JetCam
User Manual

December 2020 - Rev 1.0

KAYA INSTRUMENTS

International Distributor

Sky Blue Microsystems GmbH
Geisenhausenerstr. 18
81379 Munich, Germany
+49 89 780 2970, info@skyblue.de
www.skyblue.de

Table of Contents

1 Figures & Tables

1.1 List of Figures

1.2 List of Tables

2 Revision History

Version	Date	Notes
1.0	24.06.2020	Initial release

Table 1 – Revision History

3 Introduction

3.1 Safety Precautions

With your *JetCam* camera in hand, please take the time to read the precautions listed below in order to prevent preventable and unnecessary injuries and damage to you, other personnel or property. Read these safety instructions carefully prior to your first use of the product, as these precautions contain safety instructions that must be observed. After reading through this manual, be sure to follow it to prevent misuse of 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. This may result in a fire or electric shock due to a circuit shortage or heat generation. Contact our sales personnel prior to 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 it may 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 closed (and not running) car where the temperature becomes high. ▪ 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 body before touching any sensitive electronic components. The electronic circuits in your computer and the circuits on the *JetCam* camera and the *Komodo CLHS* 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.

3.2 Disclaimer

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

- Earthquake, thunder strike, natural disasters, fire caused by use beyond our control, wilful 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 that may occur 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 initial failure, as long as it is reported no later than two weeks post-delivery of the product.

4 Overview

This document provides an extensive overview of KAYS's JetCam camera line-up, currently consisting of the JetCam 19 and JetCam 160. All cameras are suited for a wide variety of applications, high-speed and high-quality image streaming and with 3G-SDI output.

With our customers' convenience in mind, we have made sure that connecting and streaming can be easily achieved in few easy steps and require little configurations. Advanced features and custom configurations are available using the camera's serial command line interface (see section no. 9), enabling enhanced streaming and image processing of the cameras' outputs. Hardware references, mechanical and electrical properties are also covered in this document (sections 6 and 7 respectively).

It is important to note that some parameters might vary slightly compared to this document or may be absent entirely, subject to the active firmware capabilities: a firmware upgrade might be needed to support complete functionality set. Please feel free to contact our team over at support@kayainstruments.com with any questions that may arise.

5 Mechanical Properties

This section provides information on JetCam camera unit hardware. It covers architecture, interfaces and pin assignments for various connectors.

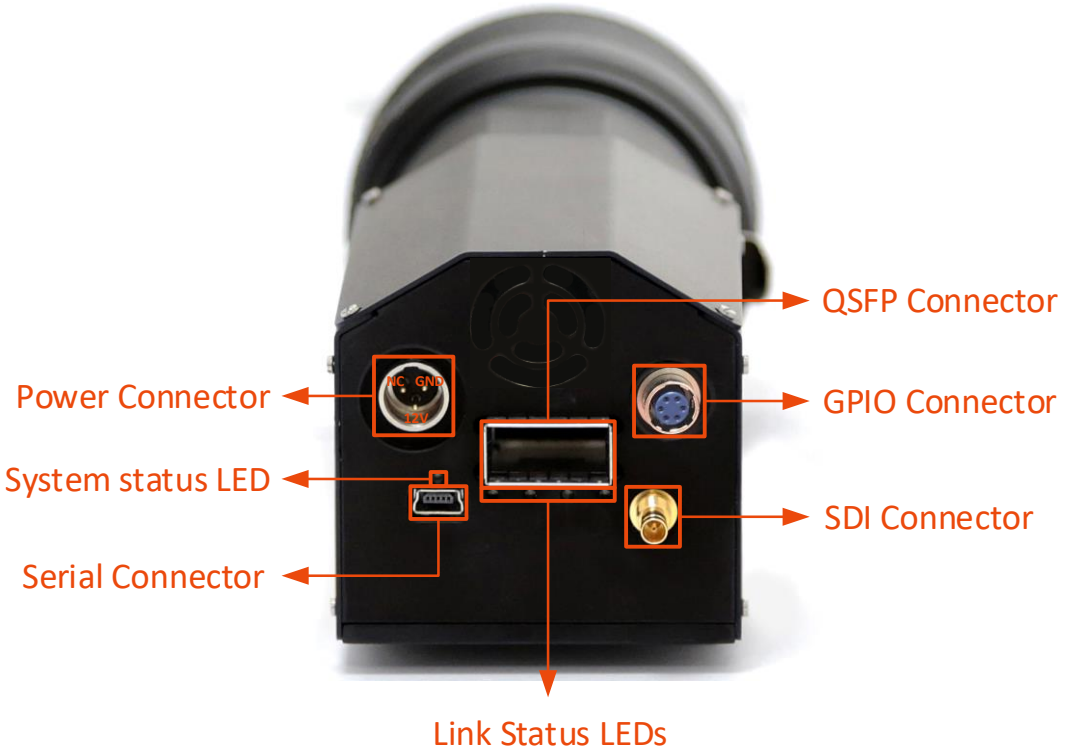


Figure 1 – JetCam camera interfaces

5.1 Link Status LEDs

The QSFP+/SFP+ bi-color LEDs are located below the QSFP+/SFP+ connectors. Color-coded indication along with exact timing for each indicator are described in the following tables:

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

Table 2 – Link connector indicating lamp states

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

Table 3 – Connector indicating lamp timings

5.2 System Status LED

The system bi-color status LED located above the serial communication connector. Color-coded indication along with exact timing for each indicator described in the following table:

	LED state	Indication
	Off	Camera is not powered
	Solid red	Camera is powering up
	Solid orange	Firmware update is in progress
	Solid green	Camera is powered on and active

Table 4 – System status indicating lamp states

5.3 Power Connector

The JetCam unit requires 12V power supply for proper function. Please, refer to section 6 for exact Power Supply requirements.
The positive pin of the power supply connected to the bottom pin of the connector, shown as “12V”, the negative pin connected to the upper right pin of the connector, shown as “GND“. The power connector shown in Figure 1. The power connector used is Tini-QG RA PC 3 pin (TRA3M SERIES). The mating connector of the power connector is TA3FX.

5.4 SDI Interface connector

The JetCam camera supports SMPTE 424M interface standard, 3G-SDI (high-definition serial digital interface) video stream, for digital video transmission over a single-link coaxial cable. The data transmission speed of the system is at 3 Gbps.

- SMPTE 424M standard
- Supports 3G-SDI with a resolutions of 1080p60
- Single-link standard coaxial 75-ohm cable
- Streams serial digital video
- 10-bit YCrCb 4:2:2 encoding

NOTE: Powering up the camera will automatically start the SDI transmission for local camera configuration. Starting acquisition using Vision Point application will turn off the SDI output and the image will be displayed only via Vision Point application interface. Once the acquisition is stopped, the SDI output will be turned back on.

5.5 Serial connector

The JetCam cameras configuration is possible via Mini USB port is available for individual link status, general information and firmware update, using a serial emulated terminal (i.e Tera Term use is recommended). The port uses a Silabs CP2101 chip. The Mini USB connector shown in Figure 1. For usage and configuration, please refer to section 8.

5.6 GPIO connector

The following table describes the pin out of the Hirose 6 pin female connector:

Pin number	Pin description
1	GND
2	RS232 TX1(1)
3	RS232 RX1(2)
4	RS232 TX2
5	RS232 RX2
6	12V (output)

Table 5 – GPIO connector pin out

(1) Used for external exposure indication as well as for the serial communication (cannot be used for both at the same time).
(2) Used for external trigger as well as for the serial communication (cannot be used for both at the same time).

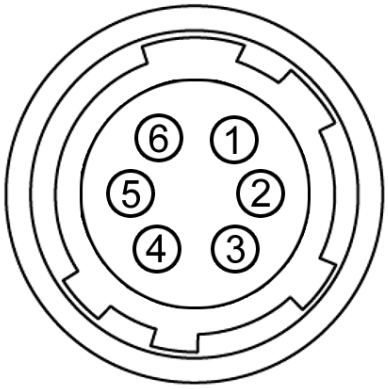


Figure 2 – GPIO connector pin out

NOTE: An HR10A-7P-6S (Hirose Electric) connector or equivalent should be used on the cable side.

5.7 QSFP+ Installation

5.7.1 Installing the QSFP+ Module

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

1. Remove the dust plugs from the module.
2. The QSFP+ module has a pull-tab latch that used to remove or install the module.
3. Hold the transceiver so that the identifier label is on the top.
4. Align the QSFP+ transceiver in front of the module's transceiver socket opening and carefully slide the QSFP+ transceiver into the socket until the transceiver makes contact with the connector.
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 pressing on the module with your thumb. In case the module is not completely seated and secured, you will hear a click as the triangular pin on the bottom of the module snaps into the hole in the receptacle.

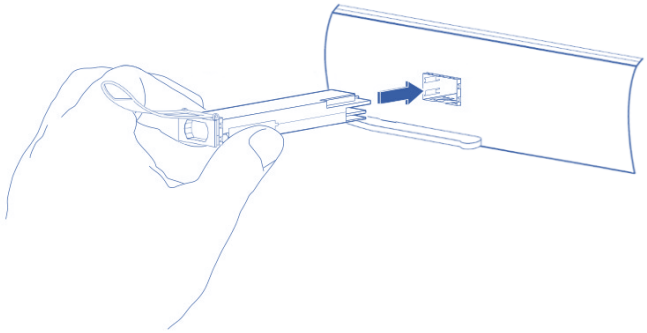


Figure 3 – Insert the QSFP+ module into the socket

5.7.2 Connecting the interface cable to QSFP+ Module

In order to properly connect the QSFP+ Fiber Breakout cable, the following steps must be taken:

1. Remove the protective dust cover from the fiber-optic cable connector.
2. Insert the fiber cable into the module.
3. Firmly push on each cable, until you will hear a click.
4. Connect the other side of the QSFP+ Fiber Breakout cable to your Frame Grabber device.

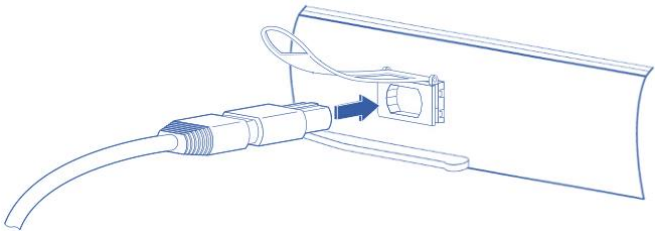


Figure 4 – Connecting the QSFP+ cable

5.7.3 Removing the QSFP+ Module

1. Turn the JetCam camera off.
2. Disconnect and remove all interface cables from the ports.
3. Hold the pull-tab latch on the QSFP+ module with your index finger, and gently pull to release the transceiver from the socket.
4. Grasp the module between your thumb and index finger and carefully remove it from the port.
5. Insert the clean dust covers into the module.

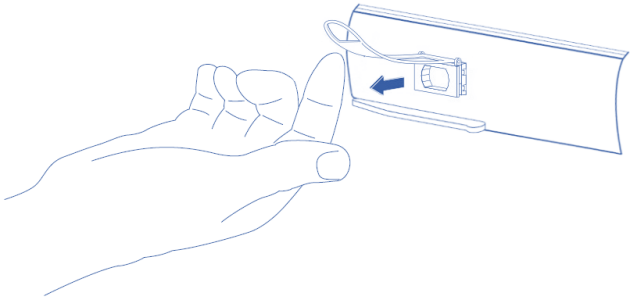


Figure 5 – Pulling the pull tab latch of a QSFP+ Module

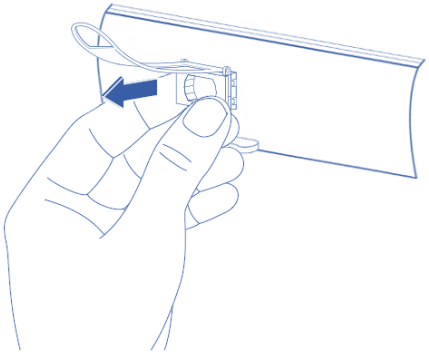


Figure 6 – Removing a QSFP+ Module from its port

5.8 Dual SFP+ Installation

5.8.1 Installing the SFP+ Module

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

1. Remove the dust plugs from the module.
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 into the JetCam camera.
4. Line up the module with the port and slide it into the port.
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 pressing on the module with your thumb. In case the module is not completely seated and secured, you will hear a click as the triangular pin on the bottom of the module snaps into the hole in the receptacle.

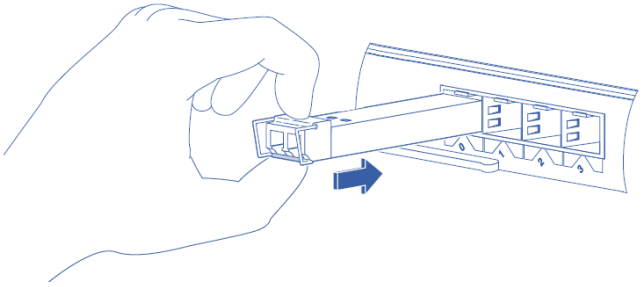


Figure 7 – Insert the SFP+ module into the socket

5.8.2 Connecting the interface cable to 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. Preform the connection according to the instructions below:
   a. Link 0 of the system must be always connected as controls are delivered with this port.
   b. A fiber cable should match an SFP+ type.
   c. Both the TX and RX fiber cables must be connected between TX output (Marked with TX or Arrow outwards the SFP+) on the JetCam camera and RX input (Marked with RX or Arrow inwards the SFP+) on your Frame Grabber device.
   d. 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.
4. Firmly push on each cable, until you will hear a click.
5. Connect the other side of the fiber cables to your Frame Grabber device.
   Note: Additional connectivity option is available using Fiber QSFP+ to SFP+ Breakout cable.

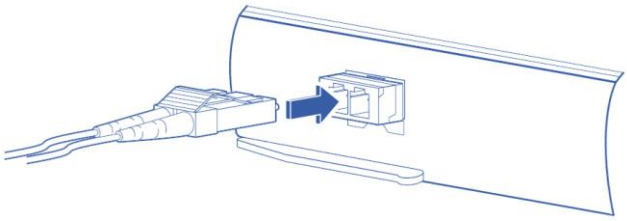


Figure 8 – Connecting the SFP+ cable

5.8.3 Removing the SFP Module

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

1. Turn the JetCam camera 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.
4. Grasp the module between your thumb and index finger and carefully remove it from the port.
5. Insert the clean dust covers into the module.

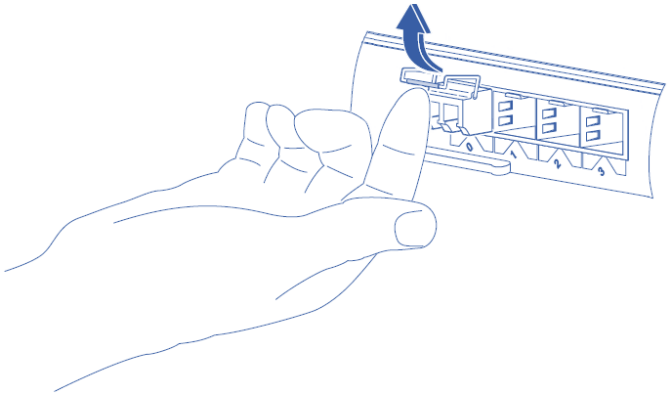


Figure 9 – Opening the bale clasp of an SFP+ Module

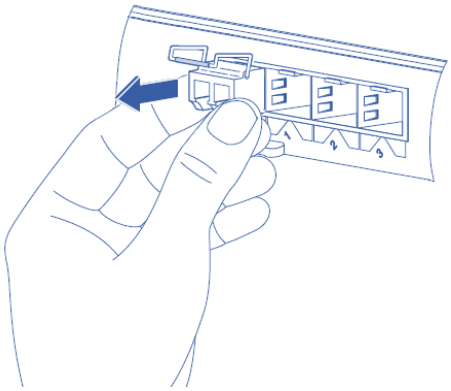


Figure 10 – Removing the SFP+ module from its port

5.9 Color Filter Array

The JetCam 19 and JetCam 160 color sensors processed with a Bayer **RGB** color pattern as shown in Figure 11. The Bayer type is **GBRG**: Pixel (0, 0) has a green filter and in the same row there is a blue filter. On the other row there is a red filter and another green filter next to it.

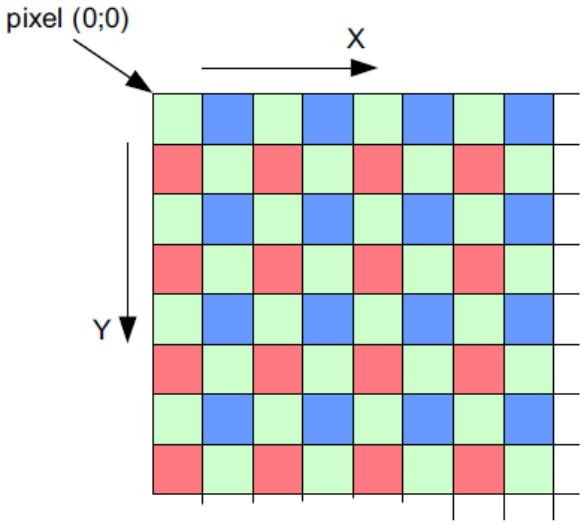


Figure 11 – Color Filter Array for the Pixel Array

5.10 Mechanical dimensions

The exact device mechanical dimensions are as defined in Figure 12.

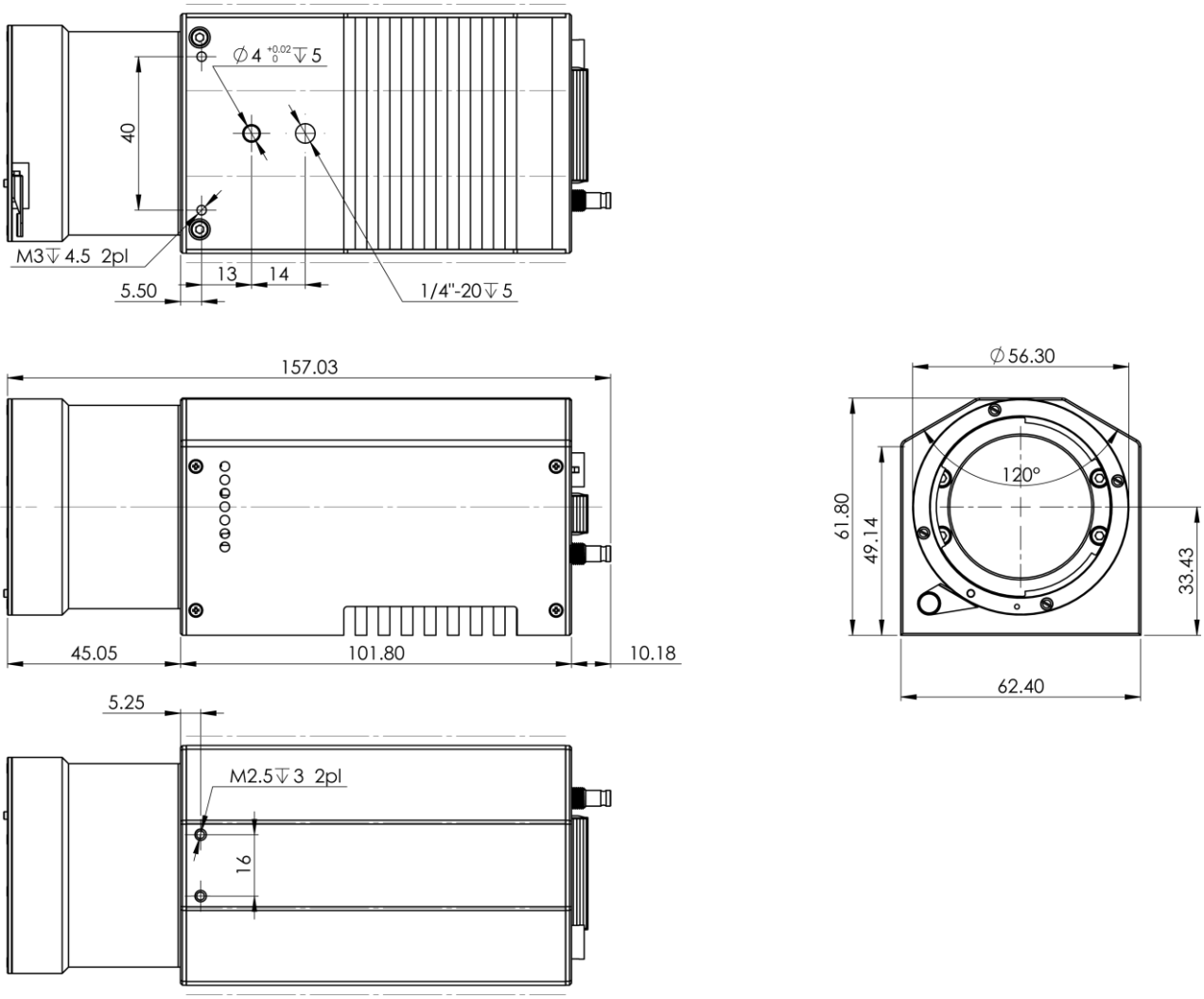


Figure 12 – Mechanical Dimensions

6 Electrical Properties

6.1 Absolute Maximum Ratings

Specification	Minimum	Maximum
12V power supply	-0.3V	14V
Storage temperature	-55°C	85°C
Operating ambient temperature	0°C (-40°C industrial grade optional)	50°C (70°C industrial grade optional)

Table 6 – Absolute maximum ratings

6.2 Absolute Maximum Ratings for GPIO

Specification	Minimum voltage [V]	Maximum voltage [V]
RS232	-	±25

Table 7 – Absolute maximum ratings for GPIO

6.3 Operating Conditions

Parameter	Description	MIN	Typical	Max
12V Vcc	12V Supply voltage	11.04V	12V	12.96V
12 Icc	Supply Current from 12V	-	0.62A	-

Table 8 – Operating conditions

Symbol	Parameter	Test condition	MIN	Max	Units
VIH	Input High Voltage		2.7	12	V
VIL	Input Low Voltage		-12	-2.7	V
IIN	Input Current	VIN = 0 V or VIN = VDD		±5	µA

Table 9 – RS232 receiver (input) specifications

Symbol	Parameter	Test condition	MIN	Max	Units
VOH	Output High Voltage	VIN = max	5.5	12	V
VOL	Output Low Voltage	VIN = min	-12	-5.5	V

Table 10 – RS232 driver (output) specifications

7 Configuration Interface

7.1 Device Control

The Device Control contains manufacturer parameters describing the currently connected hardware device. The information includes 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 complete functionality set.

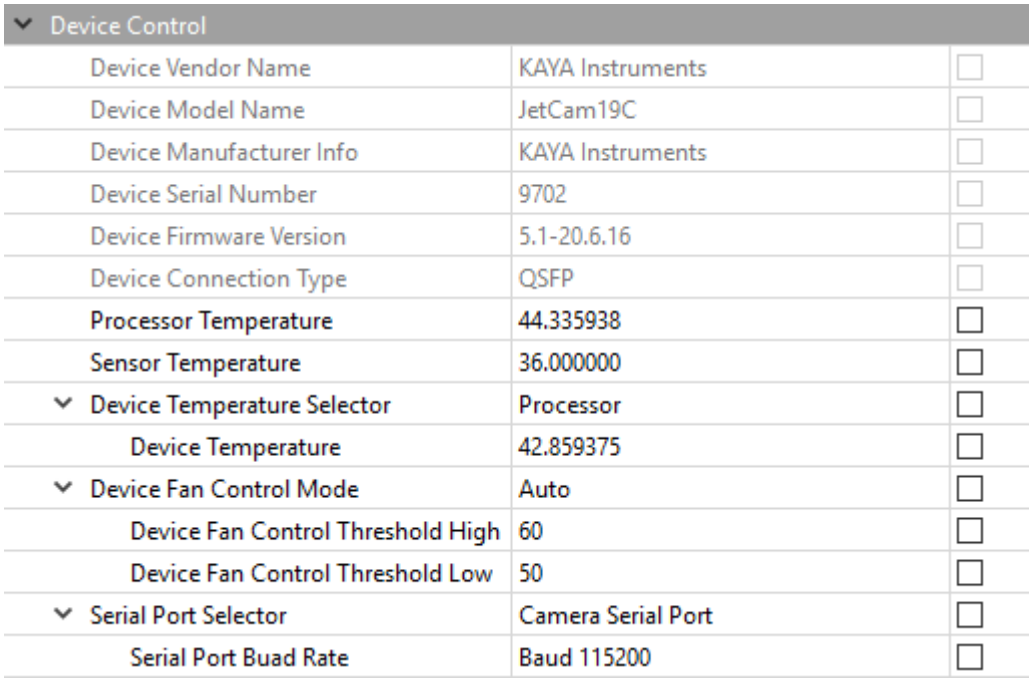


Figure 13 – Device Control category in GenICam Browser

7.1.1 Device Control XML parameters

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 Serial Number	Device's serial number. This string is a unique identifier of the device	DeviceSerialNumber	String			
Device Firmware Version	The firmware version of the device	DeviceFirmwareVersion	String			
Device Connection Type	Device's physical connection type	DeviceConnectionType	Enumeration	0	QSFP	
				1	SFP2LINKS	

Processor Temperature	Processor temperature	ProcessorTemperature	Float			In units of Celsius
Sensor Temperature	Sensor temperature	SensorTemperature	Float			In units of Celsius
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 units of Celsius
Device Fan Control Mode	Selects how to control the fan activation state	DeviceFanControlMode	Enumeration	0 1	On Auto	
Device Fan Control Threshold High	Device fan activation temperature threshold for Auto mode	DeviceFanControlThresholdHigh	Integer			In units of Celsius
Device Fan Control Threshold Low	Device fan stop temperature threshold for Auto mode	DeviceFanControlThresholdLow	Integer			In units of Celsius
Device Serial Port Selector	Selects which serial port of the device to control	DeviceSerialPortSelector	Enumeration (Selector)	0 1 2	CameraLink RS232_0 RS232_1	
Device Serial Port Baud Rate	Controls the baud rate used by the selected serial port	DeviceSerialPortBaudRate [DeviceSerialPortSelector]	Enumeration	9600 19200 38400 57600 115200 230400 460800 921600	Baud9600 Baud19200 Baud38400 Baud57600 Baud115200 Baud230400 Baud460800 Baud921600	

Table 11 – Device Control parameters

7.2 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.

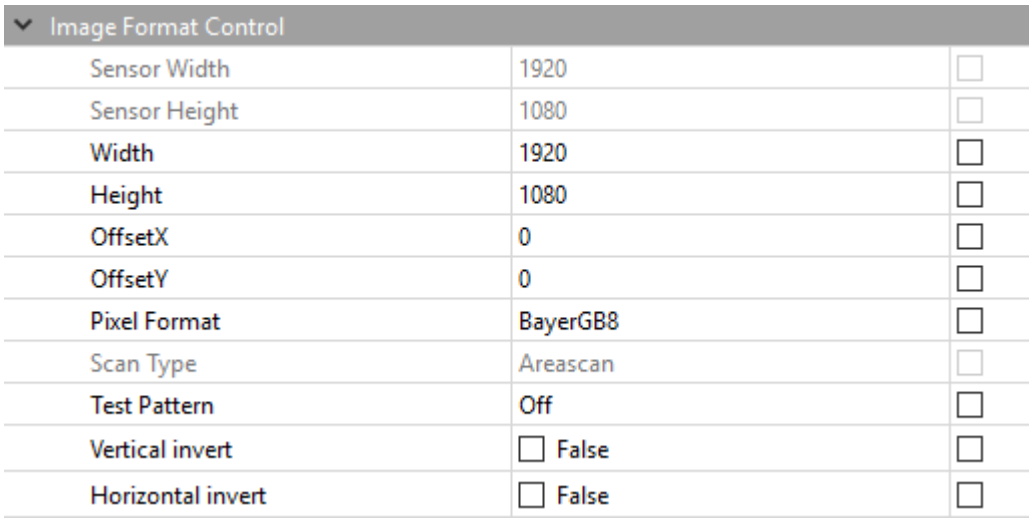


Figure 14 – Image Format Control category in GenICam Browser

7.2.1 Image Format Control XML Parameters

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: ExtendedStreamFeatures \ ImageFormatControl						
Sensor Width	Effective width of the sensor in pixels	SensorWidth	Integer			In pixels *See remark (1)*
Sensor Height	Effective height of the sensor in pixels	SensorHeight	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			
Offset Y	Vertical offset from the origin to the area of interest (in pixels)	OffsetY	Integer			
Pixel Format	Indicates the format of the pixel to use during the acquisition	PixelFormat	Enumeration	0x00000101 0x00000102 0x00000103 0x00000311 0x00000312 0x00000313 0x00000321 0x00000322 0x00000323 0x00000331	Mono8 Mono10 Mono12 BayerGR8 BayerGR10 BayerGR12 BayerRG8 BayerRG10 BayerRG12 BayerGB8	*See remark (2)*

				0x00000332	BayerGB10	
				0x00000333	BayerGB12	
				0x00000341	BayerBG8	
				0x00000342	BayerBG10	
				0x00000343	BayerBG12	
Scan Type	Scan type of the sensor of the device	DeviceScanType	Enumeration	0	Areascan	only “Areascan” is available for now
				1	Linescan	
Test Pattern	Selects the type of test pattern that is generated by the device as image source	TestPattern	Enumeration	0	Off	
				0x09	GrayHorizontalRamp	
				0x01	GrayVerticalRamp	
				0x49	GrayDiagonalRamp	
				0x0101	SensorChessboard	
				0x010	SensorGrayHorizontalRamp	
				0x030	SensorGrayVerticalRamp	
Vertical invert	Flip image vertically. The ROI will stay as original image.	ReverseY	Boolean	0	False	
				1	True	
Horizontal invert	Flip image horizontally. The ROI will stay as original image.	ReverseX	Boolean	0	False	
				1	True	

Table 12 – 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. Conversion in Frame Grabber is possible according to input camera, PixelFormat, resolution and HW capabilities.

7.3 Acquisition Control

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

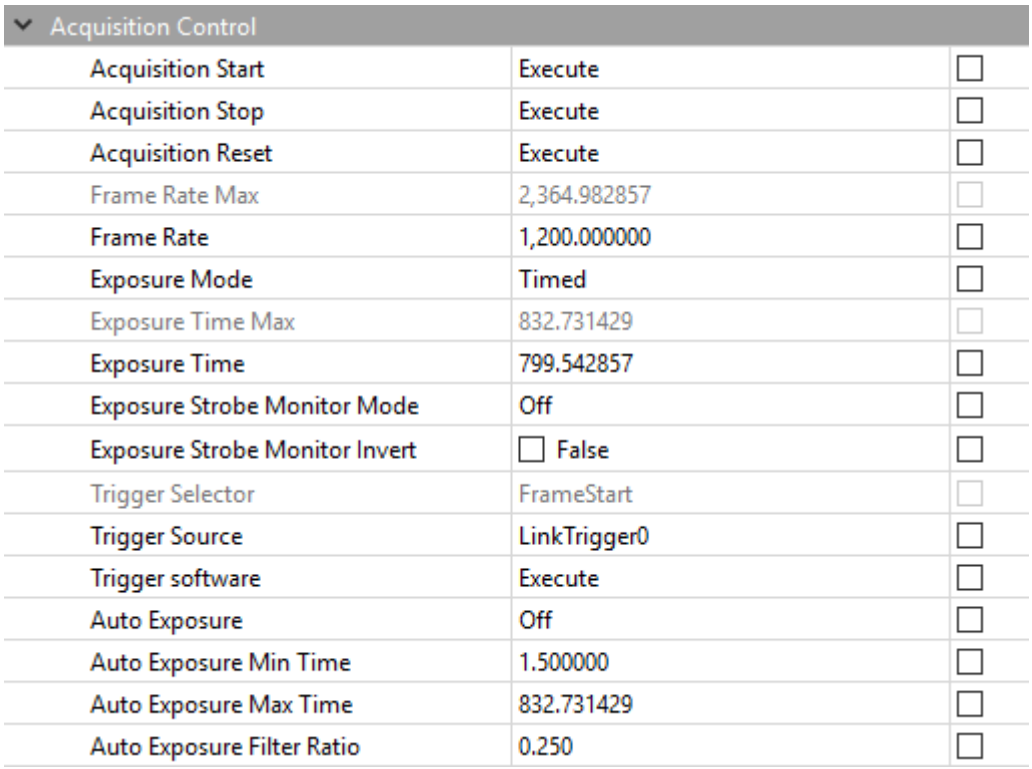


Figure 15 – Acquisition Control category in GenICam Browser

7.3.1 Acquisition Control XML parameters

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: AcquisitionControl						
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		
Acquisition Reset	Resets the image acquisition logic and counters	AcquisitionReset	Command	1 - 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	≥ 1		In units of Hz
Exposure Mode	Sets the operation mode of the Exposure (or shutter)	ExposureMode	Enumeration	0x00 0x01 0x02	Timed TriggerTimed 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	≥ 1.0		In units of microseconds (us) *See remark (1)*
Exposure Strobe Monitor Mode	Select to generate a strobe signal of sensor exposure	ExposureStrobeMonitorMode	Enumeration	0	Off	
				1	ExposureActive	
Exposure Strobe Monitor Invert	Controls the inversion of the signal generated according to ExposureStrobeMonitorMode	ExposureStrobeMonitorInvert	Boolean	0	False	
				1	True	
Trigger Selector	Selects the type of trigger to configure	TriggerSelector	Enumeration	0	FrameStart	
Trigger Source	Specifies the internal signal or physical input Line to use as the trigger source	TriggerSource	Enumeration	0	LinkTrigger0	
				1	Line1	
Trigger Software		TriggerSoftware	Command	1 - Activate		

Table 13 – Acquisition Control parameters

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

7.3.2 Exposure Time

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

$$minimum\ exposure \cong 6$$
$$maximum\ exposure \cong \frac{1{,}000{,}000}{frame\ rate}$$

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

7.3.3 Auto Exposure & Gain Algorithm

Auto Exposure and Gain features used to control the picture brightness by adjusting Exposure and Gain values in automatic mode in order 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:

7.3.3.1 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.

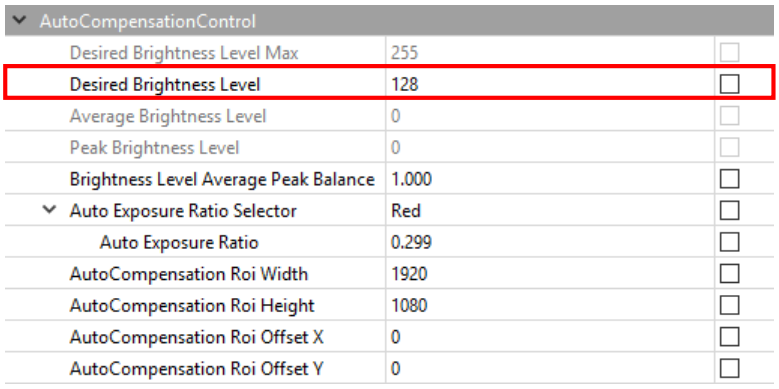


Figure 16 – Brightness level

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.

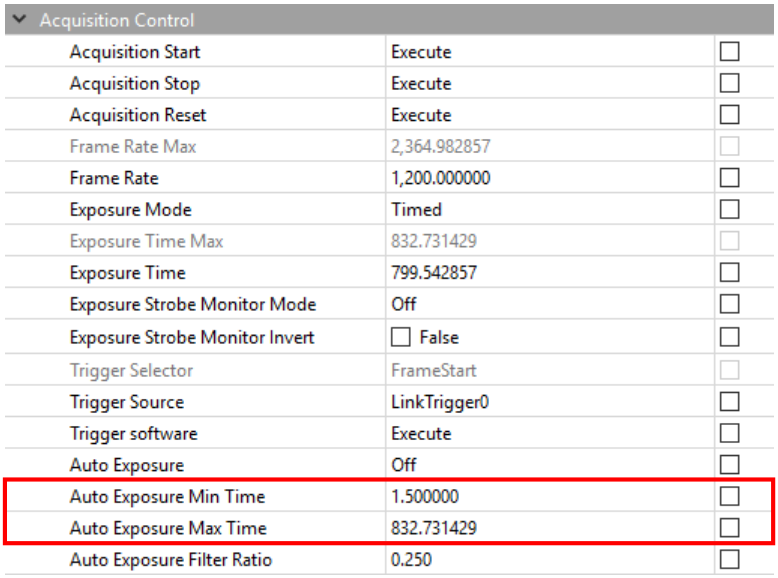


Figure 17 – Auto exposure times

3. Choose one of 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.

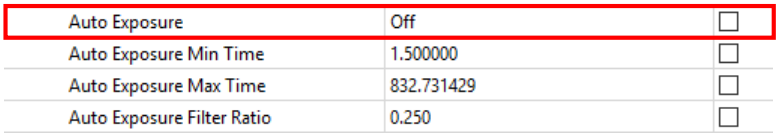


Figure 18 – Exposure mode

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	
Desired Brightness Level	Image total Brightness Level	DesiredBrightnessLevel	Float	Range: 1 to (2^bitness – 2)		
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		
Auto Exposure Filter Ratio	Sets the Auto Exposure filter effective ratio	ExposureAutoFilterRatio		Range: 0 to 1		

Table 14 – Exposure Auto control

7.3.3.2 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.

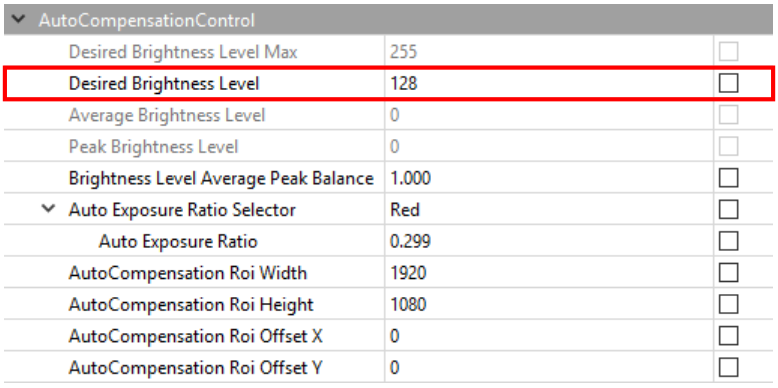


Figure 19 – Brightness Level

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.

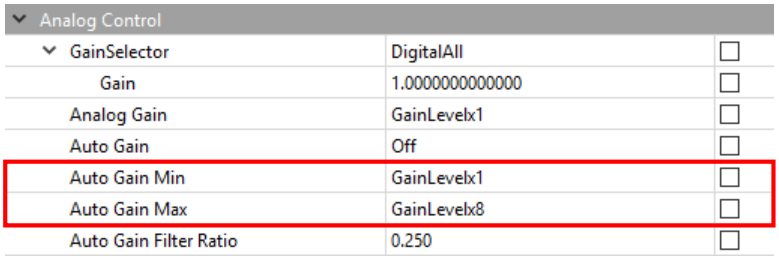


Figure 20 – Auto Gain values

3. Choose one of 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 “Continuous” mode, the gain will be adjusted continuously.

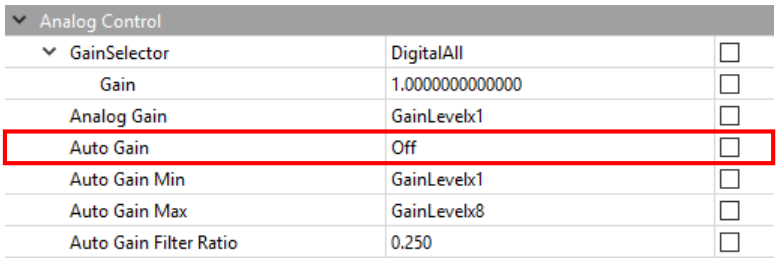


Figure 21 – Auto Gain mode selection

The auto exposure parameters specified in Table 17.

7.3.4 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 exposure value to make the picture brighter. If exposure level is at maximum value, while preferred brightness level is not reached yet, the algorithm starts to modify Gain Level and adjust 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 the section 7.3.3.1 for detailed instructions.
2. Set Auto Exposure to “Continuous” mode.
3. Define the parameters for Auto Gain; please see related section 7.3.3.2 for detailed instructions.
4. Set Auto Exposure to “Continuous” mode.

7.3.5 Brightness Level

The Desired Brightness Level reflect 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.

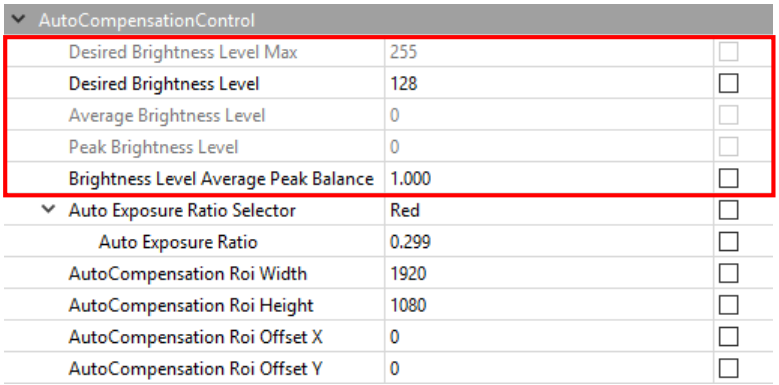


Figure 22 – Brightness level selection

The average value is calculated by the following formulas:

$$avg\_val = \text{ExposureAutoRatio}[\text{red}] * avg\_val[red] + \text{ExposureAutoRatio}[\text{green}] * avg\_val[green] + \text{ExposureAutoRatio}[\text{blue}] * avg\_val[blue]$$

$$\max\_val = \text{ExposureAutoRatio}[\text{red}] * \max\_val[red] + \text{ExposureAutoRatio}[\text{green}] * \max\_val[green] + \text{ExposureAutoRatio}[\text{blue}] * \max\_val[blue]$$

$$roi\_avg = \text{BrightnessLevelAveragePeakBalance} * avg\_val + (1 - \text{BrightnessLevelAveragePeakBalance}) * \max\_val$$

The algorithm strives to make roi_avg value as close as possible to the specified "DesiredBrightnessLevel" by changing Exposure and Analog Gain. Current average value and maximum value can be retrieved using "AverageBrightnessLevel" and "PeakBrightnessLevel" parameters.

Brightness parameters 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						
Desired Brightness Level Max	Maximum Desired Brightness Level	DesiredBrightnessLevelMax	Integer	<max pixel value>		
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 result from auto compensation	AverageBrightnessLevel	Integer	Range: 0 to <max pixel value>		
Peak Brightness Level	Current peak brightness level result 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 complement to Peak Brightness Level	BrightnessLevelAveragePeakBalance	Float	Range: 0 to 1	1 - Complete Average Level and 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 [ExposureAutoRatioSelector]	Float	Range: 0 to 1		

Table 15 – Brightness level control

7.3.6 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:

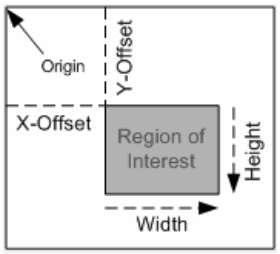


Figure 23 – ROI position in relation to the origin

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:

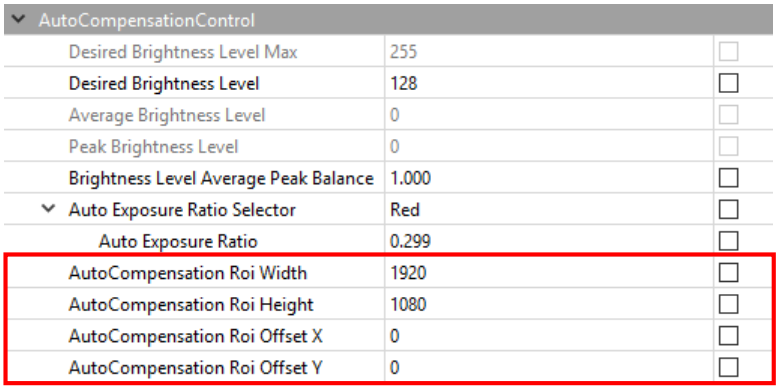


Figure 24 – ROI parameters

Auto Exposure ROI parameters 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 16 – Auto compensation ROI control

7.4 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.

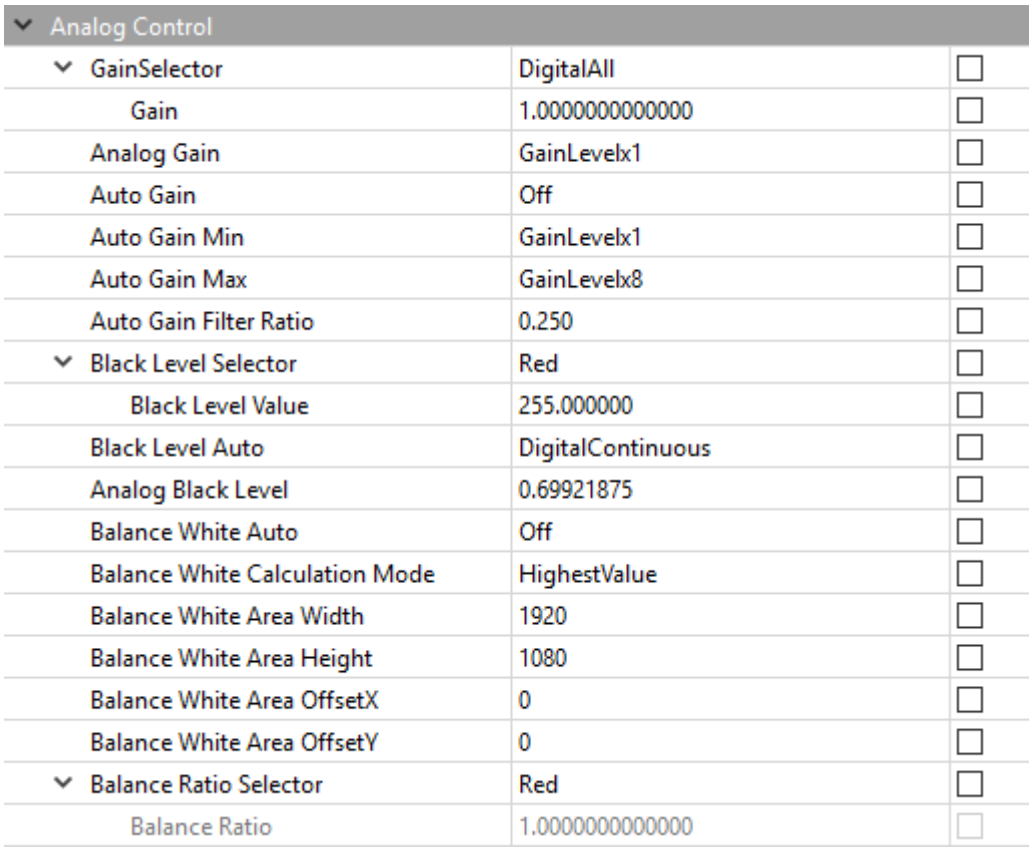


Figure 25 – Analog Control category in GenICam Browser

7.4.1 Analog and Digital Gain and Black Level XML parameters

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 is controlled by the various Gain features	GainSelector	Enumeration (Selector)	0 1 2 3	DigitalAll DigitalRed DigitalGreen DigitalBlue	
Gain	Controls the selected gain as an absolute physical value	Gain [GainSelector]	Float	Max. 7.99923		
Analog Gain Level	Controls the analog gaining level	AnalogGainLevel	Enumeration	0x00 0x01 0x03 0x07	GainLevelx1 GainLevelx2 GainLevelx4 GainLevelx8	For JetCam19/ 160
Auto Gain	Auto Gain Selector	GainAuto	Enumeration	0x00 0x01 0x02	Off Continuous Once	

Auto Gain Min	Sets the Auto Gain minimal value	GainAutoMin	Enumeration	0x01	GainLevelx1
				0x02	GainLevelx2
				0x04	GainLevelx4
				0x08	GainLevelx8
Auto Gain Max	Sets the Auto Gain maximum value	GainAutoMax	Enumeration	0x01	GainLevelx1
				0x02	GainLevelx2
				0x04	GainLevelx4
				0x08	GainLevelx8
Auto Gain Filter Ratio	Sets the Auto Gain filter effective ratio	GainAutoFilterRatio	Float	Range: 0 to 1	
Black Level Selector	Selects which Black Level is controlled by the various Black Level features	BlackLevelSelector	Enumeration	0	All
				1	Red
				2	Green
				3	Blue
Black Level Value	Controls the digital black level as an absolute physical value	BlackLevel [BlackLevelSelector]	Enumeration	Min. -1023 Max. 1023	
Black Level Auto	Controls the mode for automatic black level adjustment	BlackLevelAuto	Enumeration	0x00	Off
				0x03	DigitalOnce
				0x04	DigitalContinuous
Analog Black Level	Controls the analog black level as an absolute physical value. Represents the applied DC offset	AnalogBlackLevel	Float	Min. -1.2 Max. 1.2	

Table 17 – Analog Control parameters

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

7.4.2 White Balance XML parameters

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	Off	
				0x01	Once	
				0x02	Continuous	
				0x03	Manual	
Balance White Calculation Mode	Controls the mode for calculation algorithm of white balancing compensation	BalanceWhiteCalculationMode	Enumeration	0	HighestValue	
				1	Red	
				2	Green	
				3	Blue	

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	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 18 – White Balance parameters

Automatic white balance adjustment, compensate sensor output colors to true colors. The algorithm works on the assumption that average color of 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 result according to selected color or highest value.

7.5 ISP Features

1. Single line defected pixel correction
2. Flat filed compensation
3. Analog controls
    a. White balance (Gain per color)
    b. Gain correction
    c. Black level correction
4. LUT
    a. Gamma correction
    b. General purpose LUT per color

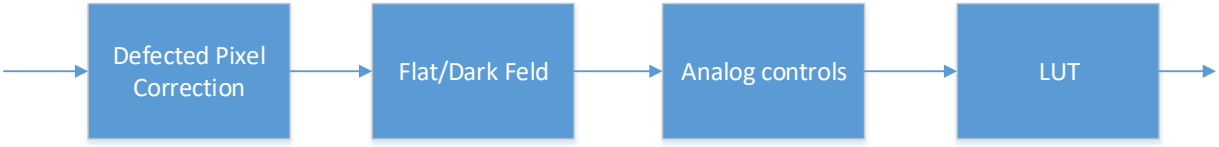


Figure 26 – ISP diagram flow

7.6 LUT control

The LUT Control can be used to re-map the camera linear output in 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.

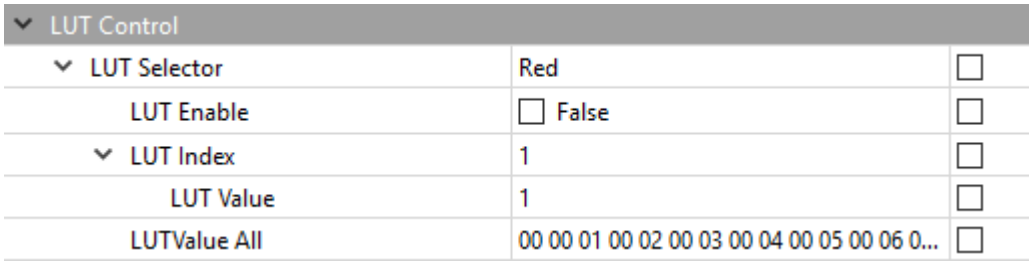


Figure 27 – LUT Control category in GenICam Browser

7.6.1 LUT Control XML Parameters

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 a single access without using individual LUTIndex	LUTValueAll [LUTSelector]	IRegister			

Table 19 – LUT Control parameters

7.6.2 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 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, for 12 bit the applied indexes will be 0-4095.
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 specific color.

7.7 Pixel Correction Control

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

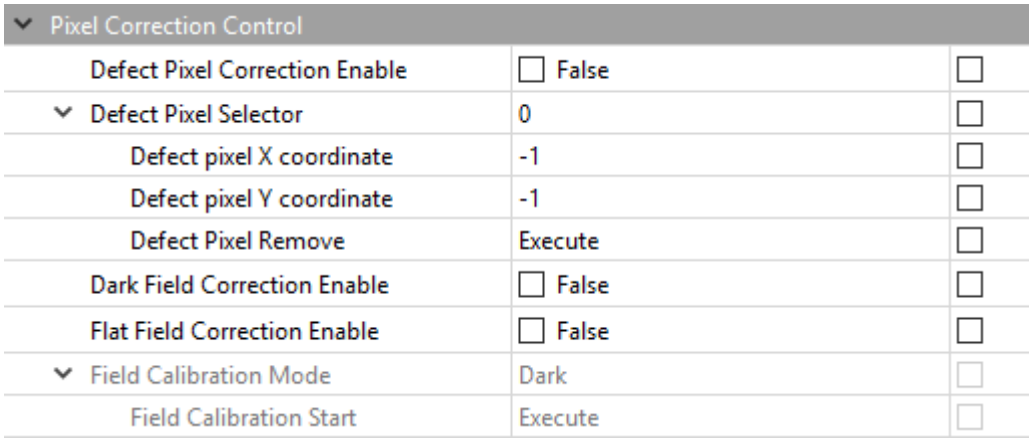


Figure 28 – Pixel Correction Control category in GenICam Browser

7.7.1 Pixel Correction Control XML Parameters

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 20 – Pixel Correction Control parameters

7.7.2 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 sensor's visible ROI, therefore identifying the correct X and Y coordinate should be done using default, full resolution image.
The algorithm will correct the defect pixel based on the value of existing adjacent pixels. The correction for 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.

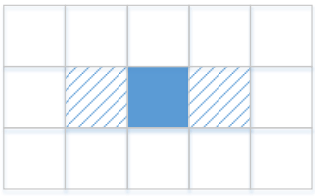


Figure 29 – Defect pixel correction position for Mono image

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.

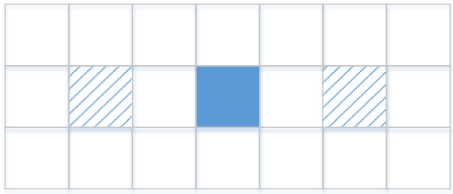


Figure 30 – Defect pixel correction position for Color image

7.7.3 Field Correction

The Flat-field and Dark-field corrections are used to improve the quality of the image by removing the artefacts that are caused by fixed pattern noise and variations in the pixel-to-pixel sensitivity of the detector. To make Dark/Flat field (DSNU / PRNU) correction, two pictures should be taken. The Dark/Flat field correction algorithm operates on rows/columns of the sensor and therefore is unable to correct pixel wise distortions like lens shading.
For DSNU a reference image has to be recorded in dark, with lens closed (offset should be boosted) or fully removed from the camera and covered with a solid cap. To calibrate for PRNU a reference image has to be recorded with a uniform illumination of around 40%. These two separate steps in the flat field correction are therefore referred to as dark field calibration and bright field calibration, respectively.
The operator is per pixel and defined according to following formula:

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

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

7.7.3.1 Dark field calibration process

The dark field correction is the easiest one to calibrate. It only requires a reference image to be recorded without illumination on the image sensor.
Follow these steps to perform dark field calibration process:

1. For this calibration, the light should be blocked from the sensor. This can be achieved by removing the lens and covering the sensor with a solid cap or closing the lens with a cap
2. Set the “Field Calibration Mode” to “Dark” (1)
3. Start camera’s stream either in free run or by applying an external trigger
4. Initiate the selected calibration with “Field Calibration Start” command Execute (2)
5. Stop camera’s stream
6. Enable the Dark filed correction (3)
7. Start camera’s stream either in free run or by applying an external trigger

7.7.3.2 Flat field calibration process

The choice of which light intensity to use for the bright field calibration requires a little bit more thought. If you perform the calibration with a light intensity too close to camera saturation you might compensate the camera too much and actually introduce more PRNU for low light intensities. If you use a weak light intensity, the differences in photo response might be too small and you under-compensate the sensor. In general a light intensity that gives a signal somewhere around 40% of the sensor full scale should give the optimal result. Follow these steps to perform flat field calibration process:

1. Prepare light source. Uniform light should be applied across the sensor. This can be achieved by removing the lens and setting a uniform light source, such as diffused light or integrating sphere, in front of the camera
2. Set the “Field Calibration Mode” to “Flat” (1)
3. Start camera’s stream either in free run or by applying an external trigger
4. Initiate the selected calibration with “Field Calibration Start” command Execute (2)
5. Stop camera’s stream
6. Enable the Flat filed correction (3)
7. Start camera’s stream either in free run or by applying an external trigger

NOTES:

1. The Flat field calibration should be performed **after** the Dark field calibration has already be performed for the selected camera settings.
2. To summarize, depending on the flat field correction variant, reference images have to be recorded in dark and in a bright field. Make sure the sensor is really dark when performing a dark field calibration and performing a bright field calibration in a light intensity range around 40% of the sensor full scale.
3. Errors might show up when a sudden peak in intensity is present in the reference scene as the correction is a low frequency correction.

4. There might be limits to the total difference that you will be able to correct for. The correction is often achieved by applying a gain per pixel or pixel segment. If the available gain is not sufficient to correct for the difference between the weakest and brightest illuminated pixel segment, a flat field cannot be achieved.
5. The PRNU and DSNU are valid for the specific camera settings and conditions, such as exposure time, gain, temperature, number of active fiber links, etc., which were selected during the calibration process. 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 section 7.9.
6. “Default” user set will load camera’s factory settings.
7. Firmware update may erase the saved user sets and may change camera’s “Default” settings.

7.8 Lens Control

The Lens control allows control over the Focus and Iris and provides general information about the mounted lens. After first initialization, of the Birger with the lens, has already been performed, data can be saved using one of the provided UserSets, to allow faster bring up and connection.
*The Lens Control interface currently support only Birger lens adaptor for Canon.

Lens Control		
Lens Selector	Birger	☐
Lens Communication Source	RS232 0	☐
Lens Initiate	Execute	☐
Lens Reset	Execute	☐
Lens Present	Yes	☐
Lens Name	Canon 18-55mm	☐
Lens Serial Number	24287	☐
Lens Identification	29mm,f43	☐
Lens Version	s:C2v23	☐
Lens Focus Control		
Focus Move Near Full	Execute	☐
Focus Move Far Full	Execute	☐
Focus Move Step	1	☐
Focus Move Near	Execute	☐
Focus Move Far	Execute	☐
Focus Minimum Position	0.250	☐
Focus Maximum Position	0.250	☐
Focus Position	0.250	☐
Focus Position Absolute	13,311.000000	☐
Lens Focus Control		
Iris Close Full	Execute	☐
Iris Open Full	Execute	☐
Iris Move Step	1	☐
Iris Close	Execute	☐
Iris Open	Execute	☐
Iris Minimum Position	4.3	☐
Iris Maximum Position	26.9	☐
Iris Position	26.9	☐
Lens Command Control		
Lens Command Request	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ...	☐
Lens Command Size	0	☐
Lens Command Send	Execute	☐
Lens Command Response	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ...	☐

Figure 31 – Lens Control parameter configuration in GenICam Browser

7.8.1 Lens Control Parameters

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	
Lens Communication Source	Source for communication to the lens	LensCommSource	Enumeration	0	RS232_0	
				1	RS232_1	
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 Serial Number	Serial Number of the lens	LensSerialNumber	StringReg			
Lens Identification	Lens type identification	LensId	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 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	
Iris Maximum Position	Lens maximum position for iris	LensIrisPositionMax	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 21 – Lens Control parameters

7.9 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. Non-volatile memory is available for user usage. Data save to this memory space will not be erase upon camera power-down.

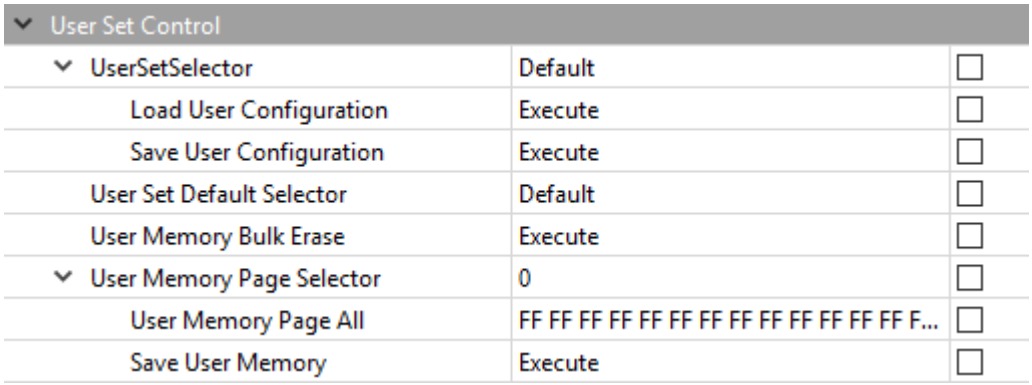


Figure 32 – UserSet Control parameter configuration in GenICam Browser

7.9.1 User Set Control XML Parameters

The User Set Control parameters are summarized in Tables 14 and 15:

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 active when the device is reset	UserSetDefault	Enumeration			

Table 22 – 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 23 – User Set Selector parameters

7.9.2 UserSet operation sequence

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

Save User Set:

1. Calibrate the desired camera parameters in “Camera” tab.
2. Open “User Set Control” category
3. Select the desired “UserSetSelector” numeration as UserSetX (X in range of 1-8).
   NOTE: “Default” user set contains factory settings and is not rewritable.
4. Execute “Save User Configuration” command.

Load User Set:

1. Select “UserSetSelector” to the desired UserSetX (X in range of 1-8).
2. Execute “Load User Configuration” command.
3. Press “Refresh” (located in the bottom of the project window).
4. In order to determine the user set configuration with which setting the camera will power up, set the desired user set in “User Set Default Selector” to UserSetX (X in range of 1-8).

NOTES:

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

The following function call sequence should be performed to achieve successful User Non-Volatile new memory save:

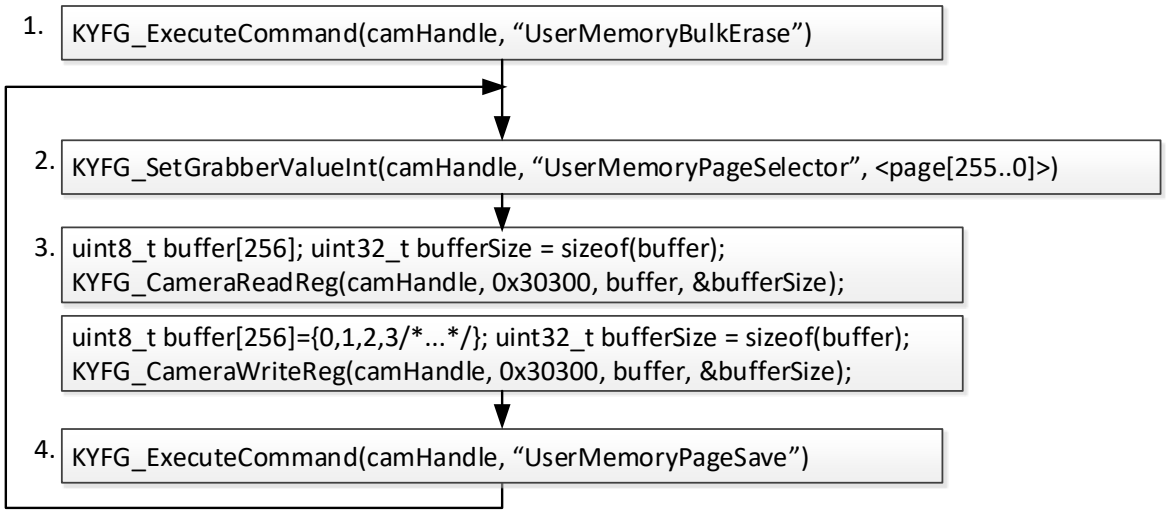


Figure 33 – Non-Volatile memory save function call sequence

1. “UserMemoryBulkErase” – erase all user non-volatile memory
2. “UserMemoryPageSelector” – select page[255..0] in memory (256 bytes for each page)
3. “UserMemoryPageAll” – array of 256 bytes to load data of specified page
4. “UserMemoryPageSave” – save selected page to non-volatile memory

Characteristics and restrictions:

1. Up to 65536 bytes can be saved into camera's non-volatile memory.
2. All data will be erased in 1 burst.
3. Data can be saved in bursts of 256 bytes each time. All 256 should be filled either with valid or padding data.
4. If data is loaded before erase operation is performed (1 time for all data), this data may be corrupted.
5. Data can be read at any time. (It is best not to read non-volatile memory while camera is streaming).
6. The access to non-volatile memory will be performed via GeniCam interface:
   Operation sequence.

7.10 Test Control

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

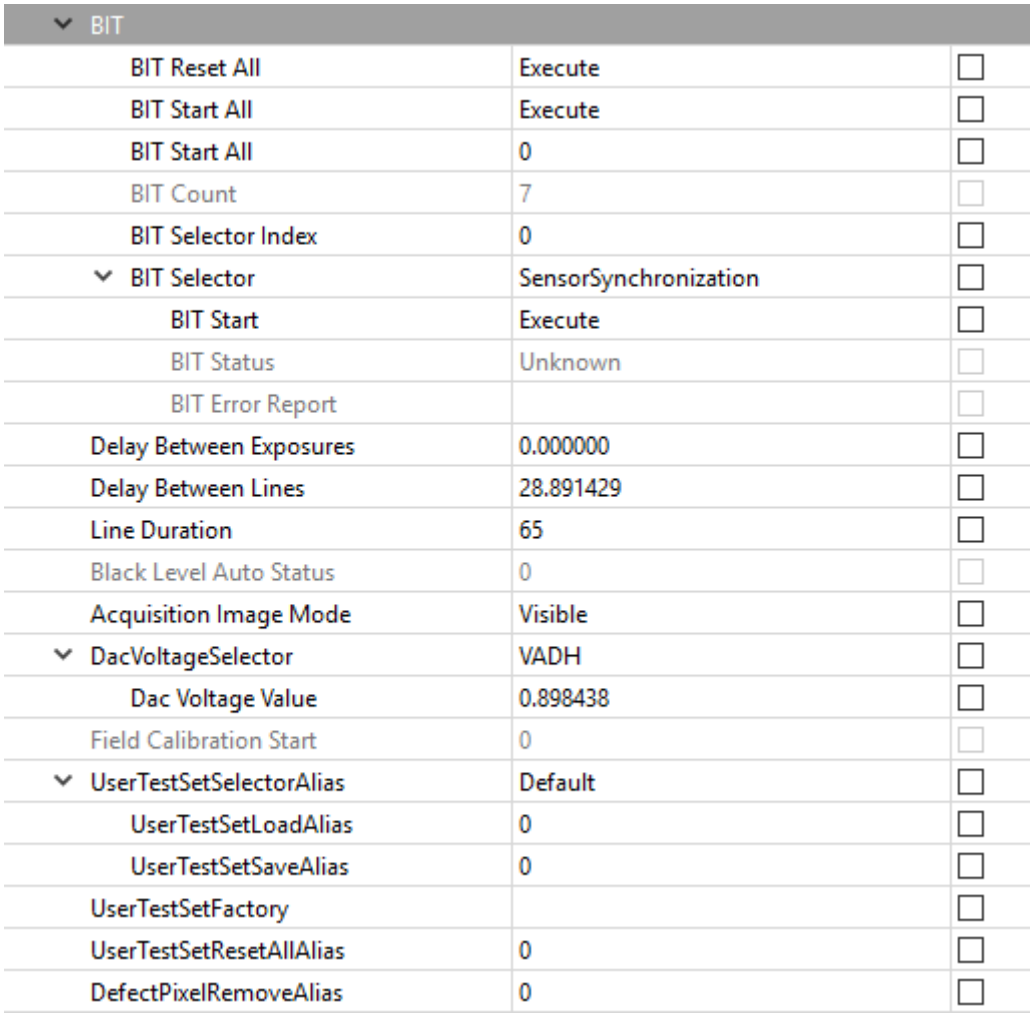


Figure 34 – Test Control parameter configuration in GenICam Browser

7.10.1 Test Control XML Parameters

Parameter	Description	Gen<i>Cam name	Type	Possible values		Remarks
				Value	Gen<i>Cam name	
Gen<i>Cam Category: TestControl						
Delay Between Exposures	Delay between exposures in microseconds(usec)	DelayBetweenExposures	Float			
Delay Between Lines	Delay between lines in microseconds(usec)	DelayBetweenLines	Float			
Line Duration	Line processing time in units of 11.43 nano-seconds(nsecs)	LineDuration	Integer			
Black Level Auto Status	Status value of Black Level Auto correction	BlackLevelAutoStatus	Integer			

Acquisition Image Mode	Selects the output image mode	AcquisitionImageMode	Enumeration	0	Visible	
				1	FullSensor	
DacVoltageSelector	Selects which dac to configure	DacVoltageSelector	Enumeration	0	VADH	
				1	VLNA	
				2	VOFF	
				3	VLNC	
				4	VABL_TST	
				5	VTX2L	
				6	VLN	
				7	VTXL	
				10	VTXH	
				11	VRSTH	
				12	VREF	
				13	VPIX	
				14	VCAS	
				15	VAD4	
Dac Voltage Value	Dac voltage value	DacVoltageValue	Integer			
Field Calibration Start	Activates the Field Calibration	FieldCalibrationStart	Integer			
UserTestSetSelectorAlias	Selects the feature User Set to load, save or configure	UserTestSetSelectorAlias	Enumeration			See Table 23 for available configurations
UserTestSetLoadAlias	Loads the User Set specified by UserSetSelector to the	UserTestSetLoadAlias	Integer			
UserTestSetSaveAlias	Save the User Set specified by UserSetSelector to the non-volatile memory of	UserTestSetSaveAlias	Integer			
UserTestSetFactory	UserSet Factory	UserTestSetFactory	String			
UserTestSetResetAllAlias	Reset all configuration user sets	UserTestSetResetAllAlias	Integer			
DefectPixelRemoveAlias	Remove the defect pixel determined by DefectPixelWriteX and DefectPixelWriteY from	DefectPixelRemoveAlias	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 24 – Test Control parameters

7.10.2 Build-In-Test

The Build-In-Test (BIT) implements 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 appropriate error report, either by starting 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 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 acceptable range.
6. Voltages – Test the analog voltages levels; they must be in acceptable range.
7. MACOM [(1)] – Test the speed configuration of the interface.
8. GPIO [(1)] – Test the functionality of the external GPIO interface. (Loopback dongle should be mounted to perform this test)

Remarks:

1. Not all camera models support this configuration.

8 CLI Interface

8.1 JetCam Terminal control

A Mini USB port is available for individual link status, general information and firmware update. The port uses a Silabs CP2101 chip. A driver from the Silabs website might have to be installed on certain PCs to gain access to the terminal port. Free supporting driver can be found at:
http://www.silabs.com/products/mcu/pages/usbtouartbridgevcpdrivers.aspx
After driver installation and USB connection is acquired a serial emulated terminal (i.e Tera Term use is recommended) can be used with the following configurations, described in the table below:

Parameter	Value
Baud rate	115200
Start bits	1
Stop bits	1
Parity	None
Flow Control	None

Table 25 – Serial communication configuration

The terminal supports the following commands. Each command must be followed by carriage return (Enter) in order to execute:
NOTE: The commands are not case sensitive.

Command	Description
Firmware	Sets the system to firmware update mode. See 8.1 chapter for firmware update information
Status	Prints the system and individual link status and general information

Table 26 – Terminal commands

8.2 JetCam Firmware update

The JetCam Cameras supports firmware update via USB using a serial emulated terminal. To initiate a firmware update follow the next steps:

1. Download the latest firmware from KAYA's website.
   NOTE: Please make sure to download the correct FW for the camera that you have, as installing an incorrect FW may cause the camera to malfunction.
2. Connect a USB cable between the computer and the camera and acquire connection using Silabs drivers (drivers need to be downloaded manually if an automatic download is not initiated).
3. Open serial emulated terminal (usage of Tera Term terminal is recommended) and set serial communication protocol as described Table 25:

For example in the Tera Term terminal, this should look as following (the port number might be different):

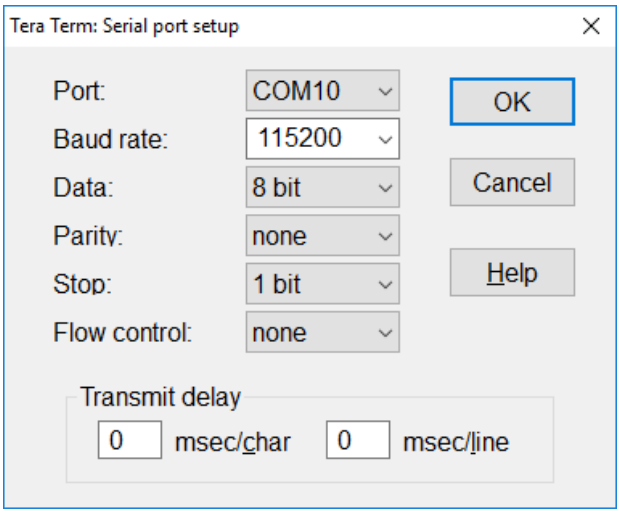


Figure 35 – Serial communication example

4. Choose the firmware update option by entering “firmware” followed by a carriage return and wait for the following message: "Now starting firmware update, please start file transfer using XMODEM:".

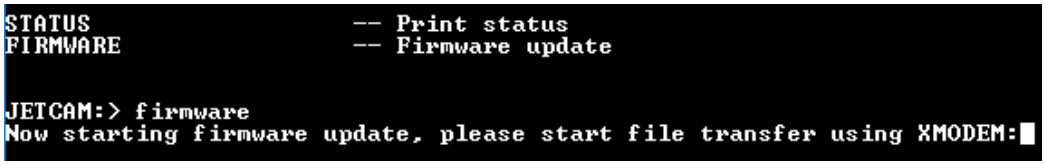


Figure 36 – Firmware update execution

5. Under the “File” tab use the terminal “transfer” capability using the XMODEM protocol to initiate the firmware update. Choose “Send” and the firmware update file: JetCam_XXX_YYY_ZZZ.bin (where XXX is the model name and YYY_ZZZ is the version number).

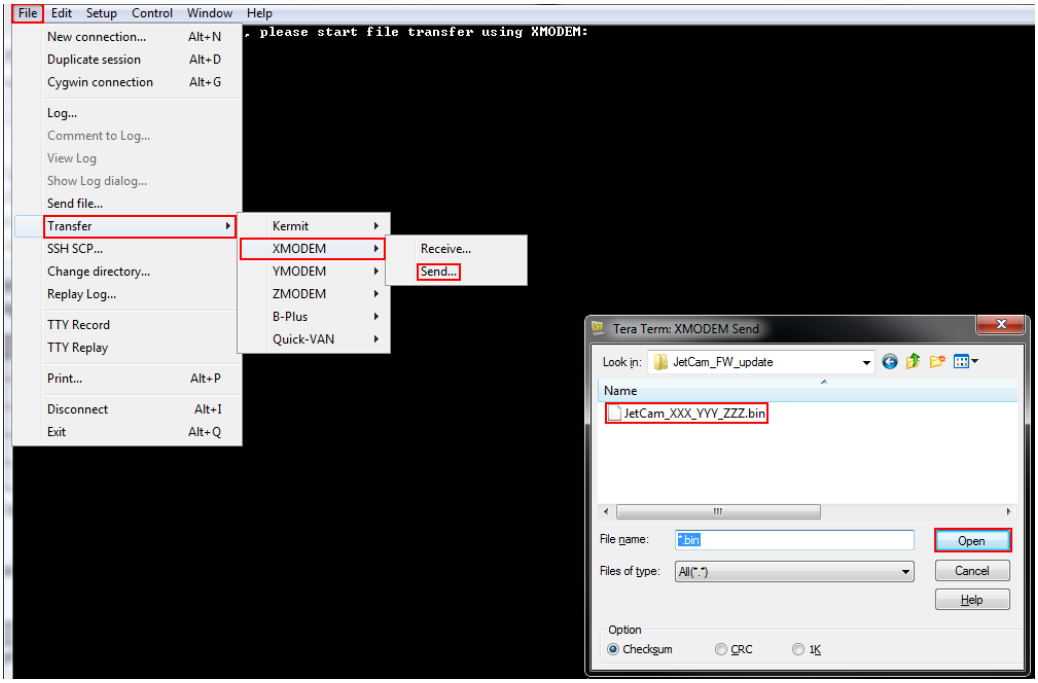


Figure 37 – Firmware terminal initiation

6. If no firmware will be sent during 1 minute, or in case of an error, the firmware update will fail and return to the previous operation mode:

```
JETCAM:> firmware
Now starting firmware update, please start file transfer using XMODEM:
update has failed
```

Figure 38 – Firmware update fail

7. The firmware update process will take about 10 minutes.

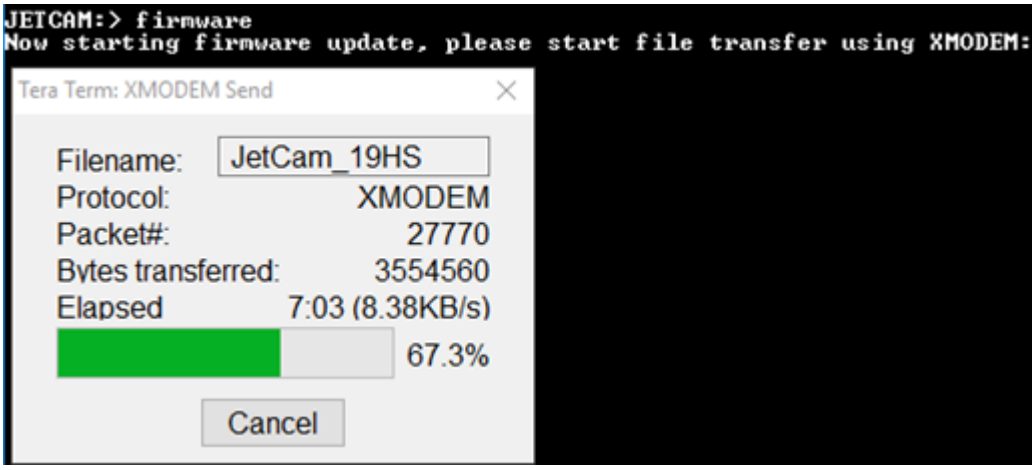


Figure 39 – Firmware update process

8. A successful update will result in an appropriate message:

```
Firmware update was successful
JETCAM:>
```

Figure 40 – Firmware update succession

9. To apply the new firmware, the camera should be power cycled by disconnecting the power supply from the camera and connecting it back after a few seconds.

8.3 Optional peripheral add-ons

The JetCam can be connected to a Canon Birger lens control module that can be purchased and that can be controlled using JetCam's virtual communication port. Here is a brief explanation on how to perform the connection and use Birger's lens control:

1. Power down the camera.
2. Connect the Birger adaptor to the Canon lens and to the camera via the GPIO connector. Connect the fiber cables and the USB cable and power up the camera.

Figure 41 – Camera with optional Birger adaptor

3. Open Vision point software and detect the camera.
4. After the camera was detected, under "Cameras" -> "Device Control" -> Serial Port Selector" select "RS232 0" and set the "Serial Port Baud Rate" to 115200.

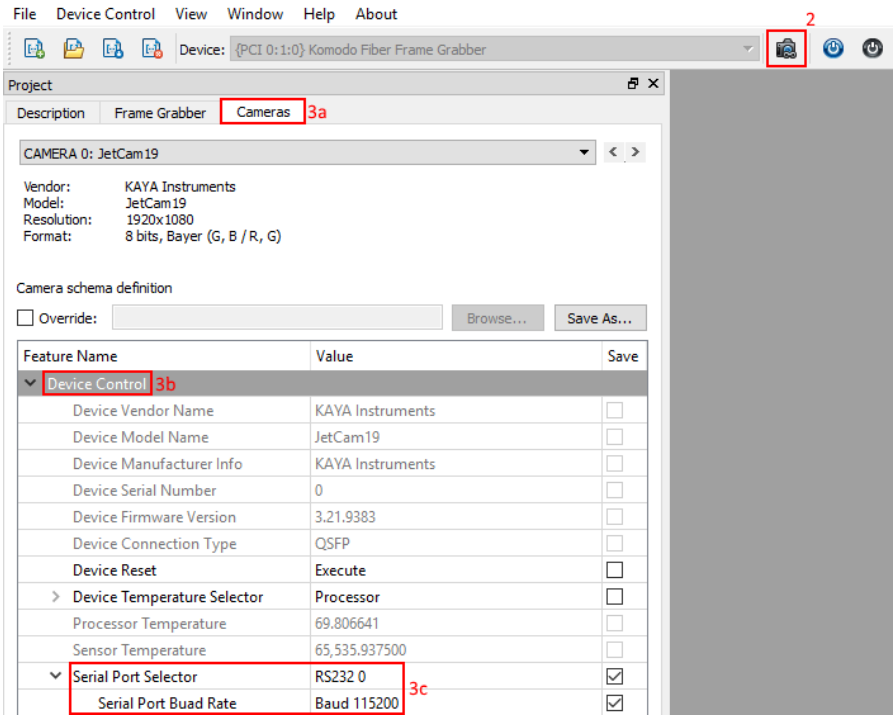


Figure 42 – Serial port setup at camera side

5. Under "Frame grabber" -> Extended Stream Features" -> "Camera selector 0" -> "Device Serial Port Control", set the "Serial Port Selector" to "PeripheralGPIO_0", Set the "Serial Port Number" to any non-zero value and check the box next to "Serial COM Port Enable".

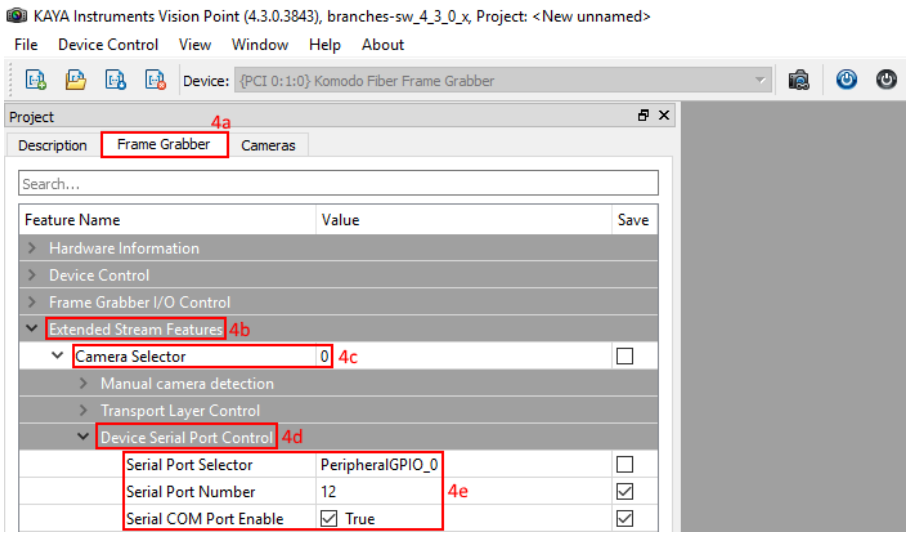


Figure 43 – Serial port setup at Frame Grabber side

6. Download and install the Birger software (BEI device interface) from the following link.
7. Open the BEI device interface software, select "File" -> "Preferences…" and make sure that in the bottom window ("Select the ports to ignore…") you see "JetCam X: RS232 0 (COM Y)", where X is the JetCam model and Y is the com port selected in the previous section (4e). Do not select anything in this window and click on "Cancel".

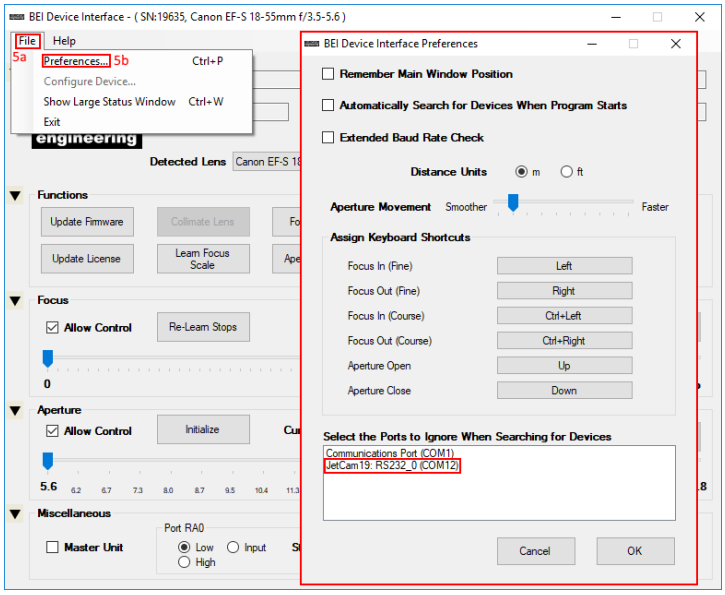


Figure 44 – Birger GUI setup 1

8. Click on "Find BEI Device" and after a few moments you should see the lens properties.

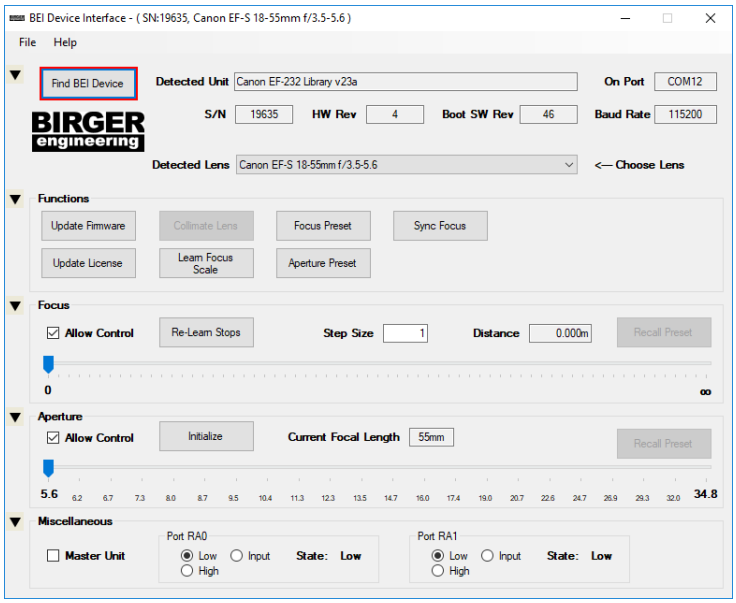


Figure 45 – Birger GUI setup 2

9 Appendix

9.1 Lens Mount Installation Manual

The following lens-mount installation instructions are for LUX19/ LUX160 SENSOR QSFP+/Dual SFP.

> ! Figures 1 to 5 depict an F-mount but the installation process is identical for all mounts offered by KAYA Instruments.

1. Position the camera in a position that will allow comfortable access to the screw holes. Prepare the lens mount in advance. As the sensor/filter, remain exposed during the process-working make sure to work in a clean environment – preferably a clean room or at least a fume-hood.

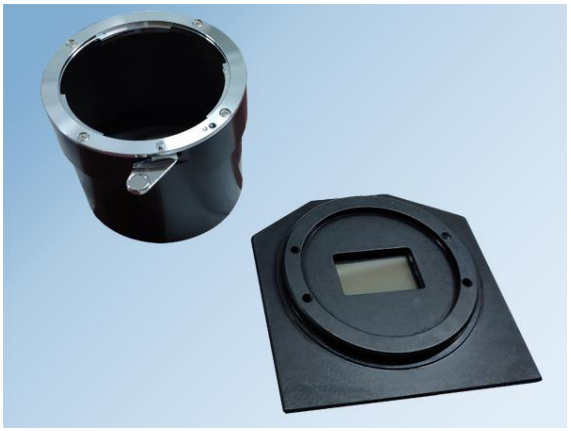


Figure 46 – JetCam front panel and the lens mount

2. Align the screw-holes on the mount with the ones on the camera's front panel.

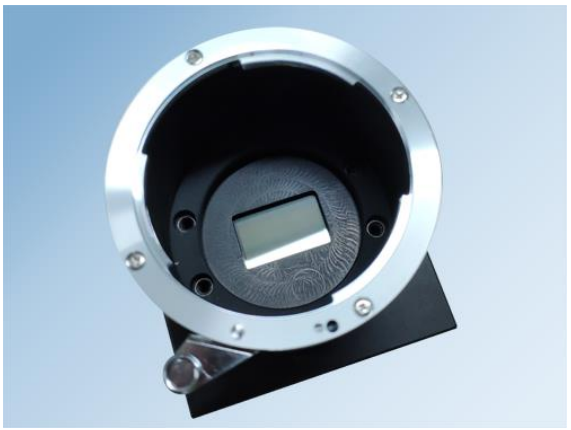


Figure 47 – Positioning the mount over the front panel

3. Using a pair of tweezers position four M2.5x4 black-coated screws in the screw-holes. ***Be very careful to not accidently drop a bolt on the imaging sensor. Do not lift a bolt before making sure it is firmly gripped.***

   Start by screwing all four of screws the about halfway in and proceed by fully screwing them in a cross-diagonal pattern (e.g. top-left, bottom right, bottom left and then top right).

Figure 48 – Carefully handle the screws to avoid scratches

4. Make sure that everything is in check and that there are no visible gaps, especially on the contact surface between ***the mount and the front panel: the mount should sit flush against the panel with no gaps.***

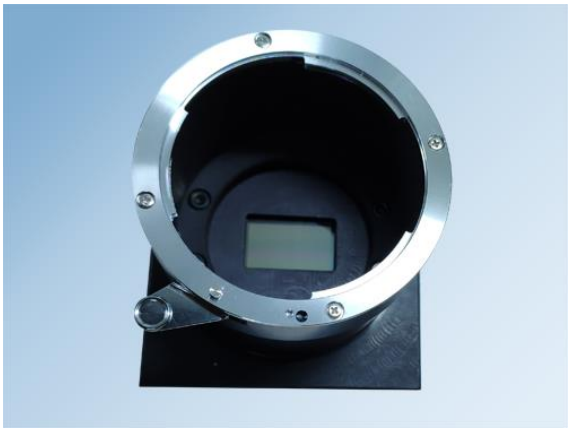


Figure 49 – The assembled mount

5. Cover the mount with the mount cover immediately after finishing and verifying everything is in order. This is critical in order to protect the sensor from dust and dirt.

Figure 50 – Covered lens mount

10 Troubleshooting

The following is a basic trouble-shooting guide for the JetCam cameras, for a more extensive support please refer to our support system by either sending a mail to support@kayainstruments.com or by visiting KAYA Support Board.

10.1 The camera is connected but the LED are not lit

When the camera is powered on, the System status LED should be lit (red) and after the camera finishes its power-up sequence, all the available Link status LED should be lit (red).

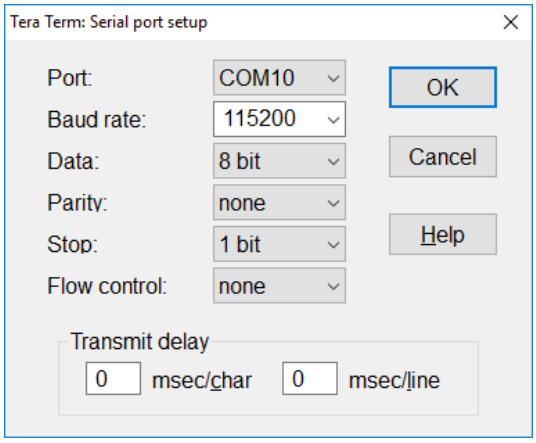
If this is not the case, please make sure that the power cable is connected firmly to the camera and that the power supply block is connected to a live power source.

10.2 The camera is powered on but not detected the image is corrupted

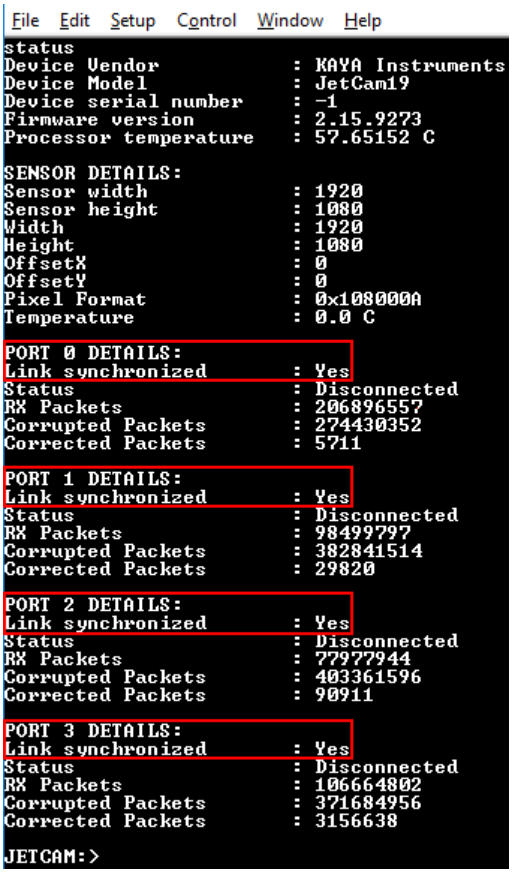
In case the camera is powered on but it can't be detected by the Frame Grabber or the image is corrupted, you'll need to check the link connectivity.
When the camera is detected correctly (with all its available links) you should see that all the link status LED are lit in green, on both the camera ("link status LEDs") and the Frame Grabber ("QSFP+ CHx LED" or "SFP CHx LED").

It is also possible to check the status of each of the available links by connecting a Mini USB cable between the camera's serial connector and a PC and acquire connection using Silabs drivers (drivers need to be downloaded manually if an automatic download isn't initiated).

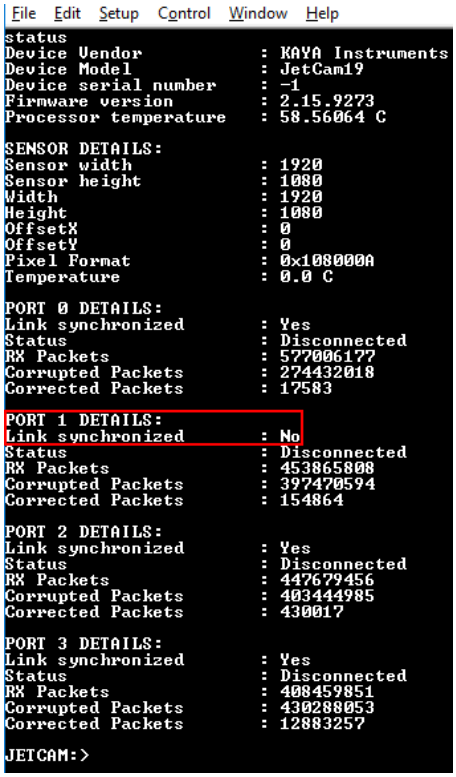
Connect the Mini USB cable to the serial sonnector. Afterwards open the serial emulated terminal (usage of TeraTerm terminal is recommended) and set serial communication protocol, for example in the TeraTerm terminal, this should look as following (the port number might be different):



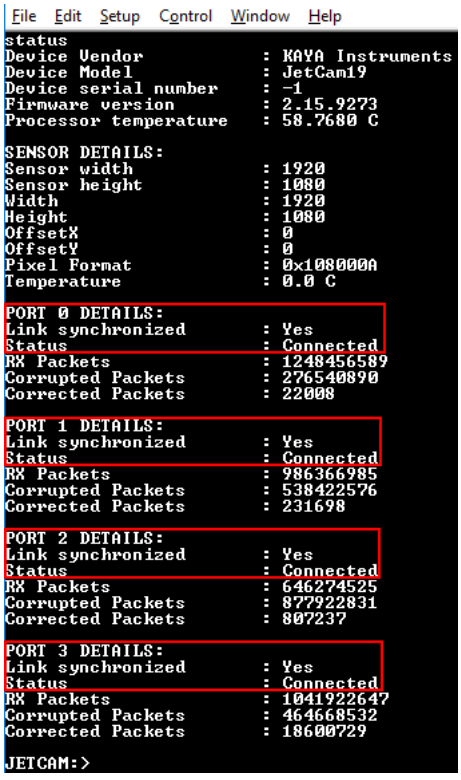
In the terminal please type "status" and click on the carriage return (Enter) in order to execute.
A similar output should be displayed if all available links are synchronized correctly (before trying to detect the camera):



If any of the available links are not synced a similar output should be displayed (before trying to detect the camera):



If this is the case please make sure that the fiber cable and the QSFP+ and\or the SFP+ modules in both the camera and the Frame Grabber are properly connected. Power down the camera, disconnect the fiber cable and remove the QSFP+\SFP+ modules from the camera and the Frame Grabber, then place them back in their places.
When all the available links are synced and the detection of the camera is OK, a similar output should be displayed (after trying to detect the camera):



When the camera is sending data, a similar output should be displayed: