PE42451

Document category: Product Specification

UltraCMOS® High-Isolation SP5T RF Switch, 450-5000 MHz

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: 95 dBm
- IIP3: 58 dBm
- High ESD tolerance: 3500 V HBM
- Optional external Vss control (Vss_{EXT})
- 3-pin CMOS logic control
- No blocking capacitors required
- Packaging: Small RoHS-compliant 24-lead 4 × 4 mm QFN

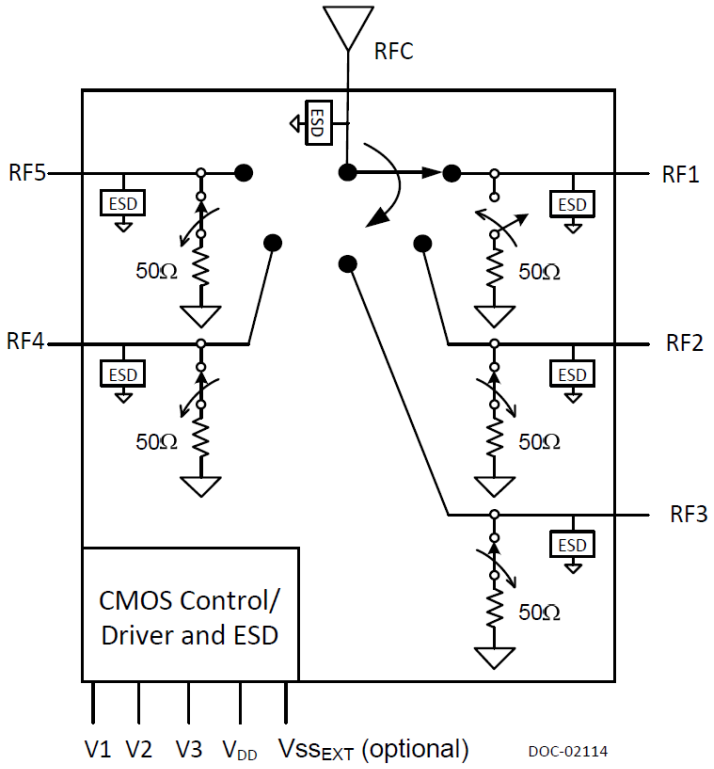

Figure 1. PE42451 functional diagram

Product description

The PE42451 is a HaRP™-enhanced absorptive SP5T RF switch developed on the UltraCMOS® process technology. This general-purpose switch is comprised of five symmetric RF ports and has extremely high isolation. An on-chip CMOS decode logic facilitates a 3-pin low-voltage CMOS control interface and an optional external Vss feature (Vss_{EXT}). High ESD tolerance and no blocking capacitor requirements make this switch 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.

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Absolute maximum ratings

Exceeding the absolute maximum ratings listed in Table 1 could cause permanent damage. Restrict operation to the limits in Table 2. Operation between the operating range maximum and the absolute maximum for extended periods could reduce reliability.

ESD precautions

When handling this UltraCMOS device, observe the same precautions as with any other ESD-sensitive devices. Although this device contains circuitry to protect it from damage due to ESD, do not exceed the rating listed in Table 1.

Latch-up immunity

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

Table 1. PE42451 absolute maximum ratings

Parameter or condition	Symbol	Min	Max	Unit
Storage temperature range	T_{ST}	-60	+150	°C
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
ESD voltage HBM, all pins(1)	V_{ESD}	–	3500	V
ESD voltage MM, all pins(2)	V_{ESD}	–	150	V

1. Human Body Model ESD Voltage (HBM, MIL_STD 883 Method 3015.7).
2. Machine Model ESD Voltage (JESD22-A115-A).

Recommended operating conditions

Table 2 lists the PE42451 recommended operating conditions. Do not operate devices outside the operating conditions listed below.

Table 2. PE42451 operating conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{DD}	2.7	3.0	3.3	V
Negative power supply voltage(1)	Vss_{EXT}	-3.3	-3.0	-2.7	V
Power supply current (V_{DD} = 3.0V, P_{IN} = 0 dBm)	I_{DD}	–	14	–	µA
Maximum 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 × V_{DD}	–	V_{DD}	V
Control voltage low	V_{IL}	0	–	0.3 × V_{DD}	V
Control current(2)	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

1. Applied only when using an external Vss power supply. Ground Pin 20 when using the internal Vss supply.
2. The pull-down resistor in the EVK schematic (Figure 17) can increase the control current.

Electrical specifications

Table 3 lists the PE42451 key electrical specifications at +25 °C and V_{DD} = 3.0V (Z_S = Z_L = 50Ω), unless otherwise specified.

Table 3. PE42451 electrical specifications

Parameter	Path	Condition	Min	Typ	Max	Unit
Operating frequency	–	–	450	–	5000	MHz
Insertion loss	RFC–RFx	450 MHz 900 MHz 2100 MHz 2600 MHz 4000 MHz 5000 MHz	–	1.60 1.65 1.95 2.05 2.25 2.50	1.95 2.05 2.30 2.40 2.75 3.15	dB
Isolation	RFC/RFx–RFx	450 MHz 900 MHz 2100 MHz 2600 MHz 4000 MHz 5000 MHz	58.5 53.0 46.5 46.5 45.0 41.0	68 62 55 53 50 43	–	dB
Return loss, active port	RFx–RFx	450–4000 MHz 4000–5000 MHz	–	16 14	–	dB
Return loss, terminated port	RFx–RFx	450–4000 MHz 4000–5000 MHz	–	15 12	–	dB
Input 1-dB compression point, P1dB[1]	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}[2]	On Off	50% Control to 90% RF 50% Control to 10% RF	–	200 200	500 500	ns

1. See the maximum operating power in Table 2.
2. 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 -3V supply is provided (pin 20 = Vss_{EXT}).

Optional external Vss Control (Vss_{EXT})

For proper operation, the Vss_{EXT} control must be grounded or at the Vss voltage specified in Table 2. When the Vss_{EXT} control pin (pin 20) is grounded, the switch FETs are biased with an internal low-spurious negative voltage generator. For applications that require the lowest possible spurious performance, apply Vss_{EXT} to bypass the internal negative voltage generator and eliminate the spurious.

SP5T control logic

Table 4. PE42451 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

Typical performance data

Figure 2–Figure 15 show the typical performance data at +25 °C and 3.0 V, unless otherwise specified.

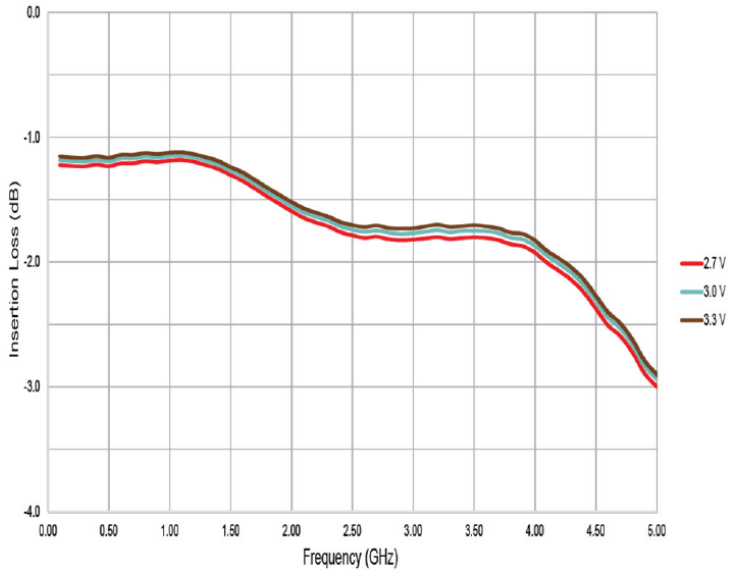

Figure 2. Insertion loss vs. frequency over voltages

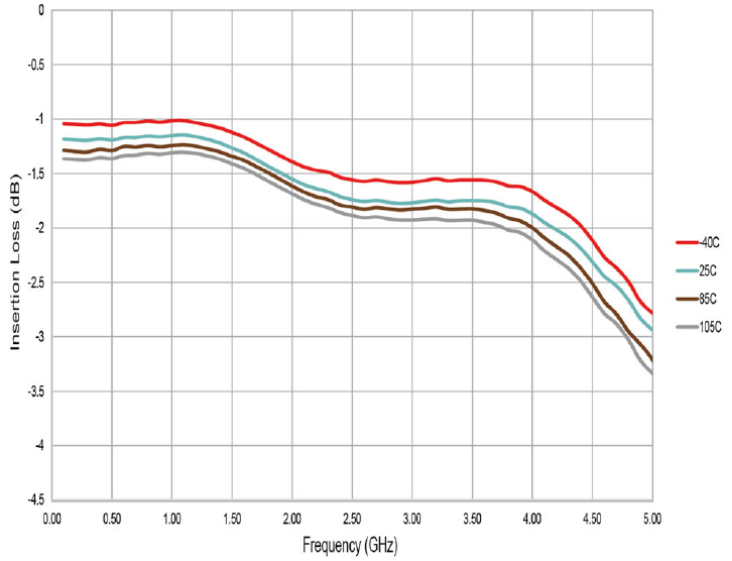

Figure 3. Insertion loss vs. frequency over temperatures

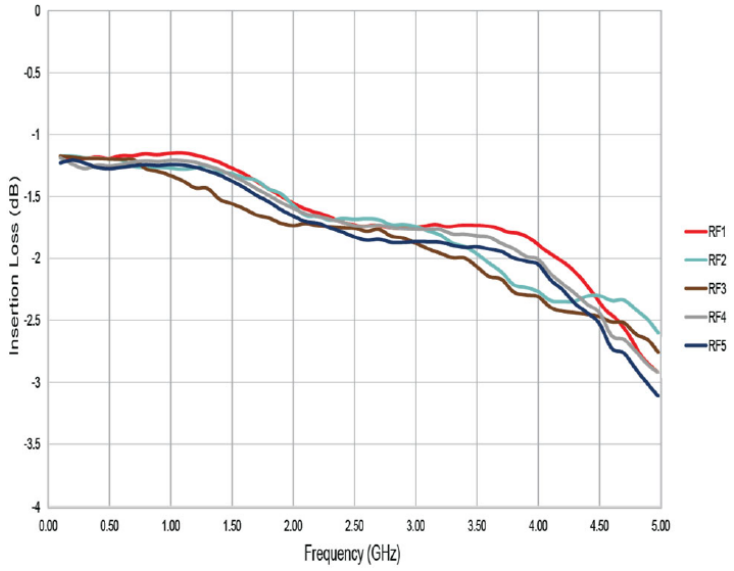

Figure 4. Insertion loss vs. frequency, all paths

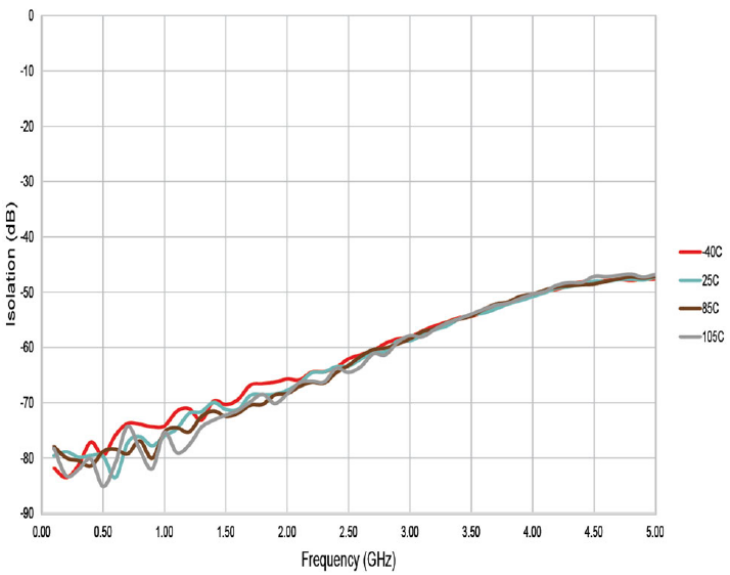

Figure 5. Isolation: RFC–RFx @ 3.0V

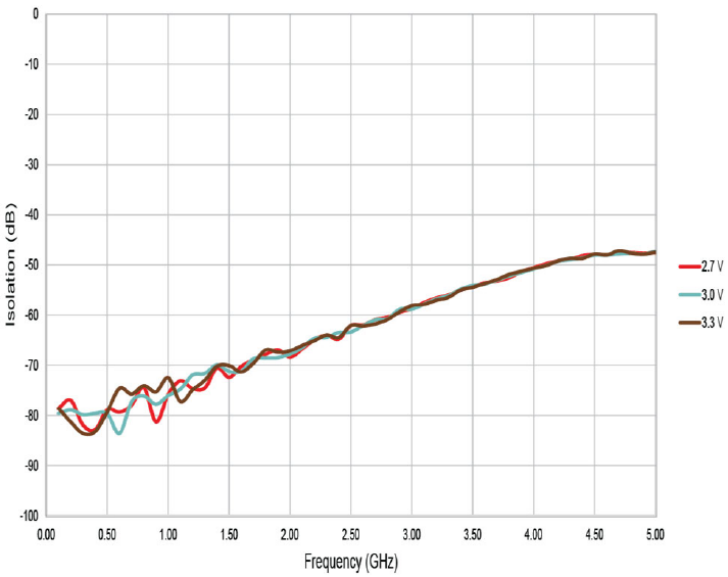

Figure 6. Isolation: RFC–RFx @ 25 °C

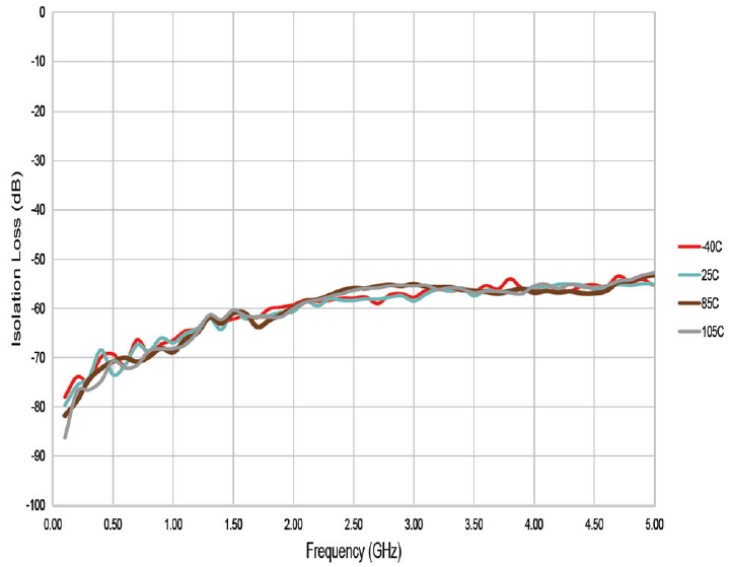

Figure 7. Isolation: RFx–RFx @ 3.0V

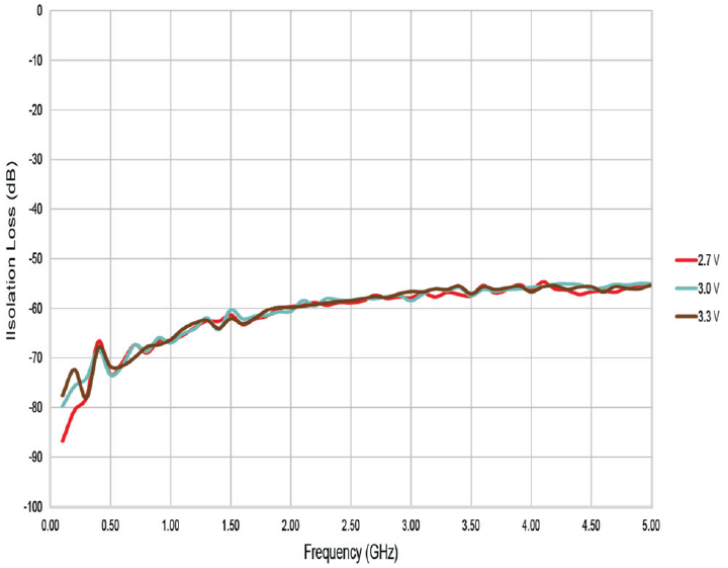

Figure 8. Isolation: RFx–RFx @ 25 °C

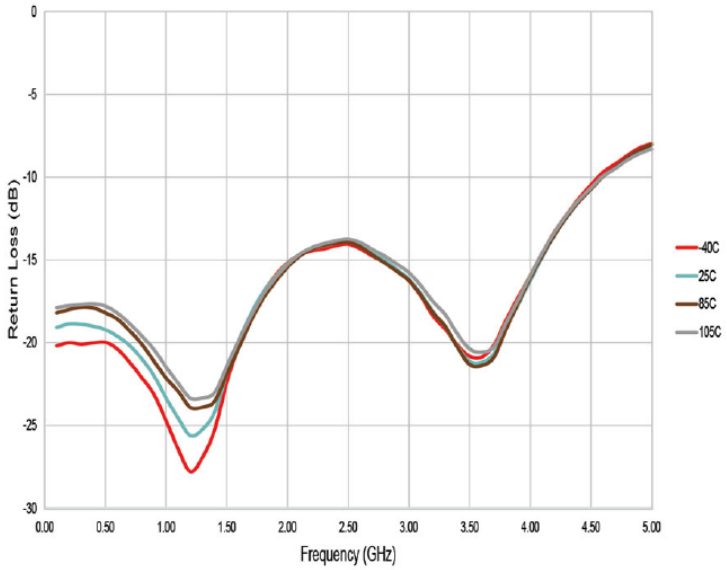

Figure 9. Return loss at active port @ 3.0V

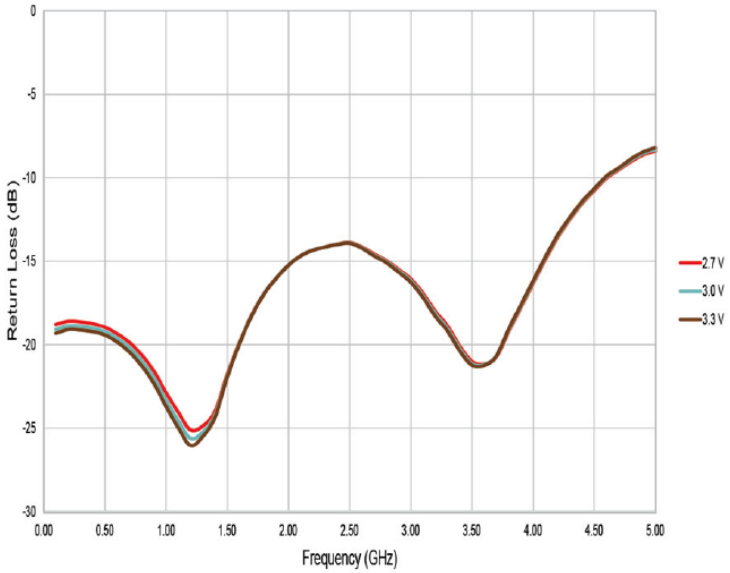

Figure 10. Return loss at active port @ 25 °C

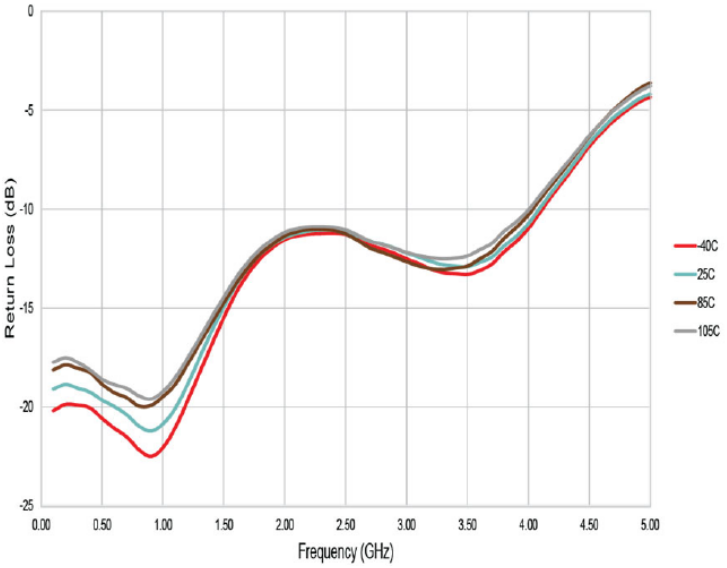

Figure 11. Return loss: RFC @ 3.0V

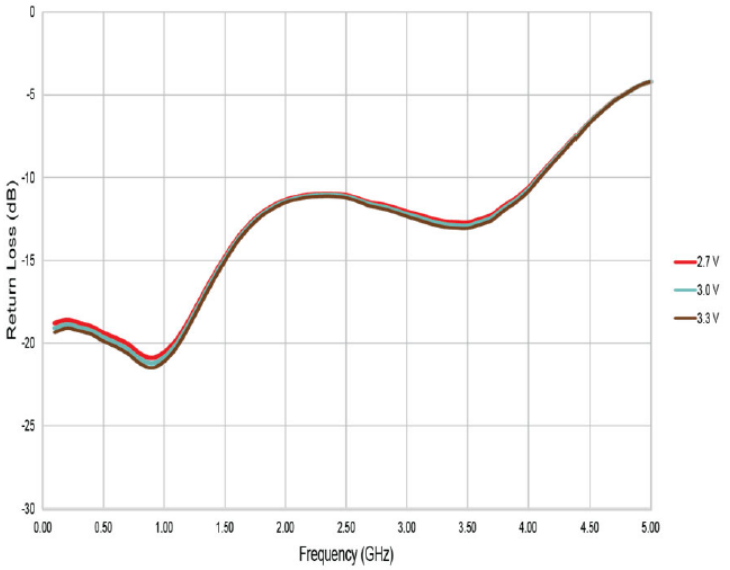

Figure 12. Return loss: RFC @ 25 °C

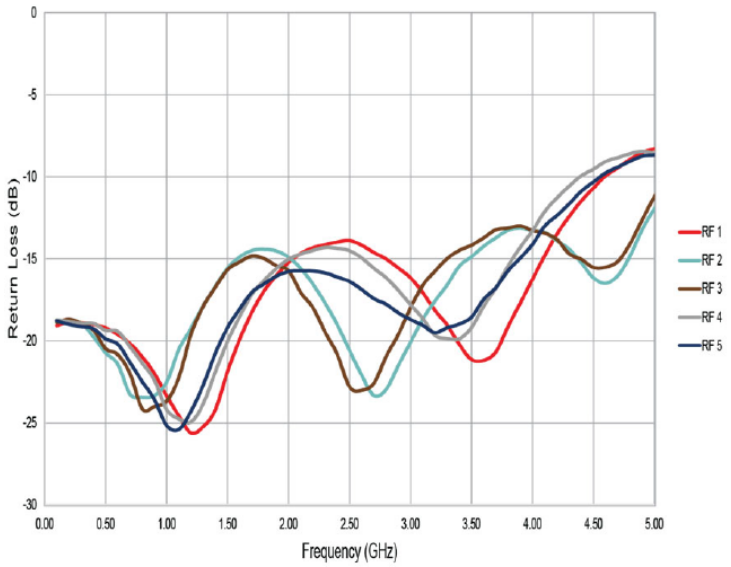

Figure 13. Return loss: All paths, terminated

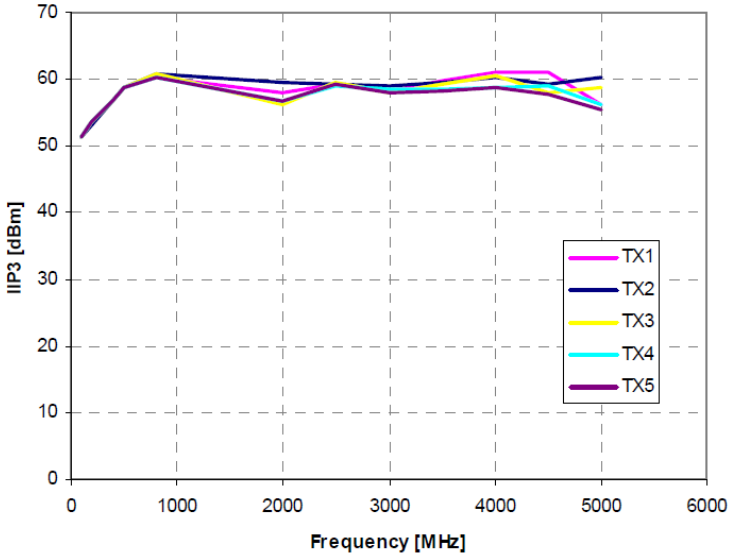

Figure 14. Nominal linearity performance (IIP3)

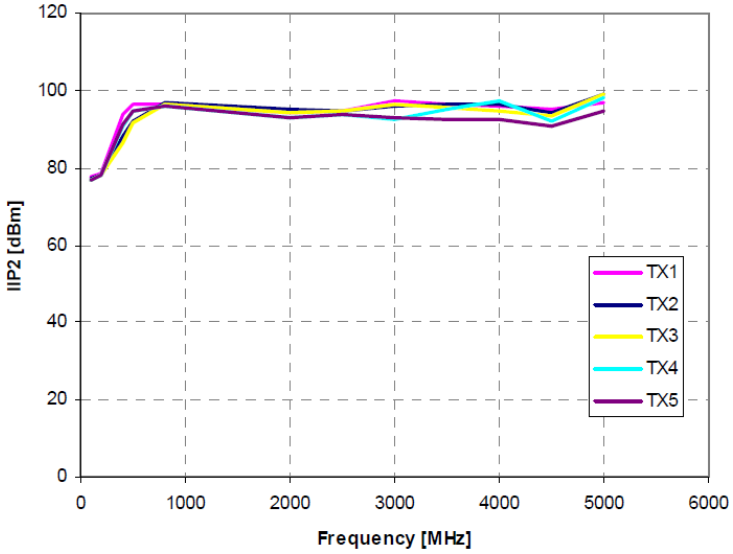

Figure 15. Nominal linearity performance (IIP2)

Evaluation kit

pSemi designed the SP5T switch evaluation board to ease your evaluation of the pSemi PE42451. The RF common port connects through a 50 Ω transmission line via the top SMA connector. RF1, RF2, RF3, and RF4 connect through 50Ω transmission lines via the side SMA connectors. A through 50Ω transmission is available via SMA connectors RFCAL1 and RFCAL2. Use this transmission line 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 50Ω transmission lines. The 50Ω transmission lines are designed in layer 2 for high isolation 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 50Ω 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. See the manufacturer's guidelines for the proper board material properties in your application. Design the PCB so that the RF transmission lines and sensitive DC i/o traces—such as Vss_{EXT}—are heavily isolated from one another, otherwise the PE42451 true performance will not be yielded.

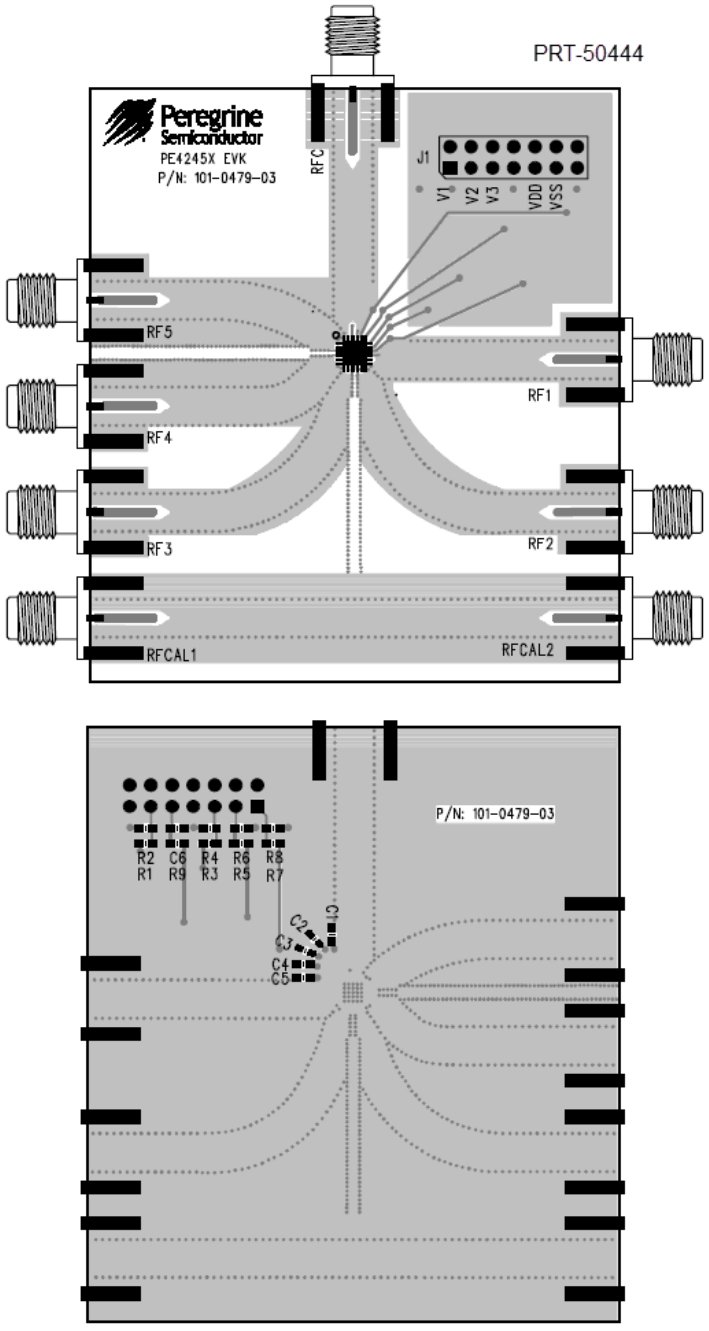

Figure 16. Evaluation board layout

Evaluation board schematic

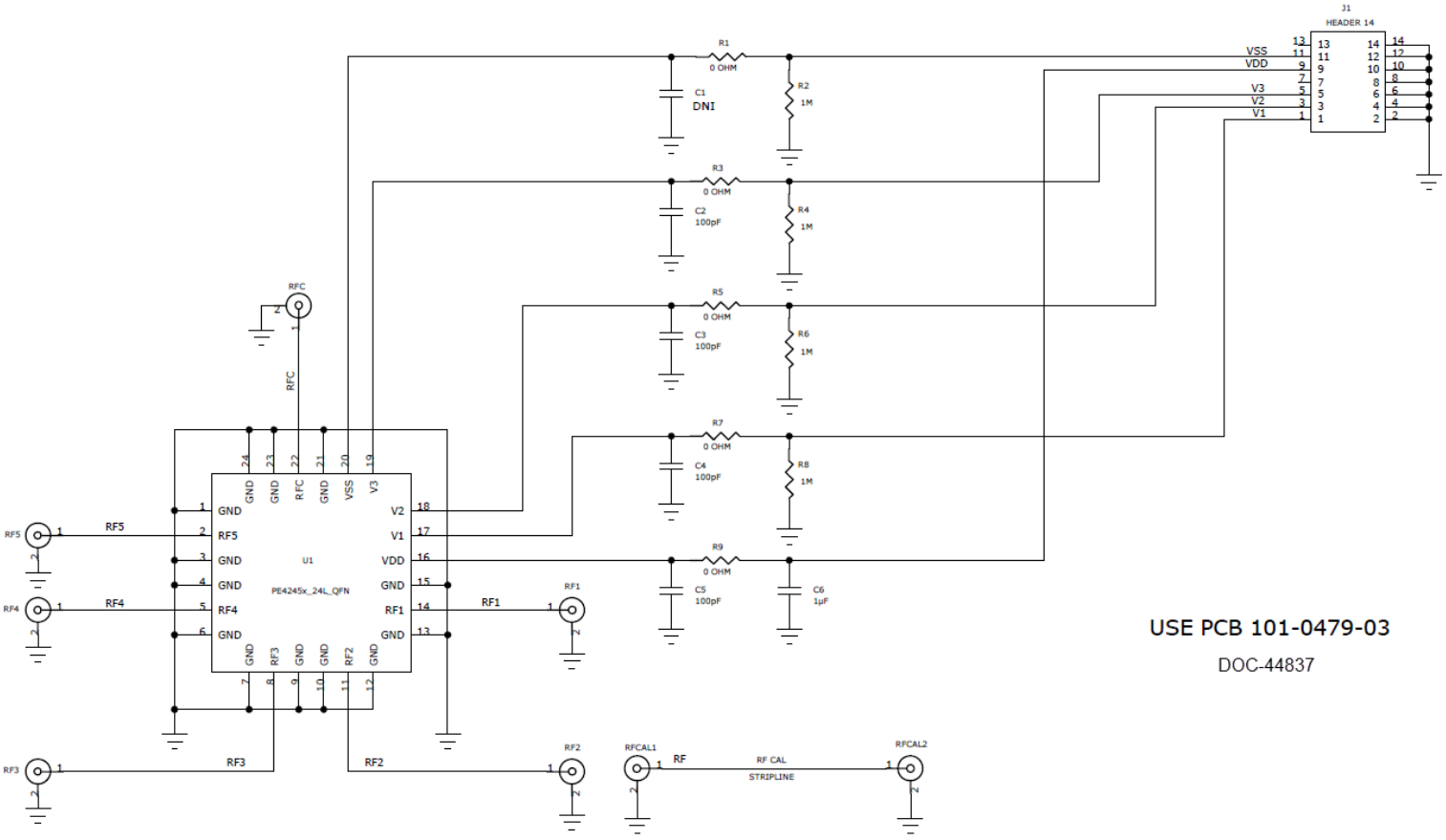

Figure 17. Evaluation board schematic

Pin information

Figure 18 shows the PE42451 pin map for the 24-lead 4 × 4 mm QFN package, and Table 5 lists the description for each pin.

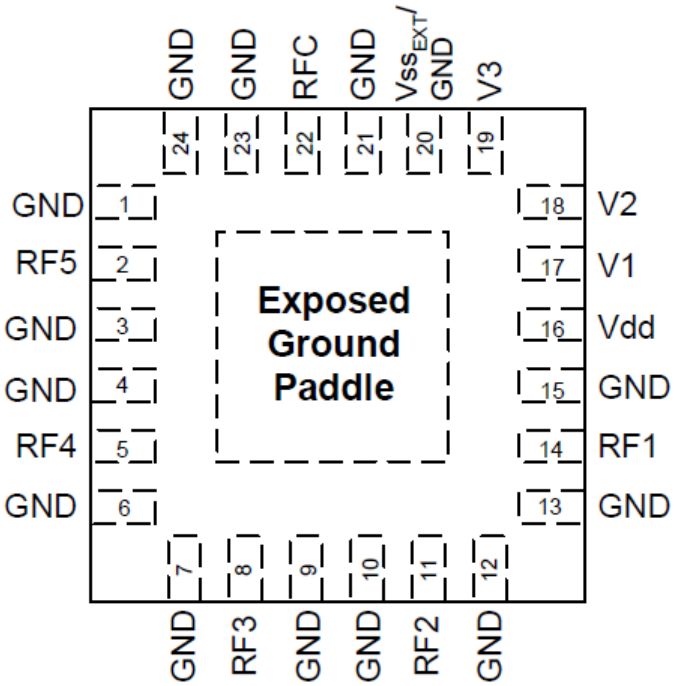

Figure 18. Pin configuration (top view)

Table 5. PE42451 pin descriptions

Pin no.	Pin name	Description
1, 3, 4, 6, 7, 9, 10, 12, 13, 15, 21, 23, 24	GND	Ground
2(1)	RF5	RF port 5
5(1)	RF4	RF port 4
8(1)	RF3	RF port 3
11(1)	RF2	RF port 2
14(1)	RF1	RF port 1
16	V_{DD}	Supply voltage
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(2)	Vss_{EXT}/GND	External Vss control/ ground
22(1)	RFC	RF common
Pad	GND	Exposed pad. Ground for proper operation.

1. Blocking capacitors are only needed when non-zero DC voltage is present.
2. When using the internal Vss supply, ground Pin 20.

Packaging information

This section provides the following packaging data:

- Moisture sensitivity level
- Package drawing
- Package marking
- Tape-and-reel information

Moisture sensitivity level

The PE42451 moisture sensitivity level rating for the 24-lead 4 × 4 mm QFN package is MSL1.

Package drawing

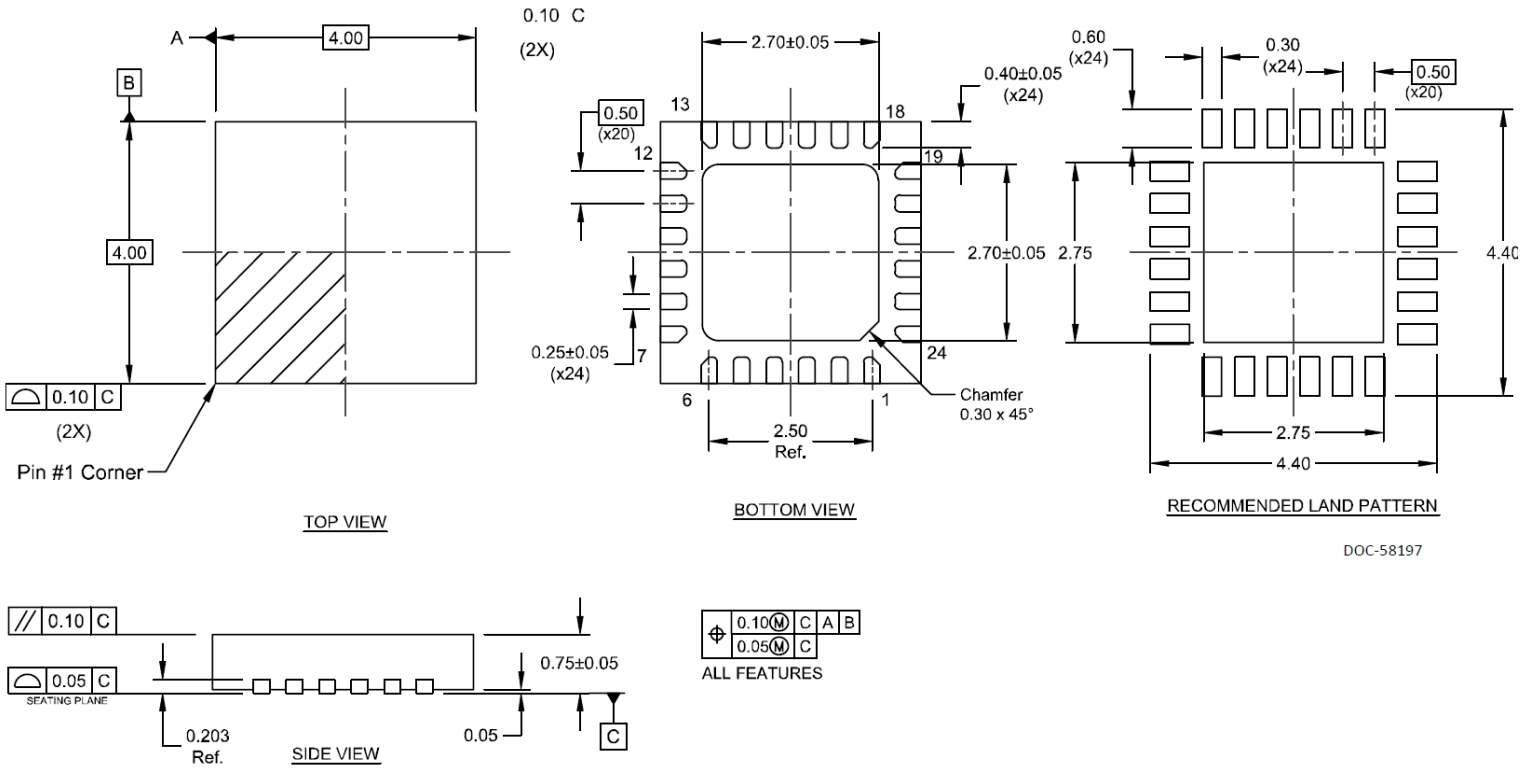

Figure 19. Package mechanical drawing for the 24-lead 4 × 4 mm QFN package

Top-marking specification

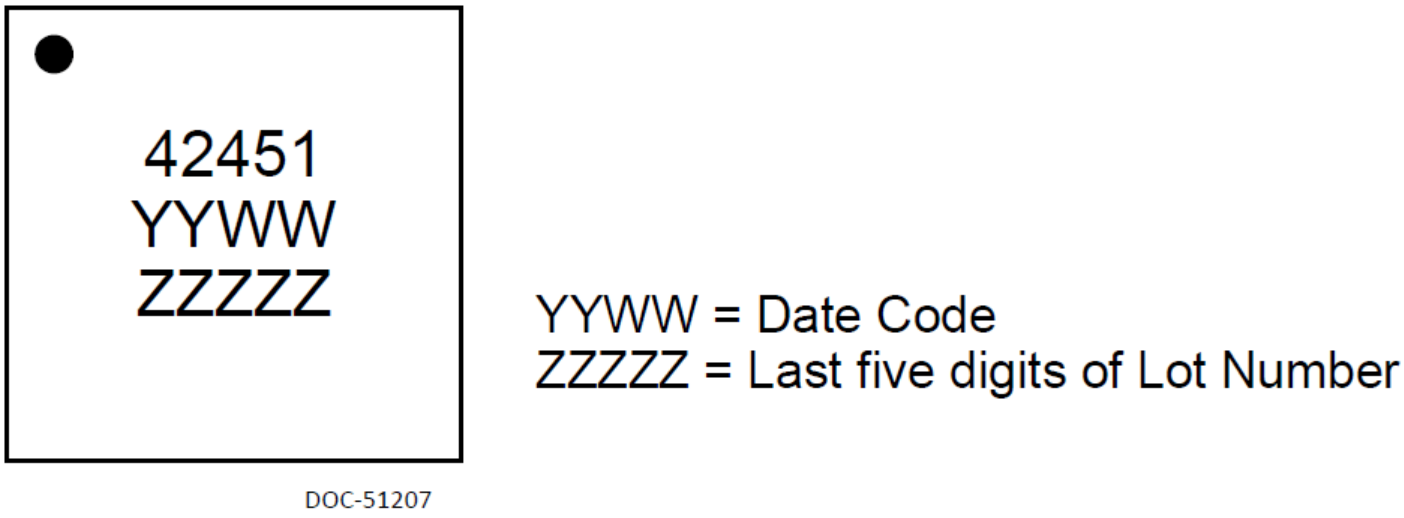

Figure 20. PE42451 package marking specification

Tape and reel specification

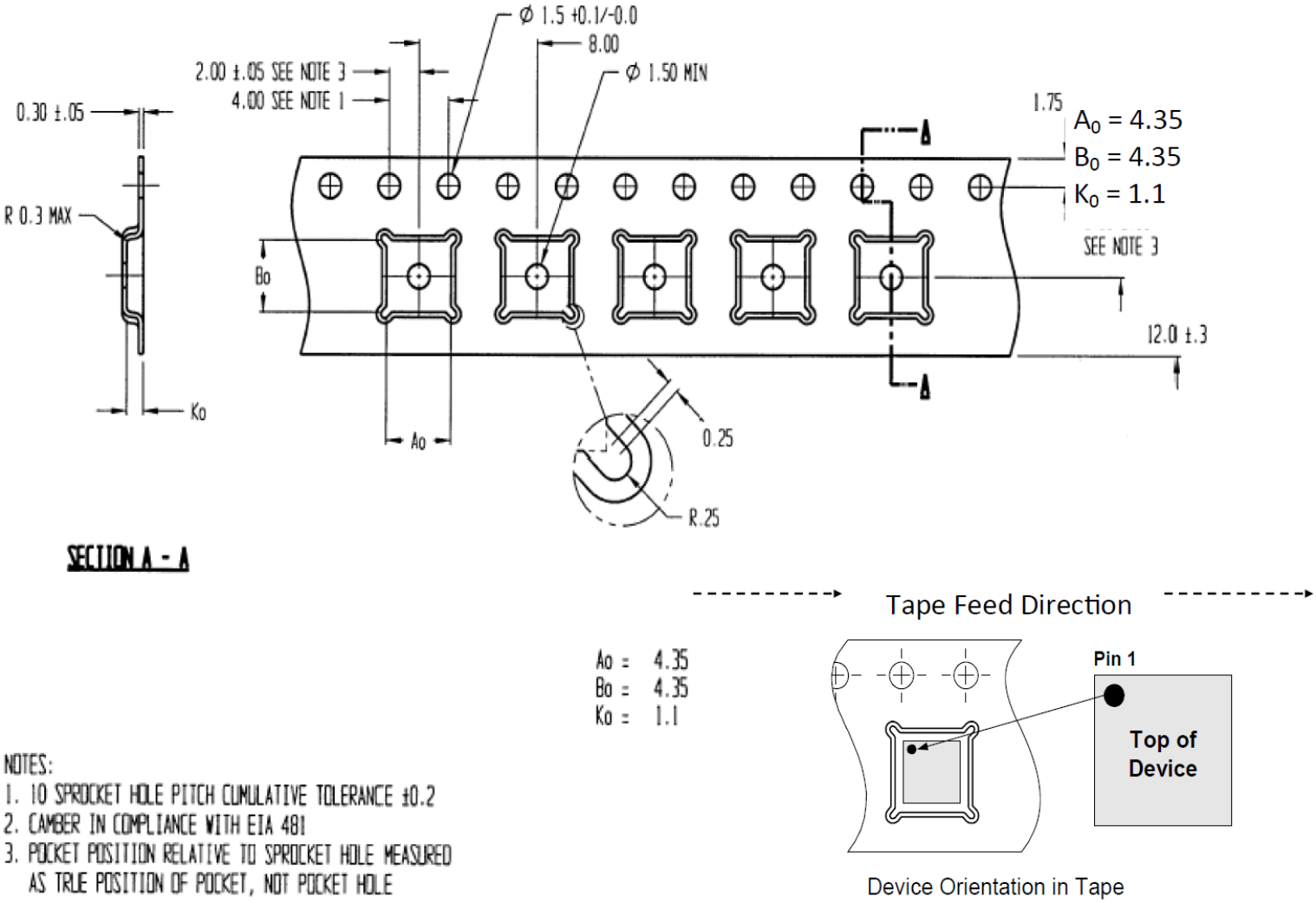

Figure 21. Tape and reel specification for the 24-lead 4 × 4 mm QFN package

Ordering information

Order code	Description	Packaging	Shipping method
PE42451B-Z	PE42451 SP5T RF switch	Green 24-lead 4 × 4 mm QFN	3000 units/T&R
EK42451-02	PE42451 evaluation kit	Evaluation kit	1/box

Document categories

Advance Information	The product is in a formative or design stage. The data sheet contains design target specifications for product development. Specifications and features may change in any manner without notice.
Preliminary Specification	The data sheet contains preliminary data. Additional data may be added at a later date. pSemi reserves the right to change specifications at any time without notice to supply the best possible product.
Product Specification	The data sheet contains final data. In the event that pSemi decides to change the specifications, pSemi will notify customers of the intended changes by issuing a Customer Notification Form (CNF).
Product Brief	This document contains a shortened version of the data sheet. For the full data sheet, contact sales@psemi.com.

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