Komodo CLHS Frame Grabber Hardware Reference and Installation Guide

(Part-No. KY-FGF-CLHS)

May 2018

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Revision History

Version	Date	Notes
1.0	20.07.15	Initial Release
2.0	03.04.18	Added SFP installation section
3.0	23.05.18	Minor corrections

2.1 Safety Precautions

With your *Komodo CLHS* Frame Grabber in hand, please take a minute to read carefully the precautions listed below in order to prevent unnecessary injuries to you or other personnel or cause damage to property.

- **Before using the product, read these safety precautions carefully to assure correct use.**

- **These precautions contain serious safety instructions that must be observed.**

- **After reading through this manual, be sure to act upon it to prevent misuse of product.**

⚠ **Caution**

In the event of a failure, disconnect the power supply.
If the product is used as is, a fire or electric shock may occur. Disconnect the power supply immediately and contact our sales personnel for repair.
If an unpleasant smell or smoking occurs, disconnect the power supply.
If the product is used as is, a fire or electric shock may occur. Disconnect the power supply immediately. After verifying that no smoking is observed, contact our sales personnel for repair.
Do not disassemble, repair or modify the product.
Otherwise, a fire or electric shock may occur due to a short circuit or heat generation. For inspection, modification or repair, contact our sales personnel.
Do not touch a cooling fan.
As a cooling fan rotates in high speed, do not put your hand close to it. Otherwise, it may cause injury to persons. Never touch a rotating cooling fan.
Do not place the product on unstable locations.
Otherwise, it may drop or fall, resulting in injury to persons or failure.
If the product is dropped or damaged, do not use it as is.
Otherwise, a fire or electric shock may occur.
Do not touch the product with a metallic object.
Otherwise, a fire or electric shock may occur.
Do not place the product in dusty or humid locations or where water may splash.
Otherwise, a fire or electric shock may occur.
Do not get the product wet or touch it with a wet hand.
Otherwise, the product may break down or it may cause a fire, smoking or electric shock.
Do not touch a connector on the product (gold-plated portion).
Otherwise, the surface of a connector may be contaminated with sweat or skin oil, resulting in contact failure of a connector or it may cause a malfunction, fire or electric shock due to static electricity.

<table>
<tbody>
<tr><td>

Do not use or place the product in the following locations.
● Humid and dusty locations
● Airless locations such as closet or bookshelf
● Locations which receive oily smoke or steam
● Locations close to heating equipment
● Closed inside of a car where the temperature becomes high
● Static electricity replete locations
● Locations close to water or chemicals
Otherwise, a fire, electric shock, accident or deformation may occur due to a short circuit or heat generation.

</td></tr>
<tr><td>

Do not place heavy things on the product.
Otherwise, the product may be damaged.

</td></tr>
<tr><td>

Be sure to drain static electricity from body before you touch any electronics component
The electronic circuits in your computer and the circuits on Komodo CLHS Frame Grabber are sensitive to static electricity and surges. Improper handling can seriously damage the circuits. In addition, do not let your clothing come in contact with the circuit boards or components. Otherwise, the product may be damaged.

</td></tr>
</tbody>
</table>

2.2 Disclaimer

This product should be used for interfacing of CLHS camera and acquiring of CLHS video streams. KAYA Instruments assumes no responsibility for any damages resulting from the use of this product for purposes other than those stated.

Even if the product is used properly, KAYA Instruments assumes no responsibility for any damages caused by the following:

- Earthquake, thunder, natural disaster or fire resulting from the use beyond our responsibility, acts caused by a third party or other accidents, the customer's willful or accidental misuse or use under other abnormal conditions.

- Secondary impact arising from use of this product or its unusable state (business interruption or others).

- Use of this product against the instructions given in this manual or malfunctions due to connection to other devices.

KAYA Instruments assumes no responsibility or liability for:

- Erasure or corruption of data arising from use of this product.

- Any consequences or other abnormalities arising from use of this product, or damage of this product not due to our responsibility or failure due to modification.

Repair of this product is carried out by replacing it on a chargeable basis, not repairing the faulty devices. However, non-chargeable replacement is offered for initial failure if such notification is received within two weeks after delivery of the product.

3.1 Overview

Komodo-CLHS is a high-performance Camera Link HS Frame Grabber supporting X Protocol (10G) standard. It is capable of receiving video streams from up to 8 CLHS X Protocol links using four SFP+ 10GigE transceivers optical interface. Each link supports standard X Protocol bitrates up to 10 Gbps. The Frame Grabber offers a flexible DDR3 memory system with up to 144 Gb of memory and 128 Gbps throughput. A high speed 8 lane Gen 3.0 PCI express interface allows fast data transfer between optical links and computer memory

This CLHS Frame Grabber is ideally suited for industrial, defense and aerospace Machine Vision Systems and applications.

This product also provides GPIO for machine control signals, such as triggers, shaft encoders, exposure control and general I/O, which can be control aside video stream acquisition.

3.2 Features

- Up to 8 CLHS links support
- PCIe Gen3 x8 Half-length card
- Up to 144 Gb image buffer
- Multi-stream support
- Camera controls and triggers
- Up to 8 re-transmit links
- Per-link LED indication on card bracket
- Flexible machine I/O:
    - 4 TTL configurable I/Os
    - 4 LVCMOS configurable I/Os
    - 2 LVDS inputs
    - 2 LVDS outputs
    - 4 opto-isolated outputs
    - 4 opto-isolated inputs
    - 4 quadrature rotary encoders
    - Integrated strobe controller
- CLHS compliant
- Multiple Camera synchronization
- Multiple Frame Grabbers synchronization

- GUI interface

- Supporting Windows and Linux OS

- API for developing custom applications

- Plug-ins modules for MATLAB, HALCON and Labview

- Gen<i>Cam compliant

- GenTL support

- Data rates up to 10 Gbps per link

- Transfer Rate of up to 55 Gbps

- 0°C to 50°C operating environment temperature

- On board Image processing

- Color space conversion with selectable bit depth

- Bayer de-mosaicing with selectable bit depth

- Tap re-ordering

- Color correction

- Custom processing engines

3.3 Product Applications

- Machine Vision

- Networking

- Algorithm Acceleration

- Broadcasting and sports analytics

- High-speed DVRs

3.4 Related documents and accessories

Documents:

- Vision Point App User Manual

- Vision Point API Reference Book

- CLHS standard

Accessories:

- Fiber cables (Multi or Single mode)

4.1 Example System Block Diagram

The Komodo CLHS Frame Grabber supports multiple modes of configuration and system topology. Few of these are presented in following diagrams.

Single Camera Topology:

One Single, Dual or Quad CLHS links with 10Gb per link topology.

Maximum throughput to PCIe of 55 Gb/sec.
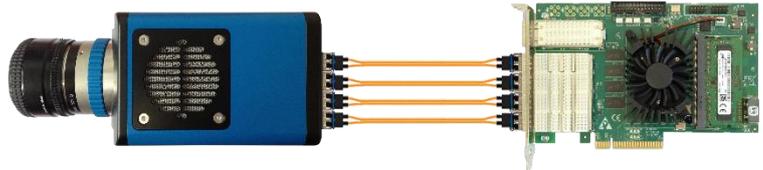
Quad Camera Topology:

Four Single or Dual CoaXPress links with 10Gb per link topology.

Maximum throughput to PCIe of 55 Gb/sec.
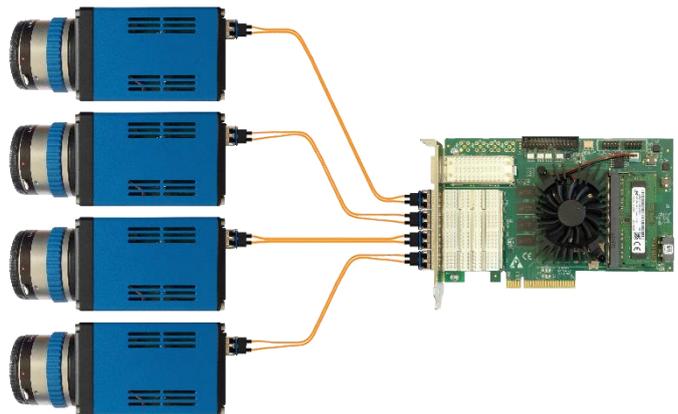
Figure 1 : CLHS system block diagram

4.2 External View of the Komodo CLHS Frame Grabber

J1

SFP+

SODIMM

PCIe
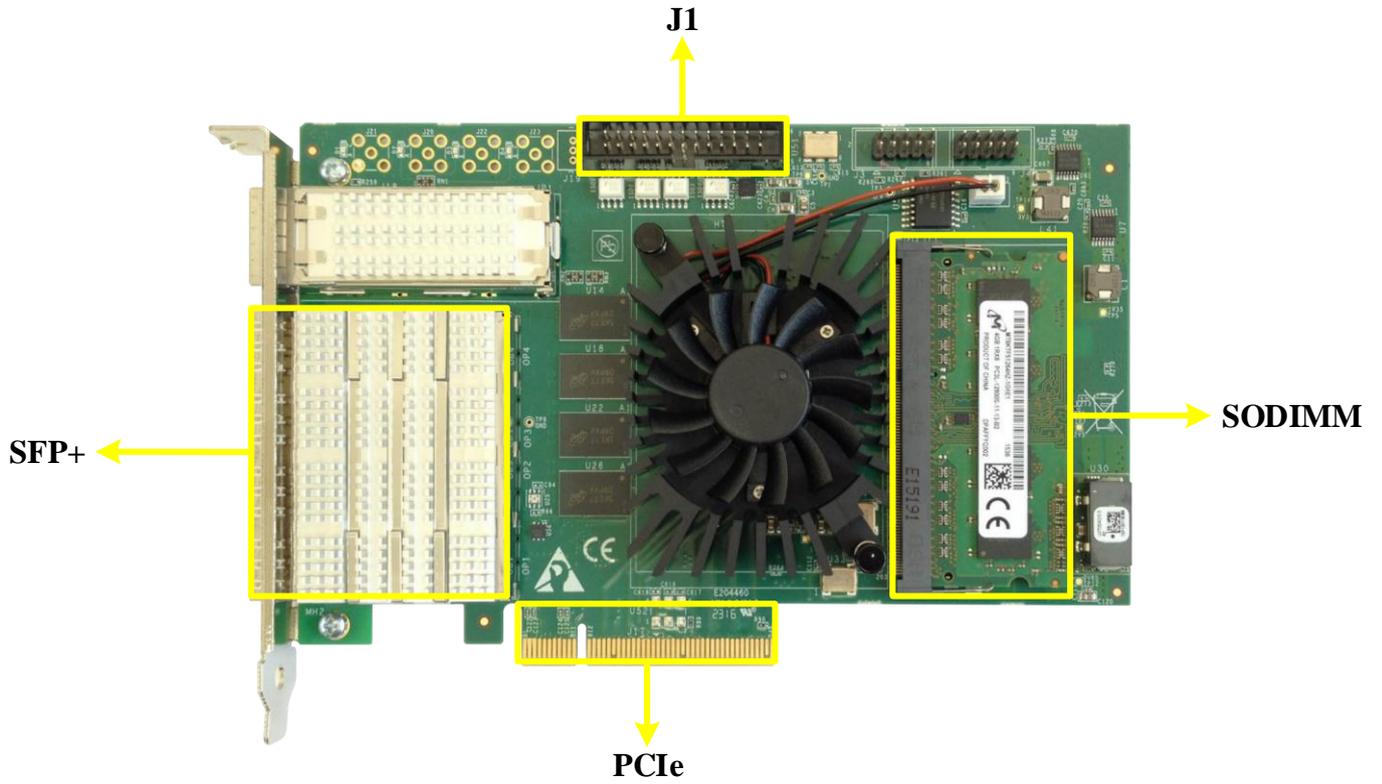
Figure 2 : Komodo CLHS Frame Grabber external view

5.1 Essentials to get started

To begin using your Komodo CLHS Frame Grabber, you must have the following:

- ✓ A computer with the following:

    - Processor with an Intel 64-bit architecture, or equivalent.

    - An availably x4 (or x8 or x16) PCIe slot. Gen 3 support is recommended to faster data transfer.

    - Vision Point Application installation

- ✓ CLHS camera

- ✓ Fiber optic cables

NOTE: KAYA Instruments doesn't guarantee compatibility with all computers that have the above specifications. Please, consult KAYA representative for any specific issue.

6.1 Komodo Frame Grabber installation instructions

Before system installation the Komodo CLHS Frame Grabber should be installed into host computer. Komodo CLHS Frame Grabber is standard PCIe card with 8 lanes connector.

It can be installed in any PCIe connector of the motherboard with 8 lanes and up.

Note: Frame Grabber should be installed before you install your software.

1. Before installing, turn off the power of the computer and its peripherals.
2. Use an ESD-preventive glove, wrist or ankle strap and follow its instructions for use.
3. Make sure there is no dust or any other foreign matter inside the PCIe slot and the Frame Grabbers PCIe connector, or blocking any of the connectors.
4. Firmly insert the Komodo CLHS Frame Grabber to PCIe connector of the motherboard.
5. Anchor the PCIe bracket to the computer chassis using M3 screw.
6. Verify the Komodo CLHS Frame Grabber inserted correctly to the PCIe slot.
7. After OS is up, you will be asked to install a driver for new Multimedia Device. At this stage, you should cancel the installation.

Under Windows and Linux OS the compatible drivers for **Komodo CLHS Frame Grabber** will be installed during installation of Vision Point software application.

You can install and use multiple **Komodo CLHS Frame Grabbers** in a single computer.

The number of **Komodo CLHS Frame Grabber** that can be installed in a computer depends on the number of available PCIe slots.

6.2 Installing and Removing SFP+ Modules

The purpose of this section is to demonstrate how to install SFP+ transceiver module, attach an optical network cable and remove an SFP+ transceiver module. It is necessary to understand the correct way of installing and removing an SFP+ transceiver, as correct operation can protect the module from being damaged and ensure its stable performance.

Before removing or installing an SFP+ module, please follow the precautions and installation instructions.

6.2.1 Precautions

1. Use an ESD-preventive wrist or ankle strap and follow its instructions for use.

2. Make sure there is no dust or any other foreign matter inside the SFP+ module, or blocking any of the connectors.

3. Clean the optic surfaces of the fiber cables before plugging them into the optical ports of an SFP+ module.

4. Removing and inserting a module can shorten its useful life, so you should not remove and insert the module any more often than is absolutely necessary.

5. Insert the clean dust covers into the module after the cables are removed. Do not remove the dust plug until you are ready to attach the network interface cable.

6. Do not install or remove the SFP+ module with fiber-optic cables attached to it because of the potential of damaging the cable, the cable connector, or the optical interfaces in the module.

7. Disconnect all cables before removing or installing a module.

8. Place the removed module on an antistatic mat or a static shielding bag if you plan to return it to the factory.

9. Protect the line card by inserting clean module cage covers into the optical module cage when there is no module installed.

10. Keep the protective dust plugs installed in the unplugged fiber-optic cable connectors and in the transceiver optical bores until you are ready to make a connection.

6.2.2 Installing the SFP+ Module

In order to install the SFP+ module, follow these steps:

1. The Komodo CLHS Frame Grabber supports the following SFP+ modules:

    KY-SFP-10G31-10 – Allows of up to 10km connection over single mode fiber cable.

    KY-SFP-10G85-3M – Allows of up to 300m connection over multi-mode fiber cable.

2. Remove the dust plugs from the module as shown in Figure 3.

3. The SFP+ module has a bale clasp that used to remove or install the SFP+ module.

4. Close the bale clasp before inserting the SFP+ module.

5. Line up the module with the port and slide it into the port as shown in Figure 4.

6. Make sure that the male connectors on the module will align with the female connectors inside the cage.

7. Verify that the modules are completely seated and secured in their assigned receptacles on the line card by firmly pushing on each module. In case the module is not completely seated and secured in the receptacle, you will hear a click as the triangular pin on the bottom of the module snaps into the hole in the receptacle.

8. Follow the exact steps to insert additional module into the CLHS camera.
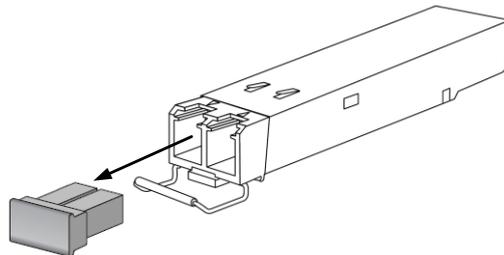
Figure 3: SFP+ Module with bale clasp open and dust plug removed
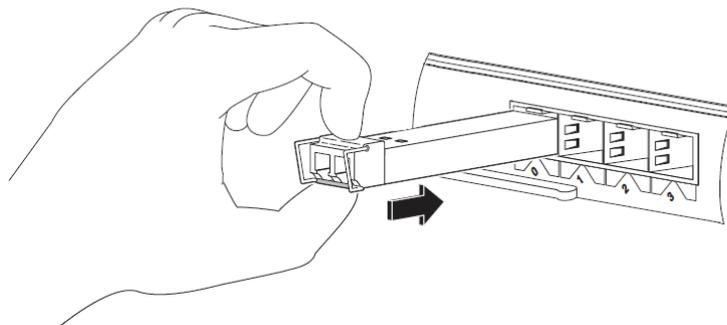

Figure 4: Installing an SFP+ Module into a port

6.2.3 Connecting the interface cable to SFP+ Module

In order to properly connect the fiber optic cables, the following steps must be taken:

1. Remove the protective dust plugs from the fiber-optic cable connectors.

2. Preform the connection according to the instructions below:

   a. Link 0 of the system must be always connected as controls are delivered with this port.

   b. A Fiber connection must be done to the same port number all over the way from camera to Frame Grabber.

   c. A fiber cable should match an SFP+ type. If a single mode SFP+ is used a single mode fiber (yellow) should be attached to it. If a multi-mode SFP+ is used a multi-mode fiber (orange) should be attached.

   d. On Fiber channel 0 both the TX and RX fiber cables must be connected. On channels 1 through 3 only one fiber cable should be connected. This cable is connected between TX output (Marked with TX or Arrow outwards the SFP+) on the camera and RX input

(Marked with RX or Arrow inwards the SFP+) on the Frame Grabber, as shown in Figure 5.

    e. If more than a single cable is used to connect to the same Frame Grabber, the cables must be of the same type and length.

3. Insert the fiber cable into the module, as shown in Figure 6.

4. Firmly push on each cable, until you will hear a click.

5. Connect the other side of the fiber cables to the CLHS camera.

6. Turn the camera and the computer on and start your Vision Point software application.
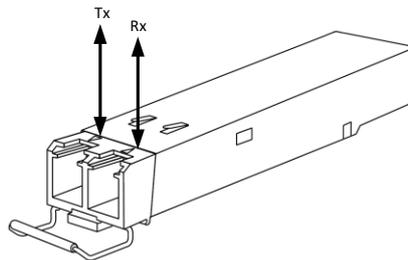
Figure 5: SFP+ Module with TX output and RX input marked
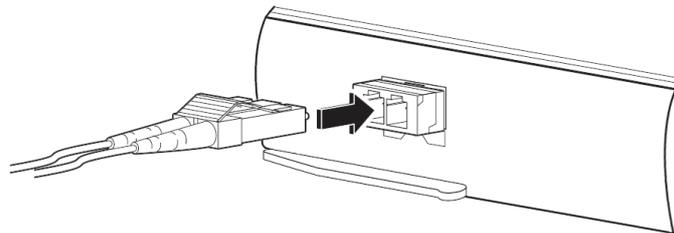
Figure 6: Connecting the cable to SFP+ Module

6.2.4 Removing the SFP Module

In order to remove the SFP+ module, follow these steps:

1. Turn the camera and the computer off.

2. Disconnect and remove all interface cables from the ports.

3. Open the bale clasp on the SFP+ module with your index finger, or a small flat-blade screwdriver, in a downward direction, as shown in Figure 7.

4. Grasp the module between your thumb and index finger and carefully remove it from the port, as shown in Figure 8.

5. Insert the clean dust covers into the module, as shown in Figure 9.
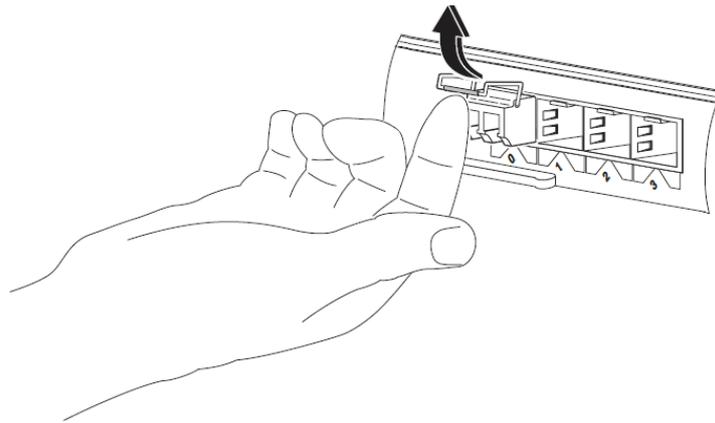
Figure 7: Opening the bale clasp of an SFP+ Module
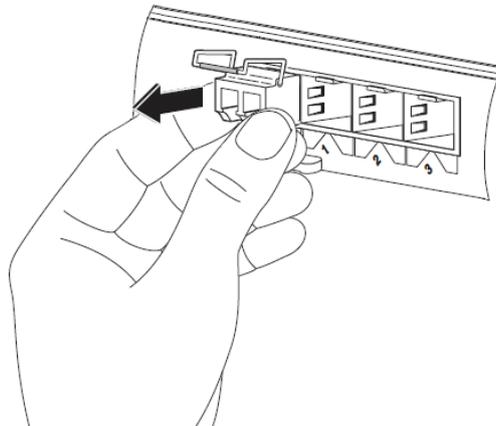
Figure 8: Removing an SFP+ Module from the port
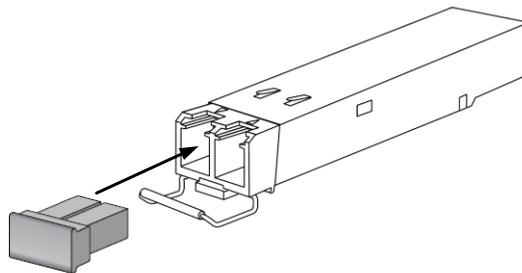
Figure 9: SFP+ Module with bale clasp open

6.3 Reducing the fiber optic cable count

The system requires 2*N fiber optical cables in order to properly operate. The N is the number of CLHS links required for the camera. But sometimes it required transferring the data over smaller number of cables.

Several options listed in the sections below exist in order to reduce the number of required optical cables. Please note that these options are available for single mode fiber infrastructure only.

Please contact KAYA representative for details of those options.

6.3.1 Bidirectional (BIDI) SFP+ option

The BIDI SFP+ can transfer data in both the directions over a single fiber cable. This option allows reducing one fiber optic cable from the system by factor of 2. For example, 4 link cameras will require 4 fiber cables.
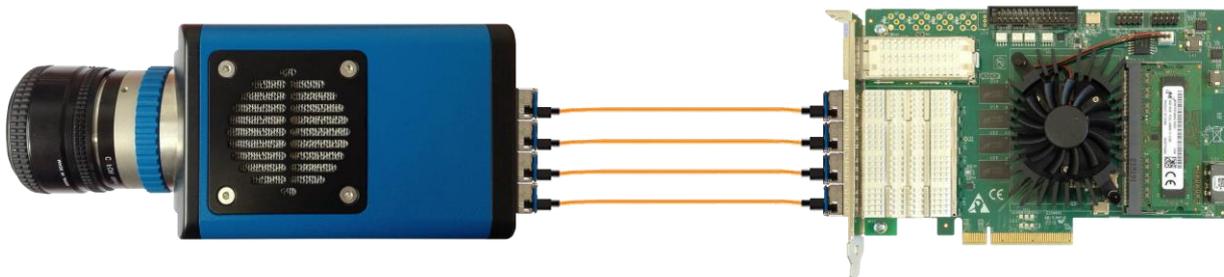
Figure 10 : Komodo CLHS Bidirectional SFP+ option

6.3.2 CWDM Option

In CWDM each optical SFP+ module operates at different wavelength and then an optical multiplexer is used to mix all the signals into a single fiber. In this mode the number of cables required in the infrastructure can down to two cables or even single cable. The CWDM also can be used to use the CLHS over existing infrastructure, sharing the same fiber cables with other applications.

Two available CWDM modes (for single or dual fibers) are described in Figure 11 and Figure 12. For assignment of CWDM wavelengths please contact KAYA Instruments representative.
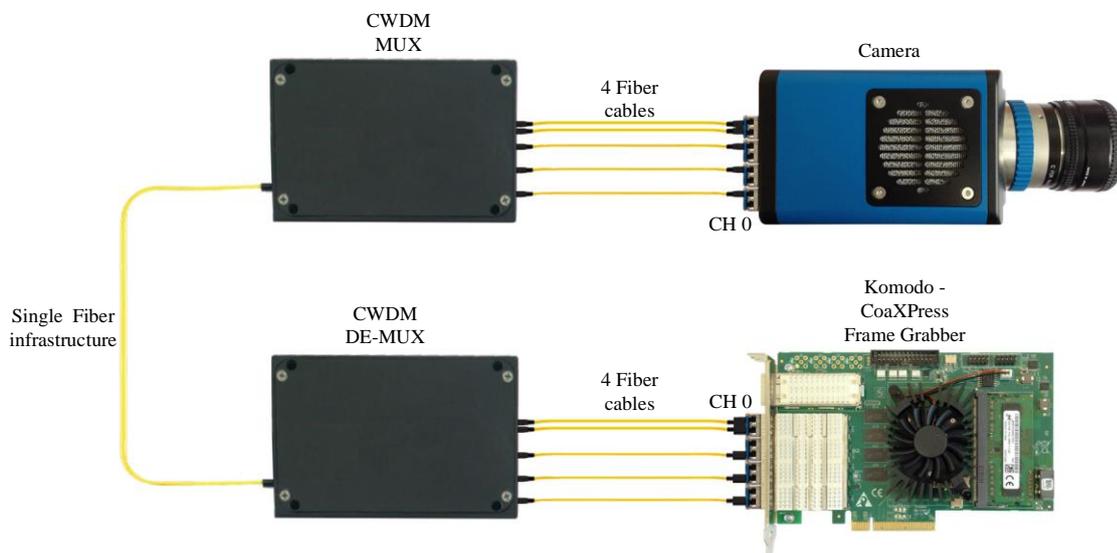
Figure 11 : CWDM mode for single fiber
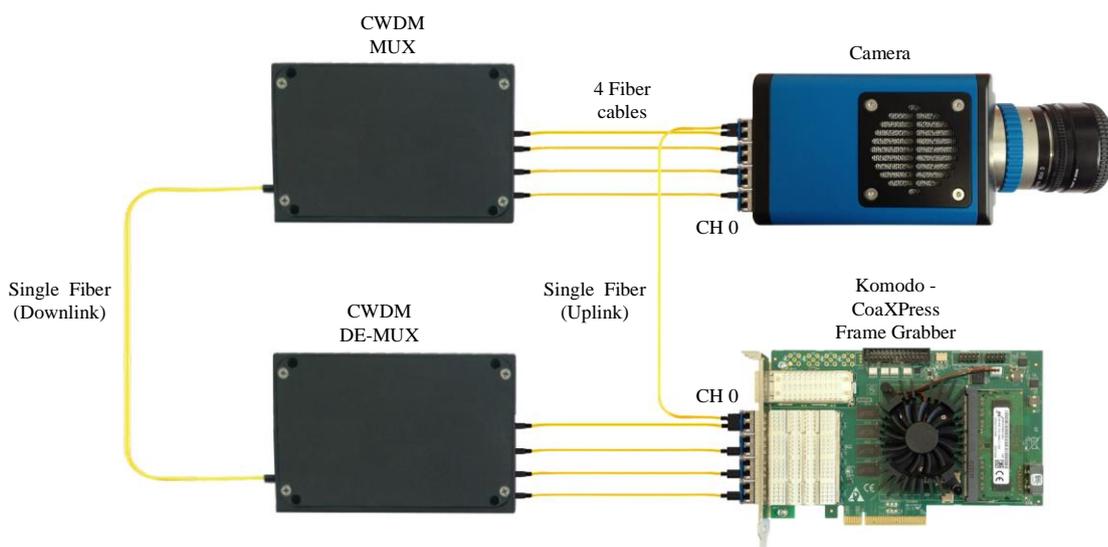
Figure 12 : CWDM mode for dual fiber

7.1 Komodo CLHS Block Diagram
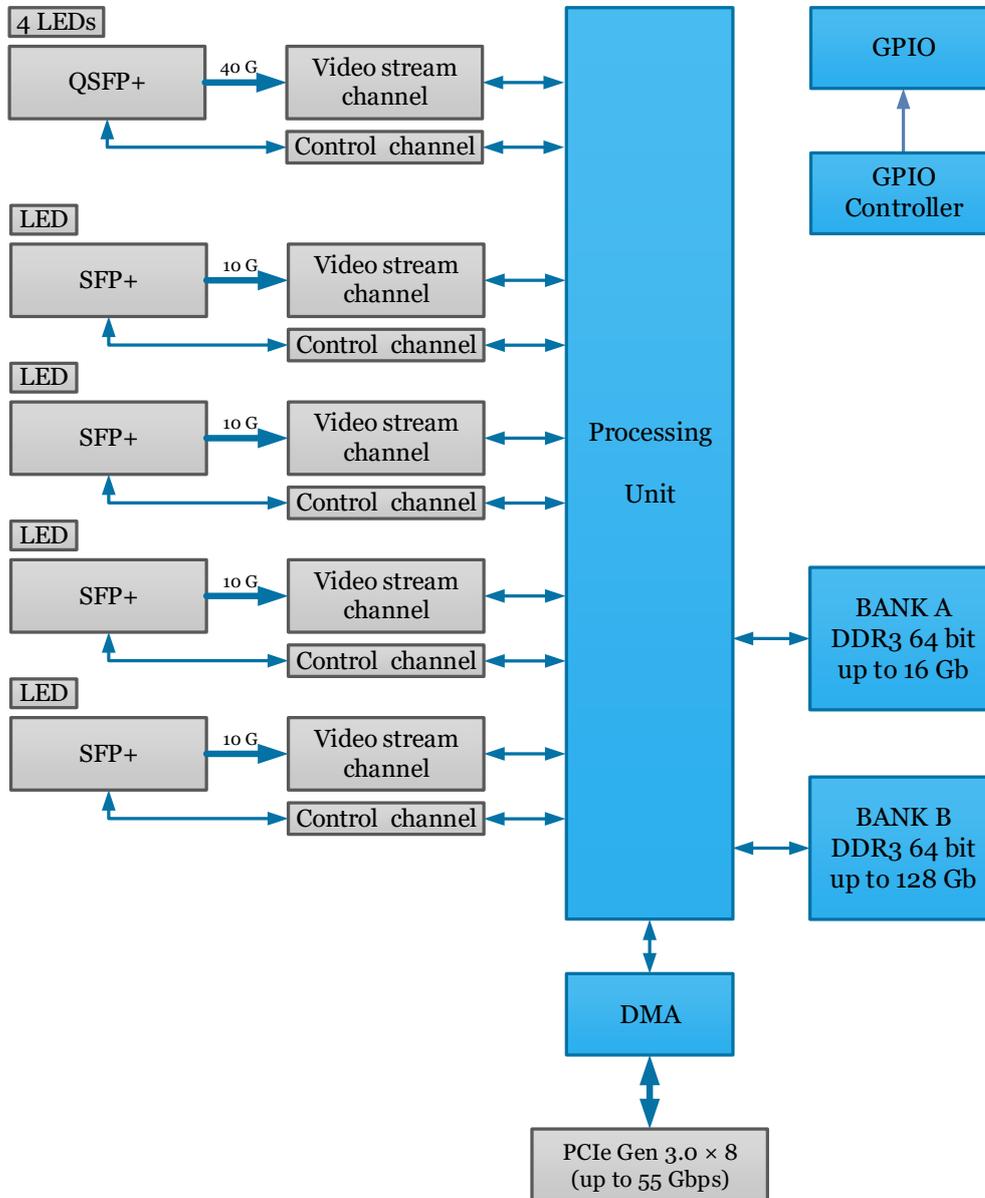
Figure 13 : Komodo CLHS Block Diagram

7.2 Komodo CLHS LEDs

Komodo CLHS Frame Grabber is equipped with indication bi-color LED for each SFP+ connector.

The LEDs behave according to definition in CLHS standard. The LEDs' different states are described in Table 1.
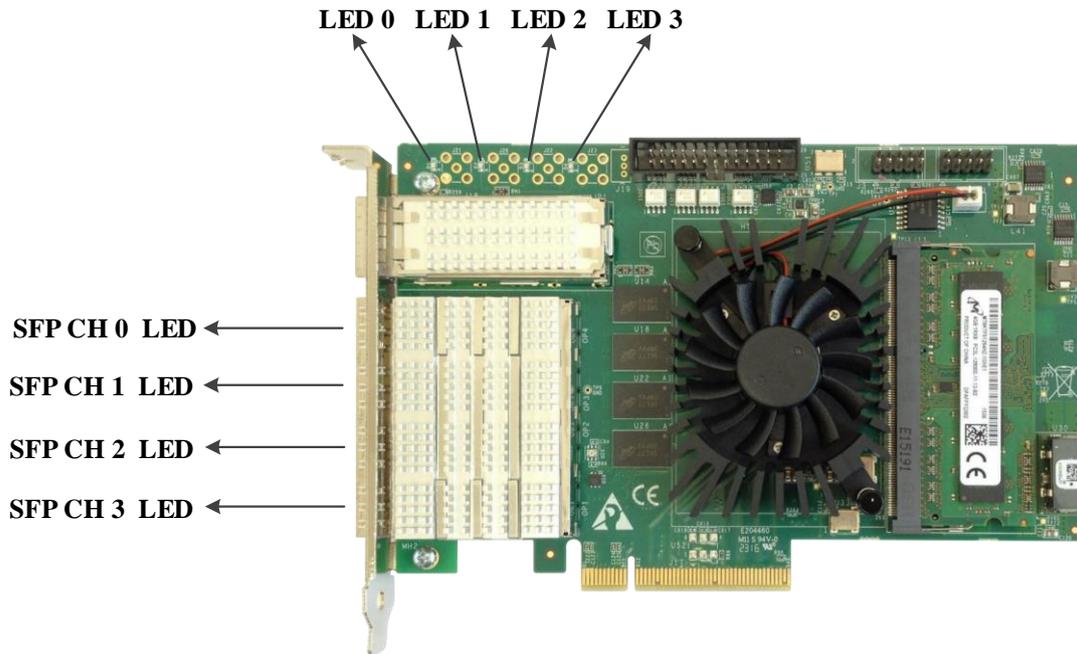
Figure 14 : Komodo CLHS LED's locations

| LED state	Description
Solid orange	System is not initialized
Slow pulse red	No camera is connected
Fast flash orange	Connection detection in progress
Solid green	Camera is connected, no data being transferred
Slow pulse orange	Camera connected. Waiting for trigger event
Fast flash green	Camera connected , data is being transferred
Slow flash alternate green / orange	Connection test packets being sent

Table 1 : Komodo CLHS links status LED's

In additional to SFP+ links LEDs, the Komodo CLHS Frame Grabber is equipped with status LEDs.

Status LEDs functionality is described in Table 2:

LED #	Description
LED 0	Alive led. Blinks when the Frame Grabber receives clock from PCIe
LED 1	PCIe L0 state. When lit, indicates that the PCIe interface is powered up at active state.
LED 2	Gen3 PCIe indicator. When lit indicates that PCIe is working as Gen3. When not lit the Frame Grabber operates either as PCIe Gen1 or Gen2
LED 3	Lane's indicator. When lit, indicates that all 8 PCIe lanes are up. If not lit, one or four lanes are up.

Table 2 : Komodo CLHS status LED's

7.3 Auxiliary Input/Output signals

The auxiliary signal of Komodo CLHS Frame Grabber can be used to initiate on-board events, transmitted to other devices or rerouted from other signals, such as triggers and GPIO's. Additionally, these auxiliary signals can be used to communicate with complex devices, such as encoders, strobe controls and drive controls.

The GPIOs can be controlled from the Vision Point API and be set as a trigger sources. The API enables routing of any input to any output as well as to the CXP IO and Trigger lines. Please see the API documentation for more information regarding the GPIO configuration. The GPIOs of Komodo CLHS Frame Grabber are routed to single IO header with 2.54 mm (100 th) pitch.
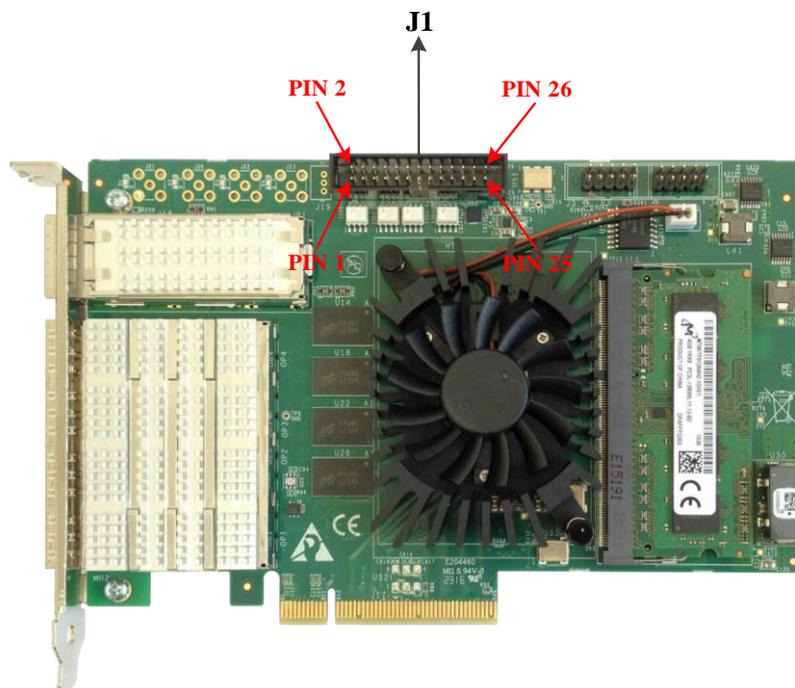

Figure 15 : GPIO connectors location

The pinout of IO connector is as described in Table 3.

Pin No.	Signal Name	Function	Electrical Standard	Description
1	LVDS Input 0p	LVDS input	LVDS	Positive signal of LVDS pair
2	LVDS Input 0n	LVDS input	LVDS	Positive signal of LVDS pair
3	LVDS Input 1p	LVDS input	LVDS	Negative signal of LVDS pair
4	LVDS Input 1n	LVDS input	LVDS	Negative signal of LVDS pair
5	LVDS Output 0p	LVDS output	LVDS	Positive signal of LVDS pair
6	LVDS Output 0n	LVDS output	LVDS	Positive signal of LVDS pair
7	LVDS Output 1p	LVDS output	LVDS	Negative signal of LVDS pair
8	LVDS Output 1n	LVDS output	LVDS	Negative signal of LVDS pair
9	OptoCoupled Output 0	Opto-Isolated output	Up to 70V	Optically isolated outputs
10	OptoCoupled Output 1	Opto-Isolated output	Up to 70V	Optically isolated outputs
11	OptoCoupled Output 2	Opto-Isolated output	Up to 70V	Optically isolated outputs
12	OptoCoupled Output 3	Opto-Isolated output	Up to 70V	Optically isolated outputs
13	OptoCoupled Input 0	Opto-Isolated input	Up to 70V	Optically isolated inputs
14	OptoCoupled Input 1	Opto-Isolated input	Up to 70V	Optically isolated inputs
15	OptoCoupled Input 2	Opto-Isolated input	Up to 70V	Optically isolated inputs
16	OptoCoupled Input 3	Opto-Isolated input	Up to 70V	Optically isolated inputs
17	OptoCoupled GND	External GND		Ground signal for opto-isolated signals on this connector.
18	GND	Board GND		Reference ground signal
19	TTL 0	GPIO	TTL (Open-drain)	General Purpose IO
20	TTL 1	GPIO	TTL (Open-drain)	General Purpose IO
21	TTL 2	GPIO	TTL (Open-drain)	General Purpose IO
22	TTL 3	GPIO	TTL (Open-drain)	General Purpose IO
23	LVTTL 0	GPIO	LVTTL	General Purpose IO
24	LVTTL 1	GPIO	LVTTL	General Purpose IO
25	LVTTL 2	GPIO	LVTTL	General Purpose IO
26	LVTTL 3	GPIO	LVTTL	General Purpose IO

Table 3 : J1 connector pinout

The electrical connection of the GPIO connector is described following principal schematic diagram:
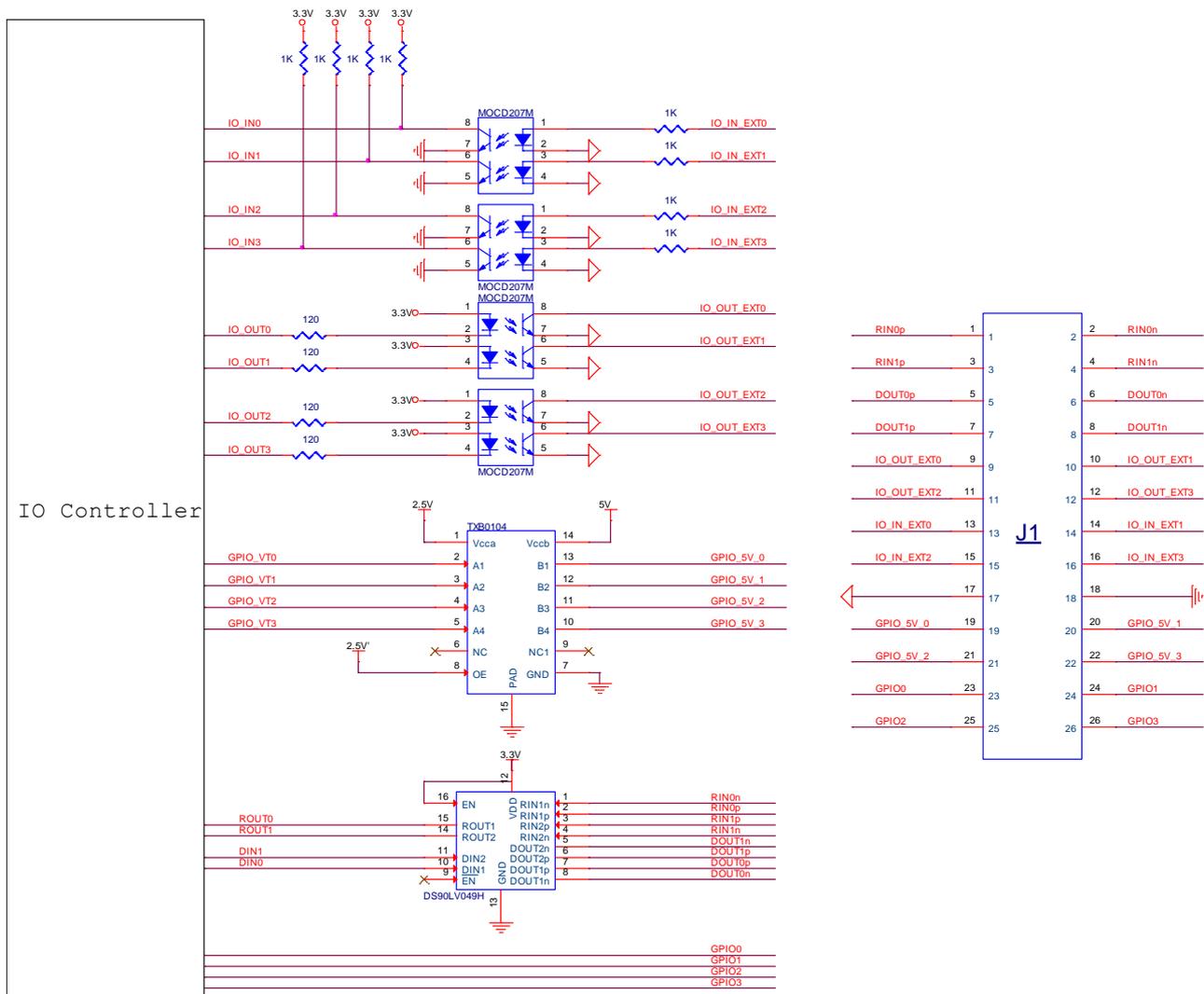
Figure 16 : GPIO Connector schematic

7.4 Absolute maximum ratings

Specification	Values
3.3V power supply	-1.0V to +7.0V
12V power supply	-0.3V to 14V
Storage temperature	-55°C to 125°C
Operating ambient temperature	0°C to 50°C

Table 4 : Absolute maximum ratings

Specification	Minimum voltage [V]	Maximum voltage [V]
LVDS	-0.3	3.6
Opto-isolated (in)	-6	60
Opto-isolated (out)	-7	70
TTL	-0.5	6
LVTTL	-0.5	3.9

Note: The maximum current that the Opto-isolated (out) IOs can support is 150mA

Table 5 : Absolute maximum ratings for GPIO

7.5 Operating conditions

Parameter	Description	Minimum	Typical	Maximum
3.3 V_{cc}	3.3V Supply voltage from PCIe	3.04V	3.3V	3.56V
12V V_{cc}	12V Supply voltage from PCIe	11.04V	12V	12.96V
3.3 I_{cc} (Host)	Supply Current from 3.3V PCIe power rail	-	2.1A	-
12 I_{cc}	Supply Current from 12V PCIe power rail	-	2A	-

Table 6 : Operating conditions

Symbol	Parameter	Condition	Pin	MIN	Typ	MAX	Units
$|V_{OD}|$	Differential Output Voltage			250	350	450	mV
ΔV_{OD}	Change in Magnitude of V_{OD} for Complementary Output States	$R_L = 100\ \Omega$			1	35	|mV|
V_{OS}	Offset Voltage			1.125	1.23	1.375	V
ΔV_{OS}	Change in Magnitude of V_{OS} for Complementary Output States		D_{OUT-} D_{OUT+}		1	25	|mV|
I_{OS}	Output Short Circuit Current[4]	ENABLED, $D_{IN} = V_{DD}$, $D_{OUT+} = 0$ V or $D_{IN} = GND$, $D_{OUT-} = 0$ V			-5.8	-9.0	mA
I_{OSD}	Differential Output Short Circuit Current[4]	ENABLED, $V_{OD} = 0$ V			-5.8	-9.0	mA
I_{OFF}	Power-off Leakage	$V_{OUT} = 0$ V or 3.6 V $V_{DD} = 0$ V or Open		-20	±1	+20	µA

Symbol	Parameter	Condition		MIN		MAX	Units
I_{OZ}	Output TRI-STATE Current	EN = 0 V and EN = V_{DD} V_{OUT} = 0 V or V_{DD}		-10	±1	+10	μA

Table 7 : LVDS Output DC specifications (Driver Outputs)

Symbol	Parameter	Condition	Pin	MIN	Typ	MAX	Units
V_{TH}	Differential Input High Threshold	V_{CM} = 1.2 V, 0.05 V, 2.35 V			-15	35	mV
V_{TL}	Differential Input Low Threshold			-100	-15		mV
V_{CMR}	Common-Mode Voltage Range	V_{ID} = 100 mV, V_{DD} = 3.3 V	R_{IN+} R_{IN-}	0.05		3	V
I_{IN}	Input Current	V_{DD} = 3.6 V V_{IN} = 0 V or 2.8 V		-12	±4	+12	μA
		V_{DD} = 0 V V_{IN} = 0 V or 2.8 V or 3.6 V		-10	±1	+10	μA

Table 8 : LVDS Input DC specifications (Receiver Inputs)

Symbol	Parameter	Test condition (note 1)	MIN	MAX	Units
V_{IH}	Input High Voltage	$V_{OUT} \geq V_{OH\ (min)}$ or	2	V_{DD}+0.3	V
V_{IL}	Input Low Voltage	$V_{OUT} \leq V_{OL\ (max)}$	-0.3	0.8	V
I_{IN}	Input Current	V_{IN} = 0 V or V_{IN} = V_{DD}		±5	μA

Note: Vdd = 3.3V, unless specified otherwise

Table 9 : LVTTL input specifications

Symbol	Parameter	Test condition	MIN	MAX	Units
V_{OH}	Output High Voltage	V_{DD} = min, I_{OH} = -2 mA	2.4		V
V_{OL}	Output Low Voltage	V_{DD} = min, I_{OL} = 2 mA		0.4	V

Note: Vdd = 3.3V, unless specified otherwise

Table 10 : LVTTL output specifications

Symbol	Parameter	Test condition (note 1)	MIN	MAX	Units
V_{IH}	Input High Voltage	$V_{OUT} \geq V_{OH\ (min)}$ or	2	5	V
V_{IL}	Input Low Voltage	$V_{OUT} \leq V_{OL\ (max)}$0	-0.3	0.8	V
I_{IN}	Input Current	V_{IN} = 0 V or V_{IN} = V_{DD}		±5	μA

Note: Vdd = 5V, unless specified otherwise

Table 11 : TTL input specifications

Symbol	Parameter	Test condition	MIN	MAX	Units
V_{OH}	Output High Voltage	V_{DD} = min, I_{OH} = -2 mA	4		V
V_{OL}	Output Low Voltage	V_{DD} = min, I_{OL} = 2 mA		0.4	V

Note: Vdd = 5V, unless specified otherwise

Table 12 : TTL output specifications

7.6 Mechanical dimensions

The Komodo CLHS Frame Grabber is a half-length PCIe card according to PCI Express Card Electromechanical Specification.

The exact board mechanical dimensions are as defined in Figure 17.

For more detailed information please, contact KAYA Instruments representative.
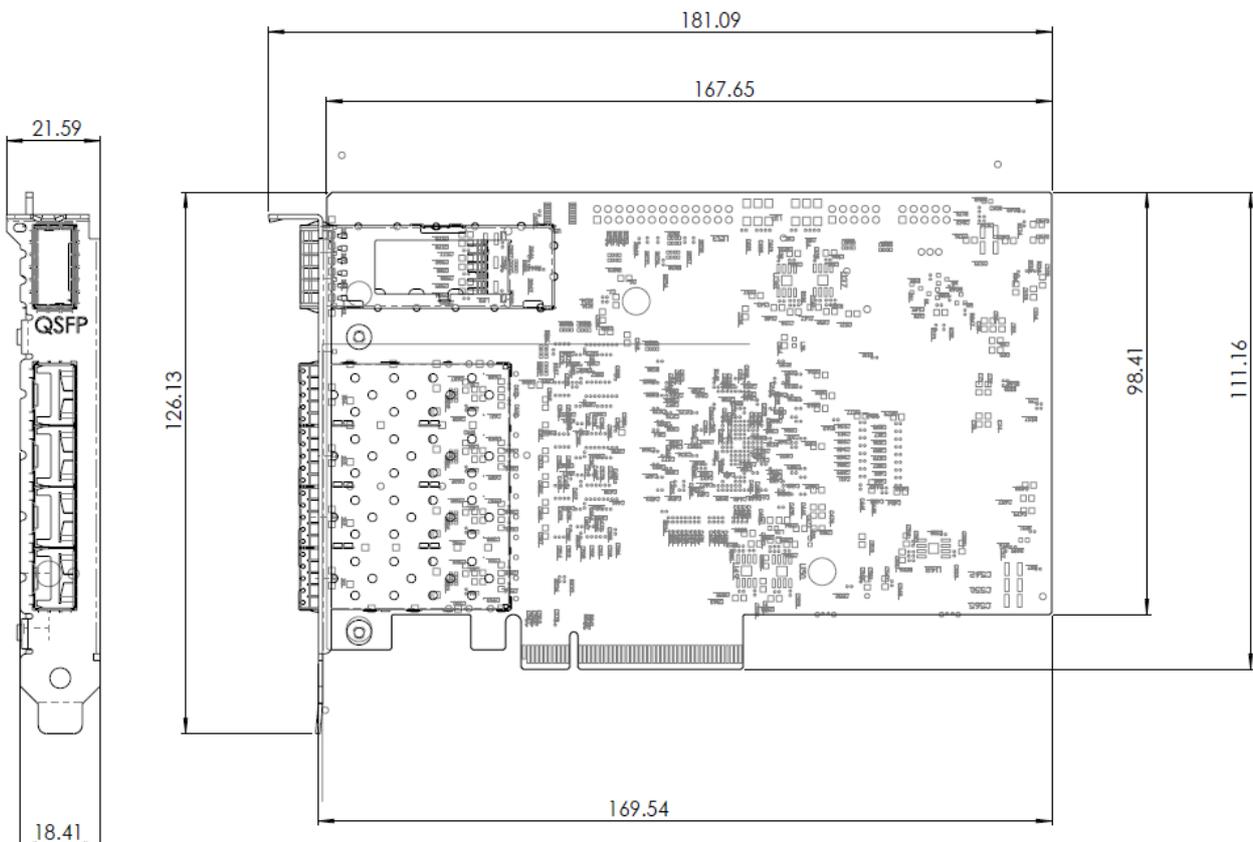
Figure 17 : PCB Mechanical Dimensions

8.1 Fiber cables

Optical fibers are widely used to permits transmission over longer distances and at higher bandwidths than other forms of communication. Fibers are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference.

Fibers that support many propagation paths or transverse modes are called multi-mode fibers (MMF), while those that only support a single mode are called single-mode fibers (SMF). Multi-mode fibers generally are used for short-distance communication links and for applications where high power must be transmitted. Single-mode fibers are used for most communication links longer than 300 meters (1,200 ft.).

9.1 Ordering information

Item name	Item part number
Komodo CLHS Frame Grabber	KY-FGF-CLHS
SFP+ 1310nm 10km single-mode module	KY-SFP-10GLR-31
SFP+ 850nm 300m multi-mode module	KY-SFP-10G85-3M
SFP+ bidirectional connection module	KY-BSFP-10G33-10
SFP+ bidirectional connection module	KY-BSFP-10G23-10
SFP+ 1310nm 10km Bidirectional module	KY-SFP-10G31-10BIDI
Fiber cable - single-mode x meter	KY-FCA-S-SM-LC-LC-XXX.X
Fiber cable - multi-mode x meter	KY-FCA-S-MM-LC-LC-XXX.X

Table 13 : Ordering Information

We are offering variety of modules and customized cable assembly, to fit your application exact needs.

Please, Contact KAYA Instruments' representative for any question and services.

We have the expertise and experiences to develop a suitable solution dedicated to customer's application, prototypes or production.