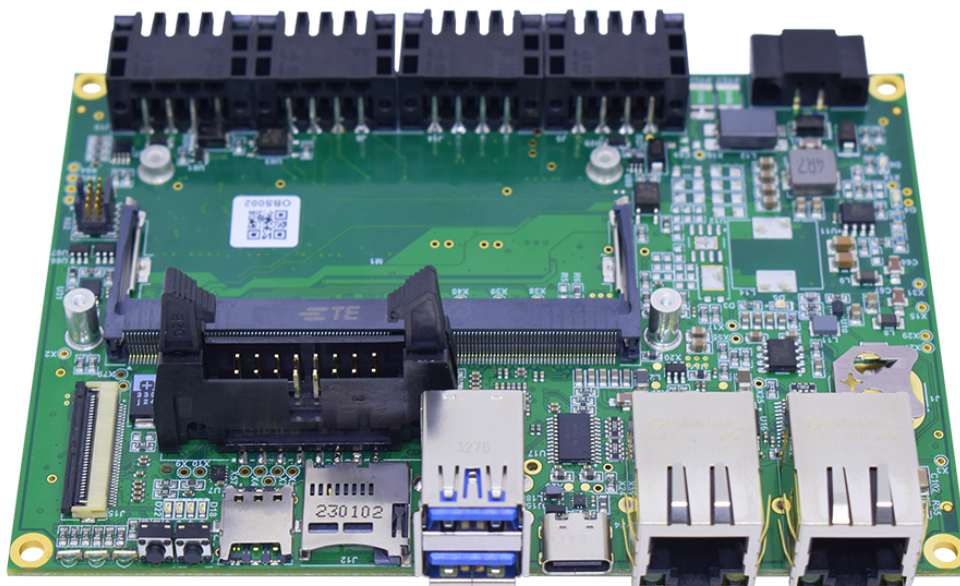


Ivy Carrier Board

HW Datasheet

Preliminary – Subject to Change



Revision History

Document Revisions

Date	Doc. Revision	Product Version	Changes
27-Feb-2024	Rev. 0.1	V1.0	Initial version for alpha prototypes 46806002
14-May-2024	Rev. 0.2	V1.1	Section 1.3 : Update dimension to 130mm x 105mm. Remove Overview section.

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1 Introduction

Ivy is a carrier board for the Verdin family of System-on-Modules (SoMs) / Computer-on-modules (CoMs). Ivy is designed to be use in a industrial enviroment.

1.1 Reference Documents

For detailed technical information, please refer to the documents listed below.

1.1.1 Verdin Family Specification

<https://docs.toradex.com/109262-verdin-family-specification.pdf>

1.1.2 Verdin Carrier Board Design Guide

<https://docs.toradex.com/108140-verdin-carrier-board-design-guide.pdf>

1.1.3 Verdin Computer on Module family overview

<https://www.toradex.com/computer-on-modules/Verdin-arm-family>

1.1.4 Toradex Developer Website – Verdin Computer on Module documents

<https://developer.toradex.com/products/verdin-som-family/modules>

1.2 Abbreviations

Table 1: Abbreviations

Abbreviation	Explanation
ADC	Analog to Digital Converter
CAN	Controller Area Network, a bus that is mainly used in the automotive and industrial environment
CAN FD	Controller Area Network Flexible Data-Rate, an extension to the original CAN bus protocol which allows higher data rates and larger message sizes.
CEC	Consumer Electronic Control, HDMI feature that allows controlling CEC compatible devices
CPU	Central Processor Unit
CSI	Camera Serial Interface
DAC	Digital to Analog Converter
DDC	Display Data Channel, interface for reading out the capability of a monitor. In this document DDC2B (based on I2C) is always meant.
DFP	Downstream Facing Port, USB Type-C port that acts as a host
DRP	Dual-Role Port, USB Type-C port that can operate as power sink and source
DSI	Display Serial Interface
DVI	Digital Visual Interface, digital signals are electrically compatible with HDMI
EDID	Extended Display Identification Data, timing setting information provided by the display in a PROM
EMI	Electromagnetic Interference, high-frequency disturbances
ESD	Electrostatic Discharge, high voltage spike or spark that can damage electrostatic-sensitive devices
FPD-Link	Flat Panel Display Link, high-speed serial interface for liquid crystal displays. In this document is also called the LVDS interface.
GBE	Gigabit Ethernet, Ethernet interface with a maximum data rate of 1000Mbit/s
GND	Ground
GND_CHASSIS	Chassis Ground
GPIO	General Purpose Input/Output, pin that can be configured as an input or output
GSM	Global System for Mobile Communications
HDA	High-Definition Audio (HD Audio), the digital audio interface between CPU and audio codec
I2C	Inter-Integrated Circuit, the two-wire interface for connecting low-speed peripherals
I2S	Integrated Interchip Sound, serial bus for connecting PCM audio data between two devices
I/O	Input-Output
JTAG	Joint Test Action Group, widely used debug interface
LCD	Liquid Crystal Display
LSB	Least Significant Bit
LVDS	Low-Voltage Differential Signaling, electrical interface standard that can transport high-speed signals over twisted-pair cables. Many interfaces like PCIe or SATA use this interface. Since the first successful application was the Flat Panel Display Link, LVDS became a synonymous for this interface. In this document, the term LVDS is used for the FPD-Link interface.
MAC	Medium Access Control is part of the second layer (data link layer) in the Ethernet stack
MIPI	Mobile Industry Processor Interface Alliance
MDI	Medium Dependent Interface, the physical interface between Ethernet PHY and cable connector
MDIO	Management Data Input/Output, an interface that is used for controlling the Ethernet PHY. The bus consists of the MDC clock and the MDIO bidirectional data signal.
mini PCIe	PCI Express Mini Card, the card form factor for internal peripherals. The interface features PCIe and USB 2.0 connectivity
MMC	MultiMediaCard, flash memory card

Continued on next page

Table 1: Abbreviations (Continued)

Abbreviation	Explanation
MSB	Most Significant Bit
NC	Not Connected
OD	Open-Drain
OTG	USB On-The-Go, a USB host interface that can also act as USB client when connected to another host interface
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect, parallel computer expansion bus for connecting peripherals
PCIe	PCI Express, a high-speed serial computer expansion bus, replaces the PCI bus
PCM	Pulse-Code Modulation, digitally representation of analog signals, standard interface for digital audio
PD	Pull-Down Resistor
PHY	The physical layer of the OSI model
PU	Pull-up Resistor
PWM	Pulse-Width Modulation
PWR	Power
QSPI	Quad SPI, SPI interface with four bidirectional data signals
RGMII	Reduced Gigabit Media-Independent Interface, the interface between Ethernet MAC and PHY for up to 1Gb/s
RJ45	Registered Jack, common name for the 8P8C modular connector that is used for Ethernet wiring
RS232	The single-ended serial port interface
RS485	Differential signaling serial port interface, half-duplex, multi-drop configuration possible
R-UIM	Removable User Identity Module, identifications card for CDMA phones and networks, an extension of the GSM SIM card
SD	Secure Digital, flash memory card
SDIO	Secure Digital Input Output, an external bus for peripherals that uses the SD interface
SIM	Subscriber Identification Module, an identification card for GSM phones
SMBus	System Management Bus (SMB), a two-wire bus based on the I ² C specifications, is used in x86 designs for system management.
SoC	System on a Chip, IC which integrates the main component of a computer on a single chip
SoM	System on a Module, PCB which integrates the main component of a computer on a single board
SPI	Serial Peripheral Interface Bus, synchronous four-wire full-duplex bus for peripherals
TIM	Thermal Interface Material, thermally conductive material between CPU and heat spreader or heat sink
TMDS	Transition-Minimized Differential Signaling, serial high-speed transmitting technology that is used by DVI and HDMI
TVS Diode	Transient-Voltage-Suppression Diode, a diode that is used to protect interfaces against voltage spikes
UFP	Upstream Facing Port, USB Type-C port that acts as a client
UART	Universal Asynchronous Receiver/Transmitter, serial interface, in combination with a transceiver an RS232, RS422, RS485, IrDA or similar interface can be achieved
USB	Universal Serial Bus, serial interface for internal and external peripherals

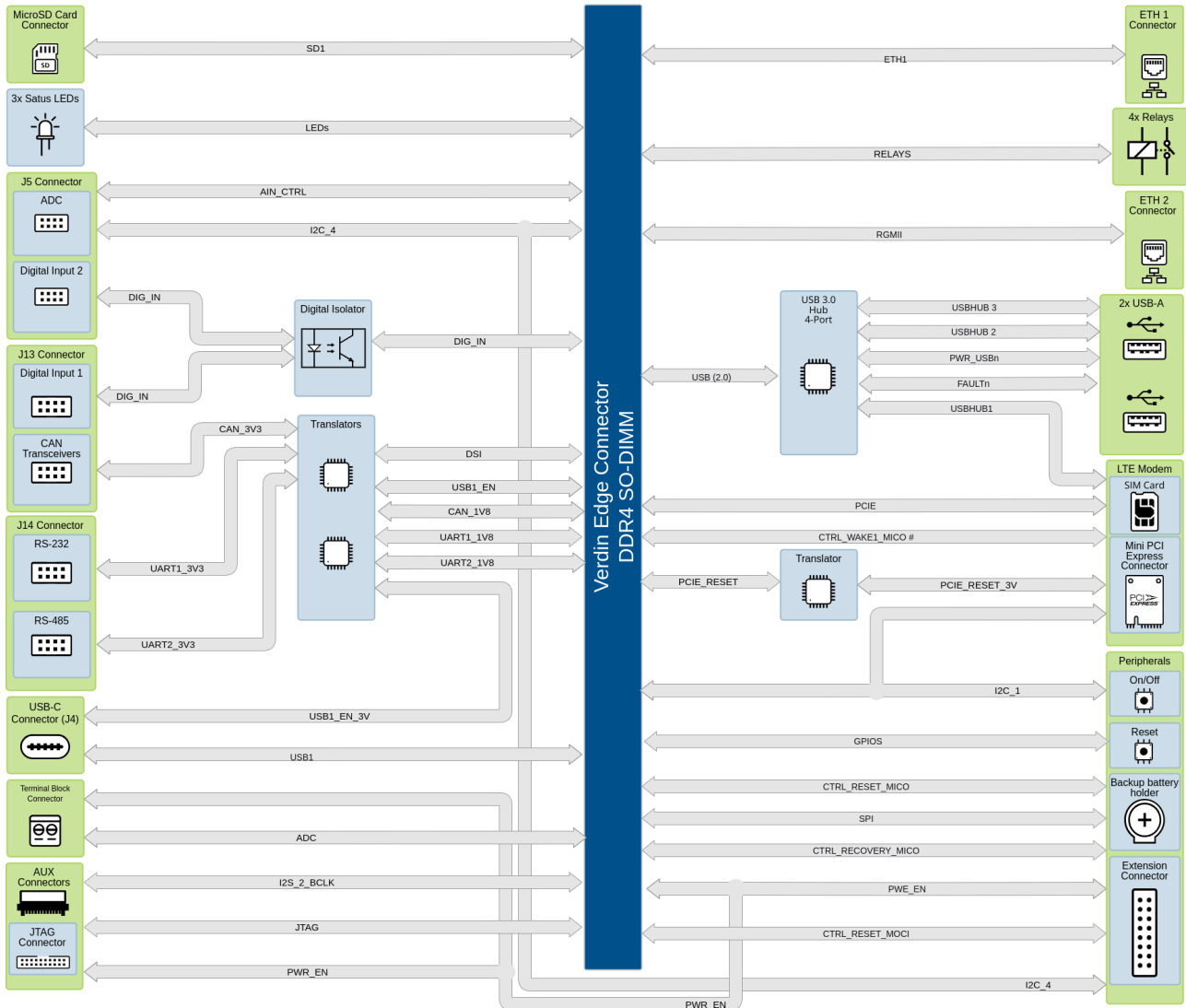
1.3 Specifications

- Supports all Toradex Verdin SOMs
- Power
 - Standard version – DC 8 to 32V, 2A
 - Extended version – DC 8 to 72V, 2A
- Operating temperature range: -40 to 85 DegC
- Size: 130mm x 105mm
- 4x SOM ADC inputs to measure major power rails (Vin, 5V, 3V3, 1V8)
- 3x GPIO controlled tri colour status LEDs (D9 green is always on)
- 2x CAN-FD transceiver, with 120 ohm split termination
 - Standard Version – Non-Isolated CAN
 - Extended Version – Isolated CAN
- 1x RS-232 Interface, with flow control
 - Standard Version – Non-Isolated RS-232
 - Extended Version – Isolated RS-232
- 1x RS-485 interface, with 120 ohm termination
 - Standard Version – Non-Isolated RS-485
 - Extended Version – Isolated RS-485
- 1x Gigabit Ethernet connector to SOM
- 1x Gigabit Ethernet RGMII (DP83867)
- 2x USB 3.0 Type A connector
- 1x USB 2.0 OTG on USB-C connector, typically used for linux image reflash
- Micro SD card connector
- 1.8V UART connection for Linux console connection (J17)
- 4x GPIO controlled +/-32V photorelays
- Extended version only:
 - 1x TPM 2.0 IC on SPI bus
 - 1x 32 KB SPI FRAM
- 1x I2C temperature sensor
- 1x 32 KB I2C EEPROM
- 2x Analog inputs for ADC measurement, with configuration of 0 to 33V or 0 to 20mA
 - Standard Version – Non-Isolated
 - Extended Version – Isolated
- 2x Digital inputs, 5 to 32V input voltage
- MIPI DSI connector for Toradex Capacitive Touch Display
- JTAG connector
- RTC backup battery holder for CR1216/1220/1225
- MiniPCle connector
 - Can be used for LTE modem, Ethernet card or other MiniPCle cards
 - PCIe signals (for Ethernet cards)
 - USB 2.0 (for LTE modems)
 - 3x LEDs
 - Nano SIM card connector
- Reset and Recovery mode buttons
- Extension connector with the following

- 1x SPI interface
- 2x I2C interfaces
- 5V, 3V3, 1V8 power
- RTC backup battery holder for CR1216/1220/1225
- MiniPCIe connector
 - Can be used for LTE modem, Ethernet card or other MiniPCIe cards
 - PCIe signals (for Ethernet cards)
 - USB 2.0 (for LTE modems)
 - 3x LEDs
 - Nano SIM card connector
- Reset and Recovery mode buttons
- Extension connector with the following
 - 1x SPI interface
 - 2x I2C interfaces
 - 5V, 3V3, 1V8 power

2 Block Diagram

Figure 1: Block diagram of Ivy board.



3 Connectors

Figure 2: Highlighted connectors on top side of board.

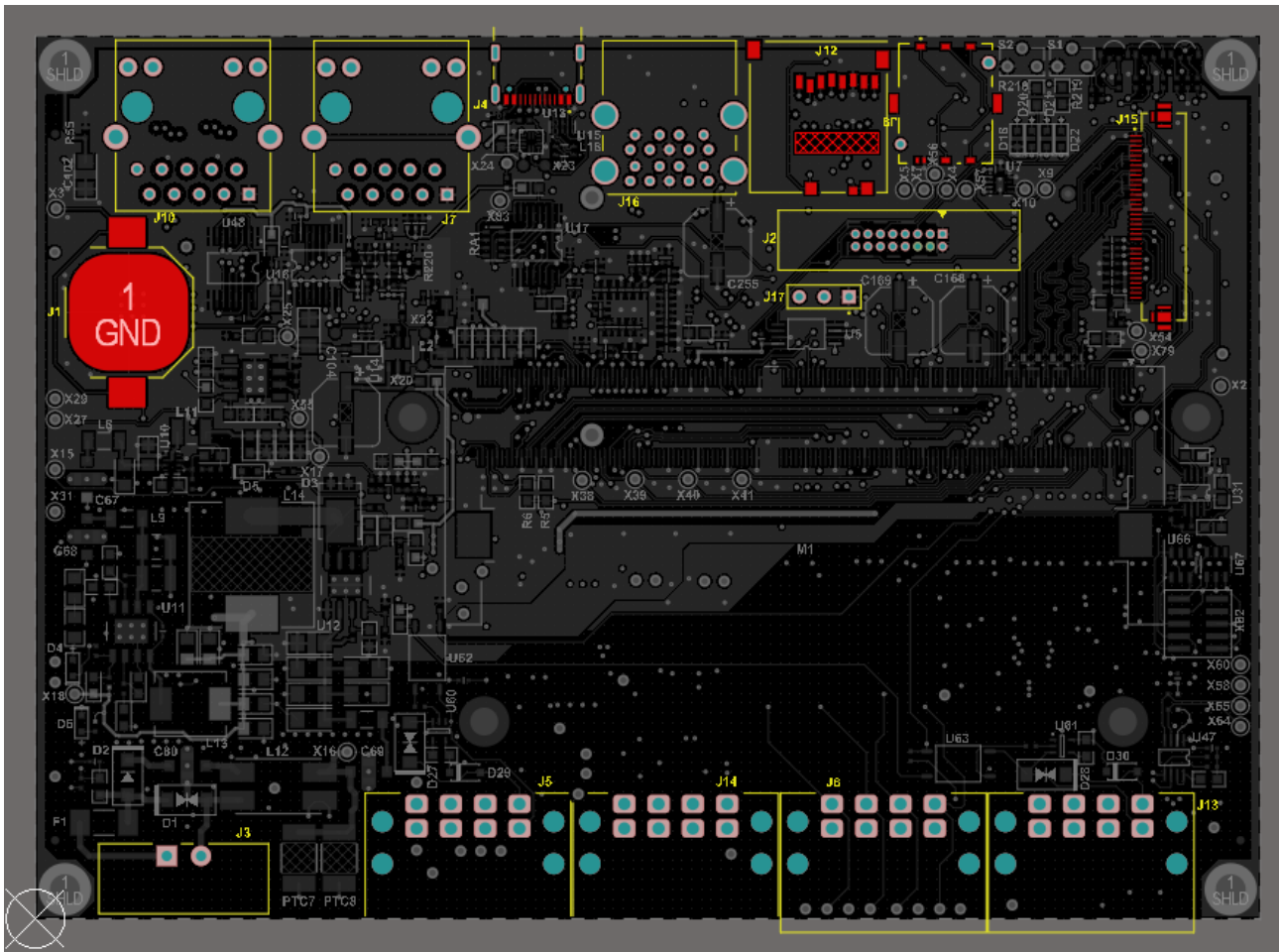
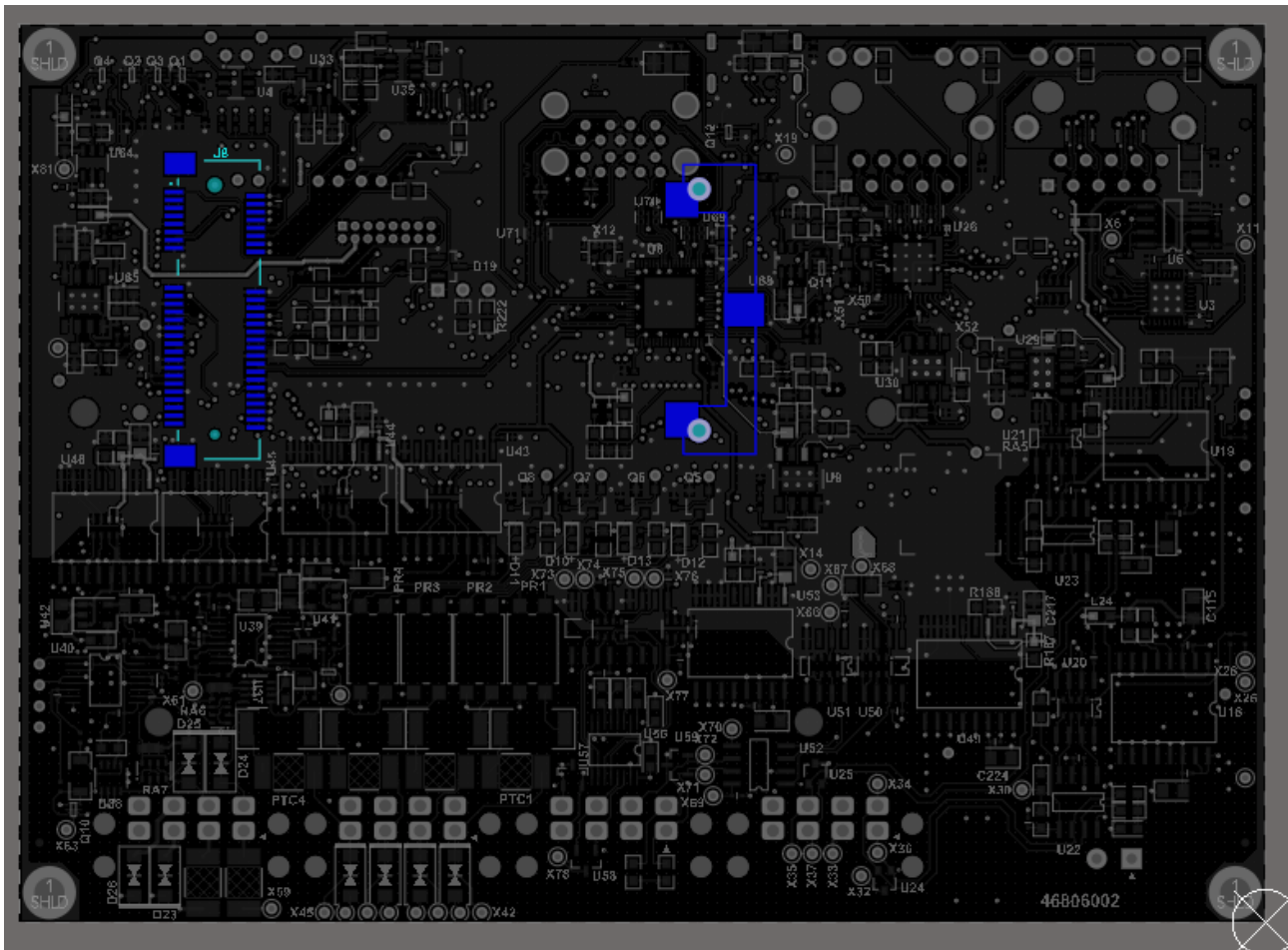


Figure 3: Highlighted connectors on bottom side of board.



3.1 Connector list

Table 2: List of connectors

Connector	Manufacture	Part Num.	Side	Description
J1	Keystone	3000	Top	Battery holder coin 1261/1220/1225
J2	CNC	3210-16-001-12-00	Top	Extension connector
J3	Molex	0395061002	Top	Main power connector
J4	GCT	USB4105-GF-A-120	Top	USB 2.0 OTG, Type-C typically used for linux image reflash
J5,J6,J13,J14	Weidmuller	1728640000	Top	Field Connectors Gigabit Ethernet
	Amphenol	KE081151A000G		
J7	Pulse	JXD0-0025NL	Top	Gigabit Ethernet
J8	TE Connectivity	1775862-2	Bottom	MiniPCle card slot, full size
J9	GCT	SIM8055-6-1-14-00-A	Top	SIM Card connector
J10	Pulse	JXD0-0025NL	Top	Gigabit Ethernet
J12	GCT	MEM2052-00-195-00-A	Top	Micro SD Card connector
J15	Wurth	687134149022	Top	MIPI DSI connector for Toradex Capacitive Touch Display
J16	Amphenol	GSB4112312HR	Top	2x USB3.0 Type A connectors
J17	N/A	N/A	Top	3 pin header. 1.8V UART connection for Linux console

4 Power Supply

Board power varies with version of board:

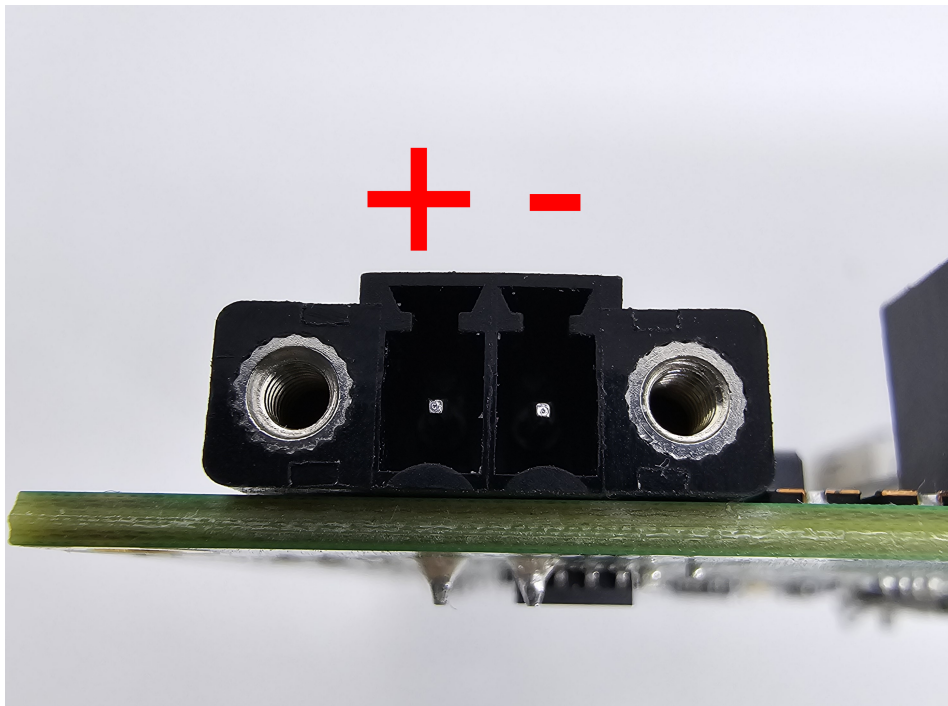
- Standard version: Rating 8 to 32VDC, 2A
- Extended version: Rating 8 to 72VDC, 2A

Power is to be applied to connector J3, with the polarity as shown in figure 4

Power consumption varies with type of SOM, connected peripherals (especially type and number of connected USB devices). With no external devices connected, board and SOM will use typically between 4 and 6 watts.

Fuse F1 is installed on power input line, located near power connector, with rating 5A, part number Bel 0680L5000-05.

Figure 4: Power connector J3 polarity.



5 Peripherals

5.1 Status LEDs

GPIO controlled status LEDs are located as shown in figure 6. These are tri colour LEDs (RGB). Table 3 also shows the related GPIO pins to control the colours from the Verdin SOM.



D9 green LED is always on, and cannot be controlled.

Figure 5: Circled in red (left to right) D7, D8, and D9.

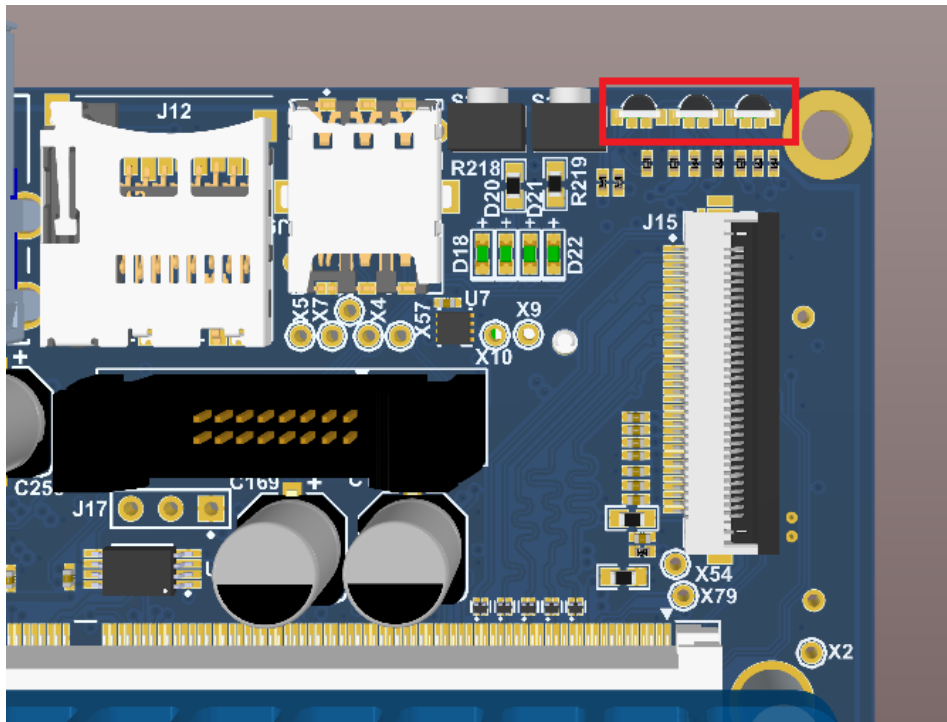


Table 3: Status LED information

Designator	Colour	GPIO Signal (High to enable)	SODIMM #
D7	Blue	LED.GPIO1	SODIMM 30
	Green	LED.GPIO2	SODIMM 32
	Red	LED.GPIO3	SODIMM 34
D8	Blue	LED.GPIO4	SODIMM 36
	Green	LED.GPIO5	SODIMM 54
	Red	LED.GPIO6	SODIMM 44
D9	Blue	LED.GPIO7	SODIMM 46
	Green	N/A	N/A
	Red	LED.GPIO8	SODIMM 48

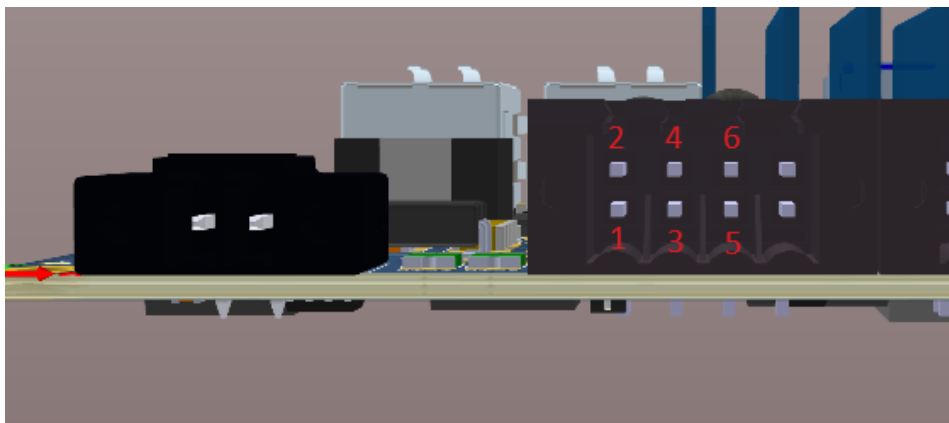
5.2 CAN Transceivers

CAN transceivers on Ivy are isolated in the extended version, and non-isolated in the standard version. CAN buses 1 and 2 are equipped with split termination. This termination is always populated. The two CAN buses go to field connector J5, where it has the following pinout:

Table 4: CAN bus pinout on connector J5

J5 Pin number	Signal
1	CAN1_L
2	CAN1_H
3	GND_CAN2
4	GND_CAN1
5	CAN2_L
6	CAN2_H

Figure 6: Pinout of J5 connector for CAN bus signals.



5.3 RS-232/RS-485

The Ivy board is equipped with a full duplex RS-232 transceiver, and a half duplex RS-485 Transceiver. The RS-232 and RS-485 interfaces are isolated in the extended version, and non-isolated in the standard version. The RS-232 and RS-485 interfaces go to field connector J14. See below for the pinout:

Table 5: RS-232 interface pinout on connector J14

J14 Pin number	Signal	SOM Interface
1	RS485_N	UART2_TX UART2_RX UART2_RTS
2	RS485_P	
3	GND_232	N/A
4	GND_485	N/A
5	RS232_TX	UART1_TX
6	RS232_RX	UART1_RX
7	RS232_RTS	UART1_RTS
8	RS232_CTS	UART1_CTS

Figure 7: Pinout of J14 connector for RS-232 and RS-485 interfaces.



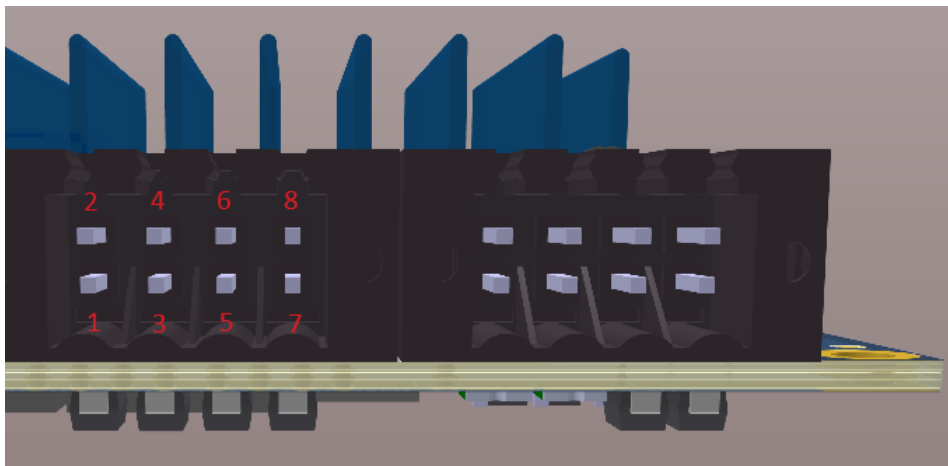
5.4 Relays

Ivy has 4 GPIO controlled photo relays, which can be accessed on field connector J6. These relays should be used with +/- 32V. See the table and figure below for pinout and GPIO information.

Table 6: Photo relay GPIO signal and J6 pinout information.

Photo Relay	GPIO Signal (High to enable)	SODIMM #	J6 Pin number	Signal
PR1	REL1	SODIMM 60	1	PR_OUT1A
			2	PR_OUT1B
PR2	REL2	SODIMM 62	3	PR_OUT2A
			4	PR_OUT2B
PR3	REL3	SODIMM 64	5	PR_OUT3A
			6	PR_OUT3B
*PR4	REL4	SODIMM 66	7	PR_OUT4A
			8	PR_OUT4B

Figure 8: Pinout of J6 connector for photo relays PR1-PR4.



5.5 ADC/Analog Inputs

Analog inputs on connector J13 can be used for single-ended or differential measurements. The rating of the ADC is 0-24V, 0-20mA. The analog inputs are isolated in the extended version and non-isolated in the standard version.

The ADC used on Ivy is part number ADS1119, and is accessed through the I2C4 interface (SODIMM 93 and 95).

AINx_MODE signal is used to select between single-ended and differential measurement modes:

- AINx_MODE = 1 for single-ended/voltage measurement.
- AINx_MODE = 0 for differential/current measurement.
- AIN1_MODE is on SODIMM 216.
- AIN2_MODE is on SODIMM 218.

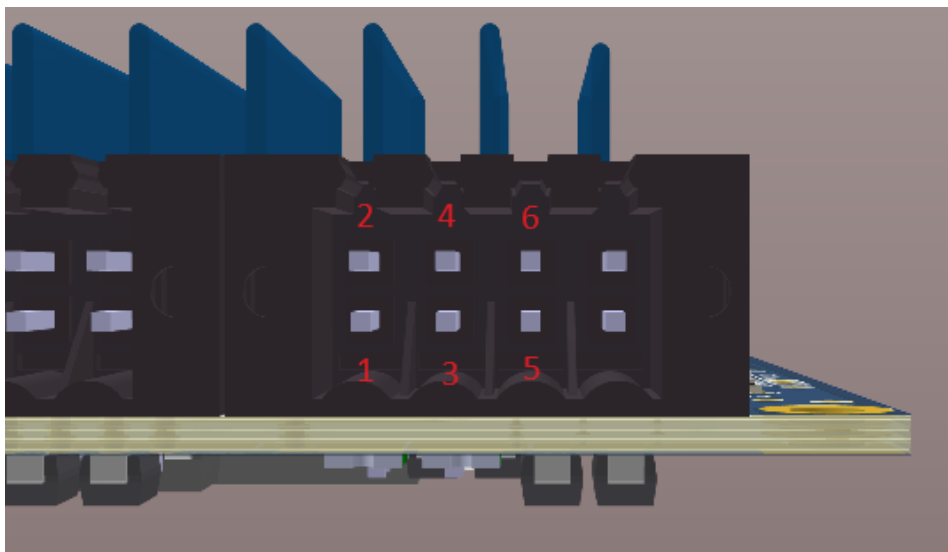
Signals AIN1_DRDY (SODIMM 220) and AIN2_DRDY (SODIMM 222) are active low digital outputs from the ADC which notifies the processor that new conversion data is ready. AINx_DRDY transitions high when conversion result is latched for output transmission

The table and figure below show the pinout information for J13.

Table 7: Analog input signals and J13 pinout information.

Analog Input	J13 Pin number	Signal
AIN1	1	PR_OUT1
	2	PR_OUT1B
AIN2	3	PR_OUT2A
	4	PR_OUT2B
N/A	5	PWR2(Vin/0.1A)
	6	PWR1(Vin/0.1A)

Figure 9: Pinout of J13 connector for analog inputs AIN1 and AIN2.



5.6 Digital Input

Ivy has 2 optically isolated digital inputs. These inputs activate at 5V, with a maximum input voltage rating of +/-32V. These digital inputs can be accessed through the field connectors J5 for DIO1 and J13 for DIO2. See the table below for pinout and GPIO information.

Table 8: Digital input GPIO signals and J5/J13 pinout information.

Digital Input	GPIO Signal	SODIMM #	Pin number	Signal
DIO1	DIGI_1	SODIMM 54	J5.8	DIO1+
			J5.7	DIO1-
DIO2	DIGI_2	SODIMM 56	J13.8	DIO2+
			J13.7	DIO2-

Figure 10: Pinout of J5 connector digital input DIO1.

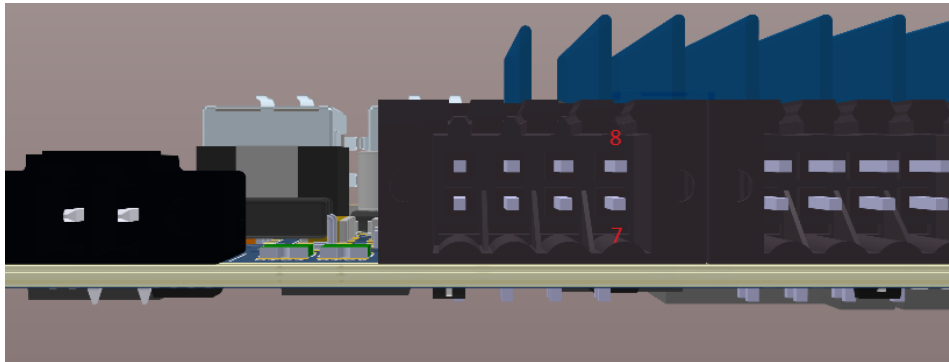
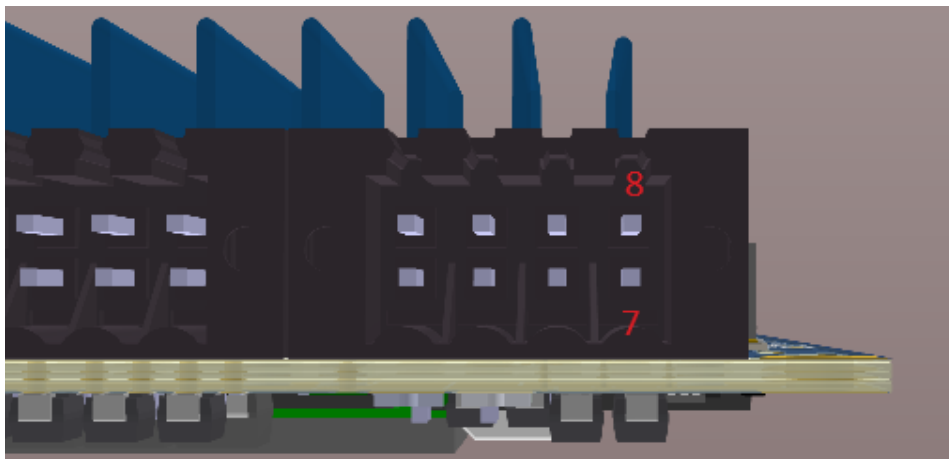


Figure 11: Pinout of J13 connector digital input DIO2.



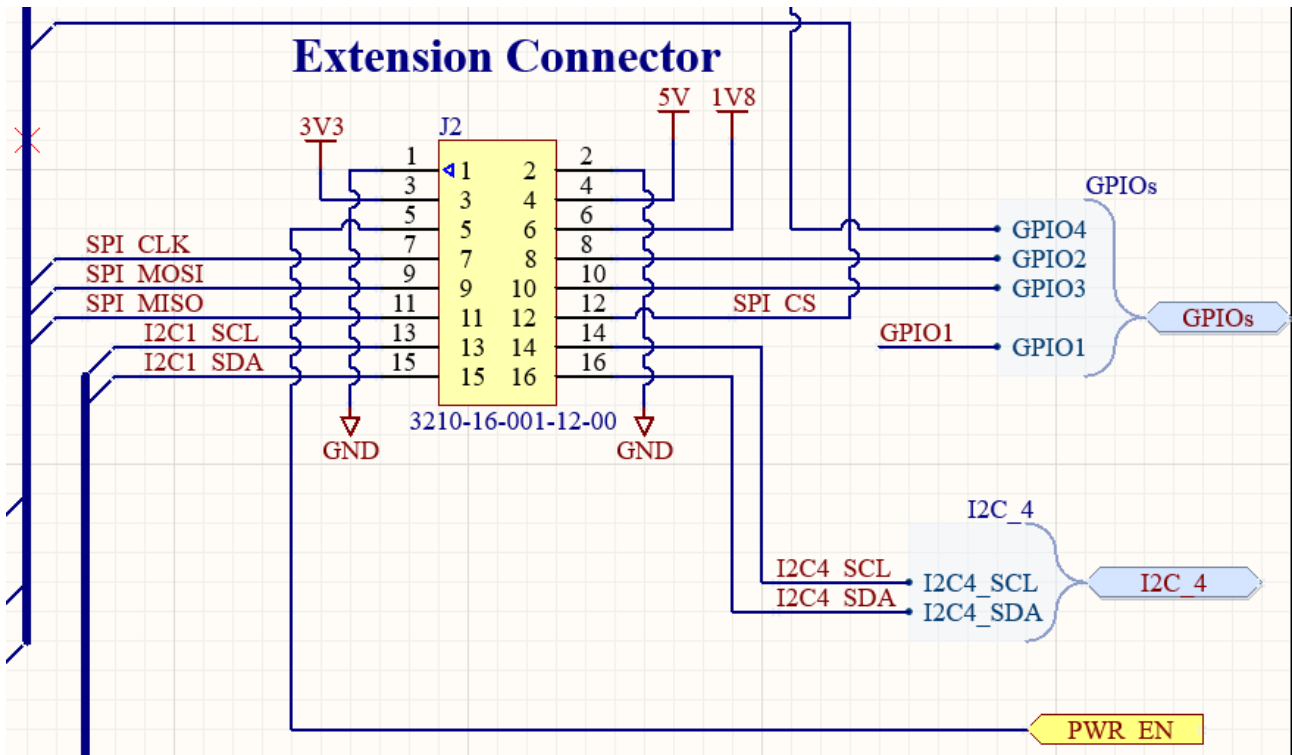
5.7 Extension Connector

The extension connector on the Ivy board is a 2×8 16 position IDC connector. The extension connector has 3 power rails (5V, 3.3V, 1.8V), ground, SPI interface with dedicated SPI_CS signal, I2C1 and I2C4 interfaces, 2 GPIOs, and power enable signal. Below is a figure and table of the pinout of the extension connector.

Table 9: Extension connector J2 signal and pinout information.

Pin Number	Signal	Voltage Level
1,2	GND	N/A
3	3V3	3.3V
4	5V	5V
5	PWR_EN	1.8V
6	1V8	1.8V
7	SPI_CLK	1.8V
8	GPIO2(SODIMM 208)	1.8V
9	SPI_MOSI	1.8V
10	GPIO1(SODIMM 206)	1.8V
11	SPI_MISO	1.8V
12	SPI_CS	1.8V
13	I2C1_SCL	1.8V
14	I2C4_SCL	1.8V
15	I2C1_SDA	1.8V
16	I2C4_SDA	1.8V

Figure 12: Pinout of J2 extension connector.



5.8 Miscellaneous Peripherals

Below is a table that lists general peripherals and their corresponding Verdin interfaces.

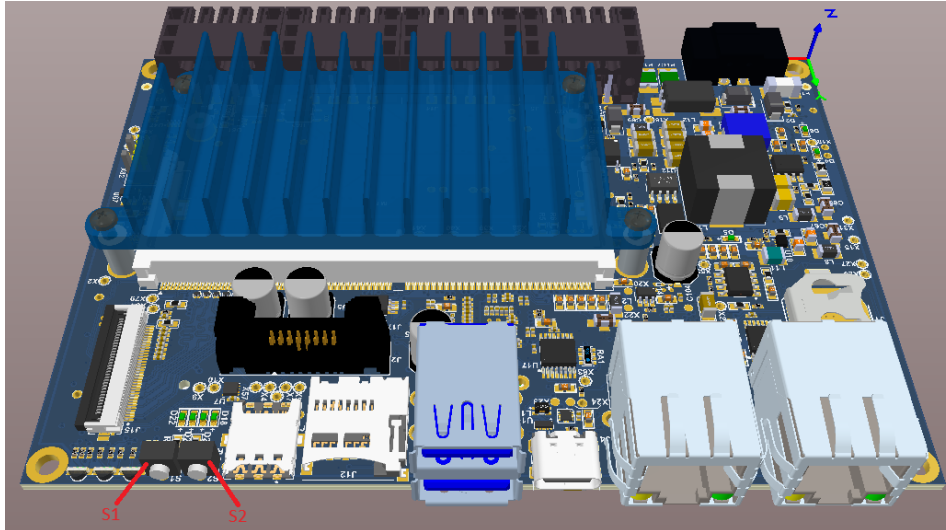
Table 10: Table of miscellaneous peripherals.

Peripheral	Part Number	Verdin Interface	Notes
USB OTG	N/A	UBS_1	
USB Hub	CYUSB3304	USB_2	
Ethernet	N/A	ETH_1	
Ethernet2	DP83867ERGZR	ETH_2_RGMII	
TPM	SLM9670	SPI_1	GPIO1 (SODIMM 206) used for chip select
FRAM	MB85RS256	SPI_1	GPIO4 (SODIMM 212) used for chip select
Temp Sensor	TMP1075DSGR	I2C_1	Address 0x4F
EEPROM	AT24C256C	I2C_1	Address 0x57
SD Card	N/A	SD_1	
MIPI DSI	N/A	DSI_1	
MiniPCIe	N/A	PCIE_1 I2C_1 (assembly option for I2C_3) USB_2 (through USB hub port 1)	
USB 3.0 Type A	N/A	Top: USB_2 (through USB hub port 2) Bot: USB_2 (through USB hub port 3)	

6 Buttons

Buttons S1 and S2 provide a means to reset the SOM module, and put the SOM into recovery mode.

Figure 13: Locations of buttons S1 and S2.



- S1 – Reset button. Pressing S1 will issues reset to SOM module.
- S2 – Recovery button. Used to enter recovery mode for Linux image reflash.

7 Power LED

Figure 14: Locations of LEDs on top side of board.

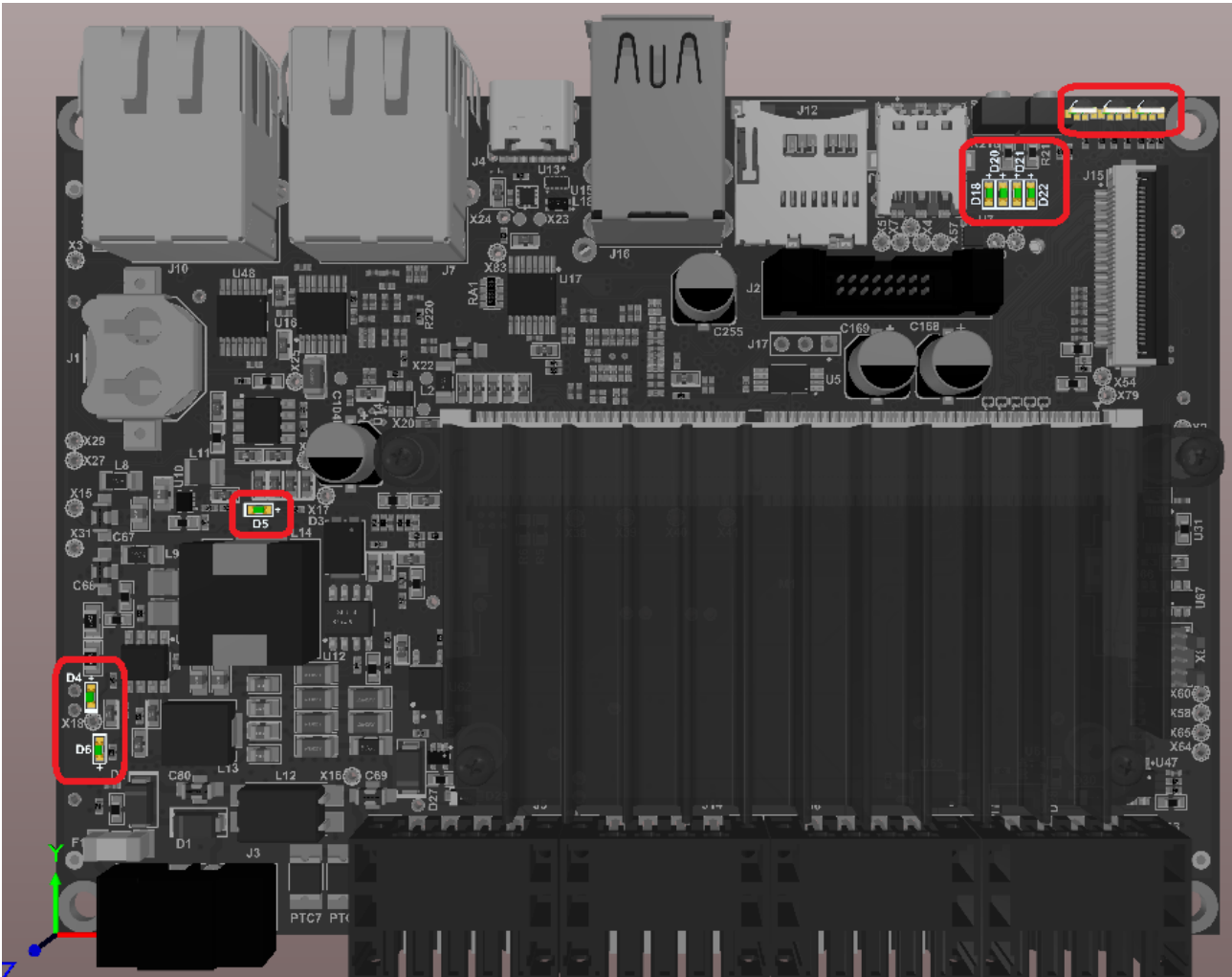


Figure 15: Locations of LEDs on bottom side of board.

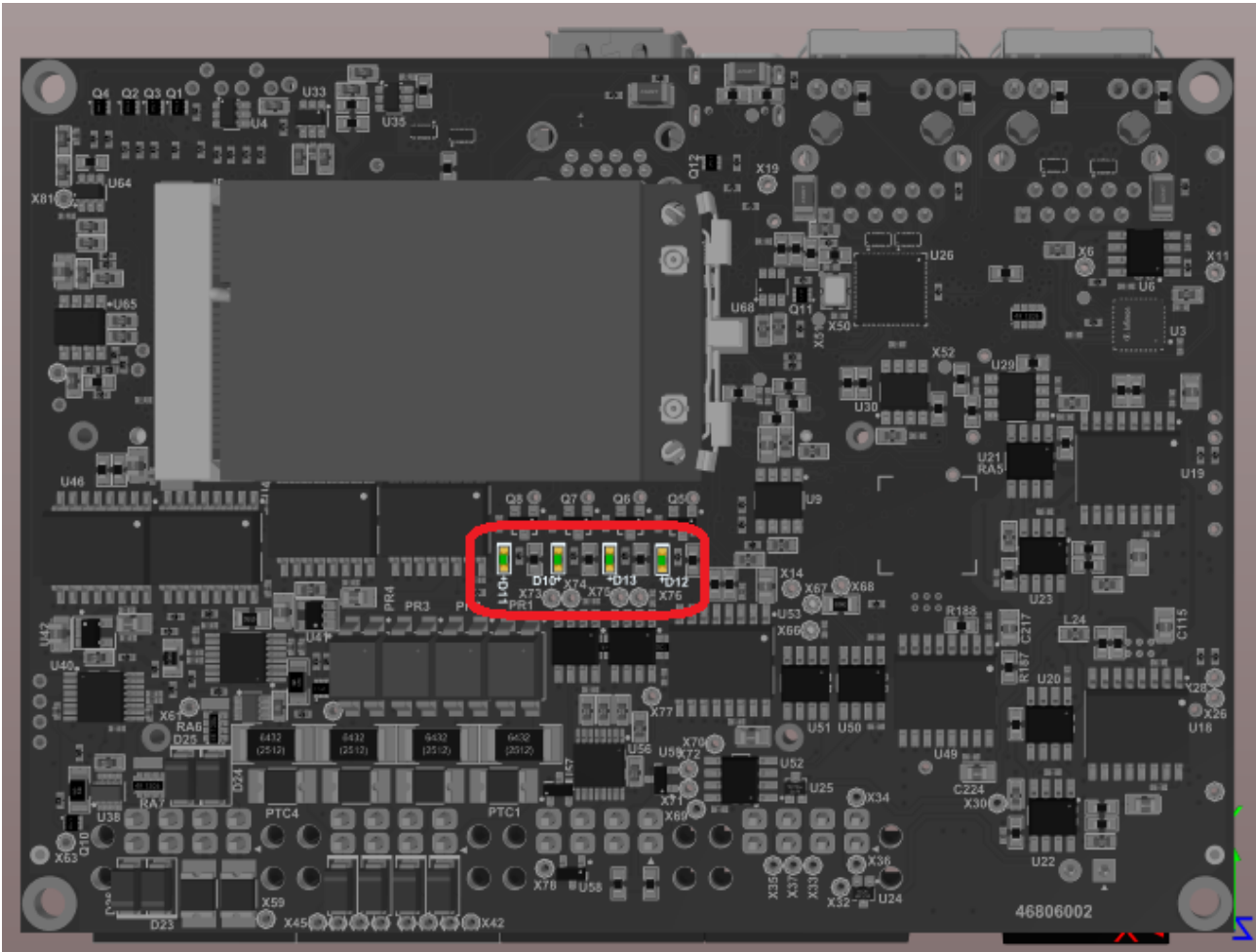


Table 11: LED designators and description.

LED	Colour	Side	Function - LED is on when:
D4	Green	Top	Power is applied at input J3
D5	Green	Top	3.3V power rail is active
D6	Green	Top	5V power rail is active
D7	Tri-colour(RGB)	Top	GPIO control signals are high – see status LED section for details
D8	Tri-colour(RGB)	Top	GPIO control signals are high – see status LED section for details
D9	Tri-colour(RGB)	Top	GPIO control signals are high – see status LED section for details
D10	Green	Bottom	PR3 relay is enabled
D11	Green	Bottom	PW4 relay is enablef
D12	Green	Bottom	PR2 relay is enabled
D13	Green	Bottom	PR1 relay is enabled
D18	Green	Top	3.3V PCIe power rail is active
D20	Green	Top	MiniPCIe device enabled WWAN LED signal

Continued on next page

Table 11: LED designators and description. (Continued)

LED	Colour	Side	Function - LED is on when:
D21	Green	Top	MiniPCIe device enabled WLAN LED signal
D22	Green	Top	MiniPCIe device enabled WPAN LED signal

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