SensiCam®
SensiCamQE

Operating Instructions

pco.
imaging

Safety Instructions

For your own safety and in order to guarantee a safe operation of the camera, please read carefully the following information prior to using the device.

- Never operate the camera at places where water or dust might penetrate.

- Place the camera on a sufficiently stable basis.
  Shocks like e.g. dropping the camera onto the floor, might cause serious damage to the device. Therefore exclusively the tripod attachment at the bottom side should be used for mounting the camera.

- Always unplug the camera before cleaning it. Do not use cleaning liquids or sprays. Instead, use a dry, soft duster.

- Never insert any objects through the device's slots. The applied voltage inside the camera can cause short-circuits or electrical shocks.

- The slots in the camera housing (bottom and rear panel) are needed for ventilation. In order to guarantee a proper operation and to prevent overheating of the camera, these slots must always be kept free.

- Make sure that the connecting cable is in good condition and that the link to the socket does not represent an obstacle.

- Detach the camera and contact the customer service in the following cases:

  - When cable or plug are damaged or worn-out.
  - When water or other liquids have soaked into the device.
  - When the device is not properly working although you followed all instructions of the user's manual.
  - When the camera fell to the floor or the housing has been damaged.
  - When the device shows apparent deviations of normal operation.

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Operating Instructions SensiCam, SensiCamQE
Version 07/2002

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1. Installation and Powering Up

The SensiCam imaging system consists of camera and PCI-Board. To get the system working properly, follow the instructions.

1.1 Computer

System Requirements

The PCI-Board should be installed in a computer with following characteristics:

- PCI-Bus with PCI-Chip Version 2.1 or higher
- Intel Processor, Pentium or AMD
- 128 MB RAM
- Possible Operating Systems
  - Microsoft Windows 95 Version 4.00.950b or higher
  - Microsoft Windows 98 or 98SE
  - Windows ME
  - Microsoft Windows NT 4.0 Workstation
  - Microsoft Windows 2000 Workstation
  - Microsoft Windows XP
  - Linux Kernel 2.2, preferable SuSE 6.3 or newer

In case of working with Linux, please contact PCO.

Graphic Board

For best display of images on the monitor we recommend the use of highest performance boards with at least 4MB RAM, preferable with AGP Bus architecture.

Graphic Setup

The camera generates 12 Bit (4096 grey levels). For display on the PC Monitor 8 Bit (256 grey levels) respectively 3x8 Bit in true color (16,7 millions colors) are generated.

In general, several graphic setups are possible. We recommend the setting with 24 or 32 Bit with 16.7 million colors.

In the 256-Color-Modus twenty colors are used by Windows for internal purposes. This modus allows to display a maximum of 236 grey levels. Therefore only 7 bit (128 grey levels) are used for black/white display.
Some graphic boards use in principle 6 bit for the 256-Color-Modus, i. e. not more than 64 grey levels can be displayed on the monitor.

Installing the PCI-Board

Caution! Before touching the PCI-Board make sure you have **not accumulated static charges**. A discharge may destroy the sensitive electronics and voids any guarantee.

Insert the PCI-Board in a free PCI-slot of your computer and screw the bow onto the PC housing.
Make sure the board does not touch any electrical conducting parts (housing, other boards, wires or chillers)
It is essential to use a **master PCI-slot**. Some computers require additional enabling of PCI-slot mastering on BIOS level.

1.2 Installation of the Hardware Driver

You can operate the camera with Windows9x/ME/2000/NT or Linux.

Installation under Windows 9x/ME/2000/XP

New-Installation of the hardware driver

If you have Windows9x/ME/XP or Windows 2000 installed, the computer should automatically recognize the new hardware (PCI-Board) and request you to insert a disk with the manufacturer's drivers.

For installation please read the actual information in the readme.txt file on the enclosed CD.

Updating the hardware driver

For updating an existing driver, please download the newest driver version from the internet under http://www.pco.de.

For installation please read the actual information in the readme.txt file which will be download automatically with the driver.
In case the downloaded drivers are compressed you have to decompress them with a suitable program (e.g. ZIP program).

Installation under Windows NT

Installation of the Hardware Driver

If you install the camera under Windows NT, you need the rights of the administrator. Please login as administrator.

For installation please read the actual information in the readme.txt file on the enclosed CD or after downloading from internet.

Installation under Linux

The Linux driver is on the enclosed CD or can be downloaded from internet under http://www.pco.de.
In case the downloaded drivers are compressed you have to decompress them with a suitable program (e.g. ZIP program, TAR program).
Detailed instructions for installation you will find in the readme file.

1.3 Installation of the Software „CamWare“

CamWare is a 32 Bit Windows application. With CamWare all camera parameters can be set. The images can be displayed on the monitor and saved on hard disk. For detailed information please see the separate manual ‚CamWare'.

You will find the software CamWare on the enclosed CD. The newest version can also be downloaded from the internet under http://www.pco.de.

Installation from CD

In case the CD will not start automatically, please start it manually by double click **starter.exe**.
Please select your camera and the software 'CamWare':

Installation from Internet

Download CamWare from the Internet to a free selected directory. The downloaded file must be decompressed with a suitable program (e.g. ZIP program) Start the installation with setup.exe.

The newest information how to install CamWare can be found in the readme.txt file.

To install CamWare under Windows 2000, Windows NT or Windows XP you need administration rights.

Remark

After successful installation the computer has to be restarted.

The installation program transfers all necessary DLL and OLE files to the respective Windows, checking automatically for existing older versions and replacing them by new ones. Windows'95 carries out all „registry“-entries.
If the program is to be deleted from the computer, a proper de-installation is carried out in

START - SETUP - SYSTEM CONTROL - SOFTWARE

After successful installation you will have the new directory 'Digital Camera Toolbox'. CamWare and some additional useful tools will be installed to this directory.

Hotline

In case you have problems during installation, call our hotline (see *„Customer Service“*).

1.4 Camera and PCI-Board

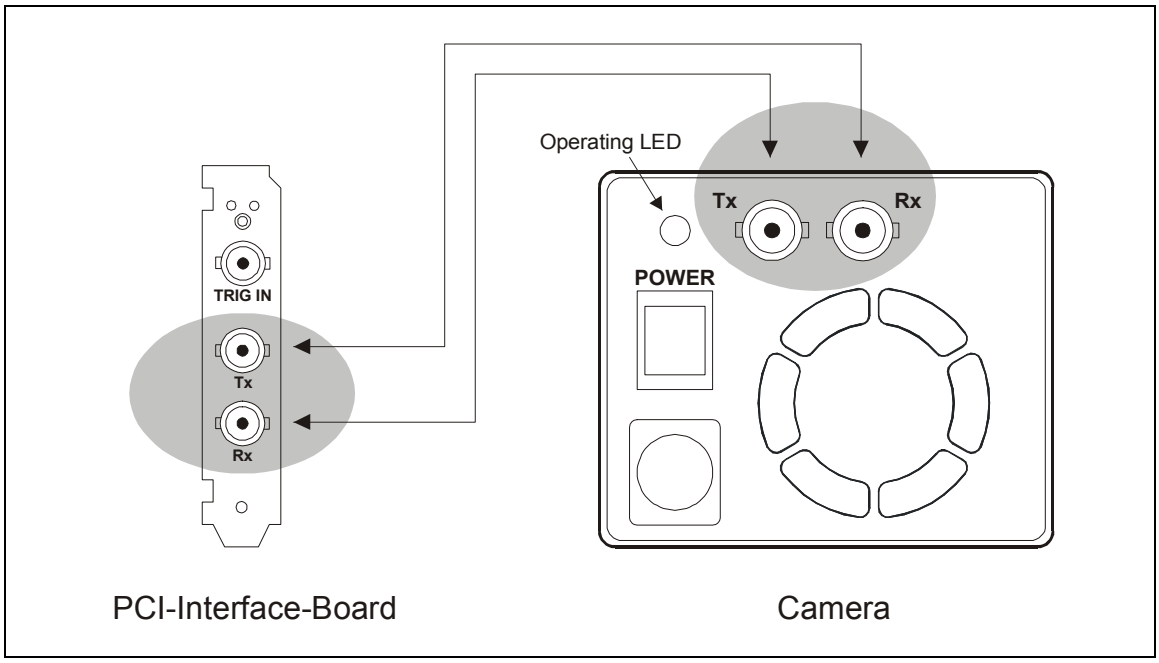
Before Powering Up, make following connections:

- **Power** from Power Supply to Camera
- **Serial Interface** between camera and PCI-Board with enclosed cables.

There is a serial data transfer between camera and PCI-Board. Depending on version, either a double-coaxial-cable or a fiber optic cable (FOL) is used.
I you have a camera version with FOL, go on reading the next page.

Double-Coaxial Cable

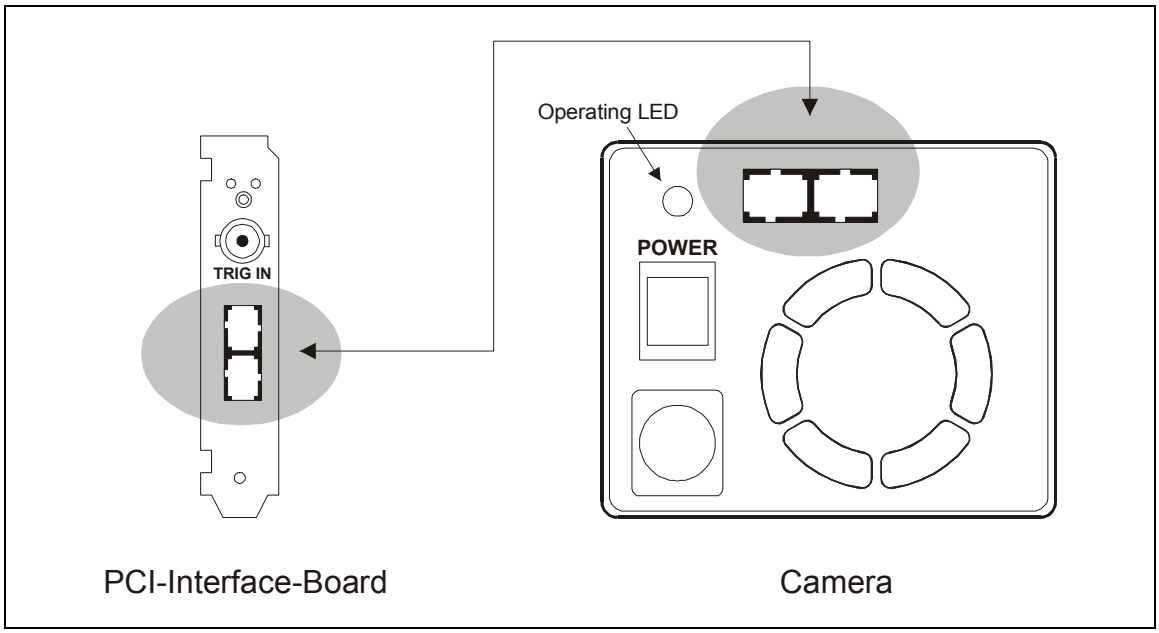
Connect the double-coaxial cable that comes along with the camera to the two BNC-sockets at the rear of the camera and the other extremity to the PCI-Board.
The cables must be crossed, i.e. Tx connected to Rx and Rx to Tx. Wrong connecting makes the LED (Display of Power Status) stay on red (see also chapter 1.5).



If other than delivered cables are to be used make sure they have an impedance of 50Ω. The maximum cable length for proper operation is 10m.

Fiber Optic Link (FOL)

Remove the protection caps from the camera and the PCI-Board. Also remove gently the small caps from either end of the cable and **keep them on a safety place**!. Plug in the cable on both devices. Because of the plug shape the cables cannot be mixed up. The plugs should slip in easily. Avoid forcing!



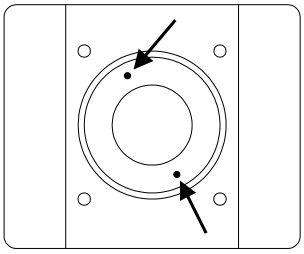
Caution!

Avoid kinking or bending it over a sharp edge (e.g. stepping on it while over a threshold). This will break the core and destroy the cable.
The maximum bending radius is 100mm!
Further avoid touching the ends with bare fingers and **replace the caps on either the cable or camera / board** to protect the sensitive optical surfaces from dust.

Lens Mount

SensiCam has a **standard C-Mount** with a back focal length of 17.52mm (Distance between front edge of C-Mount and CCD-sensor).
Standard C-Mount lenses or other lenses with their respective C-Mount adapter (e.g. photo camera lenses) can be used. The **maximum screw-in depth** of a lens (or adapter) is 9.5mm. Deeper screwing in (e.g. at some microscopes, special lenses) could destroy the protecting window of the camera (no warranty!).
The VGA Sensor has a 1/2“ format, the SVGA a 2/3“. We recommend to use for all SensiCam Versions a 2/3“ or 1“ compatible lens. Cameras with high resolution sensor should preferably be equipped with a high quality lens to take advantage of the high resolution.
Cameras with color sensor can be equipped optionally with a BG39 filter. This filter will be placed at the C-Mount ring. In this case the maximum screw-in depth is only 6mm instead of the 9.5mm.
.

Back Focal Length Adjustment



In case it might be necessary to adjust the back focal length, an appropriate allen screw key is included. A new adjustment could be necessary when the camera cannot be focused to infinity.
Loosen the two small allen screws at the knurled steel C-Mount insert and rotate the insert (M50x0.5 thread) to the desired position. To adjust to infinity, the lens must be set to infinity and the steel ring must be moved until you get a focused image.
Then secure the insert again by tightening the allen screws.

Insert Filters

Filters can be set in front of the CCD (e.g. a BG39 filter). For this purpose loose the two small allen screws at the bare steel C-Mount insert using the included allen screw key. The C-Mount insert should be screwed out completely. At the rear side of the C-Mount a milled deepening takes up a filter of 25mm diameter and maximum thickness of 2mm.
After mounting the filter, screw in the C-Mount insert, adjust it to the necessary back focal length to get a sharp image and tighten the allen screws again.

1.5 Powering Up

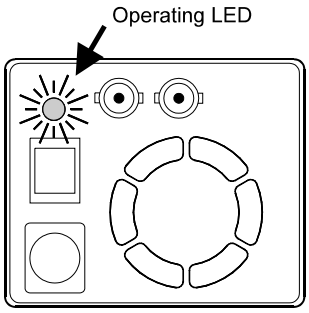
Check the following points:

- PCI-Board properly mounted?
- Camera-Board connection via double coaxial-cable or FOL properly made?
- Power supply connected to camera, to main?
- Objective lens mounted?

Switch on the computer

Switch the computer on but **do not start yet** the program CamWare

Switch on the camera



Switch the camera on by pressing the POWER button on the rear panel of the device. Observe the operation display (LED).
When properly attached, the LED will flash **red-green** for approx. 3 minutes. During this time, the system is cooled down to a temperature of approx. -15 degrees Centigrade (5 degrees Fahrenheit).
Subsequently, the diode will change to **permanently green**, indicating that the correct operation temperature has been reached and that you can now start measuring. In case the diode shows a **permanent red**, a hardware error has occurred.

The following table lists possible reasons for hardware errors.

Possible states of the LED

LED color	Status
red continuous	**Hardware error!** • Connection of Camera and PCI-Board mixed up or interrupted (check whether Tx is on Rx and vice versa) • Defective cable • Computer off • Temperature on CCD sensor above 65°C (causing automatic camera switch off)
red/green intermittent	System ready, however CCD has not yet reached its optimum temperature (-15°C). After a few minutes LED should change to continuous green. In case the intermittent state is going on constantly, there could be an error with the cooling. In this case please contact PCO.
Green continuous	**System ready!**

Starting CamWare

Now start the program „CamWare“ from the directory *Programme – Digital Camera ToolBox.*

For detailed information to CamWare please see the separate manual ‚CamWare’.

2. Functional Principle

The images, captured by the camera head, will be transferred via a high speed data transfer to the PCI-Board in the computer. The data will be saved in the RAM of the computer where the operator can decide what to do with them.
With the enclosed software ‚CamWare' the camera can be controlled within the windows environment and the images can be displayed on the monitor.
The Recorder function allows you to record image sequences and display them as "movies".
The maximum memory space for the recorded images depends solely on the RAM size of your computer.

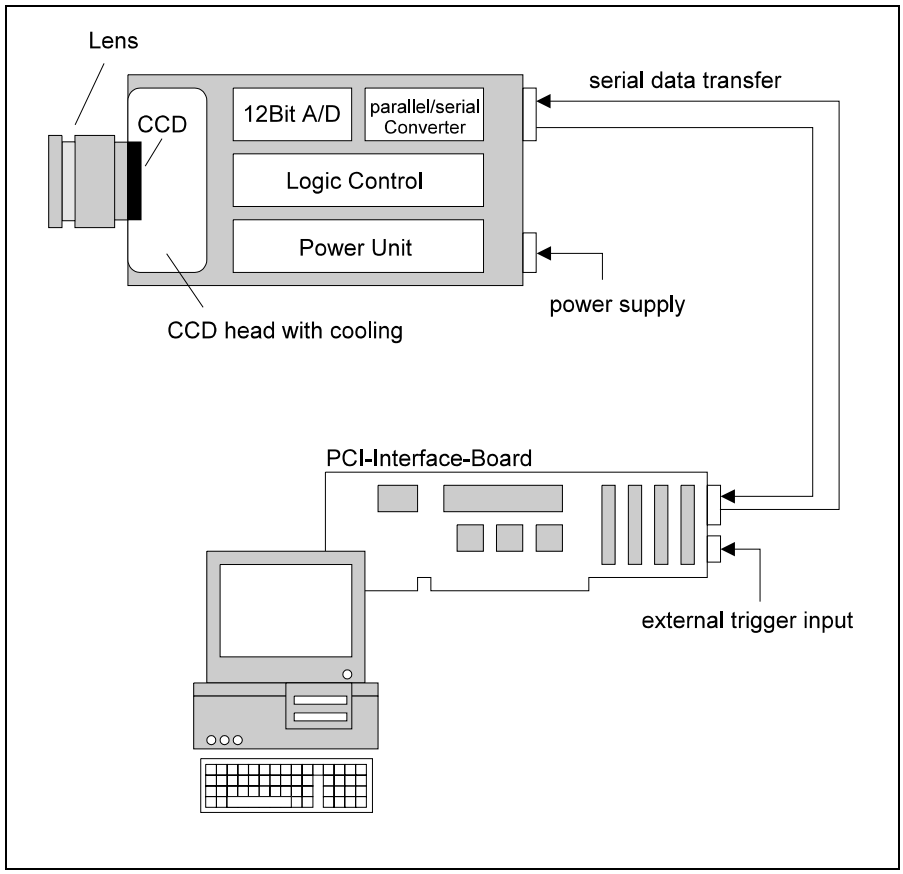
When starting the program, the software automatically recognizes the camera type.

For detailed information to CamWare please see the separate manual ‚CamWare'.

2.1 Block Diagram and Data Stream

Block Diagram

In the following block diagram the structure of the complete camera system is shown.



Internal Data Stream of black/white cameras

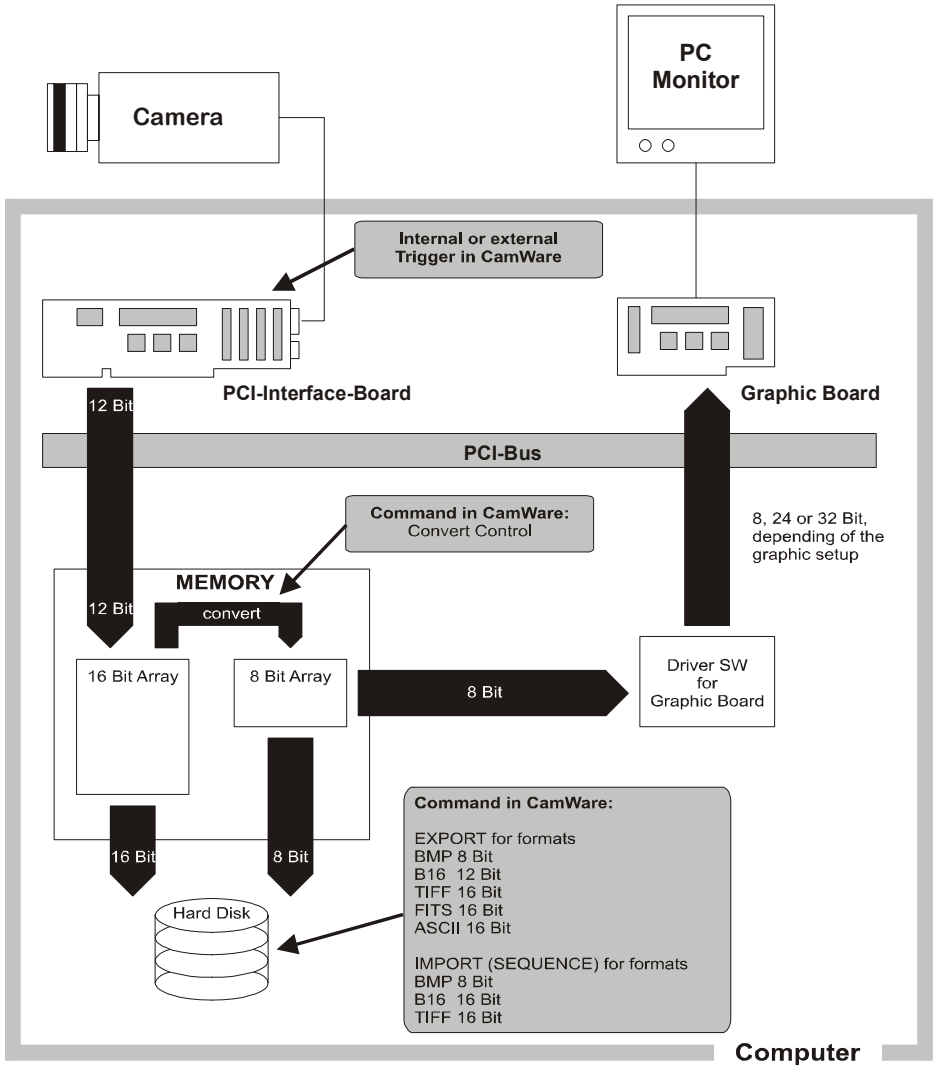
The PCI-Board gets the 12bit data from the camera and transfers it via PCI-Bus to a 16bit array (of the PC Memory). The higher 4bits are set to zero. The 16bit data are automatically converted in a 8bit array and accessed by the graphic board. Depending on graphic board setup display on the monitor is effected in 8, 24 or 32 bit.

File Formats

The command 'Export' stores 16bit or 8bit data on hard disk in B16, TIFF, FITS, BMP, or ASCII format.
For further information see Chapter 2.3.

Display

The camera which acquires always 12 bit images resolves with 4096 (2E12) grey levels between black and white, however the monitor display of the image is always limited to 8 bit and therefore to 256 (2E8) grey levels.
The command 'Convert Control' allows to select a discretionary range between 0 ... 4095 grey levels which is then displayed in 256 grey levels on the PC monitor.



Internal Data Stream of color cameras

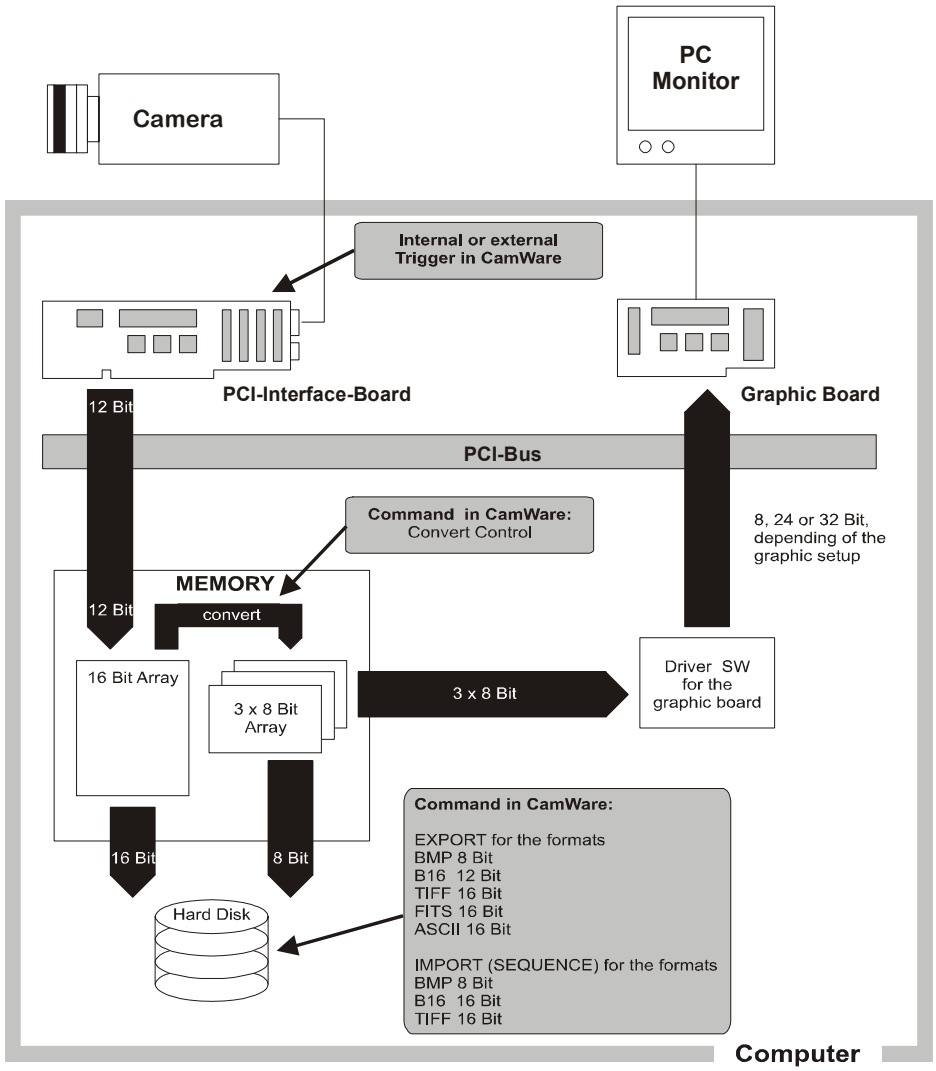
The PCI-Board gets the 12bit data from the camera and transfers it via PCI-Bus to a 16bit array (of the PC memory). The higher 4bits are set to zero. The 16 bit data are converted automatically into a 3 x 8 bit array and accessed by the graphic board. We recommend to display it in 32bits on the monitor.

File Formats

The command 'Export' stores 16bit or 8bit data on hard disk in B16, TIFF, FITS, BMP, or ASCII format.
For further information see Chapter 2.3.

Display

The camera which acquires always 12 bit images resolves with 4096 (2E12) grey levels between black and white, however the monitor display of the image is always limited to 8 bit and therefore to 256 (2E8) grey levels.
The command 'Convert Control' allows to select a discretionary range between 0 ... 4095 grey levels which is then displayed in 256 grey levels on the PC monitor.



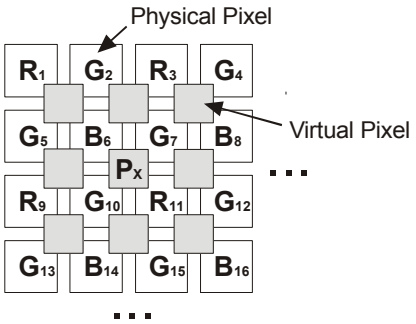
2.2 Color Definition Algorithm

Color sensors with RGB filter for the colors red, green and blue are used for the color cameras. The CCD sensor records for each pixel the light information as grey level with 12 Bit dynamic (RX, GX, BX).
With the help of the camera control software, for each pixel the 12 Bit data is converted by interpolating into a 8 Bit triplet (P_{RED}, P_{GREEN}, P_{BLUE}).
For this interpolation following algorithm is applied:

Algorithm 1

This algorithm optimises the color resolution.
A red, green and blue part of the color for virtual pixels will be calculated. These virtual pixels are placed between the original pixels. In CamWare this algorithm is also called as 'Smooth'.

- The first pixel on the top left side is **always** "red".
- Between the physical pixels, there are virtual pixels P_X which are computed with the algorithm described below.



Conversion algorithm for the new pixel P_X:

P_{RED} = (9 R_{11} + 3 R_3 + 3 R_9 + R_1)/16
P_{GREEN} = (G_7 + G_{10})/2
P_{BLUE} = (9 B_6 + 3 B_8 + 3 B_{14} + B_{16})/16

Algorithm 2

This algorithm optimises the spatial resolution. For each physical pixel, a color value (red, green and blue) is calculated, related to the corresponding neighbour pixel.

Example for $Pixel_6$
P_{RED} = (R_1 + R_3 + R_9 + R_{11})/4
P_{GREEN} = (G_2 + G_5 + G_7 + G_{10})/4
P_{BLUE} = B_6

Example for $Pixel_7$
P_{RED} = (R_3 + R_{11})/2
P_{GREEN} = G_7
P_{BLUE} = (B_6 + B_8)/2

2.3 Operating several Cameras from one Computer

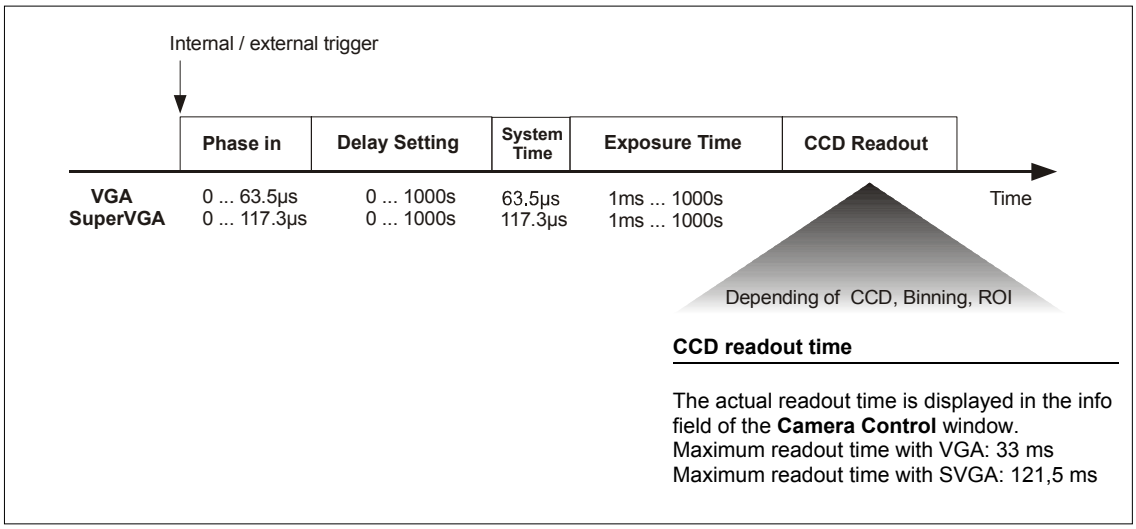
You can operate up to four cameras from one computer. The corresponding PCI boards have to be installed in the computer. For detailed information about operating the cameras please see the separate manual ‘CamWare’.

3. Timing

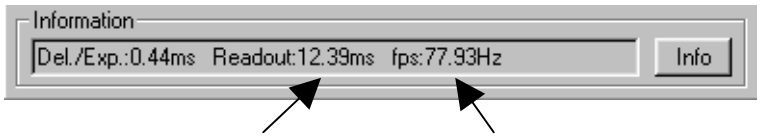
3.1 SensiCam LongExposure

With the SensiCam LongExposure you can realize exposure times between 1ms and 1000s. The exposure (sequence) will be started with an internal or external trigger signal.
The incoming light will be integrated on the CCD sensor and read out as 12 bit data to the PC.

Among the free programmable delay- and exposure times there are also system times (phase in, system time, CCD readout time) which have an influence to the camera timing.
Please find the detailed camera timing in the following overview.



Info field in the **Camera Control** window



CCD readout time Image repetition rate (fps)

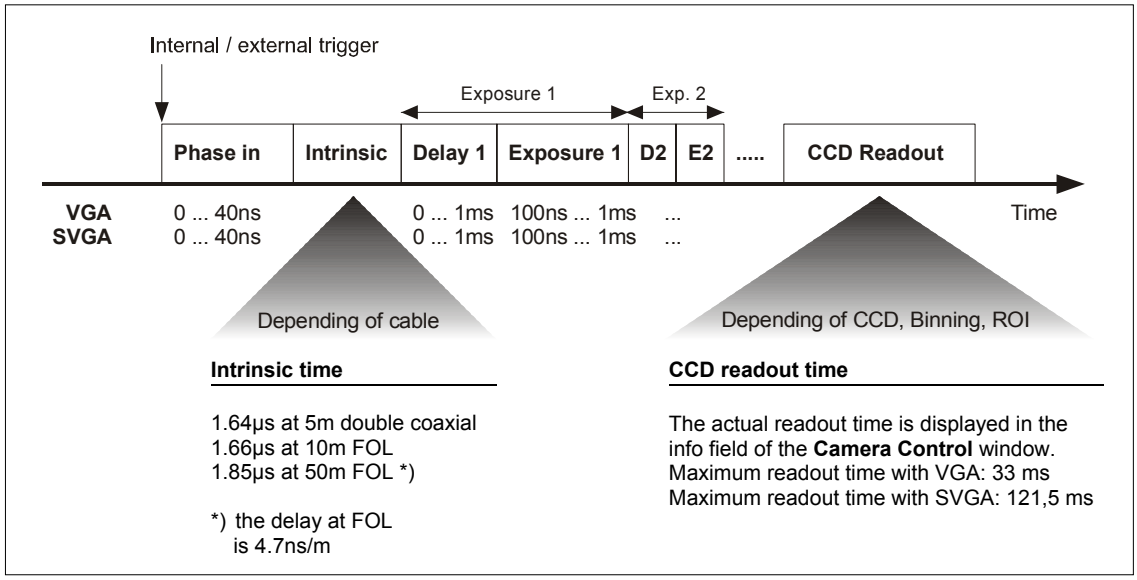
3.2 SensiCam FastShutter

The SensiCam FastShutter can be operated in the Standard Mode and in the Fast Cycles Mode. In the field ‘Options’ you can select the desired mode.
For each mode you will get a separate Camera Control window.

3.2.1 SensiCam FastShutter in Standard Mode

In the standard mode you can make single and multiple exposures with times between 100ns and 1ms. The multiple exposure allows you to make maximum 10 pairs of delay and exposure, free programmable.
The exposure must be started by an internal or external trigger signal (one trigger pulse for the complete multiple exposure). The digital 12 bit image will be read out from the CCD immediately after the exposure.
If you want to write a sequence of exposures into the allocated memory buffer, you have to trigger each single exposure and each multiple exposure block separately.

Among the free programmable delay- and exposure times there are also system times (phase in, intrinsic, CCD readout time) which have an influence to the camera timing.
Please find the detailed camera timing in the following overview.



Intrinsic time

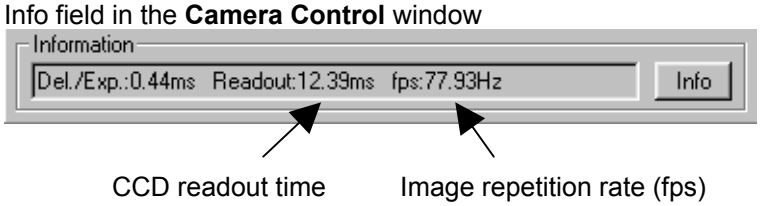
1.64µs at 5m double coaxial
1.66µs at 10m FOL
1.85µs at 50m FOL *)

*) the delay at FOL is 4.7ns/m

CCD readout time

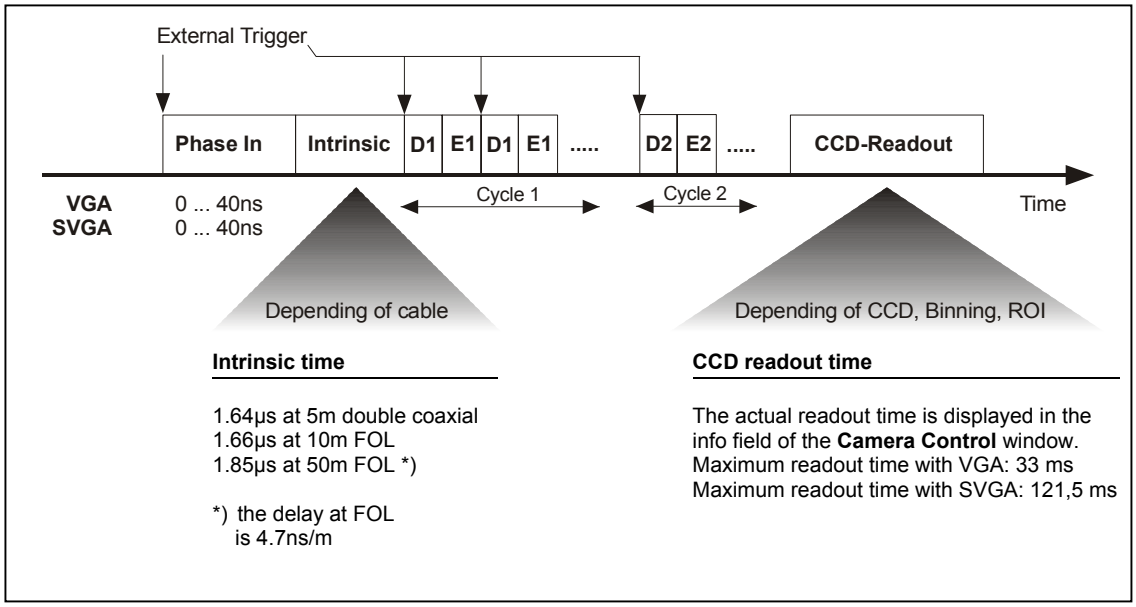
The actual readout time is displayed in the info field of the **Camera Control** window.
Maximum readout time with VGA: 33 ms
Maximum readout time with SVGA: 121,5 ms

Info field in the **Camera Control** window



3.2.2 SensiCam FastShutter in Cycles Mode

In the Fast Cycles Mode up to five blocks can be programmed. Every block consists of delay-, exposure time and cycle counter.
In the cycle counter you select the number repeating the pair delay and exposure. The exposures of all five blocks will be integrated on the sensor to one single image. After the last exposed cycle in block five the sensor will be read out, not before!
Each exposure must be triggered separately (also within the blocks)!
Among the free programmable delay- and exposure times there are also system times (phase in, intrinsic, CCD readout time) which have an influence to the camera timing.
Please find the detailed camera timing in the following overview.



Info field in the **Camera Control** window

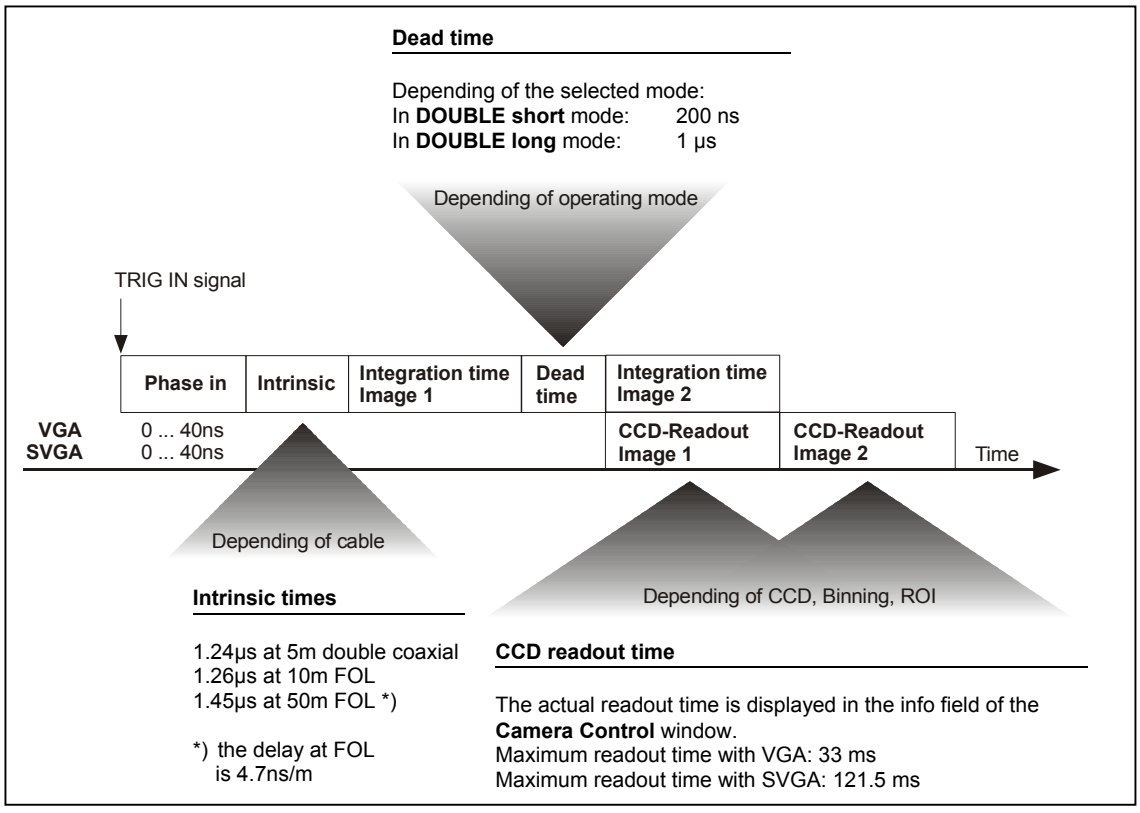


3.3 SensiCam DoubleShutter

With the SensiCam DoubleShutter you can make two separate images with full resolution (1280 x 1024 with SVGA sensor or 640 x 480 with VGA sensor). The minimum time between the two images is 200ns.
The integration time for the 1st image is defined by the user by setting the length of the externally given signal TRIG IN. The characteristic range is from 1µs to 10ms. The integration time of the 2nd image **is exclusively determined** by the CCD readout time for the 1st picture. This means, the user has no direct influence on the durance of the second integration time and thus on the second exposure.
In case a shorter exposure time is required within this time window of the second integration time, an external control should be used, e.g. by Laser, flash, mechanical shutter, … In that case the environment light should be darkened.

Among the free programmable delay- and exposure times there are also system times (phase in, intrinsic, dead time, CCD readout time) which have an influence to the camera timing.
Please find the detailed camera timing in the following overview.

Remark The SensiCam DoubleShutter has included all features of the SensiCam FastShutter.

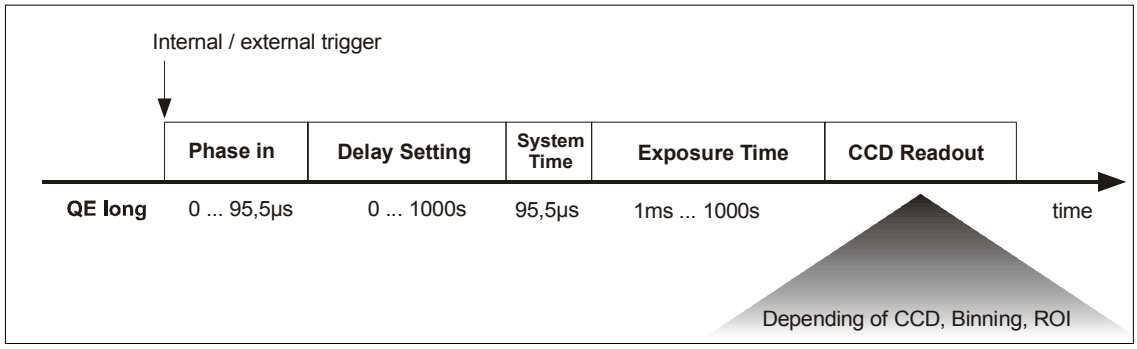


3.4 SensiCamQE Standard

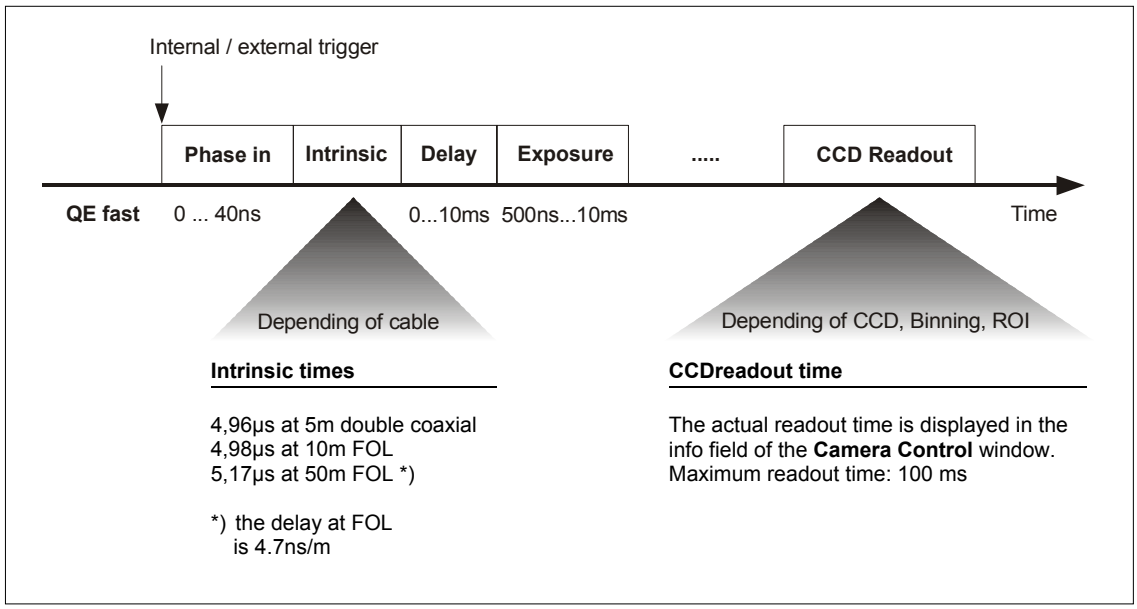
With the SensiCamQE Standard you can realize exposure times between 500ns and 1000s. The exposure (sequence) will be started with an internal or external trigger signal.
The incoming light will be integrated on the CCD sensor and read out as 12 bit data to the PC.

Among the free programmable delay- and exposure times there are also system times (phase in, system time, CCD readout time) which have an influence to the camera timing.

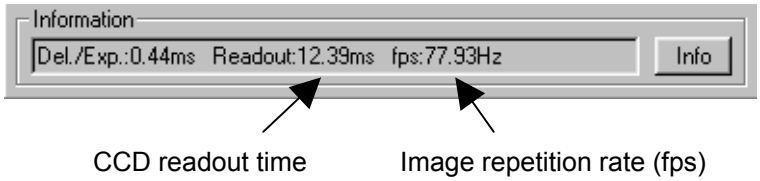
Camera timing in mode ‚LONG'



Camera timing in mode ‚FAST'



Info field in the **Camera Control** window

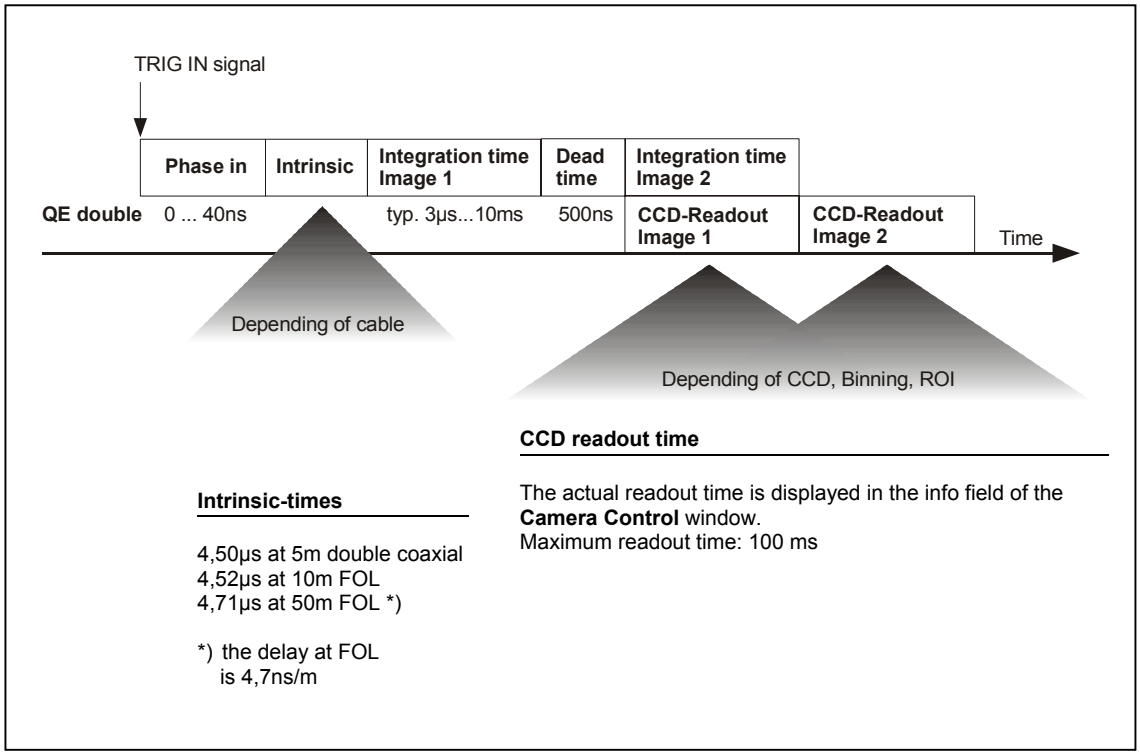


3.5 SensiCamQE DoubleShutter

With the SensiCamQE DoubleShutter you can make two separate images with full resolution (1280 x 1024 with SVGA sensor or 640 x 480 with VGA sensor). The minimum time between the two images is 500ns.
The integration time for the 1st image is defined by the user by setting the length of the externally given signal TRIG IN. The characteristic range is from 3µs to 10ms. The integration time of the 2nd image **is exclusively determined** by the CCD readout time for the 1st picture. This means, the user has no direct influence on the durance of the second integration time and thus on the second exposure.
In case a shorter exposure time is required within this time window of the second integration time, an external control should be used, e.g. by Laser, flash, mechanical shutter, … In that case the environment light should be darkened.

Among the free programmable delay- and exposure times there are also system times (phase in, intrinsic, dead time, CCD readout time) which have an influence to the camera timing.
Please find the detailed camera timing in the following overview.

Camera timing in mode ‚DOUBLE'



Intrinsic-times

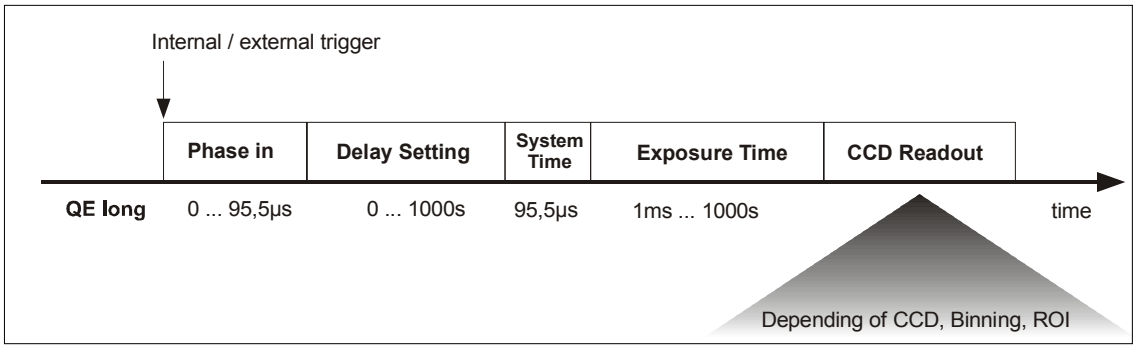
4,50µs at 5m double coaxial
4,52µs at 10m FOL
4,71µs at 50m FOL *)

*) the delay at FOL is 4,7ns/m

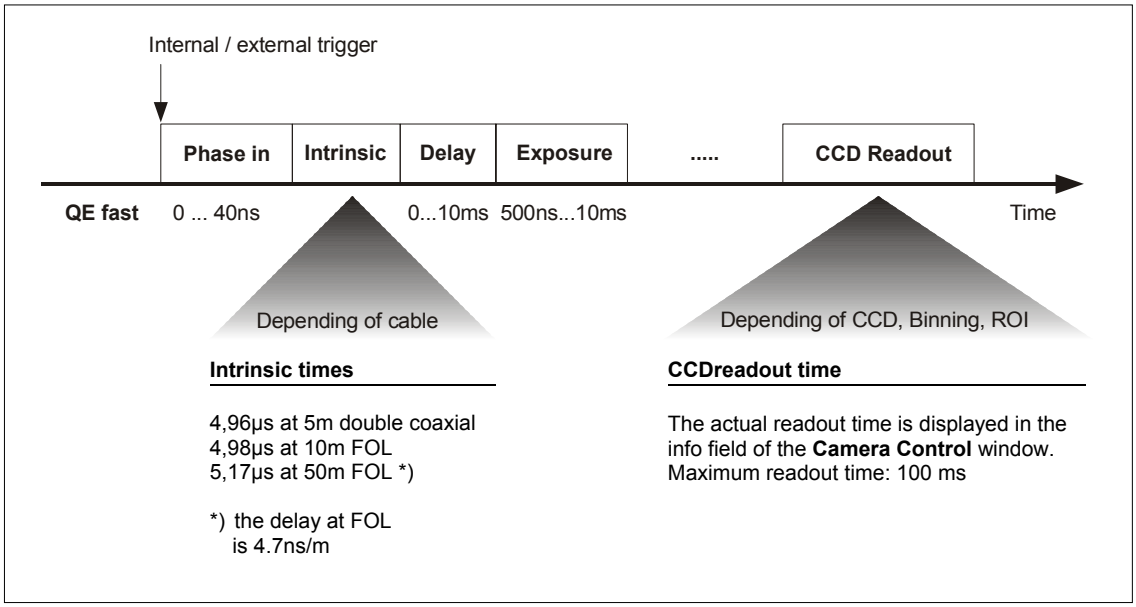
CCD readout time

The actual readout time is displayed in the info field of the **Camera Control** window.
Maximum readout time: 100 ms

Camera timing in mode ‚LONG'



Camera timing in mode ‚FAST'



Intrinsic times

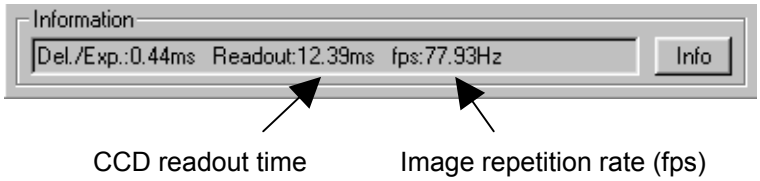
4,96µs at 5m double coaxial
4,98µs at 10m FOL
5,17µs at 50m FOL *)

*) the delay at FOL is 4.7ns/m

CCDreadout time

The actual readout time is displayed in the info field of the **Camera Control** window.
Maximum readout time: 100 ms

Info field in the **Camera Control** window



4. Trigger Control

The SensiCam can be triggered internally or externally. Depending of the camera version, you have the following trigger mode. Please see chapter 3 for a detailed timing of each camera version.

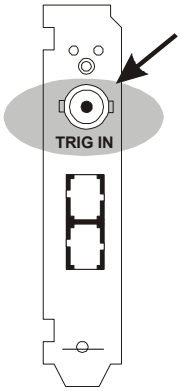
SensiCam Long Exposure and SensiCam QE
external triggering, external falling edge
external triggering, external rising edge
internal triggering, auto sequential
internal triggering, auto simultaneous (only for SensiCamQE in mode 'LONG')

SensiCam Fast Shutter (Standard Mode)
external triggering, external falling edge
external triggering, external rising edge
internal triggering, auto sequential

SensiCam Fast Shutter (Fast Cycles Mode)
external triggering, external falling edge
external triggering, external rising edge

SensiCam Double Shutter
external triggering, external falling edge
external triggering, external rising edge

External trigger "external falling" and "external rising"

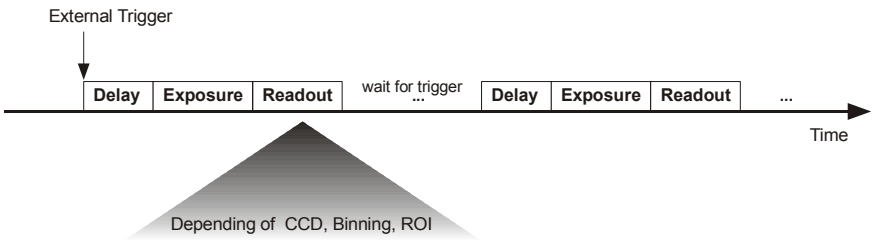


External triggering is handled via a TTL signal (low = 0V, high = 5V) which is fed in through the BNC plug on the PCI-Board.

The TTL signal can be both, "low active" (external falling) or "high active" (external rising).

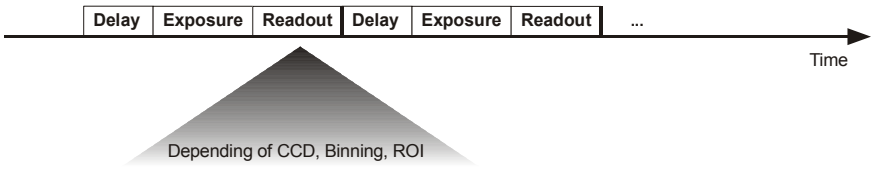
external falling = 1kΩ pull up
external rising = 1kΩ pull down

When not switched on, the trigger input is held at +5V, using a 1kΩ resistance. Thus, an external trigger signal might also produced by a short-circuit toggle.



Internal trigger "auto sequential" and "none"

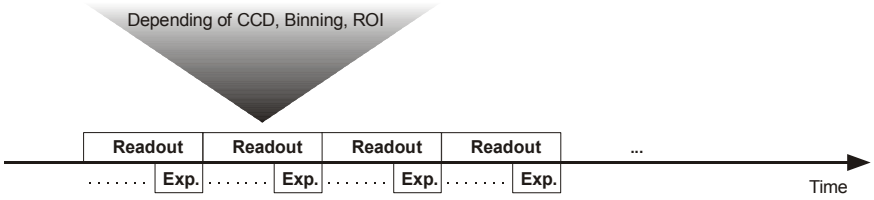
This trigger mode leads to a continuously repeated exposure of the chosen sequence.
The defined delay and exposure times always start only after read out.



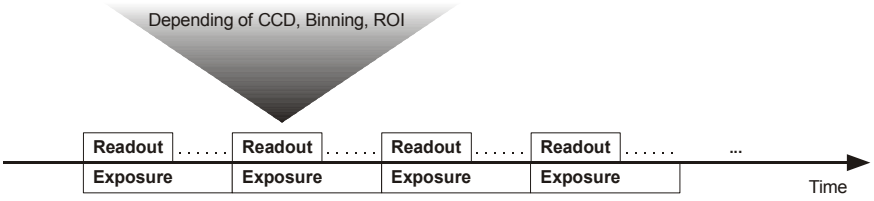
Internal trigger „auto simultaneous“

This trigger mode allows you to expose while reading out. If the exposure time is set shorter than the read out time, you can obtain the maximum imaging frequency (which depends on the given CCD sensor and on the binning). Otherwise, the picture sequence frequency depends on the durance of the set exposure time.
This mode does not allow delay time setting!

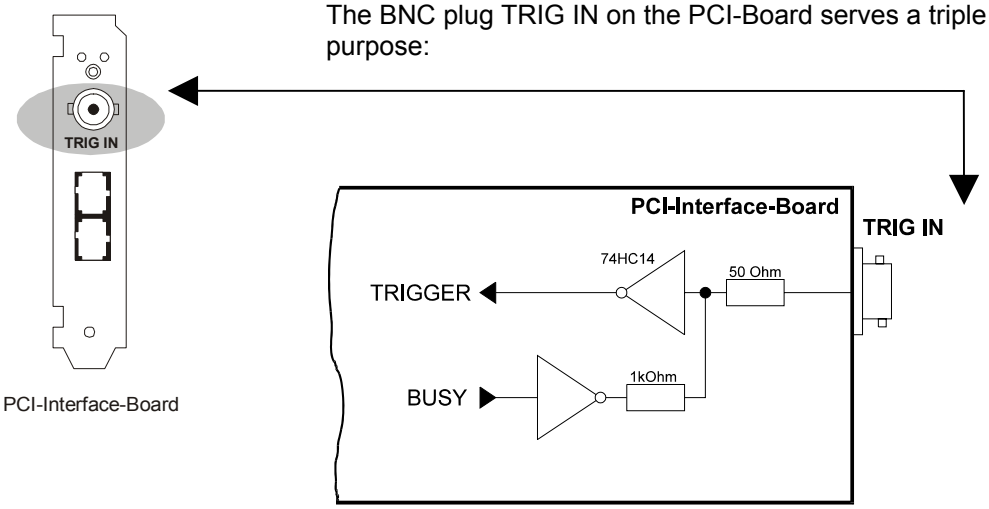
Exposure time < CCD readout time



Exposure time > CCD readout time



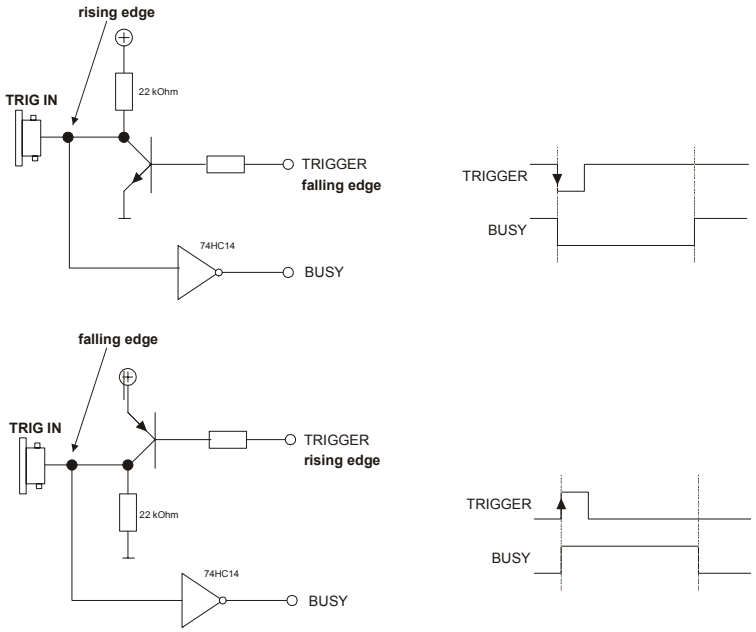
TRIG IN plug on the PCI-Board

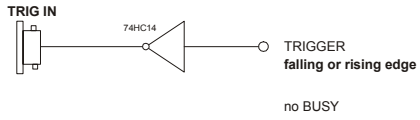


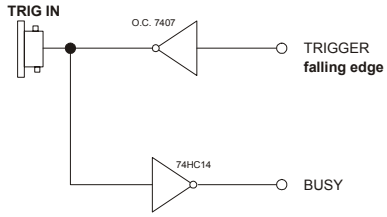
The BNC plug TRIG IN on the PCI-Board serves a triple purpose:

Function 1: Trigger Input
The camera system can be triggered via external, edge active TTL signal.

Function 2: Control Output
The BUSY signal and the EXPOS signal can be captured at this output. The same BUSY signal is available at the jack plug socket /see following page).
BUSY is active from the start of the trigger signal until writing into the PCI-Board buffer. No exposure is started during this period.



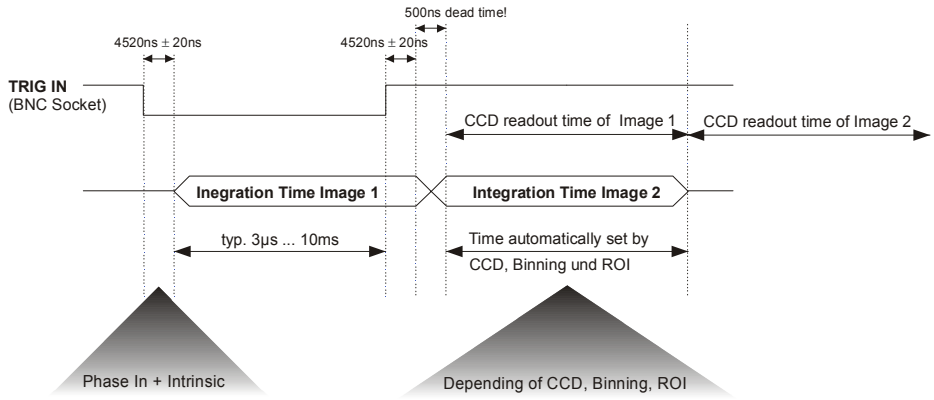




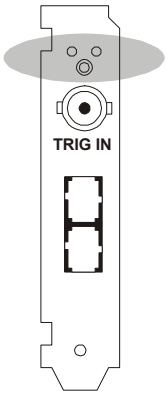
When using SensiCam LongExposure or SensiCam QE an additional signal, called **EXPOS**, is available. EXPOS is active while exposing. It is a high active signal (TTL), beginning 1ms before the start of the exposure time (when delay ≥1ms) and ending 5ms before the exposure time stops (when exposure time >5ms). EXPOS can only be used in internal triggering mode (auto sequential or auto simultaneous).
Please contact us for detailed information.

Function 3: Control of double exposure
(Only for SensiCam DoubleShutter)
The course of the double exposure must be controlled via an external TTL trigger signal (TRIG IN).

The timing in the following diagram corresponds to a SensiCam DoubleShutter with coaxial cable.

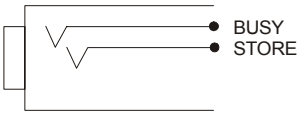


Jack Plug Socket at the PCI-Board



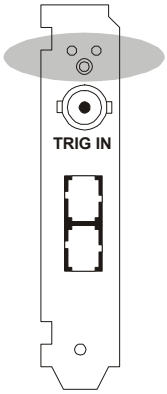
The 3.5mm stereo jack plug socket at the PCI-Board has a double function:

Function 1: BUSY Signal
This control output signals if the camera is ready to accept a new trigger signal. While BUSY is active, an external trigger signal will be ignored.
The BUSY signal edge depends of the selected trigger input edge of the TRIG IN signal. When the trigger input is falling edge (selected in the CameraControl window), an output signal low means the camera is busy, an output signal high means the cameras is ready to accept a new trigger signal.



Function 2: STORE Signal
Control Output (high active)
STORE signals the data transfer from the camera to the PCI-Board.

LEDs at the PCI-Board



There are two LEDs at the metal holder of the PCI-Board.

Green LED
Control LED is lighting when connection between camera and PCI-Board is correct.
When the LED is off, there could be the following reasons:

- Cable is not or wrong connected. When using a coaxial cables, the Tx must be connected to Rx and Rx to Tx.
- Cable defective

Red LED
This LED signals the DMA data transfer via the PCI-Bus from the PCI-Board memory to the computer RAM.

5. Software

Application Software

Shipment of the camera system includes the **CamWare** software, a complete operation software for the camera allowing to display and to save images.

For detailed information to CamWare please see the separate manual ‚CamWare'.

Plug-Ins

In case you are already working with an image processing or image analysis software appropriate Plug-Ins may be installed. Consequently camera control commands can be sent directly from the image analysis software.

- OPTIMAS, version 6.1 and higher (Media Cybernetics)
- Image-Pro Plus, version 3.0 and higher (Media Cybernetics)
- MetaMorph / MetaFluor Software (Universal Imaging)
- PMIS (GKRCC)
- IPLab Software (Scanalytics)
- LabView (National Instruments)
- AxioVision (Carl Zeiss)
- Axon Workbench (Axon Inc.)

Please feel free to ask for information about these programs.
In case your software is not listed above, please contact PCO.

Software Development Kit

In case you have written your own software or you wish to include the control software into already existing programs, the camera control may be integrated as DLL file by using our Software Development Kit (SDK).

The following SDK's with detailed manual are available:
- SDK for Windows 9x/ME/2000/NT/XP
- SDK for Linux

The SDK can be found on the CD or can be downloaded from Internet under **http://www.pco.de**.

Drivers

To work with the camera properly a Twain driver and the following PCI-Board drivers are available:
- PCI-Board driver for Windows 9x/ME/2000/XP
- PCI-Board driver for Windows NT
- PCI-Board driver for Linux

The drivers can be found on the CD or can be downloaded from Internet under **http://www.pco.de**.

6. Cooling Options

These options prove to be very helpful in extremely critical optical settings, like e.g. special microscopes, preventing possible vibrations caused by the camera ventilator. The SensiCam system can be delivered with one of the following two cooling options.

Detached fan cooling

For this cooling option the camera ventilator is placed at the end of a flexible hose with a length of 4 m (13 feet) and a diameter of 25 mm (1/10 inch). The external ventilator can be positioned on the floor. The camera's power switch also switches the ventilator on or off.
In case of hearing an unusual air whiz, it could be caused by a standing wave in the tube. By simply shorten of the tube of a few centimetres, the problem can be solved.

Water Cooling

The generated heat is removed by a water circulation instead of a ventilator.
On the bottom side of the camera there are two connections for water inflow and outflow. Shipment of this version includes two 5 meter tubes with quick-plugs serving as inflow and outflow. We recommend to directly feed the circulation from the water pipe. It suffices to have a minimum water circulation of approx. 2-3 cm jet (1 inch) at the outflow tube.

7. Servicing, Maintenance and Cleaning Instructions

Servicing, Maintenance and Cleaning Instructions

The camera is maintenance-free.
Factory settings make any inspection and servicing superfluous.

During use the camera should be protected from hard shocks or strong vibrations.
Also should the camera be protected from high humidity and temperature shocks. Avoid exposing to sunlight, since it heats up the camera housing unnecessarily and prevents the cooling from reaching its optimum operating temperature.
Keep apertures and slots free to allow air to circulate.

Objective lens or lens adapter should be screwed in gently. Avoid forcing as it will damage the tread.

Use a soft and dry cloth to clean the housing.

Cleaning Method for the Optical Part

In principle every cleaning method bears the danger of damaging an optical surface.
Therefore clean only if it is strictly necessary.

As a first step use dry air to blow out dust particles. Avoid strictly to wipe on a dry glass surface.
In case dirt cannot be removed by blowing, use special optical cleaning fluids. Adequate fluids for optical surfaces are: pure dehydrogenated alcohol, pure acetone or cleaning fluids available in photo shops. Use a soaked cotton tip and take care to wipe only on glass surfaces, avoiding contact to metal surfaces, e.g. C-Mount thread, otherwise microscopic dirt and metallic chips are released, causing irreparable scratches on the glass surface.

Never use aggressive cleaning substances, e.g. benzine, spirit, nitro solvents, etc. commonly found in labs. Such substances may destroy or damage the surface on which they are applied.

Hint The best is to avoid any dirt on optical parts, e.g. by replacing immediately the black protection cap when removing the objective lens. Do not leave the camera's optical input window open, without lens or protecting cap.

Our warranty does not cover damaged optical surfaces caused by improper cleaning methods.

Cleaning Method for the FOL

The core of the Fiber Optic Link is a 64µm diameter glass fiber. The connectors and the fiber itself should be cleaned only by dry dust free air.
Again, after disconnecting, replace the respective protection caps on either camera and cables **immediately**.

8. Appendix

Customer Service

Having a problem or a question about matters not handled in these operating Instructions, we recommend to contact us :

... by Telephone 09441/2005-0
... by Fax 09441/2005-20
... by Email support@pco.de
... by Post PCO Computer Optics GmbH
Donaupark 11
D-93309 Kelheim
Germany

For a quicker reply we need following information:

- Short description of the problem
- Experiment conditions
- Settings of delay and exposure time
- Used camera control software and version number
- Camera serial number
- PCI-Board serial number (520 ... or 525 ...)
- Operating System
- Processor type of your computer
- Size of RAM
- Type of graphic board
- Graphic setup

Warranty

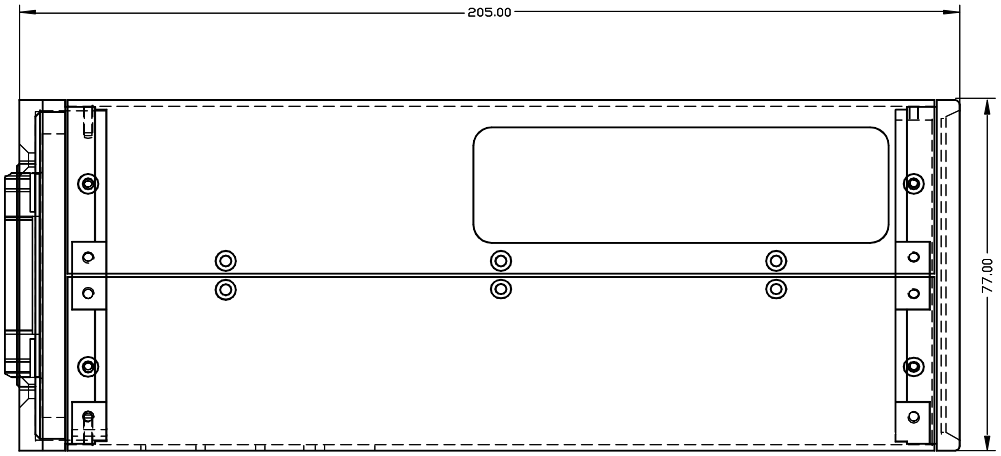
PCO grants a warranty by law for the SensiCam System (camera, PCI-Board, FOL or coaxial cable, power supply). The warranty period starts on day of delivery ex-factory. In case of defect within the warranty period replacement or repair will be made (at PCO's discretion) free of charge. The device shall be returned on customer's expenses to PCO, preferably in the original package.
PCO is not liable for consequential damages.
Before returning the camera, contact PCO via any of the Customer Services.
Pay attention to use a sufficient package if you have to send the camera via mail (keep the original package).
The FOL cable connectors and the connectors of the camera and PCI-Board must be protected with the protection caps. Don't forget to screw the C-Mount protection cap!

Attention Opening of the camera or improper handling (e.g. damage by electrostatic charge, wrong cleaning method) voids the warranty.

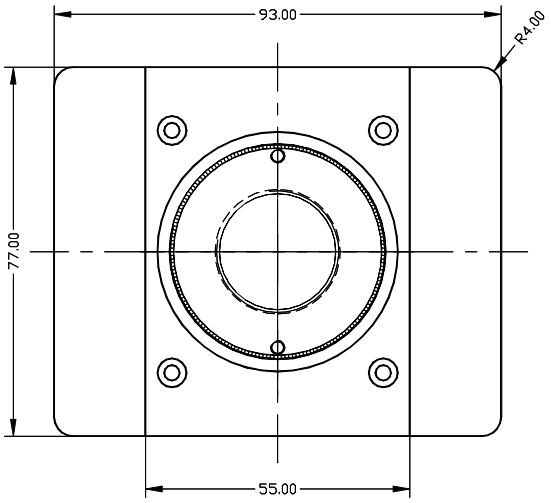
CE-Certification

SensiCam complies with the requirements of the „EMC Directions of the European Communities (089 / 336 / EWG)" and therefore bears the CE-Marking.

Dimensions and Weight

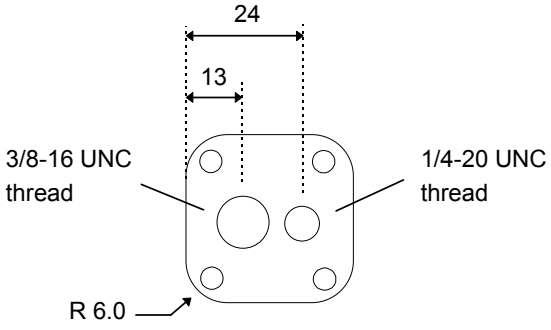


Lateral view of the SensiCam



Front view of the SensiCam

Tripod mount at the bottom



Weight: 1,6 kg

System Data

SensiCam	VGA	SVGA	SensiCam QE
Sensor Type	CCD-Interline Progressive Scan with “lens-on-chip“		
Number of Pixels	640(H) x 480(V)	1280(H) x 1024(V)	1376(H) x 1040(V)
Pixel Size	9.9µm x 9.9µm	6.7µm x 6.7µm	6.45µm x 6.45µm
Sensor Format	1/2“	2/3“	2/3“
Scan Area	6.3mm x 4.8mm	8.6mm x 6.9mm	8.9mm x 6.7mm
Cooling Type	2-stage peltier cooler with forced air cooling		
CCD Temperature	-15°C	-12°C	-12°C
Full Well Capacity	35.000 e^-	25.000 e^-	18.000 e^-
Scan Rate	12.5 MHz	12.5 MHz	16 MHz
Readout Noise @12.5 MHz	13 ... 14 e^-	7 ... 8 e^-	4 ... 5 e^- (Gain High) 5 ... 6 e^- (Gain Low)
A/D-Converter	12 Bit @12.5MHz		12 Bit @16MHz
A/D Conversion Factor	7.5 e^-/count	5 e^-/count	2 e^-/count (Gain High) 4 e^-/count (Gain Low)
Max. Quantum Efficiency monochrome, @ 520nm	≥ 40%		≥ 60%
Spectral Response (monochrome)	280 ... 1000nm		
Spectral Response (color)	RGB primary colors		not available
Average Dark Charge [7]	< 0.1 e^-/pixel·sec	< 0.1 e^-/pixel·sec	< 0.1 e^-/pixel·sec
Extinction Ratio [1]	1:2000	1:2000	1:2000
Smear [2]	< 0.005%	< 0.005%	< 0.005%
Anti Blooming [3]	> 1000	> 1000	max. 100
CCD Quality	grade 0	grade 0	grade 0
Non-Linearity	< 1%	< 1%	< 1%
Readout Frequency (Full Frame)	30 fps	8 fps	10 fps
Binning Horizontal	1...8		1…8
Binning Vertical	1...32		1...32
Blemishes			
Point Defects [4]	0	0	0
Cluster Defects [5]	0	0	0
Column Defects [6]	0	0	0
Warm Pixels [7] typ.			
# pixels > 100 e^-	0	0	0
# pixels > 5 e^-	0 - 2	0 - 2	0 - 2
# pixels > 1 e^-	250 - 1000	500 - 2000	500 - 2000
Non-Uniformity in darkness [8] typ.	1 count	1 count	1 count
Non-Uniformity in brightness [9] typ.	0.2%	0.6%	0.6%
# pixels > 12%	0	0	0
# pixels 8 ... 12%	0	0 - 2	0 - 2
# pixels 4 ... 8%	0	10 - 50	10 - 50
# pixels 2 ... 4%	0 - 5	n.a.	n.a.
Optical Input	C-Mount with adjustable focus length		
Dimension	Head: 93(W) x 78(H) x 210(L) mm		
Weight	1.6 kg		
Operating Temperature	0...40°C		
Storage Temperature	-20...+70°C		
Humidity	10...90% non condensing		
C-Mount Back Focal Length	17.92 mm		
Maximum lens screw-in depth	9.5mm (with optional filter glass: 6mm)		

x) See remarks on page 41.

High Speed Serial Link	
High Speed Serial Link	standard: coax cable ≤10m with BNC connectors optional: fiber optic link ≤2000m with SC connectors

PCI-Interface Board	
Board	PCI Local Bus compatible, revision 2.1
Buffer RAM	16 MByte
Trigger Input	TTL level (rising/falling edge); BNC connector

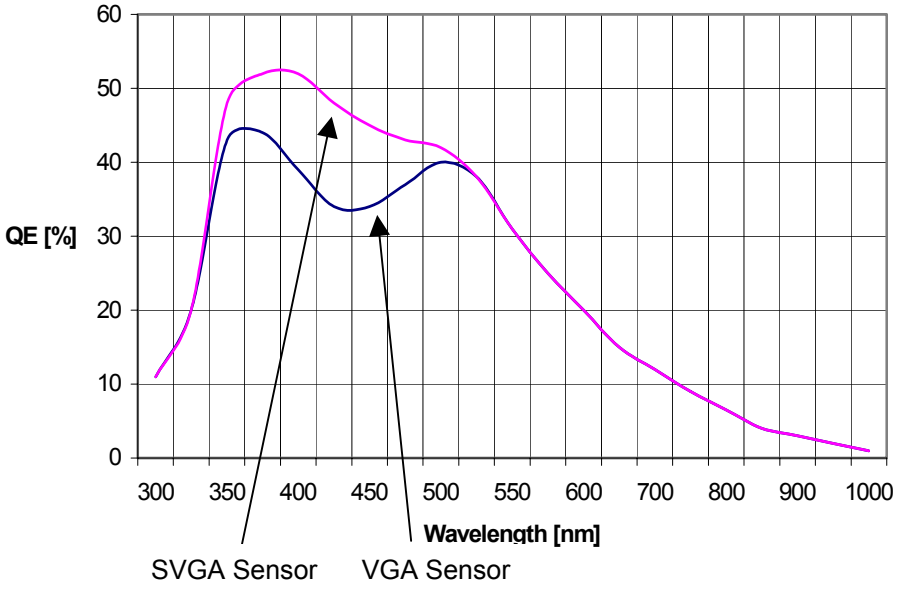
Delay / Exposure Time	
Delay / Exposure Time Setting **SensiCam** LONG EXPOSURE	0 ... 1000s delay 1ms...1000s exposure
Delay / Exposure Time Setting **SensiCam** FAST SHUTTER	0 ... 1ms delay 100ns...1ms multiple exposure (free programmable)
Delay / Exposure Time Setting **SensiCam** DOUBLE SHUTTER	two separate exposures with min. 200ns delay
Delay / Exposure Time Setting **SensiCamQE** STANDARD	0 ... 1000s delay 500ns...1000s exposure
Delay / Exposure Time Setting **SensiCamQE** DOUBLE SHUTTER	two separate exposures with min. 500ns delay

Power Supply	
Power Supply	Desktop AC/DC 90...260V/ 36W IEC connector

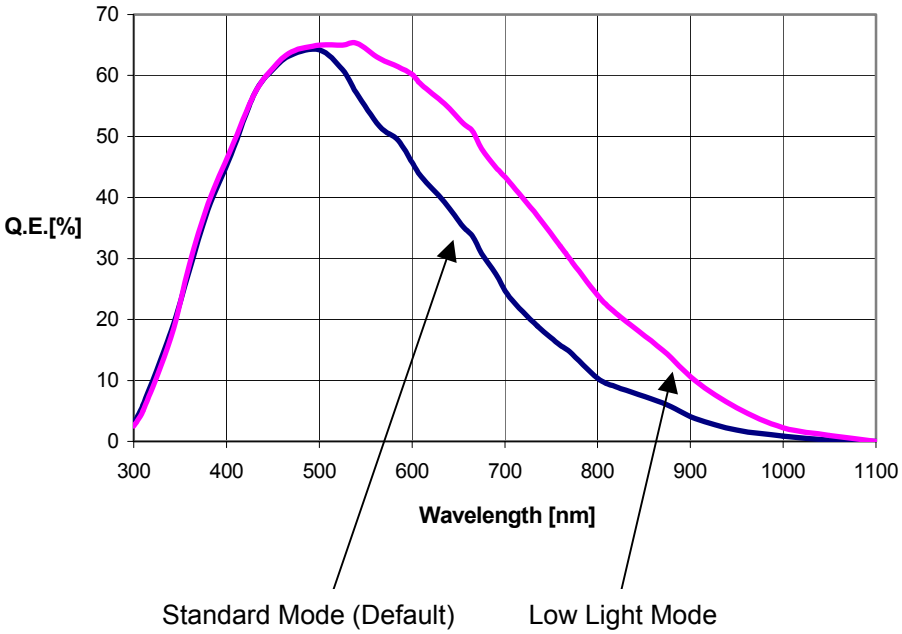
x) See remarks on page 41.

Spectral Response
(typical values)

SensiCam LongExposure
SensiCam FastShutter
SensiCam DoubleShutter



SensiCam QE



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Definitions and Measurement Conditions

1) Extinction ratio
It is the ratio of "electronic shutter off" V_{off} to "electronic shutter on" V_{on}. It is measured with an exposure time set to 100ns and a pulsed laser diode (20ns) illumination. During exposure window (100ns) light is attenuated by a factor of 1:1000 grey filter, while out of the exposure window filter is removed.

Thus: $$E = \frac{V_{off}}{V_{on}} \cdot \frac{1}{1000}$$

2) Smear
The CCD is set to 40ms exposure time with an uniform illumination to achieve 50% of saturation (V50). Then the electronic shutter is closed (readout clock is stopped, charge drain is performed by the electronic shutter) and the illumination is set to 500 times over exposure. After 40ms the CCD is read out.
The measured output signal (V_{Sm}) is substituted in the following formula:

$$Sm = \frac{V_{Sm}}{V50} \cdot \frac{1}{500} \cdot 100\%$$

3) Anti Blooming
The factor of over exposure allowed to avoid blooming in the neighbouring pixels.

4) Point Defect
Measured under Conditions A:
A point defect is a pixel whose signal deviates by more than 3 counts from the mean value of 48 neighbouring pixels (7x7 array).
Measured under Conditions B:
A point defect is a pixel whose signal deviates by more than 12 % from the mean value of 48 neighbouring pixels (7x7 array).

5) Cluster Defect
Measured under Conditions A.
Is a group of 2 ... 6 contiguous defective pixels.

6) Column Defect, Row Defect
Measured under Conditions A.
Is a group of more than 6 contiguous defective pixels along a single column or row.

7) Warm Pixel / Dark Charge
Measured under Conditions C.
A pixel is considered a warm pixel, if it has an increased dark charge generation.
No test for FastShutter version.

8) Non-Uniformity in darkness, compared to neighbouring pixels
Measured under Conditions A.
Non-uniformity of a single pixel is the deviation in counts, compared to the mean value of 48 neighbouring pixels (7x7 array).

9) Non-Uniformity in brightness, compared to neighbouring pixels
Measured under Conditions A or B.
Non-uniformity of a single pixel is the deviation in %, compared to the mean value of 48 neighbouring pixels (7x7 array).

typical deviation $$d_{typ.} = \sum_{1}^{n} |d_x|$$

with n = 307,200 for VGA (640 x 480 pixels)
with n = 1,310,720 for SVGA (1280 x 1024 pixels)

$$d_x = p_x - \sum_{1}^{48} \frac{p_n}{48}$$

d_x = deviation of the tested pixel
P_x = pixel to test
P_n = 48 neighbouring pixels (7x7 array)

Conditions for measurement

For all conditions the operating temperature is -15 °C for VGA and -12°C for SVGA

A : exposure time 40ms
Binning H1, V1
256 images averaged
dark field conditions

B : exposure time 40ms
Binning H1, V1
256 images averaged
uniform illumination to yield 75% saturation (about 3,000 counts)

C : exposure time 200 s
Binning H1, V1
16 images averaged
dark field conditions

Dear Customer,

We hope this camera will be an always valuable tool for your scientific day in, day out work.

Comments, suggestions or any new idea on our system are welcome.

We are at your disposal at any time, also after your buying of this camera.

Your PCO Team

pco.
imaging

PCO Computer Optics GmbH
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