Linea2 5GigE Series

Camera User's Manual

Color CMOS RGB and RGB-NIR Line Scan

sensors | **cameras** | frame grabbers | processors | software | vision solutions

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Notice

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About Teledyne DALSA
Teledyne DALSA, a business unit of Teledyne Digital Imaging Inc., 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.

Teledyne 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.

Contents

Linea2 5GigE Series Overview

Description

The Linea™2 5GigE is a new affordable line scan camera delivering both speed and responsivity at a competitive price. This camera is low-powered and designed for applications such as grading and inspection, transportation safety, automated optical inspection, and general purpose machine vision.

The Linea2 5GigE camera is one of a new series of affordable and easy to use digital cameras specifically engineered for industrial imaging applications requiring embedded image processing and improved network integration.

The Linea2 color model is a trilinear RGB plus additional defect or contaminant detection with near infrared. Choose between 4 lines (RGB+NIR) with line rates up to 32 kHz, or 3 lines (RGB) up to 42 kHz.

Linea2 5GigE combines standard 5 Gbps (5GBASE-T) Ethernet technology (supporting GigE Vision 1.2) with Teledyne DALSA Trigger-to-Image-Reliability it dependably captures and transfers images between the camera to the host PC.
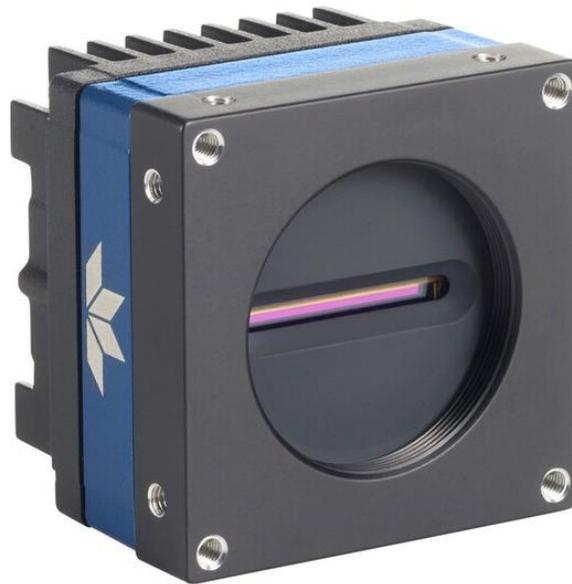
Figure 1: Linea2 5GigE Series

Linea2 5GigE Application Advantages

- 4096 pixel resolution
- 7 µm pixel size
- High speeds over 5GigE
- Multiple regions of interest for calibration and data reduction
- 4 programmable coefficient sets
- Programmable I/Os
- Compact form factor
- Configurable full well
- Precision Time Protocol
- PoE (Power-over-Ethernet)

Linea2 5GigE Firmware

Teledyne DALSA Linea2 5GigE camera firmware contains open source software provided under different open source software licenses. Information about these open source licenses can be found in the documentation that accompanies the firmware available on the Teledyne DALSA website at www.teledynedalsa.com.

Firmware updates for Linea2 5GigE are available for download from the Teledyne DALSA web site [https://www.teledynedalsa.com/en/support/downloads-center/firmware/]. Choose Linea2 5GigE Firmware from the available download sections, then choose the zip file download specific to your camera model.

When using Sapera LT, update the camera firmware using CamExpert (see File Access via the CamExpert Tool). The Camera firmware can be easily upgraded / downgraded within your application.

Part Numbers and Software Requirements

This manual covers the Linea2 5GigE models summarized below. New models are added to this manual as they are released by Teledyne DALSA. See <u>Sensor Specifications</u> for details on each model.

Camera	Resolution	Pixel size	Max. Line Rate	Lens Mount (threaded)	Product Number
Linea2 5GigE 4k	4096 x 4	7 x 7 µm	42 kHz RGB	M42 x 1	L2-GC-04K04T-00
Linea2 5GigE 4k	4096 x 4	7 x 7 µm	32 kHz RGBN	M42 x 1	L2-GC-04K03N-00

Accessories	Order Number
M42 x 1 to F-mount adapter for 12 mm BFD lens, heavy duty with clip	AC-LA-00115-xx-R
HD15 GPIO Breakout Cable Assembly	AC-CA-00002-xx-R
For a list of accessories go to http://www.teledynedalsa.com/imaging/products/cameras/accessories/	
Optical filters are available from https://midopt.com/	

Teledyne DALSA Software Platform	
Sapera LT version 8.60 Sapera LT is a free image acquisition and control software development toolkit (SDK) for Teledyne DALSA 2D/3D cameras and frame grabbers. Hardware independent in nature, Sapera LT offers a rich development ecosystem for machine vision OEMs and system integrators. Sapera LT includes CamExpert, an intuitive graphical interface that allows configuration and setup of cameras. It includes live image acquisition with interactive parameter configuration capabilities.	Available for download https://www.teledynedalsa.com/en/support/downloads-center/software-development-kits/
GigE Vision Turbo Drive Technology Module — Improved proprietary package allowing the Linea2 5GigE to sustain higher data transfers to the host system.	Contact Teledyne DALSA Sales for additional information.
Sapera Processing Imaging Development Library (sold separately)	Contact Teledyne DALSA Sales

Third-Party GigE Vision Software Platform Requirements	
Support of GenICam™ GenApi version 2.3	General acquisition and control. File access: firmware, FFC, configuration data, upload & download.
Support of GenICam™ XML schema version 1.1	
Support of GenICam™ — XML camera description file	Embedded within Linea2 5GigE.
Support of GigE Vision 1.2	

Camera Specifications Overview

Camera Controls	
Synchronization Modes	Free running, External triggered, Software trigger through Ethernet or IEEE 1588 Precision Time Protocol (PTP)
Exposure Modes	Programmable increments of 0.02 µs • minimum (in µs) is model specific • maximum is 3.0 ms Pulse controlled via Trigger pulse width
Trigger Inputs (used as Line or Frame triggers)	RS422 or single ended with programmable thresholds Debounce range from 0 to 255 µs Frame Trigger programmable delay up to 2000000 µs for 128 objects maximum.
Strobe Outputs	Aligned to the start of exposure with a programmable delay, duration and polarity (using "start of exposure on output line source" feature)

Features	
Flat Field Correction	1 Factory FFC plus 4 User Defined FFC
Binning	Digitally based: Horizontal & Vertical (2 and 4 pixel)
Digital Gain	1x to 10x
Sensor Analog Gain	0.5x to 1x
Counter and Timer	2 Counters and 2 Timers User programmable, acquisition independent with event generation
Timestamp	1 µs internal timer
Test Image	Internal generator with choice of patterns
User Settings	Select factory default or one of 4 user camera configurations

Onboard Memory	
Reserved Packet Resend Buffer	6 MB default (user-defined feature)
Reserved Data Buffer	84 MB
Total Memory	128 MB

Back Focal Distance	
M42 x 1 Mount	12 mm
M42 to Nikon F-bayonet adapter	46.5 mm (34.5 mm for the F mount adapter plus 12 mm for the camera body)

Mechanical Interface	
Camera Size	62 x 62 x 50 mm For complete dimensions, refer to section Mechanical Specifications.
Mass	< 280 g (no lens)
Power Connector	via HD15 GPIO connector or RJ45 in PoE mode
Ethernet Connector	RJ45

Electrical Interface	
Input Voltage	+12 to +24 Volts DC (+/- 10%) Supports Power Over Ethernet standard (PoE Class 2 as per IEEE 802.3af)
Power Dissipation	< 13 W
Operating Temperature	-10 to 65 °C at front plate
Output Data Configuration	5GigE Ethernet with PAUSE Frame support (as per IEEE 802.3x)
Data and Control	GigE Vision compliant

Environmental Specifications

Environmental Specifications	Performance
Storage temperature range	-20 °C to +80 °C
Humidity (storage and operation)	15% to 85% relative, non-condensing
MTBF (mean time between failures)	> 100,000 hours, typical field operation

Flash Memory Size

Camera	Flash Memory Size
L2-GC-04K04T-00	32 MB
L2-GC-04K03N-00	32 MB

Sensor Performance

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 nm. Wavelengths below 390 nm are termed ultraviolet while those above 780 nm are termed infrared.

Sensor Specifications

Item / Feature	Specification	Specification
Camera Model	L2-GC-04K04T-00	L2-GC-04K03N-00
Sensor Used	High speed CMOS line scan	High speed CMOS line scan
Minimum Line Rate	0 (external trigger) / 300 Hz (internal trigger)	0 (external trigger) / 300 Hz (internal trigger)
Maximum Line Rate	42 kHz RGB	32 kHz RGBN
Maximum Line Rate Output	System dependent on the GigE network	System dependent on the GigE network
Exposure Time	5 µs to 3000 µs Default settings (µs): Blue: 93 Green: 49 Red: 57	5 µs to 3000 µs Default settings (µs): Blue: 93 Green: 49 Red: 57 NIR: 21
External Trigger to Start of Exposure Active	~0.30 µs minimum	~0.30 µs minimum
Horizontal Line Readout Time	7.8 µs	7.8 µs
Pixel Size	7 µm x 7 µm	7 µm x 7 µm
Pixel Format	User selectable 8-bit or 12-bit	User selectable 8-bit or 12-bit
Output Dynamic Range	71 dB (typical at minimum sensor gain) > 56 dB (factory calibration)	71 dB (typical at minimum sensor gain) > 56 dB (factory calibration)
Random Noise	< 4.8 DN rms	< 4.8 DN rms
DC Offset	28 DN (FFC enabled)	28 DN (FFC enabled)
PRNU	< 2% pk-pk @ 50% Saturation (FFC enabled)	< 2% pk-pk @ 50% Saturation (FFC enabled)
FPN	< 7 DN pk-pk (FFC enabled)	< 7 DN pk-pk (FFC enabled)
SEE	Red (650 nm) 15 nJ / cm^2 Green (550 nm) 25 nJ / cm^2 Blue (480 nm) 34 nJ / cm^2	Red (650 nm) 15 nJ / cm^2 Green (550 nm) 25 nJ / cm^2 Blue (480 nm) 34 nJ / cm^2 NIR (840 nm) 37 nJ / cm^2
NEE	< 100 pJ / cm^2	< 100 pJ / cm^2
Anti-blooming	> 100 x Saturation	> 100 x Saturation
Integral non-Linearity	< 2% DN	< 2% DN

Test Conditions
- All values specified with 12-bit data, unless otherwise noted
- Measured at 1x nominal sensor analog and digital gain
- 5 kHz line rate or greater
- Light sources: broadband white LED and 850 nm LED
- Front plate temperature: < 45° C

Spectral Responsivity & Quantum Efficiency

The spectral response curves describe the sensor, excluding lens and light source characteristics.

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

Linea2 5GigE 4k Model

Spectral Responsivity
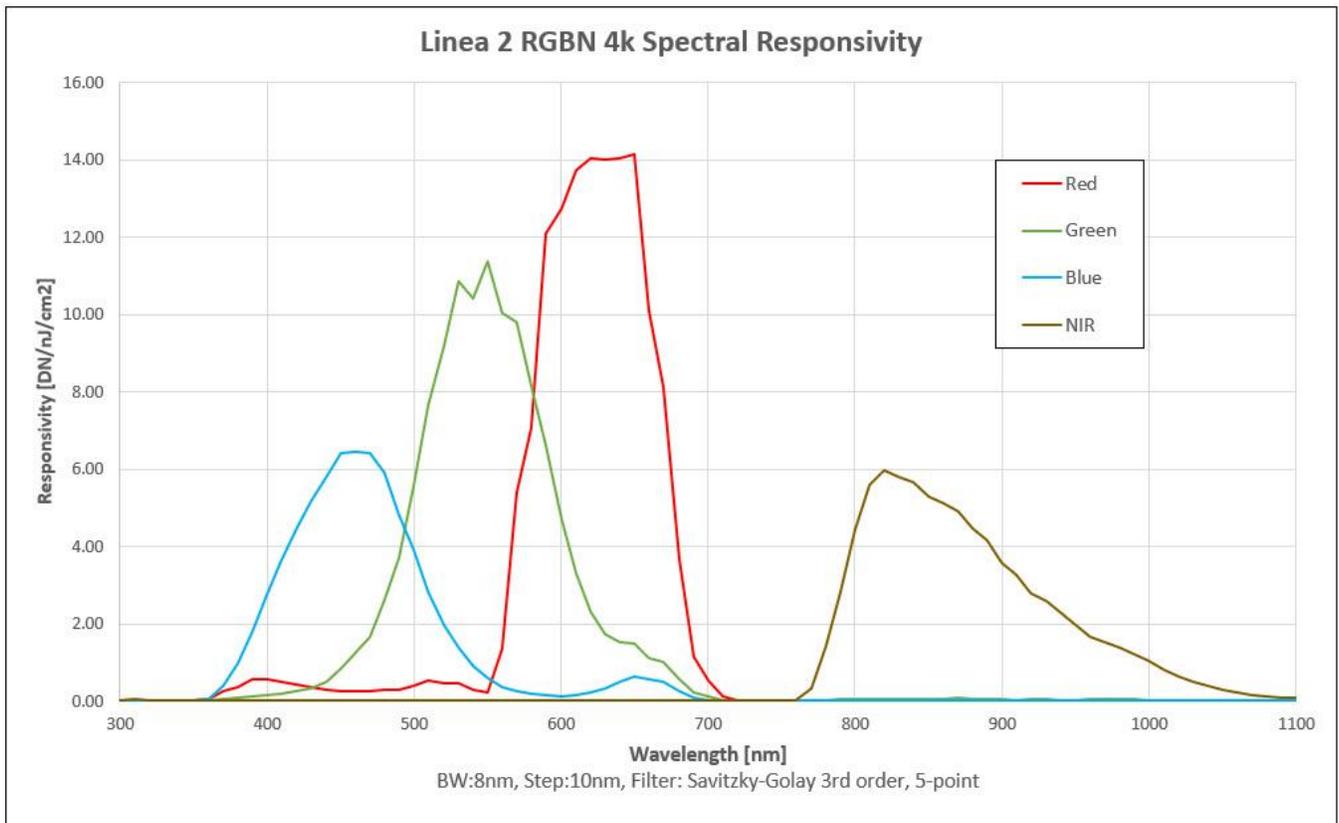
Figure 2: Linea2 4k RGBN Spectral Responsivity. NIR channel available in model L2-GC-04K03N-00 only.

Effective Quantum Efficiency
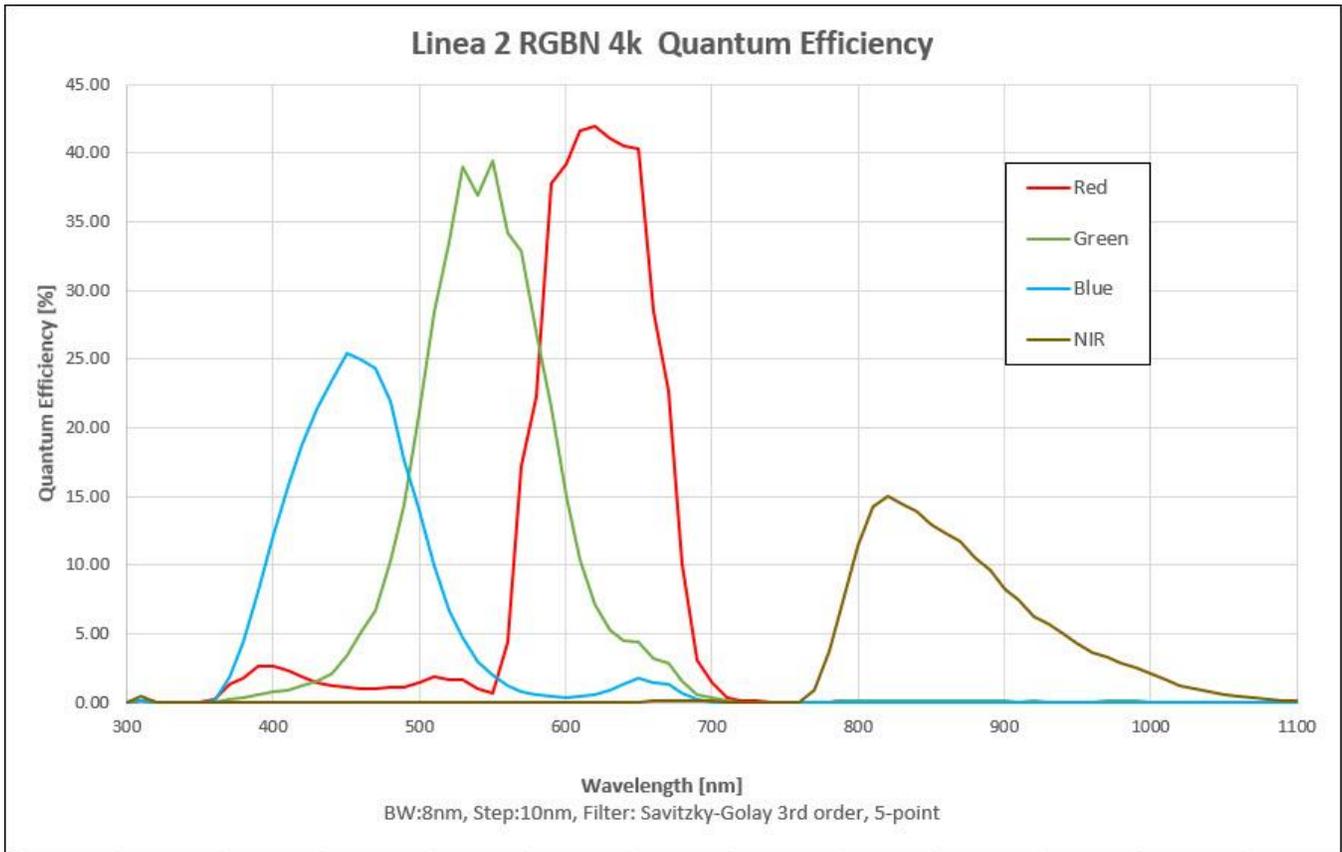
Figure 3: Linea2 4k Quantum Efficiency. NIR channel available in model L2-GC-04K03N-00 only.

Computer Requirements for Linea2 5GigE Cameras

The following information is a guide to computer and networking equipment required to support the Linea2 5GigE camera at maximum performance. The Linea2 5GigE 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 10/11 (32- or 64-bit) are supported.

5GigE Network Adapters
- 5GigE network adapter. Typically, a system will need an Ethernet 5GigE 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. Optimal settings will be system-dependent.

If the computer to be used with the Linea2 5GigE camera does not have a 5GigE network adapter or second built in 5GigE NIC, a Gigabit Network Interface adapter card (NIC) needs to be installed.

With any high-performance 5GigE NIC adapter review the NIC documentation for any drivers required for the specific host operating system.

- **Laptop computers** with built-in **GigE network adapters** may not be able to stream full line rates from Linea2 5GigE, especially when on battery power. Thorough testing is required with any laptop computer to determine the maximum frame rate possible (refer to Teledyne DALSA Network Imaging Package for Sapera LT Optimization Guide, available through the **Start** menu under **Teledyne DALSA**).
- The **Windows Firewall** exceptions feature is automatically configured to allow the Sapera GigE Server data 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 Linea2 5GigE. Testing by the user is required.

Ethernet Switch Requirements

If there are more than one device on the same network or a camera-to-PC separation is greater than 100 meters, an Ethernet switch is required. Since the Linea2 5GigE camera complies with the Internet Protocol, it should work with all standard Ethernet switches. However, care must be taken to choose the right switch for a particular application.

When using VLAN groups, the Linea2 5GigE and controlling computer must be in the same group. For more information, refer to Teledyne DALSA Network Imaging Package for Sapera LT Optimization Guide, available through the Start menu under Teledyne DALSA.

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. Linea2 5GigE cameras support the IEEE 802.3x pause frame flow control protocol automatically so images from many cameras can be reliably transmitted through the switch to the NIC efficiently.

⚠️	**Important**: The maximum virtual frame rate possible from multiple cameras which are simultaneously triggered will depend on the camera model, frame size and network configuration. Additionally, using Pause Frame may change the Jumbo Frame value which maximizes data throughput. Each imaging system should be tested for data rate maximums.

Ethernet to Fiber-Optic Interface Requirements

In cases of camera-to-PC separations of more than 100 meters a fiber-optic media converter can be used instead of an Ethernet switch. 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 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.

5GigE Network Adapter Overview

Linea2 connects to a computer's 5GigE Network Adapter (NIC). If the computer is already connected to a network, the computer requires a second network adapter.

Refer to Teledyne DALSA Network Imaging Package for Sapera LT Optimization Guide, available through the **Start** menu under Teledyne DALSA, for information on general networking and Sapera LT specific configuration settings.

Optimizing the Network Adapter used with Linea2

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 Linea2 during the installation.

In addition, refer the Sapera Getting Started Manual For GigE Vision Cameras manual installed with the Sapera LT package, for an overview of using GigE Vison cameras.

Optimizing Camera/System Performance

Camera feature settings have a direct effect on the maximum performance possible on the imaging system network. Review the following features to optimize the system.

GigE Vision Transport Layer Control

- Packet Size: The default size 1500 is often more efficient than larger jumbo packets, especially when using Ethernet switches.
- Inter-packet Delay: Inserts a delay (in µs) between packets. Dependent on the Ethernet connection, inserting a short delay (even 1 µs) can make the difference between transmission errors or no errors at all.
- Device Link Throughput Limit: Limits the maximum bandwidth of the data streamed by the device. This limiter is useful to allow each camera, when multiple cameras are on the same NIC and subnet, adequate time to transfer data to transfer data over the network.

GigE with TurboDrive

The Linea2 cameras include TurboDrive™ technology which enables high speed data transfers exceeding the GigE limit via a compression algorithm.

For information on TurboDrive see our technology primer:
https://www.teledynedalsa.com/en/learn/knowledge-center/turbodrive/

Implementing Trigger-to-Image Reliability

Review this section to implement features to monitor the system's performance.

NIC Optimization

Refer to Teledyne DALSA Network Imaging Package for Sapera LT Optimization Guide, available through the Start menu under Teledyne DALSA, for information on optimizing network adapters for GigE Vision cameras.

Power over Ethernet (PoE) Support

- Linea2 requires PoE Class 0 or Class 2 (or greater) power source for the network if not using a separate external power source connected to pins 10 & 15 of the camera's I/O Connector.

- To use PoE, the camera network setup requires a powered computer NIC supporting PoE, or PoE capable Ethernet switch, or an Ethernet power injector.

⚠️	**Important:** Connect power via the I/O or PoE, **not both**. Although Linea2 has protection, differences in ground levels may cause operational issues or electrical faults. If both supplies are connected and active, the Linea2 will use the I/O power supply connector.

- **Important:** When using PoE, the camera's I/O pin 10 (Camera Power – Ground) must not be connected to I/O pin 5 (Signals Ground).

GigE Vision Sapera Application Description

GiGE VISION ®	Linea2 5GigE cameras are 100% compliant with the GigE Vision 1.2 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 <u>GigE Vision Standard at www.automate.org</u>
GEN‹i›CAM	Linea2 5GigE 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 <u>GenICam Standard at www.emva.org</u>.

The Teledyne DALSA GigE Vision Module provides a license free development platform for Teledyne DALSA GigE hardware or Sapera vision applications. Additionally supported are Sapera GigE Vision applications for third-party hardware with the purchase of a GigE Vision Module license, or the Sapera processing SDK with a valid license.

The GigE Vision Compliant XML device description file is embedded within Linea2 5GigE firmware allowing GigE Vision Compliant applications access to camera capabilities and controls immediately after connection.
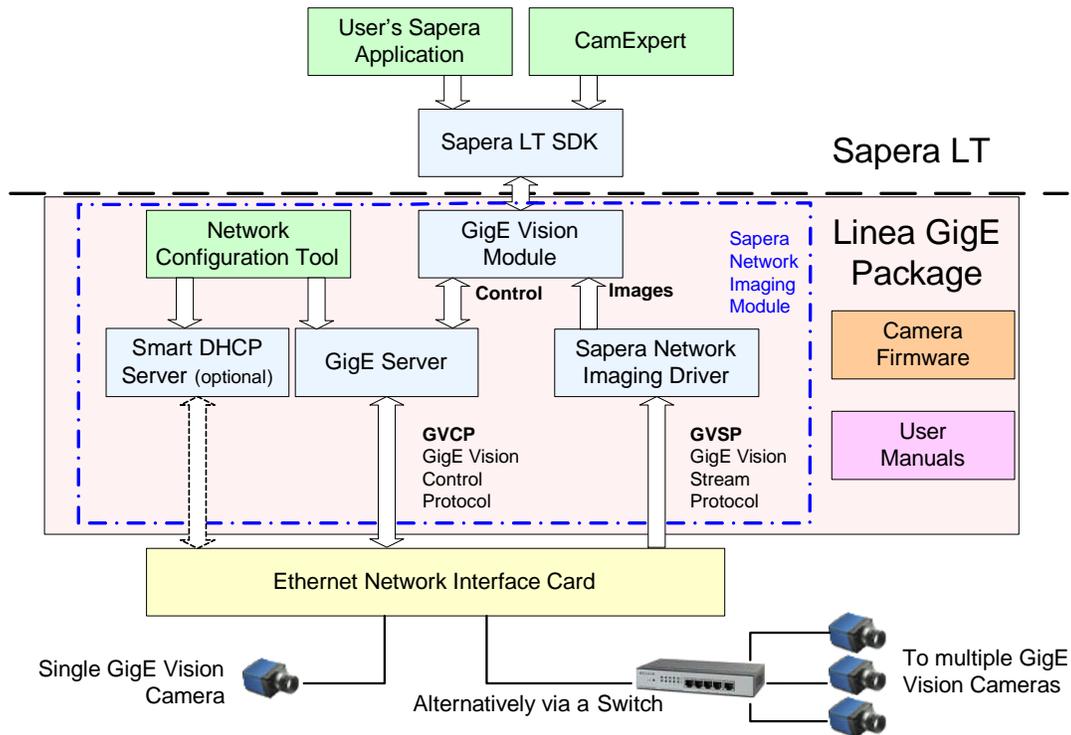
Figure 4: GigE Application Architecture

Linea2 5GigE Camera Quick Start

Sapera Software Installation

> Installation of Sapera LT and the GigE Vision package requires administrative privileges; log on to the workstation as an administrator or with an account that has administrator privileges.

When Linea2 5GigE is used in a **Sapera development environment** with Sapera LT 8.0 or later, all GigE Vision support for cameras is automatically installed.

If no Sapera development is required then the Sapera LT SDK is not needed to control the Linea2 5GigE camera; Sapera runtime with CamExpert provides everything to control the camera.

If Linea2 5GigE will be used in a **third-party GigE Vision Compliant environment**, Sapera or Sapera runtime is not required; follow the installation instructions of the third-party package.

Procedure

- Download and install Sapera LT 8.60 (or better) which automatically provides GigE Vision support. When installing, select the installation for GigE Vision support. https://www.teledynedalsa.com/en/support/downloads-center/software-development-kits/

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

> The Teledyne DALSA Sapera CamExpert tool (used throughout this manual to describe Linea2 5GigE Vision features) is installed with either the Sapera LT runtime or the Sapera LT development package. If Sapera application development is required, install Sapera LT SDK (8.60 or later for all firmware support) as described in the previous section.

Connecting the Linea2 5GigE Camera

Connecting a Linea2 5GigE to a network system is independent of whether the Teledyne DALSA Sapera LT package or a third-party GigE Vision development package is used.

Steps for Camera Startup

• Apply power to the camera: see Connectors and Powering the Camera.

• Connect Linea2 to the host computer GigE network adapter or to the Ethernet switch via a CAT5e or CAT6 Ethernet cable and wait for the GigE Server Icon in the taskbar notification area (system tray) to show that the camera is connected. The Linea2 Status LED will change to steady Blue.

• Once communication with the host computer is started the automatic IP configuration sequence will assign an LLA IP address as described in section Linea2 5GigE IP Configuration Sequence, or a DHCP IP address if a DHCP server is present on your network. The factory defaults for Linea2 are Persistent IP disabled and DHCP enabled with LLA always enabled as per the GigE Vision specification

• Check the status LED which will be initially red then switch to flashing blue while waiting for IP configuration; Refer to section LED States on Power Up.

⚠️	**Note:** Cable should not be less than 1 meter (3 feet) long or more than 100 meters (328 feet) long, per GigE Vision standard.

Connectors

The Linea2 5GigE has two connectors:

- A single **RJ45 Ethernet** connector for control and video data transmitted to/from the host computer Gigabit NIC. The Linea2 supports Power over Ethernet (PoE). Refer to Ruggedized RJ45 Ethernet Cables for information on secure cables.
- A **HD15** connector for camera power, trigger, strobe and general I/O signals. Teledyne DALSA provides an optional breakout cable; see Mating GPIO Cable Assembly. Refer to HD15 type Connector Details for pinout specifications.

The following figure of the Linea2 5GigE back end shows connector and LED locations. Refer to section Mechanical Specifications for details on the connectors and camera mounting dimensions.
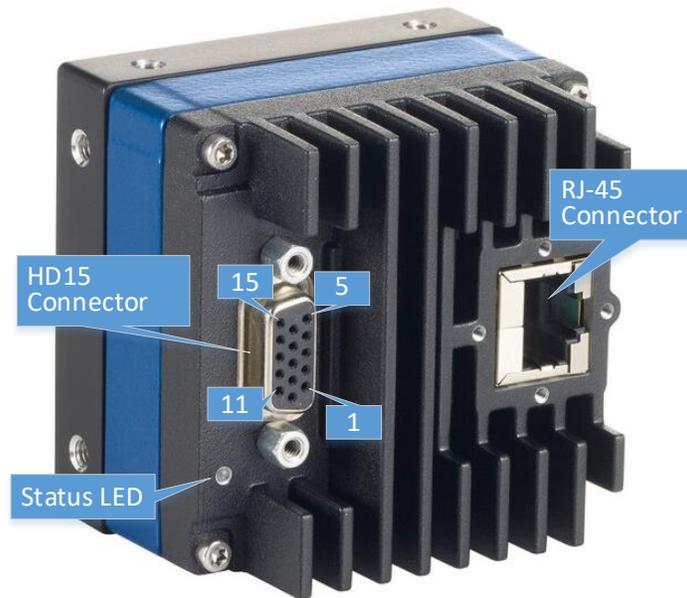
Figure 5: Linea2 5GigE Series – Rear View

Powering the Camera

Two options are available for powering the Linea2 5GigE camera:

1. Power-over-Ethernet (PoE)
2. Power supply connected to the HD15 connector.

Refer to the <u>Power over Ethernet (PoE) Support</u> section for more information.

Power supplies must meet the requirements defined in <u>Electrical Interface</u> section.

⚠️	**Important:** Connect power via the HD15 connector or PoE, **not both**. Although Linea2 has protection, differences in ground levels may cause operational issues or electrical faults. If both supplies are connected and active, the Linea2 will use the I/O power supply connector.

Preventing Operational Faults due to ESD

Linea2 5GigE 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 be solved by proper ESD management.

The Linea2 5GigE camera when used with a simple power supply and Ethernet cable, is not properly connected to earth ground and therefore is susceptible to ESD problems. An Ethernet cable has no ground connection and a power supply's 0 volt return line is not necessarily connected to earth ground.

The following methods, either individually or together, will reduce or prevent ESD problems:

- **Method 1**: Use a shielded power supply. The camera case is now properly connected to earth ground and can withstand high ESD events.
- **Method 2**: Using Power over Ethernet (PoE), Teledyne DALSA strongly recommends a shielded Ethernet cable to provide a ground connection from the controlling computer / power supply to the Linea2. PoE requires a powered computer NIC, a powered Ethernet switch or an Ethernet power injector.
- **Method 3**: Mount the camera on a metallic platform with a good connection to earth ground.
- **Method 4**: Avoid running the Ethernet cable close to or parallel to AC power lines.

GigE Server Verification

After a successful Sapera GigE Vision package installation, the GigE Server icon is visible in the desktop taskbar notification area (note that in some older OS, the icon remains hidden until a camera is connected). After connecting a camera (see following section), allow a few seconds for the GigE Server status to update. The Linea2 5GigE 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 Icon Note: It will take a few seconds for the GigE Server to refresh its state after any change.	The GigE Server icon when the device is found. The camera has obtained an IP address and there are no network issues.	The GigE Server 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 icon when the device is not found. This indicates there is an issue preventing communication with the camera, or there is no camera connected.

GigE Server Status

Once the Linea2 5GigE is assigned an IP address (its Status LED is steady blue) the GigE server icon in the notification area will indicate that the device was found. The GigE Server takes a few seconds to refresh its state after the camera has obtained an IP address.

Figure 6: GigE Server Notification Area Icon

If you hover your mouse over the GigE Server icon, the GigE Server displays the number of GigE Vision devices found by your PC. Right-click the icon and select **SHOW Status Dialog Box** to view information about all devices connected to the host system.
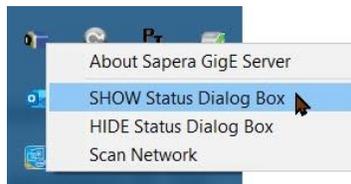
Figure 7: GigE Server Pop-up Menu

The GigE Vision Device Status window lists each connected GigE device by name along with important information such as the assigned IP address and device MAC address. The screen shot below shows a connected Linea2 5GigE with no networking problems.

Manufacturer	Model	Serial number	MAC address	Status	Camera IP	NIC IP	Filter driver	MaxPktSize	Firm ver	User name	ABI
Teledyne D...	Linea2-GigE-4K	A0002016	00:01:0D:C5:0A:66	Available	169.254.5.145	169.254.169.50	Enable	1500	1	User Name	0001

Figure 8: GigE Vision Device Status

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:** The GigE server periodically scans the network automatically to refresh its state. See the Troubleshooting section for network problems.

Refer to Running the Network Configuration Tool and Troubleshooting sections for more information.

Camera Status LED Indicator

The camera is equipped with one multicolor 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).

When the Linea2 5GigE is connected to a network, the Status LED turns a steady blue indicating the IP address is configured by the GigE Server or application. The following table summarizes the LED states and corresponding camera status.

LED State	Definition
LED is off	No power to the camera.
Steady Red	Initial state on power up before flashing. Remains as steady Red only if there is a fatal error. Camera is not initialized: Wait a few minutes for the camera to reboot.
Flashing Red	Initialization sequence in progress.
Steady Red + Flashing Blue	Fatal Error. If the camera does not reboot itself contact Technical Support.
Slow Flashing Blue	Ethernet cable disconnected. The camera continuously attempts to assign itself an IP address.
Fast Flashing Blue	File Access Feature is transferring data such as a firmware update or FCC transfer.
Steady Blue	IP address assigned but no application is connected to the camera.
Steady Green	Application connected.
Flashing Green	Acquisition in progress. Flashing occurs on frame acquisition but does not exceed a rate of 100 ms for faster frame rates.

> ⚠ **Note**: If the Linea2 5GigE has obtained an IP address, it might be on a different subnet than the NIC it is attached to. Therefore, if the Linea2 5GigE LED is blue but an application cannot see it, this indicates a network configuration problem; Refer to Troubleshooting section.

LED States on Power Up

The following LED sequence occurs when the Linea2 5GigE is powered up connected to a network with installed GigE Vision software.

Red Power connected → **Flashing Red** Initialization → **Flashing Blue** Waiting for IP → **Blue** IP assigned → **Green** Application connected

Figure 9: LED Power-Up Sequence

Quick Startup with CamExpert

If a Linea2 5GigE camera is connected to a 5GigE network adapter on a host computer, it should automatically be detected. Refer to steps below or the Using CamExpert with Linea2 5GigE Cameras section for more details.

- Start Sapera CamExpert using the desktop icon created during the Sapera installation.

- CamExpert will search for installed Sapera devices. The Device Selector list shows the connected Linea2 5GigE camera a few seconds after CamExpert completes the automatic device search (device discovery).
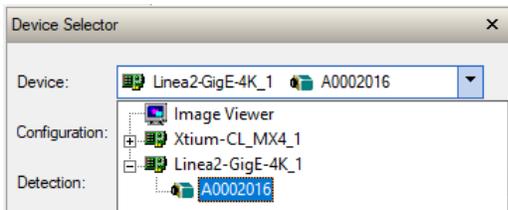
- Select the Linea2 5GigE device by clicking on the camera icon. By default, the camera is identified by its serial number. The Linea2 5GigE status LED will turn green, indicating the CamExpert application is now connected.
- Camera defaults for the following features are:
  - AcquisitionLineRate = 5000 Hz
  - TriggerMode = Off
  - ExposureMode = Timed
  - ExposureTime = Blue 93 µs, Green 49 µs, Red 57 µs, NIR 21 µs
- Click the **Grab** button for live acquisition (the Linea2 5GigE factory default is Internal Trigger mode with a vertical height parameter which defines the virtual image frame). Refer to the Operational Reference for information on camera features.
- If no lens is attached, select one of the internal test patterns available using the Test Image Selector feature.
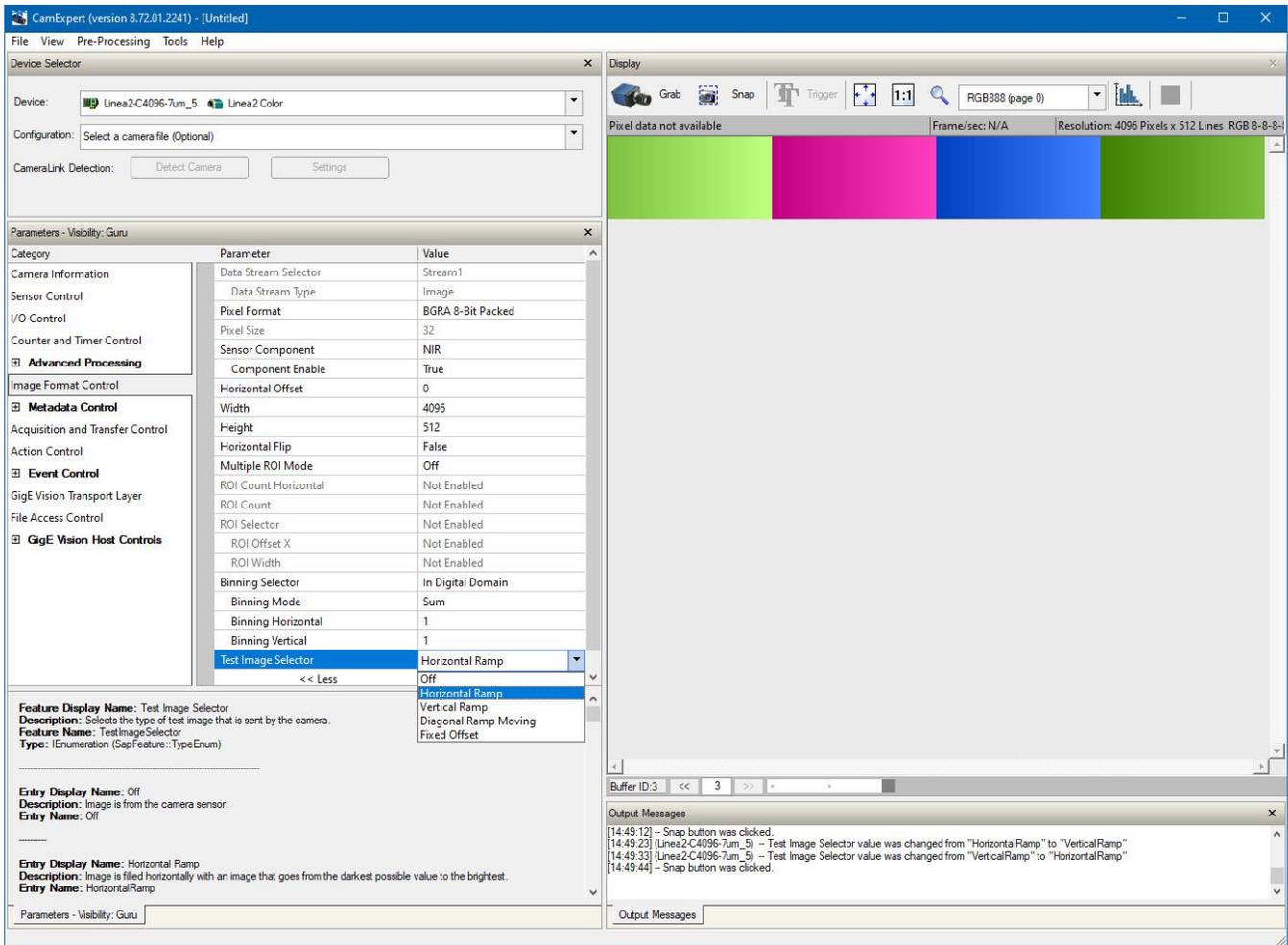
Figure 10: CamExpert Test Image

Note: CamExpert cannot grab at high virtual frame rates since it generates an interrupt for each virtual video frame; the Sapera Grab Demo application is better suited for high frame rates.

Firmware is uploaded using the File Access Control features in Sapera CamExpert; Refer to section Camera Firmware Updates.

Using CamExpert with Linea2 5GigE Cameras

The Sapera CamExpert tool is the interfacing tool for GigE Vision cameras supported by the Sapera library and hardware. CamExpert allows a user to test most features and operating modes. Additionally, CamExpert saves the Linea2 5GigE 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.

Click on any parameter and a short description is displayed below the Category pane. Alternatively, right-click on a parameter and select **What's This?** to display its context-sensitive help. Select **Help** > **Content** to open CamExpert's stand-alone help window.

	Note: The examples shown may not entirely reflect the features and parameters available from the camera model and camera mode used in your application.

CamExpert Panes

Various areas of the CamExpert tool are described in the figure below. GigE Vision device Categories and Parameter features are displayed as per the device's XML description file. The number of parameters shown is dependent on the View mode selected (Beginner, Expert, Guru – see description below).
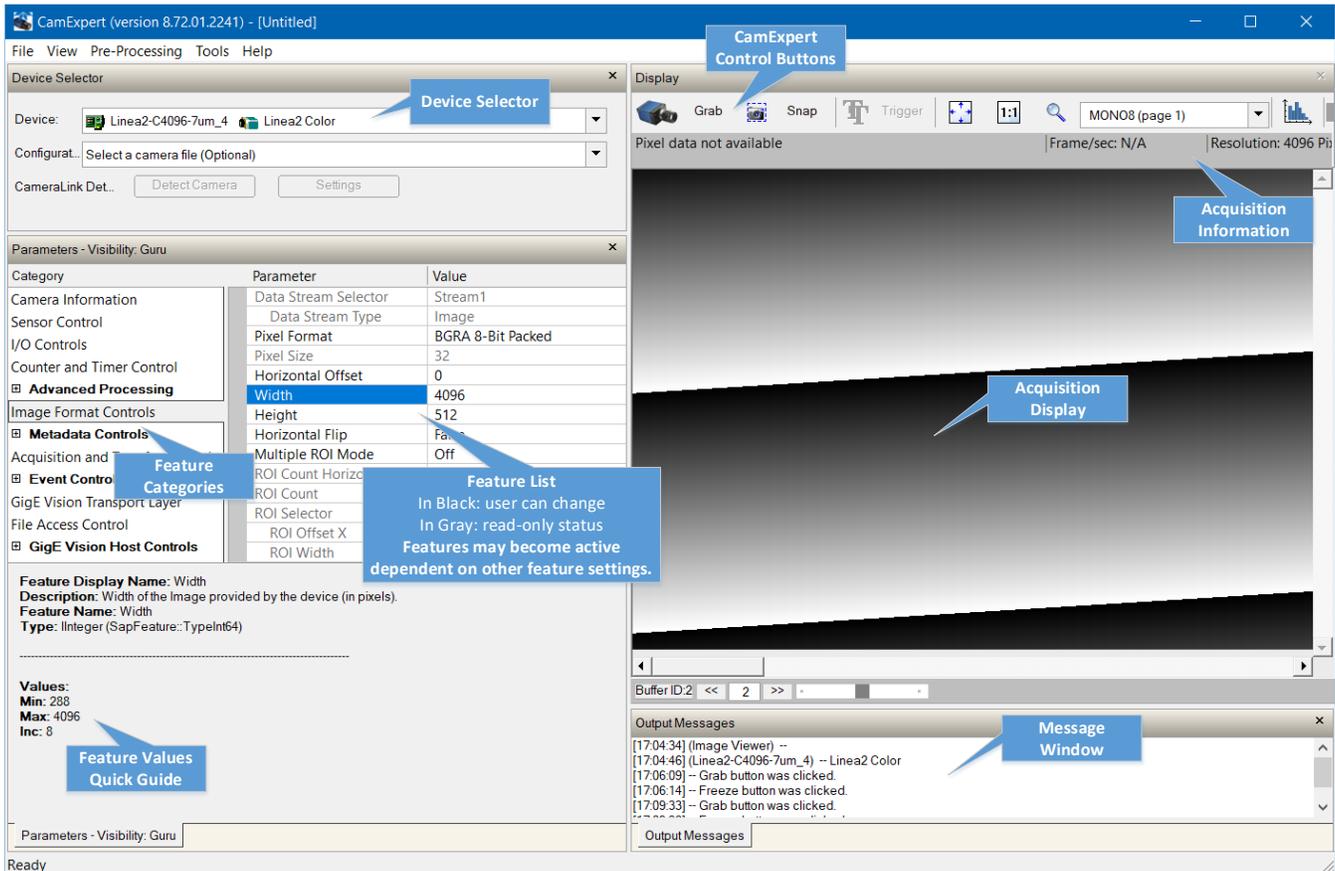
Figure 11: CamExpert Graphical User Interface (GUI)

- **Device Selector pane**: View and select from any installed GigE Vision or Sapera acquisition device. After a device is selected, CamExpert will only present parameters applicable to that device. Optionally select a camera file included with the Sapera installation or saved by the user.

- **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.

- **Display pane**: Provides a live or single frame acquisition display. Frame buffer parameters are shown in an information bar above the image window. The Display pane includes CamExpert control buttons, as decribed in the table below.

- **Output pane**: Displays messages from CamExpert or the GigE Vision driver.

	Grab	Freeze	**Acquisition control buttons:** Click once to start live grab, click again to stop.
	Snap	**Single frame grab:** Click to acquire one frame from device.
	Trigger	**Software trigger button:** With the I/O control parameters set to Trigger Enabled / Software Trigger type, click to send a single software trigger command.
1:1 RGB888 (page 0)		**CamExpert display controls:** (these do not modify the frame buffer data) Stretch (or shrink) image to fit, set image display to original size, zoom the image to any size and ratio, and choose multiformat buffer view (depending on sensor). This does not affect the acquisition.
		Histogram/Profile tool: Select to view a histogram or line/column profile during live acquisition.

CamExpert View Parameters Option

All camera features have a Visibility attribute which defines its requirement or complexity. The levels vary from Beginner (features required for basic operation of the device) to Guru (optional features required only for complex operations).

CamExpert presents camera features based on their visibility attribute. CamExpert provides quick Visibility level selection via controls below each Category Parameter list [<< Less   More >>]. The user can also choose the Visibility level from CamExpert menu **View > Parameters Options**.

Creating a Camera Configuration File in the Host

- When using the Teledyne DALSA Sapera SDK – the CCF is created automatically via a save.
- When using a third-party SDK application, if that SDK supports **GenAPI 2.4**, then the process is automatic. Simply follow the third-party *Save Camera* method as instructed.
- If the SDK is based on **GenAPI 2.3** or lower, the user must call the command DeviceFeaturePersistenceStart before using the SDK *Save Camera* method and the command DeviceFeaturePersistenceEnd at the end of the save function.

Displaying Image in the BGRA Mode

You can choose to display the RGB image or NIR image using the **Multiformat Buffer View** list on the **Display** toolbar: the RGB image is on page 0, NIR image on page 1.
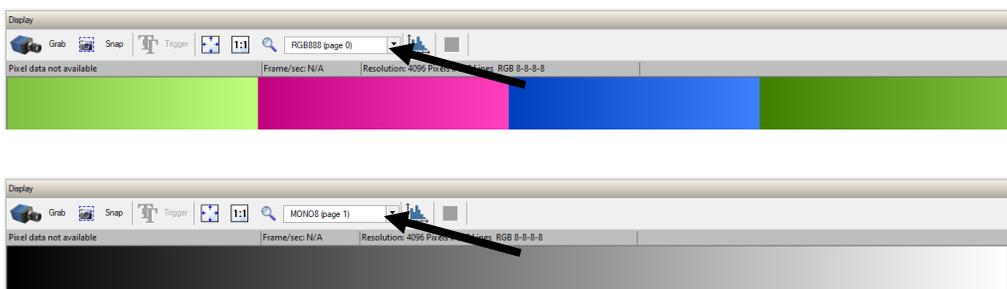
Figure 12: The Multiformat Buffer View list

Camera Performance and Features

This section is intended to be an introduction to the features of the camera, including explanations of how to use them effectively.

Acquiring Images: Triggering the Camera

Linea2 5GigE line exposures are initiated by a trigger event. The Linea2 can acquire images using its own internal trigger (free-running mode) or using an external trigger (EXSYNC) with several options for the trigger source. A trigger 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 — Line or Frame** (TriggerMode = *Off*): The Linea2 5GigE free-running mode has programmable internal timers for line rate / exposure period and frame rates. Line rate and frame rates are independent. Frame free-running simply means acquire all lines.
- **External trigger** (TriggerMode = *On*): Exposures are controlled by an external or internal trigger signal where the specific input line or source is selected by the Trigger Source feature. External signal inputs have a time programmable debounce circuit.
- **Virtual frames**: For any exposure type, the virtual frame (that is, the number of exposure lines per frame) is set by the Height feature, available in the Image Format Control category.

The Trigger Mode feature determines if the camera uses free-running mode (TriggerMode = *Off*) or an external trigger (TriggerMode = *On*).

In free-running mode, the Acquisition Line Rate feature specifies the line rate, in Hz. The maximum line rate is determined by the Exposure Time feature. The Internal Acquisition Frames Per Second (FPS) feature returns the FPS for the specified Acquisition Line Rate.

- If the Acquisition Line Rate is reduced and/or frame buffer Height is increased, the value of the Image Timeout feature (part of the GigE Vision Host Control category) may require increasing (see Buffer Incomplete Error Message).
- If error messages are shown in the Output Messages pane, try increasing the value of the Linea2 5GigE Interpacket Delay feature available from the GigE Vision Transport Layer Category. An increase from default may correct errors with NIC interfaces that do not have adequate performance. For more information, Refer to Teledyne DALSA Network Imaging Package for Sapera LT Optimization Guide, available through the **Start** menu under **Teledyne DALSA**.

External Triggers

The Trigger Selector feature selects the type of external trigger to use and configure.

Five types of external triggers are available:
- Single Line Trigger (Start)
- Single Frame Trigger (Start)
- MultiFrame Trigger (Start)
- Frame Burst
- Frame Burst Active

Trigger Selector Details

- **Single Line Trigger(Start):** Starts the acquisition of one line when acquisition is active.
- **Single Frame Trigger(Start):** Starts the acquisition of one frame when acquisition is active. The number of lines in the frame is defined by the Height feature.
- **MultiFrame Trigger(Start):** Starts the acquisition of multiple frames. The number of lines in the frame is defined by the Height feature. The number of frames is defined by the Trigger Frames Count feature. No line is lost between frames.
- **Frame Active:** Starts the acquisition of a frame. The width of the trigger signal controls the number of lines in the frame.
- **Frame Burst Active:** Starts the acquisition of multiple frames. The number of lines in the frame is defined by the Height feature. The width of the trigger signal controls the number of frames.

Trigger Source Types

- **Trigger Source = Line x**: Select the Line Input used as an external trigger.
- **Trigger Source = Rotary Encoder**: External trigger is via one or both Rotary Encoder inputs. A number of features allow selecting encoder signal direction, scaling and other parameters, to suit the imaging application. This option is only available when Trigger Selector = *Single Line Trigger(Start)*.
- **Trigger Source = Timer1End Event, Timer2End Event**: Timer1End Event or Timer2End Event is used as the internal trigger source. Refer to Counter and Timer Controls for information on those features.
- **Trigger Source = Counter1End Event, Counter2EndEvent**: Counter1End Event or Counter2End Event is used as the internal trigger source.
- **Trigger Input Line Activation**: Select the activation mode for the trigger source: Rising Edge, Falling Edge or Any Edge.

When Line Input is the trigger source, the width of the trigger signal can be used to control the exposure time by setting Exposure Mode = *Trigger Width* (Sensor Control category).
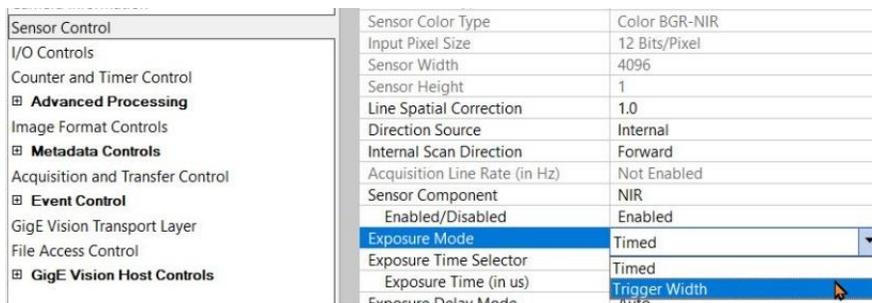
Figure 13: CamExpert – Exposure Mode

Line Rate & Synchronization

When using an external trigger such as a rotary encoder, a continuous stream of encoder trigger pulses, synchronized to the object motion, establishes the line rate. The faster the object's motion, the higher the line rate. The camera can accommodate triggers up to its specified maximum frequency. If the maximum frequency is exceeded, the camera will continue to output image data at the maximum specified. The result will be that some trigger pulses will be missed and there will be an associated distortion (compression in the scan direction) of the image data. When the line rate returns to or below the maximum specified, then normal imaging will be reestablished.

Input Line Details

The input line signals have the following features for control or status indication.

- **Feature Set:** LineSelector (RW), LineFormat (RW), LineMode (RW), lineDebouncingPeriod (RW), LineInverter (RW), LineStatus (RO), lineDetectionLevel (RO), lineElectricalTermination (RW).
- **Connector:** See HD15 Type Connector Details for connector pinout and electrical information. The cable shell and shield should electrically connect the Linea2 5GigE chassis to computer chassis for maximum EMI protection.
- **Input Line Debouncing Period:** Each input incorporates a signal debounce circuit to eliminate short noise transitions that could be wrongly interpreted as a valid pulse. The duration is user-programmable from 0 to 255 µs with CamExpert.
- **Line Input Signal Characteristics:** See Input Signals Electrical Specifications.

Output Line Details

The general purpose output line signals are either dedicated or shared with inputs. See HD15 Type Connector Details for connector pinout and electrical information.

- **Feature Set:** outputLineSource (RW), outputLinePulseActivation (RW), outputLinePulseDelay (RW), outputLinePulseDuration (RW), outputLineValue (RW), outputLineSoftwareCmd (RW), outputLineSoftwareLatchControl (RW), LineFormat (RW), LineInverter (RW), LineSelector (RW), LineMode (RW), LineStatus (RO). See Output Signals Electrical Specifications for more information.
- **External Outputs:** Can be used as a strobe signal to control lighting or to generate programmable pulses when specific events are generated by the camera.
- **Output on Events:** Each output can be set independently to the available event modes defined by the outputLineSource feature. The output delay can be set from 0 to 16 seconds in increments of 1 µs. The pulse duration can be set from 0 to 16 seconds in increments of 1 µs.

Example of Free-Run Line Mode with Frame Trigger

An example setup of free-run line acquisition with Frame Trigger and a configurable internal timer is used as follows:

- Set <u>AcquisitionLineRate</u> = 20 000 Hz
- Set image <u>Height</u> = 100
- Select <u>TriggerSelector</u> = Single Frame Trigger(Start)
- Set <u>TriggerMode</u> = On
- Select <u>TriggerSource</u> = Timer1EndEvent
- Setup Timer1:
    - Set <u>timerStartSource</u> = Timer1End
    - <u>timerDuration</u> = 5000
    - <u>timerMode</u> set = Active

Then click the CamExpert **Grab** button.

Example of Line Trigger Mode

An example setup of a Line Trigger acquisition using internal timer with a configurable internal timer is as follows:

- Set image <u>Height</u> = 100
- Select <u>TriggerSelector</u> = Single Line Trigger(Start)
- Set <u>TriggerMode</u> = On
- Select <u>TriggerSource</u> = Timestamp Modulo Event
- Setup Timestamp Modulo Event:
    - Use <u>Timestamp Latch Cmd</u> to start the timestamp using the camera's internal clock
    - <u>Timestamp Modulo Event</u> = 10 000 (frame rate = 100 Hz)

Then click the CamExpert **Grab** button.

Gain and Black Level Control Details

The Linea2 5GigE camera provides Digital Gain and Black Level adjustments. The Gain and Black Level controls can make small compensations to the acquisition in situations where lighting varies and the lens iris cannot be easily adjusted. Optimal Gain and Black Level adjustments maximize the Linea2 5GigE dynamic range for individual imaging situations. The user can evaluate Gain and Black Level by using CamExpert.

Features and limitations are described below.

- <u>Black Level</u> offset is expressed as a digital number (DN) providing a +/- offset from the factory setting. The factory setting optimized the black level offset for maximum dynamic range under controlled ideal dark conditions.
- <u>Gain</u> is expressed as a multiplication factor.

⚠	Increasing digital gain does not increase the low-level resolution and increases the sensor noise proportionately.

Features related to Gain and Black Level are found in the <u>Sensor Control Category</u>.

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 the results of the binning function (factor of 2x or 4x) on the Linea2 5GigE by using CamExpert.

Linea2 5GigE supports horizontal and vertical binning independently. Vertical binning is performed over multiple acquisition lines within the camera, therefore the virtual frame buffer height is automatically reduced when binning is enabled.

⚠	Binning is performed digitally, therefore there is no increase in acquisition line rate.

The following graphic illustrates binning.
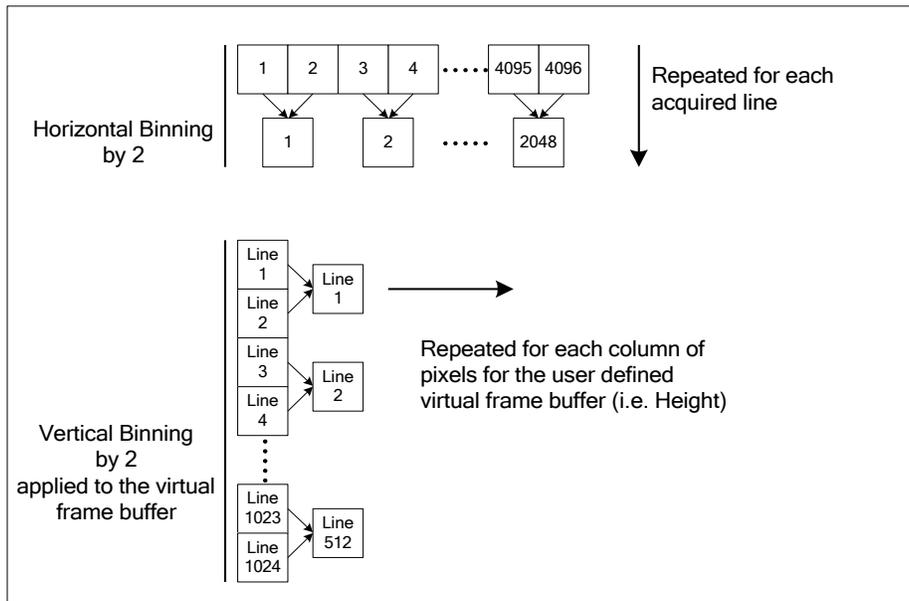
Figure 14: Horizontal & Vertical Binning

The Binning Mode feature determines whether combined pixels are averaged or summed.

Features related to binning are found in the Image Format Control Category.

Flat Field Correction

The Flat Field Correction function (FFC) consists of using two coefficients per pixel which correct the gain and offset of the corresponding pixel. These corrections compensate for Photo-Response Non-Uniformity (PRNU) and Fixed Pattern Noise (FPN) unique to each camera sensor.

With CMOS sensors, it is important to perform FFC calibration under the same operating conditions the camera will be used, otherwise sensor variations (over temperature and exposure) will make the FFC calibration invalid. Linea2 5GigE cameras have multiple FFC user memory spaces to store calibration data, allowing users to store FFC data for different optimized exposure setups.

The following diagram illustrates the camera's digital processing chain and associated GenICam features.

Figure 15: Digital Processing Chain
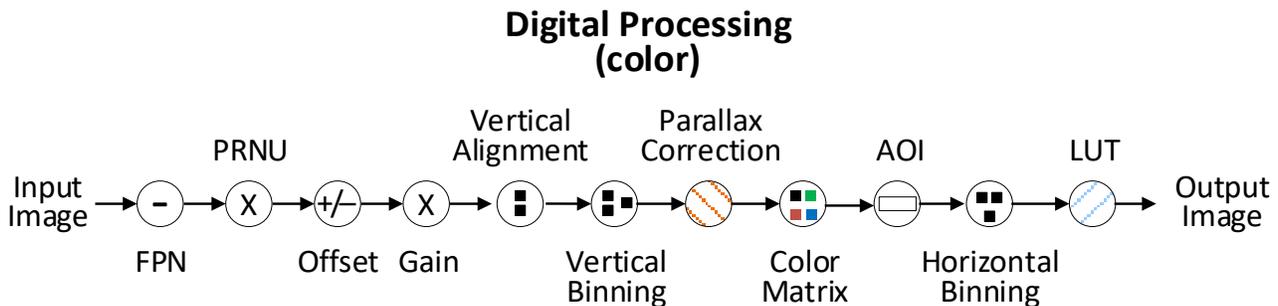
Flat Field Correction Algorithm Description

Flat Field Correction Algorithm–Method1 (flatfieldCorrectionAlgorithm) applies the following FFC formula for correcting pixel values.

newPixelValue[x] = (sensorPixelValue[x] – FFCOffset[x]) * FFCGain[x]

where:

- [**x**] is the Flat Field Correction Pixel coordinate.
  See the *flatfieldCorrectionPixelXCoordinate* feature.
- **newPixelValue** is the pixel value after Flat Field Correction is applied.
- **sensorPixelValue** is the pixel value before Flat Field correction is applied.
- **FFCOffset** is the offset coefficient value to subtract from the sensorPixelValue.
- **FFCGain** is the gain coefficient value that is multiplied with the sensorPixelValue.

⚠	**Important:** FFCOffset and FFCGain are derived factors calculated from a number of camera specific feature values (Invisible DFNC features).
	Note: Reading these values directly from the Flat Field Coefficients file will be meaningless to the user.

Information on the Sapera Flat Field Coefficients File

The Flat Field Coefficients File is a standard 16-bit TIFF file for both 8-bit and 12-bit acquisition modes. If the Flat Field calibration is made while using a 12-bit buffer, the user Flat Field Calibration coefficients file is applicable to both 12-bit and 8-bit acquisitions.

A Sapera application (such as CamExpert) creates a new SapBuffer object of the same width as the sensor 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 the SapBuffer class Save function with the "-format tiff" option, which allows saving data without loss of significant bits.

Important Factors about Flat Field Processing

⚠️	**Important:** Before calibration, the Linea2 5GigE should be powered on long enough to achieve its nominal temperature (a minimum of 30 minutes). **Important:** During calibration, no other Linea2 5GigE features should be accessed or modified. **Calibration via CamExpert or via a User Application:** Exposure and frame rates used during a Flat Field Calibration should be similar to the exposure settings used in the camera application.

Performing an FFC Setup via Sapera CamExpert

The Sapera LT CamExpert tool provides an easy GUI based method for a user to perform a Flat Field Calibration. The process requires the user to plan acquisitions in dark and bright conditions, followed by the FFC process itself. These steps are detailed below.

Set up Dark and Bright Acquisitions with the Histogram Tool

Verify the camera's acquisition with a live grab and prepare to grab a flat light image required for calibration. Ideally, a controlled diffused light source aimed directly at the lens should be used or a non-glossy paper with the lens slightly out of focus (or evenly lit wall).

If a sheet of material is being used as a white target, it must be completely free of blemishes and texture. Any dirt or texture present will generate a variation in the image that will be incorporated into the calibration coefficients of the camera. Once the target is removed, or moved, vertical stripes will be present in the scanned image. Dirt or texture that has dark characteristics will appear as bright vertical lines. Dirt or texture that has bright characteristics will appear as dark vertical lines. One way to minimize this effect is for the white target to be moving during the calibration process. This has the effect of averaging out any dirt or texture present.

Note the lens iris position for a bright but not saturated image.

Verify a Dark Acquisition

- Cover the lens with the lens cap.
- Using CamExpert, click **Grab** and then **Statistics**.
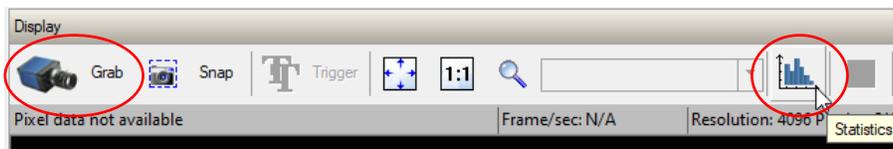
Figure 16: CamExpert – Grab & Statistics Buttons

- In the Statistics dialog, use the **Selected view** drop-down list to select Histogram.

Figure 17: CamExpert Statistics Dialog – Selected View

The following figure shows a typical histogram for a camera grabbing a dark image.
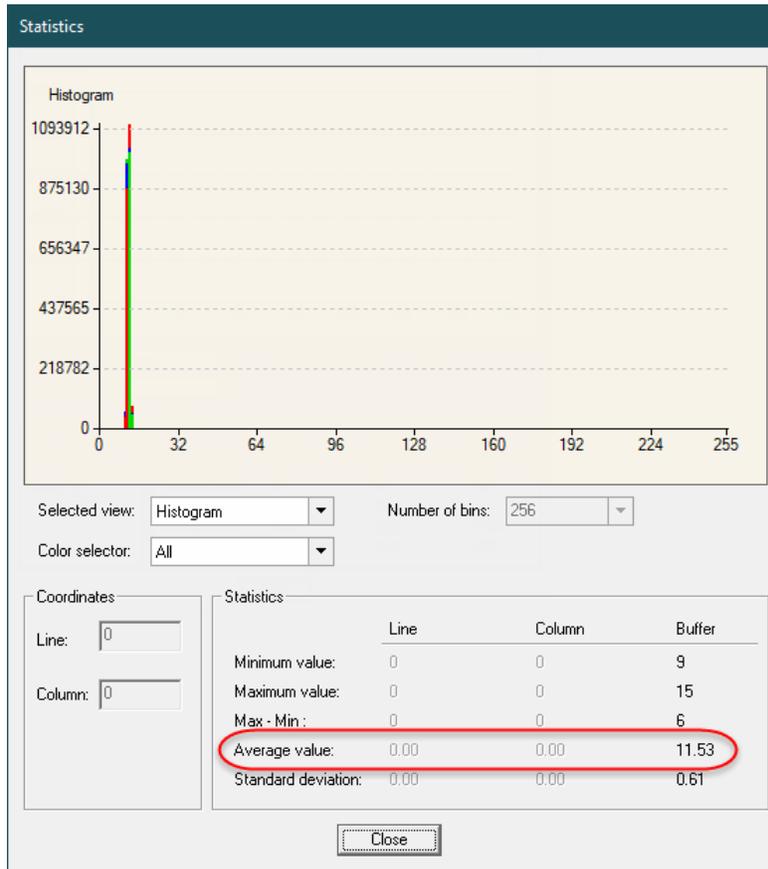
Figure 18: CamExpert Statistics Dialog – Average Dark Pixel Value

Important: The **average** pixel value for the frame is close to black.

Note: Sensors might show a much higher maximum pixel value due to one or more "hot pixels".

Verify a Bright Acquisition

Point the camera at a diffused light source or evenly lit white wall with no shadows falling on it. Click **Grab**, followed by **Statistics**. Use the lens iris to adjust for a bright gray approximately pixel value 200 (for 8-bit pixels). The following figure displays a histogram while grabbing a bright image.
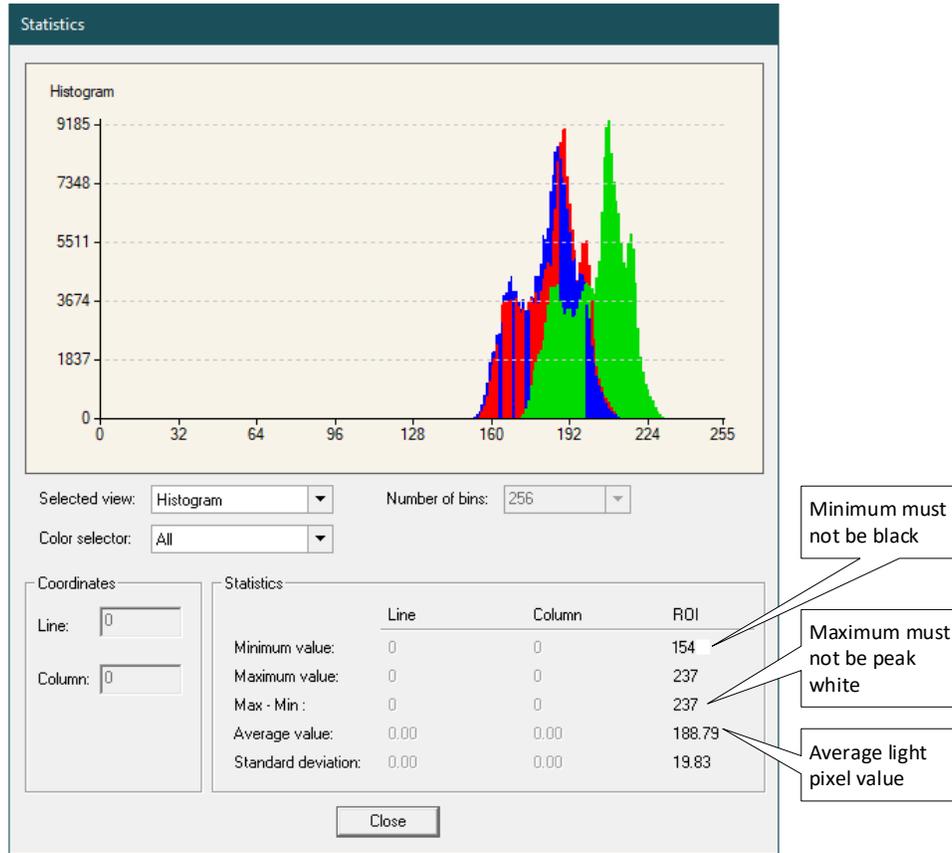
Figure 19: CamExpert Statistics Dialog – Verifying Bright Acquisition

> **Important:** In this example, the **average** pixel value for the frame is bright gray.
>
> **Note**: Sensors may show a much higher maximum or 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).

When the bright gray acquisition setup is complete, note the camera and lens iris position for repeatability in the future.

Flat Field Correction Calibration

Flat Field Correction Calibration (FFC) contains FPN (Fixed Pattern Noise) and PRNU (Photon Response non-uniformity) corrections.

> **Note**: Before performing a FFC, Teledyne DALSA recommends evaluating the "bare image" characteristics, which determine the quality of FFC, applied to the image. A bare image has no gains applied.

To obtain a bare image, disable FPN and PRNU coefficients: Choose *Off* from Flat Field Correction Mode:

- Set the <u>Flat Field Correction Mode</u> feature to *Off*.

Figure 20: CamExpert – Flat Field Correction Mode

- Use the <u>Gain Selecto</u>r to set the Gain value of all options to *1.0.*

Figure 21: CamExpert – Gain

To evaluate a bare image of a uniform white target scene use the line profile tool shown below.
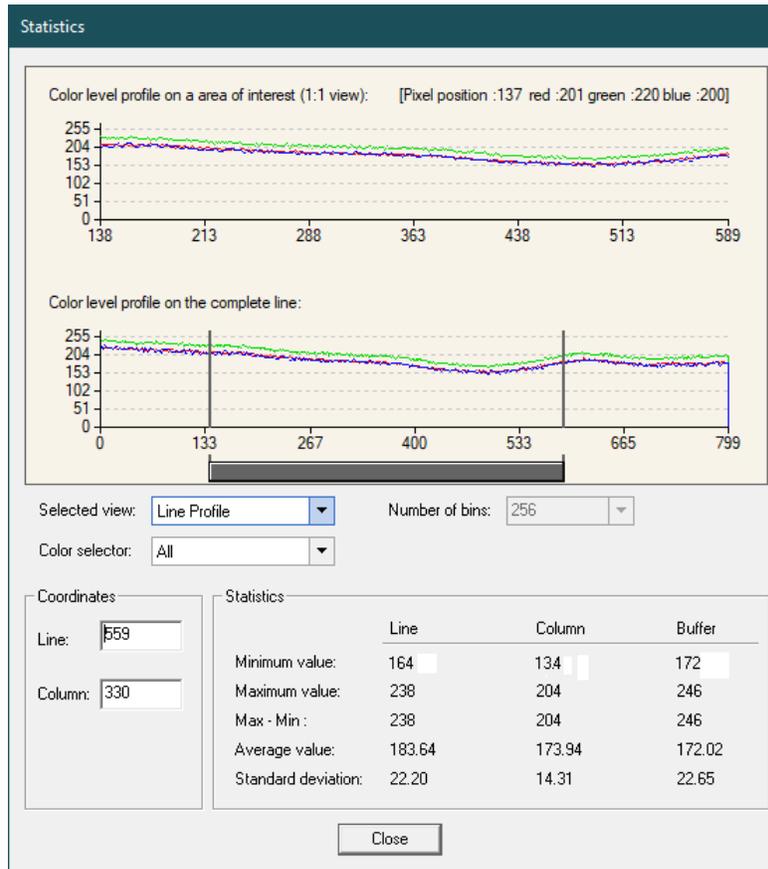
Figure 22: CamExpert Statistics Dialog – Lint Profile

A line profile is mainly determined by two factors: Flatness and Height

1) Flatness: The Line profile represents a Flat Field measurement. Due to lens-shading effect, light falls-off near the edges and results in lower output. This produces higher noise levels near the edge. A smaller aperture opening and longer focal length can reduce lens–shading effect. In some demanding applications, optimized low–shading lenses should be considered.

2) Height: An average value near your calibration target is ideal.

An extremely low output compared to the target will increase noise level significantly after the PRNU is corrected. To avoid SNR and/or DNR not meeting your application requirements, the profile should reach a level near the calibration target.

> **Note**: Changes to gain do not improve image quality from a SNR perspective. Gains are analog and digital multipliers that scale up signal and noise proportionally.

Before performing a FFC follow these guidelines:
- Ensure the camera is at normal operating temperature. Power-on for minimum 30 min.
- All parameters should meet your application's specifications. If parameters change after FFC completion, the results may no longer be accurate. Perform another FFC.

FPN Correction

In general, factory FPN correction is sufficient for most applications. However, if a new FPN correction is required, a user set FPN correction can be applied.

To perform FPN Correction

Step 1. Cover the lens (place the sensor in dark).

Step 2. Set the <u>Flat Field Correction Mode</u> to *Off* and check the line profile / histogram. If some, or all, of the pixels outputs are zero, then you should adjust the <u>Black Level</u> feature offset value to ensure that all pixel output is above zero.
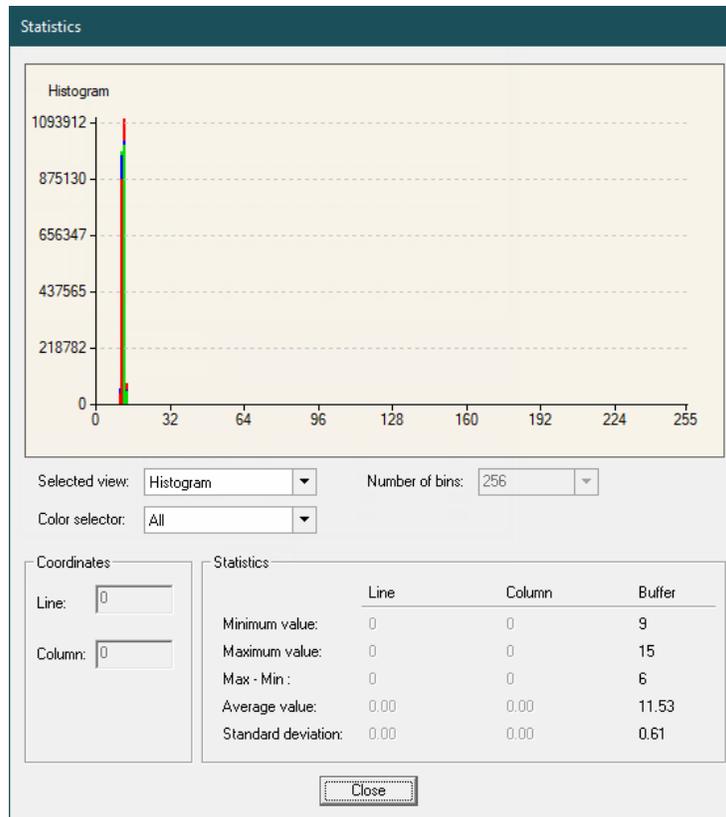
Figure 23: CamExpert Statistics Dialog – FPN Pixel Output

Step 3. Set the <u>Flat Field Correction Mode</u> to Calibration and select the required user set from <u>Flat Field Correction Current Active Set</u> list.
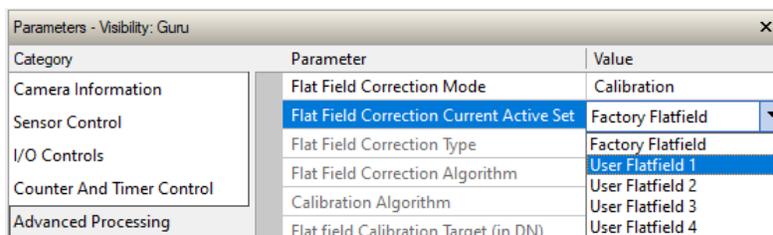
Figure 24: CamExpert – Flat Field Correction Current Active Set

Step 4. Set the Flat Field Calibration Sample Size feature to 4096 or 2048. The 4096 option returns more accurate results whereas the 2048 option reduces calculating time. In general, the 2048 results are still satisfactory for most applications.

Step 5. In the Calibrate FPN feature, click **Press** to perform the calibration.

Step 6. Uncover lens.

PRNU Correction

Step 1: Apply illumination and place a white flat target in the location where the real object will be. Ideally, you would use a professional target. For convenience, you can use white paper as the target. The result of using paper may produce grain effect — where visible vertical lines show up in grabbed images.

Two common ways to correct the grain effect are:

    1) Target in motion while PRNU Correction is performed.

    2) Defocus lens while PRNU Correction is performed.

Set the Flat Field Correction Mode to *Off* and check the bare image line profile.

Step 2. Set the Flat Field Correction Mode to *Calibration* and select the required user set from Flat Field Correction Current Active Set list.

Step 3: Adjust the calibration target in the Flat Field Calibration Target (in DN) if necessary.
Note: 200 DN is commonly used target in 8-bit output format.

Step 4. Set the Flat Field Calibration Sample Size feature to 4096 or 2048.

Step 5. In the Calibrate PRNU feature, click **Press** to perform the calibration.

Step 6: Select a User Flat field set from the Flat Field Correction Current Active Set. In the Save Calibration feature, click **Press** to save the FFC results to the selected current active set. If not saved, the FFC result will be lost when the Active Set or Calibration mode is changed.

Step 7. Set the Flat Field Correction Mode to *Active* to apply the calibrated FPN and PRNU parameters. Results can be checked using Statistics with the line profile.
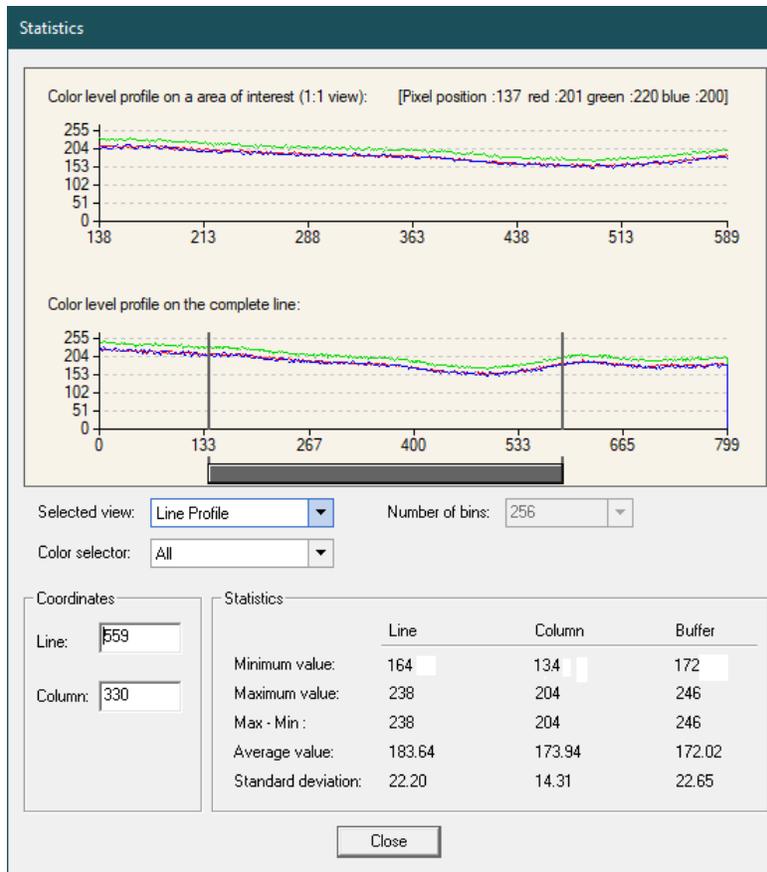
Figure 25: CamExpert Statistics Dialog – Line Profile

Step 8. To load this user set when resetting or powering on the camera, use the Power-up Configuration dialog. Click **Setting** next to the Power-up Configuration feature, in the Camera Information category.
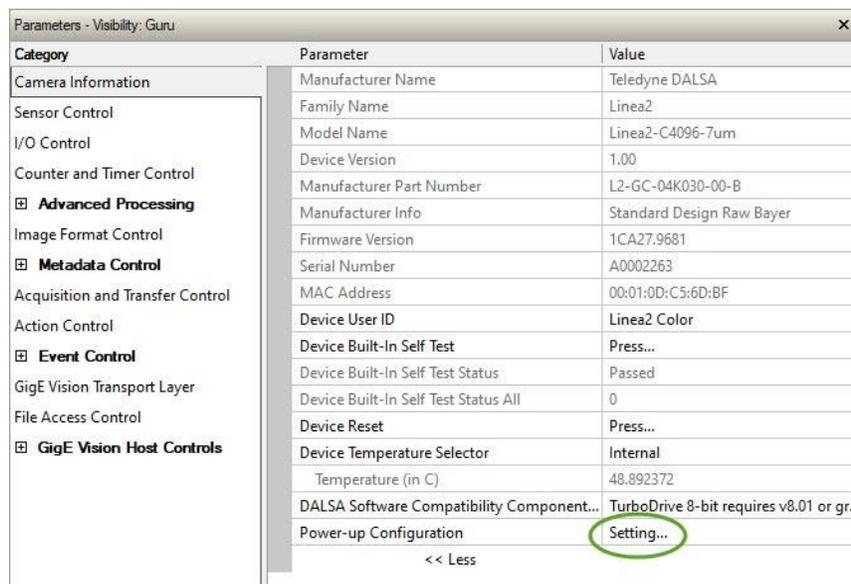
Figure 26: CamExpert – Power-up Configuration

In the *Power-up Configuration* dialog box, select one of four user sets for both **Camera Power-up configuration** and **Load / Save configuration**, and click **Save**.

This ensures the camera loads the saved parameters next time the camera is powered up.
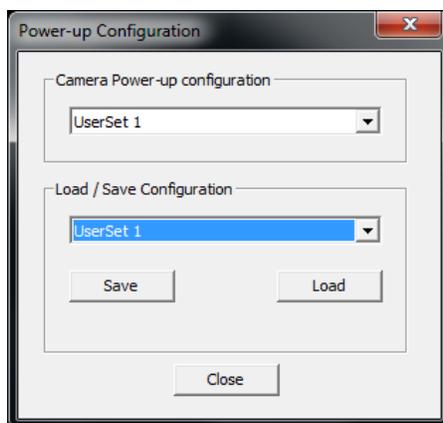
Figure 27: CamExpert – Power-up Configuration Dialog

Camera Firmware Updates

In the File Access Control category, click **Setting** to open File Access Control dialog.

Figure 28: CamExpert – File Access Control Dialog

- **Type**: select the file type to upload to the camera.
- **File selector**: select *Device Firmware*.
- Click **Browse** to open Windows Explorer.
- Select the specific file to upload.
- Click **Upload (to Camera)** to execute the file transfer to the camera.

When firmware is successfully updated the camera must reset to effect the change; CamExpert displays a dialog indicating the upload was successful and prompts to reset the camera.
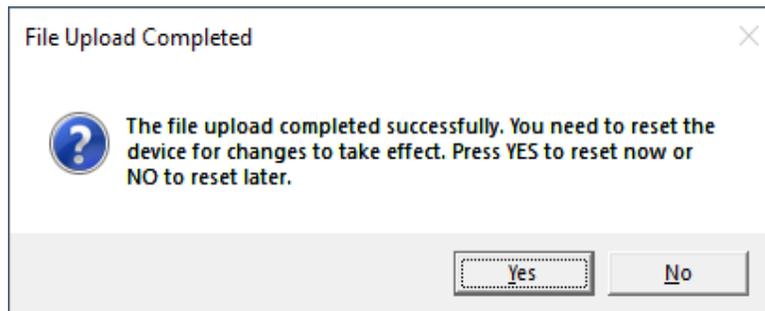
Figure 29: CamExpert – File Upload Completed Message Box

Sapera LT includes a Camera Firmware Update example that demonstrates how to perform a firmware update within an application.

Internal Test Image Generator

The camera includes a number of internal test patterns, which confirm Ethernet connection and driver installation without the need for a camera lens or proper lighting. The patterns are subject to camera processing and Binning functions.

Use CamExpert to enable and select any test pattern from the Test Image Selector feature list while the camera is not in Acquisition Mode; click **Grab** to display the pattern output.
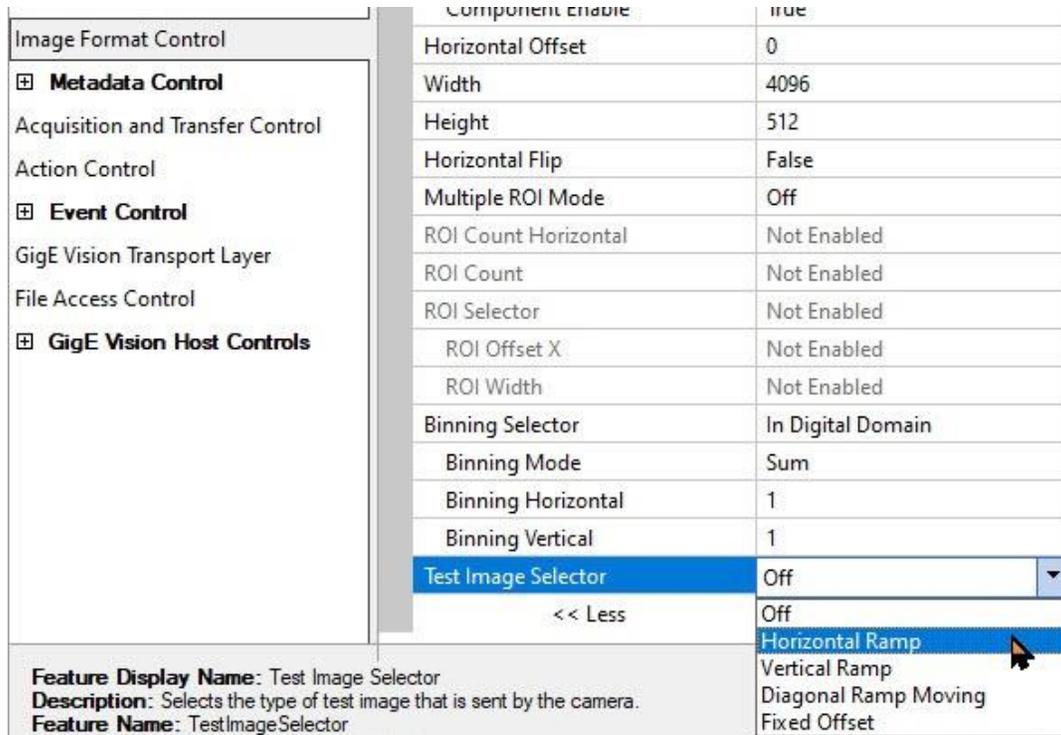
Figure 30: CamExpert – Test Image Selector

Available Test Patterns

Horizontal Ramp

Display is filled horizontally with series of green, red, and blue pixels (RGB image), or gray pixels (NIR image), that range from dark to bright. The darkest point of each color is offset such that no two colors have the same value at a given pixel.
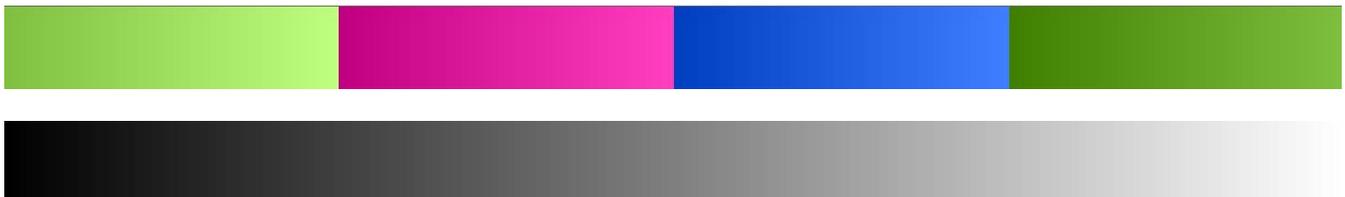
Figure 31: CamExpert Test Image: Horizontal Ramp. (Top) RGB. (Bottom) NIR.

Vertical Ramp

Display is filled vertically with series of green, red, and blue pixels (RGB), or gray pixels (NIR), that range from dark to bright. The darkest point of each color is offset such that no two colors have the same value at a given row.

Figure 32: CamExpert Test Image –Vertical Ramp. (Top) RGB. (Bottom) NIR.

Diagonal Ramp Moving

Display is filled diagonally with series of green, red and blue pixels (RGB), or gray pixels (NIR), that range from dark to bright. The image moves horizontally from right to left by 1 pixel at each frame. The darkest point of each color is offset such that no two colors have the same value at a given pixel.
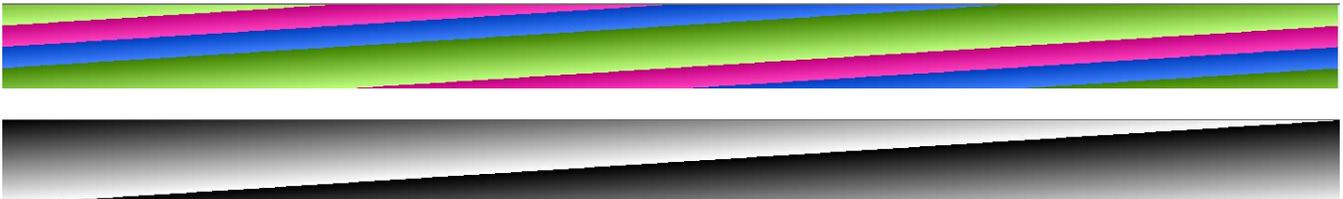
Figure 33: CamExpert Test Image –Diagonal Ramp Moving. (Top) RGB. (Bottom) NIR.

Fixed Offset

The display shows an image where all pixels have a uniform color and intensity.

Figure 34: CamExpert Test Image – Fixed Offset. (Top) RGB. (Bottom) NIR.

User-Defined Camera Name

The Linea2 5GigE camera can be programmed with a user-defined name, using the Device User ID feature, to identify multiple cameras connected to the network. For example, an inspection system with four cameras might label cameras "top view", "left view", "right view" and "bottom view".

The factory default Device User ID is the camera serial number for quick initial identification.

⚠️	The factory programmed camera serial number and MAC address are not user changeable.

When using CamExpert, multiple Linea2 5GigE cameras on the network are seen as different "Linea2_C4096_xx" 4k devices. Non-Teledyne DALSA cameras are labeled as "GigEVision Device". Click on a device 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 Device User ID. Some important considerations are listed below.

- Do not use the camera's IP address as identification (unless it is a persistent IP) because it could change with each power cycle.
- A MAC address is unique to each camera; the control application is therefore limited to the vision system that uses the camera's MAC address.
- The Device User ID can be programmed to represent the selected camera usage. This method 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.

Spatial Correction

The Linea2 color RGB-NIR color camera model has a quadrilinear configuration—color rows are spatially separated by one row, while the NIR row is separated further to accommodate NIR processing (in BGRA pixel format, the NIR line (alpha component) is extracted independently as a separate image plane and is not implicated in spatial correction).

Figure 35: Linea2 Row Spacing

The camera ensures the scan direction alignment of the three colors by delaying the image data for each color a set amount of time, as dictated by the scan direction.

If the encoder generates a pulse that is equal to the object pixel, the spatial correction value used by the camera will be 1. However, guaranteeing the encoder pulse accuracy may not always be possible. In addition, lens magnification may not be exact—which will introduce a similar error seen as color artifacts.

The Line Spatial Correction feature can correct for small encoder or magnification errors on a sub-pixel level. The user can enter a floating-point number from 0 to 1.5 to perform the spatial correction on the color lines. The sub-pixel spatial correction resolution is 1/384th of a row. The feature accepts six decimal places and will adjust the entered sub-pixel adjustment component accordingly. This feature can only be adjusted when the acquisition is stopped.

Examples of color artifacts generated by a small encoder error:
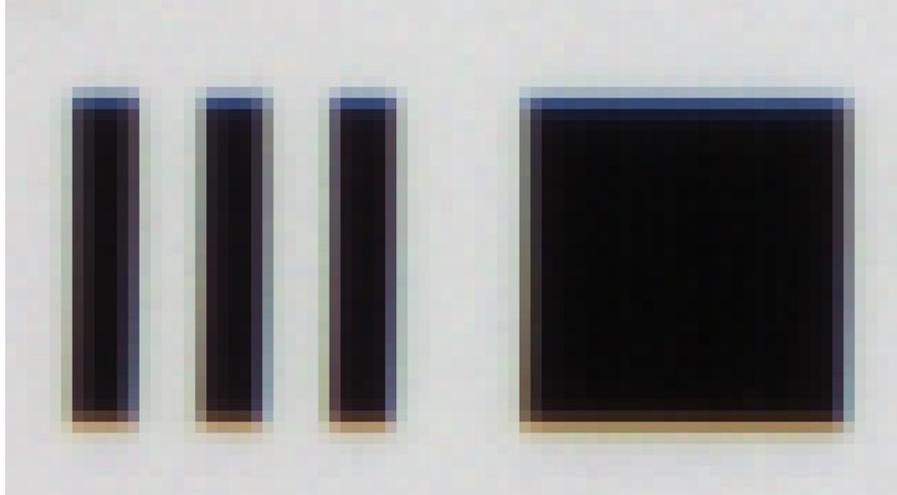
Figure 36: Color Artifacts Example (encoder 19 μm)

Image Details:

- Object Pixel Setup for 20 μm
- Can be corrected with 20/19 = 1.05 Spatial Correction
- Encoder set at 19 μm
- Forward Scanning
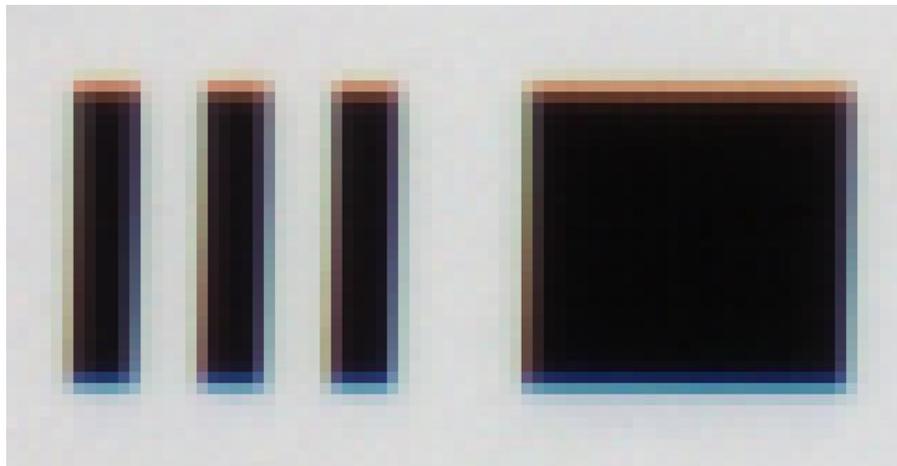
Figure 37: Color Artifacts Example (encoder 21μm)

Image Details:

- Object Pixel Setup for 20 μm
- Can be corrected with 20/21 = 0.95 Spatial Correction
- Encoder set at 21 μm
- Forward Scanning

If there are several different camera angles and associated illumination configurations in the inspection system, a single encoder pulse will not provide the correct timing for all the cameras.

For example, as the camera angle moves away from perpendicular, the image row spacing increases. If the encoder resolution remains constant for perpendicular operation, many encoder pulses will be too closely spaced, apparent row spacing will increase and the spatial correction will need to be increased.

Parallax Correction: Using the Camera at Non-Perpendicular Angles to the Object

When using a camera at an angle to the objects surface, the object pixel size for the red, green and blue (and NIR) pixel arrays are slightly different. This is due to parallax. If the camera angle and the lens angular field of view are sufficiently large, this may cause color artifacts at the extremities of the image. The color camera includes a Parallax Correction Pixel Stretch feature that can correct color artifacts. The blue or NIR row can be used as the parallax correction reference row according to the pixel format (BGR or BGRA).
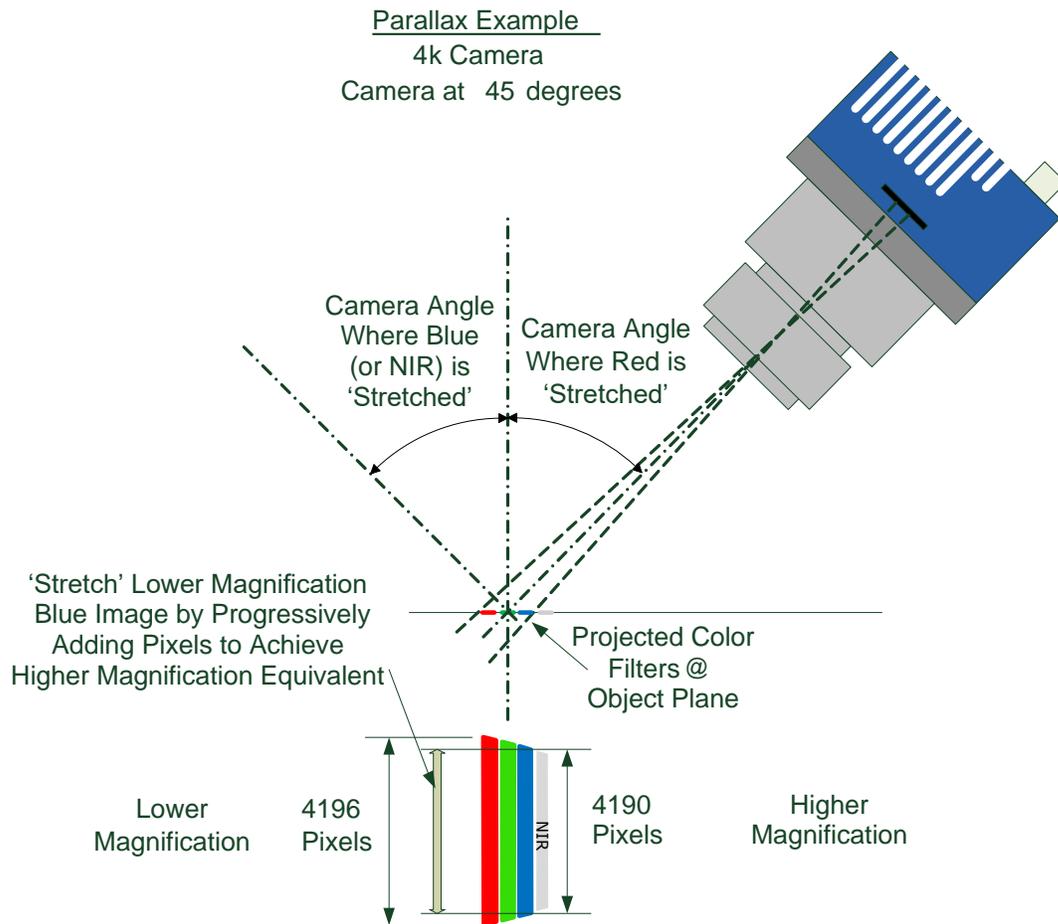
Figure 38: Camera Angle Creates Parallax

Notes:

- This feature will be most useful when processing RGB image formats using 4K cameras with long focal length lenses.
- Parallax correction of the individual colors cannot be performed due to the row summing in the sensor. Therefore, at high angles, a degradation in MTF at the end pixels may occur.

- Selection of the color to adjust is dependent on positive or negative angle. It is not sensitive to scan direction.
- The stretch value for green is always half that of the stretch value for blue or red.

The parallax distortion increases when imaging at steep angles relative to the cameras imaging plane. This is an optical effect caused by the line spacing of the three individual colors. This spacing results in a different magnification for each line at high angles. As in the figure below, there are color distortions at the ends of the image, but at the center, the color distortions do not show up.
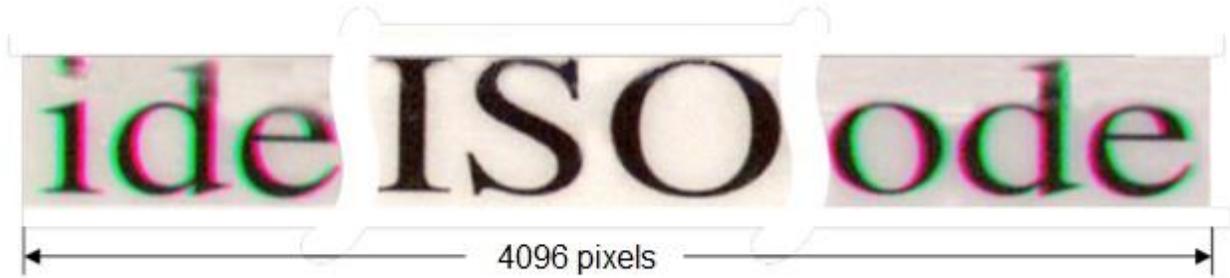
Figure 39: Image with Horizontal Color Alignment Issues

Using the camera's <u>Parallax Correction Pixel Stretch</u> feature, the optical magnification for each line is adjusted such that colors can be lined up at the extreme ends of the image without affecting the center. By tuning the ParallaxCorrection Pixel Stretch, the user can adjust the parallax correction of the image.
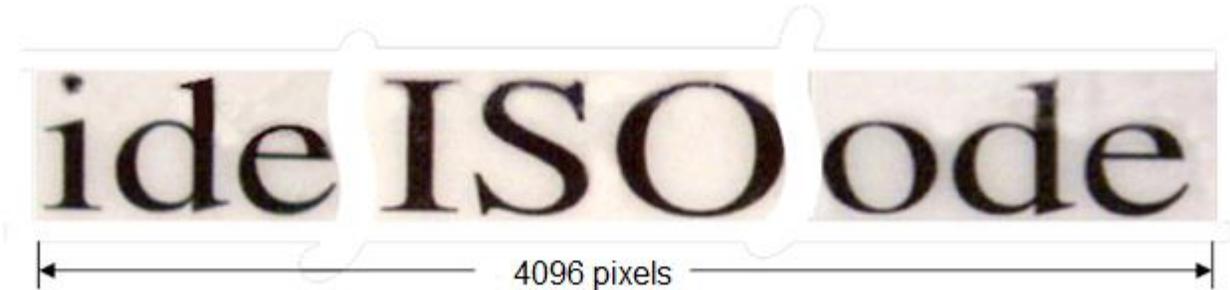
Figure 40: Corrected Image

The figure above is the same image corrected using the parallax correction.

Saving & Restoring Camera Setup Configurations

A user system may use multiple illuminations, resolutions and responsiveness configurations in order to cover different imaging situations. The camera includes 4 user sets where camera setup information can be saved and restored at power up or during operation.

⚠️	Factory setting configuration is loaded during the camera's first power-up.

Active Settings for Current Operation

Active settings are those used while the camera is running. These settings are stored in the camera's *volatile* memory and will be lost if the camera resets or loses power during operation.

The settings active during the current operation can be saved and restored when the camera is powered on using the <u>User Set Save</u> parameter. Once saved, the current settings become the selected user set.

Camera Configuration Selection Dialog

CamExpert provides a dialog than combines the selection of the Camera Power-up Configuration and the Load / Save Configuration from Linea2 5GigE memory.
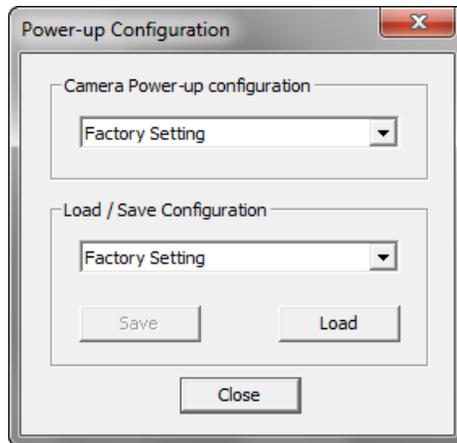
Figure 41: CamExpert – Power-up Configuration Dialog

Camera Power-up Configuration

The **Camera Power-up Configuration** list displays the camera configuration to load during power-up (see <u>UserSetDefaultSelector</u> feature). The user can choose *Factory Setting* or one of four saved *User Sets*.

Load / Save Configuration

This list allows the user to change the camera configuration after power-up (see *UserSetSelector* feature). To reset the camera to the factory configuration, select *Factory Setting* and click **Load**. To save a current camera configuration to non-volatile memory, select *User Set 1*, *2*, *3* or *4* and click **Save** (see UserSetSave feature). Select a saved user set and click **Load** to restore a saved configuration. By default, the user sets are shipped with the same settings as the factory set.

Operational Reference

Feature Descriptions

In the following feature description sections, the Standard & View column indicates which parameter is a member of the DALSA Features Naming Convention (indicated by DFNC), versus the GenICam Standard Features Naming Convention (SFNC not shown). In general, feature names that start with an uppercase letter are part of the SFNC while those starting with a lowercase letter are part of the DFNC.

Parameters in gray are read only, either always or due to another parameter being disabled. Parameters in black are user set in CamExpert or programmable via an imaging application.

Camera Information Category

The Camera Information category groups information specific to the individual GigE Vision camera. These features are typically read-only. GigE Vision applications retrieve this information to identify the camera along with its characteristics.

Figure 42: CamExpert – Camera Information Category

Camera Information Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Manufacturer Name	DeviceVendorName	Displays the device vendor name. (RO)	Beginner
Family Name	DeviceFamilyName	Displays the device family name. (RO)	Beginner
Model Name	DeviceModelName	Displays the device model name. (RO)	Beginner
Device Version	DeviceVersion	Displays the device version. This tag will also highlight if the firmware is a beta or custom design. (RO)	Beginner
Manufacturer Part Number	deviceManufacturerPartNumber	Displays the device manufacturer part number.	Beginner DFNC
Manufacturer Info	DeviceManufacturerInfo	This feature provides extended manufacturer information about the device. (RO)	Beginner
Firmware Version	DeviceFirmwareVersion	Displays the currently loaded firmware version number. Firmware files have a unique number and have the .cbf file extension. (RO)	Beginner
Serial Number	DeviceSerialNumber	Displays the factory set serial number of the device. (RO)	Expert

Display Name	Feature & Values	Description	Standard & View
MAC Address	deviceMacAddress	Displays the unique MAC (Media Access Control) address of the Device. (RO)	Beginner DFNC
Device User ID	DeviceUserID	Feature to store a user-programmable identifier of up to 15 characters. The default factory setting is the camera serial number. (RW)	Beginner
Device Built-In Self Test	deviceBIST	Command to perform an internal test which will determine the device status. (W)	Beginner DFNC
Device Built-In Self Test Status	deviceBISTStatus	Return the status of the device Built-In Self test. Possible return values are device-specific.	Beginner DFNC
Passed	*Passed*	*No failure detected*	
Last firmware update failed	*FirmwareUpdateFailure*	*Last firmware update operation failed.*	
Unexpected Error	*Unexpected_Error*	*Switched to recovery mode due to unexpected software error.*	
Sensor Initialization Failure	*SensorFailure*	*There was an error initializing the sensor; the camera may not be able to capture images.*	
Network Error	*NetworkError*	*Network encountered an error during streaming.*	
Unknown Error Returned	*Unknown_Error*	*Undefined single error or multiple simultaneous errors.*	
Device Built-In Self Test Status All	deviceBISTStatusAll	Return the status of the device Built-In Self Test as a bit field. The meaning for each bit is device-specific.	Beginner DFNC
Device Reset	DeviceReset	Resets the device to its power up state. (W)	Beginner
Device Temperature Selector	DeviceTemperatureSelector	Select the source where the temperature is read.	Beginner
Internal	*Internal*	*Value from FPGA and or PHY temperature.*	
Max Internal	*MaxInternal*	*Records the highest device temperature since power up. Value is reset on power off.*	
Temperature (in C)	DeviceTemperature	The temperature of the selected source in degrees Celsius. Maximum temperature should not exceed +70ºC for reliable operation.	Beginner
DALSA Software Compatibility Component List	DALSASoftwareCompatibilityComponentList	List the optional Teledyne DALSA software functions that are supported.	Beginner DFNC
TurboDrive 8-bit requires v8.01 or greater	*Compatibility1*	*Teledyne DALSA Turbo Drive 8-bit (Monochrome or Bayer) requires Sapera-LT 8.01 or greater.*	
TurboDrive 10-bit requires v8.10 or greater	*Compatibility2*	*Teledyne DALSA Turbo Drive 10-bit (Monochrome or Bayer) requires Sapera-LT 8.10 or greater.*	
TurboDrive 12-bit requires v8.10 or greater	*Compatibility3*	*Teledyne DALSA Turbo Drive 12-bit (Monochrome or Bayer) requires Sapera-LT 8.10 or greater.*	
Multicast requires a newer version	*Compatibility4*	*Multicast feature support requires a newer version of Sapera LT than currently installed.*	
Power-up Configuration Selector	UserSetDefaultSelector	Specify the camera configuration set to load and make active on camera power-up or reset. The camera configuration sets are stored in camera non-volatile memory. (RW)	Beginner
Factory Setting	*Default*	*Select the Factory Setting values as the Power-up Configuration.*	
UserSet 1	*UserSet1*	*Select the user defined configuration UserSet 1 as the Power-up Configuration.*	
UserSet 2	*UserSet2*	*Select the user defined configuration UserSet 2 as the Power-up Configuration.*	
UserSet 3	*UserSet3*	*Select the user defined configuration UserSet 3 as the Power-up Configuration.*	
UserSet 4	*UserSet4*	*Select the user defined configuration UserSet 4 as the Power-up Configuration.*	

Display Name	Feature & Values	Description	Standard & View
User Set Selector	UserSetSelector	Selects the camera configuration set to load feature settings from or save current feature settings to. The Factory set contains default camera feature settings. User camera configuration sets contain features settings previously saved by the user. (RW)	Beginner
Factory Setting	*Default*	Select the default camera feature settings saved by the factory.	
UserSet 1	*UserSet1*	Select the User Defined Configuration space UserSet1 to save to or load from features settings previously saved by the user.	
UserSet 2	*UserSet2*	Select the User Defined Configuration space UserSet2 to save to or load from features settings previously saved by the user.	
UserSet 3	*UserSet3*	Select the User Defined Configuration space UserSet3 to save to or load from features settings previously saved by the user.	
UserSet 4	*UserSet4*	Select the User Defined Configuration space UserSet4 to save to or load from features settings previously saved by the user.	
Load Configuration	UserSetLoad	Loads the camera configuration set specified by the User Set Selector feature, to the camera and makes it active. (W)	Beginner
Save Configuration	UserSetSave	Saves the current camera configuration to the user set specified by the User Set Selector feature. The user sets are located on the camera in non-volatile memory. (W)	Beginner

Sensor Control Category

The Linea2 5GigE Sensor Control category groups sensor specific features. This group includes parameters for line rate, exposure time, etc.

Figure 43: CamExpert – Sensor Control Category

Sensor Control Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Device Scan Type	DeviceScanType	Defines the scan type of the device's sensor. <RO>	Beginner
Areascan	*Areascan*	*Device uses an Areascan sensor.*	
Linescan	*Linescan*	*Device uses a linescan sensor.*	

Display Name	Feature & Values	Description	Standard & View
Sensor Color Type	sensorColorType	Defines the camera sensor color type. < RO >	Beginner DFNC
Monochrome Sensor	*Monochrome*	*Sensor color type is monochrome.*	
Monochrome Sensor With Polarization Filter	*Monochrome_Polarized*	*Sensor color type is monochrome with a polarization filter.*	
Bayer Sensor	*CFA_Bayer*	*Sensor color type is Bayer Color Filter Array (CFA).*	
Bayer Sensor With Polarization Filter	*CFA_Bayer_Polarized*	*Sensor color type is Bayer Color Filter Array (CFA) with a polarization filter.*	
Color BGR	*CFA_BGR*	*Sensor color type is Color Filter Array (CFA) with three individual lines for independent blue, green, and red.*	
Color BGR-NIR	*CFA_BGR_NIR*	*Sensor color type is Color Filter Array (CFA) with four individual lines for independent blue, green, red, and near infrared.*	
Input Pixel Size	pixelSizeInput	Size of the image input pixels, in bits per pixel. < RO >	Guru DFNC
8 Bits/Pixel	*Bpp8*	*Sensor output data path is 8 bits per pixel.*	
10 Bits/Pixel	*Bpp10*	*Sensor output data path is 10 bits per pixel.*	
12 Bits/Pixel	*Bpp12*	*Sensor output data path is 12 bits per pixel.*	
Sensor Width	SensorWidth	Defines the sensor width in active pixels. < RO>	Expert
Sensor Height	SensorHeight	Defines the sensor height in active lines. < RO>	Expert
Line Spatial Correction	sensorLineSpatialCorrection	Sets the number of lines of delay between color output planes from the sensor for spatial correction. Stop acquisition to change.	Beginner DFNC
Direction Source	sensorScanDirectionSource	Specifies whether scan direction is controlled by a feature or external signal.	Beginner DFNC
Internal	*Internal*	*Direction controlled by "Internal Scan Direction" feature.*	
Rotary Encoder	*Encoder*	*Direction determined from Rotary Channel A and B phase.*	
Line 1	*GPIO1*	*Direction controlled by GPIO 1, Forward: Low; Reverse: High.*	
Line 2	*GPIO2*	*Direction controlled by GPIO 2, Forward: Low; Reverse: High*	
Line 3	*GPIO3*	*Direction controlled by GPIO 3, Forward: Low; Reverse: High*	
Line 4	*GPIO4*	*Direction controlled by GPIO 4, Forward: Low; Reverse: High*	
Internal Scan Direction	sensorScanDirection	When "Scan Direction Source" feature is Internal, this feature specifies the direction.	Beginner DFNC
Forward	*Forward*	*Forward scan direction.*	
Reverse	*Reverse*	*Reverse scan direction*	
Acquisition Line Rate (in Hz)	AcquisitionLineRate	Specifies the camera internal line rate, in Hz.	Beginner
Exposure Mode	ExposureMode	Sets the operation mode for the camera's exposure (or electronic shutter).	Beginner
Timed	*Timed*	*The exposure duration time is set using the Exposure Time feature and the exposure starts with a FrameStart event.*	
Trigger Width	*TriggerWidth*	*Uses the width of the trigger signal pulse to control the exposure duration. Use the Trigger Activation feature to set the polarity of the trigger. The Trigger Width setting is applicable with Trigger Selector = Single Line Trigger(Start). Note that the Line Inverter feature setting may affect the polarity of the trigger signal and is only available when exposureAlignment = Reset.*	

Display Name	Feature & Values	Description	Standard & View
Exposure Time Selector	exposureTimeSelector	Selects the color plane for which to set an exposure time. Applicable only when the Exposure Mode feature is set to Timed.	Beginner DFNC
All	All	*Set all color planes to the same exposure time. Applicable only when the Exposure Mode feature is set to Timed.*	
Blue	Blue	*Set the blue color plane exposure time. Applicable only when the Exposure Mode feature is set to Timed.*	
Green	Green	*Set the green color plane exposure time. Applicable only when the Exposure Mode feature is set to Timed.*	
Red	Red	*Set the red color plane exposure time. Applicable only when the Exposure Mode feature is set to Timed.*	
NIR	NIR	*Set the NIR color plane exposure time. Applicable only when the Exposure Mode feature is set to Timed. (RGBN model only.)*	
Exposure Time (in us)	ExposureTime	Sets the exposure time (in microseconds) when the Exposure Mode feature is set to Timed.	Beginner
Exposure Delay Mode	exposureDelayMode	Specifies the exposure delay mode.	Beginner DFNC
Auto	exposureDelayModeDefault	*Delays are 0, T/4, 2T/4 and 3T/4 for each component accordingly.*	
Manual	exposureDelayModeCustom	*User manually sets the exposure delay for each component*	
Exposure Delay Line Selector	exposureDelaySelector	Specifies the delay in microseconds to apply after the FrameStart event before starting the ExposureStart event.	Beginner DFNC
First line	ExposureDelayFirst	Set an exposure delay for first sensor row relative to main trigger.	
Second line	ExposureDelaySecond	Set an exposure delay for second sensor row relative to main trigger.	
Third line	ExposureDelayThird	Set an exposure delay for third sensor row relative to main trigger.	
Fourth line	ExposureDelayFourth	Set an exposure delay for fourth sensor row relative to main trigger.	
Exposure Delay (in us)	exposureDelay	Specifies the delay (in microseconds) to apply after the FrameStart event before starting the ExposureStart event.	Expert DFNC
Gain Selector	GainSelector	Selects which gain is controlled when adjusting gain features.	Beginner DFNC
Sensor	SensorAll	*Apply a gain adjustment within the sensor to the entire image.*	
Digital	DigitalAll	*Apply a digital gain adjustment to the entire image. The independent gain factor is applied to the image after the sensor.*	
Digital Red	DigitalRed	*Apply a digital gain to the red component.*	
Digital Green	DigitalGreen	*Apply a digital gain to the green component.*	
Digital Blue	DigitalBlue	*Apply a digital gain to the blue component.*	
Digital NIR	DigitalNIR	*Apply a digital gain to the NIR component. (RGBN model only.)*	DFNC
Gain	Gain	Sets the selected gain as an amplification factor applied to the image. User adjusts the Gain feature or the GainRaw feature.	Beginner
Gain (Raw)	GainRaw	Raw Gain value that is set in the camera.	Guru DFNC

Display Name	Feature & Values	Description	Standard & View
Black Level Selector	BlackLevelSelector	Selects which Black Level to adjust using the Black Level feature.	Beginner
Digital	*DigitalAll*	*Sensor Dark Offset.*	
Digital Red	*DigitalRed*	*Sensor Dark Offset for red pixels.*	
Digital Green	*DigitalGreen*	*Sensor Dark Offset for green pixels.*	
Digital Blue	*DigitalBlue*	*Sensor Dark Offset for blue pixels.*	
Digital NIR	*DigitalNIR*	*Sensor Dark Offset for NIR pixels. (RGBN model only.)*	
Black Level (in DN)	BlackLevel	Controls the black level as an absolute physical value. This represents a DC offset applied to the video signal, in DN (digital number) units. The Black Level Selector feature specifies the channel to adjust.	Beginner
Parallax Correction Line Selector	imageDistortionCorrectionParallaxCorrectionSelector	Select the sensor color to set Parallax Correction stretch value relative to the row center.	Beginner DFNC
Red	*Red*	Red Row Correction.	
Green	*Green*	Green Row Correction.	
Blue	*Blue*	Blue Row Correction.	
Parallax Correction Pixel Stretch	imageDistortionParallaxCorrectionPixelStretch	Set Parallax Correction value of either Red, Blue, or Green. Stretch is relative to the row center.	Beginner DFNC

Exposure Controls Details

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

- Exposure control is defined as the start of exposure and exposure duration.
- The feature **Exposure Mode** selects the controlling method for the exposure.
- The start of exposure can be driven by an internal timer signal, an external trigger signal or a software function call.
- For External Trigger signals, the relationship between an external line trigger and the exposure period as shown in the timing diagrams below is only applicable while the external line trigger does not exceed the maximum allowable line rate.

Exposure Delay Mode

The Exposure Delay Mode defines the start of each sensor row exposure with respect to the line trigger.

- In Auto mode, the exposure starts are all set to 1/4 of the period apart.
- In Manual mode, the start of each exsync is defined by a delay from the trigger. The 7.8 µs readouts cannot overlap between multiple rows.

Internal Programmable Exposure

The Linea2 5GigE in the Internal Programmable Exposure mode has the following features:

- The TriggerSource feature (see I/O Controls Category) selects an internal signal as trigger.
- Programmable internal trigger, where the maximum line rate limit is related to the ExposureTime feature.
- Exposure duration is user programmable (exposure maximum is dependent on the line rate). Minimum exposure (in µs) is model dependent.

External Programmable Exposure

The External Programmable Exposure mode is similar to Internal Programmable except the exposure start is an external user input.

- The TriggerSource feature selects an external signal line as trigger.
- Line rates and exposure limits are defined by Internal Programmable Exposure.

External Trigger Width Exposure

An alternative external trigger mode allows the external signal width to control the exposure duration (feature ExposureMode = TriggerWidth), as illustrated in the following graphic.
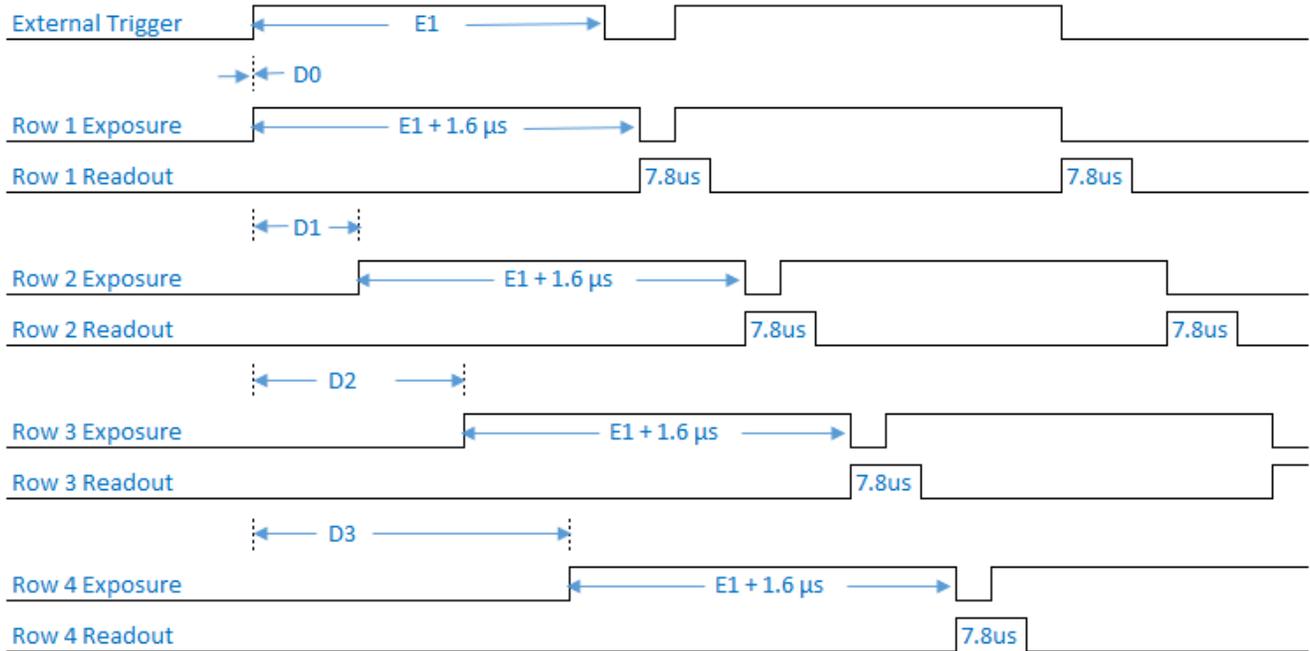
Figure 44: External Trigger Width Exposure

Notes

- In programmable exposure modes, the camera takes the additional exposure time into account and matches the exposure time set by the user to the actual sensor exposure time. The actual exposure time and the exposure time set by the user are the same.

- In external trigger width exposure mode, the pulse is passed to the sensor. Therefore, the actual exposure time is 1.6 µs longer than the exposure time determined by the trigger.

- Concurrent integration and digital readout may occur, however, in the 4k only one row may be read out at a time.

- In case the trigger frequency exceeds the allowable line rate, the camera will buffer one trigger.

I/O Control Category

The Linea2 5GigE I/O Controls category group features used to configure external inputs and acquisition actions based on those inputs, plus camera output signals to other devices.

Figure 45: CamExpert – I/O Control Category

I/O Control Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Trigger Selector	TriggerSelector	Selects which type of trigger to configure with the various Trigger features.	Beginner
Single Line Trigger(Start)	*LineStart*	*Selects a trigger starting the capture of a single line.*	
Single Frame Trigger(Start)	*FrameStart*	*Selects a trigger starting the capture of a single frame. Frame size is determined by image format feature "Height".*	
MultiFrame Trigger(Start)	*FrameBurstStart*	*Selects a trigger to capture multiple frames. The number of frames is specified by the triggerFrameCount feature.*	
Frame Active	*FrameActive*	*Selects a trigger to capture an active frame.*	
Frame Burst Active	*FrameBurstActive*	*Selects a trigger to capture an active frame.*	
Trigger Mode	TriggerMode	Controls the enable state of the selected trigger.	Beginner
Off	*Off*	*The selected trigger is turned off.*	
On	*On*	*The selected trigger is active.*	
Trigger Frames Count	triggerFrameCount	Sets the number of frames to acquire when a valid trigger is received. This feature is available when *Trigger Selector = MultiFrame Trigger(Start)*.	Beginner DFNC
Software Trigger	TriggerSoftware	Generate a software command internal trigger immediately no matter what the <u>TriggerSource</u> feature is set to.	Beginner
Trigger Source	TriggerSource	Specifies the internal signal or physical input line to use as the trigger source. The selected trigger must have its <u>TriggerMode</u> set to ON. Selection availability may depend on the value of ExposureMode.	Beginner
Line 1	*Line1*	*Select Line 1 (and associated I/O control block) to use as the external trigger source. See <u>LineSelector</u> feature for complete list.*	
Line 2	*Line2*	*Select Line 2 (and associated I/O control block) to use as the external trigger source. See <u>LineSelector</u> feature for complete list.*	
Line 3	*Line3*	*Select Line 3 (and associated I/O control block) to use as the external trigger source. See <u>LineSelector</u> feature for complete list.*	
Line 4	*Line4*	*Select Line 4 (and associated I/O control block) to use as the external trigger source. See <u>LineSelector</u> feature for complete list.*	
Rotary Encoder	*RotaryEncoder1*	*Select Rotary Encoder to use as the external line trigger source.*	DFNC
Timestamp Modulo Event	*TimestampModuloEvent*	*Select the Timestamp modulo event as the internal trigger source.*	DFNC
Action 1	*Action1*	*Select the GigEVision Action Command 1 as the internal trigger source. This is a broadcast command that multiple devices can respond to simultaneously.*	
Action 2	*Action2*	*Select the GigEVision Action Command 2 as the internal trigger source. This is a broadcast command that multiple devices can respond to simultaneously.*	
Timer1End Event	*Timer1End*	*Select the Timer1End Event as the internal trigger source.*	
Timer2End Event	*Timer2End*	*Select the Timer2End Event as the internal trigger source.*	
Counter1End Event	*Counter1End*	*Select the Counter1End Event as the internal trigger source.*	
Counter2End Event	*Counter2End*	*Select the Counter2End Event as the internal trigger source.*	
Counter1 Active	*Counter1Active*	*Select Counter1 as trigger source. The trigger will be activated when the counter is running.*	DFNC

Display Name	Feature & Values	Description	Standard & View
Counter2 Active	Counter2Active	Select Counter2 as trigger source. The trigger will be activated when the counter is running.	DFNC
Timer1 Active	Timer1Active	Select Timer1 as trigger source. The trigger will be activated when the timer is running.	DFNC
Timer2 Active	Timer2Active	Select Timer2 as trigger source. The trigger will be activated when the timer is running.	DFNC
Trigger Input Line Activation	TriggerActivation	Select the activation mode for the selected Input Line trigger source. This is applicable only for external line inputs.	Beginner
Rising Edge	RisingEdge	The trigger is considered valid on the rising edge of the line source signal (after any processing by the line inverter feature).	
Falling Edge	FallingEdge	The trigger is considered valid on the falling edge of the line source signal (after any processing by the line inverter feature).	
Any Edge	AnyEdge	The trigger is considered valid on any edge (falling or rising) of the line source signal (after any processing by the line inverter feature).	
Level High	LevelHigh	The trigger is considered valid on the high level of the line source signal.	
Level Low	LevelLow	The trigger is considered valid on the low level of the line source signal.	
Trigger Delay (in us)	TriggerDelay	Specifies the delay in microseconds to apply after receiving the trigger and before activating the triggerEvent.	Beginner
Rotary Encoder Output Mode	rotaryEncoderOutputMode	Specifies the conditions for the Rotary Encoder interface to generate a valid Encoder output signal.	Expert DFNC
Position	Position	Triggers are generated at all new position increments in the selected direction. If the encoder reverses no trigger events are generated until it has again passed the position where the reversal started.	
Motion	Motion	The triggers are generated for all motion increments in either direction.	
Rotary Encoder Direction	rotaryEncoderDirection	Specifies the phase which defines the encoder forward direction.	Expert DFNC
Clockwise	Clockwise	Inspection goes forward when the rotary encoder direction is clockwise (phase B is ahead of phase A).	
Counter Clockwise	CounterClockwise	Inspection goes forward when the rotary encoder direction is counter clockwise (phase A is ahead of phase B).	
Rotary Encoder Input A Source	rotaryEncoderInputASource	Selects which input line to assign to the rotary encoder input A (also known as shaft encoder). Note that the Line Mode feature must be set to Input. The list of supported input line sources is device-specific.	Expert DFNC
Line 1	Line1	Line1 is assigned to the Rotary Encoder Input A.	
Line 3	Line3	Line3 is assigned to the Rotary Encoder Input A.	
Rotary Encoder Input B Source	rotaryEncoderInputBSource	Selects which input line to assign to the rotary encoder input B (also known as shaft encoder). Note that the Line Mode feature must be set to Input. The list of supported input line sources is device-specific.	Expert DFNC
GND	GND	Rotary Encoder Input B is not used.	
Line 2	Line2	Line2 is assigned to the Rotary Encoder Input B.	
Line 4	Line4	Line4 is assigned to the Rotary Encoder Input B.	

Display Name	Feature & Values	Description	Standard & View
Rotary Encoder Source Activation	rotaryEncoderSrcActivation	Specifies the signal edge(s) used to increment the rotary encoder.	Expert DFNC
Rising Edge	*RisingEdge*	*The rotary encoder uses the rising edge of the source signal.*	
Any Edge	*AnyEdge*	*The rotary encoder uses either the rising edge or falling edge of the source signal.*	
Rotary Encoder Rescaler Order	rotaryEncoderRescalerOrder	Specifies the order in which the multiplier and divider are applied.	Guru DFNC
Multiplier Divider	*multiplierDivider*	*The signal is multiplied before being divided.*	
Divider Multiplier	*dividerMultiplier*	*The signal is divided before being multiplied.*	
Rotary Encoder Multiplier	rotaryEncoderMultiplier	Specifies a multiplication factor for the rotary encoder output pulse generator.	Beginner DFNC
Rotary Encoder Divider	rotaryEncoderDivider	Specifies a division factor for the rotary encoder output pulse generator.	Beginner DFNC
Rotary Encoder Position	rotaryEncoderPosition	Display the position between Input Src A and B.	Guru DFNC
Input A ahead B	*SrcA*	*Input A is ahead B.*	
Input B ahead A	*SrcB*	*Input B is ahead A.*	
Line Selector	LineSelector	Selects the physical line (or pin) of the external device connector to configure.	Beginner
Line 1	*Line1*	*Index of the physical line and associated I/O control block to use. Pin 1 and Pin 2 is the RS-422 Input Port 1+, 1-, respectively.*	
Line 2	*Line2*	*Index of the physical line and associated I/O control block to use. Pin 3 and Pin 4 is the RS-422 Input Port 2+ and 2-, respectively.*	
Line 3	*Line3*	*Index of the physical line and associated I/O control block to use. Pin 6 and Pin 7 is the Port 3+ and 3-, respectively.*	
Line 4	*Line4*	*Index of the physical line and associated I/O control block to use. Pin 8 and Pin 9 is the Port 4+ and 4-, respectively.*	
Line 5	*Line5*	*Index of the physical line and associated I/O control block to use. Pin 11 and Pin 12 is Output Port 5+ and 5-, respectively.*	
Line 6	*Line6*	*Index of the physical line and associated I/O control block to use. Pin 13 and Pin 14 is the Output 6+ and 6-, respectively.*	
Line Format	LineFormat	Specify the current electrical format of the selected physical input or output.	Expert
RS422	*RS422*	*The line accepts or sends RS422 level signals.*	
Single Ended	*SingleEnded*	*The line accepts or sends SingleEnded signals.*	DFNC
Open Collector	*OpenCollector*	*The line is output as an open collector.*	DFNC
Line Mode	LineMode	Reports if the physical Line is an Input or Output signal. (RO)	Expert
Input	*Input*	*The line is an input line.*	
Output	*Output*	*The line is an output line.*	
Line Status	LineStatus	Returns the current status of the selected input or output line. (RO)	Expert
	False/True		
Line Inverter	LineInverter	Controls the inversion of the signal of the selected input or output Line.	Beginner
	False/True		

Display Name	Feature & Values	Description	Standard & View
Input Line Detection Level	lineDetectionLevel	Specifies the voltage threshold required to recognize a signal transition on an input line.	Expert DFNC
Threshold for 3.3V	Threshold_for_3V3	A signal below 1.45V will be detected as a Logical LOW and a signal greater than 1.85V will be detected as a Logical HIGH on the selected input line.	
Threshold for 5V	Threshold_for_5V	A signal below 2.3V will be detected as a Logical LOW and a signal greater than 2.7V will be detected as a Logical HIGH on the selected input line.	
Threshold for 12V	Threshold_for_12V	A signal below 5.8V will be detected as a Logical LOW and a signal greater than 6.2V will be detected as a Logical HIGH on the selected input line.	
Threshold for 24V	Threshold_for_24V	A signal below 10.0V will be detected as a Logical LOW and a signal greater than 11V will be detected as a Logical HIGH on the selected input line.	
Input Line Debouncing Period (in us)	lineDebouncingPeriod	Specifies the minimum delay before an input line voltage transition is recognized as a signal transition.	Beginner DFNC
Line Electrical Termination	lineElectricalTermination	Controls if the electrical termination of Input Line is enabled or disabled.	Expert DFNC
Disabled	Disabled	Disabled electrical line termination for the selected line.	
Enabled	Enabled	Enabled electrical line termination for the selected line.	
Output Line Source	outputLineSource	Selects which internal signal or event driven pulse or software control state to output on the selected output line. (Note: the Line Mode feature must be set to Output. The List of supported output line sources is product-specific. The Event Control section provides details and timing diagrams for the supported trigger modes.)	Beginner DFNC
Off	Off	Line output is disabled (Tri-State) or Open with Optocoupled output.	
Pulse on: Start of Acquisition	PulseOnStartofAcquisition	Generate a pulse when the AcquisitionStart event occurs.	
Pulse on: End of Acquisition	PulseOnEndofAcquisition	Generate a pulse when the AcquisitionStop event occurs.	
Pulse on: Start of Blue Line Exposure	PulseOnExposureStartBlue	Generate a pulse on the Blue ExposureStart event.	
Pulse on: Start of Red Line Exposure	PulseOnExposureStartRed	Generate a pulse on the Red ExposureStart event.	
Pulse on: Start of Green Line Exposure	PulseOnExposureStartGreen	Generate a pulse on the Green ExposureStart event.	
Pulse on: Start of NIR Line Exposure	PulseOnExposureStartNIR	Generate a pulse on the NIR ExposureStart event.	
Pulse on: End of Blue Line Exposure	PulseOnExposureEndBlue	Generate a pulse on the Blue ExposureEnd event.	
Pulse on: End of Red Line Exposure	PulseOnExposureEndRed	Generate a pulse on the Red ExposureEnd event.	
Pulse on: End of Green Line Exposure	PulseOnExposureEndGreen	Generate a pulse on the Green ExposureEnd event.	
Pulse on: End of NIR Line Exposure	PulseOnExposureEndNIR	Generate a pulse on the NIR ExposureEnd event.	
Exposure Active Sensor Row 1	ExposureActiveSensorRow1	Generate a signal that is active when the Exposure for Sensor Row 1 is active. This is the Blue Pixel when the sensor is scanning in the forward direction.	
Exposure Active Sensor Row 2	ExposureActiveSensorRow2	Generate a signal that is active when the Exposure for Sensor Row 2 is active. This is the Red Pixel when the sensor is scanning in the forward direction.	
Exposure Active Sensor Row 3	ExposureActiveSensorRow3	Generate a signal that is active when the Exposure for Sensor Row 3 is active. This is the Green Pixel when the sensor is scanning in the forward direction.	

Display Name	Feature & Values	Description	Standard & View
Exposure Active Sensor Row 4	*ExposureActiveSensorRow4*	*Generate a signal that is active when the Exposure for Sensor Row 4 is active. This is the NIR Pixel when the sensor is scanning in the forward direction.*	
Pulse on: Action 1	*PulseOnAction1*	*Generate a pulse on the GigEVision Action Command 1.*	
Pulse on: Action 2	*PulseOnAction2*	*Generate a pulse on the GigEVision Action Command 2.*	
Pulse on: Input 1 Event	*PulseOnInput1*	*Generate a pulse on the Input signal 1 event.*	
Pulse on: Input 2 Event	*PulseOnInput2*	*Generate a pulse on the Input signal 2 event.*	
Pulse on: Input 3 Event	*PulseOnInput3*	*Generate a pulse on the Input signal 3 event.*	
Pulse on: Input 4 Event	*PulseOnInput4*	*Generate a pulse on the Input signal 4 event.*	
Pulse on: Rotary Encoder	*PulseOnRotaryEncoder1*	*Generate a pulse on the Rotary Encoder event.*	
Software Controlled	*SoftwareControlled*	*The <u>outputLineValue</u> feature changes the state of the output.*	
Pulse on: Software Command	*PulseOnSoftwareCmd*	*Generate a pulse on the Input of a Software Command.*	
Pulse on: Start of Frame	*PulseOnStartofFrame*	*Generate a pulse on the start of the Frame Active event*	
Pulse on: Valid Frame Trigger	*PulseOnValidFrameTrigger*	*Generate a pulse on the FrameTrigger event.*	
Pulse on: Rejected Frame(s) Trigger	*PulseOnInvalidFrameTrigger*	*Generate a pulse on the Invalid FrameTrigger event.*	
Pulse on: Start of Line	*PulseOnStartofLine*	*Generate a pulse on the start of the Line Active event*	
Pulse on: Valid Line(s) Trigger	*PulseOnValidLineTrigger*	*Generate a pulse on the Valid LineTrigger event.*	
Pulse on: Rejected Line(s) Trigger	*PulseOnInvalidLineTrigger*	*Generate a pulse on the Invalid LineTrigger event.*	
Frame Active	*FrameActive*	*Generate a signal that is active when the Frame Acquisition is active.*	
Pulse on: End of Timer 1	*PulseOnEndofTimer1*	*Generate a pulse on the TimerEnd 1 event.*	
Pulse on: End of Timer 2	*PulseOnEndofTimer2*	*Generate a pulse on the TimerEnd 2 event.*	
Pulse on: End of Counter 1	*PulseOnEndofCounter1*	*Generate a pulse on the CounterEnd 1 event.*	
Pulse on: End of Counter 2	*PulseOnEndofCounter2*	*Generate a pulse on the CounterEnd 2 event.*	
Output Line Pulse Signal Activation	outputLinePulseActivation	Specifies the input line activation mode to trigger the OutputLine pulse.	Beginner DFNC
Rising Edge	*RisingEdge*	*Specifies that the trigger is considered valid on the rising edge of the source signal.*	
Falling Edge	*FallingEdge*	*Specifies that the trigger is considered valid on the falling edge of the source signal.*	
Any Edge	*AnyEdge*	*Specifies that the trigger is considered valid on the falling or rising edge of the source signal.*	
Output Line Pulse Delay	outputLinePulseDelay	Sets the delay, in microseconds, before the output line pulse signal. Applicable for the OutputLineSource feature.	Beginner DFNC
Output Line Pulse Duration	outputLinePulseDuration	Sets the width (duration) of the output line pulse in microseconds.	Beginner DFNC
Output Line Value	outputLineValue	Sets the output state of the selected Line if the outputLineSoftwareLatchControl = OFF. OutputLineSource must be SoftwareControlled. If the outputLineSoftwareLatchControl = Latch , the state of the pin will change with the outputLineSoftwareCmd command.	Beginner DFNC
Active	*Active*	*Sets the Output circuit to close.*	
Inactive	*Inactive*	*Sets the Output circuit to open.*	
Output Line Software Latch Control	outputLineSoftwareLatchControl	When Off, the selected output line is set with the value in Output Line Value.	Guru DFNC
Off	*Off*	*Output pin state set by outputLineValue.*	
Latch	*Latch*	*Output pin state set by outputLineSoftwareCmd.*	

Display Name	Feature & Values	Description	Standard & View
Line Status All	LineStatusAll	Returns the current status of all available line signals, at time of polling, in a single bit field. The order is Line1, Line2 ... (RO)	Expert
Output Line Software Command	outputLineSoftwareCmd	Writing a value of 1 in the bit field applies the Latch value of the outputLineSoftwareLatchControl and/or executes the PulseOnSoftwareCmd for any output line programmed for software control. The feature outputLineSoftwareCmd can take any binary value and each bit set to 1 corresponds to a Icommand for an Output. Note that Outputs are numbered from 1 to N, therefore Bit 0 of outputLineSoftwareCmd corresponds to Output1 (Line 3); Bit 1 corresponds to Output2 (Line 4) and so on. This is applicable to OutputLineSource = *Pulse On: where Software Cmd* (for Pulse mode) or OutputLineSource = *SoftwareControlled* and OutputLineSoftwareLatchControl = *Latch* (for static states).	Expert DFNC

I/O Module Block Diagram
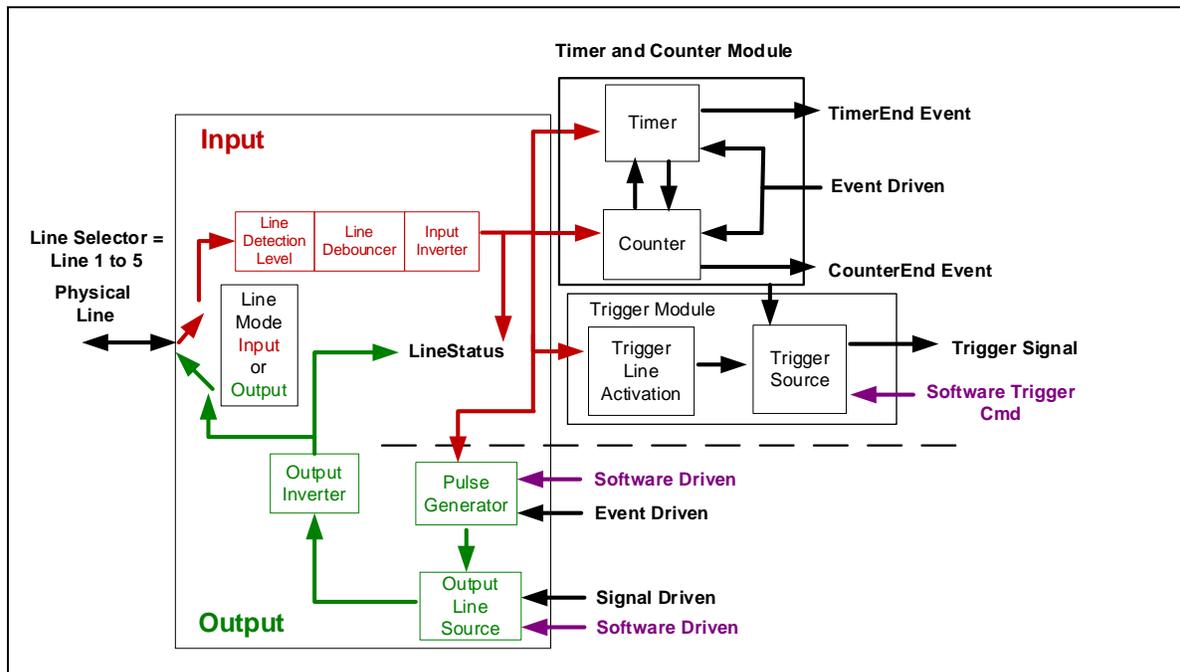
Figure 46: I/O Module Block Diagram

Counter and Timer Control Category

The Linea2 5GigE Counter and Timer Control category groups parameters used to configure acquisition counters, timers and signal edge detection.

Figure 47: CamExpert – Counter and Timer Control Category

Counter and Timer Control Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Counter Selector	counterSelector	Selects the counter to configure.	Expert DFNC
Counter 1	Counter1	*Select counter 1.*	
Counter 2	Counter2	*Select counter 2.*	
Counter Mode	counterMode	Selects the counter mode. The selected Counter is either Active or Disabled. When Disabled, the Counter can be configured.	Expert DFNC
Off	*Off*	*The selected Counter is disabled.*	
Active	*Active*	*The selected Counter is enabled.*	
Counter Status	counterStatus	Returns the current state of the counter. (RO)	Expert DFNC
Counter Idle	*CounterIdle*	*The counter is idle. The CounterStartSource feature is set to off.*	
Counter Trigger Wait	*CounterTriggerWait*	*The counter is waiting for a start trigger.*	
Counter Active	*CounterActive*	*The counter is counting for the specified duration.*	
Counter Completed	*CounterCompleted*	*The counter reached the CounterDuration count.*	
Counter Overflow	*CounterOverflow*	*The counter reached its maximum possible count.*	
Counter Start Source	counterStartSource	Select the counter start source. Counter increments from 0 to the value of the <u>counterDuration</u> feature.	Expert DFNC
CounterReset Cmd	*Off*	*The counter will start on the reception of the Counter Reset Icommand.*	
Acquisition Start	*AcquisitionStart*	*Counter starts on the reception of the Acquisition Start event.*	
Acquisition End	*AcquisitionEnd*	*Counter starts on the reception of the Acquisition End event.*	
Exposure Start	*ExposureStart*	*Counter starts on the reception of the Exposure Start event.*	
Exposure End	*ExposureEnd*	*Counter starts on the reception of the Exposure End event.*	
Exposure Start (Blue)	*ExposureStartBlue*	*Counter starts on the reception of the Exposure Start event.*	
Exposure Start (Red)	*ExposureStartRed*	*Counter starts on the reception of the Exposure Start event.*	
Exposure Start (Green)	*ExposureStartGreen*	*Counter starts on the reception of the Exposure Start event.*	
Exposure Start (NIR)	*ExposureStartNIR*	*Counter starts on the reception of the Exposure Start event.*	
Exposure End (Blue)	*ExposureEndBlue*	*Counter starts on the reception of the Exposure End event.*	
Exposure End (Red)	*ExposureEndRed*	*Counter starts on the reception of the Exposure End event.*	
Exposure End (Green)	*ExposureEndGreen*	*Counter starts on the reception of the Exposure End event.*	
Exposure End (NIR)	*ExposureEndNIR*	*Counter starts on the reception of the Exposure End event.*	
Action 1	*Action1*	*Counter starts on the reception of Action 1 event.*	
Action 2	*Action2*	*Counter starts on the reception of Action 2 event.*	
GPI Line 1	*Line1*	*Counter starts on the rising edge of signal on GPI Line 1.*	
GPI Line 2	*Line2*	*Counter starts on the rising edge of signal on GPI Line 2.*	
GPI Line 3	*Line3*	*Counter starts on the rising edge of signal on GPI Line 3.*	
GPI Line 4	*Line4*	*Counter starts on the rising edge of signal on GPI Line 4.*	
GPO Line 3	*GPOLine3*	*Counter starts on the rising edge of signal on GPO Line 3.*	
GPO Line 4	*GPOLine4*	*Counter starts on the rising edge of signal on GPO Line 4.*	
GPO Line 5	*GPOLine5*	*Counter starts on the rising edge of signal on GPO Line 5.*	
GPO Line 6	*GPOLine6*	*Counter starts on the rising edge of signal on GPO Line 6.*	
Rotary Encoder	*RotaryEncoder1*	*Counter starts on the rotary encoder signal.*	
Valid Frame Start	*FrameStart*	*Counter starts on the reception of the Frame Start event.*	
Invalid Frame Trigger	*InvalidFrameTrigger*	*Counter starts on the reception of the Invalid Frame Trigger event.*	
Valid Line Start	*LineStart*	*Counter starts on the reception of the line start event.*	

Display Name	Feature & Values	Description	Standard & View
Rejected Line Trigger	*InvalidLineTrigger*	*Counter starts on the reception of an Invalid Line Trigger event.*	
Timer 1 End	*Timer1End*	*Counter starts on the reception of the Timer 1 End event.*	
Timer 2 End	*Timer2End*	*Counter starts on the reception of the Timer 2 End event.*	
Counter 1 End	*Counter1End*	*Counter starts on the reception of the Counter 1 End event.*	
Counter 2 End	*Counter2End*	*Counter starts on the reception of the Counter 2 End event.*	
Counter Start Line Activation	counterStartLineActivation	Selects the activation mode of the input line trigger which starts the counter. This is only applicable when the counterStartSource feature selects a physical Line.	Expert DFNC
Rising Edge	*RisingEdge*	*Activate the counter on the rising edge of the selected Line.*	
Falling Edge	*FallingEdge*	*Activate the counter on the falling edge of the selected Line.*	
Any Edge	*AnyEdge*	*Activate the counter on the falling or rising edge of the selected Line.*	
Counter Incremental Source	counterIncrementalSource	Select the event source which increments the counter. (The Event Control section provides details and timing diagrams for the supported events.)	Expert DFNC
Off	*Off*	*Counter is stopped.*	
Acquisition Start	*AcquisitionStart*	*Counts the number of Acquisition Start events.*	
Acquisition End	*AcquisitionEnd*	*Counts the number of Acquisition End events.*	
Exposure Start	*ExposureStart*	*Counts the number of Exposure Start events.*	
Exposure End	*ExposureEnd*	*Counts the number of Exposure End events.*	
Exposure Start (Blue)	*ExposureStartBlue*	*Counts the number of Exposure Start events.*	
Exposure Start (Red)	*ExposureStartRed*	*Counts the number of Exposure Start events.*	
Exposure Start (Green)	*ExposureStartGreen*	*Counts the number of Exposure Start events.*	
Exposure Start (NIR)	*ExposureStartNIR*	*Counts the number of Exposure Start events.*	
Exposure End (Blue)	*ExposureEndBlue*	*Counts the number of Exposure End events.*	
Exposure End (Red)	*ExposureEndRed*	*Counts the number of Exposure End events.*	
Exposure End (Green)	*ExposureEndGreen*	*Counts the number of Exposure End events.*	
Exposure End (NIR)	*ExposureEndNIR*	*Counts the number of Exposure End events.*	
GPI Line 1	*Line1*	*Counts the number of transitions on Line 1 (based on the counterIncrementalLineActivation feature setting). See Input Signals Electrical Specifications.*	
GPI Line 2	*Line2*	*Counts the number of transitions on Line 2 (based on the counterIncrementalLineActivation feature setting).*	
GPI Line 3	*Line3*	*Counts the number of transitions on Line 3 (based on the counterIncrementalLineActivation feature setting).*	
GPI Line 4	*Line4*	*Counts the number of transitions on Line 4 (based on the counterIncrementalLineActivation feature setting).*	
GPO Line 3	*GPOLine3*	*Counts the number of transitions (based on the counterIncrementalLineActivation feature setting) of GPO Line 3.*	
GPO Line 4	*GPOLine4*	*Counts the number of transitions (based on the counterIncrementalLineActivation feature setting) of GPO Line 4.*	
GPO Line 5	*GPOLine5*	*Counts the number of transitions (based on the counterIncrementalLineActivation feature setting) of GPO Line 5.*	
GPO Line 6	*GPOLine6*	*Counts the number of transitions (based on the counterIncrementalLineActivation feature setting) of GPO Line 6.*	
Rotary Encoder	*RotaryEncoder1*	*Counter increments on the Rotary Encoder.*	
Frame Start	*FrameStart*	*Counts the number of Frame Start events.*	
Valid Frame(s) Trigger	*ValidFrameTrigger*	*Counts the number of Valid Frame(s) Trigger events.*	

Display Name	Feature & Values	Description	Standard & View
Rejected Frame(s) Trigger	InvalidFrameTrigger	Counts the number of Rejected Frames(s) Trigger events.	
Valid Line Start	LineStart	Counts the number of Line Start events.	
Valid Line Trigger	ValidLineTrigger	Counts the number of Valid Line events.	
Rejected Line Trigger	InvalidLineTrigger	Counts the number of Invalid Line events.	
Internal Clock	InternalClock	Counts the number of Internal Clock events.	
Timer 1 End	Timer1End	Counts the number of Timer End events.	
Timer 2 End	Timer2End	Counts the number of Timer End events.	
Counter Incremental Line Activation	counterIncrementalLineActivation	Selects the counter signal activation mode. The counter increments on the specified signal edge or level.	Expert DFNC
Rising Edge	RisingEdge	Increment the counter on the rising edge of the selected I/O Line.	
Falling Edge	FallingEdge	Increment the counter on the falling edge of the selected I/O Line.	
Any Edge	AnyEdge	Increment the counter on the falling or rising edge of the selected I/O Line.	
Counter Reset Source	counterResetSource	Selects the signal source to reset the counter. After a reset the counter waits for the next countStartSource signal or event.	Expert DFNC
Off	Off	Disable the Counter Reset trigger.	
Acquisition Start	AcquisitionStart	Reset Counter on reception of Acquisition Start events.	
Acquisition End	AcquisitionEnd	Reset Counter on reception of Acquisition End events.	
Exposure Start	ExposureStart	Reset Counter on reception of Exposure Start events.	
Exposure End	ExposureEnd	Reset Counter on reception of Exposure End events.	
Exposure Start (Blue)	ExposureStartBlue	Reset Counter on reception of Exposure Start events.	
Exposure Start (Red)	ExposureStartRed	Reset Counter on reception of Exposure Start events.	
Exposure Start (Green)	ExposureStartGreen	Reset Counter on reception of Exposure Start events.	
Exposure Start (NIR)	ExposureStartNIR	Reset Counter on reception of Exposure Start events.	
Exposure End (Blue)	ExposureEndBlue	Reset Counter on reception of Exposure End events.	
Exposure End (Red)	ExposureEndRed	Reset Counter on reception of Exposure End events.	
Exposure End (Green)	ExposureEndGreen	Reset Counter on reception of Exposure End events.	
Exposure End (NIR)	ExposureEndNIR	Reset Counter on reception of Exposure End events.	
GPI Line 1	Line1	Reset the Counter on the specified transitions on line 1.	
GPI Line 2	Line2	Reset the Counter on the specified transitions on line 2.	
GPI Line 3	Line3	Reset the Counter on the specified transitions on line 3.	
GPI Line 4	Line4	Reset the Counter on the specified transitions on line 4.	
GPO Line 3	GPOLine3	Reset the Counter on the specified transitions on GPO Line 3.	
GPO Line 4	GPOLine4	Reset the Counter on the specified transitions on GPO Line 4.	
GPO Line 5	GPOLine5	Reset the Counter on the specified transitions on GPO Line 5.	
GPO Line 6	GPOLine6	Reset the Counter on the specified transitions on GPO Line 6.	
Rotary Encoder	RotaryEncoder1	Reset the Counter on the rotary encoder signal.	
Valid Frame Start	FrameStart	Reset Counter on reception of Valid Frame Trigger events.	
Frame Burst End	FrameBurstEnd	Reset Counter on reception of Frame Burst End events.	
Valid Frame Trigger	ValidFrameTrigger	Reset Counter on reception of Valid Frame Trigger events.	
Rejected Frame Trigger	InvalidFrameTrigger	Reset Counter on reception of Invalid Frame Trigger events.	
Valid Line Start	LineStart	Reset Counter on reception of Line Start events.	
Rejected Line Trigger	InvalidLineTrigger	Reset Counter on reception of Invalid Line Trigger events.	

Display Name	Feature & Values	Description	Standard & View
Timer 1 End	Timer1End	Reset Counter on reception of Timer End events.	
Timer 2 End	Timer2End	Reset Counter on reception of Timer End events.	
Counter 1 End	Counter1End	Reset Counter on reception of Counter End events.	
Counter 2 End	Counter2End	Reset Counter on reception of Counter End events.	
Counter Reset Input Line Activation	counterResetLineActivation	Specify the edge transition on the selected line that will reset the selected counter.	Expert DFNC
Rising Edge	RisingEdge	Reset counter on the rising edge of the selected signal.	
Falling Edge	FallingEdge	Reset counter on the falling edge of the selected signal.	
Any Edge	AnyEdge	Reset counter on the falling or rising edge of the selected signal.	
Counter Duration	counterDuration	Sets the duration (or number of events) before the CounterEnd event is generated.	Expert DFNC
Counter Value	counterValue	Read the current value of the selected counter. (RO)	Expert DFNC
Counter Value At Reset	counterValueAtReset	Reads the value of the selected counter when it was reset by a trigger or by an explicit Counter Reset command. (RO)	Expert DFNC
Counter Reset	counterReset	Resets the selected counter to zero. The counter starts immediately after the reset. To temporarily disable the counter, set the Counter Event Source feature to Off. (WO)	Expert DFNC
Timer Selector	timerSelector	Selects which timer to configure.	Expert DFNC
Timer 1	Timer1	Select Timer 1 to configure.	
Timer 2	Timer2	Select Timer 2 to configure.	
Timer Mode	timerMode	Select the timer mode. The selected Timer is Active or Disabled. When Disabled, the Timer can be configured.	Expert DFNC
Off	Off	The selected Timer is Disabled.	
Active	Active	The selected Timer is Enabled.	
Timer Status	timerStatus	Returns the current state of the timer. (RO)	Expert DFNC
Timer Idle	TimerIdle	The timer is idle. The CounterStartSource feature is set to off.	
Timer Trigger Wait	TimerTriggerWait	The timer is waiting for a start trigger.	
Timer Active	TimerActive	The timer is counting for the specified duration.	
Timer Completed	TimerCompleted	The timer reached the TimerDuration count.	
Timer Start Source	timerStartSource	Select the trigger source to start the timer.	Expert DFNC
		The Event Control section provides details and timing diagrams for the supported events.	
TimerReset Cmd	Off	Starts with the reception of the TimerReset Icommand.	
Acquisition Start	AcquisitionStart	Start Timer on Acquisition Start event.	
Acquisition End	AcquisitionEnd	Start Timer on Acquisition End event.	
Exposure Start	ExposureStart	Timer starts on the reception of the Exposure Start event.	
Exposure End	ExposureEnd	Timer starts on the reception of the Exposure End event.	
Exposure Start (Blue)	ExposureStartBlue	Timer starts on the reception of the Exposure Start event.	
Exposure Start (Red)	ExposureStartRed	Timer starts on the reception of the Exposure Start event.	
Exposure Start (Green)	ExposureStartGreen	Timer starts on the reception of the Exposure Start event.	
Exposure Start (NIR)	ExposureStartNIR	Timer starts on the reception of the Exposure Start event.	
Exposure End (Blue)	ExposureEndBlue	Timer starts on the reception of the Exposure End event.	
Exposure End (Red)	ExposureEndRed	Timer starts on the reception of the Exposure End event.	
Exposure End (Green)	ExposureEndGreen	Timer starts on the reception of the Exposure End event.	
Exposure End (NIR)	ExposureEndNIR	Timer starts on the reception of the Exposure End event.	
Action 1	Action1	Timer starts on the reception of Action 1 event.	
Action 2	Action2	Timer starts on the reception of Action 2 event.	
GPI Line 1	Line1	Timer starts on the rising edge of signal on GPI Line 1.	

Display Name	Feature & Values	Description	Standard & View
GPI Line 2	Line2	Timer starts on the rising edge of signal on GPI Line 2.	
GPI Line 3	Line3	Timer starts on the rising edge of signal on GPI Line 3	
GPI Line 4	Line4	Timer starts on the rising edge of signal on GPI Line 4	
GPO Line 3	GPOLine3	Timer starts on the rising edge of signal on GPO Line 3.	
GPO Line 4	GPOLine4	Timer starts on the rising edge of signal on GPO Line 4.	
GPO Line 5	GPOLine5	Timer starts on the rising edge of signal on GPO Line 5.	
GPO Line 6	GPOLine6	Timer starts on the rising edge of signal on GPO Line 6.	
Rotary Encoder	RotaryEncoder1	Timer starts on the rotary encoder signal.	
Valid Frame Start	FrameStart	Timer starts on the reception of the Frame Start event.	
Frame Burst End	FrameBurstEnd	Timer starts with the reception of the Frame Burst End event.	
Valid Frame Trigger	ValidFrameTrigger	Timer starts with the reception of Valid Frame Trigger event.	
Valid Line Start	LineStart	Timer starts on the reception of the line start event.	
Rejected Line Trigger	InvalidLineTrigger	Timer starts on the reception of the Invalid Line Trigger.	
Timer 1 End	Timer1End	Start Timer on Timer 1 End event.	
Timer 2 End	Timer2End	Start Timer on Timer 2 End event.	
Counter 1 End	Counter1End	Start Timer on Counter 1 End event.	
Counter 2 End	Counter2End	Start Timer on Counter 2 End event.	
Timer Start Line Activation	timerStartLineActivation	Select the trigger activation mode which starts the timer.	Expert DFNC
Rising Edge	RisingEdge	Starts timer on the rising edge of the selected signal.	
Falling Edge	FallingEdge	Starts timer on the falling edge of the selected signal.	
Any Edge	AnyEdge	Starts timer on the falling or rising edge of the selected signal.	
Timer Duration (in us)	timerDuration	Sets the duration (in microseconds) of the timer pulse.	Expert DFNC
Timer Value	timerValue	Reads the current value (in microseconds) of the selected timer.	Expert DFNC
Timer Reset	timerReset	Resets the timer to 0 while timerStatus=TimerActive. Timer then waits for the next timerStartSource event.	Expert DFNC

Counter and Timer Group Block Diagram
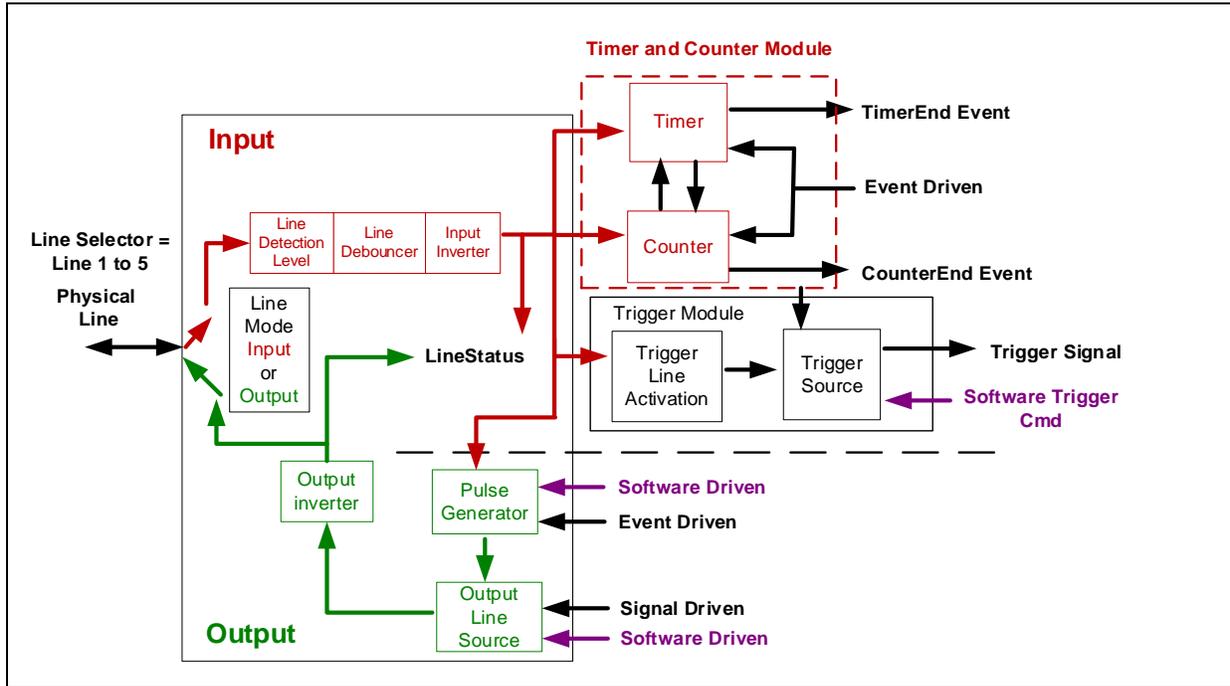
Figure 48: Counter and Timer Group Block Diagram

Example: Counter Start Source = OFF
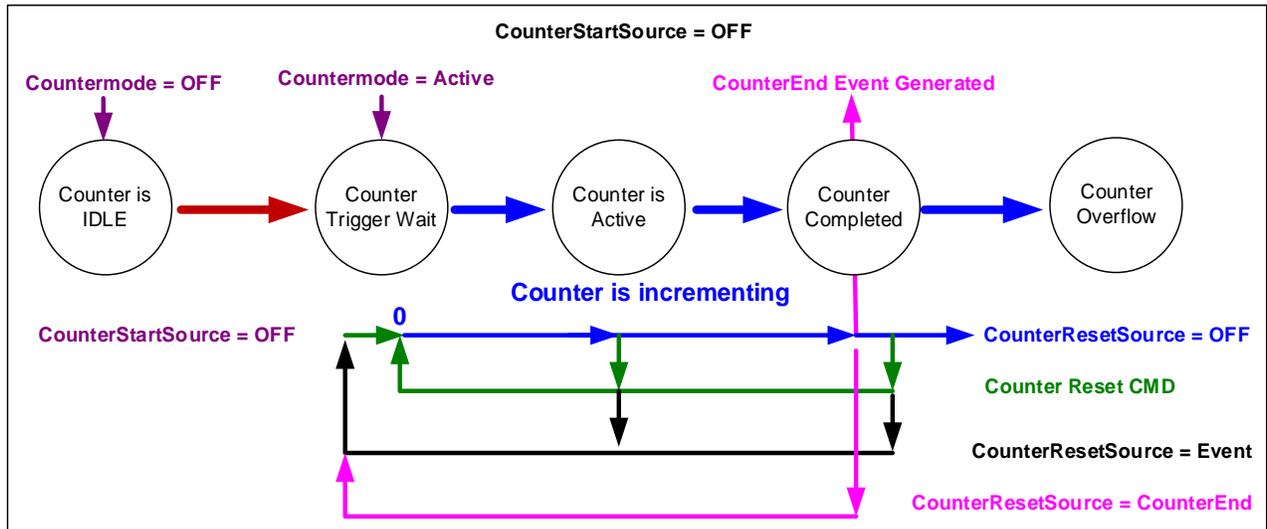
Figure 49: Example – Counter Start Source = OFF

- The counter starts on the **counterReset Cmd**.
- The counter continues unless a new **counterReset Cmd** is received, which restarts the counter at 00.
- When **Counter Reset Source = Event** or **CounterEnd** the counter is reset to 00 but does not restart counting, until the next **CounterReset Cmd**.

Example: Counter Start Source = CounterEnd (itself)
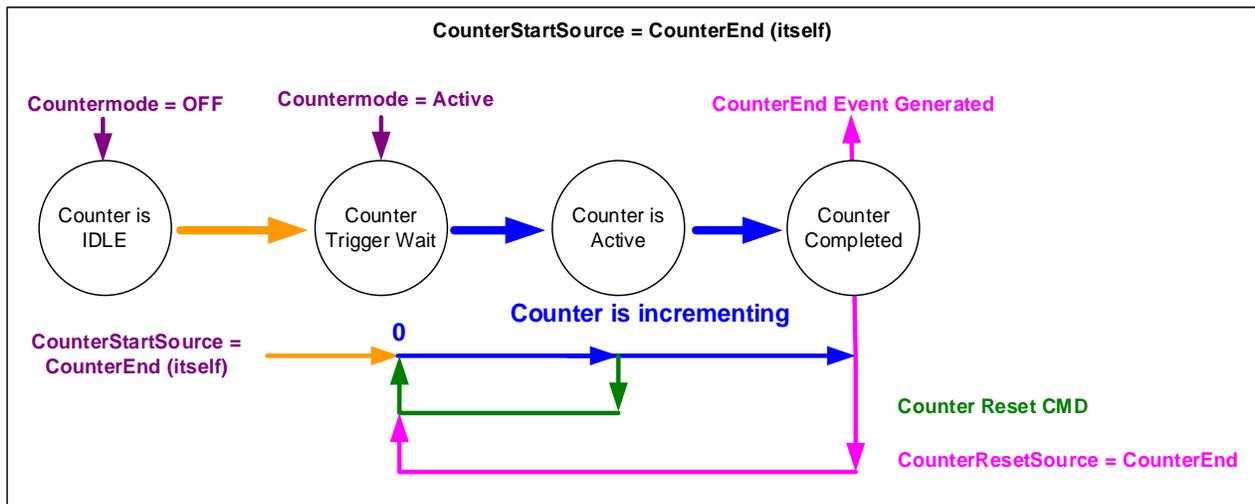
Figure 50: Example – Counter Start Source = CounterEnd

- Counter starts when **Counter Mode** is set to Active.
- A **Counter Reset CMD** will reset the counter to 00 and continues counting.
- **counterResetSource** must be set to **CounterEnd**. When the counterValue feature reaches the counterDuration value, an event is generated and the counter is reset to 00, then continues.

Example: CounterStartSource = EVENT and Signal (Edge Base)
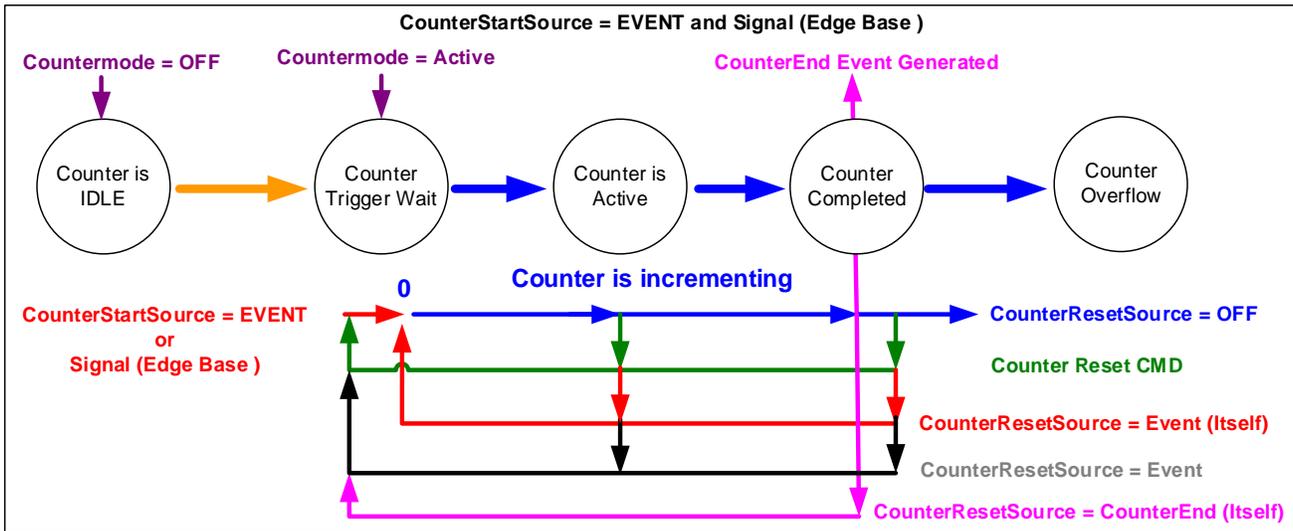
Figure 51: Example: CounterStartSource = EVENT and Signal (Edge Base)

Example: CounterStartSource = Signal (Level Base) Example 1
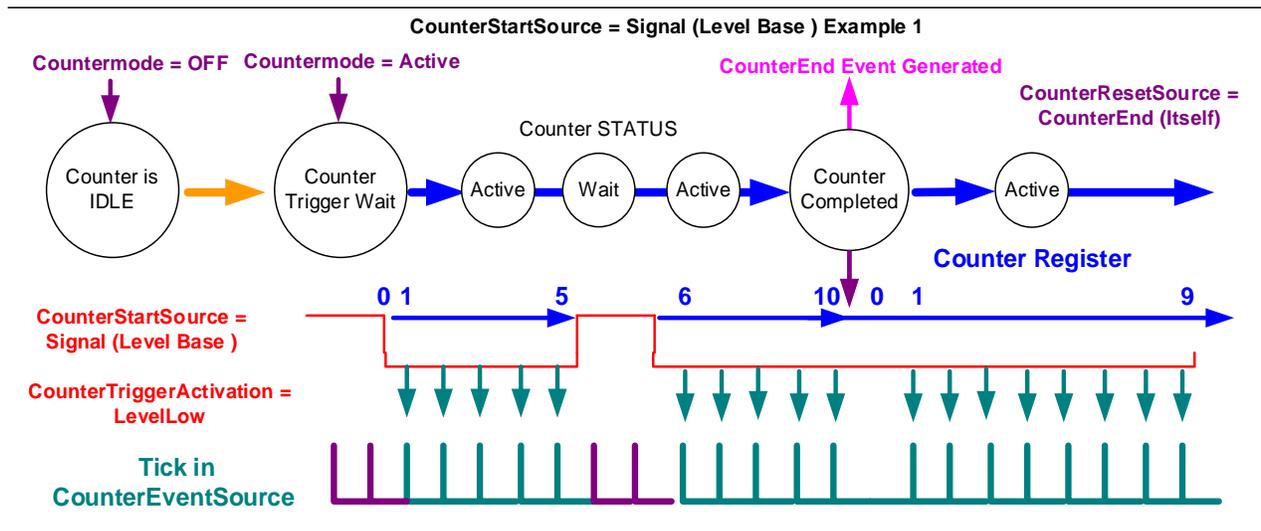
Figure 52: Example – CounterStartSource = Signal (Level Base)

Example: CounterStartSource = Line (Edge Base) Example 2
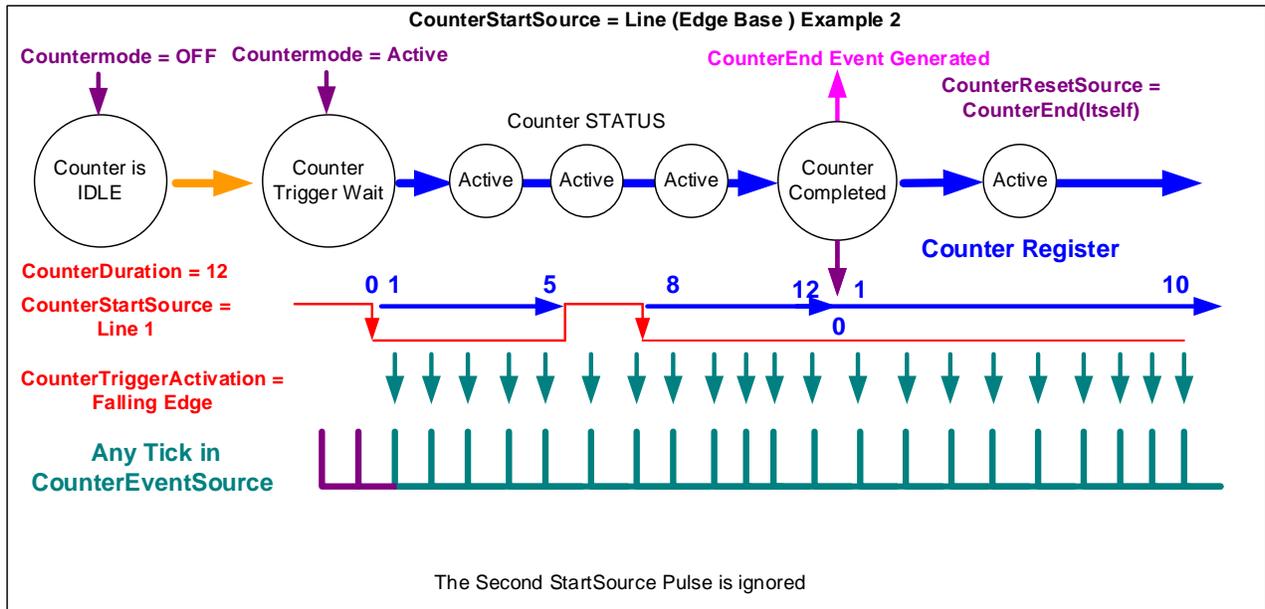
Figure 53: Example – CounterStartSource = Line (Edge Base)

Advanced Processing Category

The Linea2 5GigE Advanced Processing Control category holds lookup table (LUT) parameters, and contains two sub-categories, Flat Field Correction and Color Processing, which groups parameters used to configure flat field calibration and camera white balance/color balance features.

Figure 54: CamExpert – Advanced Processing

Figure 55: CamExpert – Advanced Processing – Flat Field Correction Category

Figure 56: CamExpert – Advanced Processing – Color Processing Category

Advanced Processing Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
LUT Mode	lutMode	Sets the enable state of the LUT module (Lookup Table).	Expert DFNC
Off	*Off*	*Disables the LUT.*	
Active	*Active*	*Enables the LUT module.*	
LUT Type	lutType	Displays the LUT type of the currently selected Lookup Table.	Expert DFNC
User Defined	*UserDefined*	*Uses the user programmable LUT.*	
Gamma Correction	*GammaCorrection*	*Uses gamma LUT.*	
Gamma Correction	gammaCorrection	Sets the gamma correction factor (i.e. inverse gamma). The gamma correction is applied as an exponent to the original pixel value.	Expert DFNC
LUT Selector	LUTSelector	Selects which LUT to control and adjust features.	Guru DFNC
Luminance 1	*Luminance1*	*LUT Luminance 1 is under control.*	
LUT Size	lutSize	Specify the LUT size of the selected LUT (Lookup Table). Available choices are model dependent.	Guru DFNC
8 Bits/Pixel	*Bpp8*	*8 bits per pixel.*	
10 Bits/Pixel	*Bpp10*	*10 bits per pixel.*	
12 Bits/Pixel	*Bpp12*	*12 bits per pixel.*	
LUT Index	LUTIndex	Selects the index (offset) of the coefficient to access in the selected LUT.	Guru
LUT Value	LUTValue	Returns the value at specified LUT index entry of the LUT selected by the LUT Selector feature.	Guru

Flat Field Correction Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Flat Field Correction Mode	flatfieldCorrectionMode	Sets the mode for the Flat Field correction.	Beginner DFNC
Off	Off	*Flat Field Correction is disabled.*	
Active	Active	*Flat Field Correction is enabled.*	
Calibration	Calibration	*When this mode is selected, the camera is configured for flat field correction calibration. The device may automatically adjust some of its features when calibrate mode is enabled. The features that are automatically adjusted are device specific. The device will not restore these features when the Flat Field Correction Mode feature is changed from Calibrate mode to another mode.*	
Flat Field Correction Current Active Set	flatfieldCorrectionCurrentActiveSet	Specifies the current set of Flat Field coefficients to use.	Beginner DFNC
Factory Flatfield	FactoryFlatfield	*Sets the factory Flat Field coefficient table as the current Flat Field.*	
User Flatfield 1	UserFlatfield1	*Sets User Flat Field 1 coefficient table as the current Flat Field.*	
User Flatfield 2	UserFlatfield2	*Sets User Flat Field 2 coefficient table as the current Flat Field.*	
User Flatfield 3	UserFlatfield3	*Sets User Flat Field 3 coefficient table as the current Flat Field.*	
User Flatfield 4	UserFlatfield4	*Sets User Flat Field 4 coefficient table as the current Flat Field.*	
Flat Field Correction Type	flatfieldCorrectionType	Specifies the Flat Field correction type.	Guru DFNC
Line-Based	LineBase	*Flat field correction is based on a single line of gain and offset coefficients.*	
Flat Field Correction Algorithm	flatfieldCorrectionAlgorithm	Specifies the Flat Field correction algorithm to use.	Guru DFNC
Method 1	Method1	*The following formula is used to calculate the flat field corrected pixel: newPixelValue[x][y] = (sensorPixelValue[x][y] - FFCOffset[x] [y]) * FFCGain[x] [y]*	
Flat Field Calibration Algorithm	flatfieldCorrectionCalibrationAlgorithm	Specifies the flatfield calibration algorithm to use.	Guru DFNC
Peak	Peak	*Each pixel is gained up to the brightest.*	
Set Target	Target	*Each pixel is gained up to the value specified in the flatfieldCalibrationTarget feature.*	
Flat Field Calibration Target (in DN)	flatfieldCalibrationTarget	Sets the target pixel value for the gain (PRNU) calibration.	Expert DFNC
Flat Field Calibration Sample Size	flatfieldCalibrationSampleSize	Set flat field calibration sample size (number of lines to sum).	Guru DFNC
2048	Lines_2048	*2048*	
4096	Lines_4096	*4096*	
Flat Field Calibration Row Selector	flatfieldCalibrationColorSelector	Selects which row/color is calibrated.	Beginner DFNC
All Rows	All	*All rows calibrated.*	
Blue	Blue	*Blue row calibrated.*	
Red	Red	*Red row calibrated.*	
Green	Green	*Green row calibrated.*	
NIR	NIR	*NIR row calibrated.*	
Flat Field Calibration Offset X	flatfieldCalibrationROIOffsetX	Sets the ROI Offset X.	Guru DFNC
Flat Field Calibration Width	flatfieldCalibrationROIWidth	Sets the ROI Width.	Guru DFNC

Display Name	Feature & Values	Description	Standard & View
Calibrate FPN	flatfieldCalibrationFPN	Performs Fixed Pattern Noise (FPN) calibration by reducing to zero dark pixel current using a pixel offset.	Guru DFNC
Calibrate PRNU	flatfieldCalibrationPRNU	Performs Photo Response Non-Uniformity (PRNU) calibration to a targeted, user-defined value. PRNU calibration eliminates the difference in responsivity between the most and least sensitive pixel, creating a uniform response to light.	Guru DFNC
Save Calibration	flatfieldCalibrationSave	Save the calibration performed by flatfieldCalibrationFPN and flatfieldCalibrationPRNU to the active set.	Expert DFNC
Reset Coefficients	flatfieldResetCoefficients	Reset all FFC coefficients to pass-through, namely, Offset = 0; Gain = 1.	Expert DFNC
Flat Field Correction Row Selector	flatfieldCorrectionColorSelector	Selects which row/color's gain/offset value is displayed.	Beginner DFNC
Red	*Red*	*Row Red Correction.*	
Green	*Green*	*Row Green Correction.*	
Blue	*Blue*	*Row Blue Correction.*	
NIR	*NIR*	*Row NIR Correction.*	
Flat Field Correction Pixel X Coordinate	flatfieldCorrectionPixelXCoordinate	Specifies the X coordinate of the flat field pixel coefficient to access.	Guru DFNC
Flat Field Correction Gain	flatfieldCorrectionGain	Sets the gain to apply to the currently selected pixel.	Guru DFNC
Flat Field Correction Offset	flatfieldCorrectionOffset	Sets the offset to apply to the currently selected pixel.	Guru DFNC

Color Processing Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Automatic White Balance	BalanceWhiteAuto	Controls the mode for automatic white balancing between the color channels. The color gains are automatically adjusted.	Expert
Off	*Off*	*White balancing is manually controlled using BalanceRatio[Red], BalanceRatio[Green], and BalanceRatio[Blue].*	
On Demand	*OnDemand*	*White balancing is automatically adjusted once by the device.*	
White Balance Gain Adjustment Option	balanceWhiteAutoMethod	Selects the method for automatic white balancing between digital and analog gain adjustment.	Expert DFNC
Digital Gains	*DigitalGains*	*White balancing is performed by adjusting digital gains.*	
White Balance On-Demand Cmd	balanceWhiteAutoOnDemandCmd	Executes the automatic white balance function. The first frame acquired is used to calculate the RGB gain adjustments, which are then applied to subsequent snaps or grabs.	Expert DFNC
Color Correction Mode	colorCorrectionMode	Sets the color correction feature (RGB gains) to manual or automatic.	Expert DFNC
Off	*Off*	*The RGB gains are manually controlled using the Gain feature.*	
Active	*Active*	*The RGB gains are automatically controlled by the color correction matrix.*	
Color Correction Current Active Set	colorCorrectionCurrentActiveSet	Specifies the active set of color correction coefficients.	Beginner DFNC
Factory Preset	*FactoryPreset*	*Loads the factory color correction coefficient set as the active set.*	
User Defined	*UserDefined*	*Loads a user-defined color correction coefficient set as the active set.*	

Display Name	Feature & Values	Description	Standard & View
Color Correction Matrix Value Selector	colorCorrectionMatrixValueSelector	Selects the Gain Factor or Offset of the color correction matrix to configure.	Guru DFNC
Gain00(RR)	*Gain00*	*Red equation, gain of the red pixel.*	
Gain01(RG)	*Gain01*	*Red equation, gain of the green pixel.*	
Gain02(RB)	*Gain02*	*Red equation, gain of the blue pixel.*	
Gain10(GR)	*Gain10*	*Green equation, gain of the red pixel.*	
Gain11(GG)	*Gain11*	*Green equation, gain of the red green.*	
Gain12(GB)	*Gain12*	*Green equation, gain of the red blue.*	
Gain20(BR)	*Gain20*	*Blue equation, gain of the red pixel.*	
Gain21(BG)	*Gain21*	*Blue equation, gain of the green pixel.*	
Gain22(BB)	*Gain22*	*Blue equation, gain of the blue pixel.*	
Offset0(R)	*Offset0*	*Red equation offset value to add.*	
Offset1(G)	*Offset1*	*Green equation offset value to add.*	
Offset2(B)	*Offset2*	*Blue equation offset value to add.*	
Color Correction Matrix Value	colorCorrectionMatrixValue	Represents the value of the selected Gain or Offset inside the correction matrix.	Guru DFNC

Lookup Table (LUT) Overview

The Linea2 camera includes a user programmable LUT table as a component of its embedded processing features. A LUT is used for operations such as gamma adjustments, invert and threshold processes.

Camera LUT tables are dependent on the sensor, which is illustrated in the following figure. Pixel data from the sensor is passed through the LUT memory array, where the new programmed pixel value is then passed to the Linea2 output circuit. The LUT data table is stored along with other parameters with the user configuration function.
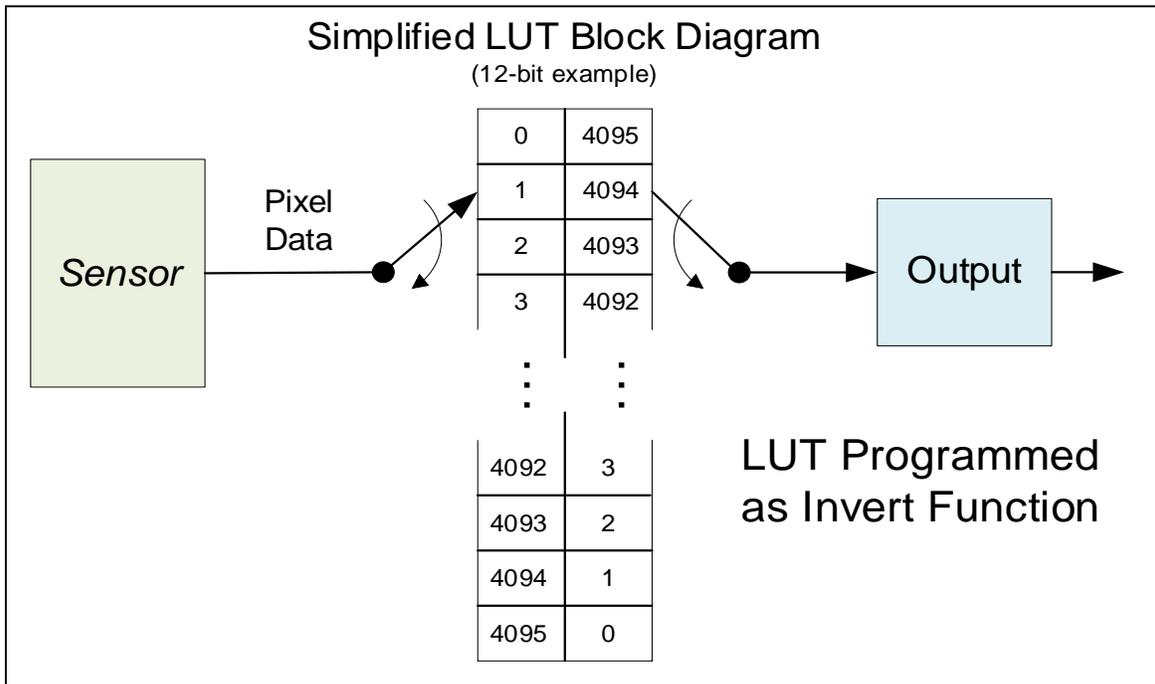
Figure 57: Example of a 12-bit LUT Invert Function

LUT Size vs. Output Pixel Format

The LUT size will be the same as the sensor pixel size. All camera processing is performed at the sensor pixel format of the camera, while the user chooses the output pixel format (such as 8-bit).

Using the example of a 12-bit camera, the LUT table is also 12-bit. The Linea2 default neutral LUT programming is as follows:

- When the **Output Pixel format = 12-bit**, the default LUT data value is equal to the LUT index value for each index. This is a linear LUT that does not modify the sensor data.
- When the **Output Pixel format = 8-bit**, the default LUT data is programmed to map the 4096 sensor pixel values to 256 output values. Therefore, LUT indices "0 to 15" have value "0", LUT indices "16 to 31" have value "1", and so on.

LUT data is selected either as a predefined gamma correction, or is programmed with individual values for various LUT index entries; a user LUT data file may be uploaded using the File Access control. Refer to the Sapera documentation for information about the SapLut Class. Note that a SapLut file can be uploaded to the device but cannot be read back.

Gamma Correction Factor

The following graphic shows LUT output data as a function of the gamma correction factor programmed by the user. An 8-bit LUT is shown as an example. Note that the graphic is not to scale.

- As Gamma Correction is reduced in value to the minimum allowed, the nonlinear output of acquisition data through the LUT effectively boosts low value data.
- As Gamma Correction is increased in value to the maximum allowed, the nonlinear output of acquisition data through the LUT effectively reduces low value data.
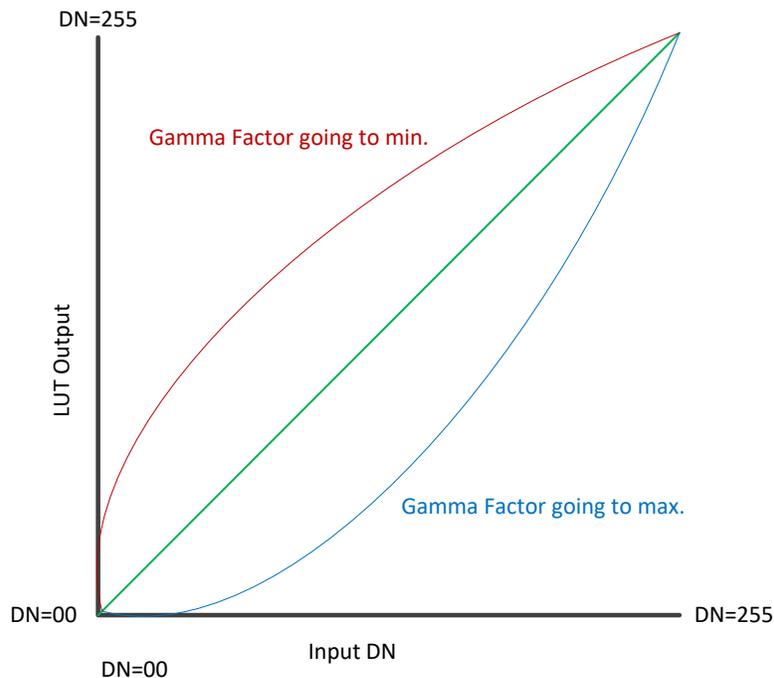
Figure 58: Depiction of a gamma function.

Color Processing Overview

Linea2 color cameras provide on-demand automatic White Balance and Color Correction features.

Note: computer monitors have wide color variations. Users should use professional monitors which have factory calibrated fixed presets conforming to sRGB or AdobeRGB color spaces.

White Balance Operation

The Linea2 white balance control uses an automatic algorithm executing on demand. Automatic mode operates under the assumption of a color neutral scene.

Color Correction Matrix

Linea2 color models support the use of a color correction matrix for adjusting the color output of the camera.

Sapera LT SDK includes the Sapera Color Calibration tool, which allows you to generate color correction coefficients that are used to adjust the sensor's color response for known colors at a specific illumination. This ensures that the camera outputs the correct color for a given scene.

The color correction coefficients (3 x 4 matrix) are saved as a *.ccor file that can be uploaded to the camera to perform real-time correction using the camera's hardware (instead of performing correction on the host computer after the image transfer).

The Sapera Color Calibration tool is available from Windows **Start** menu under **Teledyne DALSA Sapera LT**. Refer to the tool's online help for information about generating coefficients.

Image Format Control Category

The Linea2 5GigE Image Format Control category group parameters used to configure image size and format. An internal test image function is used to qualify camera setup without a lens.

Figure 59: CamExpert – Image Format Controls Category

Image Format Control Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Data Stream Selector	dataStreamSelector	Select which data stream to control (default is Stream 1).	Beginner DFNC
Stream1	Stream1	*Adjust parameters for Stream1.*	
Data Stream Type	dataStreamType	This feature is used to select or retrieve the transfer protocol used to stream blocks.	Beginner DFNC
Image	Image	*The Image data blocks are streamed using the payload type "Image".*	
Image_MetaData	Image_MetaData	*The Image_MetaData blocks are streamed using the payload type "Extended Chunk Data with Image".*	
Pixel Format	PixelFormat	Format of the pixel provided by the device. Contains all information as provided by PixelCoding, PixelSize, PixelColorFilter, combined in one single value.	Beginner
BGR 8-Bit Packed	BGR8	*Color camera: BGR8.*	
BGRA 8-Bit Packed	BGRa8	*Color Camera: BGRA8.*	
BGR 12-Bit	BGR12	*Color camera: BGR12*	
BGRA 12-Bit	BRa12	*Color camera: BFRA12*	
Pixel Size	PixelSize	Total size in bits of an image pixel. <RO>	Guru
24 Bits/Pixel	Bpp24	*Bpp24: 24-bits per pixel.*	
32 Bits/Pixel	Bpp32	*Bpp32: 32-bits per pixel.*	
64 Bits/Pixel	Bpp64	*Bpp64: 64 bits per pixel.*	

Display Name	Feature & Values	Description	Standard & View
Sensor Component *NIR*	sensorComponentSelector *nir*	Controls the enable state of the sensor lines. *Enable sensor NIR line.*	Beginner DFNC
Component Enable	sensorComponentEnable	Enable or disable sensor line.	Beginner DFNC
Horizontal Offset	OffsetX	Horizontal offset from the Sensor Origin to the Area Of Interest (in pixels), offset maximum is limited to 4096 minus the width of AOI measured in pixels.	Beginner
Width	Width	Width of Image provided by the device (in pixels).	Beginner
Height	Height	Height of the Image provided by the device (in lines).	Beginner
Horizontal Flip	ReverseX	Horizontal image flip function.	Expert
Multiple ROI Mode *Off* *Active*	MultipleROIMode *Off* *Active*	Enable the Multiple ROI (Region of Interest) per image feature. The ROI Count is set by the Multiple ROI Count feature. *Single ROI per image.* *The ROI per image feature is active.*	Expert DFNC
ROI Count Horizontal	multipleROICountHorizontal	Specifies the number of ROI (Region of Interest) available for the X axis.	Expert DFNC
ROI Selector *ROI (x1, y1)* *ROI (x2, y1)* *ROI (x3, y1)* *ROI (x4, y1)*	multipleROISelector *roi1_1* *roi2_1* *roi3_1* *roi4_1*	Select an ROI (Region of Interest) when Multiple ROI Mode is enabled. Selector range is from 1 to the Multiple ROI Count value. *ROI (x1, y1)* *ROI (x2, y1)* *ROI (x3, y1)* *ROI (x4, y1)*	Expert DFNC
ROI Offset X	multipleROIOffsetX	Horizontal offset (in pixels) from the origin to the selected ROI (Region of Interest).	Expert DFNC
ROI Width	multipleROIWidth	Width of the selected ROI (Region of Interest) provided by the device (in pixels).	
Binning Selector *In Digital Domain*	binningSelector *InDigitalDomain*	Select how the Horizontal and Vertical Binning is done. The Binning function can occur in the digital domain of a device or at the actual sensor. *The Binning function can be done inside the device but with a digital processing function. Binning doesn't affect the current data rate from the sensor or camera.*	Beginner DFNC
Binning Mode *Sum* *Average*	binningMode *Sum* *Average*	Sets the mode used to combine pixels together when BinningHorizontal and/or BinningVertical is greater than 1. *The responses from the individual pixels are added together, resulting in increased sensitivity.* *The responses from the individual pixels are averaged, resulting in increased signal to noise ratio.*	Beginner DFNC
Binning Horizontal	BinningHorizontal	Number of horizontal pixels to combine together using the method selected by binningMode. This reduces the horizontal resolution of the image.	Beginner
Binning Vertical	BinningVertical	Number of vertical pixels to combine together using the method selected by binningMode. This reduces the vertical resolution of the image.	Beginner

Display Name	Feature & Values	Description	Standard & View
Test Image Selector	TestImageSelector	Selects the type of test image that is sent by the camera.	Beginner
Off	*Off*	*Image is from the camera sensor.*	
Horizontal Ramp	*HorizontalRamp*	*Image is filled horizontally with an image in which each color goes from the darkest possible value to the brightest, wrapping at pixel 4096. The darkest point of each color is offset in the order NIR (if available), Green, Red, Blue, such that no two colors have the same value at a given pixel. The visual effect is vertical bands where each color rolls over from brightest to darkest.*	DFNC
Vertical Ramp	*VerticalRamp*	*Image is filled vertically with an image that goes from the darkest possible value to the brightest, wrapping at row 239. The darkest point of each color is offset in the order NIR (if available), Green, Red, Blue, such that no two colors have the same value at a given row. The visual effect is horizontal bands where each color rolls over from brightest to darkest.*	DFNC
Diagonal Ramp Moving	*DiagonalRampMoving*	*Image is filled horizontally and vertically with an image that goes from the darkest possible value to the brightest in increments of 1 DN increment per pixel and that moves horizontally from right to left at each frame by one pixel. The darkest point of each color is offset in the order NIR (if available), Green, Red, Blue, such that no two colors have the same value at a given pixel.*	DFNC
Fixed Offset	*FixedOffset*	*Image is fixed value for each color. In order from lowest to highest: NIR (if available), Blue, Red, Green.*	DFNC

Multiple ROI Mode

The Linea2 implements a Multiple ROI Mode, which lets you define up to four horizontal regions of interest (ROIs). An ROI is defined by its starting offset and the number of horizontal pixels to grab. The ROIs are combined as one output image, reducing transfer bandwidth requirements.

Note that ROIs cannot overlap.

To define multiple ROIs

- Set Multiple ROI Mode to *Active*.
- Set ROI Count Horizontal to the desired number of ROIs.
- Select an ROI in the ROI Selector feature (ROIs are identified as ROI (x1,y1), ROI (x2,y1), etc.), and specify:
  - ROI Offset X: the number of pixels to skip from the leftmost pixel.
  - ROI Width: the number of pixels to grab.
- Repeat for each ROI.

The display will show the combined ROIs. For instance, the following figure depicts a horizontal ramp test image without ROI, and with 2 ROIs.
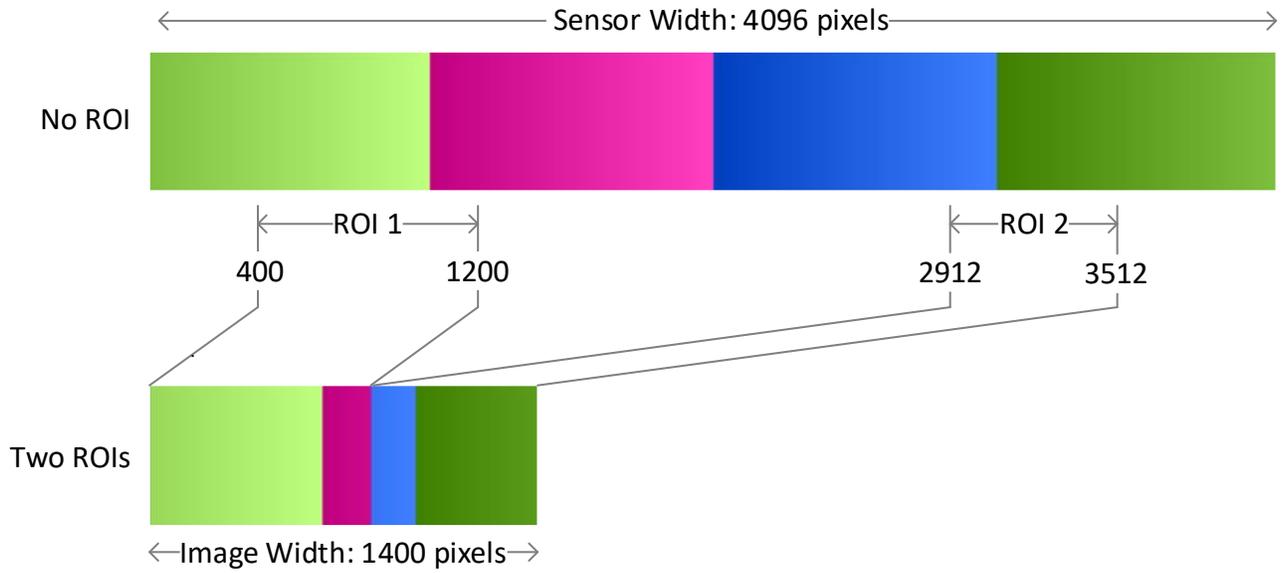
Figure 60: (Top) Test image without ROI. The entire width of the sensor is displayed. (Bottom) Multiple ROI Mode activated with two ROIs: ROI 1 has an offset of 400 pixels and is 800 pixels wide; ROI 2 has an offset of 2912 pixels and is 600 pixels wide. Both ROIs are combined to form an image 1400 pixels wide.

Metadata Control Category

The Metadata Controls category groups features to enable and select inclusion of chunk data with the image payload (as specified by the specification GigE Vision 1.2).
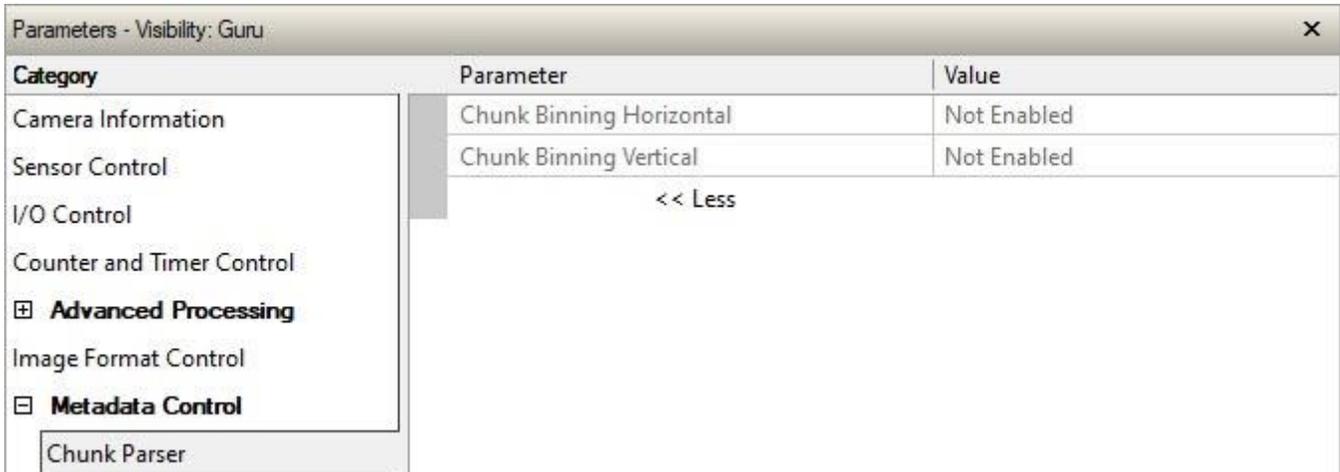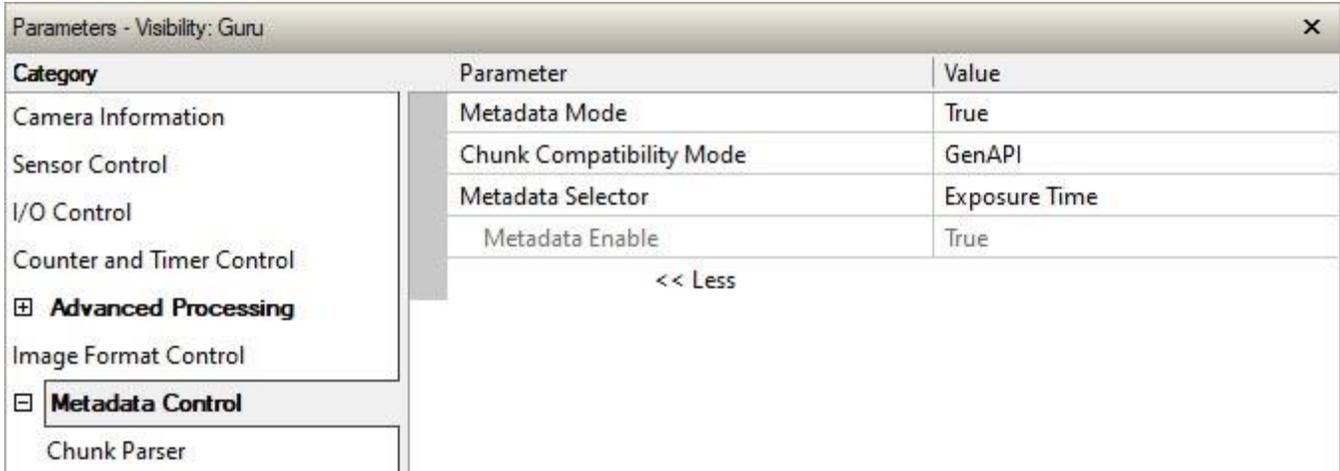
Figure 61: CamExpert – (Top) Metadata Category. (Bottom) Chunk Parser subcategory.

Metadata Controls Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Metadata Mode	ChunkModeActive	Activates the inclusion of chunk data (metadata) in the payload of the image.	Expert
	False	*No chunk data.*	
	True	*Chunk data included in payload.*	
Chunk Compatibility Mode	chunkCompatibilityMode	Selects the format of the chunk data (metadata) in the payload of the image.	Beginner DFNC
Gen API	*GenAPI*	*Metadata compatible with GenICam GenAPI.*	

Display Name	Feature & Values	Description	Standard & View
Metadata Selector	ChunkSelector	Selects the specific metadata to control, when enabled.	Expert
Offset X	*OffsetX*	*Add the OffsetX value used during the image acquisition to the metadata attached to the image.*	
Offset Y	*OffsetY*	*Add the OffsetY value used during the image acquisition to the metadata attached to the image.*	
Width	*Width*	*Add the Width value used during the image acquisition to the metadata attached to the image.*	
Height	*Height*	*Add the Height value used during the image acquisition to the metadata attached to the image.*	
Pixel Format	*PixelFormat*	*Add the PixelFormat value used during the image acquisition to the metadata attached to the image.*	
Exposure Time	*ExposureTime*	*Add the ExposureTime value used during the image acquisition to the metadata attached to the image.*	
Timestamp	*Timestamp*	*Copies the timestampValue value at the start of exposure to the metadata attached to the image.*	
Line Status All	*LineStatusAll*	*Copies the LineStatusAll value at the start of exposure to the metadata attached to the image.*	
Gain	*Gain*	*Add the Gain feature value used during the image acquisition to the metadata attached to the image.*	
counter1ValueAtReset	*counter1ValueAtReset*	*Copies the value of the feature "counterValueAtReset" at the start of Frame Readout, to the Metadata attached to the image. Supported only in GenAPI compatibility mode.*	
DeviceID	*DeviceID*	*Add the DeviceID value to the metadata attached to the image.*	
DeviceUserID	*DeviceUserID*	*Add the DeviceUserID value to the metadata attached to the image.*	
TestImageSelector	*TestImageSelector*	*Add the TestImageSelector value used during the image acquisition to the metadata attached to the image.*	
BinningVertical	*BinningVertical*	*Add the BinningVertical value used during the image acquisition to the metadata attached to the image.*	
BinningHorizontal	*BinningHorizontal*	*Add the BinningHorizontal value used during the image acquisition to the metadata attached to the image.*	
ExposureDelay	*ExposureDelay*	*Add the ExposureDelay value used during the image acquisition to the metadata attached to the image. Supported only in GenAPI compatibility mode.*	
Metadata Enable	ChunkEnable	Sets the enable state of the selected metadata. When enabled, the metadata is included in the payload of the image.	Expert
	False	*Selected metadata disabled*	
	True	*Selected metadata enabled.*	
Chunk Binning Horizontal	ChunkBinningHorizontal	Number of horizontal pixels to combine in the payload image.	Guru
Chunk Binning Vertical	ChunkBinningVertical	Number of vertical pixels to combine in the payload image.	Guru

Extracting Metadata Stored in a Sapera Buffer

For Sapera LT developers, the SapMetadata class (included with Sapera LT version 8.10 and higher) provides functions for manipulating image metadata. Metadata is appended to the end of virtual frame buffers; Sapera LT automatically adjusts the buffer size to accommodate metadata.

Sapera provides two methods to view metadata. The Sapera CamExpert tool provides a tab (when the Metadata feature is enabled) to view the metadata of the last frame capture.
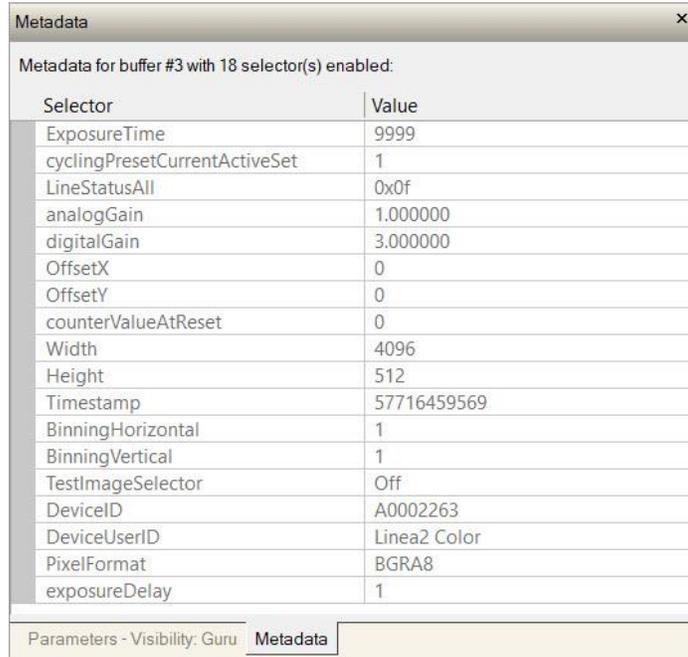
Selector	Value
ExposureTime	9999
cyclingPresetCurrentActiveSet	1
LineStatusAll	0x0f
analogGain	1.000000
digitalGain	3.000000
OffsetX	0
OffsetY	0
counterValueAtReset	0
Width	4096
Height	512
Timestamp	57716459569
BinningHorizontal	1
BinningVertical	1
TestImageSelector	Off
DeviceID	A0002263
DeviceUserID	Linea2 Color
PixelFormat	BGRA8
exposureDelay	1

Figure 62: CamExpert – Metadata Tab

Alternatively, Sapera LT provides a demo program called GigEMetaDataDemo.exe which will grab a number of frames and display the metadata or save it to a file (.csv). In addition, source code and C++ project files are included for a console-based executable.

⚠️	When an internal test pattern image is selected, the Metadata feature values for Exposure Time and Exposure Delay are not valid values and must be ignored.
	When in free-running (not triggered) mode, the Metadata value for feature Exposure Delay is not a valid value and must be ignored.
	The value of <u>LineStatusAll</u> is updated on the start of exposure.

The following figure shows Sapera Explorer with the Metadata Example highlighted.
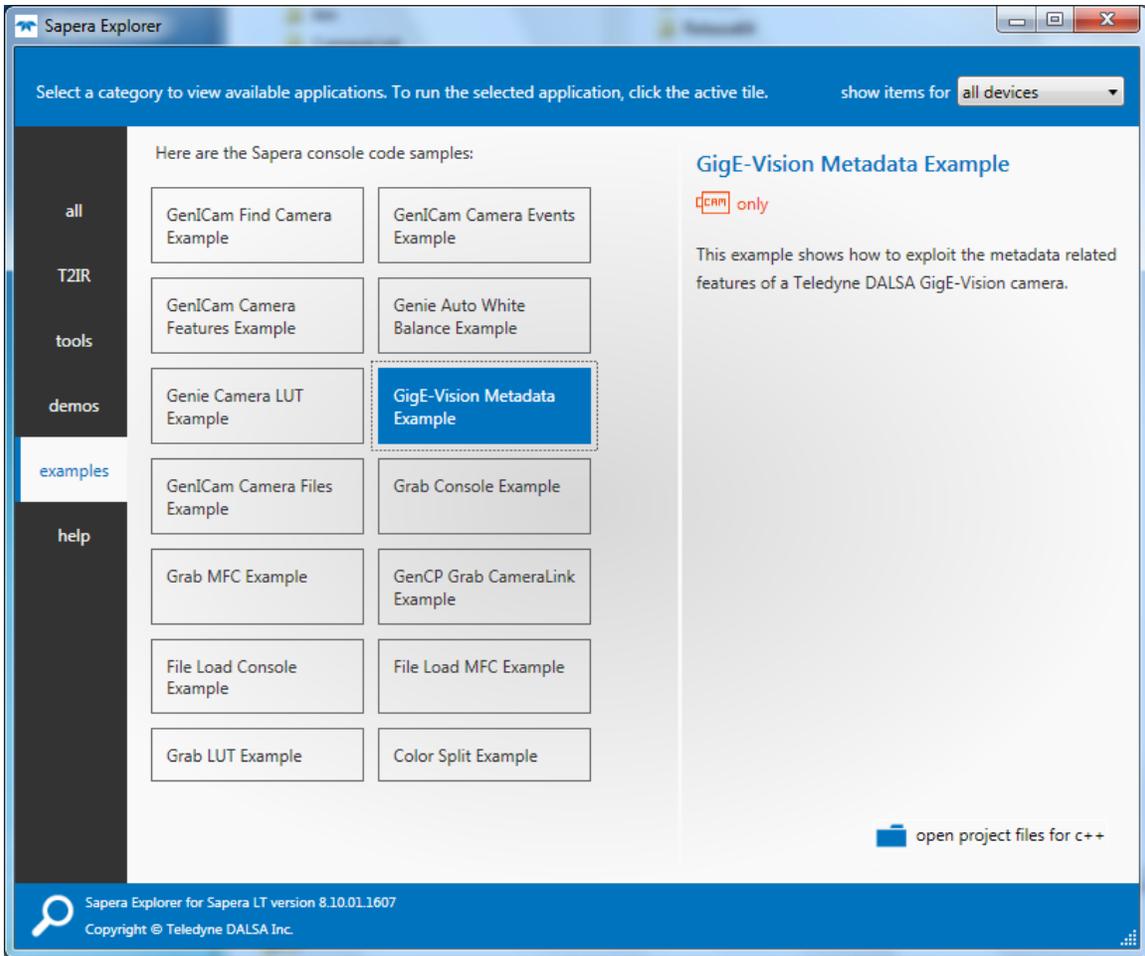
Figure 63: Sapera Explorer

Acquisition and Transfer Control Category

The Linea2 5GigE Acquisition and Transfer Control category groups parameters used to configure the optional acquisition modes of the device. These features provide the mechanism to either have acquisitions coupled to transfers (basic mode) or to decouple acquisitions from both the camera transfer module and the host transfer module.

Figure 64: CamExpert – Acquisition and Transfer Control Category

Acquisition and Transfer Control Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Acquisition Status Selector	AcquisitionStatusSelector	Selects the internal acquisition signal to read using *AcquisitionStatus*.	Expert
Acquisition Trigger Wait	AcquisitionTriggerWait	*Device is currently waiting for a trigger to start acquisition.*	
Acquisition Active	AcquisitionActive	*Device is currently doing an acquisition of one or many frames.*	
Acquisition Status	AcquisitionStatus	Reads the state of the internal acquisition signal selected using the *AcquisitionStatusSelector* feature.	Expert

Display Name	Feature & Values	Description	Standard & View
Acquisition Mode	AcquisitionMode	Set the acquisition mode of the device. It defines the number of frames to capture during an acquisition and the way the acquisition stops.	Beginner
Single Frame	*SingleFrame*	*One frame is captured for each AcquisitionStart Command. An AcquisitionStop occurs at the end of the Active Frame.*	
Multi-Frame	*MultiFrame*	*A sequence of frames is captured for each AcquisitionStart Command. The number of frames is specified by AcquisitionFrameCount feature. An AcquisitionStop occurs at the end of the Active Frame(s).*	
Continuous	*Continuous*	*Frames are captured continuously with AcquisitionStart until stopped with the AcquisitionStop command.*	
Acquisition Stop Mode	AcquisitionStopMode	Controls how the AcquisitionStop command and the acquisition stopped using a trigger, ends on an ongoing frame.	Beginner
Complete	*Complete*	*When stopped during a frame, the device will continue acquisition of lines until the specified height is reached to deliver a complete default size frame*	
Immediate With Padding	*ImmediateWithPadding*	*Acquisition stops immediately even during a frame but the remaining of the frame will be padded with data to deliver a complete default height frame.*	
Complete With Padding on Timeout	*CompleteWithPaddingOnTimeout*	*When stopped during a frame, the device will continue acquisition of lines until the specified height is reached or a trigger timeout occurs. In the case of a timeout the remaining frame will be padded with data to deliver a complete default height frame.*	DFNC
Acquisition Frame Count	AcquisitionFrameCount	Number of frames to be acquired in MultiFrame acquisition mode.	Beginner
Acquisition Arm Cmd	AcquisitionArm	Arms the device before an AcquisitionStart command. This optional command validates all the current features for consistency and prepares the device for a fast start of the acquisition. If not used explicitly, this command is automatically executed at the first AcquisitionStart but will not be repeated for subsequent ones unless a data transfer related feature is changed in the device. (WO)	Guru
Acquisition Start Cmd	AcquisitionStart	Start image capture using the currently selected acquisition mode. The number of frames captured is specified by AcquisitionMode feature. (WO)	Beginner
Acquisition Stop Cmd	AcquisitionStop	Stops the Acquisition of the device at the end of the current frame unless the triggerFrameCount feature is greater than 1. (WO)	Beginner
Acquisition Abort Cmd	AcquisitionAbort	Aborts the acquisition immediately. This ends the capture without completing the current Frame or aborts waiting on a trigger. If no acquisition is in progress, the command is ignored. (WO)	Beginner
Internal Acquisition FPS (in Hz)	internalAcquisitionFPS	Specifies the camera internal frame rate, in Hz. Use the AcquisitionFrameRate feature to control this value.	Guru DFNC
Resulting Frame Rate	resultingTransferFPS	Reports the transfer frame rate based on the current *AcquisitionFrameRate* and *internalAcquisitionFrameDropCount*. This feature does not take bandwidth limitations into account.	Guru DFNC
Transfer Control	TransferControlMode	Sets the method used to control the transfer.	Expert
Basic	*Basic*	*Basic mode ensures maximum compatibility but does not allow for control of the transfer flow.*	
User Controlled	*UserControlled*	*Manual mode allows maximum control of the transfer flow.*	

Display Name	Feature & Values	Description	Standard & View
Transfer Mode	TransferOperationMode	Sets the operation mode of the transfer.	Expert
Continuous	*Continuous*	*Blocks are transferred continuously until stopped with the TransferStop command.*	
Multi Block	*MultiBlock*	*The transfer terminates after the transition on TransferBlockCount or before on a user request.*	
Transfer Block Count	TransferBlockCount	Specifies the number of Data Blocks the device must stream during the next transfer.	Expert
Transfer Queue Mode	TransferQueueMode	Specifies the operation mode of the transfer queue.	Beginner
First In First Out	*FirstInFirstOut*	*First blocks (images) in are transferred out first. Frame can accumulating in the queue until it is full at which point the newest new frames will be discarded.*	
Circular When Stopped	*FirstInFirstOut_CircularWhenStopped*	*While the transfer module is streaming blocks (images), the first blocks in are transferred out first. Frames in the queue are not removed until they are transferred out or the transfer function is aborted. When the transfer module is stopped and the queue fills by continuing acquisitions, the oldest frames in the queue are then overwritten by new frames.*	
Transfer Queue Current Block Count	transferQueueCurrentBlockCount	Returns the current number of blocks in the transfer queue.	Expert
Transfer Queue Memory Size	transferQueueMemorySize	Indicates the amount of device memory (in Mbytes) available for internal image frame accumulation in the transfer queue. Increasing or decreasing memory reserved by devicePacketResendBufferSize will affect total memory available here.	Expert
Transferred Image Max Data Size (in MB)	transferMaxBlockSize	Biggest image (GEV blocks) data size sent on the GigE cable. The value is displayed in Megabytes. Use this value to calculate the frame rate transferred on the GigE cable. 5GigE Link speed (~115 MB) divided by Biggest Image (value) = Max fps transferred. (Note: This statistic is reset when acquisitions are stopped.)	DFNC Beginner
Transferred Image Min Data Size (in MB)	transferMinBlockSize	Smallest image (GEV blocks) data size sent on the GigE cable. The value is displayed in Megabytes. (Note: This statistic is reset when acquisitions are stopped.)	DFNC Beginner
Transferred Image Average Data Size (in MB)	transferAverageBlockSize	Average size of the last 16 images (GEV blocks) of data sent on the GigE cable. The value is displayed in Megabytes. Use this value to calculate the sustained frame rate transferred on the GigE cable. GigE Link speed (~115 MB) divided by Average size (value) = Max fps transferred. When TurboDrive is enabled, this feature allows monitoring the average throughput.	DFNC Beginner
Transfer Start	TransferStart	Starts the streaming of data Block(s) to another device.	Expert
Transfer Stop	TransferStop	Stops the streaming of data Block(s) to another device.	Expert
Transfer Abort	TransferAbort	Aborts the streaming of data Block(s)to another device.	Expert

Acquisition Buffering

Acquisitions are internally buffered then transferred to the host system. This internal buffer allows uninterrupted acquisitions without transfer delays. When the internal buffer is full an Image Lost Event will be generated.

The camera has 1 block of 256 MB. A portion of the memory could be reserved for packet resends but at the loss of accumulating frames.

Using Transfer Queue Current Block Count with CamExpert

This feature returns the number of frames buffered within the camera pending transfer to the host system. Image lines/frames are buffered in cases where the host system is experiencing high network traffic with other devices through the same Ethernet switch.

	By buffering image frames, the camera will not drop data when there are temporary delays to the transfer.

When using CamExpert, right-click on this parameter and then select **Refresh** from the context menu. The current frame count in the transfer buffer is displayed in the Value field. During live grab, if the number of frames in the transfer buffer is increasing, then there is a problem with the network or host bandwidth being exceeded. Review the Troubleshooting section and contact Technical Support for help in reviewing your camera setup.

	The ImageLost event occurs when all buffer space is consumed.

Overview of Transfer Control (*TransferControlMode*)

Linea2 5GigE acquisition transfers operate either in the basic coupled mode or in an independent decoupled user controlled mode, as described below.

TransferControlMode = *Basic*

Basic Transfer Mode provides maximum compatibility with any control application running on the host computer. The host-based acquisition program commands the camera to do a frame grab and send it through the camera's frame buffer to the camera's transfer module and the host. The acquisition rate is limited by the host transfer rate.
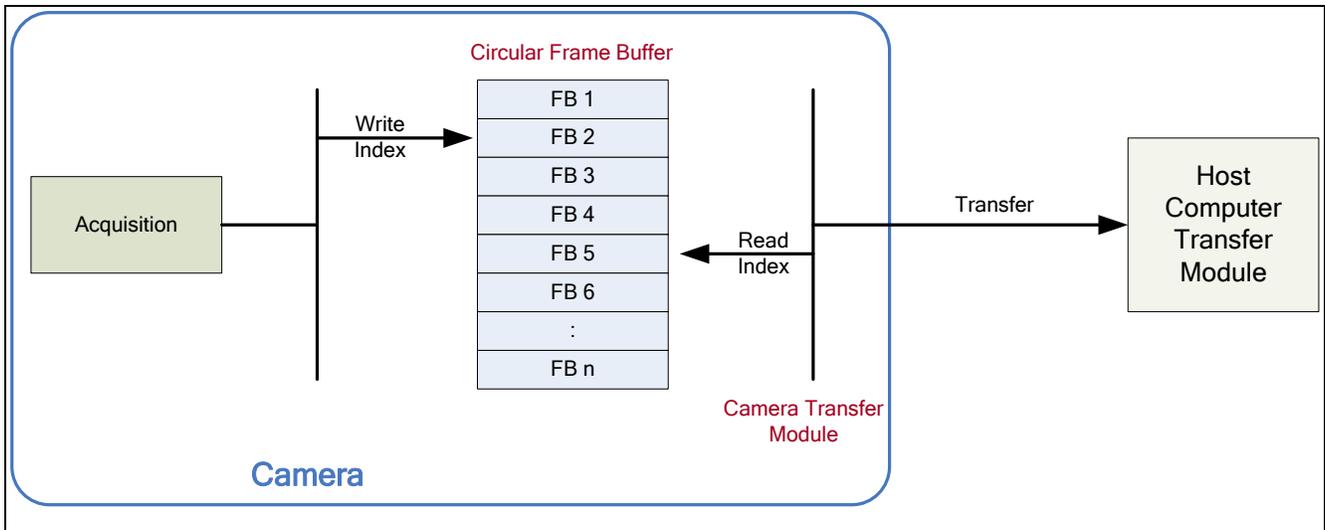
Figure 65: Transfer Control Mode

Features that cannot be changed during a Sapera Transfer

The following features cannot be changed during an acquisition or Sapera transfer.

Feature Group	Features Locked During a Sapera Transfer
CAMERA INFORMATION	UserSetLoad
SENSOR CONTROL	N/A
I/O CONTROL	N/A
COUNTER AND TIMER CONTROL	N/A
ADVANCED PROCESSING CONTROL	flatfieldCorrectionMode
IMAGE FORMAT CONTROL	PixelFormat OffsetX Width Height BinningHorizontal BinningVertical
ACQUISITION AND TRANSFER CONTROL	N/A
EVENT CONTROL	N/A
GIGE VISION TRANSPORT LAYER CONTROL	GevSCPSPacketSize
GIGE VISION HOST CONTROL	InterPacketTimeout InterPacketTimeoutRaw ImageTimeout
FILE ACCESS CONTROL	N/A

Action Control Category

Contains features related to the control of the Action Command mechanism for the device.

Figure 66: CamExpert – Action Control Category

Action Control Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Action Selector	ActionSelector	Selects the action command to configure. Certain Linea2 features support 2 Action commands.	Beginner
Action Group Key	ActionGroupKey	Provides the key that the device uses to validate that the action command message is part of the requested group.	Guru
Action Group Mask	ActionGroupMask	Provides the mask used to filter particular action command messages for the selected action.	Guru
Action Command Mode	actionCMDMode	The operation mode of the selected action command.	Guru DFNC
Slave	*Slave*	*The camera is listening on the network for an action command packet that matches its requirements. When it happens an internal action signal will be pulsed.*	
Master	*Master*	*The camera generates an action command packet to the network when the selected camera event occurs.*	

Display Name	Feature & Values	Description	Standard & View
Action Command Source	actionCMDSource	Select the camera event that will generate an action command on the network.	Guru DFNC
Off	*Off*	*Action command is disabled.*	
ValidFrameTrigger	*ValidFrameTrigger*	*A Valid Frame Trigger event will generate an action command.*	
InvalidFrameTrigger	*InvalidFrameTrigger*	*An Invalid Frame Trigger event will generate an action command.*	
StartofFrame	*StartofFrame*	*A Start of Frame event will generate an action command.*	
StartofExposure	*StartofExposure*	*A Start of Exposure event will generate an action command.*	
EndofExposure	*EndofExposure*	*An End of Exposure event will generate an action command.*	
EndofTimer1	*EndofTimer1*	*A TimerEnd1 event will generate an action command.*	
EndofCounter1	*EndofCounter1*	*A CounterEnd1 event will generate an action command.*	
Input0	*Input0*	*An Input Signal 0 event will generate an action command.*	
Input1	*Input1*	*An Input Signal 1 event will generate an action command.*	
Action Command Source Line Activation	actionCMDActivation	Specifies the activation mode to trigger an action command from the selected line of the actionCMDSource feature.	Guru DFNC
Falling Edge	*FallingEdge*	*Use the falling edge of the source signal.*	
Rising Edge	*RisingEdge*	*Use the rising edge of the source signal.*	
Action Schedule Delay (in ns)	actionScheduleDelay	Delay to add to the current time when generating the scheduled action command. A delay of 0 will generate an immediate action command (not scheduled). A high enough value must be chosen to allow for the generated action command to propagate over the network before the scheduled time expires.	Guru DFNC

GigE Vision Action Command Reference

An Action Command is a single Broadcast packet sent from the Host Software application to all cameras connected on the same network. How cameras act on an Action Command depends on its designed feature support. Cameras receiving the Action Command broadcast may have one or multiple functions acting on that received command.

Please refer to the GigE Vision® Specification — version 2.0 RC6, for configuration and usage details. Contact Teledyne DALSA Support and request example code for Action Command usage.

Features Supporting Action Command

Feature Category	Feature	Option
I/O Control	Trigger Source	Action 1, Action 2 – when Trigger Selector = *Single Line Trigger(Start), Single Frame Trigger(Start) or MultiFrame Trigger(Start)*
I/O Control	Output Line Source	Pulse On: Action 1 Pulse On: Action 2
Counter and Timer Control	Counter Start Source	Action 1, Action 2
Counter and Timer Control	Timer Start Source	Action 1, Action 2
Event Control	Timestamp Reset Source	Action 2

Event Control Category

The Linea2 5GigE Event Control category groups parameters used to configure Camera Event related features.
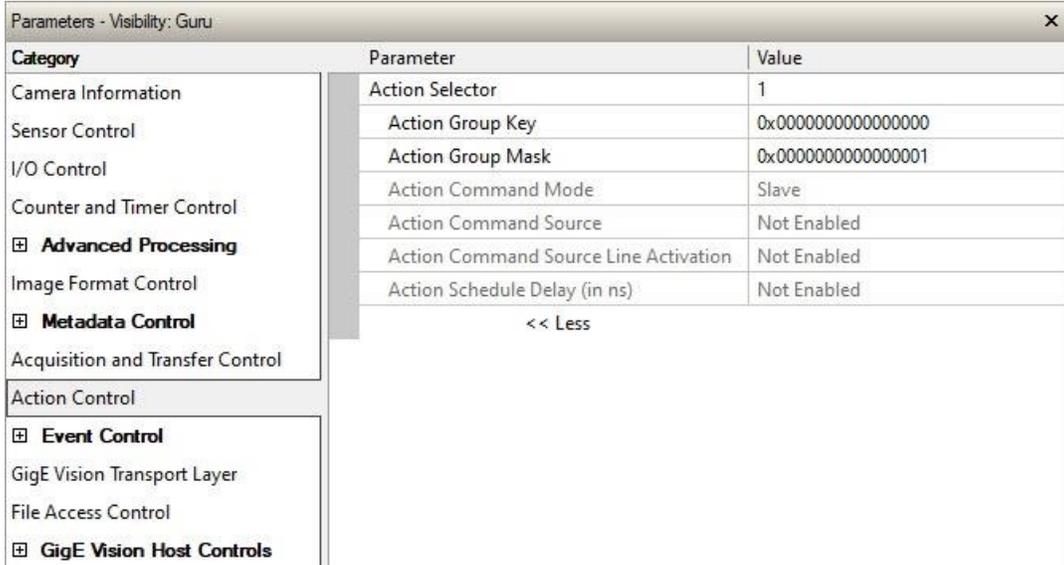

Figure 67: CamExpert – Event Control Category

Event Control Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Timestamp Latch Cmd	timestampControlLatch	Latch the current timestamp internal counter value in the timestampValue feature.	Expert DFNC
Timestamp Value	timestampValue	Returns the 64-bit value of the timestamp, which is the internal Clock timer or the PTP clock timer, depending on the Timestamp Source selection.. (RO)	Expert DFNC
TimeStamp Source	timestampSource	Specifies the source used as the incrementing signal for the Timestamp register.	Expert DFNC
Internal Clock	*InternalClock*	*The timestamp source is generated by the camera internal clock. Refer to timestampTickFrequency feature for the time base.*	
IEEE1588	*IEEE1588*	*The Timestamp source is controlled by the network IEEE1588 protocol. This source is automatically selected when PTP mode is enabled.*	
Timestamp Tick Frequency (in Hz)	timestampTickFrequency	Indicates the number of timestamp ticks (or increments) during 1 second (frequency in Hz). This feature changes depending on the Timestamp Source. (RO)	Expert DFNC
Timestamp Latch Source	timestampLatchSource	Specifies the internal event or signal that will latch the Timestamp counter into the Timestamp buffer.	Expert DFNC
Frame Start	*FrameStart*	*The timestamp is latched on frame start.*	
Timestamp Reset Source	timestampResetSource	Specifies the internal signal or physical input line to use as the timestamp reset source.	Expert DFNC
None	*None*	*No timestamp reset source is specified. Note that the Timestamp reset command can still reset the counter.*	
Line 1	*Line1*	*Use input line 1 as the timestamp reset source.*	
Line 2	*Line2*	*Use input line 2 as the timestamp reset source.*	
Action 2	*Action2*	*Select the GigEVision Action Command 2 as the timestamp reset source. This is a broadcast command that multiple devices can respond to simultaneously.*	
Timestamp Reset Line Activation	timestampResetLineActivation	Specifies the activation mode to reset the timestamp counter on the selected line of the TimestampResetSource feature.	Beginner DFNC
Falling Edge	*FallingEdge*	*Reset the timestamp counter on the falling edge of the source signal.*	
Rising Edge	*RisingEdge*	*Reset the timestamp counter on the rising edge of the source signal.*	
Any Edge	*AnyEdge*	*Reset the timestamp counter on the falling or rising edge of the source signal.*	
Timestamp Reset Cmd	timestampControlReset	Resets the timestamp counter to 0. This Feature resets both the internal Clock timer and the PTP clock timer. Note that the PTP Mode must be disabled first to reset the PTP clock timer. (WO)	Expert DFNC

Display Name	Feature & Values	Description	Standard & View
Event Selector	EventSelector	Select the Event to enable/disable with the EventNotification feature.	Expert
Start of Acquisition	*AcquisitionStart*	*Device just started the Acquisition of one or many Frames.*	
End of Acquisition	*AcquisitionEnd*	*Device just completed the Acquisition of one or many Frames.*	
Start of Frame	*FrameStart*	*Event sent on control channel on an Active Frame. This occurs with the start of the exposure delay.*	
End of Frame	*FrameEnd*	*Device just completed the capture of one Frame.*	
Valid Frame Trigger	*ValidFrameTrigger*	*Event sent on control channel when a valid frame trigger is generated.*	
Invalid Frame Trigger	*InvalidFrameTrigger*	*Event sent on control channel when a frame trigger occurs in an invalid Trigger region. The trigger is rejected and no frame acquisition occurs.*	
Invalid Line Trigger	*InvalidLineTrigger*	*Event sent on control channel when a line trigger occurs in an invalid Trigger region. Therefore the trigger is rejected and no line acquisition occurs.*	
Image Lost	*ImageLost*	*Event sent on control channel when an image is lost due to insufficient memory.*	
Timer 1 End	*Timer1End*	*Event sent when timer 1 has reached the end.*	
Timer 2 End	*Timer2End*	*Event sent when timer 2 has reached the end.*	
Counter 1 End	*Counter1End*	*Event sent when counter 1 has reached the counterDuration count.*	
Counter 2 End	*Counter2End*	*Event sent when counter 2 has reached the counterDuration count.*	
Events Overflow	*OverflowError*	*Event sent on control channel when all previous active events have been disabled because the camera cannot send them fast enough, generating an internal message overflow. All required events must be re-enabled manually.*	
Event Notification	EventNotification	Enable Events for the event type selected by the EventSelector feature.	Expert
Off	*Off*	*The selected event is disabled.*	
On	*On*	*The selected event will generate a software event.*	
GigEVisionEvent	*GigEVisionEvent*	*The selected event will generate a software event. This entry is deprecated. Using "On" is recommended.*	
Event Statistic Selector	eventStatisticSelector	Selects which Event statistic to display.	Expert DFNC
Invalid Frame Trigger	*InvalidFrameTrigger*	*Counts the frame triggers occurring in an invalid Trigger region.*	
Image Lost	*ImageLost*	*Image is acquired but lost before it's been transferred.*	
Packet Resend	*PacketResend*	*Counts the number of individual packets that are resent.*	
Packet Resend Request Dropped	*PacketResendRequestDropped*	*Counts the number of packet resend requests dropped. The camera queues the packet resend requests until they are processed. There is a limit to the number of requests that can be queued by the camera. When a new request is received and the queue is full, the request is dropped but this statistic is still incremented.*	
Ethernet Pause Frame Received	*EthernetPauseFrameReceived*	*Counts the number of Ethernet Pause Frame received. See also PAUSE Frame Support for information on Ethernet Packet size.*	
Event Statistic Count	eventStatisticCount	Display the count of the selected Event.	Expert DFNC
Event Statistic Count Reset	eventStatisticCountReset	Reset the count of the selected Event.	Expert DFNC

Display Name	Feature & Values	Description	Standard & View
PTP Mode	ptpMode	Specifies the PTP (IEEE-1588: Precision Time Protocol) operating mode as implemented by the Linea2 5GigE.	Expert DFNC
Off	*Off*	*PTP is disabled on the device.*	
Automatic	*Automatic*	*PTP is enabled on the device. The camera can become a Master or Slave device. The Master device is automatically determined as per IEEE-1588.*	
Slave	*Slave*	*Device will operate in PTP slave-only mode.*	
PTP Status	ptpStatus	Specifies dynamically the current PTP state of the device. (ref: IEEE Std 1588-2008)	Expert DFNC
Initializing	*Initializing*	*The port initializes its data sets, hardware, and communication facilities. No port of the clock shall place any PTP messages on its communication path. If one port of a boundary clock is in the INITIALIZING state, then all ports shall be in the INITIALIZING state.*	
Faulty	*Faulty*	*The fault state of the protocol. A port in this state shall not place any PTP messages except for management messages that are a required response to another management message on its communication path. In a boundary clock, no activity on a faulty port shall affect the other ports of the device. If fault activity on a port in this state cannot be confined to the faulty port, then all ports shall be in the FAULTY state.*	
Disabled	*Disabled*	*The port shall not place any messages on its communication path. In a boundary clock, no activity at the port shall be allowed to affect the activity at any other port of the boundary clock. A port in this state shall discard all PTP received messages except for management messages.*	
Listening	*Listening*	*The port is waiting for the announceReceiptTimeout to expire or to receive an Announce message from a master. The purpose of this state is to allow orderly addition of clocks to a domain. A port in this state shall not place any PTP messages on its communication path except for Pdelay_Req, Pdelay_Resp, Pdelay_Resp_Follow_Up, or signaling messages, or management messages that are a required response to another management message.*	
PreMaster	*PreMaster*	*The port shall behave in all respects as though it were in the MASTER state except that it shall not place any messages on its communication path except for Pdelay_Req, Pdelay_Resp, Pdelay_Resp_Follow_Up, signaling, or management messages.*	
Master	*Master*	*The port is behaving as a master port.*	
Passive	*Passive*	*The port shall not place any messages on its communication path except for Pdelay_Req, Pdelay_Resp, Pdelay_Resp_Follow_Up, or signaling messages, or management messages that are a required response to another management message.*	
Uncalibrated	*Uncalibrated*	*One or more master ports have been detected in the domain. The appropriate master port has been selected, and the local port is preparing to synchronize to the selected master port. This is a transient state to allow initialization of synchronization servos, updating of data sets when a new master port has been selected, and other implementation-specific activity.*	
Slave	*Slave*	*The port is synchronizing to the selected master port.*	

Display Name	Feature & Values	Description	Standard & View
Grand Master	GrandMaster	The port is in the Grand Master state (i.e. has the best clock). The camera can become GrandMaster only if the PTP Mode=Automatic and there's another device on the network that was Master.	
Error	Error	One or more ports have an error state.	
PTP Time (in ns)	ptpTime	Sets the reference PTP timestamp, in nanosecond. This is meant to be used when this camera is the PTP Master. Refer to ptpStatus feature for the current PTP Master/Slave state of this camera. Note that feature write propagation delays between the host and camera clock hardware must be taken into account for real time clock accuracy when using a UTC time reference.	Expert DFNC
PTP Time (Human Readable)	ptpTimeText	Converts PTP time as UNIX epoch to human-readable date in UTC+00 time zone. This value gets updated when timestampControlLatch is executed.	Expert DFNC
PTP Servo Status	ptpServoStatus	Specifies the IEEE1588 servo status.	Expert DFNC
Unlocked	Unlocked	The servo is not yet ready to track the master clock.	
Synchronizing	Synchronizing	The servo is unlocked and synchronizing to the master clock.	
Locked	Locked	The servo is adjusting (syntonizing to the master clock.	
Not Applicable	NotApplicable	The servo state is currently not applicable.	
PTP Master Clock Identity	ptpMasterClockId	Port identity of the current best master. The clock ID is an Extended Unique Identifier (EUI)-64 64-bit ID, converted from the 48-bit MAC address, by inserting 0xfffe at the middle of the MAC address.	Guru DFNC
PTP Master Offset (in ns)	ptpMasterOffsetNs	Dynamically returns the 64-bit value of the PTP offset with the master, in nanoseconds. This value is the input for clock corrections for the slave device clock servo algorithms.	Guru DFNC
PTP Port Last Event	ptpPortLastEvent	Logs the last PTP changed state event defining the last current status.	Expert DFNC
None	None	None	
Power up	Powerup	Power up	
Initialize	Initialize	Initialize	
Designated Enabled	DesignatedEnabled	Designated Enabled	
Designated Disabled	DesignatedDisabled	Designated Disabled	
Fault Cleared	FaultCleared	Fault Cleared	
Fault Detected	FaultDetected	Fault Detected	
State Decision Event	StateDecisionEvent	State Decision Event	
Qualification Timeout Expires	QualificationTimeoutExpires	Qualification Timeout Expires	
Announce Receipt Timeout Expires	AnnounceReceiptTimeoutExpires	Announce Receipt Timeout Expires	
Synchronization Fault	SynchronizationFault	Synchronization Fault	
Master Clock Selected	MasterClockSelected	Master Clock Selected	
Recommended State Master	RS_Master	Recommended State Master	
Recommended State Grand Master	RS_GrandMaster	Recommended State Grand Master	
Recommended State Slave	RS_Slave	Recommended State Slave	
Recommended State Passive	RS_Passive	Recommended State Passive	
PTP Transport Protocol	ptpTransportProtocol	Describes the PTP Transport Protocol used.	Expert DFNC
UDP_IPV4	UDP_IPV4	PTP runs over UDP/IPV4	

Display Name	Feature & Values	Description	Standard & View
PTP Servo Step Threshold (in us)	ptpServoStepThreshold	Specifies the servo step threshold (in µs). When the clock offset with the master exceeds the threshold, the servo unlocks and offset adjustment is started.	Expert DFNC
Threshold_10	*Threshold_10*	10	
Threshold_20	*Threshold_20*	20	
Threshold_100	*Threshold_100*	100	
Threshold_500	*Threshold_500*	500	
Threshold_1000	*Threshold_1000*	1000	
Threshold_2000	*Threshold_2000*	2000	
<u>Timestamp Modulo Event</u>	timestampModulo	Specifies the additional interval between the current timestamp tick and the event generated. This interval has an 80ns accuracy. Note that the value zero disables the event generator.	Expert DFNC
Timestamp Modulo Event Frequency (in Hz)	timestampModuloFrequency	Returns the frequency of the timestamp Modulo Event (in Hz).	Expert DFNC
Timestamp Modulo Start Time	timestampModuloStartTime	Specifies the timestamp value that must be exceeded by the incrementing timestamp counter before the modulo event starts. This Feature is also used for a "Future" Frame Acquisition.	Expert DFNC
Timestamp Modulo Actual Start Time	timestampModuloActualStartTime	Displays the actual modulo event start time as used by the device. When the user specified "timestampModuloStartTime" is in the future, timestampModuloActualStartTime= timestampModuloStartTime. When the user specified "timestampModuloStartTime" has already past, the camera automatically recalculates a future value for "timestampModuloStartTime" using the user set "timestampModulo" feature value. This new start time is reported by "timestampModuloActualStartTime".	Expert DFNC

Event Info Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
AcquisitionStart Event ID	EventAcquisitionStart	Represents the event ID to identify the EventAcquisitionStart software Event. (RO)	Guru
AcquisitionEnd Event ID	EventAcquisitionEnd	Represents the event ID to identify the EventAcquisitionEnd software Event. (RO)	Guru
FrameStart Event ID	EventFrameStart	Represents the event ID to identify the EventFrameStart software Event. (RO)	Guru
FrameEnd Event ID	EventFrameEnd	Represents the event ID to identify the EventFrameEnd software Event. (RO)	Guru
Valid Frame Trigger Event ID	EventValidFrameTrigger	Represents the event ID to identify the EventValidFrameTrigger software Event. (RO)	Guru
InvalidFrameTrigger Event ID	EventInvalidFrameTrigger	Represents the event ID to identify the EventInvalidFrameTrigger software Event. (RO)	Guru
InvalidLineTrigger Event ID	EventInvalidLineTrigger	Represents the event ID to identify the EventInvalidLineTrigger software Event. (RO)	Guru
ImageLost Event ID	EventImageLost	Represents the event ID to identify the EventImageLost software Event. (RO)	Guru
Timer 1 End Event ID	EventTimer1End	Represents the event ID to identify the EventTimer1End software Event. (RO)	Guru
Timer 2 End Event ID	EventTimer2End	Represents the event ID to identify the EventTimer2End software Event. (RO)	Guru
Counter 1 End Event ID	EventCounter1End	Represents the event ID to identify the EventCounter1End software Event. (RO)	Guru
Counter 2 End Event ID	EventCounter2End	Represents the event ID to identify the EventCounter2End software Event. (RO)	Guru
Events Overflow Event ID	EventOverflowError	Represents the event ID to identify the EventOverflowError software Event. (RO)	Guru

Overview of Precision Time Protocol Mode (IEEE 1588)

PTP Mode = Precision Time Protocol

- PTP synchronizes the Timestamp clocks of multiple devices connected via a switch on the same network, where the switch supports PTP.
- For optimal clock synchronization the imaging network should use one Ethernet switch. Daisy-chaining multiple small switches will degrade camera clock syncs.
- Additionally, the Ethernet switch connecting cameras to the imaging network should implement "PTP Boundary Clock" hardware.
- To use a multi-port NIC adapter instead of a switch, it must be configured as the common Master PTP source for all its networks. Refer to NIC's configuration software instructions.
- Linea2 cameras can automatically organize themselves into a master-slave hierarchy, or the user application configures a camera master with n-number of slaves. The auto-configuration process typically happens within 2 seconds.
- The automatic organizing procedure is composed of steps (as defined by IEEE 1588) to identify the best clock source to act as master. When only Linea2 cameras are used they are equal and the Linea2 with lowest MAC address value is set to clock master.
- The feature *TimeStamp Source* is automatically changed to *IEEE1588* when *PTP Mode* is enabled. This timestamp tick (in ns) cannot be reset by the user.
- Linea2 cameras implement additional features designed to synchronize multiple camera acquisitions via IEEE 1588 (PTP Mode) – not via external camera trigger signals.

PTP Master Clock Identity

The clock ID of the current best master is an Extended Unique Identifier (EUI)-64 "64-bit ID", converted from the 48-bit MAC address, by inserting 0xfffe at the middle of the MAC address.

- The standard MAC address in human-friendly form is six groups of two hexadecimal digits as this example shows: 0a:1b:2c:3d:4e:5f
- The Extended Unique Identifier is a 64-bit ID, converted from the 48-bit MAC address, by inserting 0xfffe at the middle of the MAC address. The format is: 0a:1b:2c:fffe:3d:4e:5f

An Example with two Linea2 Cameras

The following basic steps configure two Linea2 cameras connected to one computer via an Ethernet switch. The configured cameras use two instances of CamExpert, to grab a frame every second, controlled by a modulo event via PTP.

For each camera set features as follows:

I/O Controls —Trigger Mode = *On*, Trigger Source = *Timestamp Modulo Event*

Event Controls — PTP Mode = *Automatic*

> ⚠️ **Note**: One Linea2 is automatically set to Master while the other is set to Slave.

Event Controls —Timestamp Modulo Event = 1000000000 (one modulo event every second)

With the two cameras aimed at the same moving object, click **Grab** on each instance of CamExpert; each camera grabs frames simultaneously.

IEEE 1588 Reference Resources

For additional information: https://standards.ieee.org/

PTP Standard Reference: IEEE Std 1588-2008 — IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems

Examples using Timestamp Modulo Event for Acquisions

The Timestamp Modulo event is used to synchronize multiple camera acquisitions and automate repetitive acquisitions based on either the camera's internal Timestamp counter or a system-wide PTP counter. The Linea2 internal Timestamp clock has a 1 μs tick, while the PTP clock has 8 ns ticks (PTP: IEEE1588–Precise Time Protocol).

Both Timestamp counters increment continuously but can be reset to zero with timestampControlReset if ptpMode = Off, else only the internal camera Timestamp counter resets.

Case Examples Overview

The following case examples use a simplified Timestamp timeline, which for clarity is shown with time ticks from 00 to 60 without units. A timeline scale based on real time is not required to describe the concepts. These examples also apply equally to using an internal Timestamp clock or a system PTP clock.

Case 1: Simple Repeating Acquisitions as Upcoming Events

Conditions:

- initial timestampControlReset resets Timestamp counter
- timestampModuloStartTime at 20
- timestampModulo = 10
- timestampModuloActualStartTime = First Event generated (F1)

After the Timestamp Reset, the first acquisition is made when the Modulo reaches the +10 tick Timestamp count, following the programmed start time. Acquisitions repeat every +10 Timestamp tick until stopped.
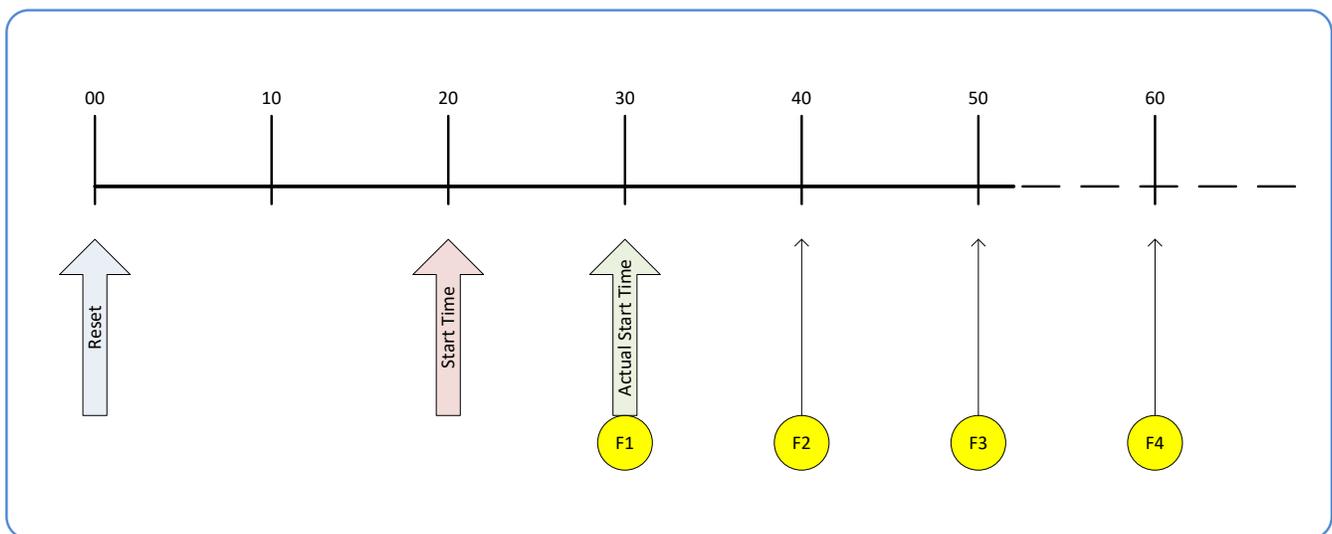

Figure 68: Case 1 - Repeating Acquisitions as Upcoming Events

Case 2: Potential Uncertainty of the Start Time

Conditions:

- initial timestampControlReset resets Timestamp counter
- timestampModuloStartTime at < 20
- timestampModulo = 10
- timestampModuloActualStartTime = first event (F1)

Case 2 differs from case 1 by showing the period of uncertainty if the start time is near the first modulo count that follows. The first frame acquisition may occur at the first modulo count time or at the following. The actual value for the uncertainty period may vary between cameras and network conditions.
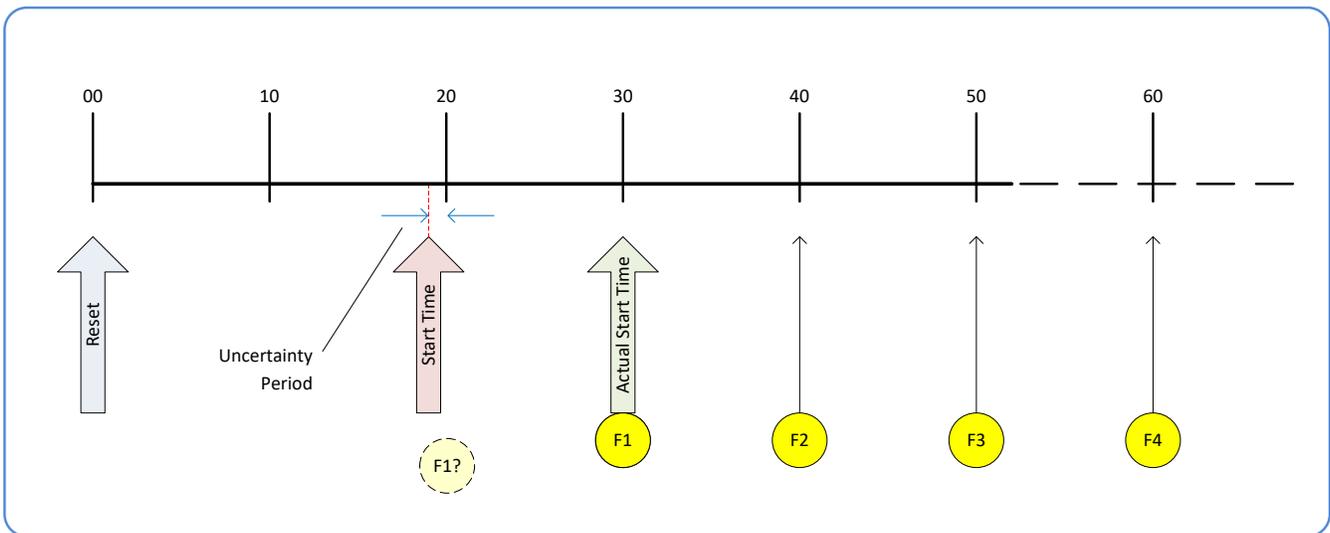

Figure 69: Case 2 – Potential Uncertainty of the Start Time

Case 3: Timer Reset before the Actual Start Time

Conditions:

- initial timestampControlReset resets Timestamp counter
- timestampModuloStartTime at 20
- timestampModulo = 10
- second timestampControlReset at count 25
- timestampModuloActualStartTime = first event (F1)

After the initial Timestamp Reset which starts the Timestamp counter, the Modulo start time is at 20. The Modulo 10 actual start time for the first acquisition is at Timestamp 30 (as described in Case 1).

If a new Timestamp Reset happens between the Start Time and acquisition Actual Start Time, the Timestamp counter will restart from time 00. The Start Time value has already been stored, thus the modulo Actual Start Time remains at 30. In this condition the Actual Start Time did not reset.
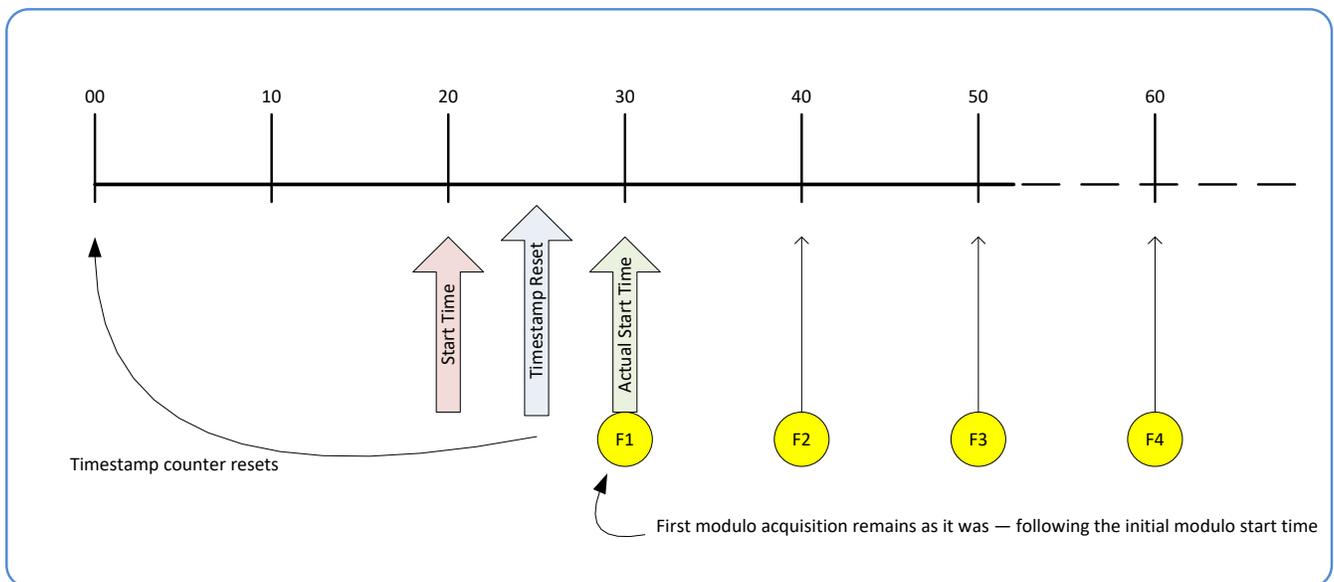

Figure 70: Case 3 – Timer Reset before the Actual Start Time

Case 4: Timer Reset after the Actual Start Time

Conditions:

- initial timestampControlReset resets Timestamp counter
- timestampModuloStartTime at 20
- timestampModulo = 10
- timestampModuloActualStartTime = first event (F1)
- second timestampControlReset at 35

This case describes the Modulo process if there is a Timestamp counter reset after a modulo controlled acquisition.

- "A" shows the initial conditions with the first acquisition (F1) at the actual start time.
- "B" shows a Timestamp reset occurring after the first acquisition.
- "C" shows that acquisitions then continue at the first modulo 10 time after the reset due to acquisitions already in progress compared to the example case 3 above.
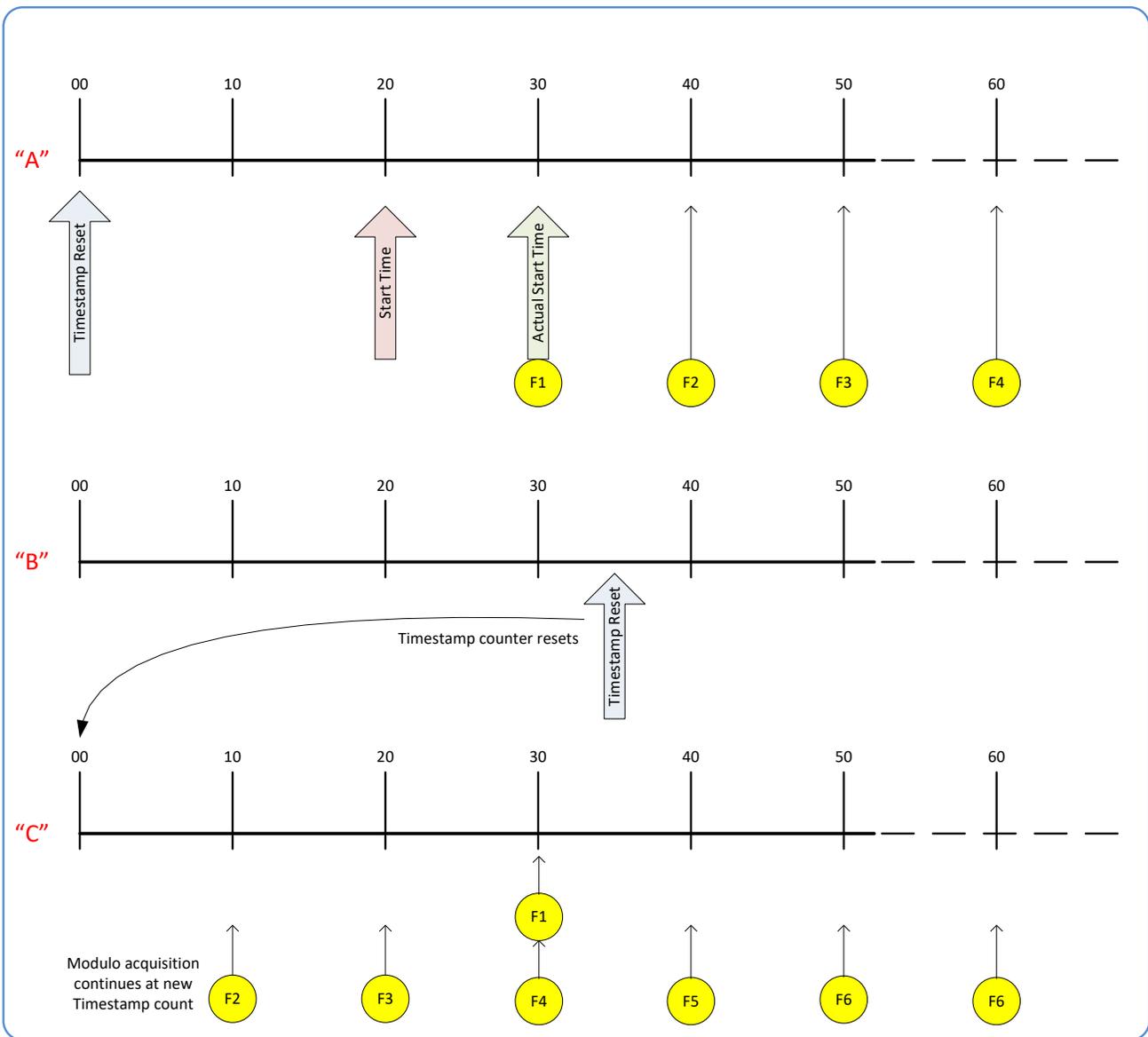

Figure 71: Case 4 – Timer Reset after the Actual Start Time

Case 5: Changing timestampModulo during Acquisitions

Conditions:

- initial timestampControlReset resets Timestamp counter
- timestampModuloStartTime at 20
- timestampModulo = 10
- timestampModuloActualStartTime = first event (F1)
- timestampModulo changes to 20

Case 5 shows that the Modulo value can be changed dynamically. Using the example of case 1, after the second acquisition (F2) the Modulo value is changed from 10 to 20. The third acquisition now occurs at modulo 20 time following the previous acquisition.
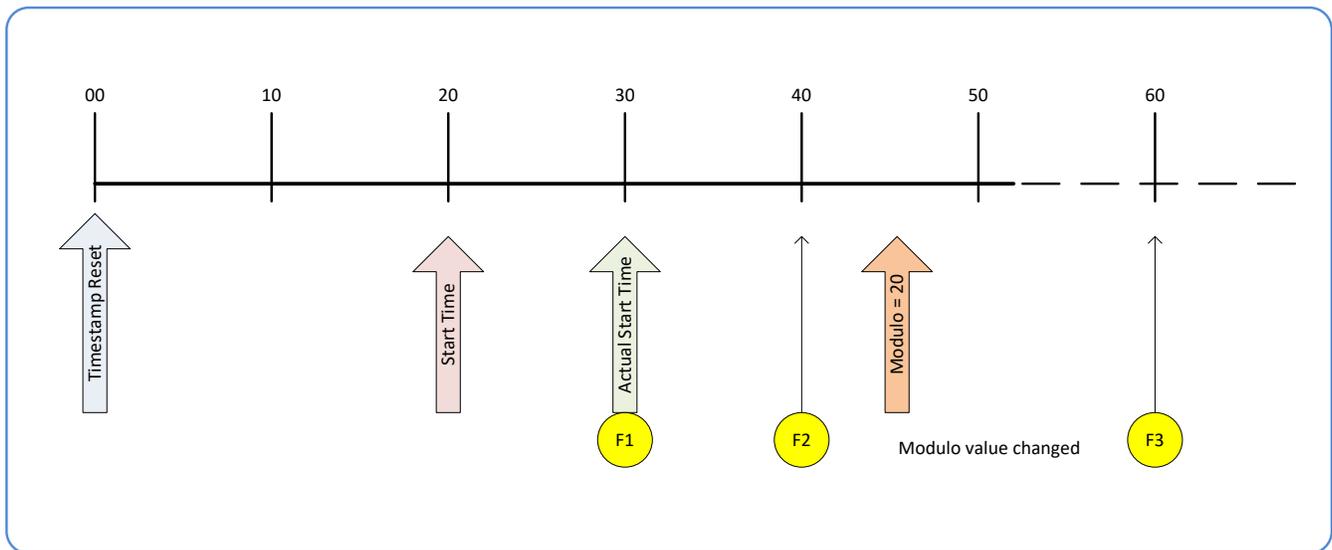

Figure 72: Case 5 – Changing timestampModulo during Acquisitions

GigE Vision Transport Layer Category

The Linea2 5GigE Vision Transport Layer Control category groups parameters used to configure features related to GigE Vision specification and the Ethernet Connection.

Figure 73: CamExpert – GigE Vision Transport Layer Category

GigE Vision Transport Layer Feature Descriptions

Display Name	Feature & Values	Description	Standard & View
Device Link Selector	DeviceLinkSelector	Selects which Link of the device to control.	Expert
Device Link Throughput Limit	DeviceLinkThroughputLimitMode	When disabled, lower level TL specific features are expected to control the throughput. When enabled, DeviceLinkThroughputLimit controls the overall throughput.	Guru
Off	*Off*	*Disables the DeviceLinkThroughputLimit feature.*	
On	*On*	*Enables the DeviceLinkThroughputLimit feature.*	
Device Link Throughput Limit (in %)	deviceLinkThroughputLimitRatio	Limits the maximum bandwidth of the data that will be streamed out by the device. This value is set as a percentage of the maximum link speed detected by the Camera.	Beginner DFNC
Device Link Throughput Limit (in Bps)	DeviceLinkThroughputLimit	Limits the maximum bandwidth of the data that will be streamed out by the device.	Guru
Stream Channel Selector	GevStreamChannelSelector	Selects the stream channel to control.	Expert
Maximum Link Speed	gevLinkSpeedLimit	Maximum speed the device will advertise during autonegotiation. Changes will take effect on the next boot.	Guru DFNC
2.5 GigE	*Speed_2500*	*The link is limited up to the 2500Base-t (2.5 GigE) link speed.*	
1 GigE	*Speed_1000*	*The link is limited up to the 1000Base-t (1 GigE) link speed.*	
Automatic	*Automatic*	*Link speed limit is autonegotiated with the device connected to the camera (switch or NIC) at 1, 2.5 or 5 GigE.*	
Device Link Speed (in Mbps)	GevLinkSpeed	Indicates the transmission speed negotiated by the given network interface. (RO)	Expert
PacketSize (in B)	GevSCPSPacketSize	Specifies the stream packet size in bytes to send on this channel.	Expert
Interpacket Delay	GevSCPD	Indicates the delay (in timestamp unit) to insert between each packet for this stream channel. Note that Interpacket delay becomes a Read-Only value when the feature "Device Link Throughput Limit" is enabled.	Expert
Packet Resend Buffer Size (in MB)	devicePacketResendBufferSize	Indicates the amount of memory to reserve in MBytes for the packet resend buffer. Increasing or decreasing this value affects the value returned by transferQueueMemorySize.	DFNC Guru
Interface Selector	GevInterfaceSelector	Selects which physical network interface to control.	Beginner
IP Configuration Status	GevIPConfigurationStatus	Reports the current IP configuration status. (RO)	Guru
None	*None*	*Device IP Configuration is not defined.*	
PersistentIP	*PersistentIP*	*Device IP Address Configuration is set to Persistent IP (static).*	
DHCP	*DHCP*	*Device IP Address Configuration is set to DHCP (Dynamic Host Configuration Protocol). Network requires a DHCP server.*	
LLA	*LLA*	*Device IP Address Configuration is set to LLA (Link-Local Address). Also known as Auto-IP. Used for unmanaged networks including direct connections from a device to a dedicated NIC.*	
ForceIP	*ForceIP*	*Device IP Address Configuration is set to ForceIP. Used to force an IP address change.*	
Current IP Address	GevCurrentIPAddress	Reports the IP address for the given network interface. (RO)	Beginner
Current Subnet Mask	GevCurrentSubnetMask	Reports the subnet mask of the given interface. (RO)	Beginner
Current Default Gateway	GevCurrentDefaultGateway	Reports the default gateway IP address to be used on the given network interface. (RO)	Beginner

Display Name	Feature & Values	Description	Standard & View
Current IP set in LLA	GevCurrentIPConfigurationLLA	Controls whether the LLA (Link Local Address) IP configuration scheme is activated on the given network interface. (RO)	Guru
Current IP set in DHCP	GevCurrentIPConfigurationDHCP	Controls whether the DHCP IP configuration scheme (Dynamic Host Configuration Protocol) is activated on the given network interface.	Guru
Current IP set in Persistent IP	GevCurrentIPConfigurationPersistentIP	Controls whether the PersistentIP configuration scheme is activated on the given network interface.	Guru
Primary Application IP Address	GevPrimaryApplicationIPAddress	Returns the IP address of the device hosting the primary application. (RO)	Guru
Device Access Privilege Control	deviceCCP	Controls the device access privilege of an application.	Guru DFNC
Exclusive Access	*ExclusiveAccess*	*Grants exclusive access to the device to an application. No other application can control or monitor the device.*	
Control Access	*ControlAccess*	*Grants control access to the device to an application. No other application can control the device.*	
Current Heartbeat Timeout (in ms)	GevHeartbeatTimeout	Indicates the current heartbeat timeout in milliseconds.	Guru
GVCP Heartbeat Disable	GevGVCPHeartbeatDisable	Disables the GVCP (GigE Vision Control Protocol) heartbeat monitor. This allows control switchover to an application on another device.	Expert
Communication Timeout (in ms)	GevMCTT	Provides the transmission timeout value in milliseconds.	Guru
Communication Retransmissions Count	GevMCRC	Indicates the number of retransmissions allowed when a message channel message times out.	Guru
Manifest Entry Selector	DeviceManifestEntrySelector	Selects the manifest entry to reference.	Guru
XML Major Version	DeviceManifestXMLMajorVersion	Indicates the major version number of the XML file of the selected manifest entry. (RO)	Guru
XML Minor Version	DeviceManifestXMLMinorVersion	Indicates the Minor version number of the XML file of the selected manifest entry. (RO)	Guru
XML SubMinor Version	DeviceManifestXMLSubMinorVersion	Indicates the SubMinor version number of the XML file of the selected manifest entry. (RO)	Guru
Schema Major Version	DeviceManifestSchemaMajorVersion	Indicates the major version number of the Schema file of the selected manifest entry. (RO)	Guru
Schema Minor Version	DeviceManifestSchemaMinorVersion	Indicates the minor version number of the Schema file of the selected manifest entry. (RO)	Guru
Manifest Primary URL	DeviceManifestPrimaryURL	Indicates the first URL to the XML device description file of the selected manifest entry. (RO)	Guru
Manifest Secondary URL	DeviceManifestSecondaryURL	Indicates the second URL to the XML device description file of the selected manifest entry. (RO)	Guru
Gev GVSP Extended ID Mode	GevGVSPExtendedIDMode	Enables the extended ID mode.	Expert
Off	*Off*	*Disables the extended ID mode.*	
On	*On*	*Enables the extended ID mode.*	

File Access Control Category

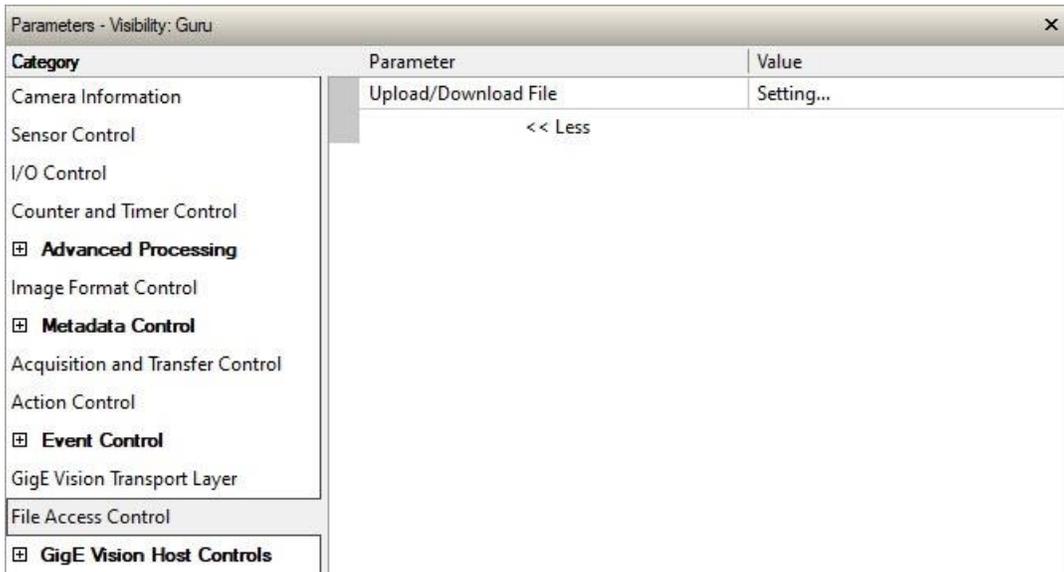The File Access control in CamExpert includes parameters related to accessing files in the connected Linea2 5GigE.

Figure 74: CamExpert – File Access Control Category

File Access Control Feature Descriptions

In CamExpert the File Access Control features are not exposed directly but are accessed through the File Access Control dialog for easier operation.

Display Name	Feature & Values	Description	Standard & View
File Selector	FileSelector	Selects the file to access. The file types which are accessible are device-dependent.	Guru
Firmware	*Firmware1*	*Upload new firmware to the camera which will execute on the next camera reboot cycle. Select the DeviceReset feature after the upload completes.*	
User Settings 1	*UserSet1*	*The first user set of the device.*	
User Settings 2	*UserSet2*	*The second user set of the device.*	
User Settings 3	*UserSet3*	*The third user set of the device.*	
User Settings 4	*UserSet4*	*The fourth user set of the device.*	
LUT Luminance 1	*LutLuminance1*	*Select to write (upload) a Look-up-Table file (Sapera .LUT file) into the camera's internal LUT Luminance 1.*	
Factory Flat Field Coefficients 1	*FlatFieldCoefficients01*	*Select factory Flat Field coefficients 1.*	
User Flat Field Coefficients 1	*FlatFieldCoefficients1*	*Select user Flat Field coefficients 1.*	
User Flat Field Coefficients 2	*FlatFieldCoefficients2*	*Select user Flat Field coefficients 2.*	
User Flat Field Coefficients 3	*FlatFieldCoefficients3*	*Select user Flat Field coefficients 3.*	
User Flat Field Coefficients 4	*FlatFieldCoefficients4*	*Select user Flat Field coefficients 4.*	
Color Correction Coefficients	*ColorCorrection*	*Select the color correction coefficients.*	
User Defined Saved Image	*userDefinedSavedImage*	*Upload and download an image in the camera.*	
Open Source Licenses	*SoftwareLicenses*	*Open Source Software Licenses.*	

Display Name	Feature & Values	Description	Standard & View
File Operation Selector	FileOperationSelector	Selects the target operation for the selected file in the device. This operation is executed when the File Operation Execute feature is called.	Guru
Open	*Open*	*Select the Open operation - executed by FileOperationExecute.*	
Close	*Close*	*Select the Close operation - executed by FileOperationExecute.*	
Read	*Read*	*Select the Read operation - executed by FileOperationExecute.*	
Write	*Write*	*Select the Write operation - executed by FileOperationExecute.*	
Delete	*Delete*	*Select the Delete operation - executed by FileOperationExecute.*	
File Operation Execute	FileOperationExecute	Executes the operation selected by File Operation Selector on the selected file.	Guru
File Open Mode	FileOpenMode	Selects the access mode used to open a file on the device.	Guru
Read	*Read*	*Select read-only open mode.*	
Write	*Write*	*Select write-only open mode.*	
File Access Buffer	FileAccessBuffer	Defines the intermediate access buffer that allows the exchange of data between the device file storage and the application.	Guru
File Access Offset (in B)	FileAccessOffset	Controls the mapping offset between the device file storage and the file access buffer.	Guru
File Access Length (in B)	FileAccessLength	Controls the mapping length between the device file storage and the file access buffer.	Guru
File Operation Status	FileOperationStatus	Displays the file operation execution status. (RO)	Guru
Success	*Success*	*The last file operation has completed successfully.*	
Failure	*Failure*	*The last file operation has completed unsuccessfully for an unknown reason.*	
File Unavailable	*FileUnavailable*	*The last file operation has completed unsuccessfully because the file is currently unavailable.*	
File Invalid	*FileInvalid*	*The last file operation has completed unsuccessfully because the selected file is not present in this camera model.*	
File Operation Result	FileOperationResult	Displays the file operation result. For Read or Write operations, the number of successfully read/written bytes is returned. (RO)	Guru
File Size (in B)	FileSize	Represents the size of the selected file in bytes.	Guru

File Access via the CamExpert Tool

- Click **Setting** to open the File Access Control dialog.
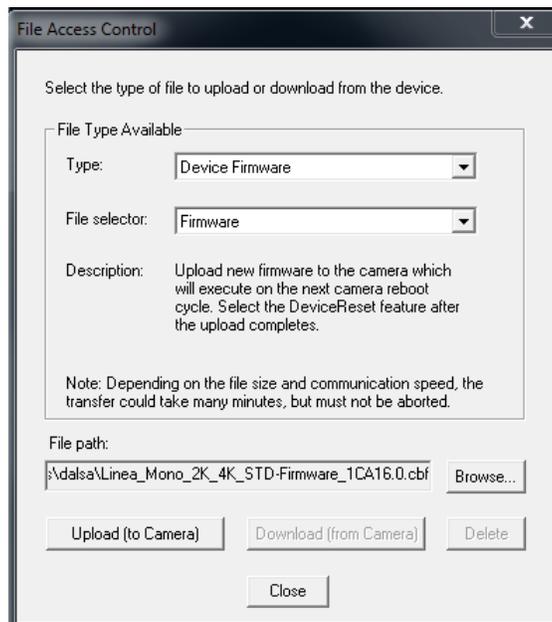

Figure 75: CamExpert – File Access Control Dialog

- **Type**: select the file type to upload to camera.
- **File Selector**: select the required file; different options may be available depending on the Type selected.
- Click **Browse** to open Windows Explorer and select the specific file to upload.
- Click **Upload (to Camera)** to execute the file transfer to the Linea2 5GigE.

GigE Vision Host Control Category

The GigE Vision Host Controls category group parameters used to configure the host computer system GigE Vision features used for Linea2 5GigE networking management. **None of these parameters are stored in any Linea2 5GigE camera.**

These features allow optimizing the network configuration for maximum bandwidth. Settings for these parameters are highly dependent on the number of cameras connected to a NIC, the data rate of each camera and the trigger modes used.

Information on these features is found in the Teledyne DALSA Network Imaging Module User manual.

Implementing Trigger-to-Image Reliability

Overview

In a complex imaging system, many points of failure exist – from acquisition to processing and transmission. Teledyne DALSA provides features, events and I/O signals that provide the system designer with tools to qualify the system in real-time.

Teledyne DALSA's website provides general information, FAQ and White Papers about the Trigger-to-Image Reliability (T2IR) framework in hardware and Sapera LT SDK.

https://www.teledynedalsa.com/en/learn/knowledge-center/trigger-to-image-reliability-t2ir/

T2IR with Linea2

Linea2 provides a number of features for system monitoring:
- Built-in Self-Test on power-up and reset after firmware change
- Image Buffer Accumulation – Count Status
- Image Buffer Memory Size
- Packet Resend Buffer Memory Size
- Internal Temperature Reporting
- In Camera Event Status Flags
  - Invalid External Trigger
  - Image Lost
  - Packet Resend & Related Status
  - Ethernet Pause Frame Requested

Linea2 Features for T2IR Monitoring

The following table presents some of the Linea2 camera features a developer can use for T2IR monitoring. The output line signals would interface to other external devices.

Camera Status Monitoring	
Device Built-In Self-Test	deviceBIST
Device Built-In Self-Test Status	deviceBISTStatus
Device Temperature Selector	DeviceTemperatureSelector
Device Version	DeviceVersion
Firmware Version	DeviceFirmwareVersion
Last firmware Update Failed	FirmwareUpdateFailure
Manufacturer Part Number	deviceManufacturerPartNumber
Manufacturer Info	DeviceManufacturerInfo
Events	
Event Selector	EventSelector
Event Notification	EventNotification
Event Statistic Selector	eventStatisticSelector
Event Statistic Count	eventStatisticCount
Events Overflow	eventsOverflow
Event Statistic Count Reset	eventStatisticCountReset
Acquisition and Triggers	
Valid Frame Trigger	ValidFrameTrigger
Invalid Frame Trigger	InvalidFrameTrigger
Image Lost	ImageLost
Output Lines	
Pulse on: Valid Frame Trigger	PulseOnValidFrameTrigger
Pulse on: Rejected Frame(s) Trigger	PulseOnInvalidFrameTrigger
Image Transfers	
Transfer Queue Current Block Count	transferQueueCurrentBlockCount
Transfer Queue Memory Size	transferQueueMemorySize
Transferred Image Max Data Size	transferMaxBlockSize
Transferred Image Min Data Size	transferMinBlockSize
Transferred Image Average Data Size	transferAverageBlockSize
Maximum Sustained Frame Rate	maxSustainedFrameRate
Packet Resend	PacketResend
Packet Resend Request Dropped	PacketResendRequestDropped
Ethernet Pause Frame Received	EthernetPauseFrameReceived
Precision Time Protocol (PTP)	
PTP Status	ptpStatus
PTP Servo Status	ptpServoStatus
PTP Master Clock Identity	ptpMasterClockId
PTP Master Offset	ptpMasterOffsetNs
PTP Port Last Event	ptpPortLastEvent

Network Overview & Tools

Linea2 5GigE IP Configuration Sequence

The IP (Internet Protocol) Configuration sequence to assign an IP address is executed automatically on camera power-up or when a connection is established to a network. As a GigE Vision compliant device, Linea2 5GigE 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 Sapera DHCP server)
- Link-Local Address (always enabled)

The factory defaults for Linea2 5GigE is Persistent IP disabled and DHCP enabled with LLA always enabled as per the GigE Vision specification.

Supported Network Configurations

The Linea2 5GigE obtains an IP address using the Link Local Address (LLA) or DHCP, by default. A LLA IP address is obtained typically in a few seconds with Microsoft Windows. If required, a persistent IP address can be assigned (see the Running the Network Configuration Tool section).

Preferably, a DHCP server is present on the network, where the Linea2 5GigE issues a DHCP request for an IP address. The DHCP server then provides the IP address. The Teledyne DALSA Network Configuration tool, installed with the Teledyne DALSA Network Imaging Package, provides a DHCP server which is easily enabled on the NIC used with the Linea2 5GigE (Refer to Teledyne DALSA's Sapera LT Getting Started Manual for GigE Vision Cameras & 3D Sensors).

The LLA method, if used, automatically assigns the camera with a randomly chosen address on the 169.254.xxx.xxx subnet. After an address is chosen, the LLA process sends an Address Resolution Protocol (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.

IP Configuration Mode Details

The following descriptions provide more information on the IP configuration modes supported by Linea2 GigE. In general, automatic IP configuration assignment (LLA/DHCP) is sufficient for most Linea2 installations.

Refer to Teledyne DALSA's **Network Imaging Package for Sapera LT Optimization Guide** for information on the Teledyne DALSA Network Configuration tool and network optimization for GigE Vision cameras and devices.

Refer to **Sapera LT Getting Started Manual for GigE Vision Cameras & 3D Sensors** for information on using GigE Vision cameras.

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.

⚠️	**Note**: Ensure only one NIC is using LLA on your PC, otherwise IP conflicts will occur.

- 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 and Linea2 5GigE 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 Teledyne DALSA Network Configuration Tool can enable the Teledyne 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 Teledyne DALSA DHCP server is used instead of LLA mode (see next section).

- Use Teledyne DALSA's Network Configuration Tool to change the Linea2 5GigE from the default DHCP/LLA mode to Persistent IP mode when required, such as when there are multiple NIC devices with Linea2 5GigE connected to each.

⚠️	Teledyne DALSA recommends DHCP/LLA as the mode of operation where a switch is used to connect multiple 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 Linea2 5GigE camera must be configured to have DHCP enabled. This is the factory default setting.

- 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 Teledyne DALSA's Network Configuration Tool can configure the Teledyne DALSA DHCP server on the NIC used for the GigE Vision network.

- Teledyne DALSA DHCP server is recommended where there are multiple NIC ports with multiple GigE Vision devices attached. Each NIC port 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.

- Windows configures a NIC in DHCP mode by default. If no DHCP server is present on the subnet, Windows reverts to LLA mode.

- Ensure a different subnet is assigned to each NIC on the network. This will automatically be managed when the Teledyne 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 Teledyne DALSA DHCP server enabled.
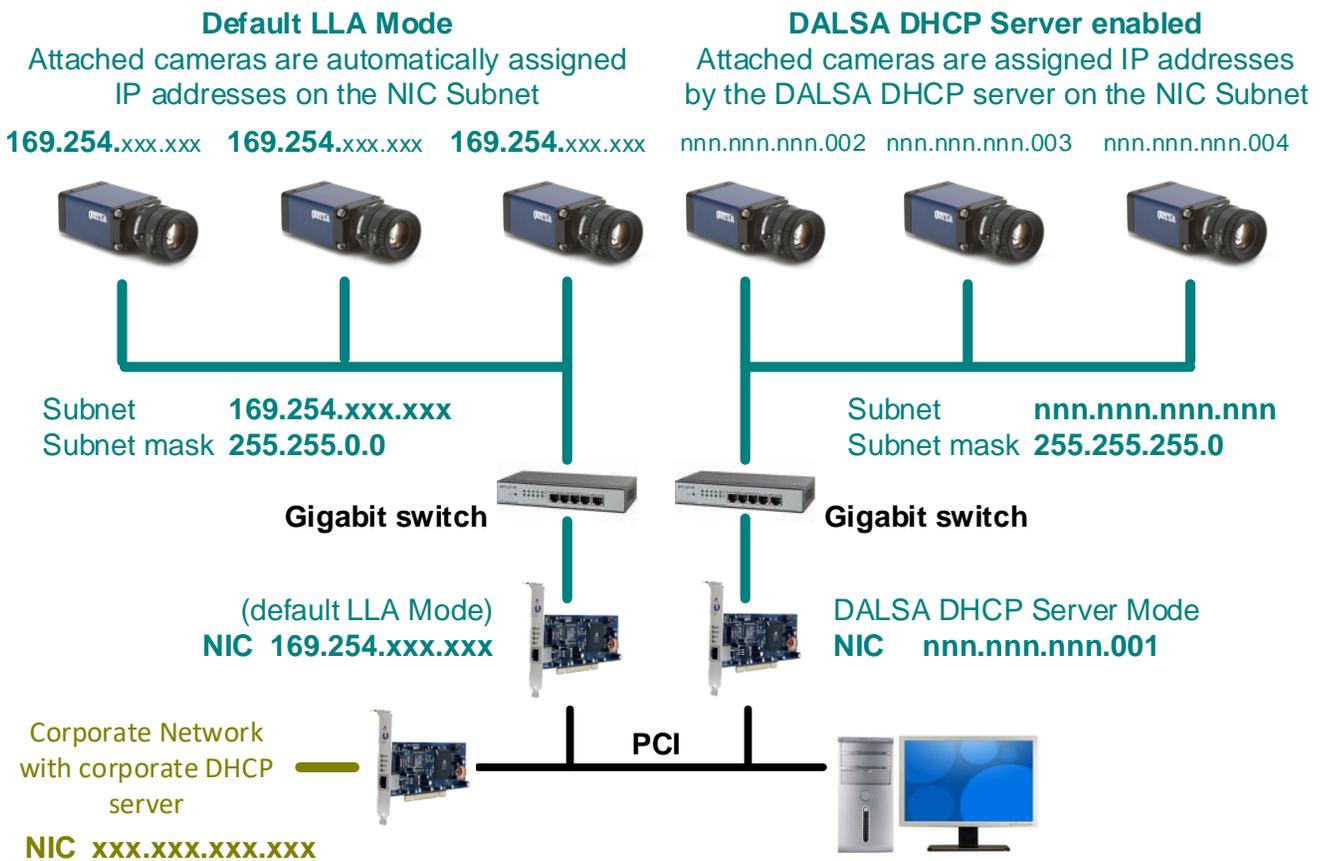

Figure 76: DHCP Configuration Overview

Persistent IP

- Allows the user full control of IP address assignment on the network.
- The camera is forced a static IP address. The NIC IP address must be the same to access the camera.
- If the camera is connected to a network with a different subnet, it cannot be accessed.
- Use Teledyne DALSA's Network Configuration Tool to set a persistent IP address. Refer to Teledyne DALSA's Network Imaging manual.
- 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 may block connecting to the camera. Use Teledyne DALSA's Network Configuration tool to recover a camera with an unknown persistent IP. It will reset the camera's factory default mode, DHCP/LLA. The camera's MAC address displayed on the exterior camera is required to perform 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 camera's 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, the second NIC and cameras connected to it are configured with persistent IP addresses. An application on the computer can control each camera, on each subnet, without conflict.
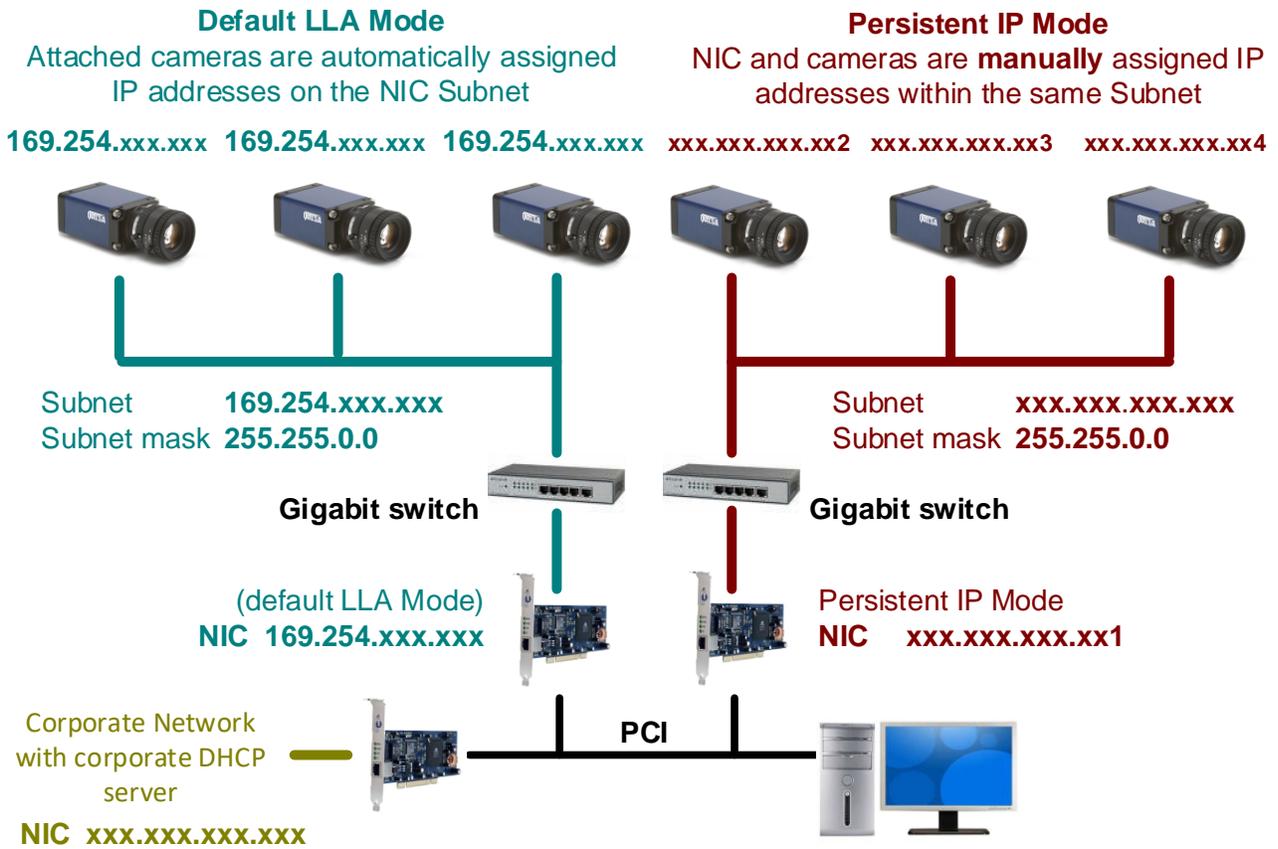
Default LLA Mode
Attached cameras are automatically assigned
IP addresses on the NIC Subnet

169.254.xxx.xxx   169.254.xxx.xxx   169.254.xxx.xxx

Persistent IP Mode
NIC and cameras are **manually** assigned IP
addresses within the same Subnet

xxx.xxx.xxx.xx2   xxx.xxx.xxx.xx3   xxx.xxx.xxx.xx4

Subnet   **169.254.xxx.xxx**
Subnet mask **255.255.0.0**

Subnet   **xxx.xxx.xxx.xxx**
Subnet mask **255.255.0.0**

Gigabit switch

Gigabit switch

(default LLA Mode)
NIC 169.254.xxx.xxx

Persistent IP Mode
NIC   xxx.xxx.xxx.xx1

PCI

Corporate Network
with corporate DHCP
server
NIC xxx.xxx.xxx.xxx

Figure 77: Persistent IP Configuration Overview

Optimizing the Network Adapter used with Linea2 5GigE

Most Gigabit network interface controllers (NIC) allow user modifications to parameters such as Adapter Buffers and Jumbo Frames. The optimal settings will be system dependent. These should be optimized for use with the Linea2 5GigE during installation; refer to Teledyne DALSA's Network Imaging Package for Sapera LT Optimization Guide for more information.

Running the Network Configuration Tool

The Network Configuration tool provides access to NIC and connected GigE Vision camera parameters 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.
- Configure the NIC as a DHCP server for connected GigE Vision camera.
- Change the Auto Discovery Interval from the default of 15 seconds.
- 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.

⚠️	**Important:** Changes made with this tool may update Linea2 5GigE parameters stored in flash memory. Do not remove power from the camera for a minimum 10 seconds.

Refer to Teledyne DALSA's **Sapera LT Getting Started Manual for GigE Vision Cameras & 3D Sensors** for more detailed information on using this tool. The Network Configuration tool can quickly verify and modify certain network configuration items of the imaging system.
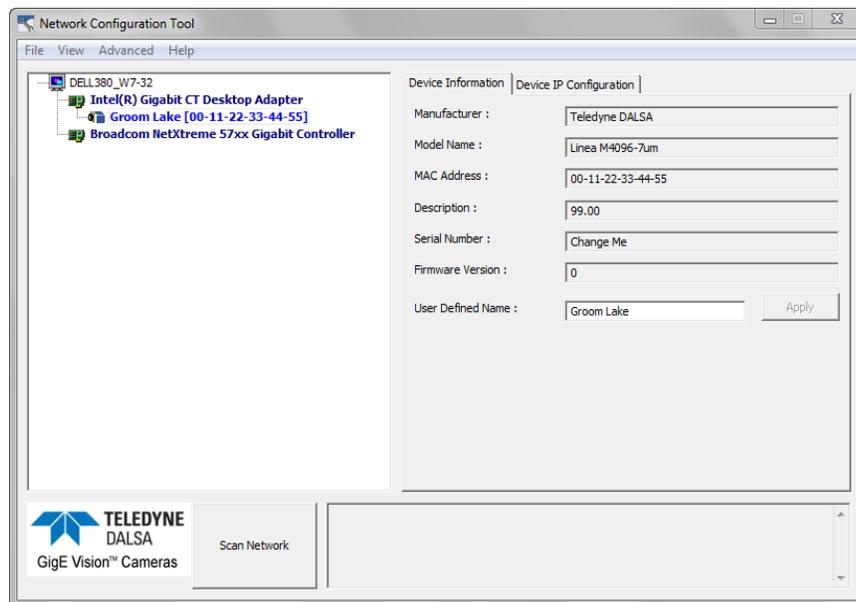

Figure 78: Network Configuration Tool

To start the Network Configuration Tool

- On Windows **Start** menu, select **Teledyne DALSA > Network Configuration Tool**.

Verify the camera appears as a child of the NIC card it is connected to. By default, the camera is identified by its serial number if no user defined name has been assigned.

PAUSE Frame Support

The Linea2 5GigE supports the Gigabit Ethernet PAUSE Frame feature as per IEEE 802.3x. PAUSE Frame is the Ethernet flow control mechanism that temporarily stops data transmission on the network. The PAUSE Frame feature can help a NIC that does not have enough buffering to handle full-speed reception. This requires that the flow control option in the NIC property settings and the Ethernet switch settings must be enabled.

⚠️	**Note**: this problem is not as common with advances in computer bus speeds and memory sizes. PAUSE Frame support is typically required to manage network traffic within an Ethernet switch when multiple cameras are simultaneously used. Using PAUSE Frame will require the user to test various values of Jumbo Frames, to determine the best data throughput. The downside to managed network traffic is that the Pause Frame control will reduce the absolute maximum transfer bandwidth possible on the network.

Technical Specifications

Mechanical Specifications

Linea2 5GigE 4k
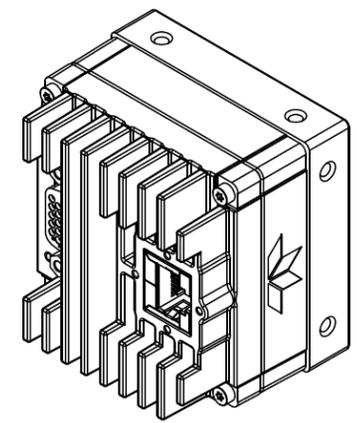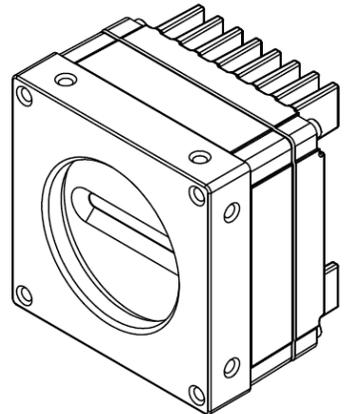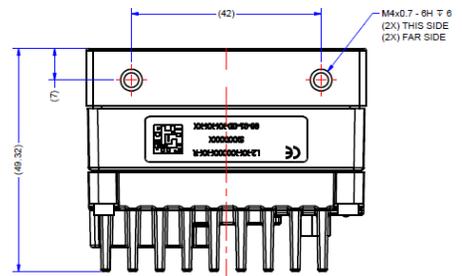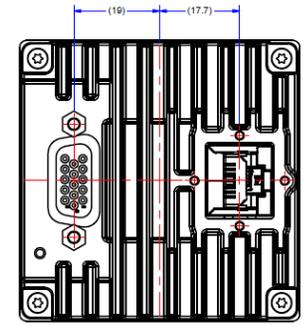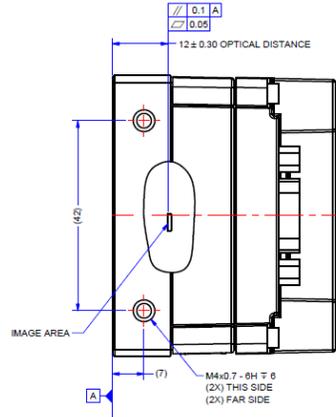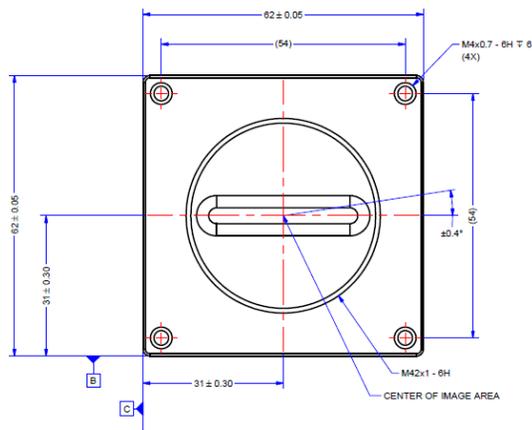
Figure 79: Linea2 5GigE 4k with M42x1 Lens Mount

Additional Notes on Linea2 5GigE Identification and Mechanical

Identification Label

	Linea2 5GigE cameras have an identification label applied to its side, with the following information: • Model Part number • Serial number • MAC Address • 2D Barcode

Additional Mechanical Notes

	Linea2 5GigE supports a screw lock Ethernet cable (see <u>Ruggedized RJ45 Ethernet Cables</u>). For information on lens requirements see <u>Lens Selection Overview</u> and <u>Optical Considerations</u>. Each camera side has two mounting holes in identical locations to provide grounding capabilities. Overall height or width tolerance is ±0.10 mm

Sensor Alignment Specification

The following figure specifies sensor alignment for Linea2 5GigE where all specifications define the absolute maximum tolerance allowed for production cameras. Dimensions "x, y, z", are in microns and referenced to the Linea2 5GigE mechanical body or the optical focal plane (for the z-axis dimension). Theta specifies the sensor rotation relative to the sensor's center and camera mechanical.
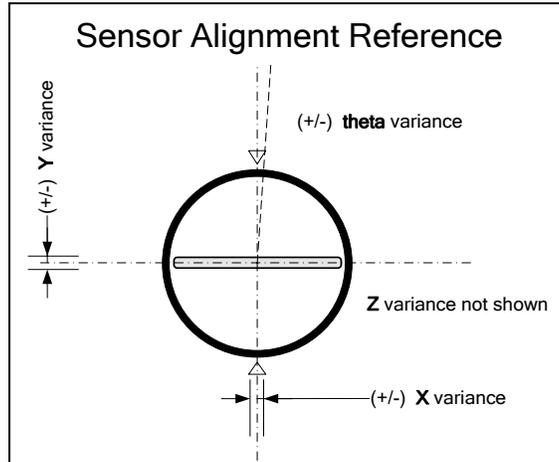

Figure 80: Sensor Alignment Reference

	Linea2 5GigE
X variance	± 300 µm
Y variance	± 300 µm
Z variance	± 300 µm
Theta variance	± 0.4°

Connectors

- **RJ45 Ethernet** connector for control and video data to the host Gigabit NIC. For industrial environments, Linea2 5GigE supports the use of screw lock Ethernet cables (see Ruggedized RJ45 Ethernet Cables).
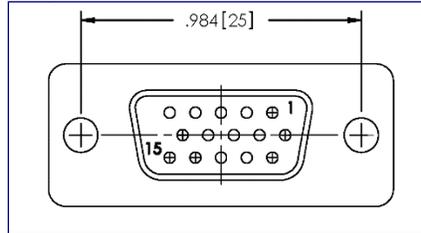- **HD15 female** connector for all I/O and DC power source.

Figure 81: HD15 Female Connector

HD15 Type Connector Details

Pin Number	Linea2 5GigE	Direction	Definition
1	Line 1+	In	RS-422/Single ended Input Port 1+
2	Line 1-	In	RS-422 Input Port 1-
3	Line 2+	In	RS-422/Single ended Input Port 2+
4	Line 2-	In	RS-422 Input Port 2-
5	Signals Ground		Signals Ground
6	Line 3+	In/Out	RS-422/Single ended Input *or* Output Port 3+
7	Line 3-	In/Out	RS-422 Input *or* Output Port 3-
8	Line 4+	In/Out	RS-422/Single ended Input *or* Output Port 4+
9	Line 4-	In/Out	RS-422 Input *or* Output Port 4-
10	PWR-GND		Camera Power Ground
11	Line 5+	Out	RS-422/Single ended Output Port 5+
12	Line 5-	Out	RS-422 Output Port 5-
13	Line 6+	Out	RS-422/Single ended Output Port 6+
14	Line 6-	Out	RS-422 Output Port 6-
15	PWR-VCC	-	Camera Power – DC +12 to +24 Volts

Mating GPIO Cable Assembly

Teledyne DALSA optionally provides for purchase a GPIO breakout cable (HD15 Male to 26-Pos Euro Block) as shown in the following drawing. Use accessory number #AC-CA-00002-00-R when placing your order.
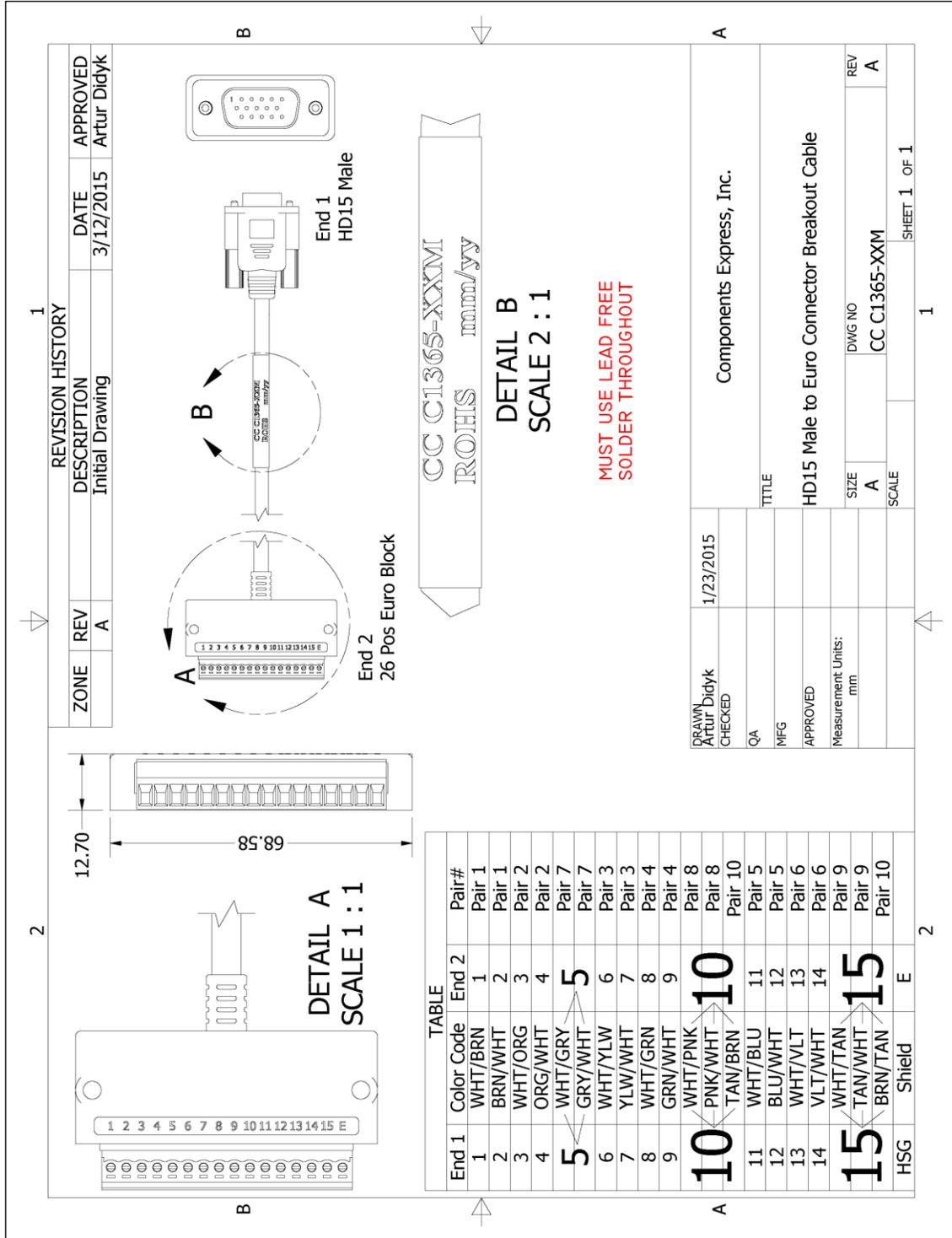
Figure 82: Mating GPIO Cable Assembly

Input Signals Electrical Specifications

External Inputs Block Diagrams
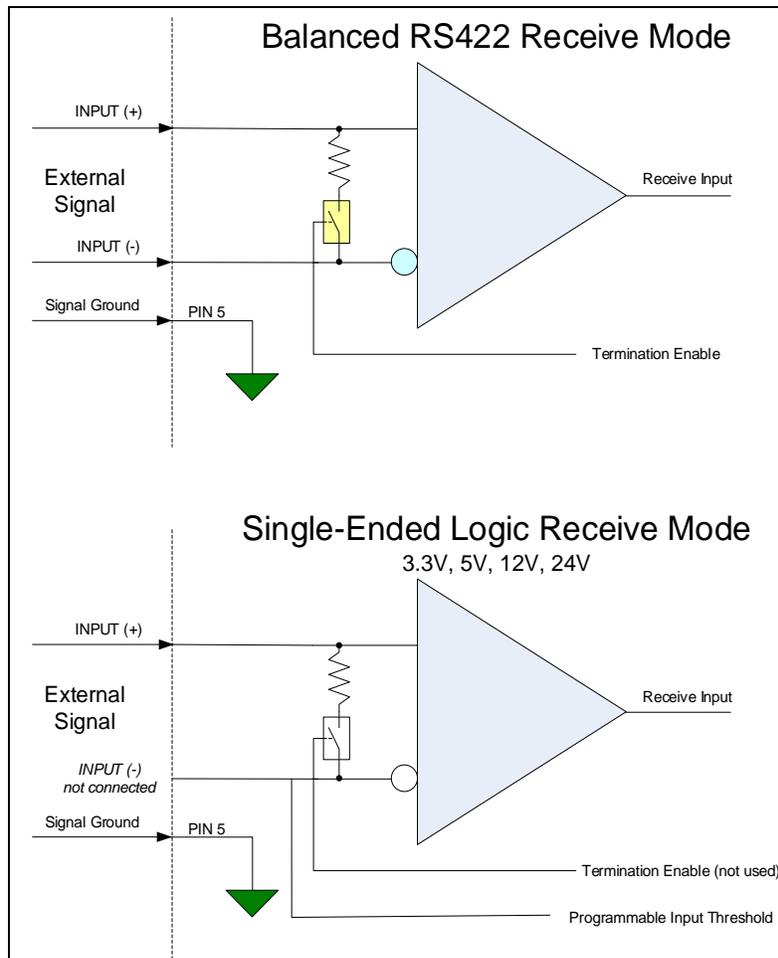
Figure 83: External Inputs Block Diagram

External Input Overview

- The input signals can be used as trigger acquisition event, counter or timestamp event, or integration control.
- The input signal can be improved by User programmable debounce time from 0 to 255 µs in 1 µs steps.

> **Caution:** It is important to correctly configure external inputs before connecting external signals. Connecting higher voltage signals to inputs configured as RS422 may damage the inputs.

External Input Electrical Characteristics

RS422 Inputs	
Common Mode Input Voltage (V$_{cm}$)	-25 V min. – 25 V max.
Differential Input Signal Threshold	200 mV
Differential Input Signal Hysteresis	150 mV (V$_{cm}$ = 0 V)

Single-Ended Inputs		
	Switching Voltage	
	Low to High	High to Low
3.3 V TTL	1.5 V	1.5 V
5.0 V TTL	2.5 V	2.5 V
12 V	6 V	6 V
24 V	11 V	11 V

External Input Timing Reference

Input Level Standard	Maximum Input Frequency	Minimum Pulse Width	Maximum Signal Propagation Delay at 60°C *Input Signal Direction*	
LVTTL (3.3 V)	20 MHz	25 ns	0 to 3.3 V	<100 ns
			3.3 V to 0	<100 ns
TTL (5.0 V)	20 MHz	25 ns	0 to 5 V	<100 ns
			5 V to 0	<100 ns
12 V	20 MHz	25 ns	0 to 12 V	<100 ns
			12 V to 0	<100 ns
24 V	20 MHz	25 ns	0 to 24 V	<100 ns
			24 V to 0	<100 ns

Output Signals Electrical Specifications
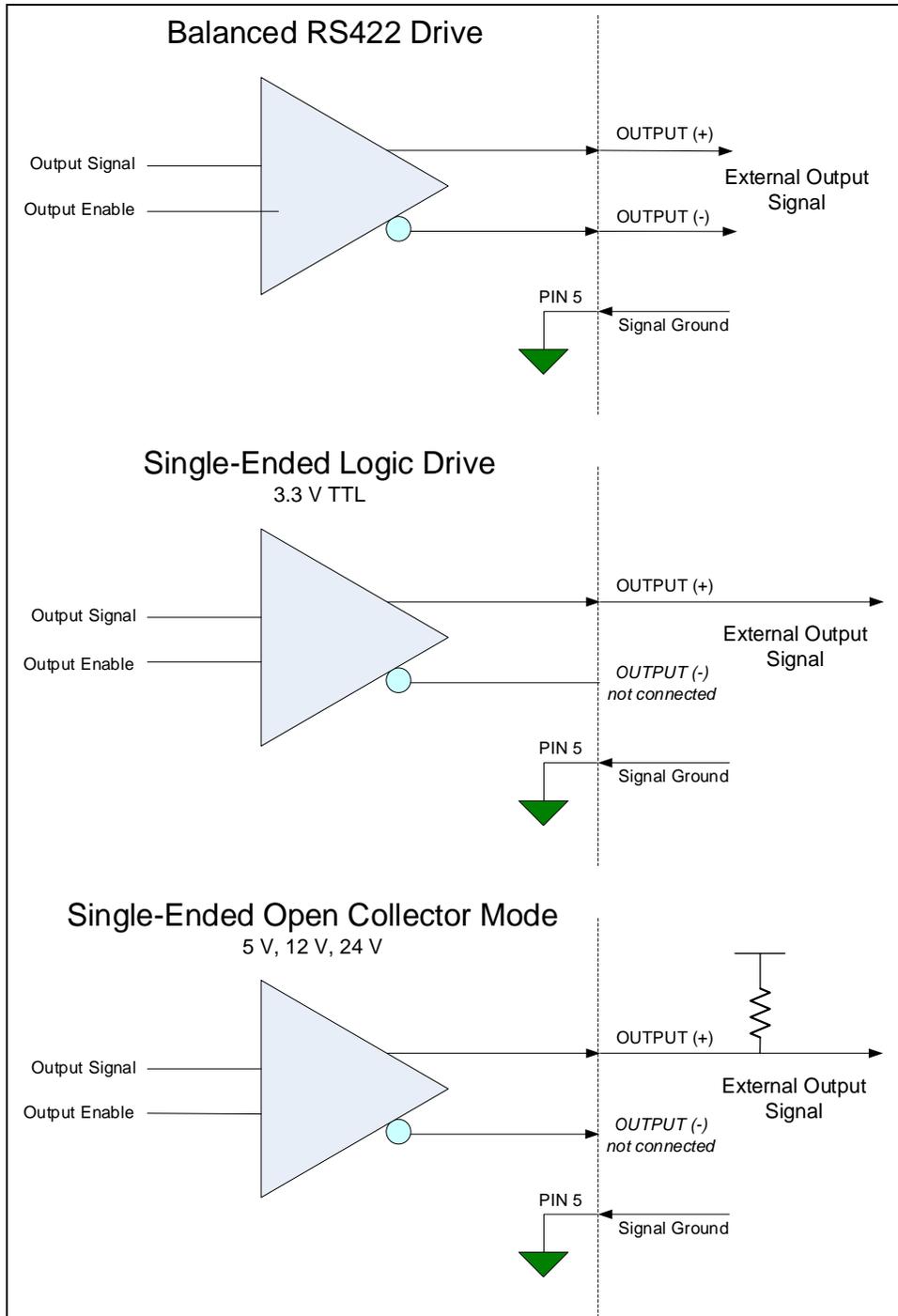
External Outputs Block Diagrams

Figure 84: External Outputs Block Diagram

External Output Details

- The output signals can be used in programmable output mode such as strobe, event notification, etc. (See *outputLineSource* feature).
- For the Single-Ended Open Collector outputs, the user supplied pull-up resistor value should be between 1 kΩ and 10 kΩ depending on supply rail. Resistor Wattage should be calculated accordingly.
- Outputs are open (disabled) on power-up with the default factory settings.
- A software reset will not reset the outputs to the open state if the outputs are active.
- A user setup configured to load on boot will not reset the outputs to the open state if the outputs are active.
- The output signals are designed to prevent an output signal glitch on power-up or polarity reversal.

- Protection Circuit – DC Ratings:
    - Output protected against shorts to ground or other voltages
    - Output maximum voltage of 26 V at 10 mA (at 60°C)

Declarations of Conformity

Copies of the Declarations of Conformity documents are available on the product page on the Teledyne DALSA website or by request.

FCC Statement of Conformance

This equipment complies with Part 15 of the FCC rules. Operation is subject to the following conditions:

1. The product may not cause harmful interference; and
2. The product must accept any interference received, including interference that may cause undesired operation.

FCC Class A Product

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment is intended to be a component of a larger industrial system.

CE Declaration of Conformity

Teledyne DALSA declares that this product complies with applicable standards and regulations.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This product is intended to be a component of a larger system and must be installed as per instructions to ensure compliance.

Additional Reference Information

Lens Selection Overview

This section provides a general overview to selecting a lens for the Linea2 5GigE. Mechanical drawings and Teledyne DALSA part numbers for available lens adapters are provided.

The first two lens parameters, Lens Mount Types and Lens Image Circle, are based on correctly matching the lens to the sensor. Brief information on other lens parameters to consider follows those sections.

Lens Mount Types

Linea2 5GigE 4k cameras use a M42x1 lens screw mount and have an optional adapter for F-mount (AC-LA-00115-A1-R) lenses, as described below.

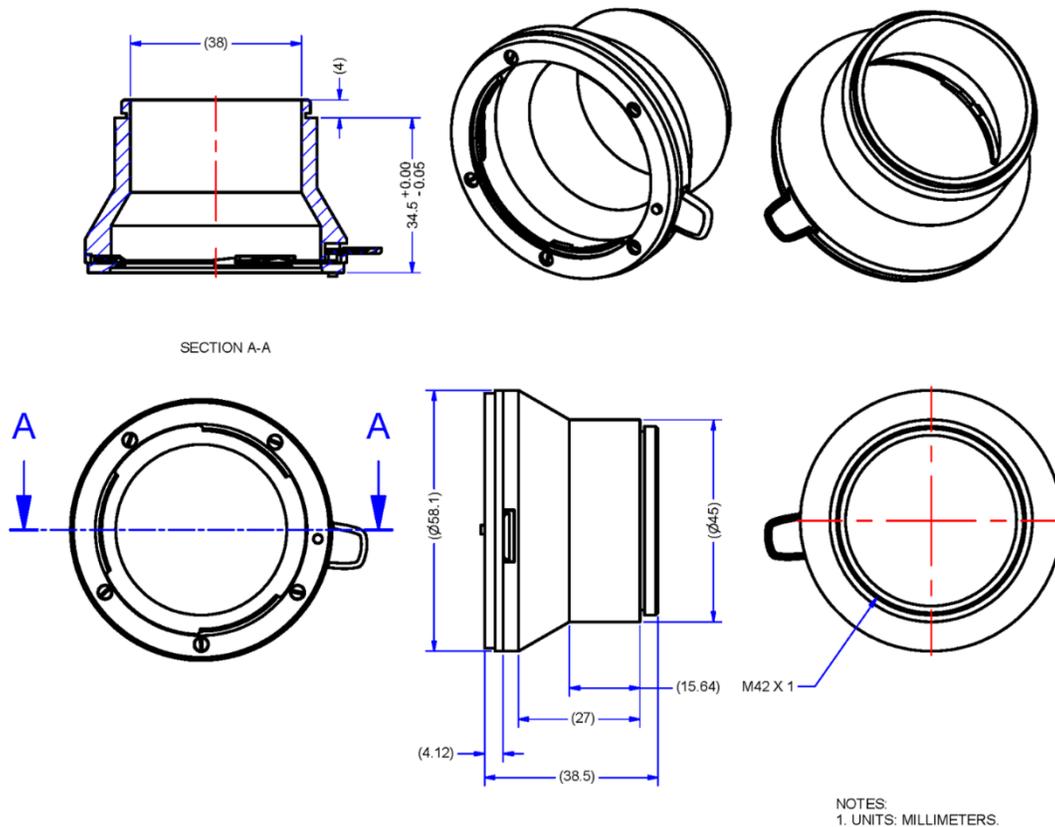**M42x1 to Nikon F Bayonet Adapter (AC LA 00115 A1-R)**

Figure 85: M42x1 to Nikon F Bayonet Adapter, 12mm BFD, HEAVY DUTY w/clip

Lens Image Circle Illustration

The Linea2 5GigE 4k models have an M42 screw mount that supports an M42 lens or F-mount lens (via the optional F-mount adapter). The lens needs to have an image circle exceeding the size of the sensor.

The graphic below illustrates the Linea2 5GigE 4k active sensor relative to the lens image circle of a Nikon F DX lens (using F-mount adapter).
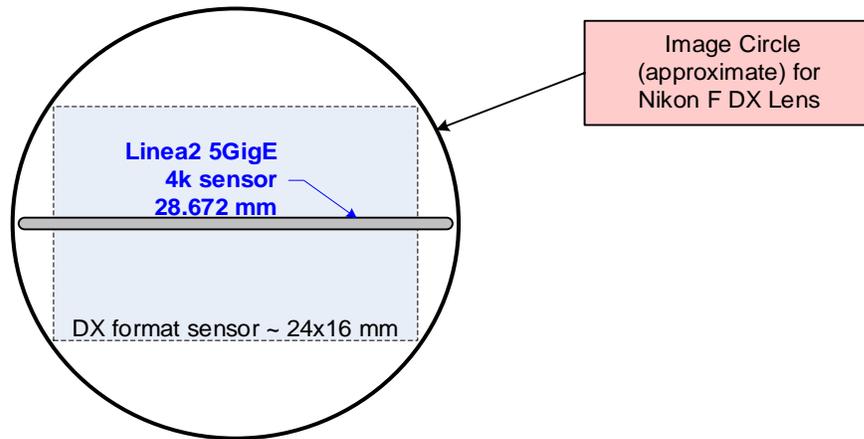

Figure 86: Lens Circle

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 Linea2 5GigE (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 tradeoff 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.
  See Camera 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 appears out of 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.

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 wavelengths and intensity of light required to capture useful images vary per application. The image will be affected by speed, spectral characteristics, exposure time, light source characteristics, environmental and acquisition system specifics, etc. Teledyne DALSA's Web Site introduces this potentially complicated issue. Browse the <u>Knowledge Center</u> and the <u>White Papers and Technology Primers</u> sections.

Exposure settings have more effect 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.

Example: 5 μJ/cm^2 can be achieved by exposing 5 mW/cm^2 for 1 ms, or 5 W/cm^2 for 1 μs.

Light Sources

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

- LED light sources are inexpensive and provide a uniform field with a longer life span compared to other light sources.
- Halogen and fiber-optic light sources provide very little blue relative to IR.
- Some light sources age and produce less illumination in some areas of the spectrum.

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.
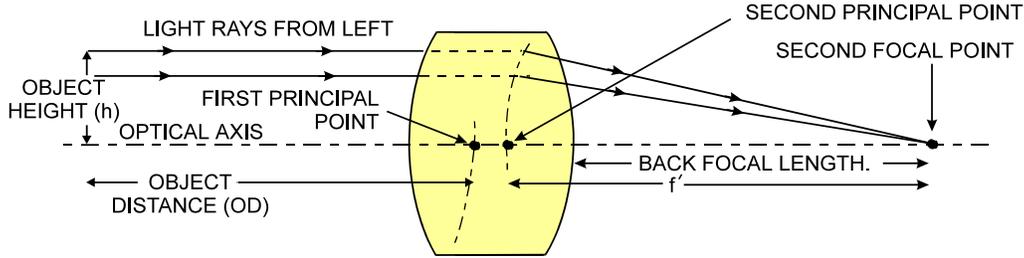
Primary Points in a Lens System

Figure 87: 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:

$m = \dfrac{h'}{h}$	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:

$m = \dfrac{f'}{OD}$	Where f' is the focal length and OD is the target object distance.

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

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

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

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

Lens selection

For best multispectral imaging performance use a lens designed for transmitting wavelength range from visible to NIR. It is recommended to check with lens supplier for lens optical performance and MTF.

Note: Standard lenses designed for visible light may not transmit NIR light fully or perform to specification outside of their intended wavelength range.

Sensor Handling Instructions

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

Electrostatic Discharge and the Sensor

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

Electrostatic charge introduced to the sensor window can induce charge buildup on the underside of the window. The dry nitrogen gas in the sensor package cavity cannot readily dissipate the ESD. Problems such as higher image lag or 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 must be handled with extreme care.

Dust can obscure pixels producing dark patches on the sensor image. 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 illumination is diffused.

Blowing compressed air on the window will remove dust particles unless they are held by an electrostatic charge. In this case, either an ionized air blower or a wet cleaning is necessary.

Touching the surface of the window will leave oily residues. Using rubber finger cots and rubber gloves can prevent oil contamination. Avoid friction between the rubber and window or electrostatic charge build up may damage the sensor.

When handling or storing the camera without a lens always install the protective cap.

⚠️	When exposed to uniform illumination a scratched window will normally have brighter pixels adjacent to darker pixels. The location of these pixels will change with the angle of illumination.

Cleaning the Sensor Window

The following steps describe various cleaning techniques to clean minor dust particles and accidental fingerprints.

⚠	**Important:** Avoid using canned air as it contains particulates that can increase the contamination of the sensor window.

- DALSA recommends the use of an ionized air gun and compressor to blow off the sensor.
- 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.

⚠	Extended airbursts will chill the sensor window causing more condensation. Condensation when left to dry naturally will deposit particles on the sensor.

- Use lint-free ESD-safe cloth wipers. 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.
- Wipe the window carefully and slowly when using these products.

⚠	Do not use regular cotton swabs, since these can introduce static charge to the window surface.

Ruggedized RJ45 Ethernet Cables

Components Express Inc. supplies an industrial RJ45 CAT6 cable. One end has a molded shroud assembly with top/bottom thumbscrews while the other end has a standard RJ45.

⚠	Ruggedized RJ45 cable is recommended in a high vibration environment.
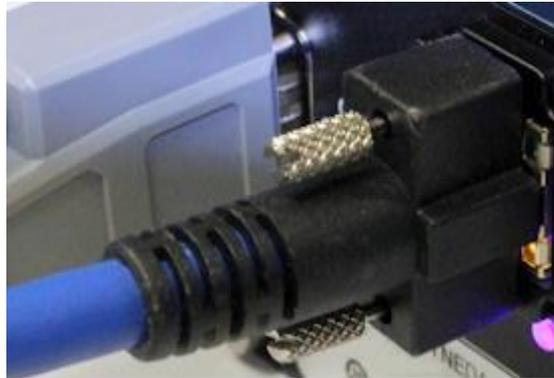
Figure 88: Ruggedized RJ45 Ethernet Cable

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/

Troubleshooting

Overview

If an installation fails or experiences problems controlling and using the Linea2 5GigE camera, the user may perform diagnostics with the methods and tools provided to correct the problem.

The GigE Server status provides visual information on possible camera problems. The three states are displayed in the following table with descriptions of possible conditions.

	An installation with no networking issue may still require optimization to perform to specification.

	Device Available	Device IP Error	Device Not Available
GigE Server Notification Area Icon			
It will take a few seconds for the GigE Server to refresh its state after any change.	The GigE Server icon when the device is found. The camera has obtained an IP address and there are no network issues.	The GigE Server 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 icon when the device is not found. This indicates there is an issue preventing communication with the camera, or there is no camera connected.

Problem Type Summary

Camera problems are either installation or setup related where the camera is found but not controllable. Additionally, the camera may be properly installed but network optimization is required for maximum performance.

Device Not Available

A red X over the GigE server tray icon indicates that the camera 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 Connecting the Linea2 5GigE Camera to verify installation steps.
- Refer to Sapera LT Getting Started Manual for GigE Vision Cameras and 3D Sensors manual to review networking details.
- The Linea2 5GigE camera cannot acquire a DHCP.
- In multiple NIC systems where the NIC for the Linea2 5GigE is using LLA mode, ensure no other NIC is in or switches to LLA mode. It is preferable that the Teledyne DALSA DHCP

server is enabled on the NIC used with the camera instead of using LLA mode, which prevents errors associated with multiple NIC ports.

- Verify NIC is running the latest driver available from the manufacturer.

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.

Refer to Sapera LT Getting Started Manual for GigE Vision Cameras and 3D Sensors manual to review networking details. Refer to Teledyne DALSA's Network Imaging Package for Sapera LT Optimization Guide for information on network optimization for GigE Vision cameras and devices.

Multiple Camera Issues

- When using multiple cameras with a computer with multiple NIC ports, confirm each Linea2 5GigE 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 Teledyne DALSA's Network Imaging Package for Sapera LT Optimization Guide.
- When using multiple cameras connected to a VLAN Ethernet switch, confirm that all cameras are on the same subnet setup on that switch. Refer to Teledyne DALSA's Network Imaging Package for Sapera LT Optimization Guide for more information.
- If a Linea2 5GigE camera installed with other GigE Vision cameras cannot 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 NIC properties and Teledyne DALSA's Sapera Network Imaging Driver does not install. Verify this issue by uninstalling the third-party driver and installing the Linea2 5GigE package again.
- Verify NIC is running the latest driver available from the manufacturer.

Device Available but with Operational Issues

A properly installed Linea2 5GigE with no network issues still may not perform optimally. Operational issues concerning cabling, Ethernet switches, multiple cameras and camera exposure are discussed in the following sections:

Always Important

- Camera firmware updated. Refer to File Access via the CamExpert Tool.
- Power Failure During a Firmware Update–Now What?
- Cabling and Communication Issues.
- Preventing Operational Faults due to ESD.

No Timeout messages

- CamExpert grabs (with no error message) but there is no image (display window stays black). Refer to Acquisition Error without Timeout Messages.
- CamExpert grabs (with no error message) but the frame rate is lower than expected. Refer to Camera acquisition is good but frame rate is lower than expected.
- No image and the line rate is lower than expected. Refer to Camera acquisition is good but frame rate is lower than expected.
- No image but the frame rate is as expected. Refer to Camera is functional, line rate is as expected, but image is black.

Other problems

- Buffer Incomplete message. See Buffer Incomplete Error Message.

Verifying Network Parameters

Teledyne DALSA provides a Network Configuration tool to verify and configure network devices and the Linea2 5GigE network parameters. If there were any problems with the automatic Linea2 5GigE software installation refer to Network Configuration Tool section of Teledyne DALSA's Network Imaging manual.

Before Contacting Technical Support

Carefully review the issues described in this Troubleshooting section. To aid Teledyne DALSA personnel when support is required, the following should be included with the request for support.

- From the **Start** menu, select **Teledyne DALSA Sapera LT** > **Log Viewer**. From the Sapera Log Viewer **File** menu, select **Save All Messages** to generate a log file.
- Report the version of GigE Vision software and Sapera version used.

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.

Camera Fails to Establish Connection with Host PC

If *No device found* is displayed, a manual IP address assignment must be made. (Click **Show Hidden Icons** on right side of task bar).

Figure 89: Windows Task Bar - Show Hidden Icons

Right-click the GigE Server icon , then select **Scan Network** to update the GigE Vision Device Status and Camera IP.

Figure 90: GigE Vision Device Status

 The camera is connected but a NIC IP is not assigned. The GigE Server icon is displaying a warning.

Open Teledyne DALSA's Network Configuration Tool from Windows **Start** menu.

Figure 91: Network Configuration Tool

Cameras displayed in red require a NIC IP. Select the camera name on the left pane, then select the **Device IP Configuration** tab.

	The network tool provides a **Scan Network** button if no cameras are displayed.

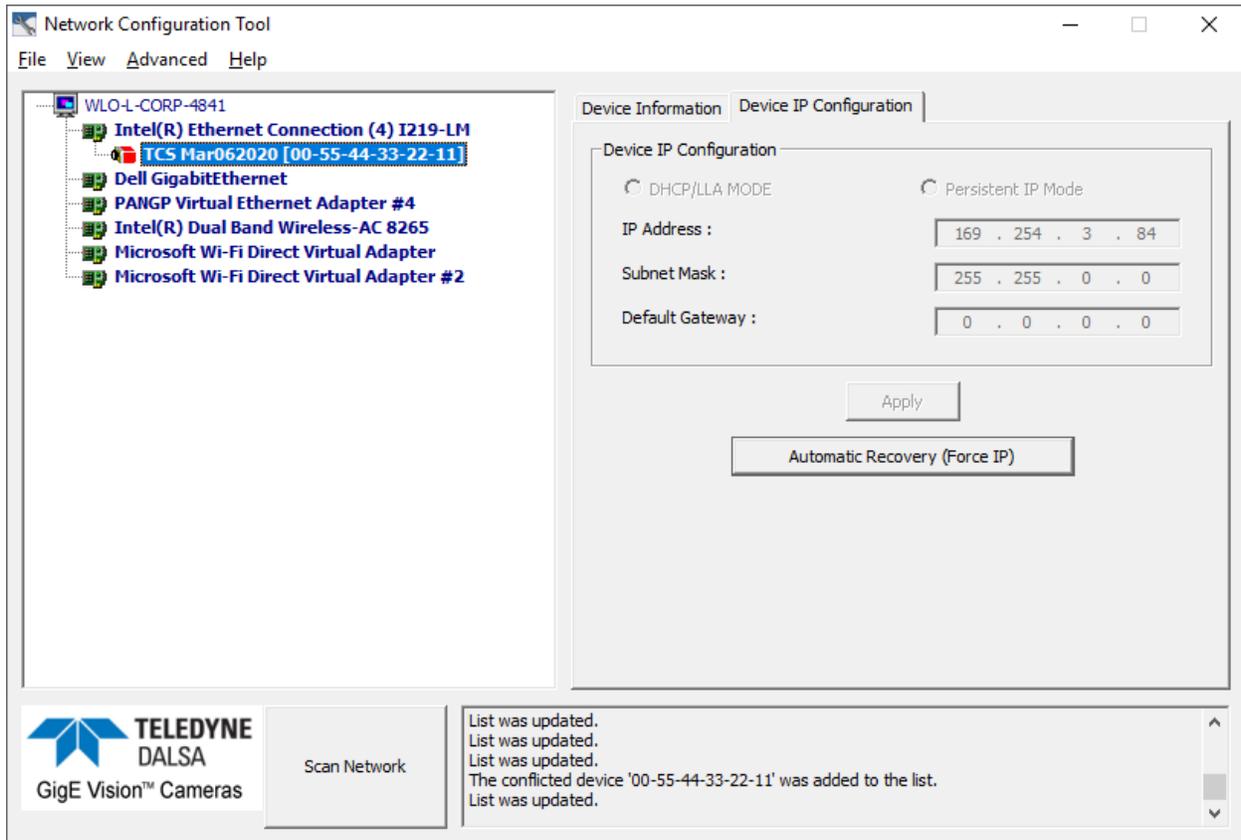Select **Automatic Recovery (Force IP)**.

Figure 92: Network Configuration Tool – Automatic Recovery (Force IP)

Cameras displayed in blue have a proper NIC IP assigned.
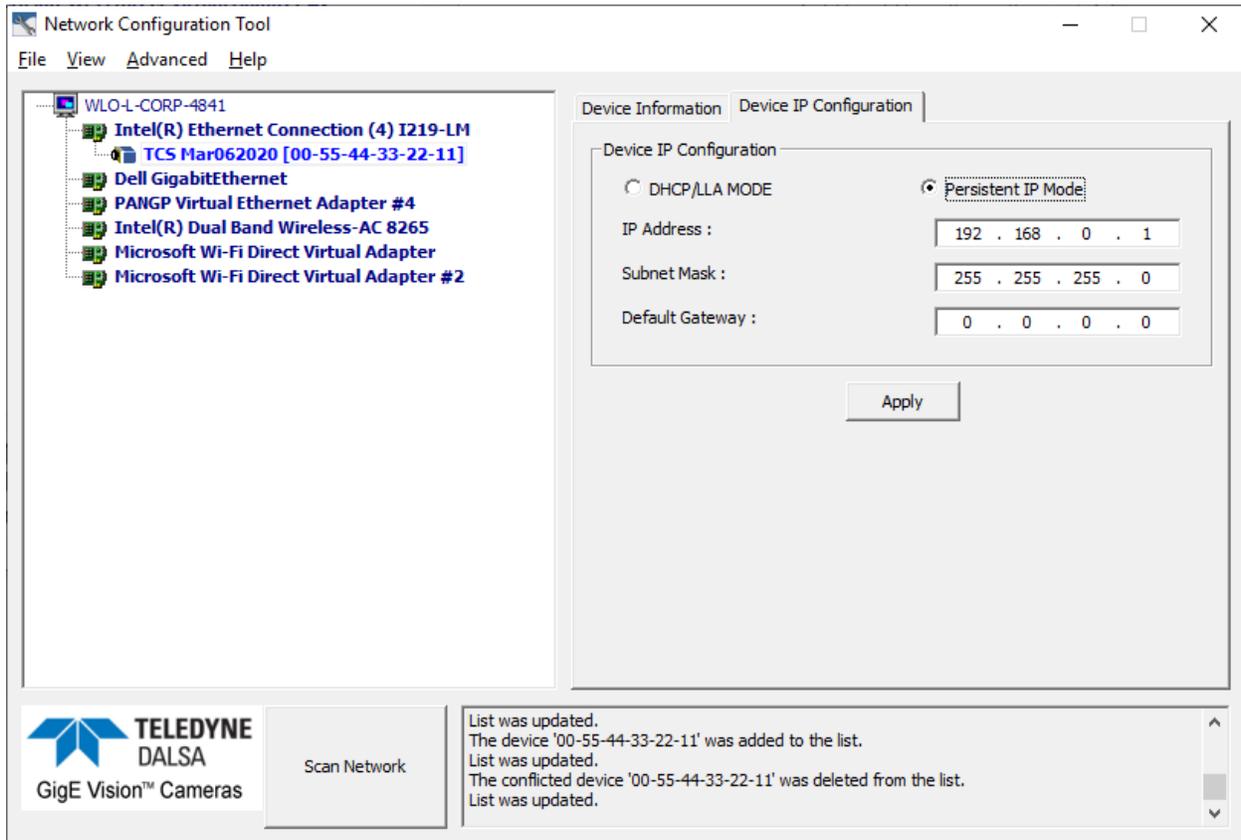
Figure 93: Network Configuration Tool – Proper IP Assigned

⚠	The Network Configuration Tool assigns a dynamic IP address, which is lost on power down. To avoid this issue, assign a persistent IP address to the camera.

Select option **Persistent IP Mode** (shown above), then click **Apply** to assign the IP address. It will automatically connect to the host PC if the IP address does not conflict with other network IP addresses. Refer to Persistent IP section for more information.

⚠	Assigning two devices the same IP Address will cause conflicts.

Device Available with Operational Issues

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

Firmware Updates

As a general rule any Linea2 5GigE installation must include the <u>firmware update procedure</u> (Refer to File Access Control Category section for feature descriptions). Linea2 5GigE camera firmware that does not match a newer version of installed GigE Vision software is likely to have unpredictable behavior.

- Linea2 5GigE is not found by the device discovery process.
- Linea2 5GigE is found by the Sapera GigE Server but an application such as CamExpert does not see the camera.
- A Linea2 5GigE that had a fault with a firmware update will automatically recover by booting with the previous firmware version.

> **Important**: New cameras installed in previously deployed systems are fully backward compatible with the older vision application.

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 Linea2 5GigE. When power returns and the host computer system has started, follow this procedure.

- Connect power to the Linea2 5GigE. The camera processor knows that the firmware update failed.
- The Linea2 5GigE will boot with the previous version of firmware and will operate normally.
- Perform the <u>firmware update procedure</u> again.

Cabling and Communication Issues

With only two cables connected to Linea2 5GigE possible cabling issues are limited.

Power supply problems:

- If the Linea2 5GigE status LED is off, the DC supply power is not connected or faulty. Verify the power supply voltage.

Communication Problems:

- Use a shielded cable where the connector shell electrically connects the Linea2 5GigE 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 camera 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 a secured Ethernet cable when the Linea2 5GigE is in a high vibration environment. Refer to <u>Ruggedized RJ45 Ethernet Cables</u> section.
- Check the Ethernet status LEDs on the Linea2 5GigE RJ45 connector. The Link Status indicator should be on and the activity LED should flash with network messages.
- Verify the Ethernet cable is CAT5e or CAT6. This is very important with long cables.
- When using long cables up to the maximum specified length of 100 m 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 Sapera Log Viewer (On the **Start** menu, select **Teledyne DALSA Sapera LT > Log Viewer**). Start a camera 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 Teledyne DALSA engineering while working with GigE Vision cameras in various computers and setups. For information on network optimization refer to Teledyne DALSA's Network Optimization Guide (available through the **Start** menu under **Teledyne DALSA**).

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 line rate maximum will be limited once the internal buffers are filled. Refer to Teledyne DALSA's Network Imaging manual for information on network optimization.
- If using an external trigger, verify the trigger source rate and camera parameters such as trigger to exposure delay.

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 installed with Sapera (on Windows **Start** menu, select **Teledyne DALSA Sapera LT** > **Sapera Monitor**).
- Make sure the **Memory Overflow** event monitor is enabled.
- Continue grabbing at maximum frame rate. If any memory overflow events are counted, the internal buffer could not be transmitted on time and was discarded. Such a condition may occur at high frame rate cameras.

> **Note:** Sapera CamExpert tool limits the maximum frame rate possible due to CamExpert generating an interrupt for each acquired frame. The Sapera Grab Demo may be better suited for testing at higher frame rates.

- Verify network parameters are optimal as described in Teledyne DALSA's Network Imaging Package for Sapera LT Optimization Guide. Ensure the host computer is not executing other network intensive tasks. Try a different Gigabit NIC.

> ⚠️ **Note:** Changed acquisition frame rate requires the acquisition to be stopped; when acquisition is restarted the new frame rate is applied.

Camera is functional, line rate is as expected, but image is black
- Verify that the lens iris is open.
- Aim the Linea2 5GigE at a bright light source.
- Check the programmed exposure duration is not too short or set it to maximum. Refer to <u>Sensor Control Category</u> for relevant features.
- Using CamExpert set the Linea2 5GigE to output its Internal Pattern Generator. This step is typically done for any camera installation to quickly verify the Linea2 5GigE and its software package. Refer to <u>Internal Test Image Generator</u> section for information on using CamExpert to select internal patterns.

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.

Buffer Incomplete Error Message

Error Messages are generated when the logical acquisition frame buffer takes longer to fill (Image Height / Acquisition Line Rate (Hz)) than the time set for the GigE Vision Host Control. Increase the Image Timeout feature value (found in GigE Vision Host Controls) as required.

Issues with Cognex VisionPro

When the Cognex VisionPro package is uninstalled, the Linea2 5GigE becomes unavailable within CamExpert due to the Cognex uninstaller removing GigE Vision components. This forces the user to reinstall the camera package.

Cognex VisionPro remains a useable third-party product except for their uninstaller fault. Users need to account for this issue until resolved by Cognex.

Revision History

Revision	Date	Change
00	2023-04-13	Initial release.
01	2023-10-13	New model L2-GC-0404T-00. Updated Trigger source types. New example for PTP use. Various updates.

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