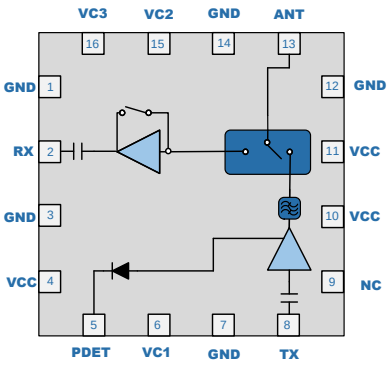
# RFFM8515

## 4.9GHz to 5.85GHz 802.11a/n/ac WiFi Front End Module

The RFFM8515 provides a complete integrated solution in a single front end module (FEM) for WiFi 802.11a/n/ac systems. The ultra-small form factor and integrated matching minimizes layout area in the customer's application and greatly reduces the number of external components. This simplifies the total front end solution by reducing the bill of materials, system footprint, and manufacturing cost. The RFFM8515 integrates a 5GHz power amplifier (PA), single pole double throw switch (SP2T), LNA with bypass, and a power detector coupler for improved accuracy. The device is provided in a 2.3mm x 2.3mm x 0.33mm, 16-pin QFN package.




Functional Block Diagram


Package: QFN, 16-pin, 2.3mm x 2.3mm x 0.33mm

## Features

- $P_{OUT}$ = +17.0dBm at 3.3V, 802.11ac 80MHz MCS9 256QAM at 1.8% Dynamic EVM Compliance
- $P_{OUT}$ = +19dBm at 3.3V, 802.11ac 80MHz MCS0 at Spectral Mask Compliance
- Input and Output Matched to 50Ω
- Integrated 5GHz PA, SP2T Switch, LNA, and PDET
- Low Height Package, Suited for Module and Chip On Board (CoB) designs
- Supports low power mode for improved efficiency

## Applications

- Cellular Handsets
- Mobile Devices
- Tablets
- Consumer Electronics
- Gaming
- Netbooks/Notebooks
- TV/Monitors/Video

## Ordering Information

| | |
|---|---|
| RFFM8515SB | Standard 5-piece sample bag |
| RFFM8515SQ | Standard 25-piece sample bag |
| RFFM8515SR | Standard 100-piece on 7 inch diameter reel |
| RFFM8515TR7 | Standard 2500-piece on 7 inch diameter reel |
| RFFM8515PCK-410 | Fully assembled evaluation board w/ 5 pc bag |

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DS20160429

## Absolute Maximum Ratings

| Parameter | Rating | Unit |
|---|---|---|
| DC Supply Voltage (No RF Applied) | 6 | V |
| PA Enable Voltage | -0.5 to 5 | $V_{DC}$ |
| DC Supply Current | 500 | mA |
| Operating Temperature Range | -40 to +85 | ºC |
| Storage Temperature | -40 to +150 | ºC |
| Maximum TX Input Power into 50Ω Load for 11a/n (No Damage) | +10 | dBm |
| LNA On Maximum RX input power (No damage) | +5 | dBm |
| Bypass Mode Maximum RX input power (No damage) | +25 | dBm |
| Moisture Sensitivity | MSL2 | |

**Caution!** ESD sensitive device.

RFMD Green: RoHS status based on EU Directive 2011/65/EU (at time of this document revision), halogen free per IEC 61249-2-21, < 1000ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

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. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

## Nominal Operating Parameters

| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min | Typ | Max | | |
| **Compliance** | | | | | **802.11a, 802.11n, 802.11ac** |
| Operating Frequency | 5.18 | | 5.825 | GHz | |
| Extended Frequency | 4.9 | | 5.925 | GHz | |
| Operating Temperature | -40 | | 85 | ºC | |
| Power Supply $V_{CC}$ | 3.0 | 3.3 | 4.2 | V | |
| Extended $V_{CC}$ | 3 | | 4.8 | V | |
| Control Voltage-high | 2.8 | 3.1 | $V_{CC}$ | V | VC1, VC2, VC3 |
| Control Voltage-low | | 0 | 0.2 | V | |
| **Transmit (TX-ANT) TX High Power Mode** | | | | | **T = 25°C, $V_{CC}$ = 3.3V, 50% Duty Cycle unless otherwise noted** |
| HT80 / HT40 Output Power | 16.0 | 17.0 | | dBm | T= 25°C, $V_{CC}$= 3.3V |
| 80MHz /40MHz 802.11ac - Dynamic EVM | | 1.5 | 1.8 | % | |
| | | -36.5 | -35.0 | dB | |
| HT80 / HT40 Output Power | 15.0 | 16.0 | | dBm | T= -10°C to +70°C, $V_{CC}$=3.3V |
| 80MHz / 40MHz 802.11ac - Dynamic EVM | | 1.5 | 1.8 | % | |
| | | -36.5 | -35.0 | dB | |
| HT20 Output Power | 17.0 | 18.0 | | dBm | T= 25°C, $V_{CC}$= 3.3V |
| 20MHz 802.11n - Dynamic EVM | | 2.5 | 3 | % | |
| | | -32 | -30.5 | dB | |
| HT20 Output Power | 16.0 | 17.0 | | dBm | T= -10°C to +70°C, $V_{CC}$=3.3V |
| 20MHz 802.11n - Dynamic EVM | | 2.5 | 3 | % | |
| | | -32 | -30.5 | dB | |
| 20MHz 802.11n - Spectral Mask Power | | 21 | | dBm | T= 25°C, $V_{CC}$= 3.3V |
| 40MHz / 80 MHz 802.11 ac Spectral Mask Power | | 19 | | dBm | |
| TX Port Return Loss | 10 | 20 | | dB | |
| ANT Port Return Loss | 10 | 15 | | dB | |
| Large Signal Gain | | 28 | 32 | dB | T = 25°C, $V_{CC}$ = 3.3V |
| | 24 | 28 | | | T= -10°C to +70°C, $V_{CC}$=3.3V |
| Gain flatness over any 80MHz BW | -0.5 | | 0.5 | dB | |

| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min | Typ | Max | | |
| **Transmit (TX-ANT) TX High Power Mode (continued)** | | | | | **T = 25°C, $V_{CC}$ = 3.3V, 50% Duty Cycle unless otherwise noted** |
| Gain flatness across band | -1 | | 1 | dB | |
| Operating Current | | 170 | 215 | mA | $P_{OUT}$ = +16.0dBm, T = 25°C, $V_{CC}$ = 3.3V |
| | | 180 | 220 | mA | $P_{OUT}$ = +17.0dBm, T = 25°C, $V_{CC}$ = 3.3V |
| | | 230 | | mA | $P_{OUT}$ = +21dBm, T = 25°C, $V_{CC}$ = 3.3V |
| Quiescent current | | 140 | 175 | mA | RF=Off, $V_{CC}$ = 3.3V |
| Second Harmonic | | -30 | -20 | dBm/MHz | $P_{OUT}$ = +21dBm, T = 25°C, $V_{CC}$ = 3.3V, using a standard IEEE802.11 11a, 6Mbps waveform. |
| Third Harmonic | | -45 | -35 | dBm/MHz | |
| Power Detector Voltage | | 0.25 | | V | $P_{OUT}$ = 0dBm |
| | | 0.76 | | V | $P_{OUT}$ = +16dBm |
| | | 0.97 | | V | $P_{OUT}$ = +21dBm |
| Variation from 0-360° load pull | -1.5 | | 1.5 | dB | 3:1 VSWR |
| ANT-RX Isolation (TX Mode-TX enabled and maximum power) | 27 | | | dB | |
| **Transmit (TX-ANT) TX Low Power Mode** | | | | | **T= 25°C, $V_{CC}$= 3.3V, 50% Duty Cycle unless otherwise noted** |
| HT80 / HT40 Output Power | 10 | 11 | | dBm | T = 25°C, $V_{CC}$ = 3.3V |
| 80MHZ 802.11ac Dynamic EVM | | 1.5 | 1.8 | % | |
| | | -36.5 | -35.0 | dB | |
| HT20 Output Power | 12 | 13 | | dBm | T = 25°C, $V_{CC}$ = 3.3V |
| 20MHz 802.11n Dynamic EVM | | 2.5 | 3 | % | |
| | | -32.0 | -30.5 | dB | |
| TX Performance – Spectral Mask | | | | dBm | |
| 20 MHz 802.11n / ac Output Power | | 15 | | dBm | T = 25°C, $V_{CC}$ = 3.3V |
| 40MHz / 80 MHz 802.11 ac Spectral Mask Power | | 13 | | dBm | |
| Operating Current | | 120 | 170 | mA | $P_{OUT}$= 10dBm |
| | | 130 | 180 | mA | $P_{OUT}$= 12dBm |
| | | 145 | 195 | mA | Pout =15dBm |
| Large Signal Gain | 24 | 27 | | dB | $P_{OUT}$= 10dBm, T = 25°C, $V_{CC}$ = 3.3V |
| Gain flatness over any 80MHz BW | -0.5 | | 0.5 | dB | |
| Power Detector Voltage | | 0.25 | | V | $P_{OUT}$ = 0dBm |
| | | 0.53 | | V | $P_{OUT}$ = +10dBm |
| | | 0.73 | | V | $P_{OUT}$ = +15dBm |
| **Receive (ANT-RX)-RX Gain Mode** | | | | | **T = +25°C, $V_{CC}$ = 3.3V, unless otherwise noted** |
| Gain | 11 | 14 | | dB | T = 25°C, $V_{CC}$ = 3.3V |
| | 10 | 14 | | | T= -10°C to +70°C, $V_{CC}$=3.0 to 4.2V |
| Gain flatness over any 80MHz BW | -0.25 | | 0.25 | dB | |
| Gain flatness across band | -0.75 | | 0.75 | dB | |
| Noise Figure | | 2.5 | 3.0 | dB | |
| Rx Port Return Loss | 9 | 15 | | dB | |
| ANT Port Return Loss | 6 | 10 | | dB | |
| Input P1dB | -6 | -3 | | dBm | |
| Current Consumption | | 10 | 17 | mA | T = 25°C, $V_{CC}$ = 3.3V |

| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min | Typ | Max | | |
| LNA Turn On Time | | 400 | 600 | nS | |

| **Receive (ANT-RX)- RX Bypass Mode** | | | | | **T = +25°C, $V_{CC}$ = 3.3V, unless otherwise noted** |
|---|---|---|---|---|---|
| LNA Bypass Current | | 2 | 10 | µA | |
| Nominal Insertion Loss | | 6 | 10 | dB | T = 25°C, $V_{CC}$ = 3.3V |
| RX Port Return Loss | 10 | 15 | | dB | |
| ANT Port Return Loss | 10 | 15 | | dB | |
| Input P1dB | 20 | 23 | | dBm | T = 25°C, $V_{CC}$ = 3.3V |
| **General Specifications** | | | | | |
| Control Line Impedance-VC1 | | 75 | | kΩ | |
| Control Line Impedance-VC2 | | 78 | | kΩ | |
| Control Line Impedance-VC3 | | 27 | | MΩ | |
| Control Line VC1 Current- Nominal | 0 | 0.5 | 1 | mA | T = 25°C, $V_{CC}$ = 3.3V RF OFF |
| Control Line VC2 Current- Nominal | 0 | 0.1 | 1 | mA | T = 25°C, $V_{CC}$ = 3.3V RF OFF |
| Control Line VC3 Current- Nominal | 0 | 0.1 | 1 | mA | T = 25°C, $V_{CC}$ = 3.3V RF OFF |
| Switching Speed | | 100 | 500 | ns | |
| ESD – Human Body Model | | 1000 | | V | |
| ESD – Charge Device Model | | 1000 | | V | |
| PA Turn-on Time | | 200 | 500 | ns | 10% to 90% |
| FEM Leakage Current | | 2 | 15 | | VCC=4.8V, RF = Off |
| PA Stability | | +20 | +22 | dBm | No spurious above -41.25dBm/MHz up to 4:1 VSWR |
| Ruggedness | | | 12 | dBm | 6:1 VSWR, $V_{CC}$ = 3.3V, 25°C; No damage |
| | | | 5 | dBm | 10:1 VSWR, $V_{CC}$ = 3.3V, 25°C; No damage |
| | | | 10:1 | VSWR | At typical operating conditions; No damage |

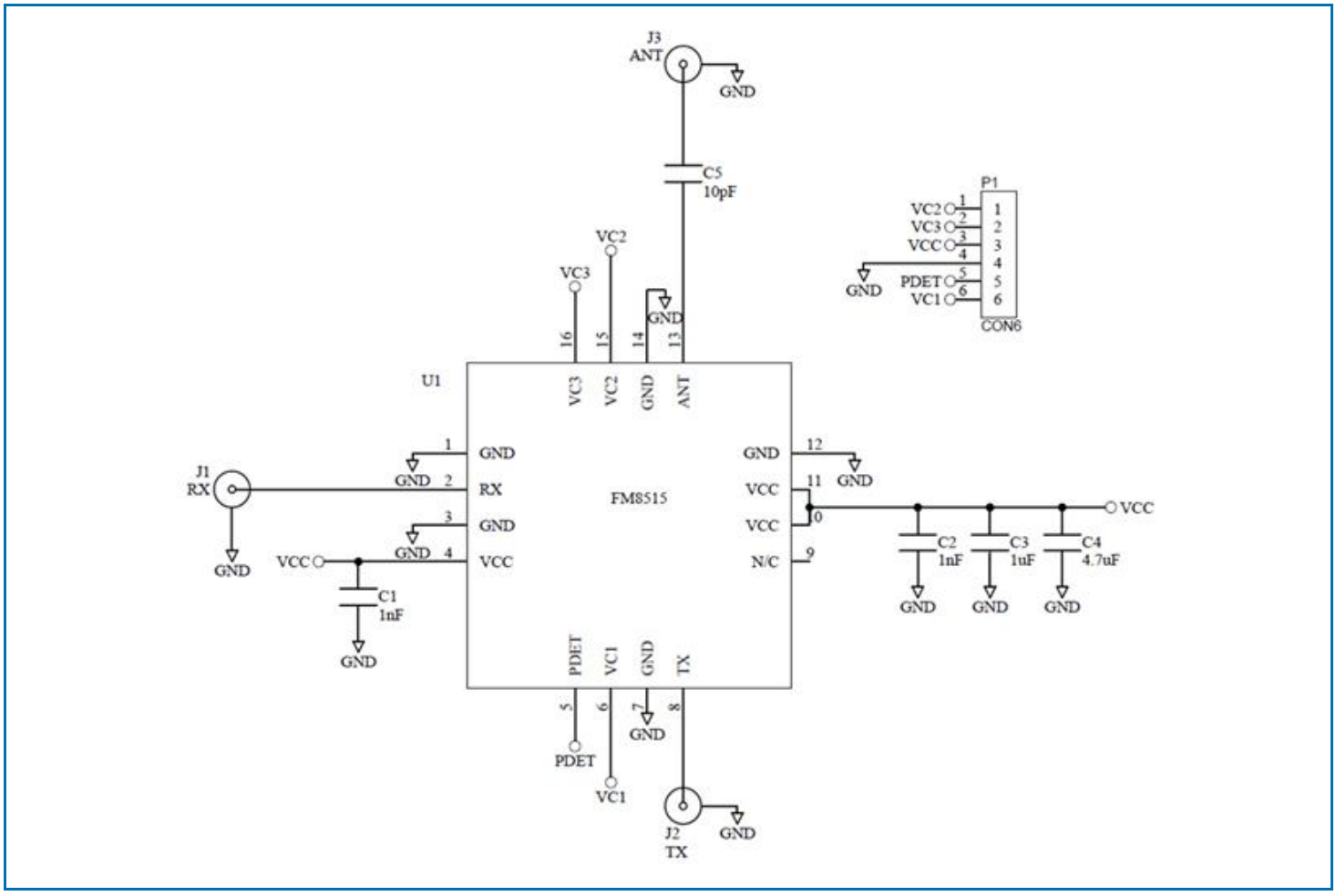
## Switch Control Logic Truth Table

| Operating Mode | VC1 | VC2 | VC3 |
|---|---|---|---|
| Standby | Low | Low | Low |
| 802.11a/n/ac TX High Power Mode | High | Low | High |
| 802.11a/n/ac TX Low Power Mode | High | Low | Low |
| 802.11a/n/ac RX Gain | Low | High | Low |
| 802.11a/n/ac RX Bypass | Low | High | High |

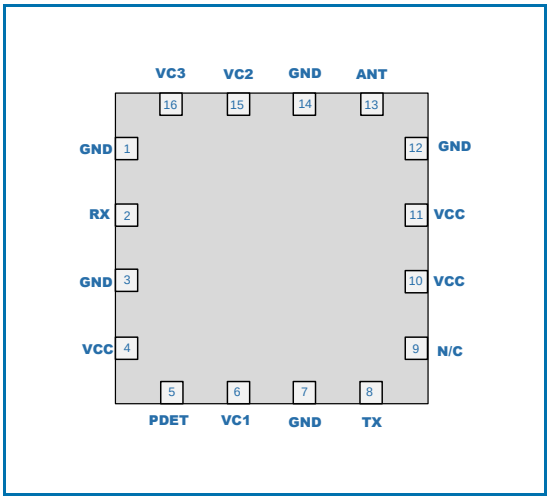
Notes:

- High = 2.8 to $V_{CC}$. Low = 0V to 0.2V

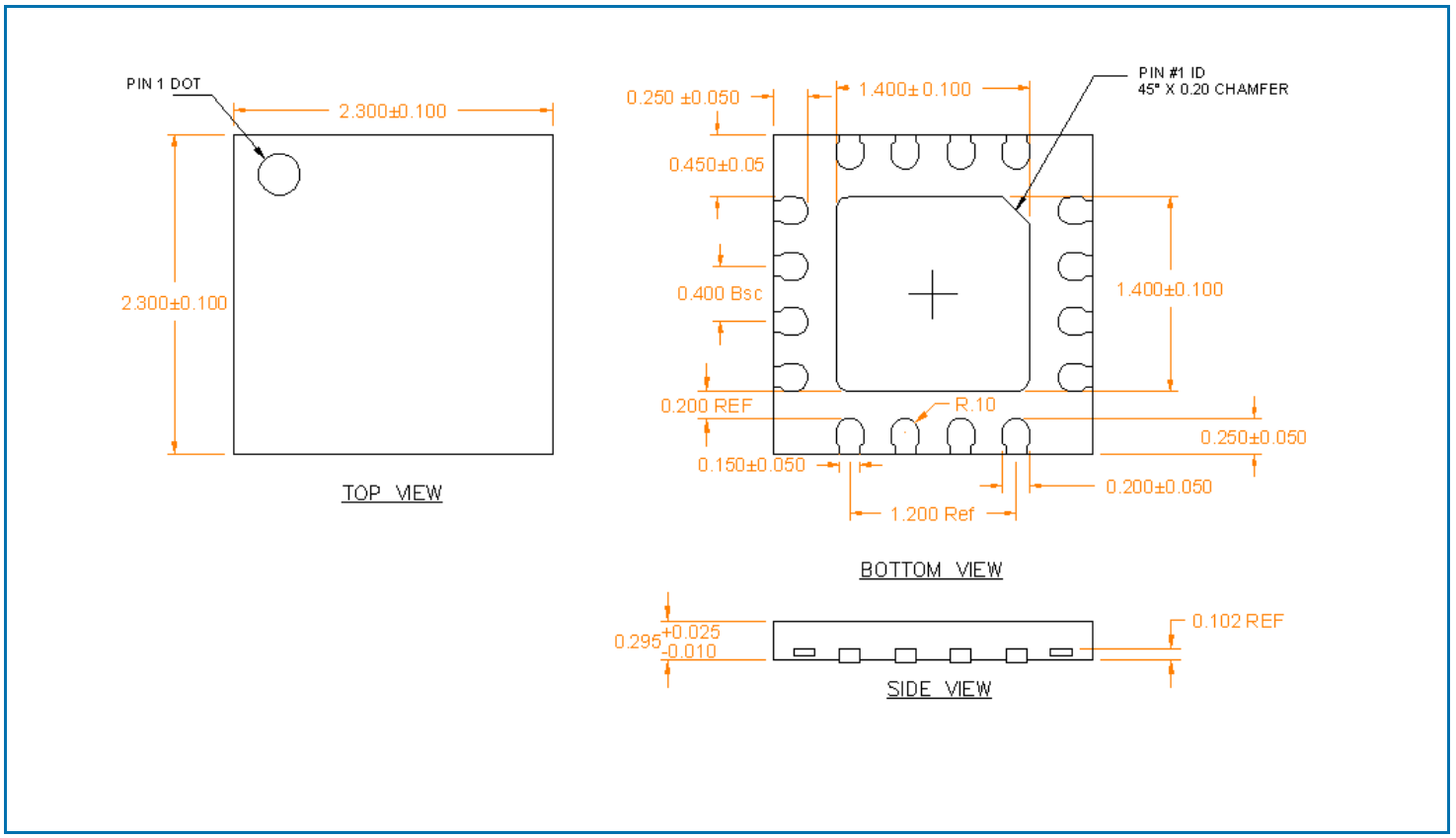
## Applications Schematic



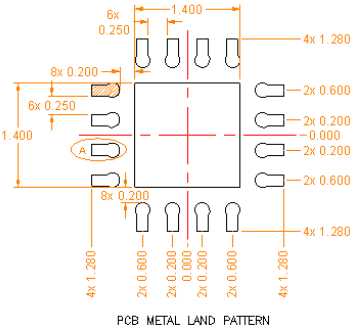
## Pin Out



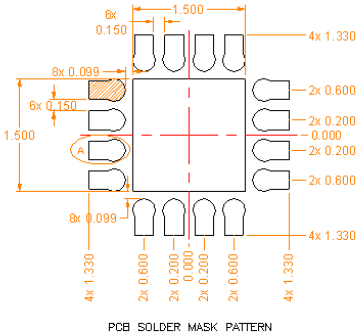

## Package Drawing



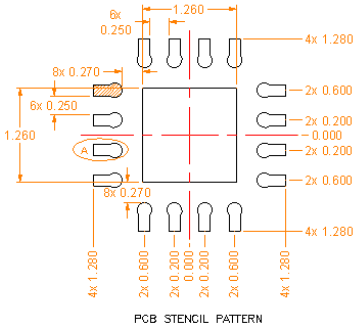
## PCB Patterns



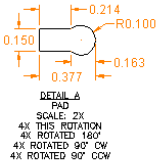

PCB METAL LAND PATTERN

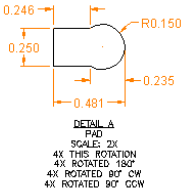


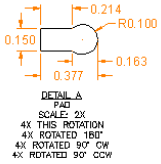

PCB SOLDER MASK PATTERN




PCB STENCIL PATTERN




Thermal vias for center slug should be incorporated into the PCB design. The number and size of thermal vias will depend on the application, the power dissipation, and the electrical requirements. Example of the number and size of vias can be found on the RFMD evaluation board layout.

## Pin Names and Descriptions

| Pin | Name | Description |
|---|---|---|
| 1 | GND | This pin is not connected internally and can be left floating or connected to ground. |
| 2 | RX | RF output port for the 802.11a/n LNA. This port is matched to 50Ω and DC blocked internally |
| 3 | GND | This pin is not connected internally and can be left floating or connected to ground. |
| 4 | VCC | Supply voltage for the LNA and PA Regulator. See applications schematic for biasing and bypassing components. |
| 5 | PDET | Power detector voltage for the TX path. May need external series R/shunt C to adjust voltage level and to filter RF noise |
| 6 | VC1 | Control Logic Pin - Refer to Logic Table |
| 7 | GND | This pin is not connected internally and can be left floating or connected to ground. |
| 8 | TX | RF input port for the 802.11a/n PA. Input is matched to 50Ω and DC blocked internally |
| 9 | N/C | This pin is not connected internally and can be left floating or connected to ground. |
| 10 | VCC | Supply voltage for the first and second stage of the PA. See applications schematic for biasing and bypassing components. |
| 11 | VCC | Supply voltage for the final stage of the PA. See applications schematic for biasing and bypassing components. |
| 12 | GND | This pin is not connected internally and can be left floating or connected to ground. |
| 13 | ANT | RF bidirectional antenna port matched to 50Ω and external DC block is required |
| 14 | GND | This pin is not connected internally and can be left floating or connected to ground. |
| 15 | VC2 | Control Logic Pin - Refer to Logic Table |
| 16 | VC3 | Control Logic Pin - Refer to Logic Table |
| Pkg Base | GND | Ground connection. The backside of the package should be connected to the ground plane through a short path, i.e., PCB vias under the device are recommended. |