# RF3108

TRIPLE-BAND GSM/DCS/PCS
POWER AMP MODULE

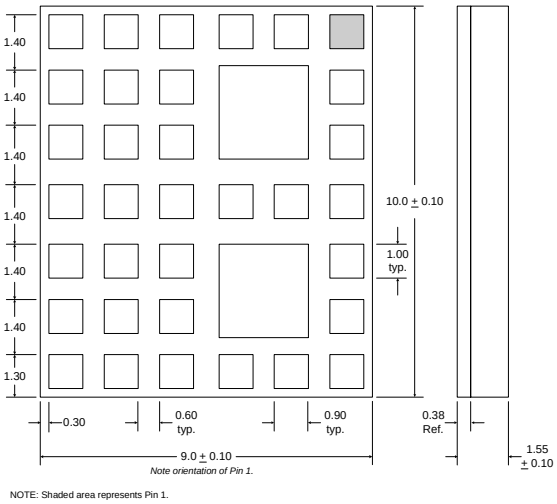


## Typical Applications

- 3V Dual-Band/Triple-Band GSM Handsets
- Commercial and Consumer Systems
- Portable Battery-Powered Equipment
- GPRS Compatible

## Product Description

The RF3108 is a high-power, high-efficiency power amplifier module offering high performance in GSM or GPRS applications. The device is self-contained with 50Ω input and output terminals. The device is manufactured on an advanced GaAs HBT process, and has been designed for use as the final RF amplifier in GSM/DCS and PCS hand held-digital cellular equipment and other applications in the 880MHz to 915MHz and 1710MHz to 1910MHz bands. On-board power control provides over 70dB of control range with an analog voltage input, and provides power down with a logic "low" for standby operation. The device is packaged in an ultra-small (9mmx10mm) LCC, minimizing the required board space.

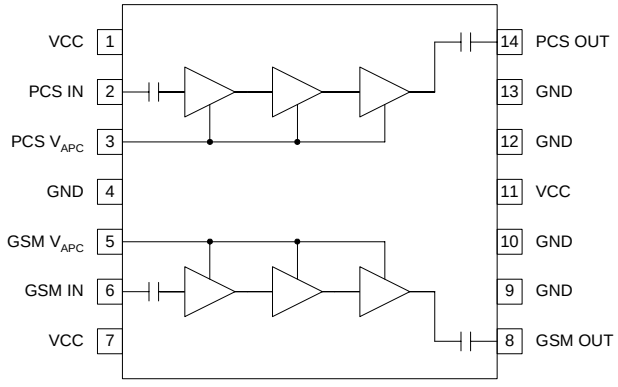



NOTE: Shaded area represents Pin 1.

Package Style: Module

### Optimum Technology Matching® Applied

- ☐ Si BJT
- ☑ GaAs HBT
- ☐ GaAs MESFET
- ☐ Si Bi-CMOS
- ☐ SiGe HBT
- ☐ Si CMOS




Functional Block Diagram

## Features

- Single 2.9V to 4.7V Supply Voltage
- +35.5dBm GSM Output Pwr at 3.5V
- +33.0dBm DCS/PCS Output Pwr at 3.5V
- 55% GSM and 50% DCS/PCS Efficiency
- Supports GSM, E-GSM and DCS/PCS
- 9mmx10mm Package Size

## Ordering Information

| | |
|---|---|
| RF3108 | Triple-Band GSM/DCS/PCS Power Amp Module |
| RF3108 PCBA | Fully Assembled Evaluation Board |

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## Absolute Maximum Ratings

| Parameter | Rating | Unit |
|---|---|---|
| Supply Voltage | -0.5 to +6.0 | $V_{DC}$ |
| Power Control Voltage ($V_{APC1,2}$) | -0.5 to +3.0 | V |
| DC Supply Current | 2400 | mA |
| Input RF Power | +13 | dBm |
| Duty Cycle at Max Power | 50 | % |
| Output Load VSWR | 8:1 | |
| Operating Case Temperature | -40 to +85 | °C |
| Storage Temperature | -55 to +150 | °C |

**Caution!** ESD sensitive device.



| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| **Overall (GSM Mode)** | | | | | Temp=+25°C, $V_{CC}$=3.5V, $V_{APCGSM}$=2.6V, $P_{IN}$=6dBm, Freq=880MHz to 915MHz, 25% Duty Cycle, Pulse Width=1154µs |
| Operating Frequency Range | | 880 to 915 | | MHz | |
| Maximum Output Power | +34.5 | 35.5 | | dBm | Temp = 25°C, $V_{CC}$=3.5V, $V_{APCGSM}$ =2.6V |
| | +32.0 | | | dBm | Temp=+85°C, $V_{CC}$=2.9V, $V_{APCGSM}$ =2.6V |
| Total Efficiency | 47 | 55 | | % | At $P_{OUT,MAX}$, $V_{CC}$=3.5V |
| Input Power for Max Output | +4 | +6 | +8 | dBm | |
| Output Noise Power | | | -72 | dBm | RBW=100kHz, 925MHz to 935MHz, $P_{OUT} \geq$ 34.5dBm |
| | | | -81 | dBm | RBW=100kHz, 935MHz to 960MHz, $P_{OUT} \geq$ 34.5dBm |
| Forward Isolation | | | -30 | dBm | $V_{APCGSM}$=0.2V, PIN=+8dBm |
| Second Harmonic | | -40 | -35 | dBc | |
| Third Harmonic | | -50 | -43 | dBc | |
| All other non harmonic spurious | | | -36 | dBm | |
| Input Impedance | | 50 | | Ω | |
| Input VSWR | | | 2.5:1 | | $P_{OUT,MAX}$-5dB<$P_{OUT}$<$P_{OUT,MAX}$ |
| Output Load VSWR | 8:1 | | | | Spurious<-36dBm, $V_{APCGSM}$=0.2V to 2.6V, RBW=100kHz |
| Output Load Impedance | | 50 | | Ω | Load impedance presented at RF OUT pad |
| **Power Control $V_{APC1}$** | | | | | |
| Power Control “ON” | 2.6 | | | V | Max. $P_{OUT}$, Voltage supplied to the input |
| Power Control “OFF” | 0.2 | 0.5 | | V | Min. $P_{OUT}$, Voltage supplied to the input |
| Power Control Range | | 70 | | dB | $V_{APC1,2}$=0.2V to 2.6V |
| Gain Control Slope | | 100 | | dB/V | $P_{OUT}$=-10dBm to 35dBm |
| APC Input Capacitance | | | 10 | pF | DC to 2MHz |
| APC Input Current | | 4.5 | 5 | mA | $V_{APC}$=2.6V |
| | | | 10 | µA | $V_{APC}$=0V |
| Turn On/Off Time | | | 2 | µS | $V_{APC}$=0 to 2.6V |
| **Overall Power Supply** | | | | | |
| Power Supply Voltage | | 3.5 | | V | Specifications |
| | 2.9 | | 4.7 | V | Nominal operating limits, $P_{OUT}$<+33dBm |
| Power Supply Current | | 2 | | A | DC Current at $P_{OUT,MAX}$ |
| | | 1 | 10 | µA | $P_{IN}$<-30dBm, $V_{APC1,2}$=0.2V, Temp=-40to+85°C |

| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| **Overall (DCS/PCS Mode)** | | | | | Temp=25°C, $V_{CC}$=3.5V, $V_{APCDCS/PCS}$=2.6V, $P_{IN}$=6dBm, Freq=1710MHz to 1910MHz, 25% Duty Cycle, Pulse Width=1154µs |
| Operating Frequency Range | | 1710 to 1910 | | MHz | |
| Maximum Output Power | +32 | +33 | | dBm | Temp=25°C, $V_{CC}$=3.5V, $V_{APCDCS/PCS}$=2.6V, 1710MHz to 1785MHz |
| | 31.5 | 32.5 | | dBm | 1850MHz to 1910MHz |
| | 29.0 | 29.5 | | dBm | Temp=+85°C, $V_{CC}$=2.9V, $V_{APC}$=2.6V, 1850MHz to 1910MHz |
| | 29.5 | 30 | | dBm | 1710MHz to 1785MHz |
| Total Efficiency | 45 | 52 | | % | At $P_{OUT,MAX,}$ $V_{CC}$=3.5V, 1710MHz to 1785MHz |
| | 40 | 47 | | % | At $P_{OUT,MAX,}$ $V_{CC}$=3.5V, 1850MHz to 1910MHz |
| Recommended Input Power Range | +4 | +6 | +8 | dBm | |
| Output Noise Power | | | -77 | dBm | RBW=100kHz, 1805MHz to 1880MHz and 1930MHz to 1990MHz, $P_{OUT} \geq$ 34.5dBm, $V_{CC}$=3.5V |
| Forward Isolation | | -37 | -30 | dBm | $V_{APCDCS/PCS}$=0.2V, $P_{IN}$=+8dBm |
| Second Harmonic | | -60 | -45 | dBc | $P_{OUT,}$ = +32.5dBm |
| Third Harmonic | | -65 | -50 | dBc | |
| All other spurious | | | -36 | dBm | |
| Input Impedance | | 50 | | Ω | |
| Input VSWR | | - | 2.5 | | $P_{OUT,MAX}$-5dB<$P_{OUT}$<$P_{OUT,MAX}$ |
| Output Load VSWR | 8:1 | | | | Spurious<-36dBm, $V_{APCDCS/PCS}$=0.2V to 2.6V, RBW=100kHz |
| Output Load Impedance | | 50 | | Ω | Load impedance presented at RF OUT pin |
| **Power Control $V_{APC2}$** | | | | | |
| Power Control “ON” | | | 2.6 | V | Max. $P_{OUT}$, Voltage supplied to the input |
| Power Control “OFF” | 0.2 | 0.5 | | V | Min. $P_{OUT}$, Voltage supplied to the input |
| Power Control Range | 62 | 68 | | dB | $V_{APC1,2}$=0.2V to 2.6V, $P_{IN}$=+8dBm |
| Gain Control Slope | | 100 | | dB/V | $P_{OUT}$=-10dBm to +33dBm |
| APC Input Capacitance | | | 10 | pF | DC to 2MHz |
| APC Input Current | | 4.5 | 5 | mA | $V_{APC}$=2.6V |
| | | | 10 | µA | $V_{APC}$=0V |
| Turn On/Off TIme | | | 100 | ns | $V_{APC}$=0to2.6V |
| **Overall Power Supply** | | | | | |
| Power Supply Voltage | | 3.5 | | V | Specifications |
| | 2.9 | | 4.7 | V | Nominal operating limits, $P_{OUT}$<+33dBm |
| Power Supply Current | | 1.3 | | A | DC Current at $P_{OUT,MAX}$ |
| | | 1 | 10 | µA | $P_{IN}$<-30dBm, $V_{APC1,2}$=0.2V, Temp=-40to+85°C |

| Pin | Function | Description | Interface Schematic |
|---|---|---|---|
| 1 | VCC1 | Power Supply for the driver stage of the DCS/PCS band. | |
| 2 | DCS/PCS IN | RF Input to the DCS/PCS band. This is a 50Ω input. | |
| 3 | DCS/PCS $V_{APC}$ | Power control for the pre-amplifier, driver, and output stage of the DCS/PCS band. | |
| 4 | GND | Ground connection to overall package. | |
| 5 | GSM $V_{APC}$ | Power control for the pre-amplifier, driver, and output stage of the GSM band. | |
| 6 | GSM IN | RF input to the GSM band. This is a 50Ω input. | |
| 7 | VCC2 | Power supply for the driver stage of the GSM band. | |
| 8 | GSM OUT | RF output for the GSM band. This is a 50Ω output. The output load line matching is contained internal to the package. | |
| 9 | GND | Ground connection to overall package. | |
| 10 | GND | Ground connection to overall package. | |
| 11 | VCC3 | Power supply for the pre-amplifier and output stage for both the DCS/PCS and GSM bands. | |
| 12 | GND | Ground connection to overall package. | |
| 13 | GND | Ground connection to overall package. | |
| 14 | DCS/PCS OUT | RF output for the DCS/PCS band. This is a 50Ω output. The output load line matching is contained internal to the package. | |
| Pkg Base | GND | Ground connection to overall package. | |

# Theory of Operation and Application Information

The RF3108 is a triple-band, GSM/DCS/PCS power amplifier with two separate RF inputs and outputs that are internally matched to 50Ω. Pins 2 and 14 of the device provide the RF input and output for the DCS/PCS band, which is optimized for performance between 1710MHz and 1910MHz. Pins 5 and 8 of the device provide the RF input and output for the GSM band, which is optimized for performance between 880MHz and 915MHz. Both bands include an internal DC-blocking capacitor to protect the device from external DC source inputs and block internal DC from exiting the inputs and outputs of the module. The performance is similar to the performance of the RF2173 and RF2174 MIMIC devices used in dual- or triple-band applications. However, the RF3108 module includes the matching and bypass capacitors required for operation internal to the 9mmx10mm module. However, some external components are required to improve stability, isolation and noise power performance. These components are included on the evaluation board and schematic, and will be described in the following paragraphs.

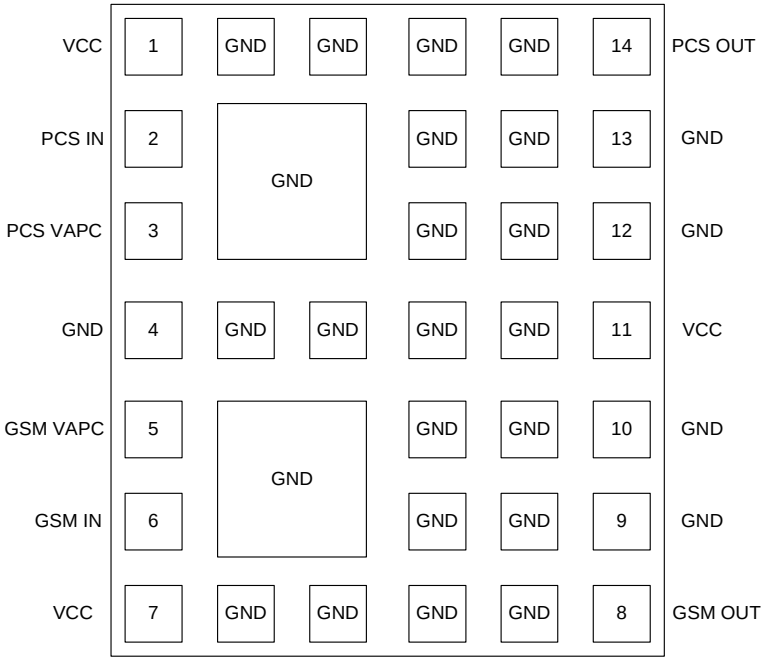
The GSM 900MHz band provides 32dB and the DCS/PCS 1710MHz to 1910MHz band provides 28dB of small signal gain at full output power. Therefore, the drive level required to fully saturate the output is +4dBm for each band. Based upon HBT (Heterojunction Bipolar Transistor) technology, the part requires only a single positive 3V supply to operate to full specification. The DCS/PCS band input is located at pin 2 of the device and requires no external components. The GSM 900MHz band input is located at pin 6 of the device and also does not require external components. However, a 180Ω resistor is included at the input of the GSM band to improve the input impedance and isolation performance at low $V_{APC}$ levels. The output for both high and low bands are internally matched to 50Ω at the output of pin 14 and 8. A 50Ω microstrip should be used to interface to the input and output connections.

Power control for the GSM 900MHz band is provided through pin 5 of the device, and pin 3 for the DCS/PCS band. The $V_{APC}$ inputs do not contain any internal bypass capacitors and will require some external filtering. Because the $V_{APC}$ filtering capacitor is external to the device, the user has the option of choosing a capacitor value that meets the control loop BW and filtering requirement for various applications. In most typical applications with a closed loop power control, the recommended bypass capacitor for this input is approximately 33pF for the GSM band, and 12pF for the DCS/PCS band. However in open loop operation, a 10nF $V_{APC}$ bypass capacitor is recommended for both bands to filter noise from the external $V_{APC}$ source. A 10nF capacitor is installed on pins 3 and 5 on the current evaluation board (see the evaluation board schematic). Noise on the $V_{APC}$ input will degrade the noise power performance of the device, so care should be used to provide a clean $V_{APC}$ input signal. This is especially important when measuring noise power or stability performance.

The voltage supply $V_{CC}$ contains internal bypass capacitors and inductors to filter unwanted noise on the DC supply voltage. However, the main $V_{CC}$ input to the device at pin 11 requires some additional bypass capacitors as shown in the evaluation board schematic. C5 (1uF) and C4 (3.3uF) are required to improve the stability performance.

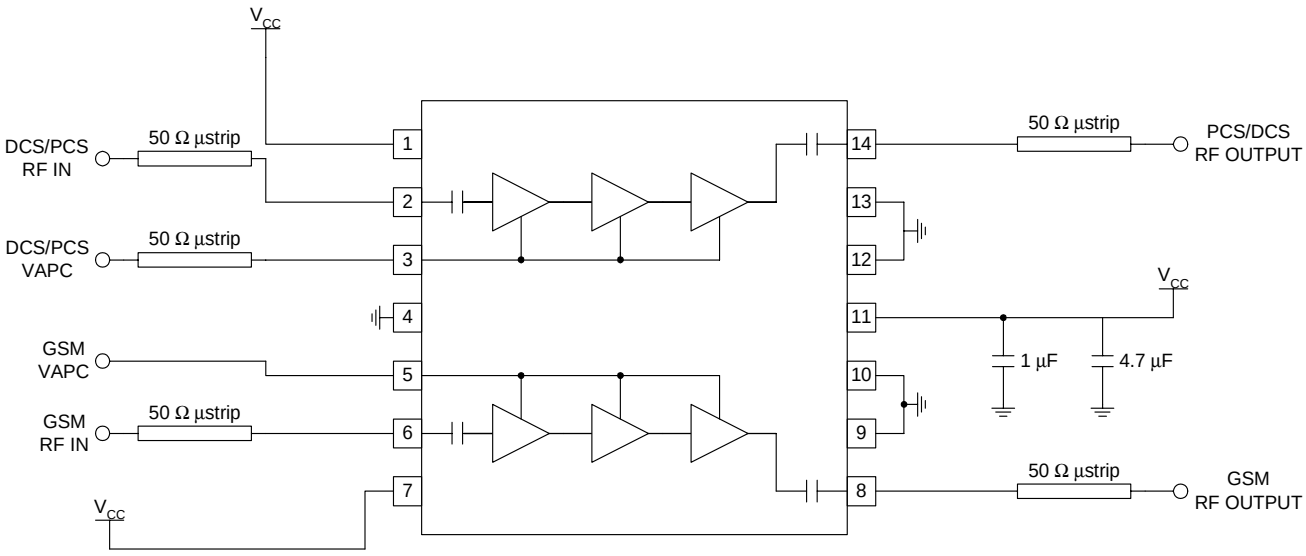
All the internal ground connections are connected to a series of ground pads located on the backside of the package as shown in the pin out diagram. Pins 4, 9, 10, 12, and 13 are also ground connections. The final stages of both bands are connected to the ground pads on the backside of the package. Therefore this ground connection is essential to dissipate heat and to provide proper current flow. Refer to the evaluation board layout as an example of the vias locations and quantity required for proper connection.

## Pin Out



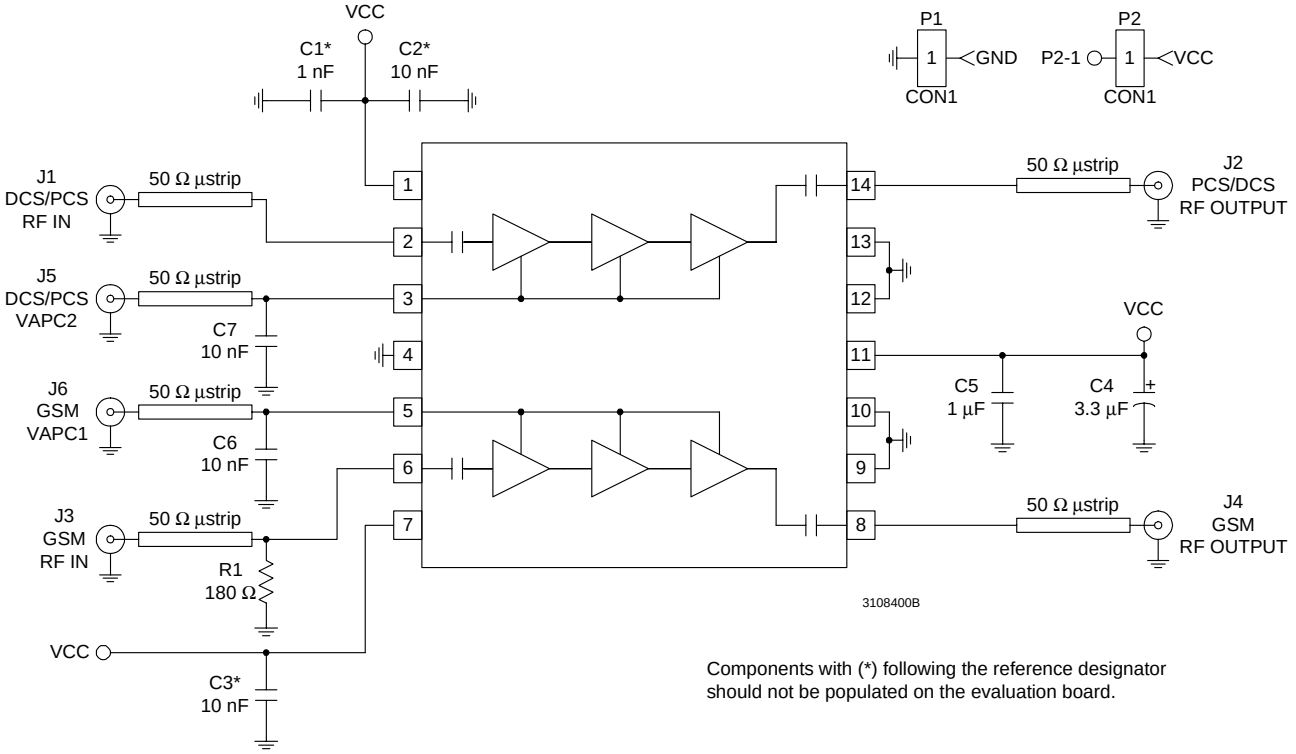

Top View

## Application Schematic




## Evaluation Board Schematic

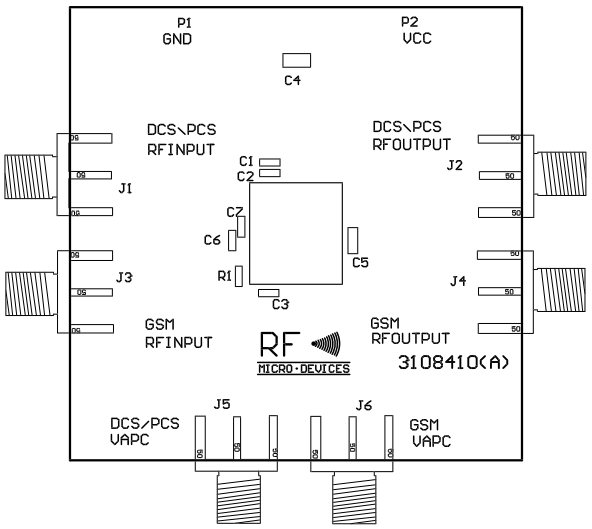
(Download Bill of Materials from www.rfmd.com.)

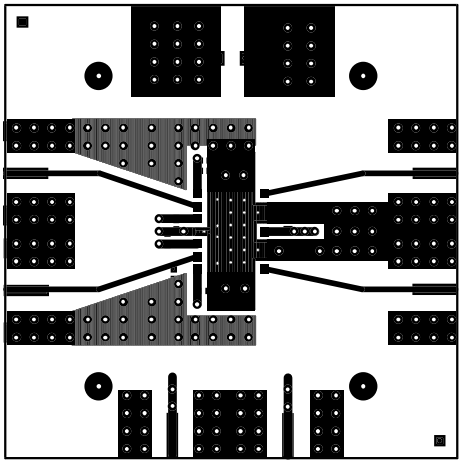


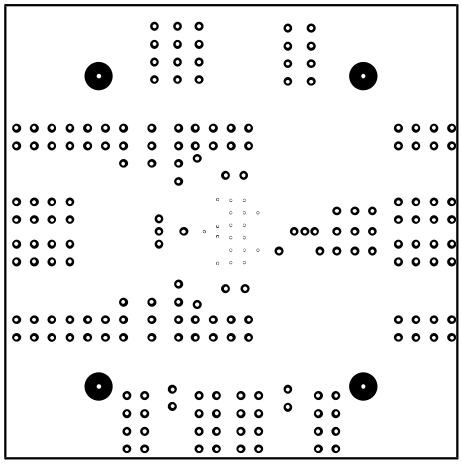

Components with (*) following the reference designator should not be populated on the evaluation board.

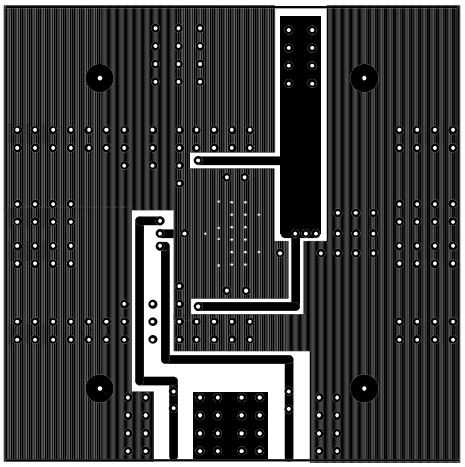
# Evaluation Board Layout
## Board Size 2.0” x 2.0”

Board Thickness 0.031”; Board Material FR-4; Multi-Layer

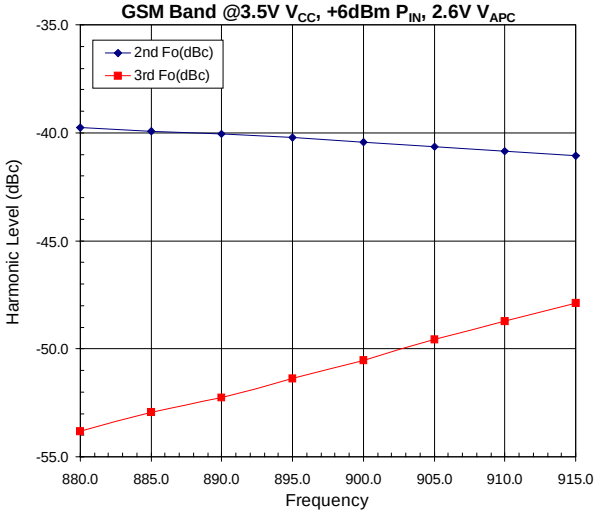


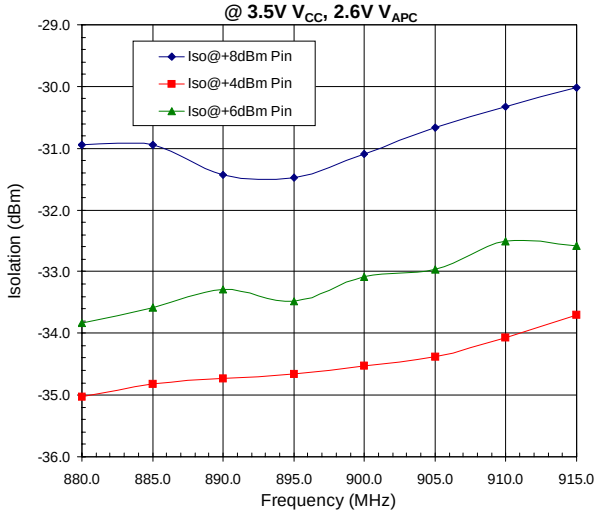




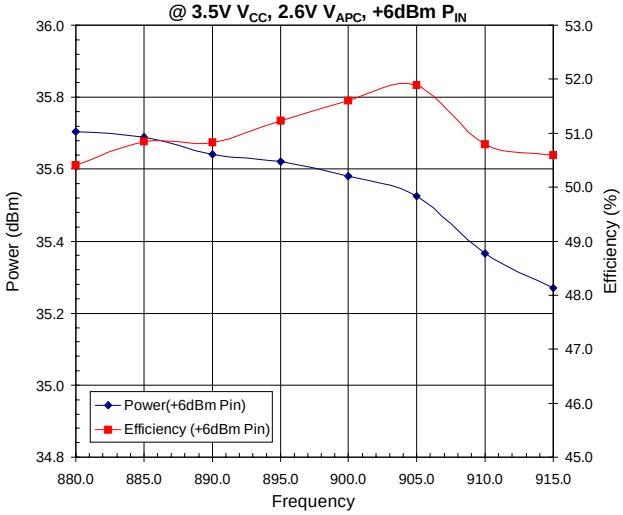
**2nd and 3rd Harmonic Performance**
**GSM Band @3.5V $V_{CC}$, +6dBm $P_{IN}$, 2.6V $V_{APC}$**



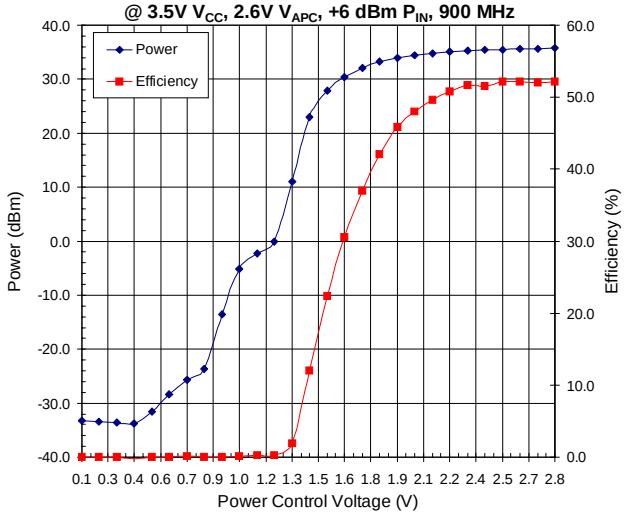

**Isolation Performance GSM Band**
**@ 3.5V $V_{CC}$, 2.6V $V_{APC}$**



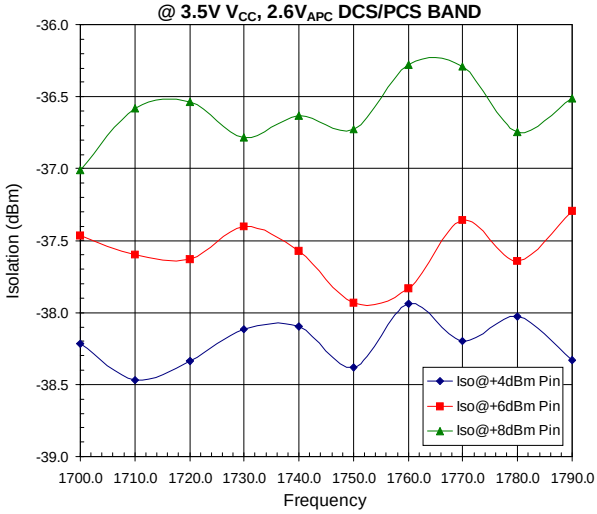

**Power and Efficiency Performance**
**@ 3.5V $V_{CC}$, 2.6V $V_{APC}$, +6dBm $P_{IN}$**



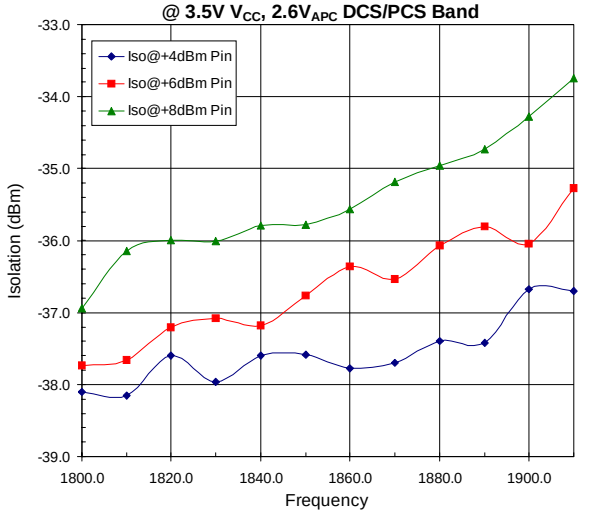

**Power Control Response**
**@ 3.5V $V_{CC}$, 2.6V $V_{APC}$, +6 dBm $P_{IN}$, 900 MHz**



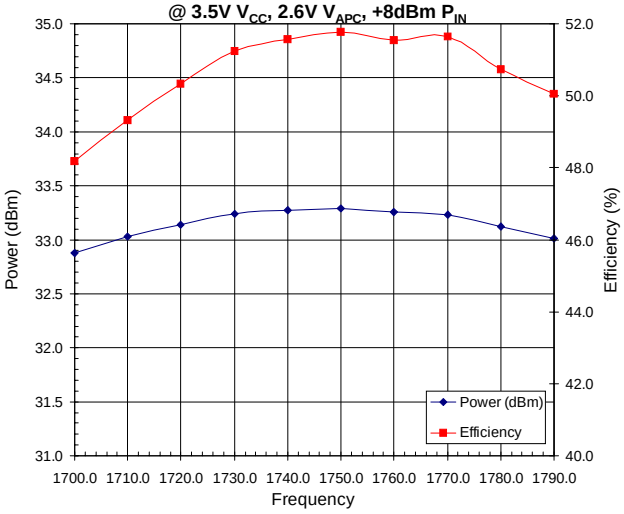

**Isolation Performance DCS/PCS Band**
**@ 3.5V $V_{CC}$, 2.6V$_{APC}$ DCS/PCS BAND**



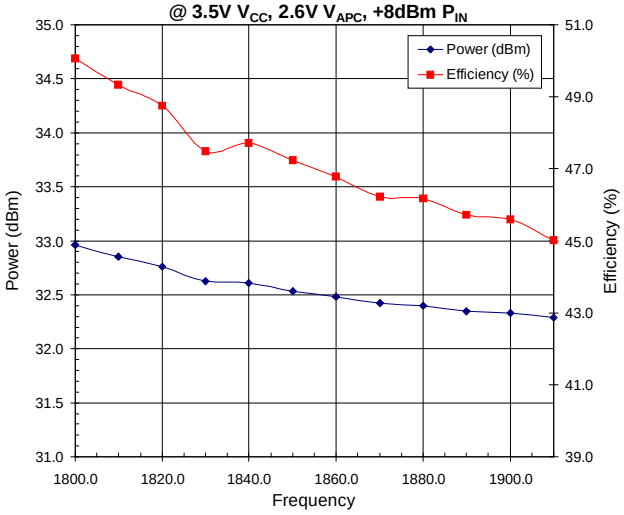

**Isolation Performance DCS/PCS Band**
**@ 3.5V $V_{CC}$, 2.6V$_{APC}$ DCS/PCS Band**



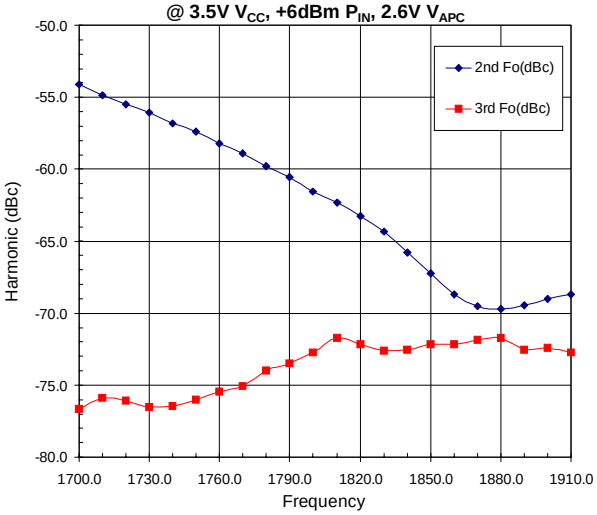
DCS Band Power and Efficient Performance
@ 3.5V $V_{CC}$, 2.6V $V_{APC}$, +8dBm $P_{IN}$



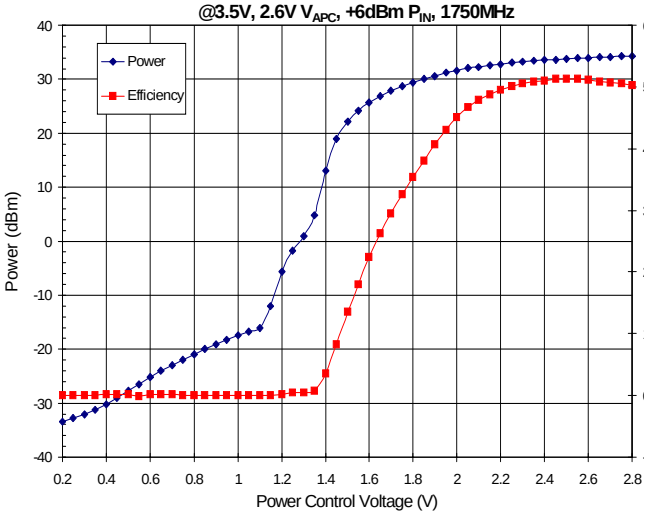

PCS Band Power and Efficiency Performance
@ 3.5V $V_{CC}$, 2.6V $V_{APC}$, +8dBm $P_{IN}$




2nd and 3rd Harmonic Performance (DCS/PCS Band)
@ 3.5V $V_{CC}$, +6dBm $P_{IN}$, 2.6V $V_{APC}$




Power Control Response
@3.5V, 2.6V $V_{APC}$, +6dBm $P_{IN}$, 1750MHz




Power Control Response
@3.5V $V_{CC}$, 2.6V $V_{APC}$, +6dBm $P_{IN}$, 1850MHz