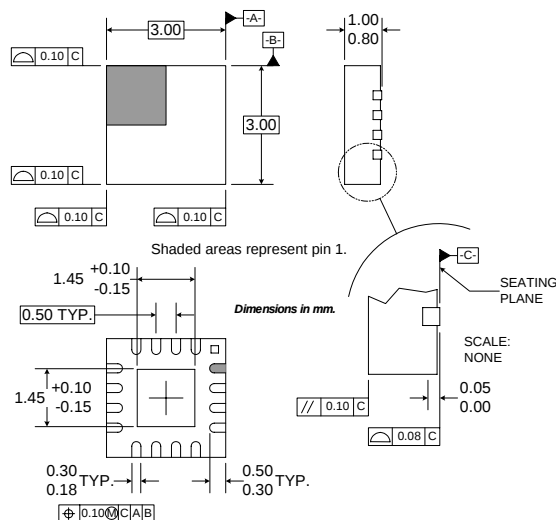


### Typical Applications

- 3V CDMA Korean-PCS Handset
- 3V CDMA2000/1X-EV-DO K-PCS Handset
- 3V CDMA2000/1XRTT K-PCS Handset
- Spread-Spectrum System

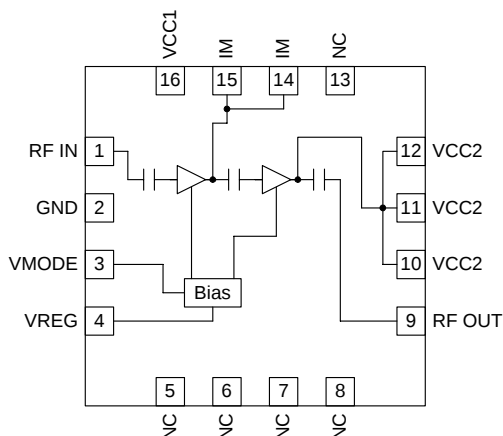
### Product Description

The RF3165 is a high-power, high-efficiency linear amplifier module specifically designed for 3V handheld systems. The device is manufactured on an advanced third generation GaAs HBT process, and was designed for use as the final RF amplifier in 3V IS-95/CDMA 2000 1X handheld digital cellular equipment, spread-spectrum systems, and other applications in the 1750MHz to 1780MHz band. The RF3165 has a digital control line for low power applications to lower quiescent current. The RF3165 is assembled in at 16-pin, 3mmx3mm, QFN package.



### Optimum Technology Matching® Applied

- |                                     |                                              |                                       |
|-------------------------------------|----------------------------------------------|---------------------------------------|
| <input type="checkbox"/> Si BJT     | <input checked="" type="checkbox"/> GaAs HBT | <input type="checkbox"/> GaAs MESFET  |
| <input type="checkbox"/> Si Bi-CMOS | <input type="checkbox"/> SiGe HBT            | <input type="checkbox"/> Si CMOS      |
| <input type="checkbox"/> InGaP/HBT  | <input type="checkbox"/> GaN HEMT            | <input type="checkbox"/> SiGe Bi-CMOS |



Functional Block Diagram

### Package Style: QFN, 16-Pin, 3x3

### Features

- Input Internally Matched @ 50Ω
- Output Internally Matched
- 28dBm Linear Output Power
- 40% Peak Linear Efficiency
- 28dB Linear Gain
- -50dBc ACPR @ 1.25MHz

### Ordering Information

|                |                                          |
|----------------|------------------------------------------|
| RF3165         | 3V 1700MHz Linear Power Amplifier Module |
| RF3165PCBA-410 | Fully Assembled Evaluation Board         |

RF Micro Devices, Inc.  
7628 Thorndike Road  
Greensboro, NC 27409, USA

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Fax (336) 664 0454  
<http://www.rfmd.com>

## Absolute Maximum Ratings

| Parameter                                        | Rating      | Unit |
|--------------------------------------------------|-------------|------|
| Supply Voltage (RF off)                          | +8.0        | V    |
| Supply Voltage ( $P_{OUT} \leq 31\text{dBm}$ )   | +5.2        | V    |
| Control Voltage ( $V_{REG}$ )                    | +3.9        | V    |
| Input RF Power                                   | +10         | dBm  |
| Mode Voltage ( $V_{MODE}$ )                      | +3.9        | V    |
| Operating Temperature                            | -30 to +110 | °C   |
| Storage Temperature                              | -40 to +150 | °C   |
| Moisture Sensitivity Level<br>IPC/JEDEC J-STD-20 | MSL 2 @260  | °C   |



**Caution!** ESD sensitive device.

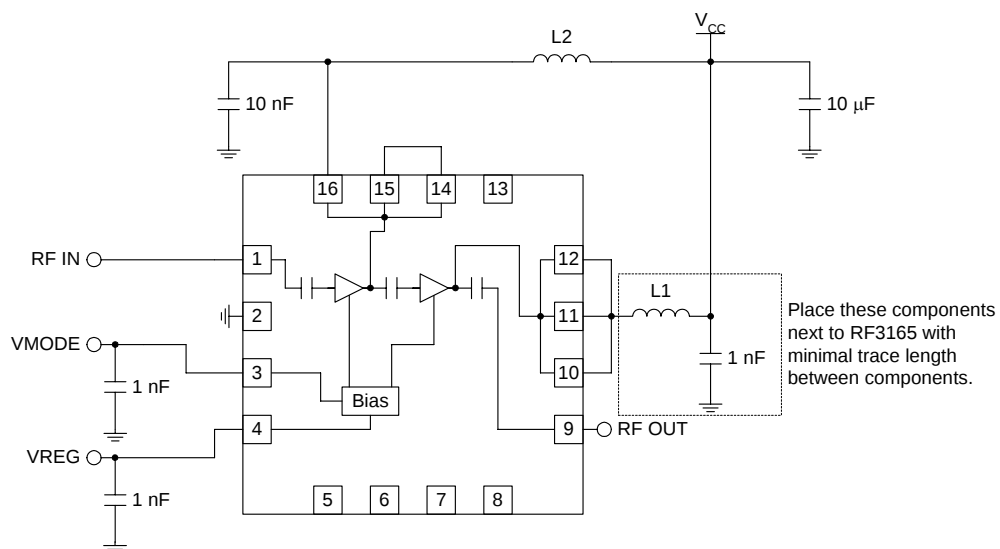
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| Parameter                                         | Specification |      |             | Unit   | Condition                                                                                                                                                                           |
|---------------------------------------------------|---------------|------|-------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                   | Min.          | Typ. | Max.        |        |                                                                                                                                                                                     |
| <b>High Gain Mode (<math>V_{MODE}</math> Low)</b> |               |      |             |        | $T=25^{\circ}\text{C}$ Ambient, $V_{CC}=3.4\text{V}$ , $V_{REG}=2.8\text{V}$ , $V_{MODE}=0\text{V}$ , and $P_{OUT}=28\text{dBm}$ for all parameters (unless otherwise specified).   |
| Operating Frequency Range                         | 1750          |      | 1780        | MHz    |                                                                                                                                                                                     |
| Linear Gain                                       | 26            | 28   |             | dB     |                                                                                                                                                                                     |
| Second Harmonics                                  |               | -35  |             | dBc    |                                                                                                                                                                                     |
| Third Harmonics                                   |               | -40  |             | dBc    |                                                                                                                                                                                     |
| Maximum Linear Output                             | 28            |      |             | dBm    |                                                                                                                                                                                     |
| Linear Efficiency                                 |               | 40   |             | %      |                                                                                                                                                                                     |
| Maximum $I_{CC}$                                  |               | 460  |             | mA     |                                                                                                                                                                                     |
| ACPR @ 1.25MHz                                    |               | -50  |             | dBc    |                                                                                                                                                                                     |
| ACPR @ 1.98MHz                                    |               | -55  |             | dBc    |                                                                                                                                                                                     |
| ACPR @ 2.25MHz                                    |               | -59  |             | dBc    |                                                                                                                                                                                     |
| Input VSWR                                        |               | 2:1  |             |        |                                                                                                                                                                                     |
| Output VSWR Stability                             |               |      | 6:1<br>10:1 |        | No oscillation > -70dBc<br>No damage                                                                                                                                                |
| Noise Power                                       |               | -138 |             | dBm/Hz | At 90MHz offset.                                                                                                                                                                    |
| <b>Low Gain Mode (<math>V_{MODE}</math> High)</b> |               |      |             |        | $T=25^{\circ}\text{C}$ Ambient, $V_{CC}=3.4\text{V}$ , $V_{REG}=2.8\text{V}$ , $V_{MODE}=2.8\text{V}$ , and $P_{OUT}=28\text{dBm}$ for all parameters (unless otherwise specified). |
| Operating Frequency Range                         | 1750          |      | 1780        | MHz    |                                                                                                                                                                                     |
| Linear Gain                                       |               | 27   |             | dB     |                                                                                                                                                                                     |
| Second Harmonics                                  |               | -35  |             | dBc    |                                                                                                                                                                                     |
| Third Harmonics                                   |               | -40  |             | dBc    |                                                                                                                                                                                     |
| Maximum Linear Output                             | 18            | 28   |             | dBm    |                                                                                                                                                                                     |
| Linear Efficiency                                 |               | 40   |             | %      |                                                                                                                                                                                     |
| ACPR @1.25MHz                                     |               | -50  |             | dBc    |                                                                                                                                                                                     |
| ACPR @ 1.98MHz                                    |               | -54  |             | dBc    |                                                                                                                                                                                     |
| ACPR @2.25MHz                                     |               | -58  |             | dBc    |                                                                                                                                                                                     |
| Maximum $I_{CC}$                                  |               | 130  |             | mA     | $P_{OUT}=16\text{dBm}$                                                                                                                                                              |
| Linear Gain                                       |               | 26   |             | dB     | $P_{OUT}=16\text{dBm}$                                                                                                                                                              |
| Input VSWR                                        |               | 2:1  |             |        |                                                                                                                                                                                     |
| Output VSWR Stability                             |               |      | 6:1<br>10:1 |        | No oscillation > -70dBc<br>No damage                                                                                                                                                |

| Parameter                                   | Specification |      |      | Unit | Condition                                                                                                                       |
|---------------------------------------------|---------------|------|------|------|---------------------------------------------------------------------------------------------------------------------------------|
|                                             | Min.          | Typ. | Max. |      |                                                                                                                                 |
| <b>Power Supply</b>                         |               |      |      |      |                                                                                                                                 |
| Supply Voltage                              | 3.2           | 3.4  | 4.2  | V    | $V_{\text{MODE}}=\text{low}$ and $V_{\text{REG}}=2.8\text{V}$<br>$V_{\text{MODE}}=\text{high}$ and $V_{\text{REG}}=2.8\text{V}$ |
| High Gain Idle Current                      |               | 65   |      | mA   |                                                                                                                                 |
| Low Gain Idle Current                       |               | 55   |      | mA   |                                                                                                                                 |
| $V_{\text{REG}}$ Current                    |               | 2    |      | mA   |                                                                                                                                 |
| $V_{\text{MODE}}$ Current                   |               | 250  |      | uA   |                                                                                                                                 |
| RF Turn On/Off Time                         |               | 1.2  | 6    | uS   |                                                                                                                                 |
| DC Turn On/Off Time                         |               | 2    | 40   | uS   |                                                                                                                                 |
| Total Current (Power Down)                  |               | 0.2  | 5    | uA   |                                                                                                                                 |
| $V_{\text{REG}}$ Low Voltage (Power Down)   | 0             |      | 0.5  | V    |                                                                                                                                 |
| $V_{\text{REG}}$ High Voltage (Recommended) | 2.75          | 2.8  | 2.95 | V    |                                                                                                                                 |
| $V_{\text{REG}}$ High Voltage (Operational) | 2.7           |      | 3.0  | V    | High Gain Mode                                                                                                                  |
| $V_{\text{MODE}}$ Voltage                   | 0             |      | 0.5  | V    |                                                                                                                                 |
| $V_{\text{MODE}}$ Voltage                   | 2.0           |      | 3.0  | V    |                                                                                                                                 |
|                                             |               |      |      |      | Low Gain Mode                                                                                                                   |

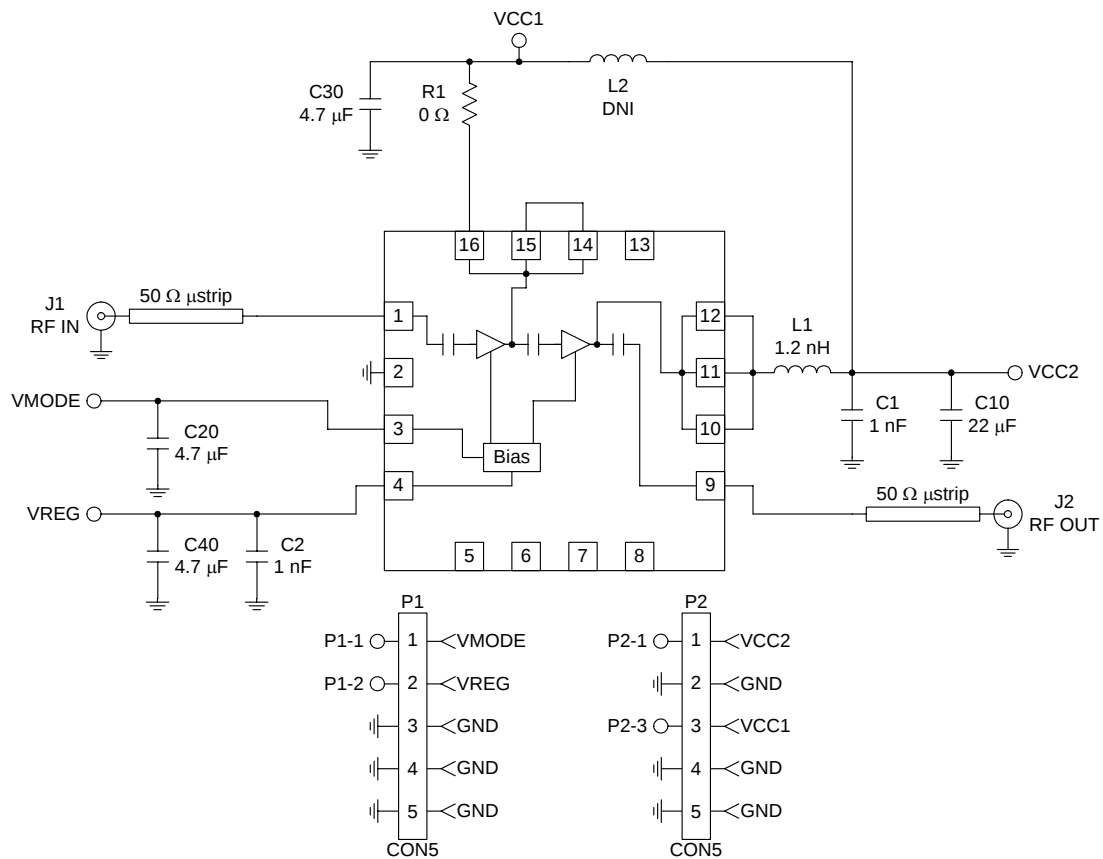
| Pin      | Function | Description                                                                                                                                                                                                         | Interface Schematic |
|----------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 1        | RF IN    | RF input internally matched to 50Ω. This input is internally AC-coupled.                                                                                                                                            |                     |
| 2        | GND      | Ground connection.                                                                                                                                                                                                  |                     |
| 3        | VMODE    | For nominal operation (High Power mode), V <sub>MODE</sub> is set LOW. When set HIGH, devices are biased lower to improve efficiency.                                                                               |                     |
| 4        | VREG     | Regulated voltage supply for amplifier bias circuit. In power down mode, both V <sub>REG</sub> and V <sub>MODE</sub> need to be LOW (<0.5V).                                                                        |                     |
| 5        | NC       | No connection. Do not connect this pin to any external circuit.                                                                                                                                                     |                     |
| 6        | NC       | No connection. Do not connect this pin to any external circuit.                                                                                                                                                     |                     |
| 7        | NC       | No connection. Do not connect this pin to any external circuit.                                                                                                                                                     |                     |
| 8        | NC       | No connection. Do not connect this pin to any external circuit.                                                                                                                                                     |                     |
| 9        | RF OUT   | RF output. Internally AC-coupled.                                                                                                                                                                                   |                     |
| 10       | VCC2     | Output stage collector supply. Please see the schematic for required external components.                                                                                                                           |                     |
| 11       | VCC2     | Same as pin 10.                                                                                                                                                                                                     |                     |
| 12       | VCC2     | Same as pin 10.                                                                                                                                                                                                     |                     |
| 13       | NC       | No connection. Do not connect this pin to any external circuit.                                                                                                                                                     |                     |
| 14       | IM       | Interstage matching. Connect to pin 15.                                                                                                                                                                             |                     |
| 15       | IM       | Interstage matching. Connect to pin 14.                                                                                                                                                                             |                     |
| 16       | VCC1     | First stage collector supply. A 4.7μF decoupling capacitor is required.                                                                                                                                             |                     |
| Pkg Base | GND      | Ground connection. The backside of the package should be soldered to a top side ground pad which is connected to the ground plane with multiple vias. The pad should have a short thermal path to the ground plane. |                     |

## Application Schematic



L1 = 1.5nH is recommended, but any value between 1.2nH to 2.2nH may be used.  
 L2 = 6.8nH is recommended, but any value between 4.7nH to 8.2nH may be used.  
 L2 may not be needed if Pin 16 is not routed directly to Pins 10, 11, and 12.

## Evaluation Board Schematic



## Electrostatic Discharge Sensitivity

### Human Body Model (HBM)

Figure 3 shows the HBM ESD sensitivity level for each pin to ground. The ESD test is in compliance with JESD22-A114.

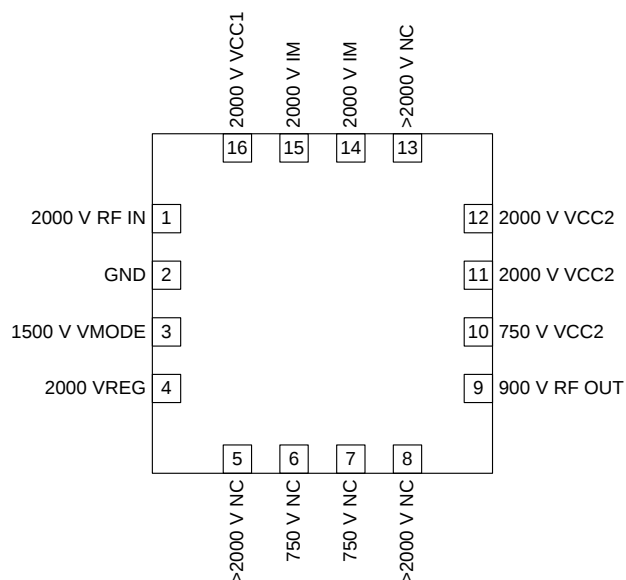


Figure 3. ESD Level - Human Body Model

### Machine Model (MM)

Figure 4 shows the MM ESD sensitivity level for each pin to ground. The ESD test is in compliance with JESD22-A115.

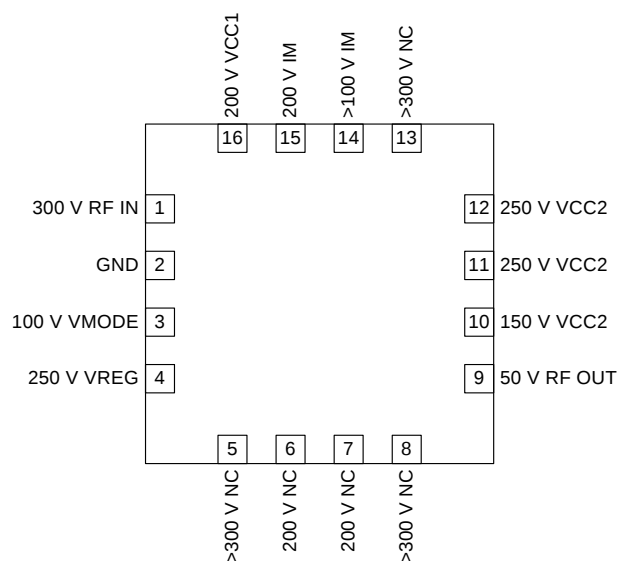


Figure 4. ESD Level - Machine Model

## PCB Design Requirements

### PCB Surface Finish

The PCB surface finish used for RFMD's qualification process is electroless nickel, immersion gold. Typical thickness is  $3\mu\text{inch}$  to  $8\mu\text{inch}$  gold over  $180\mu\text{inch}$  nickel.

### PCB Land Pattern Recommendation

PCB land patterns are based on IPC-SM-782 standards when possible. The pad pattern shown has been developed and tested for optimized assembly at RFMD; however, it may require some modifications to address company specific assembly processes. The PCB land pattern has been developed to accommodate lead and package tolerances.

### PCB Metal Land Pattern

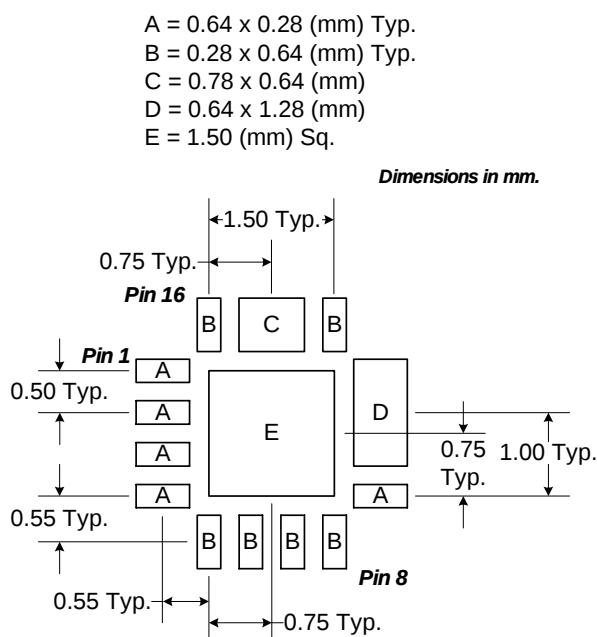


Figure 1. PCB Metal Land Pattern (Top View)

### PCB Solder Mask Pattern

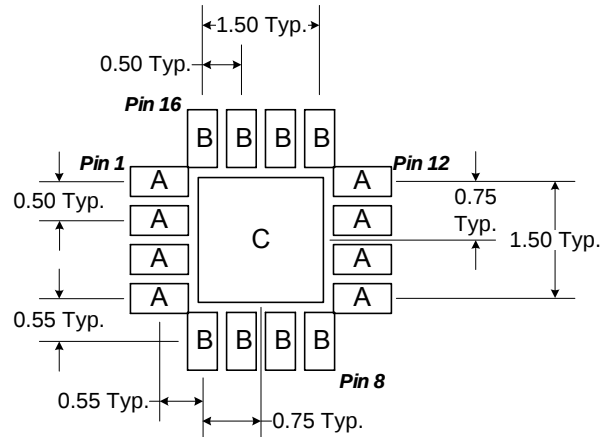
Liquid Photo-Imageable (LPI) solder mask is recommended. The solder mask footprint will match what is shown for the PCB metal land pattern with a 2mil to 3mil expansion to accommodate solder mask registration clearance around all pads. The center-grounding pad shall also have a solder mask clearance. Expansion of the pads to create solder mask clearance can be provided in the master data or requested from the PCB fabrication supplier.

A = 0.74 x 0.38 (mm) Typ.

B = 0.38 x 0.74 (mm) Typ.

C = 1.60 (mm) Sq.

*Dimensions in mm.*



**Figure 2. PCB Solder Mask Pattern (Top View)**

### Thermal Pad and Via Design

The PCB land pattern has been designed with a thermal pad that matches the die paddle size on the bottom of the device.

Thermal vias are required in the PCB layout to effectively conduct heat away from the package. The via pattern has been designed to address thermal, power dissipation and electrical requirements of the device as well as accommodating routing strategies.

The via pattern used for the RFMD qualification is based on thru-hole vias with 0.203mm to 0.330mm finished hole size on a 0.5mm to 1.2mm grid pattern with 0.025mm plating on via walls. If micro vias are used in a design, it is suggested that the quantity of vias be increased by a 4:1 ratio to achieve similar results.

