CONCLUSIVE ENGINEERING

RCHD-PF-EVAL Datasheet

Version 2.0

- 2x PCIe x1 M.2 (Key-M & Key-E)
- 1x PCIe x1 edge connector
- 2x 1Gbit/s Ethernet
- 1x 10Gbit/s SFP+
- MicroUSB OTG and console
- 1x HDMI
- MIPI-DSI2 camera connector
- Programmable LEDs and switches
- Raspberry Pi compatible 40-pin connector

Table of Contents:

1. List of tables

2. Revision history

Table 2.1 Revision History

Revision	Date	Notes
1.0	Mar 19, 2021	Initial - Preliminary
1.1	Apr 26, 2022	Review and detailed update of all sections
1.2	May 30, 2022	Minor fixes, added USB connectors types

3. Overview

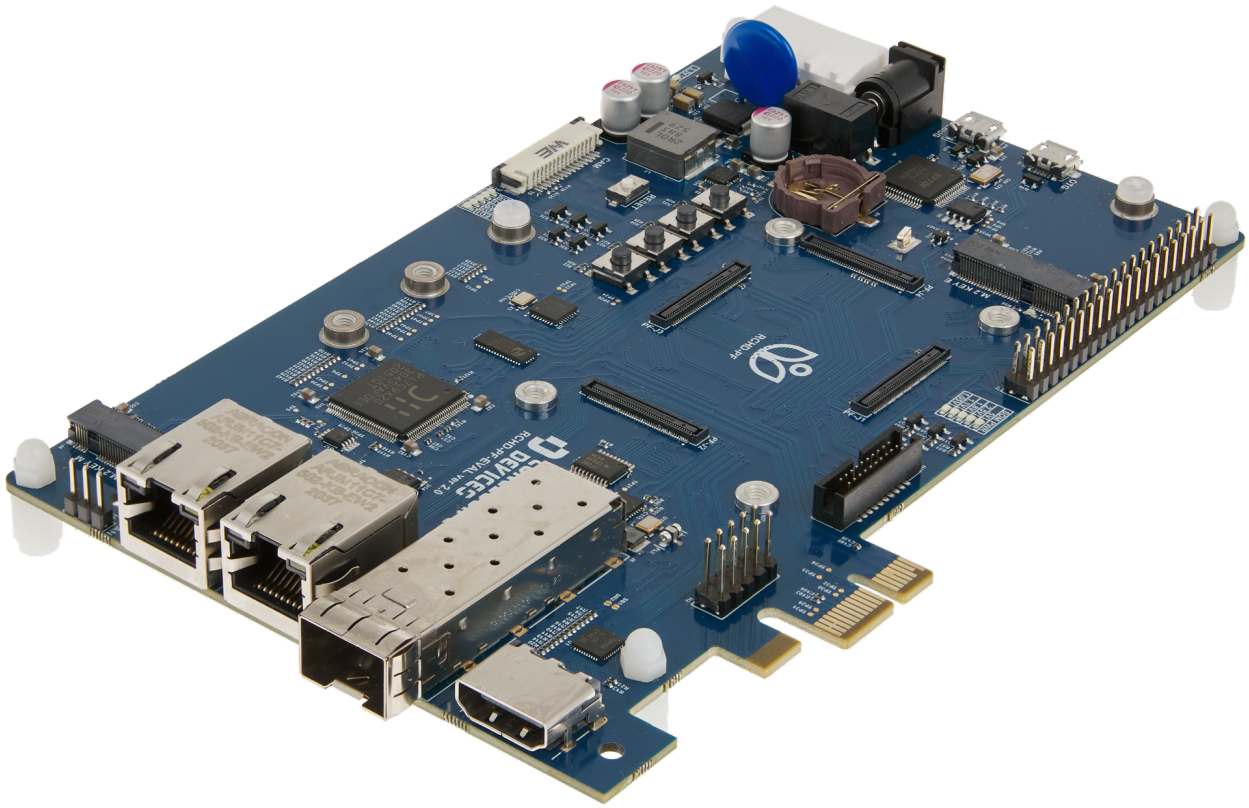

Fig. 3.1 RCHD-PF-EVAL daughterboard.

Conclusive Engineering RCHD-PF-EVAL Evaluation Board is a daughterboard for the Orchid RCHD-PF series System on Module.

It breaks out RCHD-PF's features to industry standard connectors. It is also a technological demo of RCHD-PF's feature expansion capabilities, and provides a base development platform that allows an easy start with the diminutive SoM.

RCHD-PF-EVAL can also be connected as a device to a standard PCIe port using an edge connector, and fits in standard PC cases and motherboards. This allows for easy prototyping, deployment and management of existing solutions that utilize the RCHD-PF System on Module - including circumstances where high availability of serviced equipment is of critical importance.

We can create a customized variant of RCHD-PF-EVAL that suits your needs, or design a completely different daughterboard that's made to measure.

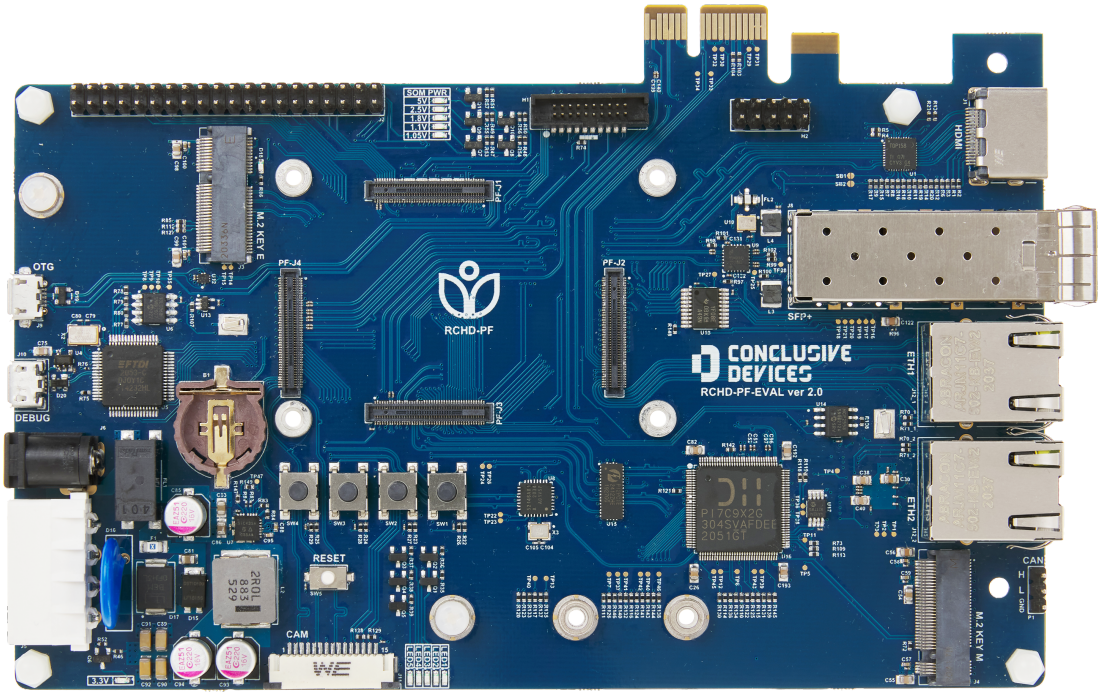

Fig. 3.2 RCHD-PF-EVAL daughterboard TOP view.

4. Features of RCHD-PF-EVAL

- RCHD-PF Evaluation Board is compatible with an entire lineup of the RCHD-PF System On Module based on the PolarFire SoC FPGA
- Debug interface: FlashPro6 JTAG connector and Conclusive Developer Cable
- **Expansion Connectors:**
    - Raspberry Pi compatible 40 pin header connector,
- **Communication Connectors:**
    - 1x 10GbE SFP+
    - 2x 1GbE RJ-45
    - 1x PCIe M.2 Key-M x1
    - 1x PCIe M.2 Key-E x1
    - 1x PCIe x1 edge card connector
    - 1x micro USB-B console
    - 1x micro USB-AB OTG
- **Display Interface:**
    - HDMI
- **Camera interface:**
    - MIPI-DSI2 - compatible with Raspberry Pi camera connector
- **User programmable headless iterface:**
    - 4x general purpose switch
    - 5x LED diode
- CR1220 battery connector for VBAT input source in RTC on SOM,
- **Power supply:**
    - 1x 2.5x5.5 DC Jack barrel connector, 12V DC, 7.5A
    - 1x 4-pin Molex power input
- Operational temperature range: 0 to +70°C (excluding CR1220 battery).
- Board size: 167.64 mm x 106.65mm x 20mm

5. Block diagram

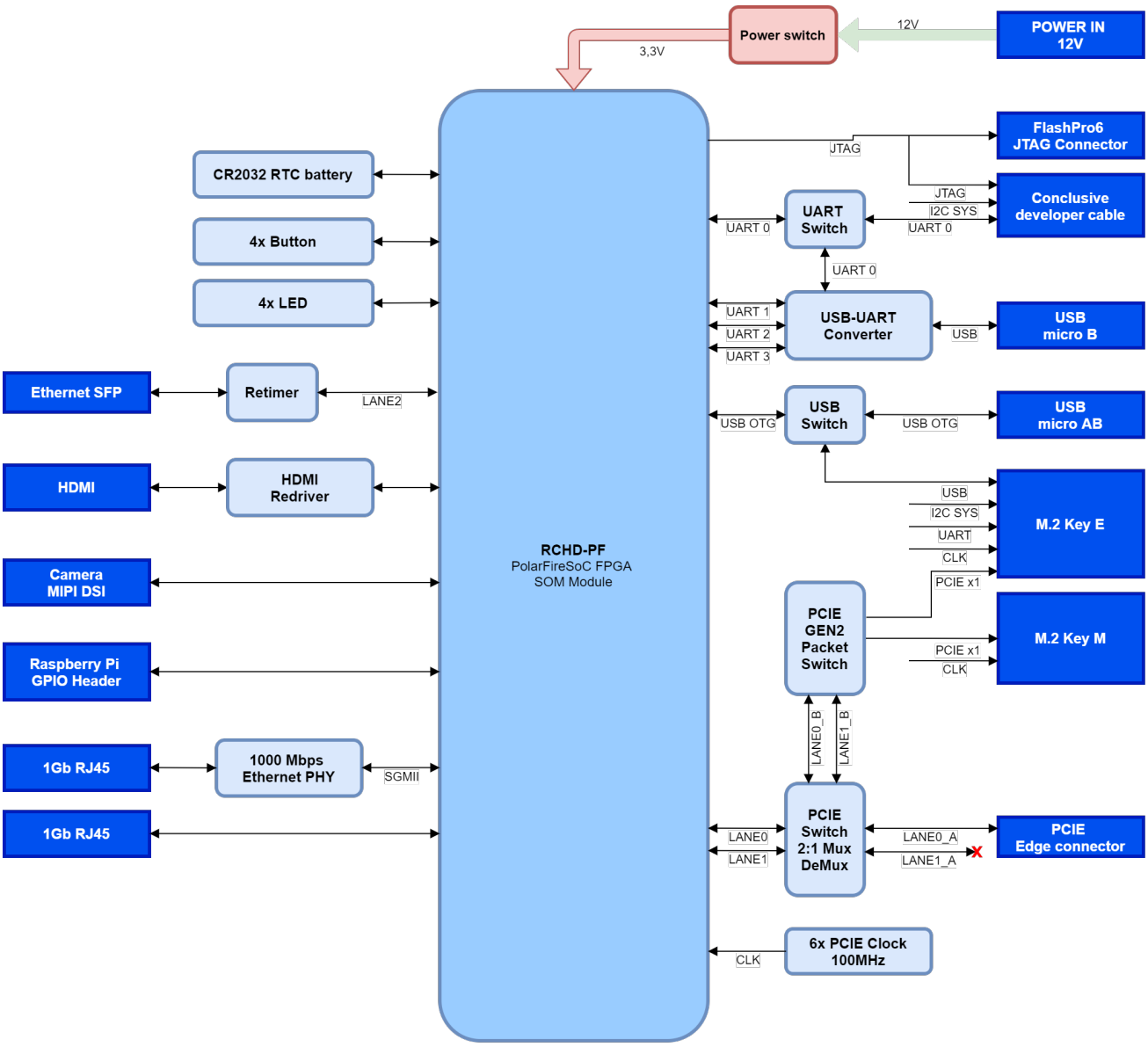

Fig. 5.1 Conclusive Engineering RCHD-PF-EVAL module block diagram.

6. Main hardware components

6.1. User-Programmable LEDs and Buttons

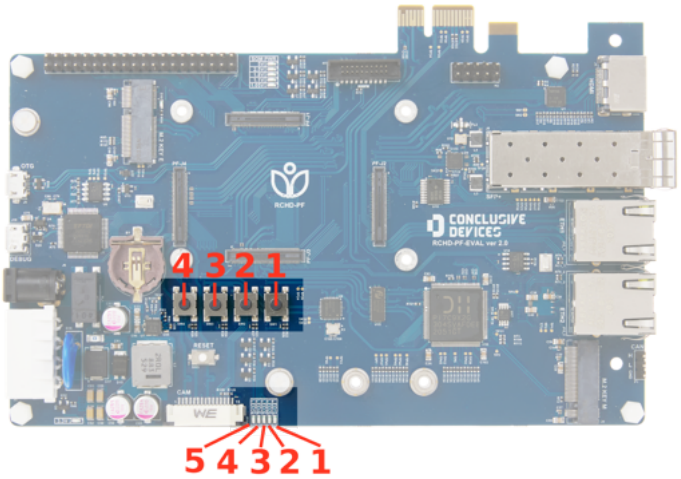

Fig. 6.1 User-programmable LEDs and buttons on the RCHD-PF-EVAL board.

4 user-programmable switches, and 5 user-programmable green LEDs. They are directly connected to HSIO pins of the RCHD-PF SoM via board-to-board connector J4.

Table 6.1 LEDs and buttons, user programmable

Signal Name	GPIO	SoC Ball	Description
LED_1	HSIO80_P	Y19	LED 0 pin
LED_2	HSIO71_P	AB21	LED 1 pin
LED_3	HSIO71_N	AA20	LED 2 pin
LED_4	HSIO80_N	Y18	LED 3 pin
LED_5	HSIO69_N	AA22	LED 4 pin
BUTTON_1	HSIO73_P	T16	Button 0 pin
BUTTON_2	HSIO83_N	W17	Button 1 pin

Signal Name	GPIO	SoC Ball	Description
BUTTON_3	HSIO83_P	W16	Button 2 pin
BUTTON_4	HSIO69_P	AA21	Button 3 pin

6.2. CR1220 RTC Battery Holder

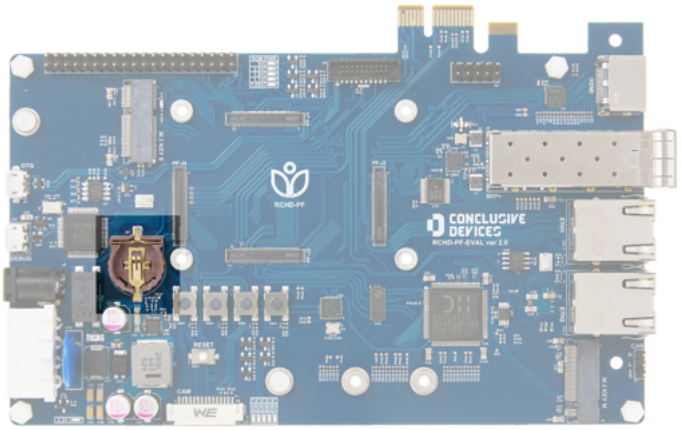

Fig. 6.2 CR1220 RTC battery holder

CR1220 RTC battery holder. The battery is used to power the Real Time Clock on SoM via connector J3, pin 2.

6.3. Reset switch

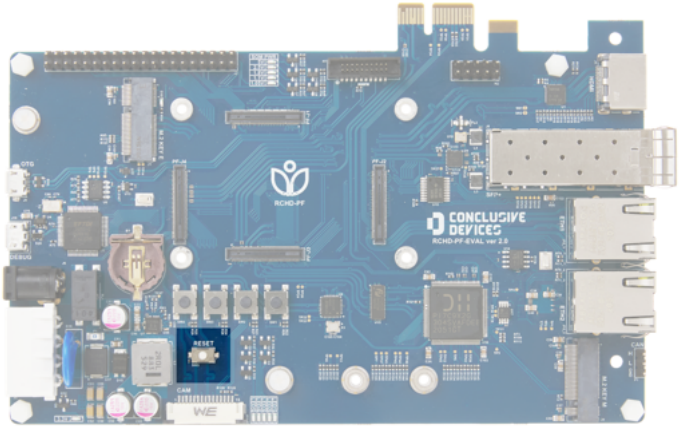

Fig. 6.3 Reset Switch

Reset switch. Pressing it pulls down the Enable pin on a Vishay SIC431AED-T1-GE3 Buck Regulator, causing a hard power cycle od the whole assembly.

6.4. 3.3V Power indicator LED

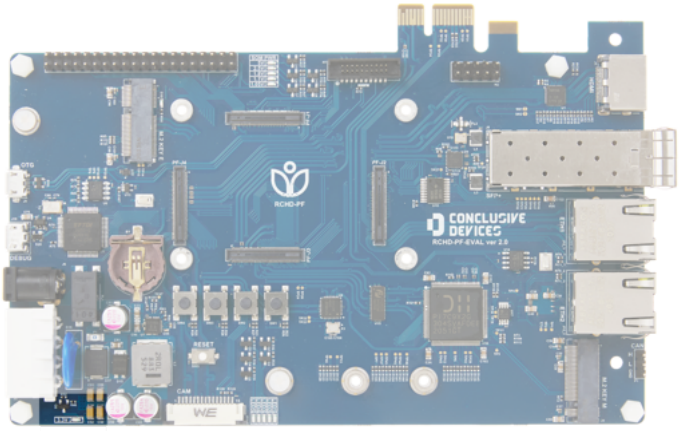

Fig. 6.4 3.3V power indicator LED

A green 3.3V power indicator LED. Lights up when the 3.3V power section is available.

6.5. SoM Power Status LEDs group

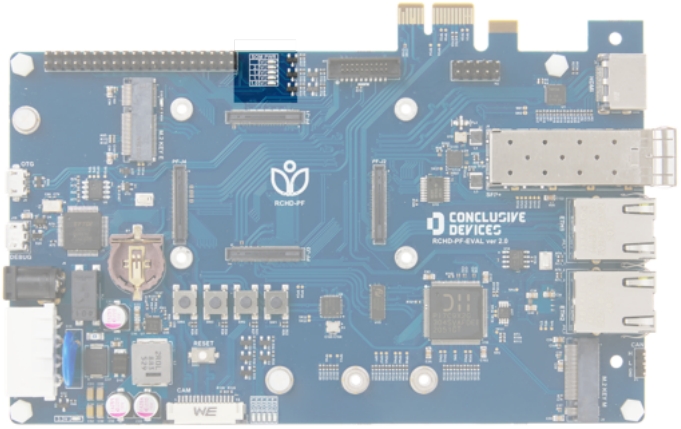

Fig. 6.5 SoM power status indicator LEDs

5 green LEDs indicating status of power sections of the SoM. The available sections are, from the top: 5V, 2.5V, 1.8V, 1.1V, and 1.05V, as described on the board silkscreen.

6.6. PCIe signal and packet switches

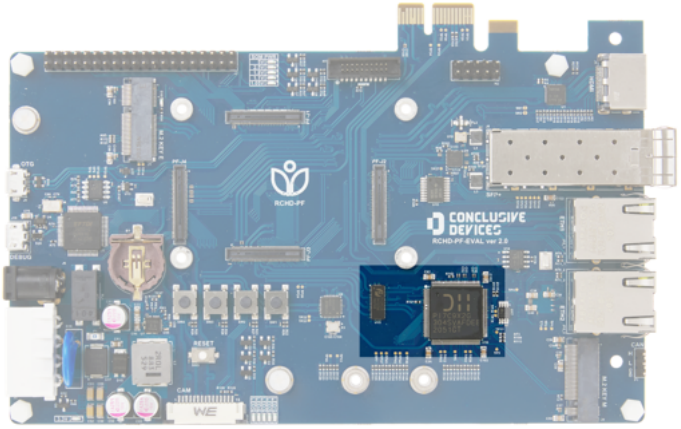

Fig. 6.6 PCIe switch

Diodes Incorporated PI7C9X2G304SVAFDEEX Gen2 PCIe signal switch, and a Pericom PI2PCIE2412ZHEX Packet Switch.

The Signal Switch changes the currently active PCIe device between:

- PCIe Edge Connector
- PCIe Switch for the two M.2 On-board Connectors

As a result, the PCIe Edge Connector cannot be used simultaneously with the M.2 On-board Connectors, and vice versa. To control the PCIe switch, please use the following table:

Table 6.2 PCIe switch pins and states

Signal Name	GPIO	SoC Ball	Pin state	Description
PCI_SWITCH_SEL	GPIO5_P	A15	1	Edge connector enabled
PCI_SWITCH_SEL	GPIO5_P	A15	0	Packet switch for M.2 connectors enabled

M.2 On-board Connectors connected via the PCIe Packet Switch utilize 2 PCIe lanes, one per M.2 connector. The Edge Connector utilizes a single PCIe lane only.

6.7. 32Kbit EEPROM

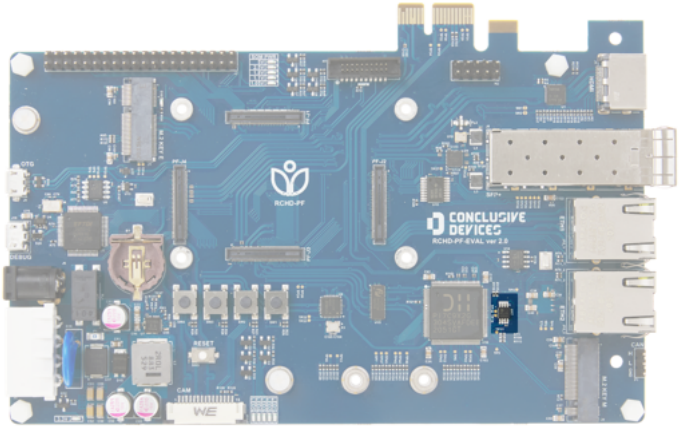

Fig. 6.7 32Kbit EEPROM

Microchip 24AA32A 32Kbit EEPROM for the PI7C9X2G304SVAFDEEX Gen2 PCIe switch.

6.8. USB to UART IC

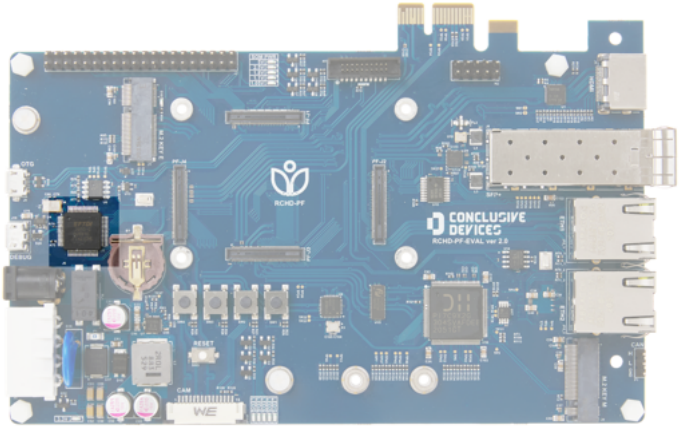

Fig. 6.8 USB to Multipurpose UART

FTDI FT4232H Hi Speed USB 2.0 to Multipurpose UART circuit. Responsible for handling UART communication for the USB-UART port.

6.9. 2Kbit EEPROM

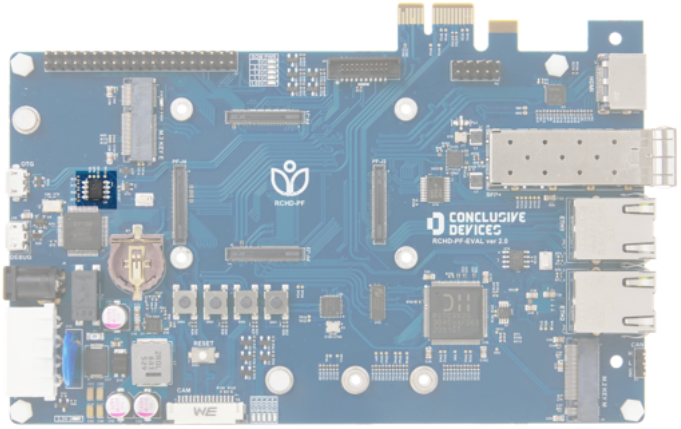

Fig. 6.9 2Kbit EEPROM

Microchip 93LC56 2Kbit EEPROM for the FTDI FT4232H UART circuit.

6.10. Fast Acting Fuse

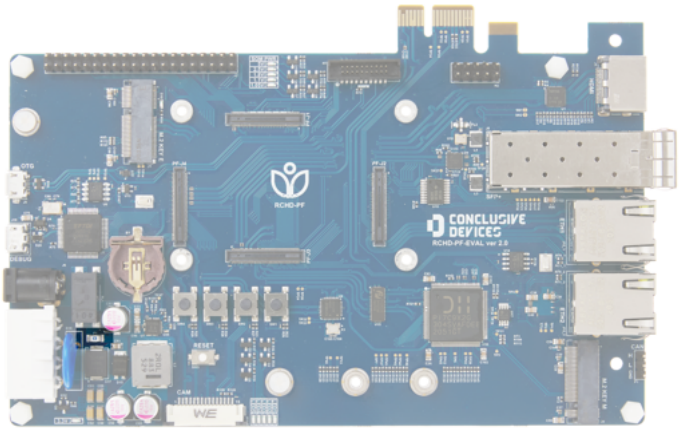

Fig. 6.10 Fast acting fuse

Littelfuse 0437008.WR Fast Acting 8A 32V Fuse on the 12V current power line from Jack and Molex power connectors.

7. External Connectors

7.1. HDMI

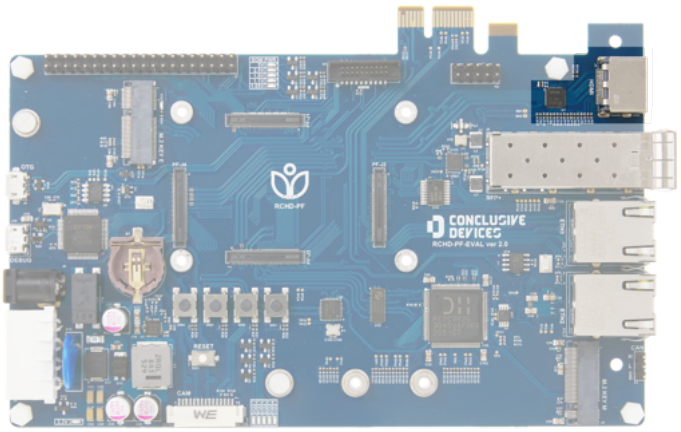

Fig. 7.1 HDMI on the RCHD-PF-EVAL board.

One HDMI connector, driven by a Texas Instruments TDP158RSBR HDMI Redriver, visible on the board just behind the connector.

Table 7.1 HDMI pinout

Signal Name	GPIO	SoC Ball	Description
D0+	HSIO90_P	V14	HDMI lane 0 positive
D0-	HSIO90_N	V15	HDMI lane 0 negative
D1+	HSIO93_P	U14	HDMI lane 1 positive
D1-	HSIO93_N	U13	HDMI lane 1 negative
D2+	HSIO95_P	R12	HDMI lane 2 positive
D2-	HSIO95_N	T13	HDMI lane 2 negative
CLK+	HSIO77_P	R15	HDMI clock positive
CLK-	HSIO77_N	R14	HDMI clock negative

Signal Name	GPIO	SoC Ball	Description
CEC	GPIO13_P	A16	HDMI CEC signal
HPD	GPIO2_P	D13	HDMI HPD signal
I2C SCL	GPIO17_P	A18	HDMI I2C SCL
I2C SDA	GPIO5_N	B15	HDMI I2C SDA

7.2. Ethernet

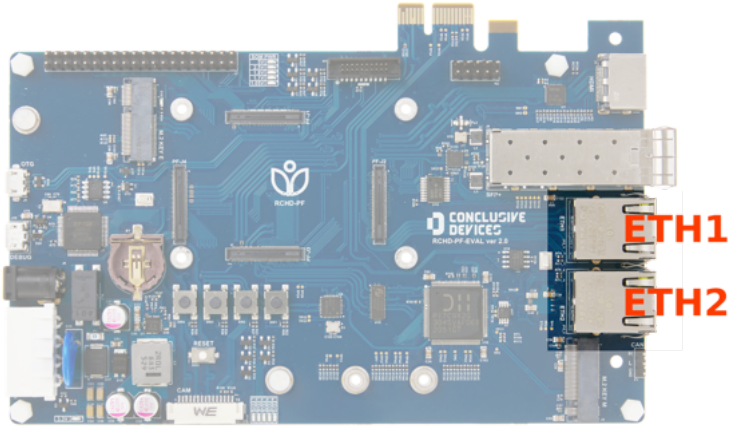

Fig. 7.2 1GBit Ethernet on the RCHD-PF-EVAL board.

Two Ethernet connectors are available on the RCHD-PF-EVAL:

- Etherent 1 - connectetd to SGMII 0 - uses PHY built into the SoM module,
- Ethernet 2 - connected to SGMII 1 - uses a Realtek RTL8211FS-CG PHY bulit into the evaluation board module.

7.3. SFP+

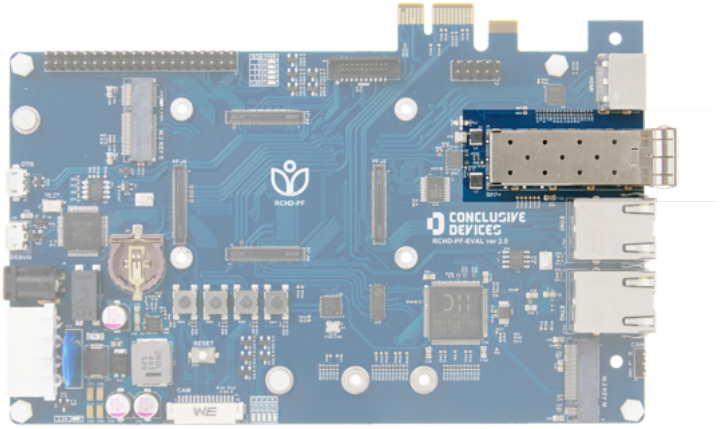

Fig. 7.3 10Gbit/s SFP ethernet on the RCHD-PF-EVAL board.

A single 10Gbit/s SFP+ connector. Connected to XCVR LANE 0 on RCHD-PF SoM with a retimer - Texas Instruments DS110DF111SQ. Diagnostics available over I2C.

7.4. CAN Bus

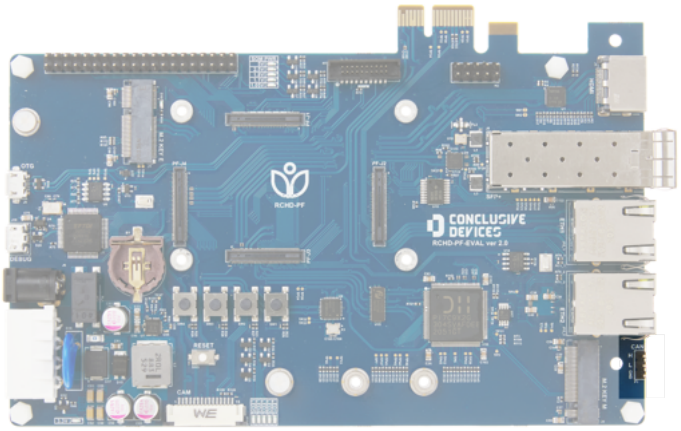

Fig. 7.4 CAN bus pins

3-pin CAN bus delivered via Microchip MCP2558FD-H/SN Can Transceiver, connected directly to SoM GPIO via pins on connector J3.

Table 7.2 CAN bus pinout

Signal Name	GPIO	SoC Ball
CAN_RX	GPIO20_P	A20
CAN_TX	GPIO19_N	B19
CAN_SILENT	GPIO19_P	B20

7.5. MIPI-DSI Camera Connector

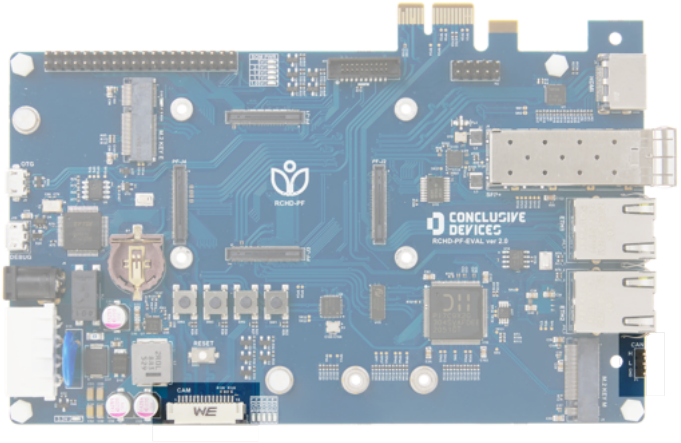

Fig. 7.5 MIPI camera connector

MIPI Display Serial Interface (DSI-2) camera connector connected directly to SoM GPIO and HSIO via J3 and J4 connectors.

Table 7.3 MIPI connector pinout

Signal Name	GPIO	SoC Ball
CAM_D0_P	HSIO68_P	W21
CAM_D0_N	HSIO68_N	V21
CAM_D1_P	HSIO66_P	W22
CAM_D1_N	HSIO66_N	V22
CAM_CLK_P	HSIO74_P	U19
CAM_CLK_N	HSIO74_N	U18
CAM_IO_2	GPIO22_P	B21
CAM_IO_1	GPIO22_N	B22

Signal Name	GPIO	SoC Ball
CAM_I2C_SDA	GPIO18_P	C19
CAM_I2C_SCL	GPIO18_N	C20

7.6. M.2 Key E

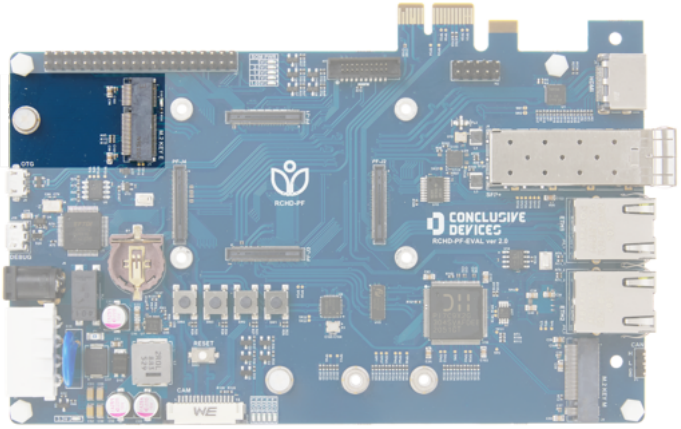

Fig. 7.6 M.2 Key E on the RCHD-PF-EVAL board.

M.2 key E provides a single PCIe lane. It is also connected to MSS UART (Microcontroller Subsystem UART1), I2C (from fabric) and USB (from MSS). USB can be rerouted to the M.2 connector via Onsemi NLAS7222AMUR2G USB switch. The USB selector pin is attached to GPIO12_N pin on the SoM. More info on USB routing to the M.2 connector can be found in the USB and USB-UART from Microcontroller Subsystem (MSS).

7.7. M.2 Key M

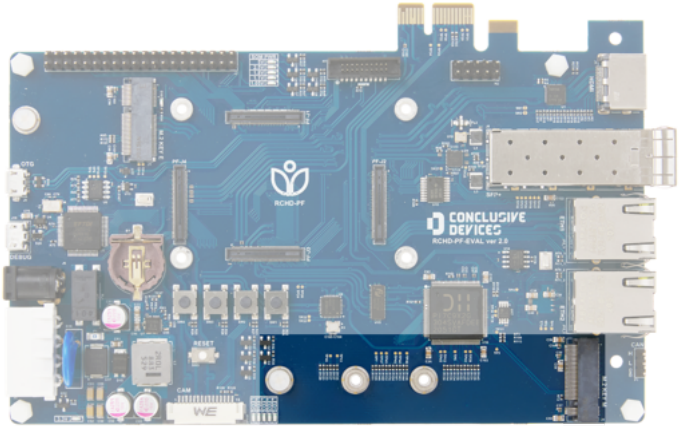

Fig. 7.7 M.2 Key M on the RCHD-PF-EVAL board.

M.2 key M provides a single PCIe lane. It supports the following M.2 card sizes:

- 2242
- 2260
- 2280

7.8. PCIe Edge Connector

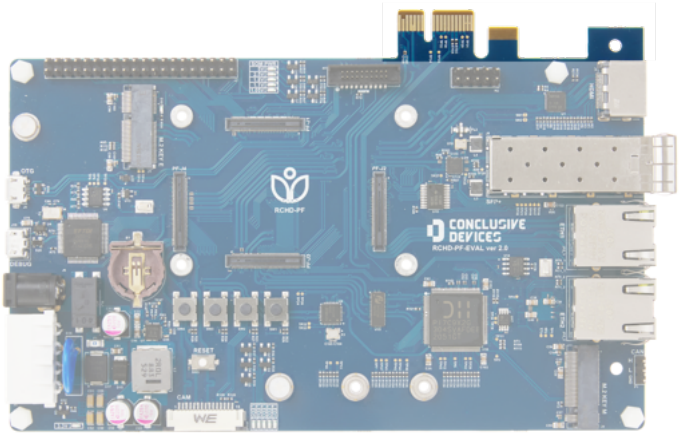

Fig. 7.8 PCIe edge connector on the RCHD-PF-EVAL board.

A single-lane male PCIe edge connector that fits into a standard female type PCIe connector commonly found on desktop and server motherboards.

7.9. Power Supply Connectors

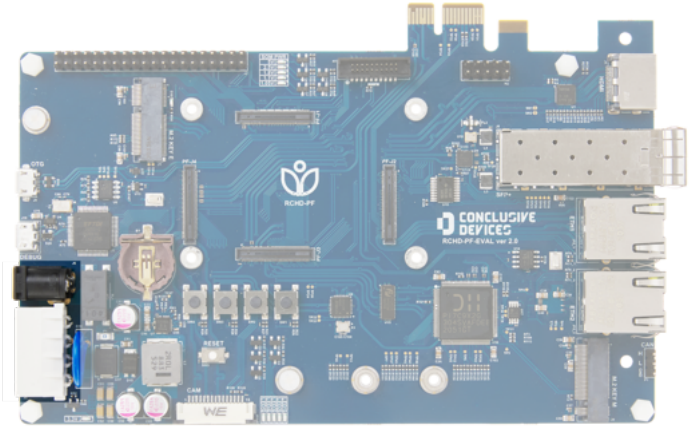

Fig. 7.9 Power supply on the RCHD-PF-EVAL board.

Two power supply inputs are available for the board:

- a DC 5.5/2.5 connector
- a 4-pin Molex connector

4-pin Molex connector is intended for use with standard ATX and compatible power supplies when installing RCHD-PF-EVAL inside of a computer enclosure via the edge PCIe connector. The Molex connector does not utilize the +5V line (red cable), it is disconnected from the board circuitry. Only the +12V power line (yellow cable), and both ground lines (two middle black cables) are used. +12V line of the Molex connector is the pin closest to the DC connector.

7.10. Raspberry Pi Header

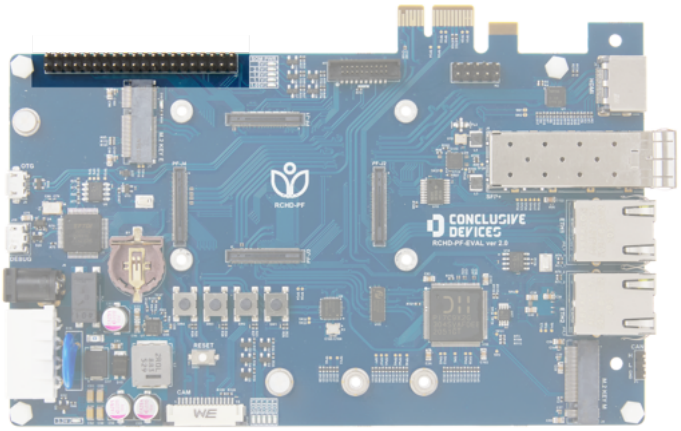

Fig. 7.10 Location of the Raspberry PI compatible connector on the RCHD-PF-EVAL board.

A 40 pin header that's pinout-compatible with a matching Raspberry Pi header and accessories. For differences, please refer to the table below:

Table 7.4 Raspberry Pi compatible connector pinout

Pin	RaspberryPi standard pinout	RaspberryPi Alternate function	RCHD-PF-EVAL pinout	RCHD-PF-EVAL Alternate function
1	3.3V PWR		3.3V PWR	
2	5V PWR		5V PWR	
3	GPIO2	I2C_SDA1	GPIO2	I2C_SDA1
4	5V PWR		5V PWR	
5	GPIO3	I2C_SCL1	GPIO3	I2C_SCL1
6	GND		GND	
7	GPIO4	GPCLK0	GPIO4	GPCLK0
8	GPIO14	UART0_TXD	GPIO14	UART0_TXD
9	GND		GND	

Pin	RaspberryPi standard pinout	RaspberryPi Alternate function	RCHD-PF-EVAL pinout	RCHD-PF-EVAL Alternate function
10	GPIO15	UART0_RXD	GPIO15	UART0_RXD
11	GPIO17		GPIO17	
12	GPIO18	PCM_CLK	GPIO18	PCM_CLK
13	GPIO27		GPIO27	
14	GND		GND	
15	GPIO22		GPIO22	
16	GPIO23		GPIO23	
17	3.3V PWR		3.3V PWR	
18	GPIO24		GPIO24	
19	GPIO10	SPI0_MOSI	GPIO10	SPI0_MOSI
20	GND		GND	
21	GPIO9	SPI0_MISO	GPIO9	SPI0_MISO
22	GPIO25		GPIO25	
23	GPIO11	SPI0_SCLK	GPIO11	SPI0_SCLK
24	GPIO8	SPI0_CE0_N	GPIO8	SPI0_CE0_N
25	GND		GND	
26	GPIO7	SPI0_CE1_N	GPIO7	SPI0_CE1_N
27	EEPROM	ID_SD	GPIO0	ID_SD
28	EEPROM	ID_SC	GPIO1	ID_SC
29	GPIO5		GPIO5	
30	GND		GND	
31	GPIO6		GPIO6	
32	GPIO12	PWM0	GPIO12	PWM0

Pin	RaspberryPi standard pinout	RaspberryPi Alternate function	RCHD-PF-EVAL pinout	RCHD-PF-EVAL Alternate function
33	GPIO13	PWM1	GPIO13	PWM1
34	GND		GND	
35	GPIO19		GPIO19	PCM_FS
36	GPIO16		GPIO16	
37	GPIO26		GPIO26	
38	GPIO20		GPIO20	PCM_DIN
39	GND		GND	
40	GPIO21		GPIO21	PCM_DOUT

7.11. USB and USB-UART from Microcontroller Subsystem (MSS)

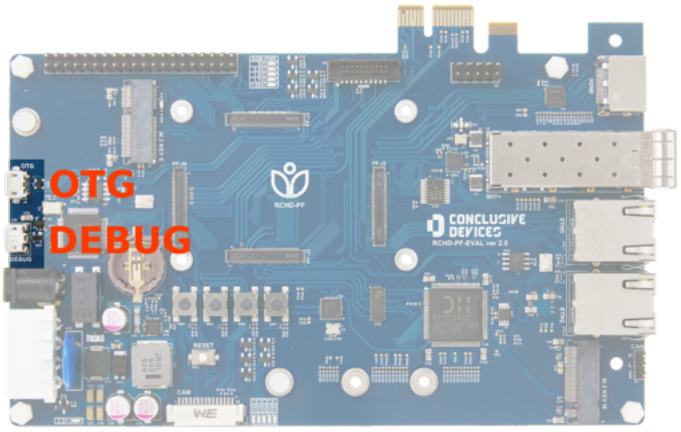

Fig. 7.11 RCHD-PF-EVAL USB connector locations

RCHD-PF-EVAL provides two USB ports, described in the following subsections:

7.11.1. MSS USB

MicroUSB-AB 2.0 port marked as OTG (On The Go) on the RCHD-PF-EVAL USB connector locations figure is connected to MSS on the PolarFireSoC FPGA. Outside of the RCHD-PF-EVAL, on the RCHD-PF SoM module, ULPI interface of the PolarFire SoC is converted to USB via a USB PHY. MSS USB is, by default, routed to the USB micro B connector, but it can be routed to M.2 Key M connector instead. This change is performed by the following USB signal switch:

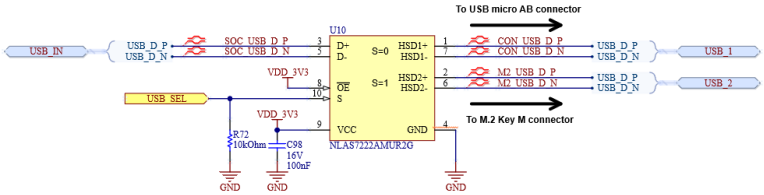

Fig. 7.12 USB signal switch.

This switch is controled by USB_SEL signal directly from the RCHD-PF SoM:

Table 7.5 USB signal switch

Signal Name	GPIO	SoC Ball	Description
USB_SEL	GPIO_12N	XY12	MSS USB selector pin

USB switching is performed by driving USB_SEL high or low, according to the following table:

Table 7.6 USB signal switch state control

USB_SEL pin state	Description
'0' - low	USB MSS is routed to USB micro AB connector
'1'- high	USB MSS is routed to M.2 Key M conncector

7.11.2. USB-UART

MicroUSB-B 2.0 port marked as DEBUG on the RCHD-PF-EVAL USB connector locations figure, is connected to FT4232 USB-UART converter and delivers serial access to the board. It converts UART1, UART2, UART3 and UART4 from MSS into virtual com port devices. UART1 is used by Haart Software Service(HSS) and Linux for communication.

Table 7.7 USB UART pinout

Signal Name	GPIO	SoC Ball	Description
UART1 TX	GPIO23_P	C22	UART1 Tx (transmit from SoC)
UART1 RX	GPIO23_N	D22	UART1 Rx (received to SoC)
UART2 TX	GPIO21_N	D20	UART2 Tx (transmit from SoC)
UART2 RX	GPIO21_P	D21	UART2 Rx (received to SoC)
UART3 TX	GPIO16_N	E18	UART3 Tx (transmit from SoC)
UART3 RX	GPIO16_P	D18	UART3 Rx (received to SoC)
UART4 TX	GPIO15_N	C17	UART4 Tx (transmit from SoC)
UART4 RX	GPIO15_P	B17	UART4 Rx (received to SoC)

7.12. Conclusive Developer Connector

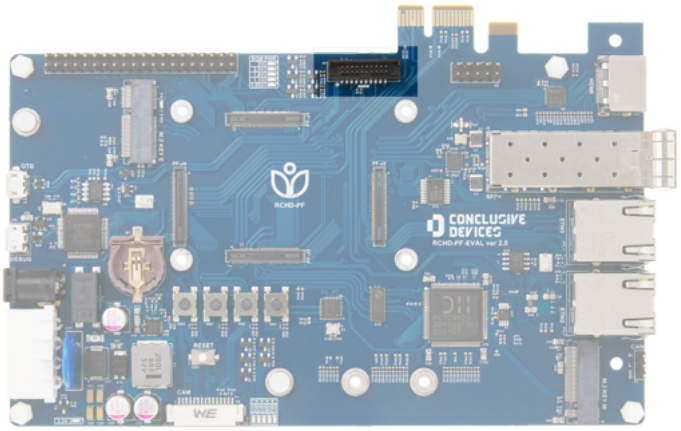

Fig. 7.13 Conclusive Developer Cable connector on the RCHD-PF-EVAL board.

Conclusive Developer Connector exposes JTAG, UART and I2C SYS in a compact, easily accessible 20 pin 1.27mm pitch connector.

Table 7.8 Developer Connector Pinout

Pin	Pin name	Direction	Description
1	VCC_IO	Power	Reference I/O voltage provided by the board
2	JTAG_TMS	In	JTAG test mode select
3	GND	Power	Ground
4	JTAG_TCK	In	JTAG clock
5	UART_RXD	Out	DEBUG_UART data receive signal
6	JTAG_TDO	Out	JTAG data output
7	UART_TXD	In	DEBUG_UART data transmit signal
8	JTAG_TDI	In	JTAG data input
9	JTAG_nTRST	In	JTAG test reset (active low)
10	JTAG_nRESET	In	JTAG reset (active low)
11	I2C_SCL	In/Out	SYS_I2C clock

Pin	Pin name	Direction	Description
12	JTAG_BSR_VSEL	In	An IEEE 1149.1 JTAG Compliance Enable
13	I2C_SDA	In/Out	SYS_I2C data
14	JTAG_TBSCAN_EN	In	An IEEE 1149.1 JTAG Compliance Enable
15	EEPROM_WP	In	EEPROM write protection (active low)
16	DEBUG_UART_MUX	In	Switch DEBUG_UART between Developer cable connector and Micro-B USB port
17	JTAG_HRESET_B	In	HRESET input (active low)
18	GND	Power	Ground
19	GND	Power	Ground
20	GND	Power	Ground

7.13. Microchip FlashPro6 Programmer Connector

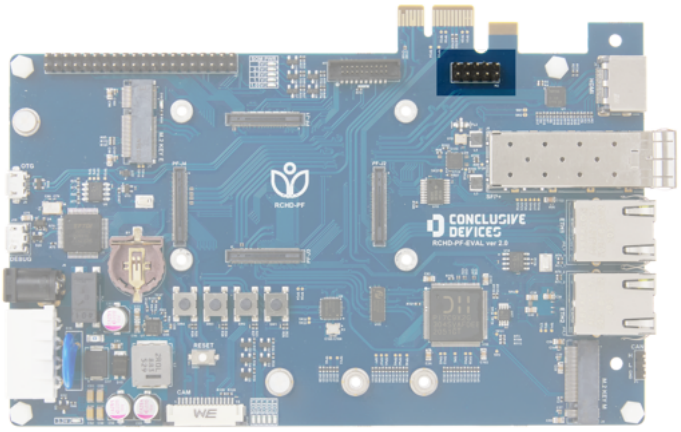

Fig. 7.14 FlashPro6 Programmer Connector

FlashPro6 Programmer Connector. FLashPro6 is a Microchip programmer device, dedicated for the PolarFire FPGAs (and others), and can work with LiberoSoC, FlashPro Express and SmartDebug software. It supports in-system programming,, IEEE 1149 JTAG programming through STAPL, and USB 2.0/3.0.

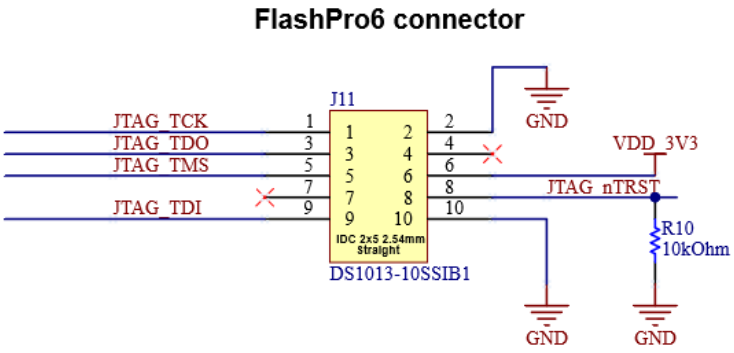

Fig. 7.15 FlashPro6 schematic on the RCHD-PF-EVAL board.

7.14. Board-To-Board RCHD-PF SoM Connectors

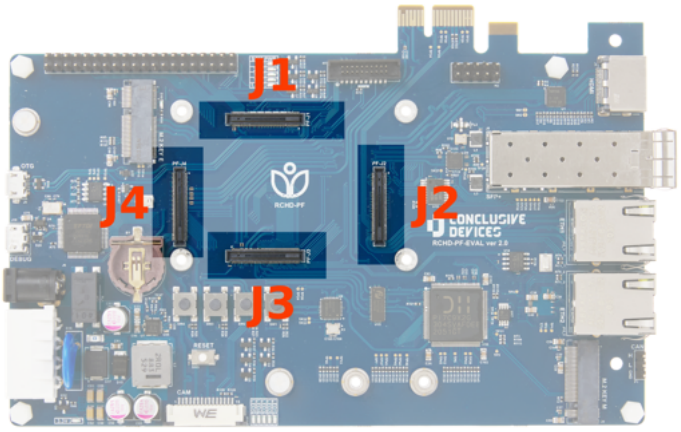

Fig. 7.16 Board-To-Board RCHF-PF SoM Connectors

4 connectors for attachment of the RCHD-PF module. For pinout description please refer to the RCHD-PF documentation.

8. Electrical Specifications

Table 8.1 Electrical Specifications

Parameter	Min	Typ	Max	Units	Comment
Power supply	9	12	14.5	V	Main power supply pins
Supply current	.	.	5	A	Excluding Camera, USB and another external loads

9. Environmental Specifications

Table 9.1 Environmental specification

Parameter	Min	Max
Operating temperature range	-40°C	+85°C
Storage Temperature (eMMC flash memory is the limiting device)	-40°C	+85°C
Junction temperature SoC	-55°C	+135°C

WARNING: System with an installed CR1220 battery must not exceed the temperature range of 0°C to +30°C at any time due to battery temperature limits.

To exceed this limit, please remove or change the CR1220 battery to one certified for target temperature use

10. SOM Dimensions

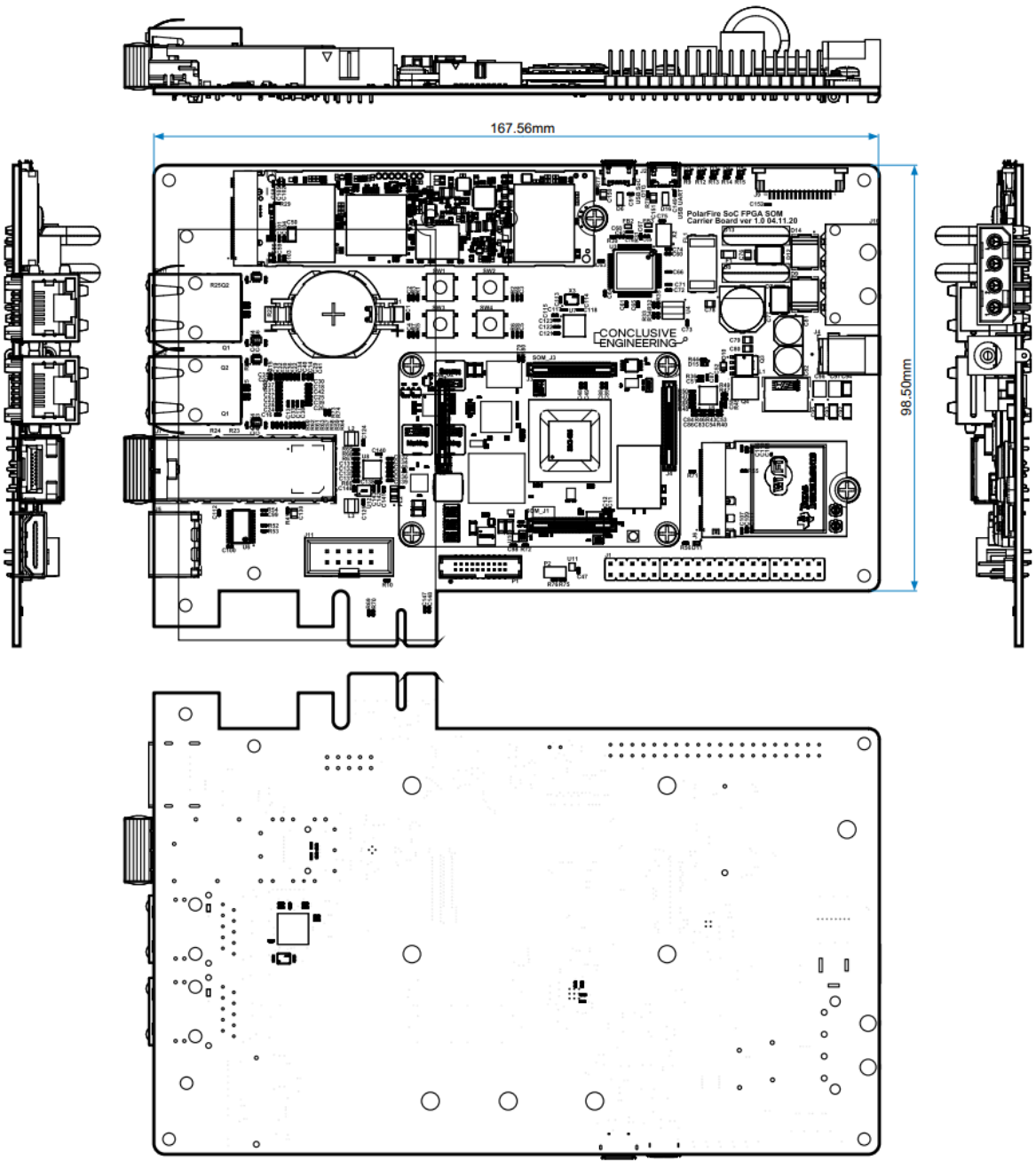

Fig. 10.1 RCHD-PF-EVAL module dimension.

11. Ordering information

Product purchase can be performed directly from our website: https://store.conclusive.pl The evaluation board for RCHD-PF is currently available in one variant only, using the following symbol:

RCHD-PF-EVAL

Build date: 2024-04-25 13:46:51. Release version: 8bb37cf.
Created using Sphinx 7.2.6.