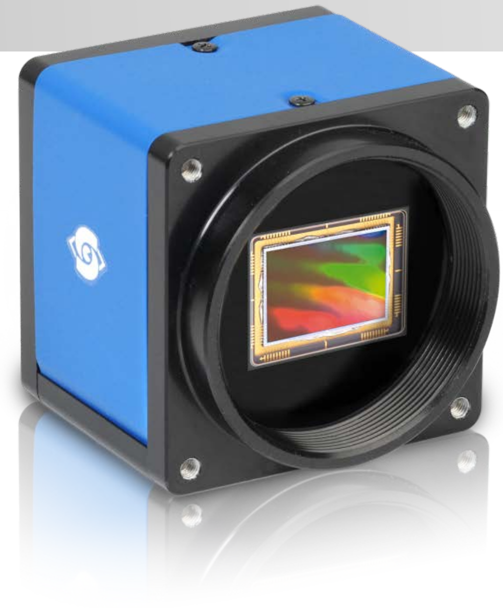


Manual EVO series

evo1050, evo2050, evo2150, eco4050, evo4070, evo8051

Company Information

SVS-VISTEK GMBH

Mühlbachstr. 20
82229 Seefeld
Germany

Tel.: +49 (0) 81 52 9985-0
Fax: +49 (0) 81 52 9985-79
Mail: info@svs-vistek.com
www.svs-vistek.com

This Operation Manual is based on the following standards::

DIN EN 62079
DIN EN ISO 12100
ISO Guide 37
DIN ISO 3864-2
DIN ISO 3864-4

This Operation Manual contains important instructions for safe and efficient handling of SVCam Cameras (hereinafter referred to as „camera“). This Operating Manual is part of the camera and must be kept accessible in the immediate vicinity of the camera for any person working on or with this camera.

Read carefully and make sure you understand this Operation Manual prior to starting any work with this camera. The basic prerequisite for safe work is compliant with all specified safety and handling instructions.

Accident prevention guidelines and general safety regulations shoud be applied.

Illustrations in this Operation Manual are provided for basic understanding and can vary from the actual model of this camera. No claims can be derived from the illustrations in this Operation Manual.

The camera in your possession has been produced with great care and has been thoroughly tested. Nonetheless, should you have reasons for complaint, then please contact your local SVS-VISTEK distributor. You will find a list of distributors in your area under: http://www.svs-vistek.com/company/distributors/distributors.php

Copyright Protection Statement

Contents

1 Safety Messages

The classification of hazards is made pursuant to ISO 3864-2 and ANSI Y535.6 with the help of key words.

This Operating Manual uses the following Safety Messages:

Risk of death or serious injury		**DANGER!** Danger indicates a hazard with a high level of risk which, if not avoided will result in death or serious injury.
		**WARNING!** Warning indicates a hazard with a medium level of risk which, if not avoided will result in death or serious injury.
		**CAUTION!** Caution indicates a hazard with a low level of risk which, if not avoided will result in death or serious injury.
Risk of damage		**PROHIBITION!** A black graphical symbol inside a red circular band with a red diagonal bar defines a safety sign that indicates that an action shall not be taken or shall be stopped.
		**CAUTION!** A black graphical symbol inside a yellow triangle defines a safety sign that indicates a hazard.
		**MANDATORY ACTION!** A white graphical symbol inside a blue circle defines a safety sign that indicates that an action shall be taken to avoid a hazard.
Cross-reference 		**NOTICE** Provides references and tips

Figure 1: Table of safety messages

2 Legal Information

Information given within the manual accurate as to: February 2, 2017, errors and omissions excepted.

These products are designed for industrial applications only. Cameras from SVS-Vistek are not designed for life support systems where malfunction of the products might result in any risk of personal harm or injury. Customers, integrators and end users of SVS-Vistek products might sell these products and agree to do so at their own risk, as SVS-Vistek will not take any liability for any damage from improper use or sale.

2.1 Europe

This camera is CE tested, the rules of EN 55022:2010+AC2011 and EN61000-6-2:2005 apply.

All SVS-VISTEK cameras comply with the recommendation of the European Union concerning RoHS Rules

2.2 USA and Canada

Labeling requirements

This device complies with part 15 of the FCC Rules. Operation is subject to the following conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Information to the user

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at its own expense.

It is necessary to use a shielded power supply cable. You can then use the “shield contact” on the connector which has GND contact to the camera housing. This is essential for any use. If not done and camera is destroyed due to Radio Magnetic Interference (RMI) WARRANTY is void!

- Power: US/UK and European line adapter can be delivered. Otherwise use filtered and stabilized DC power supply.
  For power supply voltage refers to power supply and specification.
- Shock & Vibration Resistance is tested: For detailed Specifications refer to Specification.

2.3 Features

2.3.1 Versatile I/O Concept

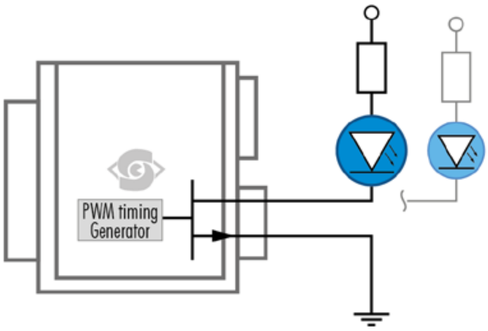


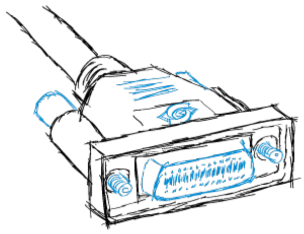
Figure 2: Illustration of 2IO concept of switching LEDs

Your camera is equipped with the 2io-Interface allowing full control of timing and illumination via the camera SDK. Each of the 2 outputs can be individually configured and managed using pulse-width control. The integrated sequencer allows multiple exposures with varied settings to be programmed, creating new and cost effective options.

- 2 x open drain in and out-put
- 2 x high power input – up to 25 volts
- Power MOSFET transistors

- PWM strobe control
- Sequencer for various configurations
  - Programmable computer software
- Trigger safe: debouncer, prescaler, high low trigger

2.3.2 Camera Link Features



Camera Link is the most direct serial connection to the sensor and preferred by integrators with high demands on bandwidth and integration in existing systems.

3 Getting Started

3.1 Contents of Camera Set

> Camera
> Power supply (if ordered/option)
> Quick guide
> User Manual
> Software installer – ConvCam
> Euresys camera file (optional)

3.2 Power supply

Connect the power supply.

CAUTION! – This camera does not support hotplugging

1. First, connect the data cable.
2. Then connect power supply.

When using your own power supply (e.g. 10 -25 V DC) see also Hirose 12-pin for a detailed pin layout of the power connector. For power input specifications refer to specifications.

3.3 Camera Link Flashing LED Codes

On power up, the camera will indicate its current status with a flashing LED on its back. The LED will change color and rhythm.

The meaning of the blinking codes translates as follows:

Flashing	Description
Yellow quickly (≈ 8 Hz)	booting
Yellow permanent	ready
Red slow (≈ 1 Hz)	error

Table 1 table of flashing LED codes

3.4 Software

Further information, documentations, release notes, latest software and application manuals can be downloaded in the download area on:
https://www.svs-vistek.com/en/login/svs-loginarea-login.php

Depending on the type of camera you bought, several software packages apply.

Your SVCam combined software installer including:

> SVConvCam
 (a controler app for SVCam Camera Link cameras)
> TL_Driver
 (GenICam drivers and transport layer DDLs)

Further information, documentations, release notes, latest software and application manuals can be downloaded in the login area on:
https://www.svs-vistek.com/en/login/svs-loginarea-login.php

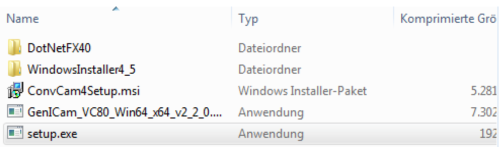
CAUTION!

Make sure you have the latest **ConvCam4**. At time of printing, this is version 4.5

3.4.1 Installation ConvCam4

1st Expand ZIP

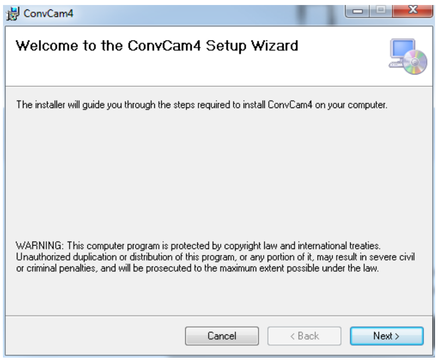
> Extract the zip archive to your local hard drive.



2st Install

> Run the executable file.1*

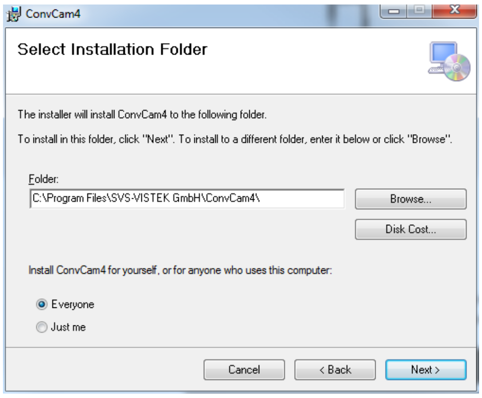
> Click “Install”



> Click “Next”

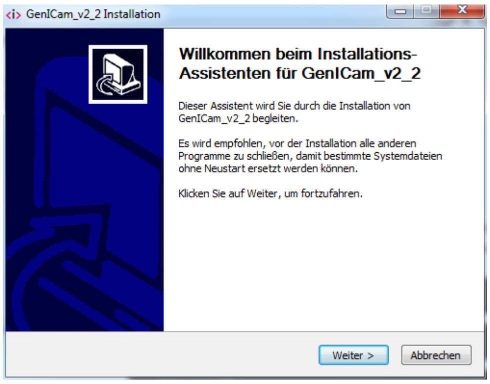
> Read and accept terms of License Agreement

> Choose Options 2* and Location to install

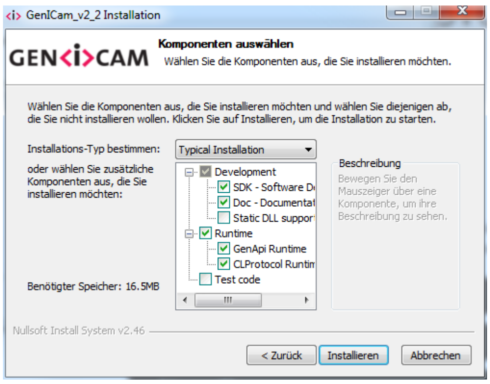


> Click “Finish”

> Install GeniCam



> Select location, startmenu and components



3.4.2 Connecting the camera

1. Connect the camera with a Camera Link cable to your frame grabber
2. Connect power source to the camera

Run the camera controller tool: ConvCam

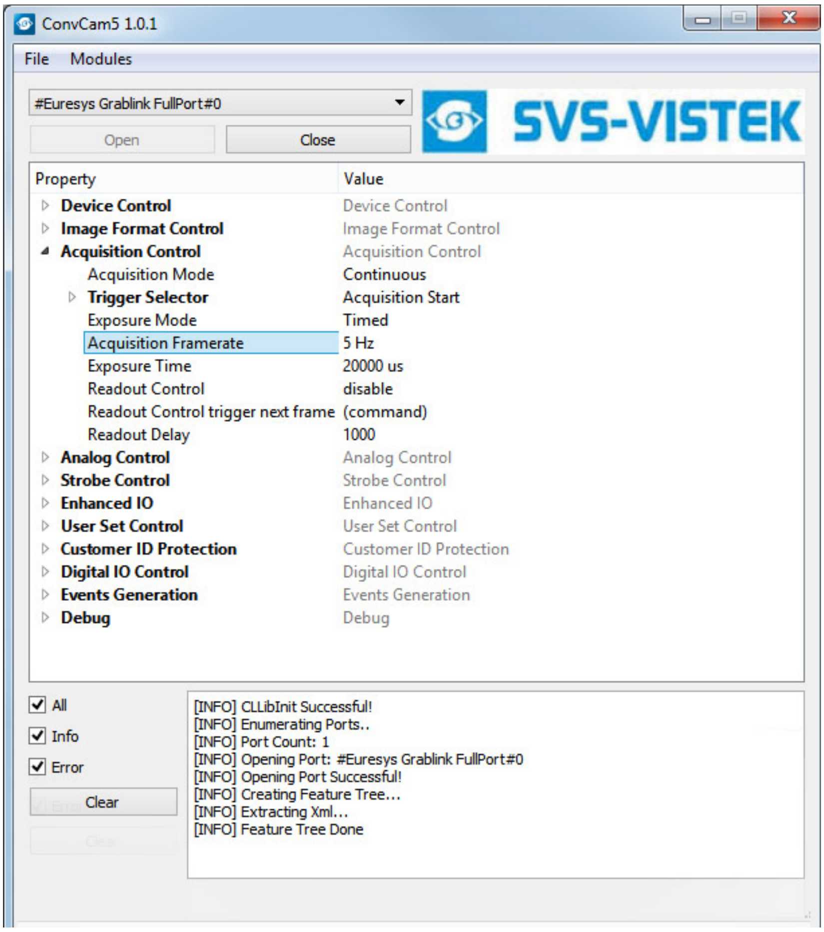
Select your frame grabber.

Information needed by your Framegrabber:

> Tap configuration
> Trigger mode
> Pixel width and hight

3.4.3 ConvCam4

Set values as needed



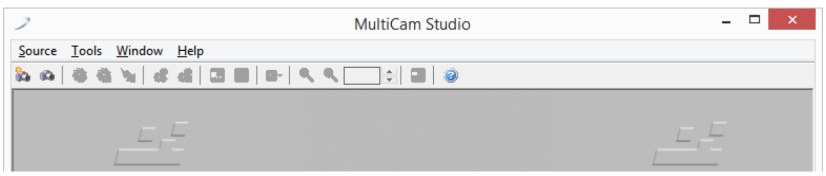
3.4.4 Viewer Software

The final image will be shown or processed by your own valued software package. After camera configuration an image will be directed to the software connected to your frame grabber.

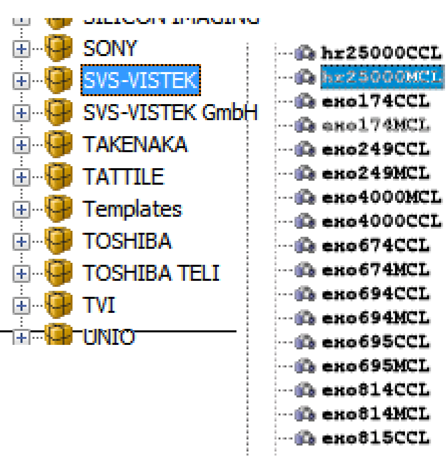
E.g. Multicam by Euresys

While using a Euresys frame grabber the first impression imaging tool "Multicam" is available to the hardware.

Run Multicam Studio.

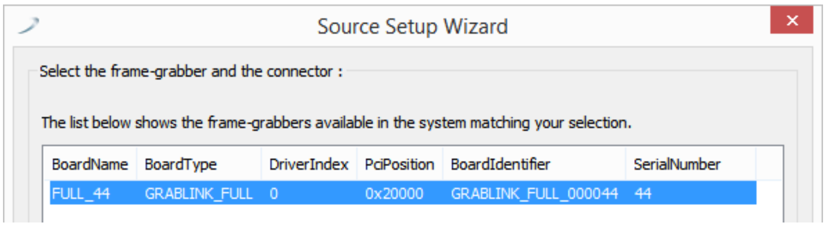


> Add a new "source" to the application
> Choose "Camera Link industrial Camera…"
> Click "next"
> In the list of camera vendors choose

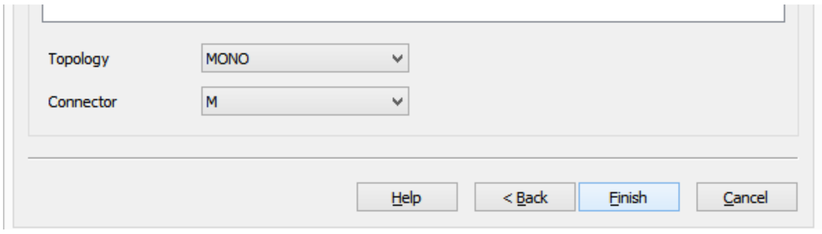


"SVS-VISTEK" and the camera you want to view.

> Select frame grabber and connector



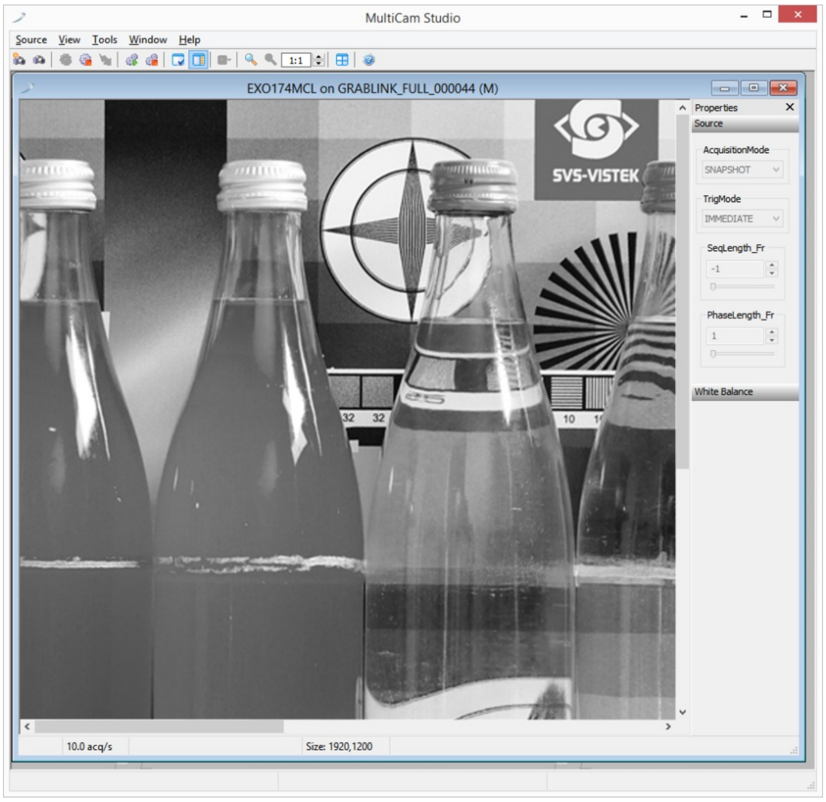
> For "Topology" values refer to the Euresys documentation. At first: stay with "Mono" for topology.



> Choose your connector configuration. (here, "M" medium is valid only)

> Klick "Finish"

Now an image should appear, according to your setup configurations made with ConvCam



For further information on Euresys Multicam Studio refer to the documentation from Euresys.

1.1.1 Firmware

Make sure your camera is running up-to-date firmware.

Some features may not have been implemented in older versions.

Firmware Update Camera Link

Firmware Update can be done with ConvCam Software

3.5 Driver Circuit Schematics

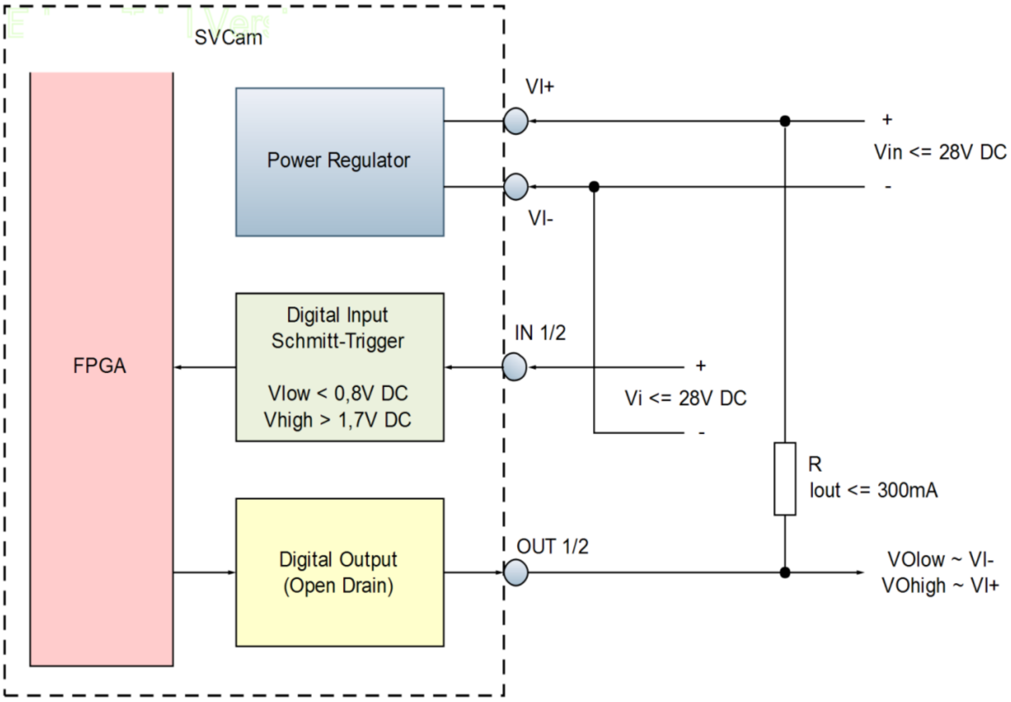
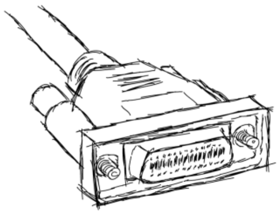


Figure 3: basic Illustration of driver circuit

4 Connectors

4.1 Camera Link™

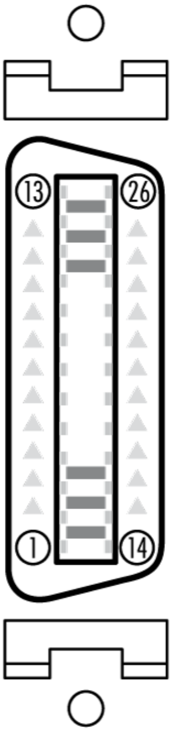


To use Camera Link a frame grabber is needed.

Frame grabbers can be purchased at SVS-VISTEK, too.

4.1.1 Connectors Camera Link™

Specification	
Type	26 Pin connector MDR female
Mating Connector	3M
Part-Nr. connector	10126-6000EL
Part-Nr. hood	10326-A200-00
Operating Mode	Camera Link™ with RS 232 communication



Pinout Pin	Signal Name	Direction	Signal Description
- 1 -	GND / 12 V	-	Shield 1 / 12 V power*
- 2 -	X0-	Camera to FG	Data
- 3 -	X1-	Camera to FG	Data
- 4 -	X2-	Camera to FG	Data
- 5 -	Xclk-	Camera to FG	Transmitter Clock / PVAL
- 6 -	X3-	Camera to FG	Data
- 7 -	SerTC+	FG to Camera	Camera Control (RS232)
- 8 -	SerTFG-	Camera to FG	Camera Control (RS232)
- 9 -	CC1-	FG to Camera	ExSync
- 10 -	CC2+	FG to Camera	Prin (not used)
- 11 -	CC3-	FG to Camera	External Camera Clock
- 12 -	CC4+	FG to Camera	nc
- 13 -	GND	-	Shield 3 / power return*
- 14 -	GND	-	Shield 2 / power return*
- 15 -	X0+	Camera to FG	Data
- 16 -	X1+	Camera to FG	Data
- 17 -	X2+	Camera to FG	Data
- 18 -	Xclk+	Camera to FG	Transmitter Clock
- 19 -	X3+	Camera to FG	Data
- 20 -	SerTC-	FG to Camera	Camera Control (RS232)
- 21 -	SerTFG+	Camera to FG	Camera Control (RS232)
- 22 -	CC1+	FG to Camera	Exsync
- 23 -	CC2-	FG to Camera	Prin (not used)
- 24 -	CC3+	FG to Camera	External Camera Clock
- 25 -	CC4 -	FG to Camera	nc
- 26 -	GND / 12 V	-	Shield 4 / 12 V power *

Figure 4: Table of Camera Link pin-out / *PoCL

4.1.2 Pinout Diagram

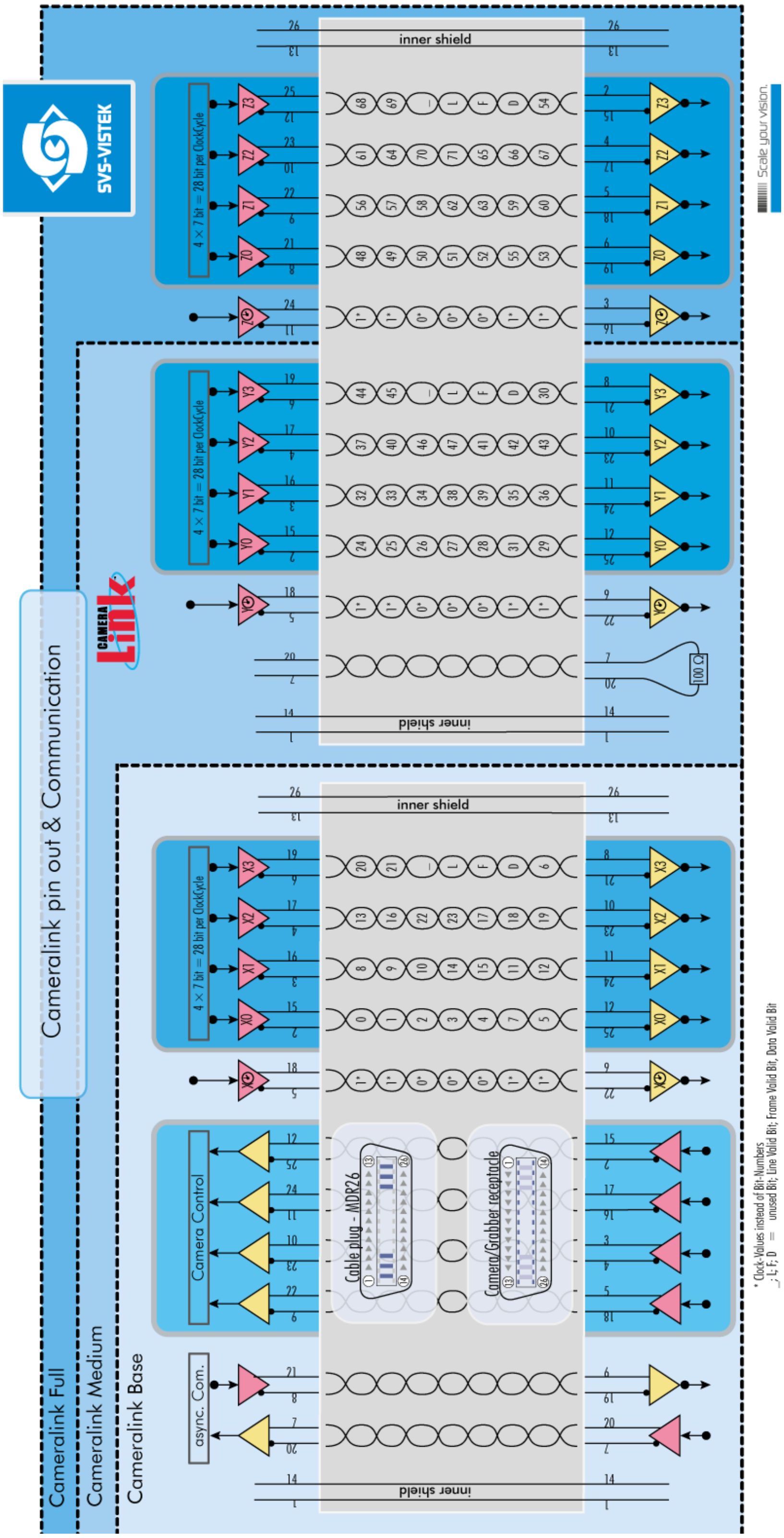


Figure 5: Illustration of Camera Link pin-out

4.1.3 Camera Link timing

It might be interesting to know when “valid data” can be expected exactly.

px_h = pixel horizontal [count]

px_v = pixel vertical [count]

LVAL – t_{Lvd}

Every line has periods with no valid data. The Duration of None Valid Data between two lines (t_{nvd}) is three time the Camera Link clock (clk). Delay before every first line is 2 times clk.

$$t_{Lvd} = \frac{px_h}{CL\_geometry\_X} \times \frac{1}{CL\_clock}$$

CL_clock = 85 MHz

FVAL – t_{Fvd}

Frames are not sent permanently. Between two frames will be a gap – even at highest frame rates. Minimum duration between two valid frame signals is the duration of one line.

$$t_{Fvd} = 2 \times \frac{1}{CL\_clock} + (t_{Lvd} + t_{nvd}) \times \frac{px_v}{CL\_geometry\_Y}$$

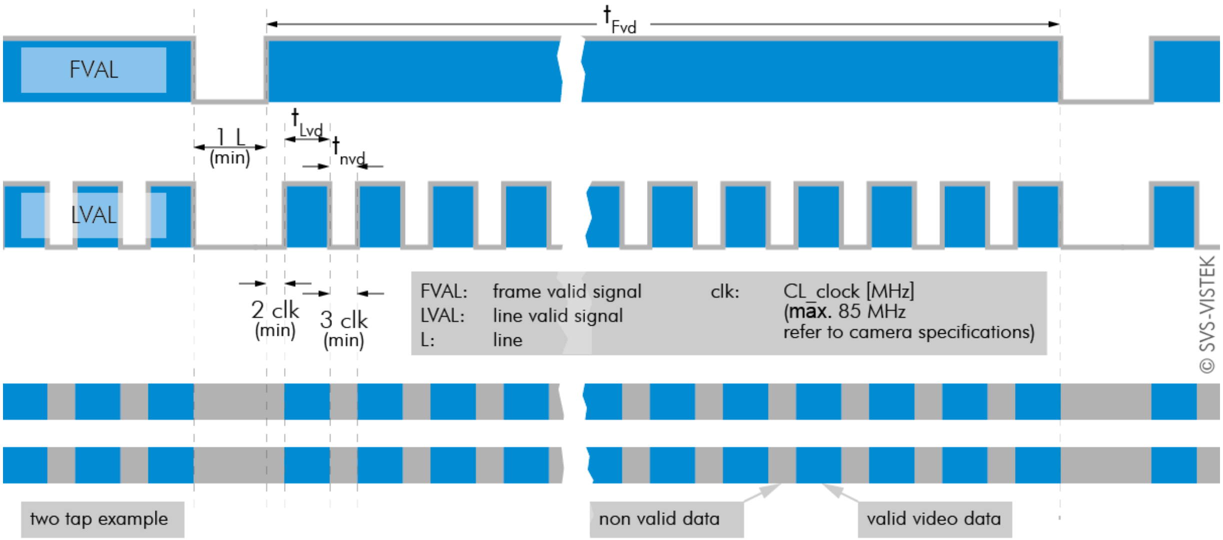


Figure 6: overview of FVAL and LVAL signal timing on Camera Link

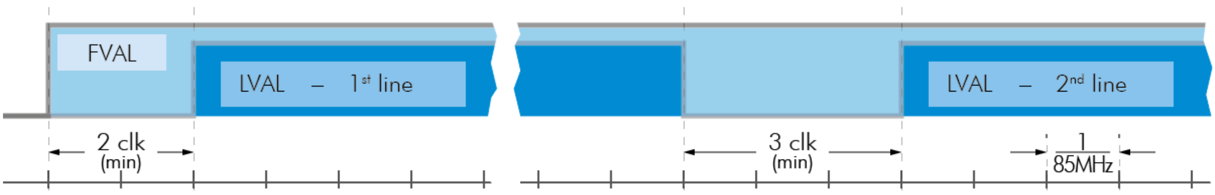


Figure 7: more detailed view of LVAL signal timing on Camera Link

Example calculation										on exo174*CL
>	t_{Lvd}	=	(1920 / 2) px in line / sent at once	×	(1/85MHz) CL_clock					
		=	960	×	$(1/85e^6)$ s				≈	11,29 µs
>	t_{nvd}	=	3 × (1/85MHz) time between two valid line data packages			=	$(3/85e^6)$ s		≈	35,3 ns
>	t_{Fvd}	=	2 x (1/85MHz) delay before first line	+	(t_{LVd}	+	t_{nvd})		×	1200 lines [count]
		=	$(2/85e^6)$ s	+	(11,29 µs	+	35,3 ns)		×	1200
		=	23,5 ns	+	(11,29 µs	+	35,3 ns)		×	1200
		=	(2 + (960 + 3) × 1200) s			/	$85e^6$		≈	13,6 ms

Camera Link architecture exo174*CL: 1X2_1Y count = 2
pixelh =1920 pixelv = 1200 CL_clock = 85 MHz

Figure 8: example calculation of Camera Link timing on a exo174*CL

4.2 Input / output connectors

For further information using the **breakout box** and simplifying OIs refer **SVCam Connectivity** manual. To be found separate within the USP manuals.

Hirose™ 12Pin

For detailed information about switching lights from inside the camera, refer to strobe control.

Specification	
Type	HR10A-10R-12S
Mating Connector	HR10A-10R-12P

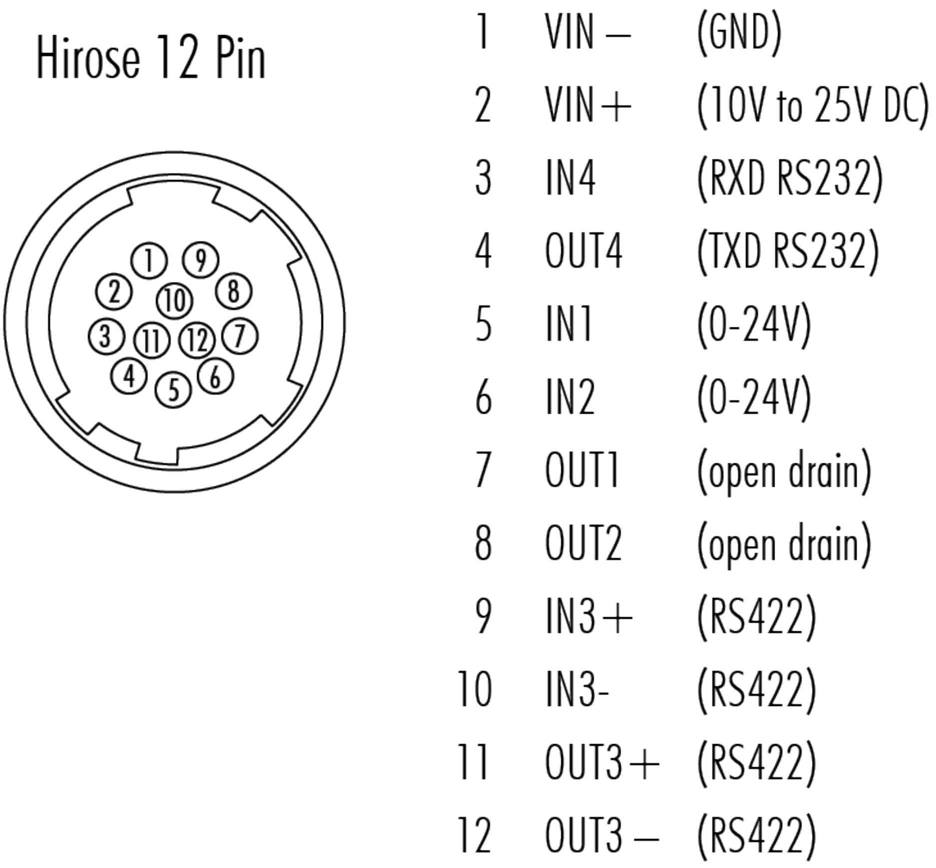


Figure 9: Illustration of Hirose 12 Pin & pin-out (HR10A-10R-12PB)

5 Dimensions

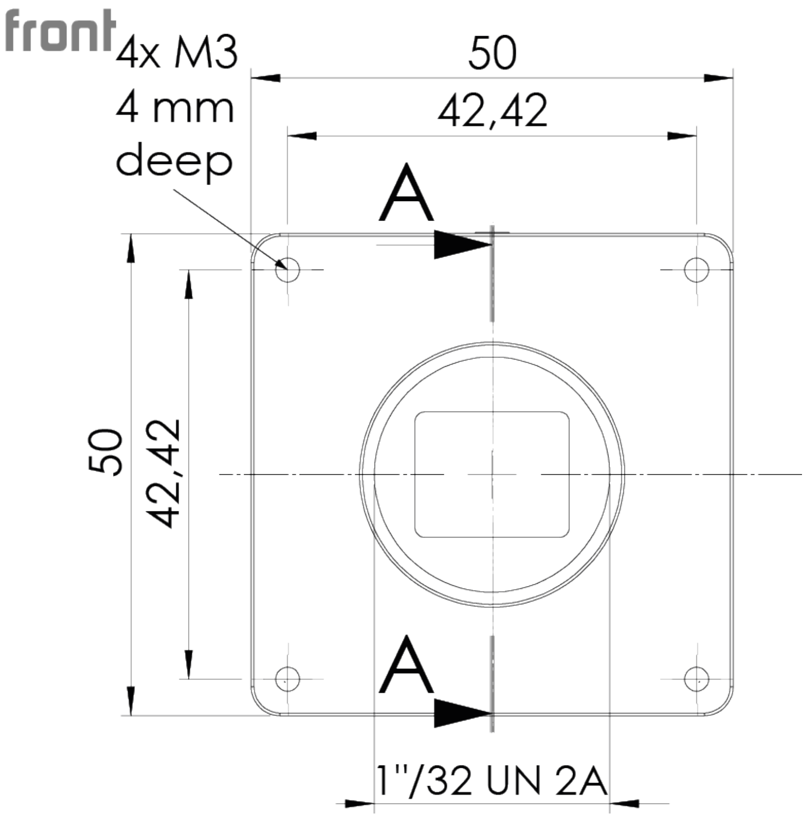
All length units in mm. CAD step files available on DVD or SVS-VISTEK.com

5.1 EVO Camera Link C mount

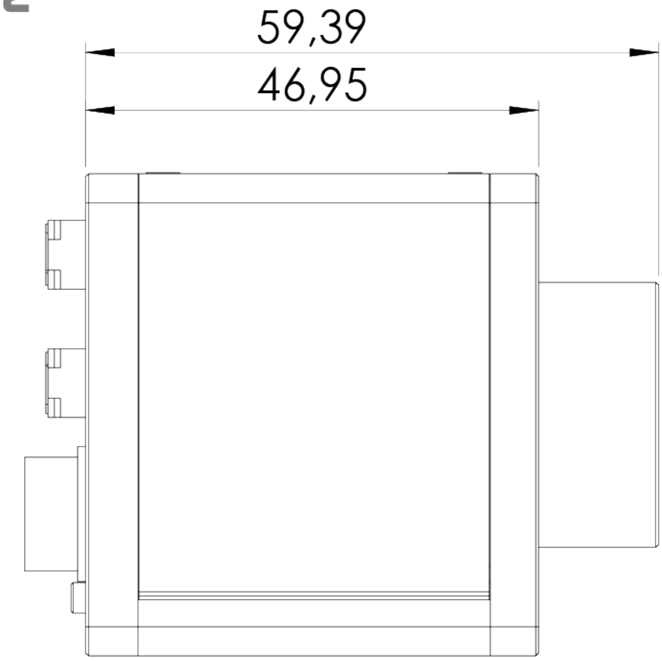
CAD step files available on DVD or SVS-VISTEK.com.

Including:

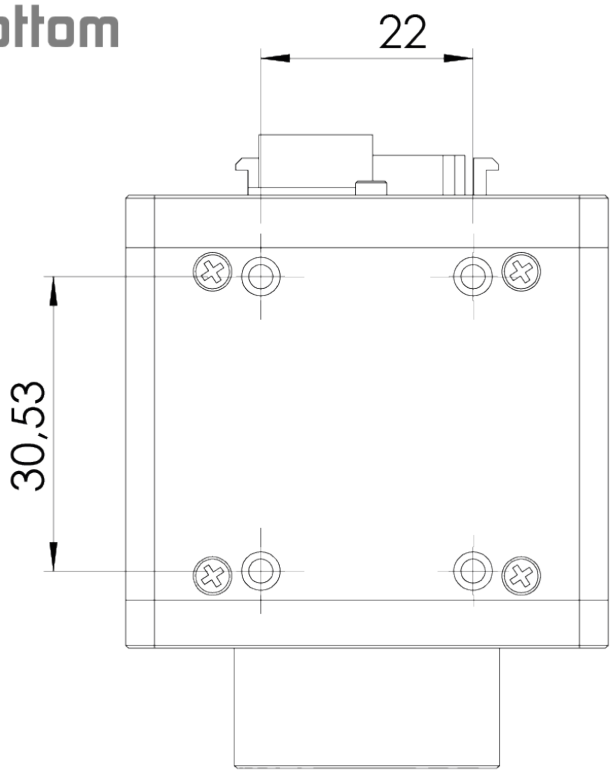
evo1050CFHCPC, evo1050MFHCPC, evo2050CFHCPC, evo2050MFHCPC, evo2150CFHCPC, evo2150MFHCPC, evo4050CFHCPC, evo4050MFHCPC



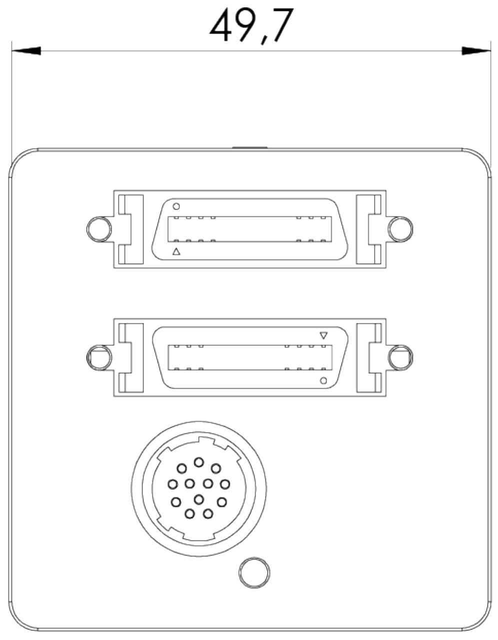
side



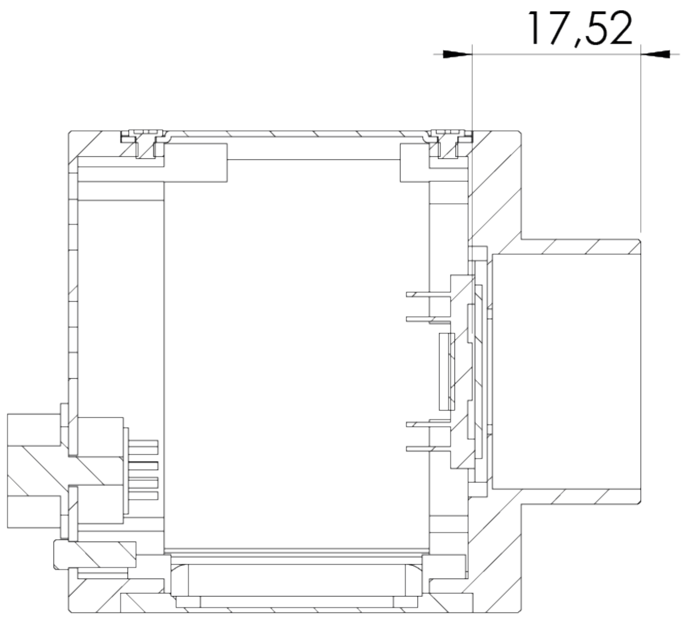
bottom



back



cross section A-A

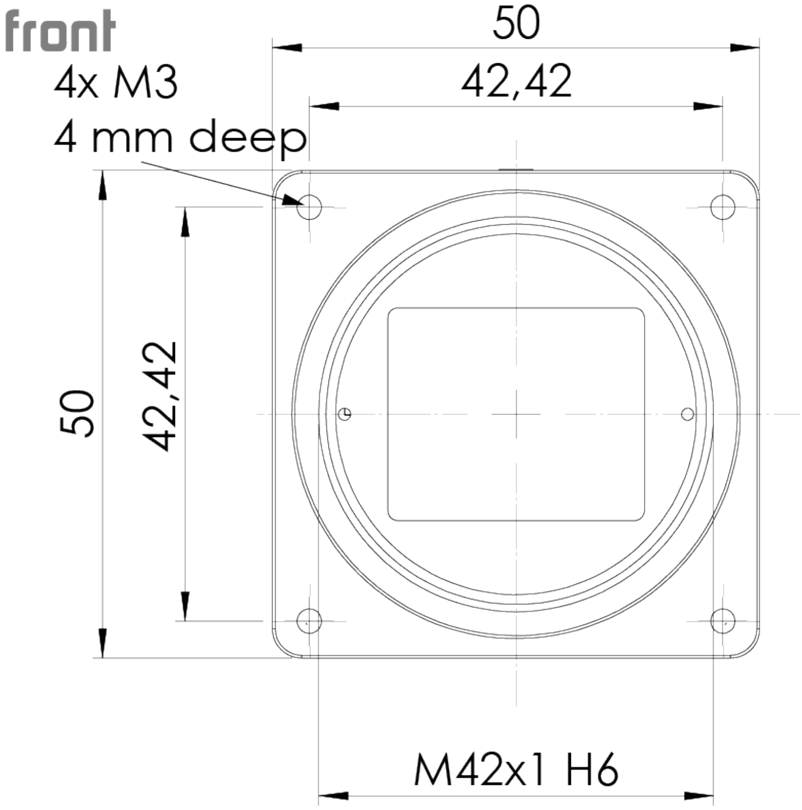


5.2 EVO Camera Link M48-mount

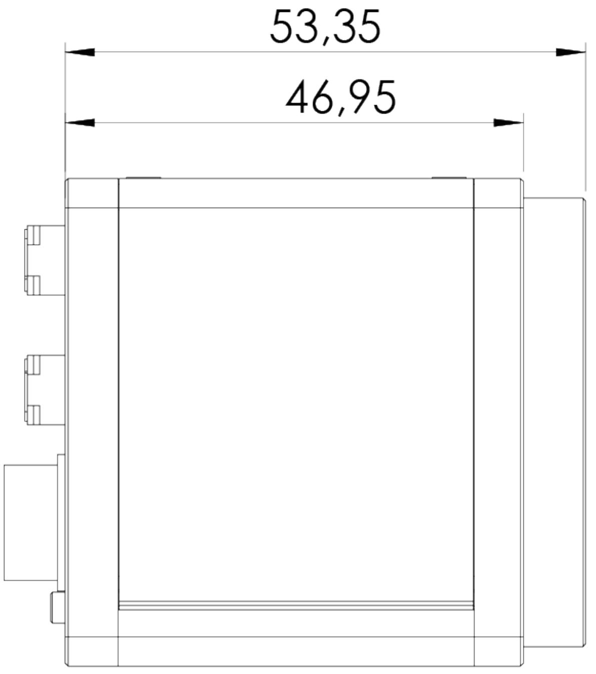
CAD step files available on DVD or SVS-VISTEK.com.

Including:

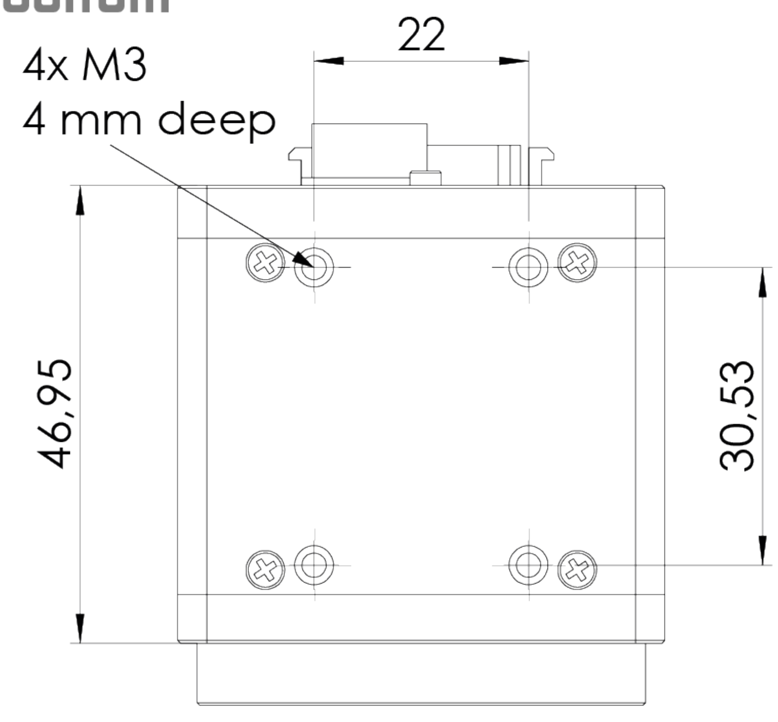
evo4070CFHCPC, evo4070MFHCPC, evo8050CFHCPC, evo8050MFHCPC, evo8051CFHCPC, evo8051MFHCPC



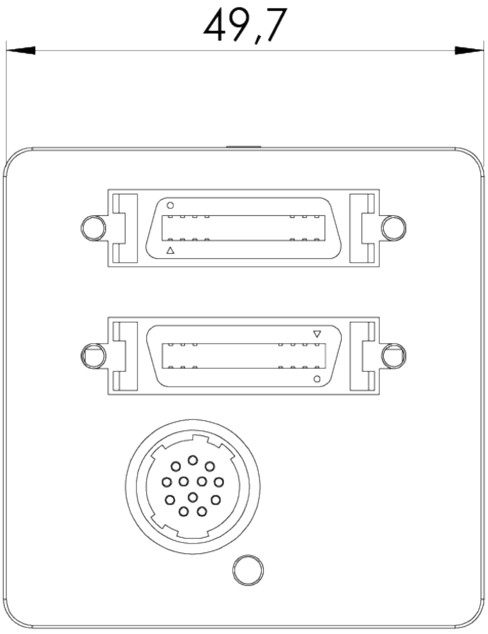
side



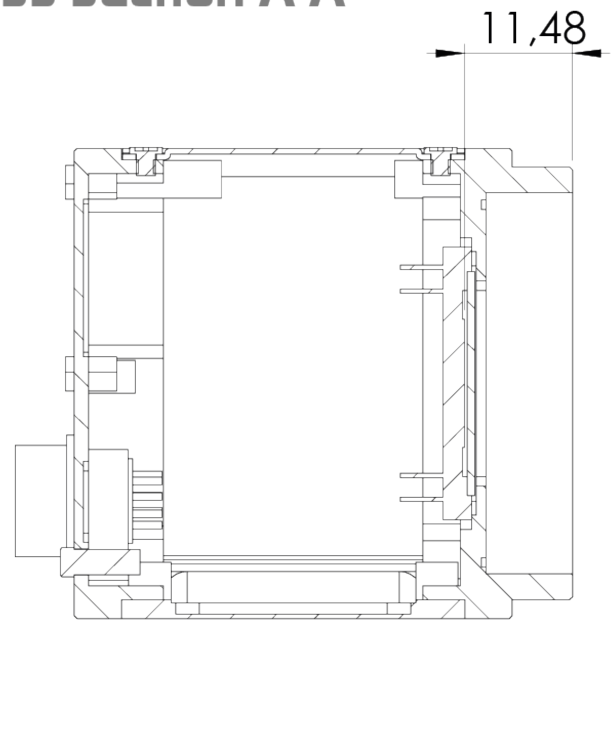
bottom



back



cross section A-A



5.3 C & CS Mount

Different back-focus distances from sensor to lens.

> C-Mount: 17,526 mm
> CS-Mount: 12,526 mm
> Diameter: 1 Inch
> Screw Thread: 1/32 Inch

CS-Mount Cameras accept both types of lenses. C-Mount lenses require a 5mm adapter ring to be fitted. (Also available at SVS-VISTEK)

C-Mount Cameras only accept C mount lenses as the flange to sensor distance does not allow a CS mount lens close enough to the Sensor to achieve a focused image.

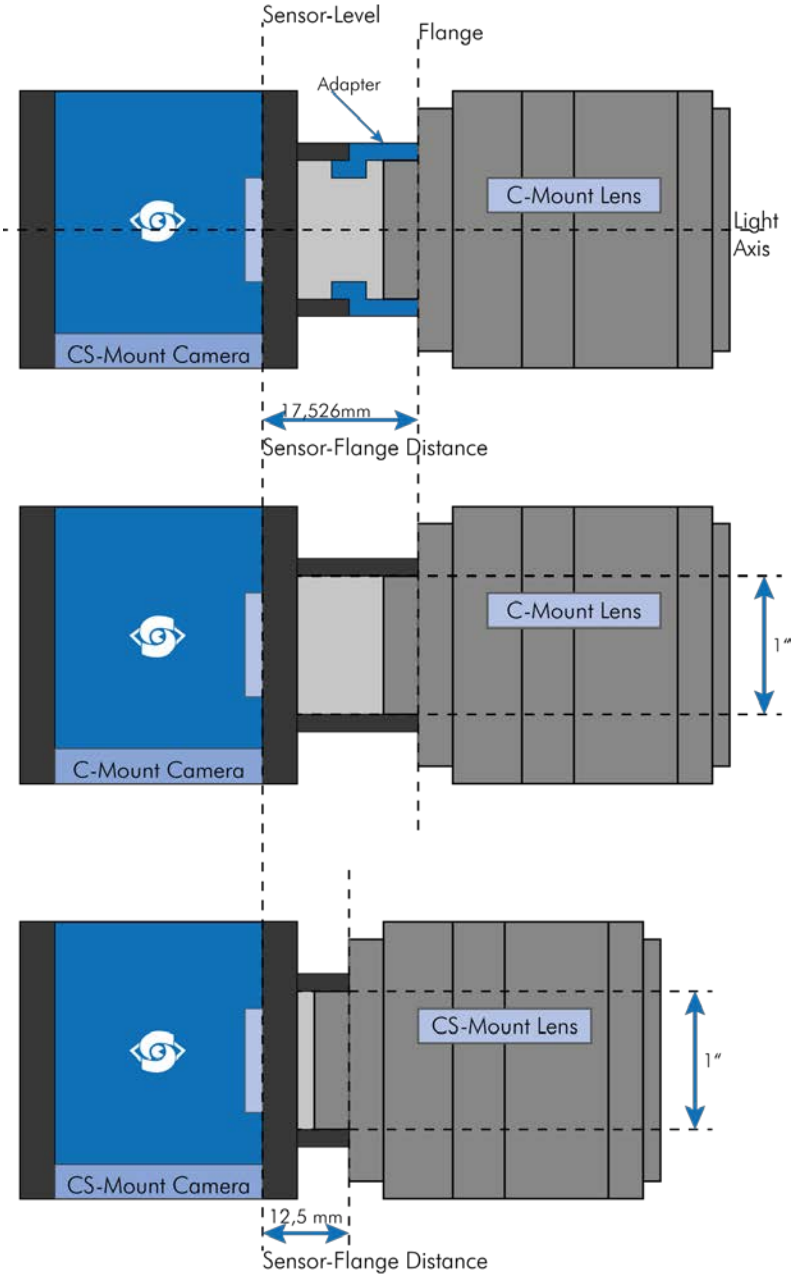


Figure 10: Illustration of C- & CS-Mount differences

5.4 M42 Mount

Diameter: 42 mm

Thread pitch 0.75 mm

Back focus distance from sensor to flange of the camera: 11.48 mm

Distance from sensor surface to lens differs depending on lens specifications and how far the lens is screwed in.

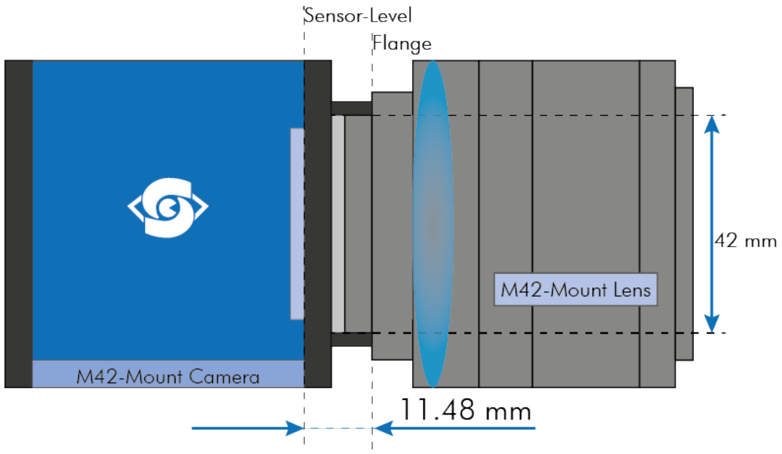


Figure 11: Illustration of M42-mount

6 Feature-Set

6.1 Basic Understanding

6.1.1 Basic Understanding of CCD Technology

Charge Coupled Device.

Light sensitive semiconductor elements arranged as rows and columns. Each row in the array represents a single line in the resulting image. When light falls onto the sensor elements, photons are converted into charge.

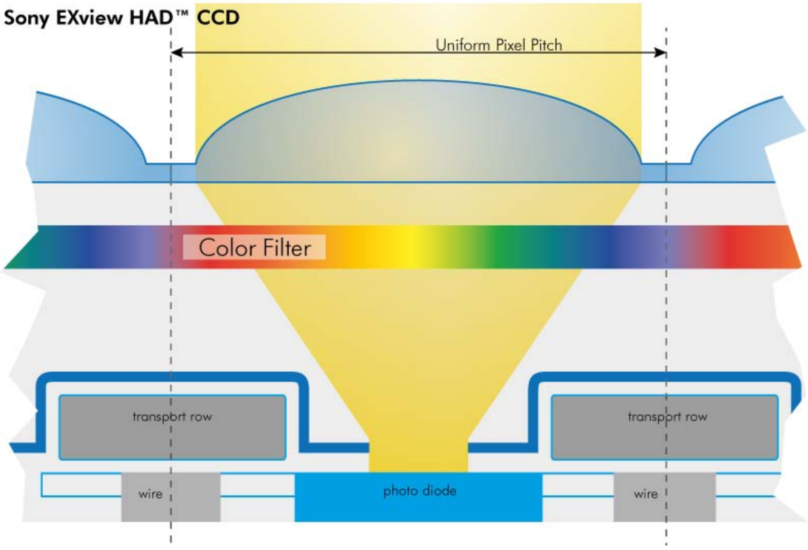
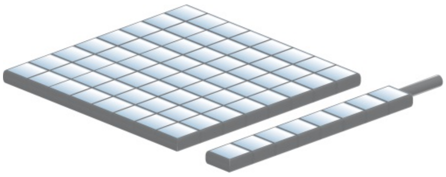


Figure 12: Illustration Cross-section of a CCD sensor from Sony

Charge is an integration of time and light intensity on the element



The sensor converts light into charge and transports it to an amplifier and subsequently to the analog to digital converter (ADC).

6.1.2 Interline Transfer

Interline Transfer is only used in CCD sensors.

With a single pixel clock the charge from each pixel is transferred to the vertical shift register. At this time, the light sensitive elements are again collecting light. The charge in the vertical registers is transferred line by line into the horizontal shift register. Between each (downward) transfer of the vertical register, the horizontal register transfers each line the output stage, where charge is converted to a voltage, amplified and sent on to the ADC. When all lines in the image have been transferred to the horizontal register and read out, the vertical registers can accept the next image…

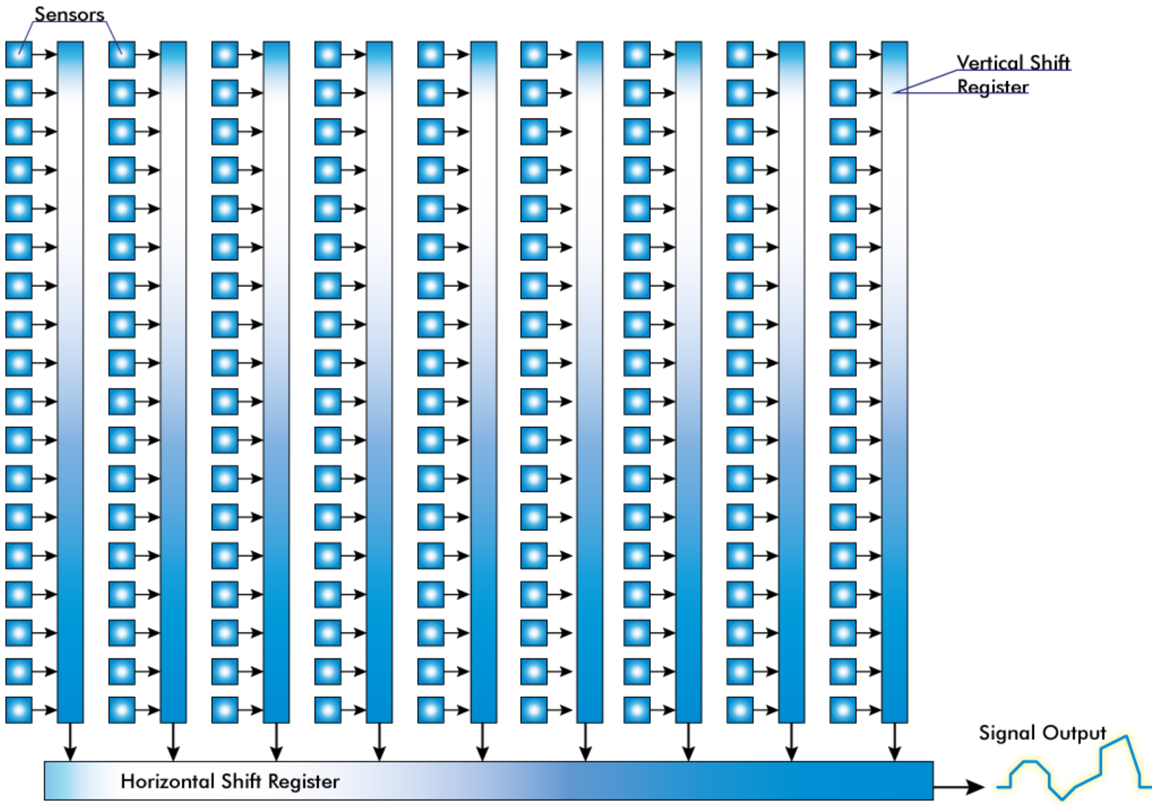


Figure 13: Illustration of interline transfer with columns and rows

6.1.3 Global Shutter / Progressive Scan

Unlike rolling shutter or interlaced scan modes all pixels are exposed at the same time. Fast moving objects will be captured without showing movement distortion.

Figure 14: Rolling shutter with fast moving object details

Figure 15: motion blur

Figure 16 rolling shutter with moving objects

Figure 17: interlaced effect

6.1.4 Frames per Second

Frames per second, or frame rate describes the number of frames output per second. The inverse (1/ frame rate) defines the frame time.

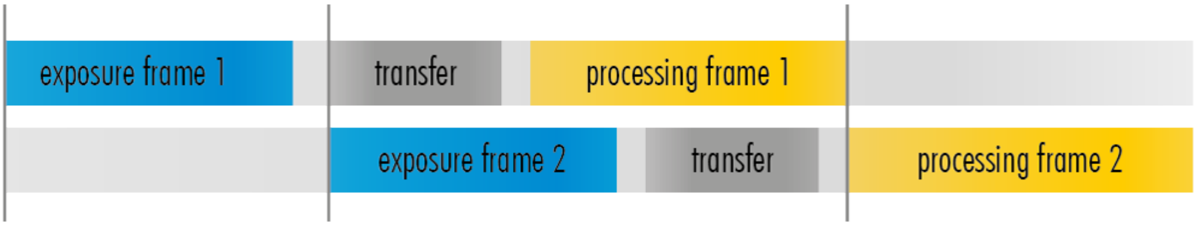
frame per second	frame time (Exposure)	applicable standard
0,25	4 s	
1	1s	
2	500ms	
20	50 ms	
24	$41,\overline{6}$ ms	Cinema
25	40 ms	PAL progressive
29,97	$33,\overline{366700033}\ldots$ ms	NTSC
30	$33,\overline{33}$ ms	NTSC
50	20 ms	PAL interlaced
75	$13,\overline{33}$ ms	
100	10 ms	

Virtually any value within the specification can be chosen.
Maximum frame rate depends on:

> Pixel clock
> Image size
> Tap structure
> Data transport limitation
> Processing time

6.1.5 Acquisition and Processing Time

The whole period of tome a picture is exposed, transferred and processed can differ and takes longer.



6.1.6 Exposure

See various exposure and timing modes in chapter: Basic capture modes.

Combine various exposure timings with PWM LED illumination, refer to sequencer.

Setting Exposure time

Exposure time can be set by width of the external or internal triggers or programmed by a given value.

6.1.7 Auto Luminance

Auto Luminance automatically calculates and adjusts exposure time and gain, frame-by-frame.

The auto exposure or automatic luminance control of the camera signal is a combination of an automatic adjustment of the camera exposure time (electronic shutter) and the gain.

The first priority is to adjust the exposure time and if the exposure time range is not sufficient, gain adjustment is applied. It is possibility to pre-define the range (min. / max. -values) of exposure time and of gain.

The condition to use this function is to set a targeted averaged brightness of the camera image. The algorithm computes a gain and exposure for each image to reach this target brightness in the next image (control loop). Enabling this functionality uses always both – gain and exposure time.

Limitation

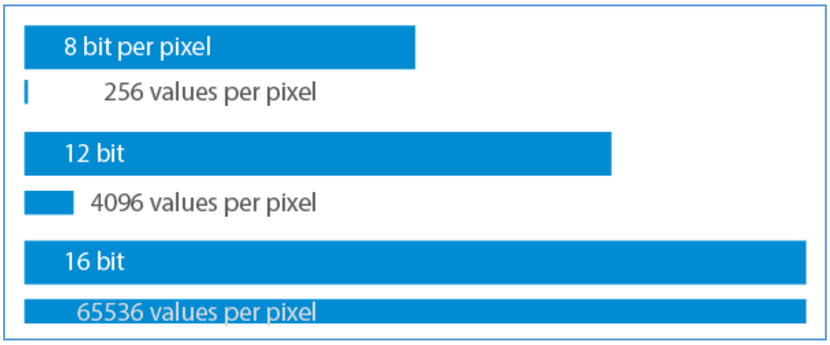
As this feature is based on a control loop, the result is only useful in an averaged, continuous stream of images. Strong variations in brightness from one image to next image will result in a swing of the control loop. Therefore it is not recommended to use the auto-luminance function in such cases.

6.1.8 Bit-Depth

Bit depth defines how many unique colors or grey levels are available in an image after digitization. The number of bits used to quantify limits the number of levels to be used.

e.g.: 4 bits limits the quantification levels to $2^4 = 16$.
Each pixel can represent 16 grey levels

8 bits to	2^8	=	256 values per pixel
12 bits to	2^{12}	=	4096 values per pixel
16 bit to	2^{16}	=	65536 values per pixel



Every additional bit doubles the number for quantification.

SVCam output is 8 or 12 bit.

Figure 18: illustration of rising amount of values/gray scales by increasing the bit format

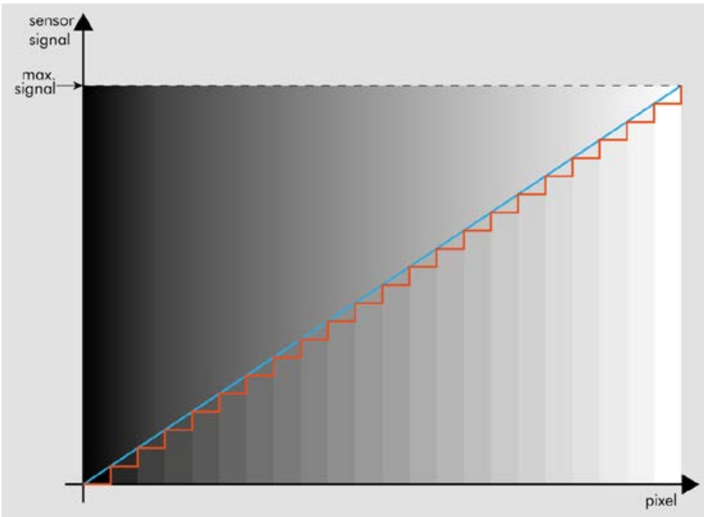


Figure 19: Simplified illustration of a quantification graph

Be aware that increasing the bit format from 8 to 12 bit also increases the total amount of data. According to the interface framerates cam be limited with higher bit depth values.

As SVCam's export pure RAW-format only, color will be added on the computer in accordance with the known Bayer-pattern.

Figure 20: illustration of shade difference in 8 bit format

As shown in figure 21 differences in shades of gray are hardly visable on screen or in print.

Figure 22: Figure of original picture - black & white

Figure 23: Figure of quantification with 6 shades of gray

6.1.9 Color

Color cameras are identical to the monochrome versions. The color pixels are transferred in sequence from the camera, in the same manner as the monochrome, but considered as "raw"-format.

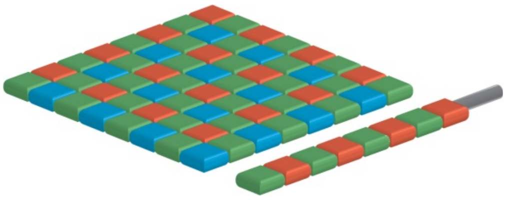


Figure 24: CCD with Bayer Pattern

The camera sensor has a color mosaic filter called "Bayer" filter pattern named after the person who invented it. The pattern alternates as follows:

E.g.: First line: GRGRGR... and so on. (R=red, B=blue, G=green) Second line: BGBGBG... and so on. Please note that about half of the pixels are green, a quarter red and a quarter blue. This is due to the maximum sensitivity of the human eye at about 550 nm (green).

Using color information from the neighboring pixels the RG and B values of each pixel is interpolated by software. E.g. the red pixel does not have information of green and blue components. The performance of the image depends on the software used.

NOTICE

It is recommended to use a IR cut filter for color applications!

White Balance

The human eye adapts to the definition of white depending on the lighting conditions. The human brain will define a surface as white, e.g. a sheet of paper, even when it is illuminated with a bluish light.

White balance of a camera does the same. It defines white or removes influences of a color tint in the image.

Influences normally depend on the light source used. These tints are measured in Kelvin (K) to indicate the color temperature of the illumination.

Light sources and their typical temperatures:

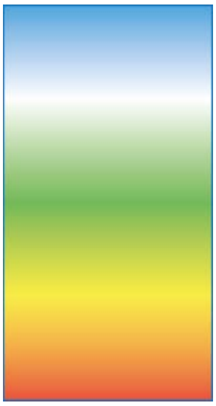
	Temperature	Common Light Source
	10.000 – 15.000 K	Clear Blue Sky
	6.500 – 8.000 K	Cloudy Sky / Shade
	5.500 – 6500 K	Noon Sunlight
	5.000 – 5.500 K	Average Daylight
	4.000 – 5.000 K	Electronic Flash
	4.000 – 5.000 K	Fluorescent Light
	3.000 – 4.000 K	Early AM / Late PM
	2.500 – 3.000 K	Domestic Lightning
	1.000 – 2.000 K	Candle Flame

Figure 25: Table of color temperatures

6.1.10 Resolution – active & effective

As mentions in the specifications, there is a difference between the active and the effective resolution of almost every sensor. Some pixels towards the borders of the sensor will be used only to calibrate the sensor values.

These pixels are totally darkened. The amount of dark current in these areas is used to adjust the offset.

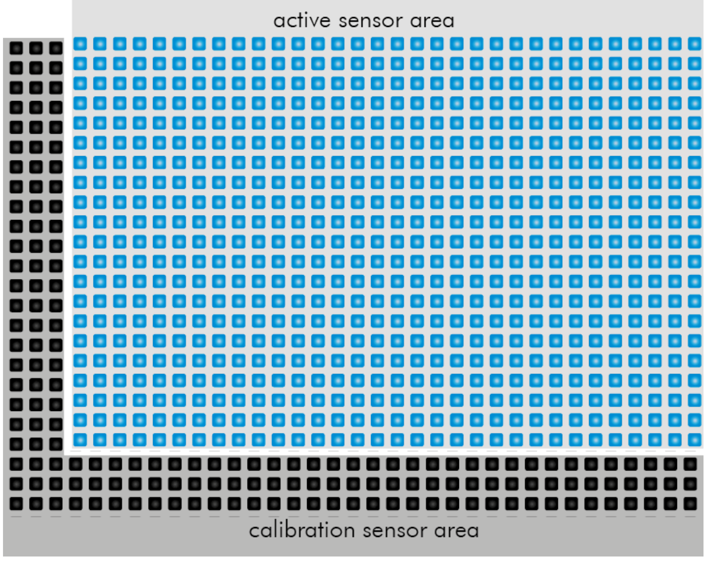


Figure 26: Illustration of active and effective sensor pixels

6.1.11 Offset

For physical reasons the output of a sensor will never be zero, even the camera is placed in total darkness or simply closed. Always there will be noise or randomly appearing electrons that will be detected as a signal.

To avoid this noise to be interpreted as a valuable signal, an offset will be set.

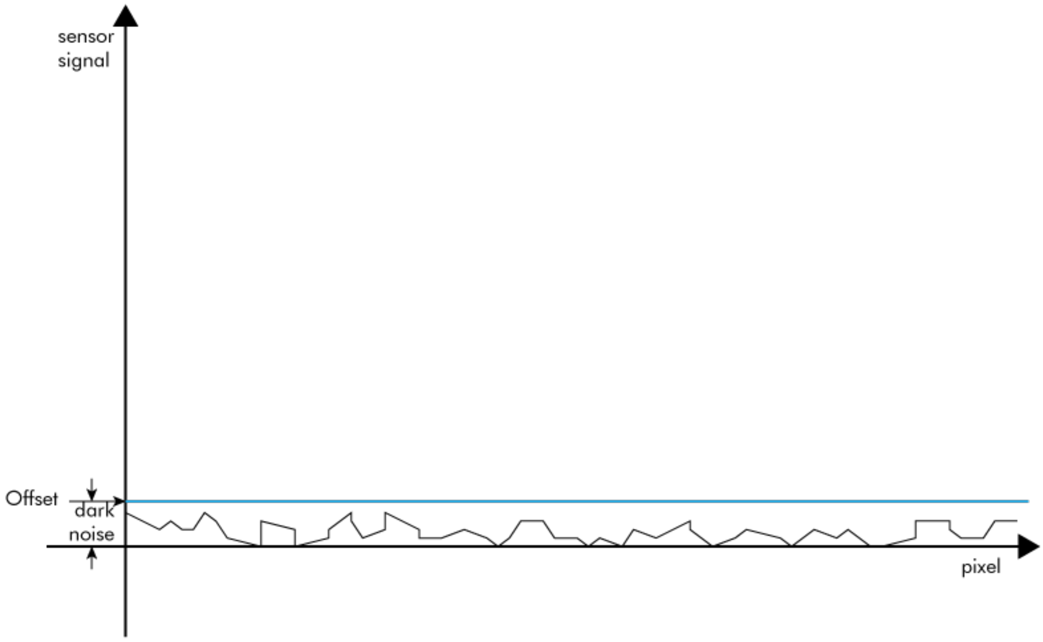


Figure 27: Illustration of dark noise cut off by the offset

Most noise is proportional to temperature. To spare you regulating the offset every time the temperature changes. A precedent offset is set by the camera itself. It references certain pixels that never were exposed to light as black (refer to "resolution – active and effective"). So the offset will be set dynamically and conditioned to external influences.

The offset can be limited by a maximum bit value. If higher values are needed, try to set a look up table.

In case of multi-tap CCD sensors:
Offset can be altered for each tap separately. Refer to "tap balancing".

6.1.12 Gain

Setting gain above 0 dB (default) is another way to boost the signal coming from the sensor. Especially useful for low light conditions.

Setting Gain amplifies the signal of individual or binned pixels before the ADC.

Referring to Photography adding gain corresponds to increasing ISO.

add 6 dB	double ISO value
6 dB	400 ISO
12 dB	800 ISO
18 dB	1600 ISO
24 dB	3200 ISO

Figure 28: Table of dB and corresponding ISO

NOTICE

Gain also amplifies the sensor's noise. Therefore, gain should be last choice for increasing image brightness. Modifying gain will not change the camera's dynamic range.

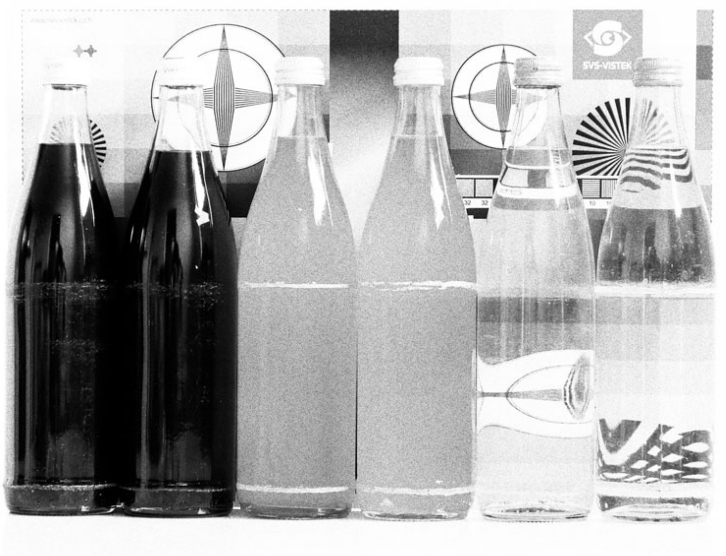


Figure 29: noise caused by increasing gain excessively

Auto Gain

For automatically adjusting Gain please refer to Auto Luminance.

6.1.13 Image Flip

Images can be mirrored horizontally or vertically. Image flip is done inside the memory of the camera, therefore not increasing the CPU load of the PC.

Figure 30: Figure of original image

Figure 31: Figure of image horizontally flipped

Figure 32: Figure of image vertically flipped

6.1.14 Binning

Binning provides a way to enhance dynamic range, but at the cost of lower resolution. Instead of reading out each individual pixel, binning combines charge from neighboring pixels directly on the chip, before readout.

Binning is only used with monochrome CCD Sensors. For reducing resolution on color sensors refer to Decimation.

Vertical Binning

Accumulates vertical pixels.

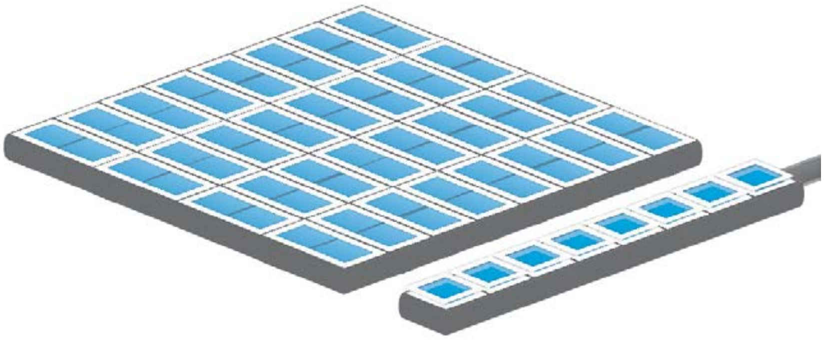


Figure 33: Illustration of vertical binning

Horizontal Binning

Accumulates horizontal pixels.

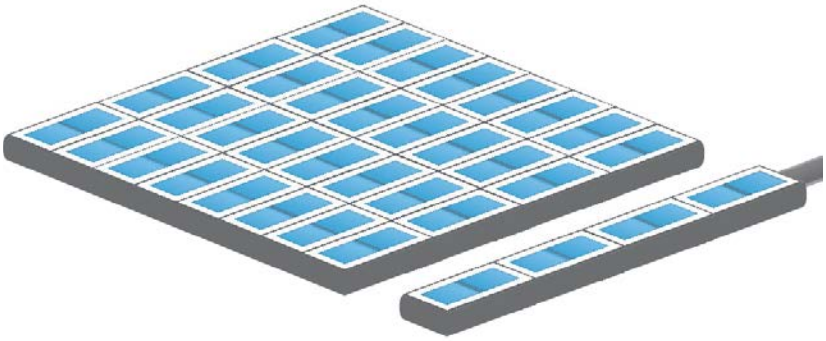


Figure 34: Illustration of horizontal binning

2×2 Binning

A combination of horizontal and vertical binning.

When DVAL signal is enabled only every third pixel in horizontal direction is grabbed.

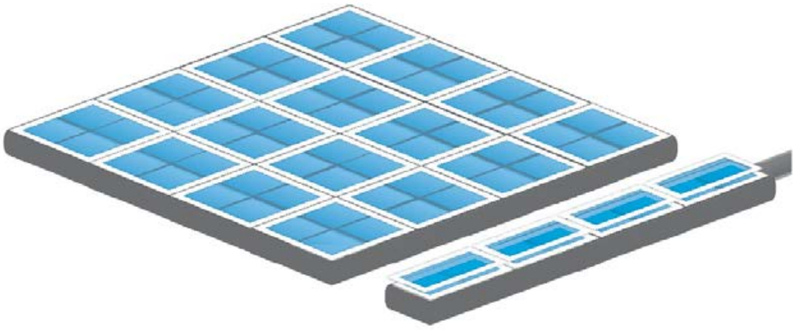


Figure 35: Illustration of 2x2 binning

Binning up to 4×4 is possible.

6.1.15 Decimation

For reducing width or height of an image, decimation can be used. Columns or rows can be ignored.

Refer to AOI for reducing data rate by reducing the region you are interested in.

Figure 36 Horizontal decimation Figure 37 Vertical decimation

Decimation on Color Sensors

The Bayer pattern color information is preserved with 1/3 horizontal and vertical resolution. The frame readout speed increases approx. by factor 2.5.

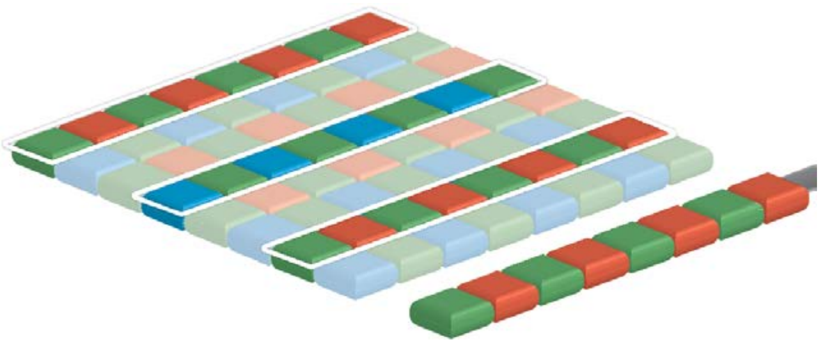


Figure 38: Illustration of decimation on color sensors

6.1.16 Burst Mode

The user interfaces provided will limit the maximum framerate to the maximum framerate of the interface of the camera (or sensor if lower). Inside the camera, the sensor speed (internal framerate) might be higher than the external interface's speed (e.g. GigE).

In triggered mode though, trigger frequency might be higher than the external interface's speed. The triggered images will stay in the internal memory buffer and will be delivered one after the other. If trigger frequency is higher than interface max fps frequency, there will be more and more images in the internal iamge buffer. As soon as the buffer is filled up, frames will be dropped. The internal-save-images and deliver-later thing is called Burst Mode.

Usage of Burst Mode

Burst Mode has 2 main purposes:

- If transfer speed breaks down (e.g. Ethernet transfer rate due to high network load), tolerate low speed transfer for a short time and deliver frames later on (buffering low speed interface performance for a short time)
- For several frames (up to full internal memory) images can be taken with higher frame rate than camera specs are suggesting (as soon as there is enough time later on to deliver the images)

Please note, as soon as the internal memory buffer is filled up, frames will be dropped.

6.2 Camera Features

6.2.1 Standard Tap Geometries

Similar to other sensor readout technologies Camera Link is sending many pixel values in parallel at the same time. The image can be split in "taps" or "channels" which can be sent in parallel. The tap geometry is describing how many taps are read and how they are transmitted through the Camera Link interface.

Table 2: recommende tap configuration for HR25 and SHR47

Camera	Tap config	Tap geometry	Maximum speed	CL type
HR25	8T8	1X8_1Y	25	Full
	10T8	1X10_1Y	31	Deca
SHR47	2T8	1X2_1Y	3,5	Base
	4T8	1X2_2YE	7	Medium
	4T12	1X2_2YE	7	Medium

6.2.2 Tap Structure

Your camera may be equipped with a two, four or even higher taped sensor.

Camera output format	Tap geometry
1X–1Y	Single tap
1X–2YE	Dual tap
2X–1Y	Dual tap
2X–2YE	Four tap

Figure 39: table of tap geometry/configurations

Tap configuration

For information according to your sensor refer to specifications.

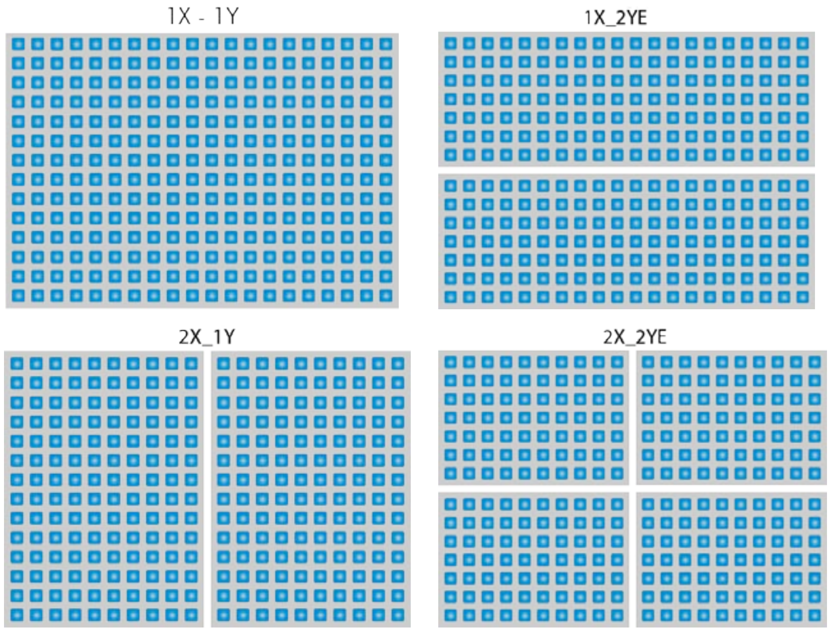


Figure 40: Illustrations of the nomenclature used in specifications

Single-Tap

In a single-tap CCD sensor the readout of pixel charge is done sequentially. Pixel by pixel, line by line. The maximum frame rate is determined by the pixel clock frequency and the total number of pixels to be read out.

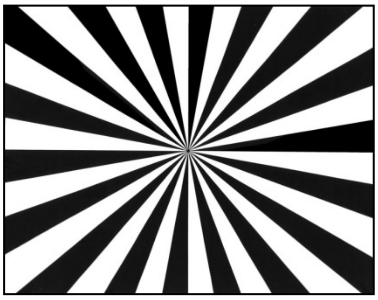


Figure 41: Figure of 1 Tap

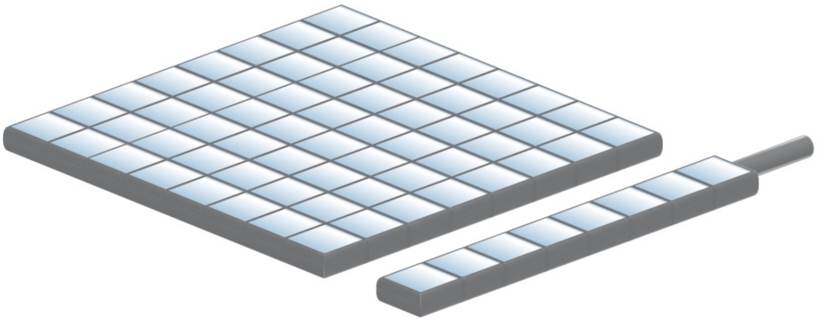


Figure 42: Illustration of 1 tap

Dual-Tap

In a dual-tap CCDs, (CCD with two outputs) the readout of pixel charge takes place in a serial/parallel sequence. Each line is divided in half and the pixels of both halves are read out simultaneously, line by line. For a given pixel clock frequency, only half the time is required to read out the entire array, resulting in twice the framerate.

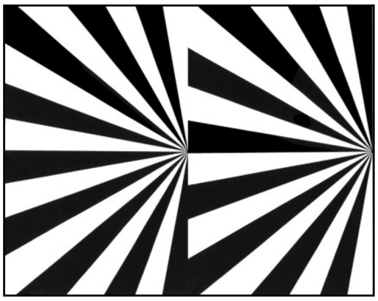


Figure 43: Figure of 2 taps

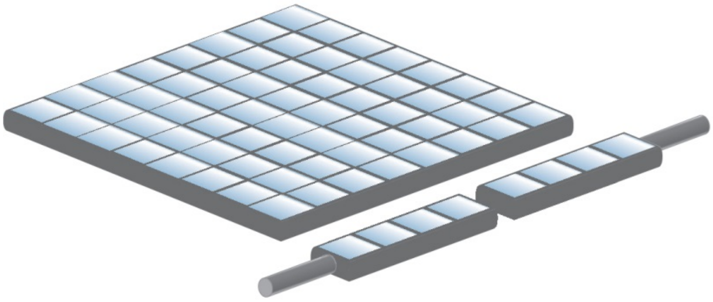


Figure 44: Illustration of 2 taps

Quad-Tap

Quad-tap CCDs (CCD with four outputs) the read out of pixels is four times faster than in a "regular" sensor.

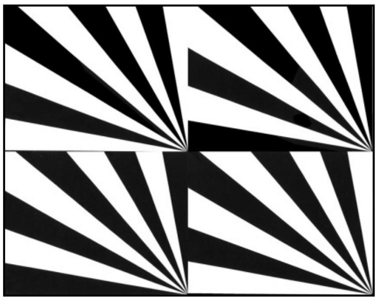


Figure 45: Figure of 4 taps

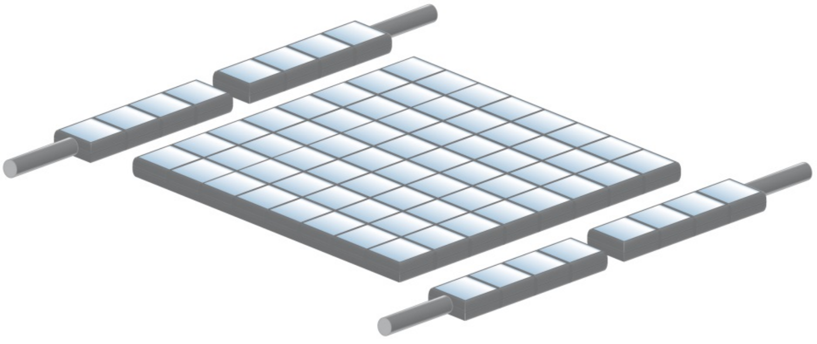


Figure 46: Illustration of 4 tap

Tap Reconstruction on Camera Link

Due to the sequence of arriving pixel information the frame grabber has to "reconstruct" the pixel information in order to display the image correctly.

6.2.3 Tap Balancing

In sensors with multiple the tap structure, parts of the picture may appear differently. Taps may display difference in dynamics and brightness.

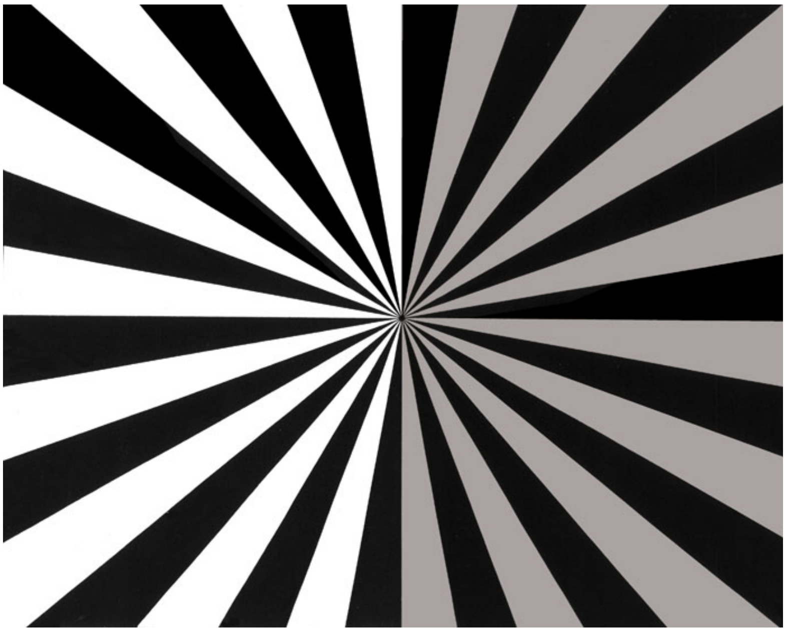


Figure 47: Figure of an unbalanced 2 tap image

To eliminate these differences, tap balancing offers gain adjustments separately for each tap.

This is due to the requirement for a dual or quad -ADC circuit to handle the simultaneous digitization of the two or more channels of analog signal coming from the CCD. The fact that the separate analog output channels not being perfectly linear and the separate output amplifiers having physically different slopes leads to the necessity to sometimes manually or automatically adjust the gain levels of each channel independently to obtain a homogenous image.

Automatic Tap Balancing

Automatic Tap Balancing analyses a narrow strip at the border of the taps. It adjusts the gain value to the average brightness value of these strips.

Continuously Tap Balancing

Automatic Tap Balancing can be done continuously. Taps will be balanced from one image to the next.

Tap Balancing once

When performing Tap Balancing once. Only one specific image will be analyzed. The gain-correction values will be saved and applied to subsequent images.

Manual Tap Balancing

Tap Balancing can be performed manually

6.2.4 System Clock Frequency

Default system clock frequency in almost every SVCam is set to 66.6 MHz. To validate your system frequency: refer to: specifications.

Using the system clock as reference of time, time settings can only be made in multiples of 15 ns.

$$t = \frac{1}{66.\overline{6}\,MHz} = \frac{1}{66\,666\,666.\overline{6}\,\frac{1}{s}} = 15 \cdot 10^{-9}\,s = 15\,ns$$

NOTICE

Use multiples of 15 ns to write durations into camera memory

6.2.5 Temperature Sensor

A temperature sensor is installed on the mainboard of the camera.

To avoid overheating, the temperature is constantly monitored and read. Besides software monitoring, the camera indicates high temperature by a red flashing LED. (See flashing LED codes)

6.2.6 Read-Out-Control

Read-Out-Control defines a delay between exposure and data transfer. Read-Out-Control is used to program a delay value (time) for the readout from the sensor.

With more than one camera connected to a single computer, image acquisition and rendering can cause conflicts for data transfer, on CPU or bus-system.

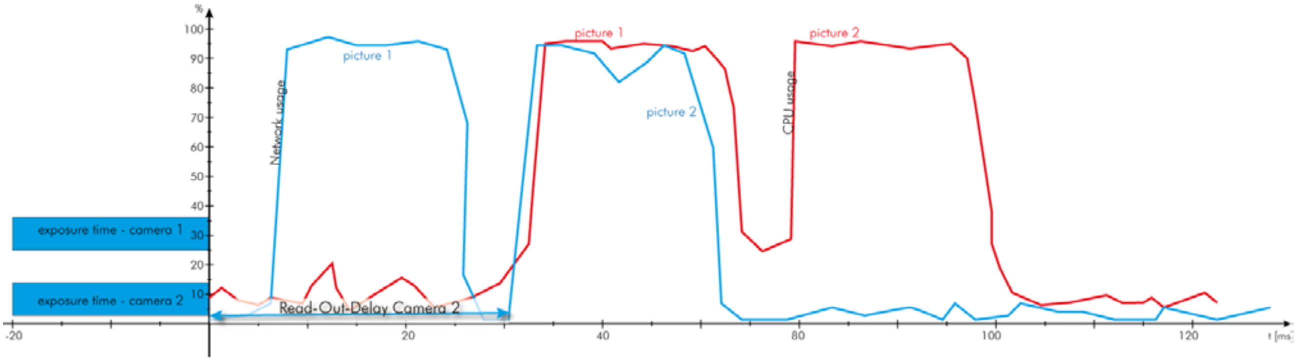


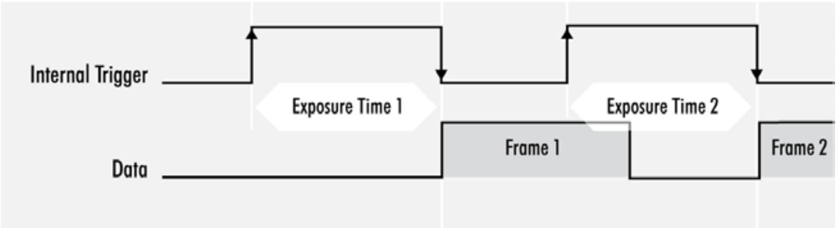
Figure 48: Illustration of physical data stream in time

6.2.7 Basic Capture Modes

Free Running

Free running (fixed frequency) with programmable exposure time. Frames are readout continously and valid data is indicated by LVAL for each line and FVAL for the entire frame.

Mode 0: Free Running with Programmable Exposure Time



There is no need to trigger the camera in order to get data. Exposure time is programmable via serial interface and calculated by the internal logic of the camera.

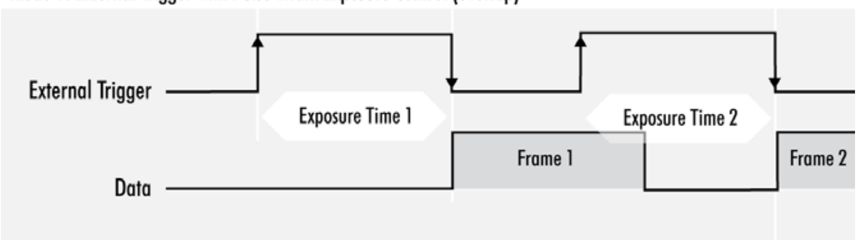
NOTICE

The fundamental signals are:
Line Valid: LVAL, Frame Valid: FVAL,
And in case of triggered modes: trigger input.

Triggered Mode (pulse width)

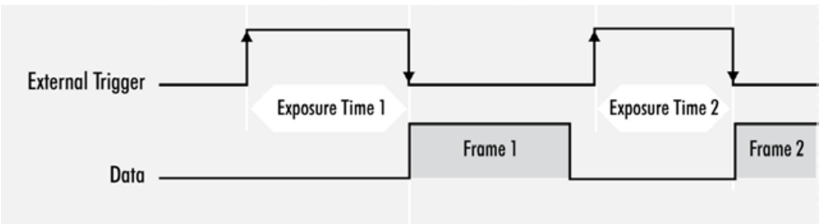
External trigger and pulse-width controlled exposure time. In this mode the camera is waiting for an external trigger, which starts integration and readout. Exposure time can be varied using the length of the trigger pulse (rising edge starts integration time, falling edge terminates the integration time and starts frame read out). This mode is useful in applications where the light level of the scene changes during operation. Change of exposure time is possible from one frame to the next.

Mode 1: External Trigger with Pulse Width Exposure Control (overlap)



Exposure time of the next image can overlap with the frame readout of the current image (rising edge of trigger pulse occurs when FVAL is high). When this happens: the start of exposure time is synchronized to the falling edge of the LVAL signal.

Mode 1: External Trigger with Pulse Width Exposure Control (non overlap)



When the rising edge of trigger signal occurs after frame readout has ended (FVAL is low) the start of exposure time is not synchronized to LVAL and exposure time starts after a short and persistant delay.

The falling edge of the trigger signal must always occur after readout of the previous frame has ended (FVAL is low).

External Trigger (Exposure Time)

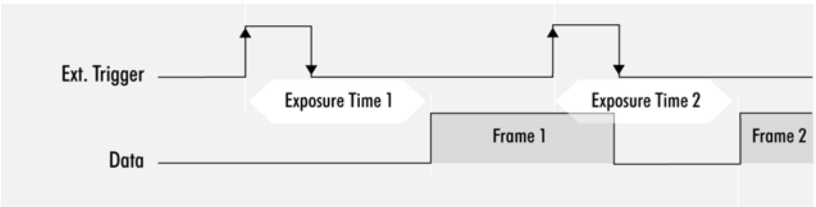
External trigger with programmable exposure time. In this mode the camera is waiting for an external trigger pulse that starts integration, whereas exposure time is programmable via the serial interface and calculated by the internal microcontroller of the camera.

At the rising edge of the trigger the camera will initiate the exposure.

The software provided by SVS-Vistek allows the user to set exposure time e.g. from 60 µs 60 Sec (camera type dependent).

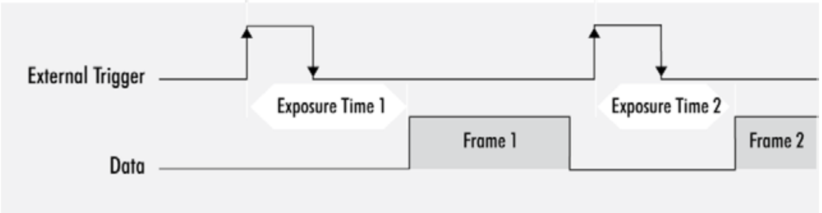
Exposure time of the next image can overlap with the frame readout of the current image (trigger pulse occurs when FVAL is high). When this happens, the start of exposure time is synchronized to the negative edge of the LVAL signal (see figure)

Mode 2: External Trigger with Programmable Exposure Time (overlap)



When the rising edge of trigger signal occurs after frame readout has ended (FVAL is low), the start of exposure time is not synchronized to LVAL and exposure time starts after a short and persistant delay.

Mode 2: External Trigger with Programmable Exposure Time (non overlap)

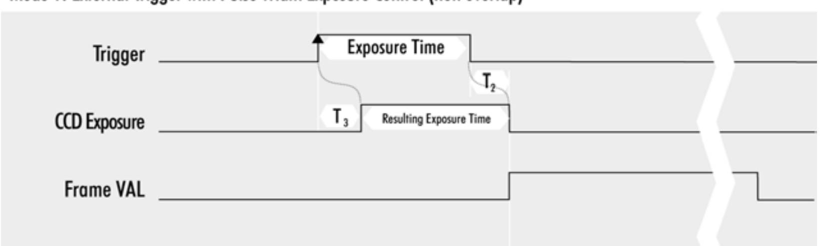


Exposure time can be changed during operation. No frame is distorted during switching time. If the configuration is saved to the EEPROM, the set exposure time will remain also when power is removed.

Detailed Info of External Trigger Mode

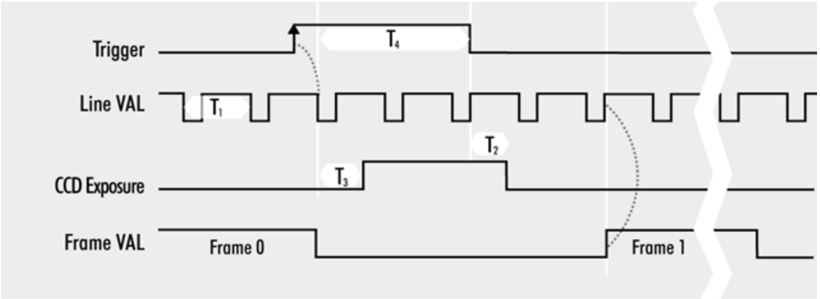
Dagrams below are aquivalent for CCD and CMOS technique.

Mode 1: External Trigger with Pulse Width Exposure Control (non overlap)



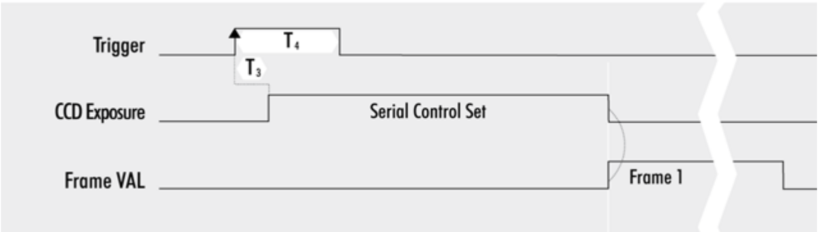
T_1: Line Duration T_2: Transfer Delay T_3: Exposure Delay T_4: min. Trigger Pulse Width

Mode 1: External Trigger with Pulse Width Exposure Control (overlap)



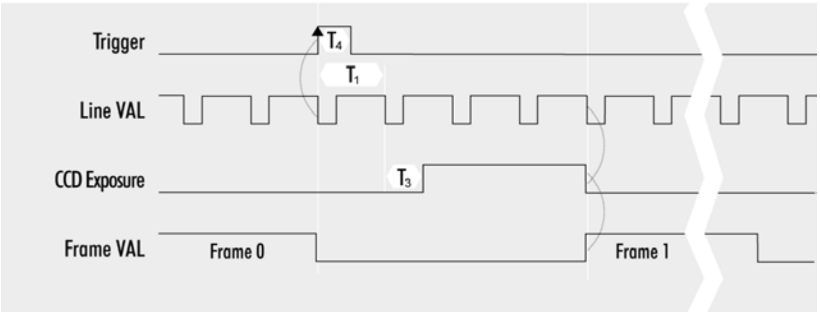
T1: Line Duration T2: Transfer Delay T3: Exposure Delay T4: min. Trigger Pulse Width

Mode 2: External Trigger with Programmable Exposure Time (non overlap)



T1: Line Duration T2: Transfer Delay T3: Exposure Delay T4: min. Trigger Pulse Width

Mode 2: External Trigger with Programmable Exposure Time (overlap)



T1: Line Duration T2: Transfer Delay T3: Exposure Delay T4: min. Trigger

Software Trigger

Trigger can also be initiated by software (serial interface).

NOTICE

Software trigger can be influenced by jitter. Avoid Software trigger at time sensitive applications

6.2.8 LookUp Table

The LookUp Table Feature (LUT) lets the user define certain values to every bit value that comes from the ADC.

To visualize a LUT a curve diagram can be used, similar to the diagrams used in photo editing software.

The shown custom curve indicates a contrast increase by applying an S-shaped curve. The maximum resolution is shifted to the mid-range. Contrasts in this illumination range is increased while black values will be interpreted more black and more of the bright pixels will be displayed as 100 % white...

For further Information about curves and their impact on the image refer to our homepage: [Knowledge Base – LUT]

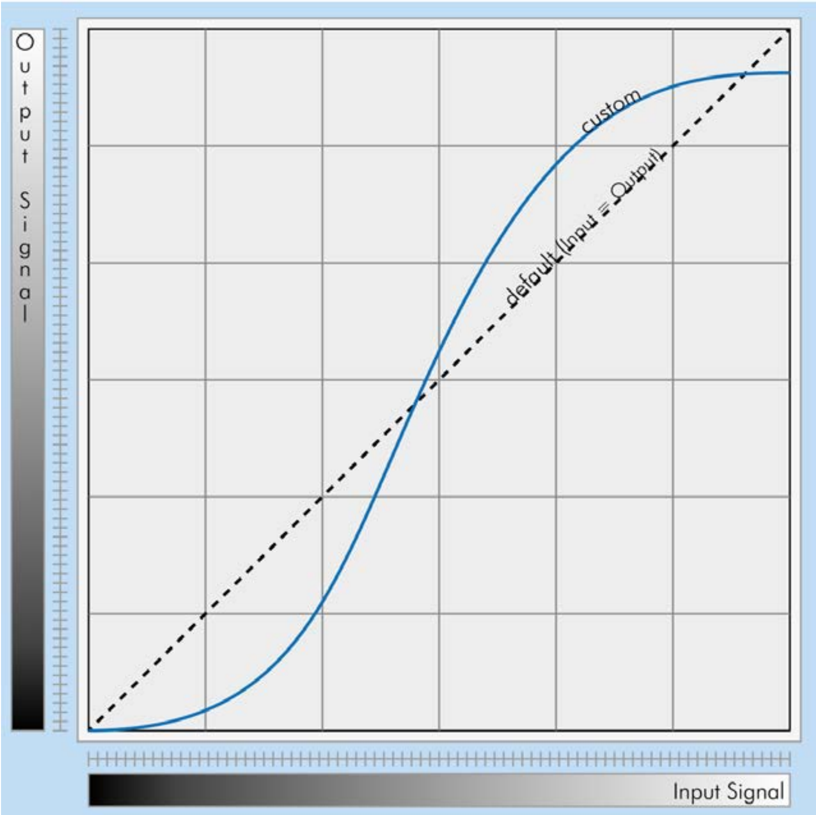


Figure 49: illustration of a custom LUT adding contrast to the midtones

NOTICE

LUT implementation reduces bit depth from 12 bit to 8 bit on the output.

Gamma Correction

Using the LookUp Table makes is also possible to implement a logarithmic correction. Commonly called Gamma Correction.

Historically Gamma Correction was used to correct the illumination behavior of CRT displays, by compensating brightness-to-voltage with a Gamma value between 1,8 up to 2,55.

The Gamma algorithms for correction can simplify resolution shifting as shown seen above.

Input & Output signal range from 0 to 1

$$\text{Output-Signal} = \text{Input-Signal}^{\text{Gamma}}$$

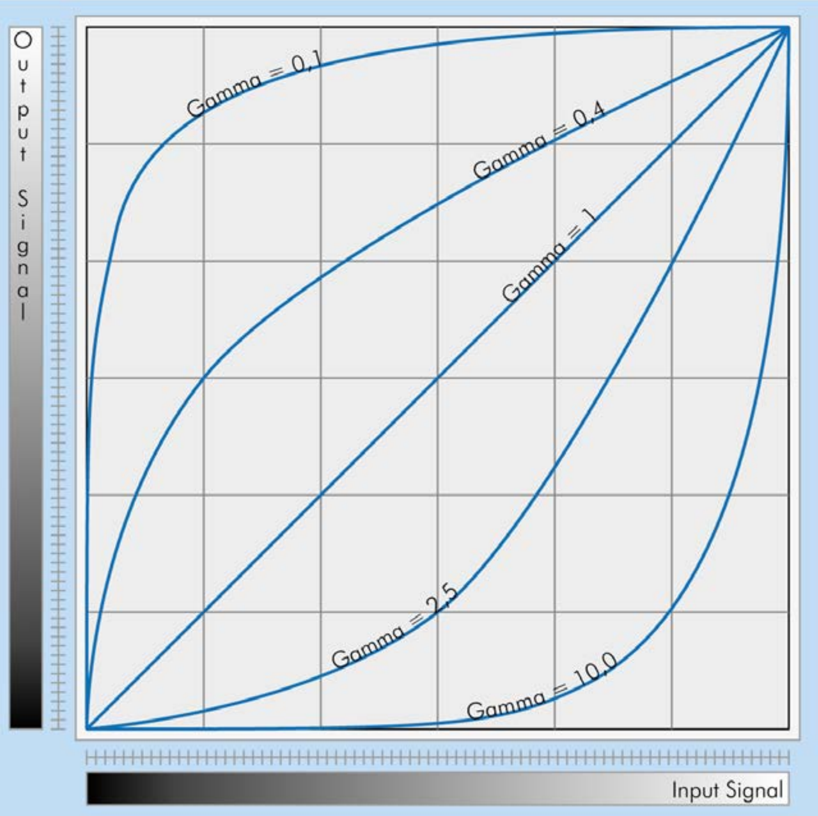


Figure 50: illustration of several gamma curves comparable to a LUT

Gamma values less than 1.0 map darker image values into a wider ranger.
Gama values greater than 1.0 do the same for brighter values.

NOTICE

Gamma Algorithm is just a way to generate a LUT. It is not implemented in the camera directly..

6.2.9 ROI / AOI

In Partial Scan or Area-Of-Interest or Region-Of-Interest (ROI) -mode only a certain region will be read.

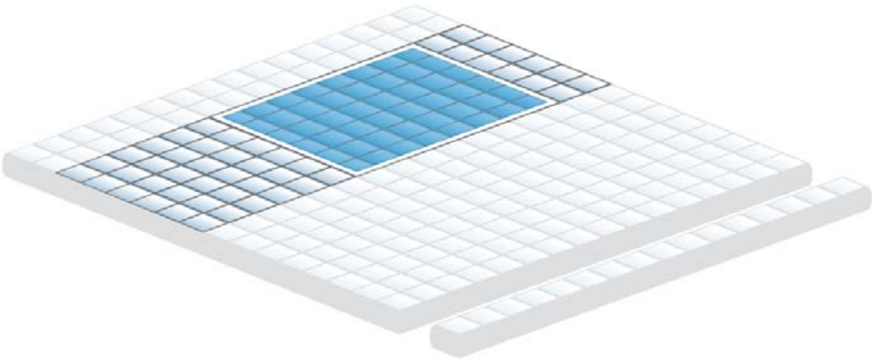


Figure 51: Illustration of AOI limitation on a CCD sensor

Selecting an AOI will reduce the number of horizontal lines being read. This will reduce the amount of data to be transferred, thus increasing the maximum speed in term of frames per second.

With CCD sensors, setting an AOI on the left or right side does not affect the frame rate, as lines must be read out completely.

6.2.10 PIV

By using PIV mode on CCD sensor cameras it is possible to capture 2 images within extremely short time.

Based on the "interline transfer" of CCD sensors, in the PIV mode the first picture is transferred to the vertical shift register, while the second picture is taken. The readout of picture 1 will take place during the second exposure time.

So the time between 2 images can be shortened to transfer time only – contact us (@ SVS-VISTEK.com) for camera and sensor specific minimum transfer time/duration.

„Triggered with external exposure" (via pulse width of the Exsync signal) or alternatively „triggered with internal exposure"(set via internal microcontroller). This is useful for "particle image velocimetry" (PIV).

The first exposure starts approx. 5 µs after the camera has detected the rising edge of Exsync.

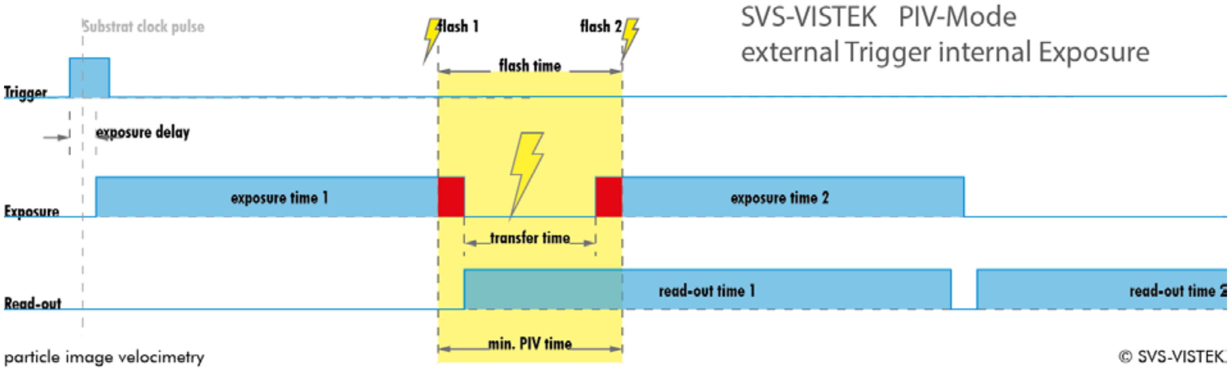


Figure 52: Illustration of PIV mode with external trigger & internal exposure time

The read-out time 1 and the exposure time 2 start both directly after the image transfer of image 1. The exposure time 2 ends when the read-out of image 1 has finished. After the read out of image 1 is done, image 2 is transferred and read out. The readout time of each camera is sensor dependent. Please contact the SVS-Vistek support team for details on sensor readout timing.

During the read out of the 2nd image the camera cannot take images until the next Exsync signal (rising edge) arrives and initiates the next exposure cycle.

Without PIV-Mode enabled, all camera modes like “free running “or “triggered with internal exposure control“ function as described.

6.2.11 Pixel Clock Frequency Selection

Besides the factory frequency setting other values can be available for CCD sensors. Please contact us in case you need higher pixel clock.

Charges will be transported faster, more frames per second will be generated.

Default value is as recommended in sensor specifications.

NOTICE

Higher Frequencies can result in a loss of quality.

6.2.12 Defect Pixel Correction

Defect Pixel Correction interpolates information from neighboring pixels to compensate for defect pixels or clusters (cluster may have up to five defect pixels).

All image sensor have defect pixels in a lesser or greater extent. The number of defects determines the quality grade and the value of all sensors integrated by SVS-VISTEK.

Defect Pixels either be dark pixels, i.e. that don't collect any light, or bright pixels (hot pixel) that always are outputting a bright signal.

The amount of hot pixels is proportional to exposure time and temperature of the sensor.

By default, all known defect pixels or clusters are corrected by SVS-VISTEK.

Under challenging conditions or high temperature environments additional defect pixels can may appear. These can be corrected.

- A factory created defect map (SVS map), defying known defects, is stored in the camera…
- A custom defect map can be created by the user. A simple txt file with coordinates has to be created. The user must locate the pixel defects manually.
- The txt file can be uploaded into the camera. Beware of possible Offset!
- Defect maps can be switched off to show all default defects, and switched back on to improve image quality.

Unlike Shading Correction, Defect Pixel Correction suppresses pixels or clusters and reconstructs the expected value by interpolating neighboring pixels that. The standard interpolation algorithm uses the pixel to the left or to the right of the defect. This simple algorithm prevents high runtime losses.

More sophisticated algorithms can be used by software.

Figure 53: Illustration of a defect pixel

6.3 I/O Features

6.3.1 Assigning I/O Lines – IOMUX

The IOMUX is best described as a switch matrix. It connects inputs, and outputs with the various functions of SVCam I/O. It also allows combining inputs with Boolean arguments.

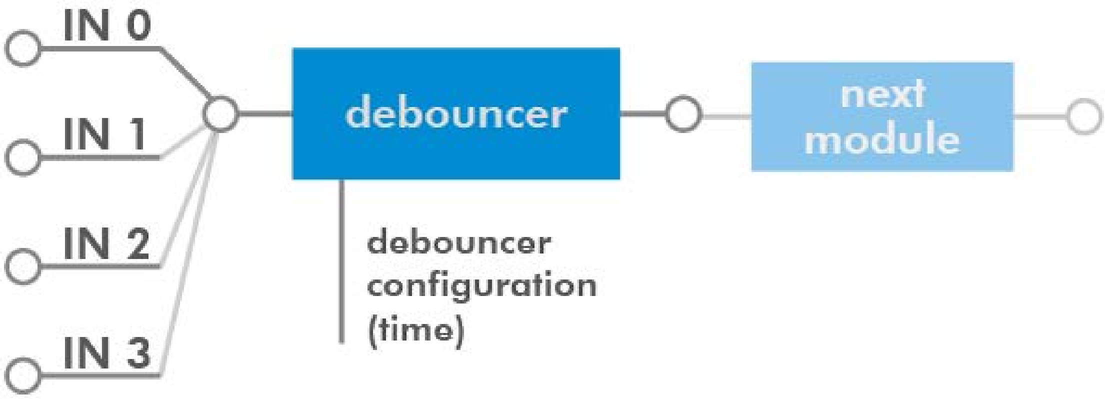


Figure 54: "IN0" connected to "debouncer"

The input and output lines for Strobe and Trigger impulses can be arbitrarily assigned to actual data lines. Individual assignments can be stored persistently to the EPROM. Default setting can be restored from within the Camera.

LineSelector	translation
Line0	Output0
Line1	Output1
Line2	Output2
Line3	Output3
Line3	Output4
Line5	Uart In
Line6	Trigger
Line7	Sequencer
Line8	Debouncer
Line9	Prescaler
Line10	Input0
Line11	Input1
Line12	Input2
Line13	Input3
Line14	Input4
Line15	LogicA
Line16	LogicB
Line17	LensTXD
Line18	Pulse0
Line19	Pulse1
Line20	Pulse2
Line21	Pulse3
Line22	Uart2 In

Note:

If you connect the camera with a non-SVS-Vistek GigEVision client, you might not see the clearnames of the lines, but only line numbers. In this case, use this list of line names

Refer to pinout in input / output connectors when physically wiring.

Also the IOMUX can be illustrated as a three dimensional dice. Long address spaces indicate which signals are routed to witch module within the camera.

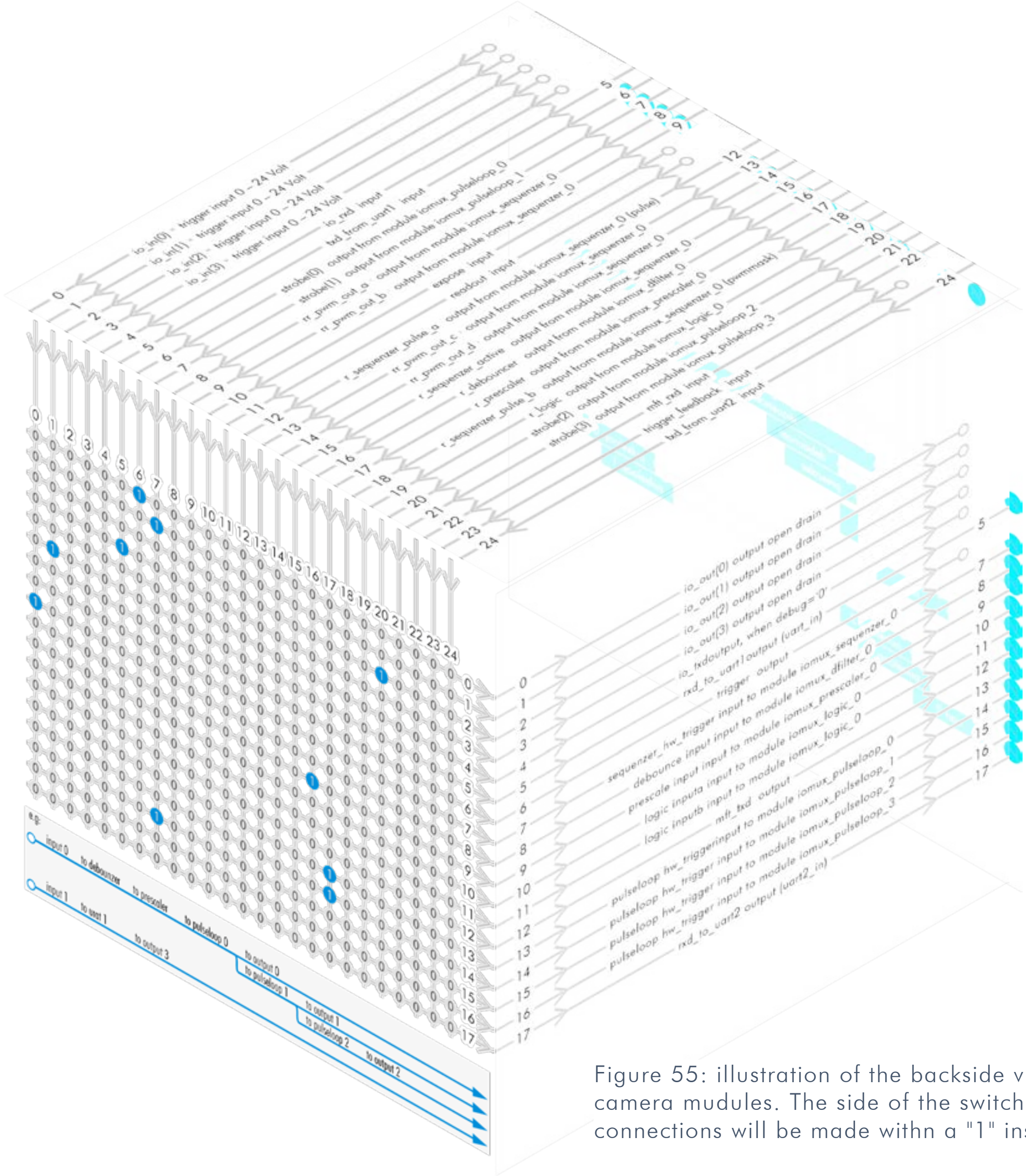
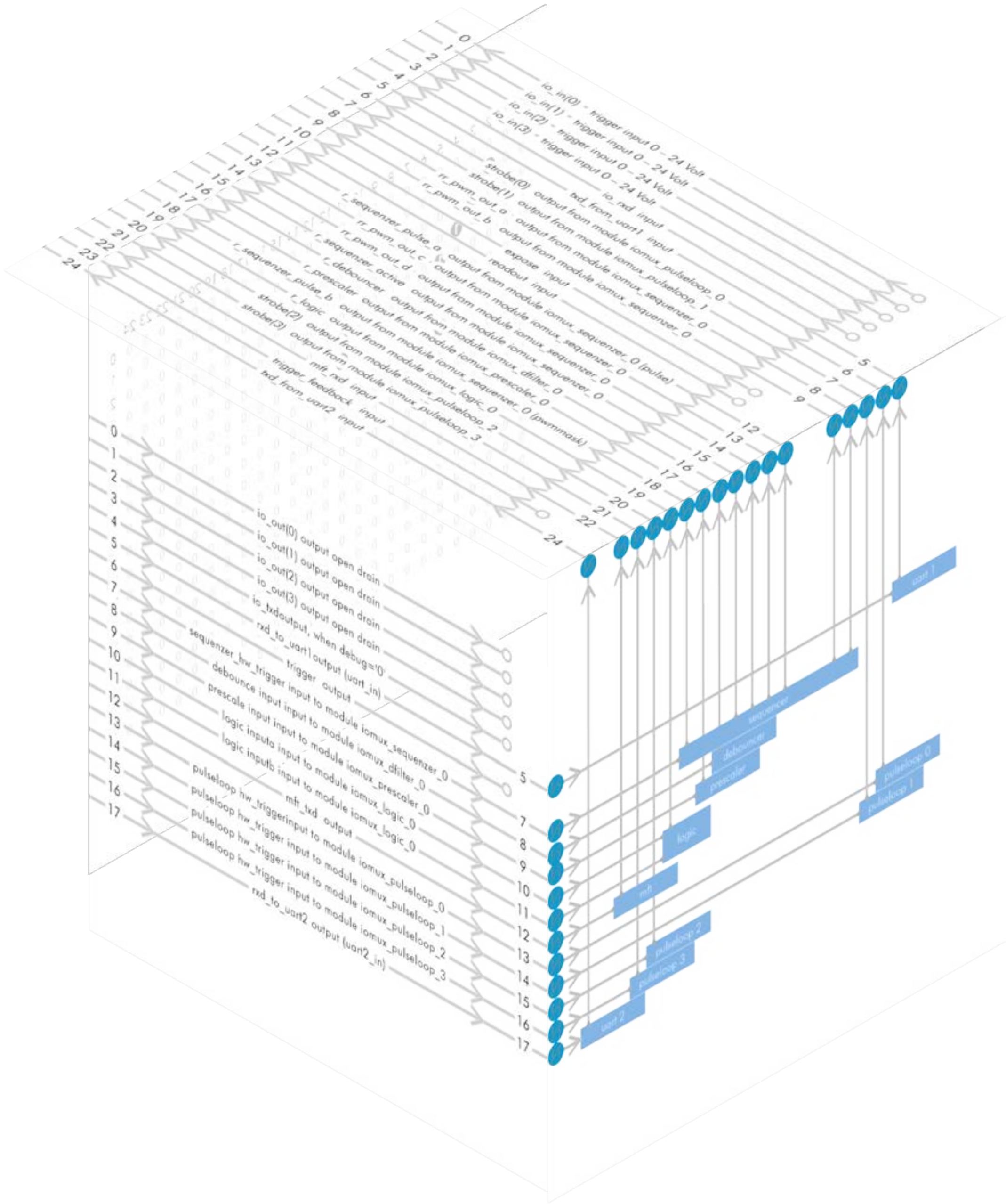


Figure 55: illustration of the backside view of the camera mudules. The side of the switch matrix. connections will be made withn a "1" instead of a "0"

Figure 56: illustration of frontside view to the camera modules.

Lines with open end indicate physical in- and outputs



input vector to switch matrix

nr.	name	description
0	io_in(0)	trigger input 0 – 24 Volt / RS-232 / opto *
1	io_in(1)	trigger input 0 – 24 Volt / RS-232 / opto *
2	io_in(2)	trigger input 0 – 24 Volt / RS-232 / opto *
3	io_in(3)	trigger input 0 – 24 Volt / RS-232 / opto *
4	io_rxd input	
5	txd_from_uart1	input
6	strobe(0)	output from module iomux_pulseloop_0
7	strobe(1)	output from module iomux_pulseloop_1
8	rr_pwm_out_a	output from module iomux_sequenzer_0
9	rr_pwm_out_b	output from module iomux_sequenzer_0
10	expose input	
11	readout input	
12	r_sequenzer_pulse_a	output from module iomux_sequenzer_0 (pulse)
13	rr_pwm_out_c	output from module iomux_sequenzer_0
14	rr_pwm_out_d	output from module iomux_sequenzer_0
15	r_sequenzer_active	output from module iomux_sequenzer_0
16	r_debouncer	output from module iomux_dfilter_0
17	r_prescaler	output from module iomux_prescaler_0
18	r_sequenzer_pulse_b	output from module iomux_sequenzer_0 (pwmmask)
19	r_logic	output from module iomux_logic_0
20	strobe(2)	output from module iomux_pulseloop_2
21	strobe(3)	output from module iomux_pulseloop_3
22	mft_rxd input	
23	trigger_feedback	input
24	txd_from_uart2	input

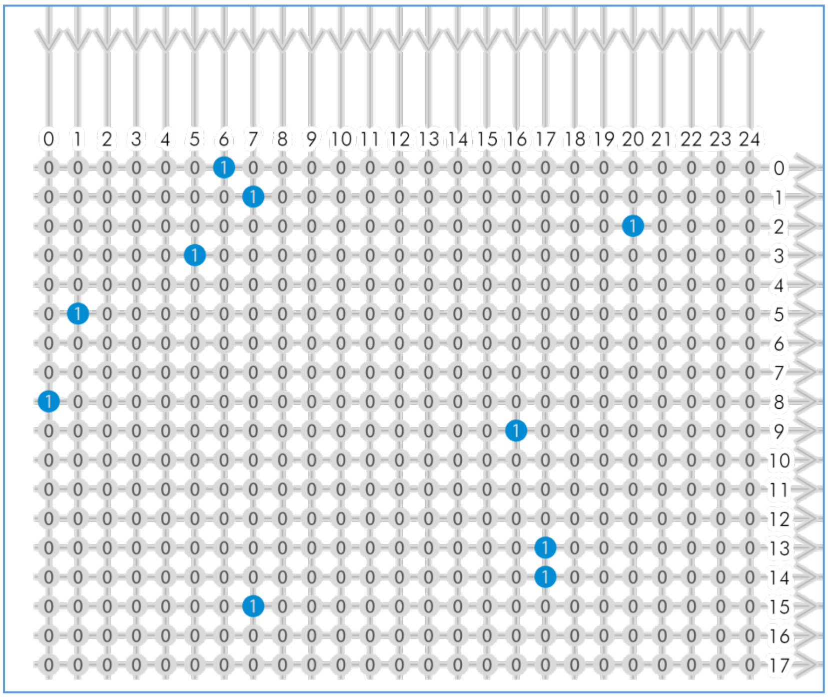
* refer to pinout or specifications

output vector from switch matrix

nr.	name / register	describtion
0	io_out(0)	output open drain
1	io_out(1)	output open drain
2	io_out(2)	output open drain *
3	io_out(3)	output open drain *
4	io_txd	output, when debug='0'
5	rxd_to_uart1	output (uart_in)
6	trigger	output
7	sequenzer_hw_trigger	input to module iomux_sequenzer_0
8	debounce input	input to module iomux_dfilter_0
9	prescale input	input to module iomux_prescaler_0
10	logic inputa	input to module iomux_logic_0
11	logic inputb	input to module iomux_logic_0
12	mft_txd	output
13	pulseloop hw_trigger	input to module iomux_pulseloop_0
14	pulseloop hw_trigger	input to module iomux_pulseloop_1
15	pulseloop hw_trigger	input to module iomux_pulseloop_2
16	pulseloop hw_trigger	input to module iomux_pulseloop_3
17	rxd_to_uart2	output (uart2_in)

* for physical number of open drain outputs refer to pinout or specifications

Example of an IOMUX configuration



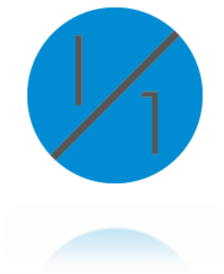
> The trigger signal comes in on line 0
> Debounce it.
connect line 0 to 8:
1000000000000000000000000
signal appears again on line 15 – debouncer out
> Use the prescaler to act only on every second pulse.
connect line 16 to 9.
0000000000000000100000000
signal appears again on line 17 – debouncer out
> Configure a strobe illumination with pulseloop module 0
connect line 17 to 13
signal from pulse loop module 0 appears on line 6
connect line 6 to 0 (output 0)
> Set an exposure signal with pulseloop module 1.
connect line 17 to 6
> Tell another component that the camera is exposing the sensor.
connect line 17 to 14
signal from pulse loop module 1 appears on line 7
connect line 7 to 1 (output 1)
> Turn of a light that was ON during the time between two pictures.
connect line 17 to 15
invert signal from pulse loop module 2
it appears on line 20
connect line 20 to 2 (output 2)

Inverter & Set-to-1

Inverter and "set to 1" is part of every input and every output of the modules included in the IOMUX.

Inverter

The inverter enabled at a certain line provides the reverse signal to or from a module.



Set to "1"

With set to "1" enabled in a certain line, this line will provide a high signal no matter what signal was connected to the line before.

Set to "1" – invers

The inverse of a set to "1" line will occour as a low signal, regardle the actual signal that came to the inverter modul.

6.3.2 Strobe Control

Drive LED lights form within your camera. Control them via ethernet.

Figure 57: use the breakout box to simplify your wiring

- SVCam cameras have built-in MOSFETs that can drive up to 3 Amperes.
- This allows using the cameras as a strobe controller – saving costs.
- High frequency pulse width modulation (PWM) for no flickering.
- Power to the LED light is provided through power of the camera.
- Setting of pulse, duty cycle is controlled via data connection / PC.
- LED-lights can be controlled over 4 different channels that can be used simultaneously or independent from each other
- According to the I/O specification of your camera two or four canals can be used as open drain. Refer to specifications.
- Max. current at 40 mSec. is 3 A

2 IO's high voltage drain

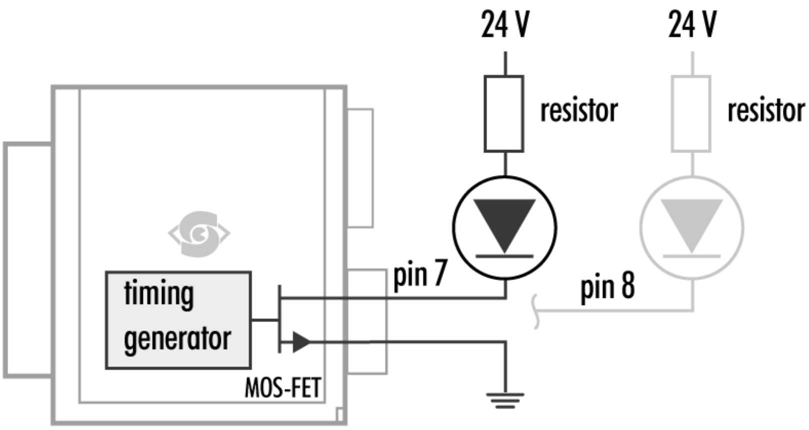


Figure 58: Illustration of two LEDs switched internal by the camera

For detailed connector pin out refer to Connectors.

For further information using the breakout box and simplifying OIs refer **SVCam Connectivity** manual. To be found separate within the USP manuals.

> **USE RIGHT DIMENSION OF RESISTOR!**
>
> To avoid overload of Driver, make sure to use the right dimension of resistor. If not done so, LEDs and/or Camera might be damaged.

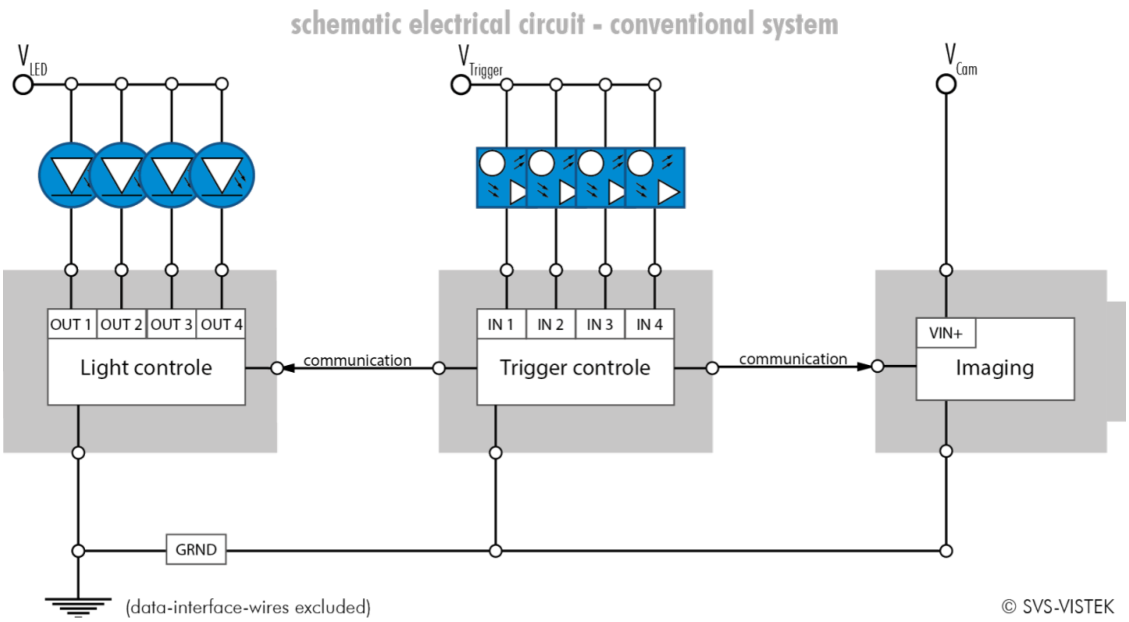


Figure 59: Illustration of conventional schematic electric circuit

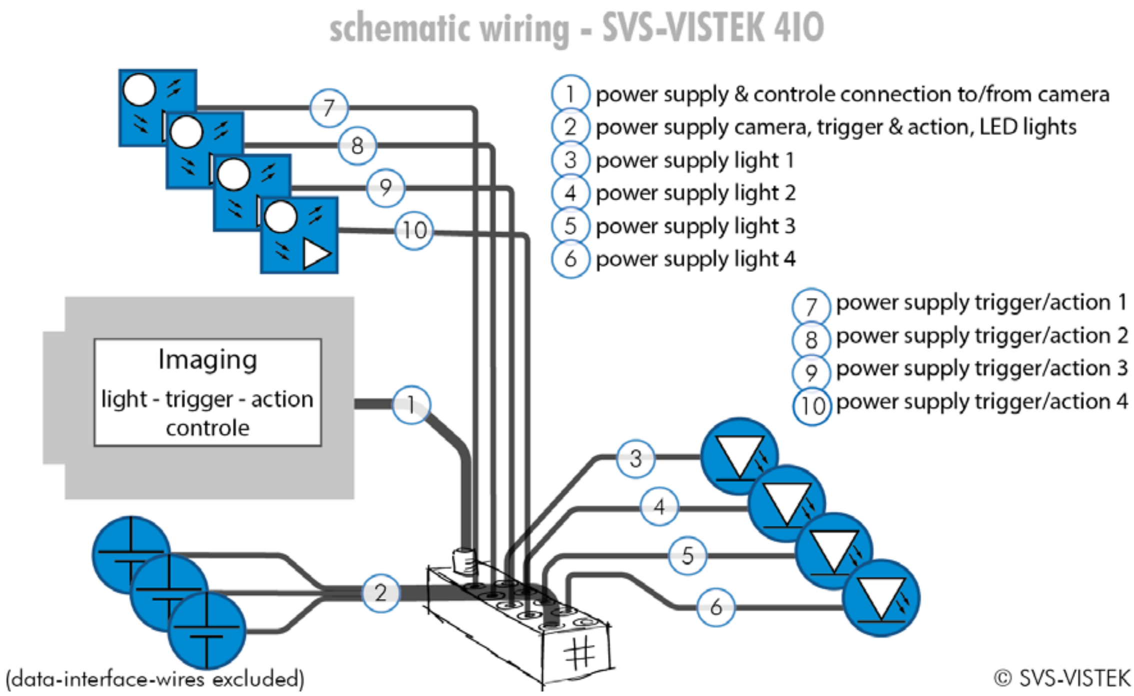


Figure 60: Illustration of schematic wiring with 4IO model using the break out box (matrix)

The pulseloop module

A fully programmable timer/counter function with four individual pulse generators (pulseloop0 - 3) that can be combined with all SVCam I/O functions, as well as physical inputs and outputs. All timing settings are programmable in 15ns intervals.

Programmable parameters:

- Trigger source (hardware or software)
- Edge or level trigger (HW trigger)
- Pulse output starting on low or high level
- Pre and post duration time
- Number of loops

Example applications

Initiated by an external trigger, the camera drives an LED illumination directly from the open drain output and initiates the camera exposure after a pre-defined delay.

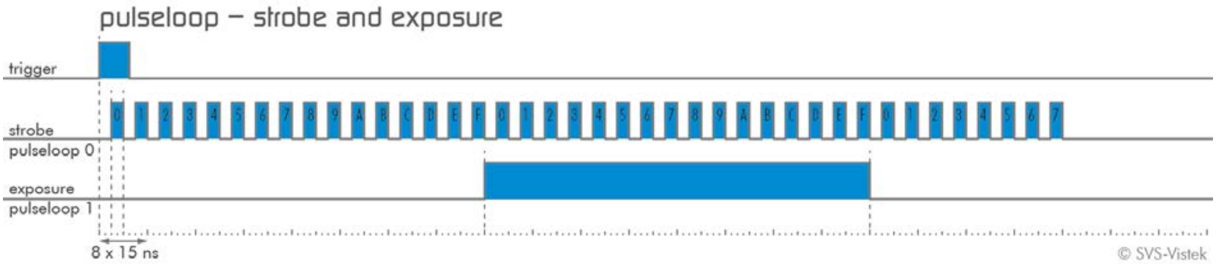


Figure 61: pulseloop for strobe and exposure

Camera cascade

Three cameras are triggered in cascade where the first camera is the master receiving the external trigger, and the master subsequently triggers the two slave cameras.

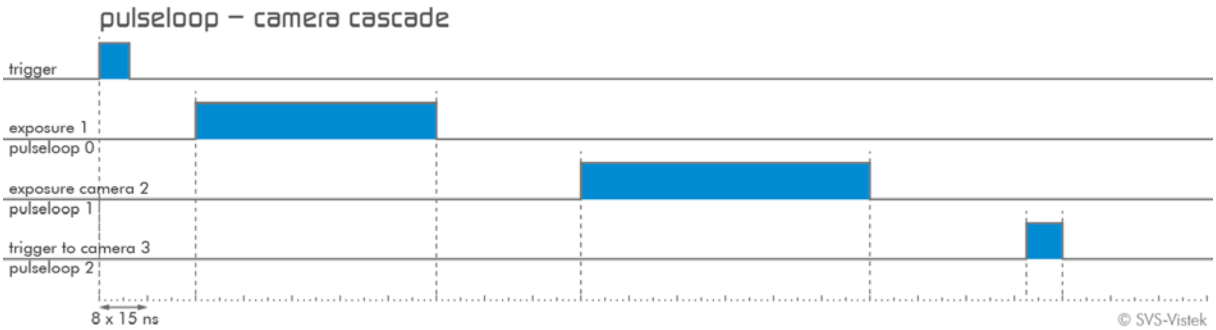
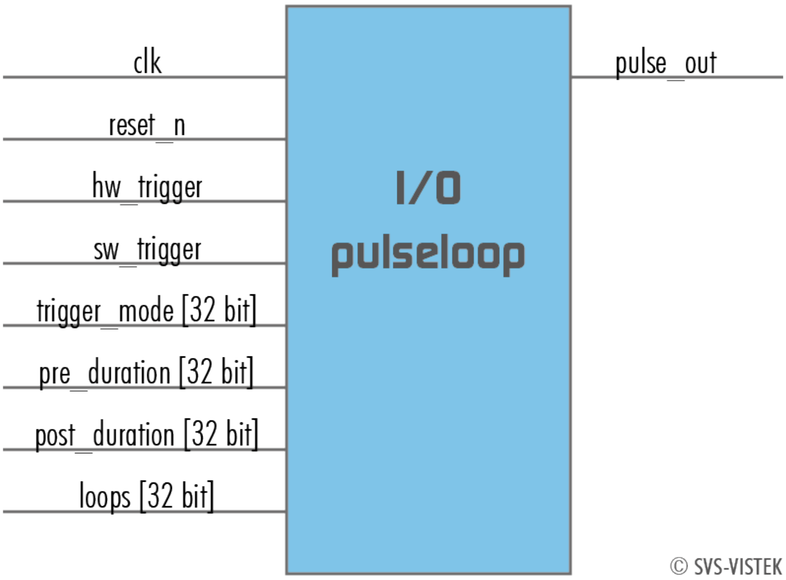


Figure 62: pulseloop – activating three cameras

Module pulseloop



LEDs in Continuous Mode

Example Calculation "No Flash" (CW Mode)	
Voltage drop al 5 LEDs, 2,2 V per LED (see spec. of LED)	11 V
Max. continuous current (see spec. of LED)	250 mA
Voltage Supply	24 V
Voltage drop at Resistor (24 V – 11 V)	13 V
Pull up Resistor R = $\frac{\mathbf{13\ V}}{\mathbf{250\ mA}}$	52 Ω

Total Power ($P = U \times I$)	6 W
Power at LEDs ($\mathbf{11\ V} \times \mathbf{250\ mA}$)	2,75 W
Power Loss at Resistor ($\mathbf{13\ V} \times \mathbf{250\ mA}$)	3,25 W

LEDs in Flash Mode

The MOS FETs at "OUT1" and "OUT2" are used like a "switch". By controlling "on time" and "off time" (duty cycle) the intensity of light and current can be controlled.

Current		"time ON" within a 1 Sec		PWM %	
0,75	A	500	ms	50	%
1	A	300	ms	33,3	%
2	A	70	ms	7	%
3	A	40	ms	4	%

Example: If pulse is 1.5 A the max. "on" time is 150 mSec. This means the "off" time is 850 mSec. The sum of "time on" and "time off" is 1000 mSec = 1 Sec.

NOTICE

The shorter the „time on" – the higher current can be used –the longer LEDs will work.

Strobe Timing

Exposure Delay

A value, representing the time between the (logical) positive edge of trigger pulse and start of integration time. Unit is 1µs. Default is 0µs.

Strobe Polarity

Positive or negative polarity of the hardware strobe output can be selected.

Strobe Duration

The exposure time of LED lights can be set in µsec. The min duration is 1 µsec. The longest time is 1 second.

Strobe Delay

The delay between the (logical) positive edge of trigger pulse and strobe pulse output can be set in µsec. Unit is 1µs. Default is 0µs.

Strobe Control Example Setup

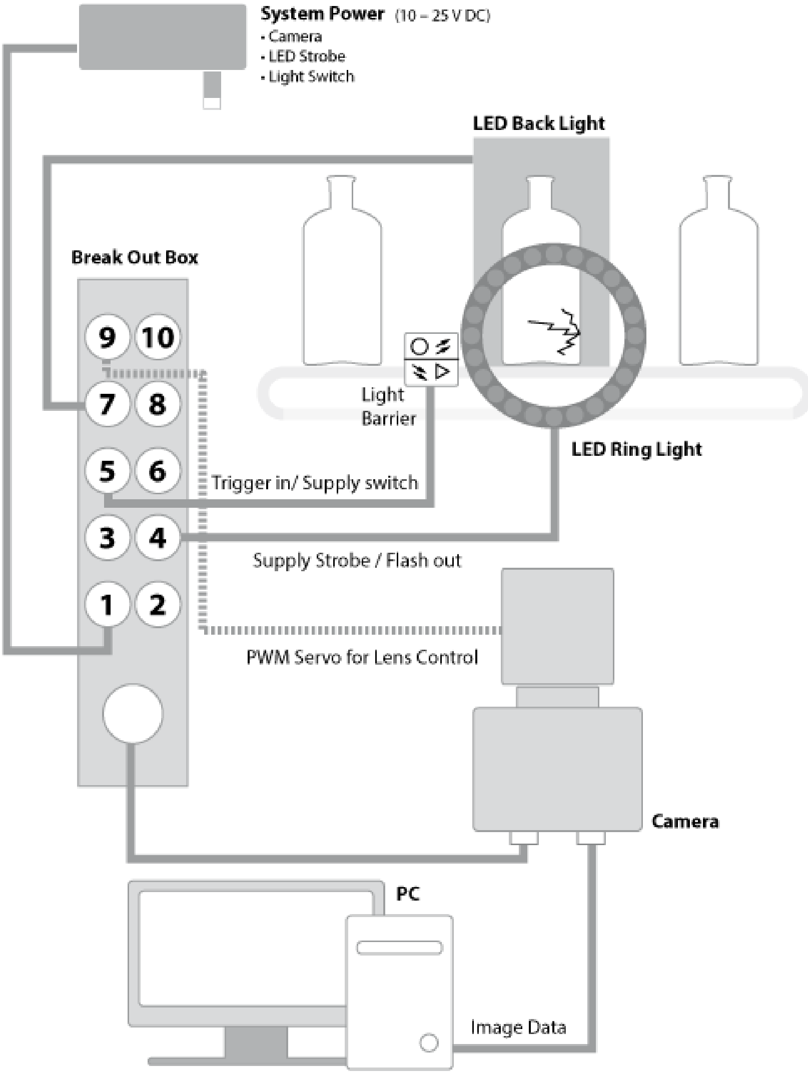


Figure 63: Illustration of an application using the 4IO

6.3.3 Sequencer

The sequencer is used when different exposure settings and illuminations are needed in a row.

E.g. the scenario to be captured may occur in three different versions and should therefore be recorded with three different light source settings. Each scenario/interval needs different illumination and exposure time.

The Sequencer allows not only detecting which scenario just appeared. Depending on the scenario there will be one optimal image for further analyzes.

Values to set	Unit	Description
Sequencer Interval	µs	Duration of the Interval
Exposure Start	µs	Exposure delay after Interval start
Exposure Stop	µs	Exposure Stop related to Interval Start
Strobe Start	µs	Strobe delay after Interval start
Strobe Stop	µs	Strobe Stop related to Interval Start
PWM Frequency	T	Basic duty cycle (1 / Hz) for PWM
PWM Line 1	%	Demodulation Result
PWM Line 2	%	Demodulation Result
PWM Line 3	%	Demodulation Result
PWM Line 4	%	Demodulation Result
Values can be set for every scenario/interval		

When setting "Exposure Start" and "Stop" consider 'read-out-time'. It has to be within the Sequencer Interval.

- Trigger Input can be set with the 4IO feature set
- For pysikal trigger input refer to pinout or specifications
- After trigger signal all programmed Interval will start.
- Up to 16 Intervals can be programmed.

Sequencer settings can be saved to EPROM or to desktop

Example:

Values to set	Interval 0	Interval 1	Interval 2
Sequencer Interval	1.000.000 µs (1s)	1.000.000 µs (1s)	1.000.000 µs (1s)
Exposure Start	220.000 µs	875.000 µs	190.000 µs
Exposure Stop	700.000 µs	125.000 µs	720.000 µs
Strobe Start	110.000 µs	125.000 µs	350.000 µs
Strobe Stop	875.000 µs	875.000 µs	875.000 µs
PWM Frequency	4 Hz	4 Hz	4 Hz
PWM Line 0	100	0	80
PWM Line 1	20	50	0
PWM Line 2	0	100	30
PWM Line 3	-	-	-
Trigger set to negative slope		Use higher frequencies	

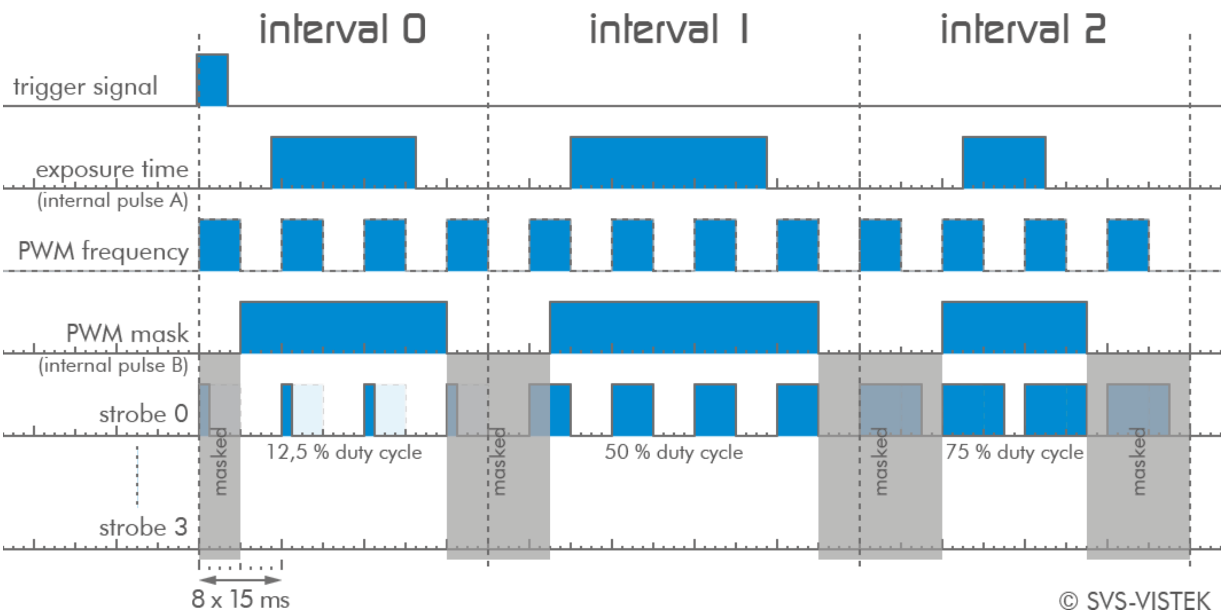


Figure 64: illustration of three sequencer intervals

6.3.4 PWM

Pulse width modulation

Description of the function used within the sequencer or implemented by the pulseloop module

During Pulse Width Modulation, a duty cycle is modulated by a fixed frequency square wave. This describes the ratio of ON to OFF as duty factor or duty ratio.

Why PWM?

Many electrical components must be provided with a defined voltage. Whether it's because they do not work otherwise or because they have the best performance at a certain voltage range (such as diodes or LEDs).

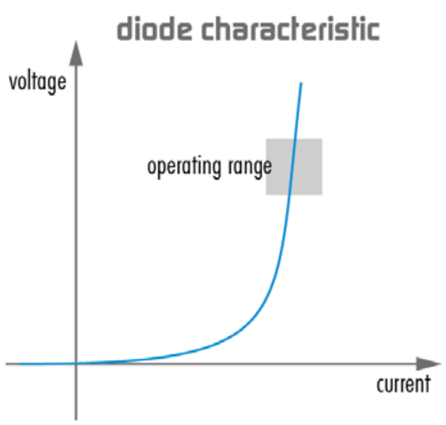
Diode characteristic

Since LEDs have a bounded workspace, the PWM ensures a variable intensity of illumination at a constant voltage on the diodes.

In addition, the lifetime of a diode increases. The internal resistance is ideal in this area. The diode gets time to cool down when operated with a PWM in its workspace.

Implementation of PWM

Modulation frequency:

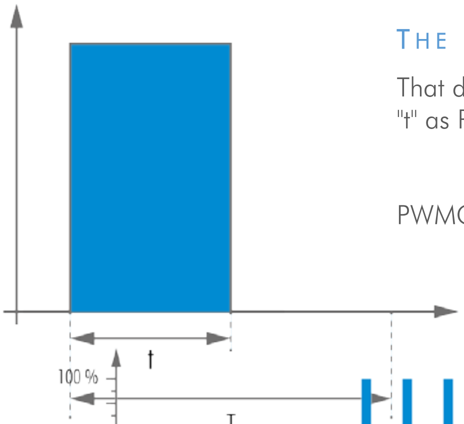


The basic frequency of the modulation is defined by the cycle duration "T".

$$T_{PWM} = \frac{1}{f_{PWM}}$$

Cycle duration "T" is written into the registry by multiple of the inverse of camera frequency. (15 ns steps) Refer to: Time unit of the camera.

$$T_{PWM} = \frac{1}{66,\bar{6}MHz} \cdot \text{PWMMax[SeqSelector]} = 15\,ns \cdot \text{PWMMax[SeqSelector]}$$



The intensity of a PWM:

That duty ratio is calculated as: Δ% = t / T. It is written about the value of "t" as PWMChange0-3[SeqSelector] per sequence into the Registry.

PWMChange0-3[SeqSelector] is to be written as a percentage value.

Examples of PWMs:

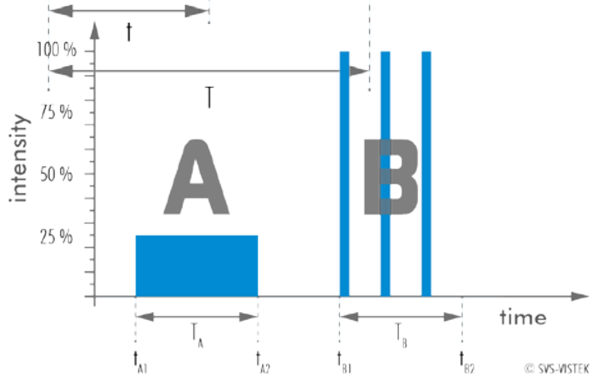


Figure 65: 25 % intensity

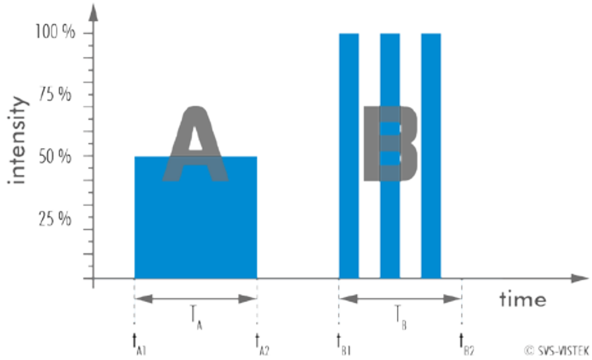


Figure 66: 50 % intensity

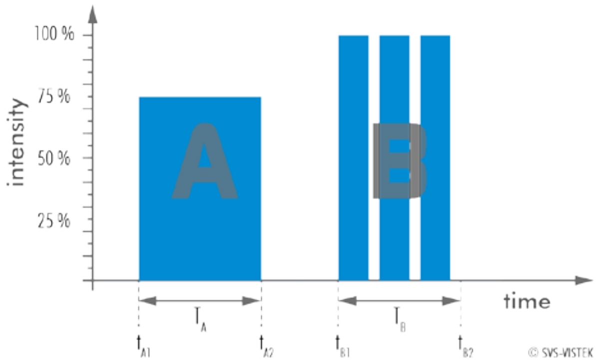


Figure 67: 75 % intensity

The integrals over both periods T_A and T_A are equal.

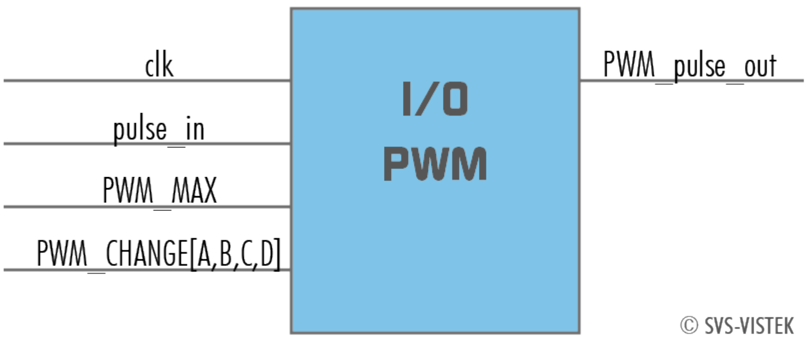
$$\int_{t_{A1}}^{t_{A2}} \mathbf{A} = \int_{t_{B1}}^{t_{B2}} \mathbf{B}$$

An equal amount of Photons will be emitted. The intensity of light is the same.

$$t_{A2} - t_{A1} = t_{B2} - t_{B1}$$

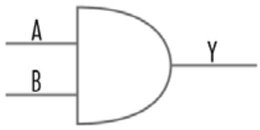
The periods T_A and T_B are equal in length.

The PWM module:



6.3.5 PLC/Logical Operation on Inputs

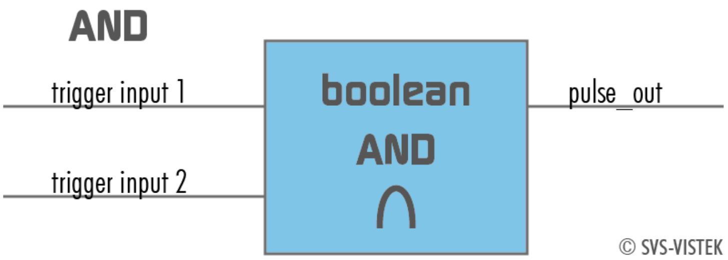
The logic input combines trigger signals with Boolean algorithms. The camera provides AND, NAND, OR, NOR as below. You might connect 2 signals on the logic input. The result can be connected to a camera trigger signal or it may be source for the next logical operation with another input. It is possible to connect it to an OUT line as well.

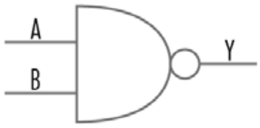


AND

Both trigger inputs have to be true.

A	B	Y = A ∧ B
0	0	0
0	1	0
1	0	0
1	1	1



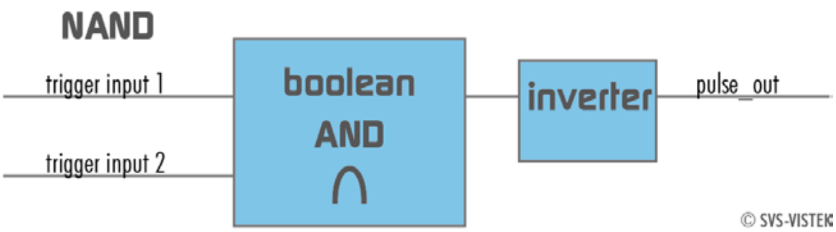


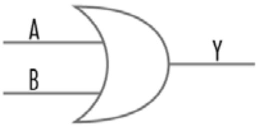
NAND

The NEGATIVE-AND is true only if its inputs are false.

Invert the output of the AND module.

A	B	Y = A NAND B
0	0	1
0	1	1
1	0	1
1	1	0



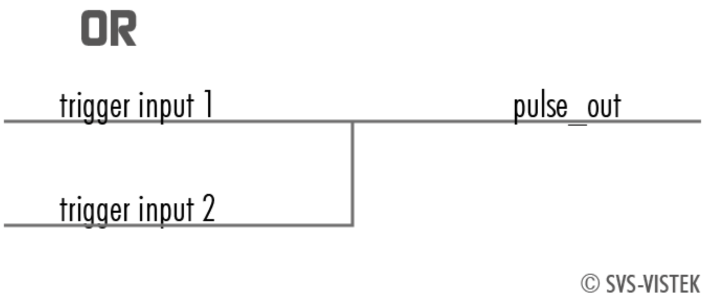


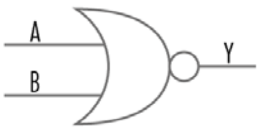
OR

If neither input is high, a low pulse_out (0) results.

Combine trigger input one and two.

A	B	Y = A v B
0	0	0
0	1	1
1	0	1
1	1	1



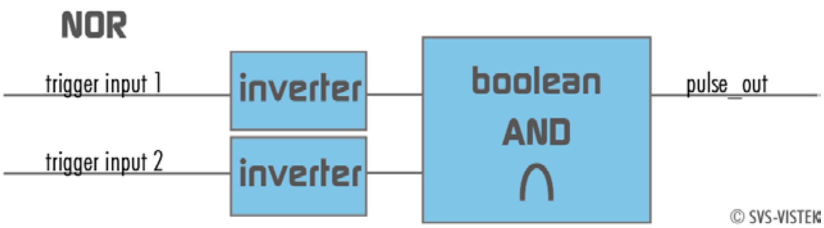


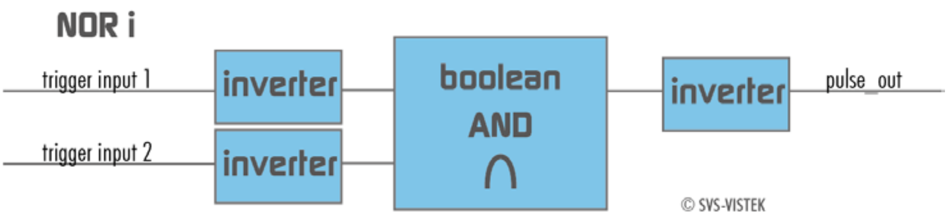
NOR

No trigger input – one nor two – results in a high or a low level pulse_out.

Invert both trigger inputs. By inverting the resulting pulse_out you will get the NOR I pulse

A	B	Y = A ⊽ B NOR	Y = A v B NOR i
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	1





6.3.6 Serial data interfaces

(ANSI EIA/) TIA-232-F

RS-232 and RS-422 (from EIA, read as Radio Sector or commonly as Recommended Standard) are technical standards to specify electrical characteristics of digital signaling circuits.

In the SVCam's these signals are used to send low-power data signals to control light or lenses (MFT).

Serial interface Parameter	RS-232	RS-422
Maximum open-circuit voltage	±25 V	±6 V
Max Differential Voltage	25 V	10 V
Min. Signal Range	±3 V	2 V
Max. Signal Range	±15V	10 V

Table 3: serial interface parameter – RS-232 and RS-422

RS-232

It is splitted into 2 lines receiving and transferring Data.

RXD receive data

TXD transmit data

Signal voltage values are:

low: -3 … -15 V

high: +3 … +15 V

With restrictions: refer to Table: serial interface parameter above.

Data transportis asynchronous. Synchronization is implemented by fist and last bit of a package. Therefore the last bit can be longer, e.g. 1.5 or 2 times the bit duration). Datarate (bits per second) must be defined before transmission.

UART

Packaging Data into containers (adding start and stop bits) is implemented by the UART (Universal Asynchronous Receiver Transmitter)

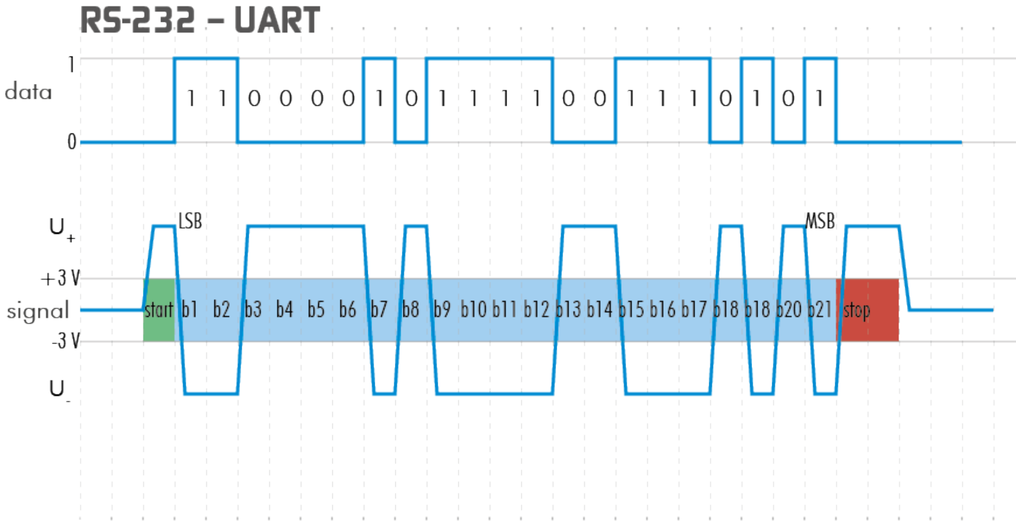


Figure 68: UART encoding of a data stream

RS-422

RS-422 is a differential low voltage communication standard.

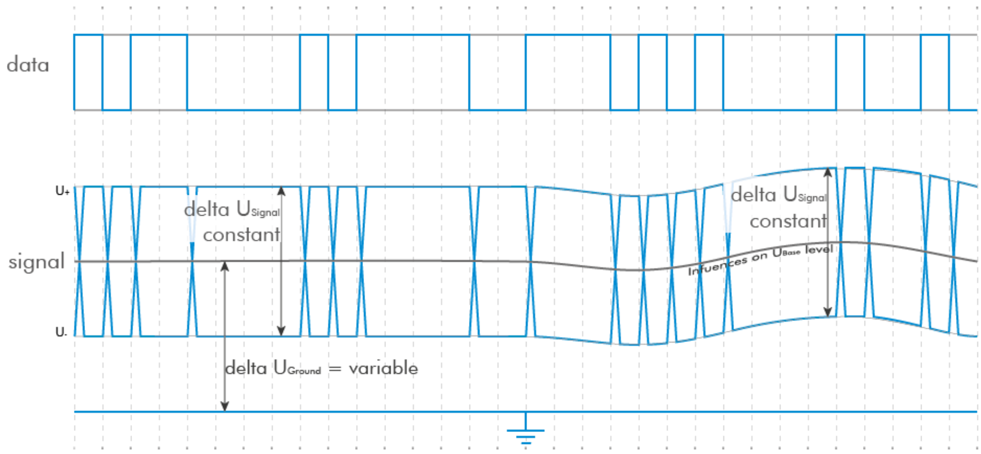


Figure 69: LVDS signal – no return to zero volt

Refer to specifications to see if RS-422 is implemented in your camera.

6.3.7 Trigger-Edge Sensitivity

Trigger-Edge Sensitivity is implemented by a “schmitt trigger”. Instead of triggering to a certain value Schmitt trigger provides a threshold.

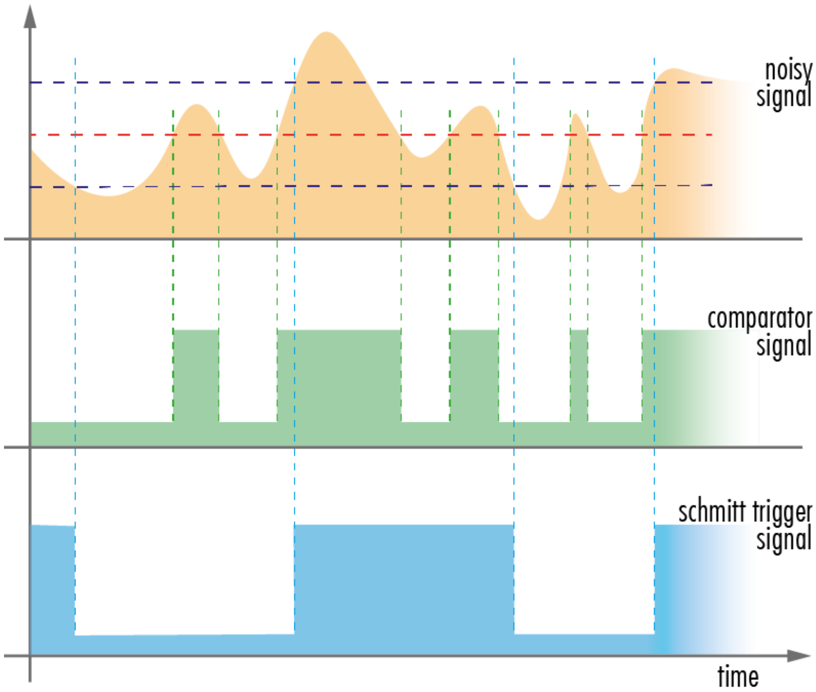


Figure 70:illlustration of schmitt trigger noise suspension - high to low I low to high

6.3.8 Debouncing Trigger Signals

Bounces or glitches caused by a switch can be avoided by software within the SVCam.

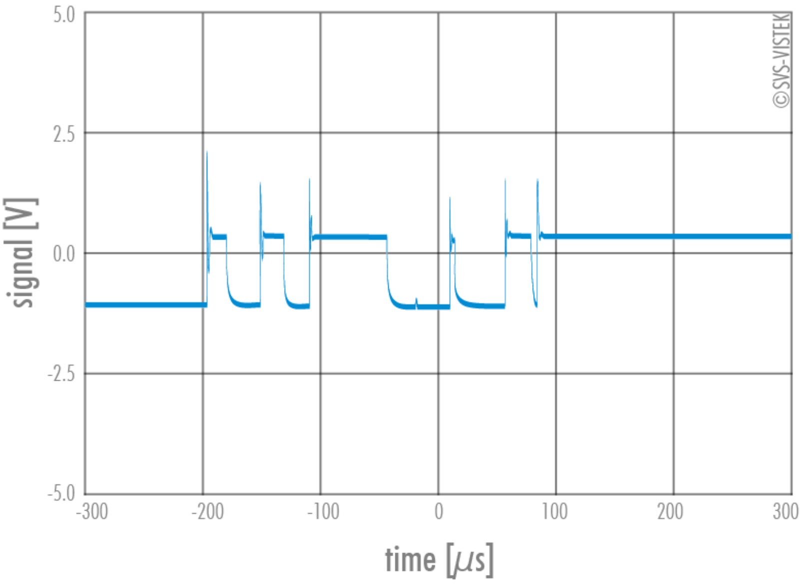


Figure 71: bounces or glitches caused by a switch during 300 µs

Therefor the signal will not be accepted till it lasts at least a certain time.

Use the IO Assignment tool to place and enable the debouncer module in between the “trigger” (schmitt trigger) and the input source (e.g.: line 1).

DebouncDuration register can be set in multiples of 15ns (implement of system clock). E.g. 66 666 ≈ 1 ms

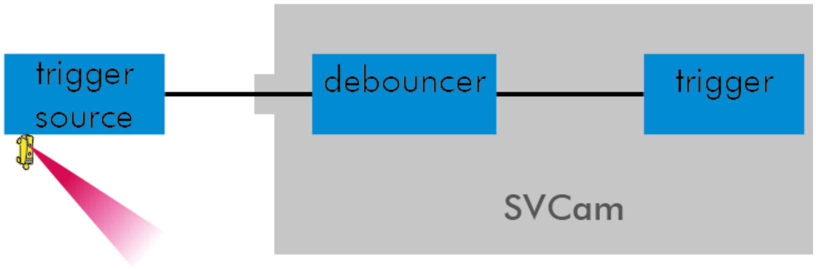


Figure 72: block diagram – debouncer in between the trigger source and the trigger

The Debouncer module

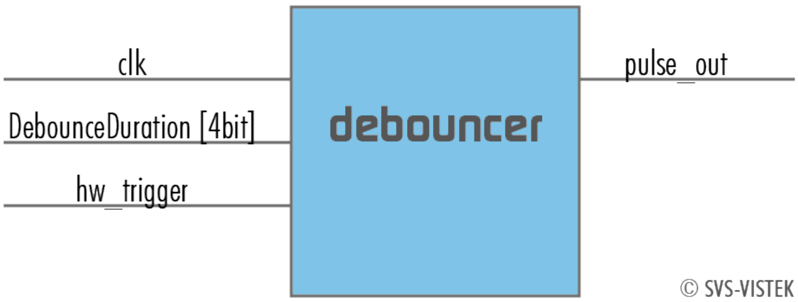


Figure 73: Illustration of the debouncer module

6.3.9 Prescale

The Prescaler function can be used for masking off input pulses by applying a divisor with a 4-bit word, resulting in 16 unique settings.

> Reducing count of interpreted trigger signal

> Use the prescaler to ignore a certain count of trigger signals.

> Divide the amount of trigger signals by setting a divisor.

> Maximum value for prescale divisor: is 16 (4 bit)

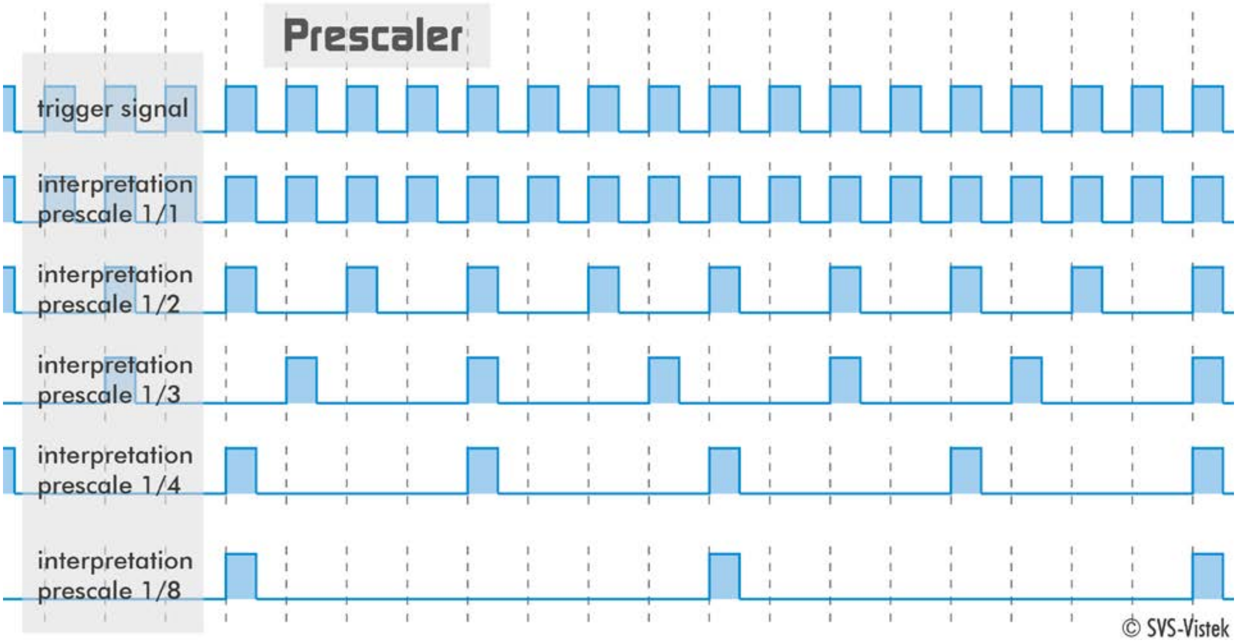


Figure 74: illustration of prescale values

The prescale module

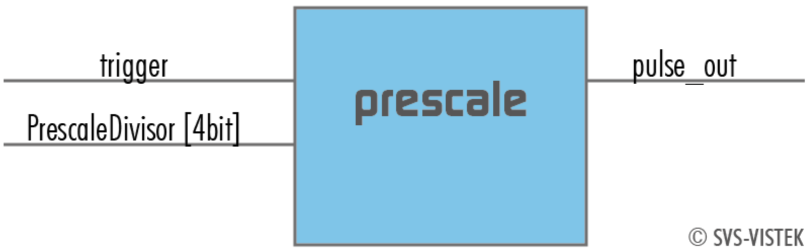


Figure 75: Illustration of the prescale module

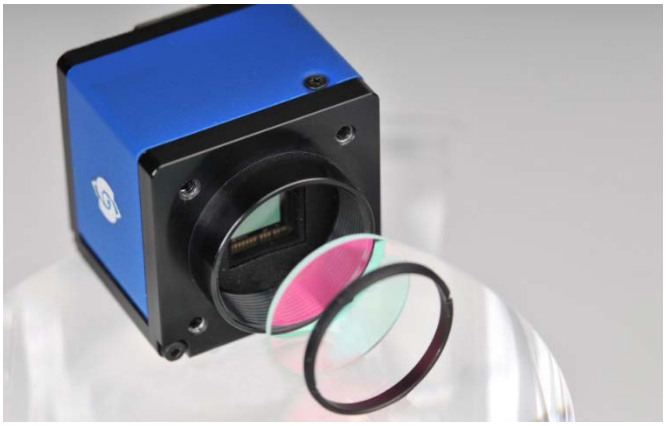
6.3.10 IR Cut Filter

To avoid influences of infrared light to your image, cameras are equipped with an IR cut filter or an anti-refection coated glass (AR filter).

Figure 76: ECO standard & ECO Blackline with IR cut filter

In addition filters raise the protection class of the camera by protecting the sensor and camera internals from environmental influences

Please refer to your camera order to see if a filter is built in. Alternatively take a close look on the sensor. Build-in IR-filters are screwed within the lens mount. (See figure below)



All kinds of filter can be ordered and placed in front of the sensors. Please refer to your local distributer.

NOTICE

As the sensor is very sensitive to smallest particles, avoid dust when removing the lens or the protection cap

Image Impact of IR Cut Filter

As a reason of chromatic aberration limiting the spectral bandwidth of the light always results in sharper images.

Without an IR cut filter:

> Monochrome sensor images get muddy.
> Chroma sensor images get influenced by a greater amount of red than you would see with your eyes. White balance gets much more difficult. Contrasts get lost because of IR light influencing also blue and green pixels.

SVS-VISTEK recommends IR cut filter for high demands on color or sharpness whether monochrome or color sensors.

Spectral Impact of IR Cut Filters

IR cut filter do influence the spectral sensitivity of the sensor. The spectral graph below shows the wavelength relative impact of the SVS-VISTEK standard filter.

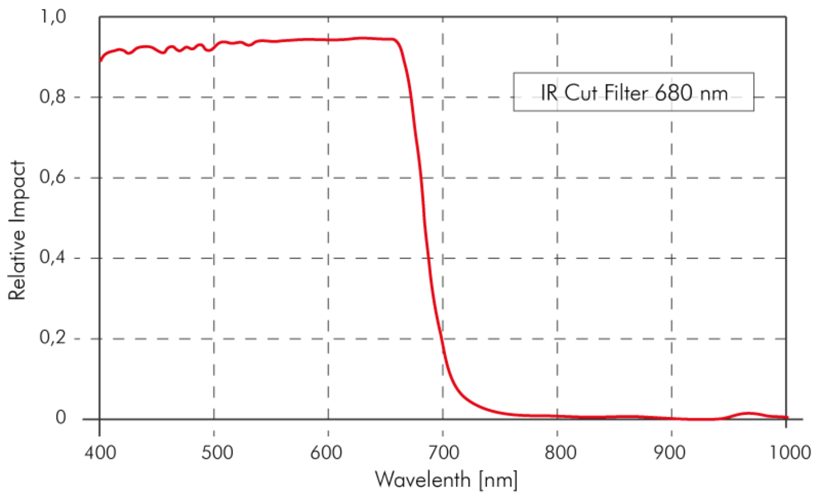


Figure 77: Diagram of light transmission – IR cut filter

Focal Impact of Filters

As an IR cut filter mainly consist of a small layer of glass (1 mm thick) there is an impact on the flange focal distance. Refraction within the layer cause shortening this distance.

When ordering a standard camera with an extra IR cut filter you might have to compensate the focal length with an extra ring. Please refer to your local distributor for more detailed information on your camera behaving on C-Mount integrated filters.

As BlackLine models have an IR cut filter by default, the focal distance is compensated by default too.

NOTICE

Removing the IR cut filter lengthen the focal distance and will invalidate the warranty of your camera.

7 Specifications

7.1 evo1050*FHCPC

Model	evo1050CFHCPC	evo1050MFHCPC
familiy	EVO	EVO
active pixel w x h	1024 x 1024	1024 x 1024
max. frame rate	180 fps	180 fps
chroma	bayer	mono
Status Sales	Camera Link Medium	Camera Link Medium

sensor name	KAI-01050-C	KAI-01050-A
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	progressive scan	progressive scan
equivalent format	1/2"	1/2"
diagonal	8,0 mm	8,0 mm
pixel w x h	5,5x5,5 μm	5,5x5,5 μm
optic sensor w x h	5,64x5,64 mm	5,64x5,64 mm
exposure time	5 μs / 60s	5 μs / 60s
max. gain	18 dB	18 dB
dynamic range	62 dB	62 dB
S/N Ratio		

frame buffer	128 MB	128 MB
CL_geometry	1x-1y;2xe-1y;2xe-2ye;	1x-1y;2xe-1y;2xe-2ye;
frequency select	40;48;64	40;48;64
camera pixel clock	64 MHz	64 MHz
exp. Time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	4 / 4	4 / 4
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	auto;manual	-
tap balancing	manual;auto	manual;auto
gain	auto;manual	auto;manual
black level	manual	manual
PIV mode	x	x
readout control	-	-
flat field correction	-	-
shading correction	-	-

defect pixel correction	off;factory;custom	off;factory;custom
image flip	false	false

trigger modes	internal;software;external	internal;software;external
trigger edge high / low	x / x	x / x
sequencer	-	-
PWM power out	-	-
trigger IN TTL-24 V	2	2
outputs open drain	2	2
optical in / out	- / -	- / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	1 / 1	1 / 1
power supply min. / max.	10...25 V	10...25 V

lens mount	C-Mount	C-Mount
dynamic lens control	-	-
size w / h / d (1)	50x50x46,7 mm	50x50x46,7 mm
weight	160 g	160 g
protection class	IP40	IP40
power consumption	6,0 W	6,0 W
ambient temperature	-10...45°C	-10...45°C
housing temperature		
status	production	production

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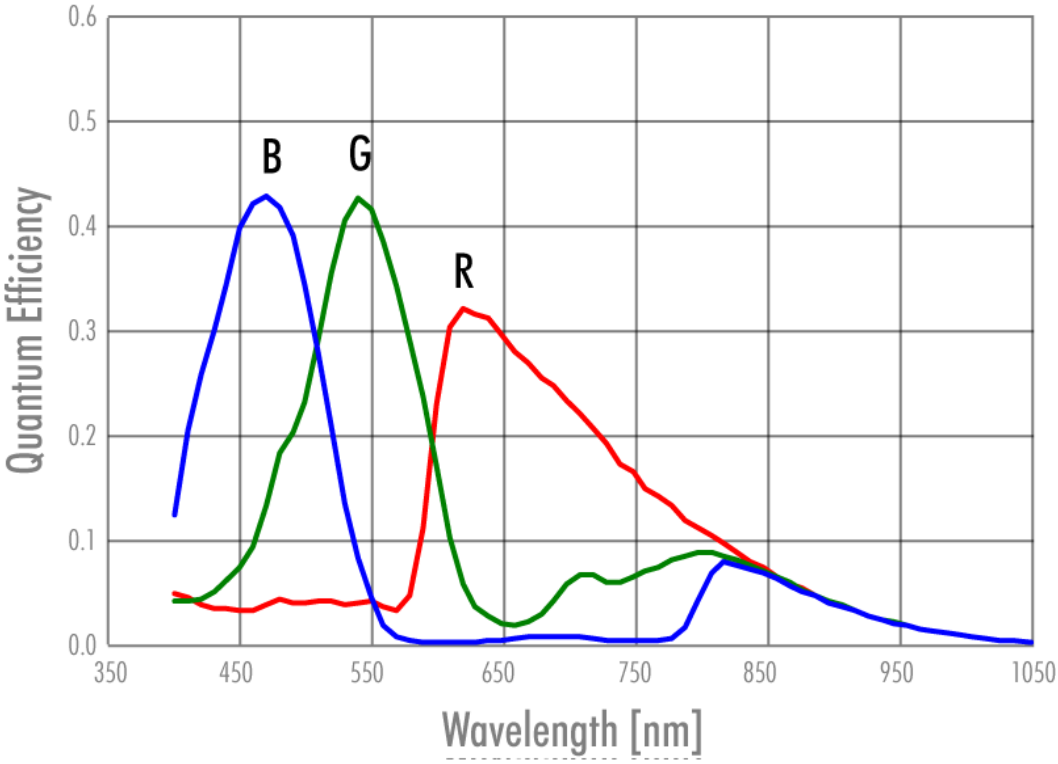
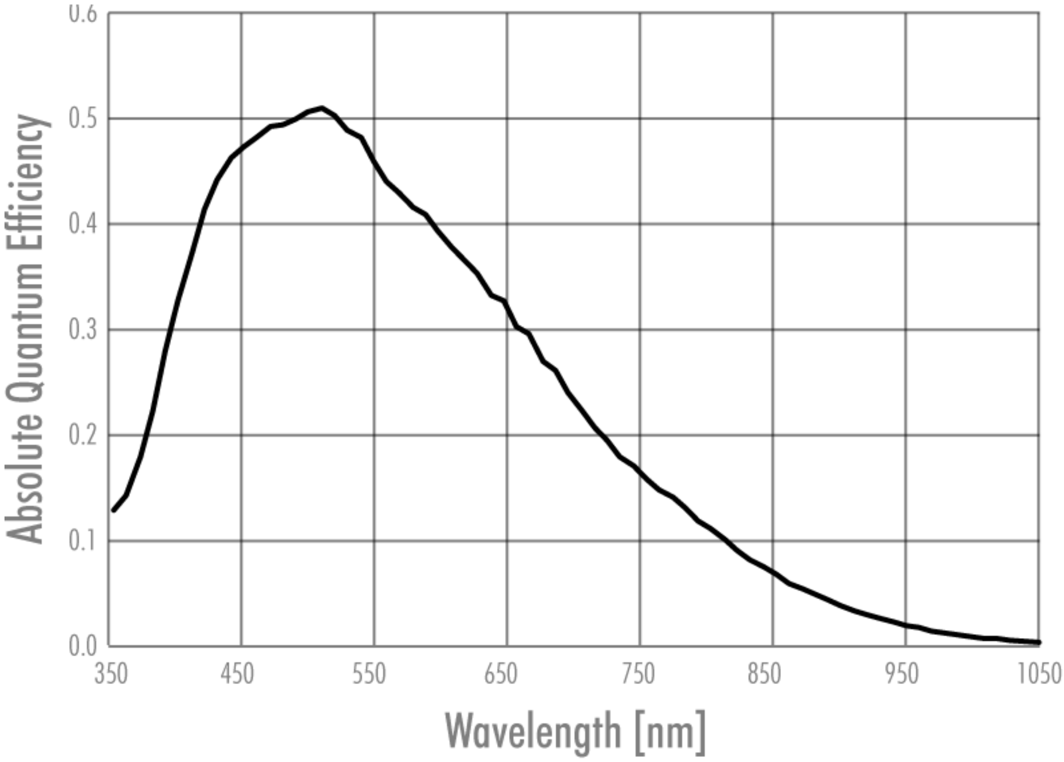
Spectral Sensitivity Characteristics KAI-01050-C



Spectral Sensitivity Characteristics KAI-01050-A



7.2 evo2050*FHCPC

Model	evo2050MFHCPC	evo2050CFHCPC
familiy	EVO	EVO
active pixel w x h	1600 x 1200	1600 x 1200
max. frame rate	106 fps	106 fps
chroma	mono	bayer
Status Sales	Camera Link Medium	Camera Link Medium

sensor name	KAI-02050-A	KAI-02050-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	progressive scan	progressive scan
equivalent format	2/3"	2/3"
diagonal	11,0 mm	11,0 mm
pixel w x h	5,5x5,5 µm	5,5x5,5 µm
optic sensor w x h	8,8x6,6 mm	8,8x6,6 mm
exposure time	5 µs / 60s	5 µs / 60s
max. gain	18 dB	18 dB
dynamic range	62 dB	62 dB
S/N Ratio		

frame buffer	128 MB	128 MB
CL_geometry	1x-1y;2xe-1y;2xe-2ye;	1x-1y;2xe-1y;2xe-2ye;
frequency select	40;48;64	40;48;64
camera pixel clock	64 MHz	64 MHz
exp. Time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	4 / 4	4 / 4
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	auto;manual	auto;manual
black level	manual	manual
PIV mode	x	x
readout control	-	-
flat field correction	-	-
shading correction	-	-
defect pixel correction	off;factory;custom	off;factory;custom
image flip	false	false

trigger modes	internal;software;external	internal;software;external
trigger edge high / low	x / x	x / x
sequencer	-	-
PWM power out	-	-
trigger IN TTL-24 V	2	2
outputs open drain	2	2
optical in / out	- / -	- / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	1 / 1	1 / 1
power supply min. / max.	10...25 V	10...25 V

lens mount	C-Mount	C-Mount
dynamic lens control	-	-
size w / h / d (1)	50x50x46,7 mm	50x50x46,7 mm
weight	160 g	160 g
protection class	IP40	IP40
power consumption	6,0 W	6,0 W
ambient temperature	-10...45°C	-10...45°C
housing temperature		
status	production	production

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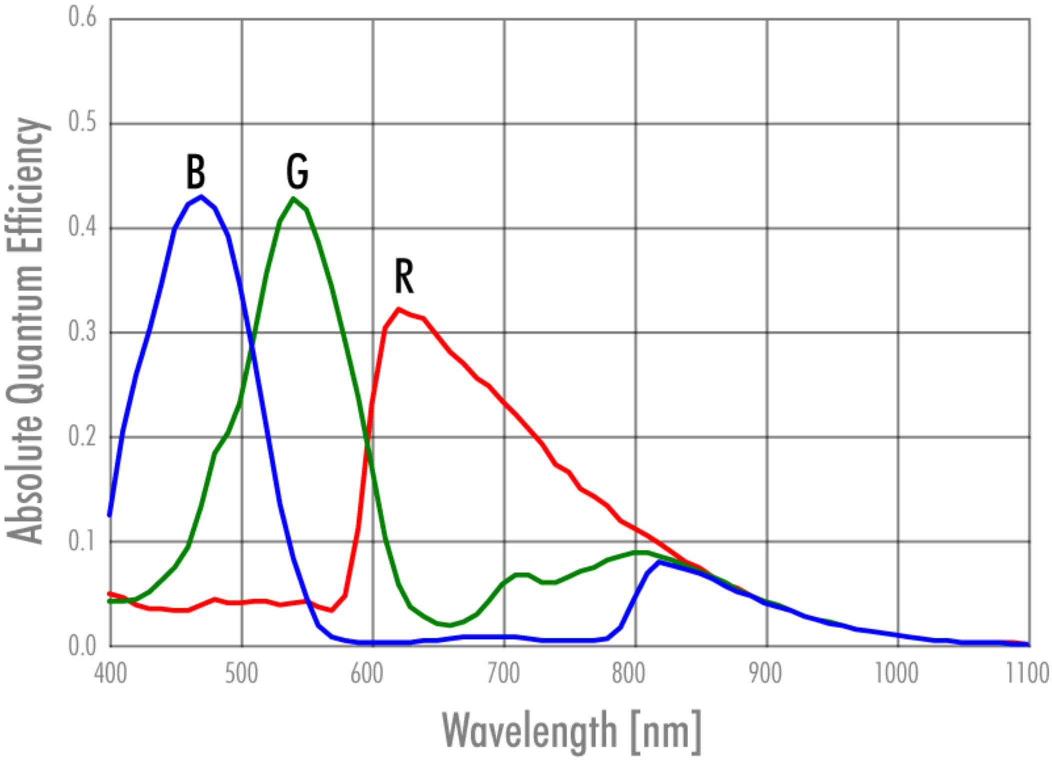
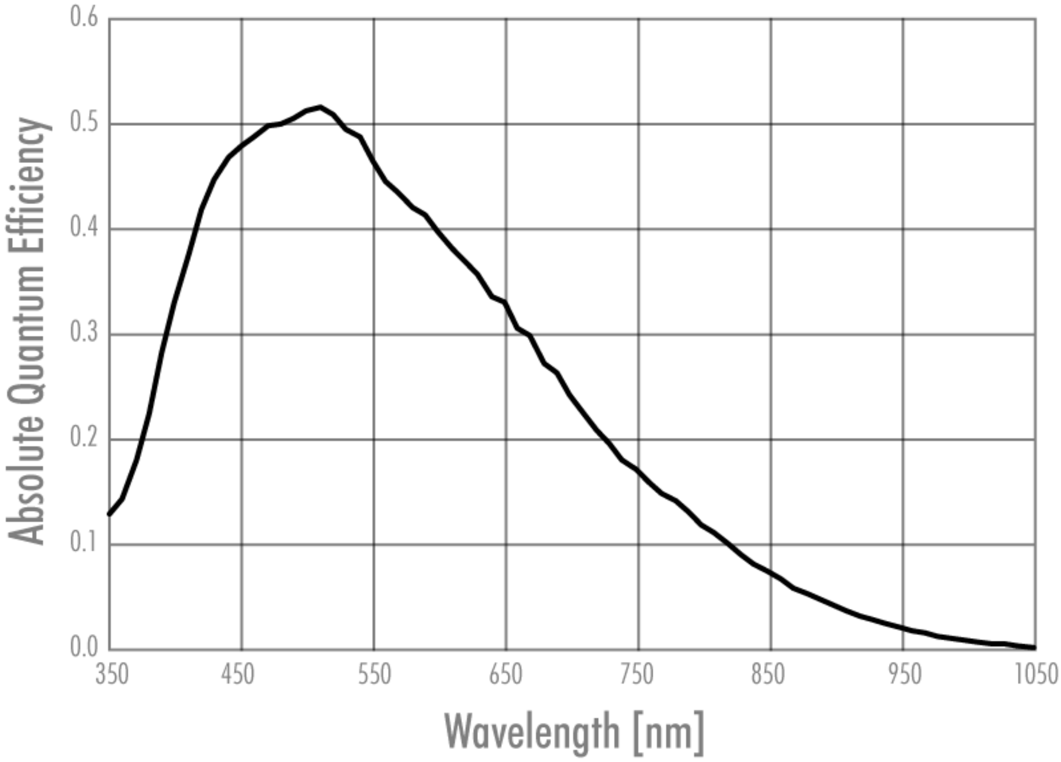
Spectral Sensitivity Characteristics KAI-02050-C



Spectral Sensitivity Characteristics KAI-02050-A



7.3 evo2150*FHCPC

Model	evo2150CFHCPC	evo2150MFHCPC
familiy	EVO	EVO
active pixel w x h	1920 x 1080	1920 x 1080
max. frame rate	100 fps	100 fps
chroma	bayer	mono
Status Sales	Camera Link Medium	Camera Link Medium

sensor name	KAI-02150-C	KAI-02150-A
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	progressive scan	progressive scan
equivalent format	2/3"	2/3"
diagonal	12,1 mm	12,1 mm
pixel w x h	5,5x5,5 µm	5,5x5,5 µm
optic sensor w x h	10,56x5,94 mm	10,56x5,94 mm
exposure time	5 µs / 60s	12 µs / 60s
max. gain	18 dB	18 dB
dynamic range	62 dB	62 dB
S/N Ratio		

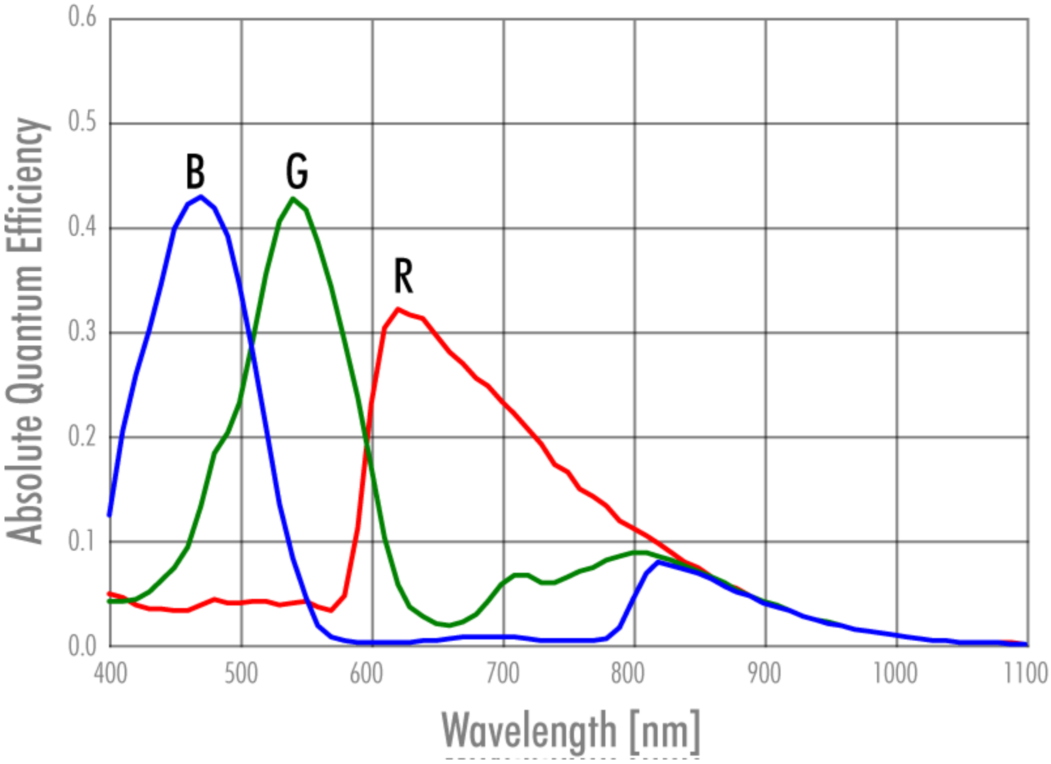
frame buffer	128 MB	128 MB
CL_geometry	1x-1y;2xe-1y;2xe-2ye;	1x-1y;2xe-1y;2xe-2ye;
frequency select	40;48;64	40;48;64
camera pixel clock	64 MHz	64 MHz
exp. Time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	4 / 4	4 / 4
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	auto;manual	-
tap balancing	manual;auto	manual;auto
gain	auto;manual	auto;manual
black level	manual	manual
PIV mode	x	x
readout control	-	-
flat field correction	-	-
shading correction	-	-
defect pixel correction	off;factory;custom	off;factory;custom
image flip	false	false

trigger modes	internal;software;external	internal;software;external
trigger edge high / low	x / x	x / x
sequencer	-	-
PWM power out	-	-
trigger IN TTL-24 V	2	2
outputs open drain	2	2
optical in / out	- / -	- / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	1 / 1	1 / 1
power supply min. / max.	10...25 V	10...25 V

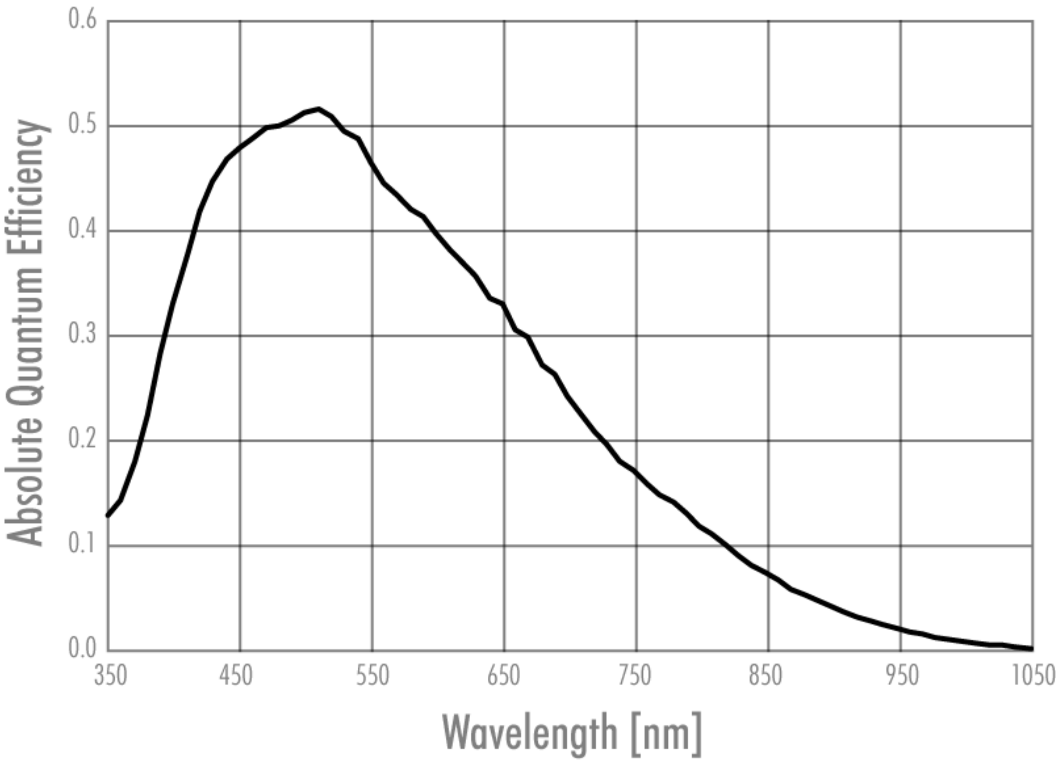
lens mount	C-Mount	C-Mount
dynamic lens control	-	-
size w / h / d (1)	50x50x46,7 mm	50x50x46,7 mm
weight	160 g	160 g
protection class	IP40	IP40
power consumption	6,0 W	6,0 W
ambient temperature	-10...45°C	-10...45°C
housing temperature		
status	production	production

 February 2, 2017 February 2, 2017

Spectral Sensitivity Characteristics KAI-02150-C



Spectral Sensitivity Characteristics KAI-01050-C



7.4 evo4050*FHCPC

Model	evo4050MFHCPC	evo4050CFHCPC
familiy	EVO	EVO
active pixel w x h	2336 x 1752	2336 x 1752
max. frame rate	52 fps	52 fps
chroma	mono	bayer
Status Sales	Camera Link Medium	Camera Link Medium

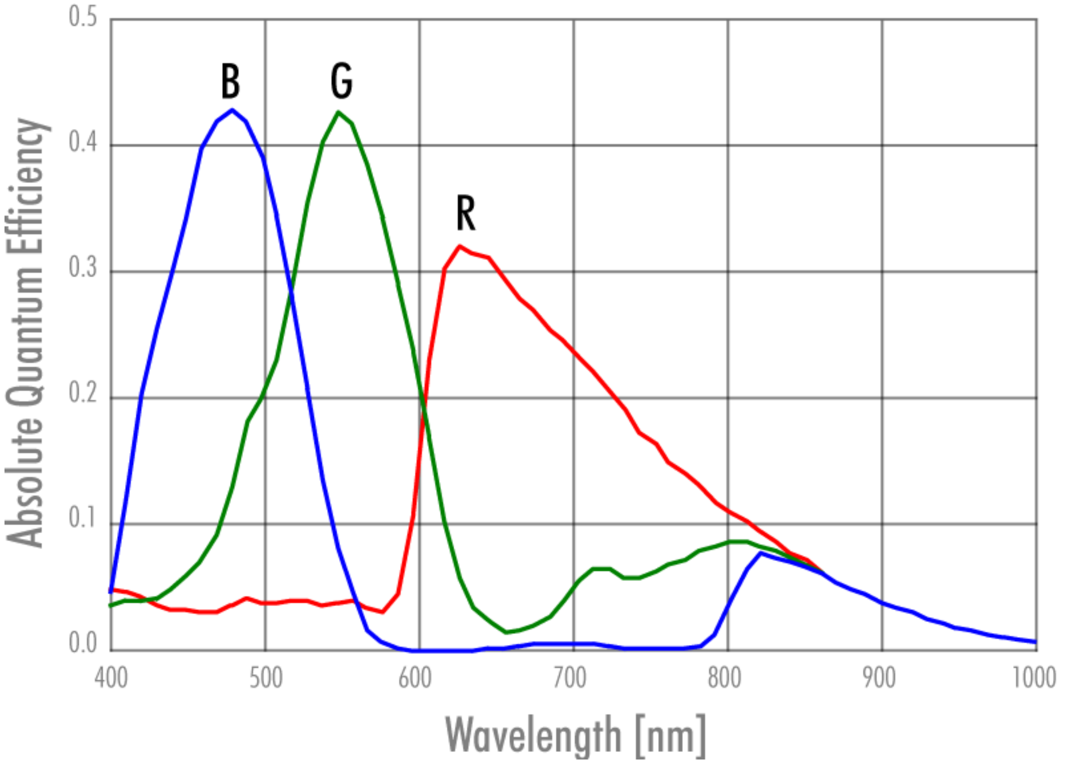
sensor name	KAI-04050-A	KAI-04050-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	progressive scan	progressive scan
equivalent format	1"	1"
diagonal	16,1 mm	16,1 mm
pixel w x h	5,5x5,5 µm	5,5x5,5 µm
optic sensor w x h	12,85x9,64 mm	12,85x9,64 mm
exposure time	6 µs / 60s	6 µs / 60s
max. gain	18 dB	18 dB
dynamic range	62 dB	18 dB
S/N Ratio		

frame buffer	128 MB	128 MB
CL_geometry	1x-1y;2xe-1y;2xe-2ye;	1x-1y;2xe-1y;2xe-2ye;
frequency select	40;48;64	40;48;64
camera pixel clock	64 MHz	64 MHz
exp. Time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	4 / 4	4 / 4
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	auto;manual	auto;manual
black level	manual	manual
PIV mode	x	x
readout control	-	-
flat field correction	-	-
shading correction	-	-
defect pixel correction	off;factory;custom	off;factory;custom
image flip	false	false

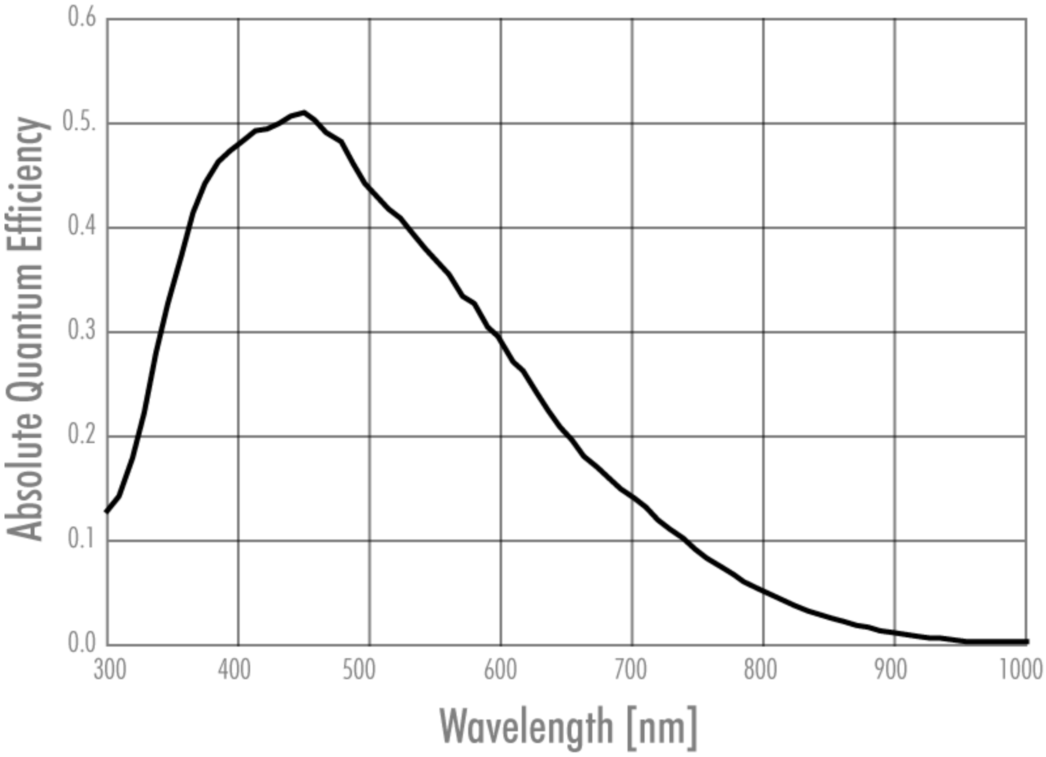
trigger modes	internal;software;external	internal;software;external
trigger edge high / low	x / x	x / x
sequencer	-	-
PWM power out	-	-
trigger IN TTL-24 V	2	2
outputs open drain	2	2
optical in / out	- / -	- / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	1 / 1	1 / 1
power supply min. / max.	10...25 V	10...25 V

lens mount	C-Mount	C-Mount
dynamic lens control	-	-
size w / h / d (1)	50x50x46,7 mm	50x50x46,7 mm
weight	160 g	160 g
protection class	IP40	IP40
power consumption	8,0 W	8,0 W
ambient temperature	-10...45°C	-10...45°C
housing temperature		
status	production	production

Spectral Sensitivity Characteristics KAI-04050-C



Spectral Sensitivity Characteristics KAI-04050-A



7.5 evo4070*FHCPC

Model	evo4070MFHCPC	evo4070CFHCPC
familiy	EVO	EVO
active pixel w x h	2048 x 2048	2048 x 2048
max. frame rate	44 fps	44 fps
chroma	mono	bayer
Status Sales	Camera Link Medium	Camera Link Medium

sensor name	KAI-4070-A	KAI-4070-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	progressive scan	progressive scan
equivalent format	1"	1"
diagonal	21,4 mm	21,4 mm
pixel w x h	7,4x7,4 µm	7,4x7,4 µm
optic sensor w x h	15,2x15,2 mm	15,2x15,2 mm
exposure time	6 µs / 60s	6 µs / 60s
max. gain	18 dB	18 dB
dynamic range	66 dB	66 dB
S/N Ratio		

frame buffer	128 MB	128 MB
CL_geometry	1x-1y;2xe-1y;2xe-2ye;	1x-1y;2xe-1y;2xe-2ye;
frequency select	40;48;64	40;48;64
camera pixel clock	64 MHz	64 MHz
exp. Time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	4 / 4	4 / 4
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	auto;manual	auto;manual
black level	manual	manual
PIV mode	x	x
readout control	-	-
flat field correction	-	-
shading correction	-	-
defect pixel correction	off;factory;custom	off;factory;custom
image flip	false	false

trigger modes	internal;software;external	internal;software;external
trigger edge high / low	x / x	x / x
sequencer	-	-
PWM power out	-	-
trigger IN TTL-24 V	2	2
outputs open drain	2	2
optical in / out	- / -	- / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	1 / 1	1 / 1
power supply min. / max.	10...25 V	10...25 V

lens mount	M42	M42
dynamic lens control	-	-
size w / h / d (1)	50x50x46,7 mm	50x50x46,7 mm
weight	160 g	160 g
protection class	IP40	IP40
power consumption	6,0 W	6,0 W
ambient temperature	-10...45°C	-10...45°C
housing temperature		
status	production	production

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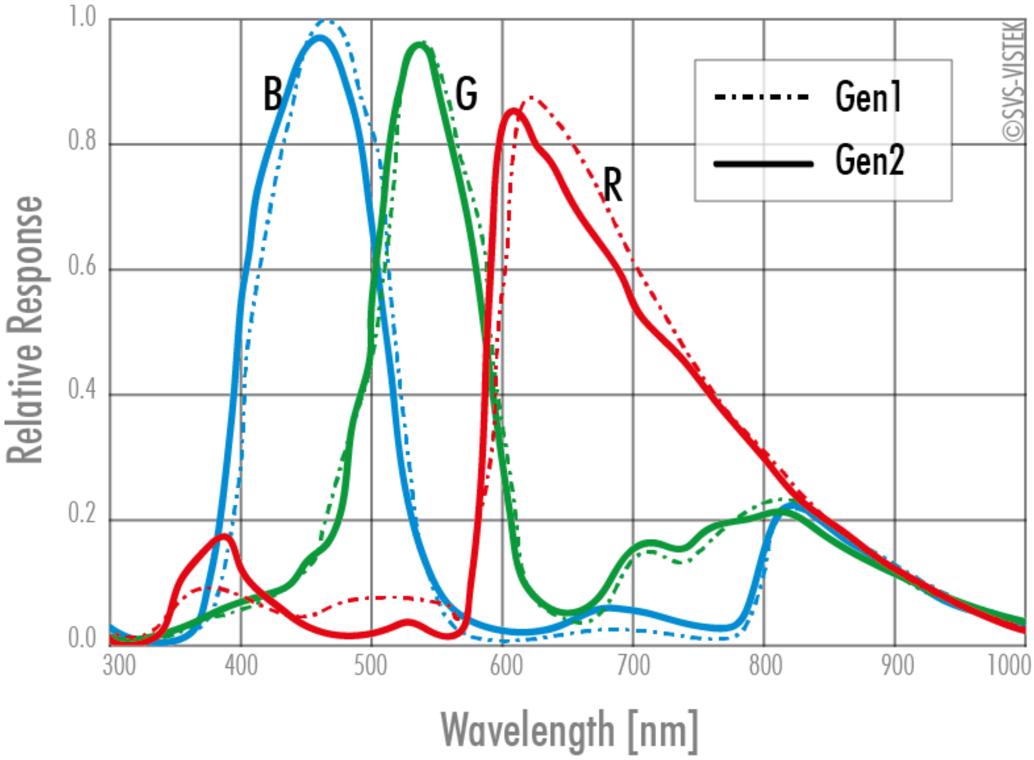
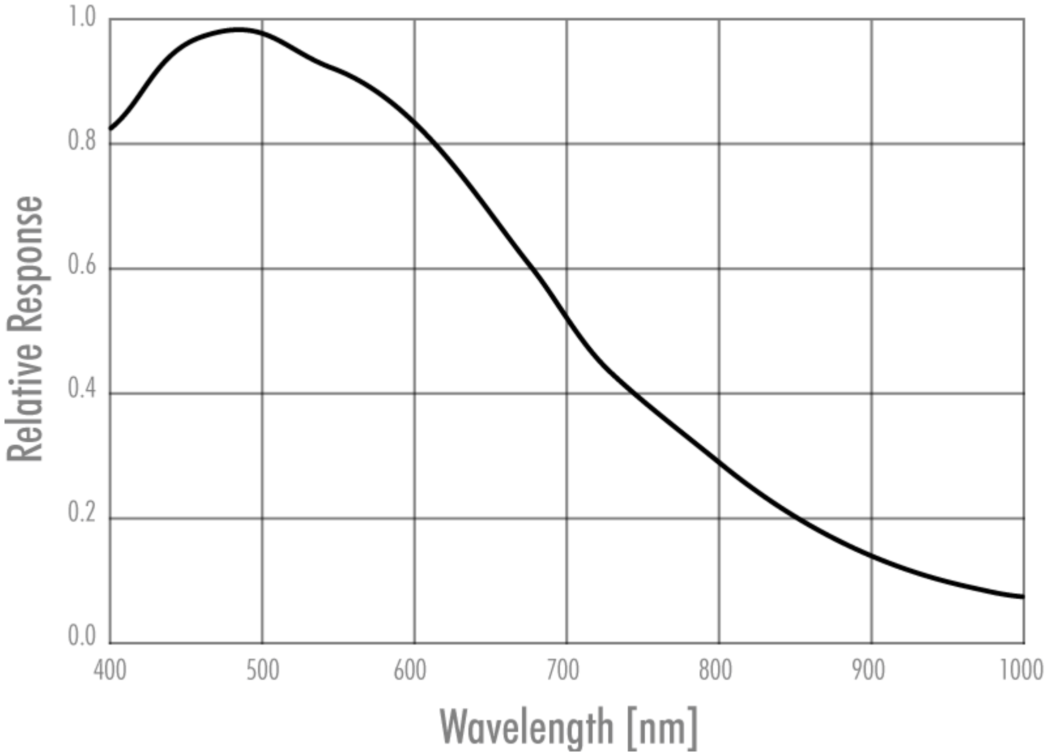
Spectral Sensitivity Characteristics KAI-04070-C



Spectral Sensitivity Characteristics KAI-04070-A



7.6 evo8050*FHCPC

Model	evo8050MFHCPC	evo8050CFHCPC
familiy	EVO	EVO
active pixel w x h	3296 x 2472	3296 x 2472
max. frame rate	26,8 fps	26,8 fps
chroma	mono	bayer
Status Sales	Camera Link Medium	Camera Link Medium

sensor name	KAI-08050-A	KAI-08050-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	progressive scan	progressive scan
equivalent format	4/3"	4/3"
diagonal	22,7 mm	22,7 mm
pixel w x h	5,5x5,5 µm	5,5x5,5 µm
optic sensor w x h	18,13x13,6 mm	18,13x13,6 mm
exposure time	11 µs / 60s	11 µs / 60s
max. gain	18 dB	18 dB
dynamic range	62 dB	62 dB
S/N Ratio		

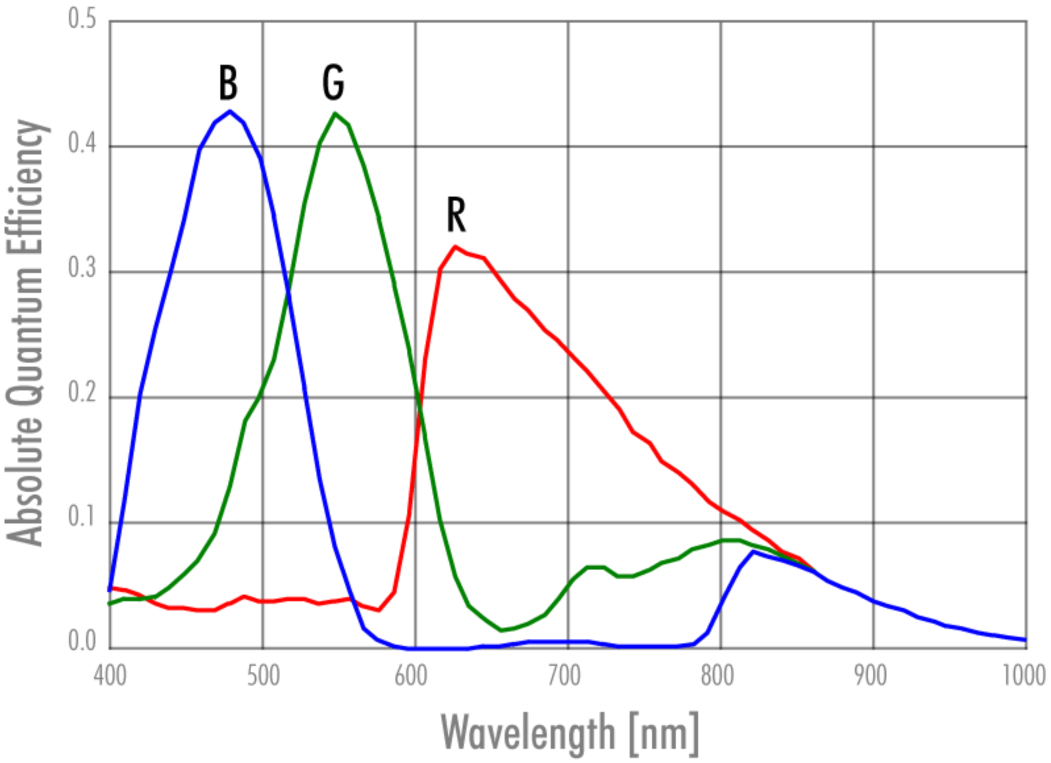
frame buffer	128 MB	128 MB
CL_geometry	1x-1y;2xe-1y;2xe-2ye;	1x-1y;2xe-1y;2xe-2ye;
frequency select	40;48;64	40;48;64
camera pixel clock	64 MHz	64 MHz
exp. Time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	4 / 4	4 / 4
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	auto;manual	auto;manual
black level	manual	manual
PIV mode	x	x
readout control	-	-
flat field correction	-	-
shading correction	-	-
defect pixel correction	off;factory;custom	off;factory;custom
image flip	false	false

trigger modes	internal;software;external	internal;software;external
trigger edge high / low	x / x	x / x
sequencer	-	-
PWM power out	-	-
trigger IN TTL-24 V	2	2
outputs open drain	2	2
optical in / out	- / -	- / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	1 / 1	1 / 1
power supply min. / max.	10...25 V	10...25 V

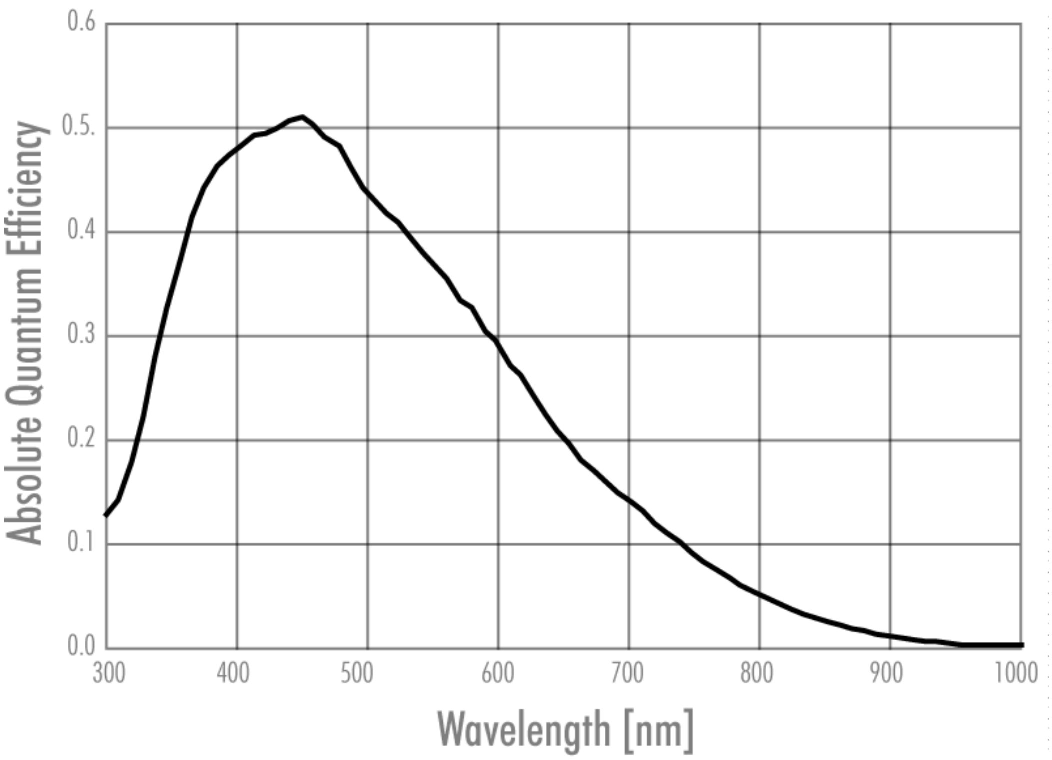
lens mount	M42	M42
dynamic lens control	-	-
size w / h / d (1)	50x50x46,7 mm	50x50x46,7 mm
weight	160 g	160 g
protection class	IP40	IP40
power consumption	8,0 W	8,0 W
ambient temperature	-10...45°C	-10...45°C
housing temperature		
status	replaced	replaced

 February 2, 2017 February 2, 2017

Spectral Sensitivity Characteristics KAI-08050-C



Spectral Sensitivity Characteristics KAI-08050-A



7.7 evo8051*FHCPC

Model	evo8051CFHCPC	evo8051MFHCPC
familiy	EVO	EVO
active pixel w x h	3296 x 2472	3296 x 2472
max. frame rate	26,8 fps	26,8 fps
chroma	bayer	mono
Status Sales	Camera Link Medium	Camera Link Medium

sensor name	KAI-08051-FXA	KAI-08051-AXA
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	progressive scan	progressive scan
equivalent format	4/3"	4/3"
diagonal	22,7 mm	22,7 mm
pixel w x h	5,5x5,5 µm	5,5x5,5 µm
optic sensor w x h	18,13x13,6 mm	18,13x13,6 mm
exposure time	11 µs / 60s	11 µs / 60s
max. gain	18 dB	18 dB
dynamic range	62 dB	62 dB
S/N Ratio		

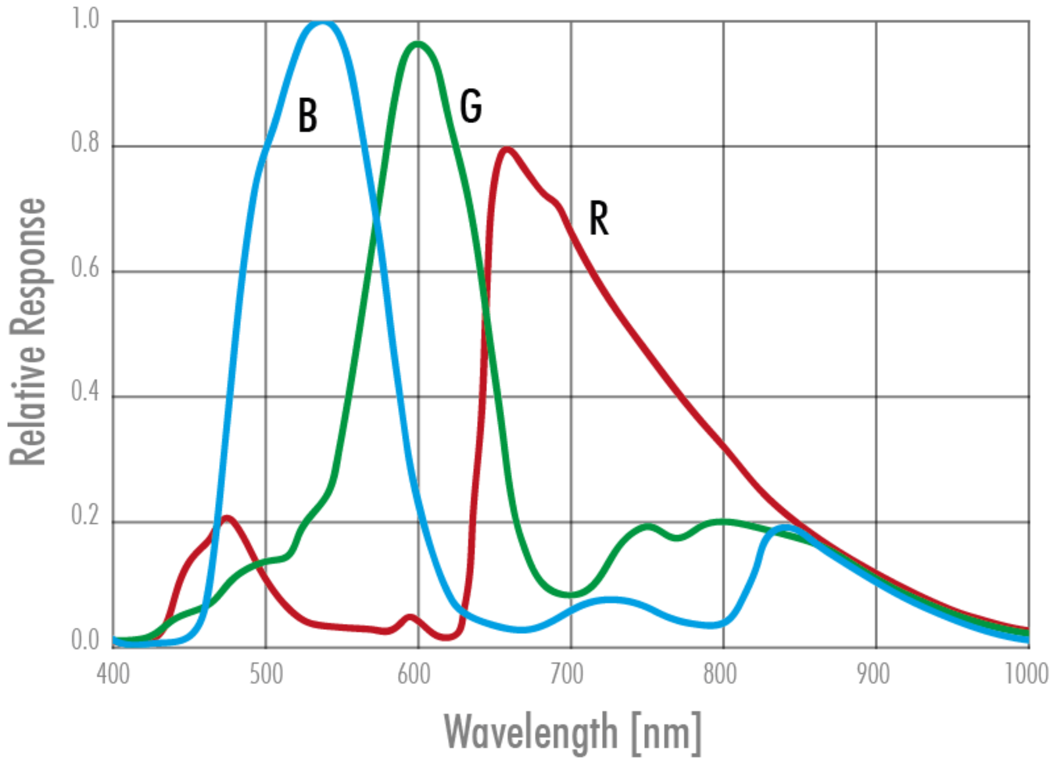
frame buffer	128 MB	128 MB
CL_geometry	1x-1y;2xe-1y;2xe-2ye;	1x-1y;2xe-1y;2xe-2ye;
frequency select	40;48;64	40;48;64
camera pixel clock	64 MHz	64 MHz
exp. Time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	4 / 4	4 / 4
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	auto;manual	-
tap balancing	manual;auto	manual;auto
gain	auto;manual	auto;manual
black level	manual	manual
PIV mode	x	x
readout control	-	-
flat field correction	-	-
shading correction	-	-
defect pixel correction	off;factory;custom	off;factory;custom
image flip	false	false

trigger modes	internal;software;external	internal;software;external
trigger edge high / low	x / x	x / x
sequencer	-	-
PWM power out	-	-
trigger IN TTL-24 V	2	2
outputs open drain	2	2
optical in / out	- / -	- / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	1 / 1	1 / 1
power supply min. / max.	10...25 V	10...25 V

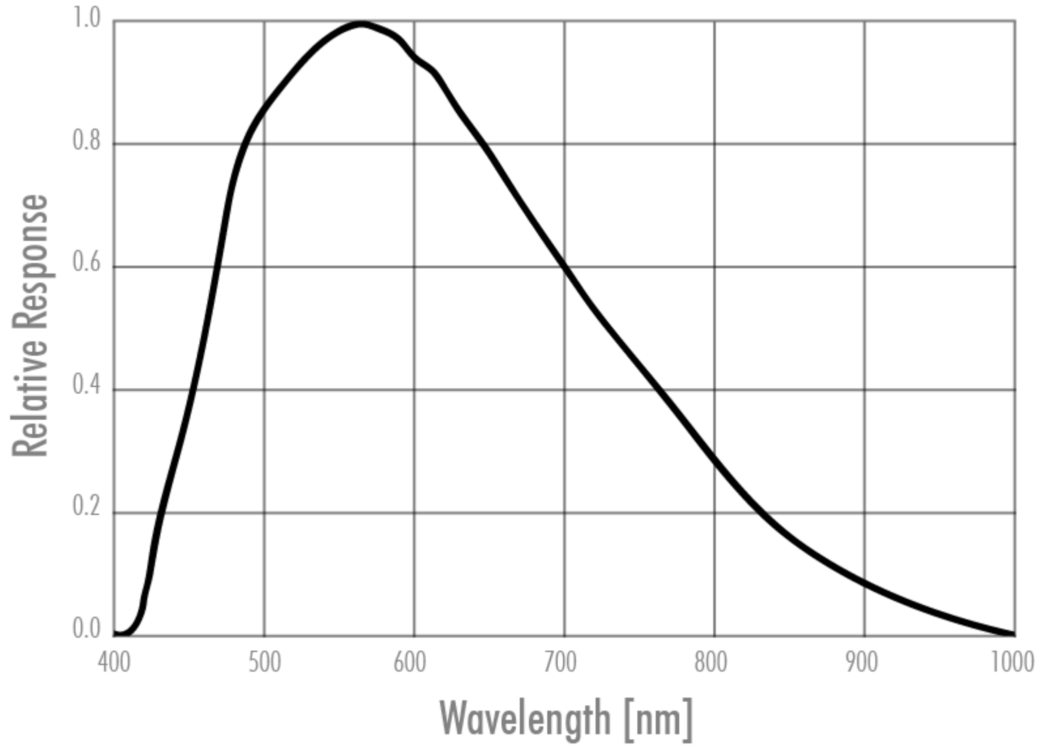
lens mount	M42	M42
dynamic lens control	-	-
size w / h / d (1)	50x50x46,7 mm	50x50x46,7 mm
weight	160 g	160 g
protection class	IP40	IP40
power consumption	8,0 W	8,0 W
ambient temperature	-10...45°C	-10...45°C
housing temperature		
status	production	production

 February 2, 2017 February 2, 2017

Spectral Sensitivity Characteristics KAI-08051-C



Spectral Sensitivity Characteristics KAI-08051-A



8 Terms of warranty

Standard Products Warranty and Adjustment	Seller warrants that the article to be delivered under this order will be free from defects in material and workmanship under normal use and service for a period of 2 years from date of shipment. The liability of Seller under this warranty is limited solely to replacing or repairing or issuing credit (at the discretion of Seller) for such products that become defective during the warranty period. In order to permit Seller to properly administer this warranty, Buyer shall notify Seller promptly in writing of any claims,; provide Seller with an opportunity to inspect and test the products claimed to be detective. Such inspection may be on customer's premises or Seller may request return of such products at customer's expense. Such expense will subsequently be reimbursed to customer if the product is found to be defective and Buyer shall not return any product without prior return authorization from Seller. If a returned product is found to be out of warranty or found to be within the applicable specification, Buyer will have to pay an evaluation and handling charge, independent of possible repair and/or replacement costs. Seller will notify Buyer of the amount of said evaluation and handling charges at the time the return authorization is issued. Seller will inform Buyer of related repair and/or replacement costs and request authorization before incurring such costs. Buyer shall identify all returned material with Sellers invoice number, under which material has been received. If more than one invoice applies, material has to be clearly segregated and identified by applicable invoice numbers. Adjustment is contingent upon Sellers examination of product, disclosing that apparent defects have not been caused by misuse, abuse, improper installation of application, repair, alteration, accident or negligence in use, storage, transportation or handling. In no event shall Seller be liable to Buyer for loss of profits, loss of use, or damages of any kind based upon a claim for breach of warranty.
Development Product Warranty	Developmental products of Seller are warranted to be free from defects in materials and workmanship and to meet the applicable preliminary specification only at the time of receipt by Buyer and for no longer period of time in all other respects the warranties made above apply to development products. The aforementioned provisions do not extend the original warranty period of any article which has been repaired or replaced by Seller.
Do not break Warranty Label	If warranty label of camera is broken warranty is void. Seller makes no other warranties express or implied, and specifically, seller makes no warranty of merchantability of fitness for particular purpose.
What to do in case of Malfunction	Please contact your local distributor first.

9 Troubleshooting

9.1 FAQ

Problem	Solution
Camera does not respond to light.	Check if camera is set to "Mode 0". I.e. free running with programmed exposure ctrl. When done, check with the program "Convenient Cam" if you can read back any data from the camera, such as "Mode", "type" of CCD, exposure time settings, etc.. If "Mode 0" works properly, check the signals of the camera in the desired operation mode like "Mode 1" or "Mode 2". In these modes, check if the ExSync signal is present. Please note that a TTL signal must be fed to the trigger connector if it is not provided by the frame grabber (LVDS type). The typical signal swing must be around 5 V. Lower levels will not be detected by the camera... If you use a TTL level signal fed to the "TB 5 connector" check the quality and swing. If these signals are not present or don't have the proper quality, the camera cannot read out any frame (Mode 1 and 2). Beware of spikes on the signal.
Image is present but distorted.	Check the camera configuration file of your frame grabber. Check number of "front- and back porch" pixel. Wrong numbers in configuration file can cause sync problems. Check if your frame grabber can work with the data rate of the camera.
Image of a color version camera looks strange or false colors appear.	If the raw image looks OK, check the camera file to see if the pixels need to be shifted by either one pixel or one line. The image depends on the algorithm used. If the algorithm is starting with the wrong pixel such effects appear.
Colors rendition of a color versions not as expected – especially when using halogen light.	Halogen light contains strong portions of IR radiation. Use cut-off filters at around 730 nm like "Schott KG 3" to prevent IR radiation reaching the CCD.
No serial communication is possible between the camera and the PC.	Use "load camera DLL" and try again.

Please fax this form to your local distributor. The right Fax number you can find on our homepage: http://www.svs-vistek.com

SENDER:

FIRM:

TEL:

MAIL:

9.2 Support Request Form / Check List

Dear valued customer,

In order to help you with your camera and any interfacing problems we request that you fill in a description of your problems when you use the camera. Please fax or email this form to the dealer/distributor from which you purchased the product.

	Operating System (E.g. Win 7, XP):
Which Camera are you using?	Type (e.g.: svs3625MTHCPC):
	Serial Number:
Which Accessories are you using?	Power Supply:
	Cable:
	Lens Type and Focal Length:
Firmware	No. of Version:
	Operation Mode:
	Please send a screenshot of “ConvCam” screen or log file.
In case of EURESYS Grabber:	Brand and Type:
	Driver Version:
	If Patch please specify:
	Camera file used:
Short Description of Problem	(E.g. missing lines, noisy image, missing bits etc.):

Space for further descriptions, screenshots and log-files

10 IP protection classes

There is a classification system regarding the kind of environment influences which might do harm to your product. These are called IP Protection Classes and consist of the letters „IP" followed by two numbers.

First Digit	Second Digit	Brief description	Definition
0		Not protected	-
1		Protected against solid foreign objects,	A probing object, a ball of 50mm in diameter, must not enter or penetrate the enclosure
		50 mm and larger	
2		Protected against solid foreign objects, 12.5 mm and larger	A probing object, a ball of 12.5mm in diameter, must not enter or penetrate the enclosure
3		Protected against solid foreign objects,	A probing object, a ball of 2.5mm in diameter, must not penetrate at all
		2.5 mm and larger	
4		Protected against solid foreign objects,	A probing object, a ball of 1mm in diameter, must not penetrate at all
		1.0 mm and larger	
5		Protected against dust	The ingress of dust is not completly prevented. The quantity of dust that enters not impair the safety or satisfactory operation of the equipment
6		Dustproof	No ingress of dust
	0	Not protected against liquids	-
	1	Protected against water droplets	Vertically falling droplets must not have any harmful effect when the enclosure is at an angle of 15° either side of the vertical
	2	Protected against water droplets	Droplets falling vertically must not have any harmful effect with enclosure at an angle of 15° either side of the vertical
	3	Protected against spray water	Water sprayed at any angle of up to 60° either side of the vertical must not have any harmful effect
	4	Protected against water splashes	Water splashing against the enclosure from any angle must not have any harmful effect
	5	Protected against water jets	Water jets directed at the enclosure from any angle must not have any harmful effect
	6	Protected against powerful water jets	Powerful water jets directed against the enclosure from any angle must not have any harmful effect
	7	Protected against the effect of brief submersion in water	Water must not enter the equipment in amounts that can have a harmful effect if the enclosure is briefly submerged in water under standardised pressure and time conditions
	8	Protected against the effect of continuous submersion in water	Water must not enter the equipment in amounts that can have a harmful effect if the enclosure is continuously submerged in water.
			The conditions must be agreed between the manufacturer and the user. The conditions must, however, be more severe than code 7
	9K	Protected against water from high- pressure and steam jet cleaning	Water directed at the enclosure from any angle under high pressure must not have any harmful effect

11 Glossary of Terms

Aberration
Spherical aberration occurs when light rays enter near the edge of the lens; Chromatic aberration is caused by different refractive indexes of different wavelengths of the light. (Blue is more refractive than red)

ADC
Analogue-to-Digital Converter, also known as A/D converter

Aperture
In optics, Aperture defines a hole or an opening through which light travels. In optical system the Aperture determines the cone angle of a bundle of rays that come to a focus in the image plane. The Aperture can be limited by an iris, but it is not solely reliant on the iris. The diameter of the lens has a larger influence on the capability of the optical system.

Bayer Pattern
A Bayer filter mosaic or pattern is a color filter array (CFA) deposited onto the surface of a CCD or CMOS sensor for capturing RGB color images. The filter mosaic has a defied sequence of red, green and blue pixels such that the captured image can be transported as a monochrome image to the host (using less bandwidth); where after the RGB information is recombined in a computer algorithm.

Binning
Binning combines the charge from two (or more) pixels to achieve higher dynamics while sacrifying resolution.

Bit-Depth
Bit-depth is the number of digital bits available at the output of the Analog-to-Digital Converter (ADC) indicating the distribution of the darkest to the brightest value of a single pixel.

Camera Link
Camera Link is a multiple-pair serial communication protocol standard [1] designed for computer vision applications based on the National Semiconductor interface Channel-link. It was designed for the purpose of standardizing scientific and industrial video products including cameras, cables and frame grabbers.

CCD
Charge Coupled Device. Commonly used technology used for camera sensors used to detect & quantify light, i.e. for capturing images in an electronic manner. CCDs were first introduced in the early 70ies.

CMOS
Complementary Metal–Oxide–Semiconductor. A more recently adopted technology used for camera sensors with in-pixel amplifiers used to detect & quantify light, i.e. capturing images in an electronic manner.

CPU
Central Processing Unit of a computer. Also referred to as the processor chip.

dB
Decibel (dB) is a logarithmic unit used to express the ratio between two values of a physical quantity.

Decimation
For reducing width or height of an image, decimation can be used (CMOS sensors only). Columns or rows can be ignored. Image readout time is thereby reduced.

Defect map
Identifies the location of defect pixels unique for every sensor. A factory generated defect map is delivered and implemented with each camera.

EPROM
Erasable Programmable Read Only Memory is a type of memory chip that retains its data when its power supply is switched off.

External Trigger
Erasable Programmable Read Only Memory is a type of memory chip that retains its data when its power supply is switched off.

fixed frequency
or programmed exposure time. Frames are read out continuously.

Gain
In electronics, gain is a measure of the ability of a two-port circuit (often an amplifier) to increase the power or amplitude of a signal from the input to the output port by adding energy to the signal.

Gamma	Gamma correction is a nonlinear operation used to code and decode luminance values in video or still image systems.
GenICam	Provides a generic programming interface for all kinds of cameras and devices. Regardless what interface technology is used (GigE Vision, USB3 Vision, CoaXPress, Camera Link, etc.) or which features are implemented, the application programming interface (API) will always be the same.
GigE Vision	GigE Vision is an interface standard introduced in 2006 for high-performance industrial cameras. It provides a framework for transmitting high-speed video and related control data over Gigabit Ethernet networks.
GPU	Graphics Processing Unit of a computer.
Hirose	Cable connectors commonly used for power, triggers, I/Os and strobe lights
ISO	see Gain.
Jumbo Frames	In computer networking, jumbo frames are Ethernet frames with more than 1500 bytes of payload. Conventionally, jumbo frames can carry up to 9000 bytes of payload. Some Gigabit Ethernet switches and Gigabit Ethernet network interface cards do not support jumbo frames.
Mount	Mechanical interface/connection for attaching lenses to the camera.
Multicast	Multicast (one-to-many or many-to-many distribution) is an ethernet group communication where information is addressed to a group of destination computers simultaneously. Multicast should not be confused with physical layer point-to-multipoint communication.
PWM	Pulse width modulation. Keeping voltage at the same level while limiting current flow by switching on an off at a very high frequency.
Partial Scan	A method for reading out fewer lines from the sensor, but “skipping” lines above and below the desired area. Typically applied to CCD sensors. In most CMOS image sensors an AOI (area of interest) or ROI (region of interest) can be defined by selecting the area to be read. This leads to increased frame rate.
Pixel clock	The base clock (beat) that operates the sensor chip is. It is typically also the clock with which pixels are presented at the output node of the image sensor.
RAW	A camera RAW image file contains minimally processed data from the image sensor. It is referred as raw in its meaning. SVS-VISTEK plays out RAW only.
Read-Out-Control	Read-Out control defines a delay between exposure and image readout. It allows the user to program a delay value (time) for the readout from the sensor. It is useful for preventing CPU overload when handling very large images or managing several cameras on a limited Ethernet connection.
Shading	Shading manifests itself a decreasing brightness towards the edges of the image or a brightness variation from one side of the image to the other. Shading can be caused by non-uniform illumination, non-uniform camera sensitivity, vignetting of the lens, or even dirt and dust on glass surfaces (lens).
Shading correction	An in-camera algorithm for real time correction of shading. It typically permits user configuration. By pointing at a known uniform evenly illuminated surface it allows the microprocessor in the camera to create a correction definition, subsequently applied to the image during readout.
Shutter	Shutter is a device or technique that allows light to pass for a determined period of time, exposing photographic film or a light-sensitive electronic sensor to light in order to capture a permanent image of a scene.

Strobe light	A bright light source with a very short light pulse. Ideal for use with industrial cameras, e.g. for “freezing” the image capture of fast moving objects. Can often be a substitute for the electronic shutter of the image sensor. Certain industrial cameras have dedicated in-camera output drivers for precisely controlling one or more strobe lights.
Tap	CCD sensors can occur divided into two, four or more regions to double/quadruple the read out time.
TCP/IP	TCP/IP provides end-to-end connectivity specifying how data should be packetized, addressed, transmitted, routed and received at the destination.
USB3 Vision	The USB3 Vision interface is based on the standard USB 3.0 interface and uses USB 3.0 ports. Components from different manufacturers will easily communicate with each other.
Trigger modes	Cameras for industrial use usually provide a set of different trigger modes with which they can be operated. The most common trigger modes are: (1) Programmable shutter trigger mode. Each image is captured with a pre-defined shutter time; (2) Pulse-Width Control trigger. The image capture is initiated by the leading edge of the trigger pulse and the shutter time is governed by the width of the pulse; (3) Internal trigger or Free-Running mode. The camera captures images at the fastest possible frame rate permitted by the readout time.
XML Files	Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format which is both human-readable and machine-readable

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