PoliSpectra® H116
Imaging Spectrometer for Hyperspectral Applications

For OEM Industrial Applications

horiba.com/oem
Overview
HORIBA has developed a high performance rugged hyperspectral imaging spectrometer with an integrated 2D scientific CMOS camera. The elegant all-concentric design combines high spatial and spectral resolution using a type-I holographic diffraction grating and mirror. This system can be used as a line-scanning instrument (push-broom) that collects full spectral data simultaneously, across the input slit height at up to 188 frames per second.

Applications
• Quality Control Inspection
• Process Monitoring
• Remote Aerial Sensing
• Advanced Machine Vision
• Environmental monitoring
• Food & Beverage Inspection
• Recycling

Optical and Mechanical Layout

Concentric spectrometer's layout providing excellent spatial imaging.

Features

Superb imaging quality due to high spectral and spatial resolution at F/2.3
Frame rates as fast as 188 fps
High throughput combined with low stray light performance
2D scientific CMOS with high quantum efficiency and low noise
On-board processing capability using powerful dual-core ARM cortex and 2 GB memory
Broad wavelength coverage from 185 nm to 1050 nm
Stable and robust
### General Spectrometer Specifications*

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral Coverage</td>
<td>185–1050 nm, Tunable at factory between these ranges: 185-920 nm and 280-1050 nm</td>
</tr>
<tr>
<td>Spectral Resolution</td>
<td>1.25 nm typical (22 µm slit width) and up, depending on the slit size</td>
</tr>
<tr>
<td>Spatial Resolution</td>
<td>50 µm typical</td>
</tr>
<tr>
<td>Spectral Dispersion</td>
<td>34.6 nm/mm; 0.38 nm/pixel</td>
</tr>
<tr>
<td>Focal Length</td>
<td>116 mm</td>
</tr>
<tr>
<td>F/#</td>
<td>F/2.3</td>
</tr>
<tr>
<td>Smile and Keystone</td>
<td>1.5 pixel (typical)</td>
</tr>
<tr>
<td>Stray Light**</td>
<td>&lt; 0.1% (typical)</td>
</tr>
<tr>
<td>Wavelength Accuracy</td>
<td>0.1 nm (using multi-area wavelength calibration)</td>
</tr>
<tr>
<td>Software</td>
<td>LabVIEW™ acquisition software for initial evaluation (DLLs provided for software integration)</td>
</tr>
</tbody>
</table>

### Specifications for Scientific Back-Illuminated CMOS Image Sensor with High Speed Electronics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector Model</td>
<td>sCMOS BI sensor with electronic rolling shutter. (All the parameters are specified at normal room temperature of 25°C unless otherwise noted.)</td>
</tr>
<tr>
<td>Sensor Format***</td>
<td>2048 x 512</td>
</tr>
<tr>
<td>CMOS Pixel Size</td>
<td>11 µm x 11 µm</td>
</tr>
<tr>
<td>CMOS Height</td>
<td>5.6 mm</td>
</tr>
<tr>
<td>CMOS QE</td>
<td>The peak QE is 77% at 250 nm and 95% at 560 nm (refer to graphs below)</td>
</tr>
<tr>
<td>Sensor Temperature</td>
<td>Uncooled</td>
</tr>
<tr>
<td>Frame Rate</td>
<td>94 fps (HDR mode), 188 fps (STD mode) on 2D sCMOS sensor</td>
</tr>
<tr>
<td>Full Well</td>
<td>80 ke− typical (HDR mode)</td>
</tr>
<tr>
<td>Readout Noise</td>
<td>1.6 e− typical, 2.0 e− maximum</td>
</tr>
<tr>
<td>Digitization</td>
<td>16-bit (HDR mode), 12-bit (High Sensitivity mode)</td>
</tr>
<tr>
<td>Dynamic Range</td>
<td>93.9 dB typical in HDR mode</td>
</tr>
<tr>
<td>Non-linearity (measured on each system)</td>
<td>1.8% (maximum) in HDR mode</td>
</tr>
<tr>
<td>Communication</td>
<td>USB 3</td>
</tr>
<tr>
<td>Environmental Conditions</td>
<td>Operating temperature 15°C to 40°C ambient; Relative humidity &lt;70% (non-condensing); Storage temperature -25°C to 45°C</td>
</tr>
<tr>
<td>Power requirements AC/DC Power Supply (provided)</td>
<td>90-264 VAC, 47–63 Hz</td>
</tr>
</tbody>
</table>

* Specifications, form factor, and spectrometer cover subject to change without notice. No LabVIEW license is needed to run our acquisition software.
** Stray light using BP Filter: Baseline light level, outside the band, divided by BP peak (unsaturated) value.
*** See sensor manufacturer's Blemish / Defect information

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**Scientific CMOS Back-Illuminated Sensor Quantum Efficiency**

![Quantum Efficiency Graph](image-url)
Features

Push Broom Hyperspectral Imaging Configuration

1951 USAF Resolution Target

Motorized axis

Resolution test configuration using the H116 hyperspectral camera and a 1951 USAF transmission resolution target via the push broom method. A lens focuses the image on the slit, which is oriented horizontally. A motorized stage moves the target vertically to assemble the hyperspectral cube. A collimated tungsten light provides illumination.

A hyperspectral cube of the 1951 USAF target stitched together from 200 images illuminated by a tungsten lamp. The hyperspectral camera acquired this image in XZ-plane slices (corresponding to real space horizontal axis and wavelength, respectively) and assembled the hyperspectral cube by stitching XZ images along the y-axis (the motorized scan axis). The intensity at each point is in units of electron counts.

A hyperspectral cube with the background subtracted

(Left) A slice of the hyperspectral cube showing the 1951 USAF resolution target at 808 nm. Pixels from the sliced hyperspectral cube were spatially averaged (within the red box at left) to produce a spectrum for that area (shown below). No sample transmission below 400 nm.

Over the last 25 years, HORIBA has been a pioneer in the field of holographic gratings and imaging spectrographs, and has been awarded many patents.

Our first patent on an Offner design, coupled with a CCD and multiple fibers at the input, was filed in 1989, and published in 1992.

Examples of key patents:
1971: First aberration-corrected grating
1972: Concave grating spectrograph with flat field
1989: Aberration-corrected grating in a Czerny-Turner spectrometer
1992: Concentric (Offner) spectrograph with holographic grating and 2D detector
1999: Concentric (Dyson) spectrograph
2010: Spectrometer with astigmatism correction
2011: Concentric (Dyson) spectrograph with improved image quality.

he PoliSpectra H116 and M116 use a new proprietary concentric layout combined with a Type-I holographic grating. Such Type-I gratings feature equidistant and parallel grooves, and are optimized for very broad spectral range.
Hyperspectral Imaging Distortions: Keystone and Smile

Definitions:

The KEYSTONE property is a band-to-band magnification that changes with wavelength. This involves mixing of spectra from adjacent field positions.

The SMILE property is a wavelength shift caused by a change in dispersion with field position [1].

KEYSTONE is measured by calculating the maximum displacement a field slit makes as it moves across the entire spectrum and the SMILE is measured by calculating the maximum displacement a wavelength makes as it moves across the entire height of the region of interest.

Excellent optical performance for PoliSpectra system showing keystone and smile smaller than 1.5 pixels

An example of the production testing for HORIBA’s hyperspectral/multichannel spectroscopy systems based on the method described above.

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Customer’s provided optics are required to image onto the 22 µm x 5632 µm spectrometer slit.
Best Selling Miniature Spectrometers for OEM Industrial Applications

Fiber-coupled USB Spectrometers:

**MiniVS20 Spectrometer with Linear UV-VIS CMOS or NIR InGaAs Sensor**
- OEM hand-held spectrometer covering 190 to 1,700 nm for various low stray light applications
- Aberration-corrected concave holographic grating options
- VIS configuration featuring a 1.7” x 1.9” x 2” size combined with full F/2.3 optics for high signal-to-noise
- High throughput, compactness and long term reliability

**MiniVS70 VIS Spectrometer with FI CMOS or BI CCD**
- NEW miniaturized VS70 configuration
  - Based on high performance aberration-corrected concave gratings fitted with a custom order-sorting filter to eliminate higher orders
  - Low cost combined with high performance and low stray light
  - Long term opto-mechanical stability and choice of front-illuminated linear CMOS or back-illuminated CCD sensors

**VS70 UV-VIS-NIR Spectrometer with Uncooled / TE-cooled CCD**
- Compact, versatile most popular VS70 OEM spectrometer and OES configurations
  - Based on high performance aberration-corrected concave gratings with full F/2.3 aperture
  - Affordable, high throughput, robust and stable
  - Electronics drivers ranging from USB-2 to Ethernet and EtherCAT

**CiCi-Raman-NIR with Scientific Camera Optimized for 785 nm**
- Most compact OEM Raman spectrometer with aberration-corrected holographic grating
  - Covers 150-3,300 cm⁻¹
  - High efficiency and low stray light
  - Available in F/2.3 and in compact F/5 configurations
  - -50° C deep-cooled scientific CCD camera with minimized etaloning and high NIR QE

**PoliSpectra® Quad Spectrometer for Simultaneous Acquisition of 4 VIS Spectra**
- CCD spectrometer for simultaneous acquisition from 4 fiber inputs (470-730 nm)
  - High-speed electronics (as fast as <1.5 msec readout time for 4 spectra)
  - QUAD-channel high throughput system (f/2.3) and ultra-low stray light
  - Industrial low-light applications from low light fluorescence to reflectance

**PoliSpectra® M116 8-32 Channel MultiTrack UV-VIS-NIR CMOS Spectrometer**
- Fiber-coupled multi-spectra system with 8- to 32-channel simultaneous measurements
  - Concentric optical design with UV extended spectral range provides minimized crosstalk
  - High throughput USB-3 system featuring a fast 2D scientific BI CMOS running at 94 to 188 frames per second, acquiring 8, 16 or 32 simultaneous spectra (2048 pixels per spectrum)

**PoliSpectra® H116 Imaging Spectrometer for Hyperspectral Work from UV to NIR**
- Ultra-high performance rugged spectrometer for hyperspectral imaging with a 2D sCMOS Camera
  - For line-image scanning, in a push-broom hyperspectral configuration
  - High throughput, USB-3 system featuring a fast 2D scientific BI CMOS with rolling shutter, running at 94 (HDR) to 188 (Standard Mode) frames per second (2048 pixels per spectrum)
OEM Philosophy and Mission

3 Centers of Excellence Dedicated to OEM Spectroscopy and Camera Solutions in US, EU, and Asia

Our mission is to provide a complete development and manufacturing experience, from optical simulations to opto-mechanical design and prototyping of spectroscopic and camera systems extending to, and including, electronics, firmware, software design and first articles.

Our products provide superior performance, reliability and stability, combined with robust cost reduction. Capable of flexible high volume production capacity in quantities of hundreds to thousands per year, we offer full confidentiality providing “Black Boxes” or private labelling, using your logo or graphics.

Unmatched customer service is provided by our exceptionally experienced workforce featuring on-time delivery and flexibility, allowing scheduling modifications.

Adhering to Copy Exactly! (CE!) processes, our fully trained staff, from engineering to manufacturing, form a dedicated OEM engineering force that supports you over the lifetime of the product.

Scientific Segment - OEM Products and Capabilities:
• Custom master optical diffraction gratings
• Diffraction grating replicas (concave, convex and flat)
• Spectrometers, optical assemblies with pre-aligned sensors (CCD, PDA, CMOS, InGaAs) using either customers’ or HORIBA's OEM electronics
• OES spectrometers
• Spectroscopy systems or modular engines, such as mini fluorometers and mini Raman systems
• Single and double scanning monochromators
• Imaging spectrographs and spectrometers with CCD or CMOS cameras
• Multiproduct spectrometers with multiple fiber inputs / MultiTrack spectroscopy
• Hyperspectral system with HORIBA or customer provided camera (Push-broom configurations)
• Cameras: Spectroscopic deep-cooled scientific cameras (1D and 2D CCD & InGaAs – Fl and Bl)
• OEM electronics for optosensors ranging from PD and PDA to CCD and CMOS sensors
• Imaging cameras: Uncooled and cooled with Fl and Bl high-end scientific CMOS
• VUV/FUV spectrometers and CCD vacuum and N2-purged cameras

Scientific Deep Cooled CCD, InGaAs and CMOS Cameras

<table>
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<tr>
<th>Camera</th>
<th>Description</th>
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<tbody>
<tr>
<td>Syncerity®</td>
<td>Low Cost -50˚C Air-cooled Camera</td>
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<tr>
<td>Synapse® Plus</td>
<td>Deep-cooled -80˚C to -100˚C Air- or Water-cooled Camera</td>
</tr>
<tr>
<td>Synapse® EM</td>
<td>EM CCD Deep-cooled Camera</td>
</tr>
<tr>
<td>VUV Syncerity®</td>
<td>TE-cooled to -50˚C (Vacuum) or -30˚C with N2 purge</td>
</tr>
<tr>
<td>Sylent®</td>
<td>Ultra-compact 4.2 MP monochrome sCMOS sensor</td>
</tr>
<tr>
<td>Synapse® InGaAs</td>
<td>Deep-cooled NIR Camera to -75˚C (Water-cooled)</td>
</tr>
</tbody>
</table>

Contact us in one of our centers of excellence

<table>
<thead>
<tr>
<th>Region</th>
<th>Email</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA &amp; Canada</td>
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</tr>
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<td>+81 (75) 313 8121</td>
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<tr>
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