TEI0026 - TRM

Revision v.11

Exported on 2020-07-16

Online version of this document:

https://wiki.trenz-electronic.de/display/DRAFT/TEI0026+-+TRM

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4 Overview

The Trenz Electronic TEI0026-01 is the Power Card 2 which delivers the possibility to change an input voltage from 5 V to lower voltages. With the assembled Intel Max 10 it is possible to select the output voltages and to realize power sequences.

Refer to http://trenz.org/tei0026-info for the current online version of this manual and other available documentation.

4.1 Key Features

- **Intel MAX 10**
  - Package: U169
  - Speed: 8
  - Temperatur: C8
- **On Board**
  - EP53A7LQI - 1 A
  - EP53A7HQI - 1 A
  - EP5348UI - 0.4 A
  - EP5388QI - 0.8 A
  - 4x LED
  - 2x Button
  - 4x DIP Switch
  - Current Sense Amplifier
  - Oscillator
- **Interface**
  - Pin Header (not assembled)
  - Screw Connector (not assembled)
  - Voltage Rails
  - 2x GPIO
  - 1x ADC Input
  - Current Sense Amplifier
  - USB to JTAG
- **Power**
  - 5.0 V Input Voltage
- **Dimension**
  - 48 mm x 35 mm
- **Notes**
  - Firmware dependent power setting

4.2 Block Diagram

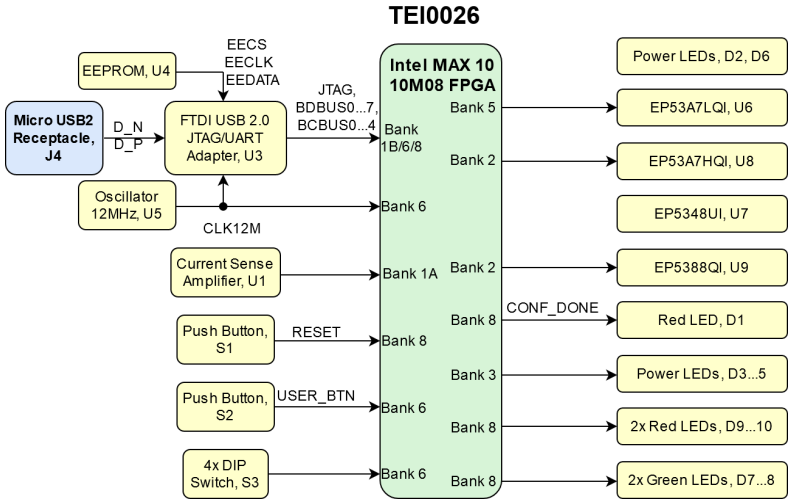

Figure 1: TEI0026 block diagram

4.3 Main Components

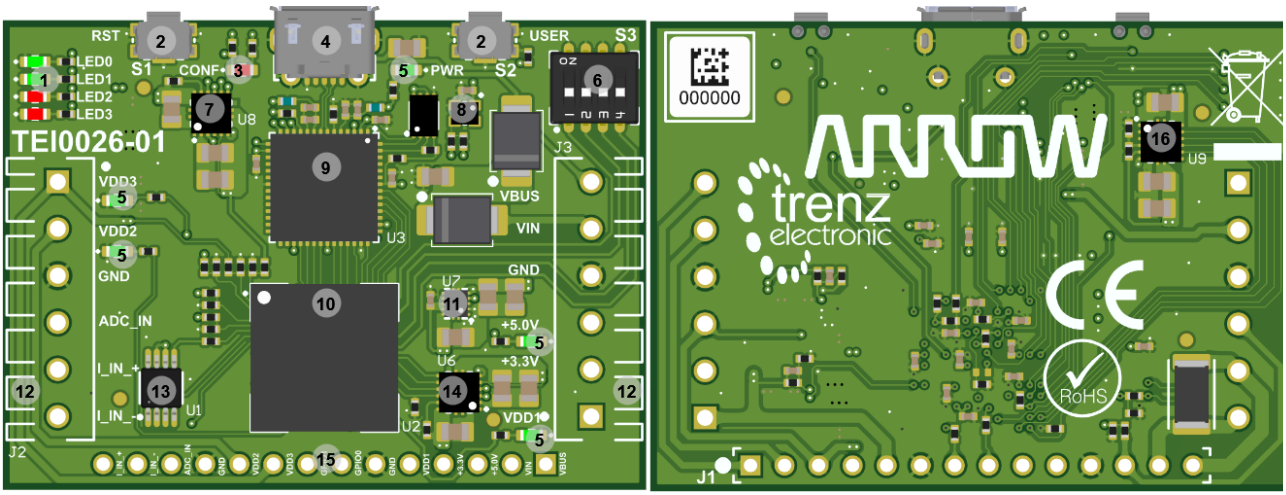

Figure 2: TEI0026 main components

1. LED (2x Green, 2x Red), D7...10
2. Button, S1...2
3. LED (Conf), D1
4. MicroUSB Connector, J4
5. Power LED, D2...6
6. DIP-Switch, S3
7. DC-DC Converter EP53A7HQI, U8
8. Oscillator, U5
9. FTDI USB to JTAG Adapter, U3
10. Intel MAX 10, U2
11. DC-DC Converter EP5348UI, U7
12. Screw Connector (not assembled), J2...3
13. Current Sense Amplifier, U1
14. DC-DC Converter EP53A7LQI, U6
15. 1x14 Pin Header (not assembled), J1
16. DC-DC Converter EP5388QI, U9

4.4 Initial Delivery State

Storage device name	Content	Notes
EEPROM	Programmed	FTDI Configuration
System Controller CPLD	Programmed	Firmware

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

4.5 Configuration Signals

The Intel MAX 10 configuration can be writen via the USB to JTAG adapter.

Reset process can be initiated by pressing the push button S1.

Signal	Push Button	Note
Reset	S1	

Table 2: Reset process.

5 Signals, Interfaces and Pins

5.1 Connector I/Os

The board contains the option for one pin header (J1) and two screw connectors (J2...3) which are not assembled. Despite, the I/Os are usable and described below.

Connector	Connection	Direction	Intel MAX 10	Voltage Level	Notes
J1 - 1	USB_VBUS	Out	-	+5.0 V	
J1 - 2	VIN	In	-	+5.0 V	Power Supply Option
J1 - 3	+5.0V	Out	-	+5.0 V	
J1 - 4	+3.3V	Out	-	+3.3 V	
J1 - 5	VDD1	Out	-	-	Firmware dependent voltage
J1 - 6	GND	-	-	-	
J1 - 7	GPIO0	In/Out	Bank 3, Pin N9	+3.3 V	
J1 - 8	GPIO1	In/Out	Bank 3, Pin M5	+3.3 V	
J1 - 9	VDD3	Out	-	-	Firmware dependent voltage
J1 - 10	VDD2	Out	-	-	Firmware dependent voltage
J1 - 11	GND	-	-	-	
J1 - 12	ADC	In	Bank 1A, Pin F1	+3.3 V	Analog Input
J1 - 13	I_IN_-	In/Out	-	-	
J1 - 14	I_IN_+	In/Out	-	-	

Table 3: Pin Header connectors information

Connector	Connection	Direction	Intel MAX 10	Voltage Level	Notes
J2 - 1	VDD3	Out	-	-	Firmware dependent voltage
J2 - 2	VDD2	Out	-	-	Firmware dependent voltage
J2 - 3	GND	-	-	-	
J2 - 4	ADC	In	Bank 1A, Pin F1	+3.3 V	Analog Input
J2 - 5	I_IN_+	In/Out	-	-	
J2 - 6	I_IN_-	In/Out	-	-	
J3 - 1	VDD1	Out	-	-	Firmware dependent voltage
J3 - 2	+3.3V	Out	-	+3.3 V	
J3 - 3	+5.0V	Out	-	+5.0 V	
J3 - 4	GND	-	-	-	
J3 - 5	VIN	In	-	+5.0 V	Power Supply Option
J3 - 6	USB_VBUS	Out	-	+5.0 V	

Table 4: Screw connectors information

5.2 JTAG Interface

JTAG access to the TEI0026 is available throught the USB to JTAG adapter connected to microUSB connector J4.

6 On-board Peripherals

Chip/Interface	Designator	Notes
Intel MAX 10(see page 11)	U2	
EP53A7LQI(see page 12)	U6	
EP5348UI(see page 12)	U7	
EP53A7HQI(see page 12)	U8	
EP5388QI(see page 13)	U9	
Current Sense Amplifier(see page 14)	U1	
FTDI USB to JTAG Adapter(see page 14)	U3	
EEPROM(see page 14)	U4	FTDI configuration
Oscillator(see page 14)	U5	
Button(see page 14)	S1...2	
DIP Switch(see page 14)	S3	
LED(see page 14)	D1...10	

Table 5: On board peripherals

6.1 Intel MAX 10

The TEI0026 contains an Intel MAX 10 (U2) for board management. Therefore, the final board configuration is firmware dependent. The firmware controls the output voltages, the user LEDs, push buttons, and the DIP switches. Furthermore, the voltages can be measured with this system controller, the current amplifier can be handled, and the GPIOs can be used.

6.2 EP53A7LQI

The EP54A7LQI (U6) is an Intel PowerSoC step-down DC-DC switching converter with integrated inductor. According to the datasheet, the efficiency is up to 94 % and it delivers up to 1000 mA. The converter delivers an output range of 0.6 V to VIN - 0.5 V. This output range can be set via the three input signals according to the next table or via an external resistor divider. Furthermore, a light load mode is available. The final output voltage is firmware dependent.

VS2	VS1	VS0	Voltage	Notes
0	0	0	1.50 V	
0	0	1	1.45 V	
0	1	0	1.20 V	
0	1	1	1.15 V	
1	0	0	1.10 V	
1	0	1	1.05 V	
1	1	0	0.80 V	
1	1	1	-	External Voltage Divider - 1.0 V

Table 6: EP53A7LQI Voltage Selection

6.3 EP5348UI

The EP5348UI (U7) is an Intel PowerSoC step-down DC-DC switching converter with integrated inductor. According to the datasheet, the efficiency is up to 90 % and it delivers up to 400 mA. The converter delivers an +3.3 V output for board power supply.

6.4 EP53A7HQI

The EP54A7HQI (U8) is an Intel PowerSoC step-down DC-DC switching converter with integrated inductor. According to the datasheet, the efficiency is up to 94 % and it delivers up to 1000 mA. The converter delivers an output range of 0.6 V to VIN - 0.5 V. This output range can be set via the three input signals according to the next table. Furthermore, a light load mode is available. The final output voltage is firmware dependent.

VS2	VS1	VS0	Voltage	Notes
0	0	0	3.3 V	

VS2	VS1	VS0	Voltage	Notes
0	0	1	3.0 V	
0	1	0	2.9 V	
0	1	1	2.6 V	
1	0	0	2.5 V	
1	0	1	2.2 V	
1	1	0	2.1 V	
1	1	1	1.8 V	

Table 7: EP53A7HQI Voltage Selection

6.5 EP5388QI

The EP5388QI (U9) is an Intel PowerSoC step-down DC-DC switching converter with integrated inductor. According to the datasheet, the efficiency is up to 94 % and it delivers up to 800 mA. The converter delivers an output range of 0.6 V to VIN - 0.5 V. This output range can be set via the three input signals according to the next table or via an external resistor divider. The final output voltage is firmware dependent.

VS2	VS1	VS0	Voltage	Notes
0	0	0	3.3 V	
0	0	1	2.5 V	
0	1	0	1.8 V	
0	1	1	1.5 V	
1	0	0	1.25 V	
1	0	1	1.2 V	
1	1	0	0.8 V	
1	1	1	-	External Voltage Divider - 1.35 V

Table 8: EP5388QI Voltage Selection

6.6 Current Sense Amplifier

The current sense amplifier (U1) is a bidirectional designed, zero drift, current sense amplifier with an inital gain of 60 V/V. It is connected to the Intel MAX 10. The final usage is firmware dependent.

6.7 FTDI USB to JTAG Adapter

The FTDI USB to JTAG Adapter (U3) realizes the connection between the USB connector and the Intel MAX 10. Via this connection the Intel MAX 10 can be handled.

6.8 EEPROM

The EEPROM (U4) contains the configuration for the FTDI USB to JTAG Adapter (U3).

6.9 Oscillator

The oscillator (U5) delivers a 12 MHz clock to the FTDI USB to JTAG Adapter (U3) and to the Intel MAX 10 (U2) bank 6 pin G9.

6.10 Button

The TEI0026 contains two buttons. Button S1 is used as reset button while button S2 is used as user button connected to the Intel MAX 10 bank 6 pin C12. The usage of the user button is firmware dependent.

6.11 DIP Switch

A DIP Switch (S3) with four switches is installed on TEI0026 which is connected to the Intel MAX 10 according to the following table. The final usage is firmware dependent.

Switch	Connected to Intel MAX 10	Position	Logical State	Note
S3A	Bank 6, Pin B13	OFF	High - 1	
S3B	Bank 6, Pin C13	OFF	High - 1	
S3C	Bank 6, Pin E13	OFF	High - 1	
S3D	Bank 6, Pin F13	OFF	High - 1	

Table 9: DIP Switch

6.12 LED

The TEI0026 contains ten LEDs (D1...10). One LED is for the configuration status (D1), five LEDs are for the power status (D2....6) whereby LEDs D3...5 are connected to the Intel MAX 10 and four LEDs are user LEDs (D7...10). The

connection is visible in the next table and the final usage is firmware dependent for LEDs connected to the Intel MAX 10.

Designator	Color	Connected to	Active Level	Note
D1	Red	Intel MAX 10 bank 8, pin C5	Active low	Configuration LED
D2	Green	+3.3V	Active high	Power Status
D3	Green	Intel MAX 10 bank 3, pin N5	Active high	Power Status
D4	Green	Intel MAX 10 bank 3, pin N4	Active high	Power Status
D5	Green	Intel MAX 10 bank 3, pin M13	Active high	Power Status
D6	Green	+5.0V	Active high	Power Status
D7	Green	Intel MAX 10 bank 8, pin A4	Active high	User LED
D8	Green	Intel MAX 10 bank 8, pin A3	Active high	User LED
D9	Red	Intel MAX 10 bank 8, pin A2	Active high	User LED
D10	Red	Intel MAX 10 bank 8, pin B2	Active high	User LED

Table 10: On-board LEDs

7 Power and Power-On Sequence

7.1 Power Supply

Power supply with minimum current capability of 1 A for system startup is recommended.

7.2 Power Consumption

Power Input Pin	Typical Current
VIN	TBD*

Table 11: Power Consumption
* TBD - To Be Determined

7.3 Power Distribution Dependencies

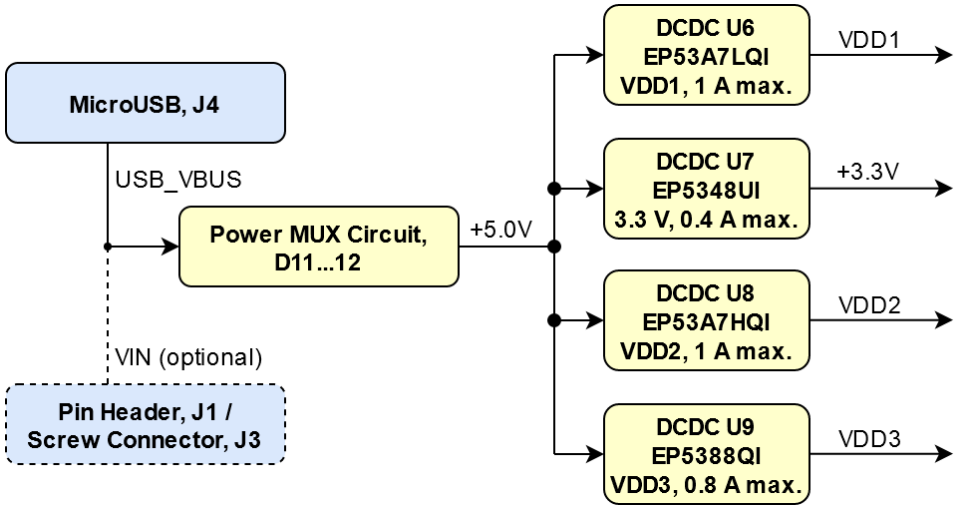

Figure 3: Power Distribution

7.4 Power-On Sequence

After connecting the USB connector to an external device or inserting VIN via the connector, +3.3 V should be generated. The further power-on sequence is firmware dependent.

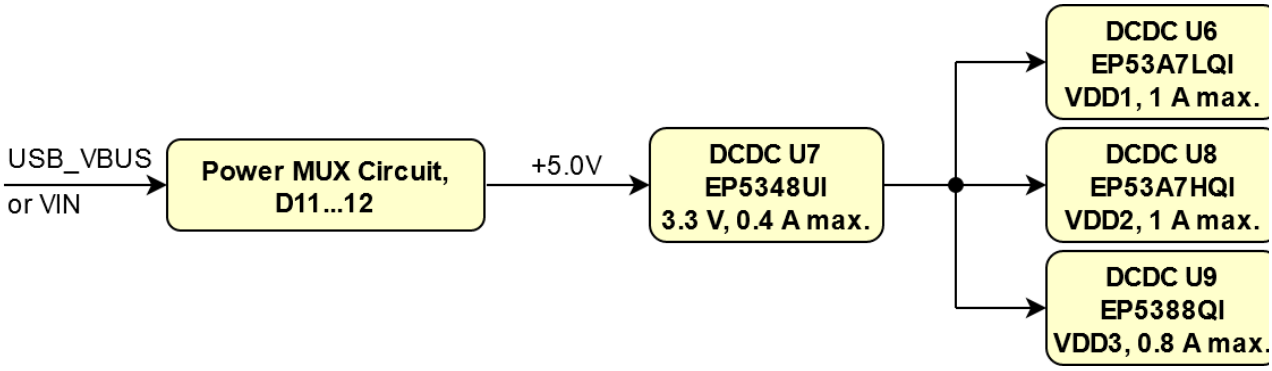

Figure 4: Power Sequency

7.5 Voltage Monitor Circuit

Generally, the Intel MAX 10 is capable to monitor voltages because some voltages are connected to the integrated ADCs. This voltage monitoring is firmware dependent.

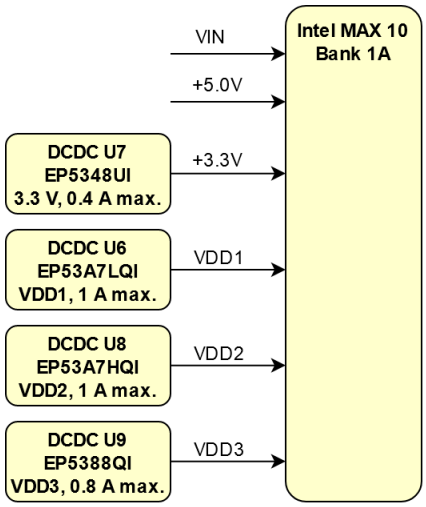

Figure 5: Voltage Monitor Circuit

7.6 Power Rails

Power Rail Name	Pin Header, J1 Pin	Screw Connector J2 Pin	Screw Connector J3 Pin	Direction	Notes
VIN	2	-	5	In	
USB_VBUS	1	-	6	Out	

Power Rail Name	Pin Header, J1 Pin	Screw Connector J2 Pin	Screw Connector J3 Pin	Direction	Notes
+5.0V	3	-	3	Out	
+3.3V	4	-	2	Out	
VDD1	5	-	1	Out	
VDD2	10	2	-	Out	
VDD3	9	1	-	Out	

Table 12: Board power rails.

7.7 Bank Voltages

Bank	Schematic Name	Voltage	Notes
1A	+3.3V	+3.3 V	
1B	+3.3V	+3.3 V	
8	+3.3V	+3.3 V	
6	+3.3V	+3.3 V	
2	+3.3V	+3.3 V	
5	+3.3V	+3.3 V	
3	+3.3V	+3.3 V	

Table 13: Intel MAX 10 bank voltages.

8 Technical Specifications

8.1 Absolute Maximum Ratings

Symbols	Description	Min	Max	Unit	Note
VIN	Power Supply	-	6	V	
GPIO0	GPIO	0	4	V	
GPIO1	GPIO	0	4	V	
ADC	ADC Input	0	6	V	
I_IN-	Current Sense Amplifier	-3.0	80.0 5.5	V V	Common mode (I_IN-/I_IN+) Differential
I_IN+	Current Sense Amplifier	-3.0	80.0 5.5	V 5.5	Common mode (I_IN-/I_IN+) Differential

Table 14: Absolute maximum ratings

8.2 Recommended Operating Conditions

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

Parameter	Min	Max	Units	Reference Document
VIN	4.75	5.25	V	
GPIO0	0	3.3	V	See Intel MAX 10 datasheet.
GPIO1	0	3.3	V	See Intel MAX 10 datasheet.
ADC	0	5.5	V	See Intel MAX 10 datasheet.

Table 15: Recommended operating conditions.

8.3 Physical Dimensions

Module size: 48 mm × 35 mm. Please download the assembly diagram for exact numbers.

PCB thickness: 1.6 mm.

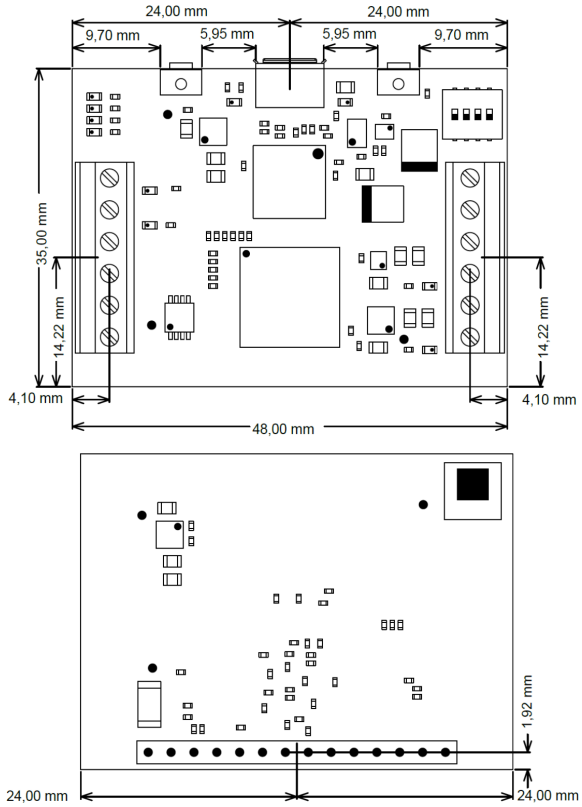

Figure 6: Physical Dimension

9 Currently Offered Variants

Trenz shop TEI0026 overview page	
English page[1]	German page[2]

Table 16: Trenz Electronic Shop Overview

1 https://shop.trenz-electronic.de/en/search?sSearch=TEI0026
2 https://shop.trenz-electronic.de/de/search?sSearch=TEI0026

10 Revision History

10.1 Hardware Revision History

Date	Revision	Changes	Documentation Link
2020-04-02	01		

Table 17: Hardware Revision History
Hardware revision number can be found on the PCB board together with the module model number separated by the dash.

Figure 7: Board hardware revision number.

10.2 Document Change History

Date	Revision	Contributor	Description
2020-04-03	v.11 (see page 6)	ED[3]	• Initial Release
--	all	ED[4]	• --

Table 18: Document change history.

3 https://wiki.trenz-electronic.de/display/~e.dyck
4 https://wiki.trenz-electronic.de/display/~e.dyck

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2019-06-07

5 http://guidance.echa.europa.eu/
6 https://echa.europa.eu/candidate-list-table
7 http://www.echa.europa.eu/