequency Range              |  | 3400 |       | 3600 | MHz   |
| Gain                                     | Rx mode  |      | 33.8  |      | dB    |
| Gain Flatness                            | Rx mode  |      | 0.5   |      | dB    |
| Noise Figure                             | Rx mode  |      | 1.2   |      | dB    |
| Input IP3                                | Rx mode, Pin/tone = -33dBm, Δf = 1MHz                |      | -0.6  |      | dBm   |
| Input P1dB                               | Rx mode  |      | -15.4 |      | dBm   |
| Input Return Loss (ANT)                  | Rx mode  |      | 26    |      | dB    |
| Output Return Loss (Rx Out)              | Rx mode  |      | 23    |      | dB    |
| Reverse Isolation                        | Rx mode  |      | 58    |      | dB    |
| Insertion Loss                           | Tx mode  |      | 0.5   |      | dB    |
| Input P0.1dB                             | Tx mode  |      | 46.6  |      | dBm   |
| Return Loss (ANT, TERM)                  | Tx mode  |      | 27    |      | dB    |
| Operating Current                        | Rx mode  |      | 240   |      | mA    |
| Operating Current                        | Tx mode  |      | 145   |      | mA    |
| Switching Time (ANT to Rx Out)           | Reaching RF full output less 0.1dB after T/R command |      | 2     |      | μs    |
| Switching Time (ANT to Term)             |  |      | 1     |      | μs    |
| Wakeup Time (ANT to Rx Out/Term)         | Reaching RF full output less 0.5dB after DC turn on  |      | 1     |      | sec.  |
| In Band Spurious Emission <sup>(1)</sup> | Rx Mode at Rx out with Pin = -49dBm <sup>(2)</sup>   |      | -85   |      | dBc   |
| Out of Band Emissions <sup>(3)</sup>     | Rx Mode at Rx out from DC to 12275MHz                |      | -65   |      | dBm   |
| Thermal Resistance                       | Rx mode  |      | 22    |      | °C/W  |
| Thermal Resistance                       | Tx mode  |      | 22    |      | °C/W  |

Notes:

1. Pin is a CW signal swept from 3.4 to 3.6GHz. Specification refers to any mixing product that occurs in 3.4 to 3.6GHz band.
2. Follow Qorvo EVB layout for lowest spur level, any deviation may increase spur level.
3. Measure Pout with IBW = 4.5MHz over frequency range with no input power applied.

**Application Circuit Schematic and Layout**



Note:  
L1 placement for in band spur suppression - 5mm from bottom edge of U1 to top edge of L1

**Bill of Material**

| Ref Des | Value  | Description                            | Manuf.    | Part Number   |
|---------|--------|--|-----------|---------------|
| n/a     | n/a    | Printed Circuit Board                  |           |               |
| U1      | n/a    | High Power Switch LNA Module           | Qorvo     | QPB9324       |
| R1, R2  | 0 Ω    | Resistor, Chip, 0402, 5%               | Various   |               |
| C1      | 1 μF   | Capacitor, Chip, 0603, 20%, X7R        | Various   |               |
| C2      | 10 pF  | Capacitor, Chip, 0402, NPO/COG, 5%     | Various   |               |
| C4, C5  | 2.2 μF | Capacitor, Chip, 1210, 100 V, 10%, X7R | Various   |               |
| D1      | n/a    | Diode, 200 V 200 mA SOT23              | Various   |               |
| L1      | 10 μH  | Inductor, Power, 10 μH, 20%, 0.84 A    | Coilcraft | LPS4018-103ML |

**Logic Table**

| Parameter          | High    | Low     |
|--------------------|---------|---------|
| T/R Switch Control | Rx Mode | Tx Mode |

## Typical Performance – Rx Mode

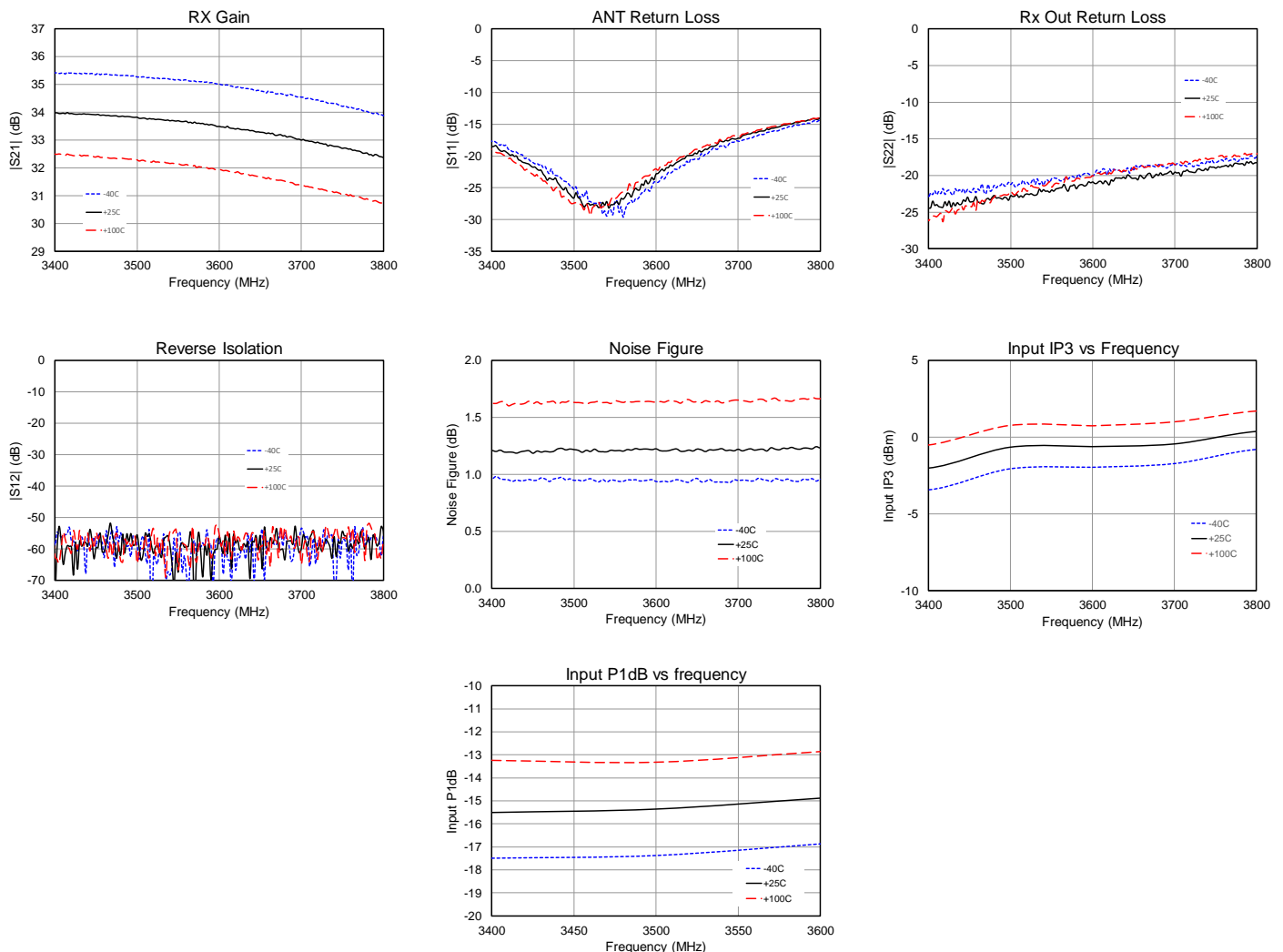
| Parameter         | Conditions <sup>(1)</sup>             | Typical Value |       |       | Units |
|-------------------|---------------------------------------|---------------|-------|-------|-------|
| Frequency         |                                       | 3400          | 3500  | 3600  | MHz   |
| Gain              |                                       | 34.0          | 33.8  | 33.5  | dB    |
| Input IP3         | Pin = -33 dBm/tone, Δf=1 MHz          | -2.0          | -0.6  | -0.6  | dBm   |
| Input P1dB        |                                       | -15.5         | -15.4 | -14.9 | dBm   |
| Noise Figure      | De-embedded from Evaluation board PCB | 1.2           | 1.2   | 1.2   | dB    |
| Return Loss       | ANT port                              | 18            | 26    | 24    | dB    |
| Return Loss       | Rx Out port                           | 24            | 23    | 21    | dB    |
| Reverse Isolation | Rx Out to ANT port                    | 58            | 58    | 58    | dB    |

**Notes:**

1. Test conditions unless otherwise noted:  $V_{CC} = +5.0\text{ V}$ ,  $T/R = 3\text{ V}$ ,  $Temp. = +25\text{ }^\circ\text{C}$

## Performance Plots – Rx Mode

Test conditions unless otherwise noted:  $V_{CC} = +5.0\text{ V}$ ,  $T/R = 3\text{ V}$ ;  $Temp. = +25\text{ }^\circ\text{C}$



## Typical Performance – Tx Mode

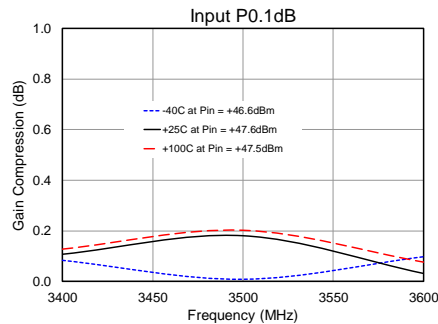
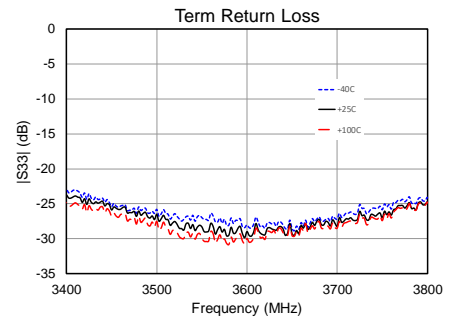
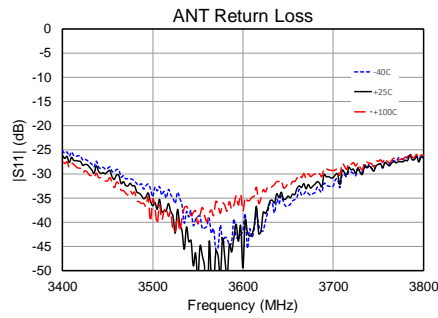
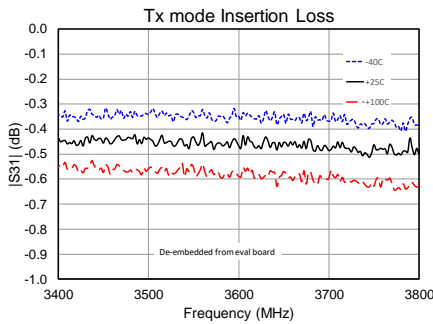
| Parameter         | Conditions <sup>(1)</sup>             | Typical Value |      |      | Units |
|-------------------|---------------------------------------|---------------|------|------|-------|
| Frequency         |                                       | 3400          | 3500 | 3600 | MHz   |
| Insertion Loss    | De-embedded from Evaluation board PCB | 0.5           | 0.5  | 0.5  | dB    |
| Input Compression | Pin = +47.6 dBm                       | 0.1           | 0.2  | 0.1  | dB    |
| Return Loss       | ANT port                              | 26            | 35   | 40   | dB    |
| Return Loss       | TERM port                             | 25            | 27   | 29   | dB    |

**Notes:**

1. Test conditions unless otherwise noted:  $V_{CC} = +5.0\text{ V}$ ,  $T/R = 0\text{ V}$ , Temp. = +25 °C

## Performance Plots – Tx Mode

Test conditions unless otherwise noted:  $V_{CC} = +5.0\text{ V}$ ,  $T/R = 0\text{ V}$ ; Temp. = +25 °C

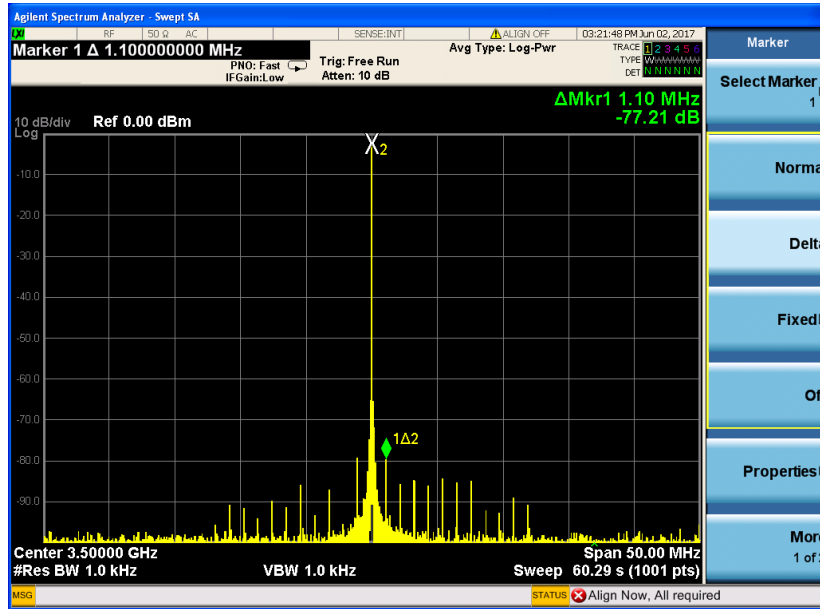


## Application Circuit for Spurious Reduction

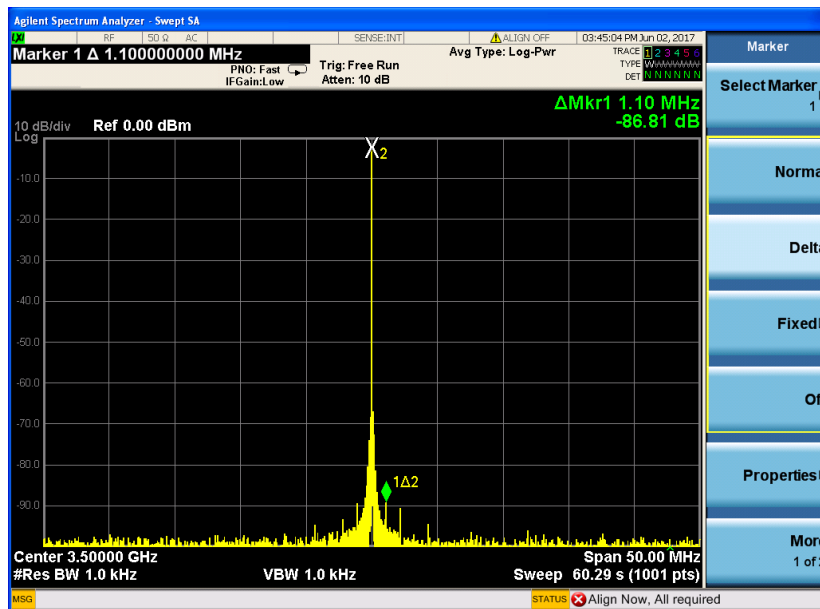
This section describes an alternative way to route the DC-DC converter signals for further improvement of in-band spurious emissions.

### Spurious (Mixing Products) Plots – Rx Mode

Test conditions unless otherwise noted:  $V_{CC} = +5.0$  V,  $T/R = +3.0$  V, RF input at ANT = -35dBm CW; Temp. = +25 °C

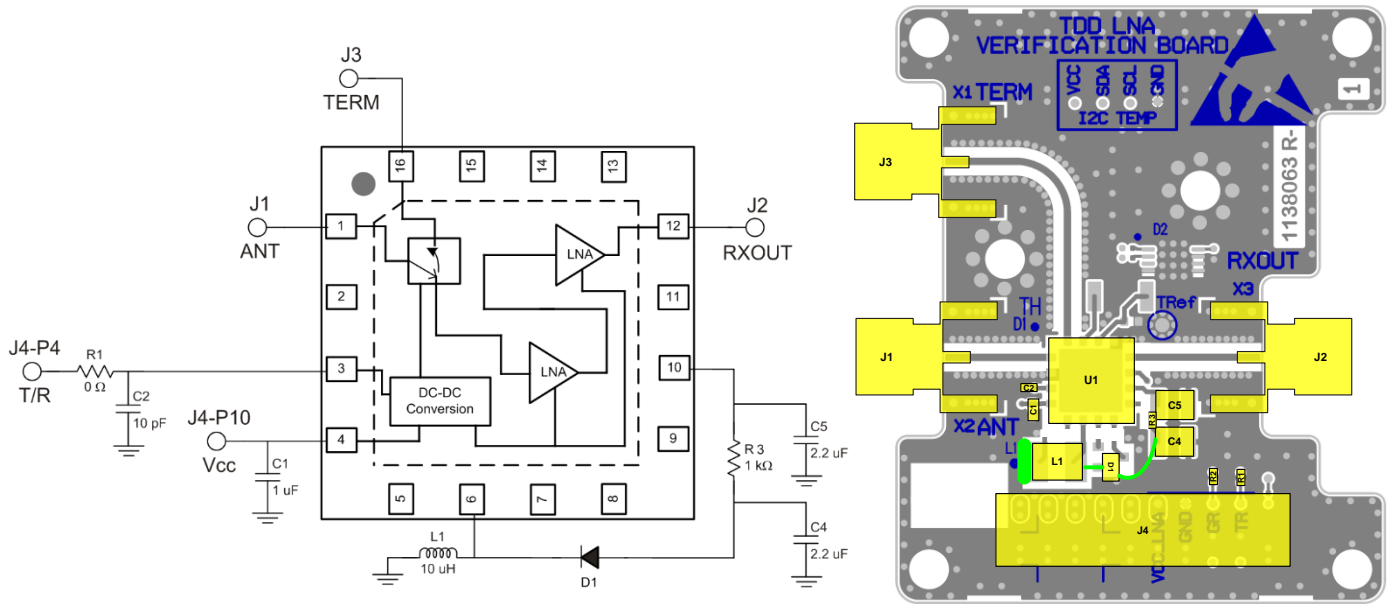


With Original EVB



With Modified Circuits and PCB

## Application Circuit Schematic and Layout – Modified EVB

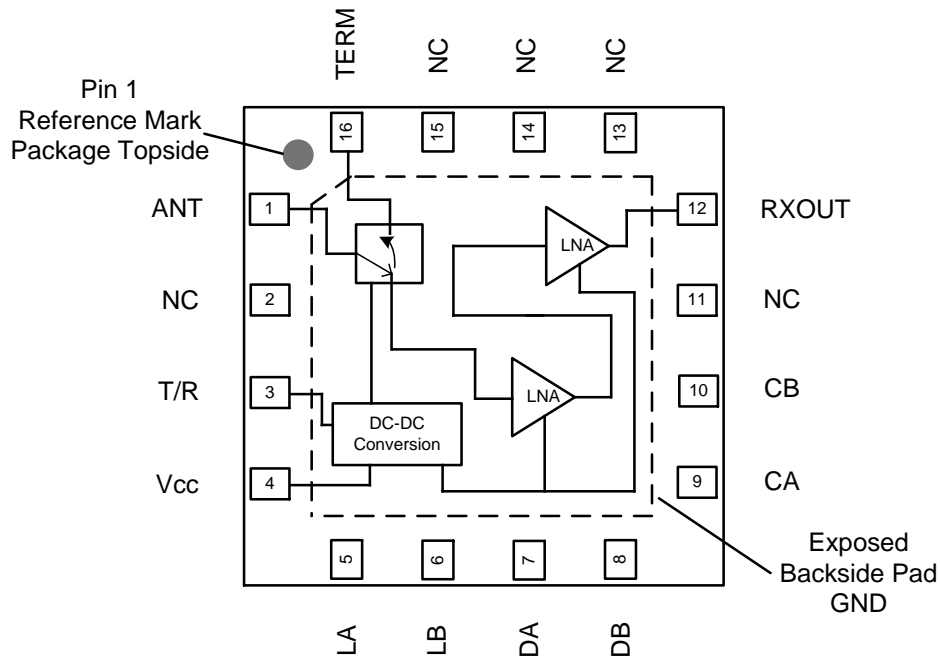


Note:  
R3 is the additional component along with PCB trace modifications. All other parts are same as the Evaluation Board on page 3.

## Bill of Material – Modified Circuits and PCB

| Ref Des | Value  | Description                            | Manuf.    | Part Number   |
|---------|--------|--|-----------|---------------|
| n/a     | n/a    | Printed Circuit Board                  |           |               |
| U1      | n/a    | High Power Switch LNA Module           | Qorvo     | QPB9324       |
| R1, R2  | 0 Ω    | Resistor, Chip, 0402, 5%               | Various   |               |
| C1      | 1 μF   | Capacitor, Chip, 0603, 20%, X7R        | Various   |               |
| C2      | 10 pF  | Capacitor, Chip, 0402, NPO/COG, 5%     | Various   |               |
| C4, C5  | 2.2 μF | Capacitor, Chip, 1210, 100 V, 10%, X7R | Various   |               |
| D1      | n/a    | Diode 200 V 200 mA SOT23               | Various   |               |
| L1      | 10 μH  | Inductor, Power, 10 μH, 20%, 0.84 A    | Coilcraft | LPS4018-103ML |
| R3      | 1 kΩ   | Resistor, Chip, 0402, 5%               | Various   |               |

## Pin Configuration and Description



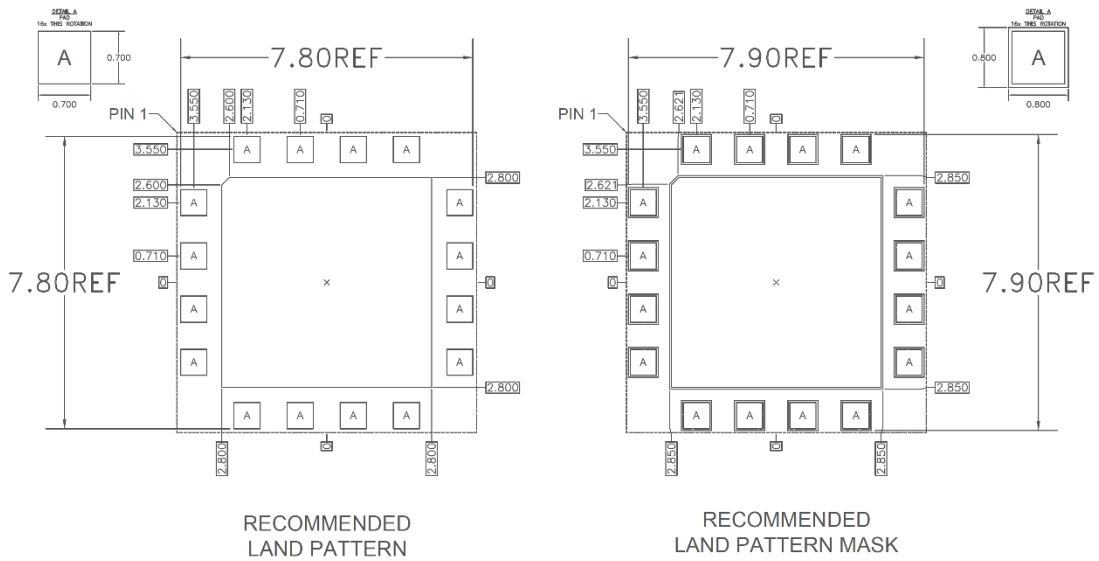
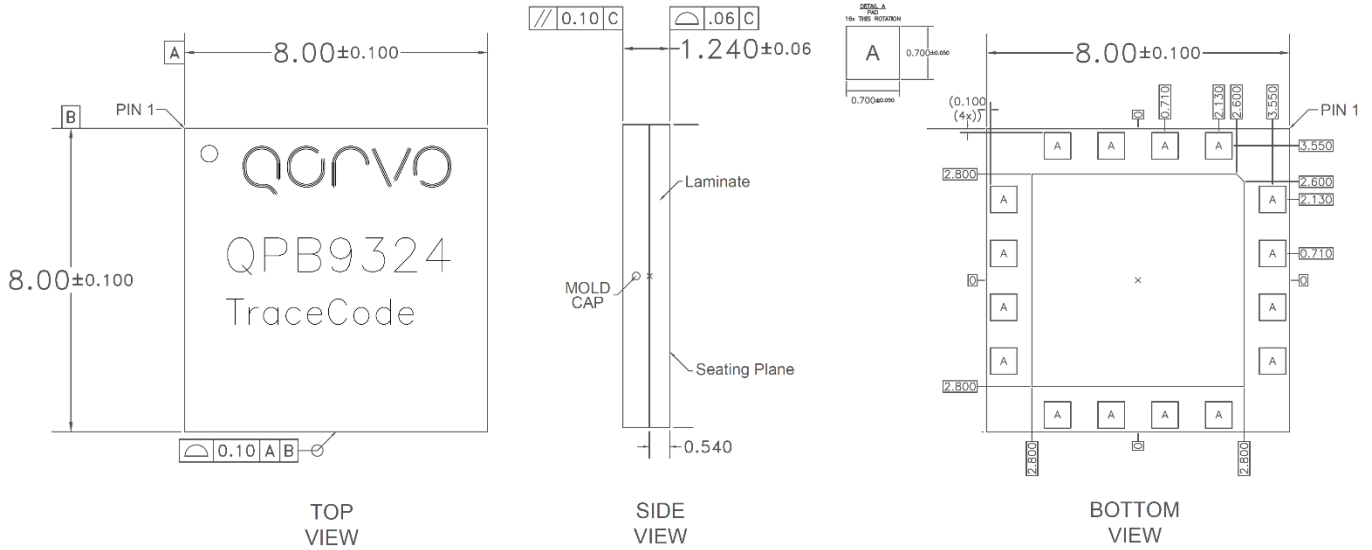
Top View

| Pin No.           | Label           | Description  |
|-------------------|-----------------|--|
| 1                 | ANT             | RF antenna input/output port, 50 $\Omega$  |
| 2, 11, 13, 14, 15 | NC              | No Internal Connection.  |
| 3                 | T/R             | Switch Control input, Tx mode Low state, Rx mode High state.   |
| 4                 | V <sub>cc</sub> | DC Power Supply Voltage input.   |
| 5                 | LA              | External inductor connection for DC-DC converter.  |
| 6                 | LB              | External inductor connection for DC-DC converter.  |
| 7                 | DA              | External diode anode connection for DC-DC converter.   |
| 8                 | DB              | External diode cathode connection for DC-DC converter.   |
| 9                 | CA              | External filtering capacitor connection for DC-DC converter.   |
| 10                | CB              | External filtering capacitor connection for DC-DC converter.   |
| 12                | Rx OUT          | RF LNA output port, 50 $\Omega$  |
| 16                | TERM            | RF termination port, 50 $\Omega$   |
| Backside Pad      | GND             | Ground connection. The back side of the package should be connected to the ground plan though as short of a connection as possible. PCB via holes under the device are required. |



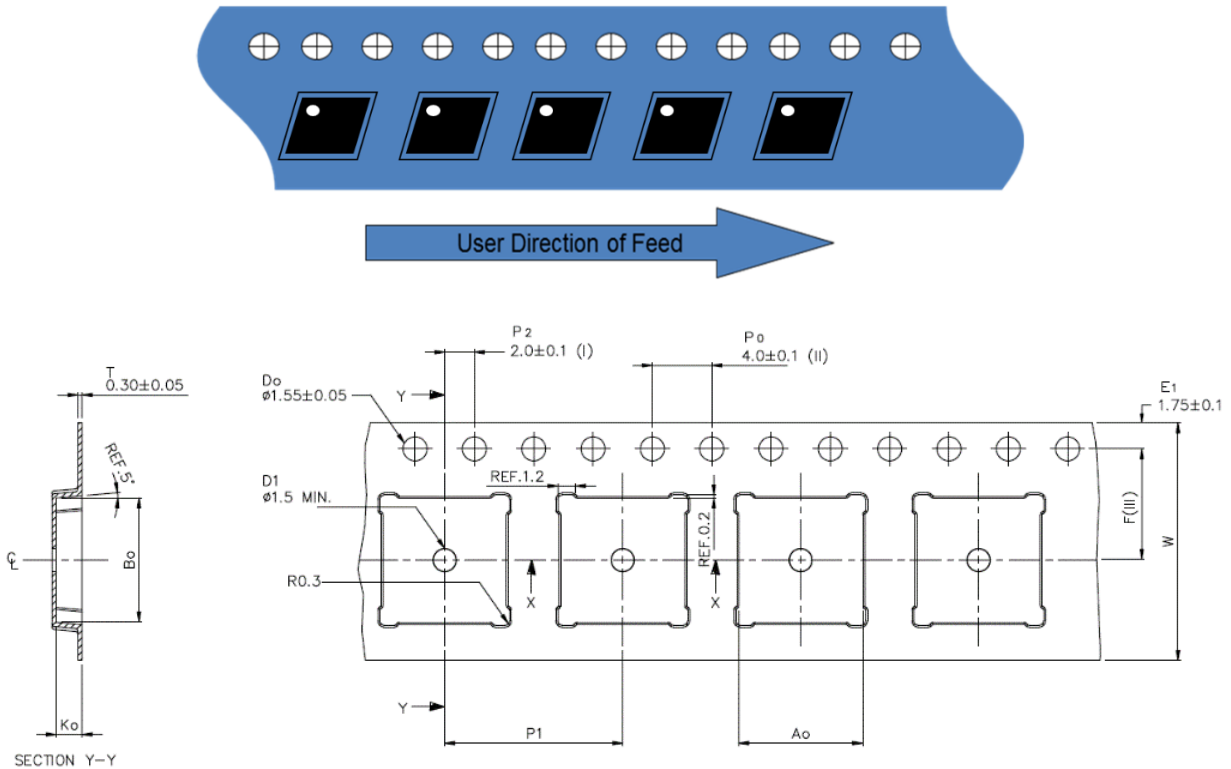
**Package Marking and Dimensions**

Marking: Part number – QPB9324  
Trace Code – Assigned by assembly sub-contractor



- Notes:
1. All dimensions are in microns. 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.

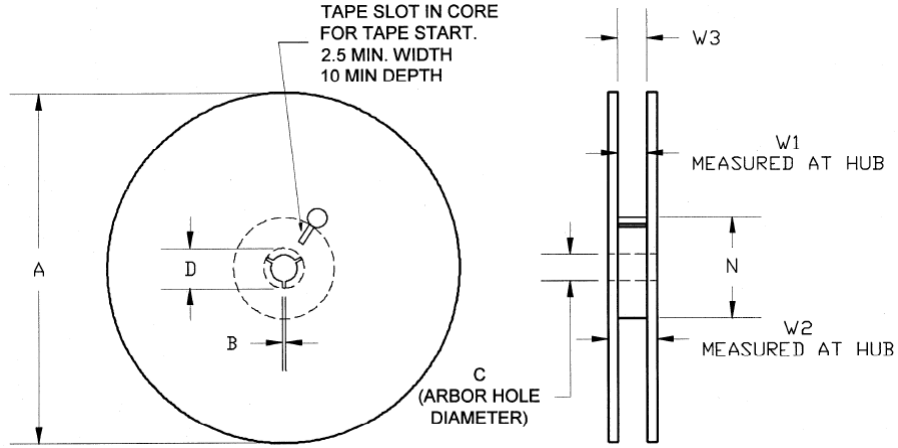
Tape and Reel Information – Carrier and Cover Tape Dimensions



| Feature             | Measure                                  | Symbol | Size (in) | Size (mm) |
|---------------------|--|--------|-----------|-----------|
| Cavity              | Length                                   | A0     | 0.329     | 8.35      |
|                     | Width                                    | B0     | 0.329     | 8.35      |
|                     | Depth                                    | K0     | 0.069     | 1.76      |
|                     | Pitch                                    | P1     | 0.472     | 12.00     |
| Centerline Distance | Cavity to Perforation - Length Direction | P2     | 0.079     | 2.00      |
|                     | Cavity to Perforation - Width Direction  | F      | 0.295     | 7.50      |
| Cover Tape          | Width                                    | C      | 0.524     | 13.30     |
| Carrier Tape        | Width                                    | W      | 0.630     | 16.0      |

**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 1C | 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 ± 3.0 μm; Au ≥ 0.10 μm*)

## 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:

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

## Contact Information

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

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

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