SONY
STARVIS™ / STARVIS 2
Technology Guide

MACNICA

SONY

Security Camera Image Sensor STARVIS™/STARVIS 2 Technology

OVERVIEW

STARVIS technology is characterized by ultra-high sensitivity, pushing the boundary of mechanical recognition to enrich society and bring safety, security, and convenience to people.
With sensitivity superior to that of the human eye, it enables object shape and color recognition even in dark locations and obtains the required information with accuracy, contributing to greater safety and security in society.

STARVIS 2, evolved from STARVIS, is the latest technology with wider dynamic range.

TECHNICAL FEATURES

Super-high sensitivity beyond the human eye

Image sensors capture light and convert it to electrical signals in order to create images and other data. It is a significant advantage for image sensors to capture images accurately in dark locations. To achieve this, it is crucial to sense the faintest light in darkness and convert this to electrical signals efficiently without allowing noise contamination.

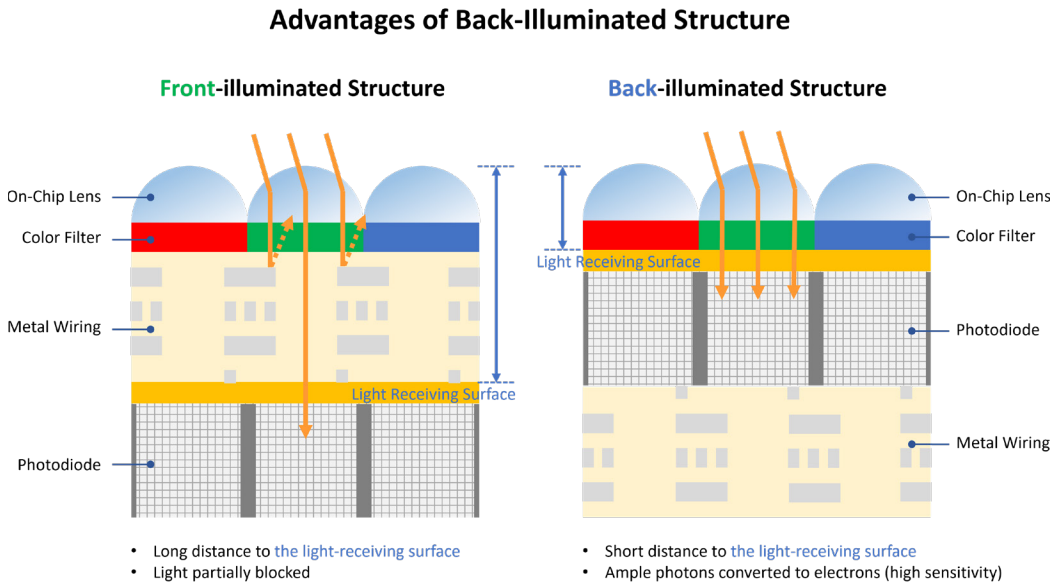
STARVIS technology is designed to capture the faintest light in a dark place, such as a small alleyway without street lights, convert this light into noise-less electrical signals, and deliver an image of the target object through the realistic rendition of its shapes and colors.

Technology to deliver high-sensitivity

Light passes through the camera lens and enters the image sensor. The light is converted into an electrical signal at the photodiode. The key to achieving high sensitivity is to collect light in these photodiodes without wasting it.
In image sensors, the arrangement of photodiodes has a significant impact on sensitivity. In a structure called a front-illuminated type, the photodiode is located below the wiring layer. This causes light to be reflected or absorbed by the wiring layer before it reaches the photodiode, resulting in a loss of sensitivity. In contrast, in the back-illuminated structure, the photodiode is placed above the wiring layer. Since light is not lost in the wiring layer, light entering the photodiode can be greatly increased. This has resulted in an approximately 4.6-fold*1 increase in sensitivity.

*1) Comparison of IMX236 (front-illuminated structure) and IMX585 (back-illuminated structure) image sensors for security cameras

In addition, the closer distance between the light-collecting on-chip lens and the photodiode allows light to enter the photodiode from more oblique angles, which, when combined with a bright lens with a small f-number, further improves imaging performance in dark areas.



Conventional front-illuminated image sensor

Back-illuminated image sensor with STARVIS technology

Technology to achieve low noise

Image sensors capture light with photodiodes, convert it into electrical signals, and then output an image as digital values. A dark image can be brightened by amplifying the signals (setting a higher gain level). However, higher gain levels cause noise in the electrical signals to be equally amplified, resulting in a grainy image.

Sony's Super High Conversion Gain technology is designed to amplify electrical signals immediately after the conversion from photons, when the noise levels are relatively low. In this way, it reduces the overall noise after amplification. As a result, lower-noise images, compared to conventional technology, can be captured even in a low-illuminance environment. Lower noise levels in images also help to enhance the accuracy in visual or AI-assisted image recognition.

Conventional front-illuminated image sensor

Back-illuminated image sensor with STARVIS technology

Capturing light ranges invisible to the human eye

Image sensors in smartphone cameras and SLR cameras are usually designed to reproduce light as we see it (visible light), but some image sensors in security cameras can also reproduce near-infrared (NIR) light, which is invisible to the human eye.

Near-infrared illumination may be used in situations where light may disturb people's lives or cause danger, such as in residential areas or on highways at night.

STARVIS technology can capture images clearly in near-infrared light. If the NIR sensitivity of the image sensor is high enough, NIR illumination can be suppressed, reducing heat and power consumption from the illumination.

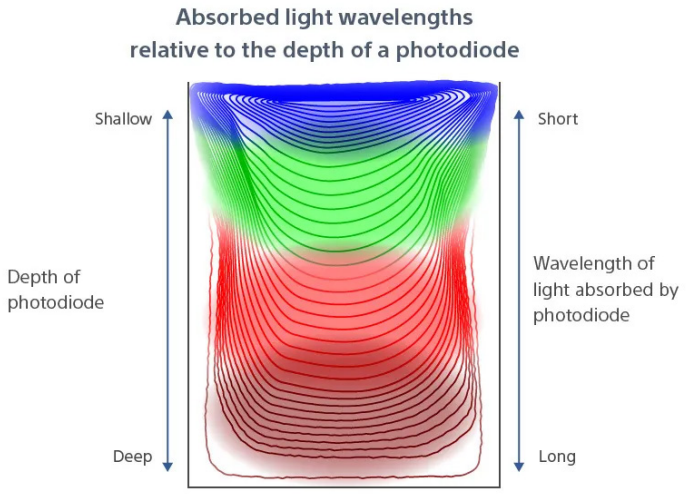
Image sensor not compatible with NIR light

Image sensor with STARVIS 2 technology

Improved sensitivity in near-infrared (NIR) region

Near-infrared light is longer than visible light in wavelength. In an Si (silicon) photodiode, short-wavelength light, such as blue light, is absorbed in the region closer to the surface of the photodiode while longer-wavelength light, such as green and red light, is absorbed in deeper regions. The absorption of near-infrared light is enhanced by increasing the depth of the photodiode.

STARVIS 2 also adopts photodiodes with uneven surfaces, which enhances NIR light absorption by refracting incident light. These structural features have led to significant improvement in NIR sensitivity.



Feature to eliminate blowouts

Image sensors can adjust the length of time to take in light (exposure time) to output images, optimized according to the brightness of the scene. A short exposure time in a bright environment avoids oversaturation of the photodiode and a long exposure time in a dark environment ensures the collection of a sufficient amount of light.

In scenes where very bright and very dark areas coexist, such as backlighting or tunnel exits, the bright areas may be blown out to white and the dark areas may be blacked out, making it difficult to see what is captured in the image. The ability to see clearly from bright to dark areas is called a wide dynamic range, and the function that achieves this is called the HDR (High Dynamic Range) function.

Without HDR

With HDR

DOL HDR

When DOL HDR (Digital-Overlap High Dynamic Range) is turned on, the image sensor captures an image with a shorter exposure time set for bright areas and an image with a longer exposure time set for dark areas in sequence, and superimposes each image to achieve HDR.

However, since there is a slight time difference between the two images, when shooting a fast-moving subject, artifacts such as blurred outlines or color changes may occur in the areas where the subject has moved.

Clear HDR

When Clear HDR is turned on, the image sensor simultaneously captures and superimposes an image with a low gain setting for bright areas and an image with a high gain setting for dark areas*2.

With this method, two images are acquired at the same time, resulting in an image free of color shifts and other artifacts, even with moving subjects. Clear HDR is suitable for applications that capture moving subjects, such as traffic monitoring and dashcams, as well as security cameras.

*2) The output image data must be post-processed in the camera in order to obtain the final HDR image. IMX585 can synthesize data internally with Clear HDR mode.

Without HDR

With DOL HDR

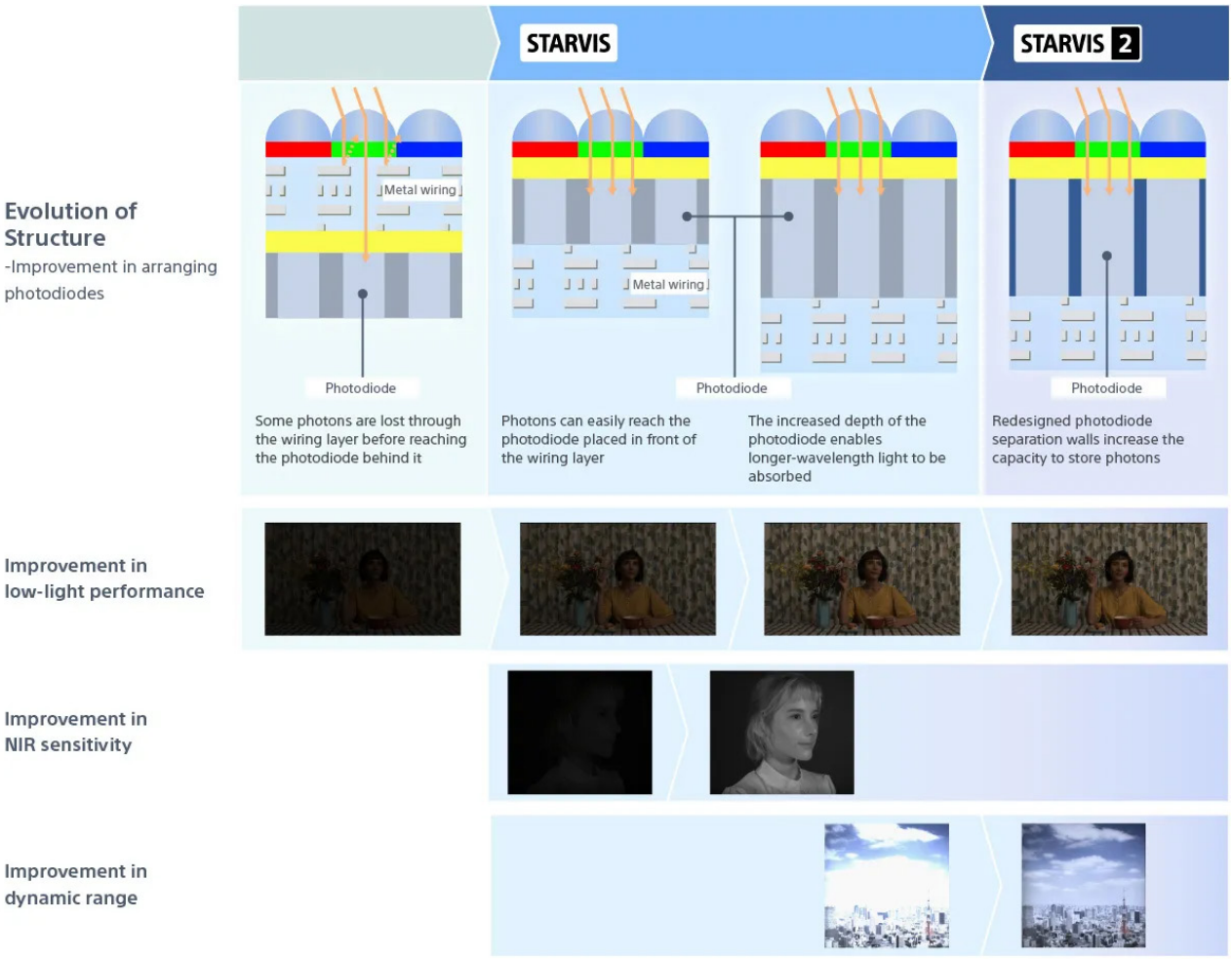
With Clear HDR

Evolving STARVIS technology

Poor visibility is an obstacle to ensuring security in everyday life. STARVIS has challenged the limits of technology and exceeded the sensitivity of the human eye. STARVIS continues to evolve to capture even scenes with harsh light and dark conditions and infrared light that cannot be detected by the human eye.

Evolving structure and improving performance

The change from a front-illuminated to back-illuminated structure has enabled super-high sensitivity, from which came STARVIS technology. (See page 2 “Technology to deliver high sensitivity”) The sensitivity and HDR feature have been improved further by increasing the amount of light to be captured, enabled by increasing the depth of a photodiode and modifying the structures and materials of the walls between photodiodes. These are not the only improvements made. The on-chip lens has improved light concentration and transmittance, the color filter has higher transmittance, the photoelectric conversion efficiency has improved, and much more. Sony is constantly evolving in its search for optimal materials, research and development, and manufacturing precision on a nanometer scale.

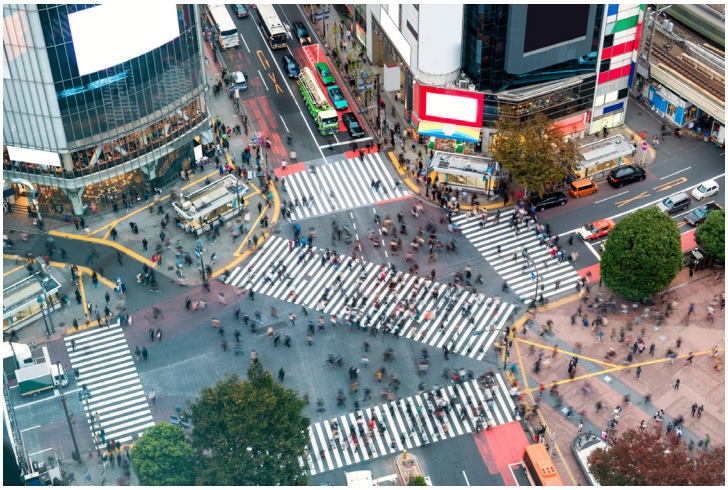


Both STARVIS and STARVIS 2 are back-illuminated pixel technology specifically developed for image sensors for security camera applications. They feature a minimum sensitivity of 2,000 mV/μm^2 (color product, when imaging with a light source of 706 cd/m^2, F5.6 in 1 sec. accumulation equivalent) and deliver high image quality in the visible light as well as near infrared light regions. STARVIS 2 further offers the wide dynamic range (AD 12-bit) of more than 8 dB in a single exposure, wider than the STARVIS pixel of the same size.

APPLICATIONS

Facility surveillance

Security cameras are widely used for security measures in commercial facilities, financial facilities, airports, and other facilities.
Security cameras with high resolution and wide viewing angles are required for environments where many people pass by, while security cameras with excellent imaging performance in dark locations are required for security measures after lights out.
Sony offers a lineup of image sensors for various types of security cameras to meet these requirements.



Street monitoring

Security cameras are widely used to maintain safety in urban environments.
Compared with those used inside facilities, security cameras are required to have high image capture performance as they are used in outdoor environments where the ambient brightness can vary greatly. Sony image sensors contribute to the safety of people's lives by providing advanced imaging characteristics beyond the human eye, such as low noise and high sensitivity required in dark environment, and the features to prevent white-outs and black-outs in complex lighting environments with a mixture of light and dark.

Traffic monitoring

In addition to monitoring traffic volume, security cameras are used to detect various traffic conditions, such as traffic jam detection, accident detection, wrong-way driving detection, and vehicle identification. Because these cameras are mainly installed outdoor with harsh lighting conditions, Sony's image sensors deliver great performance with their excellent low-light performance and wide dynamic range.

Dashboard cameras

Demand for dashboard camera (dashcam) is rapidly increasing to record accident and to record/prevent aggressive driving and road rages, which has become a problem in recent years.
Sony's image sensors use high-sensitivity, low-noise and wide dynamic range technologies to ensure that no image is missed, day or night.

Home security systems

Image sensors are also used to enhance security and safety at home. They can be used for a variety of purposes, including for guarding the house during a long period of absence and keeping an eye on elderly or young members of family at home. Our image sensors can capture the subject in clear images under various outdoor conditions.

Sony's STARVIS™ and STARVIS 2 Sensors are available through **Macnica Americas, Inc.**

The seeds of tomorrow.
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