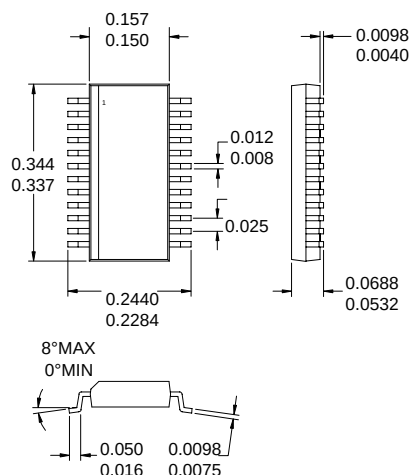


### Typical Applications

- CDMA/FM Cellular Systems
- CDMA PCS Systems
- Wireless Local Loop Systems
- Spread-Spectrum Cordless Phones
- High Speed Data Modems
- General Purpose Digital Receivers

### Product Description

The RF9957 is an integrated complete IF AGC amplifier and Quadrature Demodulator designed for the receive section of dual-mode CDMA/FM cellular and PCS applications. It is designed to amplify received IF signals, while providing 100dB of gain control range, and demodulate to baseband I and Q signals. Noise Figure,  $IP_3$ , and other specifications are designed to be compatible with the IS-98 and J-STD-018 Interim Standard for CDMA cellular communications. The IC is manufactured on an advanced 15GHz  $F_T$  Silicon Bipolar process, and is packaged in a standard miniature 24-lead plastic SSOP package.



7

QUADRATURE  
DEMODULATORS

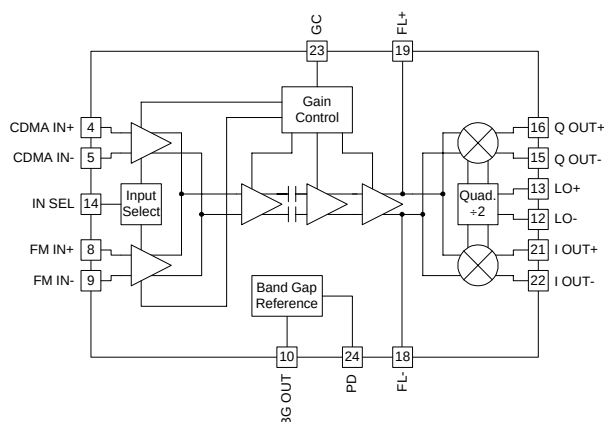
### Optimum Technology Matching® Applied

- |                                            |                                   |                                      |
|--------------------------------------------|-----------------------------------|--------------------------------------|
| <input checked="" type="checkbox"/> Si BJT | <input 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     |

Package Style: SSOP-24

### Features

- Supports Dual Mode Operation (CDMA and FM)
- Digitally Controlled Power Down Mode
- 2.7V to 3.3V Operation
- Quadrature LO Divider
- IF AGC Amp with 100dB Gain Control



Functional Block Diagram

### Ordering Information

|             |                                     |
|-------------|-------------------------------------|
| RF9957      | CDMA/FM Receive AGC and Demodulator |
| RF9957 PCBA | Fully Assembled Evaluation Board    |

RF Micro Devices, Inc.  
7625 Thorndike Road  
Greensboro, NC 27409, USA

Tel (336) 664 1233  
Fax (336) 664 0454  
<http://www.rfmd.com>

## Absolute Maximum Ratings

| Parameter                             | Rating                       | Unit            |
|---------------------------------------|------------------------------|-----------------|
| Supply Voltage                        | -0.5 to +5                   | V <sub>DC</sub> |
| Power Down Voltage (V <sub>PD</sub> ) | -0.5 to V <sub>CC</sub> +0.7 | V <sub>DC</sub> |
| Input RF Power                        | +3                           | dBm             |
| Ambient Operating Temperature         | -40 to +85                   | °C              |
| Storage Temperature                   | -40 to +150                  | °C              |



**Caution!** ESD sensitive device.

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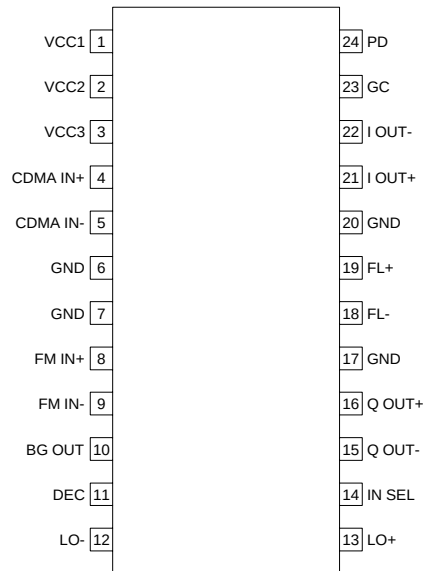
| Parameter                                | Specification |            |      | Unit             | Condition                                                                                                                                                          |
|------------------------------------------|---------------|------------|------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                          | Min.          | Typ.       | Max. |                  |                                                                                                                                                                    |
| <b>Overall (Cascaded)</b>                |               |            |      |                  | T=25 °C, V <sub>CC</sub> =3.0V, Z <sub>LOAD</sub> =5kΩ,<br>LO=170MHz @400mV <sub>PP</sub> IF Freq=85MHz,<br>Z <sub>S</sub> =500Ω (CDMA), Z <sub>S</sub> =850Ω (FM) |
| Maximum Gain                             | +45           | +50        |      | dB               | V <sub>GC</sub> =2.5V, FM or CDMA Input, Balanced                                                                                                                  |
| Minimum Gain                             |               | -55        | -50  | dB               | V <sub>GC</sub> =0.5V, FM or CDMA Input, Balanced                                                                                                                  |
| Gain Variation vs. V <sub>CC</sub> and T | -3            |            | +3   | dB               | V <sub>CC</sub> =2.7V to 3.3V and T=-30°C to +85°C                                                                                                                 |
| Input IP3                                |               | -50        |      | dBm              | V <sub>GC</sub> =2.5V, Maximum Gain                                                                                                                                |
|                                          | -39           | -36        |      | dBm              | Gain = 35 dB, P <sub>IN</sub> =-61dBm                                                                                                                              |
| Noise Figure                             |               | -4         |      | dBm              | V <sub>GC</sub> =0.5V, Minimum Gain                                                                                                                                |
|                                          |               | 5          |      | dB               | V <sub>GC</sub> =2.5V, Maximum Gain                                                                                                                                |
|                                          |               | 70         |      | dB               | V <sub>GC</sub> =0.5V, Minimum Gain                                                                                                                                |
| IF Input Frequency Range                 |               | 50 to 250  |      | MHz              |                                                                                                                                                                    |
| IF Input Impedance                       | 2040          | 2400       | 2760 | Ω                | FM or CDMA, Balanced                                                                                                                                               |
|                                          | 1020          | 1200       | 1380 | Ω                | FM or CDMA, Single Ended                                                                                                                                           |
| I/Q Frequency Range                      |               | 0 to 50    |      | MHz              |                                                                                                                                                                    |
| I/Q Amplitude Balance                    |               | 0.1        | 0.5  | dB               |                                                                                                                                                                    |
| I/Q Phase Balance                        |               | 1          | 5    | deg              |                                                                                                                                                                    |
| Max I/Q Output Voltage                   | 500           |            |      | mV <sub>PP</sub> | Balanced, maximum output level                                                                                                                                     |
| I/Q DC Output                            |               | 2.0        |      | V <sub>DC</sub>  | Common Mode                                                                                                                                                        |
| I/Q DC Offset                            |               | 5          | 20   | mV <sub>DC</sub> | I OUT+ to I OUT-; Q OUT+ to Q OUT-                                                                                                                                 |
| LO Input Frequency Range                 |               | 100 to 500 |      | MHz              |                                                                                                                                                                    |
| LO Input Level                           |               | 60 to 600  |      | mV <sub>PP</sub> | Balanced                                                                                                                                                           |
| LO Input Impedance                       | 680           | 800        | 920  | Ω                | Balanced                                                                                                                                                           |
|                                          | 340           | 400        | 460  | Ω                | Single Ended                                                                                                                                                       |
| <b>Power Supply</b>                      |               |            |      |                  |                                                                                                                                                                    |
| Supply Voltage                           | 2.7           | 3.0        | 3.3  | V <sub>DC</sub>  |                                                                                                                                                                    |
| Current Consumption                      |               | 14.5       | 18   | mA               | CDMA Mode                                                                                                                                                          |
|                                          |               | 12.5       | 16   | mA               | FM Mode                                                                                                                                                            |
|                                          |               |            | 10   | μA               | Sleep Mode (PD≤0.5V)                                                                                                                                               |

| Pin | Function | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Interface Schematic |
|-----|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 1   | VCC1     | Supply voltage for the LO flip-flop divider and limiting amp. This pin may be connected in parallel with pins 2 and 3. It should be bypassed by a 10nF capacitor. The trace length between the pin and the bypass capacitor should be minimized. The ground side of the bypass capacitor should connect immediately to ground plane. The part is designed to work from a 2.7V to 3.3V supply.                                                                                                                                                                                                           |                     |
| 2   | VCC2     | Supply voltage for the bandgap, gain control bias circuitry, and AGC stages 2, 3, and 4. This pin may be connected in parallel with pins 1 and 3. It should be bypassed by a 10nF capacitor. The trace length between the pin and the bypass capacitor should be minimized. The ground side of the bypass capacitor should connect immediately to ground plane. The part is designed to work from a 2.7V to 3.3V supply.                                                                                                                                                                                |                     |
| 3   | VCC3     | Supply voltage for the FM and CDMA AGC input stages. This pin may be connected in parallel with pins 1 and 2. It should be bypassed by a 10nF capacitor. The trace length between the pin and the bypass capacitor should be minimized. The ground side of the bypass capacitor should connect immediately to ground plane. The part is designed to work from a 2.7V to 3.3V supply.                                                                                                                                                                                                                    |                     |
| 4   | CDMA IN+ | CDMA Balanced Input pin. This pin is internally DC biased and should be DC blocked if connected to a device with a DC level present. For single-ended input operation, one pin is used as an input and the other CDMA input is AC coupled to ground. The balanced input impedance is 2.4k $\Omega$ , while the single-ended input impedance is 1.2k $\Omega$ .                                                                                                                                                                                                                                          |                     |
| 5   | CDMA IN- | Same as pin 4, except complementary input.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | See pin 4.          |
| 6   | GND      | Ground connection. Keep traces physically short and connect immediately to ground plane for best performance.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |
| 7   | GND      | Same as pin 6.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                     |
| 8   | FM IN+   | FM Balanced Input pin. This pin is internally DC biased and should be DC blocked if connected to a device with DC present. For single-ended input operation, one pin is used as an input and the other FM input is AC coupled to ground. The balanced input impedance is 2.4k $\Omega$ , while the single-ended input impedance is 1.2k $\Omega$ .                                                                                                                                                                                                                                                      |                     |
| 9   | FM IN-   | Same as pin 8, except complementary input.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | See pin 8.          |
| 10  | BG OUT   | Bandgap Voltage Reference. This voltage, constant over temperature and supply variation, is used to bias internal circuits. A 10nF external bypass capacitor is required. The trace length between the pin and the bypass capacitor should be minimized. The ground side of the bypass capacitor should connect immediately to ground plane.                                                                                                                                                                                                                                                            |                     |
| 11  | DEC      | AGC decoupling pin. An external bypass capacitor of 10nF capacitor is required. The trace length between the pin and the bypass capacitor should be minimized. The ground side of the bypass capacitor should connect immediately to ground plane.                                                                                                                                                                                                                                                                                                                                                      |                     |
| 12  | LO-      | LO Balanced Input pin. This pin is internally DC biased and should be DC blocked if connected to a device with DC present. For single-ended input operation, one pin is used as an input and the other LO input is AC coupled to ground. The frequency of the signal applied to these pins is internally divided by a factor of 2, hence the carrier frequency for the modulator becomes one half of the applied frequency. The single-ended input impedance is 400 $\Omega$ (balanced is 800 $\Omega$ ). The LO input may be driven single-ended but balanced provides optimum gain and phase balance. |                     |
| 13  | LO+      | Same as pin 12, except complementary input.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | See pin 12.         |

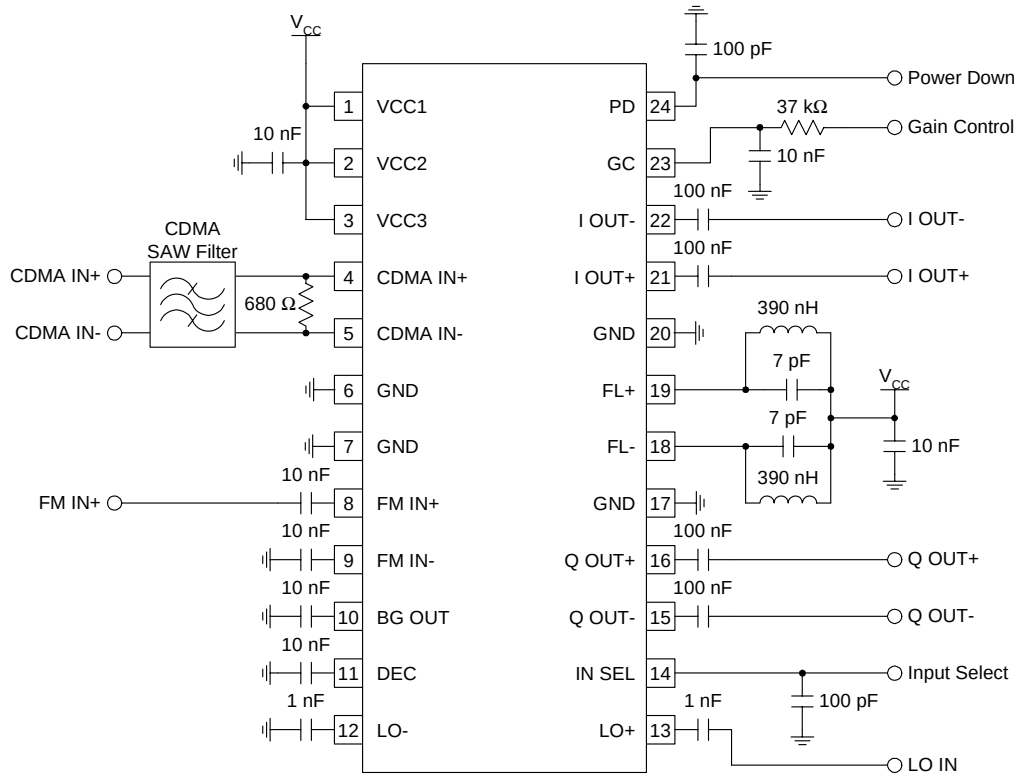
| Pin | Function | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Interface Schematic |
|-----|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 14  | IN SEL   | Selects between CDMA and FM mode. This is a digitally controlled input. A logic "high" ( $\geq V_{CC} - 0.7V_{DC}$ ) selects CDMA mode. A logic "low" ( $< 0.5V_{DC}$ ) selects FM mode. In FM mode, ONLY the I mixer is active. There is no Q output in FM mode. The impedance on this pin is 30k $\Omega$ .                                                                                                                                                                                                                  |                     |
| 15  | Q OUT-   | Balanced Baseband Output of Q Mixer. This pin is internally DC biased and should be DC blocked externally. This output is active in CDMA mode, but is NOT active in FM mode. The output can be used in a single-ended configuration by leaving one of the two pins unconnected, however half the output voltage will be lost. Each pin should be loaded with 2.5k $\Omega$ . The balanced load should be 5k $\Omega$ . The single-ended output impedance is 1k $\Omega$ , while the balanced output impedance is 2k $\Omega$ . |                     |
| 16  | Q OUT+   | Same as pin 15, except complementary output.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | See pin 15.         |
| 17  | GND      | Same as pin 6.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                     |
| 18  | FL-      | Balanced AGC Output/Demod Input. This balanced node is pinned out to allow shunt filtering of the AGC output signal as it enters the demodulator. The basic configuration of the filter should consist of a shunt inductor and shunt capacitor, both connected to the power supply, as the internal circuitry requires this power supply connection through the inductor to operate.                                                                                                                                           |                     |
| 19  | FL+      | Same as pin 18, except complementary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | See pin 18.         |
| 20  | GND      | Same as pin 6.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                     |
| 21  | I OUT+   | Balanced Baseband Output of I Mixer. This pin is internally DC biased and should be DC blocked externally. This output is active in both CDMA and FM modes. The output can be used in a single-ended configuration by leaving one of the two pins unconnected, however half the output voltage will be lost. Each pin should be loaded with 2.5k $\Omega$ . The balanced load should be 5k $\Omega$ . The single-ended output impedance is 1k $\Omega$ , while the balanced output impedance is 2k $\Omega$ .                  |                     |
| 22  | I OUT-   | Same as pin 21, except complementary output.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | See pin 22.         |
| 23  | GC       | Analog Gain Control for AGC Amplifiers. The valid control range is from 0.5 to 2.5V <sub>DC</sub> . These voltages are valid for ONLY a 37k $\Omega$ source impedance. The gain range for the AGC is 95dB.                                                                                                                                                                                                                                                                                                                     |                     |

| Pin | Function | Description                                                                                                                                                                                               | Interface Schematic |
|-----|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 24  | PD       | Power Down Control. When logic "high" ( $\geq V_{CC}-0.3V$ ), all circuits are operating; when logic "low" ( $\leq 0.5V$ ), all circuits are turned off. The input impedance of this pin is $10k\Omega$ . |                     |

## Pin Out

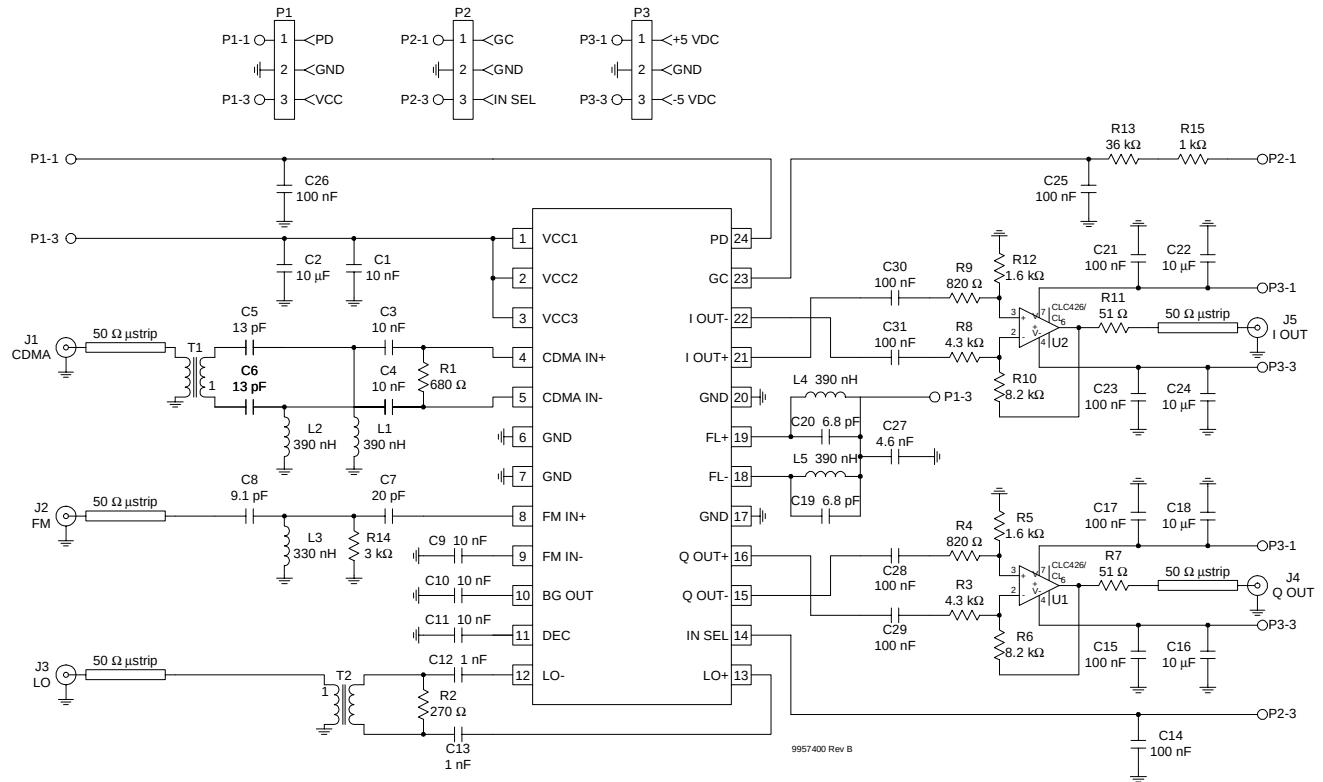


## Application Schematic

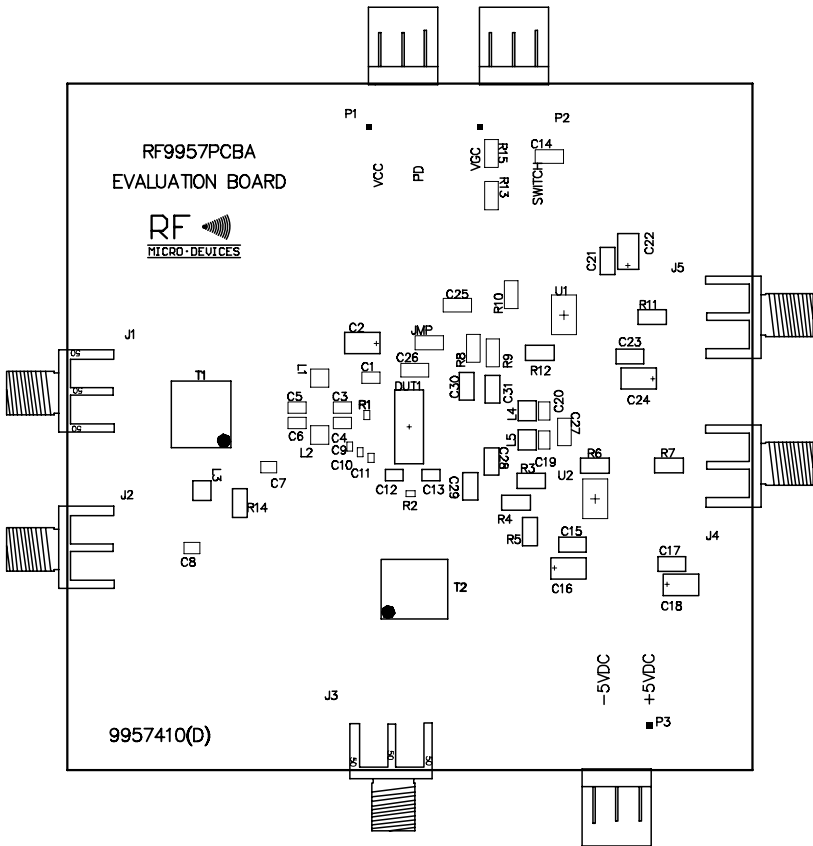


## Evaluation Board Schematic

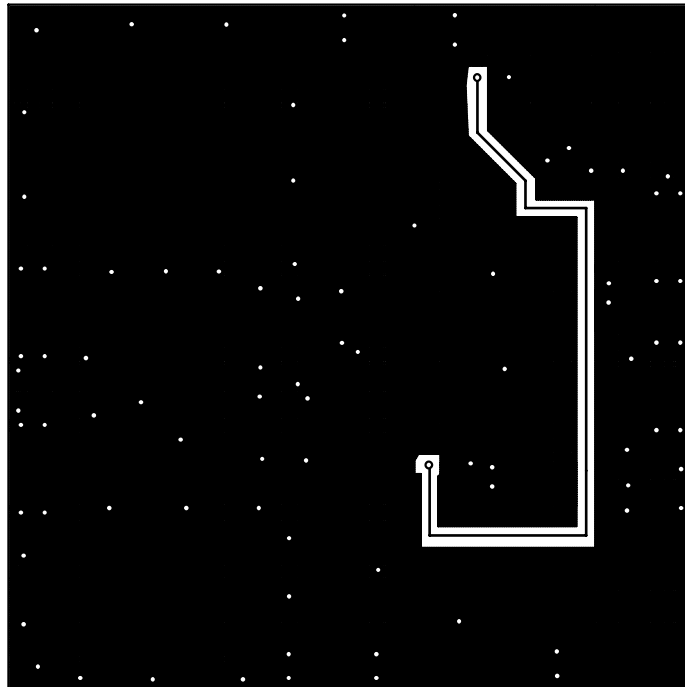
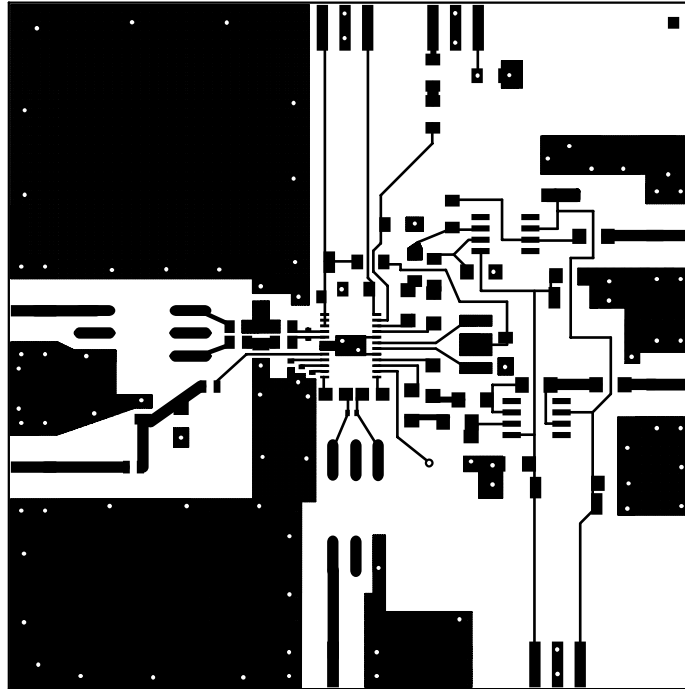
(Download [Bill of Materials](http://www.rfmd.com) from [www.rfmd.com](http://www.rfmd.com).)



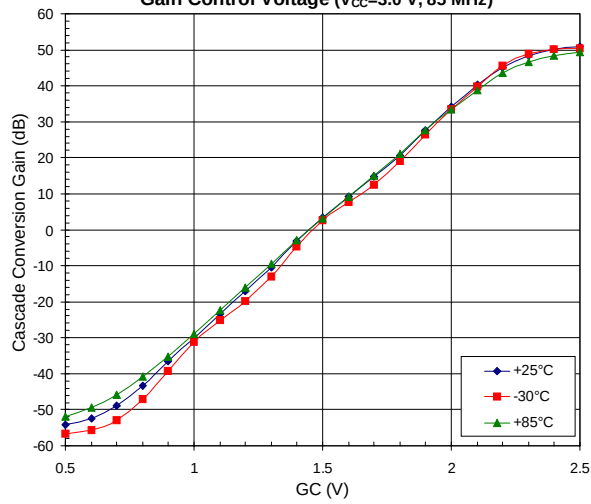
Evaluation Board Layout  
Board Size 3.025" x 3.025"  
Board Size 0.031", Board Material FR-4



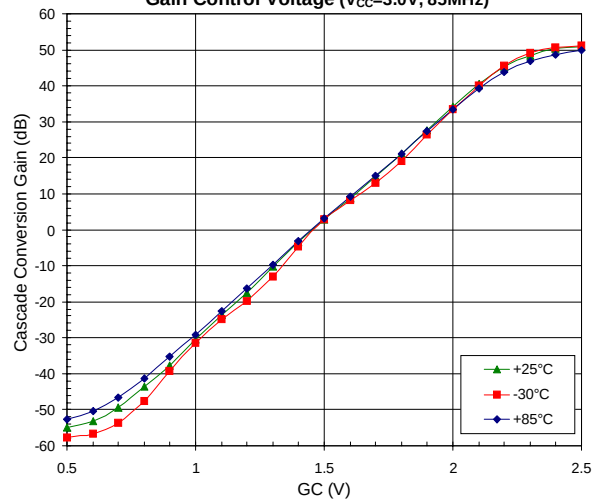




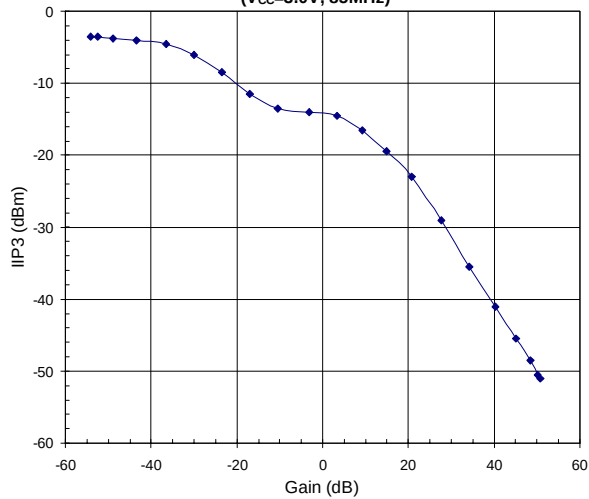
**CDMA Cascade Conversion Gain versus  
Gain Control Voltage ( $V_{CC}=3.0$  V, 85 MHz)**



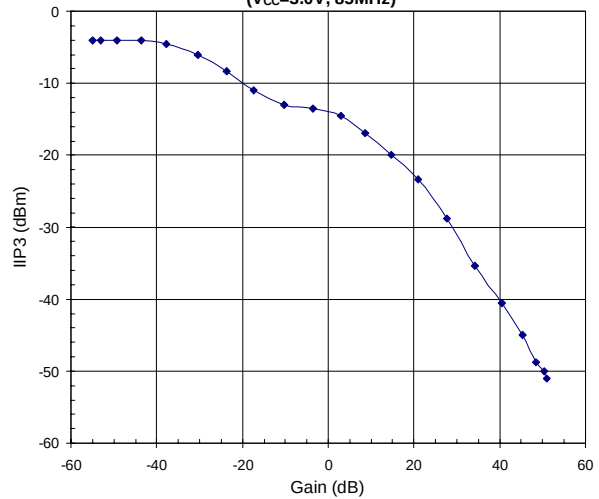
**FM Cascade Conversion Gain versus  
Gain Control Voltage ( $V_{CC}=3.0$  V, 85 MHz)**



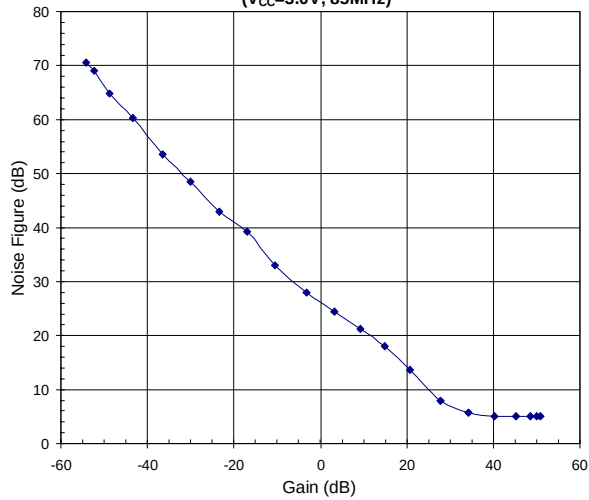
**CDMA IIP3 versus Gain  
( $V_{CC}=3.0$  V, 85 MHz)**



**FM IIP3 versus Gain  
( $V_{CC}=3.0$  V, 85 MHz)**



**CDMA Noise Figure versus Gain  
( $V_{CC}=3.0$  V, 85 MHz)**



**FM Noise Figure versus Gain  
( $V_{CC}=3.0$  V, 85 MHz)**

