WHITE PAPER

# Understanding P-Iris

## Precise iris control for optimized image quality

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AXIS COMMUNICATIONS

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# 1 Summary

P-Iris is a solution that allows a network camera to perform optimally in all lighting conditions. It enables the delivery of crisp, high-resolution video with sufficient depth of field, while automatically keeping diffraction and image aberration to a minimum.

The iris of a lens regulates the size of its opening, also called aperture. This controls the amount of light that passes through, so that an image can be correctly exposed. But the size of the opening also affects depth of field and image sharpness.

In situations with varying light levels, typically outdoors, an automatically adjustable iris is recommended. This is commonly a DC-iris lens. But a DC-iris lens responds only to light levels and does not take into account the impact of the iris opening on other image qualities, such as depth of field. This is a drawback that P-Iris was designed to overcome.

The P-Iris system comprises a P-Iris lens and specialized software in the camera. The software controls a motor in the P-Iris lens, enabling automatic and precise control of the iris. The primary objective of P-Iris is to improve image quality by enabling the optimal iris position to be set so that the central and best-performing part of the lens is used most of the time. This position, expressed as a specific f-number, is where the lens performs optimally, where many optical errors are reduced, and where image quality (with regards to contrast, resolution, and depth of field) is the best.

P-Iris lenses can be used with cameras that have support for it.

# 2 Introduction

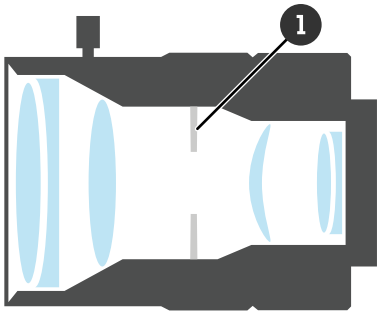
Network video surveillance of today produces images with astounding resolution. With megapixel, HDTV, or 4K image sensors, cameras deliver footage with extreme detail that helps identify people and vehicles. But image quality depends not only on the camera sensor resolution. In fact, many components and factors are involved in the production of sharp images, especially in outdoor environments where cameras must deal with vastly varying light conditions. The quality of the lens and its ability for iris control, for example, is another factor of high significance in obtaining good image quality.

To overcome some of the challenges imposed by varying light conditions, a lens with a new type of iris control was codeveloped by Axis and the lens manufacturer Kowa. The iris of this type of lens is called P-Iris, meaning *precise iris*. It is based on an open standard and works with any camera that has support for it. A P-Iris lens improves image sharpness and increases image usability in video surveillance with fixed network cameras.

This white paper provides background about the iris of a camera lens and what effects its settings can have on image quality. The paper also explains how iris control works, and details especially how a P-Iris lens adjusts the iris to optimize contrast, clarity, resolution, and depth of field in the image.

# 3 The role of the iris

The iris of a lens works essentially like the iris of the human eye. It controls the amount of light that passes through, so that an image can be correctly exposed. The iris opening is called aperture. The size of the aperture also affects the depth of field and the image sharpness.




*1 The iris of a lens controls the amount of light that passes through.*

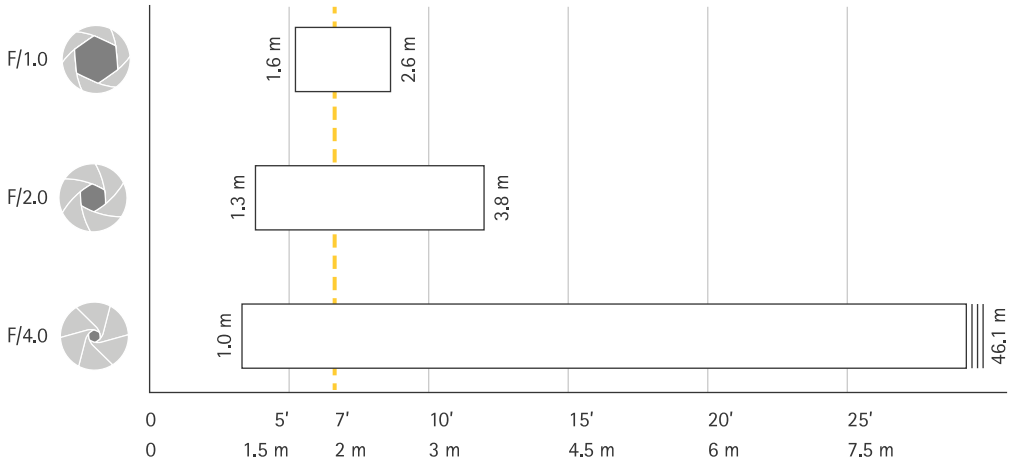
A lens can only focus precisely at a single point which is called the point of focus. However, there is a range in front of, and behind, the focus point, where objects will still appear sharp. That range is known as the depth of field, or the focus range. Depth of field is an important measure in surveillance, since a larger depth of field allows more of a scene to be clearly visible.

*Having a larger depth of field means that objects appear sharp at a larger range around the focal point.*

*1 Depth of field*

*2 Focal distance — distance from the camera to its focal point.*

The depth of field is inversely proportional to the size of the iris opening: keeping a large aperture reduces the depth of field, while a smaller aperture increases it. To maximize the depth of field, thus, a small iris (which corresponds to a large f-number) should be used.




*Depth of field examples for different iris sizes with a focal distance of 2 m (7 ft.). A smaller iris opening (that is, a larger f-number), enables objects to be in focus over a longer distance range.*

Image sharpness, however, requires not only sufficient depth of field but it also requires keeping optical errors and lens aberrations to a minimum. All lenses create some form of image aberrations when the full lens surface is used. Using a too small iris opening may instead introduce image blur caused by diffraction. This is especially a problem in bright outdoor scenes, where the intense light forces the camera to minimize the iris, causing the light to spread (diffract) over many pixels.

*An iris with a too small opening will cause diffraction, as seen in the image to the right.*

Diffraction causes more severe problems the smaller the pixel size of the camera's image sensor. With smaller pixels, the diffracted light will reach a larger number of them. This is a typical problem for cameras that use an automatic DC-iris lens in combination with megapixel sensors, with their small pixels.

# 4 Iris control options

A lens can have either a fixed or an adjustable iris opening, and adjustable lenses can be adjusted either manually or automatically. There are three kinds of automatic iris control:

- DC-iris

- Video iris
- P-Iris

With a manual iris lens, the iris opening must be adjusted by hand. For indoor applications where light levels are constant, fixed or manual iris lenses may be suitable since the iris opening does not need constant adjustment.

In situations with varying light levels, such as outdoor camera installations, a lens with an automatically adjustable iris is a better choice. DC-iris lenses and video iris lenses both use an analog signal that is converted into a control signal. In a DC-iris lens, this conversion takes place in the camera, and in a video iris lens, it is done in the lens. A DC-iris or video iris lens responds only to the light levels in the scene. It does not take into account the impact of the iris opening on other image qualities such as depth of field. With these types of lenses, the camera only knows whether the iris opens or closes in response to the level of light, and it does not know the position of the iris. This is a drawback that P-Iris was designed to overcome.

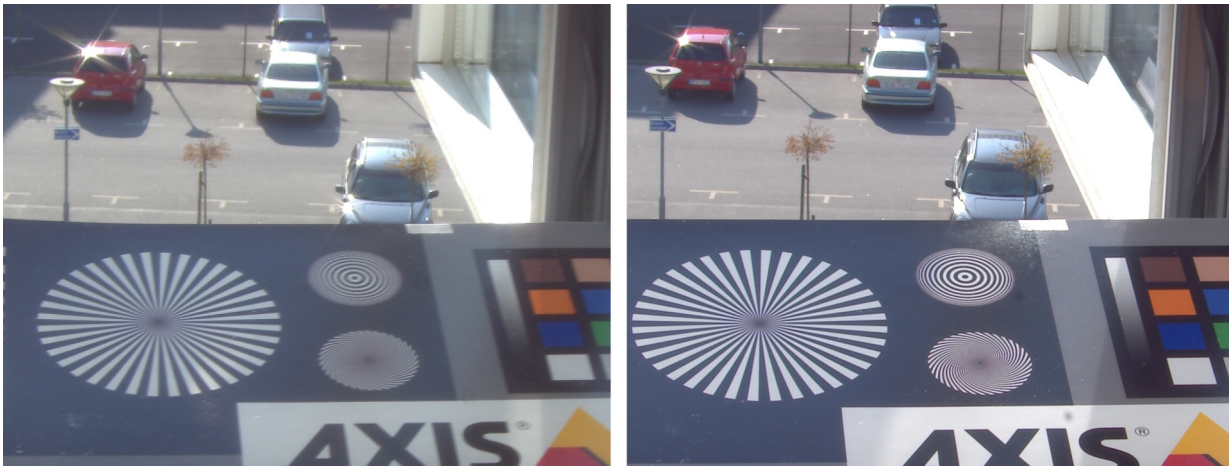
The most recent type of developed standard, the i-CS lens, combines optimized iris control, similar to that of a P-Iris lens, with autofocus and remote zoom function.

# 5 How P-Iris works

The P-Iris system comprises a P-Iris lens and specialized software in the camera. The software controls a motor in the P-Iris lens, enabling automatic and precise control of the iris. Unlike a DC-iris lens, the main task of the P-Iris control is not to continuously adjust the flow of light through the lens. The primary objective of P-Iris is instead to improve image quality by enabling the optimal iris position to be set so that the central and best-performing part of the lens is used most of the time. This position, expressed as a specific f-number, is where the lens performs optimally, where many optical errors are reduced, and

where image quality (with regards to contrast, resolution, and depth of field) is the best. This is the default setting in a network camera with P-Iris.

*The picture to the left was taken with a camera using a DC-iris lens. The picture to the right was taken with a camera using a P-Iris lens and exhibits a greater depth of field than the picture to the left.*




*The picture to the left was taken with a camera using a DC-iris lens. The picture to the right was taken with a camera using a P-Iris lens and exhibits sharper contrast than the picture to the left.*

Working in conjunction with P-Iris is the use of electronic means—gain (amplification of the signal level) and exposure time—to manage slight changes in lighting conditions and to further optimize an image. This allows the optimal iris position to be maintained as long as possible. In situations when the preferred iris position and the camera's electronic processing capabilities cannot adequately correct the exposure, a P-Iris camera will automatically instruct the iris to move to a different position. In dark conditions, for example, the iris will fully open. In bright situations, a camera with P-Iris is programmed to limit the closing of the iris to a position that avoids diffraction or blurring. Hence, in all lighting conditions, P-Iris can automatically make adjustments to deliver optimal image quality.

It is important to keep in mind that in order to use a P-Iris lens, the camera must have support for it.

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# About Axis Communications

Axis enables a smarter and safer world by creating solutions for improving security and business performance. As a network technology company and industry leader, Axis offers solutions in video surveillance, access control, intercom, and audio systems. They are enhanced by intelligent analytics applications and supported by high-quality training.

Axis has around 4,000 dedicated employees in over 50 countries and collaborates with technology and system integration partners worldwide to deliver customer solutions. Axis was founded in 1984, and the headquarters are in Lund, Sweden