user manual

pco.dimax family

S / HD / HS

pco.

PCO asks you to carefully read this manual before using the pco.dimax camera system and follow the instructions.

In case of any questions or comments, contact us at PCO.

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The cover photo shows an exemplary PCO camera system.
The lens is sold separately.

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pco.dimax User Manual V2.14 © PCO AG, Germany

TABLE OF CONTENTS

1. INTRODUCTION

High-speed meets high resolution.

This high-speed 12 bit CMOS camera family incorporates advanced CMOS and electronics technology. It is perfectly suited for high-speed camera applications such as material testing, off-board crash or impact tests or super slow motion movie clips. The camera systems feature also a variety of trigger options to cover all off-board applications required by the automotive industry.

1.1 MAIN FEATURES

	pco.dimax S1 / S4	pco.dimax HD / HD+	pco.dimax HS1/2/4 (mono)
Maximum resolution (pixel)	**S1:** 1008x1008	**HD:** 1920x1080	**HS1:** 1000x1000
			HS2: 1400x1050
	S4: 2016x2016	**HD+:** 1920x1440	**HS4:** 2000x2000
Maximum speed @full resolution (fps)	**S1:** 4467	**HD:** 2128	**HS1:** 7039
	S4: 1279 (mono)		**HS2:** 5469
	S4: 1102 (color)	**HD+:** 1603	**HS4:** 2277

- ***12 bit*** dynamic range
- ***Color*** or ***monochrome*** image sensor versions available
- ***Correlated Double Imaging*** for superior image quality
- ***Exposure time range*** 1.5 µs - 40 ms
- ***Integrated image memory*** (RAM up to 36 GB)
- ***Double shutter operation*** (standard for S/HS, optional for HD)
- ***GigE*** and ***USB 2.0/3.0*** or ***Camera Link*** data interfaces (***HD-SDI*** optional)
- ***Multiple trigger interface***
- ***Smart battery control*** (optional) for 1h full operation or 6h data backup
- ***IRIG-B*** (standard for S, HS - optional for HD/HD+) B000 through B007; B120 through B127

1.2 INTENDED USE

This camera system is designed for use by technicians, engineers and scientists. It is a scientific measuring instrument, which provides images. The camera may only be used according to the instructions of this manual. Provisions, limitations and operating conditions stated in this manual must be respected. Unauthorized modifications and alterations of the device are forbidden for safety reasons.

Areas of Application

- high-speed particle image velocimetry (PIV)
- short time physics
- spray analysis
- hyper velocity impact studies
- automotive crash tests
- material testing
- tensile tests
- airbag inflation
- fast flow visualization
- 3D high-speed photogrammetry
- hydrodynamics
- fuel injection
- sparks in electronic switches
- combustions imaging
- semiconductor quality control
- fast events in nature and industry
- super slow motion movie clips
- ballistics

2. SAFETY INSTRUCTIONS

Read the safety instructions completely.

DANGER

DAMAGED POWER CABLE OR POWER PLUG
Danger to life due to electrical shock!
➔ Each time the camera is used, check the power cable for damage.

WARNING

ELECTRIC SHOCK WARNING DUE TO VOLTAGE PARTS INSIDE
Risk of injury due to electrical shock!
➔ Never slide any items through slits or holes into the camera.

CAUTION

MOISTURE
Risk of injury due to electric shock if moisture enters the camera.
➔ To avoid the risk of water condensation, protect the camera against extreme changes of ambient temperature.

CAUTION

TRIPPING HAZARD
Risk of injury from tripping over loose cables.
➔ Never position the cable in a way that it could become a tripping hazard.

NOTICE

HUMIDITY, DUST OR RADIATION
Humidity, dust or X-rays could damage the camera.
➔ Never operate the camera in humid or dusty environments or in places with high levels of x-ray radiation.

NOTICE

SHOCK & VIBRATION
To avoid damaging the camera it must be firmly mounted and protected against strong shocks or vibrations.
➔ Use the camera's mounting threads to secure it.

NOTICE

LENS MOUNTING
Do not force the lens onto the camera.
➔ To protect the lens connector thread from damage, use minimal force when attaching a lens to the camera.

NOTICE

LIQUIDS DAMAGE CAMERA
If liquids have penetrated the device.
➔ Switch the camera off immediately, detach it from power and contact PCO's customer support.

NOTICE

DAMAGED CAMERA HOUSING
If the camera has been dropped or the camera body is damaged.
➔ Switch the camera off immediately, detach it from power and contact PCO's customer support.

NOTICE

IF CAMERA IS NOT WORKING PROPERLY
In case all actions following this manual to get the camera working properly were unsuccessful... If, after thoroughly reviewing the instruction manual, the device is still not operating properly.
➔ Switch the camera off immediately, detach it from power and contact PCO's customer support.

3. SYSTEM COMPONENTS

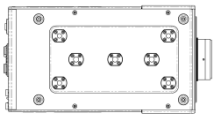
The camera system includes following parts

Camera

F-mount optical connection, see **A1.5**

Rear panel connections (see A1.2)

- Power Input (12-36 VDC)
- ON/OFF Switch
- Dust Filter (exchangeable)
- Interface (GigE – USB 2.0/3.0 – CameraLink – HD-SDI optional)
- Lemosa Connectors (Automotive / industrial applications)
- LED indicates camera status
- Serial Number Tag
- Input/Output BNC connectors (Trigger – Acquire – IRIG-B – Status – Sync-in/out)



Mounting Thread

3x 3/8''-16 UNC and 4x M8 threads (bottom) and 2x 1/4"- 20 UNC (top)

Battery Pack (optional)

Lithium Iron Phosphate ($LiFePO_4$) battery, see **A3**

Power Supply

24V AC external Power Supply ETF150-24

Power Cord

Standard IEC13 connector

Cable

Depending on your interface, see **A2.1**

Digital Camera Tools (USB flash drive content)

- Camware: software for camera control & image acquisition
- Manuals
- Driver & tools
- Software Development Kit (SDK) & demo programs in C and C++

4. INSTALLATION

You will find all necessary files on the accompanying USB flash drive. You may also download the latest versions of our software, camera driver and third party software drivers from our website.

Minimum system requirements:

- Clock speed > 2.4 GHz (Intel Core i7)
- RAM 4 GB
- Windows 7 or higher (no server version)
- HD-resolution display
- USB 2.0 or GigE (1000Mbps network interface card)

NOTE
Using Camware with more than one interface, connect your cameras only with the same data interface. Only use one single interface: CameraLink **or** GigE/USB. Priority of USB over GigE when both connections are used at the same time! Commands over GigE will be ignored

4.1 DRIVER

Interface:

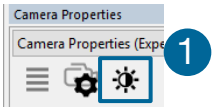
Install the appropriate driver for the interface you want to use.

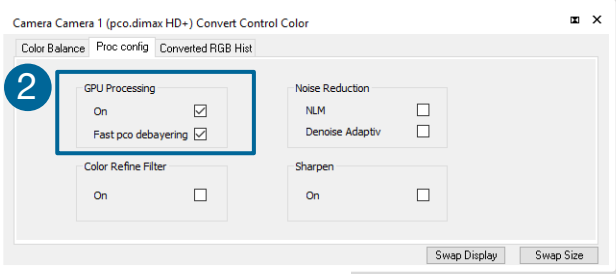
The pco.dimax camera has many different interfaces, read chapter **A2**. This chapter describes configuration and installation of all different interfaces is described

- USB 2.0 / 3.0 **A2.2**
- GigE **A2.3**
- Camera Link **A2.4**
- HD-SDI **A2.5**

NVIDIA Cuda Driver:

Update your NVIDIA driver for Camware 4 GPU Processing will not work and therefore slow image processing.





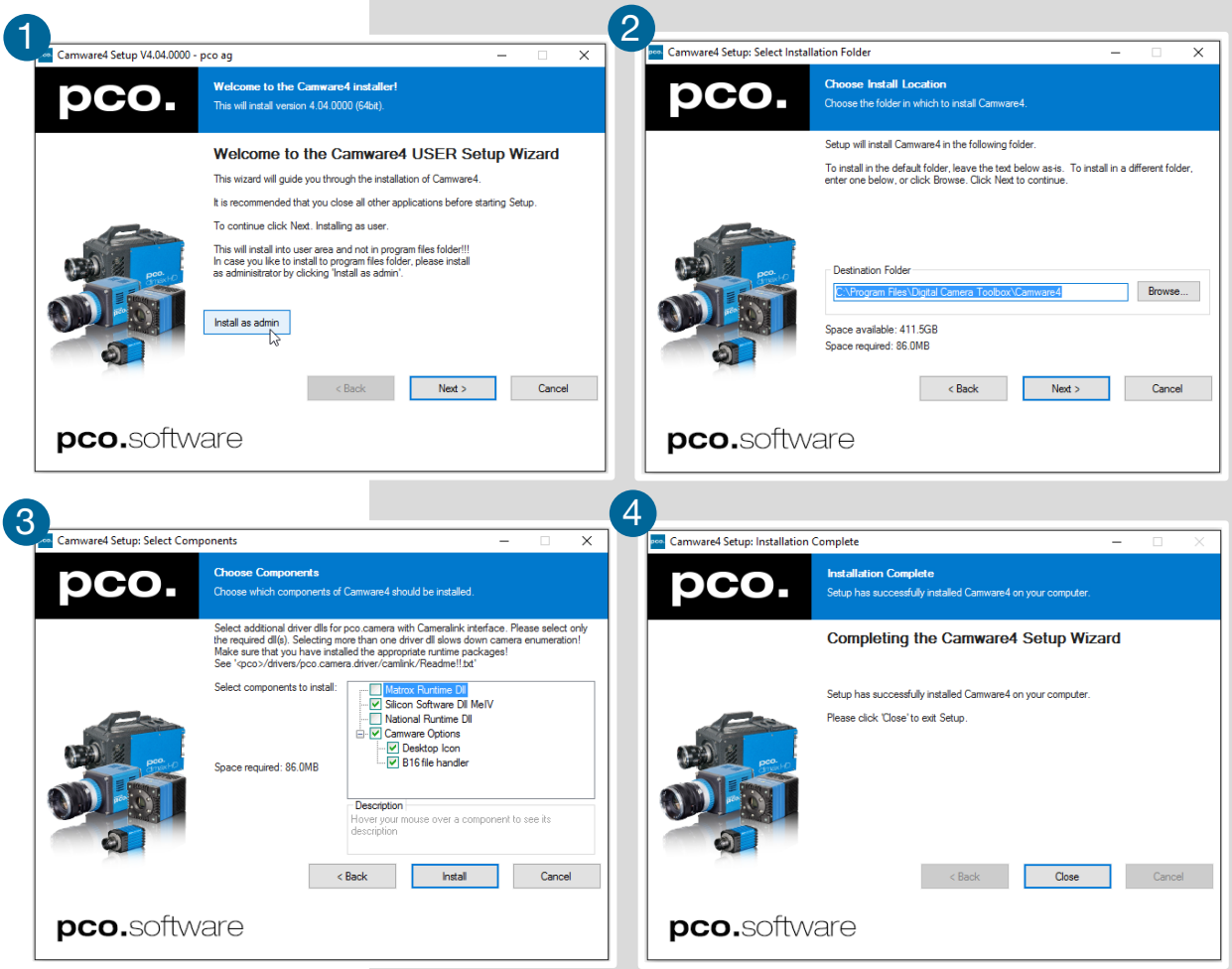
Check if ***GPU Processing*** is activated by having a look into the ***Proc config settings*** 2 in the ***Convert Control window*** 1 (see Convert Control chapter **6.3.8**).
If ***GPU Processing*** is disabled and shown grayed, update your NVIDIA driver or check the website of the computer manufacturer for graphic card driver updates. Your NVIDIA driver version must be at least ***333.11*** or higher.

4.2 CAMWARE

The Camware Windows application software enables you to control every camera parameter or setting. Images can be displayed on a monitor and may be downloaded and stored. The USB flash drive contains the software installation files for latest Windows operating systems in 32 & 64 bit.
After a successful installation, you will find the program file ***Digital Camera Toolbox*** in your program directory and a ***Camware 32/64 button*** on your desktop. Other helpful tools are also installed in the same directory.
To uninstall the Camware program, use the Software feature under Windows' System Control.

Follow the installation wizard

1. Install Camware as Admin to install to program folder, otherwise it will be installed only to user folder
2. Choose install directory
3. Choose components: select additional drivers for Camera Link Interface
4. After the next two screens installation is complete



5. QUICK START

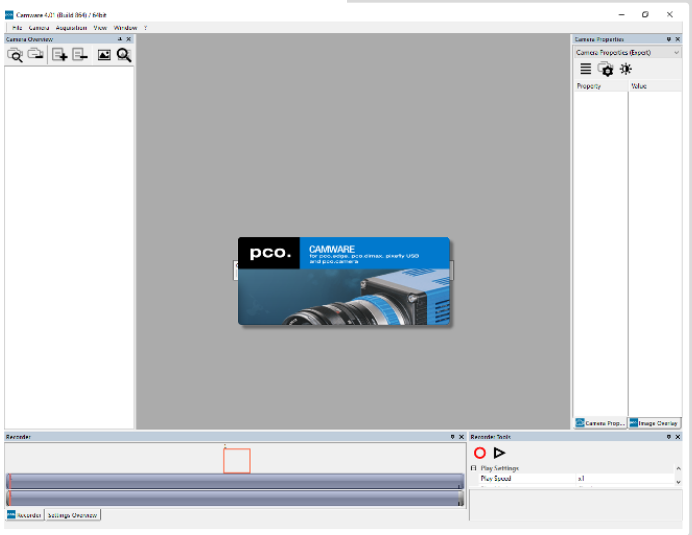
In order to get familiar with your new camera and software it might be helpful, first to aim the camera at an object easy to focus and visible at normal light conditions.

5.1 PREPARATION

- ***Computer*** is turned on
- ***Installation*** is finished (see chapter **4**)
- ***An appropriate lens*** is attached (remove cap) or the camera is attached properly to the microscope, spectrograph or other scientific device
- ***Camera*** is connected to the power supply
- ***Camera*** is connected to the computer and ***switched on***
- ***Camera*** is booted and ready after 40s when a ***beep*** sounds

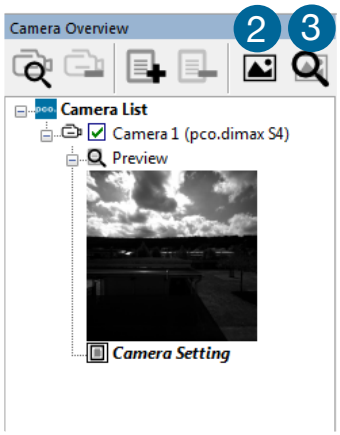
5.2 START

Start ***Camware*** and the ***graphical user interface*** will start up:



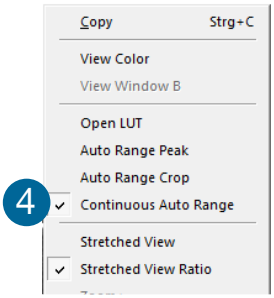
NOTE
Always install latest Camware version to get the full functionality of your camera (www.pco.de/support).

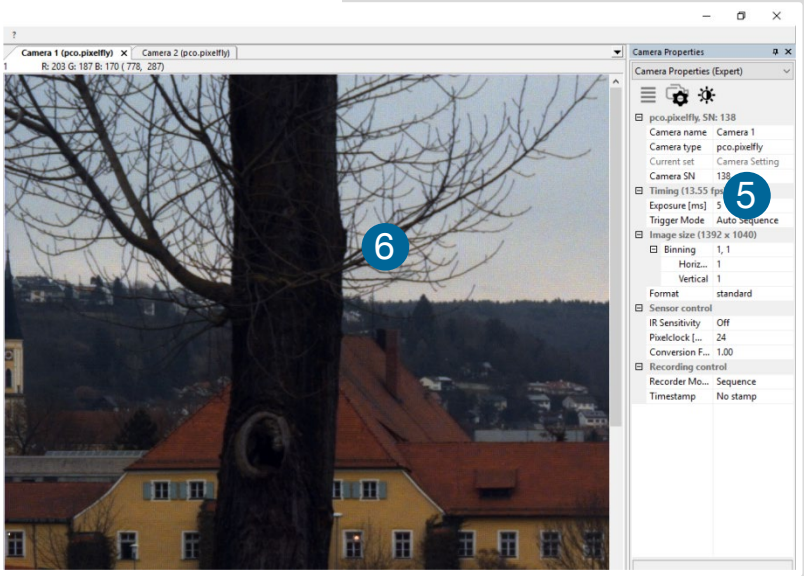
5.3 FIRST IMAGE



Follow the instructions:

- ***Camware*** must be started 1
- A view window 2 is shown automatically, if not open a new one
- Start ***live preview*** 3
- Right-click into the view window and apply ***Continuous Auto Range*** 4
- You may have to adjust ***exposure time*** 5 , ***aperture*** and ***focus***
- Now you should clearly 6 see the ***object*** in the window





If you need to change ***exposure*** time (e.g. the image is still either too dark or too bright), go to chapter **6.3.2**.

For recording and saving images, see chapter **6.3.8** and chapter **6.6** for detailed information.

NOTE
Live preview: Useful for fast and easy camera adjustment and focusing. Does not record or store images.

6. CAMWARE 4 SOFTWARE

PCO's Camware is an outperforming software for camera control, image acquisition and archiving of images in various file formats. This chapter provides a detailed description of all Camware functions.
Camware works with any kind of PCO camera. Visit PCO **website** for the latest version of this software.

6.1 CHAPTER OVERVIEW

Chapter 6.2: Camera Overview / List: shows all connected cameras and all set recording profiles

Chapter 6.3 describes the ***Camera Properties*** window.

6.3.1 TIMING	Exposure time / FPS based / Trigger modes/ Synchronization
6.3.2 IMAGE SIZE	ROI
6.3.3 SENSOR CONTROL	CDI / Double image / BW noise filter
6.3.4 MEMORY	Camera internal memory (RAM)
6.3.5 RECORDING CONTROL	Recorder mode / Acquire mode / Timestamp / Sequence trigger
6.3.6 STATUS	Temperature
6.3.7 HARDWARE I/O CONTROL	Input / Output options
6.3.8 CONVERT CONTROL	Contrast / Saturation / Gamma

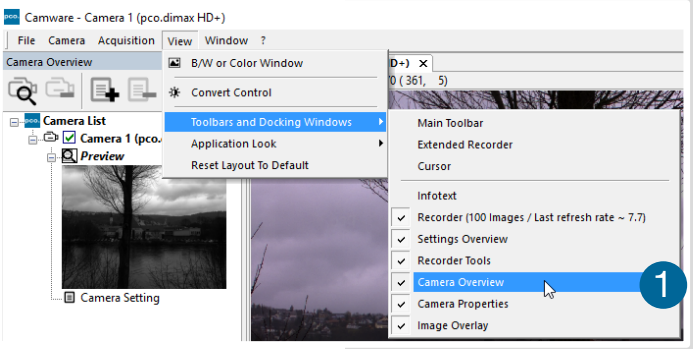
Chapter 6.4 / 6.6 / 6.7 / 6.8 describe the recording functions

6.4 IMAGE OVERLAY	Overlay for recorded images
6.5 RECORDER TOOLS	Record / Play / Settings
6.6 VIEW WINDOW	View window functions
6.7 RECORDER (IMAGES)	Preview of recorded images
6.8 SETTINGS OVERVIEW	Overview of all parameter settings / Auto Save

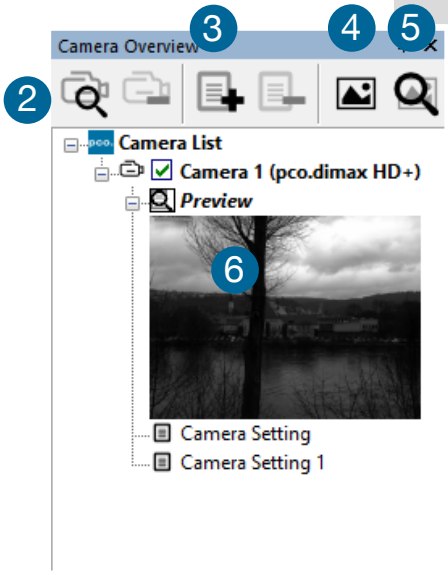
Chapter 6.9 introduces to further Camware features:

6.9.1 DEMO MODE	If no camera is connected
6.9.2 FILE MENU	Open / Save / Print files / Direct record to file / Options / AVI Codec Dialog / Lookup table
6.9.3 CAMERA MENU	Camera control / Close / Rescan
6.9.4 ACQUISITION MENU	Live preview / Acquire sequence / Auto camera RAM segment switching
6.9.5 VIEW MENU	B/W or Color window / Convert Control / Toolbars / Application Look / Reset layout to default
6.9.6 WINDOW MENU	New / Close / Split window
6.9.7 HELP MENU	Create Support file/ Logging / Support mail / About Camware
6.9.8 VIEW WINDOW MENU	Right-click menu: Zoom; Flip; Mirror; Rotate…
6.9.9 ADDITIONAL FEATURES	White Balance, Contrast, ROI by Mouse, Short-cut list

6.2 CAMERA OVERVIEW / LIST



If closed, open the ***Camera Overview*** window by selecting the ***View*** tab and ***Toolbars and Docking Windows*** → ***Camera Overview***.1

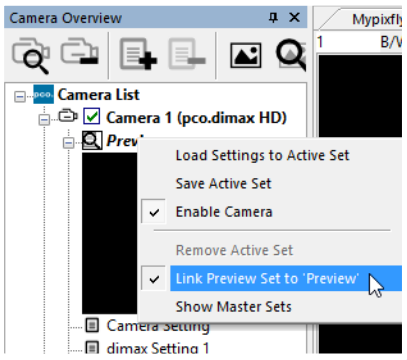


The ***Camera Overview*** window supports management of more than one PCO cameras and displays a list of the connected ones. It displays a list of all connected PCO cameras. Camware is able to ***scan*** 2 for connected cameras or close a connected camera. It allows to define several different ***Settings*** for each camera (max. 30 sets per camera → ***add new set*** 3).
New view windows 4 can be opened and the ***Live Preview*** 5 function started. When opended up, the ***Preview*** shows a ***small preview window*** 6 (always monochrome) integrated in the camera list.

Live preview facilitates the aperture and focus adjustment, allowing a first look at your object. During live preview no images are saved neither in the computer's nor in camera's RAM.

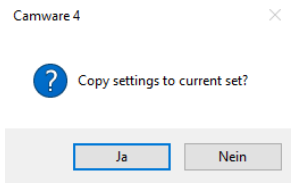
During ***Live preview Trigger*** and ***Acquire mode*** are set to ***Auto***.

Camera Setting: all ***Presettings*** in the ***Camera Properties*** (see **6.3**) are saved to ***Camera Settings***. Define different ***Settings*** with different ***Preferences*** in ***Camera Properties*** for each of your experiments. Settings can be switched easily at any time (not during record) and copied to other cameras.



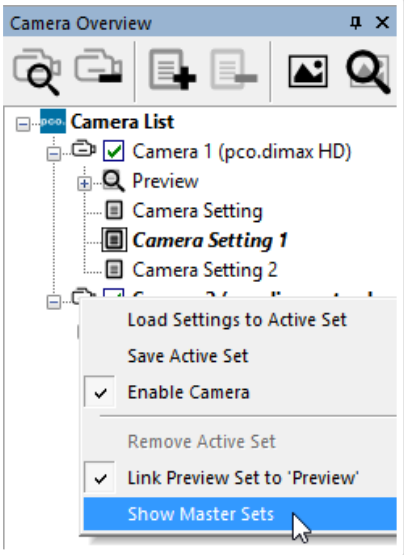
Link Preview Set to 'Preview'
When ***Link Preview Set to Preview*** is ticked the Preview will always be active with the set parameters when starting a ***Live Preview*** 5.

In case this function is deactivated, the ***Live Preview*** will always show live images with the parameters of your active setting.
Setting a higher exposure time for ***Preview*** set and linking it to the preview function is beneficial if preview light conditions are different from those in recording situations.



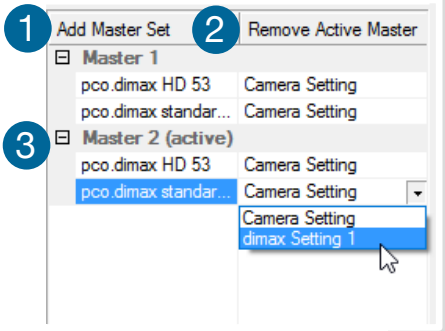
Click and drag camera setting: copy e.g. ***Camera Setting 1*** to ***Camera Setting 4***, just drag & drop ***Setting 1*** to ***Setting 4*** and Camware will ask if you want to copy the settings. Confirm it. It is possible to copy each setting to every camera.

Master Sets



This function facilitates the image acqusition with multiple cameras. Defining two or more ***Master Sets*** allows easy switching between different predefined settings for each camera during an experiment.. Each image acquisition or experiment can be recorded with its own ***Master Set***.

To display Master Sets, right-click in the ***Camera Overview*** window and select ***Show Master Sets***.



Master Set window
Define different Master Sets. Select individual ***Camera Settings*** within each ***Master Set***.

Functions:
Add ***Master Set*** 1 or ***Remove active master*** 2.
Activate it by clicking on one of your sets 3.

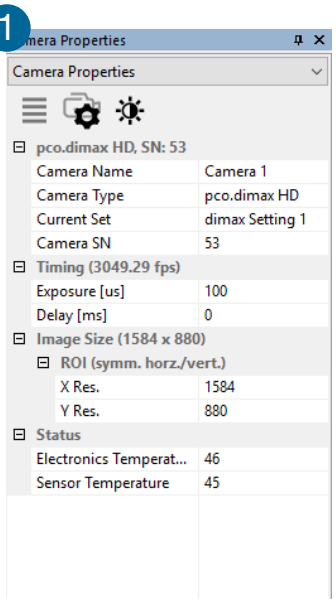
6.3 CAMERA PROPERTIES

The ***Camera Properties*** window in Camware is the main interface for all camera settings. The active set in Camera list is adjusted here.

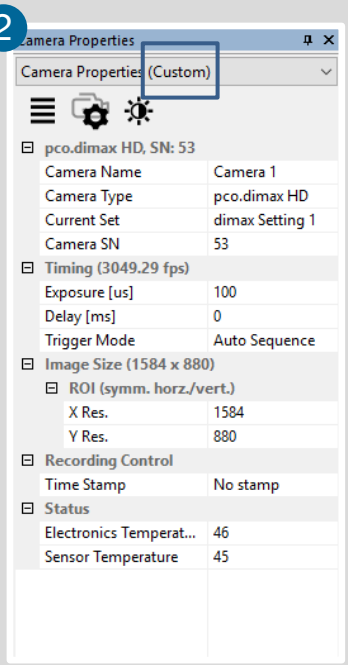
The former topic ***Camera Control*** (known from Camware 3.x) and the ***Convert Control*** (see **6.3.8**) can be opened additionally.

Three view options with various functions can be selected: ***Basic***, ***Custom*** and ***Expert***.

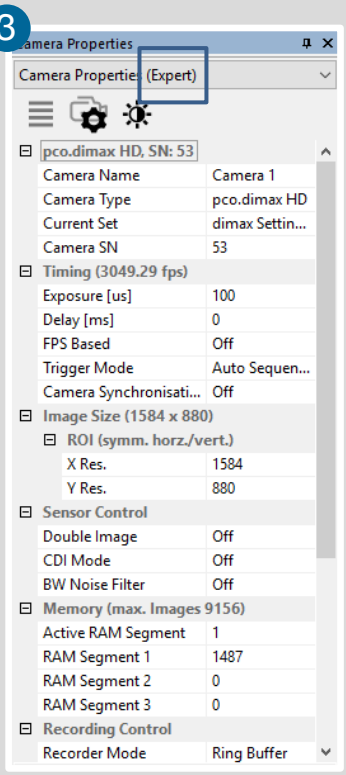
1



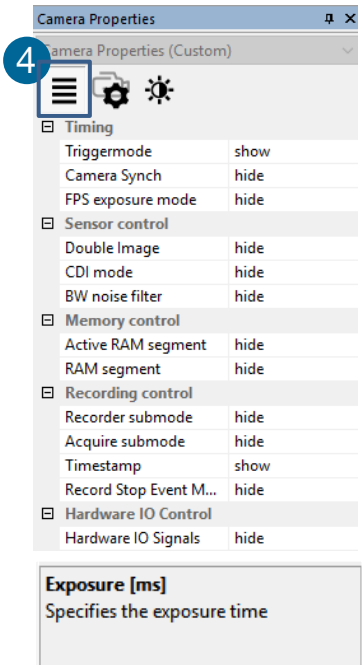
2



3



4



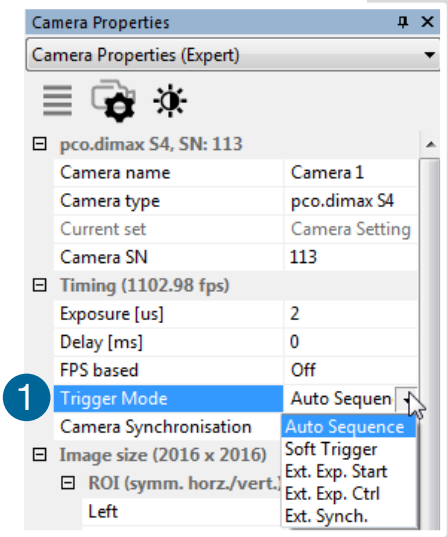
Basic mode 1 only shows camera infos, exposure time / delay time, image size (ROI – Region of Interest) and temperature settings. In ***Basic Mode*** the frame rate is always calculated automatically based on the selected exposure time, i.e. while exposure time is increased, frame rate decreases. It is recommended for Camware beginners.

Custom mode 2 shows several more setting possibilities and functions are hidden or shown by the ***Custom Properties Button.*** 4 Beside to the ***Basic*** mode many more options are selectable.

Expert mode 3 (for advanced users) shows all possible camera feature settings.

An ***explanation*** for each ***feature*** is displayed below the properties dialog.

6.3.1 TIMING

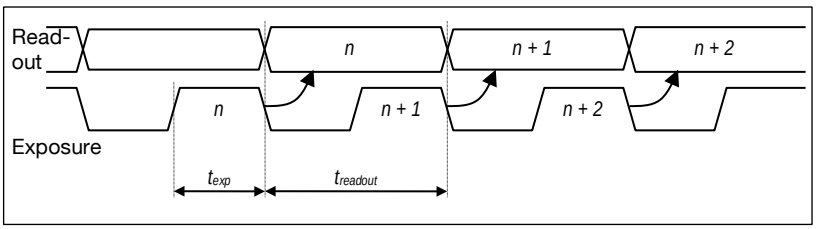


General Information

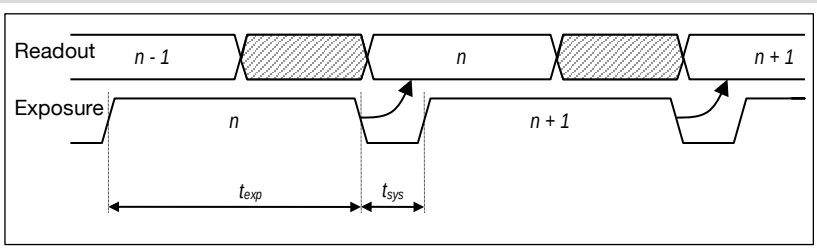
The most important parameter for a high-speed camera is the frame rate. The upper limit of the frame rate is defined by the exposure time and the readout time.
In this context ***trigger*** means exposure trigger, i.e. the trigger signal controls the exposure of a single image.

Exposure and readout of one image are done simultaneously, i.e. while image ***n*** is being read out from the sensor, image ***n+1*** is already integrated within the sensor's pixel elements.

In case of short exposure times, the ***readout*** time is the limiting factor, i.e. a new image can only be recorded, if the last image is read out.



For long exposure times, the ***exposure*** time is the limiting factor:



NOTE
As the pco.dimax is a high-speed camera, triggering single images using the ***Soft Trigger button*** will result in a significantly degraded image quality (***noisy*** images).

Trigger Modes 1

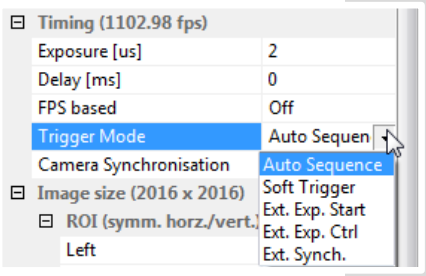
Auto Sequence: the camera optimizes the image recording to achieve the best possible frame rate. In the ***Auto Sequence*** mode, the camera determines the highest possible frame rate against the set exposure time and the time required for a frame readout. Upon a start command the sequential recording starts and lasts until a stop command.

Soft Trigger: single images are recorded by this Camware command. A single image is acquired by pressing the Single Trigger button. This button appears after pressing the Start Record button. Other signals have no influence on this operating mode.

Ext. Synch. (BNC Exp. Trig.): in addition to the Master / Slave camera synchronization mode (see **Camera Synchronization** p.19) the pco.dimax also uses an external synchronization signal feeding a ***phase-locked loop*** (PLL) in the camera.

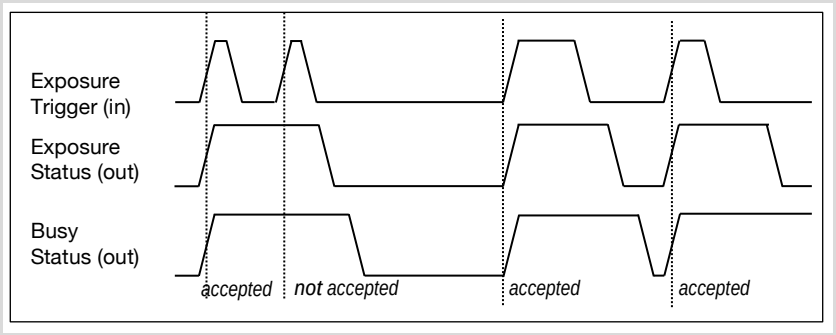
Advantages of the PLL (***External synchronization***) solution:

- Availability: Only for frequencies of 100 or 1000Hz
- Reliability: In case of dropouts of the external synchronization signal, the synchronization is kept internally by the PLL signal with only small deviation.
- Noise immunity: Interference on the signal is automatically detected and discarded.
- Flexibility: The cameras can even be set to different frame rates, as long as all frame rates are an integer multiple of the synchronization frequency.



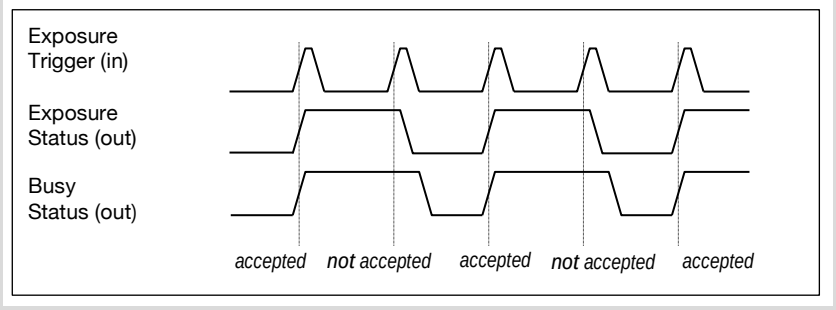
External Exposure Start The image acquisition is triggered by an external signal. The single trigger button acquires a single image for a test.

In the ***External Exposure Start*** exposure control mode, single image recording is started by the falling or rising edge of the voltage signal at the BNC Exposure Trigger input (see Appendix **A1.2**. The frame rate cannot be set, as the frame rate is defined by the frequency of the external signal. However the exposure time and ROI settings affect the maximum possible frame rate.

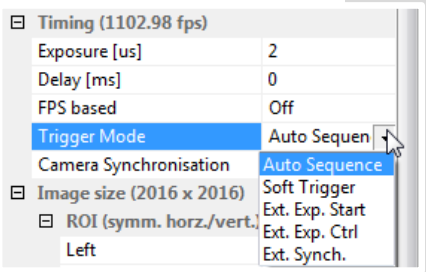


NOTE
If the trigger rate of the external signal is very near to the maximum possible frame rate (difference < 1/1000), then it will be random, whether or not a trigger is accepted!

A new trigger is possible after $t_{readout}$ or (t_{exp} + t_{sys}) (whichever is longer) after the preceeding trigger. The Busy Status signal (see chapter **6.3.6**) indicates whether a new trigger is accepted. The maximum achievable frame rate in ***External Trigger*** mode is negligibly less (about 0.1%) than in Auto Sequence mode. If the trigger rate of the external signal is higher than the maximum possible frame rate, then every second trigger pulse is ignored. Therefore the actual frame rate drops to ½ of the external trigger rate. If the trigger rate is increased further, only every 3rd, every 4th etc. trigger edge will be accepted.

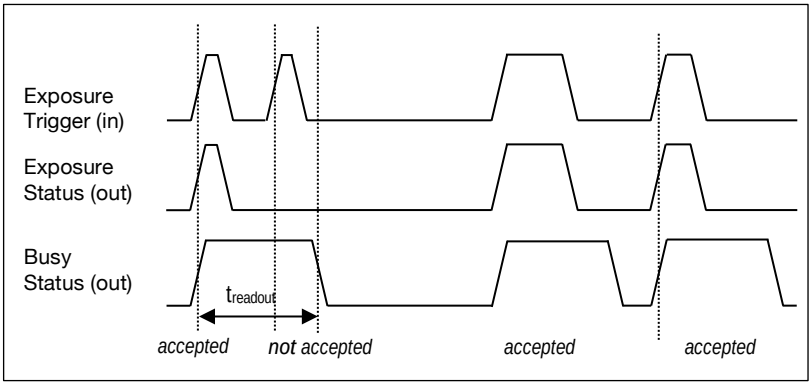


In order to avoid trade-offs at maximum frame rate use either the Busy Status signal (see chapter **6.3.6**) or make sure the external trigger rate follows this condition: External Trigger Rate ≤ f_{max} / 1.001



External Exposure Control (Ext. Exp. Ctrl) An external signal, applied to the trigger input (BNC exposure trigger), controls ***start and duration*** of the exposure (see chapter **6.3.6**).
In trigger mode External Exposure Control a new exposure starts by the falling or rising edge of the voltage signal at the BNC input (see **6.3.6**). The exposure ends when the opposite edge is detected. Thus in this mode, the start as well as the length of the exposure time can be controlled externally. No further settings can be made, as the image timing is completely controlled by the exposure trigger signal yet. There is a maximum exposure time. If the trigger pulse is longer than 20ms, the integration will be stopped at 20ms.

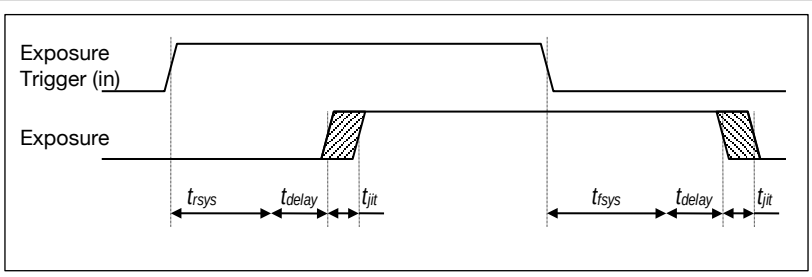
A new trigger is possible after $t_{readout}$ or (t_{exp} + t_{sys}) (whichever is longer) following the preceding trigger. The Busy Status signal (see chapter **6.3.6**) indicates whether a new trigger is accepted.



NOTE
There is no specified timing for the software trigger. The software trigger is not recommended for applications where an exact timing is required!

Detailed Timing for External Exposure Start /Control

The detailed timing for external trigger includes system delay times, an adjustable additional delay time and the jitter.



Parameters for the following tables:

- Width of the selected ROI (see **6.3.2**) must be a multiple of 24, minimum is 96.
- Data is not applicable for trigger mode ***external exposure start.***
- Trigger edges occurring within t_{delay} + 200ns after a previous trigger are ignored.

$t_{jit:}$ -0 /+25ns t_{delay} configurable 0…1ms
t_{rsys} + t_{fsys} system delay times depending on ROI (see **next** page)

List of examples for different ROIs:

pco.dimax S1, S4, HD, HD+

Double Image Mode

Model	ROI (width in pixel)	t_{rsys} (µs)	t_{fsys} (µs)
S1 Color **S1 BW** **S4 BW**	2000 (only S4)	2.377	2.729
	1440 (only S4)	2.004	2.356
	960	1.684	2.036
	720	1.524	1.876
S4 Color **HD/HD+**	2000 (only S4)	2.724	3.124
	1920	2.663	3.064
	1440	2.300	2.700
	960	1.936	2.337
	720	1.755	2.155

CDI Mode

Model	ROI (width in pixel)	t_{rys} (µs)	t_{fsys} (µs)
S1 Color **S1 BW** **S4 BW**	2000 (only S4)	5.183	3.081
	1440 (only S4)	4.436	2.708
	960	3.796	2.388
	720	3.476	2.228
S4 Color **HD/HD+**	2000 (only S4)	5.948	3.524
	1920	5.827	3.464
	1440	5.100	3.100
	960	4.373	2.736
	720	4.009	2.555

pco.dimax HS1, HS2, HS4

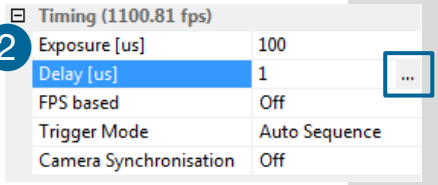
Double Image Mode

Model	ROI	t_{rys} (µs)	t_{fsys} (µs)
HS1 **HS2** **HS4**	2000 (HS4)	1.716	2.068
	1440 (HS2/HS4)	1.556	1.908
	960	1.396	1.748
	720	1.300	1.652

CDI Mode

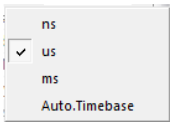
Model	ROI	t_{rys} (µs)	t_{fsys} (µs)
HS1 **HS2** **HS4**	2000 (HS4)	3.860	2.068
	1440 (Hs2/HS4)	3.540	1.908
	960	3.220	1.748
	720	3.028	1.652

Further timing settings for all pco.dimax versions available on demand.

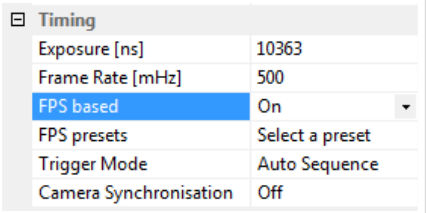


Timing 2

The exposure and delay time can be precisely set in steps of 1 µs. The effective stepsize depends on the operation mode.
The slider and the up/down control refer to the blue highlighted unit. The resulting frame rate is derived from this setting. Delay time setting is not recommended for high-speed applications.



Change time base by clicking on ... and the respective window opens.



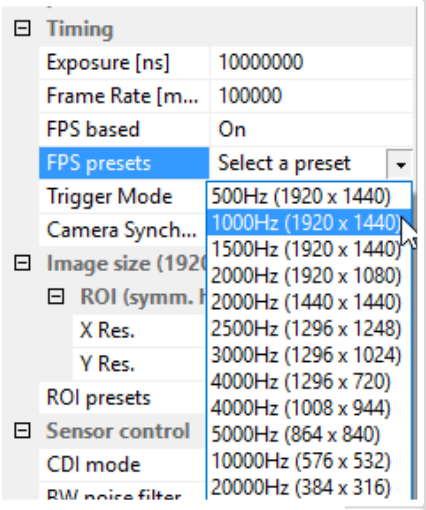
FPS based: the camera optimizes the image recording to achieve the selected frame rate. The exposure time is limited to 1/fps, lower values can be selected. (Selectable for Auto Sequence trigger mode and ***preset*** for External synchronization mode.)

First the frame rate is set. If the time required for readout of the image is longer than 1 / frame rate, then the frame rate will be reduced to 1 / treadout.

camera type	exposure time	delay time
pco.dimax	1.5 µs … 40 ms	2 µs … 40 ms

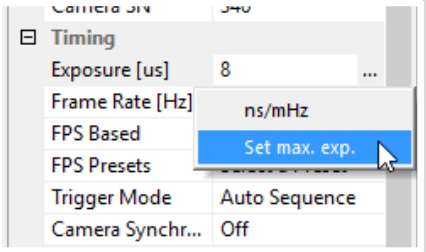
If FPS based is selected and the selected exposure time requires a lower frame rate, the exposure time will be cut to the maximum possible time at that frame rate.

The minimum selectable frame rate is 0.465 Hz, but it only makes sense to use: ***≥ 20 Hz***.

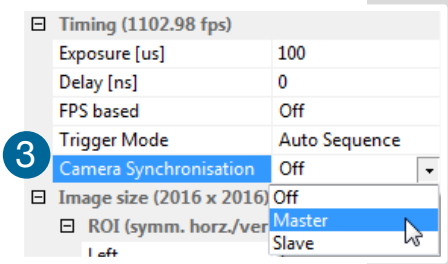


FPS Presets

If FPS Based is set to on, a predefined combination of frame rate and resolution may be selected.
These presets may vary and depend on your pco.dimax model.
For example pco.dimax HD+: 1000 Hz @ 1920x1440 (full resolution).



Clicking on ***Set max. exp.*** Camware sets the maximum possible exposure time according to the selected frame rate.



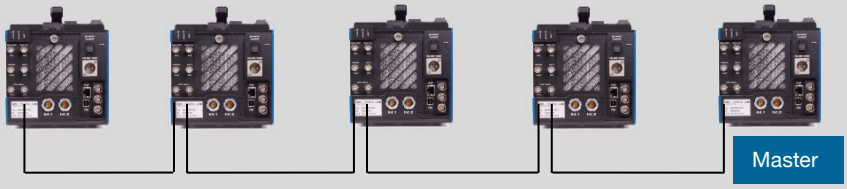
Camera Synchronization (Master / Slave) 3

The Camera Synchronization in Camware eliminates the need for an external synchronization source and simplifies camera synchronization.

Using defined settings for all cameras the master camera takes into account the maximum frequency deviation between the cameras and calculates the maximum frame rate ensuring no camera drops images.

Off: Set this camera as stand-alone, i.e. not participating in the chain.
Master: Set this camera as master in a daisy chain.
Slave: Set this camera as slave in a daisy chain.

Wiring Scheme



The camera must be wired from the ***Sync Out*** to the ***Sync In*** of the following camera in the chain. The master camera must be at the beginning of the chain.

Cameras which are configured as slave or stand-alone, do electrically repeat the synchronization signal.

A master camera ignores the signal at its ***Sync In*** port and generates a synchronization signal at the ***Sync Out*** port. Thus a master camera interrupts a wired chain.

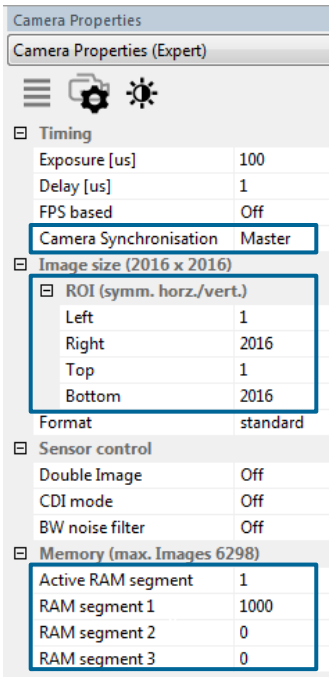
The cameras can also be wired as a ***ring structure***. In this case any one of the cameras can act as a master camera.

A camera configured as a ***stand-alone camera*** does not participate of nor interrupt the chain and can be operated individually.

All cameras should have the same ***sensor frequency***. If not, define the camera with the lowest sensor operating frequency as master.

Specifications

- up to 50 m cable (RG174 or RG58) from camera to camera
- up to five cameras
- synchronization delay less than 1 µs (five cameras, ***100 m*** cable ***in total***)
- synchronization jitter less than 50 ns (for any camera in the chain)
- the maximum achievable frame rate in camera sync mode is only about 0,5 % less than on an individual camera



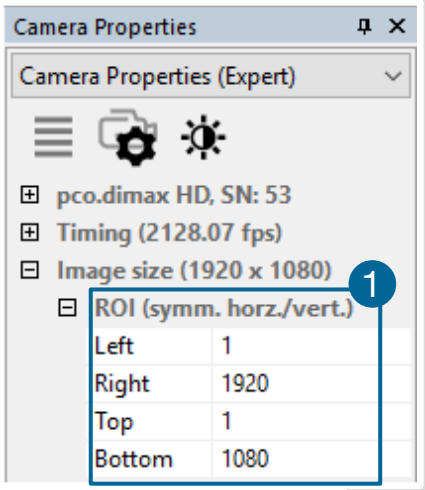
Camera Setup

- Set all cameras to ***same ROI*** and ***same size*** of the ***RAM*** segment.
- Define the ***master*** and ***slave*** cameras.
- Exposure/delay time and frame rate can only be set for the master camera.
- ***Start*** recording function of the master camera.
  Now all cameras record images. The software starts the slave cameras first and the master camera last (vice versa at acquisition stop).
- ***Stop*** master camera's recording is stopped first (Stop button in Camware).
  The ***slave cameras stop automatically*** after the master camera is stopped. All cameras have recorded the same number of images.
- Images can now be read from all of the cameras by using an index, where #1 is the first / earliest image. Images with the same index recalled from different cameras have been taken at the same time.

The ***sequence trigger*** (see **28**) can also be used in camera sync mode.
However, only the master camera must be configured for the sequence trigger and trigger delay. The sequence trigger mode setting for all slave cameras must be ***off***!

Acquire mode is ***not*** possible in camera sync mode.

6.3.2 IMAGE SIZE



Region of Interest 1

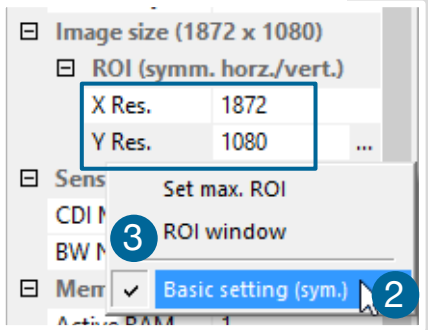
To speed up frame rate and to save storage space the ROI (region of interest) selects only a part of the sensor to be read out. Due to the sensor structure and readout electronics the selectable region is always symmetric to the center.

pco.dimax HD/HD+/S1/S4

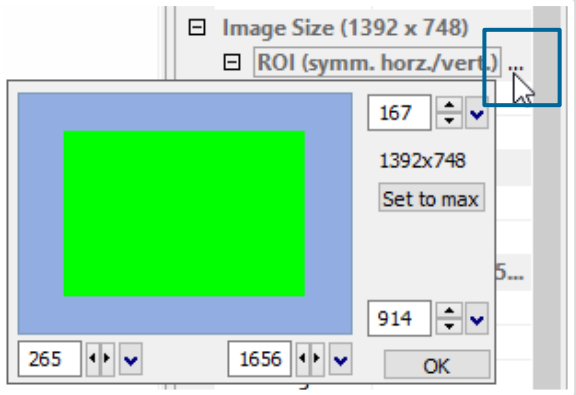
increments horizontal:	48 pixel steps
increments vertical:	4 pixel steps
minimum ROI:	48 x 8 pixels

pco.dimax HS

increments horizontal:	2 pixel steps
increments vertical:	2 pixel steps
minimum ROI:	8 x 8 pixels



Basic Setting: 2
Activate ***Basic Setting*** by clicking on ***...*** to easily set a ***ROI*** by just typing in the horizontal and vertical resolution in pixels.



ROI window
Select the ROI (symm. horz./vert.) menu and activate ROI Window by clicking on ***...*** , or use the the ***...*** right to the ***X Res / Y Res*** and click on ***ROI window***. 3

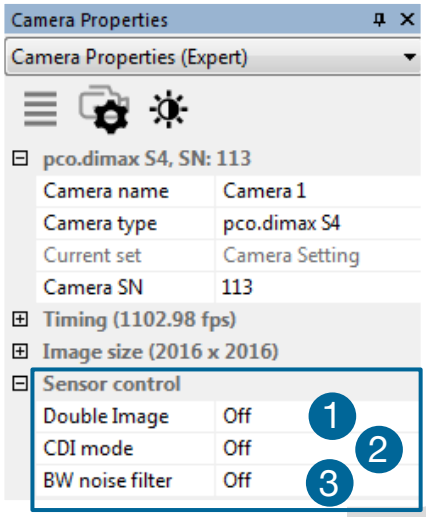
The ROI window opens and a new Region of Interest might be set by dragging a window with the mouse or by typing in the values.

NOTE
(only HS Version)
Changes in ROI produce frame rate changes in discrete steps, more notably in horizontal direction than vertically. Changes of a few pixel in vertical direction have little impact on frame rate.

Examples of a possible ROI with corresponding storage/recording values ***(only valid for pco.dimax S4 monochrome – differs for all other models)***:

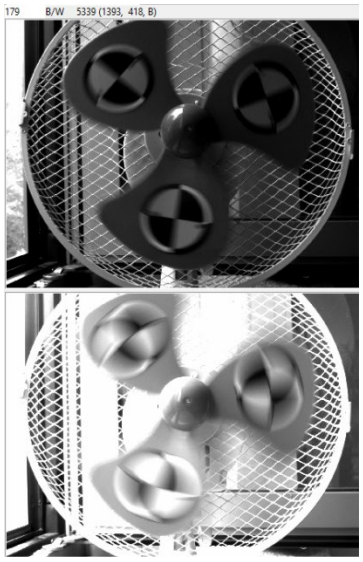
resolution horizontal (pixel)	resolution vertical (pixe)]	max frame rate (fps)	# of images in RAM (36 GB)	recording time (s)
2016	2016	1 279	6 324	4.9
1920	1080	2 470	12 395	5.0
1008	1000	4 502	25 499	5.7
720	480	11 576	74 374	6.4
240	32	126 263	3 346 862	26.5
2016	16	73 443	796 872	10.9

6.3.3 SENSOR CONTROL

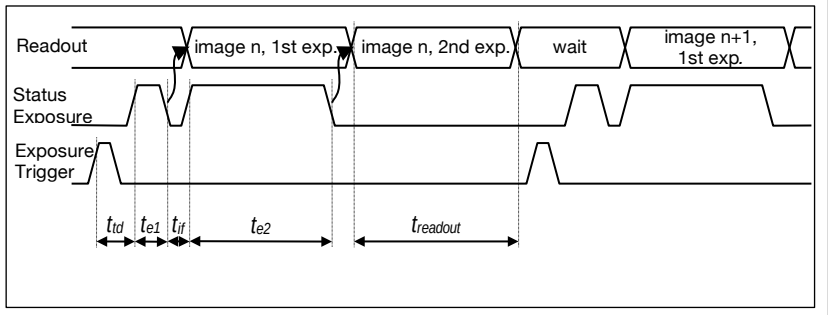


Double Image / Doubleshutter 1

(Standard for HS/S, optional for HD/HD+)
This feature is widely used for particle image velocimetry (PIV) measurements and is a(n) (optional) feature of the pco.dimax. The ***first exposure time*** t_{e1} may be any exposure time of the available range of the pco.dimax camera. The ***second exposure time*** t_{e2} cannot be directly adjusted. The length of the second exposure is the readout time of the first image. The interframing time t_{itf} denotes the transition time between end of exposure ***#1*** and start of exposure ***#2***.
As can be seen the maximum frame rate of the double image mode (where frame rate is defined as the frequency of the double images) will drop to just half the value compared to the standard mode.
The double image mode will work only in the trigger modes ***Auto Sequence*** and ***External Exposure Start***. See **6.3.1**.



Hint: to achieve a blur free second image the environment should be kept dark and the exposure duration of the second image determined by a flash light.



t_{e1}: exposure 1
t_{td}: trigger delay time
t_{if}: interframing time
t_{e2}: exposure 2
t_{id}: intrinsic delay
$t_{readout}$: readout time

CDI mode 2

The correlated double image (CDI) mode records images with increased dynamic range and a 30% better performance on the weak signal side of the images (at the expense of half of the usual frame rate, because double images are acquired).
The min. exposure time is calculated as follows:

$$t_{exp} = \frac{1}{2 * f_{CDI}}$$

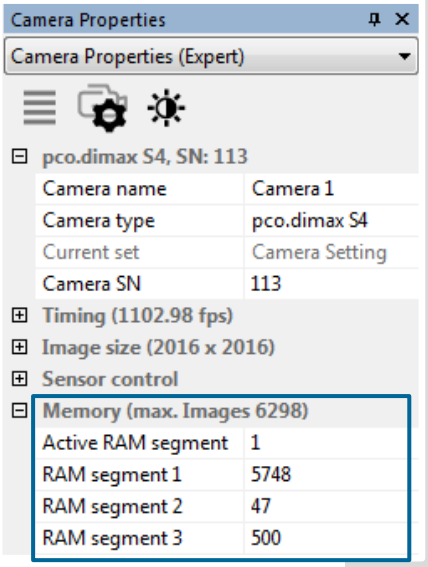
t_{exp} = min. exposure time
f_{CDI} = max. frame rate

Example:
resolution = 1920 x 1080 pixel; f_{CDI} = 1067 fps → t_{exp} = 467 µs
In this case t_{exp} is both minimum and maximum exposure time.
To increase t_{exp} ***decrease*** frame rate or resolution.

B/W Noise Filter (only available for pco.dimax b/w) 3

Intelligent spatial noise filter.

6.3.4 MEMORY



The ***Memory area*** controls the pco.dimax' built-in memory.

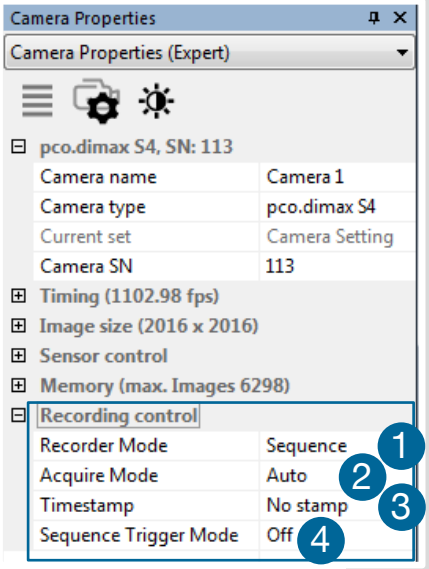
The RAM has four segments. In Camware only three are usable to save images. The fourth is used by Camware itself for internal processes.

You may record into three different segments and to set the exact number of images in each segment. Camware always shows the maximum number of images (depending on RAM size and chosen ROI).

Active RAM Segment: choose the active segment: 1, 2 or 3.

(Quantities shown on screen are just examples: e.g. pco.dimax S4 36GB Ram)

6.3.5 RECORDING CONTROL



Recorder Mode 1

In ***Sequence mode*** the camera stops after the memory (i.e. the active RAM segment) is completely filled. In ***Ring Buffer*** mode the camera records until it is stopped – overwriting the previous images continuously, starting at the first image.

Acquire Mode 2

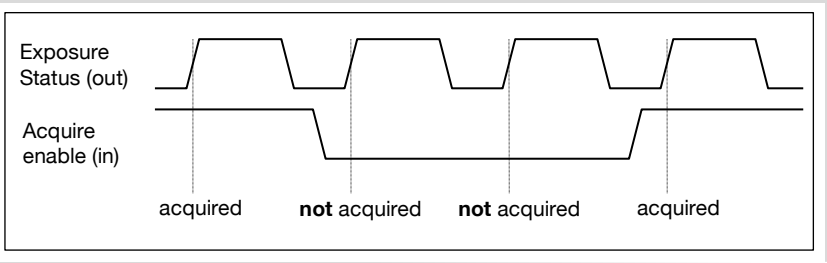
The ***Acquire Mode*** enables or disables the recording by an external signal.

If set to ***Auto*** all images are accepted and all images taken are saved. A signal at the BNC ***acq enbl*** input (see **6.3.6**) is ignored when set to ***Auto***.

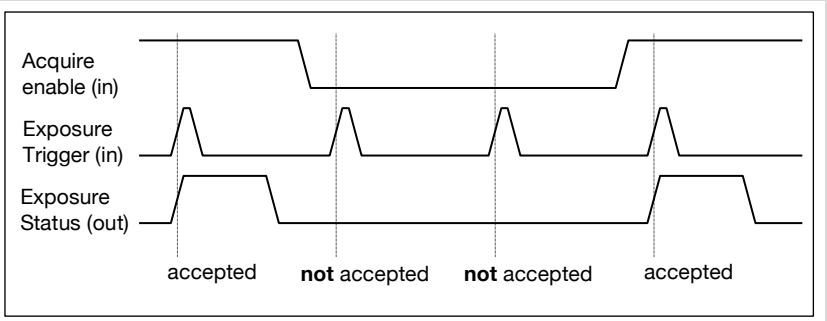
If set to ***External***, the camera only records images, when the external signal (voltage) applies.

NOTE
Acquire mode still requires initial camera recording activation by software (press record button).

The signal at the ***BNC Trig In input*** does not affect the sensor's timing scheme.
The ***BNC Trig In*** is sampled at the beginning of the exposure, shown by the rising edge of the exposure status ***(BNC I/O) output***.
BNC Trig In input high (low, when inverted): image saved to memory.
BNC Trig In input low (high, when inverted): image lost (not saved to memory).

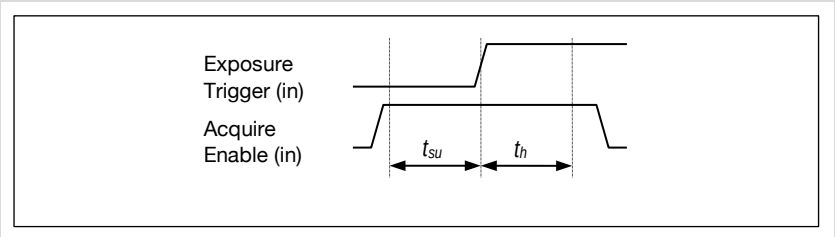


In trigger mode ***External Exp. Start (see 6.3.1)***, the ***acquire enable*** input acts like a gate for the trigger signal. A rising trigger edge (falling when ***exposure trigger*** is inverted) is accepted only when the ***acquire enable*** signal is high (low, when inverted).



In trigger mode ***External Exp. Ctrl (see 6.3.1)***, the ***acquire enable*** input works very similar to the mode ***External Exposure Start***. However, the ***acquire enable*** input is ignored for the edge which is closing the exposure time (an already started exposure will be finished).

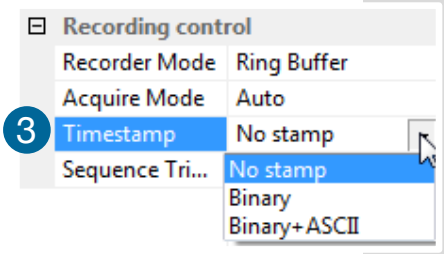
Using ***acquire enable*** in external trigger modes, following timing specification should be met:



pco.dimax model	S1/S4	HD/HD+	HS1/HS2/HS4
t_{su}	50 ns	60 ns	50 ns
t_h	50 ns	60 ns	50 ns

If the ***acquire enable*** signal changes within the window of t_{su} (set up) to t_h (hold), the behavior is random. The trigger may be accepted or ignored.

Timestamp 3

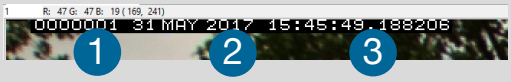


A time stamp can be placed into the upper left corner of the image. It can be either ***No stamp***, ***Binary*** or ***Binary + ASCII***. The time resolution is 1 µs.

In binary mode the first 16 pixels will be filled with the time stamp information (binary code). The numbers are coded in binary coded decimal (BCD) with one byte per pixel. Every pixel contains two digits. If the pixels have higher resolution than 8 bits, the BCD digits are right bound adjusted and the upper bits are zero. For further information refer to the SDK.

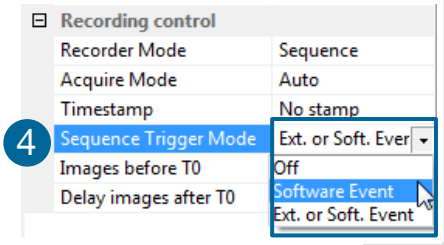
In binary and ASCII mode text will be placed into the image replacing its content (271x 8 pixels).
The timestamp indicates the end of the exposure time.

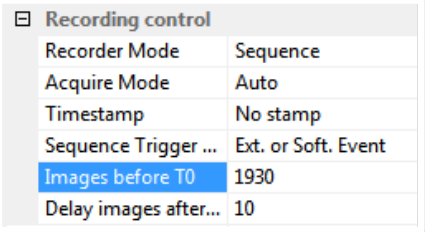
Three different ***information*** is stamped onto the image: image number 1 , date 2 and time 3 .



Additionally to ***Timestamp*** the ***Image overlay*** function is available, see chapter **6.4.**

Sequence Trigger Mode 4





The ***Sequence Trigger Mode*** stops capturing a sequence of images via an external signal. Before you do this the number of images to be stored after this event must be defined.

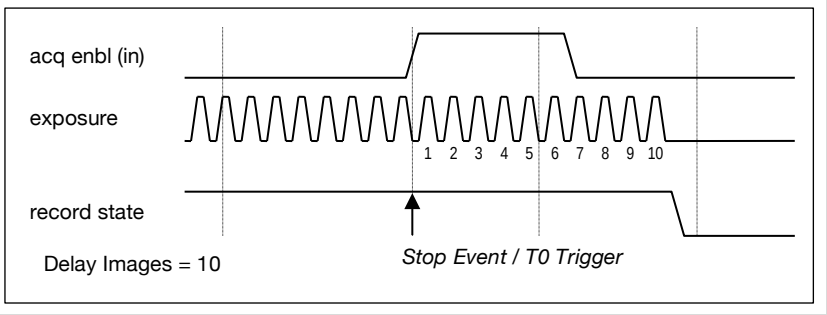
Since the ***Sequence Trigger Mode*** uses the ***BNC Trig In input*** (see **6.3.6.**), the acquire function cannot be used. The acquire mode thus has to be set to Auto. The camera already records images into the selected RAM and may have filled it completely before the Sequence Trigger Mode starts. Therefore the recorder mode should be set to ***Ring Buffer***.

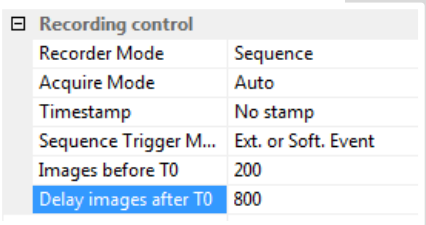
Possible trigger modes for Sequence trigger:

Off: function is not carried out; signal at ***acq enbl*** does not stop the record.

Software Event: only a software command stops the sequence.

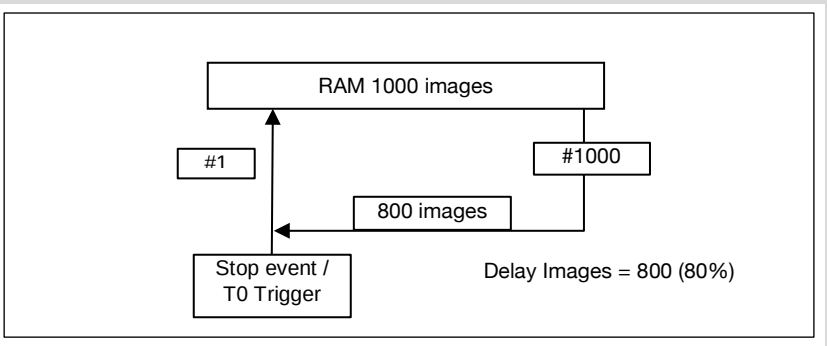
Ext. or Soft. Event: both, an edge at ***acq enbl*** or a software command stops the sequence.

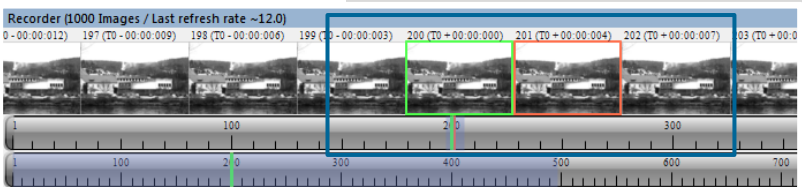




The relative position of the trigger within the recorded time window depends on the size of the ***RAM segment*** and the ***delay images*** parameter. The following figure shows an example, where the buffer size is 1000 images: The position of the trigger is always calculated backwards from the end of the buffer. The relation is always in terms of images.

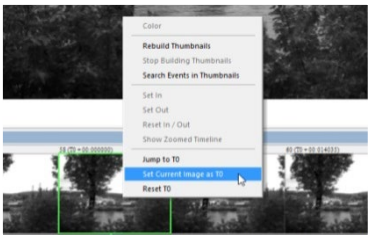
In this context T0 is the point at which the sequence trigger is set (at the ***acq. enbl.*** input).





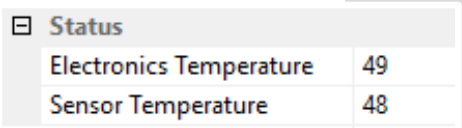
After recording is finished ***Recorder Images*** (see **6.7**) shows the thumbnail images of the last recording: Image T0 is framed in ***green,*** the currently selected image in orange.

All images before and after T0 are specifically marked, e.g. with 202 (T0 + 00:00:007). 202, in this case, corresponds to the image number and its recording point in time after T0. The time stamp is divided into min : s : ms.



Additional possibility to define T0: Right-click into the thumbnails and ***Set Current Image as T0***. Reset T0 erases this manually set T0.
For ***Recorder Images*** features see chapter **6.7**.

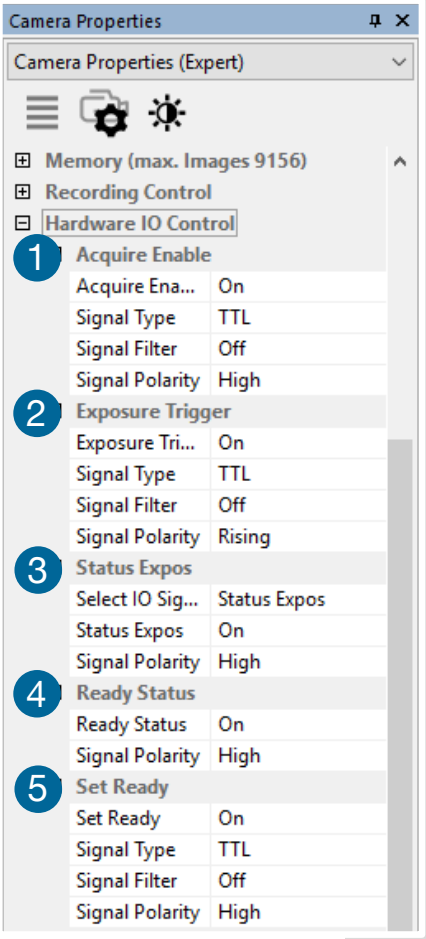
6.3.6 STATUS



Shows the current temperature level of the pco.dimax camera.

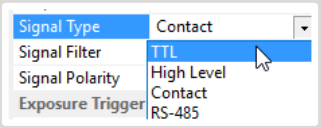
Electronics and sensor temperature are shown.

6.3.7 HARDWARE I/O CONTROL



NOTE (TYPE):
Contact high: if contact is open, camera captures images;
Contact low: if contact is closed, camera captures images.

Setting can be selected via the drop-down menu.



Acquire Enable 1

If checked, a signal for Acquire mode or Sequence Trigger mode (see chapter **6.3.5**) is accepted at the ***acq enbl*** BNC input.

Acquire Enable: On, Off
Signal Type: TTL, High Level, Contact, RS-485
Signal Filter: Off, Medium, High
Signal Polarity:

- High or Low for TTL, High Level and RS-485
- High or Low for Contact, i.e. High=Open, Low=Close

Exposure Trigger 2

If checked, a signal for External Exp. Start or External Exp. Ctrl trigger mode (see chapter **6.3.1**) is accepted at the ***exp trig*** BNC input.

Exposure Trigger: On, Off
Signal Type: TTL, High Level, Contact, RS-485
Signal Filter: Off, Medium, High
Signal Polarity: Rising or Falling

Status Exposure 3

If checked, a signal indicating exposure status or busy status is given at the ***status*** BNC output. Once an acceptable trigger edge is received, ***busy*** will be ***high***. As soon as ***busy*** is low again, a new trigger edge is accepted.

Select IO Signal: Status Expos, Status Busy
Status Expos: On, Off
Signal Polarity: High, Low

Ready Status 4

Ready status is ***High*** if camera is in recording status but has not yet received a sequence stop trigger (T0 trigger). It will go on ***Low*** immediately after a detected T0 trigger. Available on Lemo Int1 connector, see **A1.2.2**.

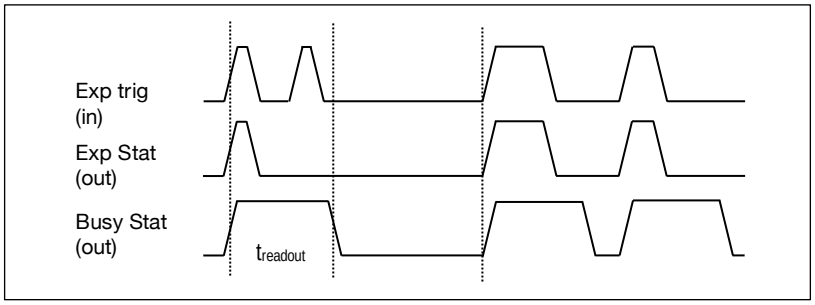
Ready Status: On, Off
Signal Polarity: High, Low

Set Ready 5

Not implemented, for future use.

Type	Explanation
TTL	Maximum low level: 0.8V Minimum high level: 2V
High Level	Maximum low level: 5V Minimum high level: 10V
Contact	Maximum switch on resistance: 100Ohms Minimum switch off resistance: 40kOhms Minimum switch voltage rating: 5VDC Minimum switch current rating: 1mA
RS485	Receiver sensitivity: +-200mV Note: termination of 120Ohms outside camera required

Explanations:

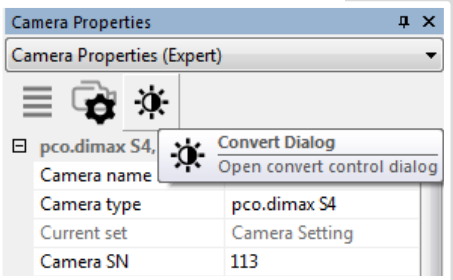


BNC connectors see chapter **A1.2**

Filter: electrical interference filters (off, medium, high). An active filter causes an internal signal delay.

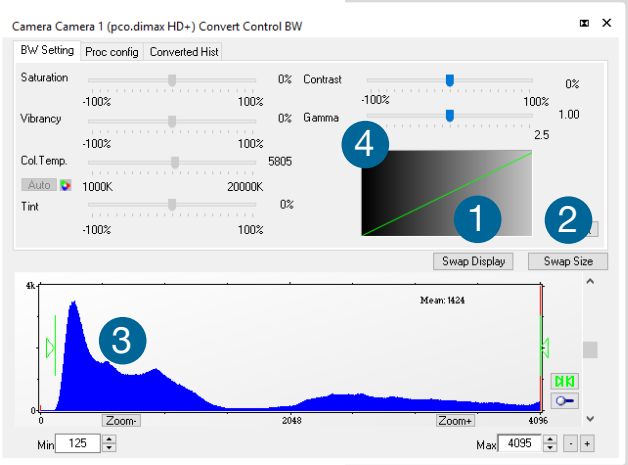
Polarity: active for high/low signal or rising/falling edge

6.3.8 CONVERT CONTROL



Start the ***Convert Control Dialog*** with the ***Black/White Button*** in Camera Properties.

Convert Control BW
The display of the original 12 bit image intensity values (x-axis) in the shown 8 bit values (y-axis) can be arranged.



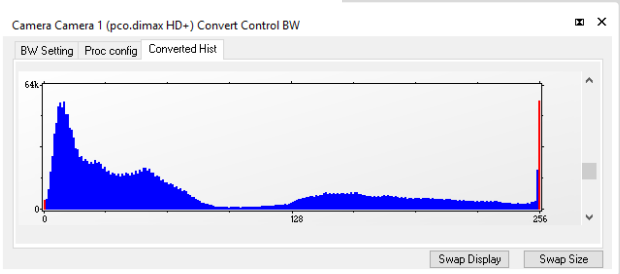
BW Settings (includes histogram of original data)

It is possible to ***hide*** the histogram of original data ❶ and to ***switch tab/histogram*** ❷.

Green sliders in histogram ❸
left slider = Min controller (corresponds to value 0 of the 8 bit display). Values below that mark are set to 0, i.e. displayed as black.
right slider = Max controller (corresponds to value 255). Values above that mark are set to 255, i.e. displayed as white.

The values in-between are converted into a value between ***0*** and ***255*** according to ***Contrast*** and ***Gamma*** settings. The small ***graph*** ❹, reflects the calculation.

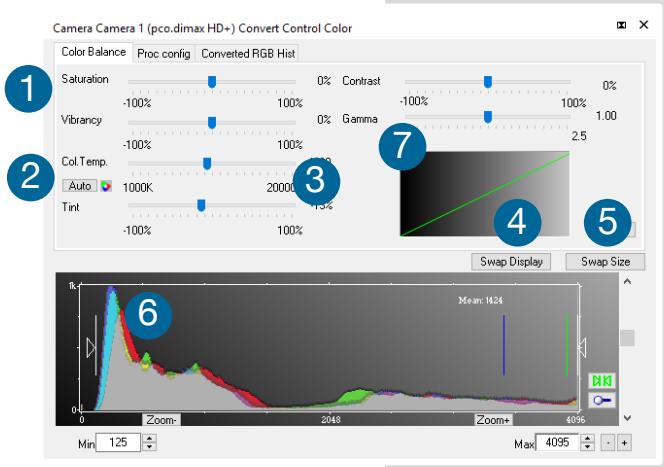
Proc config tab: see under Convert Control Color



Converted Hist
This tab shows the ***histogram of converted data.***

Other functions (Saturation, Vibrancy, Col.Temp, Tint) are inactive for monochrome cameras

Convert Control Color (only pco.dimax color)



Color Balance (Histogram of original data)

Intensity of a single color is controlled by ***Saturation*** and ***Vibrance*** (1).

Press the Auto button to set the ***white balance*** (2).

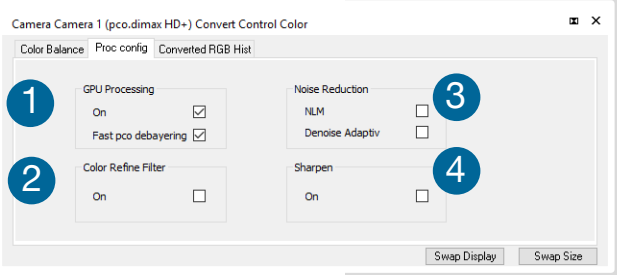
The balancing of RGB is controlled by ***Col.Temp*** and ***Tint*** (3).

It is possible to ***hide the histogram of original data*** (4) and to ***switch tab/histogram*** (5).

The display of the original 12 bit image intensity values (x-axis) in the shown 8 bit values (y-axis) can be arranged.

White sliders in histogram (6)
left slider = Min controller (corresponds to value 0 of the 8 bit display). Values below that mark are set to 0, i.e. displayed as no color.
right slider = Max controller (corresponds to value 255). Values above that mark are set to 255, i.e. displayed as full color.

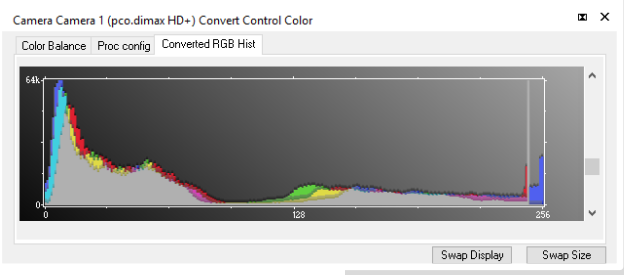
The values in-between are converted into a value between 0 and 255 according to ***Contrast*** and ***Gamma*** settings. See the small ***graph*** (7), which reflects the calculation.



Proc. Config (Process configuration)

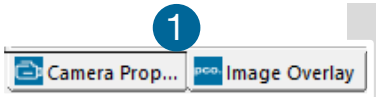
Due to proprietary high-end algorithms used for these image processing features, no detailed description is given here.

1	***GPU Processing*** ***On:*** Switch on in order to significantly reduce processing time (increases refresh rate of the live image. ***Fast pco debayering:*** only color cameras
2	***Color Refine Filter*** only color cameras
3	***Noise Reduction*** ***NLM:*** Non local means algorithm ***Denoise Adaptive:*** only color cameras
4	***Sharpen:*** ***On:*** only color cameras (first activate ***Fast pco debayering***)

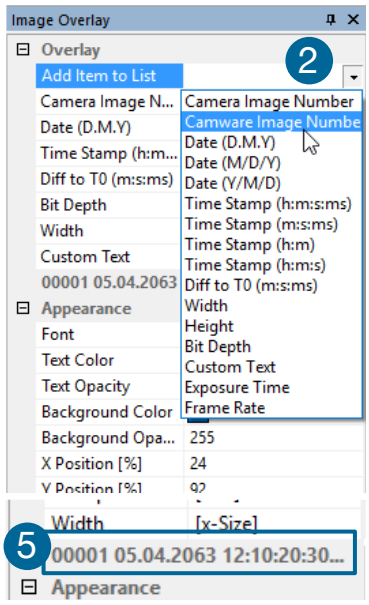


Converted Hist
This tab shows the ***histogram of converted data.***

6.4 IMAGE OVERLAY



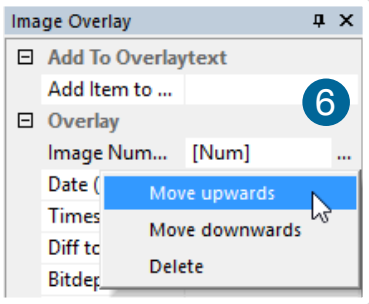
Open ***Image Overlay***: these two buttons allow easy switch between Camera Properties and image overlay. 1
If not available, see **6.9.5 *View Menu*** to activate this menu.



This function enables an ***individually configurable image overlay*** allowing to display information within the images.
Many different options are available by clicking ***Add item to...*** 2

Also the ***Appearance*** is configurable:
Font, Text color, Text opacity, Background color, Background opacity and horizontal or vertical orientation.

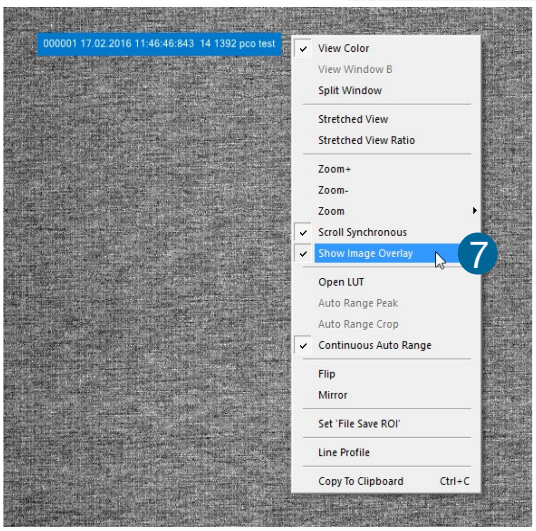
Camera image number 3 and ***Camware Image Number*** 4 are two different count methods:
Camera image number: image numbers are incremented continuously. When recording in Ring Buffer mode, the image numbers are exceed the number of images stored in the RAM memory of the camera since images are overwritten when the memory is full, starting with the first image in loop.
Camware image number: the software displays the image numbers according to the number of images recorded (starting with image 1).



A preview of the image overlay is shown. 5

Each item can be moved upwards, downwards or deleted by clicking on ... 6

By ***drag & drop*** the ***Image Overlay*** can be moved to your favorite position within an image.



Right click in the image window to turn on ***Show Image Overlay*** and activate this function. 7

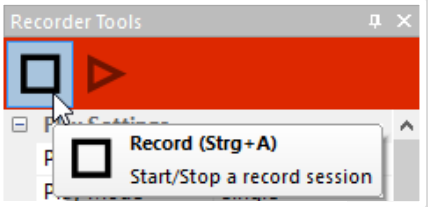
NOTE
This function does not overwrite image data.

6.5 RECORDER TOOLS

Recorder Tools provides ***Record*** and ***Play*** function, ***Play Settings*** and ***Record Settings***.
Located on the right lower side of Camware or, if closed, activated by ***View Menu*** (see chapter **6.9.5**)

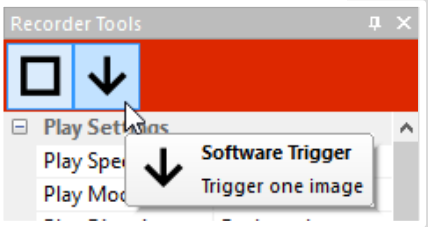
Record

Start/Stop record with Record Button.
or press ***enter*** in the ***View window*** to ***Start/Stop*** recording.



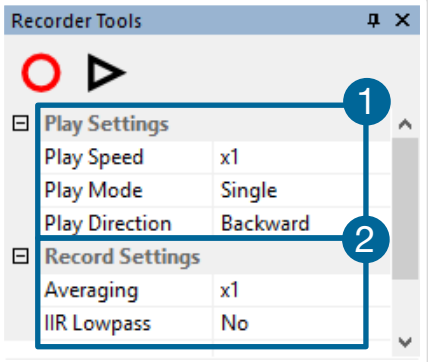
Record: in record state Camware software is highlighted in red.

Exposure time may be changed during recording. See **6.3** ***Camera Properties***.



Software Trigger Mode: after record is started an arrow pointing downwards appears. Clicking on it triggers a single image (see **6.3.1*)***.

Play Settings 1



Play Speed: selectable play speed from x1 to x256 or from 1fps to 16fps. E.g. in mode x1 a recording with 1000 fps is played with 25fps.
1 fps means that only one frame per second is played.

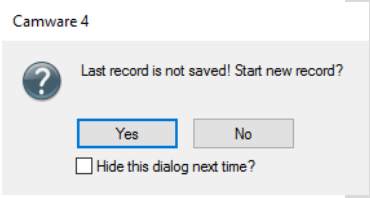
Play Mode: selectable play mode of the recorder (continuous or one-time (re)play).

Play Direction: selectable direction of record play (forward or backward)

Record Settings 2

Averaging: averaging images in the buffer reduces statistically independent (image) noise. Set a value higher than x1 in the drop-down list and this number of images will be averaged.

IIR Lowpass: another option to reduce the noise is the activation of the ***Infinite impulse response IIR lowpass filter***. This filter takes 90% of the previous image and 10% of the new image to create images with clearly reduced noise.
Image (actual) = Image (act - 1) * 0.9 + Image (new) * 0.1

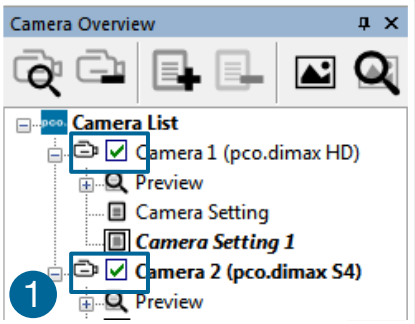


Reminder dialog
If you made a recording but did not save it yet, Camware will remind you to save the record before starting a new one.

Extended Recorder can be activated (see **6.9.5**)

Functions:

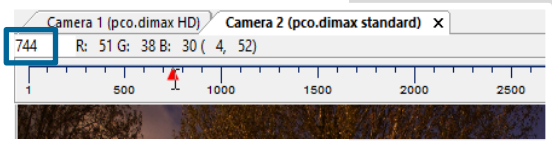
1. Start & Stop record / Stop record / Replay
2. First image (jump to first image) / Back fast (jump backward) / Back (jump one image backward)
3. Forward (jump one image forward) / Forward fast (jump forward) / Last image (jump to last image in record)



Recording with multiple cameras
With all cameras activated recording is started simultaneously for all cameras.
Recorder will use Recorder mode settings (Sequence or Ring Buffer) of the selected camera for all cameras (see **6.3.8**)
For single camera recording, deactivate cameras by removing the check mark from the box. 1

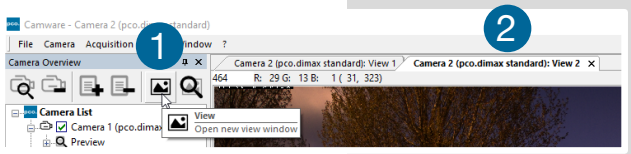
6.6 VIEW WINDOW

Fast–scroll through images

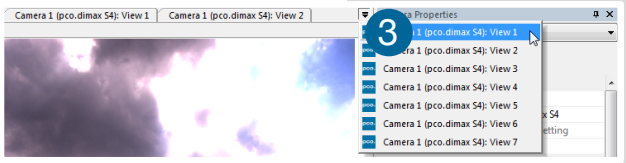


Having recorded at least 50 images, you can scroll through the images quickly. To do this, hold down the left mouse button on the image number. Additionally you can enter the ***desired image number*** directly into the number field.

More View Windows

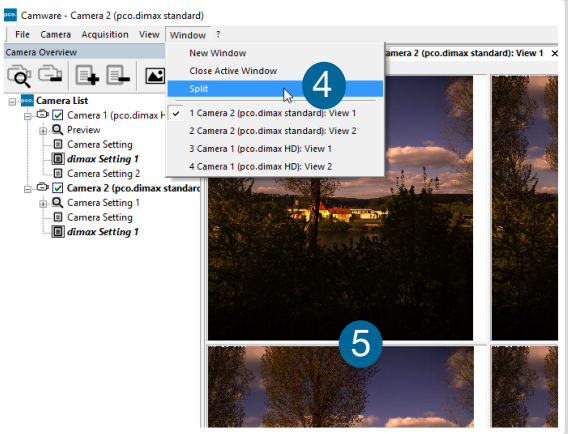


You may open more than one window for one camera: just click on ***open view window*** 1 and Camware will create a new one 2 .
Even when multiple view windows (or from multiple cameras) are open, the same image number is always shown in all of the view windows.



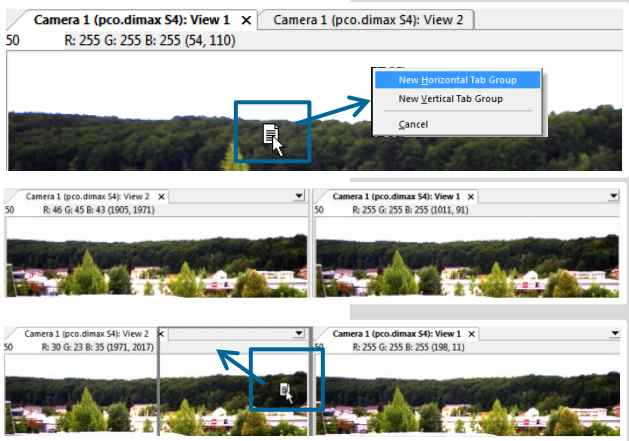
A ***dropdown menu*** 3 helps to select a view window. If there are more view windows than can be displayed on the desktop, you may select individual view windows.

Split View Window



The view window can be split. Choose ***Window*** → ***Split*** 4 and a split cross will be shown. The size of splitted window elements is easily adjusted by grabbing 5.
The main reason for this function is to view four sections of the image in one view. Choose the ***Zoom±*** function to zoom in the image (first turn off ***Stretched View***) (See **6.9.8**)
To undo the split, double click on the dividing line (after symbol 6 is visible).

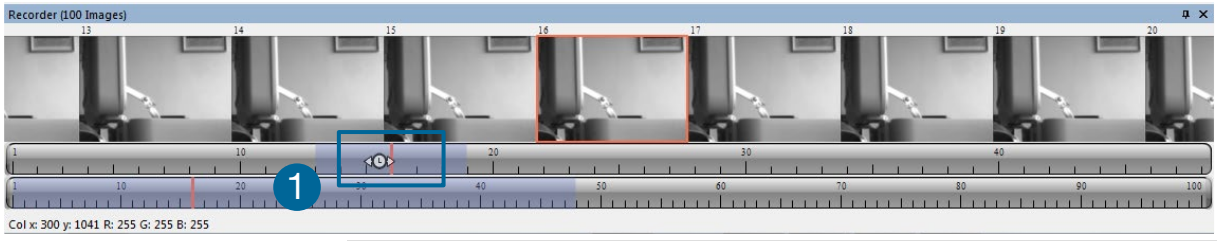
Two Tabs side by side or on top of each other



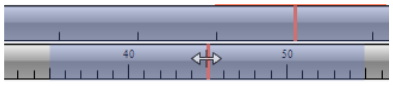
To view two tabs side by side or arranged one above the other just drag a tab and Camware will ask you whether you want to create a new horizontal or vertical tab group. Undo this by draging the tab back to its former position.
This also applies for view windows of several cameras.

6.7 RECORDER (IMAGES)

When recording is done, small preview images (thumbnails) are built and displayed automatically. This will take some time depending on the performance of your computer system and of the interface used.



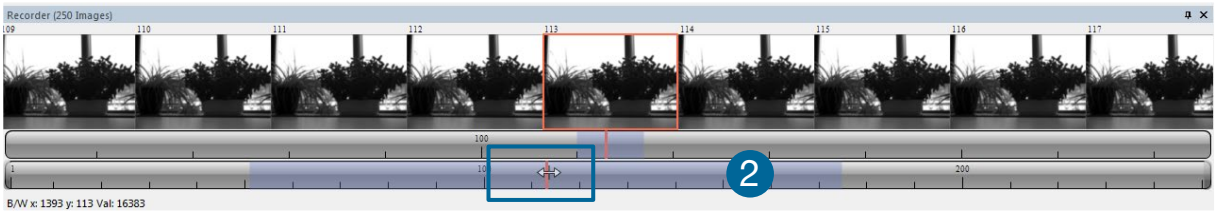
Clicking (left mouse button) within the upper scale bar 1, you can adjust the number of images shown by moving the mouse left or right. Minimum is ***20*** and maximum is ***half of the recorded images*** in this scale)



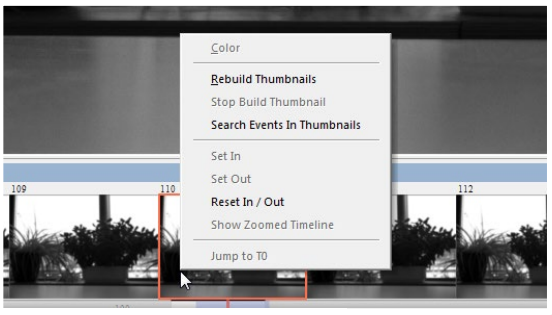
Quick scrolling: scroll through the thumbnails by dragging the orange bar with the mouse.

While ***quick scrolling***, ***Preview*** window displays the active image sequence. This allows to quickly scroll through the image sequence displaying the live images in the ***Preview*** window forwards or backwards. The ***View*** window will not actively show live images during quick scrolling (only in normal scrolling speed by mouse-wheel).

Clicking on a thumbnail image it will be shown on the view window. Scroll ***via mouse wheel*** through the thumbnails.
The upper ***blue bar*** refers to the number of displayed thumbnails. The lower blue bar shows the range of the upper scale in relation to the whole record.

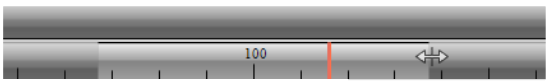


The second scale shows the total number of recorded images. It allows to scroll fast through the images 2.

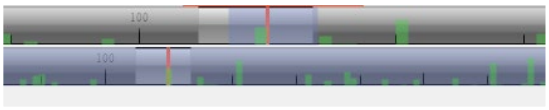


Right-click menu (click on thumbnails)
Allows to rebuild all thumbnails and to search for events.

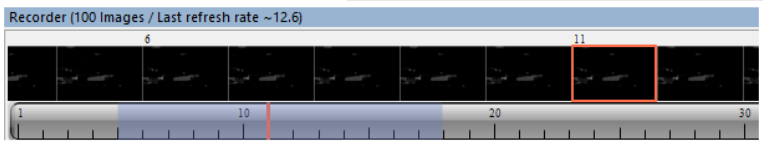
Furthermore, the ***Set In / Out*** enables to set values for a sequence, which can be played via play button. Reset In / Out discards these settings.
Set In / Out is active: if you ***save/export*** your images, only the selected ones are saved/exported (see **6.9.2**).



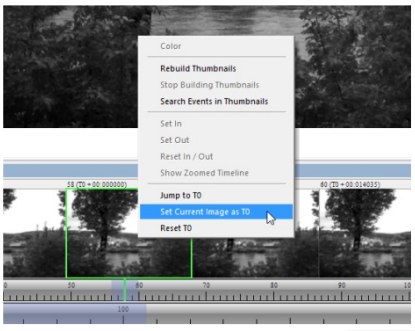
The ***light gray area*** in the upper scale shows an ***In-Out*** example area. To define a new area: just ***right-click on the start and end frame*** in one of the scales. The ***In*** image must be left to the red bar, the ***Out*** image to the right of the red bar.
Adjust the ***In / Out area*** by holding down the left mouse button and slide the boarders to increase / decrease.



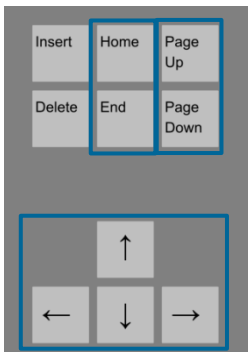
Search Events in Thumbnails: detected events are displayed as ***green bars***.



Too dark or bright thumbnails
If thumbnails are too dark or too bright, right-click in view window (see **6.9.8**) and select ***Auto Range Peak*** or ***Auto Range Crop***. Then right-click on a thumbnail image and select ***Rebuild Thumbnails***. Now the thumbnail images should conform to with the view window.



Set current Image as T0
It is possible to set a T0 Image manually. For information about T0, see ***Sequence Trigger Mode*** in chapter **6.3.5.** This T0 Image can be resetted.



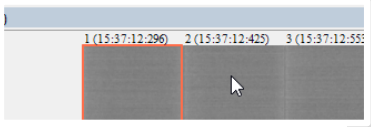
Use your keyboard to scroll through the Images:

Page up / down keys: 10 Images up or down

Arrow keys: quick scrolling through the images.
Advantage: fluent video playback in the ***View window*** (forwards or backwards).

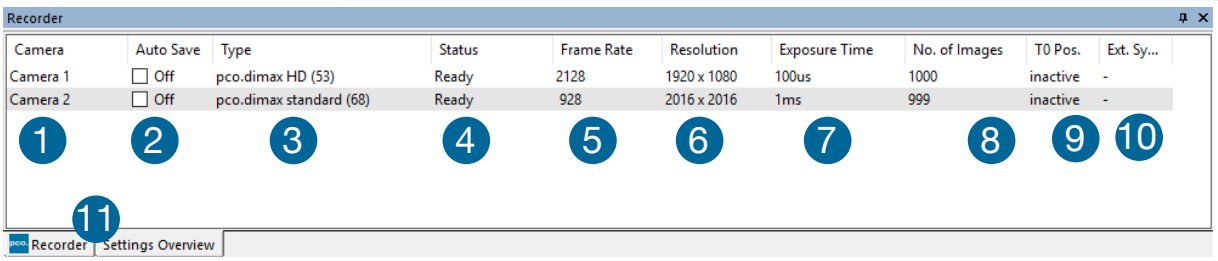
Home/Pos1 key: first image.

End key: last image.



Adddtional short-cuts:
While mouse is in the thumbnail area in ***Recorder (Images)***:
Press CTRL + left mouse button to jump to the ***first*** image
Press CTRL + right mouse button to jump to the ***last*** image

6.8 SETTINGS OVERVIEW



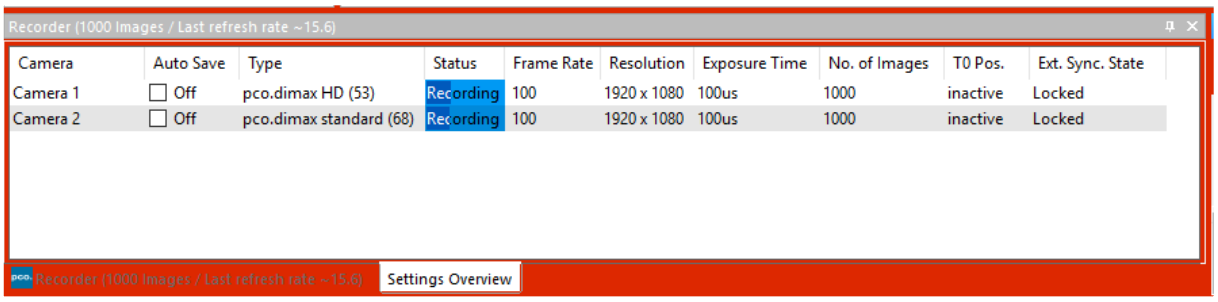
Settings overview shows the most important parameters of your camera(s) at a glance. For more than one camera connected, each camera and its parameters are listed.

The parameters can only be changed under **6.3 *Camera Properties*.**

Switch easily between the ***Recorder (Images)*** section and the ***Settings Overview.*** 11

No.	Function	Description
1	Camera name	Name
2	Auto Save	Off , Unconfigured (red), OK (green)
3	Type	Camera type and serial number
4	Status	Ready or Recording Green background: Images are in memory
5	Frame Rate	Currently selected frame rate
6	Resolution	Resolution in pixels
7	Exposure Time	Selected exposure time
8	Number of Images	Number of images to be recorded
9	T0 Position	See T0 chapter **6.3.5**
10	Ext. Sync. State	Status: ***Locked*** or **-**

Ext. Sync State is only available if the ***Trigger Mode*** of the camera is set to ***External Synchronized*** (see **6.3.1**), that means the recording of all the cameras is externally synchronized. It takes up to 30s until the synchronization is completed and ***Locked*** is displayed. This function will ***not*** display a Master / Slave synchronization.
"-" means ***not synchronized*** (Ext. Sync Mode activated / deactivated).

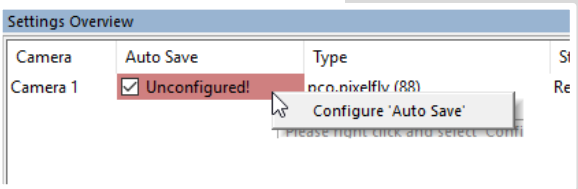


6.8.1 AUTO SAVE

Auto Save helps to save recorded images or sequences in an easy way. There is no need to save each image/sequence separately from each connected camera. Therefore this function is very useful if you use more than one camera. Once configured ***Auto Save*** allows acquiring and saving as many images/sequences as needed during your experiment. This function can store RAW (e.g. TIFF) and Export (e.g. AVI, JPG) files.

Standard file save see File Menu **6.9.2**.

Explanations will be displayed in the ***Info Text*** window at the bottom of the menu.

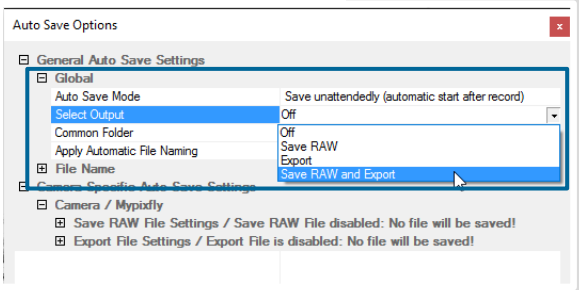


Enable ***Auto Save*** by clicking on the check box. The text changes to ***Unconfigured!*** (red background).

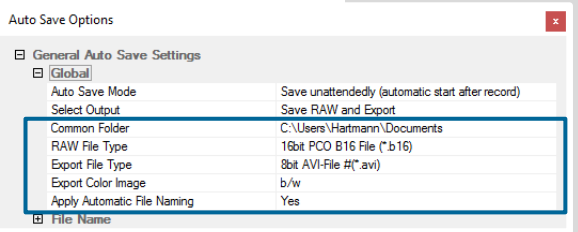
Right-click on the ***Unconfigured!*** field and click on ***Configure 'Auto Save'***.The ***Auto Save Options*** dialog is displayed.

First, configure the ***General Auto Save Settings - Global***

Auto Save Mode: two different modes are available, ***Save manually*** and ***Save unattendedly***.
The ***Save manually*** mode allows to store RAW images and export images after a recording session, when hitting the ***ALT and D*** keys. This allows to cut the image sequence in the ***Recorder Toolbar*** before saving.
The ***Save unattendedly*** mode downloads all RAW images and exports the complete image sequences of all cameras immediately after an active recording is stopped.

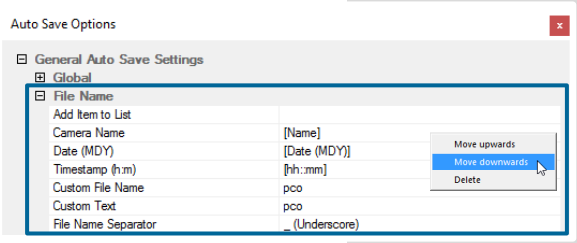


Select Output
Off – Auto Save is deactivated
Save RAW – Only 16 bit RAW files are stored (b16, pcoraw, MultiTif-File, Tiff
Export – only compressed files are stored (BMP, JPG, Tiff, AVI, MPEG, WMV)
Save RAW and Export – RAW and compressed files are stored simultaneously



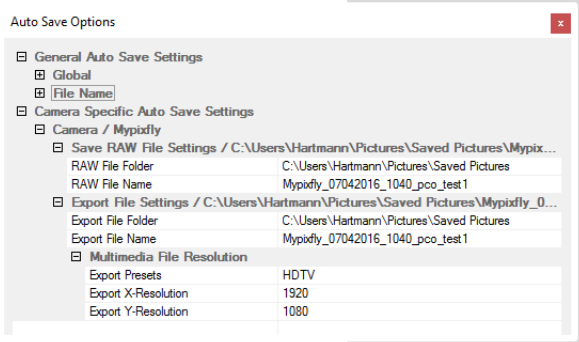
Common Folder: main folder for stored files
RAW and ***Export file Type:*** select the type of RAW and Export file
Export Color Image: select to export color images (only for color cameras)
Apply Automatic File Naming: if set to ***yes***, stored files are automatically named by Camware according to automatic file name settings.

General Auto Save Settings – File name



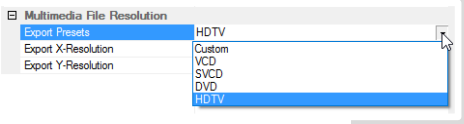
Set your file name individually by adding or deleting items. Position these elements as needed.

Camera Specific Auto Save Settings



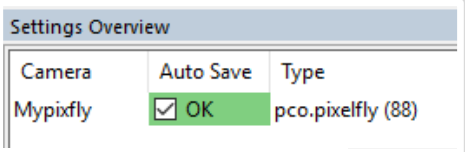
Configure camera specific settings for each connected camera.

Save RAW File Settings: set ***RAW File Folder*** and ***RAW File Name*** (if not set to automatic file naming).
Export File Settings: set ***Export File Folder*** and ***Export File Name*** (if not set to automatic file naming).



Multimedia File Resolution: set predefined video export resolution or enter a ***Custom*** x- and y-resolution.
Most likely you should set the applied resolution of your camera here.

Finish the configuration by clicking ***OK***.

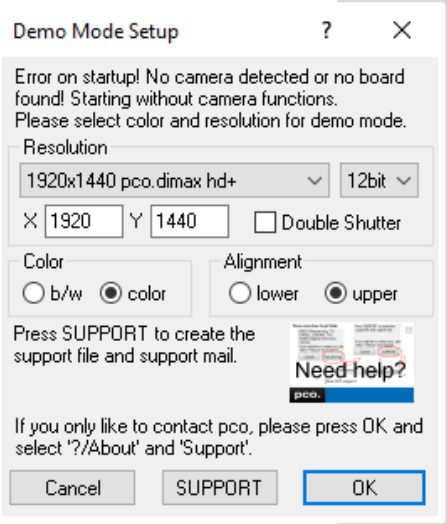


After configuration is finished, ***Auto Save*** status turns ***OK*** (green background).

6.9 CAMWARE MENU TABS & FEATURES

This chapter describes in detail the Camware Demo Mode and the File, Camera, Acquisition, View and Window menus.

6.9.1 DEMO MODE



Upon start Camware automatically recognizes the camera type of the connected and running cameras.

Camware starts in Demo Mode, if your camera is switched off or no camera is connected

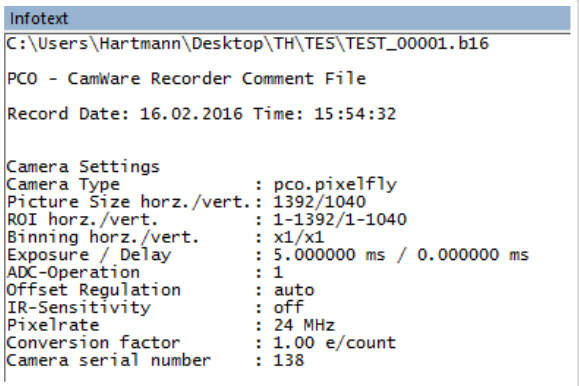
In this mode all ***image processing*** features are available, but all ***camera settings*** are deactivated. Just tell Camware the type of image you want to open. For that purpose, the ***Demo Mode Setup*** window opens and asks for the corresponding input.

Need Help? Having troubles to run the camera, this window will pop up. See instruction in appendix **A5**.

Resolution
The drop down list displays the existing image sensor spatial resolutions of all PCO camera systems. Select the specific resolution and bit depth of the images to be opened! Double Shutter mode should be ticked if such images have been recorded.

Color
Tick a button according to the image type.

Alignment
Select between ***MSB*** (most significant bit) upper alignment and ***LSB*** (least significant bit) lower alignment to display stored images.

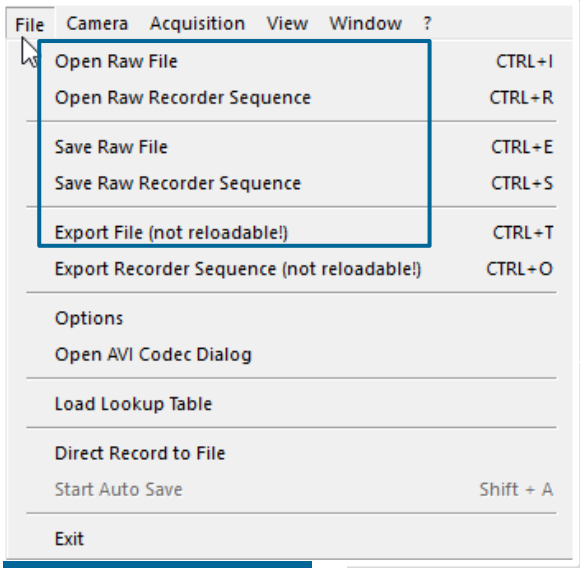


Infotext

The ***Infotext*** is automatically shown in Camware if you open a stored image sequence.
The ***Camera Properties*** settings, storing location and Record date are listed in this file.

Infotext can be activated in the View Menu **6.9.5** at any time.

6.9.2 FILE MENU

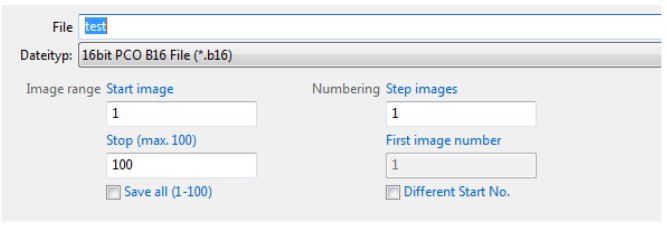


Open RAW File (single image only)
This command imports a single image into the active image window. Only files with the extension and format of ***.b16 (=PCO proprietary binary image format)*** and *.tif (16 bit TIFF image format) can be imported. If the recorder is enabled, each imported image is transferred to the buffer shown in the picture number. The image itself is fitted to the current image size. If the recorder is disabled, the current image size is set to the parameters of the imported image.

Open RAW Recorder Sequence (image sequence from one camera)
Imports a sequence of images. If more than one camera is connected and an image window is currently open, the sequence is loaded to the active window. If no image window is open, the images is loaded to camera #1. This command opens the Open file dialog box. Only files with the extension and the format of *.***b16**, *.***pcoraw**, *.***tif** and ***multi tif*** can be imported.

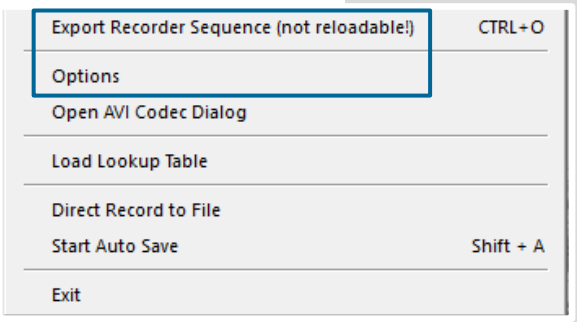
NOTE
Be aware of the different storage abilities of the formats, for example *.bmp - the bitmap format only allows for 8bit values to be stored and therefore the image content of a 16 bit image is reduced, if stored as bitmap.

Save RAW File (single image only)
Saves the image displayed in the active window and opens the Save file dialog. The image file can be saved in ***16bit *.b16*** and ***.tif*** format. If more than one camera is connected, it is possible to save all current images by selecting Export all images in the Save file dialog box. This feature saves one image of each active camera in one step (it is not necessary to repeat the save process for each camera). The Save command is not available if no image window is open. For ***Auto File Save*** see **6.8.1**



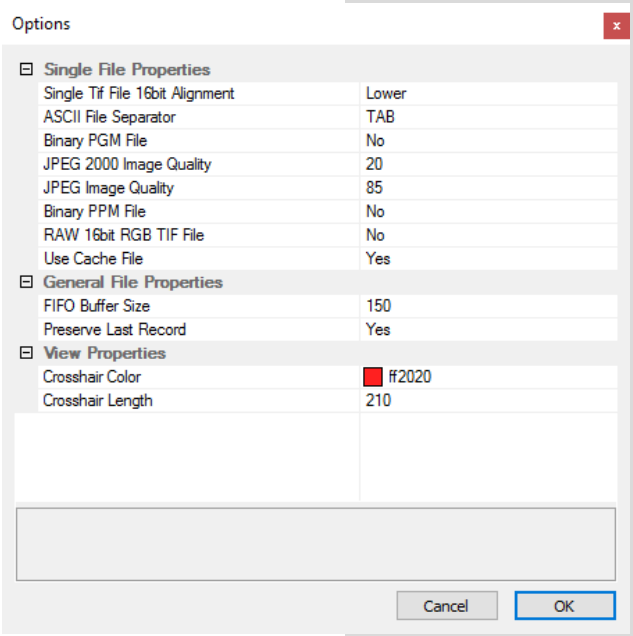
Save RAW Recorder Sequence (image sequence from one camera)
Saves or exports image sequences. If more than one camera is connected and an image window is currently open, the record of the active window will be saved. The command opens the Save recorder file dialog box. It is possible to select the number of saved images, to step images and to choose the first image number. For ***Auto File Save*** see **6.8.1**

Export File (not reloadable!)
Exports the image of the active image window. This command will opens the Export Image dialog box. Files with the extensions fts, tif, bmp, asc, jpg, and jp2 can be exported. This topic is not visible, if no image window is open. For ***Auto File Save*** see **6.8.1**



Export Recorder Sequence (not reloadable!)
To export a sequence of images. If more than one camera is connected the image record of the currently open window will be saved. If no image window is open the Export Recorder Sequence menu does not appear. This command opens the Export recorder box. Files with the extensions fts, tif, bmp, asc, avi, mpg, jpg, jp2 and wmv can be exported (see Appendix **A4**.).
Auto File Save see **6.8.1**

Options



Single File Properties

Single tif file 16 bit alignment: upper / lower
ASCII File Separator: select a separator for the values in the ASCII file. Select: Tab, space, semicolon, colon, comma, hyphen, slash or backslash.
Binary pgm file: set the format of the pgm (portable gray map) file. Select: yes, no.
Jpeg2000 image quality: set compression from 20 to 100%.
Jpeg image quality: set compression from 20 to 100%.
Binary ppm file: set format of the ppm (portable pixmap) file. Select: yes, no
RAW 16bit RGB tif file: save raw tif without color balance. Select: yes, no.
Use cache file caches image data on disc for a camera with camera internal memory and thumbnail readout. Select: yes, no

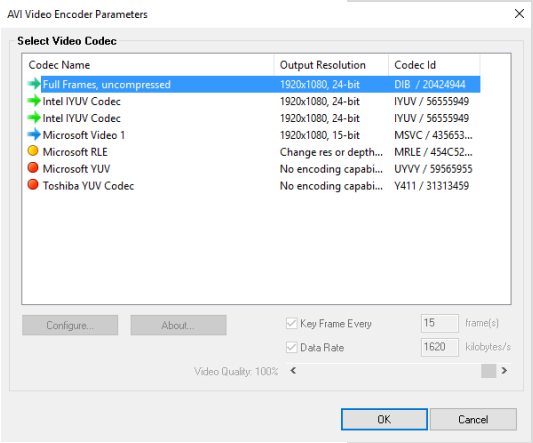
General File Properties

FIFO buffer size: set the FIFO buffer size in number of images. This avoids gaps during file write delays. Usually it is set to 150.
Preserve last record: preserve current recorded images. When set, the user will be asked whether to really start a new record or to close.

View Properties:

Crosshair color: set the crosshair color, save ROI and line tool.
Crosshair length: set the crosshair length in pixel.
Activate crosshair: see chapter **6.9.8**

Open AVI Codec Dialog



Using ***Auto File Save***, setting affects stored video sequences.
This option is needed only if Auto File Save is used. ***Auto File Save*** see **6.8.1**

Select the (compression) codec that you want to use for stored sequences. All installed codecs are listed here.

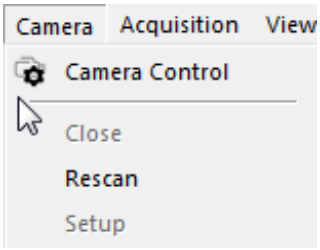
Load lookup Table (for monochrome cameras)
This feature assigns pseudo colors (Lookup-Table LUT) to a monochrome image. Either select one of the four predefined or create your own. The result is shown in the color view window.

Direct Record to File
Preset a certain number of images to be stored. If the camera captures images faster than the computer can save to disk, you will lose images. Images display doesn't interfere with the record process.

Start Auto Save
Only available if ***Auto Save*** is activated (see **6.8.1**)

Exit
Exits the program and closes all channel dialog windows. Window positions, settings and sizes are stored in the windows registry and will be loaded again at next start-up.

6.9.3 CAMERA MENU



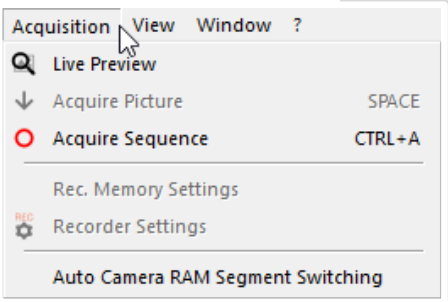
Camera Control
Opens the camera control window (see **6.3**).

Close
Disconnects camera and switches Camware to Demo Mode. In case of multiple cameras, all cameras must be closed for Camware to switch to Demo Mode.

Rescan Disconnects and reconnects all cameras.

Setup (not available for pco.dimax)

6.9.4 ACQUISITION MENU



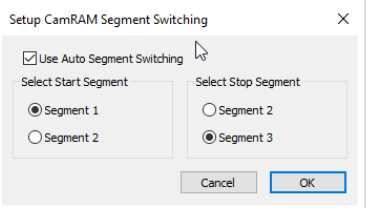
Live Preview
For fast and easy adjusting and focusing of the camera. The active window will be updated. To see another window, simply click on the window. This option is not available in double shutter mode.

Acquire Picture
Active if Recorder Mode is set to ***Soft Trigger***, see **6.3.1**

Acquire Sequence
Starts recording images into the system memory according to Trigger Mode selection (see **6.3.1**). During recording, all camera controls are locked.

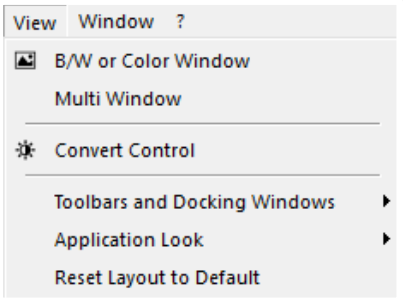
Rec. Memory Settings (not available)

Recorder Settings (not available)



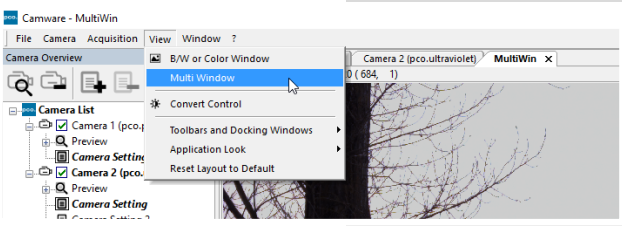
Auto Camera RAM Segment Switching
Use this function to automatically record images in two or three different camera RAM segments one after another. This results in two or three separate image sequences.
If ***Recorder Mode*** is set to ***Sequence*** and the set number of images is achieved the RAM segment switches automatically to the next segment and stops after the last segment is full.
If ***Recorder Mode*** is set to Ring Buffer a stop trigger must stop the active record into one dedicated segment, and a new record starts automatically into the next segment.

6.9.5 VIEW MENU

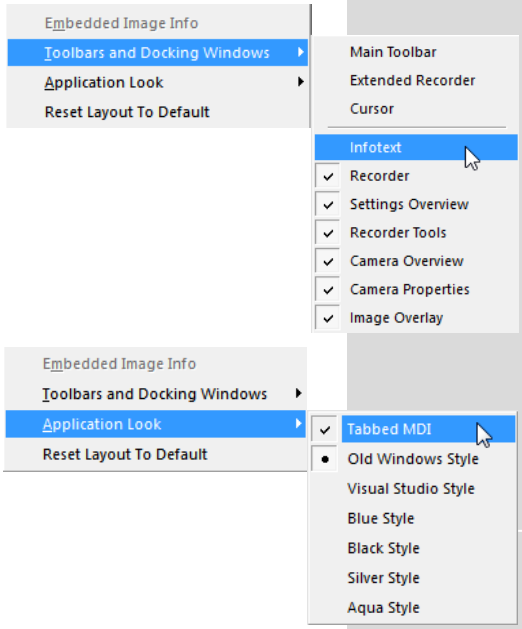


B/W or Color Window
Opens a new display window.

Convert Control
See chapter **6.3.8**.

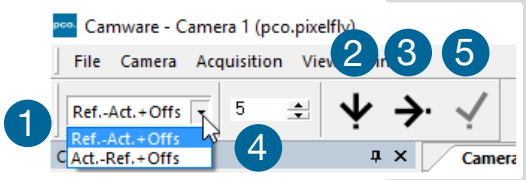


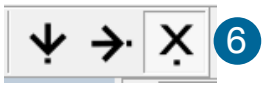
Multi window
View the images of all active cameras in ***consecutive order*** in one window. It provides an easy comparison of the views of different cameras.
Use the same ROI and timing settings for all cameras.
Only available when using more than one camera and only after a complete sequence is recorded (sequence mode) or after buffer is full for the first time (Ring Buffer).



Toolbars and Docking Windows
Standard toolbars of Camware 4 are Recorder/ Recorder Tools / Camera Overview / Camera Properties and Image Overlay. ***Additional Toolbars*** known from Camware 3.x are displayable, but not essentially needed: Main Toolbar / Extended Recorder / Cursor. For function ***Infotext*** see **6.9.1**.

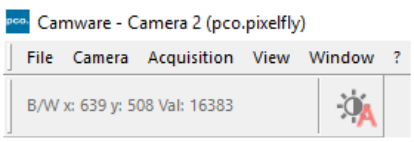
Application Look
The Style and Look of Camware can be customized; many different style sheets are selectable. The Tabbed MDI function (un)docks the view windows.





Math Tools
Calculate the difference between a reference image and the actual image. Activating math every new image acquired is subtracted from the reference image or vice versa:

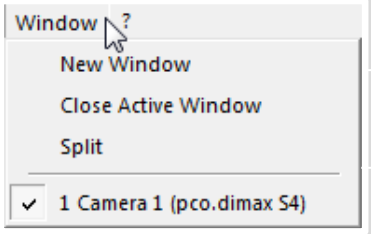
1. Reference (image) – Actual (image) + Offset or
   Actual (image) – Reference (image) +Offset
2. a reference picture is acquired and copied to reference buffer
3. last acquired image is copied to reference buffer
4. add offset to avoid negative values, which would not be visible
5. enable math function
6. disable math function



Cursor
Shows position of mouse cursor.
B/W (black/white camera) x-axis: 639; y-axis: 508; Value: 16383 counts

Reset layout to default
This resets all customized changes and restores the default layout.

6.9.6 WINDOW MENU



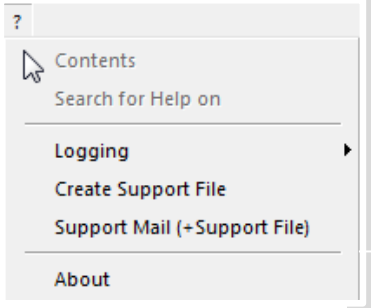
New Window
A new view window opens.

Close Window
Active window will be closes.

Split
The view window will be split in four quarters.

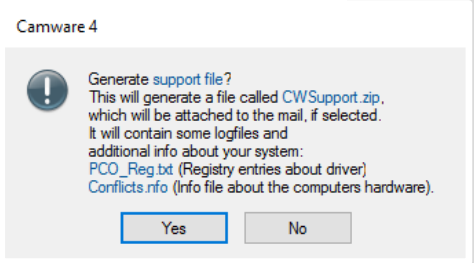
Camera overview
Shows all connected cameras, e.g. ***1 Camera 1 (pco.dimax S4)*** .

6.9.7 HELP MENU

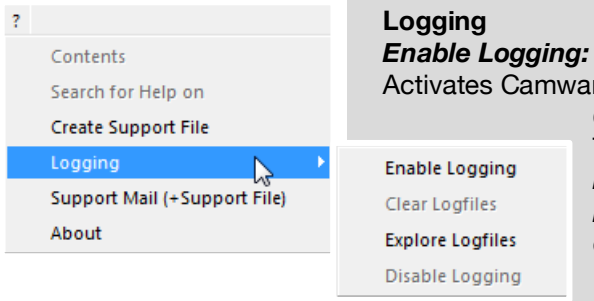


Contents
Opens the main page of the program help.

Search for Help on
Opens an index list for help.



Create Support File
Press ***YES*** to activate log files and reboot Camware and your pco.dimax.
After log files are activated it is possible to create a support file. Send this file to the PCO support (see **A5.4**).

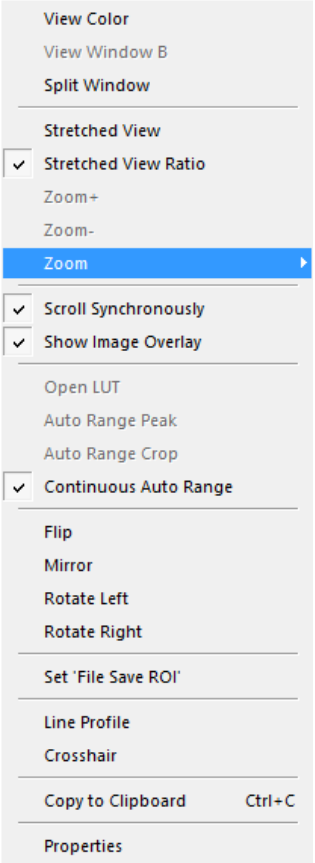


Logging
Enable Logging:
Activates Camware log files (this cuts down performance)
Clear Logfiles (only visible if logging is enabled):
This command erases all actual log files
Explore Logfiles: opens windows explorer
Disable Logging (only visible if logging is enabled):
disables logging

Support Mail
This command opens your email-program and the created support file is added automatically as attachment.

About Camware
Shows program information.

6.9.8 VIEW WINDOW MENU

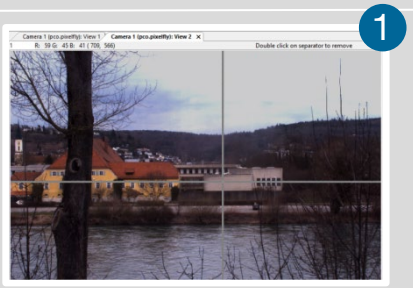


All functions of the ***View window menu*** are explained briefly. Right-click in the View window to open this menu.

View Color: color window.

View Window B: Double Shutter activation switches to window B (second image).

Split window: 1 splits the View window in four parts. Double click on separator to undo.

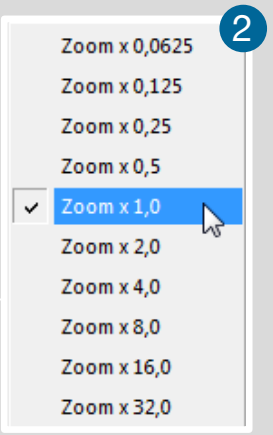


Stretched View: image is fitted into the display window.

Stretched View Ratio: aspect ratio is maintained.

Zoom +/-: 2 image zoom (only available if ***Stretched View*** is deactivated).

Zoom: set the Zoom factor (from 0.0625 to 32).



Scroll Synchronously: scroll synchronously through all open image windows (only available if ***Stretched View*** is deactivated).

Show Image Overlay: activates the overlay see **6.4**

Open LUT: opens ***look-up table*** file for false-color representation.

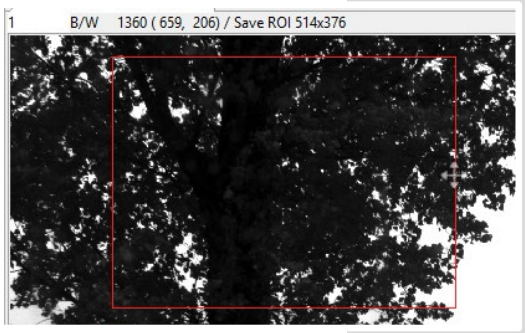
Auto Range Peak: searches for the minimum and maximum 14 bit intensity values of the image. Given these numbers the converter scales the 8 bit display (256) within these two values.

Auto Range Crop: sets the converter to ignore the extreme intensity values of the image and scales the display in a smaller range. Thus dark or bright light spots, reflections, etc. are cut off.

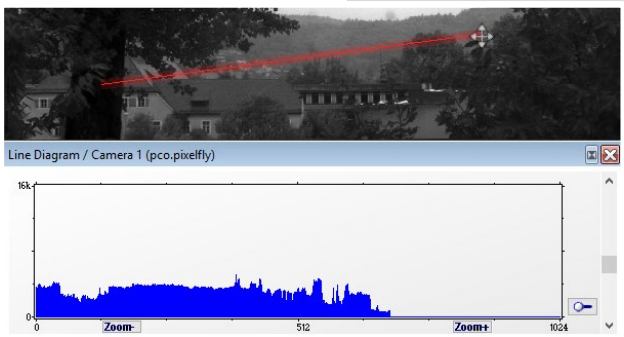
Continuous Auto Range (Crop): enables the automatic min/max function (Auto Range Crop) during record and replay.

Flip/Mirror: image will be flipped or mirrored.

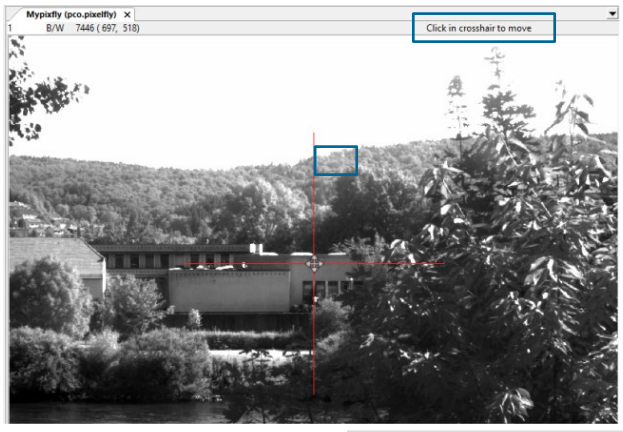
Rotate Left/Right: rotates the image in steps of 90°.



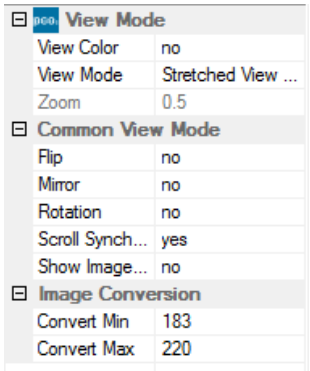
Set 'File Save ROI': to save just a part of the recorded image (region of interest), draw a rectangle with the mouse. This rectangle is valid for all recorded images and can be dragged at its edges.



Line Tool: oint the mouse where the line should start and left-click. Move the mouse to the desired line end and left click again. The line may be stretched, shrunk or moved by grasping its end point. A Line Diagram opens. The graph in the length of the line (units: pixel) is displayed showing the intensity values of the pixels along the red line.



Crosshair: activates a centered crosshair. Size and color are selectable see chapter **6.9.2**→ Options.
To move the crosshair drag it by mouse. Reset it to center position by double-click into the center of the crosshair.



Copy to Clipboard: copies the actual image to clipboard.

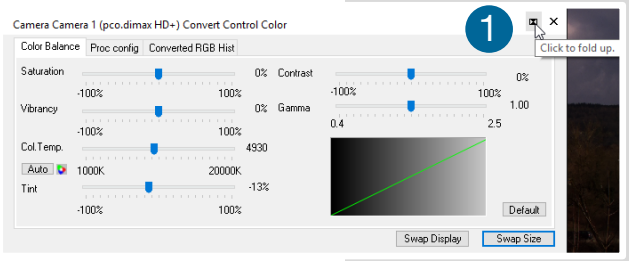
Properties: shows the current settings for ***View Mode*** / ***Common View Mode*** and ***Image Conversion.***

6.9.9 ADDITIONAL FEATURES

White Balance by Mouse

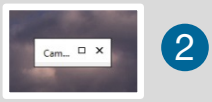
Change ***white balance*** by mouse: press the CTRL (STRG) and the shift button simultaneously and select a white or gray area within the image by dragging a rectangle while holding the left mouse button. The pixel values within the coordinates of the selection rectangle are used for calculating a new ***white balance***.

For best results we recommend to use the white balance button in the Convert Control Color (see **6.3.8**).



Fold Up Window

The Convert Control windows can be minimized / folded (1). Move the pointer over the bar and the window will unfold again (2).



Setting Contrast Area by Mouse

Control the minimum and maximum values used for the conversion from 16 bit to 8 bit with the mouse. Move the mouse cursor into a region which should be shown with maximum contrast. Press the shift and the left mouse button. Hold down the mouse button while changing the selection rectangle's size by moving the mouse. After releasing the mouse button the coordinates of selection rectangle act as a border for calculating the minimum and maximum values.

Setting a new ROI by Mouse

It is possible to change ***Region of Interest*** by mouse (see ***ROI 6.3.2***.). Just press the CTRL (STRG) button and drag an area with the left mouse button. The coordinates of the selection rectangle are used for calculating a new region of interest, which will be adapted to the camera capabilities automatically. Reset the ROI to maximum by pressing the CTRL (STRG) button and the right mouse button.

Short Cut List

- Start / Stop record: ENTER
- Acquire Picture: SPACE (Soft Trigger mode)
- Acquire Sequence: STRG + A / CTRL + A
- Auto Save: ALT + D
- Export File: STRG + T / CTRL + T
- Export Recorder Sequence: STRG + O / CTRL + O
- Open Raw Image File: STRG + I / CTRL + I
- Open Raw Recorder Sequence: STRG + R / CTRL + R
- Save Raw Image File: STRG + E / CTRL + E
- Save Raw Recorder Sequence: STRG + S / CTRL + S

APPENDIX

A1 TECHNICAL DATA

A1.1 SPECIFICATIONS

image sensor	
type of sensor	CMOS
image sensor	proprietary
pixel size (h x v)	11 µm x 11 µm
sensor format / diagonal	11.1 x 11.1 mm^2 / 15.7 mm (S1)
	22.18 x 22.18 mm^2 / 31.36mm (S4)
	21.1 x 11.9 mm^2 / 24.2 mm (HD)
	21.1 x 15.8 mm^2 / 26.4 mm (HD+)
	11.0 x 11.0 mm^2 / 15.6 mm (HS1)
	15.4 x 11.6 mm^2 / 19.3 mm (HS2)
	22.0 x 22.0 mm^2 / 31.1 mm (HS4)
shutter mode	global (snapshot)
MTF	45.5 lp/mm (theoretical)
fullwell capacity	36000 e^-
readout noise	23 e^- rms @ 62.5 MHz (typ)
	18 e^- rms @ 62.5 MHz (CDI, typ)
quantum efficiency	50% @ peak
spectral range	290 nm .. 1100 nm
dark current	530 e^-/pixel/s @20°C
DSNU	< 0.6 counts rms @ 90 % center zone
PRNU	< 1% @ 80 % signal

camera	
exposure / shutter time	1.5 µs .. 40 ms
dynamic range A/D	12 bit
A/D conversion factor	8.8 e^- / count
region of interest	48 x 4 pixel steps (centered)
non linearity	< 0.5 % (diff.) / <0.2 (integr.)
internal camera memory	9 / 18 / 36 GB
trigger input signals	frame / sequence / stop trigger
trigger output signals	exposure / busy status
data interface	USB 3.0; GigE / USB 2.0; HD-SDI, Camera Link
time stamp	in image (1 µs resolution)
time code input	IRIG-B
operational shock	30 G @ 11ms half sine wave (all axes)
operational vibration	25 G @ 1-150 Hz (all axes)
interframing time	3.15 µs (S4 mono; S1 mono/color; HS1/HS2/HS4)
	3.58 µs (S4 color; HD/HD+)

general	
power supply	90 .. 260 VAC (12 VDC optional)
power consumption	80 W (120 W with battery)
weight	7.9 kg
operating temperature	+5°C .. +40°C
operating humidity range	10% .. 90% (non-condensing)
storing temperature range	-20°C .. +70°C
optical interface	F-mount (C-mount optional)
CE / FCC certified	yes

Subject to change, refer to current data sheet available on PCO website.

A1.2 REAR PANEL

LED Colors 1
Error: red; status: green; record: blue and green

Reset button 2
Reset of the GigE interface card, image data is ***not*** lost!

Power on/off switch 3

Power connector 4
Pin1 GND; Pin2 +12-36V; Pin3 not used

Data interface 5
Selectable: USB 2.0 or 3.0 (see **A2.2**), GigE (see **A2.3**), Camera Link (see **A2.4**), HD-SDI (see **A2.5**)

Lemo connectors 6
See **A1.2.2**

Serial number tag 7

Dust filter 8
Exchangeable

BNC Connectors 10 ***(see also chapter 6.3.7)***

BNC acq enbl (aquire enable)
Function: sequence start / stop trigger
Type: Input; Feature: galvanic isolated
Lemo Int1: Pin 2 (signal), Pin3 (GND) see **A1.2.2**
Selectable: TTL; High Level TTL; CONTACT mode; RS485 differential (+ time constant input per software)

BNC exp trig (exposure trigger / sync.)
Function: single image start trigger, external sync.
Type: Input; Feature: galvanic isolated, impedance: 1kOhm (should be externally terminated with 50 Ohms); Lemo Int1: Pin 4 (signal), Pin 5 (GND) see **A1.2.2**
Selectable: TTL; High Level TTL; CONTACT mode; RS485 differential (+ time constant input per software)

BNC status [out]
Function: exposure time out, busy signal
Type: output; Feature: galvanic isolated
Lemo Int2: Pin 3 (signal), Pin 4 (GND) see **A1.2.2**
Fixed: TTL = 5V => rec. status on; TTL = 0V => rec. off

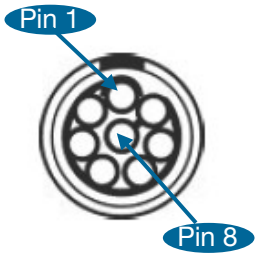
BNC opt1 [in]
Function: IRIG-B signal
Type: Input; Feature: galvanic isolated; fixed: 1…10V

BNC camera sync [out] (only Master/Slave sync.)
Function: pco.dimax camera synchronization
Type: output; Feature: non isolated; fixed: TTL

BNC camera sync [in] (only Master/Slave sync.)
Function: pco.dimax camera synchronization
Type: input; Feature: non isolated; fixed: TTL

A1.2.1 RJ45 TO LEMO ADAPTER

This adapter is plugged onto the existing RJ45 socket and screwed to the camera. It is optional equipment.



Lemo Pin assignment (ECG.1B.308.CLN)
(Fitting male connector: FGG.1B.308.CLAD62)

Lemo Pin	RJ45 Pin	RJ 45 Color	Description
1	X1	green / white	transmit data+
2	X2	green	transmit data-
3	X4	blue	not connected
4	X5	blue / white	not connected
5	X7	brown / white	not connected
6	X8	brown	not connected
7	X3	orange / white	receive data +
8	X6	orange	receive data -

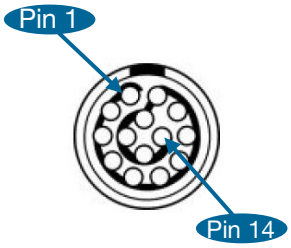
A1.2.2 PIN ASSIGNMENT OF LEMO CONNECTOR

Lemo connector is a high grade push-pull connection device.

Connector: (org. Lemosa Part Number)
Int1: ECJ.2B.314.CLD; ***Int2:*** ECJ.2B.319.CLD
e.g. fitting plug connector: (org. Lemosa Part Number)
Int1: FGJ.2B.314.CLLD72; ***Int2:*** FGJ.2B.319.CLLD72

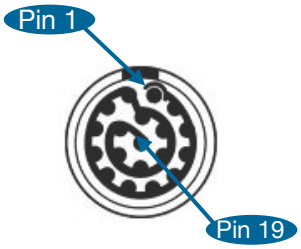
Lemosa (LEMO) Connector Int. 1 and Int. 2

LEMO Int 1 Pin assignment (14pins):



Pin	Signal name	Dir.	Feature description
1	shield		
2	trigger (signal)	IN	galvanically isolated, selectable behavior (BNC)
3	trigger (GND)	IN	
4	sync (signal)	IN	galvanically isolated, selectable behavior (BNC)
5	sync (GND)	IN	
6	ready status (sig.)	OUT	galv. isol., TTL=5V => armed (LED) TTL=0V => not armed
7	ready status (GND)	OUT	
8	fault status (sig.)	OUT	galv. isol., TTL=5V => no fault (LED) TTL=0V => fault
9	fault status (GND)	OUT	
10	supply voltage (+)	IN	input of (+) VDC
11	supply voltage (+)	IN	input of (+) VDC
12	supply voltage (-)	IN	input of (-) VDC
13	supply voltage (-)	IN	input of (-) VDC
14	NC		

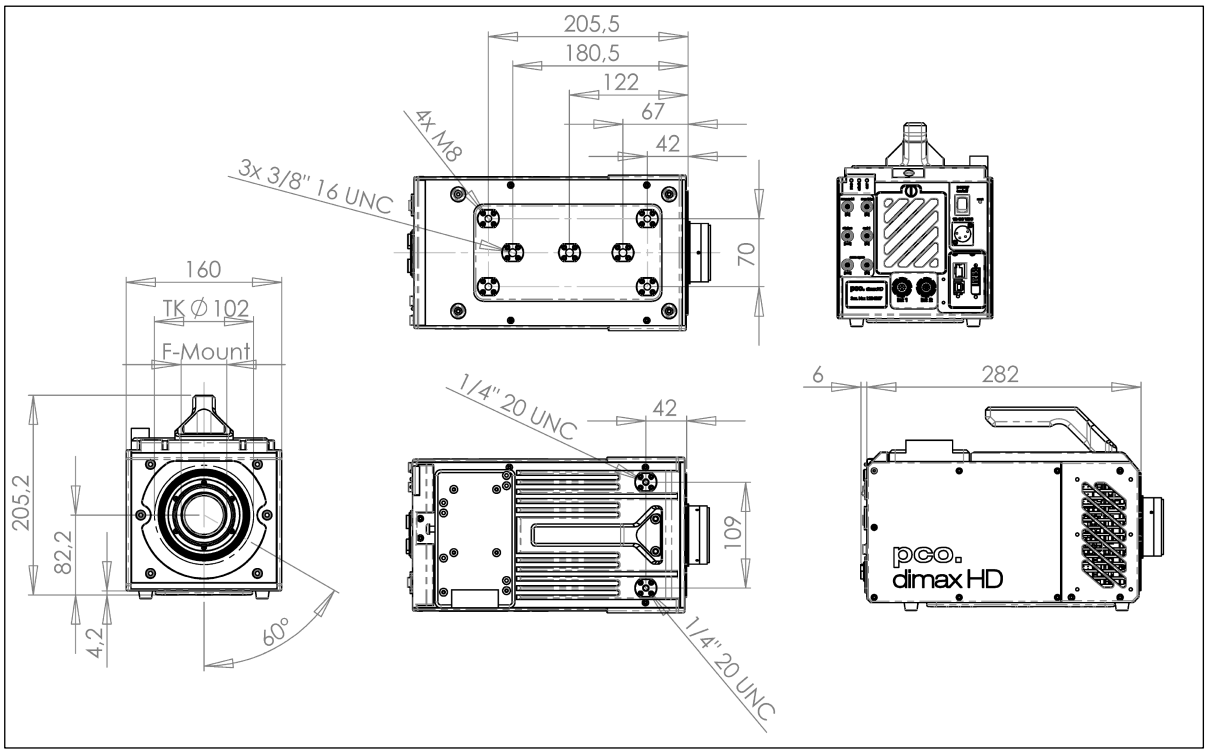
LEMO Int 2 Pin assignment (19pins):



Pin	Signal name	Dir.	Feature description
1	set ready (signal)	IN	galvanically isolated, selectable behavior
2	set ready (GND)	IN	
3	exposure time out (signal)	OUT	galvanically isolated, TTL (BNC, LED)
4	exp. time out (GND)	OUT	(BNC)
5			
6			
7			
8			
9	free definable		
..			
19			

A1.3 MECHANICAL DIMENSIONS

All dimensions given in millimeter.



A1.4 INPUT WINDOW FILTER

NOTE
F-Mount flange back focal length: 46,50 mm

Monochrome cameras have a ***Suprasil*** input window.
The safety glass as input window in front of the color sensor acts as anti-reflective coated filter (98% light transmission)

The ***pco.dimax b/w camera*** detects a standard spectral range of 300 nm – 800 nm.

The spectral range of the ***pco.dimax color camera*** is: 400 nm – 700 nm.

A1.5 F-MOUNT ADAPTER

A1.5.1 PCO F-MOUNT ADAPTER

This is PCO's ***F-mount adapter*** from PCO.
If you have got a lens with ***automatic diaphragm***, this adapter allows you to easily adjust the aperture by turning the aperture ring on the adapter.

F-mount lenses without an ***automatic diaphragm*** can be adapted to the camera's lens mount but the aperture cannot be set.

Adjust back focal length

Set the focus of your lens to infinity. After that, look for an object in infinity and generate a sharp image by turning the adapter. Use the rearmost ring to fix the setting.

Matching lenses with automatic diaphragm:

Nikon: all Nikkor lenses of type D and type G (not for type E, this one is only electronic).

Zeiss: all ZEISS ZF.2 lenses (Otus, Milvus, Interlock, Distagon, Planar).

Sigma: only lenses, which already have a manual diaphragm ring; all other lenses have an aperture control lever, which does not spring back, if you turn the aperture ring at the adapter.

Tamron: only some lenses provide automatic diaphragm (no specific lens family):

Type 35mm F-Mount
- A012 -> SP 15-30mm F/2.8 Di VC USD
- A007 -> SP 24-70mm F/2.8 Di VC USD
- A009 -> SP 70-200mm F/2.8 Di VC USD
- A011 -> SP 150-600mm F/5-6.3 Di VC USD
- F012 -> SP 35mm F/1.8 Di VC USD
- F013 -> SP 45mm F/1.8 Di VC USD
- F017 -> SP 90mm F/2.8 Di MACRO 1:1 VC USD

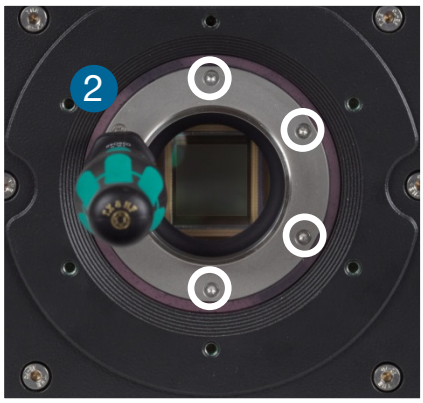
Type APS-C(H) F-Mount
- B001 -> SP AF 10-24mm F/3.5-4.5 Di II LD Aspherical [IF]
- B005 -> SP AF 17-50mm F/2.8 XR Di II VC LD Aspherical [IF]
- G005 -> SP AF 60mm F/2.0 Di II LD [IF] Macro 1:1

A1.5.2 CHANGE F-MOUNT ADAPTER

The distance between the front edge of the F-mount and the sensor is 46.50 mm (back focal length). For standard F-mount lenses and adapters.

Required Tool
Torx key T8 with 8mm width.

First step:
Remove the F-mount adapter.
Turn the F-mount adapter ***clockwise*** to remove it completely from the camera.



Second step
Remove the stainless steel ring.
Unscrew the six Torx (8mm) screws from the stainless steel ring and remove the ring itself. 2

Third step
Mount the new stainless steel ring. 3
Tighten the six Torx screws carefully (crosswise).

Fourth step
Assemble the new F-mount adapter, but do not fix it, you still need to adjust the back focal length. 4

Last step: Adjust Back Focal Length

To adjust the back focal length (e.g. you cannot focus to infinity or to the minimum object distance of your lens), proceed as follows:
Turn the F-mount adapter clockwise till its limit stop. Install a lens and set it to infinity. Start Camware and turn the F-mount adapter ***counterclockwise*** until the image is sharp.
Use the rearmost ring to fix the setting.

A2 INTERFACES

Many different interfaces are available for the pco.dimax camera. This chapter describes the installation and configuration of USB / GigE / Camera Link and HD-SDI interfaces.

A2.1 CABLING

Overview of the maximum cable lengths

Camera Link base:
- standard: 3 m
- optional: 5 m
- no cables included in standard equipment

USB 2.0 :
- standard: 5 m
- included in standard equipment

USB 3.0:
- standard: 3 m
- cable and USB 3.0 PCI express board included in standard equipment

Gigabit Ethernet :
- standard: 10 m Cat 6
- optional: 0.5 m; 2 m; 5 m; 12.5 m; 30 m; 50 m
- maximum: 100 m
- cable (10 m Cat6) included in standard equipment

A2.2 USB 2.0 / 3.0

Start the USB 2.0 or 3.0 driver installation from your pco.usb flash drive (or download the latest version from PCO website (https://www.pco.de) . ***Don't connect the camera*** to your computer before driver is completely installed.

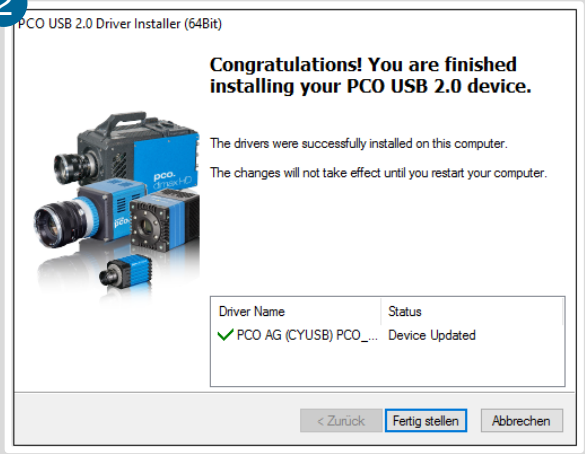
Run the provided installation file and follow the instructions of the installation wizard.1
After finishing2 the driver installation wizard connect your pco.dimax camera to its power supply and via enclosed USB 2.0 cable to your computer.

The first time the camera is connected via USB to the computer, Windows will notify that a new device has been detected.

USB 2.0:

1

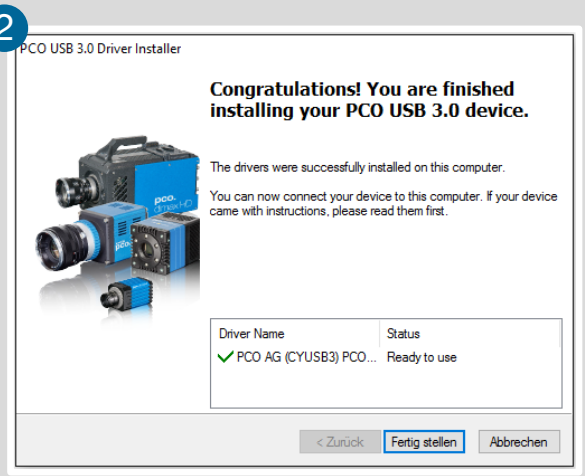
2



USB 3.0:

1

2



A2.3 GIGABIT ETHERNET

GigE is an interface standard for high-performance industrial cameras. Developed by a group of about 50 companies. GigE is based on the Gigabit Ethernet standard which uses standard Ethernet category cabling. The standard is trying to unify protocols currently used in machine vision industrial cameras and let 3rd party organizations develop compatible software and hardware (www.machinevisiononline.org).

System requirements (check PCO website for latest versions)

- GigE PCO firmware > V2.00
- Camware software package
- GigE driver generation 2 > V4.0.0.00
- Complete network environment must be GigE compliant Cat5e or higher patch cable

A2.3.1 QUICK INSTALLATION GUIDE

Follow the steps in this sequence. Additional information can be found in the respective subchapters.

First Step **NIC**	**Install network interface card** (NIC) See chapter **A2.3.2**
Second Step **IP Address**	**Configure the IP address of your NIC** See chapter **A2.3.2.1**
Third Step **Driver**	**Install GigE driver** Follow instructions. See chapter **A2.3.4**
Fourth Step **Uncheck**	**Deactivate (uncheck) the GigE driver** ***pco.camera with GigE*** at each NIC that will **not** physically be connected to your camera (Win 7/8) See chapter **A2.3.4.2**
Fifth Step **Calib Tool**	**Apply PCO GigE Calibration Tool** for camera calibration See chapter **A2.3.5**
Sixth Step **Test**	**Test your calibration** see chapter **A2.3.5.6**
Final Step	**After successful calibration** Install and start Camware

A2.3.2 NETWORK INTERFACE CARD

Your computer must have a network interface card (NIC) to connect the camera via GigE, either an onboard NIC (mainboard) or a plug-in card.

PCIe
Ideally it is a PCI Express NIC to achieve the highest data transfer rates.
The PCI Express interface allows faster and more stable data transfer rates than ordinary PCI interfaces. Finally, NIC's performance depends on the used chipset. Recommended are chipsets from Intel.

Driver
Make sure that the ***specific driver*** of the NIC is installed to your Operating System (OS) – otherwise the OS may use a standard plug & play driver not top-performing with the hardware.

Configuration
For checking your network connection or changing parameters open the ***properties dialog*** of your LAN connection. See chapter **A2.3.2.1**.

Mainboard Slot for NIC
Installing a NIC in a ***PCIe*** slot of your computer, check the data transfer rates of the preferred slot. Some mainboards do not provide the required data transfer rates on all ***PCIe*** slots. See **A2.3.6**.

A2.3.2.1 IP ADDRESS CONFIGURATION

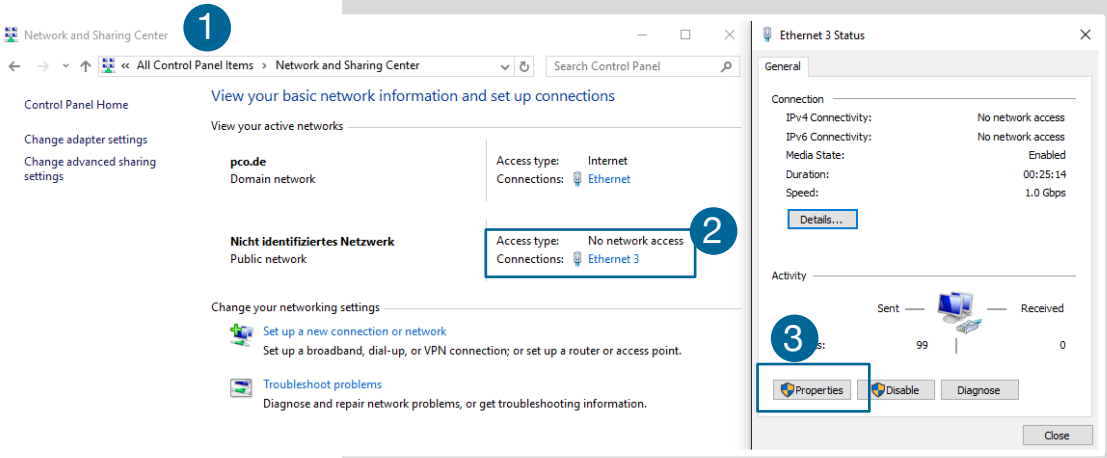
How to configure an IP address manually: exemplary for Windows 10 (configuration for Win 7/8 is identical)

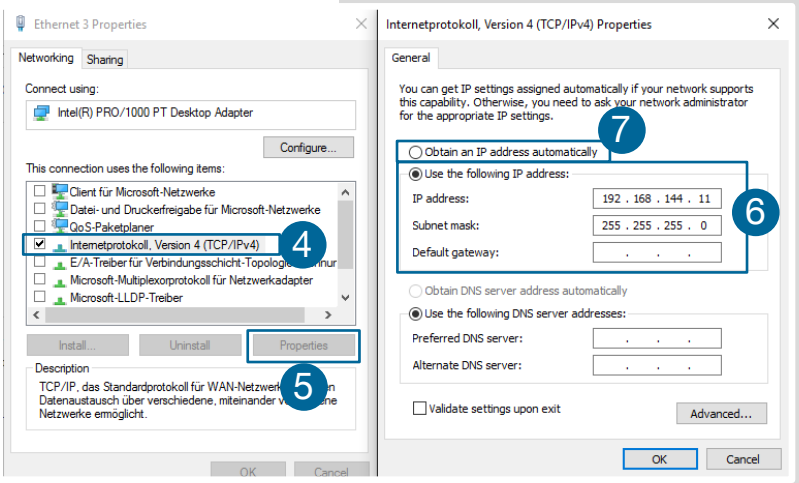
1. Start → Control Panel → Network and Sharing Center
2. Select your GigE network connection
3. Properties
4. Internet protocol version 4 (TCP/IPv4)
5. Properties
6. Use the following IP address

Use internet protocol ***version 4*** (TCP/IPv4) only, TCP/IPv6 is not supported by PCO cameras.

Recommended: configure your IP address ***manually***.

The use of ***Dynamic Host Configuration Protocol (DHCP)*** is not recommended. DHCP is active if ***obtain an IP address automatically*** is selected 7.



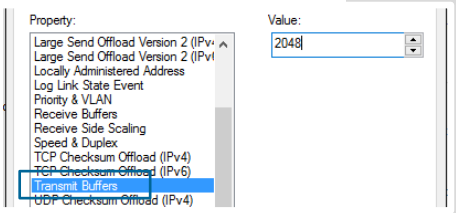


A2.3.2.2 JUMBO PACKETS / BUFFER SETTINGS

NOTICE

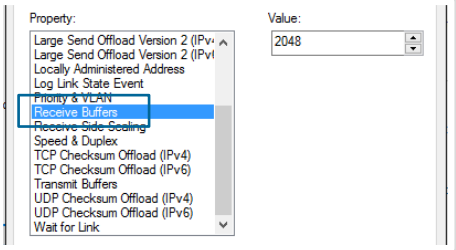
These settings are for experts' use only!

To change these settings:
Win7/8/10: Start → control panel → network and sharing center → change adapter settings → select network connection e.g. Ethernet 2 connected to your camera → right-click→ properties → configure → advanced



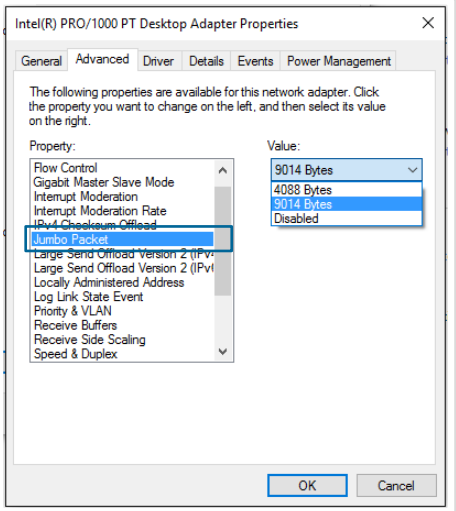
Jumbo Packets and ***Transmit / Receive Buffer*** are settings of your network card and can be changed with the windows control panel.

These ***buffer settings*** help to reduce the loss of data packets (images) while transferring data from camera to network interface card.



Transmit / receive buffer (recommended for GbE network only)

For some NIC's you may set parameters manually which affect the stability of the data transfer. The most important ones are ***Transmit and Receive Buffer***.
Always set the value of these parameters to their ***maximum.***



Jumbo packet (expert use only – one camera only)

Activate Jumbo Packet(s) to reduce overheads and CPU cycles, in case your network adapter supports it.
All of your network components must be Jumbo Packet compatible.

A2.3.2.3 RECOMMENDED HARDWARE

Following hardware components have been tested by PCO. Their use guarantees stable data transfer rates.

Hardware	GbE	10GbE
NIC	Intel Ethernet Server Adapter I210 T1	Intel Ethernet Converged Network Adapter X550-T2
NIC	Intel Ethernet Server Adapter I350 T2 (2 port)	
NIC	Intel Ethernet Server Adapter I350 T4 (4 port)	
Switch	Standard 1 Gbit switch	Netgear ProSAFE XS716T

A2.3.2.4 NETWORK ENVIRONMENT/PATCH CABLE

A correct network configuration is crucial to achieve the best image data transfer rates. It is mandatory that ***any component*** used for the network connection between camera and computer is compatible with a data transfer rate of 1000 MBit/s for Gigabit Ethernet or 10 Gigabit/s for 10 Gigabit Ethernet.

Some of these components are the NIC, router, hub, switch, etc., but also the patch cable.

The quality of patch cables is specified in categories. It is necessary to use ***category 5e-, 6-, or 7- patch cables*** for a network connection with a data transfer rate of ***GbE***, for ***10GbE*** network only ***Twisted Pair Cat 7e***.

	GbE	10GbE
Network cable	Cat 5e, 6, 7	TP Cat 7e
Max. cable length	100m	100m

A2.3.2.5 CABLE LENGTH

Available cable lengths:

	length
standard	10 m Cat 6
optional	0.5 m; 2 m; 5 m; 12.5 m; 30 m; 50 m
maximum	100 m
included	10m Cat 6 cable is included in the camera system

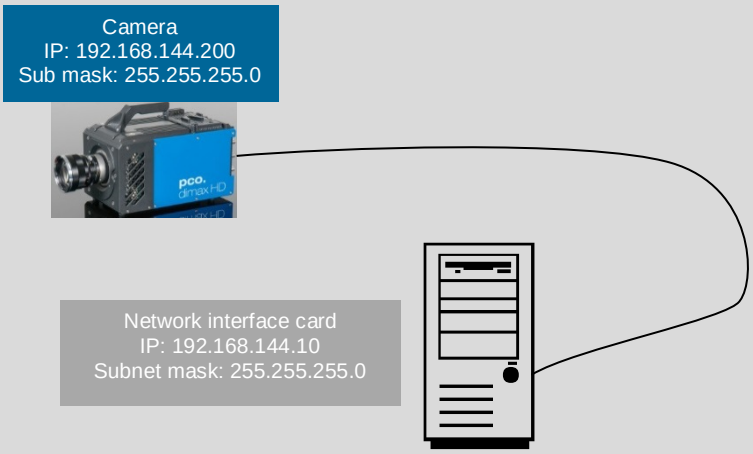
A2.3.3 SINGLE/MULTIPLE CAMERA OPERATION

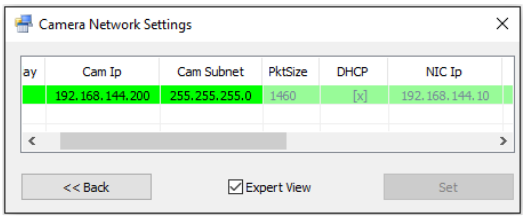
A2.3.3.1 SINGLE CAMERA

Single camera operation means camera and computer are connected via ***Point to Point*** connection, i.e. direct connection via LAN cable between the GigE connector of the camera and the network interface card of your computer.

- Connect ***NIC*** and ***camera*** via ***patch cable*** directly.
- Configure the IP address and Subnet mask of your NIC, see **A2.3.2.1**

Configuration example:





Calibration Tool:
Use the ***Calibration Tool*** to configure these settings, see chapter **A2.3.5** (e.g. configuration of a pco.dimax camera connected to a NIC).

A2.3.3.2 MULTIPLE CAMERAS

There are two basic ways to connect ***multiple cameras*** to a computer: with a ***switch*** or with one network interface ***port per camera***.

A2.3.3.3 SWITCH

The network settings using a switch can be configured manually or with a DHCP server.

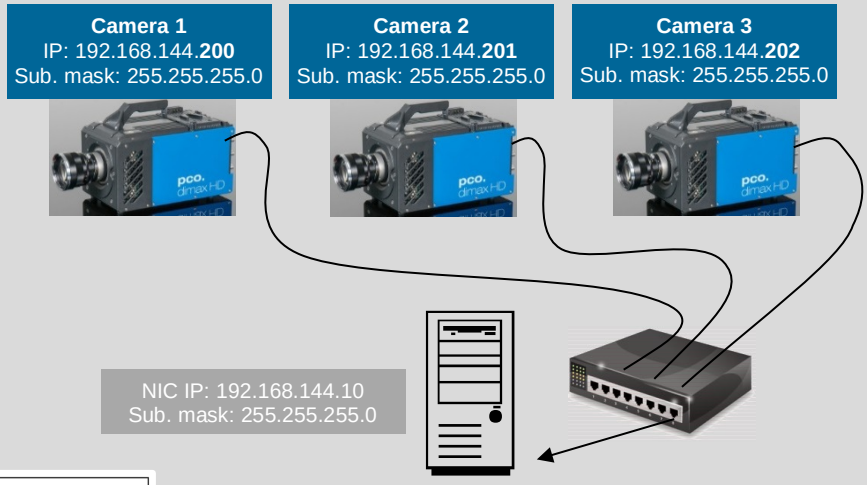
Using a switch may cause network ***performance problems***: if the connected cameras require a higher bandwidth than can be provided by the switch and the associated network card. See also Network and Packet Delay **A2.3.5.3**.

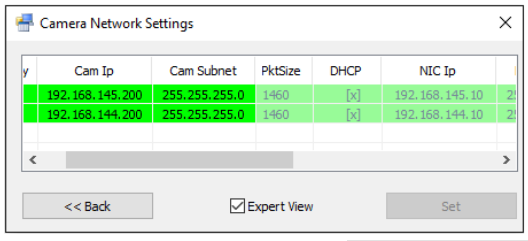
NOTICE

Via switch without a DHCP server:

- Camera and NIC IP addresses have to be set manually.
- The ***subnet*** of camera and NIC, i.e. the first three sections of camera and NIC TP address must be identical (see configuration example).
- The next section of each camera and NIC IP can be any value ***between 1 and 254***, but may not be the same for both devices.
- For example: NIC IP ***192.168.144***.10; a proper camera IP would be ***192.168.144***.100. The Subnet mask must be exactly the same, e.g ***255.255.255.0***.

Configuration example:





Calibration Tool:

Use the ***Calibration Tool*** to configure these settings, see chapter **A2.3.5** (e.g. configuration of a switch with two pco.dimax cameras).

Via switch with DHCP server:

- NIC and cameras obtain the IP addresses automatically by a DHCP server.

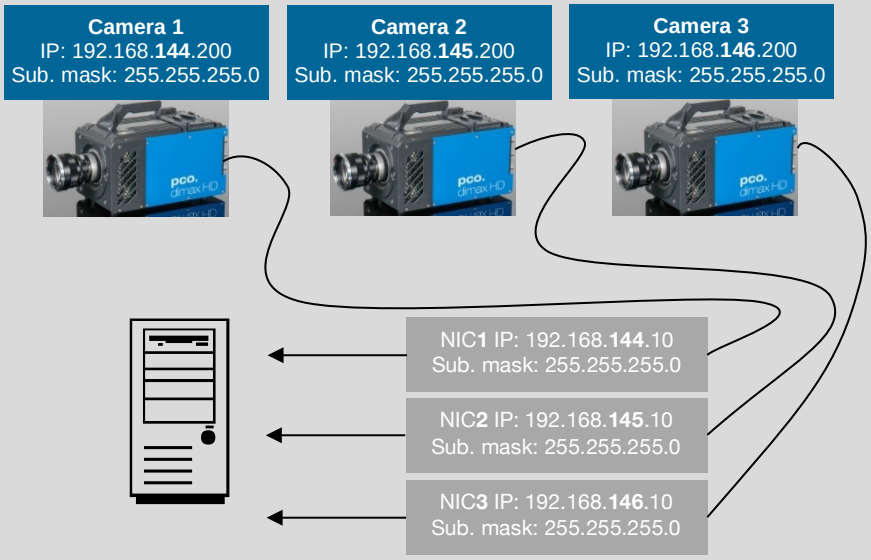
A2.3.3.4 SEVERAL NICS

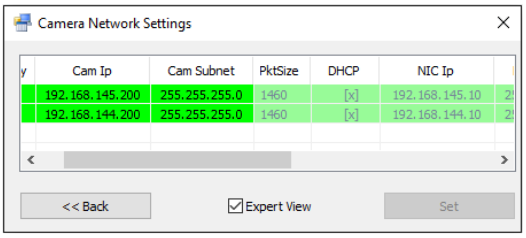
Via several NIC's (or NIC ports) at one computer:

- Camera and NIC IP addresses have to be set ***manually***.
- Each ***camera and NIC*** pair needs its own subnet (see configuration example).
- Using NICs with multiple ports: check the bandwidth of the PCIe slot.

The following example shows how to calibrate IP addresses when connecting cameras to individual NIC's. Most ***important*** is that ***each camera & NIC combination needs its own subnet*** and the camera IP address and subnet and NIC IP address and subnet have to match.

Configuration example:





Calibration Tool:

Use the ***Calibration Tool*** to configure these settings, see **A2.3.5** (e.g. configuration of two NIC's with two pco.dimax cameras).

A2.3.4 DRIVER INSTALLATION

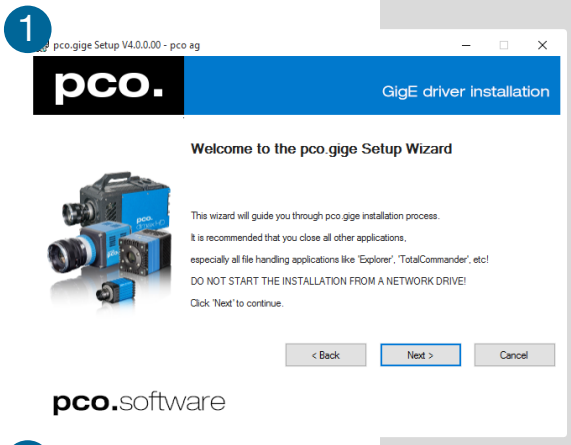
NOTE
If installer fails, use uninstaller, remove all old files and then try again.

First install the PCO GigE driver from the USB flash drive or from www.pco.de on your computer..

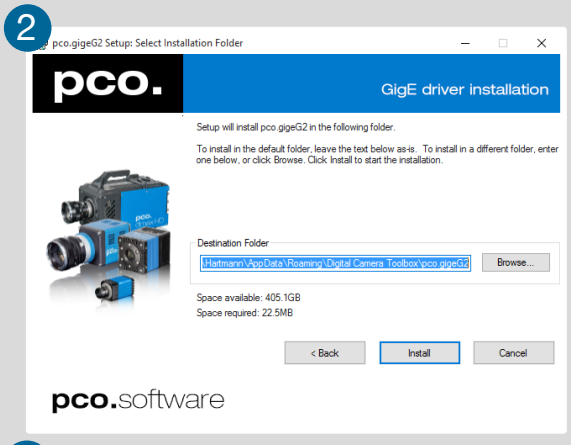
Before installing ***remove previously*** installed GigE driver. The installer does it for you. Or open ***control panel*** → ***programs and functions*** → and uninstall PCO GigE driver.

1. Start GigE driver setup and follow the instructions
2. Choose installation directory
3. GigE driver installation is completed
4. Reboot your computer to complete the installation
5. Start ***Calibration Tool*** **A2.3.5**

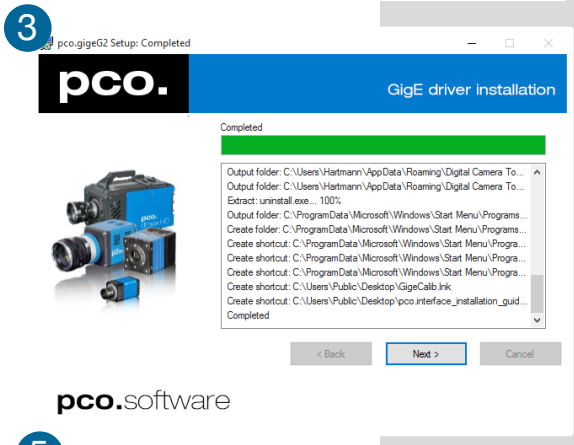
1



2

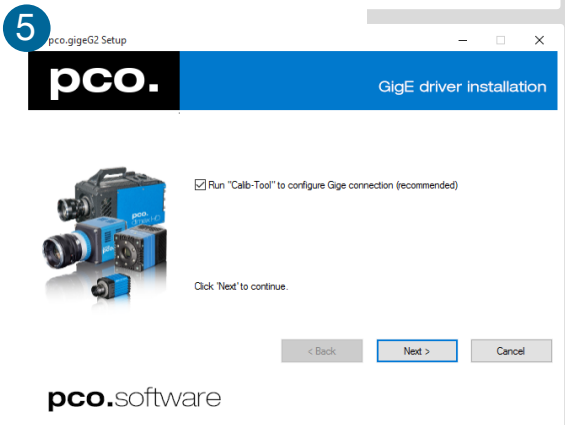


3



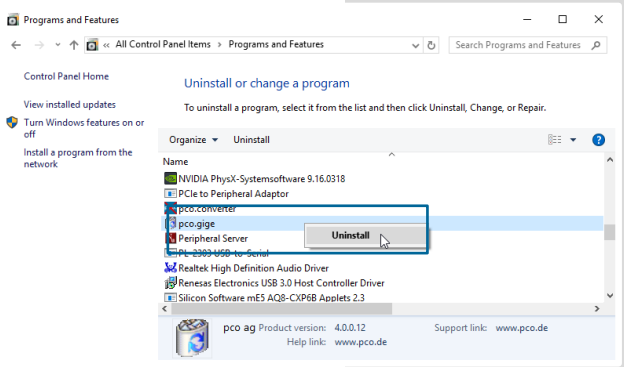
4

5



NOTE
This installation installs both drivers: Gen2 and the former Gen1 V3.1 allowing former GigE cameras to run properly.

A2.3.4.1 UNINSTALL DRIVER



Open the file ***GigE_Uninstall.exe*** (Win7/8: Right-click and select ***Run as Administrator***)

Win 7/8/10
Click Start → Control Panel → Programs and Features → Select: ***pco gige*** and double-click to uninstall

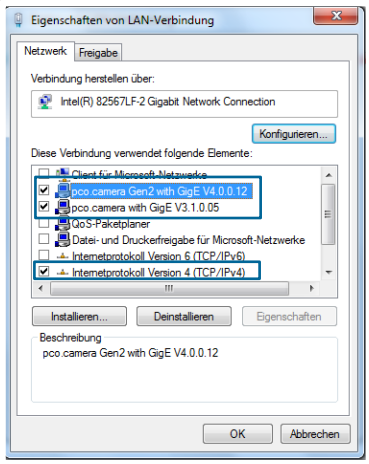
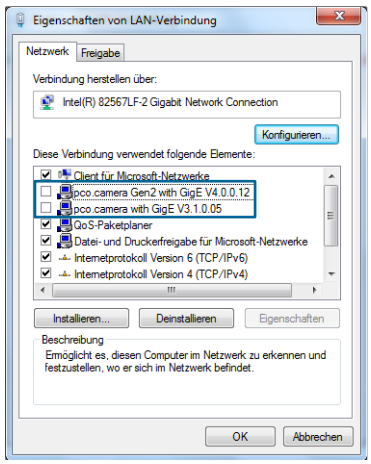
Or on Win7/8: Start → Programs → Digital Camera Toolbox → pco.gige/pco.gige2 → Uninstall

A2.3.4.2 DE/ACTIVATING FILTER DRIVER (WIN7/8)

NOTICE

It is mandatory that the PCO GigE driver is only activated at the specific NIC that is physically connected to your camera. In addition, just the service ***pco.camera with GigE*** and the ***Internet protocol Version 4 (TCP/IPv4)*** should be activated for each NIC used for PCO cameras.
With active virus scan/firewall a connected camera may not be recognized.

Tick the ***pco.camera with GigE*** check box for activating or deactivating GigE drivers.

Camera is operated with this network card.	Camera is **NOT** operated with this network card.
Activate ***both GigE drivers*** and ***internet protocol version 4*** TCP/IP. Deactivate all other elements.	Deactivate ***both GigE drivers***. Activate all other elements.
	

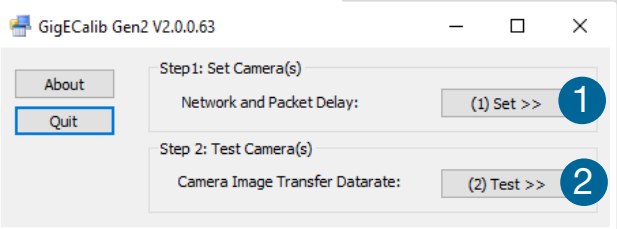
A2.3.5 CALIBRATION TOOL

The PCO GigE Calibration Tool is part of the PCO software package, starts automatically after the PCO GigE Driver installation and is automatically linked to your desktop.

- ***Win 7:*** Start → All programs → Digital Camera Toolbox → pco.gigeG2 → GigECalib
- ***Win10:*** Start → All Apps → Digital Camera Toolbox → GigECalib

The purpose of this software:

- Set camera network parameter (Packet Delay **A2.3.5.3**).
- Change the network settings (IP address & subnet mask **A2.3.5.4**) of the camera.
- Display connected PCO GigE cameras.
- Check the correct network configuration.
- Test the data transfer rate (Test **A2.3.5.5**).



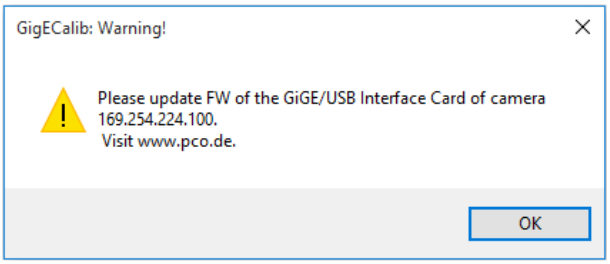
How does it work?

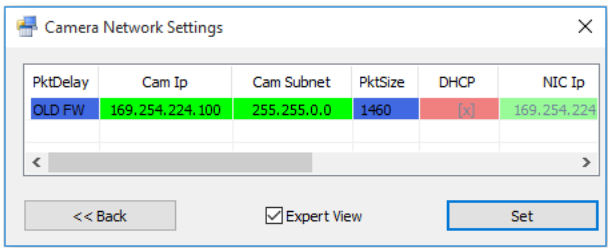
The ***Start Dialog*** offers two possibilities:

1. Choose ***Set Camera (SET≫)*** to calibrate network parameters like IP address, Subnet mask and ***Packet Delay*** of all connected cameras. See chapter **A2.3.5.3** and **A2.3.5.4**.

2. Or choose ***Test Camera (TEST≫)*** to test the image data transfer rate of all PCO GigE cameras correctly connected to your PC. See chapter **A2.3.5.6**.

A2.3.5.1 FIRMWARE WARNING



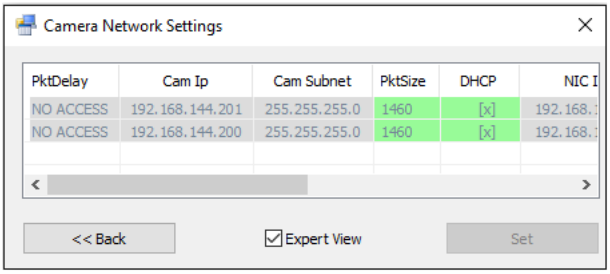


If this message pops up after clicking SET>> a calibration will not be performed.

The driver needs a new firmware version to work properly.

Download it from www.pco.de. Select Support and your camera type.

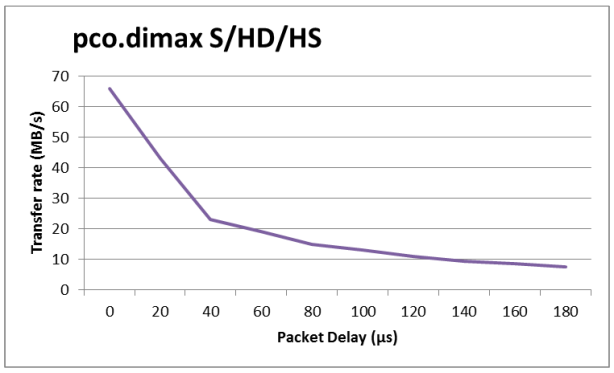
A2.3.5.2 BLOCKED ACCESS



If you can't change the configuration (all fields are grayed out) other software accesses the camera (e.g. Camware).

Close applications that directly access the camera.

A2.3.5.3 NETWORK AND PACKET DELAY



The dialog ***Camera Network Settings*** sets the ***Packet Delay*** and changes the PCO GigE Camera network settings.

The ***Packet Delay*** value indicates the ***delay (in µs)*** inserted between each ethernet packet of the image payload data.

It is an approximate flow-control mechanism, if the application or the network infrastructure cannot keep up with the ethernet packets sent by the device. A packet delay ***always slows down*** data transfer rate.

Example: if two PCO GigE cameras are connected to a single Gigabit Ethernet Port (for example via a network switch) the sum of the bandwidths has to be smaller than the maximum possible data transfer rate transmitted by GigE (100 MB/s).

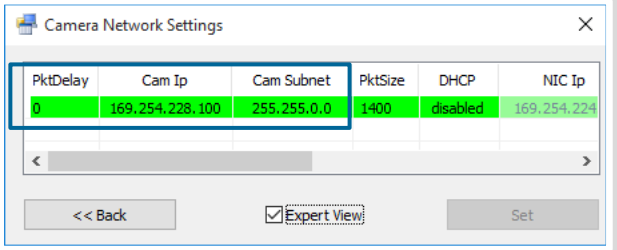
NOTICE

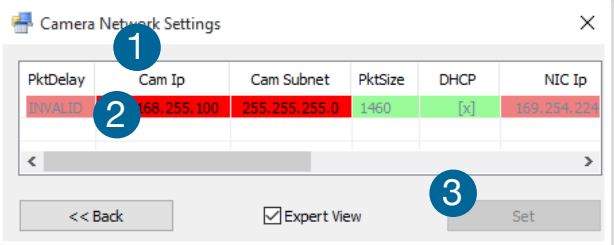
If ***Packet Delay*** is increased, the data transfer rate is decreased.

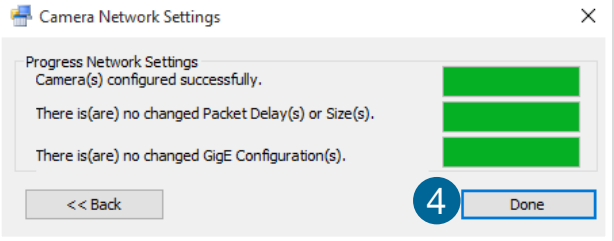
Table Delay Time and transfer rate pco.dimax HD/S/HS

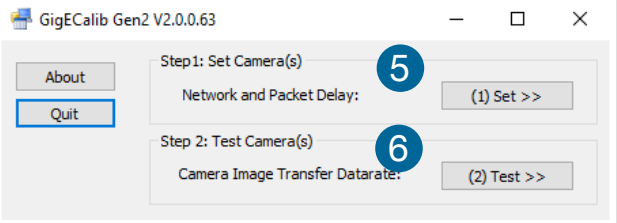
Delay/µs	0	20	40	60	80	100	120	140	160	180
MB/s	66	43	23	19	15	13	11	9.5	8.5	7.5

A2.3.5.4 SET CAMERA IP ADDRESS & PACKET DELAY









Make sure that the camera IP address (Cam IP) and the camera network mask (Cam Subnet) fit to the network interface card (NIC IP & NIC Subnet) connected to. Everything is correct if all values are highlighted in ***green***.

If camera IP or subnet is ***not correct***, it will be highlighted in ***red*** 1. The first three sections of camera and NIC IP must be identical. The fourth section between 1 and 254.
For example: NIC IP ***192.168.144***.49; a proper camera IP would be ***192.168.144***.100.
The subnet mask must be exactly the same, e.g ***255.255.255.0***.

Set ***Packet Delay***, standard is ***40***. Read **A2.3.5.3** before you set the ***Packet Delay***.

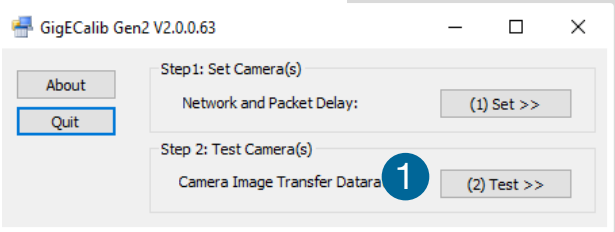
Change ***camera*** IP & subnet with this tool, but ***not*** NIC IP & subnet (for NIC configuration see **A2.3.2.1**).

Double-click onto the table 2 to change the value. Press ***Set*** 3 to validate the changings. After configuration is finished click ***Done.*** 4

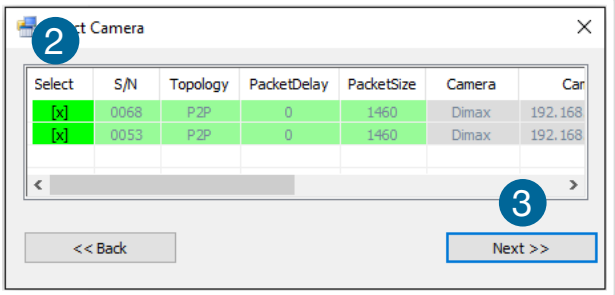
The next step is to check if IP and Subnet configuration is correct: click ***Set>>*** 5 again to check if all values are highlighted in ***green***.

Finally always ***Test>>*** 6 your settings. See chapters **A2.3.5.5** and **A2.3.5.6**.

A2.3.5.5 IMAGE DATA TRANSFER RATE

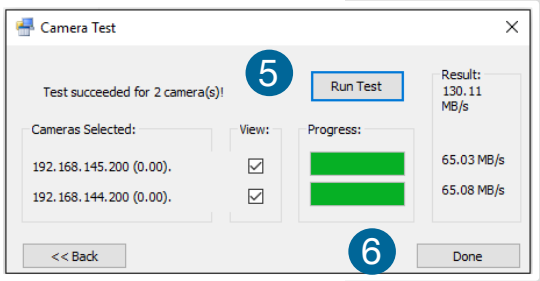


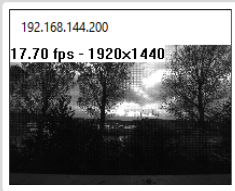
First click ***Test»*** 1 then double-click into the ***Select*** 2 column of the table to select the camera. If not highlighted in ***green*** it cannot be selected for testing. If more than one camera is selected, they are going to be tested in parallel.



Press ***Next >>*** 3 to open the ***Camera Test*** dialog.

A2.3.5.6 CAMERA TEST





All cameras selected in the ***Select Camera*** dialog are listed here. If the ***View box*** is checked the transferred images are displayed. click ***Run Test*** 5 to startbegin the ***Camera Transfer Test.*** The test grabs images from ***each*** camera listed – the images from all cameras ***are transferred in parallel!***

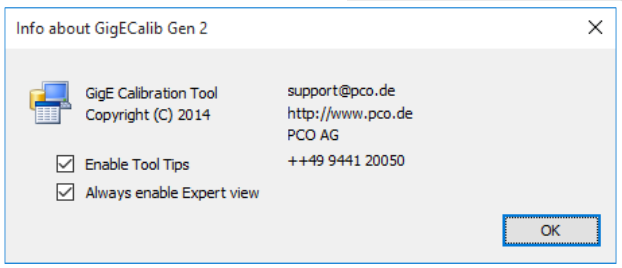
The whole ***Camera Transfer Test*** succeeds only, if each ***Single Camera Transfer Test*** succeeds. With a ***Single Camera Transfer Test*** 100 Images are transferred, and it fails, if more than 0.1% of all transferred ethernet packets got lost.
If a ***Single Camera Transfer Test*** and so the ***Camera Transfer Test for all connected cameras*** fails, the first thing to do is to check the ***Packet Delay*** value. It indicates the delay (in µs) inserted between each ethernet packet of the image payload data.

The application or the network infrastructure cannot keep up with the ethernet packets coming from the device. So, if a ***Single Camera Transfer Test*** fails, increase the ***Packet Delay*** value (see **A2.3.5.3**).
Once finished click ***Done*** 6 ***.***

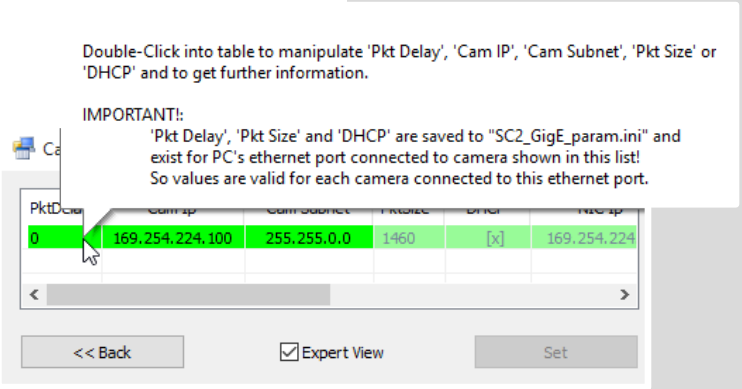
NOTICE

The Gen2 GigE maximum data transfer rate is about 100MB/s. For a pco.dimax with Gen1 GigE interface card, the maximum data rate is up to 68 MB/s.

A2.3.5.7 TOOL TIPS



To enable/disable ***Tool Tips*** run the PCO GigE Calibration Tool. Click the ***About*** button of the ***Start Dialog*** and activate/deactivate the ***Enable Tool Tips*** check box.
Enable Expert view: all setting options are enabled.



Tool Tips helps to understand the functionality of the calibration tool. Packet Delay and other settings are explained in detail.

A2.3.6 HELP GUIDE

Firewall	If your camera is not recognized, ***deactivate*** Firewall and Antivirus programs.
Driver (NIC)	Install ***original driver*** of your network interface card (e.g. intel driver) assuring full performance.
Latest Driver	Always install the ***latest*** PCO GigE driver (see https://www.pco.de/support).
Buffer	Pay attention to the network interface card ***buffer settings*** (see **A2.3.2.2**).
Firmware	If the ***calib tool*** advises to update the ***firmware***, download and install the latest version.
Slow data transfer rate (NIC)	If your computer has a network card installed (PCI / PCI express slot) and the data transfer rate is ***slow*** or data transfer is only working with a ***high packet delay*** (see **A2.3.5.3**): remove the NIC and select a different slot of your mainboard. Some slots may not reach the specified data transfer rate. Also check the wiring diagram of your mainboard to select the fastest slot. If you have a ***mainboard*** with e.g. ***two network ports***, the same problem can occur.
Windows Update	Install the latest windows updates. It ***prevents*** from problems with the GigE driver installation

A2.3.7 PERFORMANCE

The following table shows example configurations, minimum and recommended ones. The specified values are only valid for these configurations and should be an orientation.

Setup

	Minimum	Recommended	10 GbE
Network interface card (NIC)	100 Mbps NIC with standard PCI interface (only working with GigE Gen**2** driver)	GbE NIC with **PCI Express** interface Recommended NIC see **A2.3.2.3**	10GbE NIC Recommended NIC see **A2.3.2.3**
NIC configuration	Receive / transmit buffer is set to maximum		
Network connection	P2P or via switch	P2P	
Patch cable	Cat5e	Cat5e or higher	TP Cat7e
Additional network components	switch, hub, router are compatible to 100 Mbps	no additional components	no additional components
Network environment	-	virus protection/ firewall inactive	
Driver	PCO GigE driver installed		
Packet delay /max speed mode	20 µs / off	0 µs / off	0 µs / off
Computer	INTEL® Core™ i5 CPU; 2.4GHz; 4GB RAM	INTEL® Core™ i7 CPU; >2.8GHz; 8GB RAM	
Operating system	Win 7 – x64/x86	Win 7/8/10 – x64	

A2.4 CAMERA LINK

A2.4.1 FRAME GRABBER INSTALLATION

Instructions for installing and testing the ***Silicon Software microEnable IV (ME4)*** Camera Link grabber card. Hardware Installation must be performed by a technician. The device is under high voltage.

WARNING

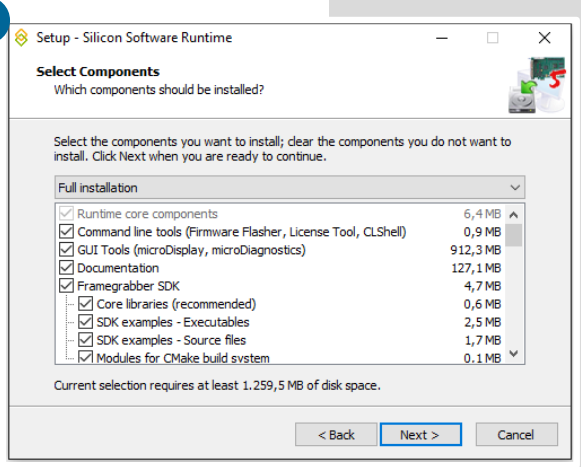
ELECTRIC SHOCK WARNING DUE TO HIGH VOLTAGE PARTS INSIDE
Risk of injury due to electric shock.
➔ Always pull the main plug before opening the computer.

Install the latest silicon software runtime package before installing the hardware. (Download: **http://www.pco.de/support/)**

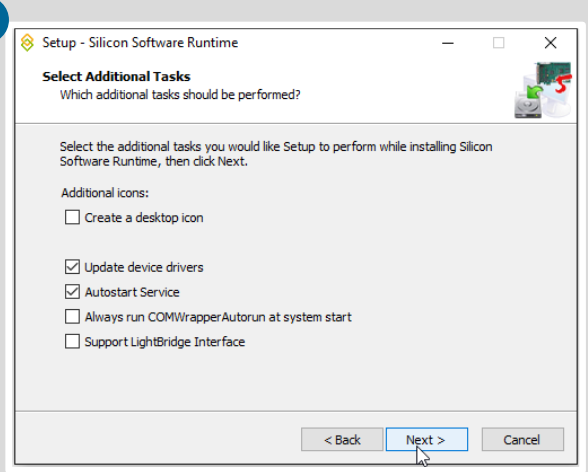
When working on a 64 bit operating system, make sure to install the proper (64 bit) runtime when also a 64 bit application shall be operated. If the application is 32 bit, you need to install the 32 bit runtime accordingly.

1. If there is no ***Gigabit Ethernet*** board installed (standard), deselect ***Support for…***
2. Let the program also update device drivers.
3. Shut your computer down, unplug it from main, open the computer case and install the ***grabber card***
4. The grabber card should be displayed in the device manager. If it is not shown this way, reinstall the ***SiliconSoftware device driver***.
5. Start the program ***microDiagnostics*** after the installation (see next page).

1

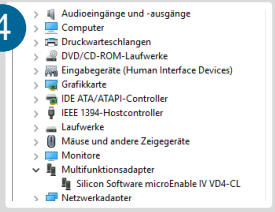


2

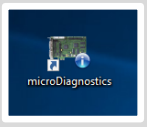


3

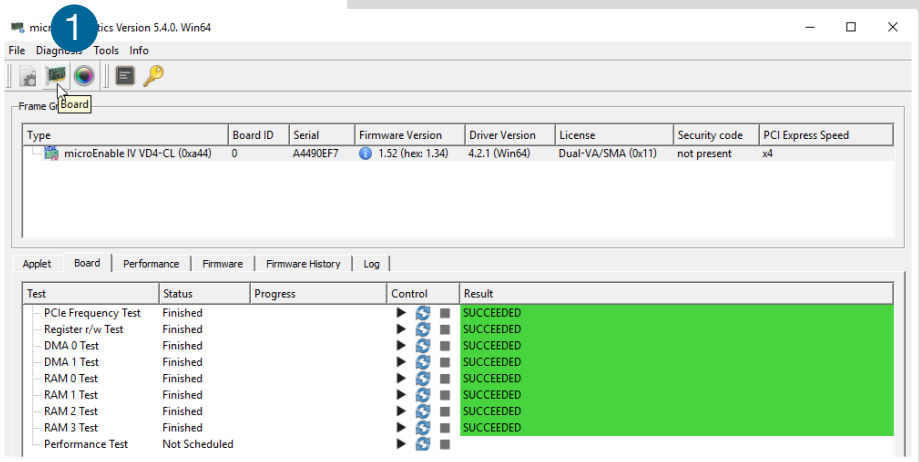
4



5

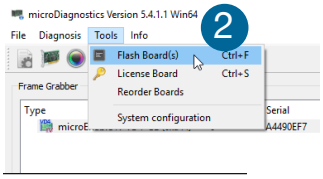


A2.4.2 MICRO DIAGNOSTICS TOOL



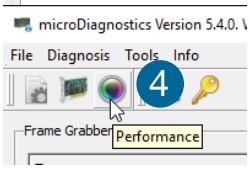
Micro Diagnostics Tool works with both meIV AD4 and VD4 frame grabber cards.

Select the board to be tested in ***Diagnosis*** and click ***Board*** 1 to start the test



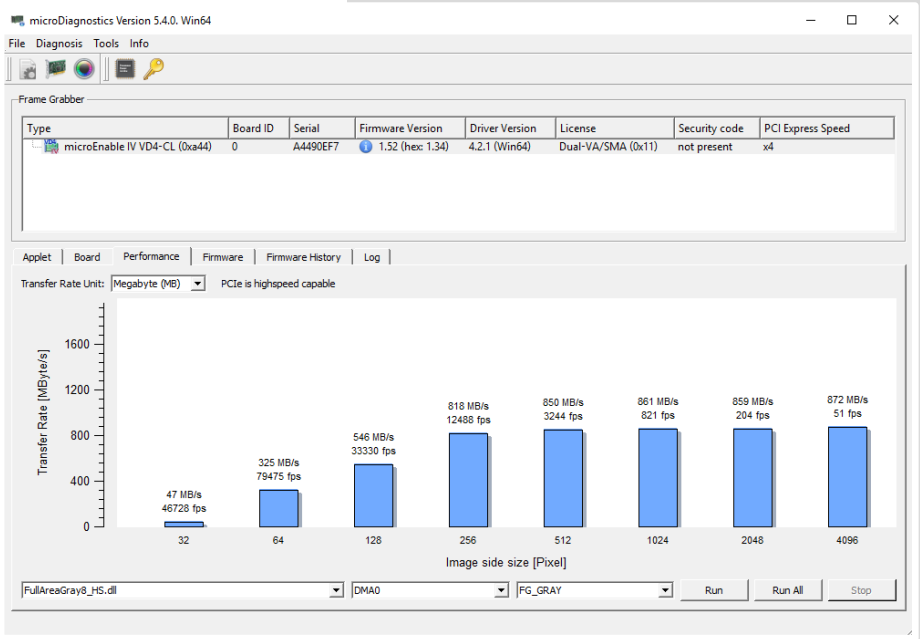
Upgrade to the supplied firmware. Select Tools → ***Flash Board(s)*** 3 and select the appropriate hap file. Micro diagnostics provides the latest available firmware version of the installed runtime.

Click on ***Yes*** when asked to proceed. You have to restart your computer after the firmware upgrade.



Test the performance of your frame grabber card by clicking on ***Performance*** 4.

For further information or problems with mainboards contact ***PCO*** support department.



A2.5 HD-SDI

HD-SDI is the ***High Definition Serial Interface*** and a special standard of the film industry.
Only available for color version of the pco.dimax S4 and HD/HD+.

HD-SDI transfers certain resolutions and frame rates only!
It can be used e.g. for an output monitor.

Possible resolutions
SingleLink, DualLink, 3G
1920x1080 Pixel (1080p/i/psf - Full HD)
1280x720 Pixel (720p - HD Ready)

Frame rates
PAL (24, 25, 30, 50 und 60 fps)
NTSC (23.98, 29.97, 59.94 fps)

Image transmission
progressive, interlaced, progressive segmented frame

Color models
RGB, YCC, RAW

Bit rate
PAL SingleLink & DualLink: 1.485 Gbit/s
PAL 3G: 2.97 Gbit/s
NTSC SingleLink & DualLink: 1.4835 Gbit/s
NTSC 3G: 2.9670 Gbit/s
$f_{NTSC} = f_{PAL}/1.001$

Cable
75 Ohm coaxial cable (RG59, Belden 1694A)

A3 BATTERY OPERATION

The pco.dimax models are optionally available with a high-performance battery pack, which is mounted on top of the camera body.

Charging the Battery

pco.dimax cameras have a built-in battery recharge circuitry, recharging the battery and maintaining the charge level, whenever the power supply is connected and working. Therefore it is not required to remove the battery pack for recharge.

NOTE
The battery is recharged automatically when the power supply of the camera is connected **AND** the camera is switched on. The recharging process starts few seconds after the power has been connected.

Battery recharge does not depend on the configured battery operating mode Standard orPower-Save.

Specifications and General Notes

Battery operating time (100% charged)

- Standard Operation Mode: 1 hour
- Power-Save Mode: 5-6 hours

Maximum recharge time

- Lithium Iron Phosphate ($LiFePO_4$): 6 hours

Calculating remaining time in Power-Save Mode (t_{ps})

- $t_{ps} = 360 \text{ min} - t_{op} * 6$
- t_{op} [min]: preceding operating time on battery backup

Power Consumption
The data for the power consumption mentioned in the pco.dimax datasheet does not include the recharge current for the battery. When recharging the battery by the camera, an additional 40 W peak power is required.

Resetting Camera by Power Switch
With power switch off, the external power supply as well as the battery is disconnected from the camera. The battery itself has only a low self- discharge current.

While the battery pack is installed, switch the camera off at its power switch. Never simply unplug it from main. In worst case the battery will be totally discharged (e.g. overnight) and frequent repetition leads to premature aging or even destruction of the battery pack.

Standard Operation Mode

The Standard Battery Operation is the default setting of the camera and activate when shipped to customer.

To maintain stable operation of the camera, the battery backup provides power immediately upon mains power failure. As soon as the mains power is reestablished, the camera draws the current again from the mains power.

Whenever the mains power is disconnected the camera runs on battery until it is fully discharged. Before the battery is in a fully discharged state, the camera shuts down completely. In that case the current settings as well as the image data are lost!

The camera informs about the current charge level of the battery. This information can be used to estimate the remaining operating time as well as to avoid loss of image data.

This mode is applicable for:

- Operating the camera in an environment where no regular mains power is available or desired.
- Backup to maintain camera operation in case of unexpected supply breakdowns.

Power–Save Mode

The Power-Save Mode will keep recorded images in the event of a major power breakdown. The camera must be configured by SDK to change into Power-Save Mode and a desired delay time defined.. After a power breakdown the camera will continue in Standard Operation Mode. If there is no power supply available during the configured delay time, the camera stops the current recording and enters into Power-Save Mode. Once power supply is reestablished, Standard Operation Mode will be restored and the battery charged.

If during delay time mains power is available for at least 10 seconds, the delay is stopped. If the mains power is disconnected again, the delay starts from the beginning. Also, the Power-Save Mode is stopped if power is available again for at least 10 seconds.

Note:

- reestablish the mains power to bring the camera back to Standard Operation Mode
- close and reopen the connection to the camera after the camera is back to Standard Operation Mode
- reconfigure all settings and validate them by an SDK ***Arm Camera*** command, when the camera shall be used for recording again
- it is possible to read recorded images from the camera memory without restoring any settings.

A4 IMAGE FILE FORMATS

There are different file formats available for saving camera images with Camware:

b16
The b16 16 bit format is similar to the bmp format. However, 16 bit pixel values are used instead of 8 bit pixel values.

The file format consists either of a Basic Header (six Long-parameter) or of an Extended Header (32 Long-parameter), the latter of which is optional for additional information. It might follow a variable comment field (ASCII code). Finally, there is the actual data set that is saved linearly (as in the case of BMP files).

With the exception of the first value, all parameters are Long Integers (4 Byte). The first six parameters must always exist. The rest of the parameters, as well as the comment field, are optional.

	Parameter	Function
1	PCO-	the first 4 byte are the characters PCO-
2	file size	file size in byte
3	header length	header size + comment field in byte
4	image width	image width in pixel
5	image height	image height in pixel
6	extended header	-1 (true), extended header follows
7	color mode	0 = black/withe camera, 1 = color camera
8	b/w min	black/white LUT-setting, minimum value
9	b/w max	black/white LUT-setting, maximum value
10	b/w linlog	black/white LUT-setting, 0 = linear, 1 = logarithmic
11	red min	red LUT-setting, minimum value
12	red max	red LUT-setting, maximum value
13	green min	green LUT-setting, minimum value
14	green max	green LUT-setting, maximum value
15	blue min	blue LUT-setting, minimum value
16	blue max	blue LUT-setting, maximum value
17	color linlog	color LUT-setting, 0 = linear, 1 = logarithmic
18 … 266	internal use	
Comment file in ASCII characters with variable length of 0…XX. The length of the comment field must be documented in the header length field.		
		16 bit pixel data
line 1, pixel 1		value of the first pixel
line 1, pixel 2		value of the second pixel
…		…

PCO recommends that all images should be saved first in the b16 or TIFF format. The advantage is to have the b16 or tiff images available all the time, having the maximum 16 bit information.
Note that not all image analysis programs can accommodate 16 bit data. The 8 bit format saves only the information displayed on the monitor screen. The 16 bit information will be lost and cannot be recovered.

pcoraw
This 16 bit PCO file format is based on the BigTIFF format, thus allowing for file size > 4GB. A new PCO proprietary compression scheme is added if necessary.

Standard File Formats

TIFF
Tag Image File Format, version 6.0 and lower. It is a 16bit monochrome and color image format.

BMP
Windows Bitmap Format, b/w or color 8 bit format images, which have been saved in BMP format can't be reloaded in Camware - only as 8 bit images, i.e. part of the original information (16 bit) is lost.

FTS
Flexible Image Transport System, Version 3.1. It is a 16 bit image format, defined by the NASA/Science Office of Standards and Technology (NOST). Some programs use the FIT extension for this format.

ASCII
16 bit format, some mathematical programs prefer ASCII data.

JPG
JPEG (named after the Joint Photographic Experts Group who created the standard) is a commonly used method of lossy compression for photographic images. The degree of compression can be adjusted, allowing a selectable tradeoff between storage size and image quality.

JP2
JPEG 2000 is a wavelet-based image compression standard and coding system. It was created by the Joint Photographic Experts Group committee in the year 2000 with the intention of superseding their original discrete cosine transform-based JPEG standard (created 1992).

AVI
Audio Video Interleave is a multimedia container format introduced by Microsoft in November 1992 as part of its Video for Windows technology.

MPG
MPEG-1, similar to JPEG, is a standard for lossy compression of video and audio developed by the Moving Picture Experts Group (MPEG).

WMV
Windows Media Video (WMV) is a compressed video format for several proprietary codecs developed by Microsoft. The original video format, known as WMV, was originally designed for Internet streaming applications, as a competitor to RealVideo.

A5 CUSTOMER SERVICE

A5.1 SERVICE

The camera is designed to operate with no need of special adjustments or periodic inspections.

A5.2 MAINTENANCE

CAUTION

UNPLUG CAMERA BEFORE CLEANING
Risk of injury due to electrical shock!
- ➔ Unplug the camera from any power supply before cleaning it.

NOTICE

CLEANING
- ➔ Use a soft, dry cloth for cleaning the camera.
- ➔ Do not clean the input window unless it is absolutely necessary.
- ➔ Be careful and avoid scratches and damage to the input window surface.
- ➔ Do not use liquid cleaners or sprays.

NOTICE

LENS CLEANING
- ➔ The lens is best cleaned with pressurized air or with liquid cleaners such as pure alcohol or with special optical cleaners that are available at premium photo stores.
- ➔ Use a cotton swab dipped in pure alcohol or optical cleaning liquid and wipe only on the glass surface.
- ➔ Do not get any cleaning liquid on the metallic parts such as the lens thread, because tiny detached particles may scratch the surface.

NOTICE

CLEANING LIQUIDS
Aggressive cleaning liquids can damage your camera.
- ➔ Never use aggressive cleaning liquids such as gasoline, acetone, spirits or nitro cleanser.
- ➔ Every time the input window is cleaned, there is the possibility of surface damage.

NOTICE

PROTECTIVE CAP
Always store the camera with the protective cap or with a lens mounted to avoid dust and dirt on the input window.

A5.3 RECYCLING

To dispose your camera, ***send it to PCO*** or take it to a local ***recycling center***.

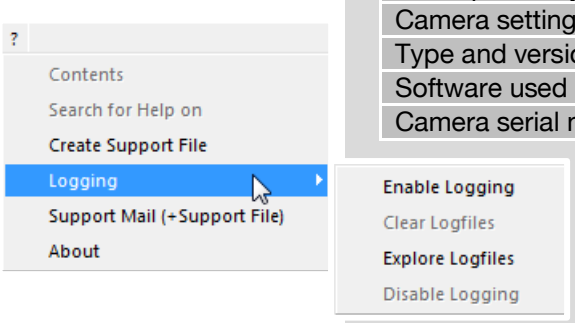
The camera includes electronic devices, which can contain materials harmful to the environment. These electronic devices must be recycled.

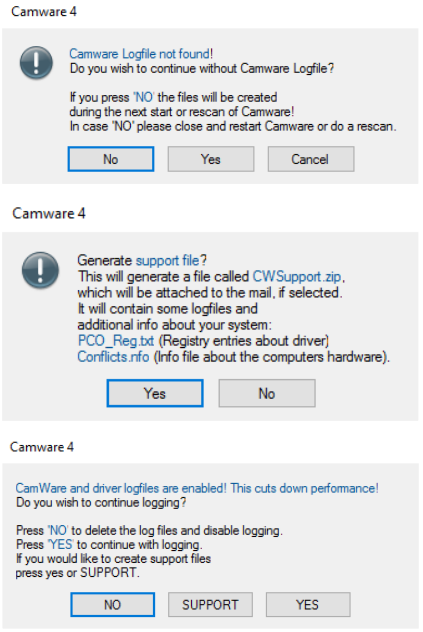
A5.4 LOGFILE / SUPPORT FILE

If you have a question, which is not adequately addressed in this manual, contact ***PCO*** or your ***local dealer.***

To speed your request up, we need following information:

Short description of the problem	Operating system (PC)
Description of your application	Processor type (PC)
Camera settings	Memory
Type and version of camera	Graphic card
Software used	Graphic card setup
Camera serial number	





How to create a logfile:

Enable log files:	? Help ***Menu*** → Logging → Enable Logfile →Camware will ask you to press ***NO*** to activate ***Logfiles*** after ***restart*** of Camware
Repeat	the workflow which produces the faults
Open the Help Menu	Click Support Mail (+ Support File) → Camware will ask you: ***Generate support file?***
Save this file	(***CWSupport.zip – don't rename it***) and send it to ***PCO Support*** (support@pco.de)
Or visit our website:	http://www.pco.de/support/ and upload the support file with our support form

Repair

Before sending the camera for ***repair***, ***first contact*** your local dealer or ***PCO*** respectively.

When shipping the camera for repair, be certain to carefully pack the camera with proper shipping materials. If possible use the original packaging. Use the protection cap to protect the camera on the lens thread.

A5.5 TROUBLE SHOOTING

Communication problems (camera is not detected)

- Take a look at the LEDs and note their state
- Disconnect and reconnect your interface (GigE, USB, CameraLink), then wait about 1 min for ***Beep*** and start Camware camera search again
- If this does not work –test another interface
  - Restart your camera by plugging off /on power supply: look at LED sequence and note their state
  - all LEDs are off for several seconds (if the break time was too short, it might be that last LED status is shown again)
  - all LEDs light up (red, green and blue)
  - green LED is blinking for several seconds, then green continuous, all other LEDs off
  - red LED means initializing failed
- Show us your log-files including extra information (any other abnormalities / camera equipped with a battery?)

Image Error (e.g. quadrant error)
Describe your error (send us a Raw B16 or TIFF screenshot)

Fan control
The pco.dimax has a fan control. After starting or restarting camera fan runs with highest rotation (noisy) and should slow down after about 30s.

GigE-Connection
After start-up or (re)connection of GigE cable or by pushing the reset-knob at the rear of the pco.dimax, the connection of the GigE interface will be reestablished.
A short beep just confirms the physical network connection, not a pco driver linkage, although an operating network connection is indispensable for the driver.
Repeating beeps signalize a defective cable, communication is interrupted (autonegotiation failed).

Firmware, Software and Driver Update

You will find all necessary software and drivers on the accompanying USB flash drive.

For the latest versions check our website:
http://www.pco.de/support/supportProducts/high-speed-cameras/

A6 INDEX

NOTE:
The mentioned page is always the starting page of a chapter!

pco.

ABOUT PCO

In 1987, PCO was founded with the objective to develop and to produce specialized fast and sensitive video camera systems, mainly for scientific applications. Meanwhile the product range of PCO cameras covers digital camera systems with high dynamic range, high resolution, high speed and low noise, which are sold in the scientific and industrial market all over the world.

Currently PCO is one of the leading manufacturers of scientific cameras. Worldwide representatives, together with our own sales department and technical support assure that PCO keeps in touch with our customers and their needs. The actual wide range of specialized camera systems is the result of technical challenge and product specific know-how. A design according to advanced techniques, a high standard of production and strict quality controls guaranty a reliable operation of the cameras. Our own developments in conjunction with an excellent contact to leading manufacturers of image sensors ensure our access to state-of-the-art CCD- and CMOS-technology for our cameras.

Since 2001, PCO is located in its own facility building in Kelheim at the shore of the beautiful and international river Danube. Here in the county Bavaria, which is well known for its excellent support and conditions for high technology companies, we share the benefits of the simple access to high performance products and services in the surrounding area.

Kelheim itself is a historical town, first documented in 866. The small city is founded at the confluence of the Danube and the Altmühl, which has been converted into the Rhine-Main-Danube bypass channel for water transport. Located in Danube-valley, it is the heart of a beautiful river and forest covered lime plateau landscape. It´s landmark, the Hall of Liberation, was built by Ludwig I. in 1863 on the Mount Michael and is visible from all over the city and valley. The beautiful Danube-Gorge, which is protected as natural monument since 1840, is located between Kelheim and the famous abbey Weltenburg.

pco.