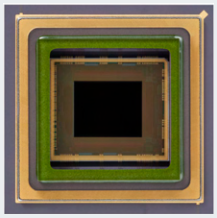
SONY

SWIR Image Sensor

IMX990	Type 1/2 (8.2 mm diagonal) approx. 1.34 effective megapixels	**IMX992**	Type 1/1.4 (11.4 mm diagonal) approx. 5.32 effective megapixels
IMX991	Type 1/4 (4.1 mm diagonal) approx. 0.34 effective megapixels	**IMX993**	Type 1/1.8 (8.9 mm diagonal) approx. 3.21 effective megapixels

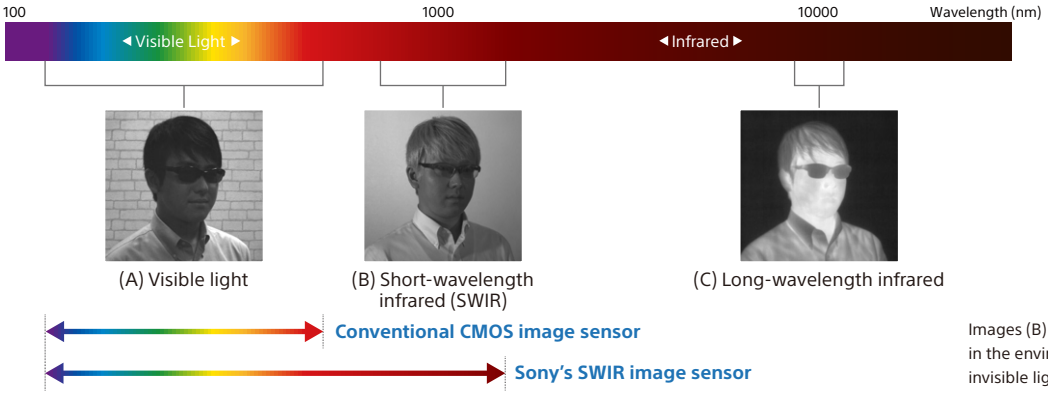


In industrial applications, we can now find cameras that capture visible light and non-visible light. This allows for new applications and previously difficult computer vision tasks to be challenged. Let us introduce our new SWIR (Short-Wavelength InfraRed) image sensor that can support these opportunities.

What is SWIR?

Generally, light with a wavelength of 400 nm to 780 nm is called visible light, and light with a wavelength of 780 nm to 10^6 nm is called infra-red light. The wavelength band of SWIR is from 900 nm to 2,500 nm, which is the region of infrared light closest to visible light.
[Photo 1] is a comparison of images taken with visible light and infra-red light of the same subject. In contrast to the visible light image (A) that we are accustomed to, the infra-red image (C), which has a long wavelength, cannot capture the characteristics of a person. On the other hand, although the SWIR image (B) looks like visible light because their wavelengths are close, unique information which is different from the visible light image can be captured under SWIR light.

[Photo 1]



Images (B) and (C) are captured in the environment under the invisible light environment.

Image sensors with SenSWIR™ technology are compatible both with the SWIR spectrum and a wide band of 400 nm to 1,700 nm wavelengths, which includes the visible light spectrum. This allows one camera to perform two functions for visible light and SWIR, not only widening the scope of items and purposes of inspection, but also helping to reduce system cost and accelerate image processing to improve throughput. Also, one camera means the captured images in two modes are identical to the pixel level, avoiding image shift.

SenSWIR

SenSWIR is a wide-band and high-sensitivity SWIR image sensor technology implemented by the combination of compound semiconductor InGaAs photodiodes and Si readout circuits through Cu-Cu connection.

Summary of application of SWIR technology

Visualizing water

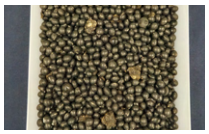
Smartphone camera image

Detecting moisture in the dents on the apple skin

Under visible light | Under SWIR (1,450 nm)

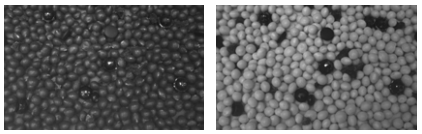
Water becomes black in an image taken with a camera set at the wavelength of 1,450 nm because water absorbs the light at this wavelength. This attribute can be leveraged for detecting moisture in objects.

Sorting materials



Smartphone camera image

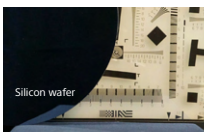
Detecting plastic and metal pieces in a pile of black beans



Under visible light | Under SWIR (1,300 nm)

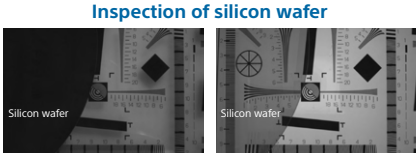
Infrared reflectance and absorptance vary at different wavelengths from one material to another. Utilizing this attribute, a specific material can be singled out among other materials, such as plastics, that may look very similar to one another under visible light.

Transmission observation



Smartphone camera image

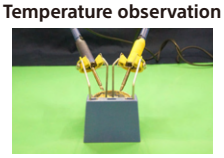
Inspection of silicon wafer



Under visible light | Under SWIR (1,550 nm)

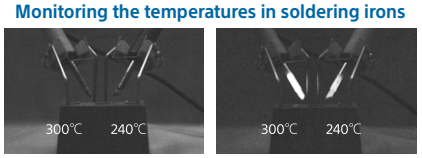
SWIR includes a spectrum that penetrates certain materials, and this has been leveraged in manufacturing, such as a transmission inspection for semiconductors.

Temperature observation



Smartphone camera image

Monitoring the temperatures in soldering irons



Under visible light | Under SWIR (1,550 nm)

Some image sensors can convert heat into luminosity information. SWIR image sensors are suitable for the observation of heat over 250°C.

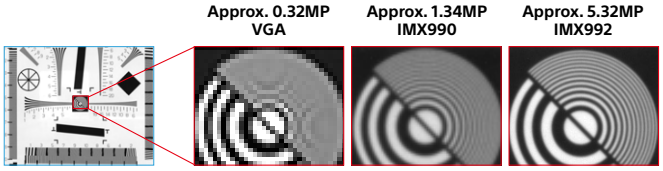
Features of image sensors with SenSWIR technology

Compact size and high resolution realized

The IMX990/IMX991 uses 5µm miniature pixels to achieve both miniaturization and a large number of pixels, achieving high image quality equivalent to SXGA. This feature can increase flexibility for camera positioning and enhance accuracy for inspections, expanding the applications of SWIR sensing.

The IMX992 has a high resolution of approximately 5.32 megapixels, and the IMX993 has a high resolution of approximately 3.21 megapixels with a miniature pixel size of 3.45 µm. This specification is a widely used specification among general global shutter image sensors compatible for C-mount size, and this is the first SWIR image sensor for industrial use to achieve similar specifications. High-resolution imaging allows even tiny objects to be captured clearly, greatly improving the accuracy of various inspections and measurements using SWIR.

Comparison of SWIR images with different resolutions



Achieves low-noise performance regardless of the brightness or darkness of the environment

The high-end model IMX992/IMX993 is equipped with shooting modes that can be selected according to the purpose. By selecting the optimal mode, high-quality images with little noise can be obtained, regardless of the brightness or darkness of the environment. This sensor demonstrates its power in scientific measurement, outdoor observation, and other applications where image quality in low-light environments is important.

High conversion gain (HCG) and low conversion gain (LCG) modes

HCG mode amplifies the signal immediately after light is converted into an electrical signal, at a stage when there is still little noise, thereby reducing noise that occurs afterwards. This allows low-noise images to be obtained even in dark shooting environments, leading to improved recognition accuracy. In bright conditions where dynamic range is important, it is possible to switch to LCG mode.

Dual-read rolling shutter (DRRS) function

Furthermore, these Sony sensors are equipped with a DRRS function that allows shooting with reduced noise. This can obtain images with noise reduced to approximately 1/4.

Digital output-ready for efficient camera design

In general, most SWIR image sensors output analog signals only. This means camera manufacturers need to add a digital conversion circuit on the camera side before developing camera functionality. Sony's SWIR image sensors incorporate a digital conversion circuit, eliminating the needs for such extra work. This allows camera manufacturers to make a quick start to develop versatile camera functions as they wish more easily and efficiently. Furthermore, the IMX992/IMX993 supports MIPI in addition to SLVS interface, which is common for industrial cameras, increasing flexibility in camera design and component selection.

Specifications

Device structure

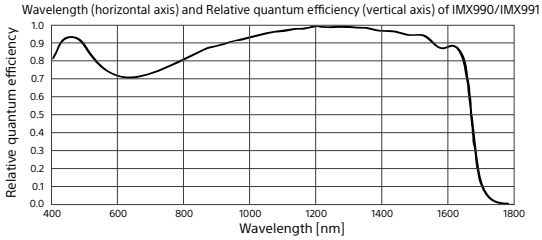
Thermoelectric cooling element included model		IMX990-AABA	IMX991-AABA	IMX992-AABA	IMX993-AABA
Thermoelectric cooling element not included model		IMX990-AABJ	IMX991-AABJ	IMX992-AABJ	IMX993-AABJ
Image size		8.2 mm diagonal (Type 1/2)	4.1 mm diagonal (Type 1/4)	11.4 mm diagonal (Type 1/1.4)	8.9 mm diagonal (Type 1/1.8)
Effective pixels		1296 (H) × 1032 (V) approx. 1.34 megapixels	656 (H) × 520 (V) approx. 0.34 megapixels	2592 (H) × 2056 (V) approx. 5.32 megapixels	2080 (H) × 1544 (V) approx. 3.21 megapixels
Unit cell size		5 µm (H) × 5 µm (V)		3.45 µm (H) × 3.45 µm (V)	
Optical black	Horizontal direction	Front 0 pixels, rear 96 pixels		Front 96 pixels, rear 0 pixels	
	Vertical direction	Front 20 pixels, rear 0 pixels		Front 24 pixels, rear 0 pixels	
Input drive frequency		37.125 MHz/74.25 MHz/54 MHz		37.125 MHz/74.25 MHz/54 MHz	
Power supply		1.2 V, 1.8 V, 2.2 V, 3.3 V, 1.2 V (Pixel), 2.2 V (Pixel)		1.2 V, 1.8 V, 2.2 V, 3.3 V, 2.2 V (Pixel)	
Shutter mode		Global shutter		Global shutter (rolling shutter when DRRS on)	
Output interface		SLVS (2 ch/4 ch)		SLVS (2 ch/4 ch/8 ch) / MIPI (2 lane/4 lane)	
Package		Thermoelectric cooling element included:30.0 mm (H) × 30.0 mm (V) Thermoelectric cooling element not included:20.0 mm (H) × 16.8 mm (V)		Thermoelectric cooling element included:30.0 mm (H) × 30.0 mm (V) Thermoelectric cooling element not included:21.0 mm (H) × 20.0 mm (V)	

Imaging characteristics

Model name	IMX990	IMX991	IMX992	IMX993	Notes
Sensitivity	121 mV		291 mV		1/30 sec. accumulation
Saturation signal	360 mV		360 mV		
Quantum efficiency	>75 %		>75 %		λ=1200 nm
Operability*1	>99.5 %		>99.5 %		

*Measurement conditions: Tj = 15 C, all-pixel readout mode.
*1: Operability: percentage of pixels free of defects

Wavelength (horizontal axis) and Relative quantum efficiency (vertical axis) of IMX990/IMX991

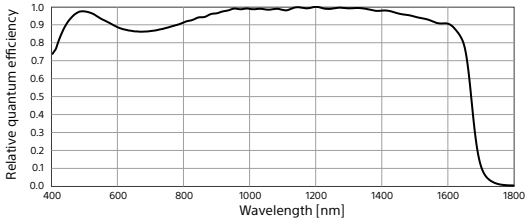


Basic drive mode

Model name		IMX990	IMX991	IMX992	IMX993
Drive mode		All-pixel readout		All-pixel readout	
Recommended recording pixels		1280 (H) × 1024 (V) Approx. 1.31 megapixels	640 (H) × 512 (V) Approx. 0.33 megapixels	2560 (H) × 2048 (V) Approx. 5.24 megapixels	2048 (H) × 1536 (V) Approx. 3.14 megapixels
Frame rate (max.)	ADC 8 bit	134 frame/s	258 frame/s	131 frame/s	173 frame/s
	ADC 10 bit	125 frame/s	240 frame/s	120 frame/s	158 frame/s
	ADC 12 bit	71 frame/s	137 frame/s	70 frame/s	93 frame/s

* Figures are subject to change without notice.

Wavelength (horizontal axis) and Relative quantum efficiency (vertical axis) of IMX992/IMX993



Data may vary depending on conditions and the environment.

URL for product information webpage about SWIR image sensors:
https://info.sony-semicon.com/en/swir-prod

Please inquire from the URL below or the QR code, to the right, for detailed information of Sony's SWIR image sensors or evaluation data samples:
https://info.sony-semicon.com/en/inquiry-form0001pr