# Camera Link Range Extender over Fiber User Manual

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# 2 Revision history

| Version | Date | Notes |
|---|---|---|
| 1.0 | 05.01.16 | Initial Release |
| 1.1 | 25.12.16 | Minor updates and typo repairs |
| 1.2 | 30.01.17 | Added Additional configurations |
| 1.3 | 08.04.18 | Added SFP+ installation section |
| 2.0 | 14.02.19 | Review and minor corrections |
| 2.1 | 04.08.21 | Updated LED status indicators (table no.2) |
| 3.0 | 11.10.22 | Document restructure for better readability<br>Updated power supply section |

Table 1 – Revision History

# 3 Introduction

## 3.1 Safety precautions

With your **Camera Link Range Extender over Fiber system (KY-EXT-CL)** in hand, please take the time to read through the precautions listed below to prevent preventable and unnecessary injuries and damage to you, other personnel, or property. Read these safety instructions carefully before your first use of the product, as these precautions contain safety instructions that must be observed. Be sure to follow this manual to prevent misuse of the product.

| ⚠ Caution! Read Carefully and do not disregard these instructions. |
|---|
| **In the event of a failure, disconnect the power supply**<br>Disconnect the power supply immediately and contact our sales personnel for repair. Continuing to use the product in this state may result in a fire or electric shock. |
| **If an unpleasant smell or smoking occurs, disconnect the power supply.**<br>Disconnect the power supply immediately! Continuing to use the product in this state may result in a fire or electric shock. After verifying that no smoking is observed, contact our sales personnel for repair. |
| **Do not disassemble, repair or modify the product.**<br>This may result in a fire or electric shock due to a circuit shortage or heat generation. Contact our sales personnel before inspection, modification, or repair. |
| **Do not place the product on unstable surfaces.**<br>Otherwise, it may drop or fall, resulting in injury to persons or the camera. |
| **Do not use the product if dropped or damaged.**<br>Otherwise, a fire or electric shock may occur. |
| **Do not touch the product with metallic objects.**<br>Otherwise, a fire or electric shock may occur. |
| **Do not place the product in dusty or humid environments, nor where water may splash.**<br>Otherwise, a fire or electric shock may occur. |
| **Do not wet the product or touch it with wet hands.**<br>Otherwise, the product may fail or it may cause a fire, smoking, or electric shock. |
| **Do not touch the gold-plated sections of the connectors on the product.**<br>Otherwise, the surface of the connector may be contaminated by sweat or skin oil, resulting in contact failure of a connector, malfunction, fire or electric shock due to static electricity discharge. |
| **Do not use or place the product in the following locations.**<br>▪ Unventilated areas such as closets or bookshelves.<br>▪ Near oils, smoke or steam.<br>▪ Next to heat sources.<br>▪ A closed (and not running) car where the temperature becomes high.<br>▪ Static electricity replete locations<br>▪ Near water or chemicals.<br>Otherwise, a fire, electric shock, accident or deformation may occur due to a short circuit or heat generation. |
| **Do not place heavy objects on the product.**<br>Otherwise, the product may be damaged. |
| **Do not look into the fiber optic cable or the panel mounted SFP+ connectors.**<br>In order to avoid possible exposure to (Class 1) laser energy. |

**Be sure to discharge static electricity from the body before touching any sensitive electronic components.**
The electronic circuits in your computer and the circuits on the *KY-EXT-CL* device are sensitive to static electricity and surges. Improper handling may 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.

## 3.2 Disclaimer

KAYA Instruments will assume no responsibility for any damage that may ensue by the use of this product for any purpose other than intended, as previously stated. Without detracting from what was previously written, please be advised that the company will take no responsibility for any damages caused by:

- Earthquake, thunderstrike, natural disasters, a fire caused by use beyond our control, willful and/or accidental misuse and/or use under other abnormal and/or unreasonable conditions.
- Secondary damages caused by the use of this product or its unusable state (business interruption or others).
- Use of this product in any manner that contradicts this manual or malfunctions that may occur due to connection to other devices. Damage to this product that is out of our control or failure due to modification
- Accidents and/or third parties that may be involved.

Additionally, KAYA Instruments assumes no responsibility or liability for:

- Erasure or corruption of data caused by the use of this product.
- Any consequences or other abnormalities following the use of this product

Repairs to this product are carried out by replacing it on a chargeable basis and not by repairing the faulty device. Non-chargeable replacement is offered for the initial failure, as long as it is reported no later than two weeks post-delivery of the product.

# 4 Key Features

## 4.1 Overview

KAYA Instruments' ***Camera Link Range Extender over Fiber system (KY-EXT-CL)*** solution provides a Camera Link video interface over fiber optic cable for distances up to 80km in single-mode and up to 300m in multi-mode. Optic fiber is electrically isolated, hence it does not radiate nor is it susceptible to electromagnetic interference, also eliminates the problems associated with grounding. The fiber cable is not easily tapped, providing more secure communication. The range extender is capable of supplying Power to Camera over PoCL. The system is constructed of two convertors, one on the camera side (KY-CL2F-D *Device Unit*) and one on the Camera Link Frame Grabber side (KY-CL2F-H *Host Unit*). The system uses flexible SFP+ modules for optical connection that can be easily changed. The range extender is able to provide bandwidth of up to 10Gbps over single fiber cable, supporting Camera Link Full (Decca) with 85 MHz clock rate.

## 4.2 Features

- Solves distance limitation of Camera Link
- Camera Link Full (Deca) support with up to 85 Mhz
- Bidirectional communication over single fiber cable
- Standard MDR26 connectors
- Extension for distances up to 80km in single-mode and up to 300m in multi-mode
- PoCL support
- Flexible SFP+ module for Fiber connection
- Easy configuration
- External power supply
- 0°C to 50°C operating environment temperature (commercial grade)
- -40°C to 70°C operating environment temperature (industrial grade) (optional)

## 4.3 Product Applications

- ✓ High speed cameras
- ✓ High definition cameras
- ✓ Panoramic cameras
- ✓ Defense remote systems
- ✓ Surveillance
- ✓ Robotic Vision

## 4.4 Optional accessories

- 12V 3A (36W) power supply

- Camera Link cables
- Fiber cables (Multi or Single mode)
- SFP+ modules (Multi or Single mode)

# 5 System Description

## 5.1 External View of the KY-EXT-CL system

Each ***KY-CL2F-D/H (device/host)*** unit is housed in a compact, metal enclosure. Each unit has a power connector, 2 Camera Link connectors (MDR), SFP+ cage, 2 x RJ45 connectors for GPIO and a Mini USB Terminal interface, as shown in Figure 1.

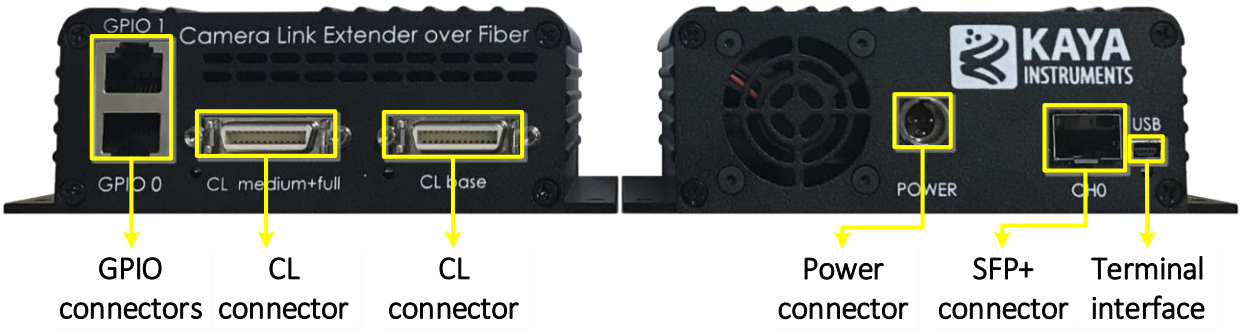


Figure 1 : KY-EXT-CL external view

Each of the Camera Link and SFP+ connectors is paired with a status LED and there is a system status LED (see 5.3 section describing the LED status).
Each unit also has mount ears for an easy and secure installation on any flat surface.

## 5.2 Power supply

This device requires 12V power supply for proper function. The positive pin of the power supply connected to the bottom pin of the connector, shown as “12V”, the negative pin connected to the upper right pin of the connector, shown as “GND”. The power connector shown in Figure 1. The power connector used in each ***KY-CL2F-D/H (device/host)*** unit is Tini-QG RA PC 3 pin (TRA3M SERIES). The mating connector of the power connector is TA3FX.
Please, refer to Electrical specification section of this document for exact Power Supply requirements.

## 5.3 LEDs description

Each unit has several status LEDs, as seen in Figure 2.


Figure 2 : KY-EXT-CL LEDs description

The System status LED, located on the Camera link side, always slow pulses in green while the system is ON. While in firmware update mode, this LED slow pulses orange. In any case of system failure, the LED will constantly light orange.

The Camera Link LED's behavior is described in Table 2:

| LED state | Condition |
|---|---|
| Slow pulse red | No valid Camera Link link detected |
| Solid red | PoCL failure (Overcurrent/Under voltage/Overvoltage) |
| Solid green | Camera link is active |

Table 2 : Camera Link status LEDs behavior

The SFP+ LED behavior is described in Table 3:

| LED state | Condition |
|---|---|
| Fast flash red OR fast flash yellow | SFP+ is unplugged |
| Solid red [1] | SFP+ is not compatible |
| Slow pulse red OR slow pulse yellow | No signal detected on optic fiber |
| Fast flash green | Link is being established |
| Solid green | Link is active |

Table 3 : SFP+ status LEDs behavior

1. Only exists in:
   - Host: version 1.15 and older
   - Device: versions 1.44 and older.

# 6 Error! Not a valid bookmark self-reference.

## 6.1 Installation procedure

The *KY-EXT-CL* system, on the host side (KY-CL2F-H *Host Unit*) is connected to Camera Link Frame Grabber. On the device side (KY-CL2F-D *Device Unit*) the system is connected to the camera, as described in Figure 3.

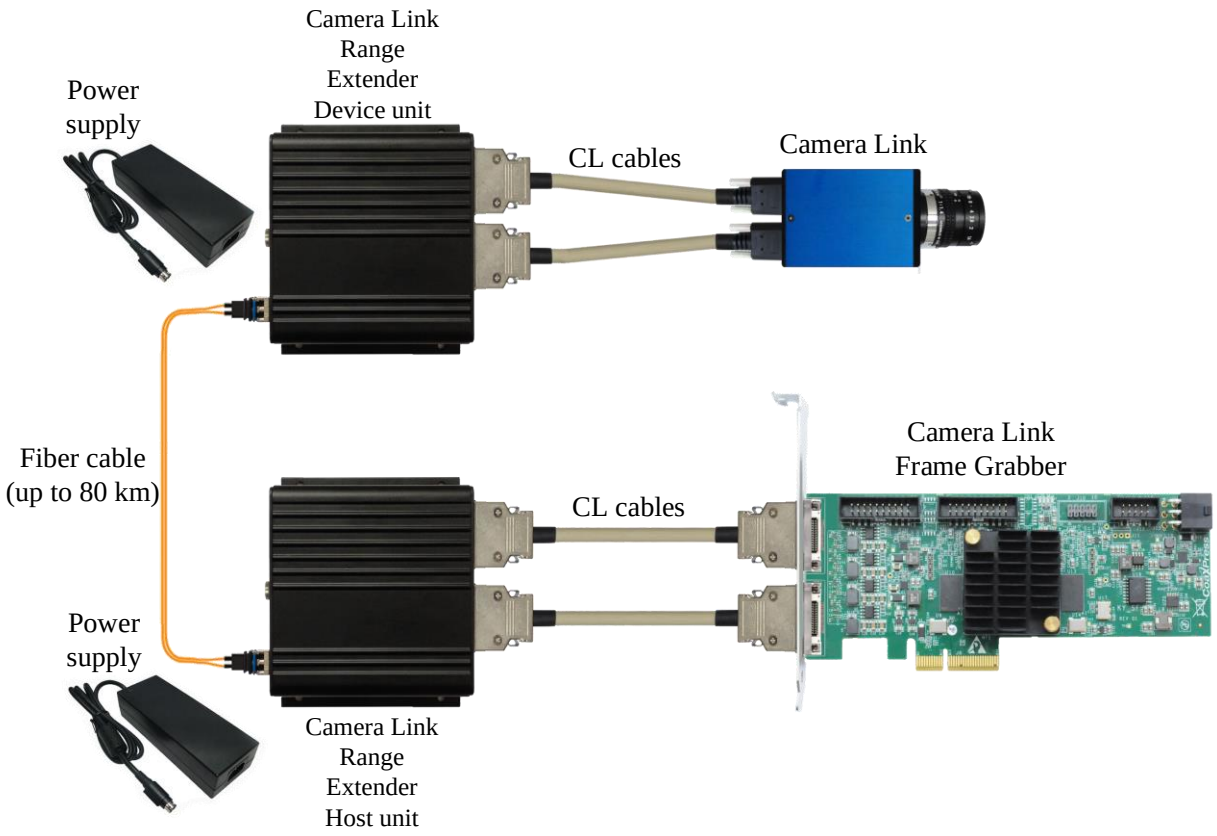


Figure 3 : KY-EXT-CL connection diagram

### 6.1.1 Camera Link Frame Grabber installation

Before KY-EXT-CL system installation please make sure your Camera Link Frame Grabber and software application are properly installed on the computer, according to the installation instructions document, provided by the vendor of your Camera Link Frame Grabber.

### 6.1.2 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.

### 6.1.3 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.

### 6.1.4 Installing the SFP+ Module

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

1. The CL Extender unit supports the following SFP+ modules:
   KY-SFP-10G31-10 – Allows of up to 10Km connection over single mode fiber cable (duplex)
   KY-SFP-10G85-3M – Allows of up to 300m connection over multi-mode fiber cable
   KY-SFP-BD-10G-10 – Allows of up to 10Km connection over single mode fiber cable (simplex)

Note: We are offering variety of customizations, to fit your application exact needs. Please, Contact KAYA Instruments' representative for any additional module options, distance ranges, etc.

2. The SFP+ module has a bale clasp that used to remove or install the SFP+ module.
3. Close the bale clasp before inserting the SFP+ module.
4. Line up the module with the port and slide it into the port as shown in Figure 4.
5. Make sure that the male connectors on the module will align with the female connectors inside the cage.
6. 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.
7. Follow the exact steps to insert additional module into the second Camera Link Extender unit.

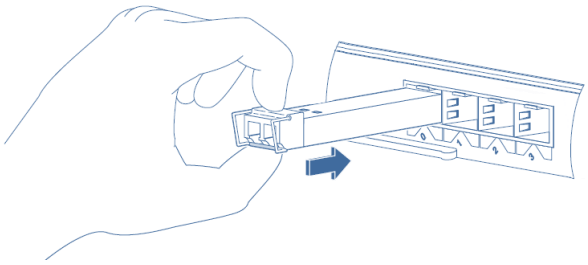

Figure 4 : Installing an SFP+ Module into a port

### 6.1.5 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 dust cups from the module as shown in Figure 5.
2. Remove the protective dust plugs from the fiber-optic cable connectors.
3. Preform the connection according to the instructions below:
   a. 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.
   b. 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 Link Extender Device unit and RX input (Marked with RX or Arrow inwards the SFP+) on the Camera Link Extender Host unit, as shown in Figure 6.
   c. Both the TX and RX fiber cables must be connected (for bidirectional communication, a single fiber cable should be connected between TX and RX).
   d. If more than a single cable is used to connect to the same Camera Link Extender unit, the cables must be of the same type and length.
4. Insert the fiber cable into the module, as shown in Figure 7.
5. Firmly push on each cable, until you will hear a click.
6. Connect the other side of the fiber cable to the Camera Link Extender Host unit (KY-CL2F-H).

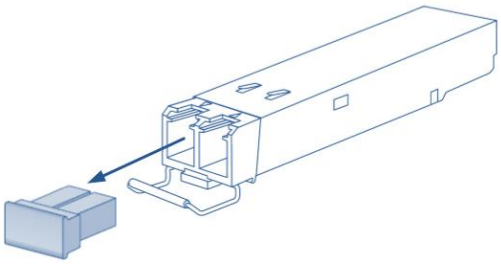

Figure 5 : SFP+ Module with bale clasp open and dust plug removed

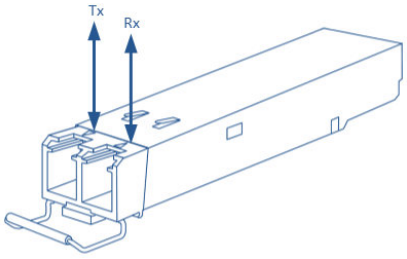


Figure 6 : SFP+ Module with TX output and RX input marked

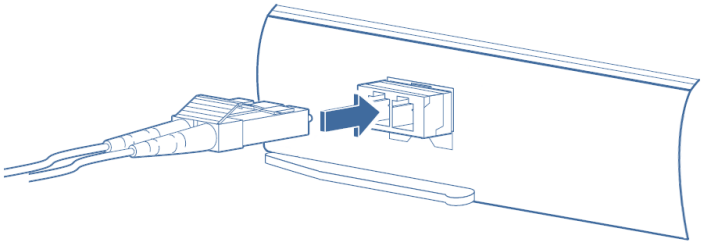

Figure 7 : Connecting the cable to SFP+ Module

### 6.1.6 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 8.
4. Grasp the module between your thumb and index finger and carefully remove it from the port, as shown in Figure 9.
5. Insert the clean dust covers into the module, as shown in Figure 10.

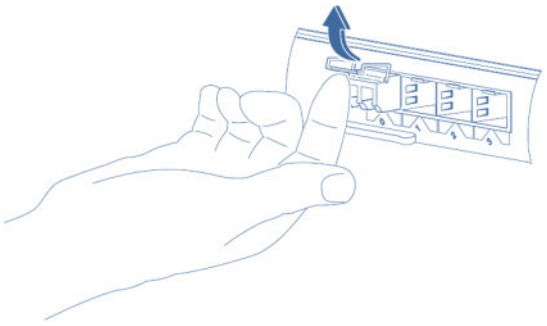

Figure 8 : Opening the bale clasp of an SFP+ Module

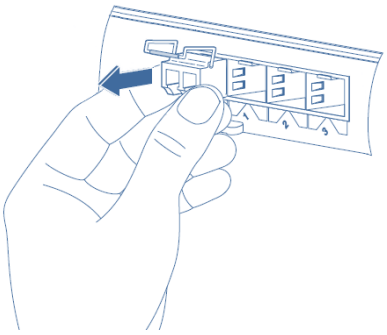

Figure 9 : Removing an SFP+ Module from the port

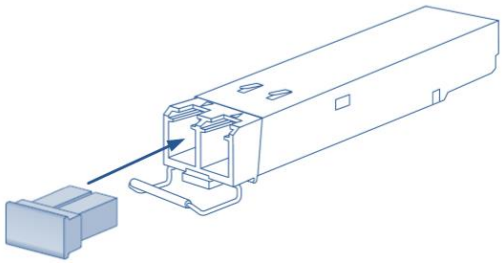

Figure 10 : SFP+ Module with bale clasp open

## 6.2 Completing the KY-EXT-CL system installation

In order to properly complete the ***KY-EXT-CL*** system installation, the following steps must be taken:

1. Make sure the fiber cable is connected properly, as described in previous section. Please refer to Figure 11 as reference:

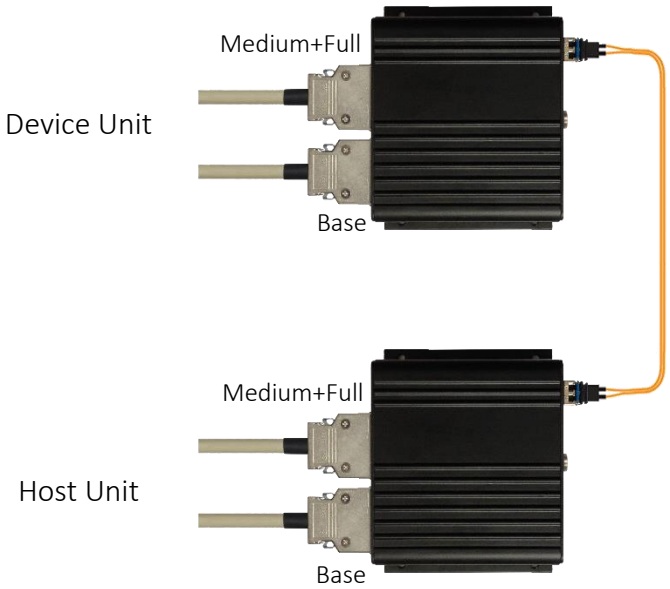


Figure 11 : Fiber cable connectivity

2. Connect the Camera link cables, as shown in Figure 11.

3. Connect the Power Adaptor to the ***KY-CL2F-D*** and ***KY-CL2F-H*** power supply connector. The ***KY-EXT-CL (Host and Device)*** requires 12V power supply for proper function for camera. Please, refer section 8.2 of this document for exact Power Supply requirements.
4. Connect the power supply to the camera (Regardless of the cameras PoCL support).
5. Turn the camera and the computer on.
6. Configure the Host Unit using terminal commands described in section 7.2.3. The following parameters should be configured:
   a. UART baud rate (uartbaud)
   b. Camera link operation mode (format command)
7. Issue save command to save active configuration.

## 6.3 Reducing the fiber optic cable count

The system requires duplex fiber optical cable in order to properly operate, but sometimes it required transferring the data over simplex fiber cable or installing the system into existing CWDM infrastructure. Several options listed in the sections below exist in order to achieve the above. 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 CWDM SFP+ option

In CWDM option the SFP+ is replaced by CWDM SFP+ that is able to transmit and receive the data on specific wavelength. By using these SFP+ modules, the system can be integrated into existing CWDM infrastructure by usage of external CWDM MUX.
Please contact KAYA representative for details.

### 6.3.2 Bidirectional (BIDI) SFP+ option

This option allows using a simplex fiber cable in the system. In this option the SFP+ is replaced by bidirectional (BIDI) SFP+ that transmits and receives on the same fiber core. Example connection is described in Figure 12.

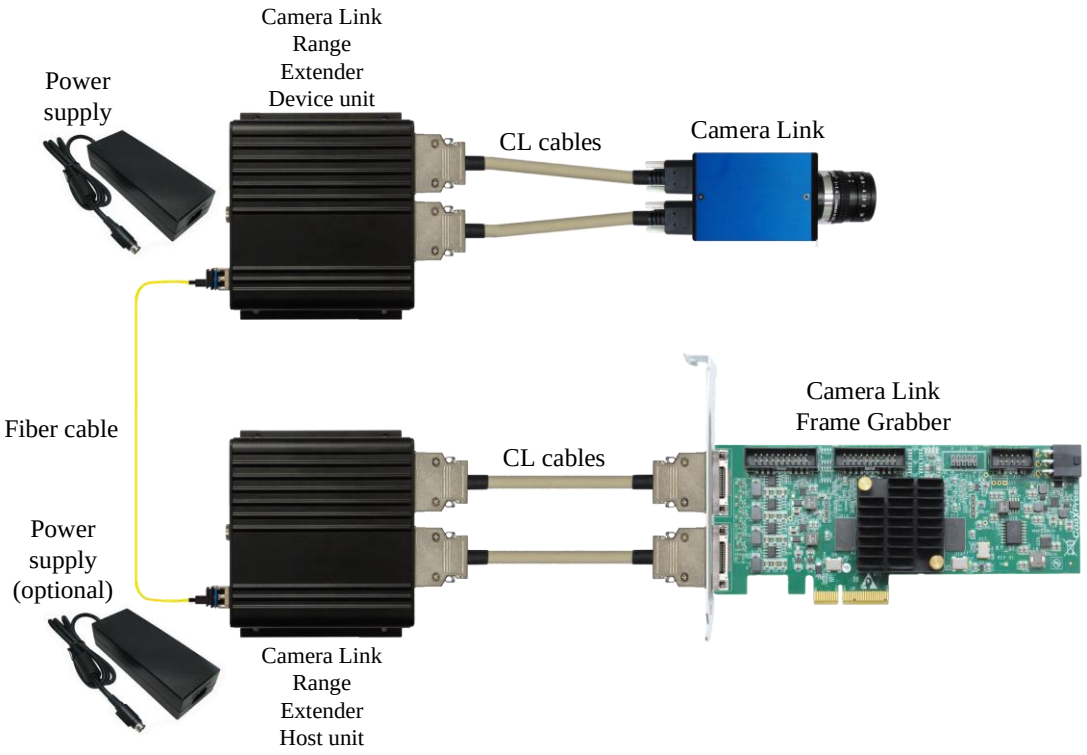


Figure 12 : Bidirectional Camera link connection

# 7 Firmware

## 7.1 Terminal control

A Mini USB port is available for individual link & general information status and firmware update. The port uses a Silabs CP2101 chip. A driver from the Silabs website might have to be installed on certain PCs to gain access to the terminal port. Free supporting driver can be found at: http://www.silabs.com/products/mcu/pages/usbtouartbridgevcpdrivers.aspx
After driver installation and USB connection is acquired a serial emulated terminal (i.e Tera Term use is recommended) can be used with the following configurations, described in Table 4:

| Parameter | Value |
|---|---|
| Baud rate | 115200 |
| Start bits | 1 |
| Stop bits | 1 |
| Parity | None |
| Flow Control | None |

Table 4 : Serial emulated terminal configurations

## 7.2 Terminal commands

The following commands are supported by the terminal; each command must be followed by carriage return (Enter) in order to execute:

### 7.2.1 KY-CL2F-H Host Unit

| Command | Description |
|---|---|
| firmware | Sets the system to firmware update mode. See 7.3 chapter for firmware update information |
| status | Prints the system and link status and general information |
| pwr | Power over CL configuration |
| default | Reset user settings |
| save | Save user settings to flash |
| format | Configure device camera format, including; CL mode and camera scan type. Where mode is mode according to Table 7 |
| uartbaud | Set serial port baud rate according to Table 7 |

Table 5 : Terminal commands for Host unit

### 7.2.2 KY-CL2F-D Device Unit configuration

| Command | Description |
|---|---|
| firmware | Sets the system to firmware update mode. See 7.3 chapter for firmware update |
| status | Prints the system and link status and general information |
| pwr | Power over CL configuration |
| default | Reset user settings |
| Save | Save user settings to flash |

Table 6 : Terminal commands for Device unit

NOTE: The commands are not case sensitive.

### 7.2.3 KY-CL2F-H Host Unit configuration

In order to format the system, choose the required command sequence:

| Command | Description | Available options |
|---|---|---|
| format | mode | 1- Base mode<br>2- Medium mode<br>3- Full mode<br>4- Deca10(8Taps) mode<br>5- Deca8(10Taps) mode |
| | type | 1- AreaScan<br>2- LineScan |
| uartbaud | port | 0-CameraLink<br>1-RS232_0<br>2-RS232_1<br>3-RS422 |
| | baud | 0-9600<br>1-19200<br>2-38400<br>3-57600<br>4-115200<br>5-230400<br>6-460800<br>7-921600 |

Table 7 : Host unit configuration

**Example:**

To configure the host to uart baud rate 9600, Deca8 mode area scan, set the following commands:

a. uartbaud 0 0
b. format 5

## 7.3 Firmware update

1. The extender supports firmware update via USB using a serial emulated terminal. To initiate firmware update the following steps should be taken:
2. Connect the USB cable to the extender and acquire connection using Silabs drivers (drivers need to be downloaded manually if an automatic download isn't initiated).
3. Open serial emulated terminal (usage of Tera Term terminal is recommended) and set serial communication protocol as described in Table 4.
4. In the terminal window type "status" followed by carriage return and checks the current firmware version.
5. Choose the firmware update option by entering "firmware" followed by carriage return and wait for the following message: "Now starting firmware update, please start file transfer using XMODEM:"

6. At this point all the LEDs will turn off and the “System status LED” will slow pulse orange indicating the extender is ready to receive the firmware binary file. Under “File” tab use the terminal “transfer” capability using the XMODEM protocol to initiate the firmware update. Choose “Send” and the firmware version: cl_ext_device_x_xx.rbf or cl_ext_host_x_xx.rbf, depending on the chosen extender, when x_xx is the version number.
7. If no firmware will be sent during 1 minute, or in case of an error the firmware update will fail and return to previous operation mode.
8. A successful update will result in appropriate message and a reboot of the extender to new firmware.
9. Check the firmware version by typing “status” followed by carriage return. Make sure that the firmware version matches the version on the firmware update package supplied; that would insure the success of the firmware update operation.

## 7.4 IO Connector

The extender incorporates two RJ45 connectors to provide GPIO functionality such as RS232 and RS422. TTL and OptoCoupled channels will be available in the future. The pin-out of the connectors can be found in the tables and diagram below:

| Pin number | Name | Description |
|---|---|---|
| 1* | TTL0 | Bidirectional TTL signal |
| 2* | OptoCoupled Output | Opto Isolated output |
| 3 | RS232 RX 0 | RS232 Receive |
| 4* | OptoCoupled GND | Opto Isolated Ground |
| 5 | GND | Signal ground |
| 6 | RS232 TX 0 | RS232 Transmit |
| 7* | TTL1 | Bidirectional TTL signal |
| 8* | OptoCoupled Input | Opto Isolated input |

Table 8 : Top I/O connector pinout

*Note: Pins labeled with an asterisk will be available in the future but are currently non-functional.

| Pin number | Name | Description |
|---|---|---|
| 1 | RS422 RXp | RS422 positive receive |
| 2 | RS422 RXn | RS422 negative receive |
| 3 | GND | Signal ground |
| 4 | RS422 TXp | RS422 positive transmit |
| 5 | RS422 TXn | RS422 negative transmit |
| 6 | GND | Signal ground |
| 7 | RS232 TX 1 | RS232 transmit |
| 8 | RS232 RX 1 | RS232 receive |

Table 9 : Bottom I/O connector pinout

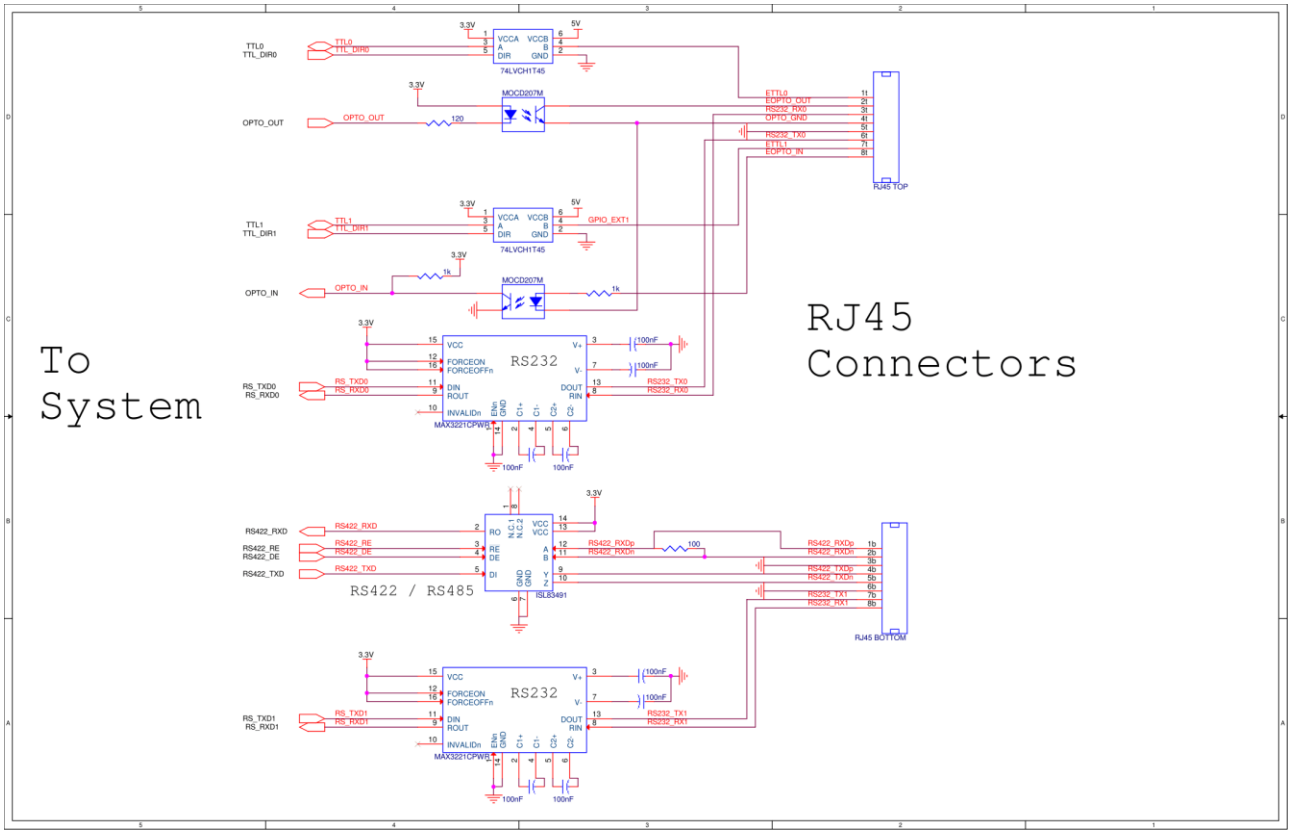


Figure 13 : Serial RJ45 connector diagram

# 8 Electrical Specifications

## 8.1 Absolute maximum ratings

| Specification | Values |
|---|---|
| Power supply voltage | 10V to 14V |
| Storage Temperature | -40°C to 85°C |
| Operating Temperature | 0°C to 50°C (Commercial) |
| Opto Isolated input voltage | -6V to 60V |
| Opto Isolated output voltage | -7V to 70V |
| Opto isolated output current | 150mA max |
| TTL I/O input voltage | -0.2V to 6V |
| RS422 input voltage | -6V to 12V |
| RS232 input voltage | -20V to 20V |

Table 10 : Absolute maximum ratings

## 8.2 Operating conditions

| Parameter | Description | Min | Typical | Max |
|---|---|---|---|---|
| $V_{cc}$ | Supply voltage | 11 V | 12V | 13 V |
| $I_{cc}$ (Host) | Supply Current from PoCL or external power supply | - | 0.9 A | 1.2 A |
| $I_{cc}$ (Device) | Supply Current from external power supply | - | 0.5 A | 1 A |
| $I_{PoCL}$ | PoCL Output current per link | 0 A | - | 0.4 A |

Table 11 : Operating conditions

Electrical characteristics for ***KY-CLEXT*** board IO's:

| Symbol | Parameter | Test condition (note 1) | Min | Max | Units |
|---|---|---|---|---|---|
| $V_{IH}$ | Input High Voltage | $V_{OUT} \geq V_{OH\ (min)}$ or $V_{OUT} \leq V_{OL\ (max)}$ | 3.5 | 5 | V |
| $V_{IL}$ | Input Low Voltage | $V_{OUT} \geq V_{OH\ (min)}$ or $V_{OUT} \leq V_{OL\ (max)}$ | 0 | 1.5 | V |
| $I_{IN}$ | Input Current | $V_{IN} = 0$ V or $V_{IN} = V_{DD}$ | | ±2 | µA |

Table 12 : KY-EXT-CL TTL input specifications

Notes: 1. Vdd = 5V, unless specified otherwise
2. TTL inputs will be available in the future but are currently non-functional

| Symbol | Parameter | Test condition (note 1) | Min | Max | Units |
|---|---|---|---|---|---|
| $V_{OH}$ | Output High Voltage | | 4 | | V |
| $V_{OL}$ | Output Low Voltage | | | 0.6 | V |

Table 13 : KY-EXT-CL TTL output specifications

Notes: 1. Vdd = 5V, unless specified otherwise
2. TTL outputs will be available in the future but are currently non-functional

| Symbol | Parameter | Condition | | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|---|
| $V_{OD}$ | Differential Output Voltage | $R_L$ = 100 Ω (RS422) | | 2 | 2.7 | | V |
| | | $R_L$ = 54 Ω (RS485) | | 1.5 | 2.3 | 3.3 | V |
| $\Delta V_{OD}$ | Change in Magnitude of VOD for Complementary Output States | $R_L$ = 100 Ω / 54 Ω | | | 0.01 | 0.2 | V |
| $\Delta V_{OS}$ | Change in Magnitude of VOS for Complementary Output States | $R_L$ = 100 Ω / 54 Ω | | | 0.01 | 0.2 | V |
| $I_{OS}$ | Output Short Circuit | | | | | 250 | mA |
| $I_{OFF}$ | Power-off Leakage | Out enabled | $V_{IN}$ = 12V | | 14 | 20 | µA |
| | | | $V_{IN}$ = -7V | -20 | -11 | | |
| | | Out disabled | $V_{IN}$ = 12V | | 0.03 | 1 | |
| | | | $V_{IN}$ = -7V | -1 | -0.01 | | |
| $I_{OZ}$ | Output TRI-STATE Current | | | -1 | | 1 | µA |
| $V_{OH}$ | Output High Voltage | | | 2.9 | | | V |
| $V_{OL}$ | Output Low Voltage | | | | | 0.4 | V |

Table 14 : KY-EXT-CL RS422 / RS485 Output DC specifications (Driver Outputs)

| Symbol | Parameter | Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| $V_{TH}$ | Differential Input High Threshold | | -0.2 | | 0.2 | V |
| $I_{IN}$ | Input Current | $V_{IN}$ = 12 V | | 0.6 | 1 | µA |
| | | $V_{IN}$ = -7 V | | -0.3 | -0.8 | µA |
| $V_{IH}$ | Input High Voltage | | 2 | | | V |
| $V_{IL}$ | Input Low Voltage | | | | 0.8 | V |

Table 15 : KY-EXT-CL RS422 / RS485 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 $V_{OUT} \leq V_{OL\ (max)}$ | 5 | | V |
| $V_{IL}$ | Input Low Voltage | $V_{OUT} \geq V_{OH\ (min)}$ or $V_{OUT} \leq V_{OL\ (max)}$ | -5 | | V |
| $I_{IN}$ | Input Current | $V_{IN}$ = 0 V or $V_{IN}$ = $V_{DD}$ | | 1 | µA |

Table 16 : KY-EXT-CL RS232 input specifications

Note: Vdd = 5V, unless specified otherwise

| Symbol | Parameter | Test condition (note 1) | Min | Max | Units |
|---|---|---|---|---|---|
| $V_{OH}$ | Output High Voltage | | 2.7 | | V |
| $V_{OL}$ | Output Low Voltage | | | 0.4 | V |

Table 17 : KY-EXT-CL RS232 output specifications

Note: Vdd = 5V, unless specified otherwise

# 9 Mechanical Specifications

## 9.1 Dimensions

Each ***KY-EXT-CL*** unit is housed in a metal enclosure. The exact dimensions of the enclosure are as shown in the images below:

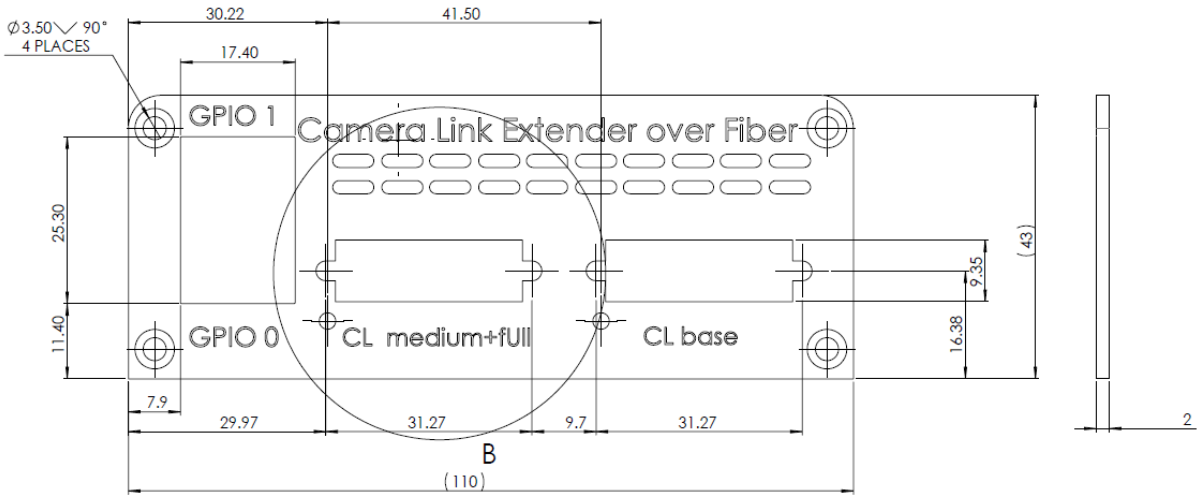


Figure 14 : External dimensions of the KY-EXT-CL Camera Link side panel

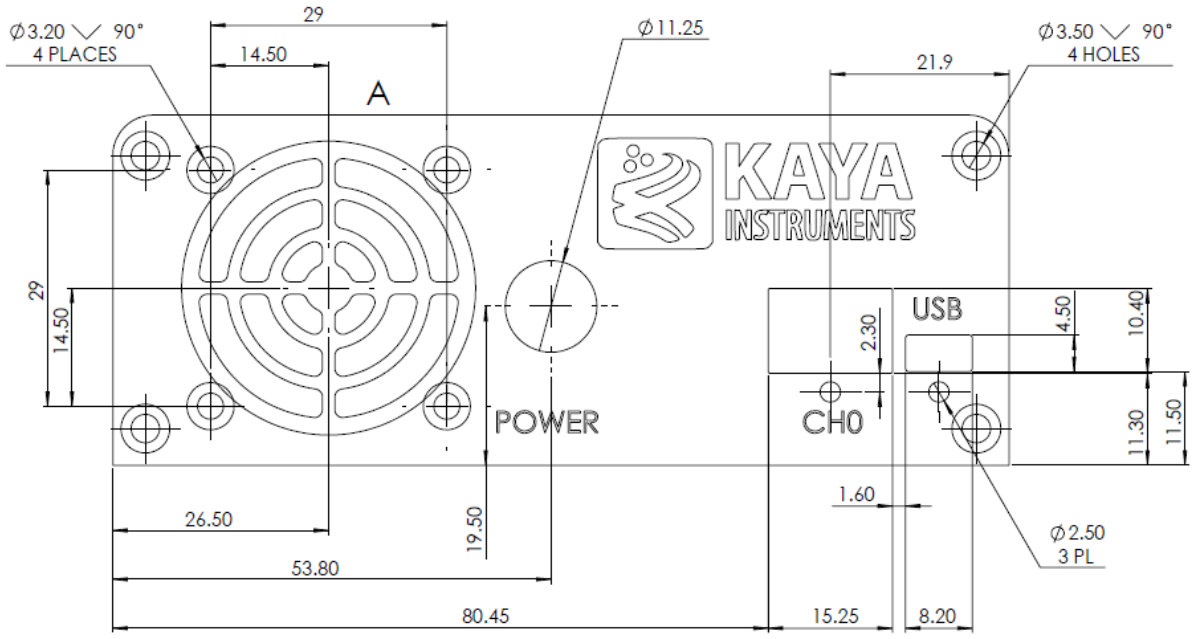


Figure 15 : External dimensions of the KY-EXT-CL Fiber side panel

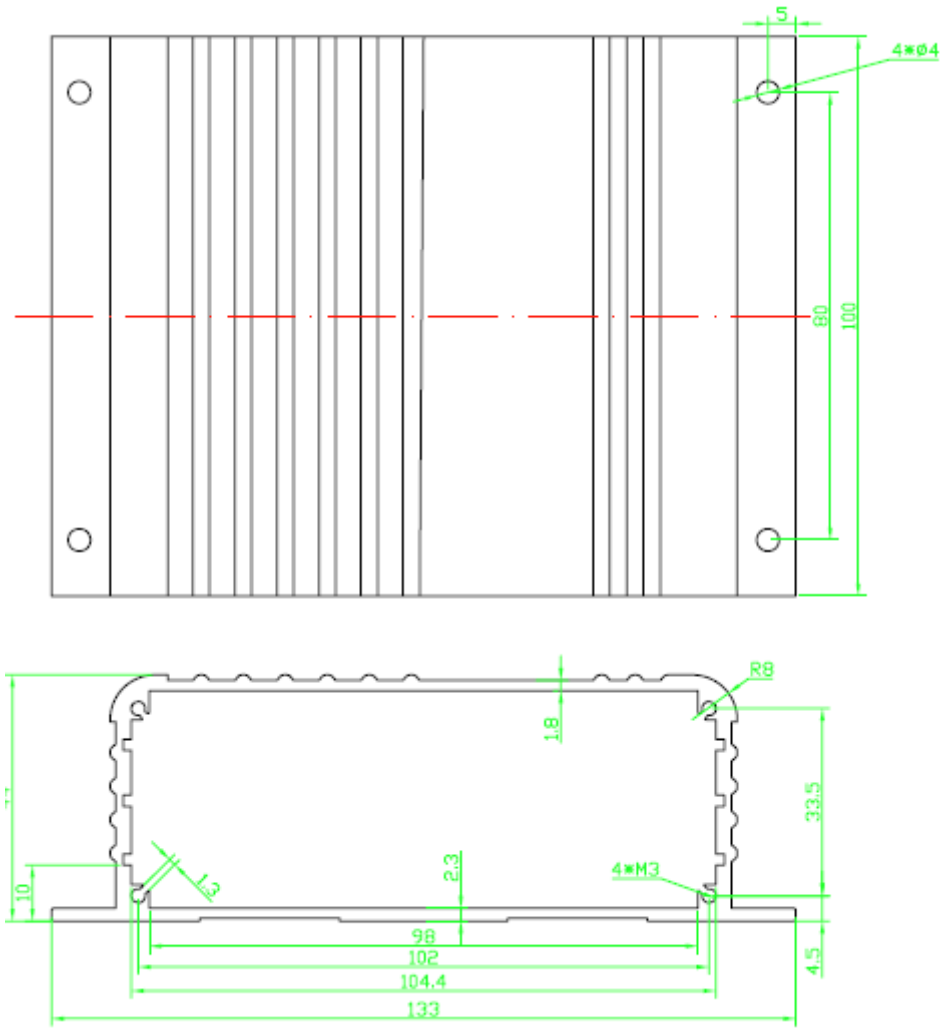


Figure 16 : External dimensions of the KY-EXT-CL enclosure box

## 9.2 Weight

Each ***KY-EXT-CL*** unit weights 356g. (metal enclosure weights 235g.)

# 10 Appendices

## 10.1 Camera Link cables

Camera Link® is a robust communications link using a dedicated cable connection and a standardized communications protocol. Camera Link is a hardware specification that standardizes the connection between cameras and frame grabbers. It defines a complete interface which includes provisions for data transfer, camera timing, serial communications, and real time signaling to the camera. Camera Link was built for real time, high bandwidth (maximum 850 MB/s) parallel communication. It is a well-established and distributed industry standard, and there are many Camera Link products on the market today.

## 10.2 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 (1,000 ft.).

# 11 Ordering information

| Item name | Item part number |
|---|---|
| Camera Link Range Extender over Fiber – Host and Device units | KY-EXT-CL |
| Camera Link Range Extender over Fiber – Device unit | KY-CL2F-D |
| Camera Link Range Extender over Fiber – Host unit | KY-CL2F-H |
| SFP+ single-mode module | KY-SFP-10G31-10 |
| SFP+ multi-mode module | KY-SFP-10G85-3M |
| SFP+ single-mode bidirectional module | KY-SFP-BD-10G-10 |
| Fiber cable (*) | KY-FCA-XX.X |

Table 18 : Ordering Information

(*) Please contact KAYA Instruments for exact Part Number or refer to our website at:
www.kayainstruments.com/category/products/cables-assembly/

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.