

Megapixel USB2.0 CMOS  
**CAMERA**

# Data Sheet

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SMX-160 Series USB2.0 Cameras

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SMX-160 Series USB2.0 Cameras Data Sheet

Revision 3.0

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4005 Avenida de la Plata, Suite 201

Oceanside, CA, 92056

Tel.: (877)233-3385; Fax: (508) 300 5526

Email: [camera@sumix.com](mailto:camera@sumix.com)

[www.sumix.com](http://www.sumix.com)

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## Introduction

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**SMX-160 USB2.0 Camera** is a 6.6 megapixel USB2.0 camera designed for applications where high resolution quality images are critical.

The SMX-160 USB2.0 Camera is available in two modifications:

- SMX-160M - monochrome
- SMX-160C - color

The camera has a 1" optical format sensor and features frame rate of 6 fps (48 MHz) at 2208 x 3000 resolution.

Capturing of initial live streaming video images and still images is provided via USB 2.0 digital interface - no additional frame grabber is needed.

The camera is provided with the Software Package, all needed drivers and API library, which allows quick integrating of the camera functions into user's applications.

## Key Features

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- 2208 x 3000 active imaging pixels
- Speed: 6 fps at 2208 x 3000 (48 MHz)
- Low image noise
- Electronic Rolling shutter
- Small size
- USB2.0 interface
- Cost effectiveness
- C-Mount
- No external power supply
- Selectable pixel data: 8 bit or 10 bit
- Complete SDK

## Specifications

**Table 1-1** Camera Specification

<b>Output video and camera control characteristics</b>		
	<b>SMX-160M</b>	<b>SMX-160C</b>
Maximum resolutions of output window	2208x 3000, full resolution mode 1104 x 1500, decimated by 2 mode	2208x 3000, full resolution mode 1104 x 1500, decimated by 2 mode
Frame rate at resolution (48MHz)*	6 fps at 2208 x 3000 (full resolution) 31 fps at 1280 x 1024 24 fps at 1104 x 1500 52 fps at 1024 x 768 91 fps at 768 x 576 126 fps at 640 x 480 219 fps at 400 x 400 426 fps at 320 x 240 494 fps at 220 x 220	6 fps at 2208 x 3000 (full resolution) 31 fps at 1280 x 1024 24 fps at 1104 x 1500 52 fps at 1024 x 768 91 fps at 768 x 576 126 fps at 640 x 480 219 fps at 400 x 400 426 fps at 320 x 240 494 fps at 220 x 220
Output bits per pixel	Selectable, 8 bits or 10 bits	Selectable, 8 bits or 10 bits
Lookup table	Downloadable for user selected 8 bits mode: converts 10 bits of imaging chip's ADC to 8 bits of output	Downloadable for user selected 8 bits mode: converts 10 bits of imaging chip's ADC to 8 bits of output
Pixel rates	3.33 MHz, 6.66 MHz, 8 MHz, 10 MHz, 12 MHz, 13.33 MHz, 16 MHz, 20 MHz, 24 MHz, 32 MHz, 40 MHz, 48 MHz	3.33 MHz, 6.66 MHz, 8 MHz, 10 MHz, 12 MHz, 13.33 MHz, 16 MHz, 20 MHz, 24 MHz, 32 MHz, 40 MHz, 48 MHz
Exposure range (at 2208 x 3000 resolution), ms	min: 0.93 (at 48 MHz) max: 2497.57 (at 3.33 MHz)	min: 0.93 (at 48 MHz) max: 2497.57 (at 3.33 MHz)
Pixel gain control	Programmable (hardware), 17 gain levels from 0 to 17.38	Programmable (hardware), 17 gain levels from 0 to 17.38 Separate software gain controls for R, G, B: 17 gain levels from 0.01 to 2 with step 0.01
Output window modes	View port (from 2208 x 3000 to 8 x 8 with 8 pixels/1 line step positioning) Frame Decimation (1:1, 1:2, 1:3, 1:4, 1:6) Horizontal mirroring Vertical flipping	View port (from 2208 x 3000 to 8 x 8 with 8 pixels/1 line step positioning) Frame Decimation (1:1, 1:2, 1:3, 1:4, 1:6) Horizontal mirroring Vertical flipping
Gamma, brightness and contrast control	Programmable with lookup table, hardware gamma correction	Programmable with lookup table, hardware gamma correction

**Table 1-1** Camera Specification

\* Listed frame rate values at the defined resolutions are not the maximal possible. Increasing of frame rate can be done by reducing the current Exposure value (the lower Exposure, the higher frame rate), hiding the active video window from the display, running the camera with a fast speed computer, etc.

### Imaging chip characteristics

Type	Monochrome 6.6 megapixel CMOS 1" sensor Manufactured by Cypress (FillFactory)	Color 6.6 megapixel CMOS 1" sensor Manufactured by Cypress (FillFactory)
Pixel size	3.5 $\mu\text{m}$ x 3.5 $\mu\text{m}$	3.5 $\mu\text{m}$ x 3.5 $\mu\text{m}$
Image array size	7.74 mm x 10.51 mm	7.74 mm x 10.51 mm
Shutter type	Electronic Rolling Shutter	Electronic Rolling Shutter
Scanning mode	Progressive	Progressive
ADC resolution	10 bits	10 bits
Pixel architecture	3-T pixel	3-T pixel
Sensitivity (peak) @ 650 nm (85 lux = 1 W/m <sup>2</sup> )	411 V.m <sup>2</sup> /W.s, 4.83 V/lux.s	411 V.m <sup>2</sup> /W.s, 4.83 V/lux.s
Sensitivity (visible) 400-700 nm (163 lux = 1 W/m <sup>2</sup> )	328 V.m <sup>2</sup> /W.s, 2.01 V/lux.s	328 V.m <sup>2</sup> /W.s, 2.01 V/lux.s
Dynamic range	1100:1 Full: 61 dB 940:1 Linear: 59.5 dB	1100:1 Full: 61 dB 940:1 Linear: 59.5 dB

### Camera electrical characteristics

Supply voltage	5 V supplied by USB2.0 interface	5 V supplied by USB2.0 interface
Supply current	360 mA (at 5.0 V)	360 mA (at 5.0 V)
Maximum power consumption	2.28 W	2.28 W

### Camera interface characteristics

Interface Type	USB2.0, 480 Mbps	USB2.0, 480 Mbps
Connector Type	USB mini-B, 5 pin	USB mini-B, 5 pin

### System requirements

Operating System	Windows XP SP1+/2003/Vista/2008/7 recommended: Windows 7 or XP 1+	Windows XP SP1+/2003/Vista/2008/7 recommended: Windows 7 or XP 1+
Processor	Intel P4 or higher recommended: Intel Core 2 Duo	Intel P4 or higher recommended: Intel Core 2 Duo

**Table 1-1** Camera Specification

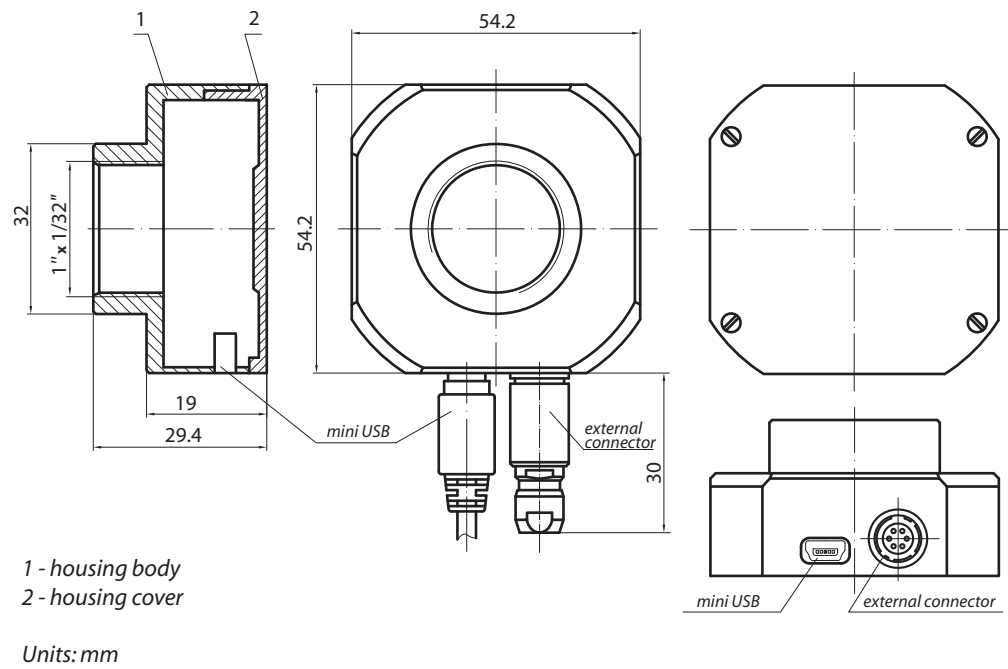
RAM	256 MB for XP (512 MB for 2008/Vista) recommended: 512 MB (1024 MB for W7)	256 MB for XP (512 MB for 2008/Vista) recommended: 512 MB (1024 MB for W7)
Performance	minimum: 300 Mflops recommended: 400 Mflops or higher	minimum: 300 Mflops recommended: 400 Mflops or higher
Hard Disk Space	About 15 MB for installation plus additional space for captured images	About 15 MB for installation plus additional space for captured images
Video	8 MB memory, recommended GeForce 4xxx/Radeon 9xxx or higher	8 MB memory, recommended GeForce 4xxx/Radeon 9xxx or higher
Hardware Interface	USB 2.0 Host Controller: recommended Intel integrated Host Controller (VIA-based USB Controller not recommended) USB 3.0 Host Controller is also supported at least one USB 2.0 port for connection	USB 2.0 Host Controller: recommended Intel integrated Host Controller (VIA-based USB Controller not recommended) USB 3.0 Host Controller is also supported at least one USB 2.0 port for connection

**Camera physical characteristics**

Operating temperature	0 to +50°C	0 to +50°C
Lens mount type	C-mount	C-mount
Weight (without lens)	108 g	108 g
Dimensions (W x L x H)	54.2 x 54.2 x 32.6 mm	54.2 x 54.2 x 32.6 mm
Camera housing material	Duralumin	Duralumin



## Camera Mechanicals



**Figure 1-1** Camera drawing

1- case body

2- case cover

Units: mm



**Figure 1-2** SMX-160 series camera outlook

## General Sensor Specifications

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### Overview

The **SMX-160 Series USB2.0 Cameras** use the IBIS4-6600 sensor - a solid state CMOS image sensor manufactured by Cypress (FillFactory). The image sensor comprises a 6.6 MPixel resolution with 2208 x 3000 active pixels. The sensor is available in monochrome version or Bayer (RGB) patterned color filter array.

The programmable gain and offset amplifier maps the signal swing to the ADC input range. A 10-bit ADC converts the analog data to a 10-bit digital word stream.

The IBIS4-6600 is designed taking into consideration interfacing requirements to standard video encoders. In addition to the 10-bit pixel data stream, the sensor outputs the valid frame, line and pixel sync signals needed for encoding.

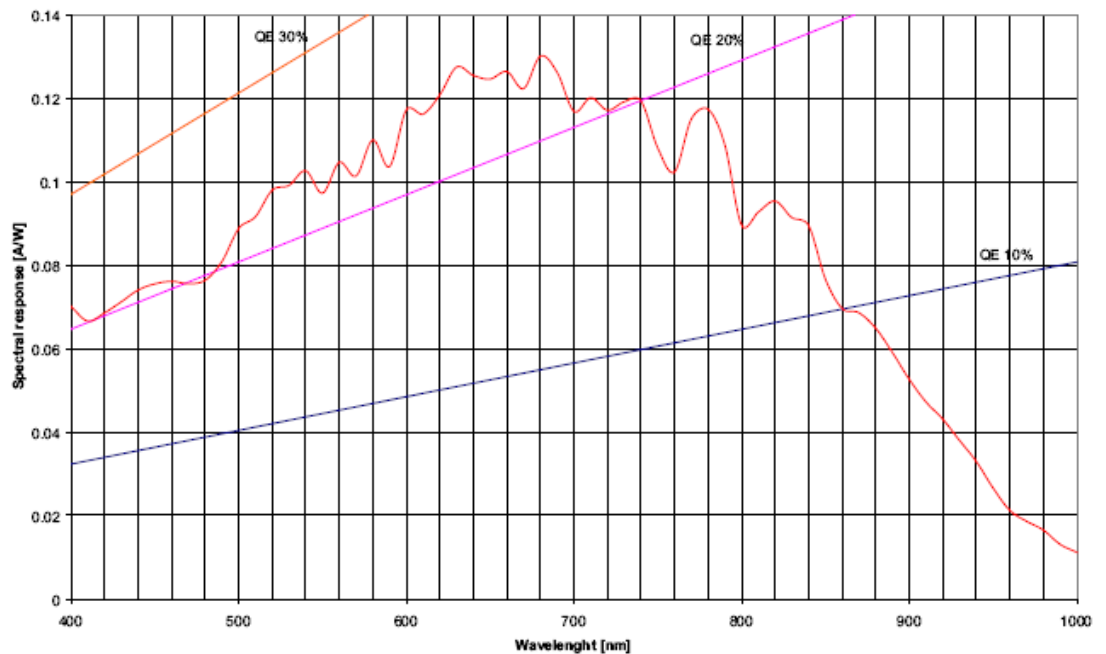
The IBIS4-6600 sensor features:

- 3.5  $\mu\text{m}$  pitch square pixels (based on the high-fill factor active pixel sensor technology of FillFactory (the U.S. patent No. 6,225,670 and others)
- A 10-bit ADC converts the analog data to a 10-bit digital word stream
- High pixel rate of 40 MHz using a 40 MHz system clock
- 10-bit digital output
- 59 dB dynamic range (895:1, measured at digital output (in the dark)
- Electronic Rolling Shutter
- Pixel addressability to support Randomly programmable Region-of-Interest windowing and sub sampling

- Programmable gain and offset amplifier

### Spectral response curve

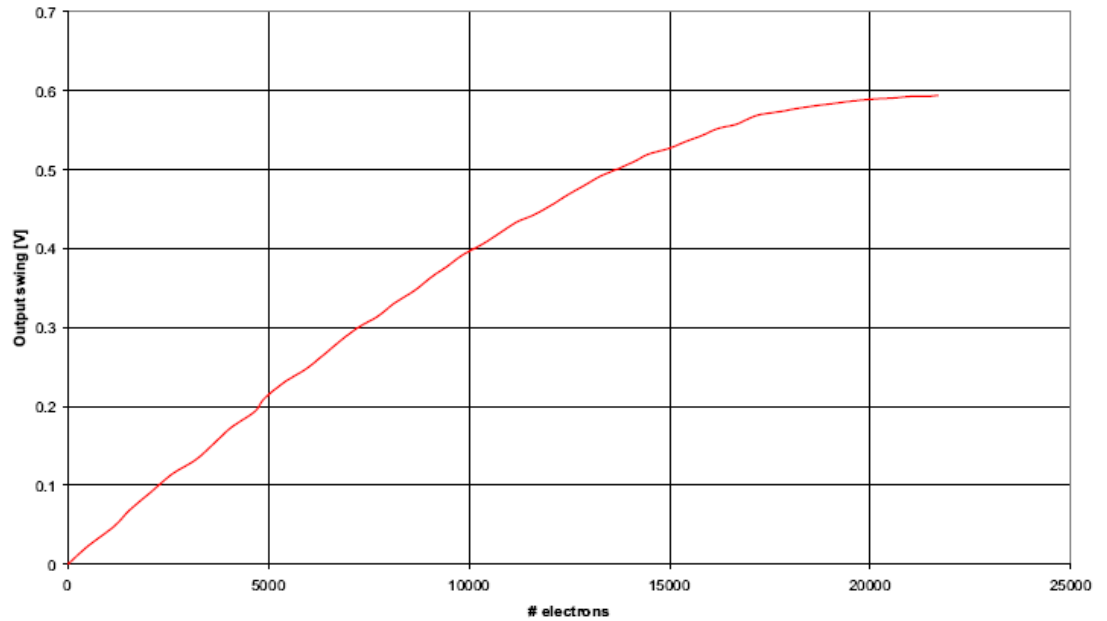
Spectral Response Curve on [Figure 1-3](#) shows the spectral response characteristic. The curve is measured directly on the pixels. It includes effects of non-sensitive areas in the pixel, e.g., interconnection lines. The sensor is light sensitive between 400 and 1000 nm. The peak QE \* FF is 25% approximately around 650 nm. In view of a fill factor of 35%, the QE is thus close to 70% between 500 and 700 nm.



**Figure 1-3** *Spectral response curve*

### Electro-voltaic response curve

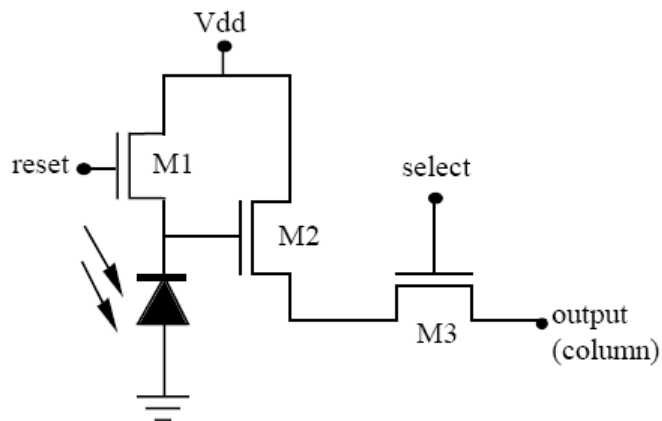
Electro-voltaic Response Curve on [Figure 1-4](#) shows the pixel response curve in linear response mode. This curve is the relation between the electrons detected in the pixel and the output signal. The resulting voltage-electron curve is independent of any parameters (integration time, etc). The voltage to electrons conversion gain is 43  $\mu\text{V}/\text{electron}$ .



**Figure 1-4** *Electro-voltaic response curve*

### Pixel architecture

The pixel architecture is the classical three-transistor pixel ([Figure 1-5](#)). The pixel has been implemented using the high fill factor technique as patented by FillFactory (the U.S. patent No. 6,225,670 and others).

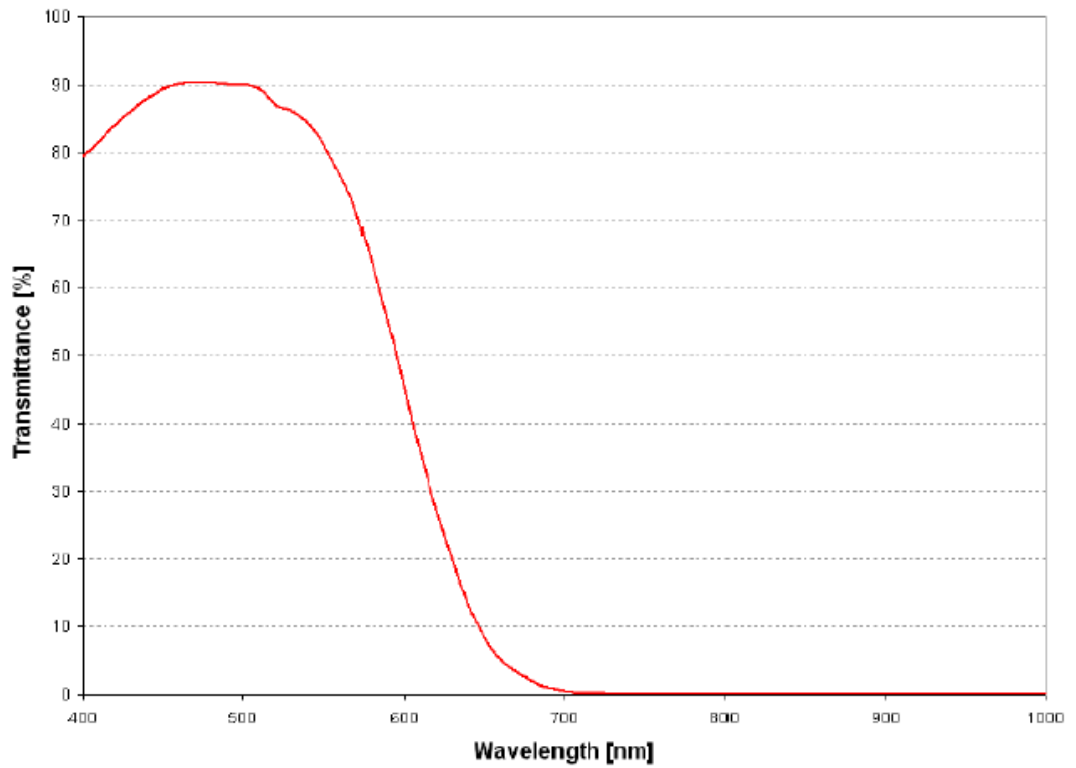


**Figure 1-5** *Architecture of the 3T-pixel*

## Glass lid

### Color sensor

S8612 glass will be used as NIR cut-off filter on top of the IBIS4-6600-C color image sensor. [Figure 1-6](#) shows the transmission characteristics of the S8612 glass.

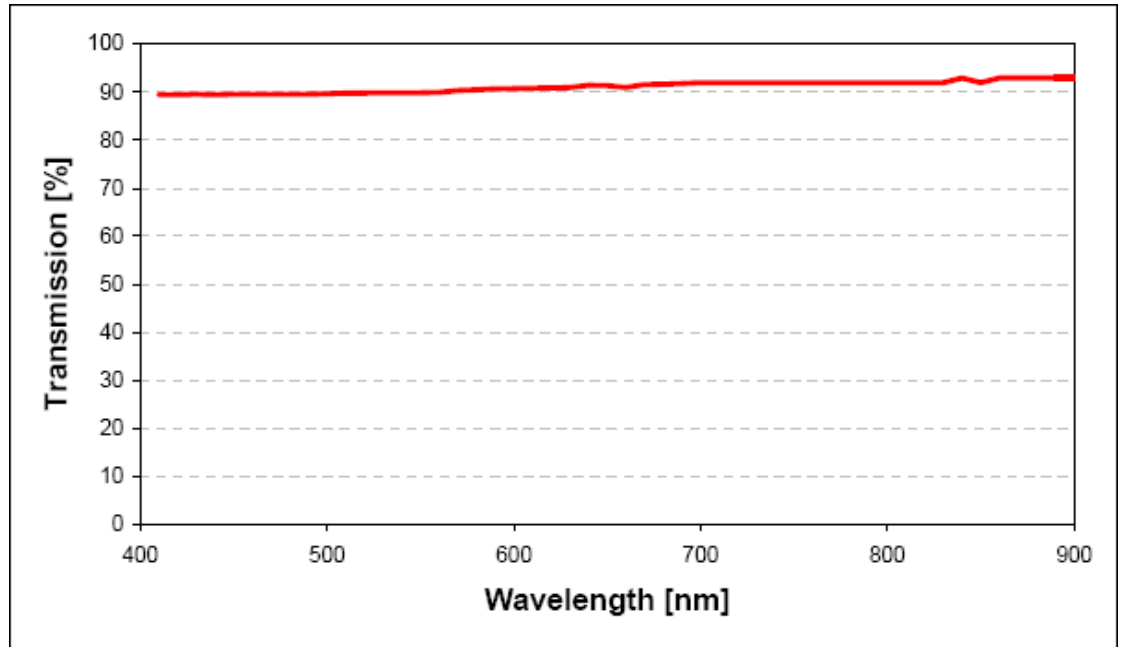


**Figure 1-6** *Transmission characteristics of the S8612 glass used as NIR cut-off filter*

### Monochrome sensor

A D263 glass will be used as protection glass lid on top of the IBIS4-6600 monochrome sensors. The refractive index of the D263 glass lid is 1.52.

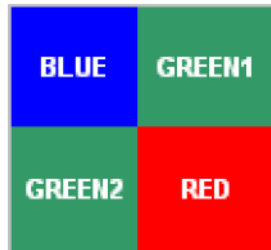
[Figure 1-7](#) shows the transmission characteristics of the D263 glass.



**Figure 1-7** Transmittance Curve of the D263 Cover Glass Lid

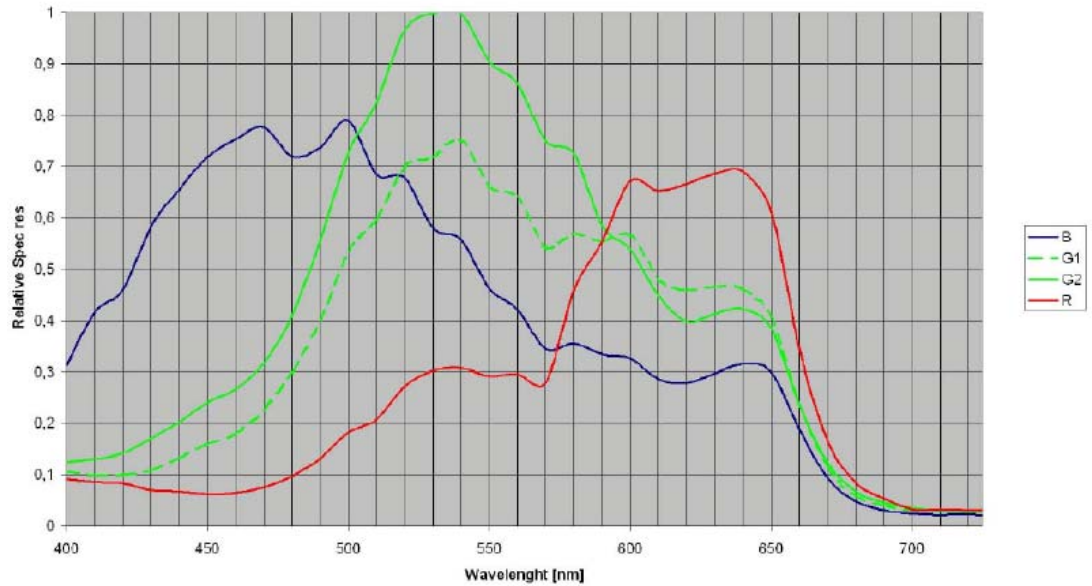
### Color filter array

The IBIS4-6600 can also be processed with a Bayer RGB color pattern. Pixel (0, 0) has a green filter and is situated on a green-red row. Green1 and green2 are separately processed color filters and have a different spectral response. Green1 pixels are located on a blue-green row; green2 pixels are located on a blue-green row; green2 pixels are located on a green-red row ([Figure 1-8](#)).



**Figure 1-8** RGB Bayer Alignment

Typical Response Curve of the RGB Filters on [Figure 1-9](#) below shows the response of the color filter array as function of the wavelength. Note that this response curve includes the optical cross talk and the NIR filter of the color glass lid as well.



**Figure 1-9** Typical Response Curve of the RGB Filters

## SMX-160 Software Package

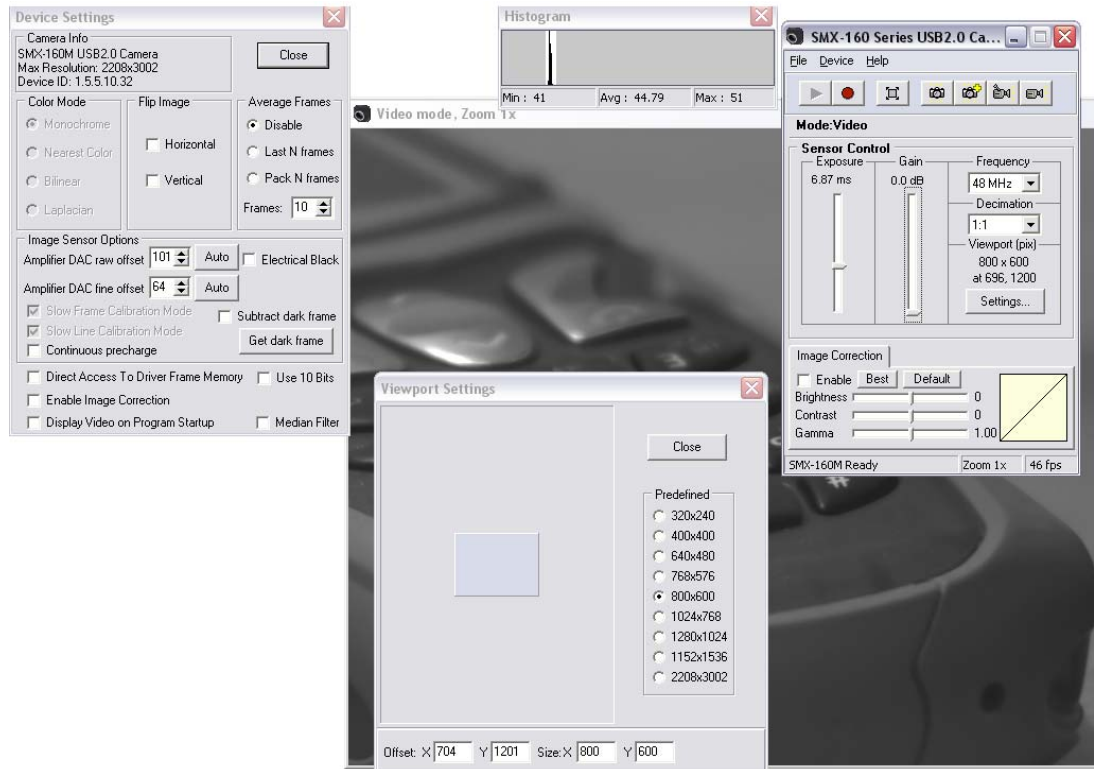
The SMX-160M USB2.0 Cameras go with the camera software package.

Camera software package contains:

- Standard Application
- Drivers
- User Guide
- SDK (API, examples, documentation)

Standard Application provides control of various set-up commands demonstrating cameras performance.

API allows full control of all camera features and along with examples and documentation enable easy integration of the camera into the customers' applications.



**Figure 1-10** SMX-160 Camera Application outlook

## Drivers

- WDM compatible

## System requirements

- Windows 7 or XP 1 and higher

For more information see [“System requirements” on page 7.](#)

## API function categories

- Get camera info
- Get/Set camera features
- Video stream controls (Start/Stop)
- Image grabbing
- Image correction controls (brightness, contrast, gamma)
- Snapshot controls (Exposure)
- Open /Close camera

## Camera application controls

- Image correction (brightness, contrast, gamma)



- Color balance (RGB)
- Color correction (HLS)
- Viewport
- Image capture
- Video capture
- Color Bayer algorithm selection
- Image sensor options
- Histogram
- Software zoom
- Selectable (8 bits or 10 bits) mode output
- White balance (color model)
- Frame rate control

A set of examples included into SDK serves as a tutorial in developing new applications.

## Third-Party IDE/Software Compatibility

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The SMX-160 Series USB2.0 Cameras are compatible with the next programming environments and software:

- Visual Studio 6.0 (2002, 2003, 2005, 2008, 2010) (SDK)
- Delphi/Builder C++ (SDK)
- C# (SDK)
- C# 2003, 2008
- C++ Net
- HALCON (SDK) (upcoming)
- LabVIEW (SDK)
- MATLAB (SDK)
- Streampix (SDK)
- Visual Basic 6.0 (SDK)

## Assistance and Help

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Our developers are ready to advise and assist with integration of the SDK into relevant applications.

## Camera Customization

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Sumix Corporation offers hardware and software customization services to meet customers' specific needs. Recent camera custom development examples:

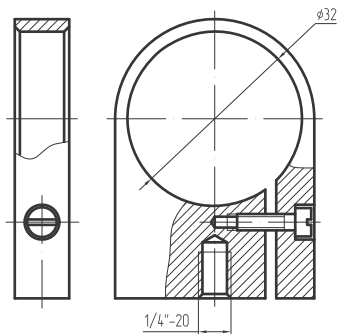
- Camera case mechanical modification
- External trigger output mode customization
- Unique sensor modification

## Camera Accessories

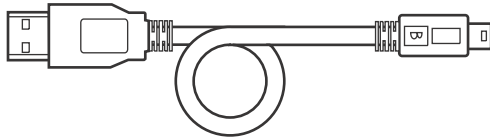
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The SMX-160 Series USB2.0 Cameras usually go with:

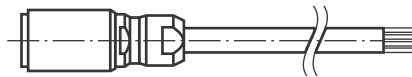
1. Tripod adapter. The lightweight duralumin adapter allows quick and easy camera fixing to the tripod, offering additional protection of the camera



**2. USB A to Mini B cable, 1.75 m long**



**3. 6 pin Hirose trigger connector (without a cable)**



**4. IR-cut Filter and Ring-adapter (for SMX-160C)**

For color models of the cameras (SMX-160C) an IR-cut filter can be used.

The SMX-160 color cameras are sensitive to IR-light. IR-cut filter will block the (near) infrared light and make the colors of the image more realistic.

When the camera is used with the IR-cut filter, the focus distance is increased to 0.66 mm. To restore the original value of focus distance (when the camera is used with no IR-cut filter ring and no ring-adapter), the ring-adapter is used.



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