GenICam ICD FLIR Camera

1 Connectivity Overview

1.1 Physical Interfaces

The FLIR IR camera, when used for GigEVision 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 a GigEVision stack 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,

- "Spinnaker SDK" from FLIR
- "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

Independent of physical interface, it is possible to access the system using TCP/IP with the exposed services described here: telnet, ssh, ftp, http, RTSP. More than one service and possibly more than

one instance of the service may be run simultaneously, for instance 2 telnet's and one ftp session together towards the same camera.

1.3.2.1 telnet

Command control, mainly for manual typing. Typical clients are the standard ***telnet*** command on a PC or teraterm. Only available on A3x5 and A6x5 cameras.

1.3.2.2 ssh

Command control, mainly for manual typing. Typical clients are ssh (Linux) or teraterm (Windows). Login credentials are *fliruser* and password is *3vlig*. Note: only available on cameras with Linux OS.

1.3.2.3 ftp

File transfer to/from the camera using an ftp client software on a PC. Typical clients are the standard ftp command on a PC. Login with user *flir* and password *3vlig*. Only available on A3x5 and A6x5 cameras.

1.3.2.4 http

Web server. Typical clients are Microsoft Internet Explorer and Firefox.

1.3.2.5 DHCP

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

1.3.2.6 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

1.3.3 Remote detection

1.3.3.1.1 Multicast DNS (Bonjour)

To query Bonjour for local FLIR IR cameras, use

- Service name: _flir-ircam
- Protocol type: _tcp
- Domain: local

Name	Example value	Explanation
model	S	Camera model, if any
ID	A320	Camera unique ID
GID	Gen_A	Generic ID
SI	FFF_RTSP	Streaming Interface
SIV	1.0.0	Streaming interface version
CI	RTREE	Command interface
CIV	1.0.0	Command interface version

TXT records

Camera	ID	GID
A310,A300	A320	Gen_A
InfraCAM	XCAM	Gen_X
P6xx	P640	Gen_P

GF3xx	GCAM	Gen_A
A615,A645,A655	A645	Gen_G
T6xx	T6X0	Gen_T
E40, E50, E60	ECAM	Gen_E
E75, E85, E95	E640	Gen_E
T1020, T1030sc, T1040,T1050sc	T1KX	Gen_T
Ax8	NCAM	Gen_A
C3 (with Wifi)	CCAM	Gen_C
Ex (with Wifi)	ZCAM	Gen_E
T530,T540	T5XX	Gen_T
T4xx	TCAM	Gen_T

For more information, see http://www.dns-sd.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 deals with image streams and transfers.

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

Inside the FLIR IR camera, there is a GigEVision transmitter. It has a number of status registers and registers that control the way in which it acquires images from the camera.

The FLIR IR camera is regarded as a GigEVision 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 GigEVision and GenICam, such as the Spinnaker SDK from FLIR.

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	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 ±3.4028235×10^38 .
Cmd	An integer value with a specific encoding used as a command.
Enum	A limited range of integer values.

They can be accessed in one of these three ways:

RO	Read only
RW	Read and write
WO	Write only

2.2.2 Status and control

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

2.2.2.1 IP Engine Status registers

Registers associated with the IP engine status. Only present for A3x5 and A6x5 cameras.

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 GenICam standard interface

2.2.3.1 Device Control

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

*) The DeviceManufacturerInfo register contains six entries separated by commas (Camera ID, Generic ID, Streaming interface, Streaming interface version, Command interface, Command interface version), for example: "A645, Gen_A, GEV,1.0.0,GEV,0.2.1".

2.2.3.2 Image Format Control

Registers associated with image size.

Name	Type	Access	Comment
Width	Integer	RW	This register represents the current image width from the camera (in pixels).
Height	Integer	RW	This register represents the current image height from the camera (in pixels).
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).
PayloadSize	Integer	RO	Number of bytes transferred for each image on the stream channel.
TestImageSelector	Enum	RW	This feature selects the type of test image that is created 0 = Off 1 = TestPattern

2.2.3.3 Acquisition Control

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

Name	Type	Access	Comment
AcquisitionFrameCount	Integer	RW	Provides the number of frames to be acquired in MultiFrame Acquisition mode.
AcquisitionMode	Enum	RW	Controls the acquisition mode of the device. 0 = Continuous 1 = SingleFrame 2 = MultiFrame
AcquisitionStart	Cmd	WO	Starts the Acquisition of the device.
AcquisitionStop	Cmd	WO	Stops the Acquisition of the device at the end of the current frame.

2.2.3.4 Transport Layer Control

Registers associated with the GigEVision transport protocol.

Name	Type	Access	Comment
GevVersionMajor	Integer	RO	The major version of the GEV specification
GevVersionMajor	Integer	RO	The minor version of the GEV specification
GevMACAddressHigh	Integer	RO	Stores the upper two bytes of the MAC address of the given network

			interface.
GevMACAddressLow	Integer	RO	Stores the lower four bytes of the MAC address of the given network interface.
GevSupportedOptionSelector	Enum	RW	Selects the GEV option to interrogate for existing support.
GevSupportedOption [GevSupportedOptionSelector]	Bool	RO	Returns true if the selected GEV option is supported.
GevCurrentIPConfigurationLLA	Bool	RW	Controls if Link Local Address IP configuration scheme is activated on the given network interface.
GevCurrentIPConfigurationDHCP	Bool	RW	Controls if DHCP IP configuration scheme is activated on the given network interface.
GevCurrentIPConfigurationPersistentIP	Bool	RW	Indicates if PersistentIP configuration scheme is activated on the given network interface
GevCurrentIPAddress	Integer	RO	Reports the current IP address for the given network interface once it has been configured.
GevCurrentSubnetMask	Integer	RO	Provides the current subnet mask of the given interface.
GevCurrentDefaultGateway	Integer	RO	Indicates the default gateway IP address to be used on the given network interface.
GevFirstURL	String (512)	RO	Holds the first URL to the XML device description file.
GevSecondURL	String (512)	RO	Holds the second URL to the XML device description file.
GevPersistentIPAddress	Integer	RW	Indicates the persistent IP address for this network interface.
GevPersistentSubnetMask	Integer	RW	Indicates the persistent subnet mask associated with the persistent IP address on this network interface.
GevPersistentDefaultGateway	Integer	RW	Indicates the persistent default gateway for this network interface.
GevCCP	Enum	RW	Grant privilege to an application. 0=Open access 1=Exclusive access 2=Control access

To make the device announce network configuration changes on the ethernet, you have to reset the device using the FLIR command register PT1000Reset or the generic DeviceReset command.

2.2.4 FLIR 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
PowerMode	Enum	RO	0 = A/C powered 1 = Power over Ethernet
PT1000Reset	Cmd	WO	Reset the iPORT engine interface board. Only present for A3x5 and A6x5 cameras.
UPNP	Bool	RW	Controls the UPNP service activation. Only valid for A3x5 and A6x5 cameras. True = Service active False = Service inactive
TSensSelector	Enum	RW	Select temperature sensor. 0 = Shutter 1 = Lens 2 = Front
TSens [TSensSelector]	Float	RO	Temperature sensor value in Kelvin.
LensConnected	Bool	RO	Indicates if a lens is connected to the camera head.
FlipValue	Integer	RO	Current image rotation state 0 = Image not flipped 1 = Image flipped vertically 2 = Image flipped horizontally 3 = Image flipped both vertically and horizontally
Segment	String(20)	RO	Model “scientific”, “automation” or “handheld”

2.2.4.2 Range (case) registers

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

There is one set of cases for each lens the camera has been calibrated with. The first lens would normally occupy cases 0, 1 and 2. The second lens cases 3, 4 and 5.

Some cases can be disabled. If the camera doesn't have a high temperature option, cases 2, 5, 8 etc will normally be disabled.

To retrieve data for a particular case, set its number in QueryCase register and read the case data in the QueryCaseXXXX registers.

Switching cases is quite a slow procedure. It can take up to 10 seconds. If it fails, the CurrentCase will eventually return to the previous value.

Name	**Type**	**Access**	**Comment**
NumCases	Integer	RO	Number of available cases
CurrentCase	Integer	RW	Current zero based case.
QueryCase	Integer	RW	Query case zero based index. This register controls the content of QueryCaseLowLimit, QueryCaseHighLimit and QueryCaseEnabled.
QueryCaseLowLimit	Float	RO	Queried case low limit in Kelvin.

QueryCaseHighLimit	Float	RO	Queried case high limit in Kelvin.
QueryCaseEnabled	Bool	RO	True if the queried case is enabled.
LensName	String(10)	RO	Current lens name

2.2.4.3 Object Parameter registers

Registers associated with infrared measurement conditions.

Name	Type	Access	Comment
ReflectedTemperature	Float	RW	Kelvin, 0.0 - 5000.0
AtmosphericTemperature	Float	RW	Kelvin, 0.0 - 5000.0
ObjectDistance	Float	RW	Meter, 0.0 - 10000.0
ObjectEmissivity	Float	RW	0.0 - 1.0
RelativeHumidity	Float	RW	Percent, 0.0 - 100.0
ExtOpticsTemperature	Float	RW	Kelvin, 0.0 - 5000.0
ExtOpticsTransmission	Float	RW	0.0 - 1.0
EstimatedTransmission	Float	RW	0.01 - 1.0 0.0 = Use calculated value.

2.2.4.4 Focus registers

Registers associated with camera focus control.

Name	Type	Access	Comment
FocusSpeed	Integer	RW	0 to 100 (0 = permanent stop)
FocusDirection	Enum	RW	0 = Stop 1 = Far 2 = Near
AutoFocusMethod	Enum	RW	0 = Coarse 1 = Fine
ContinuousFocus	Enum	RW	0 = Off 1 = Enabled
AutoFocus	Cmd	RW	Perform auto focus operation.
FocusPos	Integer	RW	Absolute focus position. A high value means a far distance on some types of cameras, a near distance on others.
FocusDistance	Float	RW	Focus position as distance in meters Min = 0 Max = 1000
FocusStep	Integer	RW	Absolute focus position change amount for FocusDecrement and FocusIncrement. Small values (<250) might not move the focus. Min = 0 Max = 1000
FocusDecrement	Cmd	WO	Decrements the focus position by the value in FocusStep
FocusIncrement	Cmd	WO	Increments the focus position by the value in FocusStep

2.2.4.5 Image quality registers

Registers associated with the image quality

Name	Type	Access	Comment
NoiseReduction	Enum	RW	0 = Off 1 = Low etc.

NUCMode	Enum	RW	Non-Uniform Correction (NUC) mode 0 = Off 1 = Automatic by camera
NUCAction	Cmd	WO	Do NUC operation. This can take up to 10 seconds.

2.2.4.6 Image stream registers

Registers associated with the image format or with image stream.

Temperature (in Kelvin) = pixel value * 0.1 (when IRFormat = 1, low resolution)

Temperature (in Kelvin) = pixel value * 0.01 (when IRFormat = 2, high resolution)

Name	Type	Access	Comment
IRFormat	Enum	RW	0 = Signal linear 1 = Temperature linear, 0.1K resolution 2 = Temperature linear, 0.01K resolution
IRTestPattern	Enum	RW	Selects the type of test image that is created by the IR camera. 0 = Off (see IRFormat) 1 = TestPattern
IRFrameRate	Enum	RW	Deprecated. Use AcquisitionFrameRate if present. Camera model dependent values, normal non-windowing examples: 0 = 60Hz/50Hz 1 = 30Hz/25Hz 2 = 15Hz/12.5Hz ... The availability of some frame rates can depend on the image width, height and offset settings. When IRWindowing is used, the frame rate increases by the same factor as the image height decreases.
IRWindowing	Enum	RW	This register can only be changed when no streaming is going on. It moves the vertical start of the image and changes the frame rate. You must change the "Height" register accordingly. 0 = Off (Full height, normal rate) 1 = Half (Half height, double rate) 2 = Quarter (Quarter height, fourfold rate)
IRAlignment	Enum	RW	0 = AlignToZeroKelvin (default) 1 = AlignToLowRangeLimit

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.

If IRAlignment is 1 and IRFormat is in Temperature linear mode then you need to add the current low range limit (in Kelvin) as offset in order to get the correct temperature value. For example, if the range is -20 C – 120 C then the offset will be 253.15 Kelvin.

Temperature (in Kelvin) = pixel value * 0.1 + offset (when IRFormat = 1, low resolution)

Temperature (in Kelvin) = pixel value * 0.01 + offset (when IRFormat = 2, high resolution)

2.2.4.7 External I/O registers

Registers associated with the image format or with image stream. These registers are all deprecated. Use the registers described in 2.2.4.9 instead.

Name	Type	Access	Comment
NumFormats	Integer	RO	Number of available I/O ports.
CurrentPort	Integer	RW	Current selected I/O port. Zero based index.
CurrentIOType	Enum	RO	Type of I/O port 0 = Digital 1 = Analog
CurrentIODirection	Enum	RO	0 = Input 1 = Output 2 = Bi-directional
CurrentIOConfig	Integer	RW	Port function configuration. 0 = General Purpose 1 = Vertical sync (output only) 2 = Set Mark in IR image (input only) 3 = Set Start mark in IR image (input only) 4 = Set Stop mark in IR image (input only) 5 = Enable image flow (input only) 6 = Disable image flow (input only)
CurrentIOPolarity	Enum	RW	Output port polarity 0 = Active High 1 = Active Low
CurrentIOState	Enum	RW	Current I/O port state 0 = Deasserted 1 = Asserted

The CurrentIOConfig Vertical sync output configuration provides a short pulse (about 150 µs) whenever a new image starts.

2.2.4.8 Measurement registers

Registers associated with converting signal to temperature. The values in these register will change if the range (case) is modified.

Temperature (in Kelvin) = B / log(R / S + F), where S is the 16-bit digital signal value. log(x) is the base-e logarithm of the x parameter.

The complete conversion formula is documented in the FLIR GEV Demo sample source code.

Name	Type	Access	Comment
R	Float	RO	Calibration parameter for conversion from corrected detector signal to temperature in Kelvin.
B	Float	RO	Calibration parameter for conversion from corrected detector signal to temperature in Kelvin.
F	Float	RO	Calibration parameter for conversion from corrected detector signal to temperature in Kelvin.
J0	Integer	RO	Global offset.
J1	Float	RO	Global gain.
alpha1	Float	RO	Spectral response parameter.
alpha2	Float	RO	Spectral response parameter.

beta1	Float	RO	Spectral response parameter.
beta2	Float	RO	Spectral response parameter.
X	Float	RO	Spectral response parameter.

2.2.4.9 Digital I/O Control

Registers associated with digital input and output features.

Name	Type	Access	Comment
LineSelector	Enum	RW	Selects the physical line (or pin) of the external device connector to configure.
LineMode [LineSelector]	Enum	RO	Indicates if the physical Line is used to Input or Output a signal. 0 = Input 1 = Output
LineInverter [LineSelector]	Bool	RW	Controls the inversion of the signal of the selected input or output Line.
LineStatus [LineSelector]	Bool	RW	Current status of the selected input or output Line.
LineSource [LineSelector]	Enum	RW	Selects which internal acquisition or I/O source signal to output on the selected Line. LineMode must be Output. 5 = FrameSync FPA frame sync signal, provides a short pulse (about 150 µs) whenever a new image starts. 6 = UserOutput0 (User defined output signal 1) 7 = UserOutput1 (User defined output signal 2) 8 = Line0 (digital input signal acts as signal source) 9 = Line1 (digital input signal acts as signal source)
LineFormat [LineSelector]	Enum	RW	Indicates the current electrical format of the selected physical input or output Line.
LineTrigger [LineSelector]	Enum	RW	This feature is used to select which action to execute on the selected Line when its LineMode is Input. 0 = Off (No action) 2 = MarkImage (Image is marked with trig flag according to LineActivation setting) 3 = StartMark (Image is marked with start flag according to LineActivation setting) 4 = StopMark (Image is marked with stop flag according to LineActivation setting) 5 = EnableImageFlow (Image flow is enabled according to LineActivation setting) 6 = DisableImageFlow (Image flow is disabled according to LineActivation setting) 7 = DisableNuc (NUC process is disabled according to LineActivation setting, Level only) 8 = ExecuteNUC 9 = AutoFocus 10 = NearFocus 11 = FarFocus
LineActivation [LineSelector]	Enum	RW	Specifies the activation mode of the line input signal. 0 = RisingEdge 1 = FallingEdge

			2 = AnyEdge 3 = LevelHigh 4 = LevelLow
UserOutputSelector	Enum	RW	Select the User Output line 0 = UserOutput0 1 = UserOutput1
UserOutputValue [UserOutputSelector]	Enum	RW	Sets the value of the selected output line 0 = False (deasserted) 1= True (asserted)