Piranha4 8K Color Camera

User's Manual

P4-CC-08K03T-01-R

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

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Teledyne DALSA, a business unit of Teledyne Digital Imaging Inc., is an international high-performance semiconductor and Electronics Company that designs, develops, manufactures, and markets digital imaging products and solutions, in addition to providing wafer foundry services.

Teledyne DALSA offers the widest range of machine vision components in the world. From industry-leading image sensors through powerful and sophisticated cameras, frame grabbers, vision processors and software to easy-to-use vision appliances and custom vision modules.

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The Piranha4 Color Camera

Camera Highlights

Based on Teledyne e2V's unique CMOS color line scan sensor architecture, the Piranha4™ 8k trilinear color cameras provide outstanding signal-to-noise performance for high speed imaging.

The Piranha4 8k model has 8k resolution with a 7.5 µm x 7.5 µm pixel size for optimized optical design. The cameras deliver a maximum line rate of 33 kHz.

Precise sensor alignment simplifies multiple camera calibration at the system level. GenICam™ or ASCII command-compliant interfaces make the camera easier to setup, control, and integrate.

Programmable features include exposure control, flat field correction, and gain settings. The Piranha4 camera is ideal for the inspection of printing, printed circuit board, solar cell, film, and large format webs.

Key Features

- CMOS trilinear color line scan sensor
- 8k pixel resolution
- 3 x 8192 RGB 7.5 µm x 7.5 µm pixels
- Line rates up to 33 kHz x 3
- 24-bits RGB

Programmability

- Camera Link interface
- GenICam or ASCII command-compliant interfaces
- Scan direction
- Flat-field correction
- Parallax correction
- Spatial correction
- White balance
- Color correction matrix

Applications

- Print and paper inspection
- PCB inspection
- Raw material surface inspection
- Parcel and postal sorting
- High resolution document scanning
- Industrial Inspection

Part Numbers and Software Requirements

The camera is available in the following configurations:

Table 1: Available Camera Models

Part Number	Description
P4-CC-08K03T-01-R	8k resolution, 33 kHz line rate, 7.5 µm x 7.5 µm pixel size, trilinear RGB

Table 2: Software

Software	Product Number / Version Number
Camera firmware	Embedded within camera
GenICam™ support (XML camera description file)	Embedded within camera
Sapera LT, including CamExpert GUI application and GenICam for Camera Link imaging driver	Version 7.2 or later

Table 3: Frame Grabbers

Brand	Model
Teledyne DALSA	Xtium CL MX4
Other compatible frame grabbers may be available from third-party vendors.	

Specifications

Camera Performance

Table 4: Camera Performance Specifications

Characteristics	Typical Value	Unit
Sensor Characteristics at Maximum Pixel Rate		
Resolution	8192 x 3	RGB Pixels
Pixel size (square)	7.5 x 7.5	µm
Line rate, maximum	33 x 3	kHz
Radiometric Performance at Maximum Pixel Rate and Minimum Camera Gain		
Bit depth	3 x 8	Bits
Response non linearity	< 1	%
PRNU HF Max	2	%
Dynamic range	56	dB
Peak Response (All Modes)		
Blue (Peak at 460 nm)	7	DN 8-bits/(nJ/cm²)
Green (Peak at 540 nm)	9.5	DN 8-bits/(nJ/cm²)
Red (Peak at 640 nm)	12	DN 8-bits/(nJ/cm²)

Test conditions:

- All values are given at Nominal Gain (0 dB) : Preamp Gain x1, Amp Gain 0 dB
- Figures in DN are for a 8-bits format
- Measured at line period = 200 µs in Ext Trig Mode (Max Exposure Time)
- Maximum data rate

Functionality (Programmable via GenICam Control Interface)		
Analog Gain	Up to 12 (x1 to x4)	dB
Offset (Black Level)	-256 to +256	DN 8-bits
Trigger Mode	Internal and External Triggered (Timed or Max Exposure Time)	
Mechanical and Electrical Interface		
Size (w x h x l)	80 x 80 x 40.1	mm
Weight	295	g
Lens Mounts	M72 x 0.75 embedded in the Front Face	-
Sensor alignment	±150 (X/Y) ±100 (Z)	µm
Sensor flatness	< 50	µm
Power supply	+12 to +24	V
Power dissipation	< 8	W
General Features		
Operating temperature (front face)	0 to 60	°C
Storage temperature	-40 to 70	°C

Camera Characterization

Table 5: Camera Characterization

	Unit	Typ.	Max
Dark Noise RMS	LSB_{10bits}	1.68	2.5
Dynamic Range	dB	55	-
RMS Noise (3/4 Sat)	LSB_{10bits}	2.27	4
Full Well Capacity	e- (per color)	13650	-
SNR (3/4 Sat)	dB	41	-
Peak Response	DN 8-bits/(nJ/cm²)	12 (R), 9.5 (G), 7 (B)	-
Non Linearity	%	0,3	1
Without Flat Field Correction			
FPN rms	DN_{10bits}	0.9	2
FPN pk-pk	DN_{10bits}	5	10
PRNU hf (3/4 Sat)	%	0.1	1
PRNU pk-pk (3/4 Sat)	%	0.7	4

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

Certifications

Table 6: Camera Certification & Compliance

Compliance
Refer to the section EC & FCC Declaration.

Flash Memory Size

Table 7: Camera Flash Memory Specifications

Flash Memory Size
32 MBytes

Supported Industry Stantemdards

GenICam™

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

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

For more information see www.genicam.org.

Sensor Responsivity and QE

Spectral Responsivity

The responsivity graph illustrates the sensor's response to different wavelengths of light (excluding lens and light source characteristics).

	Note: The responsivity of a color camera will measure approximately 1/6th that of a similar monochrome camera model as a result of the effect the color filter has on the sensor and also due to the color camera not incorporating TDI Mode.

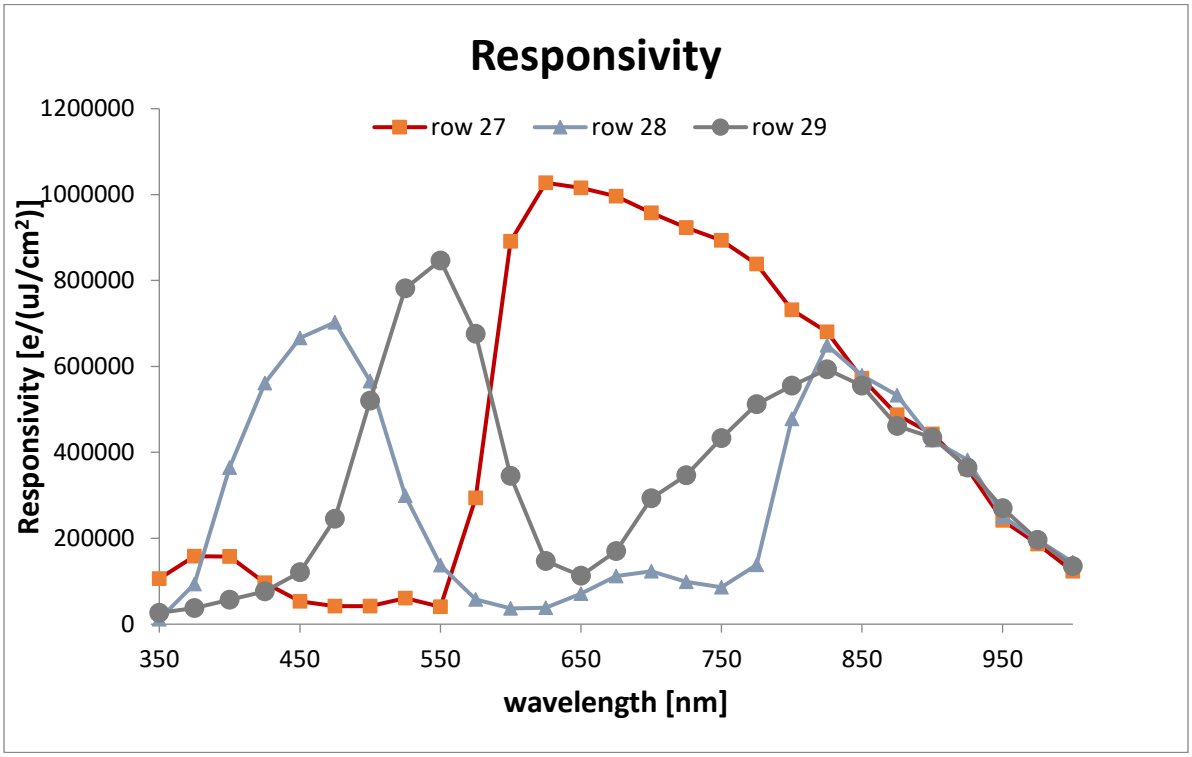


Figure 1: Trilinear Spectral Responsivity

Quantum Efficiency

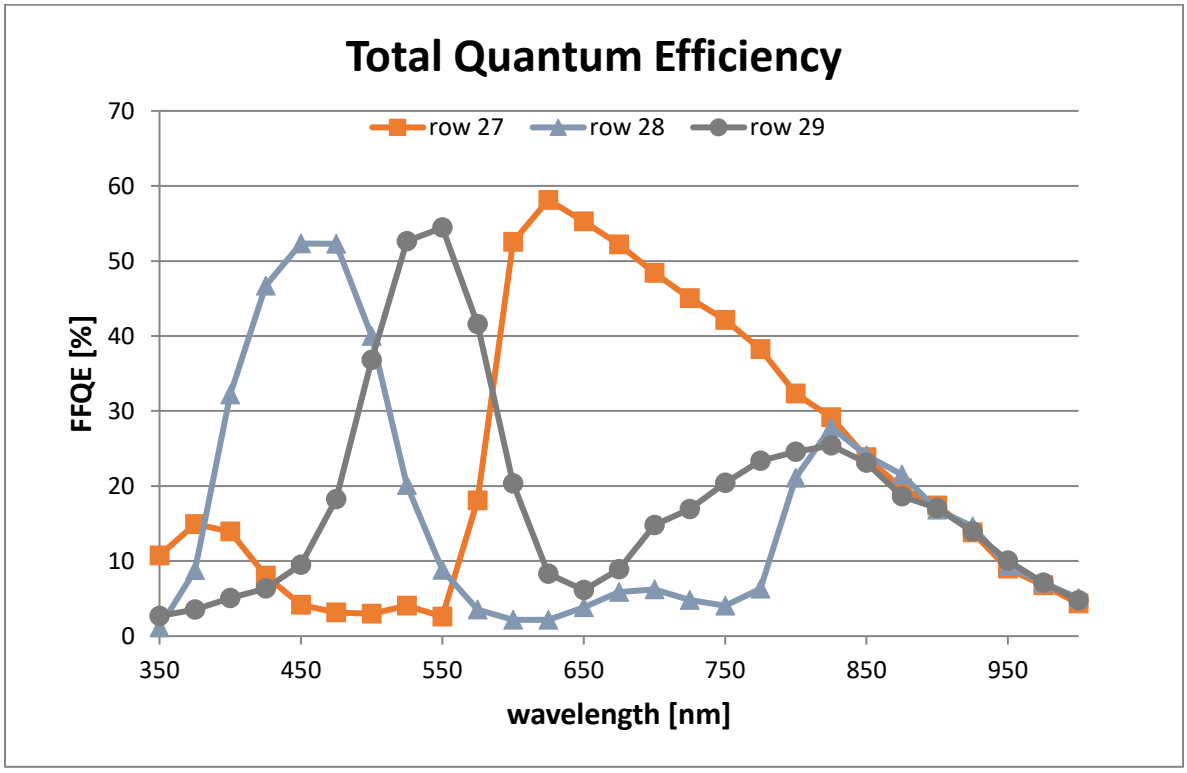


Figure 2: Trilinear Quantum Efficiency

Filters

CMOS cameras are responsive to infrared (IR) wavelengths of light. Infrared light can be problematic with halogen light sources but is not an issue with white LED sources. When infrared light is present with this camera color fidelity is reduced. To prevent infrared from distorting the images you scan, use an IR cut off filter such as a BG-38 on the lens.

Precautions

Read these precautions before using the camera.

Confirm that the camera's packaging is undamaged before opening it. If the packaging is damaged, please contact the relevant logistics personnel.

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

Keep the camera housing temperature in a range of 0 °C to +60 °C during operation.

Do not operate the camera near strong electromagnetic fields. In addition, avoid electrostatic charging, violent vibration, and excess moisture.

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

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

Electrostatic Discharge and the CMOS Sensor

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

Recommended System Requirements

To achieve best system performance, the following minimum requirements are recommended:

- High bandwidth frame grabber. For example, Teledyne DALSA Xtium-CL MX4 series frame grabbers: http://www.teledynedalsa.com/en/products/imaging/frame-grabbers/xtium-cl-mx4/.
- Operating systems: Refer to frame grabber documentation for supported platforms.

Quick Setup and Image Acquisition

Take the following steps in order to setup and run your camera system.

1. Step 1: Install and Configure Frame Grabber and Software
2. Step 2: Connect Camera Link and Power Cables
3. Step 3: Establish Communication with the Camera

Sapera LT

Installing Sapera LT gives you access to the CamExpert GUI, a GenICam™ compliant application. Sapera LT is available free of charge for download from the Teledyne DALSA website. CamExpert is the camera interfacing tool supported by the Sapera library and comes bundled with SaperaLT. Using CamExpert is the simplest and quickest way to send commands to and receive information from the camera.

ASCII Commands

As an alternative to the CamExpert (or equivalent) GUI, you can communicate with this camera using ASCII-based commands. A complete list of the commands can be found in Appendix B: ASCII Commands.

Factory Settings

The color camera has been calibrated and configured at the factory to be ready for your evaluation when first powered up.

The camera ships and powers up for the first time with the following factory settings:

- Camera Link Medium, 8-bit pixels, 85 MHz
- Internal trigger, line rate 10 kHz
- Internal exposure control, exposure time 98.5 µs
- User Flat Field disabled (dependent on light source and lens)
- Offset 0, System Gain 1x (lowest value)
- White balanced gains all set to 1x
- Color correction parameters set to neutral values
- Corrected using an 80 mm lens and a magnification of 0.8

Camera Link mode is set to the standard RGB medium mode which allows operation of up to 20 KHz line rate. The camera will run at up to a 33 KHz line rate using Camera Link Deca mode, but it may be easier to start your evaluation using the medium mode. Set your Camera Link frame grabber up to receive the standard RGB medium mode.

Setup Steps: Overview

Step 1: Install and Configure Frame Grabber and Software

Teledyne DALSA recommends its Xtium-CL MX4 series frame grabbers or equivalent. Follow the manufacturer's installation instructions.

Note: By default, Camera Link mode is set to the standard 8-bit full mode which allows operation of up to 80 kHz (2k, 4k, 8k) or 48 kHz (16k) line rate. Set your Camera Link frame grabber up to receive the standard 8-bit full mode.

A GenICam™ compliant XML device description file is embedded within the camera firmware allowing GenICam™ compliant application to know the camera's capabilities immediately after connection.

Camera Link Environment

These cameras implement the Camera link specification, which defines the device capabilities. The Camera link XML device description file is embedded within the camera firmware allowing Camera link-compliant applications to recognize the cameras' capabilities immediately after connection.

Step 2: Connect Camera Link and Power Cables

The camera uses Camera Link SDR26 cables for transmitting the Camera Link Base, Medium, Full or Deca configuration.

- Connect the required Camera Link cable(s) from the camera to the frame grabber installed on the computer.
- Connect a power cable from the camera to a +12 VDC to +24 VDC power supply.

WARNING! Grounding Instructions
Static electricity can damage electronic components. It is critical to discharge any static electrical charge by touching a grounded surface, such as the metal computer chassis, before handling the camera hardware.

Note: the use of cables types and lengths other than those specified may result in increased emission or decreased immunity and performance of the camera.

For more information on Camera Link connector specifications, see the Data Connector: Camera Link section.

Step 3: Establish Communication with the Camera

Power on the camera

Turn on the camera's power supply. The camera must boot fully before it can be recognized by the camera interface application

A green stauts LED indicates the camera is operating correctly and can connect to a client application; for more information, refer to

Start Camera Interface Application

Start Sapera CamExpert (or equivalent Camera Link compliant interface) by double clicking the desktop icon created during the software installation.

CamExpert will search for installed Sapera devices. In the Devices list area on the left side, the connected frame grabber will be shown; select the required Camera Link configuration (for example, CameraLink Medium Color RGB).

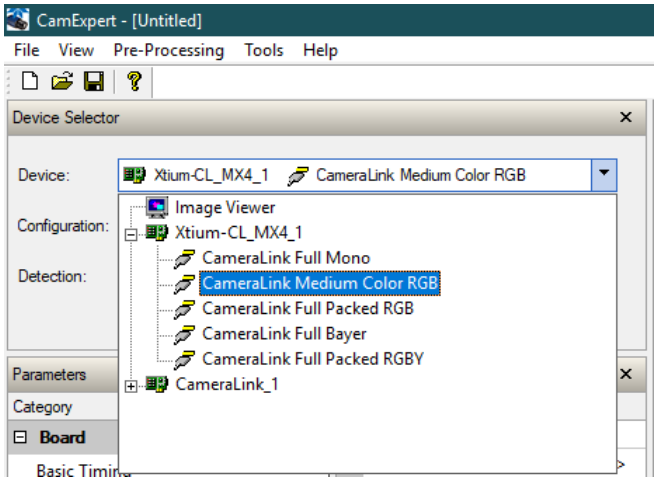


Figure 3:CamExpert Device List

The camera should be detected automatically. In CamExpert, Camera parameters are shown below the Board category.

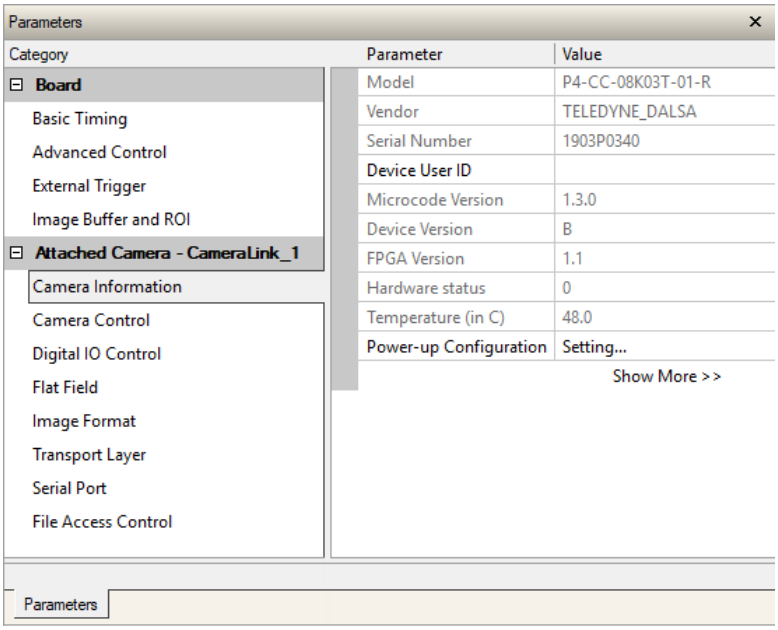


Figure 4: CamExpert Camera and Board Parameters

Establishing Data Integrity

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

Modify the camera and frame grabber parameter settings as required. For basic evaluation setup and configuration, refer to Appendix C: Evaluation Setup & Configuration.

At present, when using GenCP cameras, the camera and frame grabber parameters must be adjusted separately. Test the image acquisition by clicking the **Grab** button (an internally generated test pattern can be used).

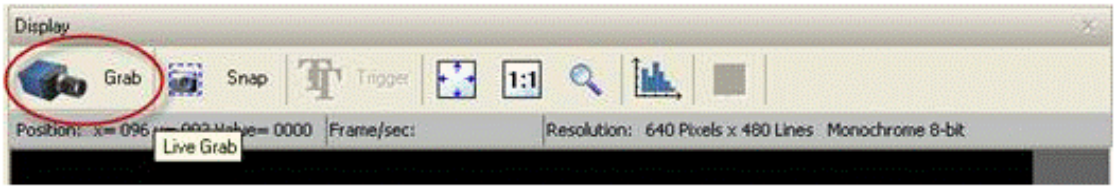


Figure 5: CamExpert Grab Button

Save the frame grabber configuration to a new *.ccf file.

Using Sapera CamExpert

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

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

Note: In a change from previous versions of the Sapera GUI, only one instance of CamExpert is required to send commands to the camera and view images.

For context sensitive help, click on the  button and then click on a camera configuration parameter.

A short description of the configuration parameter will be shown in a popup. Click on the  button to open the help file for more descriptive information on CamExpert.

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

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

CamExpert Panes

CamExpert, first instance: select Camera Link HS using the Device drop-down menu.

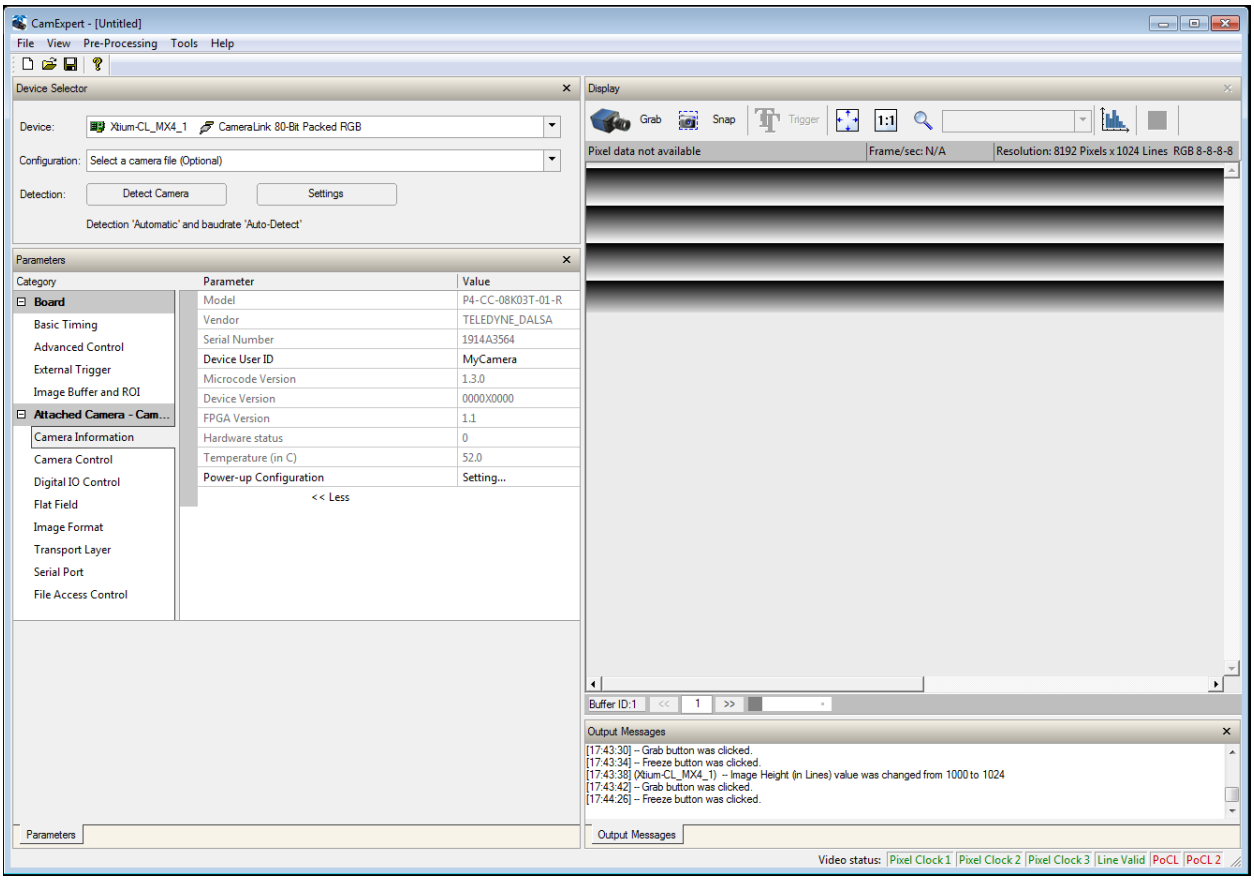


Figure 6. CamExpert Control Window

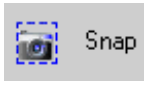
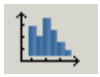
The CamExpert application uses panes to organize the selection and configuration of camera files or acquisition parameters.

Device Selector pane: View and select from any installed Sapera acquisition device. Once a device is selected, CamExpert will only show acquisition parameters for that device. Optionally, select a camera file included with the Sapera installation or saved previously.

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

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

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

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

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

Camera Operation

Spatial Correction

The 8k pixel array consists of 8,192 x 3, 7.5 µm x 7.5 µm high-performance pinned photodiode pixels. The distance center-to-center between 2 neighbor color rows is 15 µm.

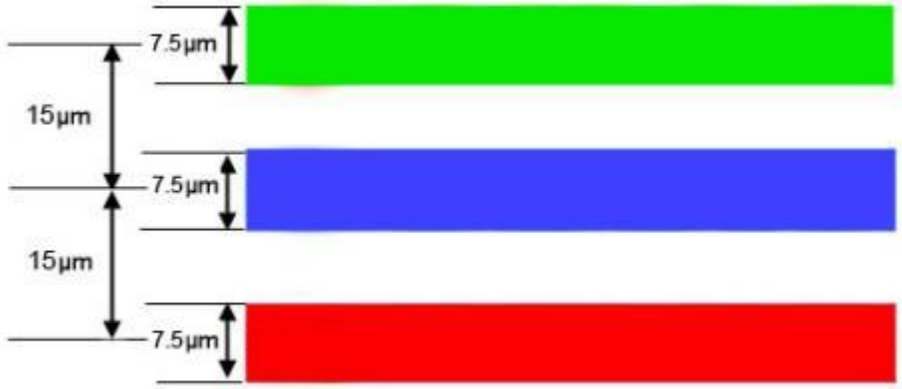


Figure 7: Sensor Row Spacing Diagram

The three rows of pixels are separated by one line of spacing and this line spacing is equal to 1x the sensor pixel size.

When the image passes the three lines of pixels, the green, blue, and red components for the same image location are captured at a different time as dictated by the line spacing. The camera automatically corrects for the line spacing to ensure that the green, blue, and red components of the image pixel are all aligned when output. However, this is only correct when the object pixel size is square; that is, the distance moved by the object for one EXSYNC period is equal to the width of the object pixel. In some applications, it may not be possible to achieve a 'square' object pixel as fine adjustment of the lens magnification and/ or the distance moved for each EXSYNC period is not possible. This scenario may be especially apparent when trying to integrate the camera into an existing system.

When it is not possible to generate a square object pixel, color artifacts will occur in the scan direction and is particularly noticeable at sharp edge transitions. The size of the edge artifact is proportional to how far the pixel is from square. To correct for this, the camera has a feature, Line Spatial Correction (or three letter command ssa), which allows fine adjustment of the compensation mechanism the camera uses to correct for the line spacing.

The default setting for this feature is 2, which is set for square object pixels. The setting can be adjusted from 0 to 5 to compensate for rectangular pixels—whether they are too long or too short.

The following examples of image artifacts show black to white image transitions and the associated corrected image after applying a specific ssa setting.

Example 1.

Target speed adjusted for square pixels.

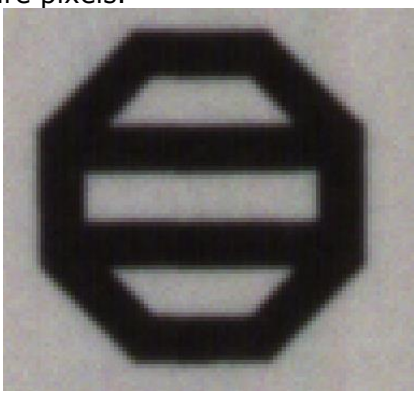


Figure 8: Spatial Correction Example 1

Example 2

Target running slower than example 1, same EXSYNC (trigger) frequency

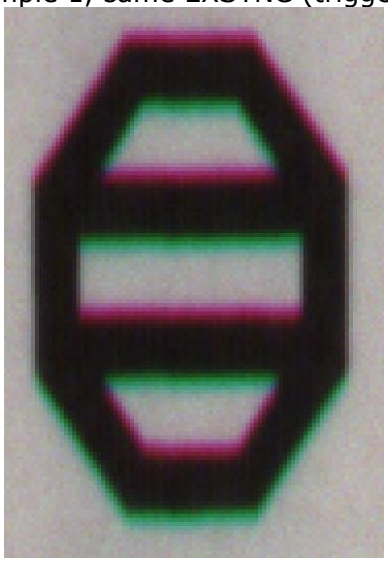


Figure 9: Spatial Correction Example 2

Example 3

Target running faster than example 1, same EXSYNC (trigger) frequency

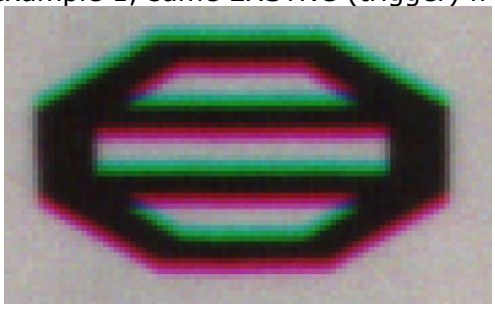


Figure 10: Spatial Correction Example 3

Parallax correction

When the camera it is not perpendicular to the object surface the camera will exhibit color alignment artifacts. The parallax distortion increases when imaging at steep angles relative to the cameras imaging plain. This is an optical effect caused by the line spacing of the three individual colors. This spacing results in a different magnification for each line at high angles. As shown in the figure below, there is color distortion at the extremes ends of the image but at the center of the image, the color distortion does not show up.

Figure 11: Image with Horizontal Color Alignment Issues

Using the camera's Parallax Correction feature, the optical magnification for each line is adjusted such that colors can be lined up at the extreme ends of the image without affecting the center. Activate the feature Image Distortion Correction Mode (*imageDistortionCorrectionMode* = Active). By tuning the feature Image Distortion Correction Pixel Stretch (*imageDistortionParallaxCorrectionPixelStretch*), the user can adjust the parallax correction of the image. The value entered here must be between -4 and 4 (pixels) by step of 0.1 (pixel).

Image Distortion Correction Mode	Off
Image Distortion Correction Algorithm	ParallaxCorrection
Image Distortion Parallax Correction Pixel Stretch	0.0

Figure 12: CamExpert Parallax Correction Controls

Figure 13: Corrected Image

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

Check Camera and Sensor Information

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

Relevant Features: DeviceModelName, DeviceID, DeviceFirmwareVersion and DeviceTemperature

Camera and sensor information can be retrieved via a controlling application (for example, CamExpert). Features such as camera model, firmware version, serial number, and so forth, are read to uniquely identify the connected device.

Verify Temperature

To determine the temperature at the camera, use the *DeviceTemperature* feature. The temperature returned is the internal temperature in degrees Celsius. For proper operation, this value should not exceed +80 °C.

If the camera exceeds the designated temperature, it may demonstrate erratic behavior. Once you have diagnosed the temperature issue, remove power, wait for the camera to cool down, and fix the temperature issue by improving your cooling strategy. You may then restart the camera.

Camera Link Configuration

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

Relevant Features: ClConfiguration and clDeviceClockFrequency

The Camera Link configuration determines the tap output of the camera, the number of cables required and the maximum line rates.

Table 8: Camera Link Configuration Details

Name	Taps	Bits per pixel	Cables
Base	3	8	1
Medium	6	8	2
Full	8	8	2
Deca	10	8	2

Trigger Modes

See the section Digital I / O Control Category in Appendix A for GenICam features associated with this section and how to use them

Related Features: TriggerMode, TriggerSource

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

- **Internal trigger (trigger disabled):** *TriggerMode* = Off
  The camera free-running mode has a programmable internal timer for line rate and a programmable exposure period.
- **External trigger (trigger enabled):** *TriggerMode* = *On*
  Exposures are controlled by an external trigger signal. The external trigger signal is the Camera Link control line CC1 (*TriggerSource* = CC1).

Exposure Controls

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

Relevant Features: TriggerMode, AcquisitionLineRate, ExposureMode and *ExposureTime*

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

- The start of exposure can be an internal timer signal (free-running mode, *TriggerMode* = Off) or an external trigger signal (*TriggerMode* = Off)
- The exposure duration can be programmable (such as the case of an internal timer) or maximum (*ExposureMode* = Timed or Maximum). When set to Maximum, the camera will maximize the exposure duration for the programmed line rate.

The camera can grab images in one of four ways. The imaging mode is set using a combination of the *ExposureMode*, *TriggerMode, ExposureTime* and *AcquisitionLineRate* parameters.

Table 9: Exposure controls

Description	Line Rate	Exposure Mode	Trigger Mode (Sync)
Internal line rate and exposure time	Internal, programmable using *AcquisitionLineRate*	Timed (internal programmable using *ExposureTime*)	Off (internal)
Internal line rate and max exposure	Internal, programmable using *AcquisitionLineRate*	Maximum	Off (internal)
External line rate (EXSYNC) and exposure time	Controlled by EXSYNC pulse	Timed (internal programmable using *ExposureTime*)	On (External: CC1)
External line rate (EXSYNC) and max exposure time	Controlled by EXSYNC pulse	Maximum	On (External: CC1)

The *ExposureTime* feature is only available when the *ExposureMode* is set to Timed. The allowable exposure range is dependent on the value of the internal line rate.

The *AcquisitionLineRate* feature is only available when the *TriggerMode* is set to Off.

Exposure Modes in Detail

Internally Programmable Line rate and Internally Programmable Exposure Time (Default)

Line rate is the dominant factor when adjusting the line rate or exposure time. When setting the line rate exposure time will decrease, if necessary, to accommodate the new line rate. When adjusting the exposure time the range is limited by the line rate.

Note: The camera will not set line periods shorter than the readout period.

GenICam Parameter Settings

Digital IO Controls: *TriggerMode* = Off

Camera Control: *ExposureMode* = Timed

Internally Programmable Line rate and Maximum Exposure Time

Line rate can be adjusted. When setting the line rate, exposure time will automatically adjust, to accommodate the new line rate.

Note: The camera will not set line periods shorter than the readout period.

GenICam Parameter Settings

Digital IO Controls: *TriggerMode* = Off

Camera Control: *ExposureMode* = Maximum

External Line Rate, Programmable Exposure Time

In this mode, the line rate is set externally with the falling edge of EXSYNC. When the line rate changes, exposure time may need to be decreased, to accommodate the new line rate. When adjusting the exposure time the range is limited by the line rate.

GenICam Parameter Settings

Digital IO Controls: *TriggerMode* = On

Camera Control: *ExposureMode* = Timed

External Line Rate and Maximum Exposure Time

In this mode, the line rate is set externally with the falling edge of EXSYNC. When the line rate changes, exposure time will automatically adjust, to accommodate the new line rate.

GenICam Parameter Settings

Digital IO Controls: *TriggerMode* = On

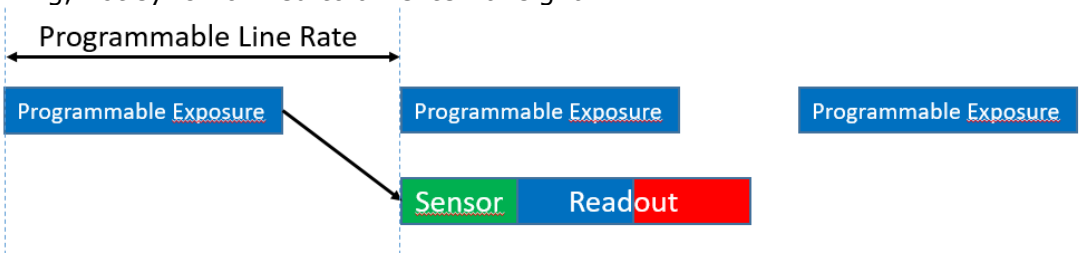
Camera Control: *ExposureMode* = Maximum

External Trigger Off, Maximum exposure

Free running, not synchronized to an external signal

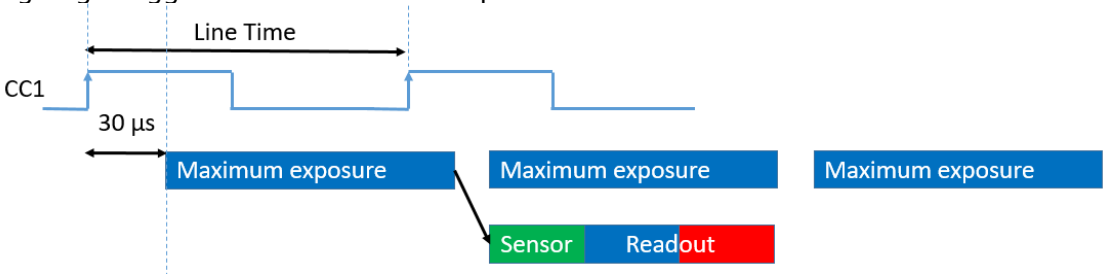
External Trigger Off, Internal Exposure Control

Free running, not synchronized to an external signal



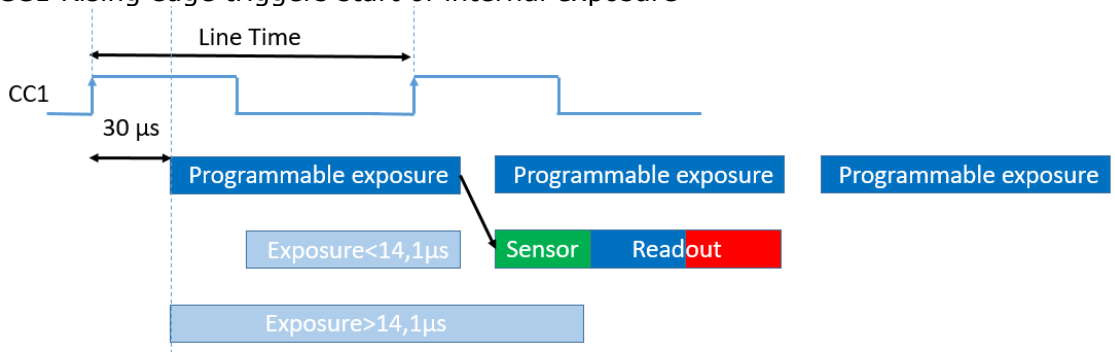
External Trigger On, Maximum exposure

CC1 rising edge triggers start of internal exposure



External Trigger On, Internal Exposure Control

CC1 Rising edge triggers start of internal exposure



Note: minimum exposure time is 14.1 µs
If Exposure time < 14,1 µs,
CC1 to Exposure start = 30 µs + (14.1-Exposure time)
If Exposure time > 14,1 µs, CC1 to Exposure start = 30 µs

Line Rate

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

Relevant Features: AcquisitionLineRate and TriggerMode

To set the camera's line rate use the *AcquisitionLineRate* parameter. This feature can only be used when the camera is in Internal mode—that is, when the start line trigger is disabled (*TriggerMode* = Off).

Maximum line rate = 33 kHz (achieved using Deca Camera Link Mode)

Note: The line rate must be less than 1 / (Exposure time + 2.5 µs). Entering a value that violates this condition will return an error ("Invalid Parameter"). You must adjust these two parameters in the correct sequence to maintain this condition.

If the external line rate exceeds 33 kHz the camera will continue to output data at its maximum line rate of 33 kHz. Though no image artifacts associated with over-speed will occur, you may notice that under over-speed conditions the image will appear compressed and the apparent distance travelled will be reduced.

Maximum Line Rates

Table 10: Maximum Line Rates vs Camera Link Mode

Camera Link Configuration	Maximum Line Rate
Base	10 kHz
Medium	20 kHz
Full	27.5 kHz
Deca	33 kHz

Table 11: Line Rate Calculation for Camera Link Clock Rates and Mode

Line Rate Formula (Hz)	CL Clock Rate			
CL Configuration	**85 MHz**	**80 MHz**	**60 MHz**	**42.5 MHz**
Base RGB8	Rate = 85 000 000 / 8192 Max = 33KHz	Rate = 80 000 000 / 8192 Max = 33KHz	Rate = 60 000 000 / 8192 Max = 33KHz	Rate = 42 500 000 / 8192 Max = 33KHz
Medium RGB8	Rate = 85 000 000 / 0.5 x 8192 Max = 33KHz	Rate = 80 000 000 / 0.5 x 8192 Max = 33KHz	Rate = 60 000 000 / 0.5 x 8192 Max = 33KHz	Rate = 42 500 000 / 0.5 x 8192 Max = 33KHz
Full RGB8	Rate = 85 000 000 / 0.375 x 8192 Max = 33KHz	Rate = 80 000 000 / 0.375 x 8192 Max = 33KHz	Rate = 60 000 000 / 0.375 x 8192 Max = 33KHz	Rate = 42 500 000 / 0.375 x 8192 Max = 33KHz
Deca RGB8	Rate = 85 000 000 / 0.3 x 8192 Max = 33KHz	Rate = 80 000 000 / 0.3 x 8192 Max = 33KHz	Rate = 60 000 000 / 0.3 x 8192 Max = 33KHz	Rate = 42 500 000 / 0.3 x 8192 Max = 33KHz

Gain and Black Level

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

Relevant Features: BlackLevel, GainSelector and *Gain*

The cameras provide gain and black level (offset) adjustments in the digital domain for the CMOS sensor. The gain and black level controls can make small compensations to the acquisition in situations where lighting varies and the lens iris cannot be easily adjusted.

The user can evaluate gain and black level by using CamExpert.

Contrast Enhancement

The offset and gain features can be used to maximize the use of the output dynamic range. Typical use is to subtract the minimum pixel value expected and then gain up to the maximum pixel value to approach full scale. This process may be useful for applications that process the RGB colors individually.

Calibrating the Camera

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

Related Features: flatfieldCorrectionMode, flatfieldCorrectionAlgorithm, flatfieldCalibrationTarget, flatfieldCalibrationSampleSize, flatfieldCalibrationFPN, FFCBankSelector, FFCSetSaveToBank,

Important: to ensure best results, the conditions under which you calibrate the camera (for example, temperature and illumination) should be as close to the actual operating conditions as possible.

The flat field calibration parameters are used to correct image distortion due to lens vignetting and uneven illumination. .

- Flat field coefficients consist of an offset and gain for each pixel.
- These are the first user corrections applied to the image.
- The flat field coefficients are saved and loaded with the user set.

Overview

The following diagram and accompanying description explain the cameras signal processing chain. Each element shown, with the exception of color interpolation, is user programmable.

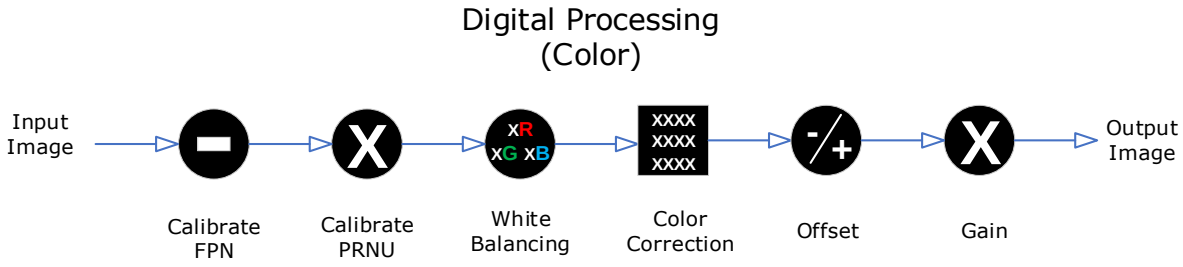


Figure 14: Camera Calibration Process.

Digital Processing

- Fixed pattern noise (FPN) calibration is used to subtract any residual dark level that may occur in the application.
- Photo response non uniformity (PRNU) calibration is used to correct for variations in the illumination intensity and / or lens vignetting. When performed, this calibration will cause the camera to have a flat response to a white target in the field of view. The output target value for PRNU calibration can be set by the user.
- The white balancing gains are used set the red, green and blue response to equal values with a white target in the field of view. The white balance gains can be individually set by the user, but will be overridden by the camera when the camera performs PRNU calibration or white balancing commands.
- Color correction is available for those users that need to compensate for the spectral transmission characteristics of the sensors color filters and the customers light source. This can be achieved by imaging the Gretag Macbeth® ColorChecker® illuminated by the application's light source and processing the image using a color correction tool to generate the desired color correction parameters to be provided to the camera via its CamExpert user interface.

Prior to imaging the Gretag Macbeth ColorChecker, the camera should have been calibrated with a white reference in place of the Gretag Macbeth ColorChecker and color correction must be turned off. The calibration process will ensure the camera output is uniform and white balanced.

- A single overall system gain is applied equally to all three colors. It will therefore not cause color distortion when changed.

Calibration

The goal of calibration is to produce a uniform, white balanced and, if required, color corrected image at the desired level out of the camera when it is imaging a uniform white object, using the optical setup of the user's application.

Adjust Exposure, Lighting and Focus

The user should configure the camera to use the EXSYNC and exposure timing they desire plus adjust the light level for normal operation. The lens should be at the desired magnification, aperture and be in focus.

White Reference

As the white reference located at the object plane will be in focus, any features on its surface (for example, dust or scratches) will end up in the calibration profile of the camera. To avoid this, use a clean white plastic or ceramic material, not paper. Ideally, the white object should move during the calibration process as the averaging process of the camera will diminish the effects on any small variation in the white reference.

Preliminary Setup

The user may wish to start the calibration process by evaluating the characteristics of their setup with no calibration enabled. To do so:

- disable FPN, PRNU and color correction coefficients
- set white balance red, green and blue gains to one
- set system gain to one.

Adjust Gain

Begin by adjusting the system gain (*GainSelector* = SystemGain, *Gain*) until the peak intensity of the three colors is at the desired DN level. You may want to use the white balance gains to adjust the peak of each color to be a similar DN value, but this is not necessary.

FPN Calibration

Before proceeding any further, it is desirable to complete an FPN calibration (*flatfieldCalibrationFPN*). This is best performed using a lens cap to ensure no light gets into the camera.

PRNU Calibration

With FPN calibration complete, a PRNU calibration (*flatfieldCalibrationPRNU*) can be performed using the average value of the line pixels as a target value. After PRNU calibration is complete (it will take several seconds), all three colors should be at the target value, and the correction coefficient will be enabled. The system gain will remain as originally set.

Save Calibration

The coefficient and gain parameters, timing and control configuration, and so forth, can be stored in any one of four user sets and automatically retrieved at power up or by user selection.

Color Correction Matrix

The RGB values output by the camera depend on the spectral responsivity of the camera and on the color temperature of the light source. For example, with a light that is more blue than red, the blues will be brighter and the reds dimmer. The camera includes a 3 x 3 matrix to correct this:

$$\begin{bmatrix} Red_{out} \\ Green_{out} \\ Blue_{out} \end{bmatrix} = \begin{bmatrix} Gain00 & Gain01 & Gain02 \\ Gain10 & Gain11 & Gain12 \\ Gain20 & Gain21 & Gain22 \end{bmatrix} \cdot \begin{bmatrix} Red_{in} \\ Green_{in} \\ Blue_{in} \end{bmatrix}$$

If a color correction matrix is desired, the user can enter and save a color correction matrix using the *colorTransformationSelector*, ColorTransformationValueSelector, ColorTransformationValue and *UserColorSetSave* features.

For the color correction to be effective, the camera should have a white balanced output when color correction is off.

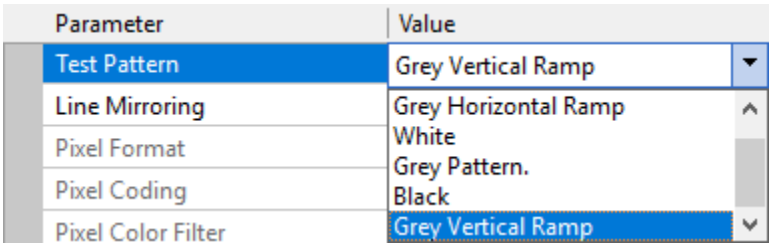
Note: An application note describing a color transformation matrix calibration (document #03-032-20181) is available. Please contact Teledyne DALSA Support for more information.

Internal Test Pattern Generator

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

Relevant Features: TestImageSelector
The Piranha4 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 the any of the test patterns from the drop menu while the camera is not in acquisition mode.



Select live grab to see the pattern output.
Test Patterns are:

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

Figure 15: Test Patterm Grey Horizontal Ramp

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

Figure 16: Test Patterm Grey Vertical Ramp

- **White**: Solid pattern RGB = 255, 255, 255
- **Grey Pattern**: Solid pattern RGB = 128, 128, 128
- **Black**: Solid pattern RGB = 0, 0, 0

Scan Direction

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

Relevant Features: ScanDirection

Selectable camera scan direction accommodates an object direction change on a web and allows you to mount the camera "upside down".

	Note: The example here assumes the use of a lens (which inverts the image).

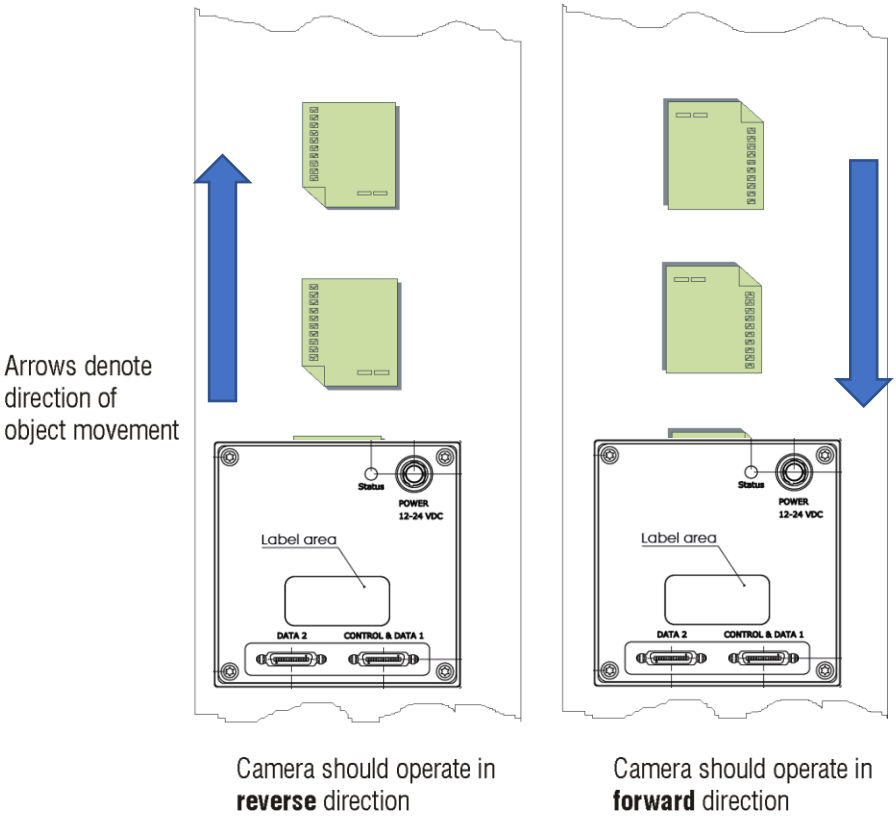


Figure 17: Object Movement and Camera Direction Example, with a Lens

Pixel Readout Direction (Mirroring Mode)

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

Relevant Features: ReverseX

Set the tap readout from left to right or from right to left. This performs a horizontal flip of the image.

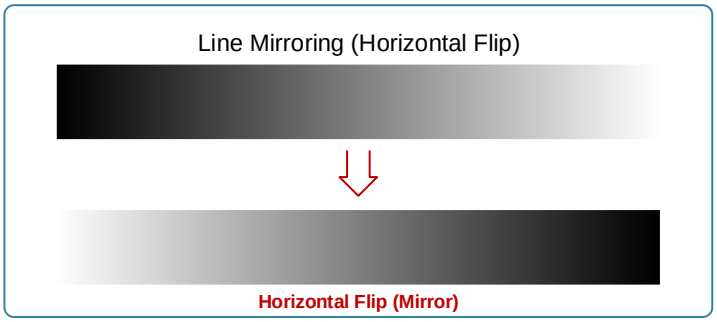


Figure 18: Line Mirroring, Horizontal Flip

Saving and Restoring Camera Settings

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

Relevant Features: UserSetSelector, UserSet1 thru UserSet4, UserSetDefaultSelector, UserSetLoad, UserSetSave

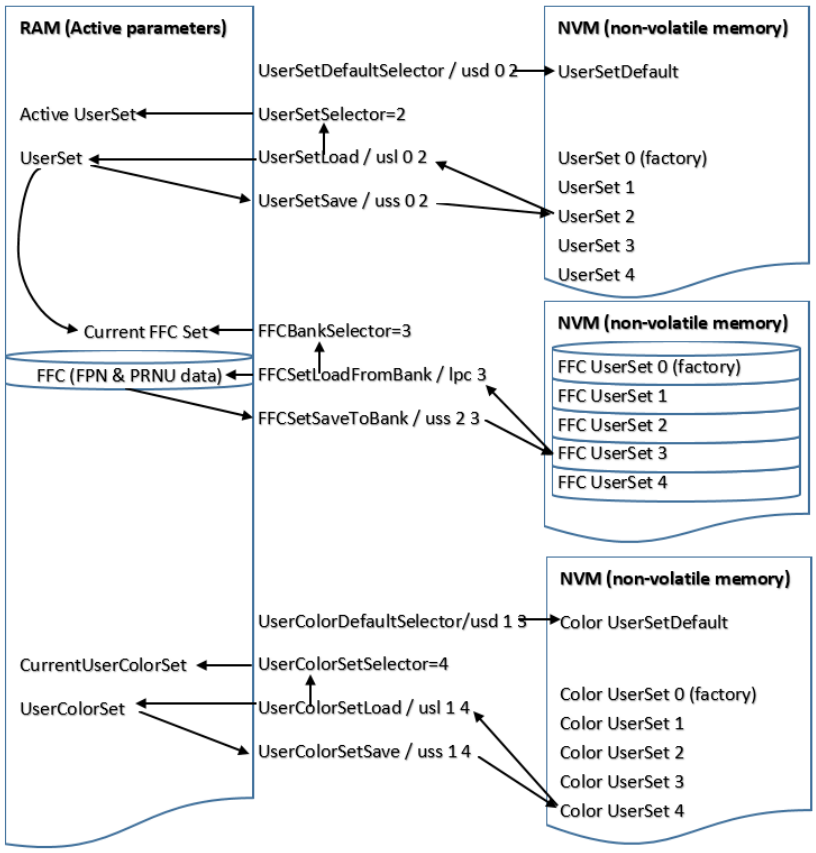
An inspection system may use multiple illumination, resolution, and responsivity configurations in order to cover the different types of inspection it performs.

The camera includes 4 user sets where camera setup information can be saved to and restored from—either at power up, or dynamically during inspection.

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

A previously saved user setting (User Set 1 to 4) or the factory settings can be restored using the user set selector and user set load features.

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


RAM (Active parameters)
NVM (non-volatile memory)
UserSetDefaultSelector / usd 0 2
UserSetDefault
Active UserSet
UserSetSelector=2
UserSet
UserSetLoad / usl 0 2
UserSetSave / uss 0 2
UserSet 0 (factory)
UserSet 1
UserSet 2
UserSet 3
UserSet 4
Current FFC Set
FFCBankSelector=3
FFC (FPN & PRNU data)
FFCSetLoadFromBank / lpc 3
FFCSetSaveToBank / uss 2 3
NVM (non-volatile memory)
FFC UserSet 0 (factory)
FFC UserSet 1
FFC UserSet 2
FFC UserSet 3
FFC UserSet 4
NVM (non-volatile memory)
UserColorDefaultSelector/usd 1 3
Color UserSetDefault
CurrentUserColorSet
UserColorSetSelector=4
UserColorSet
UserColorSetLoad / usl 1 4
UserColorSetSave / uss 1 4
Color UserSet 0 (factory)
Color UserSet 1
Color UserSet 2
Color UserSet 3
Color UserSet 4

The relationship between these four settings is illustrated below:

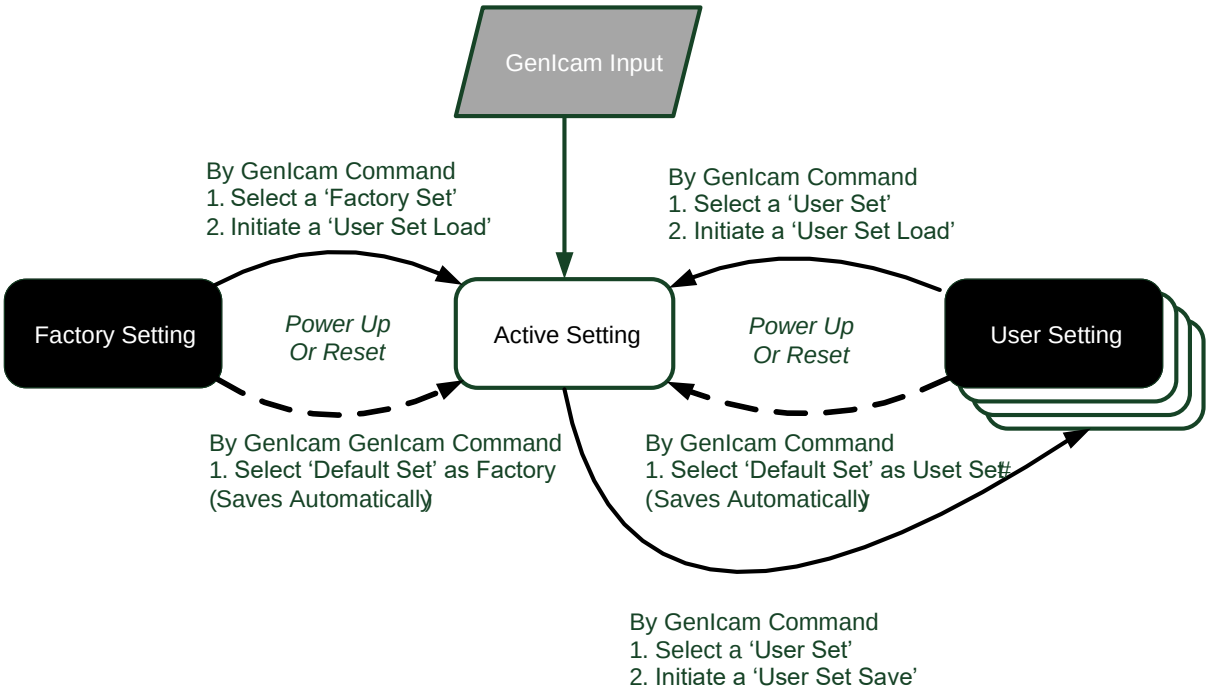


Figure 19. Relationship between the Camera Settings

Active Settings for Current Operation

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

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

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

User Setting

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

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

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

Factory Settings

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

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

Default Setting

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

Resetting the Camera

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

Relevant Features: DeviceReset

The Camera Reset feature resets the camera. The camera resets with the default settings, including a baud rate of 9600.

Serial Port Baud Rate

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

Relevant Features: DeviceSerialPortBaudRate, deviceSerialPortDataSize, deviceSerialPortParity, deviceSerialPortNumberOfStopBits

The baud rate sets the speed (in bits per second—bps) of the serial communication port. Supported baud rates range from 9600 (default) to 115200.

The following serial port settings are used:

- 9600 baud (default)
- 8 data bits
- no parity
- 1 stop bit
- no flow control

Technical Specifications

Mechanical Drawing

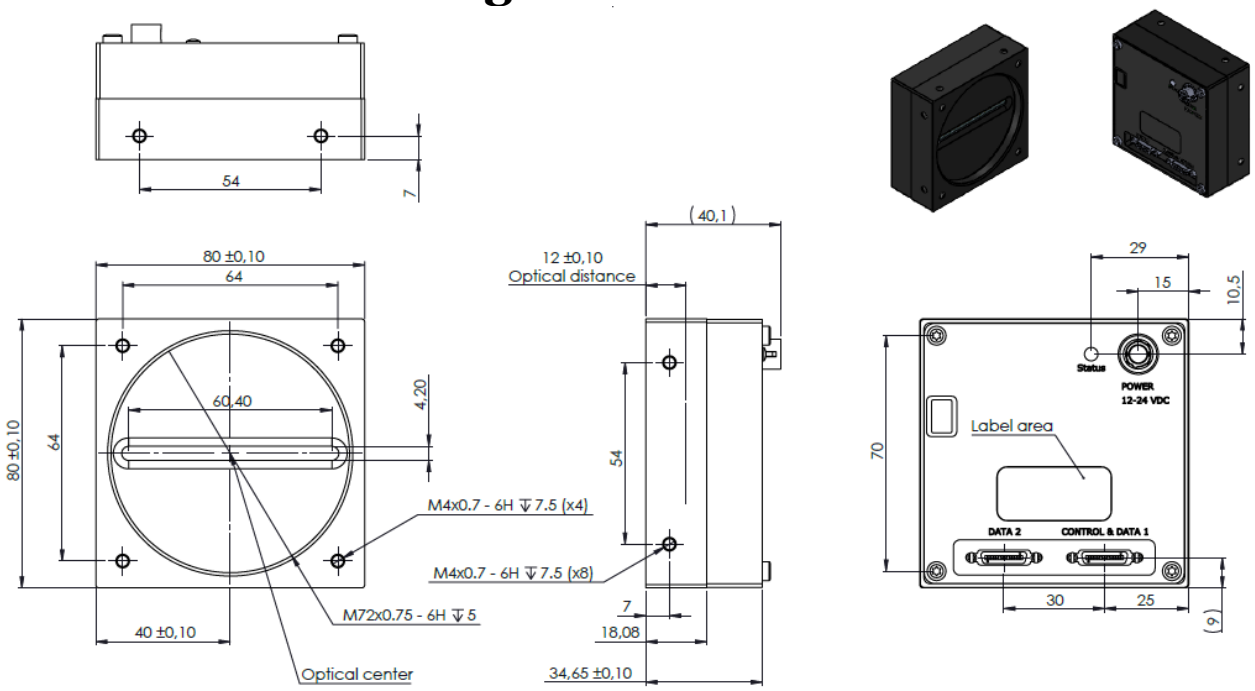


Figure 20: P4-CC-08K03T-01-R Mechanical Drawing

Input / Output Connectors and LED

Figure 21: Camera I / O Connectors

Data Connector: Camera Link

The camera uses two Camera Link SDR26 cables transmitting the Camera Link Base, Medium, Full, or Deca configuration. The figure below shows the SDR26 Camera Link Connector and the tables that follow list the Camera Link configurations.

For detailed information on Camera Link please refer to the Camera Link Road Map available from the Knowledge Center on the Teledyne DALSA Web site.

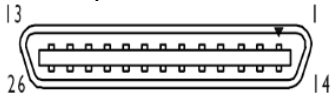


Figure 22. SDR26 Camera Link Connector

Table 12. Camera Link Connector Pin Out

Data 2			Control / Data 1		
Camera Connector	**Right Angle Frame Grabber Connector**	**Channel Link Signal**	**Camera Connector**	**Right Angle Frame Grabber Connector**	**Channel Link Signal**
1	1	inner shield	1	1	inner shield
14	14	inner shield	14	14	inner shield
2	25	Y0-	2	25	X0-
15	12	Y0+	15	12	X0+
3	24	Y1-	3	24	X1-
16	11	Y1+	16	11	X1+
4	23	Y2-	4	23	X2-
17	10	Y2+	17	10	X2+
5	22	Yclk-	5	22	Xclk-
18	9	Yclk+	18	9	Xclk+
6	21	Y3-	6	21	X3-
19	8	Y3+	19	8	X3+
7	20	100 ohm	7	20	SerTC+
20	7	terminated	20	7	SerTC-
8	19	Z0-	8	19	SerTFG-
21	6	Z0+	21	6	SerTFG+
9	18	Z1-	9	18	CC1-
22	5	Z1+	22	5	CC1+
10	17	Z2-	10	17	CC2+
23	4	Z2+	23	4	CC2-
11	16	Zclk-	11	16	CC3-
24	3	Zclk+	24	3	CC3+
12	15	Z3-	12	15	CC4+
25	2	Z3+	25	2	CC4-
13	13	inner shield	13	13	inner shield
26	26	inner shield	26	26	inner shield

Note: * Exterior Overshield is connected to the shells of the connectors on both ends. Unused pairs should be terminated in 100 ohms at both ends of the cable. Inner shield is connected to signal ground inside camera

Camera link Bit Definitions

Table 13. Camera Link Bit Definitions

Signal	Configuration	Remark
CC1	EXSYNC	Keep this signal in **low** status when idle.
CC2	Spare	
CC3	Direction	
CC4	Spare	

Camera Link Cable Quality and Length

The maximum allowable Camera Link cable length depends on the quality of the cable used and the Camera Link strobe frequency. Cable quality degrades over time as the cable is flexed. In addition, as the Camera Link strobe frequency is increased the maximum allowable cable length will decrease. We do not guarantee good imaging performance with low quality cables of *any* length. In general, we recommend the use of high quality cables for any cable length.

The following table lists some results achieved using the cameras and a selection of cables and frame grabbers:

Table 14. Camera Link Cable Maximum Distance

Camera Models	Max. Distance Tested	Frame Grabber
P4-CC-08K03T-01-R	15 m	Xtium CL MX4

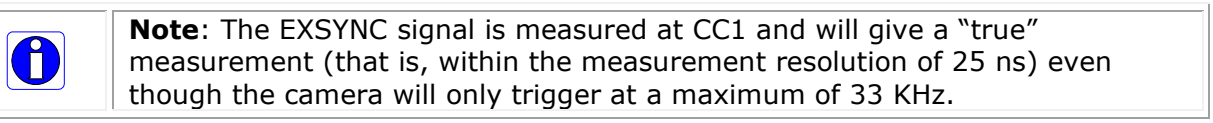
Input signals, Camera Link

The camera accepts control inputs through the Camera Link SDR26F connector. The camera ships in internal sync, and internally programmed integration.

EXSYNC (Exposure Start)

Line rate can be set internally using the GenICam features. The external control signal EXSYNC is optional and enabled through the user interface. This camera uses the rising edge of EXSYNC to start the exposure period.

The EXSYNC signal tells the camera when to integrate the image, followed by the readout. It can be either an internally generated signal by the camera, or it can be supplied externally via the serial interface. Depending upon the mode of operation the high time of the EXSYNC signal can represent the integration period.



Note: The EXSYNC signal is measured at CC1 and will give a "true" measurement (that is, within the measurement resolution of 25 ns) even though the camera will only trigger at a maximum of 33 KHz.

Output signals, Camera Link Clocking Signals

These signals indicate when data is valid, allowing you to clock the data from the camera to your acquisition system. These signals are part of the Camera Link configuration and you should refer to the Camera Link Implementation Road Map, available at our Knowledge Center, for the standard location of these signals.

Table 15. Camera Link Clocking Signals

Clocking Signal	Indicates
LVAL (high)	Outputting valid line
DVAL	Not used
STROBE (rising edge)	Valid data
FVAL	Set to 0

Power connector

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

- Apply the appropriate voltages of between +12 V to +24 V. Incorrect voltages may damage the camera.
- Before connecting power to the camera, test all power supplies.
- Protect the camera with a 2 amp slow-blow fuse between the power supply and the camera.
- Do not use the shield on a multi-conductor cable for ground.
- Keep leads as short as possible in order to reduce voltage drop.
- Use high quality supplies in order to minimize noise.
- When using a 12 V supply, voltage loss in the power cables will be greater due to the higher current. Use the Camera Information category to refresh and read the camera's input voltage measurement. Adjust the supply to ensure that it reads above or equal to 12 V.

Note: If your power supply does not meet these requirements, then the camera performance specifications are not guaranteed.

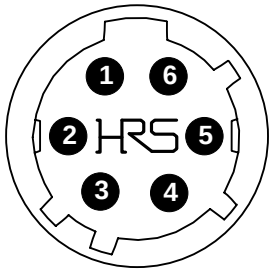


Figure 23: 6-pin Hirose Circular Male Power Plug—Power Connector

Table 16. Power Plug Pinout

Pin	Description	Pin	Description
1	+12 V to +24 V DC	4	GND
2	+12 V to +24 V DC	5	GND
3	+12 V to +24 V DC	6	GND

The camera requires a single voltage input +12 VDC to +24 VDC. The camera meets all performance specifications using standard switching power supplies, although well-regulated linear supplies provide optimum performance.

The wire gauge of the power cable should be sufficient to accommodate a surge during power-up of at least 2 amps with a minimum voltage drop between the power supply and camera. The camera can accept any voltage between +12 and +24 Volts. If there is a voltage drop between the power supply and camera, ensure that the power supply voltage is at least 12 Volts plus this voltage drop.

Status LED

The camera is equipped with a status LED on the back to display the operational status of the camera. The table below summarizes the operating states of the camera and the corresponding LED states. When more than one condition is active, the LED indicates the condition with the highest priority.

Table 17. Status LED States

Status LED Color	Meaning
Off	No power or hardware malfunction
Blinking Green	Powering up or calibrating
Green	Ready
Red	Error

Appendix A: GenICam Commands

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

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

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

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

Camera Information Category

The Camera Information category, as shown by CamExpert, groups information specific to the individual camera such as camera model, firmware version, and so forth, are read to uniquely identify the connected camera. These features are typically read-only.

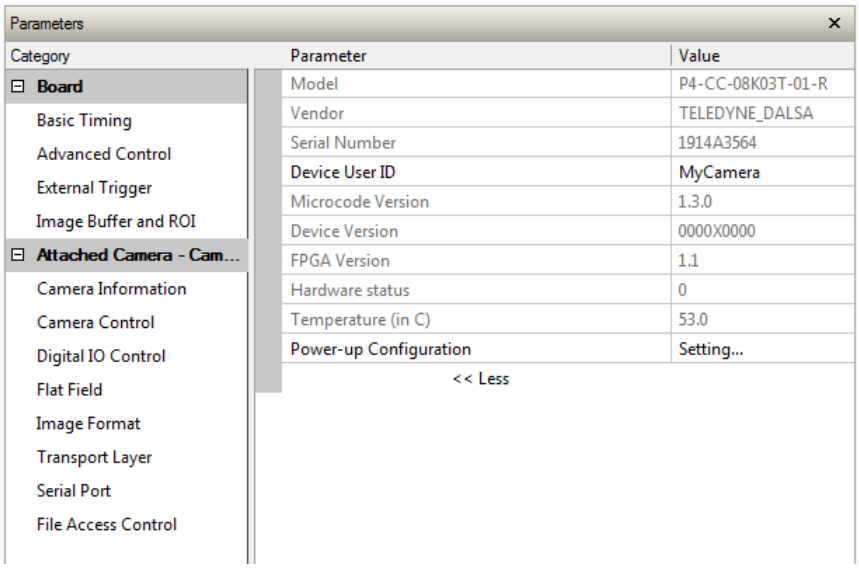


Figure 24 Example CamExpert Camera Information Panel

Camera Information Feature Descriptions

Display Name	Feature	Description	View
Model	DeviceModelName	Displays the device model name. (RO)	Beginner
Vendor	DeviceVendorName	Displays the device vendor name. (RO)	Beginner
Serial Number	DeviceID	Displays the device's factory set camera serial number. (RO)	Beginner
Device User ID	DeviceUserID	Feature to store user-programmable identifier of up to 16 characters. The default factory setting is the camera serial number. (RW)	Beginner
Microcode Version	DeviceFirmwareVersion	Displays the device firmware version. This tag will also highlight if the firmware is a beta or custom design. (RO)	Beginner
Serial Number	DeviceID	Displays the device's factory set camera serial number. (RO)	Beginner
Device User ID	DeviceUserID	Feature to store user-programmable identifier of up to 31 characters. The default factory setting is the camera serial number. (RW)	Beginner
Device Version	DeviceVersion	Displays the device manufacturing version. (RO)	Beginner
FPGA Version	DeviceManufacturerInfo	This feature provides extended manufacturer information about the device. (RO)	Beginner
Hardware status	StatusErrorHardware	Camera Status; bit set when : Bit0: no trigger during more than 1s Bit1: trigger too fast Bit8: overflow occurs during FFC calibration Bit9: underflow occurs during FFC calibration Bit11: CC3 scrolling direction(0:Fwd, 1:Rev) Bit16: hardware error detected	Beginner
Temperature	DeviceTemperature	Displays the internal operating temperature of the camera, in Celsius. (RO)	Beginner DFNC
Power-on User Set	UserSetDefaultSelector	Selects the camera configuration set to load and make active on camera power-up or reset. The camera configuration sets are stored in camera non-volatile memory. (RW)	Beginner
Factory Set	*Factory*	*Load factory default feature settings*	
UserSet1	*UserSet1*	*Select the user defined configuration UserSet 1 as the Power-up Configuration.*	
UserSet2	*UserSet2*	*Select the user defined configuration UserSet 2 as the Power-up Configuration*	
UserSet3	*UserSet3*	*Select the user defined configuration UserSet 3 as the Power-up Configuration*	
UserSet4	*UserSet4*	*Select the user defined configuration UserSet 4 as the Power-up Configuration.*	
Current User Set	UserSetSelector	Selects the camera configuration set to load feature settings from or save current feature settings to. Points to which user set (1-16) or factory set that is loaded or saved when the UserSetLoad or UserSetSave command is used. The Factory set contains default camera feature settings and is read-only. (RW)	Beginner
Factory Set	*Factory*	*Select the default camera feature settings saved by the factory*	
UserSet 1	*UserSet1*	*Select the User-defined Configuration space UserSet1 to save to or load from features settings previously saved by the user.*	
UserSet 2	*UserSet2*	*Select the User-defined Configuration space UserSet2 to save to or load from features settings previously saved by the user.*	
UserSet3	*UserSet3*	*Select the User-defined Configuration space UserSet3 to save to or load from features settings previously saved by the user.*	

Display Name	Feature	Description	View
UserSet4	*UserSet4*	*Select the User-defined Configuration space UserSet4 to save to or load from features settings previously saved by the user.*	
Load Configuration	UserSetLoad	Loads the camera configuration set specified by the User Set Selector feature, to the camera and makes it active. (W)	Beginner
Save Configuration	UserSetSave	Saves the current camera configuration to the user set specified by the User Set Selector feature. The user sets are located on the camera in non-volatile memory. (W)	Beginner

Camera Power-Up Configuration Selection Dialog

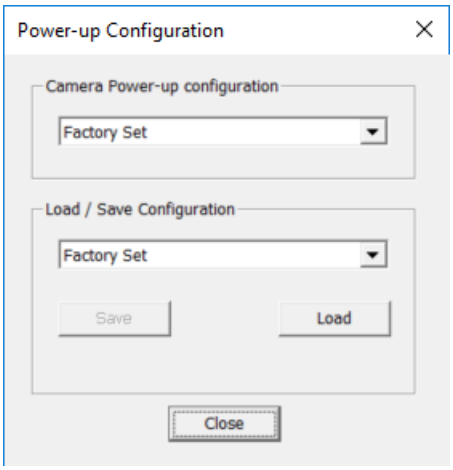


Figure 25 CamExpert Power-Up Configuration Dialog

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

Camera Power-up Configuration

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

User Set Configuration Management

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

Camera Control Category

The camera control category, as shown by CamExpert, groups control parameters such as line rate, exposure time, scan direction, and gain.

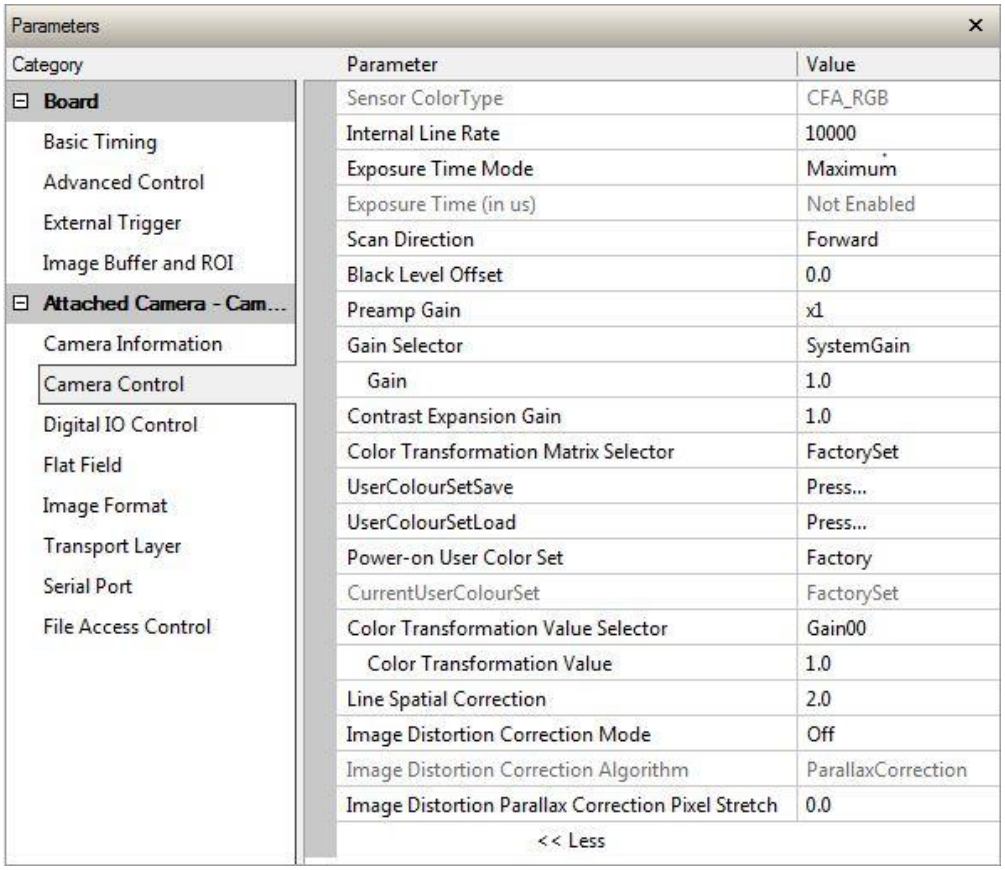


Figure 26: Camera Control Panel

Camera Control Feature Descriptions

Display Name	Feature	Description	View
Sensor Color Type *CFA_RGB*	sensorColorType *CFA_RGB*	Used to set the sensor color type mode. Only monochrome is available. *Sensor color type is RGB*	Beginner DFNC
Internal Line Rate	AcquisitionLineRate	Specifies the camera internal line rate, in Hz when TriggerMode is Off. Note that any user entered value is automatically adjusted to a valid camera value. If necessary, the exposure time will be decreased to fit within the line time.	Beginner
Exposure Time Mode *Timed*	ExposureMode *Timed*	Sets the operation mode for the camera's exposure (or shutter). (RO) *The exposure duration time is set using the Exposure Time feature and the exposure starts with a LineStart event.* *The exposure starts 30µs after EXSYNC rising edge when TriggerMode is On* *The exposure starts after Line Start event when TriggerMode is Off.*	Beginner

Display Name	Feature	Description	View
Maximum	*Maximum*	*Exposure time automatically adjusted to maximum value for current AcquisitionLineRate.*	
Exposure Time (in us)	ExposureTime	Sets the exposure time (in microseconds) when the Exposure Mode feature is set to Timed. The allowable exposure range is dependent on the value of the internal line rate: 2.6 µs to LinePeriod–2.5 µs	Beginner
Scan Direction *Forward* *Reverse* *Externally Controlled*	ScanDirection *Forward* *Reverse* *ExternallyControlled*	Sets the scan direction configuration *Forward scan direction.* *Reverse scan direction.* *Direction of the scan is defined by CC3:* • *CC3=0: Forward* • *CC3=1: Reverse*	Expert DFNC
Black Level Offset	BlackLevel	Apply a digital addition after an FPN correction; single value added to each pixel. This represents a DC offset applied to the video signal, in DN (digital number) units. The value may be positive or negative. Positive values may used to measure dark noise. Available range of -256 to +255.9375 by step of 0.0625	Beginner
Preamp Gain *PreAmpx1* *PreAmpx2* *PreAmpx4*	PreampGain *PreAmpx1* *PreAmpx2* *PreAmpx3*	Defines amplification level before Analog to Digital converter. Authorized values are: *1X gain* *2X gain* *4X gain*	Beginner DFNC
Gain Selector *System Gain* *Red* *Green* *Blue*	GainSelector *System* *Red* *Green* *Blue*	Selects which gain is controlled when adjusting gain features. *Apply a digital gain adjustment to the entire image* *Apply a digital gain adjustment to the red channel only* *Apply a digital gain adjustment to the green channel only* *Apply a digital gain adjustment to the blue channel only*	Beginner
Gain	Gain	Sets the gain, as per the gain selector setting, as an amplification factor applied to the image. Gain is a fixed point digital multiplier applied to each pixel. Possible values: 1x to 3.999x by step of 1/1024	Beginner
Contrast Expansion Gain	ContrastExpGain	Controls the digital amplification gain (between 1 and 63.9) applied to the image.	Beginner DFNC
UserColorSetSelector *Factory* *User1*	colorTransformationSelector *Factory* *User1*	Allows the user to select between factory ColorSet or 4 user ColorSet. *Factory ColorSet: Correction Matrix set neutral (diagonal matrix, no correction) and 3 color gains set to 1.* *User programmable/loaded correction matrix and 3 color gains.*	Beginner DFNC

<table>
<tr><th>Display Name</th><th>Feature</th><th>Description</th><th>View</th></tr>
<tr><td>User2
User3
User4</td><td>User2
User3
User4</td><td>User programmable/loaded correction matrix and 3 color gains.
User programmable/loaded correction matrix and 3 color gains.
User programmable/loaded correction matrix and 3 color gains.</td><td></td></tr>
<tr><td>UserColorSetSave</td><td>UserColorSetSave</td><td>Saves the active Color Set in RAM (Transformation Matrix and Color gains) to the user set specified by the UserColorSetSelector. The color user sets are located on the camera in nonvolatile memory. (W)</td><td>Beginner
DFNC</td></tr>
<tr><td>UserColorSetLoad</td><td>UserColorSetLoad</td><td>Loads the Color Set (Transformation Matrix and color gains) specified by the UserColorSetSelector feature, to the camera RAM and makes it active. (W)</td><td>Beginner
DFNC</td></tr>
<tr><td>Power-on User Color Set</td><td>UserColorDefaultSelector</td><td>Defines the Color Set Configuration that will be loaded in RAM after power-on from nonvolatile memory. (W)</td><td></td></tr>
<tr><td>CurrentUserColourSet</td><td>CurrentUserColourSet</td><td>Indicates which user color set is currently in use. (RO)</td><td>Beginner
DFNC</td></tr>
<tr><td>Color Transformation Value Selector
Gain00
Gain01
Gain02
Gain10
Gain11
Gain12
Gain20
Gain21
Gain22</td><td>ColorTransformationValueSelector
Gain00
Gain01
Gain02
Gain10
Gain11
Gain12
Gain20
Gain21
Gain22</td><td>Allows the user to manually adjust correction value in the matrix.
Allows the user to manually adjust correction value in the matrix
<table><tr><td></td><td>Red</td><td>Green</td><td>Blue</td></tr><tr><td>Red</td><td>Gain00</td><td>Gain01</td><td>Gain02</td></tr><tr><td>Green</td><td>Gain10</td><td>Gain11</td><td>Gain12</td></tr><tr><td>Blue</td><td>Gain20</td><td>Gain21</td><td>Gain22</td></tr></table>White LED matrix:<table><tr><td></td><td>Red</td><td>Green</td><td>Blue</td></tr><tr><td>Red</td><td>0,765625</td><td>0,390625</td><td>-0,15625</td></tr><tr><td>Green</td><td>-0,390625</td><td>1,234375</td><td>0,15625</td></tr><tr><td>Blue</td><td>-0,53125</td><td>-0,234375</td><td>1,765625</td></tr></table></td><td>Beginner
DFNC</td></tr>
<tr><td>Color Transformation Value</td><td>ColorTransformationValue</td><td>Value entered as pointed to by ColorTransformationValueSelector:
-256 < value < 256 by step of 0.15625 (1/64)</td><td>Beginner
DFNC</td></tr>
<tr><td>Line Spatial Correction</td><td>sensorLineSpatialCorrection</td><td>Set the number of rows between imaging lines.</td><td>Beginner
DFNC</td></tr>
<tr><td>Image Distortion Correction Mode
Off
Active</td><td>imageDistortionCorrectionMode
Off
Active</td><td>Used to enable parallax correction
Parallax correction disabled
Parallax correction is active</td><td>Beginner
DFNC</td></tr>
<tr><td>Image Distortion Correction Algorithm</td><td>imageDistortionCorrectionAlgorithm</td><td>Parallax Correction
(RO)</td><td>Beginner
DFNC</td></tr>
<tr><td>Image Distorition Parallax Correction Pixel Stretch</td><td>imageDistortionParallaxCorrection PixelStretch</td><td>Value entered indicates the number pixels to be shifted to correct the color alignment between -4.0 to +4.0 by step of 0.1</td><td>Beginner
DFNC</td></tr>
</table>

Digital I / O Control Category

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

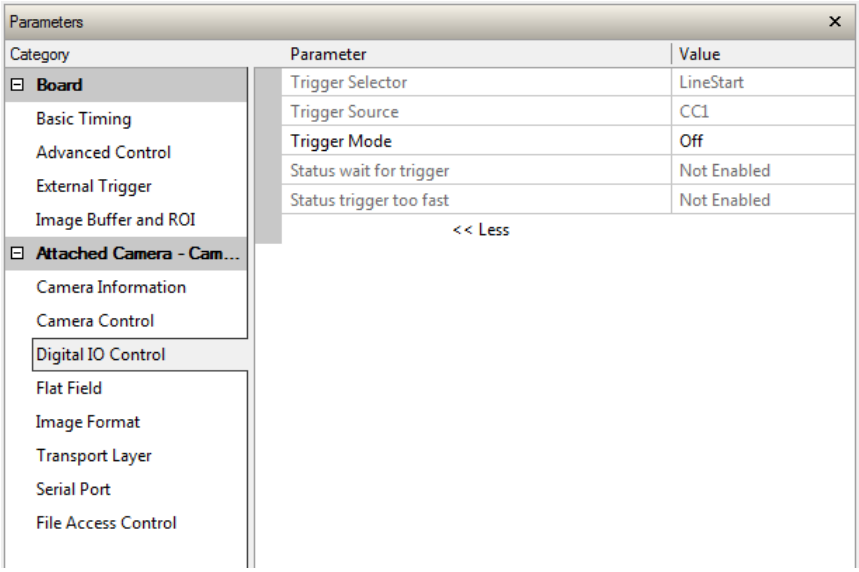


Figure 27 Digital I/O Control Panel

Digital I/O Control Feature Descriptions

Display Name	Feature	Description	View
Trigger Selector *LineStart*	TriggerSelector *LineStart*	Defines what the trigger initiates (RO) *Trigger initiates a line start.*	Beginner
Trigger Source *CC1*	TriggerSource *CC1*	Determines the source of external trigger. (RO) *Source of trigger is from the frame grabber over CC1.*	Beginner
Trigger Mode *Off* *Onl*	TriggerMode *Off* *Onl*	Determines the trigger mode of the camera, internal or external (CC1). *External trigger is off: line start is generated internally.* *External trigger is on: line start is triggered by CC1 rising edge.*	Beginner
Status wait for trigger	StatusWaitForTrigger	Bit0 of Hardware status: 1 if no trigger identified for more than 1 second.	Beginner DFNC
Status trigger too fast	StatusTriggerTooFast	Bit1 of Hardware status: 1 if missed triggers identified (trigger running too fast for camera).	Beginner DFNC

Flat Field Category

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

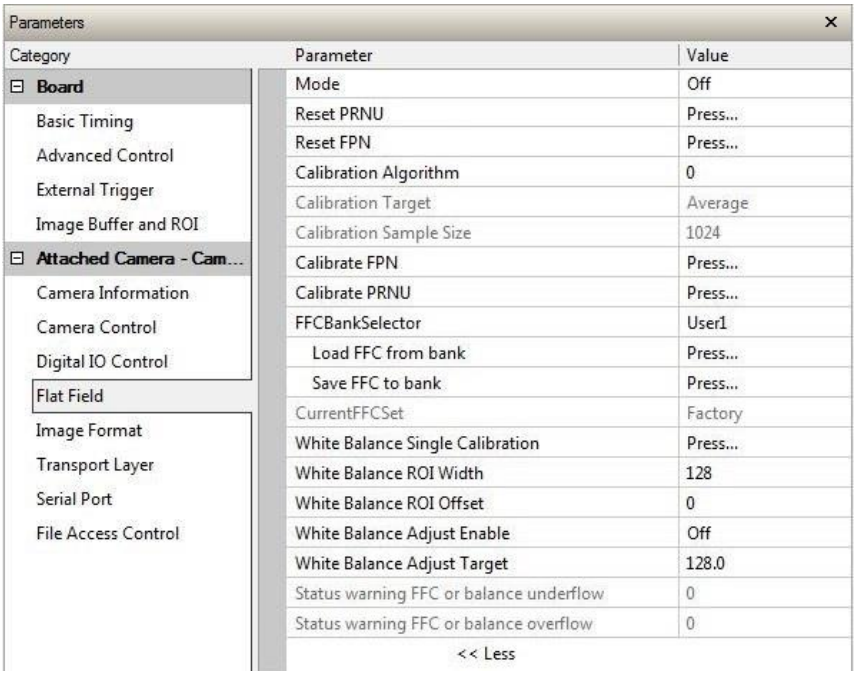


Figure 28: Flat Field Panel

Flat Field Control Feature Description

Display Name	Feature	Description	View
Mode *Off* *On*	flatfieldCorrectionMode *Off* *On*	Sets the enable state of flat field correction. FPN and PRNU correction disabled. FPN and PRNU correction enabled.	Beginner DFNC
Reset PRNU	ResetFCC	Reset all PRNU coefficients to 1.	Guru DFNC
Reset FPN	ResetFPN	Reset all FPN coefficients to 0.	Guru DFNC
Calibration Algorithm	flatfieldCalibrationFilterSize	Sets the number of pixels used by the flat field correction low pass filter. 0 Basic – Direct calculation of coefficients based on current average line values. 1 to 127 – Calculation of coefficients after applying a low pass filter of CalibrationFilterSize pixels on the averaged line, on each side of the processed pixel.	Beginner DFNC
Calibration Target *Average*	flatfieldCalibrationTarget *Average*	The calibration target is the average value of the line pixels. After calibration all pixels will be scaled to output to the average pixel value across the line. (RO) *Average line pixel value*	Beginner DFNC
Calibration Sample Size	flatfieldCalibrationSampleSize	The number of lines to be averaged during a flat field calibration: 1024. (RO)	Beginner DFNC

Display Name	Feature	Description	View
Calibrate FPN	flatfieldCalibrationFPN	Initiates the FPN calibration process. Saves average line (of *flatfieldCalibrationSampleSize* rows). This is the first user correction applied – it is subtracted from each line. This feature may not be of use to many users as the camera already subtracts true "dark current", but it may be useful for some to provide a per pixel offset correction. Default value is 0 DN for each pixel	Beginner DFNC
Calibrate PRNU	flatfieldCalibrationPRNU	Initiates the PRNU calibration process	Beginner DFNC
FFCBankSelector *Factory Set* *User Set 1 (1 thru 4)*	FFCBankSelector *Factory Set* *UserSet1 (1 thru 4)*	Allows the user to select between the factory or 4 user FFC sets. *Factory set can only be loaded.* *User generated FFC.*	Beginner DFNC
Load FFC from bank	FFCSetLoadFromBank	Loads the FFC set specified by the FFC Bank Selector feature and update CurrentFFCSet to FFCBankSelector (W)	Beginner DFNC
Save FFC to bank	FFCSetSaveToBank	Saves the current FFC to the user set specified by the FFC Bank Selector. The user sets are located on the camera in nonvolatile memory. (W)	Beginner DFNC
Current FFC Set	CurrentFCCSet	Indicates which user set is currently in use. (RO) Important: the CurrentFFCSet is an index part of the UserSet.	Beginner DFNC
White Balance Single Calibration	BalanceWhiteAuto	White Balance one-time calibration control (W)	Beginner
White Balance ROI Width	BalanceWhiteRoiWidth	Sets the White Balance ROI width for all 3 colors in pixels: between 1 and 8192.	Beginner
White Balance ROI Offset	BalanceWhiteRoiOffset	Sets the White Balance ROI offset position of the 1st pixel of the ROI: between 0 and 8191.	Beginner
White Balance Adjust Enable *Off* *On*	BalanceWhiteAdjustEnable *Off* *On*	Sets the enable state of white balance adjustment. *Target is highest color value.* *Target defined by BalanceWhiteAdjustTarget.*	Beginner DFNC
White Balance Adjust Target	BalanceWhiteAdjustTarget	Set the white Balance target value for all 3 colors: between 0 and +255.99 by step of 1/16. This target is used if BalanceWhiteAdjustEnable is Active (RW) and if target is higher than all color channel average values.	Beginner DFNC
Status warning FFC or balance underflow	StatusWarningFfcOrBalanceUdf	Status register after FFC calculation. (RO) 0: No underflow during FFC 1: Underflow during FFC	Expert DFNC
Status warning FFC or balance overflow	StatusWarningFfcOrBalanceOvf	Status register after FFC calculation. (RO) 0: No overflow during FFC 1: Overflow during FFC	Expert DFNC

Image Format Category

The camera's Image Format controls, as shown by CamExpert, group parameters used to configure line mirroring and test pattern generation features.

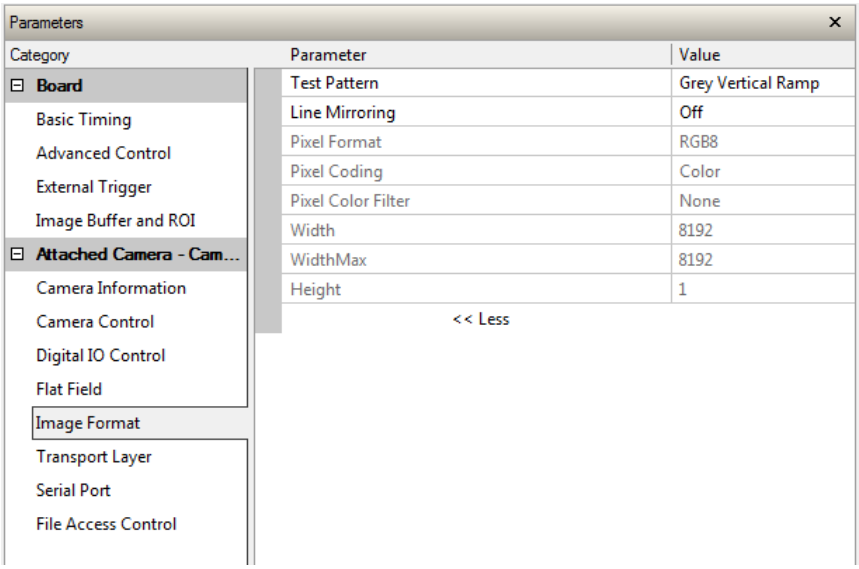


Figure 29: Image Format Panel

Image Format Control Feature Description

Display Name	Feature	Description	View
Test Pattern	TestImageSelector	Selects the type of test image that is sent by the camera. Note. Grey images are displayed so that any bit error will immediately be apparent as a color.	Beginner
Off	*Off*	*Selects sensor video to be output.*	
Grey Horizontal Ramp	*GreyHorizontalRamp*	*Selects a horizontal grey scale*	
White	*White*	*Selects a blank white pattern.*	
Grey Pattern	*GreyDiagonalRamp*	*Selects a blank grey pattern.*	
Black	*Black*	*Selects a blank black patter.n*	
Grey Vertical Ramp	*GreyVerticalRamp*	*Selects a vertical grey scale.*	
Line Mirroring	*ReverseX*	*Sets the enable state of line mirroring.This horizontally flips the image sent by the device.*	Beginner
Off	*Off*	*Video output in normal order.*	
On	*On*	*Video output in a reverse order.*	
Pixel Format	PixelFormat	Output image pixel coding format of the sensor.	Beginner
Mono 8	*Mono8*	*8-bit monochrome format is used when processesing each color separately.*	
Pixel Coding	PixelCoding	Represents the coding of the pixels in the image.	Beginner
Color	*Color*	*8 Bits / Pixel.*	
Pixel Color Filter	PixelColorFilter	Indicates the type of color filter used in the camera. (RO)	Beginner
None	*Mono*	*No pixel coding filter.*	
Width	Width	Width of the image output by the device, in pixels.(RO)	Beginner
MaxWidth	Width	The maximum horizontal dimension of the image, in pixels. (RO)	Beginner
Height	Height	Height of the image provided by the device, in lines. (RO)	Beginner

Transport Layer Control Category

The Transport Layer Control category, as shown by CamExpert, has parameters used to reset the camera and configure features related to Camera Link configuration.

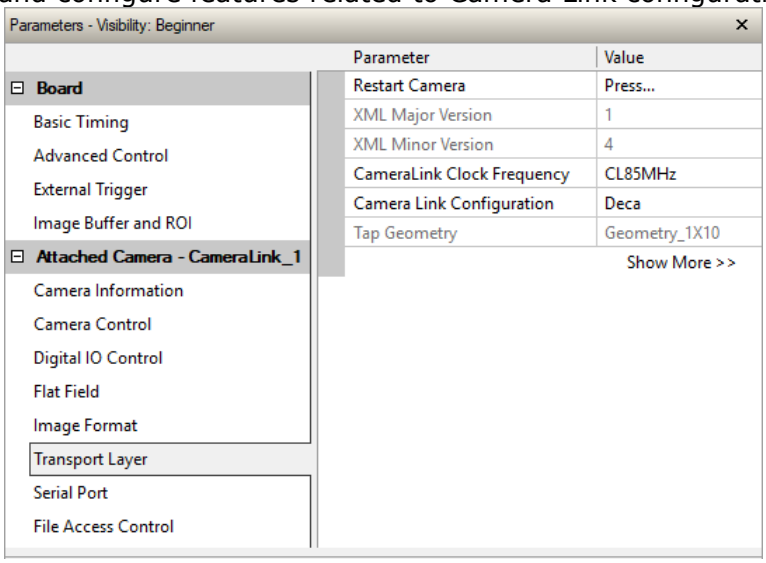


Figure 30: Transport Layer Panel

Transport Layer Feature Descriptions

Display Name	Feature	Description	View
Restart Camera	DeviceReset	Restarts the device to its power-up state (warm reset), including a 9600 baud rate.	Beginner
XML Major Version	DeviceManifestXMLMajorVersion	Together with DeviceManifestXMLMinorVersion specifies the GenICam™ feature description XML file version (RO)	Beginner
XML Minor Version	DeviceManifestXMLMinorVersion	Together with DeviceManifestXMLMajorVersion specifies the GenICam™ feature description XML file version (RO)	Beginner
Camera Link Clock Frequency	clDeviceClockFrequency	Sets the Camera Link clock rate	Beginner DFNC
CL85MHz	*CL85MHz*	*85 MHz clock*	
CL80MHz	*CL80MHz*	*80 MHz clock*	
CL60MHz	*CL60MHz*	*60 MHz clock*	
CL42_5MHz	*CL42_5MHz*	*42.5 MHz clock*	
Camera Link Configuraqtion	CLConfiguration	Camera Link output configuration, as described by the Camera Link standard.	Beginner
Base	*Base*	*Standard Base configuration.*	
Medium	*Medium*	*Standard Medium configuration.*	
Full	*Full*	*Standard Full configuration.*	
Deca	*Deca*	*Standard Deca configuration.*	
Tap Geometry	DeviceTapGeometry	Describes the geometrical properties characterizing the taps output by the camera. (RO)	Beginner
Geometry_1X3	*Geometry_1X3*	Three taps, interleaved (Base configuration).	
Geometry_1X6	*Geometry_1X6*	Six taps, interleaved (Medium configuration)	
Geometry_1X8	*Geometry_1X8*	Eight taps, interleaved (Full configuration).	
Geometry_1X10	*Geometry_1X10*	Ten taps, interleaved (Deca configuration).	

Serial Port Category

The Serial Port category of features allows the user to select an available camera serial port and review its settings.

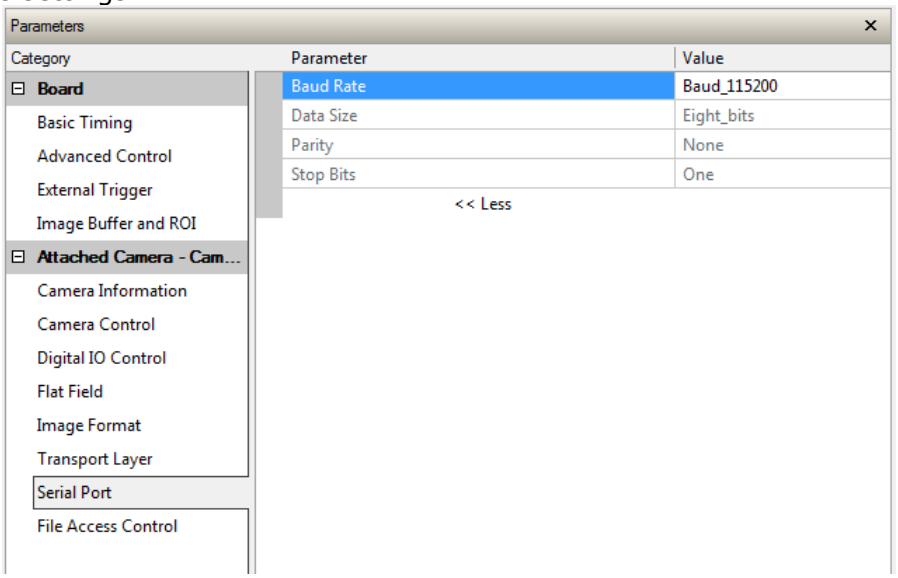


Figure 31: Transport Layer Panel

Serial Port Control Feature Descriptions

Display Name	Feature	Description	View
Baud Rate	DeviceSerialPortBaudRate	Sets the baud rate used by the selected device's serial port. Available baud rates are device-specific.	Beginner
Baud_9600	*Baud_9600*	*Baud rate is 9600*	
Baud_19200	*Baud_19200*	*Baud rate is 19200*	
Baud_38400	*Baud_38400*	*Baud rate is 38400*	
Baud_57600	*Baud_57600*	*Baud rate is 57600*	
Baud_115200	*Baud_115200*	*Baud rate is 115200*	
Data Size	deviceSerialPortDataSize	Sets the bits per character (bpc) to use (RO).	Beginner
Eight_Bits	*Eight_Bits*	*Use 8 bits per character*	
Parity	deviceSerialPortParity	Sets the parity checking type on the selected serial port.(RO)	Beginner
None	*None*	*Parity checking is disabled*	
Stop Bits	deviceSerialPortNumberOfStopBits	Sets the number of stop bits to use.	Beginner
One	*One*	*Use 1 stop bit*	

File Access Control Category

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

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

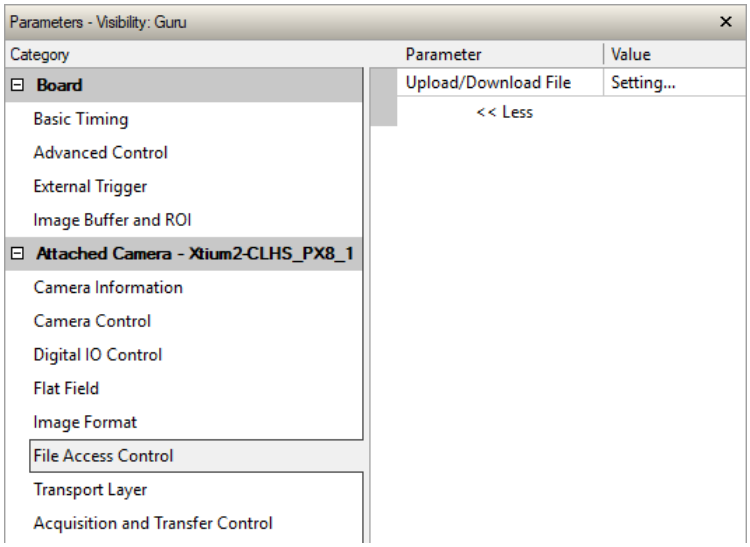


Figure 32: File Access Control Panel

File Access Control Feature Descriptions

Display Name	Feature	Description	View
File Selector	FileSelector	Selects the file to access. The files which are accessible are listed in the XML:	Beginner
XML		*Upload new XML to the camera which will execute on the next camera reboot cycle.* *Note that XML is zipped.*	
Camera Data	*Camera_Data*	*Download camera information and send for customer support.*	
Microcode	*Microcode*	*Upload new microcode to the camera which will execute on the next camera reboot cycle.*	
Miscellaneous	*FPGA_Code)*	*Upload new FPGA to the camera which will execute on the next camera reboot cycle.*	
File Operation Selector	FileOperationSelector	Selects the operation for the selected file in the device. This operation is executed when the File Operation Execute feature is called.	Guru
Open	*Open*	*Select the Open operation - executed by FileOperationExecute.*	
Close	*Close*	*Select the Close operation - executed by FileOperationExecute.*	
Read	*Read*	*Select the Read operation - executed by FileOperationExecute.*	
Write	*Write*	*Select the Write operation - executed by FileOperationExecute.*	
File Operation Execute	FileOperationExecute	Executes the operation selected by File Operation Selector on the selected file.	Guru

Display Name	Feature	Description	View
File Open Mode	FileOpenMode	Selects the access mode used to open a file on the device.	Guru
Read	*Read*	*Select READ only open mode*	
Write	*Write*	*Select WRITE only open mode*	
File Access Buffer	FileAccessBuffer	Defines the intermediate access buffer that allows the exchange of data between the device file storage and the application.	Guru
File Access Offset	FileAccessOffset	Controls the mapping offset between the device file storage and the file access buffer.	Guru
File Access Length	FileAccessLength	Controls the mapping length between the device file storage and the file access buffer.	Guru
File Operation Status	FileOperationStatus	Displays the file operation execution status. (RO).	Guru
Success	Success	The last file operation has completed successfully.	
Invalid Parameter	InvalidParameter	An invalid parameter was passed to the last feature called.	
Write Protect	WriteProtect	Attempt to write to a read-only (factory) file.	
File Not Open	FileNotOpen	The file has not been opened yet.	
File Too Big	FileTooBig	The file is larger than expected.	
File Invalid	FileInvalid	The last file operation has completed unsuccessfully because the selected file is not present in this camera.	
File Operation Result	FileOperationResult	For Read or Write operations, the number of successfully read/written bytes is returned. (RO)	Guru
File Size	FileSize	Represents the size of the selected file in bytes.	Guru

File Access via the CamExpert Tool

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

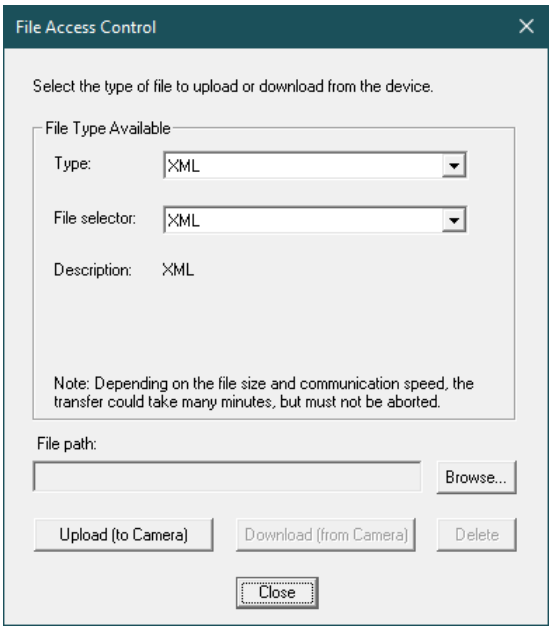


Figure 33: File Access Control Tool

2. From the Type drop menu, select the file type that will be uploaded to the camera or downloaded from the camera.
3. From the File Selector drop menu, select the file to be uploaded or downloaded.
4. To upload a file, click the Browse button to open a typical Windows Explorer window.
    a. Select the specific file from the system drive or from a network location.
    b. Click the Upload button to execute the file transfer to the camera.
5. Alternatively, click the Download button and then specify the location where the file should be stored.

	Note: firmware changes require that the camera be powered down and then back up. Additionally, CamExpert should be shut down and restarted following a reset.

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

File Transfer Protocol

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

Download File from Camera

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

Upload File to Camera

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

Appendix B: ASCII Commands

Serial Port Configuration

To use three-letter text commands via a terminal program (such as HyperTerminal), map the frame grabber serial port to an availailable COM port (for example, COM port).

For Teledyne DALSA frame grabbers, to do so:

- Run the Sapera Configuration utility and select the frame grabber serial port connected to the camera.
- Set **COM port mapping (optional)** to an available COM port (for example, COM2).

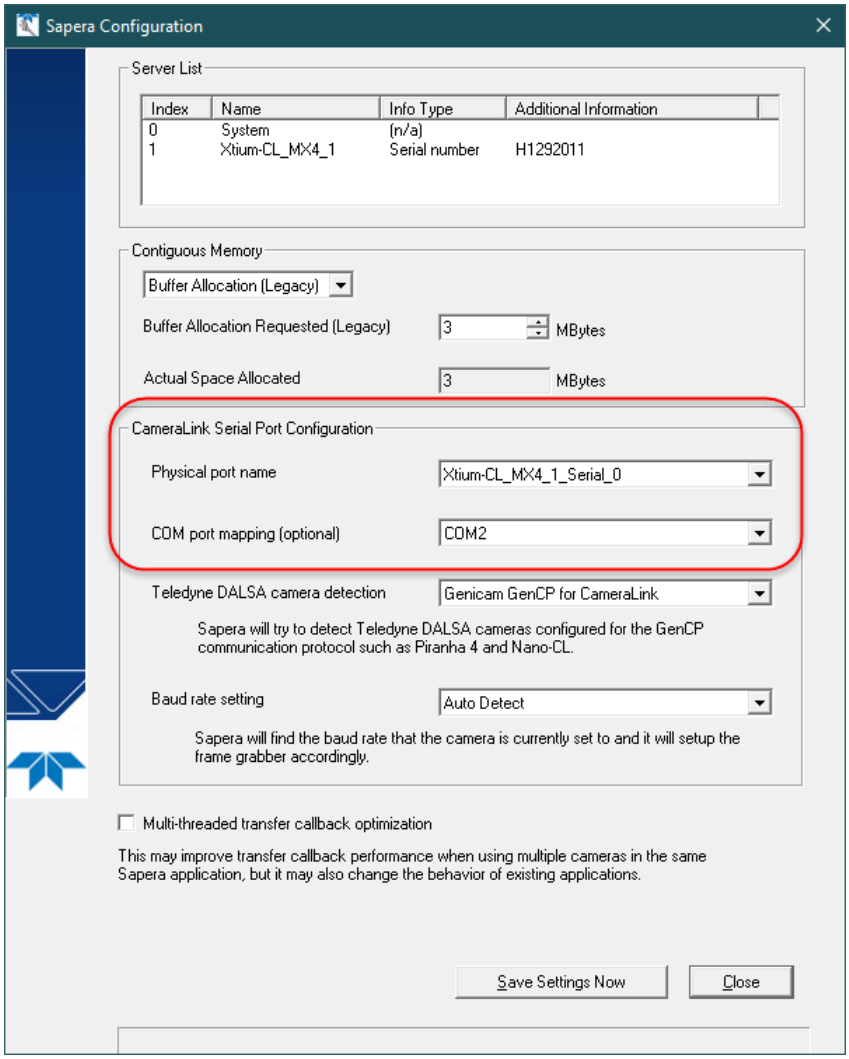


Figure 34: Sapera Configuration COM Port Mapping

Accessing the Three Letter Commands (TLC)

To access the TLC an ASCII-based communications interface application, such as HyperTerminal, is required.

Additionally it is possible to use the functions of `clserxxx.dll` or `clallserial.dll` as defined in the Camera Link Specification.

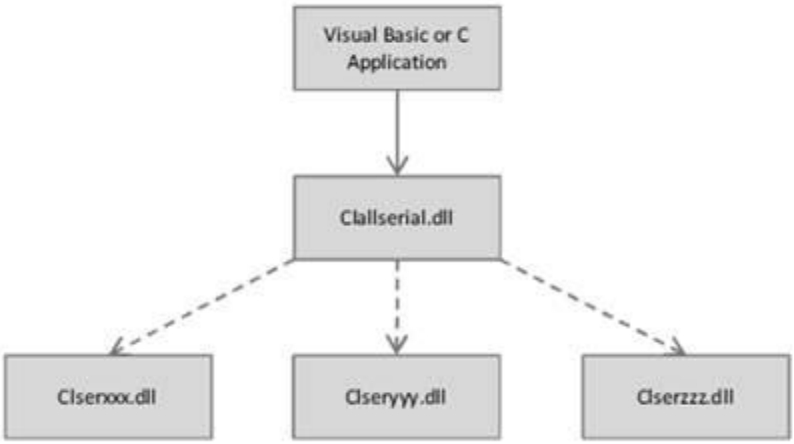


Figure 35: Serial DLL hierarchy as mentioned in the Camera Link Specification

1. Cycle power to the camera: by either a) issuing the reset camera command (rc), or b) powering the camera OFF and then ON.
2. Load the ASCII interface using:
   - 9600 baud
   - 8 data bits
   - no parity
   - 1 stop bit
   - no flow control
   - Receive: CR+LF
   - Transmit: CR
   - Local echo
3. Wait for a stable status LED color (green or red) before proceeding. Note that all entries in HyperTerminal will be ignored until a stable LED color is obtained.
4. In case of HyperTerminal, press the <ESC> key.
5. Once <ESC> has been entered, press <Return> key and the help screen appears.

Notes on Using Alternatives to HyperTerminal

- If you are using interfaces other than HyperTerminal, the ASCII character, ESC, is decimal 27 and needs to be issued. From the command line insert ESC by using ALT+2+7 of the activated Num-Pad. In some cases this needs to be followed by a carriage return or a linefeed to send this to the camera.
- In ASCII the ESC character may look like this: "←".

The camera responds to a simple ASCII-based protocol. A carriage return <CR> ends each command.

Example: to return the current detector settings

gcp <CR>

A complete list of the available detector commands, their format and parameters can be displayed by sending the help (**h**) command.

Port configuration

Baud: 9,600
Bits: 8
Parity: None
Stop bits: 1
Flow Control: None

Echo typed characters locally.

Rules

- The interface is case sensitive
- One command and argument(s) per line
- Error codes returned are the same as the GenICam™ interface – see Diagnostics | Error Codes
- Follow each command with the carriage return character – 0x0D

Commands

The following commands can be used to control the camera.

Full Name	**Balance White Auto**	
Mnemonic	**BWA**	
Argument(s)	Target mode	0: target is the highest color value 1: use 2nd argument as target.
	Target	0-4095 (target in 12 bits format); must be higher than highest color value to work properly.
	ROI Offset	0-8191 by step of 1: ROI offset in pixels
	ROI Width	1-8192 by step of 1: ROI width in pixels
Description	Single white balance calibration	
Notes	Calculates gain for each color such that the average of each is at the same level as the average of the most responsive, or at the specified target parameter if this target is higher than the most responsive color.	

Full Name	**Calibrate User FPN**	
Mnemonic	**CCF**	
Argument(s)	Start	1
Description	Calibrate user FPN dark flat field coefficients.	

Full Name	**Camera Link Mode**	
Mnemonic	**CLM**	
Argument(s)	Mode	0. Base 1. Medium 2. Full 3. Deca
Description	Camera Link Mode	

Full Name	**Camera Link Speed**	
Mnemonic	**CLS**	
Argument(s)	Frequency	0. 85 MHz 1. 80 MHz 2. 60 MHz 3. 42.5 MHz
Description	Camera Link clock frequency	

Full Name	Calibrate Flatfield	
Mnemonic	**CPA**	
Argument(s)	Start/Stop	1: Start calibration 0: Stop calibration
	Filter	0 to 127 by step of 1: use averaging filter window of n pixels on the same line and on each side of the calibrated pixel.
Description	Calibrate user PRNU flat field coefficients	
Notes	• Coefficients are saved and loaded with user set (for example, uss / usl) • Algorithm flattens each color and uses gains to even pixel response	

Full Name	Color Transformation Value	
Mnemonic	**CTV**	
Argument(s)	Selector	0. c_{rr} Gain00 1. c_{rg} Gain01 2. c_{rb} Gain02 3. c_{gr} Gain10 4. c_{gg} Gain11 5. c_{gb} Gain12 6. c_{br} Gain20 7. c_{bg} Gain21 8. c_{bb} Gain22
	Integer Value	From -256 (gain=-4) to 255 (gain=3.984375) by step of 0.015625 (=1/64)
Description	Color Transformation Matrix	

Full Name	Flatfield Mode	
Mnemonic	**FFM**	
Argument(s)	Mode	0. Disable use of user FPN and PRNU flat field correction coefficients 1. Enable use of user FPN and PRNU flat field correction coefficients
Description	Set flat field mode	
Notes		

Full Name	Display Camera Configuration
Mnemonic	GCP
Argument(s)	
Description	Display current value of camera configuration parameters
Notes	USER>gcp Model Name P4_8K FW version 2.1.0 Serial Number 2005A7683 User Id MyCamera Default User Set 0 Line Rate 10000 [Hz] Trigger Mode - Off Exposure Mode - Trigger Width Exposure time 15498 Max Exposure time 15498 Test Pattern Image - Off Scan Direction - Internal, Forward Sensor Line Spatial Correction - 512/256 Line Delay Flat Field Mode State - Off White Balance Enable - On Color Matrix Enable - Off Contrast expansion offset 0 System Numeric Gain 1024 Gain for red 1024 Gain for green 1024 Gain for blue 1024 Color matrix selector 0 Color Correction Matrix: 64, 0, 0 0, 64, 0 0, 0, 64 Mirroring Mode - Off Camera Link frequency - 85MHz Camera Link mode - 8bits RGB Medium 6Taps Pixel Format 8k TriLinear RGB USER>

Full Name	Get Value
Mnemonic	GET
Argument(s)	<parameter>
Description	The "get" command displays the current value(s) of the feature specified in the string parameter. Using this command will be easier for control software than parsing the output from the "gcp" command.

Notes

```
User>get ssf
10000
>Ok

Short  Full Name                  Displayed Value and Description
bwa    Balance white auto         0: target mode; 2048: target;
                                  1024: ROI offset; 6144: ROI width
ccf    Calibrate User FPN         0: calibration complete
cls    Camera Link Speed          0:85; 1:80; 2:60; 3:42.5 [MHz]
clm    Camera Link Mode           0: Base 1: Med 2: Full 3: Deca
cpa    Calibrate Flatfield        0: calibration complete; 0: filter
ctv    Color Transformation Value fixed point values (2exp-6) 18lines
                                  Color correction matrix gains
                                  0 49
                                  1 25
                                  2 -10
                                  3 -25
                                  4 79
                                  5 10
                                  6 -34
                                  7 -15
                                  8 113
ffm    Flat Field Mode            0: Off, 1: On
gcp    Camera Configuration       returns camera configuration
h      Help                       returns list of commands help
rc     Reset Camera               returns error
rpc    Reset Pixel Coefficients   returns error
sbr    Set Baud Rate              returns baud rate
scd    Scan Direction             0: forward, 1: reverse; 2: (CC3)
sem    Exposure Mode              0: Internal, 1: External
set    Exposure Time              10000 periods of 6.357ns
smm    Mirroring Mode             0: Off, 1:On
spf    Pixel Format               0: RGB8
ssa    Set Spatial Alignment      512: 0 (0) to 5.996 (1535) line
delay
ssb    Offset                     -4096 to 4095 in 12-bit DN
ssf    Internal Line Rate         returns line rate in Hz
ssg    Gain (7 lines)             0: Preamp, 1: System,
                                  2: contrast expansion,
                                  3: contrast offset,
                                  4:red, 5:green, 6: blue,
                                  fixed point numbers
stm    Trigger Mode               0: Off (internal), 1: On (external)
sui    Set User ID                MyCamera
svm    Test Pattern               0: sensor video,
                                  1: grey horizontal ramp,
                                  2: white, 3: Grey, 4: black,
                                  5: grey vertical ramp
usd    Default User Set           0 2: default config User Set (0-4)
                                  1 3: default color User Set (0-4)
usl    Load User Set              0 2: last loaded config userset 0-4
                                  1 3: last loaded color userset 0-4
uss    Save User Set              0 2: last saved config userset 1-4
                                  1 3: last saved color userset 1-4
                                  2 4: last saved FFC userset 1-4
vt     Temperature                returns camera internal temperature
```

Full Name	Help
Mnemonic	H
Argument(s)	
Description	Display list of three letter commands
Notes	USER>h P4 : Command Line Interpreter bwa - Balance white auto - <target-mode 0/1; 0: target=highest color level; 1: target=next argument> <target 0-4095> <ROIOffsetX 0-8191> <ROIWidth 1-8192> ccf - Calibrate FPN - <0:stop calibration 1:Start Calibration> clm - Camera Link Mode <0:Base 1:Med 2:Full 3:Deca> cls - Camera Link Speed <0:85MHz 1:80MHz 2:60MHz 3:42.5MHz> cpa - Calibrate PRNU <0:stop calibration 1:Start Calibration> <0(no filter), 1 to 127 (filter of 2n+1)> ctv - Color transformation value <0:Gain00/..../8:Gain22> <gain from x-4 (-256) to x4 (255)> ffm - Flat Field Correction Mode <0:Disable(Raw sensor) 1:Enable> gcp - Display Camera Configuration lpc - Restore current FFC <bank number from 0 to 4> rc - Reset Camera rpc - Reset Flatfield Coefficients - No parameters sbr - Set Baud Rate <9600|19200|38400|57600|115200> scd - Direction <0:Forward 1:Reverse 2:CC3 signal> sem - Exposure Mode <0:Off 1:On> set - Exposure Time <Integer: 32 bits (step of 6.357ns)> sha - Set horizontal alignment <-40 (-4 pixels) to 40 (+4 pixels)> shm - Set horizontal alignment mode <0-Off, 1-Active> smm - Mirroring <0:Off 1:On> ssa - Set Spatial Rebuild <0:(x0) to 1535:(x5.996)> ssb - Offset <-4096 to 4095 step 1> ssf - Internal Line Rate <value[Hz]> ssg - Gain <0:Preamp> <0 1 2>/ <1:System> <1024 to 4095> / <2:Contrast expansion> <1024 to 65535> / <3:Contrast offset> <-4096 to 4095> / <4:Red 5:Green 6:Blue> <1024 (x1) to 4095 (x3.999)> stm - Trigger Mode <0:Off 1:On> sui - Set User ID svm - Test Pattern <0 to 5> usd - Default <0: config User Set> <0 to 4> / <1: Color usr set> <1 to 4> usl - Load <0: config User> <0 to 4> <1: Color user set> <1 to 4> uss - save <0: config User Set> <1 to 4> / <1: Color user set> <1 to 4> / <2: FFC user set> <1 to 4> vt - Temperature USER>

Full Name	Load Pixel Coefficients	
Mnemonic	LPC	
Argument(s)	Set selector	0.Factory set 1-4. User sets
Description	Load FFC parameters in RAM from FFC user set in NVM (non volatile memory), and update current FFC set in Config parameters.	
Notes	The FFC link targets FPN and PRNU coefficients.	

Full Name	Reset Camera
Mnemonic	RC
Argument(s)	
Description	Resets the camera to the saved user default settings. These settings are saved using the usd command.
Notes	

Full Name	Reset Flatfield Coefficients
Mnemonic	RPC
Argument(s)	
Description	Reset FCC parameters in RAM: all FPN values to zero and all PRNU coefficients to one.
Notes	

Full Name	Set Baud Rate	
Mnemonic	SBR	
Argument(s)	Baud rate	9600 19200 38400 57600 115200
Description	Set baud rate	
Notes	• Send command and then change speed of HyperTerminal	

Full Name	Direction	
Mnemonic	SCD	
Argument(s)	Direction	0. Forward 1. Reverse 2. External – controlled by CC3 signal
Description	Set sensor scan direction	
Notes		

Full Name	Exposure Mode	
Mnemonic	SEM	
Argument(s)	Mode	0. Internal 1. External
Description	Set exposure time mode	
Notes	• In internal mode the exposure time is controlled by the SET command • SEM 1 overrides internally generated independent exposure times	

Full Name	Exposure Time	
Mnemonic	SET	
Argument(s)	Exposure time	2 202 to Line period - 392 [6.357 ns]
Description	Set internal exposure time	
Notes	• Line time > (Exposure time + 2,500 ns)	

Full Name	Set Horizontal Alignment	
Mnemonic	SHA	
Argument(s)	Pixels	-40 to 40 by step of 1 (unit is 1/10 pixel)
Description	The value entered will stretch/shrink the sensor red and green lines to align the colors.	
Notes		

Full Name	Set Horizontal Alignment Mode	
Mnemonic	SHM	
Argument(s)	Selector	0. Off 1. Active
Description	Enable the horizontal correction	
Notes		

Full Name	Mirroring	
Mnemonic	SMM	
Argument(s)	Mode	0. Off 1. Image is flipped on the vertical axis
Description	Set mirroring mode	
Notes		

Full Name	Set Line Delay	
Mnemonic	SSA	
Argument(s)	# of lines	0 (0 line) to 1535 (5.996 lines)
Description	Sets the number of lines of delay between colors that are read out from the sensor (default 2).	
Notes	If your line rate matches the speed of the object, then the value of the line delay will be 2. Adjust the ssa value until you remove the red and blue halos above and below a black on white horizontal line in order to set the line delay.	

Full Name	**Offset**		
Mnemonic	**SSB**		
Argument(s)	Offset	8 bit	-4096 to 4095 step 1 in DN12b
Description	Set offset		
Notes	-4096 in DN12b corresponds to -256 in DN8b		

Full Name	**Internal Line Rate**	
Mnemonic	**SSF**	
Argument(s)	Line rate	1 to 33,000 [Hz]
Description	Set internal line rate	
Notes	• Line time > (Exposure time + 2,500 ns)	

Full Name	**Gain**	
Mnemonic	**SSG**	
Argument(s)	0. Preamp 1. System 2. Contrast expansion 3. Contrast offset 4. Red gain 5. Green gain 6. Blue gain	0: x1, 1: x2, 2: x4 1024 (x1) to 4095 (x3.999) 1024 (x1) to 65535 (x63,999) -4096 (-256) to 4095 (255,9375) 1024 (x1) to 4095 (x3.999) 1024 (x1) to 4095 (x3.999) 1024 (x1) to 4095 (x3.999)
Description	Set gain	
Notes		

Full Name	**External Trigger**	
Mnemonic	**STM**	
Argument(s)	Mode	0. Off 1. On
Description	Set trigger mode	
Notes	• When off, line rate is controlled by ssf command • When on, integration starts on rising edge of CC1 signal	

Full Name	**Set User ID**
Mnemonic	**SUI**
Argument(s)	User-programmable identifier of up to 64 characters
Description	Set device user ID
Notes	

Full Name	Test Pattern	
Mnemonic	SVM	
Argument(s)	Mode	0: Off - sensor video 1: Grey horizontal ramp 2: White 3: Grey 4: Black 5: Grey vertical ramp
Description	Select test pattern	
Notes		

Full Name	Default User Set	
Mnemonic	USD	
Argument(s)	Config or Color selector	0. Config parameters 1. Color parameters
	Set selector	0. Factory set 1-4. User sets
Description	Select set for camera config or color parameters to load when camera is reset.	
Notes	Color parameters are: color gains (Red, Green, Blue) and color correction matrix. Camera parameters are all other parameters, including FFC user set (0 to 4) which is one of the camera parameters.	

Full Name	Load User Set	
Mnemonic	USL	
Argument(s)	Config or Color selector	0. Config parameters 1. Color parameters
	Set selector	0. Factory set 1-4. User sets
Description	Load parameters in RAM: Config parameters: 1. Load in RAM config parameters from NVM (non volatile memory) 2. Load in RAM FFC parameters from NVM Note that FFC userset is one of the config parameters. Color parameters: Load in RAM color parameters from NVM	
Notes	Color parameters are: color gains (Red, Green, Blue) and color correction matrix. Camera parameters are all other parameters, including FFC user set (0 to 4) which is one of the camera parameters.	

Full Name	Save User Set	
Mnemonic	**USS**	
Argument(s)	Config or Color or FFC selector	0. Config UserSet parameters 1. UserColorSet parameters 2. FFC UserSet parameters
	Set selector	1 to 4
Description	Save parameters from RAM to user set in NVM (non volatile memory) Config UserSet parameters UserColorSet parameters FFC UserSet parameters	
Notes	UserColorSet parameters are: color gains (Red, Green, Blue) and color correction matrix. FFC UserSet parameters are FPN and PRNU correction coefficients. Config UserSet parameters are all other parameters, including FFC UserSet number (0 to 4).	

Full Name	Temperature
Mnemonic	**VT**
Argument(s)	
Description	Display internal temperature in degrees Celsius
Notes	

Appendix C: Evaluation Setup & Configuration

Optical Configuration

To evaluate the camera's image quality the camera should be under operating conditions similar to those used in the application.

The illumination, lens magnification, and focus should be set up in the same manner as the application. Getting the magnification right is best accomplished by setting the object-to-sensor distance.

To calculate this distance, use the formula:

lens focal length x (*2 + 1/magnification + magnification*)

Magnification equals the sensor pixel size (7.5 µm) / (target object pixel size in um).

Camera Timing & Control

It is easiest and quickest to evaluate the camera using the internal timing setups for line rate and exposure time.

Camera Link Mode

It is recommended to start with Camera Link medium mode (*clConfiguration* = Medium); set a suitable line rate less than 20 KHz (*AcquisitionLineRate* < 20000).

If this line rate is too slow for your application, you will get a compressed image in the scan direction. This should not be a problem for a basic evaluation.

Exposure Time

Set the exposure time (*ExposureTime*). Ensure that the exposure time period is not greater than the period of the line rate minus 2.5 µsec; an error is generated if you select an exposure time that is too long (minimum exposure time is 14.1 µsec).

Set the camera direction using *ScanDirection* parameter. Refer to the Scan Direction section for more information.

Acquiring an Image

You can now begin imaging. Unless you have an application employing lots of light, the image is likely to be too dark:

- Use *PreampGain* to increase the image dynamic (x2 or x4)
- Use *Gain* to adjust the camera output to achieve the desired response. The system gain range is from 1x to 3.99x.

When you have a suitable response, you can now focus the lens.
If you are using white LEDs, your image will have reasonable color reproduction if you enter the provided WhiteLED color matrix.

The image may be darker at the edges due to lens vignetting, but this will be improved once the camera is calibrated; refer to the Calibrating the Camera section for more informaiton.

Improving Your Color Image

The color response of the P4 color camera is quite good even when using white LED's without color correction. A white LED color correction matrix can be entered to improve color response for those using white LEDs.

If you are using a different light source, a suitable color correction matrix should be entered in the camera. You will require a Gretag Macbeth ColorChecker with 4 x 6 color elements that you can scan past the camera to complete the generation of the matrix.

Contact Teledyne DALSA's technical support for further details.

Appendix D: Color Deca and Full Mode Acquisition

Overview

This section describes how to acquire images with the Piranha4 color camera under RGB 9.1 Deca mode to achieve a 68.5 KHz line rate, and under RGB 6.2 Full mode to achieve a 55 KHz line rate.

Supported Sapera LT

Sapera 7.10 or later is required.

Programming Deca Mode

The RGB 9.1 Deca mode uses Camera Link 10-tap, 8-bit mode to achieve RGB formatting. Below is the Camera Link port assignment of Deca mode.

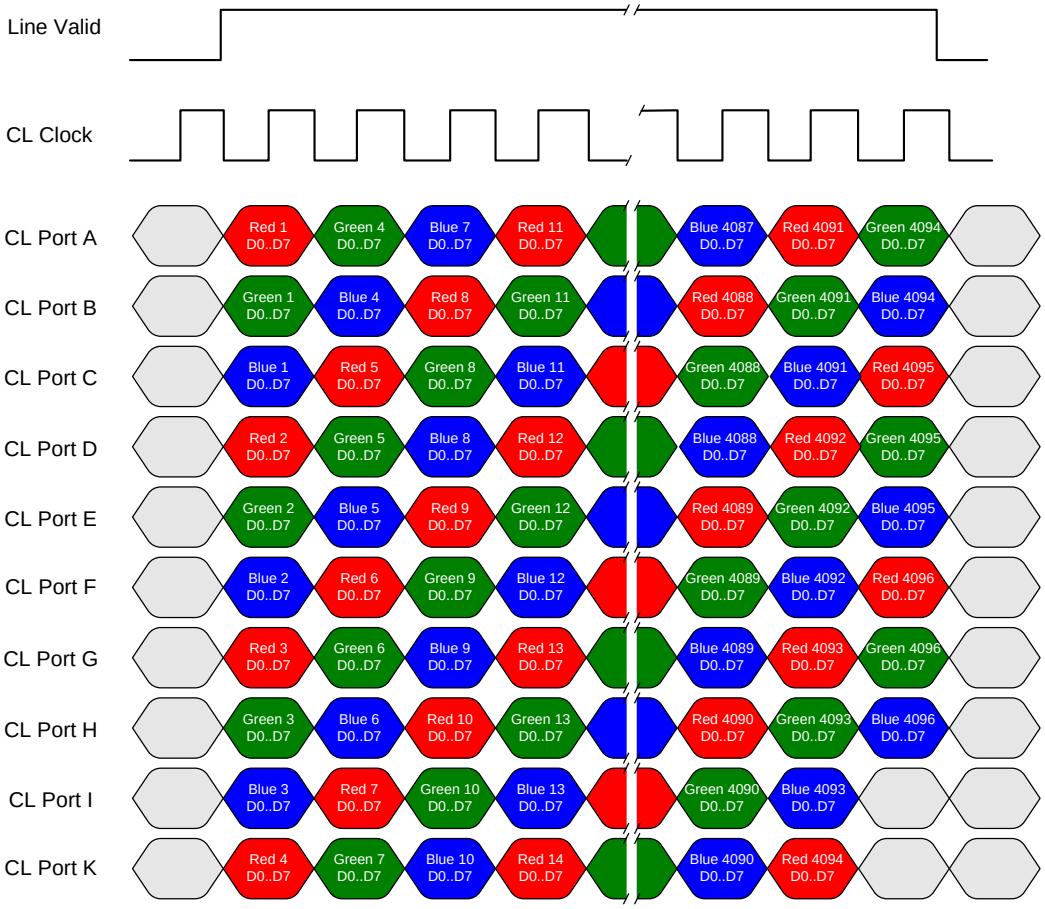


Figure 36: Camera Link Deca Mode Port Assignment

This tap arrangement allows all frame grabbers with 10-tap, 8-bit to grab images without requiring additional modifications.

However, in order to correctly format the image for processing and display purposes, frame grabbers need to support RGB 9.1 mode natively. Until then, here are some workarounds using Sapera LT.

	Note: to support this pixel format in memory, the buffer must be set to RGB 24-bit packed.

All Sapera demo and example programs extract the create acquisition buffer type from the associated camera configuration files. Until there is native support for RGB 9.1 mode, frame grabbers must be configured as monochrome, the CCF files pixel format can't be used by the programs to process the image correctly.

A simple workaround accomplishes this:

1) Acquire as if the P4 camera was a 8-bit mono, 24,576 (8192 x 3) pixel linescan camera
2) Treat acquired buffer as SapFormatRGBR888 (24bit/pixel). Sapera LT provides a feature to share buffer components between two SapBuffer objects. Buffer type may be different between the two SapBuffer objects. This can be a trick to convert buffer format without buffer copy.

Acquiring the above data as you would an 8-bit mono camera in 10-tap mode creates the acquisition buffer shown below.

Adr+0	Adr+1	Adr+2	Adr+3	Adr+4	Adr+5	Adr+6	Adr+7	Adr+8	Adr+9	Adr+10	Adr+11
Red1	Green1	Blue1	Red2	Green2	Blue2	Red3	Green3	Blue3	Red4	Green4	Blue4

First CLK Second CLK

On the other hand, the SapFormatRGBR888 format is shown below.

Pixe1 (3byte)			Pixel2			Pixel3			Pixel4		
Red1	Green1	Blue1	Red2	Green2	Blue2	Red3	Green3	Blue3	Red4	Green4	Blue4

As demonstrated above, the two buffers' content and their order are exactly same. Thus, acquiring the buffer as if the camera were a mono 8-bit, 10-tap results in the same buffer contents as the SapFormatRGBR888.

Sample Code:

```
//Assuming acquisition buffer is declared as below.
#define NUMBUFFERS   10
SapBuffer *m_Buffers;
m_Buffers = new SapBufferWithTrash(NUMBUFFERS, m_Acq);

// Call Create() for acquisition buffer
m_Buffers->Create();

// Declare SapBuffer object which shares buffer components with the acquisition buffer
SapBuffer *m_ViewBuffers;
int width, height, i;
void* pData[NUMBUFFERS];
for (i = 0; i < NUMBUFFERS; i++)
{
   m_Buffers->GetAddress(i, &pData[i]);
}
width = m_Buffers->GetWidth();
height = m_Buffers->GetHeight();
m_ViewBuffers = new SapBuffer(NUMBUFFERS, pData, width / 3, height, SapFormatRGB888);
m_ViewBuffers->Create();
```

If you declare above m_ViewBuffer as the source buffer of SapView object, you can display RGB image without any additional processing.

Appendix E: Error and Warning Messages

Hardware status under "Camera Information"

The hardware status are binary flags with each bit being independent from each other. The message should be "Good" meaning everything is functioning correctly but if a hardware failure does occur in the camera, one or more these flags could be set. Some of these flags set will result in the status light turning red.

Table 18: Hardware Status Bitfield

Flag	Definition
Bit 0	No trigger during more than 1s
Bit 1	Trigger too fast
Bit 2	SNS Pattern failed
Bit 8	Overflow occurred during FFC calibration
Bit 9	Underflow occurred during FFC calibration
Bit 10	Calibration error
Bit 11	CC3 scrolling direction (0: Fwd, 1: Rev)
Bit 15	Initialization in progress
Bit 16	Hardware error detected

GenCP Error Codes

The error codes returned by the camera are compliant with the GenCP standard.

Table 19: GenCP Error Codes

Status Code (Hex)	Name	Description
0x0000	GENCP_SUCCESS	Success
0x8001	GENCP_NOT_IMPLEMENTED	Command not implemented in the device.
0x8002	GENCP_INVALID_PARAMETER	At least one command parameter of CCD or SCD is invalid or out of range.
0x8003	GENCP_INVALID_ADDRESS	Attempt to access a not existing register address.
0x8004	GENCP_WRITE_PROTECT	Write attempt to a read only register.
0x8005	GENCP_BAD_ALIGNMENT	Attempt to access registers with an address which is not aligned according to the underlying technology.
0x8006	GENCP_ACCESS_DENIED	Attempt to read a non-readable or write a non-writable register.
0x8007	GENCP_BUSY	The command receiver is currently busy.
0x800B	GENCP_MSG_TIMEOUT	Timeout waiting for acknowledge.
0x800E	GENCP_INVALID_HEADER	The header of the received command is invalid. This includes CCD and SCD fields but not the command payload.
0x800F	GENCP_WRONG_CONFIG	The current receiver configuration does not allow the execution of the sent command.
0x8FFF	GENCP_ERROR	Generic error.

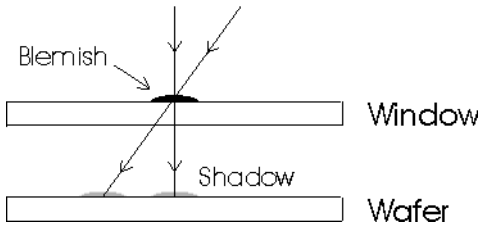
Appendix F: The Sensor Window

Cleaning and Protecting Against Dust, Oil, and Scratches

The sensor window is part of the optical path and should be handled like other optical components, with extreme care. Dust can obscure pixels, producing dark patches on the sensor response. Dust is most visible when the illumination is collimated. The dark patches shift position as the angle of illumination changes. Dust is normally not visible when the sensor is positioned at the exit port of an integrating sphere, where the illumination is diffuse. Dust can normally be removed by blowing the window surface using an ionized air gun. Oil is usually introduced during handling. Touching the surface of the window barehanded will leave oily residues. Using rubber finger cots and rubber gloves can prevent contamination. However, the friction between rubber and the window may produce electrostatic charge that may damage the sensor. To avoid ESD damage and to avoid introducing oily residues, avoid touching the sensor. Scratches diffract incident illumination. When exposed to uniform illumination, a sensor with a scratched window will normally have brighter pixels adjacent to darker pixels. The location of these pixels will change with the angle of illumination.

Important Note on Window Blemishes:

When flat field correction is performed, window cleanliness is paramount. The figure below shows an example of what can happen if a blemish is present on the sensor window when flat field correction is performed. The blemish will cast a shadow on the wafer. FFC will compensate for this shadow by increasing the gain. Essentially FFC will create a white spot to compensate for the dark spot (shadow). As long as the angle of the incident light remains unchanged then FFC works well. However when the angle of incidence changes significantly (i.e. when a lens is added) then the shadow will shift and FFC will makes things worse by not correcting the new shadow (dark spot) and overcorrecting where the shadow used to be (white spot). While the dark spot can be potentially cleaned, the white spot is an FFC artifact that can only be corrected by another FFC calibration.



Cleaning the Sensor Window

Recommended Equipment

- Glass cleaning station with microscope within clean room.
- Ionized air gun. For example, 3M ionized air gun.
- Ionized air flood system, foot operated.
- Cotton swab. For example, Swab Huby340 CA-003.
- Single drop bottle (FD-2-ESD).
- Optic cleaning fluid. For example, the E2 Eclipse optic cleaning system.

Procedure

- Use localized ionized air flow directed on to the glass during sensor cleaning.
- Blow off mobile contamination using an ionized air gun.
- Place the sensor under the microscope at a magnification of 5x to determine the presence of any remaining contamination.
- Clean the contamination on the sensor using one drop of cleaning fluid on a swab.
- Wipe the swab from left to right (or right to left but only in one direction). Do this in an overlapping pattern, turning the swab after the first wipe and with each subsequent wipe. Avoid swiping back and forth with the same swab in order to ensure that particles are removed and not simply transferred to a new location on the sensor window. This procedure requires you to use multiple swabs.
- Discard the swab after both sides of the swab have been used once.
- Repeat until there is no visible contamination present.

EC & FCC Declaration

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

Standard Conformity

The cameras have been tested using the following equipment:

- A shielded power supply cable.
- A Camera Link data transfer cable ref. MVC-1-1-5-2M from CEI (Component Express, Inc.)
-

Teledyne DALSA recommends using the same configuration to ensure the compliance with the following standards:

CE Conformity

The cameras comply with the requirements of the EMC (European) directive 2004/108/EC (EN50081-2, EN 61000-6-2).

FCC Conformity

The cameras further comply with Part 15 of the FCC rules, which states that: Operation is subject to the following two conditions:

- This device may not cause harmful interference (EN55032), and
- This device must accept any interference received, including interference that may cause undesired operation (EN55024)

This equipment has been tested and found to comply with the limits for 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.

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

Revision History

Table 20: Revision History

Revision	Change Description	Date
00	Initial release.	28 June 2019
01	Flash memory specification added: 32 Mbytes.	9 July 2019
02	Power dissipation 6.6W -> 8W 230400 bauds removal TLC h (help) text correction White Balance: the calibration process considers the 128 pixels on the left of the sensor. WhiteBalanceAdjustTarget must be greater than all channel average value. Spatial correction updates: algorithm consistent with legacy DALSA linescan cameras. Figure 7: changed for P4-CC-08K03T-01-R skeleton & changed forward/reverse arrows Exposure mode corrections: rising edge of EXSYNC, 30µs delay instead of 4.1µs flatfieldCorrectionAlgorithm: value 0 to 63 for Basic / Low Pass filter added. flatfieldCalibrationSampleSize: 1024 lines. Updated structure and format.	Oct-Dec 2019
03	minimum exposure time updated to 14.1 µsec Mechanical Drawing updated Table 4: PRNU HF corrected p. 33: no White Balance performed during PRNU calibration. Text corrected accordingly. p.48: added UserColorDefaultSelector for Power-on color userset selector p.53: added ResetFPN command. p.53: BalanceWhiteRoiWidth and BalanceWhiteRoiOffset added. p.53: flatfieldCalibrationFilterSize defined between 0 and 127. p.65: TLC updates below. BWA: ROI control and target mode added. CPA: averaging filter control added. CPL: modified explanation (camera command unchanged). SPF: removed. USD, USL, USS: updated to provide all XML capabilities.	15 December 2020

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