

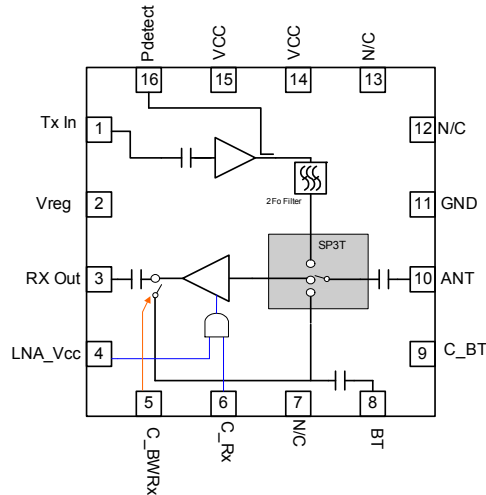


### Features

- Integrated 2.4GHz to 2.45GHz b/g/n Amplifier, LNA, SP3T Switch, and Power Detector Coupler
- Single Supply Voltage 3.0V to 4.8V
- $P_{OUT}$  = 20dBm, 11g, OFDM at <3.3% EVM, 23dBm 11b Meeting 11b Spectral Mask
- Low Height Package, Suited for SiP and CoB Designs

### Applications

- Cellular handsets
- Mobile devices
- Tablets
- Consumer electronics
- Gaming
- Netbooks/Notebooks
- TV/monitors/video
- SmartEnergy



Functional Block Diagram

### Product Description

The RF5765 provides a complete integrated solution in a single Front End Module (FEM) for WiFi 802.11b/g/n and *Bluetooth*<sup>®</sup> systems. The ultra small form factor and integrated matching greatly reduces the number of external components and layout area in the customer application. This simplifies the total Front End solution by reducing the bill of materials, system footprint, and manufacturability cost. The RF5765 integrates a 2.4GHz Power Amplifier (PA), Low Noise Amplifier (LNA), power detector coupler for improved accuracy, and some filtering for harmonic rejection. The RF5765 is capable of receiving WiFi and *Bluetooth*<sup>®</sup> simultaneously. The device is provided in a 3mmx3mmx0.5mm, 16-pin package. This module meets or exceeds the RF Front End needs of IEEE 802.11b/g/n WiFi RF systems.

### Ordering Information

|               |                                                     |
|---------------|-----------------------------------------------------|
| RF5765SQ      | Standard 25 piece bag                               |
| RF5765SR      | Standard 100 piece reel                             |
| RF5765TR7     | Standard 2500 piece reel (13")                      |
| RF5765PCK-410 | Fully Assembled Evaluation Board with 5piece Sample |

### Optimum Technology Matching<sup>®</sup> Applied

|                                               |                                      |                                                |                                   |
|-----------------------------------------------|--------------------------------------|------------------------------------------------|-----------------------------------|
| <input type="checkbox"/> GaAs HBT             | <input type="checkbox"/> SiGe BiCMOS | <input checked="" type="checkbox"/> GaAs pHEMT | <input type="checkbox"/> GaN HEMT |
| <input type="checkbox"/> GaAs MESFET          | <input type="checkbox"/> Si BiCMOS   | <input type="checkbox"/> Si CMOS               | <input type="checkbox"/> RF MEMS  |
| <input checked="" type="checkbox"/> InGaP HBT | <input type="checkbox"/> SiGe HBT    | <input type="checkbox"/> Si BJT                | <input type="checkbox"/> LDMOS    |

## Absolute Maximum Ratings

| Parameter                                                       | Rating                   | Unit |
|-----------------------------------------------------------------|--------------------------|------|
| DC Supply Voltage<br>(Continuous with No Damage)                | 5.4                      | V    |
| DC Supply Current                                               | 500                      | mA   |
| Full Specification Temp Range<br>(Full Spec. Compliant)         | -10 to +70               | °C   |
| Extreme Operating<br>(Reduced Performance)                      | -40 to -10<br>+70 to +85 | °C   |
| Storage Temperature                                             | -40 to +150              | °C   |
| Antenna Port Nominal Impedance                                  | 50                       | Ω    |
| Maximum TX Input Power into 50Ω Load<br>for 11b/g/n (No Damage) | 0                        | dBm  |
| Maximum RX Input Power (No Damage)                              | 0                        | dBm  |
| Moisture Sensitivity                                            | MSL2                     |      |



**Caution!** ESD sensitive device.

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.

RoHS status based on EUDirective2002/95/EC (at time of this document revision).

The information in this publication is believed to be accurate and reliable. However, no responsibility is assumed by RF Micro Devices, Inc. ("RFMD") for its use, nor for any infringement of patents, or other rights of third parties, resulting from its use. No license is granted by implication or otherwise under any patent or patent rights of RFMD. RFMD reserves the right to change component circuitry, recommended application circuitry and specifications at any time without prior notice.

| Parameter                         | Specification                   |       |      | Unit  | Condition                                                                                                                                                                                                                                                                                                    |                                                                                   |
|-----------------------------------|---------------------------------|-------|------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
|                                   | Min.                            | Typ.  | Max. |       |                                                                                                                                                                                                                                                                                                              |                                                                                   |
| <b>2.4GHz Transmit Parameters</b> |                                 |       |      |       |                                                                                                                                                                                                                                                                                                              |                                                                                   |
| Compliance                        |                                 |       |      |       | IEEE802.11b, IEEE802.11g, FCC CFG 15.247, .205, .209, EN, and JDEC                                                                                                                                                                                                                                           |                                                                                   |
| Operating Conditions              |                                 |       |      |       | V <sub>CC</sub> =3.0V to 4.2V (Spec Compliant); V <sub>CC</sub> > 4.2V to 4.8V (Reduced Performance); V <sub>REG</sub> =3.0V to 3.2V; Switch Control voltage=3.0V to 3.6V; Temp=-10 °C to +70 °C (Spec Compliant); Temp=-30 °C to -10 °C and +70 °C to +85 °C (Reduced Performance). Unless noted otherwise. |                                                                                   |
| Frequency                         | 2.4                             |       | 2.5  | GHz   |                                                                                                                                                                                                                                                                                                              |                                                                                   |
| Power Supply                      | 3.0                             | 3.3   | 4.2  | V     | Power Amplifier Voltage Supply (V <sub>CC</sub> )                                                                                                                                                                                                                                                            |                                                                                   |
| V <sub>REG</sub> Voltage          |                                 |       |      |       |                                                                                                                                                                                                                                                                                                              |                                                                                   |
|                                   | ON                              | 3.0   | 3.1  | 3.2   | V                                                                                                                                                                                                                                                                                                            | PA in "ON" state                                                                  |
|                                   | OFF                             |       | 0.00 | 0.20  | V                                                                                                                                                                                                                                                                                                            | PA in "OFF" state                                                                 |
| Output Power                      |                                 |       |      |       |                                                                                                                                                                                                                                                                                                              |                                                                                   |
|                                   | 11g                             | 18    | 19.5 |       | dBm                                                                                                                                                                                                                                                                                                          | 54 Mbps OFDM 64QAM, V <sub>CC</sub> > 3.0V, Temp=25 °C                            |
|                                   |                                 | 19    | 20   |       | dBm                                                                                                                                                                                                                                                                                                          | 54 Mbps OFDM 64QAM, V <sub>CC</sub> > 3.3V, Temp=25 °C                            |
|                                   | 11b                             | 20    | 23   |       | dBm                                                                                                                                                                                                                                                                                                          | 11 Mbps CCK signal, BT=0.45, V <sub>CC</sub> >=3.3V, Temp=25 °C                   |
| EVM                               |                                 |       | 3.3  | 4.0   | %                                                                                                                                                                                                                                                                                                            | P <sub>OUT(g)</sub> =Rated Output Power, 54 Mbps OFDM, 50Ω, see note 1            |
| Adjacent Channel Power            |                                 |       |      |       |                                                                                                                                                                                                                                                                                                              | P <sub>OUT(b)</sub> =23dBm, 11Mbps CCK signal, V <sub>CC</sub> >=3.3V, see note 4 |
|                                   | ACP1                            |       | -36  | -33   | dBc                                                                                                                                                                                                                                                                                                          | +/- 11 MHz Offset from carrier                                                    |
|                                   | ACP2                            |       | -56  | -51   | dBc                                                                                                                                                                                                                                                                                                          | +/- 22 MHz Offset from carrier                                                    |
| Gain                              |                                 | 26    | 30   | 34.5  | dB                                                                                                                                                                                                                                                                                                           |                                                                                   |
| Gain Variation Slope              |                                 |       |      |       |                                                                                                                                                                                                                                                                                                              | At rated power and a given supply voltage                                         |
|                                   | Range                           | 3.0   |      | 4.8   | V                                                                                                                                                                                                                                                                                                            |                                                                                   |
|                                   | V <sub>CC</sub> (Average)       |       |      | 0.5   | dB/V                                                                                                                                                                                                                                                                                                         |                                                                                   |
|                                   | V <sub>CC</sub> (Instantaneous) |       |      | 1     | dB/V                                                                                                                                                                                                                                                                                                         |                                                                                   |
|                                   | Frequency                       | -0.5  |      | +0.5  | dB                                                                                                                                                                                                                                                                                                           | 2.4GHz to 2.5GHz                                                                  |
|                                   | Over Temperature                | -1.75 |      | +1.75 | dB                                                                                                                                                                                                                                                                                                           | V <sub>CC</sub> =3.3V, V <sub>REG</sub> =3.1V, Freq=2.45GHz                       |

| Parameter                                                                                | Specification                |      |        | Unit       | Condition                                                                                                                      |
|------------------------------------------------------------------------------------------|------------------------------|------|--------|------------|--------------------------------------------------------------------------------------------------------------------------------|
|                                                                                          | Min.                         | Typ. | Max.   |            |                                                                                                                                |
| <b>2.4GHz Transmit Parameters, continued</b>                                             |                              |      |        |            |                                                                                                                                |
| Typical Input Power                                                                      |                              |      |        |            |                                                                                                                                |
|                                                                                          | 11g                          | -9   |        | dBm        |                                                                                                                                |
|                                                                                          | 11b                          | -5   |        | dBm        |                                                                                                                                |
| Power Detect                                                                             |                              |      |        |            |                                                                                                                                |
| Power Range                                                                              | 0                            |      | 23     | dBm        |                                                                                                                                |
| Voltage Range                                                                            | 0.1                          |      | 1.5    | V          |                                                                                                                                |
| Resistance                                                                               |                              | 10   |        | k $\Omega$ |                                                                                                                                |
| Capacitance                                                                              |                              |      | 10     | pF         |                                                                                                                                |
| Sensitivity                                                                              |                              |      |        |            |                                                                                                                                |
|                                                                                          | 0 < P <sub>OUT</sub> < 6dBm  | 3    |        | mV/dB      |                                                                                                                                |
|                                                                                          | 6 < P <sub>OUT</sub> < 23dBm | 8    | 350    | mV/dB      |                                                                                                                                |
| Current Consumption (I <sub>CC</sub> )                                                   |                              |      |        |            | V <sub>CC</sub> =3.3V, V <sub>REG</sub> =3.1V, T=25 °C                                                                         |
| Quiescent Current                                                                        |                              | 90   |        | mA         | RF="OFF" I <sub>CQ</sub> variation from nominal +/- 20mA                                                                       |
|                                                                                          | 11g                          | 170  | 200    | mA         | RF P <sub>OUT</sub> =18.5 dBm, 11g, 50 $\Omega$                                                                                |
|                                                                                          | 11b                          | 220  | 290    | mA         | 11Mbps CCK signal, BT=0.45, Rated Output Power, V <sub>CC</sub> =3.3V, Temp=25 °C, 50 $\Omega$                                 |
|                                                                                          | I <sub>REG</sub>             |      | 3      | mA         | V <sub>REG</sub> > 3.0V                                                                                                        |
| V <sub>CC</sub> Leakage Current                                                          |                              | 2    | 10     | $\mu$ A    | V <sub>CC</sub> =4.8V, V <sub>REG</sub> =C_BT=C_RX=C_BWRX $\leq$ 0.2 V                                                         |
| Input Port Impedance                                                                     |                              | 50   |        | $\Omega$   |                                                                                                                                |
| Input Port Return Loss                                                                   | 10                           | 15   |        | dB         |                                                                                                                                |
| Ruggedness                                                                               |                              |      |        |            | No Damage Conditions: max operating voltage, max input power, max temperature                                                  |
| Output VSWR                                                                              |                              |      | 10:1   |            |                                                                                                                                |
| Input Power                                                                              |                              |      | -5     | dBm        |                                                                                                                                |
| Stability                                                                                |                              |      |        |            | PA must be stable from 0dBm to 20dBm. No spurs above -41.25dBm for non-harmonic related signals.                               |
| Output VSWR                                                                              | 6:1                          |      |        |            | CW signal, P <sub>OUT</sub> =20dBm, all phases                                                                                 |
| Out-of-Band Emissions 2310MHz to 2390MHz and 2483.5MHz to 2500MHz (FCC restricted bands) |                              |      | -41.25 | dBm/MHz    | P <sub>OUT</sub> =16.5 dBm, 54Mbps OFDM Modulation, 64QAM, RBW=1MHz, VBW=100kHz, V <sub>CC</sub> =3.3V, V <sub>REG</sub> =3.1V |
|                                                                                          |                              |      | -41.25 | dBm/MHz    | P <sub>OUT</sub> =20.5dBm, 11Mbps CCK Modulation, BT=0.45, RBW=1MHz, VBW=100kHz, V <sub>CC</sub> =3.3V, V <sub>REG</sub> =3.1V |
| Thermal Resistance                                                                       |                              | 20   |        |            | V <sub>CC</sub> =4.8V, V <sub>REG</sub> =3.2, P <sub>OUT</sub> =20dBm, T <sub>REF</sub> =85 °C                                 |
| Harmonics                                                                                |                              |      |        |            | 11b modulation, 1Mbps, BW=1MHz, up to 3:1 load, P <sub>OUT</sub> =20 dBm                                                       |
|                                                                                          | Second                       |      | -23    | dBm        | 4.80GHz to 5.00GHz                                                                                                             |
|                                                                                          | Third                        |      | -20    | dBm        | 7.20GHz to 7.50GHz                                                                                                             |
| Turn-on/off Time                                                                         |                              | 0.5  | 1.0    | $\mu$ S    | Output stable to within 90% of final gain, Note 1                                                                              |

| Parameter                                 | Specification |      |      | Unit | Condition                                                          |
|-------------------------------------------|---------------|------|------|------|--------------------------------------------------------------------|
|                                           | Min.          | Typ. | Max. |      |                                                                    |
| <b>2.4GHz Receive Parameters</b>          |               |      |      |      |                                                                    |
| Compliance                                |               |      |      |      | IEEE802.11b, IEEE802.11g, FCC CFG 15.247, .205, .209, EN, and JDEC |
| Frequency                                 | 2.4           |      | 2.5  | GHz  |                                                                    |
| LNA Voltage Supply (LNA V <sub>CC</sub> ) | 3.0           | 3.3  | 4.2  | V    | LNA V <sub>CC</sub> can be tied to V <sub>BATT</sub> at all times  |
| LNA Current                               |               | 10   |      | mA   | LNA in "ON" state                                                  |
|                                           | 0             |      | 5    | μA   | LNA in "OFF" state (C_RX=low, LNA V <sub>CC</sub> =ON)             |
| LNA Input P1dB                            | -8            | -7   |      | dBm  |                                                                    |
| Gain                                      |               |      |      |      |                                                                    |
| WiFi RX Gain                              | 16            | 18   | 20   | dB   | WiFi RX mode                                                       |
| Simultaneous WiFi/BT RX Mode              | 11            | 13   | 15   | dB   | WiFi RX/BT Mode, LNA "ON"                                          |
| Noise Figure                              |               |      |      |      | V <sub>CC</sub> ≥ 3.3V, including switch                           |
| WiFi RX                                   |               | 2.1  | 3.5  | dB   | WiFi RX mode (LNA "ON")                                            |
| Simultaneous WiFi/BT RX Mode              |               | 3    | 4    | dB   | WiFi RX/BT Mode (LNA "ON")                                         |
| Passband Ripple                           | -0.2          |      | +0.2 | dB   | WiFi RX Mode                                                       |
|                                           | -0.5          |      | +0.5 | dB   | WiFi RX/BT Mode                                                    |
| WiFi RX Port Return Loss                  | 9.6           |      |      | dB   |                                                                    |
|                                           | 5             |      |      | dB   | Switch in WiFi RX/Bluetooth Mode                                   |
| WiFi RX Port Impedance                    |               | 50   |      | Ω    | No external matching                                               |
| <b>Bluetooth Parameters</b>               |               |      |      |      |                                                                    |
| Frequency                                 | 2.4           |      | 2.5  | GHz  |                                                                    |
| Insertion Loss                            |               |      |      |      |                                                                    |
| BT TX/RX only                             |               | 1.2  | 1.5  | dB   | Bluetooth mode                                                     |
| BT/WiFi RX GAIN (simultaneous mode)       | 11            | 13   | 15   | dB   | WiFi RX/BT Mode, LNA "ON"                                          |
| Passband Ripple                           | -0.2          |      | +0.2 | dB   | Bluetooth mode                                                     |
|                                           | -0.5          |      | +0.5 | dB   | WiFi RX/BT mode                                                    |
| Input P1dB                                | 27            | 30   |      | dB   | BT Mode, over temp, C_BT=3.3V to 3.6V                              |
| Bluetooth Port Return Loss                | 9.6           |      |      | dB   | Switch in Bluetooth Mode                                           |
|                                           | 7             |      |      | dB   | Switch in WiFi RX/Bluetooth Mode                                   |
| <b>Other Requirements</b>                 |               |      |      |      |                                                                    |
| Antenna Port Impedance                    |               |      |      |      |                                                                    |
| Output                                    |               | 50   |      | Ω    |                                                                    |
| Return Loss                               |               | 10   |      | dB   |                                                                    |
| Isolation                                 |               |      |      |      |                                                                    |
| Antenna to Receive                        | 20            |      |      | dB   | In BT Mode (measured from ANT to RX port)                          |
| Antenna to <i>Bluetooth</i> <sup>®</sup>  | 20            |      |      | dB   | In TX Mode (measured from ANT to BT port)                          |
| Antenna to Receive                        | 20            |      |      | dB   | In TX Mode (measured from ANT to RX port)                          |
| Switch Control Voltage                    |               |      |      |      | C_RX, C_BT, and C_BW_RX control lines                              |
| Low                                       |               | 0    | 0.2  | V    | Switch is in the low state (L)                                     |
| High                                      | 1.7           | 3.3  | 3.6  | V    | Switch is in the high state (H)                                    |
| Switch Control Current                    |               | 2    | 10   | μA   | Per control line (C_BT, C_BWRX)                                    |
| C_RX Current                              |               |      | 100  | μA   | Over V <sub>CC</sub> , Frequency and Temperature.                  |
| Switch Control Speed                      |               |      | 100  | μs   |                                                                    |
| Switch P1dB                               |               | 28   |      | dBm  |                                                                    |

| Parameter                            | Specification |      |      | Unit | Condition               |
|--------------------------------------|---------------|------|------|------|-------------------------|
|                                      | Min.          | Typ. | Max. |      |                         |
| <b>Other Requirements, continued</b> |               |      |      |      |                         |
| ESD                                  |               |      |      |      |                         |
| Human Body Model                     | 500           |      |      | V    | EIA/JESD22-114A RF pins |
|                                      | 1000          |      |      | V    | EIA/JESD22-114A DC pins |
| Charge Device Model                  | 500           |      |      | V    | JESD22-C101C all pins   |

Note 1: The PA module must operate with gated bias voltage input at 1% to 99% duty cycle.

Note 3: Values to be agreed to upon characterization data review: current, gain, return loss, detector sensitivity and output power.

Note 4: The output power for channels 1 and 11 may be reduced to meet FCC restricted band requirements.

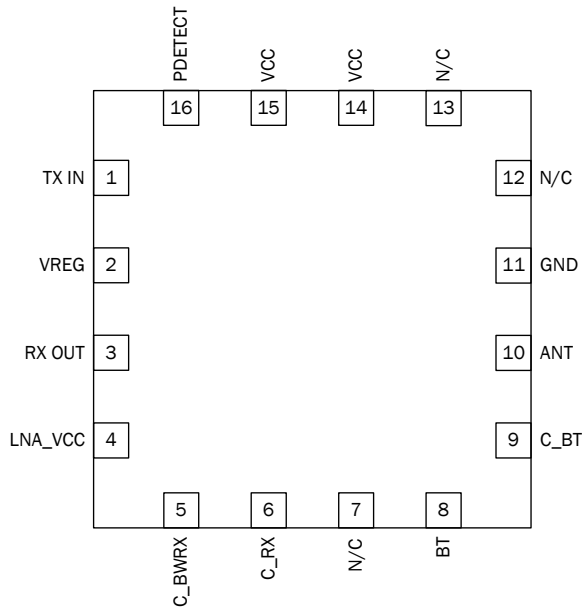
**Switch Control Logic**

| Mode        | VREG | C RX | C BT | C BWRx |
|-------------|------|------|------|--------|
| Standby     | L    | L    | L    | L      |
| WiFi TX     | H    | L    | L    | L      |
| WiFi RX     | L    | H    | L    | L      |
| WiFi RX/BT* | L    | H    | L    | H      |
| BT RX       | L    | L    | H    | L      |
| BT TX       | L    | L    | H    | L      |

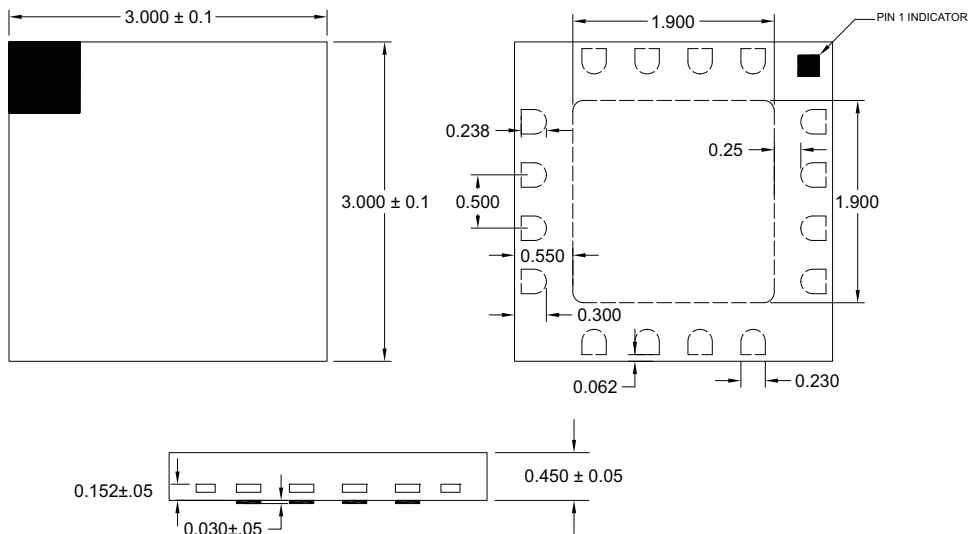
\*The FEM can be placed in receive WiFi and *Bluetooth*® modes simultaneously with increased insertion loss.

| Pin | Function | Description                                                                                                                                                                                                          |
|-----|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | TX_IN    | RF input for the 802.11b/g PA. Input is matched to 50Ω and DC block is provided.                                                                                                                                     |
| 2   | VREG     | Regulated voltage for the bias control circuit, and the TX control port of the SP3T which is also tied to this pin. An external bypass capacitor may be needed on the V <sub>REG</sub> line for decoupling purposes. |
| 3   | RX_OUT   | Receive port for 802.11b/g band. Internally matched to 50Ω. DC block provided.                                                                                                                                       |
| 4   | LNA_VDD  | Voltage supply for the LNA.                                                                                                                                                                                          |
| 5   | C_BWRX   | SPST switch control pin. (Simultaneous WiFi and BT receive.) See truth table for proper level.                                                                                                                       |
| 6   | C_RX     | Receive switch control pin. See switch truth table for proper level.                                                                                                                                                 |
| 7   | N/C      | No connect.                                                                                                                                                                                                          |
| 8   | BT       | RF bidirectional port for <i>Bluetooth</i> ®. Input is matched to 50Ω and DC block is provided.                                                                                                                      |
| 9   | C_BT     | <i>Bluetooth</i> ® switch control pin. See truth table for proper level.                                                                                                                                             |
| 10  | ANT      | Port matched to 50Ω and is DC blocked internally.                                                                                                                                                                    |
| 11  | GND      | Ground.                                                                                                                                                                                                              |
| 12  | N/C      | No connect.                                                                                                                                                                                                          |
| 13  | N/C      | No connect.                                                                                                                                                                                                          |
| 14  | VCC      | Supply voltage for the PA.                                                                                                                                                                                           |
| 15  | VCC      | Supply voltage for the bias circuit of the PA.                                                                                                                                                                       |
| 16  | PDETECT  | Power detector voltage for TX section. PDET voltage varies with output power. May need external decoupling capacitor for noise bypassing. May need external circuitry to bring output voltage to desired level.      |

## Pin Out



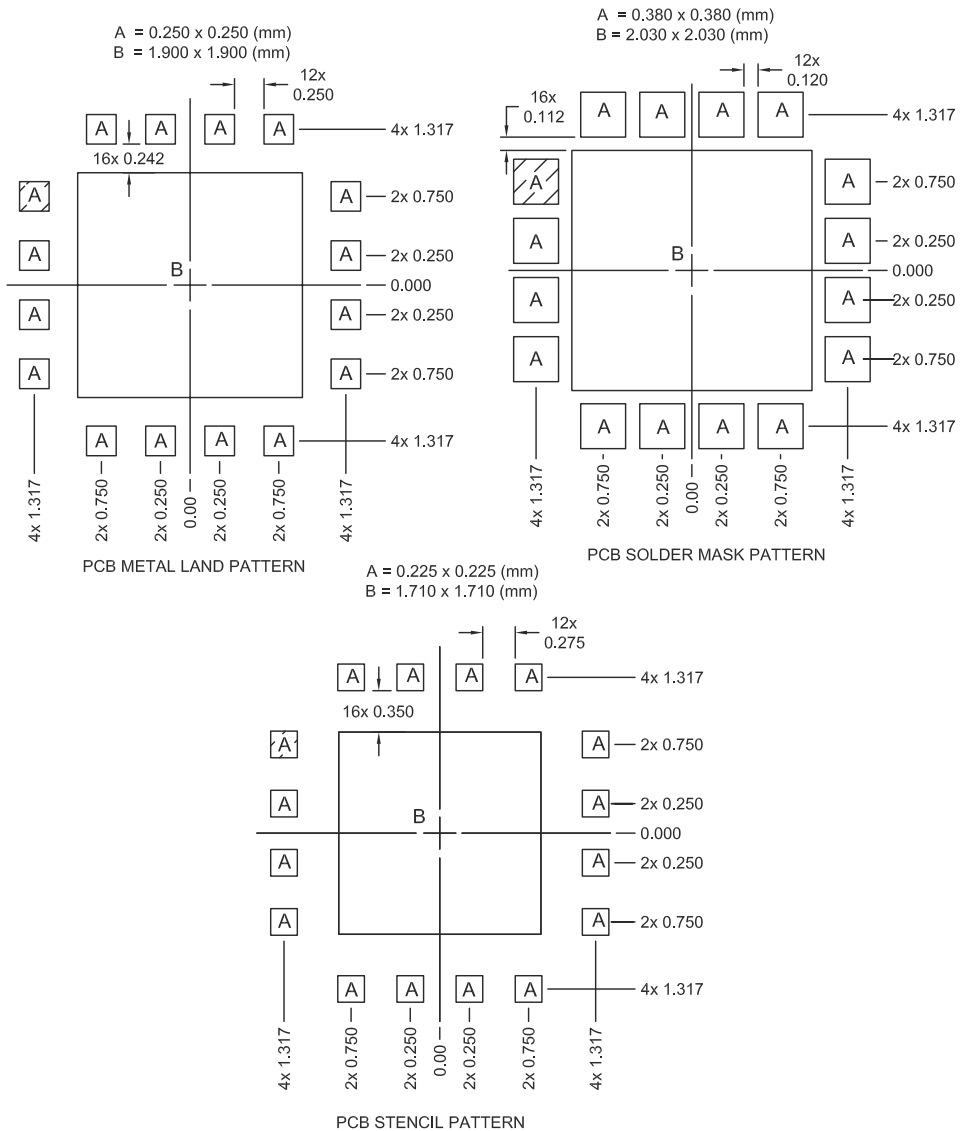
**Package Drawing**



**NOTES:**

- 1 Shaded Area is Pin 1 Indicator

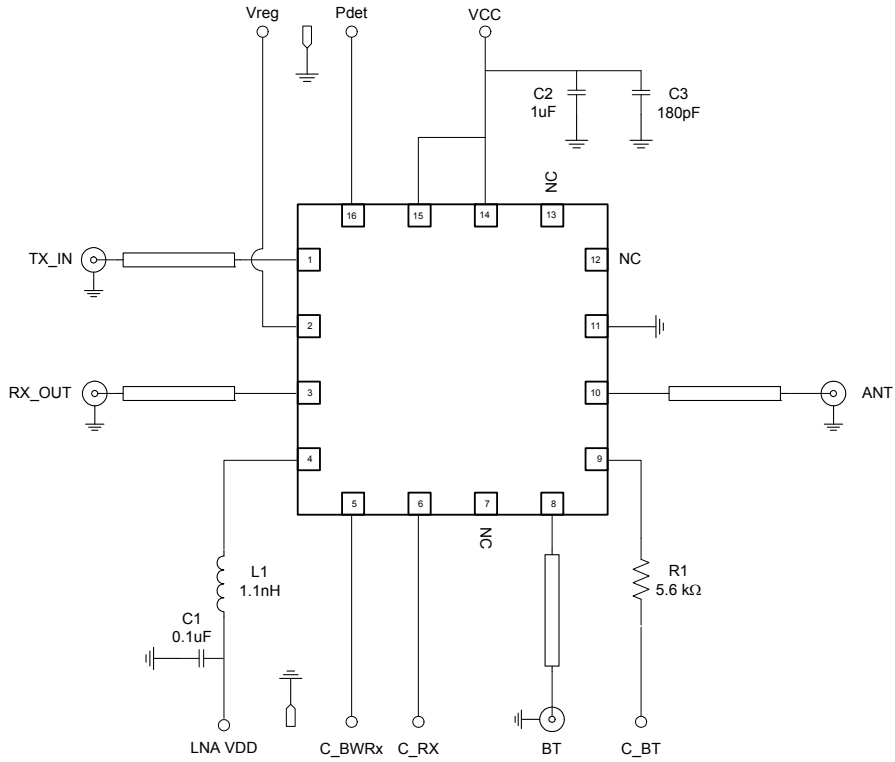
## RF5765 PCB Footprint and Stencil Recommendations



Shaded are represents Pin 1 location.



**Application Schematic**



## Theory of Operation

The RF5765 Front End Module (FEM) is designed for WiFi applications in the 2.5GHz ISM band. It can be applied in many portable applications such as handsets, Portable Media Players, and portable battery power equipment. This highly integrated module can be connected directly to the battery without additional voltage regulators.

### WiFi TRANSMIT MODE

The RF5765 requires a single positive supply ( $V_{CC}$ ), a positive supply for switch controls, and a regulated supply for the  $V_{REG}$  to maintain nominal bias current. The RF5765 transmit path has a typical gain of 30dB from 2.4GHz to 2.5GHz, and delivers 20dBm typical output power under 54Mbps OFDM modulation and 23dBm under 1Mbps 11b modulation. The RF5765 contains basic filter components to produce a bandpass response for the transmit path. Due to space constraints inside the module, filtering is limited to a few resonant poles and additional filters may be required depending upon the end-user's application. While in transmit mode, the active components are the Power Amplifier (PA) and the TX branch of the SP3T switch. Refer to the logic control table for proper settings.

### TX Biasing Instructions

- Connect the TX input (pin-1) to a signal generator and a spectrum analyzer at the Antenna output (pin-10)
- Set  $V_{CC}$  to 3.3V with  $V_{REG}$  set to 0V
- Turn  $V_{REG}$  ON and set voltage to 3.1V.  $V_{REG}$  controls the current drawn by the PA and it should quickly reach a quiescent current of approximately 90mA±20mA. Care must be exercised not to exceed 3.5V on the  $V_{REG}$  pin or the part may be damaged.
- Control bias to the transmit branch of the SP3T switch is tied directly to  $V_{REG}$
- The SP3T controls for the off branches (C\_RX and C\_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance of the PA will degrade significantly. Likewise, unused RF Ports must be terminated in 50Ω to simulate actual system conditions and prevent RF signals from coupling back to the PA.
- Turn RF ON

### WiFi RECEIVE MODE

Within the frequency band of operation 2.4GHz to 2.5GHz, the RF5765 WiFi receive path has a typical gain of 18dB and a NF of 2.1dB with about 10mA of current. In RX mode, only the RX branch of the SP3T and the LNA are active. Refer to the logic control table for proper settings.

### RX Biasing Instructions

- Connect the RX input (ANT/pin-10) to a signal generator and a spectrum analyzer at the RX output (pin-3). A VNA may be used as well.
- Turn the LNA bias ON (pin-4) and set the voltage to 3.3V
- Set C\_RX (pin-6) high. This turns ON the receive branch of the SP3T.
- The SP3T controls for the off branches ( $V_{REG}$  and C\_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance will degrade. It is recommended to terminate unused RF Ports in 50Ω.
- Set the control bias for the SPST switch (C\_BWRX/pin-5) "low" during WiFi RX only mode.
- Turn RF ON

### WiFi and BLUETOOTH® RECEIVE (SIMULTANEOUS MODE)

The RF765 WiFi and Bluetooth® receive circuits were specifically designed to address issues of simultaneous operation. In this mode both signals can be received at the same time when the C\_BWRX (pin-5) is set high. The typical gain for each RF path is approximately 13dB and a NF of 3dB. During simultaneous mode the active components are the LNA, the SPST switch, and only the RX branch of the SP3T. Refer to the logic control table for proper settings.

#### Simultaneous Mode Biasing Instructions

- Connect the RF input (ANT/pin-10) to a signal generator and a spectrum analyzer at the RX (pin-3) and BT (pin-8) RF ports. A multiport VNA may be used as well.
- Turn the LNA bias ON (pin-4) and set the voltage to 3.3V
- Set C\_RX and C\_BWRX high. This turns ON the receive branch of the SP3T and the SPST switch.
- The SP3T controls for the off branches ( $V_{REG}$  and C\_BT) must be set to a logic “low” (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic “high” the performance will degrade. It is recommended to terminate unused RF Ports in 50 $\Omega$ .
- Turn RF ON

### BLUETOOTH® MODE

The RF765 Bluetooth® only mode is implemented through the SP3T switch by setting C\_BT “high.” Typical insertion loss is about 1.2dB.

#### Bluetooth® Biasing Instructions

- Connect the RF input (ANT/pin-10) to a signal generator and a spectrum analyzer at the BT RF port. A VNA may be used in place of the Sig Gen and SA.
- Set C\_BT (pin-9) “high.” This turns the Bluetooth® branch of the SP3T switch ON.
- The SP3T controls for the off branches ( $V_{REG}$  and C\_RX) must be set to a logic “low” (0.2V max) or grounded. Do not leave floating.
- Terminate unused RF Ports in 50 $\Omega$
- Turn RF ON

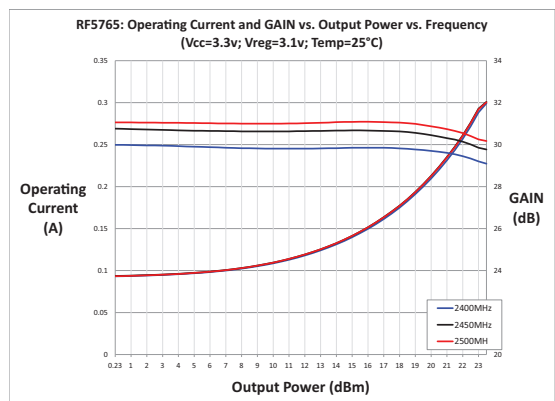
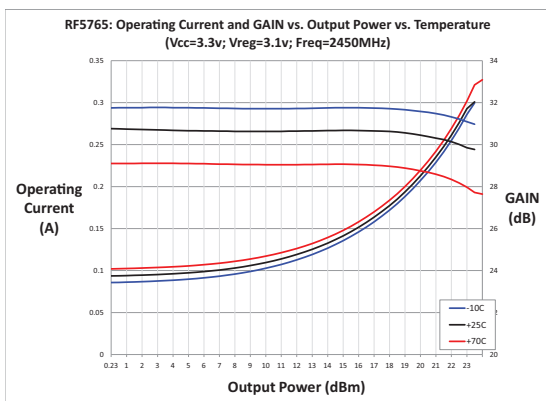
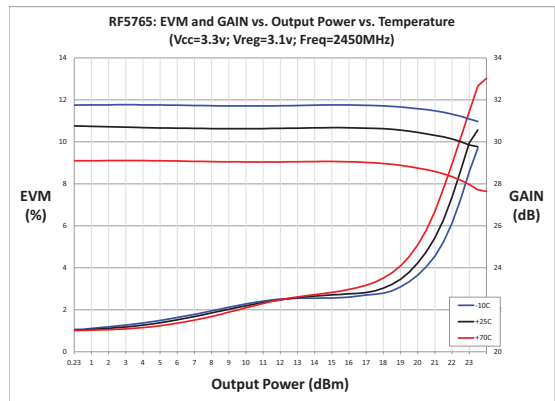
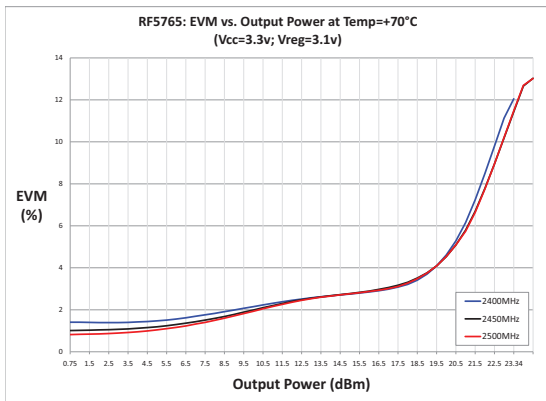
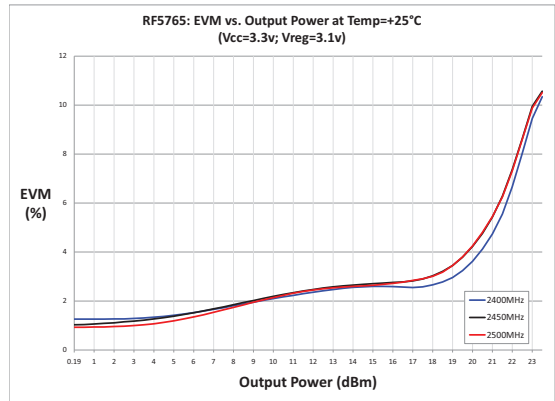
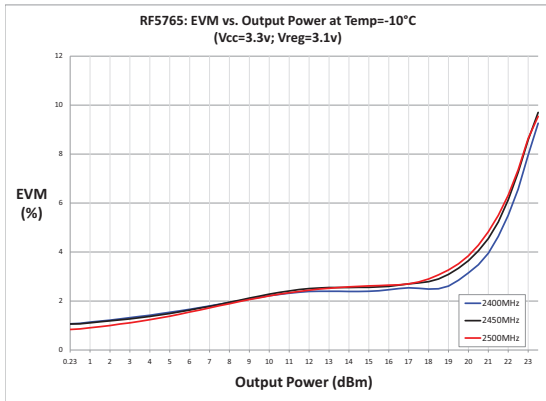
### APPLICATION CIRCUIT AND LAYOUT RECOMMENDATIONS

The RF5765 integrates the matching networks and DC blocking capacitors for all RF ports. This greatly reduces the number of external components and layout area needed to implement this FEM. Typically only a total of four external components are required to achieve nominal performance. However, depending on board layout and the many noise signals that could potentially couple to the RF5765, additional bypassing capacitors may be required to properly filter out unwanted signals that might degrade performance.

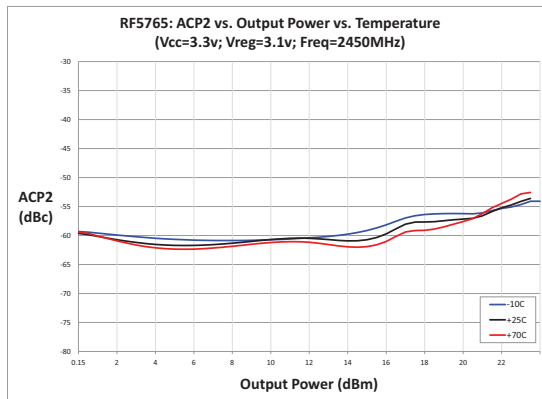
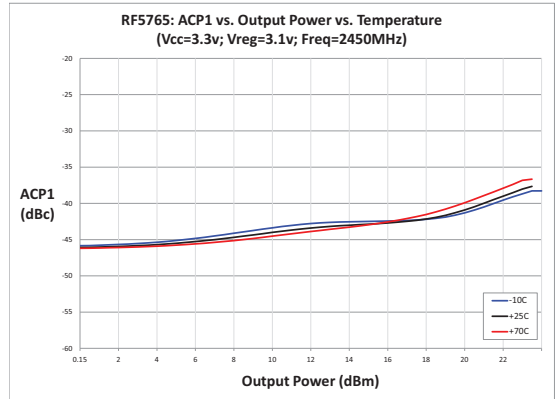
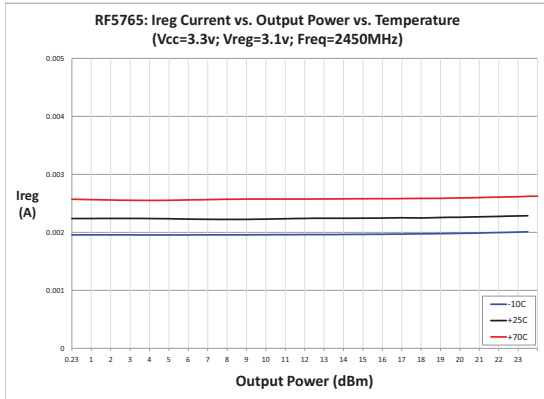
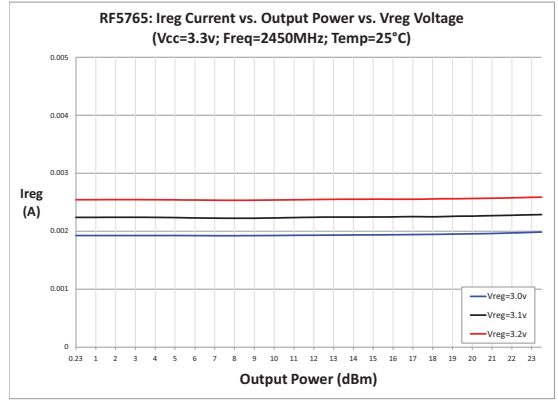
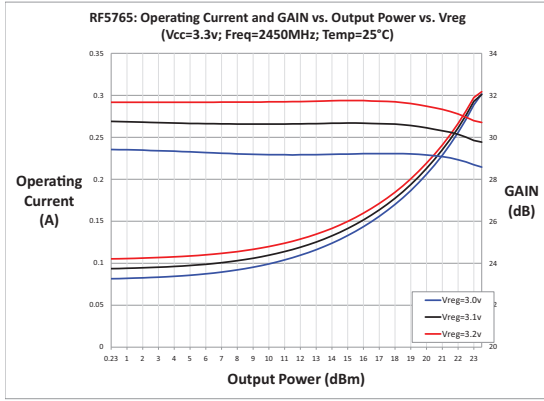
The LNA bias components consist of an inductor and a decoupling capacitor. The inductor value is critical to optimize NF and return loss at the RX output. For best performance and trade off between critical parameters such as NF, Gain, and IP3, the total inductance including board trace should be approximately 1.2nH. The 5.6k $\Omega$  series resistor for the Bluetooth® control line helps to prevent unwanted signal from coupling to this pin. The resistor should be placed as close as possible to the package pin. The last component needed in the application circuit is a low frequency bypass capacitor on the  $V_{CC}$  line. In general, it is good RF practice to have proper decoupling of supply lines to filter out noise. Occasionally, depending on the level of coupling or parasitics of the board, a high frequency bypass capacitor must be added as well.

In order to optimize performance for both the Transmit and Receive paths, a good layout design must be implemented. In addition to designing 50 $\Omega$  RF lines, proper grounding along the RF traces and on the FEM ground slug must be exercised. This will minimize coupling and provide good thermal dissipation when the PA is operating at high power. For reference, the RFMD evaluation board uses 9 thermal ground vias (hole/capture pad 12/22mil) on the ground slug. Additionally, if space permitted,  $V_{CC}$  and control lines must be isolated from each other with ground vias in between them. RFMD evaluation board gerbers are available upon request.

## RF5765 Transmit Performance Graphs



**RF5765 Transmit Performance Graphs (continued)**



## RF5765 Receive Performance Graphs

