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Application Note:
Integrating Motorized Lenses with Prosilica GX Cameras

Traditional machine vision applications rely on consistent and repeatable lighting conditions in order to ensure accurate measurements and reliable system performance. These applications are most often indoors. With the introduction of long cable length interfaces such as GigE Vision, distances between cameras and host PC have increased considerably. Long cable length interfaces are taking machine vision systems into remote environments, often outdoors where scene illumination is unpredictable and remote lens control is critical.

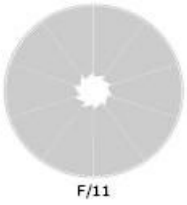
Benefits of Motorized Iris

When implementing a manual iris lens in an automated vision system, the user is required to select an optimal iris F stop setting for the application. Typically this selection cannot be changed once the system is running.

A low F stop, ie. F 1.4 provides a fully open iris, passing majority of the light through the lens and onto the sensor. Collecting as much light as possible is highly desired when capturing images of fast moving targets or a poorly illuminated scene. More light allows the camera sensor to use shorter exposure times. If insufficient light passes through the lens, exposure time or gain needs to be increased. Increasing exposure time introduces motion smear, applying gain increases noise in the image. Both of these effects reduce the accuracy or effectiveness of an imaging application.

A high F stop , eg. F 11 in comparison closes the iris to the smallest opening, minimizing the amount of light which passes through the lens and onto the sensor. Using a high F stop has many advantages including increased depth of field, and reduced smearing. A high F stop becomes necessary for outdoor applications, where the sun or specular reflections are often found within the field of view.

A manual iris lens is optimized for a particular scene illumination; camera imaging performance is compromised under changing lighting conditions. A motorized iris allows the system to change the iris F stop with changing light conditions.



Types of Motorized Lens Control

Motorized lenses have been used for security applications for many years. Most designs outfit manual focus, iris and zoom lenses with motors on the outside of the lens to provide this functionality. Smaller form factor products which mechanically incorporate electric motors into the lens design are available at a premium. Most motorized lenses offer both Auto Iris and Direct Drive control. Auto Iris lenses only motorize the iris; focus is manually adjusted. Direct Drive lenses motorize iris, focus and zoom (if available).

Direct Drive lenses (Image 1) can be used on all three axis: iris, focus and zoom depending on the capabilities of the specific lens being used. A bipolar lens uses individual control lines for each axis. Positive signal polarity opens the iris, moves focus to infinity or increases the focal length of the lens. A negative polarity signal does the opposite. Unipolar lenses have additional control lines representing negative polarity signals. A Direct Drive motorized lens does not provide any automation functionality unless the particular lens includes Video or DC Auto Iris control lines. As such, automating the iris using a Direct Drive lens requires additional application level development from the user.

Image 1 – Direct Drive lens

Image 2 – Auto Iris lens

Auto iris lenses are available in two flavors: DC Auto Iris and Video Auto Iris (Image 2). DC Auto Iris lenses take input from the camera in the form of a DC signal which represents a particular F stop. Video Auto Iris lenses rely on comparing the amplitude of a reference voltage to the video signal originating from the camera to determine if the iris should be opened or closed. The amplitude of the video signal is determined by the camera by calculating the mean of the most recent captured image. If the video signal amplitude is higher than the reference voltage, the iris is opened until the video signal amplitude is decreased. Once the video signal amplitude is below the reference signal the lens begins to close the iris. The floating iris nature of Video auto iris lenses makes it necessary to image continuously, ie 15 fps. If the camera relies on an irregular trigger for instance (ie. every 2 seconds), the iris may close completely before the next trigger is received, a new mean is calculated and the video signal is updated.

	Video Auto Iris	DC Auto Iris	Direct Drive
Prosilica GX	☑	☒	☑

Fig 1 –GX Support for Motorized Lenses

Connecting Motorized Lenses to Prosilica GX Cameras

The Prosilica GX cameras offer a dedicated Lens Control Port for Video auto iris and Direct drive motorized lens control. The mating cable connector required for the lens control port is Hirose 3240-8P-C(50).

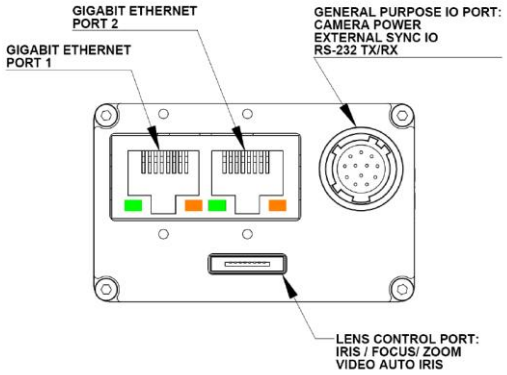
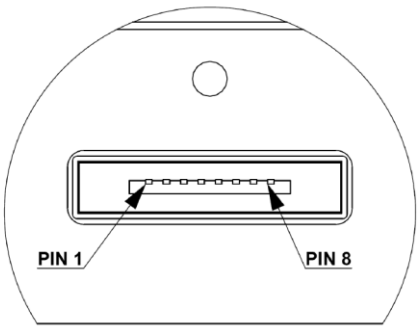


Figure 2 – Rear view of GX camera



PIN	FUNCTION
1	IRIS +
2	IRIS -
3	FOCUS +
4	FOCUS -
5	ZOOM +
6	ZOOM -
7	AUTO IRIS SIGNAL
8	GROUND

Figure 3 – GX Lens Control Port

Connecting Direct Drive Lenses

Direct drive motorized lenses are available as bipolar and unipolar electrical connections. The GX supports both. As shows below, the bipolar connection diagram utilizes a dedicated control line for each axis direction whereas the unipolar lens utilizes a single control line which can accept positive and negative control signals depending on the direction of axis rotation. Lens manufactures readily provide connection diagrams for all of their products allowing the user to easily identify if the lens offers bipolar or unipolar control signals.

Figure 4 – Direct Drive Lens, bipolar type connection diagram

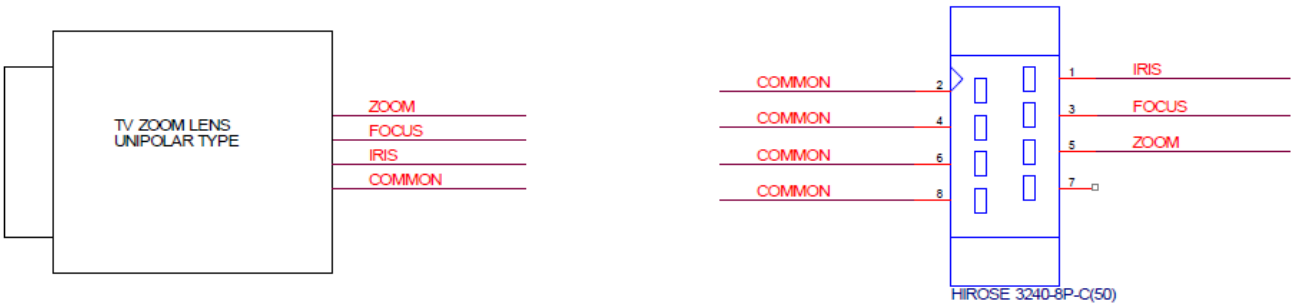


Figure 4 – Direct Drive Lens, unipolar type connection diagram

Connecting Video Auto-Iris Lenses

Video auto iris lenses are connected to the Lens Control Port on the back of the GX camera. Power for the lens can be sourced from the camera power supply as shown below.

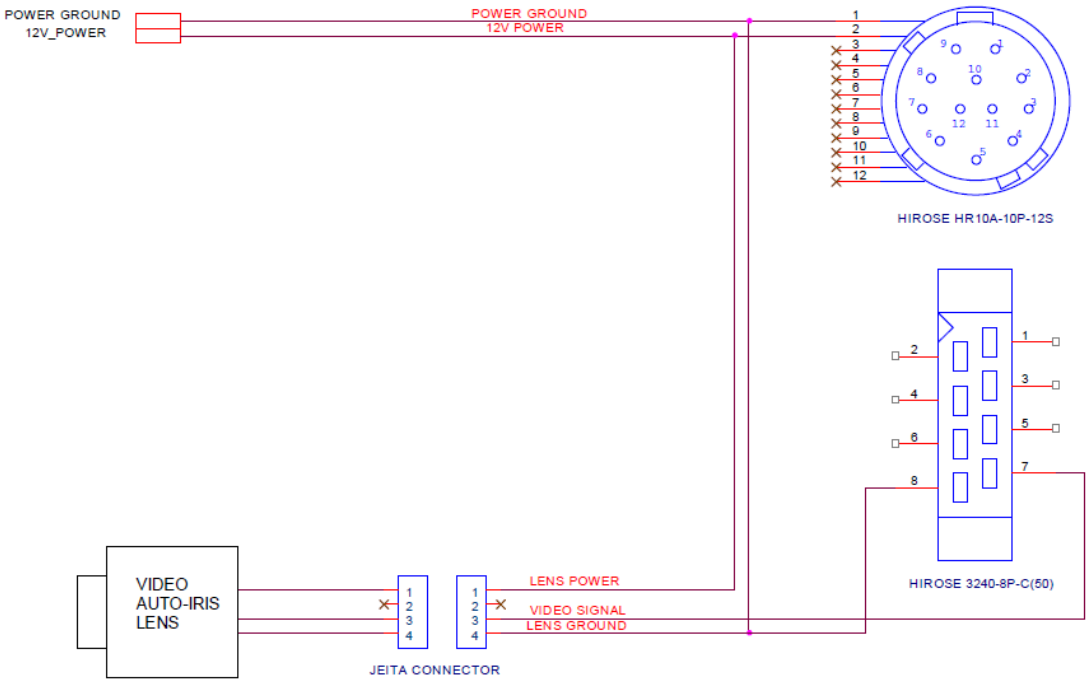


Figure 5 – Video Auto Iris lens control connection diagram

Controlling Direct Drive Lenses via API

Direct drive lens control uses parameters for each function such as open iris or zoom out along with a time parameter which defines the duration of executing each command. Unfortunately, these lenses do not offer standard voltages for interfacing with lens controllers or Prosilica GX cameras. As a result, different voltage amplitude signals are required to drive lenses from Rainbow or Schneider Optics for instance. Exceeding the specified voltage value can damage the lens. To allow users to interface direct drive lenses from almost any manufacturer, the Prosilica GX uses the LensVoltageControl attribute to encode the lens drive amplitude. The following camera control attributes are used to control direct drive lenses using a Prosilica GX camera:

LensDriveCommand – Enum – R/W

Setting to any non-Stop value will execute the function for LensDriveDuration and return to Stop.

Stop	No action.
IrisTimedOpen	Open lens iris.
IrisTimedClose	Close lens iris.
FocusTimedNear	Shorten working distance.
FocusTimedFar	Lengthen working distance.
ZoomTimedIn	Zoom in.
ZoomTimedOut	Zoom out.

LensDriveDuration – Uint32 – R/W

In ms. Duration of timed lens commands.

LensVoltage – Uint32 – R/V

In mV. Lens power supply voltage.

LensVoltageControl – Uint32 – R/W

Lens power supply voltage control. Set value as mV * 100001. E.g. 12 V = 1200012000. If a bad value is written this control resets to 0. This is done to prevent users inadvertently setting an inappropriate voltage, possibly damaging the lens. See lens documentation for appropriate voltage level. LensVoltageControl is set to zero on startup, the value cannot be saved in camera memory to prevent lens damage in the event that a different voltage lens is connected to the camera.

```
Pseudo Code:
        Set LensVoltageControl
        Select LensDriveCommand
        Select LensDriveDuration
```

Controlling Video Auto Iris Lenses via API

All video-type auto iris lenses compare the video signal coming from the camera to a reference voltage in the lens. When the video signal amplitude is higher than the reference, the iris closes. When the video signal amplitude is less than the reference, the iris opens. The auto iris algorithm running on the camera calculates the appropriate video signal - IrisVideoLevel. This is determined according to the brightness of the most recent image, taking into account other control variables such as IrisAutoTarget.

Note: The camera must be acquiring images in order for the auto iris algorithm to update.

IrisAutoTarget – Uint32 – R/W

In percent. Controls the general lightness or darkness of the auto iris feature; specifically the target mean histogram level of the image, 0 being black, 100 being white.

IrisMode – Enum – R/W

Sets the auto-iris mode.

Disabled	Turn off the video auto-iris function.
Video	Turn on the video auto-iris function.
VideoOpen	Fully open the iris.
VideoClosed	Full close the iris.

IrisVideoLevel – Uint32 – R/W

In 10 mV units. This attribute reports the strength of the video signal coming from the camera.

IrisVideoLevelMax – Uint32 – R/W

In 10 mV units. Limits the maximum driving voltage for closing the lens iris. Typically this will be 150, however it may vary dependent on the lens reference voltage.

IrisVideoLevelMin – Uint32 – R/W

In 10 mV units. Limits the minimum driving voltage for opening the lens iris. Typically this will be 0.

Pseudo Code:

```
Set IrisMode
Start Imaging
```

Controlling GX motorized lenses with 3rd party libraries

The API attributes described above are contained in the camera XML file. GigE Vision drivers use the XML file to determine camera feature support and to provide access to these features. This allows camera manufacturers to introduce new features without additional changes to third party software libraries. The screenshot below presents the GX1910 camera being used with the Measurement & Automation Explorer from National Instruments. The Video Auto Iris (Iris) and Direct Drive (LensDrive) lens controls are listed in the Camera Attributes feature tree.

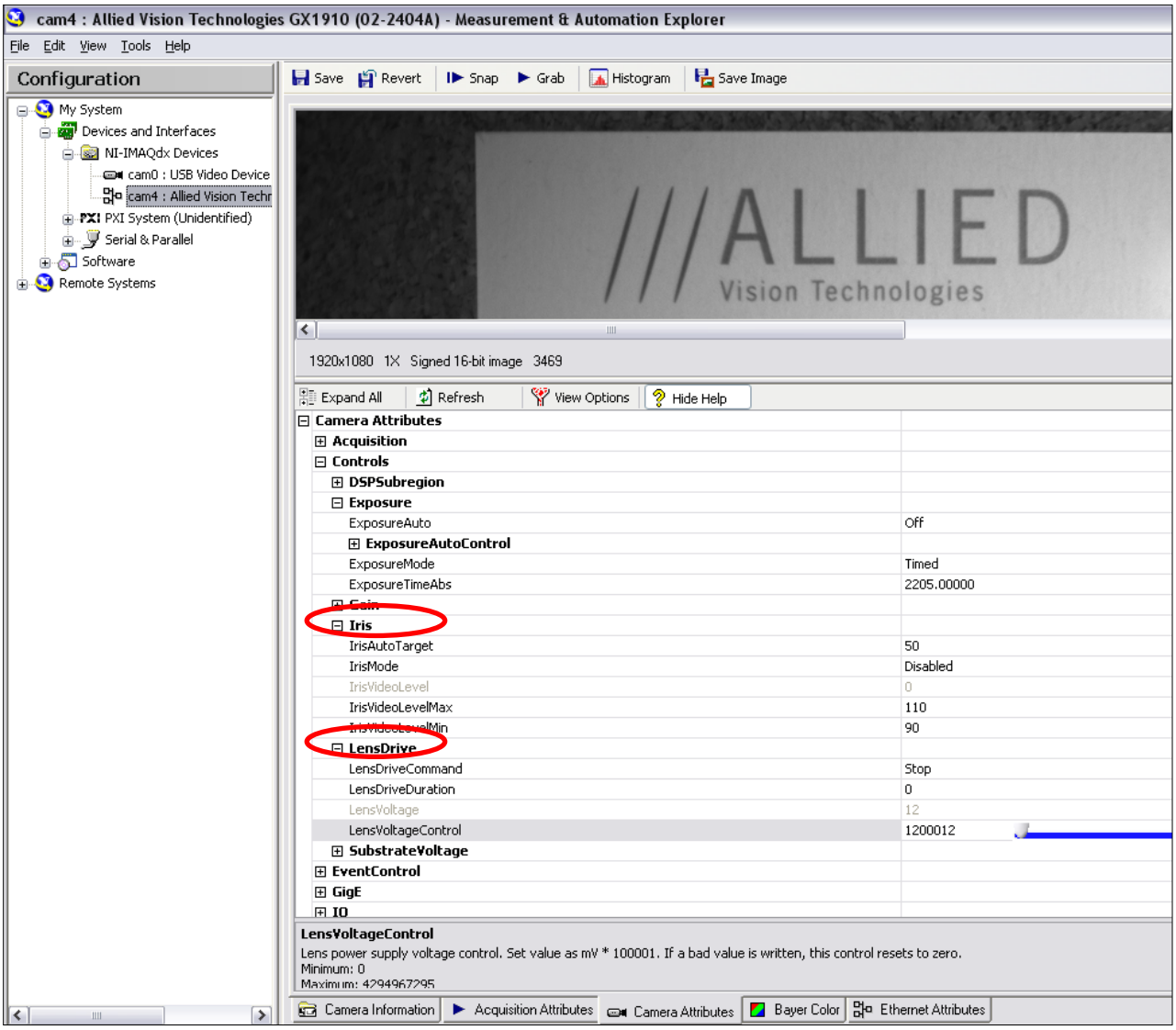


Figure 6 – Prosilica GX1910 control via Measurement & Automation Explorer from National Instruments

Motorized Lens Selection

The security market has been using motorized lenses for a long time however most of these lenses are used with low resolution cameras and small sensor formats. The GX cameras utilize 1/2" – 2/3" format sensors, limiting the selection of motorized lenses to larger sensor formats. Optical quality specific to motorized lenses is very loosely defined by the optics manufacturers.

The following listing is provided for reference only, representing a small sample of the complete list of compatible products. Exclusion from this table does not suggest the product is not compatible with the Prosilica GX. Please contact support@alliedvisiontec.com with additional questions.

Manufacturer	Description	Motorized Iris	Motorized Focus	Motorized Zoom	Video auto iris
Schneider Optics	Cinegon and Xenoplan motorized iris, high optical quality, small package, ie. Xenoplan 1.4/17MM	☑	☒	☒	☑
Linos	MeVis Motorized Series, high optical quality, ie. MeVis-Cm 1.6/16 mm	☑	☑	☒	☒
Rainbow	Motorized Zoom Series, ie. SM6X11M (EA-II)	☑	☑	☑	☑
Kowa	Motorized Zoom Series, ie. LMZ1117M3P3	☑	☑	☑	☑
Computar	Motorized Zoom Series, limited to ½" optical format (GX1050 only), ie. H6Z0812M,	☑	☑	☑	☑
Goyo Optical	Auto iris lenses upto 2/3" optical format, ie GA37514AC	☒	☒	☒	☑

Image 3 - Schneider Motorized Iris Lens

Reference Documentation

1. GX camera manual. Contain GX lens control port definition
   http://www.alliedvisiontec.com/us/support/downloads/product-literature/prosilica-gx.html
2. AVT GigE Camera and Driver Attributes. Contains lens control attribute definitions
   http://www.alliedvisiontec.com/fileadmin/content/PDF/Software/Prosilica_software/Prosilica_software_stuff/AVT_Camera_and_Driver_Attributes_v1.38.pdf

We invite comments or suggestions on this document at any time.
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