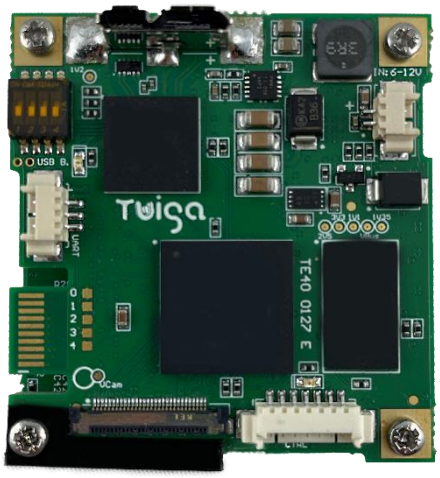
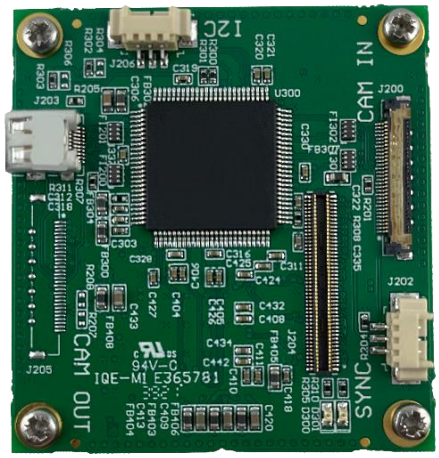
Vision & Innovation

4K to USB3

Technical Manual





P/N – TV20 0008: 4K to USB3 interface board for Sony FCB-4K camera range

P/N – TV50 0027: Mounting kit for TV20 0008 – 4K to USB3 I/F board
Includes: 30-way micro-coax camera cable, 2-way cable (power supply), 3-way cable (UART TTL), 7-way cable (GPIOs), right angle black anodized bracket, screws and spacers

P/N – TV50 0026: Cable kit for TV20 0008 – 4K to USB3 I/F board
Includes: 30-way micro-coax camera cable, 2-way cable (power supply)

Table of content

Revision History

Date	Revision	Description	Modified by	Note
17/02/22	A	Creation of the document	CBO	
28/09/22	B	Add internal registers	CBO	
07/04/23	C	Update board and kit references	CBO	
27/02/25	D	Change document organization and graphical chart	CBO	

Key features

- Super speed USB 3.2 Gen 1
- Uncompressed 4K video stream
- Low latency involved by the board: maximum 2 frames (for example 80ms with 25 fps and 33ms with 60 fps)
- Video resolution up to 2160p30
- USB Video Class (UVC) compliant
- HDMI 2.0 output
- Communication:
  - USB CDC (COM port / tty)
  - VISCA camera control via local UART
  - GPIOs for keypad connection
- Camera external power supply 6V-12VDC*
- Consumption:
  - Board only 3W
  - Camera only around 3W
- Supports Windows and Linux OS
- USB3 cable length up to 7m or 15m adding boost
- Operating temperature [0°C; 60°C]

*Refer to the camera technical manual for max power supply input

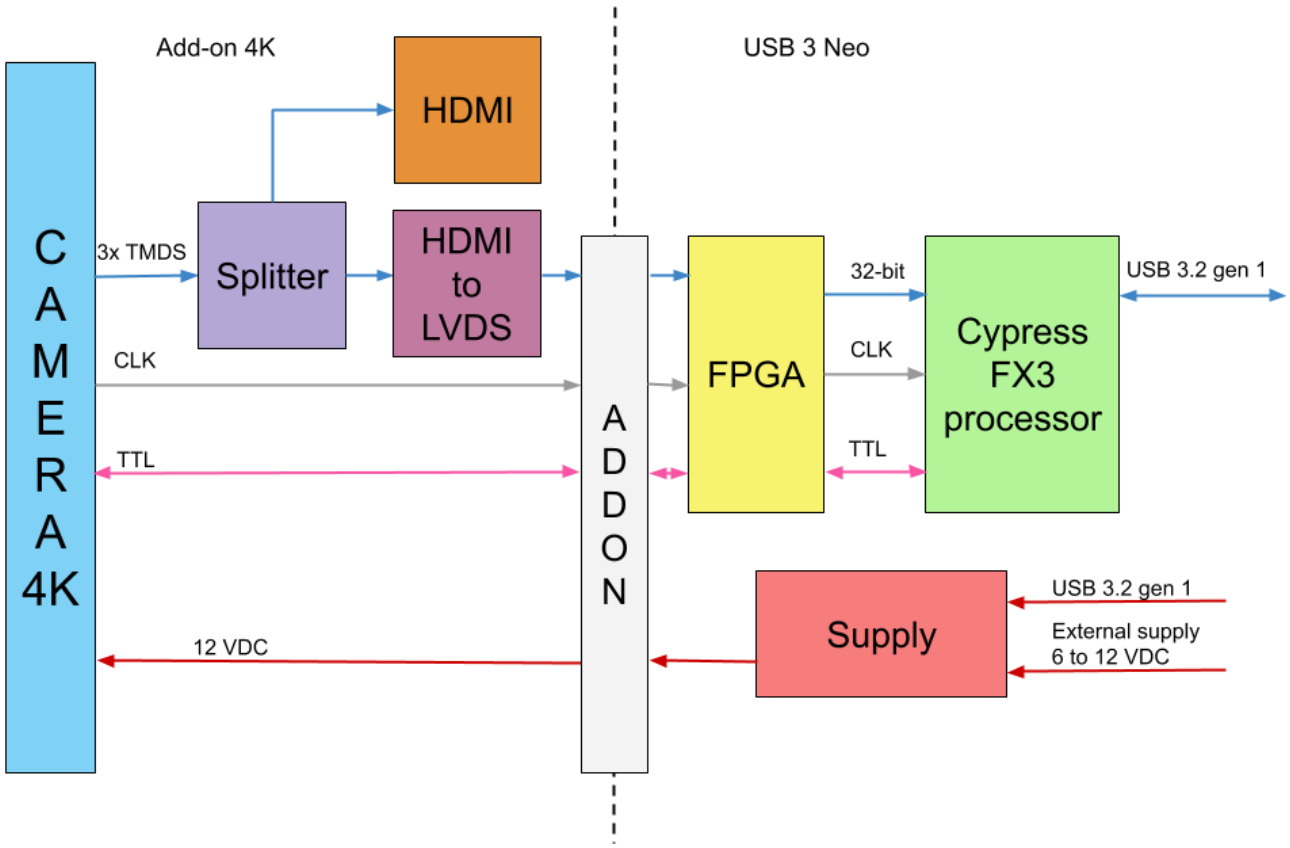
General description

USB3 is the 3rd major version of the Universal Serial Bus standard for interfacing computers and electronic devices. The SuperSpeed USB provides a transfer rate that allows to transmit uncompressed high-definition video signals from camera to a computer.
A simple USB3 cable is enough to power (external power can be needed according to your device), to control and to stream 4K video from the 4K camera. This enables easy implementation of image capture solutions on most devices with a USB3 port (single board computers, NVidia platforms or PC using Windows or Linux OS).
The USB3 Neo converts the TMDS video signal from 4K zoom bock cameras to USB3 standard. You will take advantage of new visualization, processing, and image transfer solutions by using the USB3 streaming possibilities.
The board provides uncompressed UVC compliant video stream. This enables you to use standard application (i.e VLC, Amcap, Windows camera) for image capture, recording and viewing. It also allows to develop custom application and image processing based on DirectShow, GStreamer or OpenCV.
The 4K to USB3 interface board has an HDMI video output to stream simultaneously USB3 and HDMI video. Ideal for digital inspection, UAVs or medical applications that require simultaneously video display and image processing.

Benefits of this solution

- USB3 standard offering many possibilities
- Plug and play solution, one cable for video and communication
- Video stream up to 2160p30
- Compatible with Windows and Linux
- Simultaneous HDMI 2.0 video output
- Camera external power supply connector to solve power issue
- Always keep up to date with an easy software update
- GPIOs connector to easily send basic VISCA commands (zoom in / out, freeze on / off, focus)

Block diagram



Video acquisition

The main components are the HDMI to LVDS converter, the FPGA, the FX3 for video acquisition.
The add-on board acquires TMDS video from the 4K camera block to convert it in LVDS signal sent to the FPGA. With the FX3, it provides uncompressed UVC video stream available via an USB3 connector.

Communication

The communication is possible using the CDC (COM port on Windows, tty on Linux) through the FX3 and the FPGA. An UART TTL is available on a 3 points Molex connector directly connected to the FPGA.
A flashing green LED helps to know if an error occurred according to its number of blinks.

Power supply

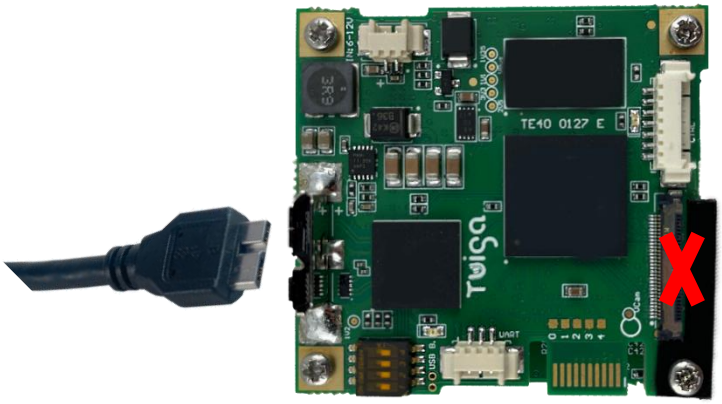
The power supply is done via the USB3.0. It supplies the 4K camera too.
However, the 4K camera only can be powered via a 2 points Molex connector for external power supply (6 to 12VDC).
The board switches automatically to the camera external power supply if you provide it.

Accessing the video

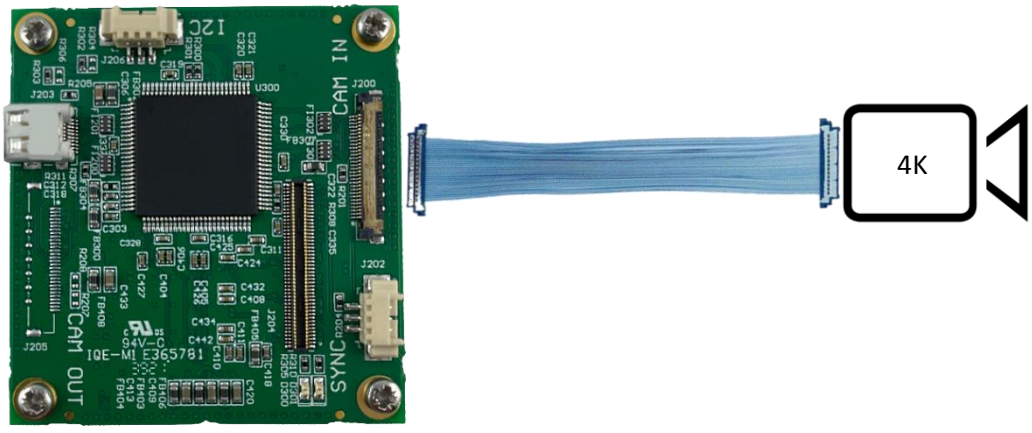
Quick setup

4K camera input is J200 available on the add-on board (P/N TS10 0089). If you connect the 4K camera block to another connector, you will break the camera.

Top side



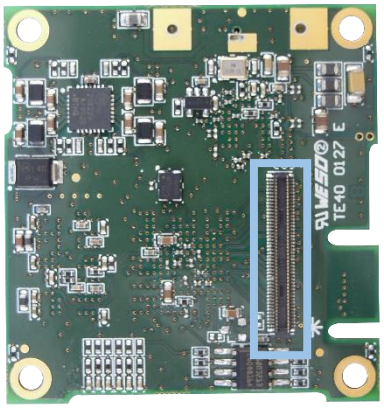
Bottom side



Installation steps:

1. Connect the KEL cable between the add-on board J200 and the 4K camera.
2. If needed (depending on the camera consumption and on your system power), connect the external camera power supply and power it on.
3. Connect the USB3.0 A type cable between the board J204 and the computer on a USB3.0 port. For tower computer please connect on a back side USB3.0 port.

Note: Boards are connected via Hirose board-to-board connectors, you receive the system already assembled.



TV10 0083 USB3 Neo

TS10 0089 Add-on 4K

The add-on board has another boar-to-board connector that can be used to add new custom features or to stack the boards with other customer's boards. On this connector you have the power supply and the communication with the camera available.

Computer configuration

The 4K to USB3 system has been tested on several Exploitation Systems:

- Windows: 7, 8, 8.1, 10, 11
- Linux: Ubuntu 16.04, Ubuntu 20.04, Fedora 33
- Nvidia: Jetson Xavier NX

On Windows

Several software tools are available to display the video:

- VLC: in Media select "Open a capture device" and select the Twiga board as Video device name
- Other 4K compatible software tested: Gstreamer, Camera application from Windows, OBS, Debut from NCH Software, Virtual Dub

On Linux

The board is automatically detected as a video device in /dev/, to find it use the command "ls /dev/". By default, the device is called video0 but it could have another number if you already have a video device connected or according to the Exploitation System version.
To display the stream, you can use a Gstreamer pipeline:

gst-launch-1.0 v4l2src device=/dev/video0 ! videoconvert ! autovideosink

Video characteristics

TMDS video input supported resolutions

	25	29.97	30	50	59.94	60
1920x1080p	✓	✓	✓	✓	✓	✓
3840x2160p	✓	✓	✓			

The video format from the 4K camera can be configured by sending VISCA command using the register 72.

USB3 video output

The output video stream is using UVC protocol and is recognized as a video device on the computer like a webcam. The video is transmitted via a USB3.0 link up to 2160p30, be sure to use a software compatible with 4K video format to receive the stream.
If you connect the board to a USB2.0 port a blue pattern will be displayed.
If the input video format is not supported a black and white pattern will be displayed.

HDMI video output

4K to USB3 module features an HDMI output through J203 Micro HDMI connector. You can get a 4K video stream over any 4K compliant devices. HDMI 2.0 standard cable is recommended.

System configuration

Communication

Communication with the camera can be done through 2 connectors:

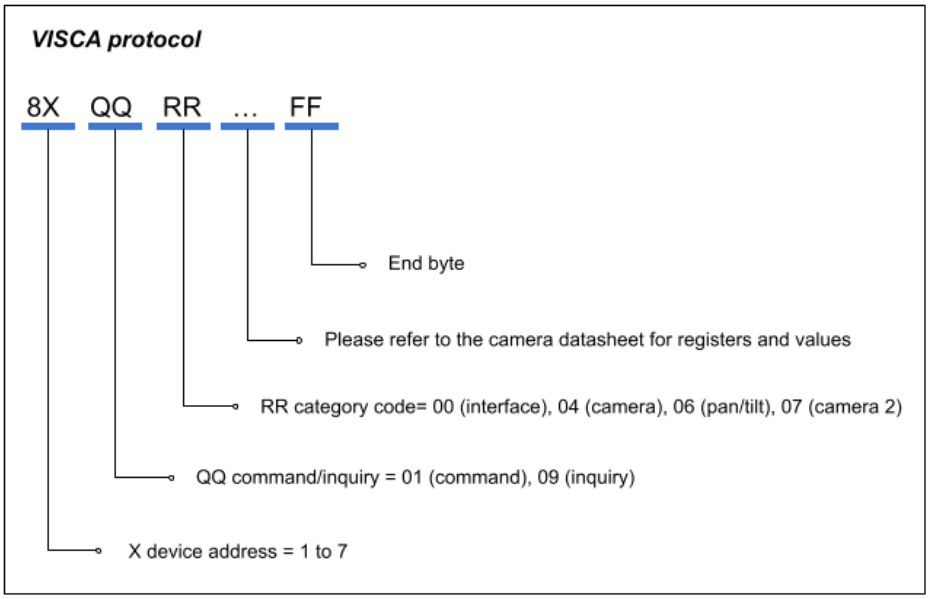
1. USB3.0 connector (J204) using CDC protocol: it allows you to send commands (VISCA) to the camera through the USB3.0 cable. You can change video format, zoom, manage camera parameters such as focus, iris, shutter… You can use basic communication software or specific software according to the camera block you use.

2. UART TTL 3 points connector (J202): you can also use this way to send VISCA commands to the camera or communicate with internal registers. The UART TTL level is 3V3.

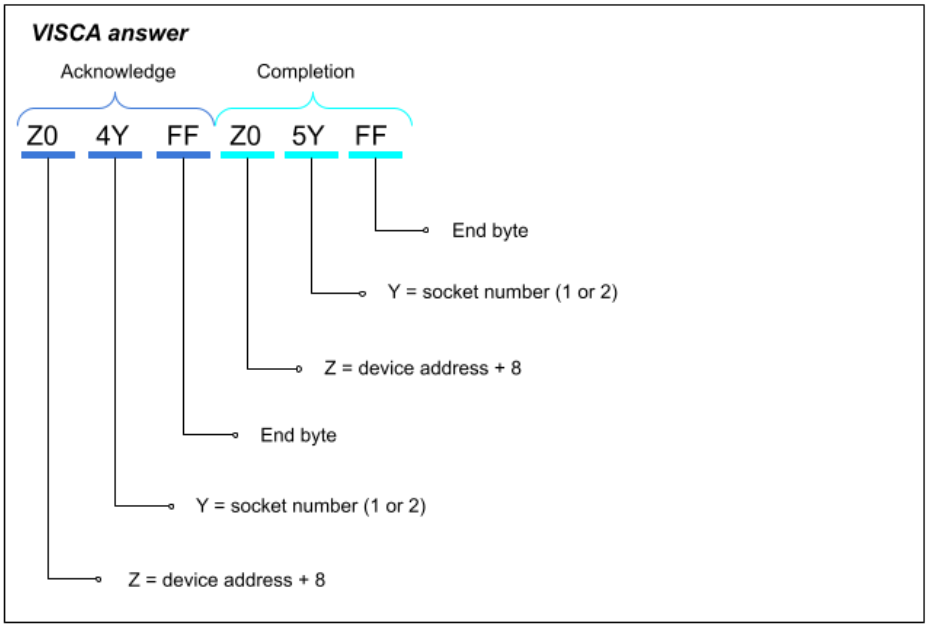
The baud rate of the serial interface will follow the baud rate configured in the camera.

To the camera

The camera communication uses VISCA protocol and will follow camera specifications. It is a standard protocol for camera blocks following this structure:

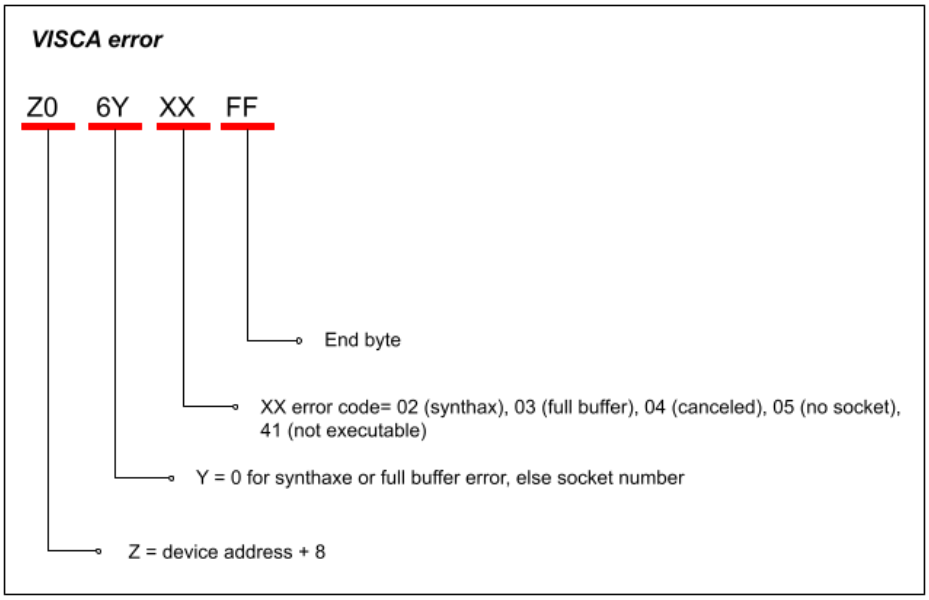


The camera answer follows this structure:



The time between the acknowledgement and the completion packet depends on the command. The answer for an inquiry is Z0 5Y followed by the information requested with FF as end byte.

If an error occurs, here the answer structure:



Example: Zoom In command with a speed of 7 is 0x81 01 04 07 27 FF and the expected answer is 0x90 41 FF followed by 0x90 51 FF.

You can communicate using communication software like Termite or the camera brand communication tool like Sony FCB Control software.

To the internal registers

You can access to internal registers via both communications (CDC and UART TTL). To get a register value you need to send the command 0x82090420XXFF with XX the register you want to read.
To set a register to a new value you need to send the command 0x82010420XXYYFF with XX the register you want to modify and YY the value you want to set in the register.

Here a list of the registers available and their utility:

Utility	Register	Read / Write	Value
FPGA status	0x00	Read only	0bxxxxxx01: FPGA ok 0bxxxxxx10: unavailable format Else: not initialized
Format width low	0x01	Read only	Low part of the width
Format width high	0x02	Read only	High part of the width
Format height low	0x03	Read only	Low part of the height
Format height high	0x04	Read only	High part of the height
FPS low	0x05	Read only	Low part of the FPS
FPS high	0x06	Read only	High part of the FPS
Fx3 ready flag	0x11	Read only	0x00: not ready 0x01: ready
Led use * (see the note)	0x13	Read / Write	0x00: standard flash 0x01: modified video format 0x02: start reinitialization 0x03: video detected 0x04: Hblank 0x05: Vblank 0x06: camera TX 0x07: camera RX 0x08: FX3 stream 0xFF: leds off
FPGA temperature	0x15	Read only	See Annex 1: FPGA temperature table
Firmware version minor	0x1E	Read only	Get the minor value of the software version
Firmware version major	0x1F	Read only	Get the major value of the software version
Serial number 1	0x36	Read only	Ascii value of the 1st digit of the serial number (X0000)
Serial number 2	0x37	Read only	Ascii value of the 2nd digit of the serial number (0X000)
Serial number 3	0x38	Read only	Ascii value of the 3rd digit of the serial number (00X00)
Serial number 4	0x39	Read only	Ascii value of the 4th digit of the serial number (000X0)
Serial number 5	0x3A	Read only	Ascii value of the 5th digit of the serial number (0000X)

This is the answer format: 0x0A41FF0A5100XXFF with XX the read value for a get or the value written for a set.

For low and high registers, you need both to get the full value. For example, if the format width low returns 0x80 and format width high returns 0x07, the final value is 0x780 = 1920.

* Note: to change the Leds use you need first to set the standard use to initialize (0x820104201300FF). Then you can send a second command with another use like Leds off (0x8201042013FFFF).

Computer configuration

On Windows

If your Windows is older than Windows 10 please ask for the driver installation procedure. The board will be automatically detected as a COM port. You can use Termite or putty to open the communication with the dedicated COM port and send VISCA commands. According to your camera brand you can use the specific tool provided by the camera manufacturer like Sony FCB control software.

On Linux

The communication port is recognized on Linux as a /dev/ttyACMx device, where "x" is the number of the device.
When a *ttyACM* device appears on Linux, some daemons software analyze it and it could not be available for about 10sec. After that the device is released and the communication works as a COM Port on Windows.

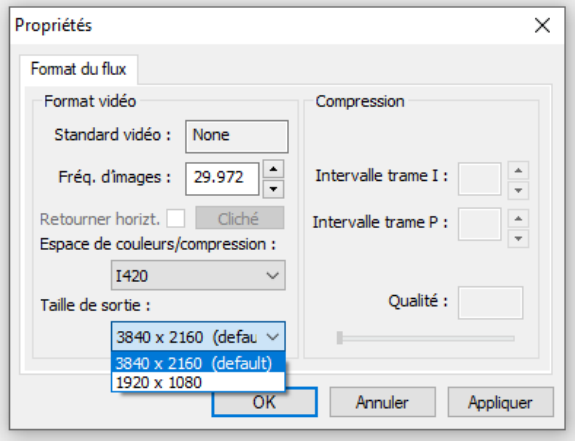
You can use a serial communication terminal to send commands to the camera (e.g. gtkterm).

You can also use the "**echo**" command with a Linux terminal:

- Configure the tty with the correct baud rate: ***stty 9600 -F /dev/ttyACMx***
- For checking the configuration use: ***stty -a -F /dev/ttyACMx***
- Send commands like zoom plus as it ***echo –en '\|x81\|x01\|x04\|x07\|x02\|xff' > /dev/ttyACMx*** where x is the device number and 8101040702FF the zoom in command in hexadecimal

Downscaling and FPS change

You can use the UVC protocol to downscale from 4K to full HD and to change the FPS of the stream.
Two video formats are available: 4K (3840x2160) and full HD (1920x1080).
Five FPS setting are available: full fps, fps/2, fps/4, fps/8, and fps/16.



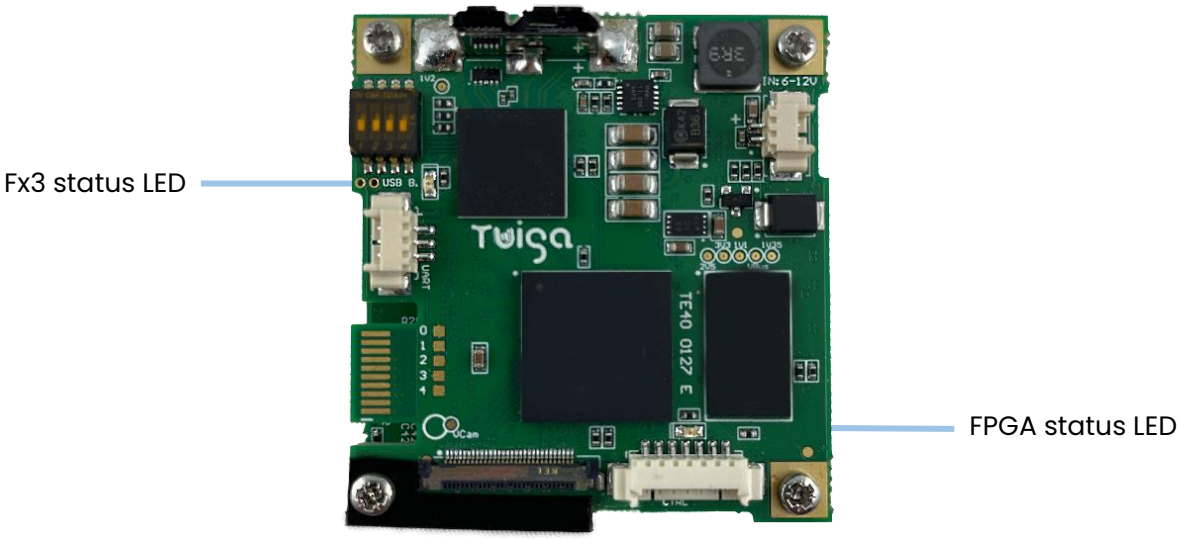
GPIOs

Six GPIOs are available on J200 connector, each one is dedicated to a specific camera function:

Pin	Action	Control	VISCA command sent
Ctrl1	Press Release	Zoom + Zoom stop	0x81 01 04 07 26 FF 0x81 01 04 07 00 FF
Ctrl2	Press Release	Zoom – Zoom stop	0x81 01 04 07 36 FF 0x81 01 04 07 00 FF
Ctrl3	Press Release	Focus Auto / Manual	0x81 01 04 38 10 FF
Ctrl4	Press Release	Focus near Focus stop	0x81 01 04 08 33 FF 0x81 01 04 08 00 FF
Ctrl5	Press Release	Focus far Focus stop	0x81 01 04 08 23 FF 0x81 01 04 08 00 FF
Ctrl6	Press Release	Image freeze toggle	0x81 01 04 62 02 FF 0x81 01 04 62 03 FF

To activate it you need to connect the pin to the ground. ESD filters and anti-bounce have been added. You can use existing keyboard to easily control them.

LED signalization



Number of Fx3 Status LED blink per 2 seconds	Meaning
1	Error
2	Communication error
3	Format error
4	Configuration ok

Number of FPGA Status LED blink per 3 seconds	Meaning
2	FX3 not detected
4	Video error
6	Configuration Ok

Multi switch

Switch number	Meaning
1	Unused
2	Unused
3	Unused
4	Unused

The DIP switches are not used for the 4K to USB3 system, please keep them in OFF position.

External synchronization

The external synchronization allows the user to use a real-time source generator to synchronize in parallel many devices. An input for an external synchronization signal is available on a simple 3pts connector (J202) on the add-on board. The synchronization signal is directly forwarded to the camera.

Note: The external synchronization feature is **only** available with the **ER8550 camera**. The external synchronization signal format must match the camera's format.

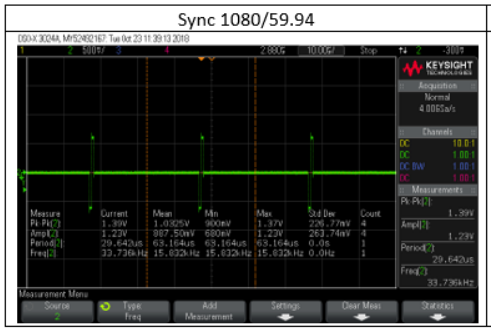
Sony ER8550 incorporates internal synchronization module which follows the following specifications:

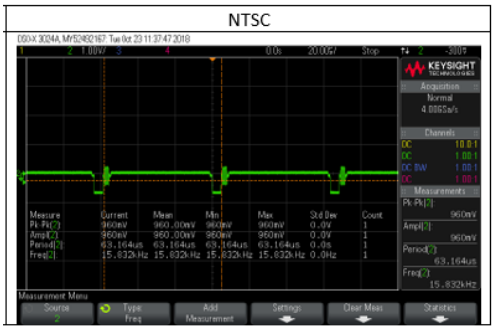
- Tri-State Sync: partial part of SMPTE 240M/274M
- NTSC Black burst: EBU N14/SMPTE RP-154
- PAL Black burst: ITU-R BT.470-6
-

Note: The H phase adoption function is not available on Sony Camera.

Valid synchronizations signals:

Input External Signal format / Camera Mode	Tri-State Sync			NTSC Black burst	PAL Black burst
	1080/59.94i	1080/50i	1080/47.95i		
3840×2160/29.97p	○	×	×	○	×
3840×2160/25p	×	○	×	×	○
3840×2160/23.98p	×	×	○	×	×
1920×1080/59.94p	○	×	×	○	×
1920×1080/59.94i	○	×	×	○	×
1920×1080/50p	×	○	×	×	○
1920×1080/50i	×	○	×	×	○
1920×1080/29.97p	○	×	×	○	×
1920×1080/25p	×	○	×	×	○
1920×1080/23.98p	×	×	○	×	×
1280×720/59.94p	○	×	×	○	×
1280×720/50p	×	○	×	×	○
720×480/59.94p	○	×	×	○	×
720×576/50p	×	○	×	×	○





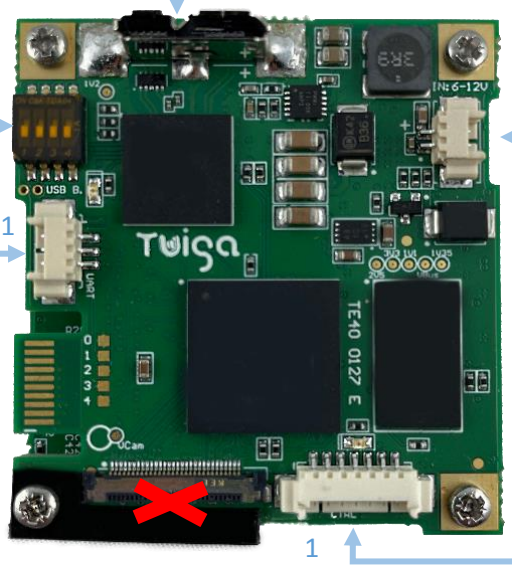
Connectors

J204	USB3.2

J300	External Camera Power supply
1	GND
2	V+

DIP switches				Configuration
1	2	3	4	
/	/	/	/	Unused Keep OFF

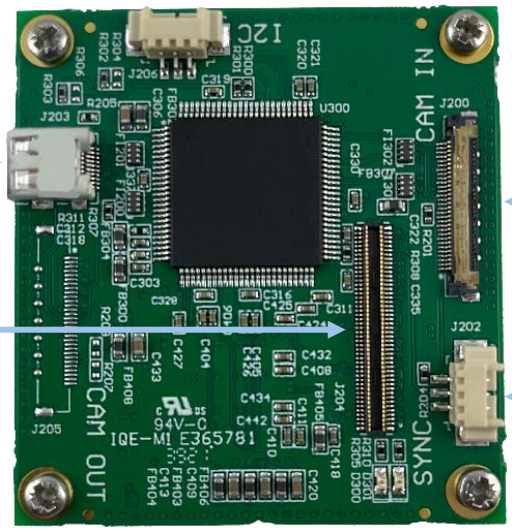
J200	GPIOs
1	GND
2	Zoom +
3	Zoom -
4	Focus Auto/Manual
5	Focus Near
6	Focus Far
7	Freeze On/Off



J202	UART TTL
1	GND
2	Rx
3	Tx

J200	4K TMDS camera input
1	DC_IN
2	DC_IN
3	DC_IN
4	DC_IN
5	RESET
6	UART_TX
7	UART_RX
8	GND
9	USB_D +
10	USB_D -
11	GND
12	USB_VBUS
13	+5.0V OUT
14	Hot Plug Detect
15	EXT_SYNC_LOCK
16	EXT_SYNC
17	XSD0_ACC_LED
18	GND
19	TMDS Data 2 +
20	TMDS Data 2 -
21	GND
22	TMDS Data 1 +
23	TMDS Data 1 -
24	GND
25	TMDS Data 0 +
26	TMDS Data 0 -
27	GND
28	TMDS Clock +
29	TMDS Clock -
30	GND

J203	HDMI 4K output

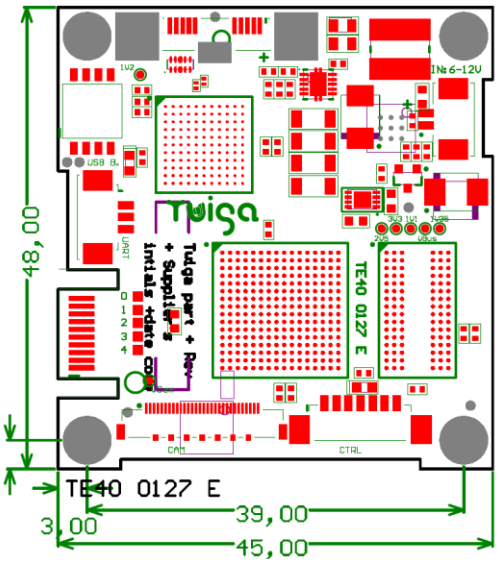


J204	Board to Board connector
Extended functionalities	

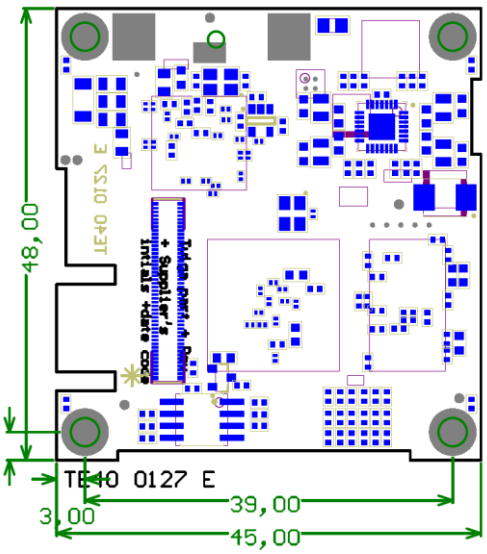
J202	External Sync
3	VID SYNC
2	SYNC LOCK
1	GND

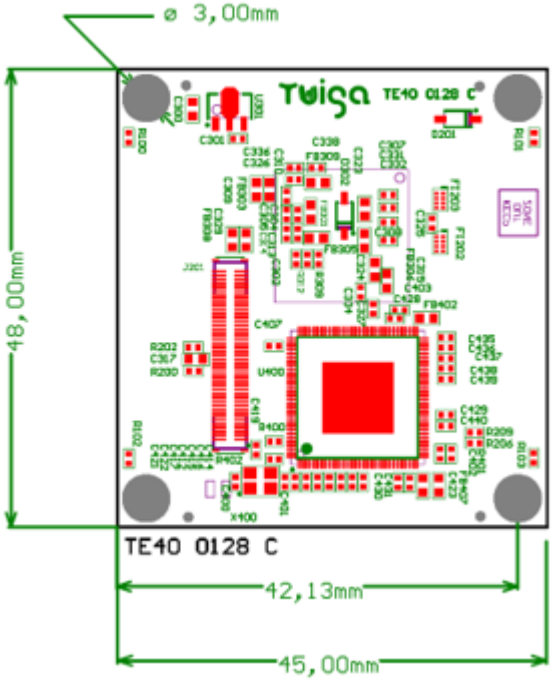
Form factor

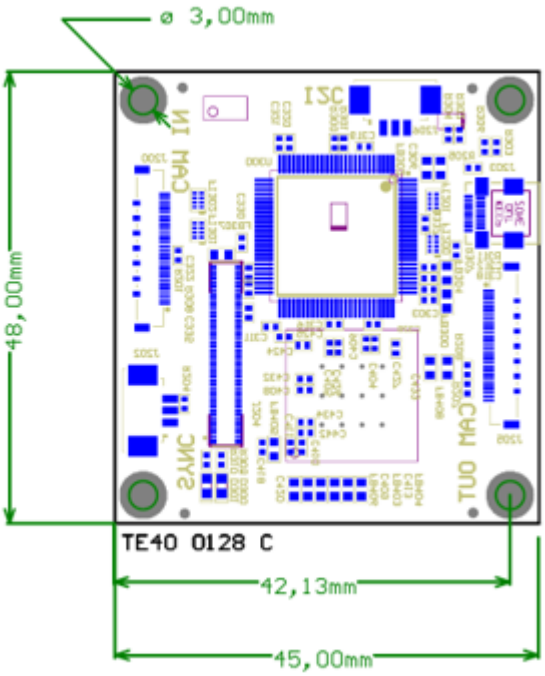
TOP



BOTTOM







48mm (H) x 45mm (W) x 18mm (D)

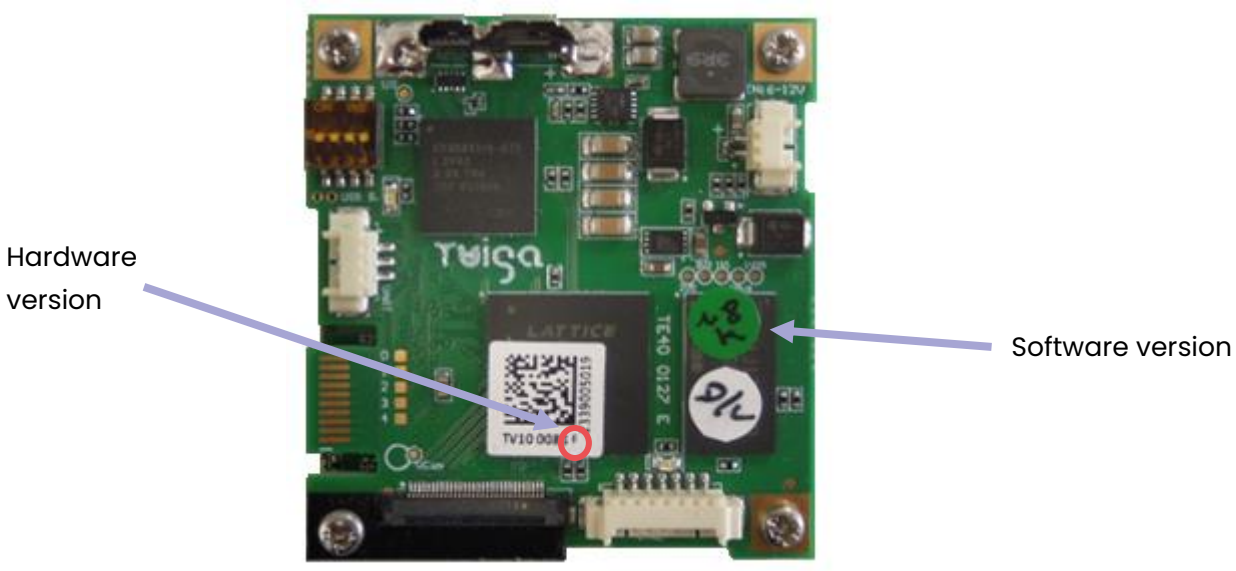
4 holes Ø 3mm

24g

Troubleshooting

Get hardware and software version

The hardware version is a letter written close to the reference of the board TV10 0083. The software version is written on a green sticker stuck on the top side of the board. Be careful, 4K to USB3 can be updated by the customer, in this case the green sticker could be at a wrong version. You can still read internal registers to get the correct version.



Update via UART

An update of the board is possible by distance, you need an UART connection with the board and a Java application made by i2S.
If you do not have this tool, please send us a mail at info@i2s.fr specifying which board you are working with. This way we will give you the right tool to perform the software update and the changes involved by the different software.

Common issues

If you have any problem getting the video, here some points you need to check:

- Power supply is correctly connected to the board, no consuming issue or overheating of the board.
- The camera does not restart in loop, if it is the case the power coming from your USB3 port is not enough to power supply the board and the camera. Please use the 2 points Molex connector for camera external power supply (12V, 1,5A).
- If the video is a blue pattern, it means your board is recognized as USB2.0 device. Please use USB3.0 cable and USB3.0 port, if it is the case try with another USB3.0 cable.
- The video format of the camera is correct and supported by the board, if not you will see a black and white pattern. If the video format is correct, try another Kel cable. Maybe try with another 4K TMDS compatible camera to be sure the issue is not coming from the camera.
- Check that all the 4 DIP switches of the board are in OFF position.

If you are not able to find the cause of the issue, please contact us at info@i2s.fr and we will give you support. Explain us the problem you are facing with as much details as possible and please add the hardware and software version of your board.

Annex

Annex 1: FPGA temperature table

Here the table to get the FPGA temperature (°C) from the value read in the register 0x15.

Register value read	FPGA temperature (°C)
0x00	−58
0x01	−56
0x02	−54
0x03	−52
0x04	−45
0x05	−44
0x06	−43
0x07	−42
0x08	−41
0x09	−40
0x0A	−39
0x0B	−38
0x0C	−37
0x0D	−36
0x0E	−30
0x0F	−20
0x10	−10
0x11	−4
0x12	0
0x13	4
0x14	10
0x15	21
0x16	22
0x17	23
0x18	24
0x19	25
0x1A	26
0x1B	27
0x1C	28
0x1D	29
0x1E	40
0x1F	50
0x20	60
0x21	70
0x22	76
0x23	80
0x24	81
0x25	82
0x26	83
0x27	84
0x28	85
0x29	86
0x2A	87
0x2B	88
0x2C	89
0x2D	95

0x2E	96
0x2F	97
0x30	98
0x31	99
0x32	100
0x33	101
0x34	102
0x35	103
0x36	104
0x37	105
0x38	106
0x39	107
0x3A	108
0x3B	116
0x3C	120
0x3D	124
0x3E	128
0x3F	132