TE0714 TRM

Revision v.55

Exported on 2019-03-04

Online version of this document:

https://wiki.trenz-electronic.de/display/PD/TE0714+TRM

1 Table of Contents

2 Table of Figures

3 Table of Tables

4 Overview

The Trenz Electronic TE0714 is an industrial-grade SoM (System on Module) based on Xilinx Artix-7, 16 MByte Flash memory and powerful switching mode power supplies for all on-board voltages. A large number of configurable I/O's is provided via rugged high-speed stacking strips. TE0714 is the smallest module with transceiver (3 x 4 cm).

Refer to http://trenz.org/te0714-info for the current online version of this manual and other available documentation.

4.1 Key Features

- Xilinx Artix-7 FPGA (A15T, A35T, A50T)
- Rugged for shock and high vibration
- 16 MByte QSPI Flash memory
- Differential MEMS oscillator for MGT clocking
- MEMS oscillator for PL clocks (Optional)
- Plug-on module with 2 × 100-pin high-speed hermaphroditic strips
    - 138 FPGA I/O's (Max 68 differential)
    - 5 IO's (QSPI or user I/O's)
    - XADC analog input
    - 4 GTP (high-performance transceiver) lanes
    - GT reference clock inputs
    - Optimized I/O and power pins for good signal integrity
- On-board high-efficiency DC-DC converters
- Power supply for all on-board components
- eFUSE bit-stream encryption (AES)
- One user configurable LED

Different configurations for cost and performance optimization available upon request. Available options are:

- FPGA Type (A15T, A35T, A50T), temperature grade
- GT clock frequency (or none if not implemented)
- PL clock frequency and precision (or none if not implemented)
- Config and B14 bank Voltage: 1.8V or 3.3V
- SPI Flash type (or none if not implemented)
- LED Color (or none if not implemented)
- PUDC Pin strapping (pull high or pull down)
- GT power enable pin strapping (default power enabled or disabled)

4.2 Block Diagram

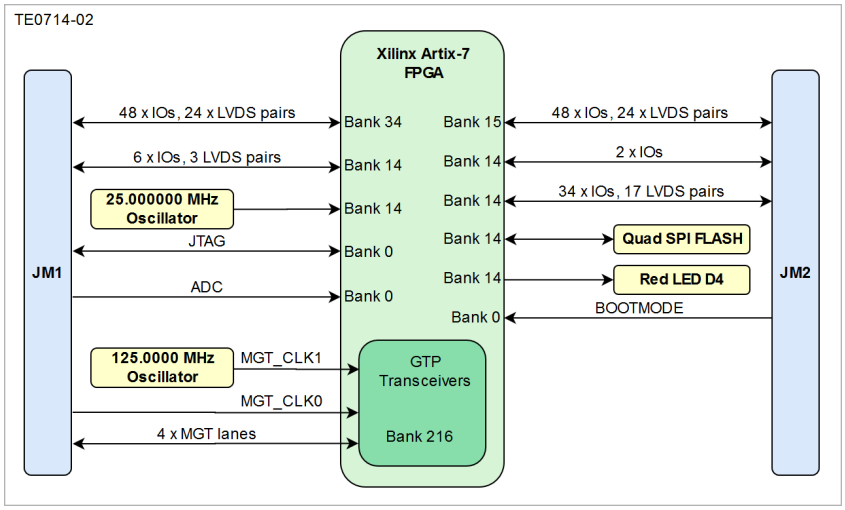

Figure 1: TE0714 block diagram

4.3 Main Components

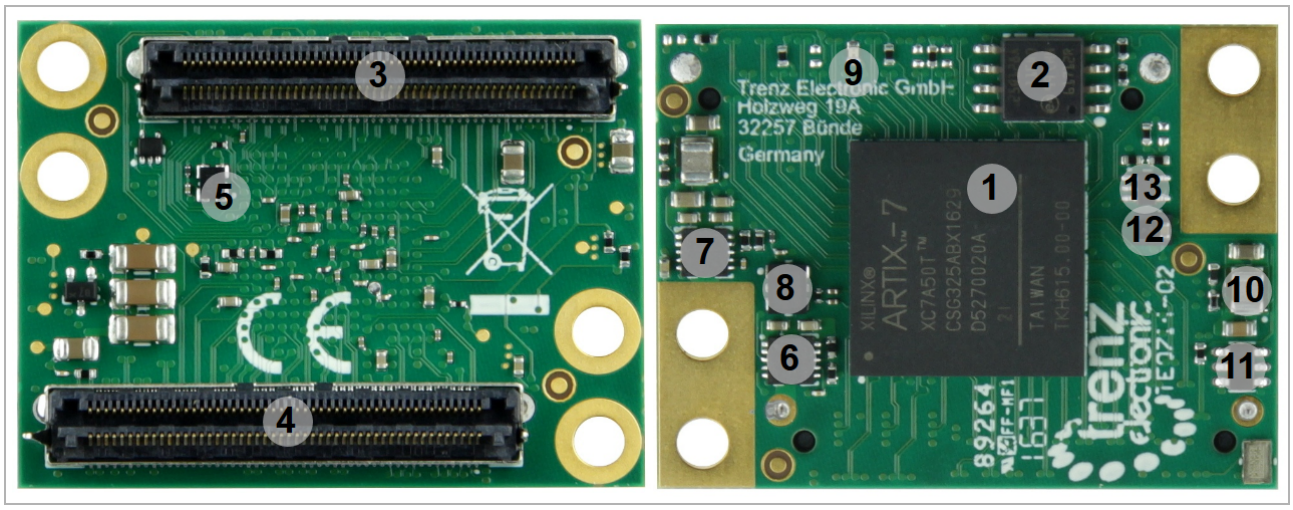

Figure 2: TE0714 main components

1. Xilinx Artix-7 FPGA (XC7A series), U4
2. 16 MByte SPI Flash, U7
3. B2B connector Samtec Razor Beam™ LSHM-150, JM2
4. B2B connector Samtec Razor Beam™ LSHM-150, JM1
5. 25 MHz oscillator, U8
6. Single output low-dropout linear regulator (1.2V_MGT), U6
7. Single output low-dropout linear regulator (1.0V_MGT), U5
8. Low-jitter precision LVDS 125 MHz oscillator (GT Clock), U2
9. Red indication LED, D4
10. Step-down DC-DC converter (1.0V), U1
11. PFET load switch with configurable slew rate (3.3V), Q1
12. Low-power step-down DC-DC converter (1.8V), U3
13. Voltage detector for circuit initialization and timing supervision, U23

4.4 Initial Delivery State

Storage device name	Content	Notes
SPI Flash OTP Area	Empty, not programmed	Except serial number programmed by flash vendor
SPI Flash Quad Enable bit	Programmed	
SPI Flash main array	demo design	
eFUSE USER	Not programmed	
eFUSE Security	Not programmed	

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

4.5 Control Signals

Boot process is controlled by signals on the board to board (B2B) connector.

Signal	Direction	Signal State	Description
BOOTMODE	input	high or open	Master SPI, x4 Mode
		low or ground	Slave SelectMAP
PROG_B	input	pulsed low	Clear FPGA configuration (falling edge) and initiate a new configuration sequenz (next rising edge).
DONE	output	high	Completion of configuration sequence.

Table 2: Boot signals.

⚠ SPI FPGA pins D02 and D03 have no pull-ups on the module, so with PUDC=High option, those pins are floating if there are no pull-ups on baseboard. As those pins have SPI RESET function when Quad mode is not enabled, it is mandatory to either add pull-ups on user baseboard or program the Quad Enable bit in Flash nonvolatile status register.

5 Signals, Interfaces and Pins

5.1 JTAG Interface

JTAG access to the Xilinx Artix-7 FPGA device is provided through connector JM1.

Signal Name	B2B Pin
TCK	JM1:89
TDI	JM1:85
TDO	JM1:87
TMS	JM1:91

Table 3: JTAG signals.

5.2 Board to Board (B2B) I/Os

FPGA bank number and number of I/O signals connected to the B2B connector:

FPGA Bank	B2B Connector	I/O Signal Count	Voltage Level	Notes
14	JM1	6	VCCIO_0	
14	JM2	36	VCCIO_0	NB! 17 LVDS pairs possible.
15	JM2	48	VCCIO15	Supplied by the baseboard.
34	JM1	48	VCCIO34	Supplied by the baseboard.
216	JM1	16	MGT_AVCC MGT_AVTT	4 x GTP lanes.

Table 4: B2B I/Os
Please refer to the Pin-out[1] tables page for additional information.

1 https://shop.trenz-electronic.de/de/Download/?path=Trenz_Electronic/Pinout

6 On-board Peripherals

6.1 Quad SPI Flash

On-board SPI flash memory S25FL127S (U7) is used to store initial FPGA configuration. Besides FPGA configuration, remaining free flash memory can be used for user application 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 bus width and clock frequency used.

⚠ SPI Flash QE (Quad Enable) bit must be set to high or FPGA is unable to load its configuration from flash. By default this bit is set to high at the manufacturing plant.

6.2 On-board LED

There is one LED on TE0714 module.

LED	Color	FPGA	Notes
D4	Red	K18	User programmable

Table 5: LED connection.

6.3 Clock

Clock	Default Frequency	IC	FPGA	Notes
CLK 25MHz	25 MHz	U8	T14	Frequency depends on the module variant. Output is compatible to 3.3V and 1.8V I/O standard of the FPGA bank.
MGT_CLK	125MHz	U2	B6/B5	Frequency depends on the module variant

Table 6: Clock signals.

7 Power and Power-On Sequence

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

TE0714 needs one single power supply with nominal of 3.3V.

7.1 Power Consumption

Test Condition (25 °C ambient)	VIN Current mA	Notes
TE0714-35, TEBT0714, empty design, GT not enabled	110mA	

Table 7: Power Consumption
Actual power consumption depends on the FPGA design and ambient temperature.

7.2 Power Distribution Dependencies

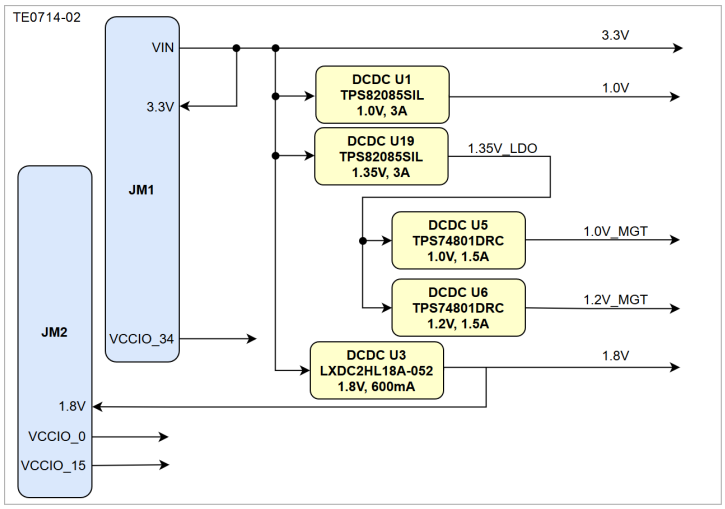

Figure 3: Power Distribution

7.3 Power-On Sequence

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

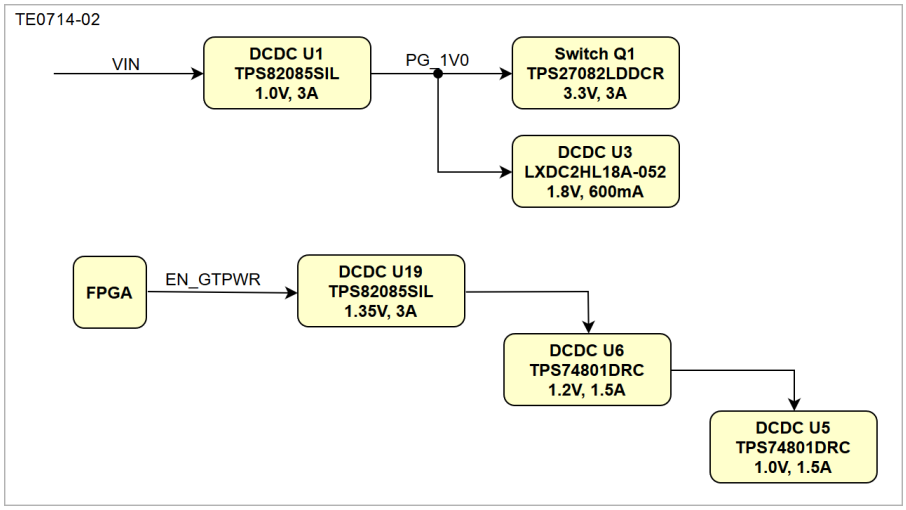

Figure 4: Power-On Sequency

7.4 Power Rails

Voltages on B2B-Connector	B2B JM1-Pin	B2B JM2-Pin	Direction	Note
VIN	98, 100	-	input	supply voltage
VCCIO_0	-	54	input	high range bank voltage
VCCIO_15	-	53	input	high range bank voltage
VCCIO_34	62	-	input	high range bank voltage
3.3V	84	-	output	internal 3.3V voltage level
1.8V	-	17	output	internal 1.8V voltage level

Table 8: Power Rails

7.5 Bank Voltages

Bank	Voltage	Notes
0 Config and B14	1.8V or 3.3V	Depends on module variant
15	User	Supplied from baseboard via B2B connector, max 3.3V
34	User	Supplied from baseboard via B2B connector, max 3.3V

Table 9: Bank Voltages

8 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.

3 x 4 modules use two Samtec Razor Beam LSHM connectors[2] 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).

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

Table 10: Connectors.
The module can be manufactured using other connectors upon request.

8.1 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 11: Speed rating.

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

8.2 Current Rating

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

8.3 Connector Mechanical Ratings

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

9 Technical Specifications

9.1 Absolute Maximum Ratings

Parameter	Min	Max	Units	Reference Document
VIN supply voltage	-0.1	6.0	V	-
HR I/O banks supply voltage (VCCO)	-0.5	3.6	V	Xilinx datasheet DS181[3]
HR I/O banks input voltage	-0.4	VCCO + 0.55	V	Xilinx datasheet DS181[4]
GTP transceivers Tx/Rx input voltage	-0.5	1.26	V	Xilinx datasheet DS181[5]
Voltage on module JTAG pins	-0.4	VCCO_0 + 0.55	V	Xilinx datasheet DS181[6]
Storage temperature	-40	+85	°C	-

Table 12: Module absolute maximum ratings.

9.2 Recommended Operating Conditions

Parameter	Min	Max	Units	Reference Document
VIN supply voltage	3.135	3.45	V	-
HR I/O banks supply voltage (VCCO)	1.14	3.465	V	Xilinx datasheet DS181[7]
HR I/O banks input voltage	-0.20	VCCO + 0.20	V	Xilinx datasheet DS181[8]
Voltage on module JTAG pins	3.135	3.465	V	Xilinx datasheet DS181[9]

Table 13: Recommended Operating Conditions

9.3 Physical Dimensions

- Module size: 40 mm × 30 mm. Please download the assembly diagram for exact numbers.
- Mating height with standard connectors: 8 mm

3 https://www.xilinx.com/support/documentation/data_sheets/ds181_Artix_7_Data_Sheet.pdf
4 https://www.xilinx.com/support/documentation/data_sheets/ds181_Artix_7_Data_Sheet.pdf
5 https://www.xilinx.com/support/documentation/data_sheets/ds181_Artix_7_Data_Sheet.pdf
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8 https://www.xilinx.com/support/documentation/data_sheets/ds181_Artix_7_Data_Sheet.pdf
9 https://www.xilinx.com/support/documentation/data_sheets/ds181_Artix_7_Data_Sheet.pdf

- PCB thickness: 1.6 mm
- Highest part on PCB: approximately 2.5 mm. Please download the step model for exact numbers.

All dimensions are shown in mm. Additional sketches, drawings and schematics can be found here[10].

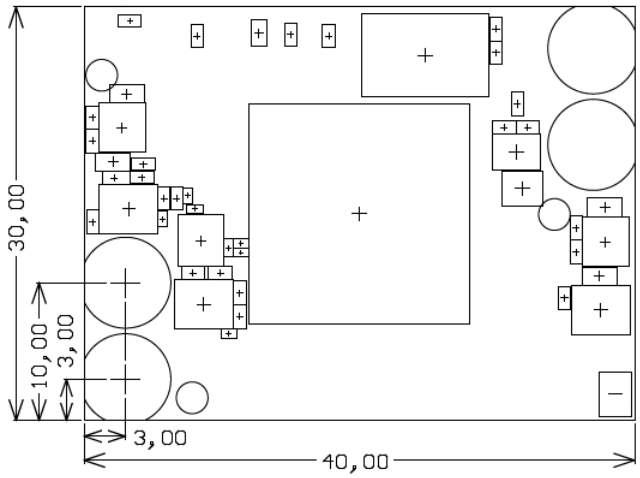
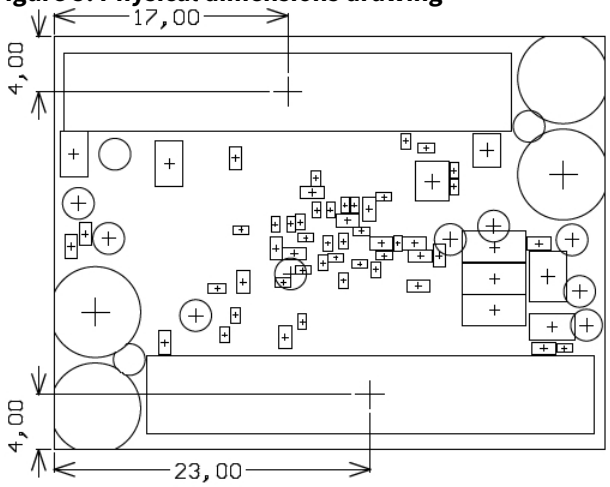


Figure 5: Physical dimensions drawing



10 https://shop.trenz-electronic.de/de/Download/?path=Trenz_Electronic/TE0714

10 Variants Currently In Production

Trenz shop TE0714 overview page	
English page[11]	German page[12]

Table 14: Trenz Electronic Shop Overview

> On REV 01 JM2 Pin 54 was connected to GND. When R27 is not populated, REV 02 is backwards compatible to REV 01. When R27 is set, check your baseboard to not connect this pin to GND. For all new baseboards JM2.54 should be used as VCCIO output (it will then be 1.8V or 3.3V depending the voltage settings on the module.

11 https://shop.trenz-electronic.de/en/Products/Trenz-Electronic/TE07XX-Artix-7/TE0714-Artix-7/
12 https://shop.trenz-electronic.de/de/Produkte/Trenz-Electronic/TE07XX-Artix-7/TE0714-Artix-7/

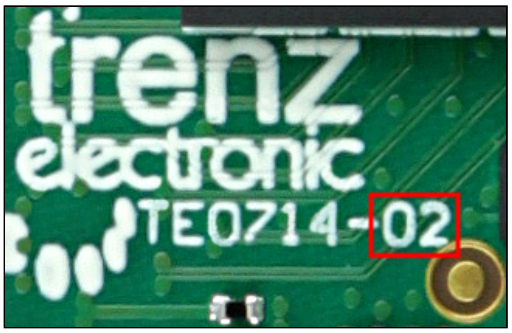
11 Revision History

11.1 Hardware Revision History

Date	Revision	PCN	Documentation Link	Note
2016-08-04	02	PCN-20160815[13]	TE0714-02[14]	VCCIO0 added to B2B
	01	-	TE0714-01[15]	-

Table 15: Hardware Revision History

Hardware revision number is printed on the PCB board next to the module model number separated by the dash.



11.2 Document Change History

Date	Revision	Authors	Description
2019-03-04	v.55 (see page 6)	John Hartfiel[16]	• Restore and modify v.50 • Correction max IO count on key features • Change history table • typo correction
2019-01-07	v.50	John Hartfiel	• Updated to TRM version 2.2 • Style modifications
2018-09-19	v.48	Martin Rohrmüller	• Updated to TRM version 2.1 • Updated B2B Connectors • Style modifications

13 https://wiki.trenz-electronic.de/display/PD/PCN-20160815+TE0714-01+to+TE0714-02+hardware+revision+upgrade
14 https://shop.trenz-electronic.de/Download/?path=Trenz_Electronic/Modules_and_Module_Carriers/3x4/TE0714/REV02
15 https://shop.trenz-electronic.de/de/Download/?path=Trenz_Electronic/TE0714/REV01
16 https://wiki.trenz-electronic.de/display/~j.hartfiel

Date	Revision	Authors	Description
2018-09-17	v.38	Martin Rohrmüller	• Added power rail section • Added Rev 02 Flash PCN • Corrected table headings
2018-09-17	v.36	Martin Rohrmüller	• Update to TRM version 2.0 with DrawIO Figures • Added Figure Power Distribution
2018-04-04	v.35	Martin Rohrmüller	Corrected clock net designator in table.
2017-05-28	v.27	Jan Kumann	• Board-to-Board I/O section added. • New physical dimensions images. • Documents sections rearranged.
2017-03-20	v.26	John Hartfiel	• Notes on Clocking section.
2017-01-27	v.25	Jan Kumann	• New block diagram.
2016-12-01	v.17	Jan Kumann	• Changes in the document structure, few corrections.
2016-11-18	v.14	Thorsten Trenz, Emmanuel Vassilakis	• Hardware revision 02 specific changes.
2016-06-01	v.9	Antti Lukats	• Initial version.
--	all	Ali Naseri[17], Antti Lukats[18], Emmanuel Vassilakis[19], John Hartfiel[20], Jan Kumann[21], Kerstin Möller[22], Martin Rohrmüller[23], Susanne	--

17 https://wiki.trenz-electronic.de/display/~a.naseri
18 https://wiki.trenz-electronic.de/display/~antti.lukats
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22 https://wiki.trenz-electronic.de/display/~k.moeller
23 https://wiki.trenz-electronic.de/display/~m.rohrmueller

Date	Revision	Authors	Description
		Kunath[24] , Thorsten Trenz[25]	

Table 16: Document change history

24 https://wiki.trenz-electronic.de/display/~s.kunath
25 https://wiki.trenz-electronic.de/display/~tht

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

2018-09-18

26 http://guidance.echa.europa.eu/
27 https://echa.europa.eu/candidate-list-table
28 http://www.echa.europa.eu/

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