DiCAM-PRO

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.

- While operating with the camera system please be careful that the image intensifier is not over exposed.
  While not using the camera, protect it by using a lens cap.

- 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.

Safety Instructions for safety use with Image Intensifiers

The camera contains a higly sensitive image intensifier, running on voltages of a few kV. To avoid damages or loss of quality, the camera should not be operated with a too high light input. The photocathodes's lifetime and its loss of sensitivity depends directly on the amount of light impinging on it. A few miliseconds or even microseconds may be sufficient to damage the photocathode if the light source is powerful enough. The photocathode is a thin layer of chemical substances transforming photons in photoelectrons which is eroded every time light strikes it while the photocathode is on. In extreme cases the layer is completely wore off and where it happens a black spot appears. The photocathode is now "blind" and there is no remedy. Bright light sources, e.g. lamps or daylight (for example while adjusting or focusing the camera) in a non-gated operation mode can permanently damage the photocathode, even when a monitor does not show any picture (when, for instance the MCP-Gain is set to a minimum).

Since the MCP is behind the cathode changing the MCP-Gain does not affect the photocathode. It is a wrong conclusion to assume lower gain would save the photocathode in an overexposed scene.

For a safe camera operation we recommend to start with a nearly closed iris (high f-stop, e. g. 22), short exposure time and maximum gain value (100%). If no image is visible or the gain not sufficient to yield an image the exposure time may be carefully increased or the iris opened step by step.

If the camera is not in use replace the cap in front of the lens or itensifier.

Operational Lifetime Values
The halflife of the image intensifier (time taken for a 50% decrease in sensitivity) is approximately 2000 hours at a light input of 1 mlux. A 10-times higher light input reduces the halflife to approx. 200 hs. This standard value is valid for light inputs of approx. 1 mlux.

Note In the gated mode a linear correspondence of halflife and light input does not apply.
In this case substantially higher light inputs are allowed.

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Operating Instructions DiCAM-PRO
Version 11/2004

1. Installation and Powering Up

The DiCAM-PRO 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 deinstallation 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

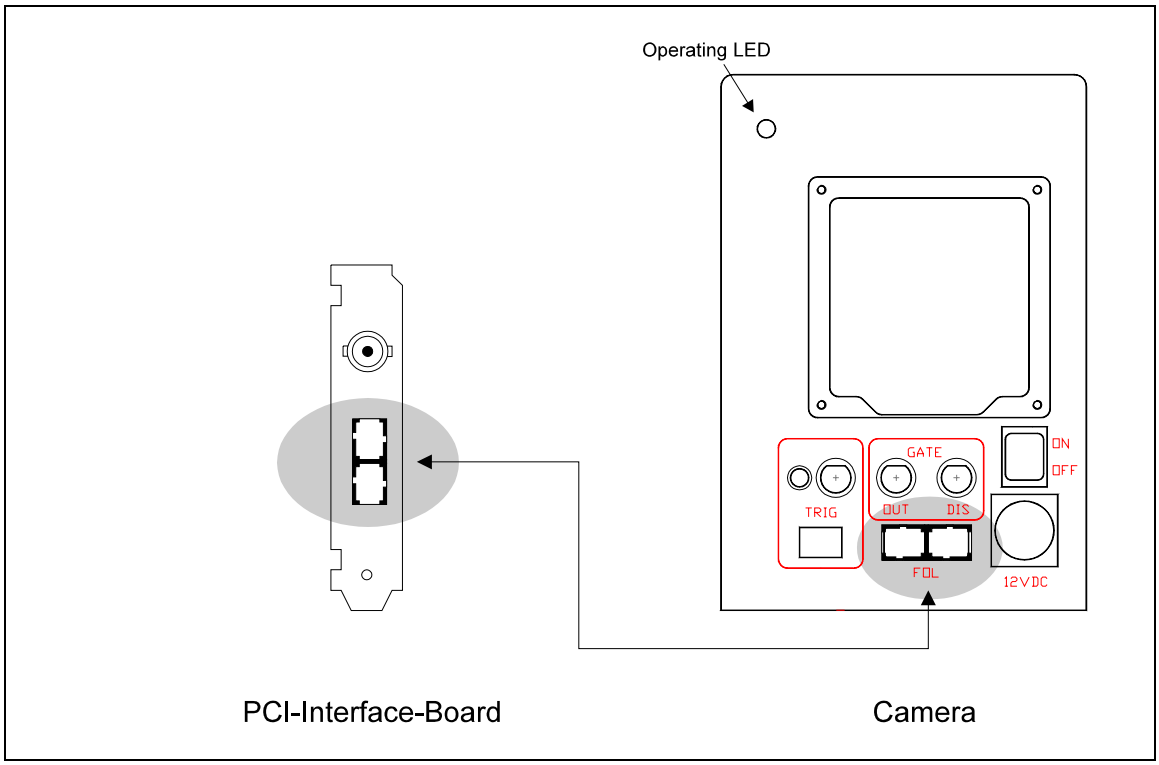
Before Powering Up, make following connections:

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

For the serial data transfer between camera and PCI-Board a fiber optic cable (FOL) is used.

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. Plug in the cable on both devices. Because of the plug shape the cables cannot be mixed up. The plugs should slip in easily. Do not force!



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. 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.
The small protection caps will be lost easily. Keep the caps on a safe place.

1.5 Lens Mount

Lens Mount

When unpacking the DiCAM-PRO a lens adapter for Nikon lenses (F-Mount) is included. It is already mounted on the camera. This adapter is fixed with three small Allen screws. It can be dismounted easily. You may also use customized adapters, taking care for the correct back focal length.

Remark

C-Mount lenses are not recommended in combination with 25mm intensifiers because the photocathode will not be used completely.

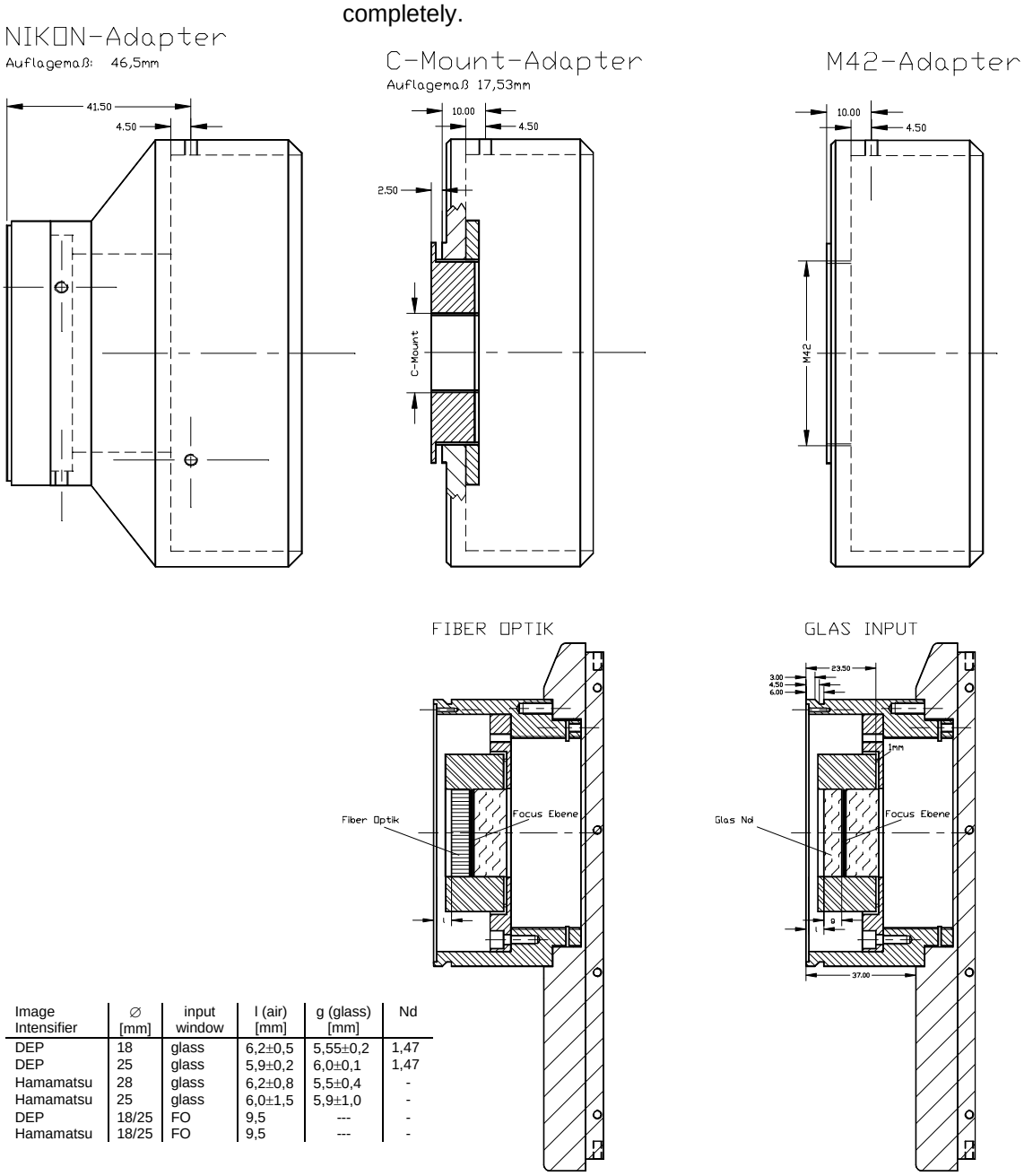


Image Intensifier	∅ [mm]	input window	l (air) [mm]	g (glass) [mm]	Nd
DEP	18	glass	6,2±0,5	5,55±0,2	1,47
DEP	25	glass	5,9±0,2	6,0±0,1	1,47
Hamamatsu	28	glass	6,2±0,8	5,5±0,4	-
Hamamatsu	25	glass	6,0±1,5	5,9±1,0	-
DEP	18/25	FO	9,5	---	-
Hamamatsu	18/25	FO	9,5	---	-

Front plate with placing of the image intensifier

1.6 Powering Up

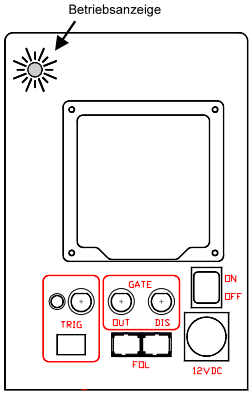
Check the following points:

- PCI-Board properly mounted?
- Camera-Board connection via FOL properly made?
- Power supply connected to camera, to main?
- Objective lens mounted?
- Protection cap **on** the lens?

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. -12 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 interrupted • 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 (-11 … -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.

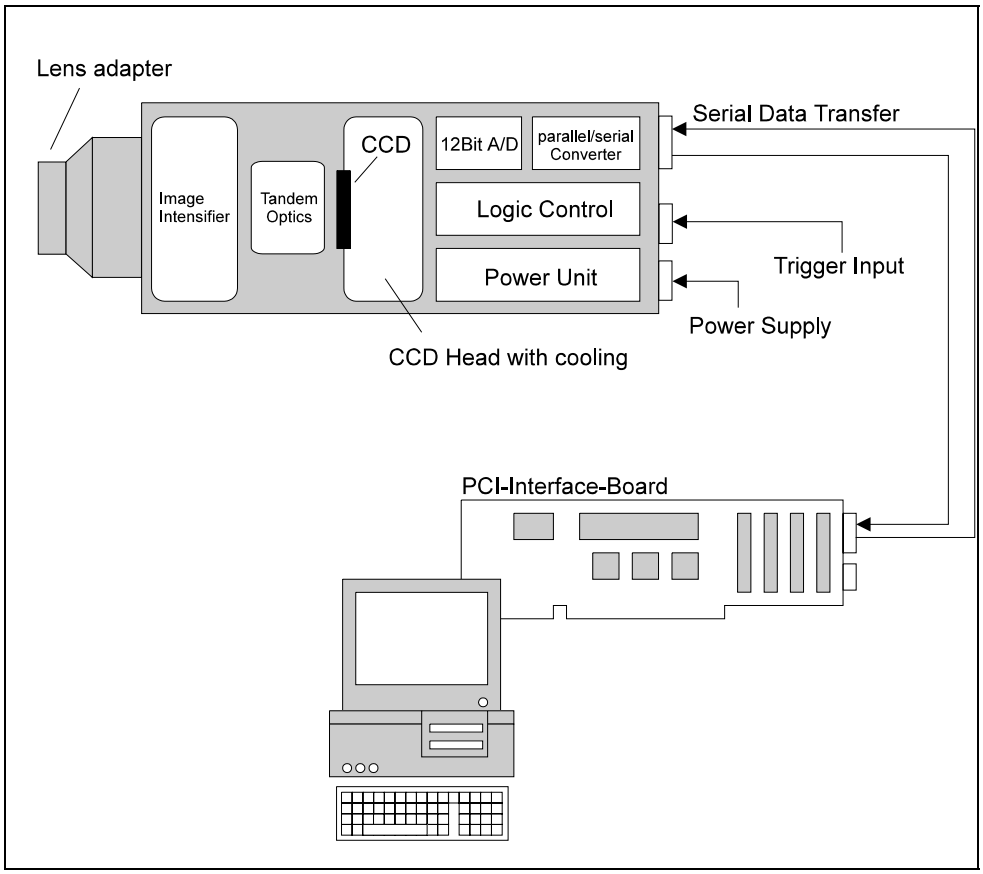
When starting the program, the software automatically recognizes the camera type.

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

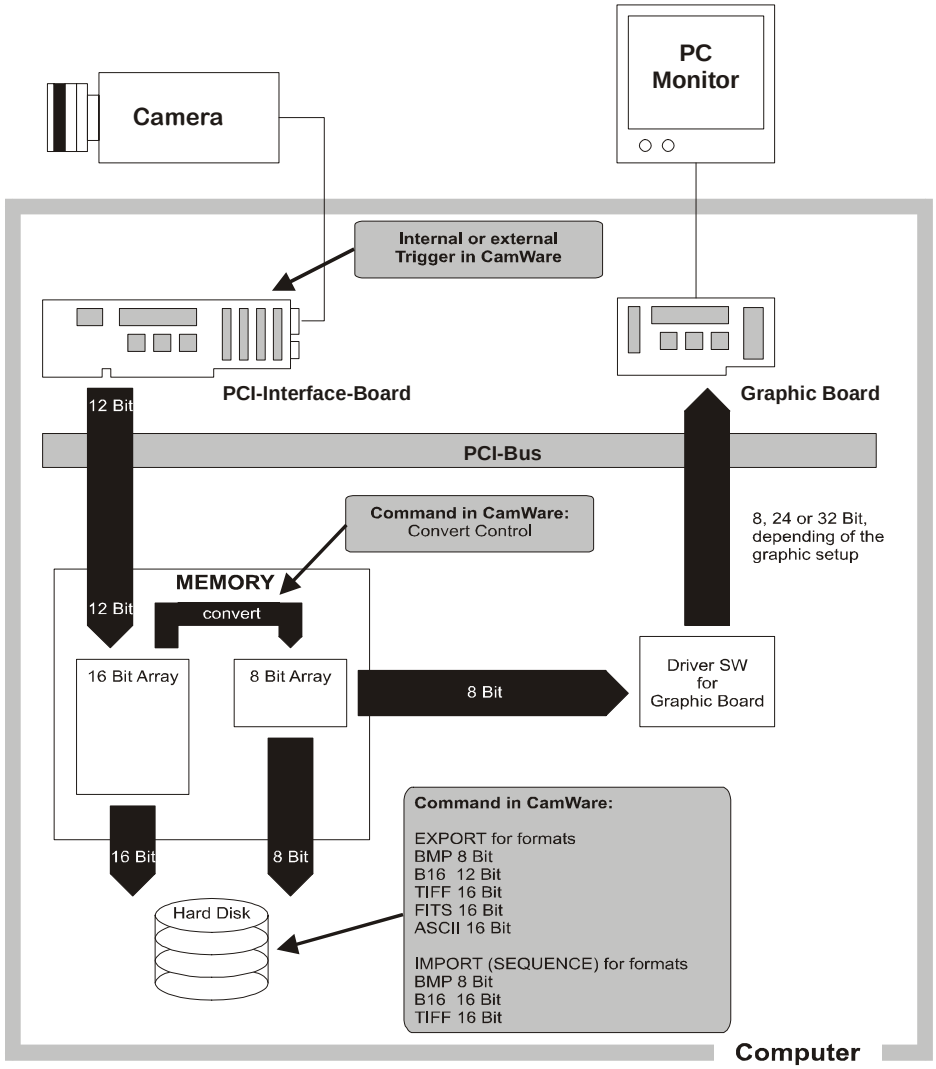
The PCI-Board gets the 12bit data from the camera and transfers it via PCI-Bus to a 16bit array (of the PC Memory). The higher 4bits are set to zero. The 16bit data are automatically converted in a 8bit array and accessed by the graphic board. Depending on graphic board setup display on the monitor is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

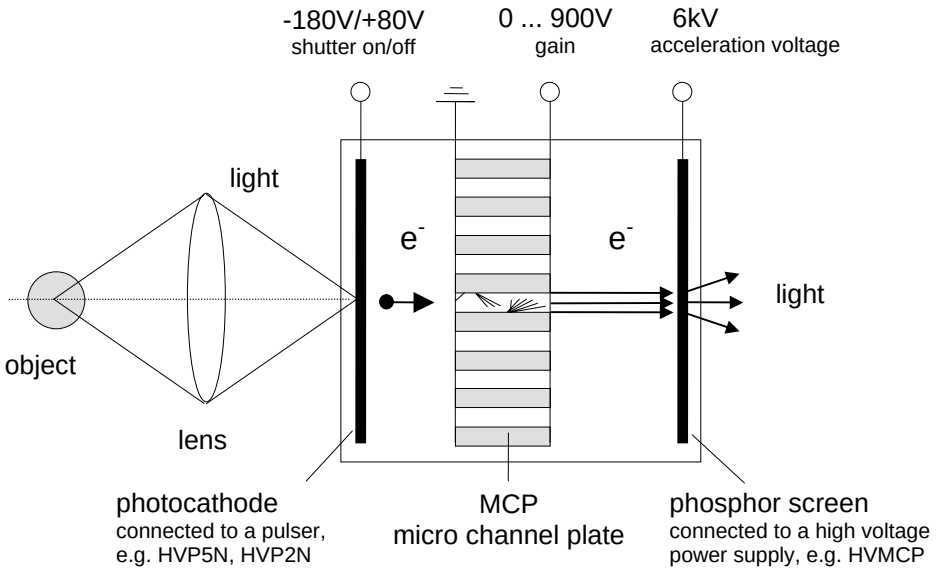
Display

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.



2.2 Principles of the Image Intensification

Following drawing sketches the function principle of the MCP intensifier.



Light emitted from an object releases photoelectrons at the photocathode. The photoelectrons enter the channels of a micro channel plate (MCP) where they are multiplied producing secondary electrons. Finally the accelerated electrons hit a phosphor screen producing a light emission.

Photocathode

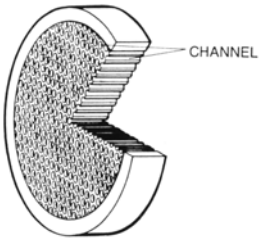
The photocathode consists of a thin layer of a material with a low activation energy for electrons and allows a high quantum efficiency down to long wavelength.
Choosing the right material and layer thickness the spectral sensitivity can be varied from the near UV to the near infrared. The quantum efficiency (number of photoelectrons to number of photons) of many materials is as high as 10% or even above. By applying a voltage to the photocathode, electrons are either pushed towards the MCP (negative voltage) or hold back in the photocathode (positive voltage).
This property of the intensifier makes it particularly suited as an electronic shutter. Not all the voltages of a few KV applied to the intensifier has to be switched for this purpose. A potential difference of 200-250 V at the photocathode is sufficient to achieve a shutter ratio of $1:10^7$.

High performance 'high voltage' generators achieve gate times of a few nanoseconds. The capacitive load (approx. 100pF) of the photocathode is switched with a rise and fall time of 1-2 ns.

Caution

The image intensifier's photocathode is the most sensitive component of the camera. Its lifetime depends decisively of the photocathode current (photo effect).
Setting a high MCP gain spares the photocathode, since a low incident light generates low photocathode current and already produces enough signal to saturate the CCD.
The intensifier's lifetime also depends on the number of exposures whether they are single ones or taken with a high imaging frequency.

Micro Channel Plate (MCP)

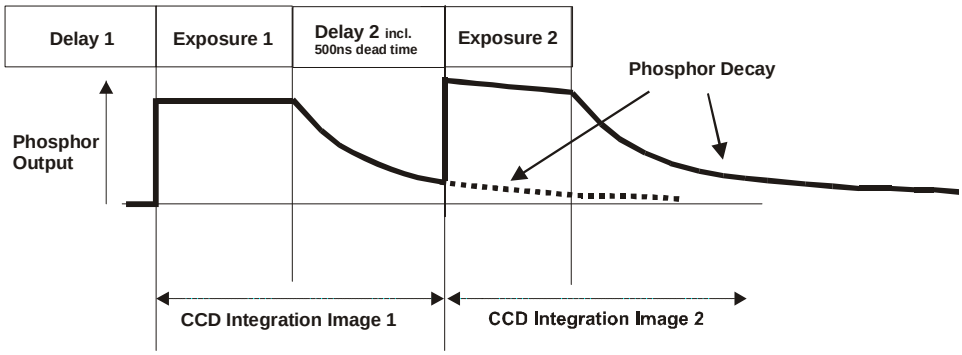


Secondary photoelectron multiplication occurs in the micro channel plate (MCP), made of lead glass and having about 10^6-10^7 microscopic channels of typically 6µm diameter and 0.5 mm length.
Each channel represents a photomultiplier which dynodes are replaced by a continuous semiconducting surface. Manufacturing of such micro channel plates is a rather complex process while the properties of the final device may be widely manipulated to yield the desired result. The intensification depends mainly from two parameters, the ratio of the channel's length to diameter and the applied voltage. The variation of the light intensification of the image intensifier is just a result of variation of the applied MCP voltage. For the described type of MCP it ranges from 0 to 10^4 V.

Phosphor Screen

After all the electrons are accelerated towards the phosphor screen by fixed bias voltage of several KV producing a light emmittance. For the choice of the right phosphor the quantum efficiency and the afterglow (decay time) play a part. The decay time may vary from a few nanoseconds to a few seconds, depending on the phosphor material. Thus it has to be carefully selected to match the applications preconditions.
Mainly the 'Double Trigger Mode' which carries out two exposures with very short time demands a fast phosphor with a short decay time.

Phosphor-decay at the ‚Double Trigger Mode':



The CamWare program allows to extend the phosphor integration time by setting an appropriate value in the Camera Control window.

General Properties

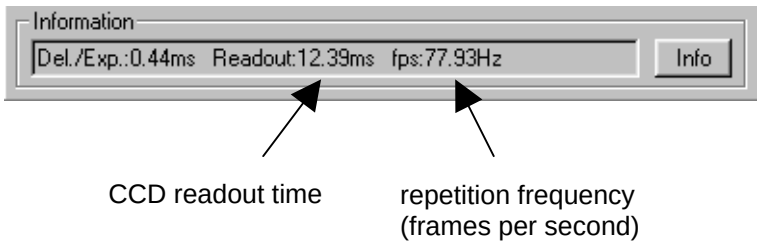
The whole unit *photocathode – MCP phosphor screen* is a sealed high vacuum device to prevent an interaction between electrons and gas atoms. In case an electron hits a gas atom an positive ion results which is accelerated towards the photocathode. There it produces undesired electrons (ion feed-back). Often image intensifiers do have fiber optic input and output windows to facilitate an optical coupling. The focal plane is transferred from the inside to the outer surface of the window.

At very high light inputs MCP channels tend to saturate, reducing dramatically its intensification. Furthermore, a too high light input may produce a local photocathode etching or even destroy the whole device.
Already too long exposure times at room lighting or short, intense laser beams, even reflected ones are sufficient to yield black spots, an irreparably damage.

Suited converter (UV, IR) are used to shift the spectral sensitivity. Further, open MCP intensifiers, without photocathode directly coupled to an evacuated experimental setup detect x-rays, electrons or other charged particles.

3. Timing

The info field of **Camera Control** contains the actual read out time and image repeat frequency (frames per second, fps), depending on the chosen setting (ROI, binning).



Pulser type

The following trigger modi of the DiCAM-PRO are different, depending of the used pulser HVP3X.

pulser type	minimum pulse length
HVP3X-3	3ns
HVP3X-5	5ns
HVP3X-20	20ns

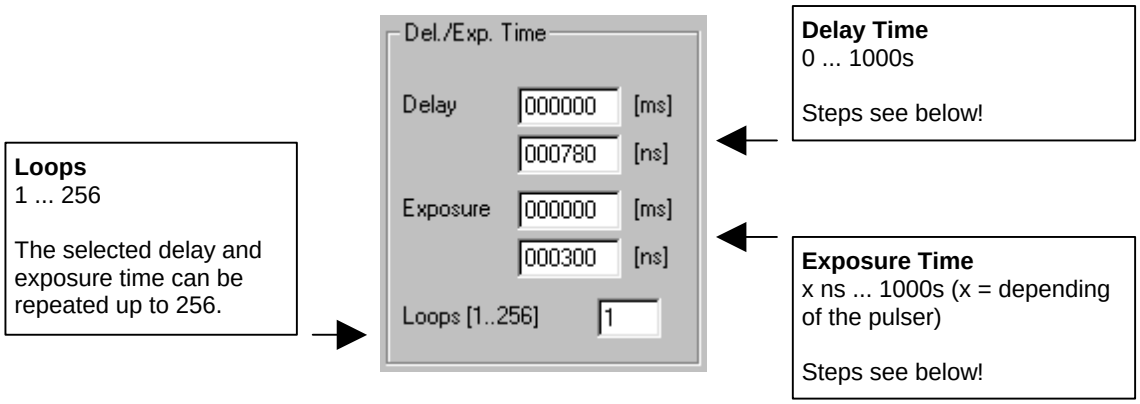
If you want to make **single exposures**, please go on reading on the next page with
DiCAM-PRO in 'Single Trigger Mode'

If you want to make **multiple exposures**, please go on reading on page 24 with
DiCAM-PRO in 'Multi Trigger Mode'

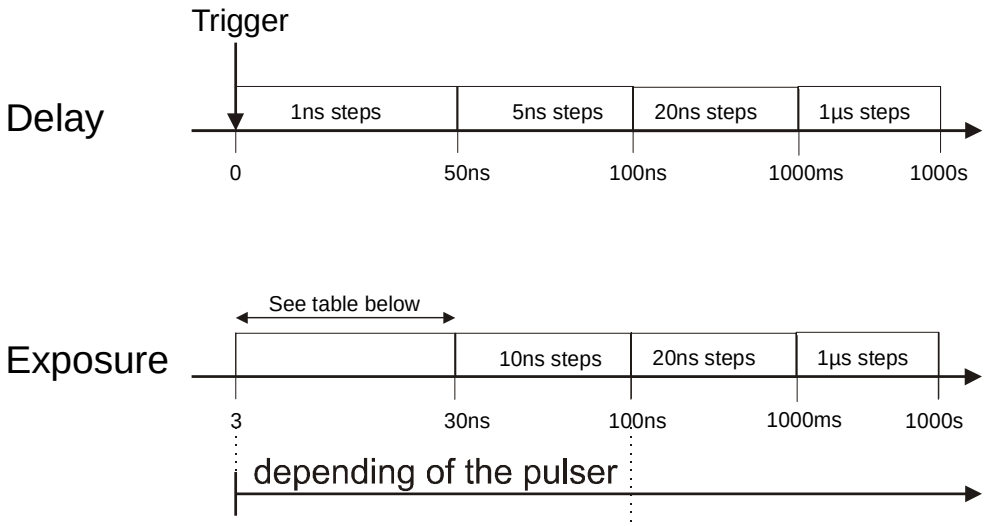
If you want to make **double exposures**, please go on reading on page 26 with
DiCAM-PRO in 'Double Trigger Mode'

3.1 DiCAM-PRO in Single Trigger Mode

Single Trigger Mode	< 20ns	≥ 20ns
max. pulse frequency	3,3 KHz	2 MHz
resulting minimum delay between two exposures	300µs	500ns

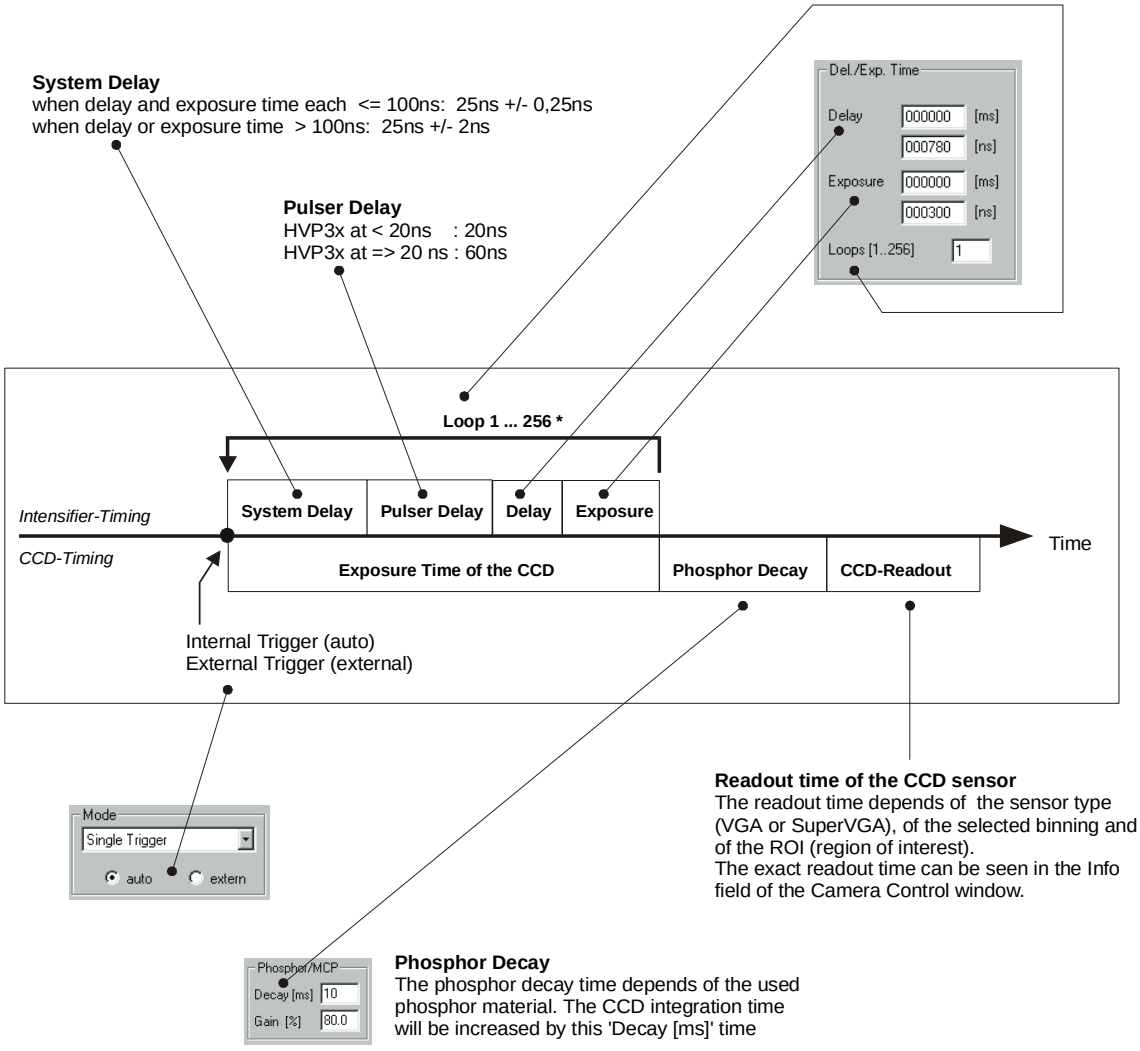


Possible settings for delay and exposure times
Following there is an overview of the possible settings for delay and exposure times.



pulser type	fixed exposure times in [ns]
HVP3X-3	3 - 10 - 20 - 25 - 30
HVP3X-5	5 - 10 - 20 - 25 - 30
HVP3X-20	20 - 25 - 30

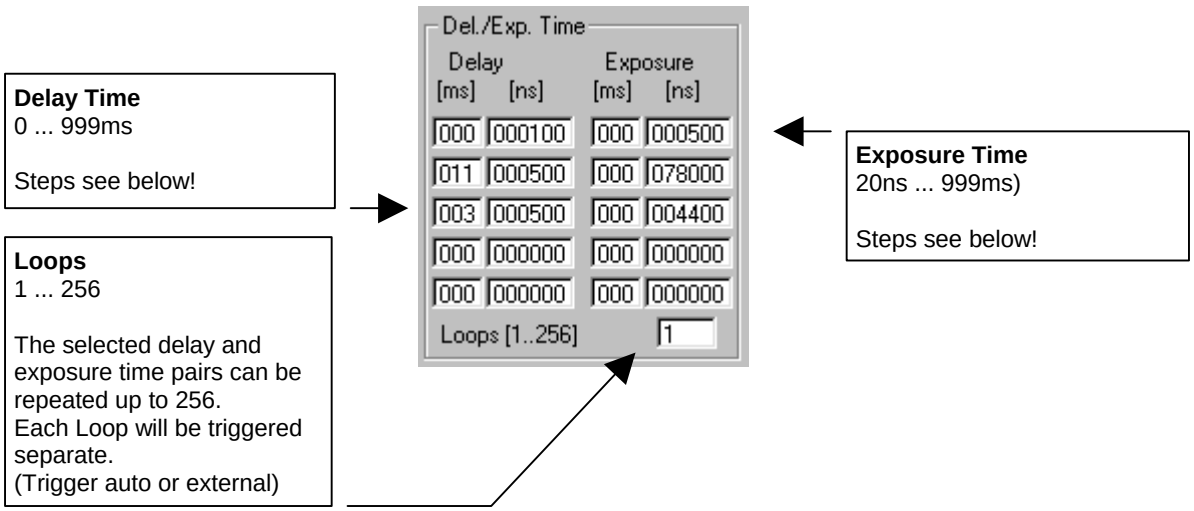
In addition to the selected delay and exposure times there is a system delay time and a pulser delay time. They are defined by the system itself and cannot be changed.



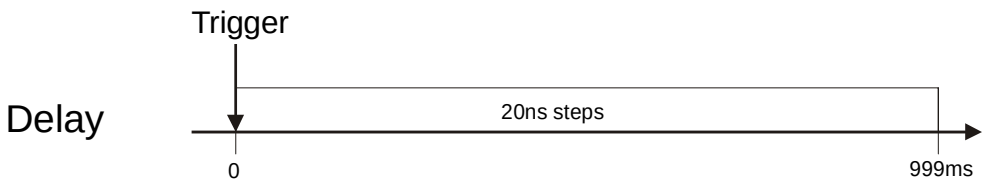
* The Loop function requires an additional internal time of 5 x 64µs (VGA sensor) respect. 5 x 117µs (SuperVGA sensor) for each loop

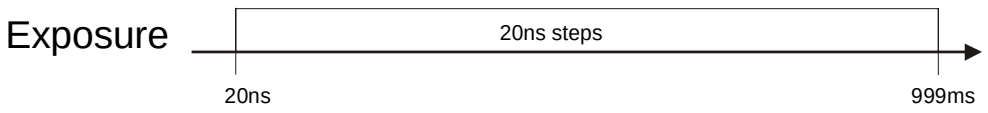
3.2 DiCAM-PRO in Multi Trigger Mode

Multi Trigger Mode	< 20ns	≥ 20ns
max. pulse frequency	not allowed	2 MHz
resulting delay between two exposures	not allowed	500ns

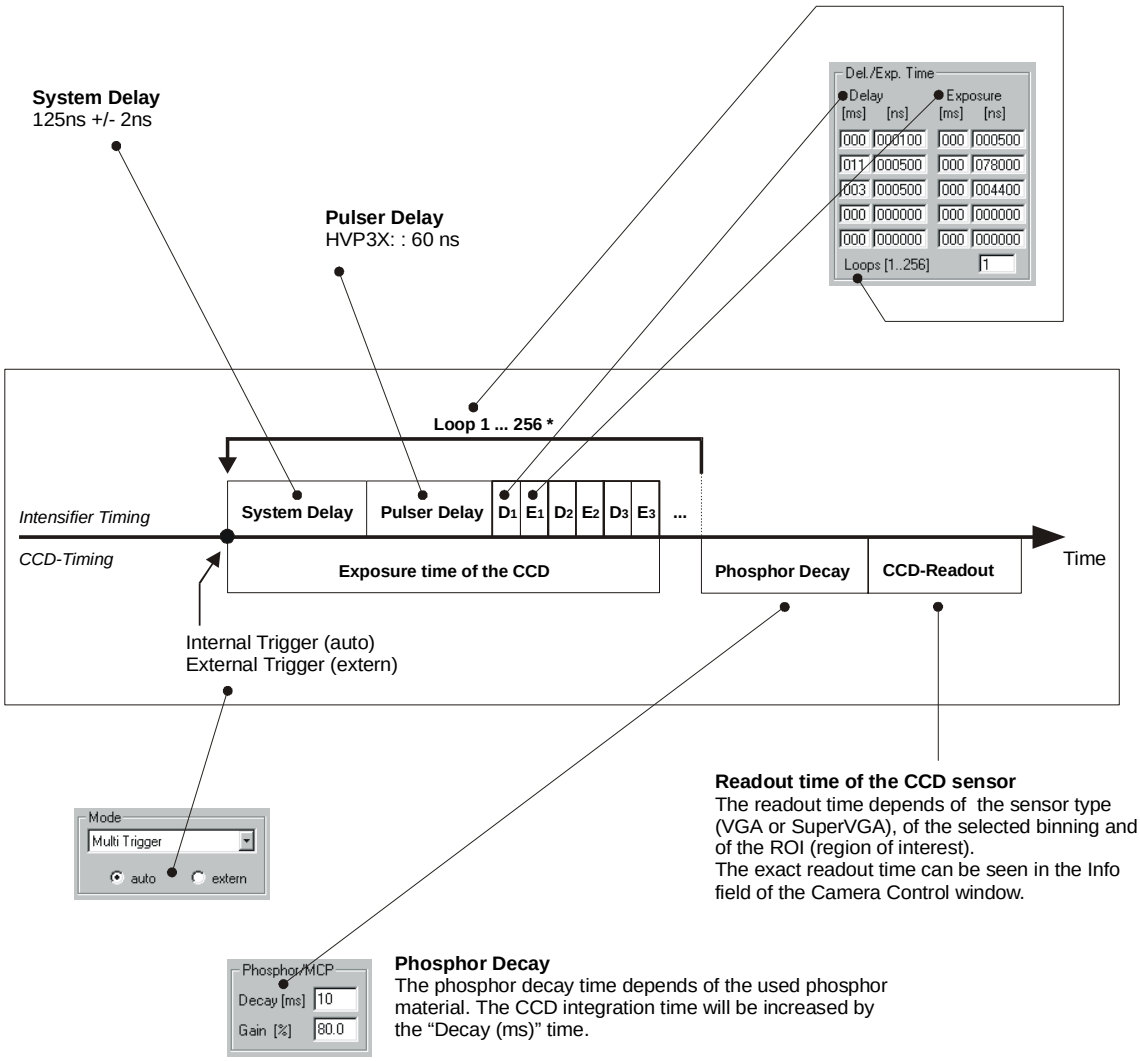


Possible settings for delay and exposure times
Following there is an overview of the possible settings for delay and exposure times.





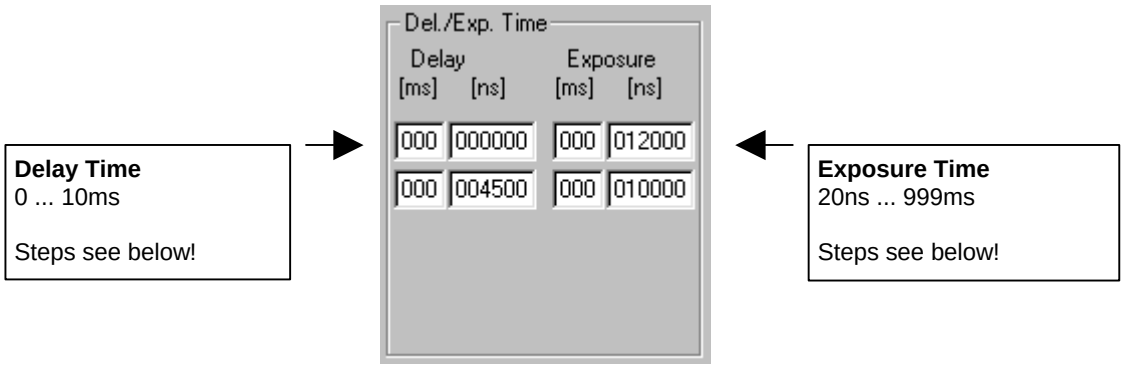
In addition to the selected delay and exposure times there is a system delay and a pulser delay time. They are defined by the system itself and cannot be changed.



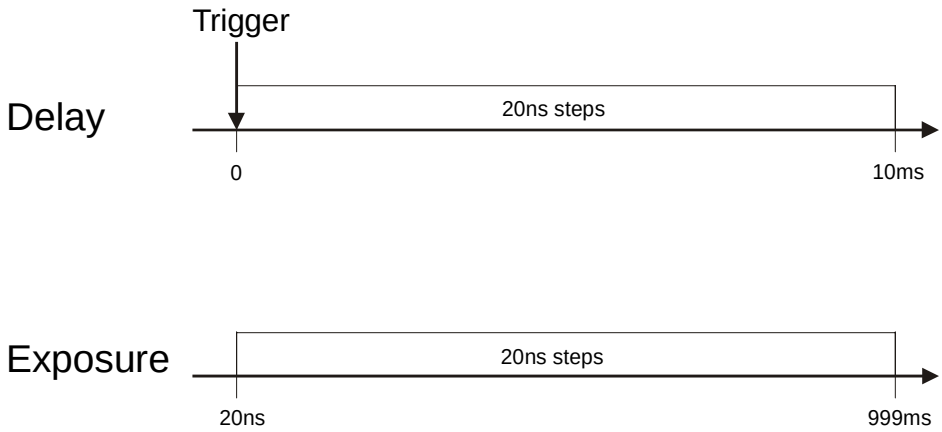
* This Loop function requires additionally approx. 700ns.

3.3 DiCAM-PRO in Double Trigger Mode

Double Trigger Mode	< 20ns	≥ 20ns
max. pulse frequency	not allowed	2 MHz
resulting delay between two exposures		500ns
min. exposure time		20ns
'dead time' between both exposures		500ns

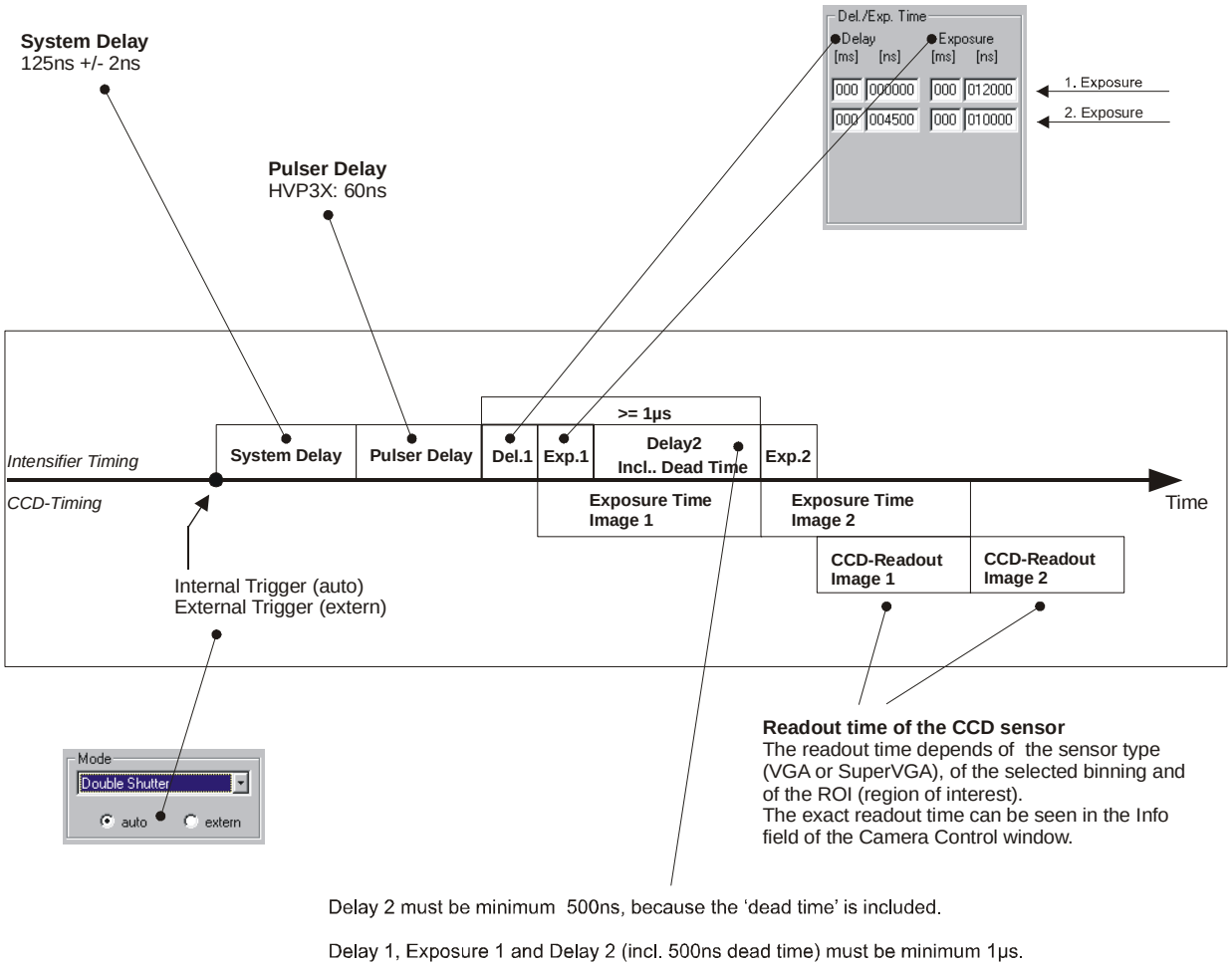


Possible settings for delay and exposure times
Following there is an overview of the possible settings for delay and exposure times.



In addition to the selected delay and exposure times there is a system delay and a pulser delay time. They are defined by the system itself and cannot be changed.

Hint The Double Trigger Mode should only be used for short time separation between the two exposures. Otherwise the camera should be operated in the 'Single Trigger Mode' or in the 'Multi Trigger Mode'.



Readout time of the CCD sensor
The readout time depends of the sensor type (VGA or SuperVGA), of the selected binning and of the ROI (region of interest).
The exact readout time can be seen in the Info field of the Camera Control window.

Delay 2 must be minimum 500ns, because the 'dead time' is included.

Delay 1, Exposure 1 and Delay 2 (incl. 500ns dead time) must be minimum 1µs.

4. Trigger Control

There are two ways of triggering the DiCAM-PRO, internally via the DiCAM-Control software and externally via the trigger input at the rear panel of the camera.
For external triggering, you can select between electrical or optical trigger.

Electrical Trigger Input

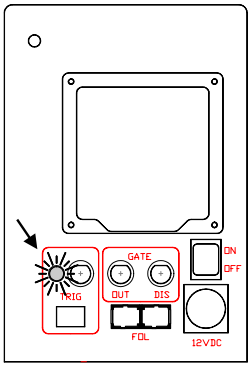
A TTL signal (5V) with rising edge is required. The rise time should be <20ns.
Internally the input is connected to ground (GND) with 1kΩ.

Optical Trigger Input

A trigger signal has to last for a minimum of 10ns. A light power of 1mW is sufficient.

Trigger LED

At the camera rear panel you will find a LED in the segment TRIG. This LED may show three colors:

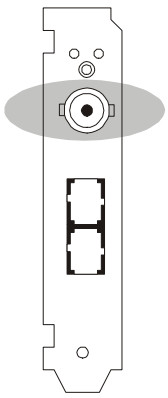


orange During time between trigger signal and CCD readout time.

red At the beginning of the CCD readout time the LED is for about 10ms red and changes to green.

green After changing from red to green, the LED stays green until a new trigger signal is sent.

BNC Socket at the PCI-Board



The BNC Socket at the PCI-Board has no function.

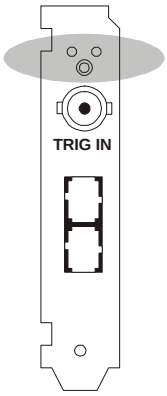
5. Control Signals

At the camera rear panel there are two BNC sockets with control signals.

GATE OUT High active TTL-control output.
For exposure times >20ns, there is a TTL high active signal at the GATE OUT socket while the photocathode is on. It starts 60ns before the photocathode on-times and ends 60ns before the off-time (pulser delay).
For exposure times <20ns the GATE OUT pulse is always 100ns.

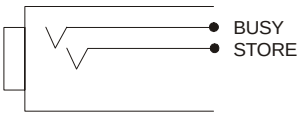
GATE DIS Low-active TTL-control input.
While the GATE OUT is active (photocathode is on) the on-time can be disabled by a low active TTL signal.
Please note that you may activate this control input only for exposure times >20ns!

Jack Plug Socket at the PCI-Board



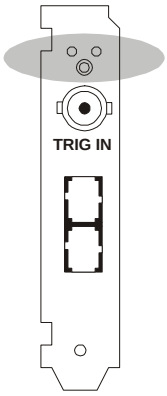
The 3.5mm stereo jack plug socket at the PCI-Board has a double function:

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.

6. 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)
- LabView (National Instruments)

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**.

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 AG
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 warranty by law for the DiCAM-PRO System (camera, PCI-Board, FOL, 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.
Image intensifiers are subject to the original manufacturer's warranty conditions
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!

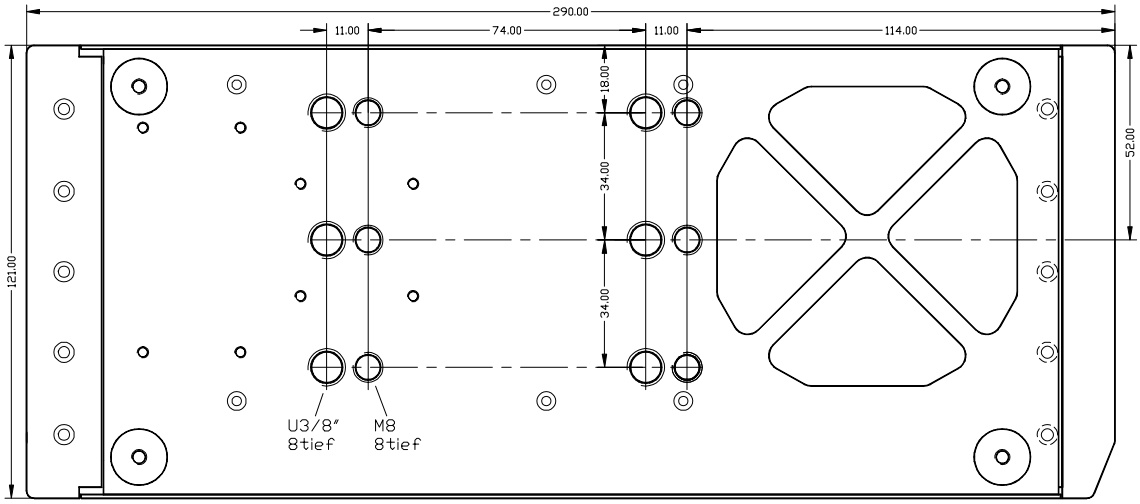
Attention Opening of the camera or improper handling (e.g. damage by electrostatic charge, wrong cleaning method) voids the warranty.

CE Certification

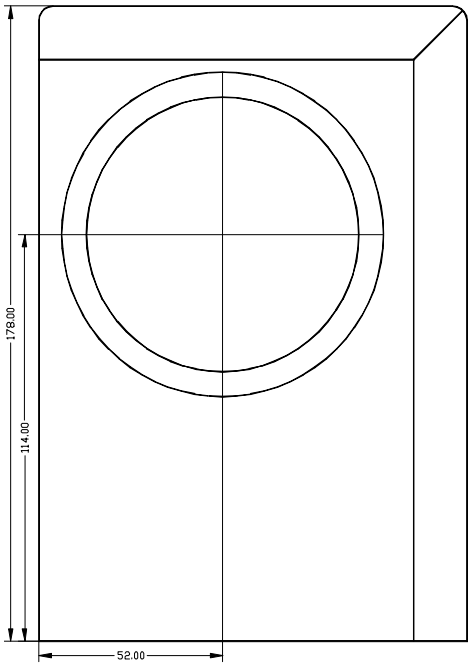
SensiCam complies with the requirements of the „EMC Directions of the European Communities (089 / 336 / EWG)“ and therefore bears the CE-Marking.

Dimensions and Weight

Bottom plate with position of the threads to mount the camera.. The axis through the two threads in the middle is also the optical axis.



Front panel of the camera with position of the optical axis.



Weight of the camera: approx. 7kg

System Data

Image Intensifier
see separate data sheet 'specification of the image intensifier'

Power and Gating Supply for the Image Intensifier	
Phosphor Voltage	6 ... 7kV, internally adjusted, ripple ±15mV
MCP Voltage	0 ... 900V, externally adjusted, ripple ±15mV
Photocathode Voltage	on: -180V, off: +80V
Gating Module HVP3X	In **Ultra Fast Gatin**g mode: min. pulse width: 5ns, optional 3ns, 1.5ns max. pulsing frequency: 3.3kHz In **High Rate Gating** mode: min. pulse width: 20ns max. pulsing frequency: 2MHz

Optical Coupling (Ultra Speed Tandem Lens)	
Collimator Lens	Rodenstock F2.5/105mm
Output Lens	F1.0/33mm or F1.5/46mm
Quantum Efficiency (typ.)	> 22%
Vignetting	< 3%
Resolution	> 60 lp/mm
Scaling Rates 18mm and VGA sensor 25mm and VGA sensor 25mm and SuperVGA sensor	 1:2.17 1:3 1:2.17

CCD Data	VGA	SuperVGA
Sensor Type	CCD-Interline Progressive Scan with "lens-on-chip"	
Number of Pixels	640(H) x 480(V)	1280(H) x 1024(V)
Pixel Size	9.9µm x 9.9µm	6.7µm x 6.7µm
Sensor Format	½"	2/3"
Scan Area	6.3mm x 4.8mm	8.6mm x 6.9mm
Cooling Type	2-stage peltier cooler with forced air cooling	
CCD Temperature	-15°C	-12°C
Full Well Capacity	35.000 e^-	25.000 e^-
Scan Rate	12.5 MHz	12.5 MHz
Readout Noise @12.5 MHz	13 ... 14 e^-	7 ... 8 e^-
A/D-Converter	12 Bit @12.5MHz	
A/D Conversion Factor	7.5 e^-/count	5 e^-/count
Max. Quantum Efficiency monochrome, @ 520nm	≥ 40%	
Spectral Response (monochrome)	280 ... 1000nm	
Average Dark Charge [7)]	< 0.1 e^-/pixel·sec	< 0.1 e^-/pixel·sec
Extinction Ratio [1)]	1:2000	1:2000

x) See „Definitions and Measurement Conditions".

CCD Data	VGA	SuperVGA
Smear [2]	< 0.005%	< 0.005%
Anti Blooming [3]	> 1000	> 1000
CCD Quality	grade 0	grade 0
Non-Linearity	< 1%	< 1%
Readout Time (Full Frame)	30 fps	8 fps
Binning Horizontal	1...8	
Binning Vertical	1...128	
Blemishes		
Point Defects [4]	0	0
Cluster Defects [5]	0	0
Column Defects [6]	0	0
Warm Pixels [7] typ.		
# pixels > 100 e^-	0	0
# pixels > 5 e^-	0 - 2	0 - 2
# pixels > 1 e^-	250 - 1000	500 - 2000
Non-Uniformity in darkness [8] typ.	1 count	1 count
Non-Uniformity in brightness [9] typ.	0.2%	0.6%
# pixels > 12%	0	0
# pixels 8 ... 12%	0	0 - 2
# pixels 4 ... 8%	0	10 - 50
# pixels 2 ... 4%	0 - 5	n.a.
Optical Input	C-Mount with adjustable focus length	
Dimension	Head: 93(W) x 78(H) x 210(L) mm	
Weight	8 kg	
Operating Temperature	0...40°C	
Storage Temperature	-20...+70°C	
Humidity	10...90% non condensing	

High Speed Serial Link	
High Speed Serial Link	standard: fiber optic link 10 ... 1500m, 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 or FOL

Power Supply	
Power Supply	Desktop AC/DC 90...260V / 12V, IEC connector 12V / 4,5A

x) See „Definitions and Measurement Conditions“

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

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

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

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 SuperVGA

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

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