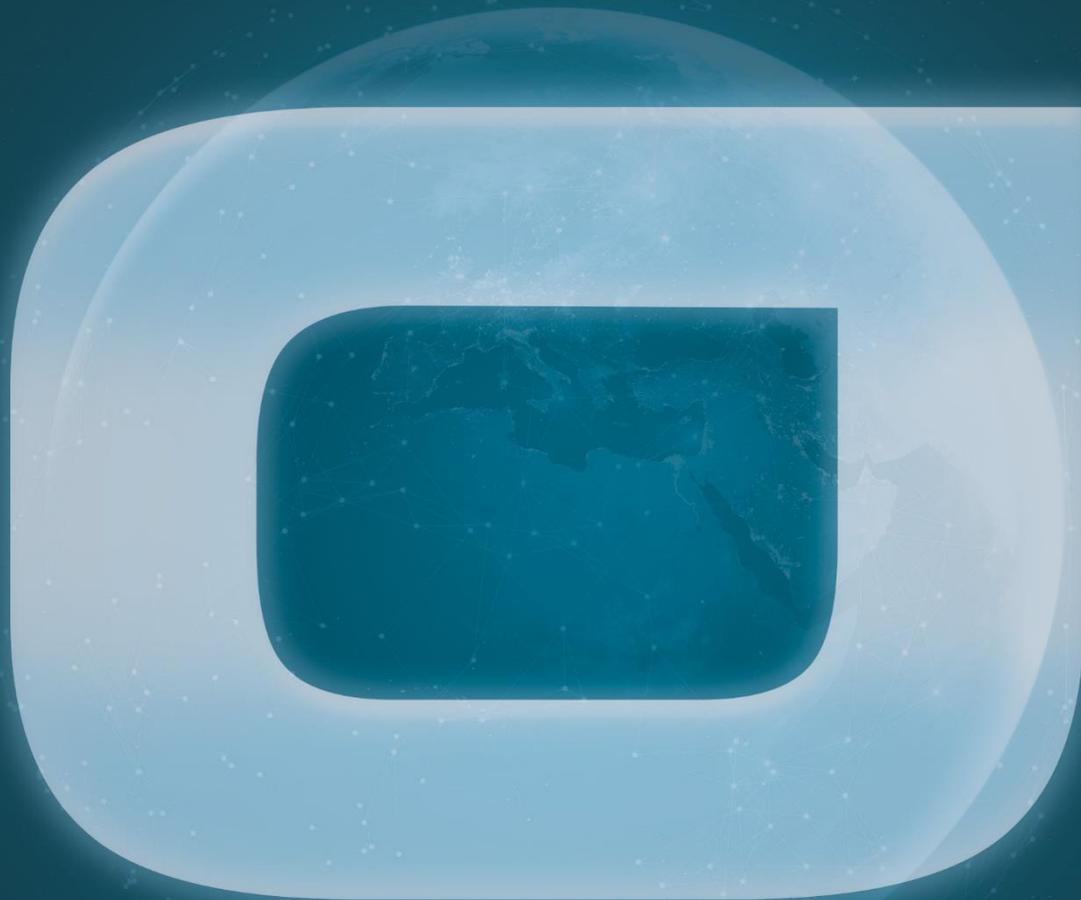


Lynx GigE/CL and
XSL-512-1024-2048

User Manual

Xenics
EXOSENS GROUP



ENG-2012-UMN018-R010

User Manual

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User Manual
Lynx GigE/CL and XSL-512-1024-2048



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Revision History

Issue	Issue date	Reason for changes	Modified by	Approved by
001	03/09/2013	Table 3.1 lenses updated. First released issue	CDU	JDS
002	03/03/2014	New issue of XLIN-TE0 Control & Operation in Appendix Second released issue	CDU	JDS
003	31/03/2014	Appendix mechanical drawing updated (EASM file removed) Third released issue.	CDU	JDS
004	08/01/2015	Fourth released issue	KNB	JDS
005	26/06/2015	5 th released issue due to update appendices (ICD)	KNB	JDS
006	04/12/2015	6 th released issue due to update appendices (ICD)	KNB	JDS
007	28/11/2016	7 th released issue due to update appendices (ICD)	KNB	PDO
008	29/11/2019	Update	SEN	PDO/DDG
009	13/02/2023	Rework of the UNM to support upgrade	WVN, UJN	SEN
010	03/05/2024	Template change	AAT	SEN

Change Details

This table lists all changes of this issue compared to the previous released one.

Chapter/Section	Changes	Modified by

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List of Abbreviations

ASY	Assembly
CC	Camera Control
CE	Conformité Européenne
CL	Camera Link protocol
CLK	Clock
CTIA	Capacitive Trans Impedance Amplifier
GigE	Gigabit Ethernet
GND	Ground
ICD	Interface Control Document
RJ	Registered Jack
SDK	Software Development Kit
SDR	Shrunk Delta Ribbon connector
SMA	Sub-Miniature version A connector
SQ	Squared pixel configuration
SW	Software
SWIR	Short-Wave Infrared
TE0	TEC-less
UMN	User Manual
XEN	Xenics Part Number
XLIN	Xenics Linear Detector
XSL	Xenics SWIR Linear Core
XSP	Xenics Serial Protocol

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1. Introduction

1.1. Scope

This User Manual describes the image processing, basic and advanced parameters and related subjects for the Lynx cameras and XSL modules.

Target group: This technical manual is written for professional users.



Please read this manual thoroughly before operating the camera or module!

1.2. Reference Documents

(Ref 1) Xenics Serial Protocol	ENG-2011-ICD003
(Ref 2) Mechanical Drawings	
(Ref 3) Lynx_XL_Control&Operation	ENG-2013-ICD009
(Ref 4) Framerate Calculator	ENG-2013-ICD011
(Ref 5) Network connection set-up for GigE	ENG-2013-ICD003
(Ref 6) Xeneth Installation Manual	see Xeneth installation directory
(Ref 7) Xeneth User Manual	see Xeneth installation directory
(Ref 8) Xeneth SDK installation manual	see Xeneth installation directory

1.3. Manual Overview

This section provides a chapter overview:

- Chapter 1 (this chapter) gives an overview of the conventions used in this manual (styles and symbols), the safety warnings, conformity information about Xenics cameras and the contact information.
- Chapter 2 gives a mechanical (2D drawings) and electrical overview
- Chapter 3 describes how to get started with the camera.
- Chapter 4 describes the optical interfaces
- Chapter 5 describes the electrical interfaces

1.4. Conventions Used in This Manual

To give this manual an easily understood layout and to emphasize important information, the following typographical styles and symbols are used:

The styles used in this manual are:

- **Bold**: used for programs, inputs (commands or parameters) or highlighting important things
- *Courier New*: used for code listings and output.
- *Italics*: used for modes and fields.

The symbols used in this manual:



Note: This symbol highlights important information.



Warning: This symbol highlights important instructions. These instructions must be followed to avoid malfunctions!

1.5. Safety Warnings

The following safety warnings must be followed:



Supply voltage polarity: Use the correct polarity of the 12 V supply voltage.



Warranty: The warranty becomes void in case of unauthorized tampering, or any manipulations not approved by the manufacturer.



Electrostatic discharge: The camera contains sensitive electronic components which can be destroyed by means of electrostatic discharge. Use sufficient grounding to minimize the risk of damage.



Environmental conditions: Operate the camera in dry and dust free environment. Regarding the signal quality of the camera, it is an advantage to operate the camera under constant ambient air temperature (~20°C). Beneath or above ambient temperature a sufficient heating or cooling may be necessary.



Warm-up Period: Depending on the prevailing environmental conditions, some time might pass after the camera start, until the image quality reaches its optimum.

1.6. Conformity

Xenics declares under its sole responsibility that all standard cameras of the Lynx family and XSL family, to which this declaration relates to, are conform with the following standard(s) or other normative document(s):

- CE, following the provisions of EMC directive 2014/30/EU
- RoHS (Directive (EU) 2015/863).

CE :

We declare, under our sole responsibility, that the previously described Lynx cameras conform to the CE directives.

1.7. Contact Information

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<https://www.exosens.com/contact-xenics>

2. Mechanical & Electrical Specifications



The design and specifications for the products described below may change without notice.



Xenics is unable to guarantee support or compatibility for lenses not offered as part of the Xenics lens portfolio.



An XSL module is highly sensitive to electric discharge, handling with ESD protection is recommended.

The mechanical drawings of Lynx-GigE, Lynx-CL and XSL module can be found in [\(Ref 2\)](#).

3. Getting Started

In this section we describe the different steps how to get started easily with the Lynx camera and the XSL module. For the XSL module, it is recommended to use the module **together with GigE or CL interface**: in this way the module can be controlled using the Xeneth software.



The Xeneth software is only used in the XSL-GigE and CL. It is not used in the XSL module without interface PCB (when using the Samtec connector)!

3.1. Xeneth installation



Xeneth imaging suite and its graphical user interface must be installed to use this demo kit.



It is good practice to first uninstall a previous Xeneth version and then install the latest version.

Xeneth imaging suite and its graphical user interface works with all Xenics products. It allows the Xenics product to be easily accessible through a standardized user interface.

A Xeneth installer is provided with your camera on the accompanying USB drive. Simply run the installer and follow the on-screen prompts. Remember to manually check the drivers for your Camera Link frame grabber during the installation process. Refer to the Xeneth User Manual (Ref 7) for more details on the installation process and the Xeneth Installation Manual (Ref 6) for a detailed guide on using the program features which are not camera dependent.

When the SDK option was ordered, the SDK installation file is delivered on the CD together with the camera as well. Install the SDK software using this file for more details check (Ref 8).

3.2. Connect to the Camera using Xeneth

Start Xeneth. The *Connection Setup* dialog will appear with the camera list.

- If the camera is not enumerated, click the refresh button on the dialog. Should this not reveal the camera, check that: The cables are all properly connected. For details about the electrical interface and cables: see chap. 5.
- On the Enumeration Settings tab the camera's communication protocol is enabled.
-
- For the Lynx CL and the XSL-CL, the required Camera Link frame grabber drivers are installed properly. For more information see chap. 0 & (Ref 6)(Ref 6).

To connect the camera via Xeneth (Figure 3.1):

- Select the camera from the *Enumerate devices* list. The number between brackets is the serial number printed on the back of your camera.
- Mark the *Start capturing on connect* box at the bottom of the dialog.
- From the *Calibration data* dropdown menu, select (*Camera memory*) to activate the onboard calibrations (note that calibrations in software can **ONLY** be used for the Lynx-CL and XSL-CL).

- Click the *Connect* button to proceed.

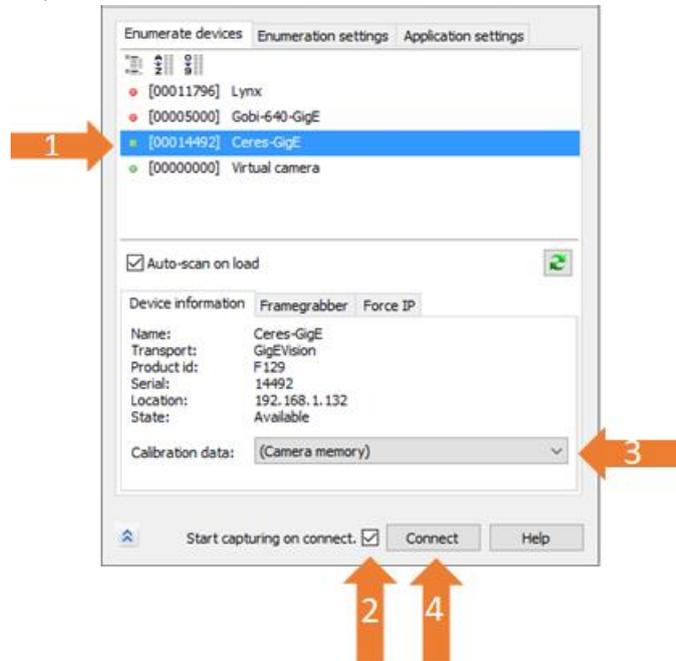


Figure 3.1: Connection setup dialog box in Xeneth.

3.3. Change Camera Properties

Perform the following steps to change the camera properties:

- To change the camera properties, press the <Camera> icon (see Figure 3.2).
- When using the camera for the first time, use the Beginner mode (see Figure 3.2).
- In the beginner mode, the following properties can be modified by the user. For more information on the camera properties, see (Ref 3), or click on the property (Right-button-click) and select <Show property documentation>.
 - o Device control:
 - Device gain: Value 0 to 15, to set the feedback capacitor value of the CTIA readout. For the values of the capacitor, see (Ref 3).
 - o Acquisition control
 - Exposure time: Sensor exposure time. Note that a correction file is only valid for 1 exposure time. When the exposure time changes, the offset should be re-calibrated.
 - o Image format control
 - Height: This value sets the number of lines within a frame.
 - o Image processing control
 - Offset: This property applies a global offset to the image.
 - Gain: This property applies a digital gain to the image
 - o GigE Vision Transport Layer (only for GigE)
 - Packet Delay

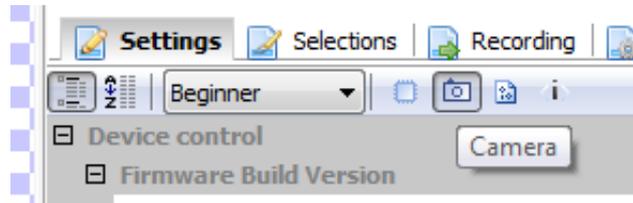


Figure 3.2 Access to the camera properties

3.4. Use of Correction Files

Perform the following to use the correction files:

- To select a different correction in **software (only for Lynx-CL and XSL-CL)**: press the <Select> button and select a different correction file.
- To upload and use a **calibration pack onboard**, perform the following steps:
 - o In Xeneth: go to the Settings tab / Storage icon (see [Figure 3.3](#))
 - o Select a calibration slot to which to upload the calibration pack
 - o Make sure the calibration set slot info says "Empty". If not, clear the slot.
 - o Upload the calibration pack:
 - Click on the "Store" property and then on the green upload arrow on the right (see [Figure 3.4](#)).
 - Select the new calibration pack.
 - Wait till the file is transferred to the camera (= wait until Xenics logo disappears: see [Figure 3.5](#)).
 - o Reconnect to the camera. While reconnecting, choose 'camera memory' calibration data (see [Figure 3.6](#)).
 - o Activate the new correction by setting the correction source to match the calibration slot number used for upload. Note: one can store this configuration in a user set to startup with these calibration data.
- The correction can be enabled and disabled using the **enable image correction button** (see [Figure 3.7](#)).

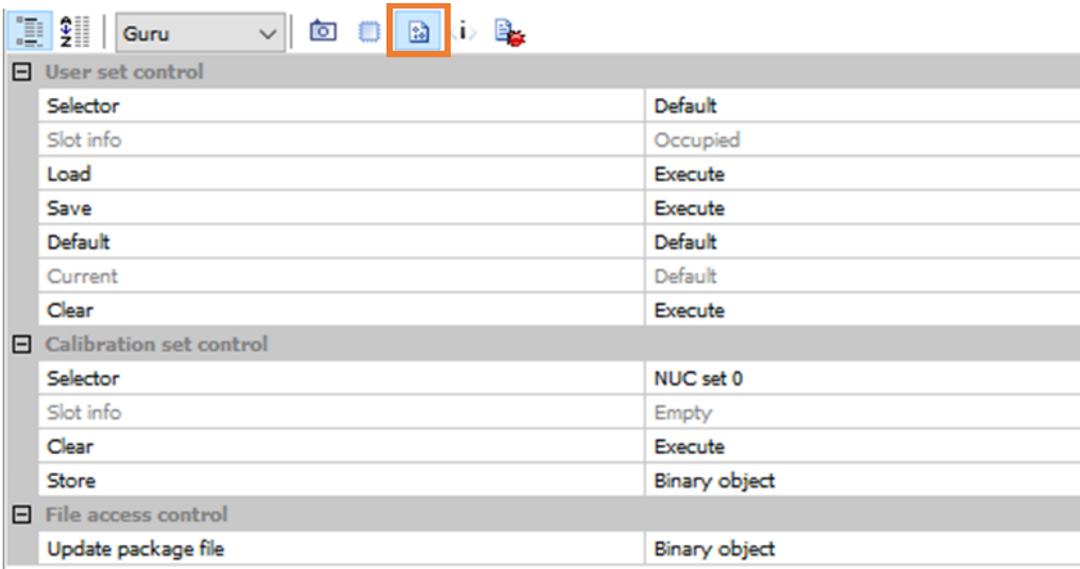


Figure 3.3 Correction pack upload: storage icon

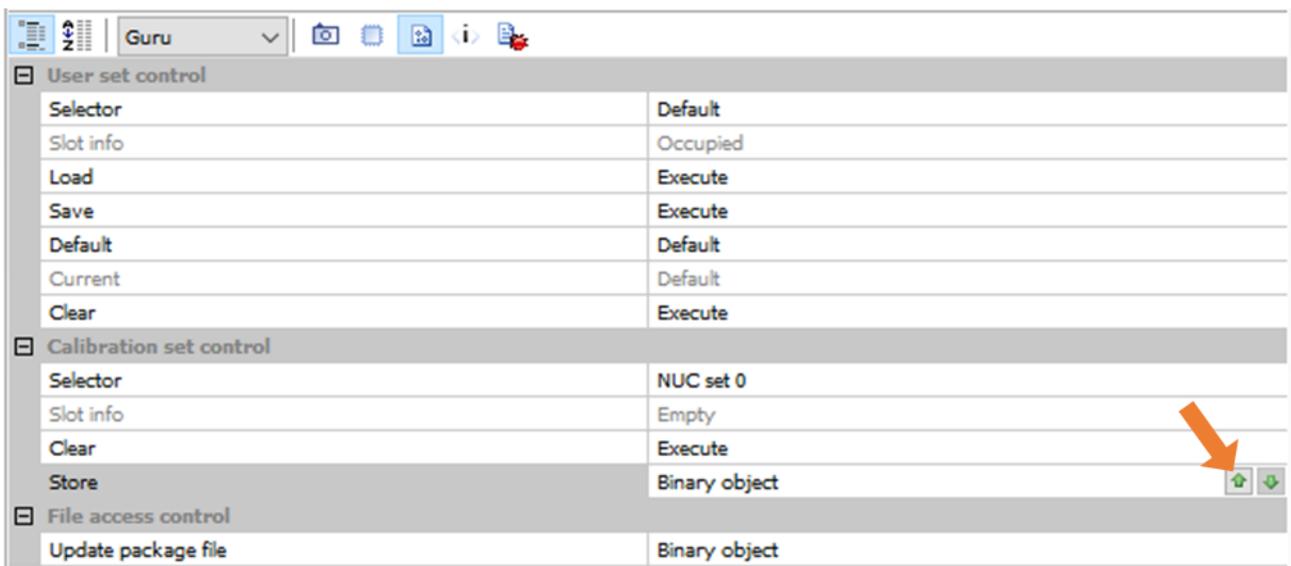


Figure 3.4 Calibration pack upload



Figure 3.5 Xenics logo while correction file upload

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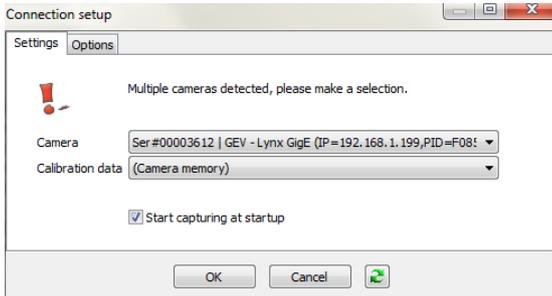


Figure 3.6 Reconnect to camera with onboard correction

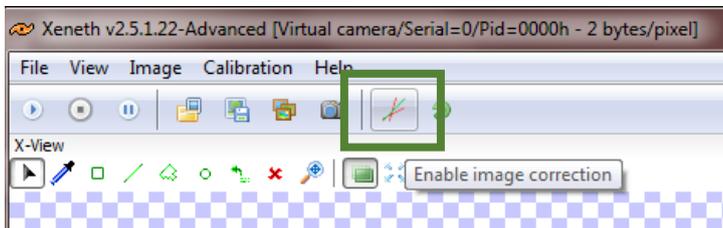


Figure 3.7 Enable image correction

4. Optical Interface

The optical interface of the camera consists of three parts: the front panel, a lens insert and the lens itself. For XSL modules, the four M3 holes in front of the module can be used for fixation of optics. The distance from front to focal plane top surface is indicated in the mechanical drawing.

i For the XSL without interface PCB (BT.656 or 16bitDV), no lenses are available.

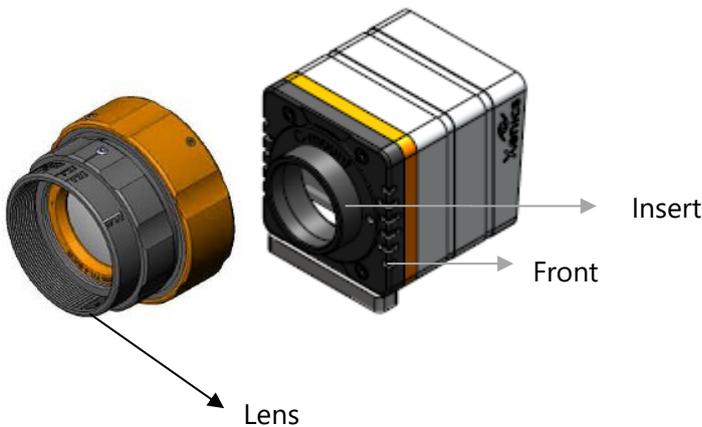


Figure 4.1 Optical components: lens – insert – front

Lens configuration Lynx family	
Other Lenses	SWIR lenses available For more information contact customer support – https://www.xenics.com/service-support/

Table 4-1 Lens configuration

It is possible to use the following different solvents to clean a lens:

- Ethanol: removal of fingerprints and other contaminants
- Alcohol: final cleaning before use.



Perform the following steps to clean a lens:

- Immerse lens tissue in Alcohol / Propanol or Ethanol (reagent grade).
- Wipe the lens in "S" motion in such way that each lens area will not be wiped more than once!
- Repeat stage 2 until the lens is clean. Use a new lens tissue each time!

5. Electrical Interface

5.1. General Overview Connectors and Specifications

Connect all cables to the connectors at the rear side (see also (Ref 2)). Table 5-1 lists the connector and interface specifications overview for the Lynx-GigE and Lynx-CL.

Interface	Connector	Specification	Camera Protocol
XSL without interface PCB			
General IO	Samtec QTE-020-02-L-D-A	See chap. 5.2	
XSL-GigE			
Input power (12V DC)	Hirose HR10-7R-4SA(73)	12V ±10%	
Trigger (either Trigger-in or Trigger-out!)	SMA	Trigger in: $V_{IN,L} = 0.8V \text{ Max.}$ $V_{IN,H} = 2V \text{ Min.}$ $V_{IN,MAX} = 30V$ Internal Pull-down: $R = 10k\Omega$	
		Trigger out: $V_{HIGH} = 3.3V \pm 10\%$ $V_{LOW} = 0V$	
Ethernet	RJ45 connector	GigE standard	GigE Vision
		PoE (IEEE802.3af specification (support for mode A and mode B))	
XSL-CL			
Input power (12V DC)	Hirose HR10-7R-4SA(73)	12V ±10%	
Trigger (either Trigger-in or Trigger-out!)	SMA	Trigger in: $V_{IN,L} = 0.8V \text{ Max.}$ $V_{IN,H} = 2V \text{ Min.}$ $V_{IN,MAX} = 30V$ Internal Pull-down: $R = 10k\Omega$	
		Trigger out: $V_{HIGH} = 3.3V \pm 10\%$ $V_{LOW} = 0V$	

Mini-camera link	CONN SDR 26POS VERT RECEPT	Serial control: 115200 baud, 8n1	XSP Protocol: see (Ref 1)
		Levels: RS-644	
		Image acquisition: CL	CL Base protocol/ 1 TAP for image acquisition

Table 5-1 Electrical interface specifications for XSL modules, Lynx-GigE, and Lynx-CL cameras

5.2. XSL Module without Interface PCB

The back panel for the XSL module is shown in Figure 5-1.

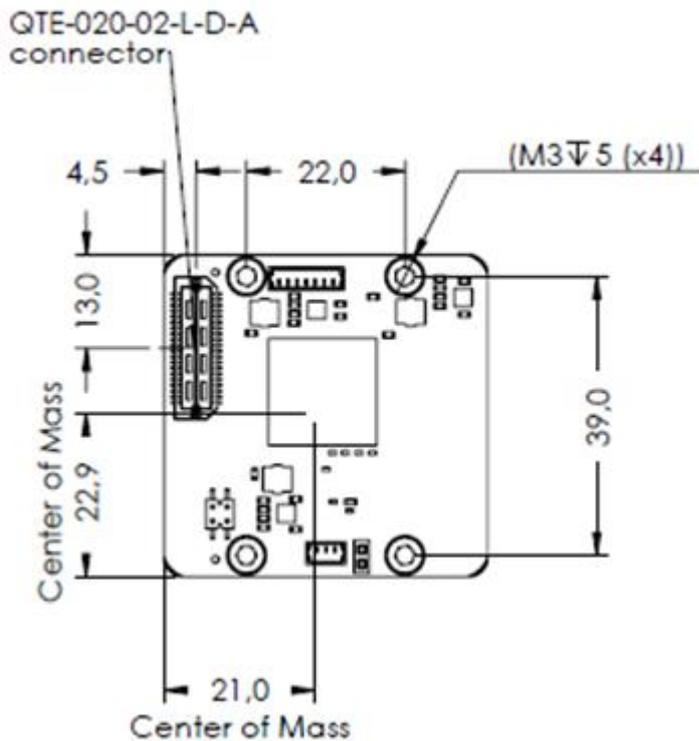


Figure 5-1 Back panel of the XSL module

A more detailed description of the connector used and the signals available on this connector is provided in the following subsections.

5.2.1. Connector Type

The connector is a Samtec connector type QTE-020-02-L-D-A (shown in Figure 5-2). Note that the height of the displayed element is different.



Figure 5-2 Samtec connector picture

This connector mates with connector type Samtec QSE-020-01-L-D-A. Figure 5-3 shows the pin numbering on this connector.

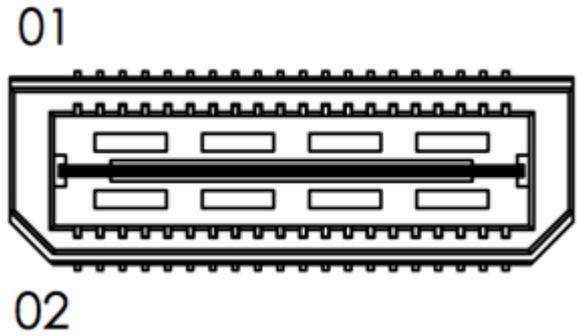


Figure 5-3 Samtec connector pin location top view

5.2.2. Pin Description

Pin#	Name	Type	Description ⁽¹⁾	Functionality
1	+3.3V	Power in	Power input to the module	Power input to the module
2	IO_25_26	Digital	2.5V IO pin	Digital video data 12
3	+3.3V	Power in	Power input to the module	Power input to the module
4	IO_25_25	Digital	2.5V IO pin	Digital video data 11
5	Trigger in2	Digital in	3.3V	Trigger in2
6	IO_25_24	Digital	2.5V IO pin	Digital video data 15 (= MSB)
7	Trigger in1	Digital in	3.3V	Trigger in1
8	IO_25_23	Digital	2.5V IO pin	Digital video data 14
9	RFU		Do not use	-
10	IO_25_22	Digital	2.5V IO pin	-
11	Trigger out	Digital out	3.3V	Trigger out
12	IO_25_21	Digital	2.5V IO pin	Digital video LVAL
13	RXD	Digital in	3.3V level serial receive	RXD
14	IO_25_20	Digital	2.5V IO pin	-
15	TXD	Digital out	3.3V level serial transmit	TXD
16	IO_25_19	Digital	2.5V IO pin	Digital video data 9

17	IO_33_1	Digital	3.3V IO pin	Digital video clock
18	IO_25_18	Digital	2.5V IO pin	Digital video data 8
19	IO_33_0	Digital	3.3V IO pin	Digital Video Interface active ⁽²⁾
20	IO_25_17	Digital	2.5V IO pin	Digital video data 5
21	I2C SDA	Digital bi-dir	Used for control of Video encoder	-
22	IO_25_16	Digital	2.5V IO pin	Digital video data 7
23	I2C SCL	Digital out	Used for control of Video encoder	-
24	IO_25_15	Digital	2.5V IO pin	-
25	IO_25_14	Digital	2.5V IO pin	Digital video FVAL
26	IO_25_13	Digital	2.5V IO pin	-
27	IO_25_12	Digital	2.5V IO pin	Digital video DVAL
28	IO_25_11	Digital	2.5V IO pin	-
29	IO_25_10	Digital	2.5V IO pin	Digital video data 6
30	IO_25_9	Digital	2.5V IO pin	Digital video data 13
31	IO_25_8	Digital	2.5V IO pin	Digital video data 0 (= LSB)
32	IO_25_7	Digital	2.5V IO pin	Digital video data 10
33	IO_25_6	Digital	2.5V IO pin	Digital video data 1
34	IO_25_5	Digital	2.5V IO pin	-
35	IO_25_4	Digital	2.5V IO pin	Digital video data 2
36	IO_25_3	Digital	2.5V IO pin	-
37	IO_25_2	Digital	2.5V IO pin	Digital video data 3
38	IO_25_1	Digital	2.5V IO pin	-
39	IO_25_0	Digital	2.5V IO pin	Digital video data 4
40	+2.5V	Power out	2.5V power supply internally generated	Power out, +2.5V
S	Ground	Power in	GND of module	GND of module

Table 5-2 Connector pin description

⁽¹⁾ Note that most IO pins are 2.5V and some IO pins are 3.3V.

⁽²⁾ If IO= high, the data stream on the digital bus is valid; if IO = low, the data stream is not valid. This IO can be used e.g., to power down a CL transceiver IC when the data stream is not valid.

5.2.3. Power Dissipation

Average power consumption is 6.3W for GigE, 4.1W for CL and 4W for 16bit DV.

Power supply to the module must be 3.3V ± 5 %.

5.2.4. IO Mapping

IO mapping is High Resolution 16 bit Video mode. High Resolution Digital Video signal mapping is as defined in Table 5-3.

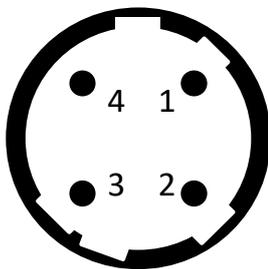
Digital Video signal	IO mapping
Digital video data 0	IO_25_8
Digital video data 1	IO_25_6
Digital video data 2	IO_25_4
Digital video data 3	IO_25_2
Digital video data 4	IO_25_0
Digital video data 5	IO_25_17
Digital video data 6	IO_25_10
Digital video data 7	IO_25_16
Digital video data 8	IO_25_18
Digital video data 9	IO_25_19
Digital video data 10	IO_25_7
Digital video data 11	IO_25_25
Digital video data 12	IO_25_26
Digital video data 13	IO_25_9
Digital video data 14	IO_25_23
Digital video data 15	IO_25_24
Digital video DVAL	IO_25_12
Digital video LVAL	IO_25_21
Digital video FVAL	IO_25_14
Digital video clock	IO_33_1

Table 5-3 High Resolution Digital Video Signal Mapping

5.3. Power Interface

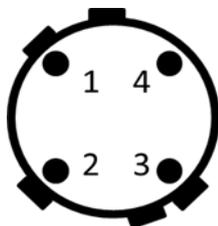
The power cable must be connected to the backside of the camera (see chap. (Ref 2) for its location). Table 5-2 lists the connector pins overview and shows schematically the pin location (upper) and the power cable (ASY-001268) the connector pins overview and schematically shown the pin location of the cable connector (Hirose HR10-7P-4P(73)).

i For XSL module, this power interface is only used in the XSL-GigE and CL. It is not used in the XSL module without interface PCB (when using the Samtec connector)!



Pin	Signal
1	+ 12V
2	+ 12V
3	Gnd
4	Gnd

Camera power connector Camera power connector 12V_{DC}



Pin	Signal
1	+ 12V
2	+ 12V
3	Gnd
4	Gnd

Cable connector Cable connector 12V_{DC}

Table 5-2 schematics and pin location of ,camera power connector and cable connector

5.4. Trigger Interface



Do not apply voltages to the trigger connector when it is configured in Trigger-OUT mode as this will damage the camera!

For the trigger interface, a SMA connector is foreseen. The pin assignment is listed in [Table 5-3 Trigger interface pin assignment](#)

The trigger interface can be configured as **Trigger-IN** or **Trigger-OUT**. The following settings can be customized (see also [\(Ref 3\)](#)).

- Trigger OUT
 - Polarity:
 - High
 - Low.
 - Width
 - Delay.
- Trigger-IN
 - Source: frame or line trigger
 - Sensitivity
 - Level
 - Edge.
 - Polarity:
 - Low level / falling edge
 - High level / rising edge.
 - Delay
 - Trigger skip-count.

Pin	Signal	Cable
Shell	GND	Shield
Center	Trigger in	Inner conductor

Table 5-3 Trigger interface pin assignment

5.5. GigE Interface

GigE Vision[®] is a camera interface standard that uses the Gigabit Ethernet (GigE) communication protocol. It provides a framework for transmitting high-speed video and related control data over Ethernet networks.

To realize the GigE communication the Lynx-GigE cameras and XSL-GigE module are equipped with a 1000Base-T Ethernet interface (RJ-45 connector). The data connection between camera and PC can be established via a standard CAT5e cable.

The GigE Vision standard defines how compliant products interact to deliver video and control information over Ethernet networks. It has the following four main elements:

- **Device discovery:** defines the sequence of events required for compliant devices to obtain valid Internet Protocol addresses, and for control applications to discover compliant devices.
- **GigE Vision control protocol (GVCP):** defines how to specify video stream channels and control and configure compliant devices.
- **GigE Vision stream protocol (GVSP):** defines how images are packetized and provides mechanisms for cameras or other types of video transmission systems to send image data and other information to compliant receivers.
- **An extensible mark-up language (XML) description file:** provides the equivalent of a computer-readable data sheet of features in compliant devices. This file must be based on standard defined by the European Machine Vision Association's GenICam™.

5.6. Camera Link Interface

Camera Link is an interface for the transfer of digital video data. The standard defines data transfer on a physical base and determines connectors, cables and components for transmission and reception. Different configurations are available, distinguishing between the numbers of parallel transferred data bits.

For the Lynx-CL camera and XSL-CL module, the **BASE configuration with 1 TAP** is used. The pin lay-out and pin assignment of the Camera Link connector on the Lynx-CL camera and XSL-CL module are shown in [Figure 5.16](#) and [Table 5-47](#).

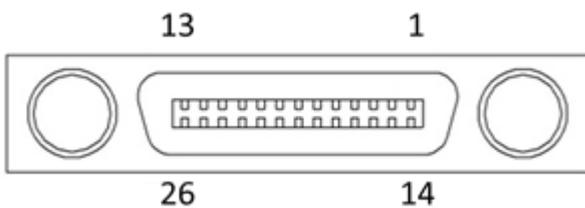


Figure 5.1 Pin out of Camera Link connector on the Lynx-CL camera

Pin	Signal	Pin	Signal
1	GND	14	GND
2	X0	15	X0+
3	X1	16	X1+

4	X2	17	X2+
5	XCLK	18	XCLK+
6	X3	19	X3+
7	SerTC+	20	SerTC-
8	SerTFG-	21	SerTFG+ P
9	CC1	22	CC1+
10	CC2+	23	CC2
11	CC3	24	CC3+
12	CC4+	25	CC4
13	GND	26	GND

Table 5-4 Camera Link connector (base) pin assignment

CC1 can be configured as line or frame trigger input (see also (Ref 3)).

CC2 to CC4 in Table 5-47 are not supported by the camera. The clock rate is 50 MHz with one tap & 16 bit/pixel.

i

Info about the timing diagram can be found in (Ref 3).

5.7. Image Acquisition

5.7.1. Introduction

As the XLIN is a linear device, the sensor produces only 1 line at a time. Internally these individual lines are collected in a frame. Each of these lines represents the content of the sensor at consecutive timing intervals.

An independent triggering operation is provided for the lines and the frames. Figure 5-2 provides an example on how *N* lines are grouped into a frame, the start of the frame and the capturing of the lines is activated by the corresponding trigger.

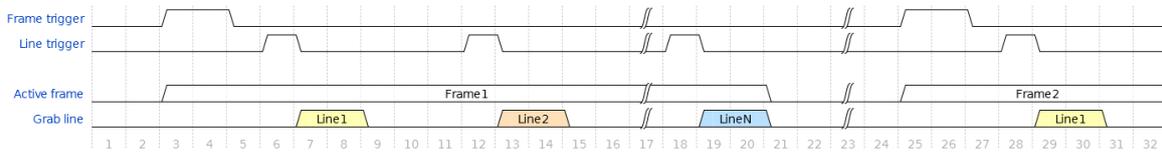


Figure 5-2 Example of a frame capturing for the Lynx camera

5.7.2. Frame Rate, Read-out Mode, and Exposure Time

5.7.2.1. Maximal Frame Rate

The maximal frame rate which can be achieved is 40 kHz for the 512 and 1024 linear array and 10 kHz for the 2048 linear array. This frame rate can only be achieved for short exposure times and in IWR (integrate while read) read-out mode.

To obtain the maximal frame rate, the exposure time should be equal to or less than:

- 20 μs (512 and 1024 linear array)

- 90 μ s (2048 linear array).

The theoretical frame rate for larger exposure times and/or for ITR mode can be calculated using the frame rate calculator (Ref 4).

5.7.2.2. Maximal Frame Rate – Footer and Minimal Frame Time



This paragraph is only applicable for:

- Cameras / cores with camera link interface.

To obtain the maximal frame rate, it is also important to make sure that the frame time is high enough. This is related to the fact that at the end of the frame, a footer is added to the frame. If the frame time is too small, the start of sending out a new image on the interface is blocked, which results in a frame rate drop.

The minimal required frame time to avoid this drop depends on different parameters, such as the number of pixels, the exposure time and read-out mode. For large exposure times, the frame time is always high enough: as a result, frame rate drops due to insertion of the footer will not occur. For small exposure times on the other hand, it is important to adjust the 'Minimal Frame time' to achieve the maximal frame rate. We will provide here the formulas to calculate the minimal required frame time for different situations. It is also possible to calculate the minimal required frame time using the excel sheet in (Ref 4).

1) 512 and 1024 linear sensor / ITR

$$\text{MinFrameTime} > (NrLines - 1) \times \text{MAX}(\text{MinLineTime}, (\text{ExposureTime} + 24.52\mu\text{s})) + 42.96\mu\text{s}$$

There will never be a frame rate drop due to the footer for exposure times > 18 μ s

2) 512 and 1024 linear sensor / IWR

$$\text{MinFrameTime} > (NrLines - 1) \times \text{MAX}(\text{MinLineTime}, (\text{ExposureTime} + 2.2\mu\text{s}), 22.32\mu\text{s}) + 42.96\mu\text{s}$$

There will never be a frame rate drop due to the footer for exposure times > 41 μ s

3) 2048 linear sensor / ITR

$$\text{MinFrameTime} > (NrLines - 1) \times \text{MAX}(\text{MinLineTime}, (\text{ExposureTime} + 93.36\mu\text{s})) + 170.96\mu\text{s}$$

There will never be a frame rate drop due to the footer for exposure times > 78 μ s

4) 2048 linear sensor / IWR

$$\text{MinFrameTime} > (NrLines - 1) \times \text{MAX}(\text{MinLineTime}, (\text{ExposureTime} + 4.4\mu\text{s}), 88.96\mu\text{s}) + 170.96\mu\text{s}$$

There will never be a frame rate drop due to the footer for exposure times > 167 μ s

5.7.3. Trigger Sources

5.7.3.1. Trigger Input Sources

On the camera the following trigger sources are available for both the line trigger and the frame trigger:

1. External SMA trigger:
This trigger is available at the SMA connector on the backside of the camera.
2. External CC1 trigger:
This trigger is connected to CC1 of the Camera Link connector.
REMARK: It is only available on Camera Link cameras!
3. Internal timer-based trigger:
Internally in the camera triggers can be generated with an accuracy at the μ s level. The user defines the frequency at which these interrupts are generated.
4. SW trigger:
Through the GUI or the XSP communication protocol the user can also generate triggers.



An external trigger (SMA or CC1) cannot be assigned to the line trigger as well as to the frame trigger simultaneously!

5.7.3.2. Trigger Output Sources

In case the SMA connector is not used as a trigger input source, it can be configured as a trigger output. The selection as an input takes priority over the configuration as a trigger output.

The following events can be placed on the trigger out:

1. The occurrence of the line trigger
2. The occurrence of the frame trigger
3. The duration of the exposure on the sensor.

As will be explained later, the trigger output pulse can be configured.

5.7.4. Trigger Configuration

5.7.4.1. Trigger Input Configuration

The following settings are provided for a trigger input (line or frame) trigger:

1. Trigger source selection: SMA / CC1 / Internal timer trigger
Remark that the software trigger has no dedicated selection setting: the user can always send a software trigger which will start the actual triggering.
2. Trigger polarity
With this setting the polarity of the external trigger input is controlled: rising edge/high level trigger or falling edge/low level trigger.
3. Trigger edge/level sensitivity
Using these settings the sensitivity of the external trigger is controlled: edge triggering or level triggering.
4. Trigger delay
This setting defines the delay between the external trigger source and the internal generated trigger in μs (see Figure 5-3)
5. Trigger skip
Counts the number of (external) triggers to be ignored.
6. Trigger frequency
The minimum time between 2 timer triggers expressed in μs . The next trigger is however delayed until the sensor is ready to start the capturing of the next frame.
7. Trigger dependent exposure time
The exposure time can be controlled through the external pulse duration.



Figure 5-3 Input trigger delay

5.7.4.2. Trigger Output Configuration

The following settings are provided for the trigger output trigger:

1. Trigger source select
This signal selects the trigger source: internal line trigger, internal frame trigger or exposure active
2. SMA output polarity
With this setting the polarity of the trigger output is controlled: rising edge trigger or falling edge trigger.
3. SMA output delay
This setting defines the delay between the internal trigger source and the external trigger output in μs , it is not applied to the exposure duration trigger out source (see also Figure 5-4)
4. SMA output width
This setting defines the width of the trigger output pulse in μs , it is not applied to the exposure duration trigger out source (see Figure 5-4).

i The *Trigger output delay* setting does not consider the delay introduced by the physical trigger hardware on the interface board PCB!

These settings are only appropriate in case the SMA is not used as trigger in. In case the SMA is used as a trigger input source for either the line or the frame trigger, the SMA direction should be put to input.



Figure 5-4 Trigger delay and trigger width settings

5.7.5. Supported Trigger Modes

An overview of the supported modes is provided in Table 5-5. The use of trigger modes not mentioned in the table leads to undefined behavior.

Line trigger source	Frame trigger source	SMA direction
Internal timer	Internal timer	Output
Internal timer	SMA connector	Input
Internal timer	CC1 Camera Link trigger	Output
SMA connector	Internal timer	Input
SMA connector	CC1 Camera Link trigger	Input
CC1 Camera Link trigger	Internal timer	Output
CC1 Camera Link trigger	SMA connector	Input

Table 5-5 Overview of the supported trigger modes

i Camera operations that require a capture stop before execution, temporarily switch the line trigger source to internal timer triggered mode. Otherwise, when lines are externally triggered, the execution of the requested operation could be postponed indefinitely. When the capturing is stopped, the camera is switched back in the original trigger mode.

i For GigE vision cameras: the modes using the CC1 Camera Link trigger are not available (greyed out in Table 5-5)!

5.7.6. Trigger Operation

It is recommended to adjust the exposure time with respect to the time between two-line trigger pulses: the time between 2 consecutive trigger pulses must be larger than the sensor exposure cycle (see Figure 5-5). In this way the sensor is always ready to start a new exposure cycle when a new trigger signal arrives.

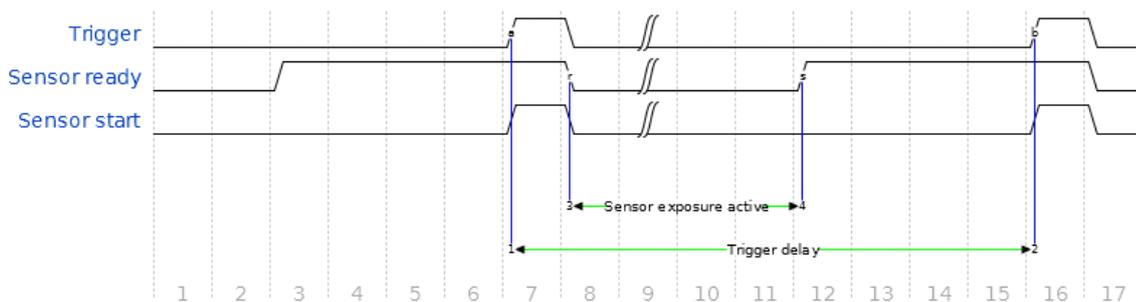


Figure 5-5 Trigger operation recommended operation



The time between 2-line triggers must be larger than the sensor exposure time!

5.7.7. Trigger-defined Exposure Time

Both external triggers (the SMA connector and the CC1 trigger) can be used to define the exposure time of the sensor. Be aware that this option is only available in edge triggering mode, using this option in level triggering mode results in undefined behavior.

The line period is determined with the period of the trigger signal, the “active” duty cycle of the trigger signal determines the exposure time. The readout of the sensor is started when the active part of the trigger pulse ends. As shown in Figure 5-6 the exposure period of the sensor can overlap with the readout period.

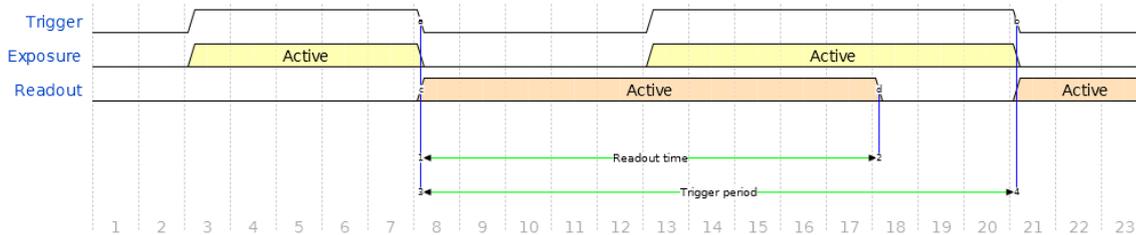


Figure 5-6 Trigger defined exposure time

It is however important that the trigger pulses are properly shaped: a new readout will not start until the previous readout has finished. The readout time is equal to 23 μs for the 512 and 1024 sensor and 92 μs for the 2048 sensor. Failing to comply with this restriction, will result in incorrect exposure times as the exposure of the sensor is stopped just prior to the start of the readout. It can even result in triggers being lost in case a new trigger arrives when the readout of the previous trigger has not yet been started. The incorrect exposure as well as the missing of triggers is illustrated in Figure 5-7.

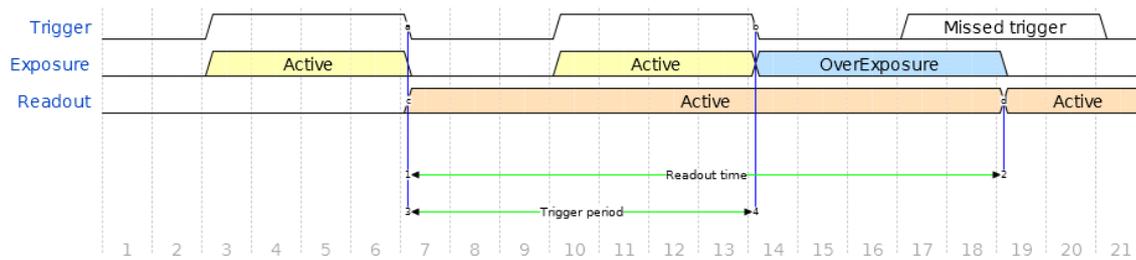


Figure 5-7 Trigger defined exposure time (incorrect operation)

To avoid issues when switching between timer-based and trigger-based exposure, the maximum exposure time of the sensor is limited to the exposure time register set by the user. As a result, the exposure time is the maximum of either the trigger pulse becoming inactive or the programmed exposure time being reached. This is illustrated in Figure 5-8.

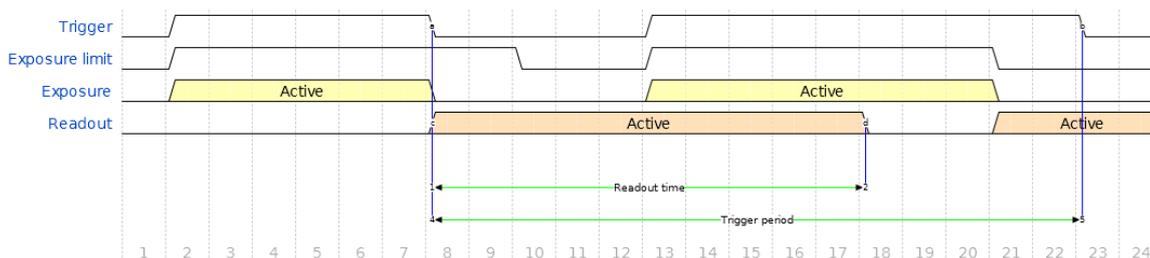


Figure 5-8 Trigger defined exposure time (exposure time limit)



There should be at least 6 μs inactive time between consecutive trigger defined exposure cycles. This time is required to rearm the trigger and a proper reset of the sensor.

The exposure time register is used for 2 purposes:



1. Define the exposure time in timer-defined exposure time

2. Define the exposure limit in trigger-defined exposure time.

5.8. Image Processing

A fixed digital gain and offset value can be imposed by the user. As a result, the image histogram will be stretched and/or shifted by a fixed value.

5.9. Image Output

5.9.1. Digital Video



This paragraph is only applicable for:

XSL-16bitDV-module

- Cameras / cores with Camera Link interface.

Footer information can be enabled to add extra information on the frame. The footer is an extra line with the width of the current WOI that is added in the frame. See footer information.

The footer can be enabled with bit 9 in the SysMode register.

Timing is shown in the following graph. The digital video clock rate is 50 MHz. The digital video data is valid when FVAL, LVAL and DVAL are high.

The FVAL signal indicates the frame valid signal. Whenever a frame is sent out on the link, the FVAL signal is high. A rising edge on the FVAL signal indicates the start of a new frame and a falling edge indicates the end of a frame.

The LVAL signal indicates the line valid signal. Whenever a line is sent out on the link, the LVAL signal is high. A rising edge on the LVAL signal indicates the start of a new line and a falling edge indicates the end of a line. The number of LVAL pulses within a frame is equal to the height of the applied window of interest. One extra line can be appended within a frame if the footer information is switched on. LVAL is always low when FVAL is low.

The DVAL signal indicates the data valid signal. Whenever a valid pixel is sent out on the link, the DVAL signal is high. During each line the number of DVAL-high cycles equals the number of pixels in a line. Remark that the DVAL signal can be toggling. DVAL is always low when LVAL is low.

Figure 5-9 gives an overview of the timing for the High Resolution Digital Video interface.

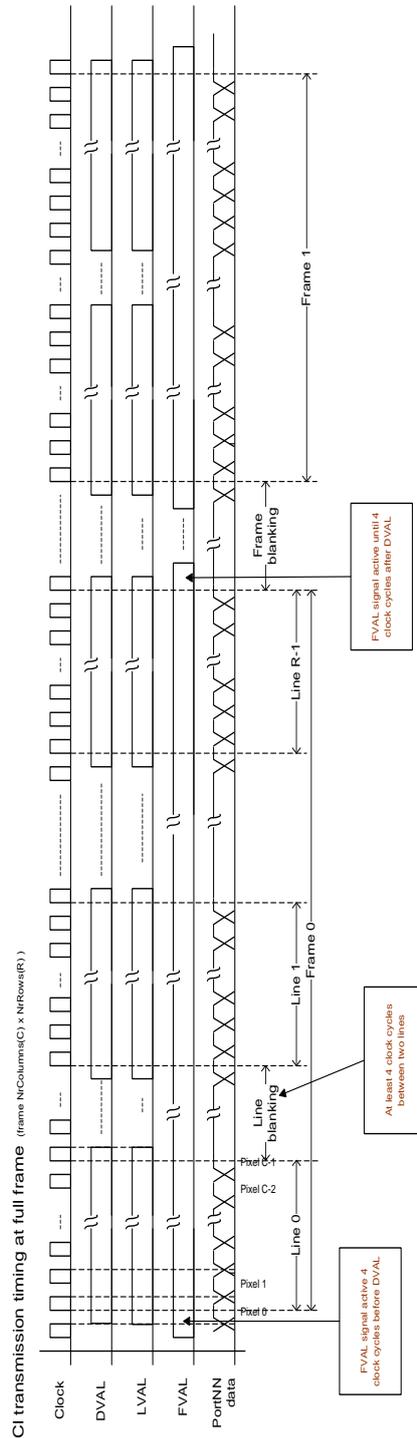


Figure 5-9 High resolution digital video timing signals

5.9.2. GigE



This paragraph is only applicable for:

- Cameras / cores with GigE interface.

For the cameras and cores with GigE interface, the image transport is compliant with the “Gigabit Ethernet Vision” standards.

6. Appendices

6.1. Firmware Upgrade

6.1.1. Firmware Upgrade Procedure



This paragraph is only applicable for cameras and modules that can be connected to Xeneth:

- Cameras / modules with Camera Link / GigE Vision interface

To upgrade the firmware, perform the following steps:

- In Xeneth: go to the Settings tab / Storage icon (see [Figure 6-1](#))
- Upgrade the firmware:
 - o Click on *Update package file*
 - o Click on the green upload arrow (= arrow up) (see [Figure 6-2](#))
 - o Select the new update package file (.pkg)
 - o A warning message will appear to keep the camera powered during upgrade. After ensuring the camera has a stable power connection click Yes
 - o Wait until the firmware is uploaded (wait until Xenics logo disappears)
 - o Wait an additional 30 seconds before proceeding
- Power cycle the camera for the new firmware to take into effect.

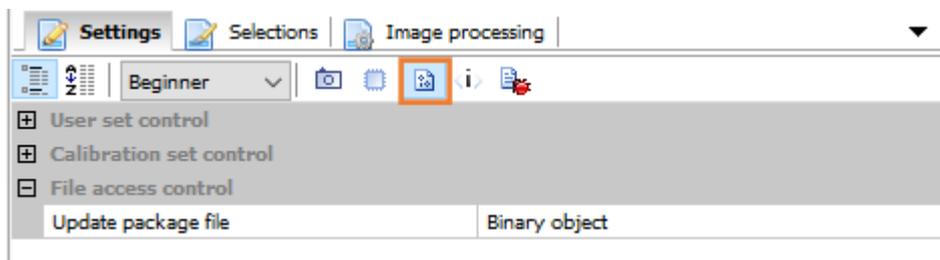


Figure 6-1 Firmware upgrade - storage icon (for CL / GigE Vision)

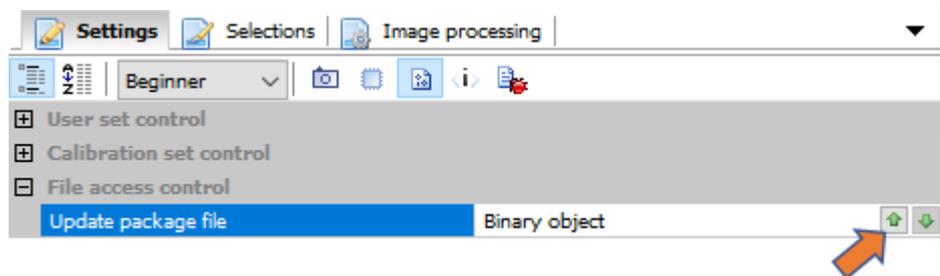


Figure 6-2 Firmware upgrade (for CL / GigE Vision)

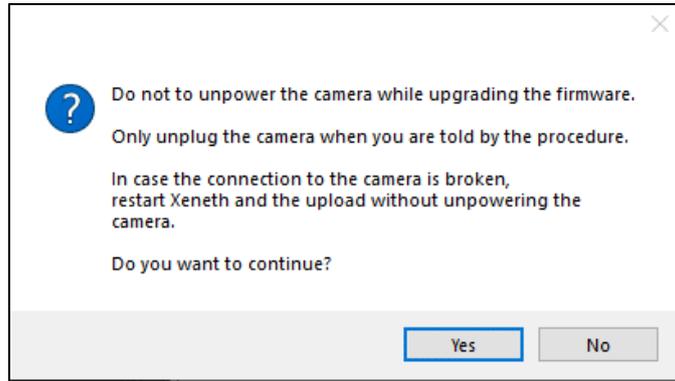


Figure 6-3 Warning message prior to start the upgrade



Figure 6-4 Xenics logo while firmware upgrade

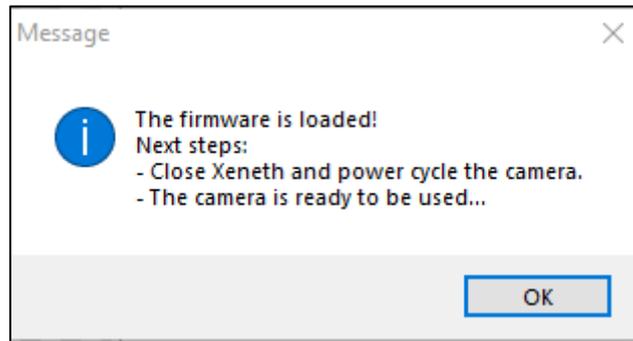


Figure 6-5 Firmware upgrade finished

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