

# Photron



## ***FASTCAM SA-X2***

### **1-Megapixel CMOS Image Sensor:**

1024 x 1024 pixels at 12,500fps  
 1024 x 1000 pixels at 13,500fps  
 768 x 768 pixels at 22,500fps  
 512 x 512 pixels at 45,000fps  
 512 x 376 pixels at 60,000fps  
 256 x 280 pixels at 120,000fps

### **Maximum Frame Rate:**

216,000fps (FASTCAM SA-X2 type 200K)  
 480,000fps (FASTCAM SA-X2 type 480K)  
 1,080,000fps (FASTCAM SA-X2 type 1080K)

### **Class Leading Light Sensitivity:**

ISO 12232 Ssat  
 • ISO 25,000 monochrome  
 • ISO 10,000 color

### **Global Electronic Shutter:**

1ms to 293ns independent of frame rate  
 (sub-microsecond shutter available on type 1080K only, subject to export control)

### **Dynamic Range (ADC):**

12-bit monochrome, 36-bit color

### **Internal Recording Memory:**

8GB, 16GB, 32GB, 64GB, or 128GB

### **Internal Memory Card Drives:**

Allowing high-speed download of images to low cost removable SD memory storage.

### **Fast Gigabit Ethernet Interface:**

Dual Gigabit Ethernet Interface provides high-speed image download to standard notebook/PC

### **Flexible Frame Synchronization:**

Frame rate may be synchronized to external unstable frequencies

### **Fan Stop Function:**

Remotely switch off cooling fans to eliminate vibration when recording at high magnifications

## High performance high-speed camera system

In order to meet the requirements of the most demanding high-speed imaging applications a balance of high frame rate, image resolution, dynamic range and light sensitivity is required. The FASTCAM SA-X2 high-speed camera system has been designed to provide a careful balance of these requirements.

FASTCAM SA-X2 brings together unique CMOS image sensor technologies and digital imaging expertise to provide optimum imaging performance. The system offers recording rates up to 13,500fps at megapixel image resolution with 12-bit dynamic range and high image quality. Frame rates greater than 1 million fps are available at reduced image resolution with shutter speeds as short as 293 nanoseconds (export restrictions may apply).

Light sensitivity is often the most critical performance criteria in high speed imaging. Without high light sensitivity, imaging at high frame rates with short exposure times is not possible. A camera system providing high light sensitivity allows a wide range of objective lenses and lighting techniques to be optimized to visualize complex high-speed phenomena.

The FASTCAM SA-X2 system may be controlled over a high-speed Gigabit Ethernet network or via the optional keypad. Standard operational features of the FASTCAM SA-X2 include a mechanical shutter to allow remote system calibration, dual-channel Gigabit Ethernet Interface for fast image download, and internal memory card drives allowing image download and storage to low cost removable recording media. The system also features memory segmentation to allow recording in one memory partition while at the same time downloading a previous recording, and the ability to remotely switch off cooling fans to eliminate vibration when recording at high magnifications.

The system is supplied with intuitive and feature rich Photron FASTCAM Viewer (PFV) software and Photron Device Control SDK (software development kit) allowing integration with user specific software. Alternatively the camera can be controlled as a device within a MATLAB® or LabVIEW environment.



### Light Sensitivity:

Expressions of light sensitivity in high-speed cameras can be confusing as a variety of differing measurement techniques are used. Photron publishes light sensitivity figures for its products using the ISO 12232 Ssat Standard.

<b>FASTCAM SA-X2</b>	<b>ISO 12232 Ssat</b>
Monochrome models	ISO 25,000
Color models	ISO 10,000

ISO 12232 Ssat values published by Photron for both monochrome and color cameras are measured excluding infrared sensitivity as defined by the ISO standard measurement procedure ISO 14524.

Monochrome sensors used in the FASTCAM SA-X2 are supplied without an IR absorbing filter, extending the camera's spectral response beyond 900nm. When the sensitivity of the FASTCAM SA-X2 is measured to tungsten light including near IR response an equivalent value of ISO 100,000 is obtained.

### Image Sensor:

The FASTCAM SA-X2 uses an advanced CMOS image sensor optimized for light sensitivity and high image quality that is unique to Photron.

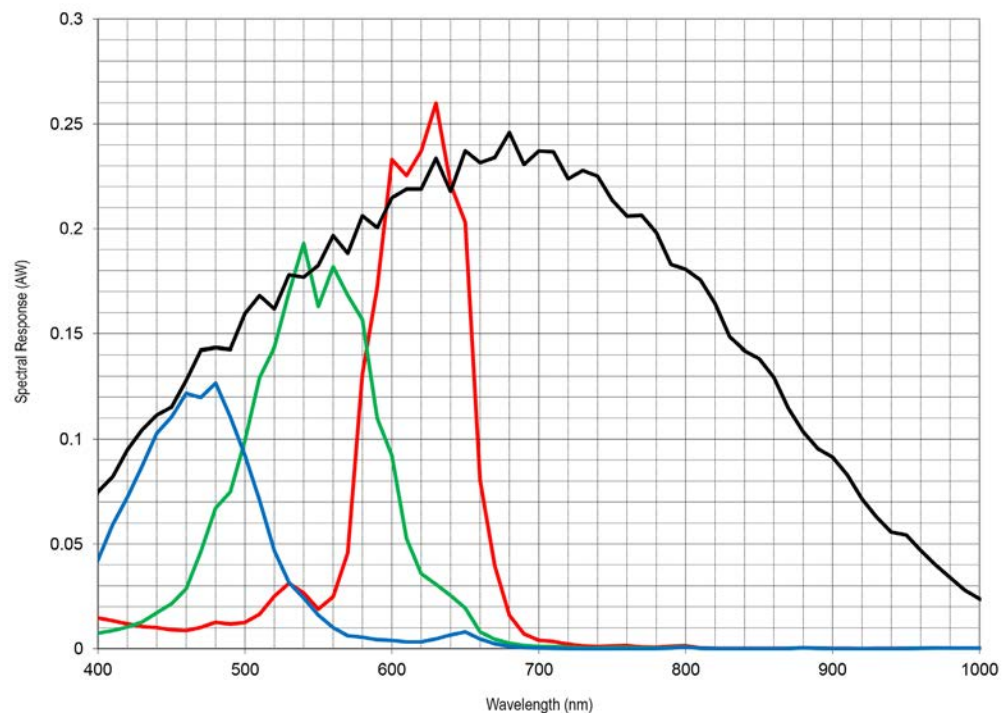
A 20-micron pixel pitch gives a sensor size at full image resolution of 20.48 x 20.48mm (diagonal 28.96mm).

Lenses designed for both FX (35mm full frame) and also DX (APS-C digital SLR) formats are fully compatible with the FASTCAM SA-X2 at full image resolution.

Sensor Type	Proprietary Design Advanced CMOS
Maximum Resolution (pixels)	1024 x 1024 pixels
Sensor Size / Diagonal	20.48 x 20.48mm / 28.96mm
Pixel Size (microns)	20µm x 20µm
Quantum Efficiency	46% at 630nm
Fill Factor	58%
Color Matrix	Bayer CFA (single sensor)
ISO 12232 Ssat sensitivity	ISO 25,000 monochrome ISO 10,000 color (monochrome sensor equivalent ISO 100,000 including near IR response)

Shutter  
Global Electronic Shutter 1ms to 1µs independent of frame rate (1080K only: 293ns shutter available subject to export control)

**FASTCAM SA-X2 Spectral Response Curves - Monochrome and Color**



## Camera Performance Specifications

Model	SA-X2
Full Frame Performance	12,500fps 1024 x 1024 pixels
Maximum Frame Rate	Type 200K: 216,000fps Type 480K: 480,000fps* Type 1080K: 1,080,000fps*
Minimum Exposure	Global electronic shutter to 1 $\mu$ s selectable independent of frame rate (293ns option available with SA-X2 type 1080K only) *
Ruggedized Mechanical Calibration Shutter	Standard Feature
Dynamic Range (ADC)	12-bit monochrome 36-bit color
Memory Capacity Options	8GB: 5,455 frames at full resolution 16GB: 10,916 frames at full resolution 32GB: 21,839 frames at full resolution 64GB: 43,684 frames at full resolution 128GB: TBA - early 2017
Memory Partitions	Up to 128 memory segments
Region of Interest	Selectable in steps of 128 pixels (horizontal) x 8 pixels (vertical)
Trigger Inputs	Selectable +/- TTL 5V and switch closure
Trigger Delay	Programmable on selected input / output triggers: 100ns resolution
Input / Output	Input: Trigger (TTL/Switch), sync, ready, event, IRIG Output: trigger, sync, ready, rec, exposure
Trigger Modes	Start, end, center, manual, random, random reset, random center, random manual, random loop, record on command
Time Code Input	IRIG-B
External Sync	+/- TTL 5Vp-p Variable frequency sync
Camera Control Interface	High-speed Gigabit Ethernet - (Single or Dual connections)
Image Data Display	Frame rate, shutter speed, trigger mode, date/time, status, real time / IRIG time, frame count, resolution
Saved Image Formats	JPEG, AVI, TIFF, BMP, RAW, RAWW, MRAW, PNG, MOV, and FTIF - Images can be saved with or without image data and in 8-bit, 12-bit, 16-bit or 36-bit depth of sensor where supported
Supported OS	Microsoft Windows operating system including: 7, 8, 8.1, 10 (32/64-bit)

\* Frame rates above 225,000fps and exposure times below 1 $\mu$ s may be subject to export control regulations in some areas

### Removable Data Storage Options:

To enable the rapid transfer of camera memory data to high capacity, removable non-volatile storage media the FASTCAM SA-X2 provides two UHS-I (SDR104) compatible SD memory card drives. This allows image data captured to camera memory to be quickly transferred to low cost storage media, allowing a new image sequence to be recorded to camera memory.

Control of download operation using on-camera user switches or via the optional Remote Control Keypad allows full camera operation and data storage without the requirement for connection to a computer.

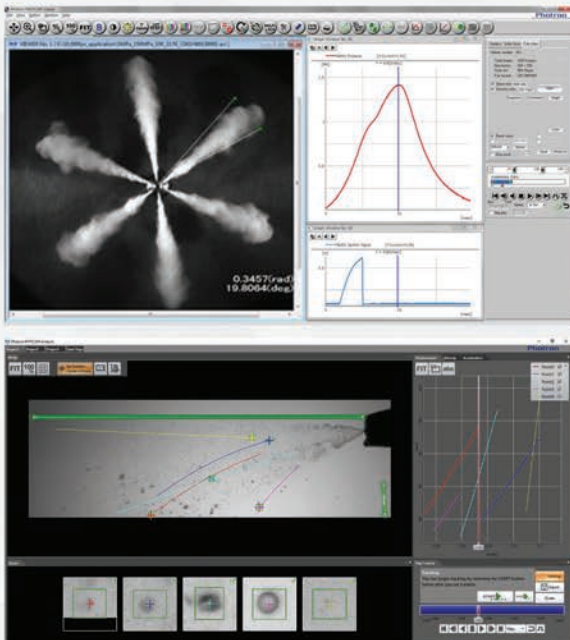


## Camera Operation Features

Frame Synchronization	Accurate frame synchronization with other cameras and with external and unstable frequencies.
Dual Slope Shutter (Extended Dynamic Range)	Selectable in 20 steps (0 to 95% in 5% increments) to prevent pixel over exposure without post processing.
Memory Partitions	Up to 128 memory segments allow multiple events to be stored in camera memory before downloading, with automatic progression to the next available partition.
Low Light Mode	Operation at minimum frame rate with independent adjustable shutter time to allow easy camera set-up and focus in ambient lighting.
Video Output	Live and playback via dual HD-SDI or RS-170 (NTSC/PAL) (zoom, pan, scroll control via optional LCD keypad).
IRIG Phase Lock	Enables multiple cameras to be synchronized to an IRIG time source.
Internal Delay Generator	Allows programmable delays to be set on input and output triggers, 100ns resolution.
Event Markers	Up to ten user entered event markers to define specific events within the recorded image sequence .
Download While Recording	FASTCAM SA-X2 supports Partition Recording Mode, allowing image data captured in one memory partition to be downloaded while at the same time recording into another partition.
Automatic Download	The system can be set to automatically download image data to the control PC and, when download is complete to re-arm in readiness for the next trigger with automatically incremented file names.
Software Binning	Virtual pixel binning (2x2, 4x4 etc.) allows increased light sensitivity with reduced image resolution without changing camera field of view.
SD Media Storage	Two UHS-I (SDR104) compatible SD memory card drives allow data transfer to low cost and convenient non-volatile removable media.

## Software Operation Features

Image Calibration	2D image calibration allows the measurement of distance and angle from the image. A calibration grid overlay can be superimposed on the image.
Image Overlay	A stored reference image may be overlaid on the live image to allow accurate camera positioning to achieve the same view as a previous test.
Import of Multiple Image Sequences	Multiple image sequences can be loaded and simultaneously replayed. Timing of image sequences can be adjusted to create a common time reference. Time based synchronization allows images captured at different frame rates to be synchronized.
High Dynamic Range Mode	Making use of the full sensor dynamic range, HDR mode allows enhanced detail in both light and dark areas of an image to be displayed simultaneously.
Motion Detector	In order to highlight subtle changes in an image, Motion Detector allows a reference image to be subtracted from a recorded sequence. Details including propagation of shock waves and surface changes during impact can be visualized using the feature.
Line Profile	A line profile representing grey levels along a line drawn across any region of the image is displayed. In live mode the Line Profile can be used to ensure optimum image focus is achieved.
Histogram	A histogram displaying grey levels within a user-defined image area is displayed. In live mode the Histogram can be used to ensure that optimum exposure levels are set for the scene being recorded.



### Photron FASTCAM Viewer:

Photron FASTCAM Viewer software (PFV) has been designed to provide an intuitive and feature rich user interface for the control of Photron high-speed cameras, data saving, image replay and simple motion analysis. Advanced operation menus provide access to features for advanced camera operation and image enhancement. Tools are provided to allow image calibration and easy measurement of angles and distances from image data. Also included are a C++ SDK and wrappers for LabView and MATLAB®.

An optional software plug-in module provides synchronisation between Photron high-speed cameras and data acquired through National Instruments data acquisition systems. Synchronised data captured by the DAQ system provides waveform information which can be viewed alongside high-speed camera images.

### Photron FASTCAM Analysis:

PFV software allows image sequences to be exported directly to optional Photron FASTCAM Analysis (PFA) Motion Analysis software. This entry level Motion Analysis software with an on screen 'step by step guide' function launches automatically from Photron FASTCAM Viewer software, and provides automated tracking of up to 5 points using feature or correlation tracking algorithms for the automated analysis of motion within an image sequence.

## Variable Region of Interest:

Region of Interest (ROI) or sub-windowing allows a user-specified portion of the sensor to be defined to capture images. By using a reduced portion of the image area, the frame rate at which images are recorded can be increased. FASTCAM SA-X2 allows the ROI to be set in increments of 128 pixels horizontal and 8 pixels vertical.

## Square Image Sensor Format:

Unlike broadcast and media applications where image formats such as 16:9 have now become standard, in scientific and industrial imaging applications an image sensor with a 1:1 image format is generally accepted to be advantageous. To capture the maximum useful image data in applications including microscopy, detonics, combustion imaging and many others, a 1:1 sensor format provides greater flexibility than 'letterbox' image formats. The FASTCAM SA-X2 image sensor allows the user to choose either square or rectangular image formats in order to obtain the maximum subject information.

## External Frame Synchronization:

The FASTCAM SA-X2 can be fully synchronized with an external event to allow the timing of when each individual image is captured to be precisely referenced. The camera can be accurately synchronized to unstable frequencies allowing complex events such as combustion in rapidly accelerating or decelerating engines to be recorded and studied.

## Record During Download Operation:

FASTCAM SA-X2 recording memory can be divided into multiple active sections. The user can record an on-going event in one memory partition while at the same time downloading a previously recorded image sequence in order to improve workflow and optimize camera operation.



SA-X2 1080K									
Resolution (h x v pixels)	Frame Rate Max fps	8GB		16GB		32GB		64GB	
		Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**
1024 x 1024	12,500	5,455	0.44	10,916	0.87	21,839	1.75	43,684	3.49
1024 x 1000	13,500	5,586	0.41	11,178	0.83	22,363	1.66	44,733	3.31
1024 x 672	20,000	8,313	0.42	16,635	0.83	33,280	1.66	66,568	3.33
896 x 496	30,000	12,874	0.43	25,760	0.86	51,531	1.72	103,074	3.44
896 x 368	40,000	17,352	0.43	34,720	0.87	69,456	1.74	138,927	3.47
768 x 272	60,000	27,391	0.46	54,805	0.91	109,632	1.83	219,287	3.65
640 x 256	72,000	34,924	0.49	69,877	0.97	139,782	1.94	279,592	3.88
512 x 512	45,000	21,827	0.49	43,672	0.97	87,363	1.94	174,744	3.88
512 x 272	81,000	41,088	0.51	82,209	1.01	164,450	2.03	328,932	4.06
384 x 264	100,000	56,445	0.56	112,934	1.13	225,912	2.26	451,868	4.52
256 x 152	200,000	147,058	0.74	294,227	1.47	588,564	2.94	1,177,238	5.89
256 x 80	300,000	279,413	0.93	559,033	1.86	1,118,274	3.73	2,236,755	7.46
128 x 48	480,000	931,382	1.94	1,863,450	3.88	3,727,585	7.77	7,455,855	15.53
128 x 40	540,000	1,117,659	2.07	2,236,140	4.14	4,473,103	8.28	8,947,027	16.57
128 x 8	1,080,000	5,588,307	5.17	11,180,712	10.35	22,365,523	20.71	44,735,144	41.42

SA-X2 480K									
Resolution (h x v pixels)	Frame Rate Max fps	8GB		16GB		32GB		64GB	
		Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**
1024 x 1024	12,500	5,455	0.44	10,916	0.87	21,839	1.75	43,684	3.49
1024 x 1000	13,500	5,586	0.41	11,178	0.83	22,363	1.66	44,733	3.31
1024 x 672	20,000	8,313	0.42	16,635	0.83	33,280	1.66	66,568	3.33
896 x 496	30,000	12,874	0.43	25,760	0.86	51,531	1.72	103,074	3.44
896 x 368	40,000	17,352	0.43	34,720	0.87	69,456	1.74	138,927	3.47
768 x 272	60,000	27,391	0.46	54,805	0.91	109,632	1.83	219,287	3.65
640 x 256	72,000	34,924	0.49	69,877	0.97	139,782	1.94	279,592	3.88
512 x 512	45,000	21,827	0.49	43,672	0.97	87,363	1.94	174,744	3.88
512 x 272	81,000	41,088	0.51	82,209	1.01	164,450	2.03	328,932	4.06
384 x 264	100,000	56,445	0.56	112,934	1.13	225,912	2.26	451,868	4.52
256 x 152	200,000	147,058	0.74	294,227	1.47	588,564	2.94	1,177,238	5.89
256 x 80	300,000	279,413	0.93	559,033	1.86	1,118,274	3.73	2,236,755	7.46
128 x 48	480,000	931,382	1.94	1,863,450	3.88	3,727,585	7.77	7,455,855	15.53
128 x 40	480,000	1,117,659	2.33	2,236,140	4.66	4,473,103	9.32	8,947,027	18.64
128 x 8	480,000	5,588,307	11.64	11,180,712	23.29	22,365,523	46.59	44,735,144	93.20

SA-X2 200K									
Resolution (h x v pixels)	Frame Rate Max fps	8GB		16GB		32GB		64GB	
		Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**
1024 x 1024	12,500	5,455	0.44	10,916	0.87	21,839	1.75	43,684	3.49
1024 x 1000	13,500	5,586	0.41	11,178	0.83	22,363	1.66	44,733	3.31
1024 x 672	20,000	8,313	0.42	16,635	0.83	33,280	1.66	66,568	3.33
896 x 496	30,000	12,874	0.43	25,760	0.86	51,531	1.72	103,074	3.44
896 x 368	40,000	17,352	0.43	34,720	0.87	69,456	1.74	138,927	3.47
768 x 272	60,000	27,391	0.46	54,805	0.91	109,632	1.83	219,287	3.65
640 x 256	72,000	34,924	0.49	69,877	0.97	139,782	1.94	279,592	3.88
512 x 512	45,000	21,827	0.49	43,672	0.97	87,363	1.94	174,744	3.88
512 x 272	81,000	41,088	0.51	82,209	1.01	164,450	2.03	328,932	4.06
384 x 264	100,000	56,445	0.56	112,934	1.13	225,912	2.26	451,868	4.52
256 x 152	200,000	147,058	0.74	294,227	1.47	588,564	2.94	1,177,238	5.89
256 x 80	216,000	279,413	1.29	559,033	2.59	1,118,274	5.18	2,236,755	10.36
128 x 48	216,000	931,382	4.31	1,863,450	8.63	3,727,585	17.26	7,455,855	34.52
128 x 40	216,000	1,117,659	5.17	2,236,140	10.35	4,473,103	20.71	8,947,027	41.42
128 x 8	216,000	5,588,307	25.87	11,180,712	51.76	22,365,523	103.54	44,735,144	207.11

\* Specifications subject to change without notice.

\*\* Recording time is an estimate and may be different depending on recording conditions and settings.

Photo:  
Marine Fuel Injection at 7,500fps



