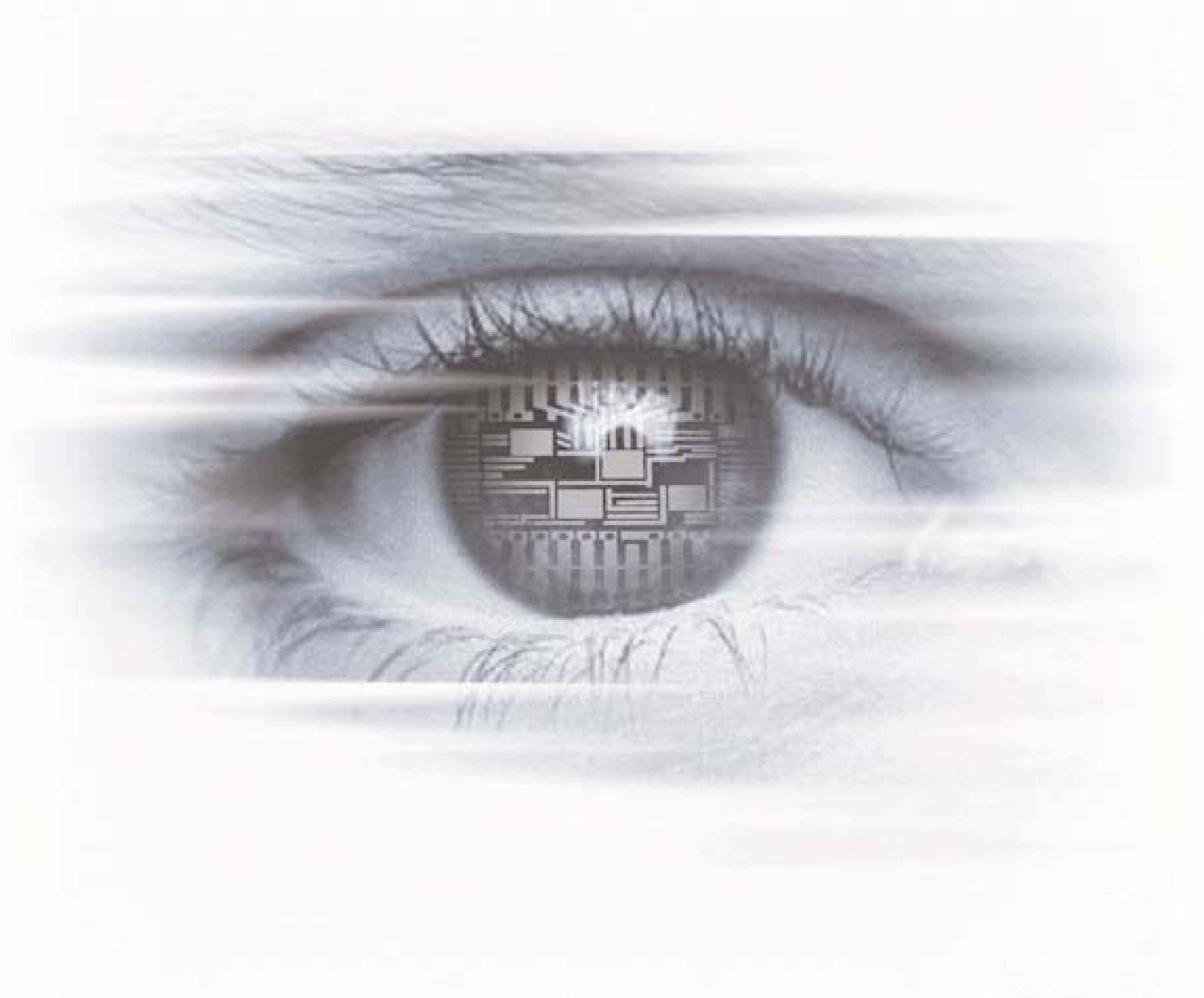
photon focus

User Manual

MV-D1024 Series

CMOS Area Scan Cameras



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Contents

1 Preface

1.1 About Photonfocus

The Swiss company Photonfocus is one of the leading specialists in the development of CMOS image sensors and corresponding industrial cameras for machine vision, security & surveillance and automotive markets.
Photonfocus is dedicated to making the latest generation of CMOS technology commercially available. Active Pixel Sensor (APS) and global shutter technologies enable high speed and high dynamic range (120 dB) applications, while avoiding disadvantages, like image lag, blooming and smear.
Photonfocus has proven that the image quality of modern CMOS sensors is now appropriate for demanding applications. Photonfocus' product range is complemented by custom design solutions in the area of camera electronics and CMOS image sensors.
Photonfocus is ISO 9001 certified. All products are produced with the latest techniques in order to ensure the highest degree of quality.

1.2 Contact

Photonfocus AG, Bahnhofplatz 10, CH-8853 Lachen SZ, Switzerland

Sales	Phone: +41 55 451 00 00	Email: sales@photonfocus.com
Support	Phone: +41 55 451 01 37	Email: support@photonfocus.com

Table 1.1: Photonfocus Contact

1.3 Sales Offices

Photonfocus products are available through an extensive international distribution network and through our key account managers. Details of the distributor nearest you and contacts to our key account managers can be found at www.photonfocus.com.

1.4 Further information

For further information on the products, documentation and software updates please see our web site www.photonfocus.com or contact our distributors.

☞ Photonfocus reserves the right to make changes to its products and documentation without notice. Photonfocus products are neither intended nor certified for use in life support systems or in other critical systems. The use of Photonfocus products in such applications is prohibited.

☞ Photonfocus and LinLog are trademarks of Photonfocus AG. CameraLink is a registered mark of the Automated Imaging Association. Product and company names mentioned herein are trademarks or trade names of their respective companies.

1.5 Legend

In this documentation the reader's attention is drawn to the following icons:

Important note.

Alerts and additional information.

Attention, critical warning.

Notification, user guide.

2

How to get started (CameraLink)

1. Install a suitable frame grabber in your PC.

   To find a compliant frame grabber, please see the frame grabber compatibility list at www.photonfocus.com.

2. Install the frame grabber software.

   Without installed frame grabber software the camera configuration tool PFRemote will not be able to communicate with the camera. Please follow the instructions of the frame grabber supplier.

3. Remove the camera from its packaging. Please make sure the following items are included with your camera:

   - Power supply connector (7-pole power plug)
   - Camera body cap

   If any items are missing or damaged, please contact your dealership.

4. Remove the camera body cap from the camera and mount a suitable lens.

   When removing the camera body cap or when changing the lens, the camera should always be held with the opening facing downwards to prevent dust or debris falling onto the CMOS sensor.

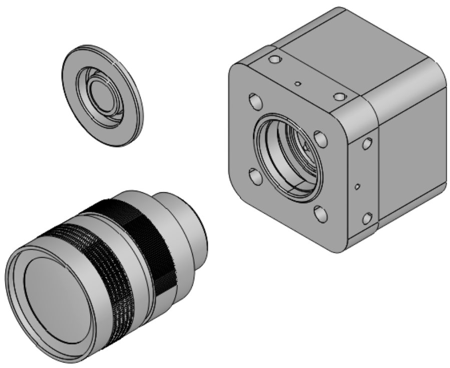


Figure 2.1: Camera with protective cap and lens.

Do not touch the sensor surface. Protect the image sensor from particles and dirt!

The sensor has no cover glass, therefore dust on the sensor surface may resemble to clusters or extended regions of dead pixel.

To choose a lens, see the Lens Finder in the 'Support' area at www.photonfocus.com.

5. Connect the camera to the frame grabber with a suitable CameraLink cable (see Fig. 2.2). CameraLink cables can be purchased from Photonfocus directly (www.photonfocus.com). Please note that Photonfocus provides appropriate solutions for your advanced vision applications.

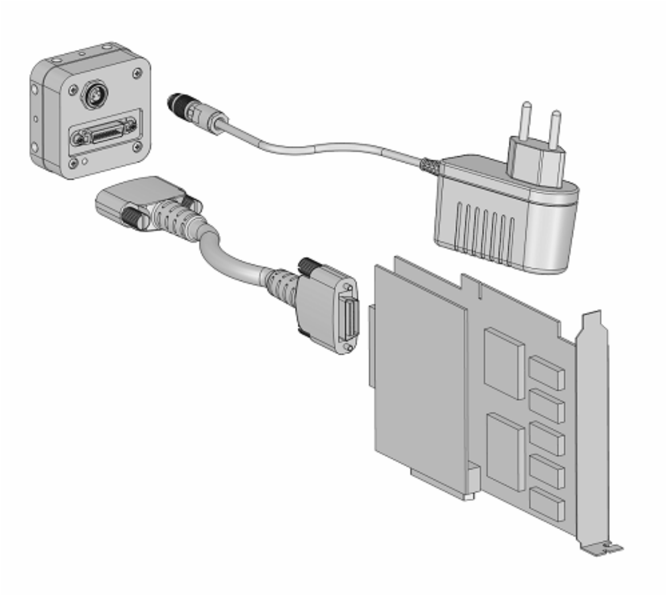


Figure 2.2: Camera with frame grabber, power supply and cable.

Do not connect or disconnect the CameraLink cable while camera power is on! For more information about CameraLink see Section 4.6.

6. Connect a suitable power supply to the provided 7-pole power plug. For the connector assembly see Fig. 11.2. The pinout of the connector is shown in Appendix 11.

Check the correct supply voltage and polarity! Do not exceed the maximum operating voltage of +12V DC ($\pm$ 10%).

7. Connect the power supply to the camera (see Fig. 2.2).

The status LED on the rear of the camera will light red for a short moment, and then flash green. For more information see Section 5.1.3.

8. Download the camera software PFRemote to your computer.

   You can find the latest version of PFRemote on the support page at www.photonfocus.com.

9. Install the camera software PFRemote. Please follow the instructions of the PFRemote setup wizard.

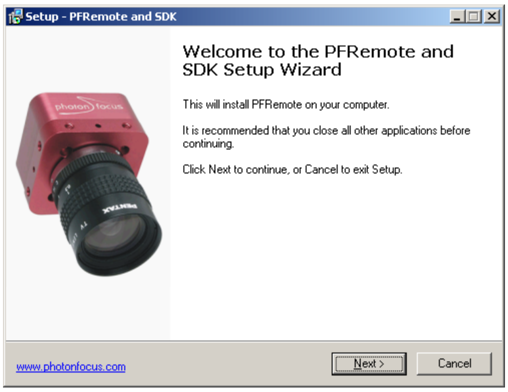


Figure 2.3: Screen shot PFremote setup wizard

10. Start the camera software PFRemote and choose the communication port.

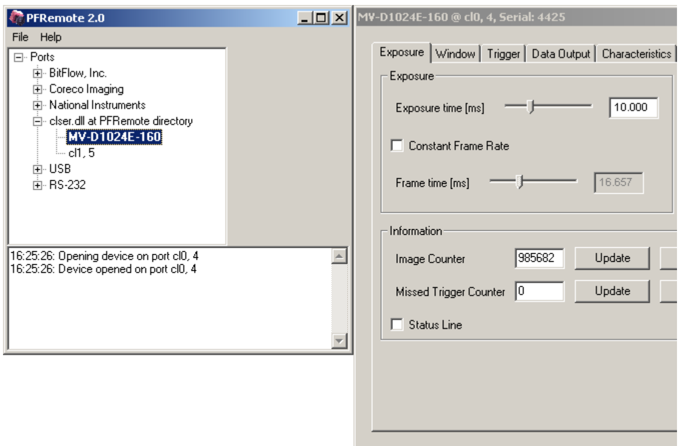


Figure 2.4: PFRemote start window

11. Check the status LED on the rear of the camera.

   The status LED lights green when an image is being produced, and it is red when serial communication is active. For more information see Section 5.1.3.

12. You may display images using the software that is provided by the frame grabber manufacturer.

3

Product Specification

3.1 Introduction

The MV-D1024 series of CMOS cameras from Photonfocus is aimed at demanding applications in industrial image processing. It provides an exceptionally high dynamic range of up to 120dB at a resolution of 1024 x 1024 pixels and a frame rate of up to 150 full images per second. The cameras are built around a monochrome CMOS image sensor, developed by Photonfocus. The principal advantages are:

- Low power consumption at high speeds
- Resistance to blooming
- Extremely high image contrast achieved by LinLog technology.
- Ideal for high speed applications: global shutter, in combination with several simultaneously selectable read out windows (Multiple ROI).
- Software is provided to set camera parameters and store them within the camera.
- The cameras have a CameraLink digital interface.
- The compact size of only 55 x 55 x 46 mm^3 makes the MV-D1024 series the perfect solution for applications in which space is at a premium.

The general specification and features of the camera are listed in the following sections.

3.2 Feature Overview

	MV-D1024-28-CL-10	**MV-D1024-80-CL-8**	**MV-D1024-160-CL-8**
Interface	CameraLink base configuration		
Camera control	PFRemote (Windows GUI) or programming library (Windows/Linux)		
Configuration interface	CLSERIAL (9600 baud)		
Trigger modes	free running / edge controlled / start-stop / combined		
Features	Linear Mode / LinLog Mode / Skimming		
	Region of Interest (ROI) / Multiple Regions of Interest (MROI)		
	Line Hopping / Master and Slave Mode (MCLK)		

Table 3.1: Feature overview for MV-D1024 series. See Chapter 4 for more information.

3.3 Technical Specification

	MV-D1024-28-CL-10	MV-D1024-80-CL-8	MV-D1024-160-CL-8
Technology	CMOS active pixel		
Scanning system	progressive scan		
Optical format / diagonal	1” / 15.42mm		
Resolution	1024 x 1024 pixels		
Pixel size	10.6μm x 10.6μm		
Sensing area	10.9mm x 10.9mm		
Random noise	< 0.5 DN RMS @ 8 bit / gain= 1		
Fixed pattern noise (FPN)	< 2.5 DN RMS @ 8 bit / gain= 1		
Dark current	2fA/pixel @ 30°C		
Full well capacity	200ke^{-}		
Spectral sensitivity	400nm ... 900nm		
Responsivity	120x10^{3} DN/(J/m^{2}) @ 610nm / 8 bit / gain = 1		
Optical fill factor	35%		
Dynamic range	> 120dB (with LinLog)		
Color format	monochrome		
Characteristic curve	linear or LinLog, skimming		
Shutter mode	global shutter		
Readout mode	sequential integration and readout		
Exposure time	10μs...0.5s		
Exposure time step resolution	35ns	50ns	25ns
Frame rate (full frame)	27fps	75fps	150fps
Pixel clock	28MHz (35ns)	40MHz (25ns)	80MHz (12.5ns)
Camera taps	1	2	2
Greyscale resolution	8 bit, 10 bit	8 bit	8 bit
Look-up table	yes, 10 bit to 8 bit	yes, 9 bit to 8 bit	no
Analog Gain	1x or 4x		
Digital Gain	1x, 2x, 4x	1x, 2x	1x
Min. MCLK frequency	20MHz	10MHz	10MHz
Max. MCLK frequency	28.375MHz	20MHz	40MHz

Table 3.2: Camera specification

For an explanation of the terms used please refer to [AN015, Glossary].
For more information regarding responsivity refer to [AN008, Photometry versus Radiometry].

	MV-D1024-28-CL-10	MV-D1024-80-CL-8	MV-D1024-160-CL-8
Operating temperature	0°C ... 60°C		
Power supply	+5V DC (+10% / -5%)		
Max. power consumption	2.0 W		
Lens mount	C-Mount		
Dimensions	55 x 55 x 46 mm^3		
Mass	200 g		
Conformity	CE		
Mountings	1/4" thread (Tripod) / M5 threads / Microbench compatible		

Table 3.3: Physical characteristics and operating ranges

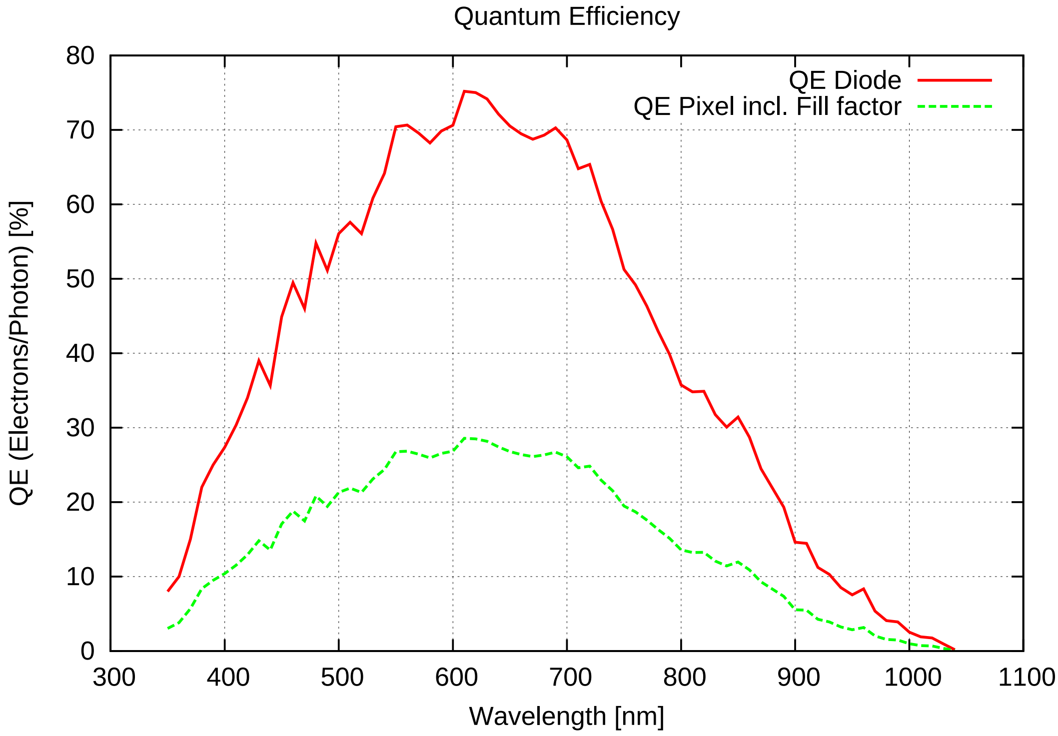


Figure 3.1: Spectral response

3.4 Framegrabber Configuration Parameters

	MV-D1024-28-CL-10	MV-D1024-80-CL-8	MV-D1024-160-CL-8
Pixel Clock per Tap	28MHz	40MHz	80MHz
Number of Taps	1	2	2
Greyscale resolution	10bit	8bit	8bit
CC-Signals	CC1: EXSYNC (common trigger signal), CC2: MCLK, CC3: not used, CC4: EXPOSURE		

Table 3.4: Summary of parameters needed for framegrabber configuration

CameraLink port and bit assignments are CameraLink-compliant (see [CL, Camera Link Specification]).

	MV-D1024-28	MV-D1024-28	MV-D1024-80/-160	MV-D1024-80/-160
Bit	**Tap 0, 8 Bit**	**Tap 0, 10 Bit**	**Tap 0, 8 Bit**	**Tap 1, 8 Bit**
0 (LSB)	A0	A0	A0	B0
1	A1	A1	A1	B1
2	A2	A2	A2	B2
3	A3	A3	A3	B3
4	A4	A4	A4	B4
5	A5	A5	A5	B5
6	A6	A6	A6	B6
7 (MSB for 8 Bit Mode)	A7	A7	A7	B7
8	-	B0	-	-
9 (MSB for 10 Bit Mode)	-	B1	-	-

Table 3.5: CameraLink port and bit assignments for MV-D1024 series

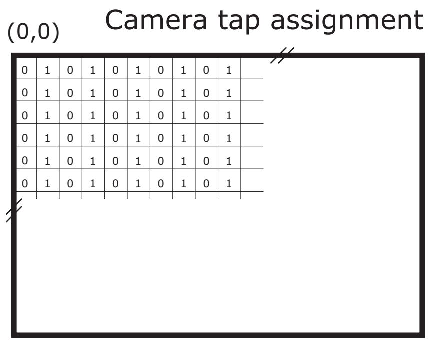


Figure 3.2: Tap assignment for the 2 tap cameras MV-D1024-80 and MV-D1024-160; 0 = tap 0, 1 = tap 1

4

Functionality

This chapter serves as an overview of the camera configuration modes and explains camera features. The goal is to describe what can be done with the camera; the setup is explained in later chapters.

4.1 Image Acquisition

4.1.1 Free-running and Trigger Mode

By default the camera continuously delivers images with a certain configurable frame rate ("Free-running mode"). When the acquisition of an image needs to be synchronised to an external event, a trigger can be used (refer to Section 4.4 and Section 5.4).

4.1.2 Exposure Control

The exposure time defines the period during which the image sensor integrates the incoming light. Depending on the model, it can be configured from 10μs to 0.5s (see Table 3.2).

4.1.3 Maximum Frame Rate

The maximum frame rate depends on the speed grade of the camera model. In addition, the maximum frame rate depends on the size of the image (see Region of Interest, Section 4.3.1). On our website, there is a frame rate calculator, which gives you the maximum frame rate for a given region of interest and exposure time.

4.1.4 Constant Frame Rate (CFR)

When the Constant Frame Rate mode (CFR mode) is switched on, the frame rate (number of frames per second) can be varied from almost 0 up to the maximum frame rate. Thus, fewer images can be acquired than would otherwise be possible.
When Constant Frame Rate is switched off, the camera delivers images as fast as possible, depending on the exposure time and the read-out time.

☞ Please see Section 5.4 for more information about constant frame rate and external trigger.

4.2 Pixel response

Normally, the camera offers a substantially linear response between input light signal and output gray level. This can be modified by the use of LinLog or Skimming as described in the following sections. In addition, a linear analog and / or digital gain (depending on model) may be applied. Please see Table 3.2 for a comprehensive summary of model-dependent information.

4.2.1 Linear Response

High Gain

High gain mode provides an analog amplification of the image intensities by a nominal factor of 4.

Gain x2, x4

Gain x2 and x4 are digital amplifications, which means that the digital image data are multiplied by a factor 2 or 4 respectively, in the camera.

4.2.2 LinLog

The LinLog feature of CMOS image sensors from Photonfocus allows the user to adapt the characteristics of the sensor to the requirements of the application. In situations involving high intrascene contrast, compression of the upper grey level region can be achieved with the LinLog technology. At low light intensities, each pixel shows a linear response. At high intensities, the response changes to logarithmic compression. The transition region between linear and logarithmic response can be smoothly adjusted and is continuously differentiable and monotonic.

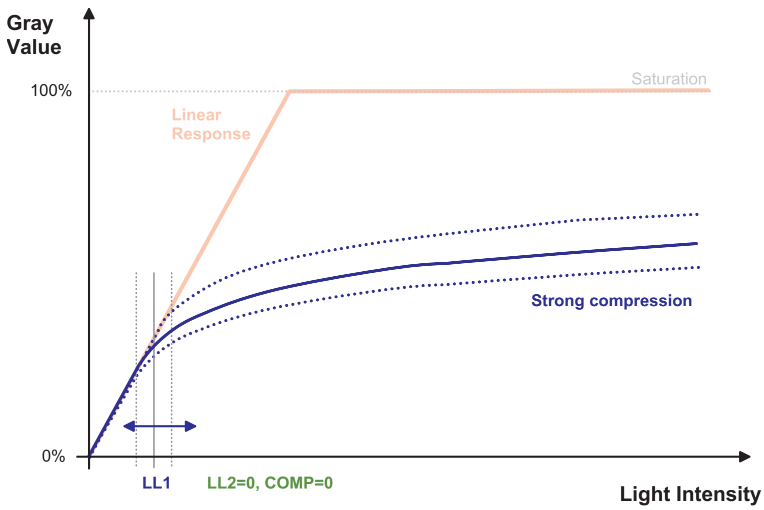


Figure 4.1: Simplest LinLog setup: LL2 = COMP = 0 (also called Linlog1 mode)

The three parameters `LL1`, `LL2` and `COMP` are used to setup LinLog. In the simplest case, `LL2` and `COMP` are not used and are set to 0. The resulting response is shown in Fig. 4.1. The high light intensities are logarithmically compressed, while the lower intensities show a linear behaviour. The transition point between linear and logarithmic behaviour can be adjusted with the `LL1` parameter. This mode is also called "LinLog1" mode.
However, for many applications, the compression as shown above may to be too strong. Therefore the two additional configuration parameters `LL2` and `COMP` were introduced. This mode is also called "LinLog2" mode.
In LinLog2, the resulting response is defined by a combination of two linear-logarithmic curves. `LL1` defines the transition point for a weaker compression, while `LL2` is used to define the transition point for a stronger compression, as shown by Fig. 4.2.
The resulting curve is composed of a certain amount of the weak compression and a certain amount of the strong compression. This amount is defined by the parameter COMP, as is shown in Fig. 4.3.

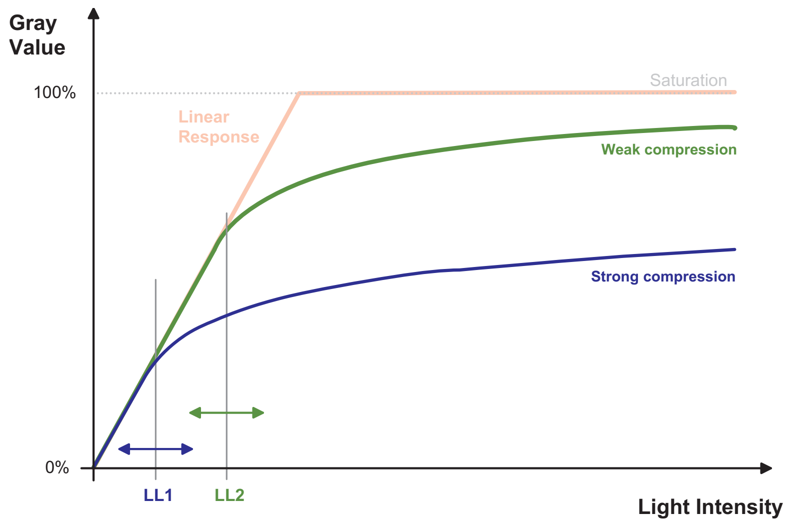


Figure 4.2: Strong and weak compression

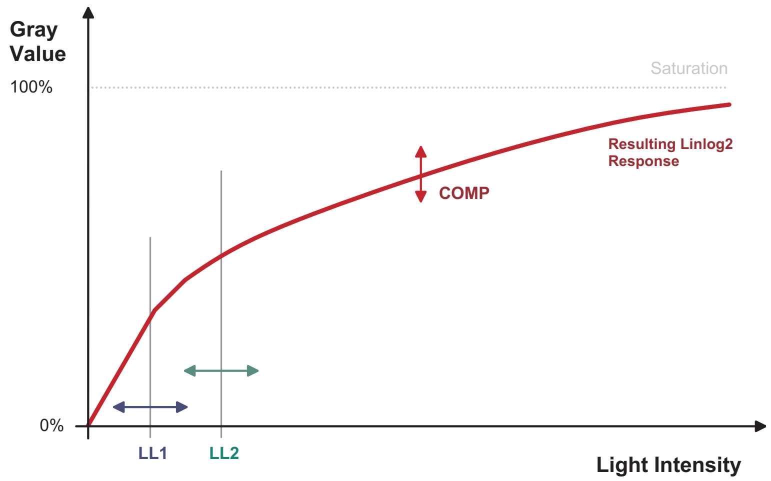


Figure 4.3: Linlog2

For more information about setting up LinLog, please refer to [AN001, LinLog] and [AN024, LinLog - Principles and Practical Example].

4.2.3 Skimming

Skimming is a Photonfocus proprietary technology to enhance detail in dark areas of an image. Skimming provides an adjustable level of in-pixel gain for low signal levels. It can be used together with LinLog to give a smooth monotonic transfer function from high gain at low levels, through normal linear operation, to logarithmic compression for high signal levels.

For best image quality, Skimming requires a longer reset time after frame read-out.

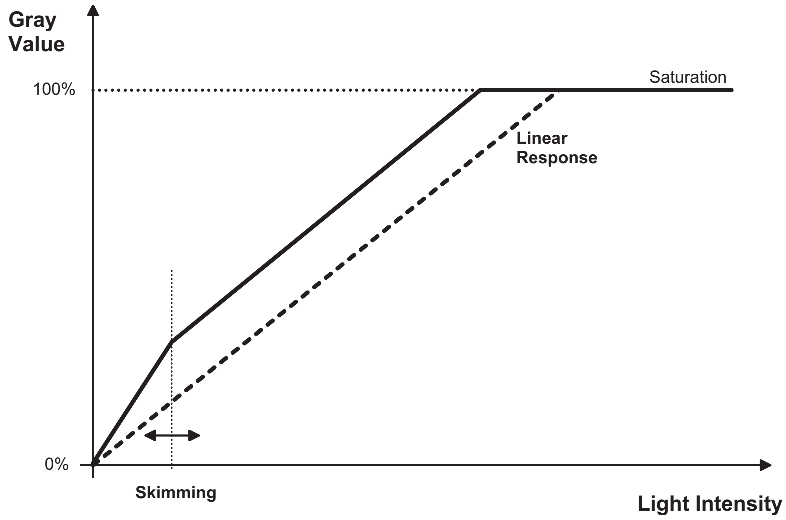


Figure 4.4: Skimming: an in-pixel gain for low signal levels

4.2.4 Gray level transformation with a Look-up table

Gray level transformation is remapping of the gray level values of an input image to new values which are intended to enhance the image in some way. The look-up table (LUT) is used to convert the grayscale value of each pixel of an image into another gray value. It is typically used to implement a transfer curve for contrast expansion.

4.3 Reduction of Image Size

With Photonfocus cameras there are several possibilities to focus on the interesting parts of an image, thus reducing the data rate and increasing the frame rate. The most commonly used feature is region of interest.

4.3.1 Region of Interest

Some applications do not need full image resolution (e.g. 1024x1024 pixels). By reducing the image size to a certain region of interest (ROI), the frame rate can be drastically increased. A region of interest can be almost any rectangular window and is specified by its position within the full frame and its width and height. Fig. 4.5 gives some possible configurations for a region of interest, and Table 4.1 shows some numerical examples of how the frame rate can be increased for the MV-D1024 models by reducing the ROI.

☞ Both reductions in x- and y-direction result in a higher frame rate.

☞ There are two restrictions when using a ROI (see below), but PFRemote and PFLib API respectively ensure that the settings are correct without any user intervention.

Please note that the width of the ROI (x-direction) needs to be a multiple of 4. This restriction does not apply in the y-direction, thus the minimum possible ROI size is 4x1.

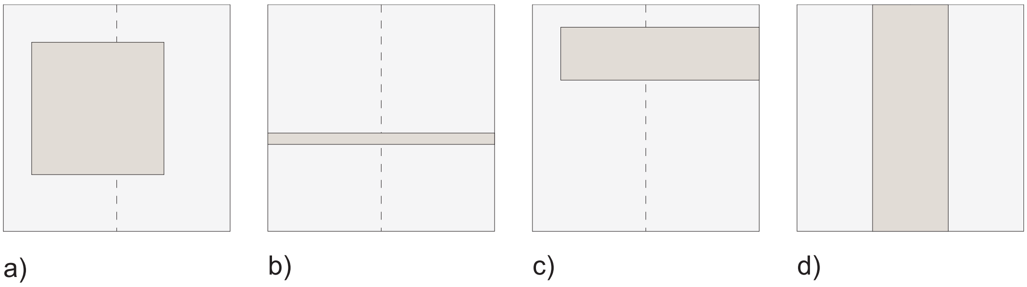


Figure 4.5: ROI configuration examples

ROI Dimension	x Offset	MV-D1024-28	MV-D1024-80	MV-D1024-160
1024 x 1024	0	27 fps	75 fps	150 fps
512 x 512	256	105 fps	290 fps	585 fps
256 x 256	384	415 fps	1130 fps	2240 fps
132 x 128	448	1550 fps	4005 fps	7725 fps
132 x 16	448	11 005 fps	23 640 fps	38 360 fps
1024 x 1	0	20 715 fps	38 910 fps	56 980 fps

Table 4.1: Example: Frame rate increase for the MV-D1024 when using a reduced region of interest (exposure time 10 μs, rounded values)

However, in order to achieve the maximum possible frame rate, the size of the ROI must be at least 128x1 pixels and it must be horizontally centered. In other words, the ROI must be placed so that at least 64 pixels overlap the middle line on both sides, as shown in Fig. 4.6 a. If it does not fulfill this rule (e.g. Fig. 4.6 b), the line pause parameter is adjusted from 8 to 32, which reduces the maximum possible frame rate. The setting of the correct line pause is done automatically by PFRemote and PFLib API respectively.

☞ For an explanation of the `linepause` parameter, please see Section 5.3. To calculate how much the frame rate is decreased by using ROIs which do not sufficiently span the center line, refer to the formula below or use the frame rate calculator in the support area of our website, and set `linepause` to 32.

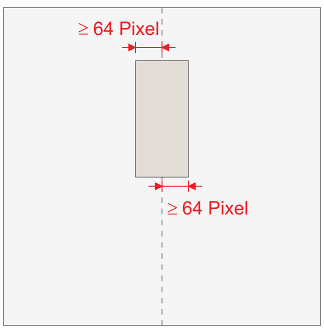


Figure 4.6: ROI configuration restriction for fastest speed

Calculation of the maximum frame rate

The frame rate depends on the exposure time, frame pause, ROI and line pause.
Frame time = (1 / frame rate)
Frame time $\geq$ (exposure time + read out time)
Frame time $\geq$ (T_{Int} + t_U (P_Y * (P_X/taps + LP) + LP + CPRE + RESET + SKIM))

T_{Int} exposure time (10 μs ... 0.5 s)

t_U pixel clock in ns (refer to Table 3.2)

P_X number of pixels in x-direction (4 ... 1024 columns)

P_Y number of pixels in y-direction (1 ... 1024 rows)

LP line pause (8 ... 255, default 8). Is increased to 32 when condition according to Figure 4.6 is not met.

CPRE clocks between completed integration and begin of data transfer (constant CPRE = 42 for all models)

RESET reset time in clocks (constant, but model dependent - see Table 4.2)

SKIM skimming reset time in clocks, only for skimming=ON (model dependent - see Table 4.2)

taps number of taps (refer to Table 3.2)

Camera Model	RESET [clocks]	SKIM [clocks]
MV-D1024-28	12 - LP	LP - 1
MV-D1024-80	66 - LP	62
MV-D1024-160	34	62

Table 4.2: Model-dependent RESET and SKIM parameter

A calculator for calculating the maximum frame rate is available in the support area of the Photonfocus website.

4.3.2 Multiple Regions of Interest

The MV-D1024 cameras can handle up to 17 different regions of interest. This feature can be used to reduce the image data and increase the frame rate. A typical application example for using multiple regions of interest (MROI) is a laser triangulation system with several laser lines. The multiple ROIs are joined together and form a single image, which is transferred to the frame grabber.
Overlapping windows are not allowed, and all windows must have the same width. The maximum frame rate in MROI mode depends on the number of rows and columns being read out. The total number of rows corresponds to the image size in the y-direction, and the total number of columns (width of the MROI) gives the size in the x-direction. See Section 4.3.1 for information on the calculation of the maximum frame rate.

4.3.3 Linehopping

Linehopping is another possibility to increase the frame rate. It transfers every n^{th} row of an image and thus reduces the image height by factor n. Line hopping can also be used together with ROI or MROI.

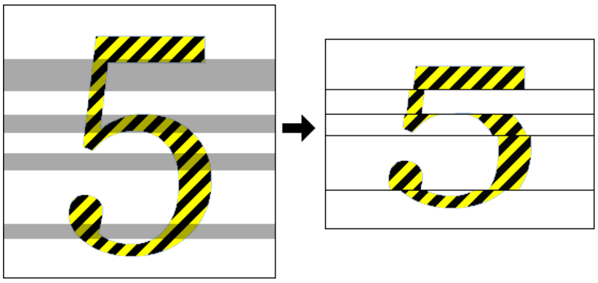


Figure 4.7: Multiple Regions of Interest

4.4 Trigger modes

With a trigger signal the acquisition of an image can be synchronised with an external event. This trigger signal can be either generated by the frame grabber itself or it can be generated by an external source such as a light barrier.
For the MV-D1024 cameras, there are 3 different trigger modes available:

Exsync Trigger Mode In this trigger mode the camera is configured with a certain exposure time. A trigger pulse starts the acquisition of an image.

Start/Stop Trigger Mode This trigger mode uses two trigger signals: The first one starts the acquisition of an image, the second signal stops it. Thus, the exposure time is set by the delay between the the two trigger signals.

ExSync/Exposure Trigger Mode In this trigger mode a trigger pulse starts the acquisition of an image as in the Exsync trigger mode, but in addition the width of the trigger pulse also controls the length of the exposure time.

For more information and the respective timing diagrams see Section 5.4.

4.5 Operating Modes

4.5.1 Camera as Master

By default, the camera is master and the frame grabber is slave. This means that the camera generates the pixel clock and transfers it to the frame grabber.

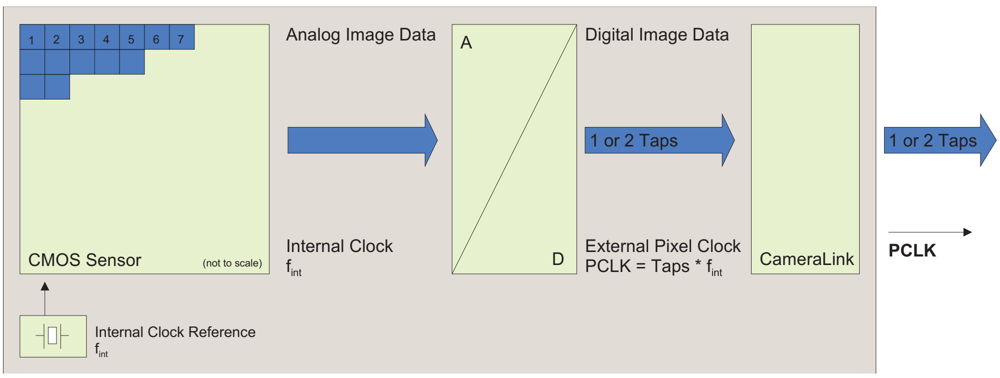


Figure 4.8: Default operation mode: Camera is master

4.5.2 Camera as Slave (MCLK mode)

For certain applications the camera can be set in a slave mode (also called "master clock mode", MCLK mode). In this case, the frame grabber is master and provides the pixel clock. Examples of using the camera in slave mode are:

- OEM applications using a custom-defined pixel clock
- Low jitter synchronisation of two or more cameras (e.g. stereo vision)

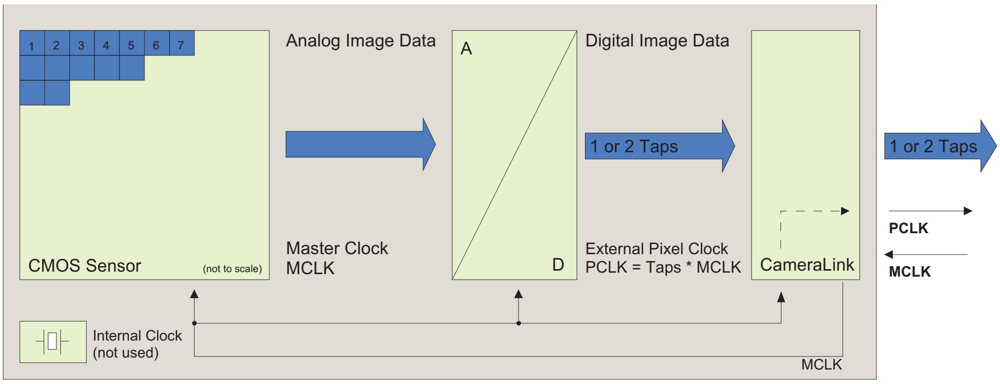


Figure 4.9: Master Clock operation mode: pixel clock is provided externally

Please see Section 5.5 for more details about using the camera in MCLK mode.

4.6 CameraLink Serial Interface

A CameraLink camera can be controlled by the user via an RS232 compatible asynchronous serial interface. This interface is contained within the CameraLink interface as shown in Fig. 4.10 and is physically not directly accessible. Instead, the serial communication is usually routed through the frame grabber. For some frame grabbers it might be necessary to connect a serial cable from the frame grabber to the serial interface of the PC.

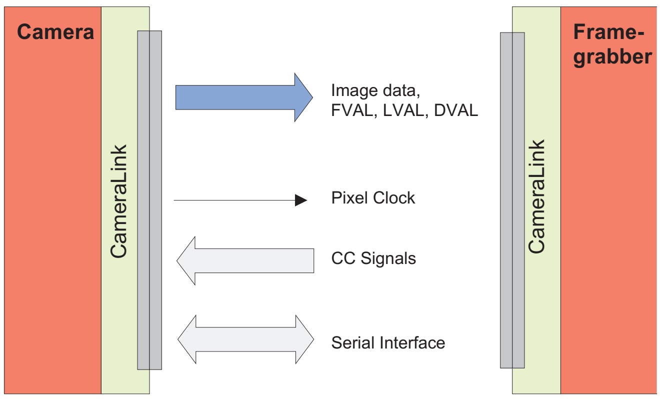


Figure 4.10: CameraLink serial interface for camera communication

To interface different cameras to different frame grabbers, the CameraLink standard defines a software API. It defines how the functions to initialise, read from, write to and close the serial interface should look. The code behind these functions is frame grabber specific and is written

by the frame grabber manufacturer. The functions are then compiled into a DLL called `clserXXX.dll`, where `XXX` is a unique identifier for the frame grabber manufacturer.
The PFRemote camera configuration tool as well as the PFLib API use the serial interface to communicate with the camera and to control its functions. The serial interface is accessed via the `clserXXX.dll`. Therefore, the appropriate `clserXXX.dll` for the frame grabber manufacturer needs to be in the same directory as the PFRemote executable (e.g. `C:\Program Files\PFRemote`). This DLL is usually located in the `windows\system32` directory after installing the frame grabber driver.
The serial configuration parameters are defined in the CameraLink standard and are as follows: 9600 baud, 1 start bit, 1 stop bit, no parity, no handshaking.

5

Hardware Interface

5.1 Connectors

The MV-D1024 cameras are interfaced to external components via

- a CameraLink connector
- a connector for the power supply.

The connectors are located on the back of the camera. Fig. 5.1 shows the plugs and the status LED which indicates camera operation.

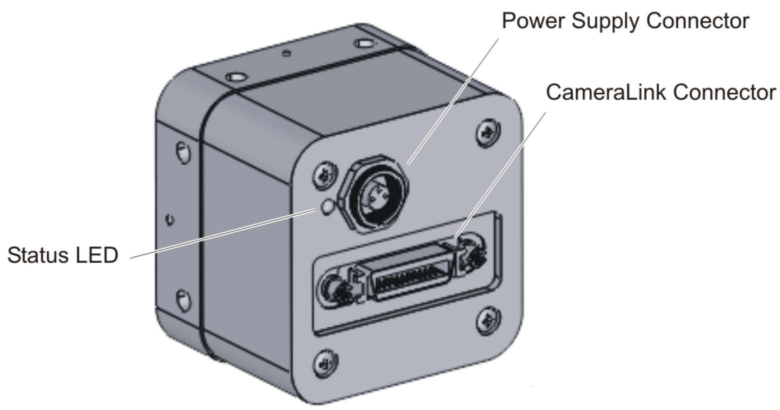


Figure 5.1: Rear view of the camera

5.1.1 CameraLink Connector

The CameraLink interface and connector are specified in [CL, CameraLink Specification]. For further details including the pinout please refer to Appendix 11. This connector is used to transmit configuration, image data and trigger signals.

5.1.2 Power Supply

The camera requires a single voltage input (see Table 3.3). The camera meets all performance specifications using standard switching power supplies, although well-regulated linear supplies provide optimum performance.

It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages will damage the camera.

A suitable power supply is available from Photonfocus.

For further details including the pinout please refer to Appendix 11.

5.1.3 Status Indicator

A status LED on the back of the camera gives information about the status of the camera.

Red LED The status LED is red when the serial communication is active.

Green LED The LED shows a green light while an image is read out. The LED blinks with the frame rate, however at high frame rates the LED changes to an apparently continuous green light, with intensity proportional to the ratio of readout time over frame time.

☞ For relatively long frame times and very small ROI settings the green pulse of the LED might be too short to be visible in daylight conditions, even if the camera is working properly.

When the camera is in default mode, the LED is red for a short time after the power has been switched on and then flickers with the frame rate.

5.2 CameraLink Data Interface

The CameraLink standard contains signals for transferring the image data, control information and the serial communication.

Data signals CameraLink data signals contain the image data. Depending on the MV-D1024 camera model, one or two taps with variable bit resolution are used to send the image data from the camera to the frame grabber. In addition, handshaking signals such as `FVAL`, `LVAL` and `DVAL` are transmitted over the same physical channel.

Camera control information Camera control signals (CC-signals) can be defined by the camera manufacturer to provide certain signals to the camera. There are 4 CC-signals available and all are unidirectional with data flowing from the frame grabber to the camera. For example, the external trigger is provided by a CC-signal (see Table 5.1 for the CC assignments of the MV-D1024 cameras).

`CC1`	`EXSYNC`	External Trigger. May be generated either by the frame grabber itself (software trigger) or by en external event (hardware trigger).
`CC2`	`MCLK`	Master Clock. By default, the camera generates its own pixel clock. However, when running in Master Clock mode, the frame grabber provides the pixel clock for the camera via `CC2`. For further details please refer to Section 5.5.
`CC3`	`CTRL`	Control. This signal is reserved for future purposes and is not used.
`CC4`	`EXPOSURE`	Is used in Start/Stop external trigger mode. The `EXSYNC` signal (`CC1`) marks the beginning of the exposure time, while the `SYNC` signal (`CC4`) defines the end of the exposure time.

Table 5.1: Summary of the Camera Control (CC) signals as used by Photonfocus

Pixel clock The pixel clock is generated by default on the camera and is provided to the frame grabber for synchronisation. In the master clock mode (MCLK, Section 5.5), the pixel clock can be provided externally.

Serial communication A CameraLink camera can be controlled by the user via an RS232 compatible asynchronous serial interface. This interface is contained within the CameraLink interface and is physically not directly accessible. Refer to Section 4.6 for more information.

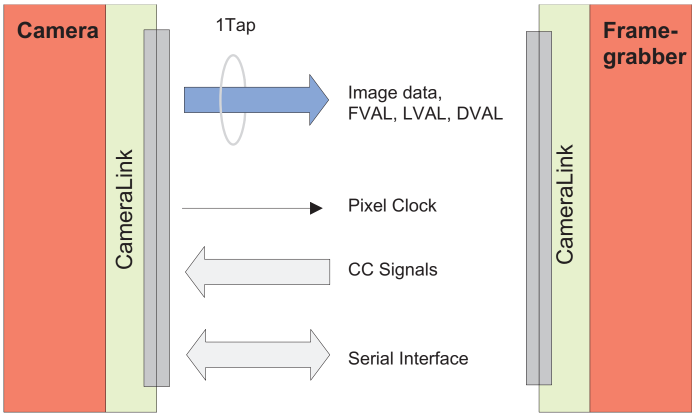


Figure 5.2: 1-tap CameraLink system

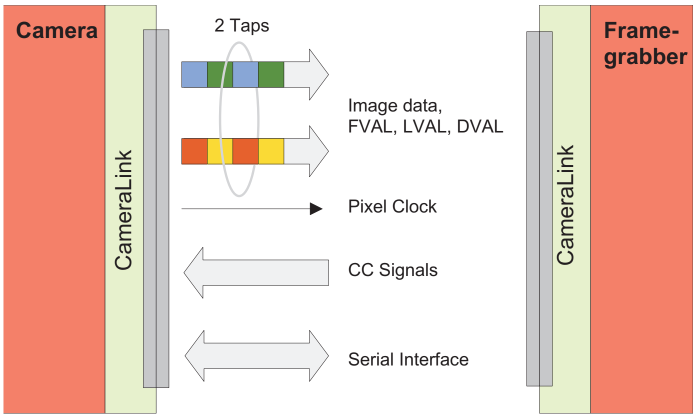


Figure 5.3: 2-tap CameraLink system

The frame grabber needs to be configured with the proper tap and resolution settings, otherwise the image will be distorted or not displayed with the correct aspect ratio. Refer to Section 3.4 for a summarised table of frame grabber relevant specifications. Fig. 5.2 and Fig. 5.3 show symbolically a 1-tap and a 2-tap system. For more information about taps refer to [AN021, CameraLink].

5.3 Read-out Timing

5.3.1 Standard Read-out Timing

By default, the camera is in free running mode and delivers images with a pre-configured frame rate without any external control signals. The sensor is always operated in non-interleaved mode, which means that the sensor is read out after the preset exposure time. Then the sensor is reset, a new exposure starts and the readout of the image information begins again. The data is output on the rising edge of the pixel clock. The signals `FRAME_VALID`

(FVAL) and LINE_VALID (LVAL) mask valid image information. The signal SHUTTER indicates the active integration phase of the sensor and is shown for clarity only.
Fig. 5.4 visualises the timing behaviour of the control and data signals.

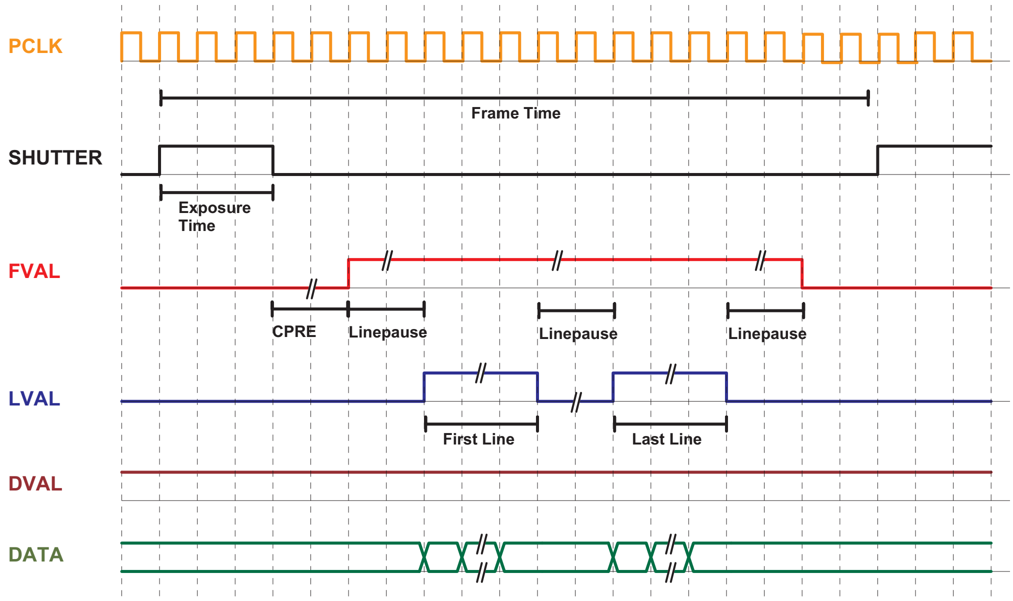


Figure 5.4: Timing diagram frame read-out

Frame time	Maximum frame time is defined as exposure time plus data read out time.
Exposure time	Period during which the pixels are integrating the incoming light.
PCLK	Pixel clock on CameraLink interface.
SHUTTER	Internal signal, shown only for clarity. Is 'high' during the exposure time, during which the pixels integrate the incoming light and the image is acquired. The actual exposure starts 4 clocks after the SHUTTER signal transition.
FVAL (Frame Valid)	Is 'high' while the data of one whole frame are transferred.
LVAL (Line Valid)	Is 'high' while the data of one line are transferred. Example: To transfer an image with 640x480 pixels, there are 480 LVAL within one FVAL active high period. One LVAL lasts 640 pixel clock cycles.
DVAL (Data Valid)	Is 'high' while data are valid.
DATA	Transferred pixel values. Example: For a 1024x1024 pixel image, there are 1024 values transferred within one LVAL active high period, or 1024*1024 values within one FVAL period.
Line pause	A programmable delay before the first line and after every following line when reading out the image data. A small line pause is needed for correct sensor operation. Set by default to 8 clock cycles; typically does not need to be adjusted by the user. See also Section 4.3.1.

Table 5.2: Explanation of control and data signals used in the timing diagram

5.3.2 Constant Frame Rate (CFR)

When the camera is in constant frame rate mode, the frame rate can be varied from almost 0 up to the maximum frame rate. Thus, fewer images can be acquired than determined by the frame time. If the exposure and read-out time are smaller than the configured frame time, the camera waits in an idle mode until the frame time has elapsed (see `VBlank` in Fig. 5.5).

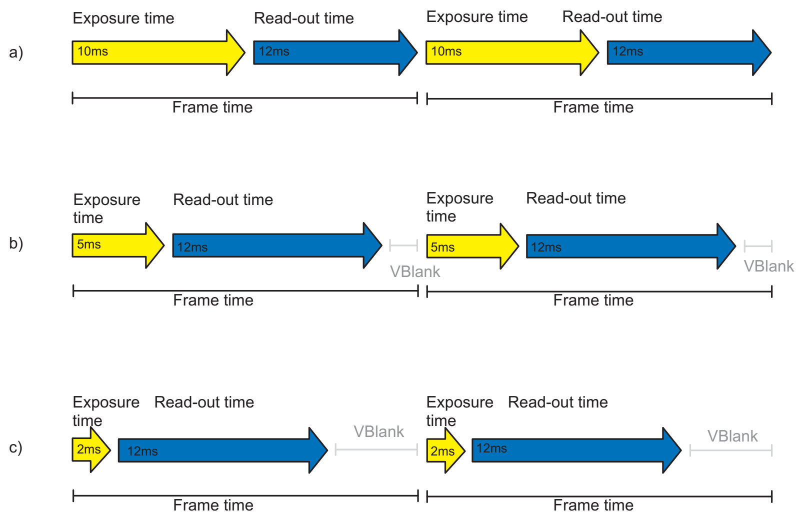


Figure 5.5: Constant Frame Rate = ON

On the other hand, if constant frame rate is switched off, the camera outputs images with maximum speed, depending on the exposure time and the read-out time. The frame rate depends directly on the exposure time. When using an external trigger, please see Section 5.4.5.

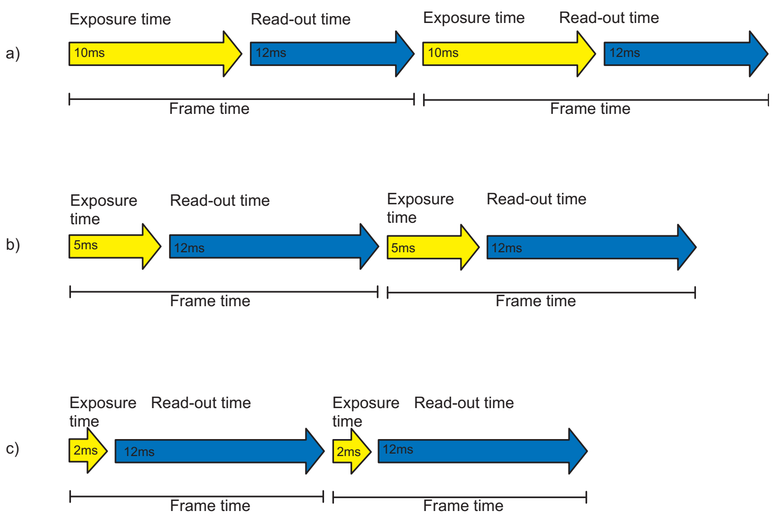


Figure 5.6: Constant Frame Rate = OFF

5.4 Trigger

5.4.1 Overview

A trigger is an event that starts an exposure. The trigger signal is either generated on the frame grabber (soft-trigger) or comes from an external device such as a light barrier.
For MV-D1024 cameras, there are three different trigger modes available. The trigger signal ExSync must be routed by the frame grabber on CC1. One of the trigger modes uses an additional signal called EXPOSURE, which must be provided on CC3.

1. Trigger ExSync: The exposure is started with an edge of the ExSync signal. The length of the exposure is defined by the exposure time preset in the camera.
2. Trigger Start/Stop: The exposure is started with an edge of the ExSync signal and stopped with the following edge of the EXPOSURE signal.
3. Trigger Exposure: The exposure is started with an edge of the ExSync signal. The width of the ExSync pulse gives the exposure time.

The polarity of the ExSync and Sync signals can be configured to be either active high (default) or active low. Fig. 5.7 gives a summary of the available trigger modes.

	Polarity Active High		Polarity Active Low	
	Exposure Start	**Exposure Stop**	**Exposure Start**	**Exposure Stop**
① **Trigger ExSync**	↑ ExSync	Software	↓ ExSync	Software
② **Trigger Start/Stop**	↑ ExSync	↑ Exposure	↓ ExSync	↓ Exposure
③ **Trigger Exposure**	↑ ExSync	↓ ExSync	↓ ExSync	↑ ExSync

↑ Rising Edge
↓ Falling Edge

Figure 5.7: Trigger Overview

In the following sections, the timing of these three trigger modes is explained for active high polarity, which is the default mode.

5.4.2 Trigger ExSync

In the ExSync trigger mode the image acquisition begins with the rising edge (active high) of an external trigger pulse. The image is read out after the pre-set exposure time. After readout, the sensor returns to the reset state and the camera waits for a new trigger pulse.
The data is output on the rising edge of the pixel clock, the CameraLink handshaking signals FRAME_VALID (FVAL) and LINE_VALID (LVAL) mask valid image information. The signal SHUTTER in Fig. 5.8 indicates the active integration phase of the sensor and is shown for clarity only.

5.4.3 Trigger Start/Stop

In the Start/Stop trigger mode the exposure time is determined by the signals ExSync and Sync as shown in Fig. 5.9.
The sensor is reset with the rising edge of an external trigger pulse (active high) and the exposure of the image begins. If necessary, the polarity can be changed to be active low. The integration ends with the rising edge of the external signal SYNC. The image is read out after the exposure time has elapsed. After readout, the sensor returns to the reset state and the

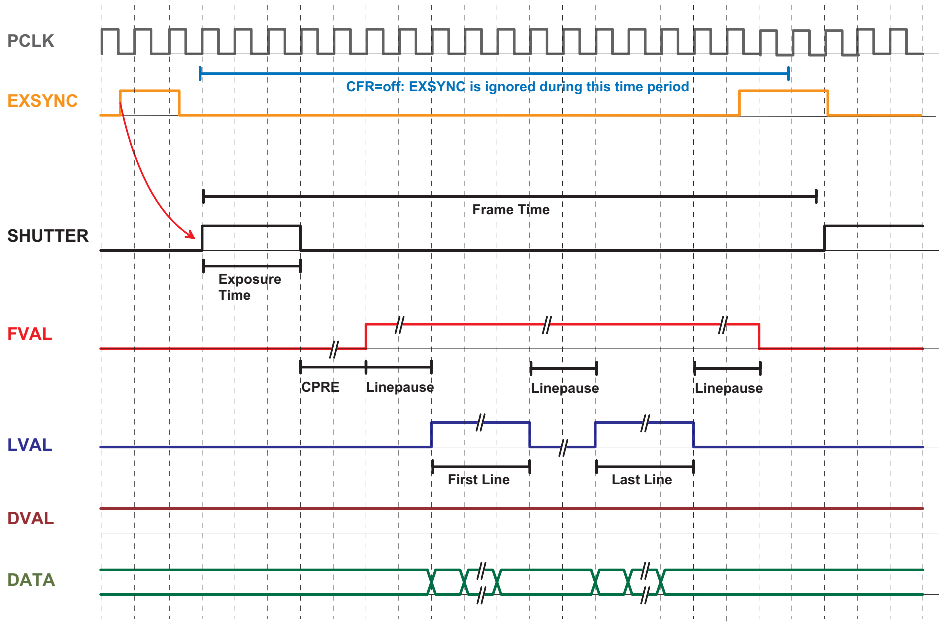


Figure 5.8: Trigger ExSync Timing diagram

camera waits for a new trigger pulse. The data is output on the rising edge of the pixel clock. The CameraLink signals `FRAME_VALID` (`FVAL`) and `LINE_VALID` (`LVAL`) mask valid image information. The signal `SHUTTER` indicates the active integration phase of the sensor and is shown for clarity only.

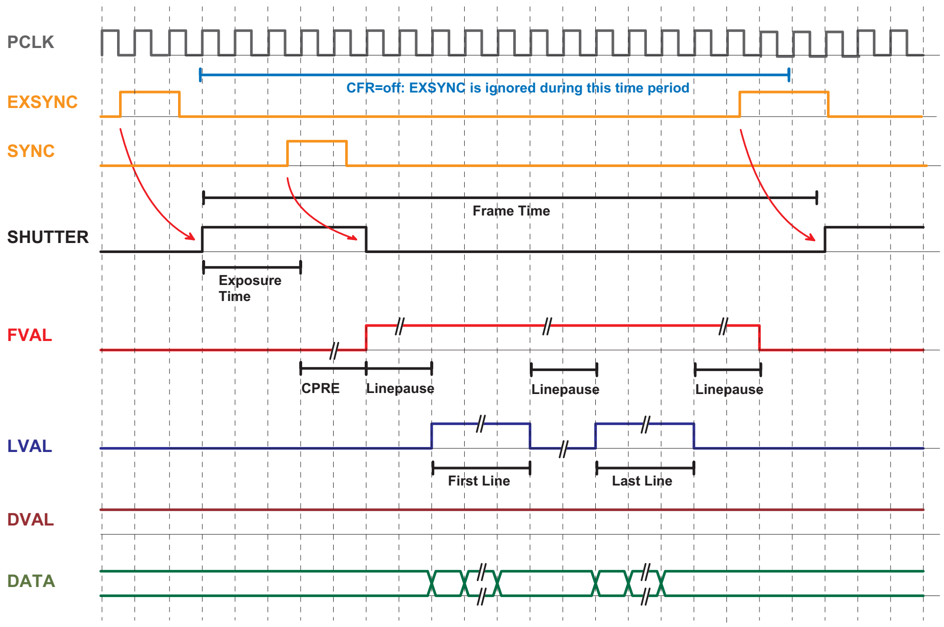


Figure 5.9: Trigger Start/Stop Timing diagram

5.4.4 Trigger ExSync/Exposure

In the ExSync-Exposure trigger mode, the sensor is reset with the rising edge of an external trigger pulse EXSYNC and the exposure of the image begins. If necessary, the polarity can be changed to be active low. The integration ends with the falling edge of the EXSYNC signal. The signal EXSYNC is clocked in the sensor control in such a way that the internal exposure control becomes active one clock cycle later (see SHUTTER signal).
The image is read out after the exposure time has elapsed. After readout, the sensor returns to the reset state and the camera waits for a new trigger pulse. The data is output on the rising edge of the pixel clock. The CameraLink signals FRAME_VALID (FVAL) and LINE_VALID (LVAL) mask valid image information. The signal SHUTTER indicates the active integration phase of the sensor and is shown for clarity only.

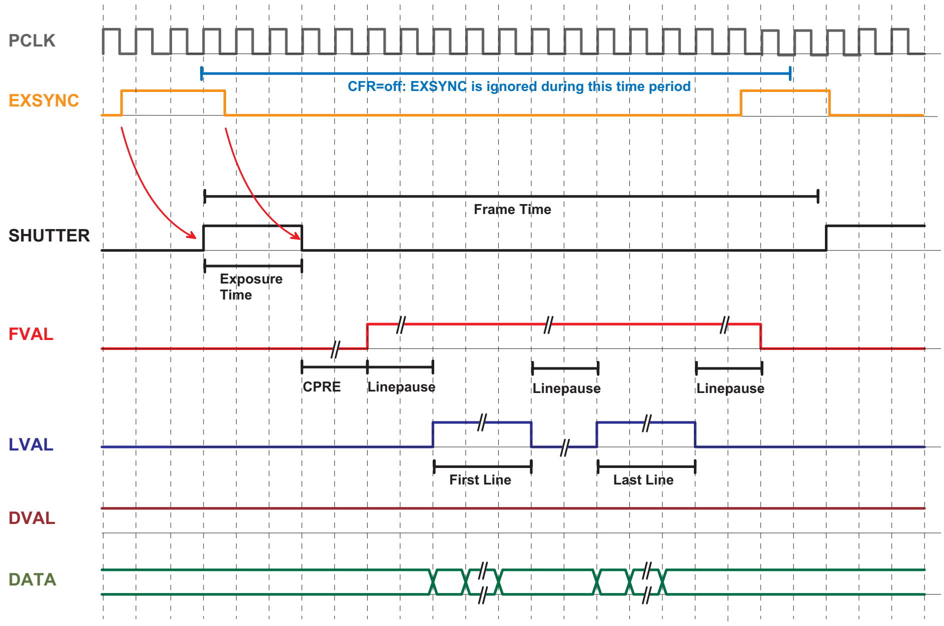


Figure 5.10: Trigger ExSync/Exposure Timing diagram

5.4.5 Notes on using External Trigger

Synchronous and Asynchronous Reset

The 'Constant Frame Rate' (CFR) mode has a second meaning when used in triggered mode.

Synchronous Reset_table	CFR = on	The camera delivers images with a constant frame rate as defined by the configured frame time. If the trigger frequency exceeds the maximum frame rate, the excess trigger pulses are discarded.
Asynchronous Reset_table	CFR = off	Excess trigger pulses are not blocked, and the camera can be used in an asynchronous reset mode. If a trigger pulse arrives during the read-out time, the camera completes the output of the current line, and then immediately starts a new exposure. This means that not the full image will arrive at the frame grabber.

Table 5.3: Synchronous and asynchronous reset configuration

LinLog

Full LinLog functionality is only available in the ExSync trigger mode (see Section 5.4.2).

The reason is that the parameter `COMP` depends on the length of the exposure time. When the exposure time is determined by external parameters such as the length of the trigger pulse, the camera cannot set the `COMP` parameter correctly. However, basic LinLog functionality (LinLog1, with `COMP` and `LL2` set to zero) is available in all trigger modes.

Trigger Delay

The total delay between the trigger edge and the camera exposure consists of the delay in the frame grabber and the camera (Fig. 5.11). Usually, the delay in the frame grabber is relatively large to avoid accidental triggers caused by voltage spikes (see Fig. 5.12).

For the delay in the frame grabber, please ask your frame grabber manufacturer. The camera delay consists of a constant trigger delay and a variable delay (jitter). Refer to Table 5.4 for the model-specific values.

Camera Model	Camera Trigger Delay (constant)	Max. Camera Trigger Jitter
MV-D1024-28	210 ns	35 ns
MV-D1024-80	300 ns	50 ns
MV-D1024-160	150 ns	25 ns

Table 5.4: Maximum camera trigger delay for the MV-D1024 series

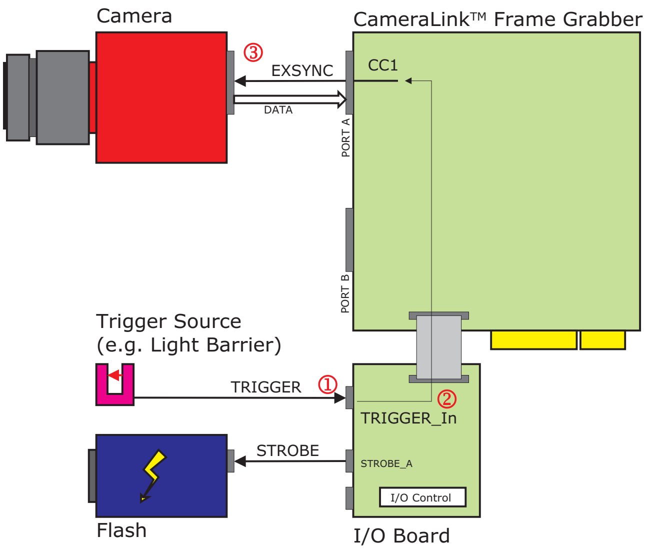


Figure 5.11: Trigger Delay visualisation from the trigger source to the camera

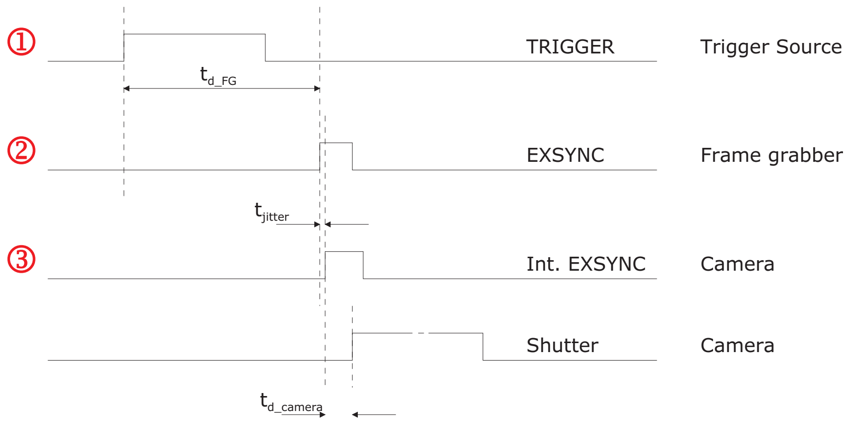


Figure 5.12: Timing Diagram for Trigger Delay

5.5 Master Clock

By default, the camera generates the pixel clock and provides it to the frame grabber for synchronisation. For certain applications it may be helpful to put the camera into a slave mode and provide it with an external pixel clock (see Section 4.5). As an example, the camera could be used in MCLK mode in order to interface it to a special pixel clock frequency. Another example would be a highly synchronous stereo vision application, where a common clock is provided to 2 or more cameras.

☞ The maximum MCLK is given by the CameraLink pixel clock frequency divided by the number of taps. The lower limit of the MCLK frequency is given by the CameraLink specification. Please see [AN010, Camera Clock Concepts] and [AN007, Camera Acquisition Mode] for more information.

The upper and lower MCLK limit depends on the camera model. Please see Table 3.2 for the specification.

6

The PFRemote Control Tool

6.1 Overview

PFRemote is a graphical configuration tool for Photonfocus cameras. The latest release can be downloaded from the support area of www.photonfocus.com.
All Photonfocus cameras can be either configured by PFRemote, or they can be programmed with custom software using the PFLib SDK ([PFLIB]).

6.1.1 CameraLink Model

As shown in Fig. 6.1, the camera parameters can be controlled by PFRemote and PFLib respectively. To grab an image use the software or the SDK that was delivered with your frame grabber.

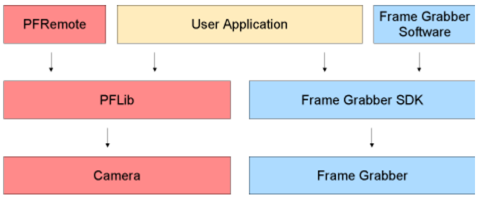


Figure 6.1: PFRemote and PFLib in context with the CameraLink frame grabber software

6.1.2 USB 2.0 Model

For the USB camera model, there is no external frame grabber necessary, as the camera connects directly to the USB 2.0 port. Instead, the frame grabber functionality was transferred into the camera.
As shown in Fig. 6.2, the camera parameters can be controlled by PFRemote and PFLib respectively. To grab an image use the MicroDisplayUSB software or the USB SDK.

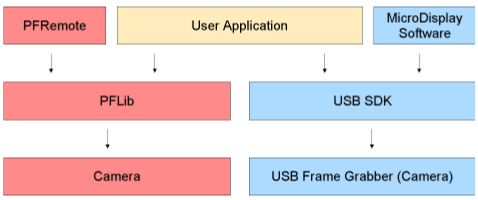


Figure 6.2: PFRemote and PFLib in context with the USB 2.0 frame grabber software

The USB isochronous interface mode (fast mode 48 MBytes/sec) works only with Windows XP and ServicePack 2 and an Intel Chipset!

6.2 Operating System

The PFRemote GUI is available for Windows OS only. For Linux or QNX operating systems, we provide the necessary libraries to control the camera on request, but there is no graphical user interface available.

If you require support for Linux or QNX operating systems, you may contact us for details of support conditions.

6.3 Installation Notes

For CameraLink Cameras: Before installing the required software with the PFInstaller, make sure that your frame grabber software is installed correctly.

For USB Cameras: Before installing the required software to control a Photonfocus camera with USB 2.0 interface, make sure that no USB camera is connected to the computer.

- During PFinstaller installation, choose "Install PFRemote with USB environment".
- After the installation, power on the camera and connect it to the USB interface.
- Windows should display the "New Hardware found" wizard automatically. If this wizard is not displayed, please continue as described in the following section.
- Let the hardware wizard install the drivers. It is not necessary to allow the search for current and updated software on the Internet. Proceed by choosing the option "Install the software automatically (Recommended)". Another hardware installation message will appear, which can be ignored ("Continue Anyway").

  The procedure described above applies to Windows XP and Service pack 2.

6.3.1 Manual Driver Installation (only USB 2.0 Model)

If Windows did not automatically install the driver for your USB camera, please proceed as follows:

- Open the Device Manager in the Windows Control Panel.
- There will be an unknown device called "Silicon Software GmbH microUSB2".
- Right click on the unknown device and choose "Update driver".
- The hardware update wizard will appear. It is not necessary to allow the search for current and updated software on the internet. Click on "No, not this time" and "Next".
- Then choose "Install the software automatically (Recommended)" and proceed with "Next".
- When you get asked about the driver location, specify `\Photonfocus\microDisplayUSB\driver`.

  ☞ This procedure applies to Windows XP and Service pack 2.

6.3.2 DLL Dependencies

Several DLLs are necessary in order to be able to communicate with the cameras:

- `PFCAM.DLL`: The main DLL file that handles camera detection, switching to specific camera DLL and provides the interface for the SDK.
- `'CAMERANAME'.DLL`: Specific camera DLL, e.g. mv_d1024e_40.dll.
- `COMDLL.DLL`: Communication DLL. This COMDLL is not necessarily CameraLink specific, but may depend on a CameraLink API compatible DLL, which should also be provided by your frame grabber manufacturer.
- `CLALLSERIAL.DLL`: Interface to CameraLink frame grabber which supports the clallserial.dll.
- `CLSER_USB.DLL`: Interface to USB port.

More information about these DLLs is available in the SDK documentation [SW002].

6.4 Graphical User Interface (GUI)

PFRemote consists of a main window (Fig. 6.3) and a configuration dialog. In the main window, the camera port can be opened or closed, and log messages are displayed at the bottom. The configuration dialog appears as a sub window as soon as a camera port was opened successfully. In the sub window of PFRemote the user can configure the camera properties. The following sections describe the general structure of PFRemote.

6.4.1 Port Browser

On start, PFRemote displays a list of available communication ports in the main window.

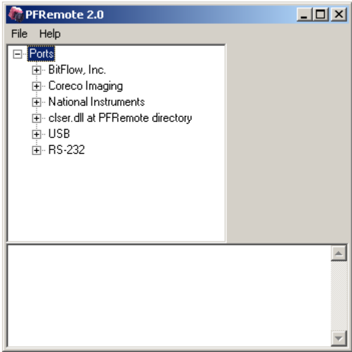


Figure 6.3: PFRemote main window with PortBrowser and log messages

To open a camera on a specific port double click on the port name (e.g. USB). Alternatively right click on the port name and choose **Open & Configure...**. The port is then queried for a compatible Photonfocus camera.
In the PFRemote main window, there are two menus with the following entries available:

File Menu

Clear Log: Clears the log file buffer

Quit: Exit the program

Help Menu

About: Copyright notice and version information

Help F1: Invoke the online help (PFRemote documentation)

6.4.2 Ports, Device initialization

After starting **PFRemote**, the main window as shown in Fig. 6.3 will appear. In the PortBrowser in the upper left corner you will see a list of supported ports.

Depending on the configuration, your port names may differ, and not every port may be functional.

If your frame grabber supports clallserial.dll version 1.1 (CameraLink compliant standard Oct 2001), the name of the manufacturer is shown in the PortBrowser.

If your frame grabber supports clallserial.dll version 1.0 (CameraLink compliant standard Oct 2000), the PortBrowser shows either the name of the dll or the manufacturer name or displays "Unknown".

If your frame grabber doesn't support clallserial.dll, copy the clserXXXX.dll of your frame grabber in the PFRemote directory and rename it to clser.dll. The PortBrowser will then indicate this DLL as "clser.dll at PFRemote directory".

After connecting the camera, the device can be opened with a double click on the port name or by right-clicking on the port name and choosing **Open & Configure**. If the initialisation of the camera was successful, the configuration dialog will open. The device is closed when PFRemote is closed. Alternatively, e.g. when connecting another camera or evaluation kit, the device can also be closed explicitely by right clicking on the port name and choosing **Close**. Make sure that the configuration dialog is closed prior to closing the port.

Errors, warnings or other important activities are logged in a log window at the bottom of the main window.

If the device does not open, check the following:

- Is the power LED of the camera active? Do you get an image in the display software of your frame grabber?
- Verify all cable connections and the power supply.
- Check the communication LED of the camera: do you see some activity when you try to access the camera?

6.4.3 Main Buttons

The buttons on the right side of the configuration dialog store and reset the camera configuration.

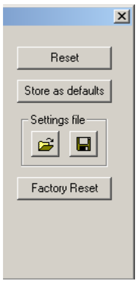


Figure 6.4: Main buttons

Reset: Reset the camera and load the default configuration.

Store as defaults: Store the current configuration in the camera flash memory as the default configuration. After a reset, the camera will load this configuration by default.

Settings file - File Load: Load a stored configuration from a file.

Settings file - File Save: Save current configuration to a file.

Factory Reset: Reset camera and reset the configuration to the factory defaults.

6.5 Device properties

Cameras or sensor devices are generally addressed as 'device' in this software. These devices have properties that are accessed by a property name. These property names are translated into register accesses on the driver DLL. The property names are reflected in the GUI as far as practicable. A property name normally has a special mark up throughout this document, for example: `ExposureTime`. Some properties are grouped into a structure whose member is accessed via dot notation, e.g. `Window.X` (for the start X value of a region of interest). When changing a property, the property name can always be seen in the log window of the main program window.

7

GUI

7.1 MV-D1024 - SERIES (-28, -80, -160)

This section describes the parameters of the following cameras.

- MV-D1024-28-CL
- MV-D1024-80-CL, MV-D1024-Track
- MV-D1024-160-CL

The following sections are grouped according to the tabs in the configuration dialog.

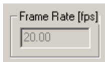


Figure 7.1: MV-D1024-SERIES frame rate and average value

Frame Rate [fps :] Show the actual frame rate of the camera in frames per second.

7.1.1 Exposure

This tab contains exposure and trigger settings.

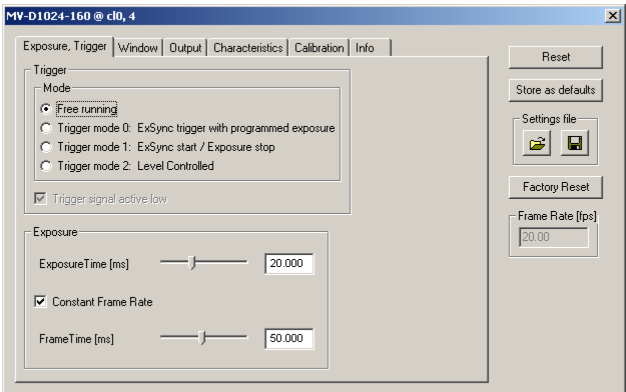


Figure 7.2: MV-D1024-SERIES exposure panel

Trigger

Free running: The camera continuously delivers images with a certain configurable frame rate.

Trigger mode 0: ExSync trigger with programmed exposure: External trigger with programmed exposure time.

Trigger mode 1: ExSync start / Exposure stop: External trigger start exposure time, Exposuretrigger stop exposure time (this feature of the trigger mode is not supported by the MV-D1024-Track).

Trigger mode 2: Level Controlled: Exposure time by length of trigger pulse. When set, the active trigger edge starts exposure and the inactive edge stops exposure.

Trigger signal active low: Define the trigger signal to be active high (default) or active low.

Exposure

Exposure time [ms :] Configure the exposure time in milliseconds.

Constant Frame Rate: When the Constant Frame Rate is switched on, the frame rate (number of frames per second) can be varied from almost 0 up to the maximum frame rate. Thus, fewer images can be acquired than would otherwise be possible. When Constant Frame Rate is switched off, the camera delivers images as fast as possible, depending on the exposure time and the read-out time.

Frame time [ms :] Configure the frame time in milliseconds. Only available if Constant Frame Rate is enabled. The exposure time sets the minimum frame time.

7.1.2 Window

This tab contains ROI, multi-ROI and decimation settings.

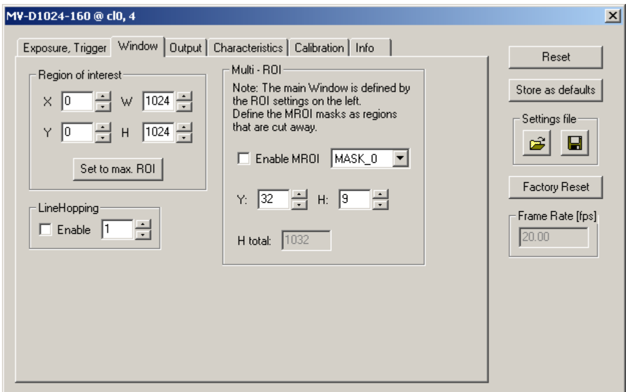


Figure 7.3: MV-D1024-SERIES window panel

Region of Interest

The region of interest (ROI) is defined as a rectangle (X, Y), (W, H) where

X: X - coordinate, starting from 0 in the upper left corner.

Y: Y - coordinate, starting from 0 in the upper left corner.

W: Window width.

H: Window height.

Set to max ROI: Set Window to maximal ROI (X=0; Y=0; W=1024; H=1024).

LineHopping

`LineHopping` reduces the number of pixels in y-direction. LineHopping can also be used together with a ROI or MROI. LineHopping transfers every n-th row only and directly results in reduced read-out time and higher frame rate respectively.

Enable: Enable decimation in x-direction.

Value: LineHopping factor. Example: Value = 4 reads every fourth line only.

Multi - ROI

The MV-D1024 camera series can handle up to 17 different regions of interest. Overlapping windows are not allowed. The maximum frame rate in MROI mode depends on the number of rows and columns being read out.

Enable MROI: Enable MROI. If MROI is enabled, the ROI and MROI settings cannot be changed.

MASK_X: Select one of the MROI window.

Y: Y - coordinate of the selected MROI. If Y is set to 1023, this and all further MROI settings will be ignored.

H: Height of the selected MROI.

H tot: Shows the sum of all MROIs as the total image height.

☞ After changing a property, always press Enter in order to make the change active.

7.1.3 Output for MV-D1024-28-CL

This tab contains image data settings of the MV-D1024-28-CL.

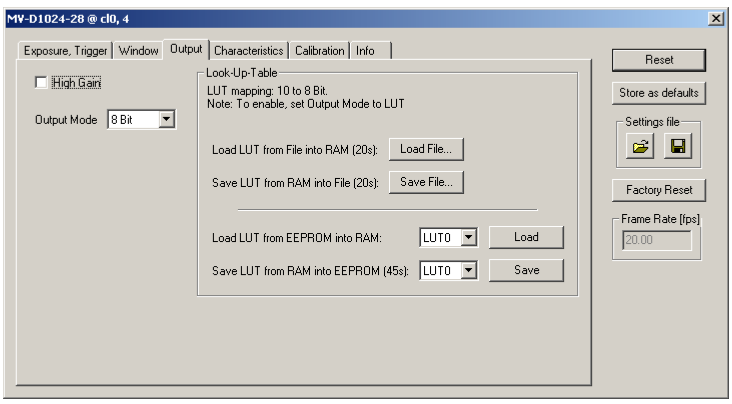


Figure 7.4: MV-D1024-28-CL output panel

Output Mode

High Gain: Increases the gain in the analog path by a factor 4 and thus makes the camera more sensitive.

Output Mode:

8 Bit: Normal mode, gray level resolution of 8 bit.

LUT: Look-Up-Table, a 10-to-8-bit mapping of gray levels.

10 Bit: Gray level resolution of 10 bit.

LFSR: Test image. Linear feedback shift register (pseudo-random image). The pattern depends on the gray level resolution.

Look-Up-Table

Gray level transformation is remapping of the gray level values of an input image to new values which transform the image in some way. The look-up-table (LUT) is used to convert the grayscale value of each pixel in an image into another gray value. It is typically used to implement a transfer curve for contrast expansion.
The MV-D1024-28-CL camera performs a 10-to-8-bit mapping, so that 1024 input gray levels can be mapped to 256 output gray levels (0 to 1023 and 0 to 255).
This camera can save 2 different LUT's in the EEPROM. The LUT in the RAM is the active one.
Buttons:

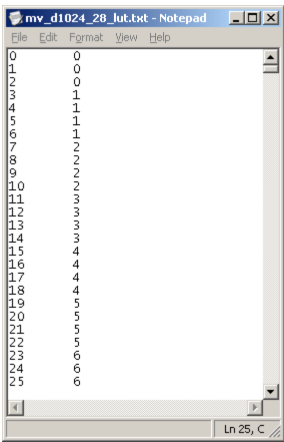
Load File...: Load a user defined LUT - file (*.txt tab delimited) into the RAM of the camera. There is an example in the PFRemote directory (mv_d1024_28_lut.txt).

Save File...: Save the current LUT from RAM into a file (*.txt tab delimited).

Load: Load selected LUT from EEPROM into RAM.

Save: Save selected LUT into EEPROM.

Example of a user defined LUT file:



0	0
1	0
2	0
3	1
4	1
5	1
6	1
7	2
8	2
9	2
10	2
11	3
12	3
13	3
14	3
15	4
16	4
17	4
18	4
19	5
20	5
21	5
22	5
23	6
24	6
25	6

Figure 7.5: Example of a user defined LUT file for MV-D1024-28-CL

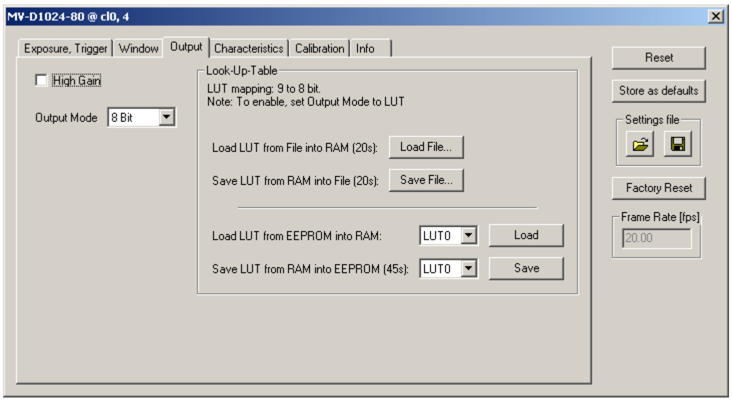


Figure 7.6: MV-D1024-80-CL output panel

7.1.4 Output for MV-D1024-80-CL

This tab contains image data settings of the MV-D1024-80-CL.

Output Mode

High Gain: Increases the gain in the analog path by a factor 4 and thus makes the camera more sensitive.

Output Mode:

8 Bit: Normal mode, gray level resolution of 8 bit.

Gain 2X: Digital gain 2.

LUT: Look-Up-Table, a 9-to-8-bit mapping of gray levels.

LFSR: Test image. Linear feedback shift register (pseudo-random image). The pattern depends on the gray level resolution.

Look-Up-Table

Gray level transformation is remapping of the gray level values of an input image to new values which transform the image in some way. The look-up-table (LUT) is used to convert the grayscale value of each pixel in an image into another gray value. It is typically used to implement a transfer curve for contrast expansion.
The MV-D1024-80-CL camera performs a 9-to-8-bit mapping, so that 512 input gray levels can be mapped to 256 output gray levels (0 to 511 and 0 to 255).
This camera can save 4 different LUT's in the EEPROM. The LUT in the RAM is the active one.
Buttons:

Load File...: Load a user defined LUT - file (*.txt tab delimited) into the RAM of the camera. There is an example in the PFRemote directory (mv_d1024_80_lut.txt).

Save File...: Save the current LUT from RAM into a file (*.txt tab delimited).

Load: Load selected LUT from EEPROM into RAM.

Save: Save selected LUT into EEPROM.

Example of a user defined LUT file:

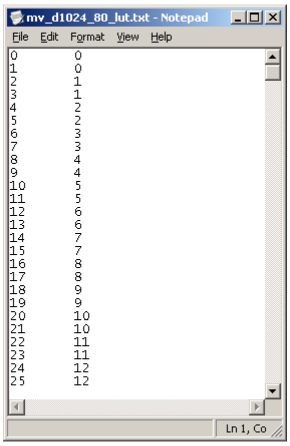


Figure 7.7: Example of a user defined LUT file for MV-D1024-80-CL

7.1.5 Output for MV-D1024-160-CL

This tab contains image data settings of the MV-D1024-160-CL.

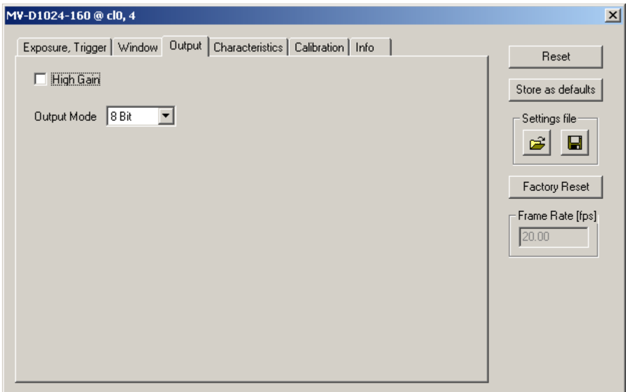


Figure 7.8: MV-D1024-160-CL output panel

Output Mode

High Gain: Increases the gain in the analog path by a factor 4 and thus makes the camera more sensitive.

Output Mode:

8 Bit: Normal mode, gray level resolution of 8 bit.

LFSR: Test image. Linear feedback shift register (pseudo-random image). The pattern depends on the gray level resolution.

7.1.6 Characteristics

This tab contains LinLog and Skimming settings.

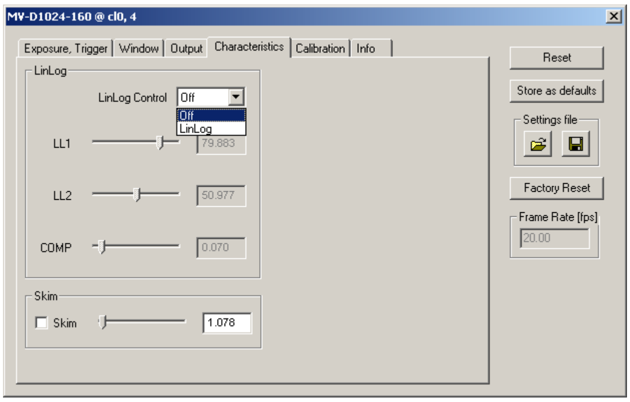


Figure 7.9: MV-D1024-SERIES characteristics panel

LinLog

The LinLog technology from Photonfocus allows a logarithmic compression of high light intensities. In contrast to the classical non-integrating logarithmic pixel, the LinLog pixel is an integrating pixel with global shutter and the possibility to control the transition between linear and logarithmic mode (Section 4.2.2). There are 3 predefined LinLog settings available. Alternatively, custom settings can be defined in the `User defined` Mode.

LinLog Control: Off: LinLog is disabled. LinLog: LinLog feature is enabled.

LL1: LinLog Value 1. The higher this value, the stronger the compression.

LL2: LinLog Value 2. The higher this value, the stronger the compression.

COMP: COMP is a value that defines the ratio between strong and week compression.

Skimming

Skimming is a Photonfocus proprietary technology to enhance detail in dark areas of an image.

Skim: Enable or disable skim. See Section 4.2.3.

Value: Skimming value. See Section 4.2.3.

7.1.7 Calibration

This tab contains black level offset settings.

Calibration

Offset LowGain: Set the Offset of the camera for the mode with disabled HighGain.

Offset HighGain: Set the Offset of the camera for the mode with enabled HighGain.

External Pixel Clock

External master Clock (Slave Mode): External pixel clock.

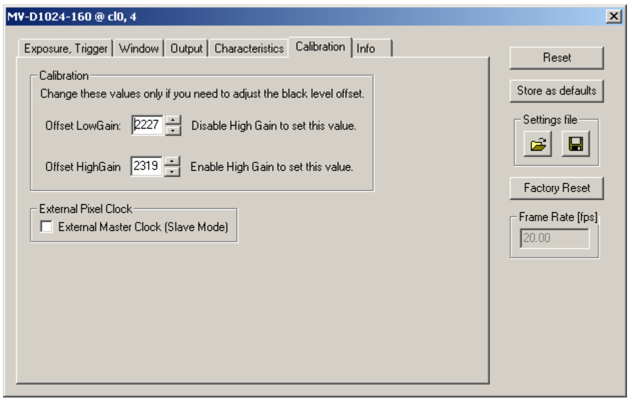


Figure 7.10: MV-D1024-SERIES calibration panel

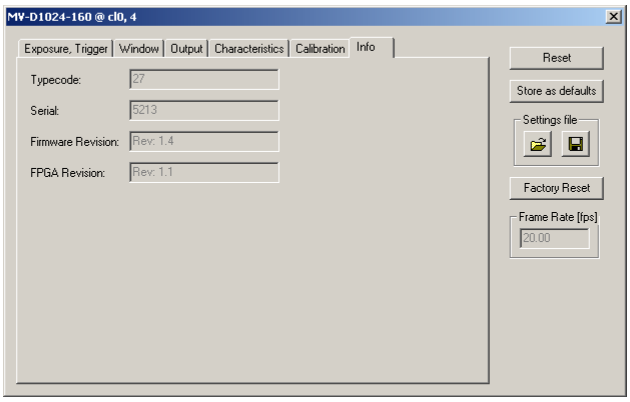


Figure 7.11: MV-D1024-SERIES info panel

7.1.8 Info

This panel shows camera specific information such as type code, serial number and firmware revision of the FPGA.

Typecode: Type code of the connected camera.

Serial: Serial number of the connected camera.

Firmware Revision: Camera firmware revision of the connected camera.

FPGA Revision: Firmware revision of built-in FPGA of the connected camera.

☞ For any support requests, please enclose the information provided on this tab.

8

Mechanical, Optical and Environmental Considerations

8.1 Mechanical Interface

The general mechanical data of the cameras are listed in section 3, Table 3.3.

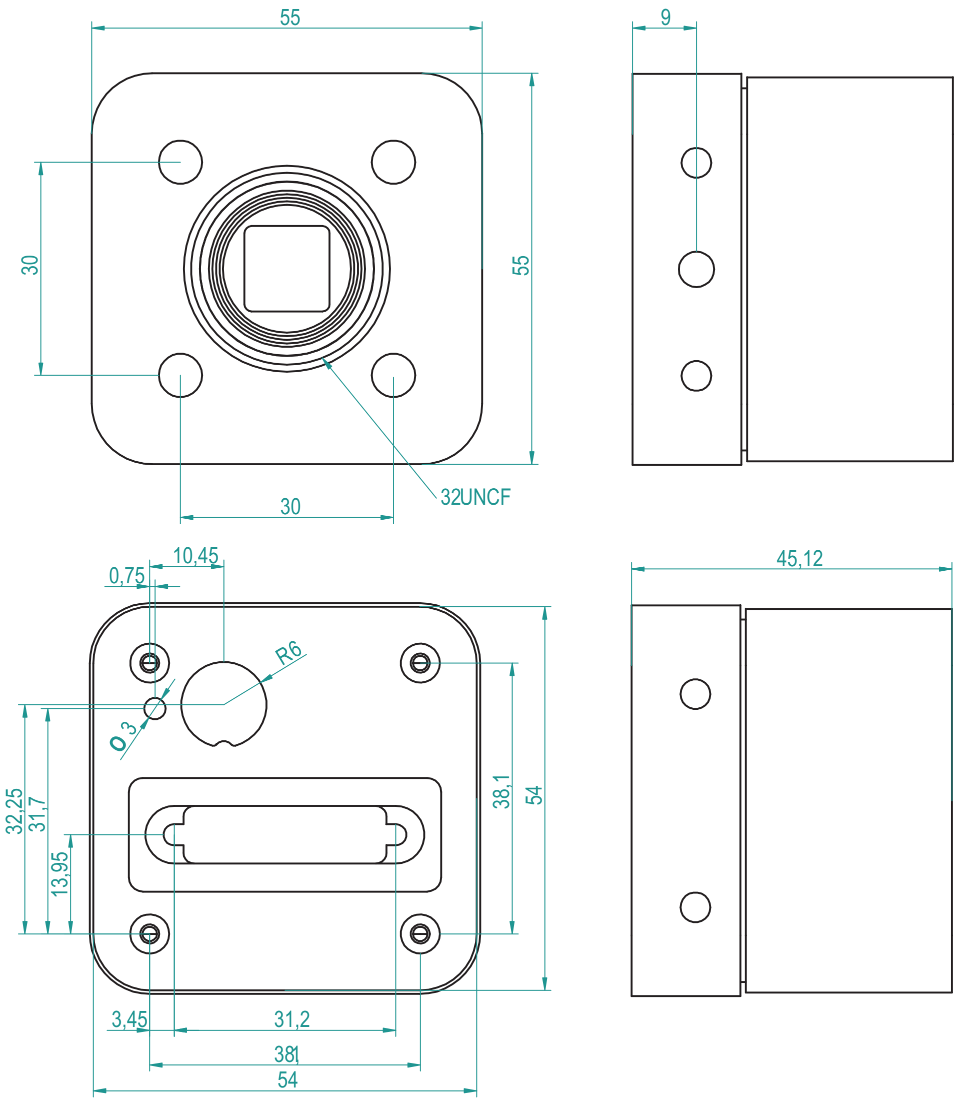


Figure 8.1: Mechanical Dimensions of the MV-D1024 models

During storage and transport, the camera should be protected against vibration, shock, moisture and dust. The original packing protects the camera adequately from vibration and shock during storage and transport. Please either retain this packing for possible later use or dispose of it according to local regulations.

8.2 Optical Interface

8.2.1 Mounting the Lens

Remove the protective cap from the C-/CS-mount thread of the camera and install the lens. When removing the protective cap or changing the lens, the camera should always be held with the opening facing downwards to prevent dust from falling onto the CMOS sensor. If the lens is removed, the protective cap should be refitted. If the camera is operated in a dusty environment, we recommend the use of a constant stream of clean air in front of the objective.

8.2.2 Cleaning the Sensor

The sensor is part of the optical path and should be handled like other optical components:**with extreme care**.
Dust can obscure pixels, producing dark patches in the images captured. Dust is most visible when the illumination is collimated. Dark patches caused by dust or dirt shift position as the angle of illumination changes. Dust is normally not visible when the sensor is positioned at the exit port of an integrating sphere, where the illumination is diffuse.

1. The camera should only be cleaned in ESD-safe areas by ESD-trained personnel using wrist straps. Ideally, the sensor should be cleaned in a clean environment. Otherwise, in dusty environments, the sensor will immediately become dirty again after cleaning.
2. Use a high quality, low pressure air duster (e.g. Electrolube EAD400D, pure compressed inert gas, www.electrolube.com) to blow off loose particles. This step alone is usually sufficient to clean the sensor of the most common contaminants.

   ⚠ Workshop air supply is not appropriate and may cause permanent damage to the sensor.

3. If further cleaning is required, use a suitable lens wiper or Q-Tip moistened with an appropriate cleaning fluid to wipe the sensor surface as described below. Examples of suitable lens cleaning materials are given in Table 8.1. Cleaning materials must be ESD-safe, lint-free and free from particles that may scratch the sensor surface.

   ⚠ Do not use ordinary cotton buds. These do not fulfil the above requirements and permanent damage to the sensor may result.

4. Wipe the sensor carefully and slowly. First remove coarse particles and dirt from the sensor using Q-Tips soaked in 2-propanol, applying as little pressure as possible. Using a method similar to that used for cleaning optical surfaces, clean the sensor by starting at any corner of the sensor and working towards the opposite corner. Finally, repeat the procedure with methanol to remove streaks. It is imperative that no pressure be applied to the surface of the sensor or to the black globe-top material (if present) surrounding the optically active surface during the cleaning process.

Product		Supplier	Remark
EAD400D	Airduster	Electrolube, UK	www.electrolube.com
Anticon Gold 9"x 9"	Wiper	Milliken, USA	ESD safe and suitable for class 100 environments. www.milliken.com
TX4025	Wiper	Texwipe	www.texwipe.com
Transplex	Swab	Texwipe	
Small Q-Tips SWABS BB-003	Q-tips	Hans J. Michael GmbH, Germany	www.hjm.de
Large Q-Tips SWABS CA-003	Q-tips	Hans J. Michael GmbH, Germany	
Point Slim HUBY-340	Q-tips	Hans J. Michael GmbH, Germany	
Methanol	Fluid	Johnson Matthey GmbH, Germany	Semiconductor Grade 99.9% min (Assay), Merck 12,6024, UN1230, slightly flammable and poisonous. www.alfa-chemcat.com
2-Propanol (Iso-Propanol)	Fluid	Johnson Matthey GmbH, Germany	Semiconductor Grade 99.5% min (Assay) Merck 12,5227, UN1219, slightly flammable. www.alfa-chemcat.com

Table 8.1: Recommended materials for sensor cleaning

For cleaning the sensor, Photonfocus recommends the products available from the suppliers as listed in Table 8.1.

✎ Cleaning tools (except chemicals) can be purchased from Photonfocus (www.photonfocus.com).

8.3 Compliance

CE Compliance Statement

We,

Photonfocus AG,
CH-8853 Lachen, Switzerland

declare under our sole responsibility that the following products

MV-D1024-28-CL-10, MV-D1024-80-CL-8, MV-D1024-160-CL-8

MV-D752-28-CL-10, MV-D752-80-CL-8, MV-D752-160-CL-8

MV-D640-33-CL-10, MV-D640-66-CL-10, MV-D640-48-U2-8
MV-D640C-33-CL-10, MV-D640C-66-CL-10, MV-D640C-48-U2-8

MV-D1024E-40, MV-D752E-40, MV-D750E-20 (CameraLink and USB2.0 Models), MV-D1024E-80, MV-D1024E-160

MV-D1024E-PP01

MV2-D1280-640-CL-8

SM2-D1024-80

DS1-D1024-40-CL, DS1-D1024-40-U2,
DS1-D1024-80-CL, DS1-D1024-160-CL

Digipeater CLB26

are in compliance with the below mentioned standards according to the provisions of European Standards Directives:

EN 61 000 - 6 - 3 : 2001
EN 61 000 - 6 - 2 : 2001
EN 61 000 - 4 - 6 : 1996
EN 61 000 - 4 - 4 : 1996
EN 61 000 - 4 - 3 : 1996
EN 61 000 - 4 - 2 : 1995
EN 55 022 : 1994

Photonfocus AG, December 2007

Figure 8.2: CE compliance statement

9 Warranty

The manufacturer alone reserves the right to recognize warranty claims.

9.1 Warranty Terms

The manufacturer warrants to distributor and end customer that for a period of two years from the date of the shipment from manufacturer or distributor to end customer (the "Warranty Period") that:

- the product will substantially conform to the specifications set forth in the applicable documentation published by the manufacturer and accompanying said product, and
- the product shall be free from defects in materials and workmanship under normal use.

The distributor shall not make or pass on to any party any warranty or representation on behalf of the manufacturer other than or inconsistent with the above limited warranty set.

9.2 Warranty Claim

The above warranty does not apply to any product that has been modified or altered by any party other than manufacturer, or for any defects caused by any use of the product in a manner for which it was not designed, or by the negligence of any party other than manufacturer.

10

References

All referenced documents can be downloaded from our website at www.photonfocus.com.

CL CameraLink Specification, October 2000

PFLIB PFLib Documentation, Photonfocus, August 2004

AN001 Application Note "LinLog", Photonfocus, December 2002

AN024 Application Note "LinLog - Principle and Practical Example", Photonfocus, March 2005

AN007 Application Note "Camera Acquisition Modes", Photonfocus, March 2004

AN008 Application Note "Photometry versus Radiometry", Photonfocus, April 2005

AN010 Application Note "Camera Clock Concepts", Photonfocus, July 2004

AN015 Application Note "Glossary", Photonfocus, July 2004

AN021 Application Note "CameraLink", Photonfocus, July 2004

AN024 Application Note "LinLog - Principle and Practical Example", Photonfocus, July 2004

11 Pinouts

11.1 Power Supply

The power supply plug is available from Binder connectors at www.binder-connector.de (see also Section 5.1).

Power supply Plug Binder subminiature series 712, order# 99-0405-00-03

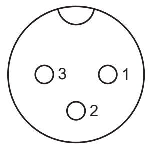


Figure 11.1: Power Supply plug, 3-pole (rear view, solder side)

Pin	I/O	Name	Description
1	PW	VDD	+5V power supply
2	PW	GND	Ground
3	PW	DNC	Do not connect

Table 11.1: Pinout of the power supply socket

A suitable power supply is available from Photonfocus.

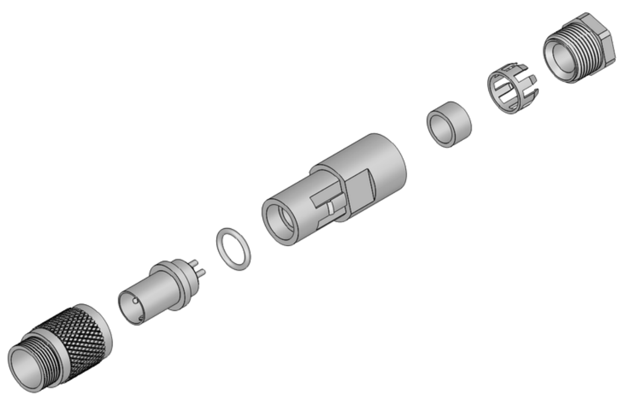


Figure 11.2: Assembly of the power supply connector

11.2 CameraLink Connector

The pinout for the CameraLink 26 pin, 0.5" Mini D-Ribbon (MDR) connector is according to the CameraLink standard ([CL]) and is listed here for reference only (see Table 11.2). The drawing of the CameraLink cable plug is shown in Fig. 11.3. CameraLink cables can be purchased from Photonfocus directly (www.photonfocus.com).

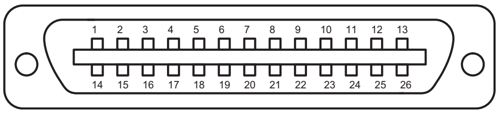


Figure 11.3: CameraLink cable 3M MDR-26 plug (both ends)

PIN	IO	Name	Description
1	PW	SHIELD	Shield
2	O	N_XD0	Negative LVDS Output, CameraLink Data D0
3	O	N_XD1	Negative LVDS Output, CameraLink Data D1
4	O	N_XD2	Negative LVDS Output, CameraLink Data D2
5	O	N_XCLK	Negative LVDS Output, CameraLink Clock
6	O	N_XD3	Negative LVDS Output, CameraLink Data D3
7	I	P_SERTOCAM	Positive LVDS Input, Serial Communication to the camera
8	O	N_SERTOFG	Negative LVDS Output, Serial Communication from the camera
9	I	N_CC1	Negative LVDS Input, Camera Control 1 (CC1)
10	I	N_CC2	Positive LVDS Input, Camera Control 2 (CC2)
11	I	N_CC3	Negative LVDS Input, Camera Control 3 (CC3)
12	I	P_CC4	Positive LVDS Input, Camera Control 4 (CC4)
13	PW	SHIELD	Shield
14	PW	SHIELD	Shield
15	O	P_XD0	Positive LVDS Output, CameraLink Data D0
16	O	P_XD1	Positive LVDS Output, CameraLink Data D1
17	O	P_XD2	Positive LVDS Output, CameraLink Data D2
18	O	P_XCLK	Positive LVDS Output, CameraLink Clock
19	O	P_XD3	Positive LVDS Output, CameraLink Data D3
20	I	N_SERTOCAM	Negative LVDS Input, Serial Communication to the camera
21	O	P_SERTOFG	Positive LVDS Output, Serial Communication from the camera
22	I	P_CC1	Positive LVDS Input, Camera Control 1 (CC1)
23	I	N_CC2	Negative LVDS Input, Camera Control 2 (CC2)
24	I	P_CC3	Positive LVDS Input, Camera Control 3 (CC3)
25	I	N_CC4	Negative LVDS Input, Camera Control 4 (CC4)
26	PW	SHIELD	Shield
S	PW	SHIELD	Shield

Table 11.2: Pinout CameraLink connector

12 Revision History

Revision	Date	Changes
1.0	June 2005	First release
1.01	February 2006	Updated frame rate formula
1.2	March 2008	Update of conformity statement