

## PRODUCT DATASHEET

# NOVA<sup>R</sup>

FASTCAM series by Photron



### FASTCAM NOVA R2

**4-Megapixel CMOS Image Sensor:**

2048 x 2048 pixels at 1,440fps

1920 x 1080 pixels at 2,560fps

**Maximum Frame Rate:**

100,000fps (Nova R2 type 100K)

**Class Leading Light Sensitivity:**

ISO 2,500 color

**Global Electronic Shutter:**

1ms to 2.7 $\mu$ s independent of frame rate

**Dynamic Range (ADC):**

36-bit color

**Compact and Lightweight:**

120mm (H) x 120mm (W) x 217.2mm (D)

4.72" (H) x 4.72" (W) x 8.55" (D)

Weight: 3.5kg (7.7 lbs.)

**Internal Recording Memory:**

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

**Optional FASTDrive Removable High Capacity Data Storage:**

4TB High-speed Solid State Drive

**Fast 10-Gigabit Ethernet Interface:**

Provides camera control and high-speed image download to standard PC

**Fan Stop Function:**

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

## COMPACT AND VERSATILE HIGH PERFORMANCE CAMERA SYSTEM WITH HIGH IMAGE RESOLUTION

The FASTCAM NOVA R2 brings together unique CMOS image sensor technologies and extensive high-speed digital imaging expertise to provide a camera with the flexibility to be used in a wide variety of applications. The FASTCAM NOVA R2 offers 12-bit image recording rates up to 1,440 frames per second (fps) at 4-megapixel image resolution, and shutter speeds to 2.7 $\mu$ s. Recording rates to 100,000fps are available at reduced image resolutions. All of this available from a camera that is rugged, compact, lightweight and provides the best light sensitivity in its class.

Standard features of the FASTCAM NOVA R2 include an internal mechanical shutter to allow remote system calibration, a high-performance 10-Gigabit Ethernet interface for camera control and high-speed image download, memory segmentation that allows recording into one memory partition while downloading from another, and compatibility with a number of industry standard lens formats to allow the use of Nikon G-Type, C-mount and Canon EF lenses.

The FASTCAM NOVA R2 also features a "sealed body" design that prevents dust and corrosive particles from contaminating sensitive electronics. An optional FASTDrive SSD can be used for the download of images at up to 1GB per second.

Intuitive and feature rich Photron FASTCAM Viewer (PFV) software is included with each FASTCAM NOVA R2 camera. Also included is a Photron Device Control SDK that allows integration of the camera with user-specific software, and libraries for controlling the camera within a MATLAB® or LabView environment.



**Light Sensitivity:**

**FASTCAM NOVA**

Color models      ISO 2,500

**Image Sensor:**

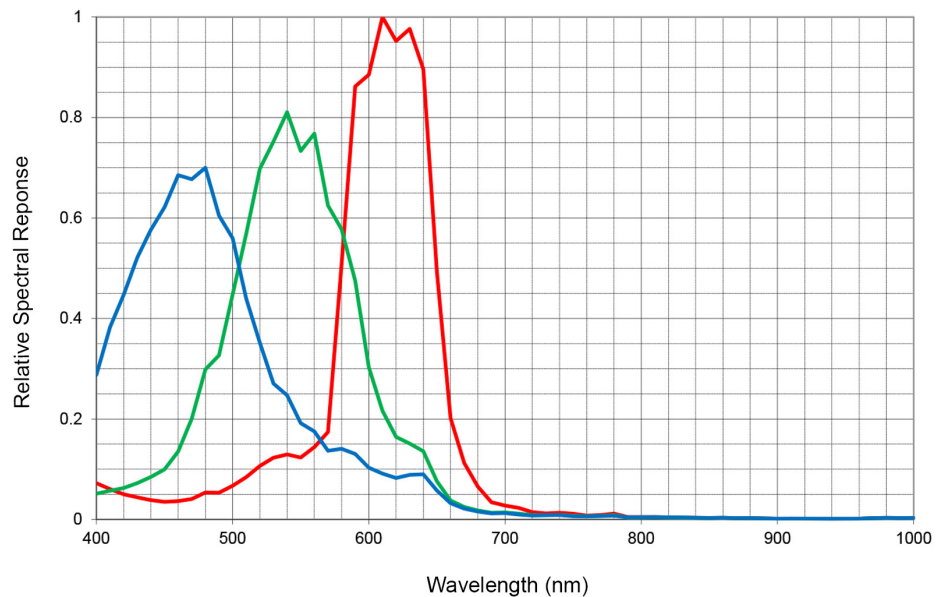
The FASTCAM NOVA R2 uses an advanced CMOS image sensor optimized for light sensitivity and high image quality that is unique to Photron.

A 10-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 NOVA R2 at full image resolution.

Sensor Type	Proprietary Design Advanced CMOS
Maximum Resolution (pixels)	2048 x 2048 pixels
Sensor Size / Diagonal	20.48 x 20.48mm / 28.96mm
Pixel Size (microns)	10µm x 10µm
Quantum Efficiency	43.8% at 630nm
Fill Factor	42%
Color Matrix	Bayer CFA (single sensor)
Light Sensitivity	ISO 2,500 color
Shutter	Global Electronic Shutter 1ms to 2.7µs independent of frame rate

FASTCAM NOVA R2 Spectral Response Curve - Color



## Camera Performance Specifications

Model	FASTCAM Nova R2
Full Frame Performance	1,440fps 2048 x 2048 pixels
Maximum Frame Rate	100,000fps (256 x 32 pixels)
Minimum Exposure Time	Global electronic shutter to 2.7µs selectable independent of frame rate (subject to export control)
Ruggedized Mechanical Calibration Shutter	Standard feature
Dynamic Range (ADC)	36-bit color
Memory Capacity Options	8GB, 16GB, 32GB, 64GB, or 128GB
Memory Partitions	Up to 128 memory segments
Region of Interest	Selectable in steps of 128 pixels (horizontal) x 16 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, record on command
Time Code Input	IRIG-B (selectable at beginning or end of frame exposure)
External Sync	+/- TTL 5Vp-p Variable frequency sync
Camera Control Interface	High-speed 1/10 Gigabit Ethernet
Image Data Display	Frame rate, shutter speed, trigger mode, date/time, status, real time / IRIG time, frame count, resolution
Saved Image Formats	BMP, TIFF, JPEG, PNG, RAWW, MRAW, AVI, MOV - Images can be saved with or without image data and in 8-bit, 16-bit or 36-bit depth of sensor where supported
Supported OS	Microsoft Windows operating system including: 8.1, 10,11 (32/64-bit)

### Optional Removable Data Storage:

The FASTCAM NOVA R2 can be supplied with the Photron FASTDrive high capacity removable SSD. The ultra-high data rate FASTDrive allows a 64GB camera recording to be transferred to a removable SSD drive in approximately 1 minute. Recorded data can then be directly accessed while coupled to the camera or the drive may be removed and inserted into the portable FASTDock station connected to any Windows PC.

### High-Speed Gigabit Ethernet Interface:

The FASTCAM NOVA R2 camera system is equipped with a high-speed 10-Gigabit Ethernet Interface to provide reliable camera control and fast download of image data.

### Dedicated I/O:

A dedicated BNC connection for a contact closure hardware trigger input is provided. In addition, two programmable inputs and two programmable output channels provide direct connection for common tasks such as synchronization of multiple cameras and operation in conjunction with Data Acquisition (DAQ) hardware.

### Ruggedized Mechanical Calibration Shutter:

The ruggedized mechanical shutter fitted as standard to the FASTCAM NOVA R2 camera allows sensor black balance calibration to be carried out remotely from the system control software.

### Optional Cannon EF Lens Mount:

In addition to the standard C-mount and Nikon G type lens adapters, all FASTAM NOVA models support an optional Canon EF lens adapter which, through Photron FASTCAM Viewer (PFV), not only enables remote operation of lens focus and aperture but also adds Auto-Focus capability.



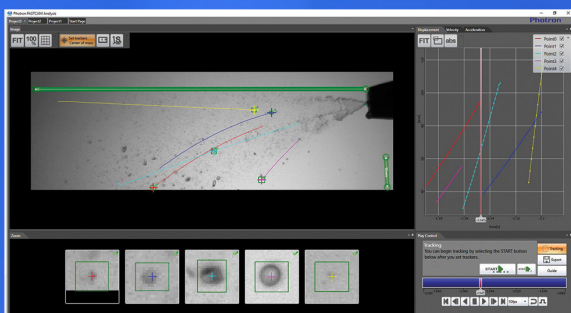
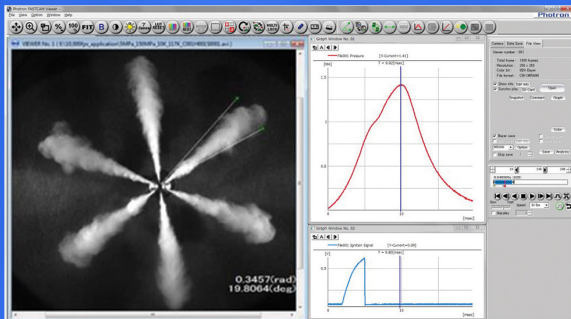


## Camera Operation Features

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 overexposure 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 separately adjustable shutter time to allow easy camera set-up and focus in ambient lighting.
Video Output (optional)	1080p live and playback via HD-SDI output.
IRIG Phase Lock	Enables multiple cameras to be synchronized together with other instrumentation equipment or to a master external time source.
Internal Time 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 NOVA 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.
FASTDrive	Optional 4TB solid state drive (SSD) memory pack provides ultra high data rate transfer to removable media.

## Operation Software 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.
Background Subtraction	In order to highlight subtle changes in an image, Background Subtraction 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 synchronization between Photron high-speed cameras and data acquired through National Instruments data acquisition systems. Synchronized 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 provides automated tracking of up to 5 points using feature or correlation tracking algorithms for the automated analysis of motion within an image sequence.

Nova R2											
Resolution (h x v pixels)	Frame Rate Max fps	8GB		16GB		32GB		64GB		128GB	
		Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**
2048 x 2048	1,440	1,338	0.93	2,703	1.88	5,434	3.77	10,895	7.57	21,818	15.15
2048 x 1472	2,000	1,861	0.93	3,761	1.88	7,560	3.78	15,159	7.58	30,355	15.18
1920 x 1080	2,560	2,707	1.06	5,469	2.14	10,992	4.29	22,039	8.61	44,132	17.24
1536 x 1152	3,000	3,172	1.06	6,409	2.14	12,881	4.29	25,827	8.61	51,718	17.24
1280 x 1024	3,750	4,283	1.14	8,652	2.31	17,391	4.64	34,867	9.30	69,819	18.62
1280 x 960	4,000	4,569	1.14	9,229	2.31	18,550	4.64	37,191	9.30	74,474	18.62
1280 x 800	4,800	5,483	1.14	11,075	2.31	22,260	4.64	44,630	9.30	89,369	18.62
1280 x 768	5,000	5,712	1.14	11,537	2.31	23,188	4.64	46,490	9.30	93,093	18.62
1280 x 720	5,000	6,092	1.22	12,306	2.46	24,734	4.95	49,589	9.92	99,299	19.86
1280 x 640	6,000	6,854	1.14	13,845	2.31	27,826	4.64	55,788	9.30	111,712	18.62
1280 x 512	7,500	8,568	1.14	17,306	2.31	34,783	4.64	69,735	9.30	139,640	18.62
1024 x 512	8,000	10,711	1.34	21,633	2.70	43,479	5.44	87,169	10.90	174,551	21.82
768 x 544	9,000	13,441	1.49	27,148	3.02	54,562	6.06	109,389	12.15	219,044	24.34
512 x 480	10,000	15,233	1.52	30,768	3.08	61,837	6.18	123,975	12.40	248,250	24.83
512 x 448	12,500	24,483	1.96	49,449	3.96	99,381	7.95	199,246	15.94	398,975	31.92
512 x 352	15,000	31,161	2.08	62,936	4.20	126,486	8.43	253,586	16.91	507,786	33.85
512 x 288	18,000	38,086	2.12	76,922	4.27	154,594	8.59	309,939	17.22	620,628	34.48
512 x 256	20,000	42,847	2.14	86,537	4.33	173,919	8.70	348,681	17.43	698,207	34.91
256 x 256	24,000	85,695	3.57	173,076	7.21	347,839	14.49	697,364	29.06	1,396,415	58.18
256 x 192	30,000	114,260	3.81	230,768	7.69	463,785	15.46	929,819	30.99	1,861,887	62.06
256 x 160	36,000	137,112	3.81	276,922	7.69	556,543	15.46	1,115,783	30.99	2,234,264	62.06
256 x 128	40,000	171,391	4.28	346,153	8.65	695,679	17.39	1,394,729	34.87	2,792,831	69.82
256 x 96	50,000	228,521	4.57	461,538	9.23	927,572	18.55	1,859,639	37.19	3,723,775	74.48
256 x 64	72,000	342,783	4.76	692,308	9.62	1,391,359	19.32	2,789,460	38.74	5,585,663	77.58
256 x 32	100,000	685,567	6.86	1,384,617	13.85	2,782,719	27.83	5,578,921	55.79	11,171,327	111.71

\* Specifications subject to change without notice.

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

### 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 NOVA R2 allows the ROI to be set in increments of 256 pixels horizontal and 32 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 NOVA R2 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 NOVA R2 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 NOVA R2 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.



## Mechanical and Environmental Specifications

Mechanical	
Lens Mount	F-mount (G-type lens compatible) and C-mount provided - Optional lens mounts available include Canon EF remote control mount
Camera Mountings	3/8 - 16 UNC, 1/4 - 20 UNC & 4 x M6 (base and side), 2 x 1/4 - 20 UNC (top)
External Dimensions	
Camera Body (excluding protrusions)	120mm (H) x 120mm (W) x 223mm (D) 4.72" (H) x 4.72" (W) x 8.78" (D)
Weight	
Camera Body	3.5kg (7.7lbs)
Environmental	
Operating Temperature	-10 to 40C, 14° to 104°F
Storage Temperature	-20 to 60C, -4° to 140°F
Humidity	85% or less (non-condensing)
Cooling	Internal fan cooling (fan-off mode supported)
Operational Shock	30G, 11ms, 6-axes 1,000 times/axis
Power	
AC Power (with supplied adapter)	100 to 240V, 50 to 60Hz
DC Power	22 to 32V, 120VA



### Nikon G-Type Compatible Lens Mount:

The FASTCAM NOVA R2 camera is equipped with an objective lens mount compatible with readily available Nikon G-type lenses. Controls provided within the lens mount allow the control of lens aperture on lenses without external iris control.

### Optional Canon EF Lens Mount:

An optional lens mount supporting Canon EF lenses is available for remote control of lens aperture and focus including Auto-Focus capability through Photron PFV software.

### Operation Environments:

The 'sealed body' design of the FASTCAM NOVA R2 ensures optimum air flow and prevents dust and corrosive particles from being ingested within the internal camera body where they can damage sensitive electronics. The fans may be disabled during recording for any vibration sensitive measurements.

The FASTCAM NOVA R2 camera has been extensively tested to ensure operation for extended periods in ambient temperatures up to 50 degrees C.

### Fan Stop Function:

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

Specifications subject to change without notice.

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