ANDOR™ TECHNOLOGY | iXon^{EM}+ DU-897 (back illuminated)

IMAGING

Andor's iXon ^{EM}+ DU-897 back illuminated EMCCD has single photon detection capability without an image intensifier, combined with greater than 90% QE of a back-illuminated sensor. Containing a 512x512 Frame Transfer CCD sensor from E2V Technologies, it enables charge to be multiplied on the sensor before it is read out, while utilizing the full QE performance of the CCD sensor. The absolute EMCCD gain of the camera can be varied linearly from unity up to a thousand times directly through the software, via a true quantitative EM gain scale. Andor are the first to offer this technology as a complete, software controlled system for scientific digital imaging applications. The system offers up to 10 MHz pixel readout rate, both EMCCD and conventional amplifier outputs and benefits from minimized dark current with unequalled thermoelectric cooling down to –100°C.

EMCCD Technology	.... Ultimate in Sensitivity from EMCCD gain – even single photon signals are amplified above the noise floor. Full QE of CCD chip is harnessed (no intensifier).
RealGain™	.... Absolute EMCCD gain selectable directly from a linear and quantitative scale.
TE cooling to –100 °C	.... Critical for elimination of darkcurrent detection limit.
> 90% QE back-illuminated sensor	.... Maximum possible photon collection efficiency
Variable readout rates up to 10 MHz	.... Quantitative accuracy at all speeds. Slower readout rate for enhanced 16-bit dynamic range.
Selectable amplifier outputs – EMCCD and conventional	.... Highly flexible camera optimized for both fast, ultra low-light imaging and 'bright-field' or conventional fluorescence imaging.
UltraVac™ ♦1	.... Critical for sustained vacuum integrity and to maintain unequalled cooling and QE performance, year after year.
High dynamic range and 16-bit digitization available	.... Extended sensor dynamic range (readout speed dependent) and matched digitization for quantization of dim and bright signals.
Minimal Clock-Induced Charge	.... Giving lowest "spurious noise" specification; essential for single photon counting
Enhanced Baseline Clamp	.... Essential for quantitative accuracy of dynamic measurements.
EMCAL™	.... Innovative user-initiated self-recalibration of EM Gain.
Built-in C-mount compatible shutter	.... Easy means to record control dark images – excellent for optimization of experimental set-up.

Camera Overview

Active Pixels	512 x 512
Pixel Size (W x H; µm)	16 x 16
Image Area (mm)	8.2 x 8.2
Active Area pixel well depth (e^-, typical)	160,000 (220,000 max)
Gain Register pixel well depth (e^-, typical)	800,000 ♦2
Max Readout Rate (MHz)	10
Frame Rate (frames per sec)	35 to several 100's
Read Noise (e^-)	< 1 to 49 @ 10 MHz

System Characteristics

Pixel Readout Rate (MHz)	**Electron Multiplying Amplifier**	10, 5, 3, 1
	Conventional Amplifier	3 and 1
Digitization @ 10, 5, 3 & 1 MHz readout rate		True 14-bit (16-bit available @ 1 MHz)
Vertical Clock Speed (µs)		0.3 to 3.3 (variable)
Linear Absolute Electron Multiplier Gain (software controlled)		1 - 1000 times
Linearity (%, maximum) ♦3		1
Triggering		internal, external, external start
Camera window type		Single window with double-sided AR coating – standard for BV model

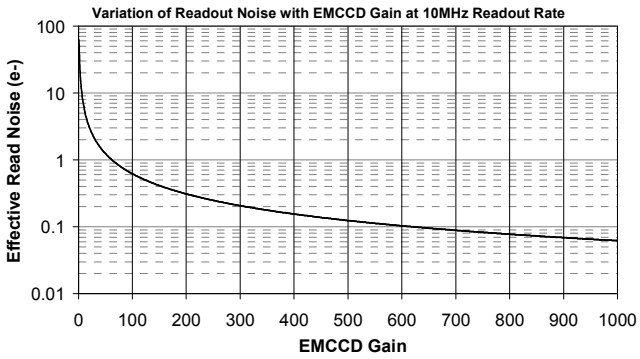
Dark Current & Background Events

Dark Current ♦4 @ -85 °C (e-/pix/sec)	0.001
EMCCD-Amplified Background Events ♦5 (events/pix)	0.005
(@ 1000 x gain and -85 °C)	

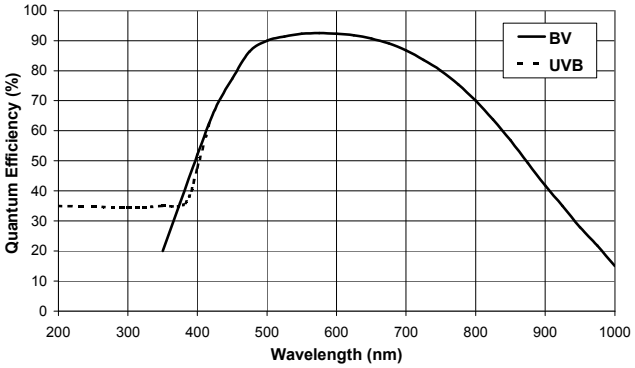
Noise

System Readout Noise **(e-)** ♦6	**Typical**	***with Electron Multiplication***
10 MHz through EMCCD amplifier	49	< 1
5 MHz through EMCCD amplifier	40	< 1
3 MHz through EMCCD amplifier	30	< 1
1 MHz (16-bit) through EMCCD amplifier	18	< 1
1 MHz (16-bit) through conventional amplifier	6	N/A

Noise & EMCCD Gain



Quantum Efficiency



Peak Quantum Efficiency at –20°C *(%)* ♦7

CCD Type		***Minimum***	***Typical***
BV	@ 575 nm	82	92.5
UVB	@ 575 nm	82	92.5

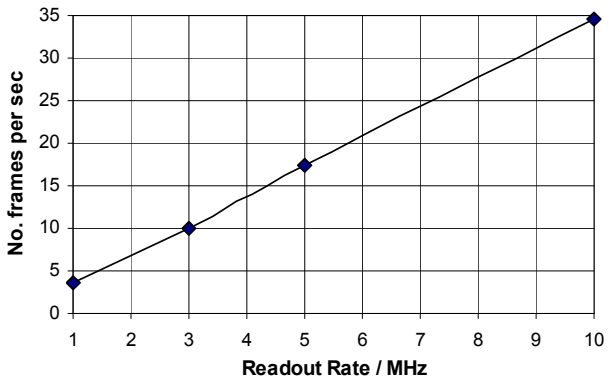
Cooling Temperature

Air cooled *(ambient air @ 20°C)*	-85°C
Water cooled using Re-circulator *(ambient air @ 20°C)*	-90°C
Water cooled using Chiller *(water @ 12°C, 0.75 l / min)*	-100°C

Max Frames per sec ♦8

Binning \ Array size	512 x 512 (full frame)	256 x 256	128 x 128	512 H x 100 V
1 x 1	35	68	132	168
1 x 2	68	132	248	313
2 x 2	68	132	248	313
1 x 4	131	246	439	549
4 x 4	131	246	439	549

Full Frame Rate ♦9



Power Requirements ♦10

0.6A @ +12V
0.3A @ -12V
3.0A @ +5V

Operating & Storage Conditions

Operating Temperature	0°C to 30°C ambient
Relative Humidity	< 70% (non-condensing)
Storage Temperature	-25°C to 55°C

Computer Requirements

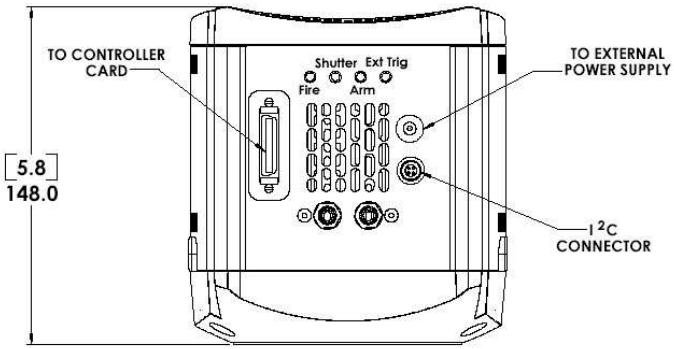
To handle data transfer rates of 10 MHz readout over extended kinetic series, a powerful computer is recommended, e.g:

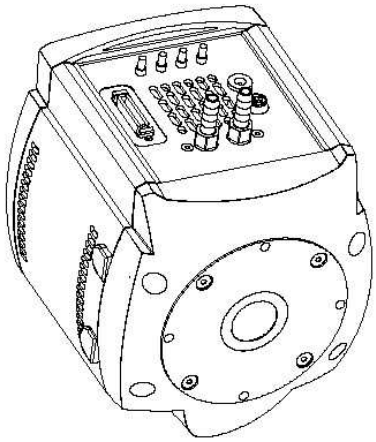
- 3 GHz Pentium (or better)
- 1GB RAM
- 10,000 rpm SATA hard drive preferred for extended kinetic series

Also:

- PCI-compatible computer
- PCI slot must have bus master capability
- Available auxiliary internal power connector
- 32 MBytes free hard disc space

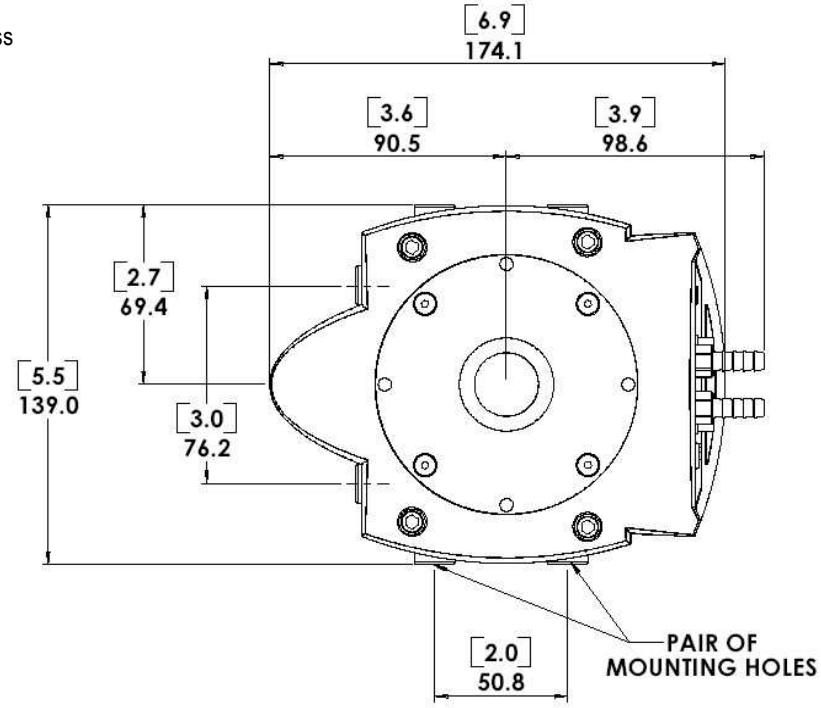
iXon EM+ Dimensions





Weight: 2.7 Kg [6 lb]

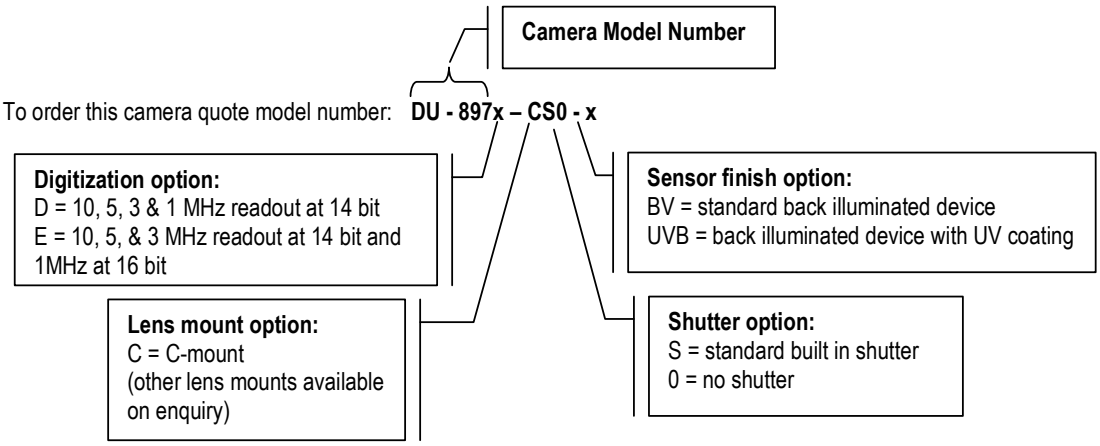
Dimensions in mm unless otherwise indicated.



Note: The clearance from the C-mount face plate to the shutter is 6mm. Please ensure that when fitting a lens, to a system with a built in shutter, that it does not extend into the housing by more than 5mm.

Note: There are mounting holes (1/4-20UNC) located on three sides of the camera. They are positioned centrally at a distance of 40mm from the front of the front face.

Ordering Information



e.g. DU-897D-CS-UVB is a back illuminated iXon EM + DU-897 camera with 14-bit digitization at 10, 5, 3 and 1MHz readout speeds, EMCCD and conventional output amplifiers, standard shutter and UV-enhanced coating.

The iXon EM + **DU-897** requires the following controller card:

CCI-22	PCI controller card

The iXon EM + **DU-897** also requires one of the following software options:

Andor-MCD	a ready-to-run Windows 2000 or XP -based package with rich functionality for data acquisition and processing.
Andor-SDK-CCD	a DLL driver and software development kit that let you create your own applications for the Andor Camera. Available for Windows 2000 or XP and Linux.
Andor-iQ	a comprehensive multi-dimensional imaging software package. Offers tight synchronization of EMCCD with a comprehensive range of microscopy hardware, along with comprehensive rendering and analysis functionality. Modular architecture for best price/performance package on the market.
Third party software compatibility	Drivers are available so that the iXon EM + range can be operated through a large variety of third party imaging packages

The iXon EM + **DU-897** may be used with the following accessories:

OPTION-C1-LM-C	C-mount lens adaptor (other mounts available on request)
XW-RECR	Re-circulator for enhanced cooling performance
XW-CHIL-150	Ultra compact chiller unit for ultimate cooling performance
REMOTE CTRL KIT	Programmable remote control for controlling functions from anywhere around the optical set-up

Contact Andor for any of your custom requirements. (Contact details on back page)

NOTE - Specifications are subject to change without notice.

♦1 Assembled in a state-of-the-art Class 10,000 cleanroom facility, Andor's UltraVac™ vacuum process combines a permanent hermatic vacuum seal (no o-rings), with a stringent protocol to minimize outgassing, including use of proprietary materials. Outgassing is the release of trapped gases that would otherwise prove highly problematic for high-vacuum systems.

♦2 The EM register on CCD97 sensors has a linear response up to 400,000 electrons max. and a full well depth of ~ 800,000 electrons max.

♦3 Linearity is measured from a plot of Counts vs. Signal up to the saturation point of the system. Linearity is expressed as a percentage deviation from a straight line fit.

♦4 This value is obtained using the traditional method of measuring dark current, as for any CCD camera, i.e. taking a long integration time (with no EM gain applied) to get a darksignal that is well above the read noise. The dark current measurement is averaged over the CCD area excluding any regions of blemishes.

♦5 Using Electron Multiplication (EM) the iXon EM + is capable of detecting single photons, therefore the true camera detection limit is set by the number of 'dark' background events. These background events consist of both residual thermally generated electrons and Clock Induced Charge (CIC) electrons (also referred to as Spurious Charge), each appearing as random single spikes that are well above the read noise floor.
A thresholding scheme is employed to count these single electron events and is quoted as a probability of an event per pixel. Acquisition conditions are full resolution and max frame rate (10 MHz readout; frame-transfer mode; 0.3 µs vertical clock speed; x 1000 EM gain; 30 ms exposure; -85°C). It is important to realise that to get to this single photon detection regime there must be sufficient cooling, such that there is significantly less than 1 event per pixel.

♦6 System Readout noise is for the entire system. It is a combination of CCD readout noise and A/D noise. Measurement is for Single Pixel readout with the CCD at a temperature of -85°C and minimum exposure time under dark conditions. Under Electron Multiplying conditions, the effective system readout noise is reduced to sub $1e^-$ levels. Noise values will change with pre-amplifier gain (PAG) selection. Values quoted are measured with highest available PAG setting.

♦7 Quantum efficiency of the CCD sensor as measured by the CCD Manufacturer.

♦8 The max frames / second for iXon EM + imaging CCDs is the maximum speed at which the device can acquire images in a standard system. Shown are the frame rates at 10MHz digitization rates for a range of binning or array size combinations. All measurements are made with 0.3 µs vertical clock speed. It also assumes internal trigger mode of operation.

♦9 The graph shows the full frame rates possible when reading out the sensor at 10, 5, 3 and 1 MHz pixel readout rates, and using 0.3 µs vertical clock speed.

♦10 These power requirements are the maximum load that will be drawn from the computer for the camera head and controller card combined.

Need more information? Contact us at:

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