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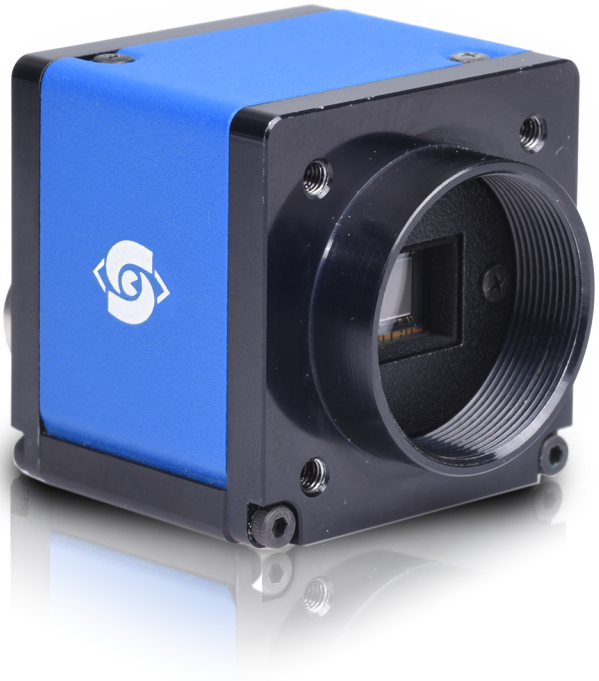
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SVS-VISTEK



GiGE VISION™

Manual ECO series

eco204, eco267, eco274, eco285, eco414, eco415, eco424,
eco445, eco618, eco625, eco655

A TKH TECHNOLOGY COMPANY

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1.1 Standards

This 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

1.2 Disclaimer

This manual contains important instructions for safe and efficient handling of SVCam products. This manual is part of the product and must be kept accessible in the immediate vicinity of the product for any person working on or with this product .

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

Accident prevention guidelines and general safety regulations should be applied.

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

The product 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

1.3 Copyright notice

Forwarding and duplicating of this document, as well as using or revealing its contents are prohibited without written approval. All rights reserved with regard to patent claims or submission of design or utility patent.

2 Legal information

Errors and omissions excepted.

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

2.1 Europe



This device 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 products comply with the recommendation of the European Union concerning RoHS Rules.

2.2 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.

NOTICE **This equipment is compliant with Class A of CISPR 32. 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 device housing. This is essential for any use. If not done and the device is destroyed due to Radio Magnetic Interference (RMI) WARRANTY is void!

- Power: US/UK and European line adapter can be delivered. Otherwise use filtered and stabilized DC power supply.
- Shock & vibration resistance is tested. For detailed specifications refer to the section on specifications ("Specifications" on page 44).

3 Getting started

3.1 Content of camera set

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

3.2 Power supply

Connect the power supply with the Hirose connector.

NOTICE **This camera does not support hotplugging.**

> First connect the data cable.

> Then connect power supply.

When using your own power supply (voltage range 10 -25 V DC) see also Hirose 12-pin for a detailed pin layout of the power connector. For power input specifications refer to "Specifications" on page 44.

3.3 Camera status LED 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:

LED status code	Indication
	nothing connected
	assiggnment of network address
	network address assiggned
	system connected
	streaming channel available
	acquisition enabled
	initialization error
	Camera overheating
	waiting for trigger
	exposure active
	readout / FVAL

Fig.: 3-1: Camera status LED codes

3.4 Software

More information, documents, release notes, latest software and manuals can be downloaded in the SVS-Vistek download area.

INFO *Depending on your camera model, several software packages apply.*

3.4.1 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 following interfaces:

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

SVCapture is included in the SVCam Kit, you can download it for free from SVS-Vistek download area. It is based on GenTL, which provides the possibility to use the SVS-Vistek driver for third-party software.

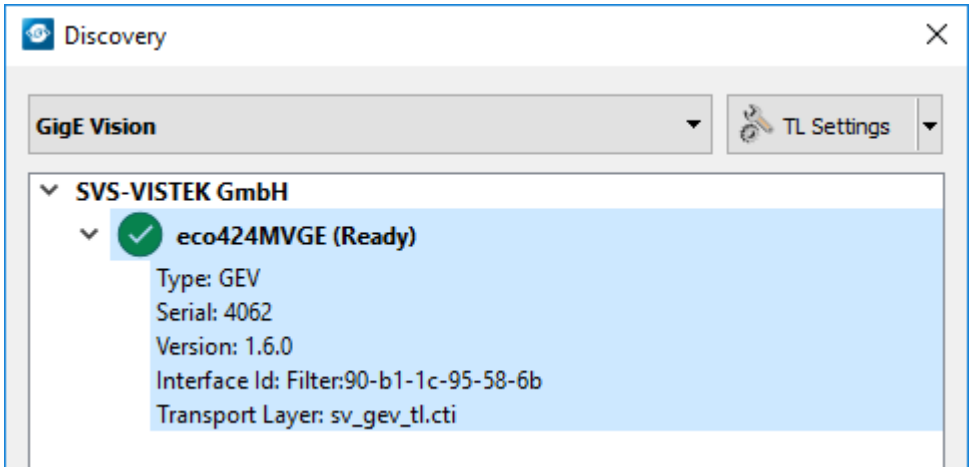
INFO *Refer to the SVCam Kit Quick Guide for details. You will find this document in the download area as well. Generally, any GenICam based software package should be able to run a SVS-Vistek camera (GigE Vision, USB3, Camera Link).*

NOTICE **It is recommended to uninstall the existing version of SVCam Kit or SVCapture before installing the new version. While installing, deactivate your firewall and anti-virus programs.**

Installation procedure

The SVCam Kit Quick Guide contains an extensive installation guide.

- Download the SVCam Kit matching your operating system.
- Disable firewall and anti-virus programs.
- If the interface is Camera Link or CoaXPress, install frame grabber driver software first.
- Unpack and install SVCapture with the drivers required for your camera's interface type.
- Enable firewall and anti-virus 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.


Discovery
GigE Vision
TL Settings
SVS-VISTEK GmbH
eco424MVGE (Ready)
Type: GEV
Serial: 4062
Version: 1.6.0
Interface Id: Filter:90-b1-1c-95-58-6b
Transport Layer: sv_gev_tl.cti

3.4.2 Firmware update

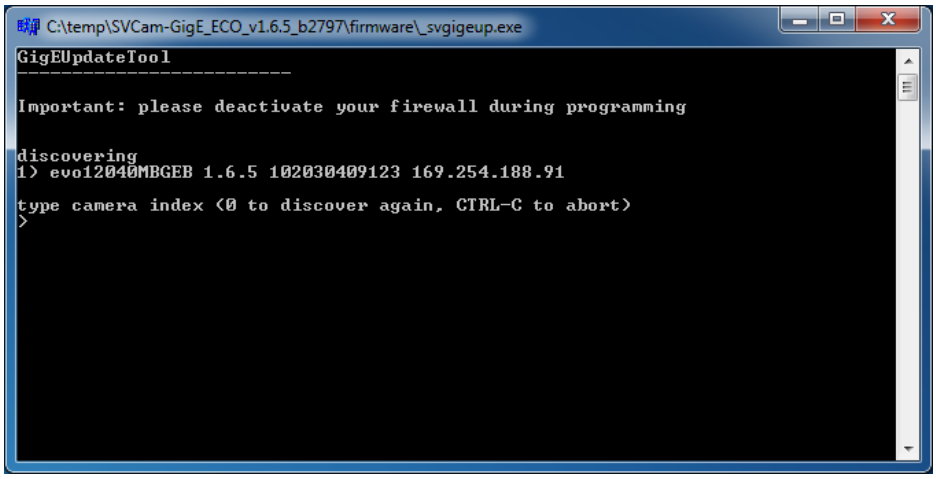
Some features may not have been implemented in older software revisions. For updating your camera firmware to the most recent version, you need the firmware tool “Firmware Update Tool.exe” and the firmware file (download it from website, login area) matching your camera model.

Execute firmware update

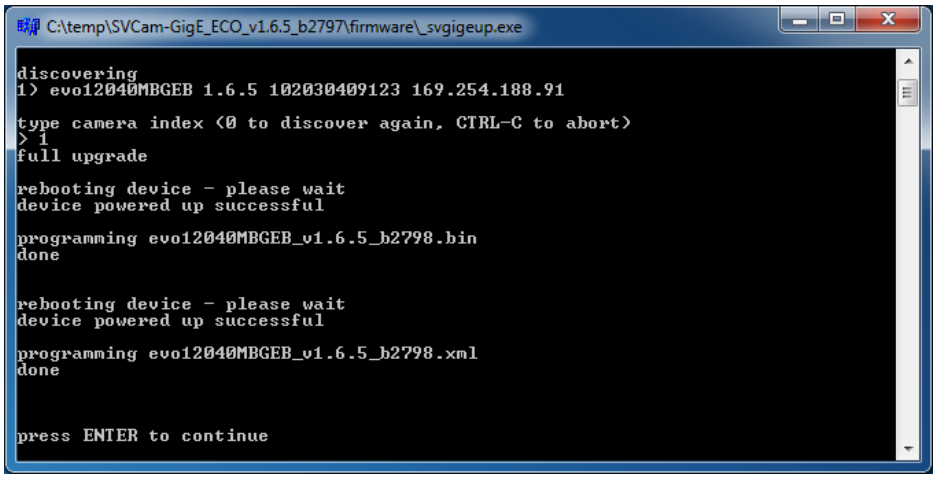
- Download the GigE firmware tool and the firmware file from the SVS-Vistek website.
- Unpack everything into any folder, e.g. “C:\temp”.
- Ensure proper network configuration.
- Run the GigE update tool.
- When the camera is displayed, choose camera by entering camera index, e.g. 1 and press ENTER.
- Make sure the new firmware is located in the current folder.

By selecting the camera on the network, the firmware update tool will search the current folder for matching firmware and start update process.

NOTICE **Do not power off during the update process.**



Wail until firmware update has been finished.



3.4.3 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.

4 Connectors

Cameras from SVS-Vistek feature a combined I/O and power supply connector (Hirose) and a data connector.

4.1 GigE Vision

4.1.1 Network (TCP/IP)

Address Assignment

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

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.

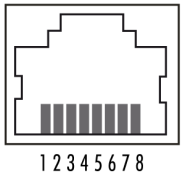


Fig.: 4-1: RJ45 socket connector

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. Jumbo frames increase the data size per Ethernet packet.



Fig.: 4-2: Data reduction with jumbo frames

INFO *Higher packet sizes require network cards that support jumbo packets.*

Lost packets

In accordance with the TCP protocol, lost or corrupted packets will be resent.

NOTICE **Resends result in higher consumption of bandwidths and will lead to drop frames. High quality cables prevent resends.**

Connecting multiple cameras

Multiple GigE cameras can be connected to a PC either via a switch or using dual or quad port network interface connectors (NIC).

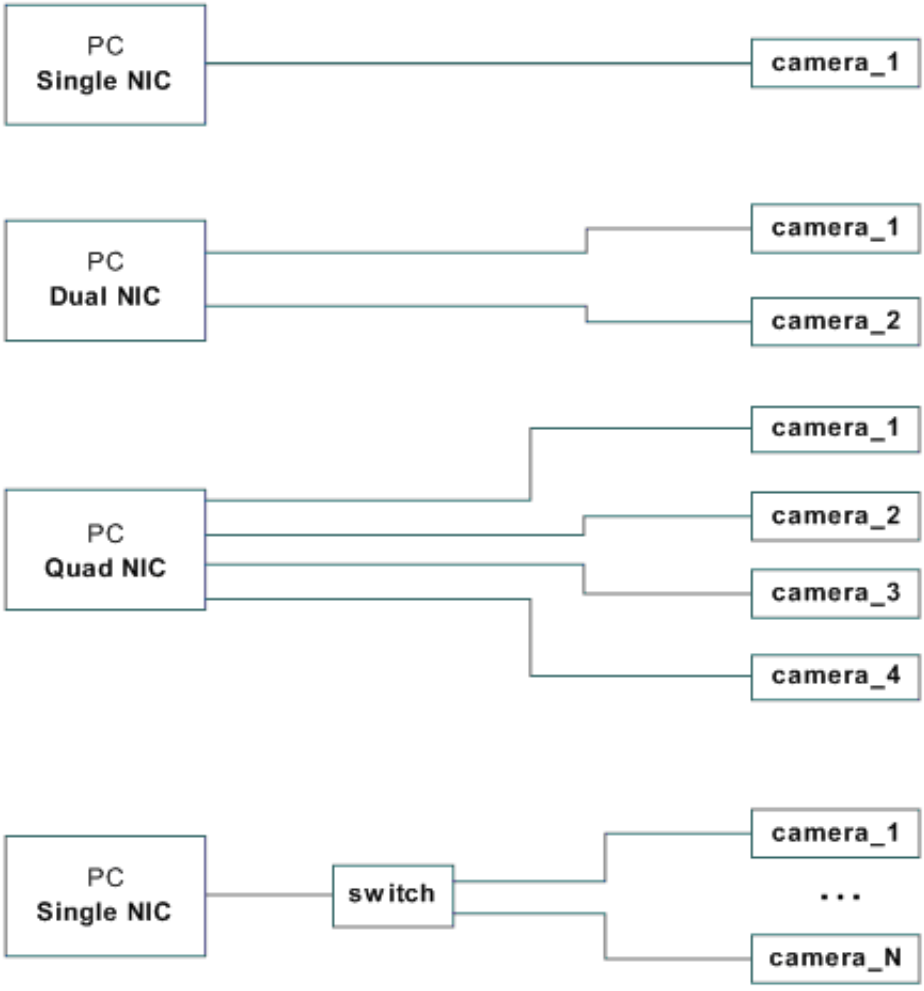


Fig.: 4-3: Connecting multiple cameras on multi NICs

Multiple cameras connected by a switch

To connect multiple cameras by a switch, the switch must be managed. It might also be necessary to operate the cameras in an “inter packet delay” applying a smother image data stream.

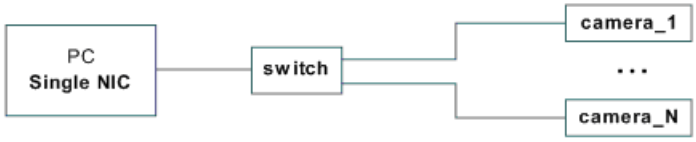


Fig.: 4-4: Illustration of connecting multiple cameras by a switch

Dual GigE connection is not supported when using a switch.

NOTICE **Performance might be lost using multiple Cameras on a single port NIC.**

Multicast

When images from a single camera need to be delivered to multiple PCs, multicast (RFC 2236) is used. A switch receives an image data stream from a camera and distributes it to multiple destinations in this mode.

Since a GigE camera always needs a single controlling application, there will be only one master application. The controlling master application has to open a camera in multicast mode (IP 232.x.x.x for local multicast groups) in order to allow other applications to connect to the same image data stream. Other applications will become listeners to an existing image data stream. They do not have control access to the camera; however, potential packet resend requests will be served in the same manner as for the controlling application.

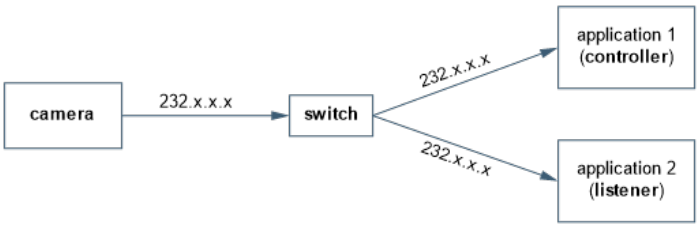


Fig.: 4-5: Camera casting to multiple receivers (multicast)

4.1.2 XML files

According to the GigE Vision standard a GigE camera provides an XML file that defines the camera's capabilities and current settings.

The XML file can be processed by software like SVCapture allowing displaying and saving it to disk. Settings can also be saved and restored on the Camera internal EEPROM.

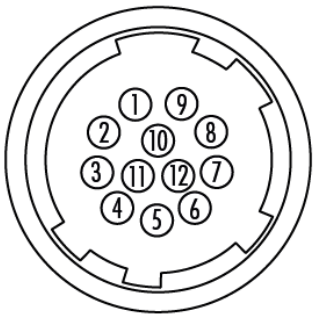
4.2 Input / output connectors

NOTICE **Make sure your external power supply meets specifications. Voltage must not exceed 25 V.**

4.2.1 Hirose™ 12-pin connector layout

The Hirose connector provides the connectors to power, inputs and outputs.

INFO *For information about switching lights from inside the camera, refer to "LED strobe control".*



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

NOTICE **The PoE (Power over Ethernet) versions do not support RS232 on pins 3, 4.**

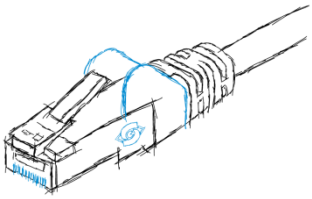
5 The ECO

5.1 The SVCam ECO Series: Extremely small

A SVCam-ECO fits into any type of application. The SVCam-ECO series impresses with its minimal footprint. And that even without compromising on performance.

Unparalleled flexibility with an excellent price-performance ratio: This is how one best would describe the SVCam-ECO series. Comprising 88 different variants, the cameras use well-known Sony CCD sensors with resolution ranging from VGA to 5 megapixel. The cameras are among the smallest industrial cameras and were specifically developed to provide the highest frame rates paired with excellent signal-to-noise ratio. Supporting GigE Vision and GenICam standards, the SVCam-ECO series opens up new possibilities for integrating into your specific applications.

5.2 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

6 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 of our website with your exact model.

https://www.svs-vistek.com/en/industrial-cameras/svs-svcam-searchresult.php

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.

6.1 Basic features

6.1.1 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 pixels 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 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: 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.

6.1.2 Rolling shutter



Rolling shutter is a method of reading out a CMOS sensor, where the whole scene is scanned line after line very rapidly. Despite the speed of scanning the lines one line after the other („rolling“) is very high, it is important to note that the instant of imaging a single line will be different to the point of time of the next line imaging. As this works out without any effect in the final image with still sceneries, at moving objects you get geometric distortions (see example of rotating propeller), showing fast moving structures in an predictable, in the first moment yet surprising way.

As it takes some time to read out a whole sensor (and the whole sensor has always to be read out!) you need to make sure that light conditions are stable while reading the sensor. This restriction applies especially to using PWM driven lights or flash lighting with rolling shutter. Unstable light conditions will result in a horizontal line structured pattern noise. Rolling shutter cameras in general are more sensitive in their light response than global shutter ones.

PWM lights with rolling shutter

PWM (Pulse Width Modulated) powered light or dimmed light is run at a fixed frequency. Experience teaches us this frequency might be less stable than expected. Unstable frequency might show up as unstable light, creating noise/line structures in the final rolling shutter image (in global shutter images the whole image is just more/less bright)

As a rule of thumb, make sure your PWM lighting frequency is at least double or triple the bitdepth of your image (e.g. 8bit image = 256, this means your PWM has to be switched at least 256*2=512 times) while exposing. If exposure time is 5ms,

required minimum PWM freq = 5ms/512 ~ 10µs ~ 100kHz

If you have the possibility to use a strobe controller or dimmer with linear regulation, this might be preferrable on short exposure times.

Light control with rolling shutter

As being said, not all sensor lines are sensitive to light at the same time. Make sure your light is ON as long any pixel are going to e exposed. An exo183xGE i.e. needs about 62ms of minimal scanning time. An exo183xCL i.e. needs about 120ms of minimal scanning time. Minimum scan time in most cases is about 1 frame length.

There are 2 general guidelines for flashing with rolling shutter:

- Make sure your light is ON and stable the whole period of time while scanning / exposing. Minimum flash time is scanning time plus exposure time. In this case, while flashing you will get geometric distortions as mentioned above. Exposure will be determined by camera exposure time and light intensity.
- If flash time is less than scanning time then exposure time has to be at least scanning time + flash time, with a delay of scanning time. In other words, your exposure time will be scanning time plus flash time, while you use a flash delay of scanning time. Thus flash release will start after the delay of scanning time, as soon the sensor is fully open. You should keep the object in total darkness while the first scanning time.
  In this case, as all lines are sensitive to light at the same time after the first scan time, flashing time can be as short as you like. You will not see the typical geometric rolling shutter distortions as shown above. Imaging will be similar to global shutter. Exposure will be determined by flash time / intensity.

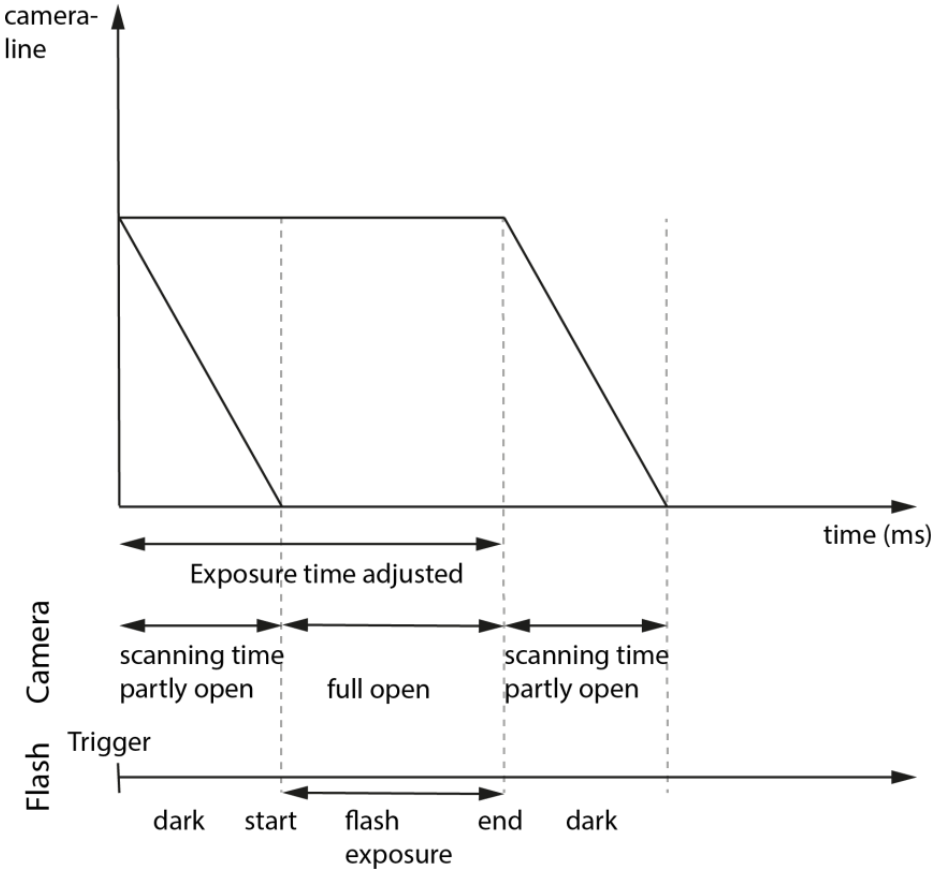


Fig.: 6-1: Rolling shutter lines light sensitivity versus time

As shown here, after triggering only part of the sensor is sensitive to light (scanning time). As soon as scanning time has finished, all pixels are sensitive to light, the sensor is fully open. While being fully open this is the time where flashing should happen. In the final scanning time, less and less pixels are sensitive to light until the sensor light sensitivity will finish.

Rolling shutter limitations

Due to the principles of rolling shutter, some standard features of SVS-Vistek cameras are not applicable.

- External exposure control (expose while trigger signal active) does not make sense with rolling shutter
- ROI with rolling shutter: With rolling shutter the whole sensor has to be read out – always. That means applying ROI will reduce the amount of final data being transmitted out of the camera (and the framerate might rise, due to the limited bandwidth of the interface). Nonetheless, the maximum achievable framerate with applied ROI will be the maximum framerate of the sensor reading the full sensor area (internal full sensor speed), please refer to relating sensor specs.

6.1.3 Exposure

- For various exposure and timing modes in chapter, see "Basic capture modes" on page 32.
- For combining various exposure timings with PWM LED illumination, refer to "Sequencer".

Setting exposure time

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

6.1.4 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 frame rates with heavy interface bus load.

Maximum frame rate might depend on:

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

6.1.5 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.

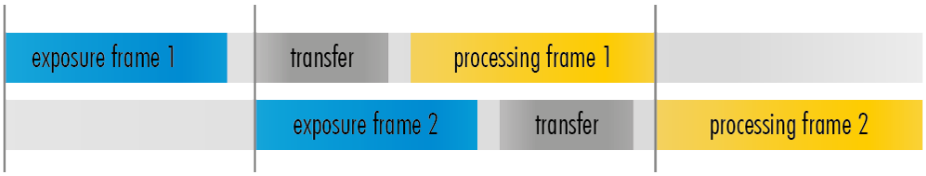


Fig.: 6-2: Acquisition and processing time

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

6.1.6 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 predefine 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.

Limitations

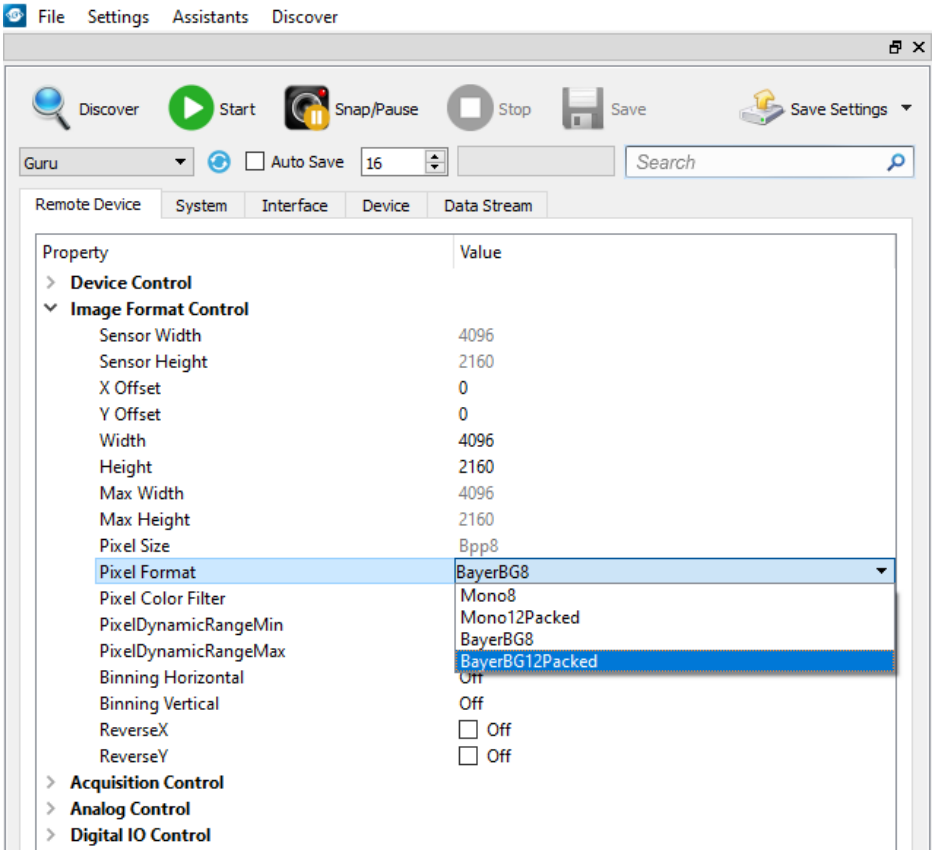
As this feature is based on a control loop, the result is only useful in an averaged, continuous stream of images. Strong variations in brightness from one image to next image will result in a swing of the control loop. Therefore it is not recommended to use the auto-luminance function in such cases.

6.1.7 Bit depth

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

No of gray 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.



INFO *Depending on camera model, different bit depths are supported.*

6.1.8 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.

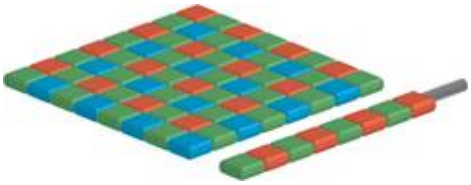


Fig.: 6-3: Sensor with Bayer pattern

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 must be done in the client software(also refer to SDK functions). Not all sensors have the same sequence of color. The GenICam property **PixelColorFilter** indicates 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. Due to this, physical resolution of color cameras is always lower than resolution of monochrome cameras.

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

INFO *It is recommended to use an IR cut filter for color applications*

INFO *Industrial vision cameras are not intended to display colors according to human perception. See also chapter "Color transformation".*

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.

- Continuous: Auto white balance will analyze the taken images and adjust exposure per color accordingly as long as the camera is taking images. Different colors of the same object in a sequence might be the result depending on the other objects in the image
- Once: Auto white balance will adjust white balance as soon it is started and will stop modifying parameters as soon white balance is finished.

6.1.9 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 (see "Offset" below).

For calculating image sizes, the maximum camera resolution is determining maximum image resolution, refer to the specifications of the camera model).

6.1.10 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.

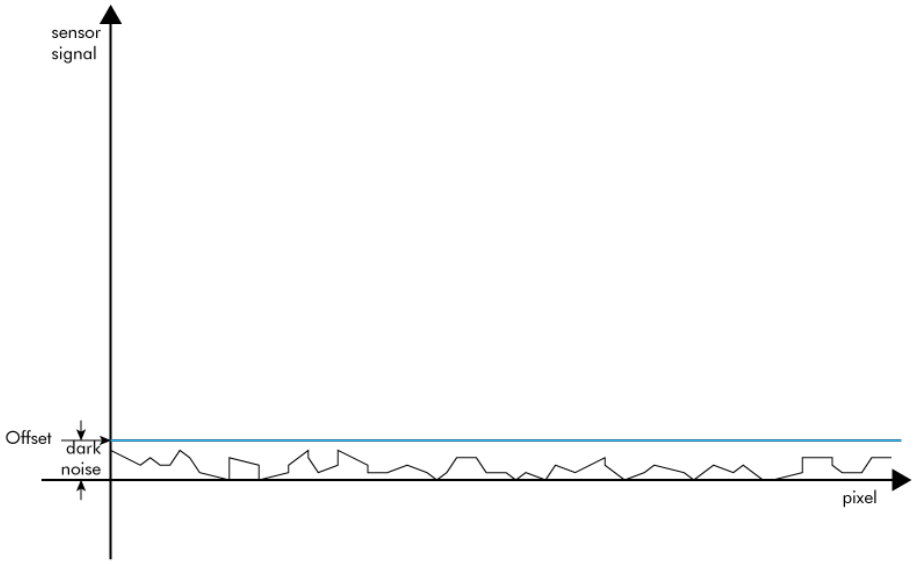


Fig.: 6-4: Dark noise cut off by the offset

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.

INFO *For multi-tap CCD sensors, the offset can be altered for each tap separately.*

6.1.11 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: 6-1: Table of dB and corresponding ISO value

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



Fig.: 6-5: Noise caused by too much gain

Auto gain

For automatic adjustment of gain refer to auto exposure (see "Auto exposure" on page 23).

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

6.1.12 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 the next page.

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.

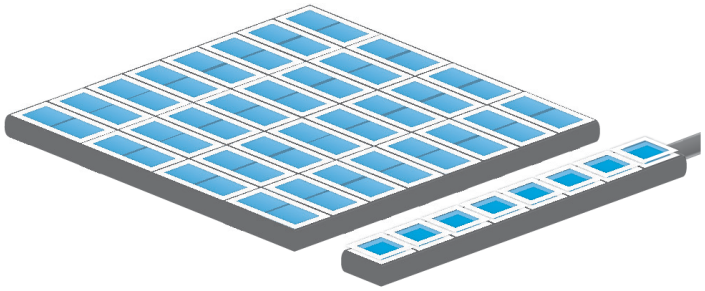


Fig.: 6-6: Vertical binning

Horizontal binning

Accumulates horizontal pixels.

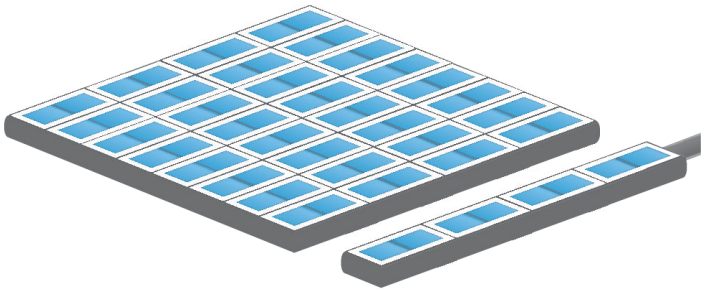


Fig.: 6-7: Horizontal binning

2×2 Binning

A combination of horizontal and vertical binning.

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

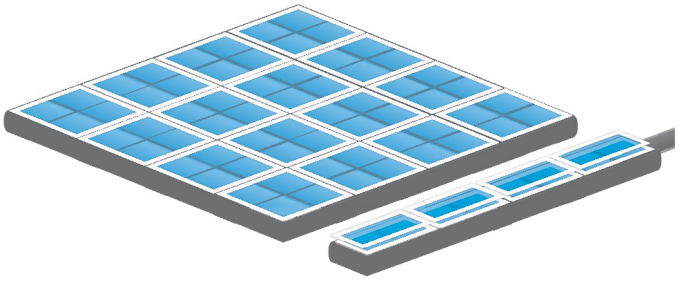


Fig.: 6-8: 2x2 binning

6.1.13 Decimation

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

INFO *Refer to "ROI / AOI" on page 39 for reducing data rate by reducing the region you are interested in.*



Fig.: 6-9: Horizontal decimation



Fig.: 6-10: 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.

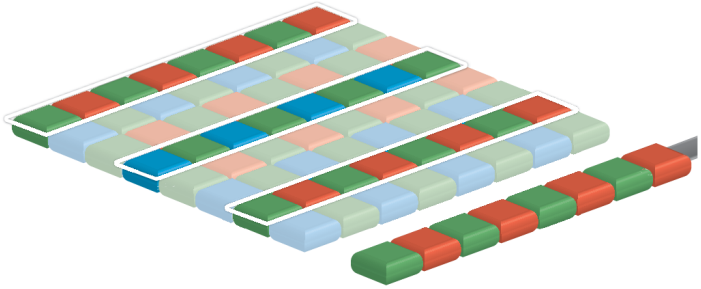


Fig.: 6-11: Decimation on color sensors

6.1.14 Burst mode

The hardware interface (GigE, USB3, etc.) of your camera may often limit the maximum frame rate of the camera to the maximum frame rate of the interface of the camera. Inside the camera, the sensor speed (internal frame rate) might be higher than the external interface speed (e.g. GigE).

In triggered mode, trigger frequency might be higher than the external interface 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 free-run frequency. The image buffer will protect against breaking data-rates of the USB line.

6.2 Camera features

The camera features of the ECO series are defined by the combination of its electronics and firmware features. Firmware features can be upgraded with new firmware releases.

6.2.1 Basic capture modes

The camera has 2 basic operation modes.

- Free run (timed) run: The camera will expose and deliver images on a fixed schedule.
- Triggered: The camera will wait for an external signal and start exposure after receiving the external trigger signal.

Free running

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

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.

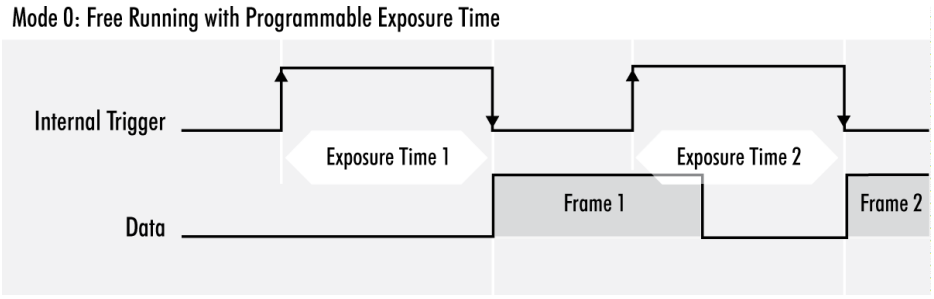


Fig.: 6-12: Basic capture modes - free running

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.

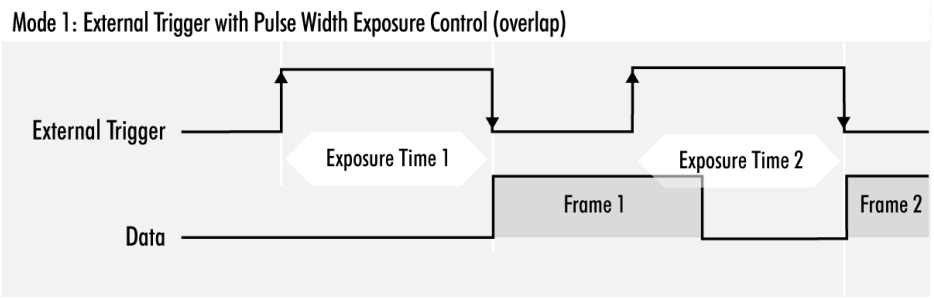


Fig.: 6-13: Basic capture modes - triggered mode (pulse width with overlap)

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.

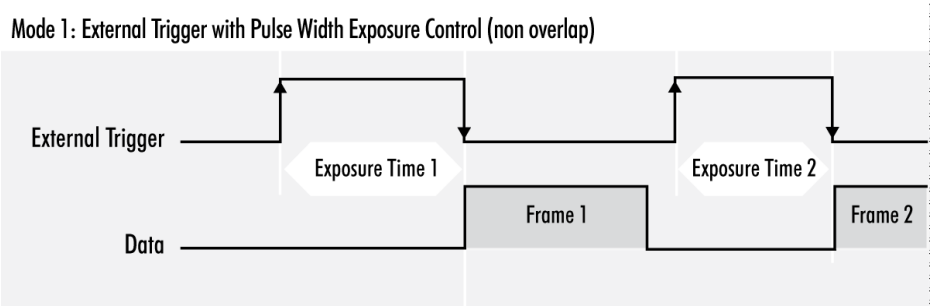


Fig.: 6-14: Basic capture modes - triggered mode (pulse width without overlap)

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 persistent 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 or serial interface.

INFO *Software trigger can be influenced by jitter. Avoid software trigger when using time sensitive applications.*

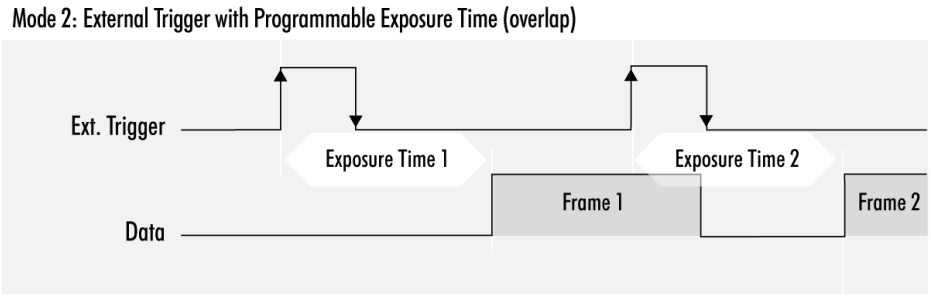
External trigger (exposure time)

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.

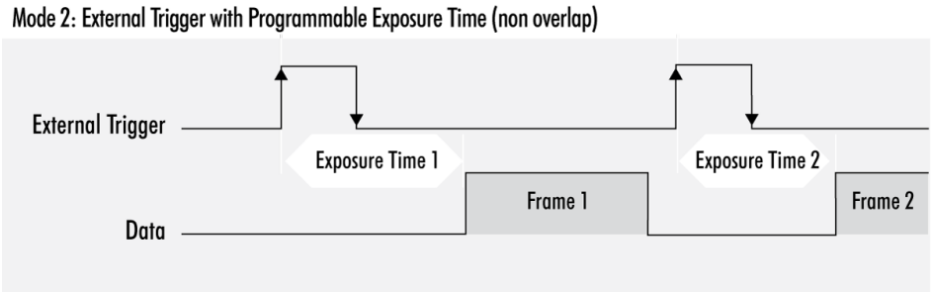
At the rising edge of the trigger the camera will initiate the exposure.

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



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 persistent delay.



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

INFO *The diagrams below are identical for CCD and CMOS technique.*

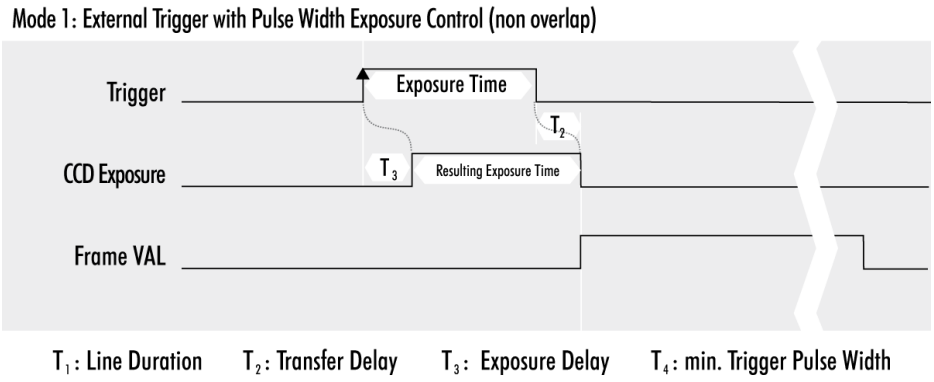


Fig.: 6-15: Mode 1: External trigger with pulse width exposure control (non-overlap)

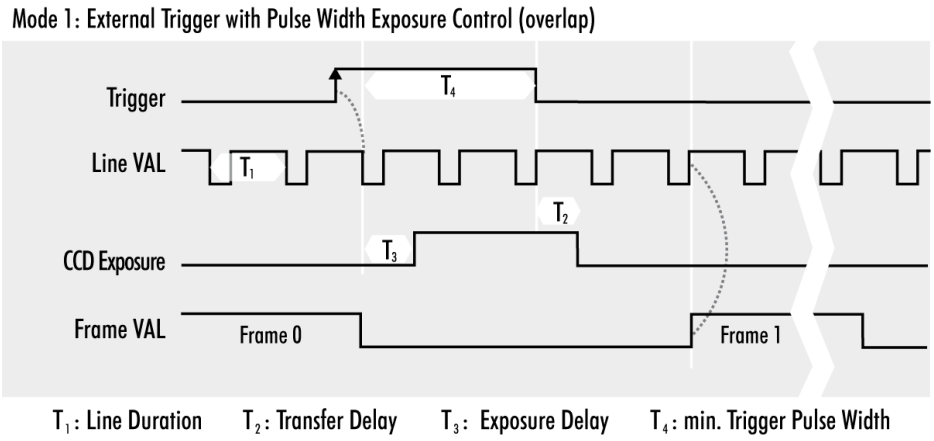


Fig.: 6-16: Mode 1: External trigger with pulse width exposure control (overlap)

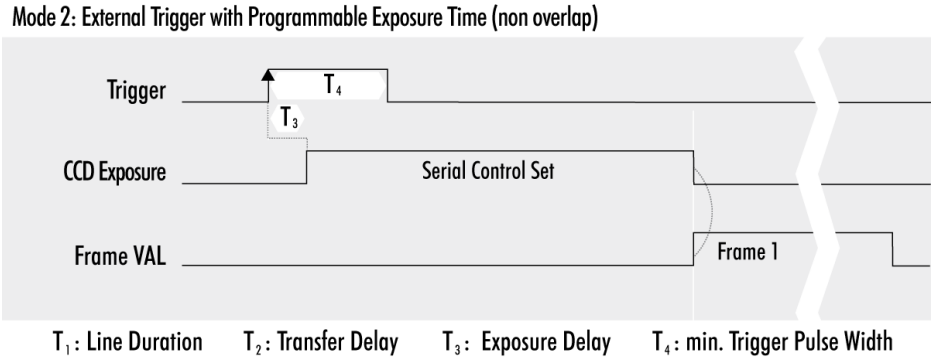


Fig.: 6-17: Mode 1: External trigger with programmable exposure time (non-overlap)

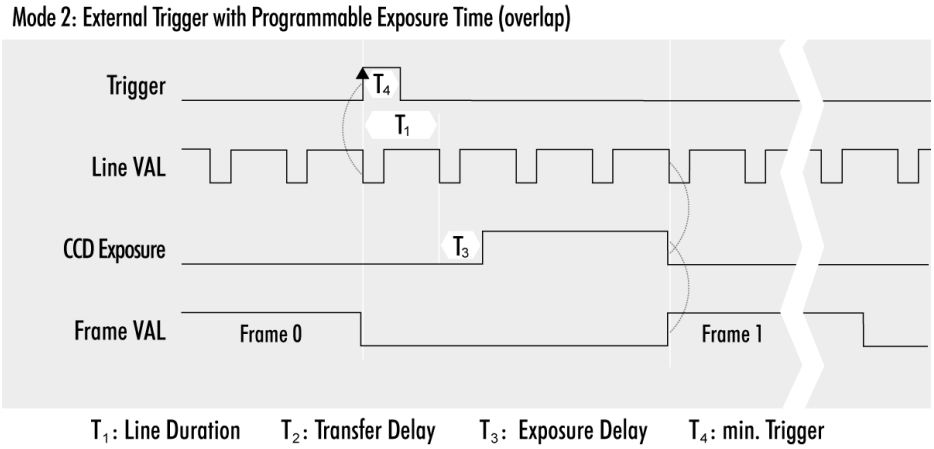


Fig.: 6-18: Mode 1: External trigger with programmable exposure time (overlap)

6.2.2 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.

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

INFO *Use multiples of 15 ns to write durations into camera memory.*

6.2.3 Temperature sensor

A temperature sensor is installed on the main board of the camera. To avoid overheating, the temperature is constantly monitored and read. Besides software monitoring, the camera indicates high temperature by a red flashing LED (see flashing LED codes).

6.2.4 Read-out control

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

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

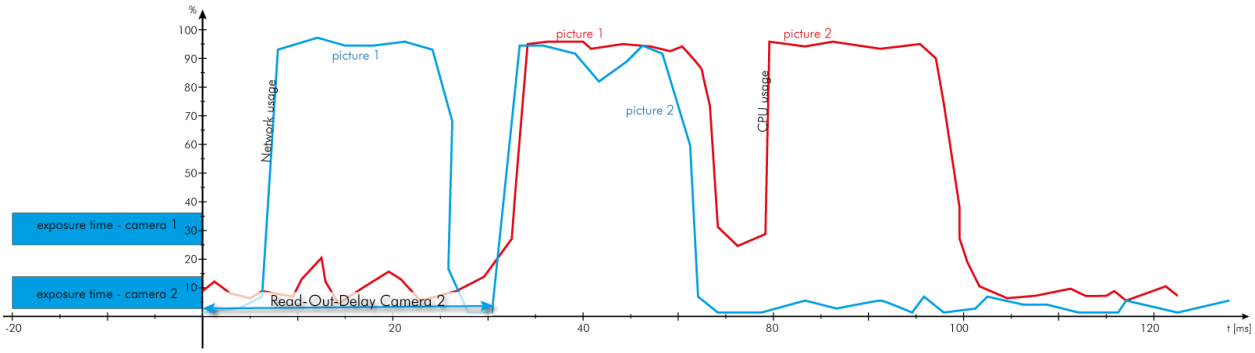


Fig.: 6-19: Illustration of physical data stream in time

6.2.5 Look-up table

The look-up 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.

INFO *For further Information about curves and their impact on the image refer to our homepage: Knowledge Base - LUT.*

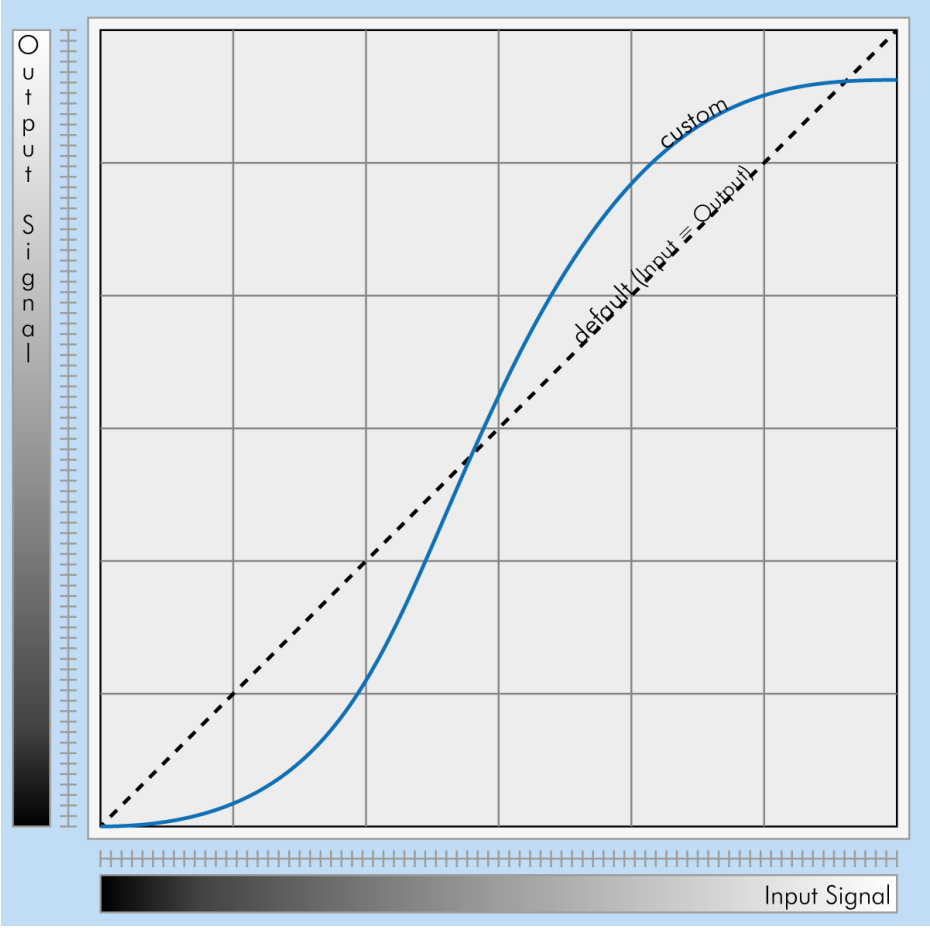


Fig.: 6-20: Custom LUT adding contrast to the mid-tones

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

Gamma correction

Using the look-up table makes is also possible to implement a logarithmic correction. This is 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 below.

- Input & output signal range from 0 to 1
- Output-signal = Input-signal^{Gamma}

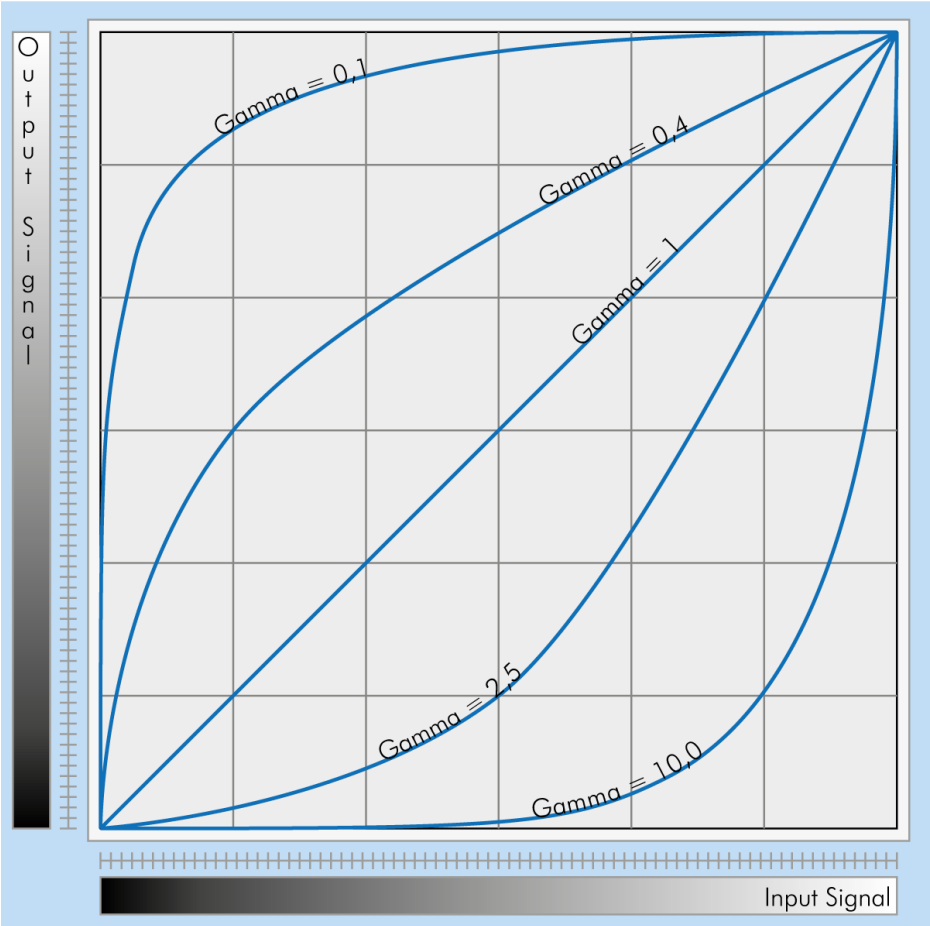


Fig.: 6-21: Several gamma curves comparable to a LUT

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

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

6.2.6 ROI / AOI

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

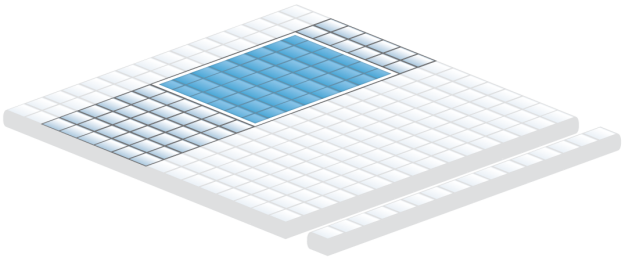


Fig.: 6-22: AOI on area sensor

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 terms 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 is sensor dependent. Some CMOS sensors require the camera to read full horizontal sensor lines internally. Reducing horizontal size with AOI might result in limited frame rate gain.

6.2.7 PIV

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

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

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

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

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

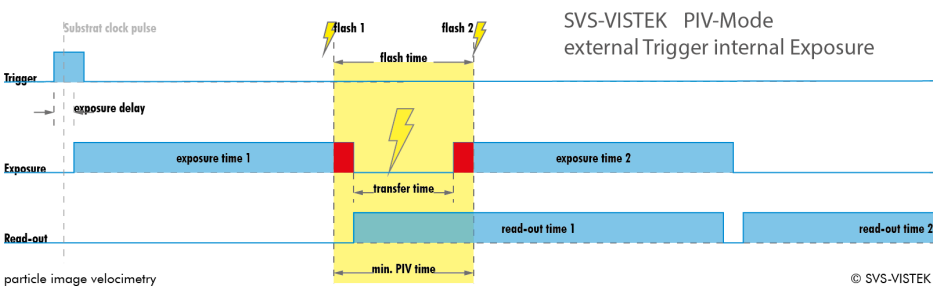


Fig.: 6-23: PIV mode flash timing

The read-out time 1 and the exposure time 2 start both directly after the image transfer of image 1. The exposure time 2 ends when the read-out of image 1

has finished. After the read out of image 1 is done, image 2 is transferred and read out. The readout time of each camera is sensor dependent.

INFO *Contact the SVS-Vistek support team for details on sensor readout timing.*

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

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

6.2.8 Pixel clock frequency selection

Besides the factory frequency setting other values can be available for some CCD sensors. Charges will be transported faster, more frames per second will be generated. IMX sensors from Sony are running with default value as recommended in sensor specifications and cannot be modified.

NOTICE **Higher Frequencies can result in a loss of quality.**

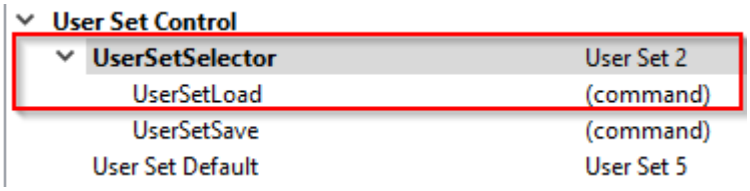
6.2.9 Predefined configurations (user sets)

The camera starts with default values for all features when turned on. Settings made during operation will expire when the camera is turned off.

All preset adjustments are located in the GenICam tree in the “User Set Control” property. It is possible to save up to 8 user sets. Each of these setups consists of a complete configuration set including exposure time, delays, I/O configuration for the camera. These user sets can be loaded at runtime. In addition, you can specify which setup is loaded as default when the camera is switched on.

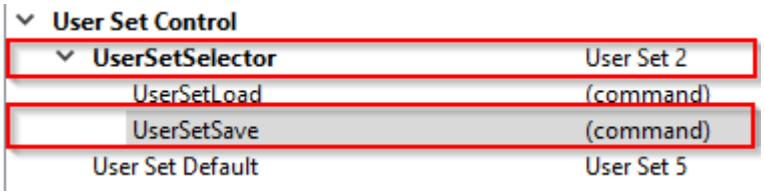
Load a user set

With UserSetSelector a user set can be selected. Select the desired user set and press UserSetLoad (command) twice to load the user set. The following example loads user set 2.



Save user sets

Select the user set to be saved in the UserSetSelector and save it with the UserSetSave command.



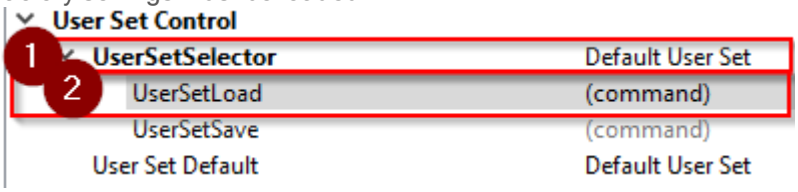
Set a user set as default

Use User Set Default to select the user set that is to be loaded when the camera is started. Save this setting with UserSetSave (In the example below, user set 5 is saved as default).

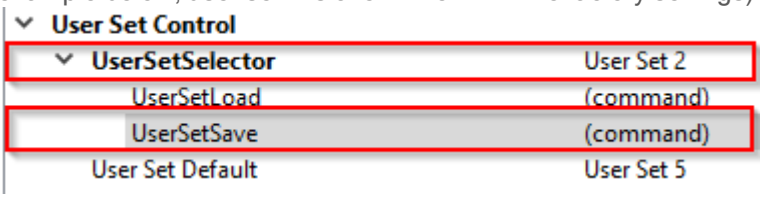


Reset to factory default

User sets can be reset to factory settings. This is a two-step process. First, the factory settings must be loaded:



Afterwards this factory default user set must be saved again as user set (in the example below, user set 2 is overwritten with the factory settings).



6.3 I/O Features

The SVCam cameras are equipped with several inputs and outputs, providing state-of-the-art control regarding input and output channels. All I/O functions are realized as modules. These functions can be connected in the GenICam tree.

6.3.1 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.

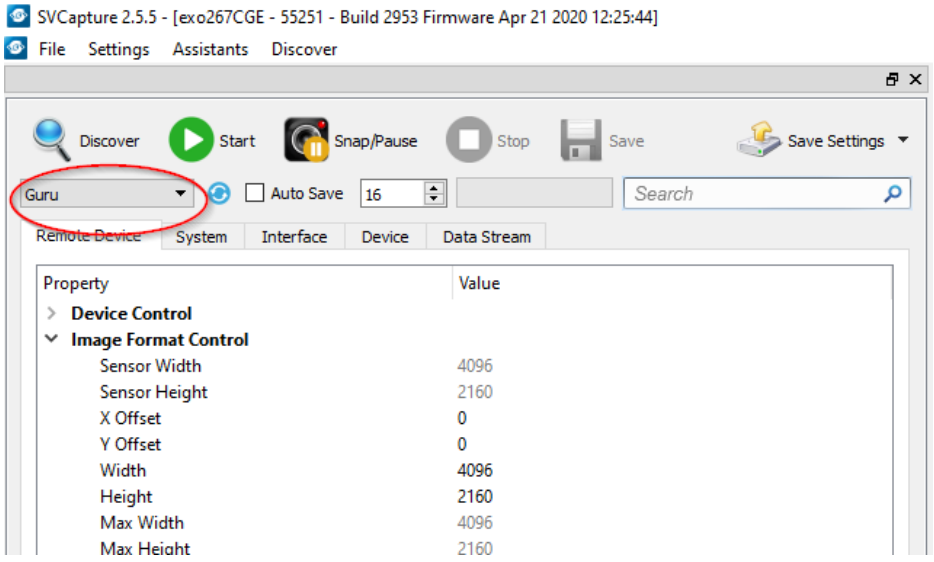
The GenICam™ standard consists of multiple modules according to the main tasks to be solved:

- GenApi: configuring the camera
- SNFC: Standard Feature Naming Convention, a catalog 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 the SVS-Vistek GenICam tree.

The GenICam properties are organized in views. The recommended way to view and adjust is by using SVCapture. If you want to have a full view of all adjustable GenICam items, activate the Guru mode. Beginner mode will show only most common attributes.



NOTICE All modfications in the GenICam tree will have immediate effect.

7 Specifications

INFO *The camera series specifications and spectral sensitivity characteristics are provided on the web site: https://www.svs-vistek.com/en/industrial-cameras/svs-svcam-search-result.php*

8 Dimensions

INFO

All length units in mm.
Find the technical 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

9 Terms 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	
What to do in case of Mal-	Please contact your local distributor first.

function

10 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.

Table: 10-1: FAQ

11 Glossary of terms

Aberration	Spherical aberration occurs when light rays enter near the edge of the lens; Chromatic aberration is caused by different refractive indexes of different wavelengths of the light. (Blue is more refractive than red)
ADC	Analogue-to-Digital Converter, also known as A/D converter
Aperture	In optics, Aperture defines a hole or an opening through which light travels. In optical system the Aperture determines the cone angle of a bundle of rays that come to a focus in the image plane. The Aperture can be limited by an iris, butit 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), whereafter 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 usedtodetect & 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 mannr.
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 witheach 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" above
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 switcheing 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 sernsorsan AOI (area of interest) or ROI (region of interest) can be definedby selecting the area to be read. This leads to increased frame rate.
Pixel clock	The base clock (beat) that operates thesensor 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 refered as raw in ist 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 camears, e.g. for “freezing” the image capture of fast moving objects. Can often be a substitute for the electronic shutter of the image sensor. Certain industrial cameras have dedicated in-camera output drivers for precisely controlling one or more strobe lights.

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

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