# THE DATASHEET OF

# PE42451MLIAA-Z

www.win-source.net 0086-755-83957316

# Product Specification

# PE42451

## SP5T Absorptive UltraCMOS® High-Isolation RF Switch 450-5000 MHz, $Vss_{EXT}$ option

### Features

- HaRP™-enhanced UltraCMOS® device
- Five symmetric, absorptive RF ports
- High Isolation:
  - 68 dB at 450 MHz
  - 62 dB at 900 MHz
  - 55 dB at 2100 MHz
  - 53 dB at 2600 MHz
  - 50 dB at 4000 MHz
  - 43 dB at 5000 MHz
- IIP2 of 95 dBm, IIP3 of 58 dBm
- High ESD tolerance of 3500 V HBM
- Optional External Vss Control ($Vss_{EXT}$)
- Three pin CMOS logic control
- No blocking capacitors required
- Small RoHS-Compliant 24-lead 4x4 mm QFN package

## Product Description

The PE42451 is a HaRP™-enhanced sbsorptive SP5T RF wwitch developed on the UltraCMOS® process technology. This general purpose switch is comprised of five symmetric RF ports and has very high isolation. An on-chip CMOS decode logic facilitates a three-pin low voltage CMOS control interface and an optional external Vss feature ($Vss_{EXT}$). High ESD tolerance and no blocking capacitor requirements make this the ultimate in integration and ruggedness.

pSemi's HaRP™ technology enhancements deliver high linearity and exceptional harmonics performance. It is an innovative feature of the UltraCMOS® process, providing performance superior to GaAs with the economy and integration of conventional CMOS.

**Figure 1. Functional Diagram**

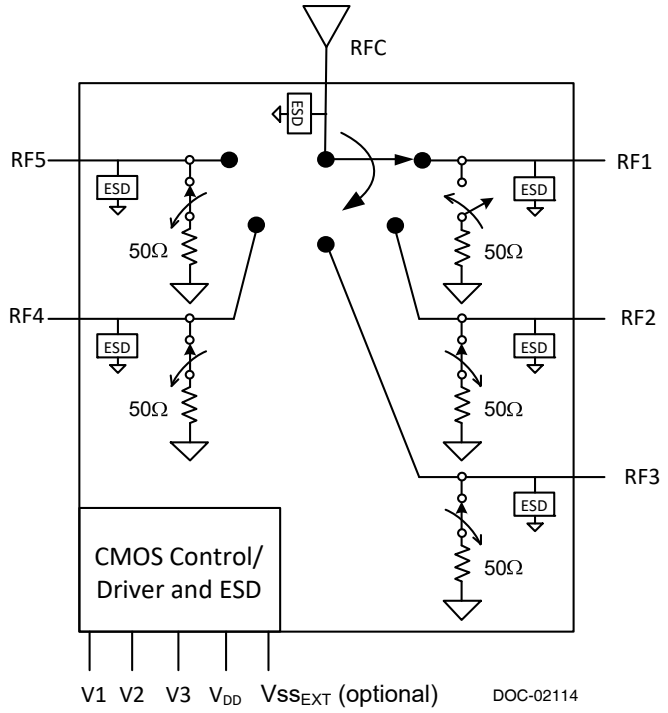
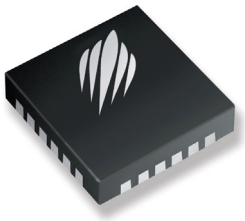



**Figure 2. Package Photo**
24-lead 4x4 mm QFN

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## Table 1. Electrical Specifications @ 25 °C, $V_{DD}$ = 3.0 V ($Z_S = Z_L = 50\ \Omega$)

| Electrical Parameter | Path | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Operating Frequency | | | 450 | | 5000 | MHz |
| Insertion Loss, IL | RFC - RFX | 450 MHz | | 1.60 | 1.95 | dB |
| | RFC - RFX | 900 MHz | | 1.65 | 2.05 | dB |
| | RFC - RFX | 2100 MHz | | 1.95 | 2.30 | dB |
| | RFC - RFX | 2600 MHz | | 2.05 | 2.40 | dB |
| | RFC - RFX | 4000 MHz | | 2.25 | 2.75 | dB |
| | RFC - RFX | 5000 MHz | | 2.50 | 3.15 | dB |
| Isolation, Iso | RFC/RFX - RFX | 450 MHz | 58.5 | 68 | | dB |
| | RFC/RFX - RFX | 900 MHz | 53.0 | 62 | | dB |
| | RFC/RFX - RFX | 2100 MHz | 46.5 | 55 | | dB |
| | RFC/RFX - RFX | 2600 MHz | 46.5 | 53 | | dB |
| | RFC/RFX - RFX | 4000 MHz | 45.0 | 50 | | dB |
| | RFC/RFX - RFX | 5000 MHz | 41.0 | 43 | | dB |
| Return Loss, Active Port | RFX - RFX | 450 - 4000 MHz | | 16 | | dB |
| | | 4000 - 5000 MHz | | 14 | | dB |
| Return Loss, Terminated Port | RFX - RFX | 450 - 4000 MHz | | 15 | | dB |
| | | 4000 - 5000 MHz | | 12 | | dB |
| Input 1 dB compression[1], P1dB | RFX - RFC | 450 - 5000 MHz,100% duty cycle | | 35 | | dBm |
| Input IP2 | RFX - RFC | 450 - 5000 MHz, 100% duty cycle | | 95 | | dBm |
| Input IP3 | RFX - RFC | 450 - 5000 MHz, 100% duty cycle | | 58 | | dBm |
| Switching Time, $T_{SW}$ | "On" | 50% Control to 90% RF | | 200 | 500 | ns |
| | "Off" | 50% Control to 10% RF | | 200 | 500 | ns |

Notes: 1. Please refer to Maximum Operating Power in Table 2

## Table 2. Operating Ranges

| Parameter | Symbol | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| $V_{DD}$ Supply Voltage | $V_{DD}$ | 2.7 | 3.0 | 3.3 | V |
| $Vss_{EXT}$ Negative Power Supply Voltage[2] | $Vss_{EXT}$ | -3.3 | -3.0 | -2.7 | V |
| $I_{DD}$ Power Supply Current $V_{DD}$ = 3.0 V, $P_{IN}$= 0 dBm | $I_{DD}$ | | 14 | | µA |
| $I_{DD}$ Max Power Supply Current $V_{DD}$ = 3.3 V, $P_{MAX}$= 33 dBm, Temperature = -40°C | $I_{DD}$ (max) | | | 50 | µA |
| Control Voltage High | $V_{IH}$ | 0.7 x $V_{DD}$ | | $V_{DD}$ | V |
| Control Voltage Low | $V_{IL}$ | 0 | | 0.3 x $V_{DD}$ | V |
| $I_{CTRL}$ Control Current[3] | $I_{CTRL}$ | | | 1 | µA |
| Maximum Operating Power (RFX-RFC, All Bands (50Ω), 100% duty cycle) | $P_{MAX}$ | | | 33 | dBm |
| Maximum power into termination (RFX, All Bands (50Ω),100% duty cycle) | $P_{MAX}$ | | | 24 | dBm |
| Operating temperature range | $T_{OP}$ | -40 | | +105 | °C |

Note: 2. Applied only when external Vss power supply used. Pin 20 must be grounded when using internal Vss supply.
3. Pull-down resistor in EVK schematic may increase control current.

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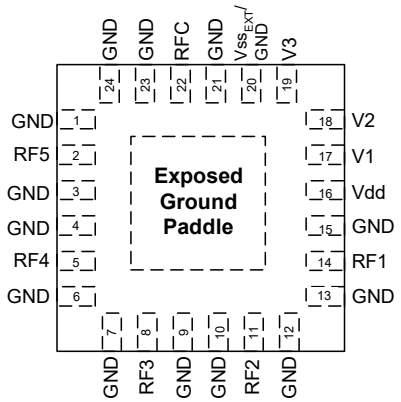
## Figure 3. Pin Configuration (Top View)




## Table 3. Pin Descriptions

| Pin # | Name | Description |
|---|---|---|
| 1, 3, 4, 6, 7, 9, 10, 12, 13, 15, 21, 23, 24 | GND | Ground |
| 2 | RF5[4] | RF I/O |
| 5 | RF4[4] | RF I/O |
| 8 | RF3[4] | RF I/O |
| 11 | RF2[4] | RF I/O |
| 14 | RF1[4] | RF I/O |
| 16 | $V_{DD}$ | Supply |
| 17 | V1 | Switch control input, CMOS logic level |
| 18 | V2 | Switch control input, CMOS logic level |
| 19 | V3 | Switch control input, CMOS logic level |
| 20 | $Vss_{EXT}$ / GND[5] | External Vss Control / Ground |
| 22 | RFC[4] | RF Common |
| Paddle | GND | Ground for proper device operation |

Note: 4. Blocking capacitors needed only when non-zero DC voltage present.
5. Pin 20 must be grounded when using internal Vss supply

## Table 4. Absolute Maximum Ratings

| Symbol | Parameter/Conditions | Min | Max | Units |
|---|---|---|---|---|
| $T_{ST}$ | Storage temperature range | -60 | +150 | °C |
| $P_{MAX}$ | Maximum Operating Power (RFX-RFC, All Bands (50Ω), 100% duty cycle) | | 33 | dBm |
| $P_{MAX}$ | Maximum power into termination (RFX, All Bands (50Ω),100% duty cycle) | | 24 | dBm |
| $V_{ESD}$ | ESD Voltage HBM[6], All Pins | | 3500 | V |
| $V_{ESD}$ | ESD Voltage MM[7], All Pins | | 150 | V |

Notes: 6. Human Body Model ESD Voltage (HBM, MIL_STD 883 Method 3015.7)
7. Machine Model ESD Voltage (JESD22-A115-A)

Exceeding absolute maximum ratings may cause permanent damage. Operation should be restricted to the limits in the Operating Ranges table.

## Electrostatic Discharge (ESD) Precautions

When handling this UltraCMOS® device, observe the same precautions that you would use with other ESD-sensitive devices. Although this device contains circuitry to protect it from damage due to ESD, precautions should be taken to avoid exceeding the specified rating.

## Latch-Up Avoidance

Unlike conventional CMOS devices, UltraCMOS® devices are immune to latch-up.

## Moisture Sensitivity Level

The Moisture Sensitivity Level rating for the PE42451 in the 24-lead 4x4 QFN package is MSL1.

## Optional External Vss Control ($Vss_{EXT}$)

For proper operation, the $Vss_{EXT}$ control must be grounded or at the Vss voltage specified in the Operating Ranges table (*Table 2*). When the $Vss_{EXT}$ control pin on the package is grounded the switch FET's are biased with an internal low spur negative voltage generator. For applications that require the lowest possible spur performance, $Vss_{EXT}$ can be applied to bypass the internal negative voltage generator to eliminate the spurs.

## Switching Frequency

The PE42451 has a maximum 25 kHz switching rate when the internal negative voltage generator is used (pin 20=GND). The rate at which the PE42451 can be switched is only limited to the switching time if an external -3 V supply is provided (pin 20=$Vss_{EXT}$).

## Table 5. Truth Table

| Mode | V3 | V2 | V1 |
|---|---|---|---|
| **All off** | 0 | 0 | 0 |
| **RF1 on** | 0 | 0 | 1 |
| **RF2 on** | 0 | 1 | 0 |
| **RF3 on** | 0 | 1 | 1 |
| **RF4 on** | 1 | 0 | 0 |
| **RF5 on** | 1 | 0 | 1 |
| **All off** | 1 | 1 | 0 |
| **Unsupported** | 1 | 1 | 1 |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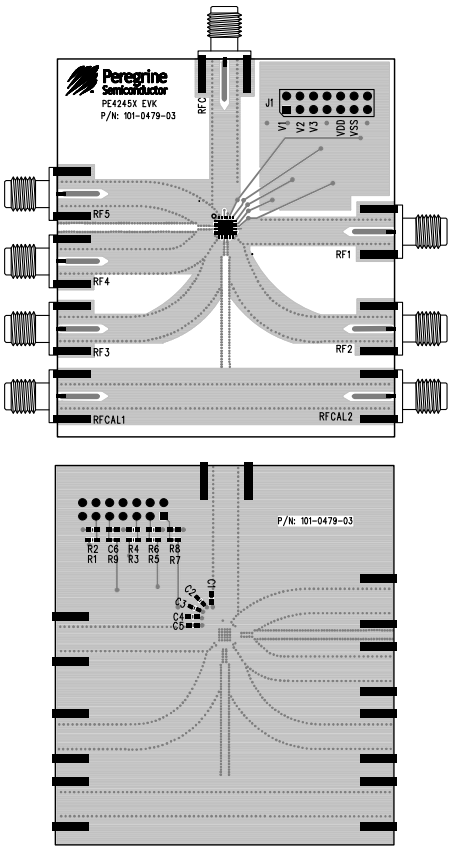
## Evaluation Kit

The SP5T switch EK Board was designed to ease customer evaluation of pSemi's PE42451. The RF common port is connected through a 50 Ω transmission line via the top SMA connector. RF1, RF2, RF3 and RF4 are connected through 50 Ω transmission lines via side SMA connectors. A through 50 Ω transmission is available via SMA connectors RFCAL1 and RFCAL2. This transmission line can be used to estimate the loss of the PCB over the environmental conditions being evaluated.

The EVK board is constructed with four metal layers on dielectric materials of Rogers 4003C and 4450 with a total thickness of 32 mils. Layer 1 and layer 3 provide ground for the 50 ohm transmission lines. The 50 ohm transmission lines are designed in layer 2 for high isolation purpose and use a stripline waveguide design with a trace width of 9.4 mils and trace metal thickness of 1.8 mils. The board stack up for 50 ohm transmission lines has 8 mil thickness of Rogers 4003C between layer 1 and layer 2, and 10 mil thickness of Rogers 4450 between layer 2 and layer 3. Please consult manufacturer's guidelines for proper board material properties in your application. The PCB should be designed in such a way that RF transmission lines and sensitive DC i/o traces such as $Vss_{EXT}$ are heavily isolated from one another, otherwise the true performance of the PE42451 will not be yielded.

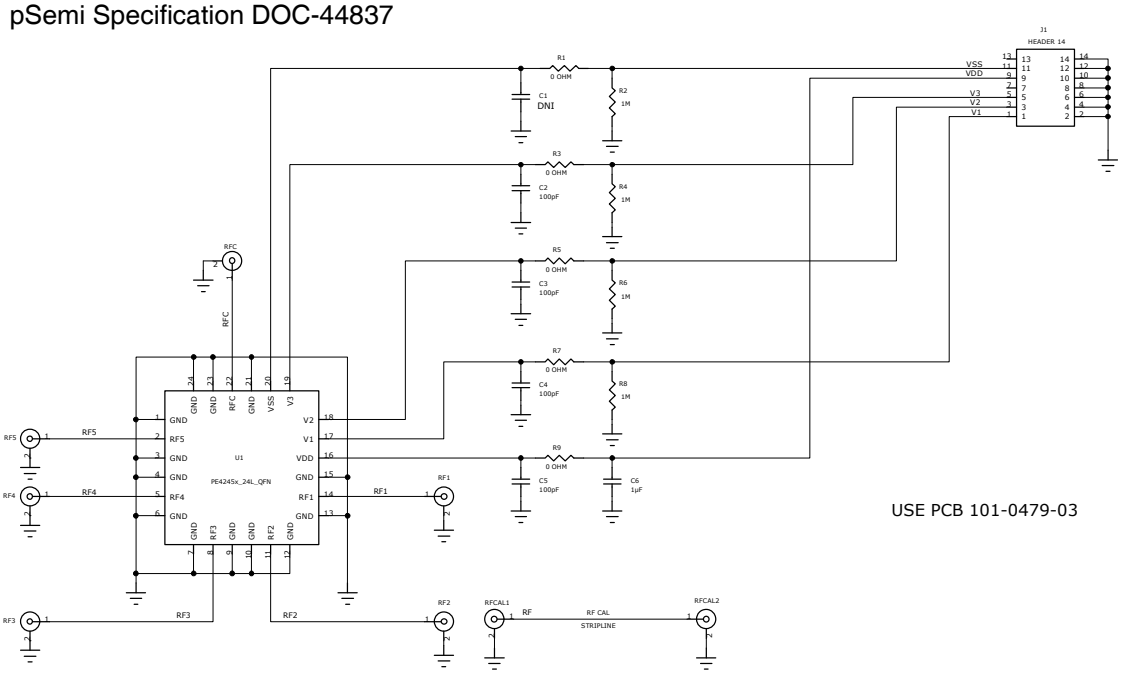
### Figure 4. Evaluation Board Layouts

pSemi Specification PRT-50444




### Figure 5. Evaluation Board Schematic

pSemi Specification DOC-44837

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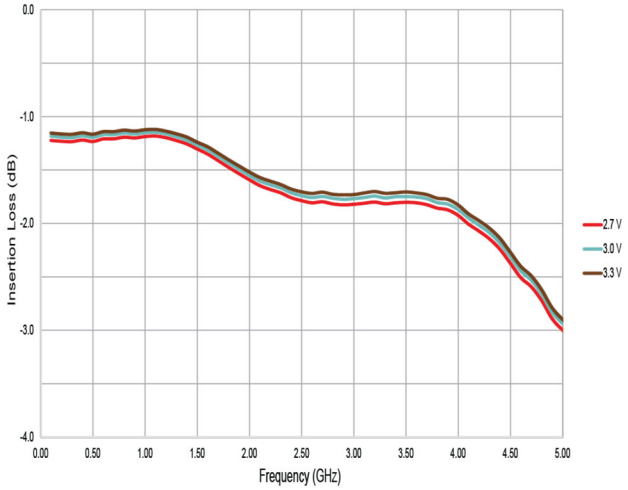
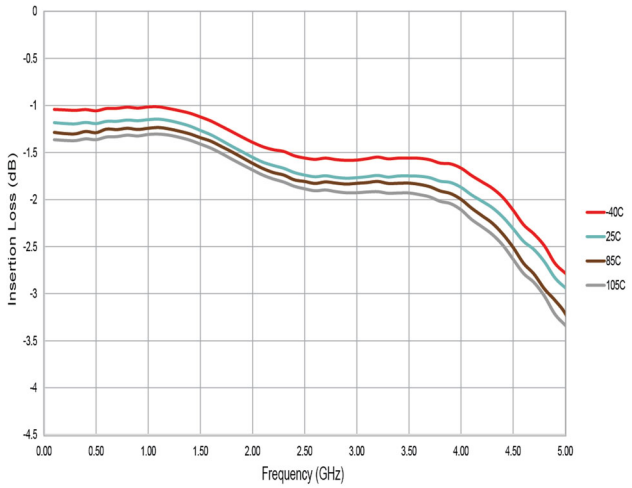
## Performance Plots @ 25 °C and 3.0 V unless otherwise specified.

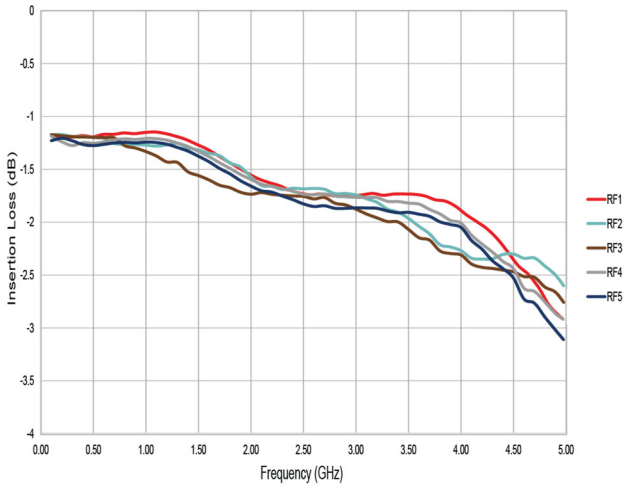
### Figure 6. Insertion Loss vs. Frequency Over Voltages




### Figure 7. Insertion Loss vs. Frequency Over Temperatures




### Figure 8. Insertion Loss vs. Frequency, All Paths





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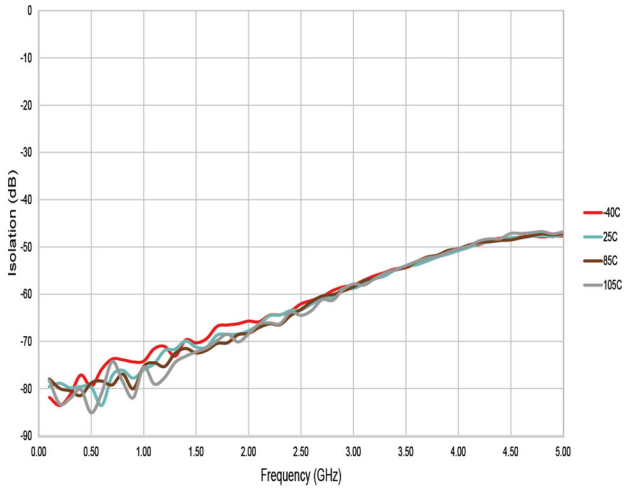
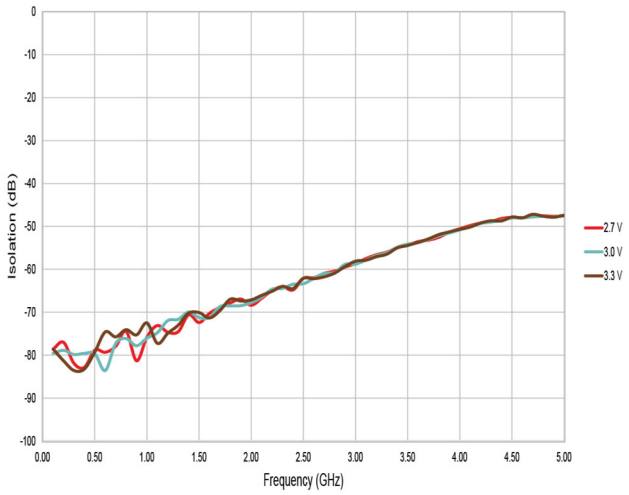
## Performance Plots @ 25 °C and 3.0 V unless otherwise specified

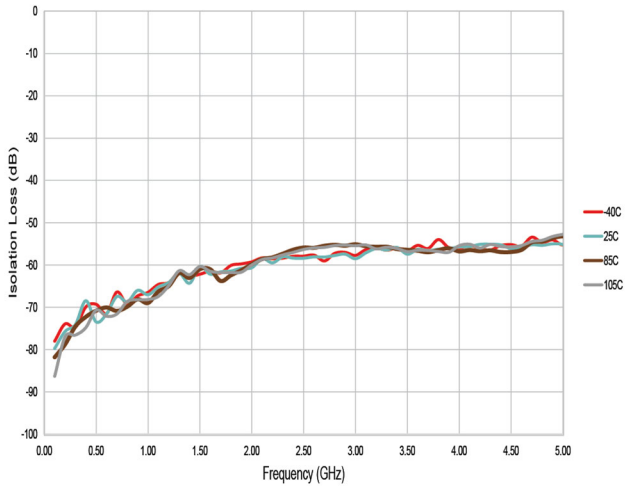
### Figure 9. Isolation: RFC-RFX @ 3.0 V



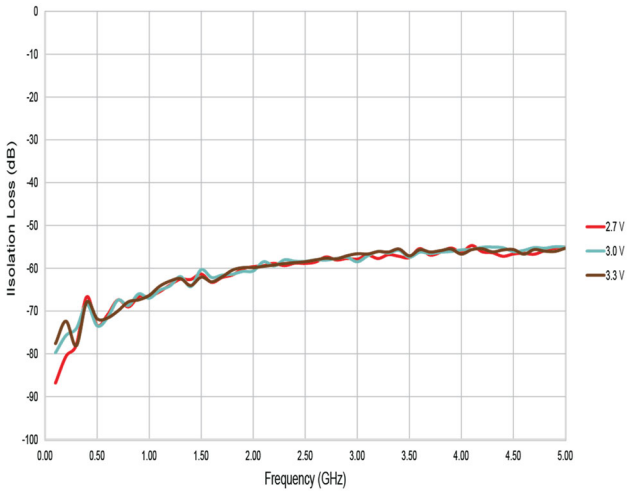

### Figure 10. Isolation: RFC-RFX @ 25 °C




### Figure 11. Isolation: RFX-RFX @ 3.0 V




### Figure 12. Isolation: RFX-RFX @ 25 °C

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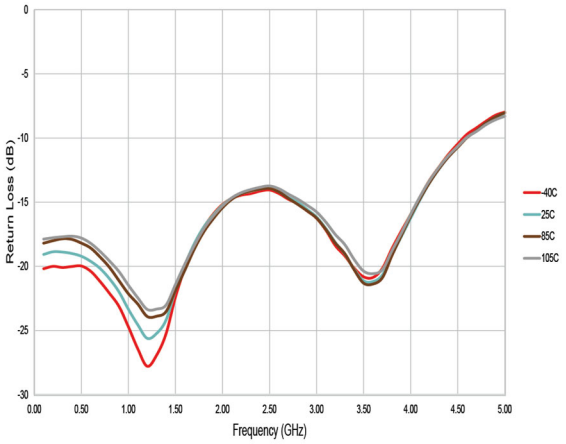
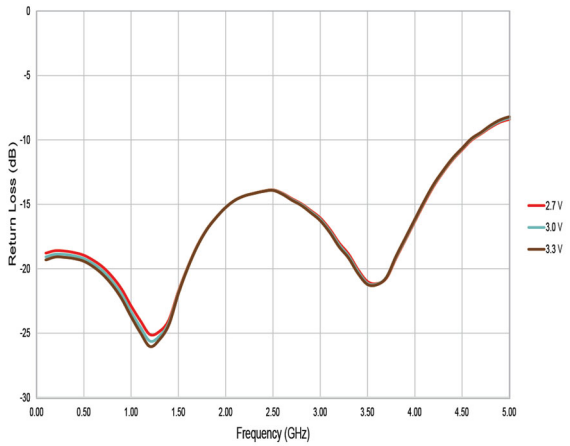
## Performance Plots @ 25 °C and 3.0 V unless otherwise specified (Continued)

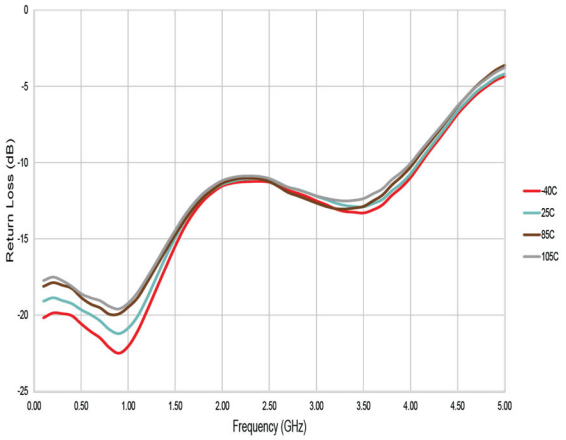
### Figure 13. Return Loss at Active Port @ 3.0 V



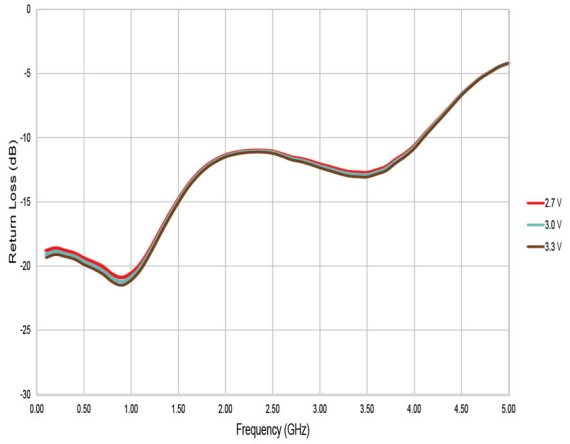

### Figure 14. Return Loss at Active Port @ 25 °C



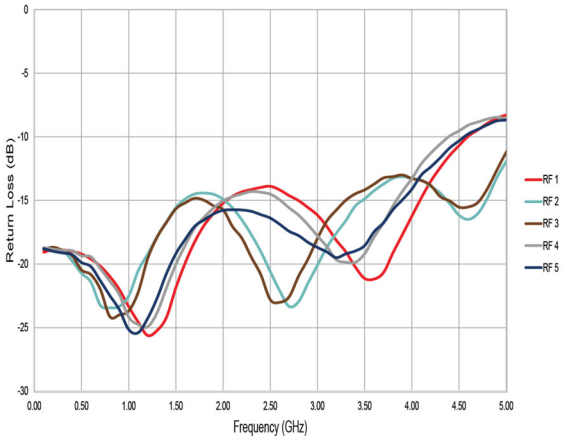

### Figure 15. Return Loss: RFC @ 3.0 V




### Figure 16. Return Loss: RFC @ 25 °C




### Figure 17. Return Loss: All Paths, Terminated





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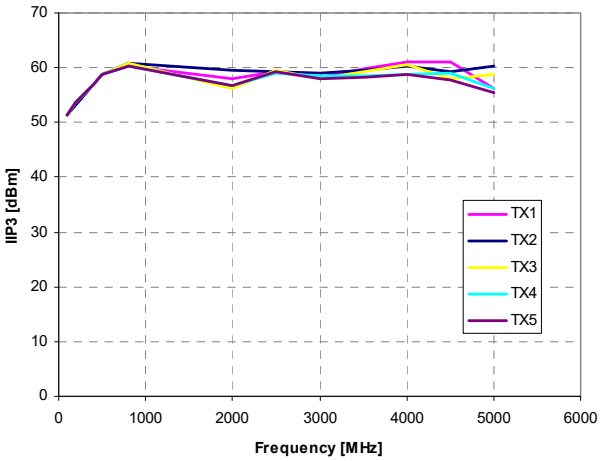
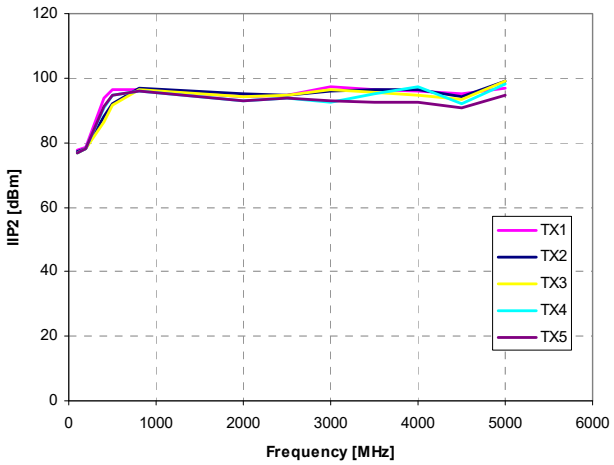
## Performance Plots @ 25 °C and 3.0 V unless otherwise specified (Continued)

### Figure 18. Nominal Linearity Performance (IIP3)




### Figure 19. Nominal Linearity Performance (IIP2)

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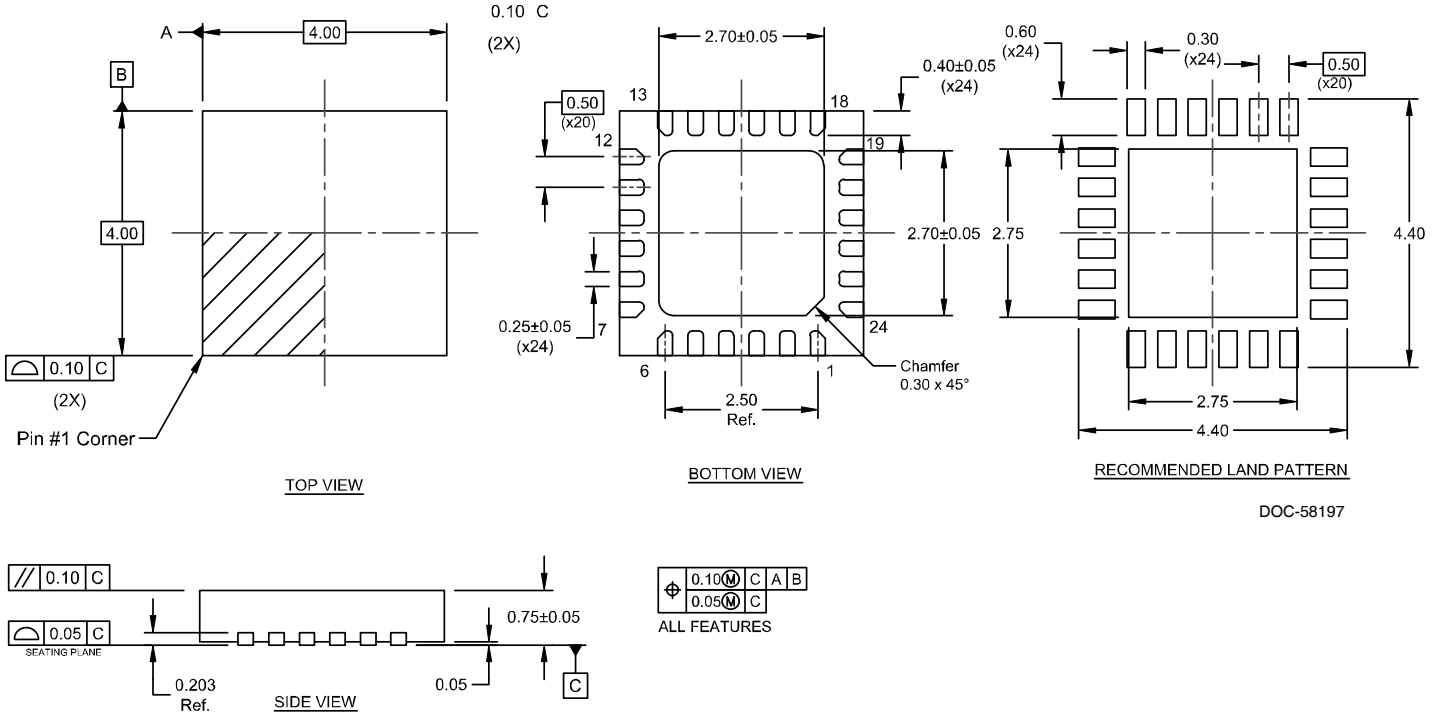
## Figure 20. Package Drawing
24-lead 4x4 mm QFN





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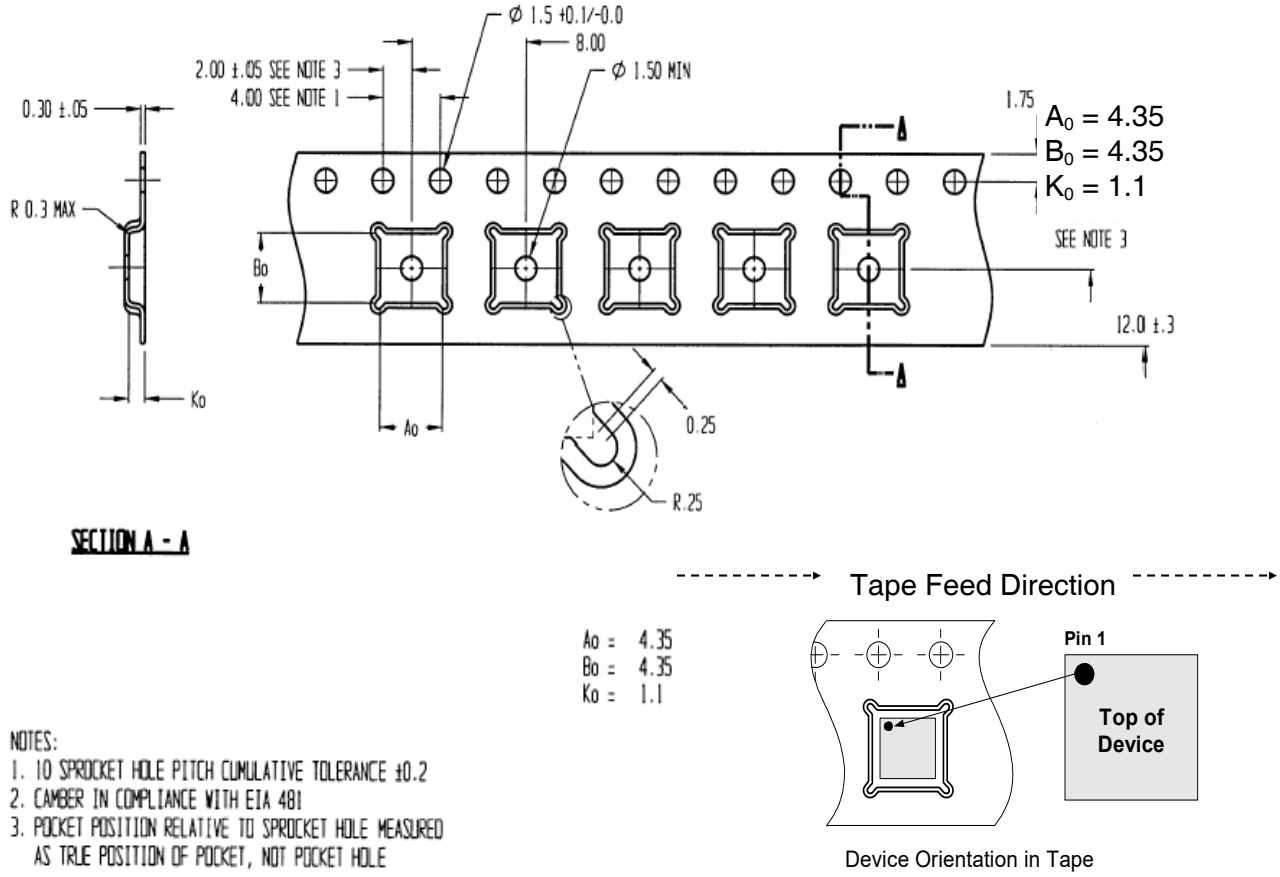
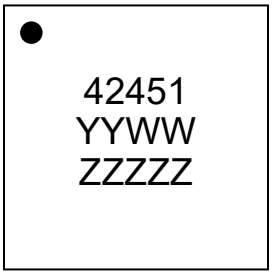
## Figure 21. Tape and Reel Drawing




## Figure 22. Marking Specifications




YYWW = Date Code
ZZZZZ = Last five digits of Lot Number

DOC-51207

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## Table 6. Ordering Information

| Order Code | Part Marking | Description | Package | Shipping Method |
|---|---|---|---|---|
| PE42451MLIAA | 42451 | PE42451G-24QFN 4x4mm-cut off tape and reel | Green 24-lead 4x4mm QFN | Bulk or tape cut from reel |
| PE42451MLIAA-Z | 42451 | PE42451G-24QFN 4x4mm-3000C | Green 24-lead 4x4mm QFN | 3000 units / T&R |
| EK42451-01 | PE42451 -EK | PE42451-24QFN 4x4mm-EK | Evaluation Kit | 1 / Box |

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