High-Speed Video Camera

Hyper Vision HPV-X
The memory capacity has been increased, boosting the number of recorded images to 256 frames (in HP mode). Now, instantaneous phenomena are captured even during ultra-high-speed recording.

Ultra-High-Speed Continuous Recording at up to 10 Million Frames per Second

The HPV-X is equipped with FTCMOS, Shimadzu’s proprietary high-speed CMOS image sensor. The world’s fastest sensor, it achieves ultra-high-speed continuous recording at 10 million frames per second.

Increasing Recording Capacity

Note: FTCMOS was developed through collaborative research with Prof. Shigetoshi Sugawa of Tohoku University.

Patents: 04931160, 04844853, 04844854

Newly Developed FTCMOS Sensor

The HPV-X is equipped with FTCMOS, a high-speed CMOS image sensor newly developed by Shimadzu for ultra-high-speed recording. The image signal is written to the memory inside the sensor chip at ultra-high speeds, enabling ultra-high-speed recording at 10 million frames per second, the world’s fastest level.

In a typical high-speed video camera, the photo diode (PD) is scanned pixel by pixel, the signal is read out, and then written to an external memory. Due to limitations on the output amplifier speed, the effective recording speed will be in the tens of thousands of frames per second, but the pixels are sub-sampled to further increase the speed. This results in an extremely poor resolution in the high-speed region.

With the FTCMOS sensor, the PD and memory are connected 1 to 1, and with the signal from each frame, all the pixels are written to memory simultaneously. Since there is no sequential readout operation, there is no output amplifier limitation, enabling high-resolution recording even at ultra-high speeds.

With conventional high-speed video cameras, as the recording speed increases, the resolution drops. With the HPV-X, video recording can be performed at the maximum resolution of 400 × 250 pixels regardless of the recording speed, enabling detailed analysis of ultra-high-speed phenomena (in FP mode).

Capable of High-Resolution Recording at the Highest Speeds

Operating Principles of the FTCMOS Sensor

This is an enlarged view of the propagation of cracks in glass.

The World as Seen by the HPV-X

Image from the HPV-X (High-resolution wide size)
A World's First* - Journey to Unknown Realms of High Resolution and Ultra-High Speeds

In a variety of scientific applications, phenomena elapse in an instant, leaving no clue to their solution. High-speed video cameras record such moments, enabling visualization through slow-motion replay. This technology is used as an important analysis tool in a variety of fields including materials failure, electric discharge, explosions, and microscopic phenomena. In recent years, such observations have progressed to ever higher speeds and increasing detail, leading to calls for ultra-high-speed recording far in excess of conventional recording speeds. The HPV-X High-Speed Video Camera is equipped with a newly developed proprietary high-speed CMOS image sensor, and has achieved ultra-high-speed continuous recording at 10 million frames/second, a world's first*.

The HPV-X opens new doorways to high-speed recording.

* According to our own research, as of September 2012
Ultra-High-Speed Continuous Recording at up to 10 Million Frames per Second

The HPV-X is equipped with FTCMOS, Shimadzu’s proprietary high-speed CMOS image sensor. The world’s fastest sensor, it achieves ultra-high-speed continuous recording at 10 million frames per second.

Increasing Recording Capacity

The memory capacity has been increased, boosting the number of recorded images to 256 frames (in HP mode). Now, instantaneous phenomena are captured even during ultra-high-speed recording.

Newly Developed FTCMOS Sensor

The HPV-X is equipped with FTCMOS, a high-speed CMOS image sensor newly developed by Shimadzu for ultra-high-speed recording. The image signal is written to the memory inside the sensor chip at ultra-high speeds, enabling ultra-high-speed recording at 10 million frames per second, the world’s fastest level.

Note: FTCMOS was developed through collaborative research with Prof. Shigetoshi Sugawa of Tohoku University.
Patents: 04931160, 04844853, 04844854

In a typical high-speed video camera, the photo diode (PD) is scanned pixel by pixel, the signal is read out, and then written to an external memory. Due to limitations on the output amplifier speed, the effective recording speed will be in the tens of thousands of frames per second, but the pixels are sub-sampled to further increase the speed. This results in an extremely poor resolution in the high-speed region.

With the FTCMOS sensor, the PD and memory are connected 1 to 1, and with the signal from each frame, all the pixels are written to memory simultaneously. Since there is no sequential readout operation, there is no output amplifier limitation, enabling high-resolution recording even at ultra-high speeds.

Capable of High-Resolution Recording at the Highest Speeds

With conventional high-speed video cameras, as the recording speed increases, the resolution drops. With the HPV-X, video recording can be performed at the maximum resolution of 400 × 250 pixels regardless of the recording speed, enabling detailed analysis of ultra-high-speed phenomena (in FP mode).
A World’s First* - Journey to Unknown Realms of High Resolution and Ultra-High Speeds

In a variety of scientific applications, phenomena elapse in an instant, leaving no clue to their solution. High-speed video cameras record such moments, enabling visualization through slow-motion replay. This technology is used as an important analysis tool in a variety of fields including materials failure, electric discharge, explosions, and microscopic phenomena. In recent years, such observations have progressed to ever higher speeds and increasing detail, leading to calls for ultra-high-speed recording far in excess of conventional recording speeds. The HPV-X High-Speed Video Camera is equipped with a newly developed proprietary high-speed CMOS image sensor, and has achieved ultra-high-speed continuous recording at 10 million frames/second, a world’s first*.

The HPV-X opens new doorways to high-speed recording.

* According to our own research, as of September 2012

Examples of Recordings with the HPV-X High-Speed Video Camera

Phenomena that could not be conventionally confirmed are now observable in any number of fields where high-speed recording is required. These include high-technology development, science and engineering research, biological research, and quality evaluations.

Scientific and Technological Fields
- Explosions, electrical discharges, materials failure, high-speed projectiles, plasmas, shock waves, crack propagation, sparks

Development and Production Fields
- Internal combustion engines, inkjet printing, wire bonding, cutting processes, laser machining, high-speed tensile tests, high-speed compression tests, high-speed injection molding, ruptures of composite materials, electrical spark machining

Micro-Scale Fields
- Inkjet printing, micro-bubbles, MEMS, cavitation

Crack Propagation (Glass)

<table>
<thead>
<tr>
<th>Recording speed: 10 million frames/second</th>
</tr>
</thead>
<tbody>
<tr>
<td>The glass is fractured by the impact of a high-speed projectile. The process of crack propagation at high speeds can be clearly observed.</td>
</tr>
</tbody>
</table>

Instantaneous Flash Lighting

<table>
<thead>
<tr>
<th>Recording speed: 10 million frames/second</th>
</tr>
</thead>
<tbody>
<tr>
<td>The transmission of a spark at the instant that a xenon flash-lamp is lit can be observed in detail.</td>
</tr>
</tbody>
</table>

CFRP High-Speed Tensile Test

<table>
<thead>
<tr>
<th>Recording speed: 10 million frames/second</th>
</tr>
</thead>
<tbody>
<tr>
<td>In CFRP materials testing with a high-speed tensile tester, the instantaneous rupture of materials can be observed in detail. (Testing speed of 10 m/s)</td>
</tr>
</tbody>
</table>

MEMS High-Speed Operation

<table>
<thead>
<tr>
<th>Recording speed: 10 million frames/second</th>
</tr>
</thead>
<tbody>
<tr>
<td>The high-speed displacement of the microscopic mirror in a MEMS device, used in a PC projector, can be observed in detail.</td>
</tr>
</tbody>
</table>

Water Spray

<table>
<thead>
<tr>
<th>Recording speed: 10 million frames/second</th>
</tr>
</thead>
<tbody>
<tr>
<td>The process by which the liquid sprayed at high speed from a nozzle becomes fine water droplets, and is then dispersed can be observed in detail.</td>
</tr>
</tbody>
</table>

Recording speed: 10 million frames/second

Instantaneous Flash Lighting

- Crack Propagation (Glass)
- Internal combustion engines
- Inkjet printing
- Laser machining
- High-speed tensile tests
- High-speed compression tests
- High-speed injection molding
- Ruptures of composite materials
- Electrical spark machining
- MEMS
- Cavitation

Recording speed: 10 million frames/second

Crack Propagation (Glass)

- Crack propagation
- High-speed tensile tests
- High-speed compression tests
- High-speed injection molding
- Ruptures of composite materials
- Electrical spark machining
- MEMS
- Cavitation

Recording speed: 10 million frames/second

Water Spray

- Water spray
- High-speed tensile tests
- High-speed compression tests
- High-speed injection molding
- Ruptures of composite materials
- Electrical spark machining
- MEMS
- Cavitation
User-Friendly Software Optimized for Ultra-High-Speed Recording

Utilizing Windows 7-compatible control software, ultra-high-speed recording can be started with a few simple settings. The recorded images can be saved in common formats such as AVI, BMP, JPEG, TIFF, and TIFF16. The camera and PC are connected by a Gigabit Ethernet for high-speed data communications.

The live monitor function enables the quick setting of recording conditions. Eight windows can be displayed simultaneously, making it easy to compare recorded data.

Start ultra-high-speed recording after setting a few simple conditions.
## Specifications

### Camera Head
- **Lens Mount**: Nikon F mount ¹
- **Image Sensor**: FT-CMOS image sensor

### Recording Speed

<table>
<thead>
<tr>
<th>Mode</th>
<th>Fixed Recording Speed</th>
<th>Variable Recording Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP mode</td>
<td>10 Mfps, 5 Mfps (fixed) (fps = frames per second)</td>
<td>Variable in a 1/(10 ns) interval in a range from 60 fps to 2 Mfps</td>
</tr>
<tr>
<td>FP mode</td>
<td>5 Mfps (fixed)</td>
<td></td>
</tr>
</tbody>
</table>

### Continuous Recording Capacity
- **HP mode**: 256 frames max.
- **FP mode**: 128 frames max.

### Resolution
- **HP mode**: 50,000 pixels (zigzag lattice pixel array) ³
- **FP mode**: 100,000 pixels (400 horizontal) × 250 (vertical)

### Exposure Time

<table>
<thead>
<tr>
<th>Mode</th>
<th>Fixed Exposure Time</th>
<th>Variable Exposure Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP mode</td>
<td>50 ns fixed (at 10 Mfps), 110 ns fixed (at 5 Mfps)</td>
<td>Variable in a 10 ns interval starting from 200 ns in a range from 60 fps to 2 Mfps</td>
</tr>
<tr>
<td>FP mode</td>
<td>110 ns fixed</td>
<td></td>
</tr>
</tbody>
</table>

### External Trigger Input
- **Type**: Two channels (TRIGIN, STANDBY) TTL level (5 V), capable of either positive or negative polarity
- **Settings**: Internal trigger, external trigger, continuous trigger
- **Output**: Two channels (The exposure start timing, trigger detection timing, etc. are output by setting)

### Optional Output
- **Type**: Two channels (The exposure start timing, trigger detection timing, etc. are output by setting)
- **Settings**: Can be set to any frame from the second frame onwards

### Interface
- **Type**: 1000 Base-T/100 Base-TX, 1 port

### Data Memory Format
- **Format**: 10-bit dedicated format, BMP, AVI, JPEG, TIFF (8-bit and 16-bit formats supported)

### Power Unit
- **Power Ratings**: Single Phase 100 V/220 V to 230 V AC, 200 VA, 50/60 Hz
- **Required Specifications for the Control PC (Order from Shimadzu.)**
  - **OS**: Windows 7 Professional (64 bit) Service Pack 1 or later
  - **CPU**: Intel Core i5 or faster
  - **Memory**: 4 GB or more
  - **Hard Disk Drive**: 250 GB or more
  - **Screen Size**: 1,366 × 768 or larger
  - **Interface**: 1000 Base-T/100 Base-TX
  - **External Recording Device**: DVD-RW
  - **Other Peripherals**: Mouse and keyboard

### Environmental Conditions
- **Operating Temperature Range**: 5°C to 40°C
- **Operating Humidity Range**: 35% to 75% RH with no condensation
- **Storage Temperature Range**: 0°C to 50°C
- **Storage Humidity Range**: 20% to 80% RH with no condensation

### Size/Weight
- **Camera Head**: 160 mm (W) × 330 mm (D) × 260 mm (H), approx. 6.4 kg
- **Power Unit**: 150 mm (W) × 392 mm (D) × 185 mm (H), approx. 5.2 kg
- **Length of Interface Cable Between Camera and Control PC**: Approx. 2 m
- **Power Unit**: Approx. 2.8 m

---

¹ Shimadzu does not guarantee that all F-mount lenses can be attached.
² The recording speed is a reference value. It is not guaranteed to be an accurate value for the time interval between recording frames.
³ Stored images will be 400 pixels (horizontal) × 250 pixels (vertical).
⁴ 10 bit is used to identify the data format. The data precision is not guaranteed.
⁵ These exposure times are rough indications and are not guaranteed as exact exposure ratios for all photographic speeds.

For details, refer to the S229-0048 specifications.