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*Preliminary*

# RF8888

## SP10T ANTENNA SWITCH MODULE TRIBAND GSM, PENTABAND UMTS

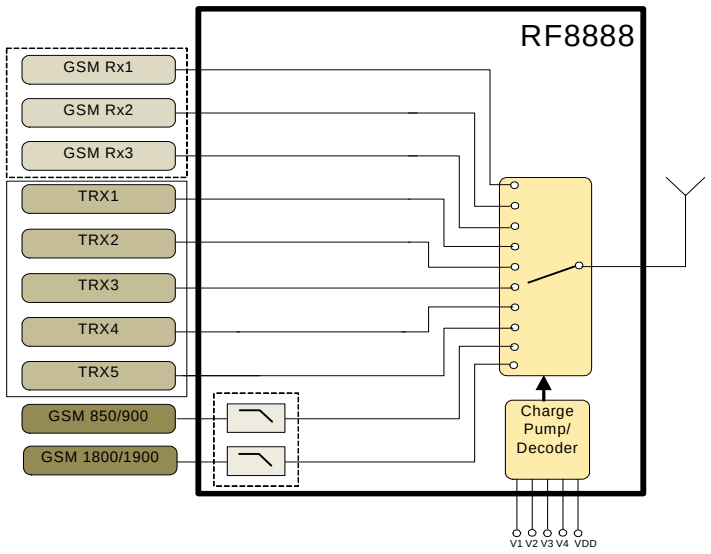
**Package Style: Laminate, 3.0mmx3.8mmx0.85mm**


## Features

- Very Low IL and High Isolation: 1dB IL: 2.17GHz GSM TRx 1.05dB IL: 1.91GHz GSM Tx HB 25dB Isolation: Between all TRx paths up to 2.17GHz
- Specifically designed to accommodate LTE B13 and GPS co-existence.
- High Isolation Between GSM Rx Paths >28dB
- Exceptional Linearity Performance
- Five Linear Paths Afford Band Combination and Air Interface Flexibility
- Integrated Low Pass Filters on 2G Paths for Best-in-Class Harmonic Attenuation
- GPIO Interface and Fully Spec Compliant with 1.8V Logic
- Small Solution Size - No DC-Blocking Capacitors Required
- Compact 3mmx3.8mmx0.85mm, 26-pin QFN Package

## Applications

- Cellular Handset Applications
- Multi-Mode GSM, EDGE, WCDMA Applications
- GSM/GPRS/EDGE Switch Applications




Functional Block Diagram

## Product Description

The RF8888 is a single-pole ten-throw (SP10T) Switch Filter Module. Very Low insertion loss along with excellent linearity performance achieved by RF8888 makes it ideal for multi-mode GSM, EDGE, and UMTS handset applications. This module builds upon RFMD's pHEMT Switch technology and integrates low pass filtering on the GSM transmit paths thus avoiding the need for external harmonic attenuation. This module also integrates a decoder and is compatible with +1.8V control logic. RF8888 is packaged in a compact 3.0mmx3.8mm, 26-pin, Module package which allows for a small solution size and lowest BOM cost as it does not require external DC blocking capacitors.

### Ordering Information

| | |
|---|---|
| RF8888 | SP10T Antenna Switch Module Triband GSM, Pentaband UMTS |
| RF8888PCBA-410 | Fully Assembled Evaluation Board |

### Optimum Technology Matching® Applied

| | | | |
|---|---|---|---|
| ☐ GaAs HBT | ☐ SiGe BiCMOS | ☑ GaAs pHEMT | ☐ GaN HEMT |
| ☐ GaAs MESFET | ☐ Si BiCMOS | ☑ Si CMOS | |
| ☐ InGaP HBT | ☐ SiGe HBT | ☐ Si BJT | |





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## Absolute Maximum Ratings

| Parameter | Rating | Unit |
|---|---|---|
| VDD, V1, V2, V3, V4 | 6.0 | V |
| Maximum Input Power | | |
| TX1 | +36, 12.5% ($T_{AMB}$=25°C) | dBm |
| TRX1, TRX2, TRX3, TRX4 | +32 ($T_{AMB}$=25°C) | dBm |
| TX2 | +34, 12.5% ($T_{AMB}$=25°C) | dBm |
| RX1, RX2, RX3, RX4 | +13 ($T_{AMB}$=25°C) | dBm |
| Operating Temperature | -30 to +90 | °C |
| Storage Temperature | -65 to +150 | °C |

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).



| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| | | | | | Nominal conditions unless otherwise stated. $V_{DD}$=2.75V, $V_{HIGH}/V_{LOW}$=1.8V/0V, Temp=25°C, 50Ω. |
| **GSM850/900 Transmit** | | | | | |
| Frequency Range (GSM850) | 824 | 836.5 | 849 | MHz | |
| Frequency Range (GSM900) | 880 | 897.5 | 915 | MHz | |
| Insertion Loss | | | | | |
| TX1 - ANT | | 1.10 | 1.30 | dB | $P_{IN}$=35dBm |
| Attenuation | | | | | |
| TX1 - ANT, $2f_0$ | 25 | 40 | | dB | $P_{IN}$=0dBm; Freq=1648MHz to 1830MHz |
| TX1 - ANT, $3f_0$ | 25 | 28 | | dB | $P_{IN}$=0dBm; Freq=2472MHz to 2745MHz |
| TX1 - ANT, $4f_0$ | 20 | 42 | | dB | $P_{IN}$=0dBm; Freq=3296MHz to 3660MHz |
| TX1 - ANT, 5f0 up to 12.75GHz | 20 | 26 | | dB | $P_{IN}$=0dBm; Freq=4120MHz to 12750MHz |
| Isolation | | | | | |
| TX1 - RX1 | 30 | 46 | | dB | TX1=824MHz to 849MHz, 880MHz to 915MHz |
| TX1 - RX2 | 30 | 48 | | dB | TX1=824MHz to 849MHz, 880MHz to 915MHz |
| TX1 - RX3 | 30 | 46 | | dB | TX1=824MHz to 849MHz, 880MHz to 915MHz |
| TX1 - TRX1 | 30 | 42 | | dB | TX1=824MHz to 849MHz, 880MHz to 915MHz |
| TX1 - TRX2 | 30 | 42 | | dB | TX1=824MHz to 849MHz, 880MHz to 915MHz |
| TX1 - TRX3 | 30 | 36 | | dB | TX1=824MHz to 849MHz, 880MHz to 915MHz |
| TX1 - TRX4 | 30 | 40 | | dB | TX1=824MHz to 849MHz, 880MHz to 915MHz |
| TX1 - TRX5 | 30 | 43 | | dB | TX1=824MHz to 849MHz, 880MHz to 915MHz |
| TX1 - TX2 | 30 | | | dB | TX1=824MHz to 849MHz, 1648MHz to 1830MHz |
| TX2 - ANT | 30 | | | dB | TX1=1710MHz to 1910MHz |


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| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| **GSM850/900 Transmit (cont.)** | | | | | |
| Harmonics | | | | | |
| TX1 - ANT, $2f_0$ | 70 | 83 | | dBc | $P_{IN}$=35dBm, 25%DC |
| TX1- ANT, $3f_0$ | 70 | 78 | | dBc | $P_{IN}$=35dBm, 25%DC |
| TX1 - ANT, $4f_0$ - 12.75GHz | 70 | 95 | | dBc | $P_{IN}$=35dBm, 25%DC |
| VSWR | | | 1.5 | | |
| **GSM1800/1900 Transmit** | | | | | |
| Frequency Range (GSM1800) | 1710 | 1747.5 | 1785 | MHz | |
| Frequency Range (GSM1900) | 1850 | 1880 | 1910 | MHz | |
| Insertion Loss | | | | | |
| TX2 - ANT | | 1.20 | 1.40 | dB | $P_{IN}$=32dBm |
| Attenuation | | | | | |
| TX2 - ANT, $2f_0$ | 25 | 34 | | dB | $P_{IN}$=0dBm; Freq=3420MHz to 3820MHz |
| TX2 - ANT, $3f_0$ | 23 | 25 | | dB | $P_{IN}$=0dBm; Freq=5130MHz to 5730MHz |
| TX2 - ANT, $4f_0$ up to 12.75GHz | 20 | 31 | | dB | $P_{IN}$=0dBm; Freq=6840MHz to 12750MHz |
| Isolation | | | | | |
| TX2 - RX1 | 32 | 37 | | dB | TX2=1710MHz to 1785MHz, 1850MHz to 1910MHz |
| TX2 - RX2 | 32 | 38 | | dB | TX2=1710MHz to 1785MHz, 1850MHz to 1910MHz |
| TX2 - RX3 | 32 | 37 | | dB | TX2=1710MHz to 1785MHz, 1850MHz to 1910MHz |
| TX2 - TRX1 | 32 | 32 | | dB | TX2=1710MHz to 1785MHz, 1850MHz to 1910MHz |
| TX2 - TRX2 | 32 | 32 | | dB | TX2=1710MHz to 1785MHz, 1850MHz to 1910MHz |
| TX2 - TRX3 | 32 | 28 | | dB | TX2=1710MHz to 1785MHz, 1850MHz to 1910MHz |
| TX2 - TRX4 | 32 | 32 | | dB | TX2=1710MHz to 1785MHz, 1850MHz to 1910MHz |
| TX2 - TX1 | 30 | 34 | | dB | TX2=1710MHz to 1785MHz, 1850MHz to 1910MHz |
| TX1 - ANT | 38 | 41 | | dB | TX1=824MHz to 915MHz |
| Harmonics | | | | | |
| TX2 - ANT, $2f_0$ | 67 | 84 | | dBc | $P_{IN}$=32dBm, 25%DC |
| TX2- ANT, $3f_0$ | 67 | 76 | | dBc | $P_{IN}$=32dBm, 25%DC |
| TX2 - ANT, up to 12.75GHz | 67 | 99 | | dBc | $P_{IN}$=32dBm, 25%DC |
| VSWR | | | 1.5 | | |

| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| **GSM RX1, RX2, RX3, RX4** | | | | | |
| Frequency Range | 869 | | 894 | MHz | |
| | 935 | | 960 | MHz | |
| | 1805 | | 1880 | MHz | |
| | 1930 | | 1990 | MHz | |
| Insertion Loss | | | | | |
| RX1, RX2, RX3 | | 1.00 | 1.20 | dB | 869MHz to 960MHz |
| RX1, RX2, RX3 | | 1.40 | 1.70 | dB | 1805MHz to 1990MHz |
| Isolation | | | | | |
| RX3 - ANT (Active path: RX2 - ANT) | 27 | 32 | | dB | 1805MHz to 1990MHz |
| RX2 - ANT (Active path: RX3 - ANT) | 27 | 32 | | dB | 1805MHz to 1990MHz |
| VSWR (ANT and RX) | | | 1.5 | | |
| **UMTS 1, 2, 3, 4, 5 - Low Band** | | | | | |
| Frequency Range | | | | | |
| Band V | 824 | | 849 | MHz | |
| | 869 | | 894 | MHz | |
| Band VIII | 880 | | 915 | MHz | |
| | 925 | | 960 | MHz | |
| Insertion Loss | | | | | |
| TRX1 - ANT | | 0.70 | 0.90 | dB | |
| TRX2 - ANT | | 0.70 | 0.90 | dB | |
| TRX3 - ANT | | 0.60 | 0.80 | dB | |
| TRX4 - ANT | | 0.70 | 0.90 | dB | |
| TRX5 - ANT | | 0.70 | 0.90 | dB | |
| Isolation | | | | | 824MHz to 960MHz |
| TRX1, TRX2 - TRX3, TRX4, TRX5 | 30 | 35 | | dB | |
| TRX1 - TRX2, TRX3 - TRX4, TRX4 - TRX5 | 17 | 27 | | dB | |
| TRX3 - TRX5 | 25 | 36 | | dB | |
| TRX1 - RX1, RX2, RX3 | 25 | 38 | | dB | |
| TRX2 - RX1, RX2, RX3 | 30 | 43 | | dB | |
| TRX3 - RX1, RX2, RX3 | 40 | 47 | | dB | |
| TRX4 - RX1, RX2, RX3 | 40 | 47 | | dB | |
| TRX4 - RX1, RX2, RX3 | 40 | 47 | | dB | |
| TRX1 - TX1 | 35 | 42 | | dB | |
| TRX1 - TX2 | 28 | 32 | | dB | |
| TRX2 - TX1 | 35 | 42 | | dB | |
| TRX2 - TX2 | 28 | 32 | | dB | |
| TRX3 - TX1 | 35 | 39 | | dB | |
| TRX3 - TX2 | 28 | 32 | | dB | |
| TRX4 - TX1 | 35 | 39 | | dB | |
| TRX4 - TX2 | 28 | 32 | | dB | |
| TRX5 - TX1 | 35 | 39 | | dB | |
| TRX5 - TX2 | 28 | 32 | | dB | |


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| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| **UMTS 1, 2, 3, 4, 5 - Low Band (cont.)** | | | | | |
| Harmonics | | | | | |
| TRX1, 2, 3, 4, 5 - ANT, $2f_0$ | 62 | 94 | | dBc | $P_{IN}$=26dBm, CW |
| TRX1, 2, 3, 4, 5 - ANT, $3f_0$ | 62 | 87 | | dBc | $P_{IN}$=26dBm, CW |
| TRX1, 2, 3, 4, 5 - ANT, up to 12.75GHz | 62 | 103 | | dBc | $P_{IN}$=26dBm, CW |
| **UMTS 1, 2, 3, 4, 5 - High Band** | | | | | |
| Frequency Range | | | | | |
| Band IV | 1710 | | 1910 | MHz | |
| | 2110 | | 2115 | MHz | |
| Band III | 1710 | | 1785 | MHz | |
| | 1805 | | 1880 | MHz | |
| Band II | 1850 | | 1910 | MHz | |
| | 1930 | | 1990 | MHz | |
| Band I | 1920 | | 1980 | MHz | |
| | 2110 | | 2170 | MHz | |
| Insertion Loss | | | | | |
| TRX1 - ANT | | 0.9 | 1.1 | dB | $P_{IN}$=26dB, CW, 1710MHz to 1880MHz |
| TRX2 - ANT | | 0.9 | 1.1 | dB | $P_{IN}$=26dB, CW, 1710MHz to 1880MHz |
| TRX3 - ANT | | 0.75 | 1.0 | dB | $P_{IN}$=26dB, CW, 1710MHz to 1880MHz |
| TRX4 - ANT | | 0.9 | 1.15 | dB | $P_{IN}$=26dB, CW, 1710MHz to 1880MHz |
| TRX5 - ANT | | 0.9 | 1.1 | dB | $P_{IN}$=26dB, CW, 1710MHz to 1880MHz |
| TRX1 - ANT | | 0.9 | 1.2 | dB | $P_{IN}$=26dB, CW, 1850MHz to 1990MHz |
| TRX2 - ANT | | 0.9 | 1.2 | dB | $P_{IN}$=26dB, CW, 1850MHz to 1990MHz |
| TRX3 - ANT | | 0.8 | 1.1 | dB | $P_{IN}$=26dB, CW, 1850MHz to 1990MHz |
| TRX4 - ANT | | 0.95 | 1.25 | dB | $P_{IN}$=26dB, CW, 1850MHz to 1990MHz |
| TRX5 - ANT | | 0.95 | 1.25 | dB | $P_{IN}$=26dB, CW, 1850MHz to 1990MHz |
| TRX1 - ANT | | 0.95 | 1.25 | dB | $P_{IN}$=26dB, CW, 1920MHz to 2170MHz |
| TRX2 - ANT | | 0.95 | 1.25 | dB | $P_{IN}$=26dB, CW, 1920MHz to 2170MHz |
| TRX3 - ANT | | 0.8 | 1.05 | dB | $P_{IN}$=26dB, CW, 1920MHz to 2170MHz |
| TRX4 - ANT | | 1.0 | 1.25 | dB | $P_{IN}$=26dB, CW, 1920MHz to 2170MHz |
| TRX5 - ANT | | 1.0 | 1.25 | dB | $P_{IN}$=26dB, CW, 1920MHz to 2170MHz |

| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| **UMTS 1, 2, 3, 4, 5 - High Band (cont.)** | | | | | |
| Isolation | | | | | 1710MHz to 1880MHz, 1850MHz to 1990MHz, 1920MHz to 2170MHz |
| TRX1, TRX2 - TRX3, TRX4, TRX5 | 25 | 27 | | dB | |
| TRX1 - TRX2, TRX3 - TRX4, TRX4 - TRX5 | 17 | 21 | | dB | |
| TRX3 - TRX5 | 25 | 29 | | dB | |
| TRX1 - RX1, RX2, RX3, RX4 | 20 | 30 | | dB | |
| TRX2 - RX1, RX2, RX3, RX4 | 26 | 35 | | dB | |
| TRX3 - RX1, RX2, RX3, RX4 | 30 | 37 | | dB | |
| TRX4 - RX1, RX2, RX3, RX4 | 30 | 37 | | dB | |
| TRX5 - RX1, RX2, RX3, RX4 | 30 | 37 | | dB | |
| TRX1 - TX1 | 50 | 56 | | dB | |
| TRX1 - TX2 | 22 | 26 | | dB | |
| TRX2 - TX1 | 52 | 57 | | dB | |
| TRX2 - TX2 | 22 | 26 | | dB | |
| TRX3 - TX1 | 50 | 53 | | dB | |
| TRX3 - TX2 | 23 | 28 | | dB | |
| TRX4 - TX1 | 50 | 53 | | dB | |
| TRX4 - TX2 | 23 | 28 | | dB | |
| TRX5 - TX1 | 50 | 53 | | dB | |
| TRX5 - TX2 | 23 | 29 | | dB | |
| Harmonics | | | | | |
| TRX1, 2, 3, 4, 5 - ANT, $2f_0$ | 62 | 93 | | dBc | $P_{IN}$=26dBm, CW |
| TRX1, 2, 3, 4, 5 - ANT, $3f_0$ | 62 | 86 | | dBc | $P_{IN}$=26dBm, CW |
| TRX1, 2, 3, 4, 5 - ANT, up to 12.75GHz | 62 | 101 | | dBc | $P_{IN}$=26dBm, CW |
| TRX3 - ANT, B13, 2fo | 95 | 104 | | dBc | $P_{IN}$=25dBm, CW |
| IIP2 (AWS, PCS, IMT) - C2K mode | 95.5 | 112 | | dBm | Refer to IIP2 test conditions for C2K |
| IIP2 (Cell) - C2K mode | 110 | 114 | | dBm | Refer to IIP2 test conditions for C2K |
| IIP2 - UMTS mode | 102 | 114 | | dBm | Refer to IIP2 test conditions for UMTS mode |
| IIP3 - UMTS mode | 61 | 65 | | dBm | Refer to IIP3 test conditions for UMTS mode |


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| Parameter | Specification | | | Unit | Condition |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| **DC Control and Electrical Specifications** | | | | | |
| $V_{DD}$ - Switch Supply Voltage | 2.5 | 2.75 | 3.0 | V | |
| $V_{DD}$ Supply Current | | | 0.65 | mA | Active Mode |
| VC1, VC2, VC3, VC4 - Control Voltage - VHIGH | 1.35 | 1.8 | 3.1 | V | |
| VC1, VC2, VC3, VC4 - Control Voltage - VLOW | | 0 | 0.4 | V | |
| Control Current | | | 50 | uA | |
| Switching Speed | | 3 | 5 | uS | 10% to 90% RF |

| Pin | Function | Description |
|---|---|---|
| 1 | GND | Ground |
| 2 | TRX3 | WCDMA RF Input/Output Port 3 |
| 3 | TRX4 | WCDMA RF Input/Output Port 4 |
| 4 | TRX5 | WCDMA RF Input/Output Port 5 |
| 5 | GND | Ground |
| 6 | GND | Ground |
| 7 | ANT | Connected to Antenna |
| 8 | GND | Ground |
| 9 | GND | Ground |
| 10 | TX2 | GSM 1800/1900 RF Transmit Input |
| 11 | GND | Ground |
| 12 | GND | Ground |
| 13 | TX1 | GSM 800/900 RF Transmit Input |
| 14 | GND | Ground |
| 15 | RX3 | GSM RF Output Port 3 |
| 16 | GND | Ground |
| 17 | RX2 | GSM RF Output Port 2 |
| 18 | RX1 | GSM RF Output Port 1 |
| 19 | TRX1 | WCDMA RF Input/Output Port 1 |
| 20 | TRX2 | WCDMA RF Input/Output Port 2 |
| 21 | GND | Ground |
| 22 | VDD | Decoder and Charge Pump supply voltage (2.75V typical) |
| 23 | V4 | RF Path control 4 (See Switch Control table) |
| 24 | V3 | RF Path control 3 (See Switch Control table) |
| 25 | V2 | RF Path control 2 (See Switch Control table) |
| 26 | V1 | RF Path control 1 (See Switch Control table) |


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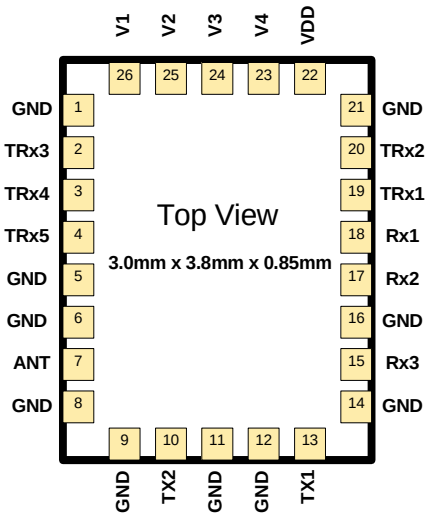
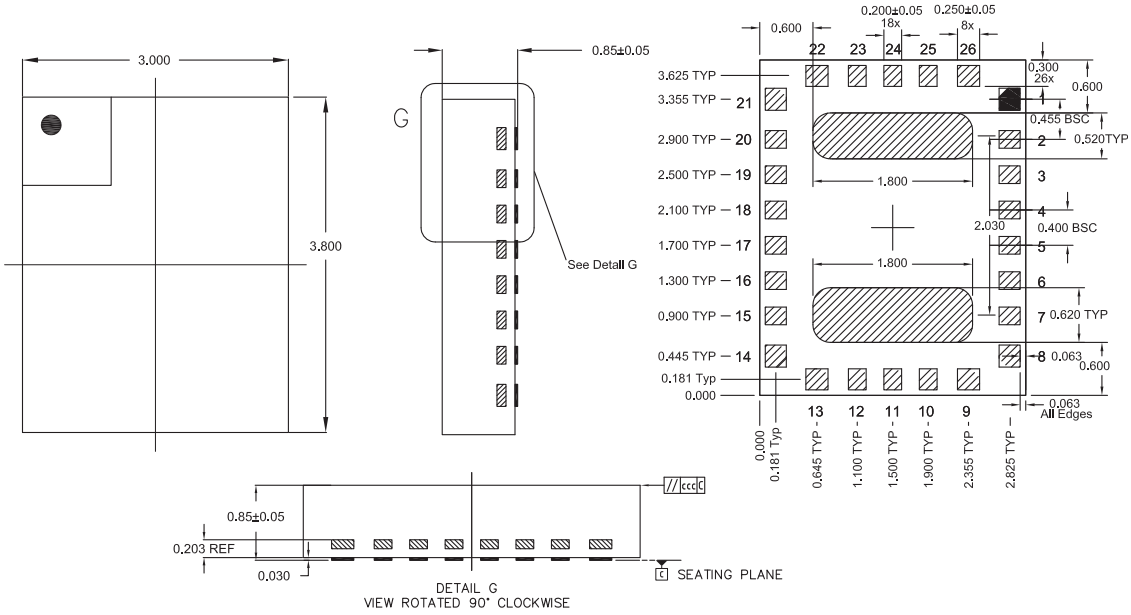
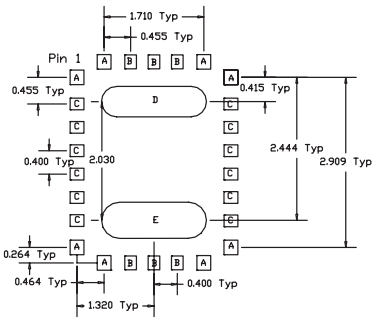
## Pin Out




## Package Drawing

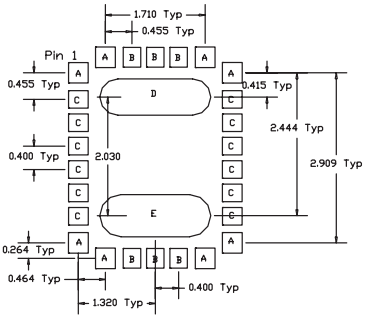



1) PIN 1 INDICATOR SHADED AREA
Notes:



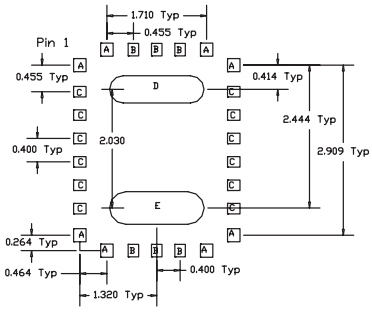

PCB METAL LAND PATTERN

A = 0.237 x 0.250 (mm) Typ
B = 0.200 x 0.237 (mm) Typ
C = 0.237 x 0.200 (mm) Typ
D = 1.800 x 0.520 (mm) Rounded rectangles with corner radius of 75%
E = 1.800 x 0.620 (mm) Rounded rectangles with corner radius of 75%




PCB SOLDER MASK PATTERN

A = 0.337 x 0.350 (mm) Typ
B = 0.300 x 0.337 (mm) Typ
C = 0.337 x 0.300 (mm) Typ
D = 1.900 x 0.620 (mm) Rounded rectangles with corner radius of 75%
E = 1.900 x 0.720 (mm) Rounded rectangles with corner radius of 75%




PCB STENCIL PATTERN

A = 0.213 x 0.225 (mm) Typ
B = 0.180 x 0.213 (mm) Typ
C = 0.213 x 0.180 (mm) Typ
D = 1.620 x 0.468 (mm) Rounded rectangles with corner radius of 75%
E = 1.620 x 0.558 (mm) Rounded rectangles with corner radius of 75%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## General Information

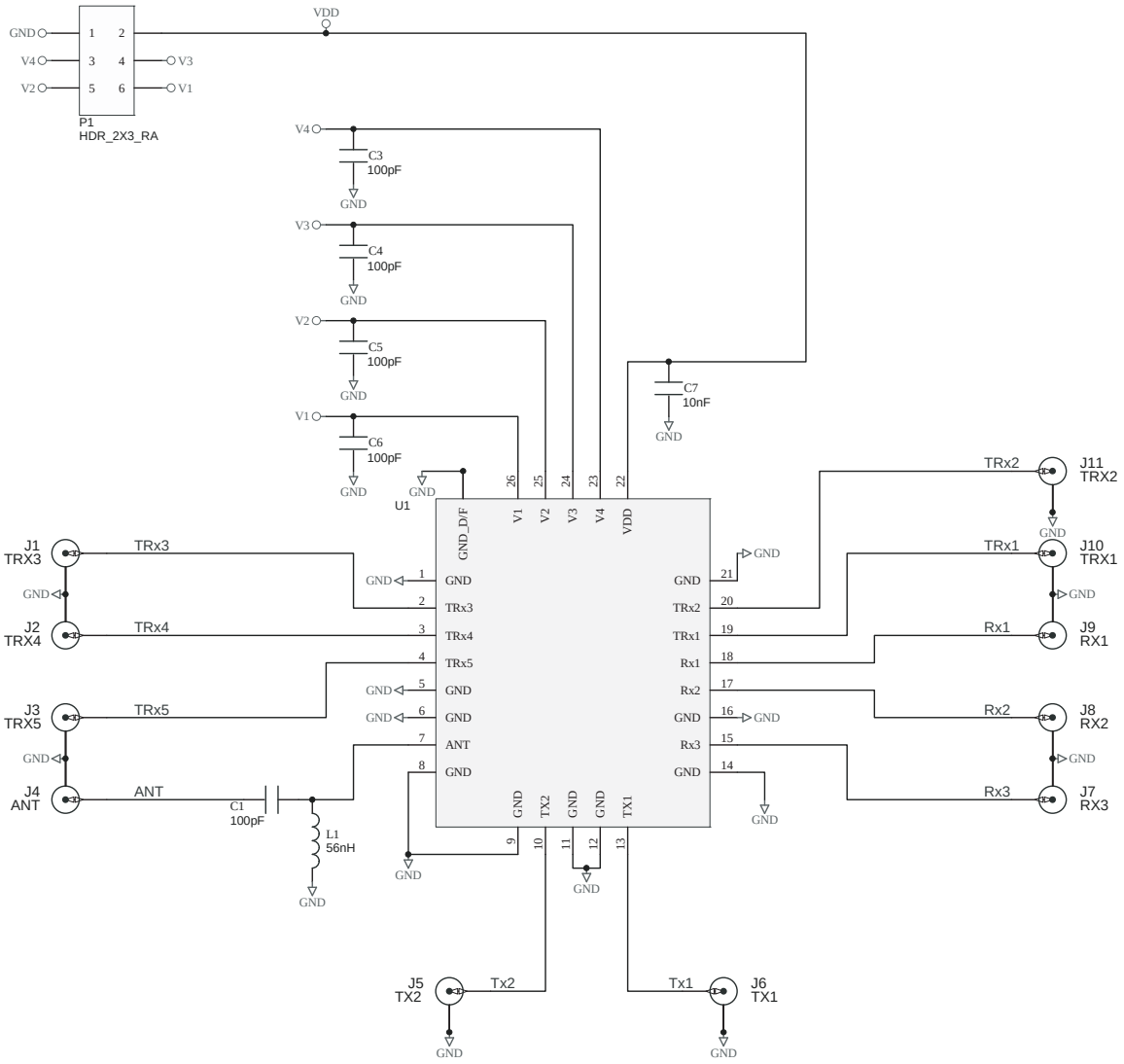
### Control Logic

The SP10T switch is controlled by V1, V2, V3, V4.

| Mode | V1 | V2 | V3 | V4 |
|---|---|---|---|---|
| ANT - GSM LB TX1 | High | High | Low | Low |
| ANT - GSM HB TX2 | High | Low | Low | Low |
| ANT - RX1 | Low | Low | High | Low |
| ANT - RX2 | Low | High | High | Low |
| ANT - RX3 | Low | High | Low | Low |
| ANT - TRX1 | High | Low | High | Low |
| ANT - TRX2 | High | High | High | Low |
| ANT - TRX3 | High | Low | High | High |
| ANT - TRX4 | High | High | High | High |
| ANT - TRX5 | High | Low | Low | High |
| Stand-by | TBD | TBD | TBD | TBD |

*-RX1, RX2, and RX3 are symmetric and can be used interchangeably for GSM low-band and high-band.

## Evaluation Board Schematic




### Application Environment

The switch can be placed directly under, or in close vicinity to, the antenna. Shielding cans covering the switch are not required, and they can be in close vicinity to the PA. The switch can be mounted on a flexible PWB.

### Application Diagram and Guidelines

Decoupling capacitors on the control pins protect the control circuitry from possible RF leakage. A 10nF decoupling capacitor is recommended on the $V_{DD}$ line. The value of L1 will depend on the Contact Discharge rating which needs to be achieved for the application.

In SP9T mode, TRX4 can be used by terminating any other unused port to Ground.

### Electrical Test Methods

The electrical parameters for the switch are measured on test PWB provided by RFMD. The test PWB includes means for decoupling RF signals from control signal port (shunt capacitor at control signal ports).

All measurements are done with calibration plane at switch pins. The effect of test board losses and phase delay are removed from the results by calibrating using the calibration board.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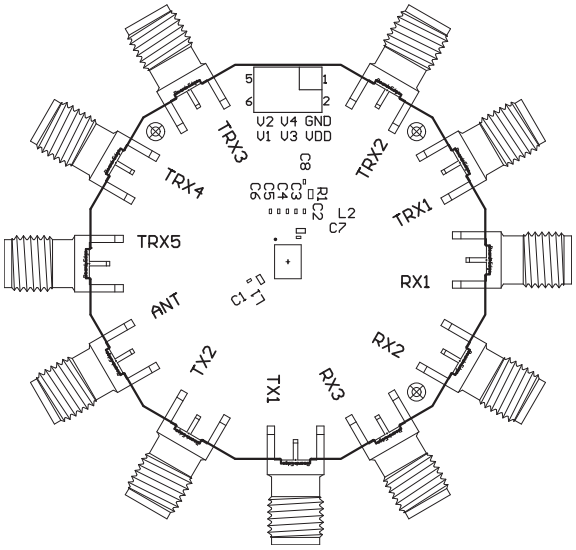
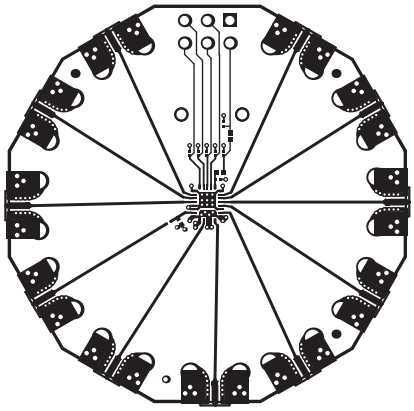
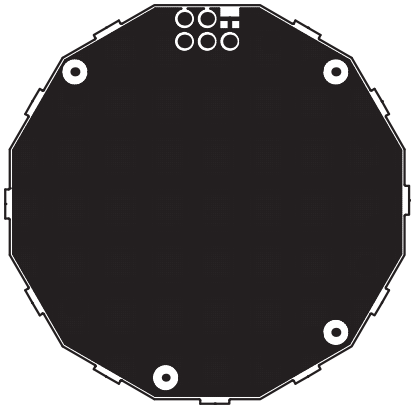
## Evaluation Board Layout
## Board Size 1.9” Diameter
### Board Thickness 0.062”, Board Material FR-4 and Rogers R04003



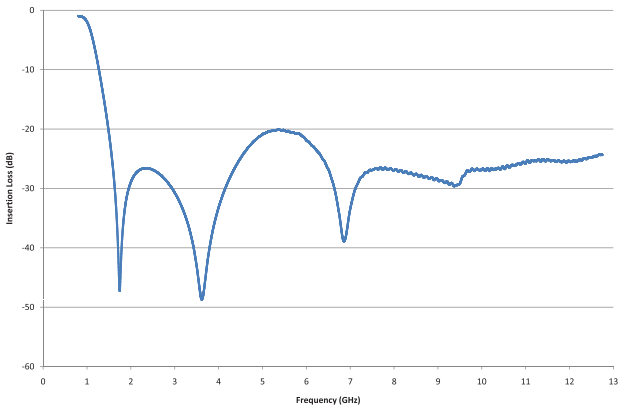





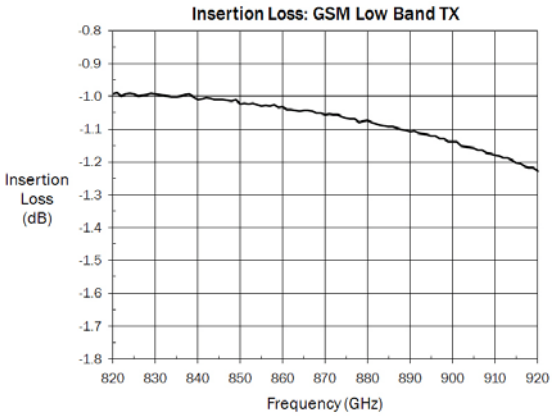
## Typical Performance Data on Evaluation Board

Fixture losses de-embedded (Temp=25°C, $V_{DD}$=2.75V, $V_{CONTROL}$ High=1.8V, $V_{CONTROL}$ Low=0V)

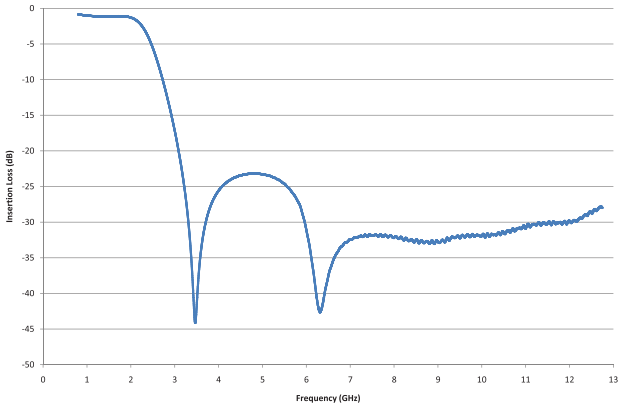
Insertion Loss: GSM Low band TX (Broad band)



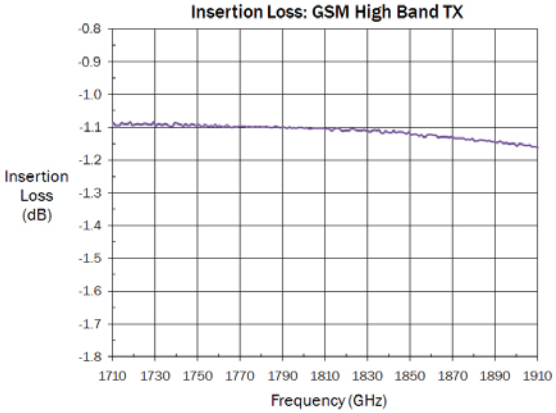

Insertion Loss: GSM Low Band TX



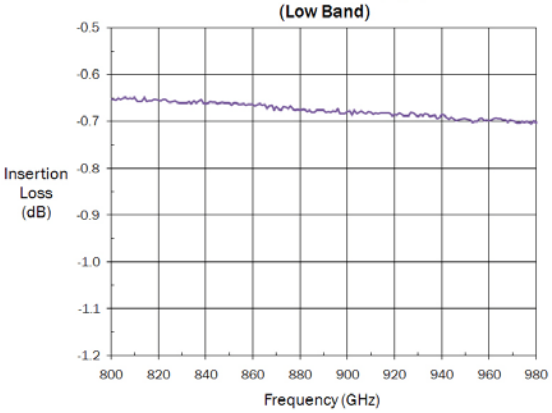

Insertion Loss: GSM High band TX (Broad band)



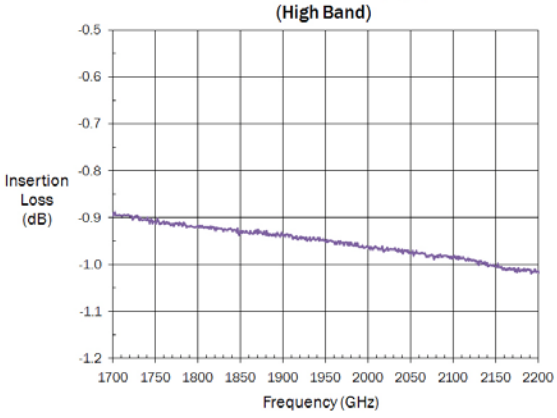

Insertion Loss: GSM High Band TX




Insertion Loss: TRX 1, 2, 4, 5 (Low Band)




Insertion Loss: TRX 1, 2, 4, 5 (High Band)





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## Typical Performance Data on Evaluation Board

Fixture losses de-embedded (Temp=25°C, $V_{DD}$=2.75V, $V_{CONTROL}$ High=1.8V, $V_{CONTROL}$ Low=0V)


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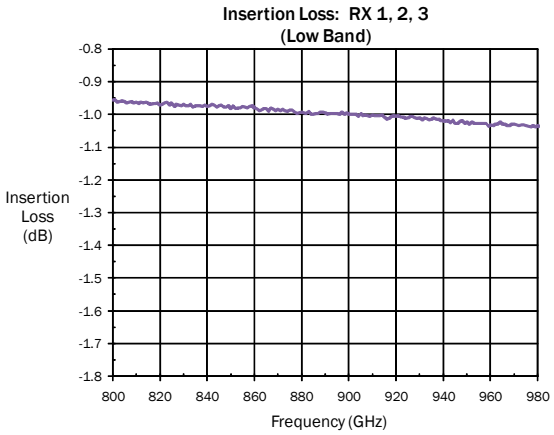


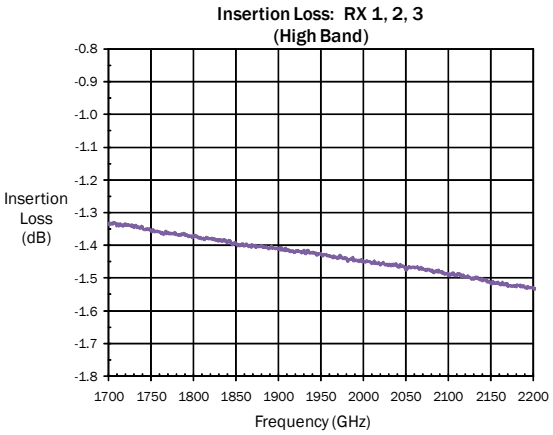



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