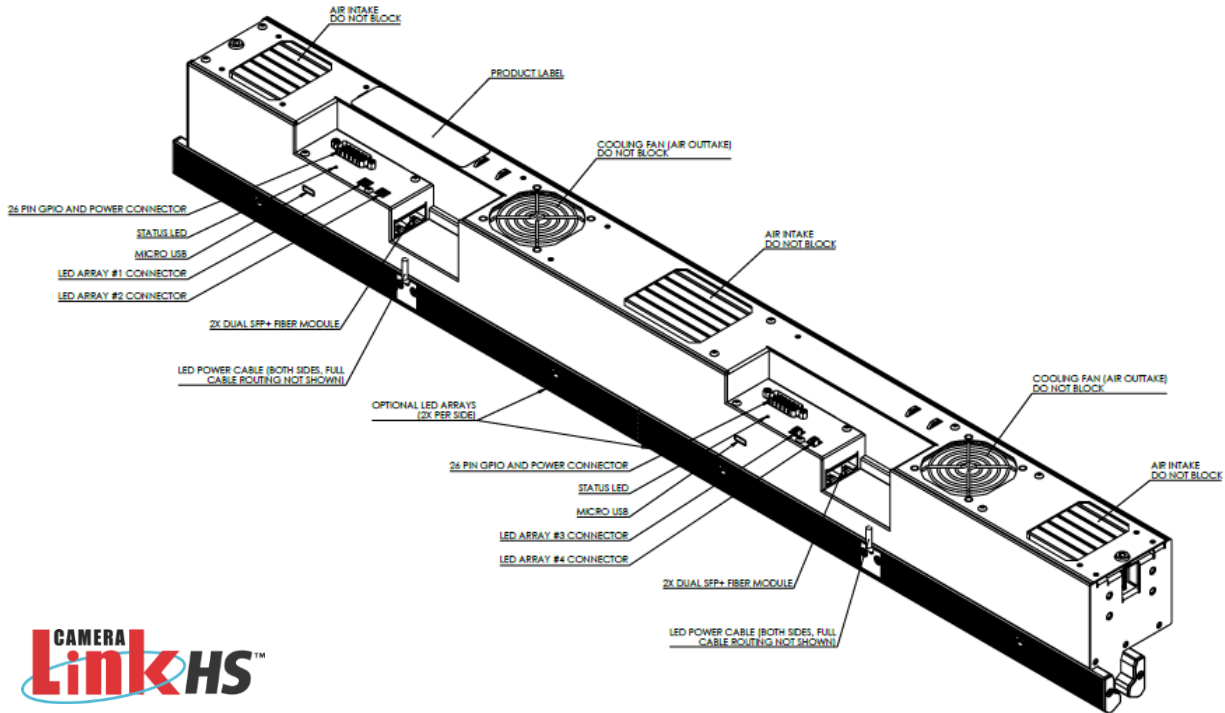# AxCIS Series

Preliminary AxCIS Features Manual

Monochrome, CIS Line Scan

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

800mm Configuration Shown

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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 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.

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AxCIS Series Camera Features

Description

This user manual is preliminary.

This document details the camera features. Please contact the factory for performance specifications or any other technical details.

Teledyne DALSA introduces a breakthrough CMOS line scan CIS format module with unprecedented speed, responsivity and low noise.

Over time, Teledyne DALSA will release the complete range of CIS modules from less than 300mm to 1500mm. The name of this product family is AxCIS. Initial offering has 400 and 800mm scan widths at 600dpi or 900dpi resolution with optional integrated white LED illumination

The AxCIS incorporates Teledyne DALSA's latest CMOS sensor technology in a staggered arrangement that ensures 100% image coverage without interpolation and self-calibration capabilities to ensure image uniformity and alignment.

These cameras have a maximum line rate of 120 kHz with up to 900dpi resolution for any length of module.

The camera uses the Camera Link HS™ interface—the industry standard for a very high-speed fiber optic camera interface with long transmission distances and cable flexing requirements

Teledyne DALSA's AxCIS modules and compatible frame grabbers combine to offer a complete solution for the next generation of automatic optical inspection systems.

These modules are recommended when there is restricted space available to locate the imaging system. Teledyne DALSA's AxCIS modules are well suited for detecting defects at high speeds over a large fields of view where the 'telocentric like' properties of the Selfoc Lens Array (SLA) are desirable for limited measurement purposes and consistent defect classification.

Preliminary Monochrome Models

Prototype Part Number	AxCIS part number	Description
CS-FM-04L12A-00	AX-FM-04A12H-00	400mm field of view, 600dpi, maximum line rate of 120 kHz, monochrome output, Camera Link HS LC fiber optic connectors. Note: Prototype includes integrated lighting, however, AxCIS requires 2 of AC-LE-10008-00 for integrated lighting.
CS-FM-04L12B-00	AX-FM-04B12H-00	400mm field of view, 900dpi, maximum line rate of 120 kHz, monochrome output, Camera Link HS LC fiber optic connectors. Note: Prototype includes integrated lighting, however, AxCIS requires 2 of AC-LE-10008-00 for integrated lighting.
CS-FM-08L12A-00	AX-FM-08A12H-00	800mm field of view, 600dpi, maximum line rate of 120 kHz, monochrome output, Camera Link HS LC fiber optic connectors. Note: Prototype includes integrated lighting, however, AxCIS requires 2 of AC-LE-10008-00 for integrated lighting.
CS-FM-08L12B-00	AX-FM-08B12H-00	800mm field of view, 900dpi, maximum line rate of 120 kHz, monochrome output, Camera Link HS LC fiber optic connectors. Note: Prototype includes integrated lighting, however, AxCIS requires 2 of AC-LE-10008-00 for integrated lighting.

CIS Optical Technology

AxCIS combines a Selfoc Lens Array (SLA), an linear array of TeledyneDALSA CMOS sensors, Image processing, power management and optional integrated LED illumination to provide a complete imaging solution. Industry refers to this configuration as Contact Image Sensor (CIS) technology.

What make CIS unique is the SLA which is an optical device consisting of an array of Gradient Index Lenses (GRIN's) that used at a magnification of 1x, reproducing the object at the sensors image plane in a line of the over long lengths with a short working distance. This allows for a very compact imaging module that can be in confined spaces.

The SLA optical arrangement also ensures a uniform image over the entire field of view unlike regular lenses that can cause image variation due to the angular field of view. This can be helpful for measurement purposes and consistent defect characteristic's ensuring reliable classification

Camera Highlights

Common Features

- Staggered arrangement ensuring no lost pixels
- 600dpi or 900dpi resolution
- Highly sensitive multi line CMOS sensors
- Up to 120 kHz line rates
- Very low noise
- Bidirectionality
- Horizontal and Vertical Binning
- Robust Camera Link HS interface
- LC Camera Link HS control & 10gb/s data connectors
- Single or dual row exposure mode for high dynamic range
- Optional integrated white LED illumination
- Compact enclosure
- 13.72mm working distance
- 0.6mm depth of field
- Single 24v+/-10% power supply

Resolution

- Monochrome Models: 600pdi and 900dpi pixel resolution
- Multiple lengths feasible in 100mm increments
- 400mm and 800mm lengths with initial offering.

Programmable Features

- Single or dual row operation with independent exposure control
- Multiple areas of interest for data reduction
- Region of interest for easy calibration of shading correction
- Flexible gain and offset control
- Module angle correction
- Encoder input multiplier
- Save & restore multiple user configurations
- Intensity control of optional LED arrays
- Test patterns & diagnostics

Applications

- Flat panel inspection
- Web & textile inspection
- Printed circuit board inspection
- 3D printer inspection
- High throughput applications

Part Numbers and Software Requirements

The camera is available in the following configurations:

Note: The prototypes are always shipped with LED arrays where the user can readily remove them if required. However, the Standard AxCIS cameras require lighting to be ordered separately.

Table 1: Camera Models Comparison

Part Number	Resolution	Field of View	Max. Line Rates	Pixel Size	Control & Data
Monochrome					
CS-FM-04L12A-00 & AX-FM-04A12H-00	600dpi	400mm	120kHz single mono /60 kHz Dual Exposure mono	42x42um	Camera Link HS LC fiber optic
CS-FM-08L12A-00 & AX-FM-08A12H-00	600dpi	800mm	120kHz single mono /60 kHz Dual Exposure mono	42x42um	Camera Link HS LC fiber optic
CS-FM-08L12B-00 & AX-FM-08B12H-00	900 dpi	800mm	120kHz single mono /60 kHz Dual Exposure mono	28x28 µm	Camera Link HS LC fiber optic

Table 2: Frame Grabber

Compatible Frame grabber	Linea HS Model
Teledyne DALSA Xtium2-CLHS FX8 (OR-A8S0-FX840)	All models

Table 3: Software

Software	Product Number / Version Number
Camera firmware	Embedded within camera
GenICam™ support (XML camera description file)	Embedded within camera
Sapera LT, including CamExpert GUI application and GenICam for Camera Link imaging driver	Latest version on the Teledyne DALSA Web site

Supported Industry Communications Standards

GenICam™

The camera is GenICam compliant and implements a superset of the GenICam Standard Features Naming Convention specification V1.5.

This description takes the form of an XML device description file using the syntax defined by the GenApi module of the GenICam specification. The camera uses the GenICam Generic Control Protocol (GenCP V1.0) to communicate over the Camera Link HS command lane.

For more information see www.genicam.org.

AxCIS module is Camera Link HS version 1.0 compliant. Camera Link HS is the next generation of high-performance communications standards. It is used where an industrial digital camera interfaces with a single or multiple frame grabbers and with data rates exceeding those supported by the LVDS based Camera Link standard.

The AxCIS modules sections come with a dual SFP+ XCVR cage where one or two 10G XCVR modules can be added along with associated LC Fiber Optic cables as required to support image data bandwidth requirements.

Note that the SFP+ XCVR are not included with the module and can be ordered separately from TeledyneDALSA or from another vendor who supplies compliant modules.
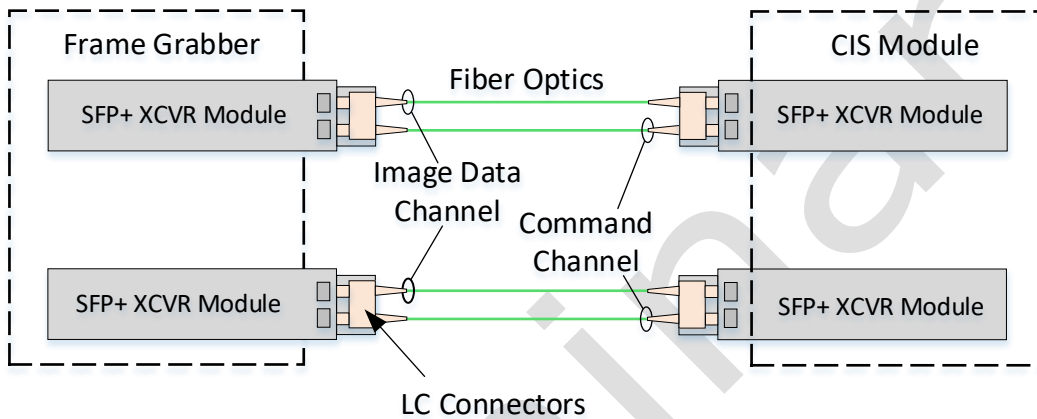
Figure 1: Linea CLHS Dual LC/SFP+ Connector Configuration

Figure 2: Single CLHS Connector Configuration

The command channel is used by the frame grabber to send commands, configuration and programming data to the camera and to receive command responses, status and image data from the camera. Image data and command transmissions use CLHS X protocol (64b / 66b) at the default speed of 10 Gb/s per cable.

Image Data Cables and Transceivers

The fiber optic cables require LC connections and XCVR modules on both ends of the cable.

LC is a small-form factor fiber optic connector that uses a 1.25 mm ferrule, half the size of a standard connector. These cables are in wide use in the telecommunications industry and available in many lengths.

The distance through which the data can be transmitted depends on the type of fiber optic used.

Recommended fiber optic cables are types OM3 and OM4.
OM4 is used for distances > 300 m, but also requires SFP+ transceiver module changes.

Contact Teledyne DALSA Support for more information on recommended cables.

Table 4: LC Fiber Optic Cable Details

Category	Fiber Diameter	Mode	Max Distance
OM3	50 µm	Multimode	< 280 m

OM4	50 µm	Multimode	> 300 m

The following is available to support the specific fiber optic cabling needs of the user. The individual parts can be ordered from TeledyneDALSA or a third party.

Individual Parts

Dalsa Part #	Child Part	Mfg'er part#	Description	MFG
	720-00335-00	OM3-LC-LC-DX-FS-10M-PVC	CABLE;Fiber Optic Patch;10M	Fiberstore
	720-00336-00	OM3-LC-LC-DX-FS-15M-PVC	CABLE;Fiber Optic Patch;15M	Fiberstore
	720-00337-00	OM3-LC-LC-DX-FS-30M-PVC	CABLE;Fiber Optic Patch;30M	Fiberstore
	720-00338-00	OM3-LC-LC-DX-FS-50M-PVC	CABLE;Fiber Optic Patch;50M	Fiberstore
AC-CA-00220-00-R	730-00091-00	SFP-10GSR-85	XCVR MOD;10GBASE-SR SFP+	Fiberstore

Mechanical Drawings
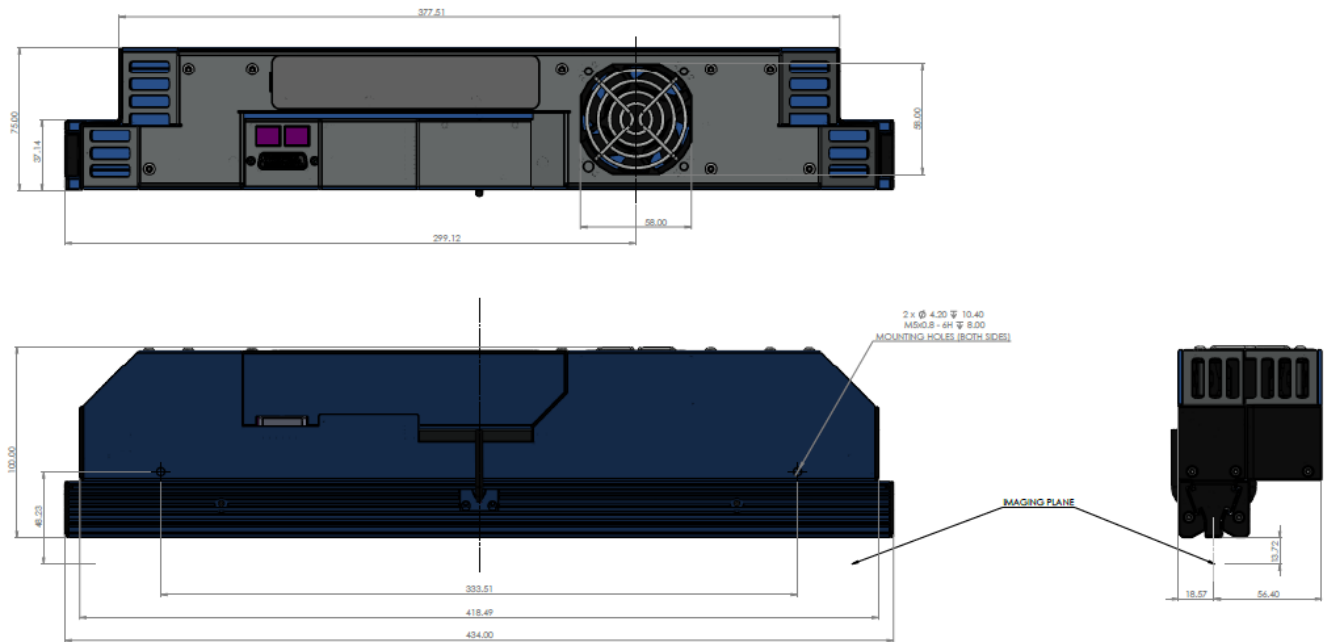
Figure 3: CS-FM-04L12A-00 Prototype Mechanical Drawing
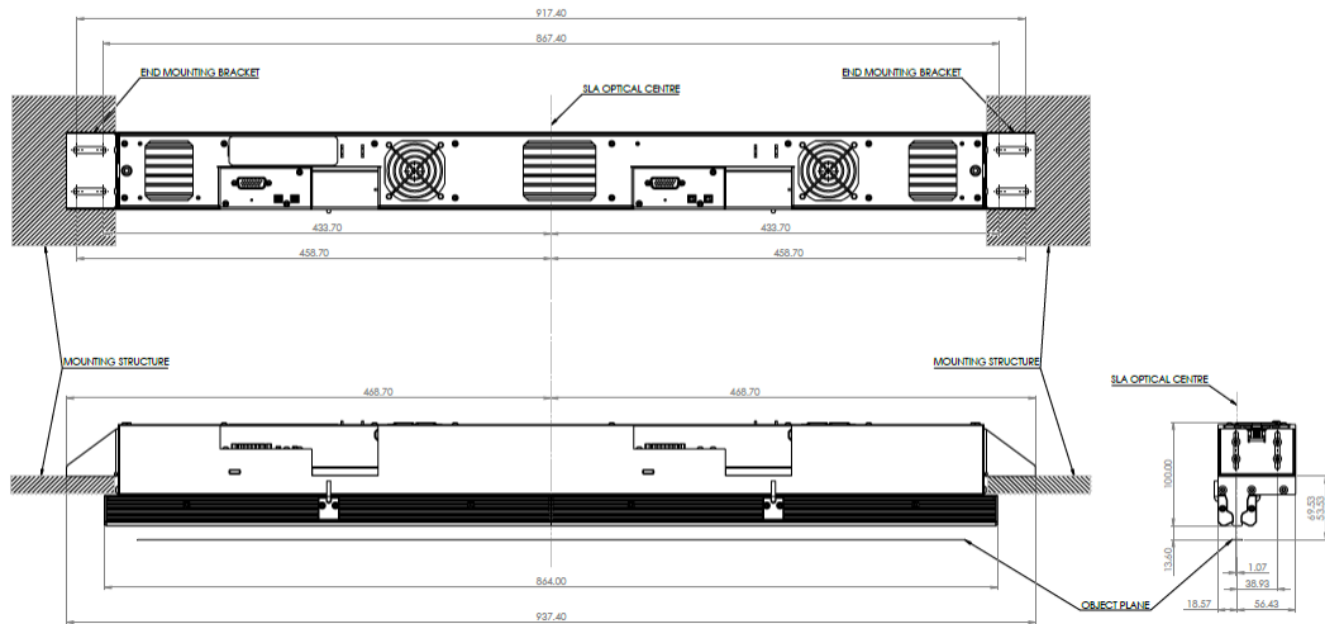
Figure 4: CS-FM-08L12A/B-50 Prototype Mechanical Drawing

Precautions

Read these precautions before using the CIS module.

Confirm that the module's packaging is undamaged before opening it. If the packaging is damaged please contact the related logistics personnel.

Do not open the housing of the module. The warranty is voided if the housing is opened.

Keep the module housing temperature in a range of 0 °C to +50 °C during operation. The module can measure its internal temperature. Use this feature to record the internal temperature of the module when it is mounted in your system and operating under the worst-case conditions. The module will stop outputting data if its internal temperature reaches +80 °C.

Do not operate the module in the vicinity of strong electromagnetic fields. In addition, avoid electrostatic discharging, violent vibration and excess moisture.

To clean the device, avoid electrostatic charging by using a dry, clean absorbent cotton cloth dampened with a small quantity of pure alcohol. Do not use methylated alcohol. To clean the surface of the camera housing, use a soft, dry cloth. To remove severe stains, use a soft cloth dampened with a small quantity of neutral detergent and then wipe dry. Do not use volatile solvents such as benzene and thinners, as they can damage the surface finish.

Though this module supports hot plugging, it is recommended that you power down and disconnect power to the module before you add or replace system components.

Electrostatic Discharge and the CMOS Sensors

Image sensors and the module's housing can be susceptible to damage from severe electrostatic discharge (ESD). Electrostatic charge introduced to the sensor windows surface can induce charge buildup on the underside of the window. The charge normally dissipates within 24 hours and the sensors returns to normal operation.

Install & Configure Frame Grabber & Software

Because of the high bandwidth of these modules, a compatible Teledyne DALSA frame grabber (Xtium2-CLHS PX8 (OR-A8S0-FX840), or equivalent, is recommended. The frame grabber requirements for the 8K and 16K cameras differ. Follow the manufacturer's installation instructions. For more details see the Teledyne DALSA website:
http://www.teledynedalsa.com/en/products/imaging/frame-grabbers

A GenICam compliant XML device description file is embedded with the module firmware. It allows GenICam compliant applications to recognize the module's capabilities, once connected.

Installing Sapera LT gives you access to the CamExpert GUI, a GenICam compliant application.

Using Sapera CamExpert

CamExpert is the camera interfacing tool supported by the Sapera library. When used with the module, CamExpert allows a user to test all module operating modes. In addition, CamExpert can be used to save the module's user settings configuration to the module or to save multiple configurations as individual module parameter files on the host system (*.ccf).
CamExpert can also be used to upgrade the module's software.

An important component of CamExpert is its live acquisition display window. This window allows verification of timing or control parameters in real-time, without need for a separate acquisition program.

The central section of CamExpert provides access to the camera features and parameters.

	Note: The availability of features depends on the CamExpert user setting. Not all features are available to all users. The examples shown are for illustrative purposes and may not entirely reflect the features and parameters available from the module model used in your application.

CamExpert Panes

CamExpert, first instance: select Camera Link HS Mono#1 using the Device drop-down menu.
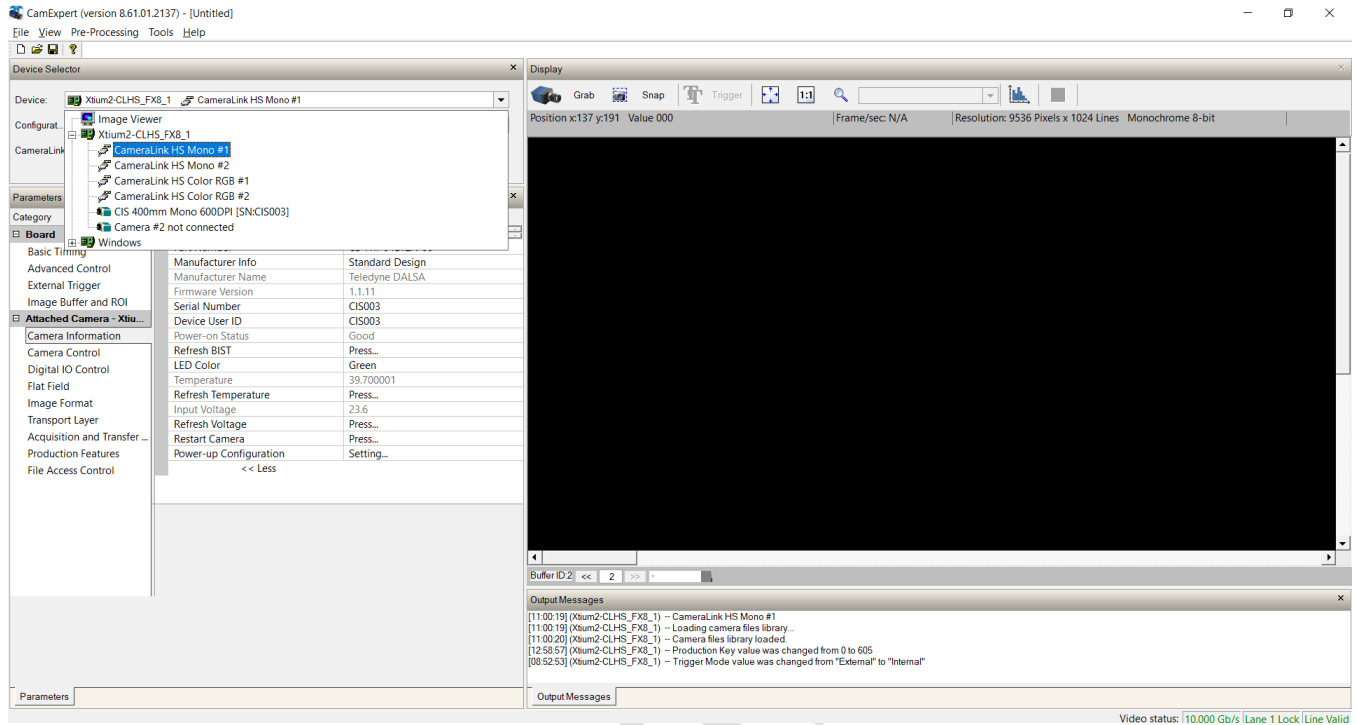
Figure 5: CamExpert Frame Grabber Control Window

The CamExpert application uses panes to organize the selection and configuration of camera files or acquisition parameters.
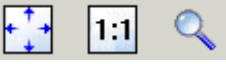
Device Selector pane: View and select from any installed Sapera acquisition device. Once a device is selected, CamExpert will only show acquisition parameters for that device. Optionally, select a camera file included with the Sapera installation or saved previously.

Parameters pane: Allows the viewing or changing of all acquisition parameters supported by the acquisition device. CamExpert displays parameters only if those parameters are supported by the installed device. This avoids confusion by eliminating parameter choices when they do not apply to the hardware in use.

Display pane: Provides a live or single frame acquisition display. Frame buffer parameters are shown in an information bar above the image window.

Control Buttons: The display pane includes CamExpert control buttons. These are:

Grab Freeze	**Acquisition control button:** Click once to start live grab, click again to stop.
Snap	**Single frame grab:** Click to acquire one frame from device.
Trigger	**Trigger button:** With the I/O control parameters set to Trigger Enabled, click to send a single trigger command.
1:1	**CamExpert display controls:** (these do not modify the frame buffer data) Stretch image to fit, set image display to original size, or zoom the image to virtually any size and ratio.
	Histogram / Profile tool: Select to view a histogram or line/column profile during live acquisition or in a still image.

Output Message Pane: Displays messages from CamExpert or the device driver.

Multiple Instances of CamExpert: Modules longer than 500mm incorporate multiple imaging sections each with a separate interface to the host frame grabber. These are treated as separate modules each requiring their own CamExpert window. Note that modules with multiple imaging sections ensure image alignment is maintained across the entire field of view. A single Xtium2-CLHS PX8 frame grabber can support up to four imaging sections if each has a single LC cable or two imaging sections if each has a two LC cables to the frame grabber. For more details on how to set up multiple instances of CamExpert see the Teledyne DALSA website: http://www.teledynedalsa.com/en/products/imaging/frame-grabbers

At this point you are ready to start operating the camera, acquire images, set camera functions and save settings.

Setting Up for Imaging
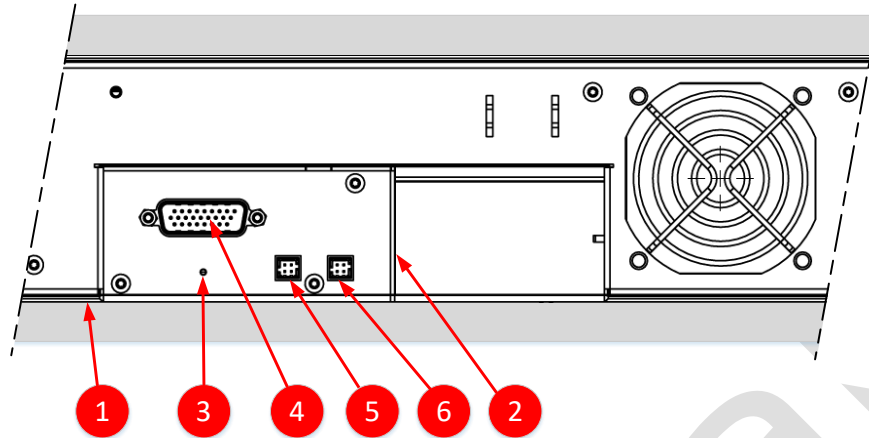
Figure 6. Module I / O Connectors

Camera I / O Connectors

1) Factory use only

2) Data and control connectors – two LC Fiber pairs

3) LED status indicators

4) Power and GPIO connectors: +24 V DC, two I/P, four O/P, 26 pin HD D-Sub connector

5) LED array#1 power. Note: Is being changed

6) LED array#2 power. Note: Is being changed

Powering the Module

⚠️	WARNING: When setting up the camera's power supply follow these guidelines:

- **The 24V supply must be isolated from frame ground of the power supply to prevent potential ground loop issues.**
- Before connecting power to the module, verify the power supply voltage.
- Apply the +24 V. Incorrect voltages may damage the camera.
- There will be no current draw and the unit will not turn on below 20.4V
- Protect each module section with a 5 amp slow-blow fuse or circuit breaker between the power supply and the module.
- Do not use the shield on a multi-conductor cable for ground.
- Keep power leads as short as possible in order to reduce voltage drop.
- Use high quality supplies in order to minimize noise.

| ⚠️ | **Note:** If your power supply does not meet these requirements, then the module performance specifications are not guaranteed. |

Power and GPIO Connections

The module uses a single 26-pin high density D-Sub male connector for power, trigger and strobe signals.

26-pin high density D-Sub Signal Details

The following figure shows the pinout identification when looking at the module's 26-pin male HD D-Sub connector. The table below lists the I/O signal connections.
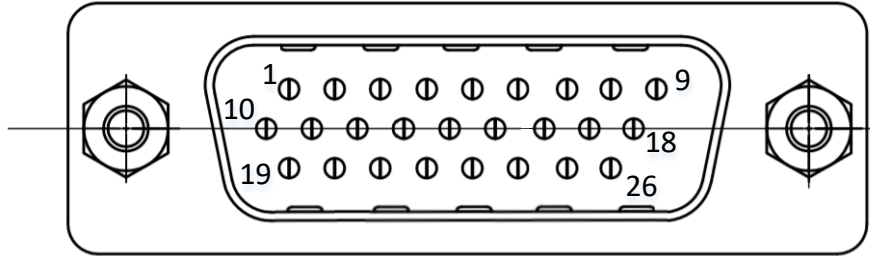
Figure 7: 26-pin high density D-Sub Pin Numbering

Table 5: 12-pin Hirose Pin Assignment

Pin Number	Signal Input / Output	Signal Details	Notes
1	Input	Encoder Phase A+	RS422 Signal
2	Input	Encoder Phase A-	RS422 Signal
3	Input	Encoder Phase B+	RS422 Signal
4	Input	Encoder Phase B-	RS422 Signal
5		+24V Power	
6		+24V Power	
7		Reserved. Do not connect	
8		Power Ground	
9		Power Ground	
10	Output	Line#1+	RS422 Signal
11	Output	Line#1-	RS422 Signal
12	Output	Line#2+	RS422 Signal
13	Output	Line#2-	RS422 Signal
14		+24V Power	
15		+24V Power	
16		Reserved. Do not connect	
17		Power Ground	
18		Power Ground	
19	Output	Line#3+	RS422 Signal
20	Output	Line#3-	RS422 Signal
21	Output	Line#4+	RS422 Signal

22	Output	Line#4-	RS422 Signal
23		Signal Ground	Do not use for power ground
24		+24V Power	
25		Reserved. Do not connect	
26		Power Ground	

The wire gauge of the power cable should be sufficient to accommodate a surge during power-up of at least 5 amps with a minimum voltage drop between the power supply and module sections. The module has a single +24 Volt supply per section. If there is a voltage drop between the power supply and module, ensure that the power supply voltage is at least 24 Volts plus this voltage drop. The module input supply voltage can be read using CamExpert. The module will not power up below approximately 20V.

Establishing Module Communications

When powering up the module, the status LED on the back will indicate one of the following conditions:

Table 6: LED States

LED State	Description
Off	Module is not powered up or is waiting for the software to start.
Constant Red	The module BIST status is not good. See BIST status for diagnosis. CamExpert can be used to get the BIST value from the module.
Blinking Red	The module has shut down due to a temperature problem.
Blinking Orange	Powering Up. The microprocessor is loading code.
Blinking Green	Hardware is good but the CLHS connection has not been established or has recently been broken.
Constant Green	The CLHS Link has been established and the module is ready for data transfer to begin.

When the module's status LED state is steady green:
- CamExpert will search for installed Sapera devices.
- In the Devices list area on the left side of the window, the connected frame grabber will be shown.
- Select the frame grabber device by clicking on the name.

Selecting the Data Format

The prototype cameras output data in the following formats:

Table 7: Output Data Formats

Output Format	Camera Models
Mono8	All monochrome models

The module always outputs data to the frame grabber in a 'planar' format—when multiple sensor rows are used such as in dual exposure mode the corresponding lines are output separately one after the other. Please refer to the frame grabber user's documentation for further details on selection input and output pixel formats.

Establishing Data Integrity

- Use the module's internal triggering. This allows for initial imaging with a static object and no encoder input is required.
- Enable the module to output a test pattern.
- Use a frame grabber CamExpert instance to capture, display and analyze the test pattern image to verify the integrity of the connection. If the test pattern is not correct, check the cable connections and the frame grabber setup.
- Disable the test pattern output.

Camera Features

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

Synchronizing to Object Motion

Acquiring Images: Triggering the Camera
Related Features: TriggerMode, TriggerSource, TriggerActivation

Several different methods can be used to trigger image acquisition in the camera:

Internal Trigger
The simplest method is to set the *Trigger Mode* feature to "Internal". This results in the camera being triggered by an internal timer, which can be adjusted using the *Acquisition Line Rate* feature. This is useful when setting up the camera with a static image.

Note that if the object is moving, the internal line rate must match the object speed in mm/sec divided by the selected pixel size of 0.042mm for 600dpi or 0.028mm for 900dpi to ensure correct alignment of the sensors images.

External Triggers
When the *Trigger Mode* feature is set to "External", the camera triggers come from a different source selected through the *Trigger Source* feature.

The available sources for the triggers are from pins 1 & 2 (Phase A) of the GPIO connector, from the Camera Link HS frame grabber, or from the rotary encoder feature (using pin 1, 2, 3 & 4 of the GPIO connector).

Use the *Trigger Activation* feature to select the edge that triggers the camera. The options are: *Rising Edge*, *Falling Edge* or *Any Edge*. When using *Any Edge* be careful that the time between edges does not exceed the maximum line rate of the module. If the line rate is exceeded edges will be ignored.

CamExpert can be used to configure the frame grabber for routing the encoder signal from the frame grabber input to the trigger input of the module via the Camera Link HS data cable.

Line Rate & Synchronization
A continuous stream of encoder trigger pulses, synchronized to the object motion, establishes the line rate. The faster the object's motion is, the higher the line rate. The module can accommodate triggers up to its specified maximum frequency as dictated by the exposure time. If the maximum frequency is exceeded, the module 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 and sensor misalignment 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.

Measuring Line (Trigger) Rate

See Camera Control Category in Appendix A for GenICam features associated with this section and how to use them.

Related Feature: measuredLineRate

The *Measured Line Rate* command is used to read the line (trigger) rate being applied, externally or internally, to the camera.

Maximum Line Rate

The maximum achievable line rate is determined by the number of cables installed.
- Maximum line rate is 60KHz in timed mode, or 30KHz in dual exposure mode with one fiber cable
- Maximum line rate is 120KHz in timed mode, or 60KHz in dual exposure mode with two fiber cables

*Linea CIS maximum line rate values shown here are theoretical. These line rates were achieved using an Xtium2-CLHS PX8 (OR-A8S0-PX40) frame grabber CamExpert application as a system setup. The maximum achievable line rate depends on the frame grabber and imaging system (including CPU) used. Depending on your setup, lower line rates may be experienced.

For advice on your setup and achieving higher line rates, contact Teledyne DALSA customer support.

Minimum Line Rate

The minimum line rate for all modules 0 Hz. The modules include special features to prevent accumulation of dark current at very low and stopped line rates.

Scan Direction

See the section Camera Control Category in Appendix A for GenICam features associated with this section and how to use them

Related Feature: sensorScanDirectionSource, sensorScanDirection

The CIS modules requires the user to indicate to the direction of travel of the object being imaged.

The source of the scan direction is set using the *sensorScanDirectionSource* feature. The options are: *Internal*, *Line 2* (pin 3 & 4 on the GPIO connector), or the *rotary encoder* feature (using pins 1, 2, 3 & 4 of the GPIO connector, only available when *TriggerSource* is "*RotaryEncoder*" and *rotaryEncoderOutputMode* is set to "*Motion*").

When set to *internal*, use the *sensorScanDirection* feature to set the direction.

Direction Change Time

The direction change time between forward and reverse is < 100 ms.

Setting the correct scan direction

Whether the scan direction is set correctly can easily be seen in live imaging. An image will appear "normal", sharp, focused and well aligned. If the working distance is not set properly the image will be out focused, blur will occur in both, horizontal (cross-scan) and vertical (in-scan), directions.

If scan direction shifts are seen between each of the sensor 25mm field of view occurs in scan direction (see below), the scan direction is set incorrectly.
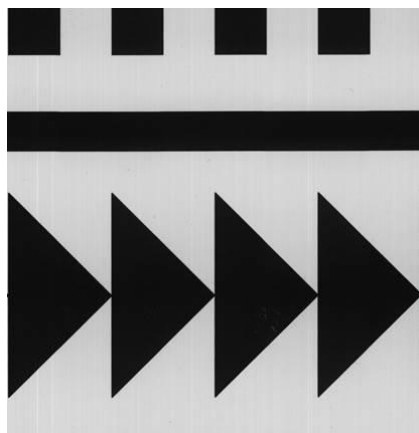
Figure 8. Image with correct scan direction
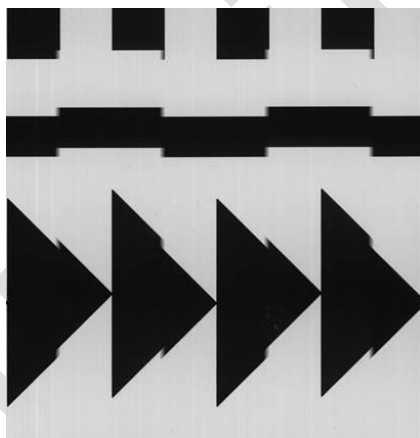
Figure 9. Image with incorrect scan direction

Camera Orientation

The diagram below shows the orientation of forward and reverse with respect to the module body looking at it rear face.
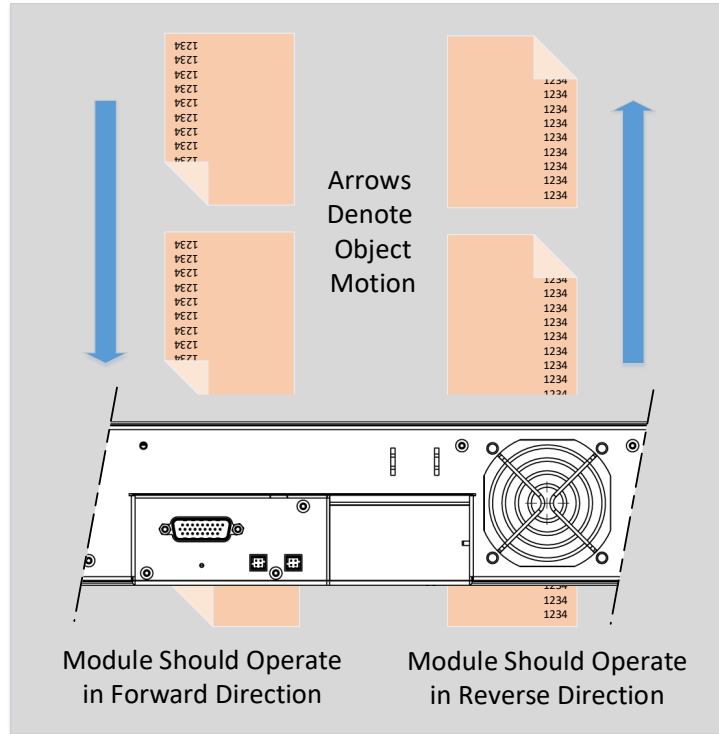
Figure 10: Example of Object Movement and Module Direction

Some inspection systems require that the scan direction change at regular intervals. For example, scanning a panel forwards, coming to a stop and then scanning backward as the camera's field of view is progressively indexed over the entire panel.

It is necessary for the system to over-scan the area being imaged by at least the 64 encoder (Exsync) pulses before the direction is changed. This ensures that valid data will be generated on the return path as the modules field of view reaches the area to be inspected.

Automatic Sensor Alignment

Other CIS modules typically comprise a linear array of small sensors butted end to end to provide a large field of view. Due to the physical characteristics of the sensors, there are lost pixels at the butt joints which need to be interpolated with associated loss of image quality. To ensure 100% image coverage, the AxCIS modules use a staggered sensor approach where adjacent sensors fields of view overlap their neighbors preserving image quality.

Each sensors physical location is accurately measured during the production calibration process where alignment parameters are sent and stored by the module for use in normal operation. The module automatically aligns each sensors image data real time in x and y directions to form a continuous single, aligned image data. Overlap image data is removed.

Maintaining Image Alignment

Adjusting the Encoder (Exsync) Input

Image alignment is assured when the encoder (exsync) pulses occur every 42um(600dpi) or 28um(900dpi) of object travel.

The user may find it inconvenient to accurately create 42um or 28um encoder (exsync) resolution, but may have another encoder source available at a different resolution. This can be readily accommodated by using the modules encoder (exsync) multiplier feature which can multiply the incoming period from 0.1x to 10x as required to achieve the desired resolution. *(See the 'rotaryEncoderFractionalMultiplier' multiplier feature)*

Imaging when not Perpendicular to the Object Surface

To obtain optimum imaging performance, the user may need to angle the module away from perpendicular to the object surface. This has the effect of changing the stagger distance between the sensors images which will affect the modules alignment algorithms. Alignment can be restored by telling the modules it's angle away from perpendicular where the module will then adjust the alignment parameters accordingly to ensure an aligned image. *(See the module 'Angle' feature)* The maximum angle the module can operate at is 45°.

Note that CIS images do not suffer from parallax issues when the module is at an angle, as with standard camera/lens configurations, due to the optical properties of the SLA.

Imaging with Non Square Object Pixels

In some applications the speed of the object and/or the available light may force the use of a scan direction object pixel size greater than 42um for 600dpi or 28um for 900dpi. Since the maximum web speed = maximum line rate x scan direction object pixel size, the larger scan direction pixel size allows for longer integration times.

Since the modules calibration was established at 42um for 600dpi and 28um for 900dpi, the module needs to adjust the calibration parameters to reflect the larger object pixel size. This is readily performed by entering the scan direction object pixel size *(See the module 'ObjectPixelSize' feature)*

Note that the default values is 42um for 600dpi or 28um for 900dpi and only larger object pixels sizes can be entered.

Dual Exposure Mode (HDR)

Some inspection applications may have areas where specific features must be identified that have very bright and very darks areas within the same field of view. Optimizing for the bright areas may result in too much noise to detect features in dark areas and optimizing for the dark areas may result in saturating the image in bright areas.

TeledyneDALSA CIS module has a dual exposure mode that can overcome these opposing requirements by imaging with a long exposure time for one row while concurrently imaging with a short exposure for a second row. The long exposure time row can be configured to detect the desired features in the dark areas while the short exposure can be configured to detect features in the bright areas.

To set up dual exposure mode see the *ExposureMode*, *ExposureTime* and *exposureTimeSelector* features.

The maximum long exposure time is dictated by the period of the line rate. The minimum short exposure times is 2µs. Therefore, the 'dynamic range' from dark to bright areas can be very large as dictated by the line rate and available illumination intensity.

The long and short exposure time rows are output from the module separately, one after the other, and captured by the frame grabber as two image panes that can be processed separately or appropriately combined by the user to meet their specific needs.

Since two rows are being processed in dual exposure mode, the maximum line rate is half that with normal monochrome imaging, i.e. 60KHz maximum.

The two rows are spatially separated in the scan direction. However, the module ensures the long and short exposure time images are aligned. If the modules is at an angle or the encoder resolution is not 42um for 600dpi or 28um for 900dpi, use the *moduleAngle* and/or the s*canDirectionObjectPixelSize* features to enter the systems configuration to ensure image alignment*.

Internal Trigger Mode

See the section Camera Control Category in Appendix A for GenICam features associated with this section and how to use them

Related Feature: AcquisitionLineRate

In the different monochrome imaging modes use the following features to set the internal trigger rate:

Standard Models

Table 8: Standard Models Internal Trigger Rate Features

Mode	Trigger Rate Feature	Maximum
Single Line monochrome	AcquisitionLineRate	120 kHz
Dual Exposure	AcquisitionLineRate	60 kHz

Establishing the Optimal Response

An important module performance characteristic is its responsivity and associated noise level at the system's maximum line rate with the required illumination configuration.

Responsivity and noise performance can be assessed using a stationary, plain white diffusing target using the optional LED illumination. Note. However, to accurately evaluate the module's real-life performance, it is important that the setup is representative of the final system configuration.

The ideal test setup meets the following conditions:

- The correct working distance is established to ensure the setup is in focus.
- The illumination configuration and intensity is equivalent to that planned of the inspection system.
- The module is operated with an exposure time that will allow the maximum line rate of the system to be achieved. The modules internal line rate generator and exposure control can be used for a stationary target.
- He stationary target should not have a texture, such as paper grain.

Image Response Uniformity & Flat Field Calibration

See the section Flat Field Category in Appendix A for GenICam features associated with this section and how to use them.

Related Features: flatFieldCorrectionMode, flatfieldCalibrationFPN, flatfieldCalibrationPRNU, flatfieldCorrectionAlgorithm, flatfieldCalibrationTarget, clearCoefficients, rowSelector

The sensor pixel responses, illumination intensity profile and the Selfoc Lens Arrays transmission characteristics may cause variations in the image response over the field of view.

The module can compensate for optical non-uniformities by using flat field calibration.

- When performing Flat Field (PRNU) calibration, the module should be imaging a front illuminated white target or rear bright field illumination source. The optical setup should be as per the inspection system, including correct working distance, illumination intensity, spectral content and illuminator beam structure.
- Flat field calibration should be performed when the camera temperature has stabilized.
- Flat field calibration will adjust all pixels to have the same value as the peak pixel value or target level, as per the calibration mode selected.
- If the flat field calibration is set to a target level that is lower than the peak value and the system gain is set to a low value, then it is possible that the sensor will maximize its output before the camera's output reaches 255 DN. This can be seen when a portion of the output stops increasing before reaching 255 DN with increasing illumination and the PRNU deteriorates. This effect can be resolved by decreasing the light level or exposure control time.

Following a flat field calibration, all pixels should be at their un-calibrated peak value or target value. Changing gain values now allows the user to make refinements to the operating responsivity level.

	Note: The best flat field calibration can be achieved by performing it at the mid DN level of the working range used in the operation. Any flat field error associated with residual non-linearity in the pixel will be halved as compared to performing a calibration at the peak value of the operating range. A simple way of performing this is to reduce exposure time to half what is used in the operation in order to get the mid DN level for flat field calibration. Once complete, return the exposure time to its original setting.

Those areas of the image where high roll-off is present will show higher noise levels after flat field calibration due to the higher gain values of the correction coefficients. Flat field calibration can only compensate for up to an 8:1 variation. If the variation exceeds 8:1 then the line profile after calibration will include pixels that are below the un-calibrated peak level.

> **Note:** The Linea CIS module has many different modes of operation. It is strongly recommended that the module be flat fielded for that mode of operation that is intended including direction of scan

Saving & Loading a PRNU Set Only

See the Flat Field Category in Appendix A for GenICam features associated with this section and how to use them.

Related Features: flatfieldCorrectionCurrentActiveSet, flatfieldCalibrationSave, flatfieldCalibrationLoad

A user set includes all the "settings" (for example, gain, line rate), FPN (Fixed Pattern Noise) and PRNU (Photo Response Non-Uniformity) coefficients. These three features let you save/load just the PRNU coefficients. Loading a complete user set takes approximately 1 second while loading only the user PRNU coefficients takes less than 200 milliseconds.

Use the User PRNU Set Selector parameter to select the set you want to save or load. There are 17 sets available—16 user and 1 factory.

The *Factory Set* is read-only and contains all ones. Loading the Factory Set is a good way to clear the user PRNU.

Save the current user PRNU coefficients using the "Save User PRNU Set" command. Load the user PRNU coefficients from the set specified using the "User PRNU Set Selector" and the "Load User PRNU Set" command features.

Flat Field Calibration Regions of Interest

See the section Flat Field Category in Appendix A for GenICam features associated with this section and how to use them.

Related Features: flatfieldCalibrationROIOffsetX, flatfieldCalibrationROIWidth

There are occasions when the module's field of view includes areas that are beyond the material to be inspected.

This may occur when module images off the edge of a panel or web or when an inspection system is imaging multiple lanes of material. The edge of the material or area between lanes may not be illuminated in the same way as the areas of inspection and, therefore, will cause problems with a flat field calibration.

The module can accommodate these "no inspection zones" by defining a Region of Interest (ROI) where flat field calibration is performed. Image data outside the ROI is ignored by the flat field calibration algorithm. The ROI is selected by the user and with the pixel boundaries defined by the pixel start address and pixel width and then followed by initiating flat field calibration for that region. Once set, another ROI can be defined and flat field calibrated.

Binning

See the section Image Format Control Category in Appendix A for GenICam features associated with this section and how to use them.

Related Features: BinningHorizontal and BinningVertical

In certain applications, lower image resolution may be acceptable if the desired defect detection can still be achieved. This accommodation can result in higher scan speeds, as the effective distance travelled per encoder pulse is increased due to the larger object pixel size. The module has a binning feature that produces rapid adjustment to a lower object pixel resolution without having to change the optics, illumination intensity, or encoder pulse resolution.

Binning is a process whereby adjacent pixels are summed. The module supports 1x, and 2x horizontal and vertical binning.

Horizontal binning is achieved by summing adjacent pixels in the same line. Therefore, 2x binning results in the object pixel doubling in size horizontally. In addition, since adjacent pixels are summed (not averaged), the image gets brighter. That is, 1x2 and 2x1 are twice as bright, 2x2 is four times brighter, and so forth.

Horizontal 2x binning will halve the amount of image data out of the camera. This can be used to save processing bandwidth in the host and storage space by creating smaller image file sizes.

When vertical 2x binning is selected, the module will divide the encoder input by 2 and multiply the Scan Line Object Pixel Size by 2x to maintain vertical image alignment. This allows the object scan speed to double, longer exposure times can be selected or a combination of both.
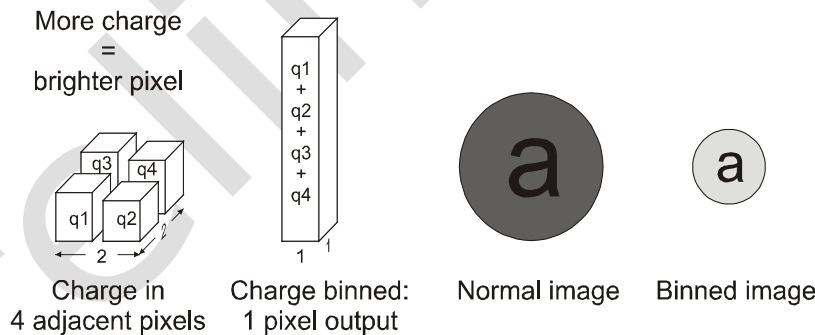
Figure 11: 2x2 Binning

For the camera, the default binning value is 1 x 1.

⚠	**Note:** Binning parameters can only be changed when image transfer to the frame grabber is stopped. Refer to the Acquisition and Transfer Control Category in the appendix for details on stopping and starting the acquisition.

Using Area of Interest (AOIs)

Reduce Image Data & Enhance Performance

See the section Image Format Control Category and Acquisition and Transfer Control Category in Appendix A for GenICam features associated with this section and how to use them

Related Features: multipleROICount, multipleROISelector, multipleROIOffsetX, multipleROIWidth, AcquisitionStart, AcquisitionStop and AcquisitionStatus

If the module's field of view includes areas that are not needed for inspection (also refer to the description in the Flat Field Calibration Region of Interest section) then the user may want to ignore this superfluous image data.

Eliminating unwanted image data that is visible in the module's field of view reduces the amount of information the host computer needs to process. This may also result in an increase to the maximum allowable line rate due to CLHS bandwidth limits when using 12-bit output data.

The module section can accommodate up to four AOIs. Image data outside the AOIs is discarded. Each AOI is user selected and its pixel boundaries defined. The module assembles the individual AOI's into one contiguous image line with a width equal to the sum of the individual AOIs. The frame grabber will need to be adjusted to accommodate the smaller overall image width. As the host computer defined the size of each individual AOI, it will be able to extract and process each individual AOI from the single larger image.

> **Note:** Since each module section is effectively a separate CLHS connection with it's own controls, four AOI's are available for each section i.e. A 400mm module has one section but an 800mm module has two sections.

Steps to Setup Area of Interest for Each Section

1. Plan your AOIs.
2. Stop acquisition, using the *AcquisitionStop* feature. In CamExpert this feature is available in the Acquisition and Transfer Control category:
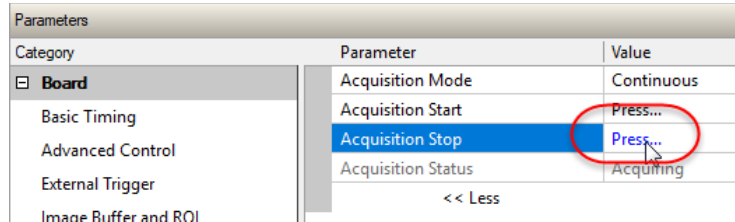
The *AcquisitionStatus* feature displays the current status as Acquiring or Not Acquiring.

3. Set the number of AOIs using the AOI Count Horizontal (*multipleROICount*) feature. In CamExpert AOI related features are available in the Image Format category:
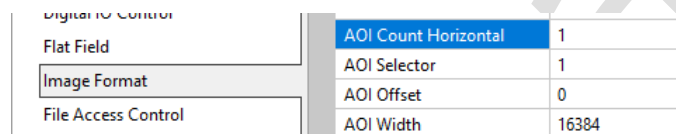
4. Select the first AOI and set the offset and width.
5. If the other AOIs are large you may need to select them first and reduce their widths.
6. Repeat for each AOI in turn.
7. Start acquisition, using the AcquisitionStart feature.

Rules for Setting Areas of Interest

The rules are dictated by how image data is organized for transmission over the available CLHS data lanes. The camera / XML will enforce these rules, truncating entered values where necessary.

> **Note:** AOI parameters can only be changed when image transfer to the frame grabber is stopped. Refer to the Acquisition and Transfer Control Category in the appendix for details on stopping and starting the acquisition.

- Acquisition must be stopped to change the AOI configuration.
- 1-4 AOIs can be selected.
- Minimum width is 96 pixels per AOI.
  - Minimum total of all AOI widths summed together must be at least 1,024.
- Maximum width of all AOI widths summed together must be no more than = 9,536
  - Maximum 8k bytes per CLHS lane.
- AOI width step size is 32 pixels.
- The offset of each AOI may be 0 to (9,536 – 96 = 9,440).
  - Overlapping AOIs are allowed.
- Offset and width for individual AOI's will "push" one another.
  - For example, if AOI has offset 0, width 9,536, and the offset is changed to 4096, then the width will be "pushed" to 5,440.
  - AOI's only affect one another by limiting the maximum width.
- AOIs are concatenated together in numerical order and sent to the frame grabber starting at column zero. If the AOI count is reduced to less than the current AOI count, the AOI selector will be changed to the largest of the new AOI count available.

Adjusting Responsivity and Contrast Enhancement

See the section Camera Control Category in Appendix A for GenICam features associated with this section and how to use them.

Related Features: GainSelector, systemGain, BlackLevel

It is best for module performance to always use the maximum exposure time possible based on the maximum line rate of the inspection system and any margin that may be required to accommodate illumination degradation. However, it will be necessary to adjust the responsivity to achieve the desired output level from the module. The module has row gain and black level (offset) features that can be used to adjust the module's responsivity.

Gain and black level settings are applied as follows:

$$DN_{out} = ((DN_{in} + Black\ Level) * Row\ Gain) * System\ Gain$$
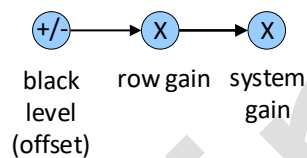
Figure 12: Black Level, Row Gain and System Gain Processing Chain

Row gain adjustment can be applied to all sensor array output rows or selectively each row; If the Exposure Mode is Timed, only one row is available. In Dual exposure, two rows are available where each can have a separate row gain values. Row gains can be adjusted from 1 to 4.99x. System Gain can be adjusted from 1 to 9.99x.

When an image contains no useful dark image data below a specific threshold, then it may be beneficial to increase the contrast of the image.

Black Level

The module has a black level (offset) feature that allows a specified level to be added or subtracted from the image data.
Negative values can be used to eliminate dark areas of no interest. The gain feature can then be used to return the peak image data to near output saturation with the result being increased image contrast. First, determine the offset value to subtract from the image with the current gain setting. Then set this as a negative offset value and apply additional gain to achieve the desired peak image data values.

Positive values can be used to eliminate black clipping of image data. This can be useful when measuring dark noise performance.

Changing Output Configuration

Pixel Format

See the section Image Format Control Category in Appendix A for GenICam features associated with this section and how to use them

Related Feature: PixelFormat, AcquisitionStart and AcquisitionStop

The module can output video data as 8-bit or 12-bit.

Use the Mono8 Pixel Format to process image data as one, or two separate image planes when operating in dual exposure mode.

⚠️	**Note:** Pixel Format, and associated features, can only be changed when the image transfer to the frame grabber is stopped. Refer to the Acquisition and Transfer Control Category in the appendix for details on stopping and starting the acquisition.

For example, to change from 8-bit to 12-bit pixel format:
1. In Acquisition and Transfer Control category, set Stop Acquisition.
2. In Image Format category, set Pixel Format to Mono 12 (or BGR 12 if supported).
3. In the host frame grabber configuration, set Pixel Depth to 12.
4. In Acquisition and Transfer Control category, set Start Acquisition.

Establishing the Desired Object Pixel Size

Encoder Multiplier

The user may have an encoder source that does not provide a pulse at the desired scan direction pixel resolution. The module includes a feature where the incoming external encoder pulse can be multiplied to establish the desired resolution.

Related Feature: Rotary Encoder Multiplier, Rotary Encoder Rescale Order

The module establishes the desired encoder resolution by a multiply-divide function if the pulse rate is low or a divide-multiply function if the pulse rate is high. The Rotary Encoder Rescale Order may be used to select which operation is most suited to their application. The multiplication value can be larger or smaller than 1x.

⚠️	**Note:** Remember to enter the object pixel size using the *Object Pixel Size*. If it deviates from 42um for 600dpi or 28um for 900dpi. If 2x vertical binning is selected, the module will automatically make the necessary adjustments.

Ensuring Image Alignment & Response Level

The module uses a staggered sensor arrangement to ensure 100% object coverage in the image requiring no interpolation as with butted sensors. To establish image alignment, the module appropriately delays the image data from each sensor. Factory calibration is performed using a scan direction pixel size of 42um or 28um with the module optical axis perpendicular to the object surface.

Object Pixel Size

If the inspection system is using a larger pixel to accommodate a faster web speed or achieve a longer integration time, scan direction adjustment of the stagger delay values is required.

Related Feature: Object Pixel Size, AcquisitionStart and AcquisitionStop

The user can enter the object pixel size being used and the module will automatically adjust the delay values to ensure image alignment.

Acquisition must be stopped to access this feature

Angle Correction

To achieve optimum defect detection, the inspection system may require the optical axis of the module to be at an angle to the object surface and adjustment of the stagger delay values is required.

Related Feature: Angle Correction, AcquisitionStart and AcquisitionStop

The user can enter the module angle away from perpendicular and the module will automatically adjust the delay values to ensure image alignment. The adjustment is not sensitive to whether the angle is positive or negative. Angles up to 45° can be accommodated

Acquisition must be stopped to access this feature

Response Leveling

Analog circuitry, as present in all types of sensors and associated analog to digital convertors, may have a tendency to change their characteristics over temperature. This could cause a small change in the response from sensor to sensor. Sensor to sensor response leveling can be automatically performed by the module

Related Feature: Response Levelling Trigger

Response leveling can be performed while imaging, however, when the leveling is applied, a small disturbance in the image may occur. The user can initiate when this occurs using the response leveling trigger. The object being imaged must be moving when Response Leveling is performed. The faster the motion, the quicker it completes as it involves averaging multiple lines.

> **Note:** To be effective, there should be no saturated pixels and reasonably bright image content, it cannot function with a very dark image. However, in dual exposure mode, this may occur where high 'dynamic range' images are required. i.e. The user has set a long and short integration time where the row with the long integration time may have saturated pixels. The module is capable of accommodating this scenario, however, the short integration time row should still have no saturated pixels.

Optional LED Array Control

The module can accommodate optional integrated white LED arrays, one on each side of the image line.

Related Features: LED Selector, LED Intensity

The LED arrays can be adjusted independently or together as controlled by the *LED Selector* feature. The LED intensity can be adjusted from 100% down to 25% or OFF.

> **Note:** As with all LED's, their output will degrade over extended periods of use. Typically by 50% over 50,000 hours. It is therefore recommended LED intensity is set to give some room for adjustment to accommodate this degradation.
> It is possible the LED arrays can be replaced by the user if degradation over time exceeds acceptable levels.

Saving & Restoring Camera Setup Configurations

See the section Camera Information Category in Appendix A for GenICam features associated with this section and how to use them

Related Features: UserSetSelector, UserSet1 thru UserSet16, UserSetDefaultSelector, UserSetLoad, UserSetSave

An inspection system may use multiple illumination, resolution and responsivity configurations in order to cover the different types of inspection it performs. The module includes 16 user sets where module setup information can be saved to and restored from—either at power up or dynamically during inspection.

The settings active during the current operation can be saved (and thereby become the user setting) using the user set save feature.

A previously saved user setting (User Set 1 to 16) or the factory settings can be restored using the user set selector and user set load features.

Either the factory setting or one of the user settings can be selected as the default setting, by selecting the set in the user set default selector (Camera Power-up configuration option in the Power-up configuration dialog accessed from the Camera Information category). The set selected is the default setting and is the set that is loaded and becomes active when the module is reset or powered up.

The relationship between these four settings is illustrated in Figure 13. Relationship Between Camera Settings:
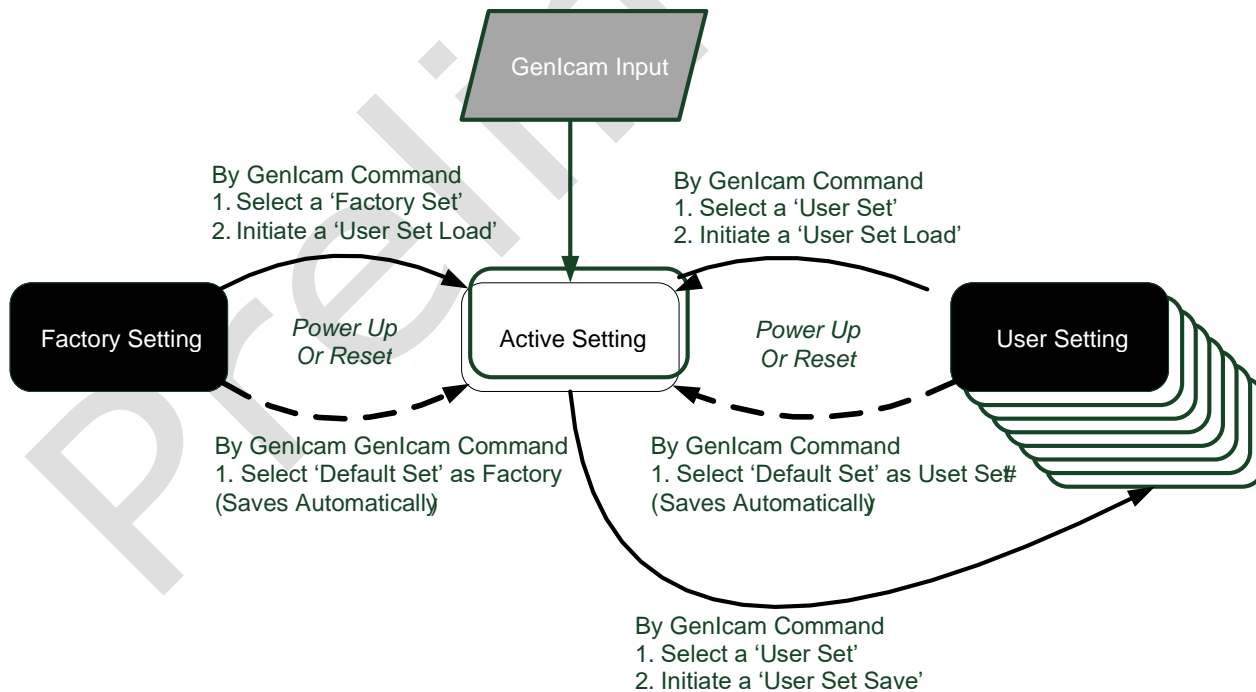
Figure 13. Relationship Between Camera Settings

Active Settings for Current Operation

Active settings are those settings used while the camera is running and include all unsaved changes made by GenICam input to the settings.

These active settings are stored in the module's *volatile* memory and will be lost and cannot be restored if the module resets, is powered down or loses power during operation.

To save these settings so that they can be restored next time you power up the modules or to protect against losing them in the case of power loss, you must save the current settings using the user set save parameter. Once saved, the current settings become the selected user set.

User Setting

The user setting is the saved set of camera configurations that you can customize, resave, and restore. By default, the user settings are shipped with the same settings as the factory set.

The command user set save saves the current settings to non-volatile memory as a user set. The module automatically restores the user set configured as the default set when it powers up.

To restore a saved user set, set the user set selector to the set you want to restore and then select the user set load parameter.

Factory Settings

The factory setting is the modules settings that were shipped with the module and which load during the camera's first power-up. To load or restore the original factory settings, at any time, select the factory setting parameter and then select the user set load parameter.

⚠️	**Note:** By default, the user settings are set to the factory settings.

Default Setting

Either the factory or one of the user settings can be used as the default setting, by selecting the set to use in the user set default selector. The chosen set automatically becomes the default setting and is the set loaded when the camera is reset or powered up.

Appendix A: GenICam Commands

This appendix lists the available GenICam camera features. The user may access these features using the CamExpert interface or equivalent GUI.

Features listed in the description table but tagged as *Invisible* are typically reserved for Teledyne DALSA Support or third-party software usage, and not typically required by end user applications.

The following feature tables describe these parameters along with their view attributes and in which version of the device the feature was introduced. Additionally, the Device Version column will indicate which parameter is a member of the DALSA Features Naming Convention (using the tag **DFNC**), versus the GenICam Standard Features Naming Convention (SFNC tag not shown).

In the CamExpert Panes, 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

	Note: The CamExpert examples shown for illustrative purposes and may not entirely reflect the features and parameters available from the model used in your application.

Camera Information Category

Camera information can be retrieved via a controlling application. Parameters such as camera model, firmware version, etc. are read to uniquely identify the connected camera. These features are typically read-only.

The Camera Information Category groups information specific to the individual camera. In this category the number of features shown is identical whether the view is Beginner, Expert, or Guru.
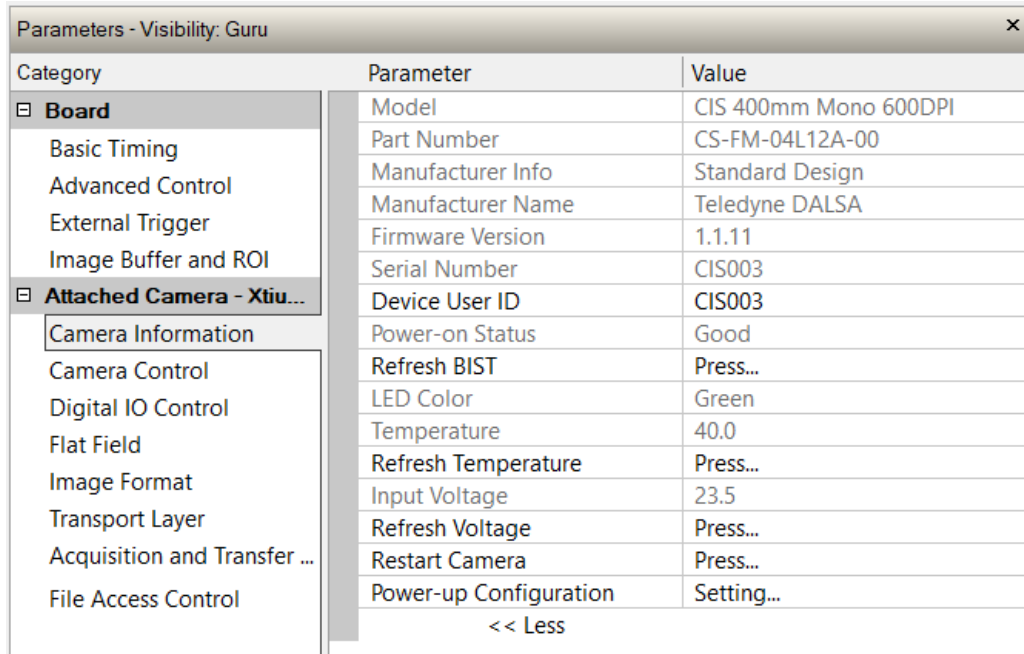
Figure 14 Example CamExpert Module Information Panel

Camera Information Feature Descriptions

Display Name	Feature	Description	View
Model	DeviceModelName	Displays the device model name. (RO)	Beginner
Part Number	deviceManufacturesPartNumber	Displays the device vendor part number. (RO)	Beginner DFNC
Manufacturer Info	DeviceManufacturerInfo	This feature provides extended manufacturer information about the device. Indicates if it is a standard product or a custom camera(RO)	Beginner
Manufacturer Name	DeviceVendorName	Displays the device vendor name. (RO)	Beginner
Firmware Version	DeviceVersion	Displays the device firmware version. This tag will also highlight if the firmware is a beta or custom design. (RO)	Beginner
Serial Number	DeviceID	Displays the device's factory set camera serial number. (RO)	Beginner
Device User ID	DeviceUserID	Feature to store user-programmable identifier of up to 31 characters. The default factory setting is the camera serial number. (RW)	Beginner
Power-on Status	deviceBISTStatus	Determine the status of the device using the 'Built-In Self Test' (BIST). Possible return values are device-specific. (RO) See Built-In Self-Test Codes for status code details.	Beginner DFNC
Refresh BIST	deviceBIST	Command to perform an internal test which will determine the device status. (W)	Beginner DFNC

Display Name	Feature	Description	View
LED Color	deviceLEDColorControl	Select the mode of the Status LED on the back of the module	Beginner DFNC
Off	*Off*	*Off*	
Red	*Red*	*BIST error.*	
Green	*Green*	*Operational.*	
Waiting for EXSYNC	*Fast_Green*	*4 Hz Green.*	
Thermal Shutdown	*Medium_Red*	*2 Hz Red.*	
Looking for link	*Slow_Green*	*1 Hz Green.*	
Busy	*Medium_Orange*	*2 Hz Orange.*	
Temperature	DeviceTemperature	Displays the internal operating temperature of the camera, in Celsius. (RO)	Beginner DFNC
Refresh Temperature	refreshTemperature	Press to update *DeviceTemperature*.	Beginner DFNC
Input Voltage	deviceInputVoltage	Displays the input voltage to the camera at the power connector (RO)	Beginner DFNC
Refresh Voltage	refreshVoltage	Press to update *deviceInputVoltage*.	Beginner DFNC
Restart Camera	DeviceReset	Soft reset of the module	Beginner SFNC
Power Up Configuration		Detailed in Dialog Box by initiating Settings…	
Power-on User Set	UserSetDefaultSelector	Selects 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 Set	*Factory*	*Load factory default feature settings*	
UserSet1	*UserSet1*	*Select the user defined configuration UserSet 1 as the Power-up Configuration.*	
UserSet2	*UserSet2*	*Select the user defined configuration UserSet 2 as the Power-up Configuration*	
UserSet3	*UserSet3*	*Select the user defined configuration UserSet 3 as the Power-up Configuration*	
UserSet4	*UserSet4*	*Select the user defined configuration UserSet 4 as the Power-up Configuration.*	
UserSet5	*UserSet5*	*Select the user defined configuration UserSet 5 as the Power-up Configuration.*	
UserSet6	*UserSet6*	*Select the user defined configuration UserSet 6 as the Power-up Configuration.*	
UserSet7	*UserSet7*	*Select the user defined configuration UserSet 7 as the Power-up Configuration.*	
UserSet8	*UserSet8*	*Select the user defined configuration UserSet 8 as the Power-up Configuration.*	
UserSet9	*UserSet9*	*Select the user defined configuration UserSet 9 as the Power-up Configuration.*	
UserSet10	*UserSet10*	*Select the user defined configuration UserSet 10 as the Power-up Configuration.*	
UserSet11	*UserSet11*	*Select the user defined configuration UserSet 11 as the Power-up Configuration.*	
UserSet12	*UserSet12*	*Select the user defined configuration UserSet 12 as the Power-up Configuration.*	

Display Name	Feature	Description	View
UserSet13	*UserSet13*	*Select the user defined configuration UserSet 13 as the Power-up Configuration.*	
UserSet14	*UserSet14*	*Select the user defined configuration UserSet 14 as the Power-up Configuration.*	
UserSet15	*UserSet15*	*Select the user defined configuration UserSet 15 as the Power-up Configuration.*	
UserSet16	*UserSet16*	*Select the user defined configuration UserSet 16 as the Power-up Configuration.*	
Current User Set	UserSetSelector	Selects the camera configuration set to load feature settings from or save current feature settings to. Points to which user set (1-16) or factory set that is loaded or saved when the UserSetLoad or UserSetSave command is used. The Factory set contains default camera feature settings and is read-only. (RW)	Beginner
Factory Set	*Factory*	*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.*	
UserSet3	*UserSet3*	*Select the User-defined Configuration space UserSet3 to save to or load from features settings previously saved by the user.*	
UserSet4	*UserSet4*	*Select the User-defined Configuration space UserSet4 to save to or load from features settings previously saved by the user.*	
UserSet5	*UserSet5*	*Select the User-defined Configuration space UserSet5 to save to or load from features settings previously saved by the user.*	
UserSet6	*UserSet6*	*Select the User-defined Configuration space UserSet6 to save to or load from features settings previously saved by the user.*	
UserSet7	*UserSet7*	*Select the User-defined Configuration space UserSet7 to save to or load from features settings previously saved by the user.*	
UserSet8	*UserSet8*	*Select the User-defined Configuration space UserSet8 to save to or load from features settings previously saved by the user.*	
UserSet9	*UserSet9*	*Select the User-defined Configuration space UserSet9 to save to or load from features settings previously saved by the user.*	
UserSet10	*UserSet10*	*Select the User-defined Configuration space UserSet10 to save to or load from features settings previously saved by the user.*	
UserSet11	*UserSet11*	*Select the User-defined Configuration space UserSet11 to save to or load from features settings previously saved by the user.*	
UserSet12	*UserSet12*	*Select the User-defined Configuration space UserSet12 to save to or load from features settings previously saved by the user.*	

Display Name	Feature	Description	View
UserSet13	*UserSet13*	*Select the User-defined Configuration space UserSet13 to save to or load from features settings previously saved by the user.*	
UserSet14	*UserSet14*	*Select the User-defined Configuration space UserSet14 to save to or load from features settings previously saved by the user.*	
UserSet15	*UserSet15*	*Select the User-defined Configuration space UserSet15 to save to or load from features settings previously saved by the user.*	
UserSet16	*UserSet16*	*Select the User-defined Configuration space UserSet16 to save to or load from features settings previously saved by the user.*	
Load User Set	UserSetLoad	Loads the camera configuration set specified by the User Set Selector feature, to the camera and makes it active. (W)	Beginner
Save User Set	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

Built-In Self-Test Codes (BIST)

In the Camera Information screen shot example above, the Power-On Status is showing "Good", indicating that the camera powered up without any problems.

Details of the BIST codes can be found in the Appendix B: Trouble Shooting Guide.

Camera Power-Up Configuration Selection Dialog
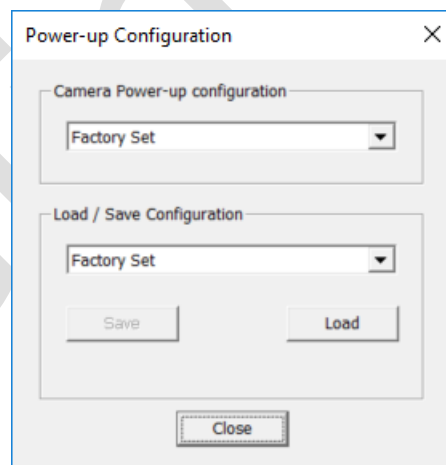
Figure 15: CamExpert Power-Up Configuration Dialog

CamExpert provides a dialog box which combines the GemICam features used to select the camera's power-up state and for the user to save or load a camera state as a specific user set that is retained in the camera's non-volatile memory.

Camera Power-up Configuration

The first drop list selects the camera configuration set to load on power-up (see feature *UserSetDefaultSelector*). The user chooses the factory data set or from one of 16 available user-saved states.

User Set Configuration Management

The second drop list allows the user to change the camera configuration any time after a power-up (see feature *UserSetSelector*). To reset the camera to the factory configuration, select *Factory Set* and click Load. To save a current camera configuration, select User Set 1 to 16 and click Save. Select a saved user set and click Load to restore a saved configuration.

Camera Control Category

The camera control category, as shown by CamExpert, groups control parameters such as line rate, exposure time, scan direction, and gain.
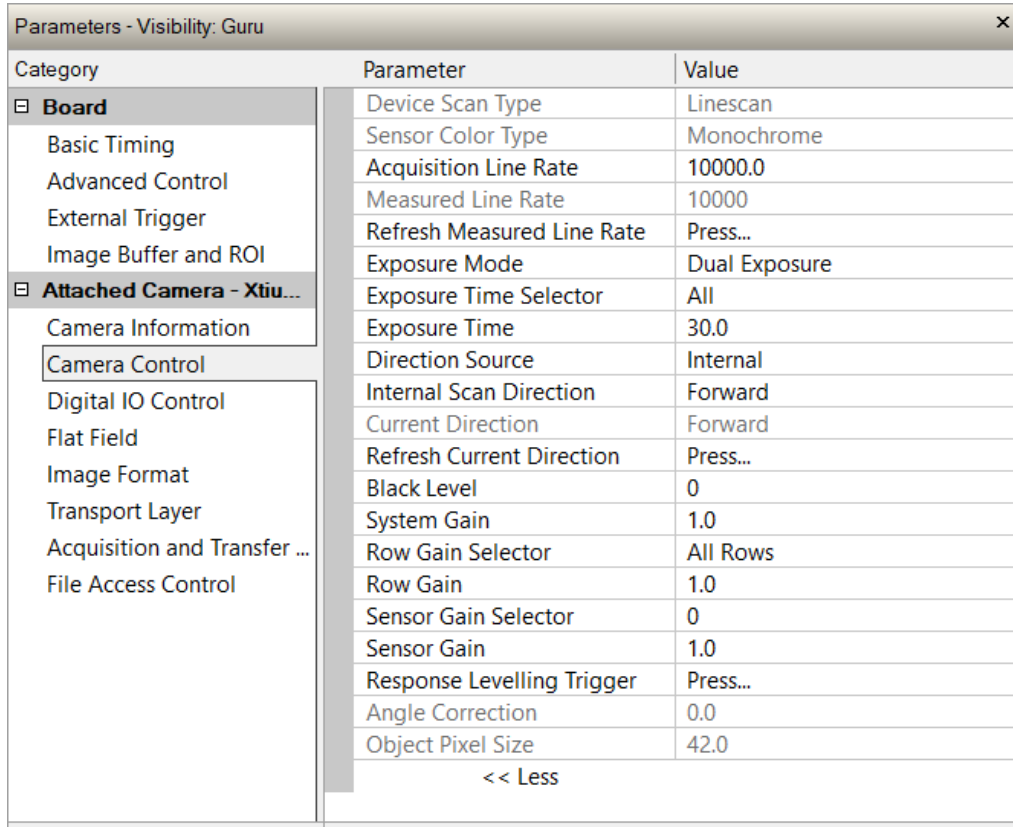
Figure 16: Module Control Panel

Camera Control Feature Descriptions

Display Name	Feature	Description	View
Device Scan Type	DeviceScanType	Used to set the camera scanning mode. Only standard line scan mode is available.	Beginner
Linescan	*Linescan*	*Linescan sensor.*	
Sensor Color Type	sensorColorType	Used to set the sensor color type mode. Only monochrome is available.	Beginner DFNC
Monochrome	*Monochrome*	*Monochrome sensor.*	
BGR	*BGR*	*BGR color sensor. (Multifield color model only)*	
Acquisition Line Rate	AcquisitionLineRate	Specifies the camera internal line rate, in Hz when Trigger mode set to internal. Note that any user entered value is automatically adjusted to a valid camera value. If necessary, the exposure time will be decreased to fit within the line time.	Beginner
Measured Line Rate	measureLineRate	Specifies the line rate provided to the camera by either internal or external source (RO)	Beginner DFNC

Display Name	Feature	Description	View
Refresh Measured Line Rate	refreshMeasureLineRate	Press to show the current line rate provided to the camera by either internal or external sources	Beginner DFNC
Exposure Mode	ExposureMode Timed Dual Exposure	Used to set select which type of mode. Single row exposure mode Dual row exposure mode	Beginner
Exposure Time Selector	exposureTimeSelector All Row1 Row2	Used to select which exposure time is being set. Default to 'ALL' in timed mode or selects both Row1 and Row 2 to set the desired exposure time Selects Row1 to set the desired exposure time Selects Row2 to set the desired exposure time	Beginner DFNC
Exposure Time	ExposureTime	Set the exposure time in µsec to the desired value.	Beginner
Direction Source *Internal* *Line 2* *RotaryEncoder*	sensorScanDirectionSource *Internal* *GPIO2* *Encoder*	Direction determined by value of: *SensorScanDirection* *Pin 6 (Low: forward, high: reverse). Available when TriggerSource is not Encoder.* *Rotary encoded. Available when TriggerSource is Encoder and rotaryEncoderOutputMode is Motion (see Digital IO Control category).*	Beginner DFNC
Internal Scan Direction *Forward* *Reverse*	sensorScanDirection *Forward* *Reverse*	When *ScanDirectionSource* is set to Internal, determines the direction of the scan *Forward scan direction.* *Reverse scan direction.*	Beginner DFNC
Current Direction	currentDirection	Used to read what the current direction (RO)	Beginner DFNC
Refresh Current Direction	refreshCurrentDirection	Updated the current direction to what is currently active	Beginner DFNC
Black Level	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 value may be positive or negative.	Beginner
System Gain	systemGain	Gain multiplier applied to all pixels.	Beginner
Row Gain Selector	GainSelector All Row1 Row2	Used to select which gain value is being set. Default to 'ALL' in timed mode or selects both Row1 and Row 2 to set the desired gain Selects Row1 to set the desired gain Selects Row2 to set the desired gain	Beginner DFNC
Row Gain	Gain	Sets the gain as per the gain selector setting.	Beginner
Sensor Gain Selector	gainSensorSelector	Selects which sensor gain is set within the module. Set "0'' for all sensors. Each sensor covers 682 adjacent pixels for 600dpi and 1,000 adjacent pixels for 900dpi.	Guru DFNC
Sensor Gain	sensorGain	Sets the sensor gain as per the sensor gain selector setting	Guru DFNC
Response Leveling Trigger	responseLevelingTrigger	Initiates the response leveling process.	Guru DFNC
Angle Correction	angleCorrection	Informs the module what the angle is to the optical axis	Beginner DFNC
Object Pixel Size	objectPixelSize	Informs the module what the scan direction object pixel size is being used	Beginner DFNC

Display Name	Feature	Description	View
Save Image to Flash	saveLastImageToFlash	Captures the current line and saves it to the cameras Flash memory as a TIFF file that can be retrieved using the File Access Control Features. *Can be used to compare the saved and transmitted image line data possibly to help with debug activities*	Guru DFNC

Digital IO Control Category

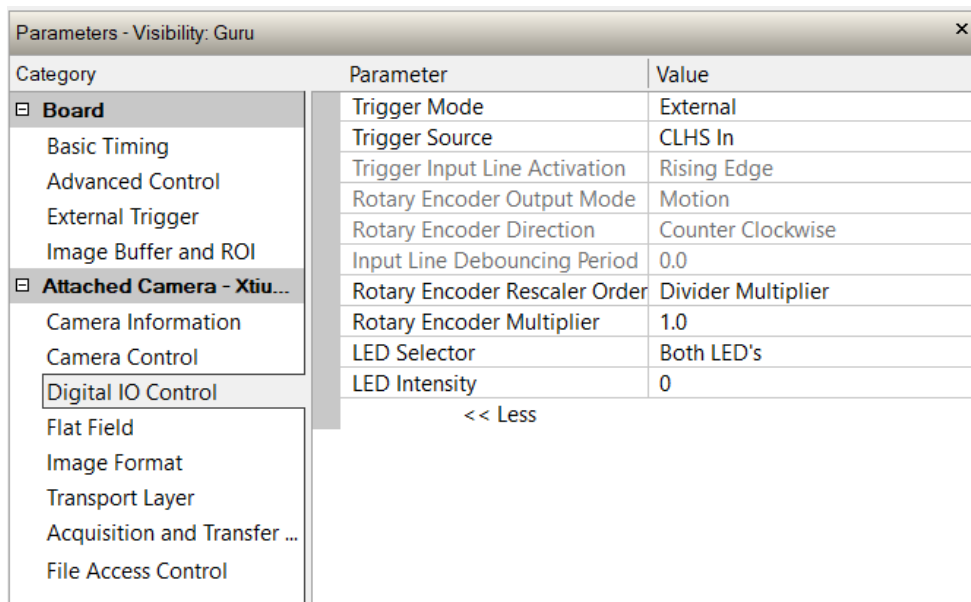The camera's Digital IO Control category is used to configure the cameras GPIO pins.

Figure 17 Digital I/O Control Panel

Digital IO Control Feature Descriptions

Display Name	Feature	Description	View
Trigger Mode	TriggerMode	Determines the source of trigger to the camera.	Beginner
Internal	*Internal*	*Line rate is controlled with AcquisitionLineRate feature.*	
External	*External*	*Trigger comes from CLHS (frame grabber) or GPIO.*	
Trigger Source	TriggerSource	Determines the source of external trigger.	Beginner
CLHS In	*CLHS*	*Source of trigger is from the frame grabber over CLHS.*	
Rotary Encoder	*Encoder*	*Trigger source is from the two shaft encoder inputs.*	
Line 1	*GPIO1*	*Trigger source is from Line 1 of the GPIO connector.*	
Trigger Input Line ActivationEdge	TriggerActivation	Determines which edge of a input trigger will activate on	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 module).*	
Falling Edge	*FallingEdge*	*The trigger is considered valid on the falling edge.*	
Any Edge	*AnyEdge*	*The trigger is considered valid on any edge.*	

Display Name	Feature	Description	View
Rotary Encoder Direction	rotaryEncoderDirection	Specifies the phase which defines the encoder forward direction.	Beginner DFNC
Counter Clockwise	*CounterClockwise*	*Inspection goes forward when the rotary encoder direction is counter clockwise (phase A is ahead of phase B).*	
Clockwise	*Clockwise*	*Inspection goes forward when the rotary encoder direction is clockwise (phase B is ahead of phase A).*	
Rotary Encoder Output Mode	rotaryEncoderOutputMode	Specifies the conditions for the Rotary Encoder interface to generate a valid Encoder output signal.	Beginner 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.*	
Input Line Debouncing Period	lineDebouncingPeriod	Specifies the minimum delay before an input line voltage transition is recognizing as a signal transition.	Beginner DFNC
Rotary Encoder Multiplier	rotaryEncoderMultiplier	Specifies a multiplication factor for the rotary encoder output pulse generator.	Beginner DFNC
Rotary Encoder Rescaler Order	rotaryEncoderRescalerOrder	Specifies the order that the multiplier and divider are applied.	Guru DFNC
Multiplier Divider	*multiplierDivider*	*The signal is multiplied before been divided.*	
Divider Multiplier	*dividerMultiplier*	*The signal is divided before been multiplied*	
LED Selector	ledSelector	Specified which LED array intensity is adjusted	Beginner DFNC
	Both	Both LED's are adjusted to the desired intensity	
	LED1	LED1 is adjusted to the desired intensity	
	LED2	LED2 is adjusted to the desired intensity	
LED Intensity	ledIntensity	Specified the selected LED intensity	Beginner DFNC

Flat Field Category

The Flat Field controls, as shown by CamExpert, group parameters used to control the FPN and PRNU calibration process.
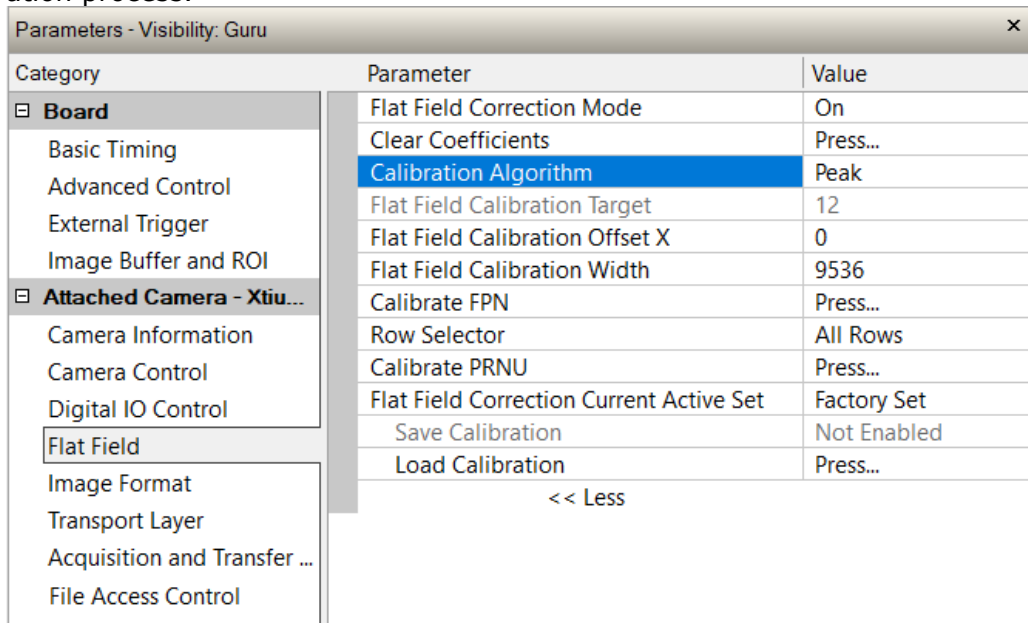
Figure 18: Flat Field Panel

Flat Field Control Feature Description

Display Name	Feature	Description	View
Flat Field Correction Mode	flatfieldCorrectionMode		Beginner DFNC
Off	*Off*	FPN and PRNU correction disabled.	
On	*On*	FPN and PRNU correction enabled.	
Clear Coefficents	flatfieldCalibrationClearCoefficient	Reset all FPN to 0 and all PRNU coefficients to 1.	Beginner DFNC

Display Name	Feature	Description	View
Calibration Algorithm	flatfieldCorrectionAlgorithm	Selection between four different PRNU algorithms.	Beginner DFNC
Peak	*Peak*	*Calculation of PRNU coefficients to bring all pixels to the peak.*	
Peak, Image Filtered	*PeakFilter*	*A low pass filter is applied to the average line values before calculating the coefficients. Use this algorithm if the calibration target is not uniformly white or if it is not possible to defocus the image. Because of the low pass filter, this algorithm is not able to correct pixel-to-pixel variations and so it is preferable to use the "Peak" algorithm.*	
Set Target	*Target*	*Calculation of PRNU coefficients to bring all pixels to the target value.*	
Set Target, Image Filtered	*TargetFiltered*	*A low pass filter is applied to the average line values before calculating the coefficients. Use this algorithm if the calibration target is not uniformly white or if it is not possible to defocus the image. Because of the low pass filter this algorithm is not able to correct pixel-to-pixel variations and so it is preferable to use the "Target" algorithm.*	
Flat Field Calibration Target	flatfieldCalibrationTarget	Sets the target value for the "Calibrate PRNU" feature.	Beginner DFNC
Flat Field Calibration Offset X	flatfieldCalibrationROIOffsetX	Set the starting point of a region of interest where a flat field calibration will be performed	Beginner DFNC
Flat Field Calibration Width	flatfieldCalibrationROIWidth	Sets the width of the region of interest where a flat field calibration will be performed	Beginner DFNC
Calibrate FPN	flatfieldCalibrationFPN	Initiates the FPN calibration process	Beginner DFNC
Row Selector	flatfieldCalibrationColorSelector	Specify which sensor rows to perform PRNU calibration on, all or individual colors.	Beginner DFNC
Calibrate PRNU	flatfieldCalibrationPRNU	Initiates the PRNU calibration process	Beginner DFNC
Flat Field Correction Current Active Set	flatfieldCorrectionCurrentActiveSet	Selects the User PRNU set to be saved or loaded.	Guru DFNC
Factory Set	*Factory Set*	*Factory set can only be loaded.*	
User Set 1 (1 thru 16)	*UserSet1 (1 thru 16)*	*Only the PRNU values are saved or loaded which is much faster than saving or loading the full Factory or User set.*	
Save Calibration	flatfieldCalibrationSave	Saves the User PRNU set specified by *flatfieldCorrectionCurrentActiveSet* to the camera.	Guru DFNC
Load Calibration	flatfieldCalibrationLoad	Loads the User PRNU set specified by latfieldCorrectionCurrentActiveSet to the camera and makes it active.	Guru DFNC

Image Format Control Category

The camera's Image Format controls, as shown by CamExpert, group parameters used to configure camera pixel format, image cropping, binning and test pattern generation features.
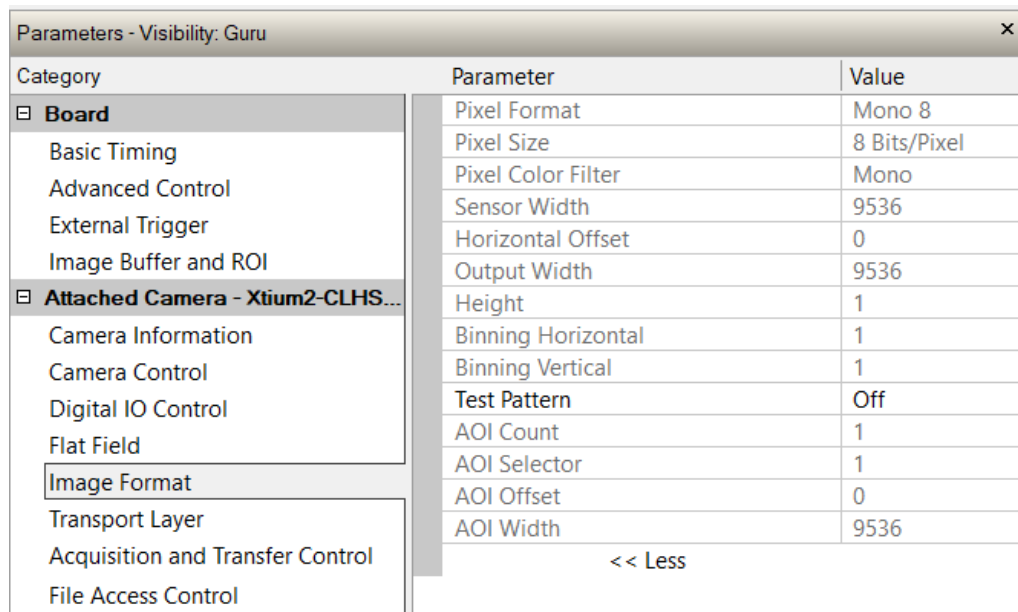

Figure 19: Image Format Panel

Image Format Control Feature Description

Display Name	Feature	Description	View
Pixel Format *Mono8* *Mono10* *Mono12* *Mono16*	PixelFormat *Mono8* *Mono10* *Mono12* *Mono16*	Output image pixel coding format of the sensor. *Available bit depths for monochrome. Lower bit depths all for higher line rates*	Beginner
Pixel Size *8-bits/Pixel*	PixelSize *Bpp8*	Total size in bits of an image pixel. Read-only. *8-bits / Pixel.*	Guru
Pixel Coding Filter *None*	PixelCodingFilter *Mono*	Indicates the type of color filter used in the camera. Read only. *No pixel coding filter when pixel format is Monochrome.*	Beginner DFNC
Horizontal Offset	OffsetX	Output image horizontal offset from the origin. This is zero for color cameras. Read only	Beginner
Output Width	Width	Horizontal width of the pixels output. Read only	Beginner
Height	Height	Height of the image provided by the device (in object pixels). 1 to 2. Read only.	Beginner
Binning Horizontal	BinningHorizontal	Number of horizontally adjacent pixels to sum together. This increases the intensity of the pixels and reduces the horizontal resolution of the image. *Stop Acquisition to change.*	Beginner

Binning Vertical	BinningVertical	Number of vertically adjacent pixels to sum together. This increases the intensity of the pixels and reduces the vertical resolution of the image. *Stop Acquisition to change.*	Beginner
Test Pattern	TestImageSelector	Selects the type of test image that is sent by the camera. Note. Grey images are displayed so that any bit error will immediately be apparent as a color.	Beginner
Off	*Off*	*Selects sensor video to be output*	
Each Tap Fixed	*EachTapFixed*	*Selects a grey scale value that is increased every 512 pixels.*	
Grey Horizontal Ramp	*Grey Horizontal Ramp*	*Selects a grey scale ramp*	
Grey Vertical Ramp	*Grey Vertical Ramp*	*Selects a grey scale ramp progressively for each row.*	
Grey Diagonal Ramp	*Grey Diagonal Ramp*	*Selects a combination of horizontal and vertical raps to form a diagonal grey scale.*	
AOI Count	multipleROICount	Specifies the number of AOIs output.	Beginner DFNC
AOI Selector	multipleROISelector	Select the AOI to contorl when setting the AOI Offset & AOI Width.	Beginner DFNC
AOI Offset	multipleROIOffsetX	Location of the start of the AOI to be output. Multiple of 32.	Beginner DFNC
AOI Width	multipleROIWidth	Width of the AOI, in pixels. Minimum is 96 per lane. For example, if there is only one AOI spread across the 5 lanes then the minimum is 5 x 96 = 480. Maximum of the sum of AOI width's is the sensor width. For example, for a 9536 pixel module, if there are two AOIs with the first 6,144 pixels wide, then the second can be no wider than 3n392 pixels.	Beginner DFNC
Input Pixel Size	pixelSizeInput	Size of the image input pixels, in bits per pixel. (RO)	DFNC Invisible
12-bits/Pixel	*Bpp12*	*Sensor input data path is 12-bits per pixel.*	

File Access Control Category

The File Access control in CamExpert allows the user to quickly upload and download of various data files to/from the connected the camera. The supported data files for the camera include firmware updates and Flat Field coefficients.

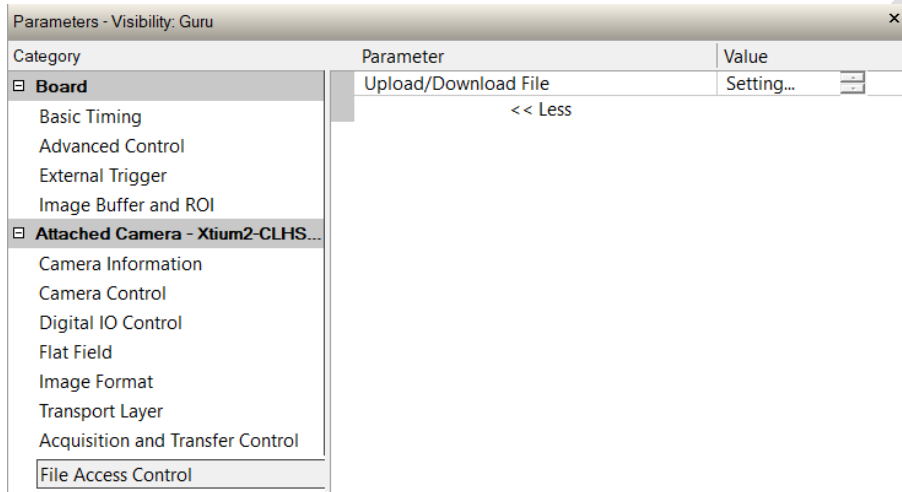| ⚠	**Note:** The communication performance when reading and writing large files can be improved by stopping image acquisition during the transfer

Figure 20: File Access Control Panel

File Access Control Feature Descriptions

Display Name	Feature	Description	View
File Selector	FileSelector	Selects the file to access. The files which are accessible are listed in the XML:	Beginner
All Firmware	*Firmware1*	*Upload micro code, FPGA code & XML as a single file to the camera which will execute on the next camera reboot cycle.*	
User Set	*User_Set*	*Use UserSetSelector to specify which user set to access.*	
Output LUT	*Output_LUT*	*Use UserSetSelector to specify which LUT to access.*	
User PRNU	*User_PRNU*	*Use UserSetSelector to specify which user PRNU to access.*	
User FPN	*User_FPN*	*Use UserSetSelector to specify which user FPN to access.*	
Current PRNU	*Cur_PRNU*	*Accesses the PRNU coefficients that are currently being used by the camera (not necessarily saved).*	
Camera_Data	*CameraData*	*Download camera information and send for customer support.*	
File Operation Selector	FileOperationSelector	Selects the 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.*	

Display Name	Feature	Description	View
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	FileAccessOffset	Controls the mapping offset between the device file storage and the file access buffer.	Guru
File Access Length	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.	
Invalid Parameter	InvalidParameter	An invalid parameter was passed to the last feature called.	
Write Protect	WriteProtect	Attempt to write to a read-only (factory) file.	
File Not Open	FileNotOpen	The file has not been opened yet.	
File Too Big	FileTooBig	The file is larger than expected.	
File Invalid	FileInvalid	The last file operation has completed unsuccessfully because the selected file is not present in this camera.	
File Operation Result	FileOperationResult	For Read or Write operations, the number of successfully read/written bytes is returned. (RO)	Guru
File Size	FileSize	Represents the size of the selected file in bytes.	Guru

File Access via the CamExpert Tool

Click on the "Setting…" button to show the File Access Control dialog box.
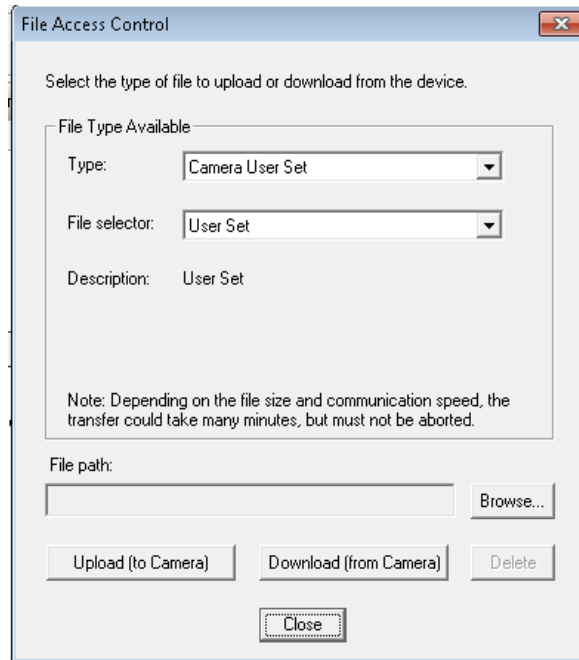

Figure 21: File Access Control Tool

From the Type drop menu, select the file type that will be uploaded to the camera or downloaded from the camera.

From the File Selector drop menu, select the file to be uploaded or downloaded.

To upload a file, click the Browse button to open a typical Windows Explorer window.

> a. Select the specific file from the system drive or from a network location.
> b. Click the Upload button to execute the file transfer to the camera.

Alternatively, click the Download button and then specify the location where the file should be stored.

Firmware changes require that the camera be powered down and then back up. When the firmware update is successfully completed, a message box is displayed to reset the camera.
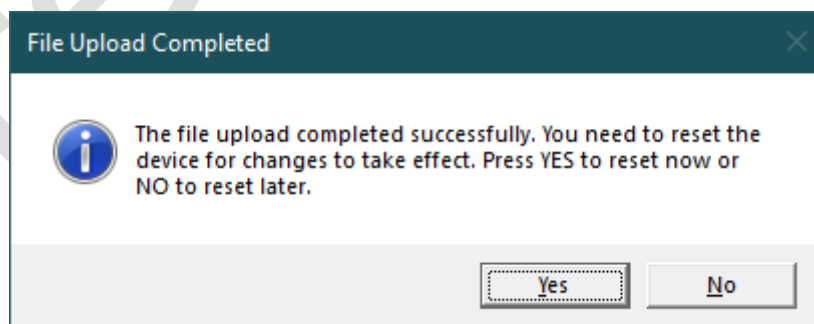

Figure 22: File Upload Completed Message Box

Caution: Do not interrupt the file transfer by powering down the camera or closing CamExpert.

CLHS File Transfer Protocol

If you are not using CamExpert to perform file transfers, pseudo-code for the CLHS File Transfer Protocol is as follows.

Download File from Camera
- Select the file by setting the FileSelector feature
- Set the FileOpenMode to Read
- Set the FileOperationSelector to Open
- Open the file by setting FileOperationExecute to 1
  This is a read-write feature - poll it every 100 ms until it returns 0 to indicate it has completed
- Read FileOperationStatus to confirm that the file opened correctly
  - A return value of 0 is success. Error codes are listed in the XML.
- Read FileSize to get the number of bytes in the file
- From FileAccessBuffer.Length you will know that maximum number of bytes that can be read through FileAccessBuffer is 988.
- For Offset = 0 While ((Offset < FileSize) and (Status = 0)) Do
  - Set FileAccessOffset to Offset
  - Set FileAccessLength to min(FileSize - Offset, FileAccessBuffer.Length), the number of bytes to read
  - Set the FileOperationSelector to Read
  - Read the file by setting FileOperationExecute to 1 and poll until 0 and complete
  - Read FileOperationStatus to confirm the read worked
  - Read FileOperationResult to confirm the number of bytes read
  - Read the bytes from FileAccessBuffer
  - Write bytes read to host file.
- Next Offset = Offset + number of bytes read
- Set the FileOperationSelector to Close
- Close the file by setting FileOperationExecute to 1 and poll until 0 and complete
- Read FileOperationStatus to confirm the close worked

Upload File to Camera
- Select the file by setting the FileSelector feature
- Set the FileOpenMode to Write
- Set the FileOperationSelector to Open
- Open the file by setting FileOperationExecute to 1
  This is a read-write feature - poll it every 100 ms until it returns 0 to indicate it has completed
- Read FileOperationStatus to confirm that the file opened correctly
  A return value of 0 is success. Error codes are listed in the XML.
- Read FileSize to get the maximum number of bytes allowed in the file
  - Abort and jump to Close if this is less the file size on the host
- From FileAccessBuffer.Length you will know that maximum number of bytes that can be written through FileAccessBuffer is 988.
- For Offset = 0 While ((Offset < Host File Size) and (Status = 0)) Do
  - Set FileAccessOffset to Offset
  - Set FileAccessLength to min(Host File Size - Offset, FileAccessBuffer.Length), the number of bytes to write
  - Read next FileAccessLength bytes from host file.
  - Write the bytes to FileAccessBuffer
  - Set the FileOperationSelector to Write
  - Write to the file by setting FileOperationExecute to 1 and poll until 0 and complete
  - Read FileOperationStatus to confirm the write worked
  - Read FileOperationResult to confirm the number of bytes written
- Next Offset = Offset + number of bytes written
- Set the FileOperationSelector to Close
- Close the file by setting FileOperationExecute to 1 and poll until 0 and complete
- Read FileOperationStatus to confirm the close worked

Download a List of Camera Parameters

For diagnostic purposes you may want to download a list of all the parameters and values associated with the camera.

- Go to File Access Control
- Click on Settings
- In the "Type" drop down box select "Miscellaneous."
- In the "File selector" drop down box select "CameraData."
- Hit "Download"
- Save the text file and send the file to Teledyne DALSA customer support.

Transport Layer Control Category

The Transport Layer Control category, as shown by CamExpert, has parameters used to configure features related to the CLHS Connection.
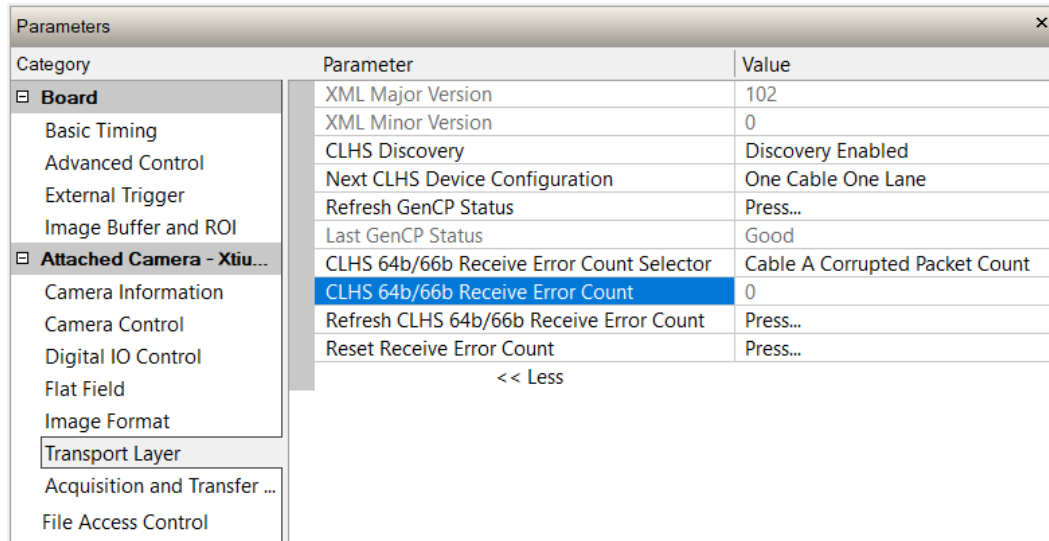

Figure 23: Transport Layer Panel

Transport Layer Feature Descriptions

Display Name	Feature	Description	View
XML Major Version	DeviceManifestXMLMajorVersion	Together with DeviceManifestXMLMinorVersion specifies the GenICam™ feature description XML file version (RO)	Beginner
XML Minor Version	DeviceManifestXMLMinorVersion	Together with DeviceManifestXMLMajorVersion specifies the GenICam™ feature description XML file version (RO)	Beginner
CLHS Discovery	clhsDiscovery	Selects whether the camera needs to be commanded to send image data after power up. Disable CLHS Discovery if not implemented in the frame grabber.	Beginner DFNC
Discovery Disabled	*DiscoveryDisable*	*CLHS transmitters are enabled immediately on power up.*	
Discovery Enabled	*DiscoveryEnable*	*CLHS transmitters enable after sending Acquisition start.*	
Next CLHS Device Configuration	clhsNextDeviceConfig	When the camera is next powered up, the specified CLHS lane configuration will be set for the camera.	Beginner DFNC
One Cable Five Lanes	*OneCableOneLanes* *TwoCablesTwoLanes*		
Refresh GenCP Status	refreshGenCPStatus	Press to update the GenCP Status.	Beginner DFNC
Last GenCP Status	genCPStatus	If a feature read or write returns that it fails, read this feature to get the actual reason for the failure Returns the last error. Reading this feature clears it. Sapera only.	Beginner DFNC

CLHS 64b/66b Receive Error Count Selector	clhsErrorCountSelector	Select the error to count	Guru DFNC
Cable A Corrupted Packet Count	*CorruptedPacketCntA*	*Count of corrupted packets on cable A.*	
Cable A Corrected Packet Count	*CorrectedPacketCntA*	*Count of corrected packets on cable A.*	
Cable B Corrupted Packet Count	*CorruptedPacketCntB*	*Count of corrupted packets on cable B.*	
Cable B Corrected Packet Count	*CorrectedPacketCntB*	*Count of corrected packets on cable B.*	
CLHS 64b/6b Receive Error Count	clhsErrorCount	CLHS 64b/66b Receive Error Count	Guru DFNC
Refresh CLHS 64b/66b Receive Error Count	clhsErrorCountRefresh	Refresh the selected *clhsErrorCount* value.	Guru DFNC
Reset Receive Error Count	clhsErrorCountReset	Reset the selected *clhsErrorCount* value to 0.	Guru DFNC

Acquisition and Transfer Control Category

The Acquisition and Transfer controls, as shown by CamExpert, has parameters used to configure the optional acquisition modes of the device.
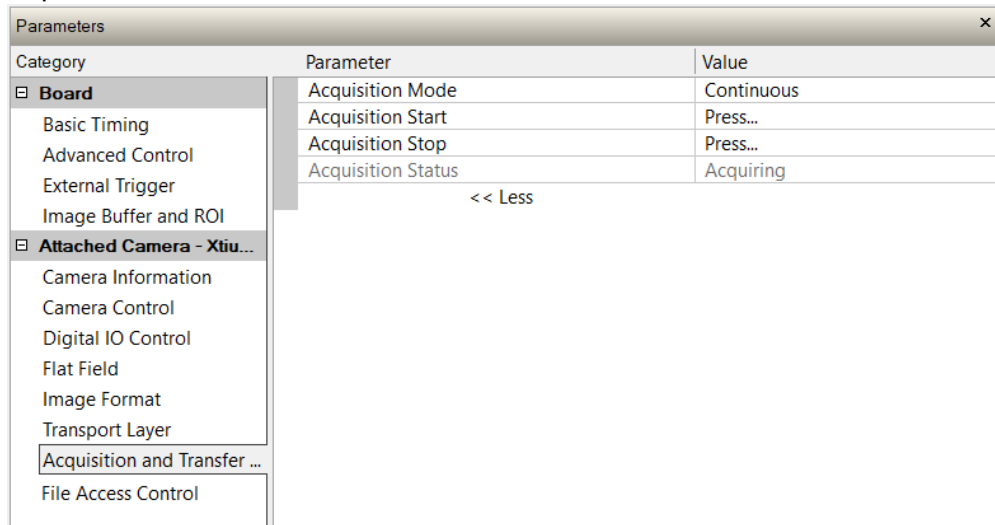

Figure 24: Acquisition & Transfer Control Panel

Acquisition and Transfer Control Feature Descriptions

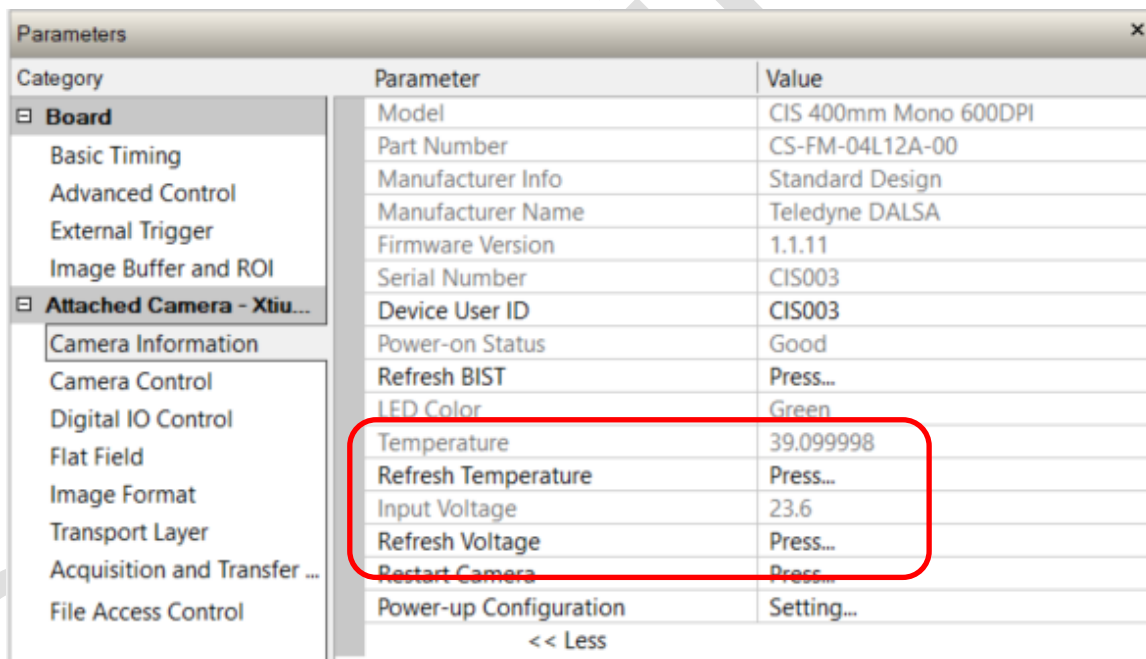| Display Name	Feature	Description	View
Acquisition Mode	AcquisitionMode	The device acquisition mode defines the number of frames to capture during an acquisition and the way it stops	Beginner
Continuous	*Continuous*	*Only continuous mode is currently available.*	
Acquisition Start	AcquisitionStart	Commands the camera to start sending image data. (WO)	Beginner
Acquisition Stop	AcquisitionStop	Commands the camera to stop sending image data at the end of the current line (WO)	Beginner
Acquisition Status	AcquisitionStatus	Reads the acquisition state.	Beginner
Acquiring	*Acquiring*	*Currently acquiring and sending image data.*	
Not Acquiring	*NotAcquiring*	*Currently not acquiring or sending image data.*	

Appendix B: Trouble Shooting Guide

Diagnostic Tools

Camera Data File

The modules data file includes the operational configuration and status of the camera
This text file can be downloaded from the camera and forwarded to Teledyne DALSA Technical
Customer support team to aid in diagnosis of any reported issues. See the Saving & Restoring
Camera Setup Configurations section for details on downloading the Camera Data file.

Voltage & Temperature Measurement

The module can measure the input supply voltage at the power connector and the internal
temperature. Both of these features are accessed using the CamExpert > Camera Information tab.
Press the associated refresh button for a real-time measurement.

Figure 25: CamExpert Voltage & Temperature Features

Test Patterns – What Can They Indicate?

The module can generate fixed test patterns that may be used to determine the integrity of the CLHS communications beyond the Lock status. The test patterns give the user the ability to detect bit errors using an appropriate host application. This error detection would be difficult, if not impossible, using normal image data.

> **Note:** Gray images are displayed so that any bit error will immediately be apparent as brighter or darker pixels in the image.

There are five test patterns that can be selected via the CamExpert > Image Format tab.
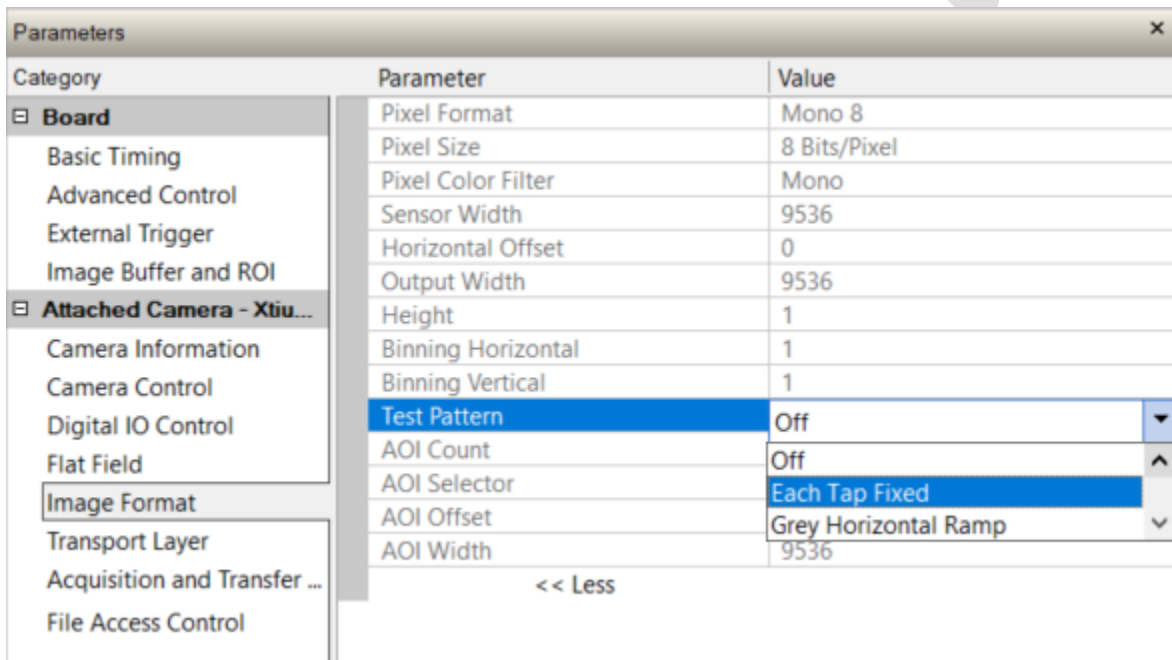
Figure 26: CamExpert Test Pattern Feature

They have the following format when using 8-bit data:

- Each Tap Fixed
    - Starting at 64 increases in by 4 steps every 512 pixels ending in 188.
- Grey Horizontal Ramp
    - 2 horizontal ramps starting at 00H increases in by 01H every 32 pixels.
- Grey Vertical Ramp
    - Vertical ramp starting with 1st row 5, next row 12, and incrementing by 3 every line
- Grey Diagonal Ramp
    - Add horizontal and vertical ramps

Built-In Self-Test Codes

The Built-In Self-test (BIST) codes are located in the Camera Information category under Power-on Status. None of these should occur in a properly functioning module except OVER_TEMPERATURE. OVER_TEMPERATURE occurs if the ambient temperature is too high where there is insufficient air circulation or heat sinking. The user can recover from OVER_TEMPERATURE by letting the camera cool down.

The user can recover from NO_USER_SETTINGS/FPN/PRNU by trying to saving settings, but is an unlikely event.

Name	Hex Position
I2C	0x00000001
FPGA_NO_INIT	0x00000002
FPGA_NO_DONE	0x00000004
SENSOR_SPI	0x00000008
ECHO_BACK	0x00000010
FLASH_TIMEOUT	0x00000020
FLASH_ERROR	0x00000040
NO_FPGA_CODE	0x00000080
NO_COMMON_SETTINGS	0x00000100
NO_FACTORY_SETTINGS	0x00000200
OVER_TEMPERATURE	0x00000400
NO_USER_FPN	0x00001000
NO_USER_PRNU	0x00002000
CLHS_TXRDY_RETRY	0x00004000
INVALID_UPGRADE	0x00008000
NO_USER_SETTINGS	0x00010000
NO_FACT_FF	0x00400000
NO_FATFS	0x00800000
IN_FACTORY_PARTITION	0x01000000

Table 9: Built-In Self-Test (BIST) Codes

Status LED

A single red / green LED is located on the back of the module to indicate status.

Table 10: Status LED States

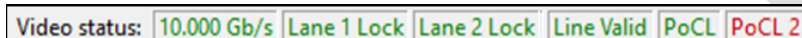| LED State	Description
Off	Module not powered up or waiting for the software to start
Constant Red	The Module BIST status is not good. See BIST status for diagnosis.
Blinking Red	The Module has stopped output and has shut down some components due to an over temperature condition.
Blinking Orange	Powering Up. The microprocessor is loading code.
Blinking Green	Hardware is good, but the CLHS connection has not been established or has been broken.
Constant Green	The CLHS Link has been established and data transfer may begin

Resolving Camera Issues

Communications

No Camera Features when Starting CamExpert

If the camera's CamExpert is opened and no features are listed, then the camera may be experiencing lane lock issues.

While using the frame grabber in CamExpert you should be able to see a row of status indicators below the image display area that indicates the status of the CLHS communications. These indicators include seven lane lock status and a line valid (LVAL) status.

Video status: | 10.000 Gb/s | Lane 1 Lock | Lane 2 Lock | Line Valid | PoCL | PoCL 2 |

If the status for one or more lane locks is red, then there is likely an issue with the CLHS SFP+ connectors at the module and / or frame grabber. Ensure that the connectors are fully engaged and locked in place. Ensure that you are also using the recommended cables.

No LVAL

If the LVAL status is red and all lane locks are green, then there may be an issue with the module receiving the encoder pulses.

- From the module's CamExpert > Digital I / O Control tab, select Internal Trigger Mode and set the CamExpert > Camera Control tab Acquisition Line Rate to the maximum that will be used.

The trigger signal from the frame grabber will not be used and the LVAL status should now be green. This will confirm the integrity of the image data portion of the CLHS cabling and connectors.
From the camera's CamExpert > Digital I / O Control tab, select External Trigger Mode.
From the Frame Grabber CamExpert > Advanced tab, select the Line Sync Source to be Internal Line Trigger and the Internal Line Trigger frequency to the maximum that will be used.
The trigger source is now being generated by the frame grabber and the LVAL status should be green. This will confirm the integrity of the General Purpose I / O portion of the CLHS cabling and connectors.
From the Frame Grabber CamExpert > Advanced tab, select the Line Sync Source to be External Line Trigger and select the Line Trigger Method to Method 2 under the same tab.
From the Frame Grabber CamExpert > External Trigger tab, select External Trigger to be enabled.
If LVAL status turns red, check the following:
   a. Is the transport system moving such that encoder pulses are being generated?
   b. Has the encoder signal been connected to the correct pins of the I/O connector of the frame grabber? See the Xtium2-CLHS frame grabber user manual for details.
   c. Do the encoder signal levels conform to the requirements outlined in the Xtium2-CLHS frame grabber user manual?

Image Quality Issues

Vertical Lines Appear in Image after Calibration

The purpose of flat field calibration is to compensate for pixel response variations and imperfections in the illumination profiles by creating a uniform response. When performing a flat field calibration, the camera must be imaging a flat white target that is illuminated by the actual lighting used in the application. Though the module compensates for illumination imperfection, it will also compensate for imperfections such as dust, scratches, paper grain, etc. in the white reference. Once the white reference is removed and the camera images the material to be inspected, any white reference imperfections will appear as vertical stripes in the image. If the white reference had imperfections that caused dark features, there will be a bright vertical line during normal imaging. Similarly, bright features will cause dark lines. It can be very difficult to achieve a perfectly uniform, defect-free white reference. The following two approaches can help in minimizing the effects of white reference defects:

- Move the white reference closer to or further away from the object plane such that it is out of focus. This can be effective if the illumination profile changes minimally when relocating the white reference.

- If the white reference must be located at the object plane, then move the white reference in the scan direction or sideways when flat field calibration is being performed. The module averages several thousand lines when capturing calibration reference images so any small imperfections are averaged out.

Use the modules flat field calibration filter feature, as detailed in the **Error! Reference source not found.** section. This algorithm implements a low pass moving average that covers several adjacent pixels. This filter can help minimize the effects of minor imperfections in the white reference. Note: this filter is NOT USED in normal imaging.

Over Time, Pixels Developing Low Response

When flat field calibration is performed using a white reference, as per the guidelines in the user manual, all pixels should achieve the same response. However, over time dust in the module windows may reduce the response of some pixels.

If the dust particles are small, they may have only a minor effect on responsivity, but still create vertical dark lines that interfere with defect detection and that need to be corrected. Window cleaning is required.

Because repeating the flat field calibration with a white reference or cleaning may not be practical while the module installed in the system, the module has a feature where the flat field coefficients can be downloaded to the host PC and adjusted using a suitable application, such as Microsoft Excel. (See section **Error! Reference source not found.** for details.)

If the location of the pixel returning a low response can be identified from the image, then the correction coefficient of that pixel can be adjusted, saved as a new file, and then uploaded to the camera; thereby correcting the image without performing a flat field calibration.

See the File Access via the CamExpert Tool for details on downloading and uploading camera files using CamExpert.

Smeared & Distorted Images

To achieve a well-defined image, the staggered sensor outputs are delayed in a manner that matches the motion of the image across the sensor.

This synchronization is achieved by sending an external synchronization (EXSYNC) signal to the module, where one pulse is generated when the object moves by the size of one object pixel. See 'External Trigger Mode' in the user manual.

Any transport motion that is not correctly reflected in the EXSYNC pulses will cause image distortion in the scan direction.

The following subsections discuss causes of poor image quality resulting from the EXSYNC signal not accurately reflecting the object motion.

Vertically Staggered Images

When accurate synchronization is not achieved, the image will have a vertical stagger in 682 pixels sections in the scan direction.

If the EXSYNC pulses are coming too fast, then the image will appear stretched in the machine direction. If the pulses are too slow, then the image will appear compressed.

Check the resolution of the encoder used to generate the EXSYNC pulses, along with the size of the rollers, pulleys, gearing, etc. to ensure that one pulse is generated for one pixel size of travel of the object. Use the exsync multiplier feature to adjust the pulses if the encoder cannot produce the desired pixel size.

It is also important that the direction of image travel across the sensor is matched to the module's scan direction, as set by the user. See 'Scan Direction' in the user manual for more information.

If the scan direction is incorrect, then the image will have a significant staggered appearance and in the scan direction. Changing the scan direction to the opposite direction should resolve this problem.

Refer to the Camera Orientation section for more information on how to determine the correct direction orientation for the camera.

> ⚠️ **Note:** The Selfoc Lens Array used in the module does not have the reversing effect on motion as with regular lenses. That is, if an object passes the module from left to right, the image also will pass from left to right.

Randomly Compressed Images

It is possible that when the scan speed nears the maximum allowed, based on the exposure time used, the image will be randomly compressed and possibly staggered for short periods in the scan direction.

This is indicative of the inspection systems transport mechanism dynamics causing momentary over-speed conditions. The module can tolerate very short durations of over-speed, but if it lasts too long, then the camera can only maintain its maximum line rate, and some EXSYNC pulses will be ignored, resulting in the occasional compressed staggered image.

Over-speeding may be due to inertia and/or backlash in the mechanical drive mechanism, causing variations around the target speed.

The greater the speed variation, the lower the target speed needs to be to avoid over-speed conditions. If the speed variation can be reduced by eliminating the backlash in the transport mechanism and/or optimizing the motor controller characteristics, then a higher target speed will be achievable.

Distorted Image when Slowing Down Changing Direction

The module must align the rows in a fashion that accurately follows the object motion.

When the scan direction changes, then the process must reverse to match the reversed image motion across the sensor. Only when all delayed rows have received will the correct image be output correctly.

Power Supply Issues

For safe and reliable operation, the module input supply must be within +24V DC. +/-10%.

The power supply to the module should be suitably current limited, as per the current specifications.

Assume a worst-case power consumption at 150% current rating for the breaker or fuse.

> **Note:** The camera will not start to draw current until the input supply is above approximately 20V and 200 ms has elapsed. If the power supply stabilizes in less than 200 ms, then inrush current will not exceed normal operating current.

It is important to consider how much voltage loss occurs in the power supply cabling to the camera, particularly if the power cable is long and the supply is operating at +24V -10% where the current draw is highest.

Reading the input supply voltage as measured by the camera will give an indication of the supply drop being experienced.

The module tolerates "hot" unplugging and plugging, though not recommended. Connect all supplies before turning the supply on.

The module has been designed to protect against accidental application of an incorrect input supply, up to reasonable limits.

With the following input power issues, the status LED will be OFF:

- The module will protect against the application of voltages above approximately +28 V. If the overvoltage protection threshold is exceeded, then power is turned off to the camera's internal circuitry. The power supply must be recycled to recover camera operation. The input protection circuitry is rated up to an absolute maximum of +30 V. Beyond this voltage, the camera may be damaged.
- The camera will also protect against the accidental application of a reverse input supply up to a maximum of -30 V. Beyond this voltage, the camera may be damaged.
- The module will not be power up below approximately 20V.

Declarations of Conformity

FCC, CE and UKCA conformance testing has yet to be completed. The prototypes must be used for evaluation and demonstration purposes only. The prototypes cannot be sold and must be retuned to TeledyneDALSA on completion of the evaluation and replaced with compliant standard production units after general Release for Sale.

Document Revision History

Revision	Description	Date
00	Preliminary Version	10th January 2023