



## TE0726 TRM

**Revision:** V.3

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## Overview

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Refer to [https://shop.trenz-electronic.de/de/Download/?path=Trenz\\_Electronic/TE0726](https://shop.trenz-electronic.de/de/Download/?path=Trenz_Electronic/TE0726) for downloadable version of this manual and additional technical documentation of the product.

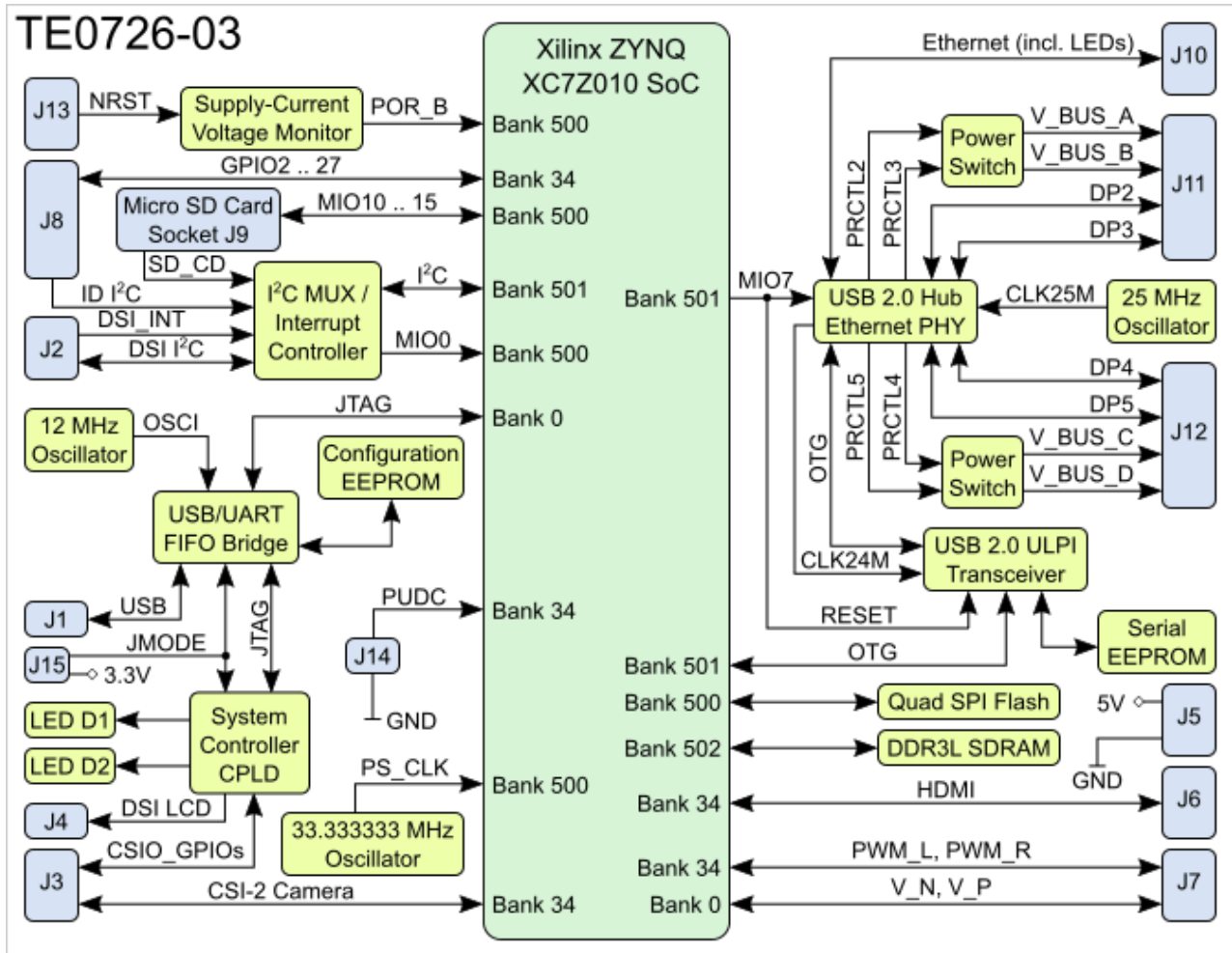
The Trenz Electronic TE0726 "ZynqBerry" is a industrial-grade Raspberry Pi form-factor compatible FPGA SoM (System on Module) based on Xilinx Zynq-7010 SoC (XC7Z010 System on Chip) with up to 512 MByte DDR3L SDRAM, 4 x USB 2.0 ports, 10/100 Mbit Ethernet port and 16 MByte Flash memory.

## Key Features

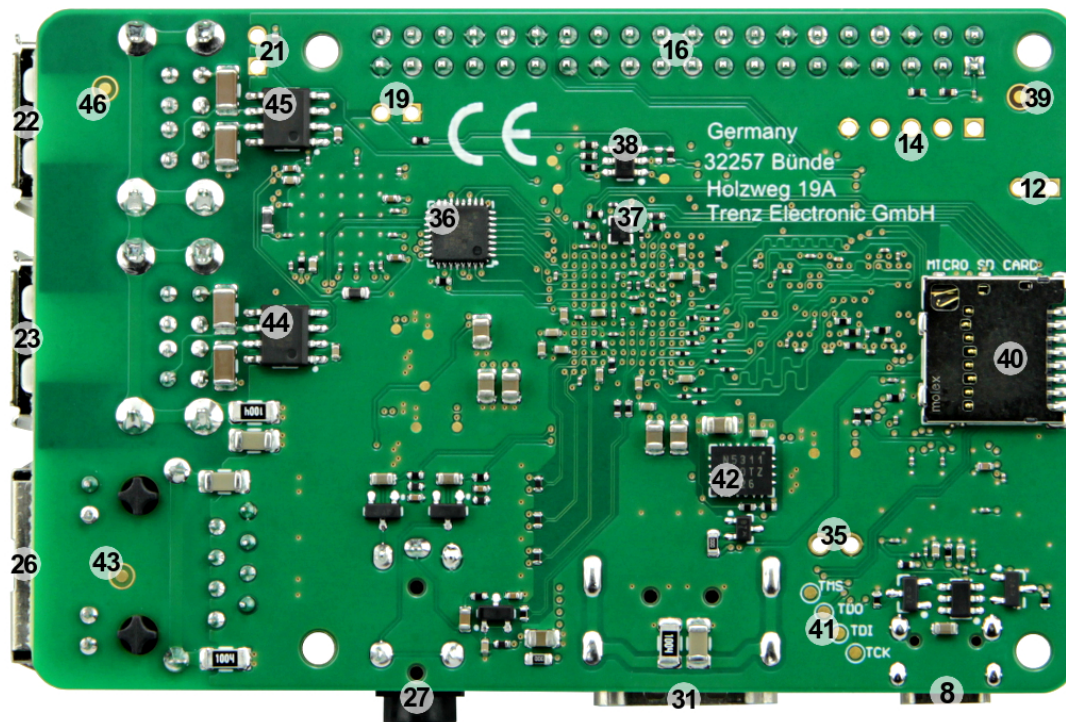
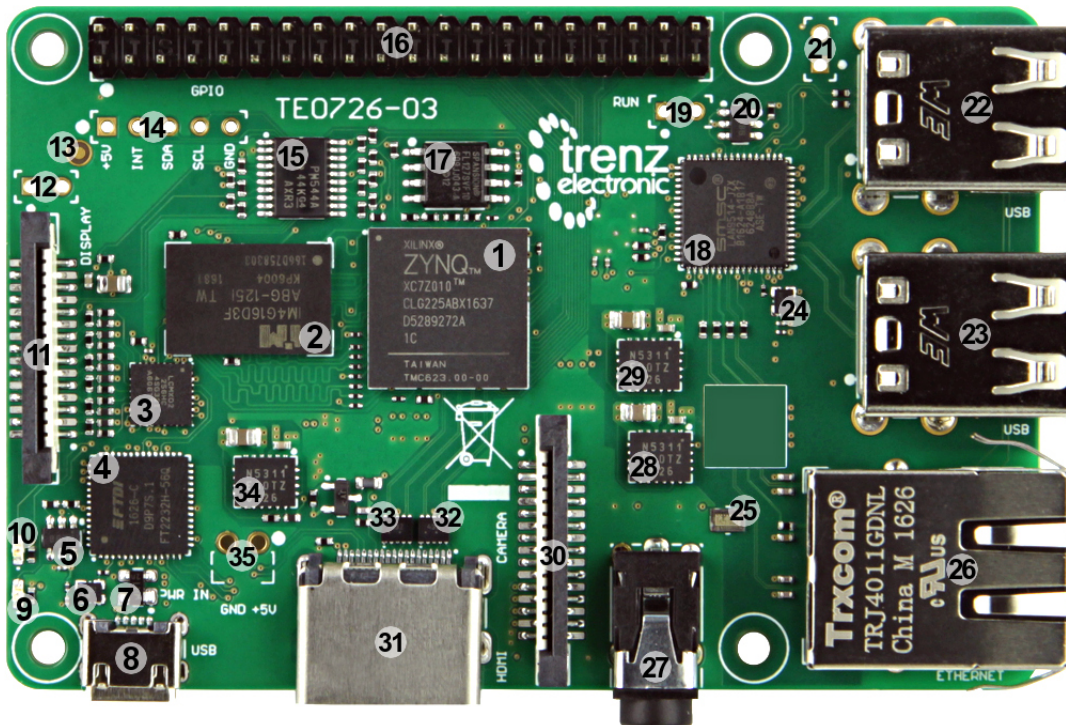
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- Xilinx Zynq XC7Z010-1CLG225C
  - REV3: DDR3L SDRAM (512 MByte)
  - REV2: DDR3L SDRAM (128 - 512 MByte)
  - REV1: LPDDR2 SDRAM (64 MByte)
- 16 MByte Flash
- [Raspberry Pi Model 2](#) form factor
- LAN9514 USB hub with 10/100 Ethernet
  - 4 x USB 2.0 with power switches
  - 10/100 Mbit Ethernet RJ45
- Micro SD card slot with card-detect switch
- HDMI connector
- DSI connector (Display)
- CSI-2 connector (Camera)
- HAT header with 26 I/Os
- Micro-USB
  - power input
  - USB UART
  - JTAG ARM- and FPGA-Debug
- 3.5 mm stereo audio socket (PWM audio output only)

## Block Diagram



## Main Components



1. Xilinx Zynq XC7Z010 All Programmable SoC, U1
2. 512 MByte DDR3L SDRAM, U8
3. Lattice Semiconductor MachXO2 System Controller CPLD, U11
4. Dual high-speed USB to multipurpose UART/FIFO, U3
5. 2 Kbit Microwire compatible serial EEPROM, U6
6. Low-power, programmable oscillator @ 12.000000 MHz, U7



7. Ultra-low capacitance double rail-to-rail ESD protection diode ,U4
8. Micro-USB 2.0 B receptacle, J1
9. Green LED (GLED), D1
10. Red LED (RLED), D2
11. DSI LCD connector, J4
12. JTAGENB, when low, TDO, TDI, TMS and TCK function as GPIOs, J15
13. Fiducial mark PM2
14. External I<sup>2</sup>C bus with interrupt signal and power line, J2
15. Low-voltage 4-channel I<sup>2</sup>C and SMBus multiplexer with interrupt logic, U10
16. 2x20 pin 2.54 GPIO header, J8
17. 128 Mbit (16 MByte) 3.0V SPI Flash memory, U5
18. USB 2.0 Hub and 10/100 Ethernet controller, U2
19. External reset
20. 2 Kbit Microwire compatible serial EEPROM, U9
21. PUDC of Zynq, active low enables internal pull-ups during configuration on all SelectIO pins
22. Dual USB A receptacle, J12. Also fiducial mark PM1
23. Dual USB A receptacle, J11
24. Low power programmable oscillator @ 25.000000 MHz, U13
25. Molex's miniature traceability S/N pad for low-cost, unique product identification
26. RJ-45 Ethernet connector with 10/100 integrated magnetics, J10. Also fiducial mark PM3
27. 3.5mm RCA audio jack, J7
28. 1A PowerSoC synchronous buck regulator with integrated inductor (3.3V), U20
29. 1A PowerSoC synchronous buck regulator with integrated inductor (1.8V), U19
30. ZIF FFC/FPC CSI-2 camera connector, J3
31. HDMI connector, J6
32. Common mode filter with ESD protection, D8
33. Common mode filter with ESD protection, D9
34. 1A PowerSoC synchronous buck regulator with integrated inductor (1.35V), U16
35. Additional external +5V power supply connector, J5
36. Highly integrated full featured hi-speed USB 2.0 ULPI transceiver, U18
37. Low-power programmable oscillator @ 33.333333 MHz, U14
38. Ultra-low supply current voltage monitor with optional watchdog, U22
39. Fiducial mark PM4
40. Micro SD memory card connector with detect switch, J9
41. JTAG interface, TP1 (TDI), TP3 (TDO), TP5 (TCK), TP7 (TMS)
42. 1A PowerSoC synchronous buck regulator with integrated inductor (1.0V), U17
43. Fiducial mark PM6
44. 0.5A dual channel current-limited power switch, U15
45. 0.5A dual channel current-limited power switch, U21
46. Fiducial mark PM5

## Initial Delivery State

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Up on delivery from Trenz Electronic System Controller CPLD is programmed with the standard firmware and FTDI FT2232H EEPROM contains pre-programmed Digilent license needed by Xilinx software tools for JTAG access, all other programmable devices are empty.

# Signals, Interfaces and Pins

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## Camera Serial Interface (CSI-2)

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The TE0726-03 module has CSI-2 specification compatible serial camera interface routed from Zynq SoC bank 34 to the connector J3.

FPGA Bank	Zynq Pin	Signal Name	Connected To
34	M10	CSI_D0_P	CSI-2 camera connector J3
34	M11	CSI_D0_N	CSI-2 camera connector J3
34	P13	CSI_D1_P	CSI-2 camera connector J3
34	P14	CSI_D1_N	CSI-2 camera connector J3
34	N11	CSI_C_P	CSI-2 camera connector J3
34	N12	CSI_C_N	CSI-2 camera connector J3

## Display Serial Interface (DSI)

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The TE0726-03 module has MIPI Alliance DSI specification compatible serial display interface routed from Zynq SoC bank 35 to the connector J4.

FPGA Bank	Zynq Pin	Signal Name	Connected To
35	F13	DSI_D0_R_N	DSI display connector J4
35	F14	DSI_D0_R_P	DSI display connector J4
35	F12	DSI_D1_R_N	DSI display connector J4
35	E13	DSI_D1_R_P	DSI display connector J4
35	E11	DSI_C_R_N	DSI display connector J4
35	E12	DSI_C_R_P	DSI display connector J4

See also section [FPGA IO Banks Pin Mapping](#), pins DSI\_XA and DSI\_XB.

## HDMI Interface

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HDMI interface is routed from Zynq SoC bank 34 to the external connector J6 via EMI4192 ESD protector /EMI filters.

FPGA Bank	Zynq Pin	Signal Name	Connected To
34	K12	CEC_B	HDMI connector J6
34	P8	HDMI_TX0_N	HDMI connector J6 via EMI filter/ESD protector
34	P9	HDMI_TX0_P	HDMI connector J6 via EMI filter/ESD protector
34	R10	HDMI_TX1_N	HDMI connector J6 via EMI filter/ESD protector
34	P10	HDMI_TX1_P	HDMI connector J6 via EMI filter/ESD protector
34	R11	HDMI_TX2_N	HDMI connector J6 via EMI filter/ESD protector
34	P11	HDMI_TX2_P	HDMI connector J6 via EMI filter/ESD protector
34	R7	HDMI_TXC_N	HDMI connector J6 via EMI filter/ESD protector
34	R8	HDMI_TXC_P	HDMI connector J6 via EMI filter/ESD protector

## Audio Output

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Pulse-width modulated stereo audio output is routed from Zynq SoC bank 34 to external 3.5mm socket J7.

FPGA Bank	Zynq Pin	Signal Name	Connected To
34	N7	PWM_L	3.5mm stereo socket J7
34	N8	PWM_R	3.5mm stereo socket J7

## SD Card Socket

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Micro SD memory card connector J9 with detect switch is connected to the Zynq Soc PS MIO bank 500. See also section [Default MIO Mapping](#).



## FPGA IO Banks Pin Mapping

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Bank	Zynq Pin	Name	Connected To
34	G14	PUDC	Jumper J14
35	G15	DSI_XA	System Controller CPLD, pin 16
35	F15	DSI_XB	System Controller CPLD, pin 17

## GPIO to Header J8 Interface Mapping

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GPIO	Zynq Pin	J8 Pin		GPIO	Zynq Pin	J8 Pin
GPIO2	K15	3		GPIO15	N13	10
GPIO3	J14	5		GPIO16	L13	36
GPIO4	H12	7		GPIO17	G11	11
GPIO5	N14	29		GPIO18	H11	12
GPIO6	R15	31		GPIO19	R12	35
GPIO7	L14	26		GPIO20	M14	38
GPIO8	L15	24		GPIO21	P15	40
GPIO9	J13	21		GPIO22	H13	15
GPIO19	H14	19		GPIO23	J11	16
GPIO11	J15	23		GPIO24	K11	18
GPIO12	M15	32		GPIO25	K13	22
GPIO13	R13	33		GPIO26	L12	37
GPIO14	M12	8		GPIO27	G12	13

## Default MIO Mapping

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### Bank 500 MIOs

MIO	Function	Notes
0	MIO0_INT	Interrupt signal from I <sup>2</sup> C MUX.
1	SPI0_CS	SPI chip select.
2	SPI0_DQ0/M0	Bi-directional data line 0
3	SPI0_DQ1/M1	Bi-directional data line 1
4	SPI0_DQ2/M2	Bi-directional data line 2
5	SPI0_DQ3/M3	Bi-directional data line 3
6	SPI0_SCK	SPI clock.
7	MIO7	RESETB of USB3320 chip, U18
8	MIO8	System Controller CPLD pin 28
9	MIO9	System Controller CPLD pin 29
10	SD_D0	Serial data 0.
11	SD_CMD	Command/Response.
12	SD_CLK	Serial clock.
13	SD_D1	Serial data 1.
14	SD_D2	Serial data 2.
15	SD_D3	Serial data 3.

### Bank 501 MIOs

MIO	Function	Notes
28	OTG-DATA4	ULPI bi-directional data bus.
29	OTG-DIR	Data bus direction control signal.
30	OTG-STP	Data throttle signal.
31	OTG-NXT	Data stream stop.
32	OTG-DATA0	ULPI bi-directional data bus.
33	OTG-DATA1	ULPI bi-directional data bus.
34	OTG-DATA2	ULPI bi-directional data bus.
35	OTG-DATA3	ULPI bi-directional data bus.
36	OTG-CLK	ULPI clock.
37	OTG-DATA5	ULPI bi-directional data bus.
38	OTG-DATA6	ULPI bi-directional data bus.
39	OTG-DATA7	ULPI bi-directional data bus.
48	MUX_SCL	I <sup>2</sup> C clock to I <sup>2</sup> C MUX.
49	MUX_SDA	I <sup>2</sup> C data to/from I <sup>2</sup> C MUX.
52	MIO52	System Controller CPLD pin 20
53	MIO53	System Controller CPLD pin 21

### LED's

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There are two LEDs on TE0726 module:

LED	Signal Name	Color	CPLD Pin	Notes
D1	GLED	Green	5	CPLD bank 3.
D2	RLED	Red	4	CPLD bank 3.

## On-board Peripherals

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### System Controller CPLD

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There is a System Controller CPLD chip LCMXO2-256HC from Lattice Semiconductor on-board. Refer to the [TE0726 CPLD](#) for more information.

### Clocking

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Signal Name	Clock IC	Default Frequency	Destination IC	Pin	Notes
PS_CLK	U14	33.333333 MHz	U1	C7	Zynq SoC system reference clock.
OSCI	U7	12.000000 MHz	U3	3	FT2232H oscillator input.
CLK24M	U2	24 MHz (see also REFSEL0 .. 2)	U18	26	Reference input/output clock, see datasheet.
CLK25M	U13	25.000000 MHz	U2	61	External 25 MHz crystal input.

### Hi-speed USB 2.0 and 10/100 Mbit Ethernet

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The TE0726-03 has on-board SMSC LAN9514 controller featuring USB 2.0 hub and 10/100 Mbit Ethernet controller. USB hub has four downstream ports and one upstream port, fully compliant with Universal Serial Bus Specification Revision 2.0. HS (480 Mbps), FS (12 Mbps), and LS (1.5 Mbps) compatible. Upstream port is connected to the SMSC USB3320 hi-speed USB 2.0 ULPI transceiver which has full support for the optional On-The-Go (OTG) protocol.


High-Performance 10/100 Ethernet controller integrated into the same LAN9514 IC is fully compliant with IEEE802.3/802.3u standards, has integrated Ethernet MAC and PHY and supports both 10BASE-T and 100BASE-TX media.

256-byte EEPROM is connected via Microwire to the LAN9514 chip to store MAC address.

### USB to JTAG/UART

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The TE0726-03 has on-board high-speed USB 2.0 to UART/FIFO FT2232H controller from FTDI with external connection to micro-USB connector J1. There is also a 256-byte EEPROM wired to the FT2232H chip via Microwire bus which holds pre-programmed license code to support Xilinx programming tools.

 Do not access the FT2232H EEPROM using FTDI programming tools, doing so will erase normally invisible user EEPROM content and invalidate stored Xilinx JTAG license. Without this license the on-board JTAG will not be accessible any more with any Xilinx tools. Software tools from FTDI website do not warn or ask for confirmation before erasing user EEPROM content.

## 4-Channel I<sup>2</sup>C Multiplexer

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Zynq MIO pin 48 (MUX\_SCL) and pin 49 (MUX\_SDA) are connected to the 4-channel I<sup>2</sup>C multiplexer chip TCA9544A from Texas Instruments having I<sup>2</sup>C address of 0x70. It has four slave I<sup>2</sup>C channels which are routed as follows:

Channel	Connected To
0	Connector J8, pin 27 (ID_SDA) and pin 28 (ID_SCL).
1	DSI connector J4, pin 12 (DSI_SDA) and pin 11 (DSI_SCL).
2	HDMI connector J6, pin 16 (SDA) and pin 15 (SCL).
3	CSI-2 camera connector J3, pin 14 (CSI_SDA) and pin 13 (CSI_SCL).

Each slave channel of TCA9544A has its own dedicated interrupt signal in order for the master to detect an interrupt on the INT output pin that can result from any of the slave devices connected to the INT0-INT3 input pins.

## Boot Process

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Xilinx Zynq devices in CLG225 package do not support SD Card boot directly from ROM bootloader.

At least FSBL must be loaded from on-board SPI Flash, later all boot process can continue from SD Card. The easiest solution is to let FSBL to load bitstream and u-boot from SPI Flash, and then let u-boot to load Linux or any other OS image from SD Card.



## Power and Power-On Sequence

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To power-up a module, 5.0V power supply with minimum current capability of 1A is recommended.

### Power Supply

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TE0726 needs one single power source via micro-USB jack J1. However it is recommended to not use any USB equipment below USB standard 2.0 to power the module. Also two-pin header J5 can be used to provide power source if needed.

### Power-On Sequence

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There is no specific power-on sequence, except to achieve minimum current draw, I/Os should be 3-stated at power-on.

### Power Rails and Bank Voltages

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Rail/Bank	Name	Voltage	Notes
VCCINT	VCCINT	1.0V	PL internal supply voltage.
VCCPINT	VCCPINT	1.0V	PS internal logic supply voltage.
VCCPLL	VCCPLL	1.8V	PS PLL supply.
VCCBATT_0	VCCBATT_0	1.8V	
VCCAUX	VCCAUX	1.8V	PL auxiliary supply voltage.
VCCPAUX	VCCPAUX	1.8V	PS auxiliary supply voltage.
VCCADC_0	VCCADC_0	1.8V	
RSVDVCC1..3	RSVDVCC1..3	3.3V	
0	VCCO_0	3.3V	Configuration bank.
34	VCCO_34	3.3V	PL HR I/O bank.
35	VCCO_35	1.8V	PL HR I/O bank.
500	VCC_MIO_500	3.3V	PS MIO bank.
501	VCC_MIO_501	3.3V	PS MIO bank.
502	VCCO_DDR_502	1.35V	DDR3L SDRAM power-supply.

## Variants Currently in Production

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TE0726 Variant	Zynq SoC	RAM	Flash	Ethernet	Temperature Range
TE0726-03R	XC7Z010-1CLG225C	128 MByte	16 MByte	-	Commercial grade
TE0726-03M	XC7Z010-1CLG225C	512 MByte	16 MByte	10/100 Mbit	Commercial grade
TE0726-03-07S-1C	XC7Z007S-1CLG225C	512 MByte	16 MByte	10/100 Mbit	Commercial grade

## Technical Specifications

If TE0726 module is powered by micro-USB connector J1  $V_{BUS}$  pin, which voltage level is controlled by supplying host according to the USB standards and should be 5V, there is not much user can control here if using standard USB equipment. However, user can also power the module by applying voltage to the J5 connector from other external sources. In both cases following maximum voltage ratings apply.

### Absolute Maximum Ratings

Parameter	Min	Max	Units	Notes
Power supply voltage J1: USB_V_BUS J5: 5V	4.75	5.25	V	-
$V_{OUT}$ of AP2152SG-13	-	$V_{IN} + 0.3$	V	Output voltage.
$I_{LOAD}$ of AP2152SG-13	-	Internal limited	A	Maximum continuous load current.
PS MIO input voltage	-0.4	$V_{CCO\_MIO} + 0.55$	V	$V_{CCO\_MIO0\_500}$ and $V_{CCO\_MIO1\_501}$ .
PL Bank 34 I/O input voltage	-0.4	$V_{CCO\_34} + 0.55$	V	-
PL Bank 35 I/O input voltage	-0.4	$V_{CCO\_35} + 0.55$	V	-
Storage temperature	-55	+125	°C	-

See also the Xilinx datasheet DS187 for more information about absolute maximum ratings.

### Recommended Operating Conditions

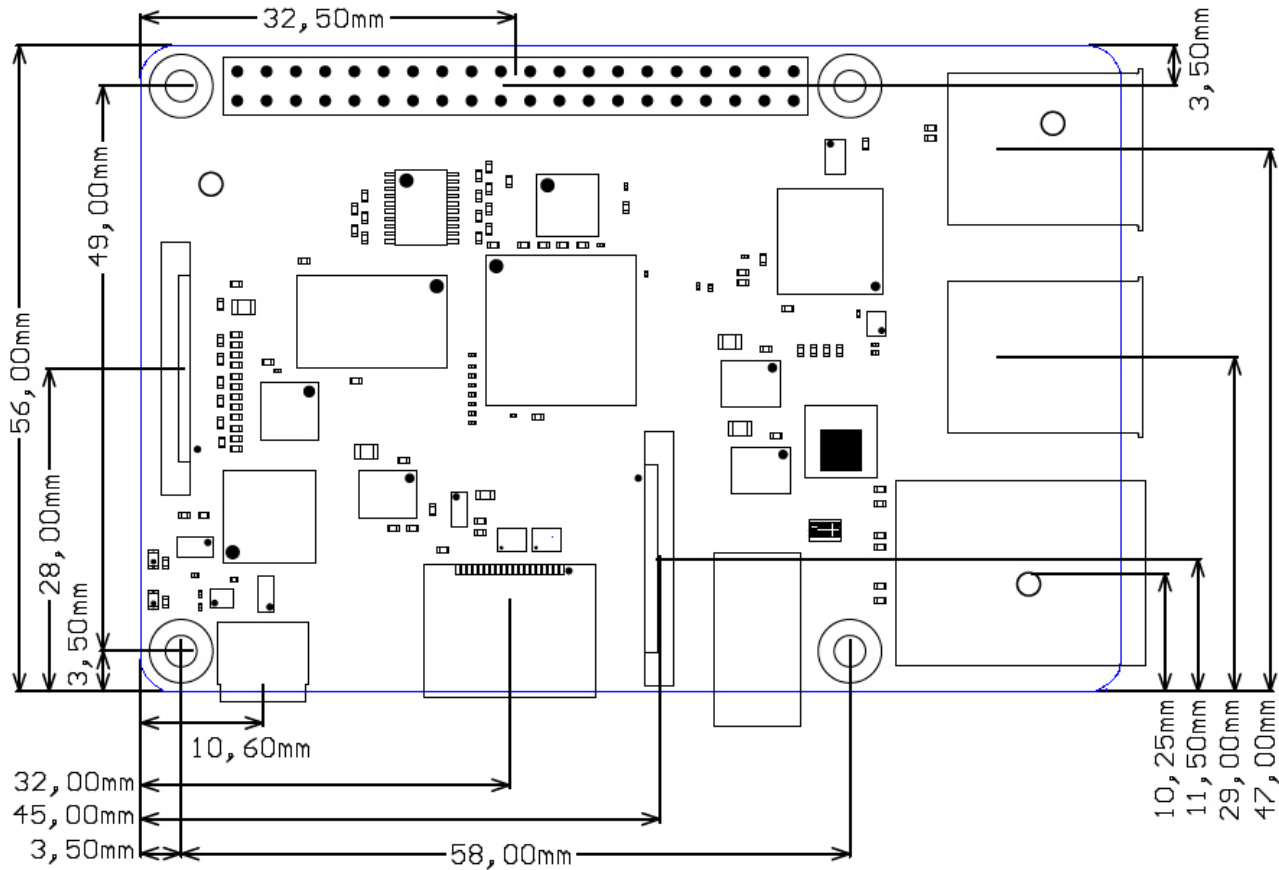
Parameter	Min	Max	Units	Notes
Power supply voltage	4.75	5.5	V	See AP2152SG-13 datasheet.
$I_{OUT}$ of AP2152SG-13	0	500	mA	-
PS MIO input voltage	-0.2	$V_{CCO\_MIO} + 0.2$	V	$V_{CCO\_MIO0\_500}$ and $V_{CCO\_MIO1\_501}$ .
PL Bank 34 I/O input voltage	-0.2	$V_{CCO\_34} + 0.2$	V	-
PL Bank 35 I/O input voltage	-0.2	$V_{CCO\_35} + 0.2$	V	-
Operating temperature	0	70	°C	See LAN9514 datasheet.

The module operating temperature range depends on customer design and cooling solution. Please contact us for options.

## Physical Dimensions

- Module size: 40 mm x 30 mm. Please download the assembly diagram for exact numbers.
- Mating height with standard connectors: 8 mm
- 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 millimeters. Additional sketches, drawings and schematics can be found [here](#).



## Weight

Variant	Weight in g	Note
TE0726-03M	---	Plain module.
TE0726-03R	---	Plain module.
TE0726-03-07S-1C	---	Plain module.

# Revision History

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## Hardware Revision History

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Date	Revision	Notes	PCN Link	Documentation Link
2016-05-06	03	-	-	<a href="#">TE0726-03</a>
2016-01-26	02	-	-	<a href="#">TE0726-02</a>
-	01	-	-	

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



## Document Change History

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Date	Revision	Contributors	Description
2017-05-24	V.3	Jan Kumann	Absolute maximum ratings. Layout redesign.
2017-05-24	V.2	John Hartfiel	Weight.
2017-05-24	V.1	Jan Kumann	Initial version.

# Disclaimer

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## Document Warranty

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## Environmental Protection

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To confront directly with the responsibility toward the environment, the global community and eventually also oneself. Such a resolution should be integral part not only of everybody's life. Also enterprises shall be conscious of their social responsibility and contribute to the preservation of our common living space. That is why Trenz Electronic invests in the protection of our Environment.



## REACH, RoHS and WEEE

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### REACH

Trenz Electronic is a manufacturer and a distributor of electronic products. It is therefore a so called downstream user in the sense of [REACH](#). 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 List](#) 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 \(ECHA\)](#).

### 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.