VISIBLE 380 – 800 nm
HYPERSPECTRAL CAMERAS

Middleton Research offers several hyperspectral cameras in the visible wavelength range from 380 – 800 nm (HS, PS, and PFD Series) from Specim Ltd.

The HS Series hyperspectral cameras are designed for visible applications that require a high throughput, high spatial and spectral resolutions and the best imaging optics. The camera consists of an imaging spectrograph (ImSpector V8E), a monochrome camera (sensitive high speed interline CCD sensor), and a base CameraLink interface. With its solid structure and exceptional performance, the HS hyperspectral camera is suited for industry, laboratory and field applications.

The Visible cased camera package includes: control unit, power supply, USB cable, Firewire cable (Firewire camera only), National Instruments CameraLink frame grabber and data cable (CameraLink cameras only), control cable, power cord set, and software CD.

Cased Camera Specifications

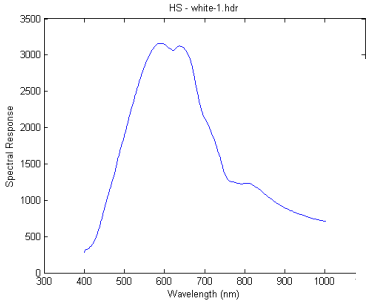
Optical Characteristics	**HS-CL-30-V8E**	**PS-FW-11-V8E**	**PFD-CL-65-V8E**
Range (nm)	380-800	380-800	380-800
Resolution (spatial x spectral)	1600 x 1200 (840 active)	1392 x 1040 (870 active)	1312 x 1024
Spectrograph	ImSpector V8E	ImSpector V8E	ImSpector V8E
Spectral Resolution	2 nm (30 µm slit)	6 nm (30 µm slit)	2 nm (30 µm slit)
Spectral Sampling	0.55 - 4.4 nm/pixel	0.48 - 3.86 nm/pixel	0.59 - 4.75 nm/pixel
Spatial Resolution	RMS spot diameter < 9 µm	RMS spot diameter < 18 µm	RMS spot diameter < 9 µm
Aberrations	Insignificant astigmatism, keystone or smile (for all)		
Numerical Aperture	F/2.4	F/2.4	F/2.4
Slit Width, default	30 µm (18, 50, 80, 150 µm)	30 µm (18, 50, 80, 150 µm)	30 µm (18, 50, 80, 150 µm)
Effective Slit Length	11.84 mm	8.98 mm	10.50 mm
Total Efficiency (typical)	> 50%, independent of polarization (for all)		
Stray Light	< 0.5% (halogen lamp, 590 nm low-pass filter) for all		
Electrical Characteristics			
Sensor	Interline CCD	Interline CCD	CMOS
Interface	Base CameraLink	Firewire	Base CameraLink
Camera Output	Digital 12-bit	Digital 12-bit	Digital 12-bit
Frame rate (full / binning)	33 Hz / 120 Hz	11 Hz / 62 Hz (1 x 8 binning)	65 Hz / (180 Hz w/binning)
Cooling	N/A	N/A	N/A
Frame Grabber	NI-PCI 1428*	N/A	NI-1429
Pixel Size	7.4 µm x 7.4 µm	6.45 µm x 6.45 µm	
Camera Control	Base CameraLink	Firewire	CameraLink
Exposure Time Range	0.1 - 100 ms	1 µm - 120 s	0.1 - 100 ms
Power Consumption	< 5 W	< 5W	< 5W
Input Voltage	24 V	24 V	24 V
Environmental Characteristics			
Storage	-20 to 50 C	-20 to 50 C	-20 to 50 C
Operating	5 to 40 C non-condensing	5 to 40 C non-condensing	5 to 40 C non-condensing
Mechanical Characteristics			
Size (LxWxH)	330 x 85 x 90 mm	330 x 85 x 90 mm	330 x 85 x 90 mm
Weight	5.0 kg	5.0 kg	2.7 kg
Body	Anodized Al w/mounting screw holes (for all)		
Lens Mount	Standard C-mount	Standard C-mount	Standard C-mount
User Adjustments	None	None	None
Shutter	Yes, w/USB control	Yes, w/USB control	Yes, w/USB control

The PS Series hyperspectral cameras provide high spatial and spectral resolution, low noise, and a rugged structure for visible applications in the laboratory or the field. Each camera is an integration of an imaging spectrograph and a monochrome area camera (sensitive high speed interline CCD sensor) and includes a Firewire interface.

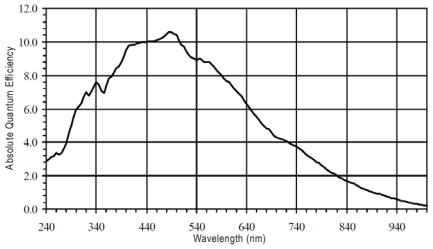
The PFD Series is a new family of visible and VNIR hyperspectral cameras that are based on a CMOS sensor and include a CameraLink interface.

Applications

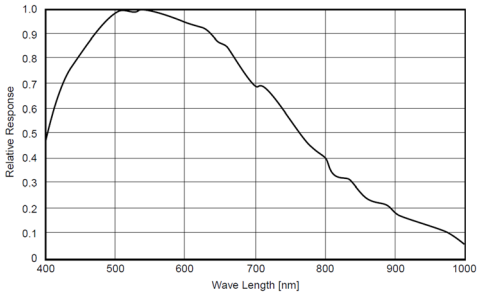
- Color control and sorting of textiles, cosmetics, and other manufactured products
- Forensics
- Scanning of art works
- Flat panel display measurement
- Color print testing
- Counterfeit detection
- Fruit and vegetable inspection and sorting
- Life science applications including fluorescence monitoring
- Plant and vegetation research
- Environmental monitoring
- Hyperspectral microscopy



Spectral response of HS camera with spectral flattening filter

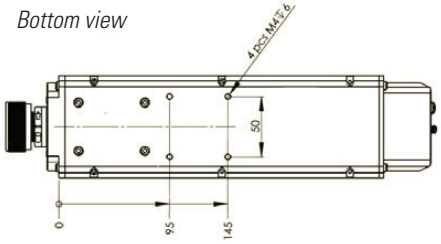


Spectral response of HS camera without flattening filter

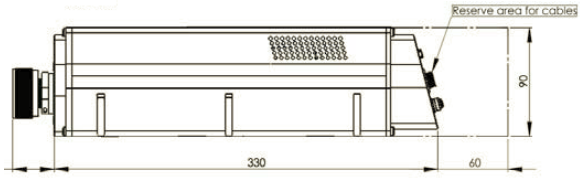


Spectral response of PS camera without flattening filter

Bottom view

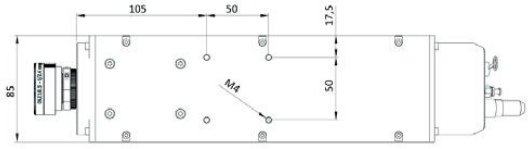


Side view

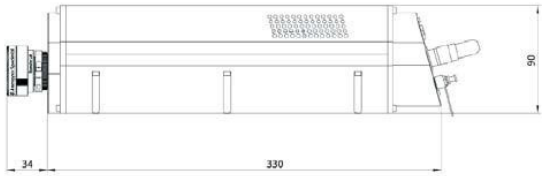


PS V8E and HS V8E Cased cameras

Bottom view



Side view



PFD V8E Cased cameras

Visible Cased Cameras Ordering Information		
Part Number	**Description**	**Product Name**
MRC-303-001-01	Visible Spectral Camera with Enhanced Spectrograph. 11 fps, 1392x1040 IT CCD, Firewire, cables included	PS-FW-11-V8E
MRC-303-001-02	Visible Spectral Camera with Enhanced Spectrograph. 30 fps, 1600x1200 IT CCD, Cameralink frame grabber + cables	HS-CL-30-V8E
MRC-303-001-05	Visible Spectral Camera with Enhanced Spectrograph. 65 fps, 1312x1024 CMOS, CameraLink frame grabber + cables	PFD-CL-65-V8E

VISIBLE 380 – 800 nm, continued
HYPERSPECTRAL CAMERAS

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 complete cameras for the purpose of establishing the dark background levels. The user may choose a camera with a lower-cost Standard Series spectrograph (ImSpector V8), or an Enhanced Series spectrograph (ImSpector V8E), the latter providing higher quality images and enhanced spectral fidelity.

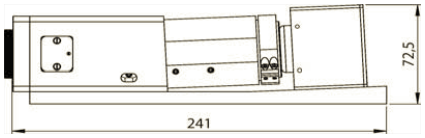
The Visible uncased camera package includes: power supply (CameraLink cameras only), Firewire cable (Firewire cameras only), National Instruments CameraLink frame grabber and data cable (CameraLink cameras only), power cord set, and software CD.

Uncased Camera Specifications

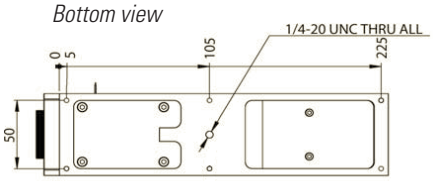
Optical Characteristis	PS-FW-11-V8-OEM	PS-FW-11-V8E-OEM	HS-CL-30-V8E-OEM	PFD-CL-65-V8E-OEM
Range (nm)	380-800	380-800	380-800	380-800
Resolution (spatial x spectral)	1392 x 1040 (990 active)	1392 x 1040 (870 active)	1600 x 1200 (840 active)	1312 x 1024
Spectrograph	ImSpector V8	ImSpector V8E	ImSpector V8E	ImSpector V8E
Spectral Resolution	6 nm (30 µm slit)	2 nm (30 µm slit)	2 nm (30 µm slit)	2 nm (30 µm slit)
Spectral Sampling	0.43 - 3.4 nm/pixel	0.48 - 3.86 nm/pixel	0.55 - 4.4 nm/pixel	0.59 - 4.75 nm/pixel
Spatial Resolution	RMS spot diam. < 60 µm	RMS spot diam. < 18 µm	RMS spot diam. < 9 µm	RMS spot diam. < 9 µm
Aberrations	Smile < 45 µm, keystone < 40 µm	Insignificant astigmatism, keystone or smile	Insignificant astigmatism, keystone or smile	Insignificant astigmatism, keystone or smile
Numerical Aperture	F/2.8	F/2.4	F/2.4	F/2.4
Slit Width, default	50 µm (25, 80, 150 µm)	30 µm (18, 50, 80, 150 µm)	30 µm (18, 50, 80, 150 µm)	30 µm (18, 50, 80, 150 µm)
Effective Slit Length	8.98 mm	8.98 mm	11.84 mm	10.50 mm
Total Efficiency (typical)	> 50%, independent of polarization	> 50%, independent of polarization	> 50%, independent of polarization	> 50%, independent of polarization
Stray Light	< 0.5% (halogen lamp, 590 nm low-pass filter)	< 0.5% (halogen lamp, 590 nm low-pass filter)	< 0.5% (halogen lamp, 590 nm low-pass filter)	< 0.5% (halogen lamp, 590 nm low-pass filter)
Electrical Characteristics				
Sensor	Interline CCD	Interline CCD	Interline CCD	CMOS
Interface	Firewire	Firewire	Base CameraLink	Base CameraLink
Camera Output	Digital 12-bit	Digital 12-bit	Digital 12-bit	Digital 12-bit
Frame rate (full / binning)	11 Hz / 62 Hz (1 x 8 binning)	11 Hz / 62 Hz (1 x 8 binning)	33 Hz / 120 Hz	65 Hz / (180 Hz w/binning)
Cooling	N/A	N/A	N/A	N/A
Frame Grabber	N/A	N/A	NI-PCI 1428*	NI-1429
Pixel Size	6.45 µm x 6.45 µm	6.45 µm x 6.45 µm	7.4 µm x 7.4 µm	
Camera Control	Firewire	Firewire	Base CameraLink	CameraLink
Exposure Time Range	1 µm - 120 s	1 µm - 120 s	0.1 - 100 ms	0.1 - 100 ms
Power Consumption	< 5W	< 5W	< 5 W	< 5 W
Input Voltage	12 V	12 V	12 V	12 V
Environmental Characteristics				
Storage	-20 to 50 C	-20 to 50 C	-20 to 50 C	-20 to 50 C
Operating	5 to 40 C non-condensing	5 to 40 C non-condensing	5 to 40 C non-condensing	5 to 40 C non-condensing
Mechanical Characteristics				
Size (LxWxH)	220 x 60 x 70	241 x 73 x 79 mm	260 x 70 x 79 mm	231 x 80.5 x 78 mm
Weight	1.8 kg	1.8 kg	1.8 kg	1.8 kg
Body	Anodized Al w/mounting screw holes	Anodized Al w/mounting screw holes	Anodized Al w/mounting screw holes	Anodized Al w/mounting screw holes
Lens Mount	Standard C-mount	Standard C-mount	Standard C-mount	Standard C-mount
User Adjustments	None	None	None	None
Shutter	No	Optional	Optional	Optional

PS V8E OEM

Side view

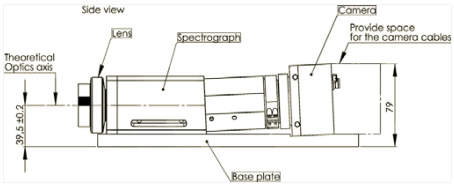


Bottom view

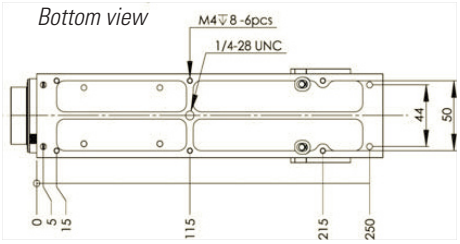


HS V8E OEM

Side view

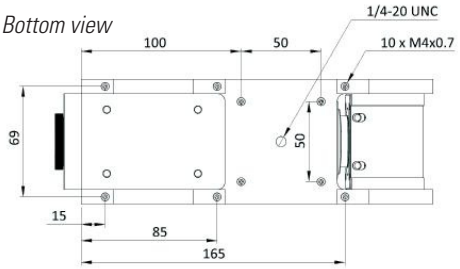


Bottom view

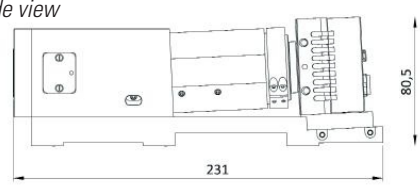


PFD V8E OEM

Bottom view



Side view



PS V8 OEM

Visible Uncased Cameras Ordering Information		
Part Number	**Description**	**Product Name**
MRC-301-001-01	OEM Visible Spectral Camera, with Standard Spectrograph. 11 fps, 1392x1040 IT CCD, Firewire, cables included.	PS-FW-11-V8-OEM
MRC-302-001-01	OEM Visible Spectral Camera, with Enhanced Spectrograph. 11 fps, 1392x1040 IT CCD, Firewire, cables included	PS-FW-11-V8E-OEM
MRC-302-001-03	OEM Visible Spectral Camera, with Enhanced Spectrograph. 30 fps, 1600x1200 IT CCD, CameraLink frame grabber + cables	HS-CL-30-V8E-OEM
MRC-302-001-06	OEM Visible Spectral Camera, with Enhanced Spectrograph. 65 fps, 1312x1024 CMOS, CameraLink frame grabber + cables	PFD-CL-65-V8E-OEM