Manual HR GigE / 10 GigE

hr11002, hr16000, hr16050, hr16070, hr29050, hr16-5, hr 16-7, hr25, hr29, hr43, hr342, hr387

Company Information

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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, DIN ISO 16016:2002-5

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, in case of any complaint, please contact your local SVS-VISTEK distributor. You will find a list of distributors in your area on www.svs-vistek.com

Copyright Protection Statement

Content

1 Legal Information

Information given within the manual accurate as to: February 12, 2019, 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.

Europe

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

The product is in compliance with the requirements of the following European directives:

2014/30/EU	Electromagnetic compatibility (EMC)
2011/65/EU	Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)

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

USA and Canada

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.

This equipment is compliant with Class A of CISPR 32. Warning: In a residential environment this equipment may cause radio interference. 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.

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.

> US/UK and European power line adapter can be delivered. Otherwise use filtered and stabilized DC power supply

> Shock & Vibration Resistance is tested: For detailed Specifications refer to Specification

2 Getting Started

2.1 Contents of Camera Set

> Camera
> Power supply (if ordered/option)
> 3D CAD files (downloadable)
> Manuals (downloadable)
> Software: GigE-Kit (Win 32/64 & Linux)

2.2 Single LED Status codes

On power up, the camera will indicate its current operation status with a flashing LED on its back. The LED will change color and rhythm.
The meaning of the blinking codes translates as follows:

Figure 1: Camera status LED codes

Flashing	Description
Yellow slow (1Hz)	No Connection
Yellow quickly (8 Hz)	Assignment of Network address
Yellow permanent	Network address assigned
Green permanent	Connected with application
Green slow (1Hz)	Streaming channel available
Green quickly (8 Hz)	Acquisition enabled
Red slow (1 Hz)	Problem with initialization
Red quickly (8 Hz)	Camera overheating
Blue permanent	Waiting for trigger
Cyan permanent	Exposure active
Violet permanent	Readout/FVAL

2.3 Software

Further information, documentations, release notes, latest software and application manuals can be downloaded in the download area on SVS-Vistek's download area. Depending on the type of camera you bought, several software packages apply.

2.3.1 SVCapture 2

SVCapture 2.x is a XML based software tool. It provides the possibility to control a GenICam based camera. The image result of any modification of a camera's adjustment is immediately visible, making it the ideal tool to optimize camera adjustments.

SVCapture covers folowing interfaces:

- GigE Vision
- 10 GigE Vision
- Camera Link
- USB3

SVCapture is included in the SVCam Kit, you can download it for free from SVS-Vistek's download area.

Please refer to the SVCam Kit Install guide for details. You will find this document in the download area as well.

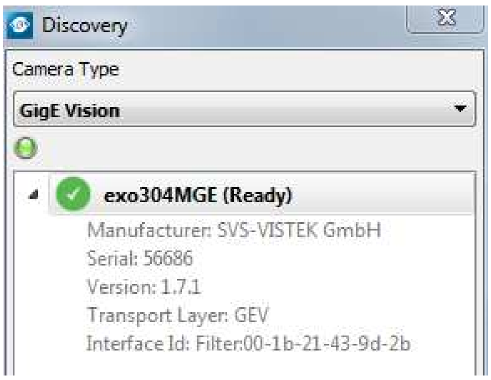
Generally, any GenICam based software package should be able to run a SVS-Vistek camera (GigE Vision, USB3, Camera Link).

It is strongly recommended to uninstall the existing version of SVCam Kit or SVCapture before installing the new version. While installing, please deactivate your firewall and antivirus programs.

Quick guide install

- Download the SVCam Kit matching to your operating system
- Disable firewall and antivirus programs
- Unpack and install the software and the drivers required for your camera's interface type
- Enable firewall and antivirus programs

Connect your camera's interface cable and power. Start SVCapture. Select your interface type in the discovery dialogue, SVCapture should show your camera after about 30 seconds.



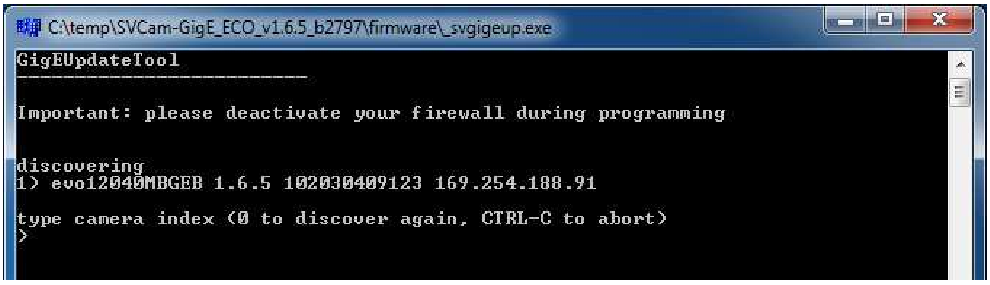
2.3.2 Firmware updater

Some features may not have been implemented in older versions. For updating your camera firmware to the most recent version, you need the firmware tool “Firmware Update Tool.exe” and the firmware file (download it from website, login area) matching your camera model.

Execute firmware update

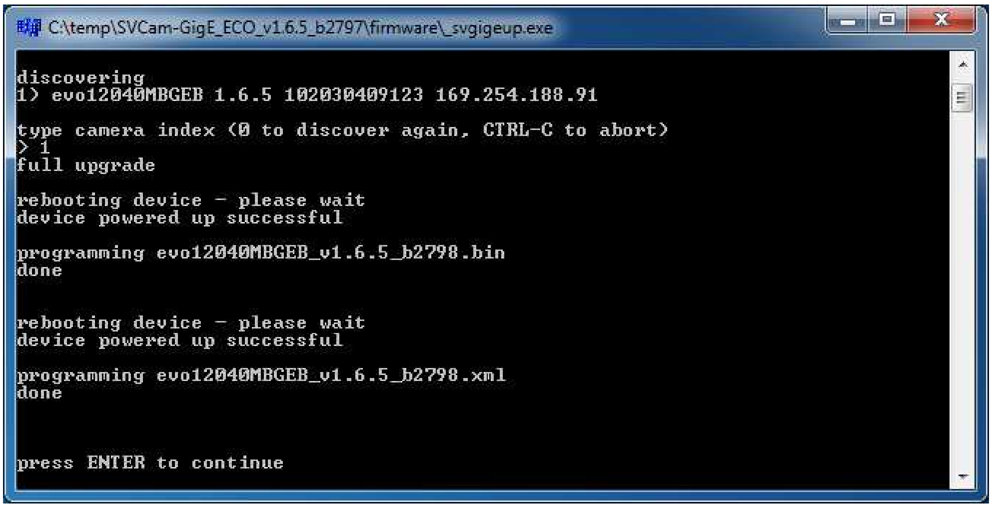
> Download the GigE firmware tool and the firmware file from the SVS-Vistek website.
> Unpack everything into any folder, e.g. “C:\temp”
> Ensure proper network configuration
> Run the GigE update tool

Your camera should appear, choose camera by entering camera index, e.g. 1 and press ENTER.



search camera for firmware update

Wail until firmware update has been finished



firmware update

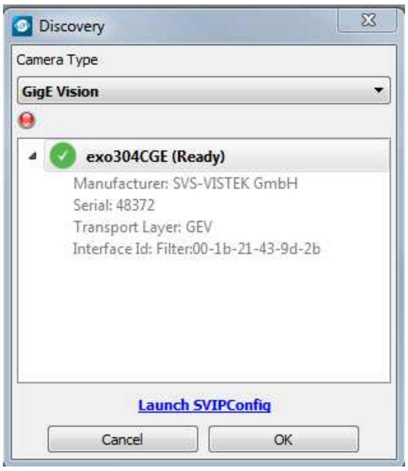
2.3.3 GigE IP Setup

Your GigEVision camera needs a working network connection. Make sure the camera is attached to the network and is powered on. Make sure everything is plugged in properly and that the firewall settings are not blocking the connection to the camera or SVCapture.

Automatic camera detection

By default, SVS-Vistek GigE Vision cameras are trying to acquire a valid network address vie LLA or DHCP from the network.

For finding and accessing your camera, start SVCapture on your computer. As soon as the camera has booted, all SVS-Vistek GigE cameras are showing up in the main window. Select the camera you want to connect to and press ok.

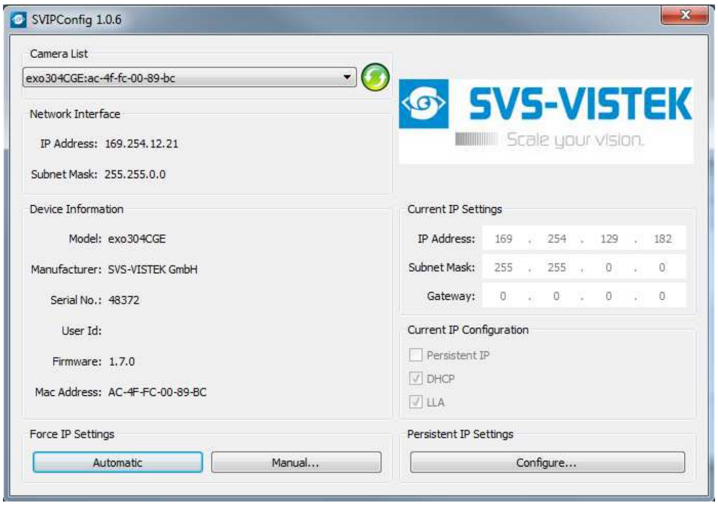


If you want to change automatic address or go back to automatic mode, use SVIPConfig.

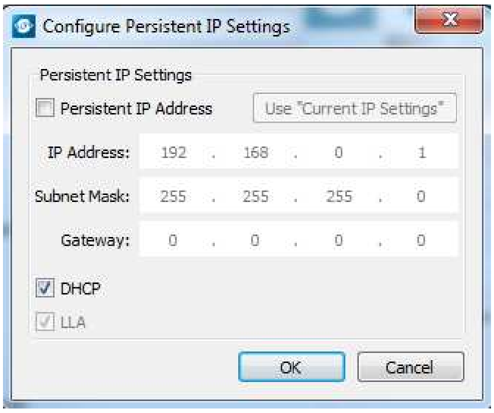
SVIPConfig

SVIPConfig allows to

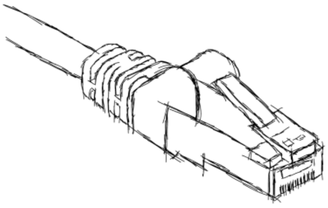
> Assign a new IP address
(make sure the address is unique and that it is valid in the current subnet)
> Save a specific address as a permanent address to the camera (Persistent)
> Save automatic address mode to the camera



For saving an persistent IP configuration (configuration will survive power off) you need to check the „Persistent IP address“.



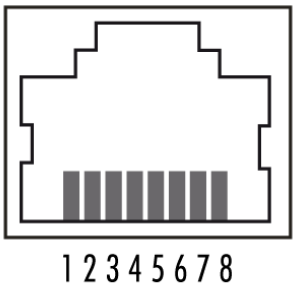
3 Connectors



3.1 Dual GigE Vision

Any dual GigE camera can be run as well with a single network connection. Dual GigE connection is required only if single network connection does not provide sufficient bandwidth. For dual GigE operation, 2 NICs need to be **teamed.** NIC teaming is a feature of the operating system.

For single line operation of dual GigE cameras use the **upper right network port** for single line operation.



physical layout of RJ45 female connector

By default, the camera does not have a persistent IP address.

For Dual GigE Vision a "Static Link Aggregation" (SLA) is recommended. Refer to Teaming.

When forcing an IP address by using the PC internal network dialog, changes are only valid until the next restart of the Camera.

For a peer-to-peer connection of a GigE camera to a PC a network address assignment based on LLA (Local Link Address) is recommended. This involves a network mask "255.255.0.0" as well as a fixed preamble "169.254.xxx.xxx" of the network address range. A GigE camera will fall back to LLA when no DHCP server is available and no fixed network address was assigned to the camera.

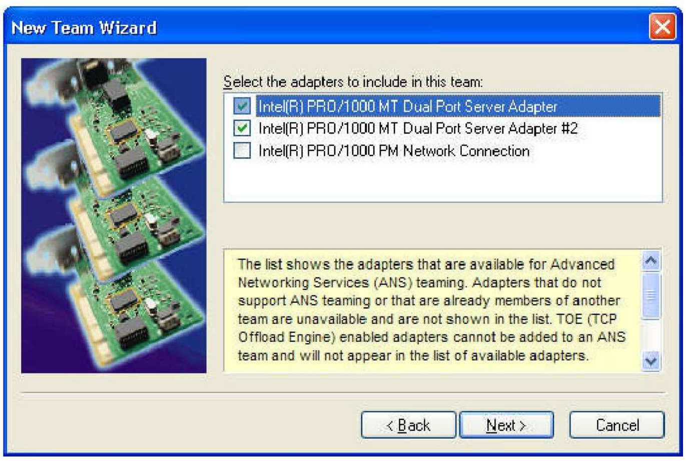
3.1.1 Teaming Dual GigE

For higher transfer rates on GigE, you might want to team 2 GigE ports together. The host computer requires 2 network interfaces or a dual NIC. The configuration below shows the configuration.

Teaming is an operating system task. The data stream will use both (teamed) network interfaces at the same time with the maximum interface bandwidth each. Teaming protocol is transparent to the network, this means data receivers might be a single or a teamed network device.

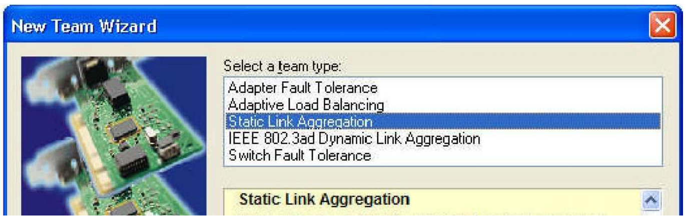
Teaming on network adapter Intel pro 1000 dual/ Windows7

After naming your Team, select doth dual port adapters to team.



team wizard

Choose Static Link Aggregation, next and finish.



setting Static Link Aggregation (SLA)

Jumbo Frames

The transport efficiency in the streaming channel can be improved by using "jumbo frames". This will reduce overhead caused by maintaining header data upon each data packet sent.

For Dual GigE Vision a value of 16128 Byte per package is recommended (instead of 9056 B).

Illustration of data reduction with jumbo frames

NOTICE

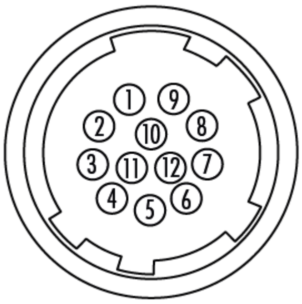
Higher packet sizes require network cards that support jumbo packets.

3.2 Input / output connectors

Hirose™ 12Pin

The Hirose connector provides the connectors to power, inputs and outputs. For detailed information about switching lights from inside the camera, refer to strobe control.

Hirose 12 Pin



1	VIN –	(GND)
2	VIN +	(10V to 25V DC)
3	IN4	(RXD RS232)
4	OUT4	(TXD RS232)
5	IN1	(0-24V)
6	IN2	(0-24V)
7	OUT1	(open drain)
8	OUT2	(open drain)
9	IN3 +	(opto In +)
10	IN3 –	(opto In –)
11	OUT3	(open drain)
12	OUT0	(open drain)

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

4 The HR Camera Series

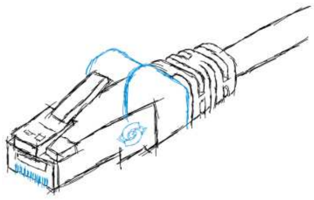
Focusing on details

The SVCam HR series is a series of industrial machine vision cameras featuring especially on very high image resolutions and interface high speed without compromising on image quality. Camera sensors and interfaces are built to deliver maximum sensor and interface bandwidth.

With this kind of high resolution sensors being already very large, the HR series comes with an M58 mount with the possibility to adapt for any kind of lens.

High end CCD and CMOS image sensors with high resolutions permit swift and effortless capture of a wide field of view, making this camera series your prime choice for demanding applications such as optical metrology, quality monitoring, wide field surveillance or traffic monitoring.

GigE-Vision features



GigE Vision is an industrial interface standard for video transmission and device control over Ethernet networks. Being an industry standard, it facilitates easy and quick interchangeability between units, shortening design cycles and reducing development costs. It provides numerous software and hardware advantages for machine vision.

> Cost effective
> Wide range of „off the shelf" industrial-standard plugs and cables
> High bandwidth data transfer rate (120 MB/sec per output)
> Up to 100 m range without additional switch
> Wide range of applications in image processing
> Remote service capability
> GenICam compliant
> SDK for Windows XP/10 (32/64 bit), and Linux
> ARM support (ARM/Jetson)
> SDK with GenTL support

In case your camera features a Dual GigE connector, the bandwidth and data transfer rate are close to double this value. Most operating systems do support link aggregation.

10 GigE Vision

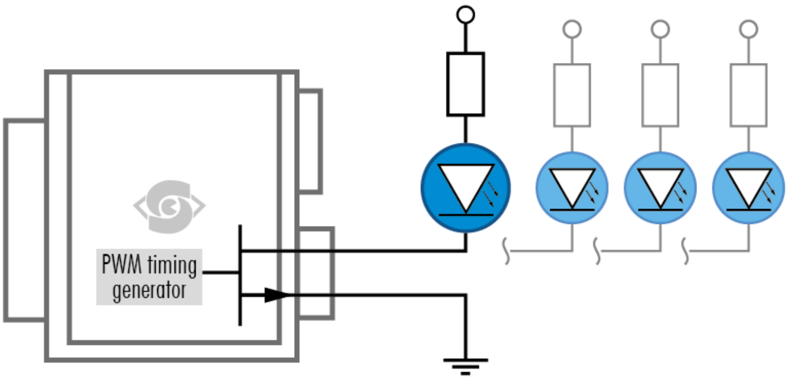
10 GigE on copper lines is a standard existing for years already in professional internet technology. Basically, it keeps the benefits and fundamental ideas of GigE and adds the ten times higher speed. There are 2 main disadvantages compared to GigE:

> Higher power dissipation in 10 GigE devices
> Reduced cable lengths

By using high-quality CAT 6 cables, cable lengths of up to 100m are possible and compensating the first disadvantage somewhat. Despite using the latest 10 GigE transceivers in the devices, the increased power dissipation still will result in slightly larger camera housings.

The benefit of 10 GigE is the higher speed: Up to 1.1 GB/s of data are possible, what is in the range of high-performance image sensors.

4IO adds Light and Functionality



4IO concept with up to 4 switching LED lights

Your SVS-Vistek camera is equipped with the innovative 4IO-interface allowing full light control, replacing external strobe controllers. Each of the outputs can be individually configured and managed using pulse-width modulation. With its high current output, the camera is able to drive LED lights directly without external light controller.

The integrated sequencer allows multiple exposures with settings to be programmed, creating new and cost effective options. Logical functions like AND / OR are supported.

- Up to 4 x open drain high power OUT
- Up to 4 x high voltage IN – TTL up to 25 Volts
- Power MOSFET transistors
- PWM strobe control
- Sequencer for various configurations
- PLC fuctionality with AND, OR and timers
- Safe Trigger (debouncer, prescaler, high low trigger)

Find an example how to operate light control in the sequencer section.

5 Feature description

This chapter covers features of SVCam cameras. Not every feature might be supported by your specific camera model. For information about the features of your specific model, please refer to the specifications area with your exact model.

5.1 Basic Understanding

5.1.1 Global shutter

The shutter is describing the functionality of exposing the light sensitive pixels of the sensor to light for a limited time. With global shutter all pixels are exposed to light at the same time for the same time.

All pixel will be exposed to light at the same starting point, and all pixel light exposure will stop at the same time. Fast moving objects will be captured without showing movement distortion, except motion blur if the moving object is so fast that the same point of the object covers different pixels at start and end while exposing.

Using flash with global shutter is straight forward: just make sure your flash is on while shutter is open, thus all pixels are exposed to light the same time. You might flash at any time within exposure time.

5.1.2 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.

5.1.3 Exposure speed

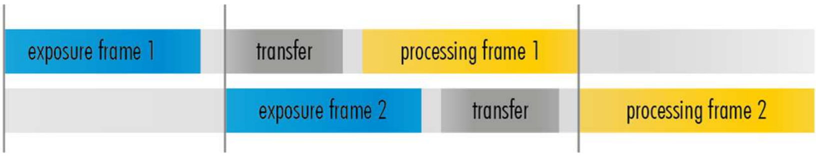
Frames per second, or frame rate describes the number of frames output per second (1/ frame time). Especially GigE and USB cameras cannot guarantee predictable maximum framerates with heavy interface bus load.

Maximum frame rate might depend on

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

5.1.4 Acquisition and Processing Time

The camera has to read the sensor, process the data to a valid image and transfer this to the host computer. Some of these tasks are done in parallel. This implies the data transfer does not end immediately after end of exposure, as the image has to be processed and transferred after exposure.



On the other side, while processing and transferring the image the sensor might capture already the next frame.

5.1.5 Auto exposure

Auto Luminance or auto exposure 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.

5.1.6 Bit-Depth

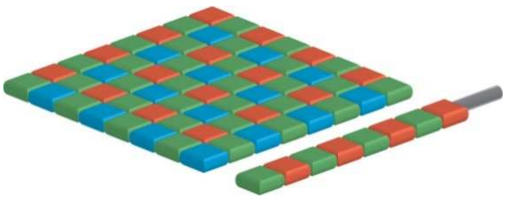
Values of brightness are internally represented by numbers. The number of bits for brightness representation is limiting the number of colour values that can be represented. Bit depth defines the maximum unique colors or grey levels in an image.

No of grey values $= 2^{\text{bit depth}}$

All SVCam models support 8-bit format. In most cases, the sensor itself is limiting maximum bit depth. Refer to specifications whether your model is supporting higher bit depth.

5.1.7 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.



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). De-Bayering is not done in the camera, it has to be done in the client software. See SDK functions as well. Not all sensors do have the same sequence of color. The GenICam property PIXELCOLORFILTER does indicate the sequence of the color pixels when reading color images.

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.

Camera Link frame grabber need information of the sequence order of the colours. The order depends on sensor type. USB3 and GigE cameras provide this in their XML file.

NOTICE

It is recommended to use an 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 based on a non-white illumination.

5.1.8 Resolution

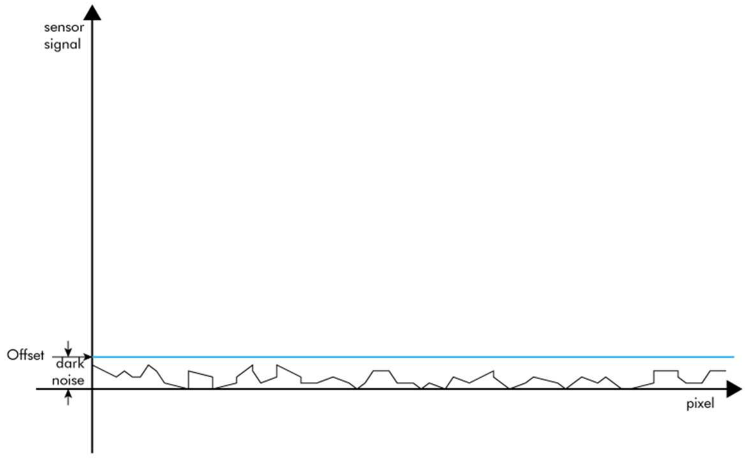
As mentioned in the specifications, there is a difference between the numerical sensor resolution and the camera resolution. Some pixels towards the borders of the sensor will be used only internally to calibrate sensor values ("dark pixels"). The amount of dark current in these areas is used to adjust the offset.

For calculating image sizes, the maximum camera resolution is determining maximum image resolution. See specifications of your model.

5.1.9 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 (dark noise: noise generated without light exposure).

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



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. 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 (see tap balancing).

5.1.10 Gain

Setting gain above 0 dB (default) is a 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. Increasing gain will increase noise as well.

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

Table of dB and corresponding ISO value

NOTICE

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

noise caused by too much gain

Auto Gain

For automatic adjustment of Gain please refer to auto exposure.

When using autogain with steps of gain the non-continous gain adjustment might be visible in final image. Depending on your application it might be preferrable to use fixed gain values instead and modify exposure with exposure time.

5.1.11 Flip Image

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

original image

horizontal flip

vertical flip

5.1.12 Binning

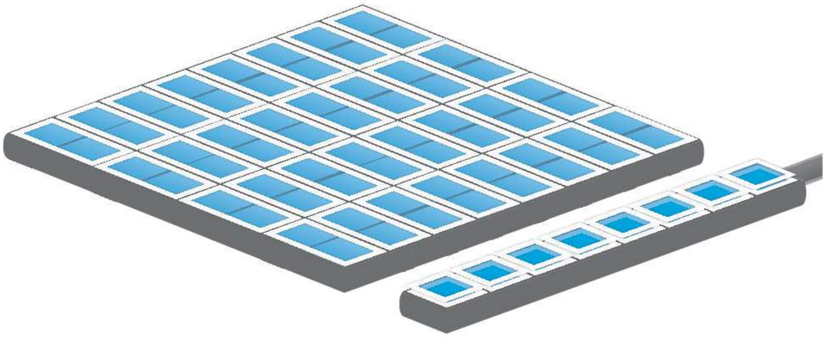
Binning provides a way to enhance dynamic range, but at the cost of lower resolution. Binning combines electron charges from neighboring pixels directly on the chip, before readout.

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

On CMOS sensors, binning will not affect image quality. In any case, binning will reduce the amount of pixel data to be transferred.

Vertical Binning

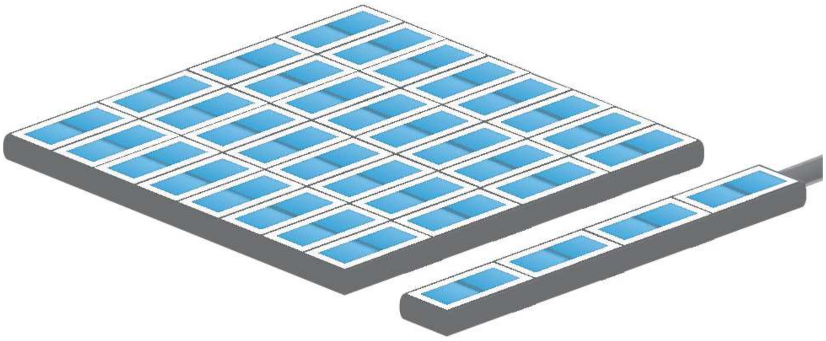
Accumulates vertical pixels.



Vertical binning

Horizontal Binning

Accumulates horizontal pixels.

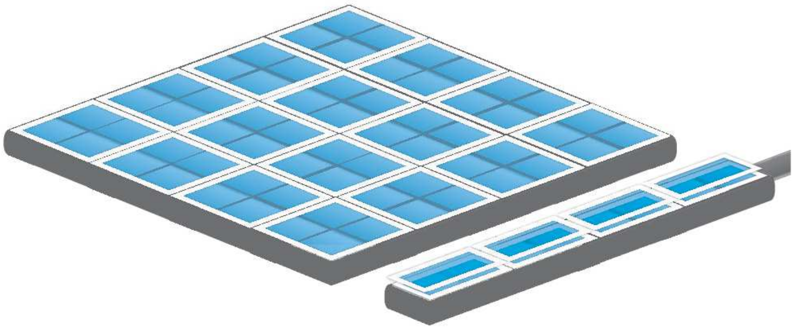


Horizontal binning

2×2 Binning

A combination of horizontal and vertical binning.

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



2x2 binning

5.1.13 Decimation

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

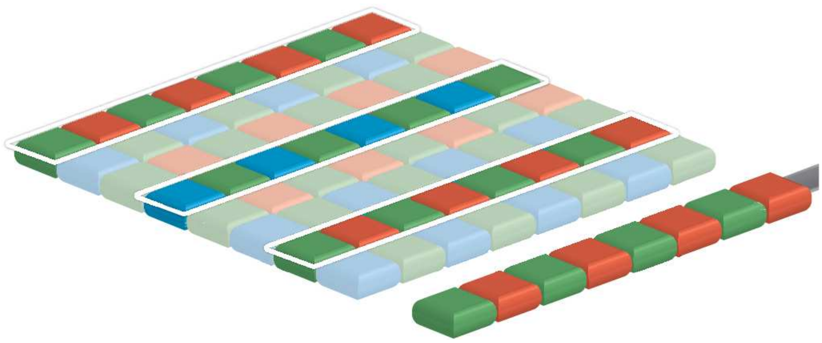
Refer to AOI for reducing data rate by reducing the region you are interested in.

Horizontal decimation

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.



Decimation on color sensors

5.1.14 Burst Mode

The hardware interface (GigE, USB3 etc) of your camera very often will limit the maximum framerate of the camera to the maximum framerate of the interface of the camera. 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 with interface speed. If trigger frequency is higher than interface max fps frequency, more and more images will stick in the internal image buffer. As soon as the buffer is filled up, frames will be dropped.

This internal-save-images and deliver-later thing is called Burst Mode.

Due to internal restriction in the image request process of the camera, on USB cameras the maximum sensor speed is limited to the maximum interface speed. This means the maximum trigger frequency cannot be higher than camera freerun frequency. The image buffer will protect against breaking datarates of the USB line, though.

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) (not applicable to USB cameras)

Please note, as soon as the internal memory buffer is filled up, frames will be dropped. Due to this reason, SVS-Vistek camers provide up to 512MB image buffer memory.

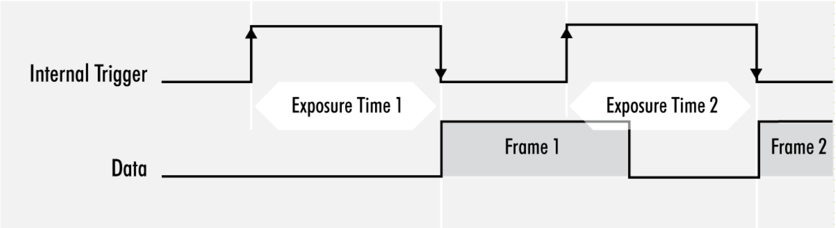
5.2 Camera Features

5.2.1 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.

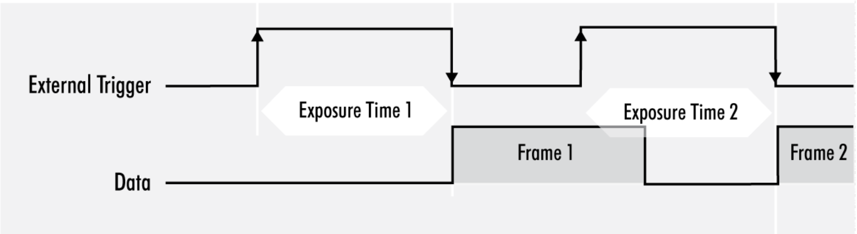
NOTICE

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

Triggered Mode (pulse width)

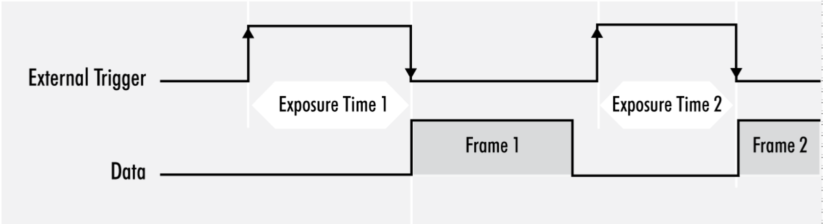
External trigger and pulse-width controlled exposure time. In this mode the camera is waiting for an external trigger, which starts integration and readout. Exposure time can be varied using the length of the trigger pulse (rising edge starts integration time, falling edge terminates the integration 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).

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

External Trigger (Exposure Time)

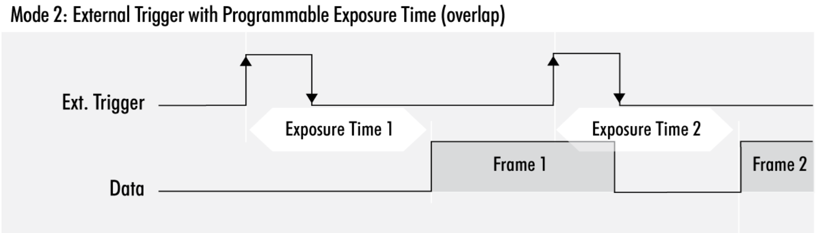
External trigger with programmable exposure time. In this mode the camera is waiting for an external trigger pulse that starts integration, whereas exposure time is programmable via the serial interface and calculated by the internal microcontroller of the camera.

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).

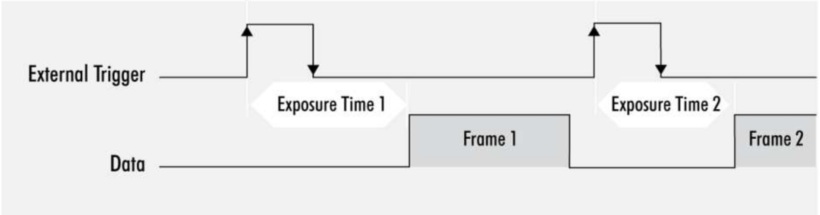
Exposure time of the next image can overlap with the frame readout of the current image (trigger pulse occurs when FVAL is high). When this happens, the start of exposure time is synchronized to the negative edge of the LVAL signal (see figure)

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)

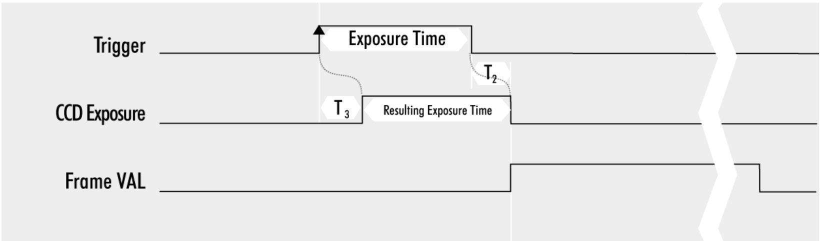


Exposure time can be changed during operation. No frame is distorted during switching time. If the configuration is saved to the EEPROM, the set exposure time will remain also when power is removed.

Detailed Info of External Trigger Mode

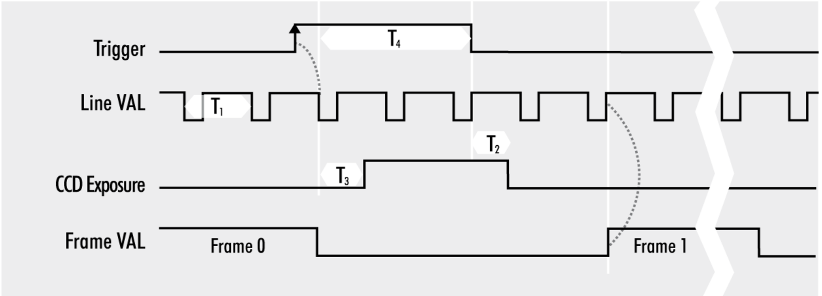
Dagrams below are aquivalent for CCD and CMOS technique.

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



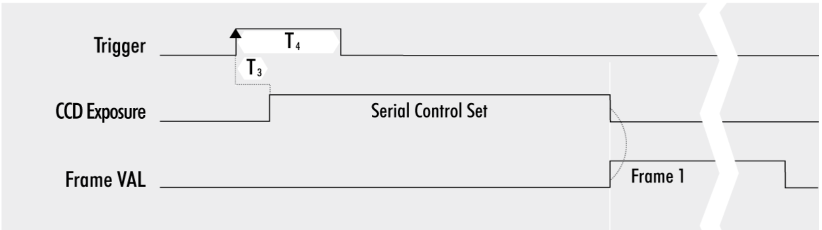
T_1: Line Duration T_2: Transfer Delay T_3: Exposure Delay T_4: min. Trigger Pulse Width

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



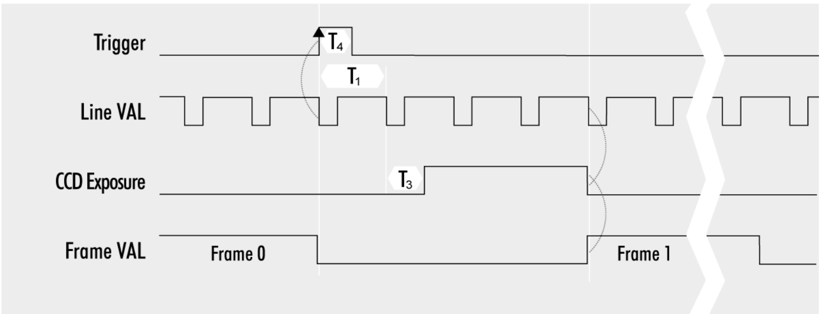
T_1: Line Duration T_2: Transfer Delay T_3: Exposure Delay T_4: min. Trigger Pulse Width

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



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

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



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

5.2.2 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 steps. In this example, the transfer rate is 66.7 MHz, thus resulting in steps 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

5.2.3 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)

5.2.4 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]

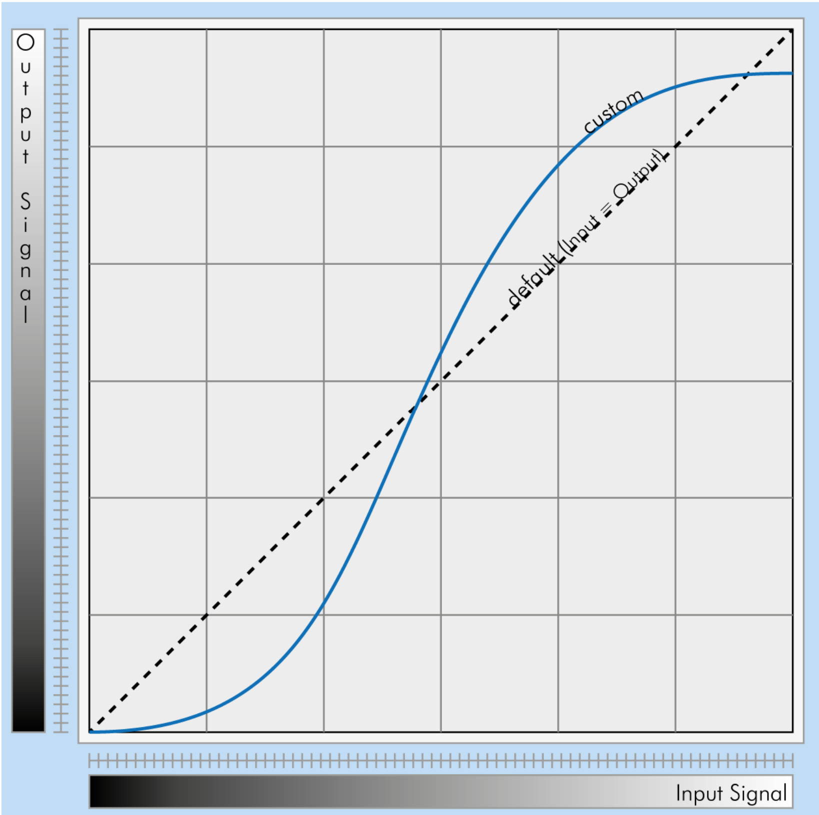


Figure 1: Custom LUT adding contrast to the midtones

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

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

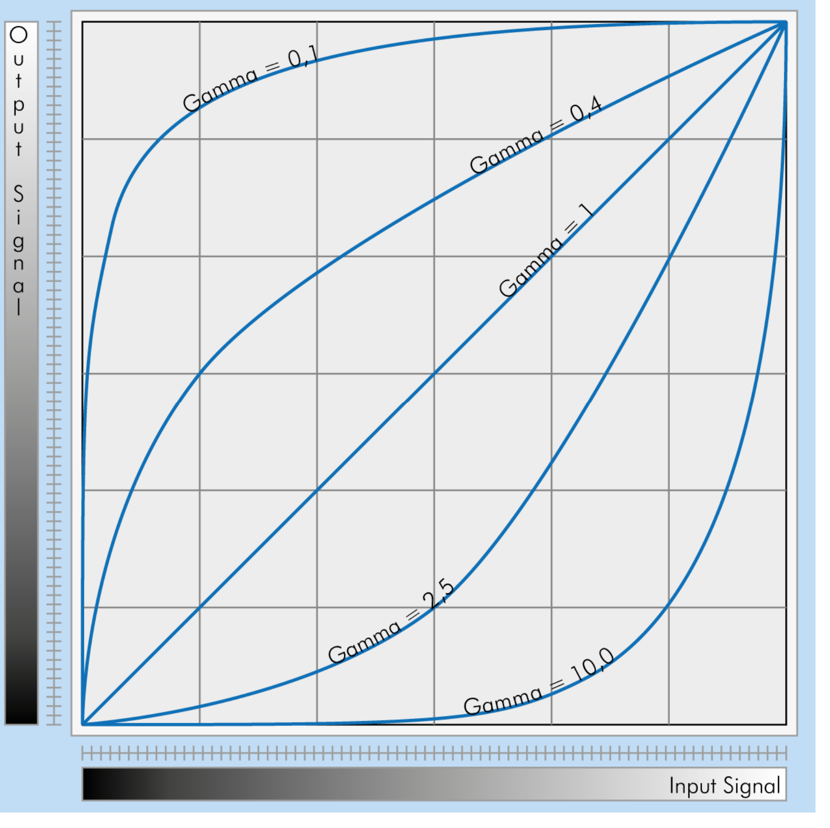


Figure 2: Several gamma curves comparable to a LUT

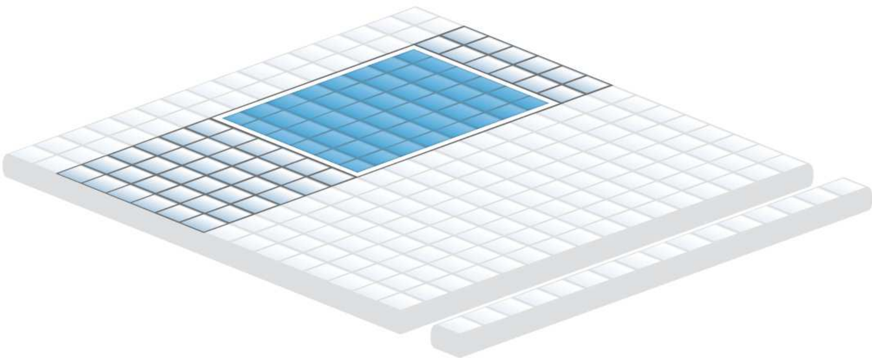
Gamma values less than 1.0 map darker image values into a wider ranger.
Gama values greater than 1.0 do the same for brighter values.

NOTICE

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

5.2.5 ROI / AOI

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



AOI 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.

With CMOS Sensors, AOI can be selected as well. Please note, most CMOS sensors require the camera to read full horizontal sensor lines internally. Reducing horizontal size with AOI might result in limited fps speed gain.

5.2.6 Defect Pixel Correction

All image sensor have defect pixels in a lesser or greater extent. Type and number of defects determine the quality grade (quality classification) of the sensor.

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

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 as a factory default.

Under challenging conditions or high temperature environments defect pixel behaviour might change. This 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 single pixels or clusters and reconstructs the expected value by interpolating neighboring pixel values. 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.

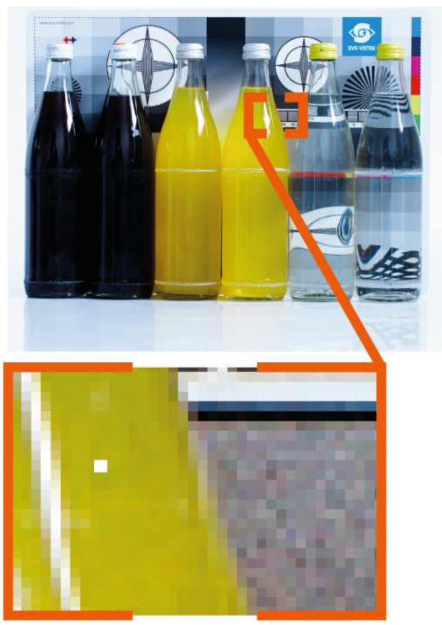


Figure 3: Illustration of a defect pixel

5.2.7 Shading Correction

The interactions between objects, illumination, and the camera lens might lead to a non-uniform flatfield in brightness. Shading describes the non-uniformity of brightness from one edge to the other or center towards edge(s).

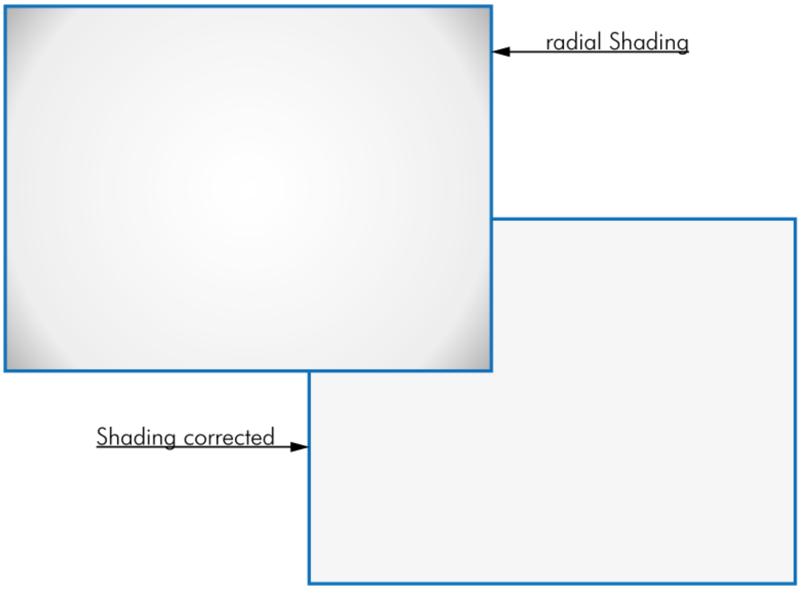


Figure 4: Original and shading corrected image

This 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 is a procedure to create a flatfield image out of a non-uniform image regardless of the reasons of the non-uniformity. Before doing shading correction, make sure your lens is clean and in perfect condition. If the lens is not clean or the lighting not uniform, the algorithm tries to compensate these as well – resulting in a wrong shading table and visible artifacts, loss of details or local noise in the final image.

In theory there are several ways to correct shading:

- In the host computer: Significant loss of dynamic range, colour ruptures
- In the camera, digital: better (smoother) shading than on the computer side (10 or 12 bit), loss of dyn range
- In the camera, analog: Change gain/offset locally on sensor to get optimum shading correction with only small changes in dynamic range

5.3 I/O Features

5.3.1 GenICam

GenICam™ provides a generic programming interface to control all kinds of cameras and devices. Regardless of the interface technology (GigE Vision, USB3 Vision, CoaXPress, Camera Link, etc.) or implemented feature, the application programming interface (API) will always be the same. The SNFC makes sure the feature names are similar throughout the manufacturers, making it more easy to switch camera models.

The GenICam™ standard consists of multiple modules according to the main tasks to be solved:

> GenApi: configuring the camera
> SNFC: Standard Feature Naming Convention, a catalogue of standardized names and types for common device features
> GenTL: transport layer interface, grabbing images
> GenCP: generic GenICam control protocol
> GenTL SFNC: recommended names and types for transport layer interface.

The GenICam properties are organized as a tree. Manufacturers can add more features.

With your SVCam, the GenICam tree does have some hardware related extensions, especially in the I/O sector. See the Quick guide install for a short introduction into SVS-Vistek's GenICam tree.

5.3.2 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.

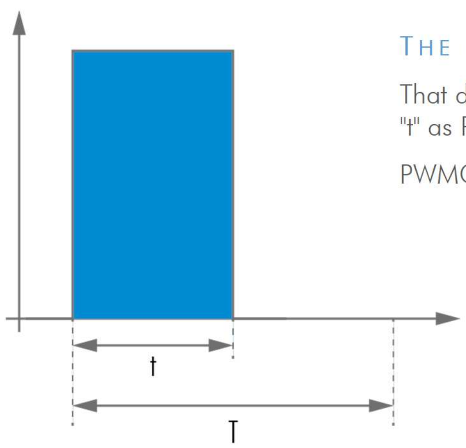
Implementation of PWM

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

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

Duty cyle "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:

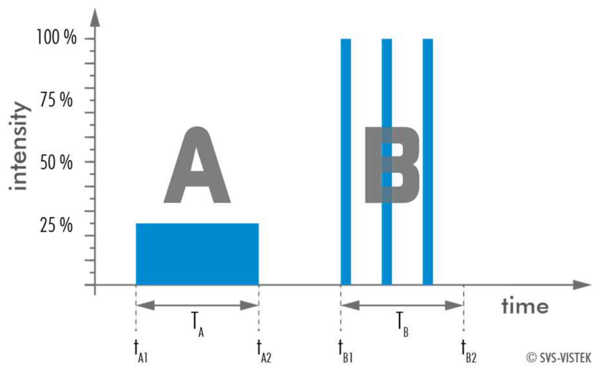


Figure 5: 25% PWM load

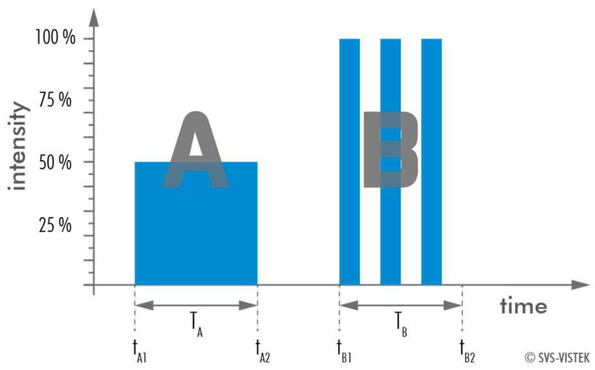


Figure 6: 50% PWM load

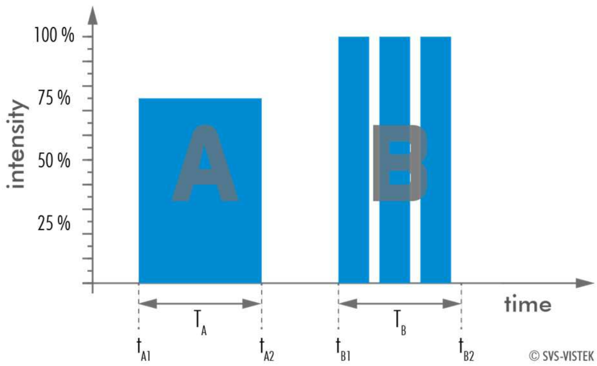


Figure 7: 75% PWM load

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:

5.3.3 Driver Circuit Schematics

Camera power supply and power supply for PWM out is 25V max. Power for PWM out has to be supplied via Hirose connector. The open drain outputs are ledged to ground, that means you connect your LED on the positive side to your (light-)power source, the negative LED connector goes to the camera out. This setup requires common ground.

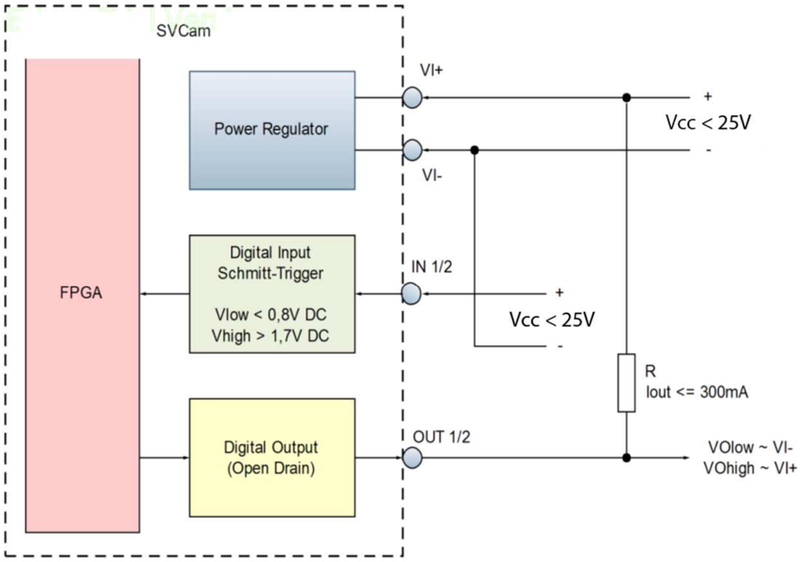


Figure 8: output driver circuit layout

5.3.4 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.

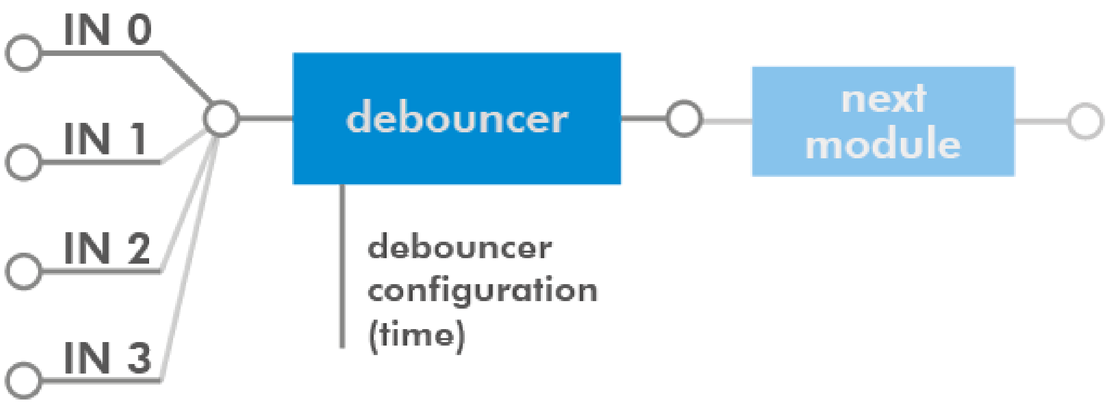


Figure 9: "IN0" connected to "debouncer"

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.

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

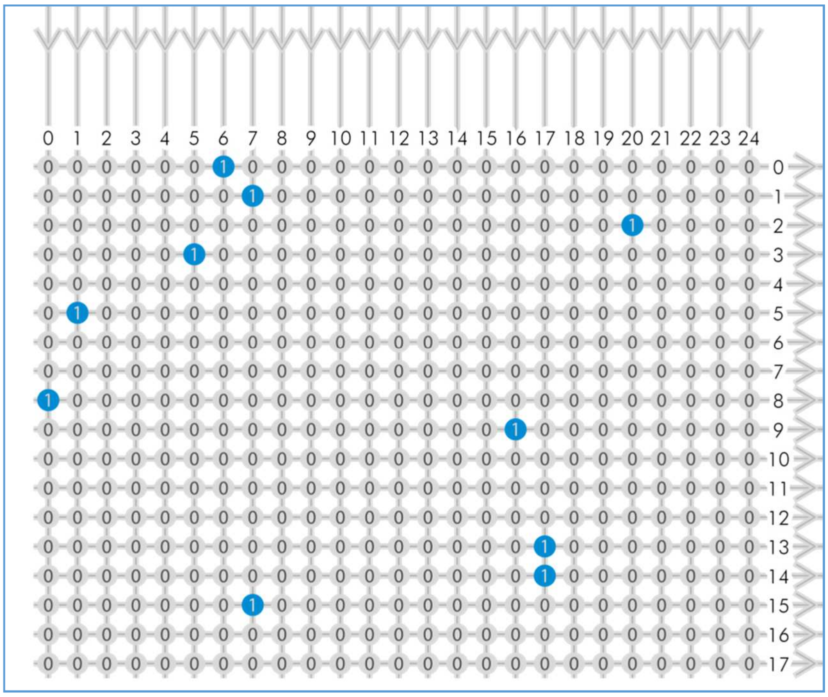
* refer to pinout or specifications

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.

5.3.5 Strobe Control

The SVCam 4I/O concept contains an integrated strobe controller. Its controls are integrated into the GenICam tree. With LED lights attached to the outputs, this enables the user to control the light without external devices. Being controlled via GenICam, any GenICam-compliant 3rd party software is able to control the light as well. Depending on the camera model, up to 4 (see specifications) independent channels are supported with a peak current of max 1 Amp.

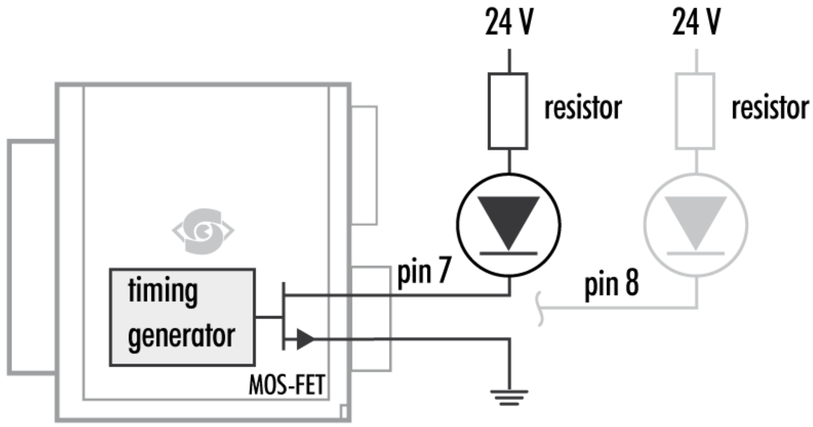


Figure 10: Attach LED lights to camera outputs. For detailed connector pin out refer to Connectors

USE RIGHT DIMENSION OF RESISTOR!

To avoid destruction of your LED light or camera, make sure to use the right dimension of shunt resistor. If not done so, LEDs and/or Camera might be damaged.

Calculate LED shunt resistors

Shunt resistors are used to limit the LED current. Make sure, neither shunt nor LED are run above specs.

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 = $\frac{13\,V}{250\,mA}$	52 Ω

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

LEDs in Flash Mode

Most LED lights can cope with currents higher than specs. This gives you higher light output when light is ON. Please refer to your LED specs if LED overdrive is permitted.

By controlling the duty cycle the intensity of light and current can be controlled. See sequencer example how to adjust the values in the GenICam tree for strobe control.

NOTICE

The shorter the „time on" – the higher current can be used when driving LEDs with current higher than spec

Strobe vocabulary

For an example how to enable and adjust the integrated strobe controller refer to sequencer. Times and frequencies are set in tics. 1 tic = 15ns.

Exposure Delay

A tic value, representing the time between the (logical) positive edge of trigger pulse and start of integration time.

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 tics. 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.

5.3.6 Sequencer

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

Values to set	Description
Sequencer interval	Duration of the interval
Exposure start	Exposure delay after interval start
Exposure stop	Exposure stop related to interval Start
Strobe start	Strobe delay after interval start
Strobe stop	Strobe stop related to interval Start
PWM frequency	Basic duty cycle (1 / Hz) for PWM
PWM change	Demodulation results

In the current GenICam implementation, all values have to be entered in tic values.

1 tic = 15 ns

Every adjustment (times, frequencies) has to be recalculated into tics and done in tics. See the example below.

When setting “Exposure Start” and “Stop” consider ‘read-out-time’ of the sensor. It has to be within the Sequencer interval.

For physical input and output connections refer to pinout or specifications or see example below. After trigger signal all programmed intervals will start. Up to 16 intervals can be programmed.

Sequencer settings can be saved to camera EEPROM.

Example

For demonstration, imagine following task to be done:

Scenario

An object should be inspected with a monochrome camera. For accentuating different aspects of the image, 4 images should be taken in a row with 4 different colours of light: Red, Green, Blue, White. White light should be generated from the RGB lights being activated at the same time. Basis is a dark environment without other light sources.

Camera wiring

- 3 LED lights are physically connected to the camera on out 0-2 (red, green, blue)
- Out 3 is not used

I/O matrix

- 4 images to be taken (RGBW) result in 4 sequences
- RGB PWM change with different intensities (duty cycle) taking care for differences in spectral response of the camera sensor
- PWM change 0-2 is connected to out 0-2
- Seq pulse A is driving the exposure (trigger)
- Seq pulse B is driving the strobe
- Seq pulse B in WHITE sequence is reduced down to 33% as light intensities of 3 lights (RGB) will add up

Notes

- Different exposure / strobe timings are used for illustration. In most cases they will show values same as exposure
- The resulting exposure time shows the period of sensor light exposure. (''masking'' of exposure time by creating strobe light impulses shorter than exposure time). This value is not adjustable at the camera
- PWM change is shown with reduced height for demonstrating reduced intensity. In reality though, PWM change will be full height (full voltage, shunt resistor might be necessary) with the adjusted duty cycle
- Use a PWM frequency high enough not to interfere with your timings (here: 1000 Hz)

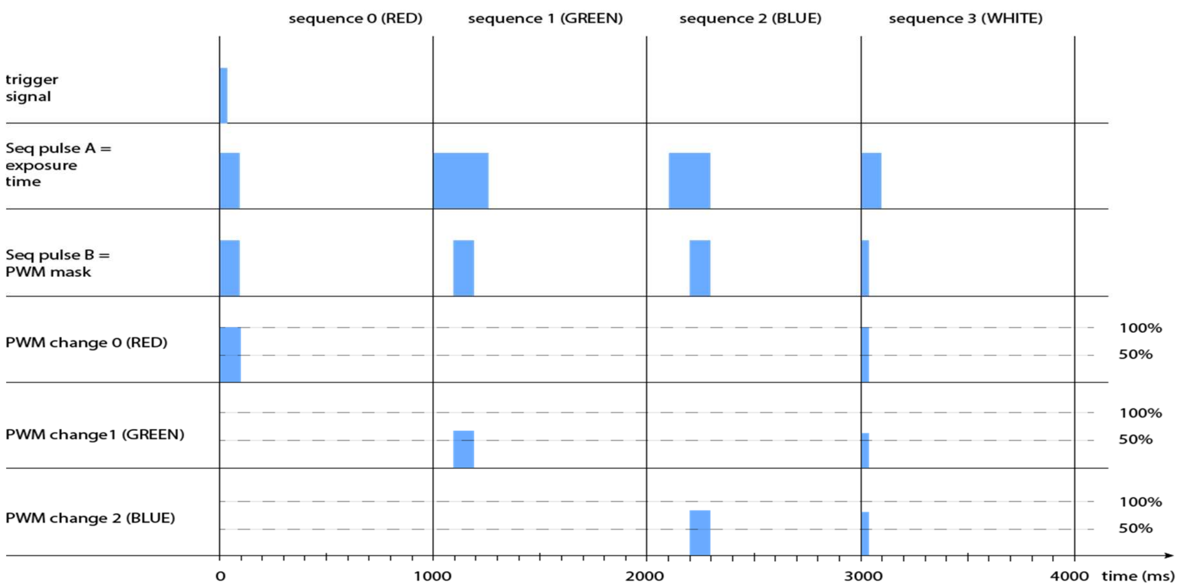
Scenario values	Interval 0 (RED)	Interval 1 (GREEN)	Interval 2 (BLUE)	Interval 3 (WHITE)
Sequencer Interval	1000 ms	1000 ms	1000 ms	1000 ms
Seq pulse A start	0 ms	0 ms	100 ms	0 ms
Seq pulse A stop	100 ms	300 ms	300 ms	100 ms
Seq pulse B start	0 ms	100 ms	200 ms	0 ms
Seq pulse B stop	100 ms	200 ms	300 ms	33 ms
PWM Frequency f	1000 Hz	1000 Hz	1000 Hz	1000 Hz
PWM change 0 (RED)	100%	0%	0%	100%
PWM change 1 (GREEN)	0%	70%	0%	70%
PWM change 2 (BLUE)	0%	0%	80%	80%
PWM change 3	-	-	-	-

As being said before, all these values have to be entered into the camera's GenICam tree as tic values.

The timing values translate like this into tics:

Values to set in GenICam properties	Interval 0 (RED)	Interval 1 (GREEN)	Interval 2 (BLUE)	Interval 3 (WHITE)
Sequencer Interval	66666667 tic (1000 ms)	66666667 tic (1000 ms)	66666667 tic (1000 ms)	66666667 tic (1000 ms)
Seq pulse A start	0 tic (0 ms)	0 tic (0 ms)	6666667 tic (100 ms)	0 tic (0 ms)
Seq pulse A stop	6666667 tic (100 ms)	20000000 tic (300 ms)	20000000 tic (300 ms)	6666667 tic (100 ms)
Seq pulse B start	0 tic (0 ms)	6666667 tic (100 ms)	13333333 tic (200 ms)	0 tic (0 ms)
Seq pulse B stop	6666667 tic (100 ms)	13333333 tic (200 ms)	20000000 tic (300 ms)	2200000 tic (33 ms)
Effective exposure time	100 ms	100 ms	100 ms	33 ms
PWM Frequency f	66667 tic (1000 Hz)	66667 tic (1000 Hz)	66667 tic (1000 Hz)	66667 tic (1000 Hz)
PWM change 0 (RED)	66667 tic (100% of 1000 Hz)	0 tic	0 tic	66667 tic (100% of 1000 Hz)
PWM change 1 (GREEN)	0 tic	46667 tic (70% of 1000 Hz)	0 tic	46667 tic (70% of 1000 Hz)
PWM change 2 (BLUE)	0 tic	0 tic	53333 tic (80% of 1000 Hz)	53333 tic (80% of 1000 Hz)
PWM change 3	-	-	-	-

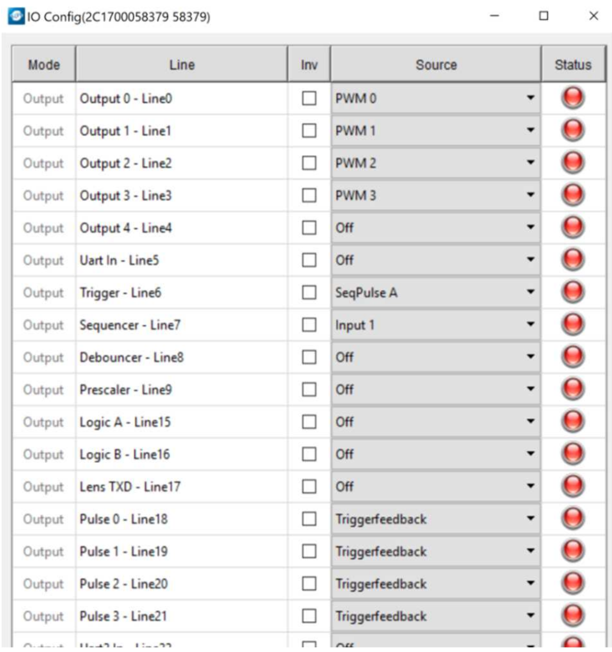
In a timings diagram, the sequence values above will look like this



Sequencer setup with SVCapture

Starting with SVCapture 2.5.2, there is a sequencer assistant, providing easy setup of the sequencer settings. The assistant will help you to setup timings for start exposure and lighting and so on. The PWMs are connected to the physical outputs (e.g. for driving LED lights)..

For making the sequencer work in general, have a look into the GenICam tree or even more simple into the I/O assistant. Connect the the I/O lines as below:



IO Config(2C1700058379 58379)

Mode	Line	Inv	Source	Status
Output	Output 0 - Line0	☐	PWM 0	
Output	Output 1 - Line1	☐	PWM 1	
Output	Output 2 - Line2	☐	PWM 2	
Output	Output 3 - Line3	☐	PWM 3	
Output	Output 4 - Line4	☐	Off	
Output	Uart In - Line5	☐	Off	
Output	Trigger - Line6	☐	SeqPulse A	
Output	Sequencer - Line7	☐	Input 1	
Output	Debouncer - Line8	☐	Off	
Output	Prescaler - Line9	☐	Off	
Output	Logic A - Line15	☐	Off	
Output	Logic B - Line16	☐	Off	
Output	Lens TXD - Line17	☐	Off	
Output	Pulse 0 - Line18	☐	Triggerfeedback	
Output	Pulse 1 - Line19	☐	Triggerfeedback	
Output	Pulse 2 - Line20	☐	Triggerfeedback	
Output	Pulse 3 - Line21	☐	Triggerfeedback	

You may start the sequence with a hardware trigger input signal (sequencer is connected to Input 1). As an alternative you might use a software trigger. For software trigger setup, adjust as below:

Feature Name	Feature Value
Acquisition Control - Acquisition Mode	Continuous
Acquisition Control – Trigger Selector - Trigger Mode	On
Acquisition Control – Trigger Selector - Trigger Source	Line 1
Acquisition Control – Trigger Selector – Exposure Mode	Trigger Width
Enhanced IO – PWMEnable	On
Enhanced IO – SeqEnable	On

The Exposure mode „trigger width" makes exposure start at a certain timing (Seq pulse A) and stop at Seq pulse B. In the GenICam tree this will reflect as following:

Property	Value
> Device Control	
> Image Format Control	
˅ Acquisition Control	
Acquisition Mode	Continuous
˅ Trigger Selector	Acquisition Start
Trigger Mode	On
Generate Software Trigger	(command)
Trigger Source	Line 1
Trigger Activation	Rising Edge
Trigger Delay	0 us
Exposure Mode	Trigger Width
Acquisition Frame Rate	10 Hz
Exposure Time	99871 us
Exposure Auto	Off
Exposure First	☐ Off
ExposureTimeMin	1000 us
ExposureTimeMax	300000 us
Sensor Shutter Mode	Global Shutter

> Strobe Control	
˅ Enhanced IO	
PWMEnable	☑ On
SeqTrigger	(command)
SeqTriggermode	Trigger on high level
˅ SeqSelector	3
SeqInterval	6700000
SeqPulseAStart	0
SeqPulseAStop	6666666
SeqPulseBStart	0
SeqPulseBStop	6666666
PWMMax	66666
PWMChange0	0
PWMChange1	0
PWMChange2	0
PWMChange3	66666
SeqCount	4
SeqEnable	☑ On
SeqLoop	☐ Off
DebounceDuration	66666
PrescaleDivisor	2
> LUT Control	

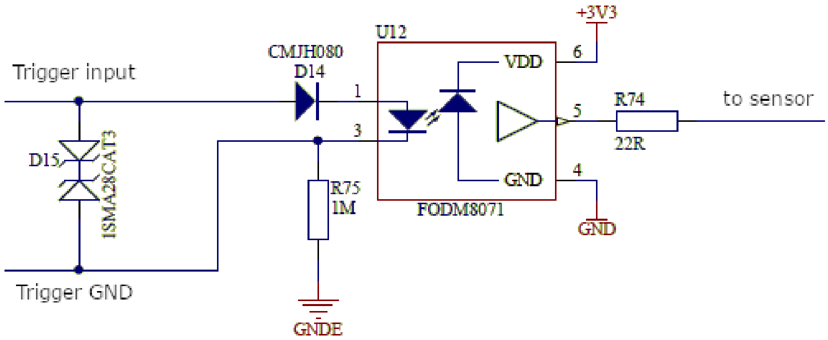
5.3.7 Optical Input

In many trigger signals you find noise, transients and voltage spikes. These are able to damage components in the camera and trigger signal interpretation might be difficult.

An optical input seperates the electrical trigger and camera circuits. The benefit of such an optical input is to avoid all these kinds of interaction from power sources or switches. The disadvantage of an optical input is that it is slower in terms of signal transmission and slew rate than a direct electrical connection.

If you need super fast response from the camera, direct electrical access is your choice. If your camera trigger is in the ms range or slower, we recommend to use the optical input.

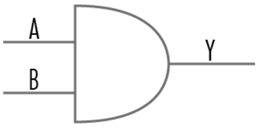
An optical input needs some current for operation. The SVS-Vistek optical input is specified to 5-24V, 8mA.



The opto coupler galvanically separates electrical circuits by emitting light on one side and interpreting light in the other. There is no direct electric interaction between both electrical circuits.

5.3.8 PLC/Logical Operation on Inputs

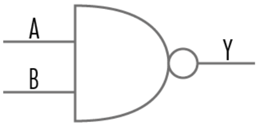
The logic input combines trigger signals with Boolean algorithms. The camera provides AND, NAND, OR, NOR as below. You might combine combine true/false states of the inputs to determine camera actions. The result can be connected to a camera trigger signal or it may be source for the next logical operation 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

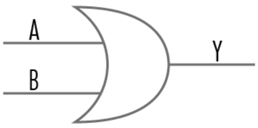


NAND

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

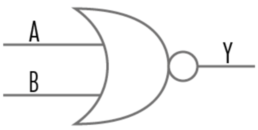


OR

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

Combine trigger input one and two.

A	B	Y = A ∨ 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 ∨ B	NOR i
0	0	1		0	
0	1	0		1	
1	0	0		1	
1	1	0		1	

5.3.9 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).

Table 1: serial interface parameter – RS-232 and RS-422

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

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)

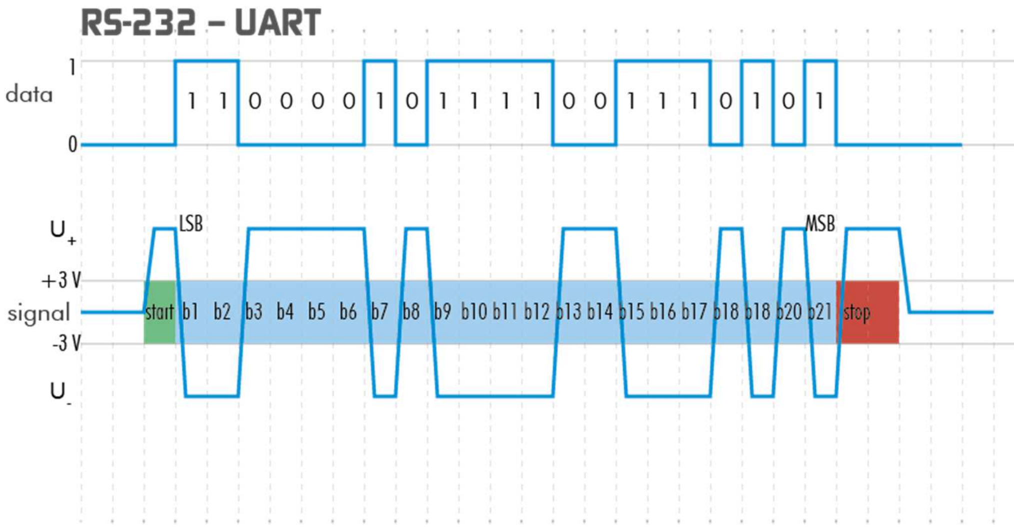


Figure 11: UART encoding of a data stream

RS-422

RS-422 is a differential low voltage communication standard.

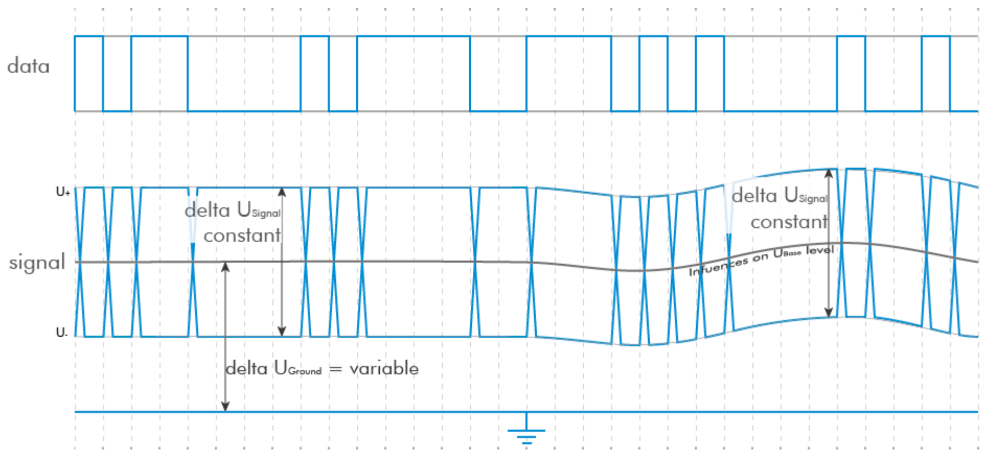
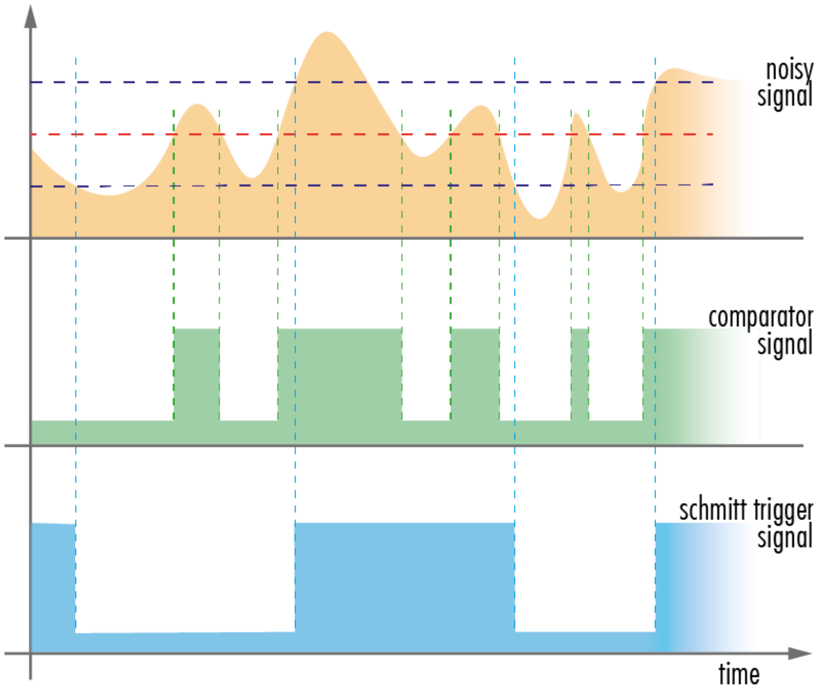


Figure 12: LVDS signal – no return to zero volt

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

5.3.10 Trigger-Edge Sensitivity

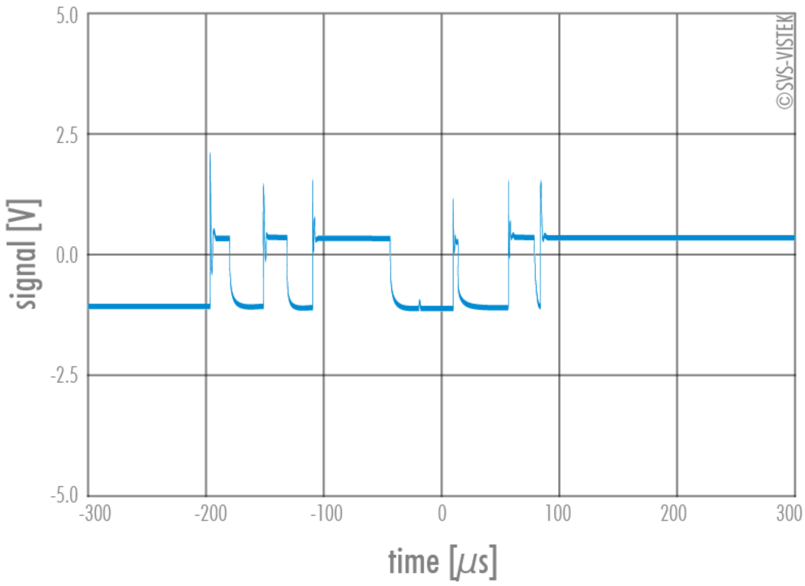
Trigger-Edge Sensitivity is implemented by a "schmitt trigger". Instead of triggering to a certain value Schmitt trigger provides a threshold.



Schmitt trigger noise suppression

5.3.11 Debouncing Trigger Signals

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

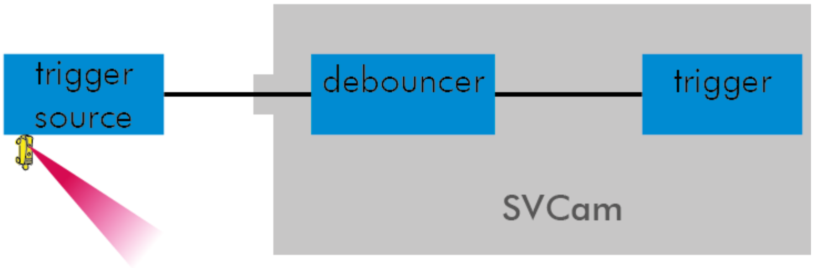


bounces or glitches caused by a switch

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

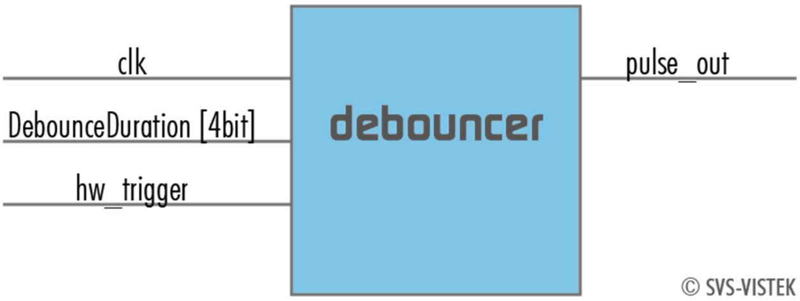
Use the IO Assignment tool to place and enable the debouncer module in between the “trigger” (schmitt trigger) and the input source (e.g.: line 1).

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



debouncer between the trigger source and trigger

The Debouncer module

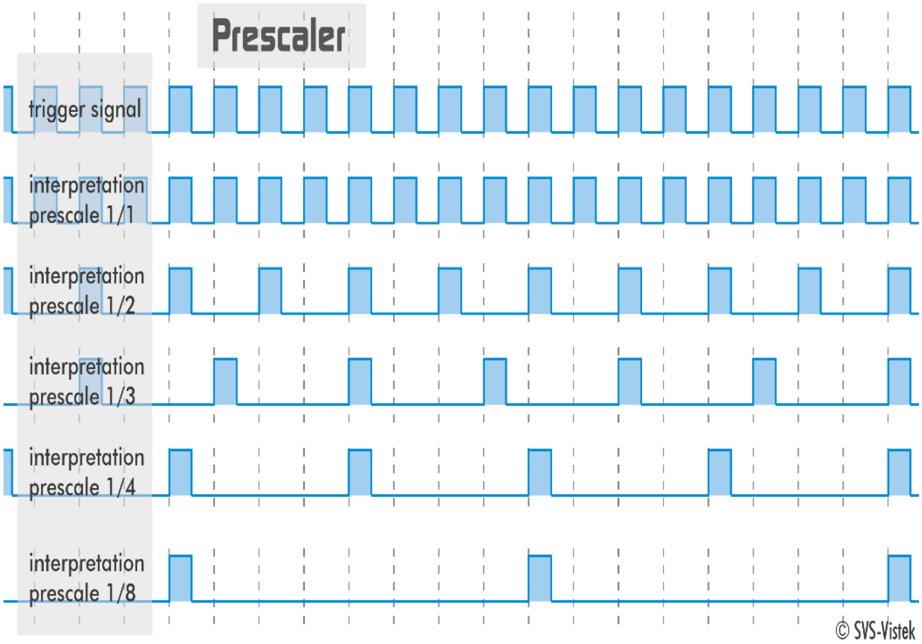


the debouncer module

5.3.12 Prescale

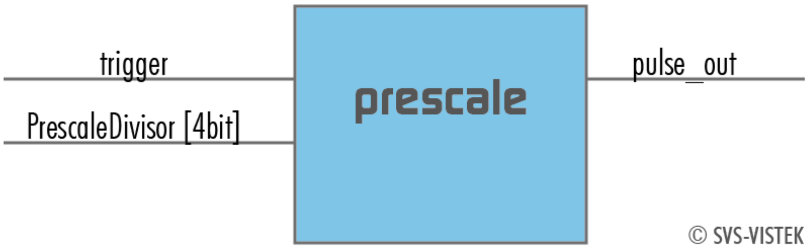
The Prescaler function can be used for masking off input pulses by applying a divisor with a 4-bit word, resulting in 16 unique settings.

> 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)



Prescale values and their result on trigger signal

The prescale module



the prescale module

6 Specifications

All specifications can be viewed as well on our website, www.svs-vistek.com. We are proud to have ongoing development on our cameras, so specs might change and new features being added. Spectral response curves are sensor only and do not include camera spectral response modifications due to filters or cover glass.

6.1 hr11002*TLGEC

Model	hr11002MTLGEC	hr11002CTLGEC
family	HR	HR
active pixel w x h	4032 x 2672	4032 x 2672
max. frame rate	6.5 fps	6.5 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-11002-A	KAI-11002-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	35 mm	35 mm
diagonal	43.4 mm	43.4 mm
pixel w x h	9x9 µm	9x9 µm
optic sensor w x h	37.35x25.7 mm	37.35x25.7 mm
exposure time	121 µs / 60s	121 µs / 60s
max. gain	18 dB	18 dB
dynamic range	60 dB environment dependant	60 dB environment dependant
S/N Ratio		

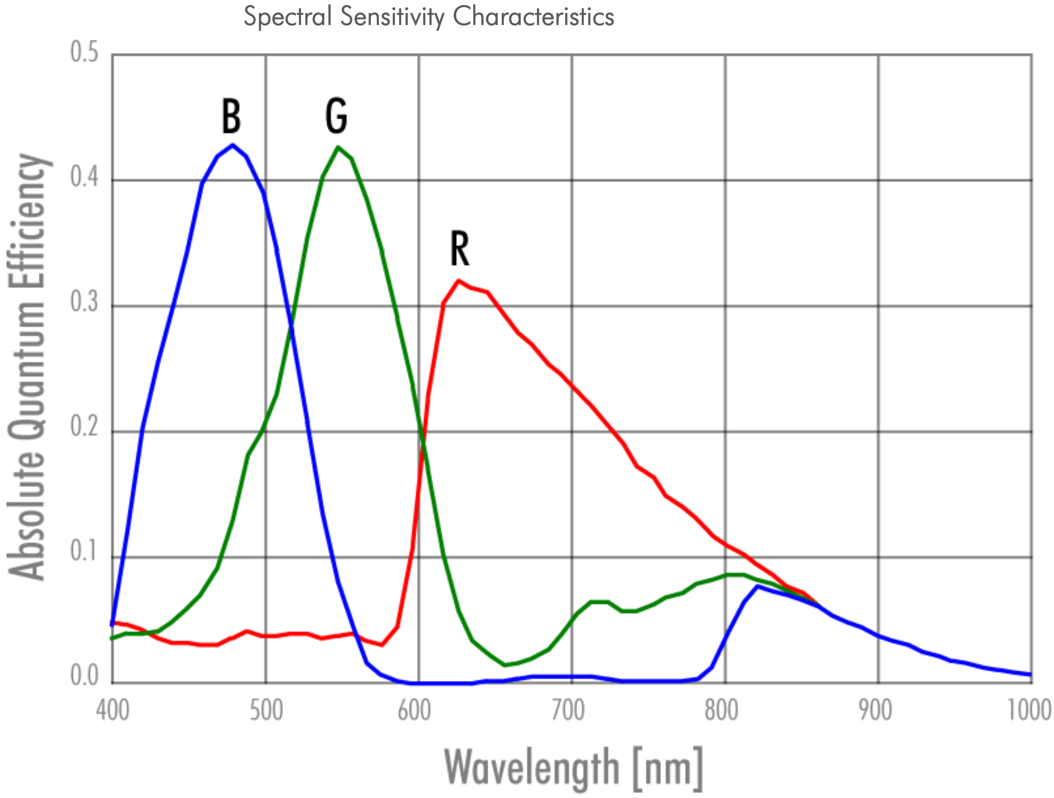
frame buffer	128MB RAM 0MB Flash	128MB RAM 0MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	manual;delayed	manual;delayed
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x
PWM power out	x	x
trigger IN TTL-24 V	2	2

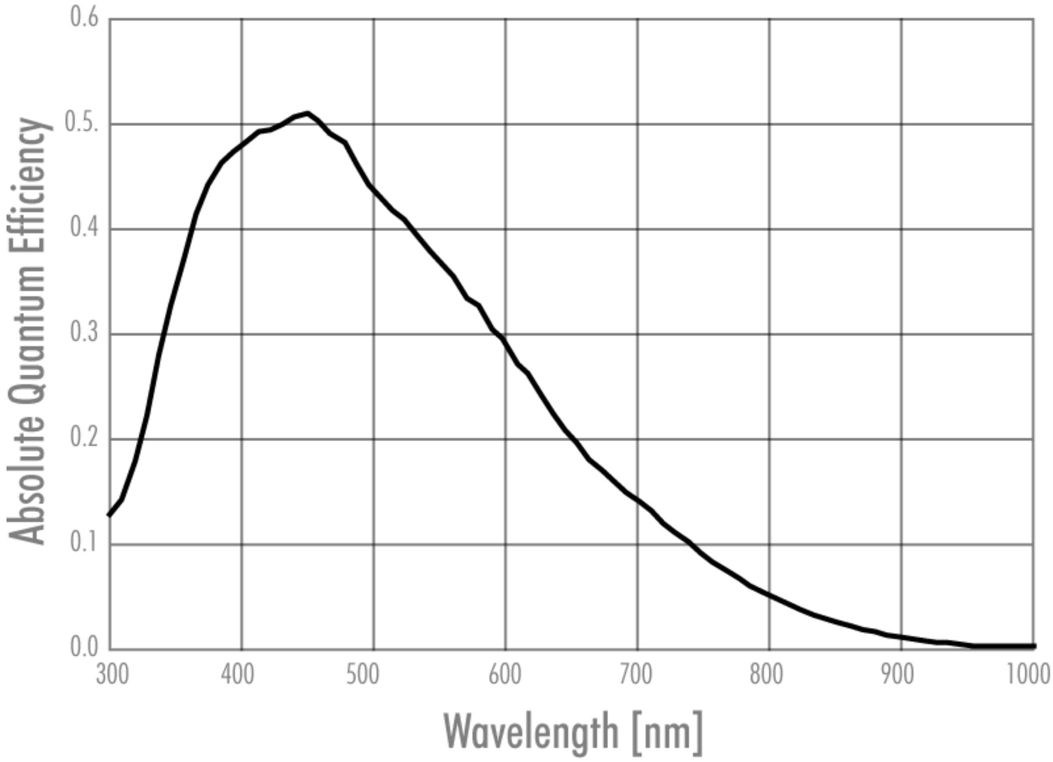
outputs open drain	2	2
optical in / out	- / -	- / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	1 / 1	1 / 1
power supply	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x71x55.4 mm	70x71x55.4 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	8.0 W	8.0 W
operating temperature	-10...60°C	-10...60°C
humidity non-condensing	10…90 %	10…90 %
status	replaced	production

(1) please refer to drawings



Spectral Sensitivity Characteristics KAI-11002-C



Spectral Sensitivity Characteristics KAI-11002-A

6.2 hr16000*TLGEC

Model	hr16000MTLGEC	hr16000CTLGEC
family	HR	HR
active pixel w x h	4896 x 3248	4896 x 3248
max. frame rate	4 fps	4 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-16000-A	KAI-16000-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	35 mm	35 mm
diagonal	43.3 mm	43.3 mm
pixel w x h	7.4x7.4 μm	7.4x7.4 μm
optic sensor w x h	36.1x24 mm	36.1x24 mm
exposure time	203 μs / 60s	203 μs / 60s
max. gain	18 dB	18 dB
dynamic range	60 dB environment dependant	60 dB environment dependant
S/N Ratio		

frame buffer	128MB RAM 0MB Flash	128MB RAM 0MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	manual;delayed	manual;delayed
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
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	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x71x55.4 mm	70x71x55.4 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	7.0 W	7.0 W
operating temperature	-10...60°C	-10...60°C
humidity non-condensing	10…90 %	10…90 %
status	production	production

(1) please refer to drawings

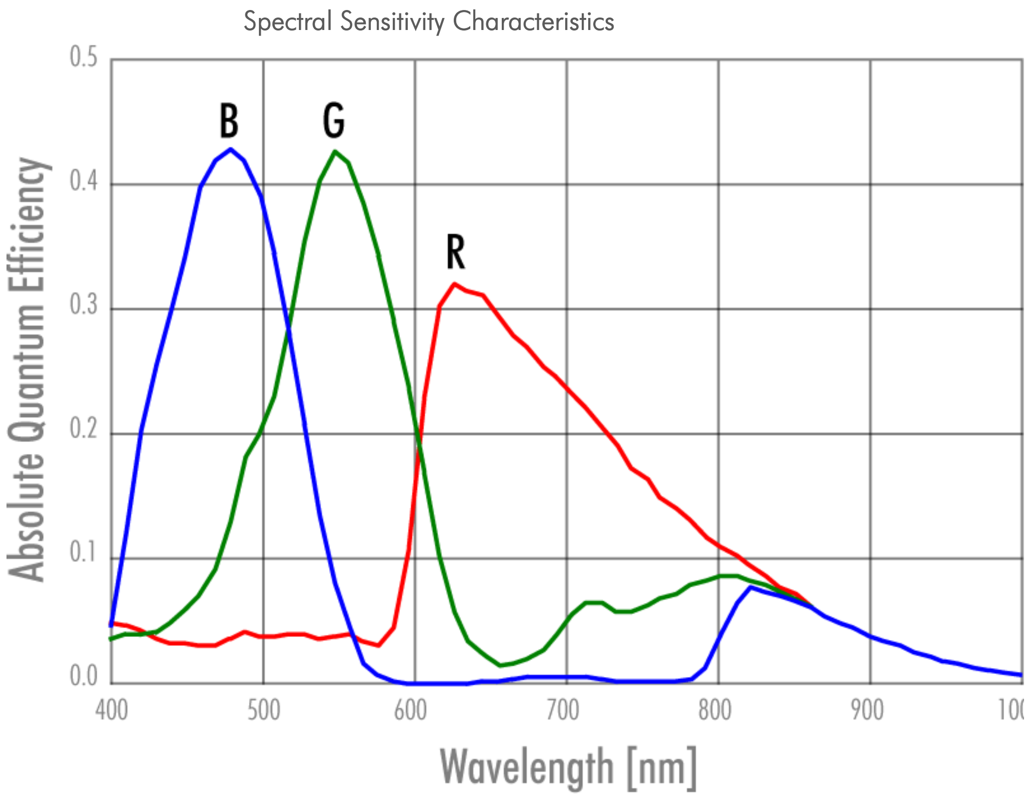


Figure 13: Spectral Sensitivity Characteristics KAI-16000-C

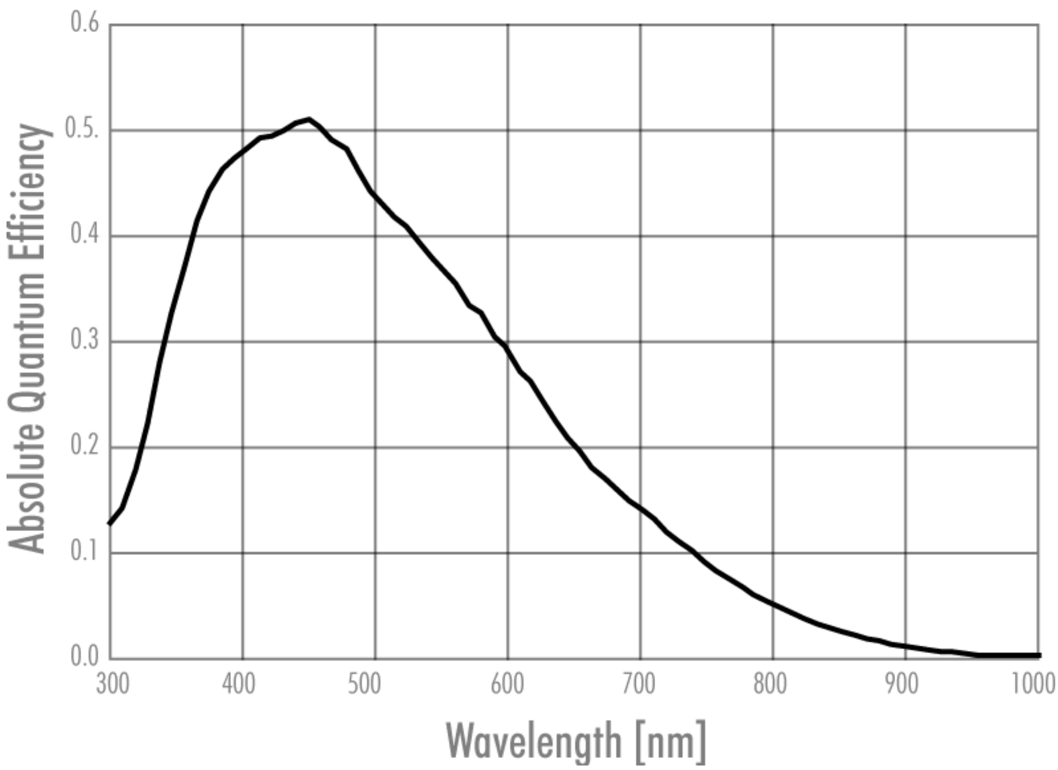


Figure 14: Spectral Sensitivity Characteristics KAI-16000-A

6.3 hr16050*FLGEA

Model	hr16050MFLGEA	hr16050CFLGEA
family	HR	HR
active pixel w x h	4896 x 3264	4896 x 3264
max. frame rate	10 fps	10.8 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-16050-A	KAI-16050-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	APS-H	APS-H
diagonal	32.4 mm	32.4 mm
pixel w x h	5.5x5.5 μm	5.5x5.5 μm
optic sensor w x h	26.93x19.95 mm	26.93x19.95 mm
exposure time	17 μs / 60s	17 μs / 60s
max. gain	18 dB	18 dB
dynamic range	62 dB environment dependant	61 dB environment dependant
S/N Ratio	44 dB environment dependant	44 dB environment dependant

frame buffer	128MB RAM 136MB Flash	128MB RAM 136MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / - / -	x / - / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	manual;delayed	manual;delayed
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
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	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x71x55.4 mm	70x71x55.4 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	10.0 W	10.0 W
operating temperature	-10...60°C	-10...60°C
humidity non-condensing	10…90 %	10…90 %
status	production	production

(1) please refer to drawings

6.4 hr16050*FLGEC

Model	hr16050MFLGEC	hr16050CFLGEC
family	HR	HR
active pixel w x h	4896 x 3264	4896 x 3264
max. frame rate	8 fps	8 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-16050-A	KAI-16050-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	APS-H	APS-H
diagonal	32.4 mm	32.4 mm
pixel w x h	5.5x5.5 µm	5.5x5.5 µm
optic sensor w x h	26.93x19.95 mm	26.93x19.95 mm
exposure time	17 µs / 60s	17 µs / 60s
max. gain	18 dB	18 dB
dynamic range	61 dB environment dependant	61 dB environment dependant
S/N Ratio		

frame buffer	128MB RAM 136MB Flash	128MB RAM 136MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	x	x
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	manual;delayed	manual;delayed
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
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	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x71x55.4 mm	70x71x55.4 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	10.0 W	10.0 W
operating temperature	-10...60°C	-10...60°C
humidity non-condensing	10…90 %	10…90 %
status	production	production

(1) please refer to drawings

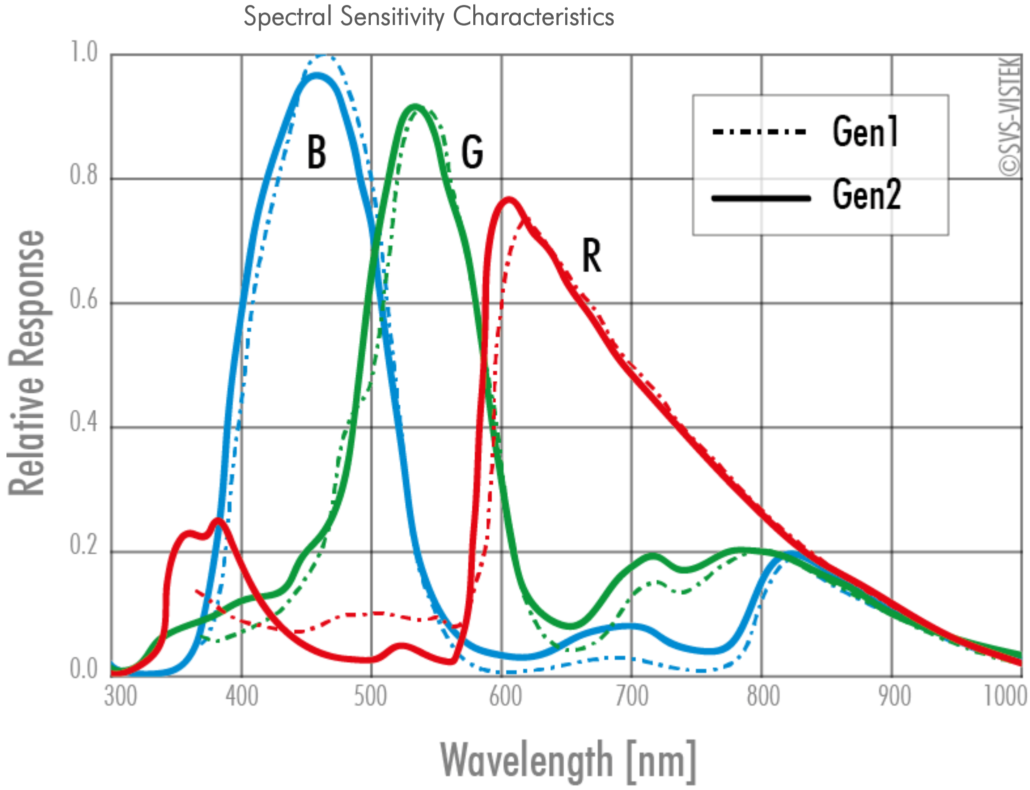


Figure 15 Spectral Sensitivity Characteristics KAI-16050-A

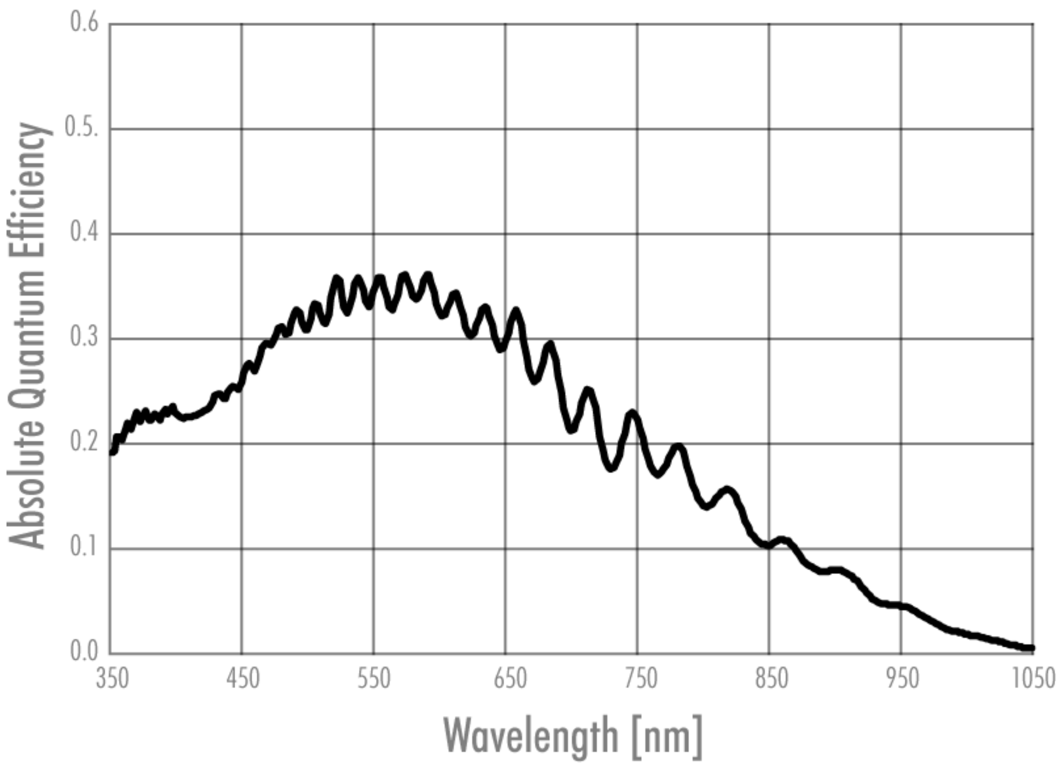


Figure 16: Spectral Sensitivity Characteristics KAI-16050-C

6.5 hr16070*FLGEA

Model	hr16070MFLGEA	hr16070CFLGEA
family	HR	HR
active pixel w x h	4864 x 3232	4864 x 3232
max. frame rate	11 fps	11 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-16070-A	KAI-16070-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	35 mm	35 mm
diagonal	43.2 mm	43.2 mm
pixel w x h	7.4x7.4 μm	7.4x7.4 μm
optic sensor w x h	36x23.9 mm	36x23.9 mm
exposure time	17 μs / 60s	17 μs / 60s
max. gain	18 dB	18 dB
dynamic range	59 dB environment dependant	59 dB environment dependant
S/N Ratio		

frame buffer	128MB RAM 136MB Flash	128MB RAM 136MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / - / -	x / - / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	manual;delayed	manual;delayed
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
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	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x71x55.4 mm	70x71x55.4 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	10.0 W	10.0 W
operating temperature	-10...60°C	-10...60°C
humidity non-condensing	10…90 %	10…90 %
status	production	replaced

(1) please refer to drawings

6.6 hr16070*FLGEC

Model	hr16070MFLGEC	hr16070CFLGEC
family	HR	HR
active pixel w x h	4864 x 3232	4864 x 3232
max. frame rate	8.8 fps	8.8 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-16070-A	KAI-16070-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	35 mm	35 mm
diagonal	43.2 mm	43.2 mm
pixel w x h	7.4x7.4 µm	7.4x7.4 µm
optic sensor w x h	36x23.9 mm	36x23.9 mm
exposure time	22 µs / 60s	22 µs / 60s
max. gain	18 dB	18 dB
dynamic range	62 dB environment dependant	62 dB environment dependant
S/N Ratio		

frame buffer	128MB RAM 136MB Flash	128MB RAM 136MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	x	x
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	manual;delayed	manual;delayed
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
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	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x71x55.4 mm	70x71x55.4 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	10.0 W	10.0 W
operating temperature	-10...60°C	-10...60°C
humidity non-condensing	10…90 %	10…90 %
status	production	production

(1) please refer to drawings

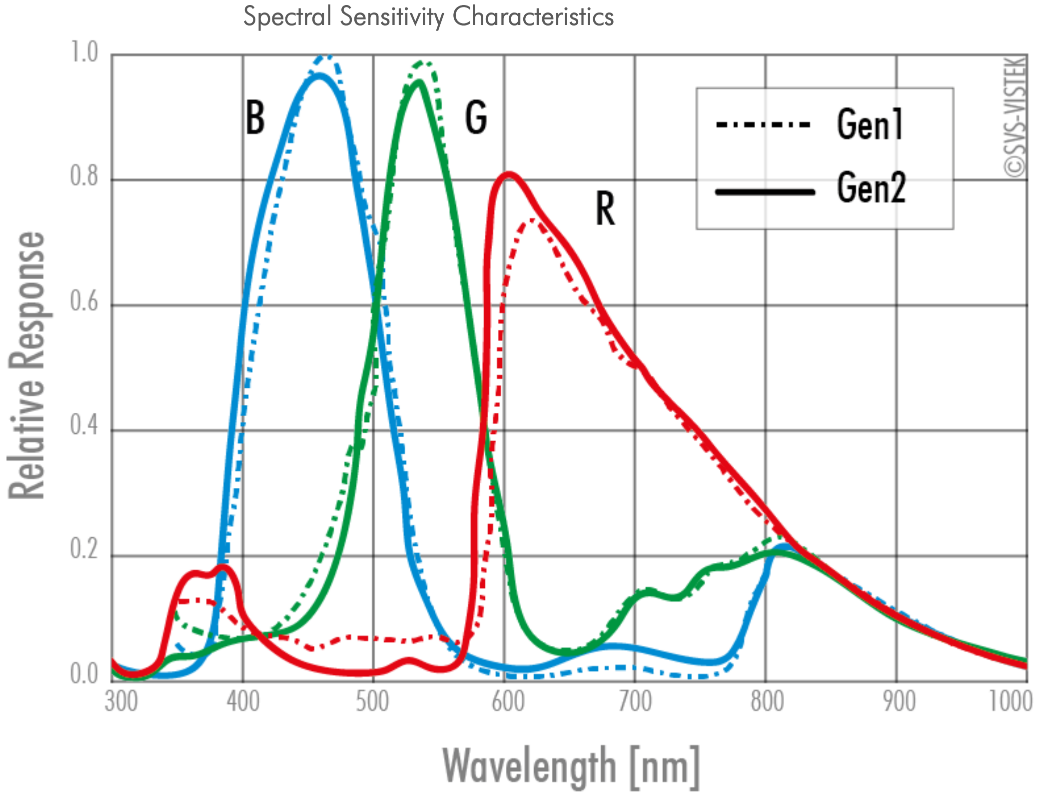


Figure 17: Spectral Sensitivity Characteristics KAI-16070-C

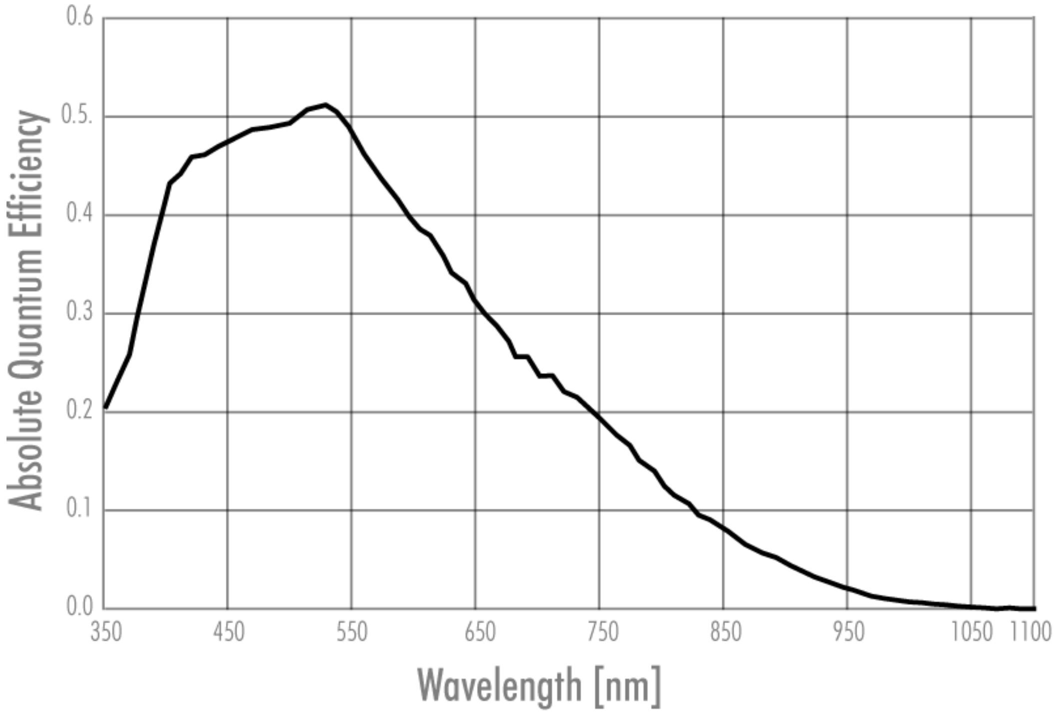


Figure 18: Spectral Sensitivity Characteristics KAI-16070-C

6.7 hr29050*FLGEA

Model	hr29050MFLGEA	hr29050CFLGEA
family	HR	HR
active pixel w x h	6576 x 4384	6576 x 4384
max. frame rate	6.2 fps	6.2 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-29050-A	KAI-29050-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	35 mm	35 mm
diagonal	43.5 mm	43.5 mm
pixel w x h	5.5x5.5 μm	5.5x5.5 μm
optic sensor w x h	36.17x24.11 mm	36.17x24.11 mm
exposure time	10 μs / 60s	10 μs / 60s
max. gain	18 dB	18 dB
dynamic range	59 dB environment dependant	59 dB environment dependant
S/N Ratio	44 dB environment dependant	43 dB environment dependant

frame buffer	128MB RAM 136MB Flash	128MB RAM 136MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / - / -	x / - / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	manual;delayed	manual;delayed
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
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	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x71x55.4 mm	70x71x55.4 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	10.0 W	10.0 W
operating temperature	-10...60°C	-10...60°C
humidity non-condensing	10…90 %	10…90 %
status	production	production

(1) please refer to drawings

6.8 hr29050*FLGEC

Model	hr29050MFLGEC	hr29050CFLGEC
family	HR	HR
active pixel w x h	6576 x 4384	6576 x 4384
max. frame rate	4.9 fps	4.9 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-29050-A	KAI-29050-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	35 mm	35 mm
diagonal	43.5 mm	43.5 mm
pixel w x h	5.5x5.5 μm	5.5x5.5 μm
optic sensor w x h	36.17x24.11 mm	36.17x24.11 mm
exposure time	22 μs / 60s	22 μs / 60s
max. gain	18 dB	18 dB
dynamic range	59 dB environment dependant	59 dB environment dependant
S/N Ratio		

frame buffer	128MB RAM 0MB Flash	128MB RAM 0MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	manual;delayed	manual;delayed
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
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	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x71x55.4 mm	70x71x55.4 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	10.0 W	10.0 W
operating temperature	-10...60°C	-10...60°C
humidity non-condensing	10…90 %	10…90 %
status	production	production

(1) please refer to drawings

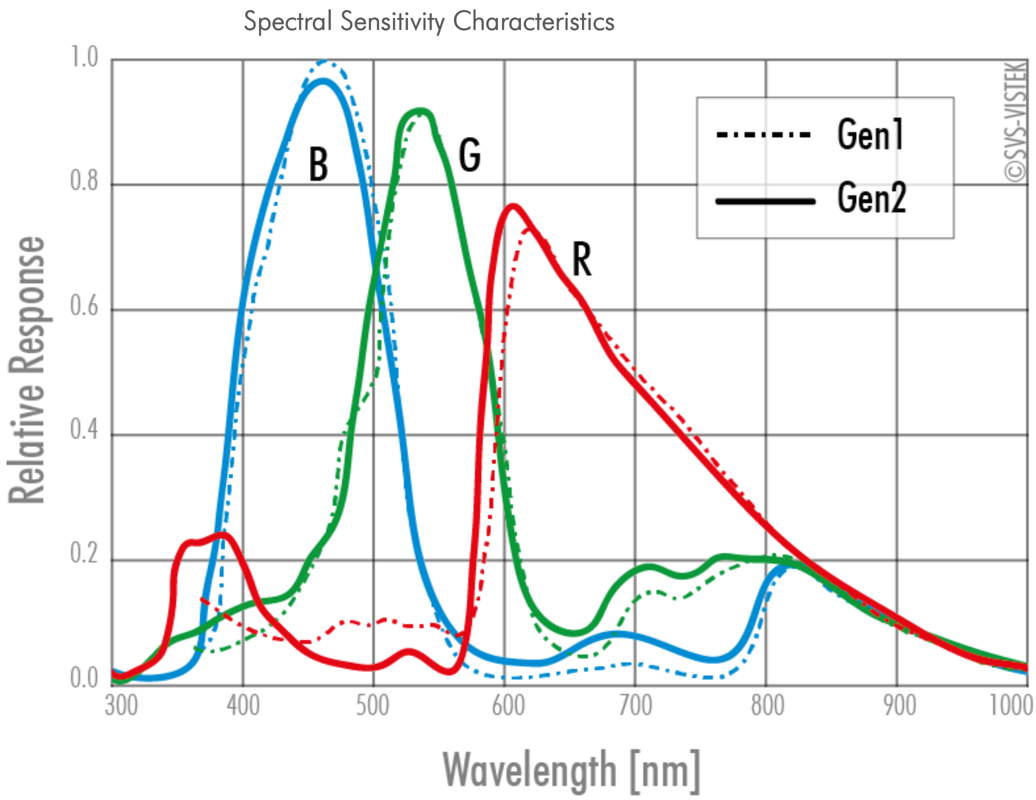


Figure 19: Spectral Sensitivity Characteristics KAI-29050-C

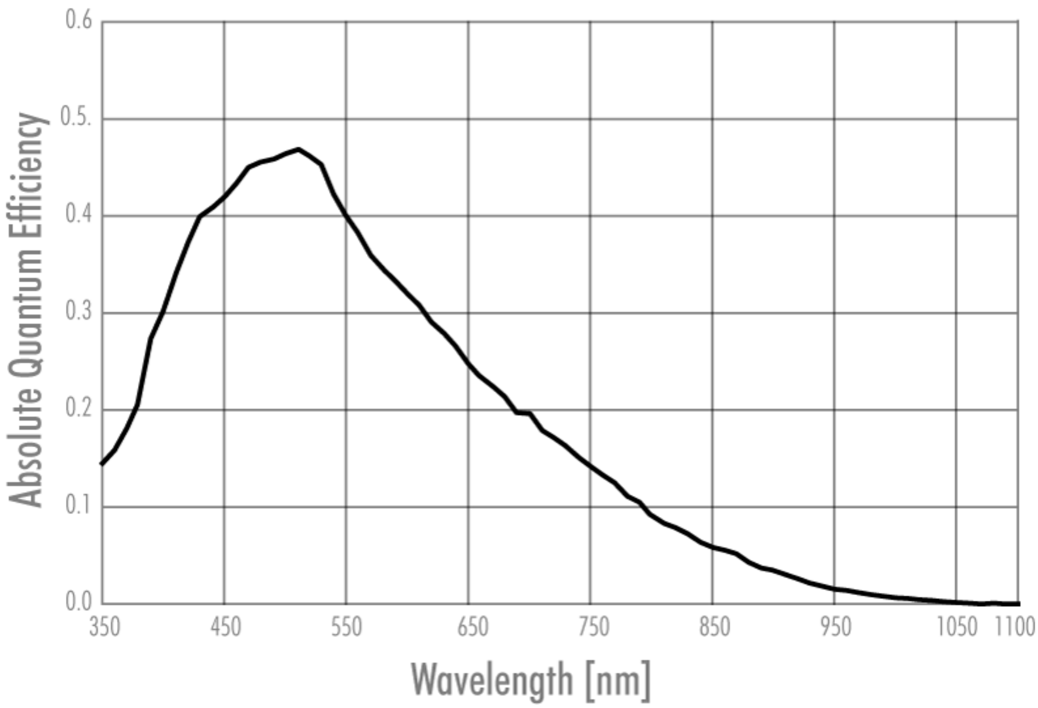


Figure 20: Spectral Sensitivity Characteristics KAI-29050-A

6.9 hr16*GE-5

Model	hr16MGE-5	hr16CGE-5
family	HR2	HR2
active pixel w x h	4896 x 3264	4896 x 3264
max. frame rate	8 fps	8 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-16050-A	KAI-16050-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	APS-H	APS-H
diagonal	32.4 mm	32.4 mm
pixel w x h	5.5x5.5 µm	5.5x5.5 µm
optic sensor w x h	26.93x19.95 mm	26.93x19.95 mm
exposure time	17 µs / 1s	17 µs / 1s
max. gain	18 dB	18 dB
dynamic range	61 dB environment dependant	61 dB environment dependant
S/N Ratio		

frame buffer	256MB RAM 160MB Flash	256MB RAM 160MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	x	x
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	-	-
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x

sequencer	x	x
PWM power out	x	x
trigger IN TTL-24 V	2	2
outputs open drain	4	4
optical in / out	1 / -	1 / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	- / -	- / -
power supply	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x70x58.8 mm	70x70x58.8 mm
weight	320 g	320 g
protection class	IP40	IP40
power consumption	10.0 W	10.0 W
ambient temperature	-10...45°C	-10...45°C
humidity non-condensing	0…0 %	0…0 %
status	production	production

(1) please refer to drawings

 February 12, 2019 February 12, 2019

6.10 hr16*GE-7

Model	hr16MGE-7	hr16CGE-7
family	HR2	HR2
active pixel w x h	4864 x 3232	4864 x 3232
max. frame rate	8.8 fps	8.8 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-16070-A	KAI-16070-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	35 mm	35 mm
diagonal	43.2 mm	43.2 mm
pixel w x h	7.4x7.4 µm	7.4x7.4 µm
optic sensor w x h	36x23.9 mm	36x23.9 mm
exposure time	22 µs / 1s	22 µs / 1s
max. gain	18 dB	18 dB
dynamic range	62 dB environment dependant	62 dB environment dependant
S/N Ratio		

frame buffer	256MB RAM 160MB Flash	256MB RAM 160MB Flash
CL geometry	-	-
frequency select	40;48;64	40;48;64
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	x	x
readout control	-	-
flat field correction	-	-
shading correction	external	external
defect pixel correction	x	x
image flip	-	-

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x

sequencer	x	x
PWM power out	x	x
trigger IN TTL-24 V	2	2
outputs open drain	4	4
optical in / out	1 / -	1 / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	- / -	- / -
power supply	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x70x58.8 mm	70x70x58.8 mm
weight	320 g	320 g
protection class	IP40	IP40
power consumption	10.0 W	10.0 W
ambient temperature	-10...45°C	-10...45°C
humidity non-condensing	0…0 %	0…0 %
status	production	production

(1) please refer to drawings

 February 12, 2019 February 12, 2019

6.11 hr25*XGE

Model	**hr25MXGE**	**hr25CXGE**
family	HR2	HR2
active pixel w x h	5120 x 5120	5120 x 5120
max. frame rate	42 fps	42 fps
chroma	mono	color
interface	10 GigE Vision	10 GigE Vision

sensor name	NOIP1SN025KA-GDI	NOIP1SE025KA-GDI
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CMOS	Area CMOS
shutter type	global	global
equivalent format	35 mm	35 mm
diagonal	32.6 mm	32.6 mm
pixel w x h	4.5x4.5 μm	4.5x4.5 μm
optic sensor w x h	23.04x23.04 mm	23.04x23.04 mm
exposure time	21 μs / 1s	21 μs / 1s
max. gain	18 dB	18 dB
dynamic range		
S/N Ratio		

frame buffer	512MB RAM 160MB Flash	512MB RAM 160MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / - / -	x / - / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	10to8(1)	10to8(1)
ROI	-	-
white balancing	-	auto;manual
tap balancing	-	-
gain	auto;manual	auto;manual
black level	manual	manual
PIV	-	-
readout control	-	-
flat field correction	x	x
shading correction	external	external
defect pixel correction	x	x
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x

sequencer	x	x
PWM power out	x	x
trigger IN TTL-24 V	2	2
outputs open drain	4	4
optical in / out	1 / -	1 / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	- / -	- / -
power supply	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x70x58.8 mm	70x70x58.8 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	10.0 W	10.0 W
ambient temperature	-10...45°C	-10...45°C
humidity non-condensing	0…0 %	0…0 %
status	production	production

(1) please refer to drawings

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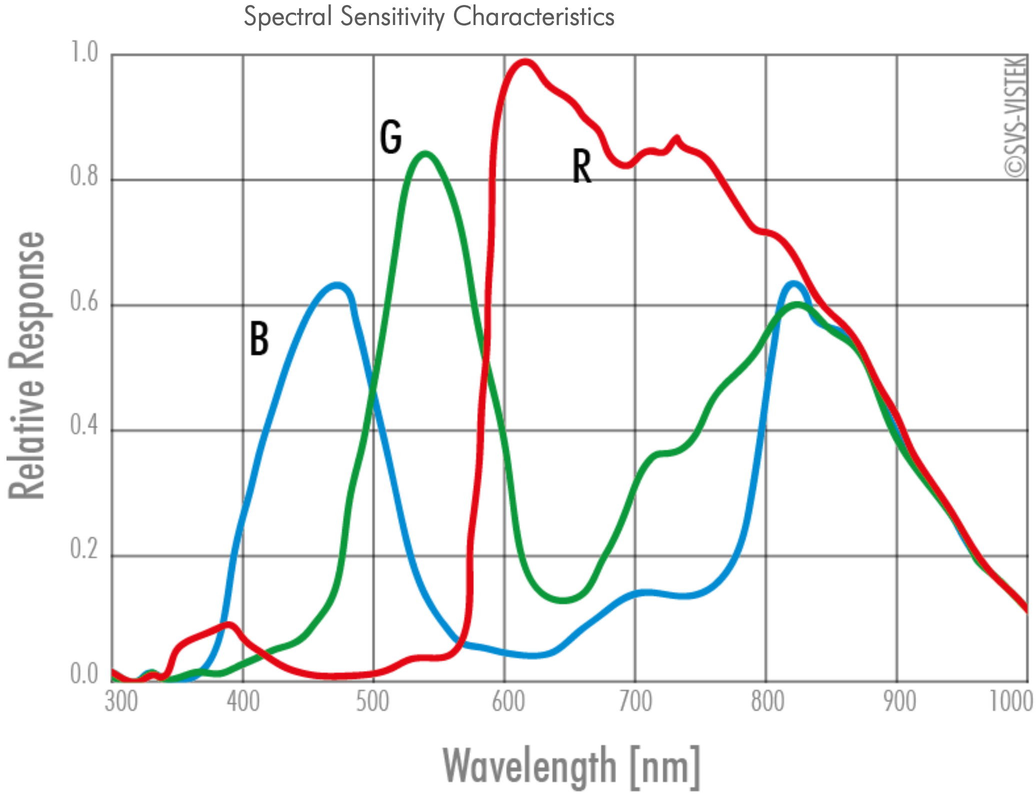


Figure 21: Spectral Sensitivity Characteristics NOIP1SN025KA

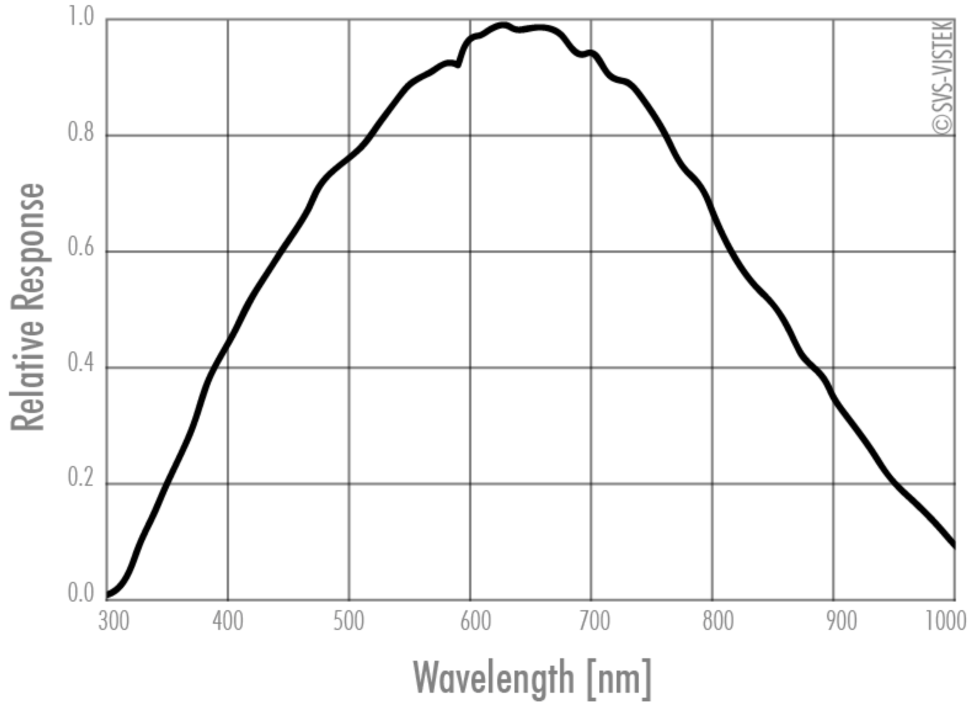


Figure 22: Spectral Sensitivity Characteristics NOIP1SE025KA

6.12 hr29*GE

Model	hr29MGE	hr29CGE
family	HR2	HR2
active pixel w x h	6576 x 4384	6576 x 4384
max. frame rate	4.9 fps	4.9 fps
chroma	mono	color
interface	Dual GigE Vision	Dual GigE Vision

sensor name	KAI-29050-A	KAI-29050-C
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	35 mm	35 mm
diagonal	43.5 mm	43.5 mm
pixel w x h	5.5x5.5 μm	5.5x5.5 μm
optic sensor w x h	36.17x24.11 mm	36.17x24.11 mm
exposure time	22 μs / 1s	22 μs / 1s
max. gain	18 dB	18 dB
dynamic range	59 dB environment dependant	59 dB environment dependant
S/N Ratio		

frame buffer	256MB RAM 160MB Flash	256MB RAM 160MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / x / -	x / x / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	12to8(1)	12to8(1)
ROI	1	1
white balancing	-	auto;manual
tap balancing	manual;auto	manual;auto
gain	manual	manual
black level	manual	manual
PIV	x	x
readout control	-	-
flat field correction	-	-
shading correction	x	x
defect pixel correction	off;factory;custom	off;factory;custom
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
trigger IN TTL-24 V	2	2
outputs open drain	4	4
optical in / out	1 / -	1 / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	- / -	- / -
power supply	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x70x58.8 mm	70x70x58.8 mm
weight	320 g	320 g
protection class	IP40	IP40
power consumption	10.0 W	10.0 W
ambient temperature	-10...45°C	-10...45°C
humidity non-condensing	0…0 %	0…0 %
status	production	production

(1) please refer to drawings

6.13 hr43*XGE

Model	hr43MXGE	hr43CXGE
family	HR2	HR2
active pixel w x h	8040 x 5360	8040 x 5360
max. frame rate	4 fps	4 fps
chroma	mono	color
interface	10 GigE Vision	10 GigE Vision

sensor name	KAI-43140-AXA-JD	KAI-43140-FXA-JD
sensor manufacturer	ON Semiconductor	ON Semiconductor
sensor architecture	Area CCD	Area CCD
shutter type	global	global
equivalent format	35mm	35mm
diagonal	43.5 mm	43.5 mm
pixel w x h	4.5x4.5 µm	4.5x4.5 µm
optic sensor w x h	36.18x24.12 mm	36.18x24.12 mm
exposure time	22 µs / 1s	22 µs / 1s
max. gain	18 dB	18 dB
dynamic range		
S/N Ratio		

frame buffer	512MB RAM 160MB Flash	512MB RAM 160MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / - / -	x / - / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	10to8(1)	10to8(1)
ROI	-	-
white balancing	-	auto;manual
tap balancing	-	-
gain	auto;manual	auto;manual
black level	manual	manual
PIV	-	-
readout control	-	-
flat field correction	x	x
shading correction	external	external
defect pixel correction	x	x
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
trigger IN TTL-24 V	2	2
outputs open drain	4	4
optical in / out	1 / -	1 / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	- / -	- / -
power supply	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x70x58.8 mm	70x70x58.8 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	0.0 W	0.0 W
ambient temperature	-10...45°C	-10...45°C
humidity non-condensing	0…0 %	0…0 %
status	production	production

(1) please refer to drawings

	February 12, 2019	February 12, 2019

6.14 hr342*XGE

Model	hr342MXGE	hr342CXGE
family	HR2	HR2
active pixel w x h	6464 x 4852	6464 x 4852
max. frame rate	26.8 fps	26.8 fps
chroma	mono	color
interface	10 GigE Vision	10 GigE Vision

sensor name	IMX342LLA	IMX342LQA
sensor manufacturer	Sony	Sony
sensor architecture	Area CMOS	Area CMOS
shutter type	global	global
equivalent format	27.9mm (APS-C)	27.9mm (APS-C)
diagonal	27.9 mm	27.9 mm
pixel w x h	3.45x3.45 µm	3.45x3.45 µm
optic sensor w x h	22.3x16.74 mm	22.3x16.74 mm
exposure time	21 µs / 1s	21 µs / 1s
max. gain	24 dB	24 dB
dynamic range		
S/N Ratio		

frame buffer	512MB RAM 160MB Flash	512MB RAM 160MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / - / -	x / - / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	10to8(1)	10to8(1)
ROI	-	-
white balancing	-	auto;manual
tap balancing	-	-
gain	auto;manual	auto;manual
black level	manual	manual
PIV	-	-
readout control	-	-
flat field correction	x	x
shading correction	external	external
defect pixel correction	x	x
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x

sequencer	x	x
PWM power out	x	x
trigger IN TTL-24 V	2	2
outputs open drain	4	4
optical in / out	1 / -	1 / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	- / -	- / -
power supply	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x70x58.8 mm	70x70x58.8 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	0.0 W	0.0 W
ambient temperature	-10...45°C	-10...45°C
humidity non-condensing	0…0 %	0…0 %
status	production	production

(1) please refer to drawings

 February 12, 2019 February 12, 2019

6.15 hr387*XGE

Model	hr387MXGE	hr387CXGE
family	SHR	SHR
active pixel w x h	5456 x 3076	5456 x 3076
max. frame rate	33.4 fps	33.4 fps
chroma	mono	color
interface	10 GigE Vision	10 GigE Vision

sensor name	IMX387LLA	IMX387LQA
sensor manufacturer	Sony	Sony
sensor architecture	Area CMOS	Area CMOS
shutter type	global	global
equivalent format	21.7mm (4/3)	21.7mm (4/3)
diagonal	21.7 mm	21.7 mm
pixel w x h	3.45x3.45 µm	3.45x3.45 µm
optic sensor w x h	18.82x10.61 mm	18.82x10.61 mm
exposure time	21 µs / 1s	21 µs / 1s
max. gain	24 dB	24 dB
dynamic range		
S/N Ratio		

frame buffer	512MB RAM 160MB Flash	512MB RAM 160MB Flash
CL geometry	-	-
frequency select	-	-
exp. time adjustment	manual;auto;external	manual;auto;external
px format 8 / 12 / 16	x / - / -	x / - / -
packed readout	-	-
max binning h / v	2 / 2	2 / 2
LUT	10to8(1)	10to8(1)
ROI	-	-
white balancing	-	auto;manual
tap balancing	-	-
gain	auto;manual	auto;manual
black level	manual	manual
PIV	-	-
readout control	-	-
flat field correction	x	x
shading correction	external	external
defect pixel correction	x	x
image flip	horizontal;vertical	horizontal;vertical

trigger int / ext / soft	x / x / x	x / x / x
trigger edge high / low	x / x	x / x
sequencer	x	x

PWM power out	x	x
trigger IN TTL-24 V	2	2
outputs open drain	4	4
optical in / out	1 / -	1 / -
RS-232 in / out	1 / 1	1 / 1
RS-422 in / out	- / -	- / -
power supply	10...25 V	10...25 V

lens mount	M58x0.75	M58x0.75
dynamic lens control	-	-
size w / h / d (1)	70x70x55.4 mm	70x70x55.4 mm
weight	320 g	320 g
protection class	IP30	IP30
power consumption	0.0 W	0.0 W
ambient temperature	-10...45°C	-10...45°C
humidity non-condensing	0…0 %	0…0 %
status	production	production

(1) please refer to drawings

 February 12, 2019 February 12, 2019

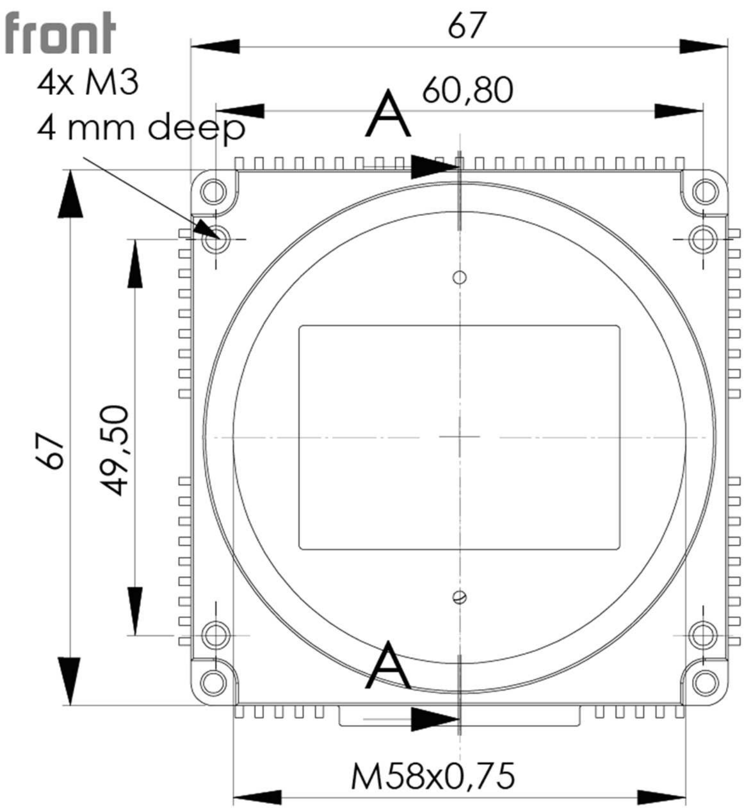
7 Dimensions

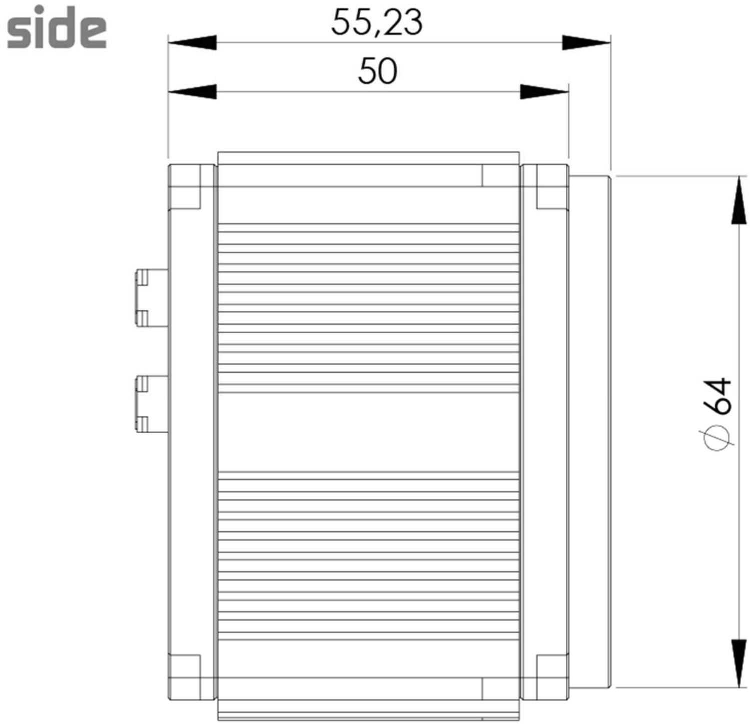
All length units in mm.
Find drawings in the web download area at
https://www.svs-vistek.com/en/support/svs-support-download-center.php

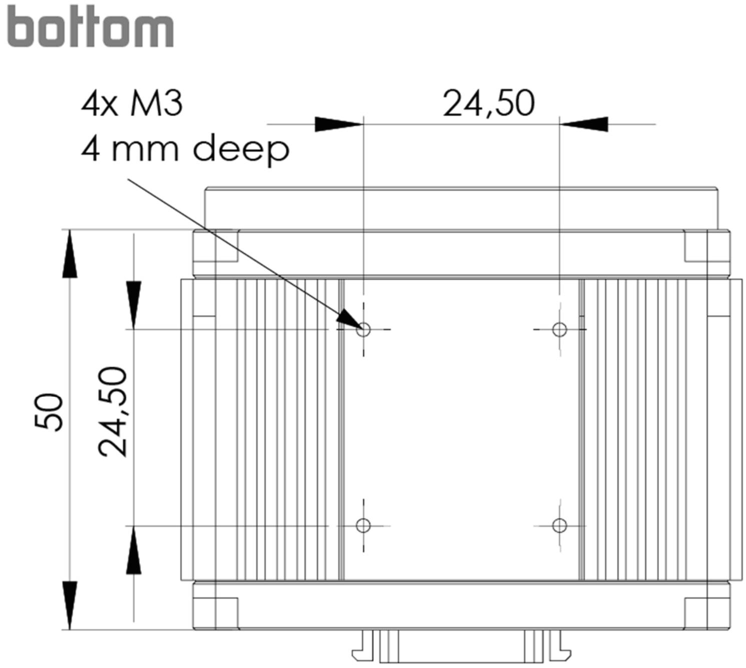
CAD step files available with valid login at SVS-VISTEK.com

7.1 hr 11002, 16000, 16050, 16070, 29050 GE

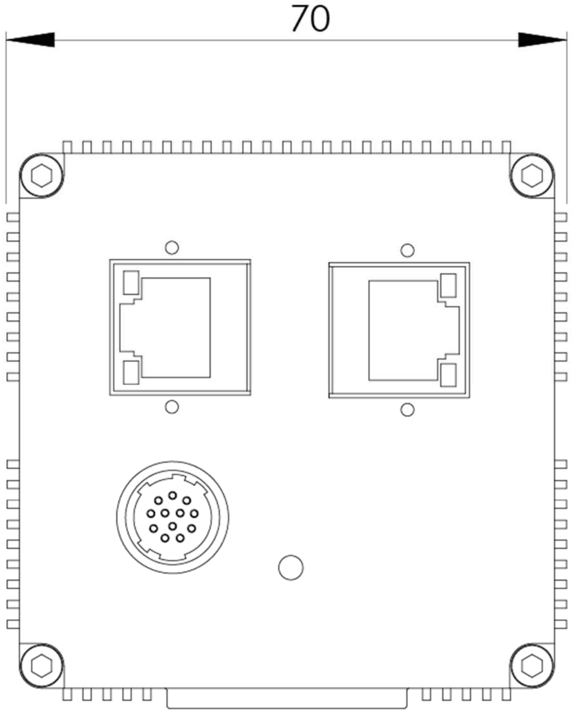
Including:
hr11002CTLGEC, hr11002MTLGEC, hr16000CTLGEC, hr16000MTLGEC, hr16050CFLGEA, hr16050CFLGEC, hr16050MFLGEA, hr16050MFLGEC, hr16070CFLGEA, hr16070CFLGEC, hr16070MFLGEA, hr16070MFLGEC, hr29050CFLGEA, hr29050CFLGEC, hr29050MFLGEA, hr29050MFLGEA4IO, hr29050MFLGEC



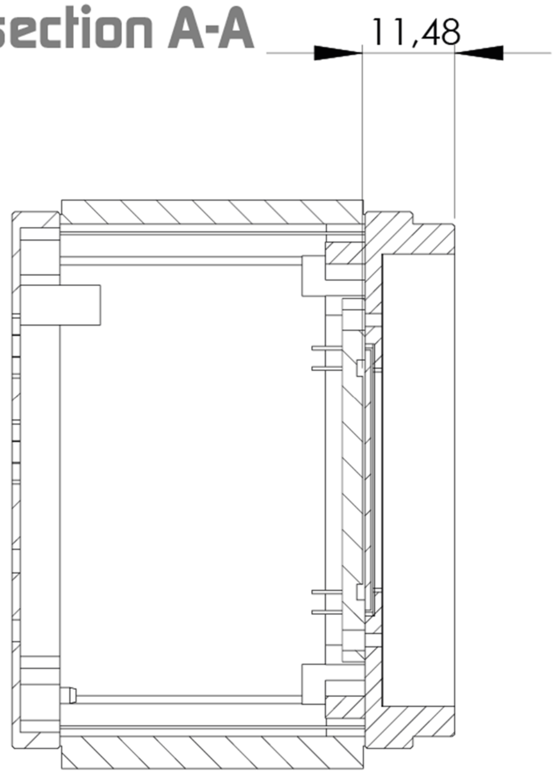

side
55,23
50
⌀ 64


bottom
4x M3
4 mm deep
24,50
50
24,50

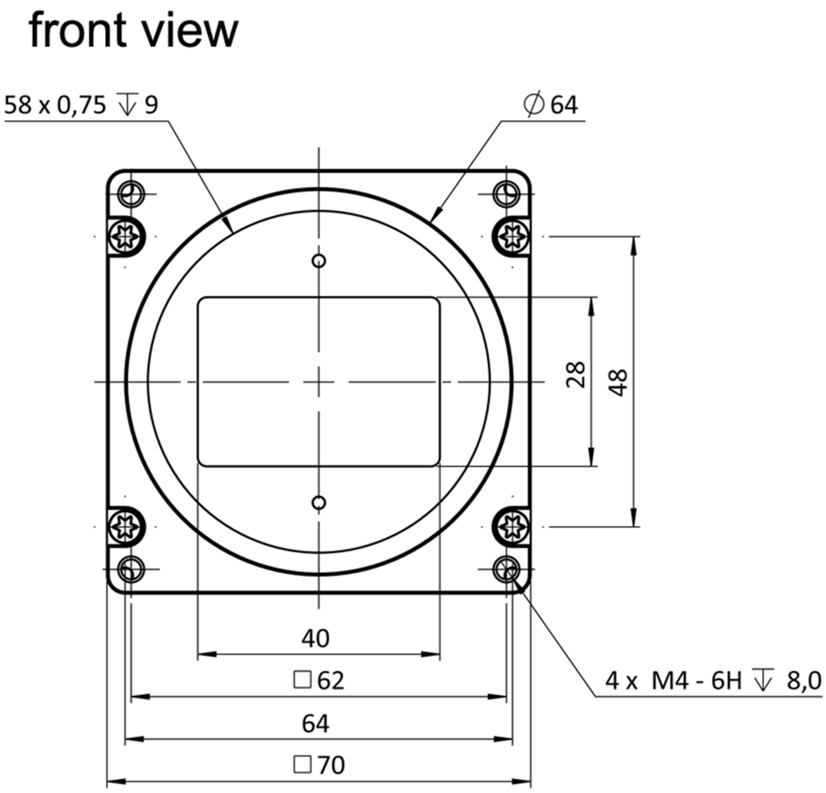
back

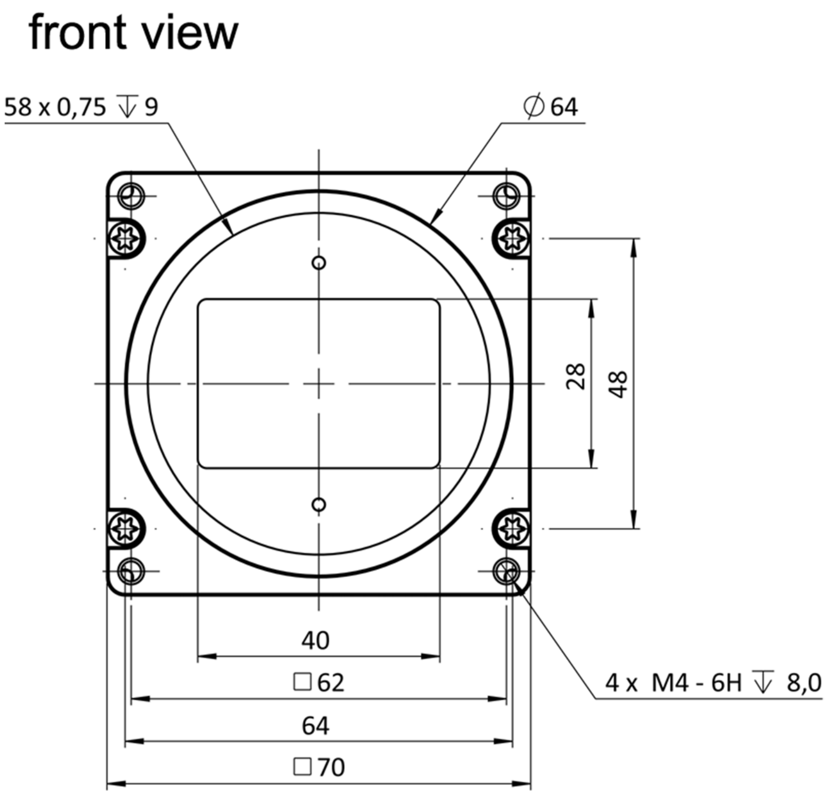


cross section A-A

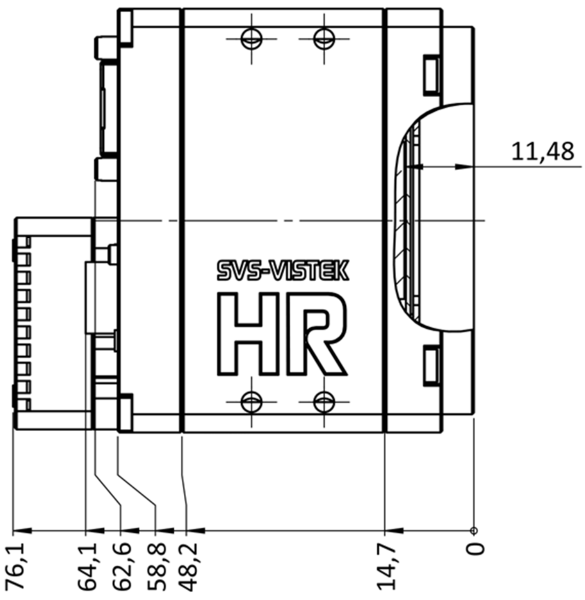


7.2 hr43*XGE

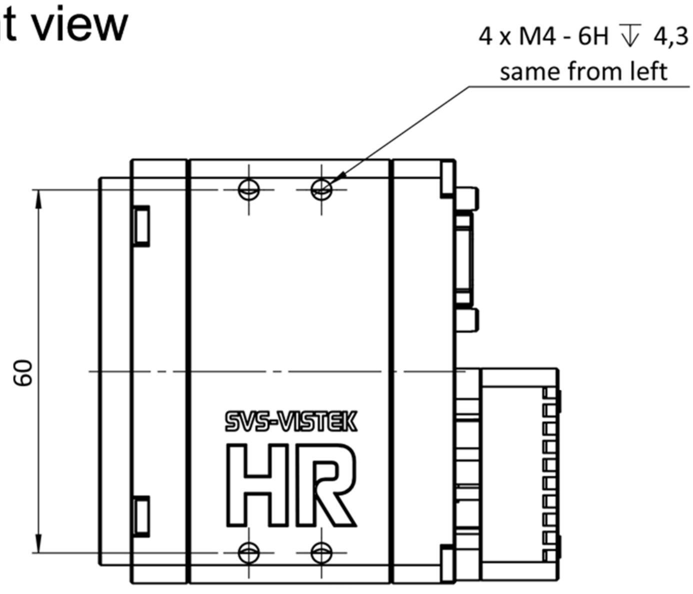

front view
58 x 0,75 ⊽ 9
∅64
28
48
40
□62
64
□70
4 x M4 - 6H ⊽ 8,0


front view
58 x 0,75 ⊽ 9
∅64
28
48
40
□62
64
□70
4 x M4 - 6H ⊽ 8,0

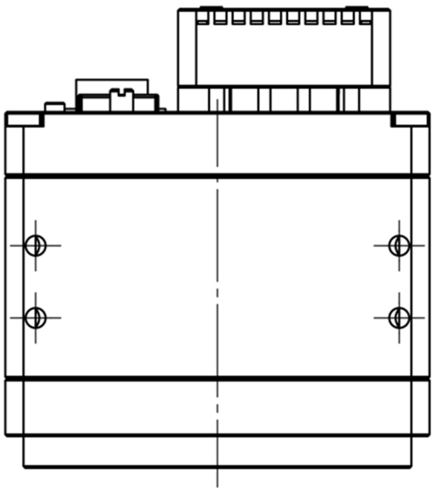
cross section



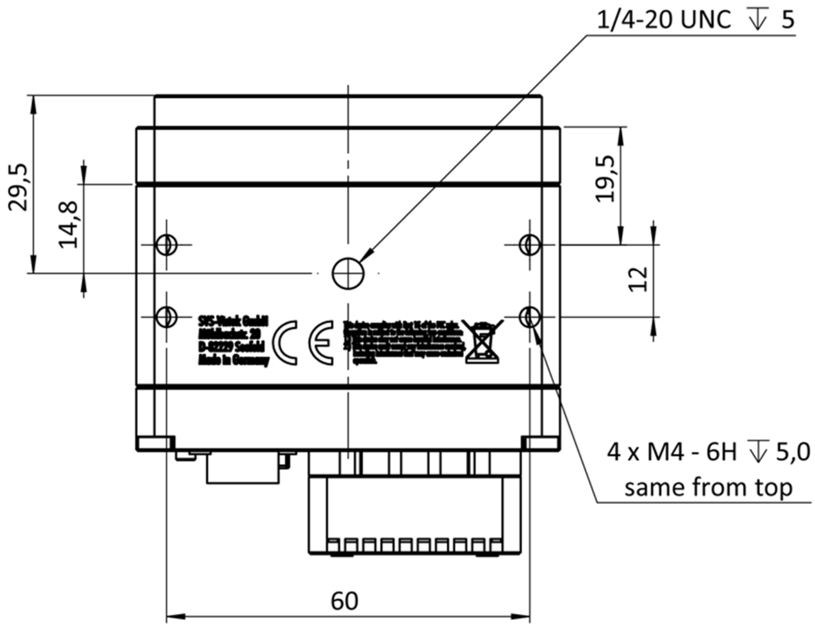
right view



top view

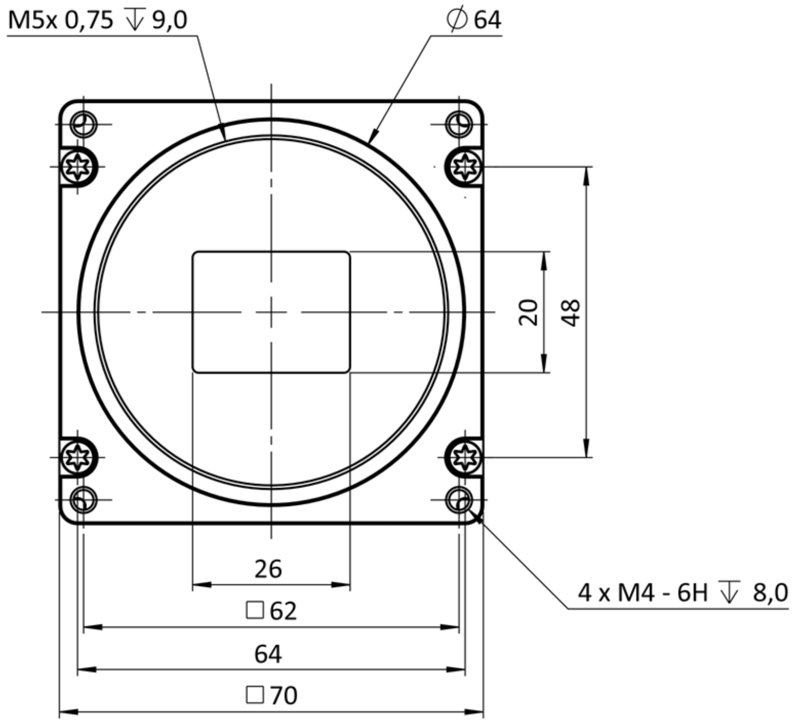


bottom view

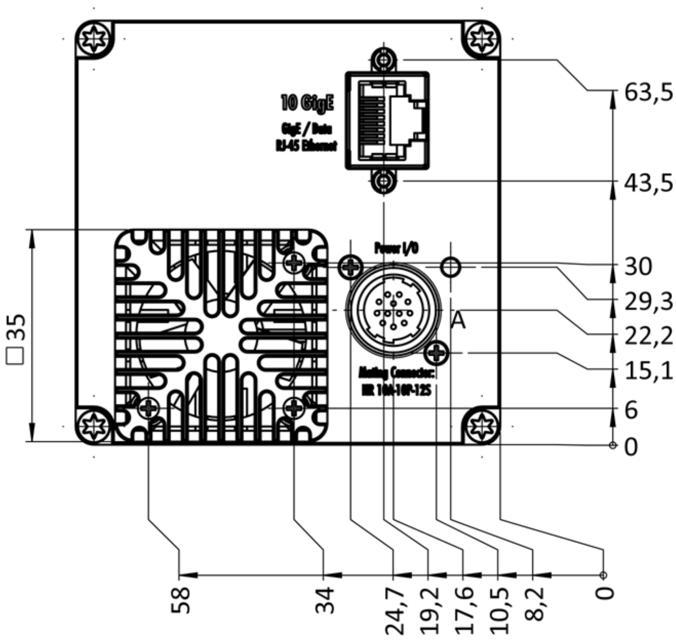


7.3 hr342*XGE

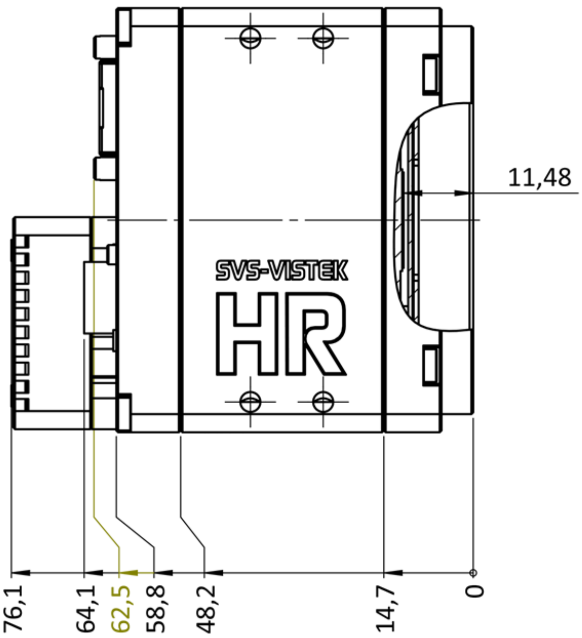
front view



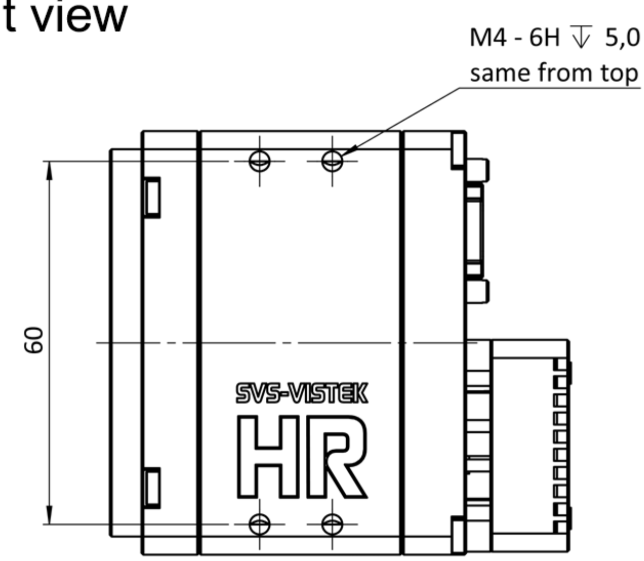
back view



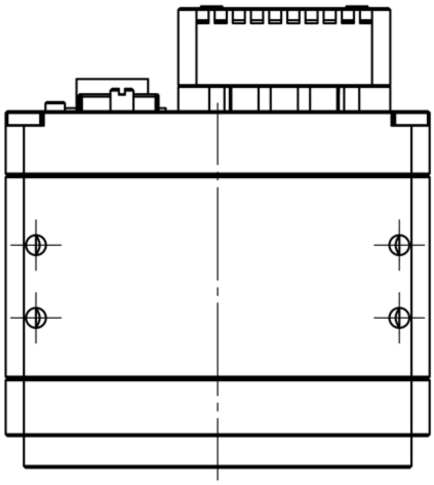
cross section



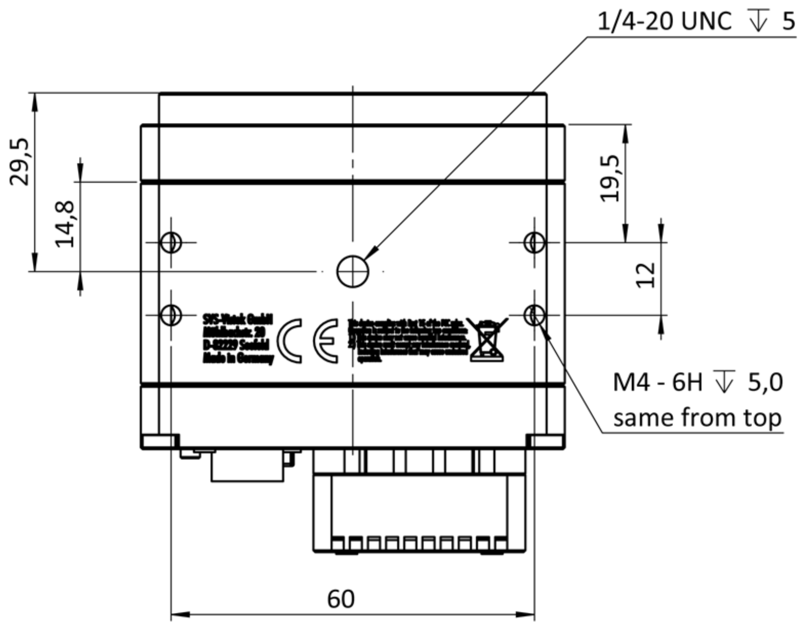
right view



top view

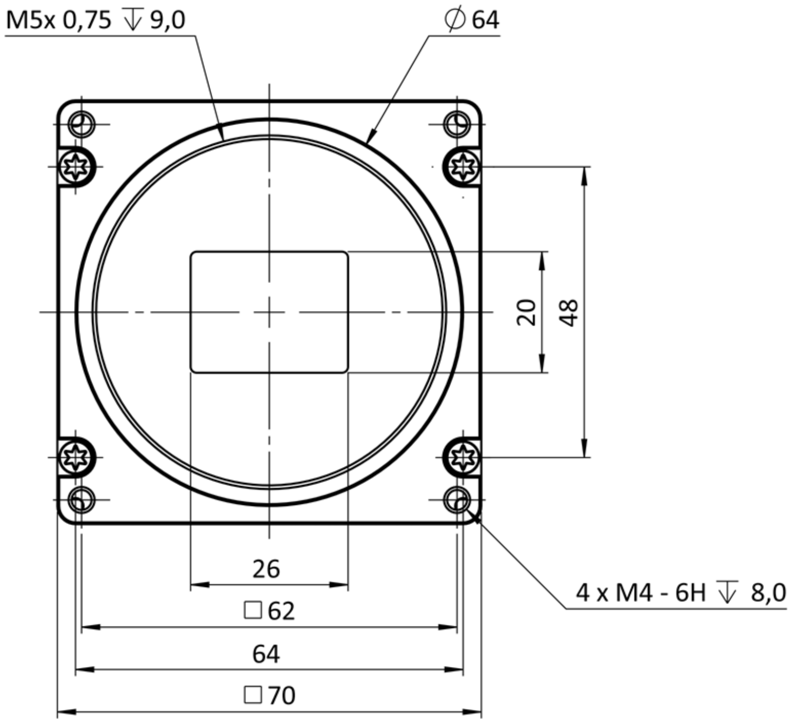


bottom view

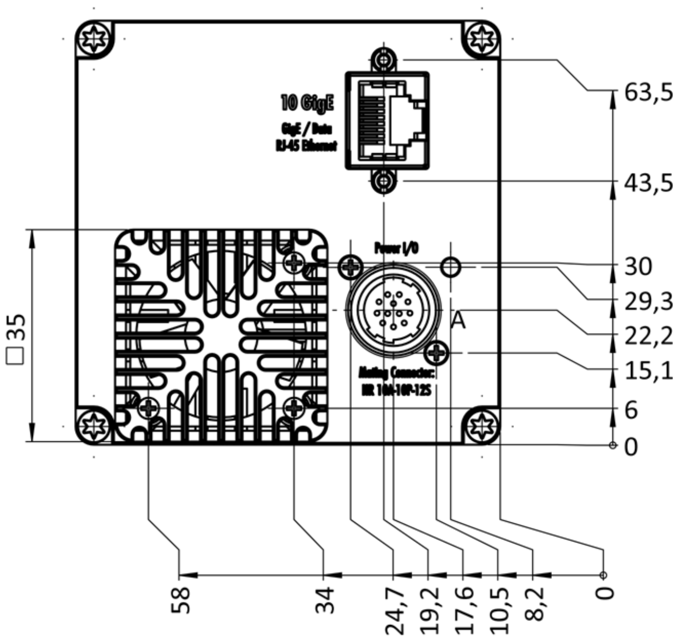


7.4 hr342*XGE

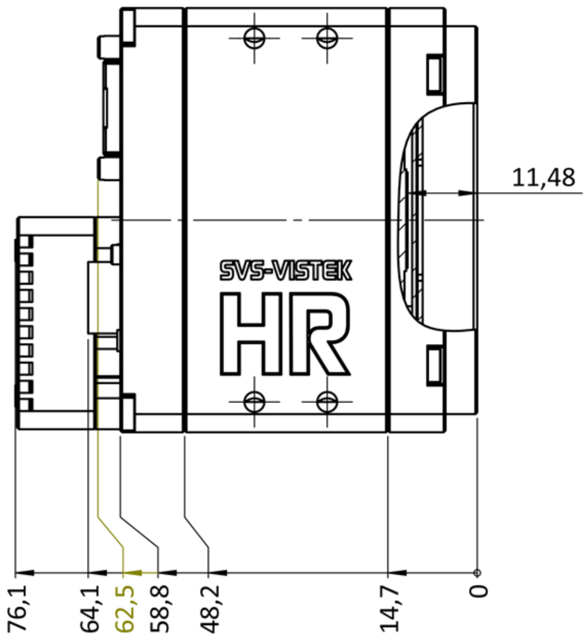
front view



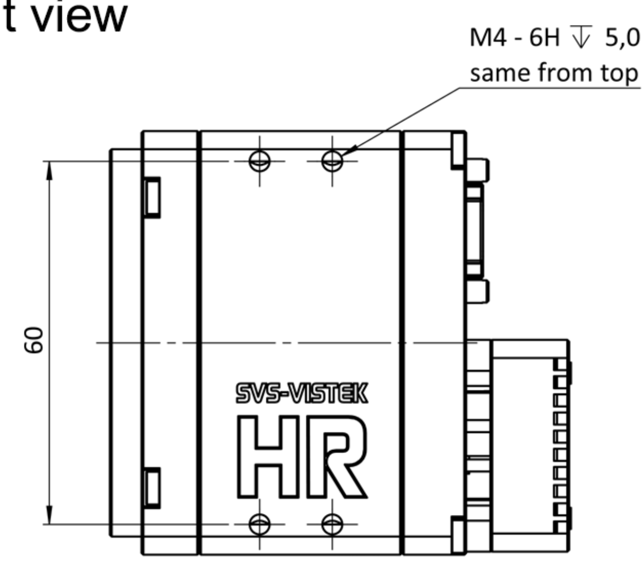
back view



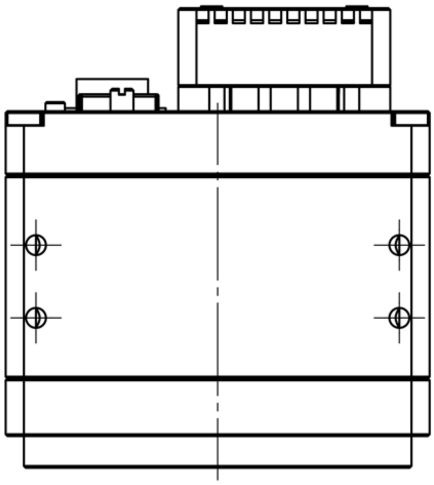
cross section



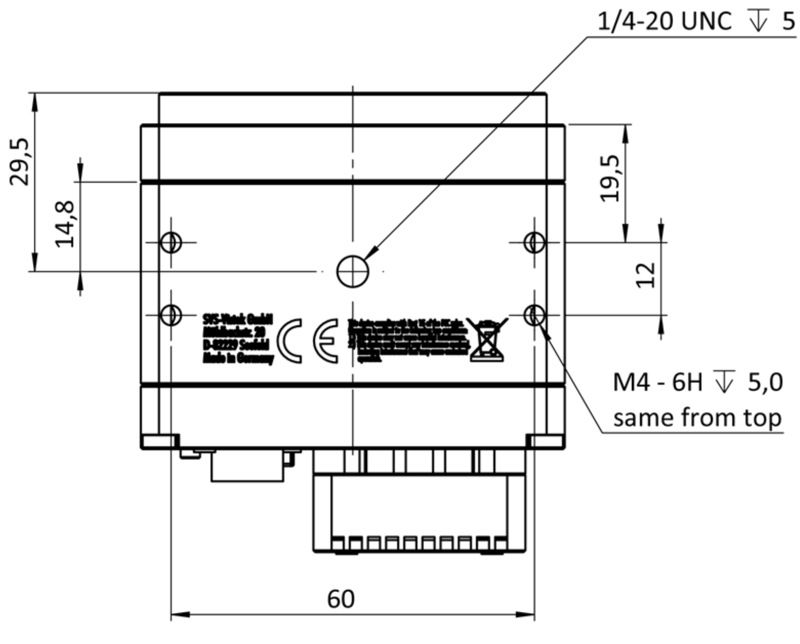
right view



top view

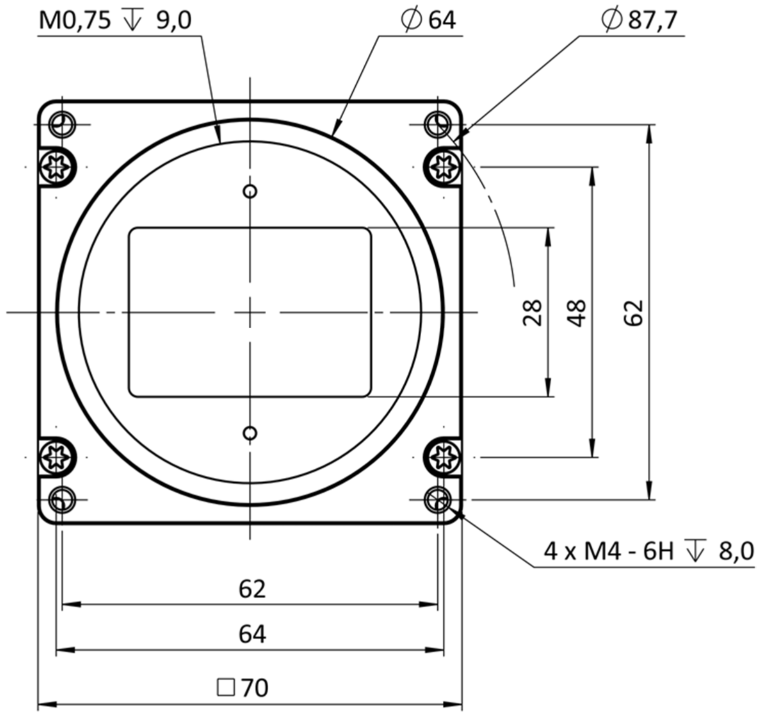


bottom view

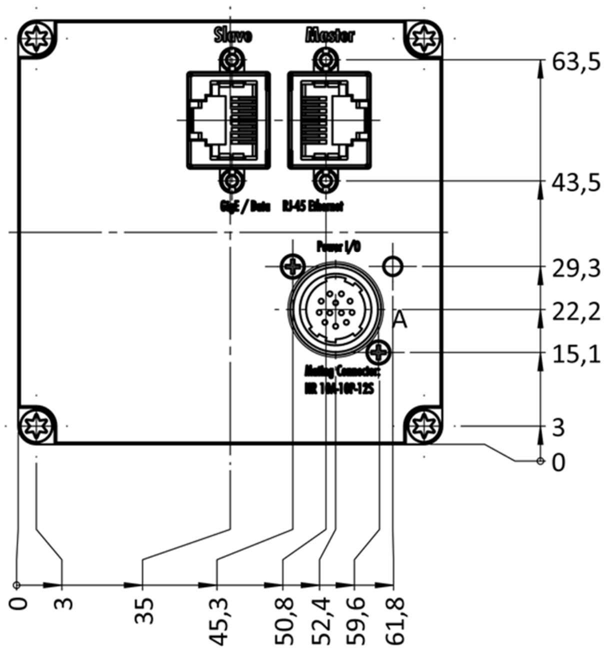


7.5 hr16-5*GE, hr16-7*GE

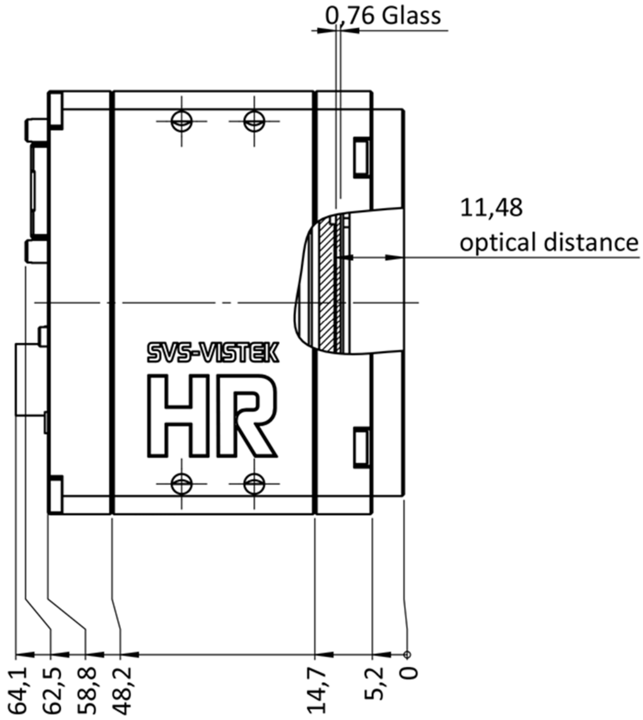
front view



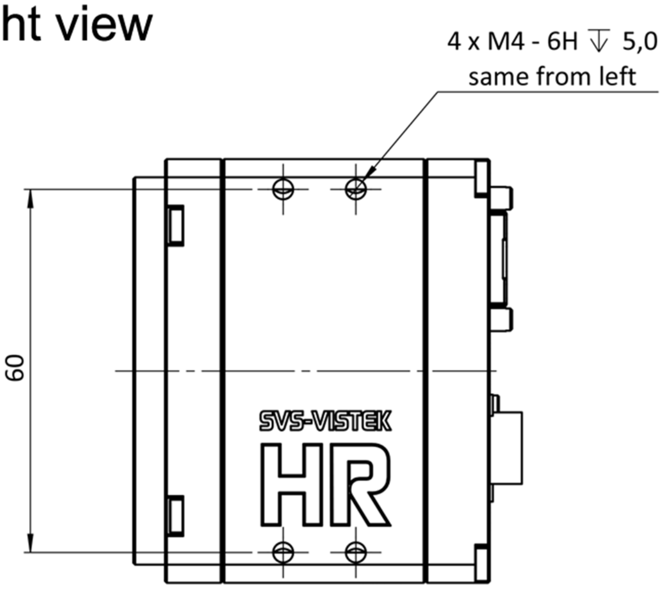
back view



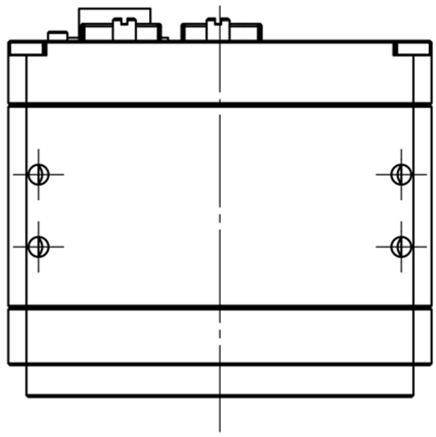
cross section



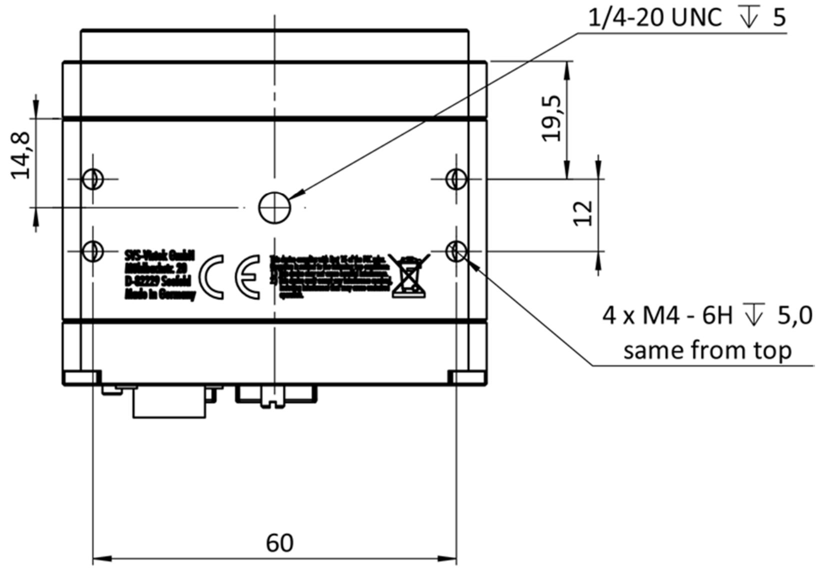
right view



top view

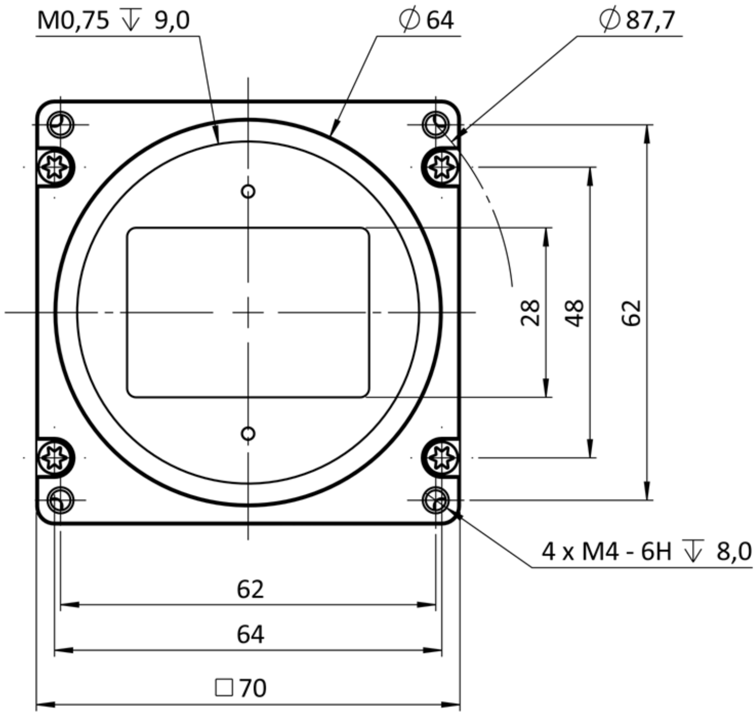


bottom view

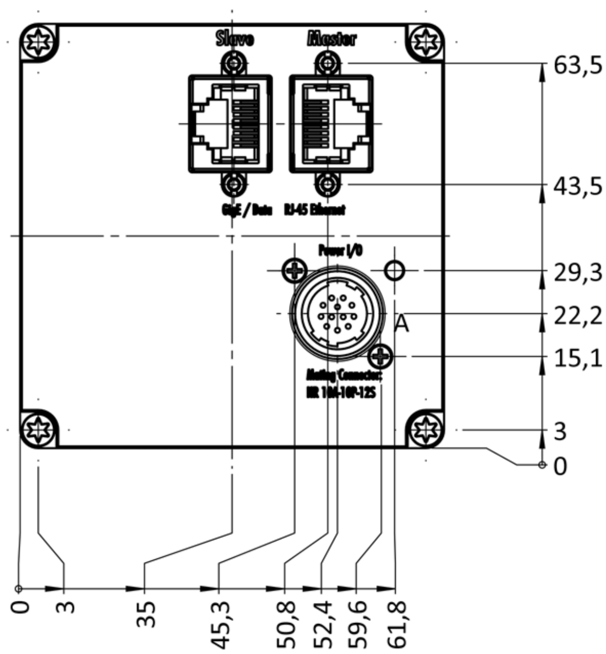


7.6 hr29*GE

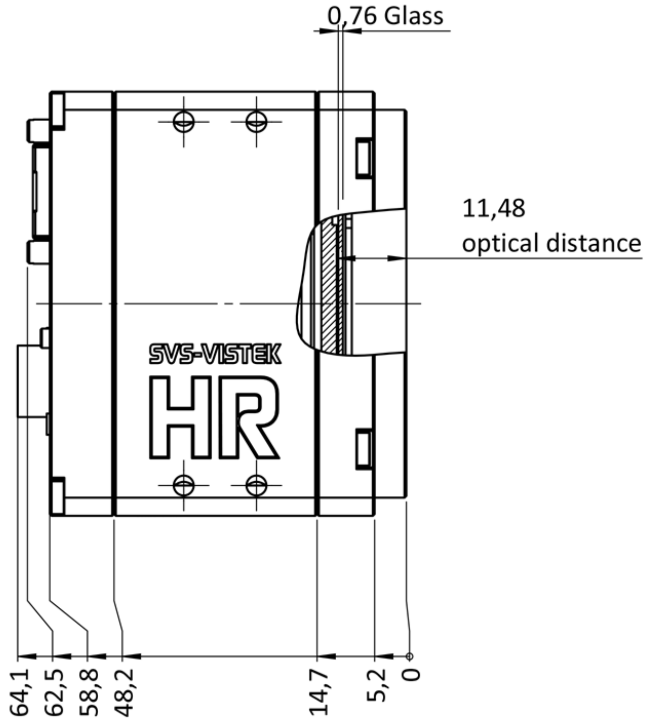
front view



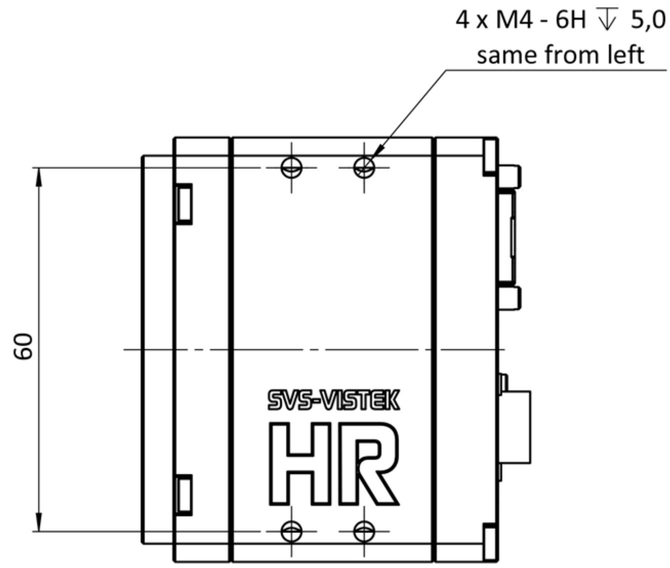
back view



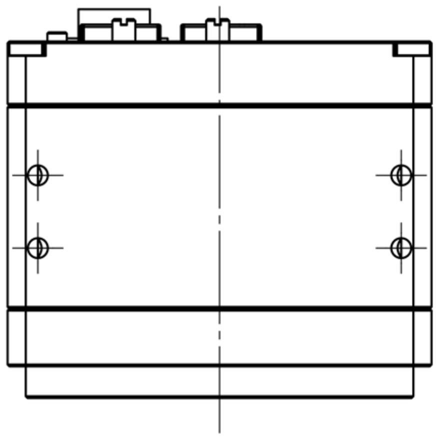
cross section



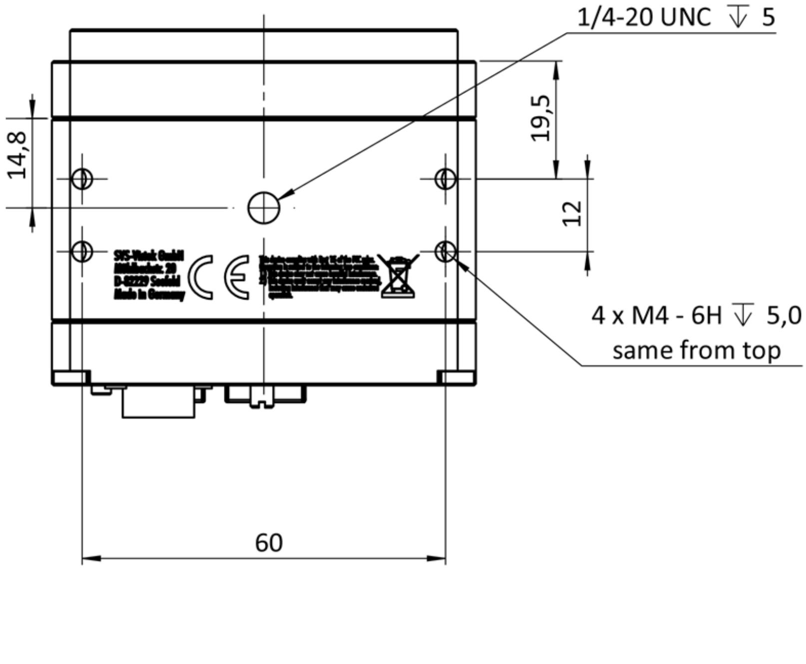
right view



top view

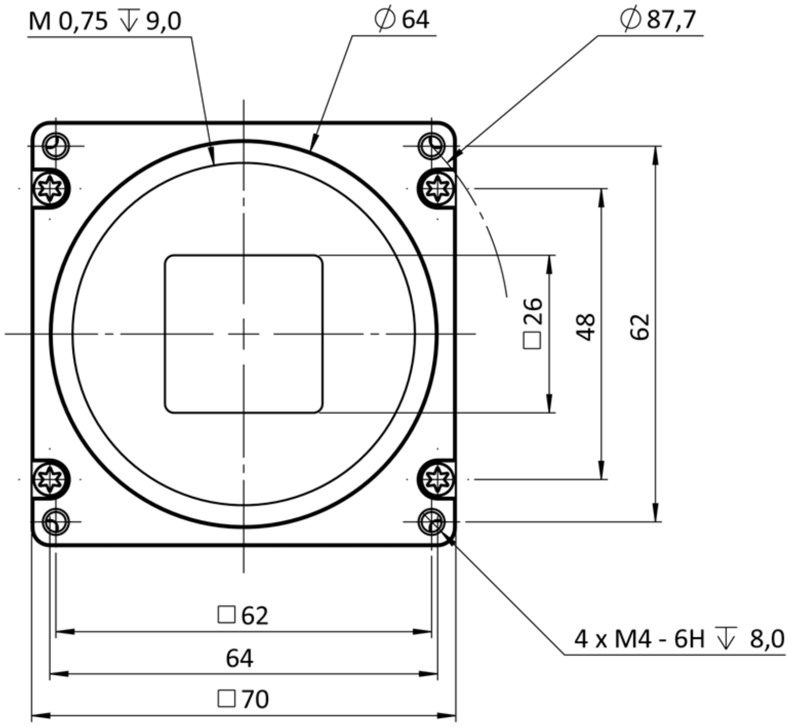


bottom view

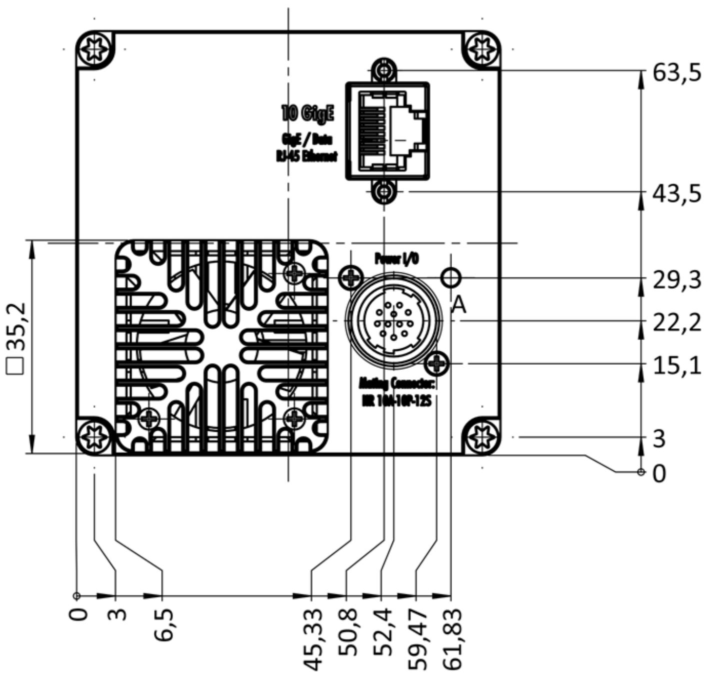


7.7 hr25*XGE

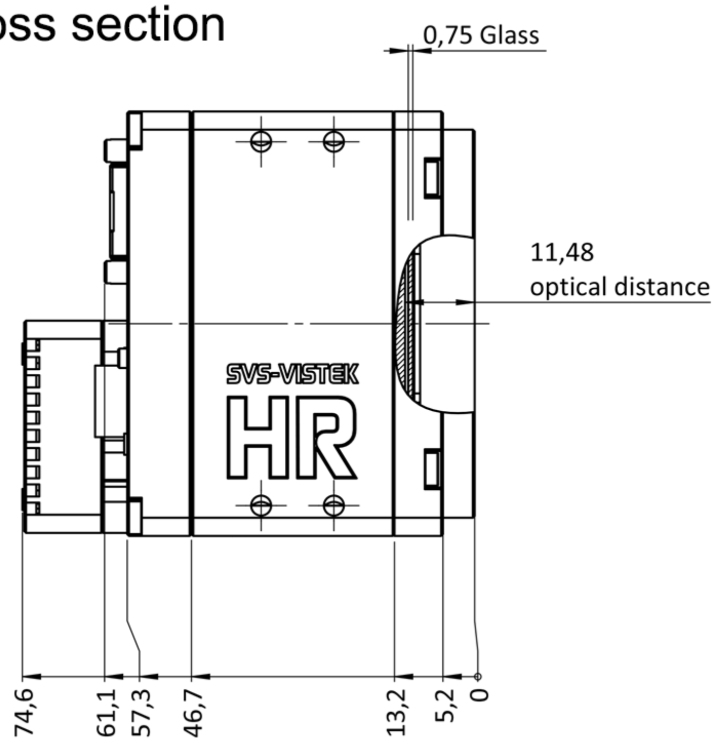
front view



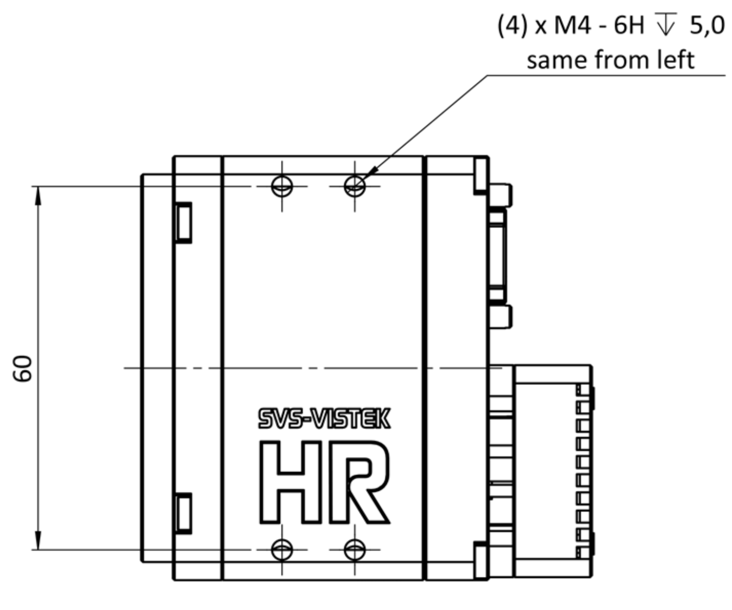
back view



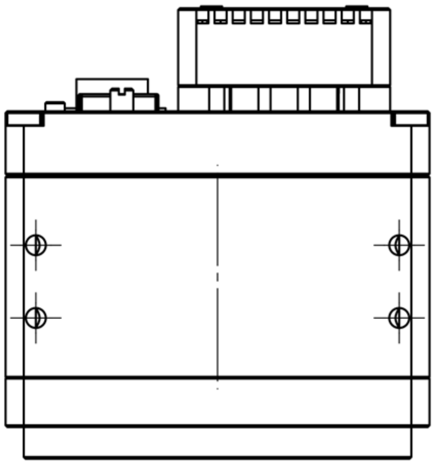
cross section



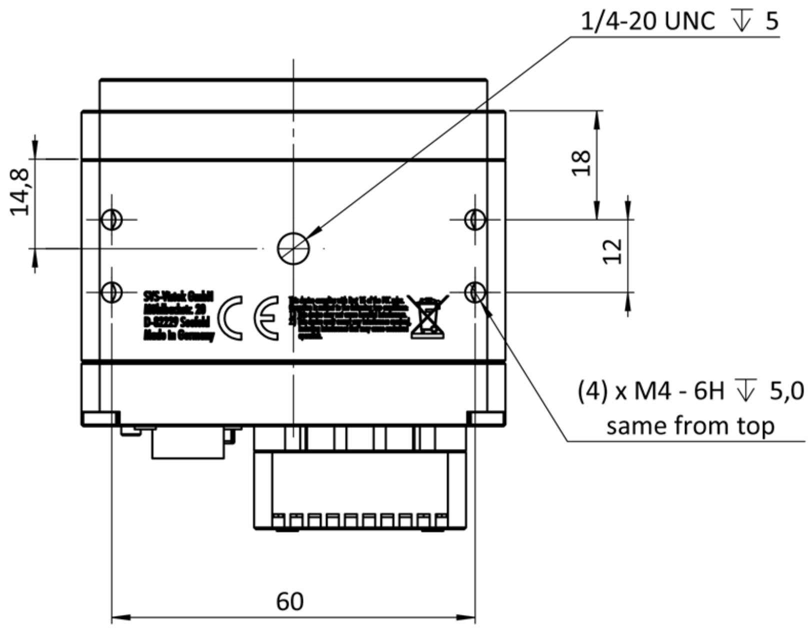
right view



top view



bottom view



7.8 M58 mount

Diameter 58 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.

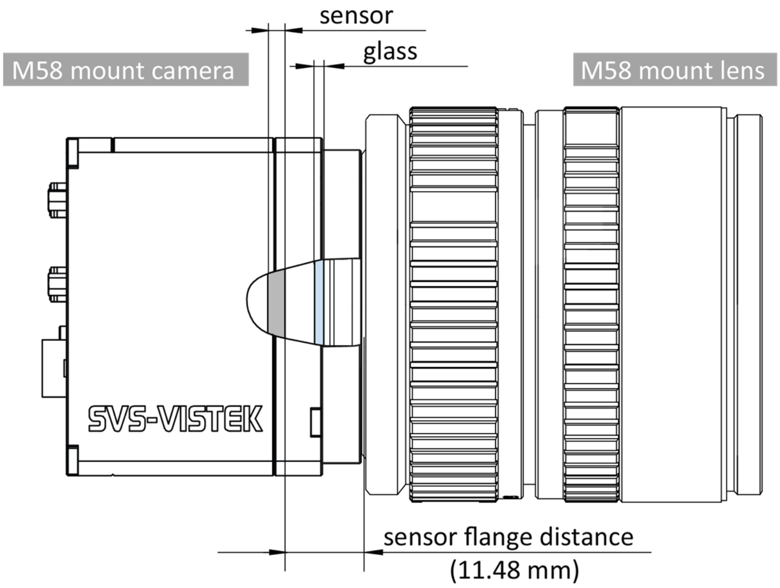


Figure 23: M58-mount

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 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.

10 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