

# TE0725LP TRM

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## Overview

The Trenz Electronic TE0725LP is a low cost small-sized FPGA module integrating a Xilinx Artix-7 and 32 MByte Flash memory for configuration and operation.

## Key Features

- Xilinx Artix-7 XC7A100T FPGA

- 32 MByte QSPI Flash memory
- 2 x 50-pin headers with 2,54mm pitch, ideal for breadboard use
- 92 x GPIOs (42 + 42 + 8)
- 25.000000 MHz system clock
- 128 KBit (16 KByte) I<sup>2</sup>C EEPROM
- 3.3V single power supply with on-board voltage regulators
- JTAG/UART connector
- 1 user LED
- Optional HyperRAM (8 to 32 MByte)
- Commercial temperature grade (Industrial on Request)
- Size 73 x 35 mm

## Block Diagram

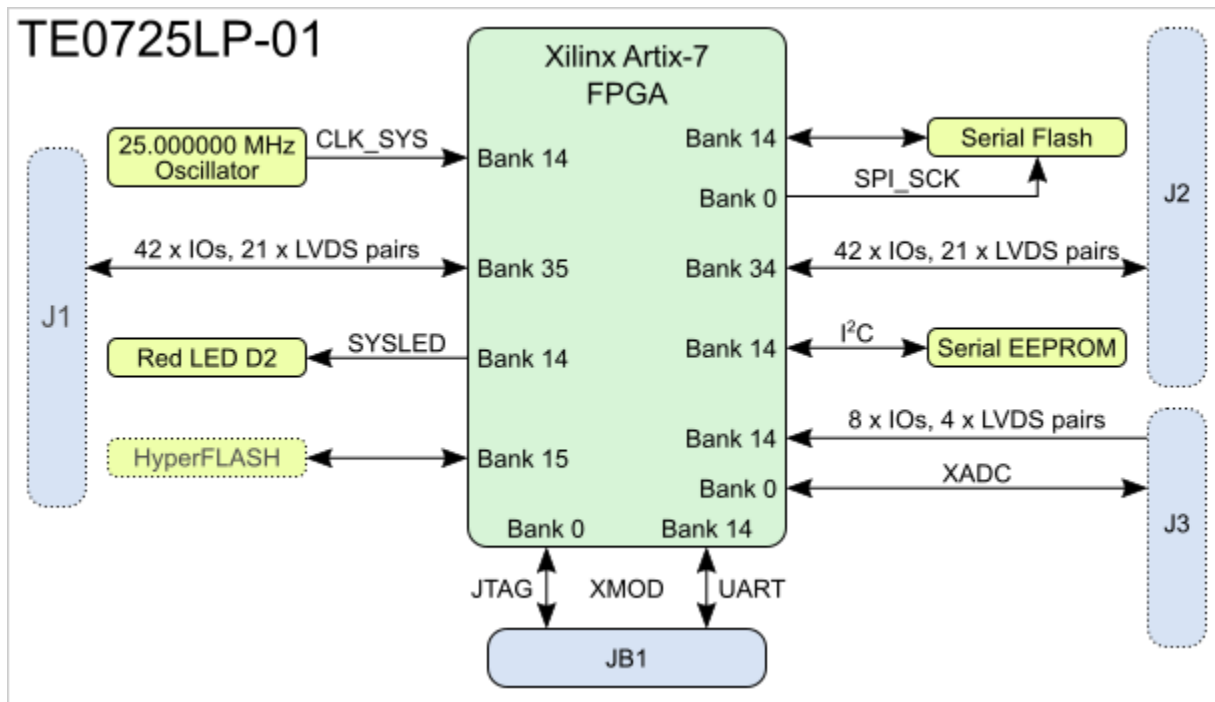
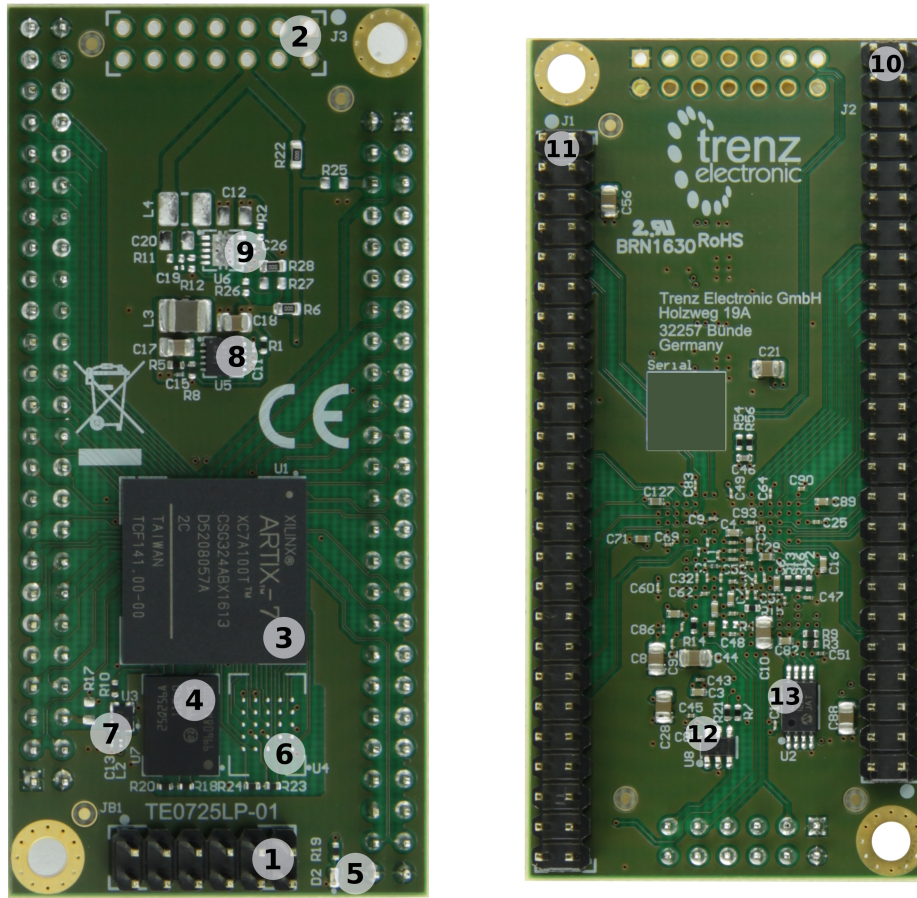


Figure 1: TE0725LP-01 Block Diagram.

## Main Components



**Figure 2:** TE0725LP-01 FPGA module (Variant TE0725LP-01-100-2D depicted).

1. XMOD header, JB1
2. 14-pin header placeholder for connector, J3
3. Xilinx Artix-7 FPGA, U1
4. 1.8V, 256 MBit (32 MByte) quad SPI serial flash memory, U7
5. Red LED (SYSLED), D2
6. Cypress S26KS512S 512 MBit (64 MByte) 1.8V HyperFlash™ memory, U4 (optional)
7. Low-power programmable oscillator @25.000000 MHz, U3
8. Low VIN high-efficiency step-down converter (1.5A max.), U5
9. Low VIN high-efficiency step-down converter (1.5A max.), U6 (optional)
10. 50-pin header placeholder for breadboard connector, J2
11. 50-pin header placeholder for breadboard connector, J1
12. Ultra-low supply-current voltage monitor with optional watchdog, U8
13. 128KBit I<sup>2</sup>C CMOS serial EEPROM, U2

## Initial Delivery State

| On-board Programmable Device | Content | Notes |
|------------------------------|---------|-------|
|------------------------------|---------|-------|

|                              |       |   |
|------------------------------|-------|---|
| Quad SPI Flash (U7) OTP area | Empty | - |
| I <sup>2</sup> C EEPROM, U2  | Empty | - |
| HyperFlash™ memory, U4       | Empty | - |

**Table 1:** Module initial delivery state of programmable on-board devices.

## Boot Process

By default the configuration mode pins of the FPGA are set to Master SPI mode, hence the FPGA is configured from serial QSPI flash memory at system start-up. The JTAG interface of the module is provided for storing the initial FPGA configuration data to the QSPI flash memory.

## Signals, Interfaces and Pins

### I/Os on Pin Headers

I/O signals of the FPGA SoC's I/O banks connected to the board's pin headers:

| Bank | Type | Pin Header | I/O Signal Count       | Bank Voltage |
|------|------|------------|------------------------|--------------|
| 14   | HR   | J3         | 8 I/O's, 4 LVDS pairs  | 1.8V         |
| 34   | HR   | J2         | 42 I/Os, 21 LVDS pairs | VCCIO34      |
| 35   | HR   | J1         | 42 I/Os, 21 LVDS pairs | VCCIO35      |

**Table 2:** General overview of single ended and LVDS I/O signals connected to pin headers

### PL I/O-Banks

| Bank | VCCIO       | Used I/O's | Available On Connectors | Notes   |
|------|-------------|------------|-------------------------|---|
| 0    | 1.8V        | 7          | 4                       | 4 I/O's used for JTAG interface, 3 control signals (DONE, PROG_B, INIT).  |
| 14   | 1.8V        | 22         | 11                      | 8 I/O's (4 LVDS pairs) connected to J3, 3 I/O's to XMOD header JB1 (2 UART I/O's, 1 user I/O), 1 I/O to LED D2. |
| 15   | 1.8V        | 18         | -                       | Used for optional HyperFlash™ U4.   |
| 34   | User select | 42         | 42                      | 0-Ohm resistor R17 option to select 1.8V I/O-bank VCCIO.  |
| 35   | User select | 42         | 42                      | 0-Ohm resistor R25 option to select 1.8V I/O-bank VCCIO.  |

**Table 3:** General overview of PL I/O-bank signals.

### JTAG Interface

JTAG access to the Xilinx Artix-7 device is provided through XMOD header JB1.

Header JB1 (2 x 6 pin) is compatible with XMOD-JTAG adapter TE0790. This adapter can be inserted from top onto the TE0725LP, if JB1 is fitted with male pin header. Optionally JB1 can be fitted with pin header from bottom, in that case the JTAG connector must be on the base board.

### XMOD FTDI JTAG-Adapter Header JB1



The JTAG interface of the FPGA can be accessed via XMOD header JB1, so in use with the XMOD-FT2232H adapter-board TE0790 the FPGA can be configured via USB2.0 interface. The TE0790 board provides also an UART interface to the FPGA device which can be accessed by the USB2.0 interface of the adapter-board while the signals between these serial interfaces will be converted.

Following table describes the signals and interfaces of the XMOD header JB1:

| Pin Schematic Name | XMOD Header JB1 Pin | Note   |
|--------------------|---------------------|--|
| F_TCK              | C (pin J3-4)        | -  |
| F_TDO              | D (pin J3-8)        | -  |
| F_TDI              | F (pin J3-10)       | -  |
| F_TMS              | H (pin J3-12)       | -  |
| UART_RXD           | A (pin J3-3)        | UART receive line, connected to PL I/O-bank 14.                      |
| UART_TXD           | B (pin J3-7)        | UART transmit line, connected to PL I/O-bank 14.                     |
| XMOD_E             | E (pin J3-9)        | User configurable, connected to PL I/O-bank 14, pin M17.             |
| NRST               | G (pin J3-11)       | Assigned to 'PROG_B' (configuration-reset signal of FPGA) via IC U8. |

Table 4: XMOD header JX1 signals and connections.

When using XMOD FTDI JTAG Adapter TE0790, the adapter-board's VCCIO will be sourced by the FPGA module's supply voltage (1.8V). The adapter board's VCC has to be sourced by the USB Host interface.

For this configuration, set the XMOD DIP-switch as follows in table below:

| XMOD DIP-switches | Position |
|-------------------|----------|
| Switch 1          | ON       |
| Switch 2          | OFF      |
| Switch 3          | OFF      |
| Switch 4          | ON       |

Table 5: XMOD adapter board DIP-switch positions for voltage configuration.



Use Xilinx compatible TE0790 adapter board (designation TE-0790-xx with out 'L') to program the Xilinx Zynq devices.

The TE0790 adapter board's CPLD have to be configured with the **Standard** variant of the firmware. Refer to the [TE0790 Resources Site](#) for further information and firmware download.

## UART Interface

UART interface is available on B2B connector JM2. With the TE0790 XMOD USB2.0 adapter, the UART signals can be converted to USB2.0 interface signals:

| UART Signal Schematic Name | B2B    | XMOD Header JX1 | Pin Header J3 | Note                    |
|----------------------------|--------|-----------------|---------------|-------------------------|
| B14_L0                     | JM2-99 | JX1-7           | J3-7          | UART-TX (transmit line) |
| B14_L25                    | JM2-97 | JX1-3           | J3-3          | UART-RX (receive line)  |

Table 6: UART interface signals.

## QSPI Interface

The QSPI interface of the FPGA device is routed to and used by the on-module QSPI flash IC U7:

| SD IO Signal Schematic Name | FPGA I/O         | Flash Memory (U7) Pin | Note             |
|-----------------------------|------------------|-----------------------|------------------|
| SPI-DQ0                     | Bank 14, pin K17 | D3                    | QSPI data        |
| SPI-DQ1                     | Bank 14, pin K18 | D2                    | QSPI data        |
| SPI-DQ2                     | Bank 14, pin L14 | C4                    | QSPI data        |
| SPI-DQ3                     | Bank 14, pin M14 | D4                    | QSPI data        |
| SPI_SCK                     | Bank 0, pin E9   | B2                    | QSPI clock       |
| SPI-CS                      | Bank 14, pin L13 | C2                    | QSPI chip select |

Table 7: QSPI interface signals.

## I2C Interface

The I<sup>2</sup>C interface of the FPGA device is routed to and used by the on-module EEPROM IC U2:

| I <sup>2</sup> C Signal Schematic Name | FPGA I/O         | EEPROM (U2) Pin | Notes   |
|--|------------------|-----------------|---|
| I2C_SDA                                | Bank 14, pin U18 | 5               | I <sup>2</sup> C data line, 1.8V reference voltage  |
| I2C_SCL                                | Bank 14, pin U17 | 6               | I <sup>2</sup> C clock line, 1.8V reference voltage |
| I2C_WP                                 | Bank 14, pin T18 | 7               | Write-protect signal of EEPROM                      |

Table 8: I<sup>2</sup>C interface signals.

## Differential Analog Input

The TE0725LP FPGA module provides access to the XADC (Analog-to-Digital Converter) unit of the Xilinx FPGA via connector J3:

| I <sup>2</sup> C Signal Schematic Name | FPGA I/O               | Connector J3 Pin | Notes |
|--|------------------------|------------------|-------|
| XADC_P                                 | Bank 0, pin J10 (VP_0) | J3-14            | -     |
| XADC_N                                 | Bank 0, pin K9 (VN_0)  | J3-13            | -     |

Table 9: XADC interface signals.

## On-board Peripherals

### Quad SPI Flash Memory

On-module QSPI flash memory (U7) is provided by Micron Serial NOR Flash Memory N25Q256A with 256 MBit (32 MByte) storage capacity. This non volatile memory is used to store initial FPGA configuration. Besides FPGA configuration, remaining free flash memory can be used for user application and data storage. All four SPI data lines are connected to the FPGA allowing x1, x2 or x4 data bus widths. Maximum data rate depends on the selected bus width and clock frequency used.

### HyperFlash™ Memory

On the TE0725LP FPGA module is optionally available a Cypress S26KS512S 512 MBit (64 MByte) 1.8V HyperFlash™ memory IC (U4). This flash memory IC is connected to the FPGA bank 15 via the Cypress specific HyperBus interface, which offers read bandwidth up to 333MByte/s.

## EEPROM

A Microchip 24AA128 128 KBit (16 KByte) CMOS Serial EEPROM (U2). The device is organized as eight blocks of 16 KBit memory with a 2-wire serial interface connected on FPGA bank 14. The memory as is available for application use. It is accessible over I<sup>2</sup>C bus with slave device address 0x50.

## System Clock Oscillator

A low-power SiTime programmable oscillator (U3) @25.000000 MHz configured on-module is connected to PL I/O-bank 14 and provides the system reference clock signal.

## On-board LEDs

There is one red LED connected to the FPGA bank 14, pin M16. This LED is user configurable to indicate for example any system status.

| LED | Color | Signal Schematic Name | FPGA    | Notes |
|-----|-------|-----------------------|---------|-------|
| D2  | Red   | 'SYSLED'              | Pin M16 | -     |

**Table 10:** LEDs of the module.

## Connectors

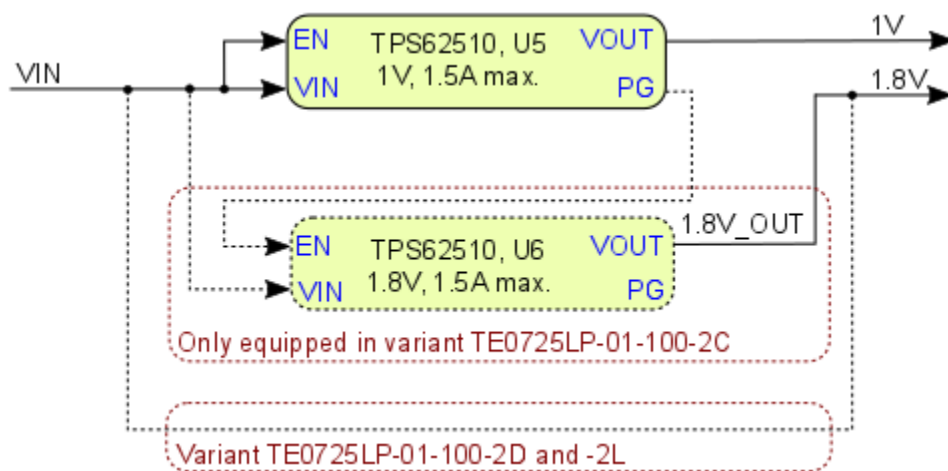
All connectors are are for 100mil headers, all connector locations are in 100mil (2.54mm) grid. The module's PCB provides footprints to mount and solder optional (B2B connector) headers, if those are not factory-fitted on module.

## Power and Power-On Sequence

To power-up a module, power supply with minimum current capability of 1A is recommended.

## Power Supply

TE0725LP needs one single power supply with nominal of 3.3V at the variant TE0725-01-100-2C or 1.8V at the variants TE0725LP-01-100-2D and TE0725LP-01-100-2L. Following diagram shows the dependencies of the power supply:



**Figure 3:** Module power supply dependencies

## Power Consumption

| FPGA              | Design         | Typical Power, 25C ambient |
|-------------------|----------------|----------------------------|
| XC7A100T-2CSG324C | Not configured | TBD*                       |

**Table 11:** Module power consumption

\*TBD - To Be Determined.

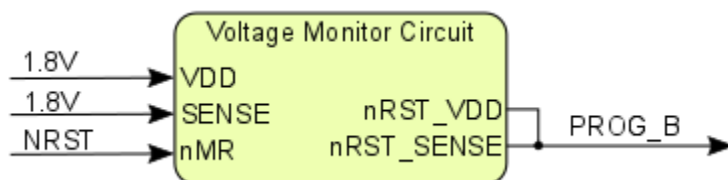
Actual power consumption depends on the FPGA design and ambient temperature.

## Power-On Sequence

There is no specific or special power-on sequence, single power source is needed as VIN.

## Voltage Monitor Circuit

The 1.8V voltage level is monitored by the voltage monitor circuit U8, which generates the PROG\_B signal to begin a new configuration sequence after reset of the FPGA. A manual reset is also possible by driving the connector pin JB1-11 ('NRST') to GND. Hence, by this pin a mounted XMOD adapter board can perform a reset on the FPGA module.



**Figure 4:** Voltage monitor circuit

## Power Rails

| Power Rail Name | J1 Pins | J2 Pins | J3 Pins | JB1 Pin | Direction | Notes                |
|-----------------|---------|---------|---------|---------|-----------|----------------------|
| VIN             | 5       | 5       | 5       | -       | Input     | Power supply voltage |
| 1.8V            | -       | -       | -       | 6       | Output    | JTAG VCCIO           |
| 1.8V_OUT        | -       | -       | -       | 6       | Output    | -                    |
| VCCIO34         | -       | 6, 45   | -       | -       | Input     | Bank voltage         |
| VCCIO35         | 6, 45   | -       | -       | -       | Input     | Bank voltage         |

**Table 13:** Board power rails

## Bank Voltages

| Bank       | Bank I/O Voltage VCCO | Voltage Range |
|------------|-----------------------|---------------|
| 0 (config) | 1.8V                  | fixed         |
| 14 (HR)    | 1.8V                  | fixed         |
| 15 (HR)    | 1.8V                  | fixed         |
| 34 (HR)    | VCCIO34               | 1.2V ... 3.3V |
| 35 (HR)    | VCCIO35               | 1.2V ... 3.3V |

**Table 14:** Board bank voltages

## Variants Currently In Production

|  |                             |
|--|-----------------------------|
| <b>Trenz shop TE0725LP overview page</b> |                             |
| <a href="#">English page</a>             | <a href="#">German page</a> |

**Table 12:** Module variants production

## Technical Specifications

### Absolute Maximum Ratings

| Parameter   | Min  | Max         | Units | Reference document   |
|---|------|-------------|-------|--|
| VIN supply voltage (Variant TE0725LP-01-100-2C)         | -0.3 | 4           | V     | TI TPS62510 data sheet   |
| VIN supply voltage (Variant TE0725LP-01-100-2D and -2L) | -0.3 | 2           | V     | Xilinx datasheet <a href="#">DS181</a> / TI TPS62510 datasheet |
| HR I/O banks supply voltage (VCCO)                      | -0.5 | 3.6         | V     | Xilinx datasheet <a href="#">DS181</a>                         |
| HR I/O banks input voltage (VCCIO single ended)         | -0.4 | VCCO + 0.55 | V     | Xilinx datasheet <a href="#">DS181</a>                         |
| Storage Temperature                                     | -40  | +100        | °C    | LED SML-P11x series datasheet                                  |

**Table 13:** Absolute maximum ratings

### Recommended Operating Conditions

| Parameter   | Min   | Max         | Units | Reference document   |
|---|-------|-------------|-------|--|
| VIN supply voltage (Variant TE0725LP-01-100-2C)         | 1.8   | 3.8         | V     | TI TPS62510 data sheet   |
| VIN supply voltage (Variant TE0725LP-01-100-2D and -2L) | 1.8   | 1.89        | V     | Xilinx datasheet <a href="#">DS181</a> / TI TPS62510 datasheet |
| HR I/O banks supply voltage (VCCO)                      | 1.14  | 3.465       | V     | Xilinx datasheet <a href="#">DS181</a>                         |
| HR I/O banks input voltage (VCCIO single ended)         | -0.20 | VCCO + 0.20 | V     | Xilinx datasheet <a href="#">DS181</a>                         |
| Operating Temperature                                   | 0     | +85         | °C    | Xilinx datasheet <a href="#">DS181</a>                         |

**Table 14:** Recommended operating conditions



Please check Xilinx datasheet [DS181](#) for complete list of absolute maximum and recommended operating ratings for the Artix-7 device.

## Physical Dimensions

Please note that two different units are used on the figures below, SI system millimeters (mm) and imperial system thousandths of an inch(mil). This is because of the 100mil pin headers used, see also explanation below. To convert mils to millimeters and vice versa use formula 100mil's = 2,54mm.

- Board size: PCB 72.9mm × 34.8mm
- PCB thickness: ca. 1.65mm
- Highest part on the PCB are the pin headers (2.54mm pitch). Please download the step model for exact numbers.

The dimensions are given in mm and mil (milli inch).





| Date | Revision | Notes                    | PCN | Documentation Link          |
|------|----------|--------------------------|-----|-----------------------------|
| -    | 01       | First production release | -   | <a href="#">TE0725LP-01</a> |

**Table 15:** Module hardware revision history


Hardware revision number is printed on the PCB board together with the module model number separated by the dash.



**Figure 6:** Module hardware revision number

Document Change History

| Date | Revision | Contributors | Description |
|------|----------|--------------|-------------|
|------|----------|--------------|-------------|

|  |  |  |   |
|--|--|--|---|
| <p><b>Error rendering macro 'page-info'</b></p> <p>Ambiguous method overloading for method jdk.proxy244.\$Proxy3589#hasContentLevelPermission. Cannot resolve which method to invoke for [null, class java.lang.String, class com.atlassian.confluence.pages.Page] due to overlapping prototypes between: [interface com.atlassian.confluence.user.ConfluenceUser, class java.lang.String, class com.atlassian.confluence.core.ContentEntityObject] [interface com.atlassian.user.User, class java.lang.String, class com.atlassian.confluence.core.ContentEntityObject]</p> | <p><b>Error rendering macro 'page-info'</b></p> <p>Ambiguous method overloading for method jdk.proxy244.\$Proxy3589#hasContentLevelPermission. Cannot resolve which method to invoke for [null, class java.lang.String, class com.atlassian.confluence.pages.Page] due to overlapping prototypes between: [interface com.atlassian.confluence.user.ConfluenceUser, class java.lang.String, class com.atlassian.confluence.core.ContentEntityObject] [interface com.atlassian.user.User, class java.lang.String, class com.atlassian.confluence.core.ContentEntityObject]</p> <p> <b>Unknown macro: 'metadata'</b></p> | <p><b>Error rendering macro 'page-info'</b></p> <p>Ambiguous method overloading for method jdk.proxy244.\$Proxy3589#hasContentLevelPermission. Cannot resolve which method to invoke for [null, class java.lang.String, class com.atlassian.confluence.pages.Page] due to overlapping prototypes between: [interface com.atlassian.confluence.user.ConfluenceUser, class java.lang.String, class com.atlassian.confluence.core.ContentEntityObject] [interface com.atlassian.user.User, class java.lang.String, class com.atlassian.confluence.core.ContentEntityObject]</p> | <ul style="list-style-type: none"> <li>• typo correction</li> </ul>   |
| 29 Jun 2018  | v.45   | Ali Naseri, Jan Kumann   | <ul style="list-style-type: none"> <li>• First TRM release</li> </ul> |

**Table 16:** Document change history

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Please also note our data protection declaration at <https://www.trenz-electronic.de/en/Data-protection-Privacy>

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Ambiguous method overloading for method `jdk.proxy244.$Proxy3589#hasContentLevelPermission`. Cannot resolve which method to invoke for `[null, class java.lang.String, class com.atlassian.confluence.pages.Page]` due to overlapping prototypes between: `[interface com.atlassian.confluence.user.ConfluenceUser, class java.lang.String, class com.atlassian.confluence.core.ContentEntityObject]` `[interface com.atlassian.user.User, class java.lang.String, class com.atlassian.confluence.core.ContentEntityObject]`