SVS-VISTEK

a **TKH Vision** brand

SWIR
SHORT WAVELENGTH INFRARED

CXP-12

10 GiGE™ VISION

Manual SWIR series

exo990MGE, exo990MU3, exo991MGE, fxo990MCX, fxo992MCX, fxo992MCX-T, fxo992MXGE, fxo992MXGE-T, fxo993MCX, fxo993MCX-T, fxo993MXGE, fxo993MXGE-T

A TKH TECHNOLOGY COMPANY

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1 General information

1.1 Company information

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1.1.1 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 has been produced with care and has been thoroughly tested. In case of any complaint, contact your local SVS-VISTEK distributor. You will find a list of distributors in your area on www.svs-vistek.com

1.1.2 Copyright notice

The specification is subject to change without notice in advance. The brand and product names are trademarks of their respective companies. Any configuration other than original product specification is not guaranteed.

1.2 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.

1.2.1 Registered trademarks

In this manual the following registered trademarks may be used:

- GenICam®
- Microsoft® and Windows®
- Intel®
- NVIDIA® Rivermax®

Throughout the manual, these trademarks are not specifically marked as registered trademarks. This in no way implies that these trademarks can be used in another context without the trademark sign.

1.2.2 Conformity and use

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These requirements are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions given in this guide, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will have to correct the interference at its own expense.

NOTICE You are herewith cautioned that any changes or modifications not expressly approved in this description could void your authority to operate this equipment.

1.2.3 Rules and regulations for 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").

1.2.4 Rules and regulations for Europe

This device is CE tested, the following rules apply:

- EN 55032:2015
- EN 61000-6-2:2019

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

- 2011/65/EU
- 2015/863/EU

All products of SVS-Vistek GmbH comply with the recommendation of the European Union concerning RoHS rules.

1.2.5 Warranty and non-warranty clause

NOTICE The camera does not contain serviceable parts. Do not open the body of the camera. If the camera has been opened, the warranty will be void.

NOTICE The camera has to be used with a supply voltage according to the camera’s specification. Connecting a lower or higher supply voltage, AC voltage, reversal polarity or using wrong pins of the power connector may damage the camera. Doing so will void warranty.

Our warranty does not protect against accidental damage, loss, or acts of nature.

INFO *SVS-Vistek GmbH cannot be held responsible for the loss of data. We recommend a backup plan.*

1.3 Supplements

For customers in Canada

This apparatus complies with the Class A limits for radio noise emissions set out in Radio Interference Regulations.

Pour les utilisateurs au Canada

Cet appareil est conforme aux normes Classe A pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

Life support applications

The products described in this manual are not designed for use in life support appliances or devices and systems where malfunction of these products can reasonably be expected to result in personal injury.

NOTICE

SVS-Vistek GmbH customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify SVS-Vistek GmbH for any damages resulting from such improper use or sale.

1.4 Tips and notes

This manual contains notes that help to avoid data loss or camera damage, and tips that provide information to improve handling the camera. They are marked as follows:

Tips

INFO

Provides information that may help to improve camera handling or avoid data loss.

Notes

NOTICE

Provides information to avoid damage to the system.

1.5 Support

In case of issues with the camera we are happy to help. For being able to help you in a fast and efficient way, we ask you for a description of the issues using camera in your support request.

- Put your support request to us via the support form: https://www.svs-vistek.com/en/support/svs-support-request.php
- Fill the form with information about the camera model, the frame grabber model, and operating system. Our support team will come back to you.

2 The SWIR camera series

The SWIR camera series is based on the EXO and FXO camera series and offers an extremely wide usable spectral range of 400-1700 nm with the Sony SenSWIR sensor, thereby extending the spectrum the human eye can see of 400-750 nm. Highly efficient thermal management of the housing is the basis of the outstanding dynamic range and homogeneity of the image.

The integrated 4-channel strobe controller supports complex illumination and analysis scenarios.

2.1 10 GigE Vision features

The 10 GigE interface is a cost-effective, easily scalable and network-able successor to the proven 1 GigE standard. 10 GigE keeps the 1 GigE benefits in network topology. Network access is transparent.

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 heat dissipation in 10 GigE devices
- Reduced cable lengths

By using high-quality (CAT6 and better) cables, cable lengths of up to 100 m are possible. However, the increased power dissipation still will result in slightly larger camera housings.

2.1.1 Speed is king

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

2.1.2 Optimized network adapter tuning

For best performance on Windows, 10 GigE adapters still need some manual tuning (refer to "Optimal network adapter settings" on page 1).

INFO *All 10 GigE and 25 GigE interface cards require Windows 10 or later. Latest Linux versions are supported as well.*

2.2 CXP-12 features

CoaXPress-12 (CXP2.0) is the currently the best option regarding high speed high volume data transfer for imaging. However, as opposed to network-ready cameras, the interface requires a frame grabber on the PC side.

The CoaXPress standard includes features like power-over-CoaXPress (PoCXP) already in the standard definition.

The main advantages of CXP-12 are:

- 12.5 Gbit/s transfer rate per line
- Lines can be teamed
- Provides data and power on a single line (PoCXP)
- Thin and flexible 75 Ohm coaxial cables
- 25 m data cable supported
- Low latency times
- Uplink speed 41.6 Mbit/s
- No-latency trigger over CXP (max. 300 kHz)
- DIN µBNC connector

INFO *When using the 4IO PWM outputs to drive your lights, you need an external power supply as PoCXP is unable to deliver the high currents requested by the lights.*

2.3 4I/O adds light and functionality

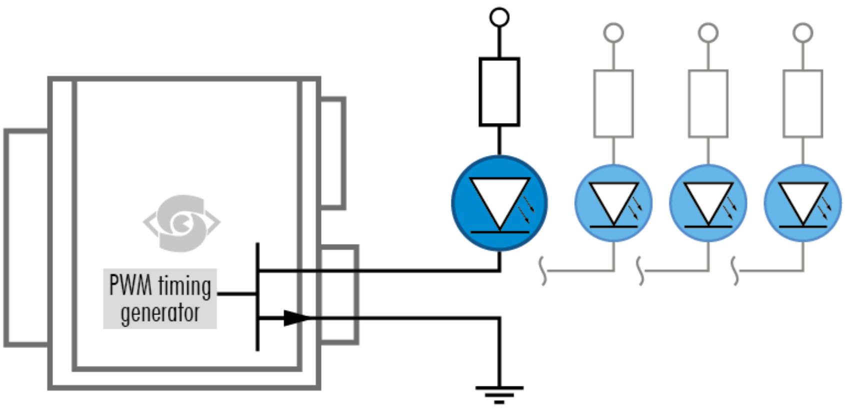


Fig. 2-1: Illustration of 4I/O concept of switching LEDs

Your SVS-VISTEK camera is equipped with the 4I/O-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. 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 functionality with AND, OR and timers
- Safe trigger (debouncer, prescaler, high low trigger)

2.4 Lens control

Various SVCam models are supporting adjustable lenses. Focus and iris of the lens can be controlled from within the camera GenICam tree. Depending on the camera series, a special Y-cable is required, contact sales@svs-vistek.com.

The following variable lens types are supported:

- MFT (Micro Four Thirds) lenses (in Tracer series) have full support of lens focus, iris and zoom. Only available in Tracer models no options selectable in GenICam tree.
- Birger mount: Ask sales@svs-vistek.com for information of usability and restrictions of the Birger adapter.
- Varioptic liquid lens: Control of extremely fast focus cycles. Make sure sensor diameter is covered by lens.
- Canon EF/EF-S lens: Focus and iris control is supported. Use Canon lenses with machine vision applications. The SVCam-EF lens adapter can be acquired from SVS-VISTEK.

INFO *Lens control (except MFT) will make use of the serial ports of the Hirose connector.*

2.4.1 Use of Varioptic liquid lenses

We are supporting Varioptic liquid lenses. The liquid lens support does variable focus only, zoom and aperture control are not existing with the Varioptic liquid lens. You need a special serial cable with Hirose for connecting the lens to the camera, please ask your dealer. Being extremely fast and robust, the liquid lens is best choice as long as variable focus is sufficient in the application and you do not need a full lens control with aperture control and zoom functionality. In case of full lens control requirement, please refer to the TRACER series.

The lens is powered and controlled by the camera. The lens can be controlled via SDK functions or more easily via GenICam property.

Liquid lenses do have some advantages and disadvantages compared to glass optics:

- Advantages of liquid lenses
  - Extremely robust to mechanical shock (best choice for fast moving robotics) and acceleration
  - Fast focus (often significantly faster than 10 ms under common conditions)
- Disadvantages of liquid lenses
  - Limited resolution
  - High chromatic aberration

- Any acceleration (gravitational as well as acceleration from movement) might increase spherical aberration as long as the force is working (will disappear if force has ceased within several 10 ms)

2.4.2 Use of Canon lenses

We are supporting Canon EF lenses. The SVCam-EF lens adapter gives you the possibility to mount Canon EF lenses with full control of focus and iris. Canon lenses are well known for their optical excellence and combine perfectly to high resolution machine vision cameras.

This camera series does have the firmware support already included in the GenICam tree and provides you with Canon lens control in all GenICam based software packages.

3 Connectors

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

3.1 GigE IP setup

GigEVision cameras require a working Gigabit Ethernet 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.

3.1.1 Automatic camera detection

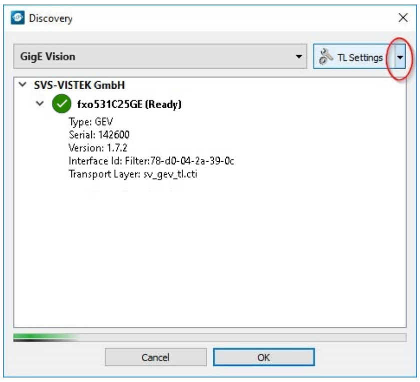
By default, SVS-VISTEK GigE Vision cameras acquire a valid network address via LLA or DHCP from the network, provided the router is set up to distribute accordingly.

INFO *Make sure to have valid network protocol with jumbo frames enabled on your host computer (refer to* *"Jumbo frames" on page 16**).*

- For finding and accessing the camera, start SVCapture on the computer. As soon as the camera has finished booting, the available camera is displayed in the main window.

NOTICE After powering up, the camera fxo992 takes about 256 seconds to be detectable by the system.

- Select the camera and click OK.

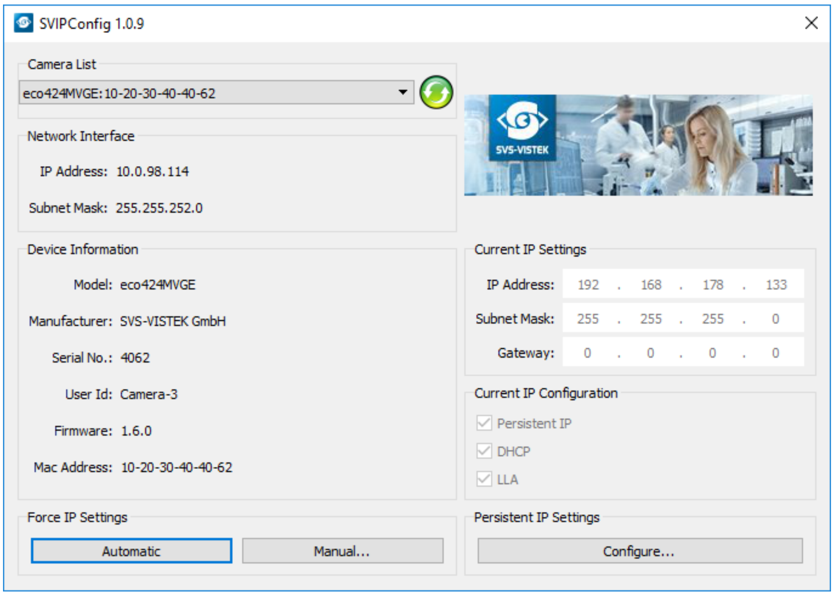


Manual configuration

Manual IP configuration can be required for the following situations:

- Assigning a unique IP address (make sure the new address valid in the current subnet)
- Saving a specific address as a permanent address of the camera (persistent)

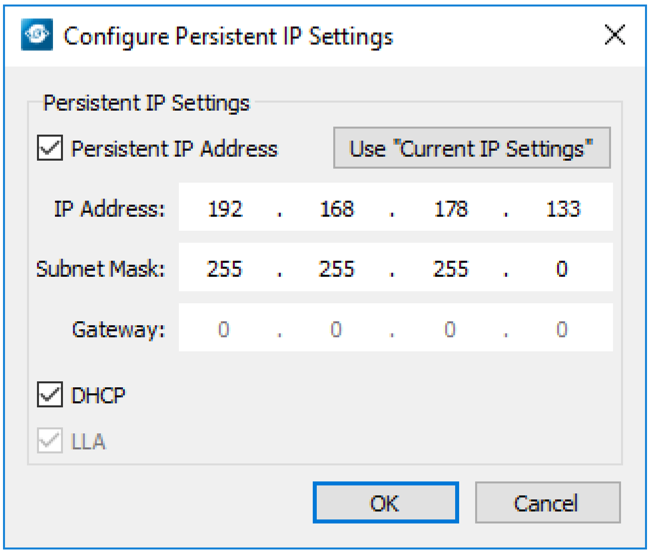
- Saving automatic address mode or the manually configured address of the camera
- To change automatic address or to go back to automatic mode, configure the IP settings in the drop down menu **TL Settings**.



Enabling a persistent IP address

A persistent IP address is used to always connect the camera with a specific IP address, even when the camera or the network is rebooted, thereby overriding the dynamically assigned IP address in a DHCP network setting.

- Select **Configure...** in the section "Persistent IP Settings".
- Enable “Persistent IP Address”.



- For assigning the currently used IP address, select Use "Current IP Settings".
- To manually assign an IP address, enter the IP address of the camera and the subnet address.

Make sure the IP address is unique within the network.

- If necessary, provide the network address of the gateway server.
- Select OK.

3.2 GigE Vision

3.2.1 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 is assigned to the camera.

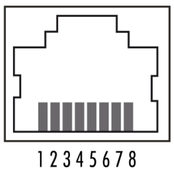


Fig. 3-1: RJ45 socket connector

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. 3-2: Data reduction with jumbo frames

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

Lost packets

In accordance with the PCT 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 cards (NIC).

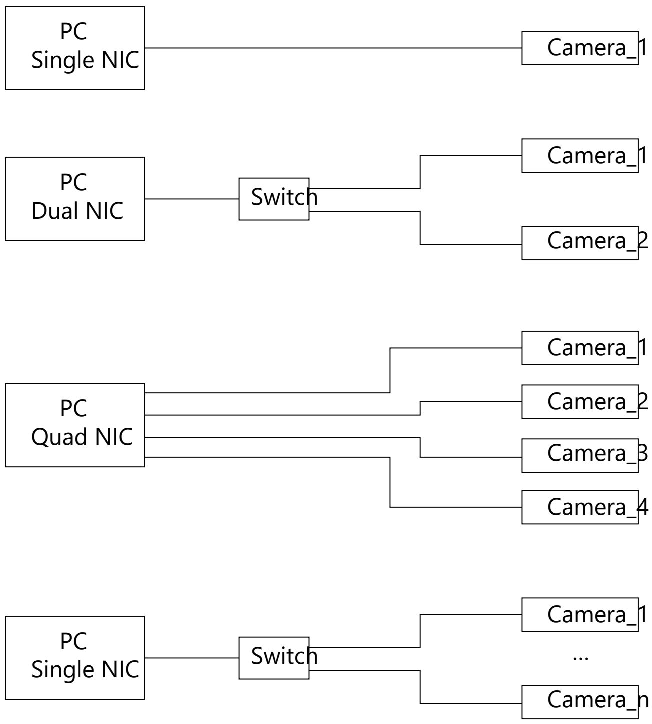


Fig. 3-3: Connecting multiple cameras on multiple network interface controllers

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.

INFO *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.

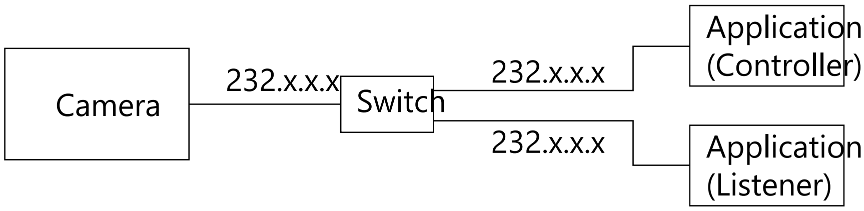


Fig. 3-4: Camera casting to multiple receivers (multicast)

3.2.2 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.

3.3 10 GigE limitations and issues

10 GigE is a high performance network protocol. Make sure your computer performance is sufficient to digest the amount of data in terms of software and in terms of hardware components, especially the combination of motherboard and network interface card (NIC).

3.3.1 Compatibility to nBase-T

Our 10 GigE cameras supports 1 GigE, 2.5 GigE and 5 GigE (nBase-T), upgradeable with firmware update. At the moment of writing, only some models with latest firmware support nBase-T and 1 GigE. The FXO series will be the first one to provide this feature.

3.3.2 Bandwidth limitation

With certain computer motherboards / 10 GigE NIC combinations, a reliable data connection might not be possible. Frame drops are the result.
To get rid of these frame drops, the 10 GigE interface of the camera does have an adjustable bandwidth limit. Reducing the bandwidth will reduce your maximum frame-rate, obviously. It might be not sufficient to reproduce stable bandwidth, though.

A solution might be a different motherboard / NIC combination together with the latest software and firmware update of your NIC and motherboard manufacturer. Latest firmware versions improve data stability.

Special NICs support 100% connections without frame drops.

3.3.3 Recommended setup

It is recommended to use a 10 GigE card with grabber capabilities. All SVS-VISTEK certification setups are using this kind of cards.

Contact sales@svs-vistek.com for details and more recommendations.

- Use high performance PC (such as Intel Core i5 or Core i7 with 16 GB, and mainboard with PCIe Gen 3)
- Use direct NIC-to-camera connections, no switches.

Reliable 10 GigE connections are reported with

- NVIDIA Mellanox ConnectX-5 (Single / Dual port 100 Gb/s Ethernet adapter)
- NVIDIA Mellanox ConnectX-6 (Single / Dual port adapter with support for 200 Gb/s Ethernet)

3.4 CoaXPress-12

The cameras support an extended CoaXPress-12 (or CoaXPress 2.0) interface with connectors and a bandwidth of up to 12.5 Gbit/s per line.

The connectors are µBNC connectors. For cables, an impedance of 75 Ohm, RG187 is recommended. SVS-Vistek GmbH uses connectors according to JIIA standard.

The CoaXPress standard supports camera control and power over CoaXPress (PoCXP).

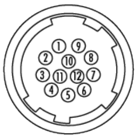
INFO — *It is recommended to use the frame grabber power supply over CoaXPress (PoCXP).*

3.5 Hirose I/O connector

The Hirose™ connector provides power, input and output signal access.

INFO — *Maximum power output is max. 2 A.*

Hirose Pinout



Pin	**Signal** ECO, ECO2, EVO, HR (CL medium, GigE only)	**Signal** EXO, FXO, HR (CL De., CXP), SHR	**Signal** 4 I/O for option ECO
1	V IN- (GND)	V IN- (GND)	V IN- (GND)
2	V IN+ (10 – 25V)	V IN+ (10 – 25V)	V IN+ (10 – 25V)
3	RxD (RS232) not available for PoE versions	IN 4 RxD (RS232)	not connected
4	TxD (RS232) not available for PoE versions	OUT 4 TxD (RS232)	not connected
5	IN 1 (0 – 24 V)	IN 1 (0 – 24 V)	IN 1 (0 – 24 V)
6	IN 2 (0 – 24 V)	IN 2 (0 – 24 V)	IN 2 (0 – 24 V)
7	OUT 1 (open drain)	OUT 1 (open drain)	OUT 1 (open drain)
8	OUT 2 (open drain)	OUT 2 (open drain)	OUT 2 (open drain)
9	IN 3+ (RS422)	IN 3+ (opto IN +)	IN 3 (0 – 24 V)
10	IN 3 – (RS422)	IN 3 – (opto IN –)	IN 4 (0 – 24 V)
11	OUT 3+(RS422)	OUT 3 (open drain)	OUT 3 (open drain)
12	OUT 3 – (RS422)	OUT 0 (open drain)	OUT 4 (open drain)
	Shielding	Shielding	Shielding

Fig. 3-5: I/O Hirose connector layout

Inputs and outputs connect via in the GenICam software tree to the appropriate actions (also refer to "Assigning I/O Lines – IOMUX" on page 1).

For detailed information about switching lights with the power outputs via GenICam, refer to "LED strobe control" on page 58.

Type	HR10A-10R-12P
Matching connector	HR10A-10P-12S

Table: 3-1: Hirose connector types

3.6 Using PoE (Power over Ethernet)

Ethernet lines are able to provide the necessary power to operate Ethernet devices via Power over Ethernet (PoE). Some GigE / 10 GigE / 25 GigE camera models are equipped with PoE. Refer to your model specification regarding your camera model.

PoE will supply the camera only. To supply the outputs, an external dedicated power supply is required.

There are 2 possibilities to get cameras operated via PoE:

- Use a PoE-enabled switch or network port
- Use a standard switch together with a PoE-injector

Depending on maximum power delivery, there are several standards for PoE:

- PoE (802.3af up to 12,9 W)
- PoE+ (802.3at up to 25.4 W)

INFO *The EXO series uses PoE standard.*
FXO, HR and SHR series comply to PoE+ standard.

3.7 Using PoCXP (Power over CXP)

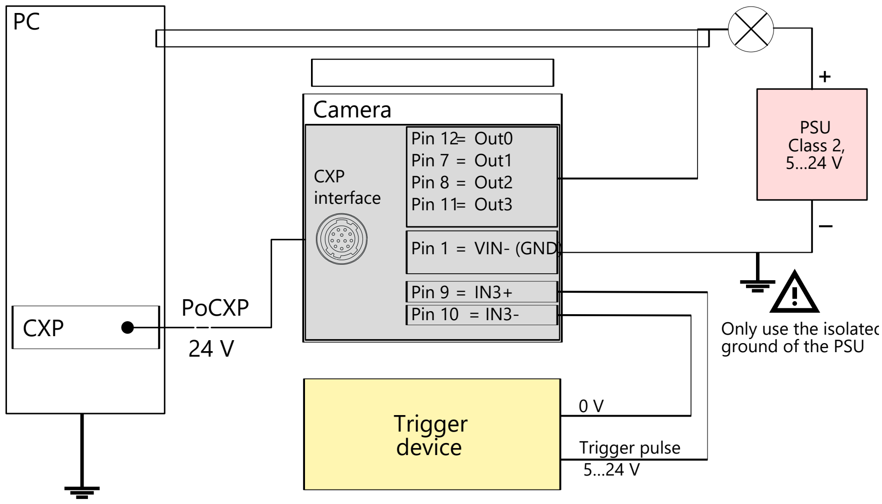


Fig. 3-6: Connection diagram for PoCXP output

- *The camera is grounded via the frame grabber card in the PC and the CXP connection.*
- *For pins and signals, refer to* *"Hirose I/O connector" on page 19**.*

- If power is supplied via PoCXP, the external power supply unit for the output must be grounded. To avoid a ground loop, use an isolated power source (PSU).
- Do not connect Pin 2 (V_{IN}+).
- To trigger the camera via the inputs, we recommend using the optocoupled input 3.
- You may also use input 1 or 2, but then an isolated power source for your trigger device is required.

4 Getting started

4.1 Find camera specs

For technical data sheets visit https://www.svs-vistek.com/en/industrial-cameras/svs-cameras.php .

Search for a specific camera, using series and model name or by using the SVCam camera finder. The details and download section provides you with manuals, drawings, as well as software and firmware.

4.2 Power safety

INFO *For safety reasons, for protection of the camera and users, use certified power supplies (Low power supply according IEC 62368-1) only. Refer to specifications for your camera model. Appropriate power supplies can be ordered at SVS-Vistek GmbH.*

NOTICE The power supply must be easily accessible at all times! For Power specs, refer to the data sheet of your model.

4.3 Connect the camera

INFO *When using your own power supply (voltage range 10…25 V DC), see also Hirose 12-pin layout of the power connector (see "Hirose I/O connector" on page 19). For power input specifications refer to the technical data information on our website.*

External power supply for USB3 Vision, CoaXPress (if PoCXP enabled) or PoE cameras is not needed. Using a separate power on the Hirose connector reduces load on the data port. The external power on the Hirose connector is the preferred power source.

The power up sequence is defined as follows:

- Power over USB3, CoaXPress port or GigE port (with PoE) or on the Hirose connector will power on the camera.
- If power is found on the Hirose connector, camera power supply will switch to the Hirose connector.
- If Hirose power supply is cut, camera power supply will switch back to power over USB3, PoE or power over CXP supply.

INFO *Camera power supply is not powering 4I/O LED lights.*

Connecting the camera

The camera does not have a power switch. The camera is powered on as soon power is available to the camera via the Hirose connector or through the interface cables.

- Connect the power supply with the Hirose connector.
- Optionally, connect the interface cables for PoE or PoCXP.

NOTICE **After powering up, the camera fxo992 takes about 256 seconds to be detectable by the system.**

Disconnecting the camera

For making sure the camera is not connected to power

- Disconnect Hirose plug from camera
- Disconnect power plug from power AC wall outlet to disable the DC power supply.

4.4 Cooling

During operation, the heat from the camera's sensor dissipates to the housing. To maintain reliable performance, it is crucial to adhere to the operating temperature range specified in the camera's technical data.

In case of overheating, the camera is automatically switched off and the communication between camera and PC is interrupted.

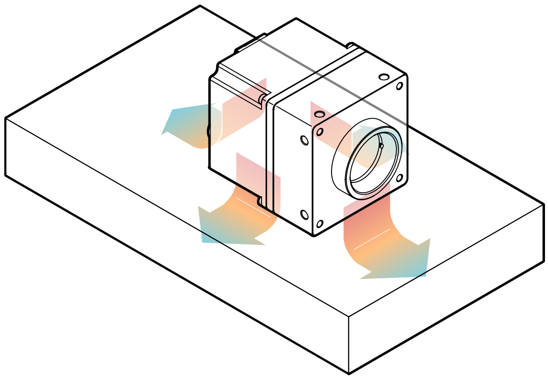
NOTICE **Durability of the camera is reduced when being operated in an environment that is constantly exceeding the maximum permissible operating temperature.**

- Install the camera so that the housing openings at the back or at the sides are not blocked and ventilation is possible under all operating conditions.
- Check the unhindered air flow after installation of surrounding components such as cables.

Additional cooling

If the temperature consistently exceeds the maximum operating temperature specified for the camera, additional cooling measures are necessary. This can be achieved by:

- Mounting the camera housing to a heat sink or other heat-dissipating material. For optimal cooling efficiency, ensure that the contact area between the camera housing and the cooling material is as large as possible, allowing for better heat transfer.



In addition, vibrations will be minimized within the entire system.

- If available, activating the built-in fan or adjust the fan control threshold (for details, see "Fan control" on page 53).
- If available, activating the built-in thermoelectric cooling feature.
- Using an air- or water-cooling system.

INFO *Even if the housing temperature remains below the maximum operating temperature, using additional cooling is recommended to ensure optimal image quality and power efficiency.*

4.5 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:

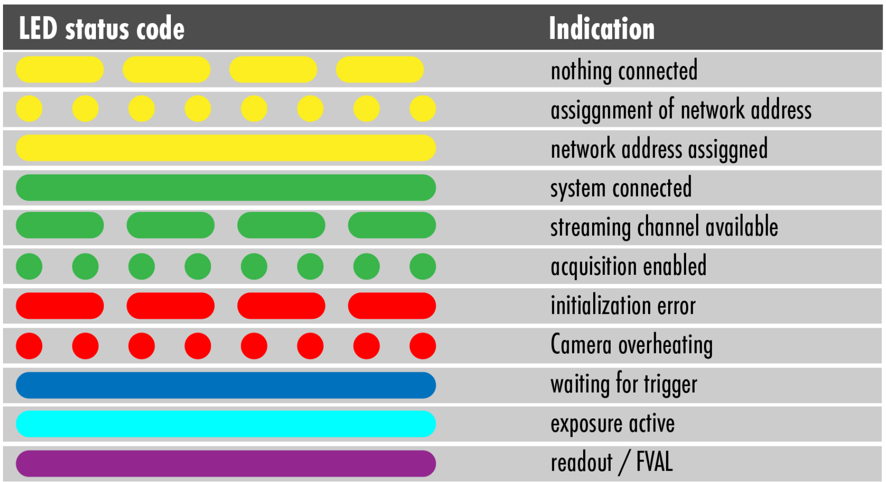


Fig. 4-1: Camera status LED codes

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, refer to the specifications area of our website with your exact model.

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

5.1 Basic features

5.1.1 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: 5-1: 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. 5-1: Noise caused by too much gain

Auto gain

INFO *For automatic adjustment of gain refer to auto exposure (see "Auto exposure" on page 36).*

When using auto-gain with steps of gain, the non-continuous 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.

5.1.2 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" on page 26).

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

5.1.3 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.

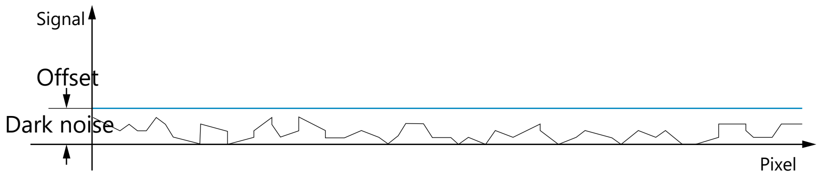


Fig. 5-2: Dark noise cut off by the offset

Most noise is proportional to temperature. The offset is automatically regulated by the camera sensor to compensate for the surrounding temperature changes by referencing specific pixels as „black“, i.e. never exposed to light. 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.

5.1.4 Image flipping

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

Image flipping is referred to in the GenICam specifications and hence in the software as follows:

- Reverse X: Flips the image along the Y axis horizontally, hence "Horizontal flipping"
- Reverse Y: Flips the image along the X axis vertically, hence "Vertical flipping"

Fig. 5-3: Original image

Fig. 5-4: Horizontal flip

Fig. 5-5: Vertical flip

5.1.5 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.

INFO — *Binning is only used with monochrome CCD sensors.*

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

The selected binning value describes the number of combined photosensitive cells, where the following value settings apply:

- Value 1 equals the value *Binning Off* from previous versions.
- Value 2 equals the previous value *Binning On* (combination of 2 cells).
- Additionally, value 4 combines four cells horizontally or vertically.

INFO — *Binning is now solely executed in the image processing chain of the FPGA and never in the sensor.*

Furthermore, it is possible to set the binning mode between *Average* or *Sum*:

- Average: The response from the combined cells will be the average value (Value: 0:
- Sum: The response from the combined cells will be added (Value: 1)

Vertical binning

Accumulates vertical pixels.

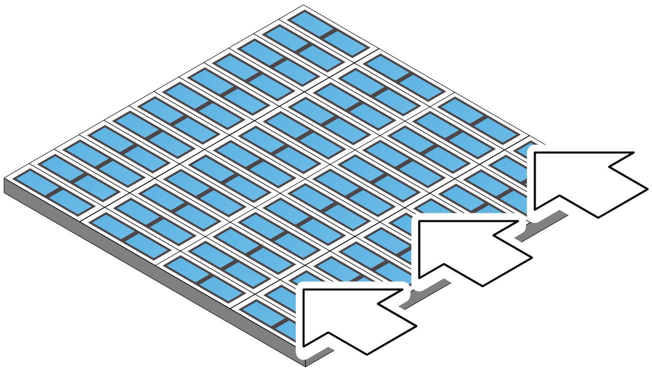


Fig. 5-6: Vertical binning

Horizontal binning

Accumulates horizontal pixels.

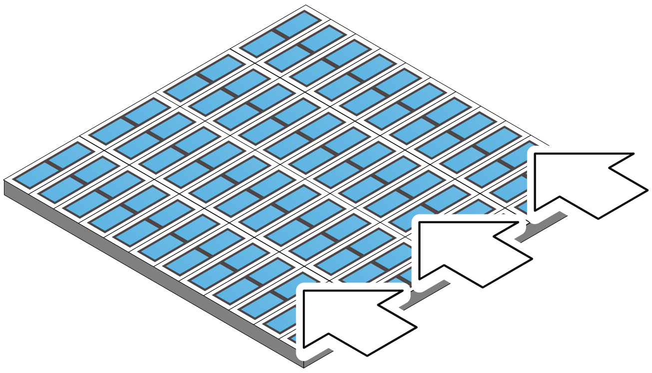


Fig. 5-7: Horizontal binning

2×2 Binning

A combination of horizontal and vertical binning.

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

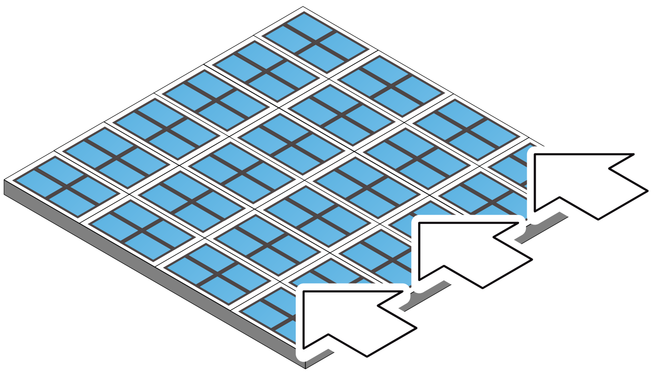


Fig. 5-8: 2x2 binning

5.1.6 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 48 for reducing data rate by reducing the region you are interested in.

Fig. 5-9: Horizontal decimation

Fig. 5-10: Vertical decimation

5.1.7 GenICam

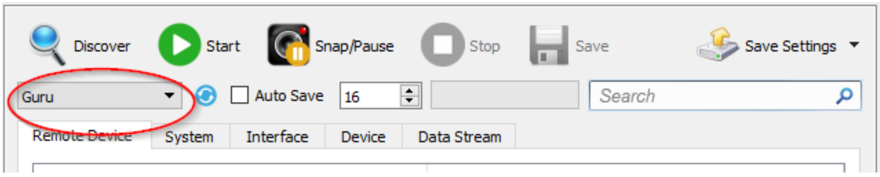
The GenICam standard provides a generic programming interface to control all kinds of cameras and devices. Regardless of the interface technology (GigE Vision, USB 3 Vision, CoaXPress, Camera Link, etc.) or implemented feature, the application programming interface (API) will always be the same. The SNFC makes sure the feature names are similar throughout the manufacturers, making it more easy to switch camera models.

The GenICam^{TM} 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 modifications in the GenICam tree will have immediate effect.

5.1.8 Trigger modes

To start capturing images, the camera has to receive a trigger signal. This trigger signal can be a software trigger, it might be an electric signal on the hardware I/O or it can be a timed trigger (sequence of images or "Precision Time Protocol" on page 54).

Software trigger

The camera exposure can be started via software. With some interface types like GigE and USB3 it is impossible to have a 100% precise software trigger. CoaXPress and Camera Link permit relatively precise triggering of the camera. If you need to have a precise trigger, usage of "External hardware trigger" on page 32 is recommended.

External hardware trigger

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.

INFO *Default input for trigger is Input1.*

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)

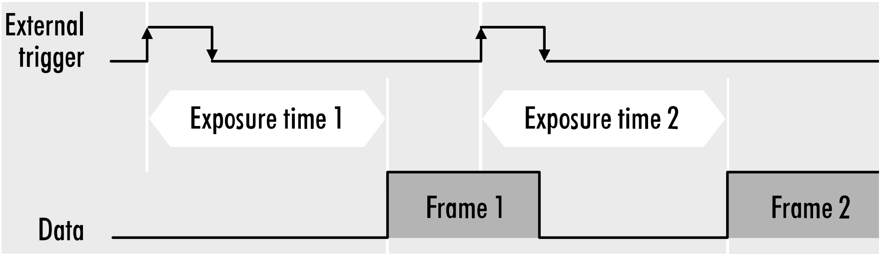


Fig. 5-11: Mode 2: External trigger with programmable exposure time (overlap)

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 persistent delay.

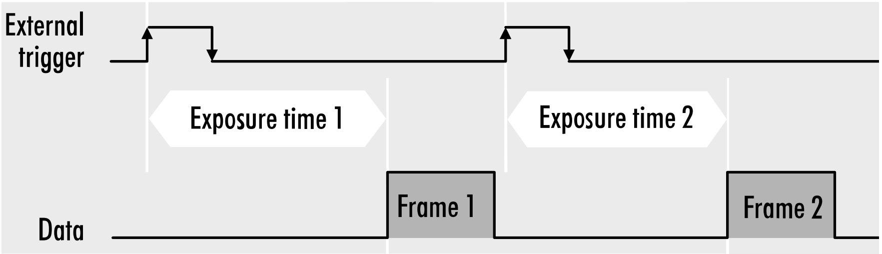


Fig. 5-12: Mode 2: External trigger with programmable exposure time (non overlap)

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

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

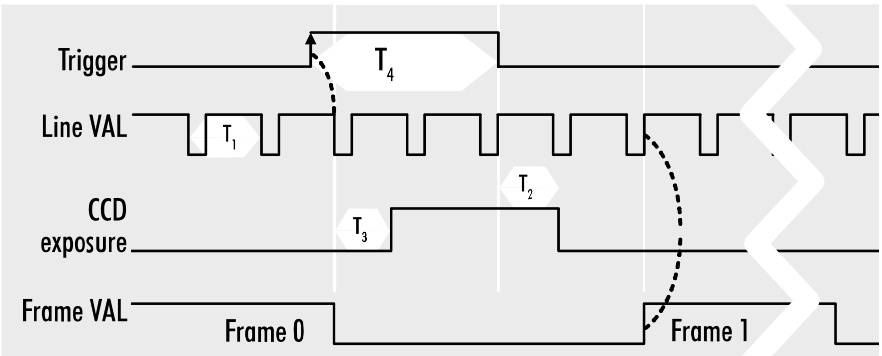


Fig. 5-13: Mode 1: External trigger with pulse width exposure control (overlap)

T_1	Line duration	T_2	Transfer delay
T_3	Exposure delay	T_4	Min. trigger pulse width

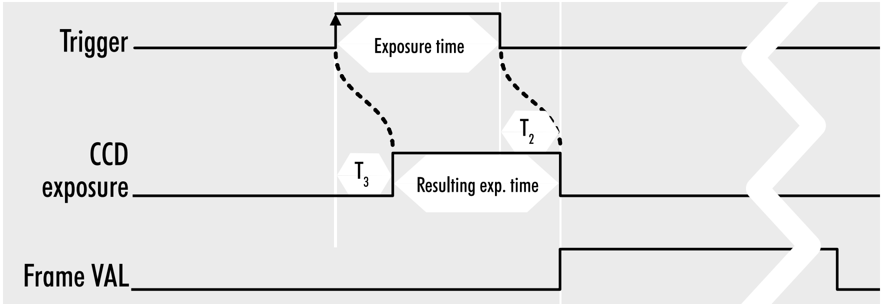


Fig. 5-14: Mode 1: External trigger with pulse width exposure control (non-overlap)

T_2	Transfer delay	T_3	Exposure delay

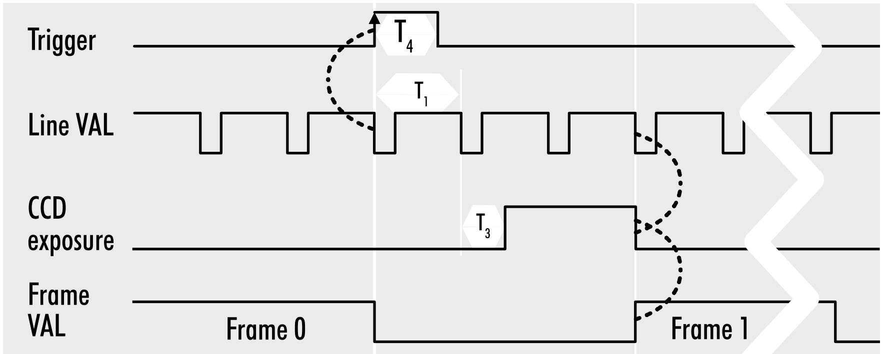


Fig. 5-15: Mode 1: External trigger with programmable exposure time (overlap)

T_1	Line duration	T_3	Exposure delay
T_4	Min. trigger pulse width		

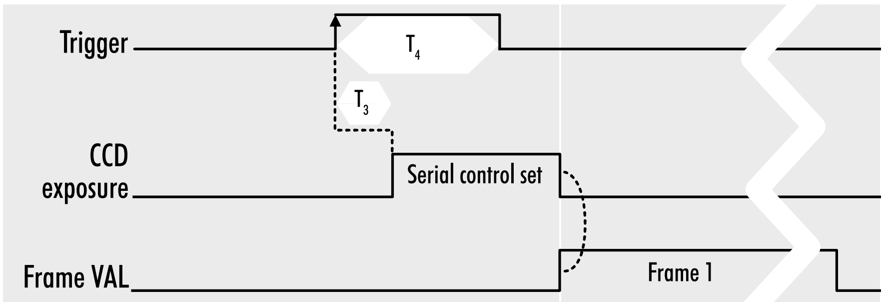


Fig. 5-16: Mode 1: External trigger with programmable exposure time (non-overlap)

T_3	Exposure delay	T_4	Min. trigger pulse width

5.1.9 Shutter modes

CCD and CMOS area cameras consist of pixels, ordered in lines and columns. All pixel are exposed to light and then read out to camera electronics.

Global shutter mode

- Global reset of all pixels
- All pixels start light integration at the same time
- All pixels stop integration at same time
- Readout line by line after exposure of whole frame is completed

5.1.10 Exposure

- For various exposure and timing modes, refer to "Basic capture modes".
- For combining various exposure timings with PWM LED illumination, refer to "Sequencer" on page 61.

Setting exposure time

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

5.1.11 Exposure speed

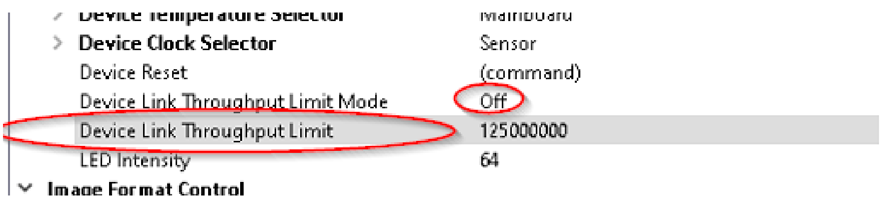
Frames per second, or frame rate describes the number of frames output per second (1/ frame time). Especially GigE and USB cameras cannot guarantee predictable maximum frame rates with heavy interface bus load.

Maximum frame rate might depend on:

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

Reducing throughput transmission speed

The throttling of the transmission speed is an SNFC-compliant packet-based traffic shaping and allows e.g. the connection of several cameras to one switch.



If the data rate resulting from the frame rate exceeds the throttle data rate with activated throttling, the 10 GigE interface automatically enters starts filling the memory. The large internal memory allows the camera to buffer many images. But as soon as the memory is full, frame drops are the result.

5.1.12 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.

5.1.13 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.

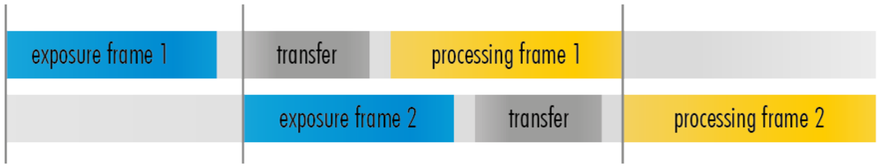


Fig. 5-17: Acquisition and processing time

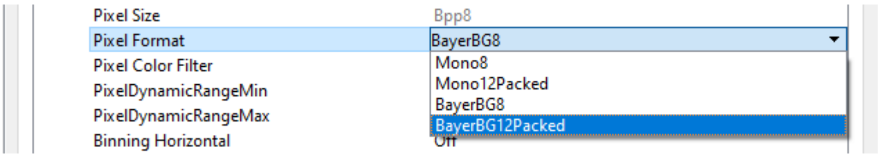
On the other hand, while processing and transferring the image the sensor might capture already the next frame.

5.1.14 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.*

Packed format

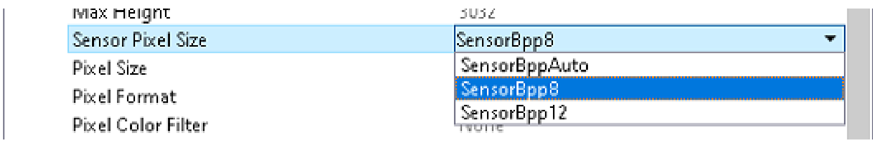
Some camera models support “packed” bitformats. Instead of using 16 bit per pixel (and transferring a lot of zeroes), 2 bytes contain more information than only 1 pixel.

For example, in the image above, “Mono12Packed” is supported. Every pixel has a bit depth of 12 bit. Information transfer has to be in 8-bit steps (8, 16, 24 etc). By packing, 2 pixel can be transferred in 3 bytes (24 bit) instead of 2 x 16 bit (4 bytes). This increases bandwidth by 25%. This packing does not affect image quality, but the image needs to be unpacked (with an SVCam SDK function, very fast) after image acquisition before the image can be processed.

NOTICE Unpacking has to be done manually, this is not a GenTL function. Thus, image acquisition in packed formats won’t be supported by most 3rd party software products.

Separated bit depth of sensor and camera

Some camera models are supporting separated bit depth adjustment of sensor readout and camera readout. Thus you can read in an image e.g. in 12 bit from the sensor, apply a 12-to-8 bit look-up table and read from the camera as an 8 bit image.



By default, sensor pixel size is "SensorBppAuto" and should follow the adjustment of pixel size.

The final bit depth exported by the camera (camera readout) is adjusted with pixel size.

Bit depth and brightness with Sony Gen 4 sensors

The FXO series (XGE / CXP) shows different brightness when switching between 8-bit and 12-bit mode (SensorPixelSize). If you read sensor 8-bit, the upper 4 bits of the sensor range are cut off.

8-bit mode sensor pixel size is 50 % faster, but the (bit-cut-off) reduced full well capacity also results in a higher noise percentage. To use the full dynamic range of the sensor, the sensor must be read out 12-bit, the transmission can then be done with (reduced) 8- or 12-bit, as required.

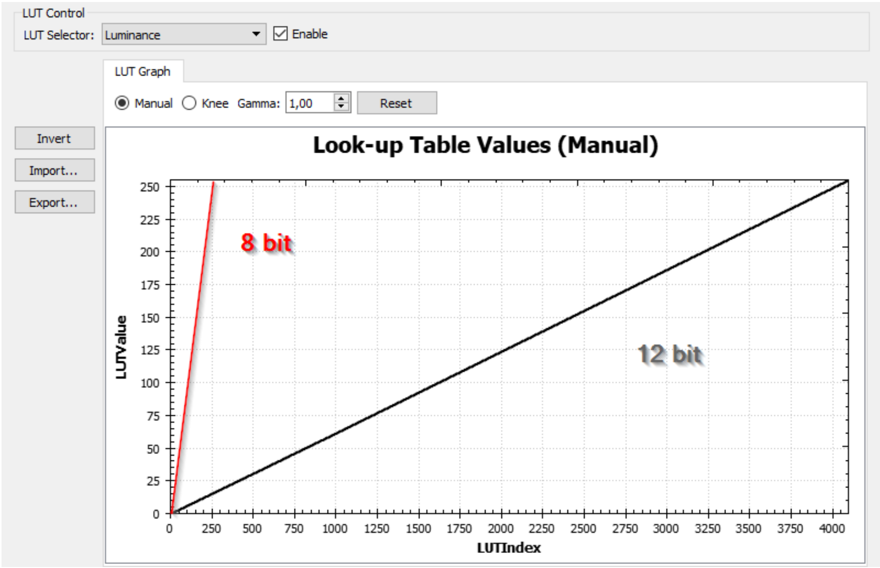


Fig. 5-18: Bit depth and brightness with Sony Gen 4 sensors

The red 8-bit curve above is the result of the sensor 12-bit capacity with the used 8-bit range. The black 12 bit curve is an applied linear 12-to-8 bit look-up table.

5.2 Camera features

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

5.2.1 2-Point NUC (non-uniformity correction)

The 2-Point Non-Uniformity Correction (NUC) is a calibration process to compensate for pixel-to-pixel variations in the sensor output. This process involves capturing several images at both a very bright and dark exposure. By comparing these images, the camera can determine and correct for discrepancies in pixel response, resulting in a more uniform and accurate output. Regularly performing 2-Point NUC ensures optimal output, particularly in applications where precise image accuracy is critical.

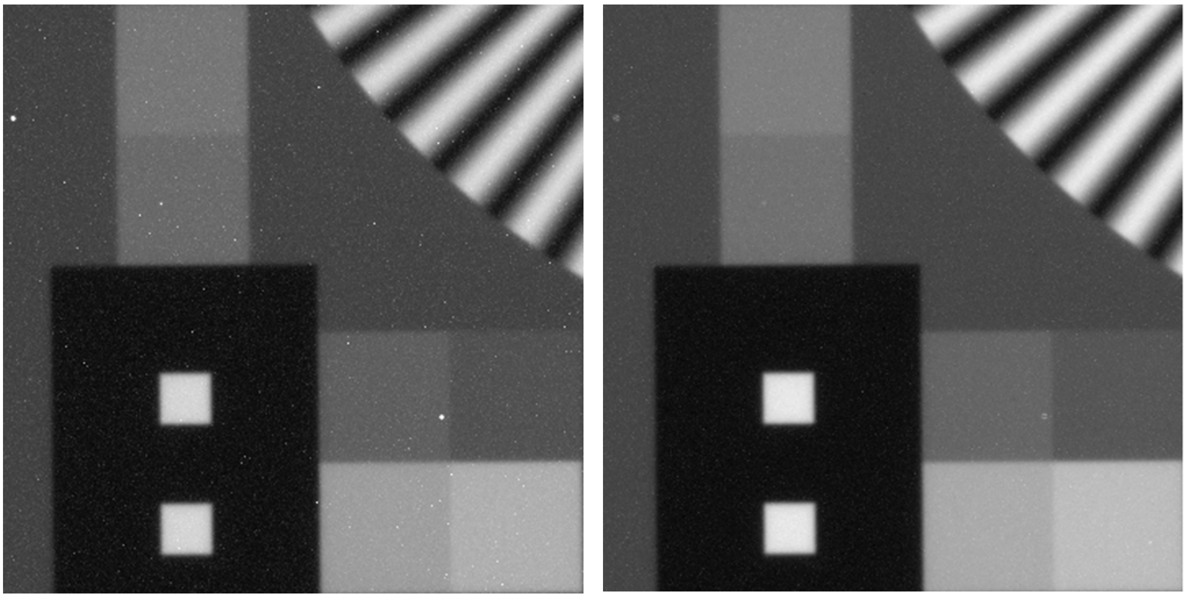


Image correction off	NUC on

Fig. 5-19: NUC example and comparison

The camera comes with two factory-calibrated NUC profiles stored in the shading maps prior to delivery. One shading map is provided empty for the user to create their own custom profile.

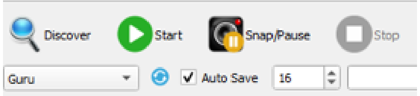
Shading map	Exposure	Comment
Shading Map 0 (default setting)	2,5 ms	Created at factory
Shading Map 1	25 ms	Created at factory
Shading Map 2	User defined	Reserved for user

The following sections describe how to set a non-uniform correction reference on the camera system.

Creating images

- Install SVCam SDK Kit.
- Connect the camera to the frame grabber or network card.
- Create a folder for dark images and a second folder for bright images.
- Open SVCapture and select the tab "Remote Device".
- In section **Shading**, set **Shading Map Selector** to "Shading Map 2".
- Disable the following image correction features:
  - In section **Defect Pixel Correction**, set **Control** to "Off".
  - In section **Shading**, set **Shading Control** to "Off".
- Open **Settings** > **Auto Save Format** and select "BMP" as the file format.

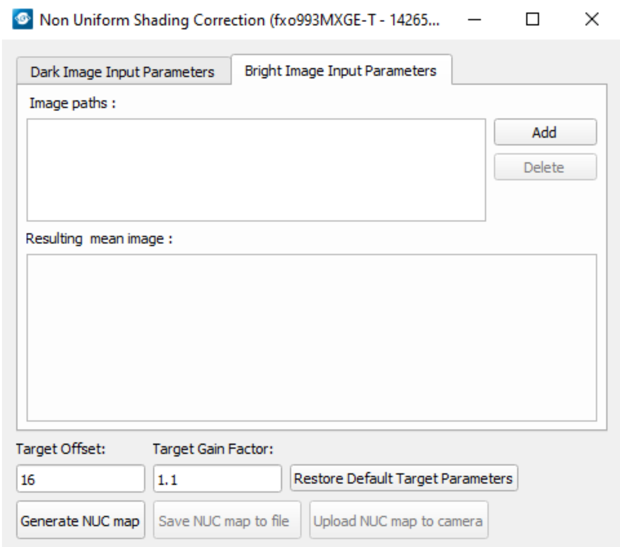
- Enable **Autosave** and set the number of images to "16".



- Specify the location of the folder for the dark images.
- In section **Acquisition Control**, set **Acquisition Frame Rate** to 1 Hz.
- Set the desired **Exposure Time**.
- Close the camera lens mount with the lens cap.
- Select **Start** and create 16 dark images.
- Click Stop and disable **Autosave**.
- Remove the lens cap.
- Place a white sheet of paper in front of the camera lens or place the lens in front of a white wall. *The sheet should be homogeneously illuminated and unfocussed (no details visible).*
- Adjust the aperture so that an image with a grey value of about 200 is obtained. The current grey value is displayed in the bottom bar ("Mono: ...").
- Enable **Autosave** and set the number of images to "16".
- Specify the location of the folder for the bright images.
- Select **Start** and create 16 bright images.

Performing the correction

- Open **Assistant** > **Shading correction** and select **Generate Map...**.



- Select the tab "Dark Image Input Parameters", select **Add**, and select the folder with the dark images.
- Select the tab "Bright Image Input Parameters", select **Add**, and select the folder with the bright images.

> *Depending on the camera settings, you may alter the **Target Offset** and the **Target Gain Factor**. It is recommended to use the default values.*

- Select **Generate NUC map**.

- After the NUC map is generated, select **Upload NUC map to camera**.
- Enable the following image correction features:
  - In section **Defect Pixel Correction**, set **Control** to "On".
  - In section **Shading**, set **Shading Control** to "On".

5.2.2 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 behavior 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 must 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 run-time losses.

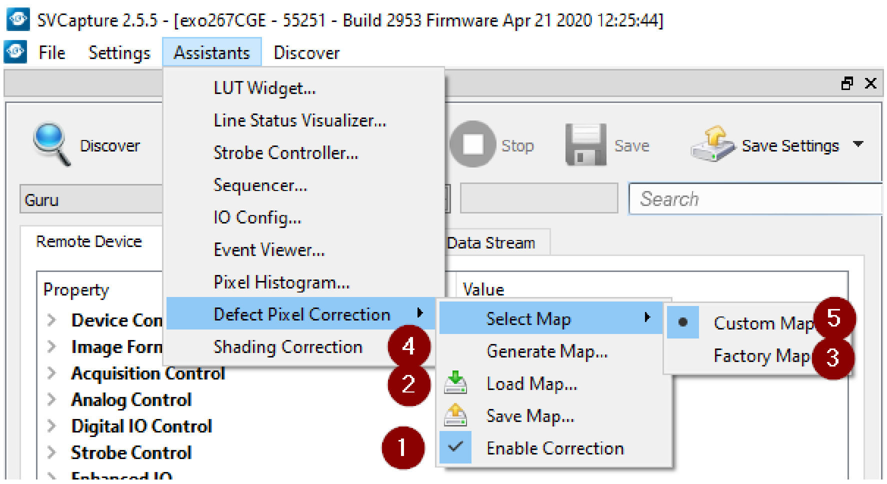
More sophisticated algorithms can be used by software.

Fig. 5-20: Illustration of a defect pixel

Procedure of pixel correction

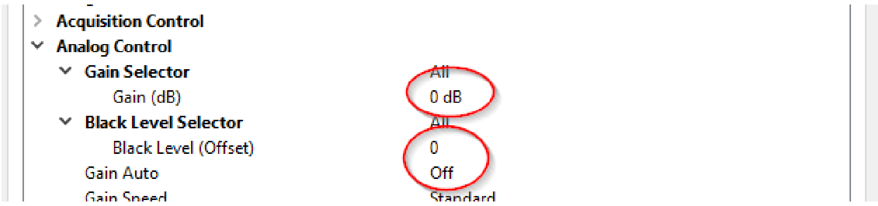
SVCapture is the tool to generate pixel correction maps. The pixel correction assistant provides everything to create, load, enable and restore defect pixel creation maps.

Defect pixel correction is possible with certain models only. See camera specs whether your model does support this. In case your camera is not supporting, the assistant will not be selectable.



- For easy image processing, it is recommended to have pixel correction activated
- Pixel correction maps can be saved and loaded
- The std factory map can be selected any time
- Generate your own custom map
- Select your own defect pixel map

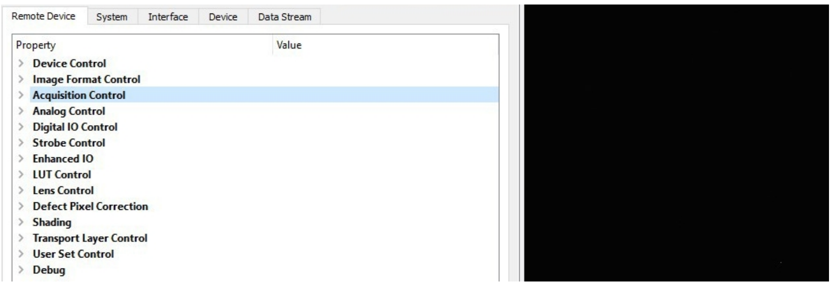
The procedure to create a std map is pretty straight forward. Befrore starting generating the map, in the GenICam tree do following:



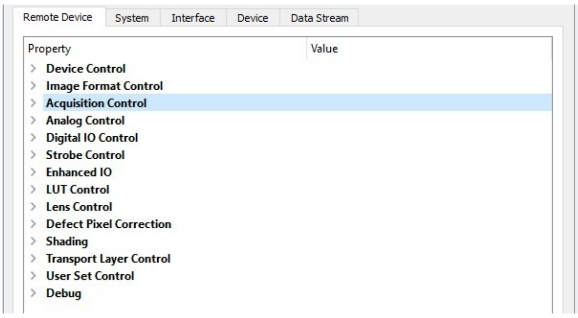
- Set gain to "0 dB".
- Disable Gain Auto.
- Set Offset to "0"
- Record a set of dark images with the lens cap on.

Defect pixel map generation

- Save a completely dark image as bmp file.

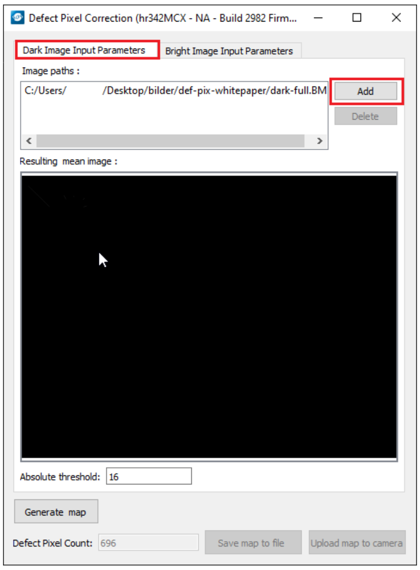


- Save a completely white image as bmp file.

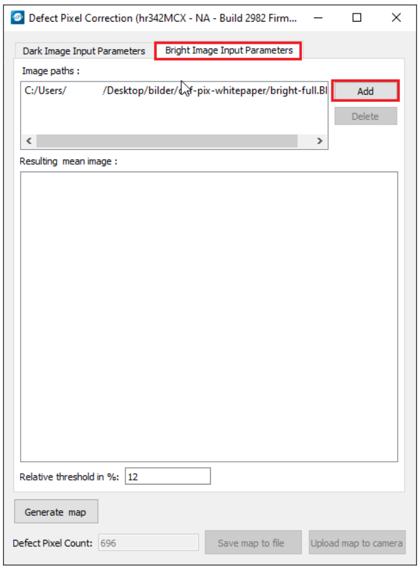


- Open Assistant > Defect Pixel Correction > Select Map > Custom Map.
- Select Generate Map….

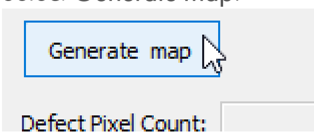
- Add a “Dark Image”.



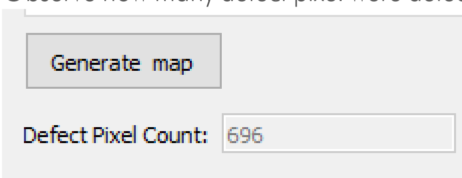
- Add a “Bright Image”.



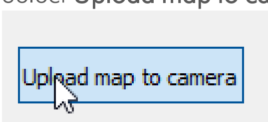
- Select **Generate map**.



- Observe how many defect pixel were detected in the “Defect Pixel Count”.



- Select **Upload map to camera**.



5.2.3 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.*

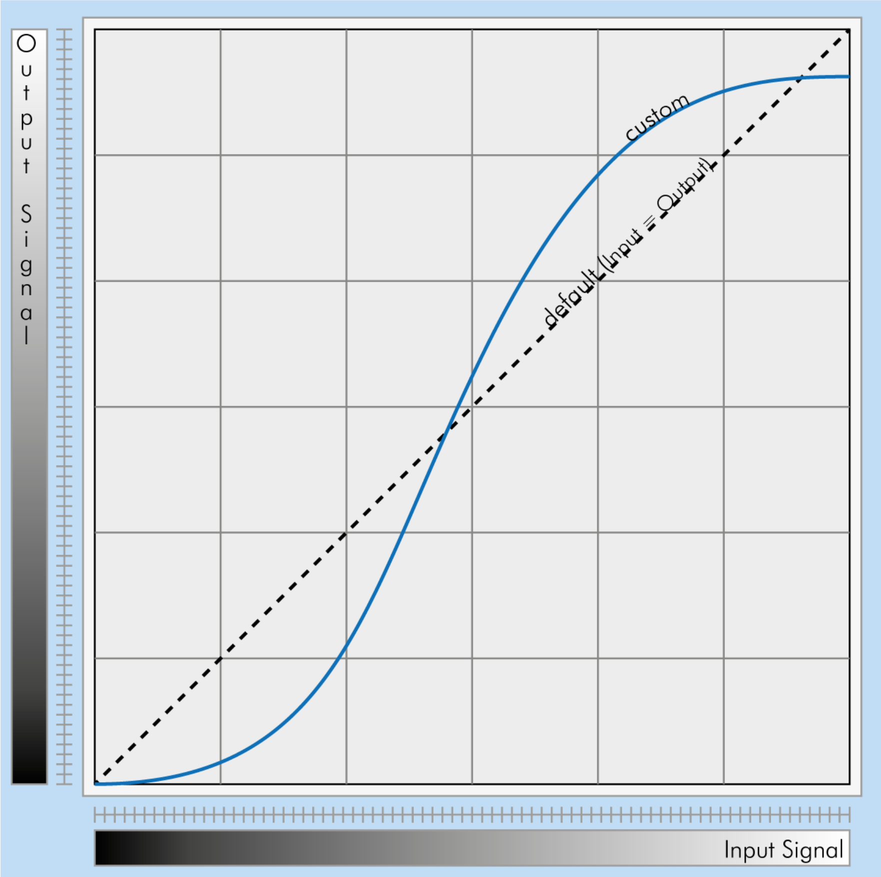


Fig. 5-21: Custom LUT adding contrast to the mid-tones

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}

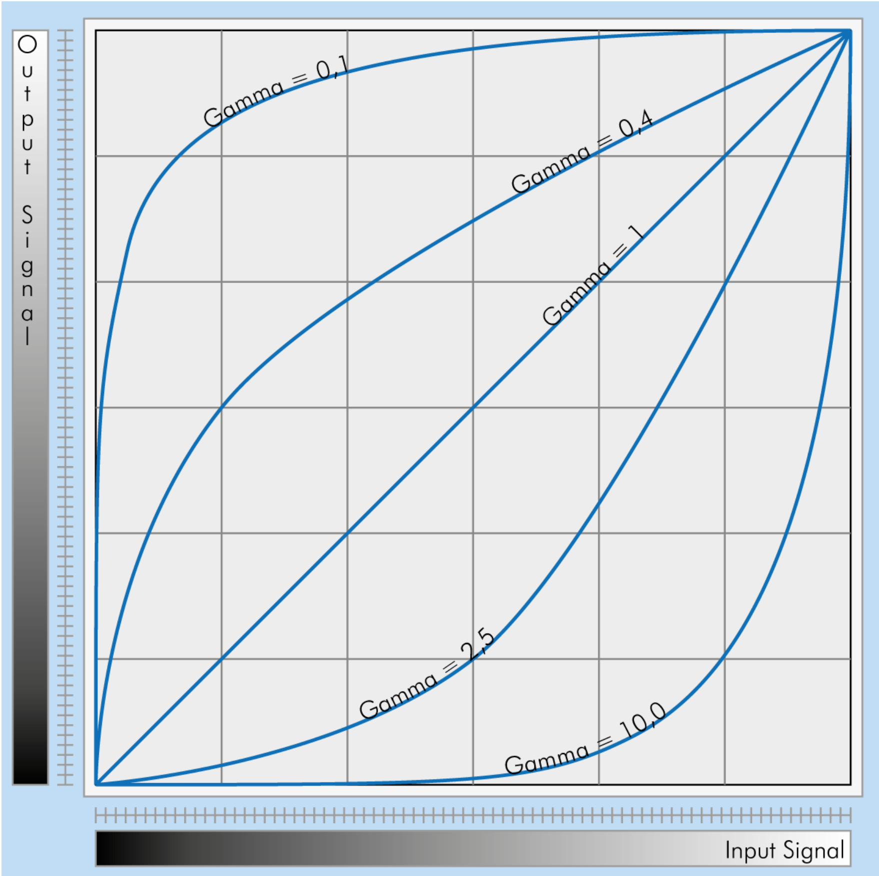


Fig. 5-22: Several gamma curves comparable to a LUT

- 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.*

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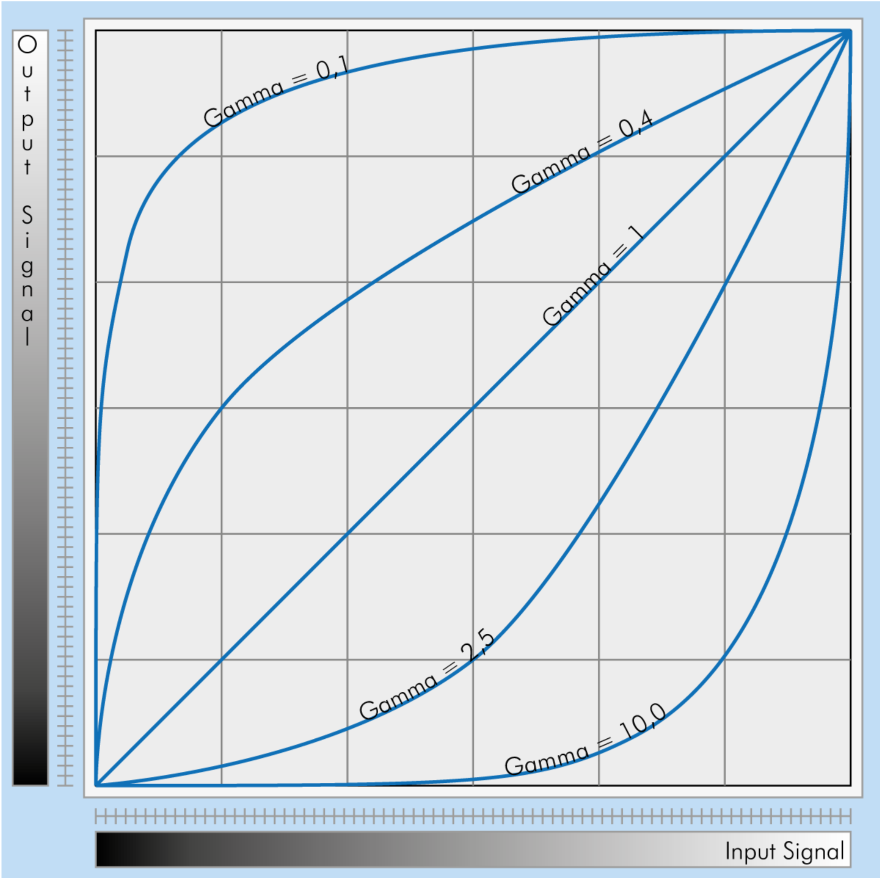


Fig. 5-23: Several gamma curves comparable to a LUT

- 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.

5.2.4 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.

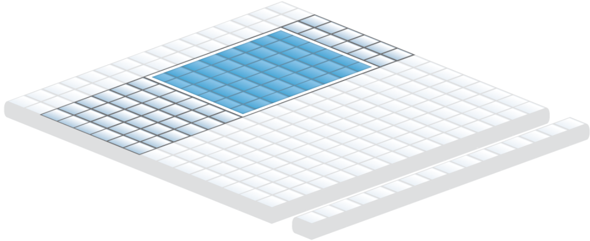


Fig. 5-24: AOI on area sensor

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.

5.2.5 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 read 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. The exposure time is set via the serial interface and calculated by the internal logic of the camera.

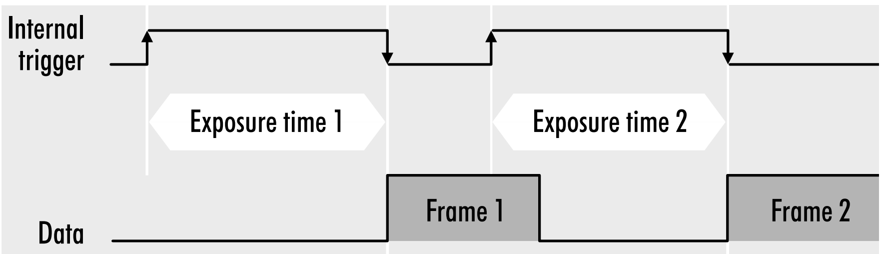


Fig. 5-25: Mode 0 - Free running with programmable exposure time

The fundamental signals are:

- Line Valid: LVAL
- Frame Valid: FVAL
- For 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.

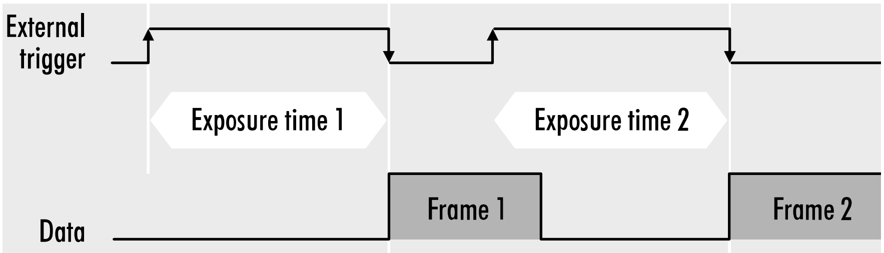


Fig. 5-26: Mode 1: External Trigger with Pulse Width Exposure Control (overlap)

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.

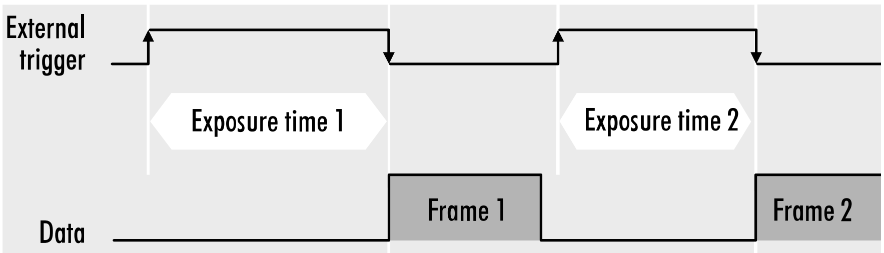


Fig. 5-27: Basic capture modes - triggered mode (pulse width without overlap)

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.*

5.2.6 Read-out control

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

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

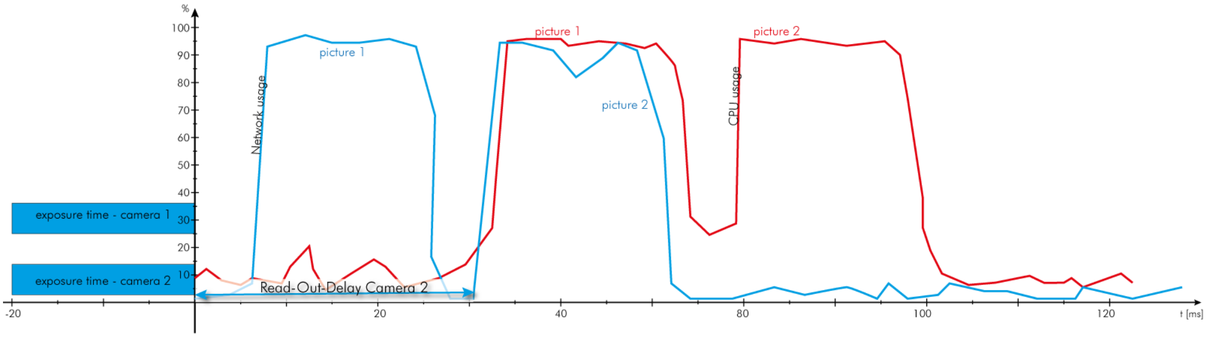


Fig. 5-28: Illustration of physical data stream in time

5.2.7 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).

Thermoelectric cooling (TEC)

Thermoelectric cooling (TEC) uses the Peltier-Seebeck effect to transport the heat from the main board of the camera to the housing, thereby cooling the mainboard and improving efficiency of the camera sensors by reducing dark current. When the mainboard heats up during operation, a difference in voltage will build up between the housing and the mainboard. This effect develops across two points of electrically conducting materials on the mainboard and the housing with a temperature difference (Δ T) between them.

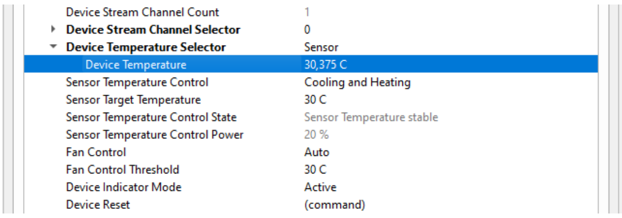
As a result, the mainboard is cooled whereas the housing gets warmer. The housing then dissipates the heat to the surrounding.

The thermoelectric cooling (TEC) feature is only available for camera models with a "-T" in their names.

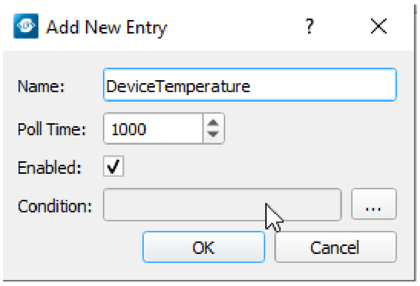
Setting the temperature control features

The settings for the **Device Temperature Selector** can be used to monitor the hardware temperature of the main board, the power supply, the FPGA, and the sensor during operation.

- Open SVCapture and navigate to **Device Temperature Selector** > **Device Temperature**. The current temperature of the device is displayed.



- Select **Device Temperature** and set the **Poll Time** interval to 1000 milliseconds, i.e. one second.



- To obtain a noise-free image, change the active cooling settings of the **Sensor Temperature Control**:
  - **Off** deactivates the current **Sensor Temperature Control** settings.
  - **Cooling** actively cools the sensor according to the selected **Sensor Target Temperature**.
  - **Cooling and Heating** actively warms or cools the sensor to the selected **Sensor Target Temperature**.
- If cooling or cooling and heating is enabled, select **Sensor Target Temperature** and adjust the sensor temperature to a value of 15 °C … 45 °C.
  - The default setting is 30 °C.

The values for **Sensor Temperature Control State** and **Sensor Control Power** display the current state and the current used power for the TEC, respectively (for TEC, see "Thermoelectric cooling (TEC)" on page 50).

5.2.8 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.

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

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

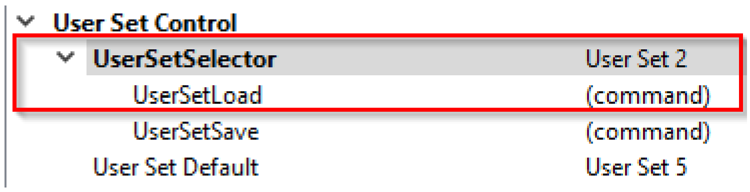
5.2.9 Predefined configurations (user sets)

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 run-time. In addition, you can specify which setup is loaded as default when the camera is switched on.

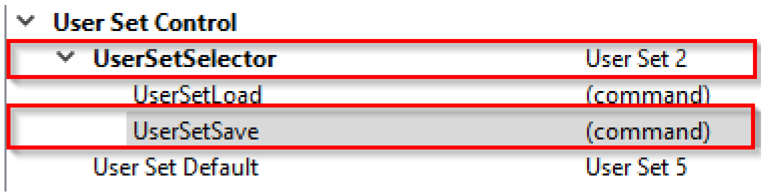
Load a user set

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 User-SetSave command.

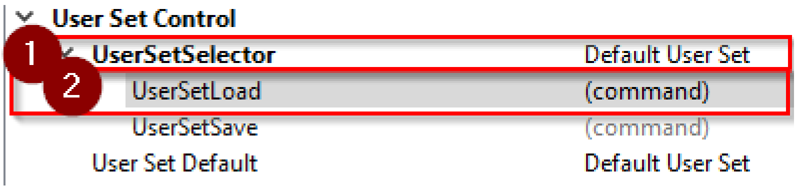


Set a user set as default

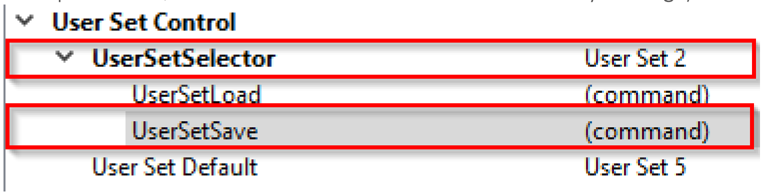
Use User Set Default to select the user set that is to be loaded when the camera is started. Save this setting with UserSetSave (In the example below, user set 5 is saved as default).

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).



5.2.10 Fan control

The camera has a built-in fan that is set to automatic mode by default. The fan directs the airflow externally past the camera to avoid contamination inside the camera. The fan offers the following advantages:

- Small camera footprint (due to lack of large heat sinks) ensures easy integration
- Large temperature range in standalone operation
- Heat dissipation mainly through the thermo-mechanical connection of the housing
- Fan can be switched off if necessary. Ensure a good thermal connection to the camera housing.
- The fan activity mode can be set in the GenICam Tree.

The threshold value in section **Fan Control** allows you to define the sensor temperature at which the fan becomes active in Auto mode (default: 60 °C).

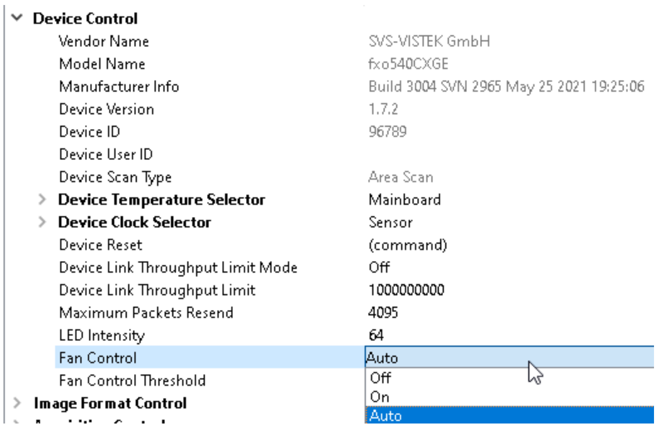


Fig. 5-29: Fan Control settings

5.2.11 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.

Usage of burst mode

Burst mode has two 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 without breaking the average frame rate of camera). This applies in particular to 10 GigE networks.
- 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)

INFO *As soon as the internal memory buffer is filled up, frames will be dropped. Due to this, SVS-VISTEK cameras provide up to 512 MB image buffer memory.*

5.2.12 Precision Time Protocol

PTP (Precision Time Protocol) is a protocol according to IEEE1588 to synchronise several devices in a common Ethernet network. PTP IEEE1588 is part of the GigE Vision Standard 2.0.

INFO *Cameras from SVS-VISTEK require firmware b2987 at least for operating PTP.*

According to the PTP protocol, several devices agree on a master. The other devices in the network communicate with the master as slaves and synchronize their own time base for the time stamp with the time base of the master. The maximum deviation permits deviations of typically 10 μs. The common time base is not to be confused with real time in normal camera systems. To obtain a fixed relation to the real world time, an NTP or GPS device has to be be defined as PTP master.

Cameras participating in PTP are set to a special PTP mode. As soon as the PTP mode is set to Master, Slave or Auto, the synchronisation of the cameras in the network begins, provided that a device has previously been configured as master. The first camera in the network sending the "Ptp Data Set Latch" command will be declared master, all others will be slave.

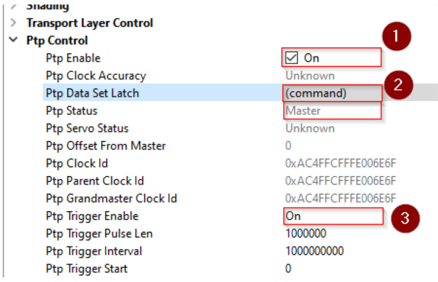


Fig. 5-30: PTP set master mode

Synchronize camera trigger

If a camera is to be triggered via PTP, it must be operated in PTP slave mode. For this, the camera has to be configured in PTP slave mode and the I/O trigger line selector must be set to PtpTrigger. The Ptp set latch command will lock the common timebase.

Only the trigger event will be snchronized. The cameras can still be run with different exposure times.

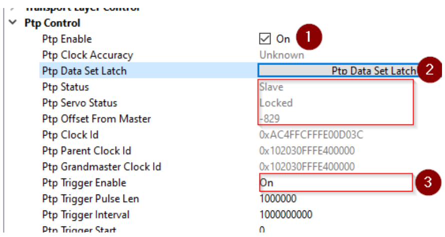


Fig. 5-31: PTP set slave mode

Enable the synced trigger in with 2 steps.

- Enable Trigger Mode and set Trigger Mode to Line1.
- Connect the Trigger with PtPTrigger source in the I/O matrix. The slave camera will follow the master's trigger events.

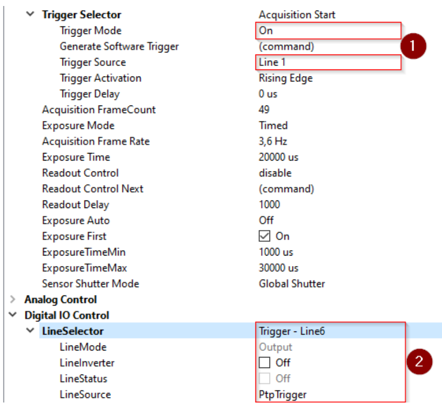


Fig. 5-32: Enable synced multi camera trigger in PTP slave mode

INFO *Slave operation with Precision Time Protocol is permitted with timed exposure only.*

INFO *It is recommended to connect the cameras with a single switch. Daisy-chain switches are not permitted.*

5.3 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.

5.3.1 Pulse width modulation

During pulse width modulation (PWM), 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?

Pulse width modulation is an extremely efficient way (in terms of power dissipation) to provide or regulate electrical power to consumers as long as they do not need uninterrupted supply (such as diodes or LEDs). The interruption times might be as short as nano seconds.

LED characteristics

Since LEDs have a bounded workspace, the PWM ensures a variable intensity of illumination at a constant current on the diodes. The constant current guarantees a linear light emission response curve of the LED from 0-100% PWM intensity. Running LED lighting in flash mode will increase LED lifetime because of reduced LED heat dissipation.

Implementation of PWM

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

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

Duty cycle "T" is written into the registry by multiple of the inverse of camera frequency in 15 ns steps.

$$T_{PWM} = \frac{1}{66,\overline{6}\,MHz} \bullet \text{PWMMax}\left[\text{SeqSelector}\right] = 15\ ns\ \bullet \text{PWMMax}\left[\text{SeqSelector}\right]$$

The intensity of a PWM

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

PWMChange0-3[SeqSelector] unit is percentage value.

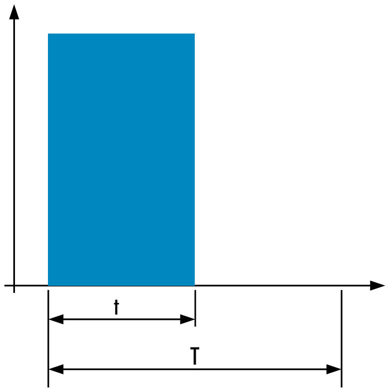


Fig. 5-33: PWM intensity

Examples of PWMs

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.

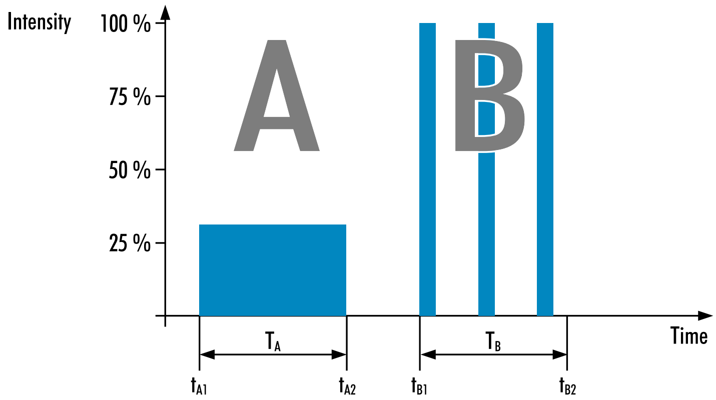


Fig. 5-34: Example: 25% PWM load

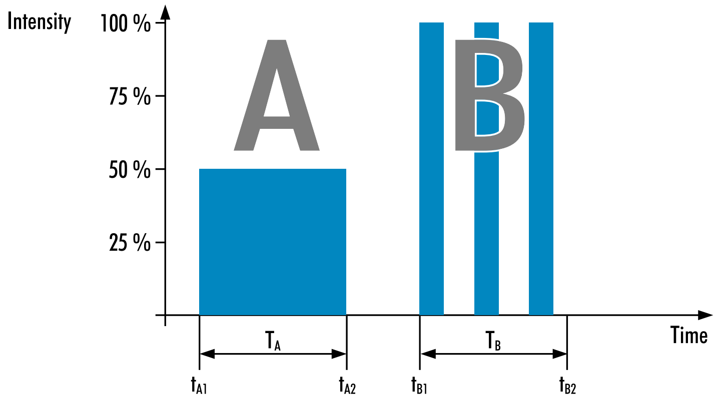


Fig. 5-35: Example: 50% PWM load

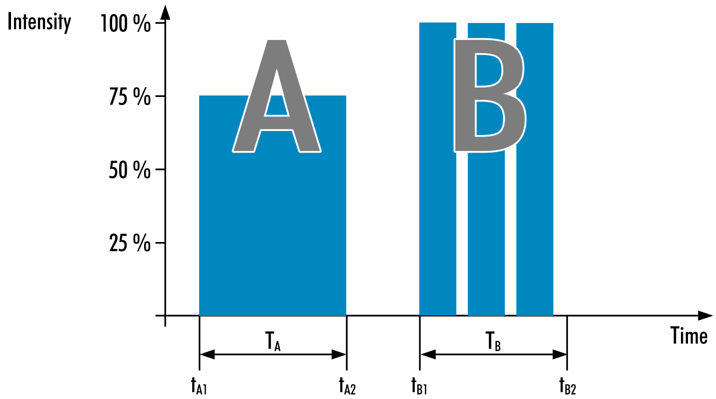


Fig. 5-36: Example: 75% PWM load

The PWM module

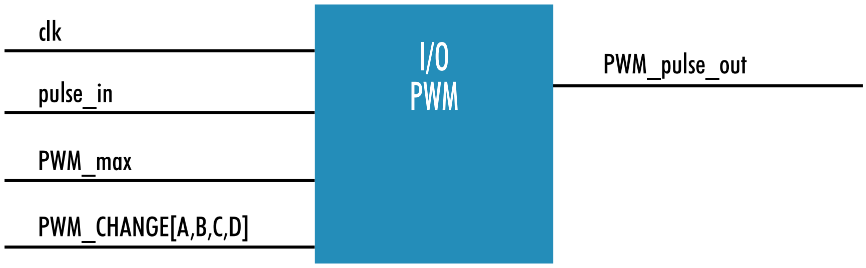


Fig. 5-37: The PWM module

5.3.2 LED 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. Maximum ON-time is 100 ms. Depending on the camera model, up to four (see specifications) independent channels are supported with a max current of 3A@40 ms per 1 s (or 4 %). Maximum continuous current is

0.3 A. Despite internal protections, higher current peaks might be able to damage the camera.

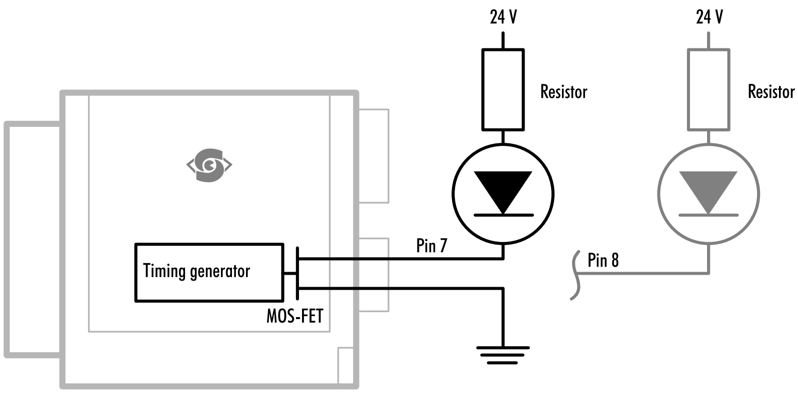


Fig. 5-38: Attach LED lights to camera outputs

NOTICE

To avoid destruction of your LED light or camera, make sure to use the right dimension of shunt resistor.

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 μs. The longest time is 1 second.

Strobe delay

The delay between the (logical) positive edge of trigger pulse and strobe pulse output.

Exposure delay

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

Calculate LED shunt resistors

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

LEDs in continuous mode

Voltage drop al 5 LEDs, 2,2V 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

Table: 5-2: LEDs in continuous mode

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

Table: 5-3: Example Calculation “No Flash” (CW Mode)

LEDs in flash mode

Most LED lights can cope with currents higher than specs. This gives you higher light output when light is ON. 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.

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

NOTICE Make sure your PWM lighting frequency is at least double or triple the bit-depth of your image (e.g. 8 bit image = 256, this means your PWM has to be switched at least 256*2=512 times) while exposing. If exposure time is 5 ms, the required minimum PWM freq = 5 ms / 512 ~ 10 µs ~ 100 kHz.

Strobe vocabulary

For an example how to enable and adjust the integrated strobe controller refer to sequencer (see "Sequencer" on page 61). Times and frequencies are set in tics. 1 tic = 15 ns.

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 μs. The longest time is 1 second.

Strobe delay

The delay between the (logical) positive edge of trigger pulse and strobe pulse output.

5.3.3 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 pin-out 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

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 colors 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

Scenario values	Interval 0 (RED)	Interval 1 (GREEN)	Interval 2 (BLUE)	Interval 3 (WHITE)
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 stated 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

Values to set in GenICam properties	Interval 0 (RED)	Interval 1 (GREEN)	Interval 2 (BLUE)	Interval 3 (WHITE)
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 the following diagram:

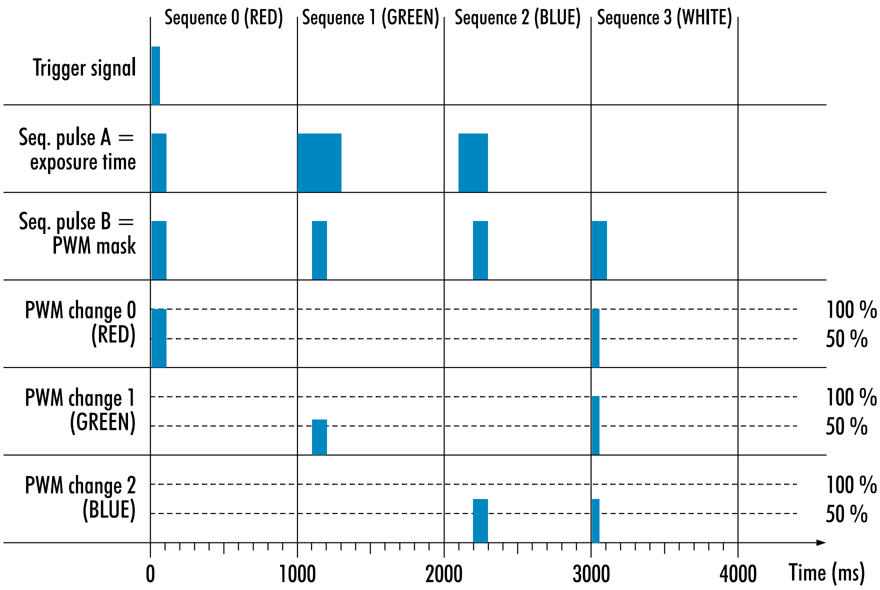


Fig. 5-39: Sequencer timing diagram

5.3.4 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 separates 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 5-24 V, 8 mA.

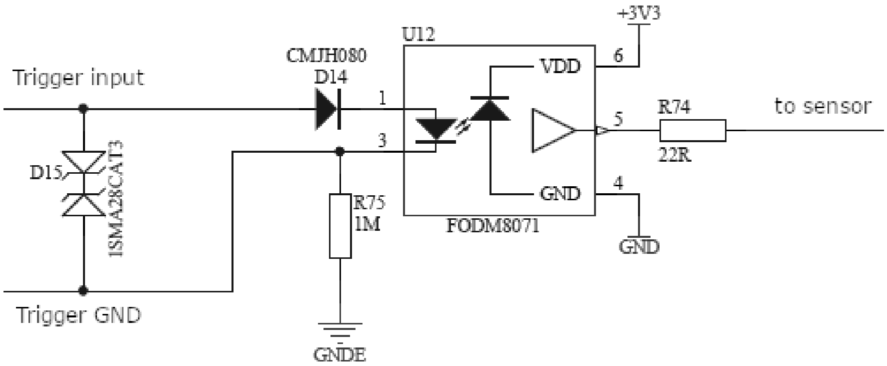


Fig. 5-40: Optical input

The optocoupler 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.

5.3.5 PLC / Logical operation on inputs

The logic input combines trigger signals with Boolean algorithms. The camera provides AND, NAND, OR, NOR, XOR, XNOR as below. You might combine combine true or 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.

GenICam tree setting

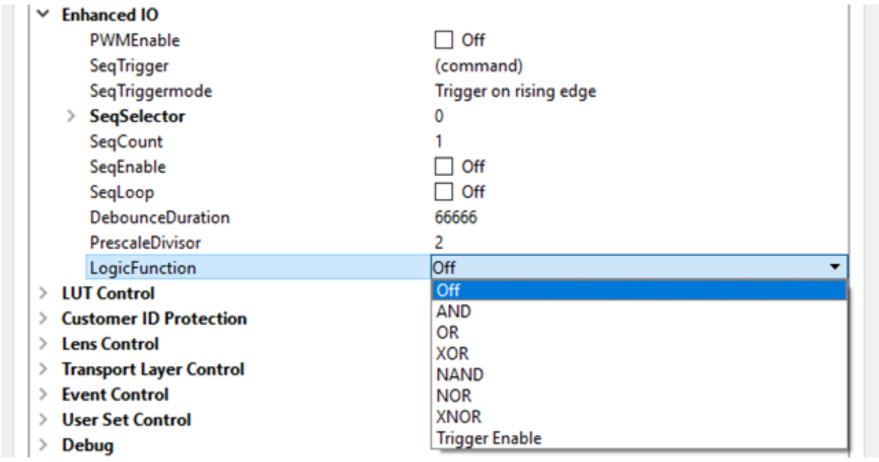


Fig. 5-41: GenICam tree setting

The logic function always combines the values of Digital IO InputA / LogicA and InputB / LogicB. In case of the trigger enabled logic function, LogicB is the trigger enable signal and will be combined with LogicA value.

<table>
<tr><th>AND</th><th>NAND</th><th>OR</th><th>NOR</th><th>XOR</th><th>XNOR</th></tr>
<tr><td>A B Y</td><td>A B Y</td><td>A B Y</td><td>A B Y</td><td>A B Y</td><td>A B Y</td></tr>
<tr><td>|0|0|0|</td><td>|0|0|1|</td><td>|0|0|0|</td><td>|0|0|1|</td><td>|0|0|0|</td><td>|0|0|1|</td></tr>
<tr><td>|0|1|0|</td><td>|0|1|1|</td><td>|0|1|1|</td><td>|0|1|0|</td><td>|0|1|1|</td><td>|0|1|0|</td></tr>
<tr><td>|1|0|0|</td><td>|1|0|1|</td><td>|1|0|1|</td><td>|1|0|0|</td><td>|1|0|1|</td><td>|1|0|0|</td></tr>
<tr><td>|1|1|1|</td><td>|1|1|0|</td><td>|1|1|1|</td><td>|1|1|0|</td><td>|1|1|0|</td><td>|1|1|1|</td></tr>
</table>

Table: 5-4: Truth table of logic function

NOTICE Expert view of the GenICam tree has to be activated to see logic functions.

5.3.6 Serial data interfaces

(ANSI EIA/) TIA-232-F

RS-232 and RS-422 (from EIA, read as Radio Sector or commonly as Recommended Standard) are technical standards to specify electrical characteristics of digital signaling circuits. Serial connection might be used to control SVCams. These signals are used to send low-power data signals to control exposure, light or lenses (MFT). Usage scenario is a control possibility without network. Be aware of low connection speed.

Serial interface parameter	RS-232	RS-422
Maximum open-circuit voltage	±25 V	±6 V
Max differential voltage	25 V	10 V

Serial interface parameter	RS-232	RS-422
Min. signal range	±3 V	2 V
Max. signal range	±15V	10 V

Table: 5-5: Serial interface parameters – RS-232 and RS-422

INFO *See your camera data sheet regarding its serial capabilities.*

Data transport is always asynchronous. Synchronization is implemented by fist and last bit of a package. Data rate (bits per second) must be defined before transmission.

RS232

RS232 is split 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

INFO *For restrictions, refer to table of serial interface parameter above.*

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

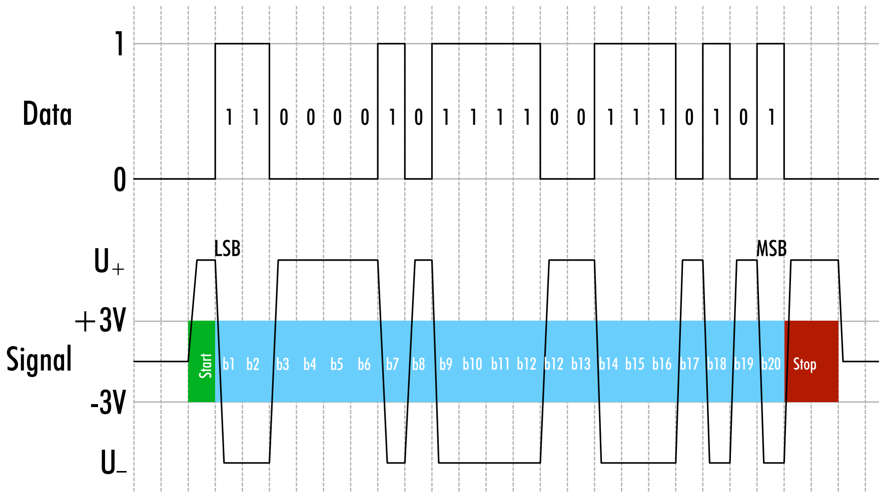


Fig. 5-42: UART encoding of a data stream

5.3.7 Trigger-edge sensitivity

Trigger-edge sensitivity is implemented by a "Schmitt trigger". Instead of triggering to a certain value, the Schmitt trigger provides a threshold.

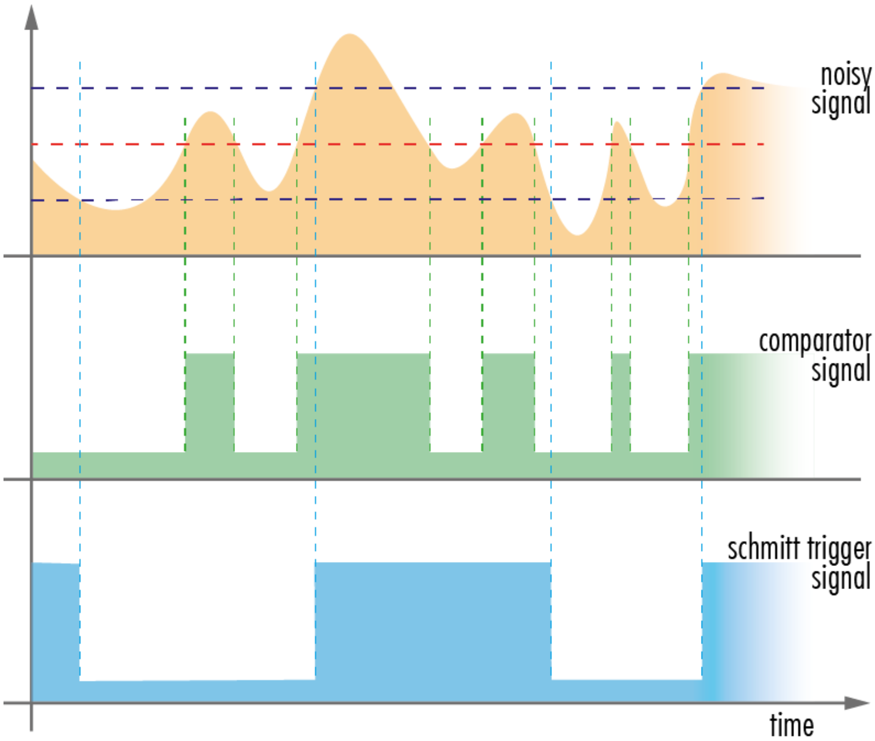


Fig. 5-43: Schmitt trigger noise suppression

5.3.8 Debouncing trigger signals

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

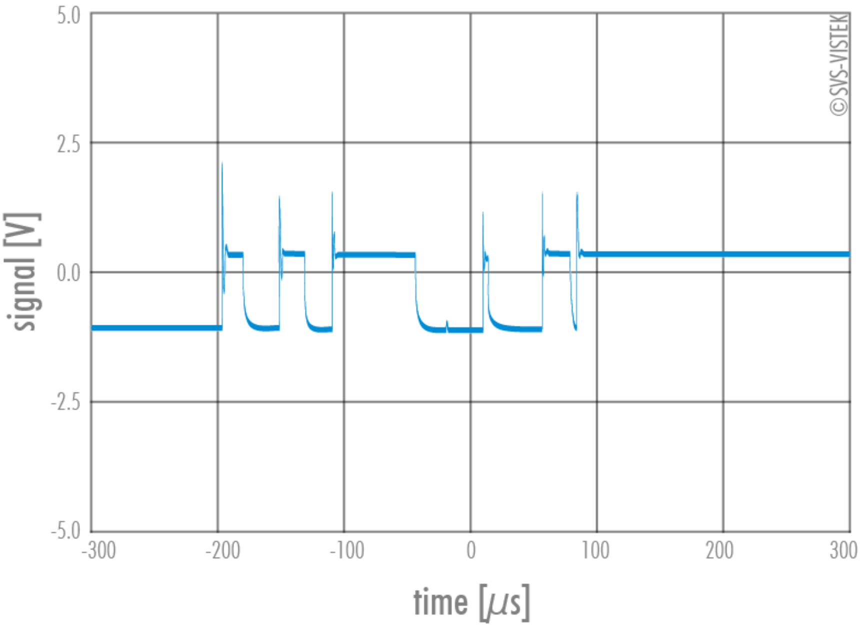


Fig. 5-44: Bounces or glitches caused by a switch

Therefore the signal will not be accepted until it lasts at least a certain time.

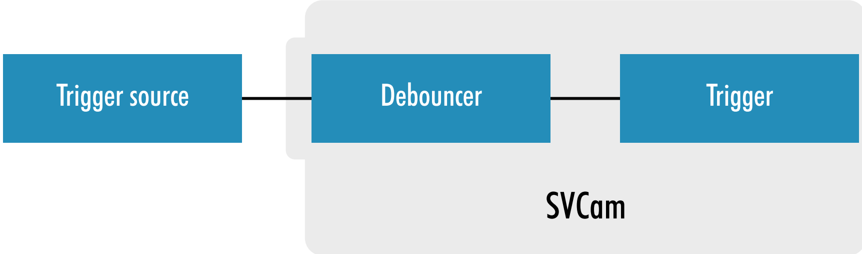
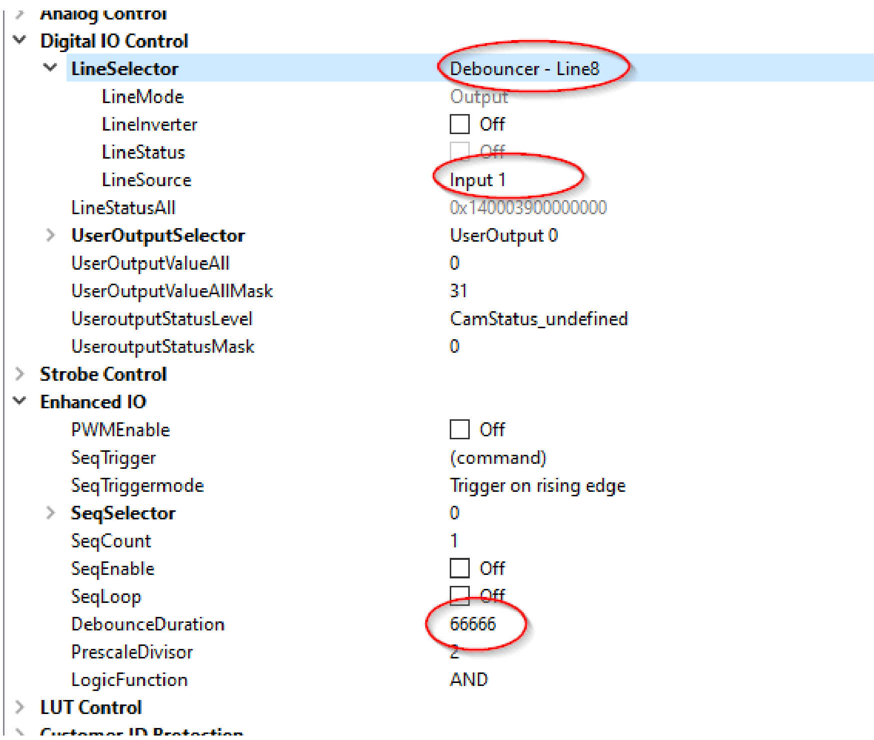


Fig. 5-45: Debouncer between the trigger source and trigger



- 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).
- Set the register “DebounceDuration” in multiples of 15 ns (implementation of system clock), e.g. 66 666 ≈ 1 ms.

Fig. 5-46: The debouncer module

5.3.9 Prescale

The prescale 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 prescale function 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)

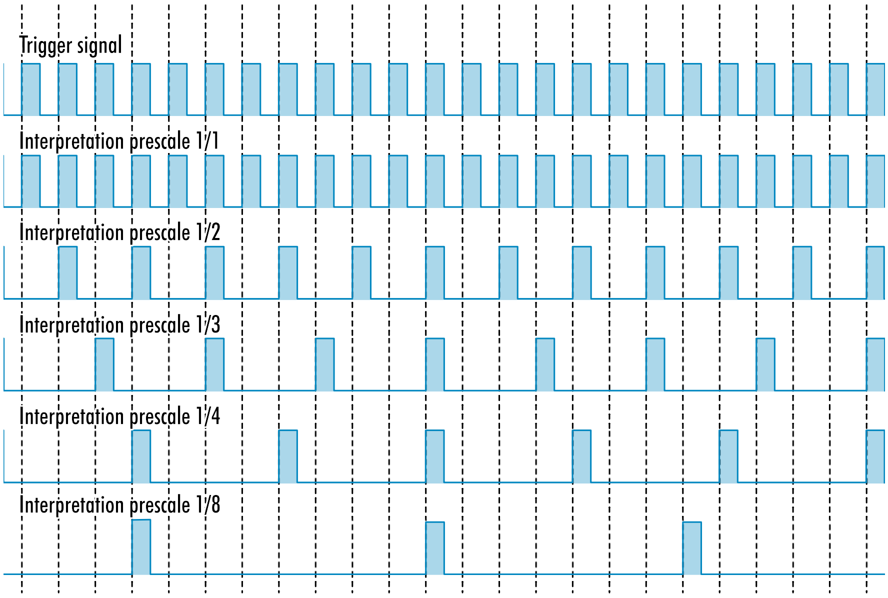


Fig. 5-47: Prescale values and their result on trigger signal

The prescale module

Fig. 5-48: The prescale module

6 Annex

6.1 Dimensions

INFO

All length units in mm.
Find the technical drawings in the web download area at
https://mikrotron.de/de/support/mik-support-download-center.php

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

6.2 I/O 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.

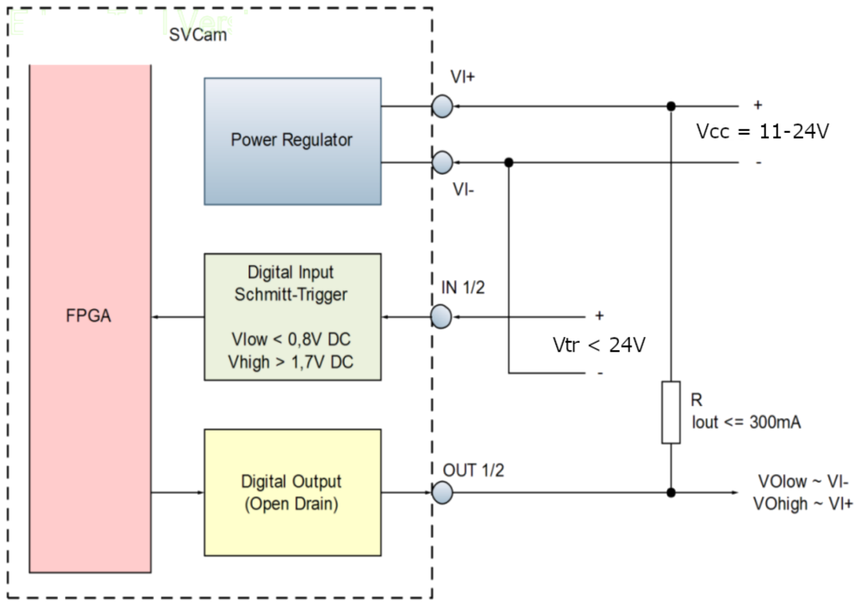


Fig. 6-1: I/O driver circuit schematics

6.2.1 Requirements Mellanox ConnectX card

- We recommend plugging the Mellanox ConnectX card into the top PCIe slot.
- For full performance, a mainboard with PCIe Gen3/4 should be used.
- 16GB RAM, fast SSD and a newer generation Intel CPU (i5 and higher) is also recommended.

6.3 Action commands

Action commands are dedicated Ethernet packets used as external so called "Trigger over Ethernet" (ToE). The trigger can be sent to one camera as unicast or to a all cameras as broadcast.

Each action command contains the following values:

- DeviceKey to authorize the action on this device.
- GroupKey to define a group of devices on which actions have to be executed.
- GroupMask to be used to filter out some of these devices from the group.

All these values can be set here:

Fig. 6-2: Action control

INFO

To fire a trigger in the camera, the DeviceKey and the GroupKey have to match and at least one bit in the GroupMask has to match.

Here are some examples of the GroupMask:

Sent GroupMask	Camera GroupMask	Camera reaction
0x7FFF FFFF	0x0000 0001	YES
0x0000 000E	0x0000 0001	NO
0x0000 FFFF	0x0000 005F	YES
0x0000 FFFF	0x0000 0800	YES
0x0000 FFFF	0x0f11 0000	NO

Table: 6-1: Examples of GroupMask

Here are some examples of action commands “ActionCMD” and the reaction of three cameras receiving these commands:

	ActionCMD	Device0			Device1	Device2
DeviceKey	0xaffe		0xaffe		0xaffe	0xaffe
GroupKey	0x1234	0x1	0x1234	0x1234	0x1	0x1234
GroupMask	0x0002	0x0001	0x0002	0x0003	0xffff	0x0001
		invalid	valid	valid	invalid	invalid

	ActionCMD	Device0			Device1	Device2
DeviceKey	0xaffe		0xaffe		0xaffe	0xaffe
GroupKey	0x0001	0x1	0x1234	0x1234	0x1	0x1234
GroupMask	1-65535	0xffff	0xffff	0xffff	0xffff	0xffff
		valid	invalid	invalid	valid	invalid

Table: 6-2: Example of action command

A short Phyton program example to generate an action command. The IP address of "server.bind" shall be adapted to the IP address of the local network card.

```
import socket import time
from struct import *
server = socket.socket(socket.AF_INET, socket.SOCK_DGRAM, sock-
et.IPPROTO_UDP) server.setsockopt(socket.SOL_SOCKET, socket.SO_
REUSEADDR, 1)
# Enable broadcasting mode server.setsockopt(socket.SOL_SOCKET,
socket.SO_BROADCAST, 1) server.settimeout(0.2)
# use local address to bind socket server.bind
(("169.254.191.50", 44444))
#message = b"your very important message" #    net8 id;
#net8 flag; #net16 command; #net16 length; #net16 req_id;
#net32 device_key; #net32 group_key; #net32 group_mask;
# gv_cmd_action;
# action ack request
#    id    flag command length req_id device_key group_key
group_mask
message = pack("!BBhhhlll", 0x42, 0x01, 0x0100, 12, 5, 1, 1, 1)
# without action ack request
#message = pack("!BBhhhlll", 0x42, 0x00, 0x0100, 12, 5, 1, 1,
1)
while True:
server.sendto(message, ('<broadcast>', 3956))
#server.sendto(message, ("169.254.185.58", 3956))
print(".") time.sleep(1/40)
```

Generating an action command

INFO *The time between receiving an action command and releasing the trigger was measured with maximum load and values between 25605 ns and 50130 ns.*

6.4 FAQ

INFO *For questions and issues, refer to the FAQ page on our website: https://mikrotron.de/de/support/mik-support-faq.php* a **TKH Vision** brand

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