

pco.2000 cooled digital 14bit 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 $10 e^-$ rms @ 10 MHz
- thermo-electrical cooling of $-50^{\circ} C$ vs. ambient
- standard interfaces (IEEE 1394, camera link)
- UV sensitive & color CCD image sensor available



pco.2000

This high resolution 14 bit cooled CCD camera system comprises advanced CCD and electronics technology. With the new approach to integrate the image memory (cam RAM) into the camera itself, it enables unmatched fast image recording with 160 MB/s. The system features thermo-electrical cooling (down to -50°C vs. ambient), an excellent high resolution (2048 × 2048 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). 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.

technical data

| | unit | setpoint | pco.2000 |
|---|------------------------------------|--------------------------------|---|
| resolution (hor × ver) ¹ | pixel | @ normal @ extended mode | 2048 × 2048 2112 × 2072 |
| pixel size (hor × ver) | μm^2 | | 7.4 × 7.4 |
| sensor format / diagonal | mm^2 / mm | @ extended mode | 15.6 × 15.3 / 21.9 |
| peak quantum efficiency | % | @ 500 nm typical | 55 |
| full well capacity of CCD | e^{-} | | 40 000 |
| linearity range of CCD output @ 40 MHz | e^{-} | KAI-4020 KAI-4010 | 20 000 40 000 |
| image sensor | | | KAI-4020 (opt. KAI-4010) |
| maximum dynamic range | dB | KAI-4020 KAI-4010 | 72 70 |
| dynamic range A/D ² | bit | | 14 |
| readout noise KAI-4020 KAI-4010 | e^{-} rms e^{-} rms | @ 10 / 40 MHz @ 10 / 40 MHz | 10 / 16 12 / 18 |
| imaging frequency, frame rate | fps | @ full frame | 14.7 |
| pixel scan rate | MHz | | 2 × 10 / 2 × 40 |
| A/D conversion factor KAI-4020 KAI-4010 | e^{-} / count e^{-} / count | | 2.1 2.1 |
| spectral range | nm | normal UV sensitive | 320..1000 200..1000 |
| exposure time | s | | 5 μs ..49 days (500 ns..49 days opt.) |

technical data

| | | | |
|---|--------------------------|-------------------------------------|--|
| 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 | 0.5 0.01 |
| region of interest | pixel | hor & ver | 1, 2, 3, 4...n |
| non linearity | % | full temperature range @ 10MHz | < 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 | 24 40 |
| power supply | VAC | | 90...260 (12 VDC optional) |
| 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 | | 1.8 |
| operating temperature range | °C | | +5...+40 |
| operating humidity range | % | | 10..90 |
| storage temperature range | °C | | -20...+70 |
| optical input | | | c-mount, Nikon f-mount |
| optical input window | | | fused silica |
| data interface | | | IEEE 1394, camera link |
| CE certified | | | yes |
| cooled CCD | °C | versus ambient temperature | Δ-50 |
| cooling method | | | 2 stage Peltier cooler with forced air cooling |
| interframing time PIV mode | ns | | 180 |

[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 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)

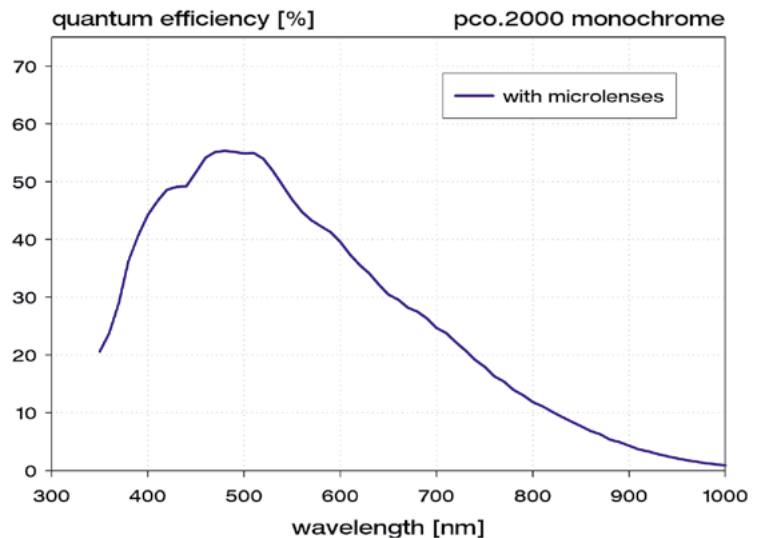
options

CCD image sensor in color & UV sensitive version
custom-made versions
camRAM available in: 512 MB, 1 GB, 2 GB & 4 GB

frame rate table [frames per second]

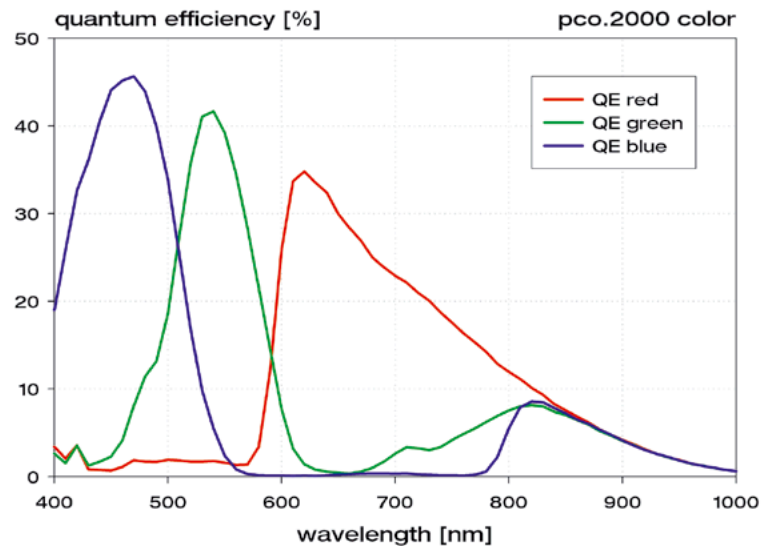
| pixelclock used A/D converters | 10 MHz 1 / 2 | 40 MHz 1 / 2 |
|-----------------------------------|-----------------|-----------------|
| full frame | 2.2 / 4.3 | 8.2 / 14.7 |
| 2 × 2 binning | 4.3 / 8.3 | 15.5 / 26.7 |
| 2 × 8 binning | 15.5 / 27.8 | 46.8 / 69.7 |
| ROI 1280 × 1024 pixel | 4.3 / 8.3 | 15.4 / 26.4 |
| ROI 640 × 480 pixel | 8.7 / 16.0 | 28.8 / 45.9 |
| ROI 320 × 240 pixel | 15.9 / 27.7 | 46.8 / 67.7 |

quantum efficiency



(KAI-4010/20 monochrome qe curve as measured by Kodak)

quantum efficiency



(KAI-4010/20 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
- piv imaging
- spray imaging
- flow visualization
- fluorescence imaging
- display quality control

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