PE423422

Document category: Product Specification

UltraCMOS® SPDT RF Switch, 100–6000 MHz

Features

- AEC-Q100 Grade 2 certified
- Operating temperature: Up to +105°C
- Low insertion loss:
  - 0.25 dB @ 1000 MHz
  - 0.40 dB @ 3000 MHz
  - 0.65 dB @ 5000 MHz
  - 0.90 dB @ 6000 MHz
- High isolation:
  - 41 dB @ 1000 MHz
  - 28 dB @ 3000 MHz
  - 20 dB @ 5000 MHz
  - 16 dB @ 6000 MHz
- Excellent linearity:
  - IIP2 of 115 dBm
  - IIP3 of 73.5 dBm
- High ESD tolerance:
  - 1kV HBM on all pins
  - 200V MM on all pins
  - 1kV CDM on all pins
- Wide supply range: 2.3–5.5V

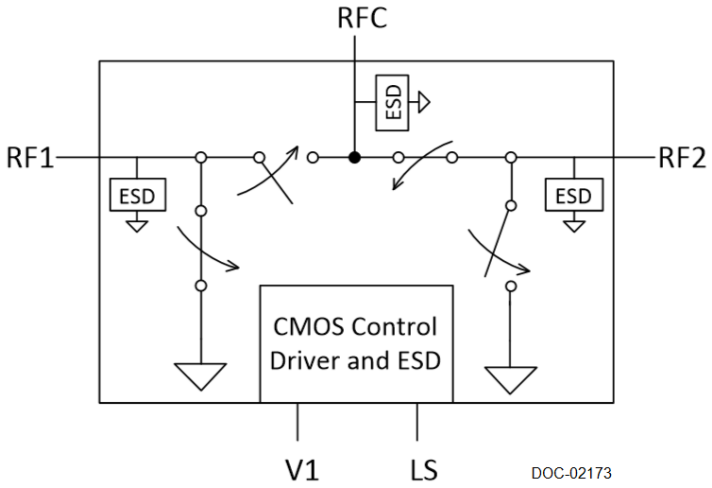


Figure 1. Functional block diagram

Product description

The PE423422 is a HaRP™ technology-enhanced reflective SPDT RF switch. It has received AEC-Q100 Grade 2 certification and meets the quality and performance standards that makes it suitable for use in harsh automotive environments. It is designed to cover a wide range of wireless applications from 100 MHz through 6 GHz, such as automotive infotainment and traffic safety applications. No blocking capacitors are required if no DC voltage is present on the RF ports.

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

The PE423422 is manufactured on pSemi's UltraCMOS® process, a patented variation of silicon-on-insulator (SOI) technology on a sapphire substrate, offering excellent RF performance.

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. PE423422 absolute maximum ratings

Parameter or condition	Symbol	Min	Max	Unit
Supply voltage	V_{DD}	-0.3	5.5	V
Digital input voltage (V1, LS)	V_I	-0.3	3.3	V
RF input power, maximum	P_{MAX_ABS}	–	See Figure 2	dBm
Storage temperature range	T_{ST}	-65	+150	°C
ESD voltage HBM, all pins(1)	$V_{ESD,HBM}$	–	1000	V
ESD voltage MM, all pins(2)	$V_{ESD,MM}$	–	200	V
ESD voltage CDM, all pins(3)	$V_{ESD,CDM}$	–	1000	V

1. Human Body Model (MIL-STD-883 Method 3015)
2. Machine Model (JEDEC JESD22-A115)
3. Charged Device Model (JEDEC JESD22-C101)

Recommended operating conditions

Table 2 lists the PE423422 recommending operating conditions. Do not operate devices outside the operating conditions listed below.

Table 2. PE423422 operating conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{DD}	2.3	3.3	5.5	V
Supply current	I_{DD}	–	120	200	µA
Digital input high (V1, LS)	V_{IH}	1.2	1.5	3.3	V
Digital input low (V1, LS)	V_{IL}	0	0	0.5	V
RF input power, CW(*)	$P_{MAX,CW}$	–	–	See Figure 2	dBm
Operating temperature range	T_{OP}	-40	+25	+105	°C

* 100% duty cycle, all bands, 50Ω.

Electrical specifications

Table 3 lists the PE423422 key electrical specifications at +25 °C and V_{DD} = 2.3–5.5V (Z_S = Z_L = 50Ω), unless otherwise specified.

Table 3. PE423422 electrical specifications

Parameter	Path	Condition	Min	Typ	Max	Unit
Operational frequency	–	–	100	–	6000	MHz
Insertion loss	RFC–RFx	100–1000 MHz	–	0.25	0.35	dB
		1000–2000 MHz	–	0.30	0.40	dB
		2000–3000 MHz	–	0.40	0.50	dB
		3000–4000 MHz	–	0.50	0.70	dB
		4000–5000 MHz	–	0.65	0.90(1)	dB
		5000–6000 MHz	–	0.90	1.25(1)	–
Isolation	RFx–RFx	100–1000 MHz	39	41	–	dB
		1000–2000 MHz	32	33	–	dB
		2000–3000 MHz	26	28	–	dB
		3000–4000 MHz	22	24	–	dB
		4000–5000 MHz	18	20	–	dB
		5000–6000 MHz	15	16	–	dB
Isolation	RFC–RFx	100–1000 MHz	41	44	–	dB
		1000–2000 MHz	33	35	–	dB
		2000–3000 MHz	27	29	–	dB
		3000–4000 MHz	22	24	–	dB
		4000–5000 MHz	18	20	–	dB
		5000–6000 MHz	15	17	–	dB
Return loss	RFC–RFx	100–1000 MHz	–	28	–	dB
		1000–2000 MHz	–	21	–	dB
		2000–3000 MHz	–	20	–	dB
		3000–4000 MHz	–	18	–	dB
		4000–5000 MHz	–	16(1)–	–	dB
		5000–6000 MHz	–	13(1)	–	dB

Parameter	Path	Condition	Min	Typ	Max	Unit
Second harmonic, 2fo	RFC–RFx	+32 dBm output power, 850/900 MHz	–	-99	–	dBc
		+32 dBm output power, 1800/1900 MHz	–	-101	–	dBc
Third harmonic, 3fo	RFC–RFx	+32 dBm output power, 850/900 MHz	–	-93	–	dBc
		+32 dBm output power, 1800/1900 MHz	–	-87	–	dBc
IMD3	–	Bands I, II, V, VIII +20 dBm CW @ TX freq at RFC, -15 dBm CW @ 2Tx-Rx at RFC, 50Ω	–	-122	–	dBm
Input IP2	RFC–RFx	100–6000 MHz	–	115	–	dBm
Input IP3	RFC–RFx	100–6000 MHz	–	73.5	–	dBm
Input 0.1 dB compression point[2]	RFC–RFx	100–6000 MHz	–	34	–	dBm
Switching time	–	50% CTRL to 90% or 10% RF	–	2	4	µs

1. High-frequency performance can be improved by external matching.
2. The input 0.1 dB compression point is a linearity figure of merit. See the RF input power $P_{MAX,CW}$ (50Ω) in Table 1.

Table 4 lists the PE423422 key electrical specifications at -40 °C to +105 °C and V_{DD} = 2.3–5.5V (Z_S = Z_L = 50Ω), unless otherwise specified.

Table 4. PE423422 electrical specifications

Parameter	Path	Condition	Min	Typ	Max	Unit
Operational frequency	–	–	100	–	6000	MHz
Insertion loss	RFC–RFx	100–1000 MHz	–	0.25	0.55	dB
		1000–2000 MHz	–	0.30	0.65	dB
		2000–3000 MHz	–	0.40	0.75	dB
		3000–4000 MHz	–	0.50	0.85	dB
		4000–5000 MHz	–	0.65	1.05(1)	dB
		5000–6000 MHz	–	0.90	1.45(1)	dB
Isolation	RFx–RFx	100–1000 MHz	38	41	–	dB
		1000–2000 MHz	31	33	–	dB
		2000–3000 MHz	25	28	–	dB
		3000–4000 MHz	21	24	–	dB
		4000–5000 MHz	17	20	–	dB
		5000–6000 MHz	16	16	–	dB
Isolation	RFC–RFx	100–1000 MHz	40	44	–	dB
		1000–2000 MHz	32	35	–	dB
		2000–3000 MHz	26	29	–	dB
		3000–4000 MHz	21	24	–	dB
		4000–5000 MHz	17	20	–	dB
		5000–6000 MHz	14	17	–	dB
Return loss	RFC–RFx	100–1000 MHz	–	28	–	dB
		1000–2000 MHz	–	21	–	dB
		2000–3000 MHz	–	20	–	dB
		3000–4000 MHz	–	18	–	dB
		4000–5000 MHz	–	16(1)	–	dB
		5000–6000 MHz	–	13(1)	–	dB
Second harmonic, 2fo	RFC–RFx	+32 dBm output power, 850/900 MHz	–	-99	–	dBc

Parameter	Path	Condition	Min	Typ	Max	Unit
		+32 dBm output power, 1800/1900 MHz	–	-101	–	dBc
Third harmonic, 3fo	RFC–RFx	+32 dBm output power, 850/900 MHz	–	-93	–	dBc
		+32 dBm output power, 1800/1900 MHz	–	-87	–	dBc
IMD3	–	Bands I, II, V, VIII +20 dBm CW @ TX freq at RFC, -15 dBm CW @ 2Tx-Rx at RFC, 50Ω	–	-122	–	dBm
Input IP2	RFC–RFx	100–6000 MHz	–	115	–	dBm
Input IP3	RFC–RFx	100–6000 MHz	–	73.5	–	dBm
Input 0.1 dB compression point[2]	RFC–RFx	100–6000 MHz	–	34	–	dBm
Switching time	–	50% CTRL to 90% or 10% RF	–	2	4	µs

1. High-frequency performance can be improved by external matching.
2. The input 0.1 dB compression point is a linearity figure of merit. See the RF input power $P_{MAX,CW}$ (50Ω) in Table 1.

SPDT control logic

Table 5 lists the PE423422 control logic truth table.

Table 5. PE423422 truth table.

Path	V1	LS
RFC–RF2	1	1
RFC–RF1	0	1
RFC–RF1	1	0
RFC–RF2	0	0

Power de-rating curve

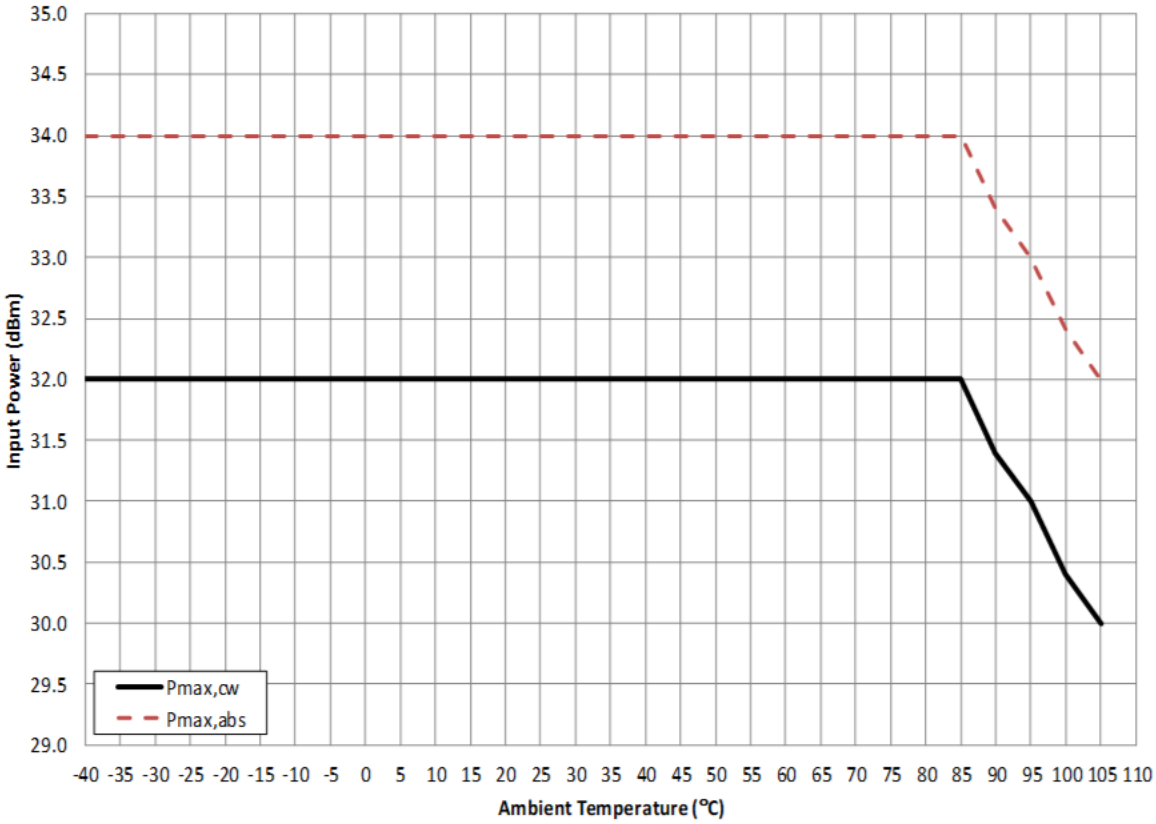


Figure 2. Power de-rating curve for 100–6000 MHz vs. ambient temperature (50Ω)

Typical performance data

Figure 3–Figure 19 show the typical performance data at +25 °C and V_{DD} = 3.3V, unless otherwise specified.

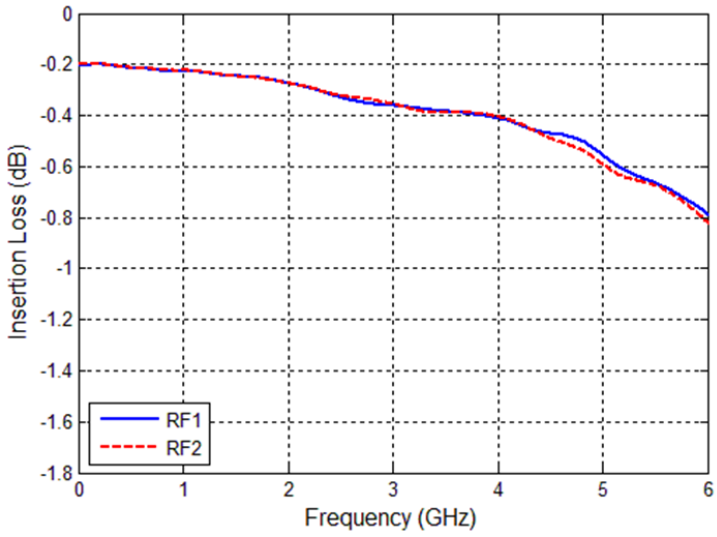


Figure 3. Insertion loss RFx

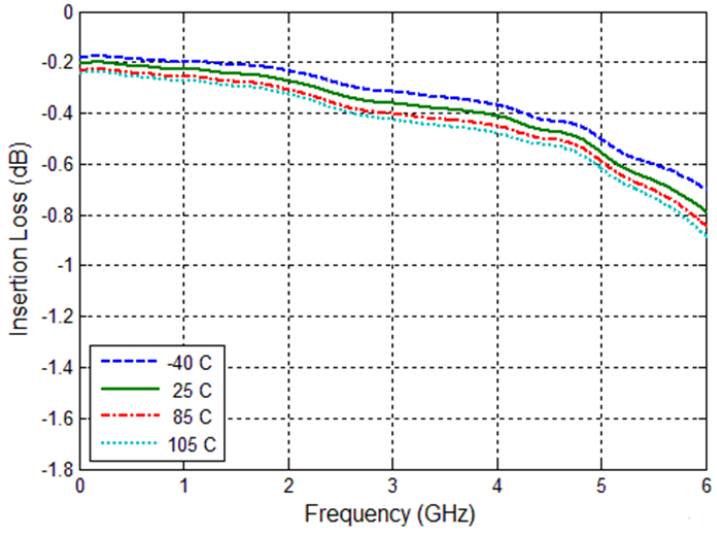


Figure 4. Insertion loss vs. temperature (RFC–RF1)

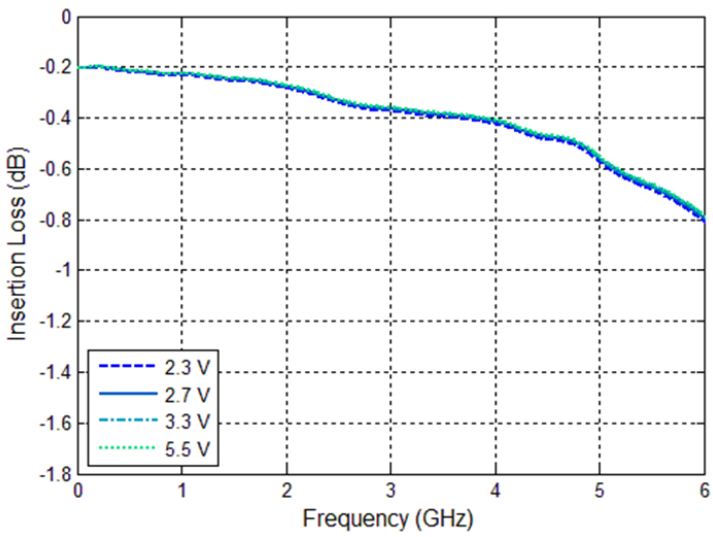


Figure 5. Insertion loss vs. V_{DD} (RFC–RF1)

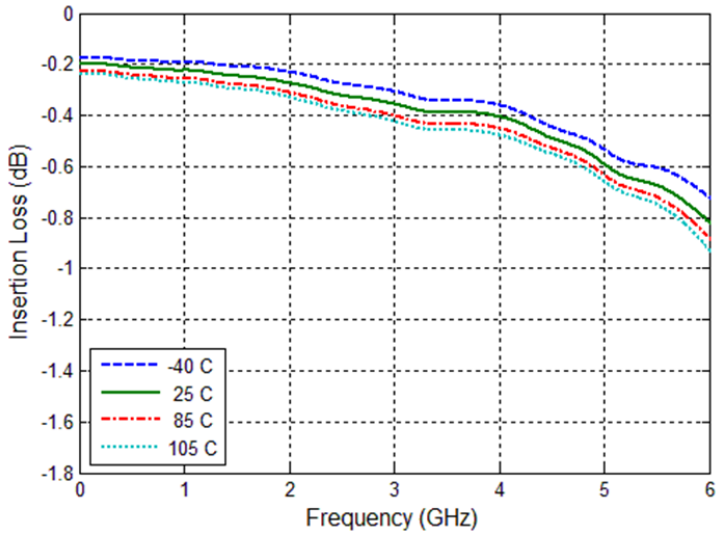


Figure 6. Insertion loss vs. temperature (RFC–RF2)

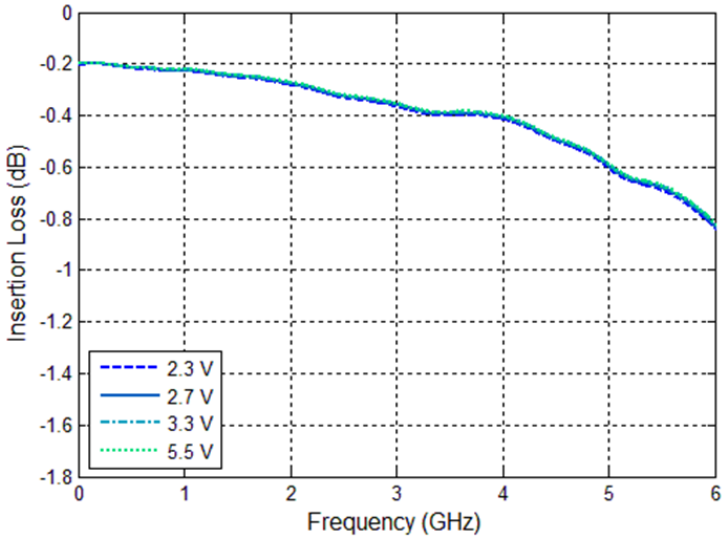


Figure 7. Insertion loss vs. V_{DD} (RFC–RF2)

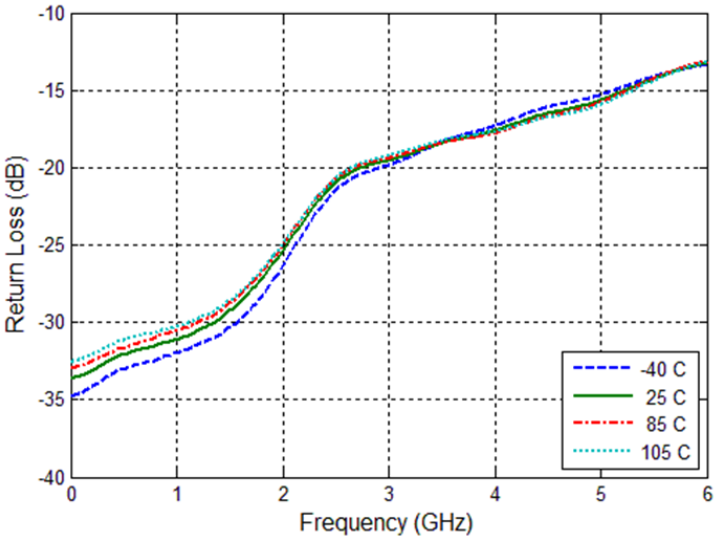


Figure 8. RFC port return loss vs. temperature (RF1 active)

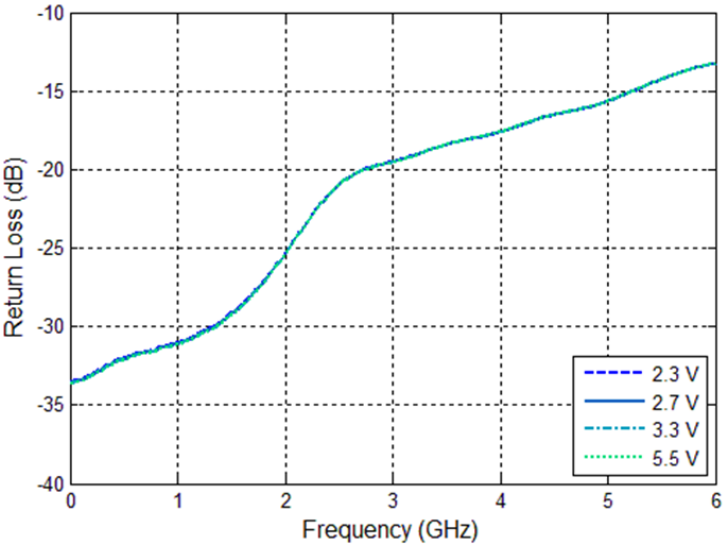


Figure 9. RFC port return loss vs. V_{DD} (RF1 active)

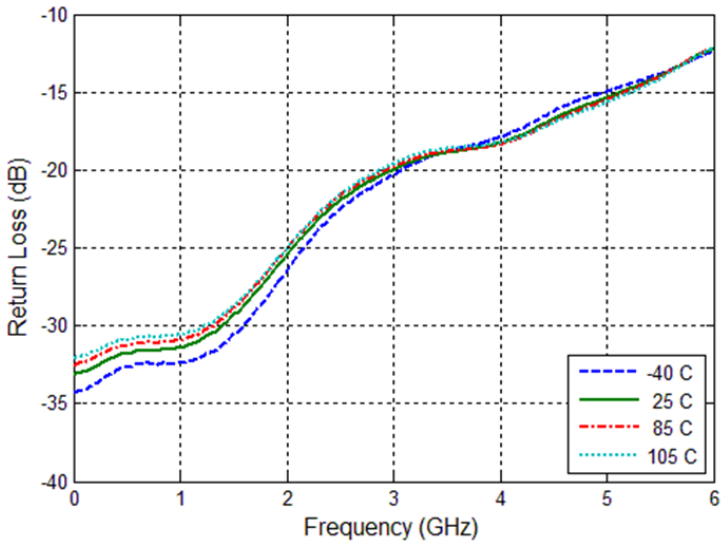


Figure 10. RFC port return vs. temperature (RF2 active)

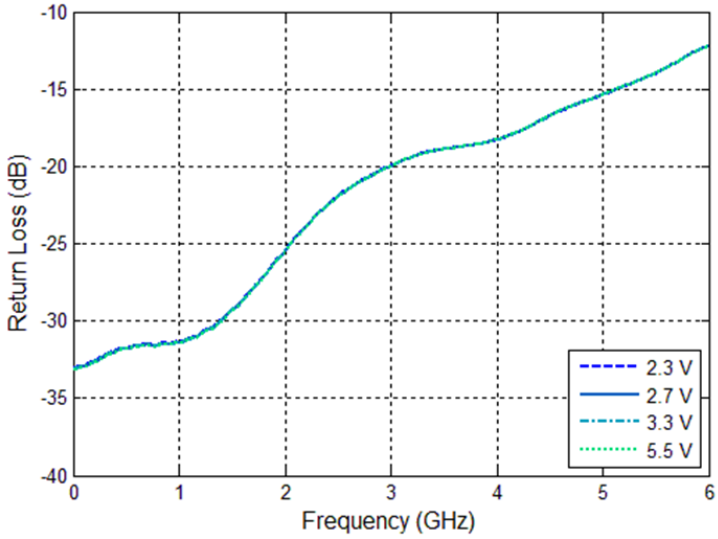


Figure 11. RFC port return loss vs. V_{DD} (RF2 active)

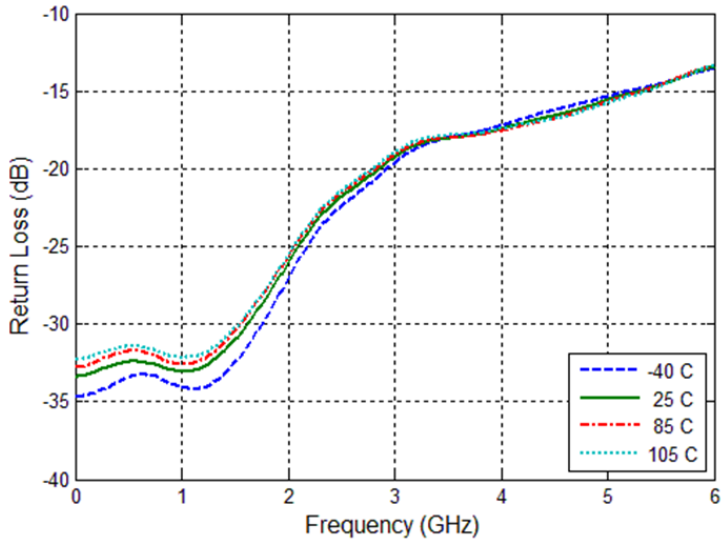


Figure 12. Active port return loss vs. temperature (RF1 active)

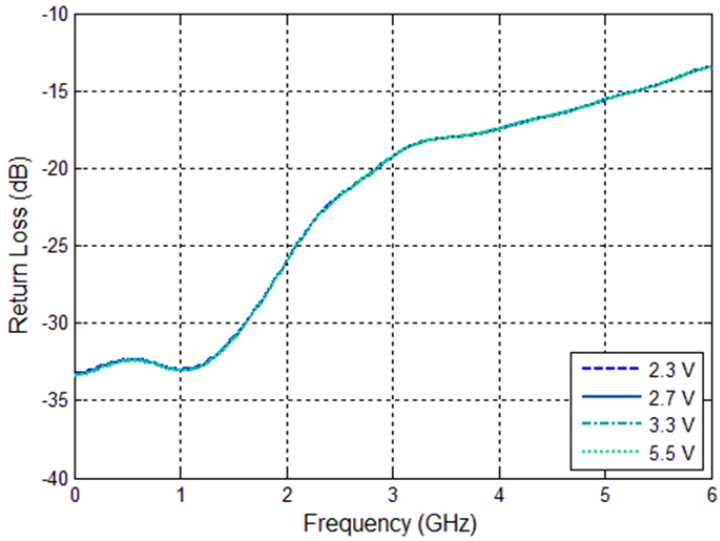


Figure 13. Active port return loss vs. V_{DD} (RF1 active)

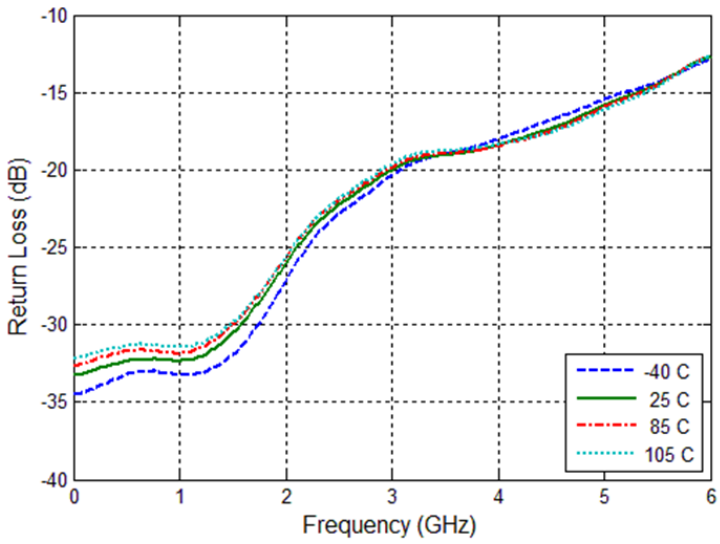


Figure 14. Active port return loss vs. temperature (RF2 active)

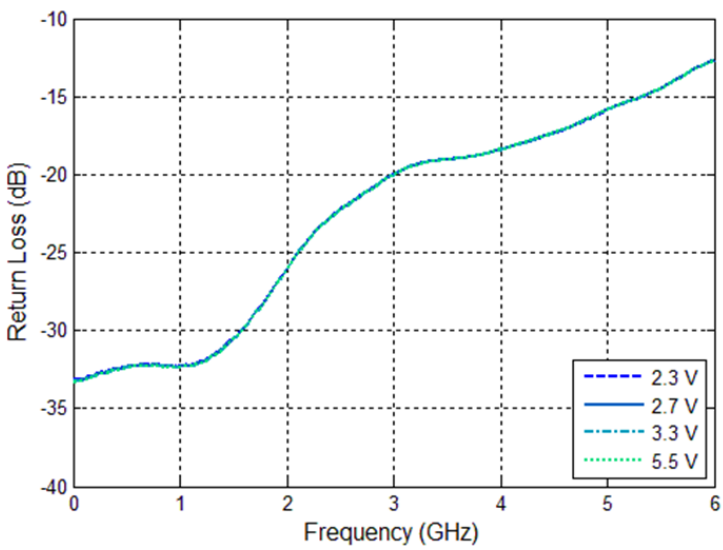


Figure 15. Active port return loss vs. V_{DD} (RF2 active)

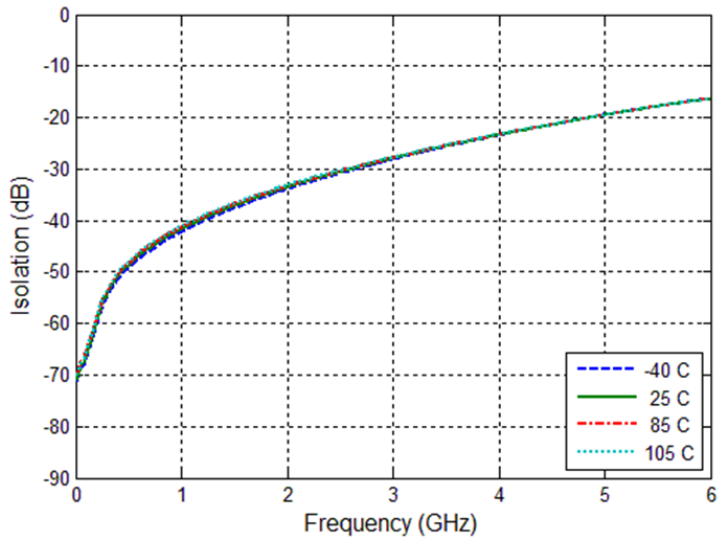


Figure 16. Isolation vs. temperature

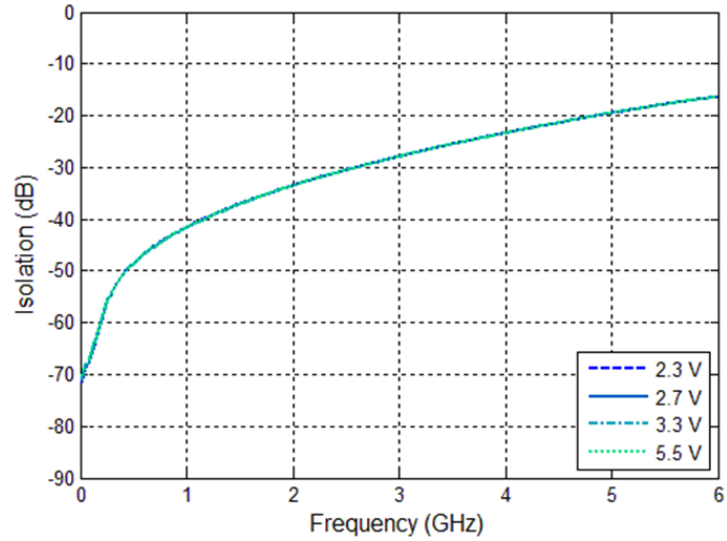


Figure 17. Isolation vs. V_{DD}

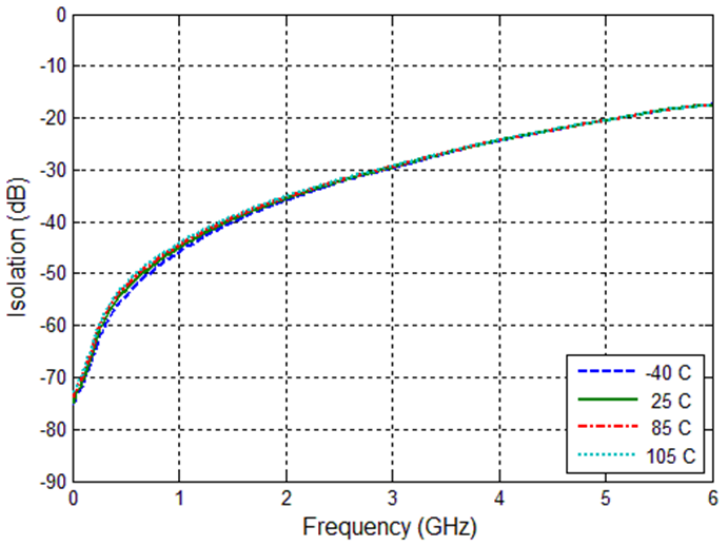


Figure 18. Isolation vs. temperature (RFC–RF2, RF1 active)

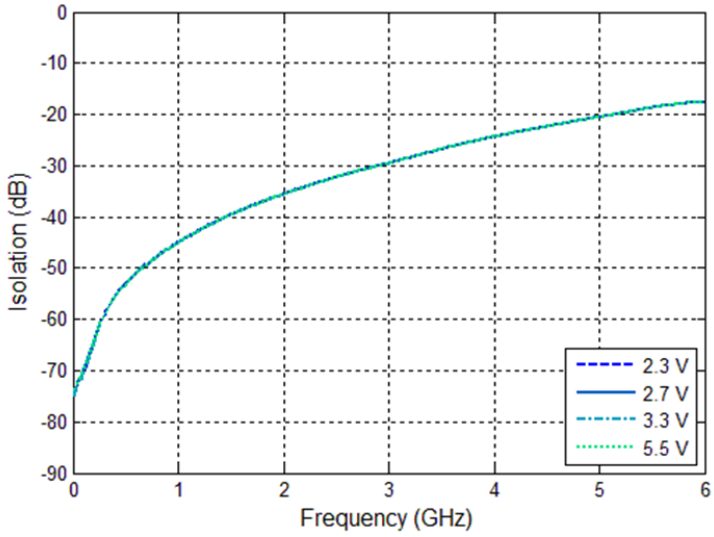


Figure 19. Isolation vs. V_{DD} (RFC–RF2, RF1 active)

Evaluation kit

pSemi designed the SPDT switch evaluation board to ease your PE423422 evaluation.

- The RF common port is connected through a 50Ω transmission line through the top SMA connector, J2.
- The RF1 and RF2 ports are connected by 50Ω transmission lines through SMA connectors J1 and J3, respectively.
- A through 50Ω transmission is available through SMA connectors J4 and J5. You can use this transmission line to estimate the loss of the PCB over the environmental conditions being evaluated.
- J8 provides the DC and digital inputs to the device.

The board is constructed of a four metal layer material with a total thickness of 62 mils. The top and bottom RF layers are Rogers RO4350 material with a 10 mil RF core. The middle layers provide ground for the transmission lines. The transmission lines were designed using a coplanar waveguide with ground plane model using a trace width of 22 mils, trace gaps of 7 mils, and a metal thickness of 2.1 mils.

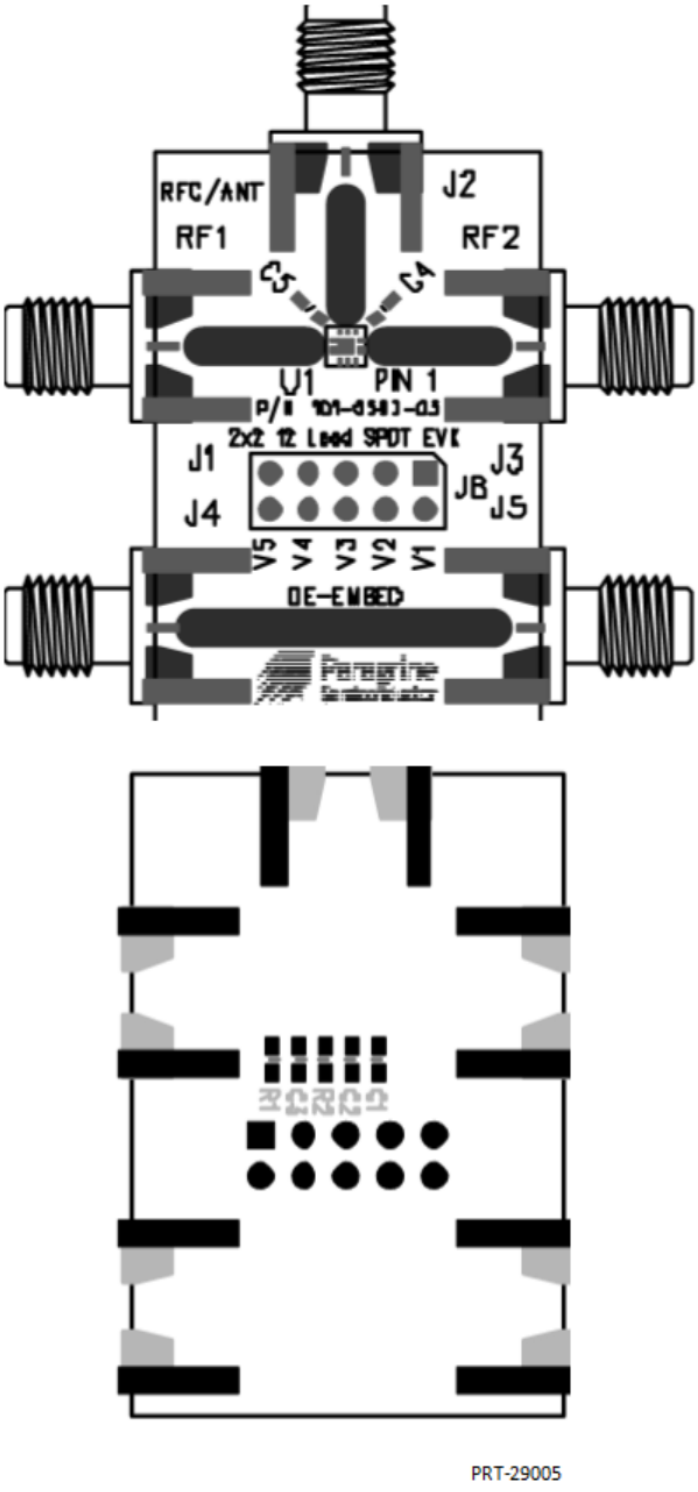


Figure 20. Evaluation board layout

Evaluation board schematic and BOM

Figure 21 shows the evaluation board schematic.

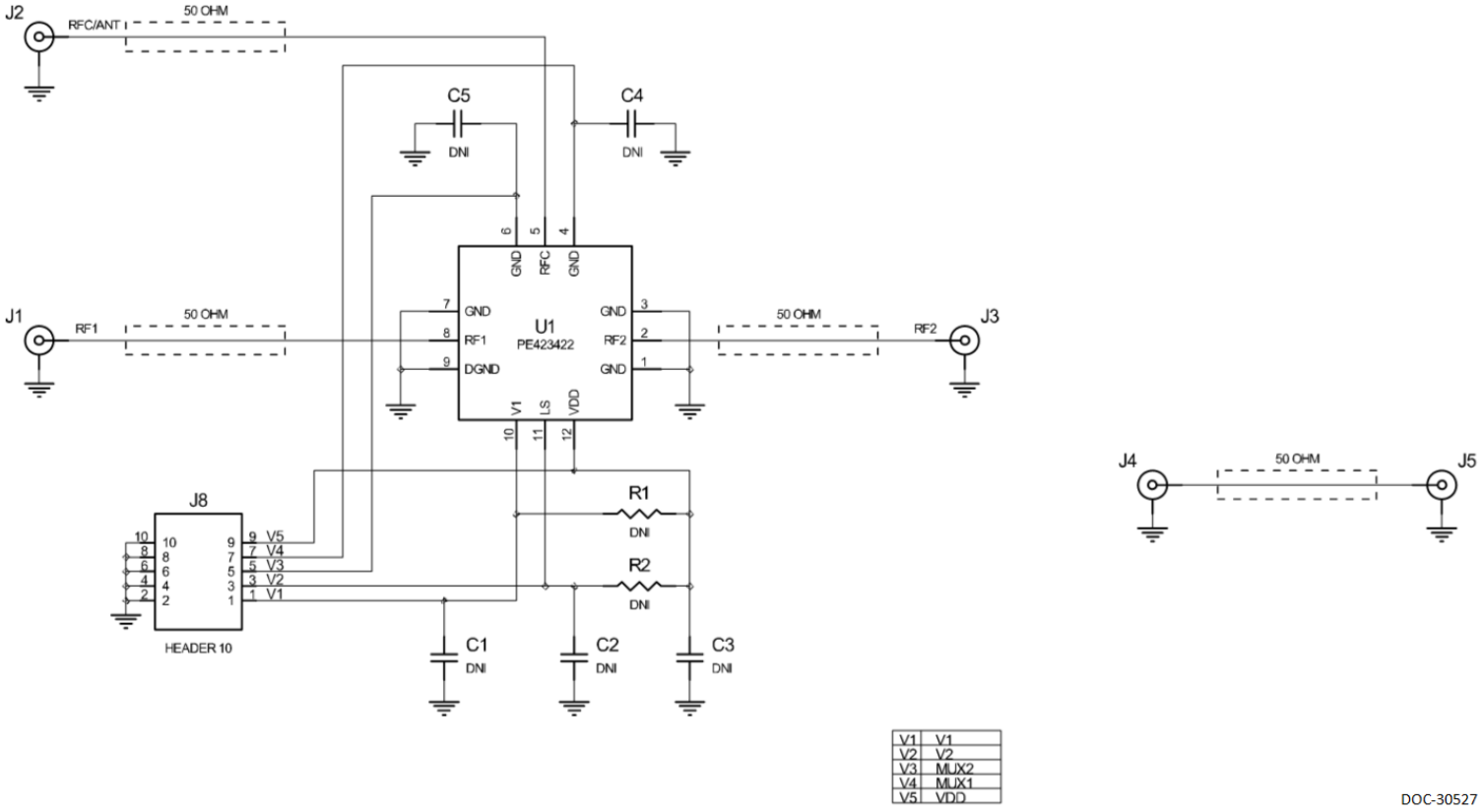


Figure 21. Evaluation board schematic

Pin information

Figure 22 shows the PE423422 pin map for the 12-lead 2 × 2 mm QFN package, and Table 6 lists the description for each pin.

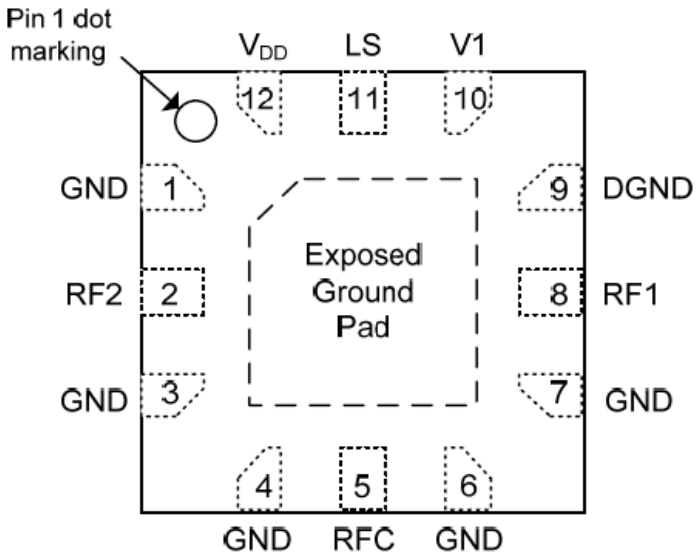


Figure 22. Pin configuration (top view)

Table 6. PE423422 pin descriptions

Pin no.	Pin name	Description
1, 3, 4, 6, 7	GND	Ground
2(*)	RF2	RF port 2
5(*)	RFC	RF common
8(*)	RF1	RF port 1
9	DGND	Digital ground
10	V1	Digital control logic input 1
11	LS	Logic select
12	V_{DD}	Supply voltage
Pad	GND	Exposed pad: Ground for proper operation

* RF pins 2, 5, and 8 must be at 0 VDC. These RF pins do not require DC blocking capacitors for proper operation if the 0 VDC requirement is met.

Packaging information

This section provides the following packaging data:

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

Moisture sensitivity level

The PE423422 moisture sensitivity level rating for the 12-lead 2 × 2 mm QFN package is MSL1.

Package drawing

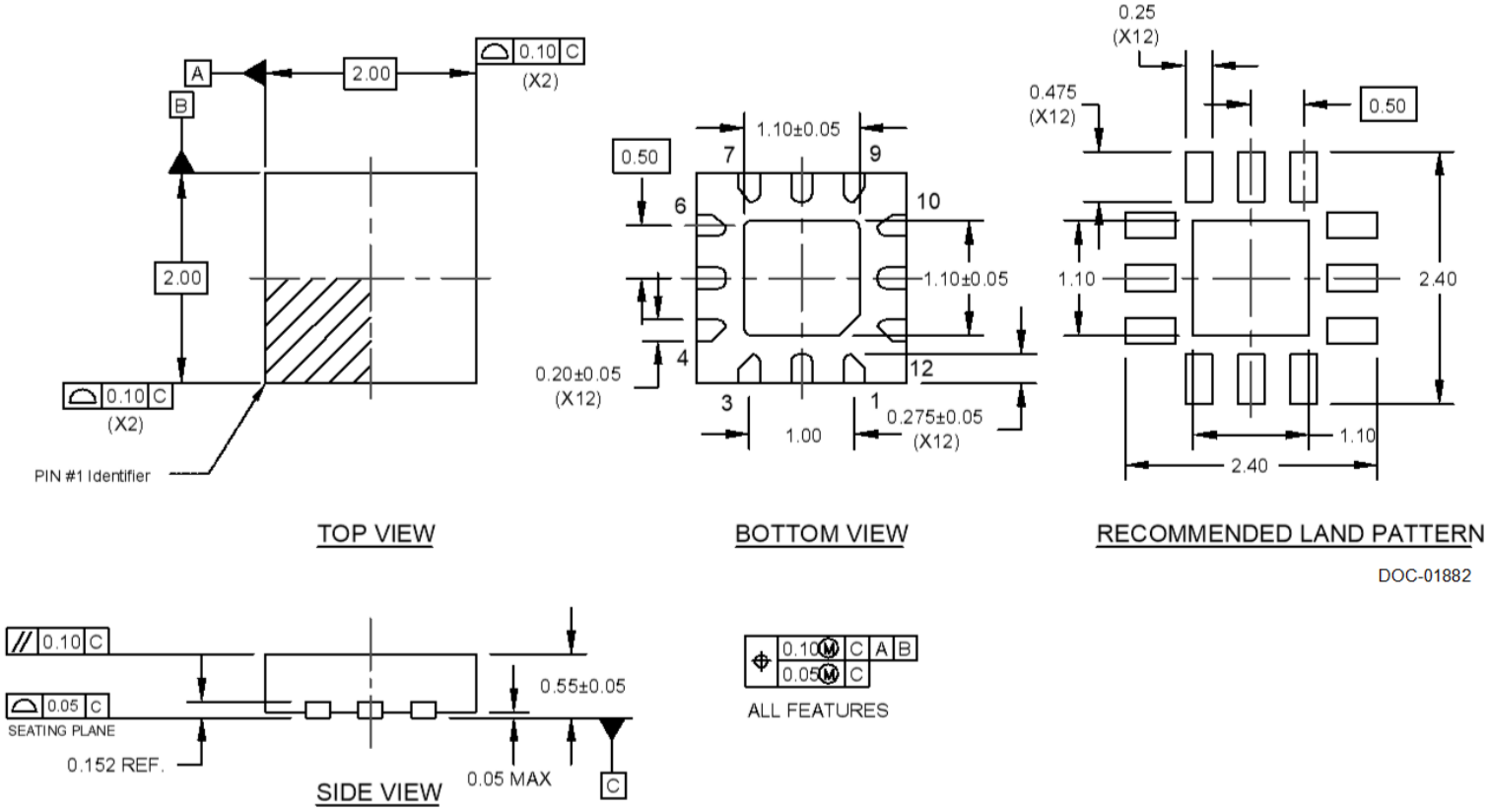
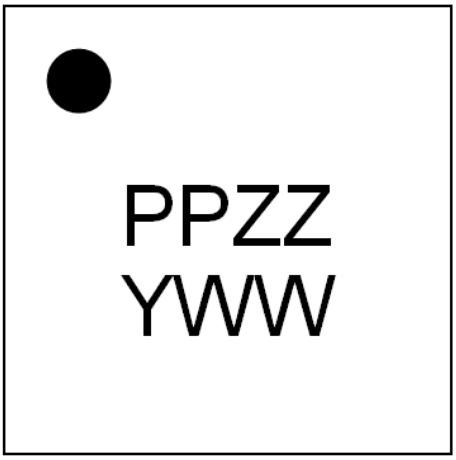


Figure 23. Mechanical drawing for the 12-lead 2 × 2 mm QFN package

Top-marking specification

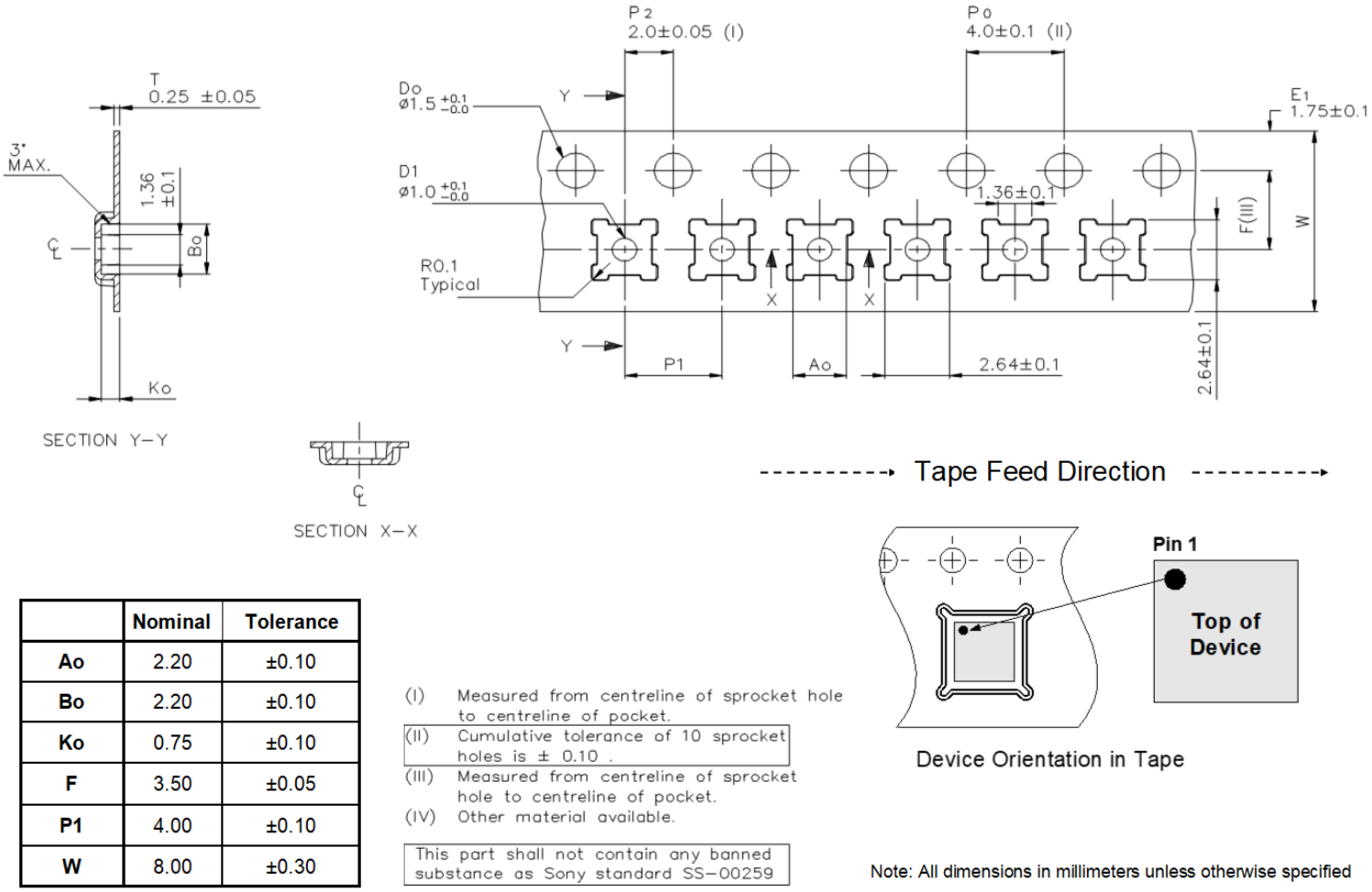


DOC-51207

Marking Spec Symbol	Package Marking	Definition
PP	DU	Part number marking for PE423422
ZZ	00-99	Last two digits of lot code
Y	0-9	Last digit of year, starting from 2009 (0 for 2010, 1 for 2011, etc)
WW	01-53	Work week

Figure 24. PE423422 package marking specification

Tape and reel specification



	Nominal	Tolerance
Ao	2.20	±0.10
Bo	2.20	±0.10
Ko	0.75	±0.10
F	3.50	±0.05
P1	4.00	±0.10
W	8.00	±0.30

(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.10 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.

This part shall not contain any banned substance as Sony standard SS–00259

Note: All dimensions in millimeters unless otherwise specified

Figure 25. Tape and reel specification for the 12-lead 2 × 2 mm QFN package

Ordering information

Table 7. PE423422 ordering codes and shipping information

Order code	Description	Packaging	Shipping method
PE423422A-Z	PE423422 SPDT RF switch	Green 12-lead 2 × 2 mm QFN	3000 units/tape and reel
EK423422-01	PE423422 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.

Contact and legal information

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