

# **SensiCam**

# **SensiCam QE**

## **Operating Instructions**

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## Safety Instructions

For your own safety and in order to guarantee 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 base.  
Shocks like e.g. dropping the camera onto the floor might cause serious damage to the device. The tripod attachment on 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 clear.
- Make sure that the connecting cable is in good condition and that the link to the socket is not obstructed.
- Detach the camera and contact customer service in the following cases:
  - When cable or plug is 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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## 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
  - Windows XP Professional
  - Linux Kernel 2.2, preferable SuSE 6.3 or newer

Please contact COOKE for more information on Linux support for our cameras.

#### Note:

Drivers for our cameras are optimized for best performance. This may have implications for some dual-processor systems. If you are planning to use a dual processor computer in your imaging application, please contact Cooke technical support for more information

#### Display Adaptor

For best display of images on the monitor we recommend the use of high performance boards with at least 8MB RAM, preferably with AGP Bus architecture.

#### Graphic Setup

The camera generates 12 Bit (4096 grey levels) images. 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 Windows, use the "settings" tab in the "Display Properties" to set "colors" to at least 24 bit, and "size" the desktop to 1024 x 768.

## 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 fans)

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. These drivers are located on the CD that was supplied with your camera.

See the "Quick Install guide" supplied with your CD for more details.

#### Updating the hardware driver

For updating an existing driver, please download the newest driver version from the internet under <http://www.cookecorp.com>.

For installation please read the actual information in the readme.txt file, which will download automatically with the driver.

If 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 administrator privileges. Please login as administrator. A "setup.exe" file is provided on the CD supplied with the camera for driver installation.

See the "Quick Install guide" for more information.

### Installation under Linux

Please contact Cooke customer support for more information on Linux support for our cameras.

### 1.3 Installation of “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 CD supplied with your SensiCam. The newest version can also be downloaded from the internet under <http://www.cookecorp.com>.

- Installation from CD** Refer to the “Quick Install guide” supplied with your SensiCam for details on software installation.
- 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 latest information how to install CamWare can be found in the “readme.txt” file.
- Note** To install CamWare under Windows 2000 and Windows NT you need administrator privileges.
- Note** After successful installation the computer has to be restarted.
- The installation program transfers all necessary DLL and OLE files to the system folders, checking automatically for existing older versions and replacing them by new ones.  
In Windows all “registry“-entries are made automatically.  
If the program is to be deleted from the computer, remove it using “Add-remove” software from the Windows control panel.
- 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** If you have problems during installation, contact customer service.

## 1.4 Camera and PCI-Board

Before Powering Up, make following connections:

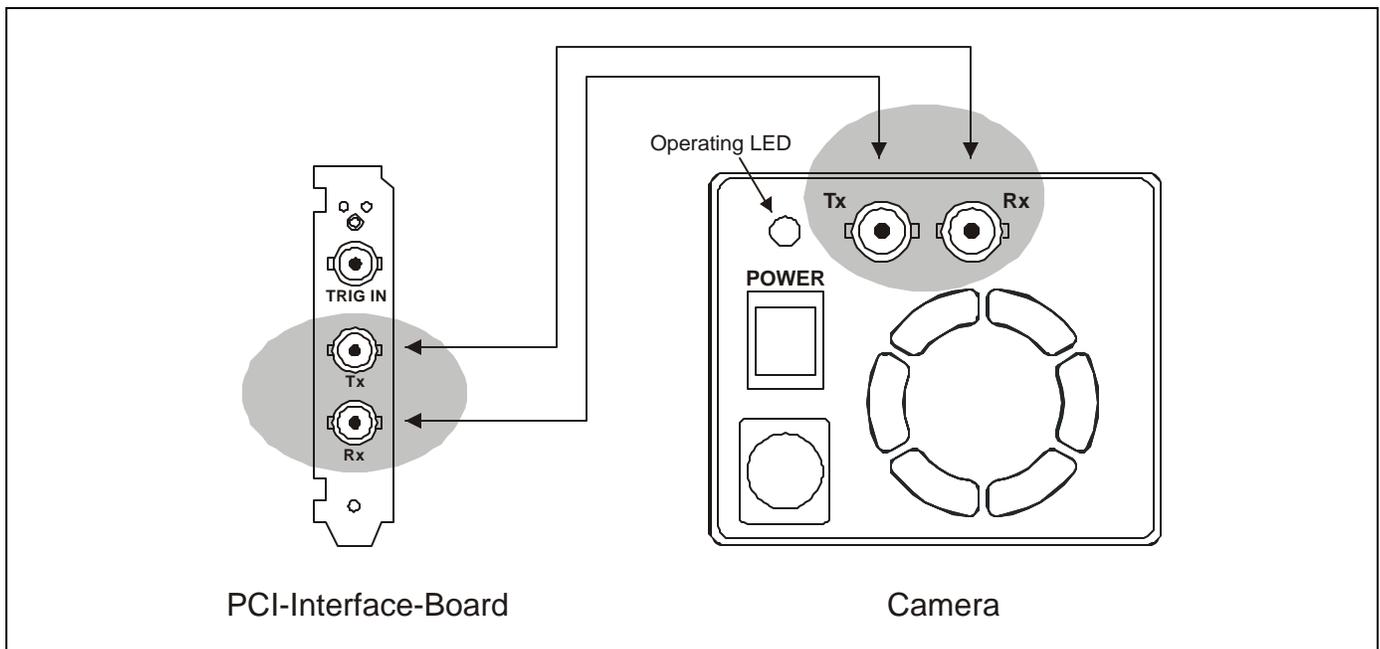
- Power** from Power Supply to Camera
- Serial Interface** between camera and PCI-Board with enclosed cables.

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

### Double-Coaxial Cable

Connect the one end of the double-coaxial cable that comes with the camera to the two BNC-sockets at the rear of the camera and the other to the PCI-Board.

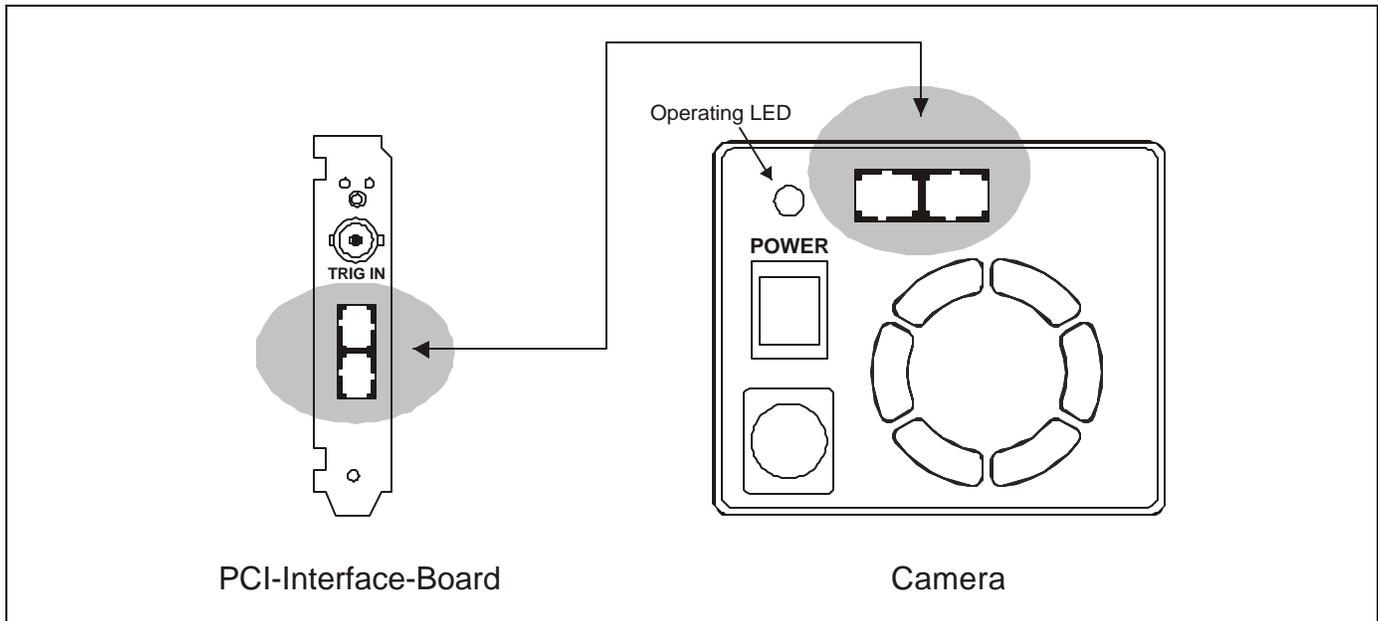
The cables must be crossed, i.e. Tx on the camera connected to Rx on the board and Rx to Tx. Improper connections cause the LED (Display of Power Status) to stay on red (see also chapter 1.5).



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 in 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!

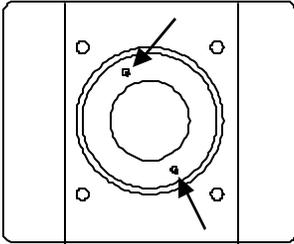


**Caution!** Avoid kinking or bending the cable over a sharp edge. This will break the core and destroy the cable. The minimum-bending radius is 100mm! When shipping or storing the camera avoid touching the ends with bare fingers and **replace the caps on the cable, camera and board** to protect the 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. Any deeper could destroy the protecting window of the camera and void the warranty. Cameras with a 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. The camera has either a 1/2" or 2/3" sensor. We recommend using for all SensiCam Versions a 2/3" or 1" compatible lens. Cameras with high-resolution sensor should be equipped with a high quality lens to take advantage of the high resolution.

### Back Focal Length Adjustment



It may be necessary to adjust the back focal length. If the camera cannot be focused to infinity.

Loosen the two small allen screws at the knurled steel C-Mount to insert with the allen key provided 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.

Secure the insert again by tightening the allen screws. Do not overtighten.

### 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 removed. At the rear side of the C-Mount a milled recess accommodates 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:

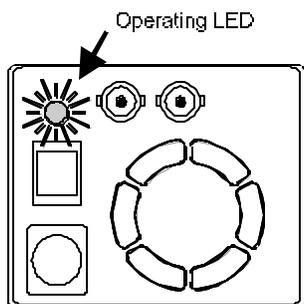
- PCI-Board properly mounted and secured to the back panel?
- Camera-Board connection via double coaxial cable or FOL properly made?
- Power supply connected to camera, to main?
- Objective lens mounted?

**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). If the camera is properly attached, the LED will flash **red-green** for approx. 3 minutes. During this time, the system is cooled down to a temperature of between -11 and -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. If the diode shows a **permanent red**, a hardware error has occurred, and you should check that the camera cable is properly attached. If the LED stays red, contact Cooke customer service.



The following table lists possible reasons for hardware errors.

**Possible states of the LED**

LED color	Status
red continuous	<b>Hardware error!</b> ?? 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. After a few minutes LED should change to continuous green. If the intermittent state is going on constantly, there could be an error with the cooling. In this case please contact COOKE.
Green continuous	<b>System ready!</b>

**Starting CamWare**

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

For detailed information to CamWare please see the separate “CamWare” manual.

## 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. Data is then transferred by DMA to system memory.

With "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.

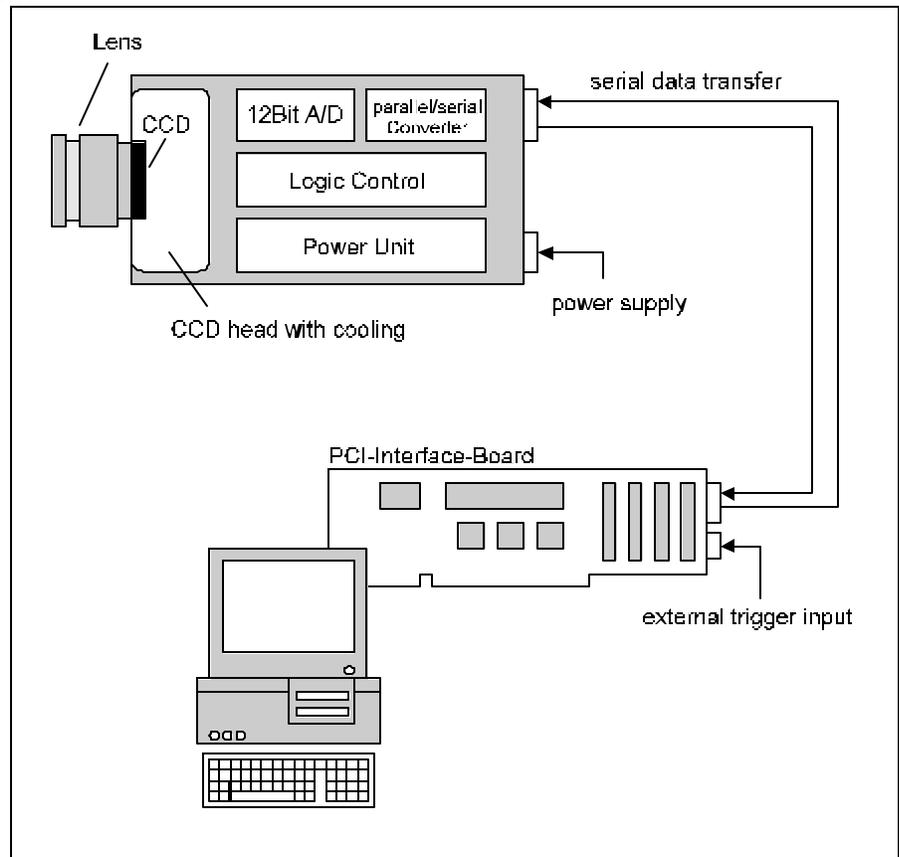
When starting the program, the software automatically recognizes the camera type.

For detailed information please see the separate "CamWare" manual.

### 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

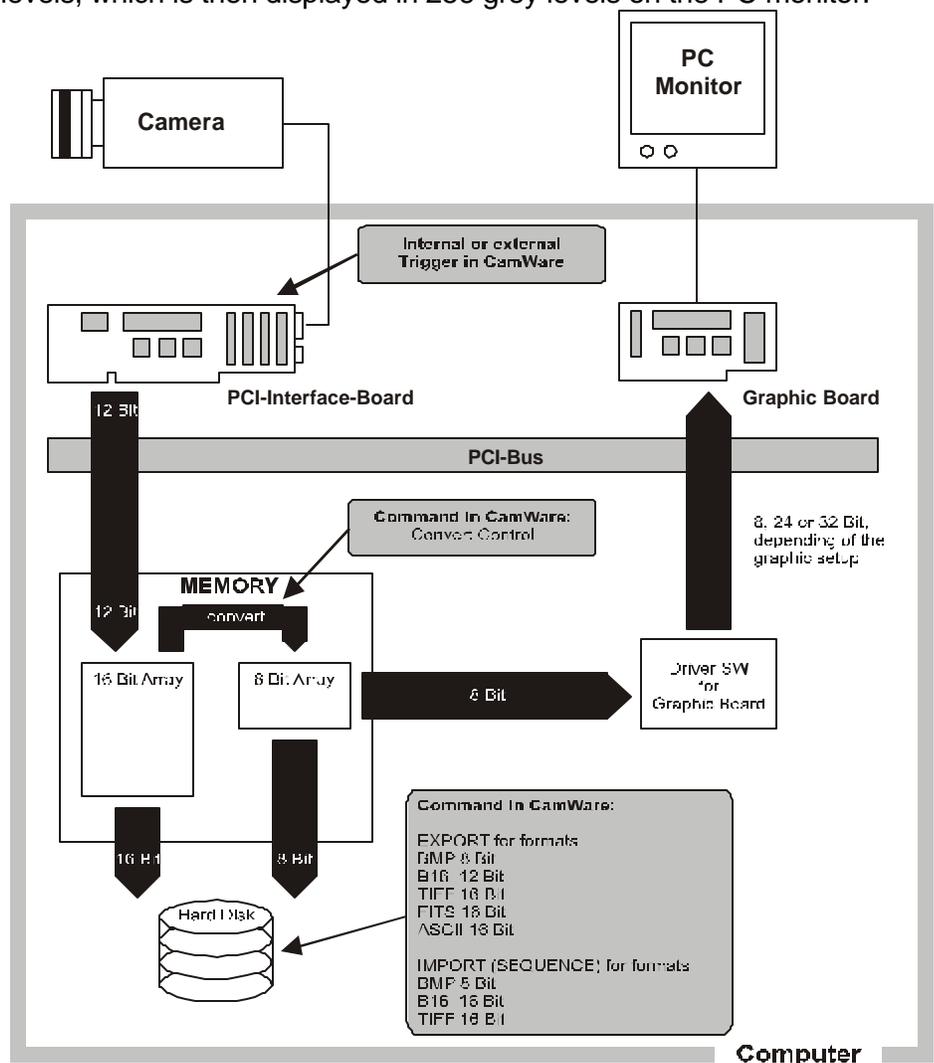
The PCI-Board gets the 12bit data from the camera and transfers it via PCI-Bus to a 16bit array (in the PC Memory). The higher 4bits are set to zero. The 16bit data are converted to an 8bit array for display. Depending on graphic board set up display on the monitor is 24 or 32 bit RGB data. For monochrome cameras, the R G and B values are made equal.

### 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 the "CamWare" manual.

### Display

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



**Internal Data Stream of color cameras**

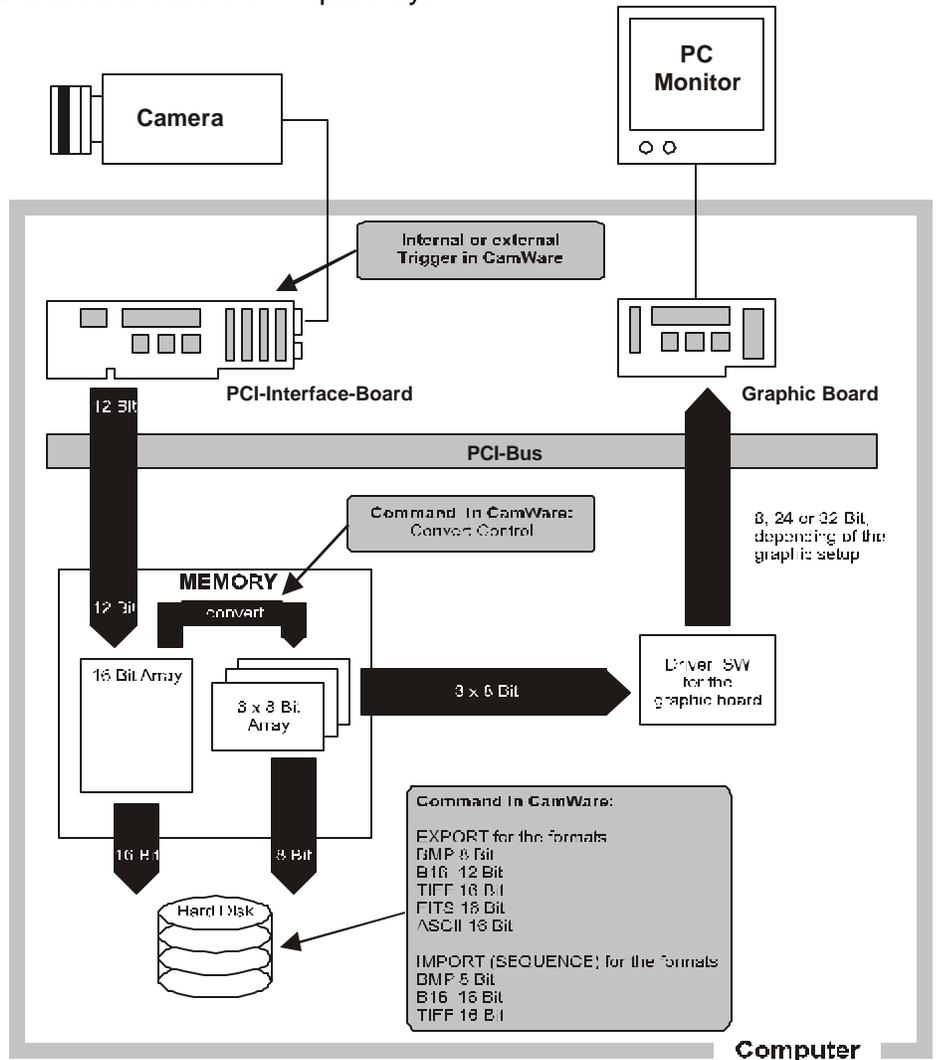
The PCI-Board gets the 12bit data from the camera and transfers it via PCI-Bus to a 16bit array (of the PC memory). The higher 4bits are set to zero. The 16 bit data are converted automatically into a 3 x 8 bit array and for display. We recommend displaying it in 32bits on the monitor.

**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 the CamWare manual.

**Display**

The camera which acquires always 12 bit images resolves with 4096 (2<sup>12</sup>) grey levels between black and white, however the monitor display of the image is always limited to 8 bit and therefore to 256 (2<sup>8</sup>) grey levels. The command 'Convert Control' selects a range between 0 ... 4095 grey levels, which is then displayed in 256 grey levels on the PC monitor. The R, G & B channels can be set separately.



## 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 range (RX, GX, BX).

With the help of the camera control software, for each pixel the 12 Bit data is converted by interpolating into an 8 Bit triplet ( $P_{RED}$ ,  $P_{GREEN}$ ,  $P_{BLUE}$ ).

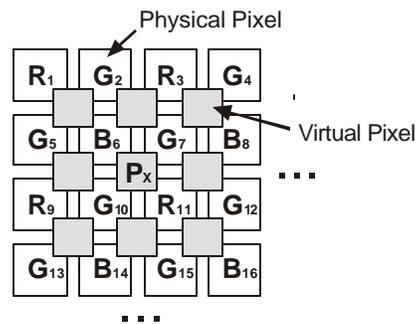
For this interpolation following algorithm is applied:

### 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 called '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<sub>6</sub>

$$P_{RED} = (R_1 + R_3 + R_9 + R_{11}) / 4$$

$$P_{GREEN} = (G_2 + G_5 + G_7 + G_{10}) / 4$$

$$P_{BLUE} = B_6$$

Example for Pixel<sub>7</sub>

$$P_{RED} = (R_3 + R_{11}) / 2$$

$$P_{GREEN} = G_7$$

$$P_{BLUE} = (B_6 + B_8) / 2$$

## 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 'CamWare' manual.

## 3. Timing

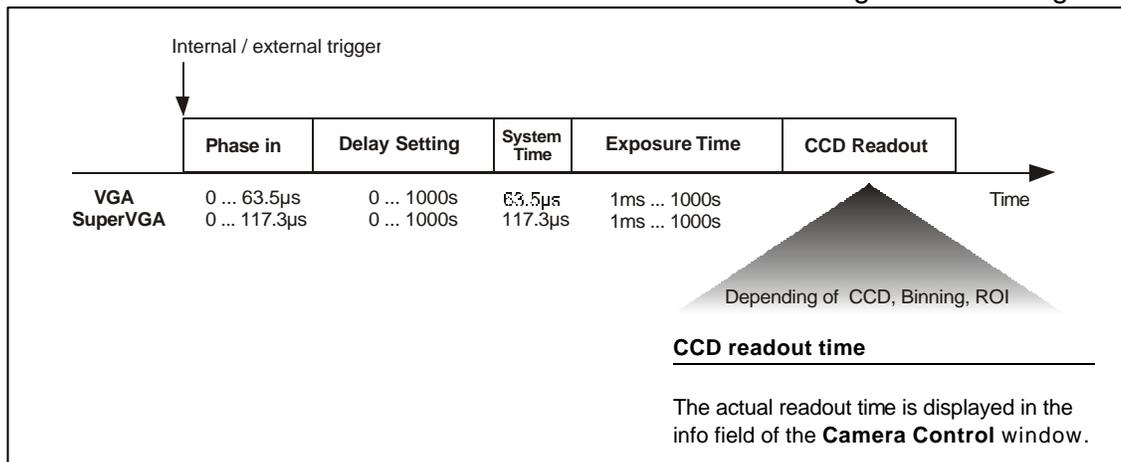
### 3.1 SensiCam High Performance

With the SensiCam High Performance and our standard software you can realize exposure times between 1ms and 1000s. For more information on how to obtain longer exposure times, contact Cooke technical support. 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.

Along with the free programmable delay- and exposure times there are also system times (phase in, system time, CCD readout time) that 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 High Speed

The SensiCam High Speed 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 High Speed in Standard Mode

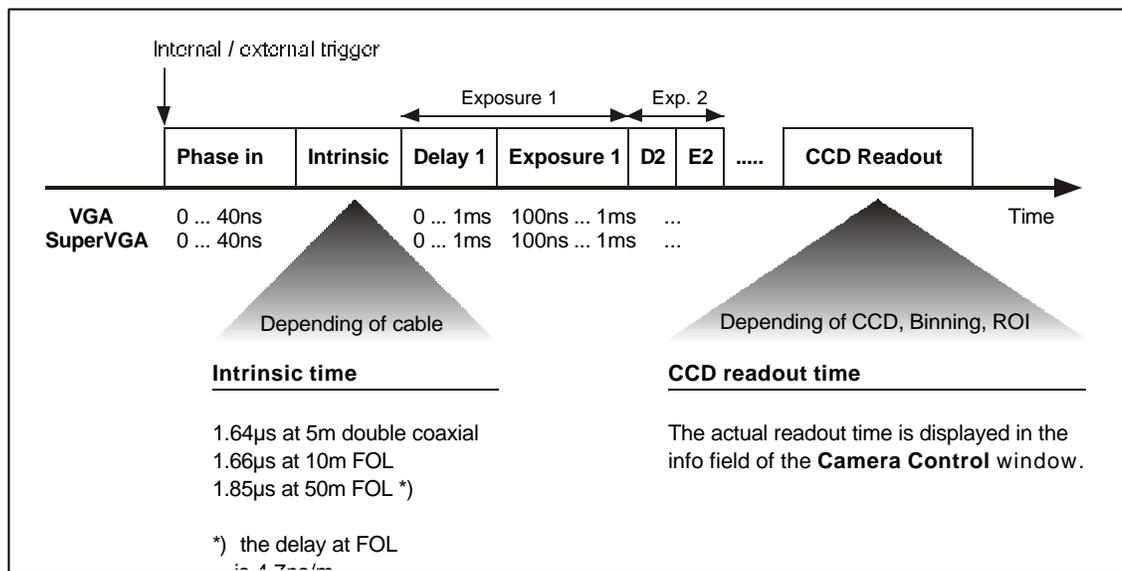
In the standard mode you can make single and multiple exposures with times between 100ns and 1ms. The multiple exposure allows you to make maximum 10 pairs of delay and exposure, with our standard software. For information on generating more than 10 delay/exposure pairs, contact Cooke technical support.

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.

Along with the programmable delay- and exposure times there are also system times (phase in, intrinsic, CCD readout time) that 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)

### 3.2.2 SensiCam High Speed in Cycles Mode

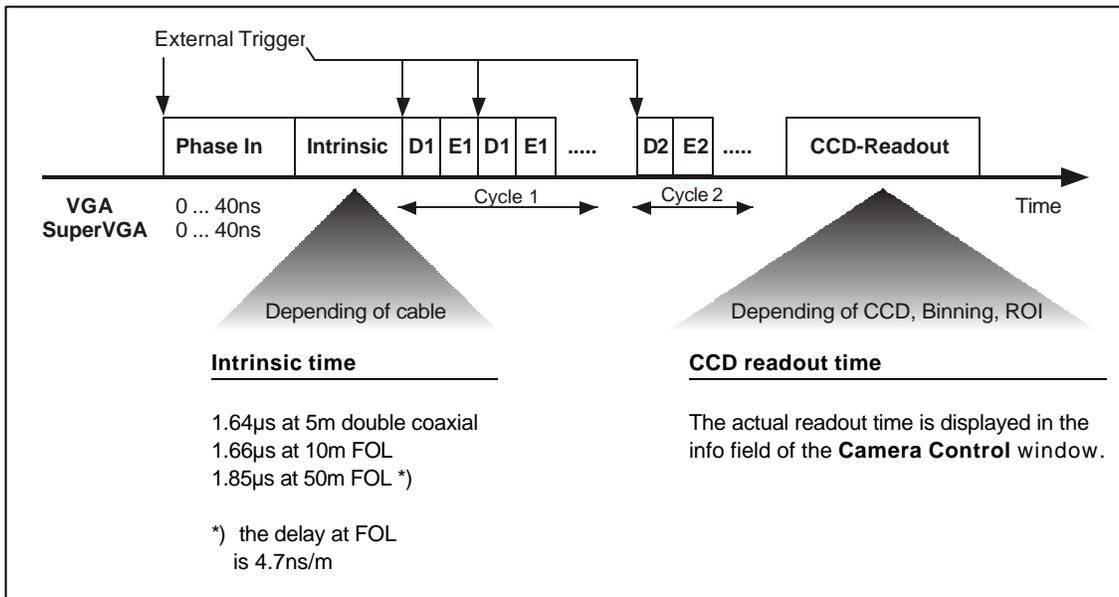
In the Fast Cycles Mode up to five blocks can be programmed. Every block consists of delay-, exposure time and cycle counter.

In the cycle counter you select the number repeating the pair delay and exposure. Each time the camera is triggered (externally) a delay exposure pair is executed, and the cycle counter decremented. 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!

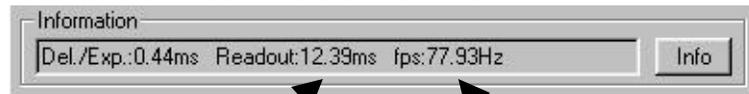
Each exposure must be triggered separately (also within the blocks)!

Along with the programmable delay- and exposure times there are also system times (phase in, intrinsic, CCD readout time) that 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)

### 3.3 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.

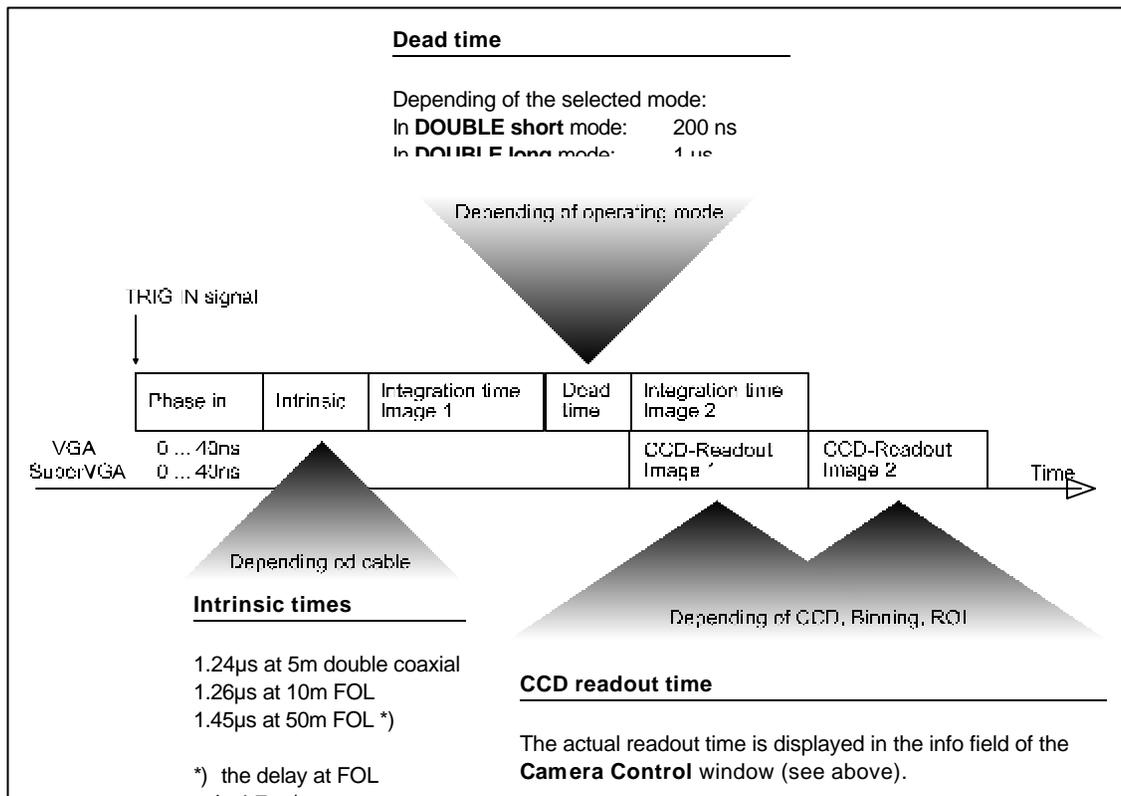
The integration time for the 1<sup>st</sup> image is defined by the user by setting the length of the externally given signal TRIG IN. The characteristic range is from 1µs to 10ms. The integration time of the 2<sup>nd</sup> image is **exclusively determined** by the CCD readout time for the 1<sup>st</sup> picture. This means, the user has no direct influence on the duration of the second integration time and thus on the second exposure.

If a shorter exposure time is required within the 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.

Along with the programmable delay- and exposure times there are also system times (phase in, intrinsic, dead time, CCD readout time) that have an influence to the camera timing.

Please find the detailed camera timing in the following overview.

**Remark** The SensiCam DoubleShutter also has all features of the SensiCam High Speed.



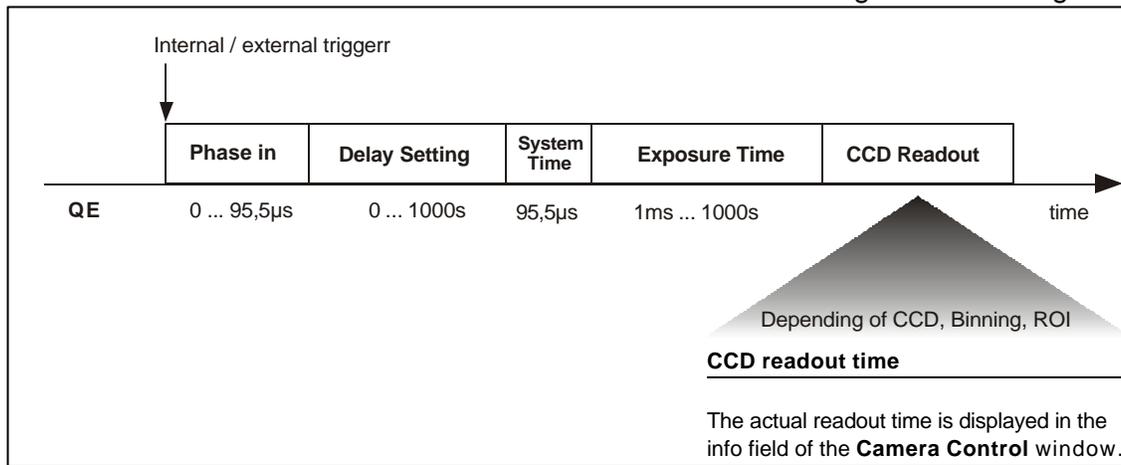
### 3.4 SensiCam QE

With the SensiCam QE and standard software you can program exposure times between 1ms and 1000s. For information on programming longer exposure times contact Cooke technical support. The exposure or 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.

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

Please find the detailed camera timing in the following overview.



Info field in the **Camera Control** window



### 4. Trigger Control

The SensiCam can be triggered internally or externally. Depending on the camera version, you have the following trigger mode. A detailed timing of each camera version you will find in chapter 3.

#### SensiCam High Performance and SensiCam QE

external triggering, external falling edge  
 external triggering, external rising edge  
 internal triggering, auto sequential  
 internal triggering, auto simultaneous

#### SensiCam High Speed (Standard Mode)

external triggering, external falling edge  
 external triggering, external rising edge  
 internal triggering, auto sequential

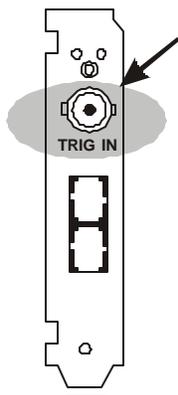
#### SensiCam High Speed (Fast Cycles Mode)

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"

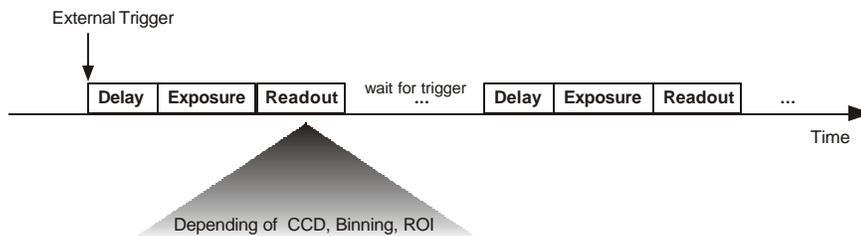


External triggering is handled via a TTL signal (low = 0V, high = 5V) that is fed in through the BNC plug on the PCI-Board.

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

external falling = 1k $\Omega$  pull up  
 external rising = 1k $\Omega$  pull down

When not switched on, the trigger input is held at +5V, using a 1k $\Omega$  resistance. Thus, an external trigger signal might also produced by a short-circuit toggle or switch closure.



**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.

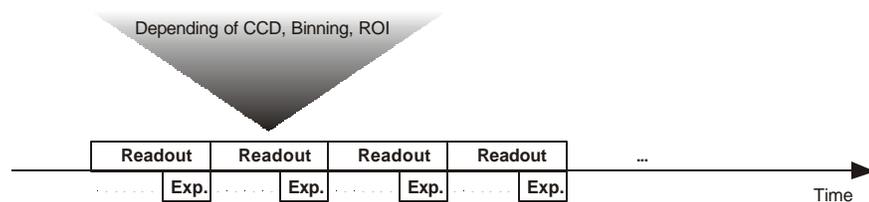


**Internal trigger "auto simultaneous"**

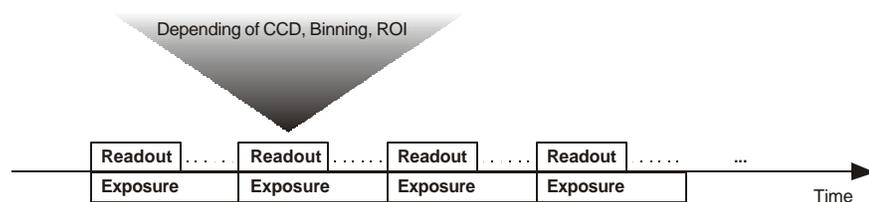
This trigger mode allows you to expose while reading out. If the exposure time is set shorter than the read out time, you can obtain the maximum imaging frequency (which depends on the given CCD sensor and on the binning). Otherwise, the picture sequence frequency depends on the duration of the set exposure time.

This mode does not allow delay time setting!

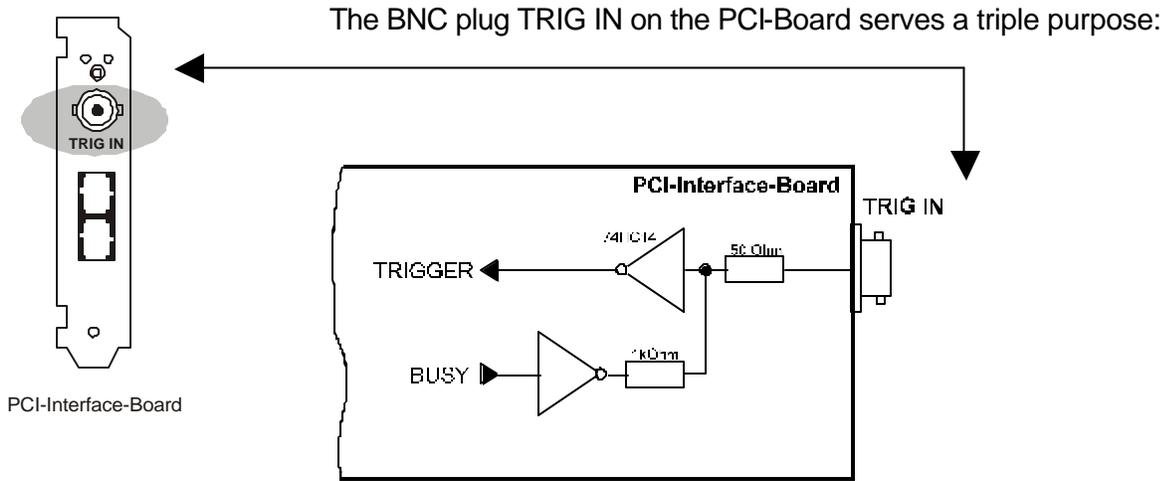
Exposure time < CCD readout time



Exposure time > CCD readout time



### TRIG IN plug on the PCI-Board



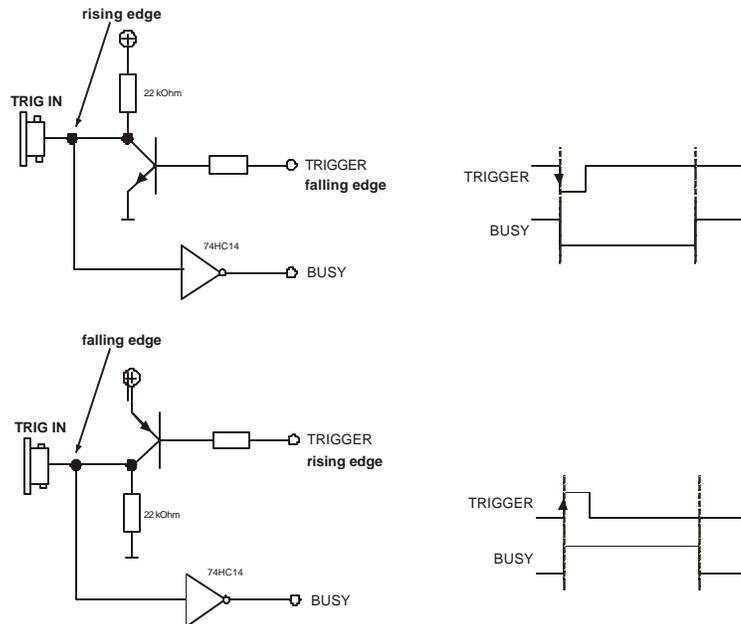
#### Function 1: Trigger Input

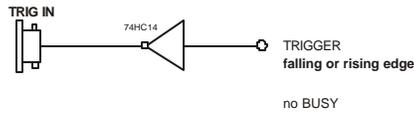
The camera system can be triggered via external, edge active TTL signal.

#### Function 2: Control Output

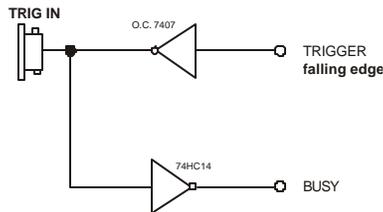
The BUSY signal and the EXPOS signal can be captured at this output. The same BUSY signal is available at the jack plug socket (see below).

**BUSY** is active from the start of the trigger signal until writing into the PCI-Board buffer is complete. No exposure is started during this period.





Decoupling the trigger signal from BUSY or EXPOS:



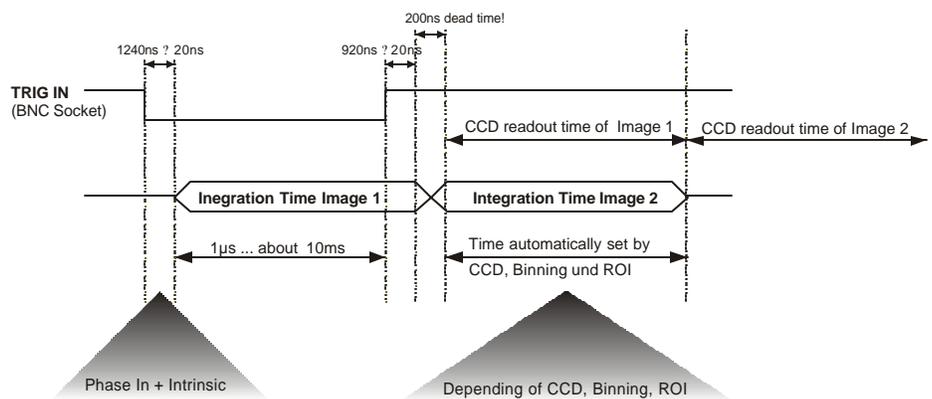
When using SensiCam High Performance or SensiCam QE an additional signal, called **EXPOS**, is available. EXPOS is active while exposing. It is a high active signal (TTL), beginning 1ms before the start of the exposure time (when delay > 1ms) and ending 5ms before the exposure time stops (when exposure 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**

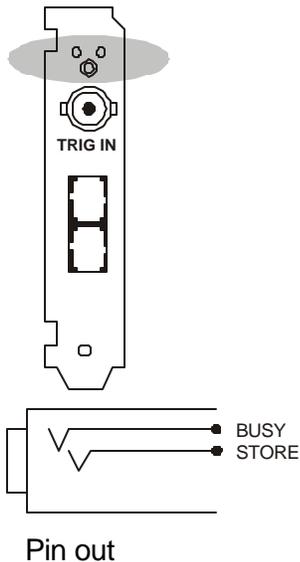
(Only for SensiCam DoubleShutter)

The 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



**NOTE:** Interface board 525 only.

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

### Function 1: BUSY Signal

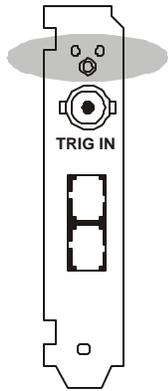
This control output signals if the camera is ready to accept a new trigger signal. While BUSY is active, an external trigger signal will be ignored. The BUSY signal edge depends of the selected trigger input edge of the TRIG IN signal. When the trigger input is falling edge (selected in the CameraControl 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. (Interface 525 only)

### Green LED

Control LED is lit when connection between camera and PCI-Board is correct.

When the LED is off, there could be the following reasons:

- Cable is not connected properly. When using 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, complete operation software for the camera allowing to display and to save images.

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

### Plug-Ins

In case you are already working with image processing or image analysis software appropriate Plug-Ins may be installed. Camera control can be performed directly from the image analysis software. SensiCam High Performance and QE cameras are supported by the following 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.)

\* indicates that the driver is on the CD provided with the camera.

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

**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
- SDK for Linux

The SDK can be found on the CD or can be downloaded from Internet under <http://www.cookecorp.com>.

### TWAIN Drivers:

TWAIN drivers are also provided for Windows 9X/ME/2000/IXP/NT and Linux

The drivers can be found on the CD or can be downloaded from Internet under <http://www.cookecorp.com>.

## 6. Cooling Options

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

### **Remote fan cooling**

For this cooling option the camera fan 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 fan can be positioned on the floor. The camera's power switch also switches the fan on or off.

### **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.

Contact Cooke for more information on water requirements.

## 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, camera must 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 wiping on a dry glass surface.

If 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. Cleaning solvents can damage the finish on the housing.

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 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 protective caps on both camera and cables **immediately**.

## 8. Appendix

### Customer Service

If you have a problem or a question about matters not handled in these operating Instructions, please contact:

... by Telephone	<b>1-866-66COOKE (1-866-662-6653)</b>
... by Fax	<b>(248) 276-8825</b>
... by Email	<b>service@cokecorp.com</b>

For a quicker reply we need following information:

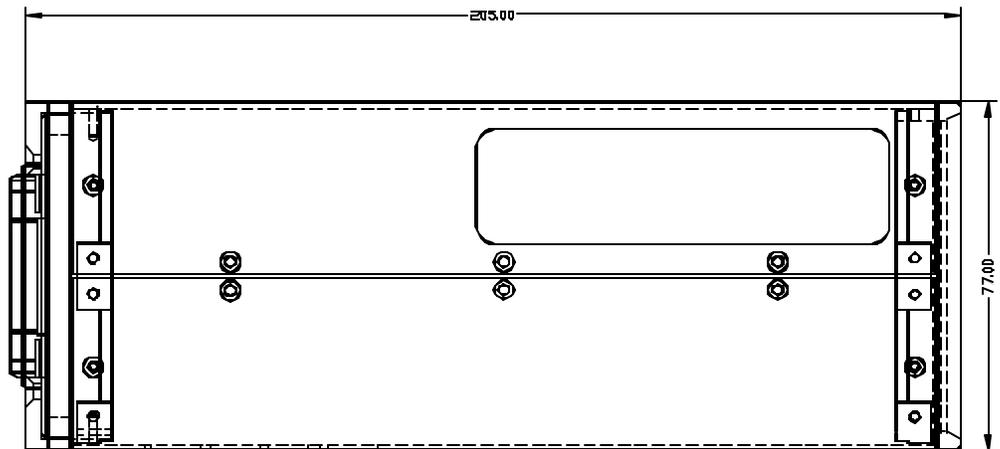
- Short description of the problem
- Experiment conditions
- Settings of delay and exposure time
- Camera control software and version number
- Camera serial number
- PCI-Board serial number (520 ... or 525 ...)
- Operating System
- Processor type of your computer
- Size of RAM
- Type of graphic board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

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

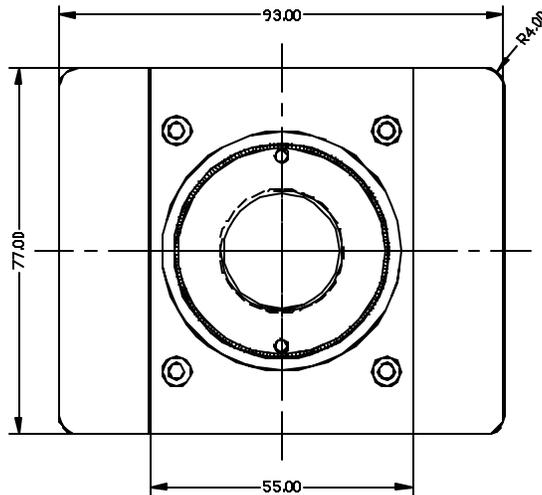
### CE-Certification

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

### Dimensions and Weight

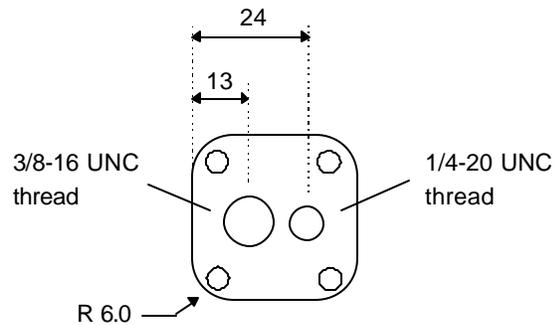


Side view of the SensiCam



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 <sup>-</sup>	25.000 e <sup>-</sup>	18.000 e <sup>-</sup>
Scan Rate	12.5 MHz	12.5 MHz	16 MHz
Readout Noise @12.5 MHz	13 ... 14 e <sup>-</sup>	7 ... 8 e <sup>-</sup>	4 ... 5 e <sup>-</sup> (Gain High) 5 ... 6 e <sup>-</sup> (Gain Low)
A/D-Converter	12 Bit @12.5MHz		12 Bit @16MHz
A/D Conversion Factor	7.5 e <sup>-</sup> /count	5 e <sup>-</sup> /count	2 e <sup>-</sup> /count (Gain High) 4 e <sup>-</sup> /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 <sup>7)</sup>	< 0.1 e <sup>-</sup> /pixel/sec	< 0.1 e <sup>-</sup> /pixel/sec	< 0.1 e <sup>-</sup> /pixel/sec
Extinction Ratio <sup>1)</sup>	1:2000	1:2000	1:2000
Smear <sup>2)</sup>	< 0.005%	< 0.005%	< 0.005%
Anti Blooming <sup>3)</sup>	> 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
<b>Blemishes</b>			
Point Defects <sup>4)</sup>	0	0	0
Cluster Defects <sup>5)</sup>	0	0	0
Column Defects <sup>6)</sup>	0	0	0
<b>Warm Pixels <sup>7)</sup> typ.</b>			
# pixels > 100 e <sup>-</sup>	0	0	0
# pixels > 5 e <sup>-</sup>	0 - 2	0 - 2	0 - 2
# pixels > 1 e <sup>-</sup>	250 - 1000	500 - 2000	500 - 2000
<b>Non-Uniformity in darkness <sup>8)</sup> typ.</b>			
	1 count	1 count	1 count
<b>Non-Uniformity in brightness <sup>9)</sup> typ.</b>			
	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 39.

<b>High Speed Serial Link</b>	
High Speed Serial Link	standard: coax cable ? 10m with BNC connectors optional: fiber optic link ? 2000m with SC connectors

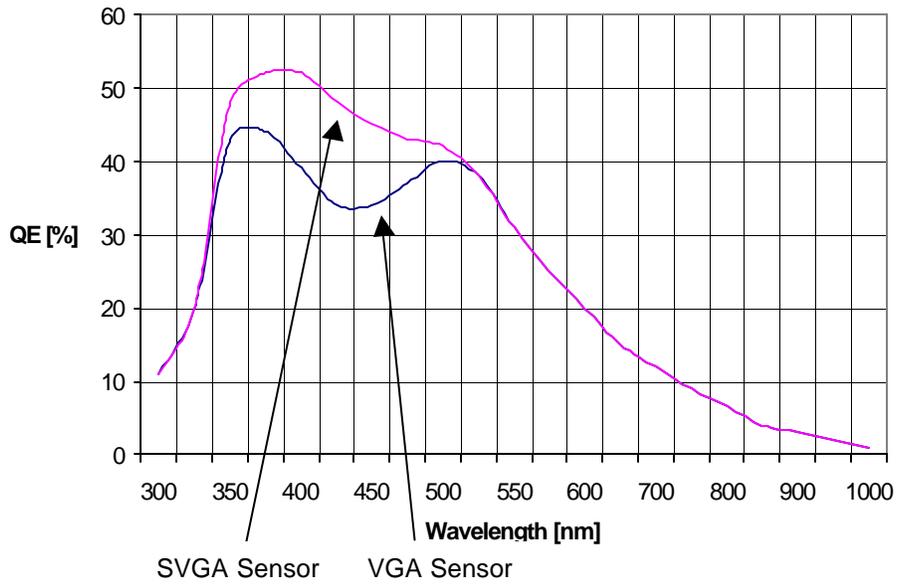
<b>PCI-Interface Board</b>	
Board	PCI Local Bus compatible, revision 2.1
Buffer RAM	16 MByte
Trigger Input	TTL level (rising/falling edge); BNC connector
Exposure/ Delay Time Setting <b>SensiCam HIGH PERFORMANCE</b>	0 ... 1000s delay 1ms...1000s exposure
Exposure/ Delay Time Setting <b>SensiCam HIGH SPEED</b>	0 ... 1ms delay 100ns...1ms multiple exposure (free programmable)
Exposure/ Delay Time Setting <b>SensiCam DOUBLE SHUTTER</b>	two separate exposures with min. 200ns delay
Exposure/ Delay Time Setting <b>SensiCam QE</b>	0 ... 1000s delay 1ms...1000s exposure

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

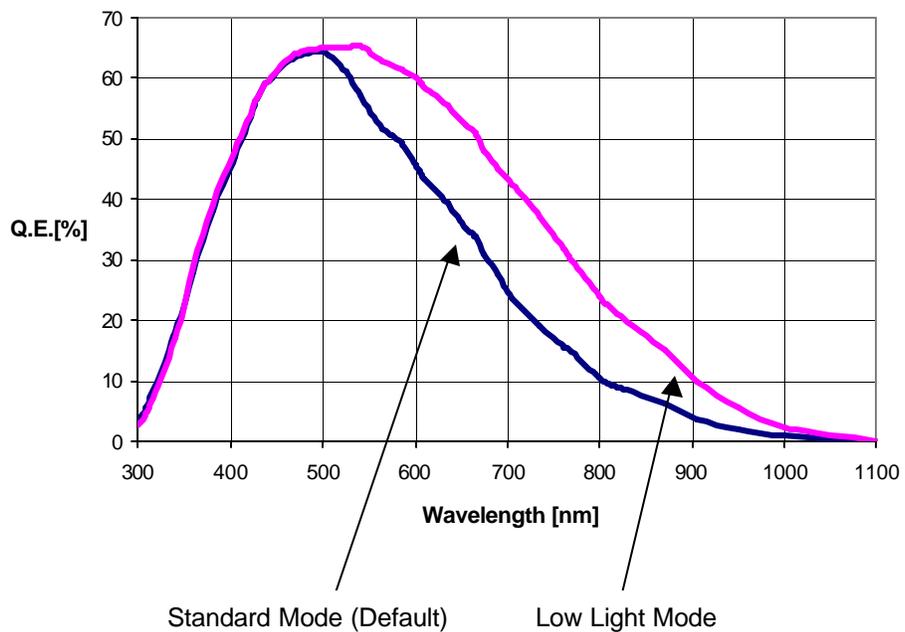
x) See remarks on page 39.

### Spectral Response (typical values)

**SensiCam High Performance**  
**SensiCam High Speed**  
**SensiCam DoubleShutter**



### SensiCam QE



## 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.

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

### 2) Smear

The CCD is set to 40ms exposure time with an uniform illumination to achieve 50% of saturation ( $V_{50}$ ). 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:

$$Sm = \frac{V_{Sm}}{V_{50}} \cdot \frac{1}{500} \cdot 100\%$$

### 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 High Speed 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).

$$\text{typical deviation } d_{typ} = \frac{1}{n} \sum_{i=1}^n |d_x|$$

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

with  $n = 307,200$  for VGA (640 x 480 pixels)

with  $n = 1,310,720$  for SVGA (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 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