



# QPC6222

## GENERAL PURPOSE DPDT TRANSFER SWITCH

### Product Overview

The QPC6222 is a dual-pole double-throw transfer switch designed for general purpose switching applications where RF port transfer (port swapping) control is needed. The low insertion loss along with excellent linearity performance makes the QPC6222 ideal for multi-mode GSM, EDGE, UMTS, and LTE applications.

The RF ports can be directly connected in  $50\Omega$  systems and control logic is compatible with +1.3V to +2.7V systems. The supply voltage is intended for connection to +2.8V systems but the device is operable from +2.4V to +3.5V.

The standard 12-pin QFN package and compact 2.0 mm x 2.0 mm size offers designers a compact, easy-to-use, switch component for quick integration into multimode, multi-band systems.

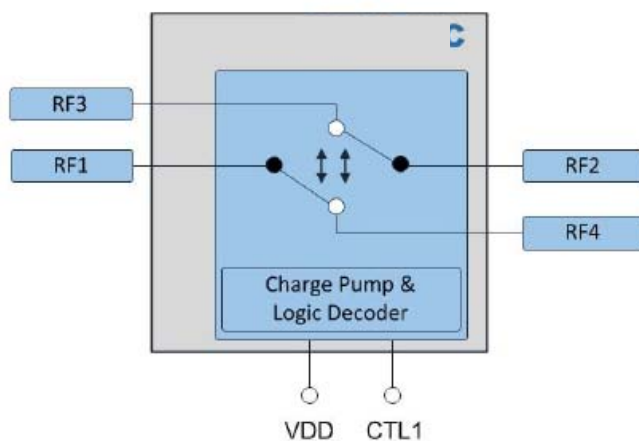


12 Pad 2.0 mm x 2.0 mm x 0.55 mm QFN Package

### Key Features

- Low Insertion Loss
- High Port-to-Port Isolation
- Power Handling up to +35 dBm
- GPIO Interface for +1.3 V to +2.7 V Control Logic
- Broadband Performance Suitable for All Cellular Modulation Schemes up to 2.7 GHz
- Very Low Current Consumption
- Linearity and Harmonic Performance Ideally Suited for LTE Applications

### Functional Block Diagram



Functional Block Diagram

Top View

### Applications

- Data Cards
- IoT
- Telemetry
- Automotive
- Cellular Modems and USB Devices
- Multi-Mode WCDMA, LTE Applications

### Ordering Information

| Part No.       | Description                         |
|----------------|-------------------------------------|
| QPC6222SB      | Sample Bag with 5 pieces            |
| QPC6222SR      | Sample Reel with 100 pieces         |
| QPC6222PCK401  | Assembled EVB + 5 Pieces Sample Bag |
| QPC6222TR13-5K | 5000 Pieces Taped on 13" Reel       |

## Absolute Maximum Ratings

| Parameter                                            | Rating                                                                                                               |
|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Storage Temperature                                  | -65 to +150 °C                                                                                                       |
| Operating Temperature (Tcase)                        | -40 to 105 °C                                                                                                        |
| Maximum VDD                                          | +4.5 V                                                                                                               |
| Maximum CTRL                                         | +3.0 V                                                                                                               |
| Max Input Power<br>(Momentary Infrequent Occurrence) | +38.5 dBm, 1:1 VSWR, +25°C<br>+37.5 dBm, 1:1 VSWR, +90°C<br>+35.0 dBm, 6:1 VSWR, +25°C<br>+34.5 dBm, 6:1 VSWR, +90°C |
| Max Input Power<br>(Continuous Operation)            | +36.5 dBm, 1:1 VSWR, +25°C<br>+35.5 dBm, 1:1 VSWR, +90°C<br>+34.5 dBm, 6:1 VSWR, +25°C<br>+34.0 dBm, 6:1 VSWR, +90°C |

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.

## Recommended Operating Conditions

| Parameter                           | Min  | Typ  | Max   | Units |
|-------------------------------------|------|------|-------|-------|
| Device Voltage (V <sub>DD</sub> )   | +2.4 | +2.8 | +3.5  | V     |
| V <sub>DD</sub> Supply Current      |      | 75   | 100   | μA    |
| C <sub>TL1</sub> Logic Low Voltage  | 0.00 | 0.00 | +0.45 | V     |
| C <sub>TL1</sub> Logic High Voltage | +1.3 | +1.8 | +2.7  | V     |
| C <sub>TL1</sub> Logic High Current |      | 0.1  | 5     | μA    |
| Turn-On Time <sup>(1)</sup>         |      |      | 20    | μs    |
| Switching Time <sup>(2)</sup>       |      |      | 5     | μs    |

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

Notes:

1. RF settling time with 0V to 2.4V step on VDD
2. Switching Time is measured at 10% to 90% RF

## Electrical Specifications Low Band

| Parameter                   |                           | Conditions <sup>(1)</sup>                                                                                                                         | Min | Typ  | Max  | Units |
|-----------------------------|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|------|-------|
| Operational Frequency Range |                           |                                                                                                                                                   | 698 |      | 960  | MHz   |
| Insertion Loss              | RF1 to RF3                | Logic State = RF1 – RF3, RF2 – RF4                                                                                                                |     | 0.35 | 0.52 | dB    |
|                             | RF1 to RF4                | Logic State = RF1 – RF4, RF2 – RF3                                                                                                                |     | 0.35 | 0.52 |       |
|                             | RF2 to RF3                | Logic State = RF1 – RF4, RF2 – RF3                                                                                                                |     | 0.35 | 0.52 |       |
|                             | RF2 to RF4                | Logic State = RF1 – RF3, RF2 – RF4                                                                                                                |     | 0.34 | 0.52 |       |
| Isolation                   | RF1 to RF3,<br>RF2 to RF4 | Logic State = RF1 – RF4, RF2 – RF3                                                                                                                | 29  | 32   |      | dB    |
|                             | RF1 to RF4,<br>RF2 to RF3 | Logic State = RF1 – RF3, RF2 – RF4                                                                                                                | 28  | 31   |      |       |
| Harmonics                   | 2nd Harmonic              | Frequency = 824 MHz, PIN = +35 dBm, CW                                                                                                            |     | –105 | –76  | dBc   |
|                             | 3rd Harmonic              |                                                                                                                                                   |     | –88  | –76  | dBc   |
|                             | 2nd Harmonic (B13)        | Frequency = 786.5 MHz, PIN = +26 dBm, CW                                                                                                          |     | –106 | –98  | dBc   |
|                             | 2nd Harmonic              | Frequency = 824 MHz to 915 MHz,<br>PIN = +26 dBm, CW                                                                                              |     | –107 | –100 | dBc   |
|                             | 3rd Harmonic              |                                                                                                                                                   |     | –106 | –98  | dBc   |
|                             | Up to 12.75 GHz           |                                                                                                                                                   |     | –105 | –95  | dBc   |
| IP2 Band 5 & 6              |                           | F1 = 836.5 MHz, P <sub>F1</sub> = +20 dBm,<br>F2 = 1718 MHz, P <sub>F2</sub> = –15 dBm,<br>Rx Freq. = 881.5 MHz                                   | 110 | 128  |      | dBm   |
| IP3 Band 5 & 6              |                           | F1 = 836.5 MHz, P <sub>F1</sub> = +20 dBm,<br>F2 = 791.5 MHz, P <sub>F2</sub> = –15 dBm,<br>Rx Freq = 881.5 MHz,<br>Measured on all through paths | 70  | 72   |      | dBm   |
| VSWR                        |                           | 824 MHz to 960 MHz (RF1, RF2, RF3, RF4)                                                                                                           |     | 1.1  | 1.3  |       |

Notes:

1. Unless otherwise stated: all unused RF ports terminated in 50 Ω, Input and Output = 50 Ω, T. = +25 °C, V<sub>DD</sub> = +2.4V, Logic State = RF1-RF4, RF2-RF3 and RF1-RF3, RF2-RF4

## Electrical Specifications – High Band

| Parameter               |                        | Conditions <sup>(1)</sup>                                                                                                                 | Min              | Typ  | Max  | Units |
|-------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------|------|------|-------|
| Frequency Range         |                        |                                                                                                                                           | 1427             |      | 2170 | MHz   |
| Insertion Loss          | RF1 to RF3             | Logic State = RF1-RF3; RF2-RF4                                                                                                            | 1427 to 1980 MHz | 0.44 | 0.62 | dB    |
|                         |                        |                                                                                                                                           | 1980 to 2170 MHz | 0.47 | 0.63 |       |
|                         | RF1 to RF4             | Logic State = RF1-RF4; RF2-RF3                                                                                                            | 1427 to 1980 MHz | 0.44 | 0.62 |       |
|                         |                        |                                                                                                                                           | 1980 to 2170 MHz | 0.47 | 0.63 |       |
|                         | RF2 to RF3             | Logic State = RF1-RF4, RF2-RF3                                                                                                            | 1427 to 1980 MHz | 0.44 | 0.62 |       |
|                         |                        |                                                                                                                                           | 1980 to 2170 MHz | 0.47 | 0.63 |       |
|                         | RF2 to RF4             | Logic State = RF1-RF3, RF2-RF4                                                                                                            | 1427 to 1980 MHz | 0.44 | 0.62 |       |
|                         |                        |                                                                                                                                           | 1980 to 2170 MHz | 0.47 | 0.63 |       |
| Isolation               | RF1 to RF3, RF2 to RF4 | Logic State = RF1-RF4, RF2-RF3                                                                                                            | 1427 to 1980 MHz | 23   | 27   | dB    |
|                         |                        |                                                                                                                                           | 1980 to 2170 MHz | 22   | 26   |       |
|                         | RF1 to RF4, RF2 to RF3 | Logic State = RF1-RF3, RF2-RF4                                                                                                            | 1427 to 1980 MHz | 21   | 25   |       |
|                         |                        |                                                                                                                                           | 1980 to 2170 MHz | 20   | 24   |       |
| Harmonics               | 2nd Harmonic           | Frequency = 1980 MHz, P <sub>IN</sub> = +33 dBm, CW,<br>Measured on all through paths                                                     |                  | -97  | -75  | dBc   |
|                         | 3rd Harmonic           |                                                                                                                                           |                  | -90  | -70  |       |
|                         | 2nd Harmonic           | Freq. = 1710 MHz to 1980 MHz, P <sub>IN</sub> = +26 dBm, CW,<br>Measured on all through paths                                             |                  | -107 | -98  |       |
|                         | 3rd Harmonic           |                                                                                                                                           |                  | -104 | -94  |       |
|                         | Up to 12.75 GHz        |                                                                                                                                           |                  | -104 | -94  |       |
| IP2 Band 2 (PCS)        |                        | F1 = 836.5 MHz, P <sub>F1</sub> = +20 dBm, F2 = 1718 MHz, P <sub>F2</sub> = -15 dBm<br>Rx Freq = 881.5 MHz, Measured on all through paths | +110             | +126 |      | dBm   |
| IP3                     | Band II (PCS)          | F1 = 1880 MHz, P <sub>F1</sub> = +20 dBm, F2 = 1800 MHz, P <sub>F2</sub> = -15 dBm<br>Rx Freq = 1960 MHz, Measured on all through paths   | +70              | +73  |      | dBm   |
|                         | Band I (IMT)           | F1 = 1950 MHz, P <sub>F1</sub> = +20 dBm, F2 = 1760 MHz, P <sub>F2</sub> = -15 dBm<br>Rx Freq = 2140 MHz, Measured on all through paths   | +70              | +73  |      |       |
| VSWR RF1, RF2, RF3, RF4 |                        | 1427 MHz to 2170 MHz                                                                                                                      |                  | 1.2  | 1.5  |       |

## Electrical Specifications – High Band LTE

| Parameter               |                        | Conditions <sup>(1)</sup>                                                             | Min  | Typ  | Max  | Units |
|-------------------------|------------------------|---------------------------------------------------------------------------------------|------|------|------|-------|
| Frequency Range         |                        |                                                                                       | 2500 |      | 2690 | MHz   |
| Insertion Loss          |                        | RFx to RFx                                                                            |      | 0.53 |      | dB    |
| Isolation               | RF1 to RF3, RF2 to RF4 | Logic State = RF1-RF4, RF2-RF3                                                        | 21   | 24   |      | dB    |
|                         | RF1 to RF4, RF2 to RF3 | Logic State = RF1-RF3, RF2-RF4                                                        | 19   | 23   |      | dB    |
| Harmonics               | 2nd Harmonic           | Frequency = 2500 MHz to 2570 MHz, P <sub>IN</sub> = +26 dBm, CW,<br>All through paths |      | -104 | -95  | dBc   |
|                         | 3rd Harmonic           |                                                                                       |      | -104 | -95  | dBc   |
| VSWR RF1, RF2, RF3, RF4 |                        | 2500 MHz to 2570 MHz                                                                  |      | 1.4  | 1.55 |       |
| IIP2                    |                        | F1 = 2535 MHz at +20 dBm, F2 = 120 MHz at -15 dBm,<br>Rx Freq = 2655 MHz              | +110 | +116 |      | dBm   |
| IIP3                    |                        | F1 = 2535 MHz at +20 dBm, F2 = 2415 MHz at -15 dBm,<br>Rx Freq. = 2655 MHz            | +70  | +72  |      | dBm   |

## Recommended Operating Power, 50 $\Omega$ System

| Frequency       | Power at T=+85 °C | Power at T=+105 °C | Theta-J(°C/W) | Input          |
|-----------------|-------------------|--------------------|---------------|----------------|
| 5 MHz           | +33 dBm           | +30 dBm            | 246           | Single RF path |
| 20 MHz to 4 GHz | +36.5 dBm         | +34.5 dBm          | 34.8          | Single RF path |
| 5 MHz           | +32 dBm           | +29 dBm            | 310           | Dual RF path   |
| 20 MHz to 4 GHz | +35.5 dBm         | +33.5 dBm          | 47            | Dual RF path   |

## Control Logic

| Logic State      | Description                                   | V <sub>DD</sub>    | CTL1 |
|------------------|-----------------------------------------------|--------------------|------|
| Off              | Off or Standby - low current state            | 0 V                | Low  |
| RF1-RF4, RF2-RF3 | RF1 connected to RF4 and RF2 connected to RF3 | "V <sub>DD</sub> " | Low  |
| RF1-RF3, RF2-RF4 | RF1 connected to RF3 and RF2 connected to RF4 | "V <sub>DD</sub> " | High |

NOTE: The switch is in the Off or Standby state only when the V<sub>DD</sub> supply is low. The RF performance is undefined in the Off state.

## Power ON and OFF sequence

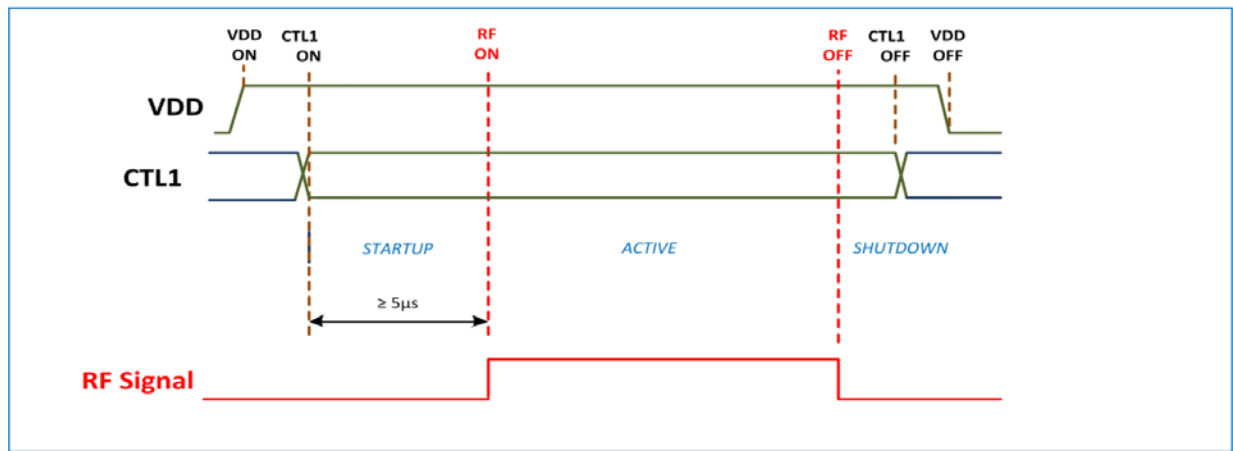
It is very important that the user adheres to the correct power-on/off sequence in order to avoid damaging the device. First apply V<sub>DD</sub> before applying a high to CTL1.

Power ON –

- 1) Apply voltage supply - V<sub>DD</sub>
- 2) Apply logic signals - CTL1
- 3) Wait 5  $\mu$ s or greater after CTL1 are stable and then apply the RF Signal

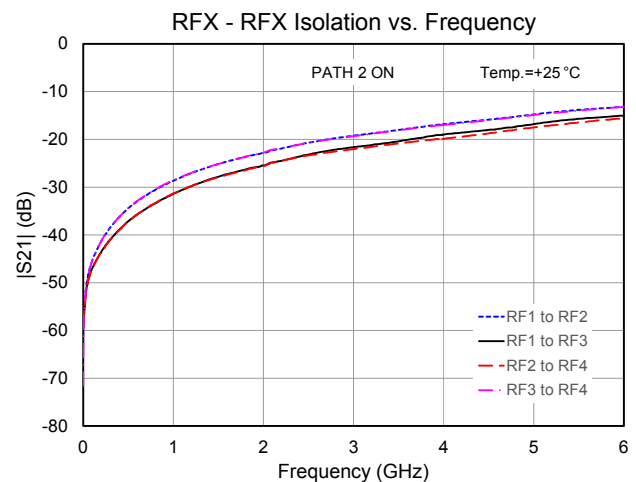
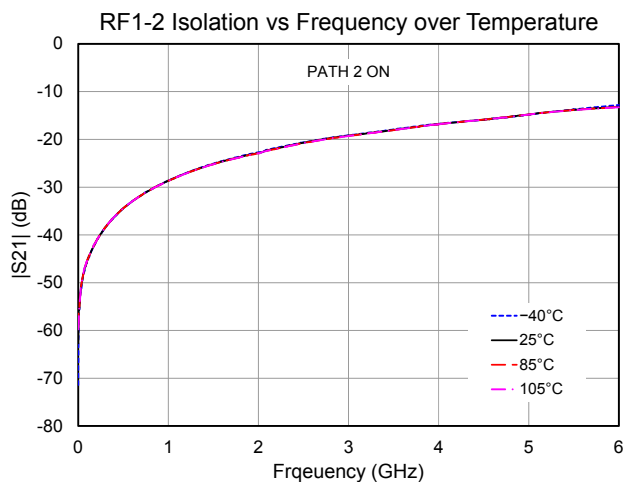
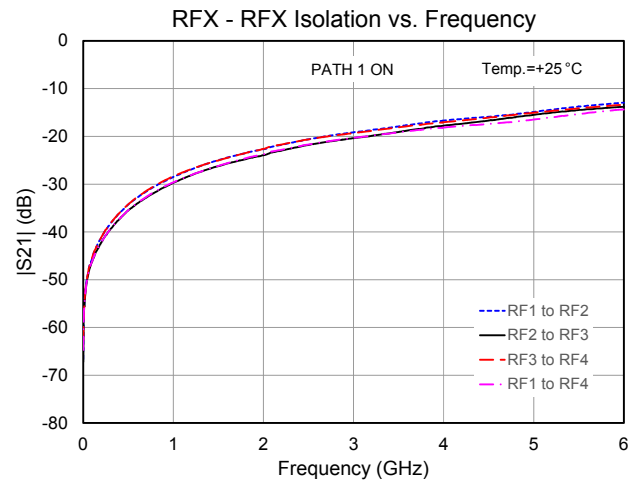
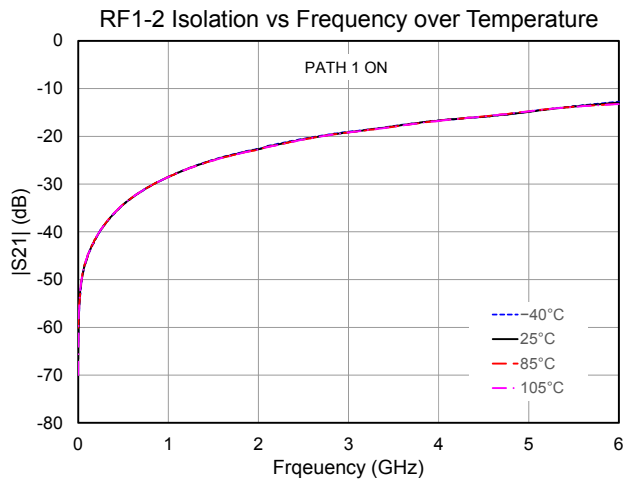
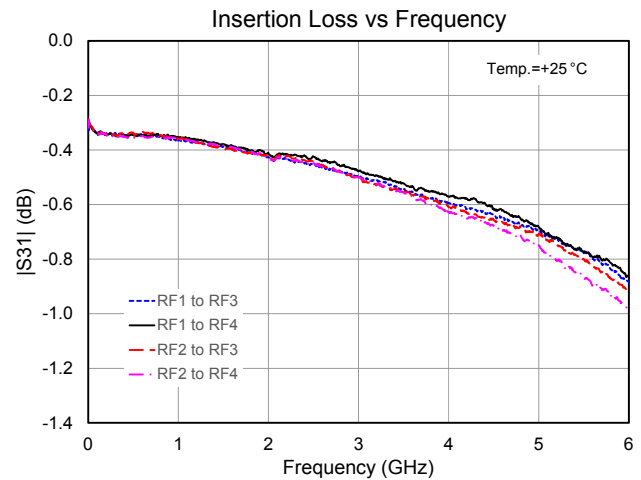
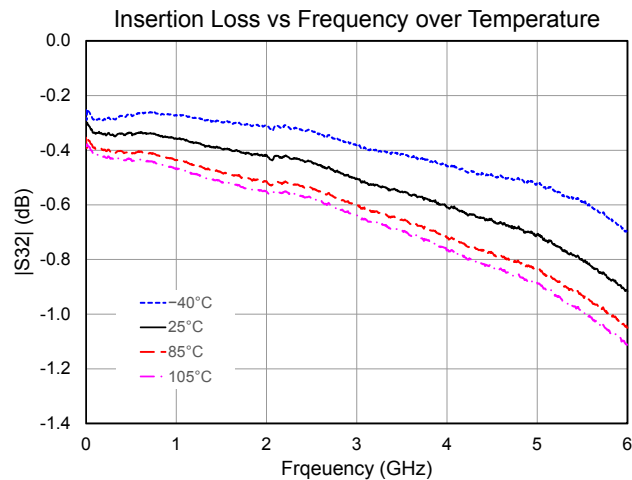
Power OFF –

- 1) Remove the RF Signal
- 2) Remove logic signals - CTL1
- 3) Remove voltage supply - V<sub>DD</sub>



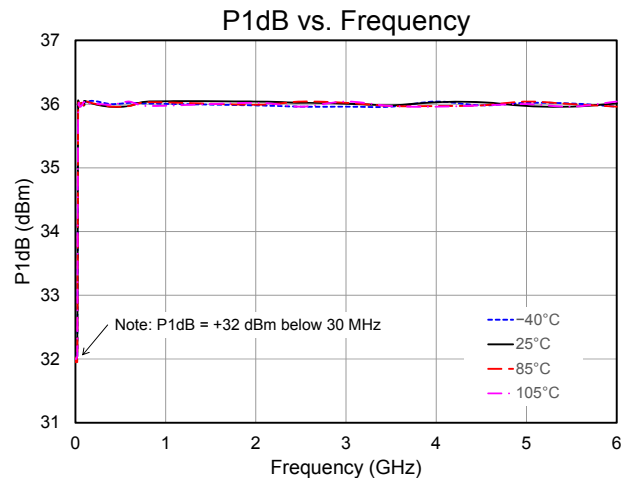
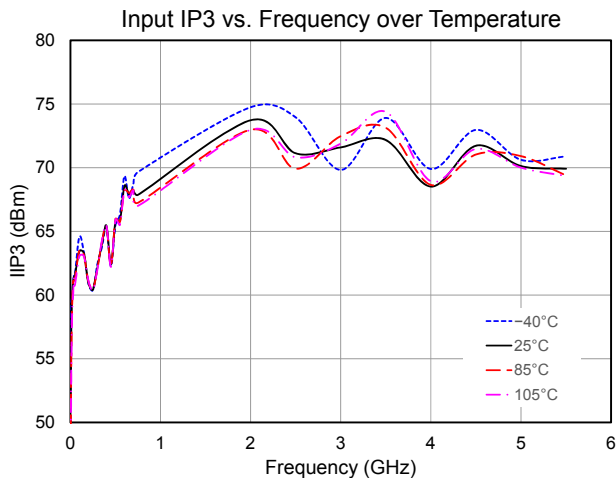
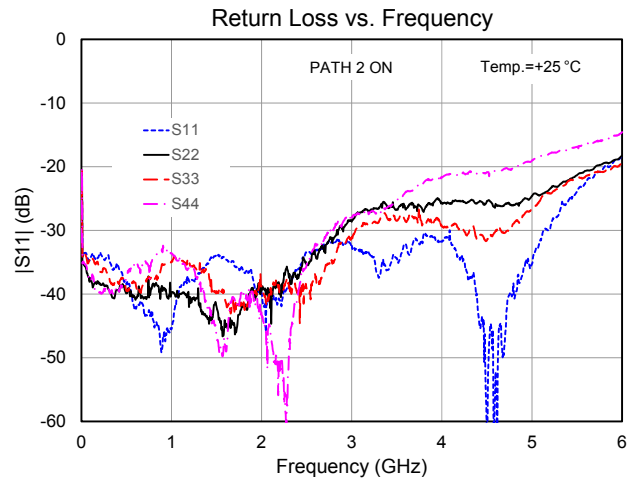
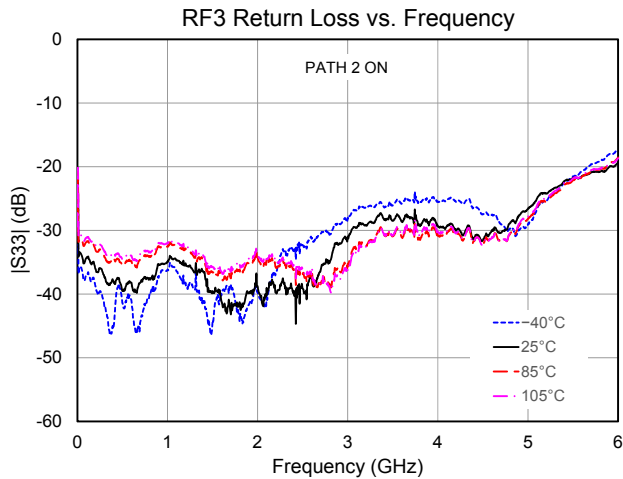
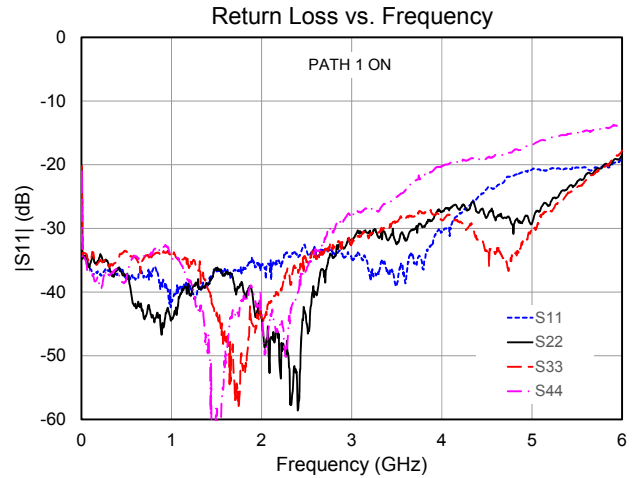
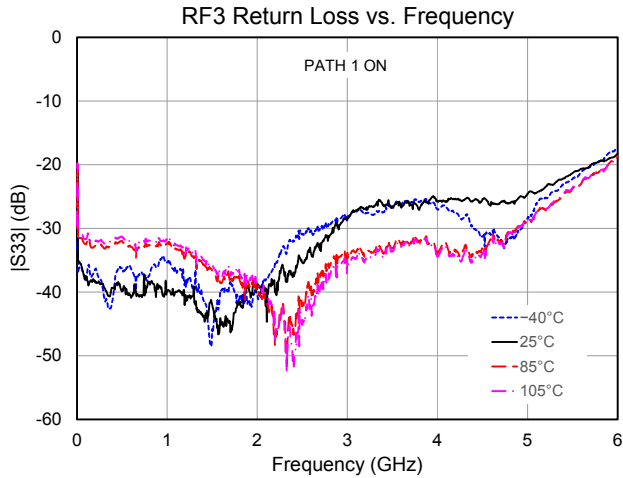
## Performance Plots

Test conditions unless otherwise noted:  $V_{DD} = +2.8V$

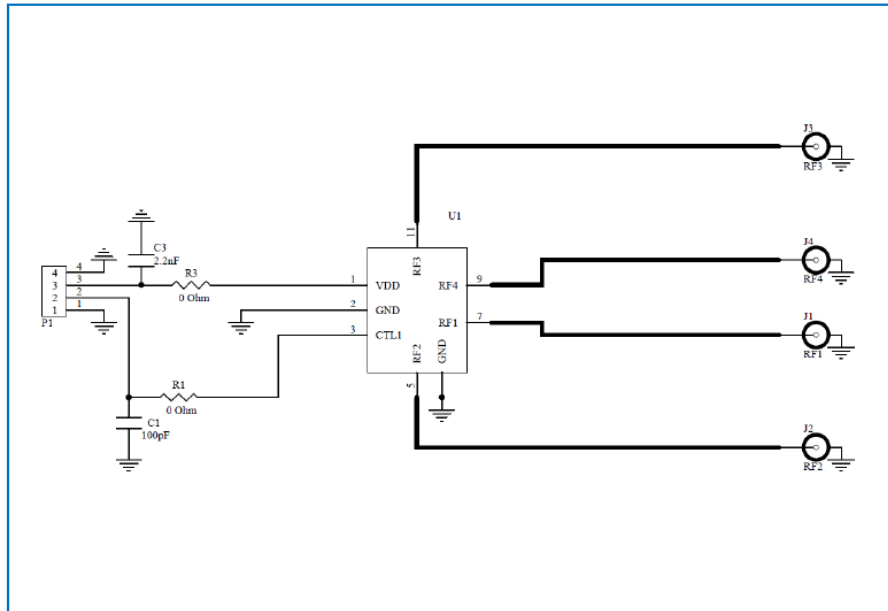


## Performance Plots

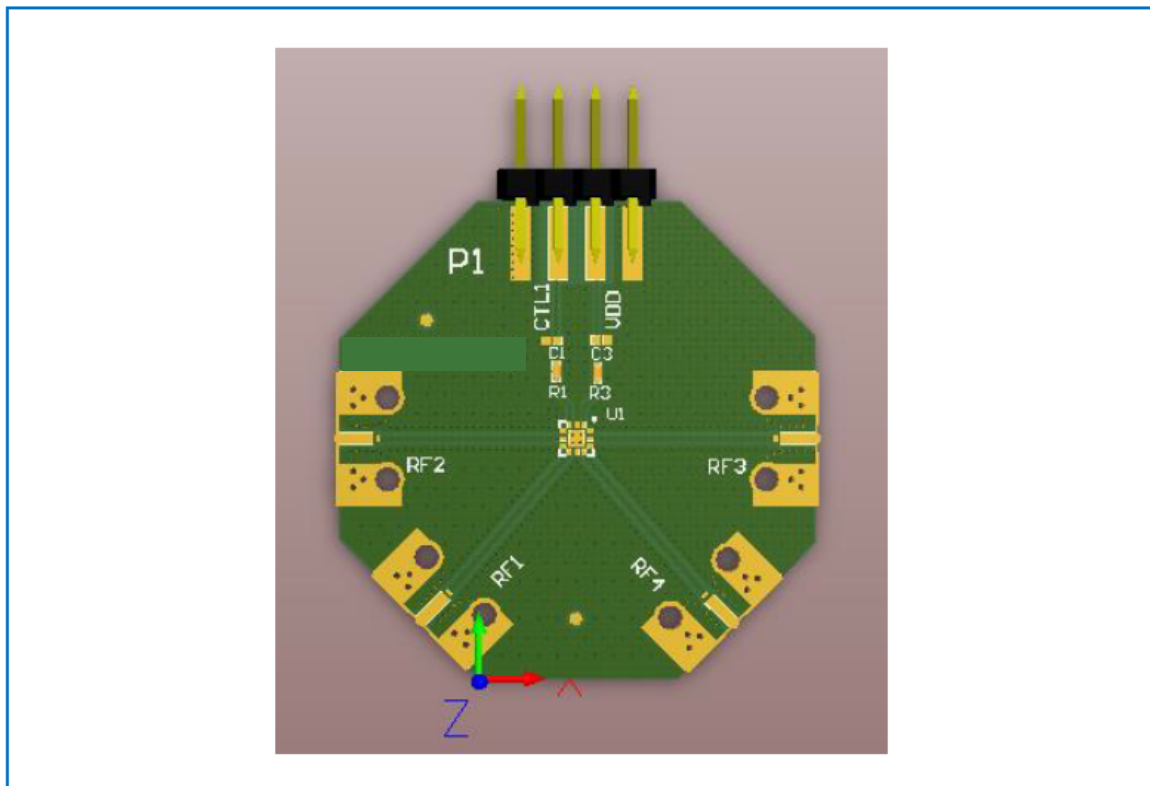
Test conditions unless otherwise noted:  $V_{DD} = +2.8V$



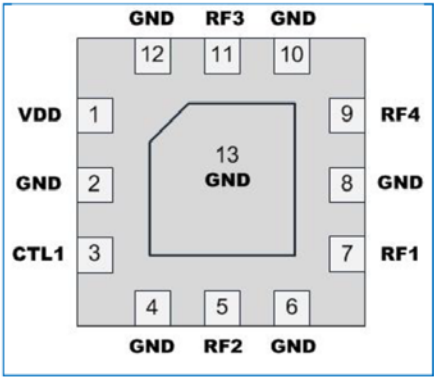
## Evaluation Board Schematic



## Evaluation Board Layout



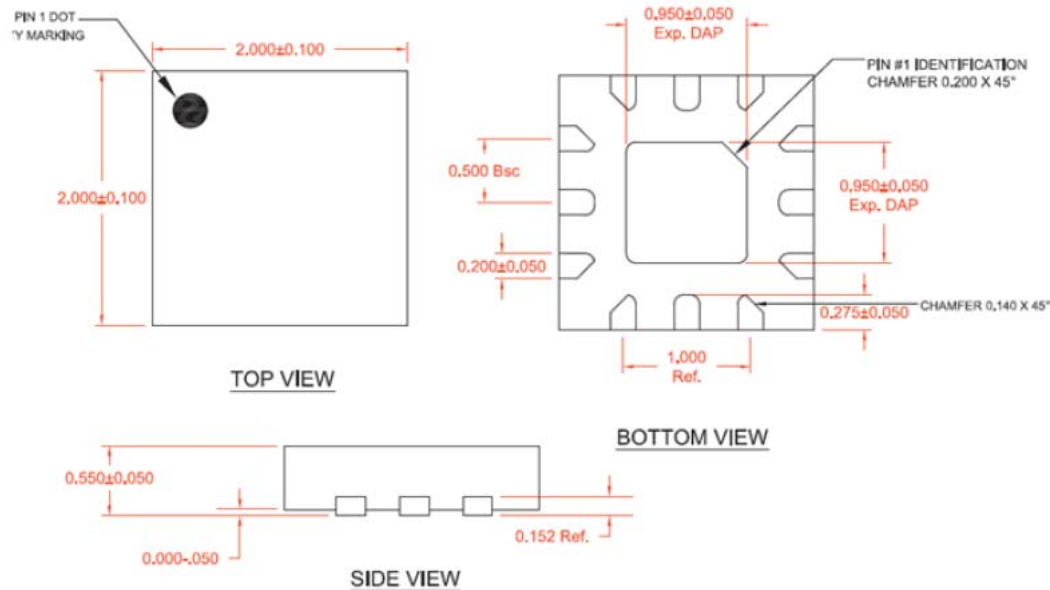
Pin Configuration and Description



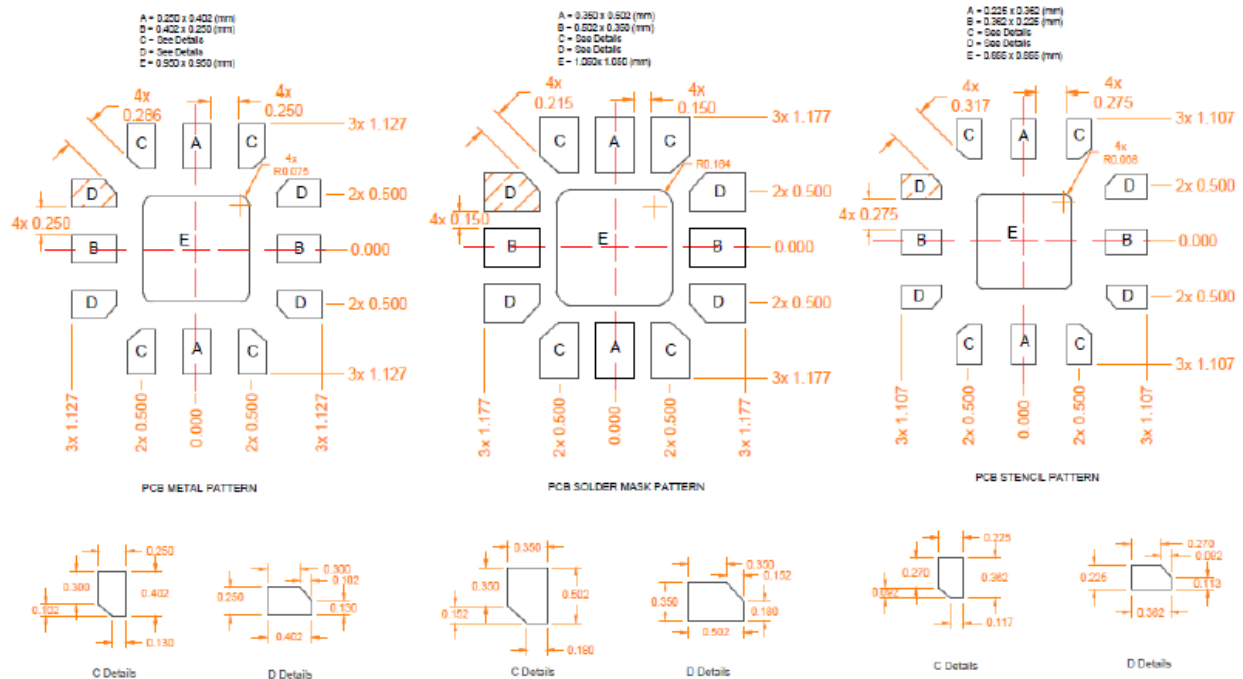
| Pad No.              | Label           | Description                                                         |
|----------------------|-----------------|---------------------------------------------------------------------|
| 1                    | V <sub>DD</sub> | Power Supply.                                                       |
| 3                    | CTL1            | Logic control pin 1.                                                |
| 5                    | RF2             | RF Port connecting to either RF3 or RF4. Avoid applying DC voltage. |
| 7                    | RF1             | RF Port connecting to either RF3 or RF4. Avoid applying DC voltage. |
| 9                    | RF4             | RF Port connecting to either RF1 or RF2. Avoid applying DC voltage. |
| 11                   | RF3             | RF Port connecting to either RF1 or RF2. Avoid applying DC voltage. |
| 2, 4, 6, 8, 10,12,13 | GND             | GND.                                                                |



## Package Marking and Dimensions



## PCB Mounting Patterns



### Notes:

1. Thermal vias for center slug "E" should be incorporated into the PCB design. The number and size of thermal vias will depend on the application, the power dissipation and the electrical requirements. An example of the number and size of the vias can be found on the Qorvo evaluation board layout.
2. Shaded pad in drawing above indicates pin 1 location.

## Handling Precautions

| Parameter                        | Rating   | Standard                 |
|----------------------------------|----------|--------------------------|
| ESD – Human Body Model (HBM)     | Class 2C | ESDA / JEDEC JS-001-2012 |
| ESD – Charged Device Model (CDM) | Class C3 | JEDEC JESD22-C101F       |
| MSL – Moisture Sensitivity Level | MSL 1    | IPC/JEDEC J-STD-020      |



Caution!  
ESD-Sensitive Device

## Solderability

Compatible with both lead-free (260°C max. reflow temp.) and tin/lead (245°C max. reflow temp.) soldering processes.  
Solder profiles available upon request.

Contact plating: NiPdAu

## RoHS Compliance

This part is compliant with 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) Free
- PFOS Free
- SVHC Free



## Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:

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**Email:** [customer.support@qorvo.com](mailto:customer.support@qorvo.com)

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