

datasheet

pco.edge 9.4 bi CLHS

the next-level sCMOS camera

bi back
illuminated

resolution

9.4 MPixel

pixel size

4.6 μm x 4.6 μm

interface

CLHS FOL



high dynamic range
23 300 : 1

high frame rate
122 fps

high resolution
4096 x 2300 pixels

ultra-low readout noise
0.3 e⁻ (med)

temperature-stabilized
image sensor

line scanning mode

technical data

image sensor

| | slow scan | medium scan | fast scan |
|--|---|--|--|
| sensor technology | back illuminated scientific CMOS (bi sCMOS) | | |
| color type | monochrome | | |
| resolution (horizontal x vertical) | 4096 px x 2300 px | | |
| pixel size (horizontal x vertical) | 4.6 μm x 4.6 μm | | |
| sensor size (horizontal x vertical) | 18.8 mm x 10.6 mm | | |
| sensor diagonal | 21.6 mm | | |
| shutter mode | rolling shutter (RS) additional feature: line scanning mode | | |
| modulation transfer function (theoretical max.) | 108.6 lp/mm | | |
| peak quantum efficiency | 85 % @ 500 nm | | |
| spectral range | 400 nm - 1100 nm | | |
| dark current (typ.) | 0.4 e ⁻ /pixel/s @ +10 °C sensor temperature | | |
| fullwell capacity | 7000 e ⁻ | 6500 e ⁻ | 6500 e ⁻ |
| readout noise (typ.)¹ | 0.4 e ⁻ rms 0.3 e ⁻ med | 0.5 e ⁻ rms 0.4 e ⁻ med | 0.6 e ⁻ rms 0.5 e ⁻ med |
| dynamic range (intra-scene)² | 23 300 : 1 (87 dB) | 16 200 : 1 (84 dB) | 13 000 : 1 (82 dB) |

¹ The readout noise values are given as median (med) and root mean square (rms) values, due to the different noise models which can be used for evaluation. All values are raw data without any filtering.

² The dynamic range value is calculated with the median value of the readout noise and rounded.

frame rate table

vertical resolution reduction in fps

| | slow scan | medium scan | fast scan |
|--------------------|-----------|-------------|-----------|
| 4096 x 2300 | 30 | 60 | 122 |
| 4096 x 2048 | 33 | 67 | 137 |
| 4096 x 1024 | 67 | 134 | 274 |
| 4096 x 512 | 133 | 267 | 546 |
| 4096 x 256 | 264 | 528 | 1079 |
| 4096 x 128 | 516 | 1033 | 2110 |
| 4096 x 64 | 988 | 1977 | 4040 |
| 4096 x 32 | 1820 | 3641 | 7440 |
| 4096 x 16 | 3143 | 6287 | 12 846 |
| 4096 x 8 | 4937 | 9874 | 20 176 |

typical resolutions in fps

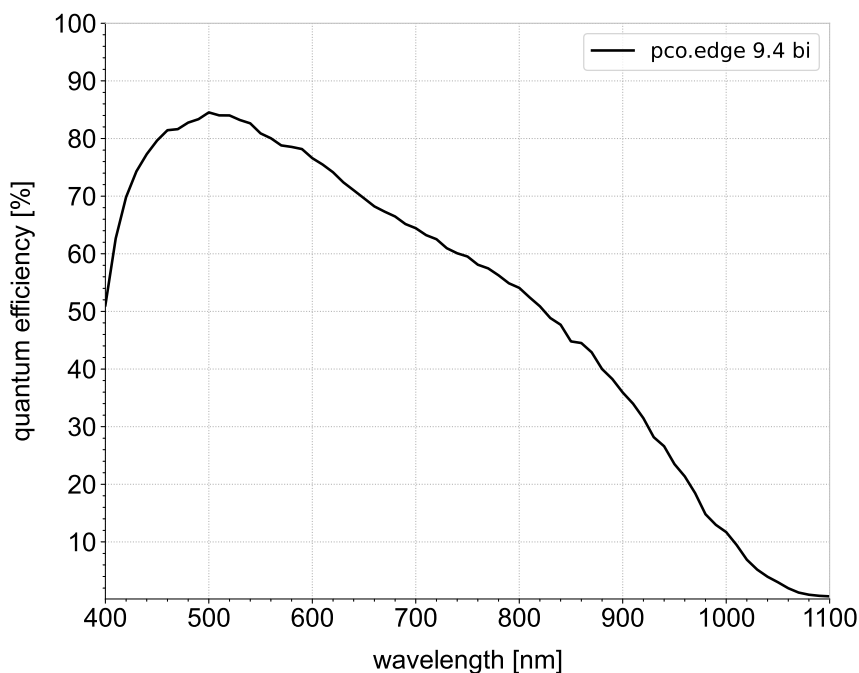
| | slow scan | medium scan | fast scan |
|--------------------|-----------|-------------|-----------|
| 2048 x 2048 | 33 | 67 | 137 |
| 1920 x 1080 | 63 | 127 | 260 |
| 1280 x 1024 | 67 | 134 | 274 |
| 640 x 512 | 133 | 267 | 546 |
| 320 x 256 | 264 | 528 | 1079 |

| camera | | | |
|--------------------------------------|---|--------------------------|--------------------|
| | slow scan | medium scan | fast scan |
| max. frame rate @ full resolution | 30 fps | 60 fps | 122 fps |
| exposure time range | 28.9 μ s - 10 s | 14.5 μ s - 10 s | 7.1 μ s - 10 s |
| dynamic range A/D ¹ | 16 bit | | |
| conversion factor ² | 0.11 e ⁻ /DN | 0.10 e ⁻ /DN | |
| pixel rate | 367 MPixel/s | 734 MPixel/s | 1467 MPixel/s |
| region of interest (ROI) | horizontal: steps of 32 columns vertical: steps of 4 rows | | |
| binning | horizontal: x2, x4 (average, sum) vertical: x2, x4 (average, sum) | | |
| non-linearity | < 0.3 % | | |
| dark signal non-uniformity (DSNU) | < 0.05 e ⁻ rms | < 0.1 e ⁻ rms | |
| photo response non-uniformity (PRNU) | < 0.1 % | < 0.2 % | |
| cooling temperature image sensor | adjustable: 0 °C to +25 °C calibration setpoint: +10 °C | | |
| cooling method | forced air & liquid cooling | | |
| trigger input signals | external exposure start, external exposure control, acquire enable | | |
| status output signals | exposure, busy, line | | |
| input / output signal connectors | SMA | | |
| time stamp | in image (1 μ s resolution) | | |
| data interface | Camera Link HS FOL | | |

¹ The high dynamic signal is simultaneously converted at high and low gain by two 11 bit A/D converters and the two 11 bit values are sophistically merged into one 16 bit value.

² According to EMVA1288, the conversion factor equals the inverse of the system gain and can be operational mode dependent.

quantum efficiency



general

| | |
|--|-----------------------------------|
| power supply | 24 VDC (±10 %) |
| power consumption | max. 40 W |
| weight | 1.35 kg |
| dimensions (height x width x length ¹) | 95 mm x 90 mm x 109 mm |
| operating temperature range | +10 °C to +40 °C |
| storage temperature range | -10 °C to +60 °C |
| humidity range (non-condensing) | 10 % to 80 % (recommended < 65 %) |
| certifications | CE, FCC, UKCA |

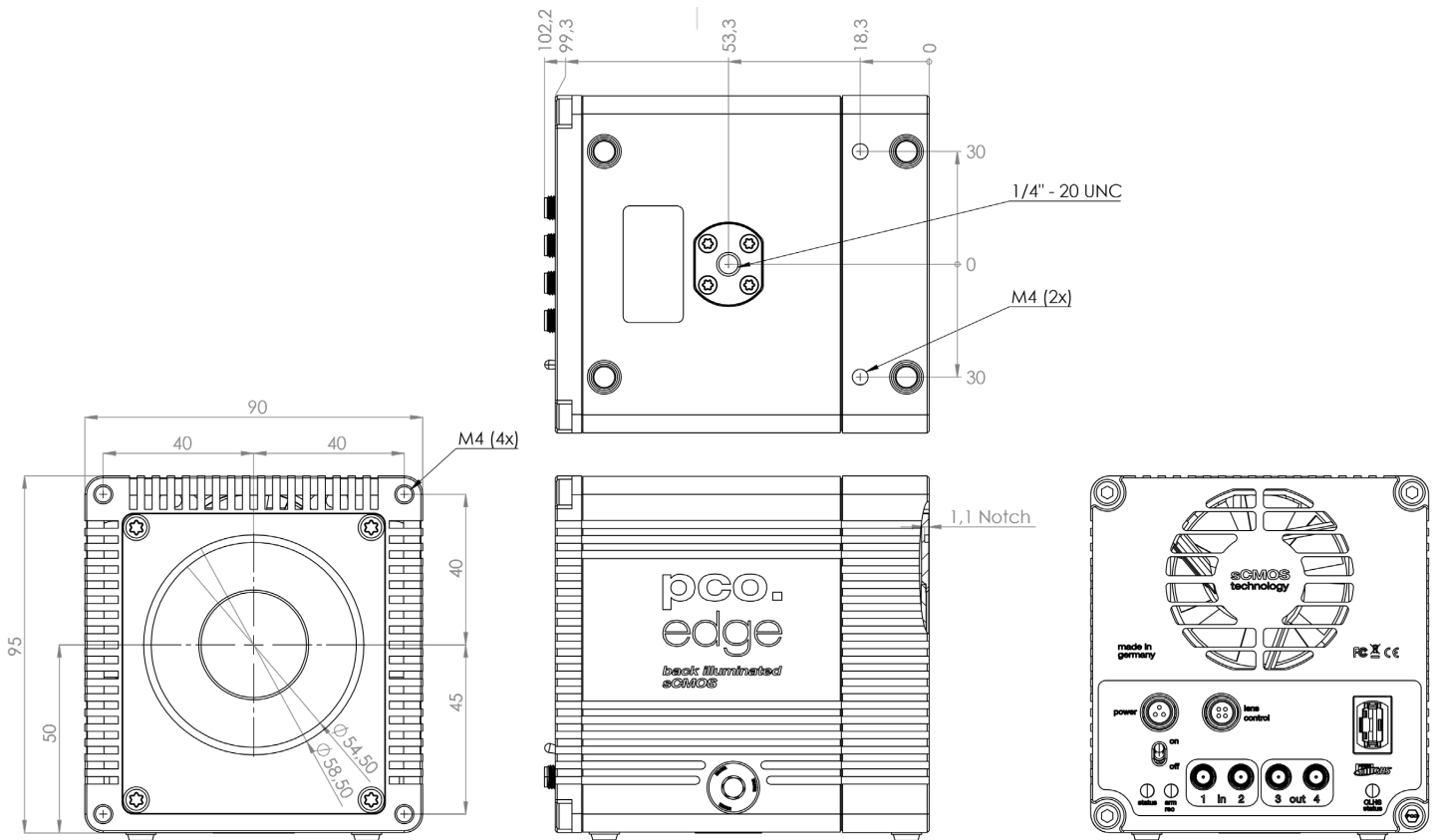
¹ This value refers to the length including the camera flange.

optical interface

| | |
|---|------------------------------|
| direct mounting distance (no camera flange) | 6.2 mm (±10 %) |
| lens mounting | C-mount, F-mount |
| optional lens mounting | TFL-mount |
| optional lens remote control | EF-mount, EF-S-mount (Canon) |

Configure your optical setup with our **MachVis Lens Selector** online tool.

dimensions



outlines of pco.edge 9.4 bi CLHS without camera flange (all dimensions given in mm)

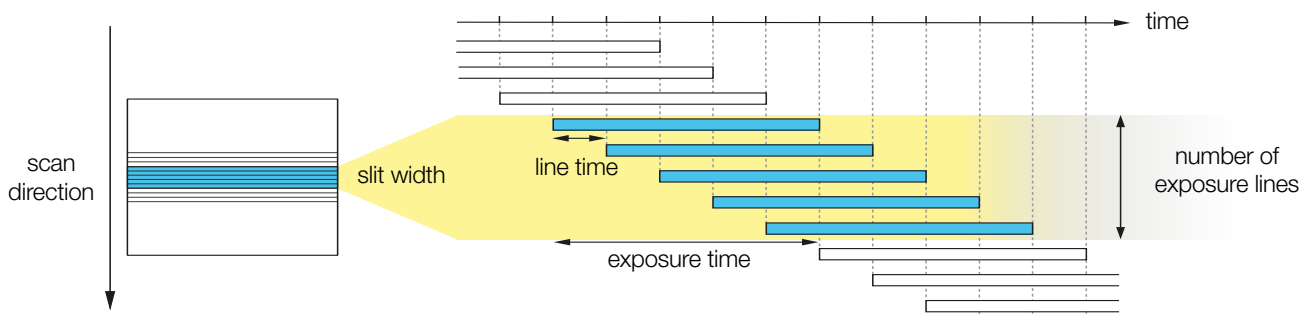
line scanning mode

The line scanning mode is a special readout mode dedicated to lightsheet fluorescence microscopy (LSFM). Built on the rolling shutter mode, this feature enables optimized synchronization of the camera and the microscope system.

Unlike the standard rolling shutter mode, in which the only adjustable parameter is the exposure time, line scanning mode allows adjustment of two key parameters: the number of exposure lines and the line time, setting the exposure time according to the relation:

$$\text{exposure time} = \text{number of exposure lines} \times \text{line time.}$$

Together, the number of exposure lines and line time control the slit characteristics—with the slit referring to the area of the sensor exposed at any given time. While the number of exposure lines defines the slit width, which corresponds to the height of the moving exposure window, the line time determines the slit speed.



exemplary readout in line scanning mode with a slit width of five exposure lines

By synchronizing the slit with the focused excitation of the lightsheet, the impact of scattered light is minimized. Additionally, the fast scan rates, high sensitivity, low readout noise, and high dynamic range of the line scanning mode enhance the benefits of LSFM.

As LSFM reduces the risk of sample damage and photobleaching while enabling 3D imaging with minimal phototoxicity, it is ideal for live-cell imaging, in vivo studies, and dynamic biological processes.

software

Your first choice is pco.camware:

Our main camera control software enables control of most camera settings and facilitates image acquisition and storage.

You can customize it exactly to your needs using different layouts, styles and features.

You prefer to use a different software:

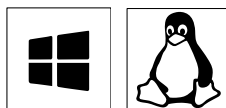
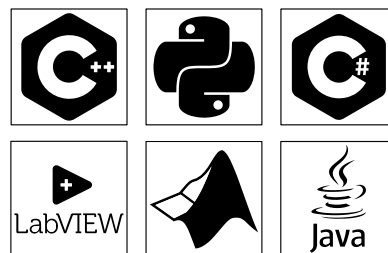
Our cameras integrate with a range of third-party software applications.

In microscopy we offer dedicated support for μ Manager, while ensuring compatibility with other software maintained by their providers.

You want to create your own application:

We feature a wide range of software development kits (SDK) for various programming languages, such as C++, Python, C#, LabVIEW, Matlab, and Java.

If you are looking for more general SDKs, we present pco.sdk and pco.recorder, our low-level SDKs with C interface.



Our software is available for Windows and Linux platforms.

Visit our **website** for detailed information, installation guidance, and Github projects.

areas of application

3D metrology | biochip reading | biometrics | brightfield microscopy | calcium imaging | digital pathology | fluorescence microscopy | fluorescence recovery after photobleaching (FRAP) | Förster resonance energy transfer (FRET) | high-speed brightfield ratio imaging | high-throughput screening | image intensifier imaging | industrial quality inspection | intravital microscopy | in vivo microscopy | lightsheet fluorescence microscopy (LSFM) | material testing | ophthalmology | raman spectroscopy | selective plane illumination microscopy (SPIM) | single molecule localization microscopy (SMLM) – PALM, STORM, dSTORM, GSDIM | structured illumination microscopy (SIM) | total internal reflection fluorescence microscopy (TIRF) | wafer inspection

ordering information

pco.edge 9.4 bi CLHS

85108076030

camera system, 4096 x 2300 pixel, monochrome, extremely low readout noise, rolling shutter, CLHS interface, air & liquid cooling

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