

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

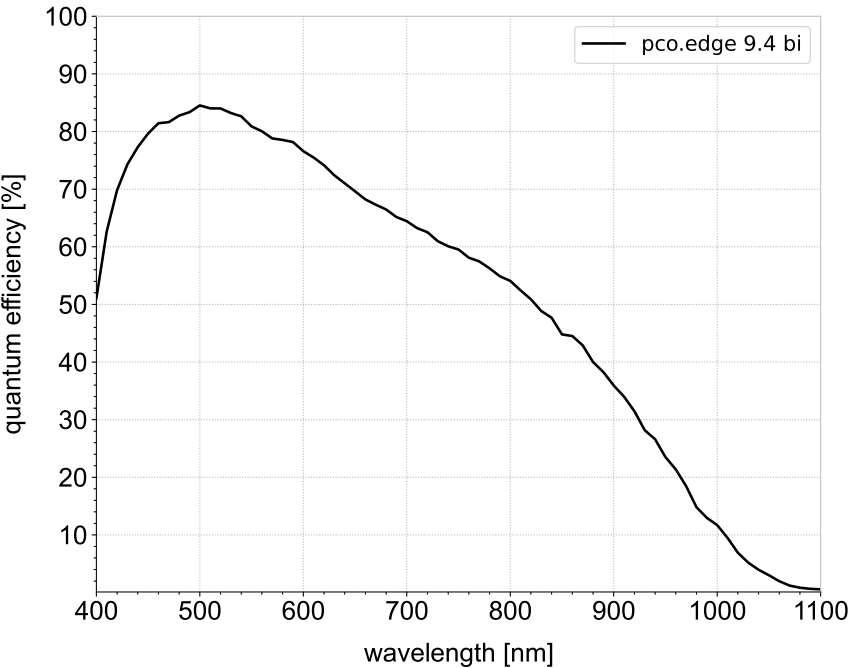
typical resolutions in fps

	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 μs - 10 s	14.5 μs - 10 s	7.1 μs - 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 μs 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

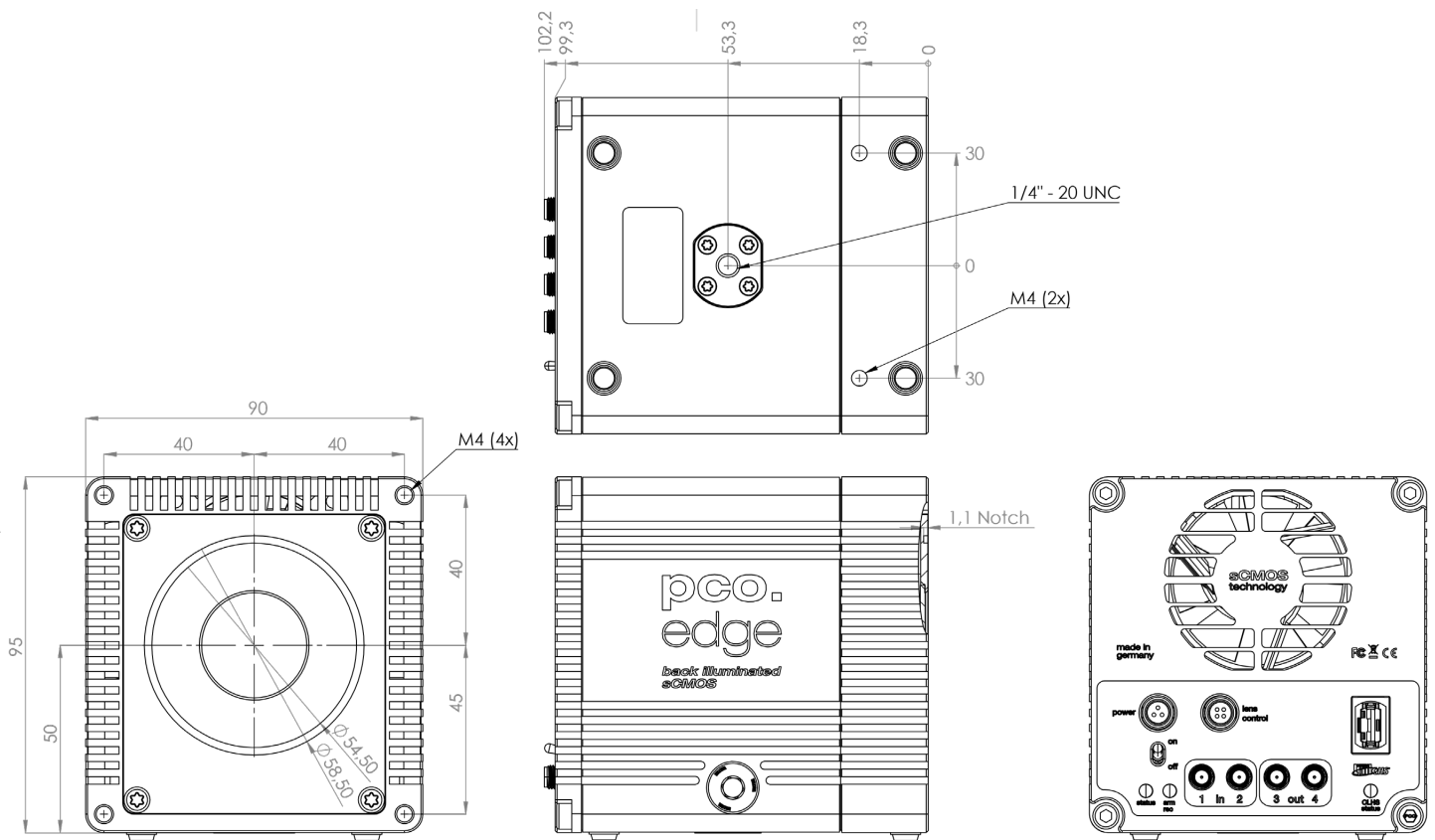
power supply	24 VDC ($\pm 10\%$)
power consumption	max. 40 W
weight	1.35 kg
dimensions (height x width x length¹)	95 mm x 90 mm x 109 mm
operating temperature range	+10 °C to +40 °C
storage temperature range	-10 °C to +60 °C
humidity range (non-condensing)	10 % to 80 % (recommended < 65 %)
certifications	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 ($\pm 10\%$)
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)

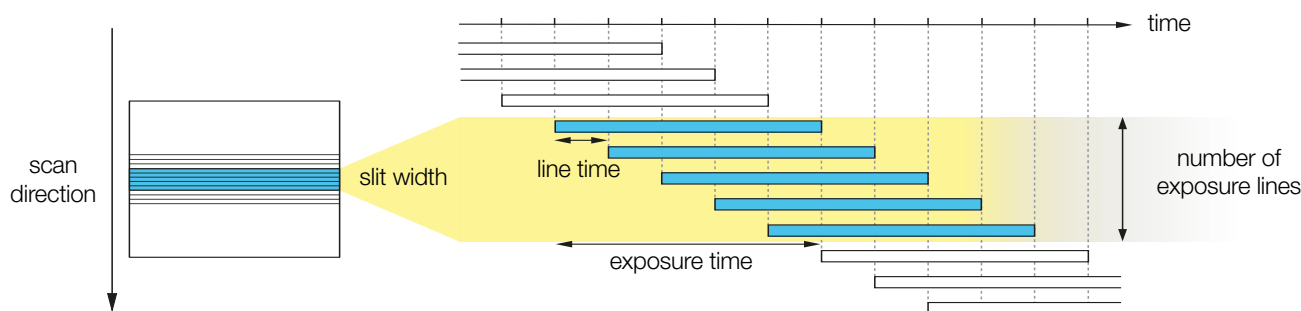
line scanning mode

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:

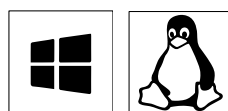
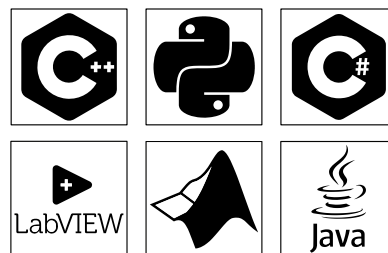
Our cameras integrate with a range of third-party software applications.

In microscopy we offer dedicated support for µManager, 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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