



TEM0007 TRM

Revision v.47

Exported on 2024-08-06

Online version of this document:

<https://wiki.trenz-electronic.de/display/PD/TEM0007+TRM>

1 Table of Contents

| | | |
|------|---|----|
| 1 | Table of Contents..... | 2 |
| 2 | Table of Figures..... | 3 |
| 3 | Table of Tables..... | 4 |
| 4 | Overview..... | 5 |
| 4.1 | Key Features..... | 5 |
| 4.2 | Block Diagram..... | 6 |
| 4.3 | Main Components..... | 6 |
| 4.4 | Initial Delivery State..... | 7 |
| 5 | Signals, Interfaces and Pins..... | 8 |
| 5.1 | Connectors..... | 8 |
| 5.2 | Test Points..... | 9 |
| 6 | On-board Peripherals..... | 11 |
| 7 | Configuration and System Control Signals..... | 12 |
| 8 | Power and Power-On Sequence..... | 13 |
| 8.1 | Power Rails..... | 13 |
| 8.2 | Recommended Power up Sequencing..... | 14 |
| 9 | Board to Board Connectors..... | 15 |
| 9.1 | Connector Mating height..... | 15 |
| 9.2 | Connector Speed Ratings..... | 16 |
| 9.3 | Current Rating..... | 16 |
| 9.4 | Connector Mechanical Ratings..... | 16 |
| 10 | Technical Specifications..... | 17 |
| 10.1 | Absolute Maximum Ratings *)..... | 17 |
| 10.2 | Recommended Operating Conditions..... | 17 |
| 10.3 | Physical Dimensions..... | 18 |
| 11 | Currently Offered Variants..... | 19 |
| 12 | Revision History..... | 20 |
| 12.1 | Hardware Revision History..... | 20 |
| 12.2 | Document Change History..... | 20 |
| 13 | Disclaimer..... | 21 |
| 13.1 | Data Privacy..... | 21 |
| 13.2 | Document Warranty..... | 21 |
| 13.3 | Limitation of Liability..... | 21 |
| 13.4 | Copyright Notice..... | 21 |
| 13.5 | Technology Licenses..... | 21 |
| 13.6 | Environmental Protection..... | 21 |
| 13.7 | REACH, RoHS and WEEE..... | 22 |

2 Table of Figures

| | |
|--|----|
| Figure 1: TEM0007 block diagram | 6 |
| Figure 2: TEM0007 main components | 6 |
| Figure 3: Physical Dimension | 18 |
| Figure 4: Board hardware revision number | 20 |

3 Table of Tables

| | |
|--|----|
| Table 1: Initial delivery state of programmable devices on the module..... | 7 |
| Table 2: Board Connectors | 8 |
| Table 3: Test Points Information | 9 |
| Table 4: On board peripherals..... | 11 |
| Table 5: Controller signal..... | 12 |
| Table 6: Module power rails..... | 13 |
| Table 7: Baseboard Design Hints..... | 14 |
| Table 8: Connectors. | 15 |
| Table 9: Speed rating. | 16 |
| Table 10: Absolute maximum ratings | 17 |
| Table 11: Recommended operating conditions. | 17 |
| Table 12: Trenz Electronic Shop Overview | 19 |
| Table 13: Hardware Revision History | 20 |
| Table 14: Document change history. | 20 |

4 Overview

Trenz Electronic TEM0007 module is an industrial-grade FPGA micromodule integrating a Microsemi Polarfire SoC FPGA, Gigabit Ethernet PHY, USB 2.0 PHY, LPDDR4 SDRAM, SPI Flash memory for configuration and operation, and power supply. A large number of configurable I/Os is provided via robust board-to-board (B2B) connectors.

Refer to <http://trenz.org/tem0007-info> for the current online version of this manual and other available documentation.

4.1 Key Features

- **SoC/FPGA**
 - Device: MPFS250T / MPFS160T / MPFS095T / MPFS025T ¹⁾
 - Device Family: -T / -TL / -TS / -TLS ¹⁾
 - Speedgrade: Blank / -1 ¹⁾
 - Temperature Range: Extended / Industrial ¹⁾
 - Package: FCVG484
- **RAM/Storage**
 - 1 GByte LPDDR4 SDRAM ²⁾
 - 64 MByte SPI Flash Memory ²⁾
 - EEPROM with MAC address
- **On Board**
 - System Controller CPLD
 - Gigabit Ethernet PHY
 - USB 2.0 ULPI Transceiver
 - Oscillator
- **Interface**
 - 3 x B2B Connector (LSHM)
 - up to 118 FPGA IOs
 - GPIO: 84
 - HSIO: 34
 - up to 14 MSSIO
 - 1 SGMII
 - 4 MGT
 - SDIO, USB, ETH, UART, I2C, JTAG, CONFIG
- **Power**
 - 3.3 V power supply via B2B Connector needed ³⁾.
- **Dimension**
 - 40 mm x 50 mm

- **Notes**

¹⁾ Please, take care of the possible assembly options. Furthermore, check whether the power supply is powerful enough for your FPGA design. **Attention: IO number connected to B2B connector depends on the used device!**

²⁾ Please, take care of the possible assembly options.

³⁾ A higher or lower input voltage may be possible.

4.2 Block Diagram

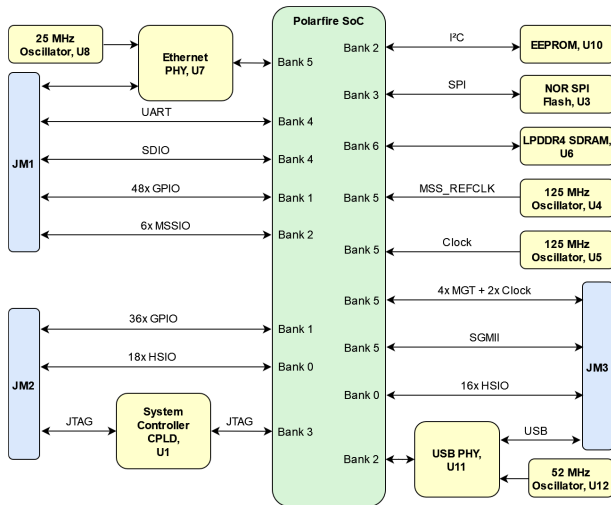


Figure 1: TEM0007 block diagram

4.3 Main Components

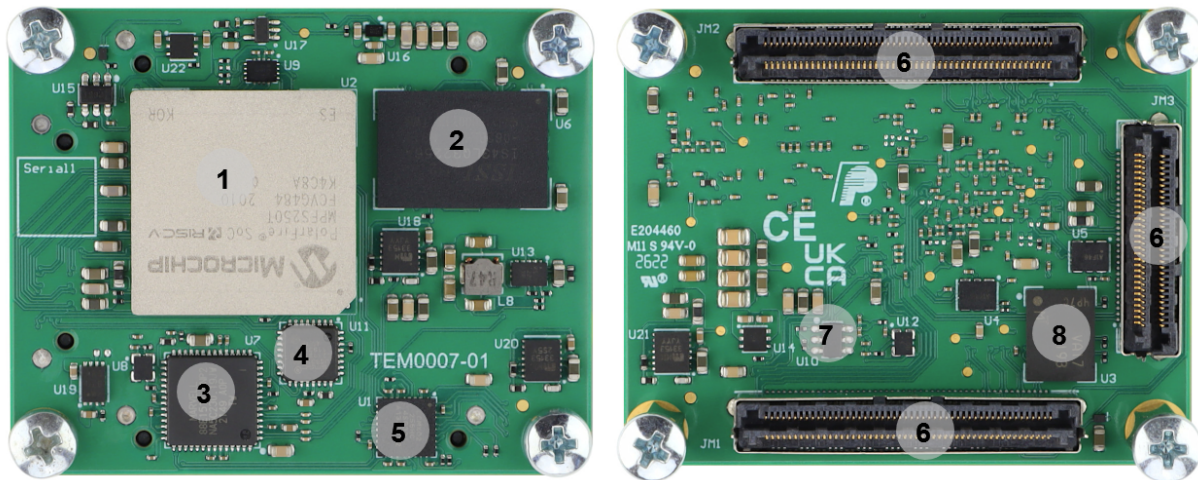


Figure 2: TEM0007 main components

1. Microsemi Polarfire SoC, U2
2. LPDDR4 SDRAM, U6
3. Ethernet Transceiver, U7
4. USB Transceiver, U11
5. System Controller CPLD, U1
6. B2B Connector, JM1, JM2, JM3
7. EEPROM, U10
8. Serial NOR Flash, U3

4.4 Initial Delivery State

| Storage device name | Content | Notes |
|----------------------------|---|--|
| LPDDR4 SDRAM | not programmed | |
| SPI NOR Flash | not programmed | |
| EEPROM | not programmed besides factory programmed MAC address | |
| System Controller CPLD, U1 | Standard firmware | See TEM0007 CPLD¹ . |

Table 1: Initial delivery state of programmable devices on the module

¹ <https://wiki.trenz-electronic.de/display/PD/TEM0007+CPLD>

5 Signals, Interfaces and Pins

5.1 Connectors

| Connector Type | Designator | Interface | IO CNT | Notes |
|----------------|------------|---------------|-----------------------|---|
| B2B | JM1 | GPIO | up to 48 SE / 24 DIFF | only 40 SE / 20 DIFF for MPFS025 variants |
| B2B | JM1 | MSSIO | 2 x MSSIO | |
| B2B | JM1 | I2C or MSSIO | I2C or 2 x MSSIO | |
| B2B | JM1 | SDIO or MSSIO | SDIO or 6 x MSSIO | |
| B2B | JM1 | UART or MSSIO | 2 x UART or 4 x MSSIO | |
| B2B | JM1 | ETH - MDI | ETH | |
| B2B | JM2 | HSIO | 18 SE / 9 DIFF | |
| B2B | JM2 | GPIO | up to 36 SE / 18 DIFF | only 8 SE / 4 DIFF for MPFS025 variants |
| B2B | JM2 | CFG | JTAG | |
| B2B | JM3 | HSIO | 16 SE / 8 DIFF | |
| B2B | JM3 | SGMII | 1 x SGMII (RX/TX) | |
| B2B | JM3 | MGT FPGA | 4 x MGT (RX/TX) | |

| Connector Type | Designator | Interface | IO CNT | Notes |
|----------------|------------|-----------|-------------|-------|
| B2B | JM3 | MGT CLK | 2 x MGT CLK | |
| B2B | JM3 | USB | USB | |

Table 2: Board Connectors

5.2 Test Points

| Test Point | Signal | Notes |
|------------|--------------|--------------------------------------|
| TP1 | +3.3V | |
| TP2 | +2.5V | |
| TP3 | +2.5V_XCVR | |
| TP4 | +1.8V | |
| TP5 | - | Signal at U17 pin 3. See schematics. |
| TP6 | +1.1V_LPDDR4 | |
| TP7 | +1.0V | |
| TP8 | VDDAUX1 | |
| TP9 | AVDD18 | |
| TP10 | AVDD33 | |
| TP11 | DVDD1V0 | |
| TP12 | VCCIOB_SW | |
| TP13 | +2.5V_VDDA | |

| Test Point | Signal | Notes |
|------------|------------|-------|
| TP14 | +1.0V_VDDA | |
| TP15 | +2.5V_VDD | |

Table 3: Test Points Information

6 On-board Peripherals

| Chip/Interface | Designator | Connecte d To | Notes |
|---------------------------|------------|--|-------|
| System Controller CPLD | U1 | B2B DCDC SoC Power Monitor | |
| Gigabit Ethernet | U7 | SoC - MSS B2B - JM1 | |
| USB PHY | U11 | SoC - MSS B2B -JM3 | |
| LPDDR4 SDRAM | U6 | SoC - MSS | |
| EEPROM | U10 | SoC - MSS | |
| SPI Flash Memory | U3 | SoC - MSS | |
| Oscillator | U4 | SoC - MSS | |
| Oscillator | U5 | Soc - FPGA | |
| Oscillator | U8 | ETH PHY | |
| Oscillator | U12 | USB PHY | |

Table 4: On board peripherals

7 Configuration and System Control Signals

| Connector +Pin | Signal Name | Direction ¹⁾ | Description |
|--|--------------------------|-------------------------|--|
| JM1-7 | NOSEQ | IN/OUT | See 4 x 5 SoM Integration Guide² and TEM0007 CPLD³ . |
| JM1-28 | SC_EN1 | IN | See 4 x 5 SoM Integration Guide⁴ and TEM0007 CPLD⁵ . |
| JM1-30 | SC_PGOOD | IN/OUT | See 4 x 5 SoM Integration Guide⁶ and TEM0007 CPLD⁷ . |
| JM1-32 | SC_BOOTMODE | IN | See 4 x 5 SoM Integration Guide⁸ and TEM0007 CPLD⁹ . |
| JM1-89 | JTAGSEL | IN | See 4 x 5 SoM Integration Guide¹⁰ and TEM0007 CPLD¹¹ . |
| JM2-18 | SC_nRST | IN | See 4 x 5 SoM Integration Guide¹² and TEM0007 CPLD¹³ . |
| JM2-93 / JM2-95 / JM2-97 / JM2-99 | TMS / TDI / TDO / TCK | Signal-dependent | JTAG configuration and debugging interface. JTAG reference voltage: 3.3VIN |

Table 5: Controller signal.

¹⁾ Direction:

- IN: Input from the point of view of this board.
- OUT: Output from the point of view of this board.

² <https://wiki.trenz-electronic.de/display/PD/4+x+5+SoM+Integration+Guide>

³ <https://wiki.trenz-electronic.de/display/PD/TEM0007+CPLD>

⁴ <https://wiki.trenz-electronic.de/display/PD/4+x+5+SoM+Integration+Guide>

⁵ <https://wiki.trenz-electronic.de/display/PD/TEM0007+CPLD>

⁶ <https://wiki.trenz-electronic.de/display/PD/4+x+5+SoM+Integration+Guide>

⁷ <https://wiki.trenz-electronic.de/display/PD/TEM0007+CPLD>

⁸ <https://wiki.trenz-electronic.de/display/PD/4+x+5+SoM+Integration+Guide>

⁹ <https://wiki.trenz-electronic.de/display/PD/TEM0007+CPLD>

¹⁰ <https://wiki.trenz-electronic.de/display/PD/4+x+5+SoM+Integration+Guide>

¹¹ <https://wiki.trenz-electronic.de/display/PD/TEM0007+CPLD>

¹² <https://wiki.trenz-electronic.de/display/PD/4+x+5+SoM+Integration+Guide>

¹³ <https://wiki.trenz-electronic.de/display/PD/TEM0007+CPLD>

8 Power and Power-On Sequence

8.1 Power Rails

| Power Rail Name/ Schematic Name | Connector + Pin | Direction ¹⁾ | Notes |
|------------------------------------|---|-------------------------|---|
| VIN | JM1.1 / JM1.3 / JM1.5 / JM2.2 / JM2.4 / JM2.6 / JM2.8 | IN | Supply voltage from the carrier board |
| 3.3VIN | JM1.13 / JM1.15 | IN | Supply voltage from the carrier board |
| 3.3VIN | JM2.91 | OUT | JTAG reference voltage |
| +1.8V | JM1.39 | OUT | Internal +1.8V voltage level |
| VCCIOB | JM2.1 / JM2.3 | IN | General purpose I/O bank voltage |
| VCCIOD | JM2.7 / JM2.9 | IN | High speed I/O bank voltage (max. +1.8 V) |
| +3.3V | JM2.10 / JM2.12 | OUT | Internal +3.3 V voltage level |

Table 6: Module power rails.

¹⁾ Direction:

- IN: Input from the point of view of this board.
- OUT: Output from the point of view of this board.

8.2 Recommended Power up Sequencing

| Sequence | Net name | Recommended Voltage Range | Pull-up/down | Description | Notes |
|----------|-----------------|----------------------------------|--------------|----------------------------------|--|
| 0 | - | - | - | Configuration signal setup. | See Configuration and System Control Signals (see page 0). |
| 1 | 3.3VIN | 3.3 V (\pm 5 %) | - | Management and SoC power supply. | Main module power supply for management and SoC. 3 A recommended. Power consumption depends mainly on design and cooling solution. |
| 2 | VIN | 3.3 V (\pm 5 %) ¹⁾ | - | Main module power supply. | Main module power supply for management and SoC. 5.5 A recommended. Power consumption depends mainly on design and cooling solution. |
| 3 | +1.8V | - | - | 1.8 V on-module power supply. | |
| 4 | VCCIOB / VCCIOD | 2) | - | Module bank voltages. | Enable bank voltages after 1.8 V are available on carrier. |

Table 7: Baseboard Design Hints

¹⁾ A higher or lower input voltage may be possible.

²⁾ See DS0147 for additional information.

9 Board to Board Connectors

⚠ These connectors are hermaphroditic. Odd pin numbers on the module are connected to even pin numbers on the baseboard and vice versa.

4 x 5 modules use two or three [Samtec Razor Beam LSHM connectors](#)¹⁴ on the bottom side.

- 2 x REF-189016-02 (compatible to LSHM-150-04.0-L-DV-A-S-K-TR), (100 pins, "50" per row)
- 1 x REF-189017-02 (compatible to LSHM-130-04.0-L-DV-A-S-K-TR), (60 pins, "30" per row) (depending on module)

9.1 Connector Mating height

When using the same type on baseboard, the mating height is 8mm. Other mating heights are possible by using connectors with a different height

| Order number | Connector on baseboard | compatible to | Mating height |
|--------------|-----------------------------|-----------------------------|---------------|
| 23836 | REF-189016-01 | LSHM-150-02.5-L-DV-A-S-K-TR | 6.5 mm |
| | LSHM-150-03.0-L-DV-A-S-K-TR | LSHM-150-03.0-L-DV-A-S-K-TR | 7.0 mm |
| 23838 | REF-189016-02 | LSHM-150-04.0-L-DV-A-S-K-TR | 8.0 mm |
| | LSHM-150-06.0-L-DV-A-S-K-TR | LSHM-150-06.0-L-DV-A-S-K-TR | 10.0mm |
| 26125 | REF-189017-01 | LSHM-130-02.5-L-DV-A-S-K-TR | 6.5 mm |
| | LSHM-130-03.0-L-DV-A-S-K-TR | LSHM-130-03.0-L-DV-A-S-K-TR | 7.0 mm |
| 24903 | REF-189017-02 | LSHM-130-04.0-L-DV-A-S-K-TR | 8.0 mm |
| | LSHM-130-06.0-L-DV-A-S-K-TR | LSHM-130-06.0-L-DV-A-S-K-TR | 10.0mm |

Table 8: Connectors.

¹⁴ <https://www.samtec.com/technical-specifications/Default.aspx?SeriesMaster=LSHM>

The module can be manufactured using other connectors upon request.

9.2 Connector Speed Ratings

The LSHM connector speed rating depends on the stacking height; please see the following table:

| Stacking height | Speed rating |
|---------------------|--------------------|
| 12 mm, Single-Ended | 7.5 GHz / 15 Gbps |
| 12 mm, Differential | 6.5 GHz / 13 Gbps |
| 5 mm, Single-Ended | 11.5 GHz / 23 Gbps |
| 5 mm, Differential | 7.0 GHz / 14 Gbps |

Table 9: Speed rating.

9.3 Current Rating

Current rating of Samtec Razor Beam™ LSHM B2B connectors is 2.0A per pin (2 adjacent pins powered).

9.4 Connector Mechanical Ratings

- Shock: 100G, 6 ms Sine
- Vibration: 7.5G random, 2 hours per axis, 3 axes total

10 Technical Specifications

10.1 Absolute Maximum Ratings ^{*)}

| Power Rail Name/ Schematic Name | Description | Min | Max | Unit |
|------------------------------------|------------------|------|------|------|
| VIN | Supply voltage | -0.3 | 6.0 | V |
| 3.3VIN | Supply voltage | -0.3 | 3.75 | V |
| VCCIOB | I/O bank voltage | -0.5 | 3.6 | V |
| VCCIOD | I/O bank voltage | -0.5 | 2.0 | V |

Table 10: Absolute maximum ratings

^{*)} Stresses beyond those listed under [Absolute Maximum Ratings](#) (see page 0) may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under [Recommended Operating Condition](#) (see page 0). Exposure to absolute-maximum rated conditions for extended periods may affect device reliability.

10.2 Recommended Operating Conditions

This TRM is generic for all variants. Temperature range can be differ depending on the assembly version. Voltage range is mostly the same during variants (exceptions are possible, depending on custom request)

Operating temperature range depends also on customer design and cooling solution. Please contact us for options.

- Variants of modules are described here: [Article Number Information](#)¹⁵
- Modules with commercial temperature grade are equipped with components that cover at least the range of 0°C to 75°C
- Modules with extended temperature grade are equipped with components that cover at least the range of 0°C to 85°C
- Modules with industrial temperature grade are equipped with components that cover at least the range of -40°C to 85°C
- The actual operating temperature range will depend on the FPGA / SoC design / usage and cooling and other variables.

| Parameter | Min | Max | Units | Reference Document |
|-----------|-------|-------|-------|--------------------|
| VIN | 3.135 | 3.465 | V | |

¹⁵ <https://wiki.trenz-electronic.de/display/PD/Article+Number+Information>

| Parameter | Min | Max | Units | Reference Document |
|-----------|-------|-------|-------|---------------------|
| 3.3VIN | 3.135 | 3.465 | V | |
| VCCIOB | 1.14 | 3.465 | V | See FPGA datasheet. |
| VCCIOD | 1.14 | 1.89 | V | See FPGA datasheet. |

Table 11: Recommended operating conditions.

1) Higher and lower values may be possible. For more information consult schematic and according datasheets.

10.3 Physical Dimensions

- Module size: 40 mm × 50 mm. Please download the assembly diagram for exact numbers.
- Mating height with standard connectors: 8 mm.

PCB thickness: 1.74 mm.

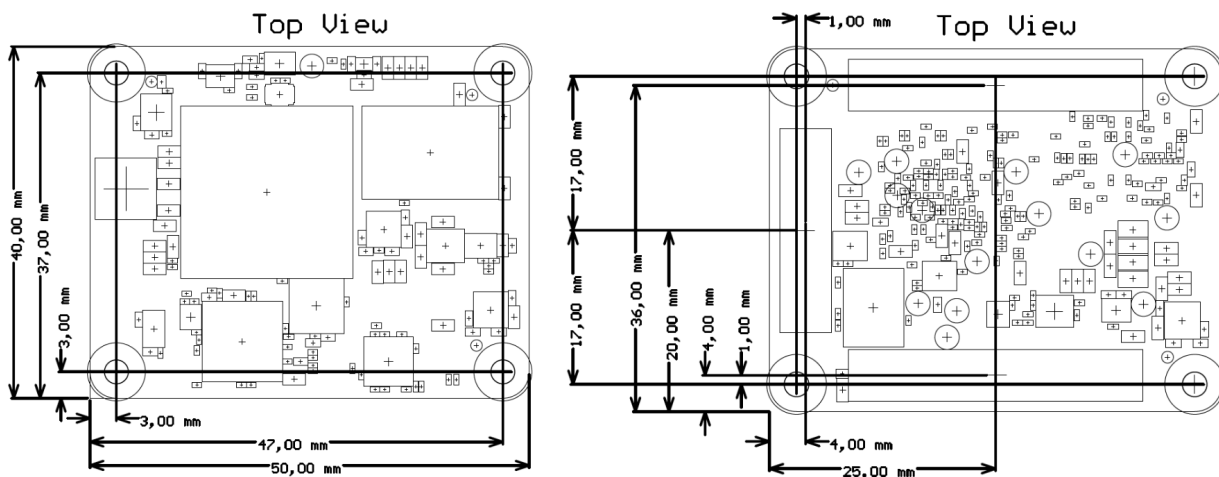


Figure 3: Physical Dimension

11 Currently Offered Variants

| Trenz shop TEM0007 overview page | |
|---|--|
| English page¹⁶ | German page¹⁷ |

Table 12: Trenz Electronic Shop Overview

¹⁶ <https://shop.trenz-electronic.de/en/search?sSearch=TEM0007>

¹⁷ <https://shop.trenz-electronic.de/de/search?sSearch=TEM0007>

12 Revision History

12.1 Hardware Revision History

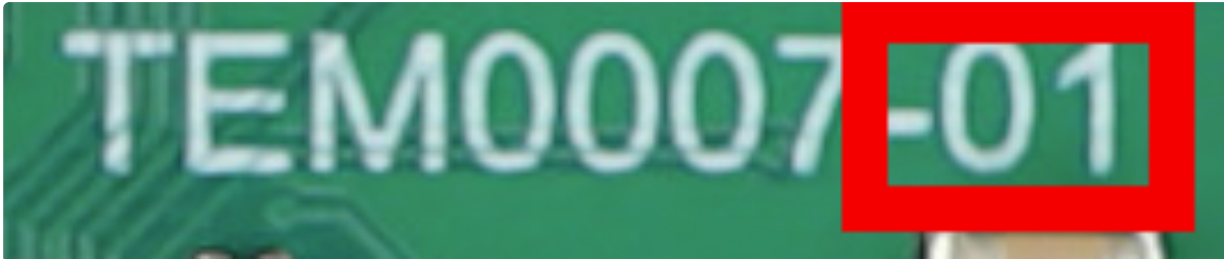


Figure 4: Board hardware revision number.

| Date | Revision | Changes | Documentation Link |
|------------|----------|-----------------|--|
| 2020-05-26 | 01 | Initial Release | TEM0007-01 ¹⁸ |

Table 13: Hardware Revision History

Hardware revision number can be found on the PCB board together with the module model number separated by the dash.

12.2 Document Change History


| Date | Revision | Contributor | Description |
|--|-----------------------------------|---|-----------------|
|  2024-03-27 | v.47 (see page 5) | Kilian Jahn ¹⁹ | Link fixed |
| 2023-11-07 | v.45 | ED | Initial Release |
| -- | all | ED ²⁰ , John Hartfiel ²¹ , Kilian Jahn ²² | • -- |

Table 14: Document change history.

¹⁸ https://shop.trenz-electronic.de/de/Download/?path=Trenz_Electronic/Modules_and_Module_Carriers/4x5/TEM0007/REV01

¹⁹ <https://wiki.trenz-electronic.de/display/~k.jahn>

²⁰ <https://wiki.trenz-electronic.de/display/~e.dyck>

²¹ <https://wiki.trenz-electronic.de/display/~j.hartfiel>

²² <https://wiki.trenz-electronic.de/display/~k.jahn>

13 Disclaimer

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13.7 REACH, RoHS and WEEE

REACH

Trenz Electronic is a manufacturer and a distributor of electronic products. It is therefore a so called downstream user in the sense of REACH²³. The products we supply to you are solely non-chemical products (goods). Moreover and under normal and reasonably foreseeable circumstances of application, the goods supplied to you shall not release any substance. For that, Trenz Electronic is obliged to neither register nor to provide safety data sheet. According to present knowledge and to best of our knowledge, no SVHC (Substances of Very High Concern) on the Candidate List²⁴ are contained in our products. Furthermore, we will immediately and unsolicited inform our customers in compliance with REACH - Article 33 if any substance present in our goods (above a concentration of 0,1 % weight by weight) will be classified as SVHC by the European Chemicals Agency (ECHA)²⁵.

RoHS


Trenz Electronic GmbH herewith declares that all its products are developed, manufactured and distributed RoHS compliant.

WEEE

Information for users within the European Union in accordance with Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE).

Users of electrical and electronic equipment in private households are required not to dispose of waste electrical and electronic equipment as unsorted municipal waste and to collect such waste electrical and electronic equipment separately. By the 13 August 2005, Member States shall have ensured that systems are set up allowing final holders and distributors to return waste electrical and electronic equipment at least free of charge. Member States shall ensure the availability and accessibility of the necessary collection facilities. Separate collection is the precondition to ensure specific treatment and recycling of waste electrical and electronic equipment and is necessary to achieve the chosen level of protection of human health and the environment in the European Union. Consumers have to actively contribute to the success of such collection and the return of waste electrical and electronic equipment. Presence of hazardous substances in electrical and electronic equipment results in potential effects on the environment and human health. The symbol consisting of the crossed-out wheeled bin indicates separate collection for waste electrical and electronic equipment.

Trenz Electronic is registered under WEEE-Reg.-Nr. DE97922676.

 2019-06-07

²³ <http://guidance.echa.europa.eu/>

²⁴ <https://echa.europa.eu/candidate-list-table>

²⁵ <http://www.echa.europa.eu/>