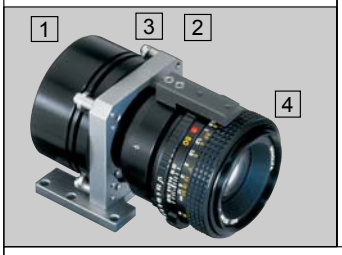
# CCD Line Scan Camera Digital b/w SK1024USD

1024 pixel, 14x14µm, 15 MHz pixel frequency, USB 2.0

Camera series USD | 512 | **1024** | 2048

1 CCD line scan camera SK1024USD
mounted on
2 Camera mount SK5105
3 Clamp set SK5102
4 Video(CCTV) lens





**Characteristics:**
- digital camera 8 Bit (optional 12 Bit)
- high dynamics
- high line frequency up to 18.4 kHz
- anti blooming
- integration control
- gain/offset programmable
- very low noise
- light sensitive
- CDS technology

## Accessories (optional)

Camera mount **SK 5105** (Order Code)
Warp resistant construction for the mounting of the CCD line scan camera.
Optional: Clamp set **SK 5102** (Order code) to lock the CCD line scan camera in arbitrary rotation.
Mounting console **SK 5105-2**
for adaptation of macro lens, extension ring ZR..., focus adapter FA22-C and the CCD- line scan camera

**Lenses:**
- high resolution enlarging lenses and macro lenses
- high speed photo lenses
- lenses with additional blocking bracket for locking of focus and aperture setting.

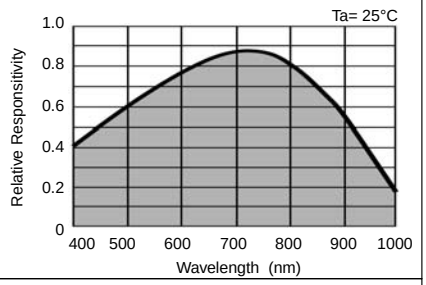
**Adapter:**
Lens adapter **AOC-...** for adapting photo lenses onto the CCD line scan camera.
Focus adapter **FA22-...**for adapting Enlarging lenses and macro lenses.

**Software: SK 91USB-WIN** (Windows® XP/2000)
Operation program SkLineScan®, driver, libraries

## Performance Specifications

| | |
|---|---|
| Camera type | SK1024USD |
| Order Code | |
| Sensor: | CCD linear |
| Type: | IL-P3-1024B |
| Pixel number: | 1024 |
| Pixel size: | 14x14µm |
| Pixel distance: | 14µm |
| Line width: | 14µm |
| Aktive Length: | 14.34 mm |
| Pixel frequency: | 15 MHz |
| Line frequ. max: | 14.10 kHz |
| Line frequ. min: | 0.03 kHz |
| Integration time min: | 0.002 ms |
| Integration time max: | 35.0 ms |
| Dynamic range: | 1:500 |
| Spectral range: | 400-1000 nm |

## Typical Spectral Responsivity




| | |
|---|---|
| Input control signals: | ext. Sync (BNC) |
| Video signal: | 8 Bit digital |
| Interface: | USB 2.0 |
| Power Supply: | |
| Voltage: | +5 V, |
| Power consumption: | 1.6 W |
| Connector: | USB, TypA |

| | |
|---|---|
| Others: | |
| Operating temp.: | + 5°C ... + 45 ° |
| Size: | Ø 65mm x 51mm |
| Weight: | 0.2 kg |
| Lens Thread: | C-Mount |





Schäfter + Kirchhoff GmbH
Kieler Str. 212, D-22525 Hamburg - Tel: +49 (0)40 853997 0 - Fax: +49 (0)40 853997 79 - eMail: info@SuKHamburg.de - Web: http://www.SuKHamburg.de

## 1. Technical Specifications of the USD Camera Series

| Camera model | SK512USD | SK1024USD | SK2048USD |
|---|---|---|---|
| Sensor: | CCD linear | CCD linear | CCD linear |
| Type: | IL-P3-512B | IL-P3-1024B | IL-P3-2048B |
| Pixel number: | 512 | 1024 | 2048 |
| Pixel size: | 14x14µm | 14x14µm | 14x14µm |
| Pixel distance: | 14µm | 14µm | 14µm |
| Line width: | 14µm | 14µm | 14µm |
| Active length: | 7.17 mm | 14.34 mm | 28.70 mm |
| Anti-Blooming | yes | yes | yes |
| Integration Control | yes | yes | yes |
| CDS 1) | yes | yes | yes |
| | | | |
| Pixel frequency: | 15 MHz | 15 MHz | 15 MHz |
| Line frequency max: | 27.17 kHz | 14.10 kHz | 7.18 kHz |
| Line frequency min: | 0.03 kHz | 0.03 kHz | 0.03 kHz |
| Integration time min: | 0.002 ms | 0.002 ms | 0.002 ms |
| Integration time max: | 35.0 ms | 35.0 ms | 35.0 ms |
| Dynamic range: | 1:500 | 1:500 | 1:500 |
| Spectral range: | 400-1000 nm | 400-1000 nm | 400-1000 nm |
| | | | |
| Cable length | | | |
| USB cable: | 1.7 m | 1.7 m | 1.7 m |
| SYNC cable: | 1.7 m | 1.7 m | 1.7 m |
| Power supply | | | |
| Operating: | USB Host (300 mA) | USB Host (300 mA) | USB Host (300 mA) |
| Standby: | ca. 50 mA | ca. 50 mA | ca. 50 mA |

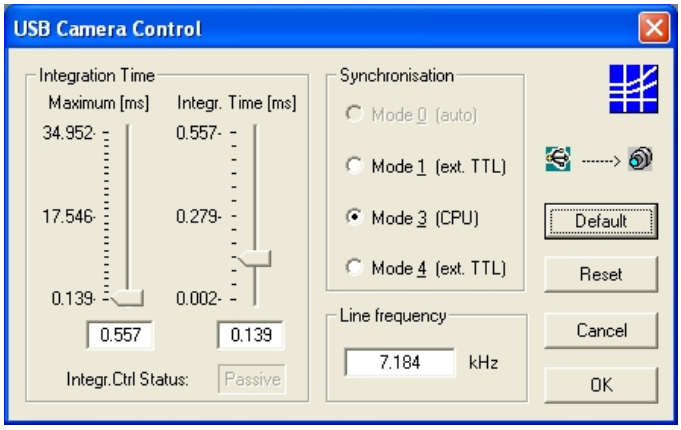
## 2. Handling details of the USB line scan camera

A successful application of the line scan camera is based upon a careful adjustment of the whole optical system. Attention should be paid to the arrangement of the illumination, the aperture setting, the focusing range of the lens, as well as the orientation of the sensor axis to the scanning direction.

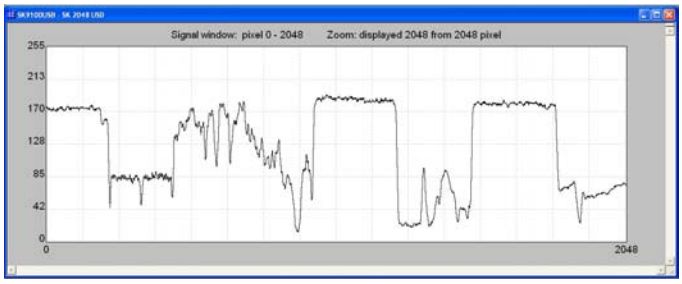
Using the **SkLineScan®** software by **Schäfter+Kirchhoff** the camera is ready for operation immediately. The oscilloscopic display of the line scan camera signal including the zoom-function and the online parameter setting of the camera is a valuable tool while arranging the optical system setup.
The comfortable methods of the class libraries for C++ support the development of user software.
USB line scan cameras from **Schäfter+Kirchhoff** need a PC or notebook with USB 2.0 connections. The grabber to the capture of the camera data in the PC is omitted.
The USB line scan cameras from Schäfter+Kirchhoff are externally synchronizable. The input cable for external synchronization as well as the USB cable to the computer are firmly connected with the camera.
The camera is shipped aligned and with default settings in gain and offset. The gain/offset values are adjustable by the software. Extensive modifications of the gain/offset-parameter can lead to a decrease in signal quality.
The last programmed gain/offset values keep stored in the camera after disconnecting the camera from the PC and are active at the next connection of the camera at any PC.
The USB 2.0 line scan cameras are not downwardly compatible to the USB 1.1 standard !

## 3. Exposure and Integration Control

The camera SK1024USD has a maximum line frequency of 14.10 kHz. The programmable range for the exposure period is 0.07 ms up to 35.0 ms.
The tool for programming the integration time with the SkLineScan program is the right vertical slider in the 'USB Camera Control' dialog. The adjustment range is defined by the left vertical slider. The changes are visible immediately in the oscilloscopic signal display.
The button 'Default' sets the integration time exactly at the minimum exposure period. The camera works now with the maximum line frequency. At shorter integration times than 0.07 ms the 'Integr.Ctrl Status' is switched to 'Active' (Shutter).




*USB camera control in the SkLineScan program with expample of SK2048USD camera*



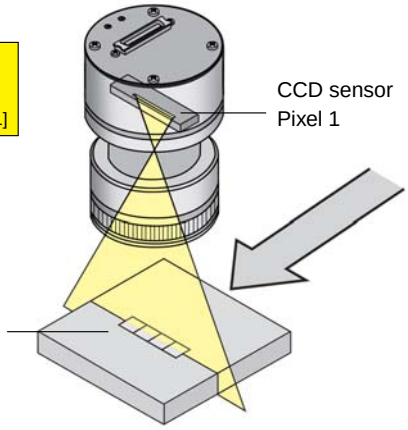

*Oscilloscopic display of the line scan camera signal*

## 4. Generating an Image – Scan a Surface

A two-dimensional image is generated by moving the object or the camera. The direction of the movement needs to be orthogonal to the sensor axis of the CCD line scan camera. To optain a propotional image with correct aspect ratio a line synchronous transport and a laterally correct pixel assignment is required.

$$V_O = \frac{W_P \cdot \beta}{t_E} \quad [1]$$

$V_O$ = Object rate
$W_P$ = Pixel width
$\beta$ = Magnification
$t_E$ = Exposure period



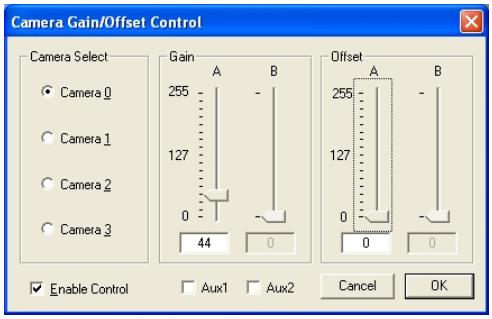

**Technical details of exposure:**
The photo sensitive elements of the sensor store the charge carrier which are generated by the incident light in a determined time interval. The accumulated charges will be transformed in voltages. The quantity of voltages depends on the intensity of the incident light in the pixel elements.
The **Integration time** is the time interval of charge carrier accumulation.
The **exposure period** $T_E$ is determined by the time which is needed to readout the charge carrier from the shift register of the sensor completely (called also **exposure time**). The maximum line frequency is the reciprocal of $T_E$ as $\mathbf{f_{L\,max} = 1/T_E}$.
With Cameras with **Integration Control** function the integration time can be programmed shorter than the exposure period (Shutter operation). By reducing the integration time the line frequency will be not greater because the exposure period remains constant.

## Synchronization

**Mode 0**: Internal synchronization by the camera. After completion of a line scan the next scan is started automatically. (free run mode)
**Mode 1**: External camera synchronization. Each line scan is started by an external trigger (TTL) which determines the line frequency. The exposure time is constant and has to be programmed prior to the first line scan. The TTL clock does not affect the integration time. The TTL period must be longer than the exposure period.
**Mode 3**: The camera exposure period is started by a software operation.
**Mode 4**: External synchronization like mode 1, but the falling edge of the trigger clock starts a new exposure period exactly (Restart-Reset-Mode). The mode 4 demands camera with Integration Control function, which does not support the shutter function in synchronization mode 4. The minimum integration time in mode 4 is 0.07 ms.

## 5. Gain / Offset

The camera is shipped aligned and with default settings in gain and offset. The programming of gain and offset is possible by using the SkLineScan software:
1. **Offset**:
Shade the line sensor and adjust the video signal near at 0 with the Offset-Slider. The line signal should be just visible.




2. **Gain**:
Illuminate the sensor and move the gain slider to a slight overexposure to identify the maximum clipping (255 or higher).
At cameras with two channel sensors the 'B''-slider will be active automatically. The intensities of even and odd pixels have to adjust with the smallest difference.

## 6. Blooming

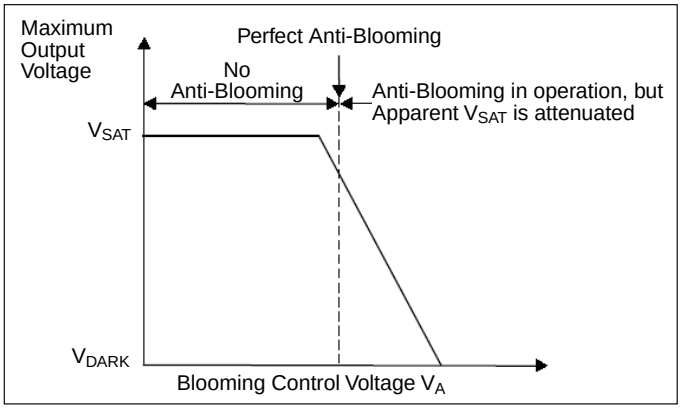
Blooming
Extended illumination of saturated pixels, which are not able to accumulate further charge due to long exposure, leads to charge overflow into adjacent pixels. This effect is called blooming. Blooming causes a corruption of the geometrical allocation of image and object in the line signal.

CCD line scan cameras with **anti-blooming** sensors direct the abundant charge to a ”drain gate”. Charge overflow into adjacent, less illuminated pixels is prevented. Depending on pixel frequency and spectral range, overexposure up to factor of 50 can thus be handled.

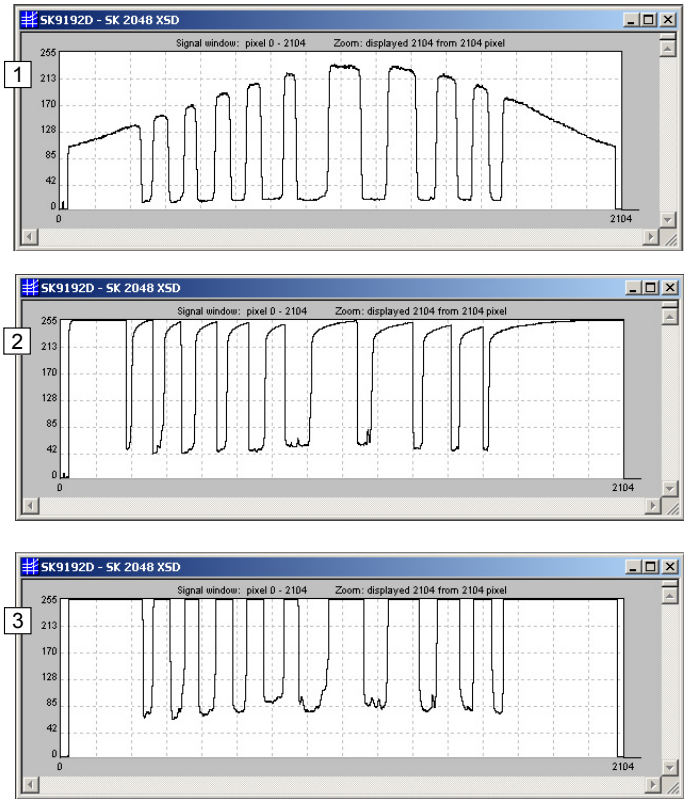
The CCD line scan cameras of the USD-series do contain anti-bloooming sensors, i.e. they are prevented from overexposure due to a special design. The Blooming Drain Gate has a limited capacity, though.

The less pixels are overexposed, the better is the anti blooming effect of the drain gate. For single pixels a charge excess of up to a factor of 50 above saturation can be drained. With increasing quantities of oversaturated pixels the charge drainage decreases.

The electronics of the USD camera series support the blooming control possibilities of the sensor. The saturation load is regulated by the blooming control voltage VA. The higher the voltage VA the lower the level of anti blooming effect initiation. A high voltage VA increases the saturation protection, but it limits the output voltage of the video signal and reduces the dynamic range of the camera. Tuning the voltage VA to a level too small, the anti blooming effect is switched off completely. The maximum output voltage of the sensor reaches the saturation level VSAT.

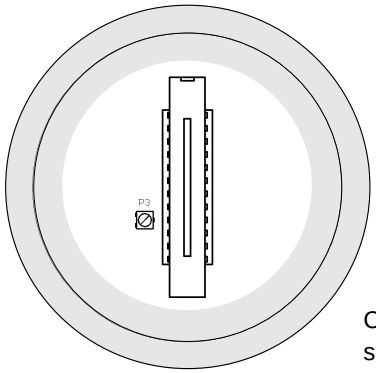



The blooming control voltage VA is by default prepared to a level where the output voltage of the camera reaches approx. 90% of the saturation voltage VSAT at maximum. Thus, an optimum anti blooming effect is ensured. The voltage VA should only be altered in exceptional cases.
The anti blooming control voltage VA is adjusted with the trimmer P3. Turning the trimmer P3 to the left, the voltage VA rises. Turning it to the right the voltage VA decreases. Turning it to the right bedstop, the anti blooming is switched off.




Oscilloscopical signal display of the CCD line scan signal (barcode with incident light), SK 2048 USD

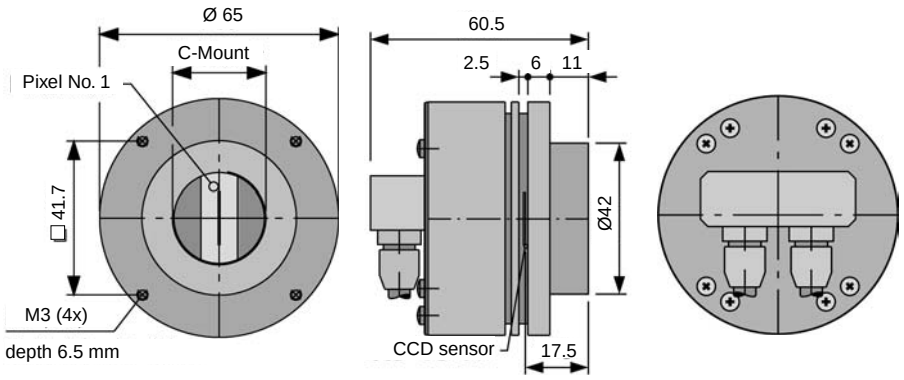
1 Line scan signal with central enhanced illumination and sharp rising signal edges. Integration time tA= 0.158 ms
2 Over exposure due to longer integrationtime (tA= 0.533 ms). The blooming effekt is raised in the sensor by misadjusting the blooming control voltage (low VA). The structures of the signal are distorted.
3 The blooming control voltage limits the output signal of the sensor to approx. 90% of the saturation voltage VSAT. The anti blooming technique ist active. Also, with even longer integration time (tA= 0.806 ms) the signal edge positions from Fig. 1 are preserved.




Camera board, sensor side

The trimmer P3 is accessed from the front of the camera with the lens taken off.
To prevent misadjustment of the line scan camera, the effect of the P3 adjustment should be performed and tracked with sufficient illumination observing an oscilloscopical display of the line scan signal on the PC monitor.

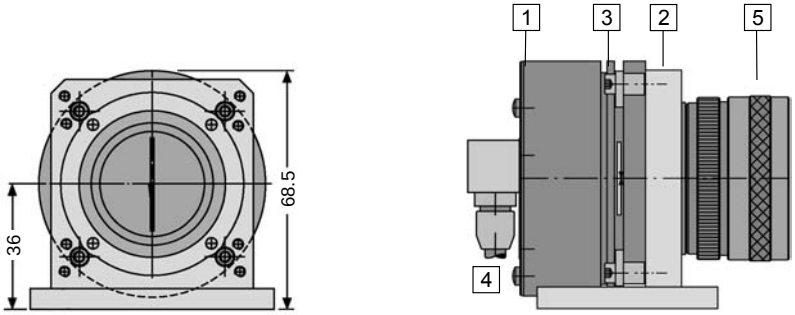
## 7. Dimension Diagrams



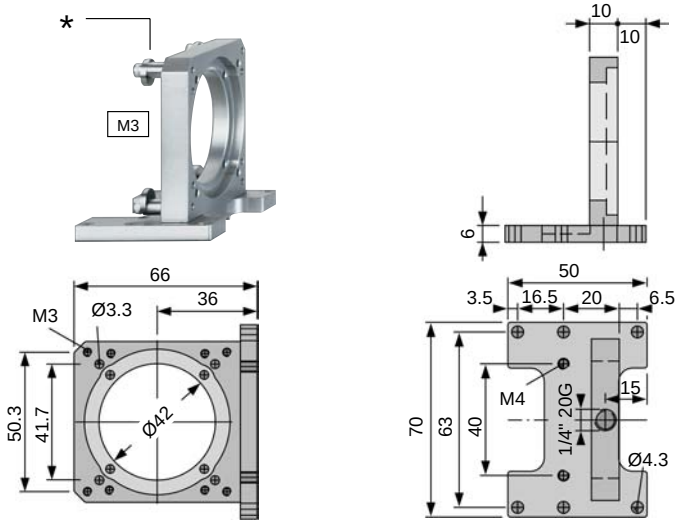

**CCD line scan camera digital**
512 – 1024 pixels

| | |
|---|---|
| Lens thread: | C-Mount |
| Working distance: | 17.5 mm |
| Connector: | USB Type A |

Camera types:
SK 512 USD, SK 1024 USD

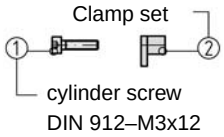


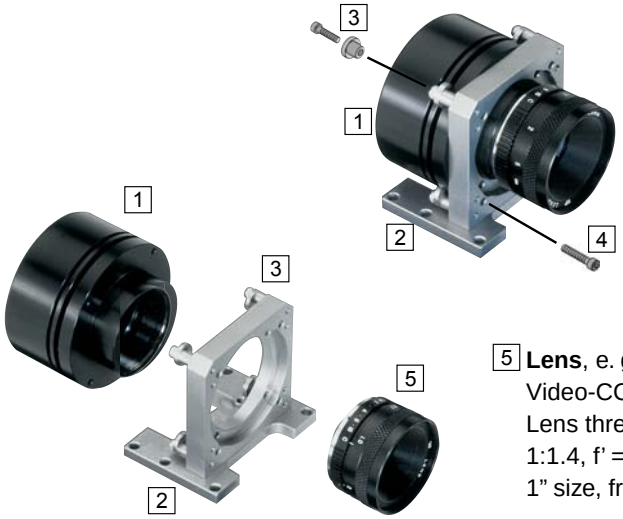

1 **CCD line scan camera digital**
256 – 1024 pixels
mounted with
2 Camera mount SK 5105
3 Clamp set SK 5102
Connection cable:
4 Cable USB 2.0, coax.
5 Lens




**Camera mount SK 5105**
for digital and analog cameras
Order Code: **SK 5105**
Warp resistant construction for the mounting of the CCD line scan camera

* **Clamp set SK 5102**
(incl. 4 units)
for the locking of the CCD line scan camera in arbitrary rotation




5 **Lens**, e. g.:
Video-CCTV lens C2514M
Lens thread: C-Mount
1:1.4, f' = 25 mm
1" size, free aperture 15.9 mm

1 **CCD line scan camera digital**
256 – 1024 pixels
mounted with
2 Camera mount SK 5105
3 Clamp set SK 5102
locking the CCD line scan camera in arbitrary rotation

optional
4 Locking with 4 units.
cylinder screws
DIN 912 - M3x16

Alternative video-, enlagement and macro lenses see brochure 'CCD Line Scan Cameras 2005'.

## 8. Sensor Data

Product by: DALSA®
Types: IL-P3-512-B, IL-P3-1024-B, IL-P3-2048-B
Data source: DALSA® Line Scan Sensors ,DALSA IL-P3-B - Data Sheet

### Block Diagram

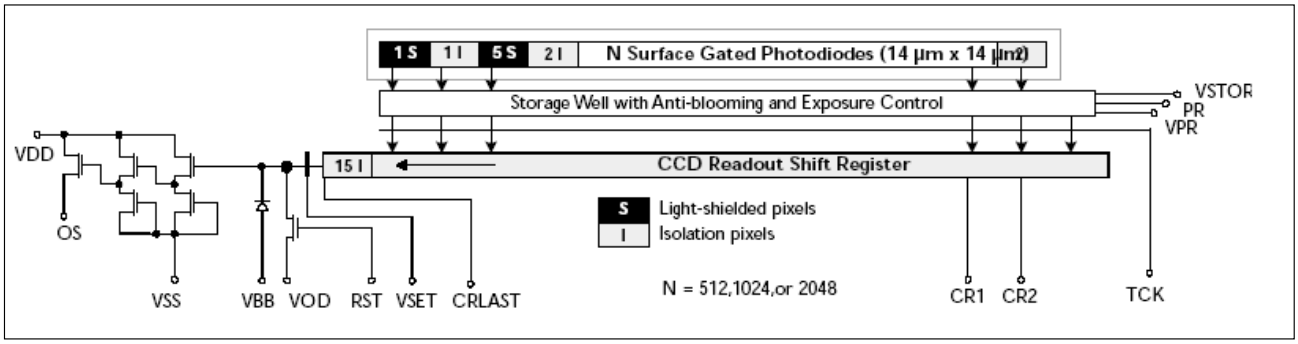
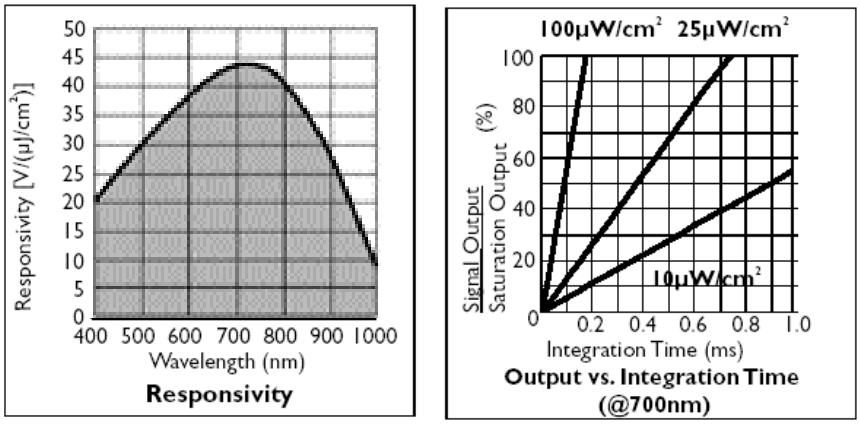



**Figure 2. Performance Measurements**



## Table 9. IL-P3-B Performance Specifications

| Specification | Unit | Min. | Typ. | Max. |
|---|---|---|---|---|
| Saturation Output Voltage (VSAT)[1] | mV | 680 | 800 | 930 |
| rms Noise | mV | | 0.44 | 0.48 |
| Wavelength of Peak Responsivity | nm | | 700 | |
| Peak Responsivity | V/(µJ/cm$^2$) | 41.3 | 43.7 | 46.5 |
| Dynamic Range | | 1420:1 | 1820:1 | 2110:1 |
| Charge Conversion Efficiency (CCE) | µV/e$^-$ | 8.8 | 9.3 | 9.9 |
| Noise Equivalent Exposure (NEE) | pJ/cm$^2$ | 9 | 10 | 12 |
| Saturation Equivalent Exposure (SEE) | nJ/cm$^2$ | 15 | 18 | |
| Full Well Capacity[1] | ke$^-$ | 73 | 86 | |
| Fixed Pattern Noise (FPN) [2,3] | mV | | < 0.5 | 1.0 |
| Photoresponse Non-Uniformity (PRNU) [4] | % OS | | | |
| 8 pixel local neighborhood | | | 3.0 | 6.5 |
| Global | | | 5.0 | 8.5 |
| Charge Transfer Efficiency (CTE) (readout register) | | 0.99997 | 0.999999 | |
| First Field Lag [5] | mV | 3.1 | 4.3 | 5.4 |
| Dark Signal, Integration time = 52µs | mV | | 0.19 | 0.22 |

**Notes:**

1. VSTOR can be adjusted to increase VSAT and full well. As these quantities increase, the antiblooming capability is compromised.
2. Maximum peak-to-peak variation of all outputs.
3. Due to its general purpose design, DALSA's camera and sensor evaluation hardware provides an output that cannot be used to directly measure low FPN.
4. The peak-to-peak variation is measured at ~50% SEE.
5. Lag is measured at 500 mV. Lag is lower if signal is lower.

**Test Conditions:**

- Operating temperature = 35°C.
- $f_{RST}$ = data rate per output = 40MHz.
- $I_{LOAD}$ = 10mA.
- $C_{LOAD}$ = 10pF.
- Tungsten halogen light source, black body color temperature 3200K, filtered with 750nm IR cutoff filter.
- See Sensor Measurement Definitions (doc# 03-36-00149) for specification definitions.

## 9. References and Warranty

Although this manual has been reviewed carefully for technical accuracy, errors are possible. The reader is kindly asked to contact us, if errors are suspected.
The indicated circuits, descriptions and tables are not warranted to be free from rights of third parties.
With the statements in the technical descriptions only assembly groups are specified. Characteristics as well as the suitability for a particular purpose is not guaranteed.
The warranty period for the CCD line scan camera is 24 months. The warranty ends with inappropriate actions.

## 10. EC-Declaration of Conformity

CE

This product meets the requirement of the EC directive 89/336/E.E.G.
The requirements of DIN EN 61326 are fullfilled.