user manual

pco.panda 4.2
pco.panda 4.2 bi
pco.panda 4.2 bi UV

pco.
panda
back illuminated
sCMOS

pco.

PCO asks you to carefully read this manual before using the pco.panda 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.

TABLE OF CONTENTS

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1. INTRODUCTION

Advantages of the pco.panda

Features

The pco.panda 4.2, pco.panda 4.2 bi and pco.panda 4.2 bi UV join the ranks as our newest members of PCO's state-of-the-art sCMOS sensor camera systems, which have revolutionized the scientific camera market since their introduction in 2010.
Our new back illuminated (bi) sensor can provide you with a quantum efficiency of up to 95 %.
Despite small-size dimensions of roughly 65 x 65 x 65 mm³, the new pco.panda camera system provides high quantum efficiency with low readout noise making it suitable for countless applications.
The addition of the USB 3.1 interface has inherent advantages as it enables a new generation of cameras with ultra-speed data transfer and direct power via the USB cable, making external power supplies redundant.

Main Features

- Ultra-compact size: 65 x 65 x 65 mm³
- Resolution: 2048 x 2048 pixels
- Back illuminated quantum efficiency of up to 95%
- Frame rate 40 fps @ full resolution
- USB 3.1 interface

1.1 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. The disclosures and operating conditions in these operating instructions installation must be respected. Unauthorized modifications and changes of the device are forbidden for safety reasons.

1.2 CONVENTIONS

The following typographic conventions are used in this manual:

bold italics	Terms that can be found in the software pco.camware.
Features	Heading within a chapter
A1.4	Bold chapter: hyperlink to a chapter
1 **1**	Numbers that help to find functions quickly
NOTE	Notes that must be observed Not to be confused with the safety instructions in chapter **2**!

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2. SAFETY INSTRUCTIONS

Read the safety instructions completely and follow them strictly.

DANGER

DAMAGED POWER CABLE OR POWER PLUG
Danger to life due to electric 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 electric 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

JOLT & 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
Screw in the lens gently to avoid thread damage.
➔ 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.
➔ Switch the camera off immediately, detach it from power and contact PCO's customer support.

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3. SYSTEM COMPONENTS

The camera system includes the following parts.

Camera

- C-mount optical connection
- F-mount adapter optional
- For standard C-mount / F-mount lenses and adapters

Rear Panel

- USB 3.1 Type C connector
- LED indicates camera status (see **A1.4**)
- SMA connectors

Serial Number Tag

Mounting Thread

- 4x M4
- 1x 1/4"- 20 UNC

USB 3.1 Cable

- USB Type A / USB Type C screwable cable
- Length 3 m

USB 3.1 Interface Card

- 2x USB Type A socket
- PCI Express x1 V2.0

Digital Camera Tools (USB flash drive content)

- pco.camware: software for camera control & image acquisition
- Camera driver & tools
- Software Development Kit (SDK) & demo programs in C and C++

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4. INSTALLATION

You 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 (www.pco.de).

Minimum system requirements:

- Intel® Core™ i7
- RAM > 8 GB DDR3
- Windows 7 or higher

- Full-HD resolution display
- USB 3.1 Gen1

4.1 DRIVER

Install PCO USB 3.0/3.1 Driver

Always install the latest USB driver version. After these two screens the driver is completely installed. ① ②
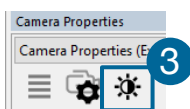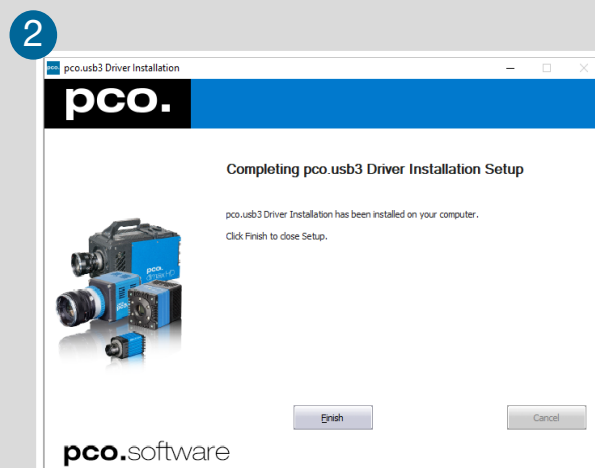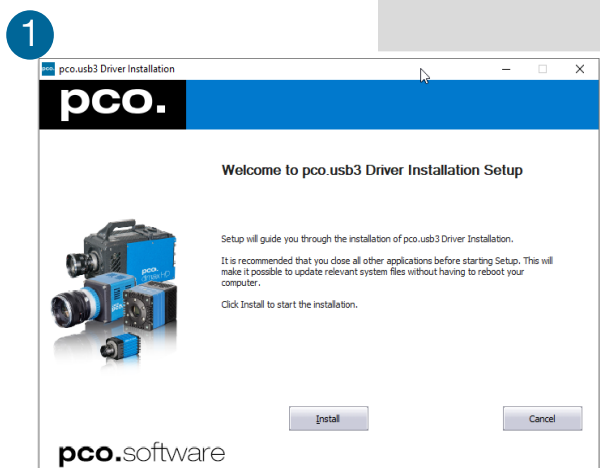
NVIDIA Cuda Driver

Only relevant if an NVIDIA graphics card is used! *GPU Processing* is only working with NVIDIA graphics cards.

Update your NVIDIA driver for pco.camware. In case of an old driver version *GPU Processing* is not working. Therefore image processing is slow.
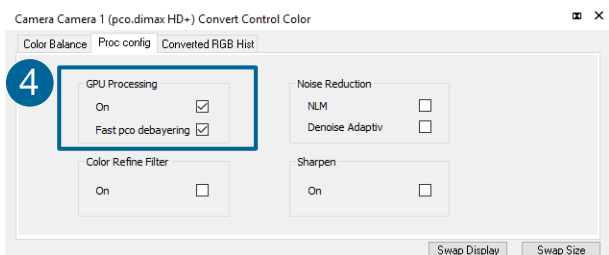
Check if *GPU Processing* is activated by having a look into the *Proc config* settings ④ in the *Convert Control* window ③ (see pco.camware manual).

If *GPU Processing* is disabled and greyed out, update your NVIDIA driver.

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4.2 CAMWARE SOFTWARE

The pco.camware application software enables 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 installation files for the software for latest Windows operating systems in 32 & 64 bit.

After a successful installation, you find the program file Digital Camera Toolbox in your program directory and a pco.camware 32 / 64 button on your desktop.

To uninstall the pco.camware program, use the software feature under Windows' system control.

Follow the Installation Wizard

① **Install as admin** to install to program folder, otherwise it is installed only to user folder

② Choose install directory

③ Choose components: select additional drivers (not recommended)

④ After the next two screens installation is complete

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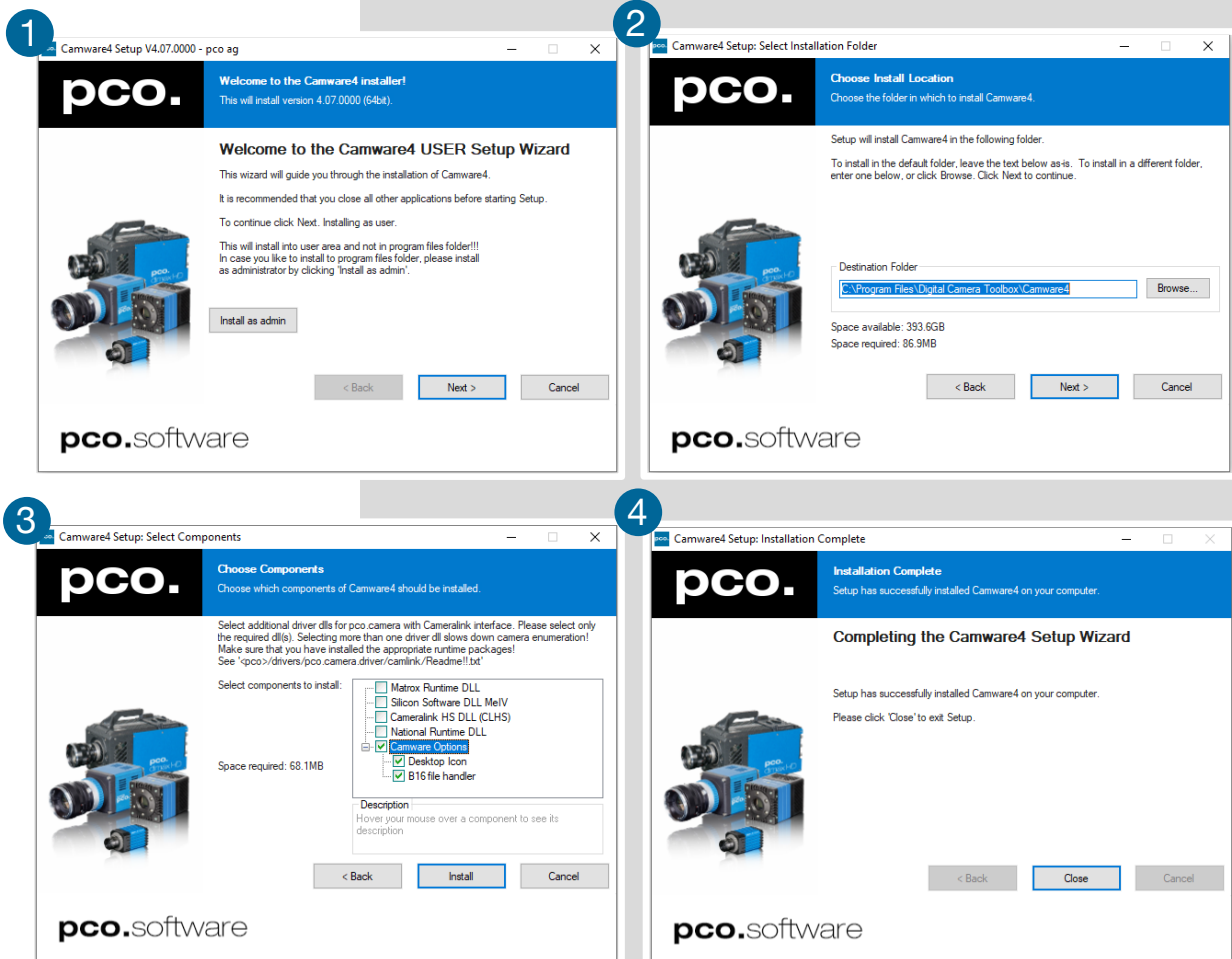
5. QUICK START

In order to get familiar with your new camera and 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

- 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 PC

5.2 START

Start pco.camware and the graphical user interface starts up:
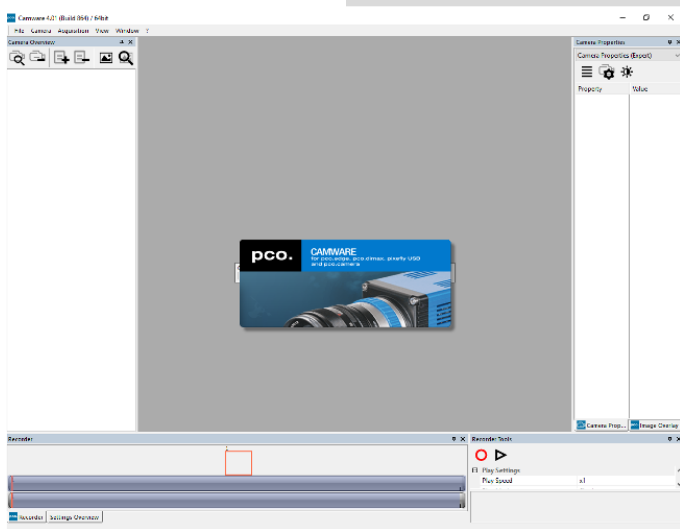
NOTE
Always install latest pco.camware version to be able to use full function of your camera (www.pco.de/support).

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5.3 FIRST IMAGE

Camera Overview
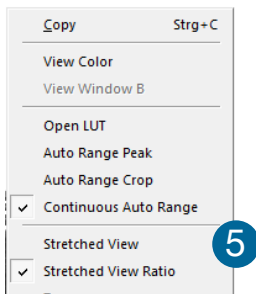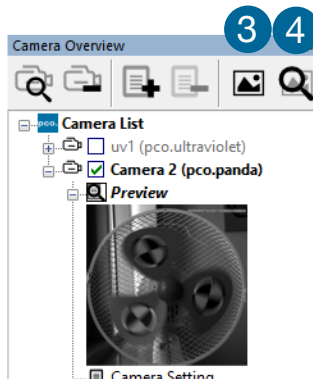
Follow the Instructions

- Start pco.camware ①

- A *View Window* ② is shown automatically or open a new one ③

- Start *Live Preview* ④

- Right-click in the view window & apply *Continuous Auto Range* ⑤

- You may adjust *Exposure* time ⑥, aperture and focus of the mounted lens

- Now you should clearly see the object in the window ⑦
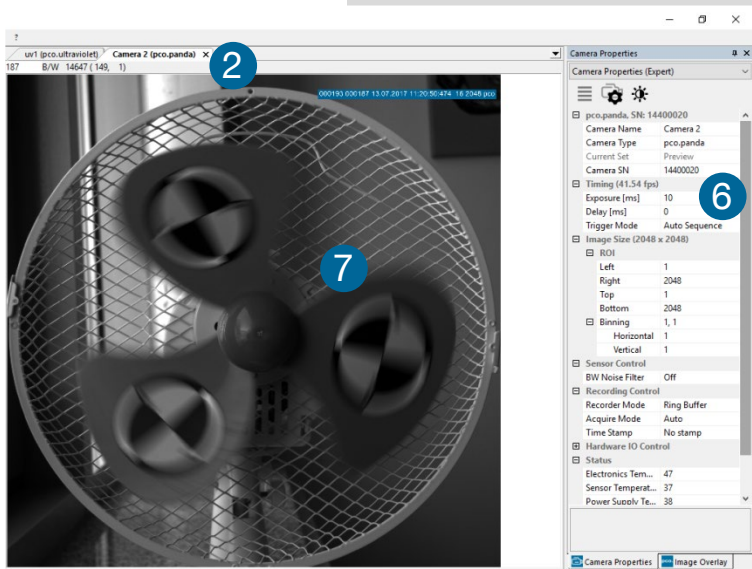
To change *Exposure* time (e.g. the image is still either too dark or too bright) or to record and save images see the pco.camware manual.

NOTE
Live preview: useful for fast and easy camera adjustment and focusing.

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6. ROLLING SHUTTER

The pco.panda uses the rolling shutter mode. In this mode the pixel reset and exposure start is carried out line by line. Each line has the same exposure time, but a different start and end of exposure. Within one line, the exposure starts simultaneously for all pixels.

The exposure time of each line starts with the corresponding reset of the line. Then after a predefined time (exposure time), the exposure is stopped. The light induced accumulated charge carriers of the pixels in a line are recorded into memory in a low noise (readout) mode. This way the content of the pixels is assembled in the memory to form the complete image.

The diagram shows different signal timing settings (see chapter **7.1**). During *Show common time of 'All Lines'* the image sensor is completely exposed to light. The labels *Show time of 'First Line'* and *'Last Line'* are the setting for the first / last exposed line and *Show overall time of 'All Lines'* for the entire exposure period.

There are two different timing cases for rolling shutter mode, which are explained on the following pages:
- exposure time > sensor readout time
- exposure time < sensor readout time

Rolling Shutter General Timing Diagram

- ▮ exposure start
- ▮ exp. stop & readout image
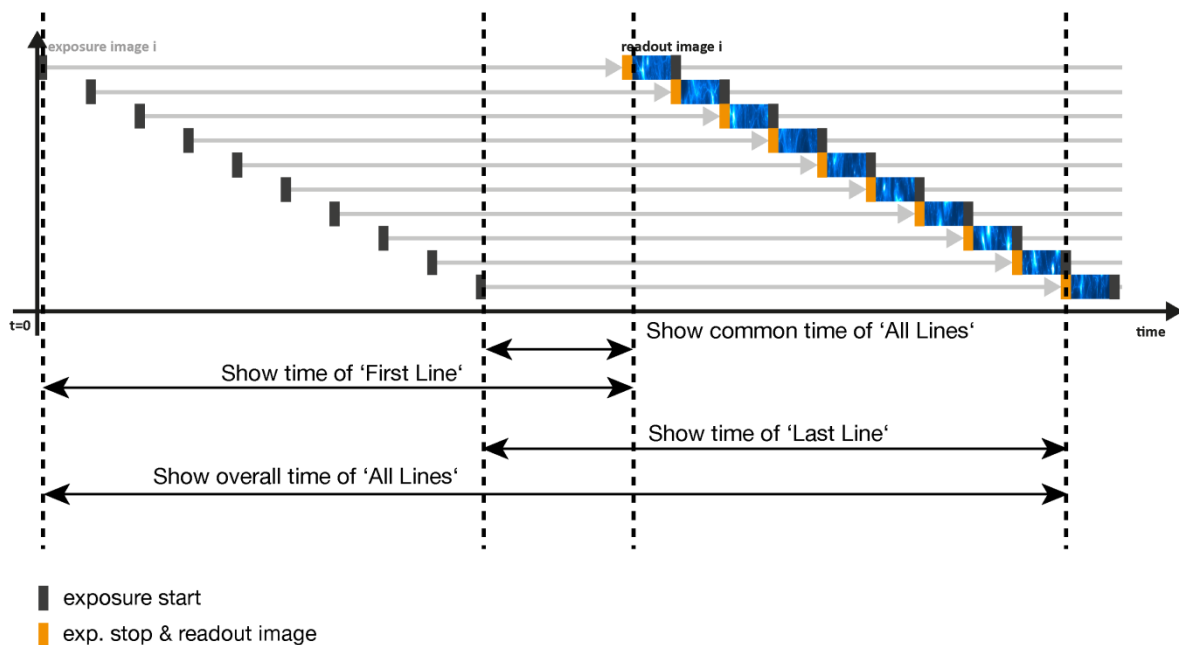
NOTE
The exposure and delay time can be adjusted in steps of one line time.

Timing

Camera	Exposure time	Delay time	Line time
pco.panda 4.2	10 µs … 5 s	0 … 5 s	12.136 µs
pco.panda 4.2 bi (UV)	10 µs … 500 ms	0 … 5 s	12.174 µs

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Exposure time > Sensor frame readout time

In case the required exposure time is longer than the frame readout time, the image sensor is completely exposed to light for some time (*Show common time of 'All Lines'* also see General Timing Diagram). In case of a triggered flash illumination, this would be the best moment to illuminate the image sensor. The hardware signal for the time *Show common time of 'All Lines'* is available on SMA connector #4 (see **7.1**).

This is an example timing diagram for *Trigger Mode Auto Sequence*, SMA explanation see **7.1**
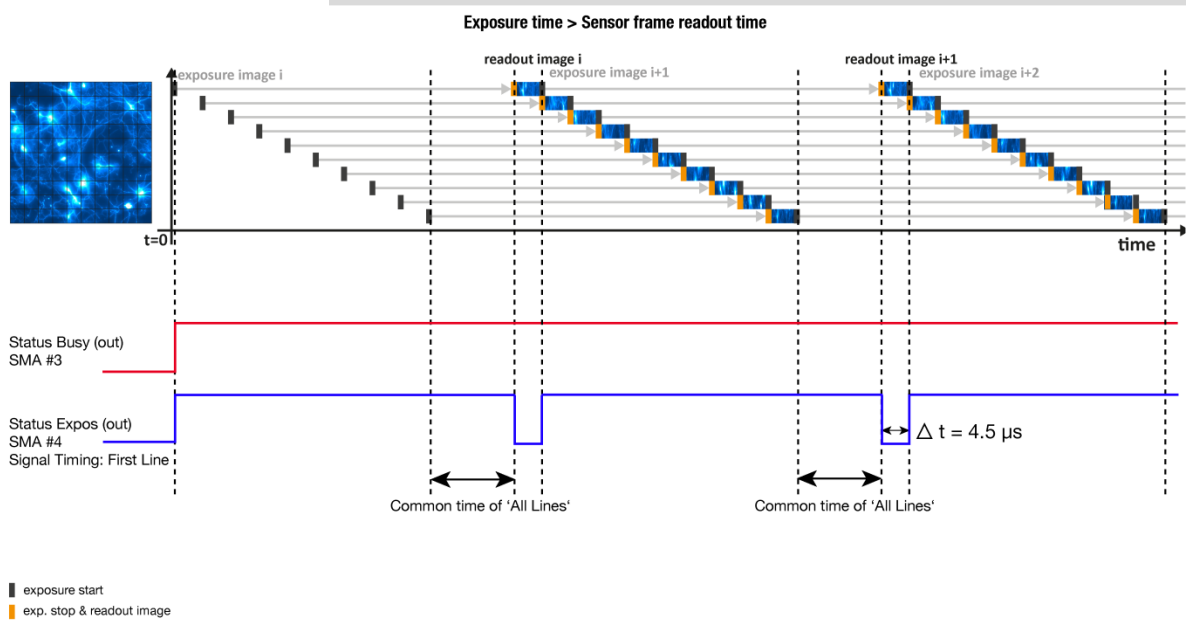
Exposure time > Sensor frame readout time

Δt = 4.5 µs (pco.panda 4.2)
Δt = 4.4 µs (pco.panda 4.2 bi (UV))

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Exposure time < Sensor frame readout time

In case the required exposure time is shorter than the frame readout time, the image is readout through an exposure band moving from the top to the bottom of the sensor.

exposure stop & readout

band of simultaneous exposures

reset & exposure start
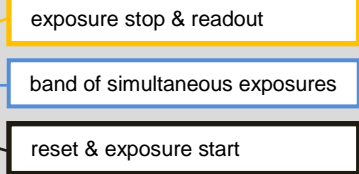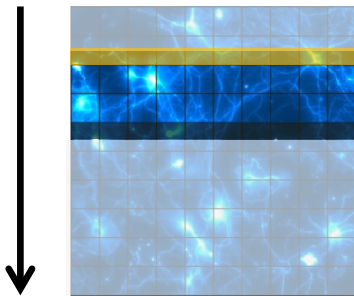
For example:
How can you calculate the band of simultaneous exposure lines at an exposure time of 100µs (@ full resolution)?

$$\frac{\text{Exposure time}}{\text{Line time}} = \text{Number of simultaneous exposure lines}$$

$$\frac{100\ \mu s}{12.136\ \mu s} = 8,2 \rightarrow 8\ \text{lines}$$

This is an example timing diagram for **_Trigger Mode Auto Sequence_**, SMA explanation see **7.1**

Exposure time < Sensor frame readout time

exposure image i   readout image i   exposure image i+1   readout image i+1   exposure image i+2   readout image i+2

t=0   time

Status Busy (out)
SMA #3

Status Expos (out)
SMA #4
Signal Timing: First Line

▌ exposure start
▌ exp. stop & readout image

pco.
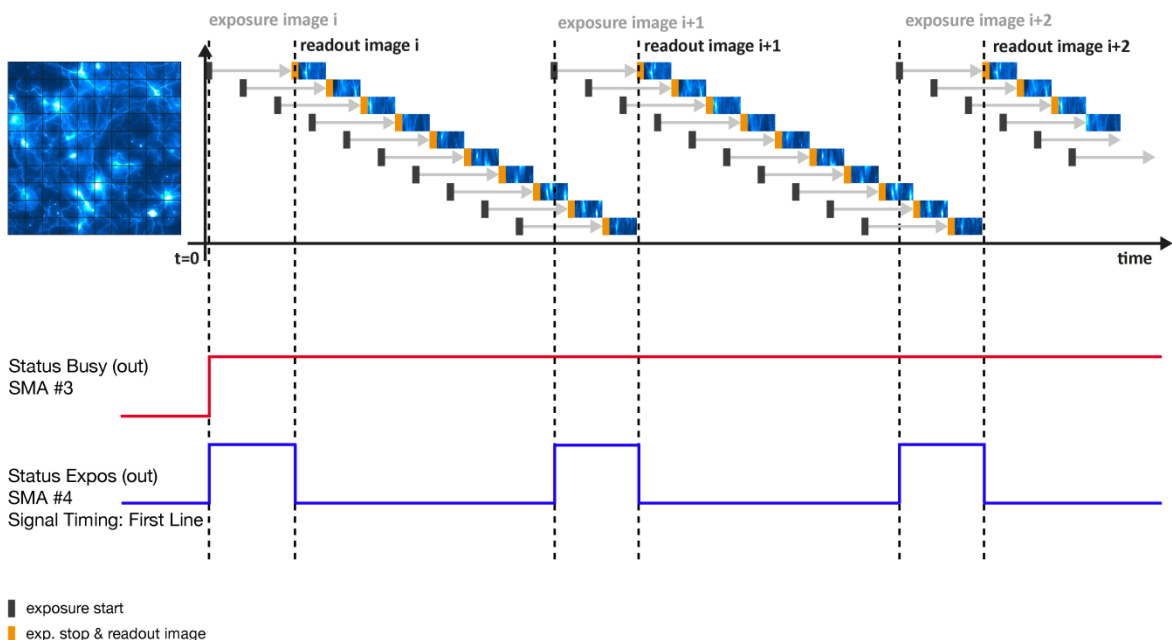
Details for External Exposure Start and External Exposure Control

The detailed timing for external trigger includes system delay times, an adjustable additional delay time, and the jitter. Explanation for all Trigger Modes see pco.camware manual.
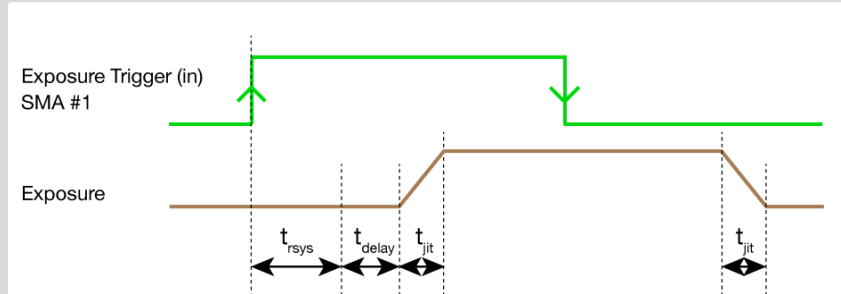
Name	Explanation	Value
t_{jit}	Jitter	≤1 line time[1]
t_{rsys}	Fixed system delay of rising edge	2x line time[1]
t_{delay}	Programmable delay time	0 µs … 5 s

[1]line time: pco.panda 4.2 / 4.2 bi (UV): 12.136 µs / 12.174 µs

For optimized synchronization (minimized jitter time) use the falling edge of the line signal at the **Status Expos** output SMA #4 (see **7.1**).

System time t_{rsys} is depending on your camera settings and can be read out from your camera, for further information see SDK manual function PCO_GetImageTiming.

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7. CAMWARE SOFTWARE

This chapter contains only camera-specific additions to the pco.camware manual. All main functions and explanations can be found in the pco.camware manual.

7.1 HARDWARE IO CONTROL

Change setting are done via drop-down menu.

Exposure Trigger ①

If checked, a signal for **External Exposure Start Trigger Mode** (see chapter **6.3.1**) is accepted at the **Exposure Trigger** SMA input #1.

Exposure Trigger: On; Off
Signal Polarity: Rising; Falling

Aquire Enable ②

If checked, a signal for **Acquire Mode** is accepted at the **Acquire Enable** SMA input #2.

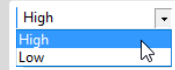**Acquire Enable:** On; Off
Signal Polarity: High; Low

Status Busy / Status Line ③

If checked on, a signal indicating busy status is provided at the **Status Busy** output. Once an acceptable trigger edge is received, 'busy' goes to status high. As soon as 'busy' goes low again, a new trigger edge is accepted. Use the falling edge of the **Status Line** signal for optimized synchronization see **Status Expos** SMA#4

Status Busy: On; Off
Signal Polarity: High; Low

Status Expos / Status Line ④

If checked, a signal indicating exposure or line status is given at the status output. **Status Expos** indicates the actual exposure window for one frame. Use the falling edge of the **Status Line** signal for optimized synchronization.
Detailed explanation for **Signal timing** see next page!

Select IO Signal: Status Expos; Status Line
Signal timing: Show time of 'First Line'; Show common time of 'All lines'; Show time of 'Last line'; Show overall time of 'All lines'
Status Expos: On; Off
Signal Polarity: High; Low

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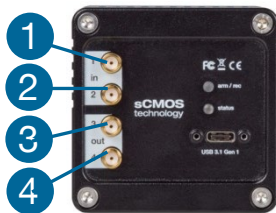
Enabling and Polarity of IO Signals

The polarity of the input and output signals indicating their active states is selectable (positive or negative logic).
The polarity of level-sensitive signals can be set to **High** (positive logic) or **Low** (negative logic).
The polarity of edge-sensitive signals can be set to **Rising** (positive logic) or **Falling** (negative logic).

Detailed Explanation for Status Expos SMA #4 Signal Timing

Setting in pco.camware:

⊟ Status Expos	
Select IO Signal	Status Expos
Signal Timing	Show time of 'Last Line'
Status Expos	On
Signal Polarity	High

Show time of 'Last Line' ▾   ①
Show time of 'First Line'   ②
Show common time of 'All Line ③
Show time of 'Last Line'
Show overall time of 'All Lines' ④
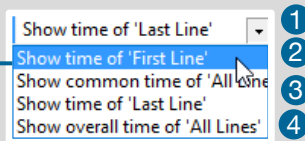
There are four different signal types selectable. The example timing diagram shows all four different possibilities:

① Shows the exposure time of the first line
② Shows when all sensor lines are exposed
③ Shows the exposure time of the last line
④ Shows if any sensor line is integrating
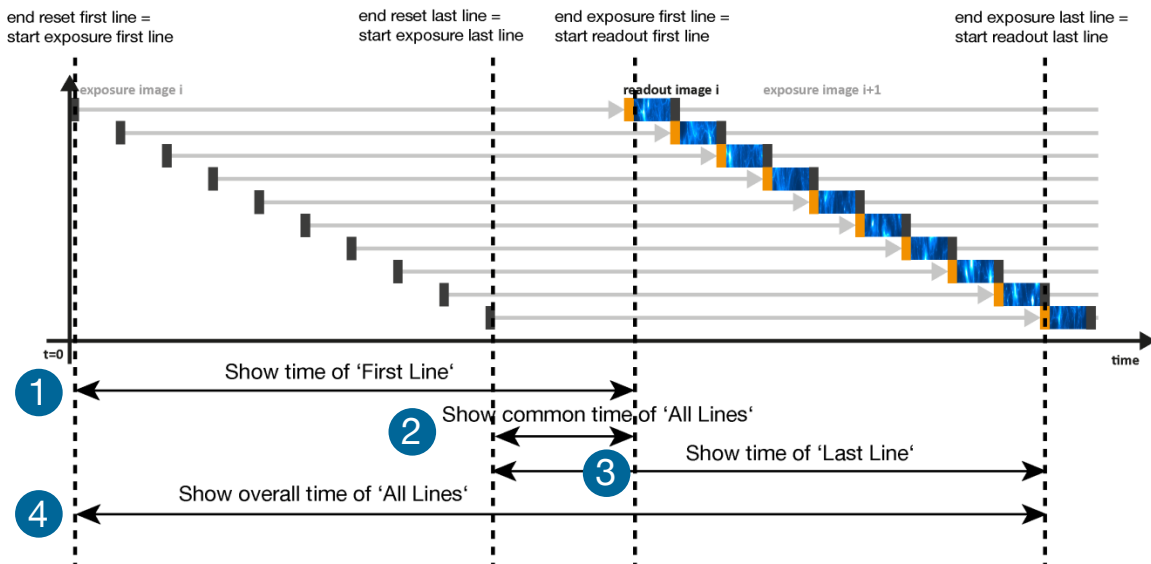
Example Timing Diagram for exposure time > readout time

APPENDIX

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A1 TECHNICAL DATA

A1.1 DATA SHEET

Image sensor	pco.panda 4.2	pco.panda 4.2 bi (UV)
Type of sensor	customized sCMOS	back illuminated sCMOS
Color	monochrome / color	monochrome
Resolution (h x v)	2048 x 2048 pixel	
Pixel size (h x v)	6.5 μm x 6.5 μm	
Sensor format / diagonal	13.3 x 13.3 mm / 18 mm	
Shutter mode	Rolling Shutter	

Camera		
Frame rate	40 fps @ full resolution	
Exposure / shutter time	10 μs ... 5 s	10 μs … 500 ms
Dynamic range A/D	16 bit	
Pixel scan rate	44 MHz	46 MHz
Pixel data rate	176.0 Mpixel/s	184 Mpixel/s
Binning (h x v)	1x1 ... 4x4	
Cooling method	passive cooled	
Trigger input signals	frame trigger, acquire (SMA connectors)	
Trigger output signals	exposure, busy (SMA connectors)	
Data interface	USB 3.1 Gen1	
Timestamp	in image (1 μs resolution)	

General	
Power delivery	via USB Type-C
Power consumption	typ. 4.5 W (max. 6.0 W)
Weight	420 g
Operating temperature	+10°C ... +40°C
Operating humidity range	10% ... 80% (non-condensing)
Storing temperature range	-10°C ... +60°C
Optical interface	C-mount, F-mount (optional)
CE / FCC certified	yes

ROI (region of interest) step sizes	
Horizontal steps	32 pixel steps
Vertical steps	8 pixel steps
Minimum ROI	64 x 16 pixel

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

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A1.2 MECHANICAL DIMENSIONS

NOTE
C-Mount flange focal distance: 17.52 mm

4 x M4 Helicoil ⚊ 4

61,8

15,8

32

65

C-Mount

1/4"20UNC Helicoil ⚊ 7

A

13,3

4 x Rubber Bumper   13,3

A

3   66

61

~ 2 (Adjustable)

12,5   4 x SMA

10 10

10 10

10

17,5

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panda
sCMOS

1
In
2

3
out
4

sCMOS
technology

made in
germany

USB 3.1 Gen 1

arm / rec

status

24,3

2 x M2   15   10,8
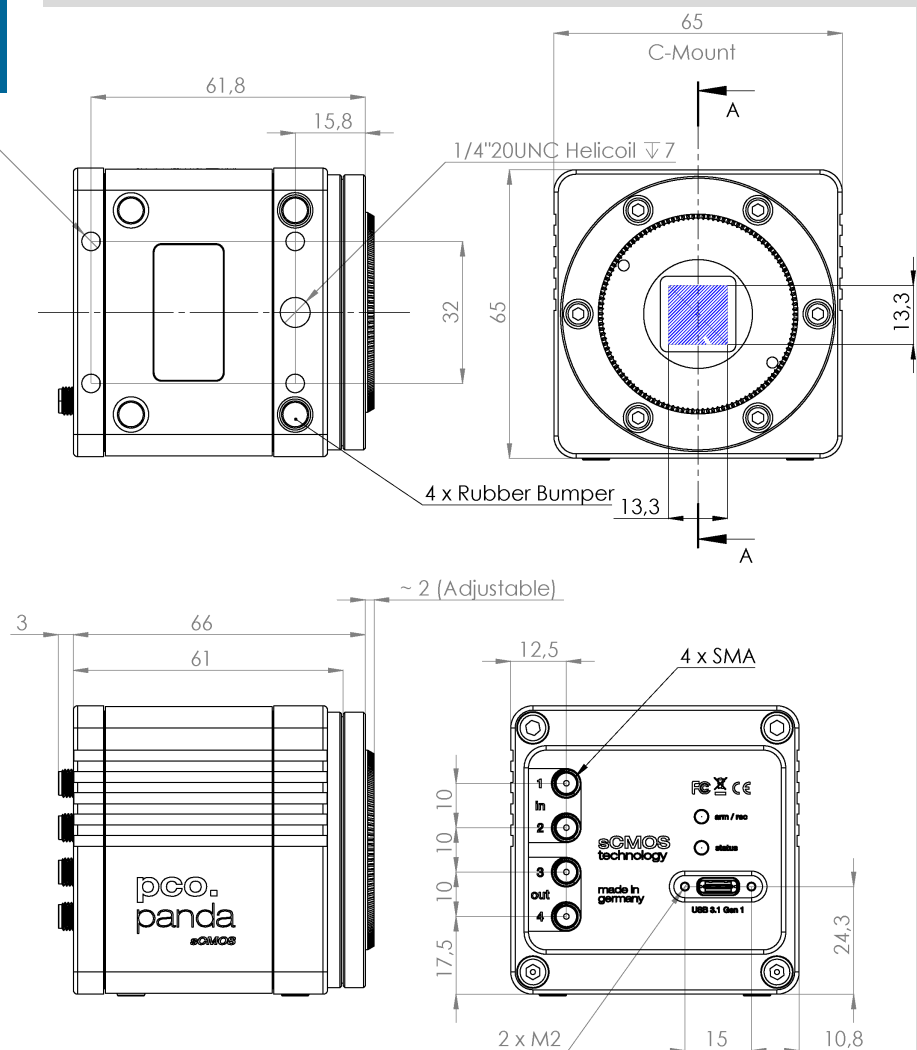
All dimensions given in millimeter.

2D and 3D technical drawings are available on our website
3D step files and further technical drawings are available on request.

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A1.3 REAR PANEL

Status LEDs ①
(LED1: green / red; LED 2: orange)

Color		Description
Red / green continuous	🟢🔴	Camera is booting
Green	🟢	Camera is ready for operation
Orange continuous	🟠	Arm camera / rec state off
Orange blinking	🟠	Recording on
Red continuous	🔴	Error

Interface Connector ②

USB 3.1 plug Type-C screwable;
Power delivery for the camera over USB cable

SMA Inputs ③

(see chapter **7.1**)

Input (1=Exposure Trigger; 2=Acquire Enable)	
Type	Digital
Level	3.3 V LVTTL (5 V tolerant)
Coupling	DC
Impedance	1 kΩ
Slew rate	> 1 V/ms

SMA Outputs ④

(see chapter **7.1**)

Output (3=Status Busy; 4=Status Expos)	
Type	Digital
Level	3.3 V LVTTL
Coupling	DC

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A2 HARDWARE MOUNTING

Instructions how to mount the components pco.panda camera system.

A2.1 USB CARD INSTALLATION

An external USB 3.0 / 3.1 Gen1 host controller card comes along with to each pco.panda camera.

Hardware Installation

First shut down your computer and install the USB 3.0 / 3.1 Gen1 host controller card. Hardware installation must be performed by a technician, because high voltages can occur on the device.

WARNING

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

NOTE
In multi-camera operation, each pco.panda camera needs its own USB host controller card.

Driver Installation Instructions

Within the provided installation files USB_HBA, open the folder U3X4-PCIE4XE101, U3X4-PCIE1XE101, U3-PCIE1XG202.

Open the subfolder driver and run RENESAS-USB3-Host-Driver-30230-setup.exe.

If your current OS is Win 7 / 8 and the user account control is enabled, a dialog prompts whether you wish to start the setup: accept with Yes.

1 At first the installation is prepared.

2 Secondly the software components are copied automatically.

3 Finally the installation is completed and the Delock USB 3.0 / 3.1 Gen1 extension card can be used.

pco.
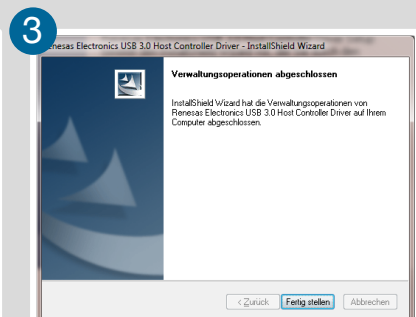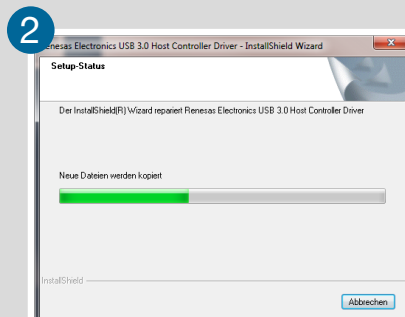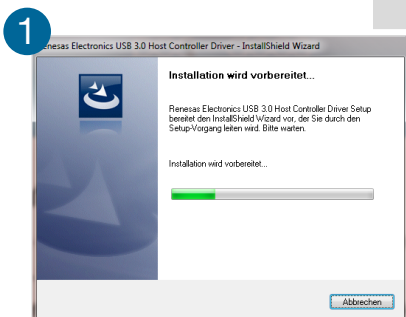
A2.2 CABLE MOUNTING
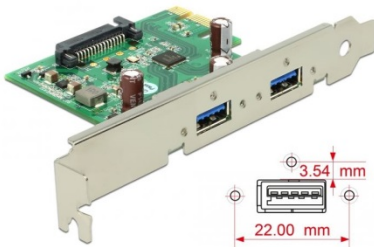
In order to ensure a proper function of the pco.panda, it is necessary to secure the USB cable by the fixing screws.

The accompanying USB cable is screwable on both ends of the cable.

The maximum torque for the screws is 0.1 Nm.

Screw Connection to the Camera (recommended)

- The screw threads of the camera are very sensitive due to the small size.
- Plug the USB cable into the camera.
- Then attach the fittings to the threads by hand.

Screw Connection to the Computer (optional)

- Attach the cable to the USB card in the same way.

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A2.3 REMOVAL OF THE INPUT WINDOW

This chapter contains an instruction manual, how to remove the input window of the pco.panda 4.2 bi UV. In addition, it explains the warranty situation, effective after the removal of the protection window.

Warranty

The explained customization below is done at your own risk. Please be aware, that once the warranty seal ③ is removed, your claim on warranty is invalid, independent of the delivery date. The operation of the pco.panda 4.2 bi UV without input window is done at your own risk. A repair of a damage, caused by the opening of the camera or which appeared as result of the direct access to the sensor surface, is within your responsibility.
The customization is only possible with the hardware of the part number 70108074007, see label on camera bottom.

Step by step instruction to remove the input window

NOTICE

The further dismantling must be done in a cleanroom to avoid that dust or dirt enters the camera and soils the sensor surface!
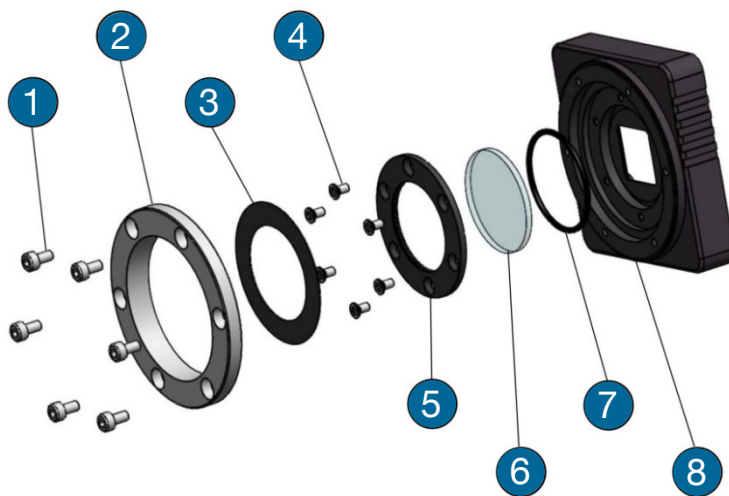
① cylinder head screw DIN912 M3x6 A2 (6 pcs.)

② M45 insert (lens mount adaption)

③ sticker (= warranty seal)

④ countersunk head screw DIN965 TX M2.5x5 A2 (6 pcs.)

⑤ fixation ring (to fixate input window)

⑥ UV optimized input window D32x2

⑦ sealing ring D29x1.5

⑧ camera front

With the help of a 2.5 mm Allen key, one can remove the M45 insert, which holds the C- or F-mount adaptor usually.
Now you have direct access to the warranty seal, which has to be removed to dismantle the input window fixation. Please be aware, the warranty sticker cannot be removed in one part, make sure that no remainders of the sticker enter the camera housing or remain on the input window. Use a TX8 screw driver to remove the countersunk head screw of the fixation ring. Be careful, as once this fixation ring is removed, the input window and the sealing ring are loose and you have direct access to the sensor surface.

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A3 F–MOUNT ADAPTER (OPTIONAL)

A3.1 PCO F-MOUNT ADAPTER

PCO's proprietary F-mount adapter for lenses with automatic diaphragm. Sets manually the lens aperture by turning the ring on the adapter.

F-mount lenses without automatic diaphragm can be fastened to the camera's mount but the aperture not changed.

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 particular 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

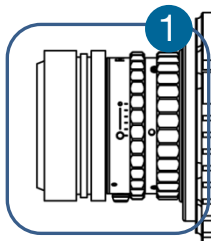**pco.**

A3.2 CHANGE FROM C-MOUNT TO F-MOUNT

How to change the optical input from F-mount to C-mount.

NOTICE

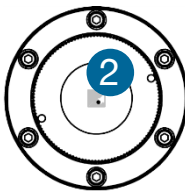**MECHANICAL DAMAGE OF THE C-MOUNT RING**
Tightening the hexagon socket setscrews too tight will permanently damage the C-mount ring.
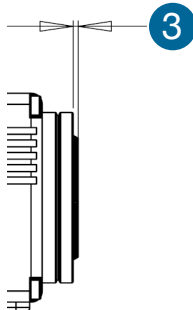➔ Use a torque wrench and select a maximum torque of 1 Nm to tighten the hexagon socket setscrews.

Step 1: Remove F—mount adapter

Turn the black lock ring ❶ counterclockwise to loosen the F-mount adapter and then unscrew it.

Step 2: Insert C—mount ring

Carefully screw the C-mount ring ❷ clockwise. The two hexagon setscrews must be visible on the outside.

Step 3: Adjust flange focal distance

In order to reach the standard support dimension of C-mount (17.526 mm), screw in the C-mount ring so far that it protrudes outwards a distance of 2mm ❸ .
For fine adjustment use a suitable lens with large aperture.
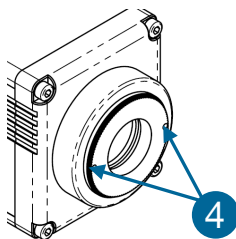
Step 4: Fix the C—mount ring

To fix the C-mount ring, tighten both hexagon setscrews ❹ (1.5 mm hex key) to a maximum torque of 1 Nm.

Limitations of C—mount Lenses

Keep in mind that C-mount lenses could cause shadings at the edges of big sized sensors. Most C-mount lenses are able to illuminate a maximum image circle of 11 mm (2/3"), 16 mm (1") or 22 mm (4/3") diameter only. The camera has a sensor diagonal of 18.0 mm, it follows that you have to use the ROI function for a shade less image while using the C-mount adapter with the two smaller C-mount diameters.

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A4 IMAGE FILE FORMATS

There are different file formats available for saving camera images with pco.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 (6 Long-parameter) or of an Extended Header (32 Long-parameter), the latter of which is optional for additional information. It may 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 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/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	
…	…	

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 is lost and cannot be recovered.

pcoraw

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

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Standard File Formats

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 (16 bit) is lost.

FTS

Flexible Image Transport System, Version 3.1. It is a 16 bit image format defined by 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.

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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 electric 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 (clean it with pressurized air).
➔ 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 high quality 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

If you want 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.
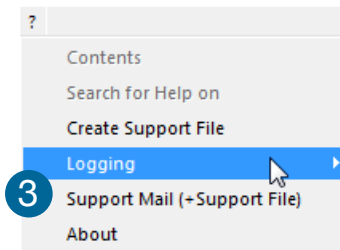
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A5.4 TROUBLE SHOOTING

Use pco.camware to create logfiles for the PCO support.

How to Create Logfiles

Enable Logging ❶
Open *? Help* menu, select *Logging* and then *Enable Logging*
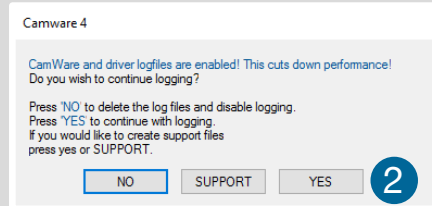The pco.camware will ask you to press *YES* ❷ to activate *Logfiles* after a restart of the software.

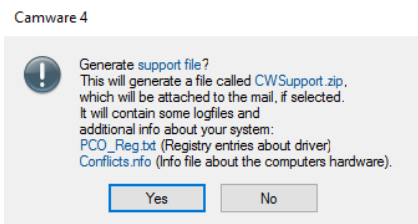*Repeat Workflow*
The workflow which produces the faults must be repeated.

Support Mail (+Support File) ❸
Open *? Help* menu, select *Support Mail (+Support File)* and a support file with all necessary files is created

The pco.camware opens a new email addressed to support@pco.de, attach the *Support File* manually to this mail and send the mail to the PCO support.

Alternatively use the support form on our website: http://www.pco.de/support/ and upload the support file.

To Speed up Your Request

Give us the following information:

- Describe your problem!
- Your application?
- Your camera:
    o Type and version
    o Serial number
- Your setup:
    o Software version
    o Operating system
    o Processor and memory
    o Graphics card

Firmware, Software and Driver Update

You will find all necessary software and drivers on the accompanying USB storage device. For the latest versions check PCO website.

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A6 INDEX

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ABOUT PCO

pco.history

"PCO" stands for what we are: a Pioneer in Cameras and Optoelectronics. With 30 years of expert knowledge and experience PCO has forged ahead to becoming a leading specialist and innovator in digital imaging used in scientific and industrial applications such as life and physical science, high-speed imaging and machine vision. However, the beginning of PCO's story of success dates back to the 1980s and a research project of the founder, Dr. Emil Ott, who was working at the Technical University Munich for the Chair of Technical Electrophysics. While performing measurements with intensified slow scan cameras, Dr. Ott realized that the existing standard did not meet the sophisticated requirements of scientific applications – and so PCO came to life in 1987. With a small team of engineers Dr. Ott began to develop his first image intensified camera followed by several variations on the original model, geared to overcoming all the existing flaws and surpassing standards of the day. During these early years PCO developed a now well established core of advance technologies used as the foundation to develop cutting edge products.

In the early 1990s PCO expanded its business activities to the global market by successfully establishing an international network of highly trained sales partners and customers. We entered additional fields beyond traditional scientific research expanding the potential for our cameras' applications in life science, automotive testing and even broadcasting. This step paved the way for a wide range of innovative highlights:

As of 2017, PCO has three decades of technical know-how and expert knowledge in the development and manufacturing of high-performing camera systems. In-house competence of all significant technical disciplines and partnering with leading image sensors manufactures ensures cutting edge sCMOS, CMOS and CCD technology for all PCO cameras.

pco.prospect

"If you want to do something special, particularly in the high end fields, you have to develop your own image sensors. So we work with partner companies who develop tailored sensors made especially for us. This is something we are doing continuously, so we're already working on the next generation of cameras that we will introduce in the coming years" – Dr. Emil Ott.

In PCO's first 30 years, Dr. Emil Ott took a company that he started right after finishing university and has built it into a major player in scientific and industrial cameras – and there's plenty more to come.

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