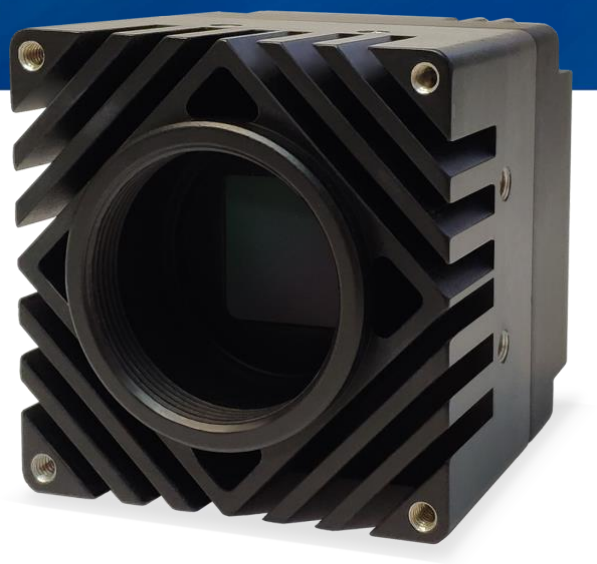
IRON

CoaXPress

User Manual



April 2025
Rev 1.9

KAYA INSTRUMENTS

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1 Revision History

Ver	Date	Notes
1.0	06.2019	Initial release
1.1	07.2019	Balance White chapter update
1.2	09.2019	Minor content and tables editing
1.3	03.2020	- Added more descriptive section for File Access Control - Added new parameters for the Exposure Auto algorithm - Document restructure for better readability
1.4	03.2021	- Updated description of Lens Control chapter - Added support for P-Iris lens control
1.5	07.2021	- Added Fan Control - Added LED Control - Added TimeStamp - Added I/O Control - Added Stream Metadata information - Added Gamma Control
1.6	09.2021	Added “Feature Support by Version” section
1.7	07.2022	Added "GPIO"
1.8	03.2025	- Added description for CoaXPress over Fiber protocol - Added Multi-Roi configuration parameters - Added feature description for 2020BSI sensor - Fixed fan operation modes
1.9	04.2025	- “Status LEDs” section updated - “Analog and Digital Gain and Black Level” section updated - “Black Level Auto” Section added

Table 1 – Revision History

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2 Introduction

2.1 Safety Precautions

With your ***Iron*** camera in hand, please take the time to read through the precautions listed below to avoid preventable and unnecessary injuries and damage to you, other personnel, or property. Read these safety instructions carefully before your first use of the product, as these precautions contain safety instructions that must be observed. Be sure to follow this manual to prevent misuse of the product.

⚠ Caution! Read Carefully and do not disregard these instructions.
In the event of a failure, disconnect the power supply Disconnect the power supply immediately and contact our sales personnel for repair. Continuing to use the product in this state may result in a fire or electric shock.
If an unpleasant smell or smoking occurs, disconnect the power supply. Disconnect the power supply immediately! Continuing to use the product in this state may result in a fire or electric shock. After verifying that no smoking is observed, contact our sales personnel for repair.
Do not disassemble, repair or modify the product. Such actions may result in a fire or electric shock due to a circuit shortage or heat generation. Contact our sales personnel before inspection, modification, or repair.
Do not place the product on unstable surfaces. Otherwise, it may drop or fall, resulting in injury to persons or the camera.
Do not use the product if dropped or damaged. Otherwise, a fire or electric shock may occur.
Do not touch the product with metallic objects. Otherwise, a fire or electric shock may occur.
Do not place the product in dusty or humid environments, nor where water may splash. Otherwise, a fire or electric shock may occur.
Do not wet the product or touch it with wet hands. Otherwise, the product may fail or cause a fire, smoking, or electric shock.
Do not touch the gold-plated sections of the connectors on the product. Otherwise, the surface of the connector may be contaminated by sweat or skin oil, resulting in contact failure of a connector, malfunction, fire, or electric shock due to static electricity discharge.
Do not use or place the product in the following locations. ▪ Unventilated areas such as closets or bookshelves ▪ Near oils, smoke, or steam ▪ Next to heat sources ▪ A car with closed doors where the temperature can become hot ▪ Static electricity replete locations ▪ Near water or chemicals Otherwise, a fire, electric shock, accident, or deformation may occur due to a short circuit or heat generation.
Do not place heavy objects on the product. Otherwise, the product may be damaged.
Be sure to discharge static electricity from the body before touching any sensitive electronic components. The electronic circuits in your computer and the circuits on the ***Iron*** camera and the ***Predator II*** board are sensitive to static electricity and surges. Improper handling may seriously damage the circuits. In addition, do not let your clothing come in contact with the circuit boards or components. Otherwise, the product may be damaged.

2.2 Disclaimer

This product should only be used for image capturing and processing. KAYA Instruments assumes no responsibility for any damage that may ensue by using the camera for any purpose other than intended, as previously stated. Without detracting from what was previously written, please be advised that the company takes no responsibility for any damages caused by:

- Earthquake, thunder strike, natural disasters, a fire caused by usage beyond our control, willful and/or accidental misuse and/or use under other abnormal and/or unreasonable conditions
- Secondary damages caused by the use of this product or its unusable state (business interruption or others)
- Use of this product in any manner that contradicts this manual or malfunctions due to connection to other devices.
- Damage to this product that is out of our control or failure due to modification.
- Accidents and/or third parties that may be involved.

Additionally, KAYA Instruments assumes no responsibility or liability for:

- Erasure or corruption of data caused by the use of this product
- Any consequences or other abnormalities following the use of this product

Repairs to this product are carried out by replacing it on a chargeable basis and not by repairing the faulty device. Non-chargeable replacement is offered for the initial failure, as long as it is reported no later than two weeks post-delivery of the product.

3 Overview

This document describes the functionality and features of the ***Iron CoaXPress and Iron CoaXPress over Fiber*** cameras. The ***Iron*** cameras are high-speed, high-quality devices for image streaming. Using a standard CoaXPress Frame Grabber, connection and streaming can be achieved in a few easy steps and requires a few configurations. Our cameras provide a vast variety of image processing algorithms and configurations to adjust the stream output.

Camera control can be achieved using the standard Gen<i>Cam interface, subordinate to the camera's descriptive schema (XML) file. Configuration features are subject to the active firmware capabilities and a firmware upgrade might be needed to support the complete functionality set.

4 Hardware Reference

4.1 Power over CoaXPress

Iron CoaXPress cameras support PoCXP (Power over CoaXPress), but must never be connected to an external power source whilst receiving power through PoCXP. Powering the camera with an external power source and over CoaXPress simultaneously may cause irreversible damage.

! Never connect an external power supply to CoaXPress cameras when PoCXP is enabled on Frame Grabbers

4.2 Micro BNC Connector

To connect the Micro-BNC cable, you first need to align the pin on the male end with the "L" shaped track on the female connector of the Coaxial cable. Once aligned, the connector should be pushed in place (see Figure 1). Only mild pressure should be applied to achieve this operation, otherwise it may cause unnecessary damage to the cable or the card.

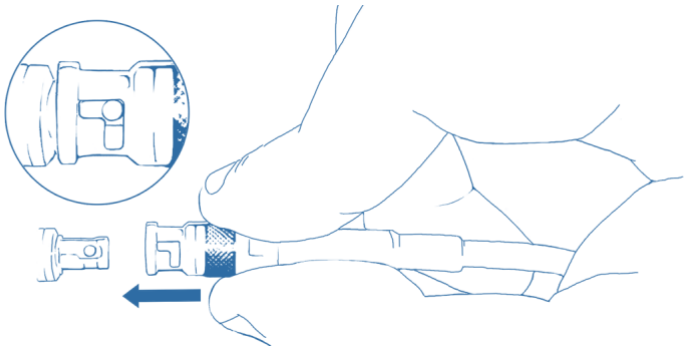


Figure 1 – Pushing the Micro-BNC connector into place

Once pushed all the way through, twist the connector clockwise. The pin will move in the track locking the connector in position:

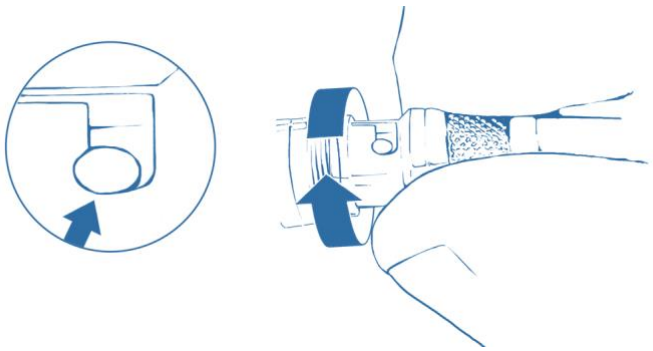


Figure 2 – Twisting the connector and securing it in position

The cable can be removed by reversing the steps: twisting the connector counter-clockwise and pulling it out.
Do not force the cable out! In case of resistance check for the pin location with the track. Adjust as needed and only then pull the cable out.

4.3 SFP+ Modules

The purpose of this section is to demonstrate how to install SFP+ transceiver module, attach an optical network cable and remove an SFP+ transceiver module. It is necessary to understand the correct way of installing and removing an SFP+ transceiver, as correct operation can protect the module from being damaged and ensure its stable performance. Before removing or installing an SFP+ module, please follow the precautions and installation instructions.

4.3.1 Precautions

1. Use an ESD-preventive wrist or ankle strap and follow its instructions for use.
2. Make sure there is no dust or any other foreign matter inside the SFP+ module or blocking any of the connectors.
3. Clean the optic surfaces of the fiber cables before plugging them into the optical ports of an SFP+ module.
4. Removing and inserting a module can shorten its useful life, so you should not remove and insert the module any more often than is absolutely necessary.
5. Insert the clean dust covers into the module after the cables are removed. Do not remove the dust plug until you are ready to attach the network interface cable.
6. Do not install or remove the SFP+ module with fiber-optic cables attached to it because of the potential of damaging the cable, the cable connector, or the optical interfaces in the module.
7. Disconnect all cables before removing or installing a module.
8. Place the removed module on an antistatic mat or a static shielding bag if you plan to return it to the factory.
9. Protect the line card by inserting clean module cage covers into the optical module cage when there is no module installed.
10. Keep the protective dust plugs installed in the unplugged fiber-optic cable connectors and in the transceiver optical bores until you are ready to make a connection.

4.3.2 Installing the SFP+ Module

In order to install the SFP+ module, follow these steps:

1. Remove the dust plugs from the module as shown in Figure 3 (a).
2. The SFP+ module has a bale clasp that used to remove or install the SFP+ module.
3. Close the bale clasp before inserting the SFP+ module.
4. Line up the module with the port and slide it into the port as shown in Figure 3 (b).
5. Make sure that the male connectors on the module will align with the female connectors inside the cage.
6. Verify that the modules are completely seated and secured in their assigned receptacles on the line card by firmly pushing on each module. In case the module is not completely seated and secured in the receptacle, you will hear a click as the triangular pin on the bottom of the module snaps into the hole in the receptacle.

7. Follow the exact steps to insert additional module into the camera's fiber interface.

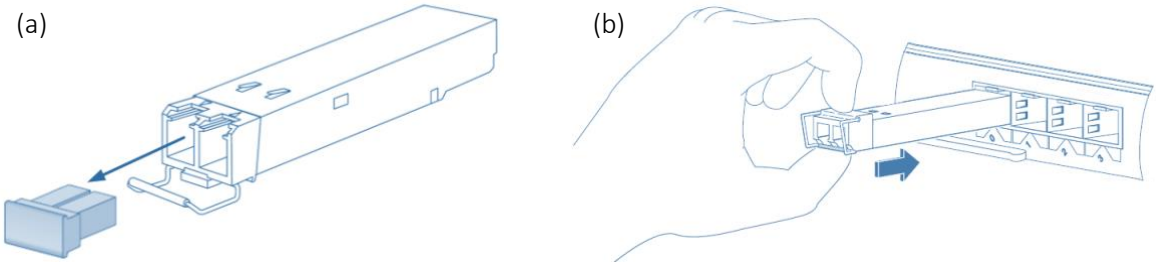


Figure 3 – SFP+ Module Installation.
(a) Cable clasp open and dust plug removed, (b) Installing an SFP+ Module into a port

4.3.3 Connecting the Interface Cable to the SFP+ Module

In order to properly connect the fiber optic cables, the following steps must be taken:

1. Remove the protective dust plugs from the fiber-optic cable connectors.
2. Perform the connection according to the instructions below:
   a. Channel 1 of the system must be always connected as controls are delivered with this port.
   b. A Fiber connection must be done to the same port number all over the way from camera to Frame Grabber.
   c. A fiber cable should match an SFP+ type. If a single mode SFP+ is used a single mode fiber (yellow) should be attached to it. If a multi-mode SFP+ is used a multi-mode fiber (orange) should be attached.
   d. On Fiber channel 1 both the TX and RX fiber cables must be connected. On channels 1 through 3 only one fiber cable should be connected. This cable is connected between TX output (Marked with TX or Arrow outwards the SFP+) on the camera and RX input (Marked with RX or Arrow inwards the SFP+) on the Frame Grabber, as shown in Figure 4 (a).
   e. If more than a single cable is used to connect to the same Frame Grabber, the cables must be of the same type and length.
3. Insert the fiber cable into the module, as shown in Figure 4 (b).
4. Firmly push on each cable, until you will hear a click.
5. Connect the other side of the fiber cables to the cameras SFP+ module.
6. Turn the camera and the computer on and start your Vision Point software application.

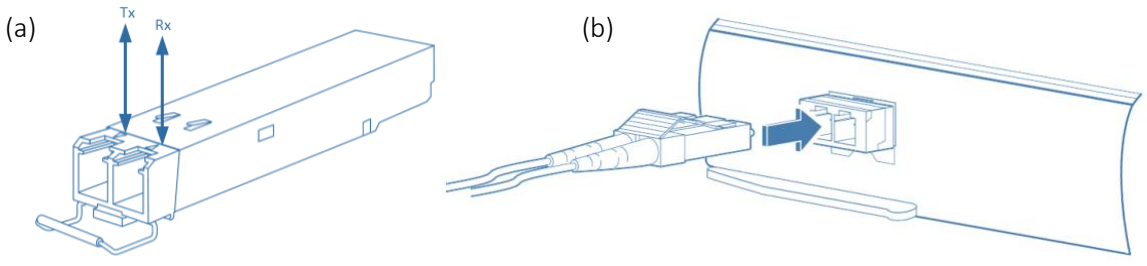


Figure 4 – Interface connecting to the SFP+ Module
(a) SFP+ module with TX output and RX input marked, b) Connecting the cable to SFP+ Module

4.3.4 Removing the SFP+ Module

1. Turn the camera and the computer off.
2. Disconnect and remove all interface cables from the ports.
3. Open the bale clasp on the SFP+ module with your index finger, or a small flat-blade screwdriver, in a downward direction, as shown in
4. Figure 5 (a).
5. Grasp the module between your thumb and index finger and carefully remove it from the port, as shown in
6. Figure 5 (b).
7. Insert the clean dust covers into the module, as shown in
8. Figure 5 (c).

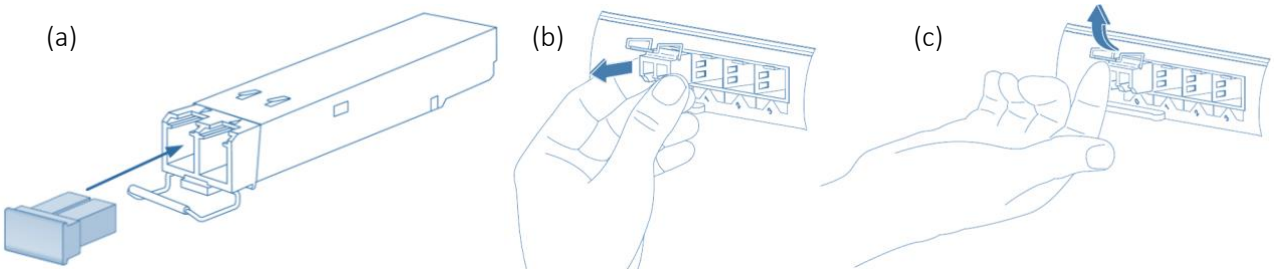


Figure 5 – Removing the SFP+ Module
(a) Opening the bale clasp of an SFP+ Module, (b) Removing an SFP+ Module from the port, (c) SFP+ Module dust plug placement

4.4 Status LEDs

The bi-color LEDs behave according to the definition in “Connector Indicator Lamps” section of the CoaXPress standard. Color-coded indications along with the exact timing for each indicator are described in the following tables:

	LED state	Indication
	Off	The camera is not powered
	Solid orange	Camera is booting
	Slow pulse red	The camera is powered but no active connection
	Fast flash alternate green/orange	Fast flash alternate green / orange - Connection detection in progress
	Solid green	The camera is connected, and no data is being transferred
	Fast flash green	The camera is connected, and data is being transferred
	Slow pulse orange	The camera is connected. Waiting for a trigger event

Table 2 – Connector indicator lamp states

	Indication	Timing
	Fast flash	12.5 Hz (20 ms on, 60 ms off)
	Slow flash	0.5 Hz (1 s on, 1 s off)
	Slow pulse	1 Hz (200 ms on, 800 ms off)

Table 3 – Connector indication lamp timings

4.5 GPIO Connectivity

Iron cameras have external inputs and outputs. Some of them are optically isolated while others operate at TTL/LVTTL levels. For pinout of GPIO connector and functional assignment please refer to specific camera datasheet. The following diagrams show GPIO electrical connections:

4.5.1 Opto-Isolated Inputs

Opto-isolated inputs don't share the same ground with the camera, and the voltage difference between the input and return pins must be positive between 3.3 and 24 Volts.

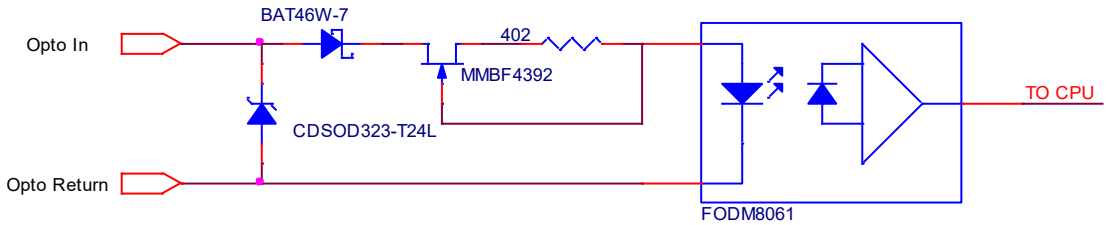


Figure 6 – Opto-Isolated input

4.5.2 TTL/LVTTL Inputs

The signal level between In and Return must be LVTTL (3.3 Volts) or TTL (5.0 Volts). The Return pin is electrically connected to the camera ground.

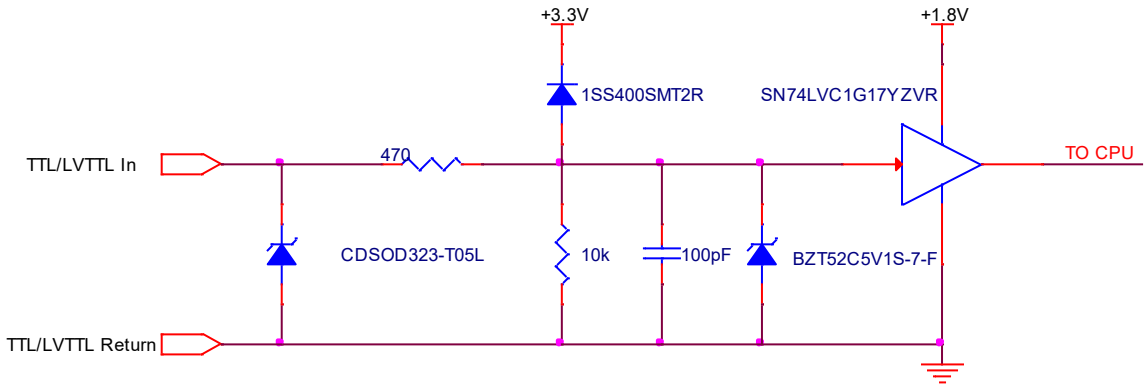


Figure 7 – TTL/LVTTL input

4.5.3 TTL Outputs

TTL Outputs are a 5V TTL (5.0 Volts) compatible signal and the maximum output current must not exceed 8 mA.

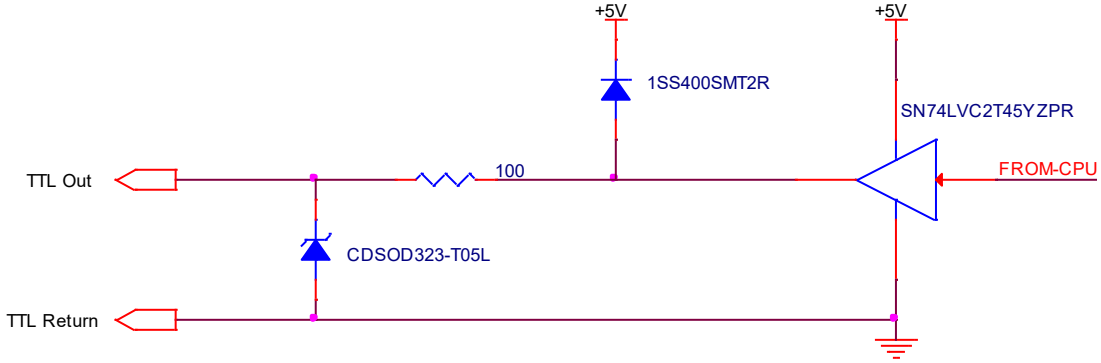


Figure 8 – TTL Output

4.5.4 Opto-Isolated Outputs

There is no pull-up voltage on either contact of the optoisolated outputs. External pull-up voltage of up to 25 V is required for operation. The voltage between Out and Return contacts must not exceed 25 V and the current through the switch must not exceed 50 mA.

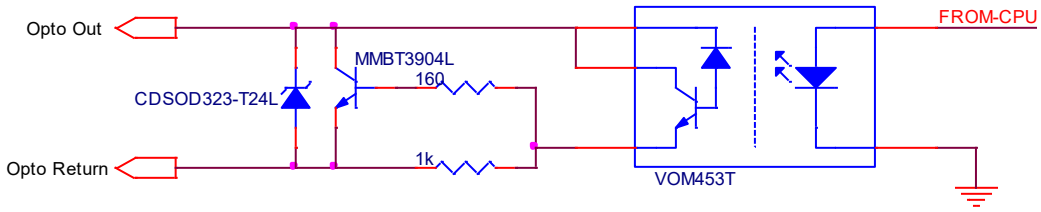


Figure 9 – Opto-Isolated output

5 Configuration Interface

5.1 Device Control

The Device Control contains manufacturer parameters describing the currently connected hardware device. The information includes the device vendor name, basic manufacturer information details, and the currently running firmware version. This information can be used to identify the specific hardware and notify in case a firmware update is needed to support the complete functionality set.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: DeviceControl						
Device Vendor Name	Name of the manufacturer of the device	DeviceVendorName	String			
Device Model Name	The model of the device	DeviceModelName	String			
Device Manufacturer Info	Extended manufacturer information about the device	DeviceManufacturerInfo	String			
Device Version	The version of the device	DeviceVersion	String			
Device Firmware Version	The firmware version of the device	DeviceFirmwareVersion	String			
Device Serial Number	Device's serial number. This string is a unique identifier of the device	DeviceSerialNumber	String			
Device Operation Time	Device operation time since first power up	DeviceOperationTime	Integer			RO in minutes
Device Temperature Selector	Selects the temperature value source	DeviceTemperatureSelector	Enumeration (Selector)	0 1	Processor Sensor	
Device Temperature	Device temperature	DeviceTemperature [DeviceTemperatureSelector]	Float	Max: 120 Min: -60		In °C
Led Activation Mode	Selects the led activation mode	LedActivationMode	Enumeration (Selector)	0 1	Automatic Off	
Device Fan Mode	Selects how to control the fan activation state	DeviceFanMode	Enumeration (Selector)	0 1 2	Auto Manual ForceOff	
Device Fan Duty Cycle	Device fan activation duty cycle. The duty cycle is the percentage of the pulse duration from the total period of the fan's rotation cycle.	DeviceFanDutyCycle [DeviceFanMode]	Integer			
Device Fan Threshold High	The high end of the temperature range desired in manual mode	DeviceFanThresholdHigh [DeviceFanMode]	Integer			In °C
Device Fan Threshold Low	The low end of the temperature range desired in manual mode	DeviceFanThresholdLow [DeviceFanMode]	Integer			In °C

Table 4 – Device Control parameters

5.1.1 Device Operation Timer

Device Operation Timer indicates how much time has the camera been operational in its lifetime. The time value units of the Timer are in minutes. For example, a value of 1234 will indicate that the camera has been operational (powered-up) for a total of 1234 minutes in its lifetime.

5.1.2 Fan Control

Allows configuring the camera fan activation behavior. This feature is only available for camera models which have a fan. Two modes are available:

1. Auto Mode:
   The fan activation is monitored and the controller automatically.
2. Manual Mode:
   The fan activation is controlled using a specified threshold and duty cycle.
3. Force On:
   The fan is always On.
4. Force Off:
   The fan is always Off.

Manual fan operation steps:
To set manual fan rotation, use the following parameter configurations:

1. Switch "Device Fan Mode" to Manual to enable temperature thresholds and fan duty cycle
2. "Device Fan Duty Cycle" represents the PWM fan speed as a percentage.
3. Set "Device Fan Threshold High" for value in Celsius at which the fan turns ON.
4. Set "Device Fan Threshold Low" for value in Celsius at which the fan turns OFF.

Important note: *Not all cameras equipped with a fan are able to gradually adjust 'Fan Duty Cycle', some models are limited to a binary switch where value of 0 is fan off and 100 is fan on.*

5.1.3 LED control

Allows controlling the led activation behavior. The configuration applies to all camera LEDs. Two modes are available:

1. Automatic:
   The LEDs will indicate status according to CoaXPress standards (please see 4.4).

2. Off:
   The camera's LEDs will turn ON when power is applied to the camera. All the LEDs will turn OFF once the camera is detected.

5.2 Timestamp

Timestamp mechanism for tagging frames and I/O events. The timestamp parameter reflects a global counter value, in nanoseconds. The counter value is represented by a 64bit unsigned integer which wraps around when the maximum value is reached and can be read from the “Timestamp” register. “TimestampReset” command force resets the timestamp counter to 0.

The timestamp counter may not be stopped but the “TimestampLatch” may capture the counter value at the moment it is issued. The captured value will be stored in 64bit unsigned integer register “TimestampLatchValue” until the next “TimestampLatch” command is issued. The timestamp parameters are summarized in the following table:

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: DeviceControl						
Timestamp	The current value of the device timestamp counter. The same timestamp counter is used for tagging images and I/O events	Timestamp	Integer (8 bytes)			Value in nanoseconds
Timestamp Reset	Resets the current value of the device timestamp counter to values specified in “TimestampResetValue”	TimestampReset	Command	1 - Activate		
Timestamp Latch	Latches the current timestamp counter into TimestampLatchValue	TimestampLatch	Command	1 - Activate		
Timestamp latched value	Latched value of the timestamp counter	TimestampLatchValue	Integer (8 bytes)			Value in nanoseconds
Timestamp reset value	Reset the value of the timestamp counter	TimestampResetValue	Integer (8 bytes)			Value in nanoseconds

Table 5 – Hardware information parameters

5.3 Image Format Control

The Image Format Control is responsible for defining the output image dimensions and format type. The resolution of the image and output format will influence the maximum frame rate which can be achieved.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: ImageFormatControl						
Width Min	Minimum width of the image	WidthMin	Integer			In pixels *See remark (1)*
Height Min	Minimum height of the image	HeightMin	Integer			In pixels *See remark (1)*
Width Max	Maximum width of the image	WidthMax	Integer			In pixels *See remark (1)*
Height Max	Maximum height of the image	HeightMax	Integer			In pixels *See remark (1)*
Width	Width of the image provided by the device (in pixels)	Width	Integer	≥ 4		
Height	Height of the image provided by the device (in pixels)	Height	Integer	≥ (*)		*Minimum value is dependent on sensor type, pixel bitness and acquisition mode
Offset X	Horizontal offset from the origin to the area of interest (in pixels)	OffsetX	Integer			*See remark (2)*
Offset Y	Vertical offset from the origin to the area of interest (in pixels)	OffsetY	Integer			*See remark (2)*
Region Mode	Controls if the selected Region of interest is active and streaming.	RegionMode	Enumeration	0 - Off 1 - On		
Region Selector	Selects the Region of interest to control.	RegionSelector	Enumeration (Selector)	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Region0 Region1 Region2 Region3 Region4 Region5 Region6 Region7 Region8 Region9 Region10 Region11 Region12 Region13 Region14 Region15	
Region Height	Height of the image provided by the device (in pixels) in multi-ROI. modeimage when HDR mode is enabled	RegionHeight [RegionSelector]	Integer	Max: HeightMaxReg Inc: 4		In pixels

Region OffsetY	Vertical offset from the origin to the area of interest (in pixels) in multi-roi mode	RegionOffsetY [RegionSelector]	Integer			
Pixel Format	Indicates the format of the pixel to use during the acquisition	PixelFormat	Enumeration	0x01080001 0x01100003 0x01100005 0x01080008 0x0110000C 0x01100010 0x01080009 0x0110000D 0x01100011 0x0108000A 0x0110000E 0x01100012 0x0108000B 0x0110000F 0x01100013	Mono8 Mono10 Mono12 BayerGR8 BayerGR10 BayerGR12 BayerRG8 BayerRG10 BayerRG12 BayerGB8 BayerGB10 BayerGB12 BayerBG8 BayerBG10 BayerBG12	*See remark (3)*
Sensor Operation Mode	Sensor sequencer operation mode.	SensorOperationMode	Enumeration	0 1 2 11 21 31 41	Invalid HDR12bit HDR11bit CMS12Bit HighSpeed11Bit GlobalReset12Bit DDS10Bit	*Available for Iron2020 BSI only*
Sensor Image Mode	Image output mode from the sensor.	SensorImageMode	Enumeration	0x00 0x01 0x02 0x03 0x04	HighGain LowGain Interlaced HDR Avarage	*Available for Iron2020 BSI only*
Image HDR Threshold	Control the image threshold of high and low gain image when HDR mode is enabled.	SensorImageHdrThreshold	Integer			*Available for Iron2020 BSI only*
Image HDR Gain	Control the image gain of high and low gain image when HDR mode is enabled.	SensorImageHdrGain	Float	Min: 0 Max: 63.999		*Available for Iron2020 BSI only*
Image HDR Offset	Control the image offset of high and low gain image when HDR mode is enabled.	SensorImageHdrOffset	Integer	Min: 32768 Max: 32767		*Available for Iron2020 BSI only*
Pixel Adc	Indicates the pixel analog output bitness during the acquisition	PixelAdc	Enumeration	0 1 2	Adc8bit Adc10bit Adc12bit	
Scan Type	Scan type of the sensor of the device	DeviceScanType	Enumeration	0 1	Areascan Linescan	only “Areascan” is available for now
Test Pattern	Selects the type of test pattern that is generated by the device as image source	TestPattern	Enumeration	0x000 0x200 0x201 0x202	Off GrayHorizontalRamp GrayVerticalRamp GrayDiagonalRamp	Camera may also contain sensor specific test patterns

				0x203 0x2FF	GrayDiagonalIntervalRamp UserTestPattern	
Vertical invert	Flip image vertically. The ROI will stay as original image.	ReverseY	Boolean	0 1	False True	
Horizontal invert	Flip image horizontally. The ROI will stay as original image.	ReverseX	Boolean	0 1	False True	
Binning Selector	Selects which binning engine is controlled by the BinningHorizontal and BinningVertical features	BinningSelector	Enumeration	0 1	Default Sensor	
Binning Vertical	Number of vertical photo-sensitive cells to combine together	BinningVertical	Integer	Min: 1 Max: 2		*See remark (4)*
Binning Horizontal	Number of horizontal photo-sensitive cells to combine together	BinningHorizontal	Integer	Min: 1 Max: 2		*See remark (5)*
Decimation Selector	Selects which decimation engine is controlled by the DecimationHorizontal and DecimationVertical features	DecimationSelector	Enumeration	0 1	Default Sensor	
Decimation Horizontal	Horizontal sub-sampling of the image	DecimationHorizontal	Integer	Min: 1 Max: 2		*See remark (6)*
Decimation Vertical	Vertical sub-sampling of the image	DecimationVertical	Integer	Min: 1 Max: 2		*See remark (7)*

Table 6 – Image Format control parameters

Remarks:

1. *The dimension is calculated after horizontal binning, decimation or any other function changing the horizontal dimension of the image.*
2. *Some cameras support dynamic offset updates. This means that "OffsetX" and "OffsetY" can also be changed during frame transmission and not just during setup.*
3. *Conversion in Frame Grabber is possible according to the input camera, "PixelFormat", resolution and HW capabilities*
4. *Reduces the vertical resolution (height) of the image. A value of 1 indicates that no vertical binning is performed by the camera.*
5. *Reduces the horizontal resolution (width) of the image. A value of 1 indicates that no horizontal binning is performed by the camera.*
6. *Reduces the horizontal resolution (width) of the image by the specified horizontal decimation factor.*
7. *Reduces the vertical resolution (height) of the image by the specified vertical decimation factor.*

5.3.1 Vertical Region Multi-ROI

The Vertical Multi-ROI feature, provide option to configure multiple regions of interest (ROIs) along the vertical axis of the sensor. This enables efficient image acquisition by capturing only relevant areas, reducing bandwidth and processing requirements. Depending on the model, up to 16 non-overlapping regions can be defined, and a composite image is transmitted instead of the full sensor output. This boosts the maximum frame rate by skipping unused rows. Ideal for applications requiring selective data extraction while maintaining high-speed performance.

Remarks:

1. *Enabled region ROI is when its "RegionHeight" is more than 0, and previous region ROI is also enabled.*
2. *"RegionOffsetY" must be in ascending order compared to previous offset value.*
3. *Sum of all "RegionHeight" must not exceed the sensor's maximum height.*
4. *The output image total height is calculated by the "Height" and NOT the "RegionHeight" parameter.*

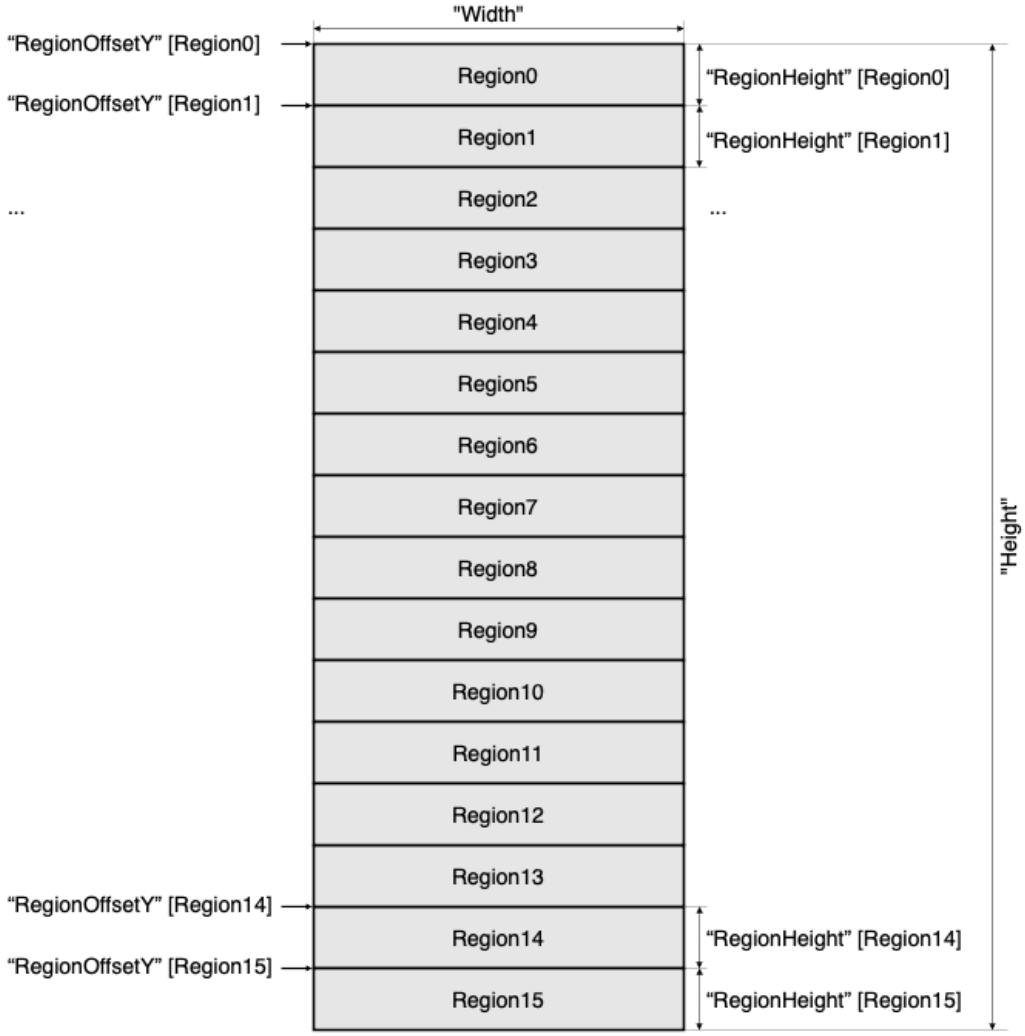


Figure 10 – Vertical region multi-ROI

5.4 Acquisition Control

The Acquisition stream control section describes settings and states for data generation (commands and stream). The acquisition can also be controlled trough executing the relevant commands from this category.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: AcquisitionControl						
Acquisition Reset	Resets the image acquisition logic and counters	AcquisitionReset	Command	1 - Activate		
Acquisition Start	Starts the Acquisition of the device	AcquisitionStart	Command	1 - Activate		
Acquisition Stop	Stops the Acquisition of the device at the end of the current Frame	AcquisitionStop	Command	0 - Activate		
Frame Rate Max	Acquisition rate maximum value	AcquisitionFrameRateMax	Float			In units of Hz
Frame Rate	Controls the acquisition rate at which the frames are captured	AcquisitionFrameRate	Float			In units of Hz
Exposure Mode	Sets the operation mode of the Exposure (or shutter)	ExposureMode	Enumeration	0x00 0x01	Timed TriggerWidth	
Exposure Time Max	Exposure time maximum value	ExposureTimeMax	Float			In units of microseconds (us)
Exposure Time	Sets the Exposure time when ExposureMode is Timed	ExposureTime	Float			In units of microseconds (us) *See remark (1)*
Trigger Selector	Selects the type of trigger to configure	TriggerSelector	Enumeration	0	FrameStart	
Trigger Mode	Controls if the selected trigger is active	TriggerMode	Enumeration	0x00 0x01	Off On	

Table 7 – Acquisition Control parameters

Remarks:

1. *Controls the duration where the photosensitive cells are exposed to light.*

5.4.1 Exposure Time

Time in microseconds [µsec] in which sensor is exposed to light. This time is subject to the specified image frame rate:

Minimum exposure depends on camera model, connection configuration and sensor characteristics

$$\text{Maximum exposure} \cong \frac{1{,}000{,}000}{\text{frame rate}}$$

Additional delays might be taken into consideration in the calculation of exposure values, like the delay between frames, etc.

5.4.2 Auto Exposure & Gain Algorithm

Auto Exposure and Gain features are used to control the picture brightness by adjusting Exposure and Gain values in automatic mode to reach desired brightness level. The algorithm calculates the average picture intensiveness inside the defined ROI and tries to adjust it to desired brightness level. The brightness is adjusted by increasing/decreasing exposure time and/or analog gain level. Three modes are available for automatic brightness adjustment:

5.4.2.1 Auto Exposure Mode

When operating in this mode, the camera tries to reach the desired brightness level of the picture by adjusting Exposure Time.

Steps to set Auto Exposure Mode:

1. Define Desired Brightness Level

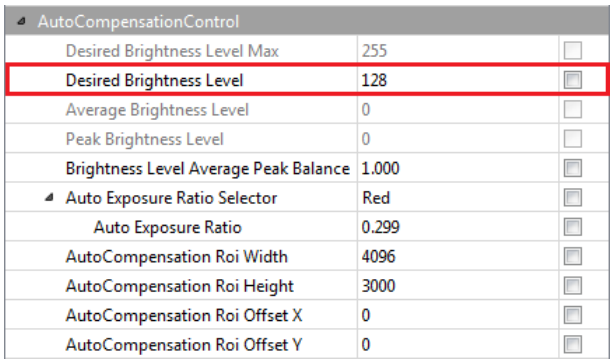


Figure 11 – Brightness level

2. Define Auto Exposure Minimum and Maximum Time. These parameters define the limits for exposure time adjustment. By default, these values will be set to maximum and minimum possible values.

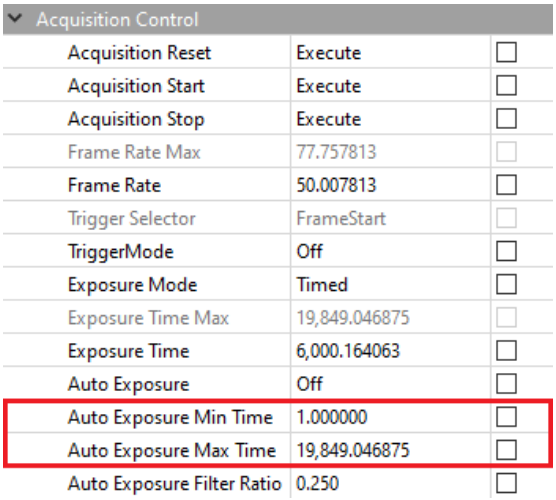


Figure 12 – Auto exposure times

3. Choose one of the Auto Exposure modes: “Once” or “Continuous”. Under “Once” mode, the algorithm will adjust the Exposure only once and then the feature will be set to OFF. Respectively under “Continuous” mode, the exposure will be adjusted continuously.

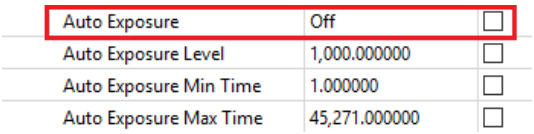


Figure 13 – Auto exposure mode

The next table specifies the Auto Exposure parameters:

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: AcquisitionControl						
Exposure Auto	Sets the automatic exposure mode when ExposureMode is Timed	ExposureAuto	Enumeration	0x00 0x01 0x02	Off Continuous Once	
Exposure Auto Min Time	Sets the Auto Exposure minimal time	ExposureAutoMinTime	Float	Range: 1 to Auto Exposure Max Time		
Exposure Auto Max Time	Sets the Auto Exposure maximum time	ExposureAutoMaxTime	Float	Range: Auto Exposure Min Time to Maximum Exposure Time		
Auto Exposure Filter Ratio	Sets the Auto Exposure filter effective ratio	ExposureAutoFilterRatio		Range: 0 to 1		

Table 8 – Exposure Auto control

5.4.2.2 Auto Gain Mode

When operating in this mode, the camera tries to reach the desired brightness level of the picture by adjusting Analog Gain Level. Steps to set Auto Gain Mode:

1. Define Desired Brightness Level

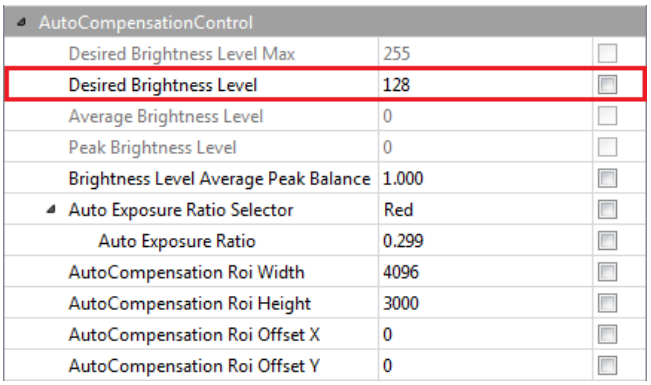


Figure 14 – Brightness Level

2. Define Auto Gain Minimum and Maximum Gain. These parameters define the limits for analog gain adjustment. By default, these values will be set to maximum and minimum possible values.

Figure 15 – Auto Gain values

3. Choose one of the Auto Gain modes: "Once" or "Continuous". Under "Once" mode, the algorithm will adjust the Analog Gain only once, and then the feature will be set to OFF. Respectively under the "Continuous" mode, the gain will be adjusted continuously.

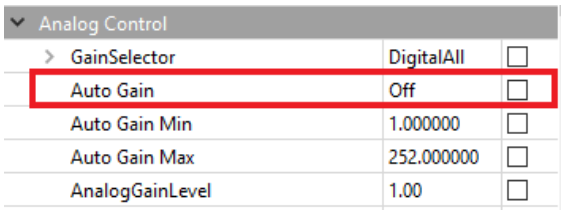


Figure 16 – Auto Gain mode selection

The following tables specify the auto exposure parameters:

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: AnalogControl						
Auto Gain	Auto Gain Selector	GainAuto	Enumeration	0x00	Off	
				0x01	Continuous	
				0x02	Once	
Auto Gain Min	Auto Gain Min Value	GainAutoMin	Float			*See remark (1)*
Auto Gain Max	Auto Gain Max Value	GainAutoMax	Float			*See remark (1)*
Auto Gain Filter Ratio	Sets the Auto Gain filter effective ratio	GainAutoFilterRatio	Float	Range: 0 to 1		

Table 9 – Gain Auto control

Remarks:

1. *The values of the Gain Auto parameters depends on sensor's analog gain range*

5.4.3 Combined Auto Exposure & Auto Gain Mode

When operating in this mode, the camera tries to reach the preferred picture brightness by adjusting both Exposure and Analog Gain values. If the camera's image intensiveness is under desired brightness level, the algorithm first increases the exposure value to make the picture brighter. If the exposure level is at maximum value, while the preferred brightness level is not reached yet, the algorithm starts to modify Gain Level and adjust the exposure level accordingly.

This mode is operational only when both Auto Exposure and Auto Gain are set to "Continues" mode.

Steps to set Combined Auto Exposure and Auto Gain Mode:

1. Define the parameters for Auto Exposure; please see section 5.4.2.1 for detailed instructions.
2. Set Auto Exposure to "Continuous" mode.
3. Define the parameters for Auto Gain; please see related section 5.4.2.2 for detailed instructions.
4. Set Auto Exposure to "Continuous" mode.

5.4.4 Brightness Level

The Desired Brightness Level reflects the average value of all pixels in the defined ROI. The value range of the Desired Brightness Level depends on the output pixel bitness. e.g. for a 10bit output, the value should be between 0 and 1023, while for 12bit output the value should be between 0 and 4095.

The average value is calculated by the following formulas:

avg_val =
ExposureAutoRatio[red]* avg_val[red]+
ExposureAutoRatio[green]* avg_val[green]+
ExposureAutoRatio[blue]* avg_val[blue]
max_val=
ExposureAutoRatio[red]* max_val[red]+
ExposureAutoRatio[green]* max_val[green]+
ExposureAutoRatio[blue]*max_val[blue]
roi_avg=
BrightnessLevelAveragePeakBalance*avg_val+
(1-BrightnessLevelAveragePeakBalance)*max_val
The algorithm strives to make roi_avg value as close as possible to the specified "DesiredBrightnessLevel" by changing Exposure and Analog Gain. The current average value and maximum value can be retrieved using "AverageBrightnessLevel" and "PeakBrightnessLevel" parameters.

Brightness parameters can be seen in the following table:

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: AutoCompensationControl						
Desired Brightness Level	Desired brightness level for auto compensation algorithm	DesiredBrightnessLevel	Integer	Range: 0 to <max pixel value>		
Average Brightness Level	Current average brightness level results from auto compensation	AverageBrightnessLevel	Integer	Range: 0 to <max pixel value>		
Peak Brightness Level	Current peak brightness level results from auto compensation	PeakBrightnessLevel	Integer	Range: 0 to <max pixel value>		
Brightness Level Average Peak Balance	Sets the effective ratio of Average Brightness Level as a complement to Peak Brightness Level	BrightnessLevelAveragePeakBalance	Float	Range: 0 to 1	1 - Complete Average Level 0 - Complete Peak Level	
Auto Exposure Ratio Selector	Selects which Exposure Auto compensation ratio to control	ExposureAutoRatioSelector	Enumeration	0x00 0x01 0x02	Red Green Blue	
Auto Exposure Ratio	Controls ratio of the selected color component to a reference color component	ExposureAutoRatio	Float	Range: 0 to 1		

Table 10 – Brightness level control

5.4.5 Auto Exposure & Gain ROI Definition

ROI definition refers to Region of Interest which will be used for brightness calculations. The ROI Offset X and Offset Y refer to the distance of the ROI from top left corner of sensor area:

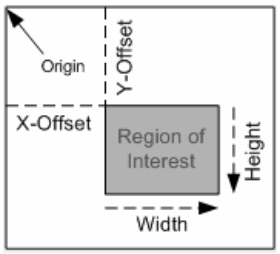


Figure 17 – ROI position in relation to the origin

By default, the ROI is defined to be maximum possible area, i.e. the horizontal and vertical offsets are 0 and the ROI width and height as the sensor dimensions. The ROI settings for brightness calculations could be modified under section Analog Control->AutoCompensationControl:

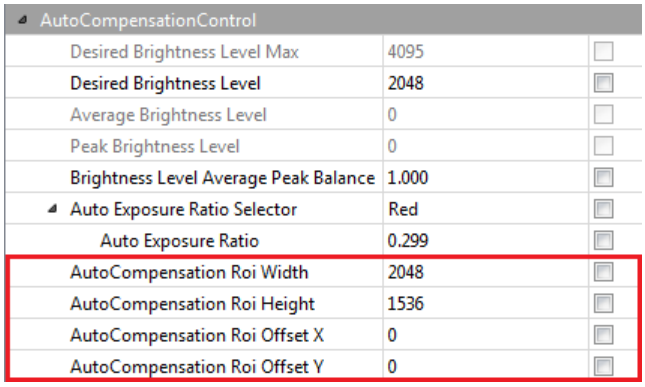


Figure 18 – ROI parameters

Auto Exposure ROI parameters are described in the following table:

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: AutoCompensationControl						
Auto Compensation ROI Width	Width of the Auto Compensation calculation ROI	AutoCompensationRoiWidth	Integer			
Auto Compensation ROI Height	Height of the Auto Compensation calculation ROI	AutoCompensationRoiHeight	Integer			
Auto Compensation ROI Offset X	OffsetX of the Auto Compensation calculation ROI	AutoCompensationRoiOffsetX	Integer			
Auto Compensation ROI Offset Y	OffsetY of the Auto Compensation calculation ROI	AutoCompensationRoiOffsetY	Integer			

Table 11 – Auto compensation ROI control

5.5 Analog Control

Analog control parameters describes how to influence the analog sensor features and digital modifiers, such as gain, black level, white balance and voltages, to manipulate image output.

5.5.1 Analog and Digital Gain and Black Level

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: AnalogControl						
Gain Selector	Selects which gain channel is controlled by the various gain features	GainSelector	Enumeration (Selector)	0 1 2 3	DigitalAll DigitalRed DigitalGreen DigitalBlue	
Gain	Multiplication factor of the selected channel's digital gain	Gain [GainSelector]	Float	Max. 7.99923		
Analog Gain Level	Controls the selected gain as an absolute physical value. This is an amplification factor applied to the video signal	AnalogGainLevel	Float			*See remark (1)*
Black Level Selector	Selects which Black Level is controlled by the various Black Level features	BlackLevelSelector	Enumeration	0 1 2 3	All Red Green Blue	
Black Level	Black offset adder of the selected channel's digital black level	BlackLevel [BlackLevelSelector]	Enumeration			*See remark (3)*
Black Level Auto	Controls the mode for automatic black level adjustment	BlackLevelAuto	Enumeration	0x00 0x01	Off AnalogContinuous	
Analog Black Level	Controls the analog black level as an absolute physical value. Represents the applied DC offset	AnalogBlackLevel	Float			*See remark (1)*
Analog Voltage Selector	Selects an analog voltage	AnalogVoltageSelector	Enumeration (Selector)			*See remark (2)*
Analog Voltage Value	Device analog voltage value in volts	AnalogVoltageValue	Float			In units of Volt (V)

Table 12 – Analog Control parameters

Remarks:

1. *The values of the Analog Gain and Analog Black Level parameters depends on sensor's analog range*
2. *The available voltages depends on camera model*
3. *Min/Max range according to the selected pixel bit depth:*
   8bit: *Range (-256) – (255)*
   10bit: *Range (-1024) – (1023)*
   12bit: *Range (-4096) – (4095)*

14bit: *Range (-16384) – (16383)*
16bit: *Range (-65536) – (65535)*

5.5.2 Analog Gain and Black Level

The Analog Control parameters can be used to adjust the gain and the black level available features.

Analog Gain is a sensor based physical multiplication enhancement. Increasing its value can help in low-light conditions but may also add noise, thus important to find a balance that suits required needs.

Analog Black Level is a sensor based physical offset compensation. The default value is set according to the sensor manufacturer's recommendation, and it is **not recommended to adjust the default value.**

5.5.3 Digital Gain and Black Level

The Gain defined the pixel value multiplication factor, per channel, before further processing.
The Black Level defines the offset, per channel, added to pixel values before further processing.
This adjustment ensures consistent image brightness and contrast across different bit depths.

The correction is performed according to the following equation:

$\overline{P_{red}}=(P_{red}+"BlackLevelRed")*"GainRed"$
$\overline{P_{green}}=(P_{green}+"BlackLevelGreen")*"GainGreen"$
$\overline{P_{blue}}=(P_{blue}+"BlackLevelBlue")*"GainBlue"$

Where P is the pixel that is being corrected, the Black Level is the offset of said pixel and the Gain is the gain of the pixel. Analog Black Level Controls the analog black level as an absolute physical value. Represents the applied DC offset.

5.5.4 Black Level Auto

Black Level Auto is an automatic noise compensation based on the sensor’s black pixels, which are not exposed to light, therefore represent fixed sensor noise. The compensation is applied on a per-line basis.
This adjustment is particularly useful under varying temperature or lighting conditions, where manual black level calibration may be impractical.

5.5.5 White Balance

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: AnalogControl						
Balance White Auto	Controls the mode for automatic white balancing between the color channels. The white balancing ratios are automatically adjusted	BalanceWhiteAuto	Enumeration	0x00 0x01 0x02 0x03	Off Once Continuous Manual	
Balance White Calculation Mode	Controls the mode for calculation algorithm of white balancing compensation	BalanceWhiteCalculationMode	Enumeration	0 1 2 3	HighestValue Red Green Blue	
Balance White Threshold	Limits the maximum threshold value when the white balance compensation algorithm counts. Assists with ignoring over-saturated pixels in calculations.	BalanceWhiteThreshold	Integer	Min: 0 Max: 4095		
Balance White Area Width	Width of the area for BalanceWhite calculation, inside the output image ROI	BalanceWhiteAreaWidth	Integer	Max: Image Width		In units of pixels
Balance White Area Height	Height of the area for BalanceWhite calculation, inside the output image ROI	BalanceWhiteAreaHeight	Integer	Max: Image Height		In units of pixels
Balance White Area Offset X	Horizontal offset from the origin to the area of BalanceWhite interest	BalanceWhiteAreaOffsetX	Integer			In units of pixels
Balance White Area Offset Y	Vertical offset from the origin to the area of BalanceWhite interest	BalanceWhiteAreaOffsetY	Integer			In units of pixels
Balance Ratio Selector	Selects which Balance ratio to control	BalanceRatioSelector	Enumeration	0 1 2	Red Green Blue	
Balance Ratio	The ratio of the selected color, compared to a reference color component selected using Balance White Calculation Mode. Used to adjust colors for white balancing	BalanceRatio [BalanceRatioSelector]	Float	Max. 7.999		

Table 13 – White Balance parameters

Automatic white balance adjustment, compensate sensor output colors to true colors. The algorithm works on the assumption that the average color of an image in selected ROI is gray. Manual adjustment can also be selected per color, for user configuration coefficients. The calculation mode can be adjusted to normalize the result according to the selected color or highest value.

5.6 LUT control

The LUT control can be used to re-map the camera linear output in a different manner. Mostly to compensate for the non-linear scene emission. LUT configuration typical applications include enhancing gamma or image contrast, brightness changes, gray value spreading, setting individual gradation curves, etc.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: LUTControl						
LUT Selector	Selects which LUT to control	LUTSelector	Enumeration (Selector)	0 1 2 0xFF	Red Green Blue All	
LUT Enable	Activates the selected LUT	LUTEnable [LUTSelector]	Boolean	0 - false 1 - true		
LUT Index	Control the index (offset) of the coefficient to access in the selected LUT	LUTIndex [LUTSelector]	Integer	Max. 4095		
LUT Value	Returns the Value at entry LUTIndex of the LUT selected by LUTSelector	LUTValue [LUTSelector] [LUTIndex]	Integer	Max. 4095		
LUT Value All	Accesses all the LUT coefficients in single access without using individual LUTIndex	LUTValueAll [LUTSelector]	IRegister			

Table 14 – LUT Control parameters

5.6.1 LUT pixel re-map algorithm

Each index at the LUT corresponds to the pixel value and the LUT value at this index corresponds to the value that the pixels should be replaced with. The applied valid LUT index and the corresponding value will be re-mapped according to selected pixel bitness. i.e For 8 bit, the applied indexes will be 0-255, for 10 bit the applied indexes will be 0-1023, and for 12 bit the applied indexes will be 0-4095.

The pixel value is replaced according to the following equation:

$$\overline{P_{red}(x,y)} = LUT_{red}[P_{red}(x,y)]$$
$$\overline{P_{green}(x,y)} = LUT_{green}[P_{green}(x,y)]$$
$$\overline{P_{blue}(x,y)} = LUT_{blue}[P_{blue}(x,y)]$$

Where P(x,y) is the pixel at offset X in horizontal and Y in vertical, of a specific color.

5.7 Gamma Control

Gamma correction is typically used to compensate for the non-linearity of the display system: it can be used to change the dynamic range of the image in such a way that more shades become visible while not losing the depth of the image.
Gamma control implements several modes: on the one hand, there are fast, preset configurations according to high-definition television standards, and on the other hand, extended configurations for fine-tuning of the gamma algorithm.

Remarks:

1. *The gamma control uses LUT tables to implement the curve correction.*
2. *All channels' LUT tables are filled and used according to selected bitness. For more details see section "5.6.1 LUT pixel re-map algorithm"*
3. *LUT control should be enabled to apply the gamma curve parameters.*

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: LutControl						
Gamma Mode	Select the Gamma mode and calculation algorithm	GammaMode	Enumeration (Selector)	0 1 2 3 4 5	Table Fast FastExtended FixedBT709 FixedPQ FixedHLG	
Gamma Reset BT.709	Reset the Gamma conversion parameters according to BT.709 standard	GammaResetBT709	Command			Available only in "Fast" and "FastExtended" modes
Gamma	Controls the gamma correction of pixel intensity. This is typically used to compensate for the non-linearity of the display system	Gamma	Float	Max: Min: Inc:	3.0 1.1 0.001	Available only in "Fast" and "FastExtended" modes
Gamma Threshold	Controls the fast gamma correction threshold where the gamma curv calculation formula turns from linear to non-linear	GammaThreshold	Float	Max: Min: Inc:	0.0 1.0 0.001	Available only in "FastExtended" mode
Gamma Linear Contrast	Controls the fast gamma correction contrast for the linear part of the formula.	GammaLinearContrast	Float	Max: Min: Inc:	0.0 20.0 0.001	Available only in "FastExtended" mode
Gamma Linear Brightness	Controls the fast gamma correction brightness for the linear part of the formula	GammaLinearBrightness	Float	Max: Min: Inc:	-1.0 1.0 0.001	Available only in "FastExtended" mode
Gamma Contrast	Controls the fast gamma correction contrast for the non-linear part of the formula	GammaContrast	Float	Max: Min: Inc:	0.0 10.0 0.001	Available only in "FastExtended" mode
Gamma Brightness	Controls the fast gamma correction brightness for the non-linear part of the formula	GammaBrightness	Float	Max: Min: Inc:	-1.0 1.0 0.001	Available only in "FastExtended" mode

Table 15 – Gamma Control parameters

5.7.1 Gamma Control Modes

1. Table Based Gamma:
   Table-based gamma correction allows for manually filling LUT tables per color. This mode disables any gamma algorithm implemented in the camera in favor of raw LUT table compensation (see section 5.6 LUT control).

2. Fast Gamma:
   Computes gamma cure according to BT.709. Allows fast change of the gamma coefficient only, while other coefficients are adapted accordingly to create a consistent curve, between the linear and non-linear sections.

3. Fast Extended Gamma:
   Computes gamma cure according to BT.709. Allows updating each of the coefficients of the formula.

4. Fixed BT.709:
   Preset BT.709 (also known as REC.709) gamma curve with the value of $\frac{1}{2.222} = 0.45$

5. Fixed PQ:
   Preset PQ gamma curve specified in ITU-R BT.2100 which can be used for HDR content.

6. Fixed HLG:
   Preset HLG gamma curve specified in ITU-R BT.2100 which can be used for HDR content.

5.7.2 BT.709 standard gamma curve algorithm

The following image shows the normalized REC.709 gamma curve and its transition from linear to non-linear (power function) parts:

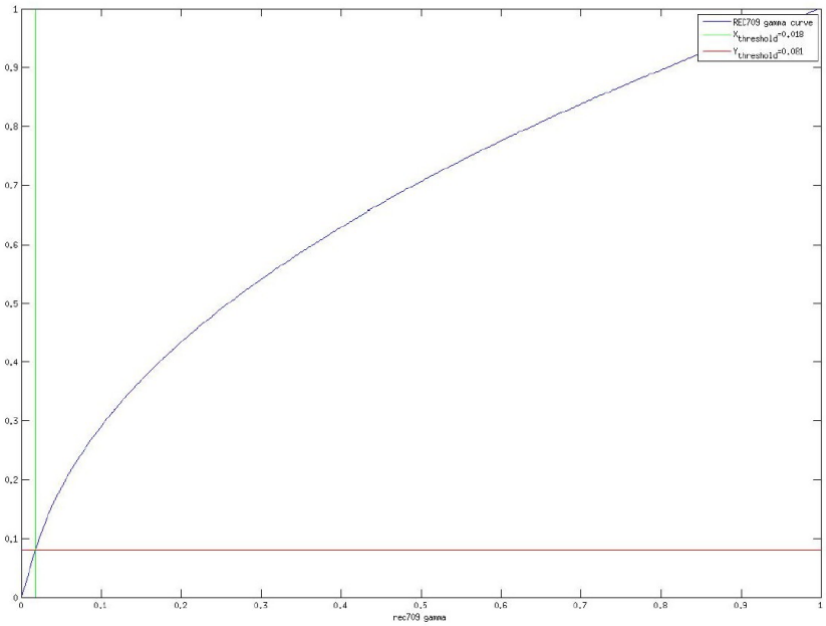


Figure 19 – REC. 709 gamma curve

The linear part ranges from 0 to <0.018 and is computed by the following formula:

$V_{out} = 4.5*V_{in}$

The maximum value in this range is:

$V_{out,min} = \lim_{V_{in} \to 0.018} (4.5* V_{in}) = 4.5*0.018 = 0.081$

The non-linear part ranges from 0.018 to 1 and is computed by the following formula:

$V_{out} = 1.099 * V_{in}^{(1/2.222)} - 0.099$

The minimum value in this range is:

$V_{out,min} = 1.099*0.018^{(1/2.222)} - 0.099 = 0.081$

To avoid a discontinuity in the gamma function select the brightness (offset) for the non-linear part by the following formula:

$V_{out,linear\ max} \approx V_{out,linear\ min}$

$brightness_{non-linear} \approx (Contrast_{linear} * threshold + Brightness_{linear}) - Contrast_{non-linear} * threshold^{Gamma}$

5.8 Pixel Correction Control

The pixel correction control allows compensating any sensor dead pixel by averaging adjacent pixels. The Dark and Flat field correction algorithm helps to solve issues with fixed pattern noise, which usually originates from the sensor.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: PixelCorrectionControl						
Defect Pixel Correction Enable	Enable the Defect Pixel correction algorithm	DefectPixelCorrectionEnable	Boolean	0 - false 1 - true		
Defect Pixel Selector Max	Total number of defect pixels to be corrected	DefectPixelSelectorMax	Integer			
Defect Pixel Selector	Total number of defect pixels to be corrected	DefectPixelSelector	Integer (Selector)			
Defect pixel X coordinate	Configure defect pixel X coordinate	DefectPixelX [DefectPixelSelector]	Integer	Min: -1 Max: SensorWidth		
Defect pixel Y coordinate	Configure defect pixel Y coordinate	DefectPixelY [DefectPixelSelector]	Integer	Min: -1 Max: SensorHeight		
Defect Pixel Remove	Remove the defect pixel determined by DefectPixelWriteX and DefectPixelWriteY	DefectPixelRemove [DefectPixelSelector]	Command	1 - Activate		
Dark Field Correction Enable	Enable the Dark Field correction algorithm	DarkFieldCorrectionEnable	Boolean	0 - false 1 - true		
Flat Field Correction Enable	Enable the Flat Field correction algorithm	FlatFieldCorrectionEnable	Boolean	0 - false 1 - true		
Field Calibration Mode	Sets the operation Field Calibration mode	FieldCalibrationMode	Enumeration (Selector)	0 1	Dark Flat	
Field Calibration Start	Activates the Field Calibration	FieldCalibrationStart [FieldCalibrationMode]	Command	1 - Activate		

Table 16 – Pixel Correction Control parameters

5.8.1 Defect Pixel Correction

The defected pixel correction will correct up to 32 pixels in the sensor and up to 2 adjacent pixels in a row. The pixel correction coordinates represent pixels of the sensor's visible ROI, therefore identifying the correct X and Y coordinate should be done using a default, full resolution image.

The algorithm will correct the defect pixel based on the value of existing adjacent pixels. The correction for the Mono and Color sensor is slightly different and described as follows:

Mono pixel correction:

The defect pixel P(x,y) value will be the average value of 2 pixels adjacent to pixel P(x,y) from both sides in the same row.

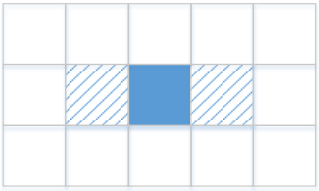


Figure 20 – Defect pixel correction position for Mono image

Color (Bayer) pixel correction:

The defect pixel P(x,y) value will be the average value of two pixels from both sides of pixel P(x,y) in the same row, corresponding to the same Bayer color element.

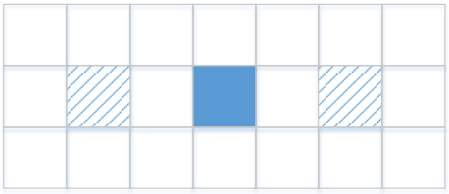


Figure 21 – Defect pixel correction position for Color image

5.8.2 Field Correction

The Flat-field and Dark-field corrections are used to improve the quality of the image by removing the artifacts that are caused by fixed pattern noise and variations in the pixel-to-pixel sensitivity of the detector. To make a Dark/Flat field correction, two pictures should be taken. One with the lens closed (offset should be boosted) and one with uniform illumination of around 40% . The operator is per pixel and defined according to the following formula:

$$\overline{P(x,y)}=Gain(x,y)[P(x,y)-P_{dark}(x,y)]$$

Where P(x,y) is the pixel at offset X in horizontal and Y in vertical. Pdark (x,y) is the offset of the pixel at offset X in horizontal and Y in vertical that was measured during the calibration stage. Gain(x,y) is the gain of the pixel at offset X in horizontal and Y in vertical that was measured during the calibration stage.

This correction is valid for the specific camera settings and conditions (gain, exposure time, temperature, etc.) which were selected during the calibration process. Follow these steps to perform the calibration process:

1. Prepare light source for specific calibration:

    a. Dark field calibration: in this case, the light should be blocked from the sensor. This can be achieved by covering the sensor with a solid cap.
    b. Flat field calibration: in this case, uniform light should be applied across the sensor. This can be achieved by setting a uniform light source in front of the camera.

2. Select the “Calibration Mode” either “Dark” or “Flat”
3. Start the camera’s stream either in a free run or by applying an external trigger.
4. Initiate the selected calibration with the “Field Calibration Start” command Execute.

Remarks:

1. *The Flat field calibration should be performed after the Dark field calibration has already been performed for the selected camera settings.*
2. *The PRNU and DSNU depend on exposure, gain, temperature, and the number of active fiber links. In case the above conditions might change during camera operation, it is advised to pre-calibrate the system on several conditions and save them as different user sets. Load the user set if the conditions have been changed. User set control is described in the section. For more information, please refer to “Flat Field correction in JetCam cameras”.*
3. *“Default” user set will load the camera’s factory settings.*
4. *Firmware updates may erase the saved user sets and may change the camera’s “Default” settings.*

5.9 File Access Control

File Access Control contains parameters related to accessing files stored on the device, including file selection, operation mode (reading and writing) as well as data transfer limitations, and information regarding file sizes.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: FileAccessControl						
File Selector	Selects the target file in the device	FileSelector	Enumeration (Selector)	0 1	FirmwareUpdate UserMemory	
File Open Mode	Selects the access mode in which a file is opened in the device	FileOpenMode	Enumeration	0 1 2	Read Write ReadWrite	
File Size	Represents the size of the selected file in bytes	FileSize	Integer			
File Operation Selector	Selects the target operation for the selected file in the device. This Operation is executed when the FileOperationExecute feature is called	FileOperationSelector	Enumeration (Selector)	0 1 2 3	Open Close Read Write	
File Access Offset	Controls the Offset of the mapping between the device file storage and the FileAccessBuffer	FileAccessOffset	Integer			
File Access Length	Controls the Length of the mapping between the device file storage and the FileAccessBuffer	FileAccessLength	Integer	Min. 0 Max. 1024		
File Access Buffer	Defines the intermediate access buffer that allows the exchange of data between the device file storage and the application	FileAccessBuffer	IRegister			
File Operation Execute	Executes the operation selected by FileOperationSelector on the selected file	FileOperationExecute	Command	1 - Activate		
File Operation Status	Represents the file operation execution status	FileOperationStatus	Enumeration	0 1	Success Failure	
File Operation Result	Represents the file operation result. For Read or Write operations, the number of successfully read/written bytes is returned	FileOperationResult	Integer			

Table 17 – File Access Control parameters

5.9.1 How to Use File Access Control

The purpose of the file access control interface is to perform large data transfers with the camera. This can be achieved using the following sequence:

Write operation sequence:

1. Select the file section to access using “FileSelector”
2. Change the “FileOpenMode” to either “Write” or “ReadWrite”
3. Set the “FileOperationSelector” to “Open” toopen write access to the selected file
4. Open the file using “FileOperationExecute” command.
5. Check the operation status in “FileOperationStatus“. On success, file will open for writing.
6. Set the “FileOperationSelector” to “Write” toselect write operation.
7. Fill “FileAccessOffset”, “FileAccessLength” and “FileAccessBuffer” with offset position, length and data for next transection.
8. Perform write operation using “FileOperationExecute” command.
9. Check the operation status in “FileOperationStatus“ and the count of transferred bytes in “FileOperationResult”
10. Proceed to the next transaction, by performing steps 7-9 until all file is transferred

Read operation sequence:

1. Select the file section to access using “FileSelector”
2. Change the “FileOpenMode” to either “Read” or “ReadWrite”
3. Set the “FileOperationSelector” to “Open” toopen read access to selected file
4. Open the file using “FileOperationExecute” command.
5. Check the operation status in “FileOperationStatus“. On success file will open for reading.
6. Set the “FileOperationSelector” to “Read” toselect read operation.
7. Fill “FileAccessOffset”, “FileAccessLength” with offset position and length for the next transection.
8. Perform read operation using “FileOperationExecute” command.
9. Check the operation status in “FileOperationStatus“ and the count of transferred bytes in “FileOperationResult”
10. On success, read the extracted data from “FileAccessBuffer”.
11. Proceed to the next transaction, by performing steps 7-10 until all file is transferred

5.9.2 Firmware Update

"FirmwareUpdate" is used to upload new firmware to the camera: only a dedicated firmware update file should be loaded using this method. The file upload process should not be interrupted and must be completed for a successful camera firmware update. After the upload of a new firmware file is finished the camera should be power cycled. Note that although the camera will not have any external indication (i.e. led), power must be applied for at least 30 seconds to complete the update operation

5.9.3 User Memory

"UserMemory" is a dedicated, non-volatile memory space reserved for user usage. Up to 74 MB can be filled with user-specific data, which can be read back at any time. This memory space will not be erased or modified on the camera power cycle. Notice that the camera does not manage the user memory space nor is it responsible for any initial value.

Write operation remarks:

Writing to any offset which is aligned to 0x10000 (0, 0x10000, 0x20000, 0x30000 …) will erase the complete sector (size of 0x10000 bytes). Writing to any offset which is not aligned to 0x10000 will just perform a write operation. Be aware that if a specified offset sector was not erased, new data will be written over existing data and may result in corrupted data.

Remark:

1. *It is advised not to perform memory access operations while the stream is running, reduce traffic which might result in an error.*

5.10 User Set Control

Eight user sets are available for saving different camera parameter configurations. In addition, a “Default” UserSet is available so it will be possible to revert to default factory settings.

The User Set Control parameters are summarized in Table 18 and Table 19

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: UserSetControl						
User Set Selector	Selects the feature User Set to load, save or configure	UserSetSelector	Enumeration (Selector)			
Load User Configuration	Loads the User Set specified by UserSetSelector to the device and makes it active	UserSetLoad [UserSetSelector]	Command	1 - Activate		
Save User Configuration	Save the User Set specified by UserSetSelector to the non-volatile memory of the device	UserSetSave [UserSetSelector]	Command	1 - Activate		
User Set Default Selector	Selects the feature User Set to load and make it active when the device is reset	UserSetDefault	Enumeration			

Table 18 – User Set Control parameters

Value	Gen<i>Cam name
0	Default
1	UserSet1
2	UserSet2
3	UserSet3
4	UserSet4
5	UserSet5
6	UserSet6
7	UserSet7
8	UserSet8

Table 19 – User Set Selector parameters

5.10.1 UserSet operation sequence

The following steps describe the sequence of saving and loading user set camera parameter configurations:

Save User Set:

1. Set the desired camera parameters.
2. Open the “User Set Control” category
3. Select the desired “UserSetSelector” enumeration as “UserSetX” (X in range of 1-8).
   Note: *“Default” user set contains factory settings and is read-only.*
4. Execute the “Save User Configuration” command.

Load User Set:

1. Select “UserSetSelector” to the desired “UserSetX” (X in range of 1-8).
2. Execute the “Load User Configuration” command.
3. Refresh the Gen<i>Cam browser to reflect the current camera settings.

Default User Set:

1. Select a “UserSetDefault” to be “UserSetX” (X in range of 1-8). These settings will be automatically loaded upon the camera’s power-up.

Remarks:

1. *“Default” user set will load the camera’s factory settings.*
2. *Firmware updates may erase the saved user sets and may change the camera’s “Default” settings.*

5.11 CoaXPress Category

The CoaXPress category deals with CoaXPress protocol-specific configuration parameters.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: CoaXPress						
Device Link ID	Bootstrap register DeviceLinkID	DeviceLinkID	Integer			
Master Host Link ID	Bootstrap register MasterHostLinkID	MasterHostLinkID	Integer			
Control Packet Data Size	Bootstrap register ControlPacketDataSize	ControlPacketDataSize	Integer			
Stream Packet Data Size	Bootstrap register StreamPacketDataSize	StreamPacketDataSize	Min. 256 Max. 8192			
Connection Config	Bootstrap register ConnectionConfig	ConnectionConfig	Enumeration	0x00010038 0x00010048 0x00010058	x1_CXP_3 x1_CXP_6 x1_CXP_12	
Connection Config Default	Bootstrap register ConnectionConfigDefault	ConnectionConfigDefault	Enumeration	0x00010038 0x00010048 0x00010058	x1_CXP_3 x1_CXP_6 x1_CXP_12	
CoaXPress Connection Selector	Selects the CoaXPress physical connection to control	CxpConnectionSelector	Integer	0 – Default		
Connection Test Mode	Test communication errors of the system cabling between devices	CxpConnectionTestMode	Enumeration	0 1	Off Mode1	
Connection Test Error Count	Reports the current connection error count for test packets received by the device on the connection selected by CxpConnectionSelector	CxpConnectionTestErrorCount	Integer			
Connection Test Rx Packets	Reports the current count for test packets received by the device on the connection selected by CxpConnectionSelector	CxpConnectionTestRxPacketCount	Integer			
Connection Test Tx Packets	Reports the current count for test packets sent to the device on the connection selected by CxpConnectionSelector	CxpConnectionTestTxPacketCount	Integer			
Tap Geometry	Vertical multi-tap geometry scanning	TapGeometry	Enumeration	0	X1_1Y	
Image1 Stream ID	Gives the Stream ID of the first image stream from the Device	Image1StreamID	Integer			

Table 20 – CoaXPress parameters

5.12 Test Control

The test Control category contains parameters for camera testing and analysis purposes only. These configurations are not required for the standard operation of the camera. Configuration of these parameters might result in unexpected camera behavior if the wrong value is input.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: TestControl						
Sensor Register Address	Sensor Register Address	SensorRegAddress	Integer			
Sensor Register Value	Returns the value of sensor register at SensorRegAddress address	SensorRegValue	Integer			
Gen<i>Cam Category: TestControl/BIT						
BIT Reset All	Reset all BITs	BITResetAll	Command	1 - Activate		
BIT Start All	Start all BITs	BITStartAll	Command	1 - Activate		
BIT Count	Number of available BITs	BITCount	Integer			
BIT Selector Index	Selects BIT configuration	BITSelectorIndex	Integer (Selector)			
BIT Selector	Selects BIT configuration	BITSelector	Enumeration	0	Flash	
				1	Uart	
				2	SensorControl	
				3	SensorLVDS	
				4	Temperature	
				5	Voltages	
				6	MACOM	
				7	GPIO	
BIT Start	Start selected BIT	BITStart	Command	1 - Activate		
BIT Status	BIT current status	BITStatus	Enumeration	0	Unknown	
				1	Pass	
				2	Fail	
				0xFF	Unsupported	
BIT Error Report	BIT last error report description	BITErrorReport	String			

Table 21 – Test Control parameters

5.12.1 Build-In-Test

The Build-In-Test (BIT) implements an option to check individual camera's interfaces to insure correct behavior in the allowed range. Each test may result in "Pass", "Fail" or "Unsupported" with an appropriate error report, either by starting an individual test or all tests together.

Following describe each test functionality:

1. Flash – Test the functionality of flash access.
2. Uart [(1)] – Test the functionality of the UART interface. (Loopback dongle should be mounted to perform this test)
3. SensorControl – Test basic communication with the sensor by reading and comparing it with a known default value.
4. SensorLVDS – Test stream interface with the sensor using a known pattern.
5. Temperature – Test the temperature of several components; they must be in the acceptable range.
6. Voltages – Test the analog voltages levels; they must be in the acceptable range.
7. MACOM [(1)] – Test the speed configuration of the CoaXPress interface.
8. GPIO [(1)] – Test the functionality of the external GPIO interface. (Loopback dongle should be mounted to perform this test)
9. DRAM [(1)] – Test the external DRAM memory access and functionality.

Remarks:

1. *Not all camera models support this configuration.*

5.13 Lens Control

The Lens control allows control over the Focus and Iris and provides general information about the mounted lens. The Lens Controller currently support Birger and P-Iris adaptors;

Please note that a camera must be ordered with the P-Iris option and P-Iris cable assembly in order for the P-Iris lens to operate.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: LensControl						
Lens Selector	Selects lens controller	LensSelector	Enumeration	0	Off	
				1	Birger	
				2	P-Iris	
Lens Communication Source	Source for communication to the lens	LensCommSource	Enumeration	0	RS232_0	
Lens Initiate	Initiates lens controller	LensInit	Command	1 - Activate		
Lens Reset	Reset lens controller	LensReset	Command	1 - Activate		
Lens Present	Indicate if lens is present	LensPresent	Enumeration	0	No	
				1	Yes	
Lens Name	Lens descriptive name	LensName	StringReg			
Lens Identification	Lens type identification	LensId	StringReg			
Lens Serial Number	Serial Number of the lens	LensSerialNumber	StringReg			
Lens Version	Firmware version of the lens	LensVersion	StringReg			
Gen<i>Cam Category: LensFocusControl						
Focus Move Near Full	Move focus to the infinity stop	LensFocusMoveNearFull	Command	1 - Activate		
Focus Move Far Full	Move focus to the zero stop	LensFocusMoveFarFull	Command	1 - Activate		
Focus Move Step	Define focus move step	LensFocusMoveStep	Integer			
Focus Move Near	Move focus to near position	LensFocusMoveNear	Command	1 - Activate		
Focus Move Far	Move focus to far position	LensFocusMoveFar	Command			
Focus Minimum Position	Lens minimum position for focus	LensFocusPositionMin	Float			
Focus Maximum Position	Lens maximum position for focus	LensFocusPositionMax	Float			
Focus Position Increment	Increment step of lens focus position	LensFocusPositionInc	Float	0.001 INC		
Focus Position	Move focus to position	LensFocusPosition	Float			
Focus Position Absolute	Move focus to absolute position	LensFocusPositionAbsolute	Float	Min 0 Max 16383 Inc 1		
Gen<i>Cam Category: LensIrisControl						
Iris Close Full	Move iris to the fully stopped down limit	LensIrisCloseFull	Command	1 - Activate		

Iris Open Full	Move iris to completely open	LensIrisOpenFull	Command	1 - Activate	
Iris Move Step	Define iris move step	LensIrisStep	Integer		
Iris Speed	Defines the aperture speed in microseconds. A lower value will increase the response speed.	LensIrisSpeed	integer		Please note that a value that is too low may result in skipped steps.
Iris Close	Close iris in incremental steps	LensIrisClose	Command	1 - Activate	
Iris Open	Open iris in incremental steps	LensIrisOpen	Command	1 - Activate	
Iris Minimum Position	Lens minimum position for iris	LensIrisPositionMin	Float		For P-Iris, please refer to the lens's manual for minimal step.
Iris Maximum Position	Lens maximum position for iris	LensIrisPositionMax	Float		For P-Iris, please refer to the lens's manual for maximal step.
Iris Position Increment	Increment step of lens iris position	LensIrisPositionInc	Float		
Iris Position	Move iris to absolute position	LensIrisPosition	Float		

Gen<i>Cam Category: LensCommandControl					
Lens Command Request	Lens command request buffer data	LensCommandRequest	Register		
Lens Command Size	Size of command to send	LensCommandSize	Integer		
Lens Command Send	Send 'LensCommandSize' bytes of command in 'LensCommandRequest'	LensCommandSend	Command	1 - Activate	
Lens Command Response	Lens command response buffer data	LensCommandResponse	Register		

Table 22 – Lens Control parameters

5.13.1 P-Iris Setup

Please note that a camera must be ordered with the P-Iris option and P-Iris cable assembly in order for the P-Iris lens to operate.

Figure 22 – Iron CoaXPress with P-Iris

Iron CoaXPress cameras have integrated Gen<i>Cam parameters for controlling P-Iris lenses.

1. Mount the P-Iris lens and connect it to the GPIO while the camera is turned off.
2. Set “LensSelector” as “P-Iris” to select P-Iris control.
3. Initialize the P-Iris using “LensInit” command. The P-Iros will calibrate and move to the initial position.
4. After successful initialization, the “LensIrisControl” category will be available to control the iris motor.
   “LensIrisSpeed” can be used to increase the iris response speed (a value that is too low may result in skipped steps.)
   “LensIrisPositionMin” and “LensIrisPositionMin” can be set to limit the step range of the iris motor (refer to the lens’s manual for step range).
5. It is recommended to save lens configuration to the camera’s non-volatile memory, in order to eliminate the need for initialization of the lens control on camera power-up. “UserSetControl” parameters can be used to save the preset settings.

   Note: *The camera will restore the lens position and settings from the previously saved UserSet. This will happen automatically upon the camera’s power-up, even if changes were made to the lens.*

5.13.2 Birger Setup

Iron CoaXPress cameras have integrated Gen<i>Cam parameters for controlling Birger lens adapters.

Figure 23 – Iron CoaXPress with Birger

6. Mount the Birger adapter with a lens, and connect it to the GPIO while the camera is turned off.
7. Set “LensSelector” as “Birger” to select Birger adaptor control.
8. Initialize the Birger using “LensInit” command. The Birger will calibrate and move to the initial position. Please note that this process might take a few minutes to learn the specific steps of the lens.
9. After successful initialization, the lens info, “LensFocusControl”, “LensIrisControl” and “LensCommandControl” categories will be available to control the different lens components.
10. It is recommended to save lens configuration to the camera’s non-volatile memory, to eliminate the need for initialization of the lens control on camera power-up. “UserSetControl” parameters can be used to save the preset settings.

    Note: *The camera will restore the lens position and settings from the previously saved UserSet. This will happen automatically upon the camera’s power-up, even if changes were made to the lens.*

5.14 I/O Controller

A variety of triggers, auxiliary signals, timers, GPIO's etc., can be used to initiate events, and transmit and receive data with configurable duration and activation modes.

5.14.1 Camera Stream Trigger

Triggers are issued through the camera CoaXPress channels or GPIO. A sequence of synchronous or asynchronous signals can be configured to be issued, and can be useful in configuring an event-controlled image acquisition: trigger origins can be selected from a number of sources. The flow of the acquisition stream trigger can be seen below:

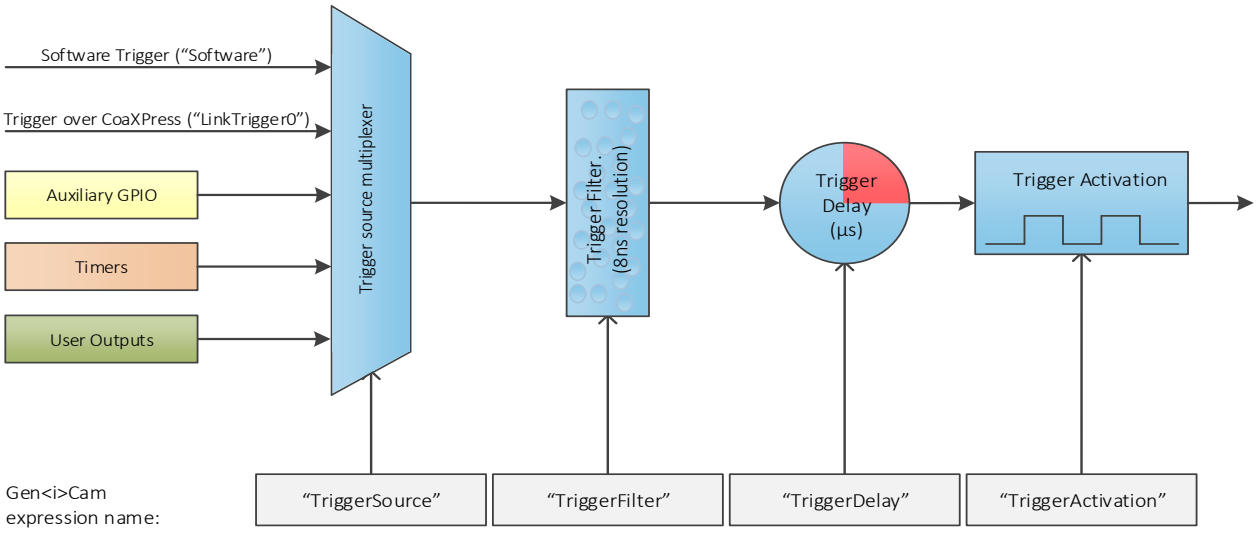


Figure 24 – Acquisition stream trigger structure

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: AcquisitionControl						
Trigger Selector		TriggerSelector	Enumeration (Selector)	0	FrameTrigger	
Trigger Mode	Controls if the selected trigger is active	TriggerMode [TriggerSelector]	Enumeration	0 1	Off On	
Trigger Activation	Specifies the activation mode of the trigger	TriggerActivation [TriggerSelector]	Enumeration	0x00 0x01 0x02 0x03 0x04	RisingEdge FallingEdge AnyEdge LevelHigh LevelLow	
Trigger Source	Specifies the internal signal or physical input Line to use as the trigger source. The selected trigger	TriggerSource [TriggerSelector]	Enumeration	0x01 0x02 0x03 0x06 0x07	Software Line0 Line1 Timer0Start Timer0End	

	must have its TriggerMode set to On			0x08 0x09 0x0A 0x0B 0x0F 0x1E 0x1F 0x20 0x21	Timer0Active Timer1Start Timer1End Timer1Active LinkTrigger0 UserOutput0 UserOutput1 UserOutput2 UserOutput3
Trigger Delay	Specifies the delay in microseconds(us) to apply after the trigger reception before activating it	TriggerDelay [TriggerSelector]	Integer		
Trigger Filter	Filter for trigger, helps prevent signal de-bouncing. 8ns resolution, units in microseconds(µs).	TriggerFilter [TriggerSelector]	Float	Min: Max:	0 34359738
Trigger Software	Generates an internal trigger. TriggerSource must be set to Software.	TriggerSoftware [TriggerSelector]	Command	1 - Activate	
Trigger Overlap	Specifies the type trigger overlap permitted with the previous frame or line. This defines when a valid trigger will be accepted (or latched) for a new frame or a new line.	TriggerOverlap [TriggerSelector]	Enumeration	0 1	Off ReadOut

Table 23 – Acquisition Triggers parameters

5.14.1.1 Trigger activation mode

The trigger activation mode configures the capture criteria of the signal state. The default value is Rising Edge, which will trigger a frame on signal rising edge event. The different modes' functionality is as follows:

1. Any Edge:
   The frames will be acquired both on rising and falling edges of the trigger source.

2. Rising Edge:
   The frames will be acquired only on the rising edge of the trigger source. The falling edge of the source is ignored.

3. Falling Edge:
   The frames will be acquired only on the falling edge of the trigger source. The rising edge of the source is ignored.

4. Level High:
   A high signal level enables continuous image acquisition, Low signal level will halt the trigger generation.

5. Level Low:
   A low signal level enables continuous image acquisition, a High signal level will halt the trigger generation.

5.14.1.2 Trigger signals filter

The filter of the trigger signals acts as a de-bouncing mechanism for better noise immunity. The filter value, represented in microseconds, is disabled by default with the value of 0. If the trigger filter is set to a higher value than the width of the trigger pulse, then the pulse will be filtered out and no trigger will occur.

5.14.1.3 Trigger Delay

The trigger delay is a mechanism for postponing the incoming signal for a specified number of microseconds. As a result, the trigger will be issued after a specified time delay to overcome known system latency or set trigger generation period. To disable, value 0 should be set.

5.14.2 Auxiliary GPIO Block

A large array of GPIO is available for configuring trigger sources from external signal generators, such as TTL and OptoCoupled. The auxiliary GPIO signals can be used to initiate stream events from a variety of sources, such as CoaXPress triggers and other GPIOs.

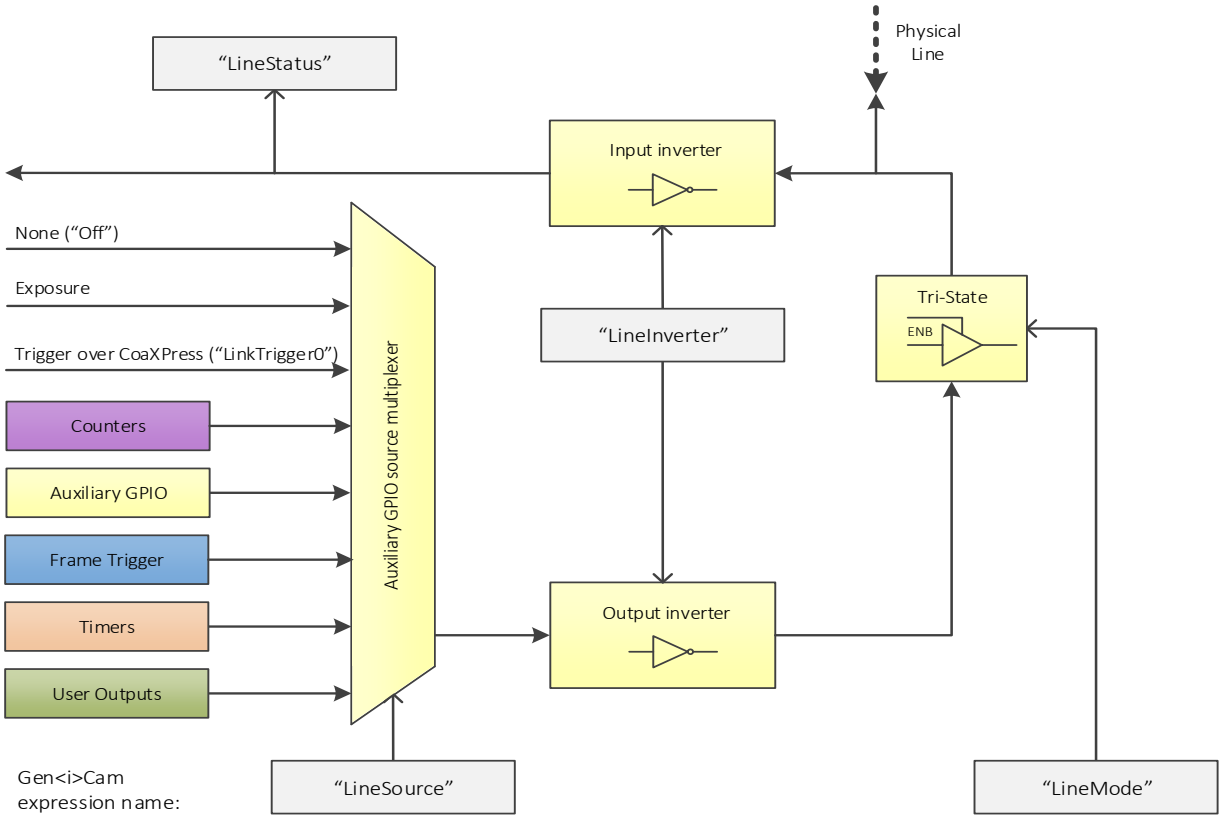


Figure 25 – Digital I/O Line structure

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: DigitalIOControl						
Line Selector	Selects the physical pin of the external camera connectors.	LineSelector	Enumeration (Selector)	0 1 2 3	Line0 Line1 Line2 Line3	GPIO output depends on camera model
Line Mode	Controls if the physical Line is used to Input or Output a signal.	LineMode [LineSelector]	Enumeration	0 1	Input Output	
Line Inverter	Controls the inversion of the signal of the selected input or output Line.	LineInverter [LineSelector]	Boolean			
Line Source	Selects which internal acquisition or I/O source signal to output on the selected Line.	LineSource [LineSelector]	Enumeration	0x00 0x02 0x03 0x08 0x0B	Off Line0 Line1 Timer0Active Timer1Active	

				0x0F	LinkTrigger0	
				0x10	AcquisitionActive	
				0x14	FrameActive	
				0x16	FrameTriggerWait	
				0x17	FrameTriggerMissed	
				0x1D	ExposureActive	
				0x1E	UserOutput0	
				0x1F	UserOutput1	
				0x20	UserOutput2	
				0x21	UserOutput3	
				0x22	Counter0Start	
				0x23	Counter0End	
				0x24	Counter0Active	
				0x25	Counter1Start	
				0x26	Counter1End	
				0x27	Counter1Active	
Line Status	Returns the current status of the selected input or output Line	LineStatus [LineSelector]	Boolean			
Line Format	Controls the current electrical format of the selected physical input or output Line.	LineFormat [LineSelector]	Enumeration	0x00	NoConnect	
				0x01	TriState	
				0x02	TTL	
				0x03	LVDS	
				0x04	RS422	
				0x05	OptoCoupled	
				0x06	LVTTL	
				0x07	NonAvailable	
				0x08	OpenDrain	
Line Status All	Returns the current status of all available Line signals at time of polling in a single bitfield.	LineStatusAll [LineSelector]	Integer			

Table 24 – GPIO parameters

5.14.3 User Output block

Software trigger source which can be controlled by the user to generate onboard events. Several User Outputs have been reserved for trigger sources, their status can be changed in two ways:

1. Individually – the setting of “UserOutputValue” parameter value for selected User Output.
2. Group value configuration - configuring a value for a group of User Outputs using a combination of “UserOutputValueAll”, which is responsible for set value, and “UserOutputValueAllMask”, which represents bitmask of User Outputs that will be affected.

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: DigitalIOControl						
User Output Selector	Selects which bit of the User Output register will be set by UserOutputValue.	UserOutputSelector [LineSelector]	Enumeration	0x00 0x01 0x02 0x03	UserOutput0 UserOutput1 UserOutput2 UserOutput4	
User Output Value	Sets the value of each of the User Output register.	UserOutputValue [LineSelector]	Boolean			
User Output Value All	Sets the value of all the bits of the User Output register. It is subject to the UserOutputValueAllMask.	UserOutputValueAll [LineSelector]	Integer			
User Output Value All Mask	Sets the write mask to apply to the value specified by UserOutputValueAll before writing it in the User Output register. If the UserOutputValueAllMask feature is present, setting the user Output register using UserOutputValueAll will only change the bits that have a corresponding bit in the mask set to one.	UserOutputValueAllMask [LineSelector]	Integer			

Table 25 – User output parameters

5.14.4 Timer Trigger Signals

Configure an internal timer for timed trigger generation. Incorporate selection of signal edge capture mode, timer signal delay and duration and inverter for timer signal.

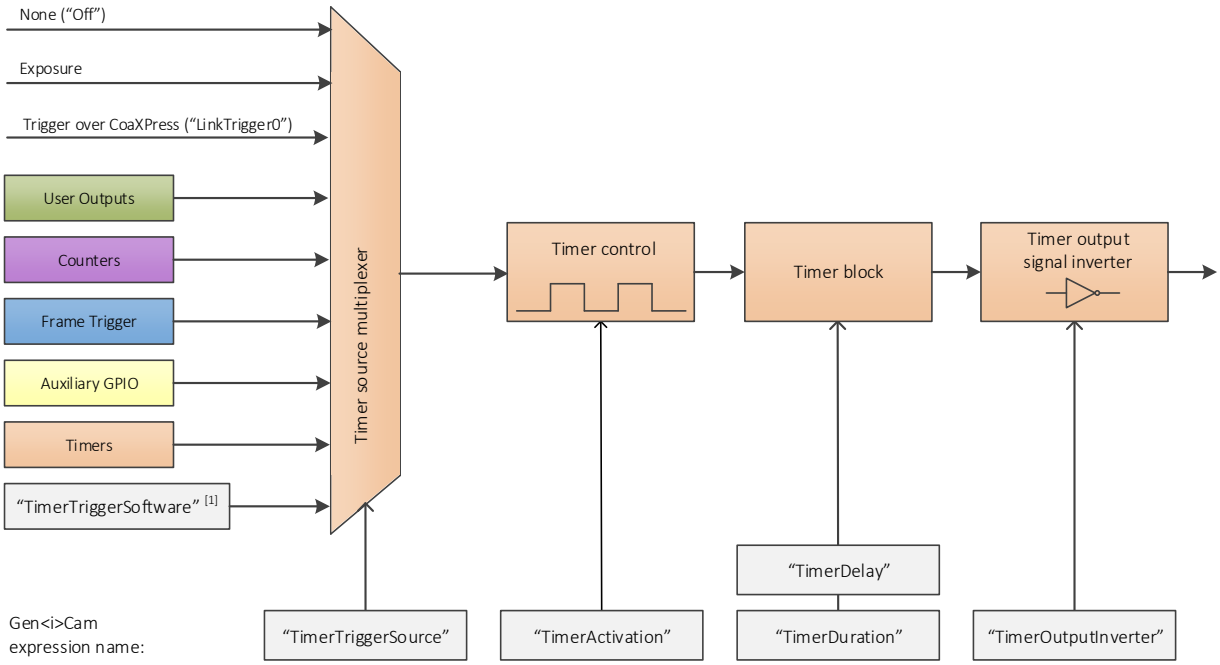


Figure 26 – Timer triggers structure

Remark:

1. *"TimerTriggerSource" should be set to "Off" touse "TimerTriggerSoftware".*

5.14.4.1 Timer activation mode

The trigger activation mode configures the capture criteria of the signal state. The default value is Rising Edge, which will issue a trigger on a signal rising edge event. The different modes' functionality is as follows:

1. Rising Edge:
   A rising edge of the selected trigger source will increment 1 timer count (Duration + Delay time), and a falling edge is ignored.

2. Falling Edge:
   A falling edge of the selected trigger source will increment 1 timer count (Duration + Delay time), and a rising edge is ignored.

3. Level High:
   A high signal level enables a continuous timer operation. A low signal level will halt the timer.

4. Level Low:
   A low signal level enables a continuous timer operation. A high signal level will halt the timer.

5.14.4.2 Timer delay, duration and signal inversion

The input value of delay, duration and inversion will determine the timer signal behavior as a rule for timer tick count. Duration will determine the ON position of the timer signal, while delay will determine the OFF position of the signal. The output inverter is responsible for flipping the signal level of duration and delay values.

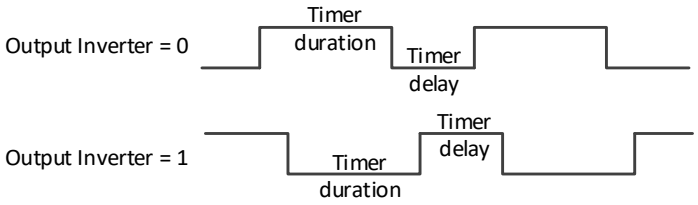


Figure 27 – Output inverters

5.14.4.3 Timer Trigger XML Parameters

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: CounterAndTimerControl						
Timer Selector	Selects which Timer to configure.	TimerSelector	Enumeration (Selector)	0x00 0x01	Timer0 Timer1	
Timer Delay	Sets the duration in microseconds(µs) of the delay to apply at the reception of a trigger before starting the Timer.	TimerDelay [TimerSelector]	Float			
Timer Duration	Sets the duration in microseconds(µs) of the Timer pulse.	TimerDuration [TimerSelector]	Float			
Timer Activation	Selects the activation mode of the trigger to start the Counter.	TimerActivation [TimerSelector]	Enumeration	0x00 0x01 0x03 0x04	RisingEdge FallingEdge LevelHigh LevelLow	
Timer Output Inverter	Controls the inversion of the timer output signal.	TimerOutputInverter [TimerSelector]	Boolean			
Timer Trigger Source	Selects the source of the trigger to start the Timer.	TimerTriggerSource [TimerSelector]	Enumeration	0x00 0x02 0x03 0x06 0x07 0x09 0x0A 0x0F 0x10 0x14 0x15 0x16 0x17 0x18 0x19 0x1A 0x1B 0x1C 0x1D 0x1E 0x1F 0x20 0x21 0x22 0x23 0x24 0x25 0x26 0x27	Off Line0 Line1 Timer0Start Timer0End Timer1Start Timer1End LinkTrigger0 AcquisitionActive FrameActive FrameTrigger FrameTriggerWait FrameTriggerMissed FrameStart FrameEnd LineStart ExposureStart ExposureEnd ExposureActive UserOutput0 UserOutput1 UserOutput2 UserOutput3 Counter0Start Counter0End Counter0Active Counter1Start Counter1End Counter1Active	

Timer Trigger Software	Generates an internal trigger. TimerTriggerSource must be set to “Off”.	TimerTriggerSoftware [TimerSelector]	Command			
Timer Reset	Does a software reset of the selected timer and starts it. The timer starts immediately after the reset unless a timer trigger is active.	TimerReset [TimerSelector]	Command			
Timer Value	Reads or writes the current value (in microseconds) of the selected Timer.	TimerValue [TimerSelector]	Float			
Timer Status	Returns the current status of the Timer.	TimerStatus [TimerSelector]	Enumeration	0x00	TimerIdle	
				0x01	TimerTriggerWait	
				0x02	TimerDelay	
				0x03	TimerActive	
				0x04	TimerCompleted	

Table 26 – Timer activation parameters

5.14.5 Counter Block

Configure a counter of events or signals. It can be used to count and monitor internal events (e.g FrameStart, Timer1End), I/O external events (e.g Input Line rising edge) and even clock ticks. It can be reset, read or written at any time. The counters can also be configured as a source of other I/O events.

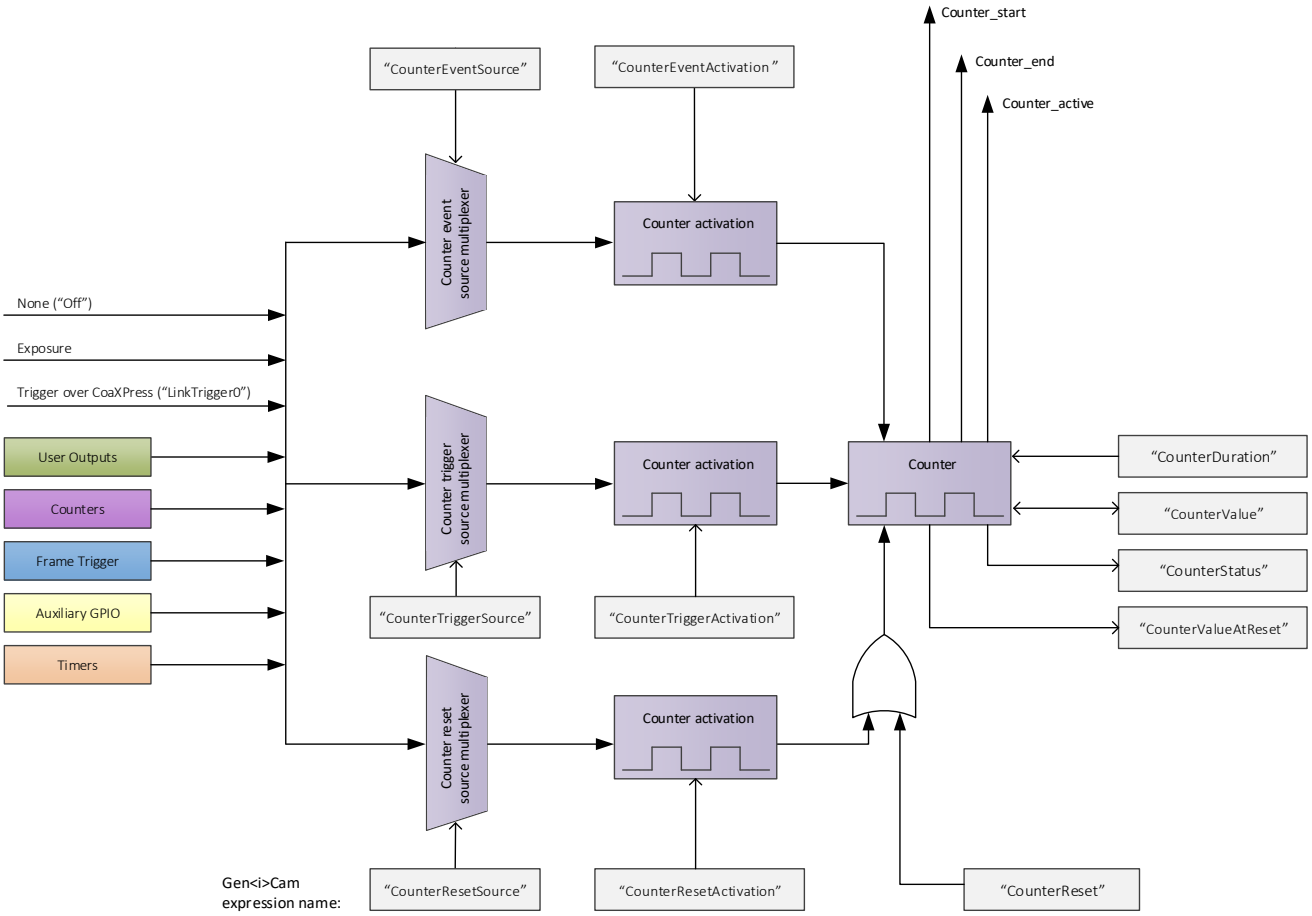


Figure 28 – Counter structure

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: CounterAndTimerControl						
Counter Selector	Selects which Counter to configure.	CounterSelector	Enumeration (Selector)	0x00 0x01	Counter0 Counter1	
Counter Event Source	Select the events that will be the source to increment the Counter.	CounterEventSource [CounterSelector]	Enumeration	0x00 0x02 0x03 0x06 0x07 0x08 0x09 0x0A 0x0B 0x0F 0x10 0x14 0x15 0x16 0x17 0x18 0x19 0x1A 0x1B 0x1C 0x1D 0x1E 0x1F 0x20 0x21 0x22 0x23 0x24 0x25 0x26 0x27	Off Line0 Line1 Timer0Start Timer0End Timer0Active Timer1Start Timer1End Timer1Active LinkTrigger0 AcquisitionActive FrameActive FrameTrigger FrameTriggerWait FrameTriggerMissed FrameStart FrameEnd LineStart ExposureStart ExposureEnd ExposureActive UserOutput0 UserOutput1 UserOutput2 UserOutput3 Counter0Start Counter0End Counter0Active Counter1Start Counter1End Counter1Active	
Counter Reset Source	Selects the signals that will be the source to reset the Counter.	CounterResetSource [CounterSelector]	Enumeration	0x00 0x02 0x03 0x06 0x07 0x08 0x09 0x0A 0x0B 0x0F 0x10 0x14 0x15 0x16 0x17 0x18 0x19 0x1A	Off Line0 Line1 Timer0Start Timer0End Timer0Active Timer1Start Timer1End Timer1Active LinkTrigger0 AcquisitionActive FrameActive FrameTrigger FrameTriggerWait FrameTriggerMissed FrameStart FrameEnd LineStart	

				0x1B	ExposureStart
				0x1C	ExposureEnd
				0x1D	ExposureActive
				0x1E	UserOutput0
				0x1F	UserOutput1
				0x20	UserOutput2
				0x21	UserOutput3
				0x22	Counter0Start
				0x23	Counter0End
				0x24	Counter0Active
				0x25	Counter1Start
				0x26	Counter1End
				0x27	Counter1Active
Counter Trigger Source	Selects the source to start the Counter.	CounterTriggerSource [CounterSelector]	Enumeration	0x00	Off
				0x02	Line0
				0x03	Line1
				0x06	Timer0Start
				0x07	Timer0End
				0x08	Timer0Active
				0x09	Timer1Start
				0x0A	Timer1End
				0x0B	Timer1Active
				0x0F	LinkTrigger0
				0x10	AcquisitionActive
				0x14	FrameActive
				0x15	FrameTrigger
				0x16	FrameTriggerWait
				0x17	FrameTriggerMissed
				0x18	FrameStart
				0x19	FrameEnd
				0x1A	LineStart
				0x1B	ExposureStart
				0x1C	ExposureEnd
				0x1D	ExposureActive
				0x1E	UserOutput0
				0x1F	UserOutput1
				0x20	UserOutput2
				0x21	UserOutput3
				0x22	Counter0Start
				0x23	Counter0End
				0x24	Counter0Active
				0x25	Counter1Start
				0x26	Counter1End
				0x27	Counter1Active
Counter Event Activation	Selects the Activation mode Event Source signal.	CounterEventActivation [CounterSelector]	Enumeration	0x00	RisingEdge
				0x01	FallingEdge
				0x02	AnyEdge
Counter Reset Activation	Selects the Activation mode of the Counter Reset Source signal.	CounterResetActivation [CounterSelector]	Enumeration	0x00	RisingEdge
				0x01	FallingEdge
				0x02	AnyEdge
				0x03	LevelHigh
				0x04	LevelLow
Counter Trigger Activation	Selects the activation mode of the trigger to start the Counter.	CounterTriggerActivation [CounterSelector]	Enumeration	0x00	RisingEdge
				0x02	FallingEdge
				0x03	AnyEdge

				0x04 0x05	LevelHigh LevelLow	
Counter Reset	Does a software reset of the selected Counter and starts it. Counter starts counting events immediately after the reset unless a Counter trigger is active.	CounterReset [CounterSelector]	Command	1 - Activate		
Counter Value	Reads or writes the current value of the selected Counter	CounterValue [CounterSelector]	Integer			
Counter Value at Reset	Reads the value of the selected Counter when it was reset by a trigger or by an explicit CounterReset command. It represents the last counter value latched before resetting the counter.	CounterValueAtReset [CounterSelector]	Integer			
Counter Duration	Sets the duration (or number of events) before the CounterEnd event is generated.	CounterDuration [CounterSelector]	Integer			
Counter Status	Returns the current status of the Counter.	CounterStatus [CounterSelector]	Enumeration	0x00 0x01 0x02 0x03 0x04	CounterIdle CounterTriggerWait CounterActive CounterCompleted CounterOverflow	

Table 27 – Counter parameters

5.15 Stream Metadata Information

Runtime metadata information can be attached to each transmitted frame. When enabled, the metadata will be available at the beginning of each frame and substitute existing stream data. The information will be relevant for the specific frame and will be updated in the next frame.

In an 8bit data image, the metadata will occupy contiguous bytes. In 10/12/14/16bit data, only the LSB byte of each pixel will be valid metadata. Metadata contains several chunks which are distinguishable by a unique id, while each chunk represents different metadata information. Each metadata chunk is aligned to 4bytes even if the actual data size is not.

Remark:

1. *Proper metadata functioning requires the frame width to be at least the size of the complete metadata information payload*.

The following table describes the metadata chunk structure:

Position (in pixels)	Format	Description
0	Unique chunk id [4 pixels]	The chunk identification
4	Data size (in bytes) [4 pixels]	The size of valid data payload in bytes
8	Data payload [K pixels]	The data that the chunk is transporting.

Table 28 – Metadata chunk structure

Available metadata information chunks:

Description	Unique Chunk Data identification	Data payload size (in bytes)	Associated "ChunkSelector"	Data payload units (after multiplication with "ChunkMutliplier")
Camera timestamp	0xCD000001	8 [1]	"Timestamp"	Nanoseconds
Current frame number	0xCD000002	4 [2]	"FrameNumber"	Index
Frame Exposure Time	0xCD000003	4 [2]	"ExposureTime"	Microseconds [µs]
Sensor Analog Gain	0xCD000004	4 [2]	"AnalogGain"	Gain multiplication factor

Table 29 – Metadata information chunks

1. Represents 64bit LittleEndian integer
2. Represents 32bit LittleEndian integer

Chunk data control GenICam interface:

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: ChunkDataControl						
Chunk Mode Active	Activates the inclusion of Chunk data in the payload of the image	ChunkModeActive	Boolean			
Chunk Selector	Selects which Chunk to control	ChunkSelector	Enumeration	0	"Timestamp"'	
				1	"FrameNumber"	
				2	"ExposureTime"	
				3	"AnalogGain"	
Chunk Transfer Block ID	Unique identifier of the transfer block used to transport the payload	ChunkTransferBlockID [ChunkSelector]	Integer			
Chunk Multiplier	Multiplication factor for selected chunk to convert metadata payload raw value to usable units	ChunkMultiplier [ChunkSelector]	Float			

Table 30 – ChunkDataControl Gen<i>Cam parameters

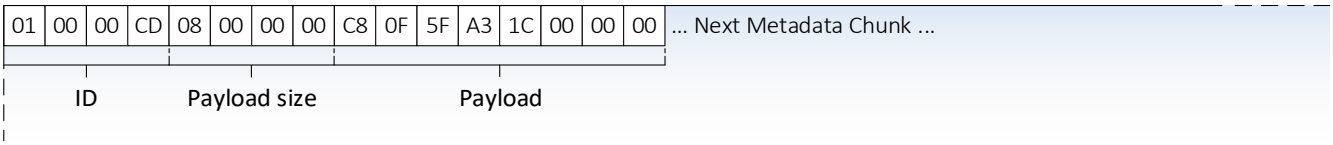
Example for metadata of "camera timestamp":

ID = 0xCD000001
Size = 8
Payload = 123,000,000,456 = 0x01CA35F0FC8

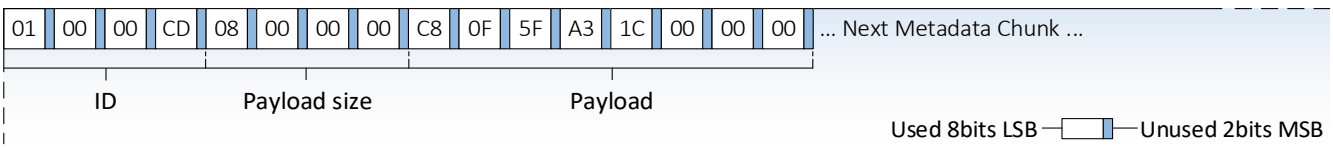
"ChunkSelector" = "Timestamp"
"ChunkMultiplier" = 8.0

Therefore, the timestamp value is 123,000,000,456 x 8.0 = 984,000,003,648 nano-seconds [ns].

8 bit:



10 bit:



Unpacked data format (10bit to 16bit):

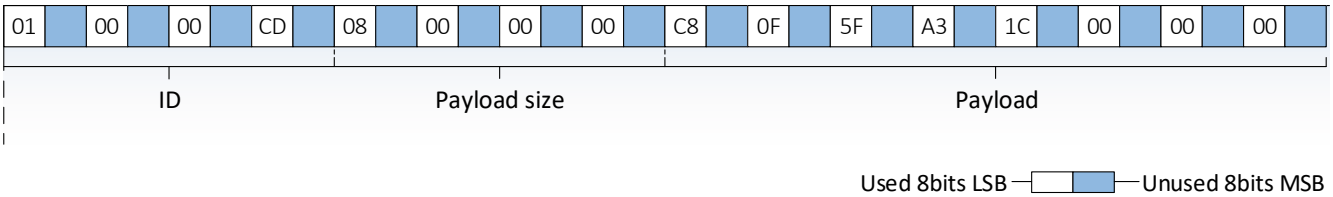


Figure 29 – Stream metadata information structure

REFERENCES

Supported vision standards:

CoaXPress GEN<i>CAM

Vision Point documentation:

Vision Point

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