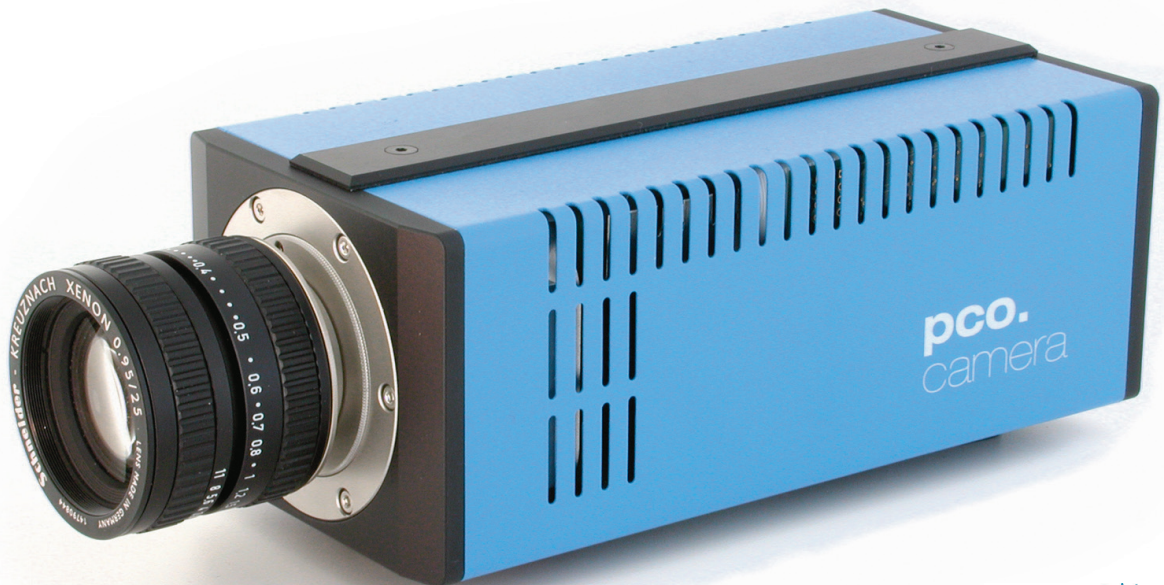# pco.1600
cooled digital 14 bit CCD camera system

- excellent resolution (1600 × 1200 pixel)
- 14 bit dynamic range
- frame rate of 30 fps at full resolution
- image memory in camera (camRAM up to 4 GB)
- excellent low noise of 10 e⁻ rms @ 10 MHz
- thermoelectrical cooling of –50 °C vs. ambient
- standard interfaces (IEEE 1394, camera link, GigE Vision)
- UV sensitive & color CCD image sensor available
- double shutter and modulate versions available

1288
EMVA Standard Compliant

data available on www.pco.de

pco.1600

This high dynamic 14 bit CCD cooled camera system comprises advanced CCD and electronics technology. With the new approach to integrate the image memory (camRAM) into the camera itself, it enables unmatched fast image recording with 160 MB/s. The system features thermoelectrical cooling (down to –50 °C vs. ambient), an excellent high resolution (1600 × 1200 pixel) and low noise (down to 10e⁻ rms). It consists of a compact camera with an external intelligent power supply. The image data are transferred via customer selectable standard data interfaces to a computer (IEEE 1394 ("firewire"), camera link, GigE Vision). The available exposure times range from 5 μs to 49 days (500 ns optional). This digital CCD camera system is perfectly suited for low light camera applications.

The camera is available as high performance pco.1600 comprising the double shutter function for PIV or as advanced scientific grade pco.1600 s. A modulation version pco.1600 mod allows in addition to accumulate multiple exposures into one image.

technical data

	unit	setpoint	pco.1600	pco.1600s
resolution (hor x ver) [1]	pixel	@ normal @ ext. mode	1600 × 1200 1648 × 1214	1600 × 1200 –
pixel size (hor x ver)	μm²		7.4 × 7.4	7.4 × 7.4
sensor format / diagonal	mm² / mm		12.2 × 9.0 / 15.2 @ ext. mode	11.8 × 8.9 / 14.8 @ normal mode
peak quantum efficiency	%	@ 500 nm typ.	55	55
full well capacity of CCD	e⁻		40 000	40 000
linearity range of CCD output @ 40 MHz	e⁻		40 000	40 000
image sensor			KAI–2001	KAI–2001
maximum dynamic range	dB		72	70
dynamic range A/D [2]	bit		14	14
readout noise	e⁻ rms	@ 10 / 40 MHz	10 / 21	12 / 21
imaging frequency, frame rate	fps	@ full frame	30	17
pixel scan rate	MHz		2 × 10 / 2 × 40	1 × 10 / 1 × 40
A/D conversion factor	e⁻ / count		2.1	2.1
spectral range	nm	normal UV sensitive	320 .. 1000 200 .. 1000	320 .. 1000 –
exposure time	s		5 μs .. 49 days (500 ns .. 49 days opt.)	5 μs .. 60 s
anti–blooming factor		typical	> 300	> 300
smear	%		0.01	0.01
binning horizontal	pixel		1, 2	1, 2

technical data

	unit	setpoint	pco.1600	pco.1600 s
binning vertical	pixel		1, 2, 4, 8	1, 2, 4, 8
dark current	e^- /pixel·s	@ 20 °C typ. @ –20 °C typ.	0.5 0.01	0.07 @ 0 °C –
region of interest (ROI)	pixel	hor & ver	1, 2, 3, 4 .. n	1, 2, 3, 4 .. n
non linearity	%	full temp. range @ 1 MHz	< 2	< 2
uniformity darkness DSNU [3]	e^- rms	@ 90 % center zone	< 20	< 20
uniformity brightness PRNU [4]	%	typical	2	2
trigger, auxiliary signals		internal external	software TTL level	software TTL level
power consumption	W	typical maximum	24 40	21 40
power supply	VAC		90 .. 260 (12 VDC opt.)	90 .. 260 (12 VDC opt.)
mechanical dimensions camera (w × h × l)	mm³		84 × 66 × 175	84 × 66 × 175
mechanical dimensions power supply (w × h × l)	mm³		135 × 51 × 195	135 × 51 × 195
weight	kg		1.8	1.8
operating temp. range	°C		+5 .. +40	+5 .. +40
operating humidity range	%		10 .. 90	10 .. 90
storage temp. range	°C		–20 .. +70	–20 .. +70
optical input			c–mount, Nikon f–mount	c–mount, Nikon f–mount
optical input window			fused silica	fused silica
data interface			IEEE 1394, camera link, GigE Vision	IEEE 1394, camera link, GigE Vision
CE certified			yes	yes
cooled CCD	°C		Δ–50 versus ambient temp.	0
cooling method			Peltier cooler	Peltier cooler
interframing time (PIV mode)	ns	double shutter version only	150	not available
max. modulation frequency	kHz	modulate version only	50	not available
max. exposures in one image		modulate version only	500 000	not available
single exposure time	s	modulate version only	500 ns .. 1 ms	not available

[1] horizontal versus vertical   [3] dark signal non–uniformity
[2] Analog–to–Digital–converter   [4] photo response non–uniformity

|			
software	Camware software for camera control, image acquisition and archiving of images in various file formats, WindowsXP, Vista and later, 32 bit–dynamic link library (DLL) is available for user customisation and integration on PC platforms (software development kit – SDK), software is operational in either single mode or with built–in recorder functions, drivers for popular third party software packages are available (see website)		
options	CCD image sensor in color & UV sensitive version custom–made versions camRAM available in: 512 MB, 1 GB, 2 GB & 4 GB external fan cooling, DC version		

frame rate table [frames per second]

The given resolutions are selected for the frame rate calculations in the tables only, they are not mandatory.

pixelclock	10 MHz		40 MHz	
used A/D converters	1	2	1	2
full frame	4.8	9.2	17.3	29.8
2 × 2 binning	9.4	17.7	32.4	53.4
2 × 8 binning	33.1	57.3	92.9	130.5

quantum efficiency

(KAI–2001 monochrome qe curves as measured by Kodak)
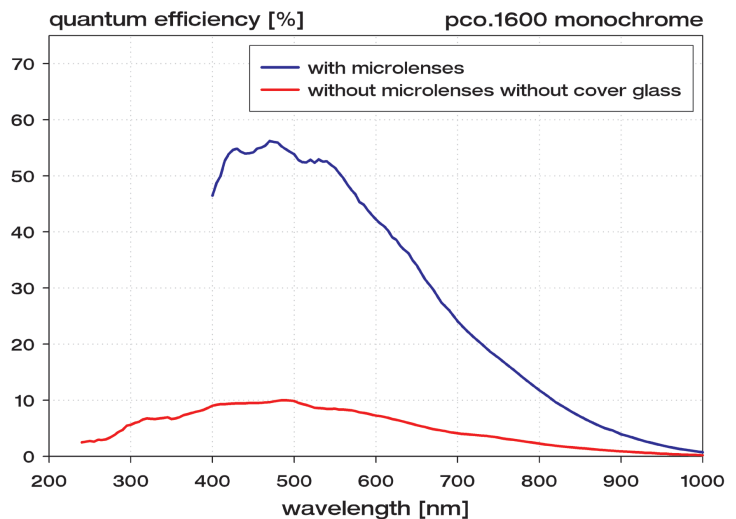
quantum efficiency
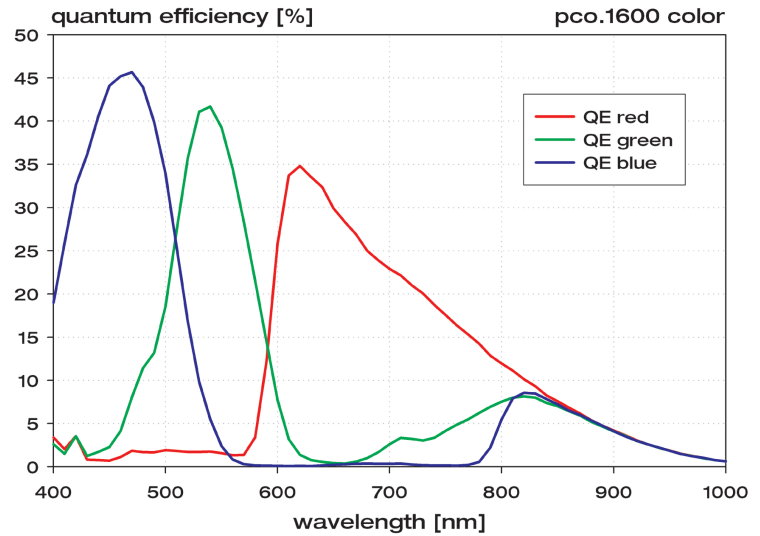
(KAI–2001 color qe curves as measured by Kodak)

areas of application

■ laser induced fluorescence ■ high resolution microscopy ■ luminescence microscopy ■ electron microscopy ■ fluorescence spectroscopy (up to NIR) ■ bioluminescence ■ chemoluminescence ■ low light level imaging ■ imaging of bio markers (e.g. green fluorescent protein, GFP) ■ time resolved spectroscopy ■ spray analysis ■ hydrodynamics ■ electrophoresis ■ absorption & luminescence spectroscopy ■ imaging of potential sensitive dyes (Neuroscience) ■ security ■ astronomy ■ combustion process analysis ■ gel imaging ■ fuel injection ■ scientific imaging ■ combustion imaging ■ spray imaging ■ PIV imaging

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