

pco.4000

cooled digital 14-bit CCD camera system

- superior resolution (4008x2672 pixel)
- 14-bit dynamic range
- fast image recording - 128MB/s
- image memory in camera (camRAM up to 4GB)
- excellent low noise of $16e^-$ rms @ 8MHz
- thermo-electrical cooling of -45°C vs. ambient
- standard interfaces (IEEE1394, camera link, ethernet)
- UV sensitive & color CCD image sensor available



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This high performance 14-bit 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 128MB/s. The system features thermo-electrical cooling (down to -45°C vs. ambient), an excellent high resolution (4008 x 2672 pixel) and low noise (down to $16e^{-}$ 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, ethernet). The available exposure times range from $5\mu\text{s}$ to 49days.

technical data

	unit	setpoint	pco.4000
resolution (hor x ver) ¹	pixel	@normal/ @extended mode	4008x2672 4072x2720
pixel size (hor x ver)	μm^2		9.0 x 9.0
sensor format/ diagonal	mm ² / mm		36.6 x 24.5 / 44.0
peak quantum efficiency	%	@ 500nm typical	50
full well capacity of CCD	e^{-}		60 000
image sensor			KAI-11000CM
maximum dynamic range	dB		71
dynamic range A/D ²	bit		14
readout noise	e^{-} rms	@8 / 16 / 32MHz	16 / 22 / 30
imaging frequency, frame rate	fps	@full frame	5.0
pixel scan rate	MHz		2 x 8 / 2 x16 2 x 32
A/D conversion factor	e^{-} /count		3.3
spectral range	nm	normal / UV sensitive	320..1000 200..1000
exposure time	s		$5\mu\text{s}$..49days
anti-blooming factor		typical	>300
smear	%		0.01
binning horizontal	pixel		1, 2
binning vertical	pixel		1, 2, 4, 8
dark current	e^{-} /pixel·s	@20 °C typical @-20 °C typical	0.7/ 0.02
region of interest	pixel		1, 2, 3, 4..n

technical data

non linearity	%	full temperature range	<2
uniformity darkness DSNU ³	e ⁻ rms	@ 90% center zone	<20
uniformity brightness PRNU ⁴	%	typical	2
trigger, auxiliary signals		internal/external	software / TTL level
power consumption	W	typical/maximum	25 / 50
power supply	VAC		90..260
mechanical dimensions camera (w x h x l)	mm ³		84 x 66 x 175
mechanical dimensions power supply (w x h x l)	mm ³		135 x 51 x 195
weight	kg		1.9
operating temperature range	°C		+5..+40
operating humidity range	%		10..90
storage temperature range	°C		-20..+70
optical input			Nikon f-mount
optical input window			fused silica
data interface			IEEE1394, camera link, ethernet
CE certified			yes
cooled CCD	°C	versus ambient temperature	Δ-45
cooling method			2 stage Peltier cooler with forced air cooling
interframing time	ns	full image	260

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

software:

Camware software for camera control, image acquisition and archiving of images in various file formats, WindowsXP 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: 512MB, 1GB, 2GB & 4GB

frame rate table [frames per second]

pixelclock	10MHz	20MHz	40MHz
used A/D converters	1 / 2	1 / 2	1 / 2
full frame	0.7 / 1.4	1.4 / 2.7	2.7 / 5.0
2x2 binning	1.4 / 2.7	2.7 / 5.2	5.2 / 9.2
2x8 binning	5.0 / 9.2	9.2 / 15.7	15.7 / 24.0
ROI 2048x2048 pixel	0.9 / 1.8	1.8 / 3.4	3.4 / 6.3
ROI 1600x1200 pixel	1.5 / 3.0	3.0 / 5.6	5.6 / 9.8
ROI 1280x1024 pixel	1.8 / 3.4	3.4 / 6.4	6.4 / 11.1
ROI 640x480 pixel	3.6 / 6.6	6.7 / 11.7	11.8 / 18.9

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) ■ night vision ■ security ■ astronomy ■ combustion process analysis ■ gel imaging ■ fuel injection

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