pco.dimax

User's Manual

pco.
imaging

In this manual you find instructions for the pco.dimax CMOS high-speed camera.

Target Audience: This camera is designed for use by technicians, engineers, and scientists.

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

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

Updated February 2010 © PCO AG

Table of Contents

1   Introduction

High Speed meets High Resolution.

Features
This high speed 12 bit CMOS camera system comprises 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 system features also a variety of trigger options to cover all off-board applications that have been required by the automotive industry.

The camera's main features are:

- 1279 fps @ full resolution 2016 x 2016 pixel
- 2410 fps @ HD resolution
- 4502 fps @ 1008 x 1000 pixel

- 12 bit dynamic range
- color & monochrome image sensor versions available
- exposure time range 2 µs - 40 ms
- image memory in camera (camRAM up to 36 GB)
- double shutter operation
- GigE & USB2.0 & Cameralink data interfaces
- multiple trigger interface optimized for automotive applications
- smart battery control (1h full operation or 6h data backup)

Areas of Application

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

2 Safety Instructions

Never operate the camera in humid or dusty environments or in places with high amounts of X-ray radiation. **Humidity**, **dust** or **X-rays** could damage the camera.

To avoid the risk of water condensation, protect the camera against extreme changes of ambient temperature. If **condensation** enters the camera, there is the risk of electric shock.

To prevent damage to the camera, the system must be kept stable and protected against **strong jolts or vibrations**. The socket at the bottom of the camera is to be used for mounting purposes only.

The slits in the camera case (side & back planes) are designed for heat dissipation by the camera fan. To prevent **overheating** of the camera, do not block these slits. Do not leave the camera system in direct sunlight to avoid the risk of overheating.

Electric shock warning – Never slide any items through the **slits** into the camera because of the risk of electric shock if the voltage parts inside are touched.

Each time the camera is used, check the **power cable** for any damage.

Never position the cable in a way that it could become a **tripping hazard**.

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.

If any of the following conditions apply, immediately switch off the camera, separate it from the power line and contact our customer support:

⚠ If the power cable or the power plug seems to be worn or damaged.

⚠ If liquids have penetrated the device.

⚠ If, after thoroughly reviewing the instruction manual, the device is still not operating properly.

⚠ If the camera has been dropped or the casing is damaged.

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3   System Components

The camera system includes the following parts.

Camera Head
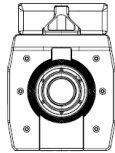
F-mount optical connection:
The distance between the front edge of the F-mount and the sensor is 46.5 mm.
For standard F-mount/SLR lenses and adapters.

LEDs indicate camera status
Recording – Status – Error

Dust Filter (exchangeable)

Input/Output BNC connectors
Trigger – Acquire – IRIG-B – Status – Sync in/out

Lemosa connectors
Automotive applications - www.lemo.com

Interface
GigE Vision – USB 2.0 – Cameralink
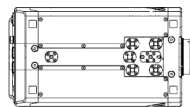
1/4-20 UNC and **3/8-16 UNC** and **M8** thread**s**
5.2 mm pinholes
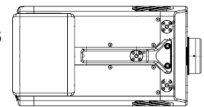
Serial Number tag

Power Supply
24V AC Desktop Power Supply with IEC14 chassis plug and XLR connector

Power Cord
Standard IEC13 connector (for Germany only)

Battery Pack (optional)
NiMH (standard), Li-Ion (upon request)

Cable
10m Patch cable RJ45 Cat6.0

Digital Camera Tools (CD-ROM)
The accompanying CD contains (see appendix A8):
• Camware: software for camera control & image acquisition
• camera driver & tools
• software development kit (SDK) and demo programs in C and C++

4   Installation

You will find all necessary files on the accompanying CD.
You may also download the newest versions of our software, camera drivers, and third party software drivers from our website (support section).

In this chapter you find the quick installation utilizing USB interface. For the more advanced GigE Vision installation and system requirements please see **appendix A3**.

Minimum computer system requirements:
- Clock speed > 1.6GHz
- RAM > 512MB
- Windows XP/ Service Pack 2 or Win2000/ Service Pack 4
- 1280 x 1024 pixel resolution display
- 32-bit-graphics card (16.7 million colors)
  recommended: CUDA-enabled GPU (see chapter 7.6)
- USB 2.0
  recommended: 1000Mbps NIC with PCI-Express (see A3-5)

4.1   USB

Please have the USB drivers and files downloaded on your computer. Connect camera with PC and start camera. The camera is ready after one beep.

4.2   Camera Driver

The first time the camera is connected via USB to the computer, Windows will notify the user that a new device has been detected. Afterwards, the typical Windows hardware drivers' installation process will begin. At this point, you are asked for the location of the corresponding PcoUSB.inf file.

Please click on the drive where the CD with the drivers has been inserted or to the directory where the installation software has been downloaded. Windows will perform any further installation and system registration automatically.

4.3   Camware

The Camware 32-bit 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 CD runs automatically (if not: please begin the installation manually by double clicking on the setup.exe file). The installation software copies all necessary DLL files into the corresponding Windows directories. While doing this, older versions of these files will be replaced, if present. All required Windows registration entries will be made automatically. After a successful installation, you will find the program file 'Digital Camera Toolbox' in your program directory. Other helpful tools are also installed in the same file (see appendix A8).

5   Quick Start

Note: In order to get familiar with your new camera & software it might be helpful, if you first aim at an object that is easy to focus and that can be seen at standard light conditions.

5.1   Preparation

- ✓   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 PC

- ✓   computer is on
- ✓   camera is on (the camera is ready after one beep)

5.2   Start

➢   start Camware
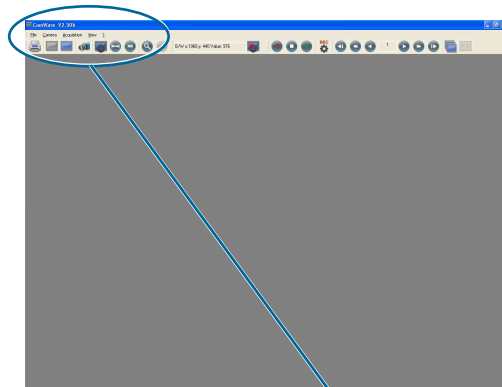
➢   open view window
     - if not already open -

➢   start "live preview"

➢   apply "auto range peak"

➢   you may adjust aperture and focus
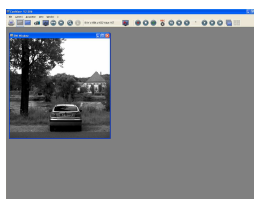
You should now clearly see the object in the window.

➢   If you need to change exposure time (e.g. the image is still either too dark or too bright), please go to chapter 6!

➢   If you want to record and save images, please see chapter 6 and chapter 7 for detailed information!

6   Camera Control for the pco.dimax

The 'Camera Control' window in Camware is the main interface for all camera settings.

For further Camware features please see chapter 7!

6.1   The "Camera Control" window

The camera control window can be opened by selecting the proper command in the "Camera"-Menu or by the corresponding button in the toolbar:

The camera control dialog always adapts to the camera type connected. For the pco.dimax the camera control settings are spread over six **property sheets** ①, which will be explained below.
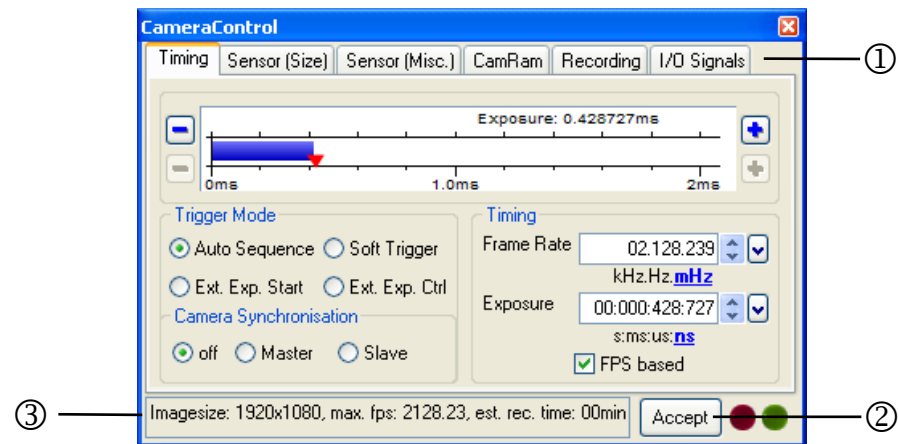
Changes to the camera control sheets must be completed by pressing the **"Accept" button** ②.

> If the "Accept" button is not pressed, these changes will be ignored and lost. If the changes are within the allowed condition limits of the camera, a message is sent to the computer, the button disappears and the green lamp will be highlighted. If an illegal change was attempted, the camera will not accept the change and the red lamp will be highlighted.

In the **information field** ③ you can view some information about the camera. Click into the info field in order to scroll through the values.
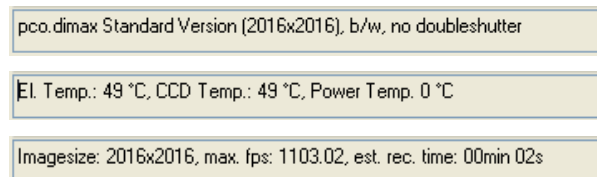
Estimated Recording Time (est. rec. time) due to selected fps, ROI, camRAM size.

6.2   The "Timing" sheet
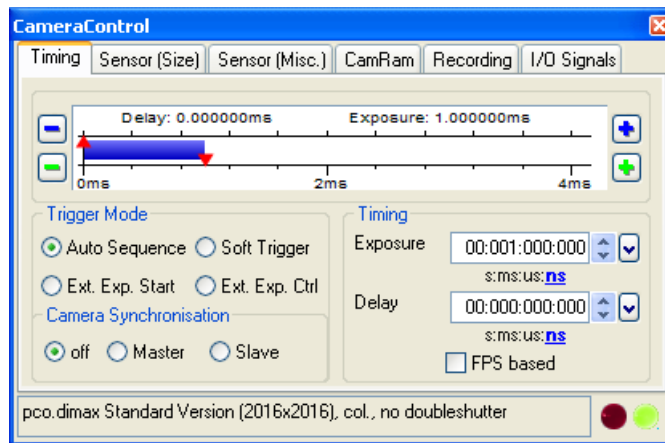
General Information

In this context **trigger** means exposure trigger, i.e. the trigger signal controls the exposure of a single image.

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

In case of short exposure times, the readout is the limiting factor:
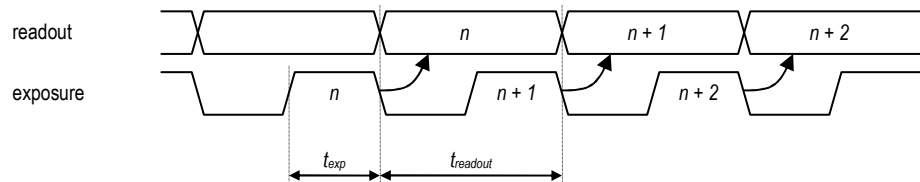
Q: What is the max possible exposure time for max speed?
A: see table

	ROI	max fps	1/fps	**max exp time**	tsys
55MHz	2016x2016	1103	907 µs	**828 µs**	79 µs
	480x480	12435	80 µs	**71 µs**	9 µs
62.5MHz	2016x2016	1279	782 µs	**713 µs**	69 µs
	480x480	14849	67 µs	**59 µs**	8 µs

For long exposure times, the exposure time is the limiting factor:
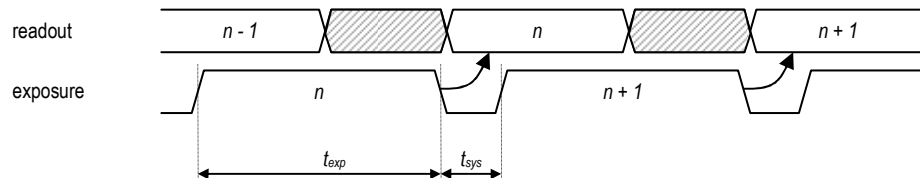
Q: What is the achievable frame rate for a given long exposure time?
A: see table

	ROI	exp time	1/exp time	**max fps**	tsys
55MHz	2016x2016	10 ms	100 fps	**99.22 fps**	79 µs
	480x480			**99.90 fps**	10 µs
62.5MHz	2016x2016	10 ms	100 fps	**99.32 fps**	68 µs
	480x480			**99.91 fps**	9 µs

Due to overhead and system times (t_{sys}) the actual max exposure time or frame rate will be shorter than expected.

For precise timing, use [External Exp. Start] or [External Exp. Ctrl] mode.

Trigger Mode

[Auto Sequence] The camera will optimize the image recording to achieve the best possible frame rate ("free running").

> In the [auto sequence] exposure control mode, the camera determines the fastest possible image uptake rate depending on the adjusted exposure time and the required readout time. After a start command is given, the sequential recording is started until a stop command is given.

[Soft Trigger] Single images can be recorded with Camware control. The single image can be acquired by pressing the "Single Trigger" button. This button appears after pressing the "Start Record" button (see chapter 7.2). Other signals cannot influence this operating mode. For test purposes only.

[External Exp. Start] The image acquisition is triggered by an external signal. It is also possible to force a software trigger for a test image with the "Single Trigger" button.

> In the [External Exp. Start] exposure control mode, single image recording is started by the falling or rising edge of the voltage signal at the BNC input (see chapter 6.7). 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.

> A new trigger is possible after $t_{readout}$ or (t_{exp} + t_{sys}) (whichever is longer) after the preceding trigger. The Busy Status signal (see chapter 6.7) indicates if a new trigger will be accepted.

exp trig (in)

Exp Stat (out)

Busy Stat (out)

acc.   ***not*** *acc.*   *accepted*   *accepted*
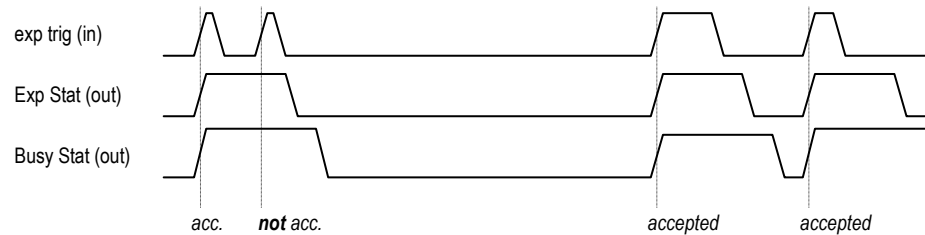
> The maximum achievable frame rate in external trigger mode is negligibly less (about 0.1%) than when operating the camera in [Auto Sequence] mode.

> Note: If the trigger rate of the external signal is quite near the maximum possible frame-rate (difference < 1/1000), then it will be random, whether or not a trigger is accepted!

> 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, then only every 3rd, every 4th etc. trigger edge will be accepted.

exp trig (in)

Exp Stat (out)

Busy Stat (out)

acc.   ***not*** *acc.*   *acc.*   ***not*** *acc.*   *acc.*   ***not*** *acc.*   *acc.*   ***not*** *acc.*

> In order to avoid trade-offs at maximum frame-rate use either the Busy Status signal (see chapter 6.7) or make sure that the external trigger rate follows this condition:

> External Trigger Rate ≤ fmax / 1.001

Imagesize: 2016x2016, max. fps: 1103.02, est. rec. time: 00min 02s

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[External Exp. Ctrl] An external signal, which is applied to the trigger input, controls the start <u>and the duration</u> of the exposure (see chapter 6.7).

In trigger mode [External Exp. Ctrl] a new exposure is started by the falling or rising edge of the voltage signal at the BNC input (see chapter 6.7). The exposure is finished when the opposite edge is detected. Thus in this mode, the start as well as the length of the exposure time can be controlled.

No further settings can be made, as the image timing is completely controlled by the exp trig signal.

There is a maximum exposure time. If the trigger pulse is longer than 20 ms, the integration will be stopped at 20 ms.

A new trigger is possible after $t_{readout}$ or (t_{exp} + t_{sys}) (whichever is longer) after the preceding trigger. The Busy Status signal (see chapter 6.7) indicates if a new trigger will be accepted.
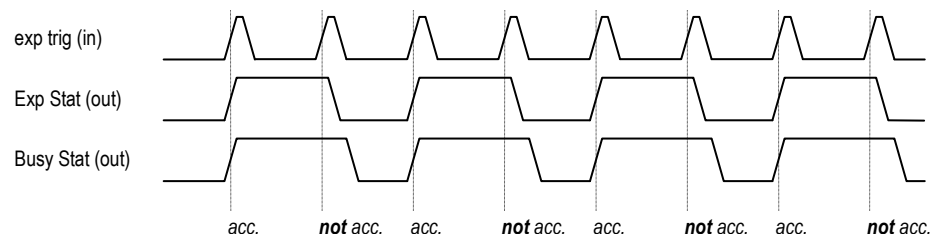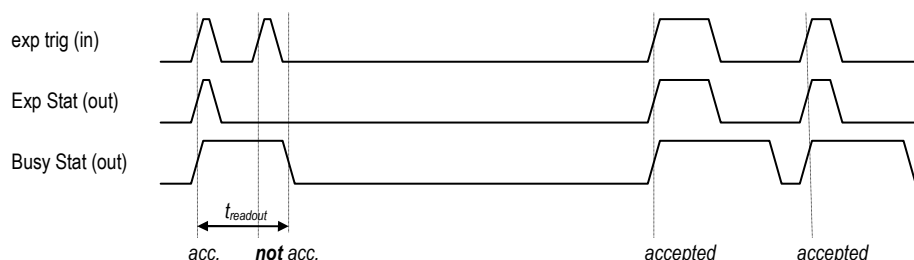

The detailed timing for external trigger includes system delay times, an adjustable additional delay time, and the jitter.

	55 MHz	62.5 MHz
trsys (rising edge)	$\left(\dfrac{W}{24}+61\right) \bullet \dfrac{1}{55\,MHz} + 100\,ns$ 2.7 µs @ full resolution 1.3 µs @ 100x100	$\left(\dfrac{W}{24}+59\right) \bullet \dfrac{1}{62.5\,MHz} + 100\,ns$ 2.4 µs @ full resolution 1.1 µs @ 100x100
tfsys (falling edge)	$\left(\dfrac{W}{24}+83\right) \bullet \dfrac{1}{55\,MHz} + 100\,ns$ 3.1 µs @ full resolution 1.7 µs @ 100x100	$\left(\dfrac{W}{24}+81\right) \bullet \dfrac{1}{62.5\,MHz} + 100\,ns$ 2.7 µs @ full resolution 1.5 µs @ 100x100
tjit (jitter)	-0 / +20 ns (max.)	-0 / +20 ns (max.)
tdelay (delay)	0 … 1 ms	0 … 1ms

W: width of selected ROI

Trigger edges occurring within (t_{delay} + 200 ns) after a preceding trigger will be ignored!

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

Delay time is not recommended for high speed applications.

Timing

Please see notes to the external trigger modes for respective timing issues.
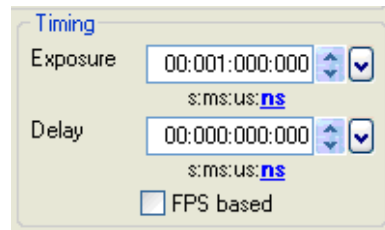
The exposure and delay time can be adjusted in steps of 1µs.

	exposure time	delay time
pco.dimax	2µs … 40ms	2µs … 1s

The slider and the up/down control refer to the blue highlighted unit s:**ms**:us:ns .

Delay time is not recommended for high speed applications.

[FPS based] The camera will optimize the image recording to achieve the selected frame rate with chosen exposure time as close as possible.
Only for [Auto Sequence] trigger mode.
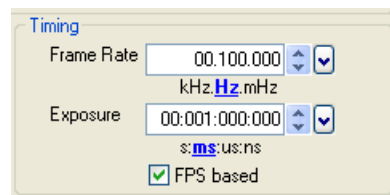
First the frame-rate is set. If the time required for readout of the image is longer than 1 / frame-rate, then the frame-rate will be reduced to 1 / t_readout.

If the selected exposure time requires a lower frame-rate, the exposure time is cut to the maximum possible time at that frame-rate.

	Frame rate	exposure time
FPS mode	0.465 …1279 Hz @ 62.5MHz 0.465 …1103 Hz @ 55MHz	2µs … 40ms

Camera Synchronisation

The Sync Mode feature eliminates the need for an external synchronization source and facilitates the operation.

> 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 such that it is ensured that 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
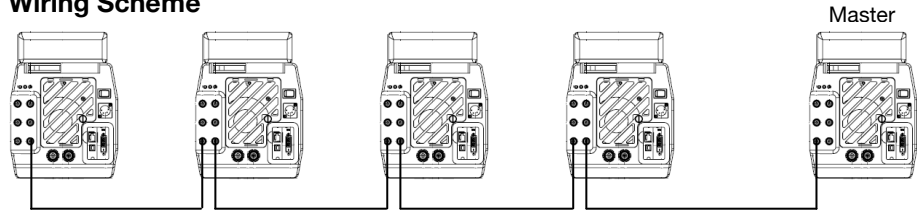
Master

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 standalone, do electrically repeat the synchronisation signal.

> A master camera ignores the signal at its Sync In port and generates a synchronisation 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 standalone camera does not participate and can be operated individually, but does not interrupt the chain.

> All cameras should have the same sensor frequency. If not, please 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 5 cameras
- synchronization delay less than 1 us (5 cameras, 100 m cable in all)
- 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 when operating the camera individually

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 all slave cameras first (record button in Camware).
  > The slave cameras do not record images but wait for the master camera to start.
- Start the master camera.
  > Now all cameras are recording images
- Stop the master camera first (Stop button in Camware).
  > The slave cameras are still in record state, but do not record. They must be stopped as well. All cameras have now recorded the same number of images.
- Images can now be read from all of the cameras.
  > This is done by using an index, where #1 is the first/earliest image. Images with the same index requested from different cameras are taken at the same time.

The sequence trigger 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 Enable mode is not possible in camera sync mode.

6.3 The "Sensor (Size)" sheet
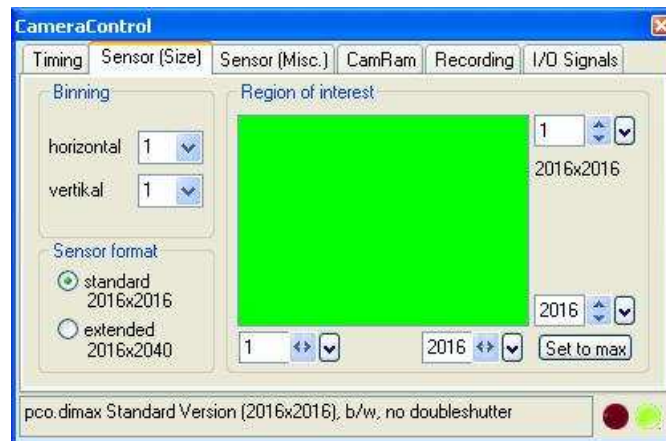
Binning

Feature not applicable for pco.dimax

Sensor Format

The implemented sensor has the option to readout a standard size (effective pixels recommended by the sensor manufacturer) or an extended size, which adds optical black pixels, which can be helpful for calibration or control purposes. In extended mode, you will not increase image size!

Region of Interest

The ROI (region of interest) selects only a part of the sensor to be read out, in order to speed up the frame rate and to save memory. Due to the sensor structure and readout electronics the selectable region is always symmetric about the center.
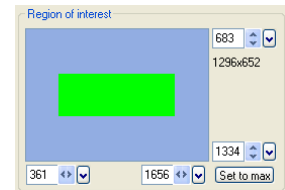
      increments horizontal: 48 pixel steps
      increments vertical: 4 pixel steps

Selection of possible ROI with corresponding storage/recording values:

resolution horizontal [pixel]	resolution vertical [pixel]	frame rate [fps]	# of images in camRAM 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	120	63 841	892 496	14.0
240	32	126 263	3 346 862	26.5
240	16	153 563	6 693 725	43.6
2016	16	73 443	796 872	10.9

Values are for estimation purposes only.

The Camware will show the actual frame rate and estimated recording time due to selected ROI and timing values in the information box:

Imagesize: 2016x2016, max. fps: 1103.02, est. rec. time: 00min 02s

6.4 The "Sensor (Misc.)" sheet
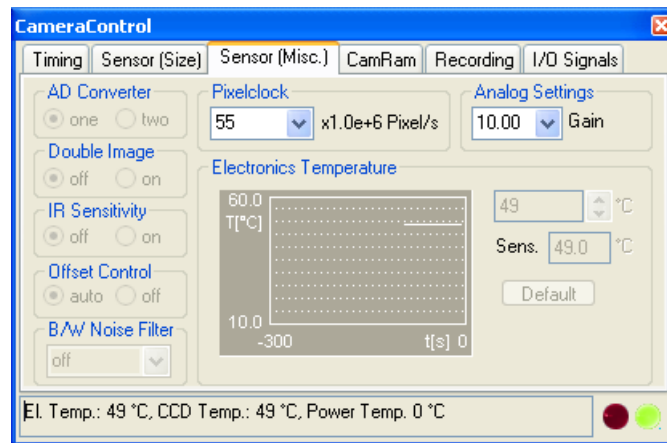
Pixelclock

The pixel clock sets the clock frequency and therefore the image sensor readout speed. In general, at higher readout speed the image quality will suffer due to higher readout noise.

	55 MHz	62.5 MHz
pco.dimax	Quality Mode	Speed Mode

AD Converter

Feature not applicable for pco.dimax

Double Image

This feature is widely used for particle image velocimetry (PIV) measurements, but not yet released for the pco.dimax.

IR Sensitivity

Feature not applicable for pco.dimax

Offset Control

Offset control is done automatically for optimal results. User control is disabled.

B/W Noise Filter

In the pco.dimax an optimal hot pixel correction is already integrated.

Conversion Factor

The conversion factor defines how many charges (electrons), which have been generated by light in the image sensor in each pixel, are necessary to generate one count (one intensity level) in the digital image. Therefore, the conversion factor describes the gain that is applied to the signal before it is converted into a digital value. The conversion is optimized for the pco.dimax @ 10 e-/count.

Electronics Temperature

Display of electronics and sensor temperature.
Active cooling by fan is implemented in the pco.dimax. There is no need for Peltier cooling. Due to digital temperature compensation and sophisticated electronic design the pco.dimax comes with ultra stable offset, where there is no need for extra black or current session references.

6.5   The "CamRam" sheet
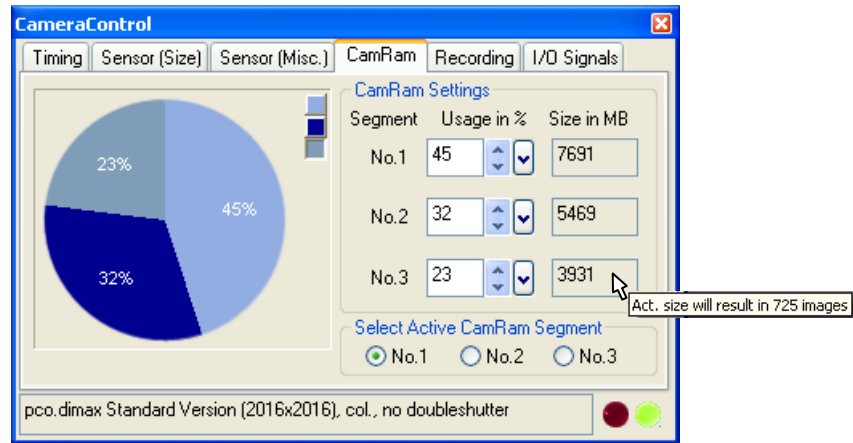
The CamRam sheet is for controlling the camera built in memory (camRAM). You have the possibility to record into 3 different segments.

Pointer over the size field will show max number of images in this segment.

		18 GB	32 GB
max number of images in CamRam (100%)	@ full resolution	3154	6324
	@ HD resolution	6182	12395

Example of single segment with 100% memory usage (18 GB):
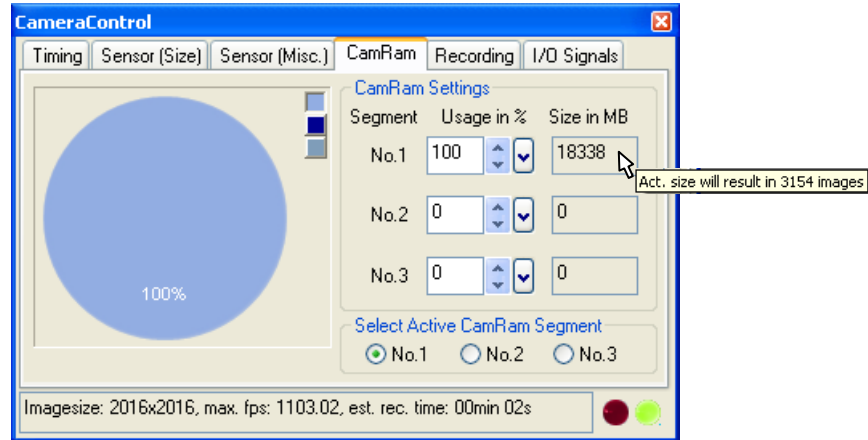
6.6   The "Recording" sheet
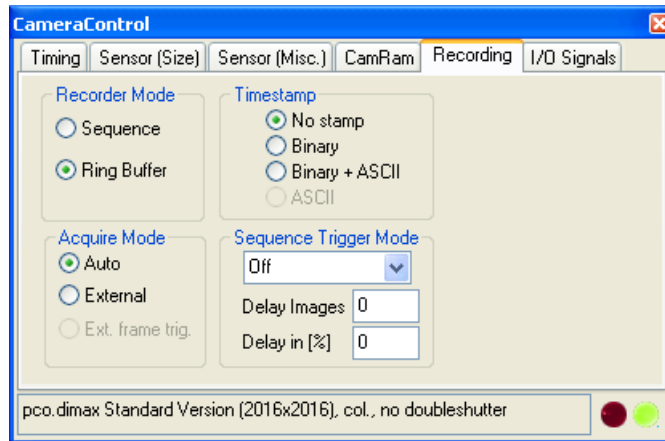
Recorder Mode

In sequence mode the camera will stop after the memory (i.e. the active camRAM segment) is completely filled. In ring buffer mode the camera will record until it is stopped, overwriting previous images.

Acquire Mode

The acquire mode gives you the ability to enable or disable the recording by an external signal. If set to **[Auto]** all images are accepted and all images taken are saved. A signal at the acq enbl input (see chapter 6.7) is ignored for this function.

If set to **[External]**, the camera will only record images, if the external signal enables recording.

> While the sensor timing scheme is not affected by the signal at the acq enbl input, the acq enbl input is sampled at the beginning of the exposure time, which can be seen at the rising edge of the exp stat input. If the acq enbl input is high (low, when inverted) at that time, the image is saved to memory. If the acq enbl input is low (high, when inverted), the image is not saved to memory (image is lost).
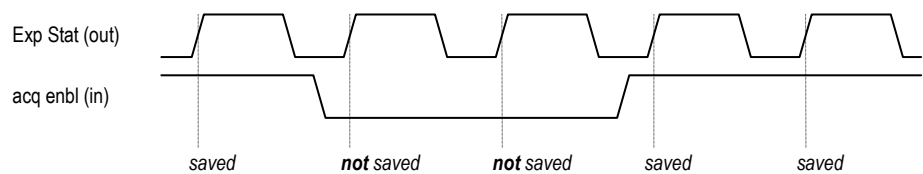
> In trigger mode [External Exp. Start], the acq enbl input works like a gate for the trigger signal. A trigger edge (rising, falling when exp trig is inverted) is accepted only when the acq enbl signal is high (low, when inverted).
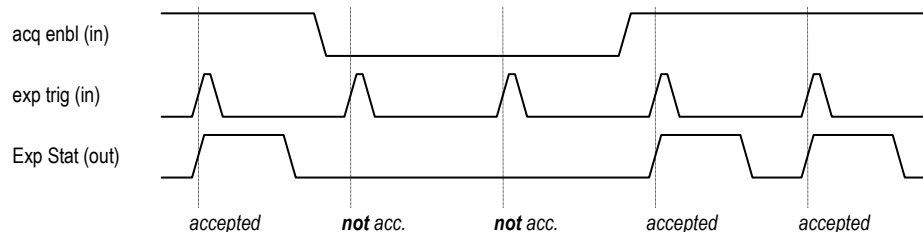
> In trigger mode [External Exp. Ctrl], the acq enbl input works very similar to the mode [External Exp. Start]. However, the acq enbl input is ignored for the edge which is closing the exposure time (started exposure will be finished accordingly).

When using acq enbl in external trigger modes, the following timing specification should be met:

tsu = 50 ns
th = 50 ns

exp trig (in)

acq enbl (in)

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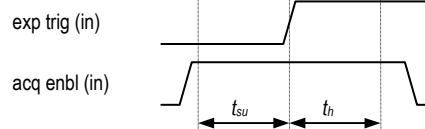
If the acq enbl signal changes within the window of tsu (set up) to th (hold), the behavior is random. The trigger may be accepted or ignored.

Sequence Trigger Mode

The Sequence Trigger enables the user to stop capturing a sequence of images via an external signal, and then the number of images to be stored after this event can be defined.

The sequence trigger function utilizes the acq enbl input port (see chapter 6.7), therefore the acquire function cannot be used, and the acquire mode has to be set to "Auto". The recorder mode should be set to "Ring Buffer", otherwise the recording may stop, when the selected RAM segment is full. For most cases, this is long before the sequence trigger occurs.

[Off] Function is not available; signal at acq enbl does not stop record.

[Software Event] Only the software command can stop the sequence.

[Ext. or Soft. Event] Both, an edge at acq enbl or a software command can stop the sequence.

acq enbl (in)

exposure

1 2 3 4 5 6 7 8 9 10

record state

Stop Event

[Delay Images] = 10
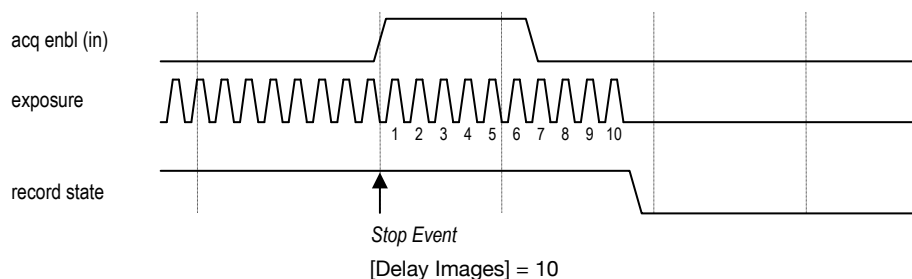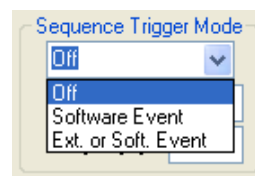
The relative position of the trigger within the recorded time window depends on the size of the RAM segment and the skip images parameters. The following figure shows one example, where the buffer size is 1000 images:

[Delay Images] = 800 (80%)

RAM 1000 images

#1   #1000

800 images

stopp event
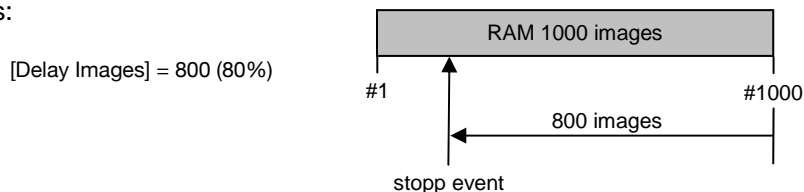
The position of the trigger is always calculated backwards from the end of the buffer. The relation is always in terms of images.

Time Stamp

A time stamp can be placed into the upper left corner of the image. Content of the image will be replaced by the text.

6.7   The "I/O Signals" Sheet
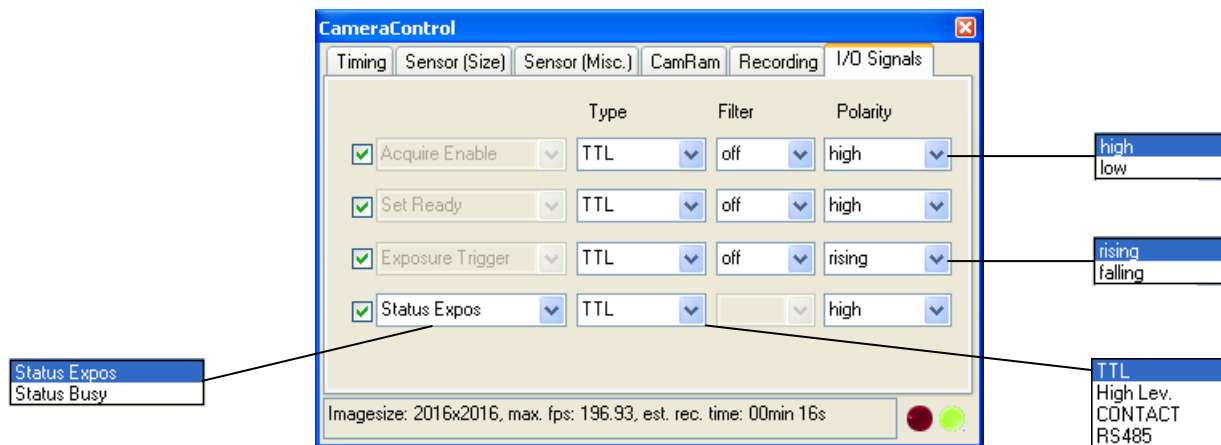
Acquire Enable

If checked, a signal for Acquire Mode or Sequence Trigger Mode (see chapter 6.6) is accepted at the acq enbl BNC input.

Set Ready

Automotive Feature (signal on Lemosa connector).

Exposure Trigger

If checked, a signal for [External Exp. Start] or [External Exp. Ctrl] trigger mode (see chapter 6.2) is accepted at the exp trig BNC input.

Status Expos / Status Busy

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 go high. As soon as busy goes low again, a new trigger edge is accepted.
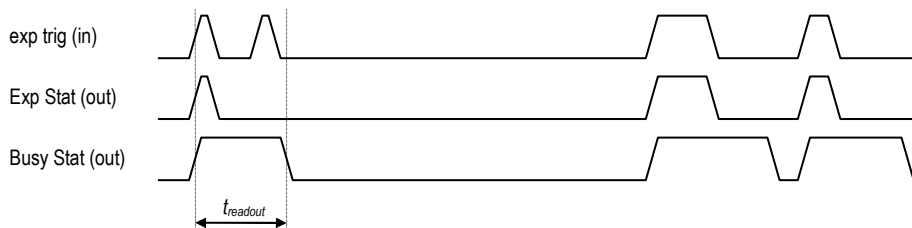
[Type] TTL:	Maximum low level: 0.8V
	Minimum high level: 2V
High Lev.:	Maximum low level: 5V
	Minimum high level: 10V
CONTACT:	Maximum switch on resistance: 100Ohms
	Minimum switch off resistance: 40kOhms
	Minimum switch voltage rating: 5VDC
	Minimum switch current rating: 1mA
RS485:	Receiver sensitivity: +-200mV
	Note: termination of 120Ohms outside camera required

[Filter] electrical interference filters

[Polarity] active for high/low signal or rising/falling edge

7   Camware Features

PCO's renowned software for camera control, image acquisition, and archiving of images in various file formats.
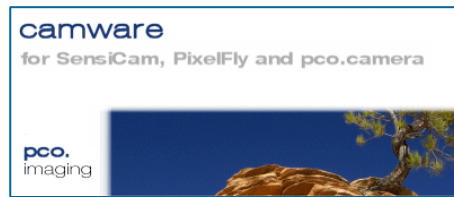
You will find an **online help** under the common Help menu.

Note: There are some features explained in the online help that are not applicable for this camera version.

7.1 If no camera is connected

When Camware is started, it automatically recognizes the camera type of the connected and running cameras.
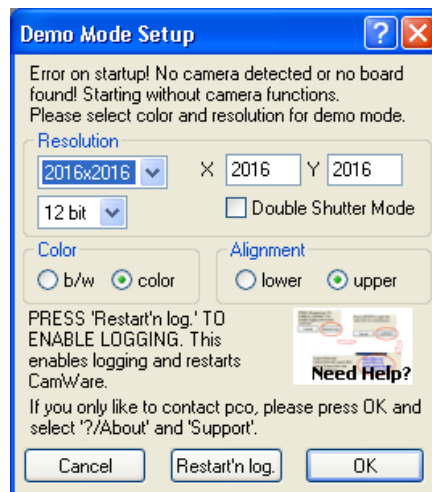
If Camware is started with no camera connected to the PC or with cameras switched off, it starts in demo mode.

In this mode all **image processing** features are available. The user only has to tell Camware which type of images will be opened. For that purpose, the "Demo Mode Setup" window opens and asks for the corresponding input.

Need Help? If this window pops up because you have trouble running the camera, please see instructions in appendix A6.

Resolution

The drop down list offers the existing image sensor spatial resolutions of all PCO camera systems. Please select the specific resolution and bit depth of the images to be opened! If double shutter images have been recorded and should be opened, "Double Shutter Mode" should be checked.

Color

With the radio buttons, the user can specify whether the image type is monochrome or color.

Alignment

These two radio buttons adjust whether MSB aligned ("upper") or LSB aligned ("lower") images have been stored (see page 24, "File Settings").

Settings to view the b16 files of the pco.dimax:

	Resolution	bit	DoubleShutter	Color	Alignment
pco.dimax	2016x2016	12	<no>	b/w	upper
pco.dimax color	2016x2016	12	<no>	color	upper

7.2 Overview

Menu Bar

  See chapter 7.3 - 7.8.

Local Menu

  The "mouse right-click" is explained in chapter 7.9.

Toolbar

	prints the currently displayed image or comment window
	opens a b/w | color display window
	opens the camera control window
	opens the convert control
	auto range peak/crop (see chapter 7.6 under "Convert Control BW")
	live preview: useful for fast and easy camera adjustment and focusing This command disables the camera control window if it is opened!
	soft trigger: records a single image (see chapter 6.2)

Cursor display

Col x:1640 y: 596 R:242 G:255 B:255	cursor: pixel position and intensity value
	continuous "auto range crop" scaling

Recorder

	record START / STOP / PLAY
	opens the recorder settings window
	replay navigation
	The 'Recorder Browser' gives an overview of the images in the recorder. A click on the desired image makes it the current image in the Black/White or Color window. 'Skip #images' allows for convenient overview at large numbers of images.
	With the "Multi Frame Window" it is possible to view all active camera images in one window. The user might select between "time" oriented or "camera number" oriented order.
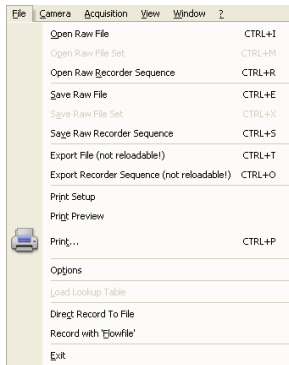
7.3 The File Menu

Open Raw File (single image only)

This command should be used to import a single image into the currently active image window. Only files with the extension and format of "*.b16" (PCO proprietary binary image format) and "*.tif" (TIFF image format) can be imported. If the recorder is enabled, each imported image will be transferred to the buffer shown in the picture number. The image itself will be fitted to the current image size. If the recorder is disabled, the current image sizes will be set to the parameters of the imported image.

Open Raw File Set (for hsfc pro camera)

This command is used to open a set of images, previously saved with the 'Save Raw File Set' command. The corresponding windows will be opened automatically. Additionally a comment window will be opened, which shows the settings of the channel and a comment. This option is not accessible in case of the recorder is switched on.

Open Recorder Sequence (image sequence from one camera)

This command is used to import a sequence of images. If more than one camera is connected and an image window is currently open, the sequence will be loaded to the active window. If no image window is open, the images will be loaded to camera #1. This command opens the "Open file" dialog box. Only files with the extension and the format of "*.b16" and "*.tif" (TIFF16) can be imported.

Save Raw File (single image only)

The "Save" command should be used to save or export the image, which is displayed in the active window. The command opens the "Save file" dialog box. The image file can be saved in "*.b16", "*.fts", "*.tif", "*.bmp" or ASCII format.

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 12 or 14bit image is reduced, if stored as bitmap.

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. With this feature it is possible to save one image of each active camera within one process step (it is not necessary to repeat the save process for each camera). The "Save" command will not be available, if there is no image window open. See 6.5 for further information!

Save Raw Set (for hsfc pro camera)

To save one image of each active camera within one single b16 file.

Save Raw Recorder (image sequence from one camera)

The "Save Recorder" command should be used to save or export image records. 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 file" dialog box. If another image format than "*.b16" or "*.tif" (16bit) is chosen, image content will be lost, and it will be impossible to reload the images. The "Save Recorder" command will not be available, if there is no image window open. See 6.5 for further information!

Export File (not reloadable!)

Use this command to export the image in the active image window. This command will open the Save file dialog box. Only files with the extensions "fts", "tif", "bmp", "asc", "jpg", and "jp2" can be exported. This item will be not visible, if there is no image window open.

Export Recorder Sequence (not reloadable!)
Use this command to export a record of images. If more than one channel is connected and an image window is currently open the record of the window which has got the input focus will be saved. If no image window is open the images of channel 1 will be saved. This command will open the Save file dialog box. Only files with the extensions "fts", "tif", "bmp", "asc", "avi", "mpg", "jpg", "jp2", and "wmv" can be exported.

If you export recorder files you will not be able to reload them into CamWare!

Print Setup
The "Print Setup" command opens the Windows "Print Setup" dialog box for adjustments and settings of the connected printer(s).

Print Preview
The "Print Preview" command opens a "Print Preview" window.

Print
Opens the Windows "Print" dialog box for the currently displayed image or comment display.

Options
This command opens the "Options" dialog, allowing special settings.

Options: File Settings
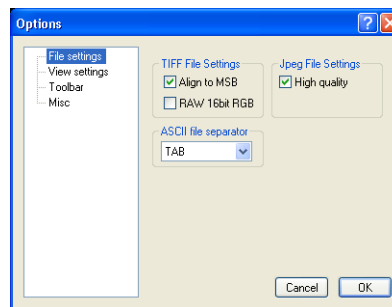
Tiff Bit Alignment
Here you can select the alignment of the pixel value. If this item is checked each pixel value is shifted from bit 12-1 to bit 16-5. This removes the 'dark image effect' inside other image applications. Check this item if you want to import Camware generated TIFF-files into other applications.

Tiff RAW
Here you can select whether the 16bit RGB tif file is saved with 16bit raw or white balanced data. If this item is checked, each 16bit RGB pixel value is saved as raw 16bit RGB (48bit) value, without white balancing. Saving to 16bit RGB can be done by selecting the color display window, export recorder, selecting 8bit-tif (yes, believe me) and checking 'Save 16bit RGB'.

ASCII file separator
Here you can select an appropriate separator for the ASCII file format.

Jpeg High Quality
Here you can select the quality of the saved jpeg/jp2 files. High quality saves images with 100% quality. Unchecking this option will create jpeg files with 85% quality.

Options: View Settings
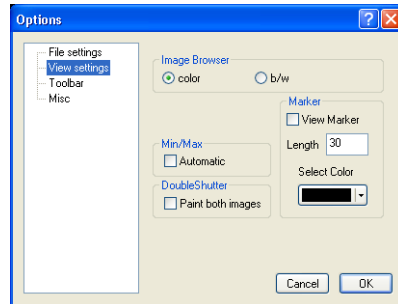
Image Browser
Here you can select between showing all image tiles inside the browser window either b/w or color. Setting b/w will result in a faster refresh. (valid only for color CCD).

Marker
Use this command to display a cross in the centre of each image.

Min/Max (Automatic) ("Continuous Auto Range Crop", see chapter 7.6 under "Convert Control BW")
This option enables the automatic min/max function during record and replay. Disable this feature if the application stops responding during this mode (due to operating system capacity problems).

Double Shutter:
This option enables the update of both double shutter images during record and replay. Disable this feature if the application stops responding during this mode (due to operating system capacity problems).

Options: Toolbar
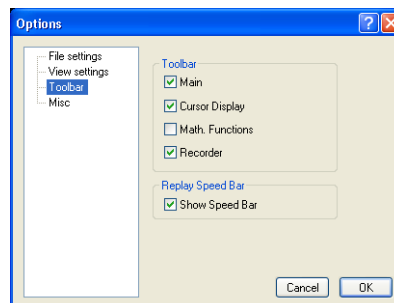
Toolbar
Opens the corresponding toolbars (see 7.2)

Math. Functions
With the math window you have the ability to build the difference between a reference image and the actual image. If you activate math every new image acquired will be subtracted from the reference image or vice versa.

 last acquired image will be copied to reference buffer

 a reference picture will be acquired and copied to reference buffer

 add offset here to avoid negative values, which would not be visible

 enable / disable math function

Replay Speed Bar
The faster replay speed is useful if large sets of image data need to be scanned.

Options: Misc
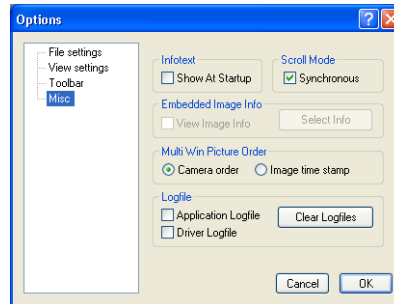
Infotext
Use this command to show or hide the start-up information dialog box.

Synchronous Scrolling
If this item is checked all opened image windows will be scrolled at the same time and in the same manner.

View Embedded Image Info (for pixelfly and sensicam models)
If this item is checked an embedded text will be shown inside the image. See chapter 7.6.

Multi Win Picture Order
With the 'Multi Window' you have the ability to view the images of all active cameras in one window. You can select between 'time' oriented or 'camera number' oriented order. 'Time' oriented means that the sequence of images depends on the individual time stamp of each image. 'Camera number' oriented means that the first image shown is from camera 1, then camera 2 and so on.

Logfile
This option enables the logging of errors and system info. Enable this feature in order to create a support file, which can help to find out troubles with the cameras (see A6 "Customer Service and Trouble Shooting").

Load lookup Table (for monochrome cameras)
With the Pseudo LUT feature you can load any LUT with one of four different formats and you can view the result in the color view window.

Use one of the attached predefined LUTs or define your own.

Direct Record To File (not recommended for high-speed)
Use this command to record images directly onto hard disk. This command will open the "Save File" dialog box. Set the number of images to store to disk. If the camera captures images faster than the computer can save to disk, then you will loose images. The displaying of the images doesn't interfere with the record process. A rate of 4-5 frames per second (fps) is typical.

Record with 'Flowfile' (for pixelfly and sensicam models)

Exit
This command 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.
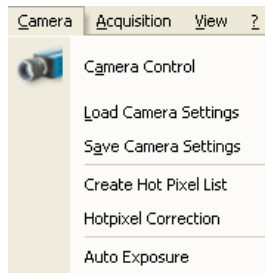
7.4 The Camera Menu

Camera Control
Use this command to open the camera control window (see 6.1).

Load Camera Settings
With this command you can reload camera settings which have been previously saved. You can reload only a file which has been made with the same camera configuration as it was found by the application at start-up.

Save Camera Settings
This command saves the actual camera settings of all existing cameras.

Create Hot Pixel List (for long exposure only)
Use this command to create a 'Hotpixel-File'. Some pixels tend to become very bright during a long exposure. These pixels are called hot pixel. To remove hot pixels from the image you have to create a hot pixel file first. If you have already a hot pixel file you only have to enable hot pixel correction. The new value of the hot pixel will be calculated from the values of the neighbour pixels. You only can create a hot pixel-file if the last exposure was longer than 5s.

This command will open the hot pixel dialog. You have to type in the desired count of hot pixels first. Then press the 'Get Hotpixel' button. After this the hot pixel list will be created, using the last acquired image.
Now you have the possibility to save the hot pixel list for later use. All list box items with a checkmark will be saved to the hot pixel file. You can select or deselect a group of items by highlighting a group and pressing the checkmark in front of one of the highlighted items. Additionally you can open a local menu inside the list box by pressing the right mouse button. You can verify your selection by scrolling through the list and by a comparison to the average value shown in the dialog.
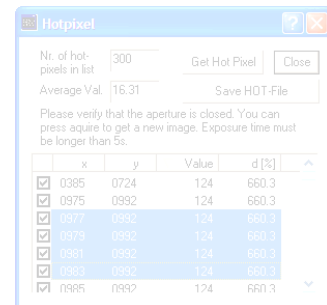
Hotpixel Correction (for long exposure only)
You can enable or disable the hot pixel correction. If hot pixel correction is disabled, a file dialog will be opened, in which you have to select the correct hot pixel file for the corresponding camera. If you have more than one camera connected you have to select the correct camera number first. If hot pixel correction is enabled this feature will be switched off.

Auto Exposure
Starts some exposures and tries to find an exposure time that captures images with grey values between 1400 and 1500. It re-adjusts the lookup tables in order to display the images with the new settings best.

In case the software is not able to calculate an appropriate setting, this message will be displayed.

7.5 The Acquisition Menu

Live Preview
The 'Live Preview' is useful 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
Records single images in case of pixelfly and sensicam cameras.

Acquire Sequence
Starts recording images into the system memory according to Trigger Mode selection (see 6.2). During the recording, the camera controls are locked.

Rec. Memory Settings
(for pixelfly and sensicam models)

Recorder Settings
This command opens the Recorder Settings dialog window.

The **Play Settings** are referred to the camera. If more than one camera is connected, the camera number is retrieved from the image window that has received the input focus (is active). If no image window is opened, the dialog is referred to camera 1. If the 'Set to all' checkbox is checked the settings apply to all connected cameras.
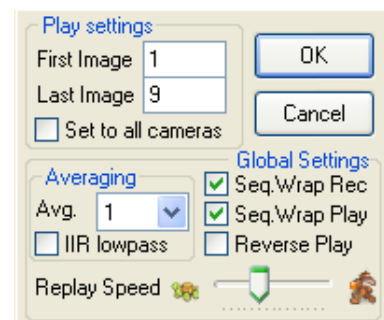
The **Global Settings** are valid for all connected cameras.

Averaging
If in the "Avg." dropdown list a value not equal to 1 is selected, the corresponding number of images is averaged in the buffer, reducing the statistically independent noise.
Another option to reduce the noise is the activation of the "IIR lowpass" IIR-filter: Image(act) = Image(act - 1) * 0.5 + Image(new) * 0.5

Replay Speed Slider
The slider can be used to adjust the sequence replay speed, from slow (turtle) to fast (rabbit).

Seq. Wrap Rec
Sequential Wrap Recording sets Recorder Mode (6.6) to "Ring Buffer".

Seq. Wrap Play
The play button starts the display for a sequence as defined by the first image/last image fields and will loop until the stop button is pressed.

Reverse Play
If the "Reverse Play" box is checked, it is possible to play the recorded images in reverse.

7.6 The View Menu

B/W Window
Use this command to open a b/w display window.

Color Window
Use this command to open a color display window.

Convert Control BW
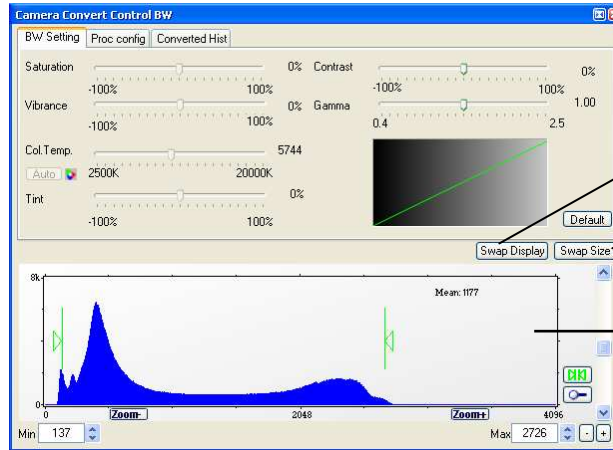
The user can influence how the 10 (12,14) bit intensity values (x-axis) of the original image are converted into 8 bit values (y-axis) in different ways.

Green sliders in histogram
- 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. See the small graph, which reflects the calculation.
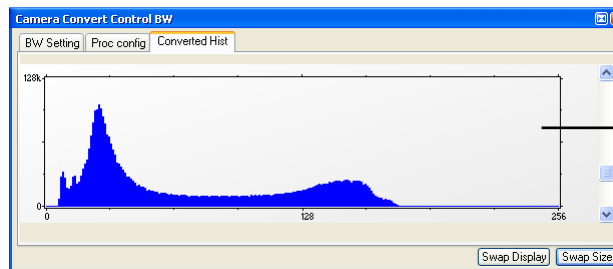
How the Auto Range applies:

Auto Range Peak searches for the minimum and maximum 12 (10,14) bit intensity values of the image. Given these number 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.

Min/Max (Automatic) = Continuous Auto Range Crop

'Proc config' sheet: please see under 'Convert Control Color'

Convert Control Color
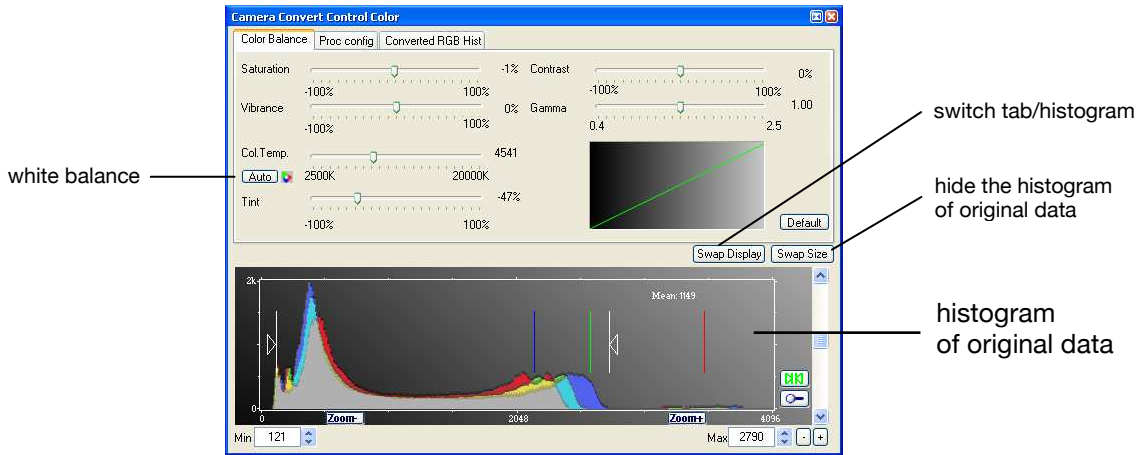
switch tab/histogram

white balance

hide the histogram
of original data

histogram
of original data

The user can influence how the 10 (12,14) bit intensity values (x-axis) of the original image are converted into 8 bit values (y-axis) in different ways.

White sliders in histogram
- 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, which reflects the calculation.

histogram
of converted data
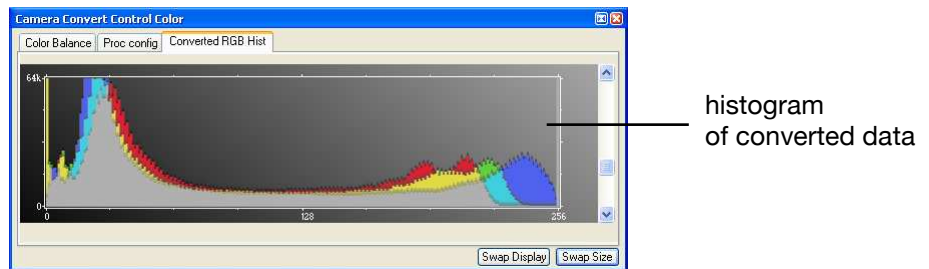
The balancing of RGB can be controlled by Col.Temp and Tint.
Press the Auto button to set the white balance.

Intensity of single color can be controlled by Saturation and Vibrance.

'non local means' algorithm

switch on
in order to significantly
reduce processing time

adaptive
to brightness and patterns

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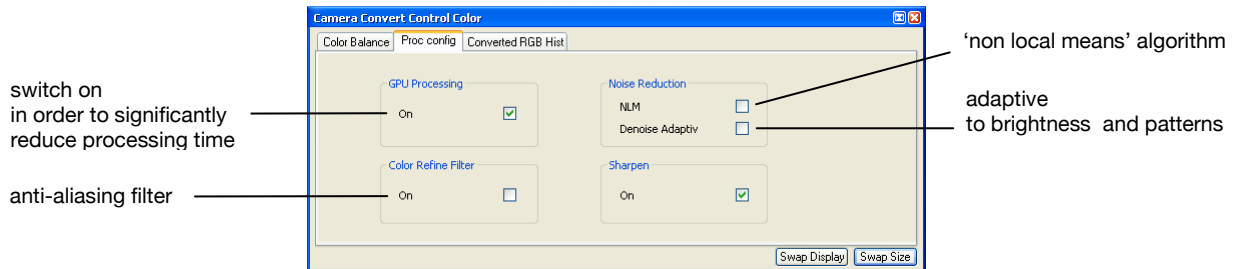
Due to proprietary high-end algorithms used for these image processing features, no detailed description is given here.

Try it and see how the fine details will improve!

GPU Processing

In order to benefit from all of Camware's advanced processing features, we highly recommend a NVIDIA CUDA-enabled graphics processing unit (GPU), e.g. NVIDIA GeForce 9600 GT or better.

Find a list of CUDA-enabled products here:
http://www.nvidia.com/object/cuda_learn_products.html
Get the CUDA driver here:
http://www.nvidia.com/object/cuda_get.html

Make sure:
- that the CUDA driver is successfully installed.
- that the GPU has at least 512MB memory.

Notebook users should look for workstation models, e.g.
- HP HDX X18-1300 Premium Notebook PC
- HP EliteBook 8730w Mobile Workstation
- Lenovo ThinkPad W700 series
- Sony VAIO VGN-AW series
- Dell Precision M6400 series
- Samsung P560-Pro P8600 Primo

Camware Image Processing

	color	monochrome
Pre Processing		
Noise Reduction	✓	✓
Bayer Processing		
Bayer Demosaicing	✓	
Sharpen	✓	
Refine Process	✓	
Chroma Blurr	✓	
Post Processing		
Offset, Gain (Min/Max)	✓	✓
Color Correction	✓	
Saturation, Vibrance	✓	
Color Temperature, Tint, White Balance	✓	
Gamma, Contrast	✓	✓

Browser

The 'Recorder Browser' gives an overview of the images in the Recorder, and helps you in an easy way to select a new current image. Simply click on the desired image to make it the current image. It may then be viewed in the Black/White and Color Window.
The Browser window can show up to 40 pictures per page, thus enabling easy printing of the Browser window. You can switch between the single pages by double clicking inside the Browser window or with the local menu (right mouse button).
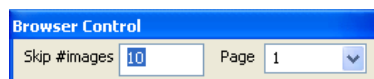
'Skip #images' allows for convenient overview at large numbers of images.

Multi Window

View the images of all active cameras in consecutive order in one window. 'Time' oriented means that the sequence of images depends on the individual time stamp of each image. 'Camera number' oriented means that the first image shown is from camera 1, then camera 2 and so on.

Embedded Image Info (only for pixelfly and sensicam models)
see Timestamp feature in chapter 6.6
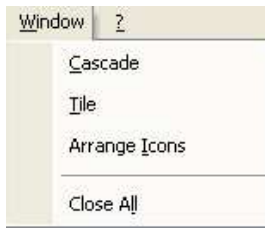
7.7 The Window Menu

Cascade
Show all windows overlapped.

Tile
Tile windows vertically or horizontally.

Arrange Icons
Rearranges all minimized topic icons on the desktop.

Close All
Close all windows.
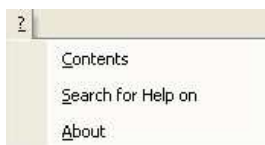
7.8 The Help Menu

Contents
Opens the main page of the online program help.

Search for Help on
Opens an index list for help.

About
This window shows program information and contains helpful support links. In case of a camera problem, support files (see 7.3 Options/Misc/Logfile) may be generated, which can be automatically attached to the email. The support files contain relevant hardware information, the log files and the PCO related registry entries. These files are moved into a zip-archive called "CWSupport.zip", which can be found in the application folder.

Camera Control	
Convert Control BW	
Convert Control Color	
Zoom +	+ Key
Zoom -	- Key
Zoom	▸
Auto Range Peak	
Auto Range Crop	
Auto Balance Color	
Auto Exposure	
Flip	
Mirror	
Rotate Left (90°)	
Rotate Right (90°)	
Line Tool	
Copy To Clipboard	
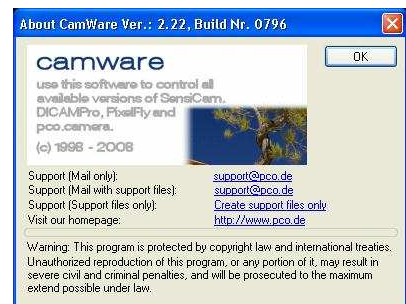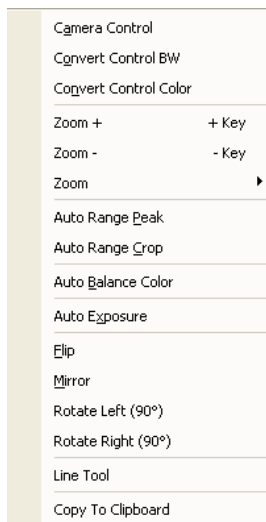
7.9 The Local Menu

The local menu is opened by clicking the right mouse button inside the client area of an image window.

Camera Control
Opens the Camera Control window (see chapter 6).

Convert Control BW/Color
Opens the corresponding Convert Control windows (see 7.6).

Zoom
Changes the zoom used to display the image.

Auto Range Peak/Crop
Displays the image in a predefined scaling (see 7.6).

Auto Balance Color
The white balance feature, which corresponds to the white balance button in the 'Convert Control Color' (see 7.6).

Auto Exposure
Auto Exposure feature (see 7.4)

Flip
The image will be flipped before display.

Mirror
The selected the image will be mirrored before display.

Rotate
The image will be rotated by 90° clockwise (right) or counterclockwise (left) before it is shown in the image window.

Line Tool
Select 'Line Tool' to show a graph, which shows the intensity of the pixels under the red line shown in the image window. The selection of this menu item determines the location of the first point. After this you can move the mouse to the second point, which can be selected by a 'left click'. Now a 'Line Diagram' opens and the length of the line (unit: pixel) is shown in a bubble and displayed in the window.
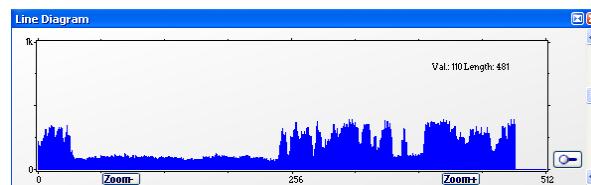
Copy To Clipboard
Copies the active image to clipboard.

7.10   Additional Features

Setting Contrast Area by Mouse

You can control the minimum and maximum values used for the conversion from 12 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 increasing the size of the rubber band window with mouse moves. After releasing of the mouse button the coordinates of the rubber band window act as a border for calculating the minimum and maximum values.

Setting a new ROI by Mouse

In the same manner you can setup a new region of interest (see ROI in Camera control) for the camera. You only have to press the CTRL (Strg) button instead of the shift button. The coordinates of the rubber band window are used for calculating a new region of interest. You can reset the ROI to maximum by pressing the CTRL (Strg) button and the right mouse button.

White Balance by Mouse

In the same manner you can change the 'white balance'. You only have to press the CTRL (Strg) and the shift button at the same time. The pixel values within the coordinates of the rubber band window 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 7.6) or the 'Auto Balance Color' in the Local Menu (see 7.9) respectively.

Time Elapse Window

If an image is recorded in soft trigger mode with an exposure time longer than 5s, a time elapse window will appear to show the remaining time of the current exposure.

Appendix

A1   Technical Data

	unit	setpoint	pco.dimax
resolution (hor x ver)	pixel		2016 x 2016
pixel size (hor x ver)	µm²		11 x 11
sensor format	mm²		22.18 x 22.18
sensor diagonal	mm		31.36
quantum efficiency	%	@ 600 nm	50
full well capacity	e⁻		39 000
dark current	e⁻/pixel · s		530
image sensor			proprietary
dynamic range	dB	camera system	65.8
dynamic range A/D	bit		12
read out noise	e⁻rms	@ 62.5 MHz	< 20
imaging frequency (frame rate)	fps	@ full frame @ HD (1920x1080) @ 1008 x 1000	1279 2470 4502
pixel scan rate	MHz		62.5 / 55
pixel data rate	GByte/s	@ 62.5 MHz	9
A/D conversion factor	e⁻/ count		9
spectral range	nm		290 … 1100
exposure time	s		2 µs … 40 ms
anti-blooming factor			no blooming
smear	%		no smear
optical input			F-mount
trigger, auxiliary signals		internal / external	software / TTL
binning (hor x ver)			-
power supply	VAC		90 … 260 V
power consumption	W	max.	80
mechanical dimensions (w x h x l)	mm³		170 x 185 x 290
weight	kg		7
ambient temperature	°C	range	+5 … +40
operating humidity	%	range	10 … 90
storage temperature	°C	range	-20 … +70
data interface			GigE Vision USB 2.0 Cameralink
CE certified			yes

Subject to change, please refer to current data sheet.
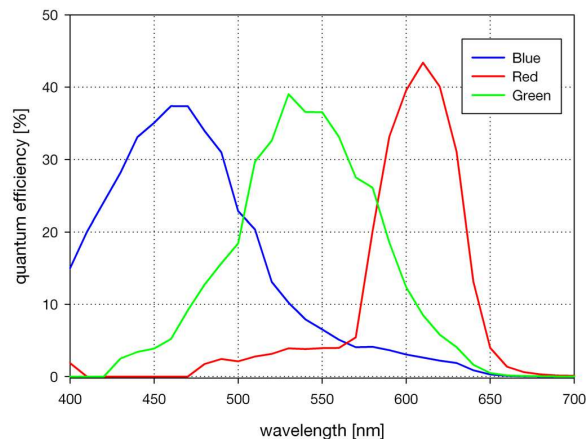
A2   Mechanical Dimensions

Please contact PCO for high resolution file.
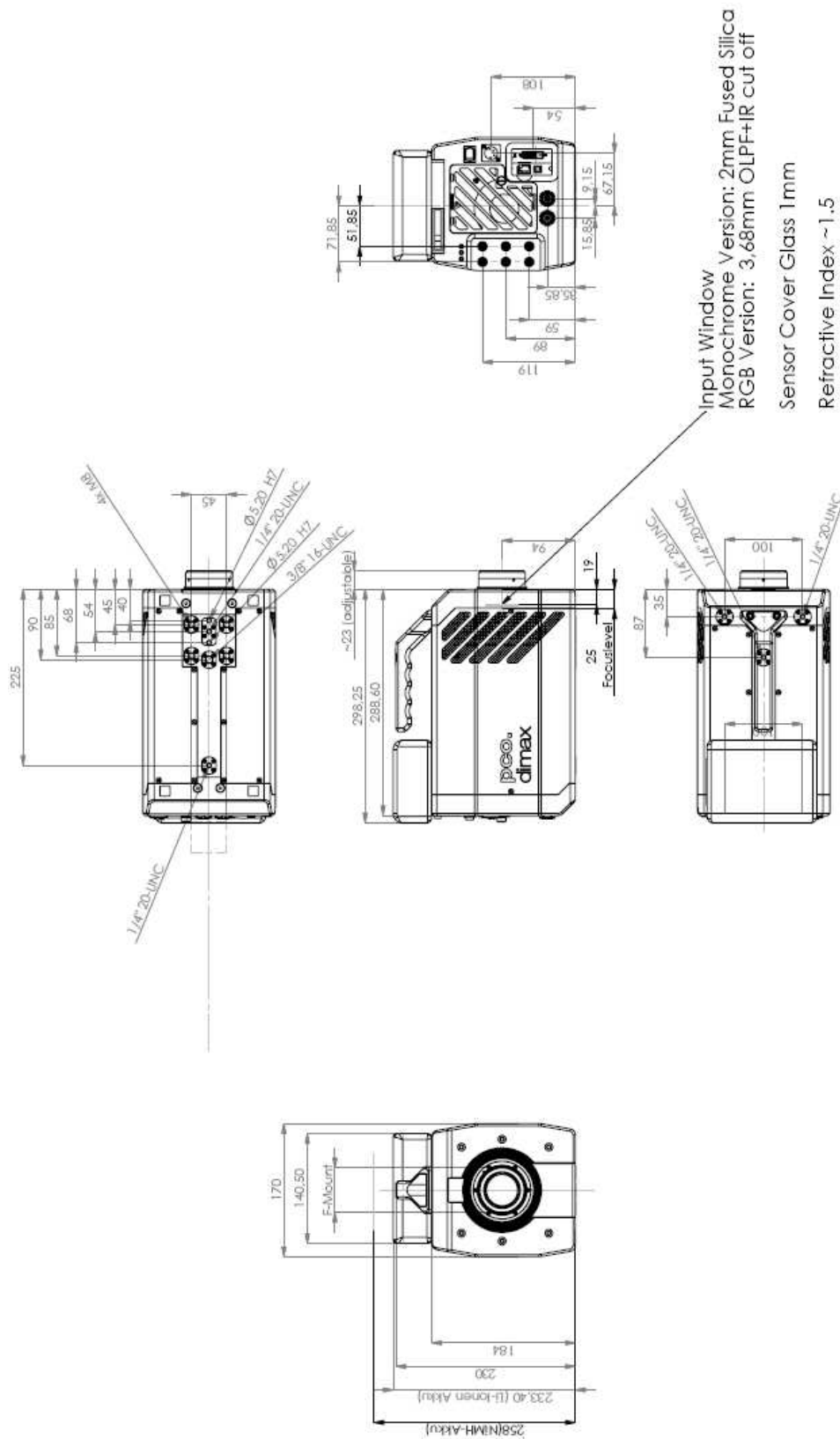
A3   GigE Vision Installation and System Requirements

GigE Vision® is an interface standard for high-performance industrial cameras. It has been developed by a group of about 50 companies. GigE Vision 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

- Camware 3.01 (check PCO website for latest version)
- GigE driver V1.04 (check PCO website for latest version)
- the complete network must be GigE compliant (see chapter 1.3)
- Cat5e or higher patch cable
- deactivated virus protection

A3-0   Quick Installation Guide

Please follow the steps in this order. Additional information can be found in the respective subchapters (e.g. chapter A3-1 for GigE card).

Install GigE card (NIC)

[1.1]

Install GigE driver

setup.exe: automatic installation
please follow instructions

[1.2]

Start PCO GigE Calibration Tool
and calibrate the camera

[1.4]

Deactivate (uncheck) the GigE driver at
each NIC that will not physically be
connected to your camera!

[1.2]

Make sure that just the service
"pco.camera with GigE" and the protocol
"Internet protocol (TCP/IP)" are activated
for each NIC used for PCO cameras!

Make sure the descriptors of your NIC
are set to its maximum!

[1.1]

Start Camware

A3-1   GigE Network Interface Card (NIC)

A gigabit network interface card (NIC) is attached to your computer and ready to use. Ideally it is a PCI-Express NIC to bring out the best data throughput, e.g. **Intel Pro/1000 Pt with Intel 82572GI chipset**.

Note: It is absolutely essential that the NIC is Gigabit compatible. Such cards should be designated with a maximum data throughput of 1000 Mbps. Furthermore it is important to know which kind of PCI interface the NIC uses. The PCI-Express interface allows a faster and more stable data transfer than ordinary PCI interfaces. Finally, the NICs vary in the used chipset. Strongly recommended are chipsets from Intel.

There are different ways to connect one or several PCO GigE cameras to a computer. Only some of them are introduced here:

One camera system:
- Point to Point connection:
  NIC and camera are connected via a patch cable directly. Before you turn on the camera set the **NIC IP address** **to 192.168.144.10** manually. Otherwise the connection between NIC and camera will not succeed, because both, camera and NIC, have to be located to the same subnet. The PCO GigE camera is set to the persistent IP address 192.168.144.200 by default, if no DHCP server is available. Use the tool "PCO GigE Configuration Tool" to change the persistent IP address (see chapter 1.4). The camera has to be reset, if the persistent IP address was changed.

Several cameras:
- Via a switch without a DHCP Server:
  Camera and NIC IP addresses have to be set manually.
- Via a switch with DHCP Server:
  NIC and cameras obtain the IP addresses automatically by a DHCP-Server.
- Via several NIC's at one PC:
  Camera and NIC IP addresses have to be set manually. Each camera-NIC pair needs a separate network/subnet.

Camera1 IP:
192.168.144.200
Sub: 255.255.255.0

Camera2 IP:
192.168.145.200
Sub: 255.255.255.0

Camera3 IP:
192.168.146.200
Sub: 255.255.255.0

NIC1 IP: 192.168.144.10
Subnet: 255.255.255.0

NIC2 IP: 192.168.145.10
Subnet: 255.255.255.0

NIC3 IP: 192.168.146.10
Subnet: 255.255.255.0
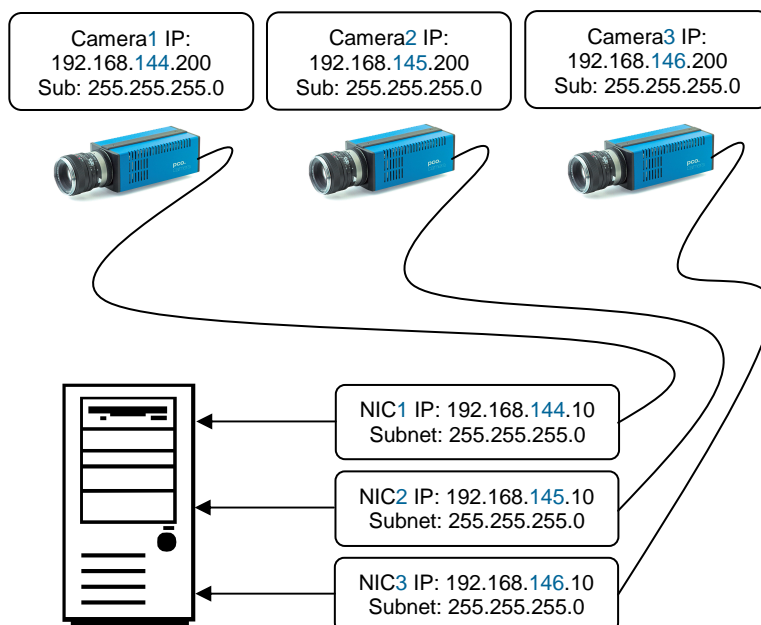
For some NIC you have the opportunity to set parameters manually affecting the stability of the data transfer. The most important one is called **Number of Descriptors**. Set the value of this parameter to its maximum. To do so open the windows device manager and right-click on the NIC, that is connected with your camera, and select Configuration under Properties. Set "Receive- and Transfer-Descriptors" to its **maximum size**.

This step is individual for each NIC. For instance, the descriptors of the Intel PRO/1000 Pt are set with its "Performance-Options" dialog. Its maximum size is 2048.

A3-2 PCO GigE Intermediate Driver

Automatic Installing
Open the GigE Driver Install Shield calling the "setup.exe". Please follow the instructions shown by the dialog-window.
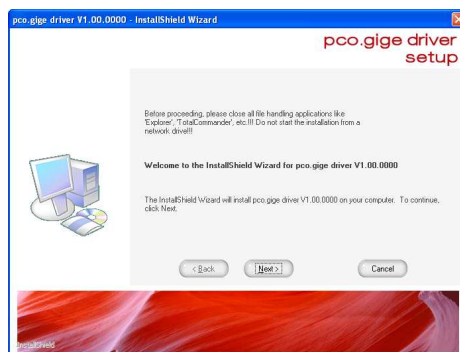
How to uninstall:
- open the file "GigE_Uninstall.exe"
  Start->Programs->Digital Camera Tools->pco.gige->UnInstall pco.gige
- or call the GigE Driver InstallShield ("setup.exe") and follow the "Remove" instructions

Activating/Deactivating
The checkbox next to "pco.camera with GigE" is checked for activating and unchecked for deactivating.
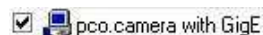
Note: It is absolutely essential that the PCO GigE driver is only activated at the specific NIC that is physically connected to your camera! In addition, just the service "pco.camera with GigE" and the "Internet protocol (TCP/IP)" should be activated for each NIC used for PCO cameras:

Appendix

A3-3   Network Environment/Patch Cable

A correct configuration of the network is important for the throughput of the image data which could be brought out. It is mandatory that any component used for the network connection between camera and computer is compatible with a data throughput of 1000Mbps. 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 throughput of 1000Mbps.

Virus protection needs to be **inactive** or uninstalled.

A3-4   PCO GigE Calibration Tool

Use this tool each time you connect a PCO camera to another NIC!

The PCO GigE Calibration Tool is part of the PCO software package and is started automatically during the PCO GigE Driver installation or can be opened by double-click on GigECalib.exe .

Start->Programs->Digital Camera Tools->pco.gige->Calib Tool

The purpose of this software is
* to set network parameter (Packet-Delay-Time, Max-Speed-Mode),
* to change the persistent IP of the camera (see chapter 1.1),
* to find out which PCO GigE cameras are currently online,
* to check, if the network is configured correctly.
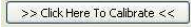
How does it work?
First of all the camera is set to default. After that images of the PCO camera are requested with a delay of 80µs between each UDP image packet. If the image could be transferred (no lost packets), the delay is decreased and again images are requested. This procedure will be repeated until a packet-delay is found at which images can be transferred without loosing packets or until the delay value is 0µs. If the image transfer succeeded at a delay of 0 µs, this transfer will be repeated at "Max-Speed-Modus". If the image transfer is successful, "Max-Speed-Modus" will be activated.

After the camera was successfully tested a respective message appears and you are asked to quit the program.

If the PCO GigE Calibration Tool is opened it is connected to each detected camera and will not allow any other program to open them.
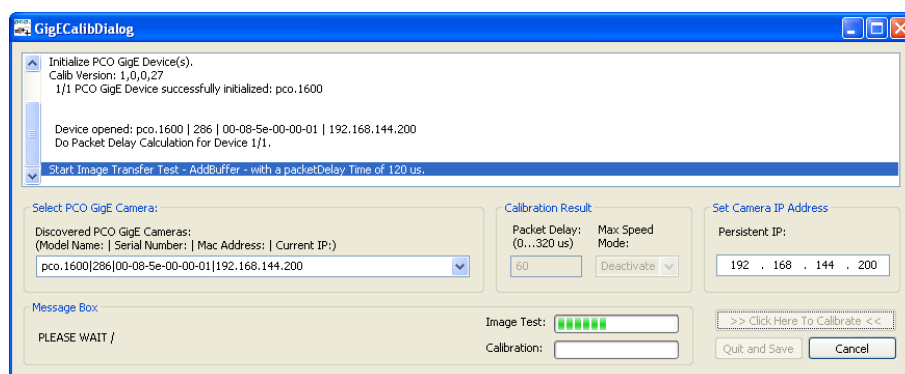
[>> Click Here To Calibrate <<]	start calibration for selected camera (new calculation)
Image Test: ▮▮▮▮▮▮	progress of current image transfer test
Calibration: [ ]	total progress of calibration
[Quit and Save]	quit program and save parameters to the Windows registry
[Cancel]	quit program without saving parameters

Configuration Parameter

These parameters are necessary to set up the communication between PCO GigE Cameras and a computer. It is recommended to always use the "PCO GigE Calibration Tool" to set the GigE Configuration Parameters. If the configuration succeeded, the parameters are saved to the windows registry. If the configuration fails or the "PCO GigE Calibration Tool" is not used default parameter values are set and the image transfer via GigE does not work with maximum performance!

„Packet Delay":
The delay between two UDP packets sent from a PCO GigE device to a computer. Values from 0µs to 320µs are possible.

‚Max Speed Mode":
With this mode a maximum data throughput up to 100 MB/s is possible.

A3-5   Performance with minimum/recommended configuration

The following tables give two example configurations, minimum and recommended. The specified values are only valid for these configurations and should act as an orientation.

Setup

	minimum	recommended
NIC	1000Mbps NIC with standard PCI interface (e.g. Intel Pro/1000 Gt with Intel 82541PI chipset)	1000Mbps NIC with PCI-Express interface (e.g. Intel Pro/1000 Pt with Intel 82572GI chipset)
NIC configuration	-	number of descriptors are set to its maximum
network connection	directly or via switch (e.g. NetGear GS 605)	directly or via switch (e.g. NetGear GS 605)
Patch cable	Cat5e	Cat5e or higher
additional network components	switch, hub, router are compatible to 1000Mbps	switch, hub, router are compatible to 1000Mbps
network environment	-	virus protection inactive
driver	PCO GigE driver installed	PCO GigE driver installed
packet delay /max speed mode	20µs / off	0 µs / on
computer	AMD Athlon 64 X2 Dual Core Processor 4600+; 2.4GHz; 2GB RAM	AMD Athlon 64 X2 Dual Core Processor 4600+; 2.4GHz; 2GB RAM

Performance

	pco.1200hs	pco.1600	pco.2000	pco.4000	pco.dimax
fps at full resolution	15.7 [1] 29.5 [2]	10.7 21.7	5.0 11.5	2.0 4.7	5.2 11.4
Ø net data throughput [MB/s]	41.3 77.3	41.0 83.4	42.1 96.5	42.6 100.7	42.2 88.7
Ø CPU load	8.3 15.6	8.1 14.6	7.6 16.9	7.7 17.3	7.8 15.6

[1] with minimum configuration
[2] with recommended configuration

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 16 bit pixel values represent "unsigned integer values", where the camera (12 bit values) sets the higher 4 bits to zero.

The file format consists either of a "Basic Header" (6 Long-parameter) or of an "Extended Header" (32 Long-parameter), the latter of which is optionally for additional information. There 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 6 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 filed 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/with 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 filed 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
…		…

We recommend 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. You will always have the maximum 12 bit information. Please 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 12 bit information will be lost and cannot be displayed later.

TIFF

Tag Image File Format, version 6.0 and lower. There 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 be loaded later only as 8 bit images, i.e. part of the original information (10bit, 12bit or 14bit) is lost.

FTS

Flexible Image Transport System, Version 3.1. There is a 16 bit image format. The NASA/Science Office of Standards and Technology (NOST) has defined this format. 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 compression 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   Service and Maintenance

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

Maintenance
Unplug the camera from any power supply before cleaning it.

Use a soft, dry cloth for cleaning the camera.
Do not use liquid cleaners or sprays.

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 high quality photo stores.

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. Do not clean the input window unless it is absolutely necessary. Be careful and avoid scratches and damage to the input window surface.

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.

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

Camera Disposal
The camera includes electronic devices, which can contain materials harmful to the environment. If the camera is to be discarded, please dispose of it in an environmentally responsible manner and use recycling facilities, where available.

A6   Customer Service and Trouble Shooting

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

To speed your request, we need the following information:
- Short description of the problem
- Description of your application
- Camera settings
- Type and version of camera software being used
- Camera serial number
- Operating system (PC)
- Processor type (PC)
- Memory
- Graphic card
- Graphic card setup

Please use the email options under the Help menu (see 7.8),

or go to our website: http://www.pco.de/support-request/

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.
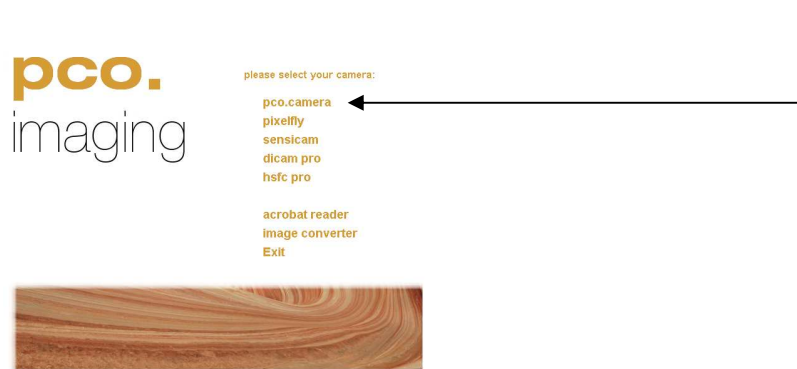
A7   Firmware Update

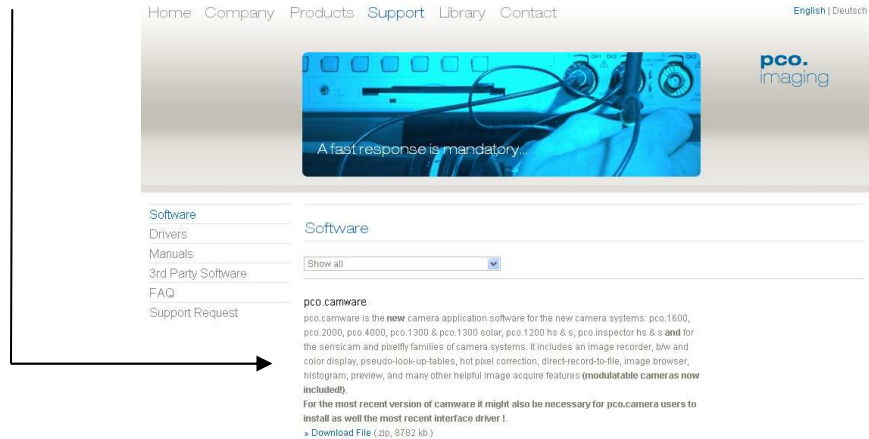Please contact our support team for further information and assistance!

A8   Digital Camera Tools CD-ROM

You find all necessary and some additional software and drivers on the accompanying CD. For the pco.dimax models please select "pco.camera".
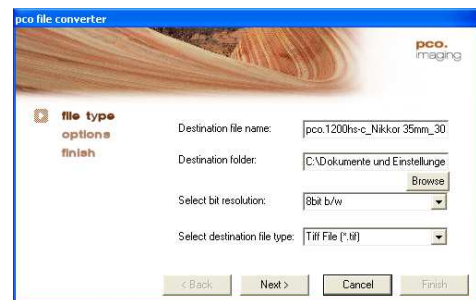
For the latest versions please check our website:

Image Converter

Use the PCO file converter to
*   convert TIFF (16bit) and b16 images to various formats
*   display file information
*   show thumbnail images

Third Party Image Viewer for PCO b16 images

We recommend the free XnView (www.xnview.com), an efficient multimedia viewer, browser and converter. Please enable "all formats". Please note, that the image will be converted to 8bit.

A9   FAQ

<tbd>

<tbd>   pco.dimax User's Manual V1.01 © PCO AG, Germany

maxim ize the moment

PCO AG was founded in 1987. The company headquarters in Kelheim employs more than 50 specialists in the development and production of optimized, fast, sensitive camera systems for scientific applications. PCO's range of products includes digital camera systems featuring high dynamics, extremely high sensitivity, high resolution, high speed, and extremely low noise, which are sold in industrial and scientific markets all over the world.

Cameras for every point of view.

The systems produced by PCO AG are cameras and scientific measuring instruments at the same time. Our high-tech systems are mostly the result of manual labor: over 50 highly specialized employees handle development and production at the Kelheim site. We deliver roughly 4.000 cameras a year to customers all over the world. As in every cutting edge technology, dialogue with the user is the main focus of PCO's approach. Worldwide representatives, in cooperation with the in-house marketing division and technical support team, ensure that PCO camera systems are developed in step with the individual requirements of our customers.