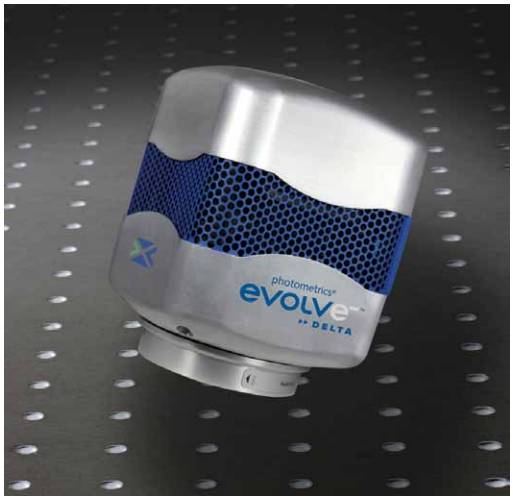

photometrics®
evolve™
DELTA

2013 Laboratory EQUIPMENT Readers' Choice WINNER

The new Evolve™ 512 EMCCD Camera

Now even faster with 67.5 frames per second

- Fastest 512 x 512 EMCCD camera on the market
- 16 x 16-µm pixels
- Lowest read noise available for a high-speed EMCCD camera
- Ideal for sophisticated researcher and multi-user labs
- Superb electron multiplication (EM) gain and bias stability
- Most accurate and fastest EM calibration technique in the industry
- Available with exclusive eXcelon™ technology
- Backed by Photometrics' worldwide support team

Primary applications:

Super-Resolution Microscopy
Quantitative FRET
TIRF
Multiprobe Experiments
Ratiometric Ion Imaging
Spinning Disc Confocal Microscopy

Available with Exclusive eXcelon™ Technology

Features	Benefits
EM gain	Very high sensitivity, low-noise, impact-ionization process Effectively reduces read noise < 1e-
Back-illuminated EMCCD	CCD97 or CCD97-X (with eXcelon technology), highest available quantum efficiency (>90% peak QE)
512 x 512 imaging array 16 x 16-µm pixels	Optimized field of view and highest sensitivity
Intelligent FPGA design	Self-calibrating linearization ensures truly quantitative data consistently, time and again Ensures bias stability to guarantee a stable background
Rapid-Cal™	Most accurate and precise integrated EM Calibration routine using a highly stable integrated light source Calibrates your EM gain in less than three minutes.
PAR feedback system (Photometrics Active Regulation)	Delivers unsurpassed EM gain stability for outstanding signal fidelity
ACE technology (Advanced Clocking Enhancement)	Provides lowest noise floor and minimizes generation of spurious charge and background events
20- and 10-MHz readout	Excellent for high-speed image acquisition, 67.5 full frames/sec at 20MHz, 1099 frames/s @ 16x16 pixel ROI, 4x4 binning
16-bit digitization	Wide dynamic range allows detection of bright and dim signals in the same image
Frame-transfer EMCCD	100% duty cycle to collect continuous data, no mechanical shutter required
C- mount	Easily attaches to microscopes, standard lenses or optical equipment
Turbo-1394™ interface (IEEE-1394a)	Universally accepted interface that provides high-bandwidth, uninterrupted data transfer with no dropped frames Windows® XP/7
PVCam® Driver	Established driver supported by numerous third-party imaging software packages
High Speed Triggering	Precise integration with complex systems, controlling illumination, shutters and filter wheels, and other triggered devices
Exclusive eXcelon Technology (optional)	Enhanced QE in Blue and near IR wavelengths Anti-Etaloning in near IR wavelengths

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Specifications			
Read noise (e- rms)	With EM Gain		
20 MHz EM Port	<1e	75e-	
10 MHz EM Port	<1e	45e-	
Pixel well depth			
Active area		180,000e-	
Gain register		800,000e-	
Bias stability			
A measurement of the camera stability when no light hits the sensor. A slope of zero would be ideal. *See footnote #1.*		≤0.003 ADU/Frame ≤0.001 ADU/Frame	
Field uniformity			
The image quality of the EMCCD is assessed for gradients. A complete lack of any gradient (i.e a flat image) would provide a numerical value of 1.00 *See footnote #2.*		20 MHZ EM 10 MHZ EM	1.010 1.003
Stabilized cooling temperature		Air cooled (@ ambient air 20˚C) - Standard Liquid cooled (@ ambient air 20˚C) - Optional	-80˚C -80˚C
Dark current		0.0015 e-/pixel/sec (*See footnote #3.*)	
Background events			
(20 MHz, 1000X EM gain) Standard operation		0.002 events/pixel (@ 1000X EM gain)	
Parallel shift rate		0.39 µseconds	
The shift rate is optimized to provide extremely high charge transfer efficiency while minimizing the generation of clock-induced charge. The incorrect setting of the shift-rate causes significant trade-offs in camera imaging behavior.			
Triggering modes		Trigger first Strobe Bulb SMART streaming (*See footnote #5.)*	
Charge transfer efficiency		As specified by CCD manufacturer's datasheet (*See footnote #6.*)	
Dark signal non-uniformity (DSNU)		As specified by CCD manufacturer's datasheet (*See footnote #6.*)	
Photoresponse non-uniformity (PRNU)		As specified by CCD manufacturer's datasheet (*See footnote #6.*)	

Note: Specifications are subject to change.

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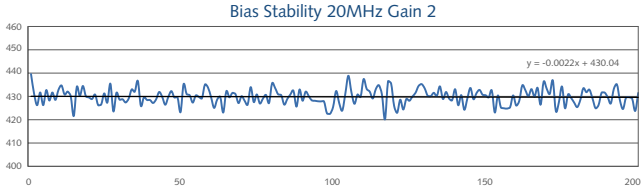
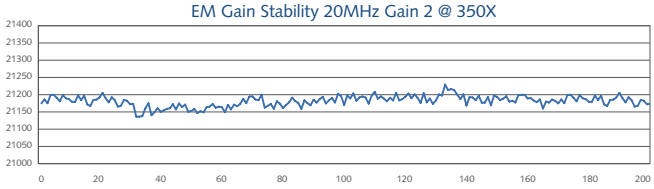
Bias Stability 20MHz Gain 2



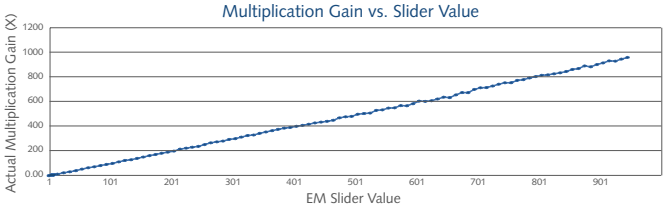
Note: Actual data.

EM Gain Stability 20MHz Gain 2 @ 350X



Note: Actual data (*See footnote #7.*)

Multiplication Gain vs. Slider Value



Note: Actual data from camera.

Region

Binning	512 x 512	256 x 256	128 x 128	64 x 64	16 x 16
1 x 1	67.5	130.6	243.6	418.1	822.4
2 x 2	130.6	243.6	418.1	632.5	985.2
4 x 4	243.6	417.9	632.1	821.7	1098.9
8 x 8	417.4	631.3	820.3	983.3	1164.1

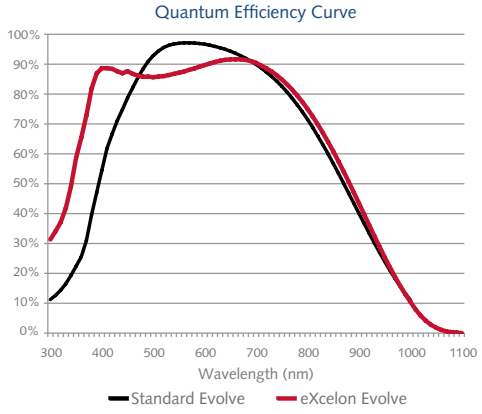
(Frames per second)

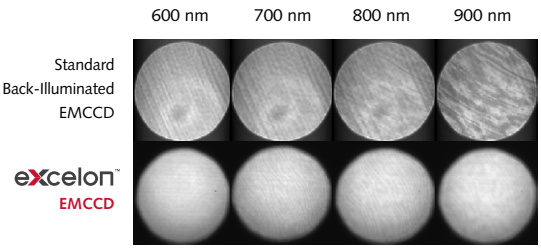
Note: Frame rates are measured at 20 MHz with 0-second exposure times.

Exclusive eXcelon Technology (optional)

eXcelon™

Quantum Efficiency Curve





Reduced Etaloning	Up to 10 times lower etaloning in near IR wavelengths compared to standard back-illuminated sensors
Improved Sensitivity	Provides higher QE in the blue (<450nm) and near IR (>700nm)
Exclusive Technology	Available on Evolve EMCCD Cameras

Liquid Cooled Evolve 512 EMCCD Camera (optional)

- Ideal for vibration-sensitive applications (eg. Atomic Force Microscopy)

- -80ºC with ambient liquid*

*Note: Use of Equipment not originally provided by Photometrics for use with Liquid Cooled Cameras will void any and all warranty coverage of the product. This is due to the specific requirements of the cooling system and camera based on the type of liquid, liquid viscosity, flow rate, among other key factors to achieve the specified performance levels.

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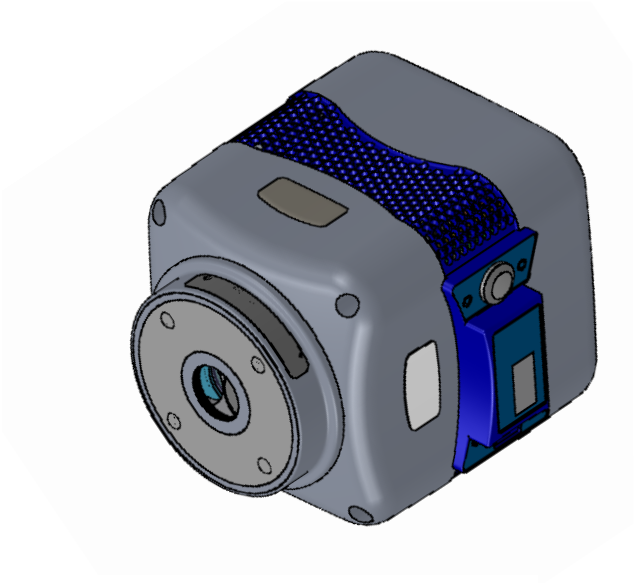

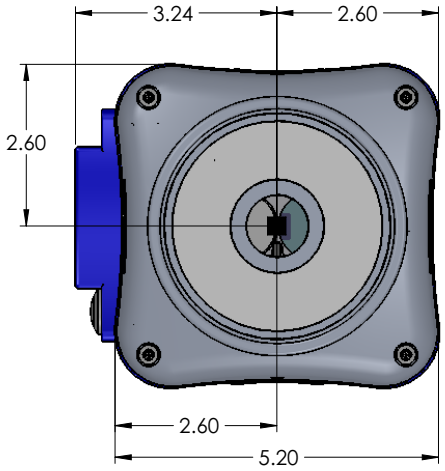

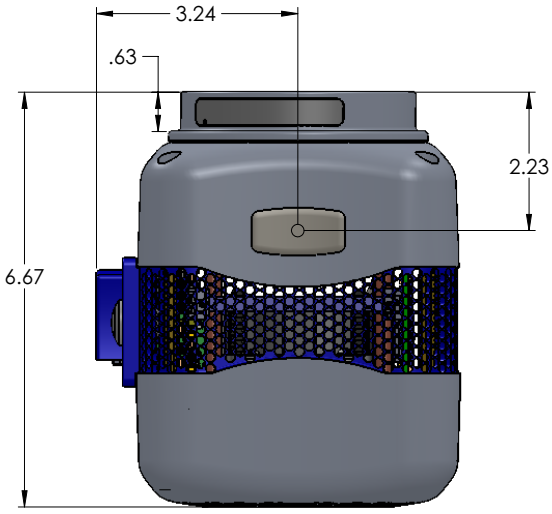

Footnotes

#1 Bias stability – The imaging stability of the EMCCD camera can be assessed by measuring its output with no light falling on the sensor and measuring the slope of the average intensity. The slope of the average intensity value of a 200 frame sequence (where y=mx+b of the least squares fit) is measured.

#2 Field uniformity – Specification was obtained using the following formula: $\sigma(\text{bias})/(\sigma(\text{bias}_1\text{-bias}_2)*.707) \leq 1.15$

#3 Dark current – This is measured in a traditional manner (as with all CCD cameras) by taking a long integration to obtain a signal. An average measurement is taken over the CCD area (excluding blemishes). It should be noted that dark current can vary significantly between different CCDs, and the numbers here are typical.

#4 Background events – As EMCCD cameras are actually capable of detecting single photons, the real detection limit of these cameras is set by the number of dark background events. These can arise from two things, dark current (which is thermal generation of an electron and is a temperature dependent phenomenon) and also clock induced charge (CIC) electrons (also called spurious charge). Each can lead to the generation of non-photon derived electrons which are multiplied through the electron-multiplication register, generating random high value pixels which are above the read noise.

These background events are measured by taking 16 ms exposure at 20MHz speed with 1000X EM Gain applied and counting the number of random high value pixels which are at a single event threshold above the modal value of the image histogram. This number is expressed as a probability of an event per pixel. The number can vary from frame to frame and sensor to sensor; however, a typical value is provided.

#5 Sequenced Multiple Acquisition in Real Time Streaming (SMART Streaming) provides the ability to set up to 12 different exposure times in a sequence, and then iterate through them repeatedly, allowing for extremely quick changes in exposure time for added experimental flexibility.

#6 http://www.e2v.com/products-and-services/high-performance-imaging-solutions/technical-papers/

#7 Gain stability – The actual amount of EM Gain applied on each image in a stream of images can vary depending on many electrical engineering factors.

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