GigE Vision Area Scan Camera

Genie™ HM/HC Series

Camera User's Manual

Genie Framework 2.00

HM640

HM1024

HM1400

HM1400 XDR

HC640

HC1024

HC1400

TELEDYNE DALSA
Everywhereyoulook™

CA-GENM-HUM00
www.imaging.com

Document Date: April 5, 2013

Document Number: CA-GENM-HUM00

About DALSA
DALSA is an international high performance semiconductor and electronics company that designs, develops, manufactures, and markets digital imaging products and solutions, in addition to providing wafer foundry services. DALSA Digital Imaging offers the widest range of machine vision components in the world. From industry-leading image sensors through powerful and sophisticated cameras, frame grabbers, vision processors and software to easy-to-use vision appliances and custom vision modules.
DALSA is a public company listed on the Toronto Stock Exchange under the symbol “DSA”.
Based in Waterloo, ON, Canada, the company has operations in Montreal, QC; Bromont, QC; Colorado Springs, CO; Eindhoven, NL; Munich, Germany and Tokyo, Japan.

Contents

This Page Intentionally Left Blank

Genie HM/HC Series Overview

Description

The Genie HM/HC camera family form a series of affordable, easy to use digital cameras specifically engineered for industrial imaging applications requiring high frame rates. Genie cameras combine standard gigabit Ethernet technology with the DALSA Trigger-to-Image-Reliability framework to dependably capture and transfer images from the camera to the host PC.

The Genie HM camera series provides monochrome acquisition while the HC camera series, using the same sensor with a Bayer filter, provides color acquisition.

All Genie cameras are supported by DALSA Sapera™ LT software libraries featuring CamExpert for simplified camera set-up and configuration. Sapera LT is field proven in thousands of robust industrial applications. Hardware independent, Sapera LT delivers the same reliable performance regardless of the image acquisition device being used. This unique feature allows OEM's to start using the Genie without re-writing applications developed for DALSA frame grabbers. In addition, Sapera LT includes powerful diagnostics and setup utilities for application development, custom camera configurations and system deployment.

Genie Application Advantages

- Compact, rugged design
- GigE Vision 1.0 compliant
- Gigabit Ethernet (GigE) interconnection to a computer via standard CAT5e or CAT6 cables
- Supports connection to the host computer NIC through a GigE network switch
- Available in multiple resolutions
- Monochrome or color acquisition
- High frame rates relative to similar products
- Digital binning for increased sensitivity
- Lookup table pre-processing
- Real-time shading correction (i.e. Flat Field processing)
- Horizontal Flip function
- Supports several trigger modes for image capture control
- 2 opto-isolated inputs
- 2 opto-isolated outputs
- Native Trigger-to-Image Reliability design framework
- Visual status LEDs on camera back plate
- 1µs internal timer or external events can timestamp images
- Supported by Sapera™ LT software libraries

Product Part Numbers

This manual covers the Genie HM and HC models summarized below. See "Camera Performance Specifications" on page 10 for each Genie model.

Camera	Resolution	Pixel size	fps (free running / flat field off)	Product Number
Genie HM640	640 x 480	7.4 x 7.4 µm	301 fps @ 8-bit	CR-GM00-H640x
Genie HM1024	1024 x 768	7.4 x 7.4 µm	136 fps @ 8-bit	CR-GM00-H102x
Genie HM1400	1400 x 1024	7.4 x 7.4 µm	75 fps @ 8-bit 37 fps @ 10-bit	CR-GM00-H140x
Genie HM1400 XDR *extended dynamic range*	1400 x 1024	7.4 x 7.4 µm	75 fps @ 8-bit 37 fps @ 10-bit	CR-GM01-H140x
Genie HC640	640 x 480	7.4 x 7.4 µm	301 fps @ 8-bit	CR-GC00-H640x
Genie HC1024	1024 x 768	7.4 x 7.4 µm	136 fps @ 8-bit	CR-GC00-H102x
Genie HC1400	1400 x 1024	7.4 x 7.4 µm	75 fps @ 8-bit 37 fps @ 10-bit	CR-GC00-H140x

Lens Mount Option	
The last digit of the Genie product number defines the mechanical lens mount. (see Mechanical Specifications)	C-Mount = 0 CS-Mount = 1 C-Mount downward right angle = 2 CS-Mount downward right angle = 3

Input Voltage
CR-GM0x-xxxxx models: +11 to +25.2 Volts DC at 0.6 Amp minimum, (over voltage–reverse voltage protected)

Software	Product Number
Genie Framework composed of the Sapera network Imaging Package, Genie Imaging Driver and latest Genie Firmware. ***Required installation.***	Included with Genie distribution CD
Sapera Runtime including CamExpert	Included and installed if desired
GenICam™ support (XML camera description file)	Embedded within Genie
Sapera LT version 6.10 or later (Sapera 7 required for 64-bit support): Provides everything you will need to develop imaging applications Sapera documentation in compiled HTML help, and Adobe Acrobat® (PDF) formats.	OC-SL00-0000000 (sold separately)
Sapera Processing Imaging Development Library (sold separately): Includes over 600 optimized image processing routines.	Contact Sales at DALSA

Genie Cables & Accessories (sold separately)	Product number
Genie I/O and Power breakout cable (Hirose to Euroconnector)	CR-GENC-IOP00
Tripod mount bracket (mount to Genie top or bottom—provides ¼-20 socket)	CA-GENA-BRA00
Industrial type CAT 6 cable assembly: Molded shroud with top/bottom thumbscrews on one end with standard Ethernet RJ45 clip on other. Available in various lengths. See "Ruggedized RJ45 Ethernet Cables" on page 119.	
C-mount NIR/UV filter available from Midwest Optical Systems. See "C/CS-Mount NIR and UV Filter" on page 120.	CA-GENL-BP550

Camera Performance Specifications

Specifications for each available sensor are listed after the general Genie camera specifications.

Camera Controls	
Synchronization Modes	Free running External triggered Software trigger (through Ethernet)
Exposure Modes	Programmable in increments of 1µs minimum 10µs in Reset Mode or 56µs in Synchronous Mode maximum is 4 seconds Pulse controlled via Trigger pulse width.
Trigger Input	Opto-isolated, 2V to 12V typical, 2mA min. Debounce range from 1µs up to 255µs (following a 100µs fixed delay)
Strobe Output	Output opto-isolated: Aligned to the start of exposure with a programmable delay, duration and polarity
Features	
LUT	8-bit (HM models) / 10-bit (only HM1400 and HM1400 XDR) Note: LUTs are not available on the HC models.
Flip	Real-time horizontal flip (All HM models) Note: Flipping is not available on the HC models.
Binning	Digitally based: Horizontal (2 pixel) and Vertical (2 line) (All HM models) Note: Binning is not available on the HC models.
Timestamp	1µs internal timer or external signal to timestamp images and events
Test image	Internal generator with choice of static and shifting patterns
User settings	Select factory default or one user camera configuration
Optical Interface	
Back Focal Distance—C-Mount	17.52 mm
Back Focal Distance—CS-Mount	12.52 mm
Mechanical Interface	
Camera Size	29(H) x 44(W) x 67(L) in mm, (see Mechanical Specifications)
Mass	< 125g (no lens)
Power connector	12 pin male Hirose
Ethernet connector	RJ45
Electrical Interface	
Input Voltage	xx-GM0x-xxxxx models +11 to +25.2 Volts DC at 0.6 Amp minimum (over voltage–reverse voltage protected) xx-GENx-xxxxx models +11 to +13 Volts DC at 0.6 Amp minimum (legacy models)
Power Dissipation	< 4W
Operating Temperature	0 to 45°C (at front plate)
Relative Humidity	5% to 90% non-condensing (operating)
Output Data Configuration	Gigabit Ethernet (IEEE 802.3)
Data and Control	GigE Vision compliant at 1000 or 100 Mbps

Certifications

CE	EN55022, class A, EN61000-4-2, EN61000-4-3, EN61000-4-4, EN61000-4-6,	Radio Disturbance Characteristics Electrostatic discharge immunity test Radiated, radio-frequency, electromagnetic field immunity test Electrical fast transient/burst immunity test Immunity to conducted disturbances, induced by radio-frequency fields
FCC	Part 15, class A	
	see "EC & FCC Declaration of Conformity" on page 124	
RoHS	Compliancy as per European directive 2002/95/EC (applies to camera part numbers CR-GENx-xxxxx)	

Vibration and Shock Certifications

Test (while operating)	Standard	Description
Sinusoidal vibrations with identification of critical frequencies	IEC 68-2-6 (1995) Test Fc	Frequency range: 10 to 2000 Hz Amplitude: 5 m/s^2 Sweep rate: 1 octave per minute Duration: 1 sweep cycle (to and fro)
Random vibrations	MIL-STD-810E (1989) method 514.4 Category 10	Levels and frequencies: 0.04 g^2/Hz from 20 to 1000 Hz -6 dB/oct. from 1000 to 2000 Hz Duration: 1 hour
Shocks	IEC 68-2-27 (1987) Test Ea and guide	Shape: half-sine Amplitude: 75 g Duration: 3 ms Number: 3 shocks (+) and 3 shocks (-)

Supported Industry Standards

Genie cameras are 100% compliant with the GigE Vision 1.0 specification which defines the communication interface protocol used by any GigE Vision device. The device description and capabilities are contained in an XML file. For more information see:
http://www.machinevisiononline.org/public/articles/index.cfm?cat=167

Genie cameras implement a superset of the GenICam™ specification which defines device capabilities. This description takes the form of an XML device description file respecting the syntax defined by the GenApi module of the GenICam™ specification. For more information see www.genicam.org.

Genie HM/HC Series Sensor Overview

The sensor description below provides a specification table and response graphics. The graph describes the sensor response to different wavelengths of light (excluding lens and light source characteristics). Visible light spans wavelengths between about 390 - 780 nanometers. Wavelengths below 390 nm are termed ultra-violet while those above 780 nm. are termed infra-red. The peak response is around 600 nanometers.

HM/HC Series Sensor Global Specifications

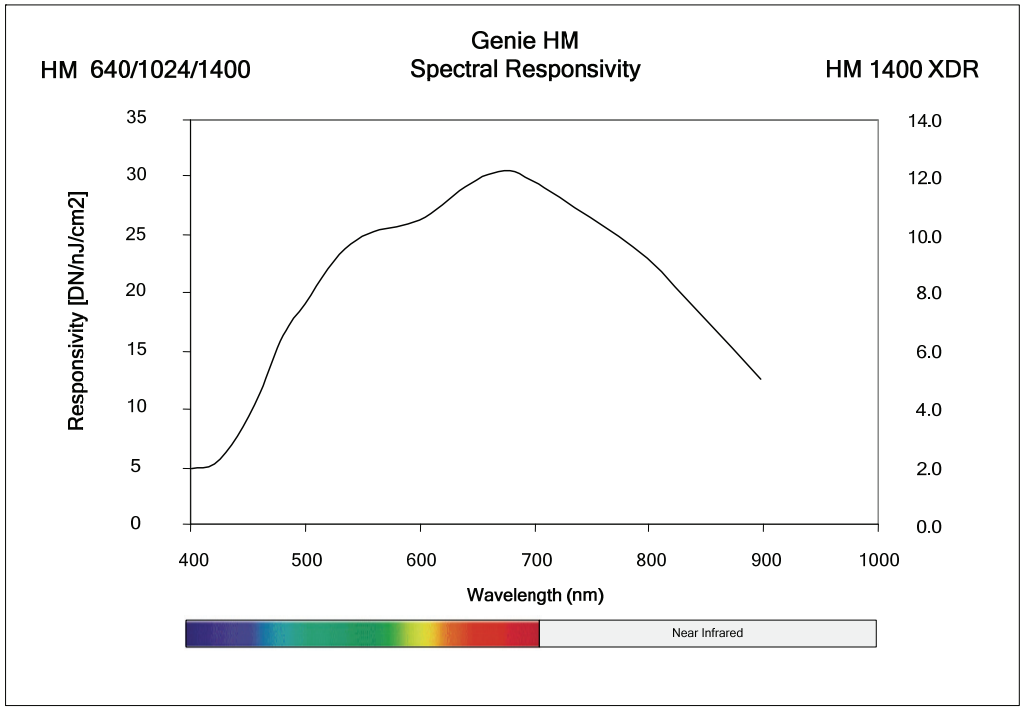
Item / Feature	Specification
Imager Features	Global Shutter, Exposure Control, Anti-Blooming
Sensor	DALSA IA-G5 Area Array
Minimum Frame Rate (free-running)	0.1 fps (one frame every 10 seconds)
Maximum Frame Rate (free-running)	Dependent on Genie HM/HC model (see Partial Scan—Window ROI)
Minimum Exposure	10µs when using reset exposure mode (triggered) 56µs when using synchronous exposure mode (free running)
Maximum Exposure	(1 / frame rate) - 10µs
Internal Trigger to Start of Exposure	100µs
Horizontal Line Time	HM640/HC640 6.7µs HM1024/HC1024 10.3µs HM1400/HC1400 (8-bit) 14µs HM1400/HC1499 (10-bit) 22.3µs
Pixel Size	7.4µm x 7.4µm
Pixel Format	8-bit all models 10-bit available only with HM1400/HM1400 XDR and HC1400
Bayer Mosaic Arrangement (HC models only)	 The HC color camera models have a Bayer filter applied to the CMOS sensor to allow for color separation. Each individual pixel is covered by either a red, green, or blue filter. The camera outputs raw color data--no color interpolation is performed. Full RGB images can be obtained by performing color interpolation on the frame grabber or host PC.
Shutter	Full frame electronic shutter
Gain Range	0dB to +12dB

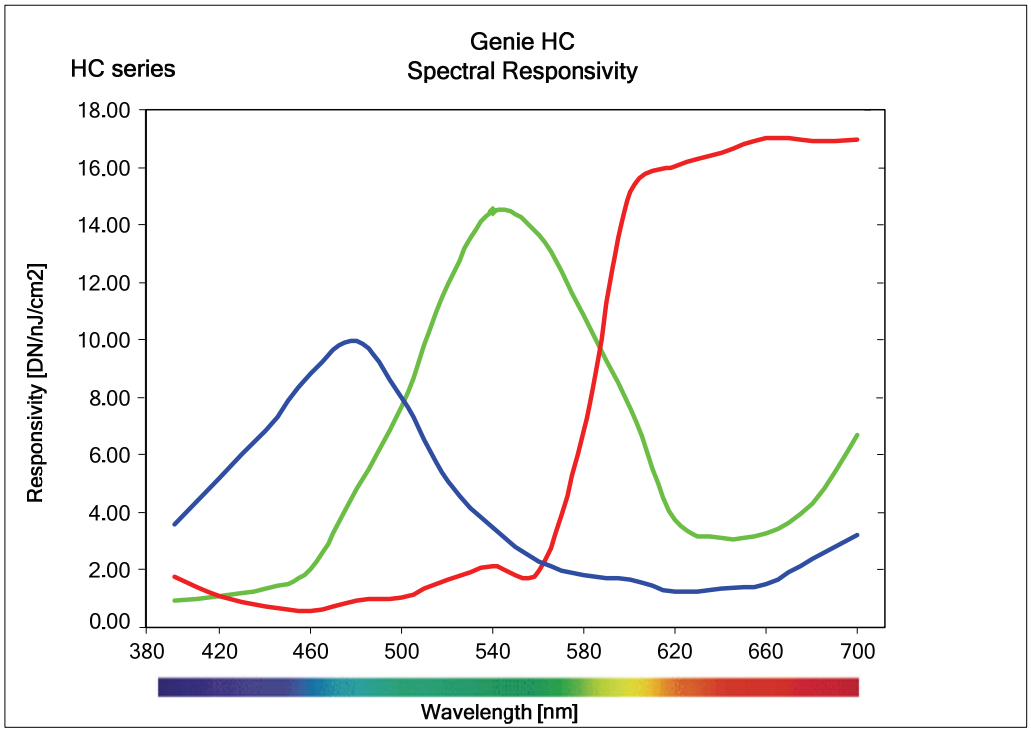
Model Specific Specifications

HM1400-XDR	Typical	Min.	Units	Notes
Output Dynamic Range	55.3	53.9	db	With FFC (Factory calibrated)
Maximum Achievable SNR	51.6	51.1	db	With FFC (Factory calibrated) †
Full Well Capacity	60 000		electron	
Responsivity	12		DN/(nJ/cm2)	@ 600 nm , 1 x Gain
HM1400/HC1400	**Typical**	**Min.**	**Units**	**Notes**
Output Dynamic Range	48.2	47.5	db	With FFC (Factory calibrated)
Maximum Achievable SNR	48.3	47.6	db	With FFC (Factory calibrated) †
Full Well Capacity	24 000		electron	
Responsivity	30.6		DN/(nJ/cm2)	@ 600 nm, 2.55 x Gain
HM1024/HC1024	**Typical**	**Min.**	**Units**	**Notes**
Output Dynamic Range	47.5	45.7	db	With FFC (Factory calibrated)
Maximum Achievable SNR	47.1	45.9	db	With FFC (Factory calibrated) †
Full Well Capacity	24 000		electron	
Responsivity	30.6		DN/(nJ/cm2)	@ 600 nm, 2.55 x Gain
HM640/HC640	**Typical**	**Min.**	**Units**	**Notes**
Output Dynamic Range	47.5	45.5	db	With FFC (Factory calibrated)
Maximum Achievable SNR	47.2	45.9	db	With FFC (Factory calibrated) †
Full Well Capacity	24 000		electron	
Responsivity	30.6		DN/(nJ/cm2)	@ 600 nm, 2.55 x Gain

† Specifically, SNR measurements are made by averaging 10 frames at 80% saturation.

Genie HM/HC Series Responsivity

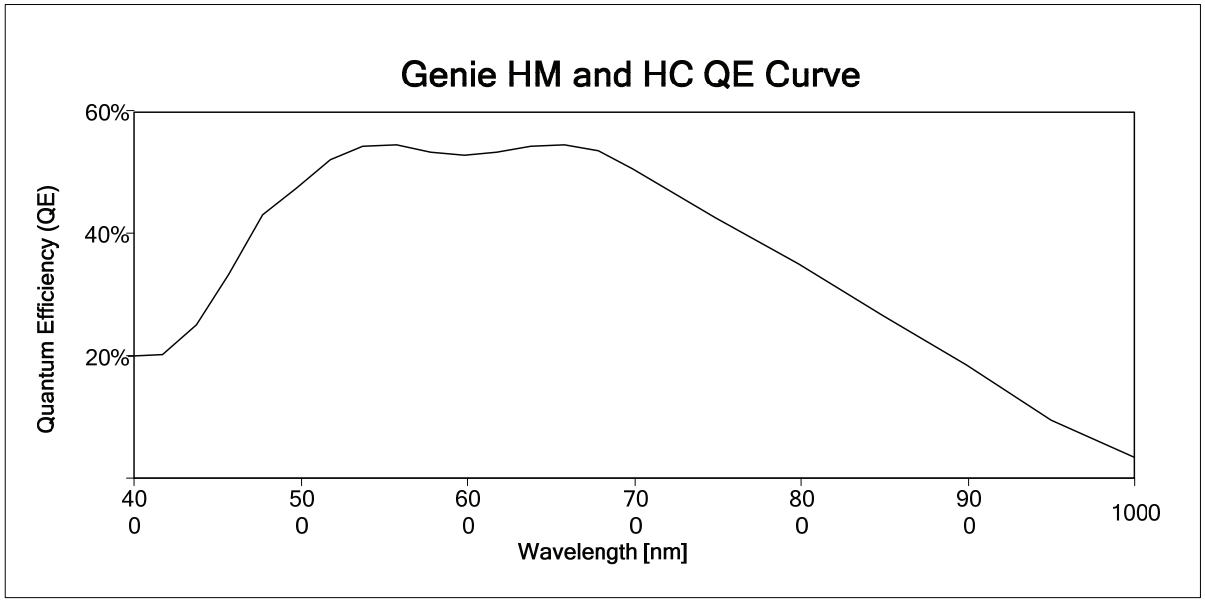




Note: DALSA recommends using a 700nm cutoff filter with the HC color series cameras since the blue and green color filters become transparent above 700nm.

Genie HM/HC Series Effective Quantum Efficiency

The following quantum efficiency graph describes the fraction of photons at each wavelength that contribute charge to the pixel.



Genie HM/HC Series Sensor Cosmetic Specifications

The following table lists the current cosmetic specifications for the DALSA sensor used in the Genie HM/HC series.

Blemish Specifications	Maximum Number of Defects
Hot/Dead pixel defects	2
Single pixel defects	100 for HM series 25 for each individual color (R, G1, G2, B) for HC series
Clusters defects	0
Column defects	0
Row defects	0

Note: All of the sensor and camera cosmetic specifications are with factory flat-field correction turned on. There are no pre-flat-field camera cosmetic specifications.

Definition of cosmetic specifications

- **Hot/Dead pixel defect:**
  Pixel whose signal, in dark, deviates by more than 400DN (10-bits) from the mean.
- **Single pixel defect:**
  Pixel whose signal, at nominal light (illumination at 50% of the linear range), deviates by more than ±30% from the mean.
- **Cluster defect:**
  A grouping of more than 8 pixel defects.
- **Column defect:**
  A column which has more than 8 consecutive pixel defects.
- **Row defect:**
  A horizontal grouping of more than 8 consecutive pixel defects.

Test conditions

- Digital gain = 1X
- Nominal light = illumination at 50% of saturation
- Temperature of camera front plate is 40°C

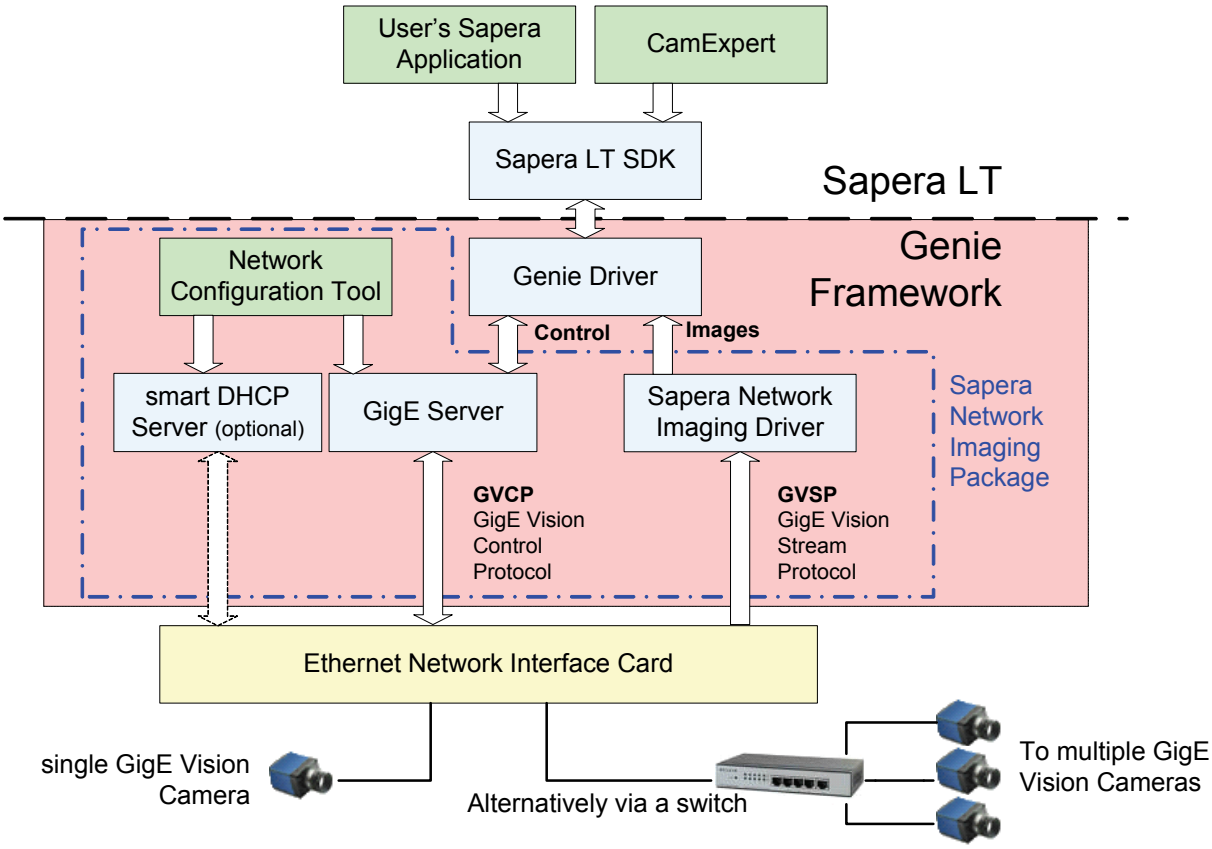
Application Development Overview

Sapera LT Library with optional Processing

Sapera LT is a powerful development library for image acquisition and control. Sapera LT provides a single API across current and future DALSA hardware. Sapera LT delivers a comprehensive feature set including program portability, versatile camera controls, flexible display functionality and management, plus easy to use application development wizards.

Sapera Processing is a comprehensive set of C++ classes for image processing and analysis. Sapera Processing offers highly optimized tools for image processing, blob analysis, search (pattern recognition), OCR and barcode decoding.

The following is a Sapera application functional block diagram. The Genie Framework installation includes the Genie driver and the Sapera Network Imaging Package.



GigE Vision Compliant Environment

The GigE Vision Compliant XML device description file is embedded within Genie firmware allowing GigE Vision Compliant applications to know Genie capabilities immediately after connection.

Installing the Genie Camera

Warning! (Grounding Instructions)

Static electricity can damage electronic components. Please discharge any static electrical charge by touching a grounded surface, such as the metal computer chassis, before performing any hardware installation.

If you do not feel comfortable performing the installation, please consult a qualified technician.

GigE Network Adapter Guideline

If the computer to be used with the Genie camera does not have a Gigabit network adapter or second built in Gigabit NIC, a PCI bus Gigabit Network Interface Card (NIC) needs to be installed. Typically under Windows, the PCI Gigabit NIC is recognized automatically when Windows boots. An example of a high performance NIC is the Intel PRO/1000 MT adapter.

Review the NIC documentation concerning any special driver required for Windows. Install the PCI bus Gigabit NIC as described by the NIC manufacture's documentation.

The Genie camera has been tested with a variety of Gigabit network adapters, both built into the system motherboard and as third party PCI adapters.

Supported Network Configurations

The Genie obtains an IP address using the Link Local Address (LLA) or DHCP, by default. A LLA IP address is obtained in about 6 seconds with Microsoft Vista/7 or in about 1 minute with Microsoft XP. If required, a persistent IP address can be assigned (see "Running the Network Configuration Tool" on page 27).

The LLA method automatically assigns the Genie with a randomly chosen address on the 169.254.xxx.xxx subnet. After an address is chosen, the link-local process sends an ARP query with that IP onto the network to see if it is already in use. If there is no response, the IP is assigned to the device, otherwise another IP is selected, and the ARP is repeated. Note that LLA is unable to forward packets across routers.

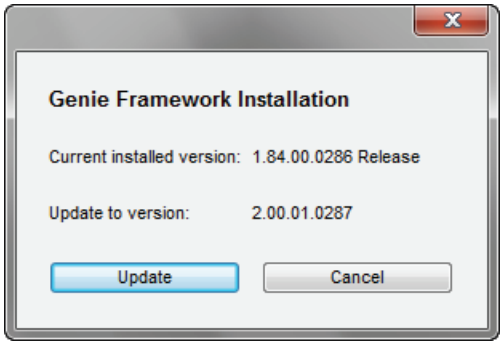
Alternatively, if a DHCP server is present on the network, the Genie is going to issue a DHCP request asking for an IP address. The DHCP server will then provide the Genie an IP address. The DALSA Network Configuration tool, installed with the DALSA Network Imaging Package, can also function as the DHCP server (refer to the DALSA Network Imaging Package user's manual).

Installation Overview & Preparations

The Genie camera installation generally follows the sequence described below. Detailed installation instructions follow this overview. This section also provides important information to prevent operational faults due to ESD (electrostatic discharge) in Genie installations.

Network and Computer Overview

- Genie needs to connect to a computer with a **GigE network adapter**, either built in on the computer motherboard or installed as a third party PCI adapter.
- **Laptop computers** with built in **GigE network adapters** may still not be able to stream full frame rates from Genie, especially when on battery power. Thorough testing is required with any laptop computer to determine the maximum frame rate possible (refer to the DALSA Network Imaging Package user's manual).
- Genie also can connect through a **Gigabit Ethernet switch**. When using VLAN groups, the Genie and controlling computer must be in the same group (refer to the DALSA Network Imaging Package user's manual).
- If Genie is to be used in a **Sapera development environment**, Sapera LT needs to be installed, either before or after the Genie software package. If Genie will be used in a GigE Vision Compliant environment, Sapera or Sapera runtime is not required and you need to follow the installation instructions of the third party GigE Vision compliant package.
- Install the **Genie Framework software package** if not using a third party GigE Vision compliant package. Also install **Sapera Run-time with CamExpert** to control the Genie.
- The **Windows Firewall** exceptions feature is automatically configured to allow the Sapera GigE Server to pass through the firewall.
- Computers with **VPN software** (virtual private network) may need to have the VPN driver disabled in the NIC properties. This would be required only on the NIC used with the Genie. Testing by the user is required.
- When **upgrading the Genie Framework** from a previous version, there is no need to uninstall the older version. The new installation will correctly update all framework files. The framework installer will prompt you to confirm the upgrade, as shown.



Installation Overview

- Before connecting power to the camera, test all power supplies. Power supplies must meet the requirements defined in section "Genie Signal Electrical Details" on page 109. Apply power to the camera.
- Connect Genie to the computer GigE network adapter or to the Ethernet switch via a CAT5e or CAT6 Ethernet cable. **Note:** cable should not be less than 1 meter (3 feet) long or more than 100 meters (328 feet) long.
- Check the diagnostic LED which will be initially red then switch to flashing blue while waiting for IP configuration. See "Status LED Codes" on page 25 for Genie LED display descriptions.
- Look at the small camera icon added to the Windows tray (next to the clock). Ensure the Genie camera has been found (right click the icon and select Status).
- A new Genie installation typically requires a firmware update. See the procedure "Updating Genie Firmware" on page 28.
- Use CamExpert (installed either with Sapera or Sapera runtime) to test the installation of the Genie camera. Set the Genie to internal test pattern. See "Sapera CamExpert Guide" on page 97.
- Set up the other components of the imaging system such as light sources, camera mounts, optics, encoders, trigger sources, etc. Test with CamExpert.

Preventing Operational Faults due to ESD

Genie camera installations which do not protect against ESD (electrostatic discharge) may exhibit operational faults. Problems such as random packet loss, random camera resets, and random loss of Ethernet connections, may all be solved by proper ESD management.

The Genie camera when used with a simple power supply and Ethernet cable, is not properly connected to earth ground and therefore is susceptible to ESD caused problems. An Ethernet cable has no ground connection and a power supply's 0 volt return line is not necessarily connected to earth ground.

DALSA has performed ESD testing on Genie cameras using an 8 kilovolt ESD generator without any indication of operational faults. The two following methods, either individually or together will prevent ESD problems.

- Method 1: Use a shielded power supply cable where the shield is connected to earth ground at the supply end and to the Hirose connector shell at the Genie end. The Genie case is now properly connected to earth ground and can withstand ESD of 8 kilovolts, as tested by DALSA.
- Method 2: Mount the Genie camera on a metallic platform which has a good connection to earth ground.

Sapera LT Library Installation

	**Note:** to install Sapera LT and the Genie device driver, logon to the workstation as an administrator or with an account that has administrator privileges.

When Sapera application development is performed on the same computer that the Genie is connected to, the Sapera Development Library (version 6.20 or later) must be installed. Else, Sapera LT is not required to control the Genie camera.

- Insert the DALSA Sapera CD-ROM. If **AUTORUN** is enabled on your computer, the DALSA installation menu is presented.
- If **AUTORUN** is not enabled, use Windows Explorer and browse to the root directory of the CD-ROM. Execute **launch.exe** to start the DALSA installation menu and install the required Sapera components.
- The installation program will prompt you to reboot the computer.
- Continue with the Genie CD Package Installation described next.

Refer to *Sapera LT User's Manual* concerning application development with Sapera.

Genie CD Package Installation

The Genie Framework software package and Sapera runtime provides all components required to control the Genie with the supplied CamExpert tool. Genie Framework software components include the Network Imaging driver (refer to the DALSA Network Imaging package manual), the Sapera GigE server, and CamExpert (if Sapera LT library is not installed).

	Note: If Sapera application development is required, install Sapera (6.20 or later) as described in the previous section.

Procedure

- When **upgrading the Genie Framework** from a previous version, there is no need to uninstall the older version. The new installation will correctly update all framework files.
- Insert the DALSA Genie CD-ROM. If **AUTORUN** is enabled on your computer, the Genie installation menu is presented.
- If **AUTORUN** is not enabled, use Windows Explorer and browse to the root directory of the CD-ROM. Execute **launch.exe** to start the installation menu and install the Genie software components.
- Click to install the Genie Framework Software which includes the Network Imaging driver, and the Sapera GigE server.
- The procedure will prompt for acceptance of the installation folder for the Genie files.
- If desired, click to install **Sapera LT run-time** which includes CamExpert. Follow the on screen prompts and reboot when the installation is complete.

GigE Server Verification

After a successful Genie Framework package installation, the GigE Server icon is visible in the desktop taskbar tray area. After connecting a camera (see following section), allow a few seconds for the GigE Server status to update. The Genie camera must be on the same subnet as the NIC to be recognized by the GigE Server.

	Device Available	Device IP Error	Device Not Available
GigE Server Tray Icon:			
	The normal GigE server tray icon when the Genie device is found. It will take a few seconds for the GigE Server to refresh its state after the Genie has obtained an IP address.	The GigE server tray icon shows a warning when a device is connected but there is some type of IP error.	A red X will remain over the GigE server tray icon when the Genie device is not found. This indicates a major network issue. ***Or in the simplest case,*** the Genie is not connected.

If you place your mouse cursor on this icon, the GigE Server will display the number of GigE Vision devices found by your PC. Right click the icon and select status to view information about those devices. See "Running the Network Configuration Tool" on page 27 and "Troubleshooting" on page 125for more information.

Connect the Genie Camera

Connect a power supply to the Genie camera and an Ethernet cable from the Genie to the host computer. Once communication with the host computer is started the automatic IP configuration sequence will assign an LLA IP address as described in section "Genie IP Configuration Sequence" on page 26, or a DHCP IP address if a DHCP server is present on your network. Note that the DALSA Network Configuration tool can enable the DALSA smart DHCP server.

The factory defaults for Genie is Persistent IP disabled and DHCP enabled with LLA always enabled as per the GigE Vision specification. For additional information see "Genie IP Configuration Mode Details" on page 93. See the next section "Connectors" on page 24 for an overview of the Genie interfaces.

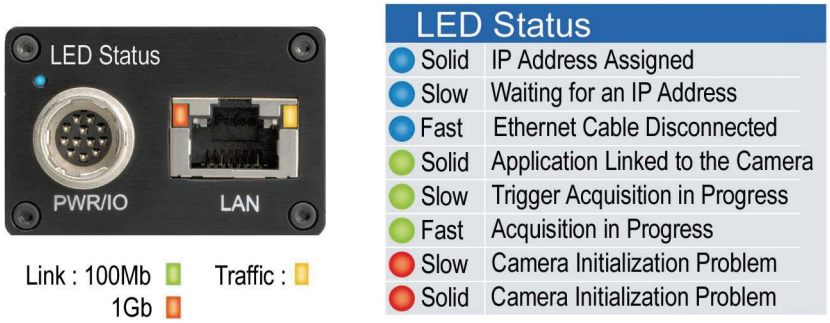
Connectors

The Genie has only two connectors:

- A single **RJ45 Ethernet** connector for control and video data transmitted to/from the host computer Gigabit NIC. See "Ruggedized RJ45 Ethernet Cables" on page 119 for secure cables.
- A single **12-pin Hirose** male connector for camera power plus trigger, strobe and general I/O signals. The suggested female cable mating connector is Hirose model HR10A-10P-12S.

The Genie has one multicolor LED to provide a simple visible indication of camera state (see figure below and section "Status LED Codes" on page 25). Additionally the RJ45 has two LEDs for network status conditions.

The following figure of the Genie back end shows connector and LED locations. See "Mechanical Specifications" on page 103 for details on the Genie connectors and camera mounting dimensions.



Genie – Rear View

Status LED Codes

The camera is equipped with a LED to display the operational status of the camera. When more than one condition is active, the LED color indicates the condition with the highest priority (such as an acquisition in progress has more priority than a valid IP address assignment). The following table summarizes the LED states and corresponding camera status.

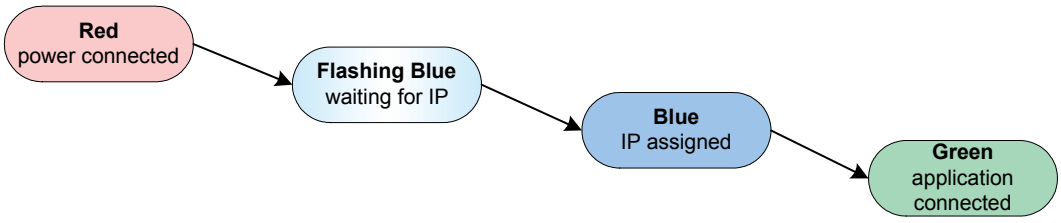
LED State	Definition
LED is off	No power to the camera
Steady Red	Camera not initialized **
Slow Flashing Red	Camera initialization problem **
	** Often there is no serious problem with the Genie hardware. Wait 2-5 minutes for the Genie to load internal default firmware, then follow these instructions (see Updating Genie Firmware).
Slow Flashing Blue	Waiting for an IP address
Fast Flashing Blue	Ethernet cable disconnected (no link)
Steady Blue	IP address assigned; no application connected to the camera
Steady Green	Application connected
Slow Flashing Green	Triggered acquisition in progress
Fast Flashing Green	Free-running acquisition in progress

Once the Genie has its RJ45 connected to a network, the Status LED will turn to steady blue when the IP address is assigned. Only at this time will it be possible by the GigE Server or any application to communicate with the camera.

Note: Even if the Genie has obtained an IP address, it might be on a different subnet than the NIC it is attached to. Therefore, if the Genie LED is blue but an application such as CamExpert can not see it, this indicates a network configuration problem. See the troubleshooting section in this manual.

Typical LED States on Power Up

The following LED sequence occurs when the Genie is powered up connected to a network with installed Genie Framework software.



Genie IP Configuration Sequence

The Genie IP (Internet Protocol) Configuration sequence to assign an IP address is executed automatically on camera power-up or when connected to a network. As a GigE Vision compliant device, Genie attempts to assign an IP address as follows.

For any GigE Vision device, the IP configuration protocol sequence is:

- Persistent IP (if enabled)
- DHCP (if a DHCP server is present such as the DALSA Smart DHCP server)
- Link-Local Address (always enabled)

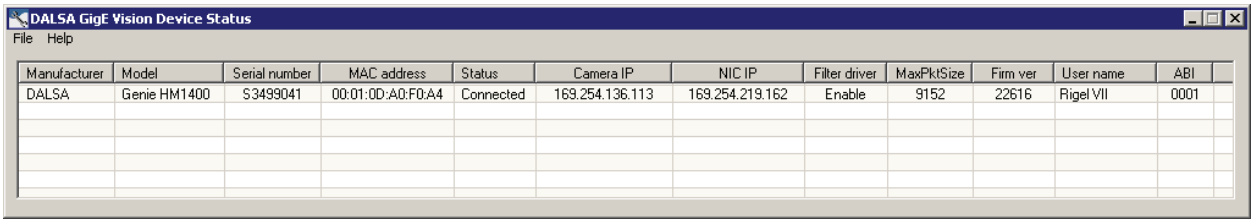
The factory defaults for Genie is Persistent IP disabled and DHCP enabled with LLA always enabled as per the GigE Vision specification. For additional information see "Genie IP Configuration Mode Details" on page 93.

GigE Server Status

Once the Genie is assigned an IP address (its Status LED is steady blue) the GigE server tray icon will not have a red X through it, indicating that the Genie device was found. It might take a few seconds for the GigE Server to refresh its state after the Genie has obtained an IP address.

Right-click the GigE Server tray icon to open the following menu.

Click on **Show Status** to open a window listing all devices connected to the host system. Each GigE device is listed by name along with important information such as the assigned IP address and device MAC address. The screen shot below shows a connected Genie with no networking problems.



In the event that the device is physically connected, but the Sapera GigE Server icon is indicating that the connected device is not recognized, click **Scan Network** to restart the discovery process. Note that the GigE server periodically scans the network automatically to refresh its state. See "Troubleshooting" on page 125 for network problems.

Optimizing the Network Adapter used with Genie

Most Gigabit network interface controllers (NIC) allow user modifications to parameters such as Adapter Buffers and Jumbo Frames. These should be optimized for use with the Genie during the installation. Refer to the DALSA Network Imaging package manual for optimization information.

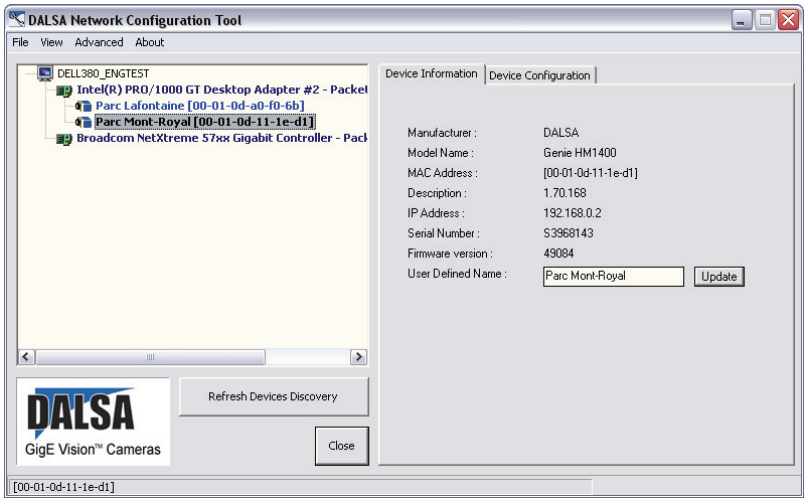
Running the Network Configuration Tool

The Network Configuration tool provides information and parameter adjustments for network adapters installed in the system and any connected GigE Vision camera without use of any Windows Control Panel application. This tool allows you to:

- Activate the Network Imaging driver use for image acquisition on any NIC or disable the imaging driver for any NIC not used with a GigE Vision camera.
- Change the Auto Discovery Interval from the default of 15 seconds.
- Configure the Windows firewall exception list.
- Configure the NIC and camera IP settings.
- Assign a User-Defined name to a connected camera.
- Assign a Persistent IP address to a camera instead of the default DHCP/LLA assigned address.
- Easily Configure the NIC as a DHCP server for connected GigE Vision camera.

Important: Any changes made with this tool will update the Genie flash memory. Do not remove power from the Genie camera for a minimum 10 seconds. Then cycle the Genie power to load the new flash settings.

Refer to the DALSA Network Imaging package manual for more detailed information on using this tool. As shown below, the Network Configuration tool can quickly verify and modify the network configuration of the imaging system.

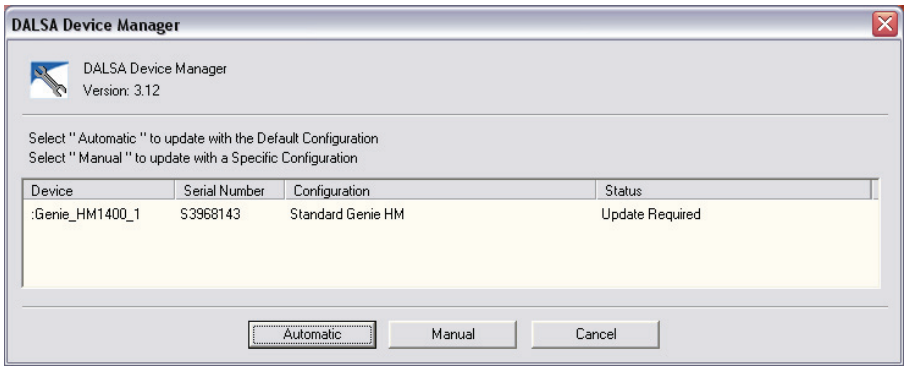


Run the tool from the Windows Start menu: **Start•Programs•DALSA Sapera Network Imaging Package•Dalsa Network Configuration Tool**. Verify the camera appears as a child of the NIC card it is connected to. By default the Genie camera is identified by its serial number if no user-defined name has been assigned.

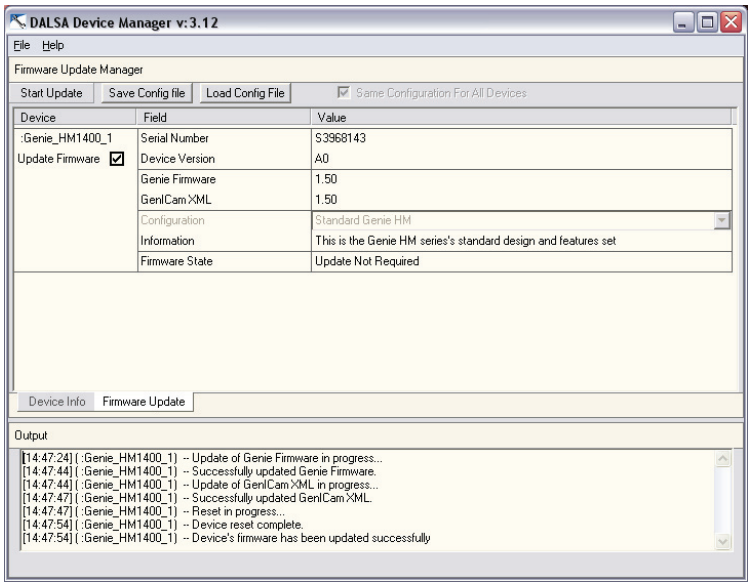
Updating Genie Firmware

The Genie firmware may need to be updated to correspond with the currently installed Genie software framework. After installing the new Genie software package and Genie camera, update the firmware by following this procedure.

- Important: Make sure that no Sapera application (such as CamExpert) is controlling the Genie camera.
- Start the DALSA Device Manager program from the windows start menu: **Start•Programs•DALSA•Genie•Firmware Update**.



- The right hand column shows whether a firmware update is **Required** or **Not Required**.
- If an update is required, click on the Automatic button. The Update Firmware manager dialog opens and the new firmware version is written to the Genie camera.
- The manual button allows the user to select from multiple Genie firmware configuration files – if such files become available for future operational modes.



- The firmware update is complete when the lower message output area says "Device reset complete". Close the Device Manager program.

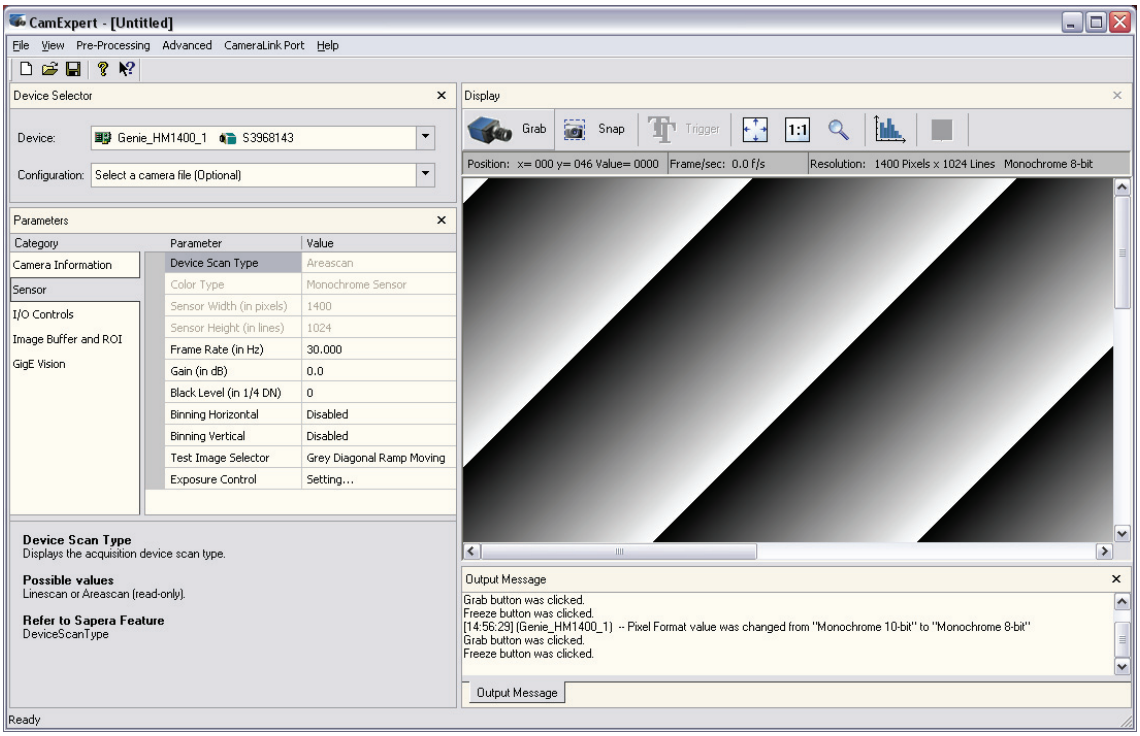
- Wait for the GigE Server to find the Genie again, then run CamExpert to test the Genie operation (as described below).

	Important: If the Genie power is accidentally cut off during the firmware update (such as a electrical source power failure or human error), the Genie is easily recovered. See "Power Failure During a Firmware Update–Now What?" on page 128.

Quick Test with CamExpert

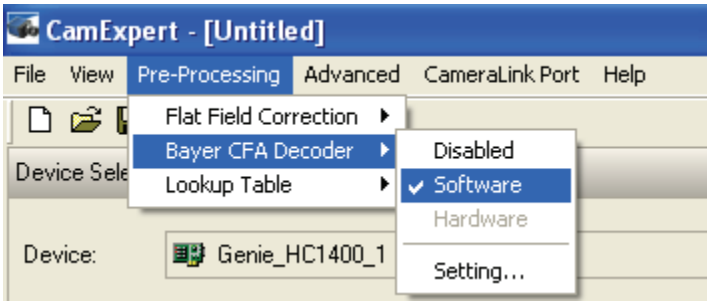
When the Genie camera is directly connected to a Gigabit network adapter on a host computer or via a network switch, testing the installation with CamExpert is a straightforward procedure.

- Start Sapera CamExpert by double clicking the desktop icon created during the Genie software installation.
- CamExpert will search for installed Sapera devices. In the Device list area on the left side, the connected Genie camera is shown or will be listed in a few seconds after CamExpert completes the automatic device search (device discovery).
- Select the Genie camera device by clicking on the camera user-defined name. By default the Genie camera is identified by its serial number. The Genie status LED will turn green, indicating the CamExpert application is now connected.
- Click on the Grab button for live acquisition (the Genie default is Free Running mode). Focus and adjust the lens iris. See "Operational Reference" on page 33 for information on CamExpert parameters with the Genie camera.
- The following figure shows CamExpert with the Genie generating a diagonal test pattern. Select this via the Test Image Selector drop menu from the Sensor Parameters tab.



Bayer CFA Decoder

For the HC camera models, to view the acquisition display in color set the Bayer CFA Decoder to Software from the CamExpert Pre-Processing menu.



About the User-Defined Camera Name

The Genie can be programmed with a user-defined name to aid identifying multiple cameras connected to the network. For instance, on an inspection system with 4 cameras, the first camera might be labeled “top view”, the second “left view”, the third “right view” and the last one “bottom view”. The factory default user name is set to match the camera serial number for quick initial identification. Note that the factory programmed Genie serial number and MAC address are not user changeable.

When using CamExpert, multiple Genie cameras on the network are seen as different "Genie_M640_x" devices as an example. Click on a Genie device user name to select it for control by CamExpert.

An imaging application uses any one of these attributes to identify a camera: its IP address, MAC address, serial number or User Name. Some important considerations are listed below.

- Do not use the camera's IP address as identification (unless it is a persistent IP) since it can change with each power cycle.
- A MAC address is unique to a single camera, therefore the control application is limited to the vision system with that unique camera if it uses the camera's MAC address.
- The User Name can be freely programmed to clearly represent the camera usage. This scheme is recommended for an application to identify cameras. In this case, the vision system can be duplicated any number of times with cameras identified by their function, not their serial numbers or MAC address.

Silent Installation of Genie Framework

The Genie Framework installation can be integrated within a developer's installation procedure. The silent installation mode allows the Genie Framework installation to proceed without the need for mouse clicks from a user.

Two steps are required:

- Preparation of a response file to emulate a user.
- Invoking the Genie Framework installer with command options to use the prepared response file.

Creating the Response File

An installer response file is created by performing a Genie Framework installation with the command line switch "-r". The response file is automatically named `setup.iss` which is saved in the \windows folder. One simple method is to execute the Framework installer from within a batch file. The batch file will have one command line.

As an example, using the executable file name for Framework version 1.40, the command line is:

```
"Genie_1.40.00.0222 Release.exe" –r
```

Important: The executable name is enclosed in quotation marks. This is required because of the space characters in the Genie Framework file name.

Running a Silent Mode Installation

A Genie Framework silent installation, whether done alone or within a larger software installation requires the Genie Framework executable and the generated response file `setup.iss`.

Execute the Framework installer with the following command line (using version 1.30 as an example):

```
"Genie_1.40.00.0222 Release.exe" -s -f1".\setup.iss"
```

where in this example, the switch –f1".\setup.iss" specifies that the `setup.iss` file is in the same folder as the Framework installer.

Windows Embedded 7 Installation

Windows Embedded 7 is not officially supported by Teledyne DALSA due to the number of possible configurations. However, Sapera LT and other Teledyne DALSA products should function properly on the Windows Embedded 7 platform provided that the required components are installed.

Teledyne DALSA provides answer files (.xml) for use during Windows Embedded 7 installation that install all necessary components for running Sapera LT 32-bit or 64-bit versions (SDK or Runtime), Sapera Processing 32-bit or 64-bit versions (SDK or Runtime), Teledyne DALSA framegrabbers or Genie devices.

For each platform (32 or 64-bit), the answer file is provided:

- SaperaGenie.xml: Configuration for Sapera LT, Sapera Processing and Teledyne DALSA Genie devices

These files are located in the following directories:

- <Install Directory>\Sapera\Install\Win7_Embedded\Win32
- <Install Directory>\Sapera\Install\Win7_Embedded\Win64

The OS footprint for these configurations is less than 1 GB. Alternatively, the Windows Thin Client configuration template provided by Microsoft in the Windows Embedded 7 installation also provides the necessary dependencies for Sapera LT, Teledyne DALSA framegrabbers and Genie devices (with an OS footprint of approximately 1.5 GB).

If you are installing other applications on the Windows Embedded 7 platform, it is recommended that you verify which components are required, and if necessary, create a corresponding Answer File.

For more information on performing dependency analysis to enable your application on Windows Embedded 7, refer to the Microsoft Windows Embedded 7 documentation.

Operational Reference

Camera and Sensor Information

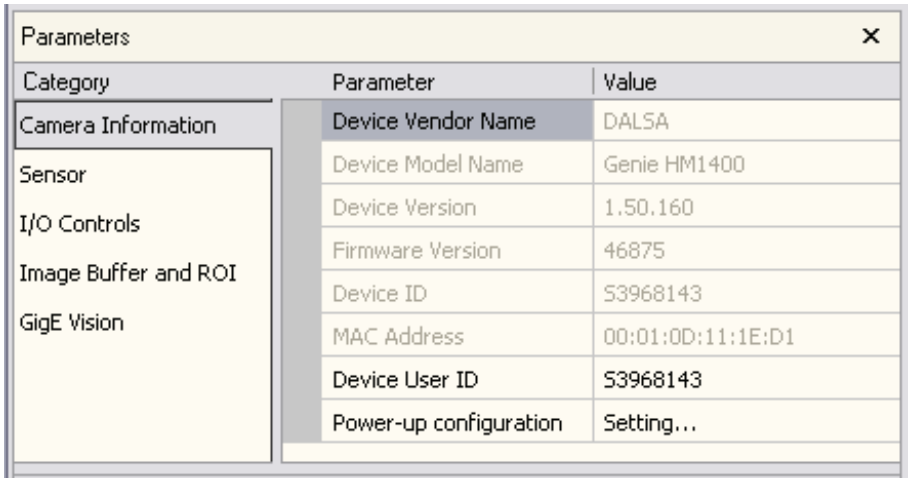
Camera and sensor information can be retrieved via a controlling application. Parameters such as camera model, firmware version, sensor characteristics, etc. are read to uniquely identify the connected Genie device.

All these features, with the exception of the DeviceUserId, are read-only. Sapera LT or GigE Vision Compliant calls are used to retrieve this information and correctly identify the camera along with its characteristics.

Following is an overview of CamExpert displaying this information followed by tables with the feature name associated to Sapera LT and to GigE Vision Compliant development environments.

Access Via CamExpert

The Camera Information Parameters tab groups information specific to the individual Genie camera.



Read Only Parameters

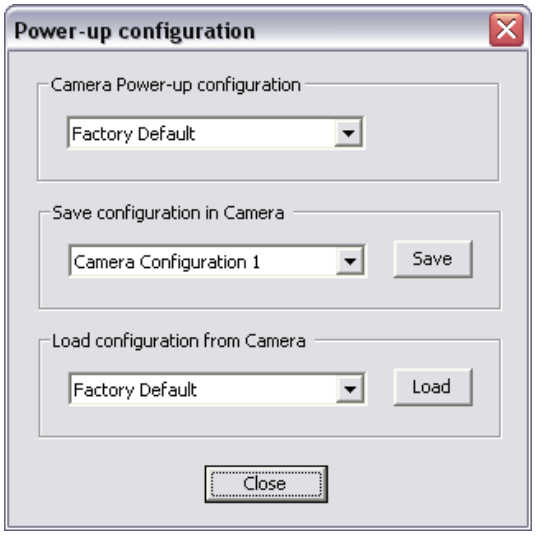
Parameter	Description
Device Vendor Name	For the Genie HM series, this is always DALSA.
Device Model Name	Displays the device model name
Device Version	Displays the device version which includes the firmware release and build.
Firmware Version	Displays the currently loaded firmware version manufacturer's code.
Device ID	Displays the factory set camera serial number.
MAC Address	Displays the unique MAC (Media Access Control) address of the Genie camera.

User Set Parameters

Parameter	Description
Device User ID	Specifies a user written ID, of up to 15 characters, for the Genie camera. By default, this field is set to the serial number of the camera.
Power-up Configuration	Click **Setting** to open the **Power-up configuration** dialog box which allows you to specify camera power-up configuration. For more information, see "Power-up Configuration" on page 34.

Power-up Configuration (Saved User Settings)

The **Power-up configuration** dialog allows you to specify the camera configuration to load when powering-up the camera. The Genie camera flash memory contains two possible configuration settings; the Factory Default (neutral parameters and in free run mode), and a user-defined Camera Configuration 1. The **Camera Power-up configuration** drop-down list box allows you to select either the Factory Default or a user specified camera configuration file. To save the current CamExpert settings to the camera user-defined (Camera Configuration) setting, click **Save**. To view in CamExpert a camera configuration file currently saved in the camera, select the configuration file in the **Load configuration from Camera** drop-down list, and click **Load**. See the parameter list below.



Power-up Parameter List

The user-defined Camera Configuration saves in camera memory features that can be configured by the user. The following table lists most of these parameters.

Parameter	Description
ROI	Region of interest used to crop the image.
Pixel Format	Defines the pixel format.
Frame Rate	Defines the frame rate for free run mode. *(see note below)*
Exposure Control mode	Defines the exposure mode (Programmable or Pulse Controlled)
Exposure duration	Defines the exposure duration for Programmable mode. *(see note below)*
Exposure synchronization	Synchronous or Reset synchronization mode.
Gain	Defines the sensor analog Gain factor, initially set to 0.0 dB.
Black Level	Defines the sensor analog Black level factor, initially set to 0.
Flip	Horizontal flip: Off or On (HM models only)
Image source	Defines the image source as the sensor or one of the stored image patterns.
Trigger enable	Free-running or triggered.
Trigger source	Selects the trigger input (input pin or software).
Trigger delay	Defines the delay from input trigger to exposure start.
GPI settings	Defines the operational mode of the general input pins.
GPO settings	Defines the operational mode of the general output pins
LUT	Lookup Table function On or Off plus the LUT data. (HM models only)
Flat Field Correction	FFC function On or Off plus the offset/gain data. *(see warning below)*

Note: Maximum frame rates and exposure durations saved previously with Genie Framework 1.40 may be slightly reduced by Framework 1.50, to improve acquisition robustness.

Warning: Non-typical or invalid Flat Field data, either from a faulty calibration setup or uploaded by the user, may cause an error when trying to save the User Settings Power-up Parameters. Such "flawed" Flat Field data is useable during camera operation but cannot be sufficiently compressed to be saved as a user setting.

Power-up Control via Sapera LT or GigE Vision Compliant Applications

Genie Sapera parameters for Power-up Configuration:

Power-upConfig = {Factory Default = 0, Camera Configuration 1 = 1}
SaveCameraConfigurationSelector = {Camera Configuration 1 = 1}
SaveCameraConfiguration = Write to save selected camera configuration
LoadCameraConfigurationSelector = {Factory Default = 0, Camera Configuration 1 = 1}
LoadCameraConfiguration = Write to load selected camera configuration

In CamExpert, these parameters are available in the “Camera Information” tab, under the “Power-up Configuration” dialog box.
See "Accessing Features with Sapera++ LT" on page 76.

	XML features for Power-up Configuration: **UserSetSelector** = Selects the feature User Set to configure {Factory = 0, UserSet1 = 1} **UserSetLoad** = Loads the User Set specified by UserSetSelector to the camera and makes it active **UserSetSave** = Saves the User Set specified by UserSetSelector to the camera **UserSetDefaultSelector** = Selects the feature User Set to load at camera reset

Camera Information via Sapera LT or GigE Vision Compliant Applications

	Genie Sapera parameters for Camera and Sensor Information: **Interface** = {GigE Vision} **DeviceVendorName** = "DALSA" **DeviceModelName** = "Genie HM1400" for Genie HM1400 **DeviceVersion** = String representing the version of the camera **FirmwareVersion** = String representing the version of the camera firmware **DeviceID** = String representing the camera serial number **MACAddress** = String representing the camera MAC address **DeviceUserID** = String representing the user-define name for the camera **DeviceMaxThroughput** = Maximum throughput of image streaming in bytes/sec. **DeviceScanType** = {Areascan} **ColorType** = Monochrome Sensor **SensorWidth** = Width of the sensor in pixels **SensorHeight** = Height of the sensor in lines **PixelSize** = Number of bits per pixel In CamExpert, these parameters are visible under "Camera Information" and "Sensor" tabs. See "Accessing Features with Sapera++ LT" on page 76.

hidden table separator

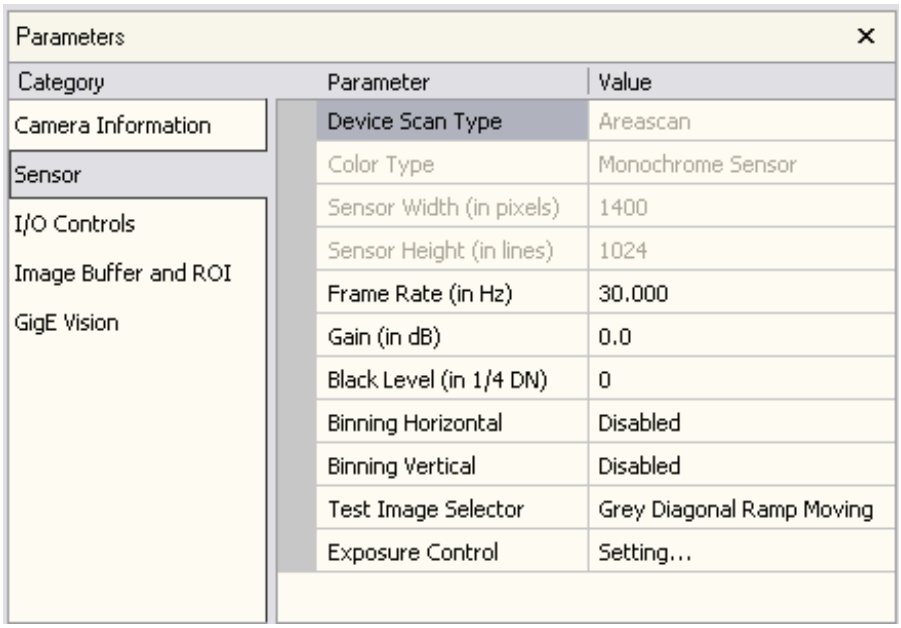
	XML features for Camera and Sensor Information: **DeviceVendorName** = Name of camera vendor **DeviceModelName** = Name of the camera model **DeviceVersion** = Displays the device version which includes the firmware release and build. **DeviceFirmwareVersion** = Displays the currently loaded firmware version manufacturer's code. **DeviceID** = Displays the factory set camera serial number. **DeviceUserID** = A user set ID of up to 15 characters. By default this field is set to the serial number of the camera. **DeviceScanType** = {Areascan} **DeviceMaxThroughput** = Maximum number of bytes per second the device supports **DeviceRegistersStreamingStart** = Announces the start of registers streaming without immediate checking for consistency **DeviceRegistersStreamingEnd** = Announces the end of registers streaming and performs validation for registers consistency before activating them **DeviceRegistersCheck** = Performs an explicit register set validation for consistency **DeviceRegistersValid** = States if the current register set is valid and consistent **SensorWidth** = Width of sensor (effective pixels) **SensorHeight** = Height of sensor (effective pixels) **PixelSize** = Number of bits per pixel (typically 8 or 10-bits per pixel) **WidthMax** = Maximum image width. Depends on binning and ROI settings **HeightMax** = Maximum image height. Depends on binning and ROI settings

Sensor Controls

Genie provides a number of sensor controls to optimize image acquisitions for most imaging solutions. Following is an overview of the CamExpert controls displaying this information, followed by individual control function descriptions and tables indicating the feature name associated to Sapera LT and to GigE Vision Compliant development environments.

Sensor Parameters: Controls Via CamExpert

The Sensor Parameters tab groups the parameters related to the camera sensor configuration for acquisition. The following figure displays the CamExpert Sensor tab for the HM camera series.



Read Only Parameters

Parameter	Description
Device Scan Type	Displays the device scan type. This is always area scan for Genie.
Color Type	Displays the color type of the sensor (Monochrome for the HM).
Sensor Width (in pixels)	Displays the sensor width (in pixels).
Sensor Height (in pixels)	Displays the sensor height (in pixels).

User Set Parameters

Parameter	Description
Frame Rate (in Hz)	Specifies the internal trigger frame rate for free run mode, in Hz. The Sapera SDK specifies the frame rate in milli Hertz. The maximum frame rate increases by using partial scan (see "Partial Scan—Window ROI" on page 40).
Gain (in dB)	Specifies the sensor gain in dB. Possible values range from 0 to 12.0 dB, in 0.1 dB increments. For more information, see "Gain and Black Level Controls" on page 39.
Black level (in DN)	Specifies the sensor black level, in digital number, which is the value assigned to a pixel in a digital image. Possible values range from 0 to 1023 (1/4 DN for 8-bit mode, 1 DN for 10-bit mode). See details below.
Color Calibration	Click Setting to open the CamExpert color control dialog which provides manual RGB gain controls plus an automatic white balance function. RGB balance adjustments can be saved with the camera user settings else they are lost when the camera is powered off. See Bayer CFA Decoder Setting on page 100.
Binning Horizontal	Enables or disables horizontal binning. Possible values are Disabled or 2 pixels. When set to 2 pixels, the image buffer width parameter is automatically adjusted. For more information, see "Binning" on page 45. Note: Binning is not available on HC model cameras.
Binning Vertical	Enables or disables the vertical binning. Possible values are Disabled or 2 lines. When set to 2 lines, the image buffer height parameter is automatically adjusted. Note: for Genie HM binning is performed digitally therefore there is no increase in frame rate. Note: Binning is not available on HC model cameras.
Test Image Selector	Specifies the test image. Possible values are: Off Grey Horizontal Ramp Grey Vertical Ramp Grey Diagonal Ramp Moving Purity For more information, see "Internal Image Test Patterns" on page 70.
Exposure Control	Click **Setting** to open the Exposure Control dialog. For more information, see "Exposure Controls" on page 47.

Gain and Black Level Controls

The Genie HM series of cameras provide gain and black level adjustments in the digital domain for the CMOS sensor. The gain and black level controls can make small compensations to the acquisition in situations where lighting varies and the lens iris can not be easily adjusted. The user can evaluate Gain and Black Level by using CamExpert.

Features and limitations are described below.

- Gain is expressed in decibels (dB). Range from 0dB to +12dB in 0.1dB increments. Gain is a multiplication factor to the signal. Increasing gain increases the sensor noise proportionately.
  Note that a gain of 6dB is a multiplier of 2 (doubles the level).
- Black level offset is expressed as a digital number ranging from 0 to 1023. As an example, if the Genie HM is used in 10-bit mode and captures a 1024 step gray level (such as the internal ramp test pattern), an offset of 1 would cause the two lowest gray levels to have a value of 0 (i.e. black level units = 1 DN). Note that in the same way, the peak white level is one less then maximum and the gain adjustment would be used to then get the full dynamic range. With the Genie HM in 8-bit mode, the offset values would change by 1 for each data entry of 4 (i.e. black level units = 1/4 DN).

	**Important:** The Genie gain adjustment range and 0dB point is arbitrarily defined by DALSA for the Genie camera series. The reference setting of 0dB must ***not*** be compared to any other product's gain settings when evaluating the signal to noise specifications of the two products. Proper comparisons of two products requires identical illumination with identical camera exposure integration time, then followed by gain control adjustments to produce an identical image gray level.

Gain and Offset Control via Sapera LT or GigE Vision Compliant Applications

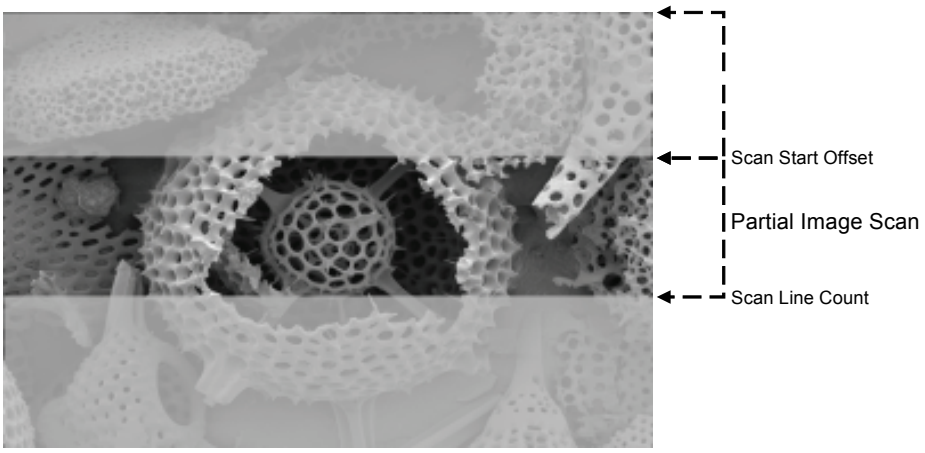
	Genie Sapera parameters for Gain and Black level: **Gain** = Amplification in dB from 0 to 12.0 dB **BlackLevel** = DC offset in DN, range from 0 to 1023 (1/4 DN for 8-bit mode, 1 DN for 10-bit mode) In CamExpert, these parameters are available under the “Sensor” tab. See "Accessing Features with Sapera++ LT" on page 76.

	XML features for Gain and Black level: **GainSelector** = Select which gain control {DigitalAll} **GainRaw** = multiplier of 1.0 to 3.0 **BlackLevelRaw** = Black level (offset) in 1/16 of DN (0 – 4092 with increments of 4 in 10-bit mode and 0 – 1023 with increments of 1 in 8-bit mode)

Partial Scan—Window ROI (cropping)

Partial Scan (vertical cropping)

The Partial Scan mode, also know as vertical cropping, reduces the number of video lines grabbed for a frame. By not scanning the full vertical area of the sensor, the maximum possible acquisition frame rate is proportionately increased. As an extreme example, the HM640 scanning a 32 line frame (with an appropriately short integration time), exposed around 1830 fps. A table of frame rates vs. sample vertical cropping values follows.



Partial Scan Illustration

Maximum Frame Rate (fps) Examples (model HM1400/HM1400XDR/HC1400)

Vertical Lines Acquired	Free Running Acquisition (synchronous mode)				Triggered Acquisition (reset mode - minimum 10µs exposure)			
	Flat Field On		Flat Field Off		Flat Field On		Flat Field Off	
	8-bit	10-bit	8-bit	10-bit	8-bit	10-bit	8-bit	10-bit
1024	64	32	75	37	64	32	75	37
768	86	43	100	50	86	43	100	50
512	129	64	150	75	129	64	150	75
480	137	68	160	80	137	68	160	80
368	179	89	208	104	179	89	208	104
256	258	129	300	150	258	129	300	150
128	516	258	600	300	498	258	600	300
64	990	516	1200	600	900	516	1200	600
32	1780	1032	2398	1200	1508	1032	1980	1200
16	2962	2020	3952	2398	2279	1677	2824	2277
8	4433	3156	4651	3597	3060	2392	4424	3058

Maximum Frame Rate (fps) Examples (model HM1024/HC1024 – 8-bit only)

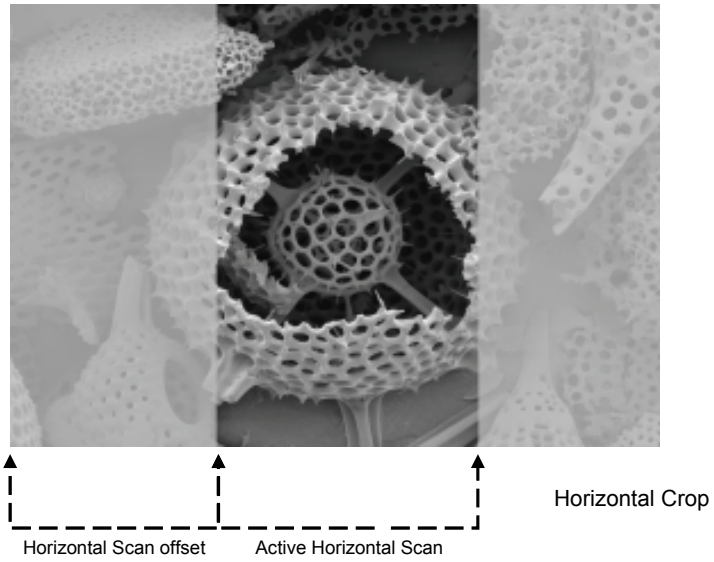
Vertical Lines Acquired	Free Running Acquisition (synchronous mode)		Triggered Acquisition (reset mode - minimum 10µs exposure)	
	Flat Field On	Flat Field Off	Flat Field On	Flat Field Off
768	117	136	117	136
512	176	205	176	205
480	188	218	188	218
368	245	285	245	285
256	352	410	352	410
128	705	820	659	820
64	1317	1639	1160	1422
32	2320	2873	1872	2217
16	3745	4524	2702	3086
8	4587	4672	3472	3831

Maximum Frame Rate (fps) Examples (model HM640/HC640 – 8-bit only)

Vertical Lines Acquired	Free Running Acquisition (synchronous mode)		Triggered Acquisition (reset mode - minimum 10µs exposure)	
	Flat Field On	Flat Field Off	Flat Field On	Flat Field Off
480	301	301	293	293
368	391	391	375	375
256	588	588	554	554
128	1054	1054	950	950
64	1926	1926	1605	1605
32	3278	3278	2444	2444
16	4694	4694	3322	3322
8	4694	4694	4032	4032

Partial Scan (horizontal cropping)

Genie also can crop the acquisition horizontally by grabbing less pixels on each horizontal line. Additionally a horizontal offset value will start the grab from any pixel count, as shown in the following figure. Note that horizontal cropping does not increase the maximum frame rate due to the CMOS sensor architecture.



Window ROI

Vertical and Horizontal Cropping can be combined to grab only a region of interest (ROI). Besides eliminating post acquisition image cropping done by software in the host computer, a windowed ROI grab reduces the bandwidth required on the Gigabit Ethernet link since less pixels are transmitted. See "CamExpert Image Buffer and ROI Parameters" on page 44 to use CamExpert to configure image cropping.

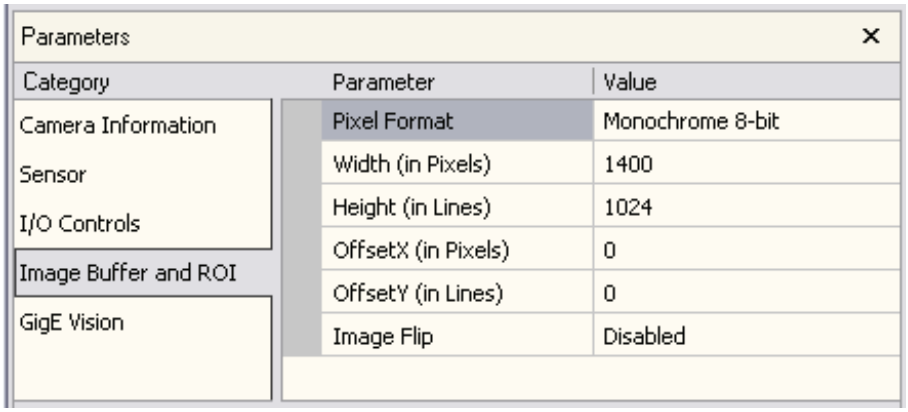
Window ROI Control via Sapera LT or GigE Vision Compliant Applications

	Genie Sapera parameters for Partial Scan and Window ROI: **Width** = Buffer width in pixels (must be an even value) **Height** = Buffer height in lines **OffsetX** = Horizontal Offset of the leftmost pixel relative to the sensor (must be an even value, in increments of 4) **OffsetY** = Vertical offset in lines of the uppermost pixel relative to the sensor (must be an even value, in increments of 2) **PixelFormat** = {Monochrome 8-bit (all models), Monochrome 10-bit (available with HM1400 and HM1400 XDR), Bayer Raw8 (all HC models), Bayer Raw10 (HC1400 only)} See "Accessing Features with Sapera++ LT" on page 76.

	XML features for Partial Scan and Window ROI: **Width** = Width of image region of interest (must be an even value) **Height** = Height of image region of interest **OffsetX** = Left coordinate of region of interest (must be an even value, in increments of 4) **OffsetY** = Top coordinate of region of interest (must be an even value, in increments of 2) **LinePitch** = Distance between consecutive lines in bytes **PixelColorFilter** = Color filter convention of the image ((None, BayerRG, BayerGB, BayerGR or BayerBG) **PixelFormat** = Format of the image pixels as per SNFC specification **PixelCoding** = Feature indicates the coding of the image pixels. Raw data is the native format of the sensor. **PixelDynamicRangeMin** = Minimum pixel value sent by camera **PixelDynamicRangeMax** = Maximum pixel value sent by camera

CamExpert Image Buffer and ROI Parameters

CamExpert provides controls to configure acquisitions via the Image Buffer and ROI Parameters tab. The image buffer can be easily cropped as desired. Below is the CamExpert dialog and parameter descriptions follow.



Parameter	Description
Pixel Format	For the Genie HM series, the image buffer format is Monochrome 8-bit or 10-bit, dependent on model.
Width (in Pixels)	Displays the image buffer width (X axis), in pixels.
Height (in Pixels)	Displays the image buffer height (Y axis), in pixels.
OffsetX (in Pixels)	Specifies the offset in X, from the left of the image, when using an ROI. The image buffer width is automatically adjusted to compensate for this offset.
OffsetY (in Lines)	Specifies the offset in Y, from the top of the image, when using an ROI. The image buffer height is automatically adjusted to compensate for this offset.
Image Flip	Enables hardware based horizontal image flip. Note: Image flipping is not available on HC model cameras.

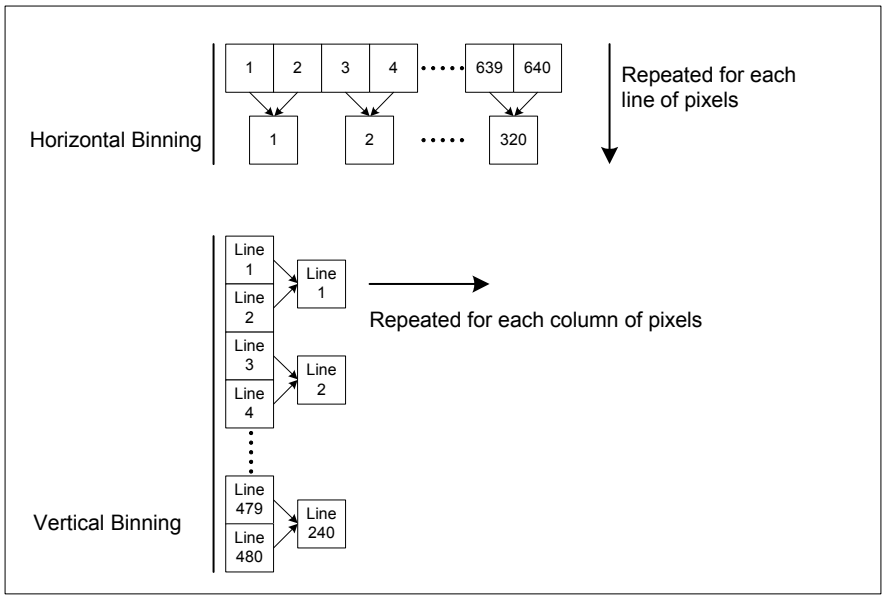
Note: When operating in binning mode, the resolution is halved and the coordinate system is scaled accordingly. For instance, an OffsetX of 20 pixels at nominal resolution is equivalent to an OffsetX of 10 pixels with horizontal binning enabled.

Binning

Binning is the process where the charge on two (or more) adjacent pixels is combined. This results in increased light sensitivity since there is twice the sensor area to capture photons. The sensor spatial resolution is reduced but the improved low-light sensitivity plus lower signal-noise ratio may solve a difficult imaging situation. The user can evaluate binning by using CamExpert.

Genie supports horizontal and vertical binning independently, by a factor of 2 in each axis. Specifically if horizontal binning only is activated, a nominal 640x480 image is reduced to 320x480. If vertical binning only is activated, the image is reduced to 640x240. With both binning modes activated, the resulting image is 320x240.

With the Genie HM, binning is performed digitally, therefore there is no increase in acquisition frame rate. The following graphic illustrates binning.



Horizontal and Vertical Binning Illustration

	Note: Binning is not available on the HC camera models.

Binning Control via Sapera LT or GigE Vision Compliant Applications

	Genie Sapera parameters for Binning: **BinningHorizontal** = {Disabled = 1, 2 pixels = 2} **BinningVertical** = {Disabled = 1, 2 lines = 2} In CamExpert, these parameters are available under the “Sensor” tab. See "Accessing Features with Sapera++ LT" on page 76.

	XML features for Binning: **BinningHorizontal** = Number of horizontally binned pixels (1=no binning, 2=binning of 2) **BinningVertical** = Number of vertically binned lines (1=no binning, 2=binning of 2 lines)

Trigger Modes

Genie image exposures are initiated by an event. The trigger event is either the camera's programmable internal clock used in free running mode, an external input used for synchronizing exposures to external triggers, or a programmed function call message by the controlling computer. These triggering modes are described below.

- **Free running (trigger disabled)**: The Genie free-running mode has a programmable internal timer for frame rate and a programmable exposure period. Frame rate is 0.1 fps to the maximum supported by the sensor. Exposures range from 56µs to a maximum also dependent on the current frame rate. This always uses Synchronous mode where exposure is aligned to the sensor horizontal line timing.
- **External trigger**: Exposures are controlled by an external trigger signal. External signals are isolated by an opto-coupler input with a time programmable debounce circuit. See "General Inputs" on page 54. The following section provides information on external trigger timing.
- **Software trigger**: An exposure trigger is sent as a control command via the Ethernet network connection. Software triggers can not be considered time accurate due to network latency and sequential command jitter. But a software trigger is more responsive than calling a single-frame acquisition (Snap command) since the latter must validate the acquisition parameters and modify on-board buffer allocation if the buffer size has changed since the last acquisition.

Exposure Controls

Exposure Control modes define the method and timing of how to control the sensor integration period. The integration period is the amount of time the sensor is exposed to incoming light before the video frame data is transmitted to the controlling computer.

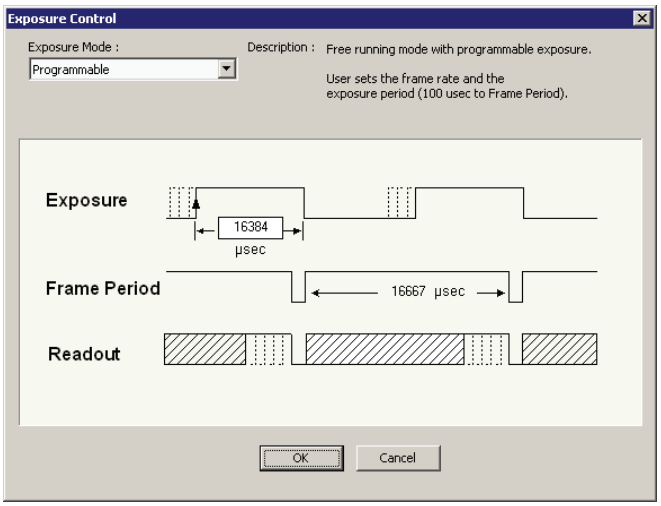
- Exposure control is defined as the start of exposure and exposure duration.
- The start of exposure can be an internal timer signal (free-running mode), an external trigger signal, or a software function call trigger.
- The exposure duration can be programmable (such as the case of an internal timer) or controlled by the external trigger pulse width.
- For the Genie camera, exposure control modes are "Free-running Programmable Exposure" on page 47 (timer), "External Trigger Programmable Exposure" on page 48 (timer) and "External Trigger Level-controlled Exposure" on page 49 (trigger pulse width). Following are details for each mode.

	**Note**: Do not change the exposure time while grabbing, else an Invalid Trigger Event may be generated. This applies to any exposure mode or trigger source. The Invalid Trigger Event is not catastrophic and only indicates the loss of a video frame. Stopping acquisitions first will avoid this error.

Free-running Programmable Exposure

Genie is in a multifunctional free running mode with the following features:

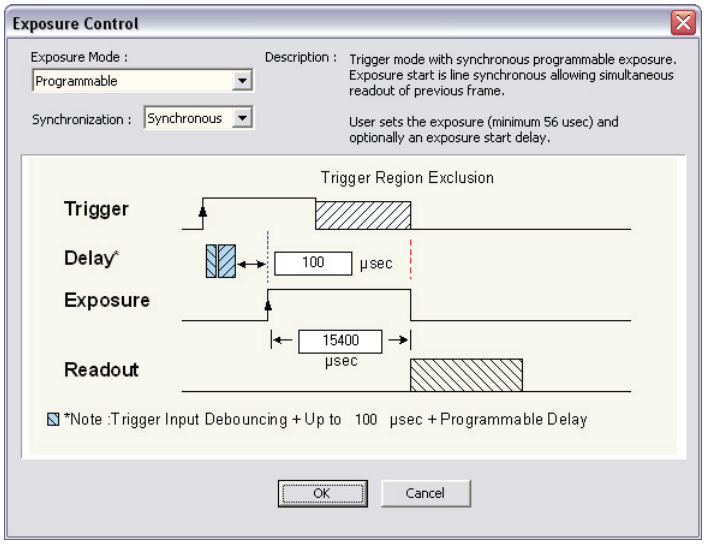
- Internal trigger programmable from maximum sensor frame rate down to 0.1Hz.
- Exposure synchronization timing is "Synchronous Mode" on page 51 where the exposure is aligned with the sensor horizontal line timing and the next acquisition is triggered by an internal programmable timer.
- Exposure duration is user programmable (exposure maximum is dependent on the frame rate and vertical cropping). Minimum exposure is 56µs.
- Image readout is simultaneous where the grabbed image frame is readout during the next frame exposure time. This allows for fastest possible frame rates. See the timing diagram below.



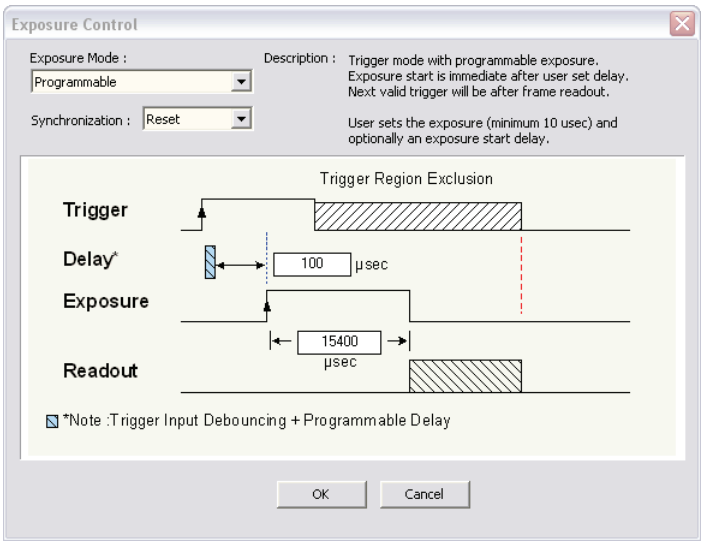
Free-running Programmable Exposure Timing

External Trigger Programmable Exposure

- Also known as “Edge Pre-select” exposure. See the timing diagram below.
- The external trigger edge initiates the exposure process. The active external trigger edge can be selected as either the low-high or high-low transition.
- The delay from active trigger edge to start of exposure is programmable from 100µs to 4 seconds (1µs steps).
- Supports "Synchronous Mode" on page 51 timing for fastest possible frame rates. Start of exposure is aligned on the next horizontal line while exposure duration granularity is 1µs. Exposure and sensor readout can be concurrent.
- Supports "Reset Mode" on page 52 timing. Exposure granularity is 1µs. Exposure and sensor readout must be sequential, limiting the maximal frame rate.
- Exposure duration is programmable from 10µs in Reset Mode or 56µs in Synchronous Mode, to 4 seconds (with 1µs steps).
- Any external trigger received before the previous exposure is complete is ignored. An application can elect to receive messages about ignored triggers. See "Events" on page 71.



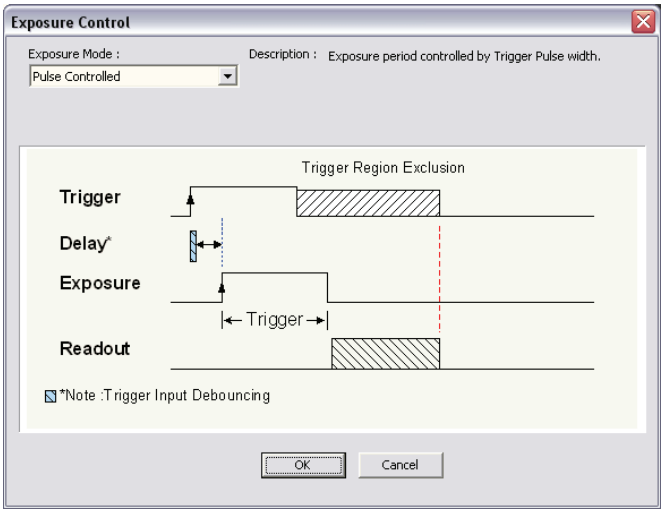
Programmable Synchronous Mode Exposure Timing



Programmable Reset Mode Exposure Timing

External Trigger Level-controlled Exposure

- Also known as “Pulse Width Control” exposure. See the timing diagram below.
- The external trigger edge initiates the exposure process. The active external trigger edge can be selected as either the low-high or high-low transition.
- There is a fixed 100µs delay from active trigger edge to start of exposure. Note that the user must also account for the input opto-coupler electrical specifications (see "External Inputs" on page 109) and any programmed input trigger debouncing period.
- Exposure is stopped by the opposite edge on the trigger signal. Therefore the exposure time is defined by the trigger pulse duration.
- Supports "Reset Mode" on page 52 trigger timing only.



External Trigger Level-controlled Exposure Timing

Exposure Controls via Sapera LT or GigE Vision Compliant Applications

Sapera	Genie Sapera parameters for Exposure Control: **FrameRate** = 0.1 Hz up to max. frame rate supported by sensor in current mode of operation. Only available with Trigger disabled. **ExposureMode** = {Programmable = 1, Pulse Controlled = 2} **ExposureTime** = Exposure duration in µs In CamExpert, these parameters are available under “Sensor” tab. See "Accessing Features with Sapera++ LT" on page 76.
GiGE VISION	XML features for Exposure Control: **ExposureMode** = {Off = 0, Timed = 1, TriggerWidth = 2,} **ExposureTimeRaw** = Exposure duration in µs **ExposureDelay** = The delay from active trigger edge to start of exposure. **AcquisitionFrameRateRaw** = Controls the desired frame rate of the camera in mHz (0.001 Hz). Only available when trigger is disabled. **AcquisitionFrameRateAbs** = Controls the desired frame rate of the camera in Hz. Only available when the frame trigger is disabled. **AcquisitionFrameCount** = Number of frames to be acquired in MultiFrame acquisition mode **AcquisitionMode** = {Continuous = 0, SingleFrame = 1, MultiFrame = 2} **AcquisitionArm** = Verify all parameters for image capture and prepares for AcquistionStart **AcquisitionStart** = Start image capture using currently selected acquisition mode **AcquisitionStop** = Stop the acquisition at the end of the current exposure **AcquisitionAbort** = Abort an acquisition immediately without completing the current frame **TLParamsLocked** = Flag to indicate if features are locked during acquisition.

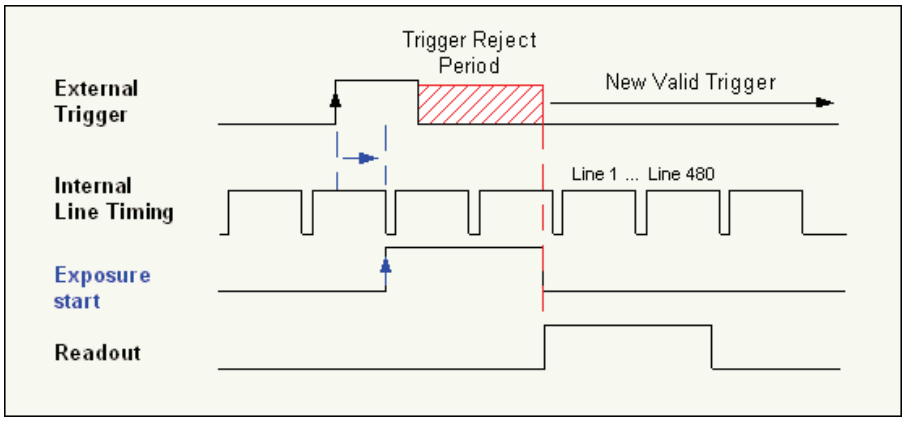
Synchronization Timing

Genie supports two types of sensor synchronization used to align the exposure to sensor timing:

- **Synchronous Mode**: Exposure is synchronous to the line timing of the sensor. Exposure granularity is 1µs and the readout can be concurrent to the exposure for the fastest possible frame rate. But the frame exposure start is subject to 1 horizontal line time jitter.
- **Reset Mode**: Timing is reset to initiate exposure of next frame. Exposure granularity is 1µs, but readout must be sequential to exposure, reducing the maximum achievable frame rate. Frame exposure start has only the fixed 100µs delay from active trigger edge to start of exposure.

Synchronous Mode

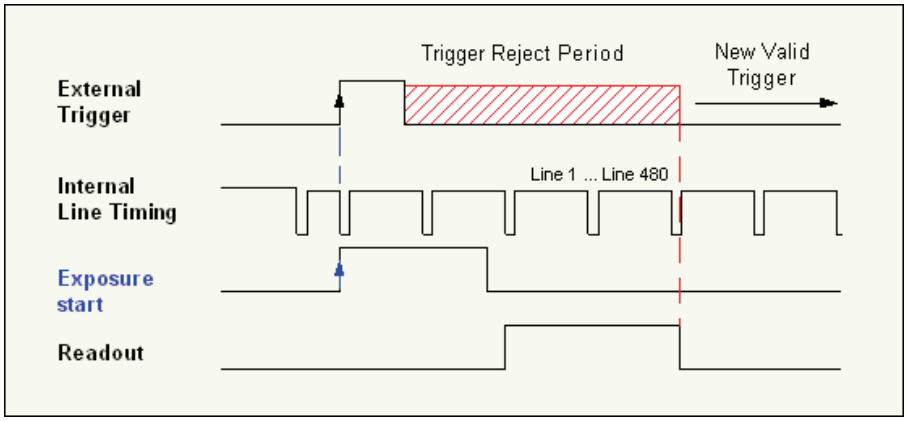
- Synchronous mode starts the exposure period aligned to the sensor horizontal line timing and the programmable duration steps are 1µs.
- Exposure duration is from a minimum of 56µs up to 4 sec.
- In this mode, sensor exposure and sensor readout of the previous frame's exposure occur simultaneously. This allows operating the sensor up to its maximum frame rate.
- Any trigger received before the end of the exposure is ignored. The application can elect to receive messages about ignored triggers. See "Events" on page 71.
- Since the external trigger is asynchronous with the Genie horizontal line timing, the frame exposure start is subject to 1 horizontal line jitter.



Synchronous Mode Timing example for Genie

Reset Mode

- Exposure starts immediately with a valid trigger (after a fixed 100µs delay). There is no jitter on the start of exposure.
- Exposure time is programmable or controlled by the trigger pulse width.
- Minimum exposure is 10µs – maximum is 4 seconds, with steps of 1µs.
- Sensor readout must complete before the next exposure can start. That is, exposure and readout are sequential. Therefore, the maximum frame rate is lower than for Synchronous mode.
- Any external trigger received before the previous exposure/read out sequence is complete is ignored. An application can elect to receive messages about ignored triggers. See "Events" on page 71.



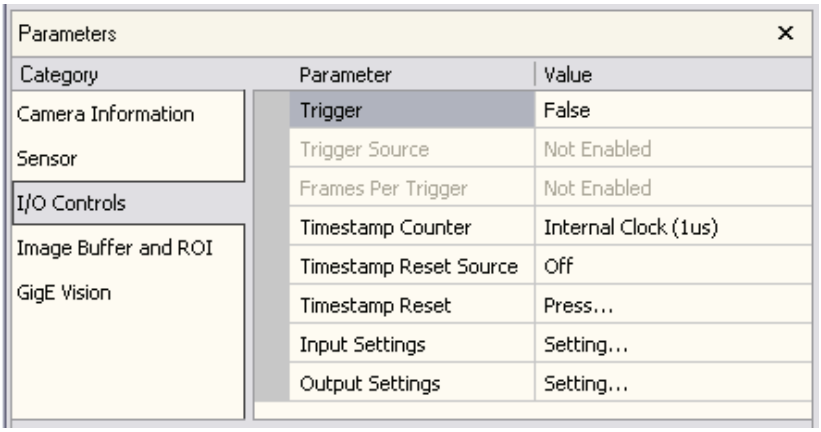
Reset Mode Timing example for Genie

Synchronization Mode via Sapera LT or GigE Vision Compliant Applications

Sapera	Genie Sapera parameters for Synchronization Mode: **ExposureAlignment** = {Synchronous = 0, Reset = 1} In CamExpert, these parameters are available under the “Sensor” tab in the “Exposure Control” dialog box. See "Accessing Features with Sapera++ LT" on page 76.
GiGE VISION	XML features for Synchronization Mode: **ExposureAlignment** = {Synchronous = 0, Reset = 1}

CamExpert I/O Controls Dialog

CamExpert groups the Genie I/O Controls Parameters in one group. These parameters allow configuring the Genie inputs and outputs for type of signal and signal polarity. The screen capture below shows the CamExpert I/O parameters dialog and is followed by a descriptive overview. Detailed information on inputs and outputs follow this section.



I/O Controls Dialog

Parameter	Description		
Trigger	Enables or disables the Genie camera trigger.		
Trigger Source	Specifies the trigger source. Possible values are Software, Input 1, or Input 2. Note that this field is only available when the Trigger parameter is True.		
Frames per Trigger	Set the number of frames acquired per trigger – max. 64k		
Timestamp Counter	Select Timestamp increment source (Internal 1µs Clock, Input 1, Input 2, End of Readout)		
Timestamp Reset Source	Select event source for Timestamp Reset (Off, Input 1, Input 2). Important; The timestamp reset function is described below, using Input 1 as the selected example (applies to Input 2 also). For correct timestamp counter operation, do not use the same "external signal input" for both the reset and counter source.		
	Case 1	Input 1 polarity setting = Active High Input 1 signal = High	Timestamp function is enabled
	Case 2	Input 1 polarity setting = Active High Input 1 signal = Low	Timestamp is held in Reset – counter is always 0
	Case 3	Input 1 polarity setting = Active Low Input 1 signal = Low	Timestamp function is enabled
	Case 4	Input 1 polarity setting = Active Low Input 1 signal = High	Timestamp is held in Reset – counter is always 0
Timestamp Reset	Software Reset: Reset the Timestamp counter immediately (click mouse in command field).		
Input Settings	Click on **Setting** to open the **Input Settings** dialog box, which allows you to specify the trigger input settings. For more information, see "General Inputs: Settings Via CamExpert" on page 54.		
Output Settings	Click on **Setting** to open the **Output Settings** dialog box, which allows you to specify the trigger output settings. For more information, see "General Outputs: Settings via CamExpert" on page 56.		

For more information on triggers, see "General Inputs" on page 54.

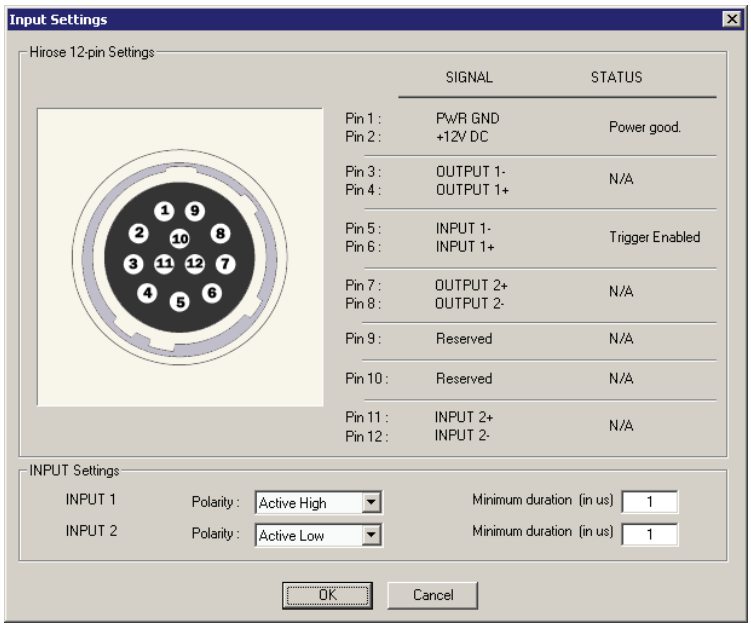
General Inputs

External Input Signal Opto-coupler & Debounce Circuit

- Genie provides two sets of opto-coupled inputs for either RS422 or TTL signals. These can be used as external trigger sources.
- See "12-Pin Hirose Connector Signal Details" on page 108 for connector pinout and electrical information. The cable shell and shield should electrically connect the Genie chassis to computer chassis for maximum EMI protection.
- For external triggers, a rising edge signal is suggested to minimize the time it takes for the opto-coupler to change state. (The opto-coupler response time is typically 10µs for rising edge compared to 50µs for falling edge).
- Each input incorporates a signal debounce circuit (following the opto-couple) to eliminate short noise transitions that could be wrongly interpreted as a valid pulse. The duration is user-programmable from 1µs to 255µs with CamExpert.
- Note, the external trigger input propagation delay is dependent on the signal used to activate the opto-coupled input. Typical delays are 3 µs for Active Open and 5 µs for Active Close.

General Inputs: Settings Via CamExpert

CamExpert provides control of inputs via the I/O Controls Parameters tab. The **Input Settings** dialog box allows you to view the signal and status for each pin on the Hirose connector. The **Polarity** drop-down list boxes, located in the **INPUT Settings** area, allow you to specify the polarity of the Input 1 and Input 2 as either **Active High** or **Active Low**. The **Minimum duration** field for each input, allows you to specify the minimum trigger length (1-255µs) so that input transitions are debounced to prevent unwanted trigger events.



Input Settings Dialog

Input Controls via Sapera LT or GigE Vision Compliant Applications

Sapera	Genie Sapera parameters for Trigger Modes, Time Stamp and General Inputs: **TriggerDelayToIntegration** = Delay in µs from trigger to exposure **TriggerEnable** = {FALSE, TRUE} **TriggerSource** = {Input 1 = 0, Input 2 = 1, Software = 2} **TriggerSoftware** = {FALSE, TRUE} **FramesPerTrigger** = Frame count 1 to 32767 **TimestampResetSource** = {Off = 0, Input 1 = 1, Input 2 = 2} **TimestampCounter** = {Internal Clock = 0, Input 1 = 1, Input 2 = 2, End of Readout = 3} **TimestampReset** = {FALSE, TRUE} **PolarityInput_x** = {Active High = 0, Active Low = 1} **DebounceInput_x** = debouncing period in µs (from 1 to 255 µs) **InputPinStatusInput_1** = {FALSE, TRUE} **InputPinStatusInput_2** = {FALSE, TRUE} See "Accessing Features with Sapera++ LT" on page 76.

GiGE VISION	XML features for Trigger Modes, Time Stamp and General Inputs: **TriggerMode** = {Off = 0, On = 1} **TriggerSelector** = Select the type of trigger to control. FrameStart currently supported. **TriggerSoftware** = Generates a software trigger to start the acquisition in any trigger mode **TriggerSource** = External input or software signal as trigger source {Line2 = 1, Software = 2} **TriggerActivation** = {LevelLow = 0, LevelHigh = 1, RisingEdge, FallingEdge, AnyEdge} **TriggerDelayAbs** = Absolute delay to apply in us after reception of the trigger signal before starting exposure **TriggerDelayRaw** = Absolute delay to apply in us after reception of the trigger signal before starting exposure **GevTimestampTickFrequency** = 64-bit value indicating the number of timestamp clock ticks in one second. **GevTimestampControlLatch** = Latches the current timestamp value of the device. **GevTimestampControlReset** = Resets the timestamp count of the device. **GevTimestampValue** = Latched 64-bit value of the timestamp. Value must first be latched using GevTimestampControlLatch. **CounterSelector** = Select counter to configure. Currently only Timestamp is supported. **CounterEventSource** = Select counter source as {Internal Clock = 0, Input 1 = 1, Input 2 = 2, End of Readout = 3} **CounterLineSource** = Source for the line to count. **CounterReset** = Resets the selected Counter. **InputLineSelector** = Index to general input {input1=0, input2=1} **InputLinePolarity** = {Active High = 0, Active Low = 1} **InputLineDebouncingPeriod** = debounce period in µs (from 1 to 255 µs) **InputLineValue** = Read input line state {low=0, high=1} **LineStatus** = Current logical state of signal at time of polling {FALSE, TRUE} **Line Mode** = Indicate if the line is an input or an output.

Strobe and General Outputs

Genie provides two sets of opto-coupled outputs (see "External Outputs" on page 111). These can be used as a strobe signal to control lighting or to generate programmable pulses when specific events are generated by the camera. They can also be set to a static state (close or open) by the application.

See "12-Pin Hirose Connector Signal Details" on page 108 for connector pinout and electrical information.

General Outputs: Settings via CamExpert

The **Output Settings** dialog box allows you to configure the event mode for both output 1 and output 2. Each output can be set independently to one of the available event modes. A typical usage of output is to control a strobe light in relation to the camera exposure. Select the output to configure by clicking on the **Output 1** or **Output 2** buttons located at the top of the dialog box. Use the **Event mode** drop-down list box to select the required event mode.

The following output signal events are available:

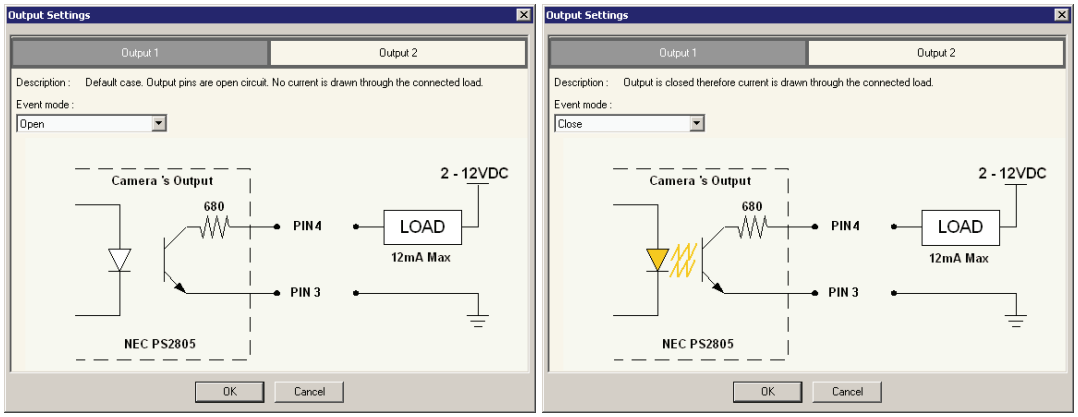
- Open (default)
- Close
- Strobe On: Start of Exposure (used for strobe pulse)
- Pulse On: Valid Trigger
- Pulse On: Invalid Trigger
- Pulse On: Start of Readout
- Pulse On: End of Readout
- Pulse On: End of Acquisition
- Pulse On: Input 1
- Pulse On: Input 2

When an event mode is selected, its trigger output schematic or signal timing diagram is displayed, as well as any other additional parameters for the mode.

For most event modes, the trigger output signal can be set to either Active Open (that is high with the load connected to a voltage source) or Active Closed (where current is drawn through the load). The output delay can be set from 0 to 4 seconds, in increments of 1 µs. The pulse duration can be set from 10µs to 4 seconds, in increments of 1 µs.

Open and Close Output Settings

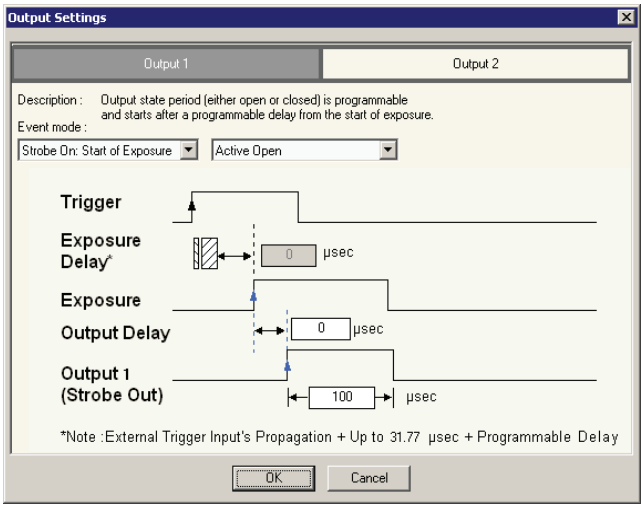
You can open and close the output circuit using software rather than hardware events, to control external devices. To control the output setting with Sapera LT see "Output Control via Sapera LT or GigE Vision Compliant Applications" on page 61.



Strobe On Start of Exposure Event Mode

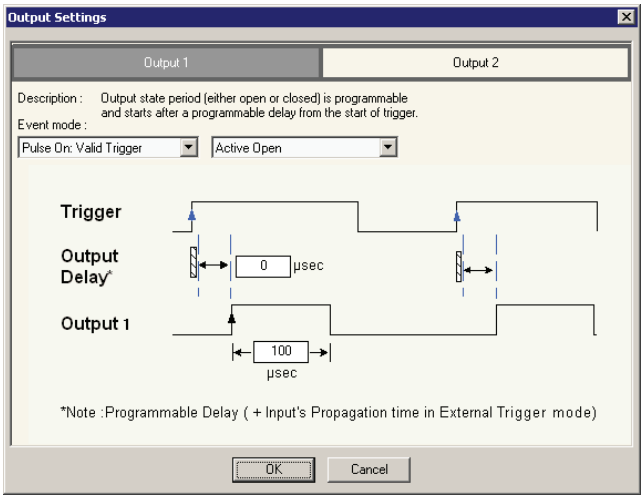
The Strobe On Start of Exposure event mode is used when controlling a strobe light using the Genie output pin. The exposure delay parameter is specified using the Sensor Parameters tab Exposure Control setting.

For Synchronous mode, the exposure start timing is aligned to the line period of the sensor. This can delay the start of exposure by an amount of up to 31.77µs for the Genie M640. For more information on exposure synchronous time see "Exposure Controls" on page 47.



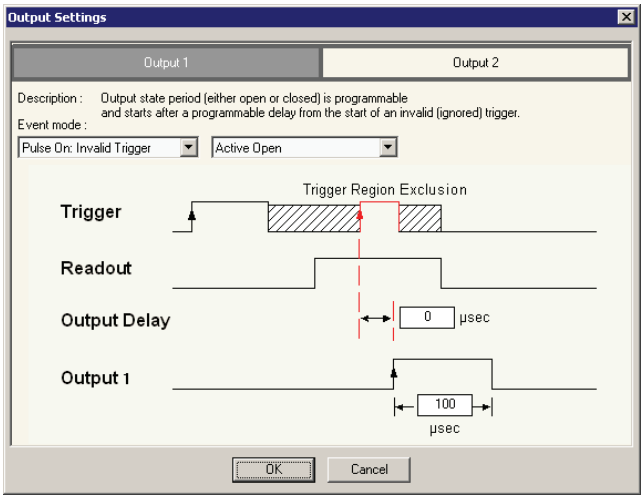
Pulse On Valid Trigger Event Mode

The Pulse On Valid Trigger event mode generates an output signal when a valid input trigger is received.



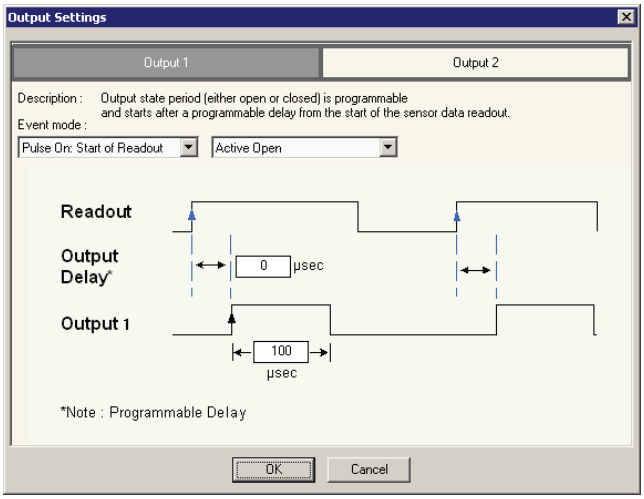
Pulse On Invalid Trigger Event Mode

This event mode generates an output signal when an invalid input trigger is received. An invalid trigger is any trigger received while the camera is engaged in frame acquisition (exposure and readout) and cannot accept trigger inputs. This is shown by the trigger exclusion region in the following diagram.



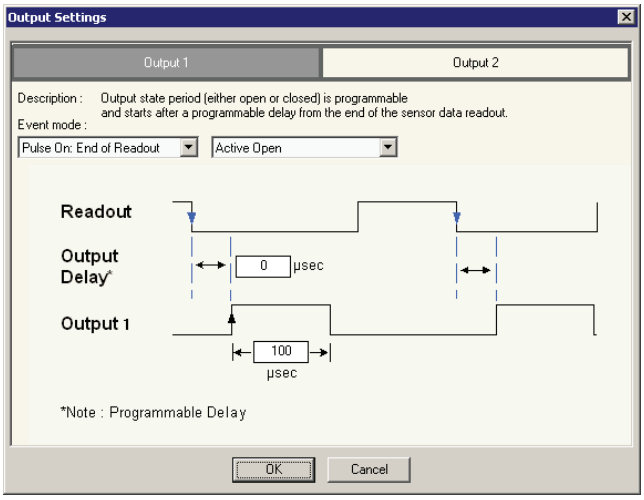
Pulse On Start of Readout Event Mode

The Pulse On Start of Readout event mode generates an output signal when the camera begins a readout operation from the sensor.



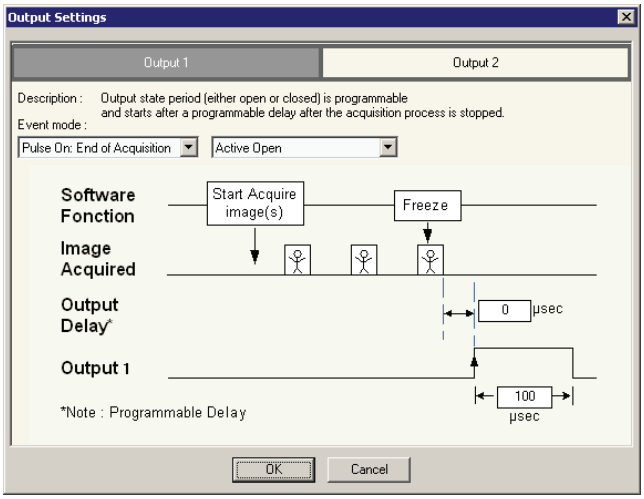
Pulse On End of Readout Event Mode

The Pulse On End of Readout event mode generates an output signal when the camera finishes a readout operation from the sensor.



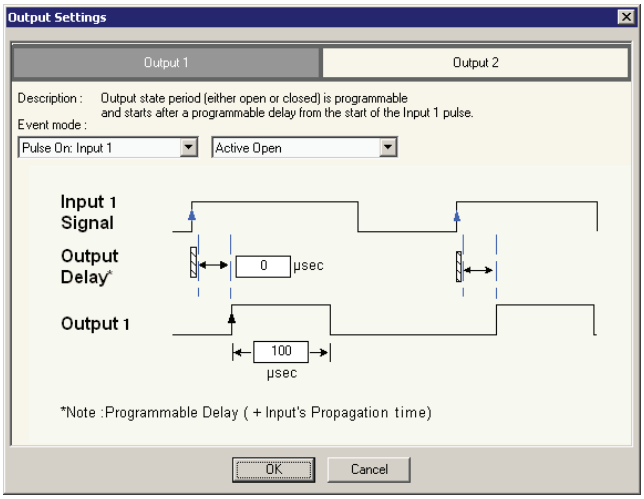
Pulse On End of Acquisition Event Mode

The Pulse On End of Acquisition event mode generates an output signal when the acquisition process is terminated using software.



Pulse On Input 1 or Input 2 Event Modes

The Pulse On Input 1 or Input 2 event modes generate an output signal when the specified input signal is asserted.



Output Control via Sapera LT or GigE Vision Compliant Applications

Sapera	Genie Sapera parameters for Strobe and General Outputs. See "Accessing Features with Sapera++ LT" on page 76. **OutputSelectorOutput_x** = {Open = 0, Close = 1, Strobe On: Start of Exposure = 2, Pulse On: Valid Trigger = 4, Pulse On: Invalid Trigger = 5, Pulse On: Start of Readout = 6, Pulse On: End of Readout = 7, Pulse On: End of Acquisition = 8, Pulse On: Input 1 = 9, Pulse On: Input 2 = 10} **PulseDelayOutput_x** = Delay in µs to assert pulse output **PulseDurationOutput_x** = Pulse duration in µs **PolarityOutput_x** = {Active Close = 0, Active Open = 1}

GiGE VISION	XML features for Strobe and General Outputs: **OutputLineSelector** = Index to select output line {output 1 = 0, output 2 = 1} **OutputLineMode** = {SoftwareDriven = 0, EventDriven = 1} **OutputLineEventSource** = Event generating output line pulse {StartOfTrigger=0, StartOfExposure=1, StartOfReadout=3, EndOfReadout=4, EndOfAcquisition=5, EventOnInputLine1=6, EventOnInputLine2=7, OverTrigger=8,} **OutputLinePulsePolarity** = State of output opto-coupler {Active Close = 0, Active Open = 1} **OutputLinePulseDelay** = Delay in µs to assert pulse output (range 0 to 9.99 sec.) **OutputLinePulseDuration** = Pulse duration in µs (range 100 to 9.99 sec) **OutputLineValue** = Static output state {Open = 0, Close = 1}

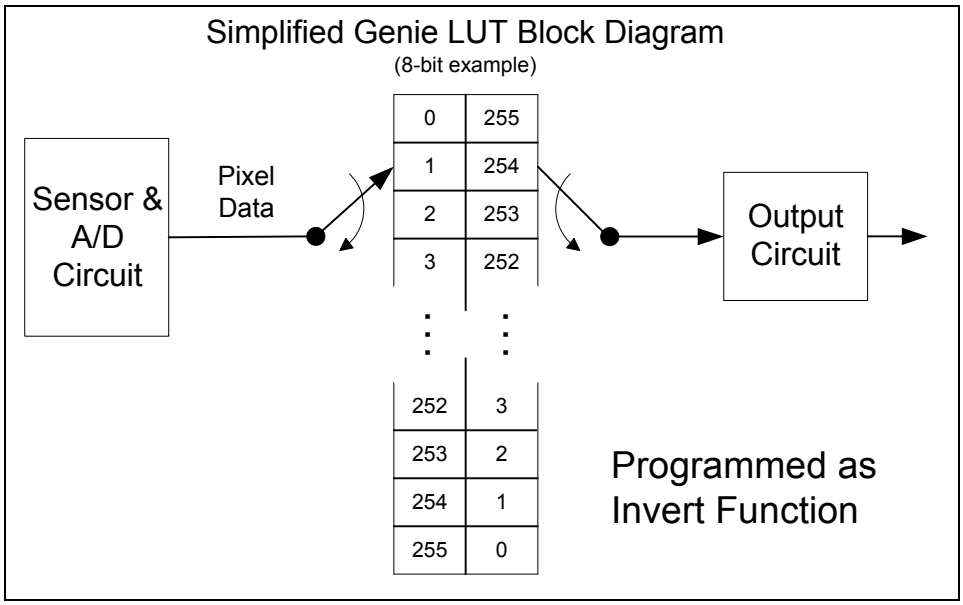
Genie Processing Features

The Genie HM series of cameras support a number of functions to enhance acquisitions or perform real time processing. Functions can be combined to solve specific imaging situations. The user can enable and evaluate each operation by using CamExpert.

Lookup Table (LUT)

The Genie camera includes a user programmable LUT as a component of its embedded processing features. The LUT is used for operations such as gamma adjustments, invert and threshold processes. CamExpert has a number of built in LUT operations for the user to explore (see "CamExpert LUT Controls" on page 99).

For HM sensors, the LUT table is a single 8-bit or 10-bit LUT (8/10-bit in, 8/10-bit out) as illustrated in the following figure. Pixel data when read out of the sensor is passed through the LUT memory array, where the new programmed pixel value is then passed to the Genie output circuit. The LUT data table is stored along with other parameters with the user configuration function (see "Power-up Configuration" on page 34).



Simplified 8-bit LUT Block Diagram

Note: LUTs are not available on the HC camera models.

LUT Control via Sapera LT or GigE Vision Compliant Applications

Genie Sapera parameters for LUT control:

LUTEnable = {FALSE, TRUE}
LUTFormat = {Mono 8, Mono 10 – Unsigned}
LUTNumberEntries = Number of entries in the LUT
(256 for an 8-bit LUT, 1024 for a 10-bit LUT)
LUTData = Array of data representing the LUT content

Sapera++ classes used:

SapLut Class implements LUT management.

BOOL SapAcqDevice::SetFeatureValue(const char *featureName, SapLut *featureLut)
BOOL SapAcqDevice::SetFeatureValue(int featureIndex, SapLut *featureLut)
BOOL SapAcqDevice::GetFeatureValue(const char *featureName, SapLut *featureLut)
BOOL SapAcqDevice::GetFeatureValue(int featureIndex, SapLut *featureLut)

In CamExpert, these features are available from the “Pre-Processing” menu.

XML features for LUT control:

LUTSelector = Select the LUT to control { Luminance=0 }
LUTEnable = Enable the selected LUT { False, True }
LUTIndex = LUT data index { 0 to 255 for 8-bit LUT, 0 to 1023 for a 10-bit LUT }
LUTValue = Value of selected LUT element at index LutIndex.

Flat Field (Image Shading) Correction

Image Shading correction, also known as Flat Field Correction is the process of eliminating small gain differences between pixels in a sensor, eliminate sensor hotspots by automatically doing pixel replacement, and also to compensate for light distortion caused by a lens. That sensor when exposed to a uniformly lit field will have no gray level differences between pixels when calibrated flat field correction is applied to the image. The Genie camera stores flat field correction data until power off or in its user setting state for recall at any time (see "Power-up Configuration" on page 34). Flat field correction data is composed of gain and offset coefficients.

The CamExpert Flat Field Correction tool (or Sapera Flat Field Demo) allows calibrating, saving, and loading the flat field calibration data for any Genie camera being controlled. CamExpert will automatically apply frame rate and exposure limits to optimize calibration (see the calibration notes below).

Information on the Flat Field Data File

A Sapera application (such as CamExpert) creates a new SapBuffer object of the same width as the image buffer but with twice the number of lines. This provides the room to store both offset and gain Flat Field data. The Flat Field offset data is contained in the top half of the new buffer, while the gain buffer is in the bottom half.

A Sapera application saves the new buffer using SapBuffer::Save with the "-format tiff" option, which allows saving both 8-bit and 10-bit offset/gain data without loss of significant bits.

The Flat Field correction formula is: correctedPixelValue = (originalPixelValue - offset) * (gain/128)

Note: If the offset data = 0xff, then that is a special flag, indicating that the pixel is replaced with an adjacent pixel, without any calculation. This is the factory calibration technique for elimination of dead or hot pixels. A pixel on the left edge (beginning of the line) would be replaced with the pixel to its right, while a pixel on the right edge (end of the line) is replaced with the pixel to its left. Any pixel within a line is replaced with the average of the its neighboring pixels (on the same line). For color sensors, the same algorithm is used except the replacement pixel is of the same color.

Important Factors about Flat Field Processing

Important: During calibration, no other Genie features should be accessed or modified. The calibration process will disable functions such as image crop or flip setting. These features need to be re-enabled by the application or user only after the flat field calibration completes.

Important: Before calibration, the Genie should be powered on long enough to achieve its nominal temperature (a minimum of 30 minutes). A metallic camera mount or a low ambient temperature may increase the time required for the Genie to reach a stable internal temperature.

Calibration via CamExpert: The CamExpert calibration function will automatically reduce the frame rate and the exposure is limited to 40ms maximum. These settings are for optimal performance from the sensor.

Calibration via a User Application: The user application must not exceed 15fps and limit exposure to 40ms (same conditions set by CamExpert). These requirements are for both free run mode (internal trigger) or when using an external trigger to capture the calibration frames.

Important Factors about the Flat Field Data (TIF) File

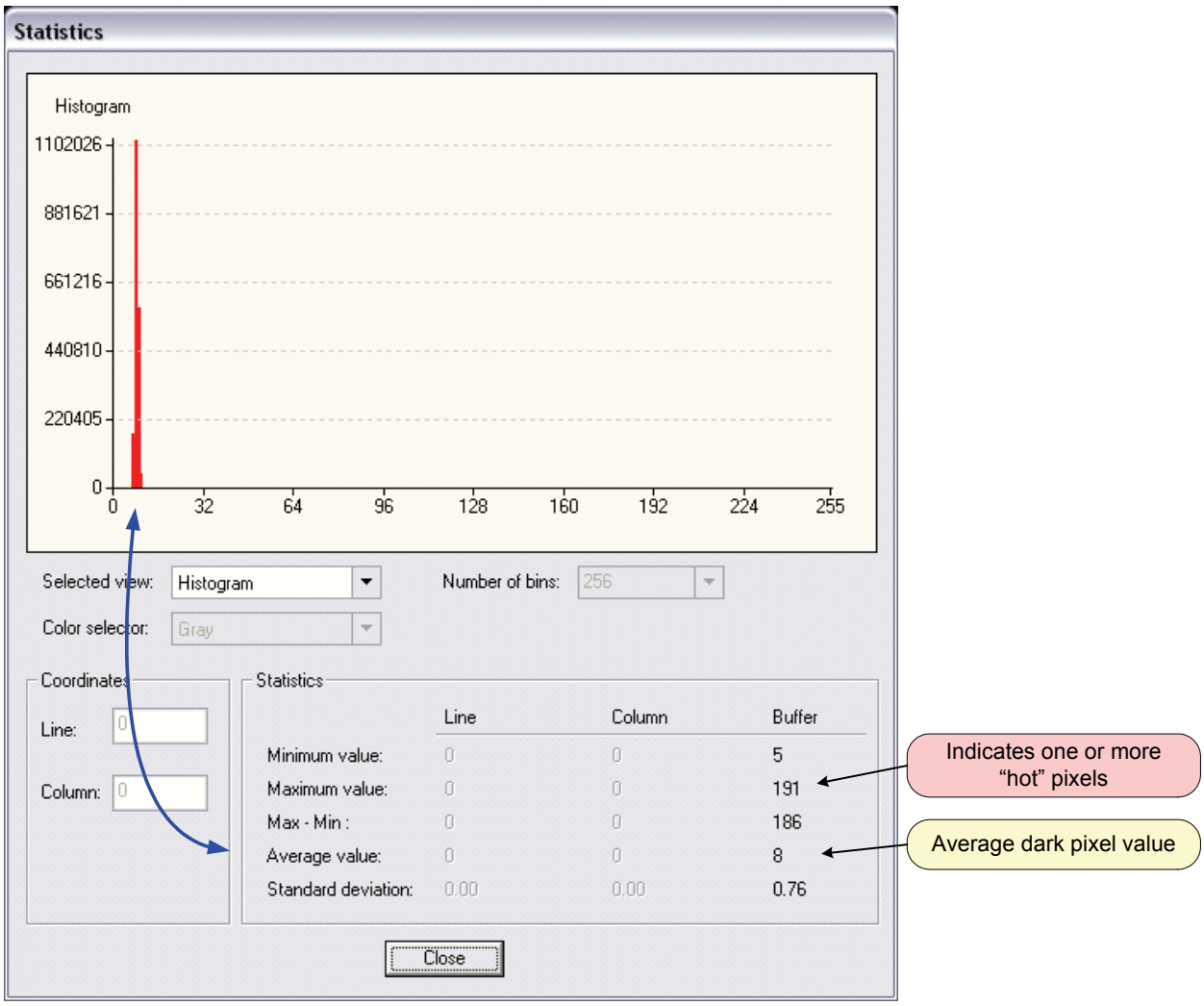
	Data Format rules: Camera Pixel format in 8-bit — Flat Field calibration data (8-bit) is saved as a 8-bit TIF file Camera Pixel format in 10-bit — Flat Field calibration data (10-bit) is saved as a 16-bit TIF file Flat Field 8-bit calibration data which is saved as an 8-bit data file (TIF) can only be loaded by a Sapera application when the application pixel format is 8-bit. Flat Field 10-bit calibration data which is saved as a 16-bit data file (TIF) can only be loaded by a Sapera application when the application pixel format is 10-bit. Flat Field 10-bit calibration data loaded in the camera remains valid if the pixel format is then changed to 8-bit. Flat Field 8-bit calibration data loaded in the camera loses the 2 LSB DN on the 10-bit image data path if the pixel format is changed to 10-bit.

Set up Dark and Bright Acquisitions with the Histogram Tool

Before performing calibration, verify Genie acquisition with a live grab. Also at this time make preparations to grab a flat light gray level image, required for the calibration, such as a clean evenly lighted white wall or non-glossy paper with the lens slightly out of focus. Ideally a controlled diffused light source aimed directly at the lens should be used. Note the lens iris position for a bright but not saturated image. Additionally check that the lens iris closes well or have a lens cover to grab the dark calibration image.

Verify a Dark Acquisition

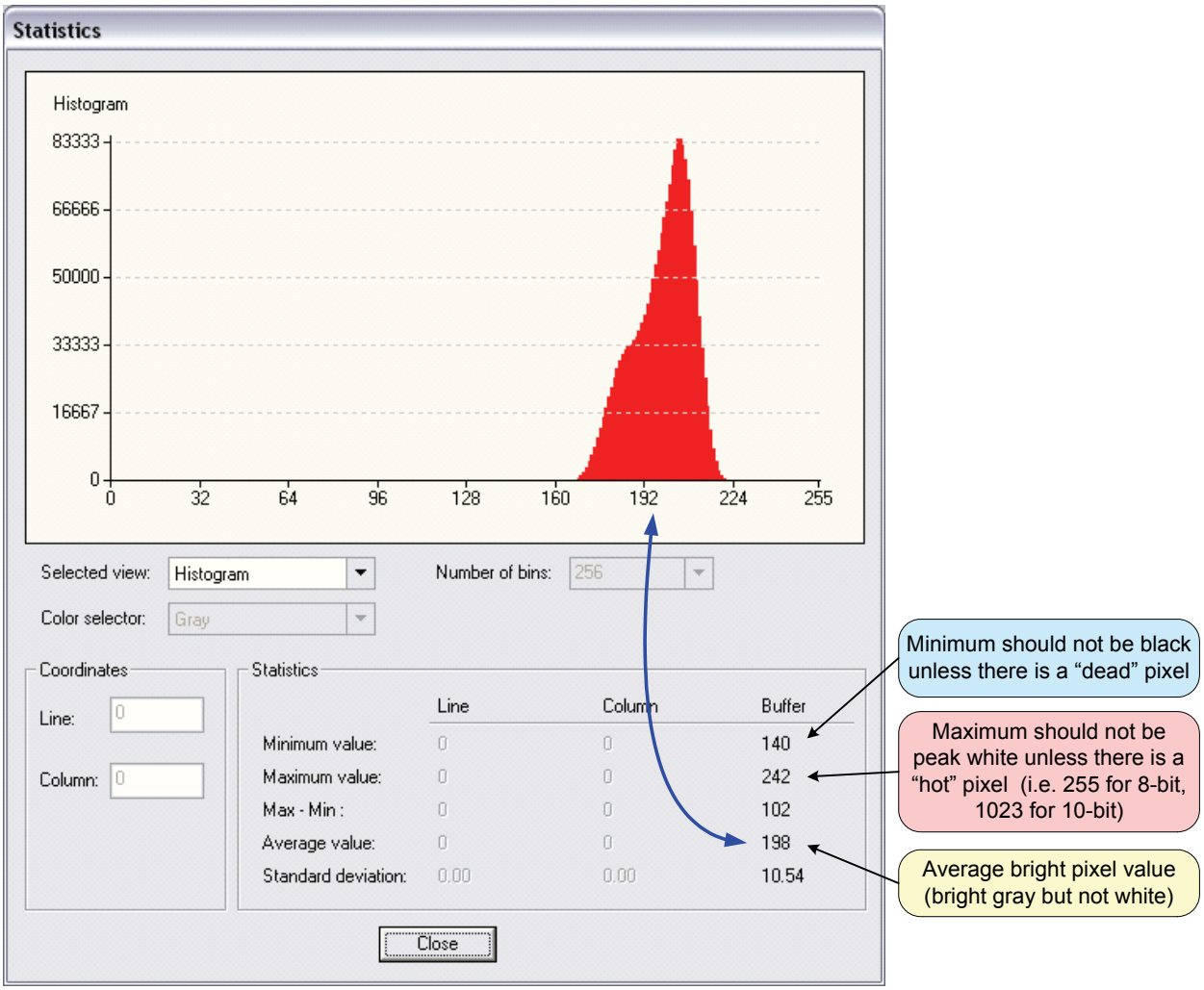
Close the camera lens iris and cover the lens with a lens cap. Using CamExpert, click on the grab button and then the histogram button. The following figure shows a typical histogram for a Genie grabbing a very dark image.



	Important: In this example, the **average** pixel value for the frame is close to black. Also note that most sensors will show a much higher maximum pixel value due to one or more "hot pixels". The sensor specification accounts for a small number of hot or stuck pixels (pixels that do not react to light over the full dynamic range specified for that sensor).

Verify a Bright Acquisition

Aim the camera at a diffused light source or evenly lit white wall with no shadows falling on it. Using CamExpert, click on the grab button and then the histogram button. Use the lens iris to adjust for a bright gray approximately around a pixel value of 200 (for 8-bit pixels). The following figure shows a typical histogram for a Genie grabbing a bright gray image.



Important: In this example, the **average** pixel value for the frame is bright gray. Also note that sensors may show a much higher maximum or a much lower minimum pixel value due to one or more "hot or dead pixels". The sensor specification accounts for a small number of hot, stuck, or dead pixels (pixels that do not react to light over the full dynamic range specified for that sensor).

Once the bright gray acquisition setup is done, note the camera position and lens iris position so as to be able to repeat it during the calibration procedure.

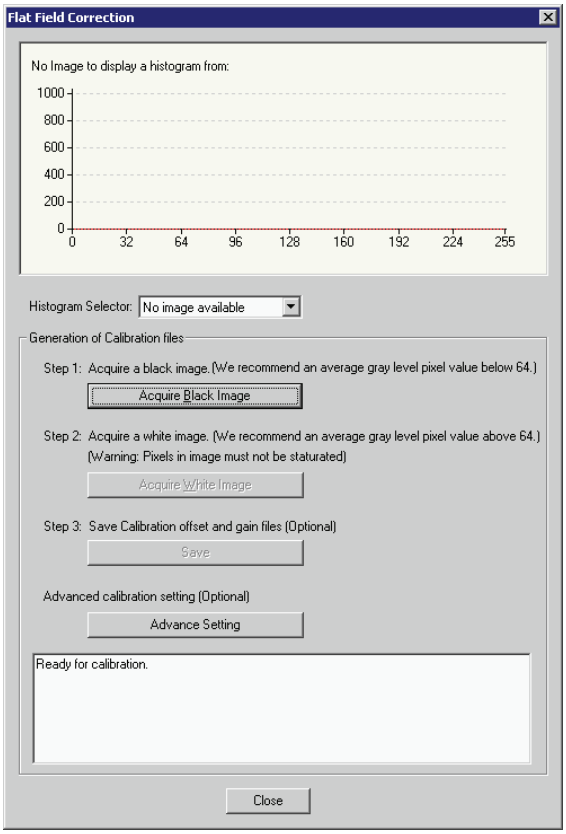
Flat Field Correction Calibration Procedure

The following procedure uses the CamExpert Flat Field tool (the Sapera Flat Field demo is similar). Calibration is the process of taking two reference images, one of a dark field – one of a bright field (not saturated), to generate correction data for images captured by Genie. Each sensor pixel data is modified by the correction factor generated by the calibration process, so that each pixel has an identical response to the same illumination.

Start the Flat Field calibration tool via the CamExpert menu bar:
Pre-processing • Flat Field Correction • Calibration.

Flat Field Calibration Window

The Flat Field calibration window provides a three step process to acquire two reference images and then save the flat field correction data for the Genie used. To aid in determining if the reference images are valid, a histogram tool is provided so that the user can review the images used for the correction data.



CamExpert Flat Field Calibration Menu

- Click on the **Advanced Setting** button to change the default number of frames averaged for each calibration step. The default value is 10 frames.
- Setup the camera to capture a uniform dark image. Black paper with no illumination and the camera lens' iris closed to minimum can provide such a dark image. Or cover the lens with a black lens cap.
- Click on **Acquire Black Image**. The flat field calibration tool will grab video frames, analyze the pixel gray level spread, and present the statistics. The desired black reference image should have pixel values less then 20. If the results are acceptable, accept the image as the black reference.
- Setup the camera to acquire a uniform white image (but not saturated white). Even illumination on white paper can be used, with a gray level of minimum of 128 (8-bit mode). It is preferable to prepare for the white level calibration step before starting the calibration procedure (see the previous section for information).
- Click on **Acquire White Image**. The flat field demo will grab video frames, analyze the pixel gray level spread, and present the statistics. The captured gray level for all pixels should be greater than 128 but not saturated. If the histogram shows a good grab accept the image as the white reference.
- Click on **Save**. The flat field correction data is saved as a TIF image with a file name of your choice (suggestions are the camera name and its serial number).

Using Flat Field Correction

From the CamExpert menu bar enable Flat Field correction (**Pre-Processing • Flat Field Correction • Hardware**). Now when doing a live grab or snap, the incoming image is corrected by the current flat field calibration data for each pixel.

Use the menu function **Tools • Flat Field Correction • Load** to load in a flat field correction image from previously saved calibration data. CamExpert allows saving and loading calibration data for all cameras used with the imaging system.

Flat Field Correction Control via Sapera LT or GigE Vision Compliant Applications

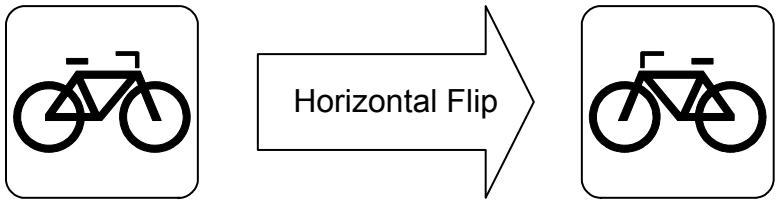
Sapera	Genie Sapera parameters for Flat Field Correction: **FlatFieldEnable** = Enable Flat Field Correction {False=0, True=1} **FlatFieldFormat** = {RO: mono 8, mono 10} **FlatFieldWidth** = read buffer width **FlatFieldHeight** = read buffer height **FlatFieldGainMin** = read minimum gain value **FlatFieldGainMax** = read maximum gain value **FlatFieldOffsetMin** = read minimum offset value **FlatFieldOffsetMax** = read maximum offset value **FlatFieldGainBuffer** = Flat Field correction gain data buffer **FlatFieldOffsetBuffer** = Flat Field correction offset data buffer Sapera++ Class constructor: SapFlatField::SapFlatField In CamExpert, these features are available from the “Pre-Processing” menu.

GiGE VISION	XML features for Flat Field Correction: **ShadingCorrectionMode** = {Enable, Disable, Calibration mode} **ShadingCorrectionPixelYCoordinate** = Pixel Y Coordinate in the coefficient table **ShadingCorrectionPixelXCoordinate** = Pixel X Coordinate in the coefficient table **ShadingCorrectionReplacePixel** = Enable pixel replacement for current pixel **ShadingCorrectionGain** = Gain factor (multiplier) for the current pixel **ShadingCorrectionOffset** = Offset value added to the current pixel after the Gain multiplier

Image Flip

Horizontal

The Genie supports a software controlled horizontal flip function as shown in the following figure. The process is done in hardware with no loss of acquisition frame rate.



Vertical

As shown in the following figure, a vertical flip function is simply accomplished by mounting the Genie camera upside down and by programming the camera to do a horizontal flip. Genie provides identical mounting holes on both its top and bottom side to ease installations.

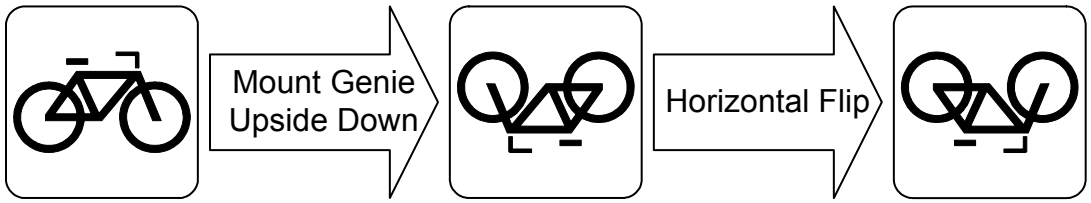


Image Flip Illustrations

	Note: Image flip is not available on the HC camera models.

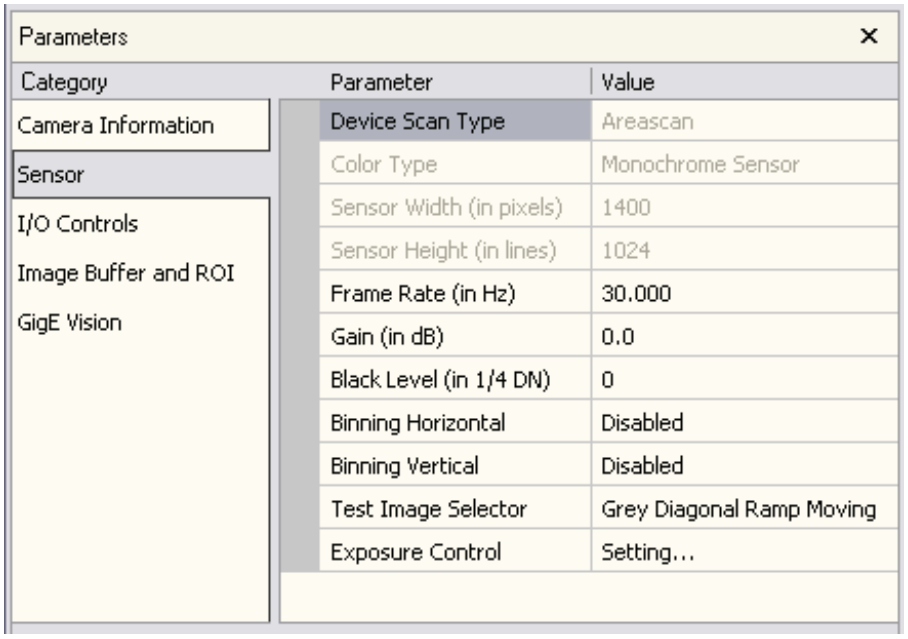
Sapera	Genie Sapera parameter for Image Flip: **ImageFlip** = {disabled=0, horizontal=1} In CamExpert, this feature is available in the Image Buffer menu. See "Accessing Features with Sapera++ LT" on page 76.

GiGE VISION	Enable Horizontal Image Flip **ReverseX** = {disabled = 0, horizontal flip enabled = 1}

Internal Image Test Patterns

The Genie camera includes a built in test pattern generator that can be used to confirm camera Ethernet connections or driver installations, without the need for a camera lens or proper lighting. The pattern generator inserts video just after the sensor A/D converter, therefore Genie processing such as the LUT act on the generator images or on sensor images.

CamExpert is used to easily enable and select the Genie test patterns. As shown in the following figure, select the Sensor tab, then select one of the four patterns from the drop menu. Select live grab to see the pattern output.



Genie Test Pattern Selection – on Sensor Tab

The Genie test patterns are:

- **Horizontal ramp**: successive pixel's gray level is incremented by 1 to maximum pixel value then repeated until the end of line. The gray level is reset to 0 on the following line.

- **Vertical ramp**: similar to the horizontal ramp, successive lines are incremented by 1 gray level then repeated for the full frame.
- **Moving diagonal ramp**: combination of the 2 previous schemes, but first pixel in image is incremented by 1 between successive frames. This is a good pattern to indicate motion when doing a continuous grab.

- **Purity**: a purity pattern where all pixels have the same value. The gray value is incremented by one on successive frames to maximum then repeated. This also provides motion for live grabs.

Test Image Select via Sapera LT or GigE Vision Compliant Applications

Sapera	Genie Sapera parameters for Image Test Patterns: **TestImageSelector** = {Off = 0, Grey Horizontal Ramp = 1, Grey Vertical Ramp = 2, Grey Diagonal Ramp Moving = 3, Purity = 4} In CamExpert, these parameters are available in the “Sensor” tab. See "Accessing Features with Sapera++ LT" on page 76.

GiGE VISION	XML features for Image Test Patterns: **TestImageSelector** = {Off = 0, HorizontalWedge = 1, VerticalWedge = 2, DiagonalMovingWedge = 3, Purity = 4}

Events

Genie supports a number of events that a control application can monitor. Events provide real time notification on various stages of the acquisition sequence and of error conditions. A Sapera application registers callbacks for those events that need monitoring.

Sapera Callbacks

Three types of callbacks can be registered for events when using the Genie:

- **Transfer events** concerning host system buffers.
  - Use the Sapera Transfer Module
  - In the Sapera C library: see CorXferRegisterCallback
  - In the Sapera++ library: see SapXferCallbackInfo class
- **Acquisition events** concerning the acquisition device, specifically the Genie camera.
  - Use the Sapera Acquisition Module
  - In the Sapera C library: see CorAcqDeviceRegisterCallbackByName or CorAcqDeviceRegisterCallbackByName
  - In the Sapera++ library: see SapAcqDeviceCallbackInfo class
- **Sapera events generated for GigE Vision devices** (see SapManager::RegisterServerCallback). Note that if Genie cameras are connected through an Ethernet switch, these GigE Vision events can only be generated after the Auto Discovery polling function of the GigE Vision driver.
  - SapManager::EventServerNew — A new device such as a Genie, has been connected while the Sapera application is running. Resources are allocated for the device.
  - SapManager::EventServerNotAccessible — The device is not accessible (device is disconnected). Sapera resources for the device do not have to be destroyed if it is expected that the device will be reconnected.
  - SapManager::EventServerAccessible — The device is accessible again (device reconnected). Sapera resources for the device if not previously destroyed, will be used again.

Feature Event Name (*case sensitive strings*)	Description
Start of Trigger	Trigger is valid based on the programmed trigger parameters
Start of Exposure	Exposure has started
End of Exposure	Exposure is complete
End of Acquisition	Transfer of image is terminated from camera. This does not mean that the host PC has received all data packets.
End of Readout	End of image readout from sensor to onboard buffer
Feature Value Changed	Parameter value is changed
Feature Info Changed	One or more parameter components has changed, such as a maximum or minimum range limit, access mode, enumeration element, or parameter value.
Invalid Trigger	Trigger event (software or external) was invalid
Input Event 0	External Input # 1 has received a valid signal
Input Event 1	External Input # 2 has received a valid signal
Output Event 0	External Output # 1 has changed state
Output Event 1	External Output # 2 has changed state
Camera Event Overflow	Signaled when the Genie HM can not generate or transmit all requested events. All active events are automatically disabled and need to be re-activated by the application. To prevent an overflow, a lower acquisition frame rate or simply less individual events should be used. An Event overflow condition can occur in conditions such as: • A high frame rate when many events are active per frame. • The camera CPU can not process all Genie events. • Conditions where the Genie internal event queue is exceeded. • Conditions where Genie events exceed the hard limit of 512. • Combinations of all of the above.

Event Selection via GigE Vision Compliant Applications

GiGE VISION®	XML features for Events: **EventSelector** = {None = 0, FrameTrigger = 2, ExposureStart = 3, ExposureEnd = 4, InvalidFRameTrigger = 0x9008, AcquisitionEnd = 0x9003} **EventNotification** = {Off = 0, GigEVisionEvent = 1} **Event_FrameTrigger_TimeStamp** = Generate an Event on a frame trigger **Event_ExposureStart_TimeStamp** = Event on exposure start **Event_ExposureEnd_TimeStamp** = Event on exposure end **Event_InvalidTrigger_TimeStamp** = Event when invalid trigger received

Using CamExpert to set Network Controls & GigE Vision Parameters

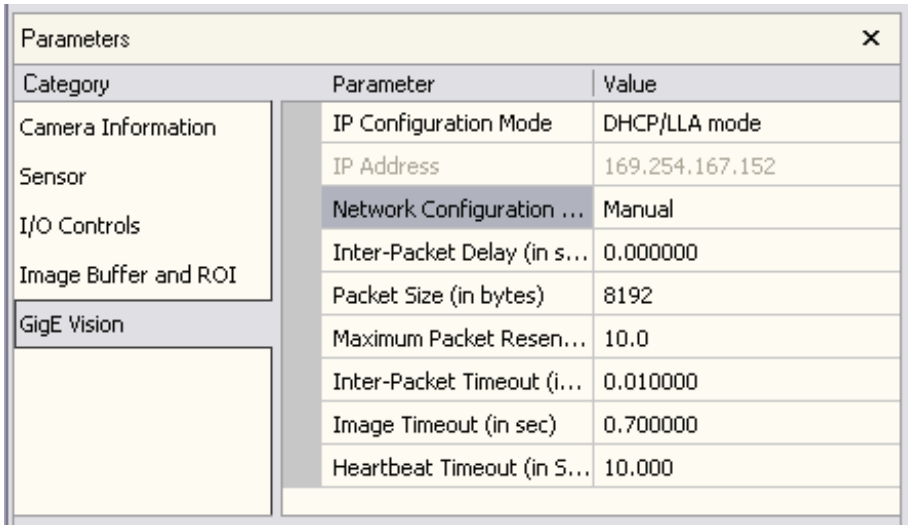
This section describes how to optimize the network configuration for maximum Genie bandwidth. Optimization of these parameters is highly dependent on the number of cameras connected to a NIC, the data rate of each camera and the trigger modes used.

	Important: Laptop computers may have issues even with a GigE NIC port, either built in or as a PCMCIA device. This section describes optimizations for both desktop and laptop computers, but laptops may require additional customization as described in the DALSA Network Imaging package manual.

CamExpert GigE Vision Parameters

Genie GigE Vision parameters can be manually modified directly from CamExpert as described below. Note that a number of parameters (IP Configuration Mode, IP Address, Packet Size, etc.), can also be modified by the DALSA Network Configuration Tool described in the DALSA Network Imaging package manual.

Select the GigE Vision category. The **Automatic** Network Configuration mode sets parameters to a default state. The **Optimize** mode sets the packet size to the maximum value as reported by the NIC driver. If this does not provide satisfactory performance, it is possible to optimize transfers by manually setting the network configuration parameters. The following screen shot of the GigE Vision Parameters shows the CamExpert control set to **Manual**. Descriptions for each parameter follow.



Parameter	Description
IP Configuration Mode	Default is DHCP/LLA mode. Select Persistent IP if manually setting the Genie IP address via the IP Address parameter.
IP Address	Displays the Genie IP address. Allows setting the IP address when the mode is Persistent IP.
Network Configuration Mode	Specifies the Network Configuration Mode as either Automatic, Manual, or Optimize. In general use Optimize mode. Some computers, especially laptops, may require manual optimization of network parameters. The following parameters can be modified when Manual mode is selected.
Inter-Packet Delay (in sec)	Specifies the inter-packet delay, in sec. The range of permitted values is 0.000000 to 0.065535. The inter-packet delay is the minimum time interval between two successive packets. This can be increased if the NIC is unable to keep up with packet arrivals (thus dropping packets–seen as video noise).
Packet Size (in bytes)	Specifies the maximum packet size, in bytes. The range of possible values is 576 to 1500, in increments of 4 bytes when the NIC does not support jumbo packet. The maximum is currently 9000 bytes when jumbo packets are supported (refer to the DALSA Network Imaging package manual to enable jumbo packets on the NIC). In most situations, use the largest possible packet size supported by your network elements. In order to support jumbo packets, all intermediate network elements must support them, otherwise they will simply be silently discarded and no image data will reach the PC.
Maximum Packet Resend	Sets the percentage of packets that can be resent for each frame. This is used to ensure the streaming data (including resends) does not exceed the Ethernet link capacity. As an example, a system capturing at 80 MB/s can allow 25% of packet resends without exceeding 100 MB/s (about the maximum capacity of a gigabit Ethernet link).
Inter-Packet Timeout (in sec)	Specifies the inter-packet timeout period used by the GigE server running on the host computer (in seconds). The inter-packet timeout is the amount of time the GigE server will wait between successive packets. If the inter-packet timeout expires, the GigE server will issue a packet resend request to the camera. The range of permitted values is 0.000000 to 0.65535. By default this value is greater than (and must be greater than) the Inter-Packet Delay inserted by the Genie (described above). Else the GigE server will force packet resends when none may be required. Increasing the timeout period is required when a NIC has a number of Genie cameras connected via an Ethernet switch, and packet resends can be avoided if the GigE server delays assuming data is lost.
Image Timeout (in sec)	Specifies the timeout period for an image acquisition used by the GigE server running on the host computer (in seconds – max=60). The Image timeout value is the amount of time the GigE server will wait for an image to be transferred from the camera to the host buffer memory. If the image timeout expires, the current buffer's contents will be incomplete and the Sapera buffer state is set to *StateOverflow*. By default this value is greater than (and must be greater than) the time required to receive a complete frame. The time required may depend on the number of Genie cameras connected to the NIC and whether they transmit frames simultaneously. If the timeout period is too short, data will be trashed and packet resend commands will be issued. If the timeout period is too long, recovery from transmission errors may be too slow.
Heartbeat Timeout (in Sec)	Specifies the heartbeat timeout, in seconds. The range of permitted values is 0.5 to 65, in increments of 0.001 seconds. This is used by the camera to ensure the PC application is still linked. If the heartbeat timeout expires, the camera will shutdown the connection to the current application.

Network Controls via Sapera LT or GigE Vision Compliant Applications

Sapera	Genie Sapera parameters for Network Configuration: **NetworkConfigurationMode** = {Automatic = 0, Manual = 1, Optimize = 2} **InterPacketDelay** = Minimum delay in µs between image packets **PacketSize** = Image packet size in bytes **HeartbeatTimeout** = Heartbeat period (watchdog) in ms before camera disconnect **MaximumPacketResend** = Sets percentage of packets that can be resent per frame In CamExpert, these parameters are available under the “GigE Vision” tab. See "Accessing Features with Sapera++ LT" on page 76.

GiGE VISION	XML features for Network Configuration: **PayloadSize** = Size of the payload in bytes. This is the total number of bytes sent in the payload. No packet headers included. **GevVersionMajor** = Specifies the major version of the GigE Vision specification supported by this device. **GevVersionMinor** = Specifies the minor version of the GigE Vision specification supported by this device. **GevDeviceModeIsBigEndian** = Endianess of Bootstrap registers (FALSE: Little-endian device, TRUE: Big-endian device) **GevDeviceModeCharacterSet** = Describes the character set of all boot strap strings. **GevInterfaceSelector** = Index to the network interface to configure. **GevMACAddress** = 48-bit MAC address of the selected interface. **GevSupportedIPConfigurationLLA** = Indicates if LLA (Auto-IP) is supported by the selected interface. **GevSupportedIPConfigurationDHCP** = Indicates if DHCP is supported by the selected interface. **GevSupportedIPConfigurationPersistentIP** = Indicates if Persistent IP is supported by the selected interface. **GevCurrentIPConfiguration** = Current camera IP configuration of the selected interface. **GevCurrentIPAddress** = IP address of the selected interface. **GevCurrentSubnetMask** = Subnet mask of the selected interface. **GevCurrentDefaultGateway** = Default gateway of the selected interface. **GevPersistentIPAddress** = Persistent IP address for the selected interface. **GevPersistentSubnetMask** = Persistent subnet mask for the selected interface **GevPersistentDefaultGateway** = Persistent default gateway for the selected interface **GevFirstURL** = NULL-terminated string to the first URL to the XML device description file. **GevSecondURL** = NULL-terminated string to the second URL to the XML device description file. **GevNumberOfInterfaces** = The number of physical network interfaces on this device. **GevMessageChannelCount** = The number of message channels supported by this device. **GevStreamChannelCount** = Indicates the number of stream channels supported by this device. **GevSupportedOptionalCommandsUserDefinedName** = Indicates if the User-defined Name register is supported. **GevSupportedOptionalCommandsSerialNumber** = Indicates if the Serial Number register is supported. **GevSupportedOptionalCommandsEVENTDATA** = Indicates if EVENTDATA_CMD and EVENTDATA_ACK are supported. **GevSupportedOptionalCommandsEVENT** = Indicates if EVENT_CMD and EVENT_ACK are supported. **GevSupportedOptionalCommandsPACKETRESEND** = Indicates if PACKETRESEND_CMD is supported. **GevSupportedOptionalCommandsWRITEMEM** = Indicates if WRITEMEM_CMD and WRITEMEM_ACK are supported.

	GevSupportedOptionalCommandsConcatenation = Indicates if multiple operations in a single message are supported.**GevHeartbeatTimeout** = Current heartbeat timeout in milliseconds. **GevTimestampTickFrequency** = 64-bit value indicating the number of timestamp clock ticks in 1 second. **GevTimestampControlLatch** = Latches the current timestamp value of the device. **GevTimestampControlReset** = Resets the timestamp count of the device. **GevTimestampValue** = Latched 64-bit value of the timestamp. Value must first be latched using GevTimestampControlLatch. **GevStreamChannelSelector** = Indicate which stream channel to configure. **GevSCPInterfaceIndex** = Index of network interface. **GevSCPSPacketSize** = The size of the stream packet to send on this channel. **GevSCPD** = Delay (in 1µs) to insert between each packet for this stream channel. Other networks parameters may be available through the 3rd party package used.

Sapera Supported Features List

The Genie features and its currently set values can be read by a Sapera application. The Sapera tool CamExpert is an example of an application that reads and writes Genie parameters to control its operation. The following tables group the Genie features by their feature type—STRING, ENUM, INT32, BOOL, and describe their possible values and limits. Following the feature type tables, Genie features are also summarized as function groups, which allows quick review of features associated with operational functions (such as trigger).

Accessing Features with Sapera++ LT

When working with Genie features, the **SapAcqDevice** class provides functions for accessing features from devices such as a GigE-Vision camera. The class also contains functions for sending commands and registering events to devices.

- **SapAcqDevice::GetFeatureInfo** returns information on a feature associated with a specified name or index.
- **SapAcqDevice::SetFeatureValue** writes a new value for a feature.
- All information about the feature is stored in a **SapFeature** class object.

An important factor when reading or modifying Sapera features values is the feature Write Mode. Each Genie feature description includes the access type and write mode as defined in the following table.

Access Type		Write Mode	
RO	Read Only	Invalid	Write Not Valid
RW	Read or Write	Always	Write Always (anytime)
Wo	Write Only	N.acq	Write when transfer object Not Acquiring
		N.conn	Write when transfer object is Not Connected

Refer to the Sapera++ LT Programmer's manual (OC-SAPM-SPPP0).

Feature Type STRING

Feature Name	Access	W-Mode	Type	Value
Server Name	RO	Invalid	STRING	Genie_M640_1 (*example*)
Number of Features	RO	Invalid	STRING	(*number dependent on firmware version*)
DeviceVendorName	RO	Invalid	STRING	DALSA
DeviceModelName	RO	Invalid	STRING	Genie M640 (*example*)
DeviceVersion	RO	Invalid	STRING	1452 (*example*)
FirmwareVersion	RO	Invalid	STRING	version 7630 (*example*)
DeviceID	RO	Invalid	STRING	S1234567 (*example*)
MACAddress	RO	Invalid	STRING	00:01:0D:11:01:2A (*example*)
DeviceUserID	RW	N.acq	STRING	Inspection-1 (*user set example*)
IPAddress	RO	Invalid	STRING	192.168.0.1 (*note: R/W in Persistent IP mode*)

Feature Type ENUM

Feature Name	Access	W-mode	Type	Values
Interface	RO	Invalid	ENUM	GigE Vision
DeviceScanType	RO	Invalid	ENUM	Area scan = 0
ColorType *(dependent on camera model)*	RO	Invalid	ENUM	Monochrome Sensor CFA Bayer Sensor GR
ExposureMode	RW	N.acq	ENUM	Programmable = 1 Pulse Controlled = 2
ExposureAlignment	RW	N.acq	ENUM	Synchronous = 0 Reset = 1
BinningVertical	RW		ENUM	Disabled = 1 2 lines binned = 2
BinningHorizontal	RW		ENUM	Disabled = 1 2 pixels binned = 2
FlatFieldFormat *(dependent on camera model)*	RO	N.conn	ENUM	Mono 8 - Unsigned = 16844800 Mono 10 - Unsigned = 16779776
Flip	RW		ENUM	Off = 0 Horizontal = 1
TestImageSelector	RW	Always	ENUM	Off = 0 Grey Horizontal Ramp = 1 Grey Vertical Ramp = 2 Grey Diagonal Ramp Moving = 3 Purity = 4
LUTFormat *(dependent on camera model)*	RO	Invalid	ENUM	Mono 8 - Unsigned = 16844800 Mono 8 - Signed = 285280256 Mono 10 - Unsigned = 16779776 Mono 10 - Signed = 285215232
TriggerSource	RW	N.acq	ENUM	Input 1 = 0 Input 2 = 1 Software = 2

OutputSelectorOutput_1	RW	Always	ENUM	Open = 0 Close = 1 Strobe On: Start of Exposure = 2 Pulse On: Valid Trigger = 4 Pulse On: Invalid Trigger = 5 Pulse On: Start of Readout = 6 Pulse On: End of Readout = 7 Pulse On: End of Acquisition = 8 Pulse On: Input 1 = 9 Pulse On: Input 2 = 10
OutputSelectorOutput_2	RW	Always	ENUM	Open = 0 Close = 1 Pulse On: End of Exposure = 3 Pulse On: Valid Trigger = 4 Pulse On: Invalid Trigger = 5 Pulse On: Start of Readout = 6 Pulse On: End of Readout = 7 Pulse On: End of Acquisition = 8 Pulse On: Input 1 = 9 Pulse On: Input 2 = 10
PolarityInput_1	RW	Always	ENUM	Active High = 0 Active Low = 1
PolarityInput_2	RW	Always	ENUM	Active High = 0 Active Low = 1
PolarityOutput_1	RW	Always	ENUM	Active Close = 0 Active Open = 1
PolarityOutput_2	RW	Always	ENUM	Active Close = 0 Active Open = 1
PixelFormat	RW	N.conn	ENUM	8-bit = 17301505 (0x1080001) 10-bit = 17825795 (0x1100003) Bayer Raw8 = 17301513 Bayer Raw10 = 17825805
Power-upConfig	RW	N.acq	ENUM	Factory Default = 0 Camera Configuration 1 = 1
TimestampResetSource	RW	Always	ENUM	Off = 0 Input 1 = 1 Input 2 = 2
TimestampCounter	RW	Always	ENUM	Internal Clock (1µs resolution) = 0 Input 1 = 1 Input 2 = 2 End of Readout = 3
SaveCameraConfigurationSelector	RW	N.conn	ENUM	Camera Configuration 1 = 1
LoadCameraConfigurationSelector	RW	N.conn	ENUM	Factory Default = 0 Camera Configuration 1 = 1
IPConfigurationMode	RW	N.acq	ENUM	DHCP/LLA mode = 0 Persistent IP mode = 1
NetworkConfigurationMode	RW	N.conn	ENUM	Automatic = 0 Manual = 1

Feature Type INT32

The feature list for type INT32 has an additional column 'Exponent' which defines the feature's native unit. This exponent value is used as a unit multiplier so that the feature value is expressed as an integer, not a decimal number.

- As an example from the following table, the Genie frame rate is 60000 with an exponent of 3. Therefore the frame rate native unit is mHz. The current value shown – 60000 mHz, is actually 60.000 Hz.

Feature Name (type INT32)	Access	Write mode	Exponent	Sample Value	Boundaries
DeviceMaxThroughput	RO	Invalid	EXP10: 0	18432000	min=0, max=0, inc=0
SensorWidth	RO	Invalid	EXP10: 0	640	1 to sensor width
SensorHeight	RO	Invalid	EXP10: 0	480	1 to sensor height
FrameRate (mHz)	RW	Always	EXP10: 3	60000	100 to camera max
BlackLevel	RW	Always	EXP10: 0	0	min=0, max=1023, inc=1
Gain (in dB)	RW	Always	EXP10: 0	0	min=0, max=12, inc=0.1dB
ExposureTime (µS)	RW	Always	EXP10: 6	16384	min=10 reset mode min=56 synchronous mode, max=xxx, inc=1
TriggerDelayToIntegration (µS)	RW	N.acq	EXP10: 6	0	min=100, max=4000000, inc=1
FramesPerTrigger	RW	Always	EXP10: 0	1	min=1, max=32767, inc=1
LUTNumberEntries	RO	Invalid	EXP10: 0	256	min=1, max=65536, inc=1
DebounceInput_1 (µS)	RW	Always	EXP10: 6	10	min=1, max=255, inc=1
DebounceInput_2 (µS)	RW	Always	EXP10: 6	10	min=1, max=255, inc=1
PulseDelayOutput_1 (µS)	RW	Always	EXP10: 6	0	min=0, max=16777215, inc=1
PulseDurationOutput_1 (µS)	RW	Always	EXP10: 6	1000	min=100, max=16777215, inc=1
PulseDelayOutput_2 (µS)	RW	Always	EXP10: 6	0	min=0, max=16777215, inc=1
PulseDurationOutput_2 (µS)	RW	Always	EXP10: 6	1000	min=100, max=16777215, inc=1
Width	RW	N.conn	EXP10: 0	640	min=8, max=sensor width, inc=4
Height	RW	N.conn	EXP10: 0	480	min=1, max=sensor height, inc=1
OffsetX	RW	N.conn	EXP10: 0	0	min=0, max=sensorwidth-8, inc=4
OffsetY	RW	N.conn	EXP10: 0	0	min=0, max=sensorheight-1, inc=1
SaperaBufferFormat	RO	Invalid	EXP10: 0	16844800	NA
PixelSize	RO	Invalid	EXP10: 0	8	NA
InterPacketDelay (µS)	RW	N.acq	EXP10: 6	0	min=0, max=65535, inc=1
PacketSize	RW	N.conn	EXP10: 0	1500	min=576, max=9152, inc=4
HeartbeatTimeout (mS)	RW	Always	EXP10: 3	500	min=500, max=65000, inc=1
MaximumPacketResend	RW	N.conn	EXP10: 1	100	min=0, max=1000, inc=1
InterPacketTimeout	RW	N.conn	EXP10: 6	10000	min=1000, max=655350, inc=1

ImageTimeout	RW	N.conn	EXP10: 6	700000	min=10000, max=6000000, inc=1
LUTData	RW	N.conn			(type Buffer)
FlatFieldGainBuffer	RW	N.conn			(type Buffer)
FlatFieldOffsetBuffer	RW	N.conn			(type Buffer)
UserBuffer *(see Accessing the Genie User Buffer)*	RW	N.acq			(memory of type Buffer available to the user)
FlatFieldGainMin	RO	N.conn	EXP10: 0	*(see note 1)*	min=0, max=16777215, inc=1
FlatFieldGainMax	RO	N.conn	EXP10: 0	*(see note 1)*	min=0, max=16777215, inc=1
FlatFieldOffsetMin	RO	N.conn	EXP10: 0	*(see note 1)*	min=0, max=16777215, inc=1
FlatFieldOffsetMax	RO	N.conn	EXP10: 0	*(see note 1)*	min=0, max=16777215, inc=1
FlatFieldWidth	RO	N.conn	EXP10: 0	*(see note 1)*	min=0, max=16777215, inc=1
FlatFieldHeight	RO	N.conn	EXP10: 0	*(see note 1)*	min=0, max=16777215, inc=1
InputPinStatusInput_1	RO	Invalid	EXP10: 0	1	min=0, max=1, inc=1
InputPinStatusInput_2	RO	Invalid	EXP10: 0	1	min=0, max=1, inc=1
InternalTemperature	RO	Invalid	EXP10: 0	30	min= -128, max= 127, inc=1 (°C)

Note 1: not displayed in CamExpert; not saved in a camera configuration file (CCF)

Feature Type BOOL

Feature Name	Access	W-mode	Type	Value	Notes
LUTEnable	RW	N.conn	BOOL	True/False	
TriggerEnable	RW	N.acq	BOOL	True/False	
TriggerSoftware	RW	Always	BOOL	True/False	
AcquisitionArm	WO	N.acq	BOOL	True/False	*(see note 2)*
FlatFieldEnable	RW	N.conn	BOOL	True/False	
FlatFieldCalibrationEnable	RW	N.conn	BOOL	True/False	*(see note 3)*
TimestampReset	WO	Always	BOOL	True/False	
SaveCameraConfiguration	WO	N.conn	BOOL	True/False	
LoadCameraConfiguration	WO	N.conn	BOOL	True/False	

Note 2: Prepares the Genie for an optimal acquisition start with minimal delay. This feature should be set true only after all other features are set else the effect of AcquisitionArm is canceled.

Note 3: FlatFieldCalibrationEnable is set True before a calibration sequence is performed. When calibration is enabled features such as Crop, Flip, LUT, etc. are reset to their default state before the calibration sequence is started. The application would need to restore these features after flat field calibration is complete.

Feature Summary List by Function Group

This section lists Genie features by function group. This simplifies identifying which features are involved with specific Genie operations (an example would be configuring and activating external trigger). For details about each feature, refer to the previous section where features are listed by data type.

Device

Feature	Type
Interface	ENUM
DeviceVendorName	STRING
DeviceModelName	STRING
DeviceVersion	STRING
FirmwareVersion	STRING
DeviceID	STRING
MACAddress	STRING
DeviceUserID	STRING
IPAddress	STRING
DeviceMaxThroughput	INT32
InternalTemperature	INT32
TestImageSelector	ENUM

User Defined Buffers

Feature	Type
UserBuffer	Sapera buffer
SaperaBufferFormat	INT32

Sensor

Feature	Type
DeviceScanType	ENUM
ColorType	ENUM
SensorWidth	INT32
SensorHeight	INT32
FrameRate	INT32
Gain	INT32
BlackLevel	INT32
PixelSize	INT32
PixelFormat	ENUM

Sensor Exposure

Feature	Type
ExposureMode	ENUM
ExposureTime	INT32
ExposureAlignment	ENUM

Acquisition ROI

Feature	Type
Width	INT32
Height	INT32
OffsetX	INT32
OffsetY	INT32
ImageFlip	ENUM

Binning Control

Feature	Type
BinningHorizontal	ENUM
BinningVertical	ENUM

LUT Control

Feature	Type
LUTEnable	BOOL
LUTFormat	ENUM
LUTNumberEntries	INT32
LUTData	Sapera buffer

Flat Field Control

Feature	Type
FlatFieldEnable	BOOL
FlatFieldCalibrationEnable	BOOL
FlatFieldFormat	ENUM
FlatFieldWidth	INT32
FlatFieldHeight	INT32
FlatFieldGainMin	INT32
FlatFieldGainMax	INT32
FlatFieldOffsetMin	INT32
FlatFieldOffsetMax	INT32
FlatFieldGainBuffer	Sapera buffer
FlatFieldOffsetBuffer	Sapera buffer

Trigger Control

Feature	Type
TriggerEnable	BOOL
TriggerSource	ENUM
FramesPerTrigger	INT32
TriggerSoftware	BOOL
TriggerDelayToIntegration	INT32
AcquisitionArm	BOOL

I/O Control

Feature	Type
PolarityInput_1	ENUM
DebounceInput_1	INT32
InputPinStatusInput_1	INT32
PolarityInput_2	ENUM
DebounceInput_2	INT32
InputPinStatusInput_2	INT32
OutputSelectorOutput_1	ENUM
PulseDelayOutput_1	INT32
PulseDurationOutput_1	INT32
PolarityOutput_1	ENUM
OutputSelectorOutput_2	ENUM
PulseDelayOutput_2	INT32
PulseDurationOutput_2	INT32
PolarityOutput_2	ENUM

Time Stamp Control

Feature	Type
TimestampCounter	ENUM
TimestampResetSource	ENUM
TimestampReset	BOOL

Network Parameters

Feature	Type
NetworkConfigurationMode	ENUM
IPConfigurationMode	ENUM
IPAddress	STRING
SubnetMask	STRING
DefaultGateway	STRING
InterPacketDelay	INT32
PacketSize	INT32
HeartbeatTimeout	INT32
MaximumPacketResend	INT32
InterPacketTimeout	INT32
ImageTimeout	INT32

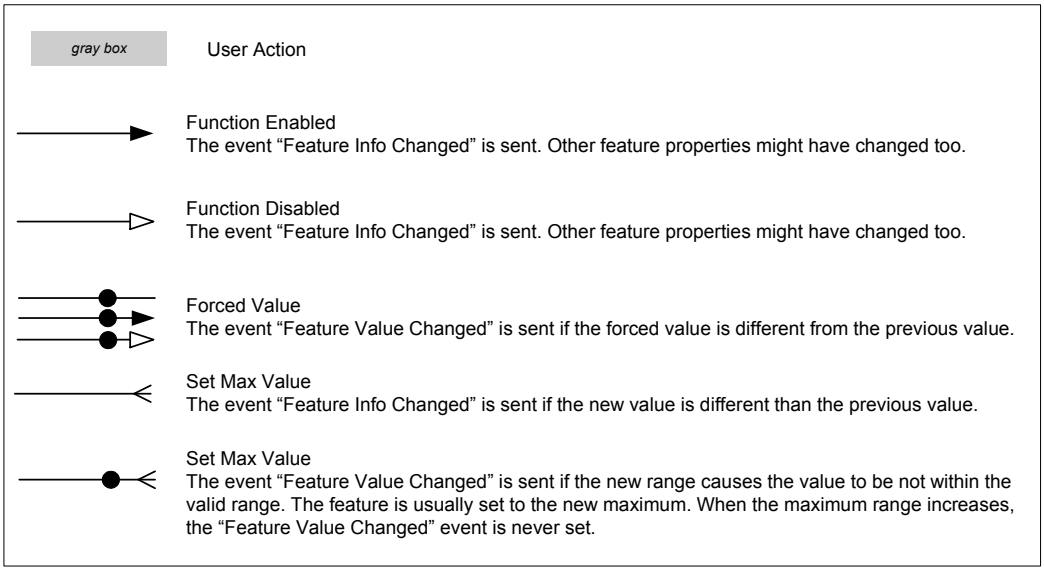
User Options

Feature	Type
Power-upConfig	ENUM
SaveCameraConfigurationSelector	ENUM
SaveCameraConfiguration	BOOL
LoadCameraConfigurationSelector	ENUM
LoadCameraConfiguration	BOOL

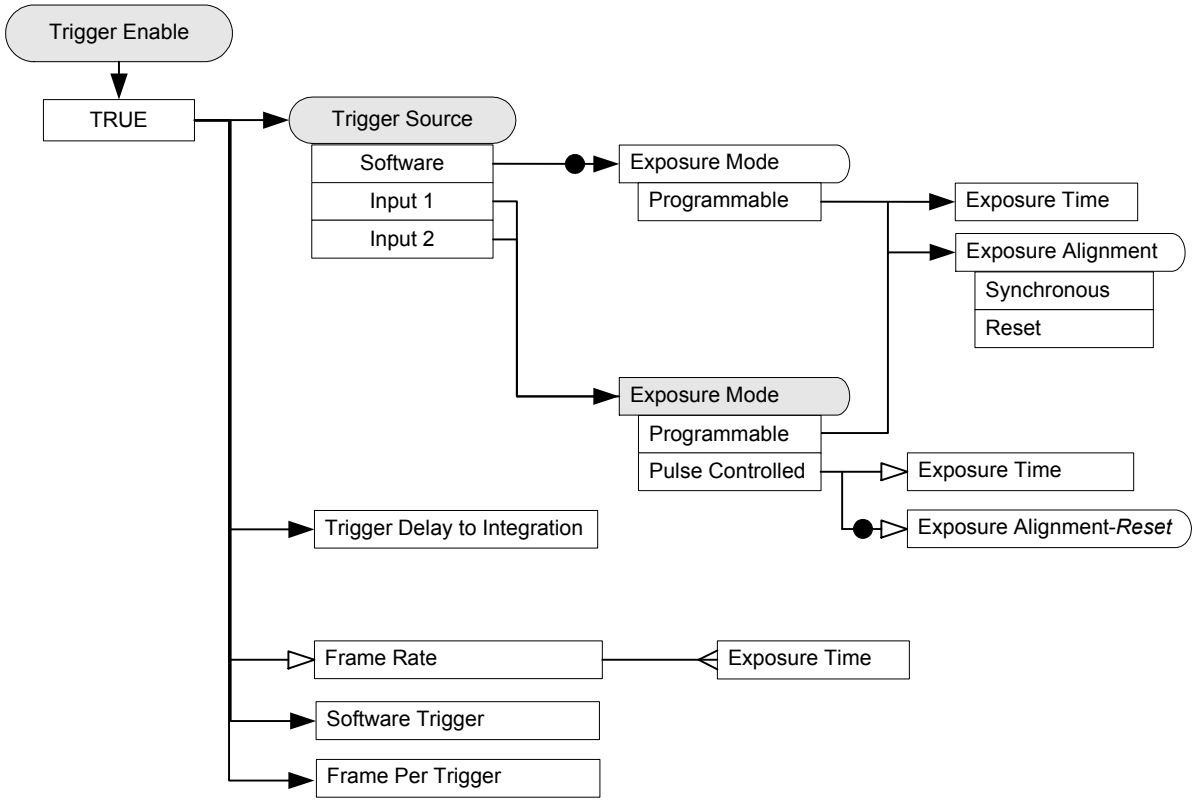
Feature Interdependence Diagrams

The following diagrams describe operational feature availability which are dependent on user selected modes. These diagrams show what features are set to a value, and they show which feature parameters remain as user variables.

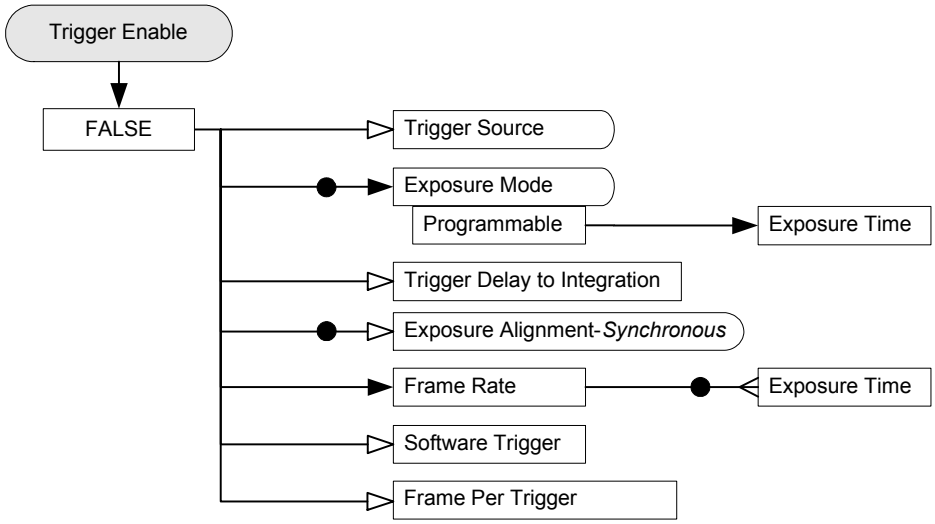
Each diagram uses the following symbol set to indicate the dependent action type.



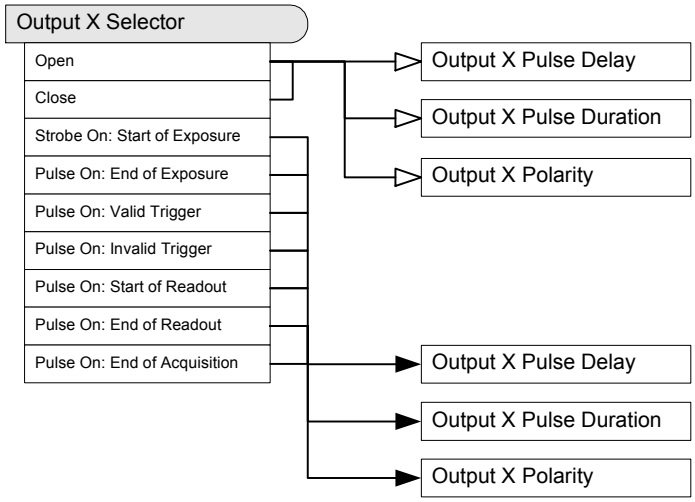
Trigger Enable - TRUE



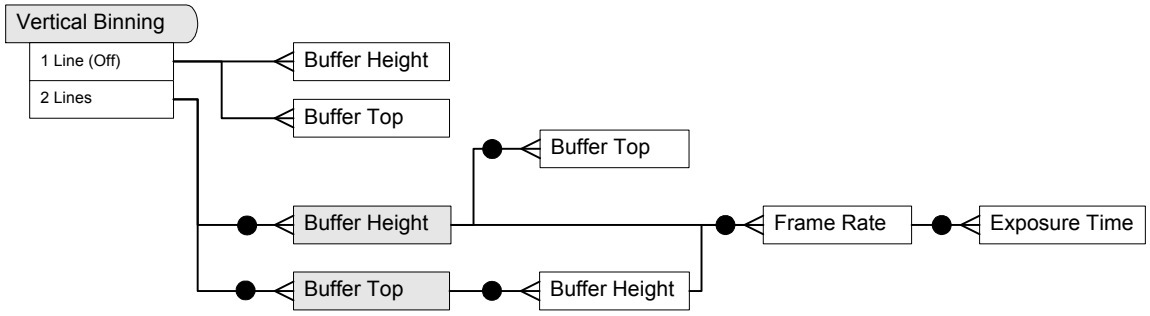
Trigger Enable - FALSE



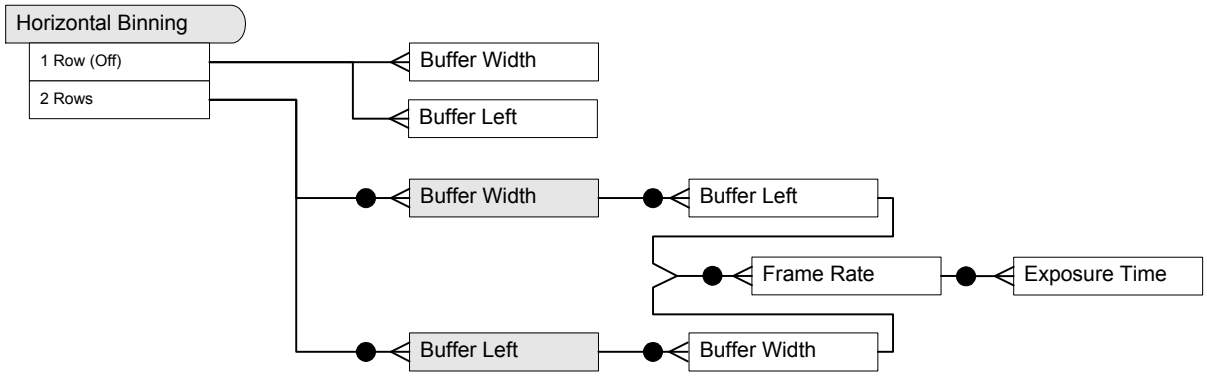
Output Selector



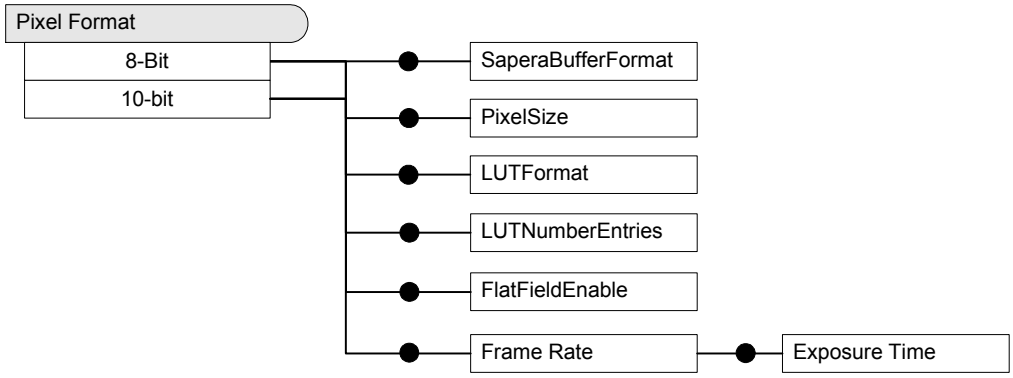
Vertical Binning



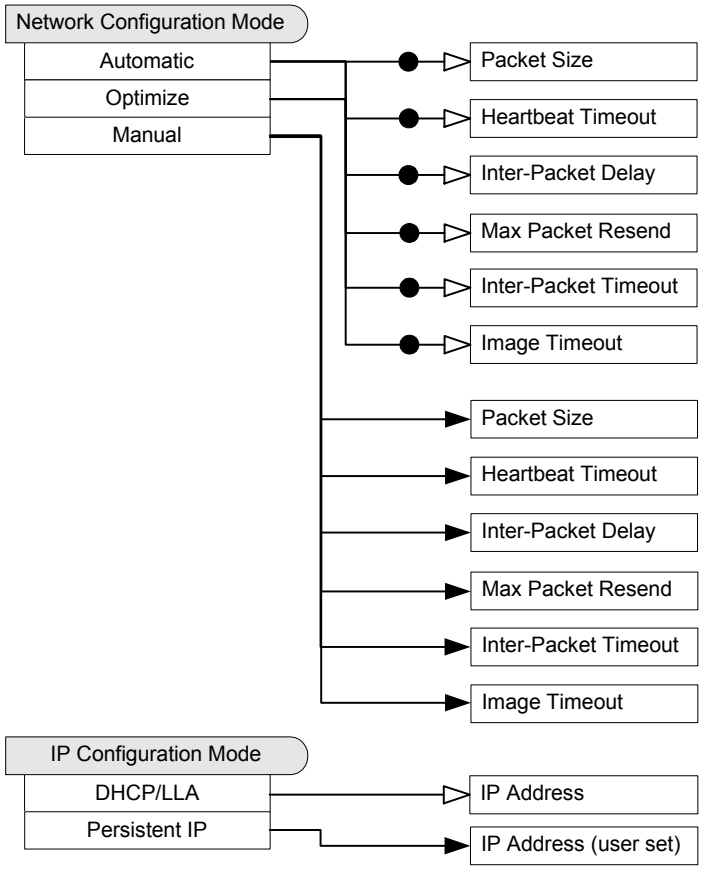
Horizontal Binning



Pixel Format

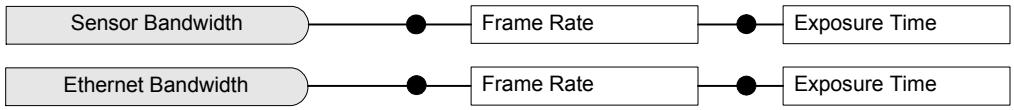


Network Configuration Mode



Miscellaneous Dependencies

These following dependencies describe operation changes that are not under user control.



Accessing the Genie User Buffer

Genie cameras have unallocated memory available to the user for random data storage. This user buffer is a feature of type SapFeature::TypeBuffer. Any type of Sapera buffer is valid as long as the buffer size in bytes is less than 4k. Access to this user buffer is by the same API as any Genie feature access. Sample code is provided below.

```
#include "SapClassBasic.h"
#include "stdio.h"

main()
{
int serverCount = SapManager::GetServerCount();
SapAcqDevice *pAcqDevice = NULL;
char serverName[CORSERVER_MAX_STRLEN];
UINT32 userBufferSize;

if (serverCount == 0)
    {
    printf("No device found!\n");
    return FALSE;
    }

for (int serverIndex = 0; serverIndex < serverCount; serverIndex++)
    {
    if (SapManager::GetResourceCount(serverIndex, SapManager::ResourceAcqDevice) != 0)
        {
        SapManager::GetServerName(serverIndex, serverName, sizeof(serverName));
        printf("Server Name: %s\n", serverName);
        pAcqDevice = new SapAcqDevice(serverName, FALSE);
        if (!pAcqDevice->Create())
            {
            printf("Error during SapAcqDevice creation!\n");
            return FALSE;
            }

        break;
        }
    }

if(!pAcqDevice)
    {
    printf("No Genie found!\n");
    return FALSE;
    }


BOOL isUserBuffer = FALSE;
if( !pAcqDevice->IsFeatureAvailable("UserBuffer", &isUserBuffer))
    {
    printf("Error in IsFeatureAvailable( \"UserBuffer\" ) !\n");
    return FALSE;
    }

if(!isUserBuffer)
    {
    printf("No UserBuffer feature!\n");
    return FALSE;
    }

SapFeature feature(serverName);
if (!feature.Create())
    {
    printf("Error during feature creation!\n");
    return FALSE;
    }

if( !pAcqDevice->GetFeatureInfo("UserBuffer", &feature))
    {
    printf("Error during GetFeatureInfo(\"UserBuffer\")!\n");
    return FALSE;
    }
```

```
// Get max only works with 1.40.01.0192 or higher.
#if 0
if( !feature.GetMax( &userBufferSize) )
    {
    printf("Error during GetMax!\n");
    return FALSE;
    }
printf("User Buffer size = %d", userBufferSize);

#else
userBufferSize = 4*1024;
#endif

SapBuffer *Buffers= new SapBuffer(1, userBufferSize, 1, CORBUFFER_VAL_FORMAT_MONO8);
if( !Buffers->Create())
    {
    printf("Error during Buffers creation!\n");
    return FALSE;
    }


// Read a buffer to the caemra user buffer
if( !pAcqDevice->GetFeatureValue( "UserBuffer", Buffers))
    {
    printf("Error in GetFeatureValue( \"UserBuffer\" ) !\n");
    return FALSE;
    }

// Write a buffer to the caemra user buffer
if( !pAcqDevice->SetFeatureValue( "UserBuffer", Buffers))
    {
    printf("Error in SetFeatureValue( \"UserBuffer\" ) !\n");
    return FALSE;
    }

delete pAcqDevice;
delete Buffers;


printf("Exit 0\n");
return 0;

}
```

This Page Intentionally Left Blank

Network Overview & Tools

Genie IP Configuration Mode Details

The following descriptions provide more information on the IP configuration modes supported by Genie. In general automatic IP configuration assignment (LLA/DHCP) is sufficient for most Genie installations.

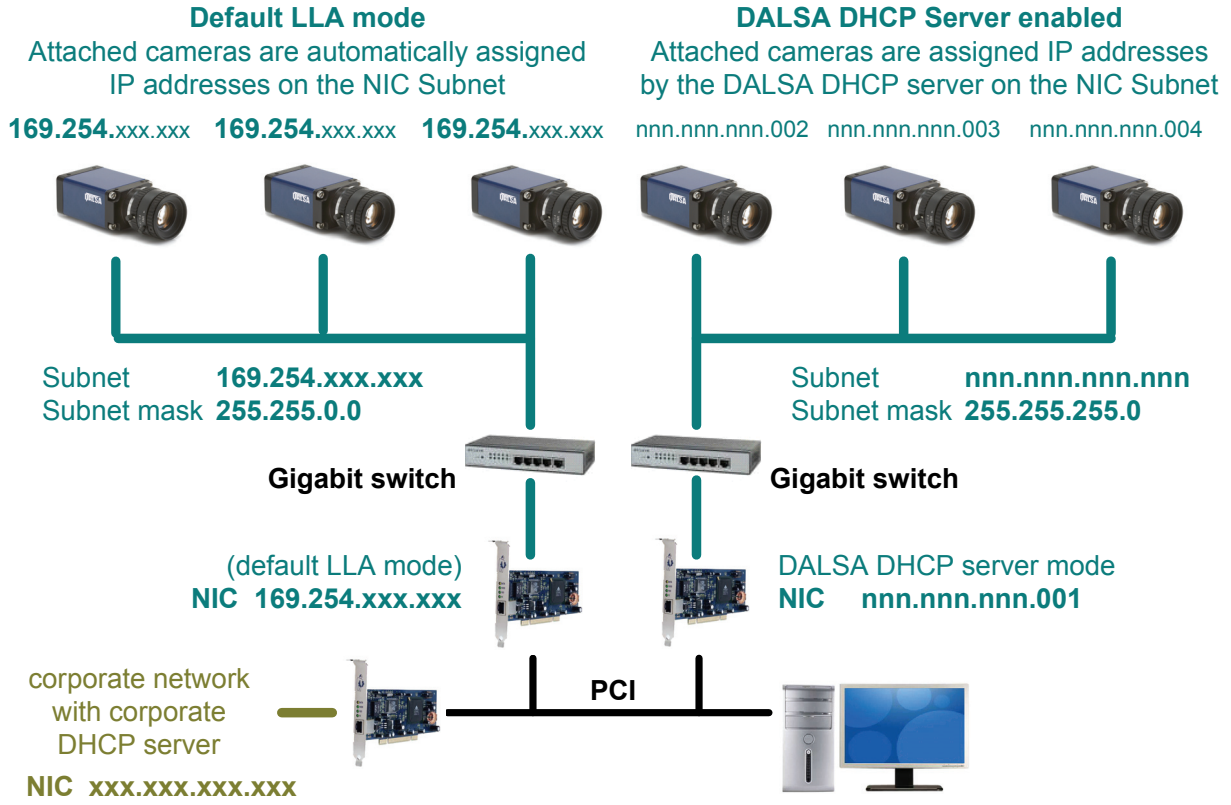
Please refer to the **DALSA Network Imaging Package** manual for information on the DALSA Network Configuration tool and network optimization for GigE Vision cameras and devices.

Link-Local Address (LLA)

- LLA is also known as Auto-IP. It is used for unmanaged networks including direct connections from a GigE Vision device to a dedicated NIC.
- A subnet configured with LLA cannot send packets across routers but only via Ethernet switches.
- LLA is the recommended scheme when only one NIC is connected to GigE cameras. LLA is fully automatic requiring no user input.
  Ensure only one NIC is using LLA on your PC, otherwise IP conflicts will result.
- The NIC will automatically assign a random IP address within the 169.254.x.x subnet. The LLA protocol ensures there are no conflicts with other devices through an arbitration scheme.
- The Windows NIC configuration must be set to DHCP (the typical default case) and no DHCP server must be present on the network. Otherwise, an IP address gets assigned by the DHCP server. Windows will turn to LLA when no DHCP server answers requests coming from the NIC.
- Windows XP takes about 1 minute to obtain an LLA IP address – Windows Vista/7 will take about 6 seconds. With Windows XP, with no DHCP server involved, the network adapter icon in the system tray (in Windows XP) typically shows "limited or no connectivity". 
  This is normal (see Microsoft KB article #892896) and indicates that the network does not have connectivity beyond routers.
- Windows and Genie are still running the DHCP process in the background. If a DHCP server becomes available on the network, the NIC will get a DHCP assigned IP address for the connected device but connections on the LLA IP address will be lost. The DALSA Network Configuration Tool can enable the DALSA DHCP server on the NIC used for the GigE Vision network.
- Important: If the host system has multiple NIC devices configured with LLA, then the communication stack cannot accurately resolve which NIC to forward an IP packet on the 169.254 segment. Limit the number of NIC configured using LLA to one interface. It is preferable that the DALSA DHCP server is used instead of LLA mode (see next section).
- Use the DALSA Network Configuration Tool to change the Genie from the default DHCP/LLA mode to Persistent IP mode when required, such as when there are multiple NIC devices with Genie connected to each. Note that DALSA recommends DHCP/LLA as the mode of operation where a switch is used to connect multiple Genie devices.

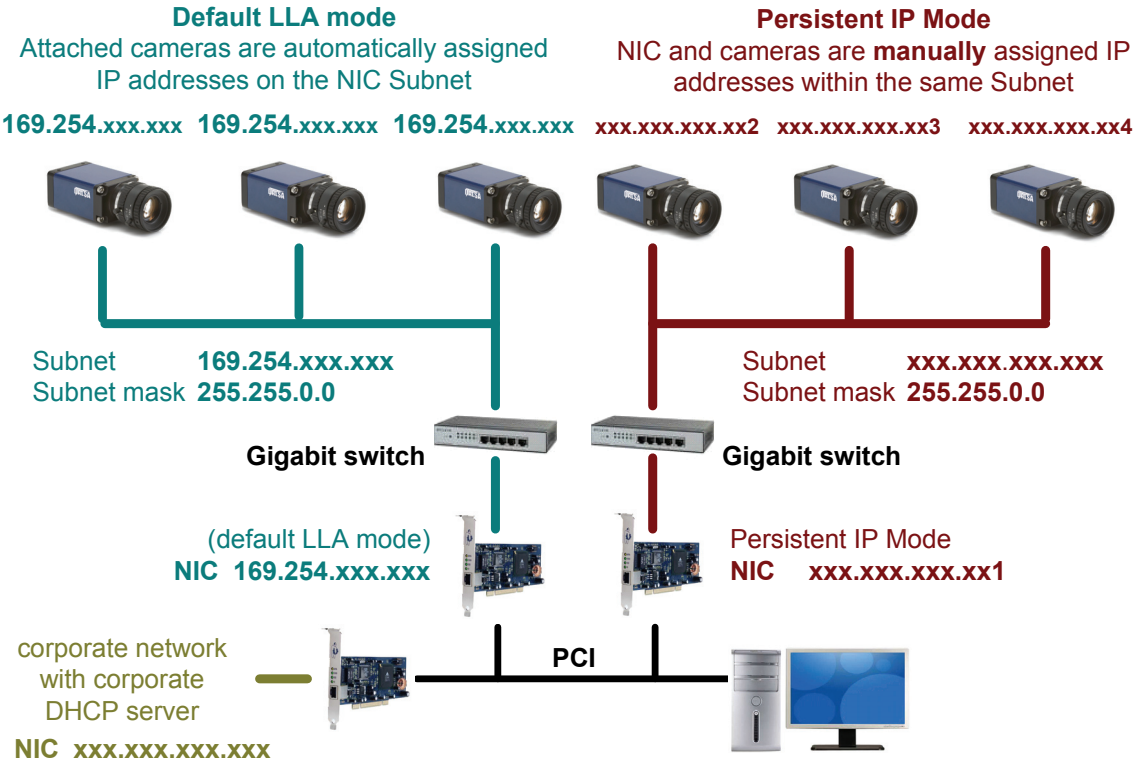
DHCP (Dynamic Host Configuration Protocol)

- This IP configuration mode requires a DHCP server to allocate an IP address dynamically over the range of some defined subnet. The Genie camera must be configured to have DHCP enabled. This is the factory default settings.
- The DHCP server is part of a managed network. Windows itself does not provide a DHCP server function therefore a dedicated DHCP server is required. The DALSA Network Configuration Tool can configure the DALSA DHCP server on the NIC used for the GigE Vision network.
- The DALSA DHCP server is recommended where there are multiple NIC ports with multiple GigE Vision devices attached. Each NIC ports must use a different subnet to avoid IP address conflicts . Persistent IP assignment is required if there is no DHCP server for any additional subnet.
- Under Windows, a NIC is configured in DHCP mode by default. If no DHCP server is present on a given subnet, Windows will revert to LLA as explained in the section above.
- Ensure that a different subnet is assigned to each NIC on the network. This will automatically be managed correctly when the DALSA DHCP server is enabled on one or all subnets used for GigE Vision devices. The graphic below illustrates a system with one NIC having the DALSA DHCP server enabled.



Persistent IP

- This configuration is only suggested if the user fully controls the assignment of IP addresses on the network.
- The GigE Vision camera is forced a static IP address. The NIC IP address must use the same subnet otherwise the camera is not accessible.
- If the Genie camera is connected to a network with a different subnet, it cannot be accessed.
- The DALSA Network Configuration Tool is used to set a persistent IP address. Refer to the DALSA Network Imaging manual.
- An example of a Persistent IP address assignment on a class B network:
  - NIC Subnet = 192.168.1.1
  - Subnet Mask = 255.255.0.0
  - Persistent IP = 192.168.1.2
  - Default Gateway = 0.0.0.0
- Warning: an incorrect IP address assignment might make it impossible to connect to the camera. In such a case the DALSA Network Configuration tool includes a function to recover a Genie camera with an unknown persistent IP and set the Genie to the factory default setting, i.e. DHCP/LLA mode. The camera MAC address must be known to use this function.
- For GigE Vision applications the FORCEIP command is used to force a new persistent IP or to change the IP configuration protocol. The Genie MAC address must be known to use the FORCEIP command.
- The following illustration shows a functional computer setup with three NIC ports, but no DHCP server. Two NIC ports are used for private GigE Vision networks. The first uses the default LLA mode for IP addresses, while the second NIC and the cameras connected to it are configured with persistent IP addresses. An application on the computer can control each Genie camera, on each subnet, without conflict.



This Page Intentionally Left Blank

Sapera CamExpert Guide

Using CamExpert with Genie HM/HC Cameras

CamExpert is the camera interfacing tool supported by the Sapera library. When used with a Genie camera, CamExpert allows a user to test all Genie operating modes. Additionally CamExpert saves the Genie user settings configuration to the camera or saves multiple configurations as individual camera parameter files on the host system (**.ccf*).

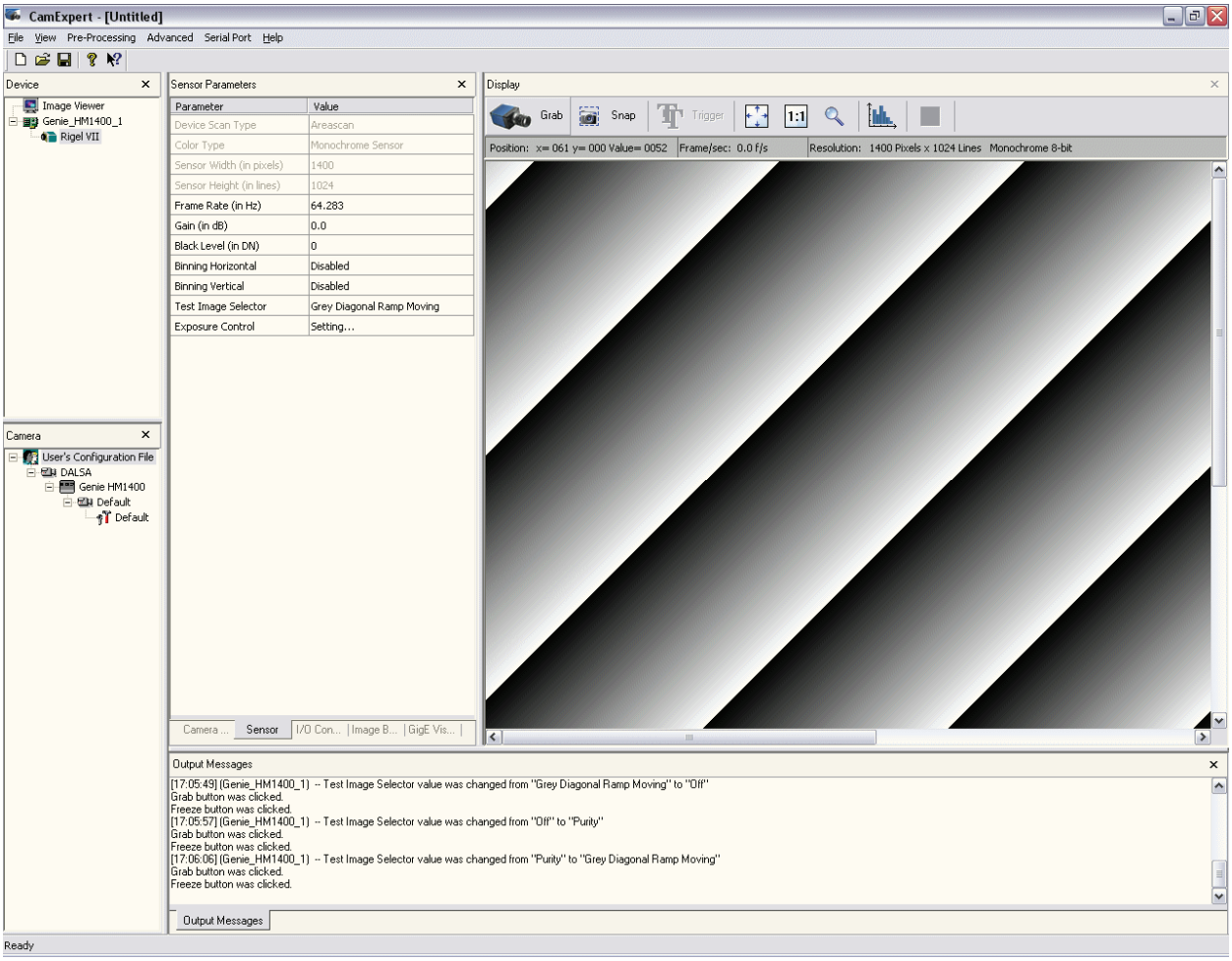
An important component of CamExpert is its live acquisition display window which allows immediate verification of timing or control parameters without the need to run a separate acquisition program.

For context sensitive help, click on the  button then click on a camera configuration parameter. A short description of the configuration parameter will be shown in a popup. Click on the  button to open the help file for more descriptive information on CamExpert.

The central section of CamExpert provides access to the Genie parameters. Five tabs group Genie parameters depending on their type as described in the summary below. Each Genie configuration parameter is described in detail following the summary.

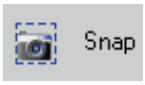
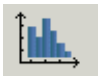
Camera Information	Displays Genie firmware details such as camera model, version, serial number and MAC address. Users can set the User ID and set the power-up configuration mode.
Sensor Parameters	Displays both static and variable sensor parameters that are Genie model specific. Variable parameters control Genie exposure, binning, gain and exposure controls. The internal test image is selected here.
I/O Controls	Provides controls for trigger source and I/O pin configuration.
Image Buffer and ROI	Provides controls for buffer pixel depth, image size and cropping.
GigE Vision	Provides advance controls to optimize the network connection.

CamExpert Panes



The CamExpert application uses 5 windows to simplify choosing and configuring camera files or acquisition parameters for the installed device.

- **Device pane**: View and select from any installed Sapera acquisition device. After a device is selected CamExpert will only present acquisition parameters applicable to that device.
- **Parameters pane**: Allows viewing or changing all acquisition parameters supported by the acquisition device. CamExpert displays parameters only if those parameters are supported by the installed device. This avoids confusion by eliminating parameter choices when they do not apply to the hardware in use.
- **Display pane**: Provides a live or single frame acquisition display. Frame buffer parameters are shown in an information bar above the image window.
- **Control Buttons**: The Display pane includes CamExpert control buttons. These are:

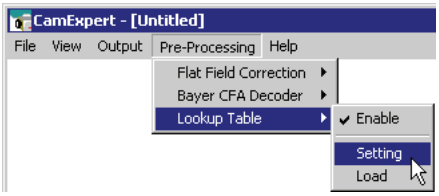
	**Acquisition control button:** Click once to start live grab, click again to stop.
	**Single frame grab:** Click to acquire one frame from device.
	**Software trigger button:** With the I/O control parameters set to Trigger Enabled / Software Trigger type, click to send a single software trigger command.
	**CamExpert display controls:** (these do not modify the frame buffer data) Stretch (or shrink) image to fit, set image display to original size, or zoom the image to any size and ratio. Note that under certain combinations of image resolution, acquisition frame rate, and host computer speed, the CamExpert screen display may not update completely due to the host CPU running at near 100%. This does not affect the acquisition.
	**Histogram / Profile tool:** Select to view a histogram or line/column profile during live acquisition.

- **Camera pane**: Allows selecting any camera file that is included with the Sapera installation. Only camera files supported by the selected acquisition device. When there is more then one acquisition server, such as monochrome and RGB, selecting an inappropriate camera file will produce a message prompting you to select the correct acquisition server.
- **Output pane**: Displays messages from CamExpert or the device driver.
- **Video Status bar**: Located on the lower right of the CamExpert window, color coded camera signal status information is displayed. Green for valid signals detected, red for missing or incorrect signals. Video status items may differ with different devices.

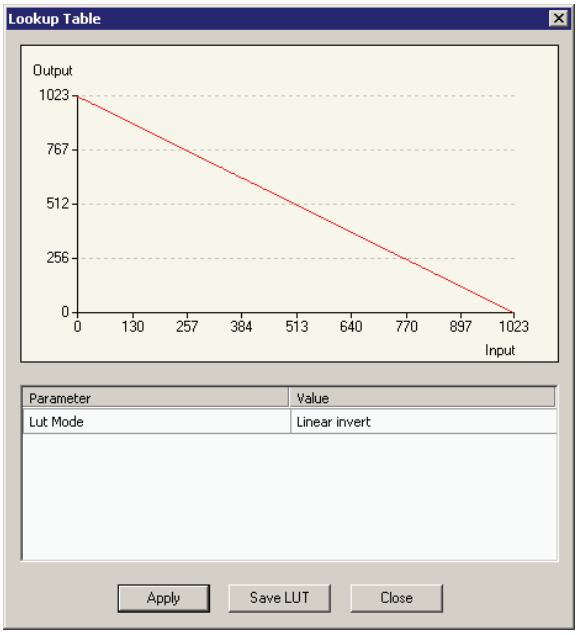
Most of these panes can be hidden via the menu bar view command. Typically after selecting an acquisition device and loading a camera file, the Device and Camera windows can be closed.

CamExpert LUT Controls

The Lookup Table dialog allows you to configure the LUT if it is available on the device. Genie HM cameras support an 8-bit or 10-bit LUT. To open this dialog, use the Pre-Processing > Lookup Table > Setting menu command. Note that you must first enable the Lookup Table, otherwise the Setting command will be grayed-out.



To select the type of LUT to use, click the LUT Mode Value field; a drop-down list box displays the available modes. The Lookup Table dialog displays a graph of the input and output values for the selected LUT. These are CamExpert common examples for LUT operations. A Sapera application can program the Genie LUT for any required LUT operation. See "Lookup Table (LUT)" on page 61 for Genie LUT support.



10-bit Invert LUT

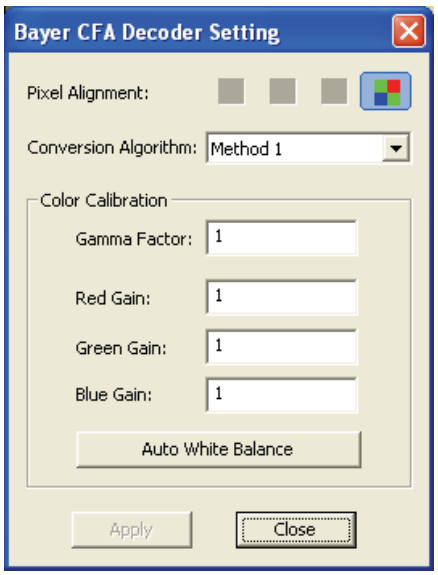
CamExpert available LUT examples are briefly described below. The LUT function graphic simplifies understanding the operation especially when user settings modify the LUT function.

- Normal (default): modifies all LUT entries using a linear mapping such that a gray level input is equal to the output
- Arithmetic operation: modifies all LUT entries using an arithmetic operation
- Binary pattern: modifies some LUT entries based on a binary pattern
- Boolean operation: modifies all LUT entries using a Boolean operation
- Gamma correction: modifies all LUT entries using Gamma correction function
- Linear invert: modifies all LUT entries using a linear mapping with a negative slope
- Position shift: modifies LUT entries with a zero position offset
- Bit shift: modifies LUT entries with a binary bit shift
- Slope within range: modifies part of a LUT with a linear mapping
- Single Threshold: modifies all LUT entries using a threshold operation
- Double Threshold: modifies all LUT entries using a dual level threshold operation

Bayer CFA Decoder Setting

The HC color camera models have a Bayer filter applied to the CMOS sensor to allow for color separation. Each individual pixel is covered by either a red, green, or blue filter. The camera outputs raw color data--no color interpolation is performed. Full RGB images can be obtained by performing color interpolation on the frame grabber or host PC.

CamExpert provides a software Bayer CFA decoder to allow you to display color images and adjust the camera color calibration. The Bayer CFA Decoder Setting dialog provides an automatic white balance function plus manual gamma and RGB gain controls. Setting preferences can be determined for your application using CamExpert, however adjustments made are lost when the CamExpert application is closed.



- Click the Auto White Balance button to have CamExpert adjust the RGB gain to achieve a realistic color cast under the current lighting conditions. The auto white balance function should be executed again when lighting conditions or color temperature change.
- The CamExpert auto white function can work on a smaller ROI. Within the CamExpert acquisition window, click and drag a ROI rectangle with the left mouse button. Having a ROI of an evenly illuminated non-saturated image of a white or light gray surface may produce superior results.
- The independent RGB gain controls, expressed in decibels (dB), range from 0db to 12db. These are used for manual white balance adjustments or specialty needs.
- Individual RGB gains are multiplied by the overall Gain adjustment.
- The Gamma Factor sets the value for the exponent of the gamma correction curve. Gamma correction is used to adjust the color response when displaying images on a monitor. Monitors typically do not have a linear response (Gamme Factor = 1), therefore it is recommended that you experiment with gamma values for your particular display. In general, a value less than 1 will be used to enhance contrast in dark pixels, where typical values are between 0.5 and 1.

Bayer Conversion Algorithms

The conversion algorithms available are provided from the Sapera LT SapBayer class. The following Bayer conversion algorithms are available:

- Method1: Technique based on bilinear interpolation. Fast, but tends to smooth the edges of the image. Based on a 3x3 neighborhood operation.
- Method2: Proprietary adaptive technique, better for preserving the edges of the image. However, it works well only when the image has a strong content in green. Otherwise, little amounts of noise may be visible within objects.
- Method3: Proprietary adaptive technique, almost as good as Method2 for preserving the edges, but independent of the image content in green. Small color artifacts of 1 pixel may be visible at the edges.

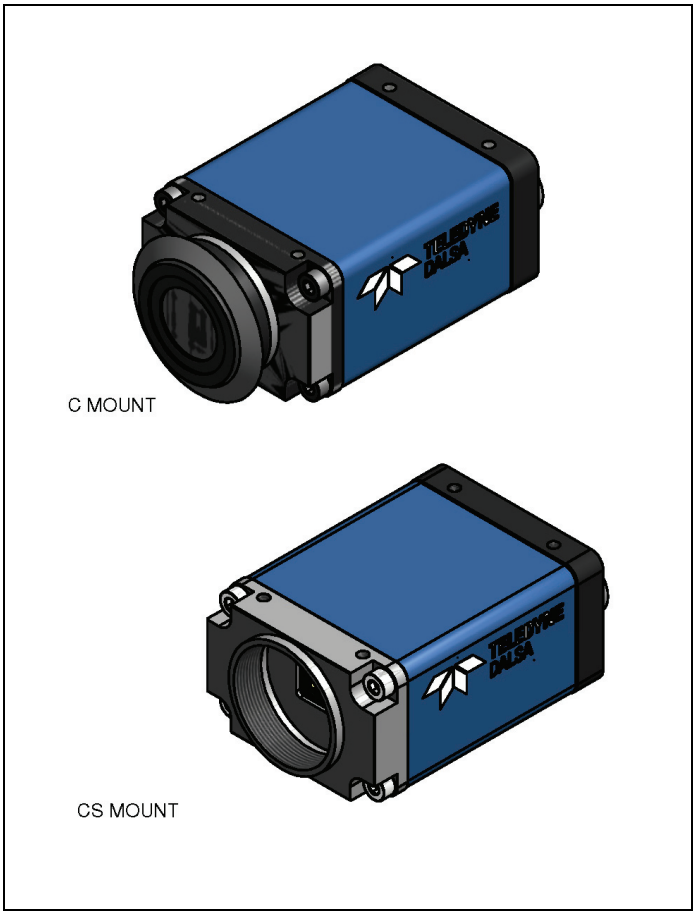
This Page Intentionally Left Blank

Technical Specifications

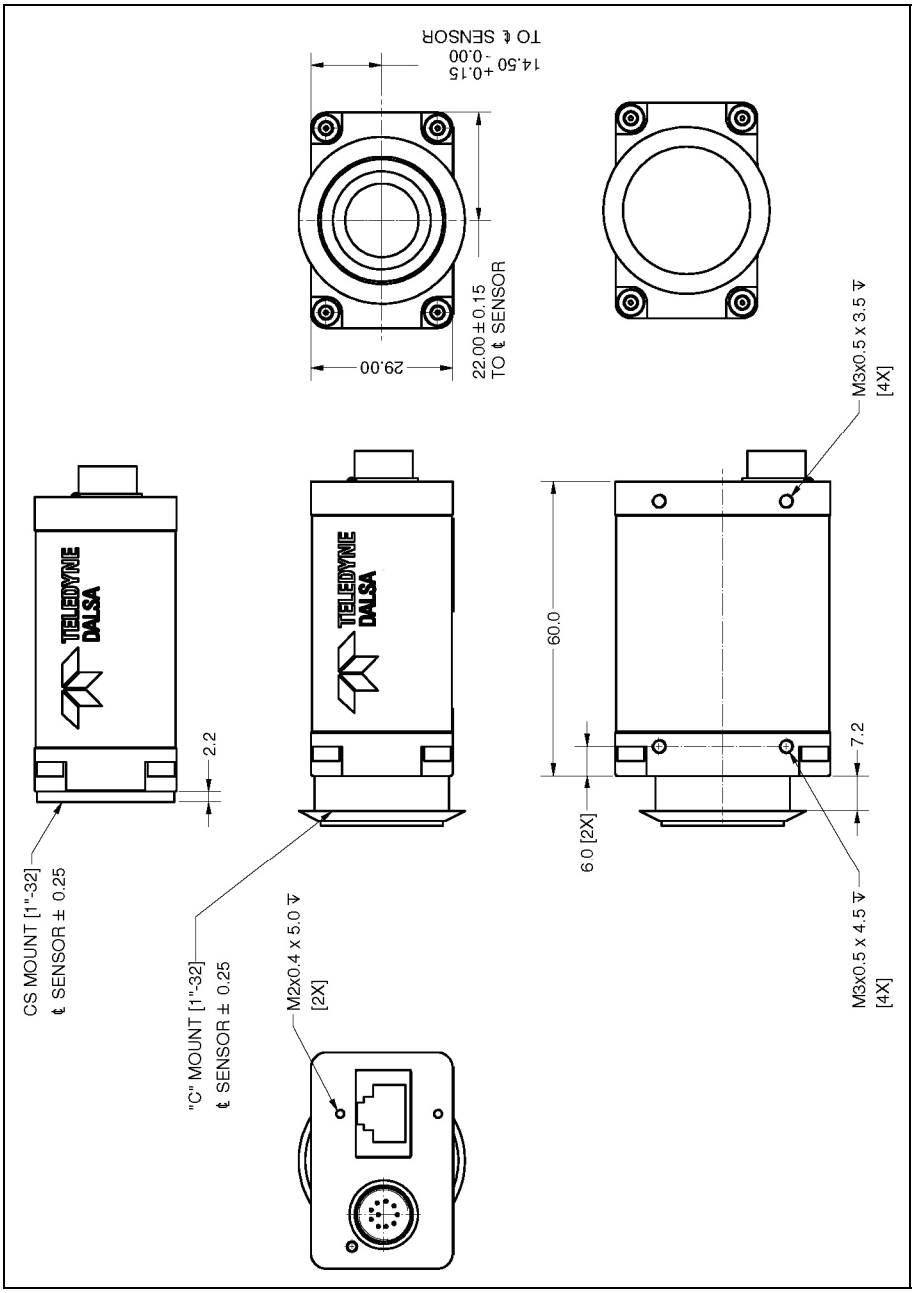
Mechanical Specifications

The following sections show 3D views and the mechanical dimensions for Genie with C-mount or CS-mount, and also for Genie with right-angled lens mounts. Additional notes follow the figures.

Genie 3D View with C-mount and CS-mount

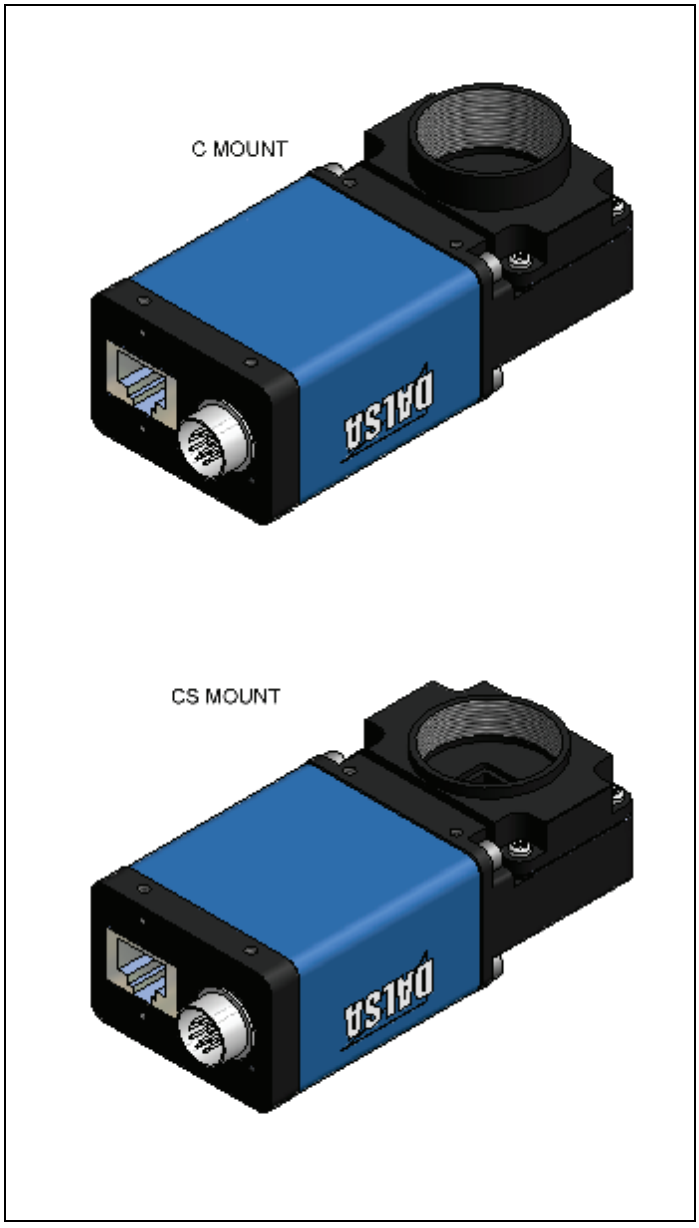


Genie C-mount and CS-mount Mechanical Specifications

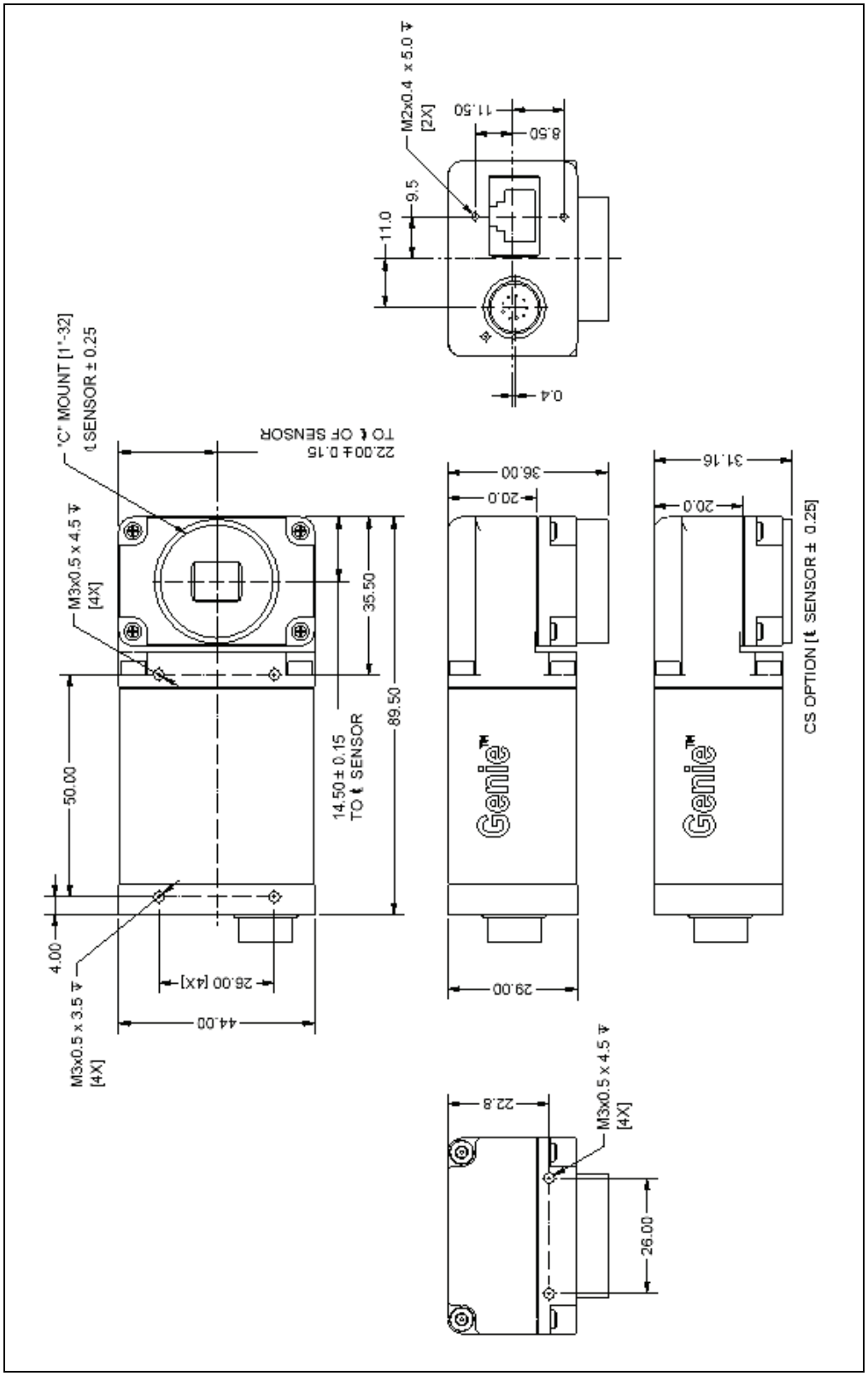


Note: Overall length tolerance is ± 0.35mm

Genie 3D View with Right-angle C-mount and CS-mount



Genie Right-angle C-mount and CS-mount Mechanical Specifications



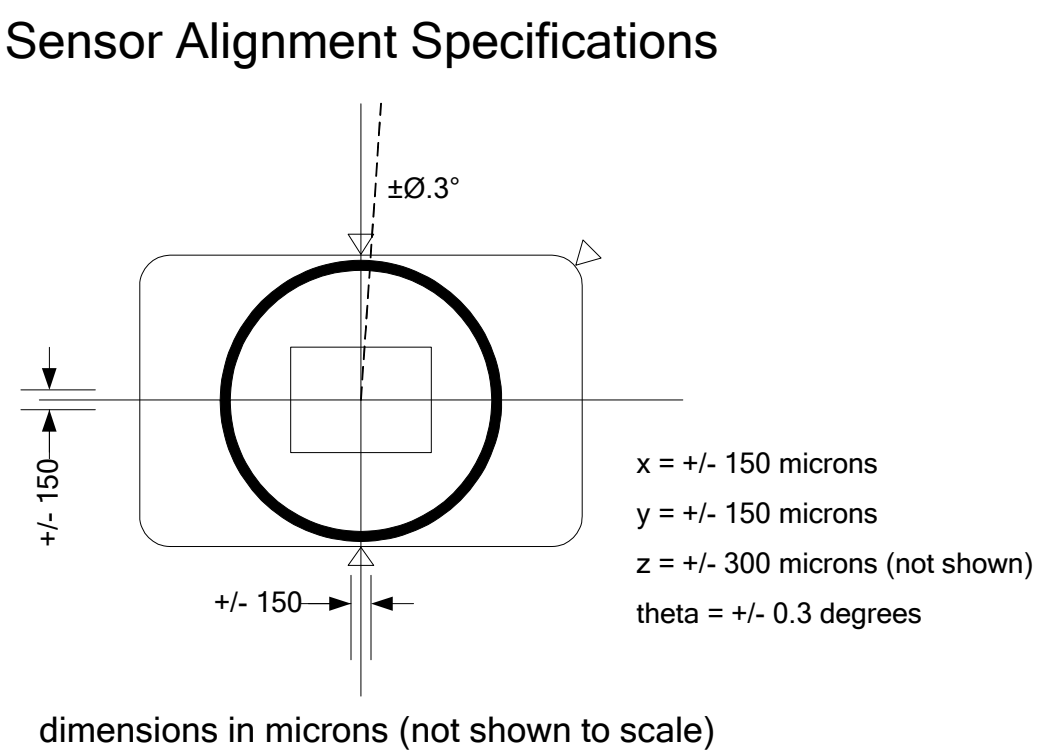
Note: Overall length tolerance is ± 0.35mm

Additional Notes on Genie Mechanical

	Genie supports a screw lock Ethernet cable (see "Ruggedized RJ45 Ethernet Cables" on page 119). For information on Genie lens requirements see "Optical Considerations" on page 112. Lens flange focal distance = 17.52 mm. Lens flange focal distance = 12.52 mm for CS-mount. The camera top also has four mounting holes in identical locations. Overall length tolerance is ± 0.35mm. Overall height or width tolerance is ± 0.15mm.

Sensor Alignment Specification

The following figure specifies sensor alignment for Genie where all specifications define the absolute maximum tolerance allowed for production cameras. Dimensions "x, y, z", are in microns and referenced to the Genie mechanical body or the optical focal plane (for the z-axis dimension). Theta specifies the sensor rotation relative to the sensor's center and Genie mechanical.

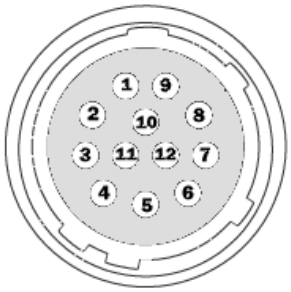


Connectors

- A single **RJ45 Ethernet** connector for control and video data to the host Gigabit NIC. Genie supports a screw lock Ethernet cable (see "Ruggedized RJ45 Ethernet Cables" on page 119).
- A single **12-pin Hirose** male connector for power, trigger and strobe signals. The suggested female cable mating connector is Hirose model HR10A-10P-12S.

12-Pin Hirose Connector Signal Details

The following figure shows the pinout identification when looking at the Genie camera 12-pin male Hirose connector. The table below the figure lists the Genie I/O signal specifications.



Pin	Direction	Genie Signal (see details below)	Notes
1	-	Power GND	
2	-	+12V DC power supply (+11 to +25.2 Volts DC at 0.6 Amp minimum) (+11 to +15.2 Volts DC at 0.6 Amp minimum) see also Camera Performance Specifications	xx-GM00-xxxxx models xx-GEN0-xxxxx models
3	Out	Output 1 -	
4	Out	Output 1 +	
5	In	Input 1 -	RS422- or TTL GND
6	In	Input 1 +	RS422+ or TTL
7	Out	Output 2 + / Strobe +	
8	Out	Output 2 - / Strobe -	
9	-	Reserved	
10	-	Reserved	
11	In	Input 2 +	RS422+ or TTL
12	In	Input 2 -	RS422- or TTL GND
shell / shield	via cable shield	Genie chassis connects to supply earth ground	improves EMI & ESD shielding (see Preventing Operational Faults due to ESD)

Genie Signal Electrical Details

- **Power Supply (pin 2)**: +12V DC nominal at 0.6 Amp minimum.
  Operating tolerance: see Camera Performance Specifications
  Over voltage and reverse voltage protection circuit built in. The protection circuit is reset by shutting down or disconnecting the power supply.
- The **12-pin Hirose** male connector shell and cable shield should connect to the supply earth ground to improve EMI and ESD shielding.

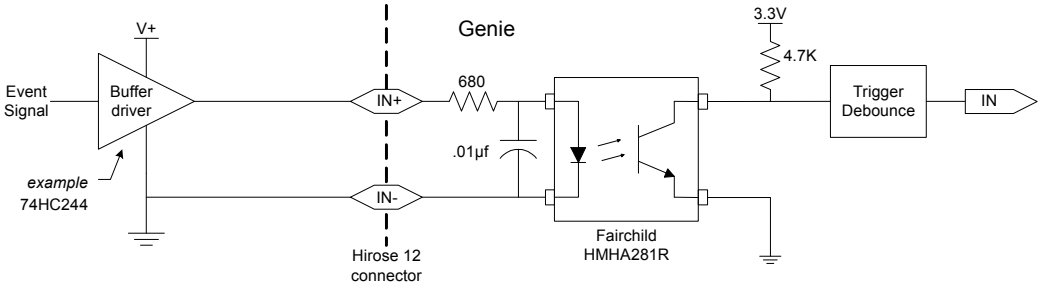
External Inputs

- Opto-coupled (2V to 12V, 2mA minimum) with internal current limit.
- RS422 or TTL signal type (see figures below).
- 24 Volt signals supported with additional external current limiting (see figure below).
- Used as trigger or integration control.
- External signal polarity selected via configuration parameter.
- User programmable debounce time from 1 to 255µs.
- See "Input Controls via Sapera LT or GigE Vision Compliant Applications" on page 55.

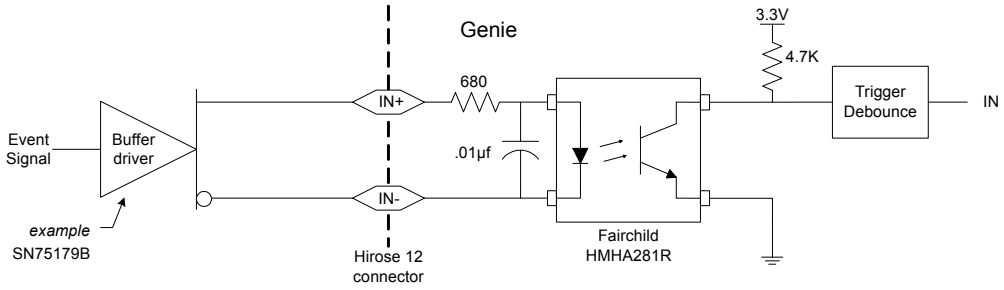
The opto-coupler is typically a Fairchild HMHA281 with the following characteristics.

Input Electrical Parameter Description	Value
Voltage threshold to turn OFF	0.8 V
Voltage threshold to turn ON	2 V
Minimum input current to turn ON	2 mA
Maximum input current	50 mA
Minimum input pulse width to turn ON	30 to 90µs typical dependent on input voltage
Output rise time (typical)	10 µs
Output fall time (typical)	50 µs
Maximum input voltage	13 V
Maximum reverse voltage	- 6 V

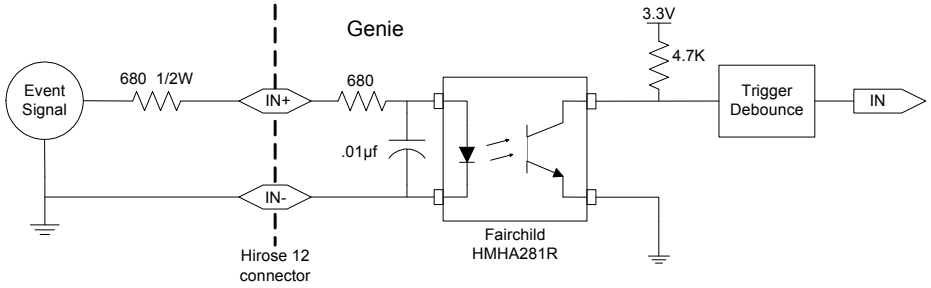
Note: The minimum input pulse width to turn ON can be slightly longer depending on the actual input voltage.



TTL External Signal Example



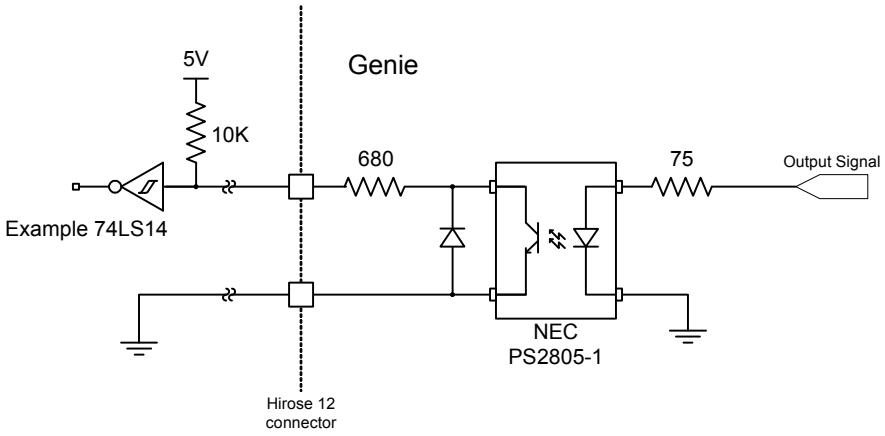
RS-422 External Signal Example



24 Volt External Signal Example

External Outputs

- Programmable output mode such as strobe, event notification, etc. (see "Output Control via Sapera LT or GigE Vision Compliant Applications" on page 61).



Output Driving a TTL User Circuit

The opto-coupler is typically a NEC PS2805-1 with the following characteristics.

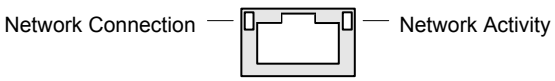
Output Electrical Parameter Description	Value
Maximum voltage difference	13 V
Maximum current through opto-coupler	12mA
Minimum output pulse width	100 us
Maximum switch closure transition time	12 µs
Maximum switch open transition time	40 µs

RJ45 LAN Ethernet Connector Details

The RJ45 LAN connector has two LEDs for network status conditions.

The LED color codes are as follows.

Network Connection		Network Activity	
Green	100Mbps	Off	no network activity
Orange	1000Mbps	Yellow	typically blinking – active



The Genie LAN connector is a standard Ethernet socket. Use CAT5e or CAT6 certified Ethernet cables. CAT5e cable is rated for 100 MHz spectral bandwidth but CAT6 cable is rated for a 200 MHz spectral bandwidth with less signal attenuation, therefore strongly recommended for long connection lengths.

The interconnection Ethernet cable can be either Straight Through or Crossover cable type. The Gigabit Ethernet standard for devices defines that they will auto-negotiate send and receive channels, eliminating the need for users to use a specific Ethernet cable type.

Camera Status LED

The Genie has one multicolor LED to provide a simple visible indication of the operational status of the camera. When more than one condition is active, the LED color indicates the condition with the highest priority. The following table summarizes the LED states and corresponding camera status.

LED State	Definition
LED is off	No power to the camera
Steady Red	Camera not initialized **
Slow Flashing Red	Camera initialization problem **
	** Often there is no serious problem with the Genie hardware. Wait 2-5 minutes for the Genie to load internal default firmware, then follow these instructions (see Updating Genie Firmware).
Slow Flashing Blue	Waiting for an IP address
Fast Flashing Blue	Ethernet cable disconnected (no link)
Steady Blue	IP address assigned; no application connected to the camera
Steady Green	Application connected
Slow Flashing Green	Triggered acquisition in progress
Fast Flashing Green	Free running acquisition in progress

Optical Considerations

This section provides an overview to illumination, light sources, filters, lens modeling, and lens magnification. Each of these components contribute to the successful design of an imaging solution.

Illumination

The amount and wavelengths of light required to capture useful images depend on the particular application. Factors include the nature, speed, and spectral characteristics of objects being imaged, exposure times, light source characteristics, environmental and acquisition system specifics, and more. The DALSA Web site, http://mv.dalsa.com/, provides an introduction to this potentially complicated issue. Click on Knowledge Center and then select Application Notes and Technology Primers. Review the sections of interest.

It is often more important to consider exposure than illumination. The total amount of energy (which is related to the total number of photons reaching the sensor) is more important than the rate at which it arrives. For example, 5μJ/cm^2 can be achieved by exposing 5mW/cm^2 for 1ms just the same as exposing an intensity of 5W/cm^2 for 1μs.

Light Sources

Keep these guidelines in mind when selecting and setting up light source:

- LED light sources are relatively inexpensive, provide a uniform field, and longer life span compared to other light sources. However, they also require a camera with excellent sensitivity.
- Halogen light sources generally provide very little blue relative to infrared light (IR).
- Fiber-optic light distribution systems generally transmit very little blue relative to IR.

- Some light sources age such that over their life span they produce less light. This aging may not be uniform—a light source may produce progressively less light in some areas of the spectrum but not others.

Filters

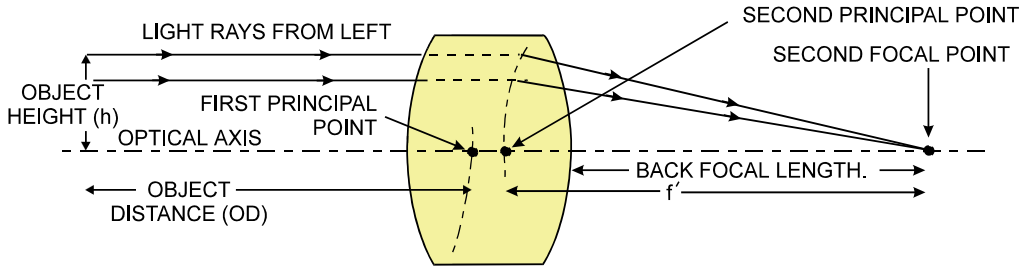
Genie HM cameras are responsive to infrared (IR) wavelengths of light. To prevent infrared from distorting the acquisitions, use a “hot mirror” or IR cutoff filter that transmits visible wavelengths but does not transmit wavelengths over 750nm. Examples are the Schneider Optics™ B+W 489, which includes a mounting ring, the CORION™ LS-750, which does not include a mounting ring, and the CORION™ HR-750 series hot mirror.

Lens Modeling

Any lens surrounded by air can be modeled for camera purposes using three primary points: the first and second principal points and the second focal point. The primary points for a lens should be available from the lens data sheet or from the lens manufacturer. Primed quantities denote characteristics of the image side of the lens. That is, *h* is the object height and *h′* is the image height.

The *focal point* is the point at which the image of an infinitely distant object is brought to focus. The *effective focal length (f′)* is the distance from the second principal point to the second focal point. The *back focal length (BFL)* is the distance from the image side of the lens surface to the second focal point. The *object distance (OD)* is the distance from the first principal point to the object.

Primary Points in a Lens System



Magnification and Resolution

The magnification of a lens is the ratio of the image size to the object size:

$m = \frac{h'}{h}$	Where m is the magnification, h’ is the image height (pixel size) and h is the object height (desired object resolution size).

By similar triangles, the magnification is alternatively given by:

$m = \frac{f'}{OD}$

These equations can be combined to give their most useful form:

$\frac{h'}{h} = \frac{f'}{OD}$	This is the governing equation for many object and image plane parameters.

Example: An acquisition system has a 512 x 512 element, 10µm pixel pitch area scan camera, a lens with an effective focal length of 45mm, and requires that 100µm in the object space correspond to each pixel in the image sensor. Using the preceding equation, the object distance must be 450mm (0.450m).

$\frac{10\mu m}{100\mu m} = \frac{45mm}{OD}$	$OD = 450mm(0.450m)$

Lens Selection Overview

Vision component suppliers and system integrators will have detailed information on lens products at different price points, relative to quality and for different imaging situations. This section provides a general overview to selecting a lens for the Genie HM.

The first two lens parameters are based on correctly matching the lens to the Genie HM model. Genie HM is available with either a C-mount or CS-mount (two standards for flange-focal length), plus one of three sensor sizes. These items are covered first followed by brief information on other lens parameters to consider.

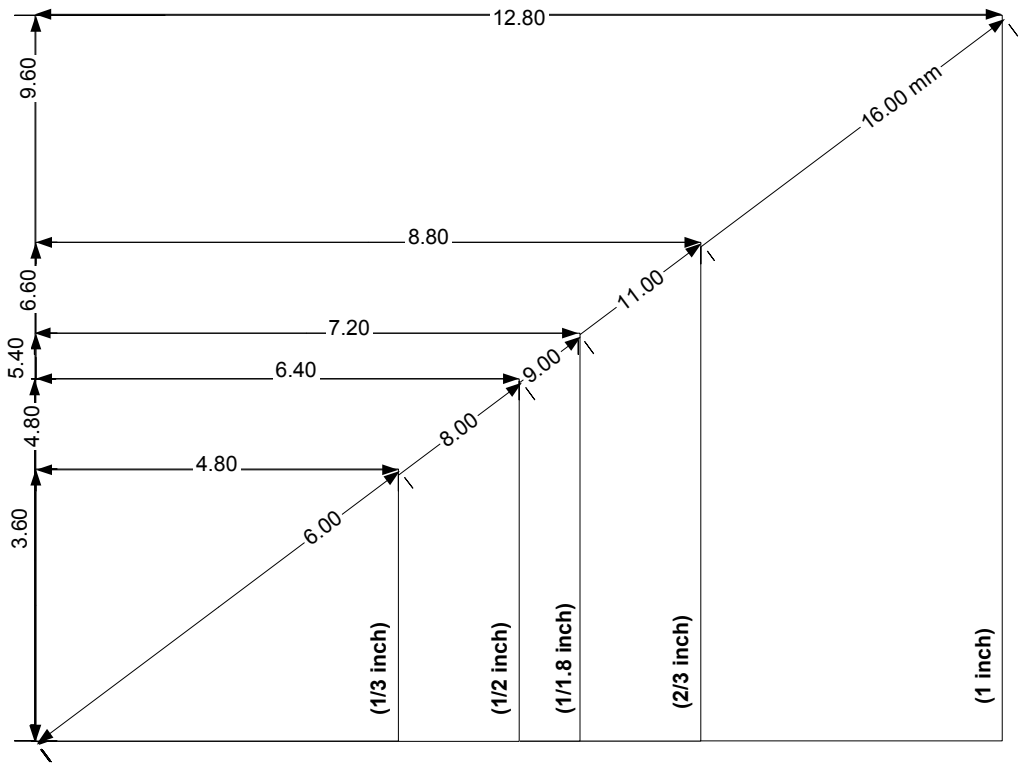
Lens Mount

As shown in "Mechanical Specifications" on page 103 Genie comes in C-mount and the CS-mount. The CS-mount is a standard with a shorter flange-focal length for space sensitive applications. The C-mount Back Focal Distance is 17.52 mm while CS-mount Back Focal Distance is 12.52 mm. The lens selected must be for the Genie mount used, else it may not be able to focus on the target.

Lens Sensor Size

An important lens parameter is its sensor size which defines the largest camera sensor usable with that lens before vignetting occurs (exposure that shades off gradually at the image edges). The lens size specification is in imperial units for historical reasons, and does not directly describe the sensor diameter (even after conversion to metric).

The following figure shows different lens size standards relative to the maximum camera sensor they will properly expose. The lens sensor standard (in imperial units) and the sensor diameter in millimeters are the two important parameters when choosing a lens. The second figure below shows vignetting when a lens for a smaller sensor is used.



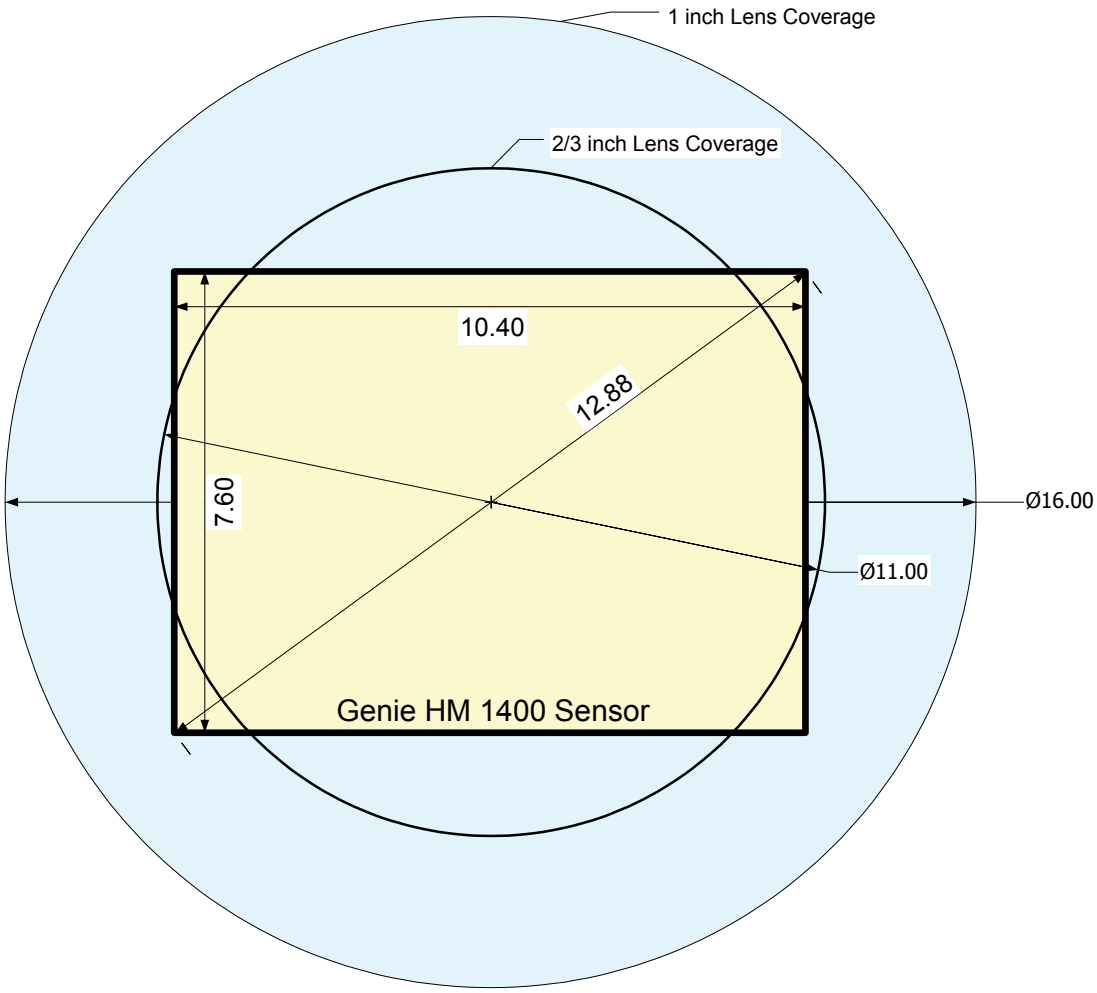
Comparison of Standard Sensor Sizes (dimensions in mm)

The following figure graphically shows the use of two different lenses with the Genie HM 1400 which has a sensor of 10.40mm by 7.60mm (a diagonal of 12.88mm).

- The outer circle shows the illumination coverage of a 1 inch lens where a sensor of up to 16mm diagonal is evenly exposed.
- The inner circle shows the illumination coverage of a 2/3 inch lens where a sensor of up to 11mm diagonal is evenly exposed.

The obvious conclusion is that a 2/3 inch lens will produce image vignetting at the sensor edges, while a 1 inch lens will evenly expose the sensor but at a greater cost in optics. The choice in lens is therefore a trade off of cost verses application requirements.

Comparison of a 2/3 Inch and 1 Inch Lens used with a Genie HM 1400



Lens Sensor Size vs. Genie HM model

Each Genie HM sensor has a square pixel of 7.4 x 7.4 µm. The following table lists the lens size required for total illumination and the next smaller lens size which will have some vignetting.

Genie Model / Illumination Coverage	Genie HM 1400	Genie HM 1024	Genie HM 640
Complete Illumination	1 inch Lens	2/3 inch Lens	1/3 inch Lens
Some Vignetting	2/3 inch Lens	1/1.8 Lens	1/4 inch Lens

Additional Lens Parameters (application specific)

There are other lens parameters that are chosen to meet the needs of the vision application. These parameters are independent of the Genie model (assuming that the Lens Mount and Lens Sensor Size parameters are correct, as previously covered in this section). A vision system integrator or lens specialist should be consulted when choosing lenses since there is a trade off between the best lenses and cost. An abridged list of lens parameters follows – all of which need to be matched to the application.

- **Focal Length**: Defines the focus point of light from infinity. This parameter is related to the Genie mount (C or CS mount). See Camera Performance Specifications — Back Focal Distance.
- **Field of View**: A lens is designed to image objects at some limited distance range, at some positive or negative magnification. This defines the field of view.
- **F-Number (aperture)**: The lens aperture defines the amount of light that can pass. Lenses may have fixed or variable apertures. Additionally the lens aperture affects Depth of Field which defines the distance range which is in focus when the lens is focus at some specific distance.
- **Image Resolution and Distortion**: A general definition of image quality. A lens with poor resolution seems to never be in focus when used to image fine details.
- **Aberrations (defect, chromatic, spherical)**: Aberrations are specific types of lens faults affecting resolution and distortion. Lens surface defects or glass faults distort all light or specific colors. Aberrations are typically more visible when imaging fine details.
- **Spatial Distortions**: Describes non-linear lens distortions across the field of view. Such distortion limits the accuracy of measurements made with that lens.

Sensor Handling Instructions

This section reviews proper procedures for handling, cleaning, or storing the Genie camera. Specifically the Genie sensor needs to be kept clean and away from static discharge to maintain design performance.

Electrostatic Discharge and the Sensor

Cameras sensors containing integrated electronics are susceptible to damage from electrostatic discharge (ESD).

Electrostatic charge introduced to the sensor window surface can induce charge buildup on the underside of the window that cannot be readily dissipated by the dry nitrogen gas in the sensor package cavity. With charge buildup, problems such as higher image lag or a highly non-uniform response may occur. The charge normally dissipates within 24 hours and the sensor returns to normal operation.

Important: Charge buildup will affect the camera's flat-field correction calibration. To avoid an erroneous calibration, ensure that you perform flat-field correction only after a charge buildup has dissipated over 24 hours.

Protecting Against Dust, Oil and Scratches

The sensor window is part of the optical path and should be handled like other optical components, with extreme care.

Dust can obscure pixels, producing dark patches on the sensor response. Dust is most visible when the illumination is collimated. The dark patches shift position as the angle of illumination changes. Dust is normally not visible when the sensor is positioned at the exit port of an integrating sphere, where the illumination is diffuse.

Dust can normally be removed by blowing the window surface using a compressed air blower, unless the dust particles are being held by an electrostatic charge, in which case either an ionized air blower or wet cleaning is necessary.

Oil is usually introduced during handling. Touching the surface of the window barehanded will leave oily residues. Using rubber finger cots and rubber gloves can prevent oil contamination. However, the friction between the rubber and the window may produce electrostatic charge that may damage the sensor.

Scratches can be caused by improper handling, cleaning or storage of the camera. When handling or storing the Genie camera without a lens, always install the C-mount protective cap. Scratches diffract incident illumination. When exposed to uniform illumination, a sensor with a scratched window will normally have brighter pixels adjacent to darker pixels. The location of these pixels changes with the angle of illumination.

Cleaning the Sensor Window

Even with careful handling, the sensor window may need cleaning. The following steps describe various cleaning techniques to clean minor dust particles to accidental finger touches.

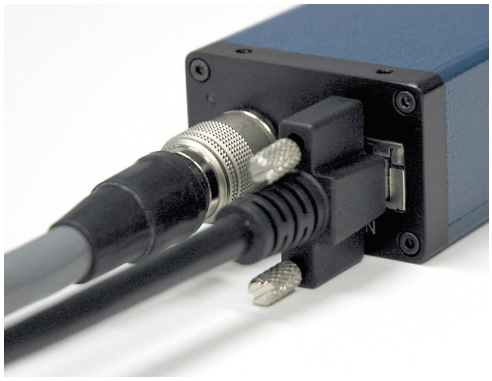
- Use compressed air to blow off loose particles. This step alone is usually sufficient to clean the sensor window. Avoid moving or shaking the compressed air container and use short bursts of air while moving the camera in the air stream. Agitating the container will cause condensation to form in the air stream. Long air bursts will chill the sensor window causing more condensation. Condensation, even when left to dry naturally, will deposit more particles on the sensor.
- When compressed air cannot clean the sensor, Dalsa recommends using lint-free ESD-safe cloth wipers that do not contain particles that can scratch the window. The Anticon Gold 9”x 9” wiper made by Milliken is both ESD safe and suitable for class 100 environments. Another ESD acceptable wiper is the TX4025 from Texwipe.
- An alternative to ESD-safe cloth wipers is Transplex swabs that have desirable ESD properties. There are several varieties available from Texwipe. Do not use regular cotton swabs, since these can introduce static charge to the window surface.
- Wipe the window carefully and slowly when using these products.

Environment

Operating Temperature:	0° to 45° C (at front plate)
Storage Temperature:	-20° to 70° C
Relative Humidity:	5% to 90% non-condensing (operating) 0% to 95% (storage)

Ruggedized RJ45 Ethernet Cables

Components Express Inc. has available an industrial RJ45 CAT6 cable that on one end has a molded shroud assembly with top/bottom thumbscrews, while the other end has a standard RJ45. This cable is recommended when Genie is installed in a high vibration environment. All Genie versions support this secure Ethernet cable.



All cables made in U.S.A. – all cables RoHS compliant.

CAT6 certified (tested for near end / far end crosstalk and return loss).

IGE-3M (3meters)
IGE-10M (10meters)
IGE-25M (25meters)
IGE-50M (50meters)
IGE-100M (100meters)

For Information contact:

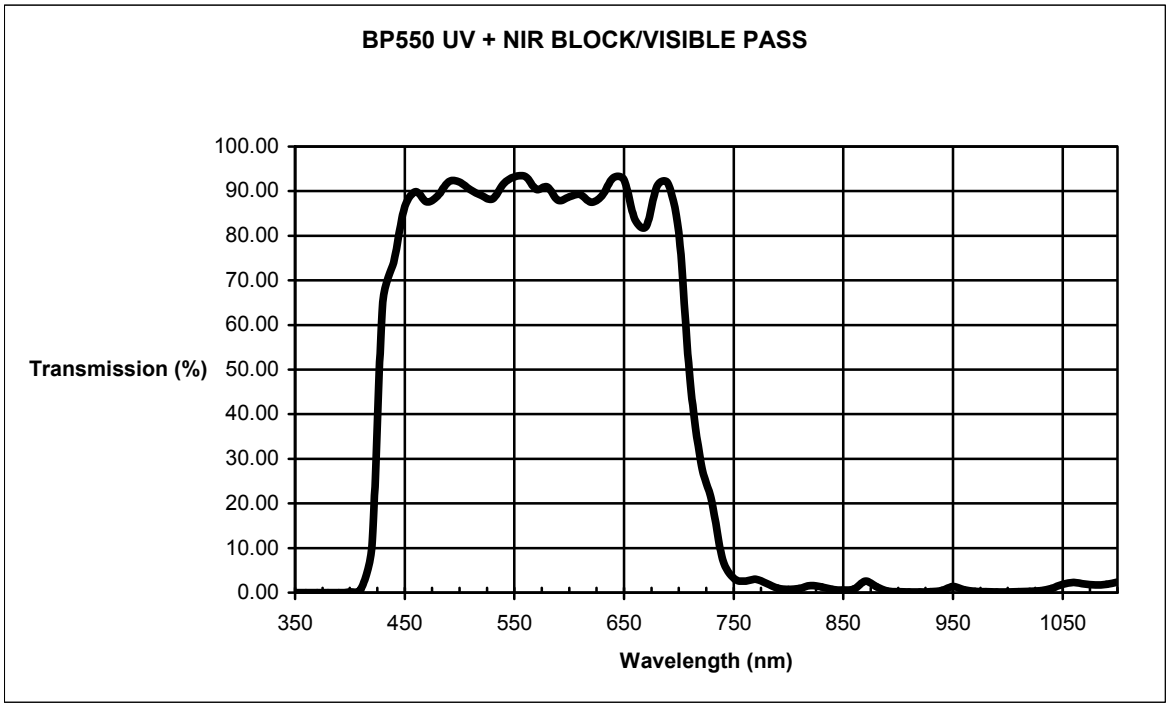
Components Express, Inc. (CEI)
10330 Argonne Woods Drive, Suite 100
Woodridge, IL 60517-4995
Phone: 630-257-0605 / 800.578.6695 (outside Illinois)
Fax: 630-257-0603
http://www.componentsexpress.com/

C/CS-Mount NIR and UV Filter

Midwest Optical Systems has available a C-mount NIR/UV filter. This filter screws into the Genie camera before mounting the lens. The figures below show the filter before mounting into the Genie, followed by the filter physical specifications and pass spectrum. Contact Midwest Optical Systems directly for technical information and pricing.

Physical Specifications:

Outside diameter: 25.4mm, 32 NS2A thread (c-mount thread)
Clear Aperture: 19.5mm
Thickness: 3.0 ±0.1mm



For Information contact:

Midwest Optical Systems
322 Woodwork Ln.
Palatine Il. 60067 USA
Tel: 847-359-3550
http://www.midwestopticalsystems.com/

Back Focal Variance when using a Filter

Inserting a filter between a lens and sensor (as when using a C-mount filter), changes the focal point of the lens used. A variable focus lens simply needs to be adjusted, but in the case of a fixed focus lens, the changed focal point needs correction. The following simplified illustration describes this but omits any discussion of the Optics, Physics, and the math behind the behavior of light through different media.

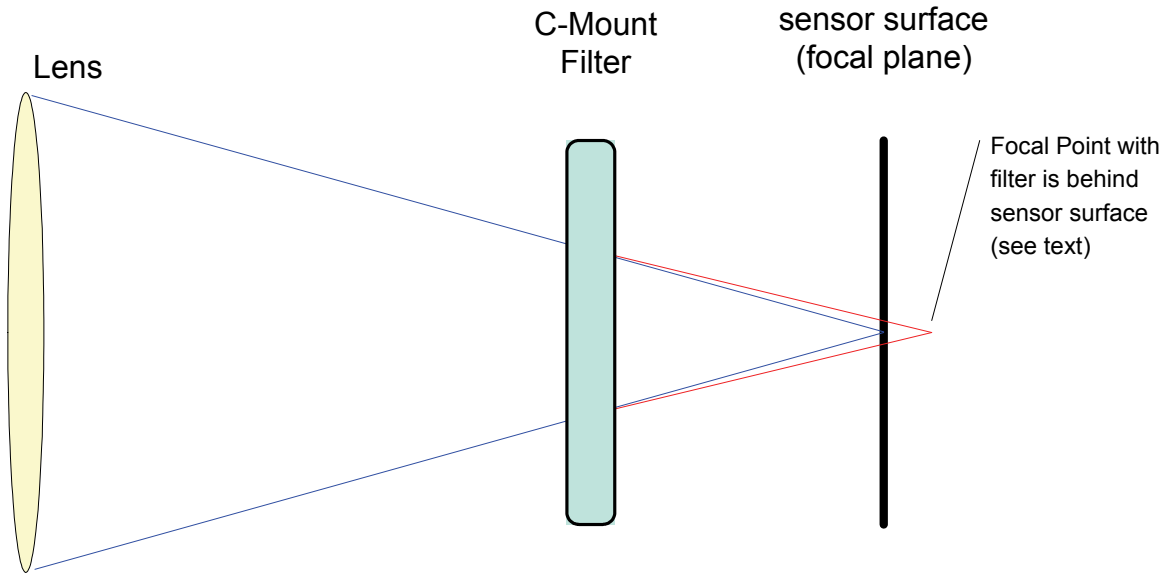


Illustration: Change of Focal Point with inserted C-mount filter

In this example using the Midwest Optical Systems C-mount NIR/UV filter, the image will be projected about 1/3 of the filter thickness behind the sensor plane. In order to compensate for this, the fixed focus C mount lens needs to be unscrewed (counterclockwise) 1/3 of filter thickness or 1000 microns. This is approximately 1.25 turns. A spacer would be preferred else the lens will need to be secured in the correct position. Alternatively use a variable focus lens and secure its focus ring after adjustment.

In simplified equation form:

$$d \cong \frac{t}{3}$$

Where:

d is the change (increase) in back focal distance, due to the filter glass higher index of refraction

t is the thickness of the filter glass

Computer Requirements for Genie Cameras

The following information is a guide to computer and networking equipment required to support the Genie camera at maximum performance. The Genie camera series complies with the current IPv4 Internet Protocol, therefore current Gigabit Ethernet (GigE) equipment should provide trouble free performance.

Host PC System

- Operating System: Windows XP, Windows Vista, Windows 7, Windows 8 (either 32-bit or 64-bit for all) are supported.

Network Adapters

- GigE network adapter (either add on card or on motherboard). The Intel PRO/1000 MT adapter is an example of a high performance NIC. Typically a system will need an Ethernet GigE adapter to supplement the single NIC on the motherboard.
- PCI Express adapters will outperform PCI adapters.
- Network adapters that support Jumbo Frames will outperform adapters with fixed packet size frames.

Laptop Information

- Older laptop computers with built in GigE network adapters may still not be able to stream full frame rates from Genie. Thorough testing is required with any laptop computer to determine the maximum frame rate possible (refer to the DALSA Network Imaging Package user's manual).

Ethernet Switch Requirements

When there is more than one device on the same network or a camera-to-PC separation greater than 100 meters, an Ethernet switch is required. Since the Genie GigE camera complies with the Internet Protocol, it should work with all standard Ethernet switches. However, switches offer a range of functions and performance grades, so care must be taken to choose the right switch for a particular application.

IEEE 802.3x Pause Frame Flow Control

Ethernet Switches supporting Full-duplex IEEE 802.3x Pause Frame Flow Control must be used in situations where multiple cameras may be triggered simultaneously. In such a case the NIC maximum bandwidth would be exceeded if there was no mechanism to temporarily hold back data from cameras. Genie cameras support the IEEE 802.3x pause frame flow control protocol automatically so that images from many cameras can be transmitted through the switch to the NIC efficiently, without data loss. As a working example, one such switch tested at DALSA is the NETGEAR GS716T.

Important: The maximum frame rate possible from a large number of Genie cameras which are simultaneously triggered will depend on the Genie model, frame size, and network details. Each imaging system should be tested for frame rate limits.

Ethernet to Fiber-Optic Interface Requirements

In cases of camera-to-PC separations of more than 100 meters but an Ethernet switch is not desired, a fiber-optic media converter can be used. The FlexPoint GX from Omnitron Systems (www.omnitron-systems.com) converts GigE to fiber transmission and vice versa. It supports multimode (MM) fiber over distances of up to 220 m (720 ft.) and single-mode (SM) fiber up to 65 km (40 mi.) with SC, MT-RJ, or LC connector types.

Important: The inclusion in this manual of GigE to fiber-optic converters does not guarantee they will meet specific application requirements or performance. The user must evaluate any supplemental Ethernet equipment.

EC & FCC Declaration of Conformity

EC & FCC DECLARATION OF CONFORMITY

We : Teledyne DALSA inc.
7075 Place Robert-Joncas, Suite 142,
St. Laurent, Quebec, Canada, H4M 2Z2

Declare under sole legal responsibility that the following products conform to the protection requirements of council directive 2004/108/EC on the approximation of the laws of member states relating to electromagnetic compatibility:

Genie HM and HC Series

The products to which this declaration relates are in conformity with the following relevant harmonized standards, the reference numbers of which have been published in the Official Journal of the European Communities:

EN55022:2006, A1:2007
ENV50205:1995
EN61000-4-2:1995, A1:1998, A2:2001
EN61000-4-3:1996, A1:1998
EN61000-4-4:2004
EN61000-4-6:1996, A1:2001

Further declare under our sole legal responsibility that the product listed conforms to the code of federal regulations CFR 47 part 15 (2008), subpart B, for a class A product.

St. Laurent, Canada — Location
2011-09-06 — Date

Eric Carey, ing.
Director,
Research and Development

Troubleshooting

Overview

In rare cases an installation may fail or there are problems in controlling and using the Genie camera. This section highlights issues or conditions which may cause installation problems and additionally provides information on computers and network adapters which have caused problems with Genie. Emphasis is on the user to perform diagnostics with the tools provided and methods are described to correct the problem.

The GigE Server status provides visual information on possible Genie problems. The three states are shown in the following table. Descriptions of possible conditions causing an installation or operational problem follow. Note that even a Genie installation with no networking issue may still require optimization to perform to specification.

	Device Not Available	Device IP Error	Device Available
GigE Server Tray Icon: Note: It will take a few seconds for the GigE Server to refresh its state after any change.			
	A red X will remain over the GigE server tray icon when the Genie device is not found. This indicates a network issue where there is no communication with Genie. ***Or in the simplest case***, the Genie is not connected.	The GigE server tray icon shows a warning when a device is connected but there is some type of IP error.	The GigE server tray icon when the Genie device is found. The Genie has obtained an IP address and there are no network issues. Optimization may still be required to maximize performance.

Problem Type Summary

Genie problems are either installation types where the Genie is not found on the network or setup errors where the Genie device is found but not controllable. Additionally a Genie may be properly installed but network optimization is required for maximum performance. The following links jump to various topics in this troubleshooting section.

Device Not Available

A red X over the GigE server tray icon indicates that the Genie device is not found. This indicates either a major camera fault or condition such as disconnected power, or a network issue where there is no communication.

- Review the section "Installation Overview & Preparations" on page 20 to verify required installation steps.
- Refer to the DALSA Network Imaging manual to review networking details.
- The Genie camera cannot acquire a DHCP address and/or the Windows firewall does not start after Windows service pack 2 or 3 has been installed. See "The Windows Firewall Service Can Not Start" on page 127.
- In multiple NIC systems where the NIC for the Genie is using LLA mode, ensure that no other NIC is in or switches to LLA mode. It is preferable that the DALSA DHCP server is enabled on the NIC used with the Genie instead of using LLA mode, which prevents errors associated with multiple NIC ports.

Device IP Error

The GigE server tray icon shows a warning with IP errors. Review the following topics on network IP problems to identify and correct the condition.

Please refer to the DALSA Network Imaging Package manual for information on the DALSA Network Configuration tool and network optimization foe GigE Vision cameras and devices.

Multiple Camera Issues

- When using multiple cameras with a computer with multiple NIC ports, confirm each Genie has been assigned an IP address by checking the GigE server.
- To reduce network traffic in configured problem free systems, use the Network Configuration tool to stop camera discovery broadcasts. Refer to the DALSA Network Imaging manual.
- When using multiple cameras connected to an VLAN Ethernet switch, confirm that all cameras are on the same subnet setup on that switch. See the DALSA Network Imaging package manual for more information. .
- If a Genie camera installed with other GigE Vision cameras can not connect properly with the NIC or has acquisition timeout errors, there may be a conflict with the third party camera's filter driver. In some cases third party filter drivers modify the NIC properties such that the DALSA Sapera Network Imaging Driver does not install. Verify such a case by uninstalling the third party driver and installing the Genie package again.

Device Available but with Operational Issues

A properly installed Genie with no network issues may still not perform optimally. Operational issues concerning cabling, Ethernet switches, multiple cameras, and camera exposure are discussed in the following sections:

Always Important

- Why should Genie firmware be updated? See "Firmware Updates" on page 128.
- "Power Failure During a Firmware Update–Now What?" on page 128.
- "Cabling and Communication Issues" on page 128.
- See "Preventing Operational Faults due to ESD" on page 21 to avoid random packet loss, random camera resets, and random loss of Ethernet connections.

No Timeout messages

- I can use CamExpert to grab (with no error message) but there is no image (display window stays black). See "Acquisition Error without Timeout Messages" on page 129.
- I can use CamExpert to grab (with no error message) but the frame rate is lower than expected. See "Camera acquisition is good but frame rate is lower than expected" on page 129.
- There is no image and the frame rate is lower than expected.
  See "Camera is functional but frame rate is lower than expected" on page 129.
- There is no image but the frame rate is as expected.
  See "Camera is functional, frame rate is as expected, but image is black" on page 130.

Other problems

- The 'Save User Configuration' function fails to save the current user settings. See warning concerning Flat Field data in section "Power-up Configuration (Saved User Settings)" on page 34 and "Minimum Sapera Version Required" on page 130.
- Unexpected 'Trigger Events'. See "Random Invalid Trigger Events" on page 130.

Verifying Network Parameters

DALSA provides the Network Configuration tool to verify and configure network devices and the Genie network parameters. See section Network Configuration Tool of the DALSA Network Imaging manual, if there were any problems with the automatic Genie software installation.

Before Contacting Technical Support

Carefully review the issues described in this Troubleshooting section. To aid DALSA personnel when support is required, the following **three status files** should be generated and included with the request for support.

- From the computer folder **[*installation drive*]:\DALSA\Genie\bin there is a *report.txt*** file automatically generated on firmware updates.
- From the Start menu, go to **Programs • Dalsa • Sapera LT • Tools** and run the **Log Viewer** program. From its File menu click on **Save Messages** to generate a log text file.

Installation Issues and Functional Problems

This section covers issues that are apparent after installation or are indicated by the GigE server tray icon showing a warning symbol.

The Windows Firewall Service Can Not Start

After installing Windows XP Service Pack 2 or 3, the Windows Firewall service will not start. Problems with the Genie camera or Framework may include:

- The Genie camera cannot acquire a DHCP address
- Registry writes fail
- Messages in the Sapera Log Viewer include "check your firewall" and the computer firewall is disabled for no reason.

After installing Windows XP Service Pack 2 or 3, the Windows Firewall service will not start. Symptoms may include the following messages:

- When you click Windows Firewall in Control Panel, you may receive the following error message:
  Windows Firewall settings cannot be displayed because the associated service is not running. Do you want to start the Windows Firewall/Internet Connection Sharing (ICS) service?
- If you try to manually start the Windows Firewall service by using Services, you may receive the following error message:
  Could not start the Windows Firewall/Internet Connection Sharing (ICS) service on Local Computer.
  Error 0x80004015: The class is configured to run as a security id different from the caller.

These symptoms are described in detail by Microsoft support at this link (http://support.microsoft.com/kb/892199).

Without covering the details mentioned in the Microsoft support web page, the solution involves deleting two registry keys in the host computer. This procedure should only be done by someone comfortable with Windows registry backups and editing. These registry keys can be deleted via the following command console instructions:

- REG DELETE HKLM\SYSTEM\CurrentControlSet\Services\SharedAccess\Security /f
- REG DELETE HKLM\SOFTWARE\Classes\AppID\{ce166e40-1e72-45b9-94c9-3b2050e8f180} /f

Reboot the computer after execution.

Device Available with Operational Issues

This section considers issues with cabling, Ethernet switches, multiple cameras, and camera exposure. All information concerning the DALSA Network Configuration Tool and other networking considerations, is available in the DALSA Network Imaging manual.

Firmware Updates

As a general rule any Genie installation must include the firmware update procedure (see "Updating Genie Firmware" on page 28). Genie camera firmware that does not match a newer version of installed Genie Framework software is likely to have unpredictable behavior. Problems might be:

- Genie is not found by the device discovery process.
- Genie is found by the Sapera GigE Server but an application such as CamExpert does not see the camera.
- A Genie that had a fault with a firmware update will boot with default safe firmware. In this case the Genie behaves normally as a network device but can not function as a camera. Opening the GigE Vision device status will show the Genie name field as Firmware required.

Important: New Genie cameras installed in previously deployed systems are fully backward compatible with the older vision application. New Genie cameras must not be programmed with older firmware.

Power Failure During a Firmware Update–Now What?

Don't panic! There is far greater chance that the host computer OS is damaged during a power failure than any permanent problems with the Genie. When electrical power returns and the host computer system has started, follow this procedure to reprogram the Genie firmware.

- Connect power to the Genie. The Genie processor knows that the operating firmware is corrupt.
- The Genie status LED is slow flashing red. This will continue for about 2 minutes (pre-2007 Genie cameras may take up to 5 minutes and has no led status).
- During this period, the Genie is loading embedded write-protected firmware. When the status LED goes blue the Genie is initialized with a minimal safe boot firmware.
- The Genie is now operating normally as a network device but will not function as a camera.
- Perform the firmware update procedure (see "Updating Genie Firmware" on page 28) again. The Genie is now be ready for use.

Cabling and Communication Issues

With only two cables connected to Genie, possible cabling issues are limited.

Power supply problems:

- If the Genie status LED is off, the DC supply power is not connected or faulty. Verify the power supply voltage at the Hirose connector. See "12-Pin Hirose Connector Signal Details" on page 108 for pinout information.

Communication problems:

- Use a shielded cable where the Hirose connector shell electrically connects the Genie chassis to the power supply earth ground. This can eliminate trigger issues in a high EMI environment.
- Check that the Ethernet cable is clipped both to the Genie and the NIC or switch on the other end.
- Verify the Ethernet cabling. Poor cables will cause connections to auto-configure at lower speeds.
- Use the Genie Ethernet status LED to confirm a gigabit connection. Note that a gigabit connection may still have many packet resends, rendering the connection useless. This condition has been seen with different NIC products.
- Use a secured Ethernet cable when the Genie is in a high vibration environment. See "Ruggedized RJ45 Ethernet Cables" on page 119.
- Check the Ethernet status LEDs on the Genie RJ45 connector. The network speed indicator should show the expect connection speed and the activity LED should flash with network messages.
- Verify that the Ethernet cable is CAT5e or CAT6. This is very important with long cable lengths.
- When using very long cables, up to the maximum specified length of 100m for gigabit Ethernet, different NIC hardware and EMI conditions can affect the quality of transmission.
- Minimum recommended Ethernet cable length is 3 feet (1 meter).
- Use the Log Viewer tool (see point below) to check on packet resend conditions.
- Run the Sapera Log Viewer: **Start•Programs•DALSA•Sapera LT•Tools•Log Viewer**. Start the Genie acquisition program, such as CamExpert. There should not be any "packet resend" messages, else this indicates a control or video transmission problem due to poor connections or extremely high EMI environments.

Acquisition Error without Timeout Messages

Streaming video problems range from total loss of image data to occasional loss of random video data packets. The following section describes conditions identified by DALSA engineering while working with Genie in various computers and setups. See the DALSA Network Imaging manual for information on network optimizations.

No camera exposure when expected

- Verify by using the camera in free-running mode. Do not use external trigger mode when testing a camera setup.
- If using free-running mode, verify that the exposure period is set to the maximum possible for the set frame rate.
- Load factory default from the Power-up Configuration in CamExpert. This will reset the camera to its nominal acquisition rate.

Camera is functional but frame rate is lower than expected

- Verify Ethernet link speed. If the LAN connection is limited to 100 Mbps, the monochrome Genie frame rate maximum will be around 30 fps for a 640x480 exposure. Higher resolution Genie models would have even lower frame rates without a Gigabit Ethernet connection. See the DALSA Network Imaging manual for information on network optimizations.
- If using an external trigger, verify the trigger source rate and Genie parameters such as trigger to exposure delay.
- Verify the exposure mode type is Synchronous, not Reset mode. (See "Synchronization Timing" on page 51).

Camera acquisition is good but frame rate is lower than expected

- While running CamExpert and grabbing in free-run mode at the maximum frame rate, start the **Sapera Monitor** tool from the Sapera Tools installed with Sapera.

- Make sure the **Memory Overflow** event monitor is enabled.
- Continue grabbing from the Genie at maximum frame rate. If any memory overflow events are counted, then the Genie internal buffer could not be transmitted on time and was discarded. Such a condition may occur with large frame color or high frame rate Genie cameras.
- Verify that network parameters are optimal as described in "CamExpert GigE Vision Parameters" on page 73. Ensure the host computer is not executing other network intensive tasks. Try a different Gigabit NIC or a PCI Express bus version.

Camera is functional, frame rate is as expected, but image is black

- Verify that the lens iris is open.
- Aim the Genie at a bright light source.
- Check that the programmed exposure duration is not too short or set it to maximum. See "Exposure Controls" on page 47.
- Using CamExpert set the Genie to output its Internal Pattern Generator. This step is typically done for any camera installation to quickly verify the Genie and its software package. See "Internal Image Test Patterns" on page 70 for information on using CamExpert to select internal patterns from Genie.

Other Problems or Issues

This section describes problems that do not fit any of the categories above. Typically these are issues found in the field under specific or unusual conditions.

Random Invalid Trigger Events

Do not change the exposure time while grabbing, else an Invalid Trigger Event may be generated. This applies to any exposure mode or trigger source. The Invalid Trigger Event is not catastrophic and only indicates the loss of a video frame. Stopping acquisitions first will avoid this error.

Minimum Sapera Version Required

Save User Configuration Failed: An unusual error that occurred with no other Genie control problem. The solution is to verify the minimum Sapera version used with the Genie Framework. The Genie HM requires Sapera version 6.20 or later. The Genie Monochrome or Color require Sapera version 6.10 or later. Sapera 7 or later is required for any Genie installation with a computer running 64-bit Windows.

Contact Information

Genie Sales Information

Visit our web site:	http://www.dalsa.com/mv
Email:	mailto:info@dalsa.com

Canadian Sales

Teledyne DALSA — Head office
605 McMurray Road
Waterloo, Ontario, Canada, N2V 2E9

Tel: 519 886 6000
Fax: 519 886 8023

Teledyne DALSA — Montreal office
7075 Place Robert-Joncas, Suite #142
St. Laurent, Quebec, Canada, H4M 2Z2

Tel: (514) 333-1301
Fax: (514) 333-1388

USA Sales

Teledyne DALSA — Billerica office
700 Technology Park Drive
Billerica, Ma. 01821

Tel: (978) 670-2000
Fax: (978) 670-2010

European Sales

Teledyne DALSA GMBH
Felix-Wankel-Str. 1
82152 Krailling, Germany

Tel: +49 – 89 89 – 54 57 3-80
Fax: +49 – 89 89 – 54 57 3-46

Asian Sales

Teledyne DALSA Asia Pacific
Ikebukuro East 13F
3-4-3 Higashi Ikebukuro,
Toshima-ku, Tokyo, Japan

Tel: +81 3 5960 6353
Fax: +81 3 5960 6354

Shanghai Industrial Investment Building
Room G, 20F, 18 North Cao Xi Road,
Shanghai, China 200030

Tel: +86-21-64279081
Fax: +86-21-64699430

Genie Technical Support

Any support question or request can be submitted via our web site:

Technical support form via our web page: Support requests for imaging product installations, Support requests for imaging applications	http://www.dalsa.com/mv/support
Product literature and driver updates	http://www.dalsa.com/mv/download

Before contacting Technical support, the following three status files should be generated and included with the request for support.

- The host computer network status file (refer to the DALSA Network Imaging Package user's manual for information on generating this file).
- From the computer folder **[*installation drive*]:\DALSA\Genie\bin there is a *report.txt*** file automatically generated on firmware updates.
- From the Start menu, go to **Programs • Dalsa • Sapera LT • Tools** and run the **Log Viewer** program. From its File menu click on **Save Messages** to generate a log text file.

Glossary of Terms

ARP

Address Resolution Protocol provides a way to retrieve the MAC address associated to an IP address.

Bandwidth

Describes the measure of data transfer capacity.

CAT5e Ethernet cable

Category 5e was designed for transmission speeds of up to 1 gigabit per second (Gigabit Ethernet).

CAT6 Ethernet cable

Same as Category 5e, except that it is made to a higher standard. Supports transmission speeds greater than Gigabit Ethernet with less signal attenuation over a given length of cable.

CCD – Charge-Coupled Device

A type of image sensor converting light into electrical charges. Has unique strengths and weaknesses compared to CMOS, giving advantages in different applications.

CMOS - Complementary Metal Oxide Semiconductor

A type of image sensor, different from CCD sensors, for capturing images digitally. Has unique strengths and weaknesses compared to CCD, giving advantages in different applications.

Contiguous Memory

A block of physical memory occupying consecutive addresses.

DHCP (Dynamic Host Configuration Protocol)

Protocol which provides a mechanism for allocating IP addresses dynamically by a DHCP server on a network. Typically dedicated DHCP servers are a component of corporate networks. Used for managed networks.

Driver

Also called a device driver, a program routine that links a peripheral device to the operating system. a device driver is required for its frame grabber capabilities.

DSNU

Dark Signal Non-Uniformity (equivalent to FPN).

Ethernet Switch

A network device performing bridging at full wire-speed based on MAC addresses. Packet collisions are eliminated when using a full duplex switch. An Ethernet Switch operates at Layer 2 of the seven-layer OSI model.

FPN

Fixed Pattern Noise (equivalent to DSNU). FPN is the peak to peak difference between the minimum and maximum measured values for all active valid pixels sensor in darkness. Fixed Pattern Noise does not include a Random Noise component.

Frame

One complete image data set or its equivalent storage space.

Frame buffer

An area of memory used to hold a frame of image data. A frame buffer may exist on the acquisition hardware or be allocated by the acquisition hardware device driver in host system memory.

GigE Vision specification

Specification of the Automated Imaging Association (AIA, www.machinevisiononline.org). Defines the communication interface protocol used by any GigE Vision device.

GenICam specification

Specification of the European Machine Vision Association (EMVA, www.emva.org). Defines the capabilities of any GigE Vision device.

Grab

Acquiring an image frame.

Grayscale

In image processing, the range of available brightness levels, displayed in shades of gray. In an 8-bit system, the gray scale contains values from 0 to 255. A 10-bit system has a range of 0-1023.

GVCP – GigE Vision Control Protocol

One of the core protocols of the GigE Vision specification used to control camera. GVCP uses UDP port 3956 on the camera.

GVSP – GigE Vision Stream Protocol

One of the core protocols of the GigE Vision specification used to stream images.

Host

Refers to the computer system that supports the installed frame grabber.

Hot Pixel

Pixels that do not react to light over the full dynamic range specified for that sensor.

IP – Internet Protocol

The Internet Protocol is the method by which data is sent from one computer to another on a network or across the Internet. Each device must have an IP address to identify that device on the network or on the Internet.

LLA

Link-Local Address is a protocol providing a scheme for devices to automatically assign themselves an IP address and check for IP conflict. Used in unmanaged networks.

NIC

Network Interface Card/Controller. For the Genie products the NIC must be a Gigabit Ethernet interface to provide sufficient bandwidth.

Pixel

A contraction of "picture element". The number of pixels describes the number of digital samples taken of the analog video signal. The number of pixels per video line by the number of active video lines describes the acquisition image resolution. The binary size of each pixel (e.g., 8-bits, 16-bits, 24-bits) defines the number of gray levels or colors possible for each pixel.

PRNU

Photo-Response Non-Uniformity. For a given even illumination the difference between the minimum and maximum measured pixel values is the PRNU.

Progressive Scan Camera

The progressive scan format outputs data from the camera (the signal) in sequential order as it is scanned. The scan format produces a full frame of video in a continuous stream, rather than half the image per output sequence in standard interlaced cameras.

Random Noise

Random noise is defined as the difference in peak to peak value for any single pixel repetitively sampled, with the sensor in darkness. For digital cameras the measurement is based on at least 512 samples from any pixel.

Router

A Router device forwards packets across networks. It operates at Layer 3 of the seven-layer OSI model. Note that broadcast packets (such as GigE Vision Device Discovery message) do not cross routers.

SAT

Saturation Output Amplitude. SAT is the average maximum output level for a specified light input.

Scatter Gather

Host system memory allocated for frame buffers is virtually contiguous but physically scattered throughout all available memory.

SNR

Signal to Noise Ratio. SNR measures the ratio between random noise and an arbitrary reference signal on the transmission path or within a device.

Subnet

The subnet is identified by performing the logical AND of the IP address with its subnet mask.

TCP

Connection-oriented transport protocol providing robustness and reliability. Used by many Internet application, such as HTML.

Trigger

A mechanism that initiates an action when an event occurs such as synchronizing an image acquisition to an external event. A trigger generally causes a program routine to be executed such as the resetting of camera exposure and/or the firing of a strobe light.

UDP

User Datagram Protocol is a connectionless transport protocol providing no guaranty of delivery or reliability. GigE Vision Control Protocol and GigE Vision Stream Protocol are based on UDP.

Vignetting

Caused by a lens designed for a smaller camera sensor. Vignetting describes the gradual reduction in exposure at the sensor edges. All machine vision lens specify the maximum sensor size usable before vignetting occurs.

VLAN

A Virtual Local Area Network is a flexible arrangement where computers connected via a VLAN Ethernet switch are not necessarily on the same LAN broadcast domain. Refer to the VLAN Ethernet switch documentation for implementation and configuration details.

VPN

A virtual private network is a private data network that makes use of the public telecommunication infrastructure, maintaining privacy through the use of a tunneling protocol and security procedures. The idea of the VPN is to give the company the same capabilities at much lower cost by using the shared public infrastructure rather than a private one. (source: www.netunlimited.com/glossary.html)

Index

I

J

L

M

N

O

P

R

S

T

U

V

W

X