PE423641

Document category: Product Specification

UltraCMOS® SP4T RF Switch, 50–3000 MHz

Features

- AEC-Q100 Grade 2 certified
- Supports operating temperature up to +105°C
- HaRP™ technology enhancements provide excellent linearity:
  - Low harmonics of 2fo = –83 dBc and 3fo = –77 dBc @ +35 dBm
  - IMD3 of –111 dBm @ WCDMA band 1
  - IIP3 of 68 dBm
- Low insertion loss:
  - 0.50 dB @ 1000 MHz
  - 0.65 dB @ 2200 MHz
- High isolation:
  - 32 dB @ 1000 MHz
  - 25 dB @ 2200 MHz
- High ESD performance:
  - 2000V HBM on all pins
  - 100V MM on all pins
  - 1000V CDM on all pins
- Integrated decoder for 2-pin control:
  - Accepts 1.8V and 2.75V levels

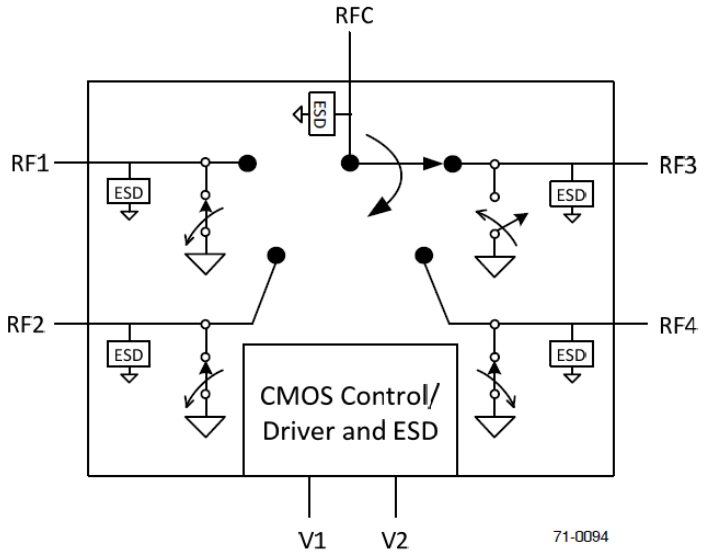

Figure 1. PE423641 functional block diagram

Product description

The PE423641 is a HaRP™ technology-enhanced reflective SP4T 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 50 MHz through 3 GHz, such as cellular antenna band switching, automotive infotainment, and traffic safety applications. No blocking capacitors are required if DC voltage is not present on the RF ports.

The PE423641 is manufactured using the pSemi UltraCMOS® process, a patented variation of silicon-on-insulator (SOI) technology on a sapphire substrate, offering excellent RF performance.

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.

Headquarters: 9369 Carroll Park Dr, San Diego, CA 92121

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. PE423641 absolute maximum ratings

Parameter or condition	Symbol	Min	Max	Unit
Supply voltage	V_{DD}	-0.3	3.7	V
Digital input oltage (V1, V2)	V_I	-0.3	3.7	V
RF input power, maximum	$P_{MAX,ABS}$	–	+37	dBm
Storage temperature range	T_{ST}	-65	+150	°C
ESD voltage HBM(1), all pins	$V_{ESD,HBM}$	–	2000	V
ESD voltage MM(2), all pins	$V_{ESD,MM}$	–	100	V
ESD voltage CDM(3), all pins	$V_{ESD,CDM}$	–	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 PE423641 recommending operating conditions. Do not operate devices outside the operating conditions listed below.

Table 2. PE423641 operating conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{DD}	2.65	2.75	3.3	V
Supply current (V_{DD} = 2.75V, +25 °C only)	I_{DD}	–	13	50	µA
Digital input high (V1, V2)	V_{IH}	1.4	–	V_{DD}	V
Digital input low (V1, V2)	V_{IL}	0	–	0.4	V
RF input power, CW(*)	$P_{MAX,CW}$	–	–	+35	dBm
Operating temperature range	T_{OP}	-40	+25	+105	°C

* 100% duty cycle, all bands, 50Ω.

Electrical specifications

Table 3 lists the PE423641 key electrical specifications at +25 °C and V_{DD} = 2.75V (Z_S = Z_L = 50Ω), unless otherwise specified.

Table 3. PE423641 electrical specifications

Parameter	Path	Condition	Min	Typ	Max	Unit
Operational frequency	–	–	50	–	3000	MHz
Insertion loss (symmetric ports)	RFC–RFx	50–1000 MHz	–	0.50	0.60	dB
		1000–2200 MHz	–	0.65	0.75	dB
		2200–2700 MHz	–	0.80	0.95	dB
		2700–3000 MHz	–	0.95	1.15	dB
Isolation	RFC–RFx	50–1000 MHz	30	32	–	dB
		1000–2200 MHz	23	25	–	dB
		2200–2700 MHz	21	23	–	dB
		2700–3000 MHz	20	22	–	dB
Return loss (active ports)	RFC–RFx	50–1000 MHz	–	24	–	dB
		1000–2200 MHz	–	19	–	dB
		2200–2700 MHz	–	16	–	dB
		2700–3000 MHz	–	14	–	dB
Return loss (common ports)	RFC–RFx	50–1000 MHz	–	23	–	dB
		1000–2200 MHz	–	16	–	dB
		2200–2700 MHz	–	14	–	dB
		2700–3000 MHz	–	13	–	dB
Second harmonic	RFx	+35 dBm output power, 850/900 MHz	–	-83	-80	dBc
		+33 dBm output power, 1800/1900 MHz	–	-85	-78	dBc
Third harmonic	RFx	+35 dBm output power, 850/900 MHz	–	-77	-73.5	dBc
		+33 dBm output power, 1800/1900 MHz	–	-78	-72.5	dBc
IMD3	–	RF Measured at 2.14 GHz at ANT port, input +20 dBm CW signal at 1.95 GHz and –15 dBm CW signal at 1.76 GHz	–	-111	–	dBm
Input IP2	RFC–RFx	50–3000 MHz	–	115	–	dBm
Input IP3	RFC–RFx	50–3000 MHz	–	68	–	dBm

Parameter	Path	Condition	Min	Typ	Max	Unit
Input 0.1 dB compression point[1]	RFC–RFx	50–3000 MHz	–	37	–	dBm
Switching time[2]	–	50% CTRL to 90% or 10% RF	–	1	2	µs

1. The input 0.1 dB compression point is a linearity figure of merit. For the operating RF input power (50Ω), see Table 2.
2. The PE423641 has a maximum 25 kHz switching frequency. Switching frequency describes the time duration between switching events. Switching time is the time duration between the point the control signal reaches 50% of the final value and the point the output signal reaches within 10% or 90% of its target value.

Table 4 lists the PE423641 key electrical specifications at -40 °C to +105 °C and V_{DD} = 2.75V (Z_S = Z_L = 50Ω), unless otherwise specified.

Table 4. PE423641 electrical specifications

Parameter	Path	Condition	Min	Typ	Max	Unit
Operational frequency	–	–	50	–	3000	MHz
Insertion loss (symmetric ports)	RFC–RFx	50–1000 MHz	–	0.50	0.75	dB
		1000–2200 MHz	–	0.65	0.90	dB
		2200–2700 MHz	–	0.80	1.10	dB
		2700–3000 MHz	–	0.95	1.30	dB
Isolation	RFC–RFx	50–1000 MHz	30	32	–	dB
		1000–2200 MHz	23	25	–	dB
		2200–2700 MHz	21	23	–	dB
		2700–3000 MHz	20	22	–	dB
Return loss (active ports)	RFC–RFx	50–1000 MHz	–	24	–	dB
		1000–2200 MHz	–	19	–	dB
		2200–2700 MHz	–	16	–	dB
		2700–3000 MHz	–	14	–	dB
Return loss (common ports)	RFC–RFx	50–1000 MHz	–	23	–	dB
		1000–2200 MHz	–	16	–	dB
		2200–2700 MHz	–	14	–	dB
		2700–3000 MHz	–	13	–	dB
Second harmonic	RFx	+35 dBm output power, 850/900 MHz	–	-83	-76	dBc
		+33 dBm output power, 1800/1900 MHz	–	-85	-74	dBc
Third harmonic	RFx	+35 dBm output power, 850/900 MHz	–	-77	-69.5	dBc
		+33 dBm output power, 1800/1900 MHz	–	-78	-68.5	dBc
IMD3	–	RF Measured at 2.14 GHz at ANT port, input +20 dBm CW signal at 1.95 GHz and –15 dBm CW signal at 1.76 GHz	–	-111	–	dBm
Input IP2	RFC–RFx	50–3000 MHz	–	115	–	dBm
Input IP3	RFC–RFx	50–3000 MHz	–	68	–	dBm

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SP4T control logic

Table 5. PE423641 truth table.

Path	V2	V1
RFC-RF1	0	0
RFC-RF2	1	0
RFC-RF3	0	1
RFC-RF4	1	1

Typical performance data

Figure 2–Figure 9 show the typical performance data at +25 °C and V_{DD} = 2.75V, unless otherwise specified.

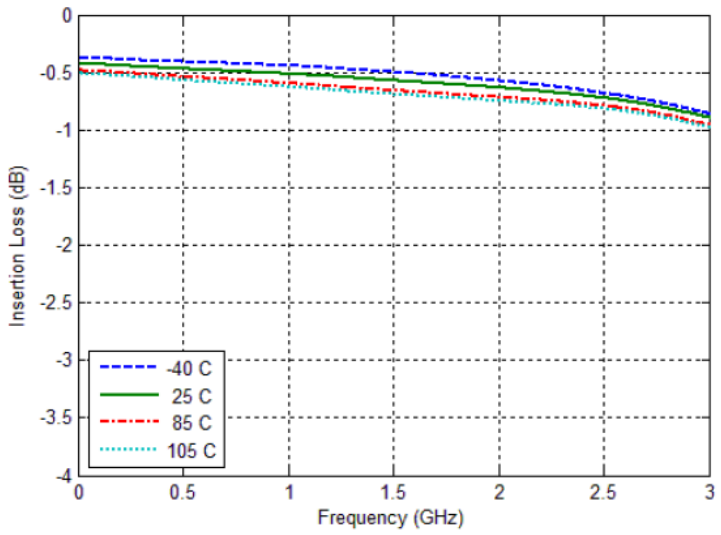

Figure 2. Insertion loss vs. temperature (RFC–RFx)

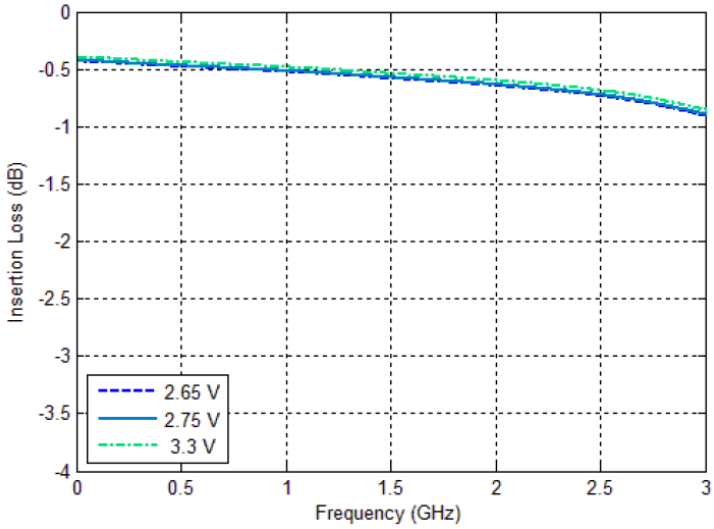

Figure 3. Insertion loss vs. V_{DD} (RFC–RFx)

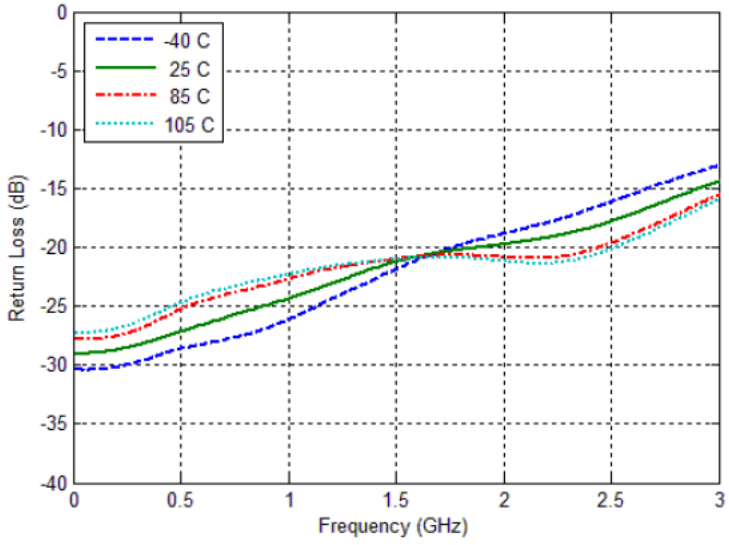

Figure 4. Return loss vs. temperature (active port)

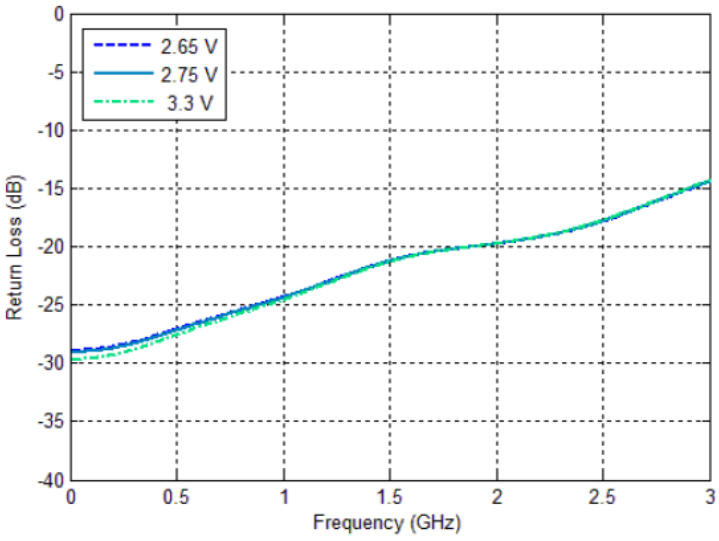

Figure 5. Return loss vs. V_{DD} (active port)

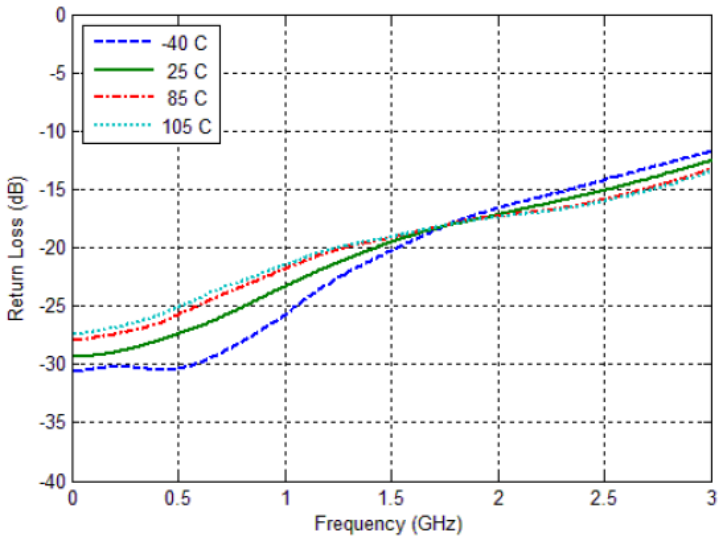

Figure 6. Return loss vs. temperature (common port)

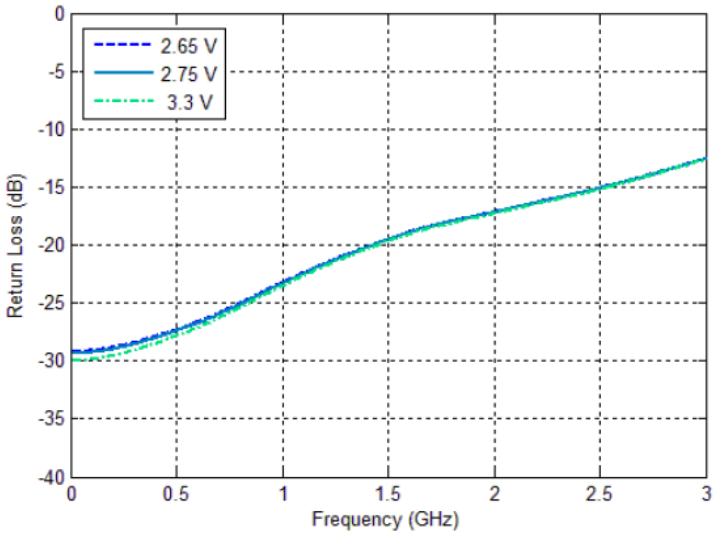

Figure 7. Return loss vs. V_{DD} (common port)

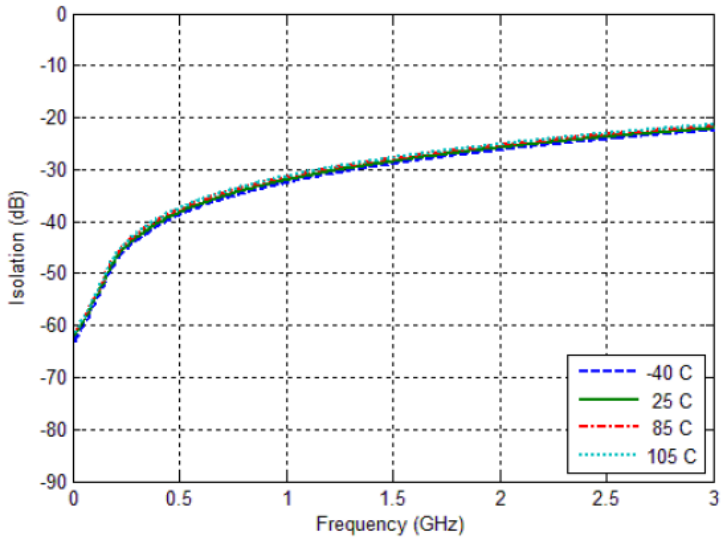

Figure 8. Isolation vs. temperature (RFC–RFx)

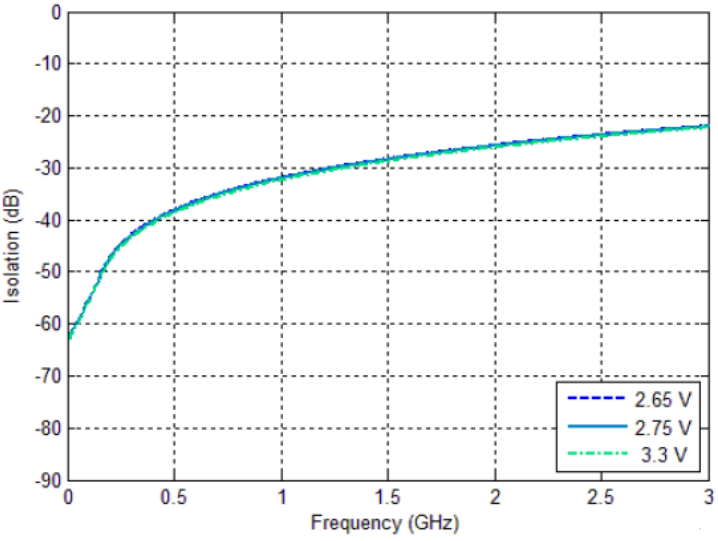

Figure 9. Isolation vs. V_{DD} (RFC–RFx)

Evaluation kit

pSemi designed the SP4T switch evaluation board to ease your evaluation of the pSemi PE423641. The RF common port is connected through a 50Ω transmission line via the top SMA connector, J1. RF1, RF2, RF3, and RF4 are connected through 50Ω transmission lines via SMA connectors J3, J5, J2 and J4, respectively. A through 50Ω transmission is available via SMA connectors J6 and J7. This transmission line can be used to estimate the loss of the PCB over the environmental conditions being evaluated.

The board is constructed of a four-layer metal FR4 material with a total thickness of 62 mils. The middle layers provide ground for the transmission lines. The transmission lines were designed using a coplanar waveguide with a ground plane model using a trace width of 32 mils, trace gaps of 25 mils, and a metal thickness of 2.1 mils.

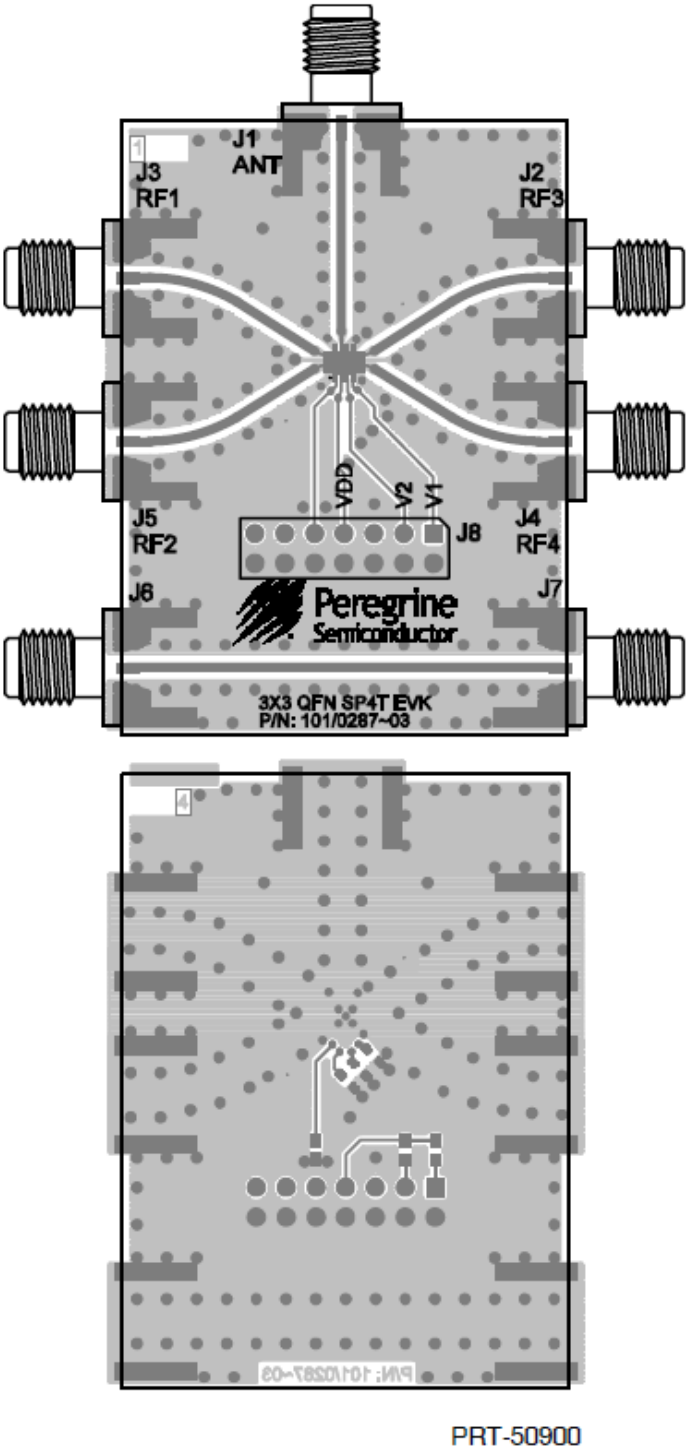

Figure 10. Evaluation board layouts

Evaluation board schematic

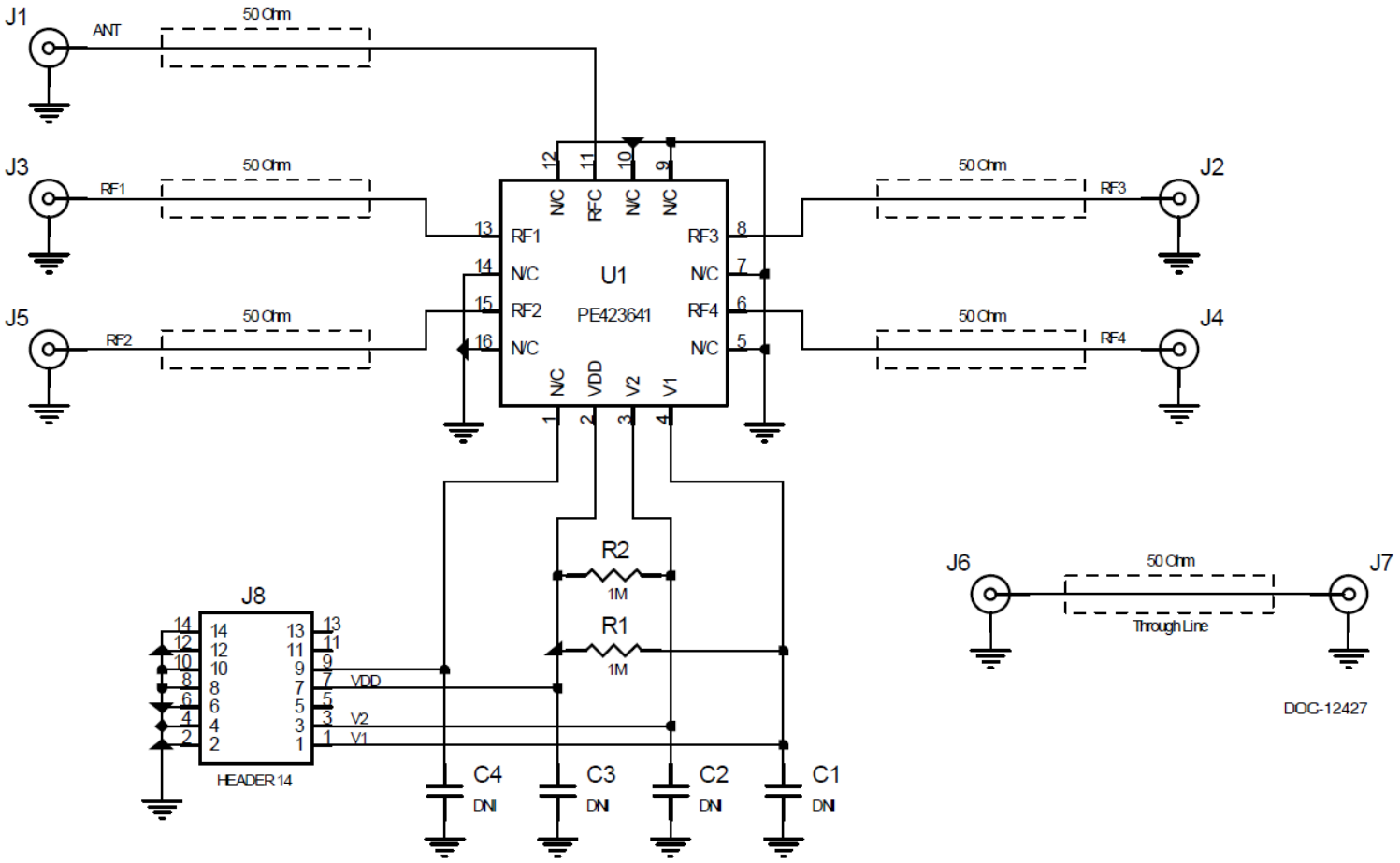

Figure 11. Evaluation board schematic

Pin information

Figure 12 shows the PE423641 pin map for the 16-lead 3 × 3 mm QFN package, and Table 6 lists the description for each pin.

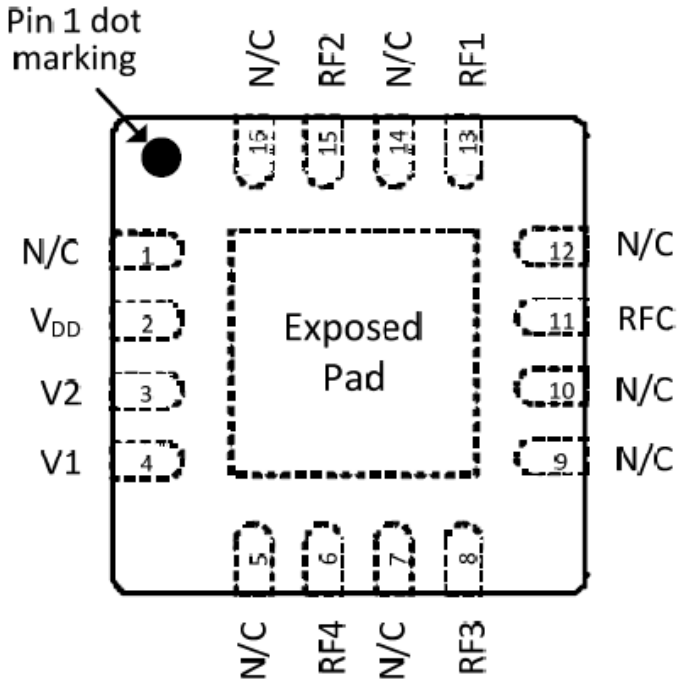

Figure 12. Pin configuration (top view)

Table 6. PE423641 pin descriptions

Pin no.	Pin name	Description
1, 5, 7, 9, 10, 12, 14, 16	N/C	No connect
2	V_{DD}	Supply voltage
3	V2	Digital control logic input 2
4	V1	Digital control logic input 1
6(*)	RF4	RF port 4
8(*)	RF3	RF port 3
11(*)	RFC	RF common
13(*)	RF1	RF port 1
15(*)	RF2	RF port 2
Pad	GND	Exposed pad. Ground for proper operation.

* RF pins 6, 8, 11, 13, and 15 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 PE423641 moisture sensitivity level rating for the 16-lead 3 × 3 mm QFN package is MSL1.

Package drawing

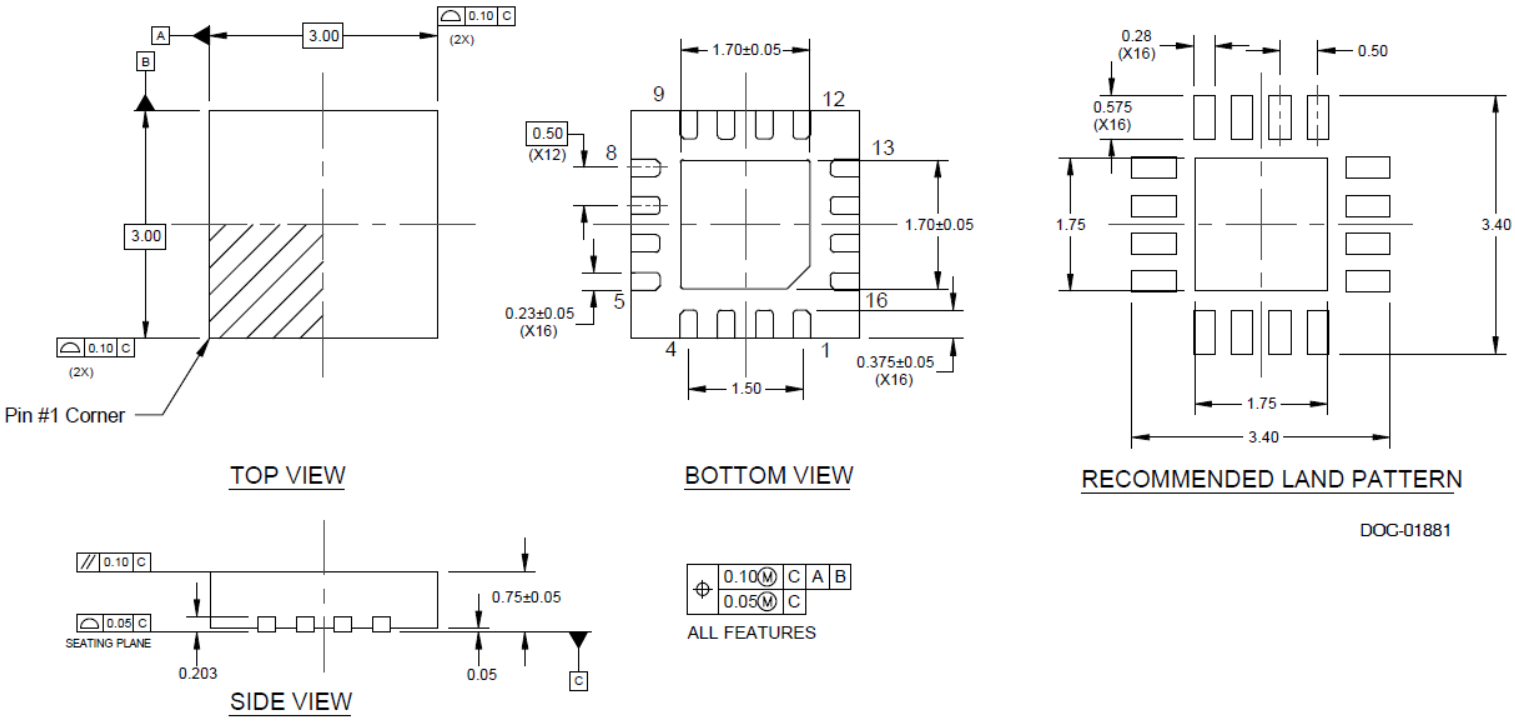

Figure 13. Package mechanical drawing for the 16-lead 3 × 3 mm QFN package

Top-marking specification

● = Pin 1 designator
YYWW = Date code, last two digits of the year and work week
ZZZZZZ = Last six characters of the assembly lot code

DOC-51207

Figure 14. PE423641 package marking specification

Tape and reel specification

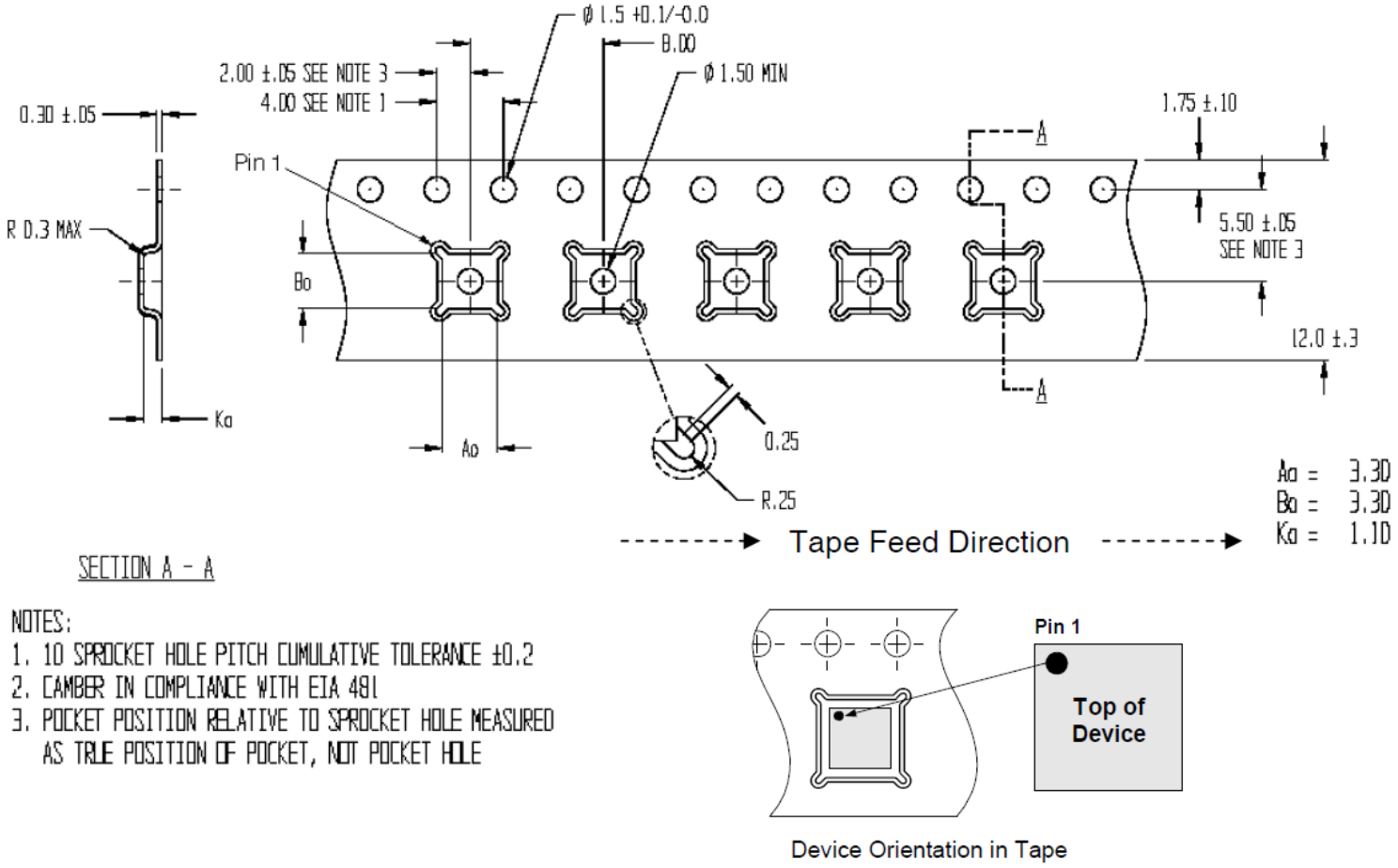

Figure 15. Tape and reel specification for the 16-lead 3 × 3 mm QFN package

Notes:

- The diagram is not drawn to scale.
- The units are in millimeters (mm).
- The maximum cavity angle is five degrees.
- The bumped die are oriented active side down.

Ordering information

Table 7. PE423641 ordering codes and shipping methods

Order code	Description	Packaging	Shipping method
PE423641MLZZ-Z	PE423641 SP4T RF Switch	Green 16-lead 3 × 3 mm QFN	3000 units/T&R
EK423641-01	PE423641 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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