

GenICam ICD FLIR AX5 Camera - PC

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1 Connectivity Overview

1.1 Physical interfaces

The FLIR IR camera, when used for GenICam data transfer, can be used in two ways.

- Dedicated Gigabit Ethernet
- Shared Ethernet

A Dedicated Gigabit Ethernet is recommended for high speed applications and when image streaming would disturb other equipment on a Shared Ethernet.

1.2 Low level protocols

On the mentioned physical interface, it is possible to run different low level protocols.

1.2.1 Ethernet

The IP GigEVision streaming protocol is used for image transfer and the GigEVision control protocol is used for camera control.

Some other IP protocols are supported for network management functions. They should work seamlessly on any LAN, provided that a proper IP adress, netmask and possibly gateway is set in the camera.

1.3 Functionality

The ethernet communication functionality is provided by an iPORT IP Engine inside the camera. You can use it to manage image streaming and control the camera through the GenICam command control interface.

1.3.1 GenICam

To be able to acquire images and control the camera, you have to have a software environment that meets the specifications of the machine vision standards GigE Vision and GenICam. For more information about this, see <http://www.genicam.org/>.

Such environments are, for example,

- "Measurement and Automation Explorer (MAX)" from National Instruments.
- "EBus SDK" from Pleora Technologies.
- "Common Vision Blox" from Stemmer Imaging.

The camera supports the GenICam standard command set, and some FLIR specific commands.

The GenICam Standard Features Naming Convention (available at <http://www.genicam.org/>) is used.

1.3.2 IP services

It is also possible to access the system using tcp/ip with the exposed services described here.

1.3.2.1 DHCP

The camera supports the client part of the Dynamic Host Configuration Protocol (DHCP).

1.3.2.2 Remote detection

1.3.2.2.1 GigEVision Control Protocol (GVCP)

GigEVision camera queries return the model name and MAC address of the cameras found.

For more information, see <http://www.machinevisiononline.org>

2 GenICam Commands

2.1 Introduction

The goal of GenICam is to provide a generic programming interface for all kinds of cameras.

The GenICam standard consists of multiple modules according to the main tasks to be solved:

- GenApi : GenICam application programming interface (API) for camera configuration and control
- GenTL : GenICam transport layer (TL) for grabbing images

The GenApi module deals with the problem of how to configure and control a camera. The key idea is to make camera manufacturers provide machine readable versions of the manuals for their cameras. These camera description files contain all of the required information to automatically map a camera's features to named *registers*.

The GenTL module is still under construction. Until it is finished, image transfers are made through software environment specific interfaces.

This section defines the GenICam registers of the GigEVision compatible camera.

Inside the FLIR AX5 camera, there is an iPORT IP Engine. It has a number of status registers and registers that control the way in which it acquires images from the camera.

From the iPORT IP Engine point of view, the FLIR AX5 camera is regarded as a GigE Vision device with some special FLIR Camera features.

To be able to use these registers to acquire images and control the camera, you have to establish a connection to it through a software environment that meets the specifications of the machine vision standards GigE Vision and GenICam, such as the eBus SDK from Pleora Technologies.

2.2 GenICam registers



Depending on the camera model, all registers may not be available or functional on a particular camera.

2.2.1 Register types

The registers have one of the following types:

| | |
|--|---|
| Integer | An integer value, between -2 147 483 648 and 2 147 483 647. |
| String (max length including null) | An ASCII string, for example "ThermaCAM". The string must be terminated with a Null (binary 0) character |
| Bool | The integer value 1 for true, or the integer value 0 for false. |
| Float | An IEEE 754 -1985 encoded floating point value, between $\pm 3.4028235 \times 10^{38}$. |
| Enum | An integer value with a specific encoding. |
| Cmd | An integer value with a specific encoding used as a command. |

They can be accessed in one of these three ways:

| | |
|----|------------|
| RO | Read only |
| RW | Read write |
| WO | Write only |

2.2.2 IP Engine status and control

To establish a connection through the Pleora eBUS SDK, you have to connect using the IP address of the camera and retrieve a handle to the map of register nodes. Information about them will automatically be downloaded from the camera.

2.2.2.1 Device Information registers

Registers associated with device information

| Name | Type | Access | Comment |
|------------------------|-------------|--------|--|
| DeviceVendorName | String (32) | RO | Provides the name of the manufacturer of the device. |
| DeviceModelName | String (32) | RO | Provides the model of the device. |
| DeviceVersion | String (32) | RO | Provides the version of the device. |
| DeviceManufacturerInfo | String (48) | RO | Provides extended manufacturer information about the device. *) |
| DeviceID | String (16) | RO | This register holds a camera identifier. |
| DeviceUserID | String (16) | RW | This register holds a user-programmable identifier. |
| DeviceReset | Cmd | WO | Resets the Camera Head and the IP Engine. |
| CameraSN | Integer | RO | Camera module serial number. |
| SensorSN | Integer | RO | Sensor serial number. |
| CameraFirmwareVersion | Integer | RO | Camera module software version. |
| SensorFirmwareVersion | Integer | RO | Sensor firmware version. |
| SensorResolution | Enum | RO | Sensor resolution 0=Tau2 640x512, 17u 1=Tau2 336x256, 17u 2=Tau2 320x256, 25u 3=Tau2 160x128 4=Tau2 80x64 |
| SensorFocalLength | Enum | RO | Sensor focal length in millimeters 0=7.5 mm 1=9 mm 2=13 mm |

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| | | | 3=19 mm 4=25 mm 5=35 mm (Fits onto the WFOV flange) 6=35 mm 7=50 mm 8=60 mm 9=100 mm 10=5 mm |
| SensorFrameRate | Enum | RO | Sensor frame rate 0=Slow 1=Fast |
| SensorTemperature | Float | RO | FPA temperature in Celsius |
| HousingTemperature | Float | RO | Sensor module housing temperature. (Added in XML interface ver 1.1.8) |
| CameraHeadReset | Cmd | WO | Resets only the Camera Head. (Added in XML interface ver 1.1.7) |

*) The DeviceManufacturerInfo register contains six entries separated by commas (Camera ID, Generic ID, Streaming interface, Streaming interface version, Command interface, Command (or XML) interface version), for example: "ATAU, Gen_A/G, GEV, 1.0.0,GEV,1.1.6".

2.2.2.2 IP Engine status registers

Registers associated with the IP Engine status

| Name | Type | Access | Comment |
|------------------------------|---------|--------|---|
| IPEngineFirmwareVersionMajor | Integer | RO | This register represents the major version of the iPORT IP Engine firmware. |
| IPEngineFirmwareVersionMinor | Integer | RO | This register represents the minor version of the iPORT IP Engine firmware. |
| IPEngineInitSequenceStatus | Integer | RO | This register reports the status of the initialization sequence. A null value indicates that the initialization sequence ran successfully. Otherwise, it returns the index of the register write that failed in the sequence. |

2.2.3 GigE Vision (GEV) standard interface

2.2.3.1 GigE Vision Image size control registers

Registers associated with the image size.

| Name | Type | Access | Comment |
|-------------------|---------|--------|--|
| Width | Integer | RW | This register represents the current image width from the camera (in pixels). Mandatory GEV feature. |
| Height | Integer | RW | This register represents the current image height from the camera (in pixels). Mandatory GEV feature. |
| OffsetX | Integer | RW | This register represents the horizontal distance (in pixels) from the center of the detector to the center of the image. This offset plus the current image width cannot exceed the detector width. |
| OffsetY | Integer | RW | This register represents the vertical distance (in pixels) from the center of the detector to the center of the image. This offset plus the current image width cannot exceed the detector height. |
| PixelFormat | Enum | RW | This register indicates the format of the pixel to use during the acquisition. Pixel format as defined in GVSP (the GigEVision Streaming Protocol). Mandatory GEV feature. The difference between Mono14 and Mono16 is the alignment of the 14-bit signal value. In Mono16 the value is MSB aligned (bit2 to bit15) and in Mono14 the value LSB aligned (bit0 to bit13). |
| PayloadSize | Integer | RO | Number of bytes transferred for each image on the stream channel. Mandatory GEV feature. |
| TestImageSelector | Enum | RW | This feature selects the type of test image that is created by the GEV interface board. 0=Off 1= TestPattern |

2.2.3.2 GigE Vision Acquisition control registers

Registers associated with the IP Engine acquisition of images from the camera and their transmission on the ethernet.

| Name | Type | Access | Comment |
|-----------------------|---------|--------|--|
| AcquisitionFrameCount | Integer | RW | This register provides the number of frames to be acquired in MultiFrame Acquisition mode. |
| AcquisitionMode | Enum | RW | This register controls the acquisition mode of the device. Mandatory GEV feature. 0=Continuous 1=SingleFrame 2=MultiFrame |
| AcquisitionStart | Cmd | WO | This register starts the Acquisition of the device. Mandatory GEV feature. |
| AcquisitionStop | Cmd | WO | This register stops the Acquisition of the device at the end of the current Frame. Mandatory GEV feature. |

2.2.3.3 GigE Vision Network Configuration registers

Registers associated with the GEV transport protocol.

| Name | Type | Access | Comment |
|---|---------|--------|--|
| GevVersionMajor | Integer | RO | This register represents the major version of the GEV specification |
| GevVersionMinor | Integer | RO | This register represents the minor version of the specification. |
| GevDeviceModeIsBigEndian | Bool | RO | Endianness might be used to interpret multi-byte data for READMEM and WRITEMEM commands. |
| GevDeviceModeCharacterSet | Enum | RO | This register represents the character set used by all the strings of the bootstrap registers. |
| GevMACAddressHigh | Integer | RO | This register stores the upper two bytes of the MAC address of the given network interface. |
| GevMACAddressLow | Integer | RO | This register stores the lower four bytes of the MAC address of the given network interface. |
| GevSupportedIPConfigurationLLA | Bool | RO | This register indicates if Link Local Address IP configuration scheme is supported by the given network interface. |
| GevSupportedIPConfigurationDHCP | Bool | RO | This register indicates if DHCP IP configuration scheme is supported by the given network interface |
| GevSupportedIPConfigurationPersistentIP | Bool | RO | This register indicates if Persistent IP configuration scheme is supported by the given network interface. |
| GevCurrentIPConfigurationLLA | Bool | RW | This register indicates if Link Local Address IP configuration scheme is activated on the given network interface. |
| GevCurrentIPConfigurationDHCP | Bool | RW | This register indicates if DHCP IP configuration scheme is activated on the given network interface. |
| GevCurrentIPConfigurationPersistentIP | Bool | RW | This register indicates if PersistentIP configuration scheme is activated on the given network interface |
| GevCurrentIPAddress | Integer | RO | This register reports the IP address for the given network interface once it has been configured. |

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| Name | Type | Access | Comment |
|-----------------------------|--------------|--------|---|
| GevCurrentSubnetMask | Integer | RO | This register provides the subnet mask of the given interface. |
| GevCurrentDefaultGateway | Integer | RO | This register indicates the default gateway IP address to be used on the given network interface. |
| GevFirstURL | String (512) | RO | This register holds the first URL to the XML device description file. |
| GevSecondURL | String (512) | RO | This register holds the second URL to the XML device description file. |
| GevNumberOfInterfaces | Integer | RO | This register indicates the number of physical network interfaces supported by this device |
| GevPersistentIPAddress | Integer | RW | This register indicates the Persistent IP address for this network interface. |
| GevPersistentSubnetMask | Integer | RW | This register indicates the Persistent subnet mask associated with the Persistent IP address on this network interface. |
| GevPersistentDefaultGateway | Integer | RW | This register indicates the persistent default gateway for this network interface. |
| GevHeartbeatTimeout | Integer | RW | This register indicates the current heartbeat timeout in milliseconds. |
| GevCCP | Enum | RW | This register is used to grant privilege to an application. 0=Open access 1=Exclusive access 2=Control access |
| GevSCPIInterfaceIndex | Integer | RW | Index of network interface to use (from 0 to 3). |

To make the iPort announce network configuration changes on the ethernet, you have to reset the iPort using the DeviceReset command register.

2.2.4 FLIR AX5 Camera interface

2.2.4.1 Feature registers

Registers associated with camera features

| Name | Type | Access | Comment |
|----------------------------|---------|--------|--|
| CameraCapabilities | Integer | RO | Camera capabilities. Bit mask. 0=Focus, auto focus single shot 1=Focus, motor 2=Digital I/O capable 3=IRWindowing |
| SensorSetDefaults | Cmd | WO | Sets all current settings as power on defaults |
| SensorSetToFactoryDefaults | Cmd | WO | Reset camera with factory header values. |
| SyncMode | Enum | RW | External sync feature. The camera provides the ability to either accept or output a frame synchronization signal. 0=Disabled (default). The camera will turn off frame synchronization. 1=SelfSyncMaster. The camera will output a frame synchronization signal on the Sync output pin of the GPIO connector. 2=SelfSyncSlave. The camera will accept a frame synchronization signal on the Sync input signal on the GPIO connector. The camera output will be frozen if the camera is in slave mode and no external synchronization signal is received. 3=ExtSyncMaster. The camera will accept a frame synchronization signal on the Sync input signal on the GPIO connector. The camera output will be frozen if the camera is in slave mode and no external synchronization signal is received. The camera will output a frame synchronization signal on the Sync output pin of the GPIO connector when configured as a Sync master. |
| BaudRate | Enum | RW | Gets or sets the baud rate of the serial comm. channel. Default is Auto detected. |

2.2.4.2 Measurement registers

The camera has a list of measurement ranges (called gain modes) which you can inspect through these registers. You can also make the camera switch to one of them using the SensorGainMode register.

Temperature (in Kelvin) = $B / \log(R / (S - O) + F)$, where S is the 14-bit digital signal value. $\log(x)$ is the base-e logarithm of the x parameter.

| Name | Type | Access | Comment |
|----------------|---------|--------|---|
| SensorGainMode | Enum | RW | Dynamic range control mode. 1=Low gain mode (lower sensitivity), high temperatures. 2=High gain mode for lower temperatures (< 100 deg Celsius) |
| R | Integer | RW | Gets and sets the Planck R constant. This value is used when converting from signal value to temperature. |
| B | Float | RW | Gets or sets Planck B constant. This value is used when converting from signal value to temperature. Value range 1300 - 1600. |
| F | Float | RW | Gets or sets Planck F constant. This value is used when converting from signal value to temperature. Value range 0.5 - 2. |
| O | Float | RW | Gets and sets Planck O (offset) constant. This value is used when converting from signal value to temperature. |
| Spot | Float | RO | Center spot meter in degrees Celsius. |
| LensNumber | Enum | RW | Gets or sets the active lens (which affects which correction terms are applied) 0=Lens type 0 (default) 1=Lens type 1 |
| LensSelector | Enum | RW | Selected lens (0 - 1) |
| FNumber | Float | RW | Selected lens F number (focal ratio), 0.5 - 8.0 |
| Transmission | Float | RW | Selected lens transmission factor, 0.5 - 1.0 |

2.2.4.3 Object Parameter registers

Registers associated with infrared measurement conditions.

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| Name | Type | Access | Comment |
|-----------------------|-------|--------|-------------------------|
| ReflectedTemperature | Float | RW | Kelvin, 224.0 - 600.0 |
| ObjectEmissivity | Float | RW | 0.5 - 1.0 (default 1.0) |
| EstimatedTransmission | Float | RW | 0.5 - 1.0 (default 1.0) |

2.2.4.4 Monochrome 8-bit video registers

Registers associated with the 8-bit monochrome video format. Manipulating these registers will only have effect if the DigitalOutput register is bit8bit and the PixelFormat is Mono8.

| Name | Type | Access | Comment |
|-------------------|---------|--------|---|
| Contrast | Integer | RW | Image contrast. Available when ImageAdjustMethod is Manual, Once bright or Autobright. |
| Brightness | Integer | RW | Image brightness. Available when ImageAdjustMethod is Manual. |
| ImageAdjustMethod | Enum | RW | 0=Plateau histogram 1=Once bright 2=Autobright 3=Manual 4=Linear |
| VideoOrientation | Enum | RW | Digital 8-bit video orientation mode 0=Normal 1=Invert (flip image vertically) 2=Revert (flip image horizontally) 3=InvertRevert (flip image vertically and horizontally) |
| PlateauLevel | Integer | RW | Plateau level for ImageAdjustMethod = histogram mode. Range 0-1000. |
| ITTMidpoint | Integer | RW | Gets and sets the ITT midpoint offset |
| BrightnessBias | Integer | RW | Gets and sets the brightness bias value in auto bright mode. Range -2048 - 2048. Only available when ImageAdjustMethod equals Autobright. |
| MaxAGCGain | Integer | RW | Gets and sets the max value of video gain. Range 0-255. |

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| Name | Type | Access | Comment |
|---------------------|---------|--------|--|
| ITFilter | Integer | RW | Gets and sets the IIR filter value. Range 0-255. The IIR filter is used to adjust how quickly the AGC algorithm reacts to a change in scene or parameter value. If the IIR filter value is set to a low value, then if a hot object enters the field of view, the AGC will adjust more slowly to the hot object, resulting in a more gradual transition. In some applications, this can be more pleasing than a sudden change to background brightness. Default value is 64. |
| SensorVideoStandard | Enum | RW | Analogue video mode. Affects frame rate on digital interface. 0=NTSC, 30 Hz 1=PAL, 25 Hz 4=NTSC, 60 Hz (default) 5= PAL, 50 Hz |

2.2.4.5 Image quality registers

Registers associated with the image quality

| Name | Type | Access | Comment |
|--------------------|---------|--------|---|
| NUCMode | Enum | RW | Non-Uniform Correction (NUC) mode 0=Off (manual) 1=Automatic by camera 2=External (no shutter is used) |
| NUCAction | Cmd | WO | Do NUC operation. |
| NUCTempDelta | Float | RO | Temperature difference in Celsius used to trigger automatic NUC. |
| NUCTempDeltaW | Integer | WO | Sets the temperature difference used to trigger automatic non-uniform corrections. Each increment represents 0.1 C. |
| NUCIntervalFrames | Integer | RO | The interval (in frames) between automatic NUC corrections. |
| NUCIntervalFramesW | Integer | WO | The interval (in frames) between automatic NUC corrections. |

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| Name | Type | Access | Comment |
|------------------|---------|--------|---|
| SensorDDEMode | Enum | RW | Dynamic Digital Detail Enhancement mode 0=Manual 1=Automatic |
| SensorDDEGain | Integer | RW | Gain of the DDE filter. Range 1-63. Available only when SensorDDEMode is Manual. |
| SensorDDEThrs | Integer | RW | Threshold of the DDE filter. Range 0-255. Available only when SensorDDEMode is Manual. |
| SensorDDESpatial | Integer | RW | DDE Spatial Threshold. Range 0-15. Available only when SensorDDEMode is Manual. |
| ShutterPosition | Enum | RW | Gets or sets the shutter position 0=Open 1=Close |

2.2.4.6 Image stream registers

Registers associated with the image format or with the image stream..

| Name | Type | Access | Comment |
|---------------|------|--------|---|
| IRTestPattern | Enum | RW | This register selects the type of test image that is created by the IR camera. 0=Off 1= Ascending ramp pattern |
| DigitalOutput | Enum | RW | Gets and sets the digital output channel mode. 2=bit8bit (mono8 digital video, default) 3=bit14bit (filtered 14-bit pixel data) |
| XPMode | Enum | RW | Gets and set the XP channel mode 0=Disabled 1=BT656 2=CMOS (default) |
| LVDSMode | Enum | RW | Gets and sets the LVDS mode 0=Disabled (default) 1=Enabled |
| CMOSBitDepth | Enum | RW | Gets and sets the CMOS mode bit depth 0=14 bit (default) 1=8 bit |
| LVDSBitDepth | Enum | RW | Gets and sets the LVDS mode bit depth 0=14 bit (default) 1=8 bit |

The image pixels are transferred left to right, row by row, from top to bottom. The byte order is in accordance with the `GevDeviceModeIsBigEndian` register.

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2.2.4.7 External I/O registers

Registers associated with configuring camera external I/O ports.

| Name | Type | Access | Comment |
|--------------------|---------|--------|---|
| LineSelector | Enum | RW | Current selected Input port. Line0 represents GPI (General Purpose Input). |
| LineMode | Enum | RO | Type of I/O port 0=Input 1=Output |
| LineStatus | Boolean | RO | Returns the current status of the selected input line |
| LineDebounceFactor | Integer | RW | Controls the width of the window during which spurious transitions from input lines are filtered out (in increments of ~480 ns). Value range is 0 to 65535. |
| UserOutputSelector | Enum | RW | Current selected Output port. UserOutput0 represents GPO (General Purpose Output). |
| UserOutputValue | Boolean | RW | Sets the current status of the selected output line. |