## Document Category: Product Specification

High Isolation UltraCMOS® SP4T RF Switch, $10 \mathrm{MHz}-8.5 \mathrm{GHz}$

## Features

- Operating frequency: Up to 8.5 GHz
- High isolation: 62 dB @ 4 GHz
- Low insertion loss: 0.7 dB @ 4 GHz
- High linearity: 65 dBm IIP3 @ 3.8 GHz
- Fast switching time: 200 nsec
- $-40^{\circ} \mathrm{C}$ to $+125^{\circ} \mathrm{C}$ operating temperature
- Packaging - 20-lead $3 \times 3$ mm LGA


## Applications

- DPD feedback loop and VSWR monitoring
- 5G massive MIMO active antenna systems
- Analog/hybrid beamforming RF front ends
- 4G/4.5G TD-LTE macro/micro cell/RRH
- Test and measurement

Figure 1 • PE42445 Functional Diagram


## Product Description

The PE42445 is a HaRP ${ }^{\text {TM }}$ technology-enhanced SP4T RF switch designed for use in 4G/5G wireless infrastructure and other high performance RF applications. It is comprised of four symmetric RF ports with very high isolation up to 8.5 GHz . The PE42445 is manufactured on pSemi's UltraCMOS® process, a patented variation of silicon-on-insulator (SOI) technology. pSemi's HaRP technology enhancements deliver high isolation, 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.

## Revision History

## Table 1 • Revision History

| Document <br> Revision | Date |  |
| :--- | :--- | :--- |
| DOC-108552-5 | November 2023 | Upper frequency range |
| DOC-108552-6 | December 2023 | Features section <br> Table 2, Absolute Maximum Ratings <br> Table 3, Recommended Operating Conditions <br> Table 4, Electrical Specifications. <br> Figure 3, Package Mechanical Drawing |
| DOC-108552-7 | February 2024 | Figures 2 through 17, Typical Performance Data <br> Table 3, Recommended Operating Conditions |
| Table 4, Electrical Specifications |  |  |
| Table note in Tables 5 and 6 |  |  |
| Figure 21, Tape and Reel Specifications |  |  |

## Absolute Maximum Ratings

Exceeding absolute maximum ratings listed in Table 2 may cause permanent damage. Operation should be restricted to the limits in Table 4. Operation between operating range maximum and absolute maximum for extended periods may 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, precautions should be taken to avoid exceeding the rating specified in Table 2.

## Latch-up Immunity

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

## Table 2 - Absolute Maximum Ratings for PE42445

| Description | Min | Typ | Max | Unit |
| :---: | :---: | :---: | :---: | :---: |
| Power supply voltage | 2.3 |  | 5.5 | V |
| Digital input voltage (V1, V2, V3) | -0.3 |  | 3.6 | V |
| Storage temperature range | -60 |  | 150 | ${ }^{\circ} \mathrm{C}$ |
| Maximum junction temperature range |  |  | 150 | ${ }^{\circ} \mathrm{C}$ |
| RF input RMS power, RFX to RFC, hot switching, LTE PAR 9 dB , Freq $=3.8 \mathrm{GHz} @ 105^{\circ} \mathrm{C}$ |  |  | 29 | dBm |
| RF input RMS power, RFX to RFC, hot switching, LTE PAR 9 dB , Freq $=3.8 \mathrm{GHz} @ 125^{\circ} \mathrm{C}$ |  |  | 26 | dBm |
| RF input RMS power terminated port, hot switching, LTE PAR 9 dB , Freq $=3.8 \mathrm{GHz} @ 105$ ${ }^{\circ} \mathrm{C}$ |  |  | 29 | dBm |
| RF input RMS power terminated port, hot switching, LTE PAR 9 dB , Freq $=3.8 \mathrm{GHz} @ 125$ ${ }^{\circ} \mathrm{C}$ |  |  | 26 | dBm |
| ESD voltage HBM1, all pins ${ }^{(1)}$ |  |  | 2000 | V |
| ESD voltage CDM2, all pins ${ }^{(2)}$ |  |  | 1000 | V |
| Notes: <br> 1) Human body model (MIL-STD 883 Method 3015). <br> 2) Charged device model (JEDEC JESD22-C101). |  |  |  |  |

## Recommended Operating Conditions

Table 3 lists the recommended operating conditions for the PE42445. Devices should not be operated outside the operating conditions listed below.

Table 3 - Recommended Operating Conditions for PE42445

| Parameter | Min | Tур | Max | Unit |
| :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\mathrm{DD}}$ supply voltage | 2.3 | 3.3 | 5.5 | V |
| Power supply current $\mathrm{V}_{\mathrm{DD}}=3.3 \mathrm{~V}$ |  | 93 | 250 | $\mu \mathrm{A}$ |
| Control voltage high | 1.07 |  | 3.6 | V |
| Control voltage low | -0.3 |  | 0.68 | V |
| Digital input current |  | 2 |  | $\mu \mathrm{A}$ |
| Operating temperature range | -40 |  | 125 | ${ }^{\circ} \mathrm{C}$ |
| Frequency range | 10 |  | 8500 | MHz |
| RF input power, $\mathrm{CW}\left(\mathrm{P}_{\mathrm{MAX}, \mathrm{CW}}+105^{\circ} \mathrm{C}\right)$ |  |  | 34 | dBm |
| RF input power, $\mathrm{CW}\left(\mathrm{P}_{\text {MAX, }} \mathrm{CW}+125^{\circ} \mathrm{C}\right)$ |  |  | 32 | dBm |
| RF input power into terminated ports, $\mathrm{CW}\left(\mathrm{P}_{\text {MAX }, \mathrm{CW}}+105^{\circ} \mathrm{C}\right)$ |  |  | 25 | dBm |
| RF input power into terminated ports, $\mathrm{CW}\left(\mathrm{P}_{\text {MAX,CW }}+125^{\circ} \mathrm{C}\right)$ |  |  | 21 | dBm |

## Electrical Specifications

Table 4 provides the PE42445 key electrical specifications @ $+25^{\circ} \mathrm{C}(Z S=Z L=50 \Omega)$, unless otherwise specified.
Table 4 • PE42445 Electrical Specifications

| Parameter | Condition | Min | Typ | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Frequency Range |  | 10 |  | 8500 | MHz |
| Insertion Loss, RFX to RFC | 10 to 900 MHz |  | 0.57 | 0.62 | dB |
|  | 900 to 2100 MHz |  | 0.62 | 0.69 | dB |
|  | 2100 to 2700 MHz |  | 0.64 | 0.73 | dB |
|  | 2700 to 4000 MHz |  | 0.68 | 0.81 | dB |
|  | 4000 to 6000 MHz |  | 0.76 | 0.98 | dB |
|  | 6000 to 8000 MHz |  | 0.91 | 1.27 | dB |
|  | 8000 to 8500 MHz |  | 1.00 | 1.50 | dB |
| Isolation, RFX to RFC | 10 to 900 MHz |  | 72 |  | dB |
|  | 900 to 2100 MHz |  | 69 |  | dB |
|  | 2100 to 2700 MHz |  | 67 |  | dB |
|  | 2700 to 4000 MHz |  | 65 |  | dB |
|  | 4000 to 6000 MHz |  | 56 |  | dB |
|  | 6000 to 8000 MHz |  | 48 |  | dB |
|  | 8000 to 8500 MHz |  | 46 |  | dB |
| Isolation, RFX to RFX | 10 to 900 MHz |  | 59 |  | dB |
|  | 900 to 2100 MHz |  | 52 |  | dB |
|  | 2100 to 2700 MHz |  | 50 |  | dB |
|  | 2700 to 4000 MHz |  | 47 |  | dB |
|  | 4000 to 6000 MHz |  | 43 |  | dB |
|  | 6000 to 8000 MHz |  | 39 |  | dB |
|  | 8000 to 8500 MHz |  | 37 |  | dB |
| Return Loss, RF1/2/3/4 On State | 10 to 900 MHz |  | 27 |  | dB |
|  | 900 to 2100 MHz |  | 24 |  | dB |
|  | 2100 to 2700 MHz |  | 24 |  | dB |
|  | 2700 to 4000 MHz |  | 23 |  | dB |
|  | 4000 to 6000 MHz |  | 20 |  | dB |
|  | 6000 to 8000 MHz |  | 15 |  | dB |
|  | 8000 to 8500 MHz |  | 13 |  | dB |

Table 4 - PE42445 Electrical Specifications (Cont.)

| Parameter | Condition | Min | Typ | Max | Unit |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Return Loss, RF1/2/3/4 Off State | 10 to 900 MHz |  | 33 |  | dB |
|  | 900 to 2100 MHz |  | 25 |  | dB |
|  | 2100 to 2700 MHz |  | 23 |  | dB |
|  | 2700 to 4000 MHz |  | 22 |  | dB |
|  | 4000 to 6000 MHz |  | 20 |  | dB |
|  | 6000 to 8000 MHz |  | 17 |  | dB |
|  | 8000 to 8500 MHz |  | 17 |  | dB |
| Input 0.1dB Compression | 3800 MHz |  | 37 |  | dBm |
| Input IP3, RFX to RFC | 3800 MHz |  | 65.5 |  | dBm |
| Input IP2, RFX to RFC | 3800 MHz |  | 110 |  | dBm |
| Switching time | $50 \%$ CTRL to $90 \%$ or $10 \%$ RF |  | 200 |  | ns |

## SP4T Control Logic

Table 5 provides the control logic truth table for the PE42445.
Table 5 - Truth Table for PE42445

| ON Port | V3 | V2 | V1 |
| :---: | :---: | :---: | :---: |
| RF4 on $^{*}$ ) | 0 | 0 | 0 |
| RF1 on | 0 | 0 | 1 |
| RF2 on | 0 | 1 | 0 |
| RF3 on | 0 | 1 | 1 |
| RF4 on | 1 | 0 | 0 |
| All off | 1 | 0 | 1 |
| All off | 1 | 1 | 0 |
| All off | 1 | 1 | 1 |

Note: * Pin 17 (V3) must be grounded for 2-pin control. 2-pin control can be used if All off mode is not required.

## Truth Table of 2-pin Control Only

Table 6 provides the truth table for 2-pin control of the PE42445.
Table 6 • 2-pin Control Truth Table for PE42445

| Mode | V2 | V1 |
| :---: | :---: | :---: |
| RF4 on $\left.{ }^{*}{ }^{*}\right)$ | 0 | 0 |
| RF1 on | 0 | 1 |
| RF2 on | 1 | 0 |
| RF3 on | 1 | 1 |

Note: * Pin 17 (V3) must be grounded for 2-pin control. 2pin control can be used if All off mode is not required.

## Typical Performance Data

[Figure 2-Figure 17 show the typical performance data at $+25^{\circ} \mathrm{C}$ TCASE, VDD $=5 \mathrm{~V}(\mathrm{ZS}=\mathrm{ZL}=50 \Omega)$, unless otherwise specified.

Figure 2 • Insertion Loss vs. Switch Path


Figure 4 • Insertion Loss vs. Voltage


Figure 6 - Isolation (RFC-RFX) vs. Temperature


Figure 3 - Insertion Loss vs. Temperature


Figure 5 • Isolation (RFC-RFX) vs. Switch Path


Figure 7 - Isolation (RFC-RFX) vs. Voltage


Figure 8 - Isolation (RFX-RFX) vs. Temperature


Figure 10 • RFX Return Loss vs. Switch Path


Figure 12 • RFX Return Loss vs. Voltage


Figure 9 • Isolation (RFX-RFX) vs. Voltage


Figure 11 • RFX Return Loss vs. Temperature


Figure 13 • RFC Return Loss vs. Switch Path


Figure 14 • RFC Return Loss vs. Temperature


Figure 16 • RFX Terminated, Return Loss


Figure 15 : RFC Return Loss vs. Voltage


Figure 17 • RFX Terminated, Return Loss vs. Temperature


## Pin Information

This section provides pinout information for the PE42445. Figure 18 shows the pin map of this device for the available package. Table 7 provides a description for each pin.

Figure 18. Pin Configuration (Top View)


Table 7 • Pin Descriptions for PE42445

| Pin No. | Pin <br> Name |  |
| :---: | :---: | :--- |
| $1,2,3,5,6,8$, <br> $10,11,13$, <br> 18,20 | GND | Ground |
| 4 | RF4 | RF port 4 |
| 7 | RF3 | RF port 3 |
| 9 | RF2 | RF port 2 |
| 12 | RF1 | RF port 1 |
| 14 | VDD | Supply voltage |
| 15 | V1 | Digital control logic input 1 |
| 16 | V2 | Digital control logic input 2 |
| 17 | V3 | Digital control logic input 3 |
| 19 | RFC | RF common |
| 21 | GND | Backside GND pad |

## Packaging Information

This section provides packaging data including the moisture sensitivity level, package drawing, package marking and tape-and-reel information.

## Moisture Sensitivity Level

The moisture sensitivity level rating for the PE42445 in the 20 -lead $3 \times 3 \mathrm{~mm}$ LGA package is MSL 3 .

## Package Drawing

Figure 19 • Package Mechanical Drawing for 20-lead $3 \times 3$ mm LGA


## Top-Marking Specification

Figure 20 • Package Marking Specifications for PE42445


$$
\begin{aligned}
\bullet & =\text { Pin } 1 \text { indicator } \\
42445 & =\text { Product part number } \\
\mathrm{YY} & =\text { Last two digits of assembly year }(2022=22) \\
\mathrm{WW} & =\text { Work week of assembly lot start date }(01, \ldots, 52) \\
\text { ZZZZZZ } & =\text { Assembly lot code (max six characters) }
\end{aligned}
$$

## Tape and Reel Specification

Figure 21 - Tape and Reel Specifications for 20-lead $3 \times 3$ mm LGA


## Ordering Information

Table 8 lists the available ordering codes for the PE42445 as well as available shipping methods.

## Table 8 : Order Codes for PE42445

| Order Godes | Description | Packaging | Shipping Method |
| :--- | :---: | :---: | :---: |
| PE42445A-Z | PE42445 SP4T RF switch | Green 20-lead $3 \times 3 \mathrm{~mm} \mathrm{LGA}$ | 3000 units/T\&R |
| EK42445-01 | PE42445 Evaluation kit | Evaluation kit | $1 / \mathrm{box}$ |

## Document Categories

## Advance Information

The product is in a formative or design stage. The datasheet contains design target specifications for product development. Specifications and features may change in any manner without notice.

## Preliminary Specification

The datasheet contains preliminary data. Additional data may be added at a later date. pSemi reserves the right to change specifications at any time without notice in order to supply the best possible product.

## Product Specification

The datasheet contains final data. In the event pSemi decides to change the specifications, pSemi will notify customers of the intended changes by issuing a CNF (Customer Notification Form).

## Product Brief

This document contains a shortened version of the datasheet. For the full datasheet, contact sales@psemi.com.

## Sales Contact

For additional information, contact Sales at sales@psemi.com.

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