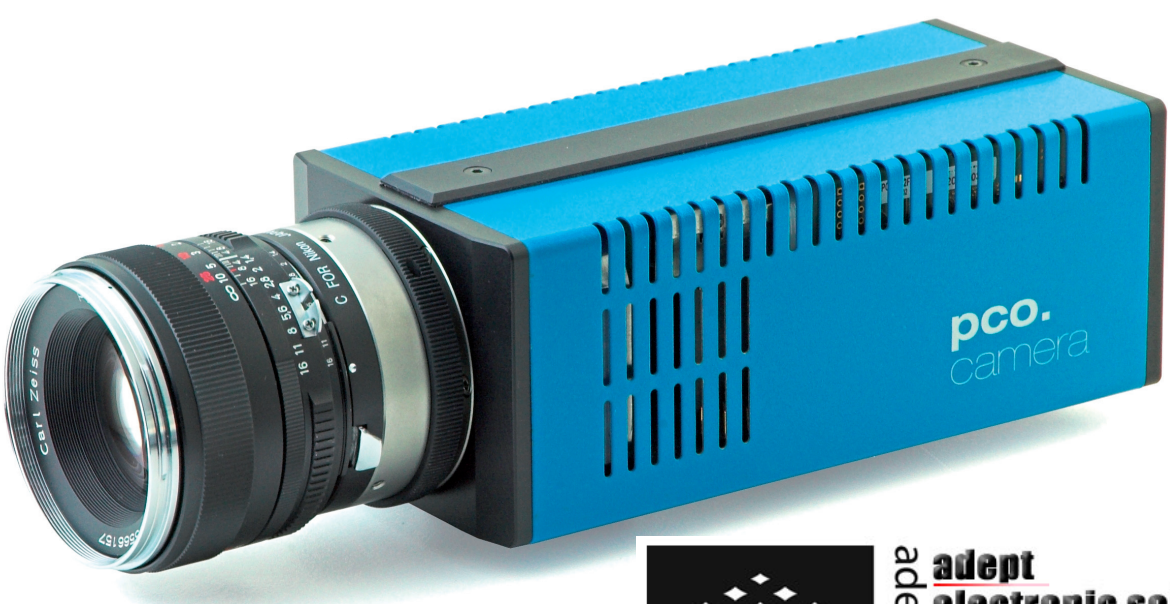
Adept Electronic Solutions
www.adept.net.au

pco.2000
cooled digital 14 bit CCD camera system

- excellent resolution (2048 × 2048 pixel)
- 14 bit dynamic range
- frame rate of 14.7 fps at full resolution
- image memory in camera (camRAM up to 4 GB)
- excellent low noise of 9 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



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This high resolution 14 bit cooled CCD 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 (2048 × 2048 pixel) and low noise (down to 9e⁻ 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 and PIV camera applications.

The camera is available as high performance pco.2000 comprising the double shutter function for PIV or as advanced scientific grade pco.2000 s. A modulation version pco.2000 mod allows in addition to accumulate multiple exposures into one image.

technical data

	unit	setpoint	pco.2000	pco.2000 s
resolution (hor × ver) [1]	pixel	@ normal @ ext. mode	2048 × 2048 2112 × 2072	2048 × 2048 –
pixel size (hor × ver)	µm²		7.4 × 7.4	7.4 × 7.4
sensor format / diagonal	mm² / mm		15.6 × 15.3 / 21.9 @ ext. mode	15.2 x 15.2 / 21.4 @ normal mode
peak quantum efficiency	%	@ 500 nm typical	55	55
full well capacity of CCD	e⁻		40 000	40 000
linearity range of CCD output @ 40 MHz	e⁻	KAI–4021 KAI–4010	20 000 40 000	20 000 –
image sensor			KAI–4021 (opt. KAI–4010)	KAI–4021
maximum dynamic range	dB	KAI–4021 KAI–4010	73 70	72 –
dynamic range A/D [2]	bit		14	14
readout noise KAI–4021 KAI–4010	 e⁻ rms e⁻ rms	 @ 10 / 40 MHz @ 10 / 40 MHz	 9 / 14 12 / 18	 10 / 16 – / –
imaging frequency, frame rate	fps	@ full frame	14.7	8.2
pixel scan rate	MHz		2 × 10 / 2 × 40	1 x 10 / 1 x 40
A/D conversion factor KAI–4021 KAI–4010	 e⁻ / count e⁻ / count		 2.1 2.1	 2.1 –
spectral range	nm	normal UV sensitive	320 .. 1000 200 .. 1000	320 .. 1000 –
anti–blooming factor		typical	> 300	> 300
smear	%		0.01	0.01
exposure time			5 µs..49 days (500 ns..49 days opt.)	5 µs..60 s
anti–blooming factor		typical	> 300	> 300

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technical data

	unit	setpoint	pco.2000	pco.2000 s
binning horizontal	pixel		1, 2	1, 2
binning vertical	pixel		1, 2, 4, 8	1, 2, 4, 8
dark current	e^- / pixel·s	@ 20 °C typical @ –20 °C typical	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 @ 10MHz	< 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)	mm^3		84 × 66 × 175	84 × 66 × 175
mechanical dimensions power supply (w × h × l)	mm^3		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	180	not available
max. modulation frequency	kHz	modulate version only	40	not available
max. exposures in one image		modulate version only	100 000	not available
single exposure time	s	modulate version only	500 ns .. 1 ms	not available

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

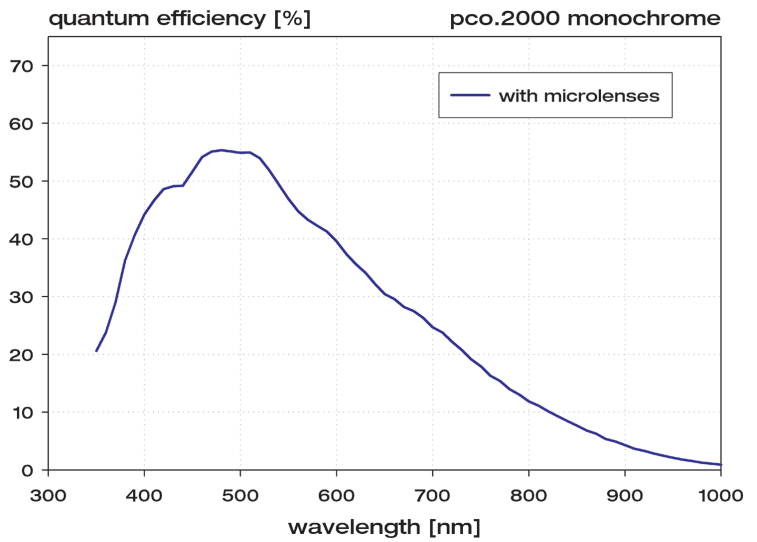
software	Camware software for camera control, image acquisition and archiving of images in various file formats, WindowsXP, Vista and later, 32 bit–dynamic link library (DLL) is available for user customisation and integration on PC platforms (software development kit – SDK), software is operational 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 used A/D converters	10 MHz 1	 2	40 MHz 1	 2
full frame	2.2	4.3	8.2	14.7
2 × 2 binning	4.3	8.3	15.5	26.7
2 × 8 binning	15.5	27.8	46.8	69.7

quantum efficiency



(KAI–4010/21 monochrome qe curve as measured by Kodak)

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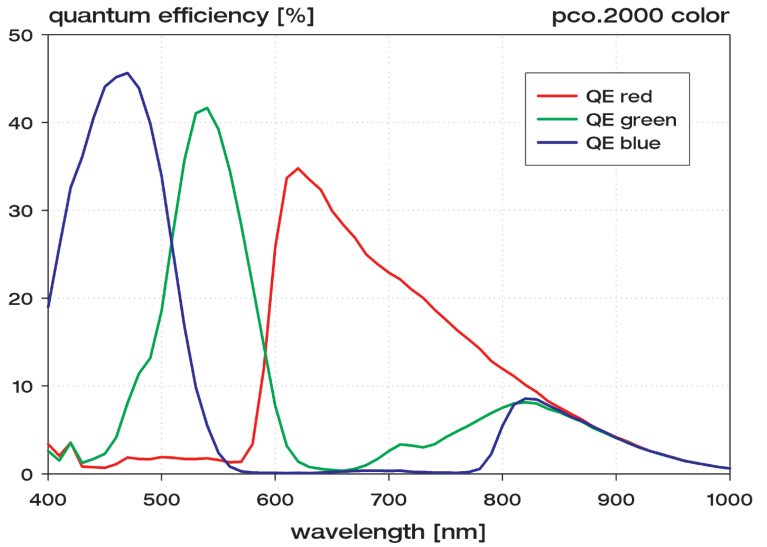
quantum efficiency



(KAI–4010/21 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 ■ electro–phoresis ■ absorption & luminescence spectroscopy ■ imaging of potential sensitive dyes (Neuroscience) ■ security ■ astronomy ■ combustion process analysis ■ gel imaging ■ fuel injection ■ scientific imaging ■ combustion imaging ■ PIV imaging ■ spray imaging ■ flow visualization ■ fluorescence imaging ■ display quality control

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