APPLICATION NOTE

AN-P06

CHEETAH CAMERA SERIES

P-IRIS LENS CONTROL

Abstract: This application note describes how to control an iris position of
a P-Iris lens in the Imperx Cheetah GigE Vision® with PoE cameras.

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Introduction

The Imperx Cheetah POE-C1911, POE-C2010, POE-C2410, POE-C3210, POE-C4010, and POE-C4110 cameras offer a P-Iris (Precise Iris) lens control option. A P-Iris lens uses a stepper motor for adjusting an iris position. You can control the iris position manually or let the camera adjust the iris by enabling Automatic Iris Control (AIC). This application note provides information on the camera's pin assignment, XML parameters, and adjustment instructions for both manual and automatic control modes.

Connecting a P-Iris Lens

The Hirose connector pinouts and pin assignment are shown below.
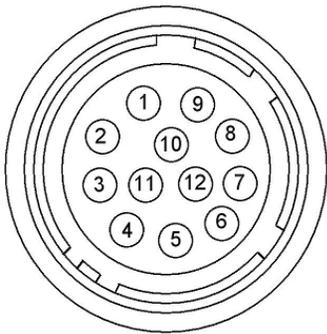
Pin	Signal Name	Description
1	+12 V DC RTN	12 VDC Main Power Return
2	+12 V DC	12 VDC Main Power
3	Reserved	Reserved
4	Reserved	Reserved
5	P-Iris Phase A+	Mapped to the pin 2 of a P-Iris jack
6	OUT1 RTN	General Purpose Output 1 Return (TTL)
7	OUT1	General Purpose Output 1 (TTL)
8	IN1	General Purpose Input 1 (Opto-isolated)
9	P-Iris Phase B-	Mapped to the pin 4 of a P-Iris jack
10	IN1 RTN	General Purpose Input 1 Return (Opto-isolated)
11	P-Iris Phase B+	Mapped to the pin 1 of a P-Iris jack
12	P-Iris Phase A-	Mapped to the pin 3 of a P-Iris jack

P-Iris Jack:
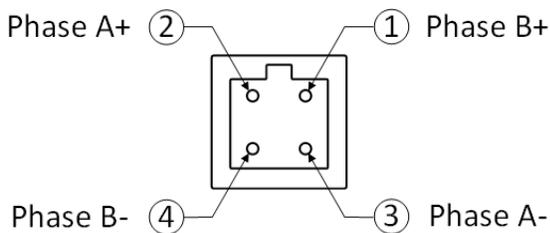
TIP ⓘ Pin assignment of your P-Iris lens may differ from the one shown above. Please refer to the documentation on your P-Iris lens for the pin assignment.

Electrical parameters:
- The Cheetah POE camera provides 3.6 V to power a P-Iris lens.

- The impedance of a P-Iris lens coil is usually in the range from 20 Ohm to 33 Ohm.

Manual P-Iris Lens Control

Upon powering up or receiving a DeviceReset, the camera sets an iris a position determined by the *InitialPIrisPosition* parameter. By default, *InitialPIrisPosition* is set to 0 (in steps) which means the iris is Fully Open (max. aperture). You can set *InitialPIrisPosition* within a range from 0 to *PIrisMax* (maximum number of steps available). Also, you can set an iris step and manually control the position of the iris using *OpenPIrisStep* / *ClosePIrisStep* commands. You can drive the iris to the Fully Open / Fully Closed position by issuing *OpenPIrisFull* / *ClosePIrisFull* commands.

P-Iris Lens Control parameters

Parameter Name	Type	Value	Access	Description
PIrisStepValue	Integer	Min: 1 Max: Depends on PIrisMax	RW	Sets the iris step to be moved with *OpenPIrisStep* and *ClosePIrisStep* commands.
PIrisMax	Integer	Min: 15 Max: 127	RW	Sets the P-Iris maximum number of steps available. This value is unique for each lens model.
InitialPirisPosition	Integer	Min: 0 Max: Depends on PIrisMax	RW	Sets the P-Iris initial position in number of steps. Equals to 0 by default. Can be saved using the UserSetControl menu.
CurrentPIrisPosition	Integer	Min: 0 Max: Depends on PIrisMax	RO	Returns the P-Iris current position in number of steps.
OpenPIrisStep	Command		WO	Opens the iris by the number of steps defined in the *PIrisStepValue* parameter.
ClosePIrisStep	Command		WO	Closes the iris by the number of steps defined in the *PIrisStepValue* parameter.
OpenPIrisFull	Command		WO	Opens the iris to the Fully Open position.
ClosePIrisFull	Command		WO	Closes the iris to the Fully Closed position.

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Configuring PIrisMax

In Default (Factory) configuration, **PIrisMax** (maximum number of steps) is pre-set to 73 (for the Kowa LM25JC5MM lens). The value depends on the lens model and manufacturer and may differ from the default one. Please refer to the documentation on your P-Iris lens for this parameter or contact a lens distributor for more information.

If the maximum number of steps of your P-Iris lens differs from the pre-set one, set *PIrisMax* to a new value and save your configuration by following the steps below:

1) On the **PIrisLensControl** panel, set *PIrisMax* to the value provided in the lens documentation.

2) On the **UserSetControl** panel, select one of the User Sets (User Set 0 – User Set 3) in *UserSetSelector*.

3) Execute *UserSetSave* command to save your configuration into the camera's non-volatile memory.

4) Select your User Set in *UserSetDefault*. The camera loads and activates this User Set upon the next reset.

5) Power-cycle the camera for the changes to take effect.

Automatic Iris Control (AIC)

Automatic Iris Control (AIC) enables the camera to maintain the same image brightness during changing lighting conditions. In AIC mode, you can set the image luminance (brightness), and the camera will adjust the iris accordingly. Luminance options are Average or Peak.

The camera starts by changing the iris within the specified min-max limits.
- If one of the iris limits is reached, the camera indicates the limit has been reached and maintains this value until the lighting conditions change.
- You can set the speed of convergence (how fast the camera stabilizes after an illumination change) using four possible rates. Slower convergence rates are more stable than faster convergence rates, if the illumination levels change quickly over a wide intensity range.

⚠ **CAUTION**	In some rapidly changing and bright lighting conditions, an image brightness oscillation (image intensity flipping from bright to dark) could occur. To prevent this, increase the AIC minimum iris position (*AicIrisMin*), decrease the convergence speed (*AgcAecAicSpeed*), decrease the gain and/or exposure.

AIC, AEC, and AGC

You can enable AIC, AEC (Automatic Exposure Control), and AGC (Automatic Gain Control) independently or together by setting them to the *Continuous* mode. With all three controls enabled together, the camera provides the best image quality by adjusting the iris, gain, and exposure.

The AIC controls the amount of light passing through a lens by changing the iris opening. The AGC affects the maximum signal-to-noise ratio (SNR) by adjusting the amplification of a video signal. Increasing gain reduces the maximum SNR. The AEC controls both the amount of light captured by the image sensor and the SNR by adjusting the time an electronic shutter stays open. Generally speaking, longer exposure times equate to improved SNR and the maximum exposure limit value should be as high as possible without introducing motion smear in the image.

When enabling AIC, AEC, or AGC, you need to specify the minimum and maximum limits of the iris position, exposure, and gain. The camera uses the gain and exposure limits to determine the initial conditions for the AEC and AGC algorithms. Otherwise, the camera applies the default ones.

Default limits	Value	Note
Gain limits		
AgcGainMin	0 dB	
AgcGainMax	48 dB	
Exposure limits		
AecExposureMin	Varies	Depends on camera model.
AecExposureMax	Varies	Depends on current frame time.
Iris limits		
AicIrisMin	0 steps	The iris is Fully Open (max. aperture).
AicIrisMax	73 steps	The iris is Fully Closed (min. aperture). The maximum possible value equals to the *PIrisMax* parameter and depends on a lens model. You may need to adjust *PIrisMax* if the **maximum number of steps** of your P-IRIS lens differs from 73.

The initial conditions for the AEC, AGC, and AIC algorithms when first activated are:

- the exposure is always set to the value:

$$\text{Exposure} = \text{AecExposureMin} + \frac{\text{AecExposureMax} - \text{AecExposureMin}}{2}$$

- the gain is always set to the minimum limit determined by *AgcGainMin* (0 by default)
- the iris is in *CurrentPIrisPosition*

If AIC, AEC, and AGC modes are enabled together, the camera starts by changing the iris position first. Depending on initial lighting conditions, the camera applies AIC, AEC, and AGC algorithms according to either Case 1 or Case 2 shown below.

CASE 1

When the Current image luminance **is lower than the** Target image luminance, the camera expands the iris opening allowing more light through the lens. When the iris is Fully Open (*AicIrisMin* is reached), the camera indicates the minimum limit (in steps) has been reached. (The iris is Fully Open when the current iris position (in steps) is minimum.) The camera then increases the exposure until the exposure reaches the maximum limit. The camera indicates the exposure maximum limit has been reached and increases the gain until either the target image luminance is achieved, or the maximum gain limit is reached.

The camera maintains these values until the lighting conditions change and starts by decreasing the gain first to decrease the image luminosity. If the gain minimum limit is reached, the cameras decreases the exposure until it reaches the minimum limit. The camera then indicates the exposure minimum limit has been reached and closes the iris until either the target luminosity is achieved, or the iris is Fully Closed (*AicIrisMax* is reached).

CASE 2

When the Current image luminance **is higher than the** Target image luminance, the camera contracts the iris opening allowing less light through the lens. When the iris is Fully Closed (*AicIrisMax* is reached), the camera indicates the maximum limit has been reached. (The iris is Fully Closed when current Piris position (in steps) is maximum.) The camera then decreases the exposure until either the luminance target is achieved, or the minimum exposure limit is reached.

The camera maintains these values until the lighting conditions change. The camera then follows the algorithm described in **Case 1** to increase the image luminance starting with iris adjustments to increase image luminance.

> **NOTE** ✱
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> The size of an iris opening (aperture) affects a depth of field (DOF). The larger the aperture, the blurrier the background and foreground of an image. The smaller the aperture, the sharper the image.
>
> A long exposure causes a blurring effect when capturing fast-moving objects.

The AIC/AEC/AGC algorithm samples all pixels for the entire frame. The camera displays the current luminance within the frame, the current exposure, the current gain, and the current iris position.

AIC, AEC, and AGC control and status parameters

Parameter Name	Type	Value		Access	Description
GainAuto	Enumeration	**String** "Off" "Continuous"	**Num.** 0 1	RW	Enables automatic gain control (AGC) mode.
AgcGainMin	Float	Min: 0 Max: AgcGainMax		RW	Sets the minimum gain applied (in dB) when AGC is enabled. Increment is 0.1 dB.
AgcGainMinRaw	Integer	Min: 0 Max: AgcGainMax		RW	Sets the minimum Digital Gain value for the AGC mode in RAW units.
AgcGainMax	Float	Min: AgcGainMin Max: 48.000		RW	Sets the maximum gain applied (in dB) when AGC is enabled. Increment is 0.1 dB.
AgcGainMaxRaw	Integer	Min: AgcGainMin Max: 480		RW	Sets the maximum Digital Gain value for the AGC mode in RAW units.

Parameter Name	Type	Value		Access	Description
ExposureAuto	Enumeration	**String** "Off" "Continuous"	**Num.** 0 1	RW	Enables automatic exposure control (AEC) mode.
AecExposureMin	Integer	Min: MinExposureTime Max: AecExposureMax		RW	Sets min. exposure time value for AEC in microseconds.
AecExposureMax	Integer	Min: AecExposureMin Max: IntExposureMax		RW	Sets max. exposure time value for AEC in microseconds.
Automatic Iris Control Parameters:					
IrisAuto	Enumeration	**String** "Off" "Continuous"	**Num.** 0 1	RW	Sets the automatic iris control (AIC) mode
AicIrisMin	Integer	Min: 0 Max: AicIrisMax		RW	Sets the Minimum Iris position (max aperture) for the AIC in steps.
AicIrisMax	Integer	Min: AicIrisMin Max: PIrisMaxValue		RW	Sets the Maximum Iris position (min aperture) for the AIC in steps.
AgcAecAicLuminanceLevel	Integer	Min: 1 Max: 4095		RW	Sets target luminance level for AGC/AEC/AIC up to 4095 counts.
AgcAecAicLuminanceType	Enumeration	**String** "Average" "Peak"	**Num.** 0 1	RW	Sets how the luminance level in the scene is determined.
AgcAecAicSpeed	Enumeration	**String** "x1" "x2" "x3" "x4"	**Num.** 0 1 2 3	RW	Sets AEC/AGC/AIC tracking speed. 4x is the fastest, 1x is the slowest.

NOTE ✱ You might need to adjust the *PIrisMax* parameter if the **maximum number of steps** of your P-IRIS lens differs from the pre-set one. Please see the Configuring PIrisMax section for more information.

Parameter Name	Type	Value	Access	Description
AgcGainCurrentValue	Float	Min: 0.0 Max: 48.0	RO	Reports current value of gain in AGC mode in dB.
AgcGainCurrentValueRaw	Integer	Min: 0 Max:480	RO	Reports current value of gain in AGC mode in RAW units.
AgcMinLimitReached	Integer		RO	Returns whether or not the minimum gain limit was reached during AGC operation.
AgcMaxLimitReached	Integer		RO	Returns whether or not the maximum gain limit was reached during AGC operation.

Parameter Name	Type	Value	Access	Description
AecExposureCurrentValue	Integer		RO	Reports current value of exposure in microseconds in AEC mode.
AecMinLimitReached	Integer		RO	Returns whether or not the minimum exposure limit was reached during AEC operation.
AecMaxLimitReached	Integer		RO	Returns whether or not the maximum exposure limit was reached during AEC operation.
Automatic Iris Status Parameters:				
AicIrisCurrentValue	Integer		RO	Displays the current position of Iris in steps
AicMinLimitReached	Integer		RO	Returns whether or not the minimum iris limit (max aperture) was reached during AIC operation.
AicMaxLimitReached	Integer		RO	Returns whether the maximum iris limit (min aperture) was reached during AIC operation.
CurrentAvgOrPeakLuminance	Integer		RO	Returns current average or peak luminance in counts.
AgcAecAicStatus	Integer		RO	Displays the value of AgcAecStatus register.

Terminology

Current image luminance (*CurrentAvgOrPeakLuminance*) is an image luminance due to the current iris position, exposure and gain values under the current lightning conditions. It might be lower, higher, or equal to the target image luminance. A camera adjusts the iris position, exposure, and gain until the target image luminance is reached.

Target image luminance (*AgcAecAicLuminanceLevel*) is a user-specified luminance level. It is used by the AIC, AEC, and AGC algorithms as a target when adjusting iris, exposure and gain. You can set the target luminance level to any value from 0 to 4095. If using 8 bits per pixel, only the upper 8 bits of this setting are used (4095 setting = 255).

Fully Open iris position:

- determines the maximum size of the iris opening (aperture). The amount of light reaching the sensor is maximum;
- is set by the *AicIrisMin* parameter, in steps (0 by default);
- is represented by the minimum f-number. The depth of field is shallow, and the image background and foreground are blurry.

f/2

Fully Closed iris position:

- determines the minimum size of the iris opening (aperture). The amount of light reaching the sensor is minimum;
- is set by the *AicIrisMax* parameter, in steps (73 by default);
- is represented by the maximum f-number. The depth of field is deep, and the image is sharp.

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