Digital Cameras for Scientific Imaging
Changing the game of scientific imaging

**ORCA®-Flash 4.0 v2**  
Featuring the Gen II scientific CMOS image sensor  
- 4.0 megapixels scientific CMOS with over QE 70 % peak  
- Very low readout noise (0.9 electrons at slow scan)  
- 100 frames/s readout (up to 25 655 frames/s by sub-array readout)  
- High dynamic range (33 000:1)  
- High resolution and short exposure times combined  
- Low noise and fast readout time simultaneously  
- Outstanding image uniformity (no fixed pattern noise)  
- Wider field of view than EM-CCD (512 × 512 pixels)  
- Two scan speeds (standard scan / slow scan)

**Sample images**

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The original high speed, low noise sCMOS camera

**ORCA®-Flash 2.8**  
Featuring the scientific CMOS image sensor  
- 2.8 megapixels scientific CMOS with QE 70 % peak  
- Very low readout noise (3 electrons rms)  
- 45 frames/s readout (up to 1273 frames/s by sub-array readout)  
- High dynamic range (4500:1)  
- High resolution and short exposure times combined  
- Low noise and fast readout time simultaneously  
- Outstanding image uniformity (no fixed pattern noise)  
- Wider field of view than CCD (2/3 inch, 1.3 megapixels)

**Sample images**

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Sample: High-sensitivity, high-resolution imaging

- Superimposed trichrome stain (Sample: FluoCells prepared slide H2)

Sample: High-speed imaging

- Spinning disk confocal
- TIRF

Sample: Superimposed trichrome stain (Sample: FluoCells prepared slide H2)

Sample: Spontaneous Ca²⁺ change of Fluo-4-loaded INS-1 cells  
Acquisition setting: 45 fps (exposure time: 22ms)
## ORCA-R²

- 1.37 megapixels interline CCD with QE over 70 % peak
- 14 MHz and 28 MHz readout modes included
- 12 bit and 16 bit digitizers are included and software selectable.
- Air and water cooling capabilities are standard.
- High resolution and short exposure times combined
- Choice of very low noise or very fast readout to suit applications
- Choice of bit depth to suit data and precision needs
- Long exposures with very low dark current and no vibration

## ORCA-D²

- 1.37 megapixels interline CCD (× 2 chips) with QE over 70 % peak
- 11.2 frames/s readout (up to 33.5 frames/s by 4 × 4 binning)
- Selectable wavelengths (changing optical blocks)
- Auto-correction of focus and alignment
- Simultaneous capture of wide-field dual wavelength images
- Dual focal plane imaging microscopy
- During image capture, the camera automatically corrects focus, alignment and color shifting to produce high-quality images

## ORCA-3CCD

- Total 4.13 megapixels on 3 progressive scan interline CCD chips
- 36 bit color resolution
- Cooled R, G and B CCDs with independent exposure settings
- High spatial resolution images of multicolor specimens in brightfield and fluorescence
- Great color fidelity with superb backgrounds
- Tremendous dynamic range of separate fluorophores

## ORCA-03G, ORCA-05G

- 1.37 megapixels interline CCD with QE over 70 % peak
- Compact head with single cable and no controller
- Wide spectral range from 400 nm to NIR region
- 14.7 MHz readout at 12 bit
- High resolution and short exposure times combined
- Fits into any laboratory space or setup
- Good for both bright fluorescence and NIR-DIC
- ORCA-03G model includes peltier cooling for extended exposures
### Camera specification comparison

<table>
<thead>
<tr>
<th>Model name</th>
<th>ORCA-Flash4.0 V2</th>
<th>ORCA-Flash2.8</th>
<th>ORCA-R2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type number</strong></td>
<td>C11440-22CU</td>
<td>C11440-10C</td>
<td>C10650-108</td>
</tr>
<tr>
<td><strong>Imaging device</strong></td>
<td>FL-400 scientific CMOS</td>
<td>FL-280 scientific CMOS</td>
<td>ER-150 progressive scan interline CCD</td>
</tr>
<tr>
<td><strong>Effective number of pixels</strong></td>
<td>2048 (H) x 2048 (V)</td>
<td>1920 (H) x 1440 (V)</td>
<td>1344 (H) x 1024 (V)</td>
</tr>
<tr>
<td><strong>Cell size (square format)</strong></td>
<td>6.5 μm (H) x 6.5 μm (V)</td>
<td>3.63 μm (H) x 3.63 μm (V)</td>
<td>6.45 μm (H) x 6.45 μm (V)</td>
</tr>
<tr>
<td><strong>Effective area</strong></td>
<td>13.312 mm (H) x 13.312 mm (V)</td>
<td>6.97 mm (H) x 5.23 mm (V)</td>
<td>8.67 mm (H) x 6.60 mm (V)</td>
</tr>
<tr>
<td><strong>Pixel clock rate</strong></td>
<td>28.0 MHz/pixel</td>
<td>14.0 MHz/pixel</td>
<td>-</td>
</tr>
<tr>
<td><strong>Readout speed</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Readout noise</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Full well capacity</strong></td>
<td>30 000 electrons</td>
<td>18 000 electrons</td>
<td>36 000 electrons (at high dynamic range mode)</td>
</tr>
<tr>
<td><strong>Dynamic range</strong></td>
<td>1.3 electrons (median) / 1.9 electrons (rms)</td>
<td>3 electrons (gain 8x)</td>
<td>10 electrons (gain 8x)</td>
</tr>
<tr>
<td><strong>Cooling method</strong></td>
<td>Peltier cooling, forced air/water cooled</td>
<td>Peltier cooling, passive air cooled</td>
<td>Peltier cooling, forced air/water cooled, hermetic sealed</td>
</tr>
<tr>
<td><strong>Cooling temperature</strong></td>
<td>-30 °C (water cooled: +15 °C)</td>
<td>+5 °C (ambient temperature: +20 °C)</td>
<td>-40 °C (absolute value) (Water cooled)</td>
</tr>
<tr>
<td><strong>Dark current</strong></td>
<td>0.05 electrons/pixel/s</td>
<td>-</td>
<td>0.0005 electrons/pixel/s</td>
</tr>
<tr>
<td><strong>A/D converter</strong></td>
<td>16 bit</td>
<td>12 bit</td>
<td>12 bit or 16 bit</td>
</tr>
<tr>
<td><strong>A/D converter speed</strong></td>
<td>16 bit</td>
<td>12 bit</td>
<td>12 bit or 16 bit</td>
</tr>
<tr>
<td><strong>Interface / Output signal (digital output)</strong></td>
<td>Camera Link Full Configur..</td>
<td>Camera Link Base Configuration</td>
<td>IEEE1394b-2002</td>
</tr>
<tr>
<td><strong>Exposure time</strong></td>
<td>1 ms to 10 s</td>
<td>20 μs to 10 s (at internal trigger / external trigger)</td>
<td>10 μs to 4200 s</td>
</tr>
<tr>
<td><strong>Sub-array</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>External trigger</strong></td>
<td>Yes</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Contrast enhancement</strong></td>
<td>High speed readout</td>
<td>-</td>
<td>Analog gain (8 times max.) and offset function</td>
</tr>
<tr>
<td><strong>Lens mount</strong></td>
<td>C-mount</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Line voltage</strong></td>
<td>AC 100 V to 240 V, 50 Hz / 60 Hz</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Power consumption</strong></td>
<td>Approx. 70 VA</td>
<td>Approx. 45 VA</td>
<td>Approx. 60 VA</td>
</tr>
<tr>
<td><strong>Ambient storage temperature</strong></td>
<td>-10 °C to +50 °C</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Ambient operating temperature</strong></td>
<td>0 °C to +40 °C</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Ambient operating / storage humidity</strong></td>
<td>70 % max. (with no condensation)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1. Calculated from the ratio of the full well capacity and average readout noise.
2. The hermetic sealed head maintains a high degree of vacuum (10⁻⁸ Torr) without re-evacuation.

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*“ORCA-3CCD Digital Color Camera with front cable mount” for the C7780-10
“ORCA-3CCD Digital Color Camera with rear cable mount” for the C7780-20

* Structure of the hermetic vacuum-sealed head

* The hermetic vacuum-sealed air-cooled head is available. Please consult your local sales representative.
### Dual wavelength imaging

<table>
<thead>
<tr>
<th>Dual wavelength imaging</th>
<th>High speed, high sensitivity and low cost</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORCA-D2</td>
<td>ORCA-03G</td>
<td>ORCA-05G</td>
</tr>
<tr>
<td>C11254-10B</td>
<td>C8484-03G02</td>
<td>C8484-05G02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C7780-10, C7780-20 *</td>
</tr>
<tr>
<td>1280 (H) x 960 (V) x 2CCD chip</td>
<td>1344 (H) x 1024 (V)</td>
<td>ER-150 progressive scan interline CCD</td>
</tr>
<tr>
<td>6.45 μm (H) x 6.45 μm (V)</td>
<td>6.45 μm (H) x 6.45 μm (V)</td>
<td></td>
</tr>
<tr>
<td>8.26 mm (H) x 6.19 mm (V)</td>
<td>8.67 mm (H) x 6.60 mm (V)</td>
<td></td>
</tr>
<tr>
<td>20.0 MHz/pixel</td>
<td>14.7 MHz/pixel</td>
<td>16.0 MHz/pixel</td>
</tr>
<tr>
<td>11.2 frames/s</td>
<td>8.9 frames/s</td>
<td>9.1 frames/s</td>
</tr>
<tr>
<td>20.2 frames/s</td>
<td>16.3 frames/s</td>
<td>18.1 frames/s</td>
</tr>
<tr>
<td>33.6 frames/s</td>
<td>27.8 frames/s</td>
<td>31.8 frames/s</td>
</tr>
<tr>
<td>50.5 frames/s</td>
<td>43.0 frames/s</td>
<td>51.5 frames/s</td>
</tr>
<tr>
<td>8 electrons rms</td>
<td>6 to 8 electrons rms</td>
<td>10 electrons rms</td>
</tr>
<tr>
<td>18 000 electrons</td>
<td>15 000 electrons</td>
<td>18 000 electrons</td>
</tr>
<tr>
<td>36 000 electrons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2250:1</td>
<td>2142:1</td>
<td>1500:1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1384:1</td>
</tr>
<tr>
<td>Peltier cooling, forced air cooled, hermetic sealed</td>
<td>Peltier cooling, forced air cooled, hermetic sealed</td>
<td>passive air cooled</td>
</tr>
<tr>
<td>–10 °C (ambient temperature: +20 °C)</td>
<td>–10 °C (absolute value)</td>
<td>–</td>
</tr>
<tr>
<td>10 electrons rms</td>
<td>0.01 electrons/pixel/s</td>
<td>0.5 electrons/pixel/s</td>
</tr>
<tr>
<td>0 μs to 60 s</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>10 μs to 1 s</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>10 μs to 1 s</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>128 μs to 10 s</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2/3 inch bayonet mount (flange back 48 mm)</td>
<td>C-mount</td>
<td>2/3 inch bayonet mount (flange back 48 mm)</td>
</tr>
<tr>
<td>AC 100 V to 240 V, 50 Hz / 60 Hz</td>
<td>DC +12 V</td>
<td>DC +8 V to DC +30 V</td>
</tr>
<tr>
<td>Approx. 70 VA</td>
<td>Approx. 24 VA</td>
<td>Approx. 8 VA</td>
</tr>
<tr>
<td>–10 °C to +50 °C</td>
<td>–10 °C to +50 °C</td>
<td>–10 °C to +50 °C</td>
</tr>
<tr>
<td>+10 °C to +35 °C</td>
<td>0 °C to +40 °C</td>
<td>0 °C to +40 °C</td>
</tr>
<tr>
<td>70 % max. (with no condensation)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Spectral response characteristics

#### sCMOS and CCD cameras

![Spectral response characteristics graph](image)

- ORCA-D2
- ORCA-R2
- ORCA-03G
- ORCA-05G
- ORCA-3CCD
- ORCA-Flash4.0 V2
- ORCA-Flash2.8

* These are typical, not guaranteed.
**Back-thinned 512 × 512 frame transfer CCD with QE over 90 % peak**

- 16 μm pixels with large full well capacity
- Optimized EM-CCD readout and stabilized dual mode cooling
- 70 frames/s readout (up to 1076 frames/s by sub-array readout)

**Large pixels for high collection efficiency**

**EmX2**

- Short exposure and fast frame rate
- Large dynamic range in both NORMAL-CCD and EM-CCD readout modes
- Highly stabilized gain and minimal dark noise

**Back-thinned 1024 × 1024 frame transfer CCD with QE over 90 % peak**

- 13 μm pixels and 11 MHz readout
- Optimized EM-CCD readout and stabilized dual mode cooling

**Large field of view**

**Em1K**

- Short exposure and high resolution
- Well matched to high NA objectives and fast readout
- Highly stabilized gain and minimal dark noise

**Spectral response characteristics**

**EM-CCD cameras**

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Quantum efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>100</td>
</tr>
<tr>
<td>600</td>
<td>90</td>
</tr>
<tr>
<td>800</td>
<td>80</td>
</tr>
<tr>
<td>1000</td>
<td>60</td>
</tr>
</tbody>
</table>

* These are typical, not guaranteed.

**Sample image**

**Sample of luminescence imaging**

Luminescence imaging of HeLa cells expressing Renilla Luciferase.

- Objective lens: 10x
- Cooling method: Water cooling (-80 °C)
- EM gain: 200x
- Exposure time: 5 min

This image is displayed by overlapping luminescence image (pseudo color) and actual image.
<table>
<thead>
<tr>
<th>Specifications</th>
<th>High-speed readout</th>
<th>High resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model name</strong></td>
<td>ImagEM X2</td>
<td>ImagEM-1K</td>
</tr>
<tr>
<td><strong>Ambient operating temperature</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pixel clock rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EM (electron multiplying) gain protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trigger output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External trigger mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output signal / External control</td>
<td>IEEE1394b</td>
<td>Camera Link</td>
</tr>
<tr>
<td>A/D converter</td>
<td>16 bit</td>
<td></td>
</tr>
<tr>
<td>Power requirements</td>
<td>AC 100 V to 240 V, 50 Hz / 60 Hz</td>
<td></td>
</tr>
<tr>
<td>Power consumption</td>
<td>Approx. 140 VA</td>
<td></td>
</tr>
<tr>
<td>Ambient storage temperature</td>
<td>-10 °C to +50 °C</td>
<td></td>
</tr>
<tr>
<td>Ambient operating temperature</td>
<td>0 °C to +40 °C</td>
<td></td>
</tr>
<tr>
<td>Performance guaranteed temperaure</td>
<td>0 °C to +30 °C</td>
<td></td>
</tr>
</tbody>
</table>

**Type number**

- ImagEM X2: C9100-23B
- ImagEM-1K: C9100-14

**Window**

- Anti-reflection (AR) coatings on both sides, single window

**AR mask**

- Yes
- No

**Imaging device**

- Electron Multiplying Back-Threshold Transfer CCD

**Effective number of pixels**

- (Room temperature: Stable at +20 °C)

- 512 (H) × 512 (V) (Water temperature: lower than +10 °C)

- 1024 (H) × 1024 (V) (-55 °C)

**Cell size**

- 16 µm (H) × 16 µm (V) (Water temperature: lower than +10 °C)

- 13 µm (H) × 13 µm (V) (-55 °C)

**Effective area**

- 8.19 mm (H) × 8.19 mm (V) (Water temperature: lower than +10 °C)

- 13.3 mm (H) × 13.3 mm (V) (-55 °C)

**Clock induced charge (typ.)**

- 0.0005 electron/pixel/s (-45 °C)

- 0.001 electron/pixel/s (-45 °C)

**Temperature stability (typ.)**

- ±0.01 °C (Water temperature: higher than +10 °C)

- ±0.01 °C (Water temperature: +20 °C)

- ±0.05 °C (Water temperature: higher than +10 °C)

- ±0.05 °C (Water temperature: +20 °C)

**Dark current (typ.)**

- 0.0005 electron/pixel/s (-45 °C)

- 0.001 electron/pixel/s (-45 °C)

- 0.001 electron/pixel/s (-70 °C)

**Clock induced charge (typ.)**

- 0.0015 electron/pixel/frame

**Gain settings**

- EM gain 1200

- EM gain 1000

- EM gain 400

**Max. output signal (typ.)**

- 0.0005 electron/pixel/s (-45 °C)

- 0.001 electron/pixel/s (-45 °C)

**Max. output signal (typ.)**

- 0.0015 electron/pixel/frame

**Image processing functions (real-time)**

- Background subtraction

- Shading correction

- Recursive filter

- Frame averaging

- Spot noise reducer

**EM gain protection**

- EM gain protection mode

- EM protection mode

**EM gain readjustment**

- Available

**Lens mount**

- C-mount

**Power requirements**

- AC 100 V to 240 V, 50 Hz / 60 Hz

**Power consumption**

- Approx. 140 VA

**Ambient operating/storage humidity**

- 70 % max. (with no condensation)

**The cooling head maintains a high degree of vacuum, 10⁻⁸ Torr, without re-evaporation.**

**Even with electron multiplying gain maximum, dark signal is kept at a low level during low light imaging.**

**Linearity is not assured when full well capacity is over 370 000 electrons, because of CCD performance.**

**The cooling temperature may not reach to this temperature; it depends on the operation condition.**

**Water volume 0.5 liter/min (C9100-23B), 1.2 liter/min (C9100-14).**

**Typical thermal charge value (not guaranteed).**

**Image smearing may appear when the exposure time is short.**

**8 x 8 and 16 x 16 binning are available on special order. Please consult with our sales office.**

**C-MOS 3.3 V with reversible polarity.**

**Recursive filter, frame averaging, and spot noise reducer cannot be used simultaneously.**
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HAMAMATSU PHOTONICS K.K., Systems Division
812 Joko-cho, Higashi-ku, Hamamatsu City, 431-3196, Japan, Telephone: (81)53-431-0124, Fax: (81)53-435-1574, E-mail: export@sys.hpk.co.jp

U.S.A.: Hamamatsu Corporation: 360 Foothill Road, P.O. Box 6910, Bridgewater, N.J. 08807-0910, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218 E-mail: usa@hamamatsu.com

Germany: Hamamatsu Photonics Deutschland GmbH: Azthbergstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-365-8 E-mail: info@hamamatsu.de

France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10 E-mail: info@hamamatsu.fr

United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Twin Road Waltham Garden City Harfordshire AL7 1BN, United Kingdom, Telephone: 44-(0)1707-29488, Fax: 44-(0)1707-32577 E-mail: info@hamamatsu.co.uk

North Europe: Hamamatsu Photonics Norden AB: Torsviksgatan 32 16440 Kista, Sweden, Telephone: (46)8-509-031-00, Fax: (46)8-509-031-01 E-mail: info@hamamatsu.se

Italy: Hamamatsu Photonics Italia: S.P.L.: Strada della Moia, 1/E, 20020 Arase, (Milano), Italy, Telephone: (39)92-935 81 733, Fax: (39)92-935 81 741 E-mail: info@hamamatsu.it

China: Hamamatsu Photonics (China) Co., Ltd: 1201 Tower B, Jiarring Center, 27 Donganqian Road North, Chaoyang District, Beijing 100020, China, Telephone: (86)10-6586-6008, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn