

R&D Project specification

xEC: XIMEA EEmbedded CCarrier board

Phoxi Board for NVIDIA Jetson TX1/TX2

Pinout and IO subsystem description

Cabling

XIMEA GmbH

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Revision history

Version	Date	Notes
V0.1	10/25/2017	Jürgen Hillmann, Initial version
V1.0	10/26/2017	Jürgen Hillmann, inserted review results from MK
V1.1	10/26/2017	Jürgen Hillmann, inserted review results from MC

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1. xEC / Phoxi Carrier Board

1.1. Overview

XIMEAs xEC is a carrier board that provides interfaces for powerful and flexible embedded vision units. xEC uses the computing capacity of the NVIDIA Jetson TX1 or TX2 System-on-Module embedded CPU/GPU platform, which provides 4 CPU and 256 GPU cores for the parallel processing of data.

As a xiTECH category device, XIMEA offers this carrier boards to realize smart, small and powerful remote or completely autonomous usable camera based systems.

1.2. Components

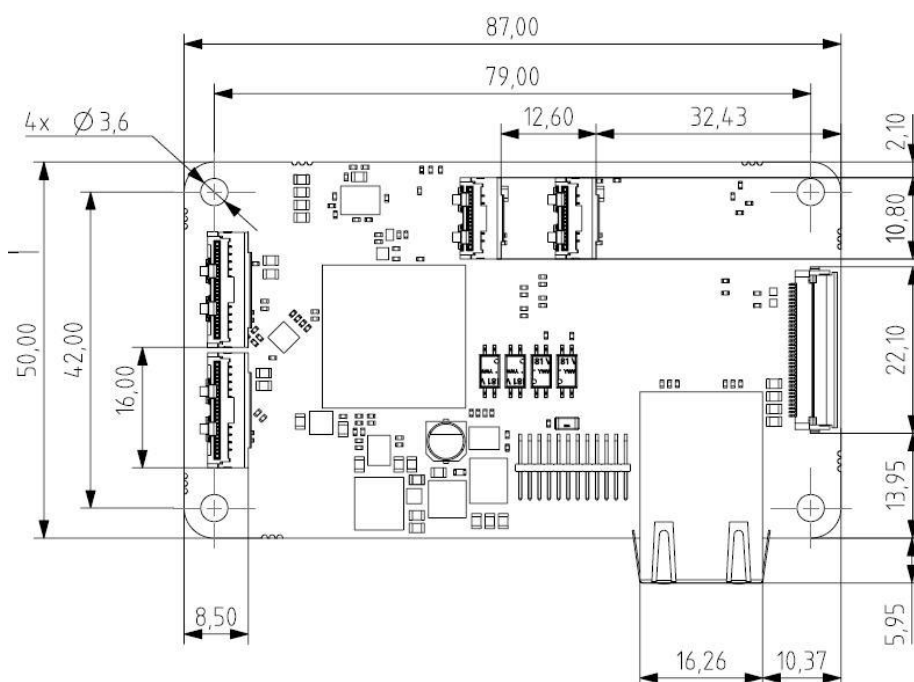


Figure 1-1, xEC board, front view

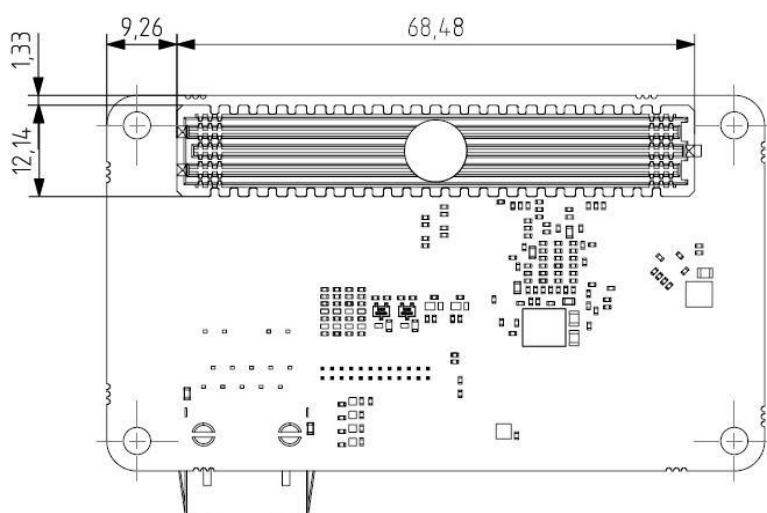


Figure 1-2, xEC board, rear view

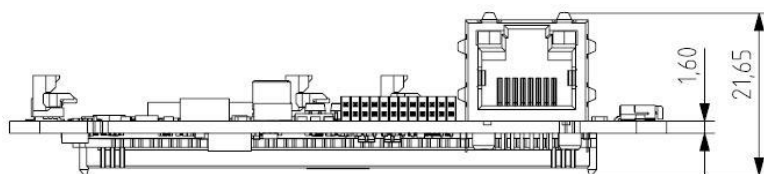


Figure 1-3, xEC board, side view

Part of the xEC board are several components / interfaces:

- 2 * USB 3.1 Gen 1
- 2 * PCIe x2 Gen 2
- 1 * USB 2.0
- IMU
- Gigabit LAN RJ45
- 4 * GPIO (non-isolated), 2 * GPI (isolated), 2 * GPO (isolated)
- PCIe switch
- Jetson Connector

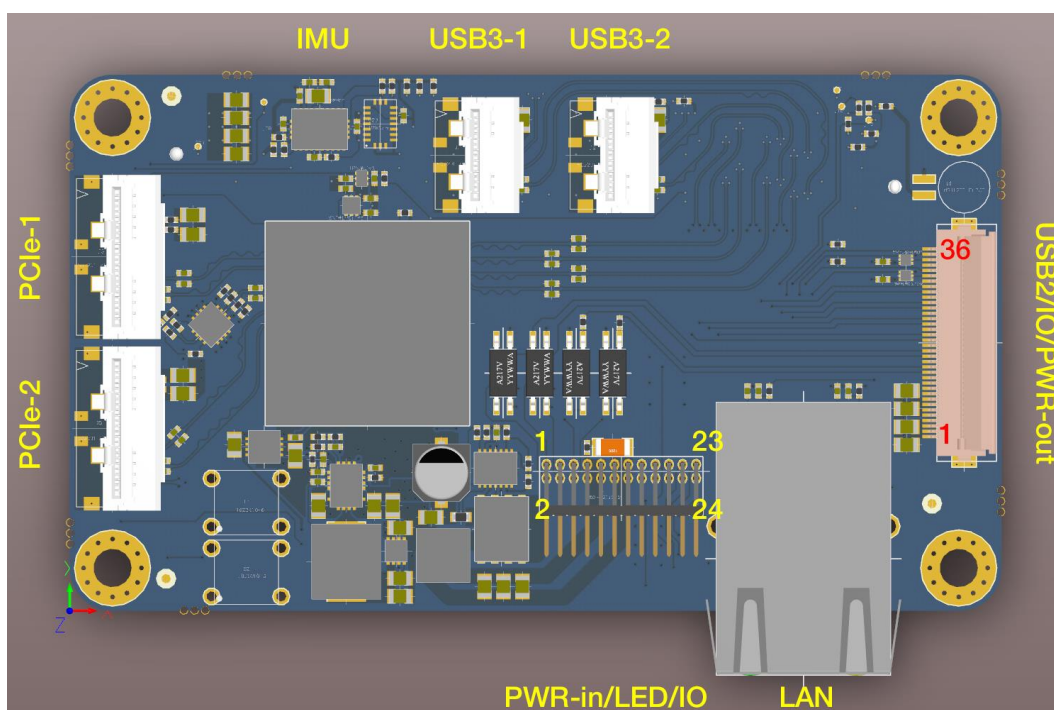


Figure 1-4, xEC board, components

1.2.1. USB3 ports

USB3-1 and USB3-2 are 2 USB3.0 Gen 1 flex cable connectors, cable orientation perpendicular to the board surface. XIMEA proprietary pinout with:

- Power for attached devices (XIMEA cameras)
- USB3.1 Gen 1, 5 GBit/s bandwidth
- IO wires



Important note:

TX2 supports USB3, but only one USB port works on PhoXi carrier due to differences with TX1. Only the port USB3-2 can be used with TX2 – please note [Figure 1-4, xEC board, components](#).

Please note [2 USB3 ports – Connectors, Cabling](#) for more details.

1.2.2. PCIe X2G2 ports

PCIe-1 and PCIe-2 are 2 flex cable connectors, 2 lanes PCIe Gen2 each, cable orientation perpendicular to the board surface. XIMEA proprietary pinout with:

- Power for attached devices (XIMEA cameras or XIMEA M.2 SSD adapter)
- 2 lanes, PCIe Gen 2, 10 GBit/s bandwidth
- IO wires

Please note [3 PCIe ports – Connectors, Cabling](#) for more details.

1.2.3. PWR-in / LED / IO port

24 pin male header connector, 2 rows, angled for:

- Power supply to power the unit and connected components, 12V, 30W (recommended)
- IO ports – pass-through to the USB2 / IO / PWR-out port
- LED-output

Please note [4 PWR-in / LED / IO port – Connector, pinout](#) for more details.

1.2.4. USB2 / IO / PWR-out port

36 pin flex cable connector with:

- USB 2.0 – configured as host port
- IO ports – pass-through from the PWR-in / LED / IO port
- IO ports – connected to the USB3 and PCIe port
- Power supply to power the unit and connected components, 12V, 30W (recommended)

Please note [5 USB2 / IO / PWR-out – Connector, pinout](#) for more details.

1.2.5. LAN port

Standard Gigabit LAN RJ45 port.

1.2.6. IMU

9-axis Absolute orientation sensor IMU ACCEL/GYRO/MAG I2C 28LGA from Bosch Sensortec, part# BNO055.

The IMU is connected to the Jetson SoC via the I²C bus.

1.2.7. PCIe switch

PCIe Switch, PLX technologies, PEX8612

1.2.8. Jetson connector

Proprietary connector to NVIDIA Jetson TX1 / TX2 – on the rear side of the xEC board.

1.3. Compatible cameras

1.3.1. USB 3 cameras

Compatible to the USB 3 flex cable connectors are various XIMEA cameras:

1.3.1.1. xiQ / xiSpec cameras

All xiQ cameras with CMV2000 and CMV4000 sensors are available as flex-ribbon variants and xEX compatible as well as all xiSpec cameras.

<https://www.ximea.com/files/brochures/xiQ-USB3-Vision-cameras-2017-brochure-HQ.pdf>

<https://www.ximea.com/files/brochures/xiSpec-Hyperspectral-HSI-cameras-2017-brochure-HQ.pdf>

http://www.ximea.com/downloads/usb3/manuals/xiq_technical_manual.pdf

1.3.1.2. xiC cameras

All xiC cameras are available as flex-ribbon variants and xEX compatible.

https://www.ximea.com/files/brochures/xiC-USB3_1-Sony-CMOS-Pregius-cameras-brochure-HQ.pdf

http://www.ximea.com/downloads/usb3/manuals/xic_technical_manual.pdf

1.3.2. PCIe cameras

Compatible to the PCIe flex cable connectors are various XIMEA cameras:

1.3.2.1. xiX cameras

All xiX cameras with a 2 lane PCIe Gen 2 interface are available as flex-ribbon variants and xEX compatible.

<https://www.ximea.com/files/brochures/xiX-OEM-cameras-for-integration-2017-brochure-HQ.pdf>

http://www.ximea.com/downloads/cb/manuals/xix_technical_manual.pdf

1.3.2.2. xiSpec cameras

All xiSpec cameras can be ordered in a special PCIe version with a flex cable 2 lane PCIe Gen 2 interface.

<https://www.ximea.com/files/brochures/xiSpec-Hyperspectral-HSI-cameras-2017-brochure-HQ.pdf>

1.4. M.2 SSD adapter

One of the PCIe slots can be used to connect a M.2 SSD to store data. The cable required to connect the adapter to one of the PCIe slots is the same as for connecting the PCIe camera. The “CAM” side of the cable has to be connected to this adapter!

The form factor of the supported SSDs is NVMe M.2, 4 lanes PCIe with a form factor of up to 2280 (80 mm long).

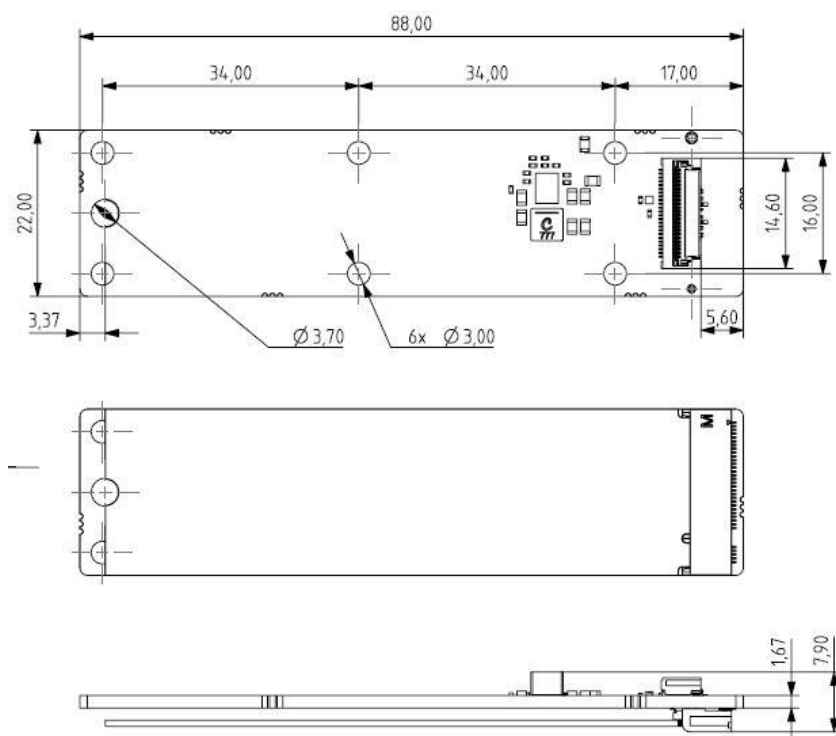


Figure 1-5, M.2 SSD adapter, drawing

1.5. Order info

The part-number of the components described above are:

xEC / Phoxi board	TX1CB-PHOXI-BRD
M.2 SSD adapter	ADPT-MX-X2G2-M2SSD-FL

2. USB3 ports – Connectors, Cabling

2.1. USB 3.1 Gen 1 + GPIO Connector pinning

The pinning of the USB3 / IO ports on the xEC is:

Pin	Signal	Technical description
15	GND	Ground for power return and for SuperSpeed signal return
14	SSRX-	SuperSpeed receiver differential pair; Accepted SSRX+
13	SSRX+	SuperSpeed receiver differential pair; Accepted SSRX-
12	GND	Ground for power return and for SuperSpeed signal return
11	SSTX+	SuperSpeed transmitter differential pair; Accepted SSTX-
10	SSTX-	SuperSpeed transmitter differential pair; Accepted SSTX+
9	GND	Ground for power return and for SuperSpeed signal return
8	D+	USB 2.0 differential pair
7	D-	USB 2.0 differential pair
6	GND	Ground for power return and for SuperSpeed signal return
5	VBUS	+5V Power input
4	VBUS	+5V Power input
3	Trigger/sync digital Output (GPO)	Open collector NPN, opto-isolated
2	Common pole (IO Ground)	
1	Trigger/sync digital Input (GPI)	Current limited (current sink) input, opto-isolated
Ground pins	SGND	Shield of FPC cable connected to shield of host controller

Table 2-1, USB + GPIO connector Pin Assignment

2.2. Connectors

The USB3 / IO connectors are:

Molex 502231-1500

2.3. USB3 - FPC cable

The FPC cable is a polarized custom cable. Camera side is laser marked "CAM" and xEC / break-out-board side is marked "BOB".

The FPC cable has to be connected to the camera and the computer / break-out-board or carrier-board in the correct orientation.



The camera and / or the computer interface can be destroyed in case of wrong cabling.



Figure 2-1, xiQ/xiC FPC cable



Important note:

The EMI/EMC performance should be evaluated by customer. The customer is liable for compliance to FCC and/or any other national regulations of device(s) containing the subassembly.

2.3.1. Camera side

The camera side of the FPC cable is laser marked “CAM”:



Figure 2-2, xiQ/xiC cable – camera side

This CAM-side of the cable has to be connected to the camera:

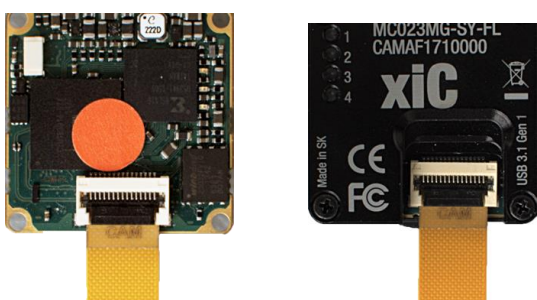


Figure 2-3, xiQ (left) and xiC (right) – camera side, correct FPC cabling

2.3.2. Break-out-board / xEC embedded computer side

The “computer” side of the FPC-cable is laser marked “BOB” (break-out-board):

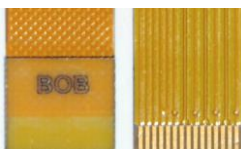


Figure 2-4, xiQ/xiC cable – break-out-board side

This BOB-side of the cable has to be connected to the xEC / break-out-box:

3. PCIe ports – Connectors, Cabling

3.1. PCIe x2 Gen 2 and GPIO pinning

The pinning of the PCIe ports on the xEC is:

Pin	Name	Level	Description
24	GND		External grounds for power supply, PCIe and non-isolated I/O
23	PCIe_REFCLK_P		
22	PCIe_REFCLK_N		
21	GND		External grounds for power supply, PCIe and non-isolated I/O
20	PCIe_PERP_1		
19	PCIe_PERN_1		
18	GND		External grounds for power supply, PCIe and non-isolated I/O
17	PCIe_PERP_0		
16	PCIe_PERN_0		
15	GND		External grounds for power supply, PCIe and non-isolated I/O
14	PCIe_PETP_1		
13	PCIe_PETN_1		
12	GND		External grounds for power supply, PCIe and non-isolated I/O
11	PCIe_PETP_0		
10	PCIe_PETN_0		
9	GND		External grounds for power supply, PCIe and non-isolated I/O
8	PCIe_RST_N		PCIe reset signal active low
7	PWR	12-24V	Power Supply Input
6	PWR		
5	INOUT1	LVTTL(3.3, 50µA)	non-isolated Input/Output
4	INOUT2	LVTTL(3.3, 50µA)	non-isolated Input/Output
3	IN	(<0.8 Low; 4-24 High)	Opto-isolated Input 1
2	IN_OUT_GND		Common ground for Opto-Isolated input and output
1	OUT	Open collector	Opto-isolated Output 1

Table 3-1, PCIe / IO connector pin assignments

3.2. Connectors

The PCIe / IO connectors are:

Molex 502231-2400

3.1. PCIe Gen 2, 2 lanes - FPC cable

The FPC cable is a polarized custom cable. Camera side is laser marked "CAM" and xEC / break-out-board side is marked "BOB".

The FPC cable has to be connected to the camera and the computer / break-out-board or carrier-board in the correct orientation.



The camera and / or the computer interface can be destroyed in case of wrong cabling.



Figure 3-1, xiX X2G2 FPC cable



Important note:

The EMI/EMC performance should be evaluated by customer. The customer is liable for compliance to FCC and/or any other national regulations of device(s) containing the subassembly.

3.1.1. Camera side

The camera side of the FPC cable is laser marked "CAM":



Figure 3-2, xiX X2G2 cable – camera side

This CAM-side of the cable has to be connected to the camera:



Figure 3-3, xiX X2G2 – camera side, correct FPC cabling

3.1.2. PCIe adapters / embedded computer side

The "computer" / adapter side of the FPC-cable is laser marked "BOB" (break-out-board):

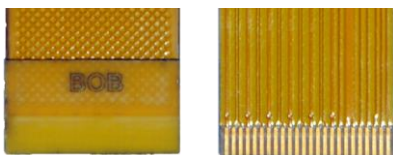


Figure 3-4, xiX X2G2 cable – break-out-board side

This BOB-side of the cable has to be connected to the xEC board

4. PWR-in / LED / IO port – Connector, pinout

24 pin male header connector, 2 rows, angled for:

- Power supply to power the unit and connected components, 12V, 30W (recommended)
- IO ports – pass-through to the USB2 / IO / PWR-out port
- LED-output

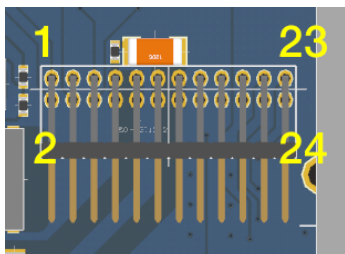


Figure 4-1, 4. PWR-in / LED / IO port – Connector

4.1. PWR-in / LED / IO port pinning

The pinning of the connector is:

Pin	Name	Level	Description
1	IN1		pass-through to the USB2 / IO / PWR-out port
2	IN2		pass-through to the USB2 / IO / PWR-out port
3	OUT_GND	GND	Common GND for OUT1 and OUT2
4	IN_GND	GND	Common GND for IN1 and IN2
5	OUT1		pass-through to the USB2 / IO / PWR-out port
6	OUT2		pass-through to the USB2 / IO / PWR-out port
7	PWR_IN_12V	+12V	Power supply input
8	PWR_IN_12V	+12V	Power supply input
9	PWR_IN_12V	+12V	Power supply input
10	PWR_IN_12V	+12V	Power supply input
11	PWR_IN_GND	GND	External grounds for power supply
12	PWR_IN_GND	GND	External grounds for power supply
13	PWR_IN_GND	GND	External grounds for power supply
14	PWR_IN_GND	GND	External grounds for power supply
15	INOUT1		pass-through to the USB2 / IO / PWR-out port
16	INOUT4		pass-through to the USB2 / IO / PWR-out port
17	INOUT2		pass-through to the USB2 / IO / PWR-out port
18	INOUT3		pass-through to the USB2 / IO / PWR-out port
19	GND	GND	
20	GND	GND	
21	LED4		Connector for status LED 4
22	LED3		Connector for status LED 3
23	LED2		Connector for status LED 2
24	LED1		Connector for status LED 1

Table 4-1, PWR-in / LED / IO port pin assignments

4.2. Connector

The connector is an:

Harwin, Archer M50 - 1.27mm (0.05") Pitch - DIL Horizontal Pin Header - M50-3901242

4.3. Power supply data

The power supply must have a voltage of 12V (8 – 13V) and, depending on the connected cameras, a power of up to 30W. The current must be $\leq 4A$.

4.4. Input / Output pins

The IO pins are not connected to the camera ports directly. These pins are connected to the USB2 / IO / PWR-out port and can be connected to the camera port IO pins there.

4.5. LEDs

The LED pins can be used to connect status LEDs, The voltage is +3.3V.

The LEDs indicate different states:

LED	Description	On	Off
1	Fault on Vin Protection: Under-/Overvoltage Pin: TX1_VIN_PWR_BAD	Ok	Fault
2	Power On indicator from TX-module TX pin A48 = CARRIER_PWR_ON	Power On	Power Off
3	GPIO1 signal active from USB2 / IO / PWR-out – Connector (Pin 19)	GPIO1 On	GPIO1 Off
4	Status of pin G8 = GPIO0_CAM0_PWR# on TX module. Could be set by the TX GPIO	On	Off

Table 4-2, status LED description

5. USB2 / IO / PWR-out – Connector, pinout

36 pin flex cable connector with:

- USB 2.0 – configured as host port
- IO ports – pass-through from the PWR-in / LED / IO port
- IO ports – connected to the USB3 and PCIe port
- Power supply to power the unit and connected components, 12V, 30W (recommended)

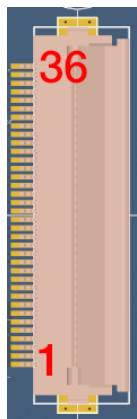


Figure 5-1, 4. 5. USB2 / IO / PWR-out – Connector

5.1. USB2 / IO / PWR-out port pinning

The pinning of the connector is:

Pin	Name	Level	Description
1	VCC5V0	+5V	PWR output
2	VCC5V0	+5V	PWR output
3	VCC5V0	+5V	PWR output
4	VCC5V0	+5V	PWR output
5	VCC12V0	+12V	PWR output
6	VCC12V0	+12V	PWR output
7	VCC12V0	+12V	PWR output
8	VCC12V0	+12V	PWR output
9	GND	GND	
10	USB2_D+		USB 2.0 Data
11	USB2_D-		USB 2.0 Data
12	GND	GND	
13	GPO2		pass-through from PWR-in / LED / IO port, pin OUT2
14	GPO1		pass-through from PWR-in / LED / IO port, pin OUT1
15	GND	GND	
16	GPI2		pass-through from PWR-in / LED / IO port, pin IN2
17	GPI1		pass-through from PWR-in / LED / IO port, pin IN1
18	GND	GND	
19	GPI01		pass-through from PWR-in / LED / IO port, pin INOUT1
20	GPI02		pass-through from PWR-in / LED / IO port, pin INOUT2

21	GND	GND	
22	GPIO3		pass-through from PWR-in / LED / IO port, pin INOUT3
23	GPIO4		pass-through from PWR-in / LED / IO port, pin INOUT4
24	GND	GND	
25	PCIE_CAM1_GPIO2	LVTTTL(3.3, 50µA)	Connected to the non-isolated Input/Output INOUT2 of PCIe port 1
26	PCIE_CAM1_GPIO1	LVTTTL(3.3, 50µA)	Connected to the non-isolated Input/Output INOUT1 of PCIe port 1
27	GND	GND	
28	PCIE_CAM2_GPIO2	LVTTTL(3.3, 50µA)	Connected to the non-isolated Input/Output INOUT2 of PCIe port 2
29	PCIE_CAM2_GPIO1	LVTTTL(3.3, 50µA)	Connected to the non-isolated Input/Output INOUT1 of PCIe port 2
30	GND	GND	
31	USB_CAM1_GPI1		Connected to the opto-isolated trigger IN port of USB3 port 1
32	USB_CAM1_GPO1		Connected to the open collector Output port of USB3 port 1
33	GND	GND	
34	USB_CAM2_GPI1		Connected to the opto-isolated trigger IN port of USB3 port 2
35	USB_CAM2_GPO1		Connected to the open collector Output port of USB3 port 2
36	GND	GND	

Table 5-1, PWR-in / LED / IO port pin assignments

5.2. Connector

The connector is an:

Hirose, CONN FFC BOTTOM 36POS 0.50MM R/A - FH12-36S-0.5SH(55)

6. Phoxi Board-Stack

The xEC board can be ordered as a board stack with a NVIDIA Jetson TX2 and mounting and cooling aluminum plates with a Power/IO plug and status LEDs.

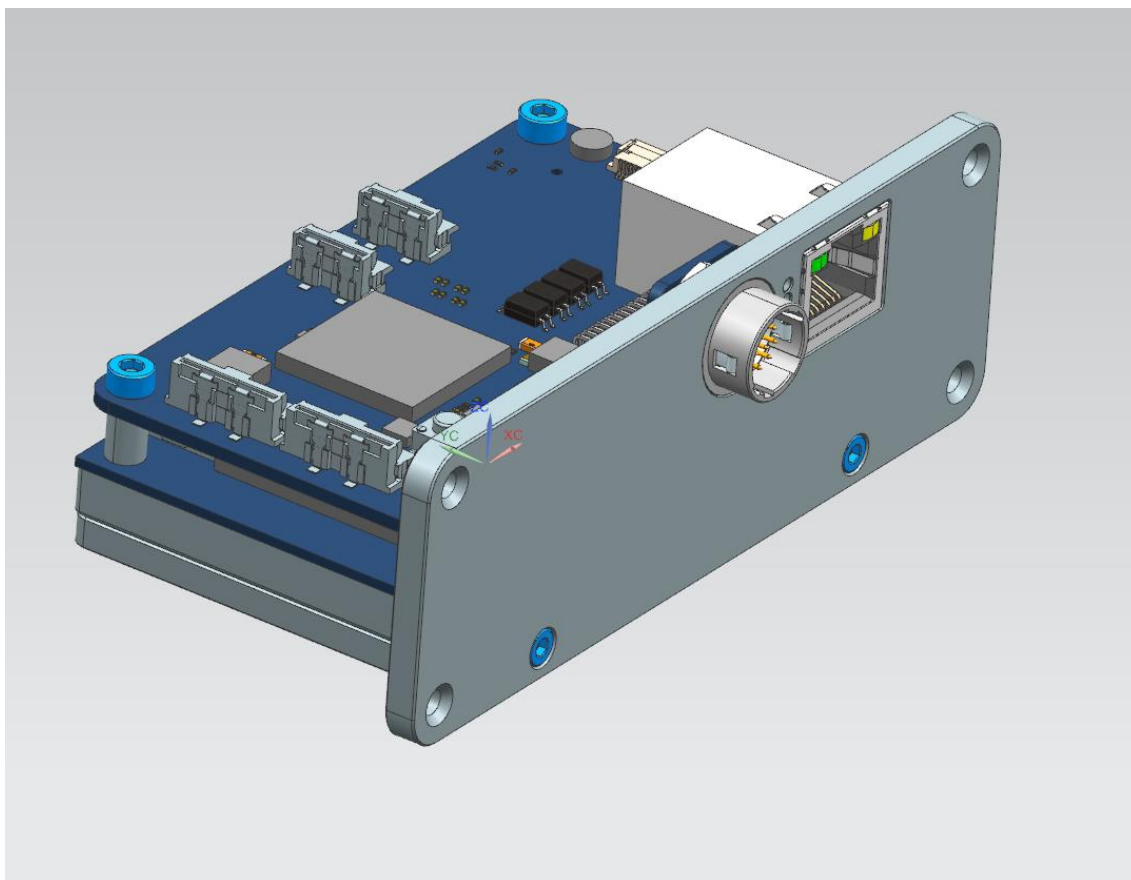


Figure 6-1, 4. 5. Phoxi board stack

6.1. Power / IO connector

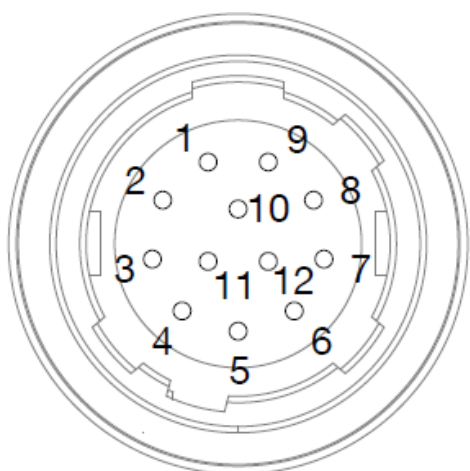


Figure 6-2, 4. 5. Phoxi board stack – PWR/IO Connector

Power / IO connector Pin Assignment:

Pin	Name	Signal	Description
1	IN2	Opto-isolated Input 2	(<0.8 Low; 4-24 High)
2	IN1	Opto-isolated Input 1	(<0.8 Low; 4-24 High)
3	OUT2	Opto-isolated Output 2	Open collector
4	OUT1	Opto-isolated Output 2	Open collector
5	AUX PWR	Power supply input	+12 V
6	GND	External grounds for power and non-isolated I/O	
7	INOUT1	Non-isolated I/O	LVTTTL(3.3, 50µA)
8	INOUT3	Non-isolated I/O	LVTTTL(3.3, 50µA)
9	INOUT2	Non-isolated I/O	LVTTTL(3.3, 50µA)
10	IN GND	Ground for Opto-Isolated Inputs (IN1, IN2)	
11	OUT GND	Ground for Opto-Isolated Out (OUT1, OUT2)	
12	INOUT4	Non-isolated I/O	LVTTTL(3.3, 50µA)

Table 6-1, Phoxi board stack, connector pinning

It is recommended using twisted pair cables for both xiB & xiB-64 IOs. Each input and output should be twisted with its respective ground.

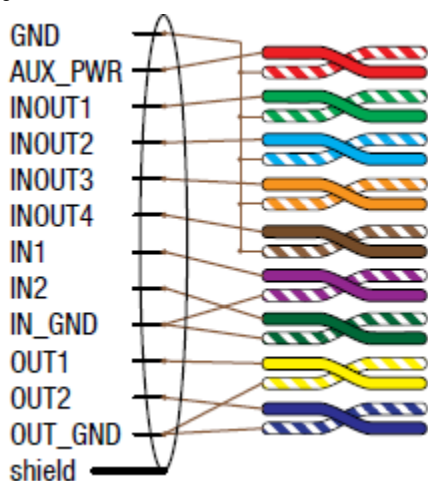


Table 6-2, Phoxi board stack, connector, Recommended twisted pair configuration

6.2. Power input

The phoxi board requires a DC input of +12V with a recommended power of about 30W. XIMEA offers a power supply which can plug into the CBL-MT-PWR-SYNC-3M0 (power/sync cable) and provide DC power to the camera from an AC 120V-230V source.

7. Additional info

7.1. Access to NVIDIA Jetson TX1 / TX2

7.1.1. Network login

After connected and powered up for 60 seconds - try to ping on local network ping tegra-ubuntu:

```
# login with SSH
putty tegra-ubuntu
user: nvidia
pass: nvidia
```

7.1.2. XIMEA Linux API on TX1 / TX2

Please note our most recent info at: https://www.ximea.com/support/wiki/apis/Linux_TX1_and_TX2_Support

The XIMEA API may be pre-installed on the Phoxi Board stack (*6 Phoxi Board-Stack*)

7.2. Useful links

General info are available at:

NVIDIA: <http://www.nvidia.com/object/embedded-systems-dev-kits-modules.html>

XIMEA <https://www.ximea.com/en/products/xilab-application-specific-custom-oem/Embedded-vision-cameras-xiX>
https://www.ximea.com/support/wiki/apis/Linux_TX1_and_TX2_Support

Bosch: https://ae-bst.resource.bosch.com/media/_tech/media/datasheets/BST_BN0055_DS000_14.pdf
https://ae-bst.resource.bosch.com/media/_tech/media/application_notes/BST-BN0055-AN007-00_Quick_Start_Guide.pdf

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