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1. Description

The MSC2 8-band near infrared multispectral camera incorporates a high performance 4MP CMOS sensor that is modified with Spectral Devices proprietary multispectral filter array technology. This miniature multispectral snapshot camera simultaneously captures images at 8 distinct bands at 89 frames per second in full frame mode. There is no requirement for additional filters, filter wheels, or tunable filters. The spectral information in the 8 bands is captured simultaneously by the multispectral sensor. The camera offers 8 bands of spectral discrimination spaced between 700 nm and 1000 nm. The camera is USB3 Vision-compliant with many pre-built software options such as 2ndlook graphical camera software. Programmers can build camera applications in Windows and Linux using the included SDKs. Power is supplied through the USB3 interface. The MSC2-NIR-1-A is ultra-compact, ultra-light, and designed for demanding near infrared imaging applications.

2. Key Features

- Snapshot Operation (capture spectral images simultaneously)
- Captures 8 Bands (720, 760, 800, 840, 860, 900, 940, 980 nm)
- Anti-X-Talk™ Technology (enhances contrast and spectral performance)
- High Frame Rate (up to 89 FPS at full frame)
- High Performance (4MP Global Shutter CMOS Sensor)
- USB3 Vision & GenICam Compliant
- Ultracompact (28 mm x 28 mm x 47 mm)
- Ultralight (< 55 g)
- Low Power Requirement (< 4W from USB cable)
- Multiple M2 and M4 Mounting Points
- SDK for Windows and Linux included

3. Applications

The camera is suitable for applications such as remote sensing for agriculture and geological surveys, close examination of artwork, biomedical imaging, robotics, and automation. Combined with Spectral Devices SBC-1 miniature vision computer, the MSC2-NIR8-1-A offers an easy-to-use lightweight and modular imaging solution for UAV users.
4. **Spectral Characteristics**

Spectral response of the filter set and sensor

![Spectral Characteristics Graph](image)

5. **Anti-X-Talk™ Technology**

Unique to Spectral Devices is an on-chip technology we refer to as Anti-X-Talk™ technology. Anti-X-Talk™ technology works at the filter level and prevents light leakage between individual filters. Without Anti-X-Talk™ technology, stray light between spectral channels is significant, often exceeding the light leakage due to spectral overlap between adjacent filters. Without Anti-X-Talk™ technology, images suffer from low contrast and spectral ambiguity. Spectral Devices invented Anti-X-Talk™ technology to overcome these problems. It works by blocking stray light between adjacent filters, so the pixel response is predictable and directly related to the actual spectral response of the overlying pixelated filter. The result is multispectral images with better spectral discrimination and higher contrast. Furthermore, high quality image data from the MSC2-NIR-1-A can be used as is without the need for proprietary post-processing algorithms and the camera can be used with a wide range of lens types, even at large apertures (e.g., f/2).
6. Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lens Mount</td>
<td>C-mount</td>
</tr>
<tr>
<td>Sensor Type</td>
<td>CMOS</td>
</tr>
<tr>
<td>Sensor Model</td>
<td>AMS CMV4000</td>
</tr>
<tr>
<td>Sensor Format</td>
<td>1-inch</td>
</tr>
<tr>
<td>Number of Spectral Channels</td>
<td>8</td>
</tr>
<tr>
<td>Image Pixels Per Spectral Channel</td>
<td>256 x 256 (512 x 512 after debayering)</td>
</tr>
<tr>
<td>Effective Pixel Size (H x V)</td>
<td>16.5 µm x 5.5 µm</td>
</tr>
<tr>
<td>Capture Method</td>
<td>Area</td>
</tr>
<tr>
<td>Spectral Channels</td>
<td>720, 760, 800, 840, 860, 900, 940, 980 nm</td>
</tr>
<tr>
<td>Spectral Bandwidth (FWHM)</td>
<td>20 nm</td>
</tr>
<tr>
<td>On-chip Spectral Enhancement</td>
<td>Anti-X-Talk™ Technology</td>
</tr>
<tr>
<td>Shutter Type</td>
<td>Global</td>
</tr>
<tr>
<td>Sync System</td>
<td>External trigger (Hardware, Software) / Free run</td>
</tr>
</tbody>
</table>
| Maximum Frame Rate (at Full Frame)     | 8bits output 89 fps  
10bits output 45 fps  
12bits output 37 fps |
| ADC bit width                          | 10bits / 12bits |
| Video Format                           | 8bits / 10bits / 12bits output  
(Support packed on 10bits / 12bits) |
| Noise Level                            | 8bits output: <3 digits (Gain 0 dB)  
10bits output: <12 digits (Gain 0 dB)  
12bits output: <48 digits (Gain 0 dB) |
| Sensitivity (*1)                       | 210 Lux |
| Exposure time                          | 22 µs to 16.77 seconds  
(Default: 11,116.0 µs) |
| Digital Gain                           | 0 to 13.9 dB (Default: 0 dB) |
| Black Level                            | 8bits output: 0 to 15 digits  
10bits output: 0 to 63 digits  
12bits output: 0 to 255 digits |
| ROI                                    | Horizontal: 32 to 2,048 pixels  
Vertical: 32 to 2,048 lines  
(Default: 2,048 x 2,048)  
Adjustable Steps for size: 16 pixels in horizontal direction / 4 lines in vertical direction  
Adjustable Steps for offset: 2 pixels in horizontal direction / 2 lines in vertical direction |
| Multi ROIs (*2)                        | 8 regions (Default: 1 region) |
| Binning                                | Turned off for multispectral readout |
| Decimation                             | Turned off for multispectral readout |
| HDR                                    | Turned off for multispectral readout |
| Image Flip                             | Horizontal / Vertical / Horizontal and Vertical / Off |
| Defective Pixel Correction             | Turned off for multispectral readout |
| Auto Exposure                          | Supported |
### Operational Mode
- Edge preset Trigger / Pulse width Trigger / Start Stop Trigger / Free run

### User Setting Storage
- Supported

### Communication
- Through USB3.0 bus

### Interface
- USB3.0 Super speed (USB3.0 micro B)

### Protocol
- USB3 Vision® 1.0.1, GenICam Standard Version (SFNC 2.2, PFNC 2.0) compliant

### Input / Output
- Three GPIOs, One Camera Hardware Reset

### Power Input Voltage
- +5V (typ.) (This conforms to USB standard)

### Power Consumption
- Less than 4.0 W

### Case Construction
- Anodized Aluminum

### Mounting Holes
- 4 x M4 (bottom), 2 x M4 (top), 3 x M2 (4 sides)

### Overall Size
- 28 mm x 28 mm x 47 mm (W x H x L)

### Weight
- < 55 g

### Operational Temperature / Humidity
- Minimum Environmental Temperature: 0 deg. C, Environmental Humidity: 0 to 85 %RH (No condensation)
- Maximum Camera housing temperature (top plate) shall not exceed 55 deg. C

### Storage Temperature / Humidity
- Environmental Temperature: -30 to +65 deg. C
- Environmental Humidity: 0 to 85 %RH (No condensation)

### Vibration
- 20 Hz to 200 Hz to 20 Hz (5 min. / cycle), acceleration 10 G, XYZ 3 directions 30 min. each

### Shock Acceleration
- 38 G, half amplitude 6 ms, XYZ 3 directions 3 times each

### Standard Compliancy
- EMS: EN61000-6-2, EMI: EN55011

### RoHS
- RoHS Compliant

(*) The sensitivity was measured as the luminance when white level achieved 100 % using the settings and conditions below with no multispectral filter array.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain Up</td>
<td>0 dB</td>
</tr>
<tr>
<td>AGC</td>
<td>Off</td>
</tr>
<tr>
<td>White Balance</td>
<td>Optimum</td>
</tr>
<tr>
<td>Electrical Shutter</td>
<td>1/100 seconds</td>
</tr>
<tr>
<td>Black Level</td>
<td>Optimum</td>
</tr>
<tr>
<td>Gamma</td>
<td>Factory Setting</td>
</tr>
</tbody>
</table>

(**) The multiple ROI regions cannot set on the same horizontal line.
7. Mechanical Drawings

8. External Connector Specifications

<table>
<thead>
<tr>
<th>External Connectors</th>
<th>USB 3.0 MicroB type, I/O signals: HR10A-7R-6PR (Hi-rose) or equivalent</th>
</tr>
</thead>
</table>

- This connector is for the output signal, not for the power of the camera. The camera power is supplied in +5V from the USB cable.
- It does not affect the voltage for the input signal.

Pin Assignment:

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Signal Name</th>
<th>I/O</th>
<th>Signal Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND for I/O signal</td>
<td>-</td>
<td>0V</td>
</tr>
<tr>
<td>2</td>
<td>Output 2(IO3)</td>
<td>OUT</td>
<td>0.8V or lower, +3.3 to +24V</td>
</tr>
<tr>
<td>3</td>
<td>Output 1(IO2)</td>
<td>OUT</td>
<td>0.8V or lower, +3.3 to +24V</td>
</tr>
<tr>
<td>4</td>
<td>Input 5(IO1)</td>
<td>IN</td>
<td>0.7V or lower, +2.5 to +5V</td>
</tr>
<tr>
<td>5</td>
<td>Input 1(IO2)</td>
<td>IN</td>
<td>0.7V or lower, +2.5 to +5V</td>
</tr>
<tr>
<td>6</td>
<td>Power supply for output signal (IO_VCC)</td>
<td>-</td>
<td>+3.3 to +24Vto</td>
</tr>
</tbody>
</table>

*Please see HR10A-7R-6PR (Hi-rose) or equivalent for the cable.
9. SDKs

Included with the MSC2-NIR8-1-A is an industrial-grade SDK for camera control and image capture. The SDK is compatible with variety of Windows, Linux and MacOS operating systems. It includes drivers, libraries, documentation, and samples. Environments such as Python and OpenCV are also supported.

<table>
<thead>
<tr>
<th>Operating System</th>
<th>Development Environments</th>
<th>SDK Includes</th>
</tr>
</thead>
</table>
| Windows 10 (32bit / 64bit)  
Windows 8.1 (32bit / 64bit)  
Windows 7 SP1 (32bit / 64bit) | Visual Studio 6  
Visual Studio 2003  
Visual Studio 2005  
Visual Studio 2008  
Visual Studio 2010  
Visual Studio 2012  
Visual Studio 2013  
Visual Studio 2015  
MinGW (Minimalist GNU for Windows)  
embarcadero Free C++ Compiler  
Python 3.6.x  
Python 3.7.x | Windows driver  
Windows SDK  
StApi (Visual C++, .net Framework 2.0, C)  
StGenTL module  
Viewing Software (StViewer)  
Sample Programs (Visual C++, Visual C#, Visual Basic, C)  
DirectShow Filter  
Documentation |
| Ubuntu 18.04 (64bit)  
Ubuntu 18.04 (ARM 64bit)  
Raspberry Pi OS (32bit) | Python 3.6.x  
Python 3.7.x | StApi (C++, C)  
StGenTL module  
Viewing Software (StViewer)  
Sample Programs (C++, C)  
Documentation |
| MacOSX Sierra  
MacOSX High Sierra  
MacOSX Catalina | Python 3.6.x  
Python 3.7.x | StApi (C++)  
StGenTL module  
Viewing Software (StViewer)  
Sample Programs  
Documentation |

10. Windows Software (optional)

2ndLook is a complete image acquisition software package that enables users to connect and acquire images from one or more multispectral cameras on a single PC. Offers real-time synchronized video recording from GenICam-compliant USB3 Vision, GigE Vision, and DirectShow cameras (Figure 10.1). Easily record directly to popular file formats such as AVI and TIFF. Record from multiple cameras to different file formats concurrently. Multispectral imaging conversion filters for Spectral Devices cameras are built in (Figure 10.2). View montage of spectral images in real-time (Figure 10.3). Easy to use interface with interactive help and user guides. Demo version provides all features, except save to disk function.
Figure 10.1. Real-time display of raw multispectral images.

Figure 10.2. Multispectral conversion filters
Figure 10.3. Real-time display of multispectral images in montage format. Example here collected with 4-band multispectral camera for agriculture.