"Andor sCMOS"

ANDOR™ TECHNOLOGY
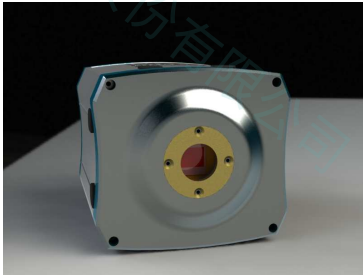
Low Light Imaging Cameras

Scientific CMOS (sCMOS) Technology

Imaging Without Compromise

Scientific CMOS (sCMOS) is the mould-breaking imaging sensor technology at the heart of Andor's new imaging camera platform. In a vacuum cooled platform, loaded with FPGA intelligence, sCMOS is designed exclusively to drive optimal performance from this exciting and innovative new technology development.

Unlike any CMOS or CCD technology to come before it, sCMOS sets radical new benchmarks in its unique ability to *simultaneously* deliver highest specifications in sensitivity, resolution, speed, dynamic range and field-of-view: true scientific imaging, without compromise.

Key Specifications

Active Pixels (W x H)	2560 x 2160 (5.5 Megapixel)
Pixel Size (W x H; μm)	6.5 μm
Image Area (W x H; mm)	16.64 x 14.0
Pixel Well Depth (e⁻, typical)	30,000
Readout speeds (MHz)	560; 166; 110; 22
Read Noise (e⁻)	1.5e⁻ @ 22MHz; 2e⁻ @ 166MHz; 3 e⁻ @ 560 MHz
Cooling (°C)	-40°C
Max. Frame Rate	100 frames/sec
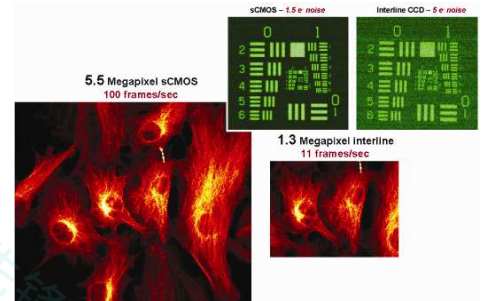
Feature	Benefit
High-Performance Without Trade-offs	The first low-light imaging technology to *simultaneously* deliver on low noise, high speed, high resolution and high dynamic range
1.5 Electron Read Noise	Proprietary sCMOS technology delivers an unprecedented 1.5e⁻ read noise floor at 22MHz readout speed (4 fps); < 2 e⁻ @ 166MHz (30 fps); < 3 e⁻ @ 560MHz (100 fps)
High Resolution	5.5 megapixel sensor format and 6.5 μm pixels deliver extremely sharp resolution over a large field of view: Ideal for cell microscopy
Rapid Frame Rates	100 full frames/s; 211 frames/s in 1.3 megapixel sub-array
High Quantum Efficiency (QE)	Microlens front-illuminated architecture offers 60% QE$_{max}$, with excellent response in red/NIR region
Extended Dynamic Range	Unique, Dual-Gain amplifiers offer extensive dynamic range capability; > 14-bit true dynamic range at 30 frames/s. No catch!
UltraVac™[*1]	Critical for sustained vacuum integrity and to maintain unequalled cooling and QE performance, year after year. Andor's 5 year vacuum warranty
TE Cooling to -40°C	Minimization of darkcurrent contribution to noise floor, enabling higher SNR with longer exposures. Deep cooling also facilitates pixel blemish reduction
16-bit Digitization	For optimal digitization of sCMOS high dynamic range signals
Rolling and Global shutter (user-selectable)	Uniquely combines user selectable choice of rolling or global (snapshot) shutter modes, affording maximum flexibility across all applications
Multi-ROI readout	Select multiple sub-arrays at user-selectable locations. No readout of unwanted rows facilitating faster frame rates and reduced data size
Enhanced Baseline Clamp	Essential for quantitative accuracy of dynamic measurements
Data Flow Monitor	Innovative way to visually manage acquisition capture rates vs data bandwidth limitations
iCam	Unique FPGA/software innovation that empowers the SCMOS to operate with market-leading acquisition efficiency through live cell microscopy software. Rapid exposure switching
Cameralink *and* USB 2.0 [*2]	USB 2.0 for Universal 'Plug and Play' connectivity. Cameralink for higher bandwidth data spooling to PC
'OEM – friendly'	Compact and robust, vacuum longevity, easily accessible SDK, Andor integration support
Comprehensive & Flexible Inputs/Outputs	Communication and synchronization within intricate experimental set-ups
Accurate Timestamp	Generated in camera hardware (FPGA) for absolute temporal accuracy (12.5ns)

Technical specifications

System characteristics

Pixel Readout Rate (MHz)	560, 166, 110, 22
Digitization	16-bit
Max. Frame Rate	100 frames/sec (rolling shutter); 50 frames/sec (snapshot shutter)
Non-Linearity (%, maximum)[3]	< 1 %
Triggering (timing inputs/outputs)	Arm, External Trigger, Frame Readout, Fire, Interline Shift, Shutter output.
Additional Inputs/Outputs	• 8 programmable TTL I/Os for control and sensing of up to 8 external devices. • 2 precision 16-bit DAC outputs for control of external analogue devices, e.g. stages. Software selectable between 0-5V and 0-10V ranges. • Regulated 5V DC output – providing power to external peripheral devices (500mA max.)

System readout noise[4]

Pixel Readout Rate (MHz)	Readout Noise (e⁻; typical)
22	1.5
166	2.0
574	3.0

Minimum sensor temperatures (typical) [5]

Water cooled (10 ⁰C)	-40ºC
Air-cooled (20 ⁰C ambient)	-30ºC

Dark current (typical) [6]

0.03 e⁻/pixel/sec @ -40ºC

Operating & storage conditions

Operating Temperature	0ºC to 40ºC ambient
Relative Humidity	< 70% (non-condensing)
Storage Temperature	-25ºC to 55ºC

Input Power requirements

Voltage	+12V ± 5%
Current	Maximum 3A at peak cooling
Ripple & Noise	Maximum 200mV
Total Power	Maximum 36W

Computer requirements (minimum):

• 2.68 GHz Quad Core + 4 Gbyte RAM
• 160GB/s continuous write, e.g. x2 Seagate Cheetah 15K.7 in Raid 0.
• USB 2.0 - Intel 82801 (or equivalent) I/O controller hub to provide USB 2.0 interface
• PCI Express x8 slot
• Windows (2000, XP, Vista, 7) or Linux

Max frames per second[7]

560MHz		
Array Size	**Rolling Shutter**	**Global Shutter**
2560 x 2160 (full frame)	100	50
2048 x 2048	108	54
1300 x 1024	211	105
512 x 512	422	211
128 x 128	1688	844

Max. sustained frames/sec through camera/PC interface options [8]

USB 2.0		
Array Size	**Rolling Shutter**	**Global Shutter**
2560 x 2160(full frame)	3.6	3.6
2048 x 2048	4.8	4.8
1300 x 1024	15	15
512 x 512	76	76
128 x 128	1221	844

Cameralink 'Base'		
Array Size	**Rolling Shutter**	**Global Shutter**
2560 x 2160 (full frame)	30	30
2048 x 2048	40	40
1300 x 1024	125	106
512 x 512	422	211
128 x 128	1688	844

Cameralink 'Turbo'		
Array Size	**Rolling Shutter**	**Global Shutter**
2560 x 2160 (full frame)	100	50
2048 x 2048	108	54
1300 x 1024	211	105
512 x 512	422	211
128 x 128	1688	844

Quantum efficiency[9]
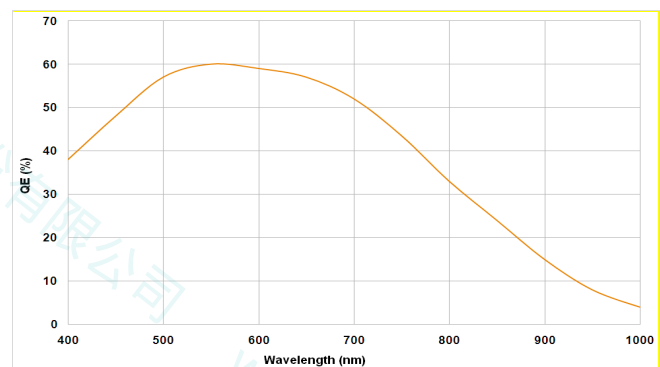
Ordering & contact information and notes

To order sCMOS, please quote the following model number:

XXXXXXXXX

The sCMOS also requires one of the following software options:

Andor Solis (i)	A ready-to-run Windows 2000, XP, Vista or 7 based package with rich functionality for data acquisition and processing.
Andor iQ	A comprehensive multi-dimensional imaging software package. Offers tight synchronization of camera with a comprehensive range of microscopy hardware, along with comprehensive rendering and analysis functionality. Modular architecture for best price/performance package on the market.
Andor SDK 3.0	Andor's newly revised Software Development Kit, combining rich functionality for data acquisition and with easy to access architecture. Available for Windows 2000, XP, Vista, 7 and Linux.
Third party software compatibility	Drivers are available so that the SCMOS can be operated through a large variety of third party imaging packages.

Key Applications

- Live Cell Microscopy
- Super Resolution Microscopy
- Genome Sequencing (2nd & 3rd generation)
- Single Molecule Detection
- High Content Screening
- Adaptive Optics
- Immunofluorescence / FISH
- Lucky Imaging / Astronomy
- Solar Astronomy
- TIRF Microscopy / Waveguides
- Spinning Disk Confocal Microscopy
- FRET / FRAP
- Photovoltaic Inspection
- Gel Documentation (chemiluminescence)
- X-ray tomography
- Particle Imaging Velocimetry (PIV)
- Biochip reading
- Hyperspectral Imaging
- Wind Tunnel Imaging
- Ophthalmic imaging

Specifications are subject to change without notice

♦1 Assembled in a state-of-the-art Class 1,000 clean room facility, Andor's UltraVac™ vacuum process combines a permanent hermetic vacuum seal (no o-rings), with a stringent protocol to minimize out-gassing, including use of proprietary materials. Outgassing is the release of trapped gases that would otherwise prove highly problematic for high-vacuum systems.

♦2 USB 2.0 is truly universal to all PCs, in contrast to a Firewire interface which often requires an internal interface card for PC compatibility. Cameralink interface requires a Cameralink frame grabber PCI card, supplied with camera.

♦3 Linearity is measured from a plot of Signal vs. Exposure Time over the full dynamic range. Non-linearity is expressed as a percentage deviation from a straight line fit.

♦4 System Readout noise is for the entire system. It is a combination of sensor readout noise and A/D noise. Measurement is the mean for Single Pixel readout with the sensor at a temperature of -35℃ and minimum exposure time under dark conditions.

♦5 Stabilized cooling temperatures are given for slowest readout speed. Use of faster readout speeds (in order to achieve faster frame rates) may require a higher cooling temperature to be set.

♦6 The dark current value is obtained using the traditional method of measuring dark current, as for any scientific camera, i.e. taking a long integration time to get a dark signal that is well above the read noise. The dark current measurement is averaged over the sensor area excluding any regions of blemishes.

♦7 The max frames/s table for SCMOS indicate the maximum speed at which the device can acquire images in a standard system at full frame and also a range of sub-array size, for both rolling and global shutter readout modes. Note that for multiple sub-array (ROIs) selection, the software will return an accurate calculation of frame rate. Internal trigger mode of operation is assumed.

♦8 The table illustrates the frame rate vs data bandwidth limitations imposed by USB 2.0 and Cameralink interface options ('Base' or 'Turbo'). Selection of binning and/or multiple ROIs will further influence frame rates. Andor's Data Flow Monitor represents a solution to visually manage acquisition frame rates vs data bandwidth limitations. Note that the write speed of the PC hard drive can impose a further restriction to achieving sustained kinetic series acquisition.

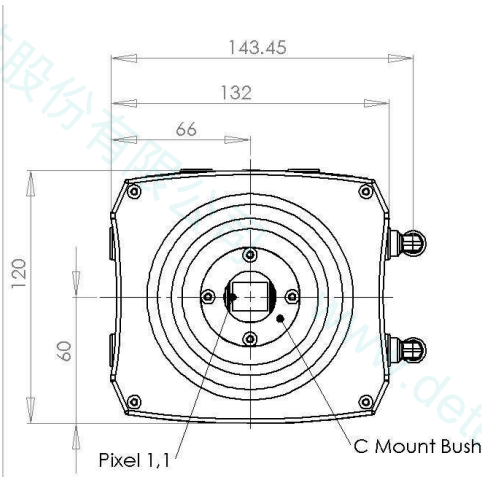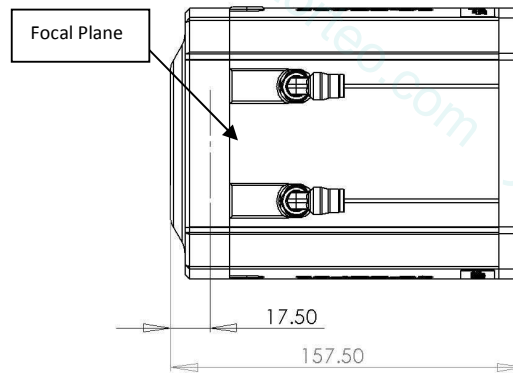♦9 Quantum Efficiency curve as provided by sensor manufacturer.

Dimensions: 120mm (x); 120mm (y); 160mm (z)   **Weight:** 3.5 kg
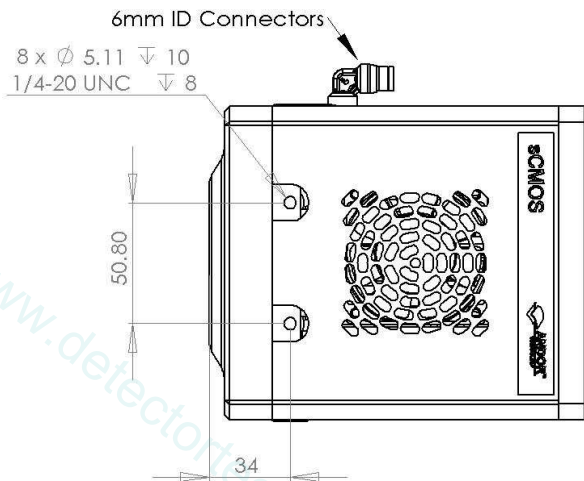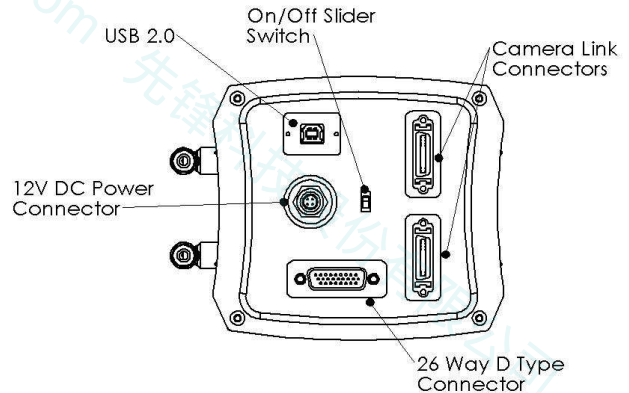
Regulatory Compliance

- Compliant with the requirements of the EU EMC and LV Directives through testing to EN 61326-1 and EN 61010-1

Compliant with the North American Safety Standards: UL 61010-1 and CAN/ CSA-C22.2 No. 61010-1-04

- External power supply PSE-approved