# RFFM8800

## Wi-Fi Front End Module

## Product Overview

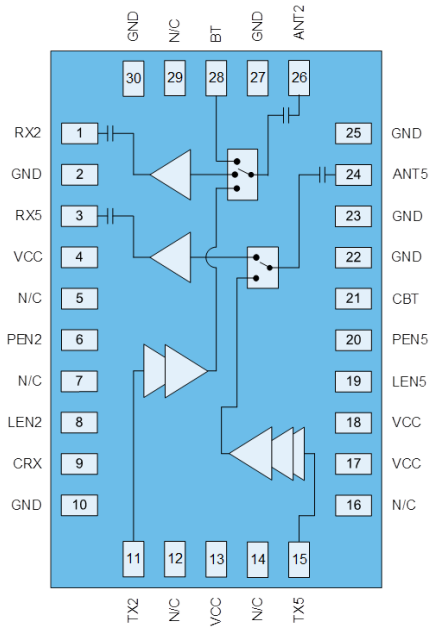
The Qorvo® RFFM8800 is an integrated dual band front end module (FEM) designed for Wi-Fi 4 systems. The compact form factor and integrated matching minimizes layout area in the application.

Performance is focused on optimizing the 2.4GHz and 5GHz PAs for a voltage range from 3 to 4.8V supply voltage that conserves power consumption while maintaining the highest linear output power.

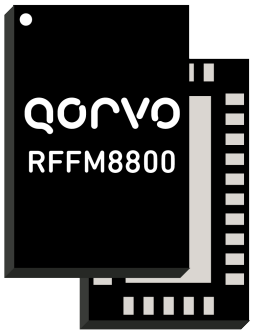
The topology lends itself to applications where 2.4GHz and 5GHz can be run independently on different antennas.

The RFFM8800 integrates a 2.4GHz and 5GHz power amplifier (PA), regulator, a 5GHz single pole two-throw switch (SP2T), a 2.4GHz single-pole three-throw switch and 2.4GHz and 5GHz low noise amplifiers (LNA).

## Functional Block Diagram




*Top View*




*30 Pin 3x5 mm Laminate Package*

## Key Features

- 5150-5850MHz & 2412 – 2484MHz
- 5GHz $P_{OUT}$ = +17.5dBm MCS7 HT20 -30dB Dynamic EVM
- 2.4GHz $P_{OUT}$ = +18.5dBm MCS7 HT20 -30dB Dynamic EVM
- 2.4GHz $P_{OUT}$ = +21.5dBm 11b Spectral Mask Compliance
- 5GHz 28dB & 2.4GHz 24dB Tx Gain
- 5GHz 2.5dB & 2.4GHz 2dB Noise Figure
- 5GHz 14dB & 2.4GHz 12dB Rx Gain

## Applications

- Access Points
- Wireless Routers
- Residential Gateways
- Customer Premise Equipment
- Internet of Things

## Ordering Information

| Part Number | Description |
|---|---|
| RFFM8800SB | Sample bag with 5 pieces |
| RFFM8800SQ | Sample bag with 25 pieces |
| RFFM8800SR | 7” reel with 100 pieces |
| RFFM8800TR13 | 13” reel with 2500 pieces |
| RFFM8800PCK-410 | Assembled Evaluation Board + 5 pcs |

## Absolute Maximum Ratings

| Parameter | Conditions | Rating |
|---|---|---|
| DC Supply Voltage | | -0.5 to +5.4V |
| Control Voltage | PEN5, PEN2, LEN5 & LEN2 | -0.5 to +5V |
| Storage Temperature | | -40 to 150 °C |
| RF Input Power at TX5 | Into 50 Ω Load for 802.11a-n (No Damage), Transmit Mode | +5 dBm |
| RF Input Power at TX2 | Into 50 Ω Load for 802.11b-n (No Damage), Transmit Mode | +0 dBm |
| RF Input Power at ANT | (No Damage), Receive LNA On Mode, CW | +0 dBm |

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 |
|---|---|---|---|---|
| Operating Frequency | 2.412 | | 2.484 | GHz |
| | 5.15 | | 5.850 | GHz |
| Device Voltage ($V_{CC}$ & $V_{DD}$) | +3 | +3.3 | +4.8 | V |
| Control Voltage – High | +2.8 | +3.1 | +4.6 | V |
| Control Voltage - Low | 0 | | +0.2 | V |
| $T_{OPERATING}$ | -10 | | +75 | °C |
| Extended $T_{OPERATING}$ | -40 | | +85 | °C |

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

## 5GHz Electrical Specifications

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| **TRANSMIT (TX5-ANT5) MODE** | **Unless otherwise noted: *f*=5150-5850MHz, $V_{CC}$=3.3V, T=+25ºC, PEN5=High** | | | | |
| Wi-Fi 4 HT40 Output Power | MCS7 64QAM 11n | | 17.5 | | dBm |
| Dynamic EVM | | | -31 | -30 | dB |
| ACP11n Spectral Mask | $P_{OUT}$ = +16 dBm, $f_C$ +/-11 MHz | | -23 | -20 | dBc |
| | $P_{OUT}$ = +16 dBm, $f_C$ +/-20 MHz | | -30 | -28 | dBc |
| | $P_{OUT}$ = +16 dBm, $f_C$ +/-30 MHz | | -43 | -40 | dBc |
| ACP11a Spectral Mask | $P_{OUT}$ = +17.5 dBm, $f_C$ +/-11 MHz | | -23 | -20 | dBc |
| | $P_{OUT}$ = +17.5 dBm, $f_C$ +/-20 MHz | | -30 | -28 | dBc |
| | $P_{OUT}$ = +17.5 dBm, $f_C$ +/-30 MHz | | -43 | -40 | dBc |
| Gain | | 25.5 | 28 | 31 | dB |
| TX5 Port Return Loss | | 5 | 10 | | dB |
| ANT Port Return Loss | | 15 | 20 | | dB |
| Quiescent Current | RF Off | | 150 | | mA |
| Operating Current | $P_{OUT}$ = +17.5 dBm | | 215 | 260 | mA |
| 2nd Harmonics | $P_{OUT}$ = +17.5 dBm, BW = 1MHz | | -24 | -20 | dBm/MHz |
| 3rd Harmonics | $P_{OUT}$ = +17.5 dBm, BW = 1MHz | | -45 | -40 | dBm/MHz |

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| **RECEIVE (ANT5-RX5) LNA ON MODE** | **Unless otherwise noted: *f*=5150-5925MHz, $V_{CC}$=5V, T=+25ºC, BS=HIgh, C1=Low, C0=Low & SLP=High** | | | | |
| Gain | | 11 | 14 | 17 | dB |
| Out of Band Gain | *f* = 800-1900MHz | | 7 | | dB |
| Noise Figure | | | 2.5 | 3.5 | dB |
| RX5 Port Return Loss | | | 9 | | dB |
| ANT5 Port Return Loss | | | 9 | | dB |
| Input $P_{1dB}$ | | -20 | -15 | | dBm |
| Input IP3 | | | -5 | | dBm |
| LNA Turn On Time | | | | 800 | nS |
| Rx Operating Current | | | 10 | 15 | mA |
| **GENERAL SPECIFICATIONS** | **Unless otherwise noted: *f*=5150-5925MHz, $V_{CC}$=5V, T=+25ºC, Switching Time Power Accuracy +/-1dB** | | | | |
| Control Current - High | LEN5 | | 2 | | µA |
| Control Current - High | CRX, CBT | | 5 | | µA |
| Switch Control Speed | | | | 100 | nS |
| Turn On/Off Time | 10⇔90% of total gain or power off gain | | 200 | 1000 | nS |
| PA Stability - Output VSWR | No Spurious above -41.25dBm/MHz, $P_{OUT}$ = 0 to 17 dBm, CW Signal | | 4:1 | | |

## 2.4GHz Electrical Specifications

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| **TRANSMIT MODE (TX2-ANT2)** | **Unless otherwise noted: *f*=2412-2484MHz, $V_{CC}$=5V, T=+25ºC, PEN2=High** | | | | |
| Wi-Fi 4 HT20 Output Power | MCS7 64QAM 11n | | 17.5 | | dBm |
| Dynamic EVM | | | | -34 | dB |
| Wi-Fi 4 HT20 Output Power | MCS7 64QAM 11n | | 18.5 | | dBm |
| Dynamic EVM | | | -32 | -30 | dB |
| 11g Output Power | 54Mbps | | 18 | | dBm |
| Dynamic EVM | | | -35 | -34 | dB |
| 11g Output Power | 54Mbps | | 19.5 | | dBm |
| Dynamic EVM | | | -32 | -30 | dB |
| Wi-Fi 4 Spectral Mask | $P_{OUT}$ = +18 dBm, $f_C$ +/-11 MHz | | -23 | -20 | dBc |
| | $P_{OUT}$ = +18 dBm, $f_C$ +/-20 MHz | | -30 | -28 | dBc |
| | $P_{OUT}$ = +18 dBm, $f_C$ +/-30 MHz | | -48 | -45 | dBc |
| 11g Spectral Mask | $P_{OUT}$ = +19.5 dBm, $f_C$ +/-11 MHz | | -23 | -20 | dBc |
| | $P_{OUT}$ = +19.5 dBm, $f_C$ +/-20 MHz | | -30 | -25 | dBc |
| | $P_{OUT}$ = +19.5 dBm, $f_C$ +/-30 MHz | | -43 | -40 | dBc |
| 11b Spectral Mask | $P_{OUT}$ = +21.5 dBm, $f_C$ +/-11 MHz | | -34 | -32 | dBc |
| | $P_{OUT}$ = +21.5 dBm, $f_C$ +/-22 MHz | | -54 | -52 | dBc |
| Gain | | 21 | 24 | 27.5 | dB |
| Gain Variance Slope | Across any 40MHz Channel | -1 | | +1 | dB |
| | Across any 20MHz Channel | -0.5 | | +0.5 | dB |

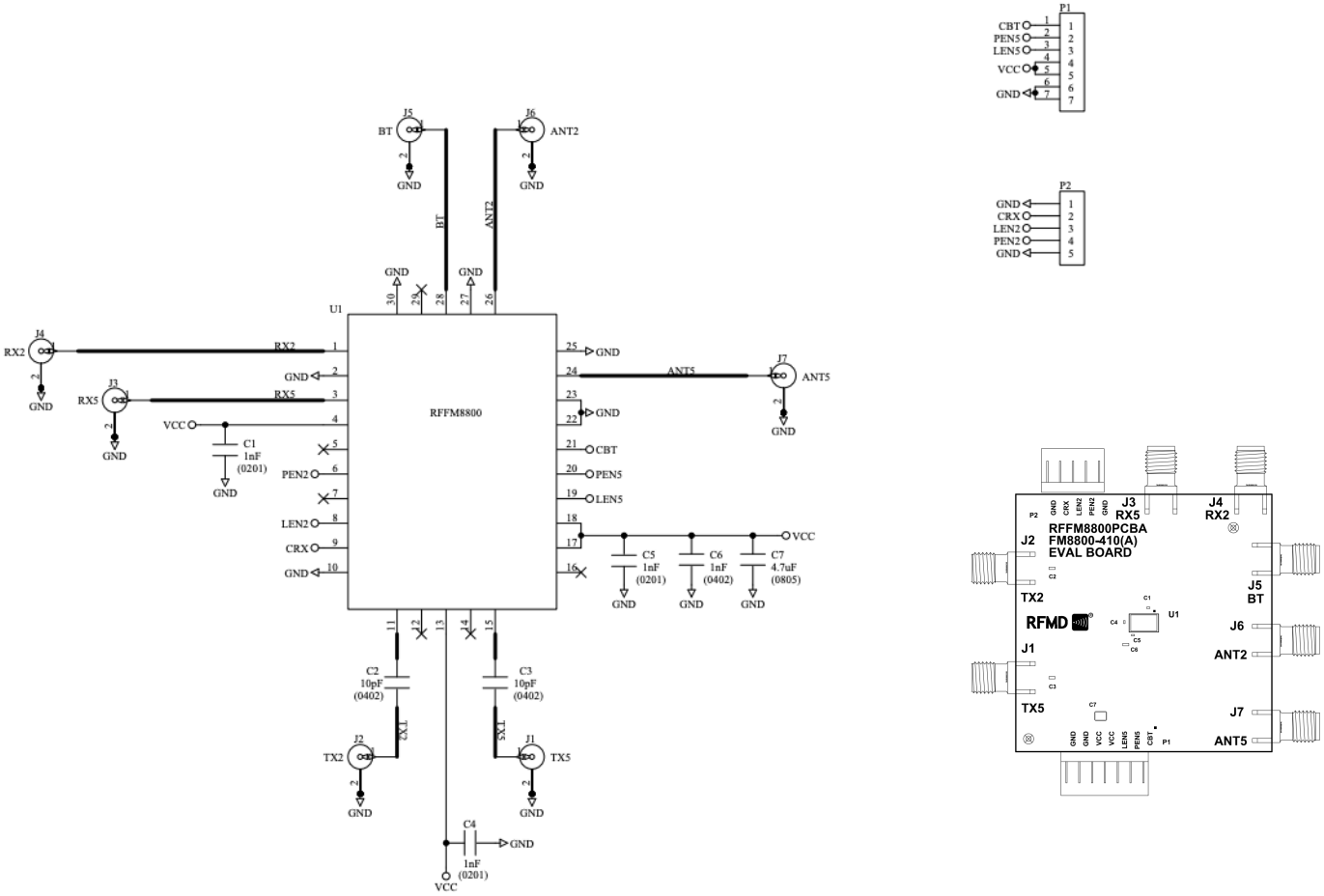
| Parameter | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| | Any 100MHz bandwidth | -2 | | +2 | dB |
| Out of Band Gain | *f* = 1600-1660MHz | | | -12 | dBc |
| TX2 Port Return Loss | | 8 | 12 | | dB |
| ANT2 Port Return Loss | | | 12 | | dB |
| Isolation | ANT2-BT | | 18 | | |
| | ANT2-RX2 | | 35 | | |
| FEM Leakage Current | RF Off, $V_{CC}$ = 4.8V | | 5 | | µA |
| Operating Current | $P_{OUT}$ = +19.5dBm | | 190 | 230 | mA |
| 2nd Harmonics | $P_{OUT}$ = +21.5 dBm, 1Mbps DSSS BW = 1MHz, up to 3:1 load | | -25 | -22 | dBm/MHz |
| 3rd Harmonics | $P_{OUT}$ = +21.5 dBm, 1Mbps DSSS BW = 1MHz, up to 3:1 load | | -40 | | dBm/MHz |
| **RECEIVE (ANT2-RX2) LNA ON MODE** | **Unless otherwise noted: *f*=2412-2484MHz, $V_{CC}$=5V, T=+25ºC, BS=Low, C1=Low, C0=Low, SLP=High** | | | | |
| Gain | | 10 | 12 | 15 | dB |
| Gain Flatness | Across any 40 MHz Channel | | 0.25 | +0.4 | dB |
| Noise Figure | | | 2 | 2.5 | dB |
| RX2 Port Return Loss | | 6 | 10 | | dB |
| ANT2 Port Return Loss | | 5 | 8 | | dB |
| Isolation | ANT2-BT | | 21 | | |
| Input $P_{1dB}$ | | -10 | -5 | | dBm |
| Input IP3 | | | 2 | | dBm |
| Rx Operating Current | | | 10 | 13 | mA |
| **BLUETOOTH (ANT2-BT) MODE** | **Unless otherwise noted: *f*=2412-2484MHz, $V_{CC}$=5V, T=+25ºC, *BS=Low, C1=Low, C0=High, SLP=High** | | | | |
| Insertion Loss | $P_{IN}/P_{OUT}$ > 20 dBm | | 0.7 | 0.9 | dB |
| BT Port Return Loss | | | 15 | | dB |
| ANT2 Port Return Loss | | | 20 | | dB |
| Isolation | ANT2-RX2 | | 35 | | dBm |
| **GENERAL SPECIFICATIONS** | **Unless otherwise noted: *f*=2412-2484MHz, $V_{CC}$=5V, T=+25ºC, Switching Time Power Accuracy +/-1dB** | | | | |
| Control Current - High | LEN2 | | 60 | 120 | µA |
| Turn On/Off Time | 10⇔90% of total gain or power off gain | | 200 | 800 | nS |
| PA Stability - Output VSWR | No Spurious above -41.25dBm/MHz, $P_{OUT}$ = 0 to 21 dBm, CW Signal | | 4:1 | | |

## Logic Truth Table

| Mode # | Mode | PEN2 | LEN2 | PEN5 | LEN5 | CRX | CBT |
|---|---|---|---|---|---|---|---|
| 0 | All Off | Low | Low | Low | Low | Low | Low |
| 1 | Bluetooth | Low | Low | Low | Low | Low | High |
| 2 | Bluetooth & 5GHz Receive | Low | Low | Low | High | High | High |
| 3 | Bluetooth & 5GHz Transmit | Low | Low | High | Low | Low | High |
| 4 | 2.4GHz Transmit | High | Low | Low | Low | Low | Low |
| 5 | 2.4GHz Receive | Low | High | Low | Low | High | Low |
| 6 | 5GHz Transmit | Low | Low | High | Low | Low | Low |
| 7 | 5GHz Receive | Low | Low | Low | High | High | Low |
| 8 | 5GHz Receive & 2.4GHz Receive | Low | High | Low | High | High | Low |

Notes:

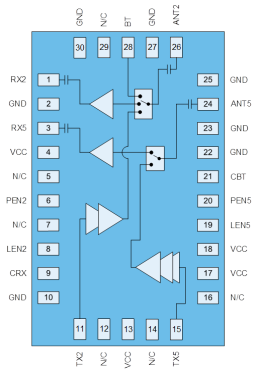
## Evaluation Board Schematic




## Bill of Material

| Ref. Des. | Value | Description | Manuf. | Part number |
|---|---|---|---|---|
| - | - | Printed Circuit Board | | |
| U1 | - | Dualband Wi-Fi Front End Module | Qorvo | RFFM8800 |
| C1, C2, C3, C4, C5, C7, C8, C11 | 1000 pF | Capacitor, Chip, 10%, 50V, X7R, 0402 | Murata | GRM155R71H102KA01D |
| C10, C12, C14, C15, C16, C17, C18 | 10 pF | Capacitor, Chip, 5%, 50V, C0G, 0402 | Murata | GRM1555C1H100JA01D |
| C13 | 1 µF | Capacitor, Chip, 10%, 6.3V, X5R, 0402 | Murata | GRM155R60J105KE19D |
| C200 | 0.1 µF | Capacitor, Chip, 10%, 25V, X7R, 0603 | Kernet | C0603C104K3RAC |
| C27, C28 | 4.7 µF | Capacitor, Chip, 10%, 10V, X5R, 1206 | Murata | GRM31CR61A475KA01L |
| R50 | 3K Ω | Resistor, Chip, 5%, 1/10W, 0805 | Panasonic | ERJ-6GEYJ302 |
| R51, R52 | 10K Ω | Resistor, Chip, 5%, 1/10W, 0805 | Panasonic | ERJ-6GEYJ103 |
| C9, C19, C20, C21, C22, C23, C24 | - | Do Not Install | | |

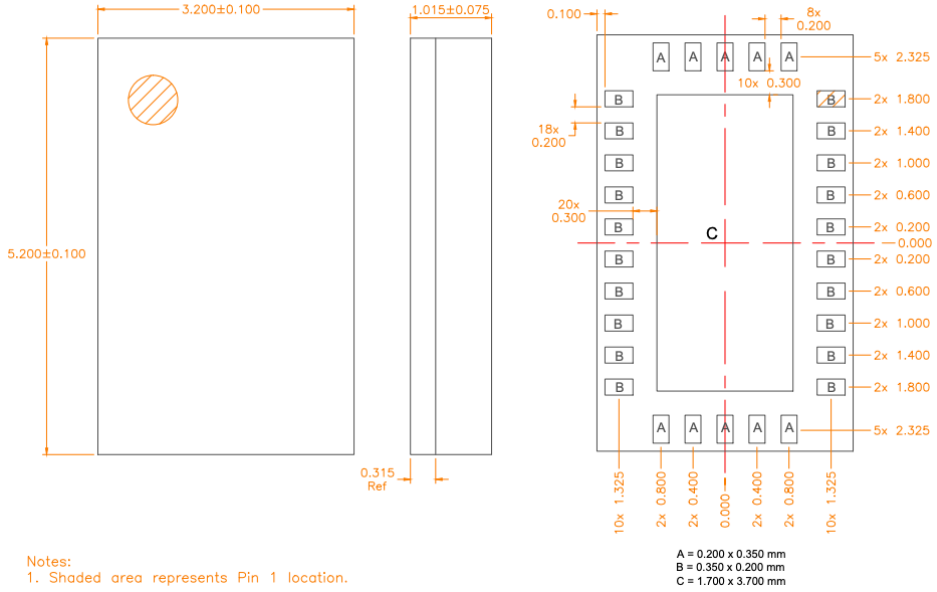
## Pin Configuration and Description



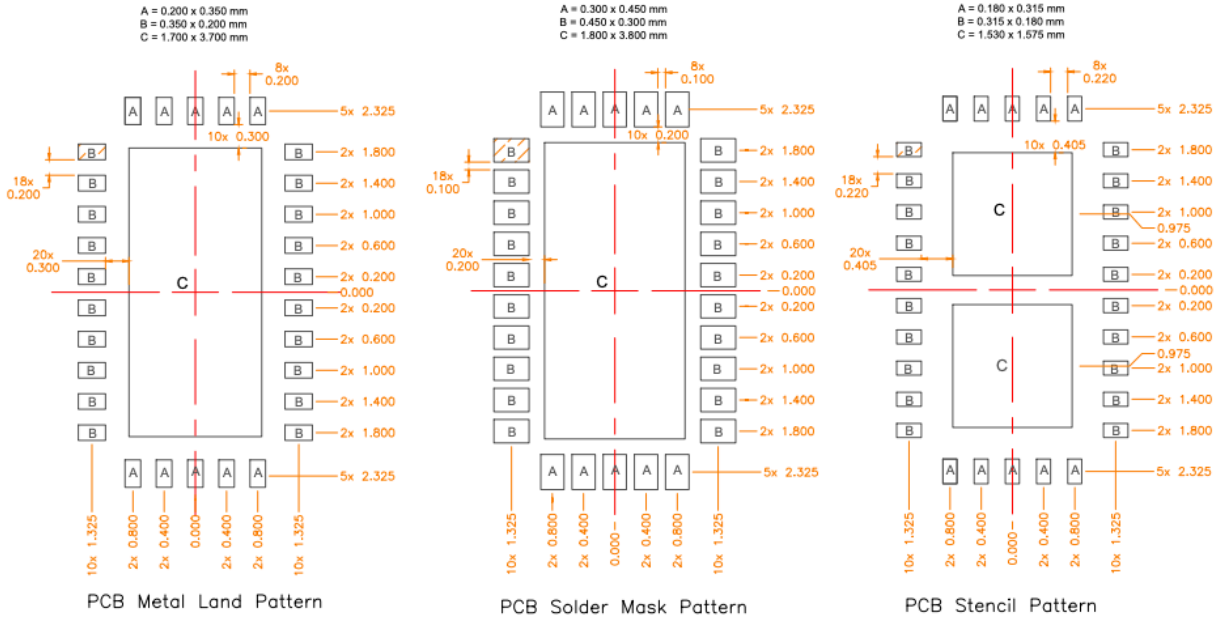

| Pin Number | Label | Description |
|---|---|---|
| 1 | RX2 | 2.4GHz RF output from the low noise amplifier. Internally matched to 50 Ω |
| 2 | GND | Ground connection |
| 3 | RX5 | 5GHz RF output from the low noise amplifier. Internally matched to 50 Ω |
| 4 | VCC | Supply voltage |
| 5 | NC | No electrical connection |
| 6 | PEN2 | Control pin |
| 7 | NC | No electrical connection |
| 8 | LEN2 | Control pin |
| 9 | CRX | Control pin |
| 10 | GND | Ground connection |
| 11 | TX2 | RF input. Internally matched to 50 Ω and DC blocked. |
| 12 | NC | No electrical connection |
| 13 | VCC | Supply voltage |
| 14 | NC | No electrical connection |
| 15 | TX5 | RF input. Internally matched to 50 Ω and DC blocked. |
| 16 | NC | No electrical connection |
| 17 | VCC | Supply voltage |
| 18 | VCC | Supply voltage |
| 19 | LEN5 | Control pin |
| 20 | PEN5 | Control pin |
| 21 | CBT | Control pin |
| 22 | GND | Ground connection |
| 23 | GND | Ground connection |
| 24 | ANT5 | RF bi-directional antenna port. Internally matched to 50 Ω. |
| 25 | GND | Ground connection |
| 26 | ANT2 | RF bi-directional antenna port. Internally matched to 50 Ω. |
| 27 | GND | Ground connection |
| 28 | BT | Bi-directional 2.4GHz RF input and output. Internally matched to 50 Ω |
| 29 | NC | No electrical connection |
| 30 | GND | Ground connection |
| Pkg Base | GND | RF/DC ground. Use recommended via pattern to minimize inductance and thermal resistance. See PCB Mounting Pattern for suggested footprint. |

# Mechanical Information

### Dimensions and PCB Mounting Pattern




Notes:
1. Shaded area represents Pin 1 location.




Notes:
1. Shaded area represents Pin 1 location.

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.

## Handling Precautions

| Parameter | Rating | Standard |
|---|---|---|
| ESD – Human Body Model (HBM) | 500V – RF Pins<br>1000V – DC Pins | JESD22-A144 |
| ESD – Charged Device Model (CDM) | III (500V) | JESD22-C101C |
| 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 temperature) and tin/lead (245 °C max. reflow temperature) soldering processes.

Package lead 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:

- Lead free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- SVHC Free

## Contact Information

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

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

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