

allPIXA wave camera | Manual



CD40172

R06 / 2022-06-07

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1 General information

1.1 About Chromasens

The name of our company, Chromasens, is a combination of 'Chroma' which means color, and 'Sens' which stands for sensor technology.

Chromasens designs, develops and produces high-quality and user-friendly products:

- Line scan cameras
- Camera systems
- Camera illumination systems
- Image acquisition systems
- Image processing solutions

Today, Chromasens GmbH is experiencing steady growth and is continually penetrating new sales markets around the globe. The company's technologies are used, for example, in products and for applications such as book and document scanners, sorting systems and inspection systems for quality assurance monitoring.

Customers from all over the world of a wide range of industrial sectors have placed their trust in the experience of Chromasens in the field of industrial image processing.

1.1.1 Contact information

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1.1.2 Support

Should you ever have problems with the allPIXA wave camera that you cannot solve by yourself, please look into this manual for additional information, check the troubleshooting chapter 10, contact your local distributor, or send us an e-mail.

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Visit our website at www.chromasens.de which features detailed information on our company and products.

1.2 Firmware and software version in this manual

This document refers to the following version:

CST: Version 2.8.3

Camera: Packet 4.20

The recent version might have additional functions. Therefore, contact the Chromasens support.

1.3 List of abbreviations

Abbreviation	Meaning	Explanation
ADC	Analog digital converter	-
CCM	Color conversion matrix	The CCM supports the conversion from for example RGB to sRGB or any user-defined conversion
CDS	Correlated double sampling	-
Corona II	LED illumination	Chromasens product
CST	Camera setup tool	Chromasens camera parameter programming software
DSNU	Dark signal non-uniformity	Irregularity in the dark image
DVAL	Data valid	Pixel-by-pixel enabled for Camera Link
FVAL	Frame valid	Frame signal for an image on the Camera Link (corresponds to VSync)
LED	Light emitting diode	-
LVAL	Line valid	Frame signal for a line on the Camera Link
PRNU	Photo response non-uniformity	Difference in sensitivity of the individual pixels
ROI	Region of interest	-
RS485		ANSI standard defining the electrical characteristics of drivers and receivers for use in serial communications systems.
VSync	Vertical synchronization	Frame signal for an image (corresponds to FVAL)
XLC4	Light controller	Controller that permits to control up to four channels of Corona II illuminations.

1.4 Definitions

Chromasens	Other used definitions	Explanation
Black-level correction	Background subtraction, Offset correction	Removes the dark offset from each pixel (DSNU)
Image start delay		Delay of the image's beginning, as a number of lines, from the beginning of the trigger condition to the beginning of the image
Flat-field correction	Shading correction, White-level correction	Corrects brightness inhomogeneities resulting from lens, light and non-uniformity of sensor pixels (PRNU)
RGB line distance	Line shift; Spatial correction	The tri- or quad-linear sensor has individual pixel lines for (gray,) red, green and blue. Inside the camera, the spatial differences are corrected.
White balancing	Setting the operation point	White balancing ensures that a reference white is kept stable in an image with color temperature or brightness changes of the illumination. This can be performed in a single setup process or in a permanent process.
White reference		The white reference is a physical patch in the field of view of the camera that can be used for a camera-internal white balancing.

1.5 Scope of supply of the allPIXA wave camera

Check your device upon delivery to ensure that it is undamaged and complete.

The following components are supplied with the allPIXA wave camera:

- allPIXA wave camera packaging

Check the packaging for damage, which may have occurred during transport.

- allPIXA wave camera

Check the camera for damage, which may have occurred during transport.

The rating plate is located on the rear of the allPIXA wave camera. It shows the camera resolution and the serial number.

- Additionally ordered and supplied accessories

Lens adapters, extension rings, lenses and other accessories are not included in the standard scope of delivery. These items must be ordered separately as accessories.

Check additionally ordered accessories for completeness and for damage, which may have occurred during transport.

Read this manual carefully before using the camera, contacting your local partners or the Chromasens support.

Should there be any questions left, do not hesitate to contact your local partner or us.

We would be pleased to be of assistance to you.

1.6 Information about the Camera Setup Tool (CST)

To download updates, refer to our website at <https://www.chromasens.de> and look in the software area of the product.

Before you install and use CST, you should check whether a more recent version of CST or of this manual is available.

If CST is already installed, you can check the version number using the **Help** menu.

For information about CST usage, see chapter 6.

1.7 Design of a line scan camera system

The following figure demonstrates the basic setup of a typical line scan camera system:

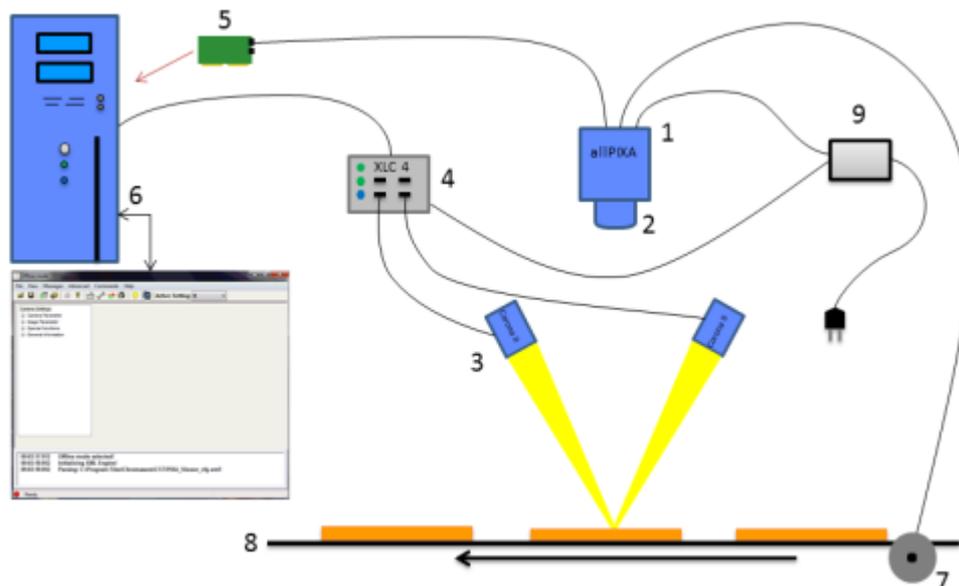


Figure 1: Design of a line scan camera application

The following components are necessary in a typical line scan camera application:

Component	No.
Line scan camera: An allPIXA wave camera, which scans the image line by line and communicates with the frame grabber (5, PC plug-in card).	1
The optical system: Optical lenses with tubes and mounts with an adjusted focusing	2
Illumination: The illumination system lights up the information carrier/scan area on the passing object. The Chromasens Corona II illumination system is an ideal supplementary option for the allPIXA wave camera.	3
Illumination controller: Controls and monitors the illumination unit. The Chromasens Corona II illumination (3) has integrated temperature/voltage sensors which can be read out with the XLC4 controller. By use of the XLC4 controller, the illumination unit can be monitored and kept stable.	4
Frame grabber (PC plug-in card): The image data are sent to a PC by use of a frame grabber with a Camera Link interface. The frame grabber establishes the necessary hardware connection to the PC (6).	5
PC: The PC system performs subsequent processing of the image data and can optionally control the illumination system (3 + 4).	6
Speed detection: The speed of the object / conveyor belt can be detected by an optional incremental encoder. The encoder can be connected either to the allPIXA wave camera or to the frame grabber.	7
Conveying unit: The conveying unit moves the scanned object past the allPIXA wave camera.	8
Power supply: Both, the allPIXA wave camera and the illumination system, require a suitable power supply.	9

2 Specifications and definitions

The allPIXA wave camera family is available in the following maximum resolutions:

- 10,240 pixels
- 15,360 pixels

The allPIXA wave camera comprises all functions required for supplying images with the same color, brightness and resolution of each operational area.

The allPIXA wave camera is especially suitable for inspection systems requiring a very high speed and a consistently high color quality.

Continuous white balancing is possible during image acquisition to ensure optimum color quality. In addition, offset and shading correction ensure the balance of different color pixel sensitivities (DSNU and PRNU) as well as the illumination process.

Via frame grabber the incremental encoder can be either sent to the CC bits of the Camera Link interface or directly connected to the allPIXA wave camera. As a result, images with a consistent quality can be generated even at transport speeds with a high fluctuation rate.

The allPIXA wave camera parameters can be configured with the Camera Setup Tool (CST). Equipped with a Camera Link base / medium / full interface support, the allPIXA wave camera achieves a data rate in medium mode of up to 170 megapixels per second with 24-bit RGB, which is equal to 510 Mbytes/s. With Camera Link Full_64 interface the data rate is 680 Mbytes/s and with Camera Link Full_80 interface the data rate is 850 Mbytes/s.

The design was fully revised during development of the housing, which is impressively tough but offers several of screw mounting options. Take notice that the wide range of adapter options makes the installation simple for users.

The standard mount connections M72x0.75 for the 10k camera, or M95x1.0 for the 15k camera, respectively, permit to use all commercially available standard lenses. In addition, special adapters are available that permit to connect Chromasens accessories.

2.1 Camera highlights

- Quad-linear color line scan camera (quad-linear CMOS line scan sensor)
- 5,6 µm pixel size
- High-accuracy sensor alignment
- 24-bit (3 x 8/12 bit) color information or 1 x 8/12-bit mono information on the output side; RGB spatial compensation in the camera (also sub-pixel correction, patented)
- Continuous white balancing maintains a constant image brightness and color irrespective of the temperature and service life of the illumination system
- Incremental encoder port on the camera; this ensures simple handling and less programming work
- Shading correction, fully automatic calculation internally in the camera or optionally calculated offline with CST
- Gamma correction, brightness and contrast controller, separate for each channel
- Multiple Color conversion matrix (CCM) and offset supported
- Internal keystone correction for multiple angle positioning of the camera
- Precise multi-camera synchronization
- Automatic insertion of machine and camera data inside the image (for example, scanning speed, CRC, time stamp, Encoder position,..)
- Fully synchronized multi-channel LED flash control
- Robust metal housing
- Adjustable Camera Link clock
- Mono-image output at individual color weights
- Standard mount connections M72x0.75 for the 10k camera, or M95x1.00 for the 15k camera, respectively
- Special adapters permit to use Chromasens accessories
- Internal test image generator
- Option for area scanning with trigger inputs (light barriers)

2.2 Camera speed for available Camera Link modes and frequency

The allPIXA wave maximum line frequency depends on the selected Camera Link type and frequency. For information about different configurations, see the tables below.

allPIXA wave 10k (10240 pixel):

Shown line frequencies are for full number of pixels; line frequencies in ROI mode are higher.

CL-Definition	Base Mode	Medium mode	Full64 mode	Full80_8Tap_10Bit	Full80_10Tap_8Bit
85.00 MHz	8.29 kHz	16.58 kHz	22.04 kHz	22.10 kHz	25.33 kHz

allPIXA wave 15k (15360 pixel):

Shown line frequencies are for full number of pixels; line frequencies in ROI mode are higher.

CL-Definition	Base Mode	Medium mode	Full64 mode	Full80_8Tap_10Bit	Full80_10Tap_8Bit
85.00 MHz	5.5 kHz	11.06 kHz	14.74 kHz	14.72 kHz	18.43 kHz

The following table shows the line frequencies for color images in ROI mode. The value in the ROI length column means the sum of the lengths of the specified ROIs.

Maximum line rates in ROI mode:

ROI length	Medium mode	Full64 mode	Full80_10Tap_8Bit
3 k	47.42 kHz	47.42 kHz	47.42 kHz
4 k	41.34 kHz	47.42 kHz	47.42 kHz
5 k	33.10 kHz	44.13 kHz	47.42 kHz
6 k	25.33 kHz	25.33 kHz	25.33 kHz
7 k	23.66 kHz	25.33 kHz	25.33 kHz
8 k	20.71 kHz	25.33 kHz	25.33 kHz
10 k	16.58 kHz	22.10 kHz	25.33 kHz
12 k	13.82 kHz	18.42 kHz	23.03 kHz
14 k	11.85 kHz	15.79 kHz	19.74 kHz

NOTE I For ROI lengths >5k the maximum line frequency is 25.33 kHz, for ROI lengths <=5k it is 47.42 kHz, independently of CL mode and ROI length.

NOTE II For ROI lengths <=5k the values in the table take only effect if the ROIs are located within the 5k pixels in the center of the sensor.

2.3 Technical specification

Sensor	Quad-linear CMOS color line sensor
Pixel size	5,6 µm x 5,6 µm (5,6 µm pitch)
Line spacing	11,2 µm between R-G and G-B
Maximum pixel rate	226 megapixels/s 24 / 30-bit RGB
Maximum data rate on the Camera Link	Base: 255 Mbytes/s Medium: 510 Mbytes/s Full_64 680 Mbytes/s Full_80: 850 Mbytes/s
Resolution	10240 / 15360px Other sensor resolutions are available on request
Maximum line frequency 3*8 Bit RGB (Preliminary)	10240 pixels: 25.33 kHz 15360 pixels: 18.43 kHz
Spectral sensitivity	360 nm to 960 nm
Video signal	8, 10 or 12-bit on the Camera Link, 4x12 bit ADC
Interface	Camera Link with up to 85 MHz
Line scan operating mode	Free-running / external trigger (incremental encoder / line trigger)
Area scan operating mode	Image size either free-running, fixed, or based on trigger pulse width
Other interfaces	Power supply (6-pin Hirose, male) External IO (15-pin D-Sub, female) Serial RS-232 (9-pin D-Sub, female)
Camera mount	M72x0.75 for allPIXA wave 10k, M95x1.0 for allPIXA wave 15k, Adapters to Chromasens accessories available
Certifications	CE, FCC compliant, RoHS
Power supply	12 to 24 VDC +/- 20 %; <19 W
Housing temperature	0°C to 50°C; 32°F to 122°F
Housing dimensions	10k: L = 102 mm, H = 76 mm, D = 56 mm 15k: L = 102 mm, H = 56 mm, D = 56 mm
Weight	<0.7 kg

NOTE Depending on the power supply, the power consumption might be up to 1 ampere@24V at power-up for a short time. It is recommended to provide a power supply with 24VDC/1amp or with higher possible power consumption.

2.4 Mechanical specification

2.4.1 Mechanical dimensions of the allPIXA wave 10k camera

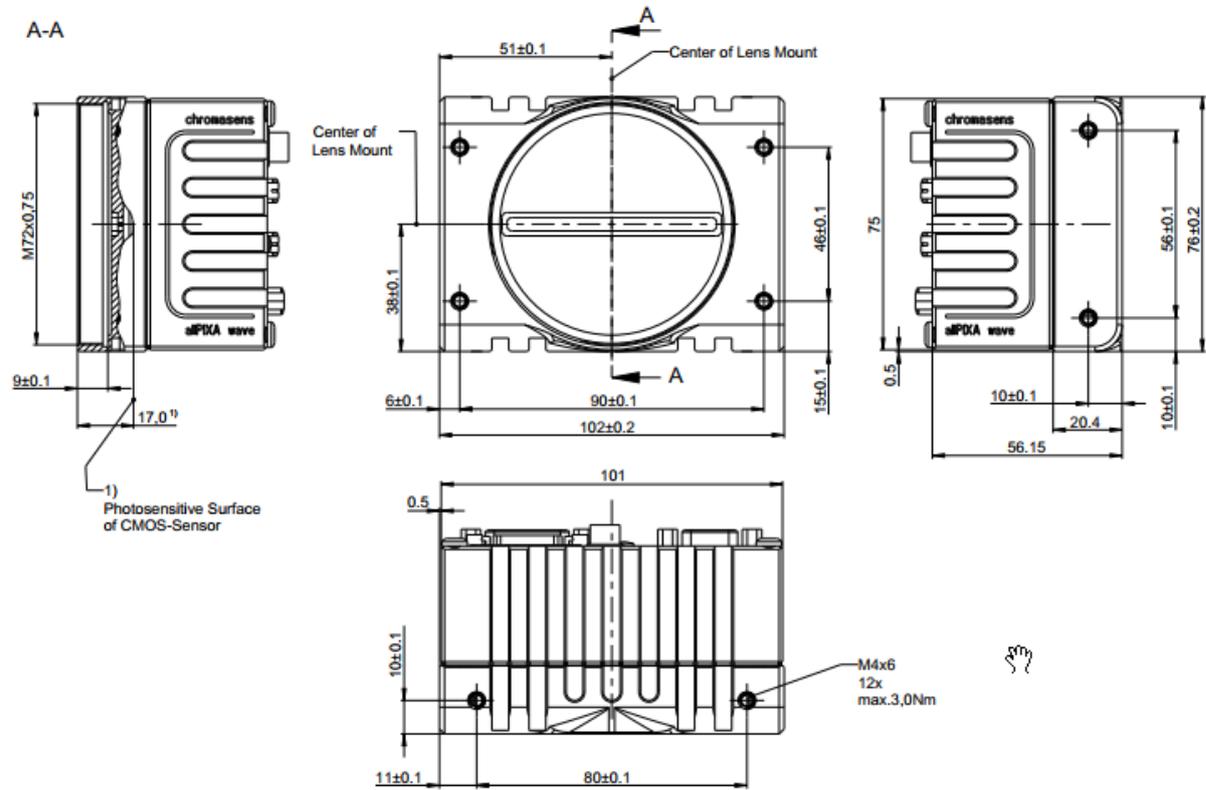


Figure 2: Mechanical dimensions of the allPIXA wave 10k camera

NOTE I Drawings and 3D-CAD-models are available on our homepage <https://www.chromasens.de> in the download section of the product

NOTE II The shown position of the Sensor surface is given as resulting optical value including lengthening of the sensor glass. For more details, refer to section 2.5.

NOTE III For information about the XYZ coordinate system and sensor alignment, see section 2.5.

2.4.2 Mechanical dimensions of the allPIXA wave 15k camera

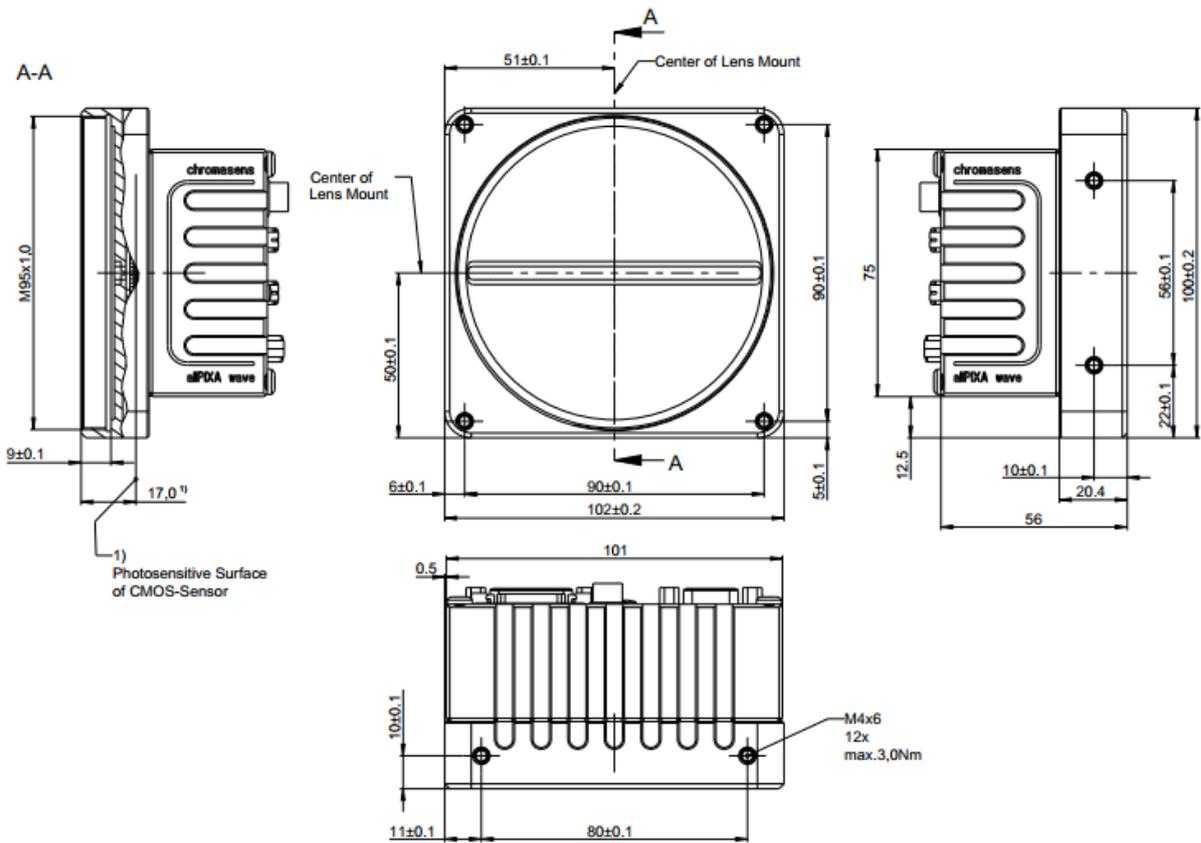


Figure 3: Mechanical dimensions of the allPIXA wave 15k camera

NOTE I	Drawings and 3D-CAD-models are available on our homepage https://www.chromasens.de in the download section of the product
NOTE II	The shown position of the Sensor surface is given as resulting optical value including lengthening of the sensor glass. For more details, refer to section 2.5.
NOTE III	For information about the XYZ coordinate system and sensor alignment, see section 2.5.

2.5 Sensor alignment and orientation

Sensor orientation and alignment in viewing from the front side of the camera. For a detailed mechanical drawing, see section 2.4.

First pixel of sensor lines:

Left side

Color lines orientation:

Blue: top
 Green: center
 Red: bottom
 Gray: below color lines

Sensor alignment:

Position:

X: < +/- 100 μm
 Y: < +/- 100 μm
 Z: < +/- 100 μm

Rotation about:

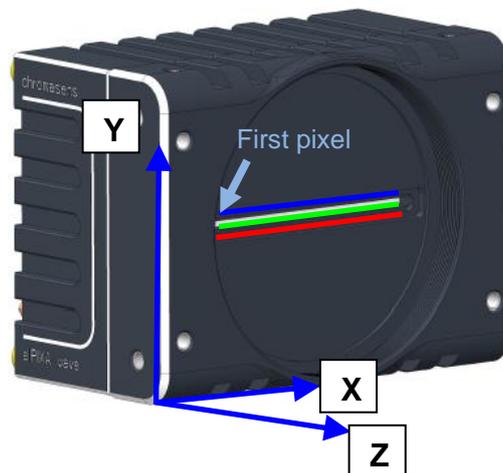
Y: < +/- 0.1 $^\circ$
 Z: < +/- 0.1 $^\circ$

Planarity of sensor surface:

< +/- 0.50 μm

Sensor window:

Thickness: 1.1 mm
 Refraction index: 1.5
 Optical path extension: 0.37 mm



Sensor alignment is an important issue for:

- Adjusting multi-camera systems
- Replacing cameras
- Mechanical design of the mounting system for the camera

2.6 Adapter and accessories

2.6.1 Lenses, adapters and mounts

Chromasens offers a large variety of accessories which are designed to provide maximum flexibility and to get most out of the camera.

For the allPIXA wave cameras, special adapters are available that permit to use the accessories of the allPIXA pro cameras.

You can find the complete list of all accessories including descriptions and detailed drawings in our website at www.chromasens.de/user in the download section of the product.

NOTE For more information about accessories, refer to the corresponding accessories catalogue or the configuration sheet at our website <https://www.chromasens.de>

2.6.2 Cooling kit

To dissipate heat and thus reduce the housing temperature, a special cooling kit is available that can be fixed to the camera, on the side and / or on the top:

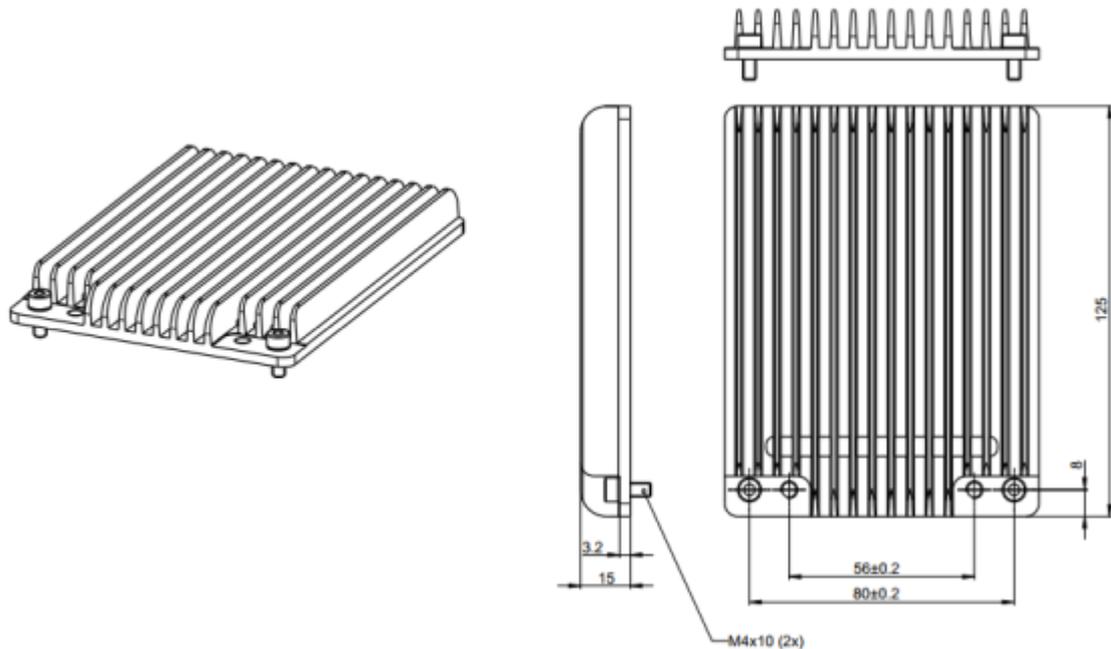


Figure 4: Cooling Kit for the allPIXA wave cameras

allPIXA wave camera	Identification No.	Pos.
allPIXA wave Cooling Kit B100	CP000540	01

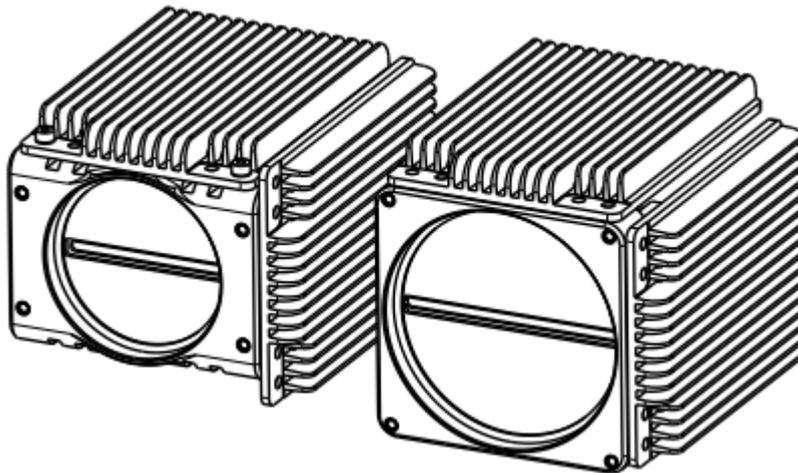


Figure 5: allPIXA wave cameras with attached Cooling Kits

2.6.3 Environmental requirements

	Value
Temperature for camera operation	See section 2.3 for the allowed housing temperature
Air humidity during camera operation	20% - 85% relative air humidity, non-condensing
Storage / transport temperature	-20 °C - +85 °C; -4 °F - +185 °F
Protection category	IP50
General ambient conditions	
Operation	IEC 721-3-3:IE33
Transport	IEC 721-3-2:IE21
Storage	IEC 721-3-1:IE11

NOTE: You should use thermal conductive mounting (for example direct attachment on metal frame) to decrease temperature and for improved camera performance. See also section 5.3.

3 Safety

3.1 Depiction of safety instructions

Safety-relevant information is indicated in this manual as follows:



WARNING

Indicates a potentially hazardous situation or task, which, if not avoided, could result in serious injury or death.



CAUTION

Indicates a potentially hazardous situation or task, which, if not avoided, may result in minor or moderate injury.

NOTICE

Indicates a potentially hazardous situation or task, which, if not avoided, could result in damage to the product or the surrounding environment.

3.2 Basic safety regulations

The basic safety regulations always observe the following:

- Do not attempt to install the device or start operation before you have read all supplied documentation carefully and have understood its contents.
- Safe and correct operation of the device requires correct and appropriate transport, storage, mounting and installation as well as careful operation and maintenance.
- Operation of the allPIXA wave camera device is only permitted if it is in a faultless and safe condition. If a fault or defect occurs, the allPIXA wave camera, the machine, or the system in which the allPIXA wave camera is installed, must be stopped immediately, and the responsible person must be informed.
- Modifications and extensions to the allPIXA wave camera are only permitted if the prior written consent of Chromasens GmbH is obtained. This applies in particular to modifications and extensions which can negatively affect the safety of the allPIXA wave camera.
- Compliance with the ambient conditions described in this manual is essential.

3.3 Safety instructions on the allPIXA wave camera



Risks from hot surfaces

The body of the allPIXA wave camera heats up during operation.

Do not touch hot surfaces without suitable protective gloves. Always allow hot surfaces to cool down before carrying out any work on the unit.



Electric voltage hazard

The allPIXA wave camera runs with electric power. Before any work is carried out on the allPIXA wave camera, be aware to disconnect the mains cables. Make sure that the device is safely isolated from the power supply!



Risk of electrostatic discharge

The allPIXA wave camera contains components and units which are sensitive to electrostatic charge.

Observe all precautionary measures for handling electrostatically sensitive equipment.

Make sure that allPIXA wave camera, its corresponding tools, its equipment, and the person who is handling it have the same electrical potential.

3.4 Purpose / applications

- The allPIXA wave camera is designed for machines and systems which are used for commercial and industrial applications.
- The owner of the machine or system in which the allPIXA wave camera has been installed is responsible for compliance with relevant safety regulations, standards and directives. Commissioning of the allPIXA wave camera is only permitted if the machine or system, in which the allPIXA wave camera is installed, complies with the safety regulations and standards of the country in which the allPIXA wave camera runs.
- The owner of the machine or system with the installed allPIXA wave camera has to verify the suitability of allPIXA wave camera for its intended use.
- Safety regulations of the country in which the device is used must be complied with it.
- The allPIXA wave camera may only be connected or used as described in this manual.
- The allPIXA wave camera must be set up and installed in compliance with the instructions contained in this manual.

3.5 Staff requirements

- The system owner must ensure that all persons working on the system are trained for the required work and have read and understood this manual. This applies particularly to the employees who only work occasionally with the allPIXA wave camera, for example, during commissioning and maintenance work.
- Work on the electrical installation of the system may only be carried out by a qualified electrician or persons who have undergone the necessary electrotechnical training under the supervision of a qualified electrician, in compliance with applicable electrotechnical regulations.
- Be aware that only suitably trained and qualified persons are permitted to work with the allPIXA wave camera. Such persons are qualified to work with the allPIXA wave camera device if they are familiar with its assembly, installation, care, and all necessary precautionary measures.
- Assignments and responsibilities of the staff charged with operation, commissioning, maintenance, and repair must be clearly defined and specified by the owner of the device in which the allPIXA wave camera is installed.

3.6 Organizational measurements

- The instruction manual must be stored safely in the vicinity of the camera in operation.
- Information contained in this manual must be integrated into the documentation of the device in which the allPIXA wave camera is installed.
- The allPIXA wave camera and all connected peripherals must be checked regularly for visible external damages.

3.7 Safety instructions for maintenance / cleaning

- Before any service or maintenance work is carried out, the responsible staff has to be informed.
- Deadlines and intervals for regular inspections must be complied with.
- Before maintenance is started, the allPIXA wave camera must be isolated from the power supply.
- Due to the risk of fire, devices such as radiators, heaters, or lighting equipment must be allowed first to cool down.
- Only technicians of the Chromasens GmbH are permitted to open or slacken screws or housing sections of the allPIXA wave camera.
- Necessary repairs may only be carried out by Chromasens GmbH.
- Cleaning of the device is only allowed with a soft, lint-free cloth and Isopropanol (optional).
- To avoid damages, the camera should only be transported in its original packaging.

3.8 Maintenance and cleaning of the allPIXA wave camera

During operation of the device, particles such as dust etc. may be settled on the optical components (lens) of the camera. These deposits affect the optical image and the function of the camera negatively.

NOTICE

Chromasens recommends regular inspection and cleaning. The cleaning intervals depend on the actual operating and ambient conditions (for example dust-laden atmosphere).

3.8.1 Cleaning intervals

Cleaning intervals depend on the environment. Regular inspection and cleaning intervals must be specified depending on the degree of soiling.

3.8.2 Cleaning process



Body of the allPIXA wave camera heats up during operation.

Before cleaning, you must switch off the device. Always allow hot surfaces to cool down before cleaning the device.



The device works with electric power. Before cleaning the device, make sure that the device is disconnected from the power supply.

All surfaces requiring cleaning can be wiped with a soft, lint-free cloth which can be moistened with Isopropanol.

Never use any other liquid or cleaning agent than those stated in this manual.

Never use hard or sharp tools for cleaning the device.

Inspect the device to ensure that cleaning was effective and repeat, if necessary.

If it is not possible to clean a component due to irremovable contamination, it must be replaced.

3.9 Disposal



This symbol indicates that electrical and electronic equipment should not be disposed with normal garbage at the end of its working life. To prevent possible harm to the environment or human health from uncontrolled waste disposal, please separate this from other types of wastes and recycle it responsibly to promote the sustainable reuse of material resources.

Please dispose this product in accordance with your local regulations and contact your local government office, for details of where and how they can take this item for environmentally safe recycling.

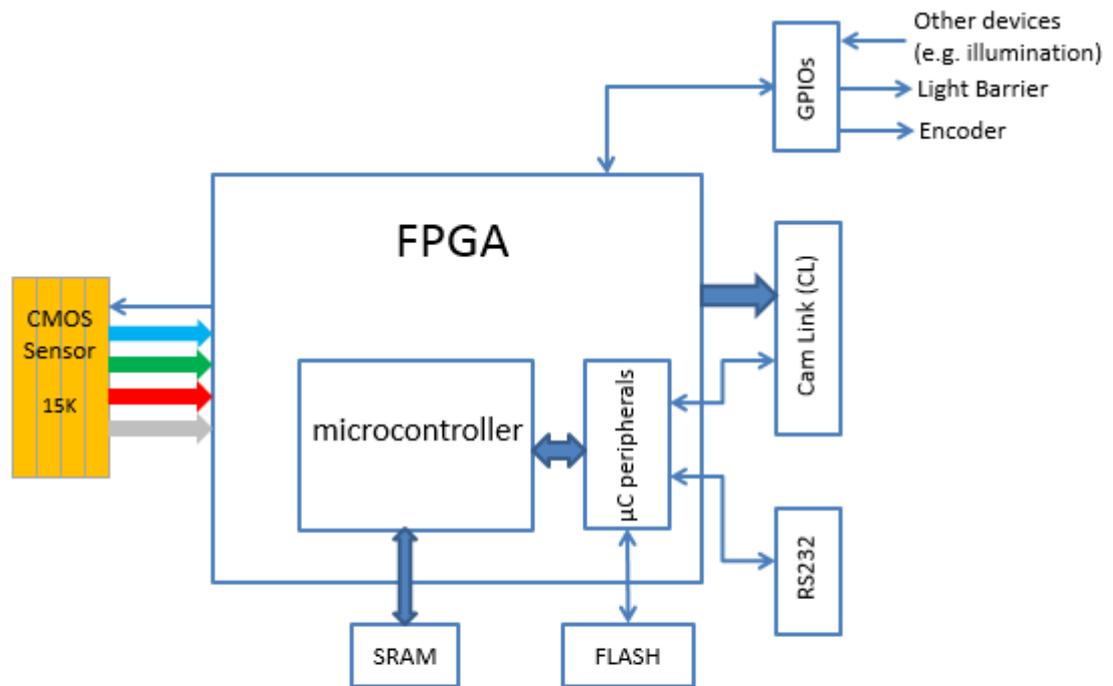
4 allPIXA wave – basic functionality

4.1 Basic design of the allPIXA wave camera

During operation, an object is scanned by the CMOS sensor. In the CMOS sensor, the analog signal of each pixel is transformed to a digital signal with its own AD converter. These parallel present pixel data are then converted via serializer into several parallel serial data streams. These serial data streams are read out with the logic of the FPGA. The FPGA includes also a softcore microprocessor with its peripherals. This softcore microprocessor with its external RAM and flash memory supports the FPGA logic during image data processing to output the images through the Camera Link connector.

The allPIXA wave camera can be configured with CST via the Camera Link interface (CL-Ser.) or the RS 232 interface.

Signals from incremental encoders or light barriers can also be input by the GPIOs (general purpose inputs/outputs) or Camera Link CC-Bits.

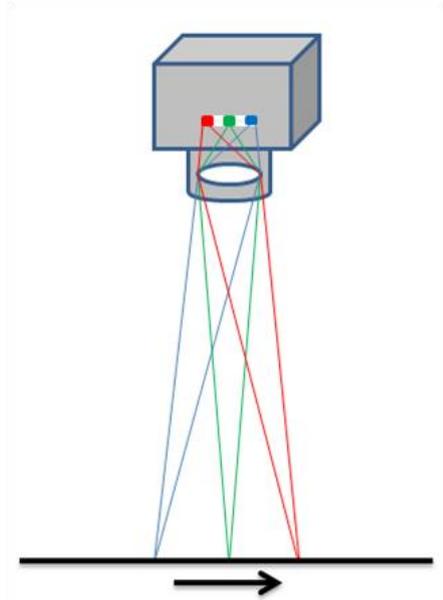


FPGA integrated circuit for programmable logic circuits
 μC microcontroller
 SRAM static random access memory; information is lost if power is removed
 Flash memory for the program and reference data

Cam Link (CL) camera connection
 RS232 serial interface
 GP IOs multi-purpose inputs/outputs

Figure 6: Basic design of the allPIXA wave camera (block diagram)

4.2 Design of the allPIXA wave camera line scan sensor

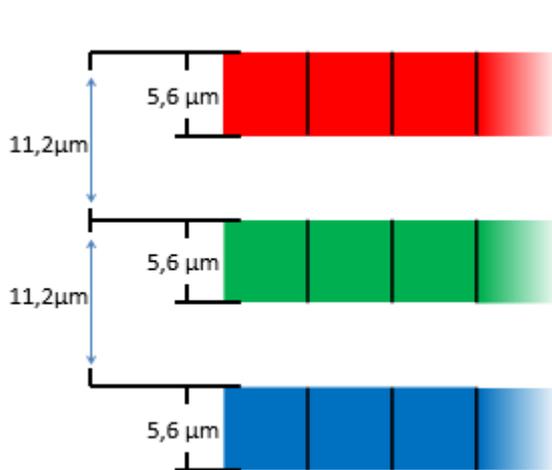


The allPIXA wave camera color line scan camera is equipped with a quad-linear CMOS line scan sensor with 4 spatially separated lines which are sensitive to brightness and the colors red, green and blue (RGB).

In this way, gray and 3-color information is obtained from each image point (RGB). The spacing of sensor lines is compensated in the allPIXA wave camera.

Compared to camera systems with interpolating processes (for example single-line or bilinear color line scan cameras), the color information is acquired with 3 x 12 bits for each image point.

Take notice that high-quality color detection is only possible in this way.



Sensor pixels are 5.6 μm wide and 5.6 μm long. The distance between the color sensor lines is 11.2 μm .

Spatial correction is achieved by the corresponding delay of the individual items of color information. As a result of the object's movement, for example, an object point first reaches the blue sensor line, then the green sensor line and finally the red sensor line.

These 3 color channels are then combined into a complete image.

Continual scanning provides a color image which can theoretically be infinitely long.

Figure 7: allPIXA wave camera line scan sensor

4.3 The allPIXA wave camera line scan sensor pixel arrangement

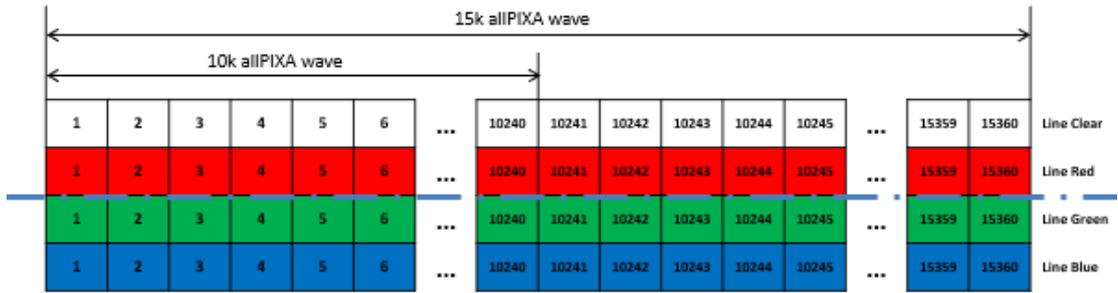


Figure 8 Pixel arrangement at the 10k and 15k allPIXA wave

4.4 Spectral sensitivity of the allPIXA wave camera line scan sensor

Normalized spectral sensitivity of the color camera (visual range 380nm – 730nm):

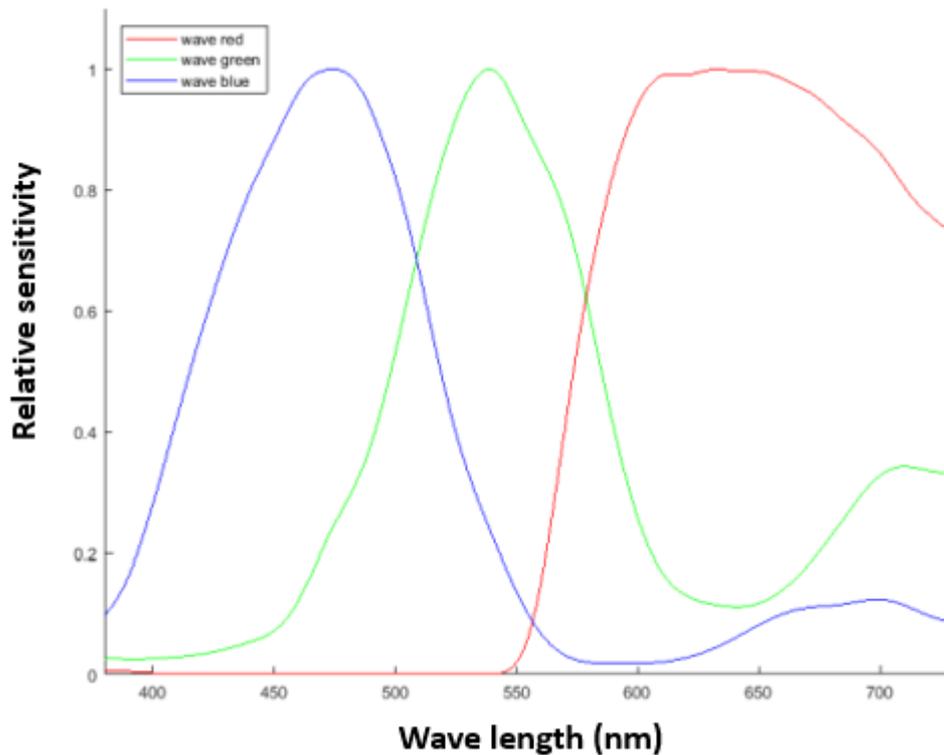


Figure 9: Spectral sensitivity of the color camera line scan sensor

Normalized spectral sensitivity of the mono camera (visual range 380nm – 730nm):

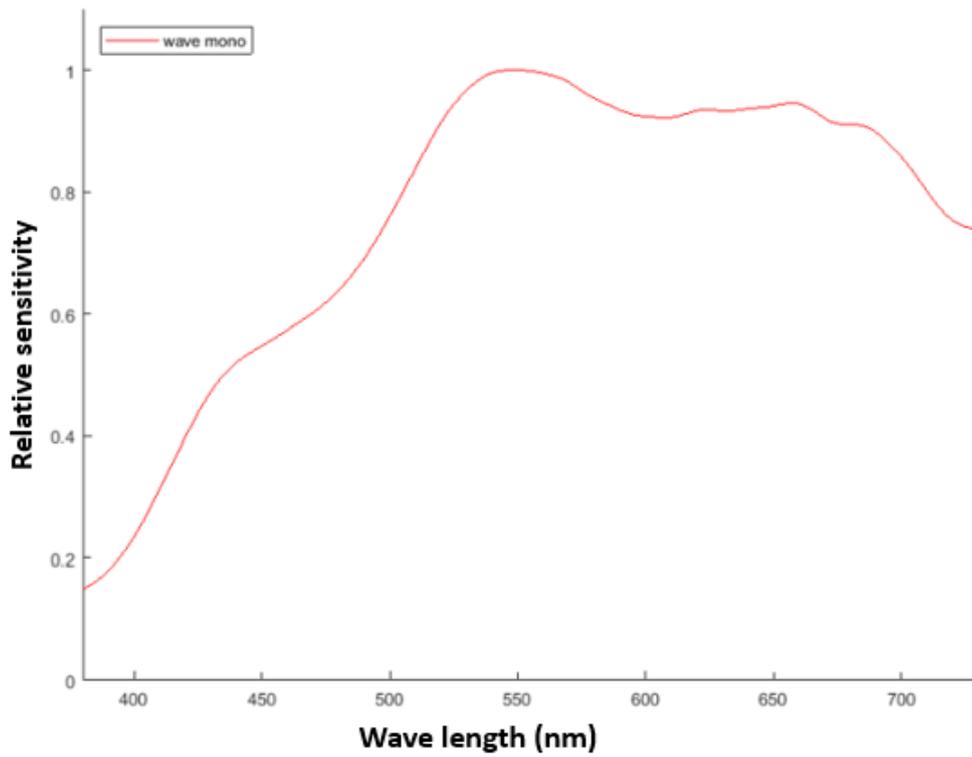


Figure 10: Spectral sensitivity of the mono camera line scan sensor

4.5 Digital image processing

Image processing in the allPIXA wave camera is digital. The following block diagram illustrates the internal processes.

The data read out from the CMOS Sensor runs through the image processing path as shown in **Figure 11**:

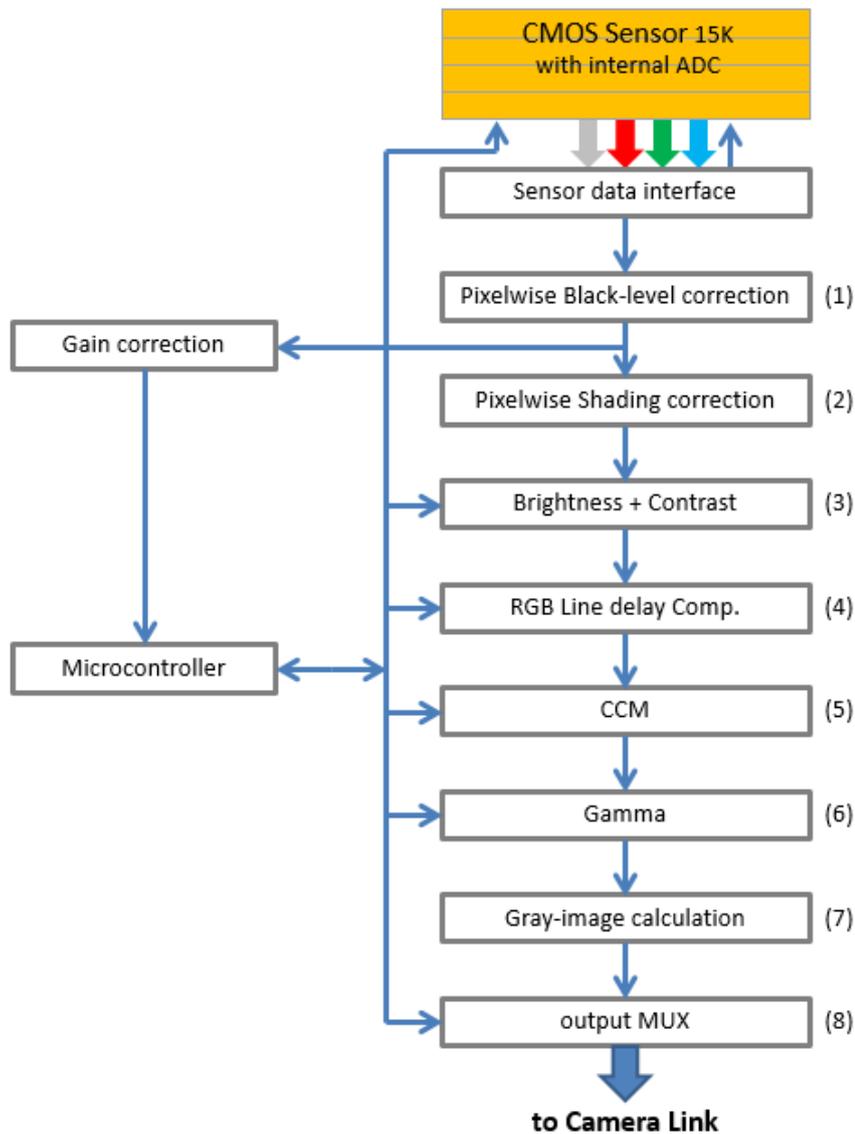


Figure 11: Digital processing of the allPIXA wave camera (block diagram)

First, pixel-by-pixel black-level correction (1) and shading correction (2) are carried out, then the image data are adjusted according to the values programmed for brightness and contrast (3). Afterwards, the spatial correction (RGB) is carried out in the line buffer (RGB line delay compensation) (4), and the colors are adjusted with the color conversion matrix (5) and gamma correction (6). The color image can also be converted into a gray image by the FPGA (7). Auxiliary data can be added to each line before the image data are output via the Camera Link connection (8).

4.6 Black-level correction and shading (flat-field) correction

The allPIXA wave camera supports black-level (offset) and shading correction.

The following points are important for understanding these kinds of operation:

- Both operations are based on pixel-by-pixel calculation, and the effects on behavior of single pixels such as PRNU (photo response non-uniformity) are eliminated.
- Both operations are carried out separately for every line ((clear), red, green, blue).
- The allPIXA wave camera offers two data sets for black-level correction and two data sets for shading correction. Therefore, you are able to deal with, for example, two different lighting systems by selecting the necessary data sets without having to transfer or generate new shading data.
- Calculation of the correction data sets can be done offline on scanned images. Often, shading data have been calculated internally with a static white reference in front of the camera. In this case, spots of dust on the white reference lead to vertical lines in the image. This effect can be eliminated by slightly defocusing the lens during generation of the references. The lighting distribution is then seen by the sensor and the lens. Another possibility to avoid this problem is to move the target slightly during the balancing process. In this way, distortions, for example by dust, may also be eliminated.
- The allPIXA wave camera permits to calculate the references offline. You can select a scanned image and define a region of the image, in which shading correction data shall be calculated. By averaging over a higher number of lines, distortions, for example caused by dust on the target, are eliminated. Therefore, it is possible to use an image with a moving white object.
- The allPIXA wave camera also permits to generate shading and offset data internally.
- Generated data sets may be stored on the hard disk of the PC. The stored data can be transferred to the camera later.
- For the calculation the following formulas can be used:

Mode Recording of black reference line:

$$BRef(x) = VidRaw \text{ with black template or without illumination}$$

Mode Recording of white reference line:

$$WRef(x) = VidRaw(x) - BRef(x) \text{ with white template}$$

Mode / Correction (white- and black-correction is activated)

$$VidSHCOOut(x,y) = \frac{(VidRaw(x,y) - BRef(x)) * VidMax}{WRef(x)}$$

This calculation is done separately for all color separations (CRGB).

- BRef Black-Reference value for each pixel in the line
- WRef White-Reference value for each pixel in the line
- VidRaw Raw values for each pixel output by A/D Converter
- (x, y) Number of pixels within the line or column
- VidMax Maximum brightness value
- VidSHCOOut(x,y) Offset- and shading-corrected pixels of the image

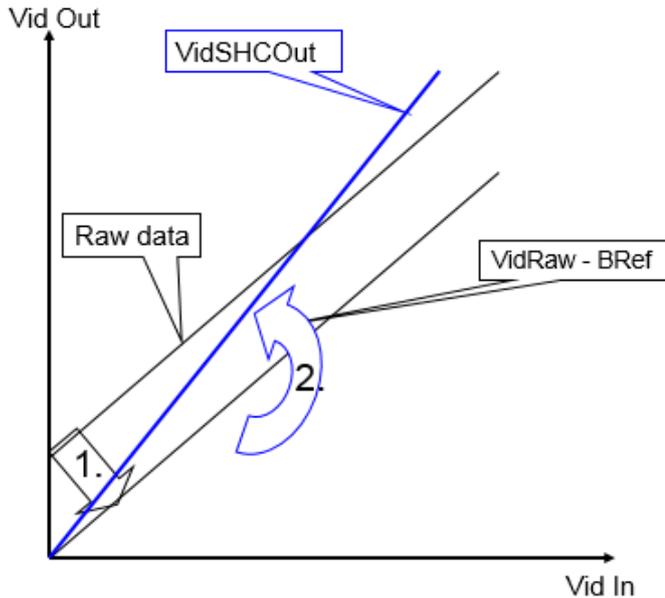


Figure 12: Offset and shading correction

- 1.: Black-level correction
- 2.: Shading (flat-field) correction

4.7 Feature: Image mode (frame scan mode)

The allPIXA wave camera is able to emulate a frame scan camera. Output data are in real frames, and the VSync signal (or FVAL = frame valid signal) is generated. Therefore, the information about frame start and image size must be supplied to the camera.

The trigger signal can be supplied with the frame grabber either by CC-Bits CC3 or CC4 or with a hardware signal by IO port. The external signals must be configured using the IO Configurator of CST.

Image height (= number of lines) can be controlled by a fixed value or an external signal depending on the object size. For a more detailed description, see sections 9.7.3 and 9.9.

4.8 Supported Camera Link modes

allPIXA wave - with color output:

- CL-Base 1X 1Tx8b RGB
- CL-Medium 1X2 2Tx8b RGB
- CL-Medium 1X 1Tx12b RGB
- CL-Full64 8Tx8b RGB (1X8 raw, RGB with 8 color planes per camera link clock)
- CL-Full80 8Tx10b RGB (1X8 raw, RGB with 8 color planes per camera link clock)
- CL-Full80 10Tx8b RGB (1X10 raw, RGB with 10 color planes per camera link clock)

allPIXA wave - color camera with mono-output:

- CL-Base 1X3 3Tx8b Mono
- CL-Medium 1X4 4Tx8b Mono
- CL-Medium 1X4 4Tx12b Mono

allPIXA wave – mono-camera version

- CL-Base 1X 3Tx8b Mono
- CL-Medium 1X4 4Tx8b Mono
- CL-Medium 1X4 4Tx12b Mono

For more information about the Camera Link interface specification, refer to the GenICam standard.

For information about minimum integration time for different camera types at different Camera Link modes, and output pixel clocks, see section 9.1.1.

4.9 Monochrome image acquisition

In addition, the color allPIXA wave camera permits to provide monochrome images which are generated internally using the color information. The weightage of the color channels during generation of a monochrome image can be set individually.

Due to the reduced data transmission rate of the mono-image, the camera uses Camera Link Base mode for the transmission. Output modes of 8 / 12 bit are available for mono-image data. (See section 9.1.6)

4.10 White balancing with a closed-loop control

To keep the video values stable on a white reference target, the allPIXA wave camera supports an automatic adjustment of the internal gain values. Therefore, a closed loop can be established, which enables an automatism of keeping the white-point stable, even if there are brightness or color temperature changes in the illumination. Usually, automatic camera functions use the brightest point for adjusting to achieve the best result for the white color.

The allPIXA wave camera permits to arbitrarily define the area of an image chosen as reference and you can also set the reference values (target values) separately for each channel.

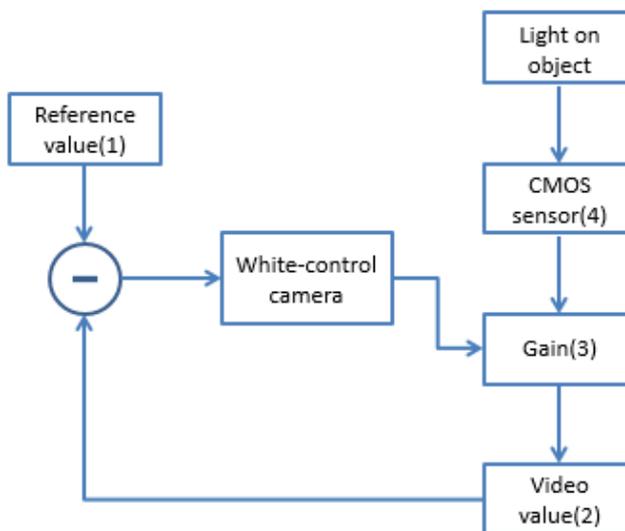


Figure 13: Closed-loop control for white balancing

This function can be used for:

- A single setup process with a static white reference in front of the camera during its installation.
- Adjusting the camera continuously during the scanning process. Therefore, it is possible to compensate warming up or aging of the light source.

4.11 Setting concept

The allPIXA wave camera offers a comprehensive setting concept:

You can store up to 18 different settings in the camera. All parameters, such as gaining or integration time, may be different from setting to setting and can be selected by short commands. Therefore, a fast change of the camera's behavior is possible for different products.

- For the user, 18 settings are available.
- Setting 19 is write-protected. As setting 19, the factory's default setting is stored and can be copied to other settings.
- The camera always starts up with setting 1.

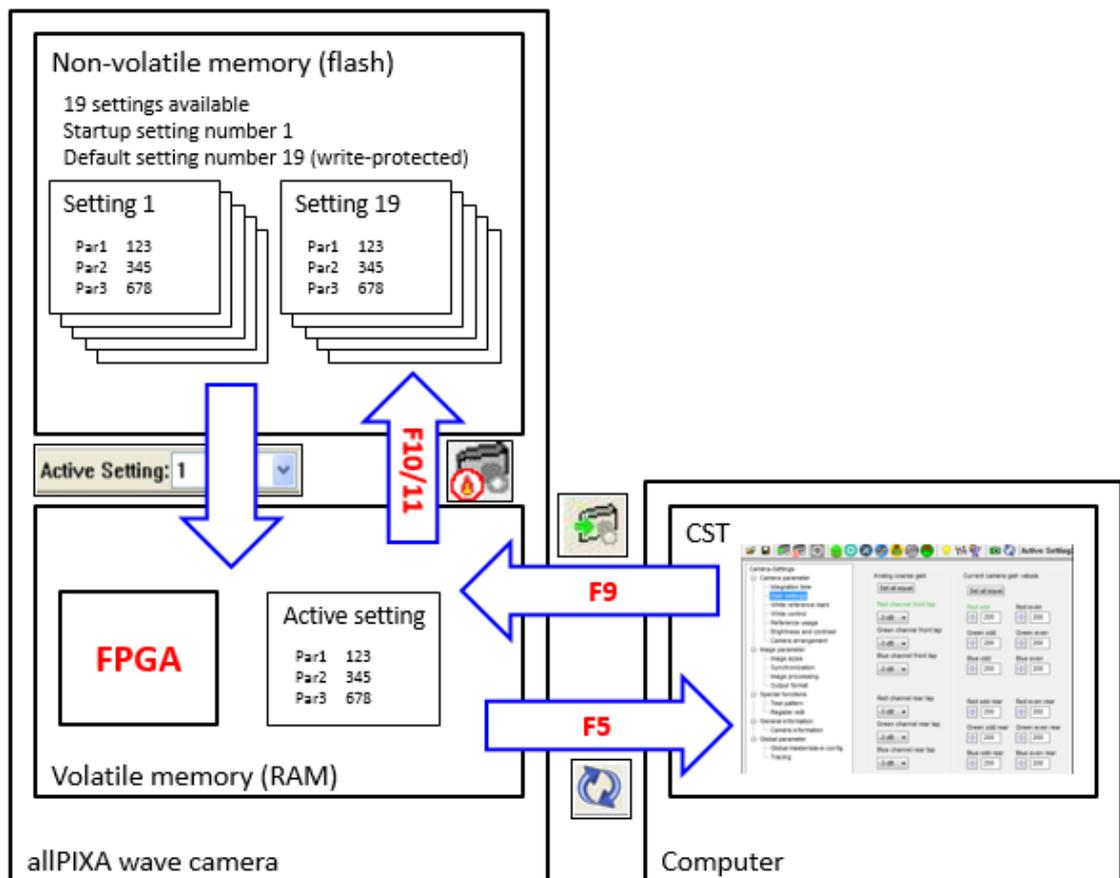


Figure 14: Setting concept

4.12 Restoring the factory default

The originally delivered camera setting can be restored by loading setting 19 and saving it to the working setting (for example setting 1).

For information, how to save settings to different setting positions, see section 6.9.

4.13 Chromasens API - communication

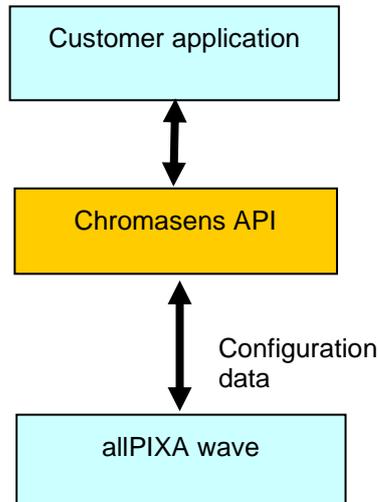


Figure 15: Chromasens API

The Chromasens API supports a set of functions that permits to communicate easily with the allPIXA wave camera.

With these functions, connection to the camera can be established via Camera Link or serial RS232 connection.

Internal working parameters of the camera can be read and modified.

Convenience functions for calibration of the camera are provided.

Calibration of the camera can be performed to adapt to current illumination conditions.

Functions for low-level communication are also implemented in the Chromasens API.

A detailed description, example code, and the necessary DLLs for integration are provided in the API Code and Samples package, which can be downloaded from the allPIXA wave download area on our website (<https://www.chromasens.de>).

5 Installing the allPIXA wave camera

5.1 Interface and status LED

On the back side of the camera you find the following interfaces:

- Two Camera Link ports (port 1 and 2) for image signaling and for communication between the allPIXA wave camera and the PC.
- A digital port (IO interface D-Sub 15 female) for the incremental encoder signal, light barriers and other freely programmable inputs and outputs.
- A serial port (serial RS485, RS 232 D-Sub 9 female, Config UART) for additional communication (for example configuration signals, light control) between the allPIXA wave camera and a PC or an XLC4 light controller.
- A power connection (Hirose HR10A-7R-6P, male) for power supply.
- A multi-color LED, which indicates the allPIXA wave camera status

NOTE If you use a USB-to-Serial converter for the connection via RS232, it is recommended to use a converter with FTDI chipset
Prolifix chipsets may cause problems if they are connected to the camera.

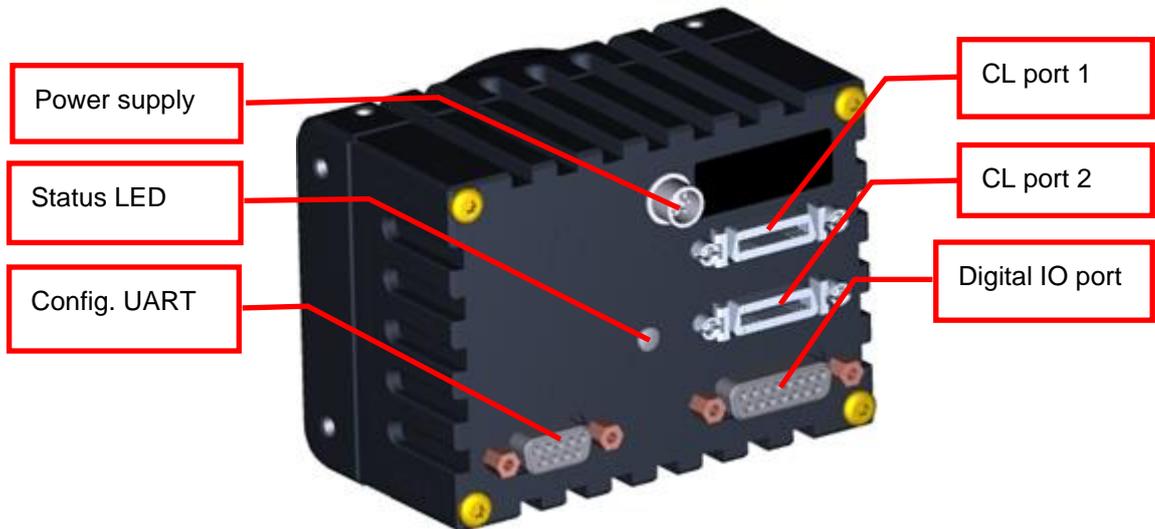


Figure 16: The allPIXA wave camera connections and status LED

5.1.1 Power supply

Take notice that the following connector is required for the power supply cable:

Manufacturer: Hirose
 Article no.: HR10A-7P-6S “female” (male connector is located on the camera)

Pin no.	Description
1	Power +24 V
2	Power +24 V
3	Not connected
4	Not connected
5	Ground
6	Ground



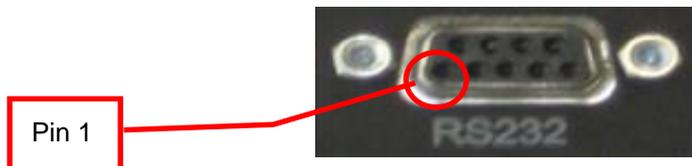
For more details about input voltage and currents, see section 2.3.

5.1.2 Config UART (serial RS 232, RS485)

Serial connection to the PC can be established by use of a 9-pin D-Sub connector (male) using the interface of serial RS 232 (V24).

Alternatively, XLC4 light controllers can be connected to the camera using the RS485 interface.

Pin no.	Description
1	RS485 (RT)
2	RS232 (Transmit data)
3	RS232 (Receive data)
4	Used for internal function, do not connect
5	Ground
6	Not connected
7	Not connected
8	Not connected
9	RS485 (RTN)



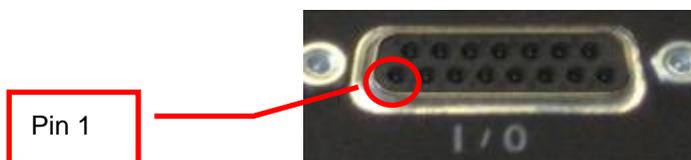
5.1.3 Digital IO port

You need a 15-pin D-Sub connector (male) to establish a connection to the digital I/O interface (X12) of the allPIXA wave camera.

Other functions can be selected at the IO configurator in CST.

Pin no.	Level	Description	Default
1	RS 422	GPIO_P0 (input)	Incremental encoder (high)
2	RS 422	GPIO_P1 (input)	Light barrier (high)
3	LVC MOS	GPIO_5	Can be used, for example, for light barriers or nSelMaster (Bridge to 0 V) There is no default level.
4	LVC MOS	GPIO_6	Selectable with IO Configurator, e.g. LED Flash Out1
5	3.3 V	Power supply	Output; max. 100 mA
6	LVC MOS	GPIO_8	e.g. LED Flash Out3
7	0 V	Ground	-
8	LVC MOS	GPIO_10	Master/Slave interface or LED Flash Out4
9	RS 422	GPIO_N0 (input)	Incremental encoder (low)
10	RS 422	GPIO_N1 (input)	Light barrier (low)
11	0 V	Ground	-
12	LVC MOS	GPIO_7	Selectable with IO Configurator, e.g. LED Flash Out2
13	0 V	Ground	-
14	LVC MOS	GPIO_9	Master/Slave interface
15	5 V	Power supply	Output; max. 100 mA

NOTE Power supply: Max 100mA
 RS422: RS422 standard, input only
 LVC MOS: With 10 Ohm series resistor, In/Out selectable.



Some requirements for using the RS422 interfaces:

- a) Although RS422 is a differential signal, a proper ground connection is required additionally between the source (for example encoder) and the drain (for example camera).
- b) The allPIXA wave contains an internal termination for the RS422 signal lines. The advantage of the internal termination is that you do not have to take care of termination if the RS422 is used as an interface between two devices. On the other hand, it is not possible to connect two (or more) cameras to one sender.

If connection of more than one camera to a single RS422 source is required, additional hardware must be used. Alternatively, using the master/slave configuration might be an option.

5.1.4 LVCMOS and RS422 levels

I/O standard	V _{IL}		V _{IH}		V _{OL}	V _{OH}
	V _{min}	V _{max}	V _{min}	V _{max}	V _{max}	V _{min}
LVCMOS	-0.5	0.7	1.7	3.6	0.4	2.1
RS422	-6	0,8	2	6		

NOTICE Maximum input level of the LVCMOS is 3.6 V!
 Use a level converter, if necessary (for example 74 LVC14).
 Non-compliance can result in irreparable damages to the allPIXA wave camera!

5.1.5 Video Camera Link port 1 and 2

Camera Link cables are supplied ready-for-use in different lengths varying from 1 m to 10 m. For connection to the allPIXA wave camera, you need a 26-pin MDR mini-D ribbon (male) connector.

NOTICE The setup of frame grabber, cable, and camera must be tested in advance to guarantee the required functionality.

5.1.6 Status LED

During image output (FVAL active), the LED lights up in blue and alternates then in green or red.

Color	Description
Green	Camera ready (FVAL inactive)
Red	Error (FVAL inactive)
Blue	allPIXA wave camera image output (FVAL active)

5.2 Mechanical installation

Various mounting options are provided by the allPIXA wave camera housing. Thanks to its numerous threaded holes for attachment, the installation of the allPIXA wave camera is very simple and versatile.



Figure 17: Mechanical connection points of the allPIXA wave 10k camera

The allPIXA wave camera is equipped with 4 fastening points on its front and 2 on each side with M4 threads (use maximum torque for full use of 6mm thread of 4 Nm).

For information about the exact mechanical dimensions, see “Mechanical specification” (section 2.4).

5.3 Thermal links / cooling

The camera works within the defined temperature range (see sections 2.3 and 2.6.3). To this purpose it may be screwed to thermally conductive parts on a wide and flat surface. A thermal connection to heat-conductive parts has a positive effect on operation of the allPIXA wave camera.

To dissipate the heat more effectively to the surrounding area, we also recommend to use heat conduction pads between the allPIXA camera and heat-conductive parts. You can also cool the allPIXA wave camera with a fan, which should be directed at a large surface area of the allPIXA wave camera.

If questions are left, or if you are not sure how to adapt the allPIXA wave camera most effectively to its ambient conditions, do not hesitate to contact our support team.

The maximum allowed internal camera temperature, which can be monitored by the camera or read out using CST, is:

- Board temperature: 80°C
- Sensor temperature: 80°C

5.4 Preventing installation errors

To ensure a high image and color quality, it is essential to align the camera correctly with the conveyor belt.

If the camera is misaligned, image artifacts may result.

5.4.1 Conveyor belt tracking

Make sure that the conveyor belt, on which the object is transported, runs completely straight.

In the left-hand section of *Figure 18* you can see the optimum tracking of the conveyor belt, that means the conveyor belt runs completely straight. The enlarged view shows that each of the 3 pixels highlighted in black acquires the same point on the object.

In the right-hand section of *Figure 18* you can see a situation in which the conveyor belt runs untrue and oscillates in a lateral direction to the transport position and then each line acquires a different area of the passing object. Therefore, the image generated by the three color lines is not aligned, resulting in chromatic aberration which occurs laterally to the transport position.

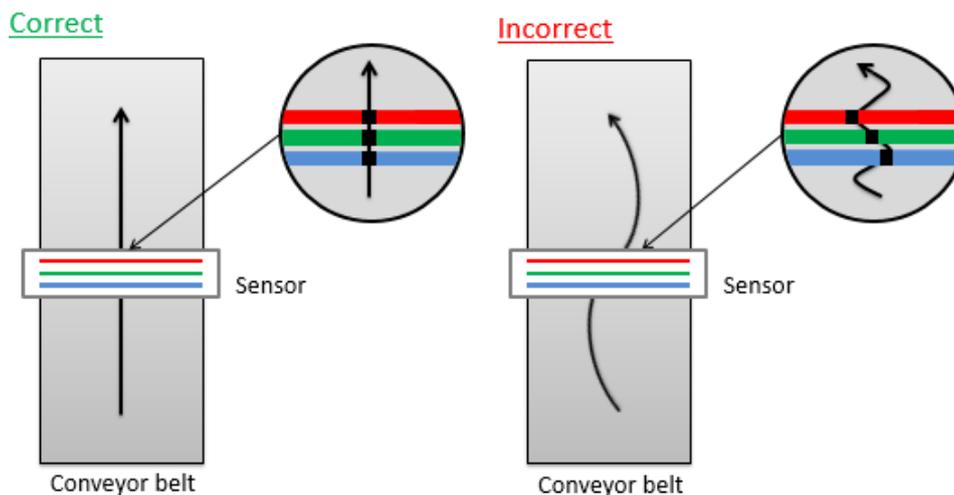


Figure 18: Optimum conveyor belt tracking

5.4.2 Perpendicularity of the sensor to the direction of transport

Make sure that the allPIXA wave camera is aligned at a right angle to the direction of transport.

In the left-hand section of *Figure 19* you can see the optimum alignment of the camera, that means, it is aligned perpendicularly to the direction of transport. The enlarged view shows that each of the three pixels highlighted in black acquires the same point on the object.

In the right-hand section of *Figure 19* the camera is not aligned perpendicularly to the transport position and therefore the same point on the object is imaged at different positions on the quad/trilinear sensor. Thus, the image generated by the three color lines is not aligned, resulting in chromatic aberration on the image:

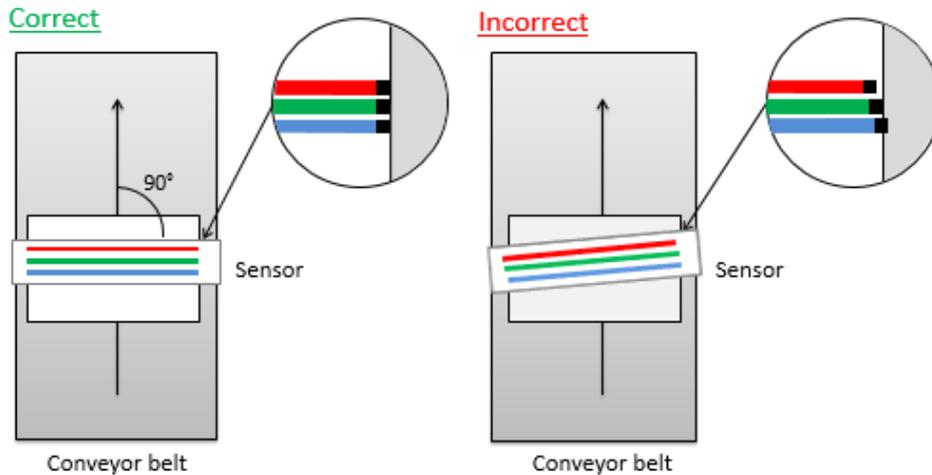


Figure 19: Rectangularity of the sensor to the object

5.4.3 Rotation around the longitudinal axis of the line scan sensor

Make sure that the longitudinal axis of the allPIXA wave camera runs parallel to the transport level.

The center section of *Figure 20* shows the optimum alignment of the camera, that means it is aligned parallel to the direction of transport.

If the allPIXA wave camera is installed in the rotated position around the longitudinal axis of the line scan sensor, chromatic aberration occurs in the image and the scale changes on the three (or four) color lines. Chromatic aberration increases symmetrically towards the outer edge.

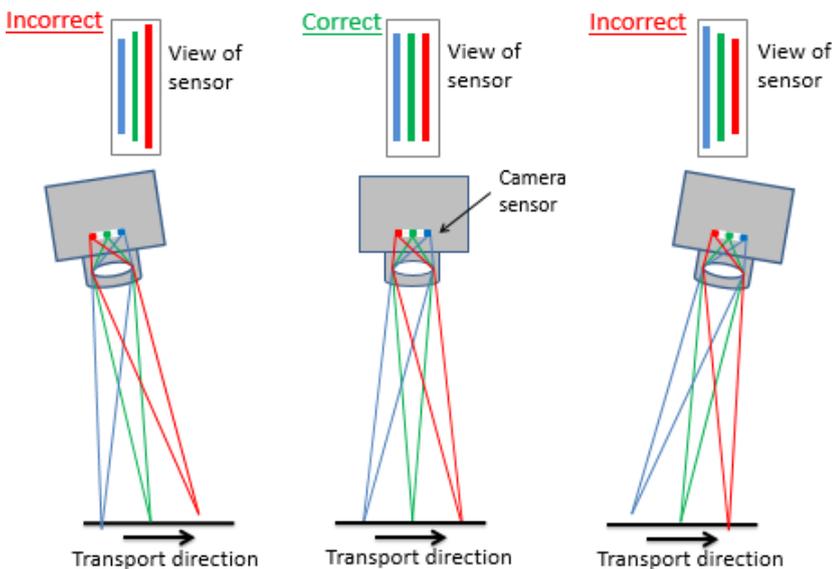


Figure 20: Rotation around the longitudinal axis of the line sensor

To obtain the best results, try to avoid the error shown in the above figure.

For situations, in which it is not possible to place the camera in the best orientation, the allPIXA wave camera provides the “Keystone correction” function:

By using the function of “Keystone correction”, the allPIXA wave camera can correct this error. For more information, see section 9.11.3 Use keystone correction.

5.4.4 Rotation around the transverse axis of the line sensor

Make sure that the transverse axis of the allPIXA wave camera runs parallel to the transport level.

In the center section of *Figure 21* you can see the optimum alignment of the camera, that means it is aligned parallel to the direction of transport.

If the allPIXA wave camera is installed in a rotated position around the transverse axis of the line scan sensor, this results in a chromatic aberration laterally to the direction of transport, and the size and color changes in relation to the angle.

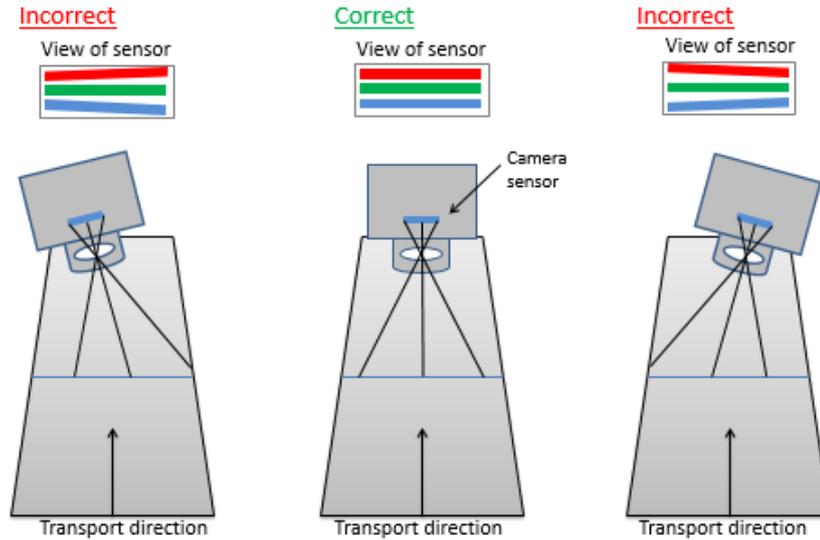


Figure 21: Rotation around the transverse axis of the line scan sensor

5.5 Electrical installation



WARNING

Only the authorized electro-technical trained staff is permitted to install and to start operation of the device.

NOTICE

Before connecting and switching on the power supply, make sure that all required plug connections have been established correctly.

This precaution prevents damage to the allPIXA wave camera and to its connected components.

NOTICE

When the allPIXA wave camera has been secured in its final working position and all cables are connected and screwed, check the cable configuration.

The weighting of the cables should not include the connectors one. No other mechanical strain should be exerted on the connectors.

NOTE

Grounding the housing and the outer cable shield:

Due to an environment with electromagnetic contamination it might be necessary to establish contact between the housing and / or the outer shield of the Camera Link cable to the installation's electrical ground.

The mounting threads for the housing are not isolated; therefore, you may use any other kind of mounting threads for connecting the housing to the electrical ground.

Connect a power cable from the camera to a 24V DC power supply.

For the pin allocation of the HIROSE see section 5.1.1.

Power: 24 VDC +/- 10 %;
1A; typical 20 W
Hirose 6 -pin

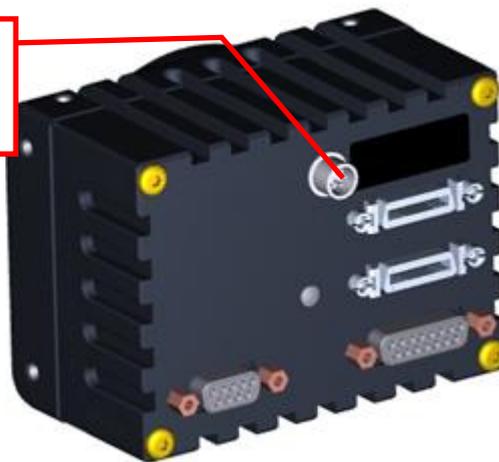


Figure 22: Connecting the allPIXA wave camera to the power supply

5.6 Connecting the camera to the PC

The camera is connected to the PC by a Camera Link cable.

NOTE Camera Link cables are supplied ready-for-use in different lengths varying from 1 m to 10 m. A 26-pin MDR mini-D ribbon (male) connector is required for connection to the allPIXA wave camera.

Camera Link specification limits cable length to at most 6 m for a pixel clock of 85 MHz. The setup of camera, cable, and the frame grabber has to be tested in advance.

1. Connect the Camera Link cable:

- Camera Link Port 1 or 1+2 of the allPIXA wave camera (Port 1+2 supports full data rate. Take notice that only with port 1 the half data rate is supported).
- Frame grabber installed in the PC.

NOTE Take care to connect the first port of the camera with the first port of the frame grabber.

Changing this may cause a switch between front and rear tap; some grabbers only offer the serial connection through the first port.

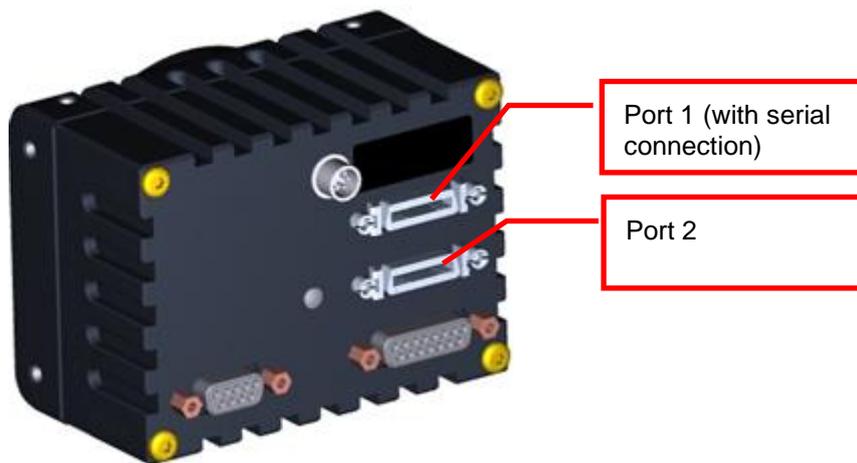


Figure 23: Connecting the allPIXA wave camera to the frame grabber

5.7 Updating the firmware of the allPIXA wave camera



Never disconnect the power or the connection to the camera during the update procedure.

Perform the following steps to update the camera safely.

To update the firmware:

1. Go to the Chromasens website: <https://www.chromasens.de>.
2. Click **Products** and click **Line Scan Cameras** in the product list.
3. Click **allPIXA wave**.
4. Click **Software** and then click **link**:

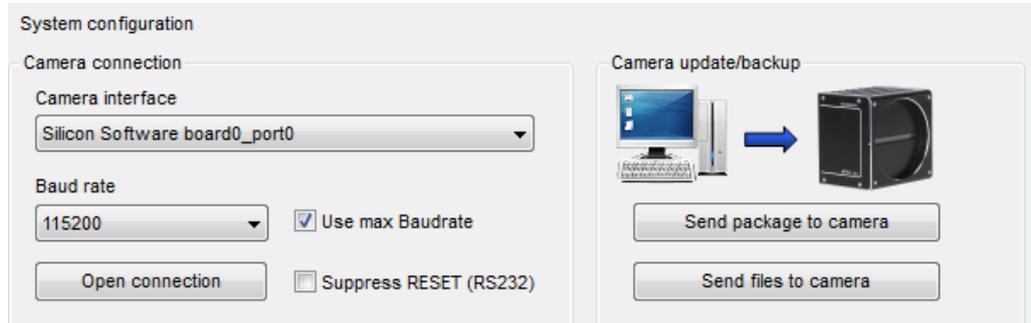


5. In the **Firmware allPIXA wave** area, download the firmware of your camera model.
6. Unzip the files.
7. Perform the following steps to send the firmware package to the camera.

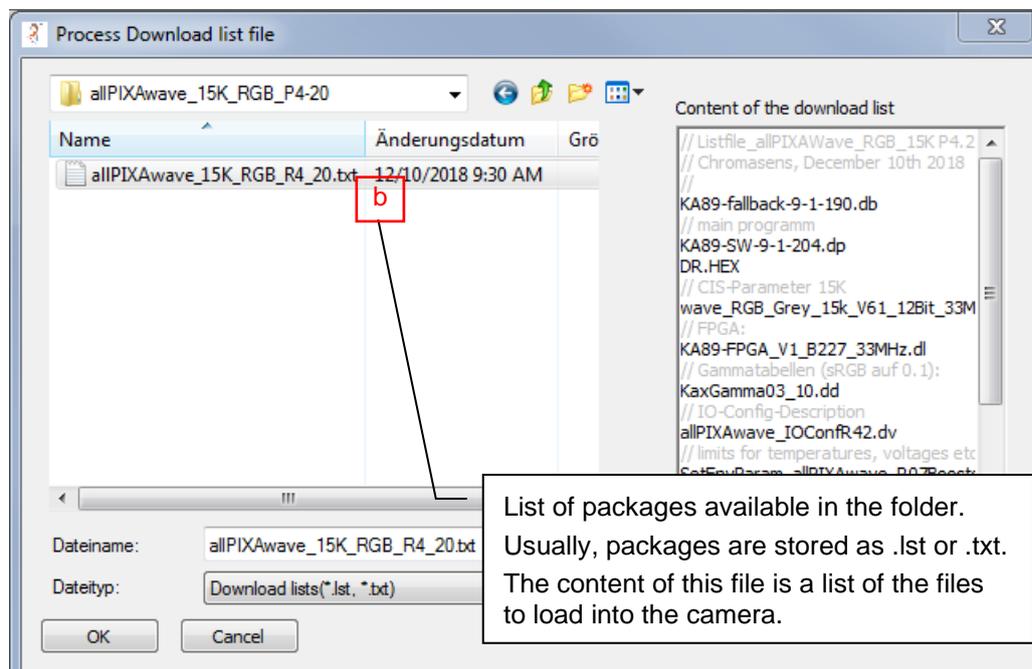
1

- Start CST and select the correct port to connect with the camera.

- Click **Send package to camera**:



2



- Select the firmware package.

Make sure that you use the correct package for your camera. Depending on the used CMOS sensor, different download packages must be used.

The naming of the package contains the length of the CMOS-sensor:
allPIXA camera **CMOS-Sensor-LENGTH** <FirmwareType> **VERSION.txt**
(for example allPIXAwave_15K_RGB_R4_20.txt)

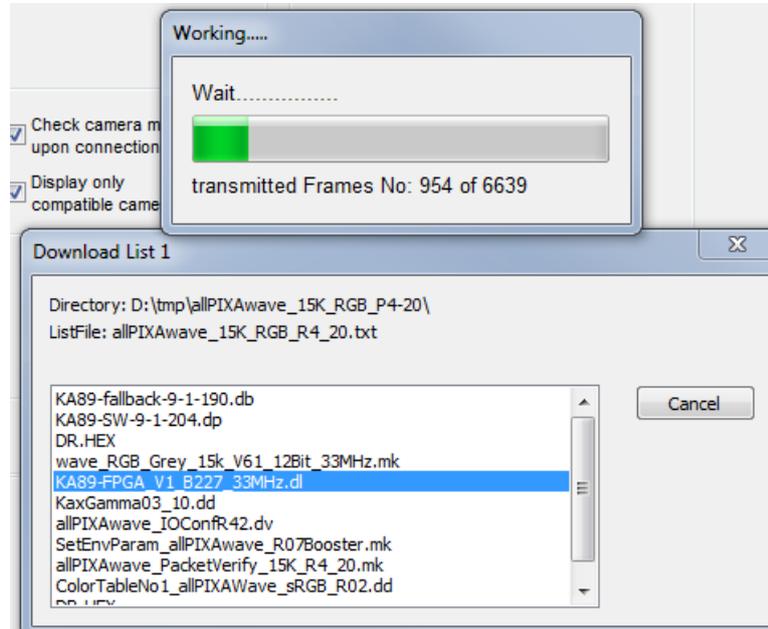
This file should be used in an allPIXA wave camera with the line length of 10.240 and it contains the package Version 4.20.

- Click **OK**.

When you click **OK**, download starts immediately.

The progress and the files that are downloaded to the camera are displayed in the **Download List** box.

The **Working** message box with the progress bar displays the progress of the current file:



3

Download is finished when the **Download List** box and the **Working** box are closed.

Then the log message view of the CST displays the following message:

14:07:27:409 Package download complete

4

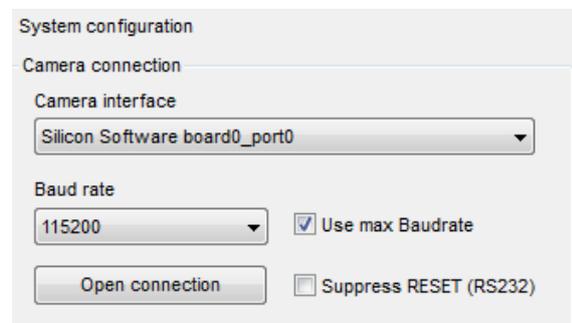
- Switch off power supply of the camera.
- Wait 5 seconds.
- Turn power on again.

Wait until the status LED of the camera switches to green again. Depending on your setting, the LED could also be flashing green/blue.

5

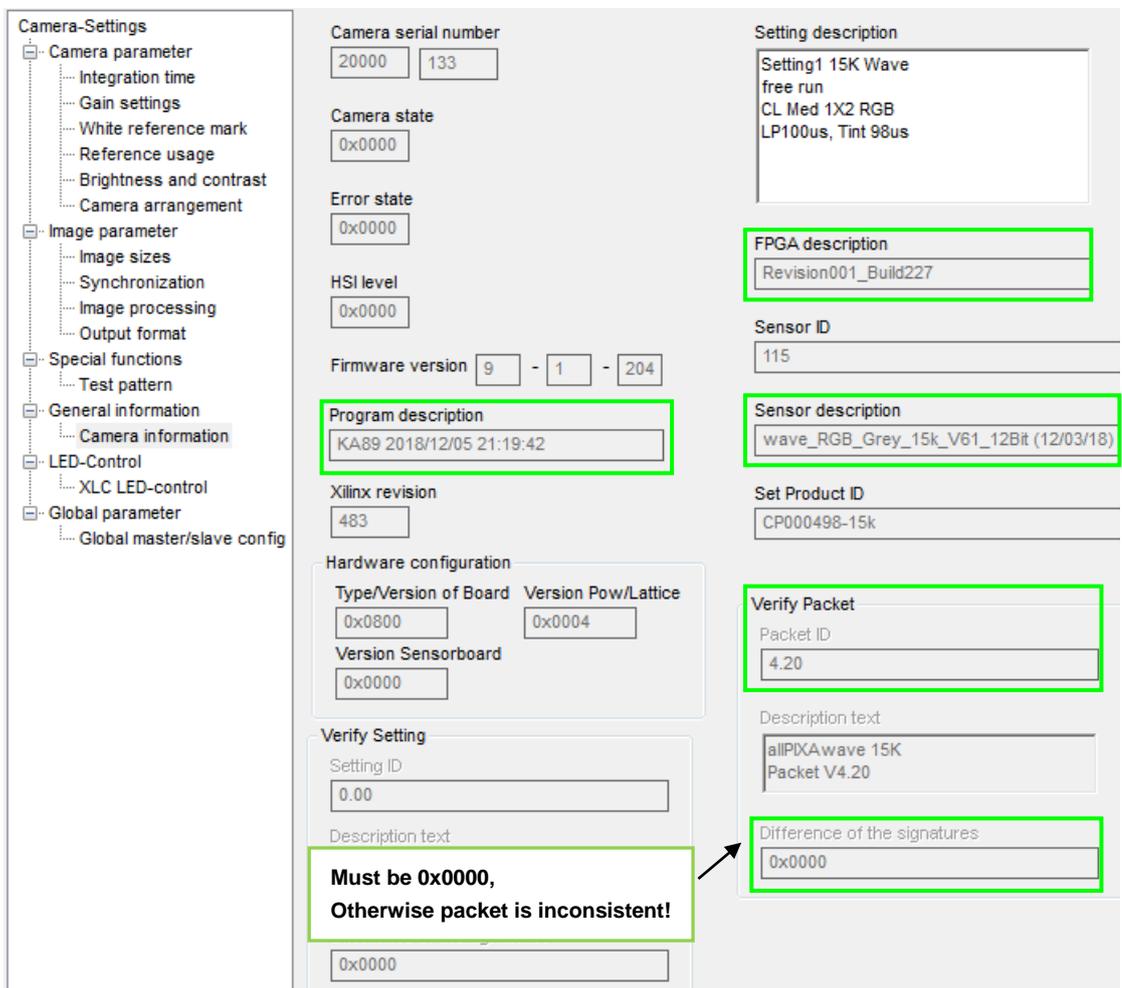
- Click **Open connection** to connect CST to the camera.

It is not necessary to restart CST.



- On the toolbar, click **Show settings** , and then click **Camera information**.
- Check that camera firmware and FPGA have the desired versions:

6



The screenshot shows the 'Camera-Settings' interface. On the left is a tree view with categories like 'Camera parameter', 'Image parameter', 'Special functions', 'General information', 'LED-Control', and 'Global parameter'. The main area contains several configuration sections:

- Camera serial number:** 20000, 133
- Camera state:** 0x0000
- Error state:** 0x0000
- HSI level:** 0x0000
- Firmware version:** 9 - 1 - 204
- Program description:** KA89 2018/12/05 21:19:42
- Xilinx revision:** 483
- Hardware configuration:** Type/Version of Board (0x0800), Version Pow/Lattice (0x0004), Version Sensorboard (0x0000)
- Verify Setting:** Setting ID (0.00), Description text (0x0000)
- Setting description:** Setting1 15K Wave free run, CL Med 1X2 RGB, LP100us, Tint 98us
- FPGA description:** Revision001_Build227
- Sensor ID:** 115
- Sensor description:** wave_RGB_Grey_15k_V61_12Bit (12/03/18)
- Set Product ID:** CP000498-15k
- Verify Packet:** Packet ID (4.20), Description text (allPIXAwave 15K Packet V4.20)
- Difference of the signatures:** 0x0000

A red box highlights the 'Verify Setting' field with the text: **Must be 0x0000, Otherwise packet is inconsistent!**

Green frames indicate the current firmware, CMOS Sensor and FPGA versions on the camera.

Now the camera is ready for operation again.

NOTE Camera parameters, such as IO-Configurator settings, and position and target values of the white reference, are contained in the camera settings. The firmware packet contains a settings file, but by default it is not transferred to the camera. Therefore, it is not necessary to save settings to files before a firmware update is performed.

6 Configuring the camera using the Camera Setup Tool

6.1 Installing the Camera Setup Tool (CST)

To download the newest release of CST, use the link <https://www.chromasens.de>.

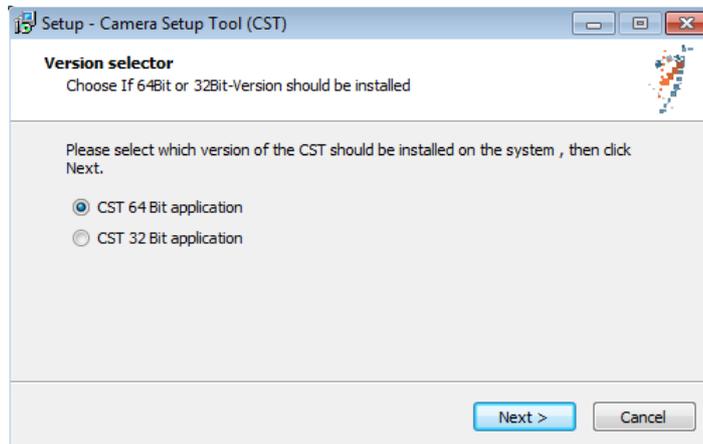
6.1.1 System Requirements

- Microsoft Windows 7, Windows 8.1, Windows, 10 32 bit or 64 bit.
- PC with a “Camera Link” Frame Grabber and optionally a serial interface RS232

6.1.2 Installing the CST Software

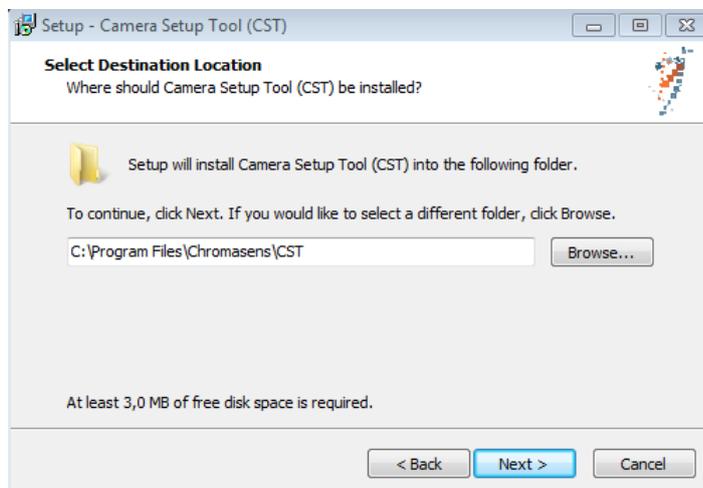
To install the CST software on your PC:

8. Start the setup program.
9. If the operating system is a 64-bit version, the **Version selector** page is shown:



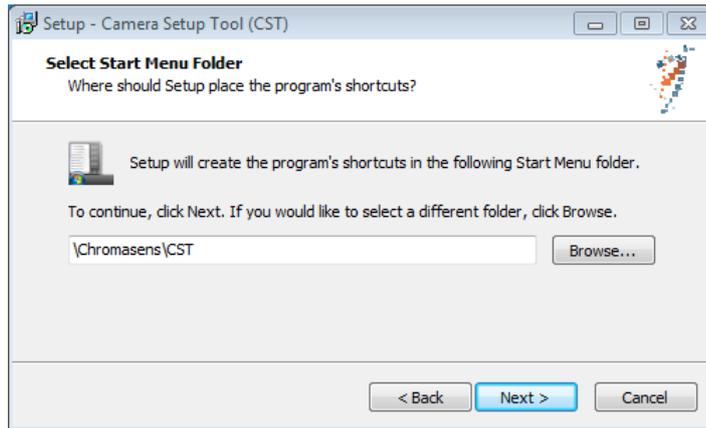
In this case, select the version that should be installed, and then click **Next**.

The **Select Destination Location** page is shown:



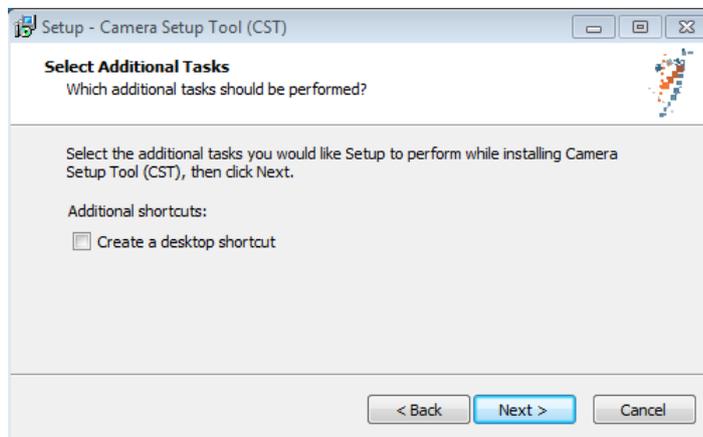
10. Select the folder in which the CST software should be installed and then click **Next**.

The **Select Start Menu Folder** page is shown:



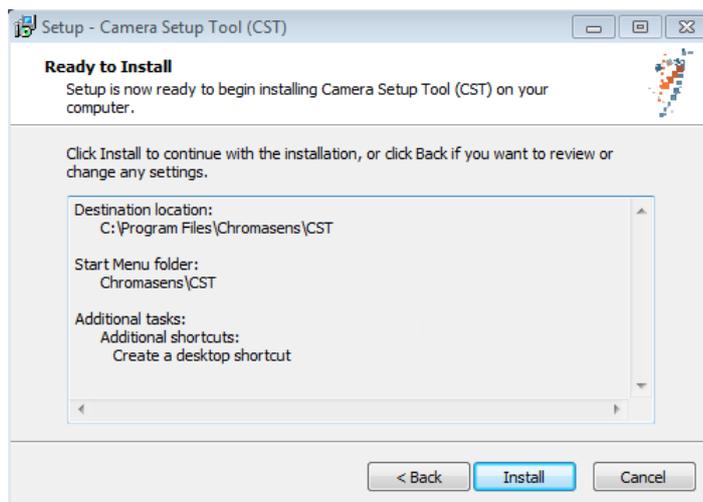
11. Select the start menu folder in which the shortcut to the CST software should be created, and then click **Next**.

The **Select Additional Tasks** page is shown:



12. If an icon should be created on the desktop, select the check box, and then click **Next**.

The **Ready to Install** page is displayed. It shows the installation parameters that you have specified:



13. To start installation of the CST software, click **Install**.

When the software has been installed successfully, the following page is displayed:



The CST software is now ready for use.

6.1.3 Establishing communication between camera and PC

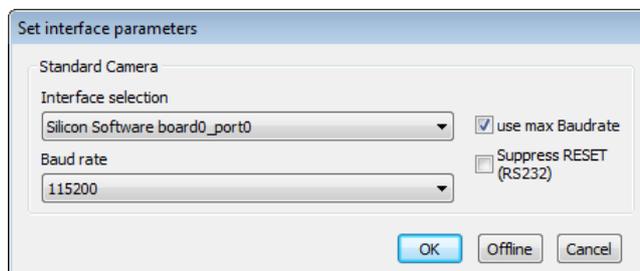
This paragraph describes basic settings of the CST software that are used to establish communication between PC and camera. When you have specified these parameters, you can configure the camera.

To establish communication between camera and PC:

1. Double-click the CST icon on the PC desktop.



The **Set interface parameters** dialog box is shown:

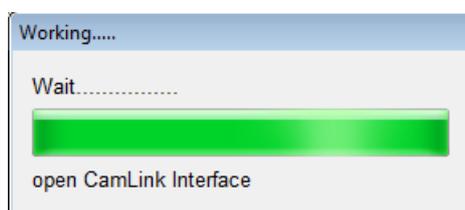


2. Select the PC interface for the communication either via Camera Link or external serial port.
3. In the **Baud rate** list, click the desired baud rate for communication.

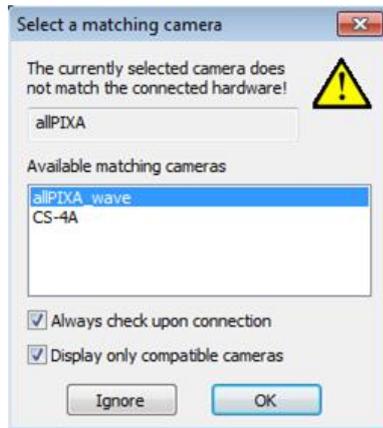
Alternatively, select the **Use max. Baud rate** check box to start automatic setup of the baud rate. CST and the allPIXA camera then determine the fastest possible baud rate up to 115 kBaud. If the frame grabber/interface does not support 115 kBaud, clear the **Use max. Baudrate** check box. The default baud rate is 19.2 kBaud.

4. Click **OK**.

The CST software now establishes communication to the camera:



- If CST has just been installed for the first time, or if a different camera model was connected earlier, the following dialog box is shown:

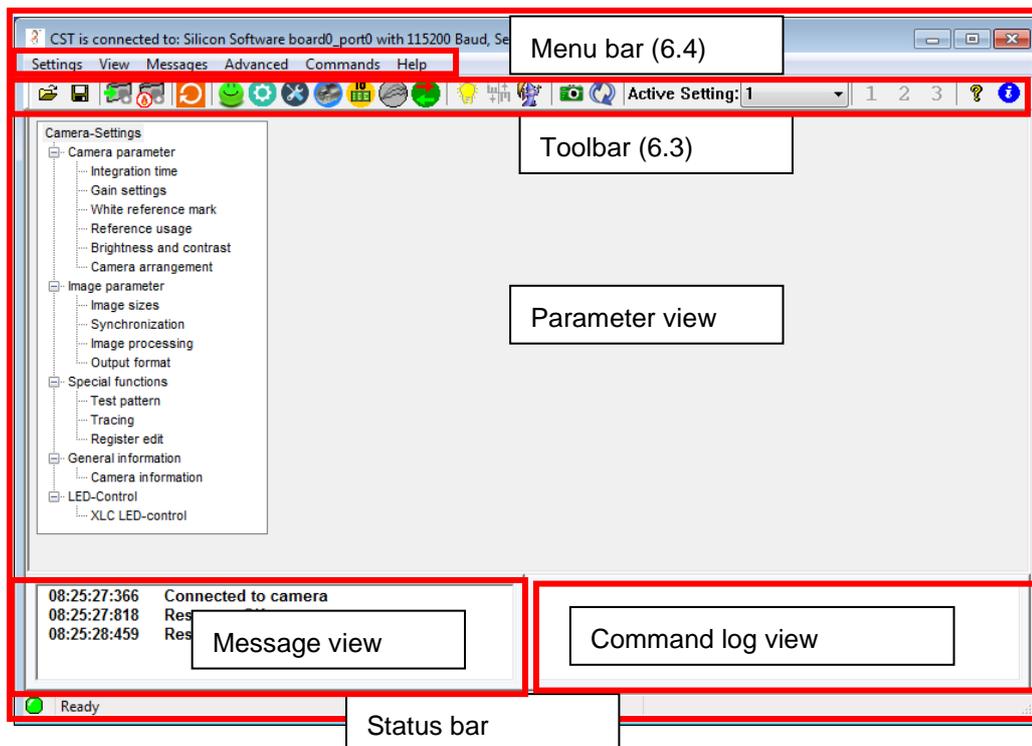


Check that **allPIXA wave** is selected in the **Available matching cameras** list, and then click **OK**.

6.2 CST program window

The CST program window comprises 5 areas:

- Toolbar: Direct access to functions and data (section.6.3)
- Menu bar: Access to all functions (section. 6.4)
- Parameter view: Displaying the data
- Status bar: Displaying the status of the connection
- Message view



6.3 Toolbar

The toolbar for the CST provides the following functions:



Figure 24: CST Toolbar

Button	Function
	Load setting from file
	Save setting to file
	Transfer setting to camera
	Burn setting permanently
	Reset camera. Take notice that the parts for signal and image processing are not restarted with this button!
	Show simple setup view. This page shows the most important parameters of the camera on one page. Very useful for first-time users.
	Show settings Shows basic parameter settings pages, for example integration time.
	Show system configuration: <ul style="list-style-type: none"> • Transfer setting data to and from the camera • Firmware update • Reset the camera • Open new “Camera Connection” • Set the user level for the CST
	Show encoder setup Encoder-related and line-trigger-related settings
	Show settings for user-configurable IO
	Show contrast values and sensor line profile
	Show current camera values This function permits to monitor the current values of important parameters of the allPIXA wave camera (for example temperature, current values of the reference for the operating point, states of the inputs, etc.)
	Perform white balancing
	Perform tap balancing

Button	Function
	Start reference wizard. The wizard guides you through the process of generating references for offset and flat-field (shading) correction.
	Show camera state and reset errors
	Refresh current camera parameters (F5)
Active Setting: 	Select and display the currently used setting
	Buttons for user-defined functions (3 available)
	Show information about CST
	Collects information about the PC system, the installed grabbers, and the connected camera. This information is very useful for the Chromasens support if you need assistance.

6.4 CST menu bar

The menu bar provides the following menus:

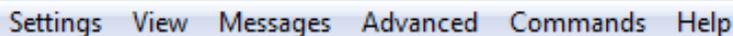


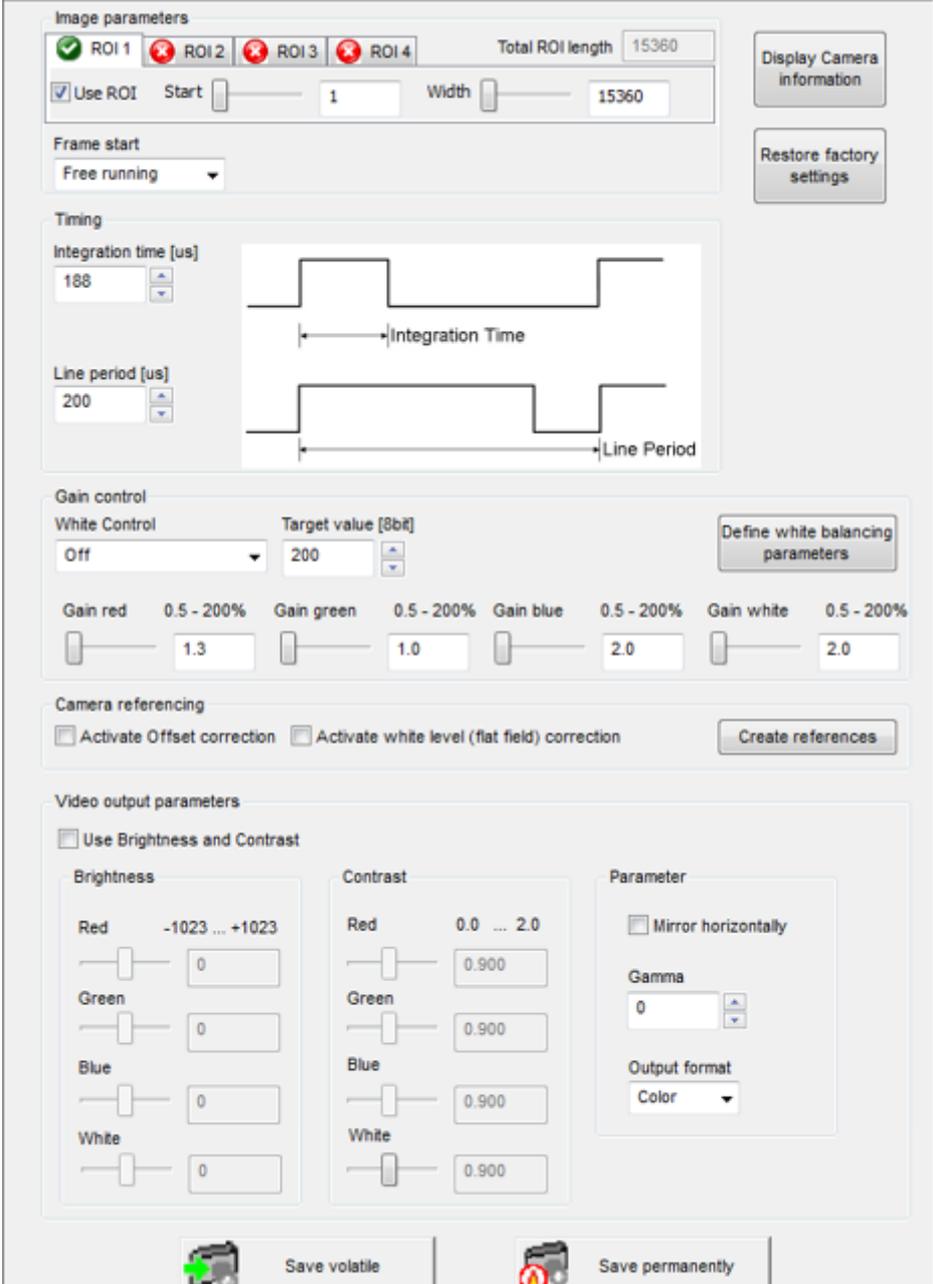
Figure 25: CST Menu Bar

Settings		
	Open setting from disk	Open a setting file from disk. Useful to check a former configuration. After a file has been loaded from disk, it can be transferred to the camera by clicking Transfer setting to volatile camera memory or by pressing F9 .
	Save setting to disk	Save current settings to disk.
	Transfer setting to volatile camera memory (F9)	Transfer settings to volatile (non-permanent) camera memory. After a reset or a power cycle, the changes are lost.
	Burn current setting permanently (F10)	Permanently burn camera settings to the currently used setting
	Burn current setting permanently as (F11)	Permanently burn camera settings to a different setting.
	Clear settings	Delete settings from camera memory
	Exit	Close CST

View	Toolbar	Show/hide the toolbar
	Status bar	Show/hide the status bar
	Simple setup	Show the simple setup page. This page shows the most important parameters of the camera on a single page. Very useful for first time users.
	Camera settings	Open basic parameter settings pages, for example integration time
	IO configurator	Show the settings for the user-configurable inputs and outputs of the camera
	Encoder setup	Encoder-related and line-trigger-related settings
	System configuration	Set system settings: <ul style="list-style-type: none"> • Transfer setting data to and from the camera • Firmware update • Reset the camera • Open new "Camera Connection" • Change the viewer configuration file to adapt the displayed parameters to your camera • Set the user level for the CST
	Current camera values	Display current camera values such as voltages temperatures, gain values or similar. This function permits to monitor the current values of important parameters of the allPIXA wave camera in live mode (for example the temperature or the current values of the reference for the operating point or the statuses of the inputs etc.)
	Show line profile	
Messages	Arrange protocol views vertically	
	Arrange protocol views horizontally	
	Show command message view	Activates the command log view. The communication data are logged here.
	Clear logging views	Clear the message view
	Save logging views	Save the message view to a log file for support cases and debugging the system.
	Show detailed command views	Activates the command log view. Additionally, the communication data are logged in a more detailed way.

Advanced	Register edit	Open a dialog box for editing and reading registers directly on the camera. Attention: Only for advanced users.
	Bootstrap board	For service only.
	Get camera trace	Return internal camera loggings. Might be requested by the Chromasens support to get detailed information about a possible problem.
	Verify packet/setting	This can be used to create consistent Setting or Firmware/FPGA packages. A checksum is generated for this Setting or Firmware package. As soon as something is changed here, the checksum is no longer consistent, and this can be detected by the camera.
	Create HIS checksum	For development purposes only. If a value in an HSI-file changes, the checksum is longer valid. This function recalculates the checksum and updates the file.
	Edit color conversion matrix	Opens a dialog box, which permits to edit the 4 color conversion matrixes saved inside the camera.
	Set IP address	If a connection to a GigE-camera should be established, the IP address can be set here
	Get current camera state	Opens a message box showing the camera state.
	Restore factory setting	Restore factory settings from internal camera memory.
Commands	Reset camera	Triggers a camera reset
	Process white balancing	Perform an automated white-balancing on the camera
	Initiate tap balancing	Perform a balancing procedure between the two camera taps to eliminate the differences at the tap border.
	Generate references (wizard)	Open the reference wizard. The wizard guides through the process of generating references for offset and flat field (shading) correction.
	Send user command	Buttons for user-defined functions (3 available)
	Configure user commands	Configuring the buttons for the user-defined functions.
Help	Information about CST	Shows a message box with version information
	Show system information	Collects information about the PC system, the installed grabbers, and the connected camera. This information is very useful for the Chromasens support if you need assistance.

6.5 Simple Setup View (overview)

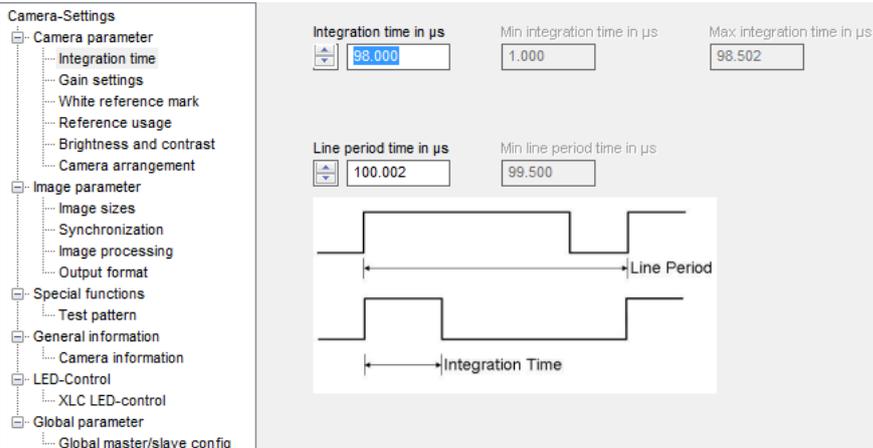
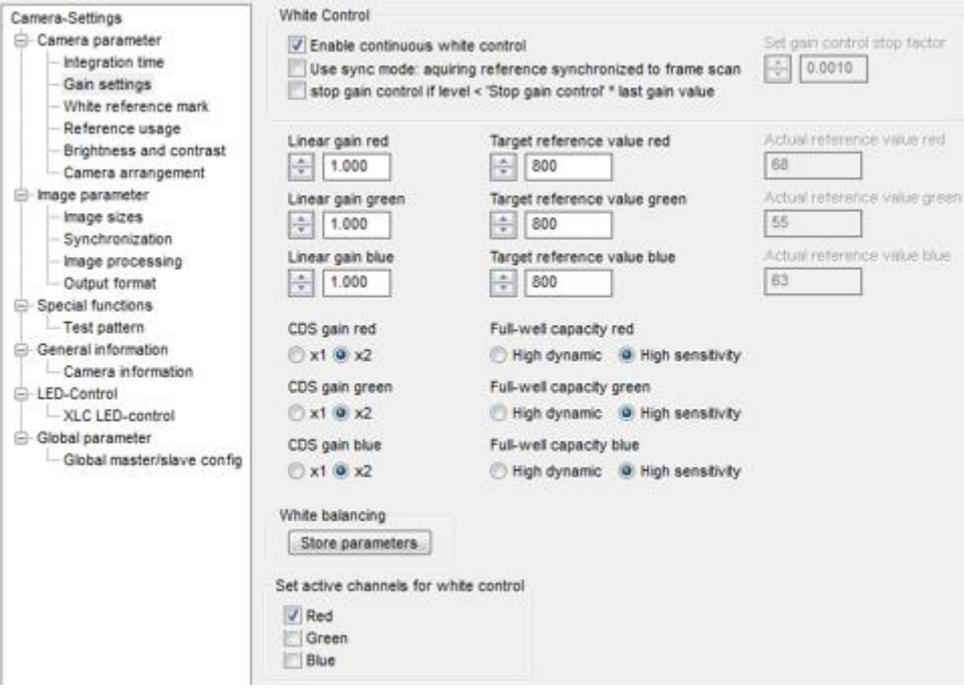
Page	Function
<p>Simple setup view</p>  <p>The screenshot displays the 'Simple setup view' interface with the following sections:</p> <ul style="list-style-type: none"> Image parameters: ROI 1 (active), ROI 2-4 (inactive). Total ROI length: 15360. Use ROI: checked. Start: 1, Width: 15360. Frame start: Free running. Timing: Integration time [us]: 188. Line period [us]: 200. Includes waveforms for Integration Time and Line Period. Gain control: White Control: Off. Target value [8bit]: 200. Gain red: 1.3, Gain green: 1.0, Gain blue: 2.0, Gain white: 2.0. Camera referencing: Activate Offset correction: unchecked, Activate white level (flat field) correction: unchecked. Create references button. Video output parameters: Use Brightness and Contrast: unchecked. Brightness (Red, Green, Blue, White) and Contrast (Red, Green, Blue, White) sliders. Parameter: Mirror horizontally (unchecked), Gamma: 0, Output format: Color. Save options: Save volatile (green plus icon), Save permanently (red flame icon). 	<p>Functions:</p> <ul style="list-style-type: none"> • Set all basic parameters of the camera to quickly receive a well-calibrated image • Section: 8.1

6.6 Basic camera parameter settings (overview)

Basic parameters of the camera are split into different groups:

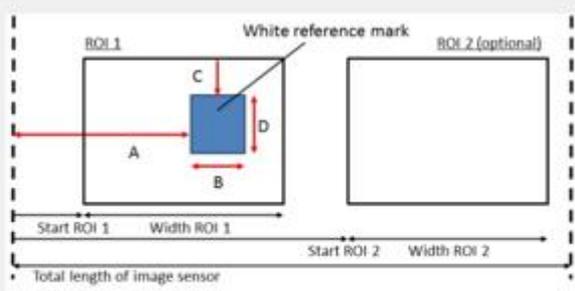
6.6.1 Camera parameter

This part contains the parameters related to the following:

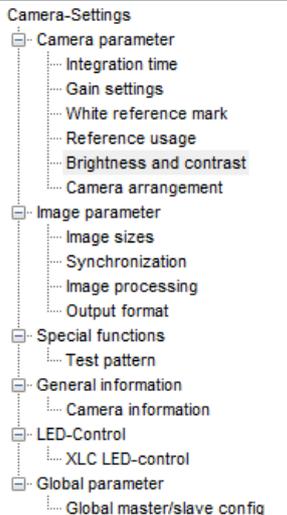
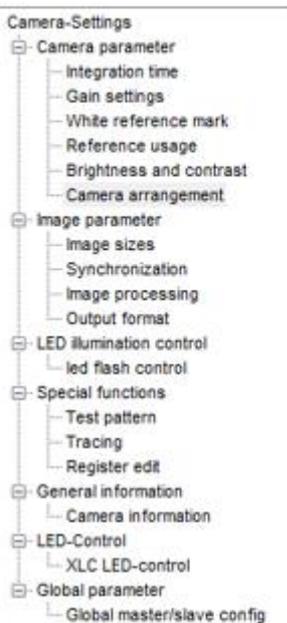
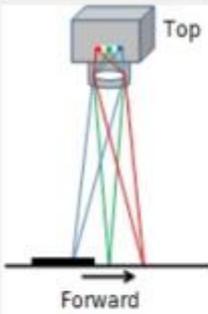
Page	Function
<p>Camera settings – Camera Parameter – Integration time</p> 	<p>Integration time:</p> <ul style="list-style-type: none"> • Set integration time • Set line period time <p>Section: 9.1</p>
<p>Camera settings – Camera Parameter – Gain settings</p> 	<p>Camera Gain and Reference Settings:</p> <ul style="list-style-type: none"> • Linear gain ¹⁾ • CDS gain ¹⁾ • Full well cap ¹⁾ • Closed-loop control for white balancing • Store gain parameters to a setting <p>Section: 9.3</p>

¹⁾ For the mono-camera, the parameters for red, green, blue are replaced by a single parameter whose name ends with `white`.

Page	Function
------	----------

Camera settings – Camera Parameter – White reference mark		
<ul style="list-style-type: none"> Camera-Settings <ul style="list-style-type: none"> Camera parameter <ul style="list-style-type: none"> Integration time Gain settings White reference mark Reference usage Brightness and contrast Camera arrangement Image parameter <ul style="list-style-type: none"> Image sizes Synchronization Image processing Output format Special functions <ul style="list-style-type: none"> Test pattern General information <ul style="list-style-type: none"> Camera information LED-Control <ul style="list-style-type: none"> XLC LED-control Global parameter <ul style="list-style-type: none"> Global master/slave config 	 <p style="font-size: small;"> A = First absolute pixel of white reference B = Number of pixels for white reference White reference mark could be inside or outside of a ROI C = First image line for white reference (may be negative), only used if white control mode is set to „sync mode“ D = Number of image lines for white reference </p> <div style="border: 1px solid #ccc; padding: 5px; margin-top: 10px;"> <p>First absolute pixel of white reference (A) <input style="width: 50px;" type="text" value="7001"/></p> <p>Number of pixels for white reference (B) <input style="width: 50px;" type="text" value="144"/></p> <p>First image line for the white reference (C) <input style="width: 50px;" type="text" value="20"/></p> <p>Number of image lines for the white reference (D) <input style="width: 50px;" type="text" value="20"/></p> <p>Number of reference samples for white reference <input type="text" value="No Average"/></p> <p>Show white reference border <input type="checkbox"/> Display white reference borders in the image</p> </div>	<p>White reference mark:</p> <ul style="list-style-type: none"> Set the position and size of the zone for the closed-loop control <p>Section: 9.4</p>

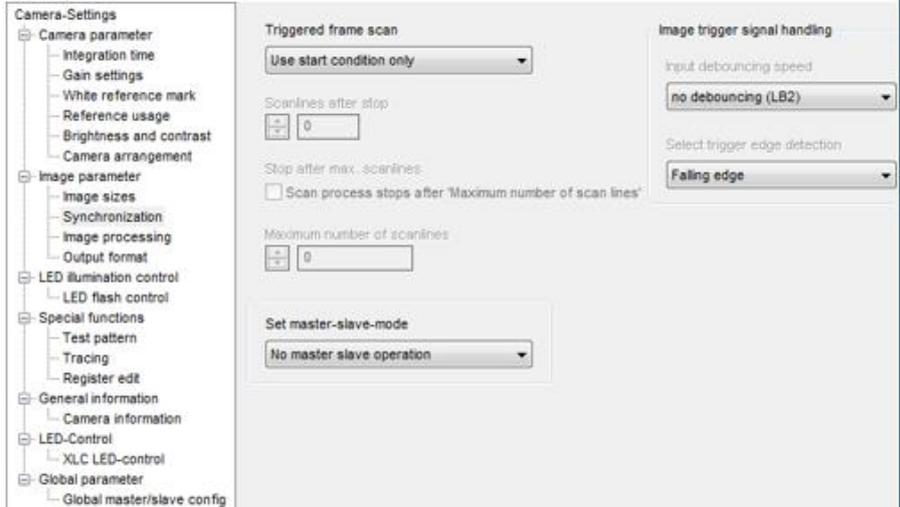
Camera settings – Camera Parameter – Reference usage		
<ul style="list-style-type: none"> Camera-Settings <ul style="list-style-type: none"> Camera parameter <ul style="list-style-type: none"> Integration time Gain settings White reference mark Reference usage Brightness and contrast Camera arrangement Image parameter <ul style="list-style-type: none"> Image sizes Synchronization Image processing Output format Special functions <ul style="list-style-type: none"> Test pattern General information <ul style="list-style-type: none"> Camera information LED-Control <ul style="list-style-type: none"> XLC LED-control Global parameter <ul style="list-style-type: none"> Global master/slave config 	<div style="border: 1px solid #ccc; padding: 5px; margin-top: 10px;"> <p>Black-level (Offset) correction <input type="checkbox"/> Activate black level correction</p> <p>Black reference data set <input type="text" value="Data set 1 is used"/></p> <p>White-level (Flat-field) correction <input type="checkbox"/> Activate white level correction</p> <p>White reference data set <input type="text" value="Data set 1 is used"/></p> <p style="text-align: center; margin-top: 10px;"><input type="button" value="Generate reference"/></p> </div>	<p>Reference usage:</p> <ul style="list-style-type: none"> Activate shading correction Activate black-level correction Select the data set for shading and black-level correction <p>Section: 9.5</p>

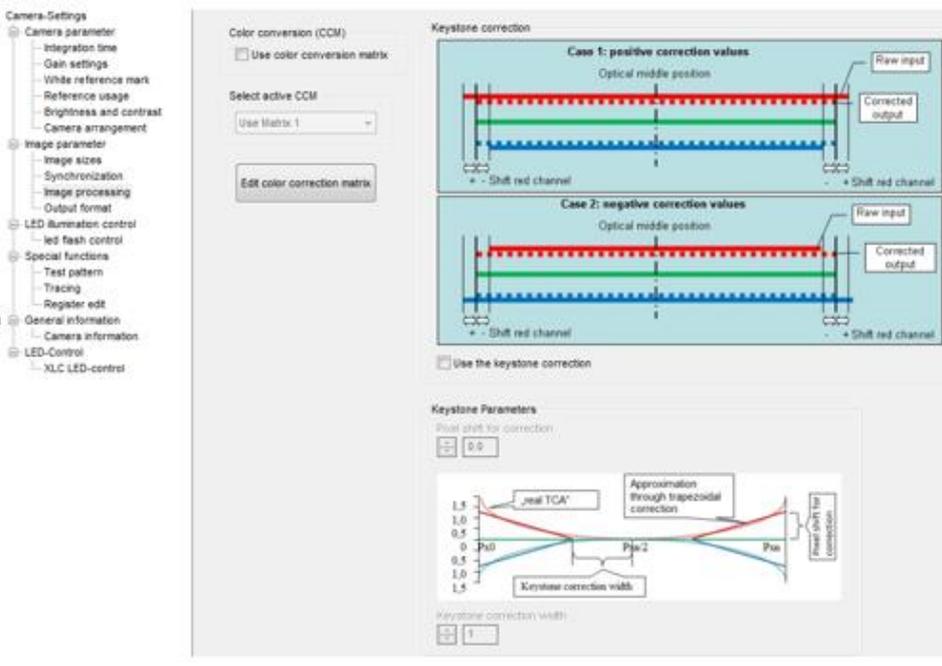
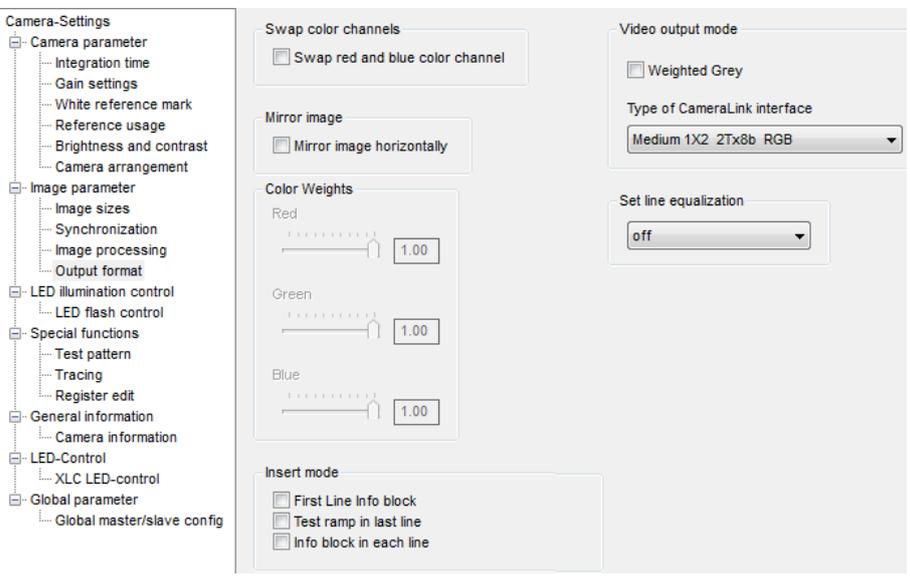
Page	Function
Camera settings – Camera Parameter – Brightness and Contrast	
	<div data-bbox="566 347 1077 862"> <p>Gamma correction</p> <p><input type="text" value="1.9"/></p> <p><input checked="" type="checkbox"/> use brightness and contrast</p> <p>Brightness offset Red <input type="text" value="0"/> Contrast gain Red <input type="text" value="0.90"/></p> <p>Brightness offset Green <input type="text" value="0"/> Contrast gain Green <input type="text" value="0.90"/></p> <p>Brightness offset Blue <input type="text" value="0"/> Contrast gain Blue <input type="text" value="0.90"/></p> </div> <p>Brightness and Contrast:</p> <ul style="list-style-type: none"> • Digital gain ¹⁾ • Digital offset ¹⁾ • Gamma correction <p>Section: 9.6</p>
Camera settings – Camera Parameter – Camera arrangement	
	<div data-bbox="566 956 1077 1948"> <p>Set RGB line distance(R->G, G->B)</p> <p><input type="text" value="2.0000"/></p> $\text{Line distance} = \frac{\text{Transport resolution(dpi)} * 2}{\text{Optical resolution(dpi)} * \cos(\alpha)}$ <p>α = viewing angle in transport direction (0° = perpendicular)</p>  <p>Set scan direction</p> <p>Forward</p>  <p>Enable suppression of lines/frame due to encoder direction</p> <p><input type="checkbox"/> Enable suppression of lines/frame</p> <p>Suppress lines/frames mode</p> <p>suppress lines against selected direction</p> </div> <p>Camera arrangement:</p> <ul style="list-style-type: none"> • Set the line shift/spatial correction • Set the scan direction <p>Section: 9.7</p>

¹⁾ For the mono-camera, the parameters for red, green, blue are replaced by a single parameter whose name ends with white.

6.6.2 Image parameter

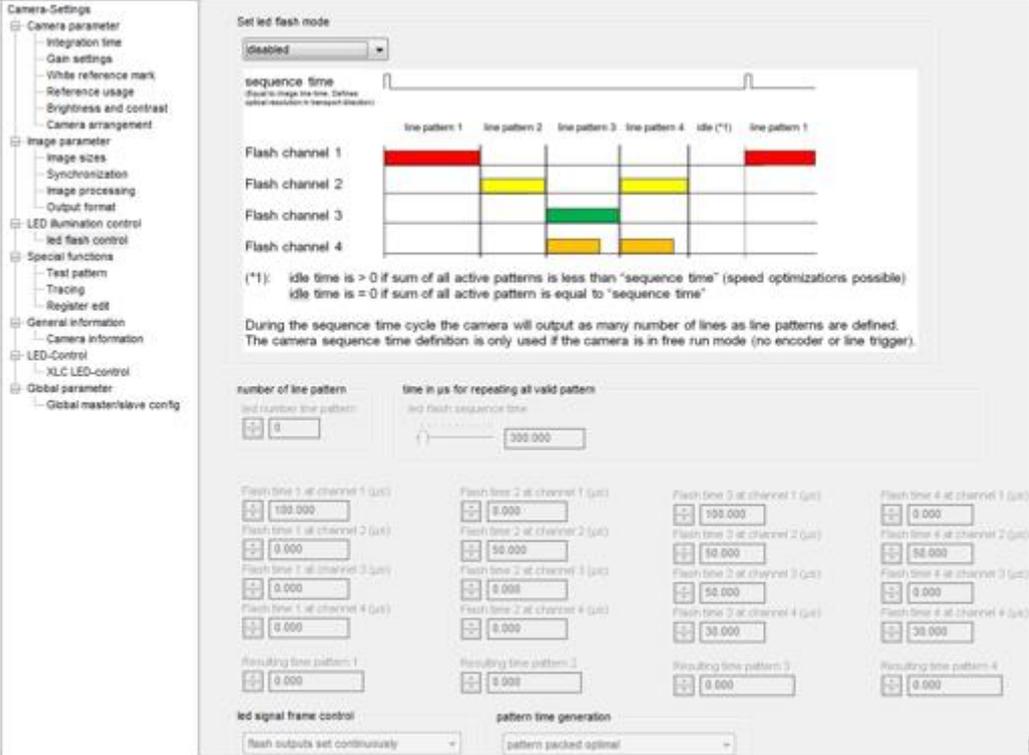
This part contains parameters related to the image.

Page	Function
<p>Camera settings – Image Parameter – Image size</p> 	<p>Image size:</p> <ul style="list-style-type: none"> Set the parameters related to the image size <p>Section: 9.8</p>
<p>Camera settings – Image Parameter – Synchronization</p> 	<p>Synchronization:</p> <ul style="list-style-type: none"> Set the parameters for triggering the frame scan modes Select the synchronization with other cameras (Master/slave mode) <p>Section: 9.9</p>

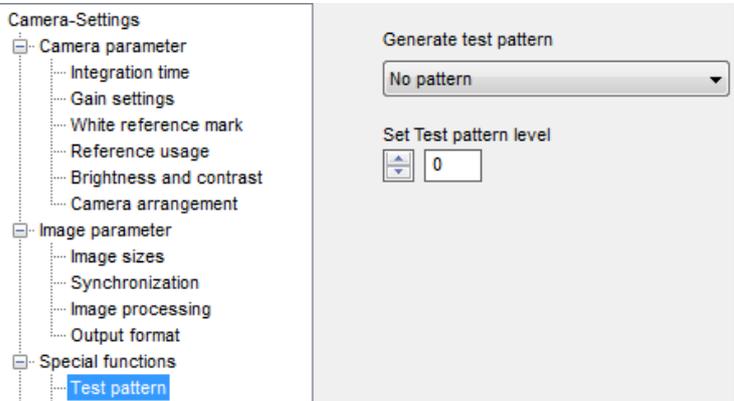
Page	Function
<p>Camera settings – Image Parameter – Image processing</p> 	<p>Image processing:</p> <ul style="list-style-type: none"> • Activate color correction <p>Section: 9.10</p>
<p>Camera settings – Image parameter – Output format</p> 	<p>Output format:</p> <ul style="list-style-type: none"> • Select the port type medium or base • Different parameters for data transfer on Camera Link • Insert information into image data • Swap red and blue color channels ¹⁾ • Mirror image horizontally <p>Section: 9.1</p>

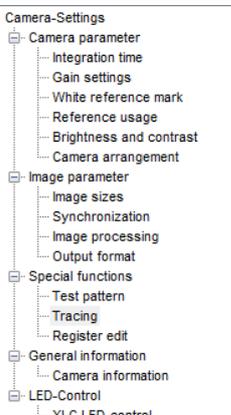
¹⁾ For a mono-camera, the parameters **Color Weights** and **Weighted gray** are replaced by a parameter **Set TDI operating mode**.

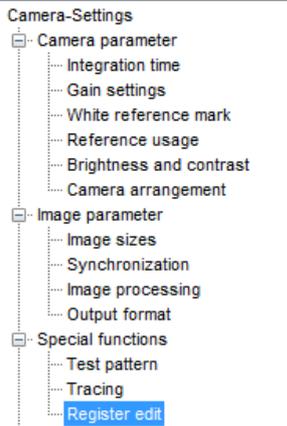
6.6.3 LED illumination control

Page	Function
Camera settings – LED illumination control – LED flash control	
	<p>LED flash control:</p> <ul style="list-style-type: none"> • LED number line pattern • LED flash sequence time • Pattern specification <p>Section: 8.8</p>

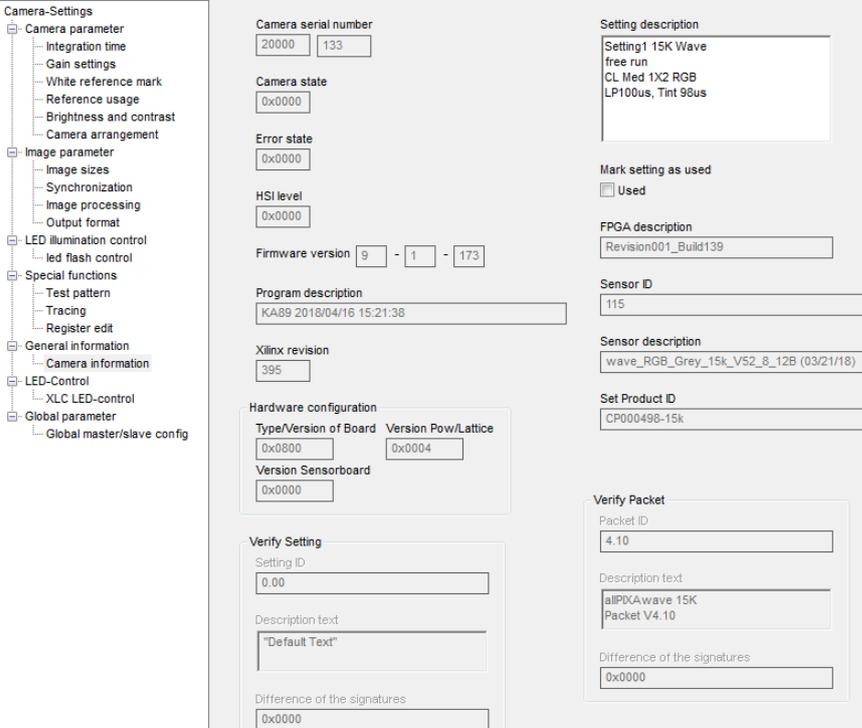
6.6.4 Special functions (Test pattern / Tracing / Register edit)

Page	Function
Camera settings – Special functions – Test pattern	
	<p>Test pattern:</p> <ul style="list-style-type: none"> • Test images can be generated inside the camera <p>Section: 9.13.1</p>

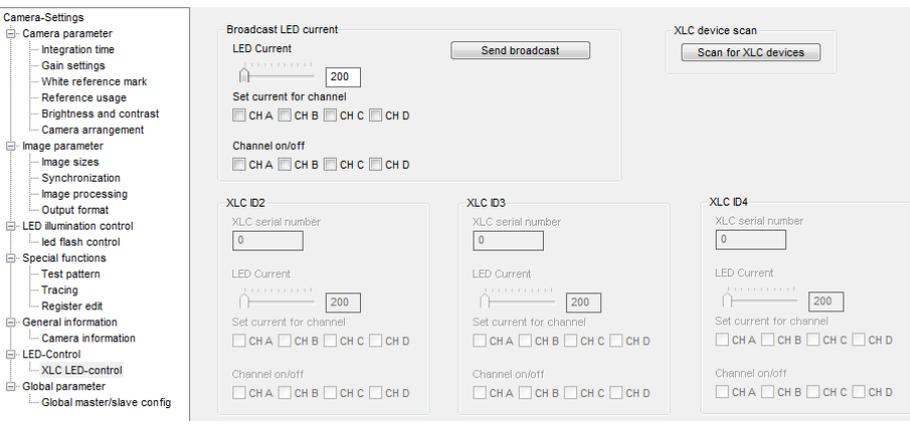
Page	Function																
Camera settings – Special functions – Tracing																	
	<div style="background-color: #f0f0f0; padding: 10px; border: 1px solid #ccc;"> <p>Set trace mask</p> <table border="0"> <tr> <td><input type="checkbox"/> General debug information</td> <td><input type="checkbox"/> Communication transport layer</td> </tr> <tr> <td><input type="checkbox"/> Communication transport layer details</td> <td><input type="checkbox"/> Reg edit information</td> </tr> <tr> <td><input type="checkbox"/> State Trace White- and Led Control</td> <td><input type="checkbox"/> States</td> </tr> <tr> <td><input type="checkbox"/> Sensor information</td> <td><input type="checkbox"/> Environment values</td> </tr> <tr> <td><input type="checkbox"/> image</td> <td><input type="checkbox"/> Reserved 09</td> </tr> <tr> <td><input type="checkbox"/> Reserved 10</td> <td><input type="checkbox"/> Reserved 11</td> </tr> <tr> <td><input type="checkbox"/> Reserved 12</td> <td><input type="checkbox"/> Sensorfile subregion parsing information</td> </tr> <tr> <td><input type="checkbox"/> Sensor timing</td> <td><input type="checkbox"/> Time stamp</td> </tr> </table> </div> <p>Tracing:</p> <ul style="list-style-type: none"> • Debugging functions <p>Section: 9.14</p> <p>Tracing is only available if User level has been set to Guru on the System configuration page.</p>	<input type="checkbox"/> General debug information	<input type="checkbox"/> Communication transport layer	<input type="checkbox"/> Communication transport layer details	<input type="checkbox"/> Reg edit information	<input type="checkbox"/> State Trace White- and Led Control	<input type="checkbox"/> States	<input type="checkbox"/> Sensor information	<input type="checkbox"/> Environment values	<input type="checkbox"/> image	<input type="checkbox"/> Reserved 09	<input type="checkbox"/> Reserved 10	<input type="checkbox"/> Reserved 11	<input type="checkbox"/> Reserved 12	<input type="checkbox"/> Sensorfile subregion parsing information	<input type="checkbox"/> Sensor timing	<input type="checkbox"/> Time stamp
<input type="checkbox"/> General debug information	<input type="checkbox"/> Communication transport layer																
<input type="checkbox"/> Communication transport layer details	<input type="checkbox"/> Reg edit information																
<input type="checkbox"/> State Trace White- and Led Control	<input type="checkbox"/> States																
<input type="checkbox"/> Sensor information	<input type="checkbox"/> Environment values																
<input type="checkbox"/> image	<input type="checkbox"/> Reserved 09																
<input type="checkbox"/> Reserved 10	<input type="checkbox"/> Reserved 11																
<input type="checkbox"/> Reserved 12	<input type="checkbox"/> Sensorfile subregion parsing information																
<input type="checkbox"/> Sensor timing	<input type="checkbox"/> Time stamp																

Page	Function																
Camera settings – Special functions – Register edit																	
	<div style="background-color: #f0f0f0; padding: 10px; border: 1px solid #ccc;"> <p style="text-align: center;">Permanently save register values into the setting</p> <table border="0"> <tr> <td>Address 1</td> <td>Data 1</td> </tr> <tr> <td><input type="text" value="0x0000"/></td> <td><input type="text" value="0x0000"/></td> </tr> <tr> <td>Address 2</td> <td>Data 2</td> </tr> <tr> <td><input type="text" value="0x0000"/></td> <td><input type="text" value="0x0000"/></td> </tr> <tr> <td>Address 3</td> <td>Data 3</td> </tr> <tr> <td><input type="text" value="0x0000"/></td> <td><input type="text" value="0x0000"/></td> </tr> <tr> <td>Address 4</td> <td>Data 4</td> </tr> <tr> <td><input type="text" value="0x0000"/></td> <td><input type="text" value="0x0000"/></td> </tr> </table> </div> <p>Register edit:</p> <ul style="list-style-type: none"> • You can edit registers directly. • This data are saved on the camera when you burn the setting. • Be careful if you use this function. It might cause a damage of the firmware or cause malfunction of the camera. <p>Section: 9.15</p> <p>Register edit is only available if User level has been set to Guru on the System configuration page.</p>	Address 1	Data 1	<input type="text" value="0x0000"/>	<input type="text" value="0x0000"/>	Address 2	Data 2	<input type="text" value="0x0000"/>	<input type="text" value="0x0000"/>	Address 3	Data 3	<input type="text" value="0x0000"/>	<input type="text" value="0x0000"/>	Address 4	Data 4	<input type="text" value="0x0000"/>	<input type="text" value="0x0000"/>
Address 1	Data 1																
<input type="text" value="0x0000"/>	<input type="text" value="0x0000"/>																
Address 2	Data 2																
<input type="text" value="0x0000"/>	<input type="text" value="0x0000"/>																
Address 3	Data 3																
<input type="text" value="0x0000"/>	<input type="text" value="0x0000"/>																
Address 4	Data 4																
<input type="text" value="0x0000"/>	<input type="text" value="0x0000"/>																

6.6.5 General information

Page	Function
Camera settings – General information – Camera information	
	<p>Camera information:</p> <ul style="list-style-type: none"> Information about firmware on the camera Attach a screenshot of this page for all support questions. <p>Section: 9.16</p>

6.6.6 Controlling LED lighting

Page	Function
Camera settings – LED control –XLC LED control	
	<p>Camera information:</p> <ul style="list-style-type: none"> Several XLC4 light controllers can be controlled <p>Section: 8.11</p>

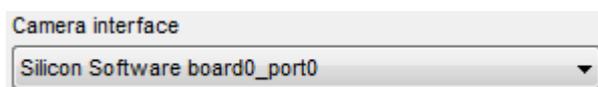
6.7 Opening serial connection to a camera

You can open a different port or re-open the same port directly. It is not necessary to restart CST and to select it in the dialog box shown during start-up.

Button	Function key	Menu
		View/System configuration

To open serial connection to a camera:

1. On the toolbar, click **Show system configuration** .
2. In the **Camera interface** list, click the desired camera connection:



3. In the **Baud rate** list, click baud rate **115200**, or select the **Use max. Baud rate** check box:



If the **Use max. Baud rate** check box is selected, CST and the camera try to get connected with the highest possible data rate.

4. Click **Open connection**:



The baud rate of the camera is 115200.

6.8 Transferring data to the camera

Button	Function key	Menu
	F9	Settings/Transfer setting to volatile camera memory

Changes in the setting must be transferred to the camera.

NOTE

- Data edited in CST are not transferred to the camera automatically
- Data edited in CST are not transferred to the camera when you press **Enter**.
- Data are lost during a restart or a reset of the camera if they were not saved to persisting memory
- If a new setting is loaded, or if the current setting is reloaded, unsaved data get lost

6.9 Saving data to the camera permanently

Up to 18 different settings are available in the camera.

Setting 19 is reserved for the backup of the default setting.

We recommend to use settings 1 to 9 for working settings and setting 10 to 18 for backup settings.

The currently selected setting is displayed in the toolbar:



To save the data to the currently selected setting, use the following:

Button	Function key	Menu
	F10	Settings/Burn current setting permanently

To save the data to different setting in the camera, use the following:

Button	Function key	Menu
	F11	Settings/Burn current setting permanently as

To save data to a different setting:

1. Press F11.

The **Burn setting as** dialog box is shown:



2. In the **Burn setting as no** list, click the desired setting number, and then click **OK**.

NOTE First, changes made inside CST must be transferred to the camera. If they are not transferred, they get lost. These functions take the data from the volatile memory in the camera for burning.

6.10 Refreshing data from the camera in CST

Some data have been changed in the camera or in the setting by the camera itself, for example by the closed-loop control for white balancing. To update the current data in CST, click the refresh button:

Button	Function key	Menu
	F5	

6.11 Selecting a setting on the camera

To select a different setting on the camera:

- In the **Active Setting** list, click the number of the respective setting.



NOTE Changes that have not been transferred and burned on the last edited setting get lost.

6.12 Saving settings to the PC

For saved camera settings, two different file types are available:

- ***.mk files:**
Binary file. The file contents can be transferred to the camera directly.
- ***.set files:**
The files are in XML format. Such files can be edited manually but this is only recommended for advanced users. Use CST to edit the files safely. Such files can also be downloaded to the camera, but CST compiles it to the binary format beforehand.

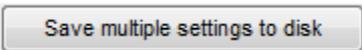
6.12.1 Saving settings from CST to hard disk

Button	Function key	Menu
		Settings/Save setting to disk

With this function you can save the setting data currently present in CST to a *.set or *.mk file.

NOTE Changes at the camera, for example caused by automatic white control, are not saved in the files. Therefore, click the refresh button, before you save the data to hard disk.

6.12.2 Saving settings from the camera to hard disk

Button	Function key	Menu
		View/System configuration
		

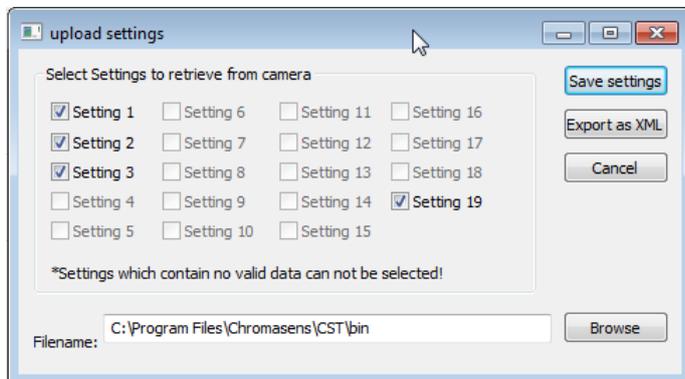
With this function, you can save permanently saved camera settings to an *.mk file in binary format or to an *.set file in XML format.

NOTE Changes get lost if they are not saved permanently to a setting.

To save camera settings to a file:

1. On the toolbar, click **Show system configuration** , and then click **Save multiple settings to disk**.

The **Upload Settings** dialog box opens and shows enabled check boxes for all available camera settings:



2. Specify the settings that should be saved by selecting or clearing check boxes as needed:
3. To specify the file name, enter path and file name in the **Filename** box, or click **Browse** to open a **File** dialog box.
4. To save the settings in binary format as *.mk file, click **Save settings**, or to save them in XML format as *.set file, click **Export as XML**.

Each selected setting is saved to a separate file, at which the setting number is appended to the file name.

6.13 Transferring saved settings from the PC to the camera

NOTE If you transfer settings to the camera, settings with the same number are overwritten.

There are two ways available for transferring settings to the camera:

- Transfer settings directly to the camera.
- Open the setting in CST and transfer data in a second step to the camera.

1. **Transferring settings with direct transfer:**

Button	Function key	Menu
		View/System configuration
		

2. **Transferring settings using CST:**

Button	Function key	Menu
		Settings/Open setting from disk

A standard file dialog box opens, and you can select *.set files or *.mk files. The setting is then shown in CST, but it is not sent to the camera.

As next step, press **F9** to send the setting to the camera. Then press **F10** to burn the setting as setting 1, or press **F11** to burn it to a setting with a different number.

6.14 Deleting settings on the camera

You can delete burned settings on the camera.

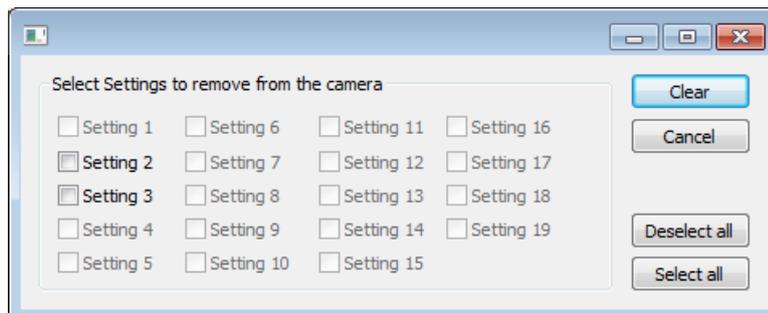
Button	Function key	Menu
		Settings/Clear settings

NOTE I It is **not allowed** to delete setting 1. If setting 1 has been changed erroneously, you can restore the default setting 1 by clicking **Restore factory settings** on the **Simple setup view**, without having to deal with download packages. In this case, the setting is restored from internal camera memory.

NOTE II This function is only available if the user level has been set to **Guru**.

To delete settings on the camera:

1. On the **Settings** menu, click **Clear settings**.
2. In the **Clear Settings** dialog box, which shows enabled check boxes for all available camera settings, select check boxes as needed:



3. To delete the specified settings, click **Clear**.

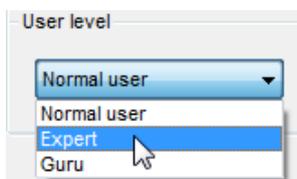
6.15 Setting the user level in CST

CST provides three different user levels. In **Normal user** level, several parameters and functions are not available, which helps to prevent undesired changes by inexperienced users. Only in **Guru** level, all features are available.

Button	Function key	Menu
		

To switch to a different user level:

1. On the toolbar, click **Show system configuration** .
2. In the **User level** list, click the desired level:



NOTE We recommend to work with **Normal user** level as much as possible to avoid erroneous settings.

The following table shows which commands of the **Advanced** menu are enabled in the different user levels:

Name	Normal User	Expert	Guru
Register edit			X
Bootstrap board			X
Get camera trace		X	X
Verify packet/setting			X
Create HSI checksum			X
Edit color conversion matrix			X
Set IP address		X	X
Get current camera state	X	X	X
Restore factory settings			X

For information about available parameters in the different user levels, see section 9.18.

6.16 Resetting the camera:

You can reset the camera from CST:

Button	Function key	Menu
		View/System configuration
		

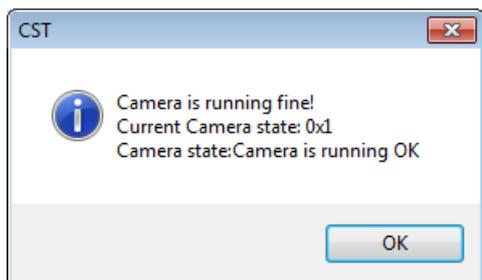
On the camera a reset is performed, and afterward CST is automatically re-connected to the camera.

6.17 Checking the camera state

Button	Function key	Menu
		Advanced/Get current camera state

When you click this button, detailed information about camera state and the currently present errors are read, and currently presented errors are cleared and acknowledged.

If the camera is OK, the following dialog box is shown:



6.18 Choosing a different configuration file for the parameter display

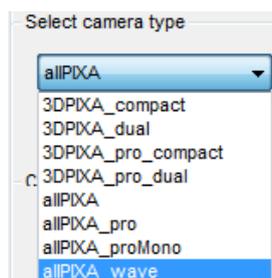
You can modify the **Parameter** view of CST according to the camera type.

Button	Function key	Menu
		View/System configuration

To switch to a different configuration file:

1. On the toolbar, click **Show system configuration** .
2. In the **Select camera type** list, click the respective item:

The default viewer configuration for the allPIXA wave camera is **allPIXA_wave**.



The changes are applied to the **Parameter** view immediately. The settings are stored in the registry, and CST uses the new viewer file when it is started next time.

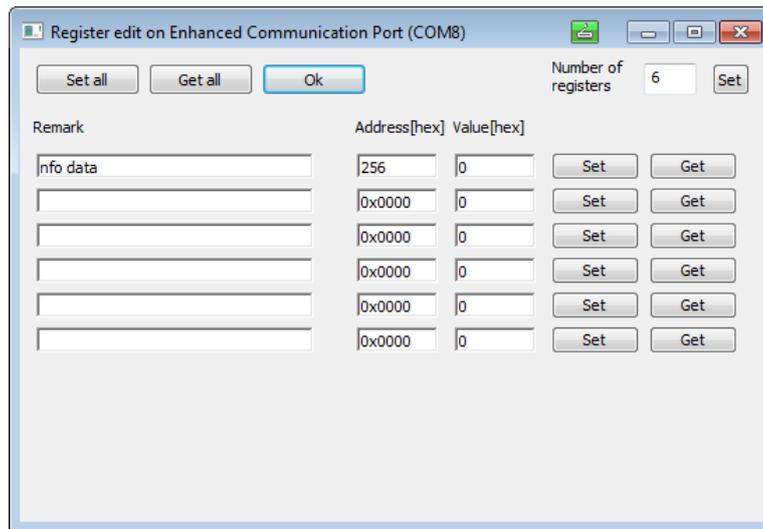
According to the different viewer file, some parameters are visible or hidden.

6.19 Register Edit

You can read and prepare registers in the camera.

Button	Function key	Menu
		Advanced/Register edit

Compared to the register edit of the basic settings (section 6.6.3), this register edit is for non-permanent memory. Each loading or sending of a setting overwrites the changes. The intended use is for debugging the system:



You can edit different registers directly. If you click **OK**, register names (**Remark**) and the address are saved on hard disk and are available for the next time.

By clicking **Set** or **Get**, you can work with a single register. By clicking **Set all** or **Get all**, you can edit all registers in the list.

To change the numbers of displayed registers, enter the new number into the **Number of registers** box, and then click **Set**.

NOTE This function is only for trained users.

7 Camera system setup – first steps

7.1 Installing the camera

Prepare the general setup:	
1	<p>Prepare the camera and lens</p> <ul style="list-style-type: none"> • Select the correct lens and accessories to operate your camera in the desired environment. (For more information about lens and tube selection, see section 11.1) • Install the lens and adapters correctly. For a detailed description of lens and mount installation, see section 2.6.
2	<p>Prepare the right cabling for your application</p> <ul style="list-style-type: none"> • Camera Link cable: The allPIXA wave provides MDR connectors. Check the plugs of your frame grabber to decide whether you need MDR-MDR or MDR-SDR Camera Link cables. • Power supply: Hirose 6-pin plug (HR10A-7P-6S). The allPIXA wave connecting interfaces are described in section 5.1. • Connect the camera to a power supply (24 VDC +/- 10 %; 1A; typical 20 W) and your frame grabber (section 5.6).
3	<p>Install the frame grabber on your PC by following the manufacturer's description</p> <ul style="list-style-type: none"> • Set the configuration of the frame grabber to adjust it to the configuration of the allPIXA wave camera. For information about the Camera Link modes, see section 4.8.
4	<p>Adjust the focusing point of your illumination unit and position it correctly</p> <ul style="list-style-type: none"> • Refer to the manual of the illumination manufacturer for proper installation of the illumination. • Make sure that the illumination is positioned correctly to illuminate the scanning area.
5	<p>Mechanically install the camera in your machine</p> <ul style="list-style-type: none"> • Make sure, it is positioned correctly The sensor line should be adjusted horizontally to the transport direction and the camera should look perpendicular to the inspection area. For a detailed description of a correct camera installation, refer to chapter 5. • Make sure, you have the correct object-to-sensor distance The sensor line is positioned 17 mm (optical photosensitive surface) behind the front surface of the allPIXA wave camera. You can find the detailed sensor position description in section 2.4.

7.2 Starting up the system

Start up the camera:

You can set camera parameters using the Camera Setup Tool (CST). For information about installation of CST, see section 6.1. For information about default parameters, see section 9.17.

- Turn on illumination and camera.
- Start CST (Camera Setup Tool) (chapter 6).
- Set up communication between PC and camera (section 6.1.3) and select the correct camera type if necessary.
- To set the correct Camera Link configuration and the connection speed, click **Show settings**  on the toolbar, click **Output format**, and then specify the parameters. Image size and output format of the camera must match the frame grabber settings.
- Click **Transfer settings to camera**  to save the setting into volatile memory.
- To specify first parameter adjustments, click **Show simple setup view**  on the toolbar.

Now, you should be able to grab and see an image in your frame grabber tool.

If your frame grabber is not able to receive an image, see the frame grabber manual or contact support service of the frame grabber manufacturer.

Proceed to section 7.3 to calibrate the camera and adjust the camera settings to your operating conditions.

(To specify the user level, click **Show system configuration**  on the toolbar. For more information, see section 6.15.)

NOTE After setting a parameter, **always** click **Transfer setting to camera**  or press **F9** to transfer settings to volatile memory!

Click **Burn setting permanently**  or press **F10** to burn the setting into the camera!

For more information about the toolbar buttons, see section 6.3.

7.3 Adjusting the camera to the environment (camera calibration)

Prepare the camera for calibration (see also section 8.2).

- Set the camera in free-running mode for lines and images
- Place a white reference target, covering the full scanning area

NOTE

If the white reference target is placed in the best focus plane of the camera, any features on its surface (for example dust, scratches) end up in the calibration profile of the camera. To avoid this if you use a static (non-moving) white reference target, use a clean white ceramic or plastic material, not paper. Ideally, the white object should move during the calibration process because the movement results in an averaging process and the camera diminishes the effects on any small variation in the white reference. If this is not possible, you could place the reference target a little bit out of the best focus plane, but take care that the illumination of the target doesn't change too much.

You can find the most important parameters and functions on the simple setup page  (see section 8.1).

To calibrate the camera setting to your operating conditions, follow the steps below.

1	Check your line scan system application:
	<ul style="list-style-type: none"> ● Illumination setting: Switch on the lighting and ensure that the adjustment of the lighting provides best illumination on the target. ● Frame grabber setting: Check your frame grabber settings. Make sure that the grabber configuration matches the allPIXA wave camera settings. ● Camera adjustment: Adjust the camera to the target for best orientation and for the best lighting. ● Focusing and f-stop: Set the camera to best focus and select the requested f-stop.
2	Set integration time:
	<ul style="list-style-type: none"> ● On the toolbar, click Show simple setup view , and then specify the integration time. You can find an instruction for calculation in the appendix (section 11.2.3). ● Click Transfer setting to camera , or press F9 to save the setting to volatile memory.
3	Set the operating point (white balancing, section 8.2):
	<p>The camera has the correct gaining values after this step.</p> <ul style="list-style-type: none"> ● On the toolbar, click Perform white balancing  for automatic white balancing or ● Follow the instructions in section 8.2.3 for manual white balancing. <p>This step must be performed again, for example, after changing the light or the f-stop. Refer to section 8.2 for a detailed description on how to set the operating point.</p>
4	Generate black-level reference (section 8.2.4):
	<ul style="list-style-type: none"> ● On the toolbar, click Start reference wizard . ● Click Black (offset) level reference and Create reference internally. ● Click Next , and follow the instructions of the wizard. ● On the toolbar, click Show simple setup view , and then select the Activate offset correction check box. ● Click Transfer setting to camera , or press F9 to save the setting to volatile memory. <p>For information about creation of a black-level reference, see section 8.3.</p>

Generate the shading reference / flat-field correction (section 8.4):

5

- On the toolbar, click **Start reference wizard** , and follow the description in section 8.4.
- On the toolbar, click **Show simple setup view** , and then select the **Activate white-level (flat-field) correction** check box.
- Click **Transfer setting to camera** , or press **F9** to save the setting to volatile memory.

For information about creation of a shading reference, see section 8.4.

Save the settings:

6

- On the toolbar, click **Burn setting permanently**  to save settings into the camera permanently.
- You may choose different settings () to configure your system to different applications. You can create backups by saving the setting into another setting (section 6.9), or by saving the settings to disk (section 6.12).

NOTE

If you select a different setting, changes that have not been saved permanently into the camera by clicking  get lost.

7.4 Trigger and image enhancement functions

Add image processing functions:

1

- You can add digital image processing functions.

Study the sections 9.6 to 9.9.8 onward to find out which image processing functions are offered by the allPIXA wave.

Set the line trigger or encoder functions

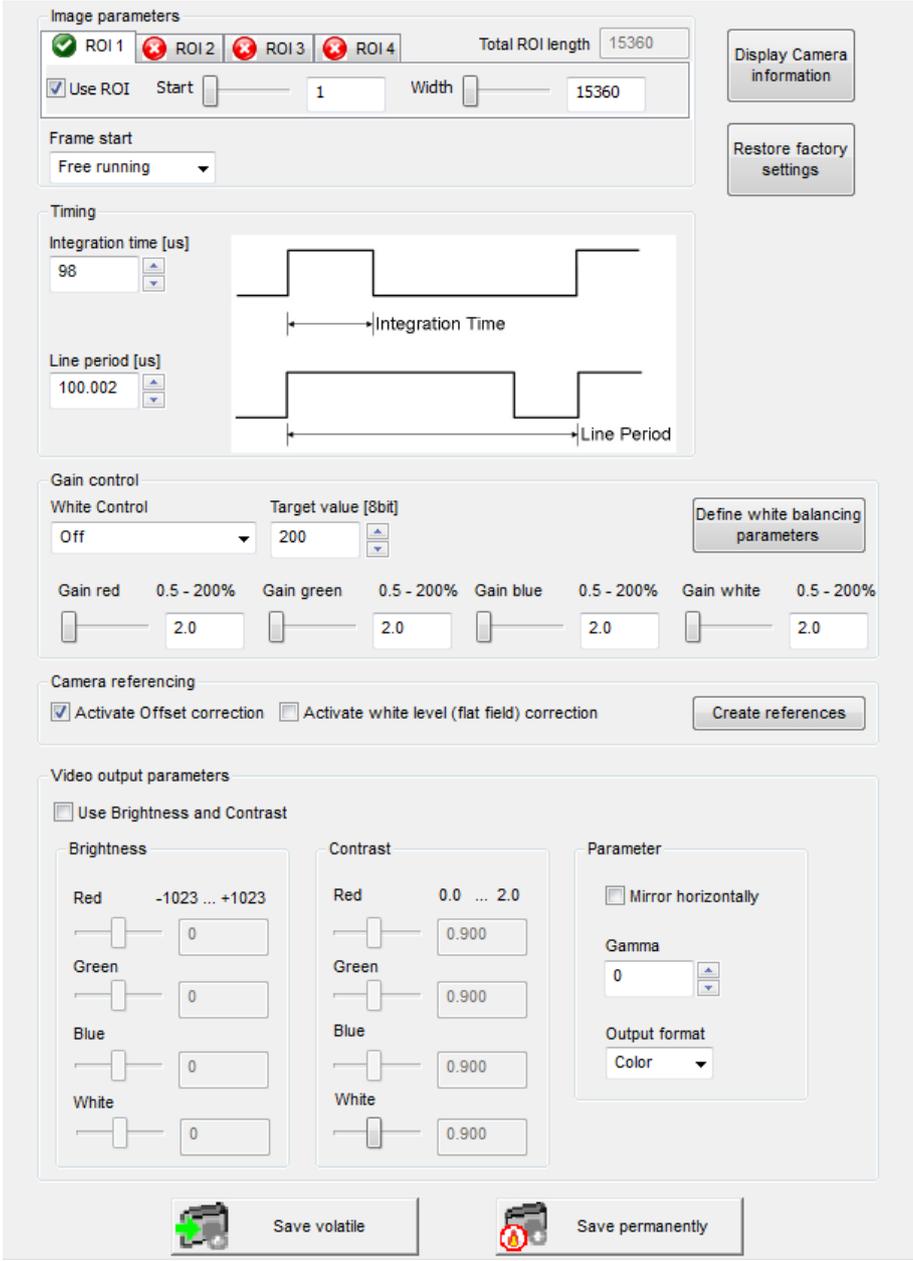
2

- Connect the encoder or line trigger with the frame grabber or directly with the camera. If the encoder is connected to the frame grabber, make sure that the signal is transferred to CC1 or CC2 (for more detailed setup, see section 8.6).
- Define the correct input signal port for the signals (see also section 8.6).
- Click **Show encoder setup**  to open the **Encoder setup** page (see section 9.10).
- Set the parameters in CST for the encoder or line trigger mode.

8 Camera operation

8.1 Easy camera configuration using the simple setup view

On the toolbar, click **Display simple setup view**  to enter the simple setup page which comprises the most important parameters and functions on a single page.



The screenshot displays the 'Simple setup view' interface for camera configuration. It is organized into several functional sections:

- Image parameters:** Includes ROI selection (ROI 1-4), Total ROI length (15360), and 'Use ROI' checkbox. Sliders for Start (1) and Width (15360) are present.
- Frame start:** A dropdown menu set to 'Free running'.
- Timing:** Features input fields for Integration time [us] (98) and Line period [us] (100.002), accompanied by a waveform diagram illustrating these parameters.
- Gain control:** Contains a 'White Control' dropdown (set to 'Off') and a 'Target value [8bit]' (200). Below are sliders for Gain red, green, blue, and white, all set to 2.0.
- Camera referencing:** Includes checkboxes for 'Activate Offset correction' (checked) and 'Activate white level (flat field) correction', with a 'Create references' button.
- Video output parameters:** Includes a 'Use Brightness and Contrast' checkbox. It has sliders for Brightness and Contrast for Red, Green, Blue, and White channels. A 'Parameter' section includes a 'Mirror horizontally' checkbox, a 'Gamma' input (0), and an 'Output format' dropdown (Color).
- Bottom toolbar:** Contains 'Save volatile' and 'Save permanently' buttons.

The parameters are placed in a functional order to give you an orientation which parameters should be set first. Start with the topmost parameter.

NOTE If you change a parameter, **always** click **Transfer setting to camera**  on the toolbar or press **F9** afterward to transfer the settings to volatile memory! Click **Burn setting permanently**  or press **F10** to burn the setting into the camera!

Image parameters:

The allPIXA wave camera permits to return up to four different ROIs (ROI=Region Of Interest) with arbitrary start positions and widths. Each ROI can be enabled or disabled separately. Enabled ROIs may even overlap. The total width of all enabled ROIs must not exceed 15k (even for the 10k camera).

By default, the first ROI is enabled and comprises the whole sensor width, as shown here for the 15k camera:

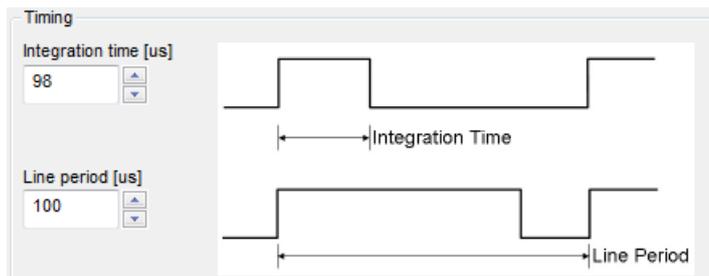


To enable an ROI, click the respective tab, select the **Use ROI** check box, and enter start position and width.

When you transfer the setting to the camera, the specified values may be adapted, and afterward **Total ROI length** shows the total length of the enabled ROIs.

The image output can be set to free-running or triggered mode.

Timing:



You can specify the integration time (9.2.1).

In triggered mode, the camera waits for an input trigger to start image acquisition. The grabbed image has the number of image lines defined in the image parameters.

Gain control:

To achieve good image quality, specify gain and white-reference parameters.



At the **White control** list, specify whether white control/balancing should operate continuously, only once per frame, or whether it should be switched off. If you select **Continuous**, the camera gain values are adjusted continuously during the scanning process.

You can specify the target value for white control, which is given as 8-bit value (0-255). The camera tries to reach the set target value (section 9.3.5) by adjusting the analog camera gain values.

You can specify the camera gain values manually (section 9.3.4).

If you click **Define white balancing parameters**, the **White reference mark** page is shown on which you can specify all white balancing parameters manually following the description in section 8.2.3.

Camera calibration:

Specify whether offset and white-level (flat-field) correction should be used:

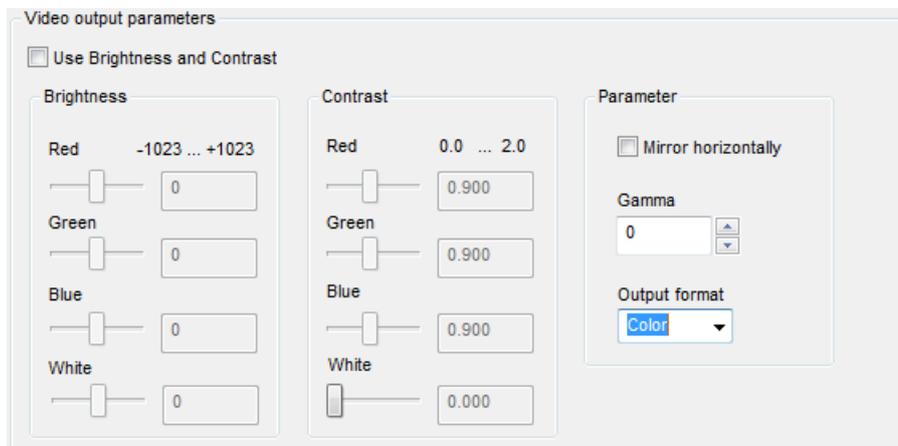


If the references for black-level and flat-field correction were already generated, simply activate/deactivate them by selecting or clearing the respective check box.

Click **Create references**, to start the reference wizard, and follow the instructions of the wizard to generate a black-level reference (section 8.2.4) or a white-level (shading) reference (section 8.4).

Video output parameters:

You can specify further digital image processing by setting the desired output parameters:



If the brightness and contrast parameters should be applied to the image, select the **Use Brightness and Contrast** check box. For more information about these parameters, see section 9.6.

Parameter description:

Brightness

The specified value is added to the output value. The values are in the 8-bit range.

Contrast

The output values are multiplied by the specified value. This is very useful to desaturize images after the flat-field correction.

Mirror horizontally

If you select this check box, the output image is mirrored. For example, if you use an output width of 4096 pixels, input pixel 4095 is output as pixel 0 and input pixel 0 is output as pixel 4095.

Gamma

A gamma correction table is applied to the image.

$$\text{video_out_level} = \text{video_in_level}^{1/\text{Gamma}}$$

This is valid for values > 0.4. If 0.1 is selected for the gamma value, a special table for sRGB conversion is used.

To disable gamma correction, set **Gamma** to 0.

Output format

The camera can be set to output color or gray images. If you set **Output format** to **Mono** (gray images), only one Camera Link connection is used. The data are transmitted on Camera Link port 1. Port 2 is idle.

For a detailed description of the transmission of data according Camera Link specification, see section 4.8.

Transfer and burn setting:

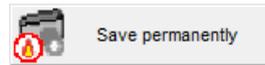
To transfer your setting into camera memory, click **Save volatile**



Alternatively, you can click **Transfer setting to camera** on the toolbar, or press **F9**.

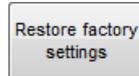
Changes get lost if you select a different setting, or if you reset the camera or switch it off.

To burn your setting permanently into the camera, click



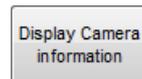
Alternatively, you can transfer the setting to the camera and then click **Burn setting permanently** on the toolbar, or press **F10**.

Restoring the default factory setting:

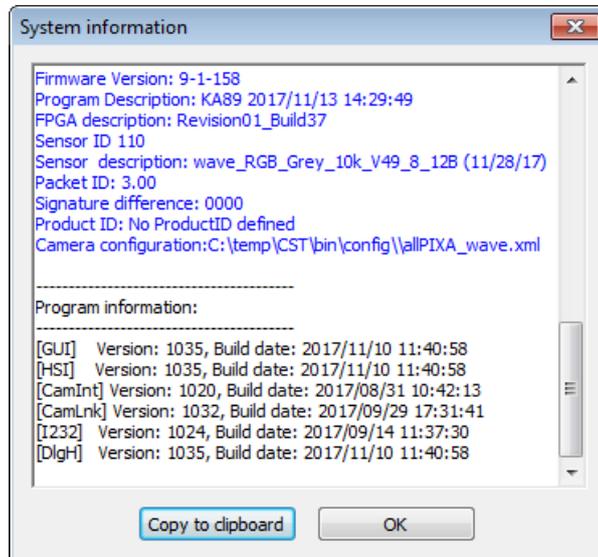


By clicking you can overwrite the current setting with the setting used for the commissioning of the camera at the Chromasens production facility. This only affects the currently active setting.

Obtaining camera information:



To obtain camera information, click **Display camera information**. The following dialog box is shown:



If there are any problems with the camera or the parameter settings, it is very helpful for the Chromasens support to obtain the camera information.

To add this information to an email to Chromasens support, click **Copy to clipboard** and paste the information into your email.

8.2 Performing a white balancing on the camera

You can perform white balancing automatically (see section 8.2.2) or manually (see section 8.2.3). For more information about gain levels, see section 9.3.1 or 9.3.7.

8.2.1 System preparation for white balancing

Setup

- Set the camera to free-running mode (disable encoder and frame trigger)
- Use a white balancing reference that covers the entire scanning range.

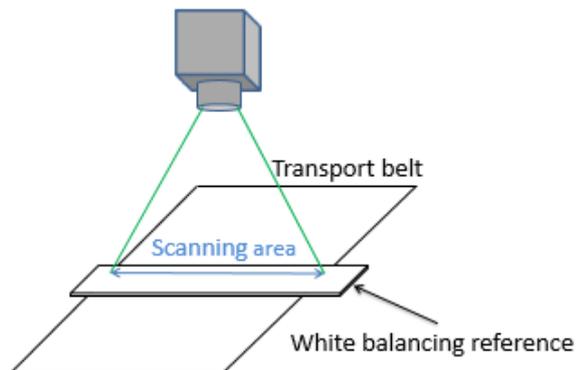


Figure 26: allPIXA wave camera with a white balancing reference

- Check the alignment of the illumination and the allPIXA wave camera by using a suitable viewer (for example the line plot display of your frame grabber software):

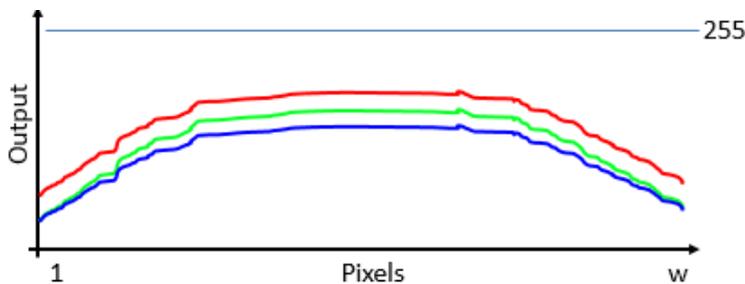
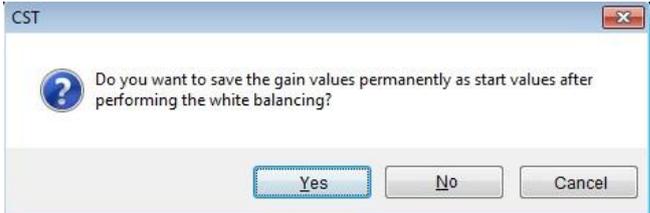


Figure 27: Line plot display

8.2.2 Setting the operation point automatically

NOTE

- The position of the white reference mark (control zone) and the target gain value for the control zone are used as specified in the setting (see section 9.4)
- This operation only takes place in the currently selected setting.
- This function must receive line data inside the camera. If the camera is set to line trigger or encoder mode and the transport is not moving, an error occurs.
- Set the camera to internal line trigger.

1	<p>Prepare the setup for the operation.</p> <ul style="list-style-type: none"> • Make sure that a valid black-level correction is enabled (see section 9.5.1).
2	<ul style="list-style-type: none"> • On the toolbar, click Perform white balancing . <p>A dialog box is shown:</p>  <ul style="list-style-type: none"> • If you want to use the determined gain values as startup values (recommended), click Yes. Otherwise click No. <p>If the process succeeds, White balancing succeeded appears in the message box.</p> <p><u>Possible errors:</u></p> <p>White balancing error occurred. Error code No: 0x10D: no reference data → Camera is not in free-running mode, but there are no trigger signals and thus no reference data are available. ⇒ Adapt your configuration accordingly.</p> <p>White balancing error occurred. Error code No: 0xF6: maximum gain exceeded → Digital gain value exceed internal limit. ⇒ Increase analog coarse gain or increase illumination intensity. (see also section 9.3.7)</p> <p>White balancing error occurred. Error code No: 0x41: minimum gain exceeded → Digital gain value has reached lower limit. ⇒ Decrease analog coarse gain or reduce illumination intensity.</p> <p>White balancing error occurred. Error code No: 0xF7: White balance cannot be leveled → White balance process has exceeded time limit but up to now no error has occurred. White balance may last very long if white reference area is large, line period is high. ⇒ Restart of white balance may finish the process successful.</p> <p>For a special single camera color channel calibration (individual red/green and blue calibration), see section 8.2.4 Fehler! Verweisquelle konnte nicht gefunden werden..</p>
3	<ul style="list-style-type: none"> • On the toolbar, click Refresh current camera parameters . <p><u>Optional:</u></p> <ul style="list-style-type: none"> • On the Gain settings page, check the Linear gain values. To achieve good image quality, they should be low. If they are near or above 50, you should modify parameters until you can reduce the linear gain values accordingly. For example, you could select x 2 at the CDS gain options or select High sensitivity at the Full-well capacity options.
4	<ul style="list-style-type: none"> • On the toolbar, click Burn setting permanently .
5	

8.2.3 Setting the operation point manually

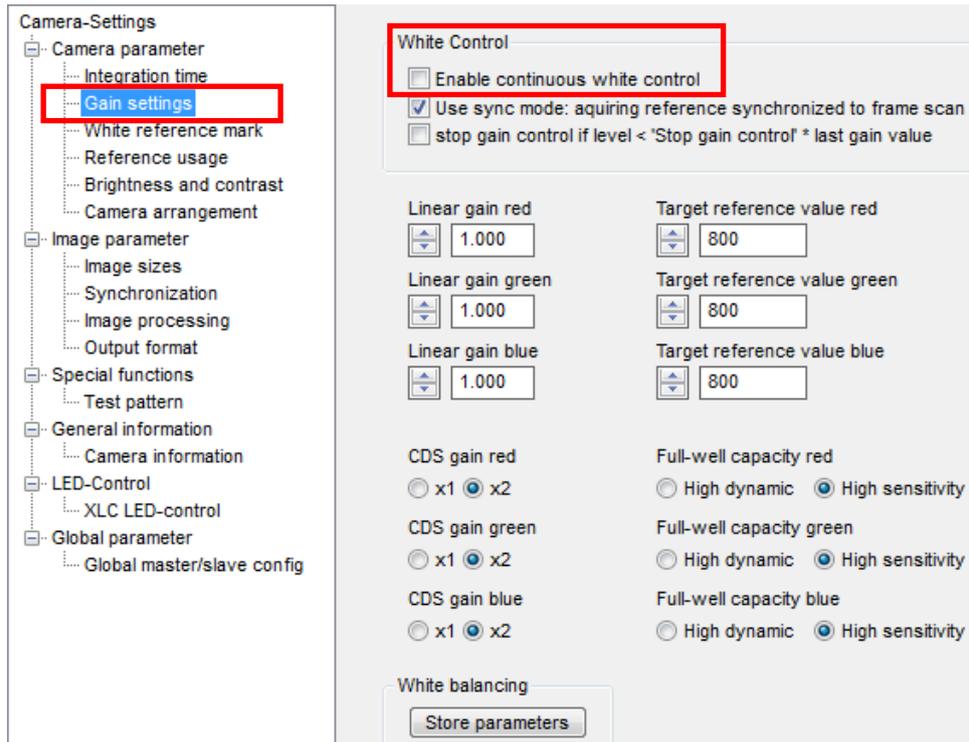
Manual operating point setting serves to determine the area which is viewed by the allPIXA wave camera for carrying out the shading correction.

Gain and reference settings

Continuous white control must be disabled:

- On the **Gain settings** page check that the **Enable continuous white control** check box is cleared.

1



Camera-Settings

- Camera parameter
 - Integration time
 - Gain settings**
 - White reference mark
 - Reference usage
 - Brightness and contrast
 - Camera arrangement
- Image parameter
 - Image sizes
 - Synchronization
 - Image processing
 - Output format
- Special functions
 - Test pattern
- General information
 - Camera information
- LED-Control
 - XLC LED-control
- Global parameter
 - Global master/slave config

White Control

- Enable continuous white control
- Use sync mode: acquiring reference synchronized to frame scan
- stop gain control if level < 'Stop gain control' * last gain value

Linear gain red: 1.000 Target reference value red: 800

Linear gain green: 1.000 Target reference value green: 800

Linear gain blue: 1.000 Target reference value blue: 800

CDS gain red: x1 x2 Full-well capacity red: High dynamic High sensitivity

CDS gain green: x1 x2 Full-well capacity green: High dynamic High sensitivity

CDS gain blue: x1 x2 Full-well capacity blue: High dynamic High sensitivity

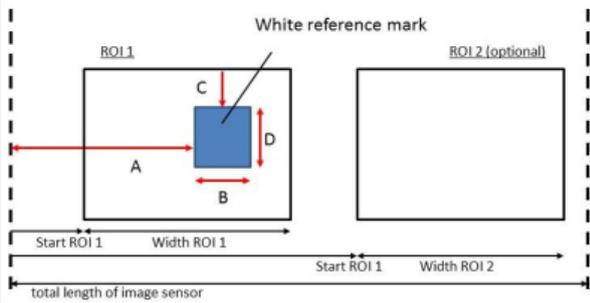
White balancing

Store parameters

Selection and adjustment of the white reference mark position

Camera-Settings

- Camera parameter
 - Integration time
 - Gain settings
 - White reference mark**
 - Reference usage
 - Brightness and contrast
 - Camera arrangement
- Image parameter
 - Image sizes
 - Synchronization
 - Image processing
 - Output format
- Special functions
 - Test pattern
 - Tracing
 - Register edit
- General information
 - Camera information
- LED-Control
 - XLC LED-control



White reference mark

ROI 1 ROI 2 (optional)

Start ROI 1 Width ROI 1 Start ROI 1 Width ROI 2

total length of image sensor

A = First absolute pixel of white reference
 B = Number of pixel for white reference
 White reference mark could be inside or outside of a ROI
 C = First image line for white reference (may be negative),
 only used if *white control mode* is set to „sync mode“
 D = Number of image lines for white reference

First absolute pixel of white reference (A) **A**

Number of pixels for white reference (B) **B**

First image line for the white reference (C) **C**

Number of image lines for the white reference (D) **D**

Number of reference samples for white reference

Show white reference border
 Display white reference borders in the image

2

- On the **White reference mark** page, specify the parameters **A** to **D** for the position and size of the white reference mark. It should be at the brightest region of the image. Often this will be the center of the image.
- To check your parameter settings, you can temporarily select the **Display white reference borders in the image** check box.

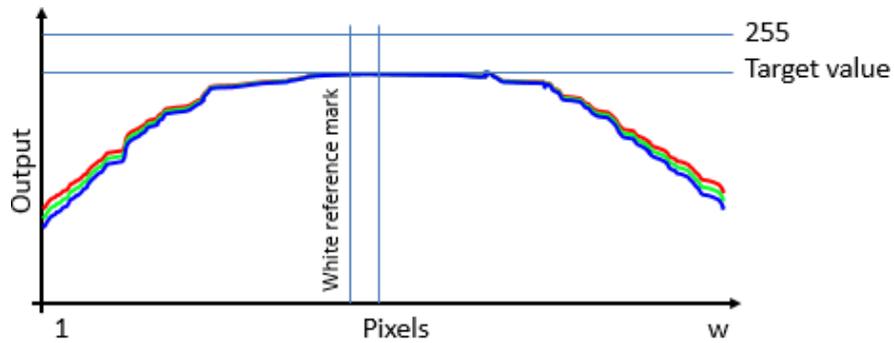
3

- Click **Transfer setting to camera**  (or press **F9**).
 Current camera parameters are saved non-permanently in the camera.

Setting of Target White Reference Values (Video Levels)

- On the tree view, click **Gain settings**.
- Set the **Target reference value** a for the colors.
- On the toolbar, click **Transfer setting to camera**  .

The target video levels must be set in such a way that the brightest image points are set below the saturation point. Take notice that the brightest scanned reference should not bring the AD converter to saturation. If the objects are brighter than the current white reference to be scanned during subsequent operation, the distance to saturation must be increased by this ratio (max. = 255 - the max. dark value of the offset reference at the white reference mark area).



Use the "Actual reference values" displayed on the right as a starting point.

4

Target white reference settings.

Current white reference levels

Camera-Settings

- [-] Camera parameter
 - Integration time
 - Gain settings
 - White reference mark
 - Reference usage
 - Brightness and contrast
 - Camera arrangement
- [-] Image parameter
 - Image sizes
 - Synchronization
 - Image processing
 - Output format
- [-] LED illumination control
 - LED flash control
- [-] Special functions
 - Test pattern
 - Tracing
 - Register edit
- [-] General information
 - Camera information
- [-] LED-Control
 - XLC LED-control
- [-] Global parameter
 - Global master/slave config

White Control

Enable continuous white control Set gain control stop factor

Use sync mode: acquiring reference synchronized to frame scan

stop gain control if level < 'Stop gain control' * last gain value

Linear gain red a

Linear gain green

Linear gain blue

Target reference value red

Target reference value green

Target reference value blue

CDS gain red x1 x2

CDS gain green x1 x2

CDS gain blue x1 x2

Full-well capacity red High dynamic High sensitivity

Full-well capacity green High dynamic High sensitivity

Full-well capacity blue High dynamic High sensitivity

White balancing

Actual reference value red

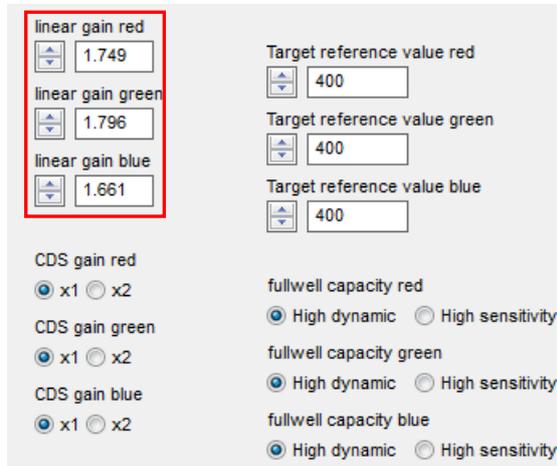
Actual reference value green

Actual reference value blue

Note: For a mono-camera, instead of three parameters for the different colors, there is only a single parameter, whose name ends with `white`.

Check/re-adjust video levels

- On the toolbar, click **Refresh current camera parameters** .
- Check the **Linear gain** values. They should be in a range between 0.5 and 50:



- If gain values are too high, select **x2** at the **CDS gain** options, select **High sensitivity** at the **Full well capacity** options, or adjust the **Target reference value** parameters.

Note: For a mono-camera, instead of three parameters for the different colors, there is only a single parameter, whose name ends with white.

- If you modified parameters, click **Transfer setting to camera**  on the toolbar, and then start again with step 5.
- If you receive a satisfying result, proceed to **Step 6**.

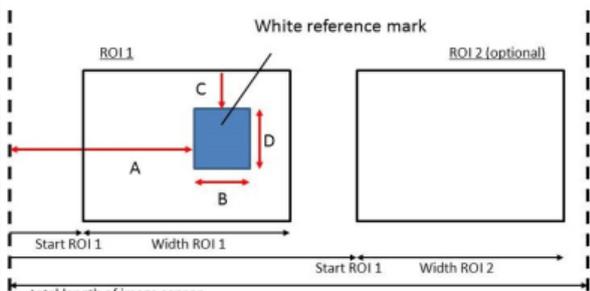
Disable display of white reference mark:

- If you selected the **Display white reference borders in the image** a check box, clear the check box:

6

Camera-Settings

- [-] Camera parameter
 - Integration time
 - Gain settings
 - White reference mark
 - Reference usage
 - Brightness and contrast
 - Camera arrangement
- [-] Image parameter
 - Image sizes
 - Synchronization
 - Image processing
 - Output format
- [-] Special functions
 - Test pattern
 - Tracing
 - Register edit
- [-] General information
 - Camera information
- [-] LED-Control
 - XLC LED-control



White reference mark

ROI 1 ROI 2 (optional)

A = First absolute pixel of white reference
 B = Number of pixel for white reference
 White reference mark could be inside or outside of a ROI
 C = First image line for white reference (may be negative),
 only used if *white control mode* is set to „sync mode“
 D = Number of image lines for white reference

First absolute pixel of white reference (A)

Number of pixels for white reference (B)

First image line for the white reference (C)

Number of image lines for the white reference (D)

Number of reference samples for white reference

Show white reference border a

Display white reference borders in the image

7

Transfer settings to the camera:

- On the toolbar, click **Transfer setting to camera** , or press **F9**.
The current camera parameters are saved non-permanently in the camera.

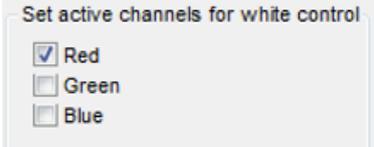
8

Save settings:

- On the toolbar, click **Burn setting permanently** , or press **F10**.
The current camera parameters are now saved permanently in the camera.

8.2.4 Independent color channel white balancing

For special tasks a special illumination setup may be necessary. If an inspection task is performed for which in each color channel different information is evaluated by using a special illumination per channel, the balancing procedure must be performed individually per channel.

1	<p>Prepare the camera for the operation:</p> <ul style="list-style-type: none"> • Make sure that a valid black-level correction is enabled (see section 9.5.1).
2	<p>Select color channel:</p> <ul style="list-style-type: none"> • On the tree view, click Gain settings and at Set active channels for white control select only the Red check box: 
3	<p>Prepare the setup for the operation</p> <ul style="list-style-type: none"> • Turn on the illumination for the red channel. • Put the appropriate calibration chart in front of the camera.
4	<p>Perform balancing:</p> <ul style="list-style-type: none"> • Perform white balancing according to section 8.2.
5	<p>Repeat for the other channels</p> <ul style="list-style-type: none"> • Repeat steps 2 to 4 for the green and blue color channels.
6	<p>Transfer settings to the camera:</p> <ul style="list-style-type: none"> • Click Transfer setting to camera  or press F9. <p>The current camera parameters are saved non-permanently in the camera.</p>
7	<p>Save settings:</p> <ul style="list-style-type: none"> • Click Burn setting permanently , or press F10. <p>The current camera parameters are now saved permanently in the camera.</p>

For information about an individual offset (shading) correction on each color channel, see section 8.4.4.

8.3 Generating black (offset) reference

To generate a black (offset) reference, click **Start reference wizard**  on the toolbar.

You have three options to generate a black reference:

1) Create a black (offset) reference internally (8.3.1)

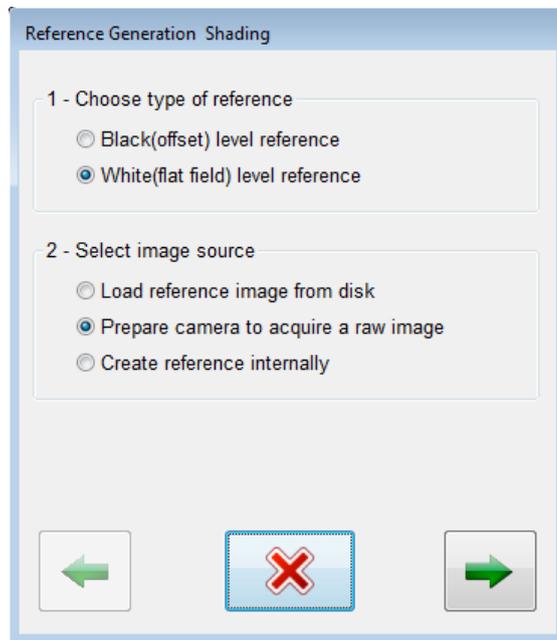
Use this option if you want to perform offset correction directly inside the camera.

2) Use a stored black (offset) level reference image (8.3.2)

Use this option if you have a stored black-level reference image on your hard disk.

3) Prepare camera to acquire a black(offset) reference (8.3.3)

Use this option if you do not have a black-level reference image and want to generate a black reference with an image acquisition software. You can directly do an offset correction after grabbing the black reference. The wizard guides you through this process.



8.3.1 Create a black-level (offset) reference internally

Creation of a black-level reference is only necessary during commissioning or if the gain values are changed considerably.

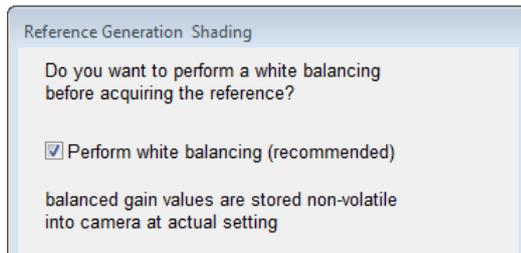
1	Get the camera to the desired working point
	<p>Prepare the camera:</p> <ul style="list-style-type: none"> • Place a white reference in front of the camera • Check lighting and focusing • On the Gain settings page, clear the Enable continuous white control check box. • On the toolbar, click Transfer setting to camera .
2	Start the reference wizard
	<ul style="list-style-type: none"> • On the toolbar, click Start reference wizard .
3	Select reference type and image source
	<ul style="list-style-type: none"> • Click Black (offset) level reference. • Click Create reference internally: <div style="border: 1px solid #ccc; padding: 10px; margin: 10px 0;"> <p>Reference Generation Shading</p> <p>1 - Choose type of reference</p> <p><input checked="" type="radio"/> Black(offset) level reference</p> <p><input type="radio"/> White(flat field) level reference</p> <p>2 - Select image source</p> <p><input type="radio"/> Load reference image from disk</p> <p><input type="radio"/> Prepare camera to acquire a raw image</p> <p><input checked="" type="radio"/> Create reference internally</p> </div> <ul style="list-style-type: none"> • Click Next .

Optional: White balancing

Decide whether you want to perform white balancing:

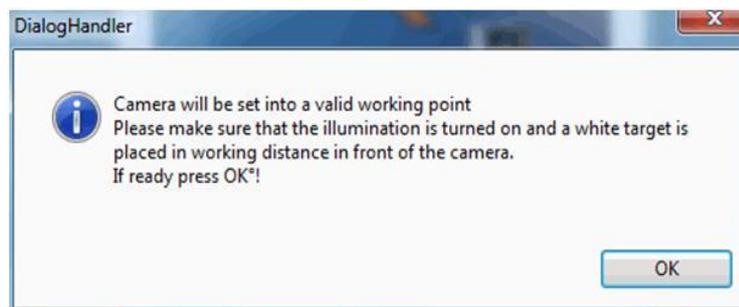
To achieve the best performance / image quality, it is recommended to perform white balancing. By performing a white balancing, the camera gain values are set correctly to acquire the desired image for a black-level reference.

- If you don't want to perform white balancing, clear the **Perform white balancing** check box and continue with Step 5.



4

- Click **Next**  . The following dialog box is shown:

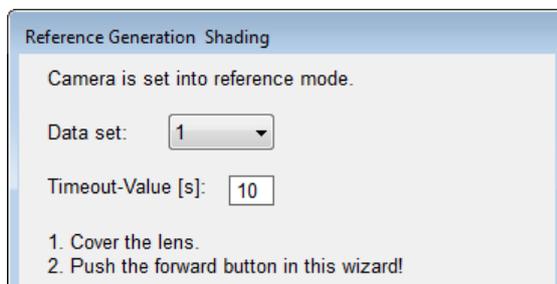


- Follow the instructions in the message box, and then click **OK**.

Note: Changes that have not been saved at this point get lost.

Start black-level correction:

- In the **Data set** list, select the data set, in which the generated offset reference should be stored:



5

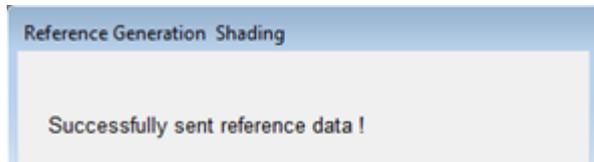
- In the **Timeout value** box, enter the timeout value in seconds.
- Cover the lens so that the sensor is completely dark.

- Click **Next**  .

Wait for result

6

A progress bar is shown while the reference is created and stored. When it has finished successfully, the wizard shows the following message:

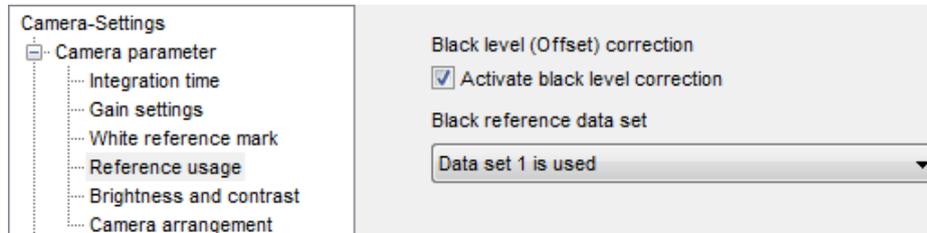


- To close the wizard and to restore the camera settings, click **Next** .

Activate black-level correction and check the result on the image.

7

- On the toolbar, click **Show settings** , and then click **Reference usage**.
- To check black-level correction, select the **Activate black-level correction** check box and check that the just updated data set is used:



At least a few pixels should have a value greater than 0 (for example 1 or 2) in the black image with activated black-level correction and covered lens. Otherwise, (if **all** pixels are 0) the image is over-compensated, and you should repeat the steps for reference generation.

- Click **Transfer setting to camera**  to save the setting to volatile memory.
- You may proceed to section 8.4 to generate a shading reference.

8.3.2 Use a stored black (offset) level reference image

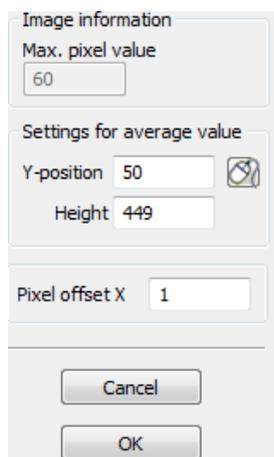
The creation of a black-level reference is only necessary if the gain values are changed considerably.

1	Start the reference wizard
2	<ul style="list-style-type: none"> On the toolbar, click Start reference wizard  .
2	<p>Select reference type and image source</p> <ul style="list-style-type: none"> Click Black (offset) level reference. Click Load reference image from disk: <div data-bbox="384 741 983 1164" style="border: 1px solid #ccc; padding: 5px; margin: 10px 0;"> <p>Reference Generation Shading</p> <p>1 - Choose type of reference</p> <p><input checked="" type="radio"/> Black(offset) level reference</p> <p><input type="radio"/> White(flat field) level reference</p> <p>2 - Select image source</p> <p><input checked="" type="radio"/> Load reference image from disk</p> <p><input type="radio"/> Prepare camera to acquire a raw image</p> <p><input type="radio"/> Create reference internally</p> </div> <ul style="list-style-type: none"> Click Next  .
3	<p>Select offset reference image</p> <ul style="list-style-type: none"> Click Select file: <div data-bbox="384 1435 983 1675" style="border: 1px solid #ccc; padding: 5px; margin: 10px 0;"> <p>Reference Generation Shading</p> <p>1 - Select reference image</p> <p style="text-align: right;">C:\temp\BlackRef.tif</p> <p style="text-align: center;"><input type="button" value="Select file"/></p> </div> <ul style="list-style-type: none"> In the file dialog box, select the reference file, and click Open. Click Next  .

Define the area where the reference values should be calculated

4

The dialog box shows the reference image. On the right side, the following parameters are shown:



- At the **Y position** box and the **Height** box, specify the area which should be used to calculate the reference values.

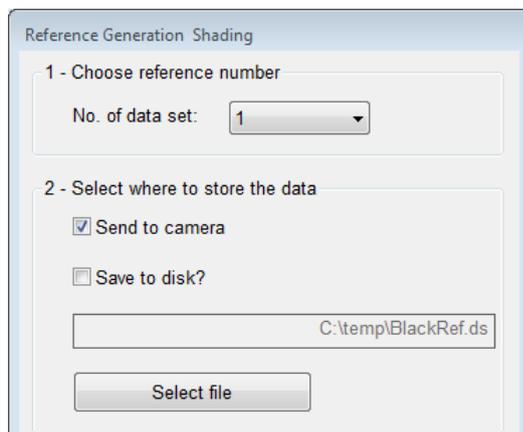
Use at least 100 lines for calculation of the reference values to eliminate noise. The values used for the reference are calculated by averaging each column in the selected area.

- Click **OK**.

Save reference data

5

- In the **No. of data set** list, click the number of the data set in which the reference data should be stored:



- If the reference data should not be sent to the camera, clear the **Send to camera** check box.
- To save the reference data to a file as backup, select the **Save to disk** check box, and then click **Select file** to specify folder and file name and then click **Next** .

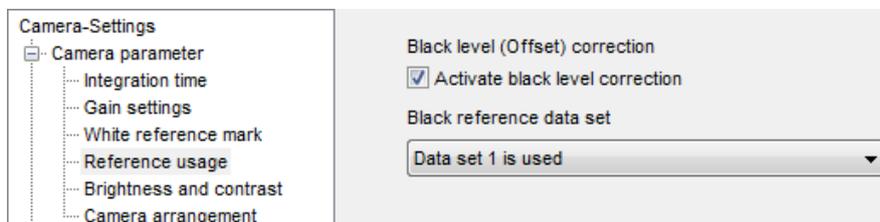
If the reference data are sent to the camera, a progress bar is shown, and the camera is reset afterward to make sure that the initial settings are again active. The last used setting is activated automatically.

- Again click **Next**  to close the wizard.

Activate black-level correction and check the result on the image.

6

- On the toolbar, click **Show settings** , and then click **Reference usage**.
- To check black-level correction, select the **Activate black-level correction** check box and check that the just updated data set is used:



At least a few pixels should have a value greater than 0 (for example 1 or 2) in the black image with activated black-level correction and covered lens. Otherwise, (if **all** pixels are 0) the image is over-compensated, and you should repeat the steps for reference generation.

- Click **Transfer setting to camera**  to save the setting to volatile memory.
- You may proceed to section 8.4 to generate a shading reference.

8.3.3 Prepare camera to acquire a black (offset) reference

The creation of a black-level reference is only necessary during commissioning or if the gain values are changed considerably.



Make sure that all changes made to your current setting are saved permanently to the camera before using the Reference wizard. Otherwise, all changes get lost!

Get the camera to the desired working point

1

- Place a white reference in front of the camera.
- Check lighting and focusing.
- Disable continuous white control.
- Save the parameters to the camera.

Start the reference wizard

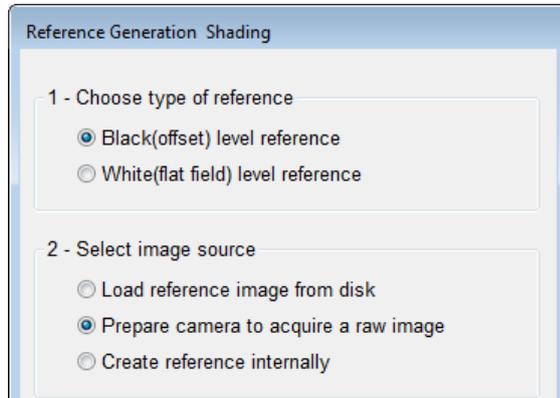
2

- On the toolbar, click **Start reference wizard** .

Select reference type and image source

3

- Click **Black (offset) level reference**.
- Click **Prepare camera to acquire a raw image**:



- Click **Next**  .

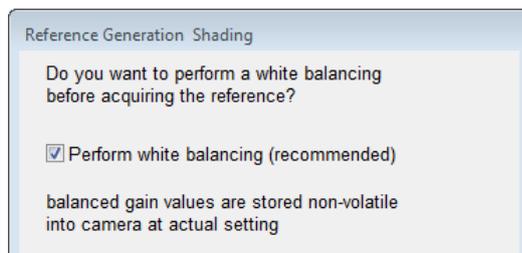
Optional: White balancing

Decide whether you want to perform a white balancing:

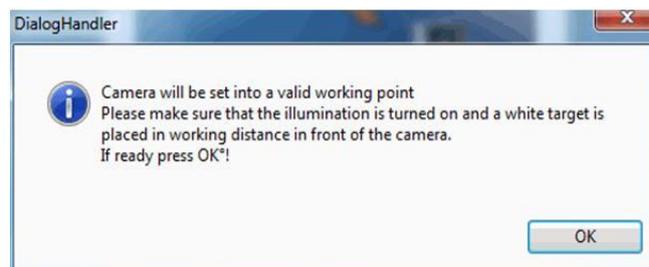
To achieve the best performance / image quality, it is recommended to perform white balancing. By performing a white balancing, the camera gain values are set correctly to acquire the desired image for a black-level reference.

- If you don't want to perform white balancing, clear the **Perform white balancing** check box and continue with Step 5.

4



- Click **Next**  . The following dialog box is shown:



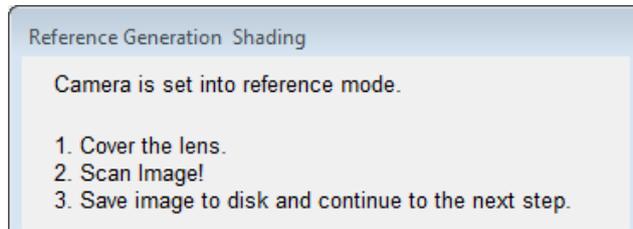
- Follow the instructions in the message box, and then click **OK**.

Note: Changes that have not been saved at this point get lost.

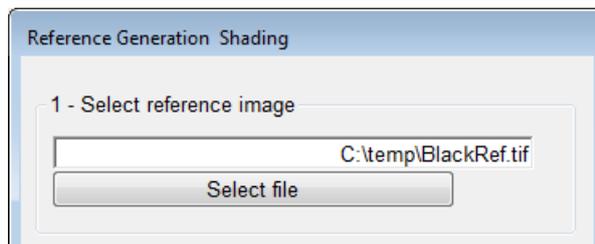
Acquire a black reference:

5

- Perform the steps shown on the next page of the wizard:



- Cover the lens so that there is no light on the sensor.
- Grab an image using the appropriate acquisition software.
- Save the image to a file, and then click **Next** .
- On the next page of the wizard, click **Select file**:

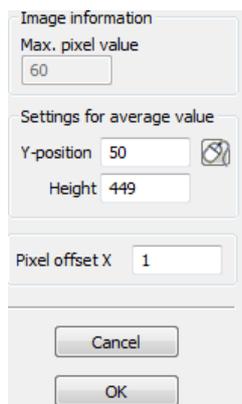


- Select the reference file in the appearing file dialog box, and then click **OK**.
- Click **Next** .

Define the area where the reference values should be calculated

6

The dialog box shows the reference image. On the right side, the following parameters are shown:

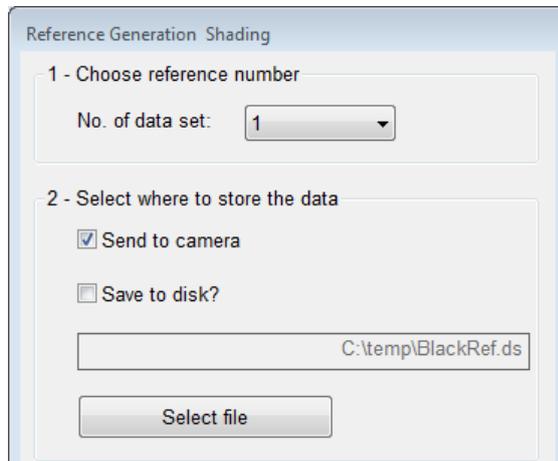


- At the **Y position** box and the **Height** box, specify the area which should be used to calculate the reference values.
Use at least 100 lines for calculation of the reference values to eliminate noise. The values used for the reference are calculated by averaging each column in the selected area.
- Click **OK**.

Save reference data

7

- In the **No. of data set** list, click the number of the data set in which the reference data should be stored:



The dialog box titled "Reference Generation Shading" contains two sections:

- 1 - Choose reference number:** A dropdown menu labeled "No. of data set:" with the value "1" selected.
- 2 - Select where to store the data:**
 - A checked checkbox labeled "Send to camera".
 - An unchecked checkbox labeled "Save to disk?".
 - A text field containing the path "C:\temp\BlackRef.ds".
 - A "Select file" button.

- If the reference data should not be sent to the camera, clear the **Send to camera** check box.
- To save the reference data to a file as backup, select the **Save to disk** check box, and then click **Select file** to specify folder and file name.

- Click **Next** .

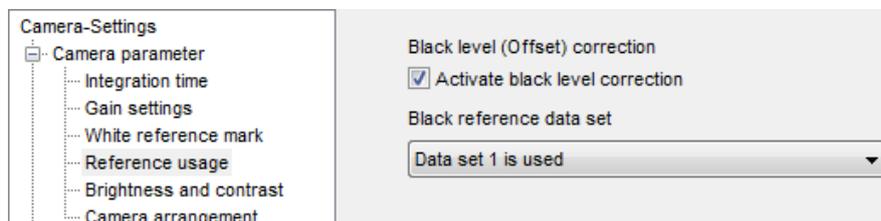
If the reference data are sent to the camera, a progress bar is shown, and the camera is reset afterward to make sure that the initial settings are again active. The last used setting is activated automatically.

- Again click **Next**  to close the wizard.

Activate black-level correction and check the result on the image.

8

- On the toolbar, click **Show settings** , and then click **Reference usage**.
- To check black-level correction, select the **Activate black-level correction** check box and check that the just updated data set is used:



The "Camera-Settings" dialog box shows a tree view on the left with "Reference usage" selected. The right pane shows:

- Black level (Offset) correction
 - Activate black level correction
- Black reference data set
 - Dropdown menu: "Data set 1 is used"

At least a few pixels should have a value greater than 0 (for example 1 or 2) in the black image with activated black-level correction and covered lens. Otherwise, (if **all** pixels are 0) the image is over-compensated, and you should repeat the steps for reference generation.

- Click **Transfer setting to camera**  to save the setting to volatile memory.
- You may proceed to section 8.4 to generate a shading reference.

8.4 Generating shading/ flat-field reference

To generate a shading / flat-field reference, click **Start reference wizard**  on the toolbar.

You have three options to generate a shading reference:

1) Create a flat-field reference internally (8.4.1)

Use this option if you want to perform shading/flat-field correction directly inside the camera.

2) Use a stored flat-field reference image (8.4.2)

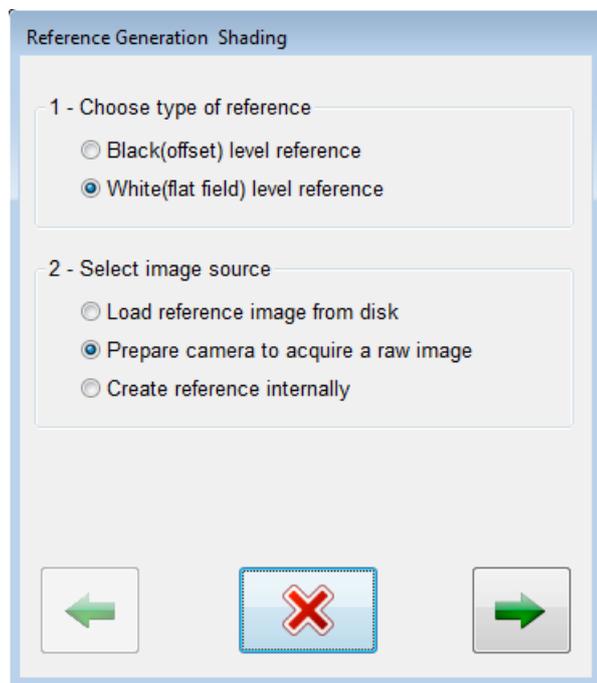
Use this option if you have a stored white/shading reference image on your hard disk.

This option should also be used if you need to use separate images for the single color channels (for example if you work with different illumination setups, flash illumination, etc.)

3) Prepare camera to acquire a flat-field reference (8.4.3)

Use this option if you do not have a white-level reference image and want to generate a white/shading reference with an image acquisition software. You can directly perform an offset correction after grabbing the black-level reference. The wizard guides you through this process.

NOTE For option 1 and 3 black-level (offset) correction is always active during reference generation, even if it is switched off in the current settings.



8.4.1 Create flat-field reference internally

Creation of a flat-field reference is only necessary during commissioning or if the gain values are changed considerably.

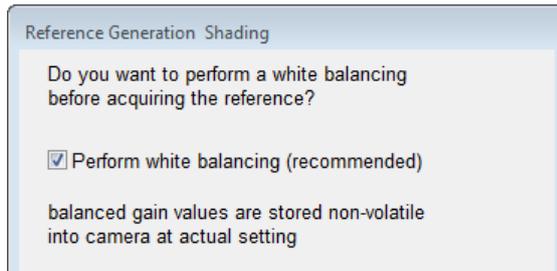
1	Get the camera to the desired working point
	<ul style="list-style-type: none"> Place a white reference in front of the camera Check the lighting and focusing Disable continuous white control Save the parameters to the camera Optional: Activate black-level correction Optional: Perform white-balancing <p>Note: If the white reference target is placed in the best focus plane of the camera, any features on its surface (for example dust, scratches) end up in the calibration profile of the camera. To avoid this if you use a static (non-moving) white reference target, use a clean white ceramic or plastic material, not paper. Ideally, the white object should move during the calibration process because the movement results in an averaging process and the camera diminishes the effects on any small variation in the white reference. If this is not possible, you could place the reference target a little bit out of the best focus plane, but take care that the illumination of the target doesn't change too much.</p>
2	Start the reference wizard
	<ul style="list-style-type: none"> On the toolbar, click Start reference wizard .
3	Select reference type and image source
	<ul style="list-style-type: none"> Click White (flat-field) level reference. Click Create reference internally: <div style="border: 1px solid #ccc; padding: 10px; margin: 10px 0;"> <p style="text-align: center; margin: 0;">Reference Generation Shading</p> <p>1 - Choose type of reference</p> <p><input type="radio"/> Black(offset) level reference</p> <p><input checked="" type="radio"/> White(flat field) level reference</p> <hr/> <p>2 - Select image source</p> <p><input type="radio"/> Load reference image from disk</p> <p><input type="radio"/> Prepare camera to acquire a raw image</p> <p><input checked="" type="radio"/> Create reference internally</p> </div> <ul style="list-style-type: none"> Click Next .

Optional: White balancing

Decide whether you want to perform a white balancing:

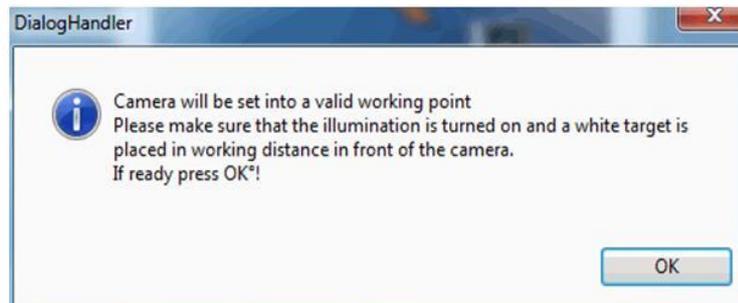
To achieve the best performance / image quality, it is recommended to perform white balancing. By performing a white balancing, the camera gain values are set correctly to acquire the desired image for a black-level reference.

- If you don't want to perform white balancing, clear the **Perform white balancing** check box and continue with Step 5.



4

- Click **Next**  . The following dialog box is shown:

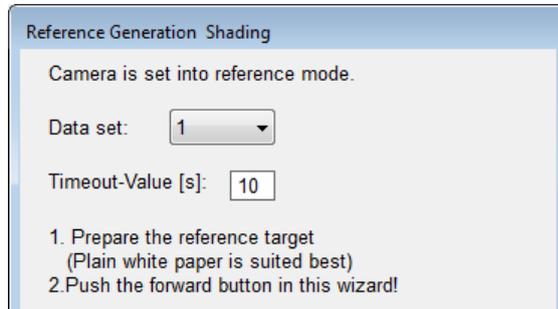


- Follow the instructions in the message box, and then click **OK**.

Note: Changes that have not been saved at this point get lost.

Start the shading correction:

- In the **Data set** list, select the data set, in which the generated offset reference should be stored:



5

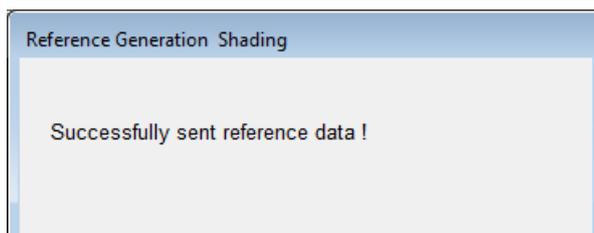
- In the **Timeout value** box, enter the timeout value in seconds.
- Move the target slightly or defocus the lens to avoid streaky images, if necessary.

Note: Any features on the target surface (for example dust, scratches) end up in the calibration profile of the camera. To avoid this if you use a static (non-moving) white reference target, use a clean white ceramic or plastic material, not paper. Ideally, the white object should move during the calibration process because the movement results in an averaging process and the camera diminishes the effects on any small variation in the white reference.

- Click **Next** .

Wait for result

A progress bar is shown while the reference is created and stored. When it has finished successfully, the wizard shows the following message:

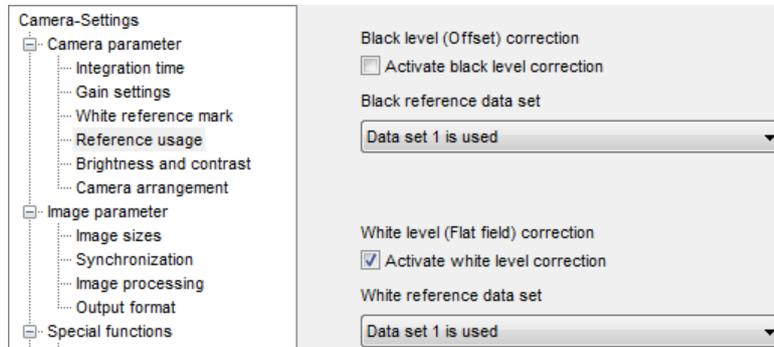


6

- To close the wizard and to restore the camera settings, click **Next** .

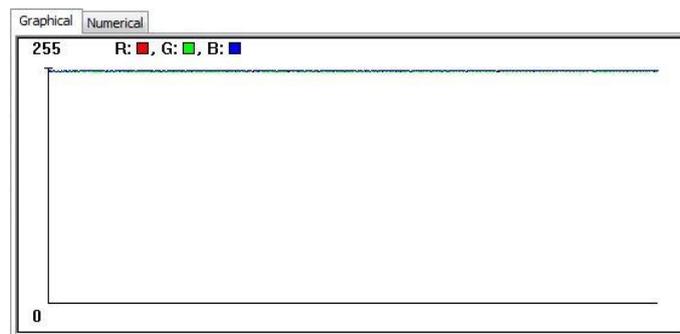
Activate shading correction and check the result on the image.

- On the toolbar, click **Show settings** , and then click **Reference usage**.
- To check white-level correction, select the **Activate white-level correction** check box and check that the just updated data set is used:



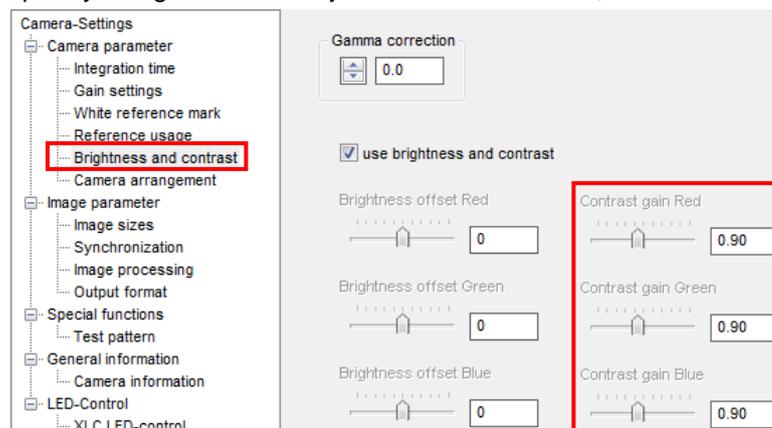
- Click **Transfer setting to camera**  to save the setting to volatile memory.

Brightness of the newly scanned white balancing reference should be exactly at the saturation limit. (255 @8Bit).



7

Note: At a later point, the image can be "desaturated" to a target value of, for example, 230 for a white paper by using a contrast adjustment of $230/255=0,90$.



Note: For the mono-camera, the three parameters for the different colors are replaced by a single parameter whose name ends with *white*.

Save the setting

8

- On the toolbar, click **Burn setting permanently** , or press **F10** to save the setting permanently into the camera.

8.4.2 Use a stored flat-field reference image

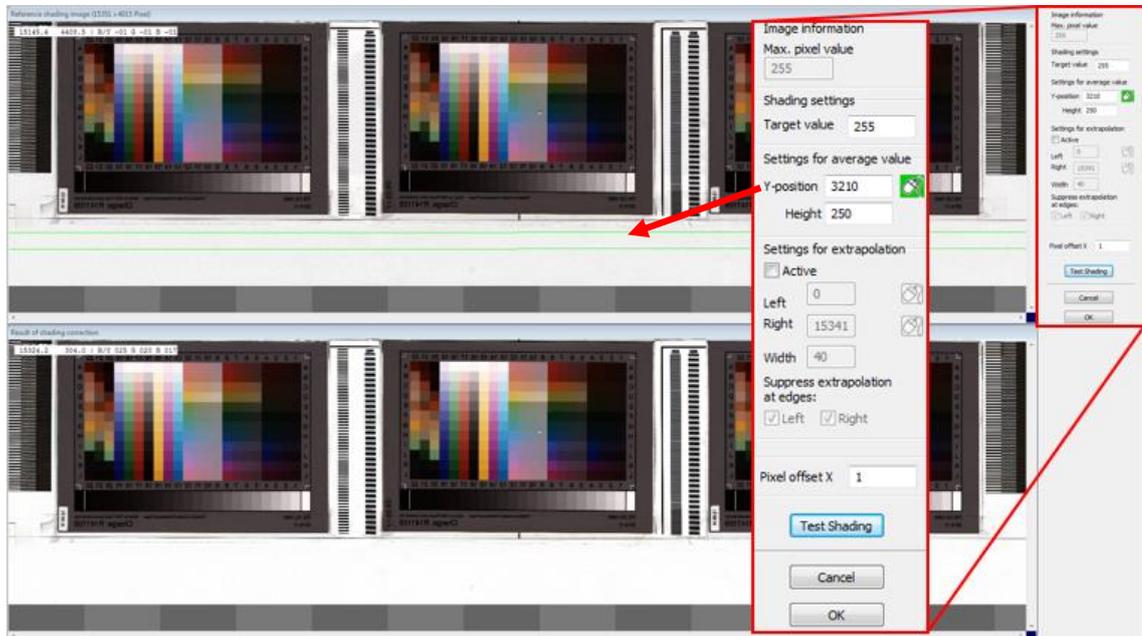
Creation of a flat-field reference is only necessary during commissioning or if the gain values are changed considerably.

Note: If the white reference target is placed in the best focus plane of the camera, any features on its surface (for example dust, scratches) end up in the calibration profile of the camera. To avoid this if you use a static (non-moving) white reference target, use a clean white ceramic or plastic material, not paper. Ideally, the white object should move during the calibration process because the movement results in an averaging process and the camera diminishes the effects on any small variation in the white reference. If this is not possible, you could place the reference target a little bit out of the best focus plane, but take care that the illumination of the target doesn't change too much.

1	Start the reference wizard
2	<ul style="list-style-type: none"> On the toolbar, click Start reference wizard .
2	<p>Choose reference type and source</p> <ul style="list-style-type: none"> Click White (flat-field) level reference. Click Load reference image from disk: <div style="border: 1px solid #ccc; padding: 10px; margin: 10px 0;"> <p>Reference Generation Shading</p> <p>1 - Choose type of reference</p> <p><input type="radio"/> Black(offset) level reference</p> <p><input checked="" type="radio"/> White(flat field) level reference</p> <p>2 - Select image source</p> <p><input checked="" type="radio"/> Load reference image from disk</p> <p><input type="radio"/> Prepare camera to acquire a raw image</p> <p><input type="radio"/> Create reference internally</p> </div> <ul style="list-style-type: none"> Click Next .
3	<p>Choose white reference image</p> <ul style="list-style-type: none"> Click Select file: <div style="border: 1px solid #ccc; padding: 10px; margin: 10px 0;"> <p>Reference Generation Shading</p> <p>1 - Select reference image</p> <p>C:\Pictures\ShadingRef.tif</p> <p>Select file</p> </div> <ul style="list-style-type: none"> In the file dialog box, select the reference file, and click Open. Click Next . <p>Note: For special applications, the three color levels can also originate from various images. In this case select the check box. The page then changes, and you can select separate files for the three color channels.</p>

Define the area where the reference values should be calculated

Sample image:



4

- Specify the area from which the reference values should be calculated: in the **Y position** box, enter the number of the first line, in the **Height** box the number of lines to be used. Use at least 100 lines for calculation of the reference values to eliminate noise. The values used for the reference are calculated by averaging each column in the selected area. Start and end position are indicated by green lines on the image (marked by the red arrow on the image above).
- If the white reference target covers the full scanning width, click **OK**, and then proceed with **Step 5**.
- If the white reference target does not cover the full scanning width, in the **Settings for extrapolation** area select the **Active** check box.
- Specify the areas for extrapolation: in the **Left** and **Right** boxes, enter the start positions, and in the **Width** box the width as number of pixels. (The start position of the left area will be 0 in most cases.)

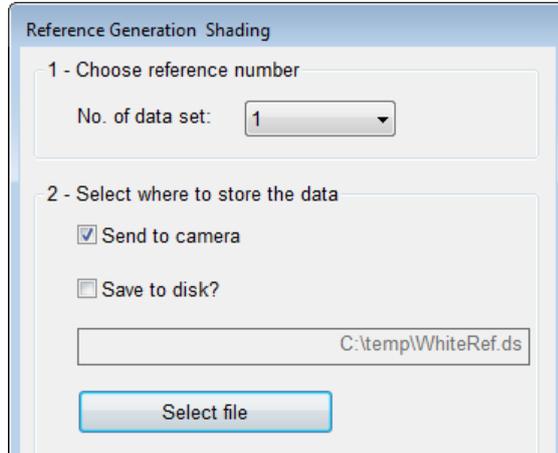
Instead of entering values for the start positions, you can click  and then click the respective start position on the image.

Start and end position are then indicated by red lines on the image. The data within this area are used to determine a gradient, which is used to extend the shading data to the image borders.

- Click **OK**, and then proceed with **Step 5**.

Saving reference data

- In the **No. of data set** list, click the number of the data set in which the reference data should be stored:



When you activate white-level correction in step 6, you must select the same data set number.

- To save the reference data to a file as backup, select the **Save to disk** check box, and then click **Select file** to specify folder and file name.

- Click **Next** .

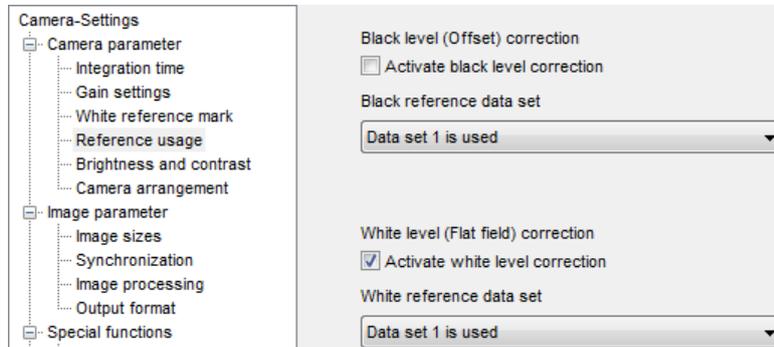
If the reference data are sent to the camera, a progress bar is shown, and the camera is reset afterward to make sure that the initial settings are again active. The last used setting is activated automatically.

- Again click **Next**  to close the wizard.

5

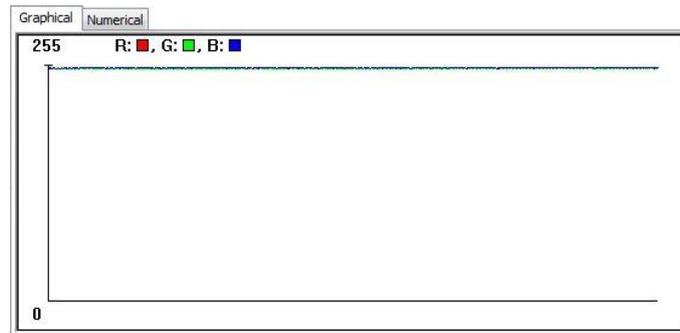
Activate shading correction and check the result in the image.

- On the toolbar, click **Show settings** , and then click **Reference usage**.
- To check white-level correction, select the **Activate white level correction** check box and in the **White reference data set list**, select the data set, in which you stored the data in step 5.

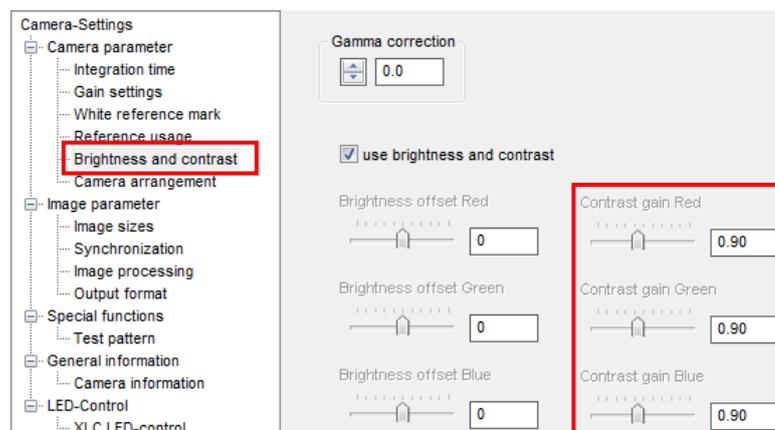


- Click **Transfer setting to camera**  to save the setting to volatile memory.

Brightness of the newly scanned white balancing reference should be exactly at the saturation limit. (255 @8Bit).



Note: At a later point, the image can be "desaturated" to a target value of, for example, 230 for a white paper by a using a contrast adjustment of $230/255=0,90$.



Note: For the mono-camera, the three parameters for the different colors are replaced by a single parameter whose name ends with *white*.

Save the setting

7

- On the toolbar, click **Burn setting permanently** , or press **F10** to save the setting permanently into the camera.

8.4.3 Prepare camera to acquire a flat-field reference

Creation of a flat-field reference is only necessary during commissioning or if the gain values are changed considerably.



Make sure that all changes made to your current setting are saved permanently to the camera before you use the Reference wizard. Otherwise, all changes get lost!

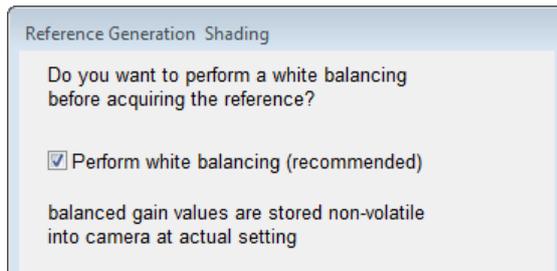
1	Get the camera to the desired working point
	<ul style="list-style-type: none"> Place a white reference in front of the camera Check the lighting and focusing Disable continuous white control Save the parameters to the camera Optional: Activate black-level correction Optional: Perform a white balancing <p>Note: If the white reference target is placed in the best focus plane of the camera, any features on its surface (for example dust, scratches) end up in the calibration profile of the camera. To avoid this if you use a static (non-moving) white reference target, use a clean white ceramic or plastic material, not paper. Ideally, the white object should move during the calibration process because the movement results in an averaging process and the camera diminishes the effects on any small variation in the white reference. If this is not possible, you could place the reference target a little bit out of the best focus plane, but take care that the illumination of the target doesn't change too much.</p>
2	Start the reference wizard
	<ul style="list-style-type: none"> On the toolbar, click Start reference wizard .
3	Select reference type and image source
	<ul style="list-style-type: none"> Click White (flat-field) level reference. Click Prepare camera to acquire a raw image: <div style="border: 1px solid #ccc; padding: 10px; margin: 10px 0;"> <p>Reference Generation Shading</p> <p>1 - Choose type of reference</p> <p><input type="radio"/> Black(offset) level reference</p> <p><input checked="" type="radio"/> White(flat field) level reference</p> <p>2 - Select image source</p> <p><input type="radio"/> Load reference image from disk</p> <p><input checked="" type="radio"/> Prepare camera to acquire a raw image</p> <p><input type="radio"/> Create reference internally</p> </div> <ul style="list-style-type: none"> Click Next .

Optional: White balancing

Decide whether you want to perform a white balancing:

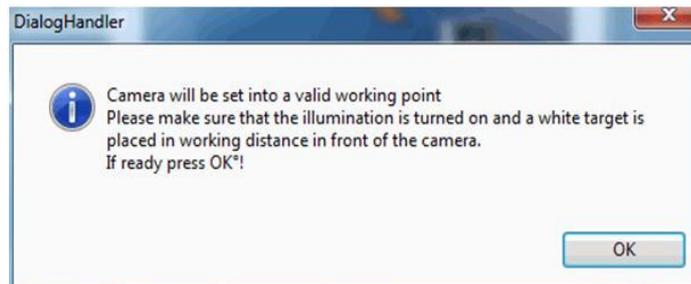
To achieve the best performance / image quality, it is recommended to perform white balancing. By performing a white balancing, the camera gain values are set correctly to acquire the desired image for a black-level reference.

- If you don't want to perform white balancing, clear the **Perform white balancing** check box and continue with Step 5.



4

- Click **Next**  . The following dialog box is shown:

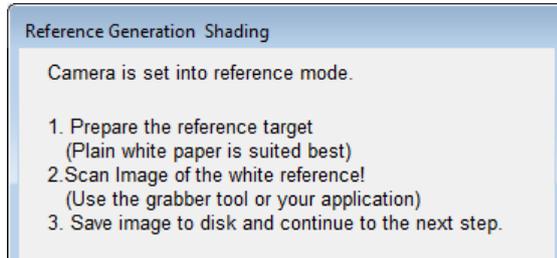


- Follow the instructions in the message box, and then click **OK**.

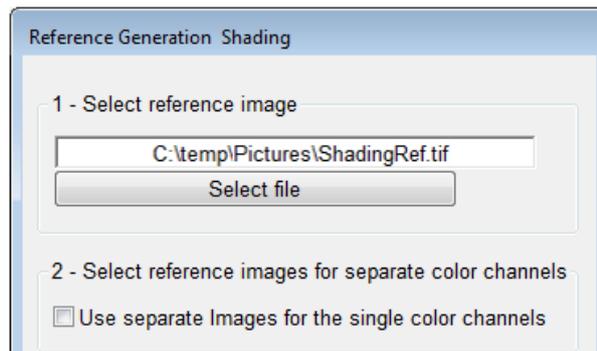
Note: Changes that have not been saved at this point get lost.

Acquire a shading reference:

- Perform the steps shown on the next page of the wizard:



- Prepare the reference target.
- Grab an image of the white reference target.
Preferably use a moving target to avoid wrong data due to dirt.
- Save the image to a file, and then click **Next** .
- On the next page of the wizard, click **Select file**:

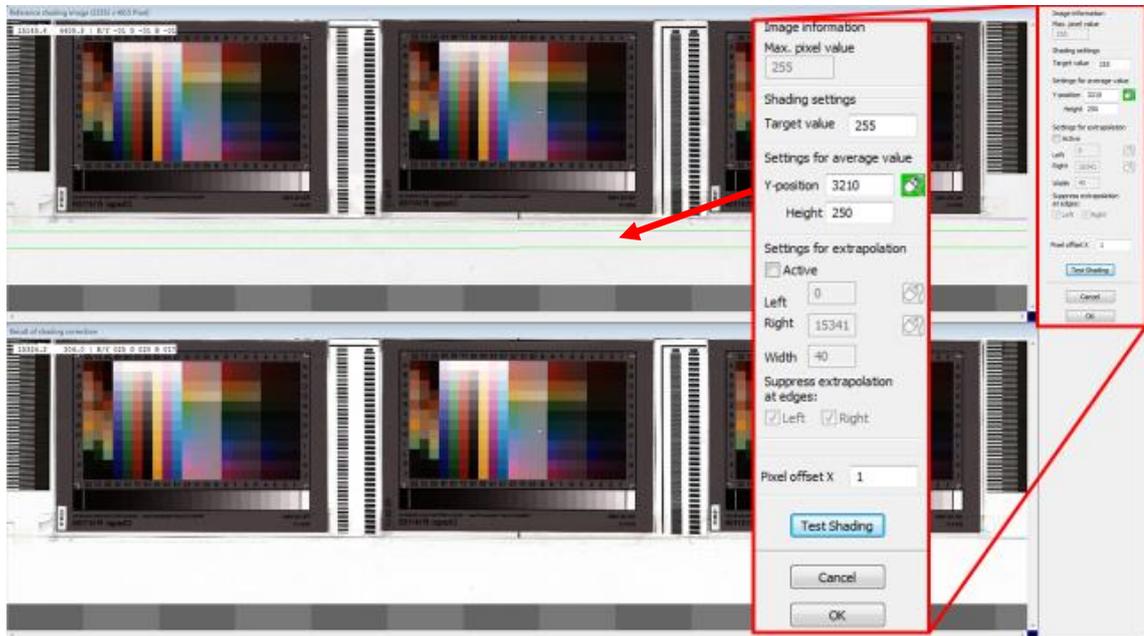


- Select the reference file in the appearing file dialog box, and then click **OK**.
- Click **Next** .

Note: For special applications the three color levels can also originate from various images. In this case select the **Use separate images for the single color channels** check box.

Define the area where the reference values should be calculated

Sample image:



6

- Specify the area from which the reference values should be calculated: in the **Y position** box, enter the number of the first line, in the **Height** box the number of lines to be used. Use at least 100 lines for calculation of the reference values to eliminate noise. The values used for the reference are calculated by averaging each column in the selected area. Start and end position are indicated by green lines on the image (marked by the red arrow on the image above).
- If the white reference target covers the full scanning width, click **OK**, and then proceed with **Step 5**.
- If the white reference target does not cover the full scanning width, in the **Settings for extrapolation** area select the **Active** check box.
- Specify the areas for extrapolation: in the **Left** and **Right** boxes, enter the start positions, and in the **Width** box the width as number of pixels. (The start position of the left area will be 0 in most cases.)

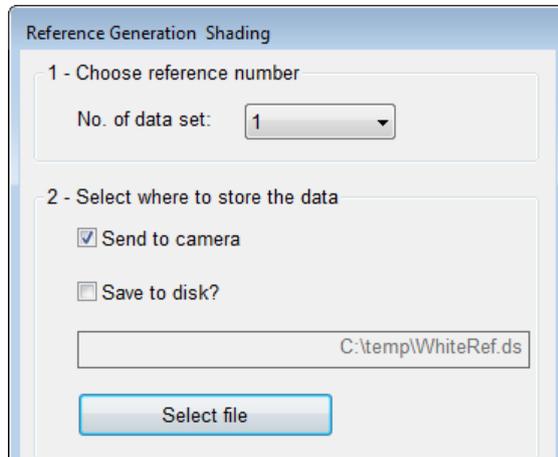
Instead of entering values for the start positions, you can click  and then click the respective start position on the image.

Start and end position are then indicated by red lines on the image. The data within this area are used to determine a gradient, which is used to extend the shading data to the image borders.

- Click **OK**, and then proceed with **Step 7**.

Save reference data

- In the **No. of data set** list, click the number of the data set in which the reference data should be stored:



When you activate white-level correction in step 8, you must select the same data set number.

- To save the reference data to a file as backup, select the **Save to disk** check box, and then click **Select file** to specify folder and file name.

- Click **Next** .

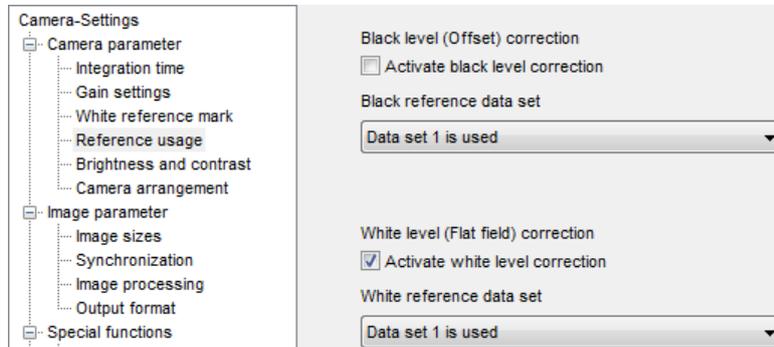
If the reference data are sent to the camera, a progress bar is shown, and the camera is reset afterward to make sure that the initial settings are again active. The last used setting is activated automatically.

- Again click **Next**  to close the wizard.

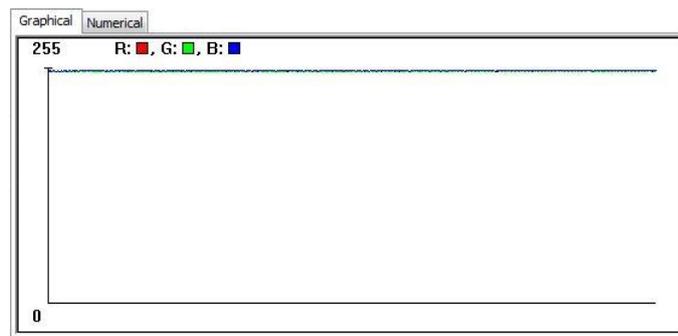
7

Activate shading correction and check the result on the image.

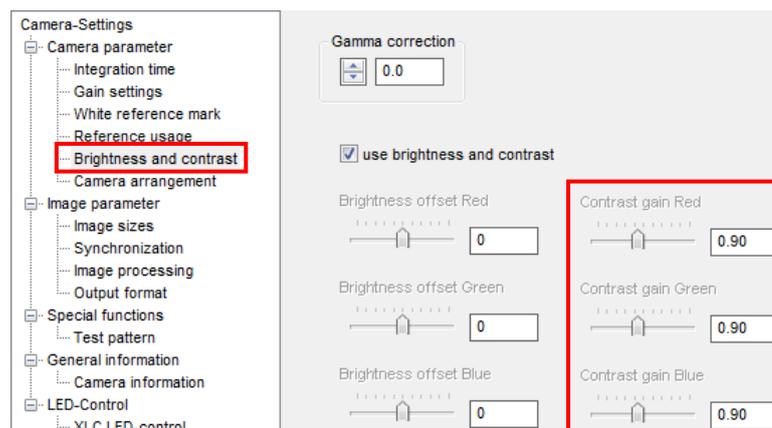
- On the toolbar, click **Show settings** , and then click **Reference usage**.
- To check white-level correction, select the **Activate white level correction** check box and in the **White reference data set list**, select the data set, in which you stored the data in step 7.



- Click **Transfer setting to camera**  to save the setting to volatile memory. Brightness of the newly scanned white-balancing reference should be exactly at the saturation limit. (255 @8Bit).



Note: At a later point, the image can be "desaturated" to a target value of, for example, 230 for a white paper by using a contrast adjustment of $230/255=0,90$.



Note: For the mono-camera, the three parameters for the different colors are replaced by a single parameter whose name ends with *white*.

Save the setting

- On the toolbar, click **Burn setting permanently** , or press **F10** to save the setting permanently into the camera.

8.4.4 Single color channel reference generation for special illumination situations (Separate lighting for each color channel)

Note: With a mono-camera, this feature is not available.

For special tasks, a special illumination setup might be necessary. If an inspection task is performed in which in each color channel different information is evaluated by using a special illumination per channel, the balancing procedure must be done individually per channel.

The creation of a shading reference is only necessary during commissioning or if the gain values are changed considerably.



Make sure that all changes made to your current setting are saved permanently to the camera before you use the Reference wizard. Otherwise, all changes get lost!

1	Get the camera to the desired working point
	<ul style="list-style-type: none"> Set up the working point of the camera before grabbing the reference images according to section 8.2.4. Optional: Activate black-level correction (Do not use with the separate color channels) Optional: Perform a white balancing (Do not use with the separate color channels) <p>Note: If the white reference target is placed in the best focus plane of the camera, any features on its surface (for example dust, scratches) end up in the calibration profile of the camera. To avoid this if you use a static (non-moving) white reference target, use a clean white ceramic or plastic material, not paper. Ideally, the white object should move during the calibration process because the movement results in an averaging process and the camera diminishes the effects on any small variation in the white reference. If this is not possible, you could place the reference target a little bit out of the best focus plane, but take care that the illumination of the target doesn't change too much.</p>
2	Start the reference wizard
	<ul style="list-style-type: none"> On the toolbar, click Start reference wizard .
3	Select reference type and source
	<ul style="list-style-type: none"> Click White (flat-field) level reference. Click Prepare camera to acquire a raw image: <div style="border: 1px solid #ccc; padding: 10px; margin: 10px 0;"> <p>Reference Generation Shading</p> <p>1 - Choose type of reference</p> <p><input type="radio"/> Black(offset) level reference</p> <p><input checked="" type="radio"/> White(flat field) level reference</p> <p>2 - Select image source</p> <p><input type="radio"/> Load reference image from disk</p> <p><input checked="" type="radio"/> Prepare camera to acquire a raw image</p> <p><input type="radio"/> Create reference internally</p> </div> <ul style="list-style-type: none"> Click Next .

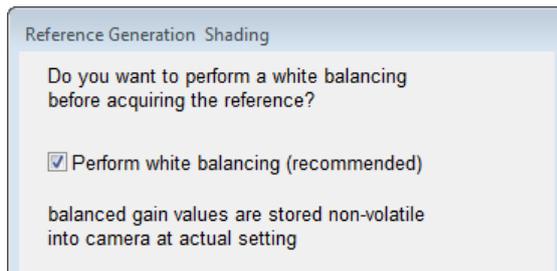
Optional: White balancing

Decide whether you want to perform a white balancing:

The camera must have been balanced before by using the white and tap balancing functions on the separate color channels (see section 8.2.4).

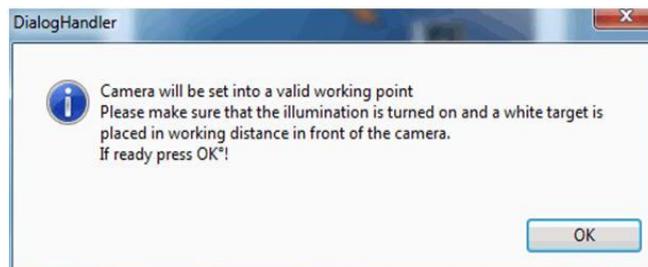
Do not use the white-balancing functions of the reference wizard if you use separate color channels!

- If you don't want to perform white balancing, clear the **Perform white balancing** check box and continue with Step 5.



4

- Click **Next**  . The following dialog box is shown:

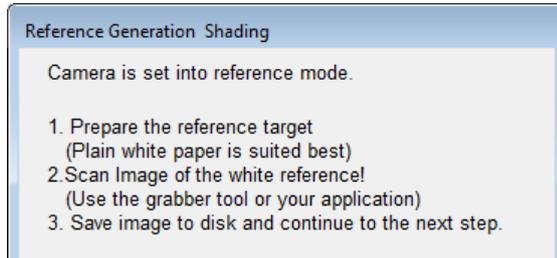


- Follow the instructions in the message box, and then click **OK**.

Note: Changes that have not been saved at this point get lost.

Acquire a shading reference:

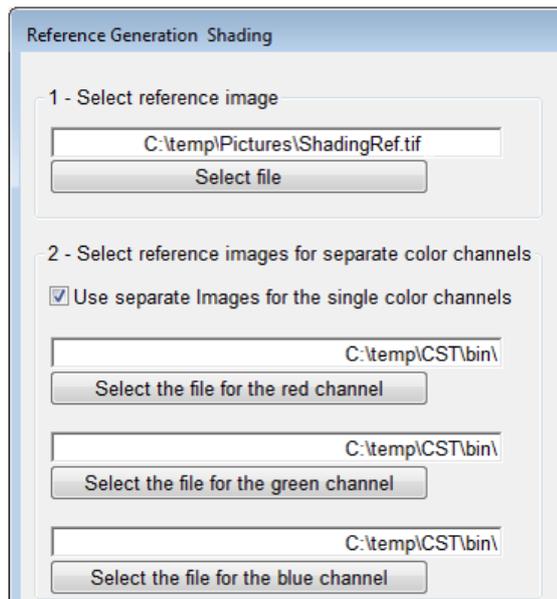
- Perform the steps shown on the next page of the wizard:



- Prepare the reference target.
- Grab an image of the white reference target.
Preferably use a moving target to avoid wrong data due to dirt.

- Save the image to a file, and then click **Next** .

- On the next page of the wizard, select the **Use separate images** check box. The page is then modified and permits to select three separate files for the three color channels:



- For each color, click the respective **Select** button, select the reference image, and click **Open**.

Note: Uncompressed gray and color images are allowed as input format.

- Click **Next** .

5

Define the area where the reference values should be calculated (a)

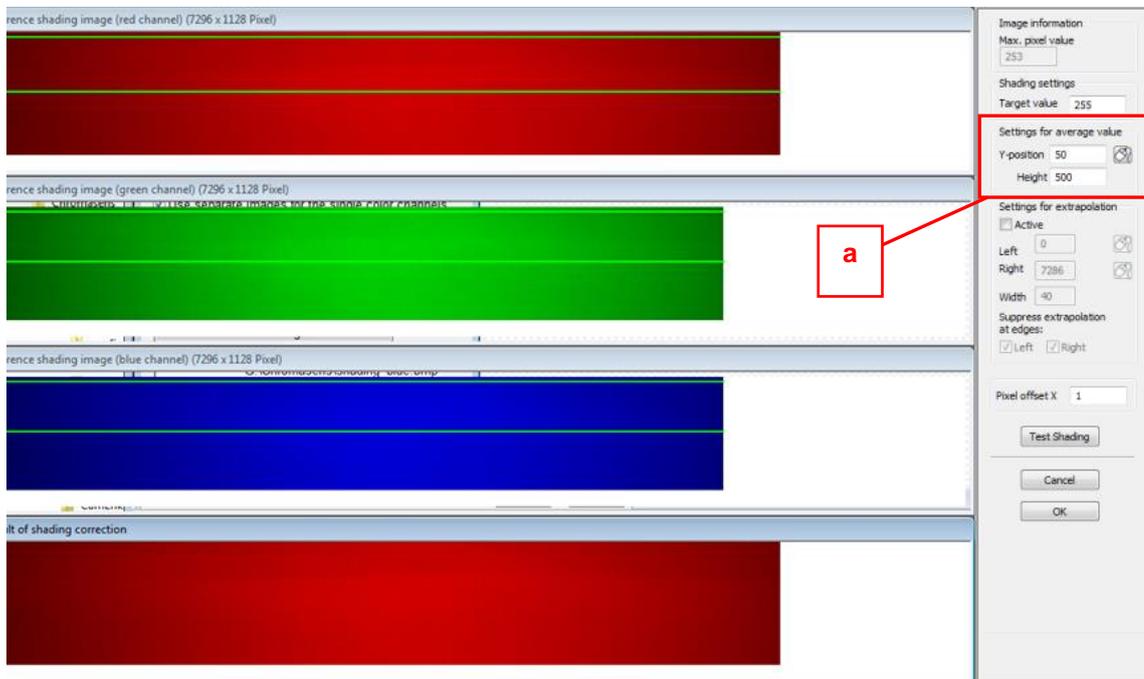
- If it is not possible to cover the full scanning width with a white reference target (for example due to mechanical conditions), the resulting black image borders on the left and right side can also be substituted by extrapolated values. So the bright area is extended outwards.
→ Proceed with **Step 7**.
- **The white reference target covers the full scanning range:**
- Specify the area from which the reference values should be calculated: **a**

In the **Y position** box, enter the number of the first line, in the **Height** box the number of lines to be used.

Use at least 100 lines for calculation of the reference values to eliminate noise. The values used for the reference are calculated by averaging each column in the selected area.

It is only possible to define one area for the reference data which is used for every color channel. **Make sure that you set this area to fit all channels!**

6



The screenshot shows a software interface with four panels on the left and a settings panel on the right. The panels on the left are titled 'reference shading image (red channel) (7296 x 1128 Pixel)', 'reference shading image (green channel) (7296 x 1128 Pixel)', 'reference shading image (blue channel) (7296 x 1128 Pixel)', and 'fit of shading correction'. Each panel shows a horizontal bar with a color gradient. The settings panel on the right has the following fields:

- Image information: Max. pixel value: 253
- Shading settings: Target value: 255
- Settings for average value: Y-position: 50, Height: 500
- Settings for extrapolation: Active, Left: 0, Right: 7296, Width: 40
- Suppress extrapolation at edges: Left, Right
- Pixel offset X: 1
- Buttons: Test Shading, Cancel, OK

A red box labeled 'a' highlights the 'Settings for average value' section, and another red box labeled 'a' highlights the 'Settings for extrapolation' section.

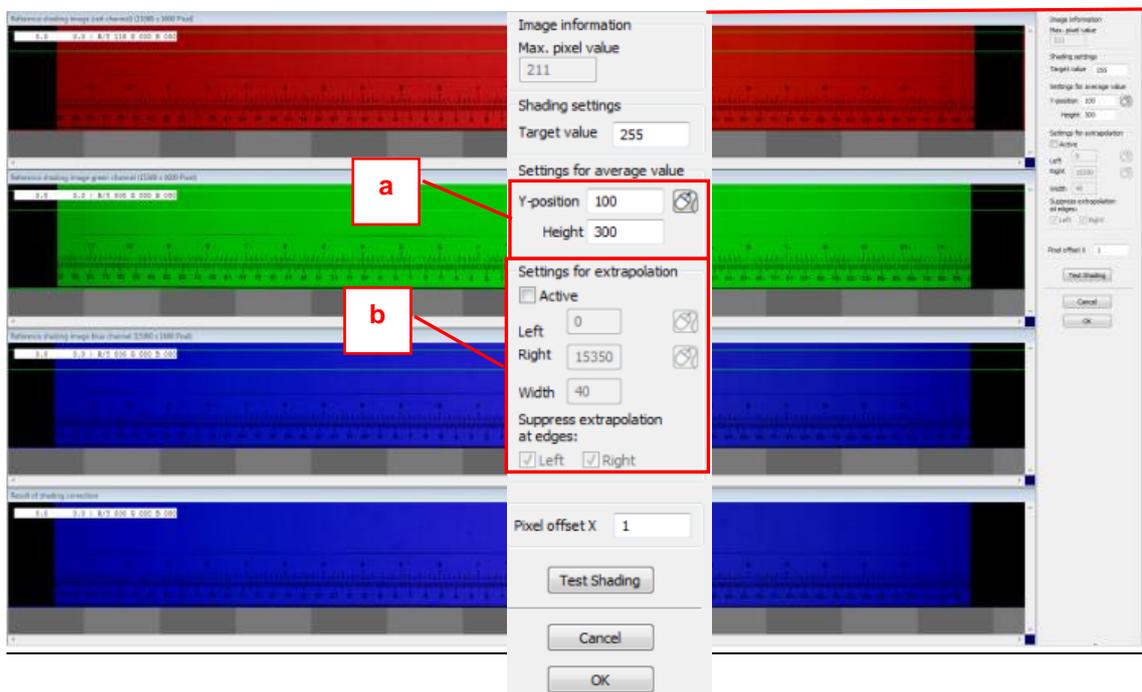
- Click **OK**, and then proceed with **Step 8**.

Define the area where the reference values should be calculated (b)

- If it is not possible to cover the full scanning width with a white reference target (for example due to mechanical conditions), the resulting black image borders on the left and right side can also be substituted by extrapolated values. So the bright area is extended outwards.
- Set the area where the reference values should be calculated: **a**

Use at least 100 lines for calculation of the reference values to eliminate noise. The values used for the reference are calculated by averaging each column in the selected area.

Sample image if the white reference target only partially covers the field of view of the camera:



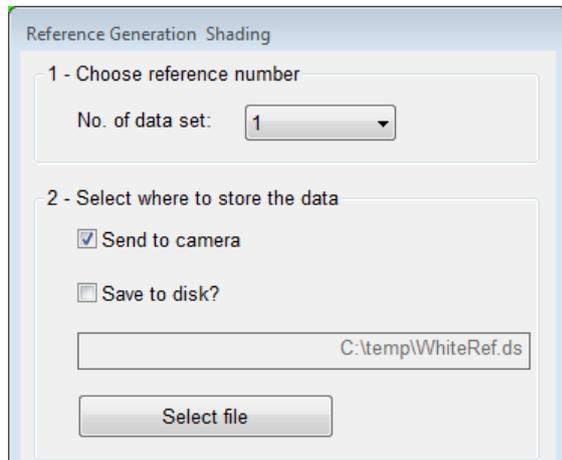
- Mark the edges of the white reference: **b**
 - In the **Settings for extrapolation** area, select the **Active** check box.
 - Specify the areas for extrapolation: in the **Left** and **Right** boxes, enter the start positions, and in the **Width** box the width as number of pixels.

Instead of entering values for the start positions, you can click  and then click the respective start position on the image. Place the areas near the left and right edge of the reference target.

- Click **OK** and proceed with **Step 8**.

Save reference data

- In the **No. of data set** list, click the number of the data set in which the reference data should be stored:



- If the reference data should not be sent to the camera, clear the **Send to camera** check box.
- To save the reference data to a file as backup, select the **Save to disk** check box, and then click **Select file** to specify folder and file name.

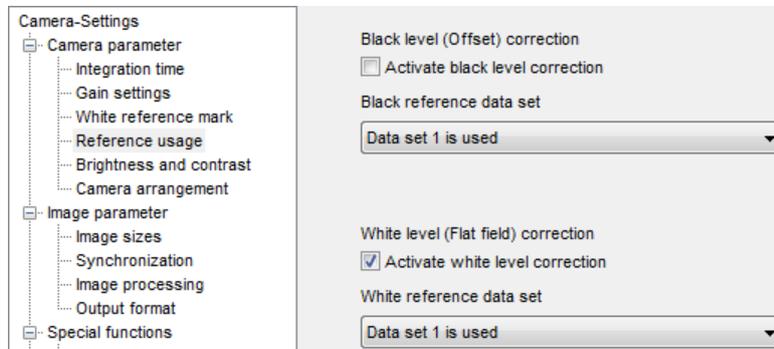
- Click **Next** .

If the reference data are sent to the camera, a progress bar is shown, and the camera is reset afterward to make sure that the initial settings are again active. The last used setting is activated automatically.

- Again click **Next**  to close the wizard.

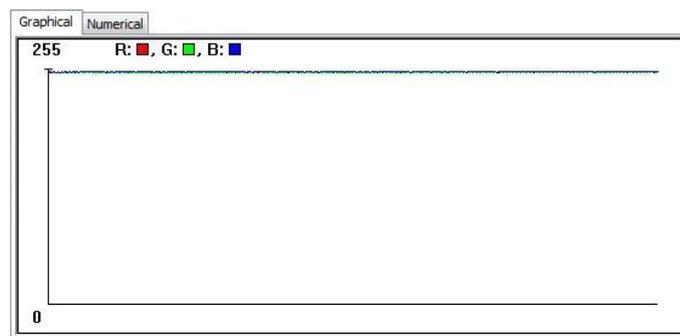
Activate shading correction and check the result in the image.

- On the toolbar, click **Show settings** .
- To check white-level correction, select the **Activate white-level correction** check box and check that the just updated data set is used:

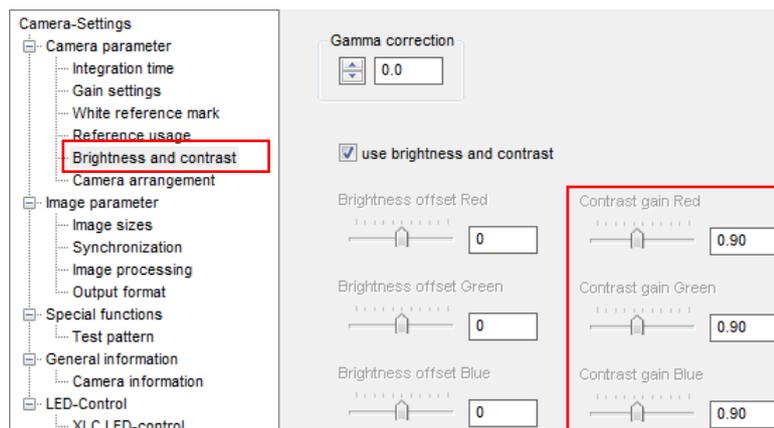


- Click **Transfer setting to camera**  to save the setting to volatile memory.

Brightness of the newly scanned white balancing reference should be exactly at the saturation limit. (255 @8Bit).



Note: At a later point, the image can be "desaturated" to a target value of, for example, 230 for a white paper by using a contrast adjustment of $230/255=0,90$.



Note: For the mono-camera, the three parameters for the different colors are replaced by a single parameter whose name ends with *white*.

Save the setting

- On the toolbar, click **Burn setting permanently** , or press **F10** to save the setting permanently into the camera.

8.5 Using continuous white control

8.5.1 Continuous operating point adjustment at the edges

Continuous operating point adjustment at the edges can be used in both, the line scan and the area scan operating modes.

The allPIXA wave camera evaluates the brightness of the respective channels in this range and compares the results with a programmable set value. The amplification values for each color channel are adjusted automatically.

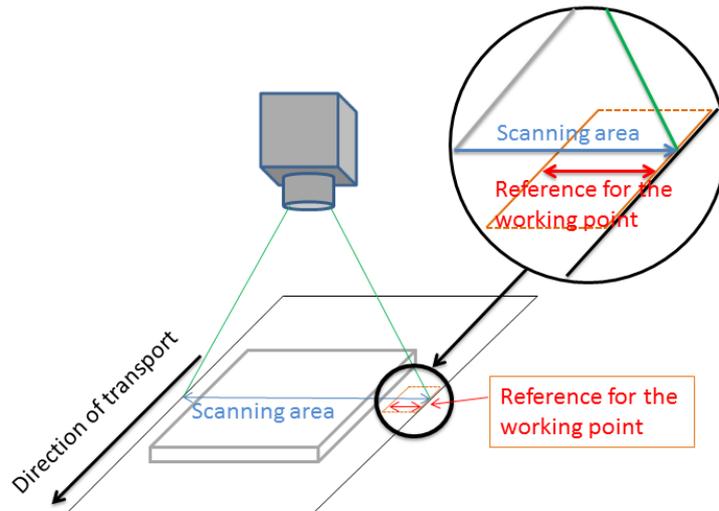


Figure 28: allPIXA wave camera with continuous automatic white balancing

1	<ul style="list-style-type: none"> • Set up the camera.
2	<ul style="list-style-type: none"> • Place the static white reference in front of the camera and check the position.
3	<ul style="list-style-type: none"> • In CST, on the toolbar, click Show settings , and on the tree view click White reference mark. • Select the Display white reference borders in the image check box. • Specify position and size of the white reference (see also section 9.4)

4	<ul style="list-style-type: none"> On the tree view, click Gain settings. Select the Enable continuous white control check box, and clear the Use sync mode check box: <div data-bbox="411 353 1018 488" style="border: 1px solid gray; padding: 5px; margin: 10px 0;"> <p>White Control</p> <p><input checked="" type="checkbox"/> Enable continuous white control</p> <p><input type="checkbox"/> Use sync mode: acquiring reference synchronized to frame scan</p> <p><input type="checkbox"/> stop gain control if level < 'Stop gain control' * last gain value</p> </div> Specify the target values: <div data-bbox="411 548 678 772" style="border: 1px solid gray; padding: 5px; margin: 10px 0;"> <p>Target reference value red</p> <p><input type="text" value="800"/></p> <p>Target reference value green</p> <p><input type="text" value="800"/></p> <p>Target reference value blue</p> <p><input type="text" value="800"/></p> </div> <p>Note: For a mono-camera, instead of three parameters for the different colors, there is only a single parameter, whose name ends with <i>white</i>.</p> <p>If the white target is placed at the borders of the image, they might be lower than in the center.</p> On the toolbar, click Transfer setting to camera , or press F9.
5	<ul style="list-style-type: none"> Wait for a balanced image. Check for saturation. In CST, on the toolbar, click Refresh current camera parameters . On the toolbar, click Burn setting permanently , or press F10.
6	<ul style="list-style-type: none"> Check the function by lowering the light in the control zone, for example by a shadow.

8.5.2 Image-synchronous operating point adjustment on the object (ROI)

The image-synchronous operating point adjustment can only be used in area scan operating mode.

If the object has an area which is suitable as reference for the operating point, this area can be set in the allPIXA camera as an ROI (Region of Interest). The allPIXA camera evaluates the brightness of the respective channels in this range and compares the results with a programmable set value. The amplification values for each color channel are adjusted automatically.

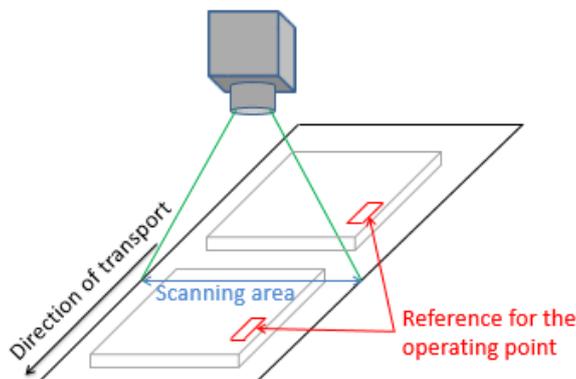


Figure 29: Image-synchronous operating point adjustment on the object (ROI)

NOTE I This mode requires a frame trigger signal at the allPIXA wave camera. The frame trigger can be provided by CC3 through the Camera Link or by the IO port of it. The allPIXA wave camera must be operated in frame scan mode. Gain control must be set to image-synchronized mode.

NOTE II At image-synchronized mode, the behavior of the closed-loop control is slower than in free-running mode.

1	<ul style="list-style-type: none"> Set up the camera.
2	<ul style="list-style-type: none"> Start the transport with sample objects.
3	<ul style="list-style-type: none"> In CST, on the toolbar, click Show settings , and on the tree view click White reference mark. Select the Display white reference borders in the image check box. Specify position and size of the white reference area (see also section 9.4).
4	<ul style="list-style-type: none"> On the tree view, click Gain settings. Select the Enable continuous white control check box, and select the Use sync mode check box: <div data-bbox="411 1025 1023 1160" style="border: 1px solid #ccc; padding: 5px; margin: 10px 0;"> <p>White Control</p> <p><input checked="" type="checkbox"/> Enable continuous white control</p> <p><input checked="" type="checkbox"/> Use sync mode: acquiring reference synchronized to frame scan</p> <p><input type="checkbox"/> stop gain control if level < 'Stop gain control' * last gain value</p> </div> Specify the target values: <div data-bbox="411 1223 675 1442" style="border: 1px solid #ccc; padding: 5px; margin: 10px 0;"> <p>Target reference value red</p> <p><input type="text" value="800"/></p> <p>Target reference value green</p> <p><input type="text" value="800"/></p> <p>Target reference value blue</p> <p><input type="text" value="800"/></p> </div> <p>Note: For a mono-camera, instead of three parameters for the different colors, there is only a single parameter, whose name ends with <i>white</i>.</p> <p>If the white target is placed at the borders of the image, they might be lower than in the center.</p> On the toolbar, click Transfer setting to camera , or press F9.
5	<ul style="list-style-type: none"> Wait for a balanced image. Check for saturation. In CST, on the toolbar, click Refresh current camera parameters : On the toolbar, click Burn setting permanently , or press F10.
6	<ul style="list-style-type: none"> Check the function by lowering the light in the control zone, for example by a shadow.

8.6 IO configuration

The allPIXA wave camera offers different ports for synchronizing image data.

- Line trigger or encoder
- Frame trigger

Two ways are provided to transfer the signals to the camera:

- CC bits on the Camera Link cable
- IO-port (D-Sub-15) on the allPIXA wave camera

External ports must be connected to the internal functions by using the IO Configurator.

For detailed information about encoder setup, see section 8.6.

Button	Function key	Menu
		View/IO Configurator

	Name of IO function	Connector	Internal Function	IO-Standard	Bit Value
01	Encoder Ch 0 /line trigger	CL 1-CC1	Encoder0/line trigger	LVDS	<input type="checkbox"/>
02		X12-1/9	Encoder0/line trigger	RS422	<input checked="" type="checkbox"/>
03		X12-4	Encoder0/line trigger	LVCOS	<input type="checkbox"/>
04		---	Encoder0/line trigger -> static Low	---	<input type="checkbox"/>
05		---	Encoder0/line trigger -> static High	---	<input type="checkbox"/>
06	Encoder Ch 1	CL 1-CC2	Encoder1	LVDS	<input type="checkbox"/>
07		X12-2/10	Encoder1	RS422	<input type="checkbox"/>
08		X12-12	Encoder1	LVCOS	<input type="checkbox"/>
09		---	Encoder1 -> static Low	---	<input type="checkbox"/>
10		---	Encoder1 -> static High	---	<input type="checkbox"/>
11	Enable Encoder	---	Enable Increments-> static Low	---	<input type="checkbox"/>
12		---	Enable Increments-> static High	---	<input checked="" type="checkbox"/>
13		CL 1-CC2	Enable Increments	LVDS	<input type="checkbox"/>
14		CL 1-CC4	Enable Increments	LVDS	<input type="checkbox"/>
15	SelectScanDir	CL 1-CC2	SelectScanDir	LVDS	<input type="checkbox"/>
16		X12-2/10	SelectScanDir	RS422	<input type="checkbox"/>
17		X12-12 (Pull-Down)	SelectScanDir	LVCOS	<input type="checkbox"/>
18	Invert ScanDir from Encoder	---	Inv. ScanDir from Encoder	---	<input type="checkbox"/>
19	Lightbarrier Default	CL 1-CC3	All debouncing levels	LVDS	<input checked="" type="checkbox"/>
20		CL 1-CC4	All debouncing levels	LVDS	<input type="checkbox"/>
21		X12-1/9	All debouncing levels	RS422	<input type="checkbox"/>
22		X12-2/10	All debouncing levels	RS422	<input type="checkbox"/>
23		internal Lightbarrier	All debouncing levels	---	<input type="checkbox"/>
24		X12-3	All debouncing levels	LVCOS	<input type="checkbox"/>
25	Select master camera	X12-3 (Pull-Up)	nSelMaster	LVCOS	<input type="checkbox"/>
26		CL 1-CC4	nSelMaster	LVDS	<input type="checkbox"/>
27	Master / Slave interface	X12-14	MS_Interface	LVCOS	<input type="checkbox"/>
28		X1-1	MS_Interface internal	LVCOS	<input type="checkbox"/>
29		X12-14/-8	MS_Interface + Hub	LVCOS	<input type="checkbox"/>
30	Test signals	X12-4	VSUNC / FVAL	LVCOS	<input type="checkbox"/>
31		X12-12	HSUNC / LVAL	LVCOS	<input type="checkbox"/>

Line trigger inputs

Enable Line trigger inputs

Frame trigger inputs

- Avoid double use of internal functions (only select one input for line trigger or frame trigger)
- To transfer the selection to the camera, click **Transfer setting to camera**  on the toolbar, or press **F9**.
- To save changes on the camera permanently, click **Burn setting permanently**  on the toolbar, or click **F10**.

8.7 Encoder connection and setup

For more information about the parameters, see section 9.10.

8.7.1 Line trigger and encoder settings

Settings for line trigger and encoder mode are edited within this view. For more information about of the parameters, see section 9.10.

Button	Function key	Menu
		View/Encoder setup

8.7.2 Connecting the encoder to the camera

There are two different ways to transmit the encoder signals to the camera:

- Connect the camera using Camera Link CC bits
 - If the encoder is connected to the frame grabber, make sure that the signal is transferred to the CC1 bit and, optionally for a detection of the scan direction, to the CC2 bit of the Camera Link cable.
- Directly connect the encoder to the camera:
 - To connect the encoder signals directly to the camera, you can use the I/O connector (D-Sub15 Pin 1/9 and, optionally for a detection of the scan direction, 2/10).
 - For detailed information about pin assignment, see section 5.1.3
 - Also see the input level definition in section 5.1.4

8.7.3 Defining the input channel in the camera

After connection of the signals, the camera must be set up to the correct input channel for the encoder signals. Therefore, use the I/O Configurator page of CST (section 8.6).

To open the I/O Configurator page, click **Show settings for user-configurable IOs**  on the toolbar.

To define the input channels of the encoder, the inputs can be combined to the following groups:

	Name of IO function	Connector	Internal Function	IO Pin	Signal name	IO-Standard	Bit Value
01	Encoder Ch 0 / line trigger	CL1-CC1	Incr0/Linetrigger	CL.1-9/22	CL_CC1	LVDS	<input type="checkbox"/>
02		X5-1/9	Incr0/Linetrigger	IO-Interface-1	GPIO_P1	RS422	<input checked="" type="checkbox"/>
03		X5-4	Incr0/Linetrigger	IO-Interface-4	GPIO_P2	LVC MOS	<input type="checkbox"/>
04	Encoder Ch 1	CL1-CC2	Incr1	CL.1-10/23	CL_CC2	LVDS	<input type="checkbox"/>
05		X5-2/10	Incr1	IO-Interface-2	GPIO_P1/N1	RS422	<input type="checkbox"/>
06		X5-12	Incr1	IO-Interface-12	GPIO_P2	LVC MOS	<input type="checkbox"/>
07	Enable Encoder	---	Enable Increments-> static Low	---	Static low	---	<input type="checkbox"/>
08		---	Enable Increments-> static High	---	Static high	---	<input checked="" type="checkbox"/>
09		CL1-CC2	Enable Increments	CL.1-10/23	CL_CC2	LVDS	<input type="checkbox"/>
10		CL1-CC4	Enable Increments	CL.1-12/25	CL_CC4	LVDS	<input type="checkbox"/>
11	Invert ScanDir from Encoder	---	Inv. ScanDir from Encoder	---	Inv. ScanDir from Er	---	<input type="checkbox"/>
12	Lightbarrier Default	CL1-CC3	All debouncing levels	CL.1-11/24	CL_CC3	LVDS	<input checked="" type="checkbox"/>
13		CL1-CC4	All debouncing levels	CL.1-12/25	CL_CC4	LVDS	<input type="checkbox"/>
14		X5-1/9	All debouncing levels	IO-Interface-1	GPIO_P1/N1	RS422	<input type="checkbox"/>
15		X5-2/10	All debouncing levels	IO-Interface-2/10	GPIO_P1/N1	RS422	<input type="checkbox"/>
16		internal Lightbarrier	All debouncing levels	---	internal Lightbarrier	---	<input type="checkbox"/>
17		X5-3	All debouncing levels	IO-Interface-3	GPIO_P4	LVC MOS	<input type="checkbox"/>

1. Define input encoder channel 0 (line 1-3)
 - In this section the input channel for the encoder channel 0 can be selected from different external pins.
 - In this section only one option should be selected.

2. Define input encoder channel 1 (line 4-6)
 - In this section the input channel for the encoder channel 1 can be selected from different external pins.
 - If only a one-channel encoder is used, select a defined level on this pin (static low).
 - In this section only one option should be selected.

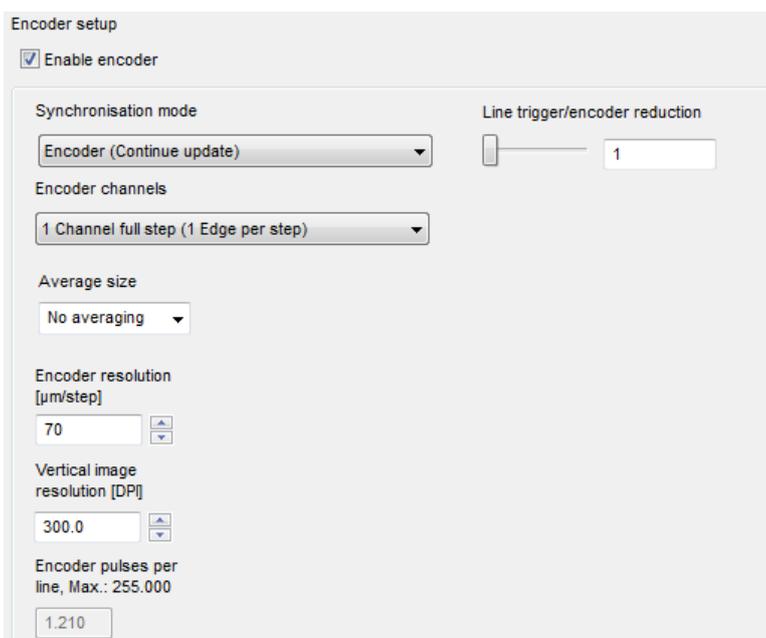
3. Define enable signal of encoder (line 7-10)
 - This section allows you to define an external enable signal for the encoder mode. (see also section 9.10.1).
 - If no external enable signal is used, select line 7 (default). The encoder is then controlled with the camera setting.
 - In this section only one option should be selected.
 - With Invert Input (Line 11) you could invert the line trigger / first encoder channel. This could be helpful to match the scan direction forward/backward in free-running and triggered mode.

4. Define frame trigger input (line 12-17)
 - In this section the input channel for the frame trigger can be selected from different CC bits or external pins.
 - In this section only one option should be selected.

8.7.4 Configuring encoder mode and resolution

For configuration, use the encoder setting page of CST to specify all parameters. For more information, see section 9.10.

To open the **Encoder setup** page, click **Show Encoder setup**  on the toolbar.



The screenshot shows the 'Encoder setup' window with the following settings:

- Enable encoder
- Synchronisation mode: Encoder (Continue update)
- Line trigger/encoder reduction: 1
- Encoder channels: 1 Channel full step (1 Edge per step)
- Average size: No averaging
- Encoder resolution [$\mu\text{m}/\text{step}$]: 70
- Vertical image resolution [DPI]: 300.0
- Encoder pulses per line, Max.: 255.000
- Encoder pulses per line: 1.210

To set up the encoder parameters:

1. Select the **Enable encoder** check box.
2. In the **Synchronization mode** list, click the desired mode (for more information, see section 9.10.2):

Line trigger mode (Const. int time): In line trigger mode, the camera sends a single line per pulse. If you specify a value at **Line trigger/ encoder reduction**, the camera sends a single line for the number of specified pulses. The remaining parameters are not available in this mode.

Encoder (continuous update): The encoder mode uses the internal intelligent encoder functionality. The camera measures the speed of the object and sends lines based on the defined encoder resolution and the vertical image resolution.

3. In the **Encoder channels** list, click the number of recognized edges per step of the encoder signal.
4. Specify a value for **Line trigger/encoder reduction**:

In line trigger mode: The value defines how many trigger signals are used to trigger a single scanning line.

In encoder mode: This factor can be used to reduce the number of encoder pulses per line. If the number of encoder pulses per line exceeds 255, this factor must be used to reduce the number below 255.

5. In the **Average size** list, specify how many encoder increments are averaged for speed measurements. For more information, see section 9.10.4.
6. In the **Encoder resolution** box, enter the resolution of the encoder in $\mu\text{m}/\text{step}$. For more information, see section 9.10.5.
7. In the **Vertical image resolution** box, specify the physical resolution in transport direction in dpi / line. For more information, see section 9.10.6.

You can calculate as follows: 1 dpi = 25,4mm, for example ($100\mu\text{m}/\text{line} = 254\text{dpi}$)

With this definition, the camera calculates and displays the encoder pulses per line.

Note: If scanning speed (defined by integration time for one line as well as $\mu\text{m}/\text{step}$ and $\mu\text{m}/\text{line}$) is higher than the maximum camera speed (see section 2.3), the camera goes into free-running mode with maximum speed. The camera goes into normal encoder mode, as soon as the speed drops again below maximum speed.

8. Check the value of **Encoder pulses per line**:

This value is calculated by the camera using the values of the specified parameters. The maximum allowed value is 255.

The minimum value should be at least 0.1, smaller values decrease accuracy.

If this value exceeds 255, change the value of **Line trigger/encoder reduction** to reduce this value below 255.

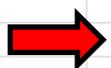
8.7.5 Encoder - enable /disable by external input signal

With the enable increments setting you can enable/disable the encoder input by using an external I/O Port (CC-Bit3 or CC-Bit4 of the Camera Link interface). This feature can be useful to enable the encoder in real time (for example: application with several cameras). The function is configured on the IO Configuration page.

For detailed information about encoder setup, see section 8.7

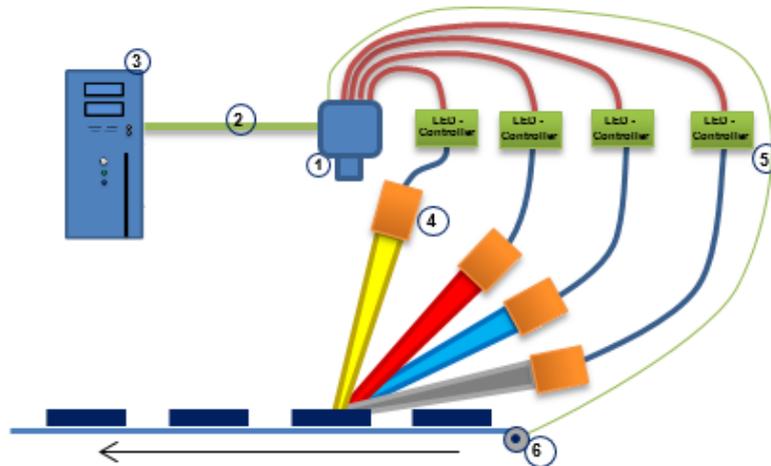
NOTE If this feature is not used, the configuration must be set to default = enabled!
Otherwise the encoder input is disabled

	Name of IO function	Connector	Internal Function	IO-Standard	Bit Value
01	Encoder Ch 0 /line trigger	CL1-CC1	Encoder0/line trigger	LVDS	<input type="checkbox"/>
02		X12-1/9	Encoder0/line trigger	RS422	<input checked="" type="checkbox"/>
03		X12-4	Encoder0/line trigger	LVCOS	<input type="checkbox"/>
04		---	Encoder0/line trigger -> static Low	---	<input type="checkbox"/>
05		---	Encoder0/line trigger -> static High	---	<input type="checkbox"/>
06	Encoder Ch 1	CL1-CC2	Encoder1	LVDS	<input type="checkbox"/>
07		X12-2/10	Encoder1	RS422	<input type="checkbox"/>
08		X12-12	Encoder1	LVCOS	<input type="checkbox"/>
09		---	Encoder1 -> static Low	---	<input type="checkbox"/>
10		---	Encoder1 -> static High	---	<input type="checkbox"/>
11	Enable Encoder	---	Enable Increments-> static Low	---	<input type="checkbox"/>
12		---	Enable Increments-> static High	---	<input checked="" type="checkbox"/>
13		CL1-CC2	Enable Increments	LVDS	<input type="checkbox"/>
14		CL1-CC4	Enable Increments	LVDS	<input type="checkbox"/>
15	SelectScanDir	CL1-CC2	SelectScanDir	LVDS	<input type="checkbox"/>
16		X12-2/10	SelectScanDir	RS422	<input type="checkbox"/>
17		X12-12 (Pull-Down)	SelectScanDir	LVCOS	<input type="checkbox"/>
18	Invert ScanDir from Encoder	---	Inv. ScanDir from Encoder	---	<input type="checkbox"/>
19	Lightbarrier Default	CL1-CC3	All debouncing levels	LVDS	<input checked="" type="checkbox"/>
20		CL1-CC4	All debouncing levels	LVDS	<input type="checkbox"/>
21		X12-1/9	All debouncing levels	RS422	<input type="checkbox"/>



8.8 Multi-channel flash control

With the multi-channel LED control, the camera provides up to four individual flash outputs for illumination controllers. The flash outputs are fully synchronized to the line trigger to permit high speed-synchronous triggering of different illuminations.



1. allPIXA wave camera
2. Camera Link cable
3. Host PC
4. Illumination modules
5. LED driver
6. Encoder / Trigger

NOTE: If the Master/Slave interface with hub is used, LED flash control does not work. Therefore at most two slave cameras can be used if you want to use LED flash control.

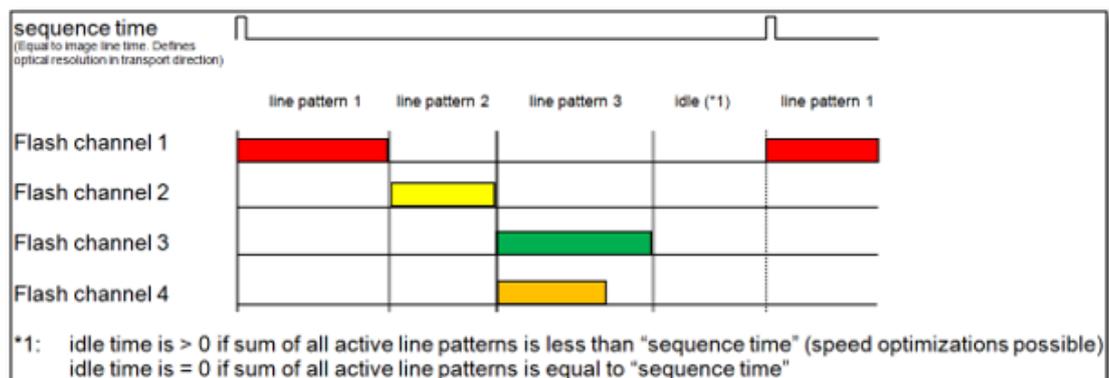
8.8.1 Operation principle

To see the flash control parameters, you must set **User level** to **Guru** in CST!

The camera provides up to four different outputs which can be operated individually to control illumination drivers.

Several outputs can be individually combined to be triggered at the same time. Each flashing scenario can be defined individually as line pattern. The camera provides up to four different line patterns which are executed in a sequence. This sequence is repeated as long as scanning or triggering is active.

The following diagram demonstrates a sequence cycle with three different line patterns. In this example, the duration for each line pattern is set individually. All four available output channels are used:



NOTE If flash mode is active, the camera uses the individually defined line pattern times to set up the integration time of each scanning line.

The camera integration time setting value is ignored if the flash mode is used.

Line pattern time

For each output channel (1...4) a time can be defined at which the specific output is active. The resulting time for each line pattern is determined by the largest value.

Example corresponding to the diagram above:

Line pattern 3: -> active time for flash channel 3 = 150 μ s
 -> active time for flash channel 4 = 110 μ s
→ the resulting duration of line pattern 3 = 150 μ s

The minimum time for a line pattern is defined by the following parameters:

1. Minimum integration time of the camera:
The minimum integration time depends on the speed of the camera (minimum possible integration time) and the scan line length.
2. Minimum time for output of a scan line via Camera Link interface:
The time for transfer of a scan line via Camera Link depends on the selected Camera Link mode (base, medium, full) and the Camera Link frequency.

A table with the dependencies of the possible scan line speed with different Camera Link modes is shown in section 2.2 „Camera speed for available Camera Link modes and frequency“.

NOTE If the length of a line pattern is shorter than the minimum possible line time (regarding minimal camera integration time and Camera Link speed), the camera automatically increases the specific line pattern time before starting next line pattern.

 This then also increases the required sequence time.

Sequence time:

Free-running mode:

The camera sequence time is the defined time for one full sequence with up to 4 individual line patterns. During one sequence time cycle the camera outputs as many number of lines as line patterns are defined.

The sequence time (in combination with the transport speed) defines the transport resolution of the image.

Triggered mode (encoder/line trigger):

One full sequence is executed per trigger signal. Within such a sequence the camera outputs as many lines as line patterns are defined (1 up to 4 line patterns are possible). If four line patterns are used, the camera outputs four lines for each trigger signal.

Make sure that the sum of all line pattern time definitions is short enough to be completely executed at full-speed scanning.

If the allowed value for the sequence time is too short to cover all defined line pattern times, the camera returns an appropriate error code:

0xD7: LED flash mode: sum of all patterns exceeds sequence time

The camera also goes into free-running mode operating with the speed defined by sequence/patter time.

Flash channel

Signal output channel for control of an illumination controller.

Idle time:

Idle time in free-running mode:

If the sum of all active line patterns is less than “sequence time”, the patterns can be changed without changing the transport resolution of the camera/system.

Idle time in encoder/line trigger mode:

After the last line pattern, the camera waits for the next line trigger to start the next sequence.

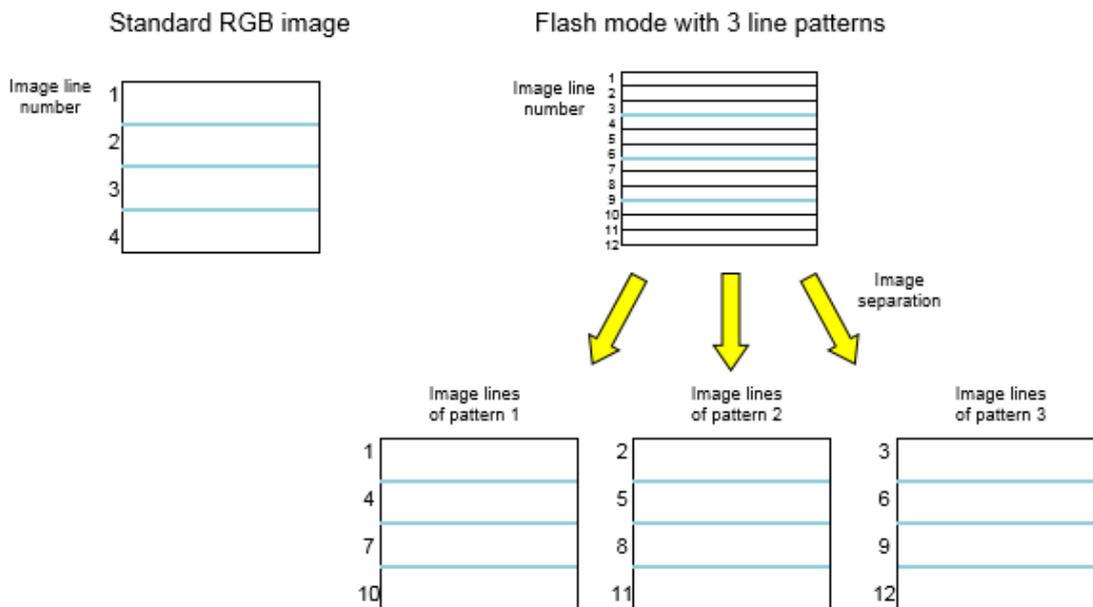
In both cases (free-run/with external line trigger) the camera automatically adapts the subline time (sum of all active line patterns) to the minimum required time. This optimization function permits to use the camera at maximum possible speed of the system with regard to the flash times. For a detailed speed optimization sample, see section 8.8.5.1 Feature: scan speed optimization.

8.8.2 Flash mode – Image size

In standard RGB mode, the camera outputs one line per line trigger. If flash mode is used, the camera provides one full sequence per line trigger. Therefore, the camera outputs as many lines per line trigger as the selected number of line patterns.

This permits to achieve the same image resolution in the separated flash images compared to the standard scanning image without flash mode. Thus, the size (height) of the transmitted raw image increases by the factor of the used pattern (for example; if you use three line patterns, the raw image is three times as long).

In the following diagram, the standard scanning mode and the flash mode using three line patterns are demonstrated:



8.8.3 Registration Error Compensation - RGB line distance for flash mode

If you use the flash mode, image size and scanning speed increase (see section 8.8.2).

In normal scanning operation, a single line is output per sequence. If you use the flash mode, the camera outputs several lines (depending on the number of the used pattern) per sequence. Therefore, the registration error adjustment has to be adapted.

For automatic compensation of the registration error by the camera, the parameter **RGB line distance** on the **Camera arrangement** page can be defined accordingly. For the use of flash mode, the parameter can be adapted according to the following procedure:

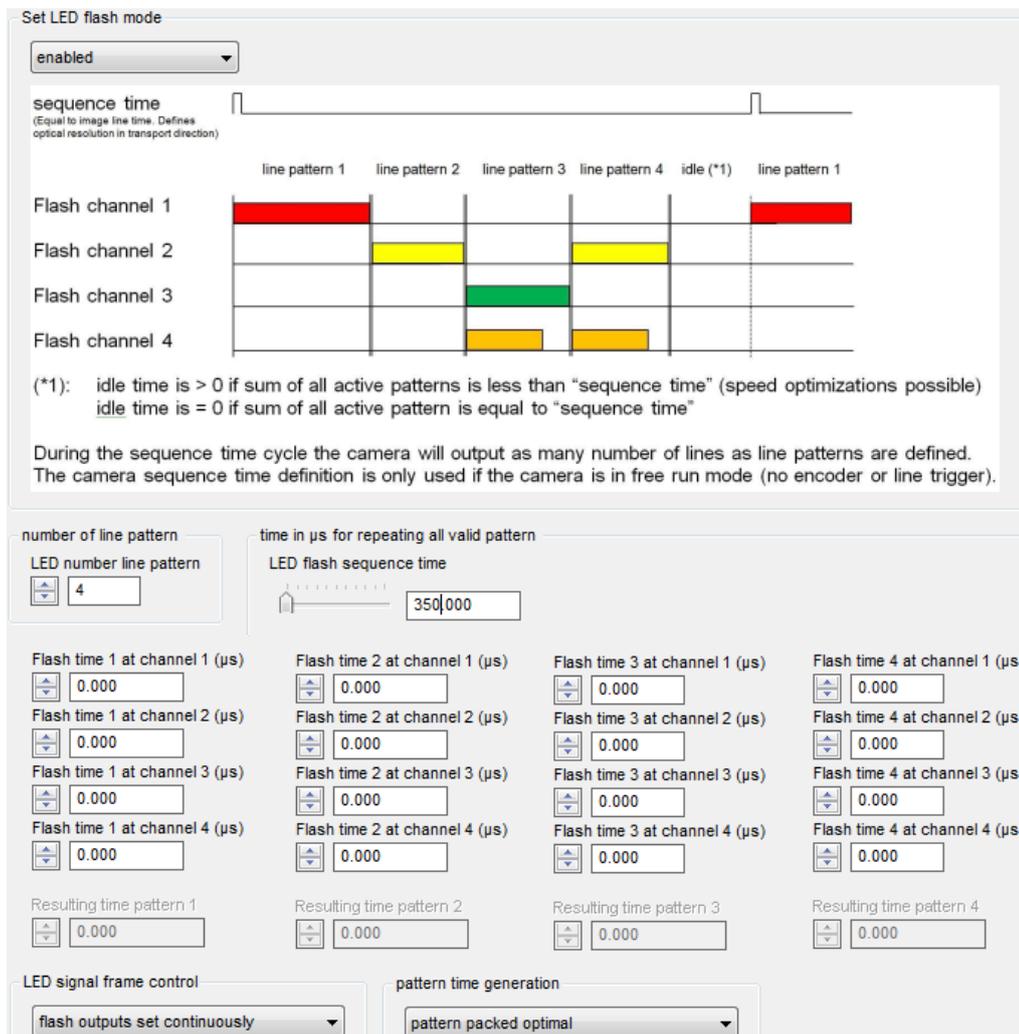
No. of used line patterns	RGB line distance value
1	1 x "used line distance without flash mode"
2	2 x "used line distance without flash mode"
3	3 x "used line distance without flash mode"
4	4 x "used line distance without flash mode"

The allPIXA wave camera is capable to automatically compensate up to 5 lines (see section 9.7.1).

Additional compensation should be integrated into image post-processing on PC side if maybe also the different lines in the image are separated.

8.8.4 Setting up the multi-channel LED control

The CST software provides an easy setup of the multi-channel flash control:



Set LED flash mode

enabled

sequence time
(Equal to image line time. Defines optical resolution in transport direction)

line pattern 1 line pattern 2 line pattern 3 line pattern 4 idle (*1) line pattern 1

Flash channel 1

Flash channel 2

Flash channel 3

Flash channel 4

(*1): idle time is > 0 if sum of all active patterns is less than "sequence time" (speed optimizations possible)
idle time is = 0 if sum of all active pattern is equal to "sequence time"

During the sequence time cycle the camera will output as many number of lines as line patterns are defined. The camera sequence time definition is only used if the camera is in free run mode (no encoder or line trigger).

number of line pattern
LED number line pattern: 4

time in µs for repeating all valid pattern
LED flash sequence time: 350,000

Flash time 1 at channel 1 (µs): 0.000

Flash time 2 at channel 1 (µs): 0.000

Flash time 3 at channel 1 (µs): 0.000

Flash time 4 at channel 1 (µs): 0.000

Flash time 1 at channel 2 (µs): 0.000

Flash time 2 at channel 2 (µs): 0.000

Flash time 3 at channel 2 (µs): 0.000

Flash time 4 at channel 2 (µs): 0.000

Flash time 1 at channel 3 (µs): 0.000

Flash time 2 at channel 3 (µs): 0.000

Flash time 3 at channel 3 (µs): 0.000

Flash time 4 at channel 3 (µs): 0.000

Flash time 1 at channel 4 (µs): 0.000

Flash time 2 at channel 4 (µs): 0.000

Flash time 3 at channel 4 (µs): 0.000

Flash time 4 at channel 4 (µs): 0.000

Resulting time pattern 1: 0.000

Resulting time pattern 2: 0.000

Resulting time pattern 3: 0.000

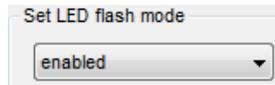
Resulting time pattern 4: 0.000

LED signal frame control: flash outputs set continuously

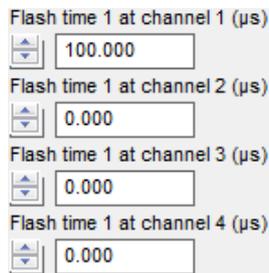
pattern time generation: pattern packed optimal

To set up LED control:

1. On the toolbar, click **Show settings** , and then click **LED flash control**.
2. In the **Set LED flash mode** list, click **enabled**.

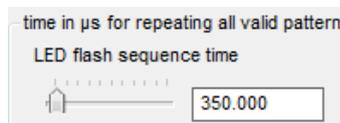


3. In the **Number of line patterns** box, enter the number of line patterns you want to use (up to 4).
4. Enter the desired flashing times of the output channel for each line pattern which is used. You can use up to 4 channels. If a channel is not used, enter 0.0:



5. Enter a suitable sequence time. This time is used for free-running mode (without external line trigger).

The sequence time defines the time for one full sequence cycle and therefore defines the transport resolution (in combination with the transport speed). For more information see section 8.8.1.

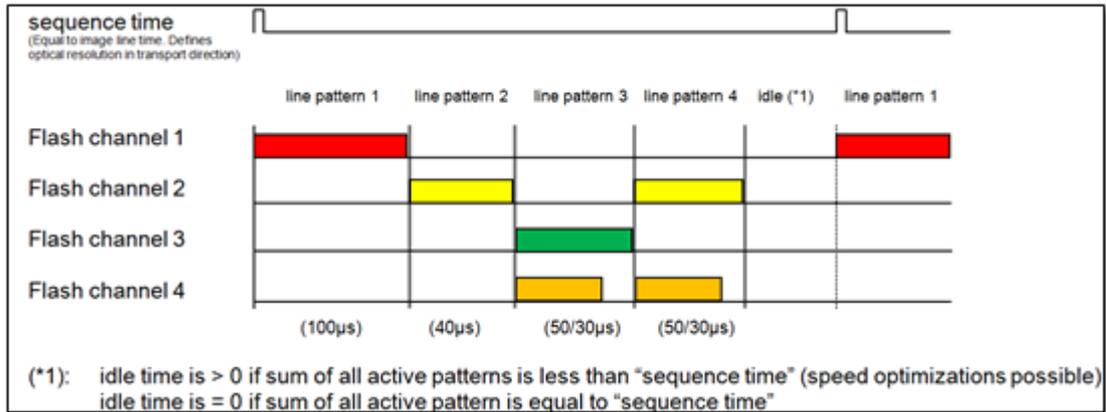


8.8.5 Sample setup for four different illumination units (free-running)

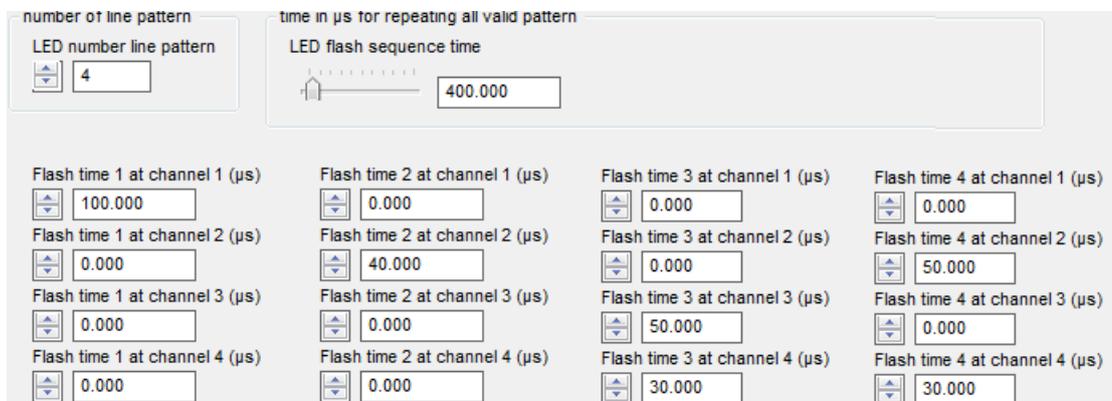
Operation sample for a flash control setup with 4 individual illuminations and 4 patterns:

Operation mode: free-run
 Camera integration time: not used
 (The line time is defined individually by the definition of each line pattern. The parameter **Integration time** in the camera is ignored if flash mode is used).
 Used LED channels: 4
 Line patterns: 4
 Sequence time: 400 µs

Timing diagram:



Camera setup with CST:



The screenshot shows the camera setup interface with the following parameters:

- number of line pattern: LED number line pattern: 4
- time in µs for repeating all valid pattern: LED flash sequence time: 400.000
- Flash time 1 at channel 1 (µs): 100.000
- Flash time 2 at channel 1 (µs): 0.000
- Flash time 3 at channel 1 (µs): 0.000
- Flash time 4 at channel 1 (µs): 0.000
- Flash time 1 at channel 2 (µs): 0.000
- Flash time 2 at channel 2 (µs): 40.000
- Flash time 3 at channel 2 (µs): 0.000
- Flash time 4 at channel 2 (µs): 50.000
- Flash time 1 at channel 3 (µs): 0.000
- Flash time 2 at channel 3 (µs): 0.000
- Flash time 3 at channel 3 (µs): 50.000
- Flash time 4 at channel 3 (µs): 0.000
- Flash time 1 at channel 4 (µs): 0.000
- Flash time 2 at channel 4 (µs): 0.000
- Flash time 3 at channel 4 (µs): 30.000
- Flash time 4 at channel 4 (µs): 30.000

8.8.5.1 Feature: scan speed optimization

If the sum of all line patterns is shorter than the sequence time, the scanning speed can be optimized as follows:

Based on the sample data from above, the total active time (sum of all line pattern times) for all of the 4 line patterns is 240 µs (minimum sequence time).

The sequence time is set to 400µs. This results in an idle time for this setup of about 160µs.

This permits to reduce the sequence time and thus to speed up the total scanning speed.

Conventional camera setup:

- 4 individual flash scenarios
- Integration time 100µs
- Required time for one full sequence = 400µs

allPIXA wave- optimized camera setup by use of the flash function:

- 4 individual flash scenarios
- Parameter **Pattern time generation** is set to **Pattern packed optimal**
- Using the real individual line pattern times for scanning:
resulting sequence time = 240µs (100µs+40µs+50µs+50µs)
- Required time for one full sequence = 240µs
- Depends also on minimum integration time and camera link mode.

The optimized flash scenario leads to a much faster sequence time of 240µs instead of 400µs. By use of the allPIXA wave flash function the next flash sequence can be started right after 240µs. This in total saves 160µs of scanning time per sequence.

⇒ Scanning speed increase of about **66%** by using the allPIXA wave flash function

8.8.6 Sample setup for two different illumination units (triggered mode)

Operation sample for triggered mode with two individual illuminations and three patterns:

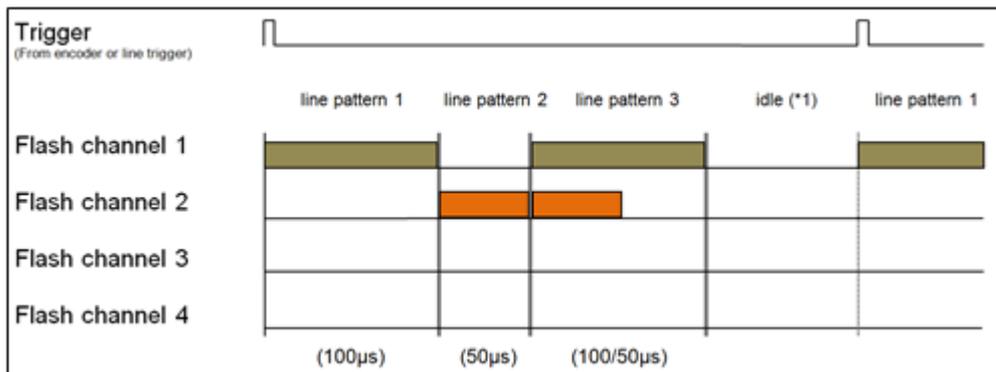
Operation mode: encoder, line trigger
 Camera integration time: not used (The line time is defined individually by the definition of each line pattern. The parameter **Integration time** in the camera is ignored if flash mode is used.)
 Used LED channels: 2
 Line patterns: 3
 Sequence time: not used in encoder mode. The sequence time must be set larger than the sum of the individual line patterns.

NOTE One full sequence is executed per trigger signal. Within such a sequence the camera outputs the same number of lines as line patterns are defined. In this example the camera outputs three lines for each trigger signal.

Make sure that the sum of the used line patterns times is short enough to be completely executed at full-speed scanning.

If the trigger speed is faster than the sequence time, the camera automatically switches to free-running mode operating with defined speed of the sequence / pattern times.

Timing diagram:



Camera setup with CST:

number of line pattern LED number line pattern <input type="text" value="3"/>	time in µs for repeating all valid pattern LED flash sequence time <input type="text" value="300.000"/>		
Flash time 1 at channel 1 (µs) <input type="text" value="100.000"/>	Flash time 2 at channel 1 (µs) <input type="text" value="0.000"/>	Flash time 3 at channel 1 (µs) <input type="text" value="100.000"/>	Flash time 4 at channel 1 (µs) <input type="text" value="0.000"/>
Flash time 1 at channel 2 (µs) <input type="text" value="0.000"/>	Flash time 2 at channel 2 (µs) <input type="text" value="50.000"/>	Flash time 3 at channel 2 (µs) <input type="text" value="50.000"/>	Flash time 4 at channel 2 (µs) <input type="text" value="0.000"/>
Flash time 1 at channel 3 (µs) <input type="text" value="0.000"/>	Flash time 2 at channel 3 (µs) <input type="text" value="0.000"/>	Flash time 3 at channel 3 (µs) <input type="text" value="0.000"/>	Flash time 4 at channel 3 (µs) <input type="text" value="0.000"/>
Flash time 1 at channel 4 (µs) <input type="text" value="0.000"/>	Flash time 2 at channel 4 (µs) <input type="text" value="0.000"/>	Flash time 3 at channel 4 (µs) <input type="text" value="0.000"/>	Flash time 4 at channel 4 (µs) <input type="text" value="0.000"/>

8.8.7 Electrical interface (pin assignment)

For information about voltage levels (LVCMOS) of input (e.g. trigger) signals, see section: 5.1.4

NOTICE

You should check for correct input voltage levels.
Non-compliance can result in irreparable damages to the allPIXA wave camera!

Cabling requirements:

- The connection cable from camera to LED controller must be fully shielded.
- Use the **same** ground potential for all devices (cameras, LED-Drivers, shielding for all cables, ...). Also use 0V ground pins for ground potential at the controller.

***** TBD- The max length of the cable between camera and LED controllers is 5m *****

Pin no.	Level	Description	LED-Flash
1	RS 422	GPIO_P0 (input)	---
2	RS 422	GPIO_P1 (input)	---
3	LVCMOS	GPIO_P4	---
4	LVCMOS	GPIO_P2	Out1; over 680 Ohm + Pull-Down
5	3.3 V over 100 Ohm	Power	---
6	LVCMOS	GPIO_P3	Out3; over 10 Ohm + Pull-down
7	0 V	Ground	0V
8	LVCMOS	GPIO_N4	Out4; over 10 Ohm + Pull-Down
9	RS 422	GPIO_N0 (input)	---
10	RS 422	GPIO_N1 (input)	---
11	0 V	Ground	0V
12	LVCMOS	GPIO_N2	Out2; over 10 Ohm + Pull-Down
13	0 V	Ground	0V
14	LVCMOS	GPIO_N3	Pull-Down
15	5 V over 100 Ohm	Power supply	---

Out 1 – Out 4: LED trigger output signal for channel 1 – 4
0V: 0V signal ground potential for use with Out 1-4 at the LED controller

NOTE I

Always use 0V ground signal level of the camera in addition to the OUT channels for the signal levels at the LED controller.

8.8.8 I/O port configuration

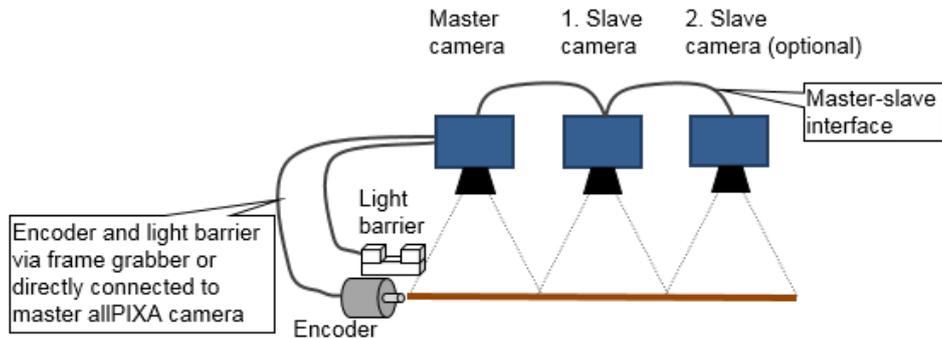
For the operation of flash control, the selected output ports (Out 1...4) are allocated automatically if flash control is activated.

Make sure that the ports are not in use for other functionality. Any definitions for these output channels in the I/O Configurator () are ignored as soon as the flash control is activated.

8.9 Principle of master-slave synchronization

The trigger signals from light barrier (frame trigger) and/or encoder (line trigger) are connected to the master camera only.

This could be done with the CC bits via the frame grabber or by directly connecting the signals to the master allPIXA wave camera. This trigger information is transferred via the master-slave interface to the slave camera(s). Due to this synchronization interface all cameras run with exactly the same timing for lines and optional frames.

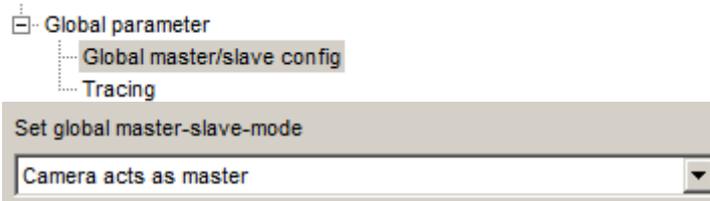


8.9.1 Set up the cameras for master-slave synchronization

There are three options to set the cameras either to master or slave:

(a) Global:

In this mode, master/slave-mode is not affected by the setting parameters. Therefore the same setting files can be used if the operation modes are changed by transmitting .set or .mk files to the cameras.



or



I/O definition

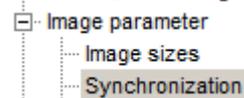
If the master/slave definition is set by software setting as above, the configuration of nSelMaster input is ignored. Therefore, no selection for nSelMaster has to be performed.

(b) By Setting:

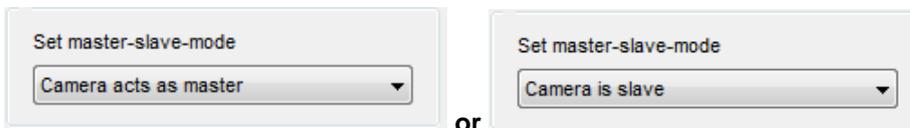
If the global master-slave mode is



the setting decides whether the camera acts as a master or a slave:



The cameras have dedicated settings or the PC sets the camera to master or slave via the TAG_MASTER_SLAVE_CONFIGURATION



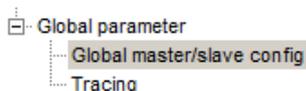
I/O definition

If the master/slave definition is set by software setting as above, the configuration of nSelMaster input is ignored. Therefore, no selection for nSelMaster has to be performed.

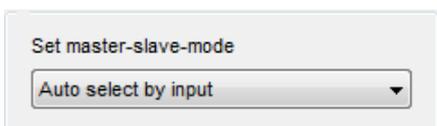
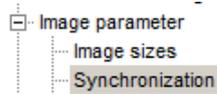
(c) Hardware (external input signal for master definition):

To set the camera for master/slave detection with external pin assignments by the I/O connector or CC bit 4 from the Camera Link interface, select the option **Auto-select by input**:

This could be done globally with



or from each setting:



The automatic master-slave detection uses the input pin assignment on the 15 pin I/O connector or the CC4 bit via Camera Link. The definition must be as follows:

Background information: The signal nSelMaster is low active. A logic 0 on this input switches the camera to master, a logic 1 (or open on I/O Interface) sets the camera as slave. The input pin 3 of the I/O connector is held high by an internal pull-up.

- Master camera definition:

1. By using pin assignment: external master definition by applying a low voltage level (ground) to pin 3 (nSelMaster). Therefore, an electrical connection from pin 3 to pin 11 (GND) on the D-Sub 15 connector can be used. (see following section "8.8.3. Connecting the master/slave cameras (cabling)")
2. By using the CC4 bit: apply a low signal on this bit via the frame grabber.

- Slave camera definition:

1. By using pin assignment of pin 3 on the D-Sub 15: no pin assignment is needed.
2. By using the CC4 bit: apply a high signal on this bit via the frame grabber.

I/O definition

If the master camera definition is defined externally, check the desired input for nSelMaster. For example, for defining master slave by hardware, check the IO Interface-3 as shown. If you want to use CC4 bit signal to define master slave, select the check box in the line below.

25	Select master camera	X12-3 (Pull-Up)	nSelMaster	LVC MOS	<input checked="" type="checkbox"/>
26		CL1-CC4	nSelMaster	LVDS	<input type="checkbox"/>

8.9.2 Connecting the master-slave cameras (cabling)

The master/slave interface consists of a single timing signal for standard setup (pin 14). This signal must be connected 1:1 between the master and all slave camera(s). In addition, the ground signal must be connected between master and slave cameras. Therefore pin 7 and 13 can be used for a 1:1 connection between master and slave camera(s).

NOTE: At least one ground signal (pin 7 or pin 13) must be connected in addition to the timing signal (pin 14).

I/O definition

To enable the I/O input for master-slave communication, select the appropriate input in the I/O configurator as shown below.

25	Select master camera	X12-3 (Pull-Up)	nSelMaster	LVC MOS	<input checked="" type="checkbox"/>
26		CL1-CC4	nSelMaster	LVDS	<input type="checkbox"/>
27	Master / Slave interface	X12-14	MS_Interface	LVC MOS	<input checked="" type="checkbox"/>
28		X1-1	MS_Interface internal	LVC MOS	<input type="checkbox"/>
29		X12-14/-8	MS_Interface + Hub	LVC MOS	<input type="checkbox"/>

Cabling between master-slave cameras

Make sure that at least pins 14 and 7 (GND) are 1:1 connections between all master and slave cameras. For master definition using pin assignment, additionally connect pins 3 and 11 at the master camera.

Pin no.	Level	Description	Default	Connection at slave camera(s)
1	RS 422	GPIO_P0 (input)	Incremental encoder (high)	Open
2	RS 422	GPIO_P1 (input)	Light barrier (high)	Open
3	LVC MOS	GPIO_5	Can be used, e.g., for light barriers or nSelMaster (Bridge to 0 V)	Open, internal PullUp
4	LVC MOS	GPIO_6	Selectable with IO Configurator	Only at Master! (only if master selection by hardware is used)
5	3.3 V	Power supply	Output; max. 100 mA	Open
6	LVC MOS	GPIO_8	-	-
7	0 V	Ground	-	Ground
8	LVC MOS	GPIO_10	Master/Slave interface	Master/Slave-interface
9	RS 422	GPIO_N0 (input)	Incremental encoder (low)	Open
10	RS 422	GPIO_N1 (input)	Light barrier (low)	Open
11	0 V	Ground	-	Ground
12	LVC MOS	GPIO_7	Selectable with IO Configurator	-
13	0 V	Ground	-	Ground
14	LVC MOS	GPIO_9	Master/Slave interface	-
15	5 V	Power supply	Output; max. 100 mA	Open

Internal Master/Slave interface (OEM-Versions only):

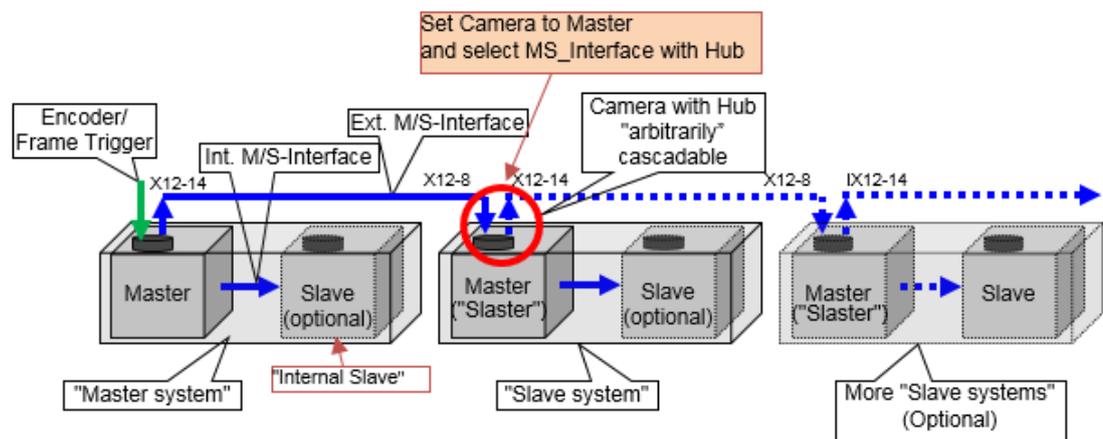
For OEM-Versions of the allPIXA wave (for example Dual-3D-PIXA) internal master/slave connections are used.

27	Master / Slave interface	X12-14	MS_Interface	LVC MOS	<input type="checkbox"/>
28		X1-1	MS_Interface internal	LVC MOS	<input checked="" type="checkbox"/>
29		X12-14/-8	MS_Interface + Hub	LVC MOS	<input type="checkbox"/>

NOTE: These internal connections are set by factory and must not be changed!

Master/Slave interface with hub:

If more than one slave camera is used, there is an additional option to connect further slaves using the allPIXA wave as a hub for the Master/Slave interface:



Pin 14 of the 15-pin connector is used for output and pin 8 is used for input of the master slave interface.

NOTE: At least one ground signal (pin 7 or 13) must be connected in addition to the timing signal (pin 14).

O definition

To enable the Master/Slave interface with hub, choose the appropriate input interface:

27	Master / Slave interface	X12-14	MS_Interface	LVC MOS	<input type="checkbox"/>
28		X1-1	MS_Interface internal	LVC MOS	<input type="checkbox"/>
29		X12-14/-8	MS_Interface + Hub	LVC MOS	<input checked="" type="checkbox"/>

Wiring for "Master/Slave interface with hub"

A single output from the Master is connected to the input of the next slave. This slave acts as a master for the next slave. (In = Slave, Out = Master ⇒ "Slaster")

From master to slaster: Pin 14⇒Pin 8

Additionally, a wire for GND (1:1).

At the first master, frame trigger and line trigger/encoder can be connected optionally.

D-Sub15	Signal name Master	Wire	Signal name Slaster_1	Wire	Signal name Slaster_2	Wire	Signal name Slaster_3 etc.
1	IncrInP (Opt)		---		---		---
2	LBIInP (Opt)		---		---		---
3	LBIInSelMaster (Opt)		GP-I/O		GP-I/O		GP-I/O
4	GP-I/O (LED1)		GP-I/O		GP-I/O		GP-I/O
5	(3,3V)		(3,3V)		(3,3V)		(3,3V)
6	GP-I/O (LED3)		GP-I/O		GP-I/O		GP-I/O
7	Ground	→	Ground	→	Ground	→	Ground
8	GP-I/O (LED8)		M/S-Int(0)-In		M/S-Int(0)-In		M/S-Int(0)-In
9	IncrInN (Opt)		---		---		---
10	LBIInN (Opt)		---		---		---
11	Ground	→	Ground	→	Ground	→	Ground
12	GP-I/O (LED2)		GP-I/O		GP-I/O		GP-I/O
13	Ground		Ground		Ground		Ground
14	M/S-Int(0)-Out		M/S-Int(0)-Out		M/S-Int(0)-Out		M/S-Int(0)-Out
15	(5V)		(5V)		(5V)		(5V)
Shield							

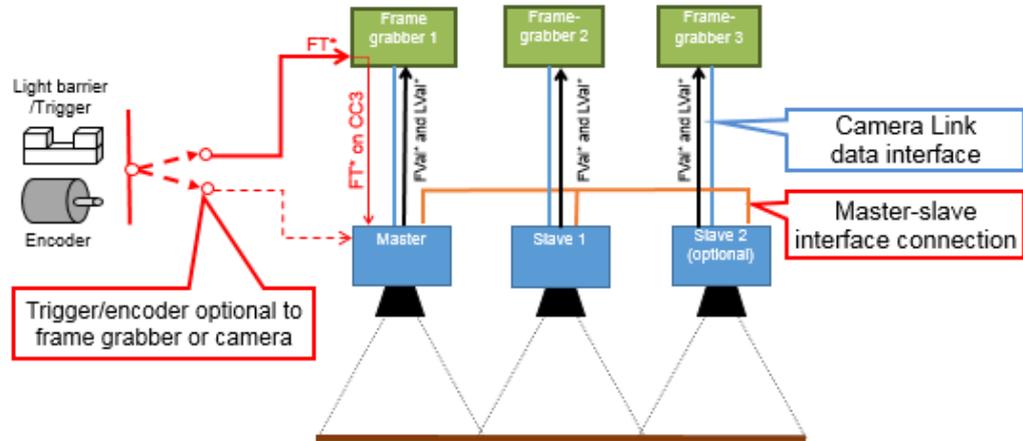
NOTE: If the Master/Slave interface with hub is used, LED flash control does not work. Therefore, at most two slave cameras can be used if you want to use LED flash control.

8.9.3 Frame grabber setup information for Master/Slave operation

There are two basic strategies for camera/frame grabber configurations to set up the system for master / slave mode.

Option 1 (Frame grabber in frame/area mode, preferred):

- Frame Signal: Frame trigger signal is provided only to the master camera (for example directly to the camera or via CC3 on Camera Link)
- Frame grabber mode: Frame/area mode
- Master Camera operation: Line: free-running mode or line trigger/encoder mode
Frame: free-running mode or frame trigger mode
- Slave camera synchronization: Cameras are synchronizing each line and also provide FrameValid signal to the frame grabbers
- Operation: The frame trigger signal is only sent to the master camera, for example by the use of CC3 bit. Each frame grabber is set to frame/area mode. The cameras run fully synchronized. The cameras provide the frame grabber with the LineValid and FrameValid signals.



- *FT – Frame trigger (optional)
- *LT – Line trigger/Encoder (optional)
- *FVAL – FrameValid (from each camera to the corresponding frame grabber)
- *LVAL – LineValid (from each camera to the corresponding frame grabber)
- *Light barrier / Trigger and Encoder can be connected independently to the frame grabber or to the camera IO, e.g. Encoder -> Frame grabber IO -> CC1; Light barrier / Trigger -> Camera IO -> X12-1/9

Option 2 (Frame grabber in line mode):

Frame Signal:	Frame trigger signal is provided to each frame grabber
Frame grabber mode:	Line mode
Camera synchronization:	Cameras are synchronizing each line
Camera operation:	Free-running mode / encoder mode

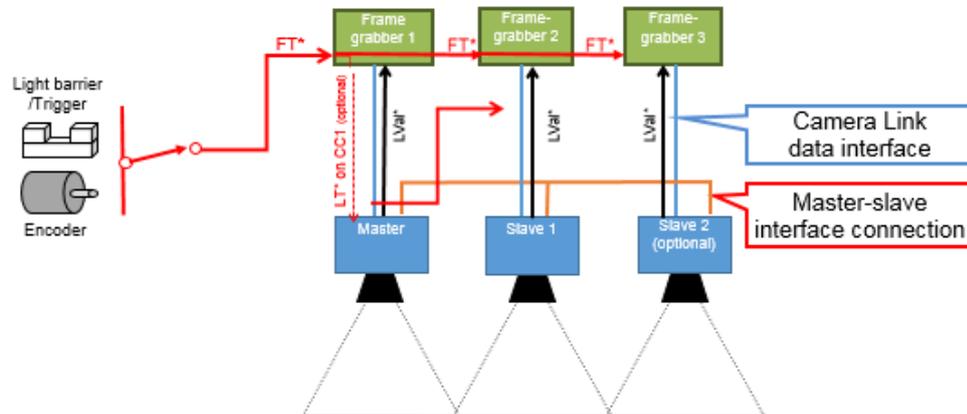
Operation: The frame trigger signal is sent to each frame grabber, for example by the use of a dedicated connection cable. So each frame grabber has the same FrameValid signal available.

The cameras synchronize each line to each other. Each camera is outputting lines continuously.

Special feature: use FVal to also trigger the frame grabbers in line mode.

If the master camera is triggered by frame trigger, all cameras also provide an FVal signal to the frame grabber. Depending on the functionality of the used frame grabber in line mode, the frame grabber is able to process the FVal signal for image start or not.

If the frame grabber is restricted in functionality and cannot process the FVal signal, it must be provided to each frame grabber (as shown below).



- *FT – Frame trigger
- *LT – Line trigger
- *FVAL – FrameValid
- *LVAL – LineValid

For more information about the detailed setup of the frame grabber, refer to your frame grabber manual or contact support of your frame grabber dealer.

NOTE: With Option 2, the frame grabbers receive the frame trigger signal not exactly at the same time. Therefore, it may sometimes happen that a frame grabber misses the first line so that the images of the different frame grabbers are not synchronous.

8.9.4 Image start delay / Position of the white reference mark

To ensure synchronous operation, the master camera provides an internal image and line trigger.

Image start delay can be specified separately for master and slave cameras. This permits to correct small deviations due to incorrect mechanical adjustment.

Also, the position of the white reference mark can be specified separately because the mark may be at different positions for the different cameras.

NOTE

- The following modes should be set to the same values for all cameras:
Line trigger modes:
 - Free-running
 - Line trigger
 - Encoder modeFrame trigger modes:
 - Free-running
 - Use start condition
 - Use start/stop condition
- The position of the image in transport direction (Y) of each camera can be set separately (by **Image start delay**)
- Also, the position (X + Y) and the size of the white reference could be set separately in each camera
- The connection between master and slave must be specified by the I/O configuration!
- For OEM-Versions of the allPIXA wave also internal connections could be chosen.

8.10 Editing the color conversion (correction) matrix

For color conversion 4 color conversion matrix tables are available in the camera.

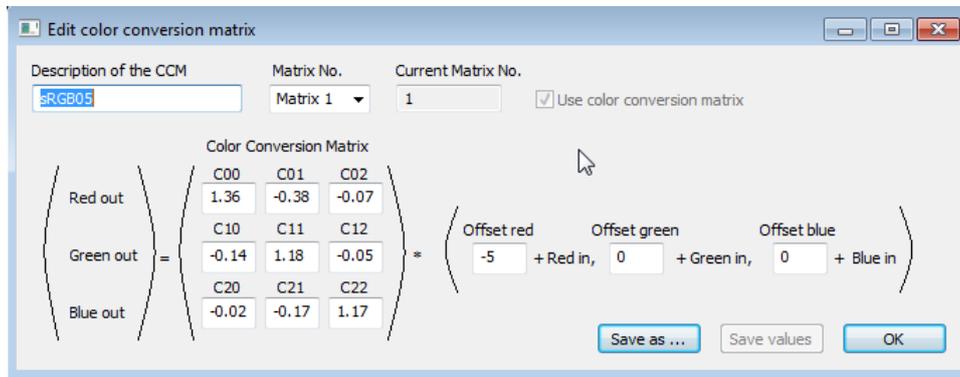
$$\begin{pmatrix} R_{out} \\ G_{out} \\ B_{out} \end{pmatrix} = \begin{pmatrix} C_{00}, C_{01}, C_{02} \\ C_{10}, C_{11}, C_{12} \\ C_{20}, C_{21}, C_{22} \end{pmatrix} * \begin{pmatrix} R_{in} + Offset_R \\ G_{in} + Offset_G \\ B_{in} + Offset_B \end{pmatrix}$$

With:

Offset: Additional Offset in 10Bit range, from -511 to +511 corresponding -0,5 to +0,5

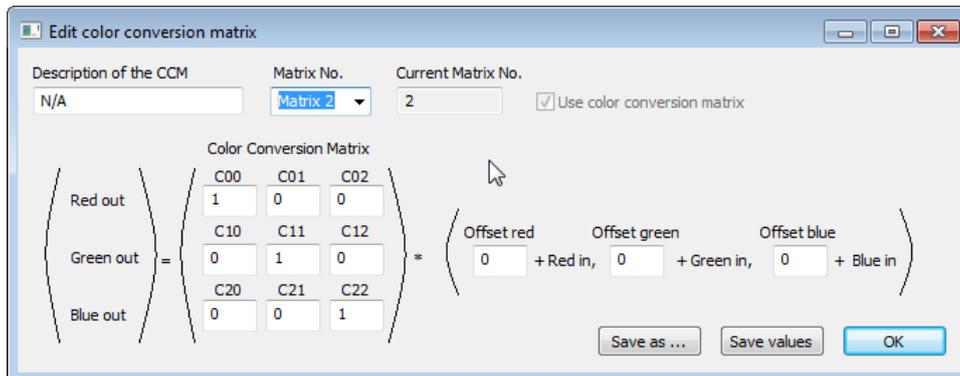
Cxy Gain factor from -2.0 to +2.0.

Matrix 1 is a preconfigured color conversion matrix for sRGB conversion. It is write-protected and cannot be modified:



NOTE To use the sRGB conversion, additionally set **Gamma correction** to 0.1 on the **Brightness and contrast** page of the Camera Settings.

Matrix 2 to Matrix 4 are preconfigured as transparent color conversion matrix:



Matrix 2 to Matrix 4 can be modified.

To modify a matrix:

1. On the **Advanced** menu, click **Edit color conversion matrix**. The **Edit color conversion matrix** dialog box opens and shows the values of Matrix 1.
2. In the **Matrix No** list, select the matrix whose values you want to modify.
3. Modify values, click **Save as** and select one of the matrixes **Matrix 2** to **Matrix 4**.
4. If the currently selected matrix is not **Matrix 1**, you can alternatively click **Save values** to save the values to the currently selected matrix.

NOTE The command **Edit color conversion matrix** is only available in user mode **Guru**.

8.11 Configuring XLC4 light controllers using the RS485 interface

XLC4 light controllers are part of the Corona II LED illumination system. If you want to use it, you must order it separately. For more information about Corona II, see the *Corona II + LED-Control Unit XLC4-1* manual.

Several XLC4 light controllers connected to the camera using the RS485 interface (see section 5.1.2) can be controlled. During operation, each active XLC light controller connected to the RS485 bus must have a unique ID in the range 0x2 to 0xF.

ID 0 is used by CST to send broadcast messages to all connected light controllers. ID 1 is a service ID. If a light controller with ID 1 is added to the RS485 bus, the camera automatically assigns the lowest free ID to the controller.

NOTE Automatic ID assignment makes it easy to replace a light controller if the controllers have consecutive addresses starting with 0x02. If you replace a controller with a controller with service ID 1, it automatically is assigned the ID of the replaced controller.

At startup or on request from CST, the camera scans the RS485 bus for connected and running XLC4 devices and adds them to the network.

Take notice that a pull-up or a pull-down may be required for different signals of the RS485 bus.

8.11.1 Adding XLC4 light controllers using automatic ID assignment

Because all light controllers must have unique IDs, you can only connect a single light controller with service ID 1 to the RS485 bus.

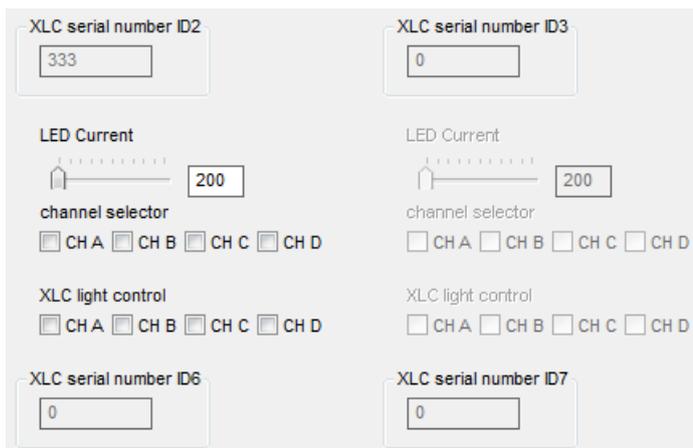
To add several light controllers with service ID 1 to the bus:

1. Start CST, click **Show settings** , and then click **XLC LED control**.
2. Add a single light controller to the RS485 bus.
3. At CST, click **Scan for XLC devices**. The camera then assigns the lowest free ID to the added light controller.
4. Repeat steps 2 and 3 for each light controller.

8.11.2 Configuring single XLC4 light controllers with CST

To configure a light controller, click **Show settings**  on the toolbar, and then click **XLC LED control**.

For light controllers detected by the camera, CST shows the serial number, and their parameters are available. In the following example, a single light controller with serial number 333 was detected:



For each available light controller, the current of each connected LED light can be changed with CST, and the lights can be switched on or off.

To configure a light controller:

1. To change the current, move the slider or enter a value in the text box, and at **Channel selector** select the check boxes of the channels, at which the change should take effect.
2. To switch lights on or off, select or clear the respective check boxes at **XLC light control**.
3. Press **F9** to send the request to the camera.

NOTE If you use a multi-channel Corona II light controller, the current is always changed for the complete module and the complete module is switched on or off. For more information, see the *Corona II + LED-Control Unit XLC4-1* manual.

NOTE You can specify changes for several light controllers before you press **F9** to put them into effect. To configure identical changes at all connected light controllers, you can use broadcasting as described in the following section.

NOTE Be aware that the **LED current** value only shows the value you specified. It is not possible to read out the used current for any LED light.

NOTE Take notice that the check boxes at **Channel selector** and at **XLC light control** have different meaning:

If a check box is cleared at **Channel selector**, the respective LED light is not affected if you press **F9**, i.e. its current remains unchanged.

If a check box is cleared at **XLC light control**, the light at the respective channel is switched off if you press **F9**. Thus, the state of the check boxes determines for all channels whether the connected lights are switched on or off.

NOTE Take notice that some LED lights have a lower maximum current than CST permits to specify. If you try to specify a high current in this case, an LED Voltage error may be returned.

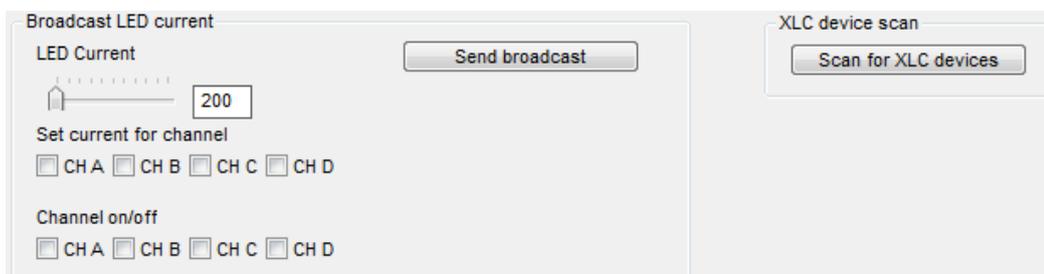
NOTE By pressing **F10** or **F11** you can save the configuration of the light controllers to a setting.

During start-up, the light controllers are configured according to setting 1 in the following way:

- If a **Channel selector** check box was selected in the last request before the settings were burned, the current is set to the specified value for the respective LED light, whereas for the remaining lights it is set to the default value.
- Lights are switched on or off according to the selected **XLC light control** check boxes.

8.11.3 Configuring all connected light controllers using broadcasting

If you want to configure all connected light controllers identically, you can use the parameters for broadcasting, shown in the upper part of the **XLC LED control** page:



To configure all light controllers identically:

1. To change the current, move the slider or enter a value in the text box, and at **Set current for channel** select the check boxes of the channels, at which the change should take effect at all light controllers.
2. To switch lights on or off at all light controllers, select or clear the respective check boxes at **Channel on/off**.
3. Click **Send broadcast** to send the request to the camera.

NOTE Be aware that the **LED current** value only shows the value you specified. It is not possible to read out the used current for any LED light.

NOTE Take notice that the check boxes at **Set current for channel** and at **Channel on/off** have different meaning:

If a check box is cleared at **Set current for channel**, the respective LED lights are not affected if you press **F9**, i.e. their current remains unchanged.

If a check box is cleared at **Channel on/off**, the lights at the respective channel are switched off if you press **F9**. Thus, the state of the check boxes determines for all channels whether the connected lights are switched on or off.

NOTE By pressing **F10** or **F11** you can save the configuration of the light controllers to a setting.

During start-up, the light controllers are configured according to setting 1 in the following way:

- If a **Set current for channel** check box was selected in the last request before the settings were burned, the current is set to the specified value for the respective LED light, whereas for the remaining lights it is set to the default value.
- Lights are switched on or off according to the selected **Channel on/off** check boxes in the last request before the settings were burned.

8.11.4 Error codes

The light controllers check the temperature of the LED lights regularly. If the temperature exceeds its limit, the respective light is switched off to prevent damage.

The camera checks the controllers regularly for errors. All occurring errors are reported in the trace with the XLC error code. In addition, errors may be returned if you send a request to the camera or if you request the camera status.

The following error codes may be returned:

XLC error code	CST description
	NO ACK RS485 light control unit not available!
	XLC light controller not connected
100 101	XLC_Error!
102	XLC parameter exceeds limits
103	XLC_Error!
200 201 202 203 215	LED Voltage error!
204	XLC warning temperature exceeded
205	XLC temperature exceeds limits
206	XLC_Error!
210 211 212 213	XLC memory error
214	XLC Corona fan error (Corona: Chromasens LED illumination)

9 Camera parameters

The camera parameters are arranged in the same order as they are listed in the CST software. In this part of the manual, the parameters are described “as they are”. For a description how to setup the camera, refer to chapter 8 “Camera operation”.

The visibility of the parameters is defined by the selected user level in CST. For information about the user level that is required to modify certain parameters, see section 9.18.

You may find a general overview of the camera parameters and their general functions on the CST user interface in chapter 6.

9.1 Output format

9.1.1 Camera Link interface type

Name	
Name	Type of Camera Link interface
Function	Sets the output to Base, Medium, Full64 or Full80 mode
Channels	All
Unit	Integer
Dependency	For color output, six RGB modes are available. If the Weighted gray check box is selected and with a mono camera, three Mono modes are available.
Notes	<ul style="list-style-type: none"> • For some modes, the line rates and integration time are limited. • For some modes, the scan line length must be a multiple of x. • For Base mode, the Camera Link connector 1 must be used. • allPIXA wave-Mono supports only Mode 2 and 3
RGB	
Mono	
Lower limit	Base 1X 1Tx8b RGB
	Base 1X 3Tx8b Mono
	Medium 1X2 2Tx8b RGB
	Medium 1X4 4Tx8b Mono
	Medium 1X 1Tx12b RGB
	Full64 1X8 8Tx8b RGB-Raw
	Full80 1X10 10Tx8b RGB-Raw
Upper limit	Medium 1X4 4Tx12b Mono
Upper limit	Full80 1x8 8Tx10b RGB-Raw

*) According to Camera Link Specification only Raw, i.e. planes/tap because these modes are only defined for Mono output, that means three gray values must be interpreted as a single RGB pixel (see Camera Link Specification, or GenICam SFNC).

9.1.2 Set line equalization

Name	
Name	Set line equalization
Function	For some versions of the allPIXA wave hardware, this parameter permits to increase output signals if problems with long cables occur.
Channels	All
Unit	Byte
Dependency	Not available for newest allPIXA wave hardware that detects problems and increases signals automatically.
Notes	
Camera	Values
All	off
All	low
All	medium
All	high

If problems occur due to very long cables, you should try which value of this parameter eliminates the problem.

9.1.3 Swap red and blue color channel

Name	
Name	Swap red and blue color channel
Function	On video output, the red and the blue channel are changed
Channels	Red, blue
Unit	Bool
Dependency	This parameter is only present for a color camera
Notes	Some frame grabbers first expect the blue channel instead of the red channel, and this may cause wrong colors in the resulting image. Swapping the channels can be done in real-time inside the camera. It is usually faster than doing it with the frame grabber.
Camera:	Values:
Lower limit	All Off
Upper limit	All On

9.1.4 Mirror image horizontally

Name	
Name	Mirror image horizontally
Function	Mirrors the lines inside the camera.
Channels	All
Unit	Bool
Dependency	None
Notes	Function must be switched off for the acquisition of the black-value and shading reference (white balancing).
Camera: Values:	
Lower limit	All Off
Upper limit	All On

This function changes the sequence of the pixels within the line; that means, the left pixels are replaced by the right ones. As a result, the alignment of the line with the direction of transport is possible, irrespective of the camera's installation position (pixel 1 left or right).



With mirroring



Without mirroring

9.1.5 Set TDI operating mode

Name		
Name	Set TDI operating mode	
Function	By default, the data of the first sensor line are output. If you select 2-TDI or 3-TDI , a weighted gray value is output, using two, or all three sensor lines, respectively. This can be used to increase sensitivity.	
Channels	All	
Unit	Integer	
Dependency	Only for mono-camera	
Notes		
Camera:		Values:
Lower limit	Mono	1-TDI
	Mono	2-TDI
Upper limit	Mono	3-TDI

9.1.6 Video output mode

Name		
Name	Weighted gray	
Function	By default, the output mode on the Camera Link port is RGB. By selecting the check box, you can change it to gray-level output.	
Channels	All	
Unit	Integer	
Dependency	Only for color camera with RGB or white-output, not for mono-camera	
Notes	For the gray image calculation, the values of Color weights are used.	
Camera:		Values:
Lower limit	All	Off
Upper limit	All	On

9.1.7 Color weights

Name			
Name	Color weights		
Function	Calculates the mono-value for the pixel using data from RGB, weighted with this factor.		
Channels	Red; Green; Blue		
Unit	Float	Step:	0,01
	Linear		
Dependency	Only available if the Weighted gray check box is selected		
Notes	<p>The sum of these 3 parameters should be 1.0. A higher sum causes a “brighter” image, and a lower sum causes a “darker” image. Standard values by NTSC and the default values in the camera are:</p> <p>Red: 0.299 Green: 0.587 Blue: 0.114</p>		
Camera:		Value:	
Lower limit	All		0
Upper limit	All		1

9.1.8 Insert mode

On request the camera can add different information to the image. This can be helpful for analyzing the system behavior and to identify problems.

Name		
Name	Insert mode	
Function	Specifies that different camera data should be displayed in the first pixels of the image (for example image counter or line counter)	
Channels	All	
Unit	Byte	
Dependency	None	
Notes	The parameter inside the camera is measured in bytes. In CST the single bits can be set by the check boxes.	
Camera	Function	
All	First line info block	
All	Test ramp last line	
All	Info block in each line	

Single information is displayed in the image as shown below:

- „FirstLine InfoBlock“:
Image-related information is shown in the first 22 pixels of the image’s first line. The image functionality is required.
- „EachLine InfoBlock“:
Line-related information is shown in the first 10 or 17 pixels of each line, depending on the selections for **Insert Mode**.

Last line information:

There are 2 options for the last line of the image:

- A test ramp is inserted into the last line. Image functionality is required. It starts with 128 from outside, increments with 1 and overruns with 255.
- The check sum for the image data is inserted into the last transmitted pixels of each tap. In the resulting image they are located centrally on both sides of the tap border. image functionality is required.

9.1.8.1 First line information

Overview of the info block „First line info block“ (RGB and Gray):

For RGB, the three colors contain the identical information. For gray, the description is valid for 8 bits per plane. For gray with 12 bits per plane, the information is left-aligned in the first 8 bits. To get the value, the data must be shifted to the right by 4 bits.

Pixel	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Line 0		Serial no.					Image count		Integration time			Line time			Encoder clocks				Error reg.		Time stamp			

Information	Pixel	Description
Serial number	1 – 2 – 3 – 4	Displays the serial number of the camera as 16+16-bit value: Px 1 MSByte SerialNumber_FirstPart, Px 2 LSByte SerialNumber_FirstPart, Px 3 MSByte SerialNumber_SecondPart, Px 4 LSByte SerialNumber_SecondPart, Sample:1000-1234 = allPIXA camera with serial number 1234.
Image Count	6 – 7	16-bit image counter starts at power on with 0 and could be preset by software using TAG_IMAGECOUNTER (291 H). Px 6 MSByte, Px 7 LSByte, The counter is incremented at the end of an image. Thus it contains the number of completely transferred images.
Integration time	8 – 9	16-bit value of the current integration time for the SENSOR in pixel clocks at 33.33 MHz. Integration time, which are measured in μ s, is: $IntTime * ClkPeriod / 1000000 * 1,5$ (ClkPeriod of EachLineInfo) Px 8: MSByte, Px 9 LSByte. Only available for RGB.
Line time	11 – 12 – 13	20-bit value of the current line time for the SENSOR in pixel clocks. Line time, measured in μ s, is: $LineTime * ClkPeriod / 1000000$ (ClkPeriod of EachLineInfo) Px 11: MSByte Px 12 MidByte Px 13 LSByte
Encoder clocks	14 – 15 – 16 – 17	32-bit counter starts with power-on with 0 and has an overflow at 2^{32} . Line trigger pulses (line trigger active) and encoder pulses (encoder active), counts depending on the selected mode; can be used as position information by a sequence of documents. Can be reset by software (TAG_CLEAR_ENCODER, 947 H). Px 14: MSByte Px 15 higher MidByte Px 16 lower MidByte Px 17 LSByte

Error register	18-19	<p>Gray output: Px 18: error code MSByte, Px 19: error code LSByte,</p> <p>RGB output: Px18 Red: error code MSByte, Px19 Red: error code LSB. Px18 Green: board temperature, Px19 Green: 0, Px18 Blue: sensor temperature, Px19 Blue: 0.</p>
Time stamp	20 – 21 – 22	<p>„Real time clock“</p> <p>Output is in a 16.8b seconds value. TimeStamp (23:8) states the seconds when the power is on or in case of reset. TimeStamp (7:0) issues the decimal places in a multiple of 4 milliseconds. (0...249)</p> <p>Sample: TimeStamp = 0x123456 → 0x1234 = 4660 seconds since start = 1h, 17min, 40 seconds → 0x56 = 86 *4= 344 ms.</p> <p>Px 20 MSByte Px 21 MidByte Px 22 LSByte</p>
Markers	0 – 5 – 10 – 23	<p>It is used for marking the info block with red pixels.</p> <p>Red xFF Blue x00 Green x00</p>

9.1.8.2 Each line information

Overview of the info block „Each line info block“ (RGB):

Pixel	0	1	2	3	4	5	6	7	8	9
Value										
Red	xFF	Error register	Speed2High Line time (19:16)	Encoder clock (23:16)	Next line pos. (15:8)	Time stamp (15:8)	MaxVal. (23:16)	Null	Reserved	xFF
Green	Cont Line CNT 15:8	Line count (15:8)	Line time (15:8)	Encoder clock (15:8)	Next line pos. (7:0)	Time stamp (15:8)	MaxVal. (15:8)	ClkPeriod(15:8)Period	Reserved	
Blue	Cont Line CNT 7:0	Line count (7:0)	Line time (7:0)	Encoder clock (7:0)	Next line pos. Frac.(7:0)	Time stamp (7:0)	MaxVal. (7:0)	ClkPeriod(7:0)	Reserved	

Information	Pixel	Channel	Description
ContLineCNT	0	G/B	If Image start delay has the value 0, a line count is inserted as 16-bit value in the green and blue channel. The lines are counted continuously, i.e. the count is not reset at the start of a new image. Can be used to check whether lines are missing between adjacent images.
Error state	1	R	In case of an error: 0x80. The error code can be found in FirstLineInfoBlock.
Line Count	1	G/B	16-bit line count since image start
Speed too high	2	R (7)	The highest bit has the value of "Speed2High" (the line time decreases the set integration time). Now the camera is in free running line mode (only in Encoder/Line trigger mode if the speed becomes too high).
Line time	2	R/G/B	20-bit value of the current line time for the SENSOR in pixel clocks. The line time, measured in μs , is: $\text{LineTime} \cdot \text{ClkPeriod} / 1000000$ (ClkPeriod of EachLineInfo) Red MSByte (3:0), Bits (6:4) are zero Green MidByte Blue LSByte
Encoder clock	3	R/G/B	24-bit counter starts at power-on with 0 and overflows at 2^{24} Line trigger pulses (line trigger active) and encoder pulses (encoder active) are counted depending on the selected mode and can be used as position information by a sequence of documents. It can be reset by software using TAG_CLEAR_ENCODER (947 H). Red MSByte Green MidByte Blue LSByte
Next line trigger position	4	R/G/B	Information of the next line trigger position in encoder pulses (only at encoder mode). The calculated position is shown in a 16.8b value. If encoder averaging is used, the value is divided by the average size. Red MSByte integer part Green LSByte integer part Blue decimal place
Time stamp	5	R/G/B	„Real time clock“ Output is in a 16.8b seconds value. TimeStamp (23:8) states the seconds when the power is on or in case of reset. TimeStamp (7:0) issues the decimal places in a multiple of 4 milliseconds. (0...249) Sample: TimeStamp = 0x123456 → 0x1234 = 4660 seconds since start = 1 h, 17 min, 40 seconds → 0x56 = 86 *4= 344ms. Red MSByte Green MidByte Blue LSByte
Max video value	6	R/G/B	Maximum (raw-) video value for each color of the last whole line.
ClkPeriod	7	G/B	Period time in ps for the LineTime (Px2) and IntTime / LineTime (In FirstLineInfo) Green MSByte Blue LSByte
Marker	0	R/G/B	It is used for marking the info blocks with red pixels. Red xFF Blue x00 or ContLineCNT first byte Green x00 or ContLineCNT second byte (see above)

Overview of the info block „Each line info block“ (Mono):

Pixel	0	1
Value		
Mono	LineCNT (15:8)	LineCNT (7:0)

With 12-bit camera link mode, the values are left-adjusted. To get the true values, they must be shifted by 4 bits.

9.1.8.3 Last line information

A test ramp can be inserted into the last line. It starts with 128. With 12 bits per plane, the values are left-adjusted in the first 8 bits of each pixel.

The test ramp can be used to determine the last line of an image.

The values increase in the following way:

	RGB	Mono
8 bits per plane	by 1 every pixel	by 1 every 3 pixels
12 bits per plane	by 16 every pixel	By 16 every 3 pixels

9.2 Integration time parameters

9.2.1 Integration time in μ s

Name			
Name	Integration time		
Function	Sets the integration time in microseconds		
Unit	Float	Step:	0.001
	Linear		
Dependency	None		
Camera:		Value CST:	
Lower limit	10k	1,0 μ s	
	15k	1,0 μ s	
Upper limit	all	Line Period – 1,5 μ s	

Please note: In some of the following graphs the abbreviation *Int.time* is used sometimes.

9.2.2 Min Integration time in μs

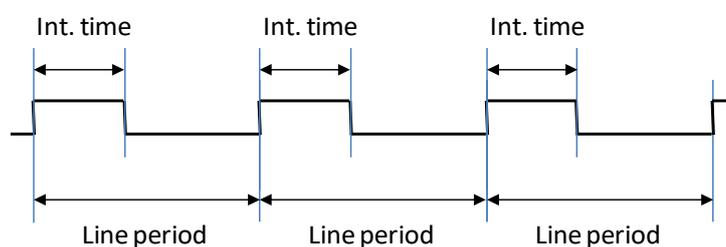
Name			
Name	Min Integration time in μs		
Function	Shows the minimum adjustable integration time in microseconds.		
Unit	Float	Step:	0.001
	Linear		
Dependency	None		
Camera:		Value CST:	
Lower limit	10k	1,0 μs	
	15k	1,0 μs	
Upper limit	all	Line Period – 1,5 μs	

9.2.3 Max Integration time in μs

Name			
Name	Max Integration time in μs		
Function	Shows the maximum adjustable integration time in microseconds.		
Unit	Float	Step:	0.001
	Linear		
Dependency	None		
Camera:		Value CST:	
Lower limit	10k	1,0 μs	
	15k	1,0 μs	
Upper limit	all	Line Period – 1,5 μs	

9.2.4 Line period time

Name			
Name	Line period time in μs		
Function	Sets the value for line period in microseconds to the camera.		
Unit	Float	Step:	0,001
	Linear		
Notes	Value must be greater than Integration time .		
Camera:		Value CST	
Lower limit	10k	Depending on image size, ROI position, and Camera Link mode.	
	15k		
Upper limit	All	10 ms	



9.2.5 Min Line period time in μ s

Name			
Name	Min Line period time in μ s		
Function	Shows the minimum adjustable Line period time in microseconds		
Unit	Float	Step:	0,001
	Linear		
Notes	For easiest handling, the camera calculates the minimum adjustable value for Line period time in microseconds automatically.		

9.3 Gain and reference

9.3.1 Enable continuous white control

Name		
Name	Enable continuous white control	
Function	Enables the closed loop control for white balancing	
Channels	all	
Unit	Bool	
Dependency	None	
Notes		
Camera: Values:		
Lower limit	all	Off
Upper limit	all	On

9.3.2 White control mode

Name	
Name	White control
Function	Set the mode of the white control function
Channels	All
Unit	
Dependency	It is only available if the Enable continuous white control check box has been selected.
Notes	Function is only available if User level has been set to Guru .

Two options are available:

- Use sync mode: If you use this option, white control sets the white reference into the image regarding to the necessary frame trigger.
- Stop gain control: If the value of the white reference video level is lower than the specified value, the closed-loop control for white balancing can be paused by using this option (for example, if the light on the white reference is lowered without any present document (stray-light from the document)).

9.3.3 Gain control stop factor

Name			
Name	Set gain control stop factor		
Function	Sets the pause condition for the white control.		
Channels	All		
Unit	Float	Step:	1/1024
Dependency	It is only available if the check boxes Enable continuous white control and Stop gain control are both selected in the White control area.		
Notes	<p>If you use this condition, the white control pauses: Average of all current "Current white reference values" < value * Average of the last valid "Current white reference values".</p> <p>This parameter is only shown if User level has been set to Guru.</p>		
Camera:		Value CST:	
Lower limit	All		0
Upper limit	All		1

1. Description of paper (object) detection function:

During the scan, the camera is set to automatically control the image brightness using the implemented function "Automatic white control". The control mechanism of the camera uses the reference area on the object to adapt the camera gain values as defined within the camera parameters.

In certain situations during the scan process it can occur that an object is missing on the transport. If no object is on the transport, the reference area for the brightness control appears darker than the normal paper white. Therefore, a missing object can irritate and misguide the automatic gain process. With the paper detection functionality, the existence of a sheet is detected, and the automatic gain control stops if no object (certain degree of brightness) is found on the transport.

2. Basic functionality description:

The camera reads the white value of the reference area. If the brightness of the reference area is below the suppress condition, automatic white control is disabled only for the currently scanned image. The procedure is applied separately to each acquired image.

3. Suppress condition:

Mean of value of current reference area < (mean value of desired values of all channels * threshold factor).

4. Feedback camera signal:

While gain control is disabled, the image is scanned with the last valid gain values. The camera sets a flag if the values in the reference area are too low (-> no paper) and the "automatic gain control" function is disabled.

Example:

All desired values for the white reference target value are set to 800, stop gain control factor is set to 0.5.

If sum of all current white references drops below $0.5 * 800 = 400$, then automatic gain control is disabled.

9.3.4 Linear camera gain values

This parameter describes the main gaining parameters of the camera.

Name		
Name	Linear gain	
Function	Gaining values for the gaining of the camera.	
Channels	White, Red, Green, Blue	
Unit	Float	
	Linear	
Dependency	For an RGB camera, separate parameters for the colors red, green, and blue are shown. For a mono-camera only a single parameter for white is shown.	
Notes	<p>Due to the linear functionality, the gain for a desired video level is easy to calculate:</p> $\text{Gain}_{\text{new}} = \text{Gain}_{\text{old}} * (\text{desired video value} / \text{actual video value})$ <p>These gain values are stored in settings of the camera.</p> <p>The gaining values stored in these settings are also used as startup values for a faster startup behavior of the closed-loop control for white balancing.</p>	
Camera:		Value:
Lower limit	all	0.5
Upper limit	all	50

9.3.5 Target reference values

Name		
Name	Target reference values	
Function	Video value for the desired value of the closed-loop control for white balancing	
Channels	White, Red, Green, Blue	
Unit	Integer	
	Linear	
Dependency	For an RGB camera, separate parameters for the colors red, green, and blue are shown. For a mono-camera only a single parameter for white is shown.	
Notes	<ul style="list-style-type: none"> Refers to the white control mark. Inside this area the closed-loop control tries to adjust gain to reach these desired values. Internal value is a 12-bit video, GUI values are 10-bit video value, the range of the output image depends on the camera link mode and can be 8bit or 12bit. 	
Camera:		Value:
Lower limit	all	0
Upper limit	all	1023 – dark reference value

This parameter refers to the reference values labeled with (1) in the diagram in section 4.10.

NOTE I The maximum reachable value for the target values is **Target values = 1023 - max dark reference value** (with active black-level correction). The typical dark reference values are about 16 ...64 (in 10 bit) in the raw image data.

NOTE II The level of the target value has to be adapted to the position of the white reference control zone (see **Figure 30** . For zone 1, the values have to be set to a lower value than for zone 2. If the target values for zone 1 are too high, this results in saturation at the center of the image.

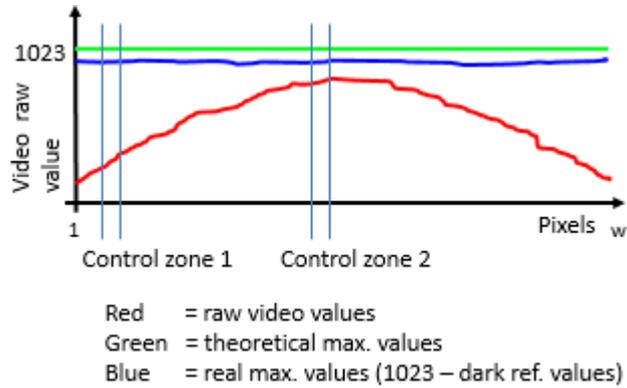


Figure 30 Sample of raw and theoretical video and dark reference values (with 10-bit GUI value range)

9.3.6 Actual reference values

Name		
Name	Actual reference value	Read-only
Function	Video value measured by the camera inside the white control mark; mean value over the defined area and the number of ROIs defined for averaging	
Channels	White, Red, Green, Blue	
Unit	Integer	
	Linear	
Dependency	For an RGB camera, separate parameters for the colors red, green, and blue are shown. For a mono-camera only a single parameter for white is shown.	
Notes	<ul style="list-style-type: none"> Refers to the white control mark. 10-bit video output value. Output range of the image at the Camera Link port is usually in the 8-bit range 	
Camera:		Value:
Lower limit	all	0
Upper limit	all	1023

This parameter refers to the video values labeled with (2) in the diagram of section 4.10.

9.3.7 Analog CDS gain

This parameter describes the CDS gain parameter of the camera which takes effect before the digitalization of the analog signal.

Name	
Name	CDS Gain
Function	Pre-amplification before the ADC.
Channels	Red, Green, Blue, White
Unit	*1, *2
	Linear
Dependency	For an RGB camera, separate parameters for the colors red, green, and blue are shown. For a mono-camera only a single parameter for white is shown.
Notes	Use this parameter for a rough adjustment of gaining at the first step.
Camera:	Value CST:
Lower limit	all *1
Upper limit	all *2

CDS gain is a pre-amplification factor (basically to adapt the output signal before the ADC). With this “adjustable two-step amplification” it is possible to adjust the allPIXA wave for a wide range of applications.

Usage: If the linear gaining values are higher than 10 (which results in a higher gain), the **CDS gain** amplifier may be used (set to a higher amplification factor) to decrease gain values. Otherwise, the image pixel noise increases.
It is recommended to operate the camera with linear gaining values in a range from 1 – 10 for best image quality by using the **CDS gain** function to pre-adjust the actual gain range.

9.3.8 Full-well capacity

Name	
Name	Full-well capacity
Function	Selecting High dynamic doubles pixel capacity.
Channels	Red, Green, Blue, White
Unit	High dynamic, High sensitivity
	Linear
Dependency	For an RGB camera, separate parameters for the colors red, green, and blue are shown. For a mono-camera only a single parameter for white is shown.
Notes	Use this parameter for a rough adjustment of gaining at the first step.
Camera:	Value CST:
Lower limit	all High dynamic
Upper limit	all High sensitivity

9.3.9 Select active channels for white control

Name		
Name	Select active channels	
Function	Determines which channels are active during automatic white balancing	
Channels	All	
Unit		
Dependency	Applies only to all automatic gain control functions such as white balancing. Only available if User level has been set to Guru .	
Notes	<p>If you work with “white” illumination, leave all channels set to “Enabled” (Standard use of the allPIXA wave).</p> <p>This function is useful if you work with different lighting conditions. If you are for example working with three different light setups for the different color channels you could turn on the lights for one channel, disable the other “Active channels” and perform white and tap balancing. After this you run through the same procedure for the other channels. If you disable the channel, the old values for the white or tap balancing are not overwritten.</p>	
Camera:		Value:
Lower limit	All	0
Upper limit	All	1

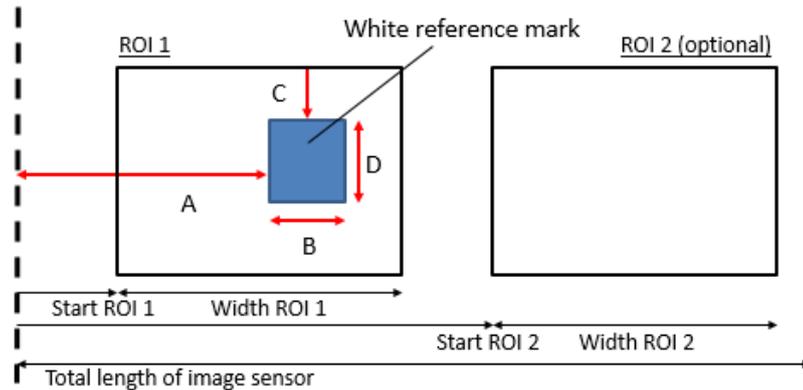
For more details, see section 8.4.4.

9.4 White reference mark

9.4.1 Position and size in sensor direction

“Absolute” x position of the white reference mark:

The x position of the white reference mark can be defined “absolute” to the first pixel of the sensor within the whole scan window. The reference position **does not** move if the width of the current ROI window is changed.



A = First absolute pixel of white reference (see section 9.4.3)

B = Number of pixels for white reference (see section 9.4.4)

C = First image line of white reference (may be negative), only used if *white control mode is set to “sync mode”* (see section 9.4.5)

D = Number of image lines for white reference (see section 9.4.6)

Total length of the image sensor depends on the type of camera:

allPIXA wave camera 10K : number of valid pixels = 10240

allPIXA wave camera 15K : number of valid pixels = 15360

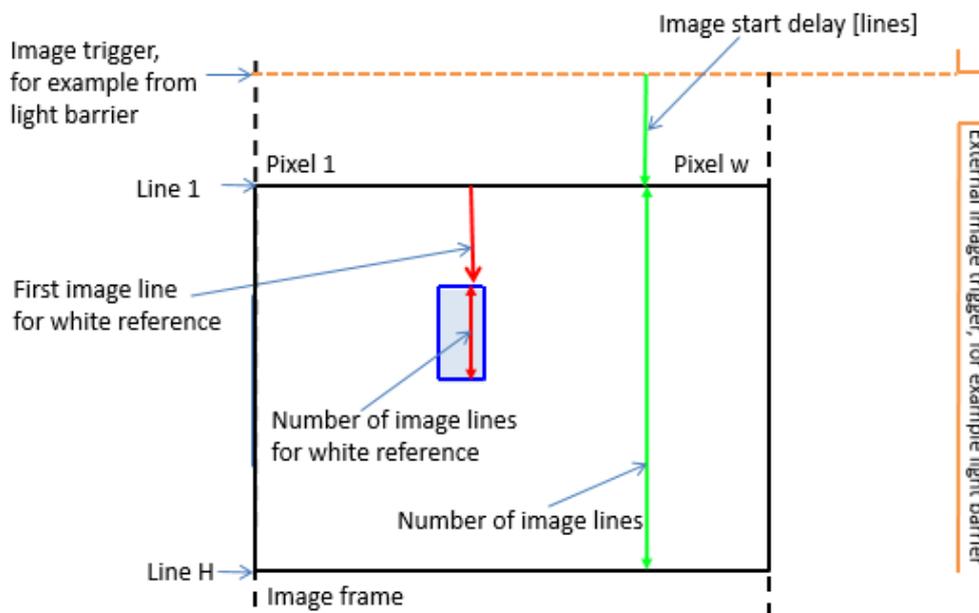
Size of the white reference area is defined by **Number of pixels for white reference**.

9.4.2 Position and size in transport direction (sync. mode)

By default, the reference area is not synchronized to image frame acquisition. Measurement of white reference values is done continuously, no matter if the image frame is active or not.

If **Use sync mode** is selected at **White control** (9.3.2), the reference area is defined as ROI to the captured image frame.

The y position of the white reference ROI is defined “relative” to the current image window.



The vertical size of the white reference area is defined by **Number of image lines for the white reference**.

9.4.3 First absolute pixel of white reference

Name	
Name	First absolute pixel of white reference
Function	Describes the start pixel of the control zone for the white balancing in the line / image (beginning from first pixel of the camera)
Channels	All
Unit	Integer
Dependency	None
Notes	<p>The white reference is independent of the ROIs and can also be in a non-visible area outside the active ROIs.</p> <p>For the RGB mode, the camera requires odd values! To simplify the operation for the user, the camera corrects the values entered by the user to odd values.</p> <p>For the Mono-line mode, the camera requires values that are divisible by 6. To simplify the operation for the user, the camera corrects the values entered by the user to values which are divisible by 6.</p>
Camera: Value:	
Lower limit	All 3
Upper limit	10k 10240 – Number of pixels of white reference
	15k 15360 – Number of pixels of white reference

9.4.4 Number of pixels for white reference

Name		
Name	Number of pixels for white reference	
Function	Describes the width in pixel of the control zone for the white balancing in the line/image	
Channels	All	
Unit	Integer	
Dependency	None	
Notes	For the 3-line RGB mode, the camera requires values that are divisible by 8. To simplify the operation for the user, the camera corrects the values entered by the user to values which are divisible by 8. For the Mono-line mode, the camera requires values that are divisible by 24. To simplify the operation for the user, the camera corrects the values entered by the user to values which are divisible by 24.	
Camera:		Value:
Lower limit	All	2
Upper limit	All	1022

9.4.5 First image line for the white reference

Name		
Name	First image line for the white reference	
Function	First image line of control zone in transport direction	
Channels	All	
Unit		
Dependency	Only if the image-synchronized mode is used for white balancing.	
Notes		
Camera:		Value:
Lower limit	All	1 – Image start delay [lines], >=-8000
Upper limit	All	Image start delay [lines] + Number of scan lines per image – Number of image lines for the white reference <=32767

9.4.6 Number of image lines for the white reference

Name		
Name	Number of image lines for the white reference	
Function	Length of control zone in transport direction	
Channels	All	
Unit	Integer	
Dependency		
Notes		
Camera:		Values:
Lower limit	All	0
Upper limit	All	240

9.4.7 Number of reference samples (Average)

Name		
Name	Number of reference samples for white reference	
Function	Number of ROIs needed for averaging of current video value for closed-loop control, either with synchronization or in free-running mode.	
Channels	All	
Unit	Integer	
	None; 2; 4; 8; 16; 32	
Dependency	None	
Notes		
Camera: Values:		
Lower limit	All	None
		2 samples
		4 samples
		8 samples
		16 samples
Upper limit	All	32 samples

9.4.8 Show white reference border

Name		
Name	Display white reference borders in the image	
Function	Displays the border of the control zone in the image with blue lines.	
Channels	All (Blue: 255(4095); Red and Green: 0)	
Unit	Bool	
Dependency	None	
Notes	Function must be switched off for taking reference images regarding to black-level and white-level correction.	
Camera: Values:		
Lower limit	All	Off
Upper limit	All	On

9.5 Reference usage

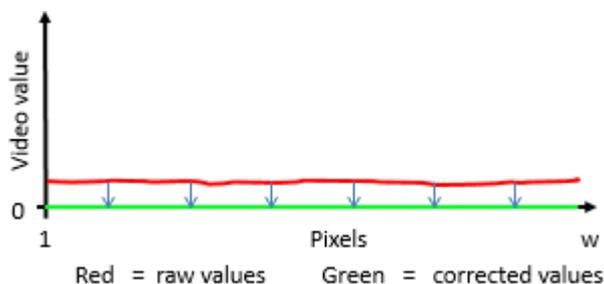
9.5.1 Black-level correction (offset correction)

Name		
Name	Activate black-level correction	
Function	This function enables the pixel-wise black-level correction inside the camera.	
Channels	All	
Unit	Bool	
Dependency	None	
Notes		
Camera:	Values:	
Lower limit	All	Off
Upper limit	All	On

Black-value correction is made of the pixel-by-pixel mode and corrects the different behavior of the individual pixels (**DSNU** = **D**ark **S**ignal **N**on-**U**niformity) in dark images. Black-value correction is carried out with a non-exposed sensor (for example if the lens is closed, the illumination is switched off, or a black reference is scanned).

Black-value correction is carried out individually on each allPIXA wave camera during factory calibration.

Two reference sets for the black-level correction are supported by the allPIXA wave camera as well as two reference sets for the shading correction. You can specify the reference position number if you create the reference using the Reference Wizard in CST, and it can be selected in the allPIXA wave camera setting. All reference sets can be used for different setups, for example different f-stops or different illuminations.



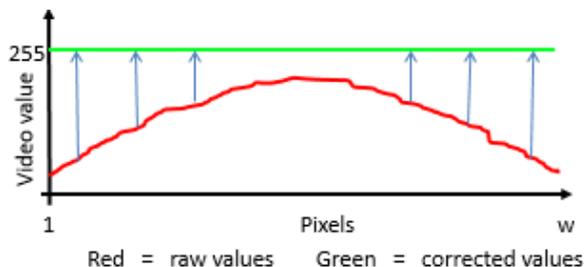
This parameter refers to the video values labeled with **(1)** in the diagram of section 4.6.

9.5.2 Shading correction (flat-field correction)

Name		
Name	Activate white-level correction	
Function	This function enables the pixel-wise shading correction inside the camera.	
Channels	All	
Unit	Bool	
Dependency	None	
Notes		
Camera:	Values:	
Lower limit	All	Off
Upper limit	All	On

Shading correction is made of the pixel-by-pixel mode and corrects the different behavior of the individual pixels in the images (**PRNU = Photo Response Non-Uniformity**). Additionally, it compensates any non-homogeneities in illumination.

Two reference sets for the shading correction are supported by the allPIXA wave camera, as well as two reference sets for the black-level correction. The reference position number can be entered if the reference is created using the Reference Wizard in CST, and it can be selected in the allPIXA wave camera setting. All reference sets can be used for different setups, for example, for different f-stops or different illuminations.



This parameter refers to the video values labeled with **(2)** in the diagram of *section 4.10*.

Internal processing is not limited to 255@8bit. This means that after shading correction it is possible to additionally process higher values such as 300, which can be taken without loss into the visible area by using the brightness and contrast control afterwards.

9.5.3 Black reference data set

Name	
Name	Black reference data set
Function	Select the data set for black-level correction.
Channels	All
Unit	Integer
Dependency	None
Notes	Two data sets for black-level reference can be stored inside of the camera. The number for the storage space must be selected in CST during the Shading wizard process.
Camera: Values:	
Lower limit	All Data set 1 is used
Upper limit	All Data set 2 is used

9.5.4 White reference data set

Name	
Name	White reference data set
Function	Select the data set for shading correction.
Channels	All
Unit	Integer
Dependency	None
Notes	Two data sets for white-level reference can be stored inside the camera. The number for the storage space must be selected in CST during the Shading wizard process.
Camera: Values:	
Lower limit	All Data set 1 is used
Upper limit	All Data set 2 is used

9.6 Brightness and contrast

These parameters describe the digital gaining and offset parameters for the camera. This operation takes place in step (3) of the digital image processing pipeline (see section **Fehler! Verweisquelle konnte nicht gefunden werden**. Figure 11: Digital processing of the allPIXA wave camera (block diagram”).

NOTE

If these parameters are used to adjust image brightness in a wide range to get brighter images, this may degrade image quality.

First, use linear gaining to adjust brightness of the image (see section 9.3.4). For instance, after adjusting linear gain and performing a shading correction (it sets the values for white to 255), you can get the white slightly out of the area of image saturation from 255 to 245.

Internal processing is not limited up to 255@8bit. This means that after shading correction it is possible to additionally process higher values such as 300, which can be taken without loss into the visible area by using the brightness and contrast control afterwards.

9.6.1 Gamma correction

Name			
Name	Gamma correction		
Function	Performs a LUT operation for gamma correction with image data		
Channels	All		
Unit	Float	Step	0.1
	Log.		
Dependency	None		
Notes	<ul style="list-style-type: none"> The value 0 causes the camera to ignore the mentioned image processing step with the LUT; value “1” causes a linear LUT (output=input) which may be used. For the value 0.1 a special gamma table for sRGB conversion is stored! See also section 8.9.4. This function must be switched off for the acquisition of the black-value and shading reference (white balancing). 		
Camera:		Values:	
Lower limit	all		0
Upper limit	all		2.5

A CMOS sensor has a linear sensitivity (the brightness sensitivity of the human eye is non-linear). Gamma correction can be used to adapt the linear sensitivity curve of a camera to the human eye. As a result, the brightness in certain areas of the image is increased, whereas it is lowered in others.

With a gamma value of 1, the curve is linear, if the gamma value is lower than 1, the images are darker, and images with a gamma value above 1 are brighter.

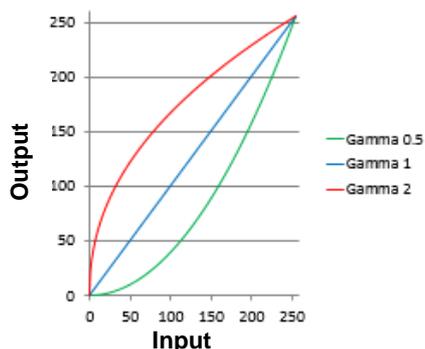


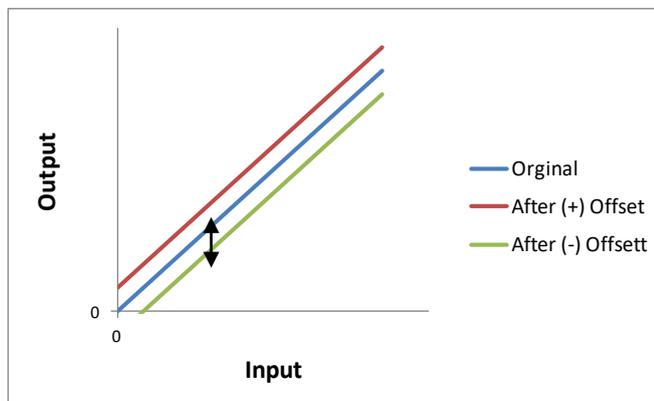
Figure 31: Gamma correction

9.6.2 Use brightness and contrast

Name		
Name	Use brightness and contrast	
Function	Enables the digital gaining and contrast function in the camera.	
Channels	All	
Unit	Bool	
Dependency	None	
Notes		
Camera:	Values:	
Lower limit	all	Off
Upper limit	all	On

9.6.3 Brightness

Name			
Name	Brightness offset		
Function	Digital offset		
Channels	Red; Green; Blue		
Unit	Integer		
	Linear		
Dependency	Only available if the Use Brightness and Contrast check box has been selected.		
Notes	<p>For an RGB camera, separate parameters for the colors red, green, and blue are shown. For a mono-camera only a single parameter for white is shown.</p> <p>The value refers to 12-bit image data, in an 8-bit /12-bit output image.</p>		
Camera:	Value:	Output image:	
Lower limit	all	-1023	-63@8bit -1023@12bit
Upper limit	all	1023	63@8bit 1023@12bit



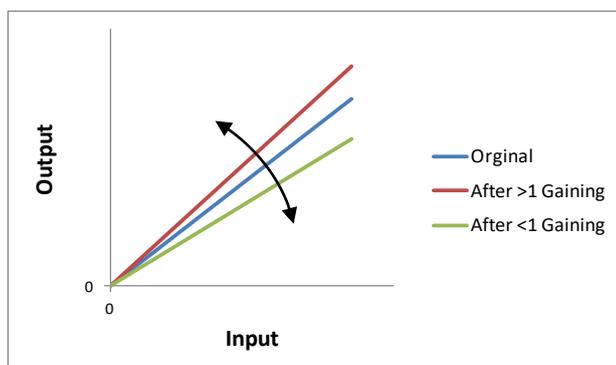
Take notice that using “Brightness” causes a digital offset in the image data:

$$Vid\ Brightness\ Out(x,y) = (VidIn(x,y) + Offset)$$

- VidIn(x,y) Pixel-normalized image after shading correction (0...8191 in 12Bit area = 0...2.0)
- Offset Additional adjustable “Brightness” for this color separation (-1023... 0 +1023 in 12Bit area)
- (x, y) Number of pixels within a line or column
- Vid Brightness Out(x,y) Output of this step (area 0...4095)

9.6.4 Contrast

Name			
Name	Contrast gain		
Function	Digital gaining		
Channels	Red; Green; Blue		
Unit	Float	Step	0.01
	Linear		
Dependency	For an RGB camera, separate parameters for the colors red, green, and blue are shown. For a mono-camera only a single parameter for white is shown Only available if the Use Brightness and Contrast check box has been selected		
Notes			
Camera:		Values:	
Lower limit	all	0	
Upper limit	all	2	



Take notice that using „Contrast“ causes digital increase or decrease of sensitivity.

$$Vid\ Contrast\ Out(x,y) = Vid\ Brightness\ Out(x,y) * Gain$$

- Vid BrightnessOut (x,y) Pixel-normalized image after the Vid Brightness correction (0...8191 in 12Bit area = 0...2.0)
- Gain Additionally adjustable “Contrast” for this color separation (0...1...2.0)
- (x, y) Number of pixels within a line or column
- VidContrastOut (x,y) Output of this step (area 0...4095)

NOTE Calculation is performed in the following order (see section **Fehler! Verweisquelle konnte nicht gefunden werden.** (Figure 17)):

1. Brightness
2. Contrast

9.7 Camera arrangement

9.7.1 RGB line distance

Name			
Name	Set RGB line distance		
Function	Delays the line output for the two other lines to match the shift by different positions on the sensor which is also called "Spatial correction".		
Channels	All		
Unit	Float	Step	1/1024
	Linear		
Dependency	None		
Notes	<p>The value "0" switches this function off.</p> <p>For cameras up to 10k, the line delay can be set up to three lines; for cameras with sensor length more than 10k it is limited to two lines.</p>		
Camera:		Values:	
Unit		In 1/1 lines	
Lower limit	All	0.0	
Upper limit	> 10.240 pixel	2.0	
Upper limit	<= 10.240 pixel	3.0	

The trilinear lines of the allPIXA wave camera signify that the camera disposes of 3 individual color lines (RGB) which means that for each image point the accurate information is obtained. The 3 line sensors are physically arranged in different locations, resulting in the acquirement of the individual color channels to an image of a moving object at different points. For more information, see section 4.2 "Design of the allPIXA camera line scan sensor" / sensor alignment.

For spatial correction, the lines are buffered, and the respective lines are re-aligned with a corresponding correction. The color lines have been delayed by a specific number of lines and, therefore, the values of R, G, and B match each corresponding object point. The allPIXA wave camera enables this compensation with up to 2 lines spacing according to the camera with sensor length of more than 10240 pixels, for sensor length up to 10240 pixels a spacing of up to 3 lines is possible. Correct color images are only generated correctly if the ratio of the optical resolution is the same as the resolution of transport direction.

If you observe according to the standard conditions, the line resolution is the same as the transport resolution; the value "2" must be applied. In some applications it might be helpful, if the camera displays correct images even if the transport resolution differs from the resolution in sensor line direction which is useful, for example if the transport resolution is lower than the optical one.

If you prefer to receive pixels in a non-square shape (transport resolution shall not be the same as the resolution in sensor direction), line resolution may be reduced to the transport resolution which means that the camera internally applies a subpixel-based correction. The result is that the images do not have any colored edges, even if the transport resolution does not match the resolution in sensor direction (=optical resolution).

For calculation of the setting value, you may use one of the following formulas:

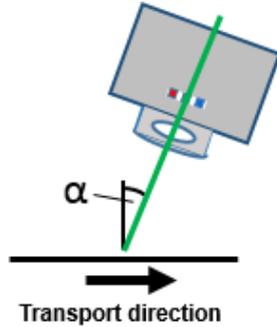
Either

$$\text{Line distance} = \frac{\text{TransportResolution}(dpi) * 2}{\text{OpticalResolution}(dpi) * \cos(\alpha)}$$

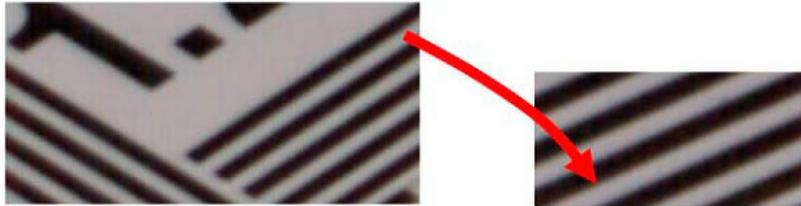
Or

$$\text{Line distance} = \frac{\text{OpticalPixelSize} \left(\frac{mm}{pixel} \right) * 2}{\text{TransportPixelSize} \left(\frac{mm}{pixel} \right) * \cos(\alpha)}$$

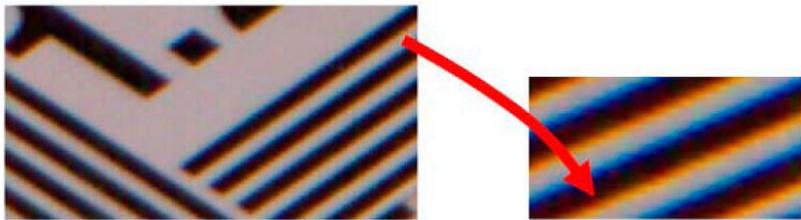
α viewing angle in transport direction (0° = perpendicular)



Function of the subpixel line shift:



With subpixel compensation



Without patented subpixel compensation

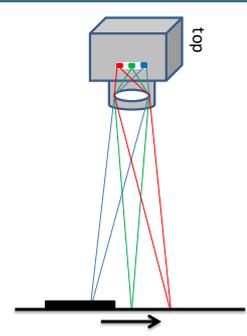
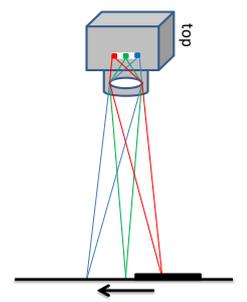
9.7.2 Scan direction

Name	
Name	Set scan direction
Function	Changes the sequence from forward to backward for example from R-G-B to B-G-R), to adapt to the movement direction of a conveyor regarding to the orientation of the camera.
Channels	All
Unit	Bool
Dependency	None
Notes	
Camera:	Values:
Lower limit	All Forward
Upper limit	All Backward

Direction of the spatial correction depends on the direction of transport regarding to the orientation of the camera, that means the sequence of the lines in the direction of transport can be either red-green-blue (RGB) or blue-green-red (BGR) but the sequence can be changed, if necessary. Then the color offset is being corrected, irrespective of the installation position of the camera.

If the encoder is activated, the transport direction is determined by the encoder controller. This direction is either forwarded directly or inverted.

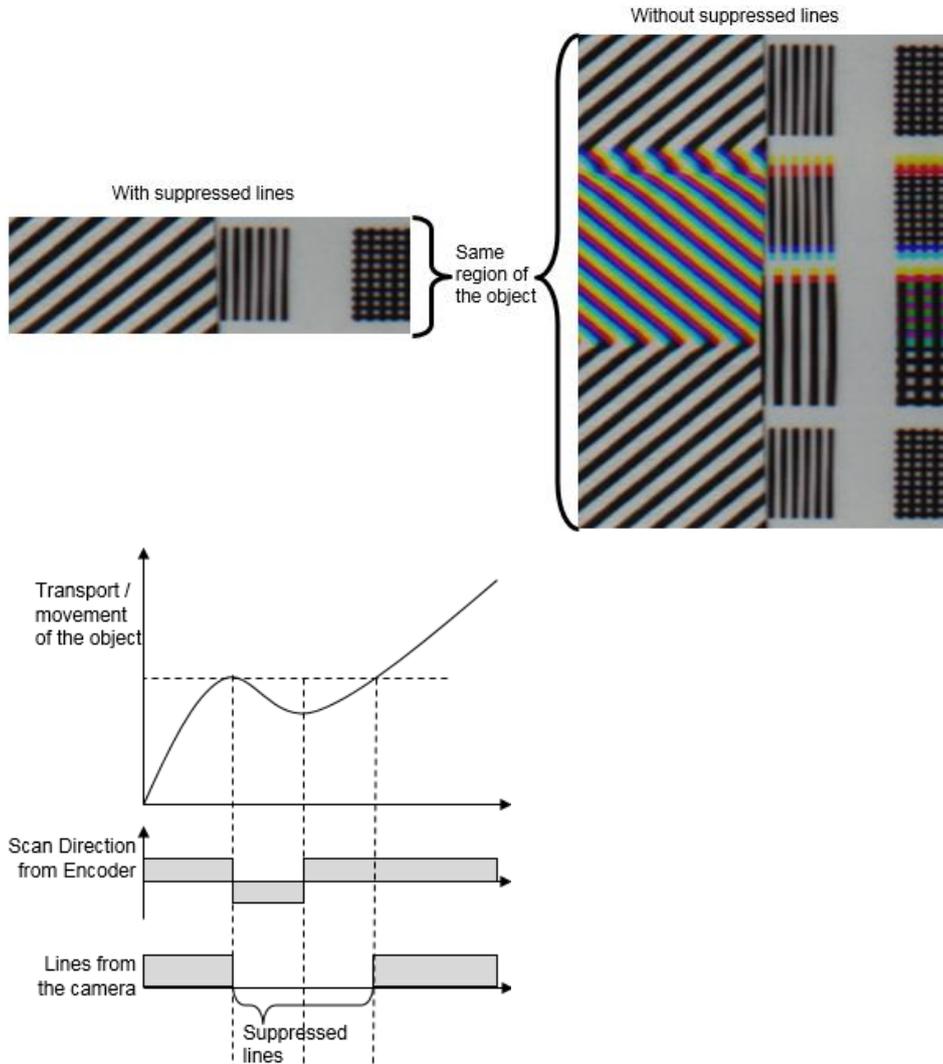
In the IO Configurator, the second encoder bit can be inverted so that the scan direction is identical in the free-running setting and the encoder-controlled setting.

Direction:	Image for value „0“ - Forward:	Image for value „1“ - Backward:
		
		

9.7.3 Enable suppression of lines/frames due to encoder direction

Name							
Name	Enable suppression of lines/frame due to encoder direction						
Function	Enables the suppression of lines / frames						
Channels	All						
Unit	Bool						
Dependency	Only available if the scan direction could be detected by two-channel encoder or input.						
Notes	<p>On the Camera arrangement page, Set scan direction must be set to Forward or to Backward.</p> <p>The second encoder input or the direction input is specified using the IO Configurator in the same way as for Set by ext. pin or Set by encoder direction.</p> <p>If in IO configuration an Encoder Ch 1 pin and a SelectScanDir pin a both selected, Encoder Ch 1 is used.</p>						
	<table border="1"> <thead> <tr> <th>Camera:</th> <th>Value:</th> </tr> </thead> <tbody> <tr> <td>Lower limit</td> <td>all Off</td> </tr> <tr> <td>Upper limit</td> <td>all On</td> </tr> </tbody> </table>	Camera:	Value:	Lower limit	all Off	Upper limit	all On
Camera:	Value:						
Lower limit	all Off						
Upper limit	all On						

If during scanning transport stops and moves backwards for a short time, a part of the object is scanned twice with color distortions. If a two-channel encoder is used, or if a motor direction bit is connected by use of the IO Configurator, the camera can correct this by suppressing up to 64K lines until the object is again at the position at which transport changed direction beforehand:



9.7.4 Suppress lines/frames mode

Name	
Name	Suppress lines/frames mode
Function	Defines the direction for suppression
Channels	All
Unit	Bool
Dependency	Only available if the Enable suppression of lines/frame check box is selected.
Notes	
Camera:	Value:
Lower limit	all Suppress lines against selected direction
Upper limit	all Suppress lines in selected direction

9.8 Image sizes

The allPIXA wave camera permits to return up to four different ROIs (ROI=Region Of Interest) with arbitrary start positions and widths. Each ROI can be enabled or disabled separately. Enabled ROIs may even overlap. The total width of all enabled ROIs must not exceed 15k (even for the 10k camera). When the setting is transferred to the camera, **Total ROI length** shows the total length of all enabled ROIs.

9.8.1 Use ROI

Name		
Name	Use ROI #	
Function	Enables the respective ROI	
Channels	All	
Unit	Bool	
Dependency	None	
Notes		
Camera:		Values:
Lower limit	All	Off
Upper limit	All	On

9.8.2 Start ROI

Name		
Name	Start ROI #	
Function	Start position of the respective ROI	
Channels	All	
Unit	Integer	
Dependency	Takes effect only if the respective ROI is enabled.	
Notes		
Camera:		Value:
Lower limit	All	1
Upper limit	All	10240 for the 10k camera, 15360 for the 15k camera

9.8.3 Width ROI

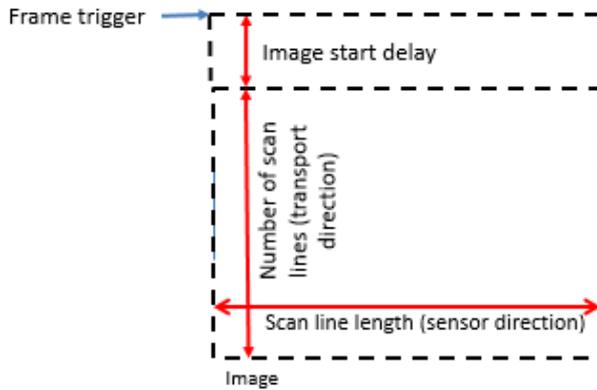
Name		
Name	Width ROI #	
Function	Width of the respective ROI as number of pixels	
Channels	All	
Unit	Integer	
Dependency	Takes effect only if the respective ROI is enabled.	
Notes		
Camera:		Value:
Lower limit	All	1
Upper limit	All	10240 for the 10k camera, 15360 for the 15k camera

9.8.4 Number of scan lines per image (frame mode)

Name		
Name	Number of scan lines per image	
Function	Image size in transport direction	
Channels	All	
Unit	Integer	
Dependency	Only in frame scan mode	
Notes		
Camera:		Value:
Lower limit	All	8
Upper limit	All	1048576 (1M) for fixed object length (use start condition only) 65535 for mixed object lengths (use start and stop condition)

The camera can be operated in frame scan mode and generates the FVAL signal (VSync, frame valid). This operation mode can be either used on free-running or in a triggered operation mode.

For the triggered mode, the information about the frame start can be received via Camera Link signals CC3 / CC4 or at the IO Port. The external signals must be linked to the internal trigger functions by using the IO-configurator e.g. in CST or by the according command using the programming interface.



9.9 Synchronization (frame synchronization)

Because the allPIXA wave camera is able to generate frame information, some settings are needed to be able to use this mode.

NOTE I First, the hardware ports have to be connected to the internal functions of the camera. Therefore, use the IO Configurator in CST and refer to section 8.6.

NOTE II If the camera is used in “Triggered Frame Scan” with active LineTrigger or Encoder, the linesync (Encoder or LineTrigger) must fit some pulses before light barrier input.

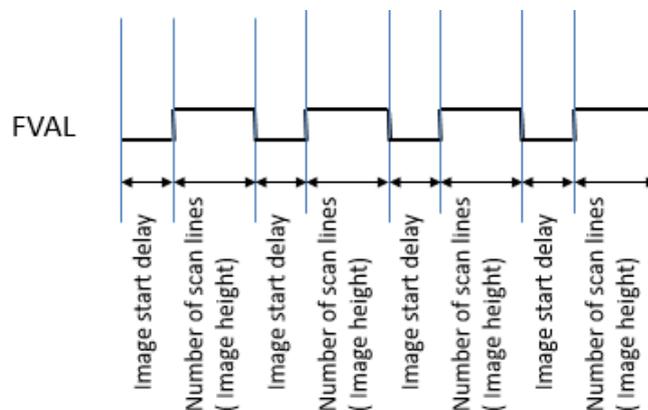
9.9.1 Triggered frame scan

Name		
Name	Triggered frame scan	
Function	Enables the triggered frame scan modes	
Channels	All	
Unit	Integer	
Dependency	None	
Notes		
Camera	Values	
Lower limit	All	Free-running
	All	Use start condition only
	All	Reserved
Upper limit	All	Use start and stop condition

There are 4 different modes:

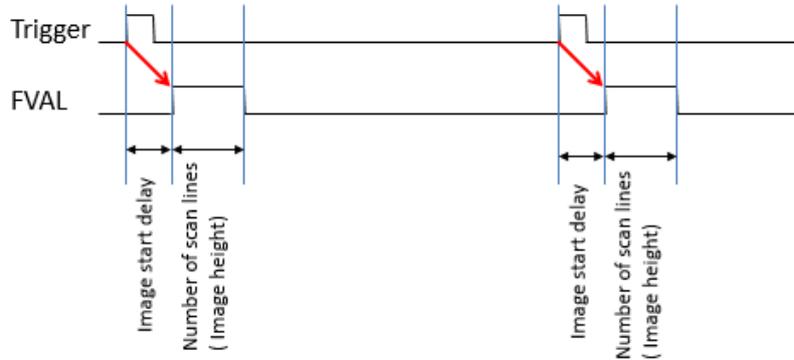
a) (0) Free-running:

FVAL is generated continuously, depending on **Number of scan lines** (Image height) and **Image start delay**.

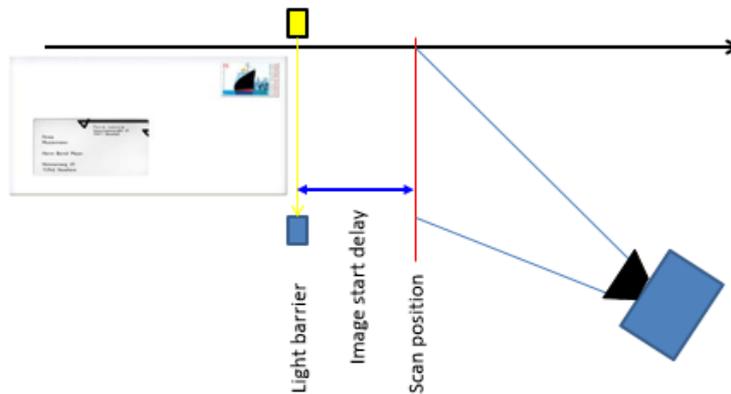


b) (1) Use start condition only:

FVAL (Frame valid) is generated after receiving a trigger signal. The frame is delayed by the value of **Image start delay** and the image length is defined by **Number of scan lines** (Image height).



Sample: Image acquisition is started automatically. It is possible to specify a delay if the light barrier is positioned at some distance before the scanning position:

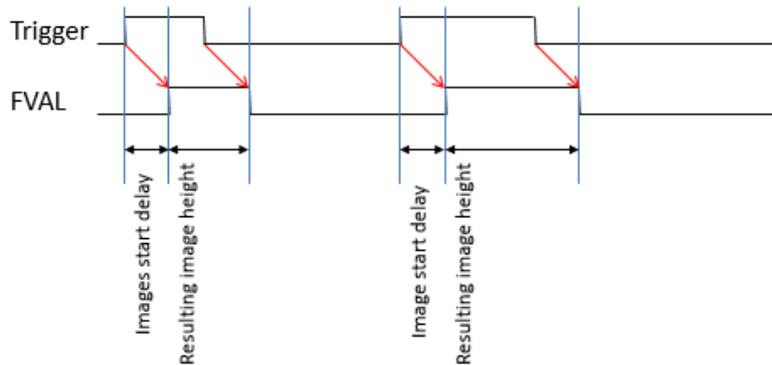


c) (2) Reserved:

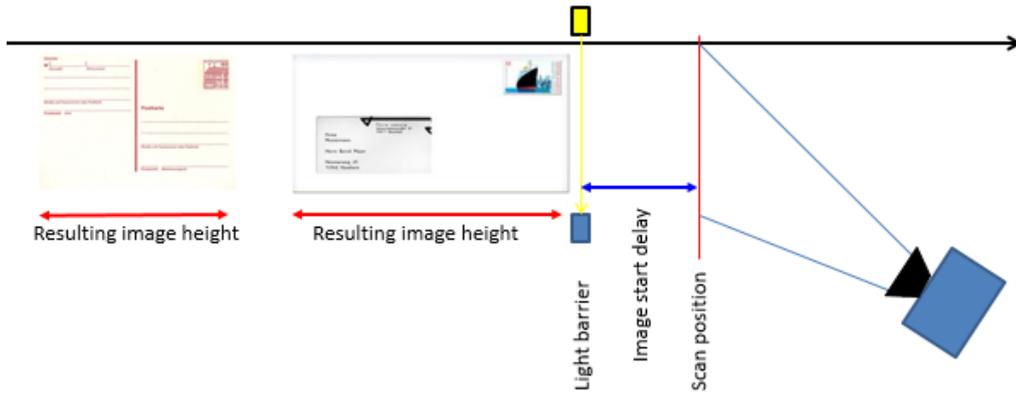
This is reserved for OEM and future use.

d) (3) Use start and stop condition:

FVAL is generated after receiving a trigger signal. The frame is delayed by the value of **Image start delay**. Image length depends on the length of the pulse from the trigger port.



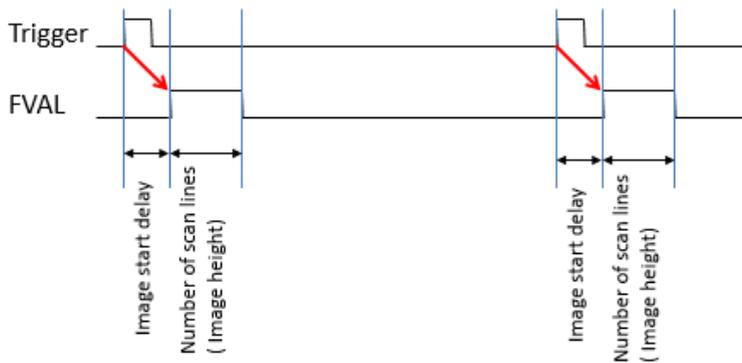
Sample: This function is useful for automatic detection of different object sizes; the camera thus always sends a correctly sized image.



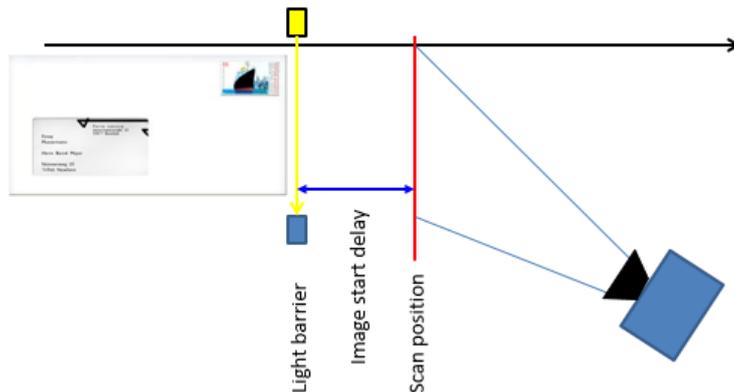
For information about **Number of scan lines** and **Image start delay**, see sections 9.7.4 and 9.8.2

9.9.2 Image start delay

Name		
Name	Image start delay	
Function	Delay of image start after frame trigger in lines; the frame trigger can be taken internally or externally.	
Channels	All	
Unit	Integer	
Dependency	Only in frame scan mode	
Notes		
Camera:	Value:	
Lower limit	All	0
Upper limit	All	32767

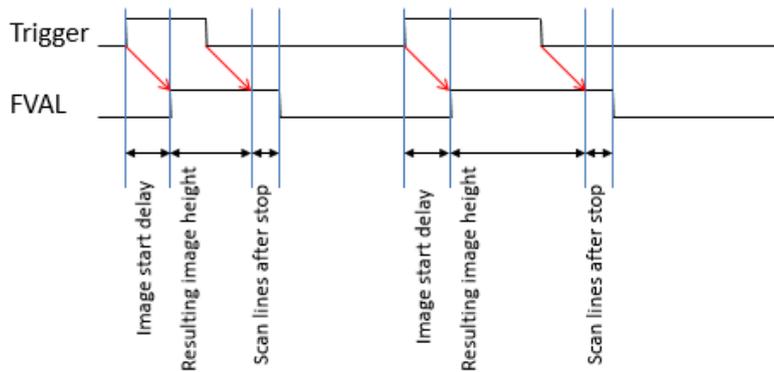


Sample for using Image start delay:

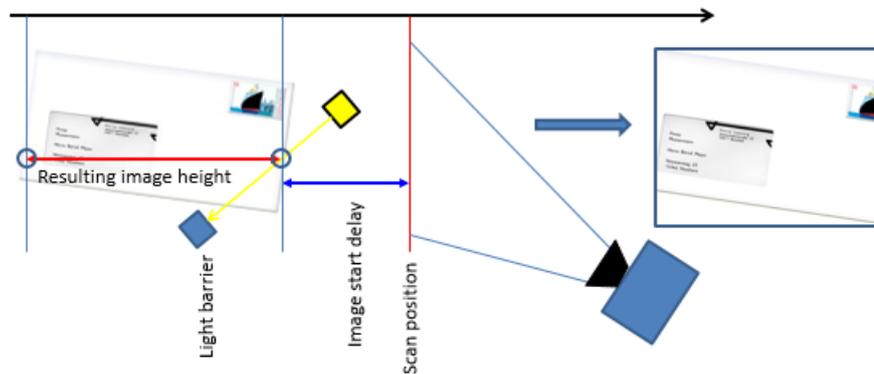


9.9.3 Scan lines after stop

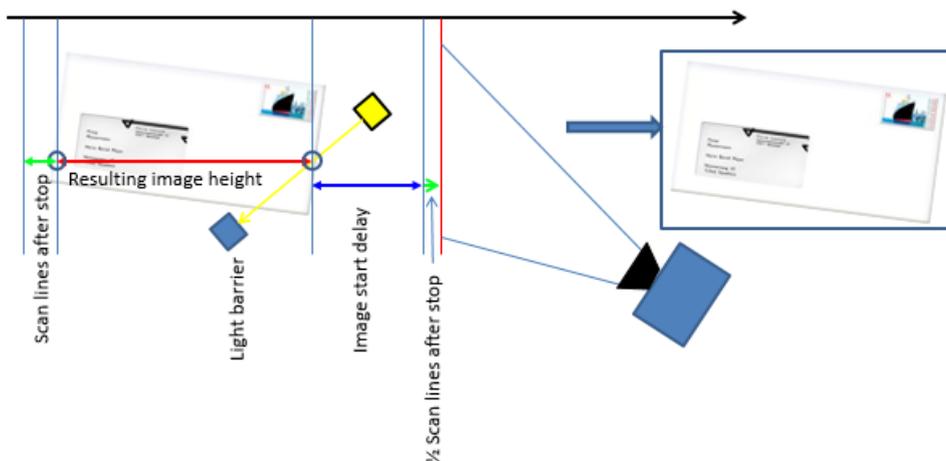
Name		
Name	Scan lines after stop	
Function	Sets the number of lines added to the image after the stop condition.	
Channels	All	
Unit	Integer	
Dependency	Only available if Use start and stop condition is selected at Triggered frame scan	
Notes		
Camera	Value	
Lower limit	All	0
Upper limit	All	65535



Sample: If the transported object is rotated, the result with **Use start and stop condition** is not satisfactory.



If you use the parameter "Scan lines after stop", setup deals with this issue:



- Sets a suitable value for the parameter **Scan lines after stop**, for example 300 lines.
- Reduces the value for the parameter **Image start delay** by the half of the value for **Scan lines after stop**, for example: original value of 1000 lines – (300 lines / 2) = 850 lines

9.9.4 Stop after maximum number of scan lines

Name	
Name	Scan process stops after Maximum number of scan lines .
Function	Stops the image if no ending edge or signal of the frame trigger is detected after the specified value of Maximum number of scan lines .
Channels	All
Unit	Bool
Dependency	Only available if Use start and stop condition is selected at Triggered frame scan
Notes	The parameter Maximum numbers of scan lines must be set to a reasonable value.
Camera	Values:
Lower limit	All Off
Upper limit	All On

9.9.5 Maximum number of scan lines

Name	
Name	Maximum number of scan lines
Function	Stops the image after getting the maximum number of lines if no falling edge of the frame trigger is detected.
Channels	All
Unit	Integer
Dependency	Only available if Use start and stop condition is specified at Triggered frame scan and Stop after max. scan lines has been activated.
Notes	
Camera	Value
Lower limit	All 1
Upper limit	All 65535

9.9.6 Input debouncing speed

For triggering images from an external source, the signal of the trigger, for example of a light barrier, must be connected to the hardware ports of the camera. This could be done through the frame grabber using CC bits or the D-Sub 15 IO port on the camera.

These external signals must be connected to the internal functions (LB 0 to LB 3) which must be selected regarding to signal duration and signal quality of the trigger by use of the IO Configurator in CST.

The single inputs do have different properties regarding the debouncing speed.

Name	
Name	Input debouncing speed
Function	Enables the internal ports to be used as frame trigger
Channels	All
Unit	
Dependency	Only available if Use start condition or Use start and stop condition is selected at Triggered frame scan .
Notes	
Camera:	Values:
All	no debouncing (LB2)
All	35 ns (LB1)
All	4 image lines (LB3)
All	70 image lines (LB0)

By using this option, you can select the internal function ports for frame trigger. The external ports (for example CC3 from Camera Link) must be connected to internal functions by use of the IO Configurator in CST (section 8.6).

There are different methods for debouncing the signal:

- LB 2: no debouncing, peak holder
- LB 1: 4 clock pulses ~ 35 ns
- LB 3: 4 output lines
- LB 0: 60 output lines

Selection of the internal functions for triggering the image can be done in CST.

9.9.7 Select trigger edge detection

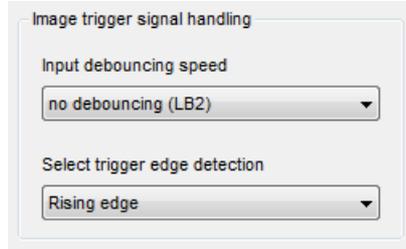
Name	
Name	Select trigger edge detection
Function	Determines whether the trigger is evaluated at the rising or the falling edge.
Channels	All
Unit	
Dependency	Only available if Use start condition or Use start and stop condition is selected at Triggered frame scan .
Notes	
Camera:	Values:
Lower limit	All
Upper limit	All

This function determines whether the image starts at rising or falling edge of the signal. Setting differs for **Use start condition only** and for **Use start and stop condition**.

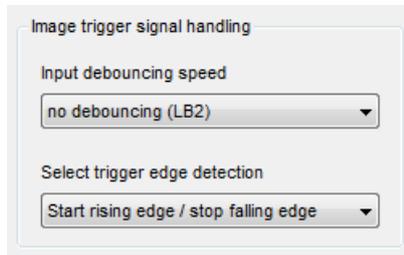
The state of the ports is checked synchronized with the line frequency clock. At each rising edge of the line frequency clock, the state is checked and the debouncing condition must be complied with.

The following tables show suitable sequences and their function:

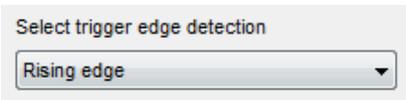
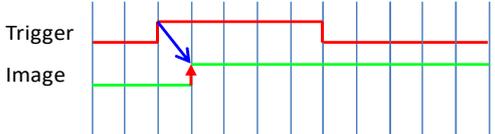
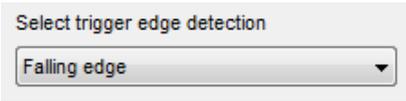
If **Use start condition only** is selected at the **Triggered frame scan** parameter:



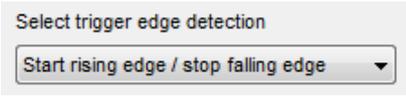
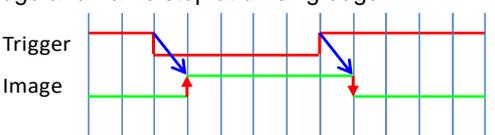
If **Use start and stop condition** is selected at the **Triggered frame scan** parameter:



1. “Use start condition only”

Select trigger edge detection	Function
	<p>These sequences cause frame start at a rising edge:</p> 
	<p>These sequences cause frame start at a falling edge.</p> 

2. “Use start and stop condition”

Select trigger edge detection	Function
	<p>These sequences cause frame start at a rising edge and frame stop at a falling edge.</p> 
	<p>These sequences causes frame start at a falling edge and frame stop at a rising edge.</p> 

9.9.8 Master-slave setup

Name	
Name	Set master-slave mode
Function	Synchronization of several allPIXA wave cameras
Channels	All
Unit	
Dependency	Set this parameter in all slave cameras similarly. Use only one camera as a master.
Notes	<ul style="list-style-type: none"> The position of the image in transport direction (Y) of each camera can be set separately. The image length is defined by the master. Also, the position (X + Y) and the size of the white reference can be set separately. This parameter only takes effect if Global master/slave mode is set to Get master/slave from setting.
Camera	Value
All	No master slave operation
All	Camera acts as master
All	Camera is slave
All	Auto-select by input

If more than one camera is used, for example in print inspection, these cameras must be synchronized accurately to achieve the best system performance.

Connect line trigger / frame trigger to the master camera.

Connect master and slave camera(s)

For more information, see section 8.9.

9.10 Line trigger and encoder setup (line synchronization)

NOTE I Due to internal timing limitations, there is a small delay in the start of the integration time after the line trigger, and this delay may jitter. Therefore, a pulsed illumination which is synchronous to the trigger signal may cause problems in image quality.

NOTE II If the camera is used in the “Triggered Frame Scan” with active LineTrigger or encoder, the linesync (Encoder or LineTrigger) must fit some pulses before light barrier input.

For detailed information about encoder setup, see section 8.7.

9.10.1 Enable encoder

Name	
Name	Enable encoder
Function	Enables the line trigger or encoder mode in the camera and the main selection between internal and external line trigger.
Channels	All
Unit	Bool
Dependency	None
Notes	If you use this mode, the external ports must be connected with the internal function using the IO Configurator of CST.
Camera	Values
Lower limit	All Off (Internal)
Upper limit	All On (External)

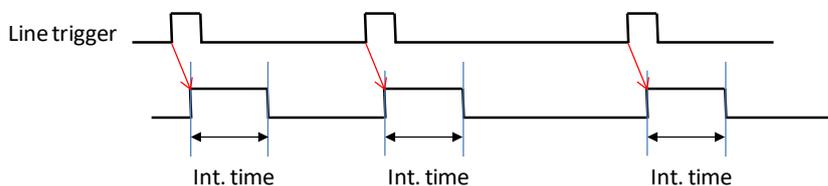
9.10.2 Synchronization mode

Name	
Name	Synchronization mode
Function	Selects the mode Encoder or Line trigger mode .
Channels	All
Unit	Integer
Dependency	Only available if Enable Encoder is active.
Notes	If you use this mode, the external ports must be connected with the internal function using the IO Configurator of CST.
Camera:	Values:
All	Encoder (Continue update)
All	Line trigger mode (Const int. time)

The following two modes are available:

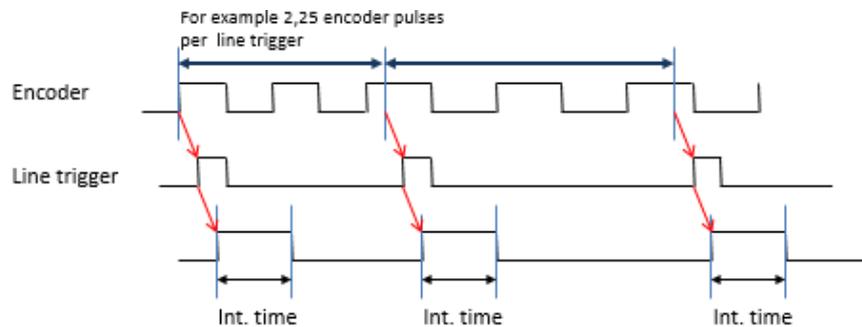
- **Line trigger mode:**

With the line trigger, the camera sends one line per pulse.



- **Encoder:**

The camera measures the distance of the signals and sends lines with the requested resolution. An internal line trigger is generated. The desired transport and encoder resolution must be specified in CST.



For detailed information about encoder setup, see section 8.7.

NOTE Minimum pulse duration is 45ns. Shorter pulses are ignored
 Minimum speed with encoder mode is:

$$V_{min} = \frac{mm}{Encoder\ pulse} \cdot 0,59s$$

Example for the required minimum speed with encoder mode:

Encoder has 12.5 pulses per mm

1 Encoder pulse is 1/12.5mm = 0.08mm

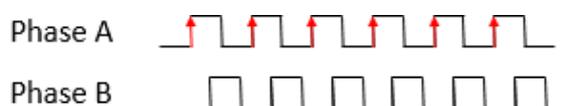
$$\Rightarrow V_{min} = 0.08mm/0.59s = 0.135mm/s$$

9.10.3 Encoder channels

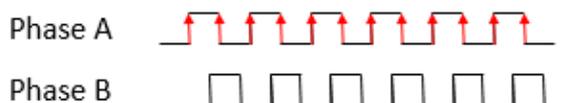
Name			
Name	Encoder channels		
Function	Sets the mode according to the edges of the encoder will be taken for speed measurement.		
Channels	All		
Unit	Integer		
Dependency	Only available if Encoder is selected at Synchronization mode .		
Notes	If you use this mode, the external ports must be connected with the internal function using the IO Configurator of CST.		
	Camera:	Value:	Function:
Lower limit	All	0	One Channel full step
	All	1	One Channel encoder
Upper limit	All	2	2-Channel encoder

The following three modes are available:

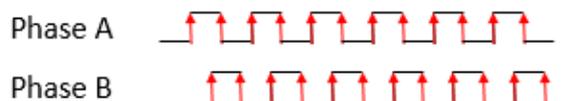
1. One Channel full step (1 edge per step):



2. One Channel encoder (2 edges per step):



3. Two Channel encoder (4 edges per step):



NOTE Best results are reached with encoder mode 0 and without encoder averaging. This mode avoids errors due to tolerances in the duty factor of the pulses.

9.10.4 Average size for the encoder

Name		
Name	Average size	
Function	Sets the number of increments taken for distance measurement to average the speed measurement	
Channels	All	
Unit	Integer	
	None; 2; 4; 8; 16	
Dependency	Only available if Encoder is selected at Synchronization mode .	
Notes	Best results are reached with encoder mode 0 and without encoder averaging. This mode avoids errors due to tolerances in the duty factor of the pulses.	
Camera		Value:
Lower limit	All	None
		2
		4
		8
Upper limit	All	16

9.10.5 Encoder resolution

Name			
Name	Encoder resolution		
Function	Sets the distance of which the transport might be moved by one increment of the encoder.		
Channels			
Unit	Float	Step:	0.001
	µm per increment		
Dependency	Only available if Encoder is selected at Synchronization mode .		
Notes	Refers to a full increment of the encoder.		
Camera		Value CST	
Lower limit	All	0 µm	
Upper limit	All	100,000 µm	

NOTE The value **Encoder pulses per line** is calculated internally by the camera and may not exceed 255. Recommended values are between 0.5 and 255. Take notice that values less than 0.5 cause a decrease in transport resolution accuracy. For a detailed calculation, see section 9.10.6

9.10.6 Vertical image resolution

Name			
Name	Vertical image resolution		
Function	Define the desired transport (vertical) resolution for the encoder mode.		
Channels	All		
Unit	Float	Step:	0.01
	DPI (dots per inch)		
Dependency	Only available if Encoder is selected at Synchronization mode .		
Notes	This parameter is needed for the calculation of internal parameters for the encoder mode.		
Camera		Value CST	
Lower limit	All	0	
Default	All	4,000 (*0,01dpi)	

NOTE The value **Encoder pulses per line** is calculated internally by the camera and may not exceed 255. Recommended values are between 0.5 and 255. Take notice that values less than 0.5 cause a decrease in transport resolution accuracy.

This value is calculated automatically with one of the following formulas with the values that were specified using CST:

$$EncoderPulsesPerLine = \frac{EncoderChannel \left(\frac{Edges}{Step} \right) * 25,4 \left(\frac{mm}{inch} \right) * 1000}{EncoderResolution \left(\frac{\mu m}{Step} \right) * VerticalImageResolution \left(\frac{Dots}{inch} \right)}$$

By using dots per inch (dpi) for this calculation, you must use the following formula:

$$EncoderPulsesPerLine = FullIncrementResolution(dpi) * \frac{Edges/step}{TransportResolution(dpi)}$$

The value for encoder pulses per line can also be calculated with the following formula:

$$EncoderPulsesPerLine = TransportResolution \left(\frac{\mu m}{pixel} \right) * \frac{Edges/step}{FullIncrementResolution \left(\frac{\mu m}{incr} \right)}$$

Afterwards CST shows the result.



NOTE The resulting scanning speed should not exceed the maximum speed of the camera. The setup of **Vertical image resolution** and **Integration time** must match the speed of the transport.
 The time for one line (speed divided by resolution) should be longer than the shortest possible integration time (scanning speed is within the maximum camera speed). If the encoder setup requires higher speed than the maximum camera speed, the camera switches to free-running line mode with maximum possible speed.

For detailed information about encoder setup, see section 8.6

9.10.7 Line trigger / encoder reduction

Name	
Name	Line trigger/encoder reduction
Function	Internal pre-counter for the line trigger or encoder signal, outputs an internal line trigger after the set value of signals from external line trigger source.
Channels	All
Unit	Integer
Dependency	Only available if Enable encoder is selected.
Notes	
Camera	Value
Lower limit	All 1
Upper limit	All 256

If line trigger reduction is used, the vertical image resolution is reduced by factor:

$$TransportResolution, reduced [dpi] = \frac{TransportResolution [dpi]}{\text{Line trigger reduction factor}}$$

$$TransportResolution, reduced [\mu m] = \text{Line trigger reduction factor} * TransportResolution [\mu m]$$

For information about detailed encoder setup, see section 8.7.

9.11 Image processing

9.11.1 Color conversion matrix

Name	
Name	Use color conversion matrix
Function	Enables the color conversion by a 3x3 matrix, for example from RGB to sRGB
Channels	All
Unit	Bool
Dependency	None
Notes	The color conversion matrix must be generated offline and must be transferred to the camera.
Camera: Values:	
Lower limit	All Off
Upper limit	All On

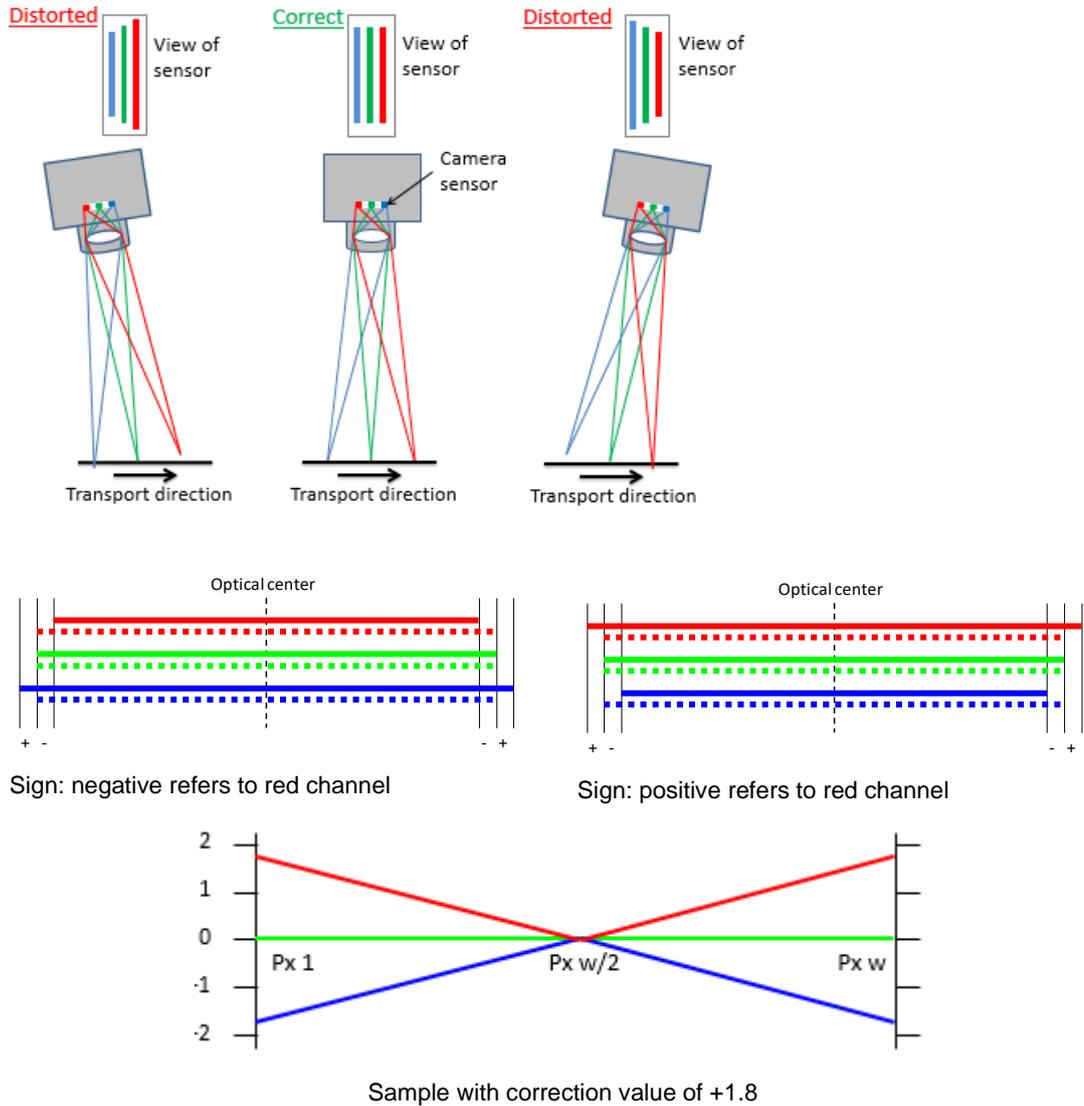
For information about editing the color conversion matrix, see section 8.10.

9.11.2 Select active CCM

Name	
Name	Select active CCM
Function	Selects the number of the used color conversion matrix. Four matrix tables are available.
Channels	All
Unit	Integer
Dependency	It is only available if Use color conversion matrix has been selected.
Notes	Matrix 1 is the default table and not editable in CST.
Camera: Values:	
Lower limit	All Matrix 1
Upper limit	All Matrix 4

9.11.3 Use keystone correction

Name	
Name	Use the keystone correction
Function	Enables the function keystone correction.
Channels	Red, Blue
Unit	Bool
Dependency	None
Notes	
Camera: Values:	
Lower limit	All Off
Upper limit	All On

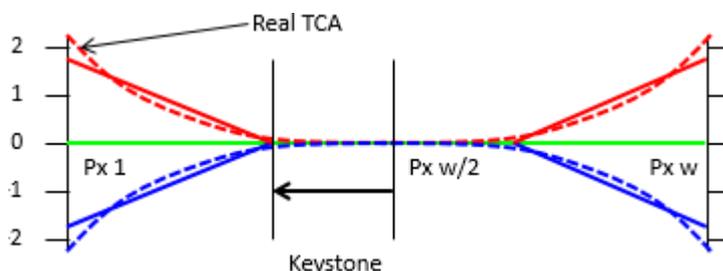


9.11.4 Pixel shift for correction

Name			
Name	Pixel shift for correction		
Function	Sets the pixel shift up to +/- 4 pixels for the first and the last pixel. Between the center and the first and last pixels they are linearly interpolated between 0 and the specified value.		
Channels	Red, Blue		
Unit	Float	Step	0.1
Dependency	Only available if the option Use keystone correction has been activated.		
Notes	The start value for the first and last pixels relates to the nominal length of the camera (10K with a 10K allPIXA wave)		
Camera:		Value:	
Lower limit	All	- 2.0	
Upper limit	All	+ 2.0	

9.11.5 Keystone correction width

Name		
Name	Keystone correction width	
Function	Start value from the center for keystone/TCA correction	
Channels	Red, Blue	
Unit	Integer	
Dependency	Only available if the option Use the keystone correction has been activated.	
Notes	Set to 1 to use as a standard keystone correction.	
Camera:		Value:
Lower limit	All	1 = default
Upper limit	10k	4620
Upper limit	15k	7180



TCA (= Transversal Chromatic Aberration) is an objective-caused displacement of the three colors increasing at the edge

9.12 LED flash control

For a detailed description, see section 8.8.

9.12.1 LED flash control

Name		
Name	Set LED flash mode	
Function	If set to enabled , the functionality of LED flash control is active	
Channels	All	
Unit	Bool	
Dependency	None	
Notes	For more information, see section 8.8	
Camera:		Values:
Lower limit	All	disabled
Upper limit	All	enabled

9.12.2 LED number line pattern

Specifies the number of patterns to be used in the LED flash control sequence. The sequence starts with pattern 1.

Name	
Name	Number of line patterns
Function	Sets the number of patterns
Channels	All
Unit	Integer
Dependency	Only used if LED flash control is enabled
Notes	For more information, see section 8.8 <i>"Multi-channel flash control"</i>
Camera	Value
Lower limit	All 0
Upper limit	All 5

9.12.3 LED flash sequence time

Name	
Name	Time for repeating all valid patterns
Function	Gives the time for the sequence of all valid patterns in microseconds.
Unit	Float Step: 0.001
	Linear
Dependency	If encoder / line trigger mode is active, LED flash sequence time is ignored
Notes	For more information, see section 8.8 <i>"Multi-channel flash control"</i>
Camera	Value
Lower limit	All 0
Upper limit	All 9.200.000

9.12.4 LED line pattern

Name	
Name	Flash time # at channel #
Function	Sets the active time for 1 of 4 available patterns and of 1 of 4 available output channels in microseconds
Unit	Float Step: 0.001
	Linear
Dependency	If all line patterns for an output channel are set to 0, the output channel is disabled
Notes	For more information, see section 8.8 <i>"Multi-channel flash control"</i>
Camera	Value
Lower limit	All 0
Upper limit	All 2.300.000

9.12.5 LED signal frame control

Name	
Name	LED signal frame control
Function	Controls whether the flash sequence is active continuously or only within image frames.
Unit	Bool
Dependency	None
Notes	For more information, see section 8.8 <i>"Multi-channel flash control"</i>
Camera	Value
Lower limit	All Flash outputs set continuously
Upper limit	All Flash outputs controlled by image frame

9.12.6 Pattern time generation

Name	
Name	Pattern time generation
Function	If set to Pattern packed optimally , the individual line pattern times are used for scanning, minimizing the sequence time if different pattern times are used.
Unit	
Dependency	Depends on minimum integration time and camera link mode.
Notes	For more information, see section 8.8 <i>"Multi-channel flash control"</i> .
Camera	Value
Lower limit	All Pattern packed optimally
Upper limit	All Pattern enlarged to sequence time

9.13 Special functions

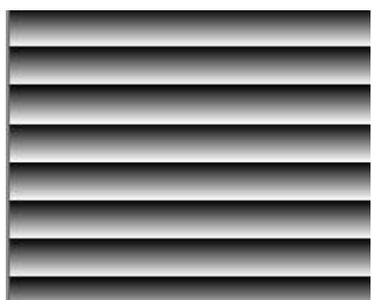
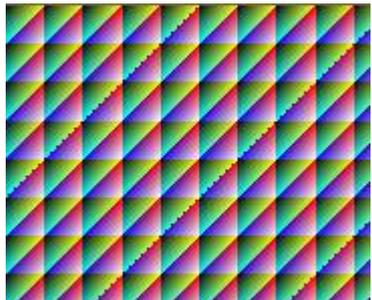
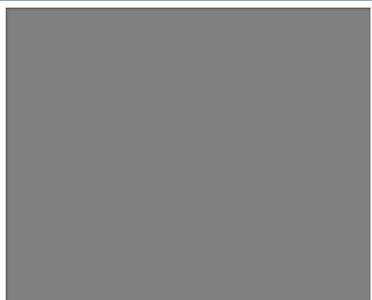
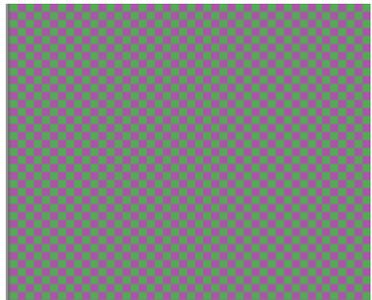
9.13.1 Test pattern

To be able to check the system setup, it is helpful to generate exactly defined test images inside the camera. This explicitly helps to check:

- Frame grabber connection
- Frame grabber setting
- Transmission quality over the Camera Link cable

Name	
Name	Generate test pattern
Function	Enables different test images in the camera.
Channels	All
Unit	Integer
Dependency	None
Notes	Test patterns 6-15 only for internal use
Camera	Value
Lower limit	All 0
Upper limit	All 5

The following different test images are available:

Image	Name
	<p>Test pattern 1:</p> <p>Gray ramp in sensor direction (here shown for 8 bits)</p>
	<p>Test pattern 2:</p> <p>Gray ramp in transport direction (here shown for 8 bits)</p>
	<p>Test pattern 3:</p> <p>Color ramp; only available for RGB. Format:</p> <p>Red: X-ramp Green: XY-ramp Blue: Y-ramp.</p>
	<p>Test pattern 4:</p> <p>Gray image. Brightness is determined by Test pattern level. The value of this parameter refers to 10 bits per pixel. Example: To produce the shown image with a gray value of 128 with 8 bits, Test pattern level must be set to 512.</p>
	<p>Test pattern 5:</p> <p>Chess pattern with RGB colors (85,170,85) and (170,85,170). The pattern changes with each pixel in both directions.</p> <p>Only available for RGB. In Mono mode, it can be used to test the TDI feature.</p>
	<p>Test pattern 6-15:</p> <p>Internal use only</p>

9.13.2 Test pattern level

Name	
Name	Set test pattern level
Function	Sets the video level for some test images
Channels	All
Unit	Integer
	Linear
Dependency	Takes effect only with test pattern 4
Notes	Refers to 10-bit image data
Camera	Value
Lower limit	All 0
Upper limit	All 1023

9.14 Tracing

Function for debugging the system.

For more information, ask the Chromasens support.

E-Mail: support@chromasens.de

9.15 Register edit

All registers can be written directly on the camera.

There are two possibilities to directly modify the register:

- **Permanent modification:**

Values entered by the user are stored in the setting and are available after the camera is restarted or after a setting has been loaded.

You can find this function in CST at **Camera settings > Special functions > Register edit**. There are 4 places for saving register edits directly to a setting.

- **Non-permanent modification:**

Changes are transferred to the camera, but they are not stored permanently. If the camera is restarted or a setting is reloaded, the changes get lost. You can find this function in CST at the command **Register edit** of the **Advanced** menu.

NOTICE

It is possible to damage the function of the camera by using this function.

Therefore, this function is only available if **User level** has been set to **Guru**.

For more information, see section 6.15 "Setting the user level in CST".

9.16 Camera information

9.16.1 Camera serial number

Note All allPIXA wave cameras have an individual serial number. If you contact Chromasens support, provide the serial number of the camera.

Name			
Name	Camera serial number	Read only	
Function	Returns camera type and serial number of the camera		
Channels	All		
Unit	Two integers		
Dependency	None		
Notes	The first value is the camera type (20000 for the allPIXA wave camera). The second value is the serial number.		
	Camera	Value camera type	Value serial number
Lower limit	All	20000	0
Upper limit	All	20000	65535

9.16.2 Setting description

Name	
Name	Setting description
Function	You can provide a short description for each setting of the camera.
Channels	All
Unit	String of up to 40 characters
Dependency	None
Notes	Keep in mind, that a carriage return counts as two characters! This may result in descriptions that seem to be cut by the camera.
	Value
	All

9.17 Default parameters

The camera is delivered with the following default parameters. (Setting 1)

Section	Name	10k	15k
9.2.1	Integration time in μs	98.00 μs	98.00 μs
9.2.4	Line period time	100.00 μs	100.002 μs
9.3.1	Enable continuous white control	Off	Off
9.3.2	White control mode	Use sync mode	Off
		Stop gain control	Off
9.3.3	Gain control stop factor	0.001	0.001
9.3.4	Linear camera gain values	*)	*)
9.3.5	Target reference values	800	800
9.3.7	Analog CDS gain	X2	X2
9.3.8	Full-well capacity	High dynamic	High dynamic
9.4.3	First absolute pixel of white reference	5001	7801
9.4.4	Number of pixels for white reference	96	144
9.4.5	First image line for the white reference	10	20
9.4.6	Number of image lines for the white reference	100	100
9.4.7	Number of reference samples (Average)	None	None
9.4.8	Show white reference border	Off	Off
9.5.1	Black-level correction (offset correction)	On	On
9.5.2	Shading correction (flat-field correction)	Off	Off
9.5.3	Black reference data set	1	1
9.5.4	White reference data set	1	1
9.6.1	Gamma correction	0	0
9.6.2	Use brightness and contrast	Off	Off
9.6.3	Brightness	0	0
9.6.4	Contrast	0.9	0.9
9.7.1	RGB line distance	2.0	2.0
9.7.2	Scan direction	Forward	Forward
9.8.1	Use ROI	ROI 1: On	ROI 1: On
9.8.2	Start ROI	ROI 1: 1	ROI 1: 1
9.8.3	Width ROI	ROI 1: 10240	ROI 1:15360
9.8.4	Number of scan lines per image (frame mode)	2000	5000
9.9.2	Image start delay	10	1000

Section	Name	10k	15k
9.9.1	Triggered frame scan	Free-running	Free-running
9.9.2	Image start delay	0	0
9.9.4	Stop after maximum number of scan lines	Off	Off
9.9.5	Maximum number of scan lines	0	0
9.9.6	Input debouncing speed	LB2:no debouncing	LB2:no debouncing
9.9.7	Select trigger edge detection	Falling edge	Falling edge
9.11.1	Color conversion matrix	Off	Off
9.11.2	Select active CCM	1	1
9.11.3	Use keystone correction	Off	Off
9.11.4	Pixel shift for correction	0	0
9.11.5	Keystone correction width	1	1
9.1.1	Swap red and blue color channel	Off	Off
9.1.4	Mirror image horizontally	Off	Off
9.1.5	Set TDI operating mode	1-TDI	1-TDI
9.1.6	Video output mode	3x8 Bit	3x8 Bit
9.1.7	Color weights	1.0	1.0
9.1.1	Camera Link interface type	Medium 1X2	Medium 1X2
9.1.2	Set line equalization	Off	Off
9.1.8	Insert mode	Off	Off
9.13.1	Test pattern	Off	Off
9.13.2	Test pattern level	512	512
9.14	Tracing	None	None
9.15	Register edit	None	None
9.16.1	Camera serial number	*)	*)
9.16.2	Setting description		
9.10.1	Enable encoder	Off	Off
9.10.2	Synchronization mode	Encode	Encoder
9.10.3	Encoder channels	1 channel full step	1 channel full step
9.10.4	Average size for the encoder	Off	Off
9.10.5	Encoder resolution	200 µm	200 µm
9.10.6	Vertical image resolution	800 dpi	800 dpi
9.10.7	Line trigger / encoder reduction For detailed information about encoder setup, see section 8.6	1	1

*) Settings differ from camera to camera. Serial numbers are individual for each camera. Some settings result from the camera final test.

9.18 User levels of parameters

Visibility (and as a result the accessibility) of parameters is defined by the **User level** that is selected in CST.

The following table shows the user level for single parameters:

For more information about setting the **User level**, see section 6.15.

Section	Name	Normal User	Expert	Guru
9.2.1	Integration time	X	X	X
9.2.2	Min Integration time in μs	X	X	X
9.2.3	Max Integration time in μs	X	X	X
9.2.4	Line period time	X	X	X
9.2.5	Min Line period time in μs	X	X	X
9.3.1	Enable continuous white control	X	X	X
9.3.2	White control mode	Use sync mode	X	X
		Stop gain control	X	X
9.3.3	Gain control stop factor	X	X	X
9.3.4	Linear camera gain values	X	X	X
9.3.5	Target reference values	X	X	X
9.3.6	Actual reference values	X	X	X
9.3.7	Analog CDS gain	X	X	X
9.3.8	Full-well capacity	X	X	X
9.4.3	First absolute pixel of white reference	X	X	X
9.4.4	Number of pixels for white reference	X	X	X
9.4.5	First image line for the white reference	X	X	X
9.4.6	Number of image lines for the white reference	X	X	X
9.4.7	Number of reference samples (Average)	X	X	X
9.4.8	Show white reference border	X	X	X
9.5.1	Black-level correction (offset correction)	X	X	X
9.5.2	Shading correction (flat-field correction)	X	X	X
9.5.3	Black reference data set	X	X	X
9.5.4	White reference data set	X	X	X
9.6.1	Gamma correction	X	X	X
9.6.2	Use brightness and contrast	X	X	X
9.6.3	Brightness	X	X	X
9.6.4	Contrast	X	X	X
9.7.1	RGB line distance	X	X	X
9.7.2	Scan direction	X	X	X

Section	Name	Normal User	Expert	Guru
9.8.1	Use ROI	X	X	X
9.8.2	Start ROI	X	X	X
9.8.3	Width ROI	X	X	X
9.8.4	Number of scan lines per image (frame mode)	X	X	X
9.9.2	Image start delay	X	X	X
9.9.1	Triggered frame scan	X	X	X
9.9.2	Image start delay	X	X	X
9.9.4	Stop after maximum number of scan lines	X	X	X
9.9.5	Maximum number of scan lines	X	X	X
9.9.6	Input debouncing speed	X	X	X
9.9.7	Select trigger edge detection	X	X	X
9.11.1	Color conversion matrix	X	X	X
9.11.2	Select active CCM	X	X	X
9.11.3	Use keystone correction	X	X	X
9.11.4	Pixel shift for correction	X	X	X
9.11.5	Keystone correction width		X	X
9.1.3	Swap red and blue color channel	X	X	X
9.1.4	Mirror image horizontally	X	X	X
9.1.5	Set TDI operating mode	X	X	X
9.1.6	Video output mode	X	X	X
9.1.7	Color weights	X	X	X
9.1.1	Camera Link interface type	X	X	X
9.1.2	Set line equalization	X	X	X
9.1.8	Insert mode	X	X	X
9.13.1	Test pattern	X	X	X
9.13.2	Test pattern level	X	X	X
9.14	Tracing			X
9.15	Register edit			X
9.16.1	Camera serial number	X	X	X
9.16.2	Setting description	X	X	X
9.10.1	Enable encoder	X	X	X
9.10.2	Synchronization mode	X	X	X
9.10.3	Encoder channels	X	X	X
9.10.4	Average size for the encoder	X	X	X
9.10.5	Encoder resolution	X	X	X
9.10.6	Vertical image resolution	X	X	X
9.10.7	Line trigger / encoder reduction	X	X	X

10 Troubleshooting and Support

The troubleshooting information in this chapter may help you to identify common problems and lets you know how to solve them.

If you are not able to solve the problem with the information in this troubleshooting chapter, you may decide to contact Chromasens technical support for further help. Before you contact Chromasens technical support, take a look at the support form (see section 10.4) and prepare the answers or fill out the form completely. With this information you can make sure that you have most of the information available which is required for the technical support team to help you best with your problem.

10.1 Camera status identification by the camera status LED

The camera status LED indicates the current status of the camera. After boot-up is finished, the camera performs self-checks continuously. If an error is detected, the camera indicates this by changing the LEDs color.

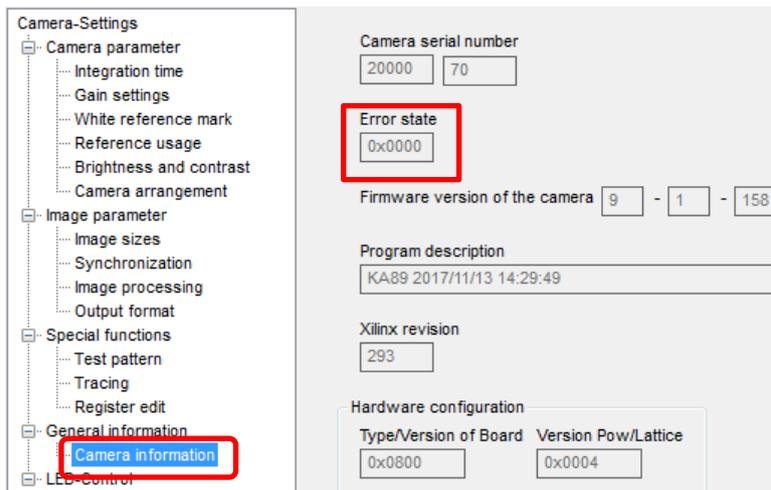
LED color	Description
Off	No power is present at the camera or the input voltage is out of the limits. (see also section 2.3 for power rating and section 5.1.1 for the pin layout)
Green	Camera has power and is OK (FVAL inactive)
Red	The camera is in error condition. You may check the detailed camera status using CST (see section 10.2)
Blue	Camera is OK and provides image data (FVAL active)
LED alternates green/blue	The camera is OK and provides image data frequently, based on a trigger signal
Sequence of long green, short orange, green	This is the normal power-up sequence. After this sequence, the camera continues operation according to the definitions which have been made in setting 1.

10.2 Identifying the camera status using CST

If you want to get more detailed information about the current camera condition, you can check the camera status using CST.

To get a quick camera state feedback, do one of the following:

- On the **Advanced** menu, click **Get current camera state**, or on the toolbar, click **Show camera state and reset errors**  (see also section 6.17).
- On the toolbar click **Show settings**  , and then click **Camera information** in the tree view:



If an error occurs, the camera shows an error message and resets **Error state** afterward. Therefore, **Error state** is >0 only in case of a permanent error, for example if the temperature is above the allowed maximum value.

10.3 Camera overheating protection

For safety reasons, the camera is equipped with an internal three-step overheating protection.

Step 1: high-temperature warning:

If the camera internal temperature increases above the defined limit, the camera indicates this warning status by:

- Status LED of the camera turns red, but it is still blue while image data are provided. Therefore, you cannot see an error warning if image data are provided continually without gaps.
- The camera returns error state 0x3d or 0x3e

Let the camera cool down and check environment. Improve cooling conditions of the camera if necessary.

Step 2: final safety shutdown:

If the temperature is still increasing, the camera automatically switches to safety mode to protect the camera electronics from overheating.

This camera state is indicated by:

- Status LED of the camera turns red
- The camera returns error state 0x40
- The camera outputs the following image:



To get the camera back from step 2 to normal operation:

1. Let the camera cool down.
2. Check the environment and improve cooling if necessary.

3. Restart the camera (power off/on)

For information about temperature level definitions, see sections 2.3 and 5.3.

10.4 Before contacting Chromasens technical support

If you have a problem with the camera and decide to contact Chromasens technical support, it is very important that you collect all relevant system information beforehand.

This may guarantee a quick and efficient problem-solving process together with Chromasens technical support.

To collect the most important information of your issue, you may use the following list as a guideline. You can also download the list from our website at <https://www.chromasens.de> in the support section.

Please fill out this list and provide the information including the requested files before you contact Chromasens technical support.

The contact options to the service department of Chromasens are listed in section 1.1.2

For the first contact we recommend sending an email to the support address (support@chromasens.de), as this will automatically create a support ticket in our system.

Contact Data

Company name			
Name			
E-Mail		Phone	
Street		City	
Zip code		State/Country	
Contact person CS		Date	

Technical Information

System Information			
Camera type	<input type="checkbox"/> allPIXA	<input type="checkbox"/> allPIXA wave	<input type="checkbox"/> 10k <input type="checkbox"/> 15k
Camera serial number			
CST version used			
Operating system			
Frame grabber			Type + Manufacturer
Camera Link cable length + type			m

Problem Description

Description of the problem: (as detailed as possible)			
When did the problem occur?	<input type="checkbox"/> after start	<input type="checkbox"/> during operation	
	<input type="checkbox"/> at a specific action, please describe:		
How often did problem occurs?	<input type="checkbox"/> once	<input type="checkbox"/> always	
	<input type="checkbox"/> regularly <input type="checkbox"/> rarely please describe:		
Did the application ever run ok	<input type="checkbox"/> yes	<input type="checkbox"/> no	
If known, please describe the reason for the problem or any abnormal behaviors			

Image and Parameter Files

Camera parameter settings	<input type="checkbox"/> (It is very important to provide a copy of the exact camera settings when the problem occurred)
Live images	<input type="checkbox"/> (Live or test images showing the problem. Save images in BMP format)
Computer System Information	<input type="checkbox"/> (Press the  -button in the CST-toolbar and copy the output into a file or the support mail)

10.5 Returning material (obtain an RMA number)

Before returning material to Chromasens you must request an RMA number (Return Material Authorization). This RMA number must be stated in all of your delivery documents if material is returned to Chromasens GmbH. Returned material without RMA number may not be processed in time and we also reserve the right to reject material without an RMA number.

To obtain an RMA number, please contact Chromasens support first.

Chromasens GmbH

Max-Stromeyer-Straße 116
D-78467 Konstanz
Germany

Phone: +49 (0) 7531 - 876-0

Fax: +49 (0) 7531 - 876-303

E-Mail: info@chromasens.de

Internet: www.chromasens.de

For return of material you should use the original packaging material to avoid any damages to the cameras.

11 Appendix

11.1 EC conformity declaration

 chromasens <small>Imaging for Professionals</small>	<u>EU Declaration of Conformity</u>	DCE_CHR_00001 Rev. 01
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We declare that the following products comply with the requirements of the listed directives and standards. Each type listed below, stands for all its related model variants.

Designation: High speed CMOS line scan camera with Camera Link Interface
 Series: Chromasens allPIXA wave
 Types: CP000498-XXk-X (all derivations)

Manufacturer authorized representative: **Chromasens GmbH**
 Max-Stromeyer-Str. 116
 D-78467 Konstanz
 Germany
 www.chromasens.com

The object of the declaration described above is in conformity with the relevant Union harmonisation legislation:

Electromagnetic compatibility	2014/30/EU	of February 26, 2014
RoHS	2011/65/EU	of June 8, 2011

Applied standards:

Risk Assessment:

- DIN EN ISO 12100:2011-03

Electromagnetic Compatibility Emission:

- DIN EN 61000-6-4:2011-09 | IEC 61000-6-4:2006 + A1:2010
- DIN EN 55032:2016-02 | CISPR 32:2015

Electromagnetic Compatibility Immunity:

- DIN EN 61000-6-2:2006-09 | IEC 61000-6-2:2005
- DIN EN 61000-4-2:2009-12 | IEC 61000-4-2:2008
- DIN EN 61000-4-3:2011-04 | IEC 61000-4-3:2006 + A1:2007 + A2:2010
- DIN EN 61000-4-4:2013-04 | IEC 61000-4-4:2012
- DIN EN 61000-4-5:2015-03 | IEC 61000-4-5:2014
- DIN EN 61000-4-6:2014-08 | IEC 61000-4-6:2013

The notified body (Reg. No. D-PL-19366-01-01) performed measurements of Electromagnetic compatibility and issued the certificate: 18PBI030902 (15.10.2018)

Konstanz, October 19, 2018



Martin Hund, CEO

11.2 Camera system design / lens selections

11.2.1 Calculating the object-to-image distance

You need the following parameters for calculating the optical setup:

- Image size (Sensor size of camera (**which is in use**))
- Object size/width
- Focal length (from data sheet of the lens)
- Principal main plain distance (from data sheet of the lens)

First, calculate the magnification:

$$m = \frac{\text{ImageSize}/\text{mm}}{\text{ObjectSize}/\text{mm}}$$

After getting the result for the magnification, calculate the object-to-image distance by following:

Calculate the image distance:

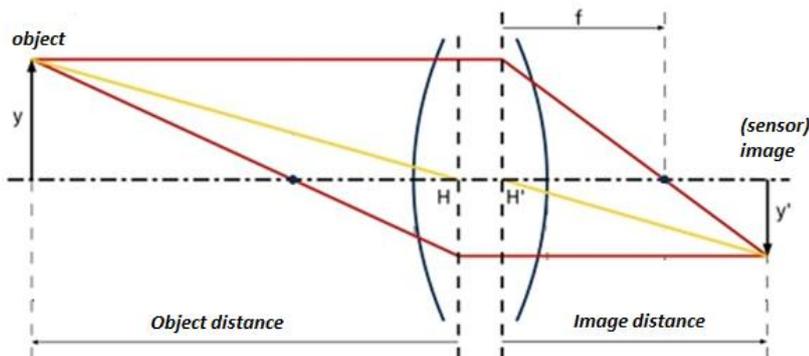
$$\text{ImageDistance} = \text{FocalLength} * (m + 1)$$

Calculate the object distance:

$$\text{ObjectDistance} = \text{FocalLength} * \left(\frac{m + 1}{m}\right)$$

Calculate the object-to-image distance with note of the main plain distance:

$$\text{ObjectImageDistance} = \text{ImageSize} + \text{ObjectSize} + \text{Main plain distance}$$



- f = focal length
- y = object size
- y' = image size

You can see a calculation example on the next page.

Example:

Camera: allPIXA wave camera 15k 86 mm (5.6µm/pixel * 15360 pixels)
 Object width/size: 450 mm
 Lens: 90.1 mm real focal length
 -2.5 mm principal main plain distance

$$m = \frac{ImageSize}{ObjectSize} = 0.162$$

$$ImageDistance = FocalLength * (m + 1) = 104.72 \text{ mm}$$

$$ObjectDistance = FocalLength * \left(\frac{m + 1}{m}\right) = 645,51 \text{ mm}$$

$$ObjectImageDistance = ImageSize + ObjectSize + Main \text{ plain distance} = 747.73$$

(w/o glass plates in the optical path)

11.2.2 Calculating the distance rings (tubes) for the allPIXA wave camera

Some applications require distance rings (tubes) for mounting the lens in the right position on the allPIXA wave camera. This section shows an example how to calculate the length of the distance ring.

To calculate the needed distance rings, you have to get some information about the optical setup:

Optical parameter:

- Real focal length (from data sheet)
- Image distance (calculated)

Parameters of the lens:

- Back flange length at infinite distance (from data sheet)

Parameters of additional focusing unit:

- Minimum offset distance of the unit from flange of the lens
- Maximum offset distance

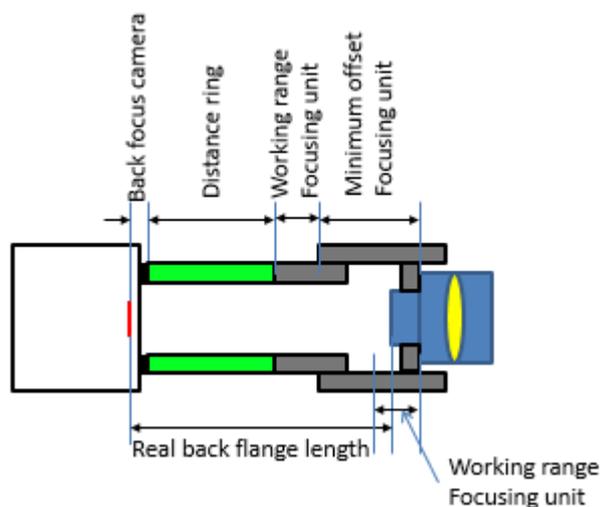


Figure 32

Example:

Camera: allPIXA wave camera
 Lens: Linos Apo Rodagon 90 mm
 90.1 mm real focal length
 93.5 mm flange length@infinite
 Focusing unit: Modular Fokus
 Minimum offset 20 mm
 Maximum offset 45 mm
 Object width/size: 450 mm

1. Calculating image distance:

a. Calculating the magnification:

$$m = \frac{ImageSize/mm}{ObjectSize/mm}$$

b. Calculating the image distance:

$$ImageDistance = FocalLength * (m + 1)$$

Result is: 104.72 mm

2. Calculating the difference between image distance@infinite and flange length@infinite:

Image distance@infinite converged to focal length: 90.1 mm
 Difference: 93.5 mm - 90.1 mm = 3.4 mm

3. Calculating flange distance at working point:

Flange distance@working point: 104.72 mm + 3.4 mm = 108.12 mm

4. Calculating the sum of the distances:

Real flange distance:	+	108.12
Back focus of the allPIXA wave camera:	-	17.526 mm (C-Mount)
Minimum offset focusing unit:	-	20.0 mm
Sum:	=	70.954 mm

Therefore, we use a **distance ring of 60.0 mm**. This covers flange distances from 97.526 mm up to 122.56 mm.

11.2.3 Calculating the integration time

The relationship between the line frequency and the integration time is as follows:

$$IntegrationTime/sec. = \frac{1}{LineFrequency/Hz}$$

For the calculation of the integration time the following parameters are necessary:

- o Maximum or nominal speed of the transport (mm/s)
- o Desired transport resolution (mm/pixel or dpi)

Calculate the integration time with the formula as follows:

$$IntegrationTime = \frac{TransportResolution \left(\frac{mm}{pixel}\right)}{NominalSpeed \left(\frac{mm}{s}\right)}$$

Note: If the transport resolution is stated in dpi and the speed in metric values, the values must be converted (1 inch= 25.4 mm).

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