

CAMERAS

hyperspectral cameras

General Description

Middleton Research offers a complete line of fully-integrated and calibrated hyperspectral cameras for high-speed hyperspectral imaging. Hyperspectral cameras can be used for many industrial and laboratory-based applications. The cameras, manufactured by Specim Ltd., operate with push-broom technology, collecting full spectral ranges of data simultaneously for each pixel on an imaged line. These cameras scan the whole image, line by line. The push-broom technology is a good fit with on-line process control applications where products are continuously moving. As the target moves past the camera, the spectrum of each point is measured and the results data can be either reported line-by-line or assembled into composition maps or images.



The basic building blocks of push-broom hyperspectral camera systems, as seen above, are: filters (such as spectral flattening filters), imaging lenses, spectrographs, order blocking filters and focal plane array (FPA) sensors. Other important components, such as optical mounting plates, shutters, controllers, housing and electronic components are not shown.

“Cameras” in this chapter refer to fully integrated hyperspectral cameras that are pre-aligned and calibrated.*

Modules contained in hyperspectral cameras require significant expertise to properly integrate them into a complete camera unit. Not all FPA cameras can be integrated with spectrographs, even if they are nominally C-mount compatible.

Fully integrated hyperspectral cameras include:

- Factory alignment and calibration of the spectrograph slit position and focus
- Non-uniformity correction at different camera integration times to account for the possible pixel-to-pixel differences of the actual FPA camera component
- Wavelength calibration to achieve the best wavelength accuracy across entire wavelength range
- Compatibility with optional SpectralDAQ™ camera driver and data collection software

Spectral Cameras	Range (nm)	Sensor	Pixels in full frame (spatial x spectral)	Interface	Frame rate (full frame)
UV	200-400	Frame transfer CCD	1000 x 1000	Base CameraLink	33 Hz / 159 Hz
VIS	380-800	Interline CCD	1392 x 1040 / 1600 x 1200	Firewire / Base CameraLink	11 Hz / 33 Hz
VNIR	400-1000	Interline CCD	1392 x 1040 / 1600 x 1200	Firewire / Base CameraLink	11 Hz / 33 Hz
NIR	900-1700	TE-cooled InGaAs photodiode array	320 x 256 / 640 x 512	USB / Base CameraLink	15-350 Hz
SWIR	970-2500	MCT camera	320 x 256	LVDS	100 Hz
LWIR	8-12 μm	LWIR uncooled microbolometer / MCT	384 x 200 / 384 x 48	LVDS	60 Hz / 100 Hz

*Please note that in some literature the focal plane array (FPA) camera modules are also referred to as “cameras”, because they are used on their own as broadband imaging devices in their respective wavelength regions.

Spectral cameras are available in several wavelength ranges, from UV to LWIR and with multiple data interfaces, allowing for the best optimization for specific application requirements. Please see the chart below and the following pages for more details.

Several spectral cameras are offered as either cased or uncased models. The cased, complete cameras are constructed with an exterior housing to protect the sensitive optical components, and thus are better suited for outdoor or process applications. Data cables, power cables, control cables, and lenses are connected to the exterior of the cased camera.



Visible cased camera (HS V8E / V10E)

The uncased camera models are fully functional hyperspectral cameras without the housing. These models are more economical but lack the protection provided by the exterior casing. Uncased models also lack the computer controlled shutter that is included in cased cameras for the purpose of establishing the dark background levels. The shutter can be added to an uncased model as a separate device. In general, uncased models are suitable for Original Equipment Manufacturer (OEM) applications where the camera is part of a larger system, making the exterior housing unnecessary.



Visible uncased camera (HS V8E / V10E)

Several of the spectral cameras are offered as either a standard series camera or enhanced (E-series) camera. The standard series cameras are lower cost models that are equipped with standard imaging spectrographs (models V8 or V10). The E-series cameras are designed for applications that require higher image quality and spectral purity.

Binning

Some of the spectral cameras allow for the binning of the spatial and/or spectral axis of the detector. This allows for higher acquisition rates as well as improved signal to noise. The figure in the glossary demonstrates how binning can increase the frame rate of a typical camera.

Software

Hyperspectral cameras are matched to the optional SpectralDAQ software for camera control and data acquisition. SpectralDAQ saves datacubes in an ENVI-compatible, user-friendly format for further hyperspectral data processing. For more information on software specifications, see the software chapter of this catalog.

Accessories

There are several accessories available to complement the hyperspectral cameras, including:

- Fore objective lenses optimized for each spectral range
- Fiber optics that are used to create a multiple-point spectrometer
- Mirror scanners or rotating stages for stationary targets or scenes
- Moving sample stages for microscopes and other laboratory applications

Three different sizes of rugged transport cases can be provided with the cameras for shipping and portability. These cases are optional but recommended to protect the cameras.