Falcon™ 4-CLHS Series

Camera User's Manual

CLHS True High Performance Area Scan

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

P/N: 03-032-20295-05
www.teledynedalsa.com

TELEDYNE DALSA
Everywhereyoulook™

Notice

Document Date: 2023-04-25
Document Number: 03-032-20295-05

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 easy-to-use vision appliances and custom vision modules.

Contact Teledyne DALSA

Teledyne DALSA's headquarters are in Waterloo, Ontario, Canada. We have sales offices in the USA, Europe and Asia, plus a worldwide network of representatives and agents to serve you efficiently.

Contact information for sales, support inquiries and directions to our offices are found on our web site:

Sales Offices
https://www.teledynedalsa.com/en/contact/contact-sales/

Technical Support
https://www.teledynedalsa.com/en/support/options/

Contents

Series Overview

Description

The Falcon4-CLHS series provides affordable easy to use digital cameras specifically engineered for industrial imaging applications, starting with the industry's latest leading sensors such as the E2V Lince 11M series of global shutter high frame rate CMOS sensors. Cameras are available in a number of models implementing different sensors, image resolutions and feature sets.

Falcon4-CLHS supports the Teledyne DALSA Trigger-to-Image-Reliability framework to dependably capture and transfer images from the camera to the host PC.

Falcon4-CLHS Overview

- CLHS 10 Gbps interface per lane
- Supports a power supply input of 10 to 30 Vdc
- Supports the CLHS device discovery methodology providing plug and play capability
- Implements GenICam and associated GenCP compatible with Teledyne DALSA or third party CLHS frame grabbers
- Acquisitions in 8 or 10-bit
- Optimized, rugged design with a wider operating temperature
- Available in multiple models of different resolutions and maximum frame rates
- Visual camera multicolor status LED on back plate
- Uses one CX4 cable connection
- Flexible general-purpose Counter and Timer functions available for internal and external controls
- Defective Pixel Replacement and Flat Field Correction available
- Lens Shading Correction maps for lens vignetting
- Horizontal and Vertical Binning
- Application development with the freely available Sapera™ LT software libraries
- Native Teledyne DALSA Trigger-to-Image Reliability design framework
- Refer to the Operation Reference and Technical Specifications section of the manual for full details
- Compliant with Camera Link HS (CLHS) specification version 1.0 (X-Protocol)
  (visit www.automate.org/vision for details on industry standards)

Model Part Numbers

This manual covers the released Falcon4-CLHS monochrome models summarized in the table below. See Falcon4-CLHS Specifications for details.

Monochrome Cameras

Falcon4 Model Full Resolution	Sensor / max FPS	Data Format	Lens Mount	Part Number
M2240 2240 x 1248	E2V Lince 2.8M (proprietary) (1200 fps)	8-bit or 10-bit Mono	M42 mount	**FA-HM10-M2245**
M4400 4480 x 2496	E2V Lince 11M (330 fps)	8-bit or 10-bit Mono	M42 mount	**FA-HM11-M4405**
M4480 4480 x 2496	E2V Lince 11M (600 fps)	8-bit or 10-bit Mono	M42 mount	**FA-HM00-M4485** **FA-HM10-M4485**
M8200 8192 x 8192	E2V Emerald 67M (90 fps)	8-bit or 10-bit Mono	M42 mount	**FA-HM10-M8205**

Supported Teledyne DALSA Frame Grabbers

Falcon4 Model	Teledyne DALSA Frame Grabber	Part Number
M2240, M4400	Xtium2 CLHS PX8	**OR-A8S0-PX870**
	Xtium2 CLHS PX8 LC	**OR-A8S0-PX840**
M4480, M8200	Xtium2 CLHS PX8	**OR-A8S0-PX870**

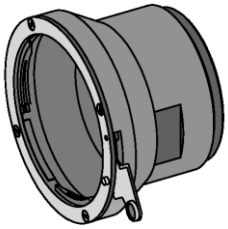
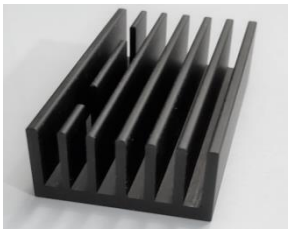
Camera Firmware

Teledyne DALSA Falcon4-CLHS camera firmware contains open-source software provided under different open-source software licenses. More information about these open-source licenses can be found in the documentation that accompanies the firmware, which is available on the Teledyne DALSA website at www.teledynedalsa.com.

Firmware updates are available for download from the Teledyne DALSA web site www.teledynedalsa.com/en/support/downloads-center.

When using Sapera LT, update the camera firmware using CamExpert (see Updating Firmware via File Access in CamExpert). The firmware can also be easily upgraded within your own application via the API. The camera has a failsafe scheme which prevents unrecoverable camera errors even in the case of a power interruption.

Accessories

Falcon4 Accessories & Cables (sold separately)		Order Number
I/O Breakout Cable (2 meter Screw Retention to Euroblock connector)		G5-AIOC-BRKOUT2M
Generic 12 volt power supply for the I/O & Power connector (Samtec 10-Pin) – 4 Meter length		G3-APWS-S10S04M
M42 to F-mount (Nikon) adapter *Note that there is no support for Nikon lens features such as focus and aperture motor controls.*		G2-AM42-MOUNT4
Heatsink compatible to Falcon4 casing, 51mm x 28mm x 15mm (screws included)		G3-AHSK-51X28
Mounting Bracket Plate, with 1/4 inch screw mount (tripod mount) 28 mm or 35mm of depth		G3-AMNT-BRA02
Active Optical Cable (AOC) cable 10 meters, with screw lock CX4 connector		AC-CA-00007-00-R

Hardware and Software Environments

The following describes suggested hardware and supported software for successful imaging systems using the Falcon4-CLHS.

Mounting

The camera requires a mounting platform which includes camera heatsinking. Thermal management and heat dissipation is mandatory to ensure the camera remains within the stated operating temperature specification. See section Mechanical Specifications with M42 Mount for the location of the camera mounting screw holes.

Frame Grabbers and Cabling

A Teledyne DALSA frame grabber, such as the Xtium2-CLHS PX8, is recommended for error free acquisitions with the Falcon4 camera (contact sales for additional information). See Frame Grabber and Cables.

See Cable Manufacturers Contact Information for contact information for information on CLHS CX4 cable suppliers and various I/O assemblies for your imaging solution.

Software Platforms

Platform	Notes
Support of GenICam GenCP	Camera setting, acquisition and other controls
Support of GenICam File access implementation	File access support for firmware update
Support of GenICam XML schema version 1.1	
GenICam™ support — XML camera description file	Embedded within Falcon4

Development Software for Camera Control

Teledyne DALSA Software Platform for Microsoft Windows	
Sapera LT for Windows — • **M2240, M4400, M4480**: version 8.6 or later • **M8200**: version 8.70 or later Includes Sapera Runtime and CamExpert. Provides everything you will need to develop imaging applications Sapera documentation provided in compiled HTML help and Adobe Acrobat® (PDF)	Available for download https://www.teledynedalsa.com/en/products/imaging/vision-software/sapera-lt/download/
Third Party Software Platforms	
GenICam GenCP Compliant Software and Tools	Contact your supplier

Falcon4-CLHS Specifications

Common specifications, model-specific functional features and timing details are listed here.

Common Specifications

Camera Controls	
Communication Protocol	GenCP (GenICam GenCP compliant software), CLHS X Protocol
Synchronization Modes	Free running, Triggered (via CX4 cable or external I/O)
Exposure Control	Internal – Programmable via the camera API External – Timed Trigger or Trigger Width modes supported via I/O
Exposure Time Minimum / Maximum	5 µs – 0.5 s (M2240, M4400, M4480) 8 µs – 0.5 s (M8200)
Exposure Modes	Timed: Programmable in increments of 1µs (minimum time (in µs) is model specific) Trigger Width: Pulse controlled via external Trigger pulse width
Input / Output Ports	2 input / 3 output ports (FA-HM00-M4485), opto-coupled 2 input / 4 output ports (FA-HM10-M2245, FA-HM11-M4405, FA-HM10-M4485, FA-HM10-M8205), opto-coupled
Features	
Gain	In-sensor gain (sensor-specific), digital gain
Defective Pixel Replacement	Up to 1022 entries
Binning	2 x 2, horizontal and vertical (not available in M2240)
Lens Shading Correction	1 user coefficient set
LUT	Programmable LUT (lookup table) up to 10-bit
Counter and Timer	1 Counter and 1 Timer. User programmable, acquisition independent, with event generation, and can control Output I/O pins
Test image	Internal generator with choice of static patterns
Metadata	Metadata output at the end of the images (also known as GenICam Chunk Data)
Cycling Mode	Automatic cycling between 64 camera setups
Multi ROI	Multiple regions of interest. Max ROIs: 32 without cycling, 8 with cycling (not available in M2240)
User settings	Select factory default or either of two user saved camera configurations
CLHS Link Speed	10.3 Gbps per Lane 4 Data Lanes (FA-HM10-M2245, FA-HM11-M4405) 7 Data Lanes (FA-HM00-M4485, FA-HM10-M4485, FA-HM10-M8205)
Back Focal Distance	
	12 mm (with M42 lens mount)
Optical Interface	
Sensor Alignment (Relative to sides of camera)	
Flatness	50 µm
Θ y	200 µm (Parallelism vs. front plate)
x	± 100 µm (Cross-Scan Direction)
y	± 100 µm (In-Scan Direction)
z	± 300 µm (Along optical axis)
Θ z	± 1.0° (Rotation around optical axis)

Mechanical Interface	
Camera (H x W x L) see Mechanical Specifications	59 mm x 59 mm x 74.5 mm (M2240, M4400, M4480) 59 mm x 59 mm x 74.93 mm (M8200)
Mass	Small Case: ~ 317g
CX4 Connector Type	Camera Link HS
Power connector	Camera power via the power pins on the 10-pin I/O connector
Electrical Interface	
Input Voltage	+24 V nominal (+10 to +30 V DC maximum range)
Power Dissipation (typical)	<13 W @ 24 V DC (M2240, M4400, M4480) <15 W @ 24 V DC (M8200)
Environmental Conditions	
Operating Temperature (*at camera front plate*)	All Models: -20 °C to +50 °C (-4 °F to +122 °F). *Any metallic camera mounting provides heat sinking, thereby reducing the internal temperature*
Operating Relative Humidity	5% to 90% non-condensing
Storage	-40 °C to +80 °C (-40 °F to +176 °F) temperature at 20% to 80% non-condensing relative humidity
Conformity	GenIcam compliant CE, FCC, RoHS, KC EU RoHS2, EU REACH, China RoHS2
IP Rating	IEC60529 IP40 (Protected against foreign object of 1 mm diameter, no protection against water.)

Sensor Cosmetic Specifications

After Factory Calibration and/or Corrections are applied (if applicable — dependent on sensor)

Blemish Specifications	Maximum Number of Defects	Blemish Description
Hot/Dead Pixel defects	Typical 0.0025% Max 0.005%	Any pixel that deviates by ±15% from the average of neighboring pixels at 80% saturation including pixel stuck at 0 and maximum saturated value.
Spot defects	none	Grouping of more than 5 pixel defects within a sub-area of 3x3 pixels, to a maximum spot size of 5x5 pixels.
Clusters defects	none	Grouping of more than 5 single pixel defects in a 3x3 kernel.
Column defects	none	Vertical grouping of more than 10 contiguous pixel defects along a single column.
Row defects	none	Horizontal grouping of more than 10 contiguous pixel defects along a single row.

Test conditions

- Nominal light = illumination at 80% of saturation
- Temperature of camera is 45°C
- At exposures lower than 0.25 seconds
- At nominal sensor gain (1x)

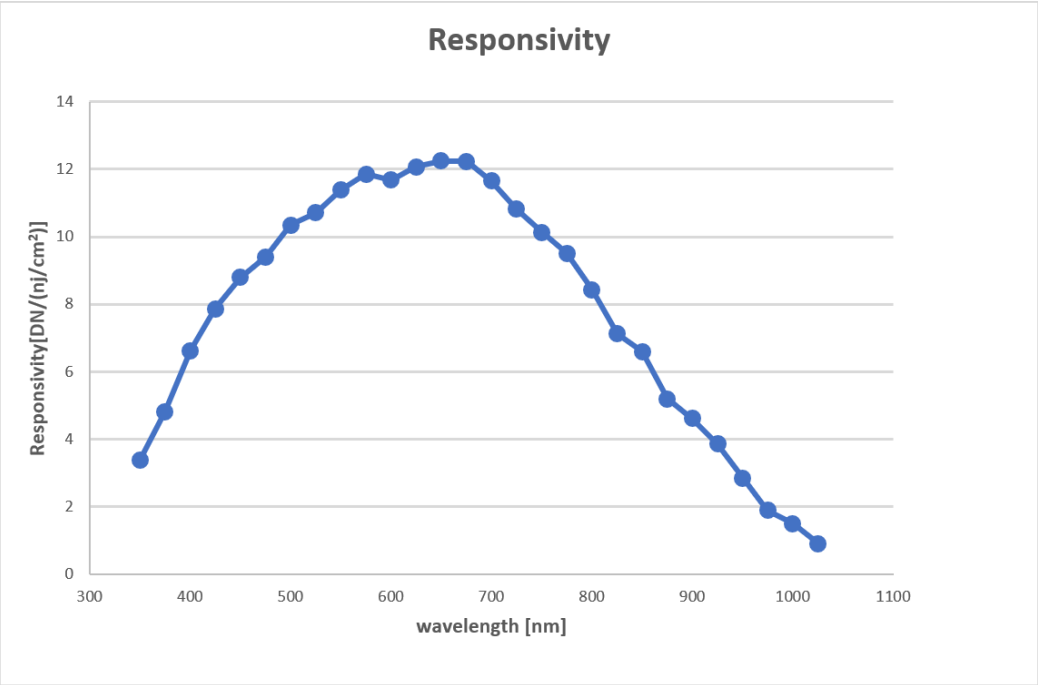
Falcon4-CLHS Specifications: M4480, M4400, M2240

Supported Features	M4480	M4400	M2240
Resolution	4480 x 2496	4480 x 2496	2240 x 1248
Sensor	E2V Lince 11M	E2V Lince 11M	E2V Lince 2.8M (Proprietary)
Pixel Size	6 µm x 6 µm		12 µm x 12 µm
Shutter Type	Full frame electronic global shutter function		
Full Well Charge	> 38 ke		> 142 ke
Maximum Frame Rate (8-bit)	600 fps	330 fps	1206 fps
CLHS configuration (X-Protocol)	7-Lanes	4-Lanes	
Pixel Format (Mono) ◑	Monochrome 8 or 10-bit		
Sensor Synchronization	Synchronous mode via external trigger signal or free running		
Trigger to Exposure Minimum Delay (*Synchronous Exposure*)	9 µs (8-bit)		
Trigger to Exposure Minimum Delay (*Reset Exposure*)	9 µs (8-bit)		
Trigger to Exposure Start Jitter (*Synchronous Exposure*)	Up to 1 line time		
Trigger to Exposure Start Jitter *(Reset Exposure)*	0 µs		
Exposure Time Minimum (see exposureTimeActual)	5 µs		
Horizontal Line Time	0.655 µs		
Min. Time from End of Exposure to Start of Next Exposure	4.47 µs		
Readout Time (full frame size)	Number of rows must be a multiple of 8 8-bit / fast readout active: 20.3e-9*(128)*(number of rows+16) / 4+20.3e-9*(128) (M4480 ONLY) 8-bit / fast readout off: 20.3e-9*(137)*(number of rows+16) / 4+20.3e-9*(137) 10-bit / fast readout active: 20.3e-9*(154)*(number of rows+16) / 4+20.3e-9*(154) (M4480 ONLY) 10-bit / fast readout off: 20.3e-9*(165)*(number of rows+16) / 4+20.3e-9*(165)		
Black Offset Control	Yes (in DN)		
Gain Control	In-sensor Analog Gain (1x to 4x), FPGA Digital Gain		
Defective Pixel Replacement	Yes, up to 1022 pixel positions		
Multi-ROI Support	Yes		No
Output Dynamic Range (dB)	> 59.5		> 63
SNR (dB)	46		52

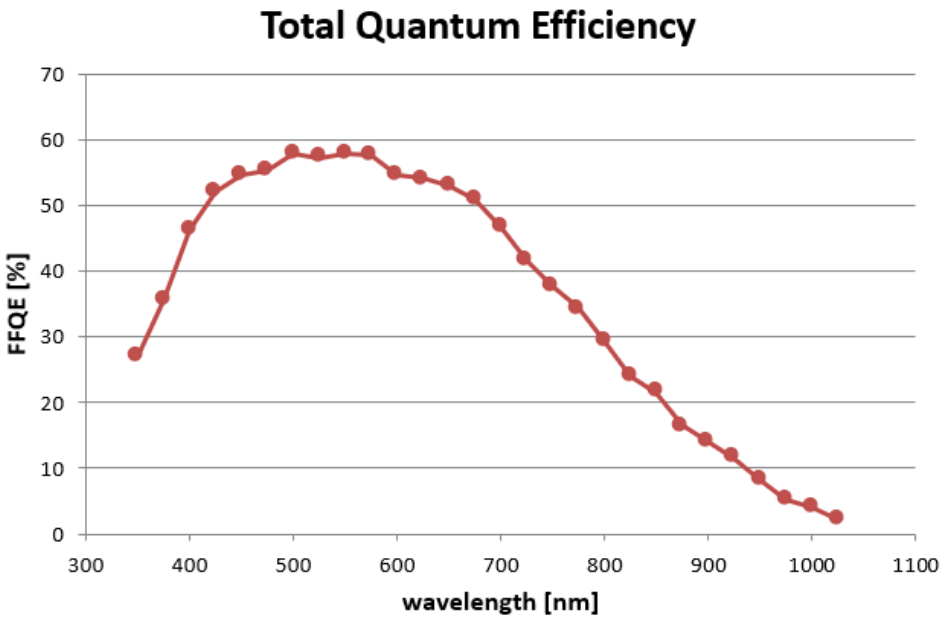
Quantum Efficiency Curves M2240, M4400, M4480

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

Spectral Responsivity



Effective Quantum Efficiency



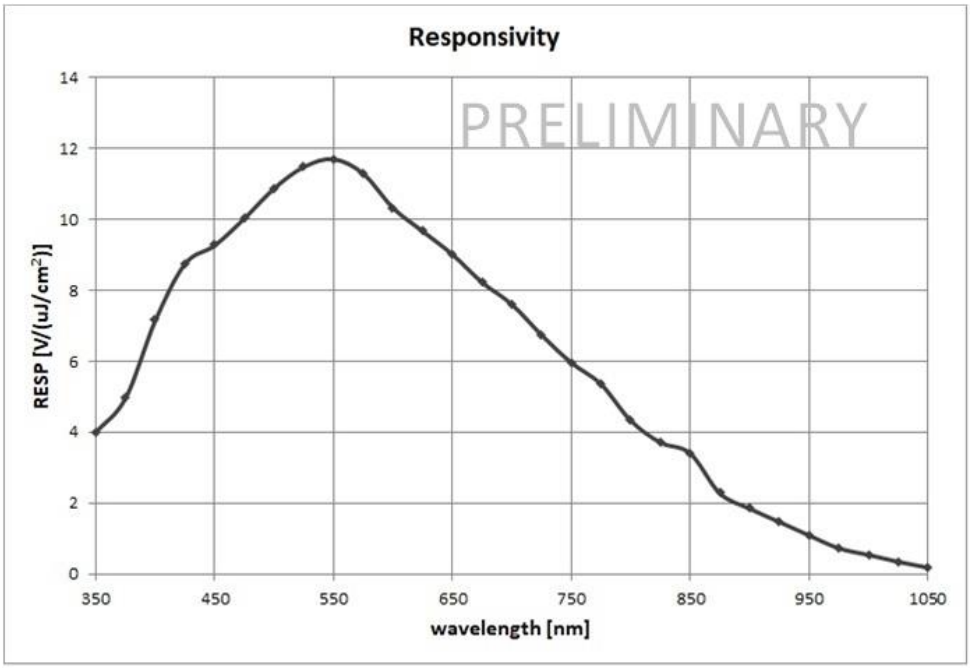
Falcon4-CLHS Specifications: M8200

Supported Features	M8200
Resolution	8192 x 8192
Sensor	E2V Emerald 67M
Pixel Size	2.5 µm x 2.5 µm
Shutter Type	Full frame electronic global shutter function
Full Well Charge	> 5 ke
Maximum Frame Rate (8-bit)	90 fps
CLHS configuration (X-Protocol)	7-Lanes
Pixel Format (Mono)	Monochrome 8-bit or 10-bit
Sensor Synchronization	Synchronous mode via external trigger signal or free running
Trigger to Exposure Minimum Delay (*Synchronous Exposure*)	8 µs (8-bit)
Trigger to Exposure Minimum Delay (*Reset Exposure*)	8 µs (8-bit)
Trigger to Exposure Start Jitter (*Synchronous Exposure*)	Up to 1 line time
Trigger to Exposure Start Jitter *(Reset Exposure)*	0 µs
Exposure Time Minimum (see exposureTimeActual)	8 µs
Horizontal Line Time	2.68 µs
Min. Time from End of Exposure to Start of Next Exposure	7.5 µs
Readout Time (full frame size)	Number of rows must be a multiple of 2 10 980 µs (8-bit) 12 148 µs (10-bit)
Black Offset Control	Yes (in DN)
Gain Control	In-sensor Analog Gain (1x to 4x), FPGA Digital Gain
Defective Pixel Replacement	Yes, up to 6132 pixel positions
Multi-ROI Support	Yes
Output Dynamic Range (dB)	> 52.25
SNR (dB)	36

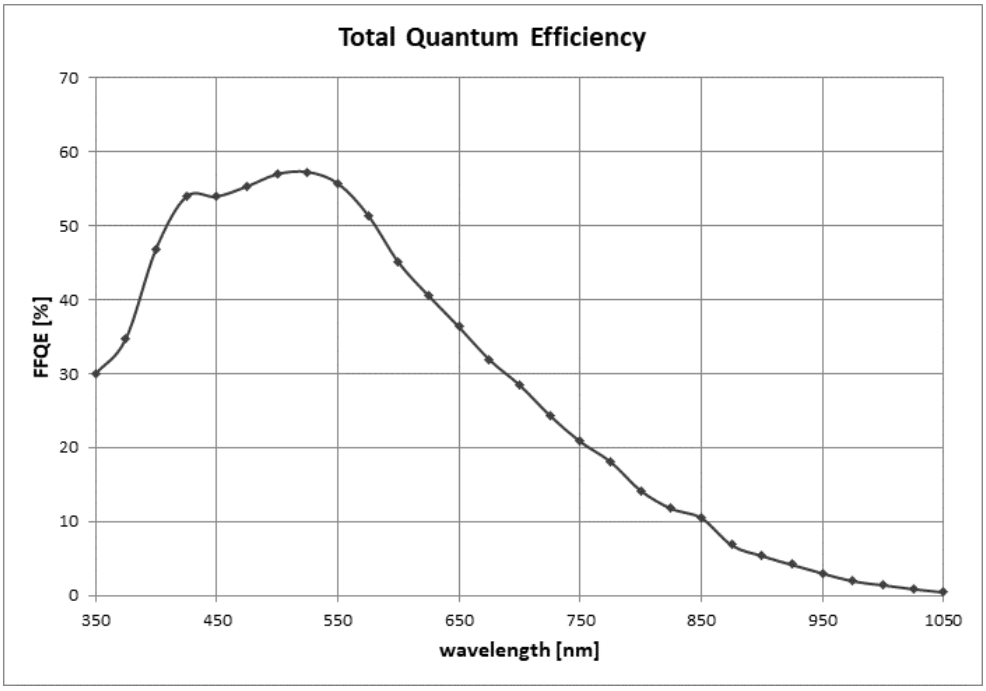
Quantum Efficiency Curves M8200

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

Spectral Responsivity



Effective Quantum Efficiency



Installation

If you are familiar with CLHS cameras and Teledyne DALSA frame grabbers follow the Quick Start section to quickly install and acquire images with the Falcon4-CLHS and the CamExpert tool provided with Sapera LT.

If using CLHS cameras with frame grabbers is new to you, review the Requirements section for what you need before you start. See Installation Details for additional information on Sapera LT installation. Refer to your frame grabber's user manual for instructions related to the board installation.

Note that you need administrator rights for installation and updates.

Requirements

Frame Grabber and Cables

A frame grabber board such as the Teledyne DALSA Xtium2-CLHS PX8 / PX8 LC is the recommended computer interface.

Falcon4 Model	Teledyne DALSA Frame Grabber	Part Number
M2240 M4400	Xtium2 CLHS PX8	OR-A8S0-PX870
	Xtium2 CLHS PX8 LC	OR-A8S0-PX840
M4480 M8200	Xtium2 CLHS PX8	OR-A8S0-PX870

Camera Link HS Cables

The camera uses a Camera Link HS SFF-8470 (CX4) cable; AOC (Active Optical Connectors) cables are recommended due to the high-bandwidth CLHS X-Protocol (C3 copper cables < 2m may work but are not recommended). See Falcon4-CLHS Connectors and Status LED.

Note: CX4 AOC cables are directional; ensure that the connector labelled **Camera** and **FG** are attached accordingly to the camera and frame grabber.

Visit our web site for additional information on the CLHS interface:
www.teledynedalsa.com/en/learn/knowledge-center/clhs/

Camera Power

Cameras with part number FA-HMxx-xxxxx support Power via the Auxiliary Connector (12 to 24 Volt DC). See Falcon4-CLHS Connectors and Status LED.

The frame grabber PoCL (Power-over-Cable) powers the electronics in the Active Optical Cable (AOC) module. This frame grabber feature should not be disabled for normal operation.

Software, firmware, and device driver downloads

Download the appropriate camera firmware, software and board driver from the Teledyne DALSA website. If the required version is not available, contact your Teledyne DALSA representative.

FALCON4-CLHS Model	Falcon4-CLHS Firmware Design	Software SDK	Xtium2-CLHS PX8/PX8 LC Board Driver
M2240 M4400	Falcon4-CLHS_e2v_11M_STD_Firmware_256.293.cbf or higher	Sapera LT 8.6 (or higher)	Version 1.31 or higher
M4480	Falcon4-CLHS_e2v_11M_STD_Firmware_256.101.cbf or higher	Sapera LT 8.6 (or higher)	Version 1.31 or higher
M8200	Falcon4-CLHS_e2v_37-67M_STD_Firmware_xx.xx.cbf* or higher	Sapera LT 8.70 (or higher)	Version 1.40 or higher

* See the Teledyne DALSA link below, or contact your Teledyne DALSA sales representative.

The latest **Falcon4-CLHS** firmware files can be downloaded from the Teledyne DALSA website:

www.teledynedalsa.com/en/support/downloads-center/firmware

Sapera LT SDK (full version) is the image acquisition and control software development kit (SDK) for Teledyne DALSA cameras. It includes the CamExpert application, which provides a graphical user interface to access camera features for configuration and setup. Sapera LT is available for download from the Teledyne DALSA website:

www.teledynedalsa.com/en/products/imaging/vision-software/sapera-lt/download/

Xtium2-CLHS PX8/PX8 LC Board Drivers are available from the Teledyne DALSA website. Follow the installation instructions from the board's User Manual for the computer requirements, installation, and update.

www.teledynedalsa.com/en/support/downloads-center/device-drivers/

Quick Start (using a Teledyne DALSA Frame Grabber)

The following steps summarize the installation procedure. You need administrator rights for installation and updates.

- Turn off computer.
- Install the Xtium2-CLHS PX8 (or PX8 LC) into an available PCI Express x8 Gen3 slot.
- Turn on the computer.
- Download and install the Sapera LT SDK or its runtime library:
  - version 8.6 or newer required for models M2240, M4400, M4480
  - version 8.70 or newer required for model M8200
- Download and install the Xtium2-CLHS PX8/PX8 LC board driver:
  - version 1.31 or newer required for models M2240, M4400, M4480
  - version 1.40 or newer required for model M8200
- Update the board firmware, if required (a dialog will open in that case).
- Reboot the computer.
- Connect the Falcon4-CLHS with a CLHS camera cable to the CLHS frame grabber.
- Power the camera using an appropriate power supply. The Falcon4-CLHS status LED will indicate power and the Device / Host connection with a steady green color when connected. See section Camera Status LED Indicator for a complete list of Status LED indicators.

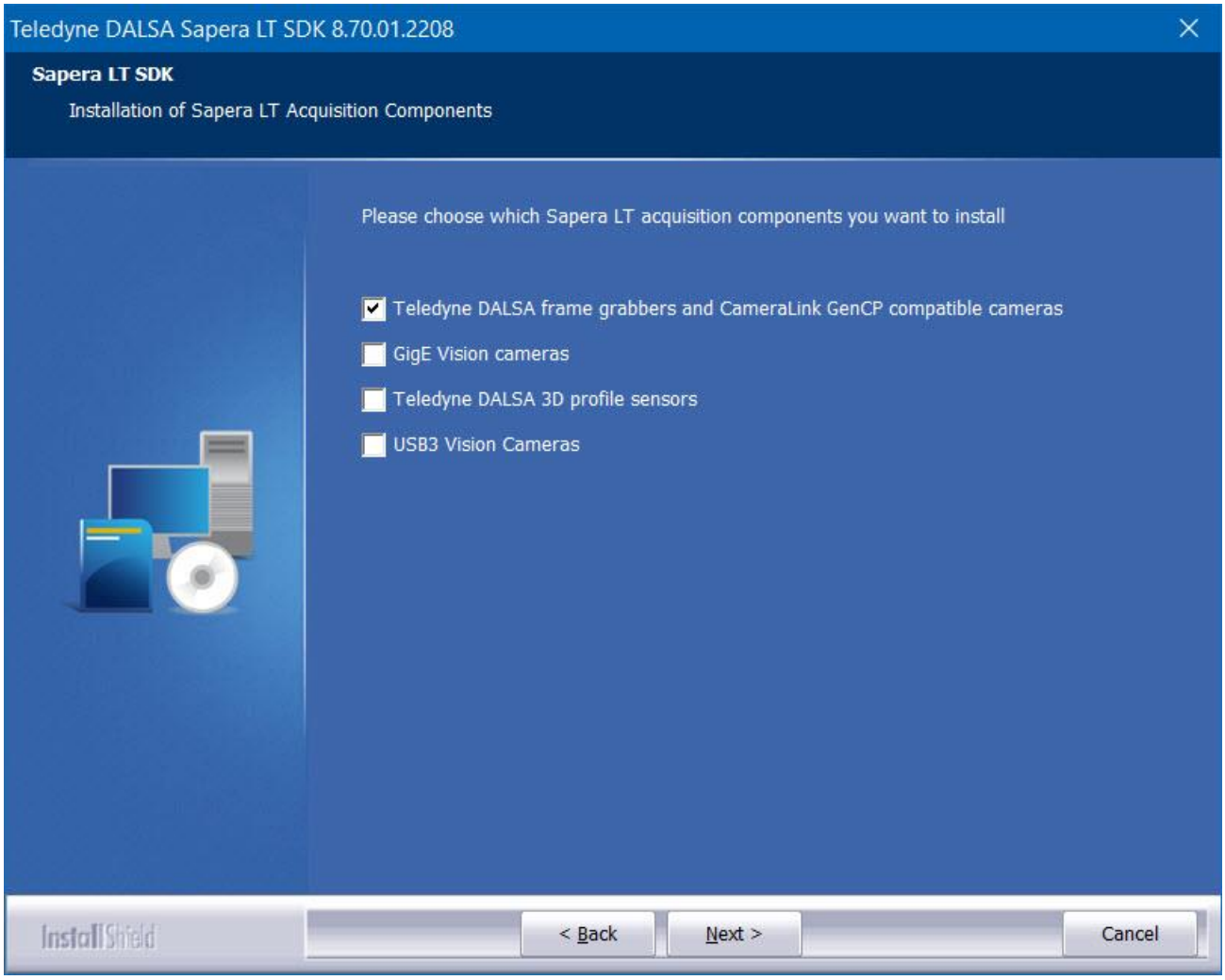
Once installed, upload new camera firmware and test acquisition:

- Start **CamExpert**. The plug-and-play feature of the frame grabber and camera will automatically configure frame buffer, data lanes, and frame rate parameters to match the Falcon4 model being used. At this time do not configure for an external trigger.
- Upload new camera firmware. See Updating Firmware via File Access in CamExpert.
- From the Falcon4 Image Format Feature Category, select a test pattern from the *Test Image Selector* Parameter.
- Click **Grab**. You will see the pattern in the CamExpert display window.
- If a camera lens is attached, turn off the test pattern and grab live again. Adjust the lens aperture plus focus, and/or adjust the camera Exposure Time and Frame Rate as required.

Installation Details

Sapera LT Installation

Start the Sapera LT installer and follow instructions. On the Acquisition Components page, select the *Teledyne DALSA frame grabbers and CameraLink GenCP compatible cameras* option.



The installation program will prompt to reboot the computer. It is not necessary to reboot the computer between the installation of Sapera LT and the installation of the board driver. Reboot will be required after software and board driver are installed.

Board Driver Installation

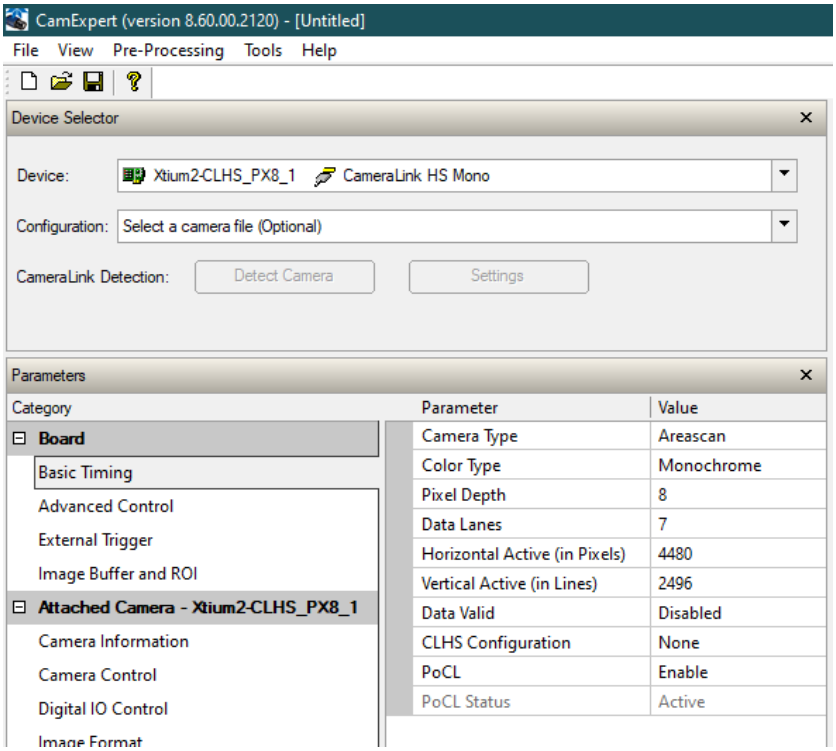
Follow instructions in the frame grabber's user manual for installation of the frame grabber and board driver.

Testing Acquisition

Start CamExpert

Sapera CamExpert is included as part of the Sapera LT SDK. It is Teledyne DALSA's camera and frame grabber interfacing tool that allows you to quickly validate hardware setup, change parameter settings, and test image acquisition. It is available from the Windows **Start** menu under **Teledyne DALSA Sapera LT**, or from the desktop shortcut (created at installation).

If there is only one Teledyne DALSA frame grabber, the **Device** list automatically has the Xtium2-CLHS PX8 selected and the connected Falcon4-CLHS is also automatically detected as shown in the image below.



If the camera is not automatically detected, verify that the camera is properly powered and that the fiber optic cable is connected correctly to the appropriate connectors on the frame grabber and camera; cables are uni-directional and connectors are labelled *Camera* and *F G* (frame grabber).

See also Using CamExpert with Falcon4-CLHS.

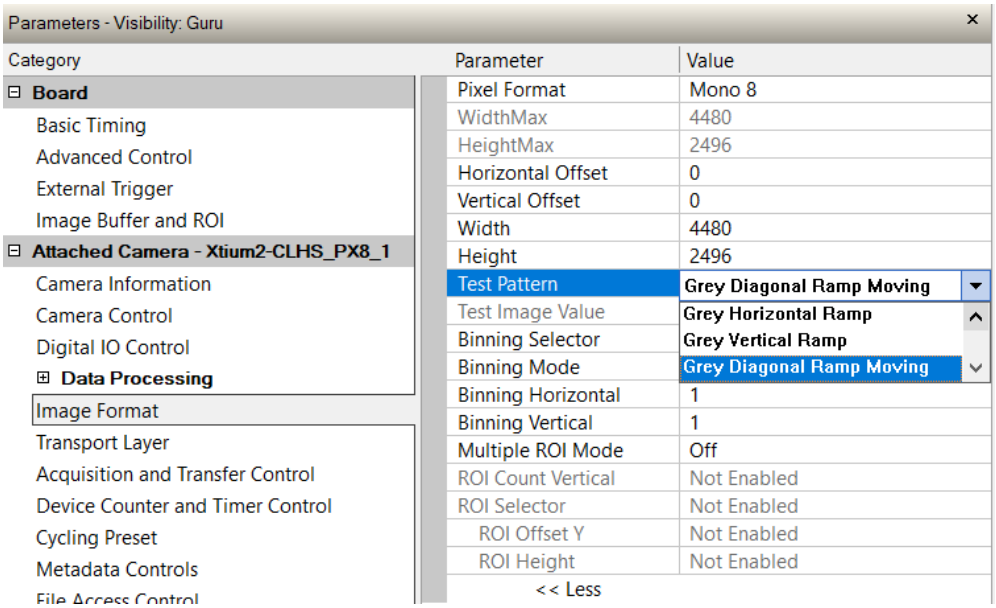
Upload Camera Firmware

Under Windows, the user can upload new firmware using the Upload/Download File feature in the File Access Control category provided by the Sapera CamExpert tool. See Updating Firmware via File Access in CamExpert.

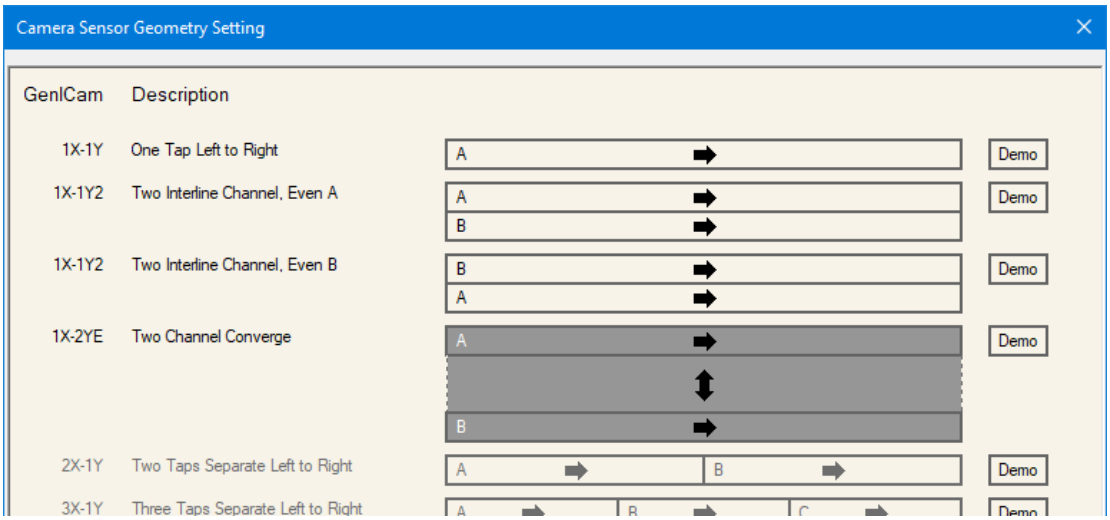
Verify Basic Acquisition

To verify basic acquisition, the camera can output a test pattern to validate that parameter settings are correctly configured between the camera and frame grabber.

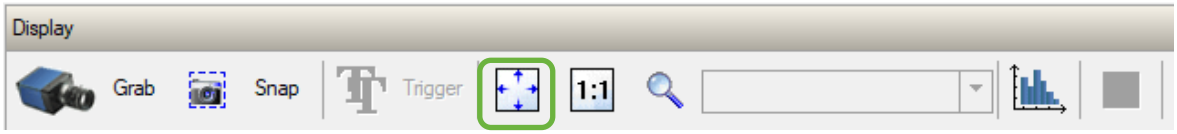
- In the Image Format category, select Test Pattern – *Grey Diagonal Ramp Moving*.



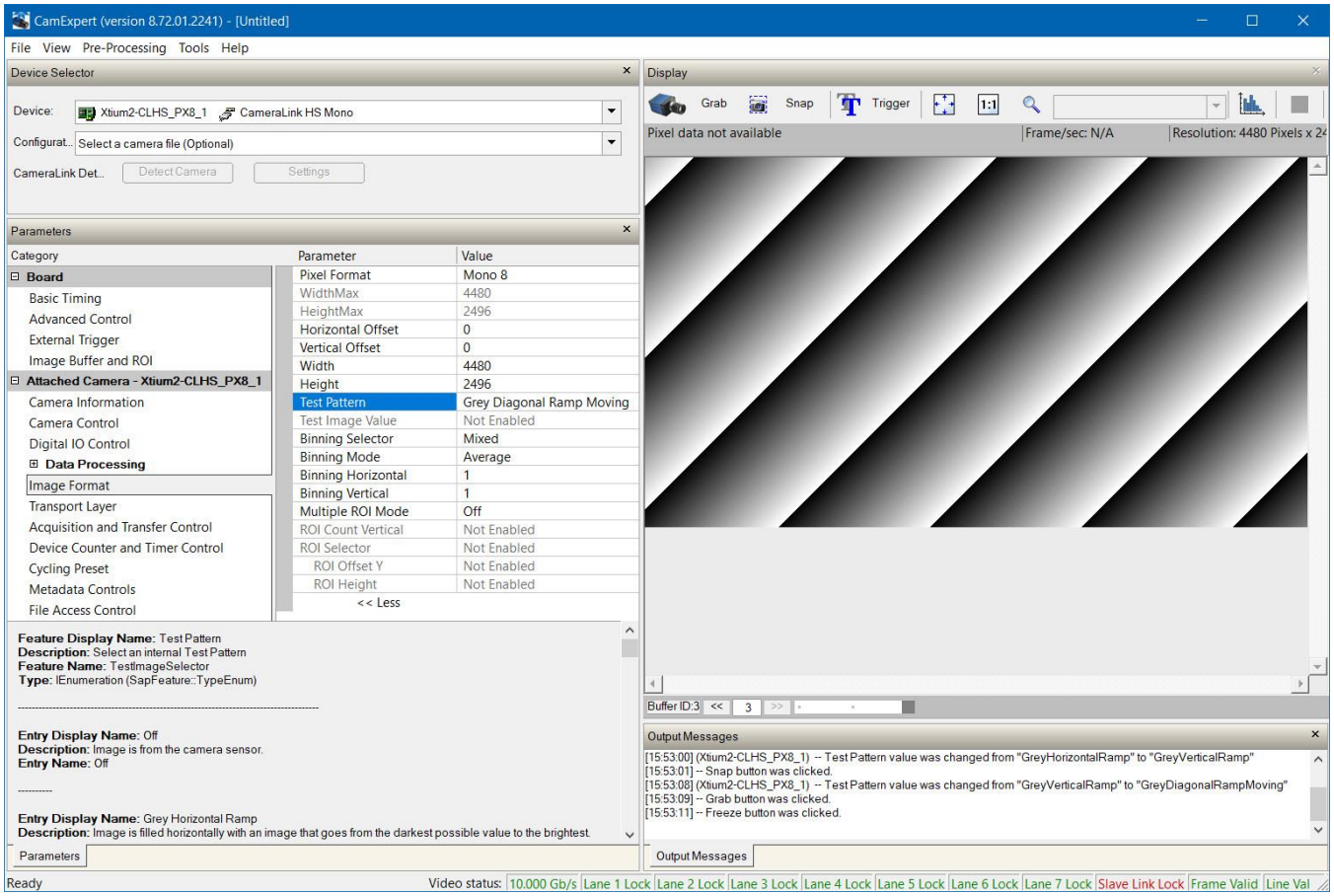
- (For model M8200 only) In the Basic Timing board category, click the Camera Sensor Geometry Setting value, and select *1X-2YE Two Channel Converge* as depicted.



- On the Display toolbar, click **Fit to Screen** to view the complete acquisition in the display window (the actual acquisition data is unmodified).



- Click **Grab** to view the diagonal ramp acquisition.


CamExpert (version 8.72.01.2241) - [Untitled]
File View Pre-Processing Tools Help
Device Selector
Device: Xtium2-CLHS_PX8_1 CameraLink HS Mono
Configurat... Select a camera file (Optional)
CameraLink Det... Detect Camera Settings
Parameters
Category
Parameter
Value
Board
Basic Timing
Advanced Control
External Trigger
Image Buffer and ROI
Attached Camera - Xtium2-CLHS_PX8_1
Camera Information
Camera Control
Digital IO Control
Data Processing
Image Format
Transport Layer
Acquisition and Transfer Control
Device Counter and Timer Control
Cycling Preset
Metadata Controls
File Access Control
Pixel Format Mono 8
WidthMax 4480
HeightMax 2496
Horizontal Offset 0
Vertical Offset 0
Width 4480
Height 2496
Test Pattern Grey Diagonal Ramp Moving
Test Image Value Not Enabled
Binning Selector Mixed
Binning Mode Average
Binning Horizontal 1
Binning Vertical 1
Multiple ROI Mode Off
ROI Count Vertical Not Enabled
ROI Selector Not Enabled
ROI Offset Y Not Enabled
ROI Height Not Enabled
<< Less
Feature Display Name: Test Pattern
Description: Select an internal Test Pattern
Feature Name: TestImageSelector
Type: IEnumeration (SapFeature::TypeEnum)
Entry Display Name: Off
Description: Image is from the camera sensor.
Entry Name: Off
Entry Display Name: Grey Horizontal Ramp
Description: Image is filled horizontally with an image that goes from the darkest possible value to the brightest.
Parameters
Display
Grab Snap Trigger 1:1
Pixel data not available
Frame/sec: N/A
Resolution: 4480 Pixels x 24
Buffer ID:3 << 3 >>
Output Messages
[15:53:00] (Xtium2-CLHS_PX8_1) -- Test Pattern value was changed from "GreyHorizontalRamp" to "GreyVerticalRamp"
[15:53:01] -- Snap button was clicked.
[15:53:08] (Xtium2-CLHS_PX8_1) -- Test Pattern value was changed from "GreyVerticalRamp" to "GreyDiagonalRampMoving"
[15:53:09] -- Grab button was clicked.
[15:53:11] -- Freeze button was clicked.
Output Messages
Ready
Video status: 10.000 Gb/s Lane 1 Lock Lane 2 Lock Lane 3 Lock Lane 4 Lock Lane 5 Lock Lane 6 Lock Lane 7 Lock Slave Link Lock Frame Valid Line Val

Falcon4-CLHS Connectors and Status LED

Connectors

The Falcon4-CLHS has connectors for CX4 data/control and I/O:

- A **10 pin I/O** (Samtec) connector for camera power, trigger, strobe and general I/O signals. The connector supports a retention latch, while additionally the case supports an I/O cable with locking thumbscrews. Teledyne DALSA provides optional cables for purchase (see I/O Cable Accessories). Also see 10-pin I/O Connector Details for pin out specifications.
- A **CX4 connector** supporting the CLHS data output and control signals. See Cable Manufacturers Contact Information for a variety of CX4 cables.

The following figure of the Falcon4-CLHS back shows connector and LED locations along with identification labels. See Mechanical Specifications for details on the connectors and camera mounting dimensions.

Falcon4-CLHS – Rear View

LED Indicators

The Falcon4-CLHS has one multicolor LED to provide a simple visible indication of camera state, as described below. The CX4 connector does not have any status LED indicator.

Camera Status LED Indicator

The camera is equipped with one LED to display its operational status. When more than one condition is active, the LED color indicates the condition with the highest priority. The following table summarizes the LED states.

LED State	Definition
LED is off	No power to the camera
Flashing Orange	Camera initialization sequence in progress.
Flashing Green	Looking for link; hardware is fine but connection not established.
Steady Green	Link established. Device and host connected and data transfer may take place.
Fast Flashing Blue	File Access Feature is transferring data such as a firmware update, etc.
Constant Red	System error (for example, internal error).

Preventing Operational Faults due to ESD

Camera installations which do not protect against ESD (electrostatic discharge) may exhibit operational faults. Problems such as random data loss, random camera resets and other non-reoccurring control issues may all be solved by proper ESD management.

Teledyne DALSA has performed ESD testing on cameras using an 8 kilovolt ESD generator without any indication of operational faults.

To help prevent ESD problems, mount the camera on a metallic platform with a good connection to earth ground.

Operational Reference

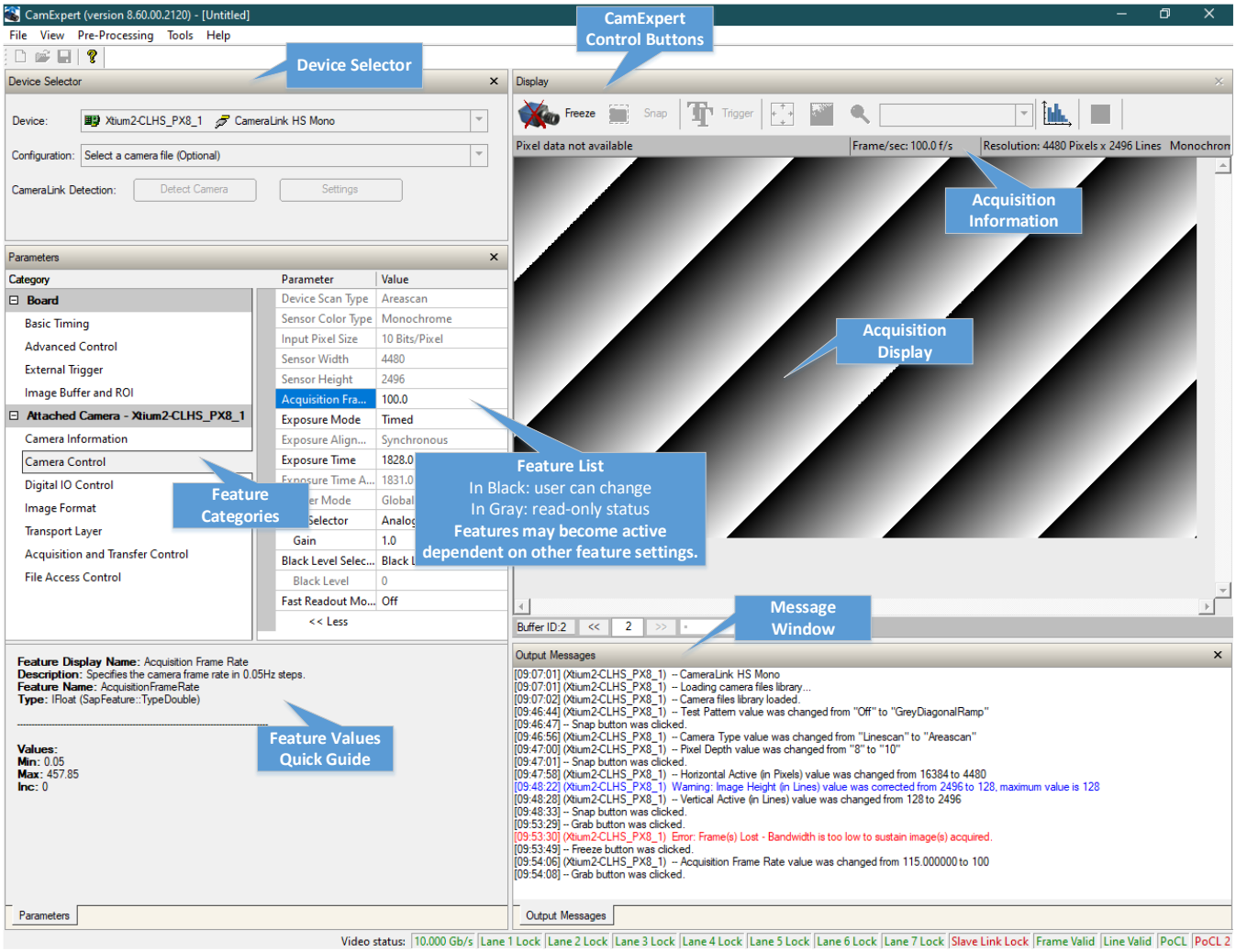
Using CamExpert with Falcon4-CLHS

The Sapera CamExpert tool allows a user to test the camera and frame grabber combination and their functions. CamExpert saves the Teledyne DALSA frame grabber user settings as individual camera parameter files on the host system (*.ccf). The camera settings are saved within the camera as a user set.

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

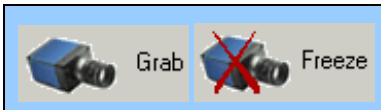
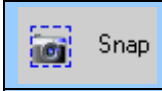
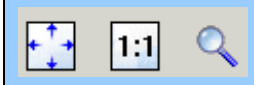
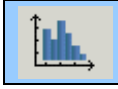
CamExpert Panes

The various areas of CamExpert are summarized in the figure below.



- **Device Selector pane**: View and select from any installed Sapera acquisition device if more than one is installed in the computer. After a device is selected CamExpert will only present parameters applicable to that device.

- **Parameters pane**: Allows viewing or changing all acquisition parameters supported by the acquisition device or frame grabber. This avoids confusion by eliminating parameter choices when they do not apply to the hardware in use.
  When using a Teledyne DALSA frame grabber and camera, CamExpert groups all frame grabber parameters under the **Board** heading, and the supported camera features under the **Attached Camera** heading.
- **Display pane**: Provides a live or single frame acquisition display. Frame buffer parameters are shown in an information bar above the image window.
- **Control Buttons**: The **Display** pane includes CamExpert control buttons. These are:

	**Acquisition control button:** Click once to start the frame grabber live grab mode, click again to stop. The Falcon4 is always in free running acquisition mode unless configured to use an external trigger.
	**Single frame grab:** Click to acquire one frame from the frame grabber device.
	**Software trigger button:** With the I/O control parameters set to Trigger Enabled / Software Trigger type, click to send a single software trigger command.
	**CamExpert display controls:** (these do not modify the frame buffer data) Stretch (or shrink) image to fit, set image display to original size, or zoom the image to any size and ratio. Note that under certain combinations of image resolution, acquisition frame rate, and host computer speed, the CamExpert screen display may not update completely due to the host CPU running at near 100%. This does not affect the acquisition.
	**Histogram / Profile tool:** Select to view a histogram or line/column profile during live acquisition.

- **Output Messages pane**: Displays messages from CamExpert, camera or the interface driver.
- **Link Signals**: Displays the status of various Link.

CamExpert View Parameters Option

While the **Board** section shows all frame grabber parameters, the **Attached Camera** section shows camera features filtered by a Visibility attribute that selects the targeted user level. These vary from Beginner (features required for basic operation of the device) to Guru (optional features required only for complex operations).

Choose the parameter visibility via the [<< Less More>>] control below each feature list. You can also choose the visibility level from the **View** > **Parameters Options** > **Visibility** menu.

Camera Feature Categories

The following sections describe the available categories and their features in detail.

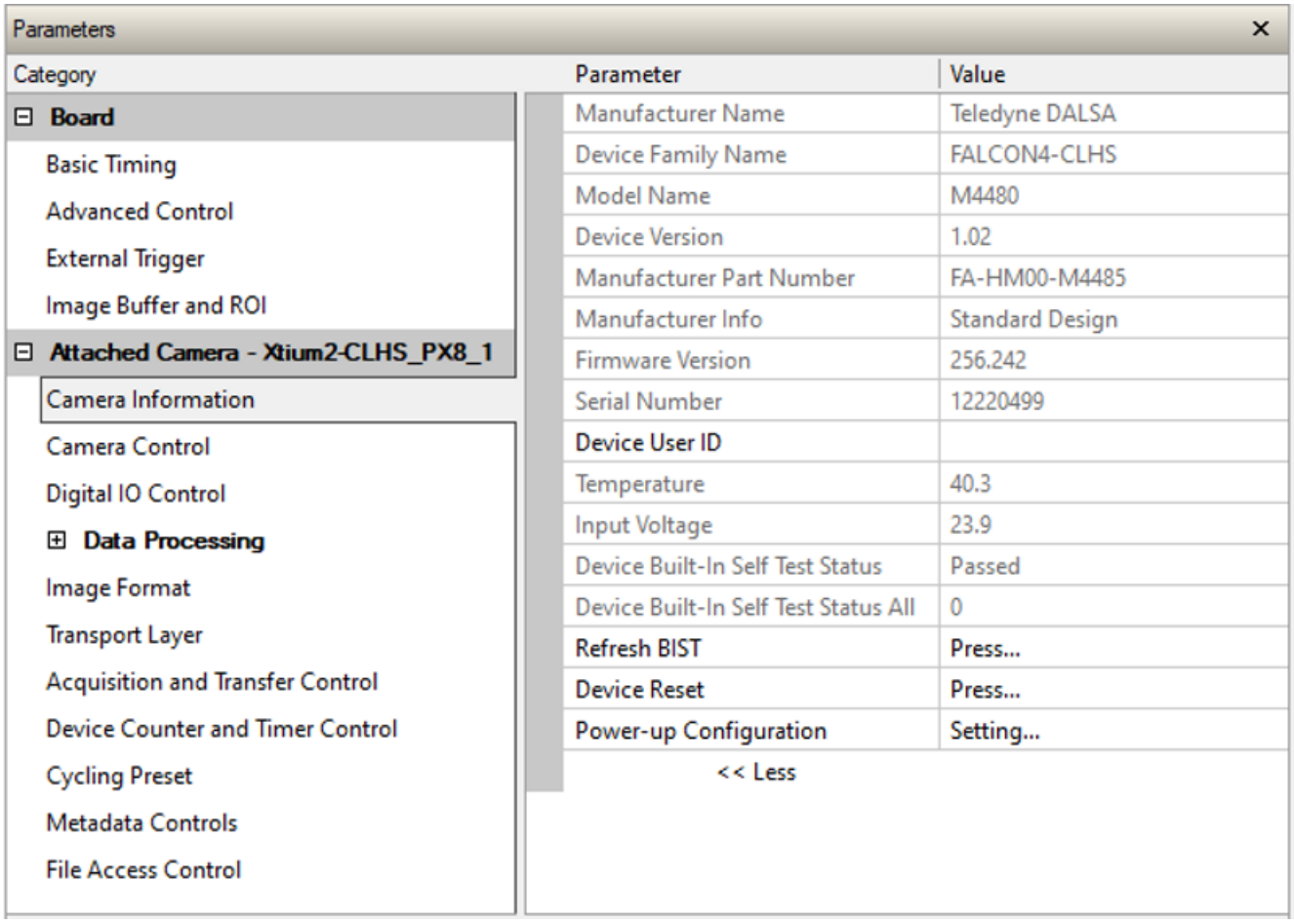
Many of the features shown in CamExpert may be changed directly in CamExpert or programmatically via an imaging application. Their availability may depend on other feature settings, and while some features are read only, others may be changed during acquisition. Note that features shown by CamExpert may change with different Falcon4 models implementing different sensors and image resolutions; that is, a specific camera model may not support the full feature set defined in a category.

The tables found in each category describe the features and their possible values, along with their view attribute (beginner, expert, guru) and the device version in which the feature was introduced. A device version number represents the camera software functional group, not a firmware revision number. As Falcon4 capabilities evolve, the device version increases, identifying the supported function package. New features for a major device version release are indicated by green text for easy identification. For each feature, the device version may differ for each camera sensor available.

The last column also indicates whether the parameter is a member of the DALSA Features Naming Convention (DFNC), or of the GenICam Standard Features Naming Convention (SFNC–tag not shown). Features tagged as *Invisible* are usually for Teledyne DALSA or third-party software usage—not typically needed by end user applications.

Camera Information Category

Camera information can be retrieved via a controlling application. Parameters such as camera model, firmware version, etc., uniquely identify the connected Falcon4-CLHS device and provide information on its state. These features are typically read-only.



Camera Information Feature Descriptions

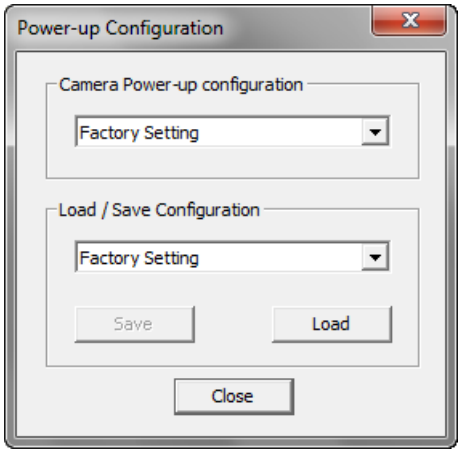
Display Name	Feature & Values	Description	Device Version & View
Manufacturer Name	DeviceVendorName	Displays the device vendor name.	1.00 Beginner
Device Family Name	DeviceFamilyName	Displays the device family name.	1.00 Beginner
Model Name	DeviceModelName	Displays the device model name.	1.00 Beginner
Device Version	DeviceVersion	Displays the device version. This tag will also highlight if the firmware is a beta or custom design.	1.00 Beginner
Manufacturer Part Number	deviceManufacturerPartNumber	Displays the device manufacturer part number.	1.00 DFNC Beginner

Display Name	Feature & Values	Description	Device Version & View
Manufacturer Info	DeviceManufacturerInfo	This feature provides extended manufacturer information about the device. Falcon4 cameras show which firmware design is currently loaded.	1.00 Beginner
Firmware Version	DeviceFirmwareVersion	Displays the currently loaded firmware version number. Firmware files have a unique number and have the .cbf file extension.	1.00 Beginner
Serial Number	DeviceSerialNumber	Displays the device's factory set serial number.	1.00 Beginner
Device User ID	DeviceUserID	This feature stores a user-programmable identifier.	1.00 Beginner
Temperature	DeviceTemperature	Internal temperature in degrees Celsius	1.00 Beginner
Input Voltage	deviceInputVoltage	Voltage at power connector (V)	1.00 DFNC Beginner
Device Built-In Self Test Status	deviceBISTStatus	List the BIST status. Display the most critical error if there are multiple errors.	1.00 Beginner
	Passed	*No errors.*	
	I2C	*Errors on I2C devices.*	
	SENSOR_CAL	*Sensor calibration failed.*	
	SENSOR_SPI	*Sensor SPI failed self test.*	
	FPGA_ECHO_BACK	*FPGA failed echo back.*	
	FLASH_TIMEOUT	*SPI flash timeout.*	
	FLASH_ERROR	*SPI flash ID invalid (communication fail).*	
	NO_FPGA_CODE	*FPGA: no code in SPI flash.*	
	NO_COMMON_SETTINGS	*No common settings.*	
	NO_FACTORY_SETTINGS	*No factory settings.*	
	OVER_TEMPERATURE	*Over temperature.*	
	SENSOR_PATTERN	*Sensor Test pattern failed.*	
	CLHS_TXRDY_RETRY	*CLHS Tx Retry.*	
	INVALID_UPGRADE	*Firmware upgrade failure.*	
	NO_USER_SETTINGS	*No user settings.*	
	NO_SCRIPT	*No start script.*	
	FACT_CODE	*Run from factory code.*	
	NO_FATFS	*No FAT filesystem.*	
	WRONG_DAC	*Wrong DAC values.*	
Device Built-In Self Test Status All	deviceBISTStatusAll	Result of Basic Internal Self-Test	1.00 DFNC Beginner
Refresh BIST	deviceBIST	Refresh Basic Internal Self-Test	1.00 Beginner
Device Reset	DeviceReset	Write to this feature to reset the device to its power up state.	1.00 Beginner
Power-on User Set	UserSetDefaultSelector	Selects the feature User Set to load at camera reset.	1.00 Beginner
Factory Setting	*Default*	Select the default camera feature settings saved by the Factory.	
User Set 1	*UserSet1*	*Select the user defined configuration UserSet 1 as the Power-up Configuration.*	
User Set 2	*UserSet2*	*Select the user defined configuration UserSet 2 as the Power-up Configuration.*	

Display Name	Feature & Values	Description	Device Version & View
User Set Selector	UserSetSelector	Selects the camera configuration set to load feature settings from or save current feature settings to. The Factory set contains default camera feature settings.	1.00 Beginner
Factory Setting	*Default*	*Select the default camera feature settings saved by the factory.*	
UserSet 1	*UserSet1*	*Select the User Defined Configuration space UserSet1 to save to or load from features settings previously saved by the user.*	
UserSet 2	*UserSet2*	*Select the User Defined Configuration space UserSet2 to save to or load from features settings previously saved by the user.*	
Load User Set	UserSetLoad	Loads the camera configuration set specified by the User Set Selector feature, to the camera and makes it active.	1.00 Beginner
Save User Set	UserSetSave	Saves the current camera configuration to the user set specified by the User Set Selector feature.	1.00 Beginner
Serial Number	DeviceID	Displays the device's factory set camera serial number.	1.00 Invisible
Device TL Version Major	DeviceTLVersionMajor	Major version of the device's Transport Layer.	1.00 Invisible
Device TL Version Minor	DeviceTLVersionMinor	Minor version of the device's Transport Layer.	1.00 Invisible
Temperature Monitor	temperatureMonitorON	Turn on/off the temperature monitor function.	1.00 DFNC Invisible
DFNC Major Rev	deviceDFNCVersionMajor	Major revision of Dalsa Feature Naming Convention which was used to create the device's XML.	1.00 DFNC Invisible
DFNC Minor Rev	deviceDFNCVersionMinor	Minor revision of Dalsa Feature Naming Convention which was used to create the device's XML.	1.00 DFNC Invisible
SFNC Major Rev	DeviceSFNCVersionMajor	Major Version of the Genicam Standard Features Naming Convention which was used to create the device's XML.	1.00 DFNC Invisible
SFNC Minor Rev	DeviceSFNCVersionMinor	Minor Version of the Genicam Standard Features Naming Convention which was used to create the device's XML.	1.00 DFNC Invisible
SFNC SubMinor Rev	DeviceSFNCVersionSubMinor	SubMinor Version of the Genicam Standard Features Naming Convention which was used to create the device's XML.	1.00 Invisible

Power-up Configuration Dialog

CamExpert provides a dialog box which combines the features to select the camera power-up state and to save or load a Falcon4 camera state.



Camera Power-up Configuration

The **Camera Power-up Configuration** list allows the selection of the camera configuration state to load on power-up (see feature *UserSetDefaultSelector*). The user chooses from one factory data set or one of two possible user saved states.

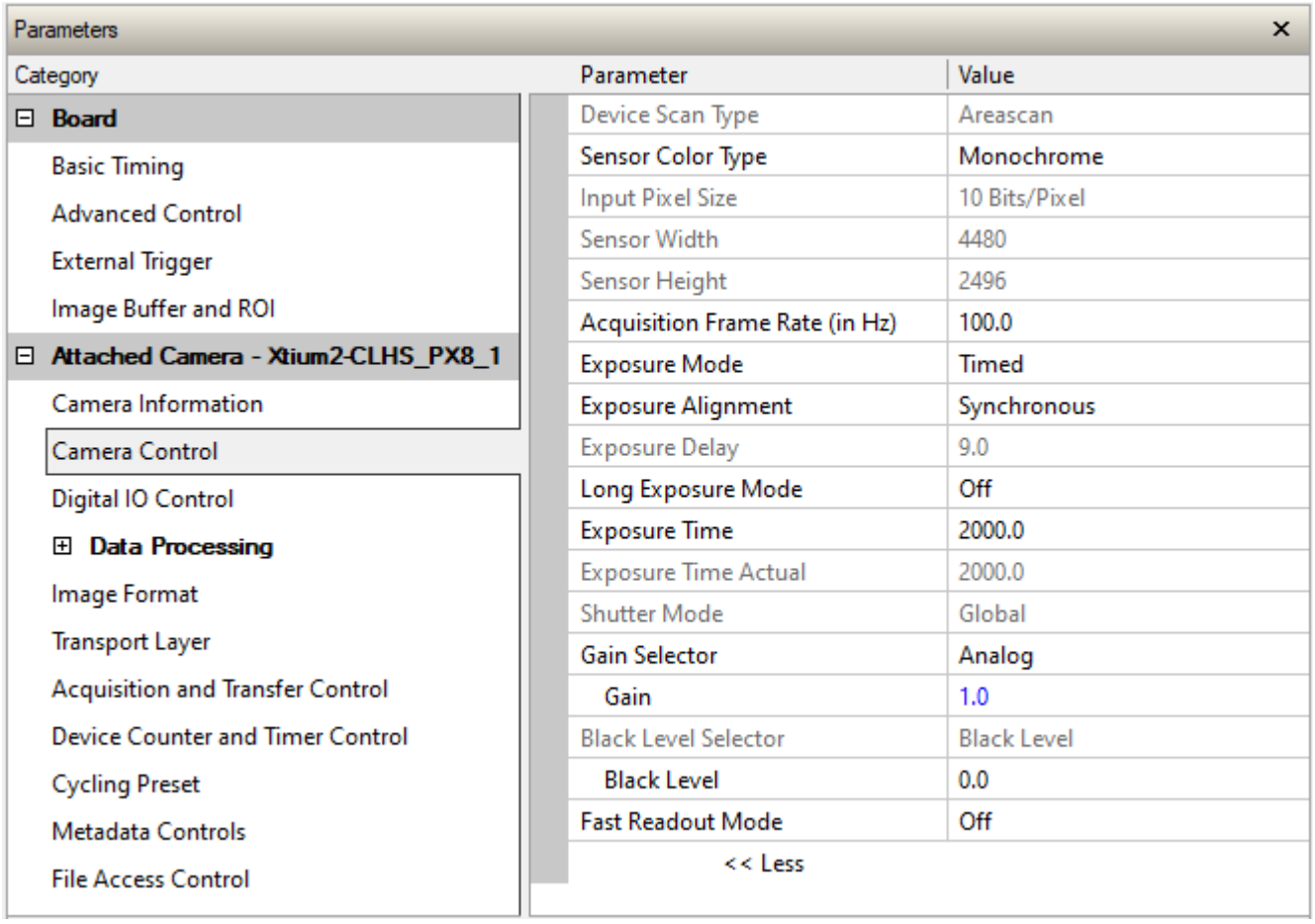
Load / Save Configuration

The **Load/Save Configuration** 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 Setting* and click **Load**.
- To save a current camera configuration, select a user set and click **Save**.
- To restore a saved configuration, select a saved user set and click **Load**.

Camera Control Category

The Falcon4-CLHS Camera Control category, as shown by CamExpert, groups sensor specific parameters, which includes controls for frame rate, exposure time, gain, etc.



Camera Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Device Scan Type *Areascan*	DeviceScanType *Areascan*	Scan type of the sensor. *2D Area-scan sensor*	1.00 Beginner
Sensor Color Type *Monochrome*	sensorColorType *Monochrome*	Sensor color type. *Monochrome.*	1.00 DFNC Beginner
Input Pixel Size *10 Bits/Pixel*	pixelSizeInput *Bpp10*	Size of the image input pixels, in bits per pixel. *Sensor output data path is 10 bits per pixel.*	1.00 DFNC Guru
Sensor Width	SensorWidth	Defines the sensor width in active pixels.	1.00 Expert

Display Name	Feature & Values	Description	Device Version & View
Sensor Height	SensorHeight	Defines the sensor height in active lines.	1.00 Expert
Acquisition Frame Rate	AcquisitionFrameRate	Specifies the camera frame rate in 0.1 fps steps.	1.00 Beginner
Exposure Mode *Timed* *Trigger Width*	ExposureMode *Timed* *TriggerWidth*	Selects the exposure control operating mode. *The length of the exposure is controlled with the "Exposure Time" feature. The exposure starts with the trigger event.* *Uses the width of the trigger signal pulse to control the exposure duration. Use the Trigger Activation feature to set the polarity of the trigger. The Trigger Width setting is applicable with Trigger Selector = Single Frame Trigger(Start). Available when using Line1 or Line2 as trigger.* ***Note**: the actual exposure time is 3 µs longer than the trigger width. That is, the pulse width is always 3 µs shorter than the required exposure time.*	1.00 Beginner
Long Exposure Mode *Off* *Active*	longExposureMode *Off* *Active*	Selects the sensor's exposure time mode. *For exposure times up to 50 000 µs.* *For exposure times above 10 000 µs.*	1.02 Beginner
Exposure Alignment *Synchronous* *Reset*	exposureAlignment *Synchronous* *Reset*	Specifies how the exposure is executed in relationship to the sensor capabilities and current frame trigger. *Exposure is synchronous to the internal timing of the sensor. The readout is concurrent to the exposure for the fastest possible frame rate. When a valid trigger is received and the ExposureTime is shorter than the readout period, the ExposureStart event is latched in the previous frame's readout. That is, the ExposureStartEvent is delayed and is initiated when the actual exposure starts such that the exposure ends and readout begins as soon as the previous readout has completed.* *Sensor timing is reset to initiate exposure when a valid trigger is received. Readout is sequential to exposure, reducing the maximum achievable frame rates. A trigger received during exposure or readout is ignored since data would be lost by performing a reset.*	1.00 DFNC Guru
Exposure Delay	exposureDelay	Specifies the delay in microseconds to apply after the FrameStart event before starting the ExposureStart event.	1.00 Guru DFNC
Exposure Time	ExposureTime	Sets the exposure time of the sensor in microseconds (µs).	1.00 Beginner
Exposure Time Actual	exposureTimeActual	Measured Exposure Time in microseconds (µs).	1.00 DFNC Guru
Shutter Mode *Global*	SensorShutterMode *Global*	Select the sensor shutter mode. *Select sensor global shutter mode.*	1.00 DFNC Guru
Gain Selector *Analog* *Digital*	GainSelector *AnalogAll* *DigitalAll*	Selects which gain and offset to control. *Analog Gain and offset applied to the sensor.* *Apply a digital gain adjustment to the entire image. This independent gain factor is applied to the image after the sensor.*	1.00 Beginner 1.02
Gain	Gain	Video signal multiplier.	1.00 Beginner

Display Name	Feature & Values	Description	Device Version & View
Black Level Selector	BlackLevelSelector	Selects which offset to control.	1.00 Beginner
Black Level	BlackLevel	A signed offset added to the output. DN_out = (DN_in + Black_Level) * Gain	1.00 Beginner
Fast Readout Mode *Off* *Active*	fastReadoutMode *Off* *Active*	Selects the sensor's readout mode. *When this mode is off, the sensor is operated in low noise mode; row timing and/or row readout are normal.* *When this mode is active, the sensor is operated in high speed mode; row timing and/or row readout are shorter.*	1.00 DFNC Guru

Long Exposure Mode, Time Exposure, Fast Readout Mode, and Gain

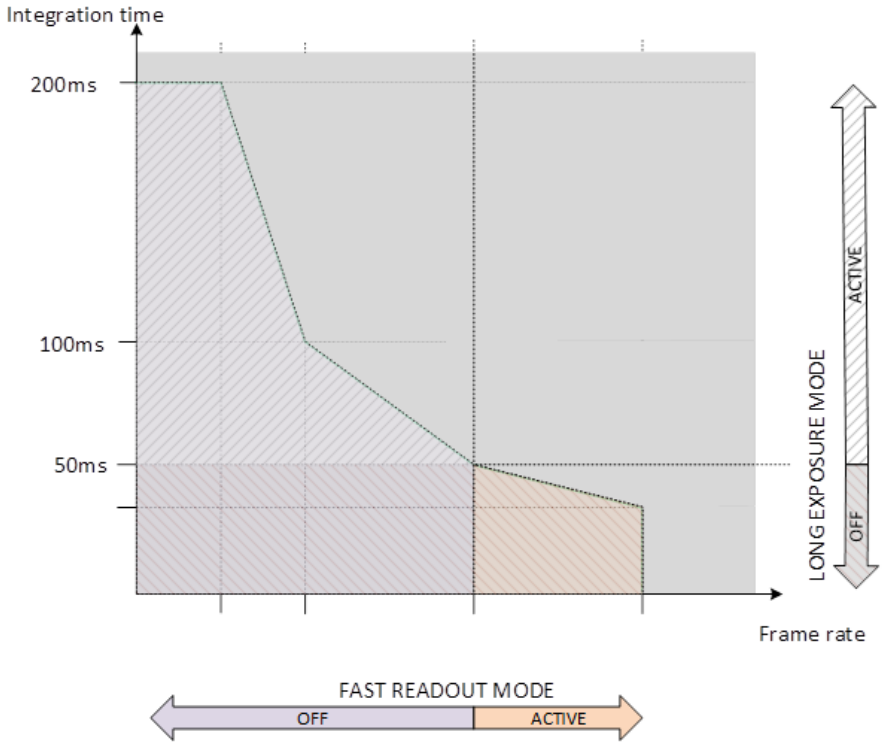
The setting of the Long Exposure Mode feature affects other feature settings, as described in the table below.

Model	Long Exposure Mode	Exposure Time Range (µs)	Analog Gain	Fast Readout Mode
All	Off	5 – 50 000	1x to 4x	Off/Active
M2240, M4400, M4480	Active	10 000 – 500 000	Minimum 1.5x	Off
M8200	Active	10 000 – 16 000 000	Minimum 1.5x	N/A*

** Fast Readout Mode is not available on the M8200.*

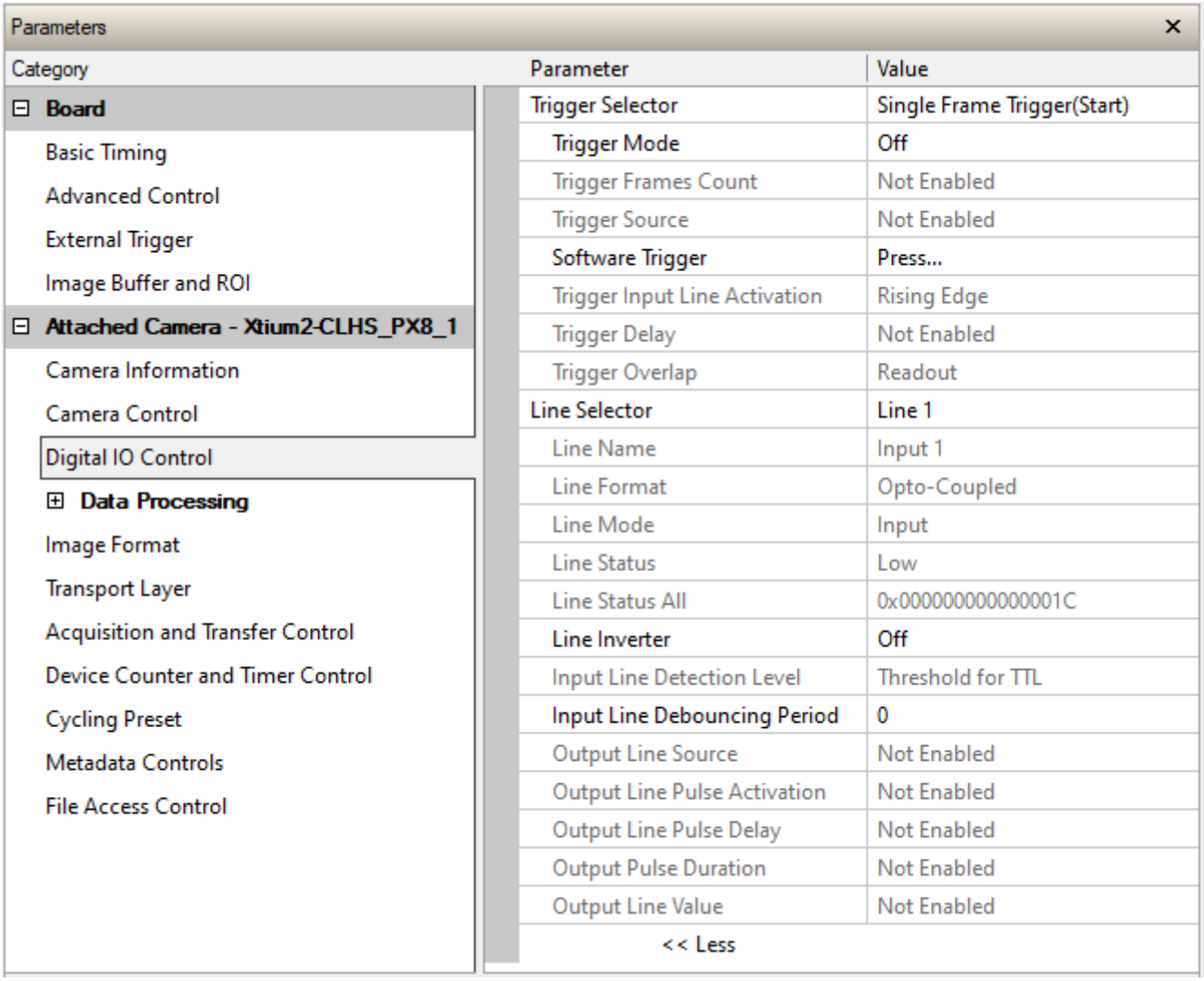
Note that Fast Readout and Long Exposure cannot be both active; setting Long Exposure Mode to *Active* will automatically set Fast Readout Mode to *Off*.

The following diagram depicts the effect of Long Exposure Mode and Fast Readout Mode on the frame rate and exposure (integration) time. (Provided as an example, does not reflect the specific exposure time range of this model.)



Digital IO Control Category

The Digital IO Control category, as shown by CamExpert, groups features used to configure acquisition inputs and outputs.



Digital IO Control Feature Descriptions

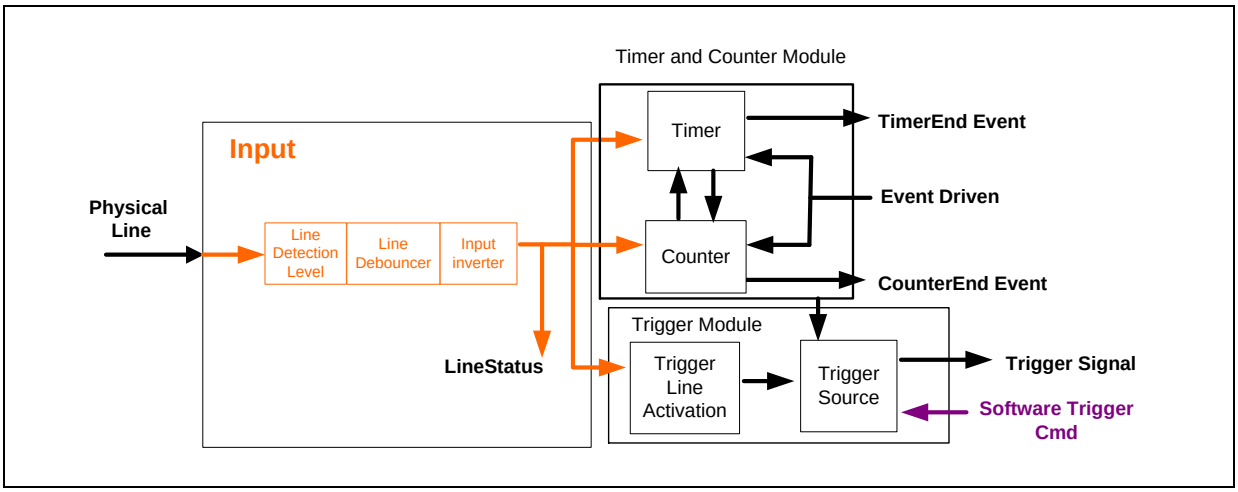
Display Name	Feature & Values	Description	Device Version & View
Trigger Selector	TriggerSelector	Selects which type of trigger to configure with the various Trigger features.	1.00 Guru
Single Frame Trigger(Start)	*FrameStart*	*Selects a trigger starting the capture of a single frame.*	
MultiFrame Trigger(Start)	*FrameBurstStart*	*Selects a trigger to capture multiple frames. The number of frames is specified by the "triggerFrameCount" feature.*	
Trigger Mode	TriggerMode	Controls whether the external trigger is active.	1.00 Beginner
Off	*Off*	*Line rate is controlled by Acquisition Frame Rate feature.*	
On	*On*	*Trigger comes from CLHS (frame grabber) or GPIO.*	

Display Name	Feature & Values	Description	Device Version & View
Trigger Frames Count	triggerFrameCount	Sets the total number of frames to acquire when a valid trigger is received. This feature is available when Trigger Selector = MultiFrame Trigger(Start).	1.00 Guru DFNC
Trigger Source	TriggerSource	Specifies the internal signal or physical input line to use as the trigger source. The selected trigger must have its TriggerMode set to ON.	1.00 Guru
Line 1	*Line1*	*Select Line 1 (and associated I/O control block) to use as the external trigger source.*	
Line 2	*Line2*	*Select Line 2 (and associated I/O control block) to use as the external trigger source.*	
CLHS In	*LinkTrigger0*	*Trigger comes from frame grabber over LinkTrigger0.*	
Timer1 End	*Timer1End*	*Select the Timer1 End event as the internal trigger source.*	
Counter1 End	*Counter1End*	*Select the Counter1 End event as the internal trigger source.*	
Software	*Software*	*The trigger command source is only generated by software using the TriggerSoftware command.*	
Software Trigger	TriggerSoftware	Generates an internal trigger. The TriggerSource feature must be set to Software.	1.00 Guru
Trigger Input Line Activation	TriggerActivation	Edge of the input signal that will trigger camera.	1.00 Guru
Rising Edge	*RisingEdge*	*Specifies that the trigger is considered valid on the rising edge of the source signal.*	
Falling Edge	*FallingEdge*	*Specifies that the trigger is considered valid on the falling edge of the source signal.*	
Any Edge	*AnyEdge*	*Specifies that the trigger is considered valid on the falling or rising edge of the source signal.*	
Trigger Delay	TriggerDelay	Specifies the delay in microseconds to apply after receiving the trigger and before activating the trigger event.	1.00 Guru
Trigger Overlap	TriggerOverlap	States if a trigger overlap is permitted with the Active Frame readout signal. This feature defines if a new valid trigger will be accepted (or latched) for a new frame.	1.00 Guru
Off	*Off*	*No trigger overlap is permitted.*	
ReadOut	*ReadOut*	*Trigger is accepted immediately after the start of the readout.*	
Line Selector	LineSelector	Selects the physical line (or pin) of the external device connector to configure.	1.00 Beginner
Line 1	*Line1*	*Selects Line 1 (input 1)*	
Line 2	*Line2*	*Selects Line 2 (input 2)*	
Line 3	*Line3*	*Selects Line 3 (output 1)*	
Line 4	*Line4*	*Selects Line 4 (output 2)*	
Line 5	*Line5*	*Selects Line 5 (output 3)*	
Line 6	*Line6*	*Selects Line 6 (output 4)*	
Line Name	lineName	Description of the physical Pin associated with the logical line.	1.00 Beginner DFNC
Input 1	*Input1*	*Associated with the logical line Input 1*	
Input 2	*Input2*	*Associated with the logical line Input 2*	
Output 1	*Output1*	*Associated with the logical line Output 1*	
Output 2	*Output2*	*Associated with the logical line Output 2*	
Output 3	*Output3*	*Associated with the logical line Output 3*	
Output 4	*Output4*	*Associated with the logical line Output 4*	
Line Format	LineFormat	Specify the current electrical format of the selected physical input or output.	1.00 Beginner
Opto-Coupled	*OptoCoupled*	*The line is opto-coupled.*	

Display Name	Feature & Values	Description	Device Version & View
Line Mode	LineMode	Reports if the physical Line is an Input or Output signal.	1.00 Beginner
Input	*Input*	*The line is an input line.*	
Output	*Output*	*The line is an output line.*	
Line Status	LineStatus	Returns the current status of the selected input line.	1.00 Expert
Low	*Low*	*Line level is low*	
High	*High*	*Line level is high*	
Line Status All	LineStatusAll	Returns the current status of all available line signals, at time of polling, in a single bitfield. The order is Line1, Line2, Line3, ...	1.01 Expert
Line Inverter	LineInverter	Controls whether to invert the polarity of the selected input or output line signal.	1.00 Beginner
Off	*Off*	*Leave signal unchanged*	
On	*On*	*Invert line signal*	
Input Line Detection Level	lineDetectionLevel	Specifies the voltage threshold required to recognize a signal transition on an input line.	1.00 Beginner DFNC
Threshold for TTL	*Threshold_for_TTL*	*A signal below 0.8V will be detected as a Logical LOW and a signal greater than 2.4V will be detected as a Logical HIGH on the selected input line.*	
Input Line Debouncing Period	lineDebouncingPeriod	Specifies the minimum delay before an input line voltage transition is recognized as a signal transition.	1.00 Beginner DFNC
Output Line Source	outputLineSource	Selects which internal signal, event driven pulse or software control state to output on the selected Line. LineMode must be Output.	1.00 Beginner DFNC
Off	*Off*	*Line output is disabled (Tri-State) or Open with Optocoupled output.*	
Software Controlled	*SoftwareControlled*	*The OutputLineValue feature changes the state of the output.*	
Pulse On: Start of Frame	*PulseOnStartofFrame*	*Generate a pulse on the start of the Frame Active event.*	
Pulse On: Start to Exposure	*PulseOnStartofExposure*	*Generate a pulse on the ExposureStart event.*	
Pulse On: End of Exposure	*PulseOnEndofExposure*	*Generate a pulse on the End of Exposure event.*	
Pulse On: Start Of Readout	*PulseOnStartOfReadout*	*Generate a pulse on the ReadoutStart event.*	
Pulse On: End Of Readout	*PulseOnEndOfReadout*	*Generate a pulse on the ReadoutEnd event.*	
Pulse On: Valid Frame Trigger	*PulseOnValidFrameTrigger*	*Generate a pulse on the FrameTrigger event.*	
Pulse On: Invalid Frame Trigger	*PulseOnInvalidFrameTrigger*	*Generate a pulse on the Invalid Frame(s)Trigger event.*	
Pulse On: End of Timer1	*PulseOnEndofTimer1*	*Generate a pulse on the end of timer1.*	
Pulse On: End of Counter1	*PulseOnEndofCounter1*	*Generate a pulse on the end of counter1.*	
Pulse On: Input1	*PulseOnInput1*	*Generate a pulse on the Input Signal 1 event.*	
Pulse On: Input2	*PulseOnInput2*	*Generate a pulse on the Input Signal 2 event.*	
Pulse On: Link CLHS In	*PulseOnLinkTrigger0*	*Generate a pulse on LinkTrigger0 signal.*	
Exposure Active	*ExposureActive*	*Generate the Exposure Active state on specific output.*	
Output Line Pulse Activation	outputLinePulseActivation	Specifies the input line activation mode to trigger the OutputLine pulse.	1.00 Beginner DFNC
Rising Edge	*RisingEdge*	*Specifies that the trigger is considered valid on the rising edge of the source signal.*	
Falling Edge	*FallingEdge*	*Specifies that the trigger is considered valid on the falling edge of the source signal.*	
Any Edge	*AnyEdge*	*Specifies that the trigger is considered valid on the falling or rising edge of the source signal.*	
Output Line Pulse Delay	outputLinePulseDelay	Sets the delay (µs) before the output line pulse duration signal.	1.00 DFNC Beginner

Display Name	Feature & Values	Description	Device Version & View
Output Pulse Duration	outputLinePulseDuration	Sets the width (duration) of the output line pulse in microseconds (µs).	1.00 DFNC Beginner
Output Line Value *Low* *High*	outputLineValue *Low* *High*	Set the GPIO out value when outputLineSource is SoftwareControlled. *Output line is low* *Output line is high*	1.00 DFNC Expert

I/O Module Block Diagram



Trigger Mode Details

Falcon4-CLHS image exposures are initiated by an event. The trigger event is either the camera's programmable internal clock used in free running mode, an external input to the controlling frame grabber used for synchronizing exposures to external triggers, or a programmed function call message by the controlling computer. These triggering modes are described below.

- **Free running (Trigger Mode = Off)**: The free-running mode has programmable internal timers for frame rate and exposure period. Frame rate minimums, maximums and increments supported are sensor specific. Maximum frame rates are dependent on the required exposure.
- **Trigger Source (Trigger Mode = On)**: Exposures are controlled by an external trigger signal where the specific input line is selected by the **Trigger Source** feature.

Trigger Source Types (Trigger Mode = On)

- **Trigger Source = Line1**: The frame grabber initiates the exposure via the external line 1.
- **Trigger Source = Line2**: The frame grabber initiates the exposure via the external line 2.
- **Trigger Source = CLHS In**: The external trigger comes from frame grabber over LinkTrigger0.
- **Trigger Source = Timer1End Event**: The Timer1 End Event is used as the internal trigger source. Refer to Counter and Timer Controls for information on those features.
- **Trigger Source = Counter1End Event**: The Counter1 End Event is used as the internal trigger source.
- **Trigger Source = Software**: An exposure trigger is sent as a software command. Software triggers cannot be considered time accurate due to computer latency and sequential command jitter. But a software trigger is more responsive than calling a single-frame acquisition since the latter must validate the acquisition parameters and modify on-board buffer allocation if the buffer size has changed since the last acquisition.

Trigger Overlap: Feature Details

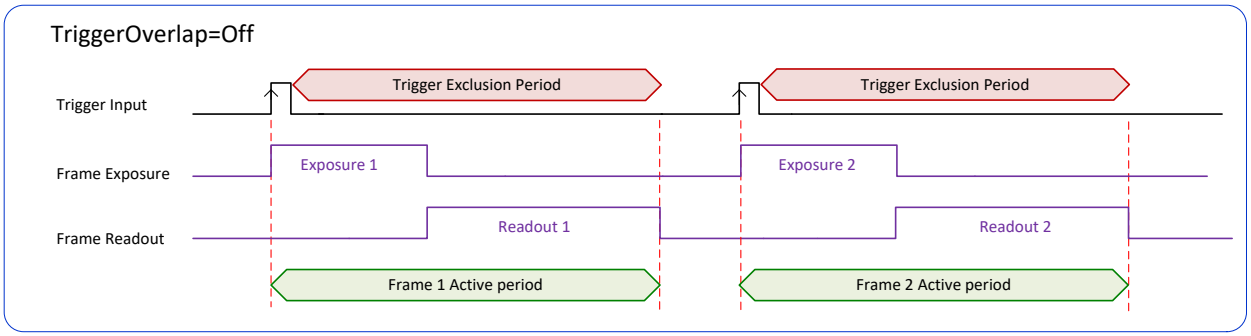
The Trigger Overlap feature defines how the Falcon4-CLHS handles triggers that might occur more frequently than the Frame Active period (an exposure plus readout period). If TriggerOverlap = *Off*, then triggers received before the end of the Frame Active period are ignored. Other TriggerOverlap values are dependent on the camera model and sensor used.

TriggerOverlap = Off

No trigger overlap is permitted.

Diagram Conditions:

- TriggerMode = On
- ExposureMode = Timed
- TriggerActivation = RisingEdge
- TriggerDelay = 0
- TriggerSelector = FrameStart
- ExposureAlignment = Reset



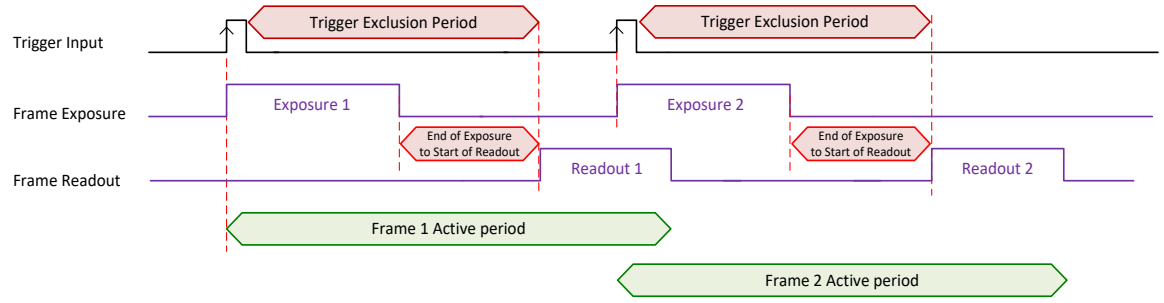
TriggerOverlap = ReadOut

Trigger is accepted at the beginning of the frame Readout. The “End of Exposure to Start of Readout” time is sensor dependent.

Diagram Conditions:

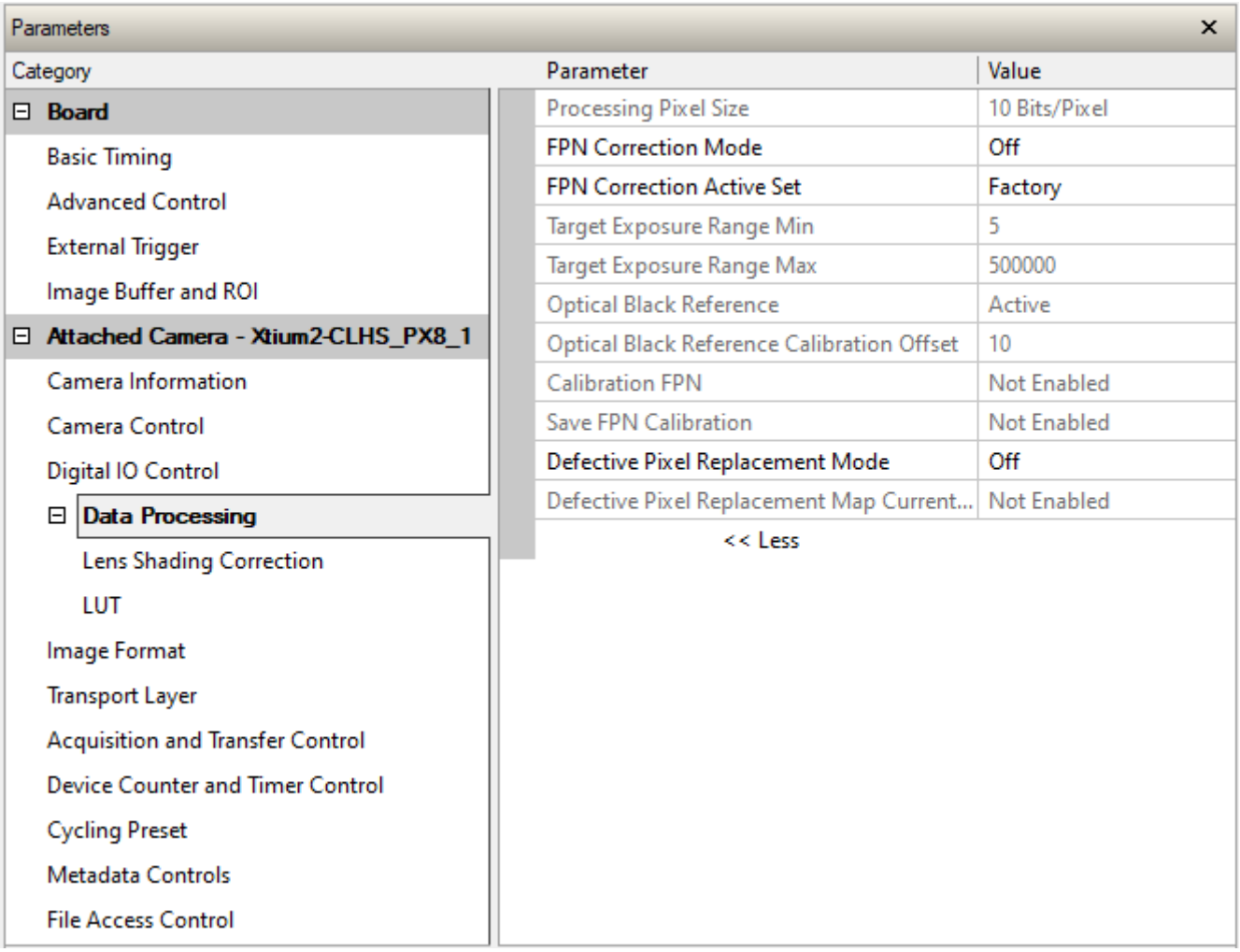
- TriggerMode = On
- ExposureMode = Timed
- TriggerActivation = RisingEdge
- TriggerDelay = 0
- TriggerSelector = FrameStart
- ExposureAlignment = Synchronous

TriggerOverlap=Readout



Data Processing Category

The Data Processing category, as shown by CamExpert, groups features used to configure fixed pattern noise (FPN) correction; it also includes the Lens Shading Correction subcategory.



Data Processing Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Processing Pixel Size *10 Bits/Pixel*	processingPathBpp *Bpp10*	Pixel size in bits per pixel during processing. *Sensor output data path is 10 bits per pixel.*	1.00 Guru DFNC
FPN Correction Mode *Off* *Active* *Calibration*	FPNCorrectionMode *Off* *Active* *Calibration*	Sets the mode for the FPN correction. *Optical Black Reference FPN correction applied if available in the current active set.* *FPN is enabled. If Optical Black Reference FPN correction is available in the current active set it is also applied.* *When selected, the camera is configured for FPN correction calibration.*	1.00 Expert DFNC

Display Name	Feature & Values	Description	Device Version & View
FPN Correction Active Set	FPNCorrectionActiveSet	Specifies the current set of FPN coefficients to use. This feature cannot be changed during acquisition.	1.00 Expert DFNC
Factory	*FPNFactory*	*Sets the factory FPN coefficient table as the current FPN set.*	
User Set 1	*FPNUser1*	*Sets User Set 1 coefficient table as the current FPN set.*	
User Set 2	*FPNUser2*	*Sets User Set 2 coefficient table as the current FPN set.*	
Target Exposure Range Min	FPNCalibrationTargetExposureMin	Sets the minimum exposure time, in µs, for FPN calibration.	1.00 Guru DFNC
Target Exposure Range Max	FPNCalibrationTargetExposureMax	Sets the maximum exposure time, in µs, for FPN calibration.	1.00 Guru DFNC
Optical Black Reference	FPNCalibrationOpticalBlackReference	Sets the enable state of dark current correction using values generated on a row-by-row basis using shielded pixels.	1.00 Guru DFNC
Off	*Off*	*Row-by-row dark current correction is disabled. When the FPN Correction Mode is set to active only ADC related correction is applied.*	
Active	*Active*	*Row-by-row dark current correction coefficients are generated during calibration and included in the FPN correction for the selected user set.*	
Optical Black Reference Calibration Offset	FPNCalibrationOpticalBlackReferenceOffset	Sets the offset to apply to the optical black reference correction to ensure that values are above 0.	1.00 Guru DFNC
Calibration FPN	FPNCalibrationCalibrate	Performs Fixed Pattern Noise (FPN) calibration by reducing to zero dark pixel current using a pixel offset.	1.00 Guru DFNC
Save FPN Calibration	FPNCalibrationSave	Save the calibration performed by FPNCalibrationCalibrate to the active set.	1.00 Guru DFNC
Defective Pixel Replacement Mode	defectivePixelReplacementMode	Sets the enable state for defective pixel replacement.	1.01 Expert DFNC
Off	*Off*	Disable defective pixel replacement.	
Active	*Active*	Enable defective pixel replacement.	
Defective Pixel Replacement Map Current Active Set	defectivePixelReplacementMapCurrentActiveSet	Sets the defective pixel replacement map set to use.	1.01 Expert DFNC
Factory Map	*FactoryMap*	*Factory default defective pixel replacement map.*	
User Set 1	*UserMap1*	*User defective pixel replacement map.*	

FPN Correction

The fixed pattern noise (FPN) correction compensates for dark current noise unique to each camera sensor.

The Falcon4 uses 2 stages of FPN correction:

- Row-by-row dark current correction, using values generated with shielded reference pixels (Optical Black Reference and Optical Black Reference Calibration Offset features).
- ADC noise correction.

Both stages can be enabled and disabled independently. The FPN Correction Mode and Optical Black Reference features determine the type of FPN correction applied. When the Optical Black Reference feature is set to *Active* during calibration, the correction coefficients are generated and always applied.

Optical Black Reference (during calibration)	FPN Correction Mode	Result
Active	Off	Optical Black Reference correction applied. (ADC correction disabled).
	Active	Optical Black Reference and ADC correction applied.
Off	Off	No correction applied.
	Active	ADC correction applied.

FPN calibration is always performed using 10-bits (regardless of the Pixel Format setting).

With CMOS sensors, it is important to perform FPN calibration under the same operating conditions the camera will be used, otherwise sensor variations (over temperature and exposure) will make the FPN calibration invalid.

Falcon4 cameras has two FPN user memory spaces to store calibration data, allowing users to store FPN data for different optimized exposure setups. A user set can store coefficients for specific gain settings (gain = 1, 1.5, 2.0, 2.5, 3.0, 3.5 and 4); a calibration must be performed with each gain setting and saved to the same user set (gain settings which are not user calibrated use the factory default).

Performing an FPN Calibration via Sapera CamExpert

The Sapera LT CamExpert tool provides an easy GUI-based method for a user to perform an FPN Calibration. For FPN calibration the camera must acquire a suitable dark image.

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

Important: Before calibration, the Falcon4 should be powered on long enough to achieve its nominal temperature (a minimum of 30 minutes). A low ambient temperature may increase the time required for the camera to reach a stable internal temperature.

Important: During calibration, no other Falcon4 features should be accessed or modified.

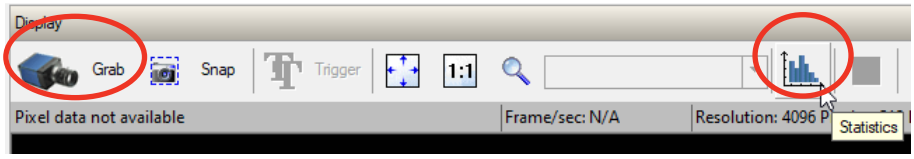
Calibration via CamExpert or via a User Application: Exposure and frame rates used during a Flat Field Calibration should be similar to the exposure settings used in the camera application.

To perform FPN Calibration

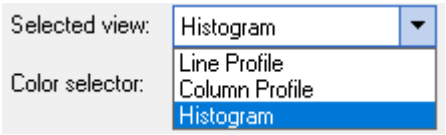
Step 1. Cover the lens (place the sensor in dark).

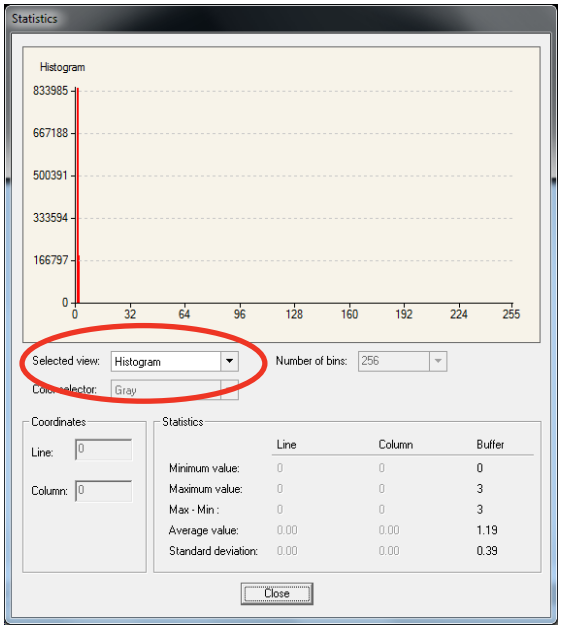
Step 2. Set the FPN Correction Mode to *Off* and check the histogram.

Using CamExpert, click **Grab** and then **Statistics**.



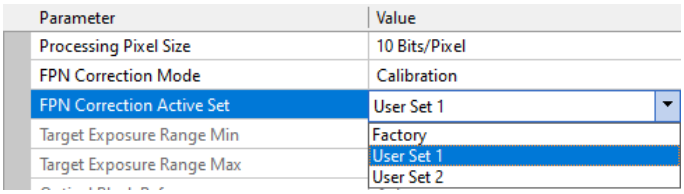
In the Statistics dialog, use the **Selected view** list to select *Histogram*.





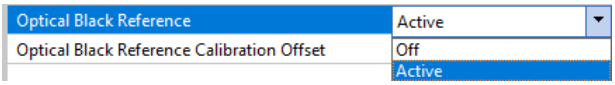
Pixel values should all be above zero. Note that the Black Level setting is not applied during calibration.

Step 3. Set the FPN Correction Mode to *Calibration* and select the required user set from FPN Correction Active Set list.

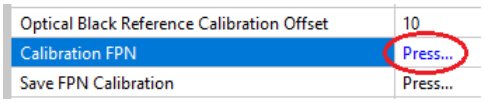


Step 4. Set the Target Exposure Range Min and Target Exposure Range Max to values that correspond to the exposure range required for the camera's expected operating conditions.

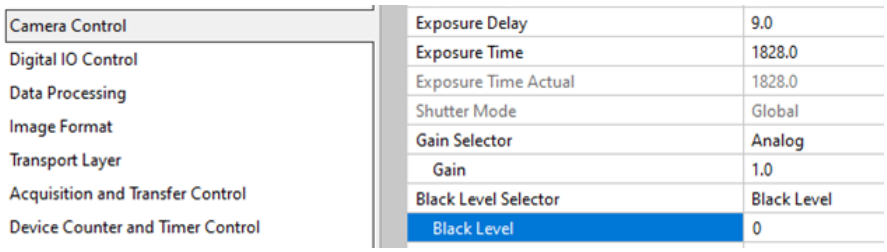
Step 5. If Optical Black Reference correction is required, set the feature to *Active*.



Step 6. Next to Calibration FPN, click **Press** to perform the calibration.



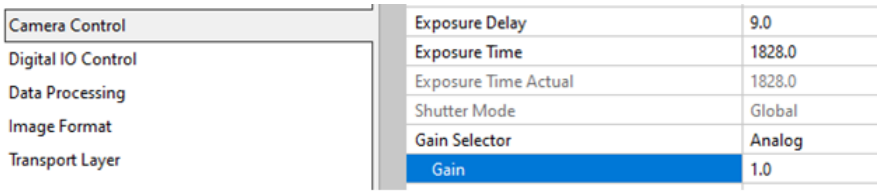
Step 7. If required, verify the Optical Black Reference Calibration Offset setting; set the FPN Correction Mode to *Off* and Black Level to *0*.



Grab an image and use a histogram to verify that pixel values are above zero; if necessary, adjust the Optical Black Reference Calibration Offset. Higher offset values may be required when the camera is operating at very high temperature and frame rates. Set the FPN Correction Mode back to *Calibration* and use the Calibration FPN command to recalculate the calibration and adjust the offset until the result is satisfactory.

Step 8. If the calibration is satisfactory, in the Save FPN Calibration feature click **Press** to save the calibration to the selected user set.

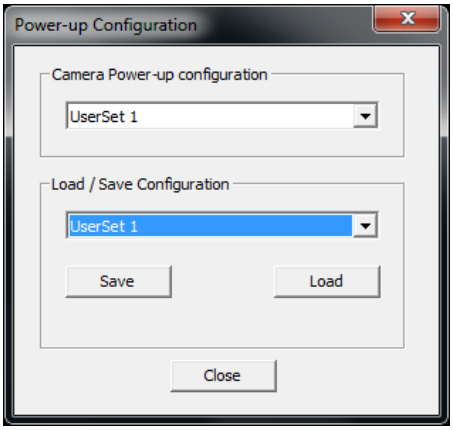
For each gain setting required perform and save the calibration; coefficients for each gain setting are saved in the user set (gain settings for which no calibration is done use default coefficients).



Step 9. To load this user set when resetting or powering on the camera, select the Camera Information category, and next to the Power-up Configuration feature, click **Setting**.

In the *Power-up Configuration* dialog box, select the required user set in both *Camera Power-up configuration* and *Load / Save configuration* lists, then select **Save**.

This ensures that the camera loads the saved parameters the next time the camera is turned on.



The FPN Correction coefficient file is a standard 16-bit TIFF file for both 8-bit and 10-bit acquisition modes.

Defective Pixel Replacement

The Pixel Replacement algorithm is based on a predefined bad pixel map (as an XML file), either supplied by the factory (file loaded as *Factory Map*) or generated by the user (file uploaded as User Map 1).

Note: Identifying bad pixels is left to the user's discretion, but Teledyne DALSA technical support can provide guidance.

The following XML code sample forms the template for the user to build bad pixel maps for any of their Falcon4 cameras.

Example User Defective Pixel Map XML File

The following example shows the required components of the defective pixel map file. Each bad pixel position (relative to the image origin which is the upper left corner), must be identified by the XML statement:

<DefectivePixel OffsetX="***number***" OffsetY="***number***"/>

Note: Pixels must be sorted in the XML file by ascending row (OffsetY); within each row, pixels must also be sorted in ascending order horizontally (OffsetX). That is, the order is from top-left of the image to the bottom-right.

The pixel format (whether 8-bit or 10-bit) is handled transparently, thus requires no special consideration by the user.

This example XML listing has four "bad" pixels identified (maximum number of entries is model dependent). The algorithm descriptions that follow defines the rules used by the Falcon4 firmware to replace an identified bad pixel.

```
<?xml version="1.0" encoding="utf-8"?>

<!--Example User Defective Pixel Map-->
<!--maximum 1022 coordinates-->
<!--filename: Falcon4ExampleBadPixels.xml-->

<Coordinates>

  <DefectivePixel OffsetX="100" OffsetY="0"/>
  <DefectivePixel OffsetX="468" OffsetY="50"/>
  <DefectivePixel OffsetX="223" OffsetY="600"/>
  <DefectivePixel OffsetX="800" OffsetY="600"/>


</Coordinates>
```

Note: The Falcon4 automatically adjusts the defective pixel map if binning is enabled by combining adjacent row defects. Pixel replacement occurs in the processing chain before horizontal binning.

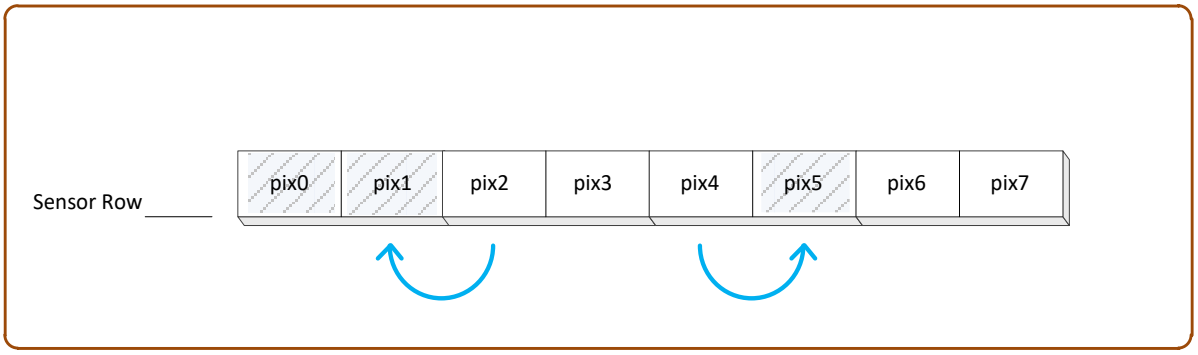
The user defective pixel map can be downloaded or uploaded to the camera using the features available in the File Access Control category. The factory map can also be downloaded.

Monochrome Defective Pixel Replacement Algorithm Description

The replacement algorithm follows a few basic rules as defined below, which in general provides satisfactory results.

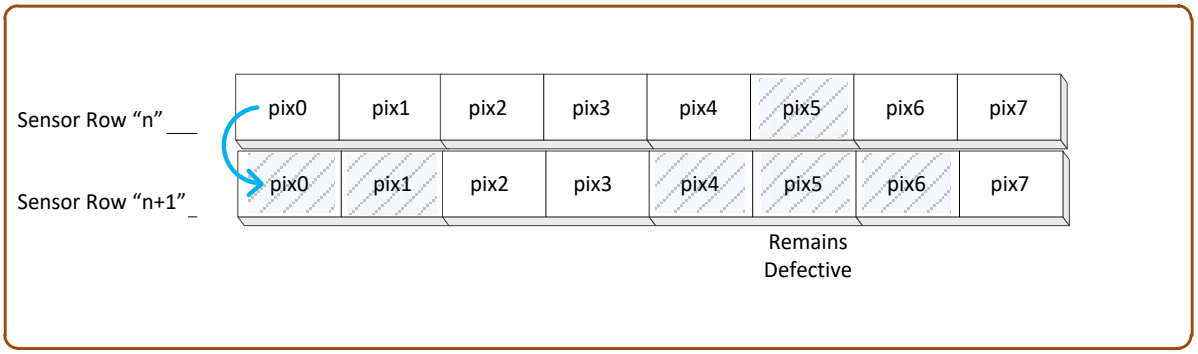
Single bad pixel in a sensor line with a good adjacent pixel

- A defective pixel is replaced by the following good pixel if previous pixel is bad or not existent.
- Or a defective pixel is replaced by the previous good pixel.



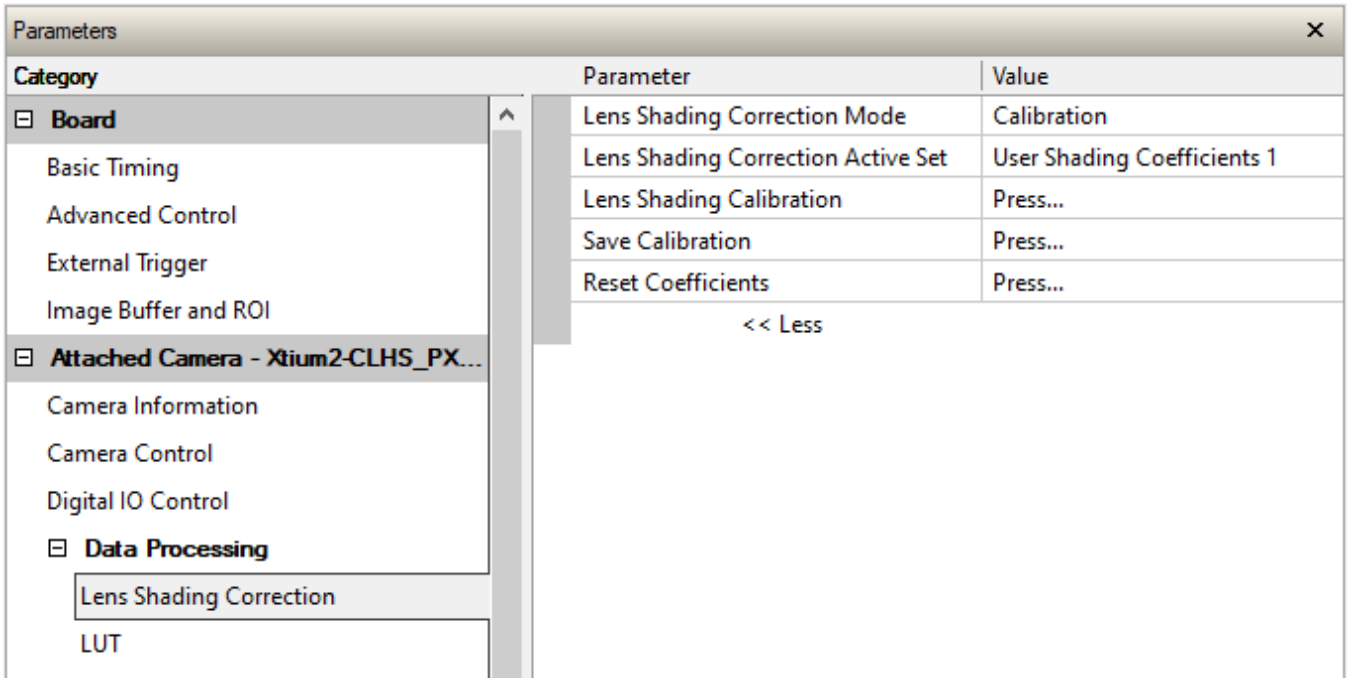
Bad pixel in a sensor line with bad adjacent pixels

- Replace bad pixel with the corresponding pixel of the previous line.
- Do nothing when the neighboring pixels are also bad.



Lens Shading Correction Category

The Falcon4 Lens Shading Correction controls, as shown by CamExpert, has parameters to configure the lens shading correction features.



Lens Shading Correction Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Lens Shading Correction Mode *Off* *Active* *Calibration*	lensShadingCorrectionMode *Off* *Active* *Calibration*	Sets the mode for the lens shading correction. *Lens Shading Correction is Disabled* *Lens Shading Correction is Enabled* *When selected, the camera is configured for Lens Shading correction calibration. Some processing will be disabled even if the associated feature is enabled.*	1.01 Expert DFNC
Lens Shading Correction Active Set *User Shading Coefficients 1*	lensShadingCorrectionCurrentActiveSet *ShadingCoefficients1*	Specifies the current set of Lens Shading Coefficients to use. *Sets User Shading Coefficients set 1 as current.*	1.01 Expert DFNC
Lens Shading Calibration	lensShadingCorrectionCalibrationBright	Perform a bright calibration for lens shading correction. This calibration requires a bright featureless acquisition that is not saturated. (70% illumination is recommended).	1.01 Expert DFNC
Save Calibration	lensShadingCorrectionCalibrationSave	Save the calibration results of the lensShadingCorrectionCalibrationBright operations to the active set.	1.01 Expert DFNC
Reset Coefficients	lensShadingResetCoefficients	Reset lens shading coefficients to pass-through.	1.01 Expert DFNC

Lens Shading Calibration

It is recommended that a Lens Shading Calibration procedure be done for any Falcon4/lens combination. Lens Shading Calibration eliminates any lens vignetting in the image corners or any other shading differences across the image field. It will allow using a lens with a slightly smaller image circle that does not quite evenly expose the whole sensor. For more information refer to the Choosing a Lens with the Correct Image Circle section.

CamExpert allows quick calibration by the user:

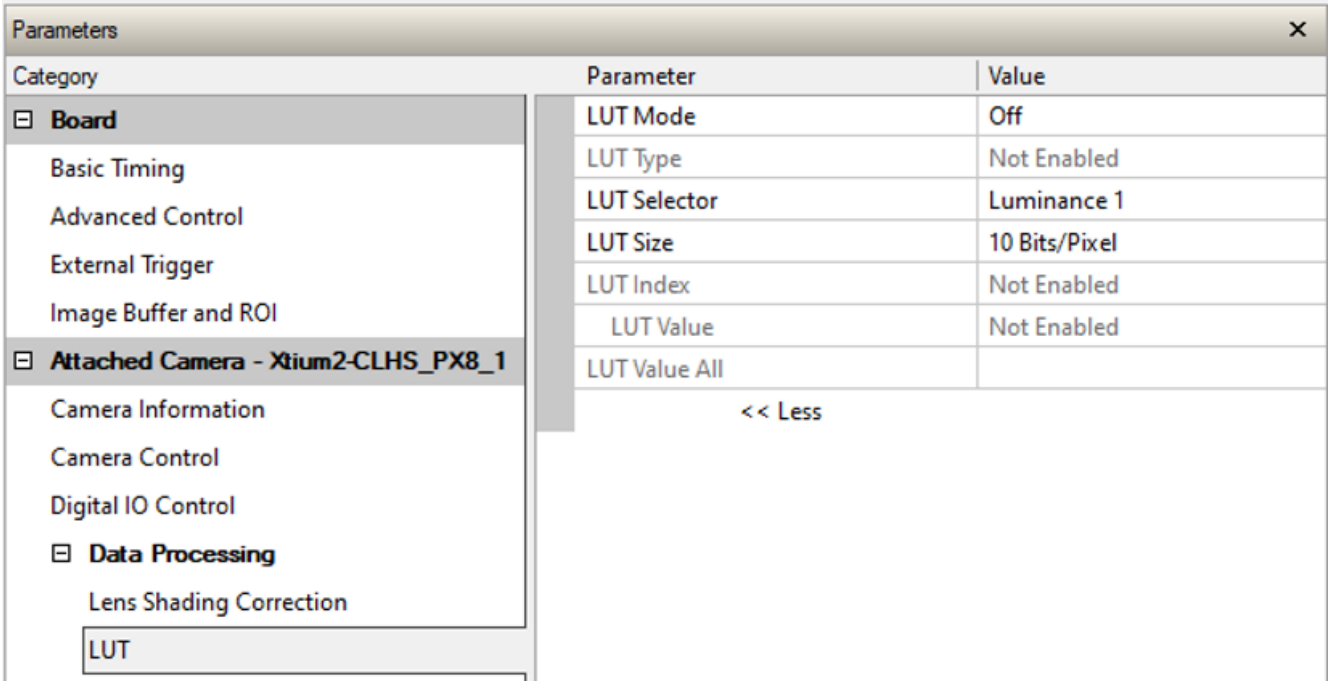
1. Set the Lens Shading Correction Mode to *Calibration*.
2. With a bright featureless acquisition that is not saturated (70% illumination is recommended), in the Lens Shading Correction feature field click **Press…** to execute the calibration.
3. After calibration, if satisfactory, the data should be saved to the user set; in the Save Calibration feature field click **Press…** to save the coefficients to the user set.

The features for the Lens Shading Correction category can also be accessed by the user designed application.

The lens shading correction user set can be downloaded or uploaded to the camera using the features available in the File Access Control category.

LUT Category

The LUT category, as shown by CamExpert, groups parameters used to configure lookup tables LUT on monochrome cameras.



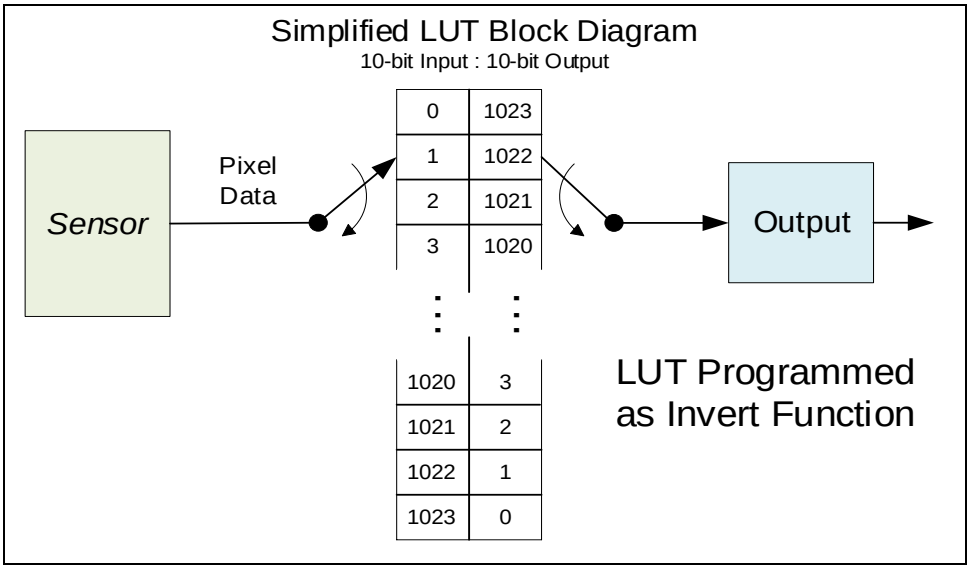
LUT Feature Description

Display Name	Feature & Values	Description	Device Version & View
LUT Mode *Off* *Active*	lutMode *Off* *Active*	Sets the enable state of the LUT module (Lookup Table). *Disables the LUT.* *Enables the LUT module.*	1.02 Expert DFNC
LUT Type *User Defined*	lutType *UserDefined*	Displays the LUT type of the currently selected Lookup Table. *Uses the user programmable LUT.*	1.02 Expert DFNC
LUT Selector *Luminance 1*	LUTSelector *Luminance1*	Selects which LUT to control and adjust features. *Luminance 1 is under control.*	1.02 Guru DFNC
LUT Size *10 Bits/Pixel*	lutSize *Bpp10*	Specify the LUT size of the selected LUT (Lookup Table). *10 bits per pixel.*	1.02 Gugu DFNC
LUT Index	LUTIndex	Select the LUT index.	1.02 Guru DFNC
LUT Value	LUTValue	Returns the value at specified LUT index entry of the LUT selected by the LUT Selector feature.	1.02 Guru DFNC
LUT Value All	LUTValueAll	Accesses all the LUT coefficients in a single access without using individual LUT indices.	1.02 Guru

Lookup Table (LUT) Overview

The Falcon4-CLHS cameras include a user programmable LUT (lookup table) as a component of its embedded processing features. A LUT is used for operations such as gamma adjustments, invert function and threshold processes.

The camera LUT tables depend on the sensor (see feature LUT Size) and is illustrated in the following figure. Pixel data from the sensor is passed through the LUT memory array, where the new programmed pixel value is then passed to the camera output circuit. The LUT data table is stored along with other parameters with the user configuration function.



Simplified Example 10-bit to 10-bit LUT Block Diagram

LUT Size vs. Pixel Format

The LUT size will correspond to the camera's sensor pixel size; for the current Falcon4-CLHS standard firmware, this is 10 bits per pixel, i.e., 1024. All camera processing is performed at the 10-bit sensor pixel format of the camera, while the end user chooses the pixel format (8-bit or 10-bit format) to output.

The default neutral LUT programming is as follows:

- With **Pixel Format = Mono 10**, the default LUT data value is equal to the LUT value for each index. This is a linear LUT that does not modify the sensor data.
- With **Pixel Format = Mono 8**, the LUT remains to be a 10 bit in 10 bit out. The conversion to 8 bit occurs after the LUT.

LUT data is selected as a user file uploaded using the File Access controls. Refer to the Sapera documentation for information about the SapLut Class. Note that a SapLut file can be uploaded but cannot be read back.

Image Format Control Category

The Image Format controls, as shown by CamExpert, groups parameters used to configure camera pixel format, image cropping, etc.

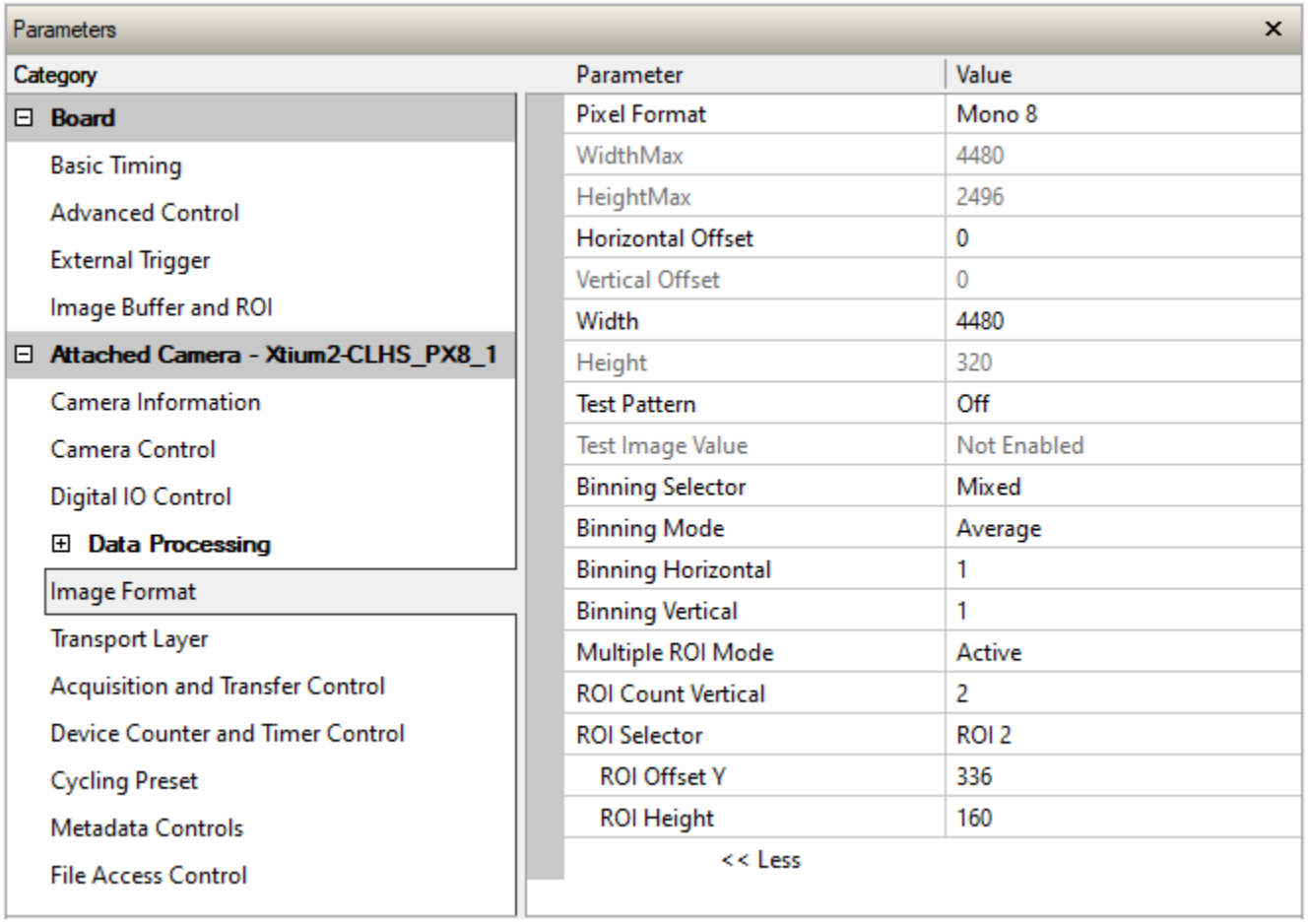


Image Format Control Feature Description

Display Name	Feature & Values	Description	Device Version & View
Pixel Format *Mono 8* *Mono 10*	PixelFormat *Mono8* *Mono10*	Pixel Format. *Pixel Format Mono8* *Pixel Format Mono10*	1.00 Beginner
Width Max	WidthMax	The maximum image width is the dimension calculated after any other function changing the horizontal dimension of the image.	1.00 Beginner
Height Max	HeightMax	The maximum image height is the dimension calculated after any other function changing the vertical dimension of the image.	1.00 Beginner
Horizontal Offset	OffsetX	Output image horizontal offset from the origin (always zero). To set, stop acquisition.	1.00 Beginner
Vertical Offset	OffsetY	Output image vertical offset from the origin (always zero).To set, stop acquisition.	1.00 Beginner
Width	Width	Horizontal width in output pixels for the selected CLHS port.	1.00 Beginner

Display Name	Feature & Values	Description	Device Version & View
Height	Height	Height of the image provided by the device (in pixels). To set, stop acquisition.	1.00 Beginner
Test Pattern	TestImageSelector	Select an internal Test Pattern.	1.00 Beginner
Off	*Off*	*Image is from the camera sensor.*	
Grey Horizontal Ramp	*GreyHorizontalRamp*	*Image is filled horizontally with an image that goes from the darkest possible value to the brightest.*	
Grey Vertical Ramp	*GreyVerticalRamp*	*Image is filled vertically with an image that goes from the darkest possible value to the brightest.*	
Grey Diagonal Ramp	*GreyDiagonalRamp*	*Image is filled diagonally with an image that goes from the darkest possible value to the brightest.*	
Constant	*Constant*	*Image is filled completely with the pixel value set by the TestImageValue feature.*	
Test Image Value	TestImageValue	The value for Constant test pattern.	1.00 Beginner
Binning Selector	binningSelector	Selects where the Horizontal and Vertical Binning is performed.	1.01 Beginner DFNC
Mixed	*Mixed*	*Vertical binning is done inside the Sensor itself; horizontal binning is done inside the device but with a digital processing function.*	
Binning Mode	binningMode	Determines how resulting pixel values are calculated.	1.01 Beginner DFNC
Average	*Average*	*The responses from the individual pixels are averaged, resulting in increased signal to noise ratio.*	
Binning Horizontal	BinningHorizontal	Number of horizontal photo-sensitive cells to combine together. This reduces the horizontal resolution of the image. Note, if horizontal binning is applied, vertically binning is also automatically applied.	1.01 Expert
Binning Vertical	BinningVertical	Number of vertical photo-sensitive cells to combine together. This reduces the vertical resolution of the image. Note, if vertical binning is applied, horizontal binning is also automatically applied.	1.01 Expert
Multiple ROI Mode	multipleROIMode	Enable the Multiple ROI (Region of Interest) per image feature. The ROI Count is set by the Multiple ROI Count Vertical feature.	1.02 Expert DFNC
Off	*Off*	*Single ROI per image.*	
Active	*Active*	*The ROI per image feature is active.*	
ROI Count Vertical	multipleROICountVertical	Specifies the number of possible ROI (Region of Interest) available in an acquired image. Two is minimum, while the maximum is device specific.	1.02 Expert DFNC
ROI Selector	multipleROISelector	Select an ROI (Region of Interest) when Multiple ROI Mode is enabled. Selector range is from 1 to the ROI Count Vertical value.	1.02 Expert DFNC
ROI 1	*roi1_1*		
ROI 2	*roi1_2*		
…	*...*		
ROI 32	*roi1_32*		
ROI Offset Y	multipleROIOffsetY	Vertical offset (in pixels) from the origin to the selected ROI (Region of Interest).	1.02 Expert DFNC
ROI Height	multipleROIHeight	Height of the selected ROI (Region of Interest) provided by the device (in pixels).	1.02 Expert DFNC

Width and Height Features for Partial Scan Control

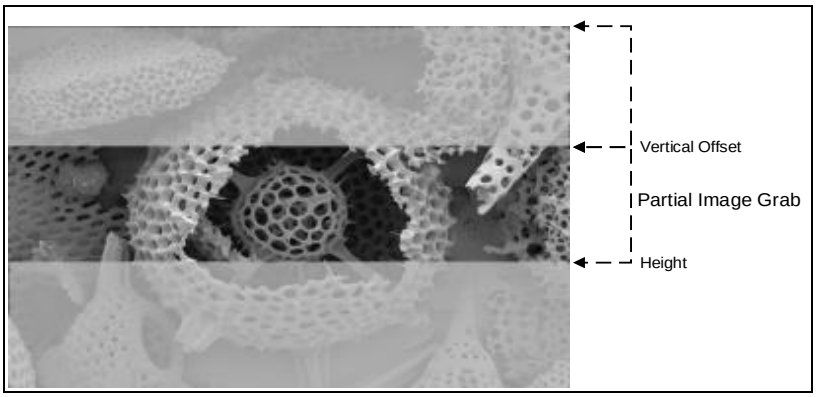
Width and Height controls along with their respective offsets, allow the Falcon4-CLHS to grab a region of interest (ROI) within the full image frame. Besides eliminating post acquisition image cropping done by software in the host computer, a windowed ROI grab reduces the bandwidth required since fewer pixels are transmitted.

Any reduction of the camera's acquisition area from its maximum must be matched by the same reduction in the frame grabber's buffer dimensions. The Teledyne DALSA CLHS frame grabber will generate "Buffer Incomplete" errors when the buffer dimensions do not match the cropped acquisition.

Vertical Cropping (Partial Scan)

The Height and Vertical Offset features, used for vertical cropping, reduce the number of video lines grabbed for a frame. By not scanning the full height of the sensor, the maximum possible acquisition frame rate is proportionately increased, up to the model maximum.

The following figure is an example of a partial scan acquisition using both Height and Vertical Offset controls. The Vertical Offset feature defines at what line number from the sensor origin to acquire the image. The Height feature defines the number of lines to acquire (to a maximum of the remaining frame height). Note that only the partial scan image (ROI) is transmitted to the host computer.



Partial Scan Illustration

Maximum Frame Rate Examples

Example frame rates for M2240, M4400 and M4480 models

Conditions:

- 8-bit
- Minimum Exposure Time: 5 µs
- Fast Readout Mode: Active (not available in M2240 and M4400 models)
- Exposure Alignment: Synchronous

Vertical Lines Acquired	M2240	M4400	M4480*
2496	NA	335	600
1248	1 206	664	1 187
624	2 358	1 303	2 325
312	4 524	2 512	4 465
160	8 196	4 587	8 064
80	14 285	8 130	14 084
40	22 727	13 157	22 222
24	29 411	17 543	29 411
16	35 714	20 833	34 482
8	43 478	26 315	41 666

*frame rate will be lower if camera is set to cycle exposure time

Example frame rates for M8200 model

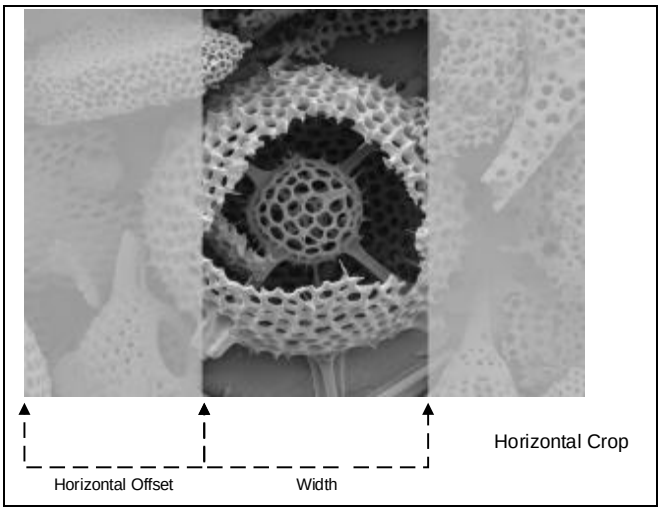
Conditions:

- 8-bit
- Minimum Exposure Time: 8 µs
- Exposure Alignment: Synchronous.
- ROI centered on the imaging area of the sensor

Vertical Lines Acquired	M8200
8192	91
6144	121
4096	181
1024	711
512	1 386
256	2 637
128	4 805
40	11 053
16	17 127
8	20 967
4	23 615

Horizontal Cropping (Partial Scan)

The Width and Horizontal Offset parameters are used to crop the acquisition horizontally by grabbing fewer pixels on each horizontal line. Horizontal offset (OffsetX) defines the start of the acquired video line while horizontal width (Width) defines the number of pixels per line.



Multiple ROIs

The Falcon4-CLHS allows for multiple regions of interest to be acquired.

You can define up to 32 regions of interest in the ROI Count Vertical feature. ROIs are defined as a number of lines to grab. The ROIs retain the full width of the sensor, unless you specify a Width and a Horizontal Offset, in which case they apply to all ROIs.

To define multiple ROIs:

- Set Multiple ROI Mode to *Active*.
- Specify the number of regions in ROI Count Vertical.
- Select an ROI in the ROI Selector, and specify the line number from the sensor origin (ROI Offset Y) and the number of lines to grab (ROI Height).
- Repeat for each ROI.
- In the Image Buffer and ROI category in the Board, modify the Image Width (in Pixels) and Image Height (in Lines) features to match your image width and total number of lines of your ROIs.

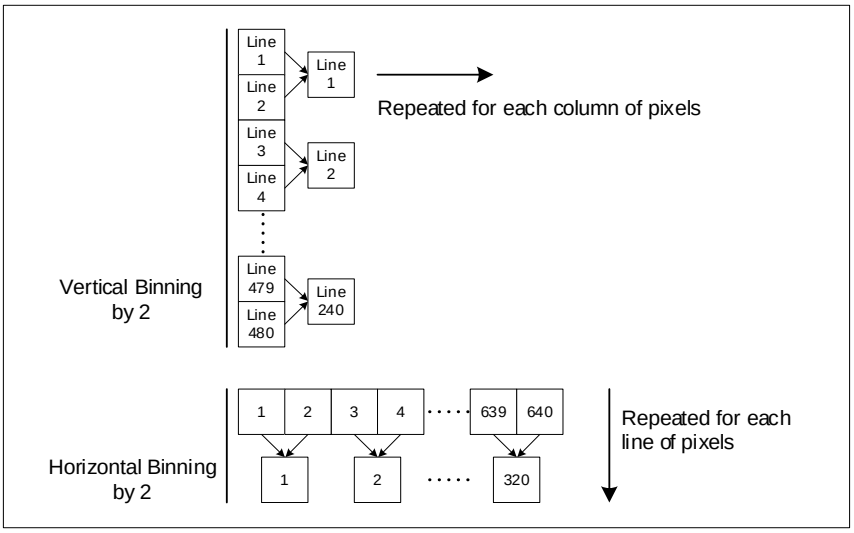
Binning Function

Binning is the process where the charge on two adjacent pixels is combined. This results in increased light sensitivity since there is twice the sensor area to capture photons. The sensor spatial resolution is reduced but the improved low-light sensitivity plus lower signal-noise ratio may solve a difficult imaging situation. The user can evaluate the results of the binning function on the Falcon4 by using CamExpert.

Horizontal and vertical binning functions are applied together, by factors of 2 in each axis (2x2). Specifically with binning activated, a nominal 640x480 image is reduced to 320x240.

Vertical binning is performed in-sensor and horizontal binning digitally; therefore with binning there is an increase in acquisition frame rate (maximum frame rate at full resolution, minimum exposure time = 1206.2 fps (M4480) and 664.4 fps (M4400)).

The following graphic illustrates the horizontal and vertical binning mechanism.



Internal Test Pattern Generator

The camera includes a number of internal test patterns which easily confirm camera installations, without the need for a camera lens or proper lighting. Use CamExpert to easily enable and select a test pattern from the drop menu while the camera is not in acquisition mode. Select live grab to see the pattern output.

The Test Patterns are:

- **Grey Horizontal ramp**: Image is filled horizontally with an image that goes from the darkest possible value to the brightest.

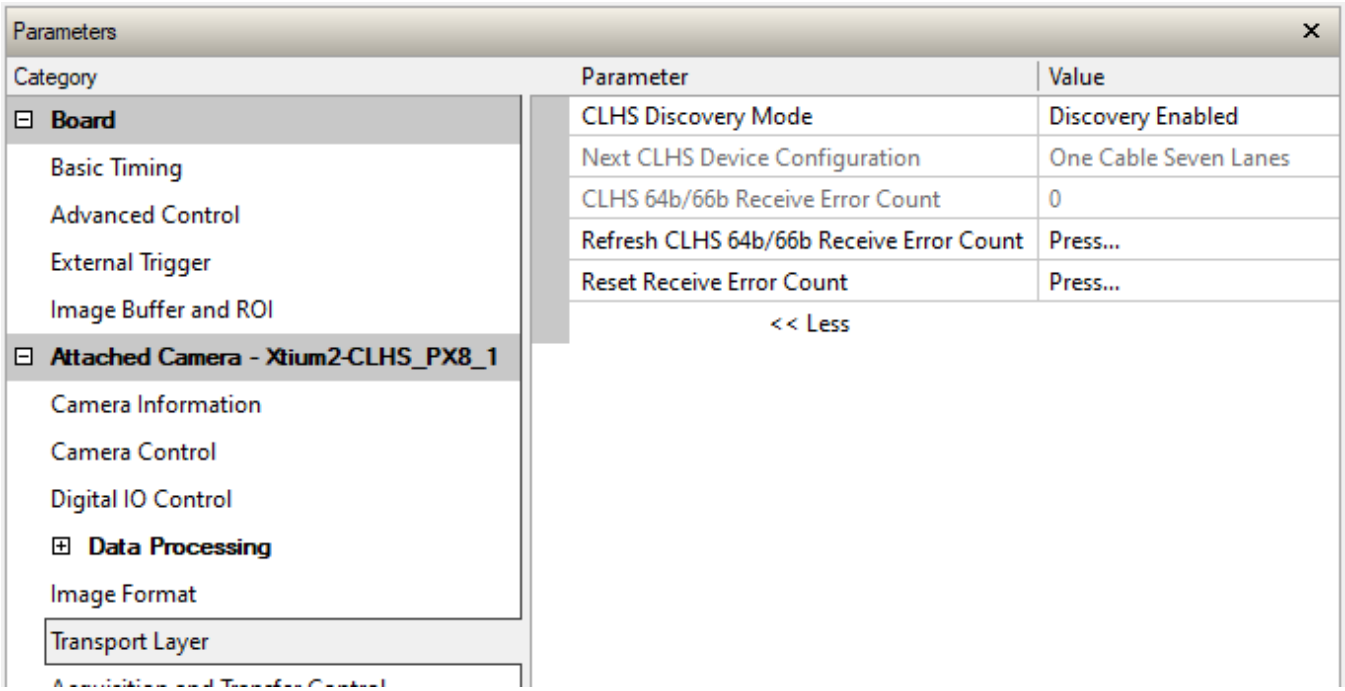
- **Grey Vertical ramp**: Image is filled vertically with an image that goes from the darkest possible value to the brightest.

- **Grey Diagonal Ramp Moving**: Image is filled diagonally with an image that goes from darkest to brightest, and that moves when grabbing.

- **Constant**: Image filled completely with the pixel value set by the Test Image Value feature.

Transport Layer Category

The Transport Layer Control Features are related to CLHS specification.

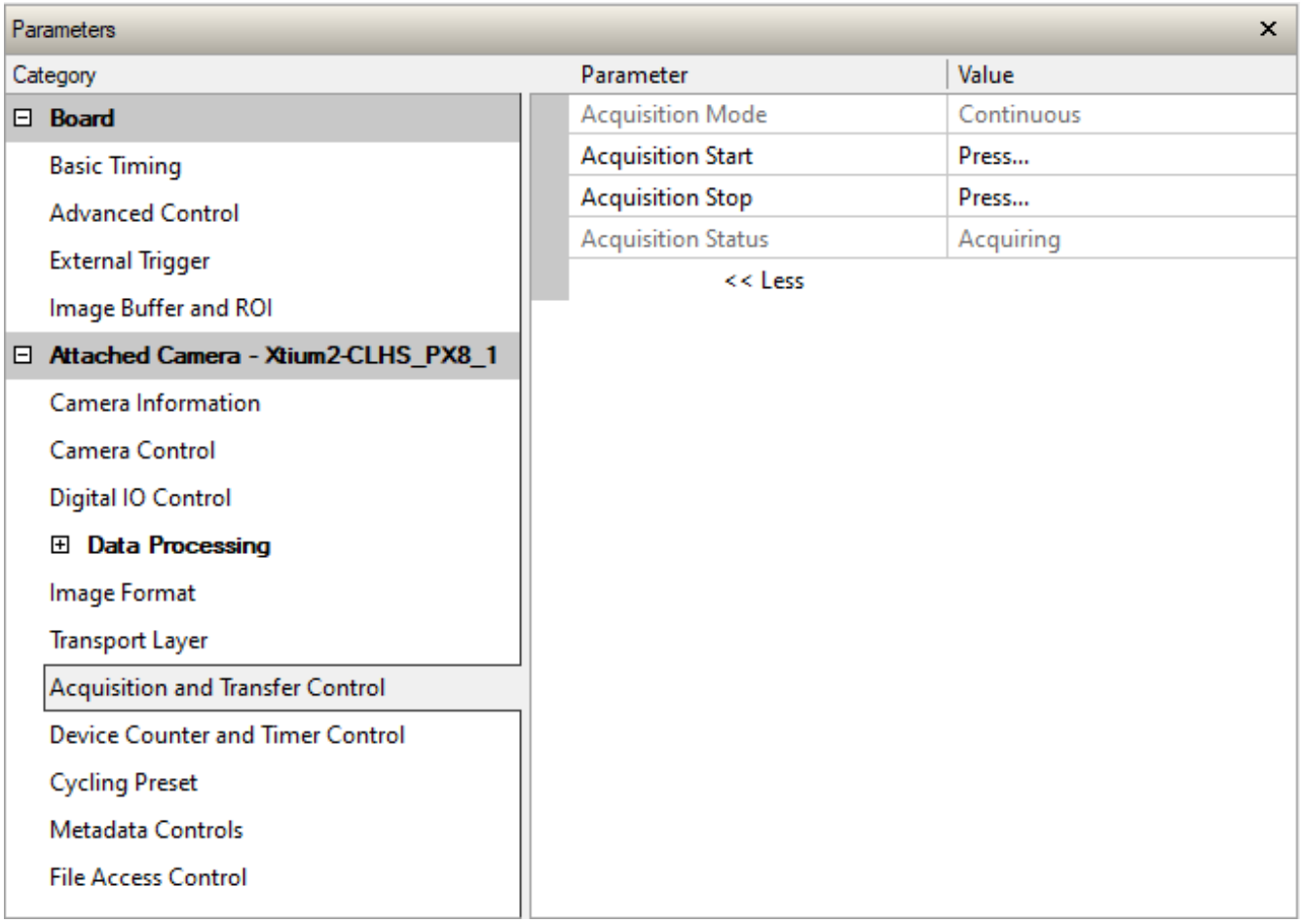


Transport Layer Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
CLHS Discovery Mode *Discovery Disabled* *Discovery Enabled*	clhsDiscovery *DiscoveryDisable* *DiscoveryEnable*	Disable CLHS Discovery if not implemented in frame grabber. If disabled then camera will enable image transmitters as soon as the cable is connected. *Discovery Disabled* *Discovery Enabled*	1.00 DFNC Beginner
Next CLHS Device Configuration *One Cable Four Lanes* *One Cable Seven Lanes*	clhsNextDeviceConfig *OneCableFourLanes* *OneCableSevenLanes*	Select next CLHS device configuration from valid list. Reboot or reconnect cable to activate. *One cable with 4 data lanes (M2240, M4400 models).* *One cable with 7 data lanes (M4480, M8200 models).*	1.00 DFNC Beginner
CLHS 64b/66b Receive Error Count	clhsErrorCount	CLHS 64b/66b Receive Error Count	1.00 DFNC Guru
Refresh CLHS 64b/66b Receive Error Count	clhsErrorCountRefresh	Refresh CLHS 64b/66b Receive Error Count	1.00 DFNC Guru
Reset Receive Error Count	clhsErrorCountReset	Reset current CLHS 64b/66b Receive Error Count to Zero	1.00 DFNC Guru

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.



Acquisition and Transfer Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Acquisition Mode *Continuous*	AcquisitionMode *Continuous*	Defines the way that frames are acquired. *Frames are captured continuously until stopped with the "Acquisition Stop" command.*	1.00 Beginner
Acquisition Start	AcquisitionStart	Commands the camera to start sending image data.	1.00 Beginner
Acquisition Stop	AcquisitionStop	Commands the camera to stop sending image data at the end of the current line.	1.00 Beginner
Acquisition Status *Not Acquiring* *Acquiring*	AcquisitionStatus *NotAcquiring* *Acquiring*	Indicates whether the camera has been commanded to send image data. *Not Acquiring* *Acquiring*	1.00 Beginner

Acquisition Buffering

All acquisitions are internally buffered and transferred as fast as possible to the host system. This internal buffer allows uninterrupted acquisitions no matter of any transfer delays that might occur. Only when the internal acquisition buffer is consumed would an Image Lost Event be generated.

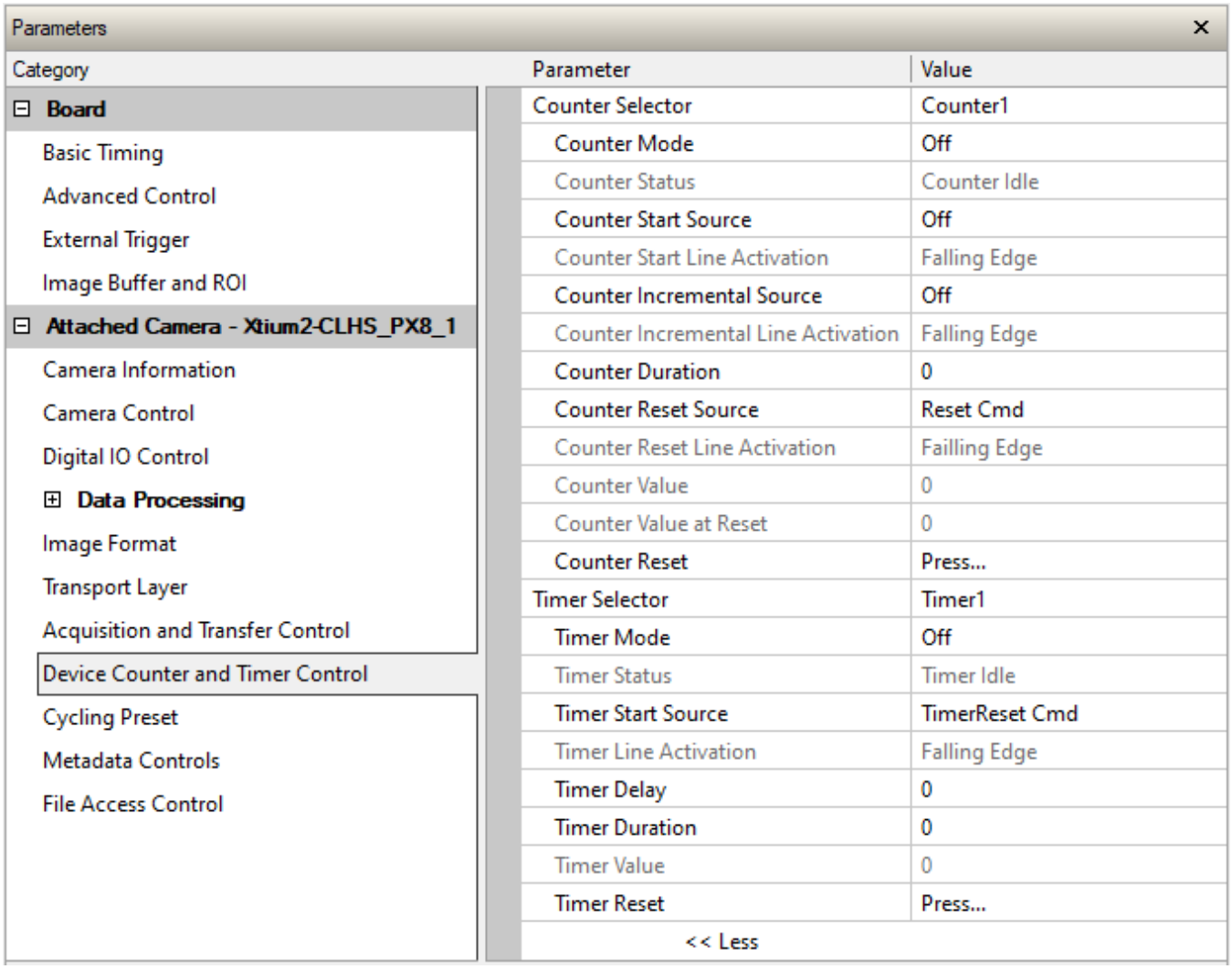
Features that cannot be changed during a Transfer

The following features cannot be changed during an acquisition or when a transfer is connected.

Feature Category	Features Locked During a Sapera Transfer
CAMERA INFORMATION	UserSetLoad, deviceBIST, DeviceReset
CAMERA CONTROL	*AcquisitionFrameRate, ExposureMode, exposureAlignment* *GainSelector*
DIGITAL IO CONTROL	TriggerSelector, TriggerMode, triggerFrameCount TriggerSource, TriggerDelay, TriggerOverlap-
DATA PROCESSING	FPNCorrectionMode FPNCorrectionActiveSet FPNCalibrationTargetExposureMin FPNCalibrationTargetExposureMax FPNCalibrationOpticalBlackReference FPNCalibrationOpticalBlackReferenceOffset FPNCalibrationCalibrate FPNCalibrationSave flatfieldResetCoefficients defectivePixelReplacementMode defectivePixelReplacementMapCurrentActiveSet lensShadingCorrectionMode, lensShadingCorrectionCurrentActiveSet lensShadingCorrectionCalibrationSampleSize lensShadingCorrectionCalibrationBright lensShadingResetCoefficients
DEVICE COUNTER AND TIMER CONTROL	*NA*
IMAGE FORMAT CONTROL	PixelFormat OffsetX (except within the Cycling Mode) OffsetY (except within the Cycling Mode) Width, Height TestImageSelector BinningHorizontal BinningVertical
ACQUISITION AND TRANSFER CONTROL	DeviceRegistersStreamingStart DeviceRegistersStreamingEnd
FILE ACCESS CONTROL	*NA*

Device Counter and Timer Control Category

The Device Counter and Timer Control category, as shown by CamExpert, groups parameters used to configure acquisition counters and timers for various input lines and signal edge detection.



Device Counter and Timer Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Counter Selector *Counter 1*	counterSelector *Counter1*	Selects the counter to configure. *Select counter 1*	1.00 Beginner DFNC
Counter Mode *Off* *Active*	counterMode *Off* *Active*	Selects the counter mode. The selected Counter is either Active or Disabled. When Disabled, the Counter can be configured. *The selected Counter is Disabled* *The selected Counter is Enabled*	1.00 Beginner DFNC

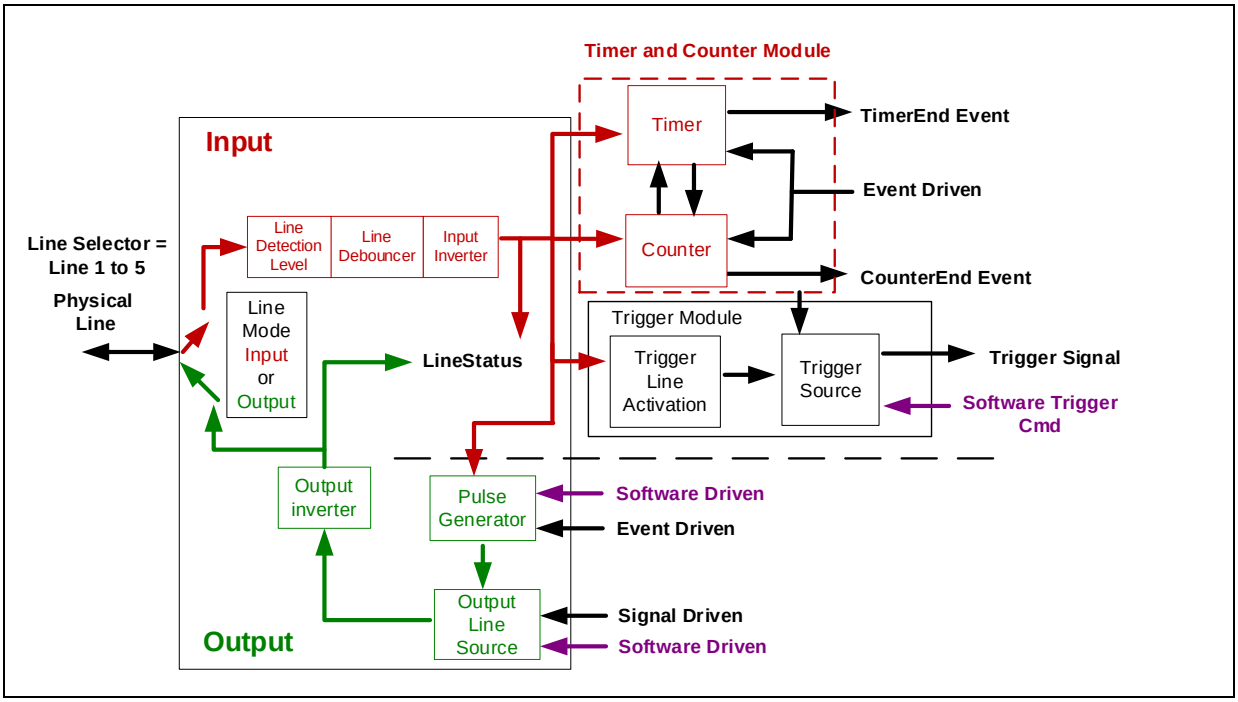
Display Name	Feature & Values	Description	Device Version & View
Counter Status	counterStatus	Returns the current state of the counter.	1.00 Beginner DFNC
Counter Idle	*CounterIdle*	*The counter is idle.* *The counterStartSource feature is set to off.*	
Counter Trigger Wait	*CounterTriggerWait*	*The counter is waiting for a start trigger.*	
Counter Active	*CounterActive*	*The counter is counting for the specified duration.*	
Counter Completed	*CounterCompleted*	*The counter reached the CounterDuration count.*	
Counter Overflow	*CounterOverflow*	*The counter reached its maximum possible count.*	
Counter Pause	*CounterPause*	*The counter is paused.*	1.00 Beginner DFNC
Counter Start Source	counterStartSource	Select the counter start source. Counter increments from 0 to the value of the counterDuration feature.	1.00 Beginner DFNC
No Source	*Off*	*Counter is stopped.*	
Exposure Start	*ExposureStart*	*Counter starts on the reception of the Exposure Start event*	
Exposure End	*ExposureEnd*	*Counter starts on the reception of the Exposure End event.*	
Readout Start	*ReadoutStart*	*Counter starts on the reception of the Readout Start event.*	
Readout End	*ReadoutEnd*	*Counter starts on the reception of the Readout End event.*	
Frame Start	*FrameStart*	*Counter starts on the reception of the Frame Start event.*	
Valid Frame Trigger	*ValidFrameTrigger*	*Counter starts on the reception of the Valid Frame Trigger.*	
Invalid Frame Trigger	*InvalidFrameTrigger*	*Counter starts on the reception of the Invalid Frame Trigger.*	
Line 1	*Line1*	*Counter starts on the specified transitions on Line 1* See Input Signals Electrical Specifications.	
Line 2	*Line2*	*Counter starts on the specified transitions on Line 2*	
CLHS In	*LinkTrigger0*	*Counter starts on the transitions of LinkTrigger0 (based on the counterIncrementalLineActivation feature setting).*	
Timer 1 End	*Timer1End*	*Counter starts on the reception of the Timer 1 End event.*	
Counter 1 End	*Counter1End*	*Counter starts on the reception of the Counter 1 End event.*	
Counter Start Line Activation	counterStartLineActivation	Selects the activation mode of the input line trigger which starts the counter. This is only applicable when the counterStartSource feature selects a physical Line.	1.00 Beginner DFNC
Rising Edge	*RisingEdge*	*Starts counting on rising edge of the selected Line.*	
Falling Edge	*FallingEdge*	*Starts counting on falling edge of the selected Line.*	
Any Edge	*AnyEdge*	*Starts counting on the falling or rising edge of the selected Line.*	

Display Name	Feature & Values	Description	Device Version & View
Counter Incremental Source	counterIncrementalSource	Select the event source which increments the counter. The Event Control section provides details and timing diagrams for the supported events.	1.00 Beginner DFNC
Off	*Off*	*Counter is stopped.*	
Exposure Start	*ExposureStart*	*Counts the number of Exposure Start events.*	
ExposureEnd	*ExposureEnd*	*Counts the number of Exposure End events.*	
Readout Start	*ReadoutStart*	*Counts the number of Readout Start events.*	
Readout End	*ReadoutEnd*	*Counts the number of Readout End events.*	
Frame Start	*FrameStart*	*Counts the number of Frame Start events.*	
Valid Frame Trigger	*ValidFrameTrigger*	*Counts the number of Valid Frame Triggers.*	
Frame Burst	*FrameBurstEnd*	*Counts the number of multi-frame end triggers.*	
CLHS In	*LinkTrigger0*	*Counts the number of transitions on LinkTrigger0.*	
Line 1	*Line1*	*Counts the number of transitions on Line 1 (based on the counterIncrementalLineActivation feature setting)* See Input Signals Electrical Specifications.	
Line 2	*Line2*	*Counts the number of transitions on Line 2 (based on the counterIncrementalLineActivation feature setting)*	
Invalid Frame Trigger	*InvalidFrameTrigger*	*Counts the number of rejected frame triggers.*	
Internal Clock	*InternalClock*	*The counter increments on each microsecond tick of the device internal Clock.*	
Timer 1 End	*Timer1End*	*Counts the number of Timer 1 End events.*	
Counter Incremental Line Activation	counterIncrementalLineActivation	Selects the counter signal activation mode. The counter increments on the specified signal edge or level.	1.00 Beginner DFNC
Rising Edge	*RisingEdge*	*Increment the counter on the rising edge of the selected I/O Line.*	
Falling Edge	*FallingEdge*	*Increment the counter on the falling edge of the selected I/O Line.*	
Any Edge	*AnyEdge*	*Increment the counter on the falling or rising edge of the selected I/O Line.*	
Counter Duration	counterDuration	Sets the duration (or number of events) before the CounterEnd event is generated.	1.00 Beginner DFNC
Counter Reset Source	counterResetSource	Selects the signal source to reset the counter. After a reset the counter waits for the next countStartSource signal or event.	1.00 Beginner DFNC
Off	*Off*	*Reset on reception of the Reset Icommand.*	
Exposure Start	*ExposureStart*	*Reset on reception of the Exposure Start event.*	
Exposure End	*ExposureEnd*	*Reset on reception of the Exposure End event.*	
Readout Start	*ReadoutStart*	*Reset the counter on the reception of the Readout Start event.*	
Readout End	*ReadoutEnd*	*Reset the counter on the reception of the Readout End event.*	
Frame Start	*FrameStart*	*Reset on reception of the Frame Start.*	
Valid Frame Trigger	*ValidFrameTrigger*	*Reset on reception of the Valid Frame Trigger.*	
Invalid Frame Trigger	*InvalidFrameTrigger*	*Reset on reception of the Invalid Frame Trigger.*	
FrameBurst End Trigger	*FrameBurstEnd*	*Reset on reception of the Frame Burst end.*	
Line 1	*Line1*	*Reset counter on the specified transition on line 1.* See Input Signals Electrical Specifications.	
Line 2	*Line2*	*Reset counter on the specified transition on line 2.*	
CLHS In	*Link0Trigger*	*Reset on reception of CLHS In (Link0Trigger).*	
Timer 1 End	*Timer1End*	*Reset on reception of the Timer End.*	
Counter 1 End	*Counter1End*	*Reset on the reception of the Counter end.*	

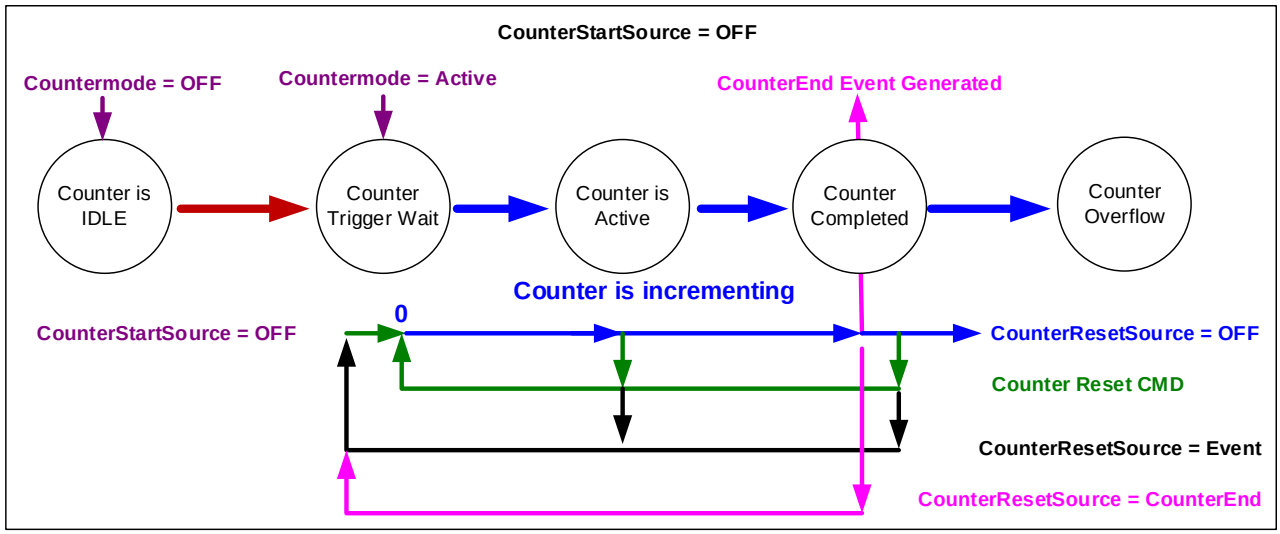
Display Name	Feature & Values	Description	Device Version & View
Counter Reset Line Activation	counterResetLineActivation	Specify the edge transition on the selected line that will reset the selected counter.	1.00 Beginner DFNC
Rising Edge	*RisingEdge*	*Reset counter on rising edge of the selected signal.*	
Falling Edge	*FallingEdge*	*Reset counter on falling edge of the selected signal.*	
Any Edge	*AnyEdge*	*Reset counter on the falling or rising edge of the selected signal*	
Counter Value	counterValue	Read the current value of the selected counter.	1.00 Beginner DFNC
Counter Value at Reset	counterValueAtReset	Stores the counter value of the selected counter when it was reset by a trigger or by an explicit Counter Reset command.	1.00 Beginner DFNC
Counter Reset	counterReset	Resets the selected counter to zero. The counter starts immediately after the reset. To temporarily disable the counter, set the Counter Start Source feature to Off.	1.00 Beginner DFNC
Timer Selector	timerSelector	Selects which timer to configure.	1.00 Beginner DFNC
Timer 1	*Timer1*	*Timer 1 selected*	
Timer Mode	timerMode	Select the Timer mode. The selected Timer is Active or Disabled. When Disabled, the Timer can be configured.	1.00 Beginner DFNC
Off	*Off*	*The selected Timer is Disabled.*	
Active	*Active*	*The selected Timer is Enabled.*	
Timer Status	timerStatus	Returns the current state of the timer.	1.00 Beginner DFNC
Timer Idle	*TimerIdle*	*The timer is idle. The TimerStartSource feature is set to off.*	
Timer Trigger Wait	*TimerTriggerWait*	*The timer is waiting for a start trigger.*	
Timer Active	*TimerActive*	*The timer is counting for the specified duration.*	
Timer Completed	*TimerCompleted*	*The timer reached the TimerDuration count.*	
Timer Start Source	timerStartSource	Select the trigger source to start the timer. The Event Control section provides details and timing diagrams for the supported events.	1.00 Beginner DFNC
TimerReset Cmd	*Off*	*Starts with the reception of the TimerReset Icommand.*	
Exposure Start	*ExposureStart*	*Start Timer on Exposure Start event.*	
ExposureEnd	*ExposureEnd*	*Start Timeron Exposure End event.*	
Readout Start	*ReadoutStart*	*Start Timer on Readout Start event.*	
Readout End	*ReadoutEnd*	*Start Timer on Readout End event.*	
Frame Start	*FrameStart*	*Start Timer on Frame Start event.*	
Valid Frame Trigger	*ValidFrameTrigger*	*Start Timer on Valid Frame Trigger.*	
Frame Start	*FrameStart*	*Start Timer on Frame Start event.*	
Frame Burst End	*FrameBurstEnd*	*Start Timer on Frame Burst End event.*	
Line 1	*Line1*	*Start Timer on a transition of I/O Line 1 event.* See Input Signals Electrical Specifications.	
Line 2	*Line2*	*Start Timer on a transition of I/O Line 2 event.*	
CLHS In	*LinkTrigger0*	*Start Timer on a transition of CLHS In (LinkTrigger0).*	
Timer 1 End	*Timer1End*	*Start Timer on Timer End event.*	
Counter 1 End	*Counter1End*	*Start Timer on Counter 1 End event.*	

Display Name	Feature & Values	Description	Device Version & View
Timer Line Activation *Rising Edge* *Falling Edge* *Any Edge*	timerStartLineActivation *RisingEdge* *FallingEdge* *AnyEdge*	Select the trigger activation mode which starts the timer. *Starts counter on rising edge of the selected signal.* *Starts counter on falling edge of the selected signal.* *Starts counter on the falling or rising edge of the selected signal.*	1.00 Beginner DFNC
Timer Delay	timerDelay	Sets the duration (in microseconds) of the delay to apply at the reception of a Start Trigger before starting the timer.	1.00 Beginner DFNC
Timer Duration	timerDuration	Sets the duration (in microseconds) of the timer pulse.	1.00 Beginner DFNC
Timer Value	timerValue	Reads the current value (in microseconds) of the selected timer.	1.00 Beginner DFNC
Timer Reset	timerReset	Resets the timer to 0 while *timerStatus=TimerActive*. Timer then waits for the next *timerStartSource* event.	1.00 Beginner DFNC

Counter and Timer Group Block Diagram

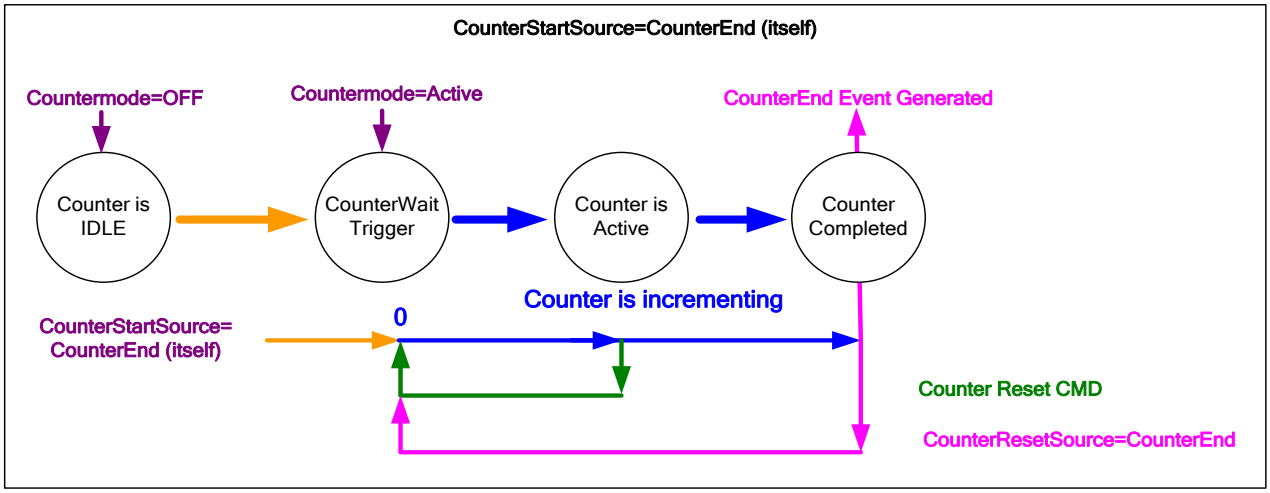


Example: Counter Start Source = OFF



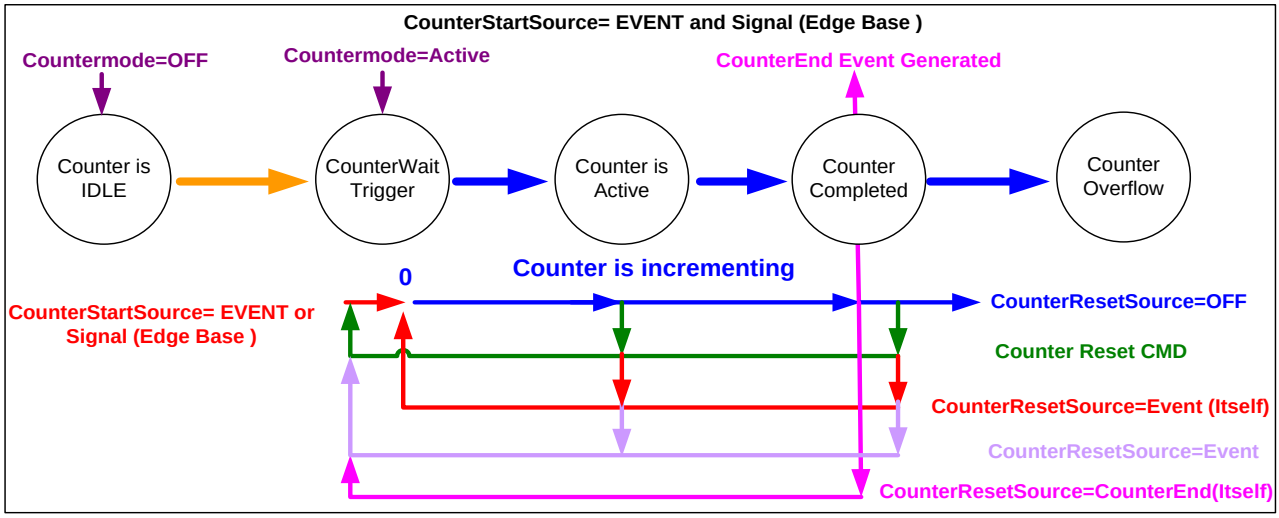
- The counter starts on the **counterReset Cmd**.
- The counter continues unless a new **counterReset Cmd** is received, which then restarts the counter at 00.
- When **Counter Reset Source = 'Event' or 'CounterEnd**' the counter is reset to 00 but does not restart counting, until the next **CounterReset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

Example: Counter Start Source = CounterEnd (itself)

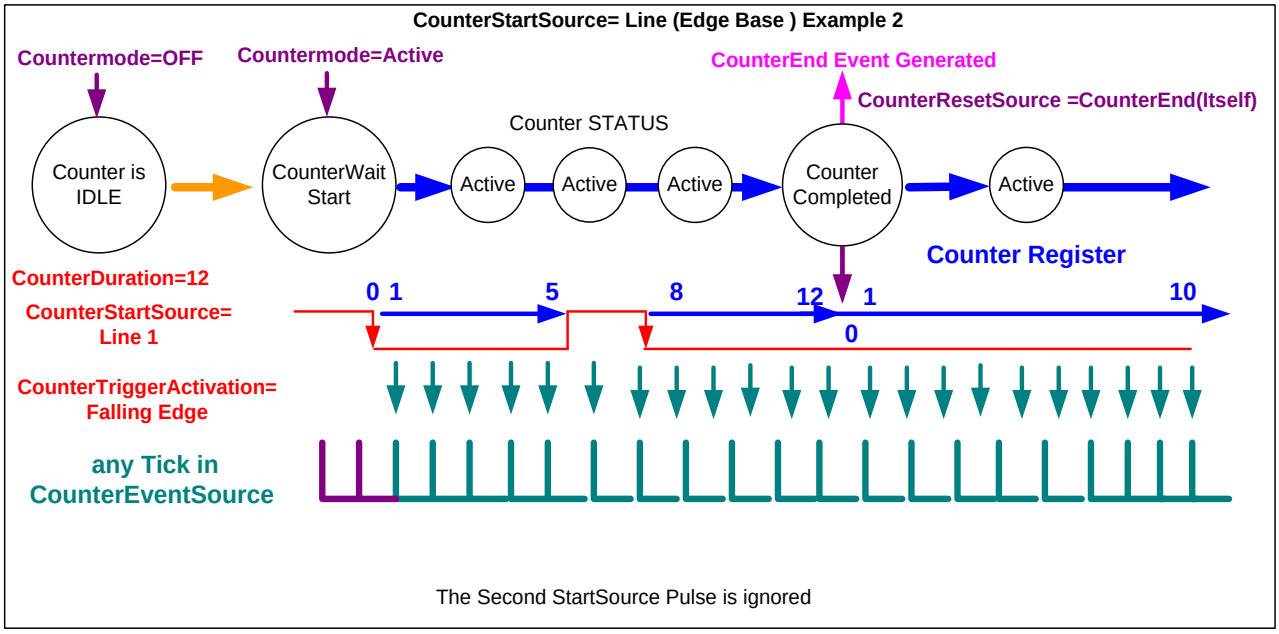


- Counter starts when Counter Mode is set to Active.
- A **Counter Reset CMD** will reset the counter to 00 and it then continues counting.
- **counterResetSource** must be set to **CounterEnd**. When the counterValue feature reaches the counterDuration value an event is generated and the counter is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

Example: CounterStartSource = EVENT and Signal (Edge Base)

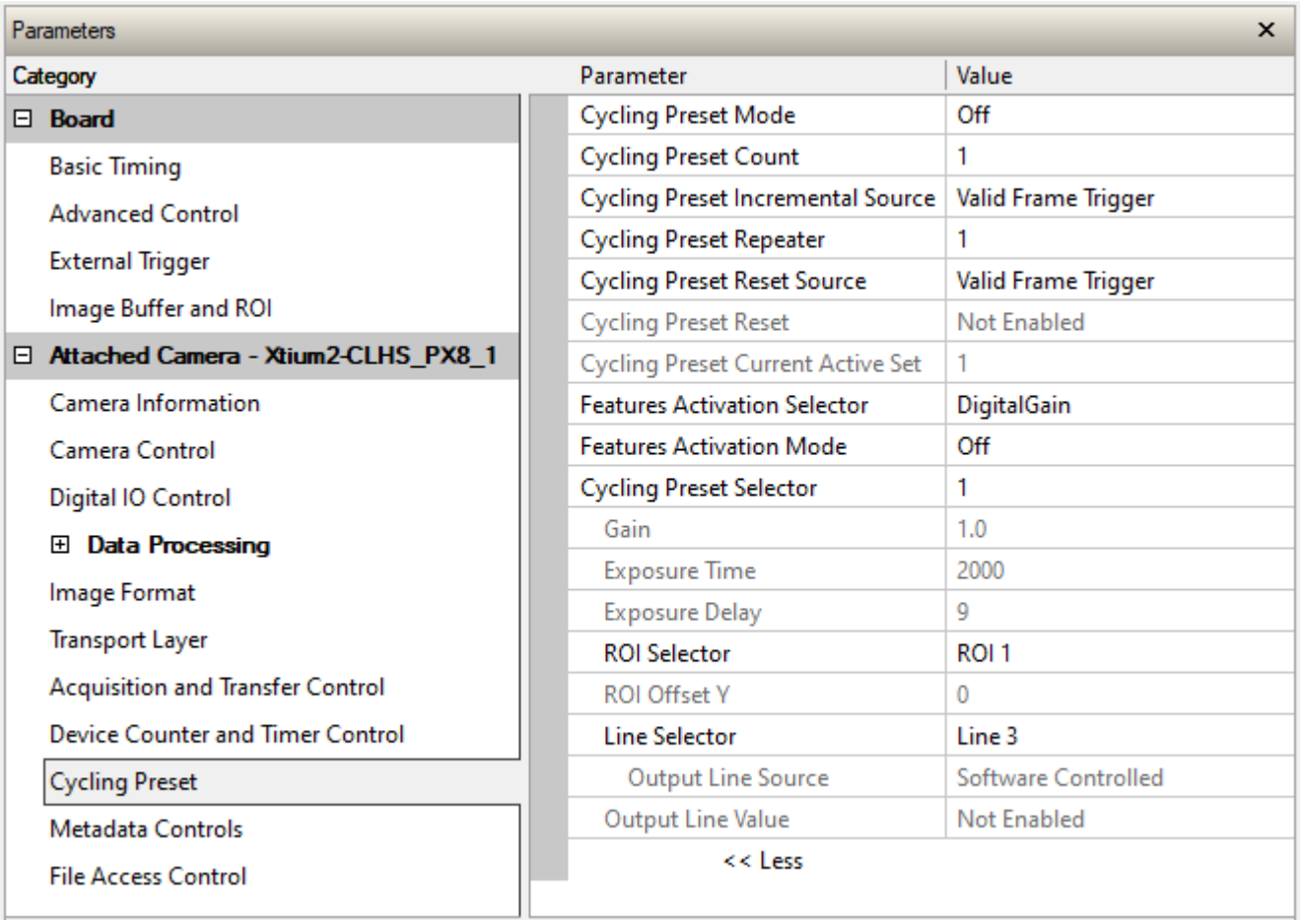


Example: CounterStartSource = Line (Edge Base) Example



Cycling Preset Category

The Cycling Preset Mode Control parameters are used to configure the camera Cycling features. Cycling controls allow the user to configure a number of camera operational states and then have the camera automatically switch between states in real-time, on a frame-by-frame basis. Only the features programmed to change are updated when switching between camera states, thus ensuring immediate camera response. A setup example follows the feature table.



Cycling Preset Mode Feature Description

Display Name	Feature & Values	Description	Device Version & View
Cycling Preset Mode *Off* *Active*	cyclingPresetMode *Off* *Active*	Sets the state of the Cycling Preset Mode. *Disable the Cycling Preset Mode feature.* *Enable the Cycling Preset Mode feature.*	1.02 Expert DFNC
Cycling Preset Count	cyclingPresetCount	Specifies the number of possible Presets available.	1.02 Expert DFNC

Display Name	Feature & Values	Description	Device Version & View
Cycling Preset Incremental Source	cyclingPresetIncrementalSource	Specifies the source that increments the currently active cycling preset.	1.02 Expert DFNC
None	*None*	*Feature cyclingPresetCurrentActiveSet is used to select the current active set.*	
Valid Frame Trigger	*ValidFrameTrigger*	*Increment on a Valid Frame Trigger.*	
Counter 1 End	*Counter1End*	*Increment on the end of Counter 1.*	
Start of Frame	*StartOfFrame*	*Increment on the Start of Frame event.*	
Line2	*Line2*	*Select Line 2 (and associated I/O control block) to use as the external increment source.*	
Cycling Preset Repeater	cyclingPresetRepeater	Specifies the required number of cycling preset increment events (generated by the Cycling Preset Incremental Source) to increment the index of the Cycling Preset Current Active Set. The difference with cyclingPresetRepeater is that this feature value is specific to the current cycling set specified by cP_PresetConfigurationSelector.	1.02 Expert DFNC
Cycling Preset Reset Source	cyclingPresetResetSource	Specifies the source that resets the currently active cycling preset to the first set.	1.02 Expert DFNC
Valid Frame Trigger	*ValidFrameTrigger*	*Reset when a Valid Frame Trigger occurs.*	
Counter 1 End	*Counter1End*	*Reset when Counter 1 ends.*	
Acquisition End	*EndOfAcquisition*	*Use End of Acquisition as the reset source. An End of Acquisition occurs on acquisition stop.*	
Software	*Software*	*Use a software command as the reset source.*	
Cycling Preset Reset	cyclingPresetResetCmd	Reset the position of the preset cycling to 1 and the count to 0.	1.02 Expert DFNC
Cycling Preset Current Active Set	cyclingPresetCurrentActiveSet	Specifies the currently active cycling preset.	1.02 Expert DFNC
Features Activation Selector	cP_FeaturesActivationSelector	Selects the feature to control by the cP_FeaturesActivationMode feature.	1.02 Expert DFNC
Exposure Time	*ExposureTime*	*The cP_FeaturesActivationMode feature controls the exposure time.*	
Exposure Delay	*ExposureDelay*	*The cP_FeaturesActivationMode feature controls the exposure delay.*	
Output Line3	*OutputLine3Control*	*The cP_FeaturesActivationMode feature controls output line3.*	
Output Line4	*OutputLine4Control*	*The cP_FeaturesActivationMode feature controls output line4.*	
Output Line5	*OutputLine5Control*	*The cP_FeaturesActivationMode feature controls output line5.*	
Output Line6	*OutputLine6Control*	*The cP_FeaturesActivationMode feature controls output line6.*	
Multiple ROI	*MultiROI*	*The cP_FeaturesActivationMode feature controls the ROI positions. Only OffsetY is cycled, the height of each ROI is from multi ROI height on Image Format page. Smaller ROI id has smaller OffsetY Enable MultiROI mode to activate cyclying MultiROI.*	
DigitalGain	*DigitalGain*	*The cP_FeaturesActivationMode feature controls the digital gain.*	
Features Activation Mode	cP_FeaturesActivationMode	Enable the selected feature to be part of the cycling. When activating the selected feature, this will automatically set the corresponding standard camera feature to read only.	1.02 Expert DFNC
Off	*Off*	*Exclude the selected feature from the cycling.*	
Active	*Active*	*Include the selected feature in the cycling.*	

Display Name	Feature & Values	Description	Device Version & View
Cycling Preset Selector	cP_PresetConfigurationSelector	Selects the Cycling Preset to configure its feature.	1.02 Expert DFNC
Gain	cP_DigitalGain	Sets the selected gain as an amplification factor applied to the image. This gain is applied when the current Cycling index is active.	1.02 Expert DFNC
Exposure Time	cP_ExposureTime	Sets the exposure time in microseconds. Applicable only when the Exposure Mode feature is set to Timed. This setting will be applied when the current Cycling index occurs (varying exposure will have an impact on maximum framerate available).	1.02 Expert DFNC
Exposure Delay	cP_ExposureDelay	Sets the exposure delay in microseconds for the selected set.	1.02 Expert DFNC
ROI Selector	cP_MultiROISelector	Select an ROI (Region of Interest) when Multiple ROI Mode is enabled. Selector range is from 1 to the Multiple ROI Count Vertical value, or maximum 8 if Multiple ROI Count Vertical is greater than 8. The height of each ROI is from Multi ROI Height on Image Format page. Smaller ROI ID has smaller OffsetY.	1.02 Expert DFNC
ROI Offset Y	cP_MultiROIOffsetY	Vertical offset (in pixels) from the origin to the selected ROI (Region of Interest).	1.02 Expert DFNC
Line Selector	cP_LineSelector	Cycling Preset Line Selector.	1.02 Expert DFNC
Line 3	*Line3*	*Index of the physical line and associated I/O control block to use. Pin 6 is the Output Signal and Pin 4 is the common output power on the I/O connector.*	
Line 4	*Line4*	*Index of the physical line and associated I/O control block to use. Pin 8 is the Output Signal and Pin 4 is the common output power on the I/O connector.*	
Line 5	*Line5*	*Index of the physical line and associated I/O control block to use. Pin 9 is the Output Signal and Pin 4 is the common output power on the I/O connector.*	
Line 6	*Line6*	*Index of the physical line and associated I/O control block to use. Pin 10 is the Output Signal and Pin 4 is the common output power on the I/O connector.*	
Output Line Source	cP_OutputLineSource	Selects what to output on the selected output line.	1.02 Expert DFNC
Off	*Off*	*Line output is disabled (Tri-State) or Open with Optocoupled output.*	
Pulse On: Start of Exposure	*PulseOnStartofExposure*	*Generate a pulse on the ExposureStart event.*	
Pulse On: End of Timer 1	*PulseOnEndofTimer1*	*Generate a pulse on the end of timer1.*	
Pulse On: End of Counter 1	*PulseOnEndofCounter1*	*Generate a pulse on the end of Counter1.*	
Pulse On: Input 1	*PulseOnInput1*	*Generate a pulse on the Input Signal 1 event.*	
Pulse On: Input 2	*PulseOnInput2*	*Generate a pulse on the Input Signal 2 event.*	
Software Controlled	*SoftwareControlled*	*The OutputLineValue feature changes the state of the output.*	
Pulse On: CLHS In	*PulseOnLinkTrigger0*	*Generate a pulse on LinkTrigger0 signal.*	
Exposure Active	*ExposureActive*	*Generate the Exposure Active state on specific output.*	
Output Line Value	cP_OutputLineValue	Cycling Preset Output Line Value.	1.02 Expert DFNC
Active	*Active*	*Active sets the output circuit to closed.*	
Inactive	*Inactive*	*Inactive sets the output circuit to open.*	

Using Cycling Presets—a Simple Example

As presented in this category's overview, the cycling preset features allow setting up camera configurations that can change dynamically and repeatedly, with minimum overhead. The features that change, along with the trigger for the feature change are preprogrammed in the camera. Additionally, a set of preset features can be updated while the camera is acquiring with a different preset. Such dynamic feature changes allow applications to perform tracking algorithms.

The following example describes a simple cycling sequence (using free running acquisitions) with exposure change steps that will repeat until stopped by the user. This example uses the Sapera CamExpert tool to set features and test the sequence.

Multi-Exposure Cycling Example Setup

In the Camera Control category, set the following features as follows:

- Acquisition Frame Rate: 4.0
- Exposure Time: 1000 µs (somewhat short).

In the Cycling Preset category, set the following features as follows:

- Cycling Preset Mode: *Active*. This feature enables the Cycling Preset Module.
- Cycling Preset Count: 4. This represents the number of presets which will be configured and used.
- Cycling Preset Incremental Source: *Start Of Frame*. This event will be used to increment the cycling preset index, and is a logical choice in a free-running acquisition setup.
- Cycling Preset Repeater: 4. This represents the number of incremental source events to count before switching to the next preset. In this example we are counting *Start Of Frame* events, thus a value of 4 (with a test setup of 4 fps) will switch preset every 1 second.
- (Optional) Cycling Preset Reset Source: *Acquisition End*. This feature defines the event that will reset the preset index back to 1. In this example, setting the feature to *Acquisition End* returns the cycling preset index to the start (1) when the Acquisition Stop feature is clicked in CamExpert to stop the acquisition.
- Features Activation Selector: *Exposure Time*.
- Features Activation Mode: *Active*. The *Exposure Time* field now controls the camera exposure time. The primary exposure time field in the Camera Control Category is now indicating a read only field.
- Cycling Preset Selector: 1.
- Exposure Time: leave as is. The feature shows the last exposure time used by the camera (before cycling was enabled, namely 1000 µs).
- Cycling Preset Selector: 2.
- Exposure Time: higher value than the previous setting. This will increase acquisition brightness.
- Repeat for Cycling Preset Selector 3 and 4, each with a longer exposure.

Test the Example

- With 4 different exposure times saved in four presets, click the CamExpert **Grab** button to start the cycling free-running acquisition.
- The CamExpert live display window will show a live grab of 4 fps, where each second shows a step increase in exposure, which then returns to the first exposure after 4 seconds, cycling continuously until stopped by the user.

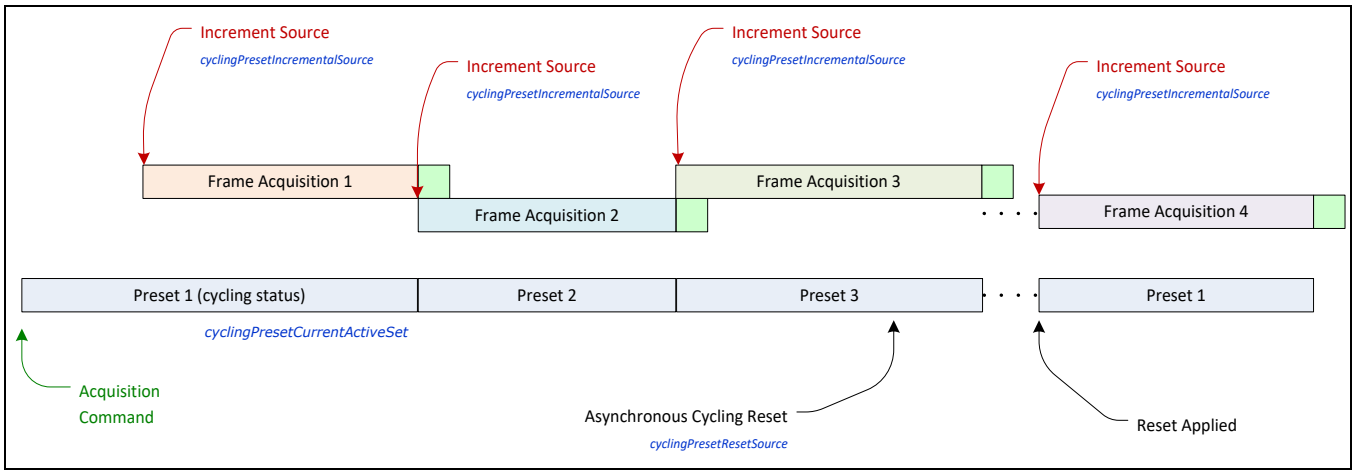
Cycling Reset Timing Details

This section describes the cycling function with two cycling feature configurations. These configurations (or cases) are dependent on the cycling preset increment source as follows:

- **Internal Synchronous Increment:** the preset increment source is either a Start of Frame or Valid Frame Trigger event (cyclingPresetIncrementalSource = *StartOfFrame* or *ValidFrameTrigger*).
- **External Asynchronous Increment:** the preset increment source is either a Counter 1 End event, a Line2 signal, or None (cyclingPresetIncrementalSource = *Counter1End* or *Line2* or *cyclingPresetCurrentActiveSet*).

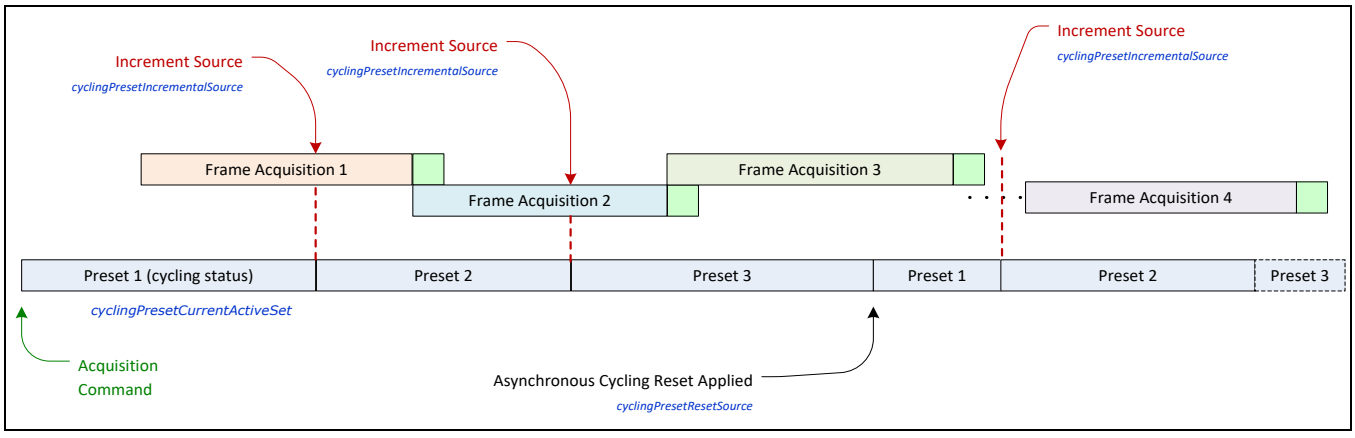
Case 1: Cycling with Internal Synchronous Increment

With an Internal Synchronous Cycling Increment, a cycling reset command will execute on the next cycling increment event.



Case 2: Cycling with External Asynchronous Increment

With an External Asynchronous Cycling Increment, a cycling reset command executes immediately and sets the cycling preset to set number 1.



Using Cycling Presets with Output Controls

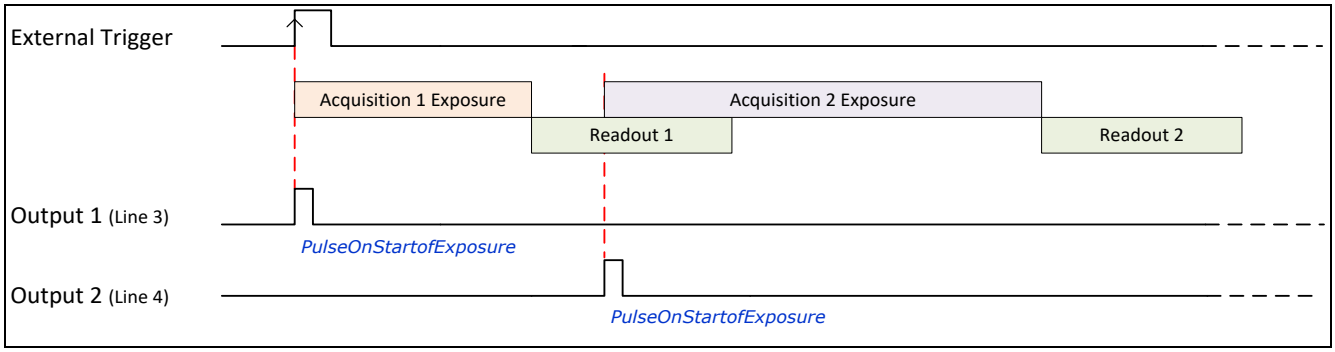
The following graphic shows a Cycling Preset function setup where a two-stage setup performs exposures of different length and additionally provides an output pulse at the start of each exposure.

As an example, by using both output lines, this setup can trigger two separate light strobes of different wavelengths. This dual exposure sequence example is controlled by a single external trigger.

Feature Settings for this Example

Below are listed key features for this setup. Other features will be as required by the user.

- I/O Controls:
- TriggerSelector = FrameBurstStart
- TriggerMode = On
- triggerFrameCount = 2
- Cycling Preset
- cyclingPresetMode = Active
- cyclingPresetCount = 2
- cyclingPresetIncrementalSource = StartOfFrame
- cP_FeaturesActivationSelector = ExposureTime
- cP_FeaturesActivationMode = Active (plus set required exposure for each cycling preset)
- cP_LineSelector = Line3 (for preset 1) and Line4 (for preset 2)
- cP_OutputLineSource = PulseOnStartofExposure (line3–preset 1, line4–preset 2)



Cycling Mode Constraints with Changing ROIs

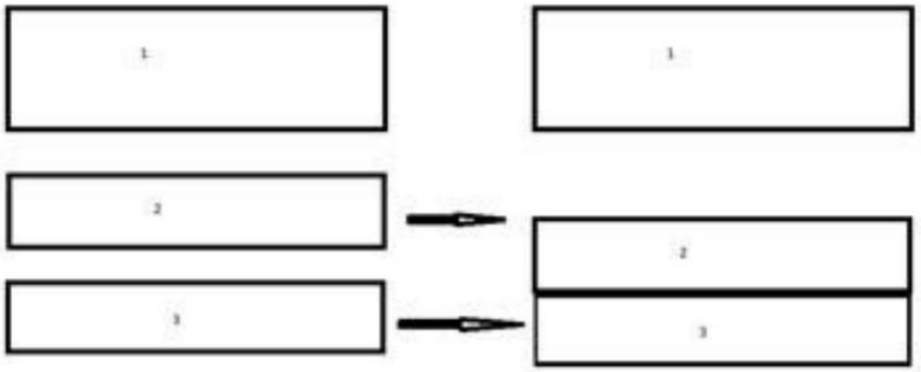
The Cycling Preset Mode features support changing ROIs from one preset to the next. An ROI in this case refers to a single acquisition area which is a subset of the complete image frame.

The initial position and size of the ROIs (i.e., features ROI Offset Y, ROI Height) are setup via the Image Format category, but may be overriden in the Cycling Preset category.

- During cycling, the image width, the height of each ROI, and the number ROIs remain same (Width, ROI Height, and ROI Count Vertical, respectively). The only feature that may change from one preset to the next is the ROI Offset Y feature of each ROI.
- The number of ROIs to be cycled is defined by the ROI Count Vertical value in the Image Format category, up to a maximum of 8.
- The Multiple ROI Mode in the Image Format category must be set to *Active* to use cycling presets with Multiple ROI (Features Activation Selector = *Multiple ROI*). It will become unavailable when the Features Activation Mode is set to *Active* and will be made available again only when the Features Activation Mode is set to *Off*.
- The ROI Offset Y values can be changed for each cycling preset. To do so, the following features should be set as indicated:

Category	Feature	Value
Image Format	Multiple ROI Mode	Active
Cycling Preset	Features Activation Selector	Multiple ROI
Cycling Preset	Features Activation Mode	Active
Cycling Preset	Cycling Preset Mode	Off

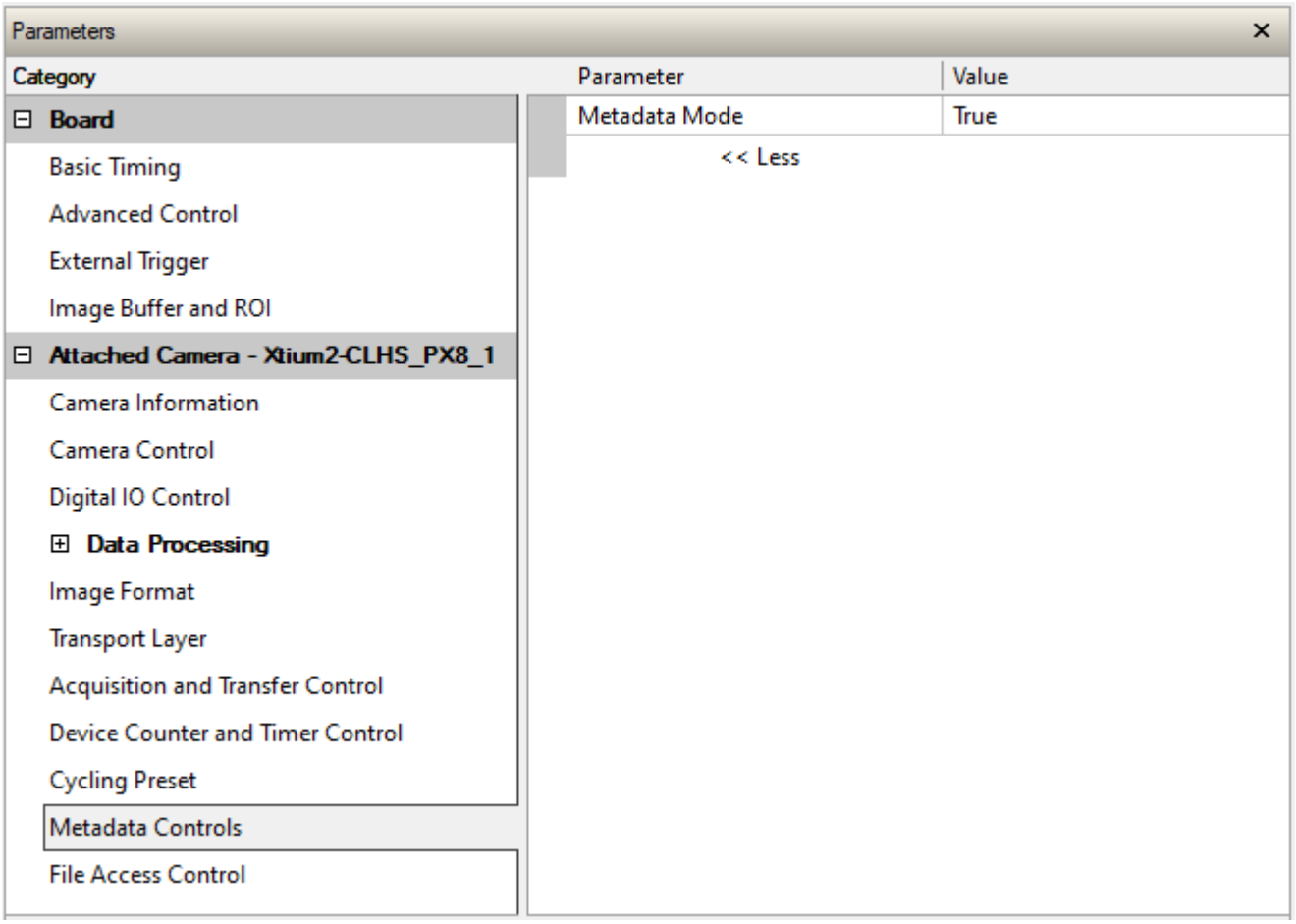
- ROIs cannot overlap in a preset. If a change causes an overlap to occur, the ROI Offset Y value will be automatically adjusted to eliminate it. In the example below, if modifying the Offset Y of ROI_2 causes an overlap with ROI_3, then the Offset Y value of ROI_3 will be adjusted.



Metadata Controls Category

The Metadata Controls category groups parameters used to configure the inclusion of various metadata (referred to as chunk data in GenApi) in the payload of the image.

Note that metadata is only available in 8-bit mode. Also, if an ROI is defined, the horizontal ROI must be at least 416 columns (pixels) wide.

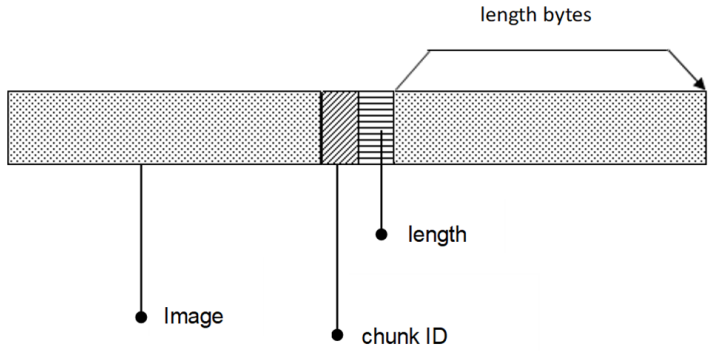


Metadata Controls Feature Description

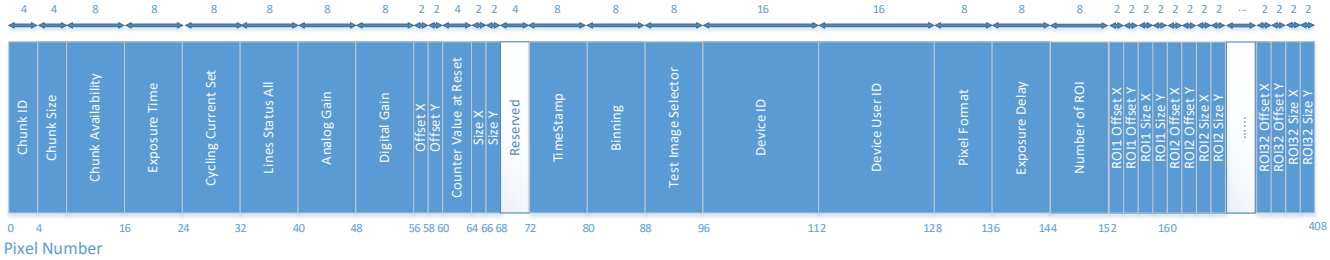
Display Name	Feature & Values	Description	Device Version & View
Metadata Mode	ChunkModeActive	Activates the inclusion of chunk data in the payload of the image.	1.02 Guru

Extracting Metadata Stored in a Sapera Buffer

The metadata location is always the beginning of the last line of the image.



Metadata is ordered as follows:



The Chunk ID, Chunk Size and Chunk Availability fields are always present in the metadata; all the other fields are optional.

Metadata Structure

The metadata currently contains the following values, in this order.

Type	Value	Description	Available Bit
unsigned int	Chunk ID	The Chunk ID is hardcoded to 0xCD000002 when pixels are read in reverse order (3 – 0).	Always available.
unsigned int	Chunk Size	The Chunk Size is currently 400. This value is hardcoded in pixel 7.	Always available.
unsigned long long	Chunk Availability	Determines the availability of metadata. For bits [1:31]: 0: Metadata not available. 1: Metadata available. Refer to the Metadata Availability section for information on the bit field structure.	Always available (bit 0 not used)
unsigned long long	Exposure Time	Exposure time, in µs.	1
unsigned long long	Cycling Current Set	Cycling current set.	2

Type	Value	Description	Available Bit
unsigned long long	Line Status All	The line status for available lines is represented as a bitfield, with 0 = low and 1 = high. bit0: GPIO bit1: GPI1 bit2: GPO0 bit3: GPO1 bit4: GPO2 bit5: GPO3 bit6: GPO4 bit7: CLHS Trigger	6
unsigned long long	Analog Gain	Analog gain. Values returned in units of 0.1 gain. For example, 30 = 3.0.	8
unsigned long long	Digital Gain	Digital gain, as raw gain.	4
unsigned long long	Factory Gain	Factory gain, as raw gain.	4
unsigned short	Offset X	Offset X, in pixels.	10
unsigned short	Offset Y	Offset Y, in pixels	
unsigned int	Counter Value at Reset	Counter1 value at reset.	16
unsigned short	Width	Image width (size X), in pixels.	11
unsigned short	Height	Image height (size Y), in pixels.	
unsigned int	Reserved	Not used.	
unsigned long long	Timestamp	Timestamp (in microseconds) of the start of the frame's acquisition, as identified by the camera's internal Timestamp clock.	12
unsigned long long	Binning	Binning is coded using the first byte (pixel 80): Bits [0:3]: binning horizontal Bits [4:7]: binning vertical For example, no binning is indicated by 1 in horizontal and 1 in vertical: 0001 0001 (decimal = 17)	14
unsigned long long	Test Image Selector	Test pattern image. Possible values are: 255: Off 0: GreyHorizontalRamp 1: GreyVerticalRamp 9: GreyDiagonalRampMoving	28
unsigned char [16]	Serial Number	ASCII codes for device serial number.	29
unsigned char [16]	Device User ID	ASCII codes for Device User ID.	30
unsigned long long	Pixel Format	Pixel format. Possible values are: 0x01080001: Mono8 0x01100003: Mono10	31
unsigned long long	Exposure Delay	Exposure delay. If not used, the default value 10 µs is returned.	15
unsigned int	Reserved	Not used.	
unsigned int	Reserved	Not used.	
unsigned long long	Number of ROIs	The total number or ROIs	27
unsigned short	ROI1 Offset X	ROI1 Offset X, in pixels.	
unsigned short	ROI1 Offset Y	ROI1 Offset Y, in pixels.	
unsigned short	ROI1 Size X	ROI1 Size X, in pixels.	
unsigned short	ROI1 Size Y	ROI1 Size Y, in pixels.	
unsigned short	…	…	
unsigned short	ROI32 Offset X	ROI32 Offset X, in pixels.	
unsigned short	ROI32 Offset Y	ROI32 Offset Y, in pixels.	
unsigned short	ROI32 Size X	ROI32 Size X, in pixels.	
unsigned short	ROI32 Size Y	ROI32 Size Y, in pixels.	

Digital Gain (raw)

Digital gain is expressed in the metadata in its raw format. To convert from this raw format to an actual gain value use this formula:

$$Gain = \frac{\text{Digital Gain (raw)}}{\text{Factory Gain (raw)}}$$

Example: a digital gain raw value of 4402 and a factory gain raw value of 2201 would translate to an actual gain of 2.

Analog Gain (raw)

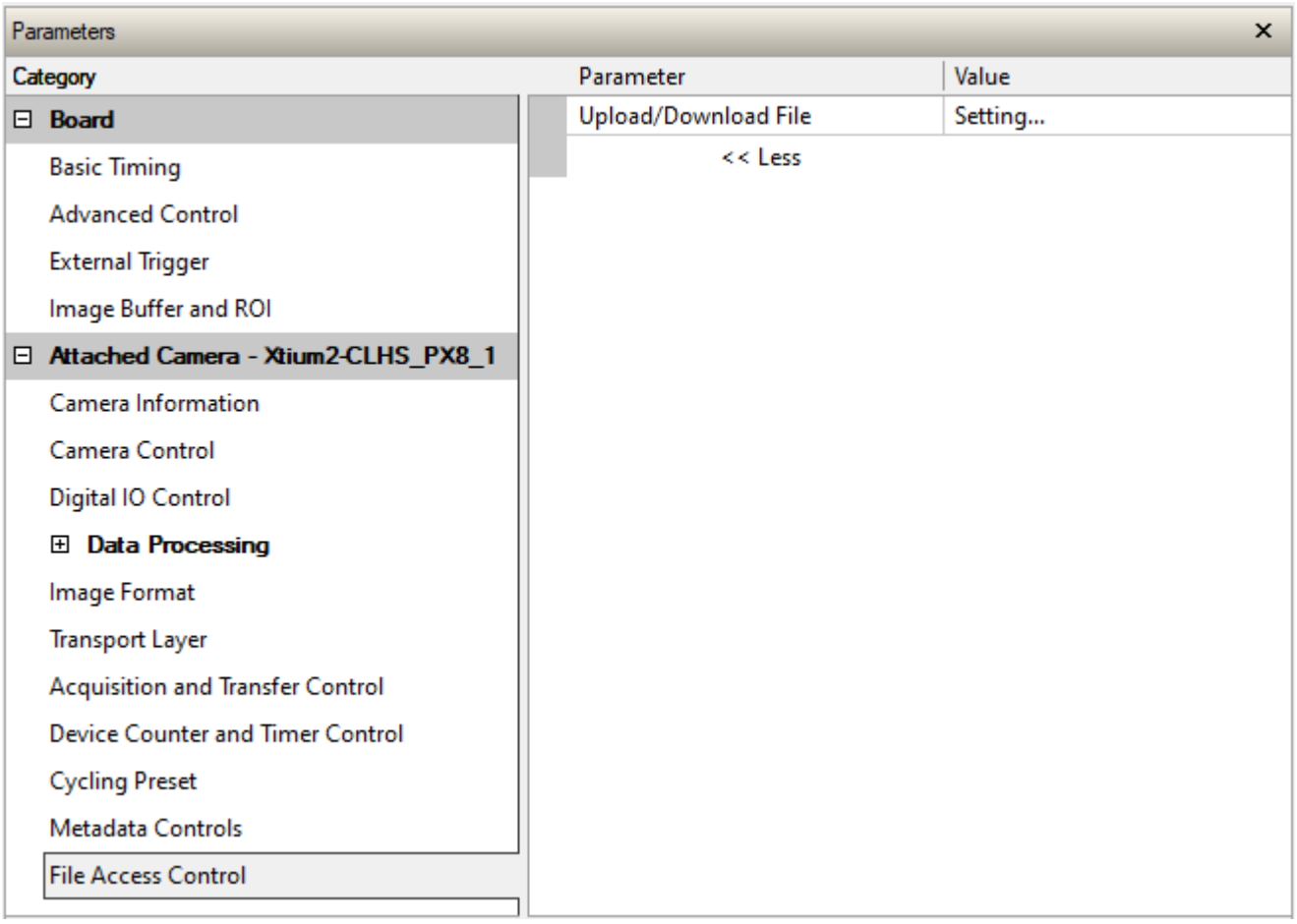
Analog gain is expressed in the metadata in its raw format. To convert from this raw format to an actual gain value use this formula:

$$Analog\ Gain = \frac{\text{Analog Gain (raw)}}{10}$$

Example: an analog gain raw value of 20 would translate to an actual gain of 2.

File Access Control Category

The File Access control in CamExpert allows the user to quickly upload various data files to the connected Falcon4 device. The supported data files are for firmware updates and other types.



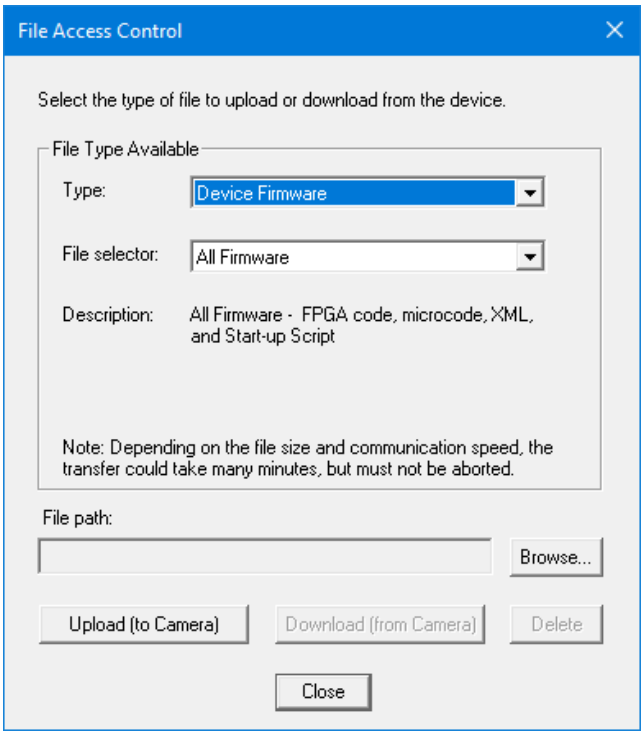
File Access Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
File Selector	FileSelector	List of device files.	1.00 Guru
All Firmware	*Firmware1*	*All Firmware - FPGA code, microcode, XML, and Start-up Script.*	
Factory settings	*UserSet0*	*Set the camera settings to factory defaults.*	
User settings 1	*UserSet1*	*User settings set 1.*	
User settings 2	*UserSet2*	*User settings set 2.*	
Last Saved Image	*SavedImage*	*Last saved image.*	
User Shading Coefficients 1	*ShadingCoefficients1*	*Lens Shading coefficients set 1.*	
Factory Defective Pixel Map	*BadPixelCoordinate0*	*Select the Factory Defective Pixel Map.*	
User Defective Pixel Map	*BadPixelCoordinate1*	*Select the User Defective Pixel Map.*	
LUT	*LUT*	*LUT.*	

Display Name	Feature & Values	Description	Device Version & View
File Operation Execute	FileOperationExecute	Executes the operation selected by File Operation Selector on the selected file.	1.00 Guru
File Open Mode	FileOpenMode	Selects the access mode used to open a file on the device.	1.00 Guru
Read	*Read*	*Select READ only open mode.*	
Write	*Write*	*Select WRITE only open mode.*	
File Access Offset	FileAccessOffset	Controls the file Offset where the read or write operation will be perform.	1.00 Guru
File Access Length	FileAccessLength	The number of bytes to transfer between the file and the FileAccessBuffer.	1.00 Guru
File Access Buffer	FileAccessBuffer	Defines the intermediate access buffer that allows the exchange of data between the device file storage and the application.	1.00 Beginner
File Size	FileSize	Represents the size of the selected file in bytes.	1.00 Beginner
File Operation Selector	FileOperationSelector	Selects the target operation for the selected file in the device.	1.00 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.*	
File Operation Status	FileOperationStatus	Returns the status of the last file operation.	1.00 Guru
Success	*Success*	*The last file operation has completed successfully.*	
Invalid Parameter	*InvalidParameter*	*The last file operation has completed unsuccessfully because of an invalid parameter.*	
Write Protect	*WriteProtect*	*The last file operation has completed unsuccessfully because the file is read-only.*	
File Invalid	*FileInvalid*	*The last file operation has completed unsuccessfully because the selected file in not present in this camera model.*	
File Not Open	*FileNotOpen*	*The last file operation has completed unsuccessfully because the selected file has not been opened.*	
File Too Big	*FileTooBig*	*The last file operation has completed unsuccessfully because the file is larger than expected.*	
File Operation Result	FileOperationResult	The number of successfully read/written bytes during the last operation.	1.00 Beginner
Save Last Image to Flash	saveLastImageToFlash	Command that saves the last acquired image to camera flash memory. Use the file transfer feature to read the image from camera.	Invisible

Updating Firmware via File Access in CamExpert

1. Click **Setting** next to the Upload/Download File parameter. The File Access Control dialog opens.



2. From the **Type** list, select the file type to upload to the camera, in this case *Device Firmware*.
3. From the **File Selector** list, select *All Firmware*.
4. Click **Browse** to select the specific file from the system drive or from a network location.
5. Click **Upload (to Camera)** to transfer the file to the camera.
6. Reset the Falcon4 when prompted.

Implementing Trigger-to-Image Reliability

Overview

In a complex imaging system, a lot can go wrong at all points – from initial acquisition, camera processing, to data transmission. Teledyne DALSA provides features, events, and I/O signals that provide the system designer with the tools to qualify the system in real time.

The Teledyne DALSA website provides general information, FAQ, and White Paper downloads about the Trigger-to-Image Reliability (T2IR) framework in hardware and Sapera LT software SDK. See https://www.teledynedalsa.com/en/learn/knowledge-center/trigger-to-image-reliability-t2ir/.

T2IR with Falcon4-CLHS

Benefits for imaging systems include:

- Makes system more predictable
- Prevents many errors before they happen
- Manages system exceptions in controlled manner
- Provides system debugging and tracing
- Reduces downtime

The Falcon4 provides a number of features for system monitoring:

- Built-in Self-Test on power-up and reset after firmware change
- Internal temperature reporting
- In-camera event status flags
- Invalid external trigger
- Image lost

Features for T2IR Monitoring

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

Camera Status Monitoring	
Refresh BIST	deviceBIST
Device Built-In Self Test Status	deviceBISTStatus
Device Version	DeviceVersion
Firmware Version	DeviceFirmwareVersion
Manufacturer Part Number	deviceManufacturerPartNumber
Manufacturer Info	DeviceManufacturerInfo
Acquisition and Triggers	
Valid Frame Trigger	ValidFrameTrigger
Invalid Frame Trigger	InvalidFrameTrigger

Technical Specifications

Both 2D and 3D design drawings are available for download from the Teledyne DALSA web site [https://www.teledynedalsa.com/en/products/imaging/cameras/falcon4-clhs/].

Falcon4-CLHS Identification and Mechanical

Identification Label

Falcon4 cameras have an identification label applied to the bottom side, with the following information:

- Model Part Number
- Serial number
- Calibration date
- Barcode

Additional Mechanical Notes

For information on lens requirements see Choosing a Lens with the Correct Image Circle.

Each camera side has two mounting holes in identical locations, which provide good grounding capabilities.

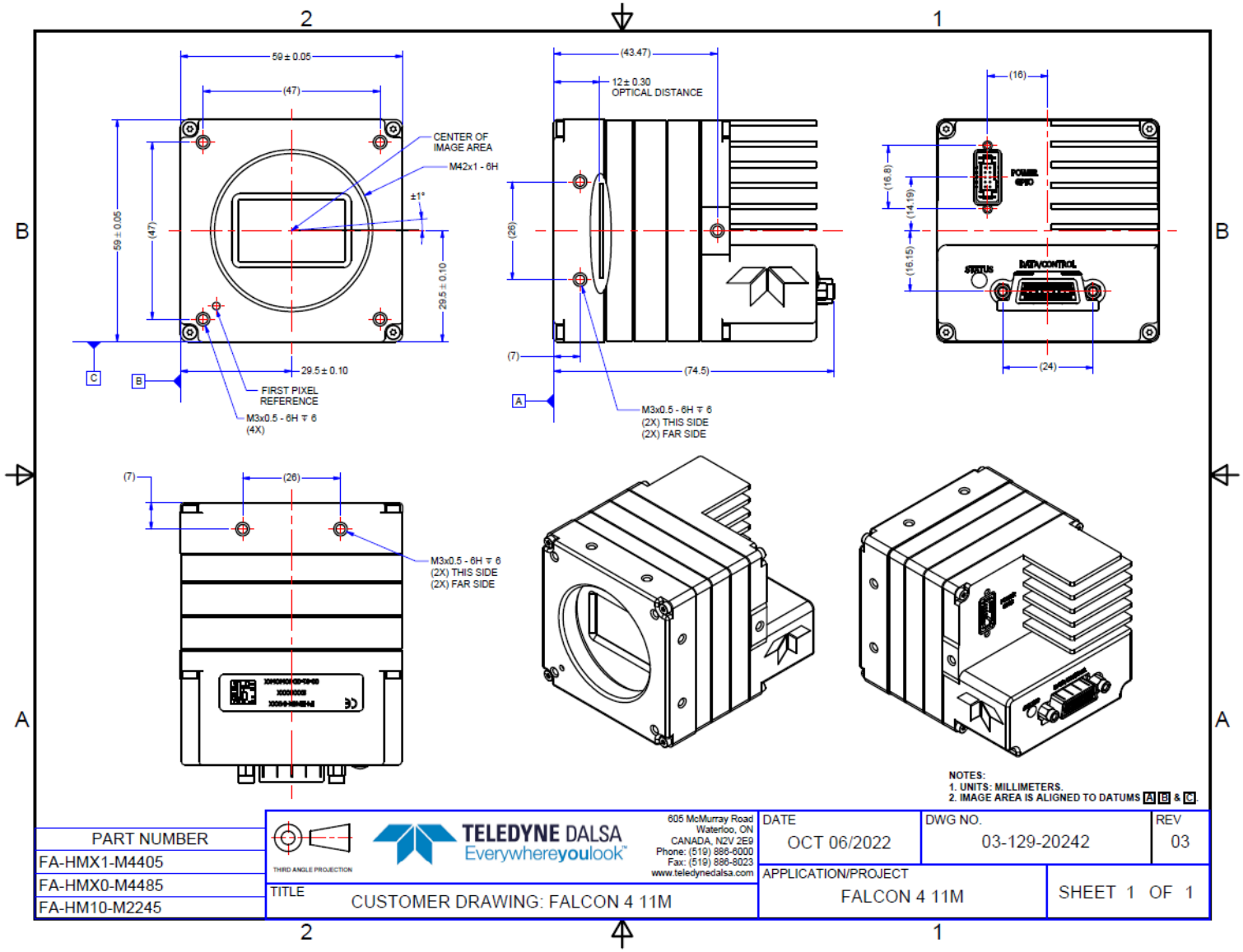
Overall height or width tolerance is ± 0.05mm.

Temperature Management

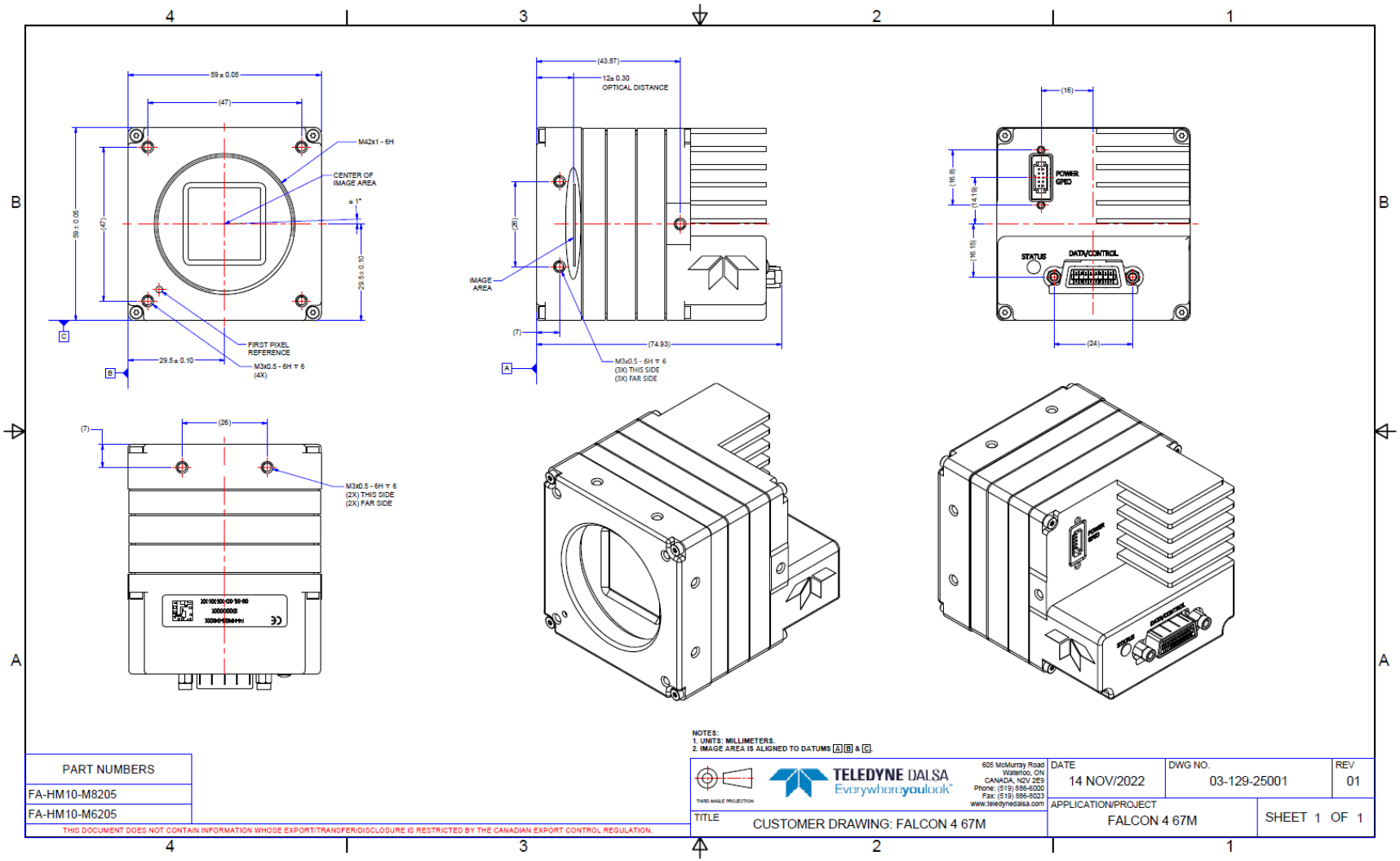
Falcon4-CLHS cameras are designed to optimally transfer internal component heat to the outer metallic body. If the camera is free standing (that is, not mounted) it will be hot to the touch.

Basic heat management is achieved by mounting the camera onto a metal structure via its mounting screw holes. Heat dissipation is improved by using thermal paste between the camera body (not the front plate) and the metal structure plus the addition of a heatsink structure.

Mechanical Specifications with M42 Mount



Falcon4 11M, models M2240, M4400 and M4480.

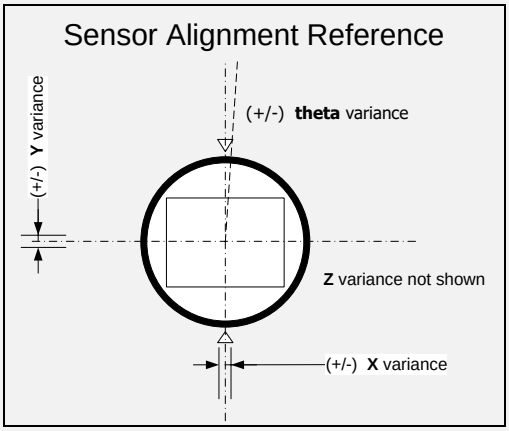


Falcon4 67M, model M8200.

Sensor Alignment Specification

The following figure specifies sensor alignment for Falcon4 where all specifications define the absolute maximum tolerance allowed for production cameras. Dimensions X, Y, Z, are in microns and referenced to the Falcon4 mechanical body or the optical focal plane (for the Z-axis dimension). Theta specifies the sensor rotation relative to the sensor's center and Falcon4 mechanical.

X variance	+/- 100 microns
Y variance	+/- 100 microns
Z variance	+/- 300 microns
Theta variance	+/- 1 degree

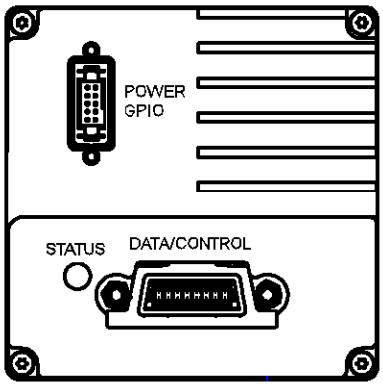


Connectors

The Falcon4-CLHS camera has two connectors on its back panel. There is one CLHS (CX4) standard data and control connector plus a locking 10-pin connector for power and I/O signals. These are described below.

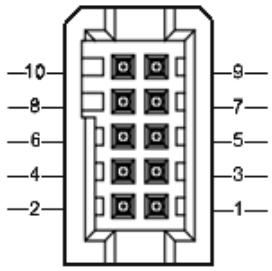
Camera Link HS (CX4)

The Camera Link HS camera connector (CX4) is defined in document **Specifications of the Camera Link HS Interface Standard for Digital Cameras and Frame Grabbers**, which is at version 1.1 at the time of this manual's writing. Typically, there is no need to be concerned with the physical pinout of the CX4 connector or cables. Refer to the site www.automate.org for additional information.



10-pin I/O Connector Details

A DC power source is connected to the 10-pin connector (SAMTEC TFM-105-02-L-D-WT). Falcon4-CLHS supports connecting cables with retention latches and/or screw locks. The following figure shows the pin number assignment.



SAMTEC
TFM-105-02-L-D-WT

Teledyne DALSA makes available optional I/O cables as described in I/O Cable Accessories. Contact Sales for availability and pricing.

Pinout Details for FA-HM00-M4485

Pin Number	Signal	Direction	Definition
1	PWR-GND	—	Camera Power – Ground
2	PWR-VCC	—	Camera Power – DC +10 to +30 Volts
3	GPI-Common	—	General Input/Output Common Ground
4	GPO-Power	—	General Output Common Power
5	GPI 1	In	General External Input 1
6	GPO 1	Out	General External Output 1
7	GPI 2	In	General External Input 2
8	GPO 2	Out	General External Output 2
9	GPO 3	Out	General External Output 3 / Fast Switching Output
10	Reserved		Do not use.

Pinout Details for FA-HM10-M2245, FA-HM11-M4405, FA-HM10-M4485, FA-HM10-M8205

Pin Number	Signal	Direction	Definition
1	PWR-GND	—	Camera Power – Ground
2	PWR-VCC	—	Camera Power – DC +10 to +30 Volts
3	GPI-Common	—	General Input/Output Common Ground
4	GPO-Power	—	General Output Common Power
5	GPI 1	In	General External Input 1
6	GPO 1	Out	General External Output 1 / Fast Switching Output
7	GPI 2	In	General External Input 2
8	GPO 2	Out	General External Output 2 / Fast Switching Output
9	GPO 3	Out	General External Output 3 / Fast Switching Output
10	GPO 4	Out	General External Output 4 / Fast Switching Output

Camera DC Power Characteristics

DC Operating Characteristics		
Input Voltage	+10 Volts minimum	
Input Power Consumption	@ +12 Volt Supply	10.02 Watts typical*
Input Power Consumption	@ +24 Volt Supply	9.6 Watts typical*

* M2240, M4400 and M4480 models. Values for M8200 to be confirmed later.

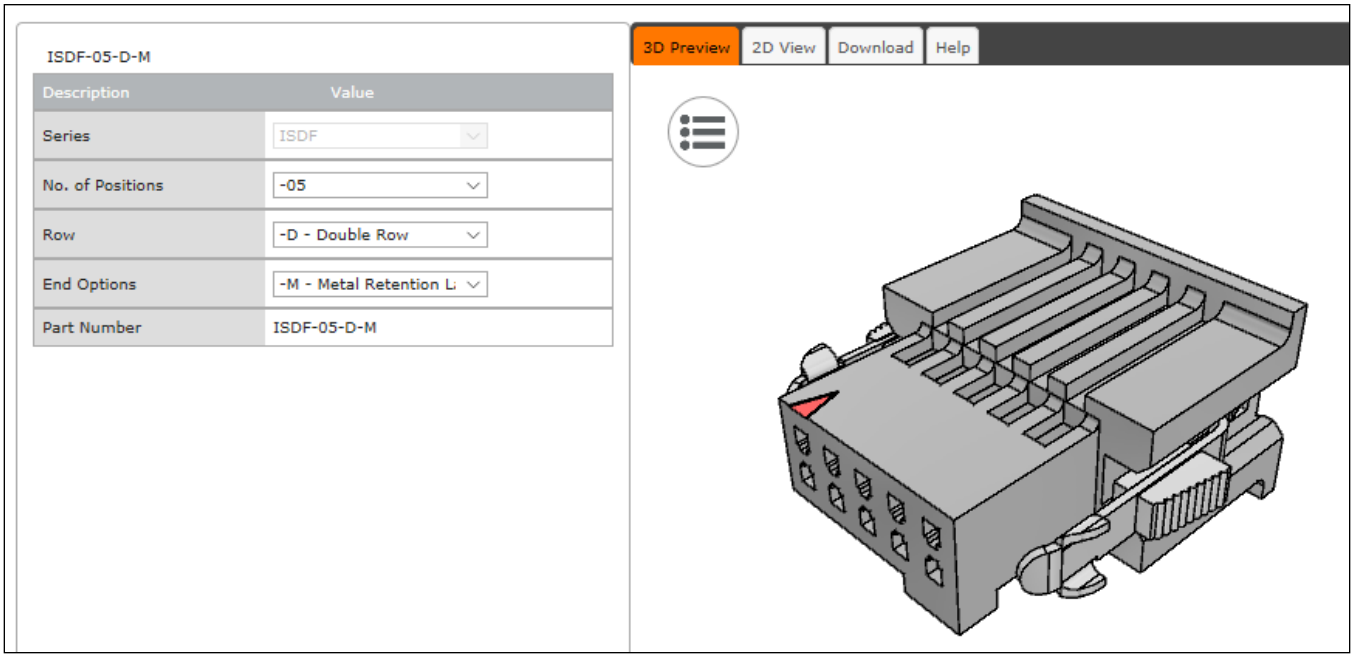
Absolute Maximum DC Power Supply Range before Possible Device Failure		
Input Voltage	–50 Volt DC	+50 Volts DC

I/O Mating Connector Specifications & Sources

For users wishing to build their own custom I/O cabling, the following product information is provided to expedite your cable solutions. The SAMTEC web information for the discrete connector and a cable assembly with retention clips follows the table below.

MFG	Part #	Description	Data Sheet
Samtec	ISDF-05-D ISDF-05-D-M (*see image below*)	Discrete Connector *(see example below)*	https://www.samtec.com/products/isdf
Samtec	SFSD-05-[WG]-G-[AL]-DR-[E2O] *WG : Wire Gauge* *AL : Assembled Length* *E2O : End 2 Option*	Discrete Cable Assembly *(see example below)*	https://www.samtec.com/products/sfsd
ISDF-05-D-M Connector Availability On-Line			
North-America (specific country can be selected)		http://www.newark.com/samtec/isdf-05-d-m/connector-housing-receptacle-10/dp/06R6184	
Europe (specific country can be selected)		http://uk.farnell.com/samtec/isdf-05-d-m/receptacle-1-27mm-crimp-10way/dp/2308547?ost=ISDF-05-D-M	
Asia-Pacific (specific country can be selected)		http://sg.element14.com/samtec/isdf-05-d-m/receptacle-1-27mm-crimp-10way/dp/2308547?ost=ISDF-05-D-M	
Important: *Samtec ISDF-05-D-S is not compatible with Falcon4.*			

Samtec ISDF-05-D-M mating connector for customer-built cables w/retention clips
“.050” Tiger Eye™ Discrete Wire Socket Housing”

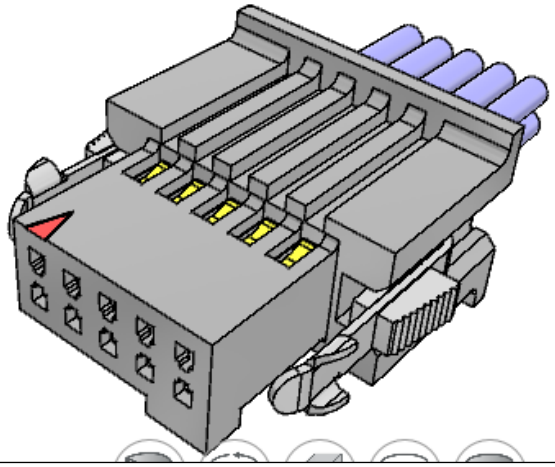


Samtec connector-cable assembly SFSD-05-28-H-03.00-SR w/retention clips
“.050” Tiger Eye™ Double Row Discrete Wire Cable Assembly, Socket”

SFSD-05-28-H-03.00-SR

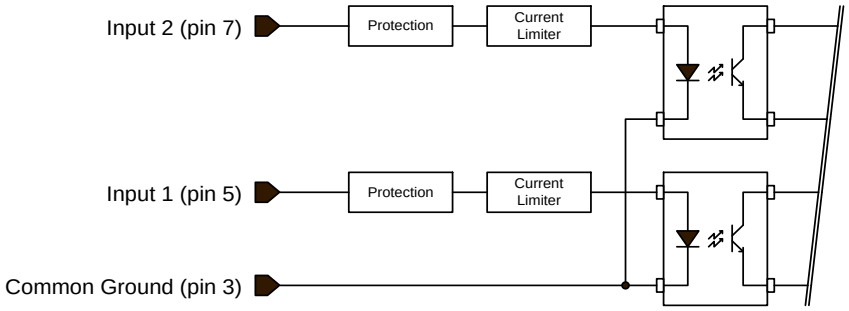
Description	Value
Series	SFSD
No. of Positions	-05
Wire Gauge	-28 AWG
Wire Color Code	All Black Wire
Plating Options	-H - 30µ" Heavy Gold
Assembly Length	3.00 INCH
End Option	-SR - Single Ended wit
Notch Option	Not Available
Part Number	SFSD-05-28-H-03.00-SR
Cable Type Option	PVC Cable

3D Preview | 2D View | Download | Help



Input Signals Electrical Specifications

External Inputs Block Diagram



External Input Details

- Opto-coupled with internal current limit.
- Single input trigger threshold level
  (TTL standard: <0.8 V = Logical LOW, >2.4 V = Logical HIGH. See *lineDetectionLevel* feature).
- Used as trigger acquisition event, counter or timestamp event, or integration control.
- User programmable debounce time from 0 to 255 µs in 1 µs steps.
- Source signal requirements:
  - Single-ended driver meeting TTL, 12 V, or 24 V standards (see table below)
  - If using a differential signal driver, only one input can be used due to the shared input common (see details below)

External Input DC Characteristics

Operating Specification	Minimum	Maximum
Input Voltage	+3 V	+36 V
Input Current	7 mA	11.8 mA
Input logic Low		0.8 V
Input logic High	2.5 V	

Absolute Maximum Range before Possible Device Failure

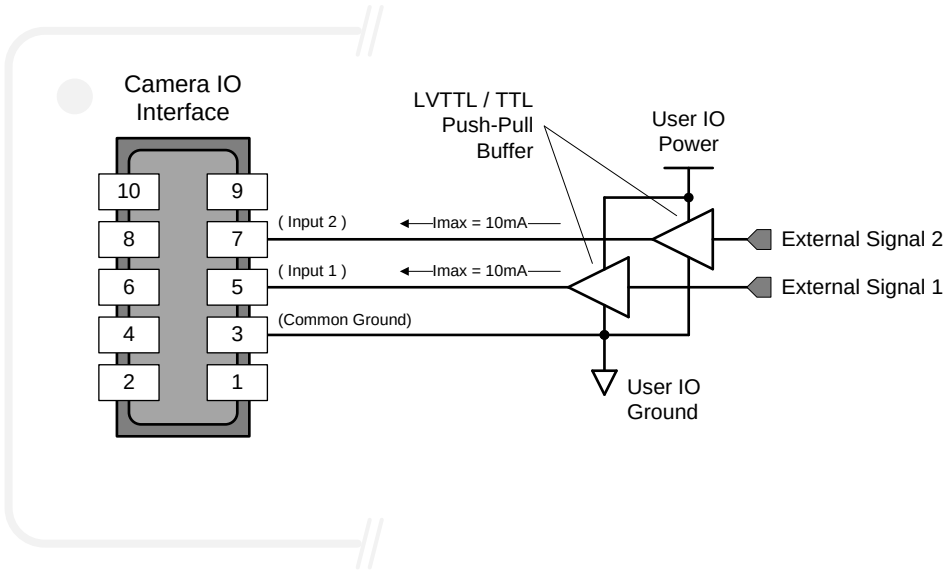
Absolute Ratings	Minimum	Maximum
Input Voltage	–36 Volts	+36 Volts

External Input AC Timing Characteristics

Conditions	Description	Min	Unit
Input Pulse 0V – 3V	Input Pulse width High	132	µs
	Input Pulse width Low	1.22	µs
	Max Frequency	392	KHz
Input Pulse 0V – 5V	Input Pulse width High	202	µs
	Input Pulse width Low	1.28	µs
	Max Frequency	392	KHz
Input Pulse 0V -12V	Input Pulse width High	345	µs
	Input Pulse width Low	1.28	µs
	Max Frequency	392	KHz
Input Pulse 0V – 24V	Input Pulse width High	132	µs
	Input Pulse width Low	1.22	µs
	Max Frequency	392	KHz

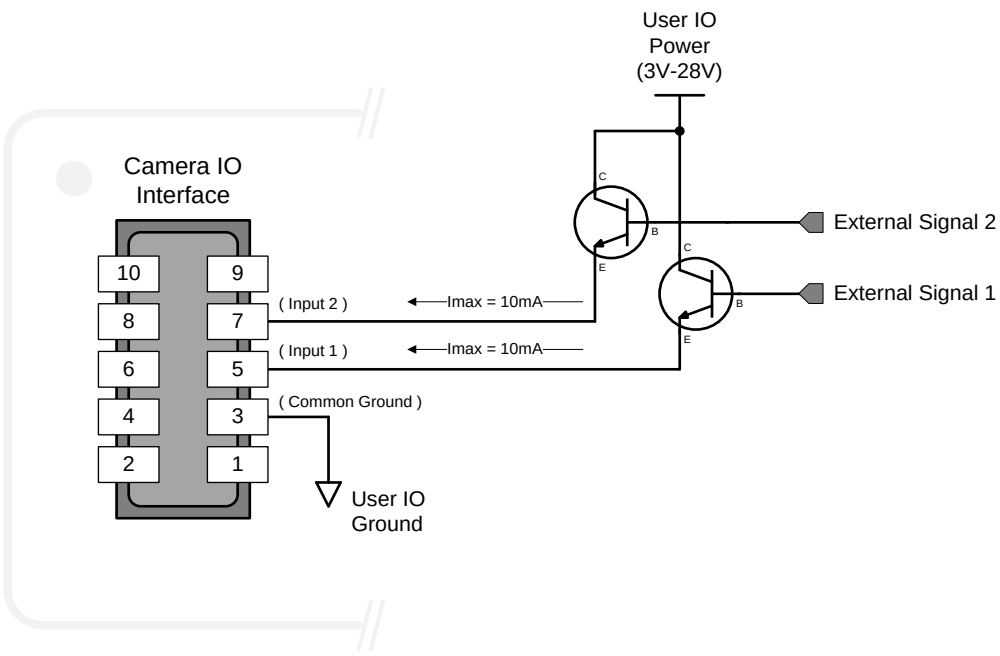
External Inputs: Using TTL/LVTTL Drivers

- External Input maximum current is limited by the Falcon4 circuits to a maximum of 12 mA.



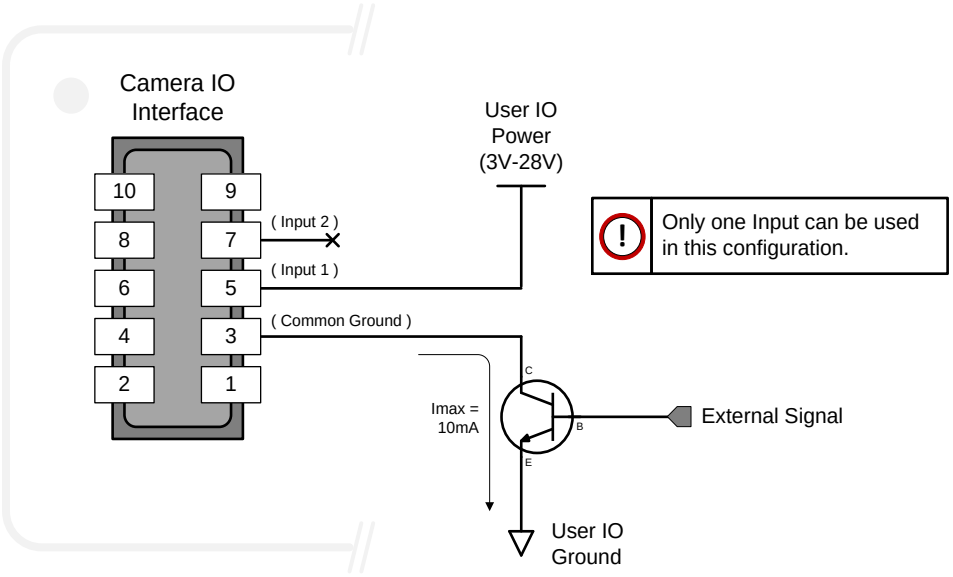
External Inputs: Using Common Collector NPN Drivers

- External Input maximum current is limited by the Falcon4 circuits to a maximum of 12 mA.



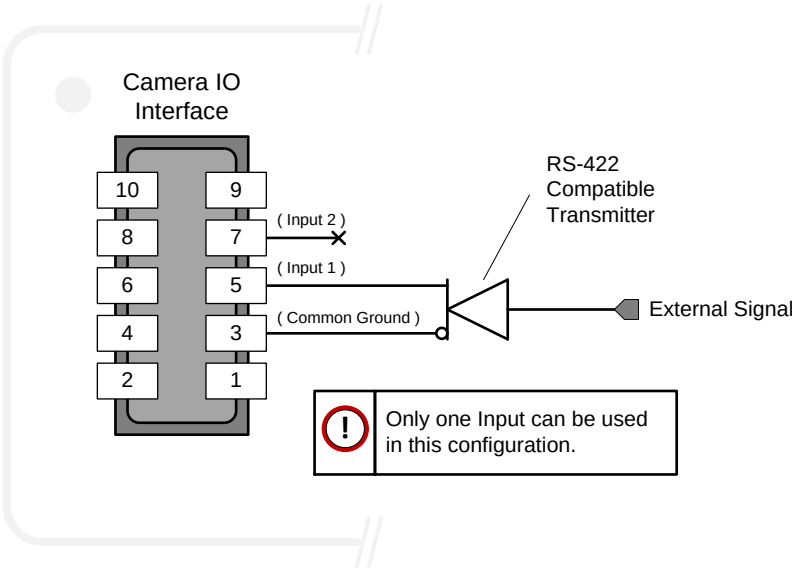
External Inputs: Using Common Emitter NPN Driver

- External Input maximum current is limited by the Falcon4 circuits to a maximum of 12 mA.
- Warning: Only one External Signal can be used (input 1 or input 2).



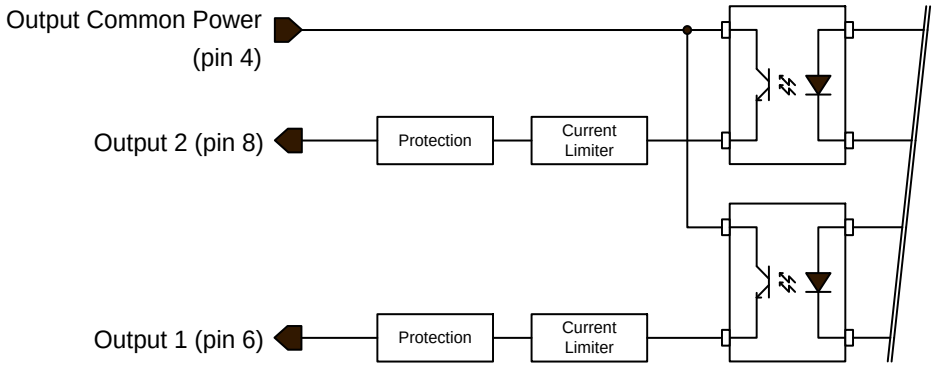
External Inputs: Using a Balanced Driver

- Warning: Only one External Signal can be used (input 1 or input 2).



Output Signals Electrical Specifications

External Outputs Block Diagram

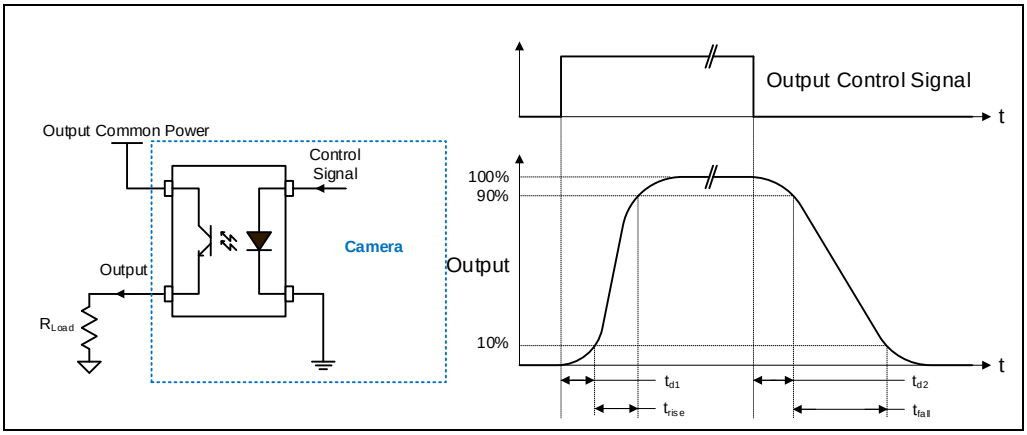


External Output Details and DC Characteristics

- Programmable output mode such as strobe, event notification, etc. (see *outputLineSource* feature)
- Outputs are open on power-up with the default factory settings
- A software reset will not reset the outputs to the open state if the outputs are closed
- A user setup configured to load on boot will not reset the outputs to the open state if the outputs are closed
- No output signal glitch on power-up or polarity reversal
- **Typical** Operating Common Power Voltage Range: +3 V to 28 Vdc at 24 mA
- **Maximum** Common Power Voltage Range : ±30 Vdc
- **Maximum** Output Current: 36 mA

External Output AC Timing Characteristics

The graphic below defines the test conditions used to measure the Falcon4 external output AC characteristics, as detailed in the tables that follows.



Output Characteristics, FA-HM00-M4485

Opto-coupled Output: AC Characteristics

Note: All measurements subject to some rounding.

The following tables describes **GPO 1** and **GPO 2** when the load is connected to a user-provided ground. Test conditions are with front plate temperature ~60C.

Output Common Power	Output Current	R_{load} *Test (ohm)*	t_{d1} (µs) *Leading Delay*	t_{rise} (µs) *Rise Time*	t_{d2} (µs) *Trailing Delay*	t_{fall} (µs) *Fall Time*	V_{out} (V)
3V	8 mA	240	0.459	3	11	20.41	2.17
	12ma	144	0.6	6.95	4.4	20	1.75
	16 mA	40	0.6	11	1	12.9	0.559
5V	8 mA	523	0.469	2.64	12	22	4.24
	16 mA	159	0.485	7.52	2.55	12	2.57
	24 mA	69	0.64	7.52	1	8.42	1.69
12V	8 mA	1400	0.52	3.28	10.6	25.64	11.23
	16 mA	595	0.52	3.28	4.12	13.86	9.61
	24 mA	360	0.531	3.76	2.48	13.8	8.72
24V	8 mA	2907	0.541	1.63	22.8	37.8	23.31
	16 mA	1346	0.556	2.2	7.4	18.32	21.58
	24 mA	861	0.567	2.5	6.61	12.93	20.72

General Purpose Output 3 Fast Switching

GPO 3 supports a fast switching mode with ground of the user load connected to pin 3 (General Input/Output Common Ground). Note, **GPO 1** and **GPO 2** do not support fast switching. Test conditions are with front plate temperature ~60C.

Output Common Power	Output Current	R_{load} Test (ohm)	t_{d1} (us) Leading Delay	t_{rise} (µs) Rise Time	t_{d2} (µs) Trailing Delay	t_{fall} (µs) Fall Time	V_{out} (V)
5V	8 mA	561	1	0.7	3.64	0.5	4.53
	16 mA	277	1	0.7	3.48	0.659	4.45
	24 mA	182	1	0.7	3.32	0.65	4.37
12V	8 mA	1444	0.934	0.2321	2.88	0.949	11.49
	16 mA	713	0.945	0.2563	2.86	0.42	11.41
	24 mA	467	0.952	0.2739	2.78	0.224	11.33
24V	8 mA	2930	0.81	0.2079	3.542	1.639	23.57
	16 mA	1464	0.803	0.2244	2.908	0.981	23.47
	24 mA	970	0.82	0.2222	2.6	0.616	23.39

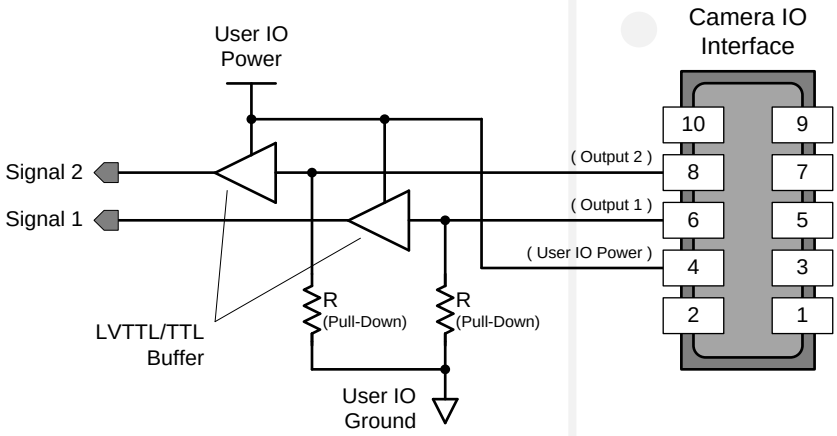
Output Characteristics, FA-HM10-M2245, FA-HM11-M4405, FA-HM10-M4485, FA-HM10-M8205

General Purpose Outputs 1, 2, 3 and 4 Fast Switching

On these models, all general-purpose outputs support a fast switching mode with ground of the user load connected to pin 3 (General Input/Output Common Ground). Test conditions are with front plate temperature ~60C.

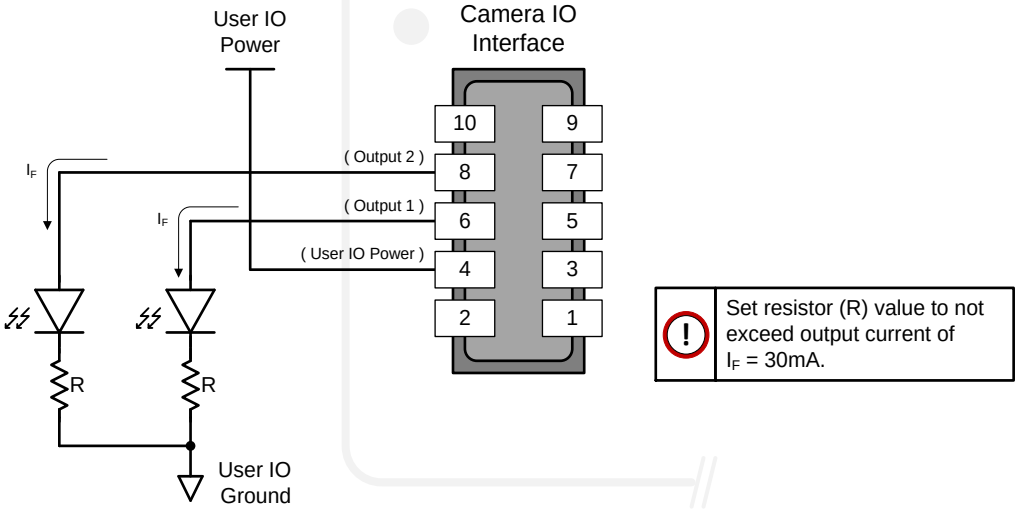
Output Common Power	Output Current	R_{load} Test (ohm)	t_{d1} (us) Leading Delay	t_{rise} (µs) Rise Time	t_{d2} (µs) Trailing Delay	t_{fall} (µs) Fall Time	V_{out} (V)
5V	8 mA	561	1	0.7	3.64	0.5	4.53
	16 mA	277	1	0.7	3.48	0.659	4.45
	24 mA	182	1	0.7	3.32	0.65	4.37
12V	8 mA	1444	0.934	0.2321	2.88	0.949	11.49
	16 mA	713	0.945	0.2563	2.86	0.42	11.41
	24 mA	467	0.952	0.2739	2.78	0.224	11.33
24V	8 mA	2930	0.81	0.2079	3.542	1.639	23.57
	16 mA	1464	0.803	0.2244	2.908	0.981	23.47
	24 mA	970	0.82	0.2222	2.6	0.616	23.39

External Outputs: Using External TTL/LVTTL Drivers

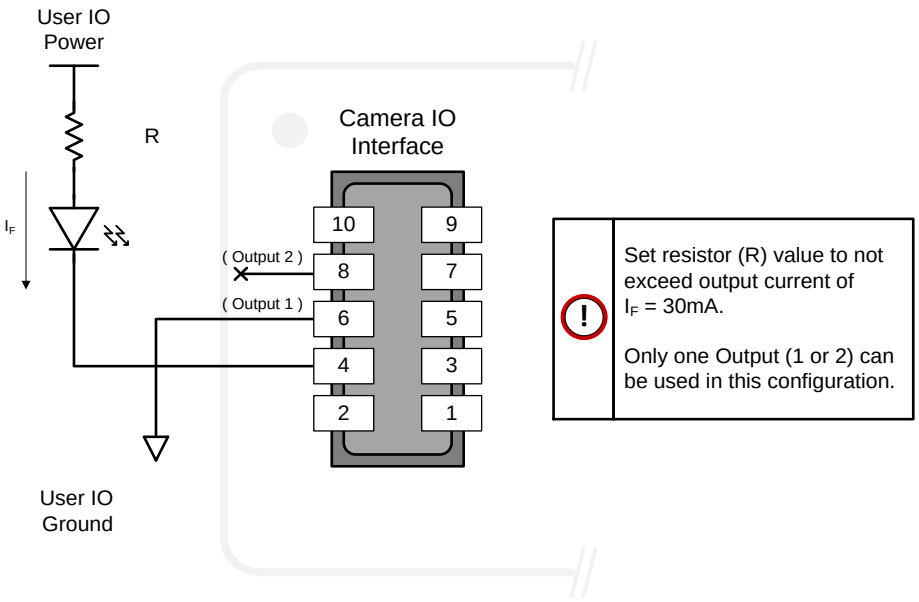


External Outputs: Using External LED Indicators

- Two external LEDs can be connected in the Common Cathode configuration.

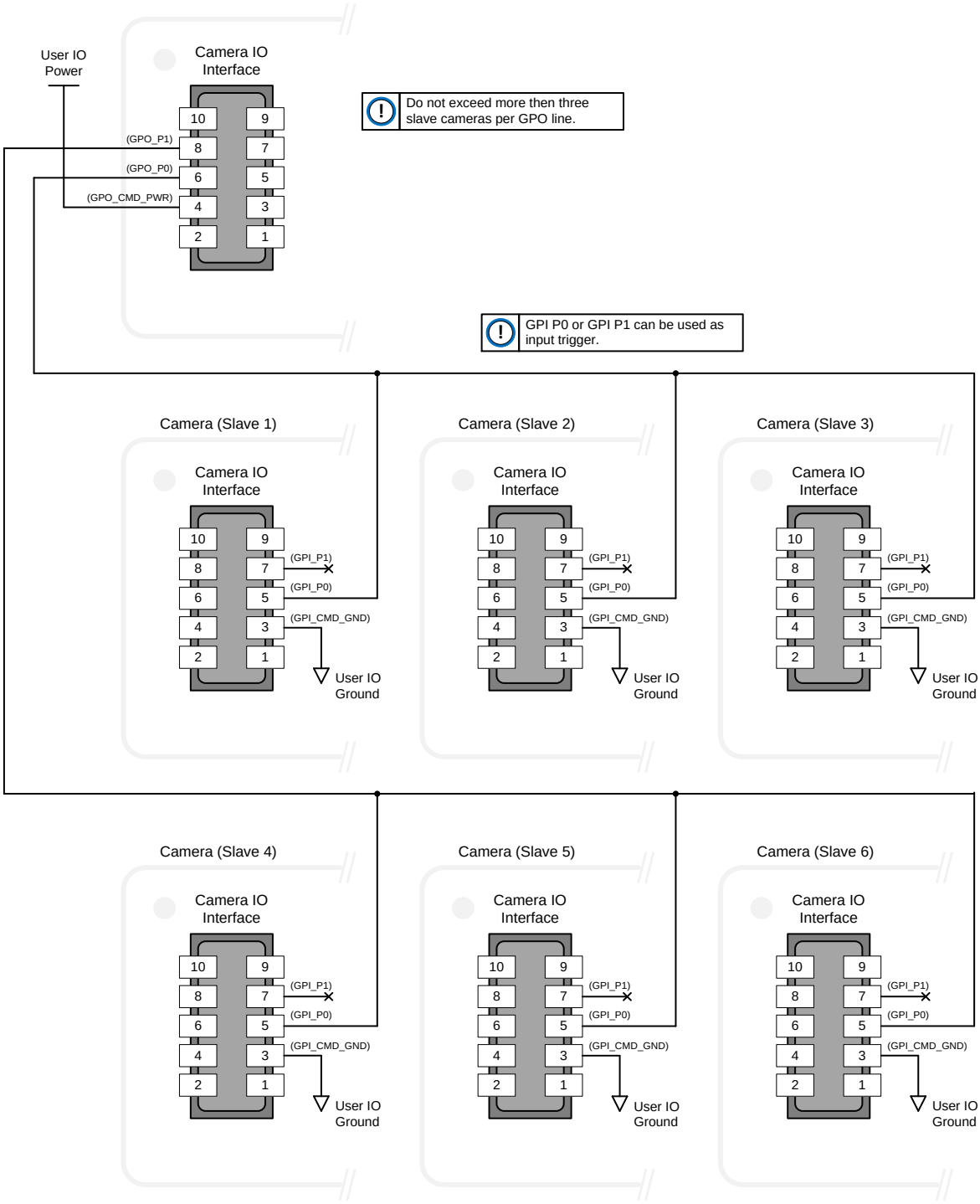


- Alternatively, one external LED can be connected in the Common Anode configuration.



Using Falcon4 Outputs to drive other Falcon4 Inputs

- A synchronization method where one Falcon4 camera signals other Falcon4 cameras.
- Note: One Falcon4 output can drive a maximum of three Falcon4 inputs, as illustrated below.


User IO Power
Camera IO Interface
10
9
8
7
6
5
4
3
2
1
(GPO_P1)
(GPO_P0)
(GPO_CMD_PWR)
Do not exceed more then three slave cameras per GPO line.
GPI P0 or GPI P1 can be used as input trigger.
Camera (Slave 1)
Camera (Slave 2)
Camera (Slave 3)
Camera (Slave 4)
Camera (Slave 5)
Camera (Slave 6)
(GPI_P1)
(GPI_P0)
(GPI_CMD_GND)
User IO Ground

Declarations of Conformity

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

FCC Statement of Conformance

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

1. The product may not cause harmful interference; and

2. The product must accept any interference received, including interference that may cause undesired operation.

FCC Class A Product

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

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

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

EU and UKCA Declaration of Conformity

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

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

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

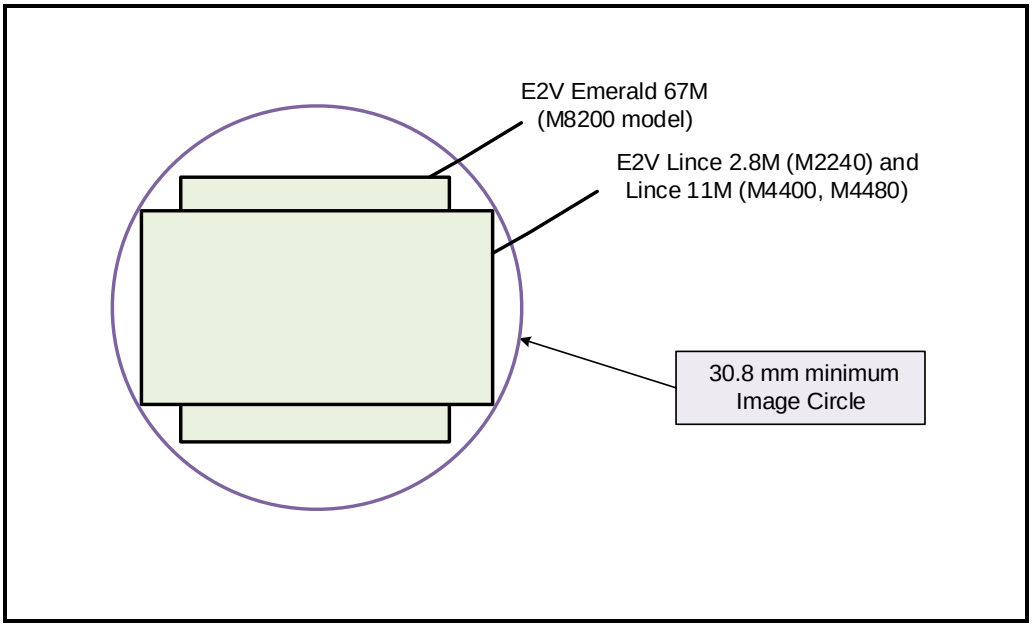
Additional Reference Information

Choosing a Lens with the Correct Image Circle

Falcon4 requires a lens with an image circle specification to fully illuminate the sensor. The following section graphically shows the minimum lens image circle for each model along with alternative lens types. Brief information on other lens parameters to consider follows those sections.

Lens Options for Models with M42 Mounts

- The following figure shows the lens image circles relative to Falcon4-CLHS models using the Lince 2.8 M, Lince 11M, and Emerald 67M sensors.
- Cameras with a M42 screw mount need image circles exceeding the diameter of the sensors.



Additional Lens Parameters (application specific)

There are other lens parameters that are chosen to meet the needs of the vision application. These parameters are independent of the Falcon4. A vision system integrator or lens specialist should be consulted when choosing lenses since there is a tradeoff between the best lenses and cost. An abridged list of lens parameters follows – all of which need to be matched to the application.

- **Focal Length**: Defines the focus point of light from infinity. See Camera Specifications — Back Focal Distance.
- **Field of View**: A lens is designed to image objects at some limited distance range, at some positive or negative magnification. This defines the field of view.
- **F-Number (aperture)**: The lens aperture defines the amount of light that can pass. Lenses may have fixed or variable apertures. Additionally, the lens aperture affects Depth of Field which defines the distance range which is in focus when the lens is focus at some specific distance.
- **Image Resolution and Distortion**: A general definition of image quality. A lens with poor resolution appears out of focus when used to image fine details.
- **Aberrations (defect, chromatic, spherical)**: Aberrations are specific types of lens faults affecting resolution and distortion. Lens surface defects or glass faults distort all light or specific colors. Aberrations are typically more visible when imaging fine details.
- **Spatial Distortions**: Describes non-linear lens distortions across the field of view. Such distortion limits the accuracy of measurements made with that lens.

Optical Considerations

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

Illumination

The wavelengths and intensity of light required to capture useful images vary per application. The image will be affected by speed, spectral characteristics, exposure time, light source characteristics, environmental and acquisition system specifics, etc. Look at Teledyne DALSA's Knowledge Center for articles on this potentially complicated issue.

Exposure settings have more effect than illumination. The total amount of energy (which is related to the total number of photons reaching the sensor) is more important than the rate at which it arrives.

Example: 5 $\mu J/cm^2$ can be achieved by exposing 5 mW/cm^2 for 1 ms or exposing 5 W/cm^2 for 1 μs.

Light Sources

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

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

Back Focal Variance when using any Filter

Inserting a filter between a lens and sensor changes the back focal point of the lens used. A variable focus lens simply needs to be adjusted, but in the case of a fixed focus lens, the changed focal point needs correction.

The following simplified illustration describes this but omits any discussion of the optics, physics, and math behind the refraction of light through glass filter media.

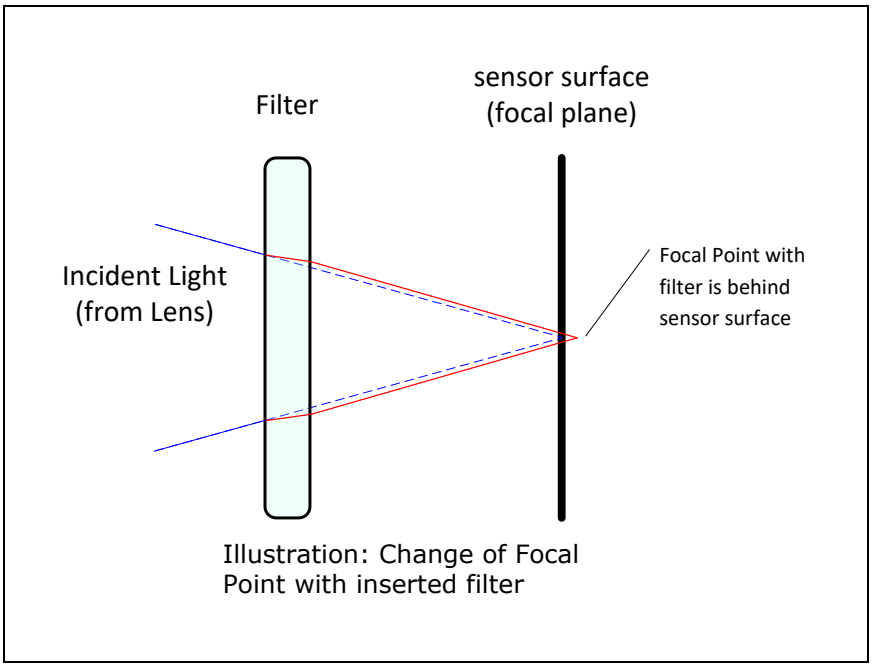


Illustration: Change of Focal Point with inserted filter

In this example when a glass filter is inserted between the lens and the camera sensor, the focal point is now about 1/3 of the filter thickness behind the sensor plane.

Lens Modeling

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

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

Primary Points in a Lens System

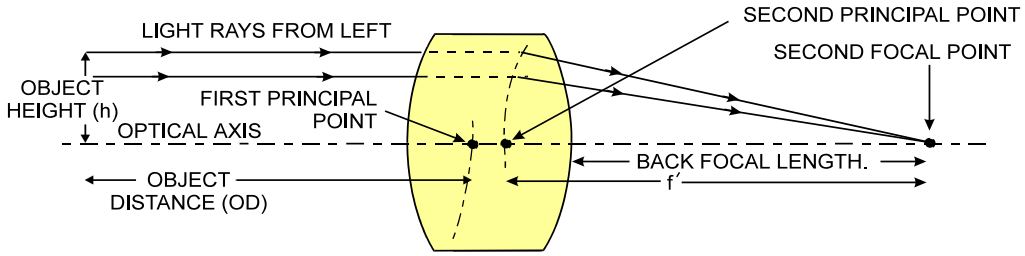


Figure 1: Primary Points in a Lens System

Magnification and Resolution

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

$m = h'/h$	Where m is the magnification, h' is the image height (pixel size) and h is the object height (desired object resolution size).

By similar triangles, the magnification is alternatively given by:

$m = f'/OD$	Where f' is the focal length and OD is the target object distance.

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

$h'/h = f'/OD$	This is the governing equation for many object and image plane parameters.

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

$(10\ \mu m)/(100\ \mu m) = (45\ mm)/OD$	$OD = 450\ mm\ (0.450\ m)$

Sensor Handling Instructions

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

Electrostatic Discharge and the Sensor

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

Electrostatic charge introduced to the sensor window can induce charge buildup on the underside of the window. The dry nitrogen gas in the sensor package cavity cannot readily dissipate the ESD. Problems such as higher image lag or non-uniform response may occur.

Note: The charge normally dissipates within 24 hours and the sensor returns to normal operation.

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

Protecting Against Dust, Oil and Scratches

The sensor window is part of the optical path and must be handled with extreme care.

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

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

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

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

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

Cleaning the Sensor Window

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

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

- DALSA recommends the use of an ionized air gun and compressor to blow off the sensor.
- Use compressed air to blow off loose particles. This step alone is usually sufficient to clean the sensor window. Avoid moving or shaking the compressed air container and use short bursts of air while moving the camera in the air stream. Agitating the container will cause condensation to form in the air stream.

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

- Use lint-free ESD-safe cloth wipers. The Anticon Gold 9”x 9” wiper made by Milliken is both ESD safe and suitable for class 100 environments. Another ESD acceptable wiper is the TX4025 from Texwipe.
- An alternative to ESD-safe cloth wipers is Transplex swabs that have desirable ESD properties. There are several varieties available from Texwipe.
- Wipe the window carefully and slowly when using these products.

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

I/O Cable Accessories

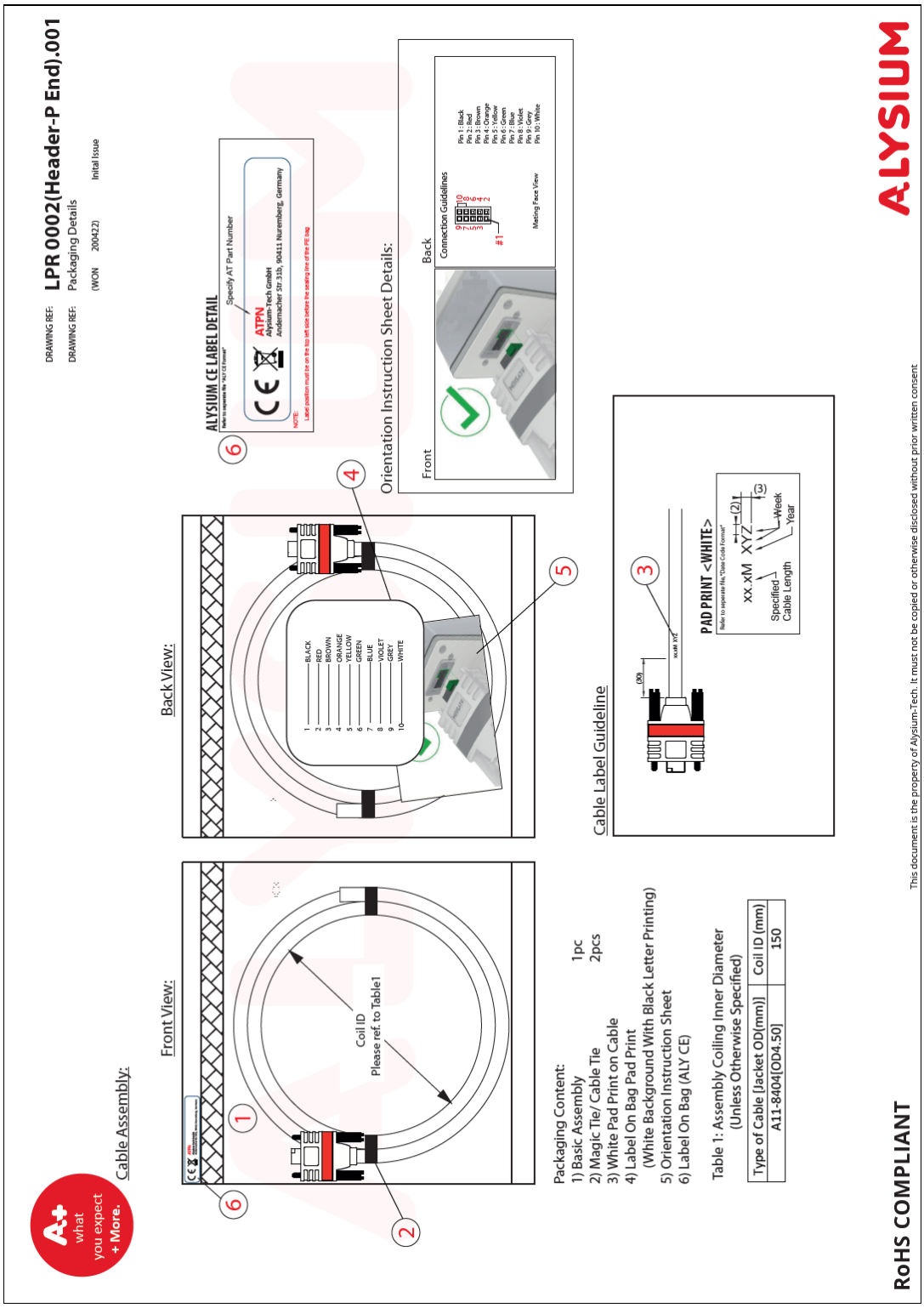
Teledyne DALSA provides optional I/O cable assemblies. Users wishing to build their I/O cabling by starting from available cable packages should consider these popular assemblies described below. Contact Sales for pricing and delivery.

Users also may order cable assembly quantities directly from Alysium-Tech or Hewtech. In such cases use the manufacturer's part number shown on the cable assembly engineering drawing.

Cable Manufacturers Contact Information

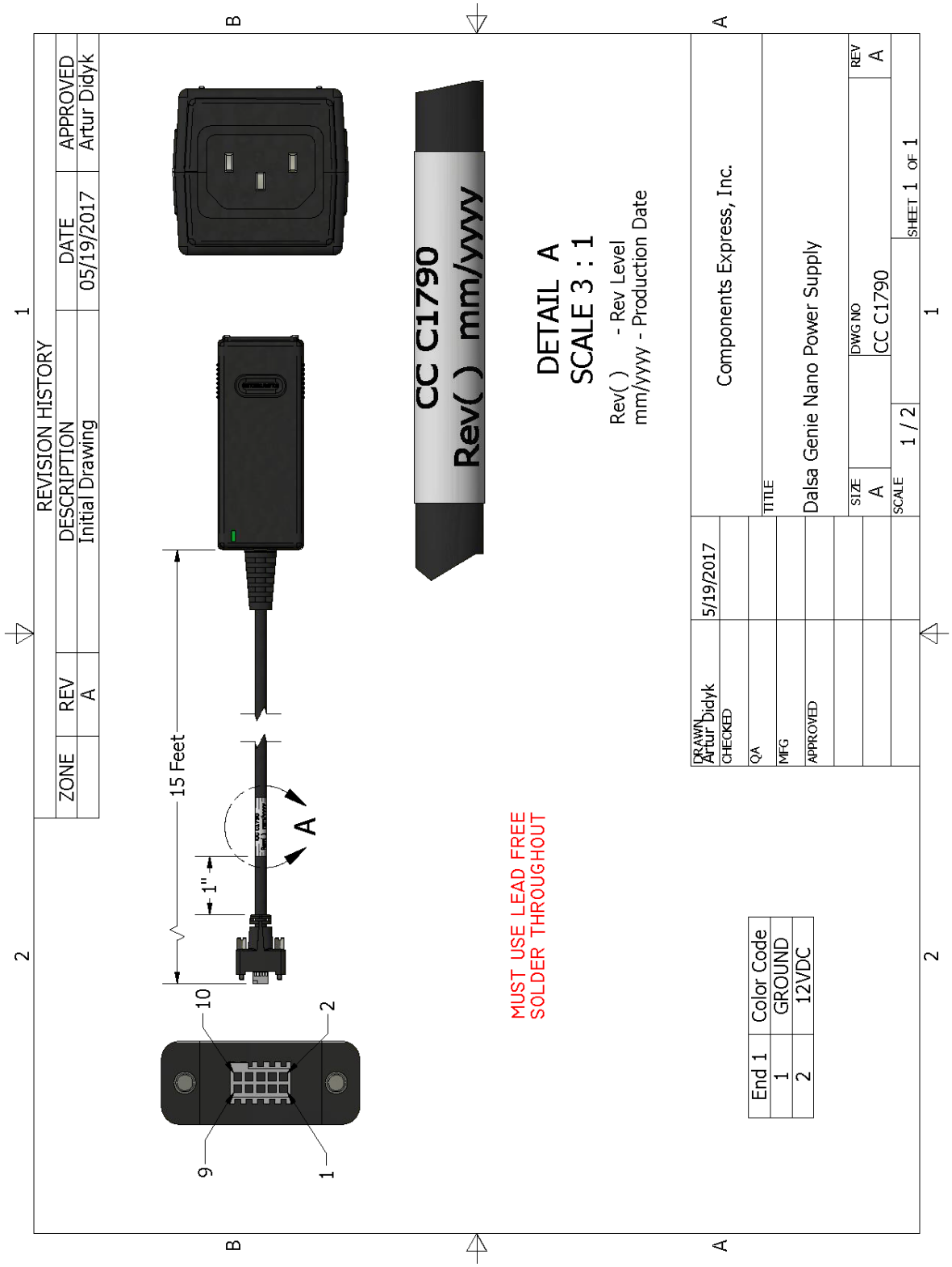
For Information contact: *(see their web site for worldwide offices)*	Alysium-Tech 101 Montgomery Street, Suite 2050 San Francisco, CA 94104 Phone: 415 248 7807 Fax: 415 248 7800 https://www.alysium.com/
	HIRAKAWA HEWTECH CORP Sales Division. 3-28-10 Minami-Ooi, Shinagawa, Tokyo 140-8551 Tel: 03-5493-1711 https://www.hewtech.co.jp/e/index.html

Cable Assembly G5-AIOC-BLUNT2M




ROHS
08/2016

Generic Power Supply with no I/O



Troubleshooting

Overview

In rare cases an installation may fail or there are problems in controlling and using the camera. This section highlights issues or conditions which may cause installation problems. Emphasis is on the user to perform diagnostics with the tools provided plus methods are described to correct the problem.

Problem Type Summary

Problems are either installation issues due to cabling or power, or setup errors with the frame grabber configuration.

Before Contacting Technical Support

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

- From the **Start** menu, select **Teledyne Dalsa Sapera LT** > **Sapera Log Viewer**.
- From its **File** menu click on **Save Messages** to generate a log text file.
- Report the version of camera Firmware and Sapera version used.
- Report the frame grabber brand and model used. Provide specifications for any third party frame grabber used.

Device Available with Operational Issues

This section considers issues with frame grabbers, cabling, multiple cameras and camera exposure.

Firmware Updates

As a general rule any installation must include the firmware update procedure to ensure having the latest build (see Updating Firmware via File Access in CamExpert).

Note:

- A Falcon4 that had a fault with a firmware update will automatically recover by booting with the previous firmware version.

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

Power Failure during a Firmware Update–Now What?

Don’t panic! There is far greater chance that the host computer OS is damaged during a power failure than any permanent problems with the Falcon4. When power returns and the computer restarts, follow the procedure below to complete the firmware update.

- Connect power to the camera. The processor knows that the firmware update failed.
- The camera will boot with the previous version of firmware and will operate normally.
- Perform the firmware update procedure again.

Cabling and Communication Issues

Power supply problems:

- Verify the DC power supply voltage and I/O cable wiring.

Communication Problems:

- Use quality CX4 AOC (Active Optical Cable) cables. For I/O, use quality shielded I/O cables. This can eliminate issues in a high EMI environment. Purchase CX4 cables from certified sources.
- Use the Sapera Log Viewer tool for error conditions:
- From the **Start** menu, select **Teledyne Dalsa Sapera LT** > **Sapera Log Viewer**.
- Start an acquisition program, such as CamExpert.
- Review the log output for error messages.

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

- Using CamExpert, set the Falcon4 to output its Internal Pattern Generator (with external trigger Off). This step is typically done for any camera installation to quickly verify the camera and its software package.
- If using an external trigger exposure (via the frame grabber), verify the trigger source rate and pulse width coming from the grabber parameters.
- Verify that the lens iris is open.
- Aim the camera at a bright light source.
- Check that the programmed exposure duration is not too short or set it to maximum.

Revision History

Revision	Date	Major Change Description
03-032-20295-00	August 18, 2021	Initial release.
03-032-20295-01	February 2, 2022	Binning and Lens Shading Correction.
03-032-20295-02	July 18, 2022	New Long Exposure Mode feature. Update of Output Dynamic Range and Full Well charge values. Update of Responsivity graph.
03-032-20295-03	September 29, 2022	Additional model. New features: Cycling Preset, Metadata, Multi ROI, LUT, Digital Gain.
03-032-20295-04	December 5, 2022	New M8200 model. Updates in metadata (factory gain).
03-032-20295-05	April 25, 2023	New M2240 model.

Contact Information

Sales Information

Visit our web site:	https://www.teledynedalsa.com/en/products/imaging/
Email:	mailto:info@teledynedalsa.com

Canadian Sales

Teledyne DALSA — Head office
605 McMurray Road
Waterloo, Ontario
Canada N2V 2E9
Tel: +1 519-886-6000
Fax: +1 519-886-8023

Teledyne DALSA — Montreal office
880 Rue McCaffrey
Saint-Laurent, Quebec
Canada H4T 2C7
Tel: +1 514-333-1301
Fax: +1 514-333-1388

USA Sales

Teledyne DALSA — Billerica office
700 Technology Park Drive
Billerica, MA
USA 01821
Tel: +1 978-670-2000
Fax: +1 978-670-2010

European Sales

Teledyne DALSA GMBH
Lise-Meitner-Str. 7
82152 Krailling (Munich),
Germany
Tel: +49 – 89 89545730
sales.europe@teledynedalsa.com

Asian Sales

Teledyne DALSA Asia Pacific
Ikebukuro East 6F
3-4-3 Higashi Ikebukuro, Toshima-ku
Tokyo, 170-0013
Japan
Tel: +81 3-5960 6353
Fax: +81 3-5960 6354
sales.asia@teledynedalsa.com

Teledyne DALSA Asia Pacific
Room 904, Block C, Poly West Bund Center
75 Rui Ping Road
Shanghai 200032
China
Tel: +86-21-60131571

sales.asia@teledynedalsa.com

Technical Support

Submit any support question or request via our web site:

Technical support form via our web page: Support requests for imaging product installations, Support requests for imaging applications	https://www.teledynedalsa.com/en/support/options/
Camera support information	
Product literature and driver updates	