

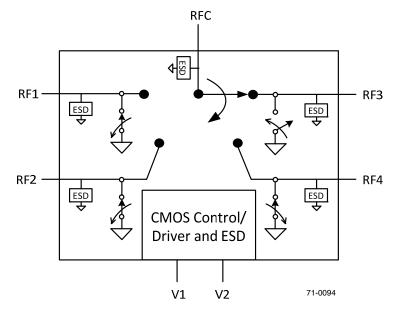
Product Description

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 on Peregrine's UltraCMOS® process, a patented variation of silicon-oninsulator (SOI) technology on a sapphire substrate, offering excellent RF performance.

Peregrine'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.

Figure 1. Functional Diagram



Product Specification

PE423641

UltraCMOS® SP4T RF Switch 50-3000 MHz

Features

- AEC-Q100 Grade 2 certified
- Supports operating temperature up to +105°C
- HaRPTM 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
 - 2 kV HBM on all pins
 - 100V MM on all pins
 - 1 kV CDM on all pins
- Integrated decoder for 2-pin control
 - Accepts 1.8V and 2.75V levels

Figure 2. Package Type 16-lead 3 x 3 mm QFN





Table 1. Electrical Specifications @ +25°C, V_{DD} = 2.75V (Z_S = Z_L = 50Ω)

| Parameter | Path | Condition | Min | Тур | Max | Unit |
|---|-------------|--|-----|------|-------|------|
| Operational frequency | | | 50 | | 3000 | MHz |
| | | 50–1000 MHz | | 0.50 | 0.60 | dB |
| Insertion loss | RFC-RFX | 1000–2200 MHz | | 0.65 | 0.75 | dB |
| (symmetric ports) | RFC-RFX | 2200–2700 MHz | | 0.80 | 0.95 | dB |
| | | 2700–3000 MHz | | 0.95 | 1.15 | dB |
| | | 50–1000 MHz | 30 | 32 | | dB |
| Isolation | RFC-RFX | 1000–2200 MHz | 23 | 25 | | dB |
| Isolation | 111 0-111 X | 2200–2700 MHz | 21 | 23 | | dB |
| | | 2700–3000 MHz | 20 | 22 | | dB |
| | | 50–1000 MHz | | 24 | | dB |
| Return loss (active ports) | RFC-RFX | 1000–2200 MHz | | 19 | | dB |
| Hetuiri ioss (active ports) | RFC-RFX | 2200–2700 MHz | | 16 | | dB |
| | | 2700–3000 MHz | | 14 | | dB |
| | RFC-RFX | 50–1000 MHz | | 23 | | dB |
| | | 1000–2200 MHz | | 16 | | dB |
| Return loss (common ports) | | 2200–2700 MHz | | 14 | | dB |
| | | 2700–3000 MHz | | 13 | | dB |
| and haven ania | RFX | +35 dBm output power, 850/900 MHz | | -83 | -80 | dBc |
| 2nd harmonic | HEX | +33 dBm output power, 1800/1900 MHz | | -85 | -78 | dBc |
| Outhorner | RFX | +35 dBm output power, 850/900 MHz | | -77 | -73.5 | dBc |
| 3rd harmonic | | +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 |
| Input 0.1 dB compression point ¹ | RFC-RFX | 50–3000 MHz | | 37 | | dBm |
| Switching time | | 50% CTRL to 90% or 10% RF | | 1 | 2 | μs |

Note 1: Input 0.1 dB compression point is a linearity figure of merit. Refer to $Table\ 3$ for the operating RF input power (50 Ω).



Table 1A. Electrical Specifications @ –40 to +105°C, V_{DD} = 2.75V ($Z_S = Z_L = 50\Omega$)

| Parameter | Path | Condition | Min | Тур | Max | Unit |
|---|-----------|--|-----|------|-------|------|
| Operational frequency | | | 50 | | 3000 | MHz |
| | | 50–1000 MHz | | 0.50 | 0.75 | dB |
| Insertion loss | RFC-RFX | 1000–2200 MHz | | 0.65 | 0.90 | dB |
| (symmetric ports) | NFU-NFX | 2200–2700 MHz | | 0.80 | 1.10 | dB |
| | | 2700–3000 MHz | | 0.95 | 1.30 | dB |
| | | 50–1000 MHz | 30 | 32 | | dB |
| Isolation | RFC-RFX | 1000–2200 MHz | 23 | 25 | | dB |
| Isolation | ni O-ni X | 2200–2700 MHz | 21 | 23 | | dB |
| | | 2700–3000 MHz | 20 | 22 | | dB |
| | | 50–1000 MHz | | 24 | | dB |
| Return loss (active ports) | RFC-RFX | 1000–2200 MHz | | 19 | | dB |
| neturn loss (active ports) | | 2200–2700 MHz | | 16 | | dB |
| | | 2700–3000 MHz | | 14 | | dB |
| | RFC-RFX | 50–1000 MHz | | 23 | | dB |
| | | 1000–2200 MHz | | 16 | | dB |
| Return loss (common ports) | | 2200–2700 MHz | | 14 | | dB |
| | | 2700–3000 MHz | | 13 | | dB |
| Out the second | DEV | +35 dBm output power, 850/900 MHz | | -83 | -76 | dBc |
| 2nd harmonic | RFX | +33 dBm output power, 1800/1900 MHz | | -85 | -74 | dBc |
| Out have a size | RFX | +35 dBm output power, 850/900 MHz | | -77 | -69.5 | dBc |
| 3rd harmonic | | +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 |
| Input 0.1 dB compression point ¹ | RFC-RFX | 50–3000 MHz | | 37 | | dBm |
| Switching time | | 50% CTRL to 90% or 10% RF | | 1 | 2 | μs |

Note 1: Input 0.1 dB compression point is a linearity figure of merit. Refer to $Table\ 3$ for the operating RF input power (50 Ω).



Figure 3. Pin Configuration (Top View)

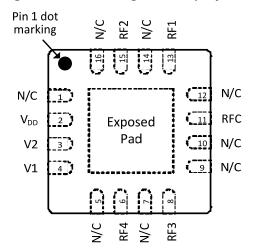


Table 2. Pin Descriptions

| Pin # | 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 ¹ | RF port |
| 8 | RF3 ¹ | RF port |
| 11 | RFC ¹ | RF common |
| 13 | RF1 ¹ | RF port |
| 15 | RF2 ¹ | RF port |
| Pad | GND | Exposed pad: Ground for proper operation |

Note 1: RF pins 6, 8, 13, and 15 must be at 0 VDC. The RF pins do not require DC blocking capacitors for proper operation if the 0 VDC requirement is met.

Table 3. Operating Ranges

| Parameter | Symbol | Min | Тур | Max | Unit |
|--|---------------------|------|------|----------|------|
| Supply voltage | V_{DD} | 2.65 | 2.75 | 3.3 | ٧ |
| Supply current (V _{DD} = 2.75V, +25°C only) | I _{DD} | | 13 | 50 | μΑ |
| Digital input high (V1, V2) | V_{IH} | 1.4 | | V_{DD} | ٧ |
| Digital input low (V1, V2) | V _{IL} | 0 | | 0.4 | V |
| RF input power, CW1 | P _{MAX,CW} | | | +35 | dBm |
| Operating temperature range | T _{OP} | -40 | +25 | +105 | °C |

Note 1: 100% duty cycle, all bands, 50Ω

Table 4. Absolute Maximum Ratings

| Parameter/Condition | Symbol | Min | Max | Unit |
|---|-----------------------|------|------|------|
| Supply voltage | V_{DD} | -0.3 | 3.7 | V |
| Digital input voltage (V1, V2) | Vı | -0.3 | 3.7 | ٧ |
| RF input power, max | 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 | ٧ |
| 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)

Exceeding absolute maximum ratings may cause permanent damage. Operation should be restricted to the limits in the Operating Ranges table. Operation between operating range maximum and absolute maximum for extended periods may reduce reliability.



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 PE423641 in the 16-lead 3x3 mm QFN package is MSL1.

Table 5. Truth Table

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

Switching Frequency

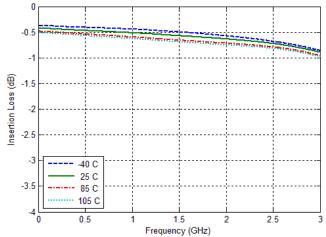
The PE423641 has a maximum 25 kHz switching frequency.

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. Switching time is provided in *Table 1* and *Table 1A*.



Typical Performance Data @ +25°C and V_{DD} = 2.75V, unless otherwise specified

Figure 4. Insertion Loss vs Temp (RFC-RFX)



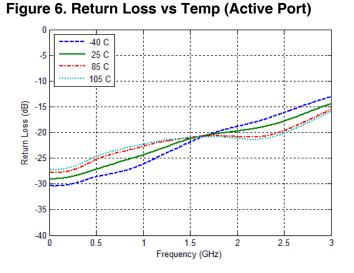
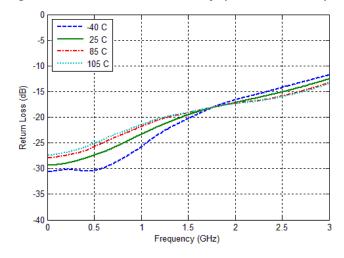


Figure 8. Return Loss vs Temp (Common Port)



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Figure 5. Insertion Loss vs V_{DD} (RFC–RFX)

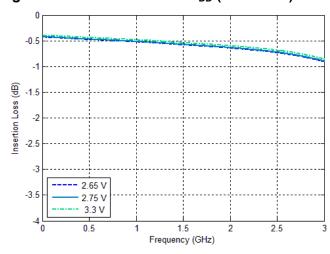


Figure 7. Return Loss vs V_{DD} (Active Port)

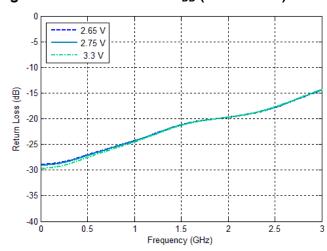
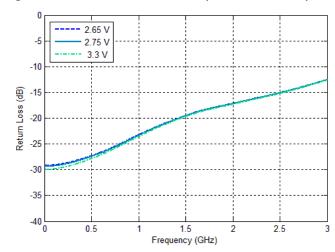


Figure 9. Return Loss vs V_{DD} (Common Port)



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Typical Performance Data @ +25°C and V_{DD} = 2.75V, unless otherwise specified

Figure 10. Isolation vs Temp (RFC-RFX)

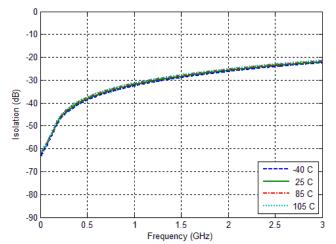
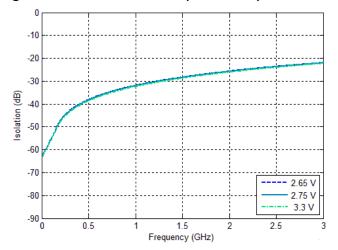


Figure 11. Isolation vs V_{DD} (RFC-RFX)



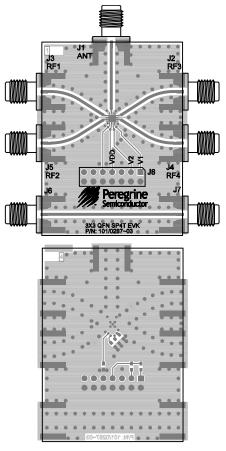


Evaluation Kit

The SP4T switch evaluation board was designed to ease customer evaluation of Peregrine's 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 metal layer 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 ground plane model using a trace width of 32 mils, trace gaps of 25 mils, and metal thickness of 2.1 mils.

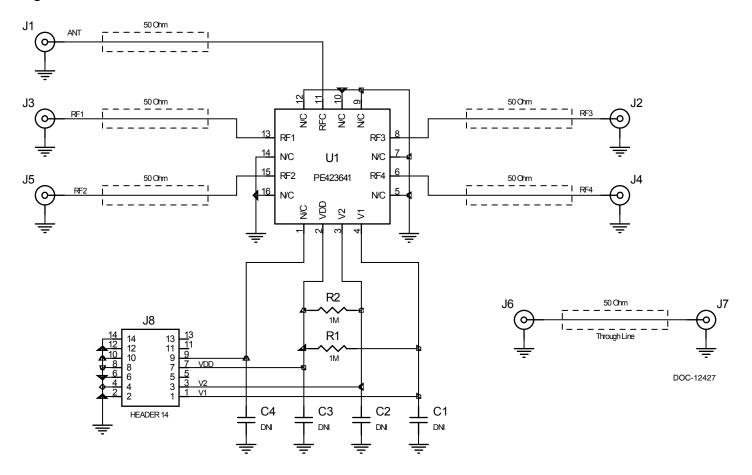
Figure 12. Evaluation Board Layouts



PRT-50900



Figure 13. Evaluation Board Schematic



Caution: Contains parts and assemblies susceptible to damage by electrostatic discharge (ESD).



Figure 14. Package Drawing 16-lead 3x3 mm QFN

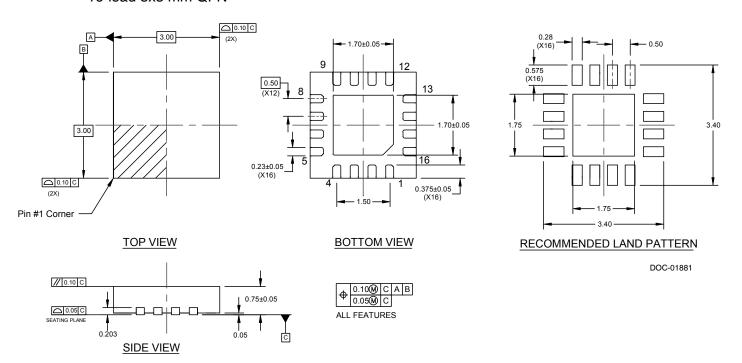


Figure 15. Top Marking Specification



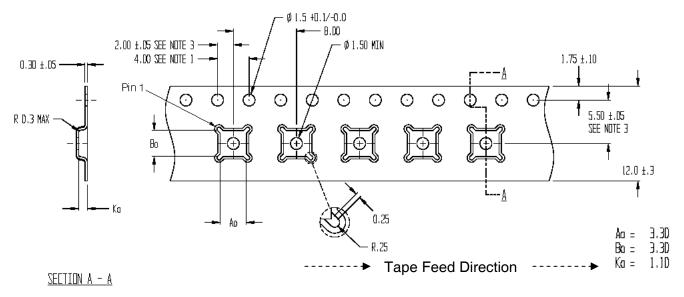
● = Pin 1 designator

YYWW = Date code, last two digits of the year and work week

ZZZZZZ = Last six characters of the assembly lot code

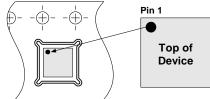


Figure 16. Tape and Reel Specifications



NOTES:

- 1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
- 2. CAMBER IN COMPLIANCE WITH EIA 481
- 3. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE



Device Orientation in Tape

Table 6. Ordering Information

| Order Code | Description | Package | Shipping Method | |
|----------------|-------------------------|----------------------------|------------------|--|
| PE423641MLAA-Z | PE423641 SP4T RF switch | Green 16-lead 3 x 3 mm QFN | 3000 units / T&R | |
| EK423641-01 | PE423641 Evaluation kit | Evaluation kit | 1 / Box | |

Sales Contact and Information

For sales and contact information please visit www.psemi.com.

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