

# Piranha4

## Camera User's Manual

RGB + NIR / Monochrome Cameras

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



© 2015 Teledyne DALSA, Inc. All information provided in this manual is believed to be accurate and reliable. No responsibility is assumed by Teledyne DALSA for its use. Teledyne DALSA reserves the right to make changes to this information without notice. Reproduction of this manual in whole or in part, by any means, is prohibited without prior permission having been obtained from Teledyne DALSA.

## About Teledyne Technologies and Teledyne DALSA, Inc.

Teledyne Technologies is a leading provider of sophisticated electronic subsystems, instrumentation and communication products, engineered systems, aerospace engines, and energy and power generation systems. Teledyne Technologies' operations are primarily located in the United States, the United Kingdom and Mexico. For more information, visit Teledyne Technologies' website at [www.teledyne.com](http://www.teledyne.com).

Teledyne DALSA, a Teledyne Technologies company, is an international leader in high performance digital imaging and semiconductors with approximately 1,000 employees worldwide, headquartered in Waterloo, Ontario, Canada. Established in 1980, the company designs, develops, manufactures and markets digital imaging products and solutions, in addition to providing MEMS products and services. For more information, visit Teledyne DALSA's website at [www.teledynedalsa.com](http://www.teledynedalsa.com).

## Support

For further information not included in this manual, or for information on Teledyne DALSA's extensive line of image sensing products, please contact:

### North America

700 Technology Park Drive  
Billerica, MA  
USA, 01821  
Tel: 978-670-2000  
Fax: 978-670-2010  
Email: [Sales.Americas@teledynedalsa.com](mailto:Sales.Americas@teledynedalsa.com)

### Europe

Felix-Wankel-Str. 1  
82152 Krailling  
Germany  
Tel: +49 89 89 54 57 3-80  
Fax: +49 89 89 54 57 3-46  
Email: [Sales.Europe@teledynedalsa.com](mailto:Sales.Europe@teledynedalsa.com)

### Asia Pacific

Ikebukuro East 13F  
3-4-3 Higashi Ikebukuro, Toshima-ku,  
Tokyo, Japan  
Tel: +81 3 5960 6353  
Fax: +81 3 5960 6354  
Email: [Sales.Asia@teledynedalsa.com](mailto:Sales.Asia@teledynedalsa.com)

**Document revised September 16, 2015.**

# Contents

|  |           |
|--|-----------|
| System Precautions .....   | 6         |
| Precautions .....  | 6         |
| Electrostatic Discharge and the CMOS Sensor .....                  | 6         |
| <b>1. The Piranha4 RGB + NIR / Mono Camera .....</b>               | <b>7</b>  |
| Camera Highlights .....  | 7         |
| Camera Performance Specifications .....                            | 8         |
| Certifications .....   | 10        |
| Supported Industry Standards .....                                 | 10        |
| Sensor Responsivity and Design .....                               | 10        |
| Responsivity .....   | 10        |
| Spatial Correction and Quadlinear Sensor Design .....              | 14        |
| Parallax Correction .....  | 17        |
| Camera Direction .....   | 18        |
| Mechanicals .....  | 19        |
| Camera Mounting and Heat Sink Considerations .....                 | 20        |
| <b>2. Quick, Simple Steps to Acquire an Image .....</b>            | <b>21</b> |
| <b>3. Software and Hardware Setup .....</b>                        | <b>22</b> |
| Recommended System Requirements .....                              | 22        |
| Setup Steps: Overview .....  | 22        |
| 1. Install and Configure Frame Grabber and Software .....          | 22        |
| 2. Connect Camera Link and Power Cables .....                      | 22        |
| 3. Establish communicating with the camera .....                   | 22        |
| 4. Operate the Camera .....  | 22        |
| Step 1. Install and configure the frame grabber and software ..... | 23        |
| Install Frame Grabber .....  | 23        |
| Install Sapera LT and CamExpert GUI .....                          | 23        |
| Step 2. Connect Data, Trigger, and Power Cables .....              | 24        |
| Data Connector: Camera Link .....                                  | 25        |
| Camera Link Bit Definitions .....                                  | 25        |
| Camera Timing .....  | 26        |
| Camera Link cable quality and length .....                         | 35        |
| Input Signals, Camera Link .....                                   | 35        |
| Output Signals, Camera Link Clocking Signals .....                 | 35        |
| Power Connector .....  | 36        |
| LEDs .....   | 36        |
| Step 3. Establish Camera Communication .....                       | 37        |
| Power on the camera .....  | 37        |
| Connect to the frame grabber .....                                 | 37        |
| Connect to the camera .....  | 37        |
| Check LED Status .....   | 37        |
| Software Interface .....   | 37        |
| Using Sapera CamExpert with Piranha4 Cameras .....                 | 38        |

|  |           |
|--|-----------|
| CamExpert Panes .....  | 39        |
| Review a Test Image .....  | 41        |
| <b>4. Camera Operation .....</b>   | <b>42</b> |
| Factory Settings .....   | 42        |
| Check Camera and Sensor Information .....  | 42        |
| Verify Temperature and Voltage .....   | 43        |
| Saving and Restoring Camera Settings .....   | 44        |
| Camera Link Configuration .....  | 46        |
| Trigger Modes .....  | 46        |
| Exposure Controls .....  | 46        |
| Exposure Modes in Detail .....   | 48        |
| Color Exposure Time Guidelines .....   | 50        |
| Set Line Rate .....  | 50        |
| Set Exposure Time .....  | 51        |
| Control Gain and Black Level .....   | 51        |
| Set Image Size .....   | 52        |
| Set Baud Rate .....  | 52        |
| Pixel Format .....   | 53        |
| Camera Direction Control .....   | 53        |
| Pixel Readout Direction (Mirroring Mode) .....                                     | 53        |
| Resetting the Camera .....   | 53        |
| Calibrating the Camera .....   | 54        |
| <b>Appendix A: GenlCam Commands .....</b>  | <b>58</b> |
| Camera Information Category .....  | 58        |
| Camera Information Feature Descriptions .....                                      | 59        |
| Camera Configuration Selection Dialog .....  | 62        |
| Camera Power-up Configuration .....  | 62        |
| User Set Configuration Management .....  | 62        |
| Camera Control Category .....  | 63        |
| Camera Control Feature Descriptions .....  | 64        |
| Independent Exposure Control .....   | 67        |
| Digital I/O Control Feature Descriptions .....                                     | 69        |
| Flat Field Category .....  | 70        |
| Flat Field Control Feature Description .....                                       | 70        |
| Region of Interest (ROI) .....   | 72        |
| Image Format Control Category .....  | 72        |
| Image Format Control Feature Description .....                                     | 74        |
| Area of Interest (AOI) Setup .....   | 75        |
| Instructions on using the camera scan direction to control camera parameters ..... | 78        |
| Transport Layer Control Category .....   | 81        |
| Transport Layer Feature Descriptions .....   | 82        |
| Acquisition and Transfer Control Category .....                                    | 83        |
| Acquisition and Transfer Control Feature Descriptions .....                        | 83        |
| Serial Port Control Category .....   | 84        |
| Serial Port Control Feature Descriptions .....                                     | 84        |

|   |            |
|---|------------|
| File Access Control Category .....                                      | 85         |
| File Access Control Feature Descriptions .....                          | 86         |
| File Access via the CamExpert Tool .....                                | 87         |
| Download a List of Camera Parameters .....                              | 88         |
| <b>Appendix B: ASCII Commands .....</b>                                 | <b>90</b>  |
| Port Configuration .....  | 91         |
| Commands .....  | 92         |
| <b>Appendix C: Quick Setup and Image Acquisition .....</b>              | <b>105</b> |
| <b>Appendix D: The Sensor Window .....</b>                              | <b>108</b> |
| Cleaning and Protecting Against Dust, Oil, and Scratches .....          | 108        |
| Cleaning the Sensor Window .....  | 109        |
| <b>Appendix E: Camera, Frame Grabber Communication .....</b>            | <b>110</b> |
| Setting Up Communication between the Camera and the Frame Grabber ..... | 110        |
| <b>Appendix F: Error and Warning Messages .....</b>                     | <b>112</b> |
| <b>EMC Declaration of Conformity .....</b>                              | <b>114</b> |
| <b>Revision History .....</b>   | <b>115</b> |
| <b>Index .....</b>  | <b>116</b> |

# System Precautions

## Precautions

Read these precautions and this manual carefully 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 65 °C during operation.

Do not operate the camera in the vicinity of 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 bodies housing are susceptible to damage from electrostatic discharge (ESD). Electrostatic charge introduced to the sensor window surface can induce charge buildup on the underside of the window that cannot be readily dissipated by the dry nitrogen gas in the sensor package cavity. The charge normally dissipates within 24 hours and the sensor returns to normal operation.

Additional information on cleaning the sensor window and protecting it against dust, oil, blemishes, and scratches can be found here, [Appendix D: The Sensor Window](#).

---

# 1. The Piranha4 RGB + NIR / Mono Camera

## Camera Highlights

The new Piranha4 quadlinear RGB + NIR / Mono cameras provide industry leading speeds to meet future requirements of higher throughput in multi-spectral imaging applications.

Based on Teledyne DALSA's unique CMOS line scan technology, the Piranha4 multi-spectral camera delivers superb color plus near-infrared (NIR) fidelity, spectrally independent outputs, all in a compact footprint and with an easy to use interface. New features include multiple regions of interest for data reduction and regional calibration, sub-pixel spatial correction, white balance and color calibration tools.

### Key Features

- High speed: up to 70 kHz line rates
- Three native colors (RGB) plus NIR / Mono per pixel
- Spectrally Independent RGB + NIR outputs
- Bi-directional
- Compact camera body
- Sub-pixel spatial correction
- Horizontal Parallax Correction

### Programmability

- Multiple Regions of Interest for calibration and data reduction
- 8, 10, or 12 bit output
- Flat field and lens shading correction
- 8 programmable coefficient sets
- GenICam or ASCII compliant interfacing

### Applications

- 100% print inspection (pharmaceuticals, bank note)
- Electronics inspection
- Materials grading systems
- Web inspection
- High performance color sorting systems
- Food inspection
- General purpose machine vision

## Models

The camera is available in the following configurations:

**Table 1: Camera Models Overview**

| Model Number      | Description   |
|-------------------|---|
| P4-CC-02K07Q-00-R | 2k resolution, 70 kHz line rate, 14.08 $\mu\text{m}$ x 14.08 $\mu\text{m}$ pixel size, RGB + Mono |
| P4-CC-02K07N-01-R | 2k resolution, 70 kHz line rate, 14.08 $\mu\text{m}$ x 14.08 $\mu\text{m}$ pixel size, RGB + NIR  |

**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            |

# Camera Performance Specifications

**Table 3: Camera Performance Specifications**

| Specifications                                | Performance  |
|---|--|
| Imager Format                                 | CMOS tri-linear color (RGB) plus NIR / Mono line scan  |
| Resolution                                    | 2048 x 4 pixels  |
| Pixel Size                                    | 14.08 $\mu\text{m}$ x 14.08 $\mu\text{m}$  |
| Line Rate                                     | 0 kHz minimum to 70 kHz maximum  |
| Exposure Time                                 | 7 $\mu\text{s}$ minimum to 3,000 $\mu\text{s}$ maximum   |
| Bit Depth                                     | 8, 10, and 12 bits, selectable   |
| <b>Connectors and Mechanicals</b>             |  |
| Control & Data Interface                      | 2 SDR-26 mini Camera Link connectors used to transmit Base, Medium, Full, or Deca configurations |
| Power Connector                               | Hirose 6-pin circular  |
| Power Supply                                  | + 12 V to + 24 V DC  |
| Power Dissipation                             | 8 W  |
| Size  | 62 mm (W) x 62 mm (H) x 48 mm (D)  |
| Mass  | < 340 g (without heat sinks)   |
| Operating Temp                                | 0 °C to 65 °C, front plate temperature   |
| <b>Optical Interface</b>                      |  |
| Lens Mount                                    | M42 x 1<br>F-mount adapter available   |
| Sensor to Camera Front Distance               | 12 mm  |
| Sensor Alignment (aligned to sides of camera) |  |
| Flatness                                      | 50 $\mu\text{m}$   |
| $\Theta$ y (parallelism)                      | 0.08° or 81 $\mu\text{m}$  |
| x   | $\pm 100 \mu\text{m}$  |
| y   | $\pm 100 \mu\text{m}$  |
| z   | $\pm 250 \mu\text{m}$  |
| $\Theta$ z                                    | $\pm 0.2^\circ$  |
| <b>Compliance</b>                             |  |
| Regulatory Compliance                         | CE, FCC and RoHS, GenICam  |



**Table 4: P4-CC-02K07Q-00-R Operating Specifications**

| Operating Ranges       | Performance  |                           |                           |                           |
|------------------------|--|---------------------------|---------------------------|---------------------------|
|                        | Red  | Green                     | Blue                      | Mono                      |
| Dynamic Range          | 61.8 dB  | 61.8 dB                   | 61.8 dB                   | 61.8 dB                   |
| Random Noise           | 3.36 DN ** rms   | 3.36 DN rms               | 3.36 DN rms               | 3.36 DN rms               |
| Responsivity           | Refer to graph   |                           |                           |                           |
| Gain                   | 1x to 10x Nominal Range (not including individual RGB gains for white balance) |                           |                           |                           |
| DC Offset              | < 11 DN  | < 11 DN                   | < 11 DN                   | < 11 DN                   |
| PRNU                   | < 2% @50% Sat  | < 2% @50% Sat             | < 2% @50% Sat             | < 2% @50% Sat             |
| FPN                    | < 6.3 DN   | < 6.3 DN                  | < 6.3 DN                  | < 6.3 DN                  |
| SEE                    | 3.96 nJ / cm <sup>2</sup>  | 4.39 nJ / cm <sup>2</sup> | 6.80 nJ / cm <sup>2</sup> | 3.64 nJ / cm <sup>2</sup> |
| NEE                    | 3.2 pJ / cm <sup>2</sup>   | 3.6 pJ / cm <sup>2</sup>  | 5.6 pJ / cm <sup>2</sup>  | 3.0 pJ / cm <sup>2</sup>  |
| Antiblooming           | > 100 x Saturation   |                           |                           |                           |
| Integral non-linearity | < 2% DN  |                           |                           |                           |

\*\*DN = digital number

**Test Conditions:**

- Values measured using 12-bit, 1x gain.
- 10 kHz line rate
- Light source: white LED
- No white balancing
- Front plate temperature: 45° C

**Table 5: P4-CC-02K07N-01-R Operating Specifications**

| Operating Ranges       | Performance  |                          |                           |                          |
|------------------------|--|--------------------------|---------------------------|--------------------------|
|                        | Red  | Green                    | Blue                      | NIR                      |
| Dynamic Range          | 61 dB  | 61 dB                    | 61 dB                     | 61 dB                    |
| Random Noise           | 3.52 DN ** rms   | 3.00 DN rms              | 2.50 DN rms               | 3.52 DN rms              |
| Responsivity           | Refer to graph   |                          |                           |                          |
| Gain                   | 1x to 10x Nominal Range (not including individual RGB gains for white balance) |                          |                           |                          |
| DC Offset              | < 11 DN  | < 11 DN                  | < 11 DN                   | < 11 DN                  |
| PRNU                   | < 2% @50% Sat  | < 2% @50% Sat            | < 2% @50% Sat             | < 2% @50% Sat            |
| FPN                    | < 4.7 DN   | < 4.7 DN                 | < 4.7 DN                  | < 5.7 DN                 |
| SEE                    | 4.76 nJ / cm <sup>2</sup>  | 5.1 nJ / cm <sup>2</sup> | 6.07 nJ / cm <sup>2</sup> | 8.3 nJ / cm <sup>2</sup> |
| NEE                    | 4.2 pJ / cm <sup>2</sup>   | 3.9 pJ / cm <sup>2</sup> | 3.8 pJ / cm <sup>2</sup>  | 2.1 pJ / cm <sup>2</sup> |
| Antiblooming           | > 100 x Saturation   |                          |                           |                          |
| Integral non-linearity | < 2% DN  |                          |                           |                          |

\*\*DN = digital number

**Test Conditions:**

- Values measured using 12-bit, 1x gain.
- 10 kHz line rate
- Light source: white LED
- No white balancing
- Front plate temperature: 45° C

# Certifications

| Compliance  |
|---|
| EN 55011, FCC Part 15, CISPR 11, and ICES-003 Class A Radiated Emissions Requirements   |
| EN 55024, and EN 61326-1 Immunity to Disturbance*   |
| RoHS per EU Directive 2002/ 95/ EC and WEEE per EU Directive 2002/ 96/ EC and China Electronic Industry Standard SJ/ T11364-2006*   |
| GenICam XML Description File, Superset of the GenICam™ Standard Features Naming Convention specification V1.5, Camera Link Serial Communication: GenICam™ Generic Control Protocol (GenCP V1.0) |

## Supported Industry Standards

### GenICam™

Piranha4 cameras are GenICam compliant. They implement a superset of the GenICam™ Standard Features Naming Convention specification V1.5. This description takes the form of an XML device description file respecting 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 serial port. For more information see [www.genicam.org](http://www.genicam.org).

## Sensor Responsivity and Design

### Responsivity

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

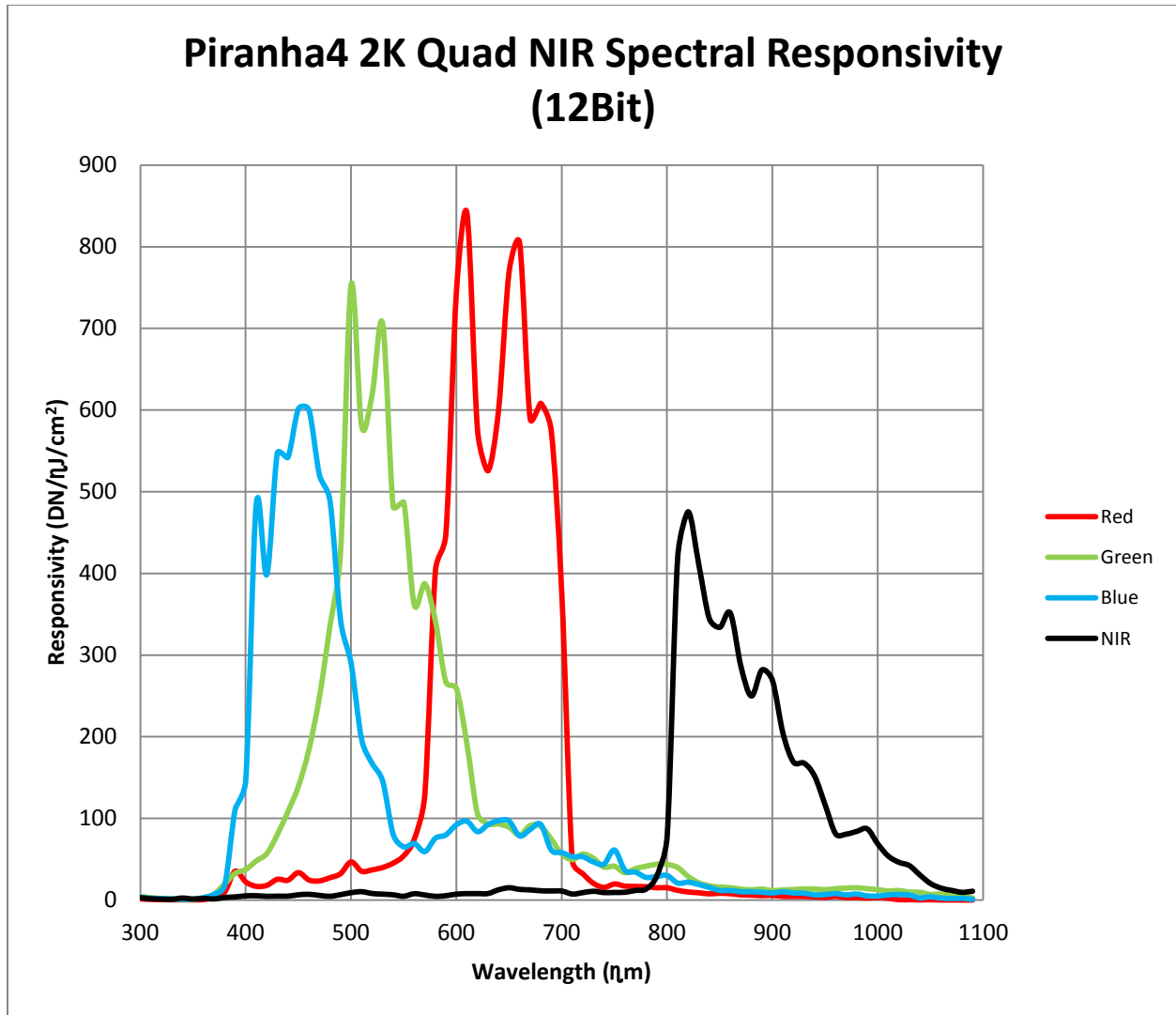
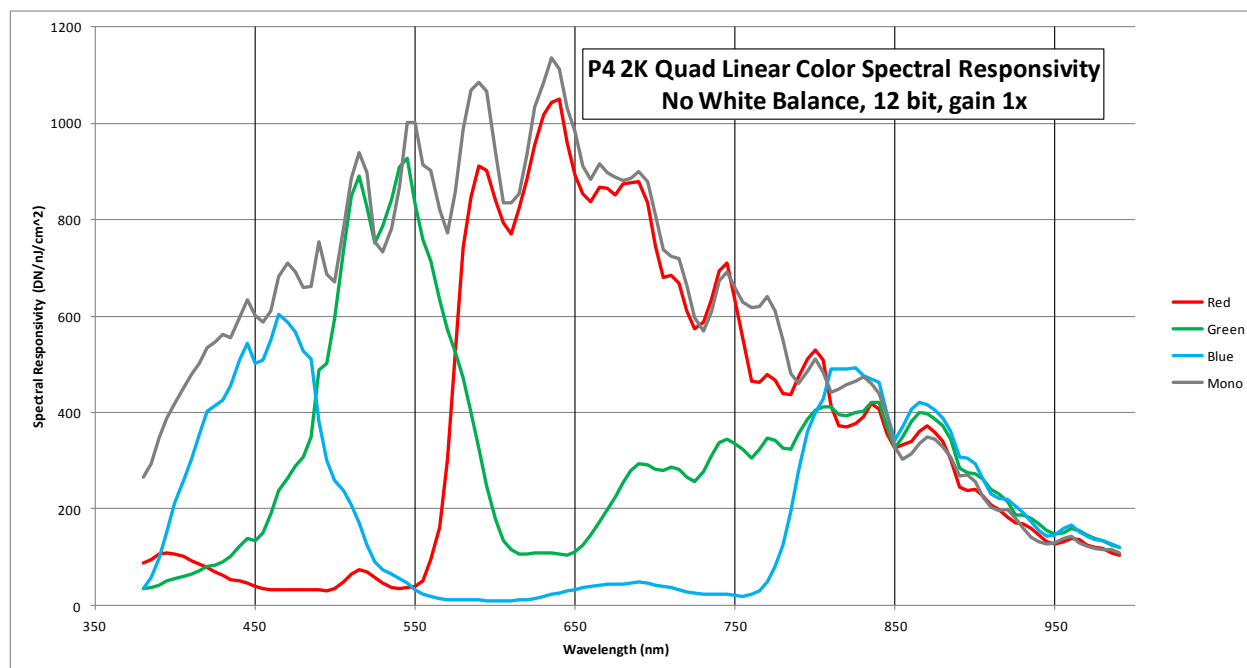
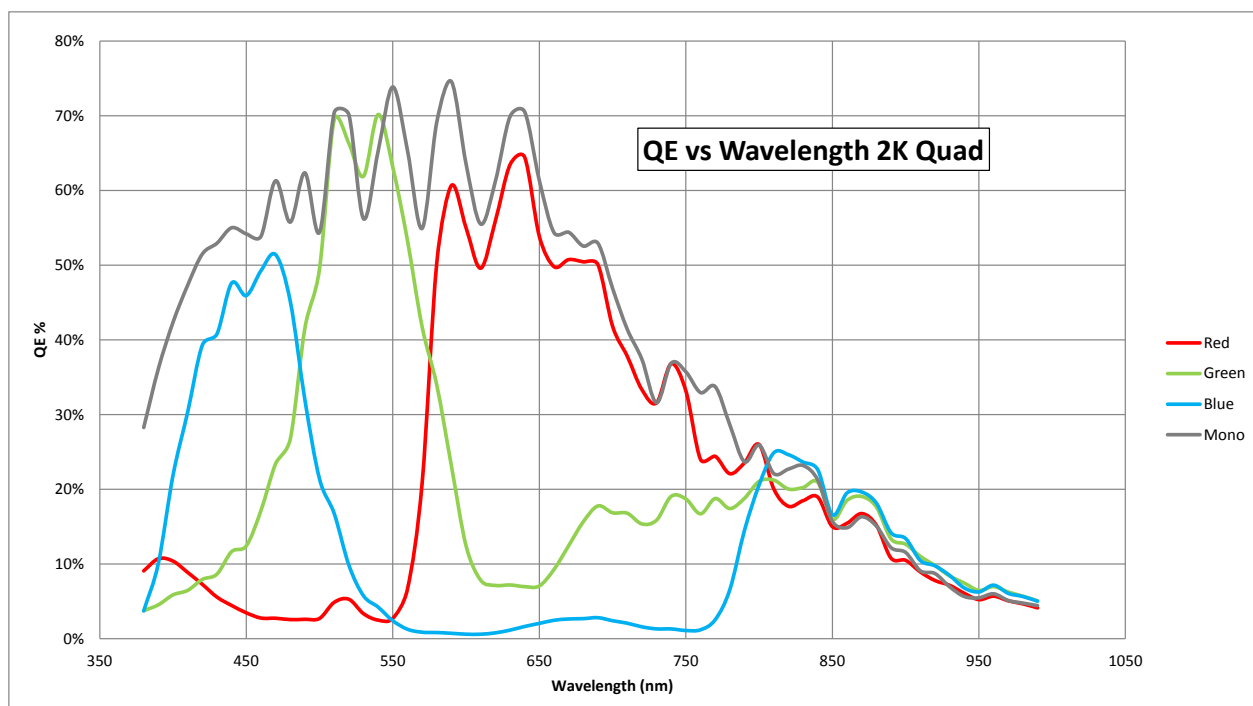


Figure 1: Spectral Responsivity (NIR)

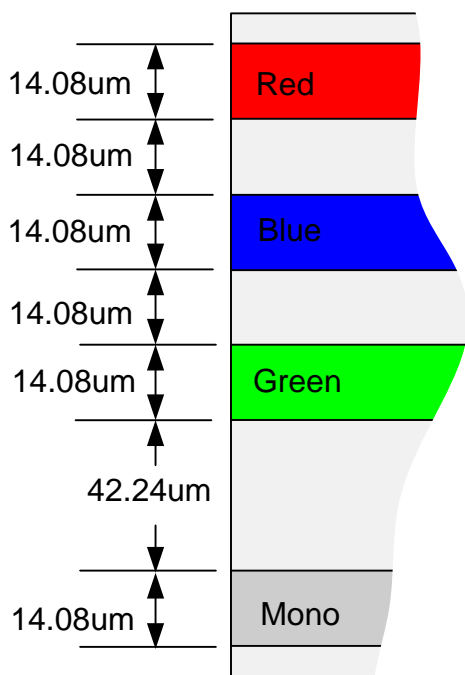


**Figure 2: Spectral Response (Mono)**

**Figure 3: QE Vs Wavelength**

## Spatial Correction and Quadlinear Sensor Design

The P4-CC-02K07Q-00-R camera uses a quadlinear sensor where four separate 2K lines of pixels are used—one for red, one for blue, one for green, and the last for monochrome / NIR.



**Figure 4: 2K Quadlinear Sensor Line Spacing Diagram**

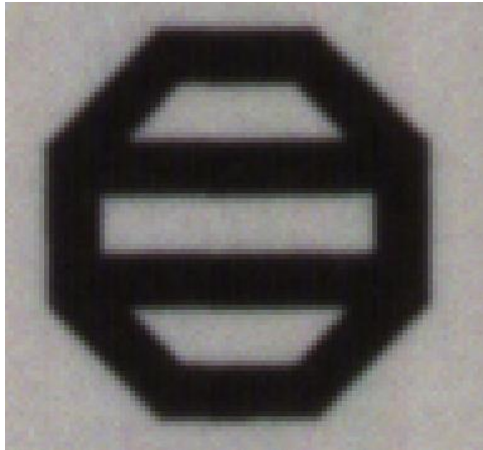
In the case of the 2k cameras, only a single line of space separates the colored lines—with the exception of the monochrome line, which has three lines of spacing.

When the image passes the three lines of pixels, the red, blue and green 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 red, blue and green components of the image pixel are all aligned when output. However, this is only correct when the object pixel size is square; i.e., 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.

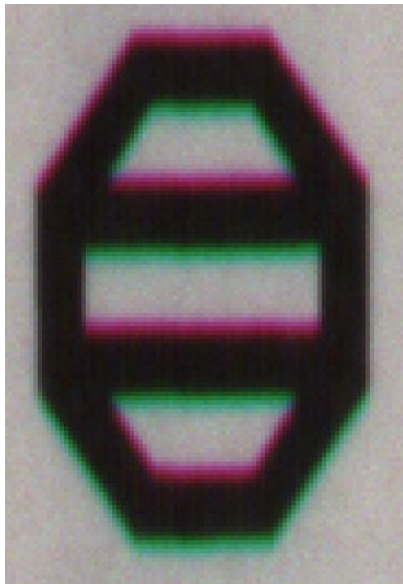
When it is not possible to generate a square object pixel, color artefacts will occur in the scan direction and is particularly noticeable at sharp edge transitions. The size of the edge artefact is proportional to how far the pixel is from square. To correct for this, the camera has a feature, Line 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 artefacts show black to white image transitions and the associated corrected image after applying a specific line spatial correction (ssa) setting.

**Example 1. Target speed adjusted for square pixels**

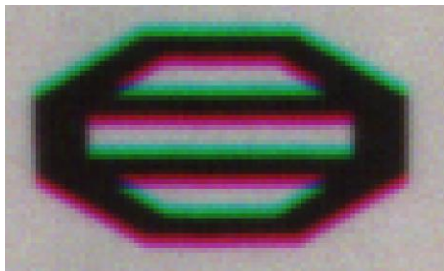
Line Spatial Correction = 3 (ssa = 3). This is the default condition.

**Example 2. Target running slower than example 1, same EXSYNC (trigger) frequency**

Line Spatial Correction = 3 (ssa = 3)



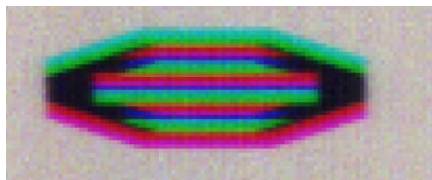
Line Spatial Correction = 4.3 (ssa = 4.3)

**Example 3. Target running faster than example 1, same EXSYNC (trigger) frequency**

Line Spatial Correction = 3 (ssa = 3)



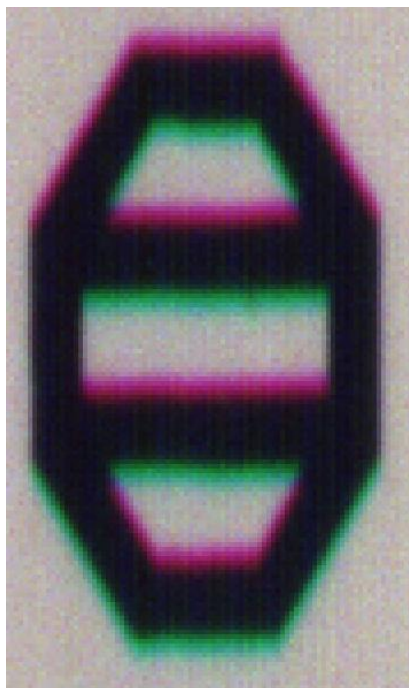
Line Spatial Correction = 1.73 (ssa = 1.73)

**Example 4. Target running slower than EXSYNC**

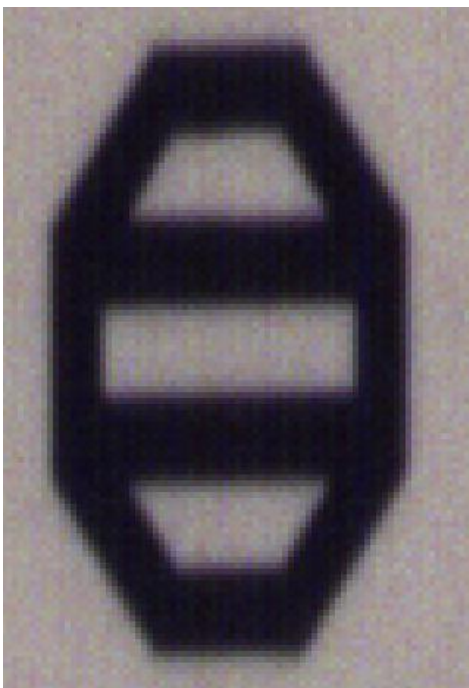
Line Spatial Correction = 3 (ssa = 3)



Line Spatial Correction = 1 (ssa = 1)

**Example 5. Target running faster than EXSYNC**

Line Spatial Correction = 3 (ssa = 3)



Line Spatial Correction = 5 (ssa = 5)



# Parallax Correction

When the camera it is not perpendicular to the object surface the P4 color camera will exhibit color. 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 centre of the image the color distortion does not show up.

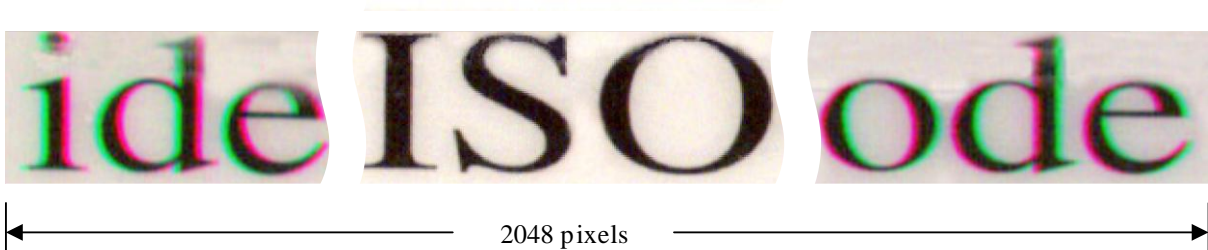


Figure 5: Image with Horizontal Color Alignment Issues

Using the P4 color cameras 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. Using the feature Image Distortion Correction Mode (shm = 1) this feature can be turned on. Using the feature Image Distortion Correction Line Selector the user can select red and green to correct the distortion. Note. The red and green lines are adjusted to to align with the center blue line. Image Distortion Parallax Correction Pixel Stretch (sha - Set horizontal alignment in float f<value 0-3>) is used to add the amount of correction needed to the image. The value entered here must be between 0 and 3 (decimal values are accepted).

|  |                    |
|--|--------------------|
| Image Distortion Correction Mode                   | Off                |
| Image Distortion Correction Algorithm              | ParallaxCorrection |
| Image Distortion Correction Line Selector          | Red                |
| Image Distortion Parallax Correction Pixel Stretch | 0                  |

Figure 6: CamExpert Parallax Correction Controls

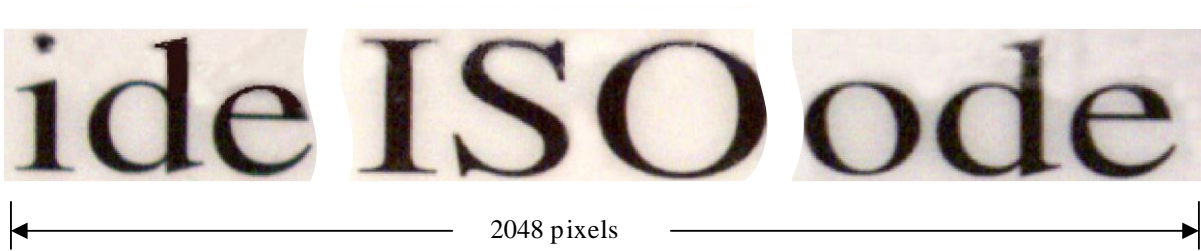


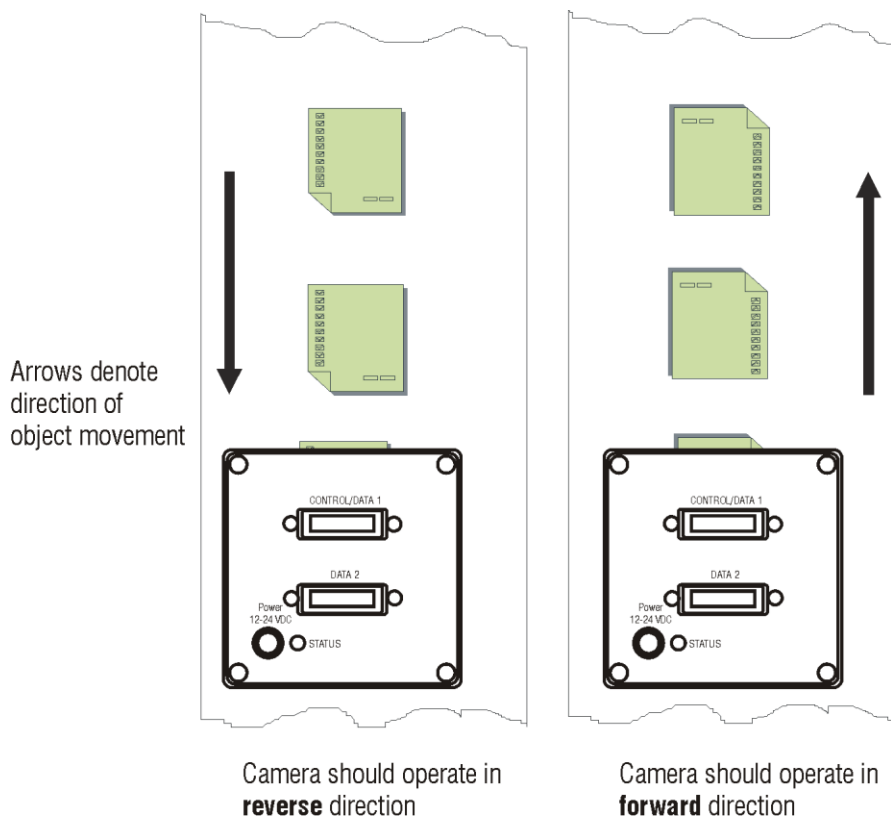
Figure 7: Figure 8 Corrected Image

The figure above is the same image corrected using the parallax correction. In this example the value of 3 was used to correct the image.

## Camera Direction

Selectable camera 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).

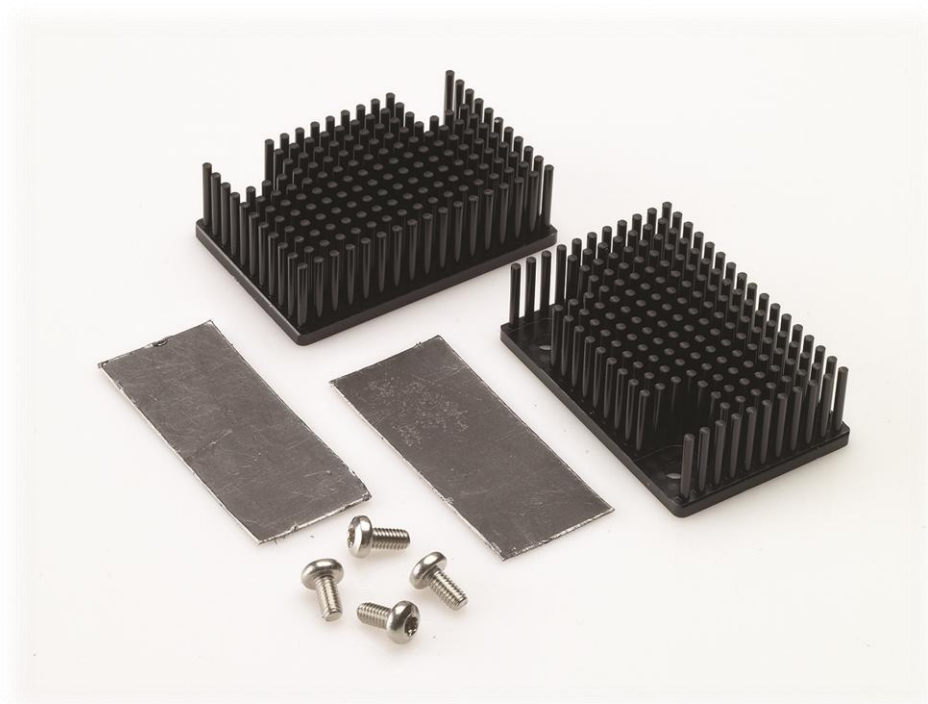


**Figure 9: Object Movement and Camera Direction Example, with a Lens**

# Mechanicals

[ADD MECHANICALS]

**Figure 10: Camera Mechanical**



**Figure 11: Piranha4 Heat Sink Accessories Kit**

**Optional Lens Mount and Heat Sink Accessories**

| Description            | Description      |
|------------------------|------------------|
| M42 to F-mount adapter | AC-LA-00115-A0-R |
| M42 to C-mount adapter | AC-LC-00001-00-R |
| Heat sink              | AC-MS-00108-01-R |

## Camera Mounting and Heat Sink Considerations

Up to two optional heat sinks can be installed on the camera. As illustrated, they are ideally positioned to allow close spacing of the cameras. These heat sinks are designed to provide adequate convection cooling when not obstructed by enclosures or mounting assemblies.

Teledyne DALSA recognises that each customer's application can be unique. In consideration, camera's heat sinks have been designed in such a way that they can be repositioned on the different faces of the camera or removed entirely, depending on the mounting configuration and its heat sinking potential.

Repositioning or removal of the heat sinks must be performed with care in order to avoid temperature issues. The camera has the ability to measure its internal temperature. Use this feature to record the internal temperature of the camera when it is mounted in your system and operating under the worst case conditions. The camera will stop outputting data if its internal temperature reaches 80 °C.

---

## 2. Quick, Simple Steps to Acquire an Image

For users who are familiar with Camera Link cameras, have a basic understanding of their imaging requirements, and who are primarily interested in evaluating the camera, an overview of the steps required to get this camera operational and acquiring images quickly can be found in [Appendix C: Quick Setup and Image Acquisition](#).

---

# 3. Software and Hardware Setup

## Recommended System Requirements

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

- High bandwidth frame grabber, e.g. Xcelera-CL PX8 Full Camera Link frame grabber (Part # OR-X8CO-XPFO0): [www.teledynedalsa.com/imaging/products/fg/OR-X8CO-XPFO0/](http://www.teledynedalsa.com/imaging/products/fg/OR-X8CO-XPFO0/).
- Operating systems: Windows XP / Vista / 7, 32 / 64-bit.

## Setup Steps: Overview

Take the following steps in order to setup and run your camera system. They are described briefly below and in more detail in the sections that follow.

### 1. Install and Configure Frame Grabber and Software

We recommend the Xcelera-CL PX8 Full frame grabber or equivalent, described in detail on the [teledynedalsa.com](http://teledynedalsa.com) site [here](#). If your host computer does not have a PX8 full Camera Link frame grabber then you will need to install one. Follow the manufacturer's installation instructions.

A GenCP (Generic Control Protocol) compliant XML device description file is embedded within the camera firmware allowing GenCP-compliant applications to know the camera's capabilities immediately after connection. Installing SperaLT gives you access to the CamExpert GUI, a tool that supports GenCP-compliant devices.

### 2. Connect Camera Link and Power Cables

- Connect the Camera Link cables from the camera to the computer.
- Connect a power cable from the camera to a +12 VDC to +24 VDC power supply.

### 3. Establish communicating with the camera

Start the GUI and establish communication with 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 here, [Appendix B: ASCII Commands](#).

### 4. Operate the Camera

At this point you will be ready to start operating the camera in order to acquire images, set camera functions, and save settings.

# Step 1. Install and configure the frame grabber and software

## Install Frame Grabber

Install a Full configuration Camera Link frame grabber according to the manufacturer's description.

We recommend the Xcelera-CL PX8 frame grabber or equivalent, described in detail on the [teledynedalsa.com](http://teledynedalsa.com) site [here](#).

## Install Sopera LT and CamExpert GUI

Communicate with the camera using a Camera Link-compliant interface. We recommend you use CamExpert. CamExpert is the camera interfacing tool supported by the Sopera library and comes bundled with SoperaLT. Using CamExpert is the simplest and quickest way to send commands to and receive information from the camera.

### 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 Data, Trigger, and Power Cables

**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.

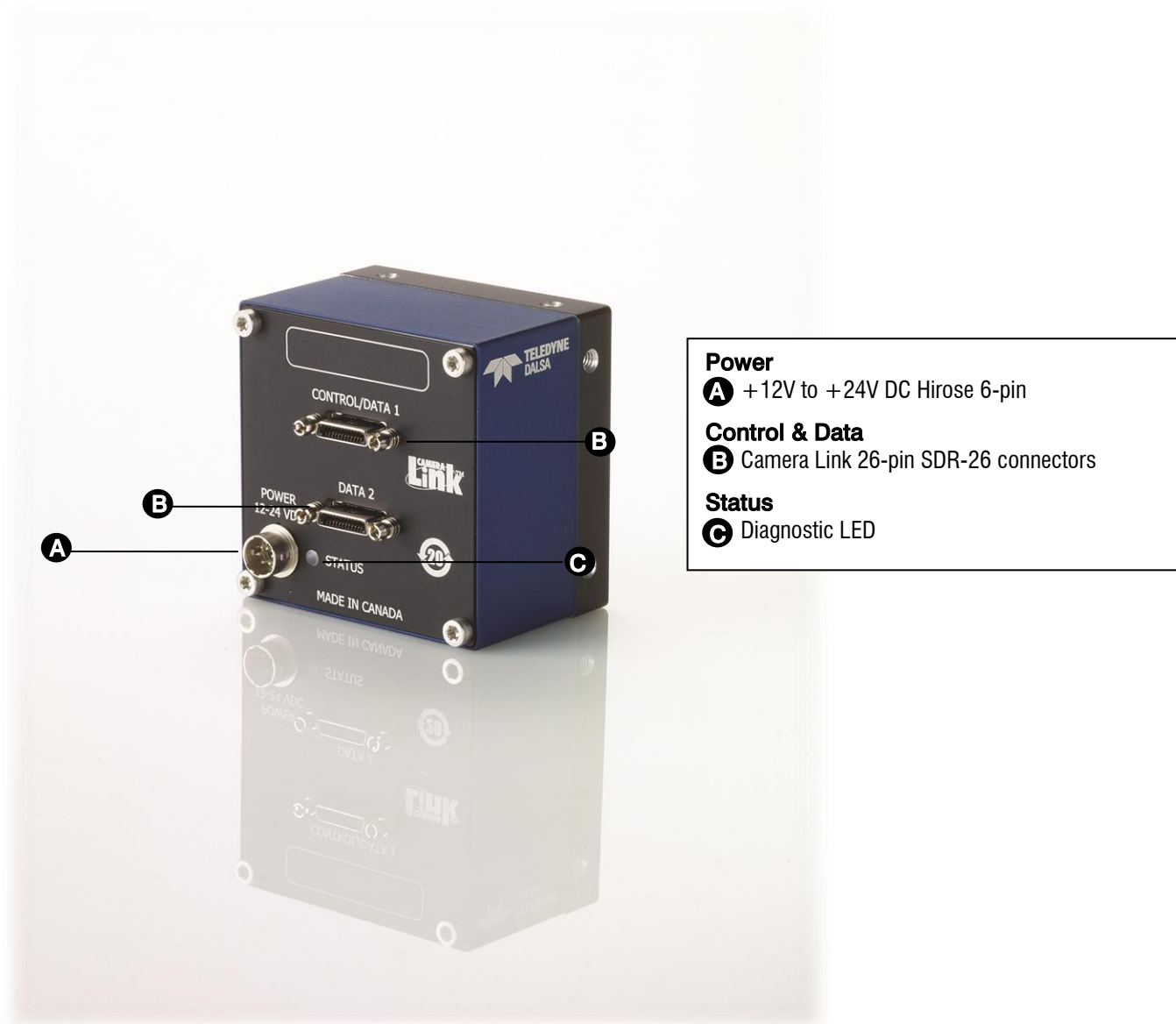


Figure 12: Input and Output, trigger, and Power Connectors



### WARNING! Grounding Instructions

Static electricity can damage electronic components. It's critical that you discharge any static electrical charge by touching a grounded surface, such as the metal computer chassis, before handling the camera hardware.



## 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.

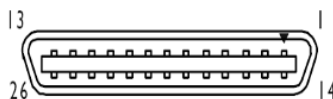


Figure 13. SDR26 Camera Link Connector

| 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

| Signal | Configuration |
|--------|---------------|
| CC1    | EXSYNC        |
| CC2    | Spare         |

|     |           |
|-----|-----------|
| CC3 | Direction |
| CC4 | Spare     |

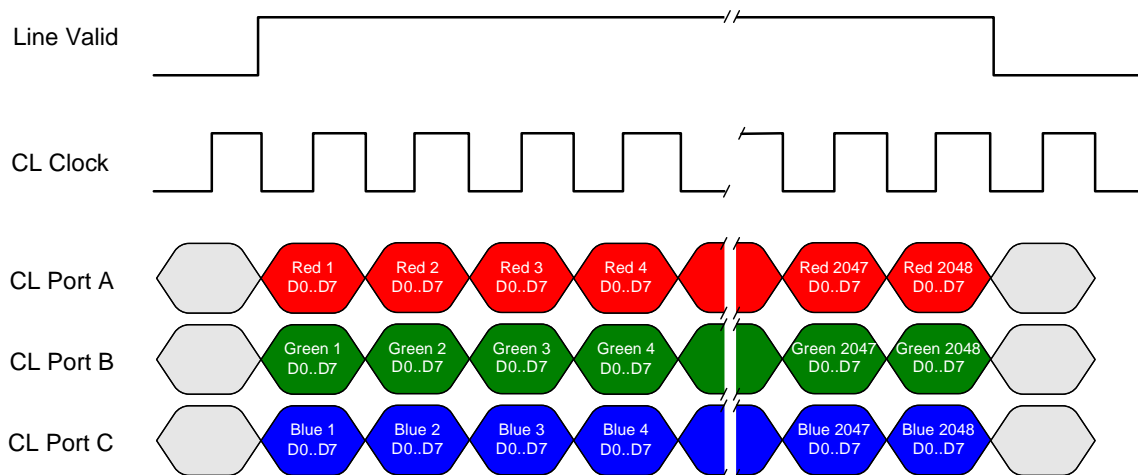
**Table 6: Camera Control Configuration**

For additional Camera Link documentation refer to the Teledyne DALSA Web site's [Knowledge Center application notes](#).

## Camera Timing

Note: Information on setting up the camera's AOI can be found here, [Area of Interest \(AOI\) Setup](#).

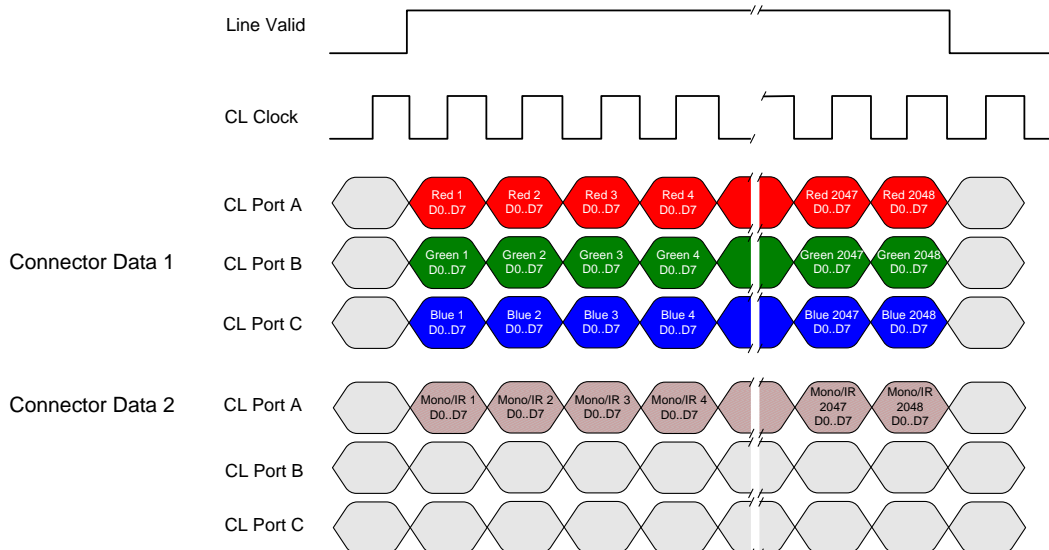
### RGB 8 bit, CL base, maximum line rate 40 kHz, no AOI and 85 MHz CL clock



This timing can be used for applications that require line rates only up to 40 kHz and therefore can use Camera Link Base mode with only one cable.

The RGB output format is compatible with the Camera Link specification for Base RGB. Line rates up to 70 kHz can be achieved by using the Area of Interest (AOI) feature; where the smaller the AOI, the greater the potential line rate.

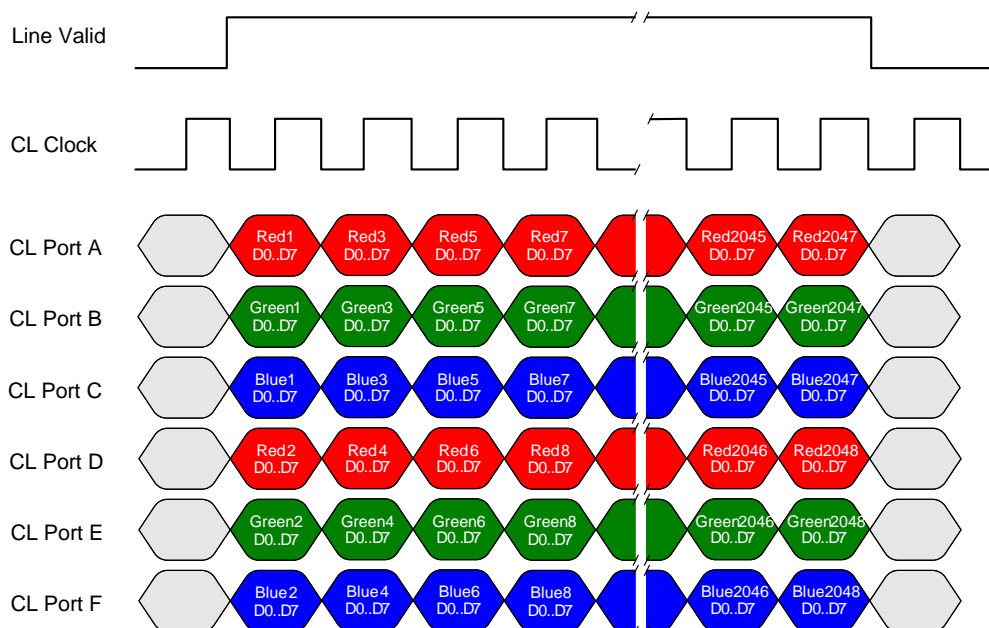
## Dual base RGB 8 bit plus 8 bit monochrome, maximum line rate 40 kHz, no AOI and 85 MHz CL clock



This timing can be used for applications that require line rates only up to 40 kHz and therefore can use Camera Link Dual Base mode with only one cable.

The RGB output format is compatible with the Camera Link specification for Base RGB. Line rates up to 70 kHz can be achieved by using the Area of Interest (AOI) feature; where the smaller the AOI, the greater the potential line rate.

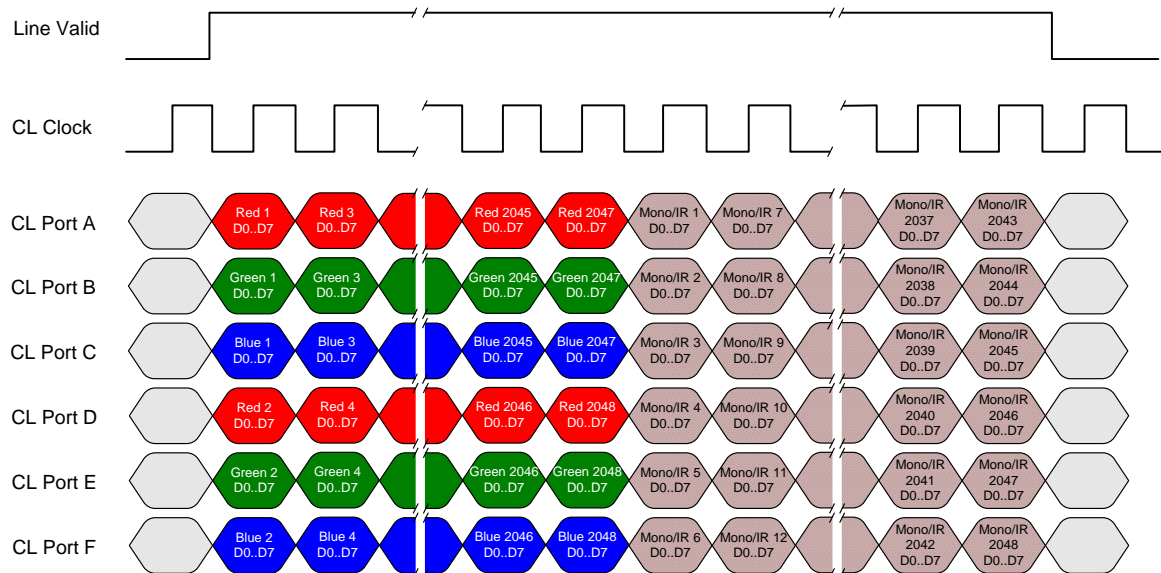
## RGB 8 bit, CL Medium, maximum line rate 70 kHz, no AOI and 85 MHz CL clock



This timing can be used for applications that require line rates up to 40 kHz and therefore must use Camera Link Medium mode and two cables.

The RGB output format is compatible with the Camera Link specification for Medium RGB. Line rates up to 70 kHz can be achieved by using the Area of Interest (AOI) feature; where the smaller the AOI, the greater the potential line rate.

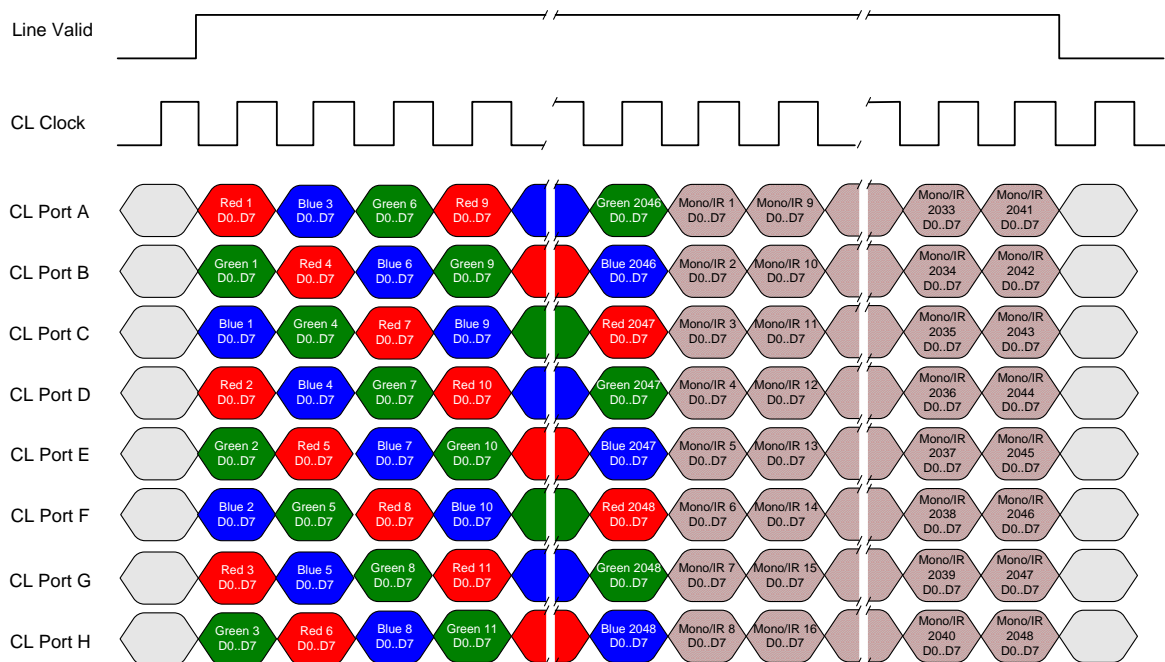
### RGB plus monochrome 8 bit CL Medium, maximum line rate 62 kHz, no AOI and 85 MHz CL clock



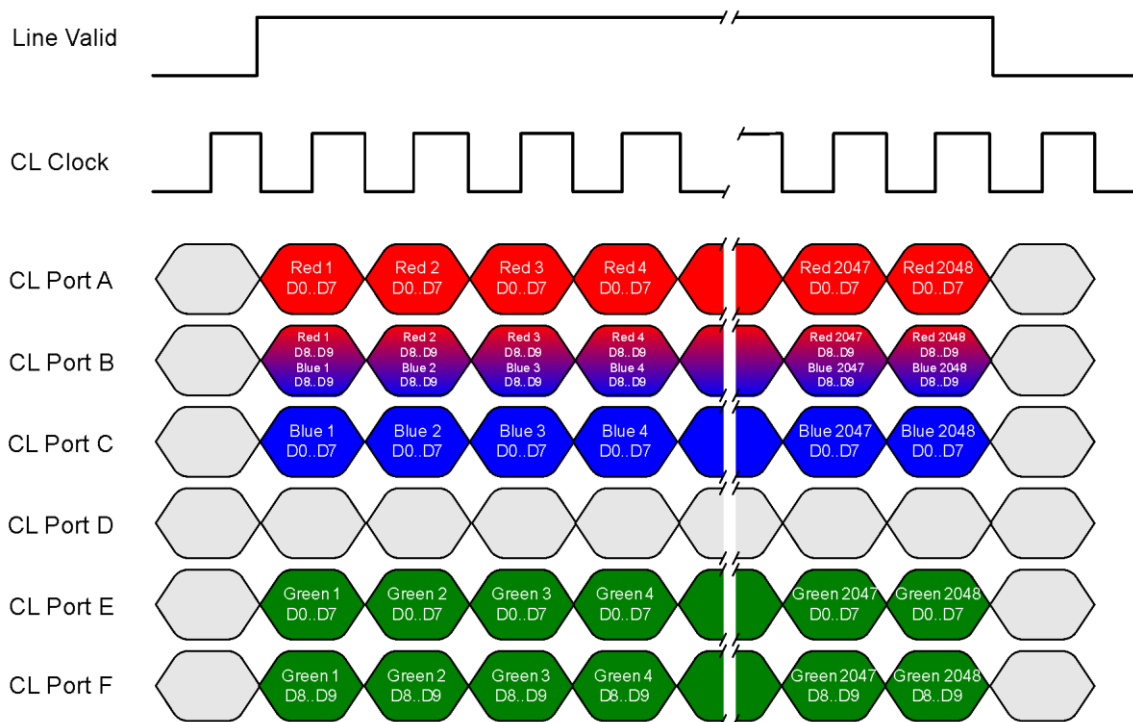
This timing can be used for applications that require line rates up to 60 kHz and therefore must use Camera Link Medium mode and two cables.

The RGB output format is not defined in the Camera Link specification Deca. The RGB format is such that when using a Camera Link frame grabber compatible with the Deca format configured for the mono standard, the R, G and then B pixels will be written sequentially into the frame grabber buffer. This process simplifies the extraction of the RGB data from the frame grabber buffer by the host application. Line rates up to 70 kHz can be achieved by using the Area of Interest (AOI) feature; where the smaller the AOI, the greater the potential line rate.

## RGB 8 bit CL Full plus monochrome 8 bit CL full



## RGB 10 bit CL Medium, maximum line rate 40 kHz, no AOI and 85 MHz CL clock

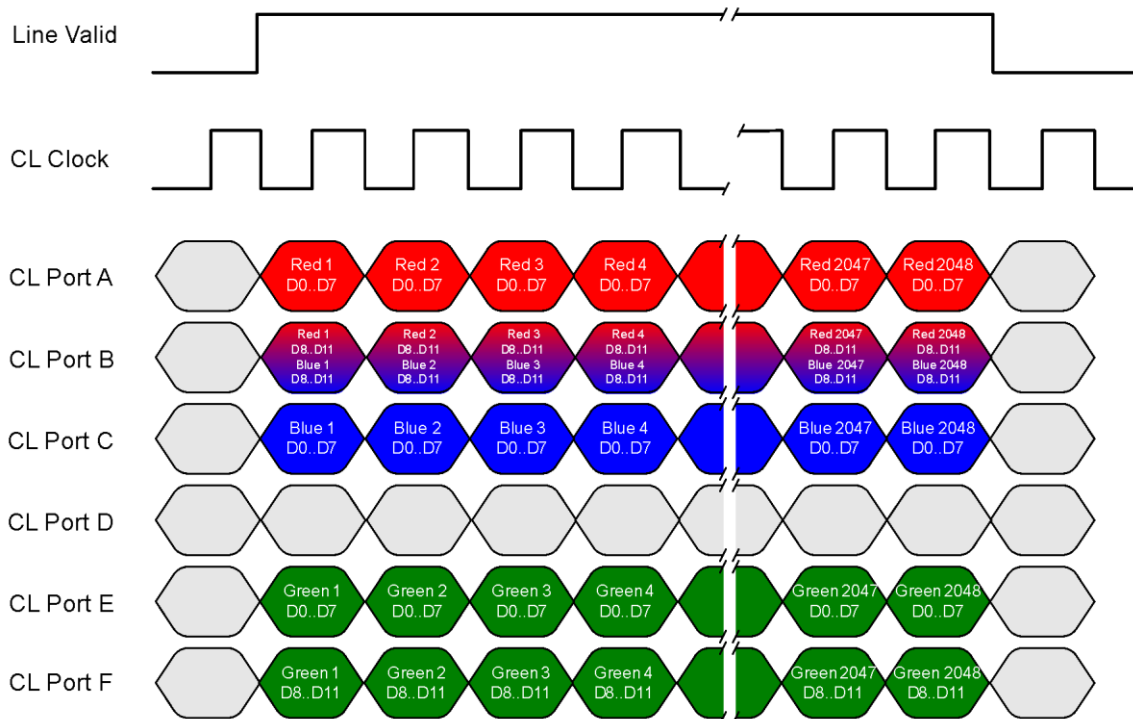


| Port B Bit Assignments |        | Port F Bit Assignments |         |
|------------------------|--------|------------------------|---------|
| D0                     | Red 8  | D0                     | Green 8 |
| D1                     | Red 9  | D1                     | Green 9 |
| D2                     | N/ A   | D2                     | N/ A    |
| D3                     | N/ A   | D3                     | N/ A    |
| D4                     | Blue 8 | D4                     | N/ A    |
| D5                     | Blue 9 | D5                     | N/ A    |
| D6                     | N/ A   | D6                     | N/ A    |
| D7                     | N/ A   | D7                     | N/ A    |

This timing can be used for applications that require line rates up to 20 kHz and therefore must use Camera Link Medium mode and two cables.

The RGB output format is compatible with the Camera Link specification for Medium RGB. Line rates up to 70 kHz can be achieved by using the Area of Interest (AOI) feature; where the smaller the AOI, the greater the potential line rate.

## RGB 12 bit CL Medium, maximum line rate 40 kHz, no AOI and 85 MHz CL clock

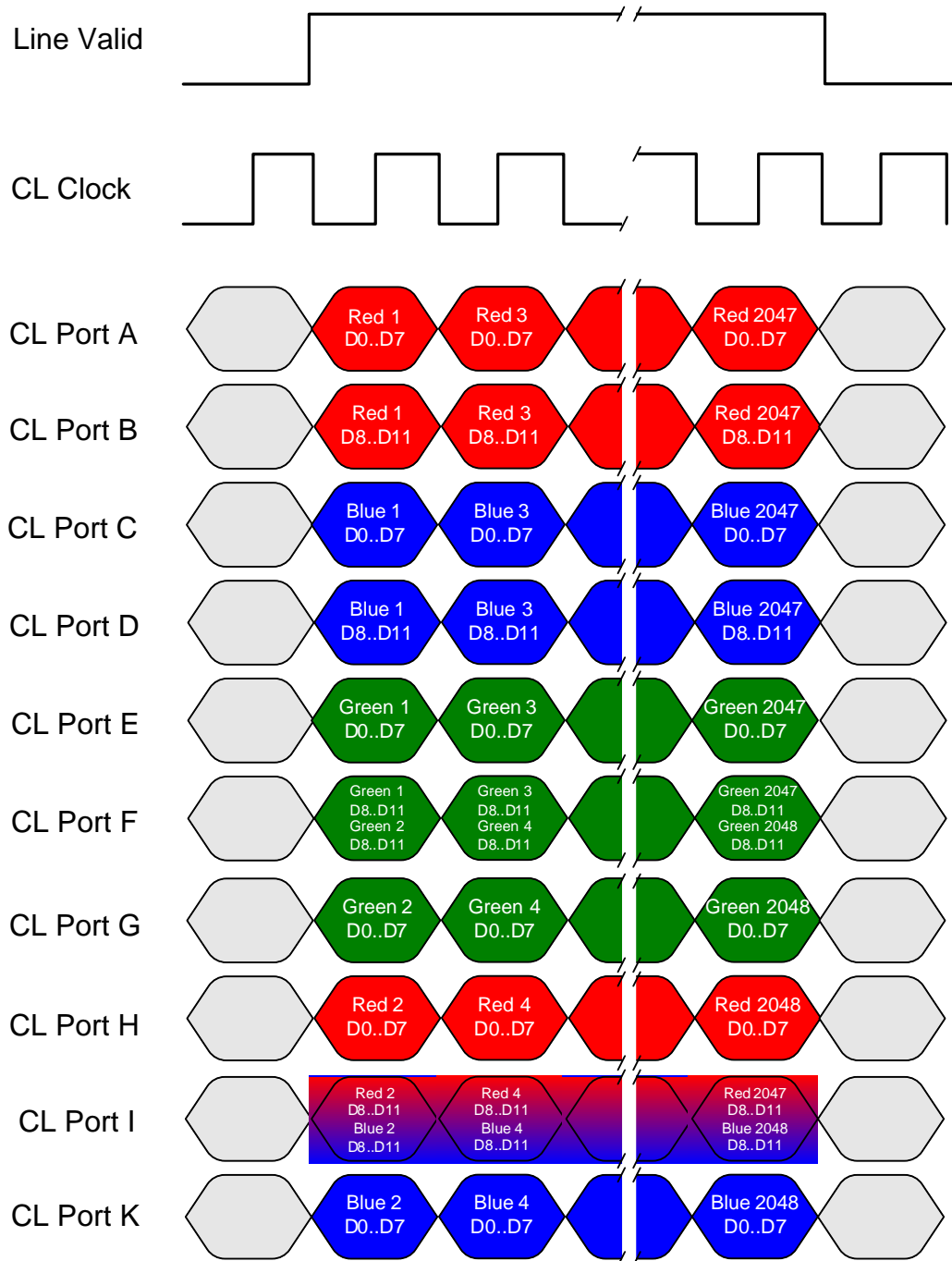


| Port B Bit Assignments |         | Port F Bit Assignments |          |
|------------------------|---------|------------------------|----------|
| D0                     | Red 8   | D0                     | Green 8  |
| D1                     | Red 9   | D1                     | Green 9  |
| D2                     | Red 10  | D2                     | Green 10 |
| D3                     | Red 11  | D3                     | Green 11 |
| D4                     | Blue 8  | D4                     | N/ A     |
| D5                     | Blue 9  | D5                     | N/ A     |
| D6                     | Blue 10 | D6                     | N/ A     |
| D7                     | Blue 11 | D7                     | N/ A     |

This timing can be used for applications that require line rates up to 20 kHz and therefore must use Camera Link Medium mode and two cables.

The RGB output format is compatible with the Camera Link specification for Medium RGB. Line rates up to 70 kHz can be achieved by using the Area of Interest (AOI) feature; where the smaller the AOI, the greater the potential line rate.

## RGB 12 bit CL Deca, maximum line rate 70 kHz, no AOI and 85 MHz CL clock



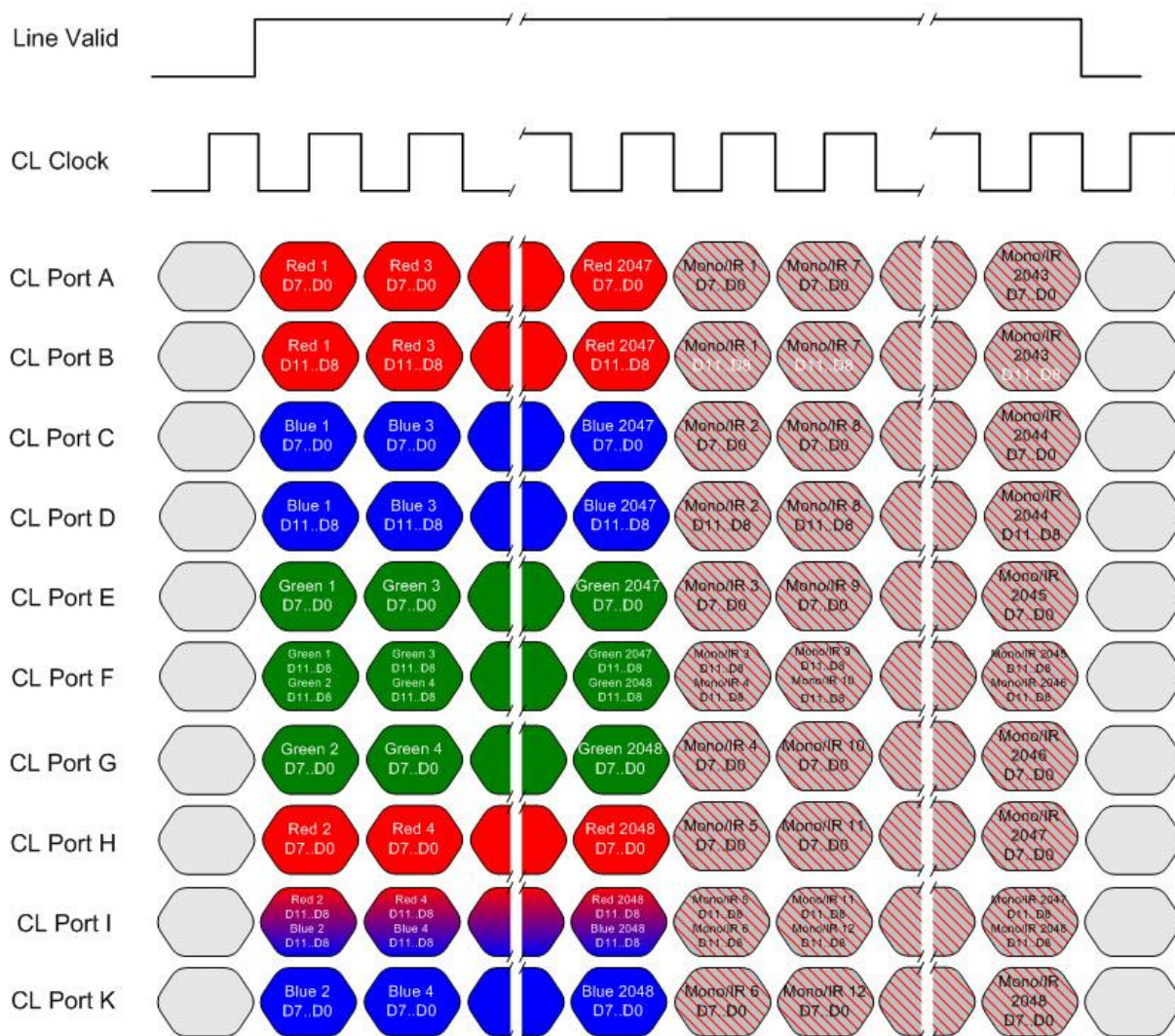
This timing can be used for applications that require line rates up to 69 kHz and therefore must use Camera Link Deca mode and two cables.

The RGB output format is not defined in the Camera Link specification Deca. The RGB format is such that when using a Camera Link frame grabber compatible with the Deca format configured for the mono standard, the R, G and then B pixels will be written sequentially into the frame grabber buffer. This process simplifies the extraction of the RGB data from the frame grabber buffer by the host application.



Line rates up to 70 kHz can be achieved by using the Area of Interest (AOI) feature; where the smaller the AOI, the greater the potential line rate.

### RGB plus monochrome / NIR 12 bit CL Deca, maximum line rate 70 kHz, no AOI and 85 MHz CL clock



This timing can be used for applications that require line rates up to 70 kHz and therefore must use Camera Link Deca mode and two cables.

The RGB output format is not defined in the Camera Link specification Deca. The RGB format is such that when using a Camera Link frame grabber compatible with the Deca format configured for the mono standard, the R, G and then B pixels will be written sequentially into the frame grabber buffer. This process simplifies the extraction of the RGB data from the frame grabber buffer by the host application. Line rates up to 70 kHz can be achieved by using the Area of Interest (AOI) feature; where the smaller the AOI, the greater the potential line rate.

## RGB Vs BGR

The data output can be presented in two alternative formats: RGB or BGR. The previously mentioned output modes are still valid in BGR mode except the positions of the red and the blue are exchanged. Green is still in its previously stated position.

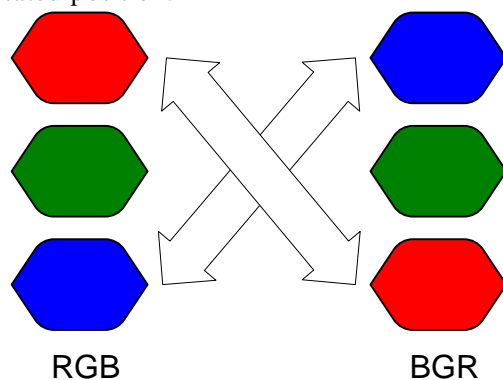


Figure 14 RGB Vs BGR

## Base and Medium Modes

- 1) The total number of pixels within each AOI must be a multiple of 8 and must be greater than or equal to 40.
- 2) In normal mode, the first pixel of each AOI (AOI left edge) must have the location  $8i$ , where  $i = 0, 1, 2 \dots, 511$  (i.e. 8, 960 are allowed, 12 is not allowed).
- 3) In mirror mode, the first pixel of each AOI (AOI right edge) must have the location  $8i + 7$ , where  $i = 0, 1, 2 \dots, 511$  (i.e. 7, 15, 4095 are allowed, 8 is not allowed).

## Deca RGB Mode

- 1) The total number of pixels within each AOI must be a multiple of 40.
- 2) In normal mode, the first pixel of each AOI (AOI left edge) must have the location  $8i$ , where  $i = 0, 1, 2 \dots, 511$  (i.e. 8, 960 are allowed, 12 is not allowed).
- 3) In mirror mode, the first pixel of each AOI (AOI right edge) must have the location  $8i + 7$ , where  $i = 0, 1, 2 \dots, 511$  (i.e. 7, 15, 4095 are allowed, 8 is not allowed).

## 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 camera and a selection of cables and frame grabbers.

| Distance Tested | Cable Manufacture | Frame grabber |
|-----------------|-------------------|---------------|
| 10 m            | Component Express | PX4 and PX8   |
| 15 m            | Component Express | PX8           |

## 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 falling 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 (i.e. within the measurement resolution of 25 ns) even though the camera will only trigger at a maximum of 70 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.

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

## Power Connector



**WARNING:** It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages may damage the camera. Input voltage requirement: +12 VDC to +24 VDC, 2 Amps. Before connecting power to the camera, test all power supplies.

Hirose 6-pin Circular Male



Mating Part: HIROSE  
HR10A-7P-6S

**Figure 15: 6-pin Hirose Circular Male Power Plug—Power Connector**

**Table 7. 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.

### **WARNING: When setting up the camera's power supplies follow these guidelines:**



- Apply the appropriate voltages.
- 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.

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

## LEDs

The camera is equipped with an 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.

| Color of Status LED | Meaning   |
|---------------------|---|
| Off                 | No power or hardware malfunction                  |
| Blinking Green      | Powering up or calibrating                        |
| Green               | Ready   |
| Red                 | Error. Check BiST register for the specific error |

## Step 3. Establish Camera Communication

### Power on the camera

Turn on the camera's power supply. You may have to wait while the camera readies itself for operation. The camera must boot fully before it will be recognized by the GUI—the LED shines green once the camera is ready.

### Connect to the frame grabber

1. Start Spera CamExpert (or equivalent Camera Link compliant interface) by double clicking the desktop icon created during the software installation.
2. CamExpert will search for installed Spera devices. In the Devices list area on the left side, the connected frame grabber will be shown.
3. Select the frame grabber device by clicking on the name.

Note: The first time you set up the camera you will need to establish a communication link between the camera and frame grabber. Instructions are available here in [Appendix E: Camera, Frame Grabber Communication](#).

### Connect to the camera

1. Start a new Spera CamExpert application (or equivalent Camera Link compliant interface) by double clicking the desktop icon created during the software installation.
2. In the Devices list area on the left side, select the COM port below the Camera Link label.

### Check LED Status

If the camera is operating correctly at this point, the diagnostic LED will shine green.

### Software Interface

All the camera features can be controlled through the CamExpert interface. For example, under the Sensor Control menu in the camera window you can control the line rate and exposure times.



---

At this point your host and camera system should be setup and you can verify the camera's operation by retrieving a test pattern and setting the camera's trigger and exposure time.

## Using Sapera CamExpert with Piranha4 Cameras

CamExpert is the camera interfacing tool supported by the Sapera library. When used with a Piranha4 camera, CamExpert allows a user to test all camera operating modes. Additionally CamExpert saves the camera user settings configuration to the camera or saves 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 which allows immediate verification of timing or control parameters without the need to run a separate acquisition program.

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

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

**Note:** The availability of the features is dependent on the CamExpert user setting.

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

## CamExpert Panes

| Parameters - Visibility: Guru    |  |                        |
|----------------------------------|--|------------------------|
| Category                         | Parameter  | Value                  |
| Acquisition and Transfer Cont... | Sensor ColorType                                   | CFA_RGB                |
| Camera Information               | Internal Line Rate                                 | 10000                  |
| Camera Control                   | Measured Line Rate                                 | 10000                  |
|                                  | Refresh Measured Line Rate                         | Press...               |
| Digital IO Control               | Exposure Time Source                               | Timed                  |
| Flat Field                       | Exposure Time Color Selector                       | All                    |
| Image Format                     | Exposure Time                                      | 49                     |
| Transport Layer                  | Measured Exposure Time                             | 51                     |
| Serial Port                      | Refresh Measured Exposure Time                     | Press...               |
| Production Features              | Direction Source                                   | Internal               |
| File Access Control              | Internal Direction                                 | Forward                |
|                                  | Offset   | 0                      |
|                                  | Gain Selector                                      | SystemGain             |
|                                  | Gain   | 1                      |
|                                  | Color Transformation Matrix Selector               | NoCorrectionFactorySet |
|                                  | Color Transformation Value Selector                | Gain00                 |
|                                  | Color Transformation Value                         | 1                      |
|                                  | Line Spatial Correction                            | 2                      |
|                                  | Image Distortion Correction Mode                   | Off                    |
|                                  | Image Distortion Correction Algorithm              | ParallaxCorrection     |
|                                  | Image Distortion Correction Line Selector          | Red                    |
|                                  | Image Distortion Parallax Correction Pixel Stretch | 0                      |
|                                  | << Less  |                        |

Figure 16. CamExpert's Camera Control Window

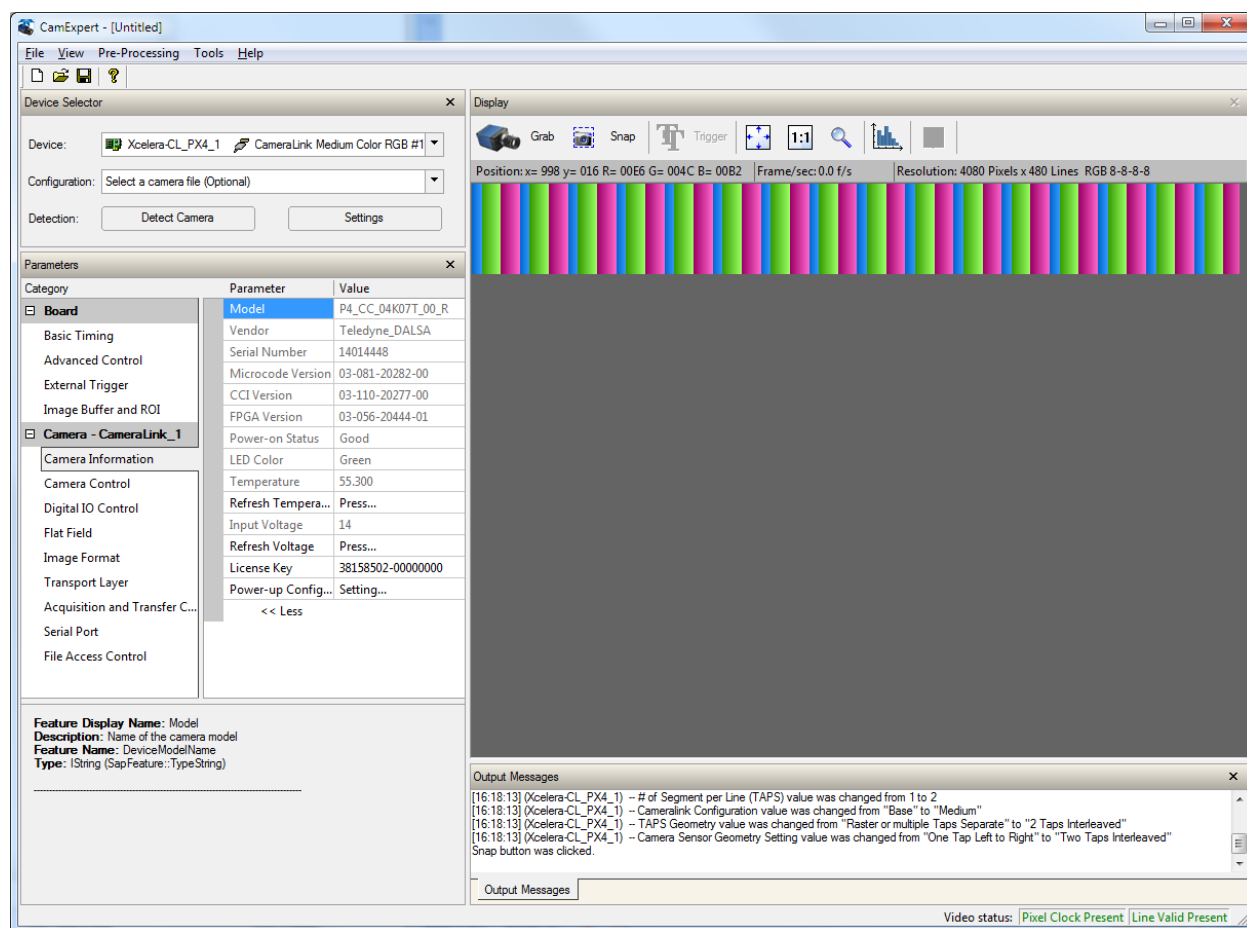






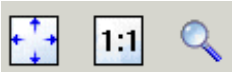

Figure 17. CamExpert GUI showing connected camera

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

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

|  |   |
|--|---|
|  Grab<br> Freeze | <b>Acquisition control button:</b><br>Click once to start live grab, click again to stop. |
|  Snap   | <b>Single frame grab:</b><br>Click to acquire one frame from device.                      |



|   |   |
|---|---|
|  | <b>Software trigger button:</b><br>With the I/ O control parameters set to Trigger Enabled / Software Trigger type, click to send a single software trigger command.                              |
|  | <b>CamExpert display controls:</b><br>(these do not modify the frame buffer data)<br>Stretch image to fit, set image display to original size, or zoom the image to virtually any size and ratio. |
|  | <b>Histogram / Profile tool:</b><br>Select to view a histogram or line/ column profile during live acquisition or in a still image.   |

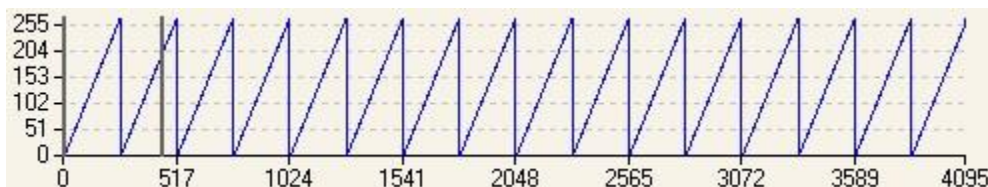
- **Output Message pane:** Displays messages from CamExpert or the device driver.

## Review a Test Image

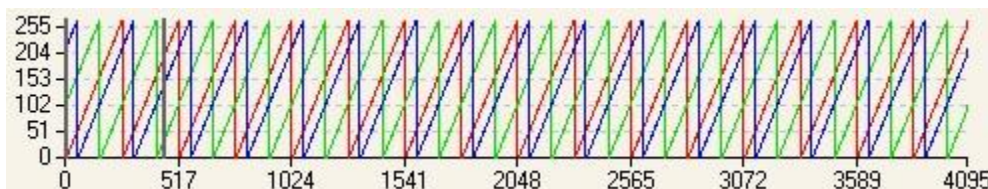
The camera is now ready to retrieve a test pattern. Select **Image Format Control > Test Pattern** and choose one of the following available test images.

0. Off: Sensor Video

1. Grey Ramp



2. Ramp



Pixels: {1, 2, 3...}  
 Red Value: {0, 1, 2...}  
 Green Value: {102, 103, 104...}  
 Blue Value: {204, 205, 206...}  
 Values roll over at 255.

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

---

# 4. Camera Operation

## Factory Settings

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 30.5  $\mu$ s
- Flat field disabled
- User coefficients set to 1x
- Offset 0, System Gain 1x
- White balanced gains all set to 1x
- Color correction, not applied
- Corrected using an 80 mm lens and a magnification of 0.8

## Check Camera and Sensor Information

Camera and sensor information can be retrieved via a controlling application—for example, the CamExpert GUI shown in the following examples. Parameters such as camera model, firmware version, sensor characteristics, etc. are read to uniquely identify the connected device.

The camera information parameters are grouped together as members of the Camera Information set.

| Parameters   |                        |                   |
|--|------------------------|-------------------|
| Category   | Parameter              | Value             |
| <div> <div>Board</div> <div> Basic Timing Advanced Control External Trigger Image Buffer and ROI </div> </div>   |                        |                   |
| <div> <div>Camera - CameraLink_1</div> <div> Camera Information Camera Control Digital IO Control Flat Field Image Format Transport Layer Acquisition and Transfer Control Serial Port File Access Control </div> </div> |                        |                   |
|  | Model                  | P4_CC_04K07T_00_R |
|  | Vendor                 | Teledyne_DALSA    |
|  | Serial Number          | 14014448          |
|  | Microcode Version      | 03-081-20282-00   |
|  | CCI Version            | 03-110-20277-00   |
|  | FPGA Version           | 03-056-20444-01   |
|  | Power-on Status        | Good              |
|  | LED Color              | Green             |
|  | Temperature            | 55.300            |
|  | Refresh Temperature    | Press...          |
|  | Input Voltage          | 14                |
|  | Refresh Voltage        | Press...          |
|  | License Key            | 38158502-00000000 |
|  | Power-up Configuration | Setting...        |
|  | << Less                |                   |

Figure 18. CamExpert's Camera Information Window

## Verify Temperature and Voltage

To determine the voltage and temperature at the camera, use the **Refresh Voltage** and **Refresh Temperature** features found in the **Camera Information** set.

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 will stop imaging and the LED will turn red. Once you have diagnosed and remedied the issue use the **reset camera** function.

The voltage displayed is the camera's input voltage.

**Note:** The voltage measurement feature of the camera provides results typically within 1%. This measurement can be used to set the applied voltage to the camera.

# Saving and Restoring Camera Settings

The parameters used to select, load and save user sets are grouped together under the Camera Information set of features. There are 8 user sets available and one factory set.

| Camera Information        |  |
|---------------------------|--|
| Parameter                 | Choices  |
| User Set Default Selector | Select the camera parameters to load when the camera is reset or powered up as the Factory set, or as User Set 1 to 8.<br><br>Selecting the set from the list automatically saves it as the default set. |
| User Set Selector         | Select the Factory or User set to Save or Load.<br>-Factory Set<br>-User Set 1 to 8.   |
| User Set Load             | Load the set specified by User Set Selector to the camera and make it the active / current set.  |
| User Set Save             | Save the current set as selected user set.   |

## Description of the Camera Settings

The camera operates in one of three settings:

1. Current session.
2. User setting.
3. Factory setting (read-only).
4. Default setting.

The current settings can be saved (thereby becoming the user setting) using the User Set Save parameter. A previously saved user setting (User Set 1 to 8) or the factory settings can be restored using the User Set Selector and User Set Load parameters.

Either the Factory or one of the User settings can be saved as the Default Setting by selecting the set in the User Set Default Selector. The chosen set automatically saves as the default setting and is the set loaded when the camera is reset or powered up.

The relationship between these three settings is illustrated in Figure 19. Relationship between the Camera Settings:

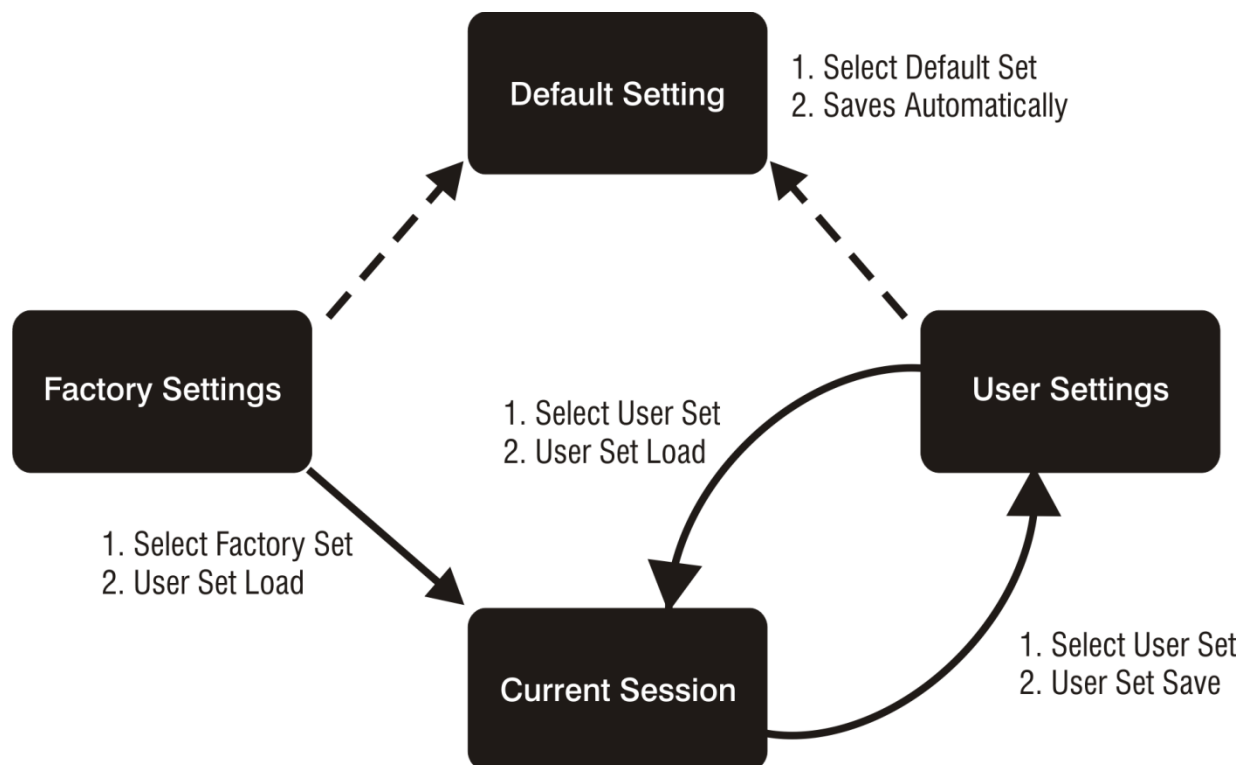


Figure 19. Relationship between the Camera Settings

## Active Settings for Current Session

The active setting for the current session is the set of configurations that are operating while the camera is currently running, including all unsaved changes you have made to the settings before saving them.

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

To save these settings for reuse the next time you power up or reset 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 last saved user settings when it powers up.

To restore the last saved user settings, select the **User Set** parameter 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 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.

# Camera Link Configuration

| Name      | Taps | SPF*      | Cables |
|-----------|------|-----------|--------|
| Base      | 3    | 8, 10, 12 | 1      |
| Dual Base | 4    | 8         | 2      |
| Medium    | 6    | 8, 10, 12 | 2      |
| Full      | 8    | 8         | 2      |
| Deca      | 10   | 8, 12     | 2      |

\*Set Pixel Format (number of bits per pixel)

## Trigger Modes

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

## Exposure Controls

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

- Exposure control is defined as the start of exposure and exposure duration.
- The start of exposure can be an internal timer signal (free-running mode) or an external trigger signal.
- The exposure duration can be programmable (such as the case of an internal timer) or controlled by the external trigger pulse width.

The camera can grab images in one of three ways. You determine the three imaging modes using a combination of the Exposure Mode parameters (including I/ O parameters), Exposure Time and Line Rate parameters.

| Description  | Line Rate                  | Exposure Time         | Trigger Source (Sync) |
|--|----------------------------|-----------------------|-----------------------|
| Internal line rate and exposure time                             | Internal, programmable     | Internal programmable | Internal              |
| External line rate and exposure time                             | Controlled by EXSYNC pulse | External (EXSYNC)     | External              |
| EXSYNC pulse controlling the line rate. Programmed exposure time | Controlled by EXSYNC pulse | Internal programmable | External              |

Figure 20. Exposure controls

The parameters used to select the imaging modes—trigger sources (sync), exposure time, and line rate—are grouped together as the Camera Controls.

| Camera Controls |   |
|-----------------|---|
| Parameter       | Description   |
| Exposure Mode   | Set the operation mode for the camera's exposure. Trigger Width or Timed. Trigger Width is only available when Trigger Mode is enabled. |
|                 | <b>Trigger Width</b><br>Uses the width of the current line trigger signal pulse to control the exposure duration.                       |
|                 | <b>Timed</b><br>The exposure duration time is set using the Exposure Time feature and the exposure starts with the Line Start event.    |
|                 | <b>Exposure Time Selector</b><br>Internally generated. Allows for an independent exposure time to be applied to each individual color.  |
| Exposure Time   | Sets the exposure time (in microseconds). Exposure Mode feature must be set to Timed  |

# Exposure Modes in Detail

## 1. 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 parameters to set:**

**I / O Controls > Trigger Mode > Off**

## 2. External Line Rate, Programmable Exposure Time

In this mode, the line rate is set externally with the falling edge of EXSYNC generating the rising edge of a programmable exposure time.

**GenICam parameters to set:**

- **I / O Controls > Trigger Mode > On**
- **Sensor Control > Exposure Mode > Timed**

## 3. External Line Rate and External Exposure Time (Trigger Width)

In this mode, EXSYNC sets both the line period and the exposure time. The rising edge of EXSYNC marks the beginning of the exposure and the falling edge initiates readout. Note:

$$\text{maximum line rate} = \frac{1}{(\text{exposure time} + \text{low time}^*)}$$

\*Exposure time must be greater than 8  $\mu\text{s}$ , and low time greater than 1,500 ns

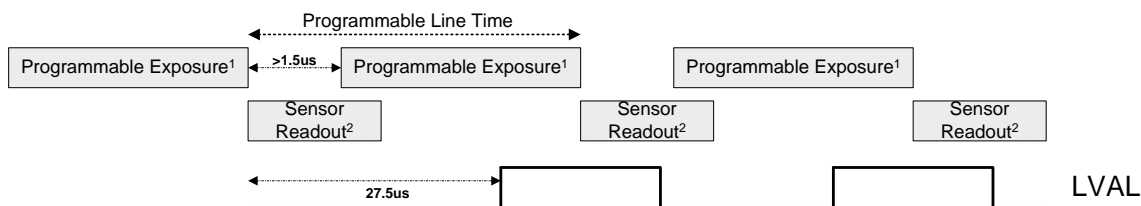
**GenICam parameters to set:**

- **I / O Controls > Trigger Mode > On**
- **Sensor Control > Exposure Mode > Trigger Width**

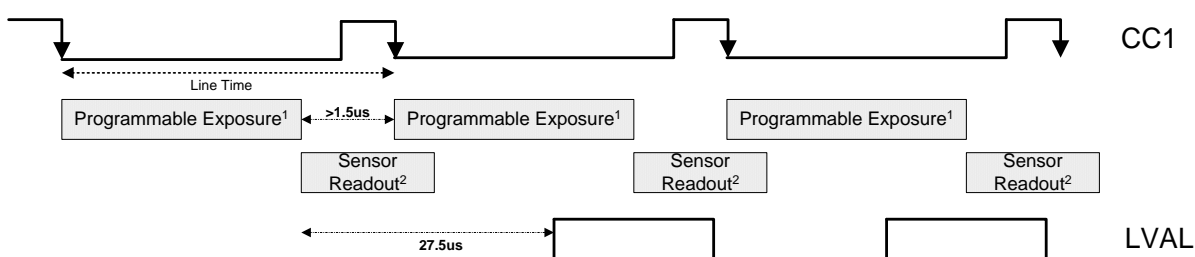
**Warning!** When running external line rate and external exposure time, the line rate must not exceed 1 / (exposure time + 1,000 ns). Under these conditions the exposure time will become indeterminate and result in image artefacts. This is not the case when running internal exposure control.



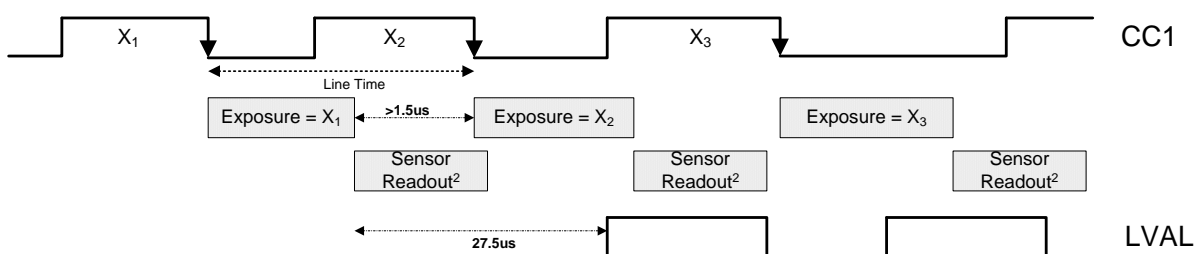
1. External Trigger Off, Internal Exposure Control  
Free running, not synchronized to an external signal



2. External Trigger On, Internal Exposure Control  
CC1 Falling edge triggers start of internal exposure³



3. External Trigger On, External Exposure Control  
CC1 Falling edge triggers start of exposure  
CC1 high duration sets the exposure time



Notes:

1. Exposure time > 7 micro-seconds
2. Sensor Readout time = 14 micro-seconds
3. One additional falling edge during exposure is latched

**Figure 21. Exposure Modes**

## Color Exposure Time Guidelines

The camera has no limitations on the combinations of the exposure times available for each color except the maximum of 3 ms and the minimum of 7 $\mu$ s exposure times. Operating the camera with the conditions stated below will give the user optimum image performance. Operating the camera beyond the stated limits may be possible but may also compromise image quality.

### Tri-Linear Ideal Operating Conditions

For optimum image performance all of the following must be true

1. Blue  $\geq$  Red by 1 $\mu$ s
2. Blue  $\geq$  Green by 1 $\mu$ s or Green  $\geq$  Blue by 1 $\mu$ s
3. Red  $\geq$  Green by 1 $\mu$ s or Green  $\geq$  Red by 1 $\mu$ s

### Quad-Linear Ideal Operating Conditions

For optimum image performance all of the following must be true

1. Blue  $\geq$  Red by 1 $\mu$ s
2. Green  $\geq$  Mono by 1 $\mu$ s
3. Blue  $\geq$  Green by 1 $\mu$ s or Green  $\geq$  Blue by 1 $\mu$ s
4. Blue  $\geq$  Mono by 1 $\mu$ s or Mono  $\geq$  Blue by 1 $\mu$ s
5. Red  $\geq$  Green by 1 $\mu$ s or Green  $\geq$  Red by 1 $\mu$ s
6. Red  $\geq$  Mono by 1 $\mu$ s or Mono  $\geq$  Red by 1 $\mu$ s

## Set Line Rate

To set the camera's line rate use the line rate parameter, part of the Sensor Controls set. This feature can only be used when the camera is in Internal mode—that is, when the start line trigger is disabled (Trigger Mode Off).

$$\text{maximum line rate} = \frac{1}{(\text{exposure time} + \text{low time}^*)}$$

\*Exposure time must be greater than 8  $\mu$ s, and low time greater than 1,500 ns

**Note:** The line rate must be less than 1 / (Exposure time + 1500ns). 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 70 kHz the camera will continue to output data at its maximum line rate of 70 kHz. Though no image artefacts 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.

| Camera Control    |  |
|-------------------|--|
| Parameter         | Description  |
| Line Rate (in Hz) | <p>Camera line rate in a range from 0 Hz to 70 KHz.</p> <p>This feature is only available when the camera is in Internal Mode—line trigger is disabled (Trigger Mode off).</p> |

| Line Rates                |                      |
|---------------------------|----------------------|
| Camera Link Configuration | Maximum Line Rate    |
| Base                      | 40 kHz               |
| Medium                    | 41 kHz               |
| Full                      | 55 kHz               |
| Deca                      | 68.5 kHz (Deca RGB8) |

**Note:** 70 kHz line rate can be achieved using AOI mode for all Camera Link Mode. For more information, see [Area of Interest \(AOI\) Setup](#).

## Set Exposure Time

To set the camera's exposure time, use the **Exposure Time** parameter—a member of the Sensor Controls set. This feature is only available when the **Exposure Mode** parameter is set to **Timed**. The allowable exposure range is from 7  $\mu$ s to 3,000  $\mu$ s, dependent on the value of the internal line rate.

**GenICam parameters:**

**Sensor Controls > Exposure Time (Timed Exposure Mode) > 8  $\mu$ s to 3,000  $\mu$ s.**

## Control Gain and Black Level

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

The parameters that control gain and black level are grouped together in the Sensor Controls set.

| Sensor Controls |   |
|-----------------|---|
| Black Level     | Apply a digital addition after an FPN correction: $\pm 1/8$ of the available range of -32 to +31 in 8-bit mode, -128 to +127 in 10-bit mode, and -512 to +511 in 12-bit mode. |
| Gain            | Set the gain as an amplification factor applied to the video signal across all pixels: 1x to 10x.   |

## Set Image Size

To set the height of the image, and therefore the number of lines to scan, use the parameters grouped under the Image Format Control set.

| Image Format Control                      |  |
|---|--|
| Control the size of the transmitted image |  |
| Width                                     | Width of the image.  |
| Height                                    | Height of the image in lines.                                    |
| Pixel Format                              | 8 bit depth to Camera Link.                                      |
| Test Image Selector                       | Select an internal test image:<br>Off<br>Color Ramp<br>Grey Ramp |

## Set Baud Rate

The baud rate sets the speed (in bits per second—bps) of the serial communication port and is available as part of the Serial Port Control parameters.

| Serial Port Control                                       |                     |  |
|---|---------------------|--|
| Action  | Parameter           | Options  |
| Control the baud rate used by the camera's serial port    | Baud Rate           | 9600 (factory default)<br>19200<br>57600<br>115200<br>230400*<br>460800*<br>921600*<br><br><b>Note:</b> During connection CamExpert automatically sets the camera to maximum allowable baud.<br><br>*Your system requires a Px8 frame grabber to achieve these baud rates. |
| Number of bits per character used in the serial port      | Data Size           | 8  |
| Parity of the serial port                                 | Parity              | None   |
| Number of stop bits per character used in the serial port | Number of Stop Bits | 1  |

## Pixel Format

Use the Pixel Format feature, found in the **Image Format Control** set, to select the format of the pixel to use during image acquisition.

| Image Format Control |                    |
|----------------------|--------------------|
| Parameter            | Description        |
| Pixel Format         | RGB8, RGB10, RGB12 |

## Camera Direction Control

Found in the **I / O Control > Direction Control** set of features.

| Direction Control     |   |
|-----------------------|---|
| Parameter             | Description   |
| Sensor Scan Direction | This command lets you select the <b>Internal</b> or <b>external direction control</b> . Use this feature to accommodate object direction change on a web and to mount the camera "upside down." |
| Scan Direction        | Read the current direction.   |

## Pixel Readout Direction (Mirroring Mode)

Set the tap readout from left to right or from right to left. This feature is especially useful if you want to mount the camera "upside down."

| Image Format Control |   |
|----------------------|---|
| Parameter            | Description   |
| ReverseX             | Off: All pixels are read out from left to right.<br>On: All pixels are read out from right to left. |

## Resetting the Camera

The feature **Camera Reset**, part of the **Transport Layer** set, resets the camera. The camera resets with the default settings, including a baud rate of 9600.

| Camera Information |   |
|--------------------|---|
| Parameter          | Description   |
| Camera Reset       | Resets the camera and puts in the default settings, including a 9600 baud rate. |

# Calibrating the Camera

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

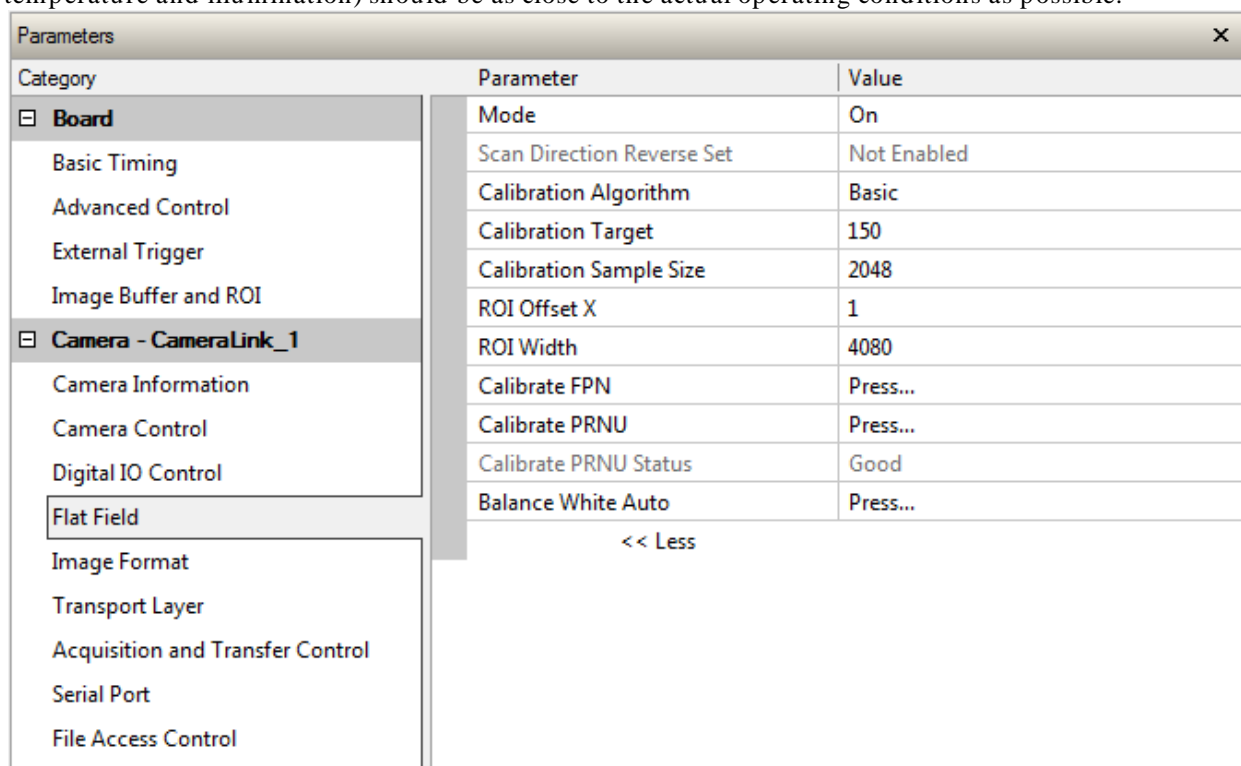


Figure 22: Flat Field Calibration in CamExpert

## 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.

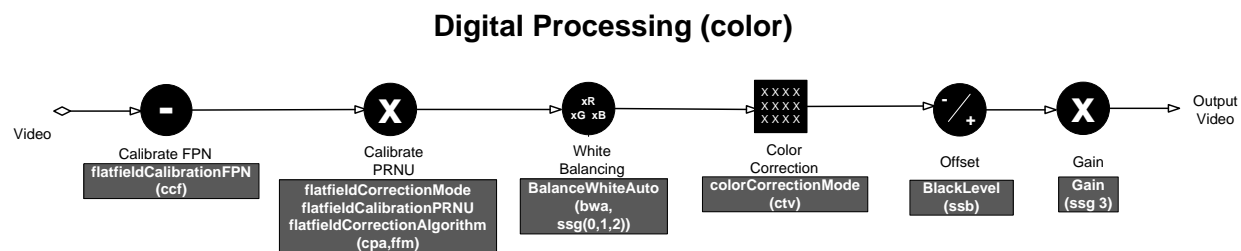


Figure 23: Camera Calibration Process.

## Digital Processing

1. Fixed pattern noise (FPN) calibration is used to subtract any residual dark level that may occur in the application.
2. 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.

3. 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.
4. 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 demonstration tool provided as part of Teledyne DALSA's Sopera Processing software. This tool will generate the desired color correction file that can be downloaded to the camera.  
**Note:** 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.
5. The introduction of offsets has limited value in color applications as it will cause color distortion. However, the camera has the ability to add either a positive or negative offset as required by a specific application. This offset can be useful when trying to measure dark noise where black level clipping will cause an error in the result.
6. A single overall system gain is applied equally to all three colors. It will therefore not cause color distortion when changed.
7. A factory setting for white LED color correction can be applied, if needed.

## 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.

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. As the white reference located at the object plane will be in focus, any features on its surface (e.g. dust, 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.

The user may wish to start the calibration process by evaluating the characteristics of their setup with no calibration enabled. This can be readily achieved by disabling FPN, PRNU & color correction coefficients, setting white balance red, green and blue gains to one, and the system gain to one.

Begin by adjusting the system 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. Before proceeding any further, it is desirable to complete an FPN calibration. This is best performed using a lens cap to ensure no light gets into the camera. Once complete, a PRNU calibration can be performed using a target value you want all the pixels to achieve. This target value can be higher or lower than the peak values you observed while initially setting up the camera. Once PRNU calibration is complete, it will take several seconds, all three colors should be at the target value, white balance gains will have been adjusted to suit the cameras optimum setup for a balanced white output, and the correction coefficient will be enabled. The system gain will remain as originally set. The coefficient and gain parameters, timing and control configuration etc can be stored in any one of eight

user sets and automatically retrieved at power up or by user selection. If a color correction matrix is desired, the user can download and save a color correction file derived from the process described above.

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



CamExpert has a default timeout of 20 seconds per command, which is too short for the FFC calibration to run fully. You can change the default timeout by setting a command line argument in the short-cut:

- Right click on the short-cut in the start menu and select properties.
- Add -timeout 60 to increase the command timeout to 60 seconds (See below). **Note** that you must include a character space between the closing quotation mark in the target and the hyphen before the timeout value.
- Repeat for desktop short-cut

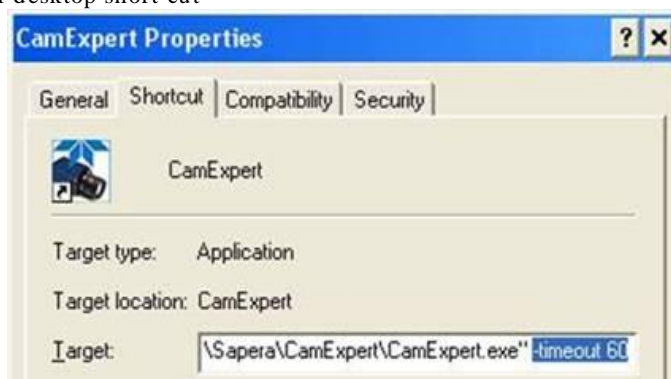


Figure 24: Setting the camera's timeout value

## 1. Flat Field

This Flat Field set contains a number of features that are used to correct image distortion due to lens vignetting and uneven illumination. .

**Note:**

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

| Flat Field                   |  |
|------------------------------|--|
| Parameter                    | Description  |
| flatfieldCorrectionMode      | <ol style="list-style-type: none"> <li>1. Off – Flat field correction coefficients are not applied.</li> <li>2. On – Flat field correction coefficients are applied.</li> <li>3. Initialize – Sending this value will reset all current coefficients (offsets to 0 and gains to 1x).</li> </ol>  |
| flatfieldCorrectionAlgorithm | <ol style="list-style-type: none"> <li>1. Basic – Direct calculation of coefficients based on current average line values and target.</li> <li>2. LowPass – A low pass filter is first applied to the current average line values before calculating the coefficients. Use this algorithm if the calibration target is not uniform white or it is not possible to defocus the image. Because of the low pass filter this algorithm is not able to correct pixel-to-pixel variations and so it is preferable to use the “Basic” algorithm if possible.</li> </ol> |



|                                |  |
|--------------------------------|--|
| flatfieldCalibrationTarget     | <ol style="list-style-type: none"> <li>After calibration all pixels will be scaled to output this level <ul style="list-style-type: none"> <li>Range: 8 bit, 0 to 255 DN</li> </ul> </li> </ol>  |
| flatfieldCalibrationSampleSize | <ol style="list-style-type: none"> <li>Number of lines to average when calibrating</li> <li>2048</li> </ol>  |
| flatfieldCalibrationROIOffsetX | <ol style="list-style-type: none"> <li>Together with “flatfieldCalibrationROIWidth” specifies the range of pixels to be calibrated. Pixel coefficients outside this range are not changed. It is possible to calibrate different regions sequentially.</li> </ol>  |
| flatfieldCalibrationROIWidth   |  |
| flatfieldCalibrationFPN        | <ol style="list-style-type: none"> <li>Save average line (of “flatfieldCalibrationSampleSize” rows). This is the first user correction applied – it is subtracted from each line.</li> <li>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.</li> <li>Range 0 to 31 DN, 8 bit</li> <li>Default value is 0 DN for each pixel</li> </ol> |
| flatfieldCalibrationPRNU       | <ol style="list-style-type: none"> <li>Use “flatfieldCorrectionAlgorithm” to calculate the per pixel gain to achieve the specified target output.</li> <li>Max 15.9998x</li> <li>Default 1x</li> </ol>   |

## 2. 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.

### Offset

- Single value added to each pixel
- Range -32 to +31 DN
- Positive values may be used to measure dark noise

### Gain

- Floating point digital multiplier applied to each pixel
- Range 1x to 10x

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

---

# Appendix A: GenICam Commands

This appendix lists the available GenICam camera features. Access these features using the CamExpert interface.

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

**A note on the CamExpert examples shown here: The 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

Camera information can be retrieved via a controlling application. Parameters such as camera model, firmware version, etc. are read to uniquely identify the connected P4 device. These features are typically read-only.

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

Features listed in the description table but tagged as *Invisible* are usually for Teledyne DALSA or third party software usage—not typically needed by end user applications.

| Parameters                       |                        |                   | X |
|----------------------------------|------------------------|-------------------|---|
| Category                         | Parameter              | Value             |   |
| [-] <b>Board</b>                 | Model                  | P4_CC_04K07T_00_R |   |
| Basic Timing                     | Vendor                 | Teledyne_DALSA    |   |
| Advanced Control                 | Serial Number          | 14014448          |   |
| External Trigger                 | Microcode Version      | 03-081-20282-00   |   |
| Image Buffer and ROI             | CCI Version            | 03-110-20277-00   |   |
|                                  | FPGA Version           | 03-056-20444-01   |   |
| [-] <b>Camera - CameraLink_1</b> | Power-on Status        | Good              |   |
| Camera Information               | LED Color              | Green             |   |
| Camera Control                   | Temperature            | 32.200            |   |
| Digital IO Control               | Refresh Temperature    | Press...          |   |
| Flat Field                       | Input Voltage          | 14                |   |
| Image Format                     | Refresh Voltage        | Press...          |   |
| Transport Layer                  | License Key            | 38158502-00000000 |   |
| Acquisition and Transfer Control | Power-up Configuration | Setting...        |   |
| Serial Port                      | << Less                |                   |   |
| File Access Control              |                        |                   |   |

## Camera Information Feature Descriptions

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

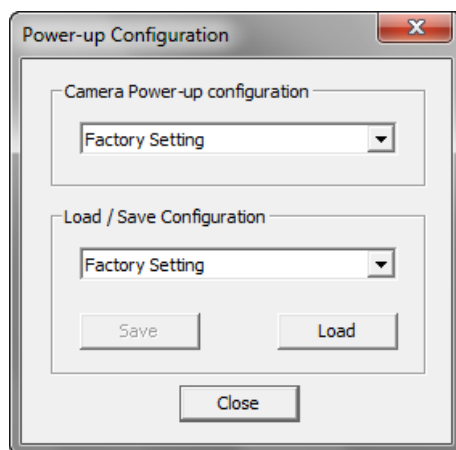
The Device Version number represents the camera software functional group, not a firm ware revision number.

| Display Name      | Feature                | Description   | Device Version & View |
|-------------------|------------------------|---|-----------------------|
| Vendor Name       | DeviceVendorName       | Displays the device vendor name. (RO)   | 1.00<br>Beginner      |
| Model Name        | DeviceModelName        | Displays the device model name. (RO)  | 1.00<br>Beginner      |
| Device Version    | DeviceVersion          | Displays the device version. This tag will also highlight if the firm ware is a beta or custom design. (RO)                         | 1.00<br>Beginner      |
| Manufacturer Info | DeviceManufacturerInfo | This feature provides extended manufacturer information about the device. (RO)  | 1.00<br>Beginner      |
| Firm ware Version | DeviceFirm wareVersion | Displays the currently loaded firm ware version number. Firm ware files have a unique number and have the .cbf file extension. (RO) | 1.00<br>Beginner      |

|                                 |                        |  |                  |
|---------------------------------|------------------------|--|------------------|
| Serial Number                   | DeviceID               | Displays the device's factory set camera serial number. (RO)   | 1.00<br>Beginner |
| Power-up Configuration Selector | 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) | 1.00<br>Beginner |
| Factory Setting                 | Default                | Load factory default feature settings  |                  |
| UserSet1                        | UserSet1               | Select the user defined configuration UserSet 1 as the Power-up Configuration.   |                  |
| UserSet2                        | UserSet2               | Select the user defined configuration UserSet 2 as the Power-up Configuration  |                  |
| UserSet3                        | UserSet3               | Select the user defined configuration UserSet 3 as the Power-up Configuration  |                  |
| UserSet4                        | UserSet4               | Select the user defined configuration UserSet 4 as the Power-up Configuration.   |                  |
| UserSet5                        | UserSet5               | Select the user defined configuration UserSet 5 as the Power-up Configuration.   |                  |
| UserSet6                        | UserSet6               | Select the user defined configuration UserSet 6 as the Power-up Configuration.   |                  |
| UserSet7                        | UserSet7               | Select the user defined configuration UserSet 7 as the Power-up Configuration.   |                  |
| UserSet8                        | UserSet8               | Select the user defined configuration UserSet 8 as the Power-up Configuration.   |                  |
| User Set Selector               | UserSetSelector        | Selects the camera configuration set to load feature settings from or save current feature settings to. The Factory set contains default camera feature settings. (RW) | 1.00<br>Beginner |
| Factory Setting                 | Default                | Select the default camera feature settings saved by the factory  |                  |
| UserSet 1                       | UserSet1               | Select the User-defined Configuration space UserSet1 to save to or load from features settings previously saved by the user.   |                  |
| UserSet 2                       | UserSet2               | Select the User-defined Configuration space UserSet2 to save to or load from features settings previously saved by the user.   |                  |
| UserSet3                        | UserSet3               | Select the User-defined Configuration space UserSet3 to save to or load from features settings previously saved by the user.   |                  |
| UserSet4                        | UserSet4               | Select the User-defined Configuration space UserSet4 to save to or load from features settings previously saved by the user.   |                  |
| UserSet5                        | UserSet5               | Select the User-defined Configuration space UserSet5 to save to or load from features settings previously saved by the user.   |                  |
| UserSet6                        | UserSet6               | Select the User-defined Configuration space UserSet6 to save to or load from features settings previously saved by the user.   |                  |
| UserSet7                        | UserSet7               | Select the User-defined Configuration space UserSet7 to save to or load from features settings previously saved by the user.   |                  |

|                                  |                        |  |                          |
|----------------------------------|------------------------|--|--------------------------|
| UserSet8                         | UserSet8               | Select the User-defined Configuration space UserSet8 to save to or load from features settings previously saved by the user.   |                          |
| Power-on User Set                | UserSetDefaultSelector | Allows the user to select between the factory set and 1 to 8 user sets to be loaded at power up  | 1.00<br>Beginner         |
| Current User Set                 | UserSetSelector        | Points to which user set (1-8) or factory set that is loaded or saved when the UserSetLoad or UserSetSave command is used  | 1.00<br>Beginner         |
| Load Configuration               | UserSetLoad            | Loads the camera configuration set specified by the User Set Selector feature, to the camera and makes it active. (W)  | 1.00<br>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) | 1.00<br>Beginner         |
| Device Built-In Self Test Status | deviceBISTStatus       | Determine the status of the device using the 'Built-In Self Test'. Possible return values are device-specific. (RO)  | 1.00<br>DFNC<br>Beginner |
| LED Color                        | deviceLEDCOLORControl  | Displays the status of the LED on the back of the camera. (RO)   | 1.00<br>DFNC<br>Beginner |
| Temperature                      | DeviceTemperature      | Displays the internal operating temperature of the camera. (RO)  | 1.00<br>DFNC<br>Beginner |
| Refresh Temperature              | refreshTemperature     | Press to display the current internal operating temperature of the camera.   | 1.00<br>DFNC<br>Beginner |
| Input Voltage                    | deviceInputVoltage     | Displays the input voltage to the camera at the power connector (RO)   | 1.00<br>DFNC<br>Beginner |
| Refresh Voltage                  | refreshVoltage         | Press to display the current input voltage of the camera at the power connector  | 1.00<br>DFNC<br>Beginner |
| License Key                      | securityUpgrade        |  | 1.00<br>DFNC<br>Guru     |

## Camera Configuration Selection Dialog



CamExpert provides a dialog box which combines the features to select the camera power up state and for the user to save or load a camera state from memory.

### Camera Power-up Configuration

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

### User Set Configuration Management

The second drop list allows the user to change the camera configuration anytime after a power-up (see feature *UserSetSelector*). To reset the camera to the factory configuration, select *Factory Setting* and click Load. To save a current camera configuration, select User Set 1 to 8 and click Save. Select a saved user set and click Load to restore a saved configuration.

# Camera Control Category

The camera controls, as shown by CamExpert, group sensor specific parameters. This group includes controls for line rate, exposure time, scan direction, and gain. 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.

| Parameters - Visibility: Guru    |  |                        |
|----------------------------------|--|------------------------|
| Category                         | Parameter  | Value                  |
| Acquisition and Transfer Cont... | Sensor ColorType                                   | CFA_RGB                |
| Camera Information               | Internal Line Rate                                 | 10000                  |
| Camera Control                   | Measured Line Rate                                 | 10000                  |
| Digital IO Control               | Refresh Measured Line Rate                         | Press...               |
| Flat Field                       | Exposure Time Source                               | Timed                  |
| Image Format                     | Exposure Time Color Selector                       | All                    |
| Transport Layer                  | Exposure Time                                      | 49                     |
| Serial Port                      | Measured Exposure Time                             | 51                     |
| Production Features              | Refresh Measured Exposure Time                     | Press...               |
| File Access Control              | Direction Source                                   | Internal               |
|                                  | Internal Direction                                 | Forward                |
|                                  | Offset   | 0                      |
|                                  | Gain Selector                                      | SystemGain             |
|                                  | Gain   | 1                      |
|                                  | Color Transformation Matrix Selector               | NoCorrectionFactorySet |
|                                  | Color Transformation Value Selector                | Gain00                 |
|                                  | Color Transformation Value                         | 1                      |
|                                  | Line Spatial Correction                            | 2                      |
|                                  | Image Distortion Correction Mode                   | Off                    |
|                                  | Image Distortion Correction Algorithm              | ParallaxCorrection     |
|                                  | Image Distortion Correction Line Selector          | Red                    |
|                                  | Image Distortion Parallax Correction Pixel Stretch | 0                      |
|                                  | << Less  |                        |

## Camera Control Feature Descriptions

The following table describes these parameters along with their view attribute and minimum camera firmware version required. Additionally the firmware column will indicate which parameter is a member of the DALSA Features Naming Convention (DFNC), versus the GenICam Standard Features Naming Convention (SFNC not shown).

The Device Version number represents the camera software functional group, not a firmware revision number.

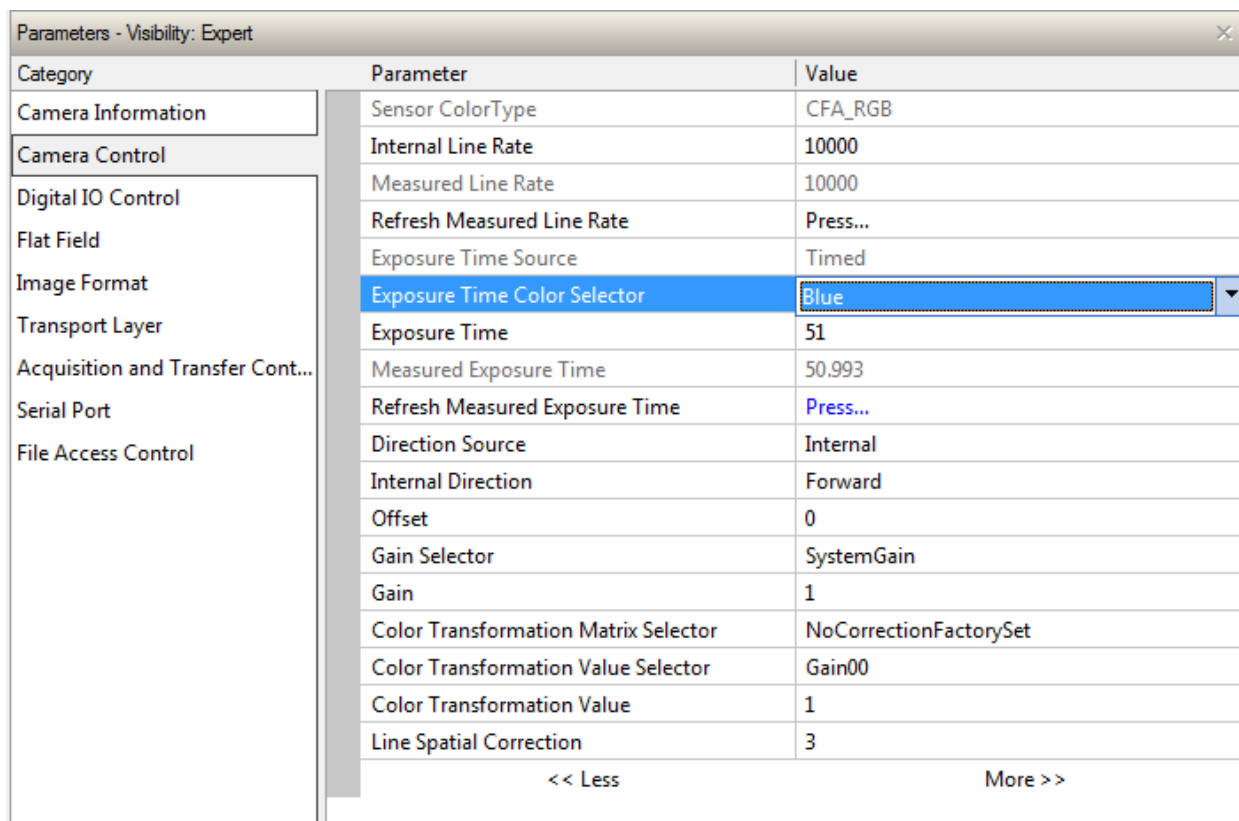
| Display Name                     | Feature                     | Description   | Device Version & View |
|----------------------------------|-----------------------------|---|-----------------------|
| Sensor Color Type                | sensorColorType             | Defines the camera sensor color type. (RO)  | 1.00<br>DFNC          |
|                                  | CFA_RGB                     | Sensor color type is RGB  | Beginner              |
| Internal Line Rate               | AcquisitionLineRate         | Specifies the camera internal line rate, in Hz when Trigger mode set to internal. Note that any user entered value is automatically adjusted to a valid camera value. | 1.00<br>Beginner      |
| Measured Line Rate               | measureLineRate             | Specifies the line rate provided to the camera by either internal or external source (RO)   | 1.00<br>Beginner      |
| Refresh measured line rate       | refreshMeasureLineRate      | Press to show the current line rate provided to the camera by either internal or external sources   | 1.00<br>Beginner      |
| Exposure Time Source             | ExposureMode                | Sets the operation mode for the camera's exposure (or shutter). (RO)  | 1.00<br>Beginner      |
| Timed                            | Timed                       | The exposure duration time is set using the Exposure Time feature and the exposure starts with a LineStart event.   |                       |
| Trigger Width                    | TriggerWidth                | Uses the width of the trigger signal pulse to control the exposure duration.  |                       |
| Exposure Time Selector           | exposureTimeSelector        | Selects which color that the exposure time value is to apply to.  | 1.00<br>Beginner      |
|                                  | All                         | Exposure time setting applies to all colors.  |                       |
|                                  | Red                         | Exposure time setting applies to red.   |                       |
|                                  | Green                       | Exposure time setting applies to green.   |                       |
|                                  | Blue                        | Exposure time setting applies to blue.  |                       |
|                                  | Mono (02K07Q only)          | Exposure time setting applies to mono.  |                       |
|                                  | NIR (02K07N only)           | Exposure time setting applies to NIR.   |                       |
| Exposure Time                    | ExposureTime                | Sets the exposure time (in microseconds) when the Exposure Mode feature is set to Timed.  | 1.00<br>Beginner      |
| Measured Exposure Time           | measureExposureTime         | Specifies the exposure time provided to the camera by either internal or external source (RO)   | 1.00<br>Beginner      |
| Refreshed measured exposure time | refreshMeasureExposure Time | Press to display the current exposure time provided to the camera.  | 1.00<br>Beginner      |



|                               |                                      |  |                  |
|-------------------------------|--------------------------------------|--|------------------|
| Direction Source              | sensorScanDirectionSource            | Direction determined by value of SensorScanDirection   | 1.00<br>Beginner |
|                               | Internal<br>External                 | Direction control determined by value on CC3   |                  |
| Internal Direction            | sensorScanDirection                  | When ScanDirectionSource set to Internal, determines the direction of the scan   | 1.00<br>Beginner |
|                               | Forward<br>Reverse                   |  |                  |
| Gain Selector                 | GainSelector                         | Selects which gain is controlled when adjusting gain features.   | 1.00<br>Beginner |
|                               | SystemGain                           | Apply a digital gain adjustment to the entire image  |                  |
|                               | Red                                  | Apply a digital gain adjustment to the red channel only  |                  |
|                               | Green                                | Apply a digital gain adjustment to the green channel only  |                  |
|                               | Blue                                 | Apply a digital gain adjustment to the blue channel only   |                  |
|                               | Mono (2K07Q only<br>NIR (2K07N only) | Apply a digital gain adjustment to the mono (NIR) channel only   |                  |
| Gain                          | Gain                                 | Sets the selected gain as an amplification factor applied to the image.  | 1.00<br>Beginner |
| Offset                        | BlackLevel                           | Controls the black level as an absolute physical value. This represents a DC offset applied to the video signal, in DN (digital number) units. | 1.00<br>Beginner |
| Color Transformation Selector | colorTransformationSelector          | Allows the user to select between two factory programmed matrixes or two user loaded sets  | 1.00<br>Beginner |
|                               | WhiteLEDFactorySet                   | Color Correction Matrix for a white LED  |                  |
|                               | NoCorrectionFactorySet               | No correction  |                  |
|                               | MatrixUserSet1                       | User programmable/ loaded correction matrix  |                  |
|                               | MatrixUserSet2                       | User programmable/ loaded correction matrix  |                  |

|  |   |  |                  |
|--|---|--|------------------|
| Color Transformation Value Selector                | ColorTransformationValueSelector              | Allows the user to manually adjust correction value in the matrix                      | 1.00<br>Beginner |
|  | Gain00  |  |                  |
|  | Gain01  |  |                  |
|  | Gain02  |  |                  |
|  | Gain10  |  |                  |
|  | Gain11  |  |                  |
|  | Gain12  |  |                  |
|  | Gain20  |  |                  |
|  | Gain21  |  |                  |
|  | Gain22  |  |                  |
|  | Offset1                                       |  |                  |
|  | Offset2                                       |  |                  |
|  | Offset3                                       |  |                  |
| Color Transformation Value                         | ColorTransformationValue                      | Value entered as pointed to by ColorTransformationValueSelector, -16 < value < 16      | 1.00<br>Beginner |
| Line Spatial Correction                            | sensorLineSpatialCorrection                   | Set the number of rows between imaging lines   | 1.00<br>Beginner |
| Image Distortion Correction Mode                   | imageDistortionCorrectionMode                 | Used enable parallax correction  | 1.00<br>Beginner |
| Image Distortion Correction Algorithm              | imageDistortionCorrectionAlgorithm            | Read only – Parallax Correction  | 1.00<br>Beginner |
| Image Distortion Correction Line Selector          | imageDistortionCorrectionLineSelector         | Used to select between the green or red lines to be corrected                          | 1.00<br>Beginner |
| Image Distortion Parallax Correction Pixel Stretch | imageDistortionParallaxCorrectionPixelStretch | Value entered indicates the number pixels to be shifted to correct the color alignment | 1.00<br>Beginner |

# Independent Exposure Control



The cameras feature independent exposure control. This feature allows the user to set a different exposure times for each color. The screenshot above shows the blue color selected. Green and red are selected from the same drop-down box.

Adjust the independent exposure control using either the GUI or the 3-letter commands:

## CamExpert GUI

| In the Camera Control Set    |                             |
|------------------------------|-----------------------------|
| Parameter                    | Value                       |
| Exposure Time Color Selector | All, Red, Green, Blue, Mono |
| Exposure Time                |                             |

## Three-Letter Commands

| In the Camera Control Set                 |  |
|---|--|
| Parameter                                 | Value  |
| scl (Select Exposure Time Color Selector) | Select 0-ALL, 1-Red, 2-Green, 3-Blue, 4-Mono |
| set (Set Exposure Time)                   | Executes the command.                        |

**Note** that the red and green exposure times must be set *at least 1  $\mu$ sec shorter than the blue exposure time*.

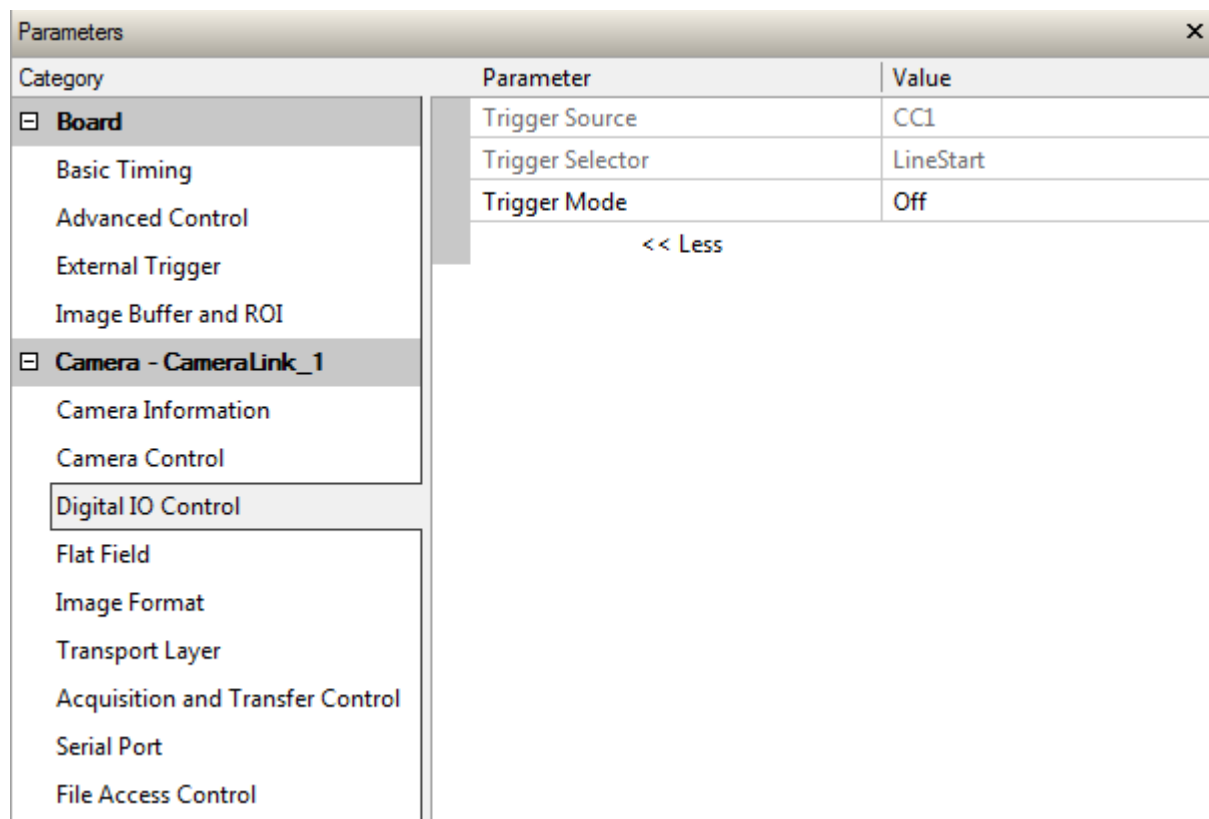
The above restriction should not be an issue for most applications, as commercial light sources generally output less power at the blue end of the spectrum. If the Exposure Time Color Selector is set to *All*, then this criteria is automatically met.

**Further note** that the order in which the exposure time color selector values are entered is important. When entering the exposure times using either the GenICam interface or the three-letter command interface, checks are performed on the entered exposure times. If a blue integration time is entered that is shorter than the green or red integration time, then an error condition will be indicated and the value will not be accepted by the camera. The same is true if a red or green integration time is entered that is not smaller by 1  $\mu$ sec than the blue integration time.

Be aware that the above checking is performed on the value being entered against the values the camera currently has set and therefore that the order that the values are entered is important. For example, if the revised blue value is less than the current blue value, enter the green and red values first. If the new blue value is greater than the current blue value, enter the blue value first.

## Digital I/O Control Feature Descriptions

The Digital I / O control category, as organized by CamExpert, groups together the sensor specific parameters. This group includes the controls for line rate, exposure time, scan direction, and gain. Parameters in gray are read-only, either always or due to another parameter being enabled or disabled. Parameters in black are user set in CamExpert or programmable via an imaging application.



The following table describes the digital I / O control parameters along with their view attributes and the minimum camera firmware version required. Additionally, the firmware column indicates which parameter is a member of the DALSA Features Naming Convention (DFNC), versus the GenICam Standard Features Naming Convention (SFNC not shown). The Device Version number represents the camera software functional group, not a firmware revision number.

| Display Name     | Feature          | Description  | Device Version & View    |
|------------------|------------------|--|--------------------------|
| Trigger Source   | Trigger Source   | Defines the source of external trigger (RO)                                | 1.00<br>DFNC<br>Beginner |
| Trigger Selector | Trigger Selector | Defines what the trigger initiates (RO)                                    | 1.00<br>DFNC<br>Beginner |
| Trigger Mode     | Trigger Mode     | Determines the source of trigger to the camera, internal or external (CC1) | 1.00<br>DFNC<br>Beginner |

# Flat Field Category

The Flat Field controls, as shown by CamExpert, group parameters used to configure camera pixel format, and image cropping. Additionally a feature control to select and output an internal test image simplifies the process of setting up a camera without a lens.

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.

Features listed in the description table but tagged as *Invisible* are usually for Teledyne DALSA or third party software usage—not typically needed by end user applications.

| Parameters                       |                            |             |
|----------------------------------|----------------------------|-------------|
| Category                         | Parameter                  | Value       |
| [-] Board                        | Mode                       | On          |
| Basic Timing                     | Scan Direction Reverse Set | Not Enabled |
| Advanced Control                 | Calibration Algorithm      | Basic       |
| External Trigger                 | Calibration Target         | 150         |
| Image Buffer and ROI             | Calibration Sample Size    | 2048        |
| [-] Camera - CameraLink_1        | ROI Offset X               | 1           |
| Camera Information               | ROI Width                  | 4080        |
| Camera Control                   | Calibrate FPN              | Press...    |
| Digital IO Control               | Calibrate PRNU             | Press...    |
| Flat Field                       | Calibrate PRNU Status      | Good        |
| Image Format                     | Balance White Auto         | Press...    |
| Transport Layer                  | << Less                    |             |
| Acquisition and Transfer Control |                            |             |
| Serial Port                      |                            |             |
| File Access Control              |                            |             |

## Flat Field Control Feature Description

The following table describes these parameters along with their view attribute and minimum camera firmware version required. Additionally the firmware column will indicate which parameter is a member of the DALSA Features Naming Convention (DFNC), versus the GenICam Standard Features Naming Convention (SFNC not shown).

The Device Version number represents the camera software functional group, not a firm ware revision number.

| Display Name | Feature                 | Description                               | Device Version & View |
|--------------|-------------------------|---|-----------------------|
| Mode         | flatfieldCorrectionMode |   | 1.00                  |
| Off          | Off                     | FPN and flat field coefficients disabled. | Beginner              |

|  |   |   |                          |
|--|---|---|--------------------------|
| On   | On  | FPN and flat field coefficients enabled.  | DFNC                     |
| Initialize   | Initialize                                | Reset all FPN to 0 and all flat field coefficients to 1.  |                          |
| ScanDirectionControlled                                | ScanDirectionControlled                   | Different user set loaded depending on direction.   |                          |
| Select flatfield Correction Scan Direction Reverse Set | flatfieldScanDirectionReverseSet          | When flatfieldCorrectionMode is set to ScanDirectionControlled this feature selects the UserSet (1 to 8) which will be used for the reverse scan direction.   | 1.00<br>Beginner<br>DFNC |
| FlatField Calibration Color Selector                   | flatfieldCalibrationColorSelector         | Select which color or colors are the target of flat fielding control. Available in P4-CC-02K07N-01-R model only   | 1.00<br>Beginner<br>DFNC |
| Red<br>Green<br>Blue<br>NIR<br>RGB<br>All              | Red<br>Green<br>Blue<br>NIR<br>RGB<br>All |   |                          |
| Calibration Algorithm                                  | flatfieldCorrectionAlgorithm              | Selection between two different flat field algorithms.  | 1.00<br>Beginner<br>DFNC |
| Basic  | Basic                                     | Direct calculation of coefficients based on average line values and target. First each color is flat fielded to its peak value and then the color gains are used to achieve the target.   |                          |
| LowPass  | LowPass                                   | A low pass filter is first applied to the average line values before calculating the coefficients. Use this algorithm if the calibration target is not uniformly white or it is not possible to defocus the image. Because of the low pass filter this algorithm is not able to correct pixel-to-pixel variations and so it is preferable to use the “Basic” algorithm. |                          |
| Calibration Target                                     | flatfieldCalibrationTarget                | Set a value between 0 and 255 to which the flat field algorithm will target the image to.   | 1.00<br>Beginner<br>DFNC |
| Calibration Sample Size                                | flatfieldCalibrationSampleSize            | Sets the number of lines to be averaged during a flat field calibration   | 1.00<br>Beginner<br>DFNC |
| Lines_2048   | Lines_2048                                |   |                          |
| ROI Offset X   | flatfieldCalibrationROIOffsetX            | Set the starting point of a region of interest where a flat field calibration will be performed   | 1.00<br>Beginner<br>DFNC |

|                    |                              |   |                          |
|--------------------|------------------------------|---|--------------------------|
| ROI Width          | flatfieldCalibrationROIWidth | Sets the width of the region on interest where a flat field calibration will be performed | 1.00<br>Beginner<br>DFNC |
| Calibrate FPN      | flatfieldCalibrationFPN      | Initiates the FPN calibration process   | 1.00<br>Beginner<br>DFNC |
| Calibrate PRNU     | flatfieldCalibrationPRNU     | Initiates the PRNU or Flatfield process   | 1.00<br>Beginner<br>DFNC |
| Balance White Auto | BalanceWhiteAuto             | Initiates the process of balancing the colors to produce a white balance                  | 1.00<br>Beginner<br>DFNC |

## Region of Interest (ROI)

The ROI feature is related to flat field calibration. It is important to specify an ROI when the object being imaged has areas that have black, non illuminated areas such as beyond the edge of a film that is front illuminated, or is saturated, again beyond the edge of a film but in this case bright field back illuminated. The ROI feature allows from one to four specific regions of the pixel line to be specified where flat field calibration will take place. Pixel data outside the ROI will not be used when performing flat field calibration.

## Image Format Control Category

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

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.

Features listed in the description table but tagged as *Invisible* are usually for Teledyne DALSA or third party software usage—not typically needed by end user applications.



| Parameters                       |                    |            | × |
|----------------------------------|--------------------|------------|---|
| Category                         | Parameter          | Value      |   |
| [-] <b>Board</b>                 | Test Pattern       | Color_Ramp |   |
| Basic Timing                     | Line Mirroring     | Off        |   |
| Advanced Control                 | Pixel Format       | RGB8       |   |
| External Trigger                 | Pixel Coding       | Color      |   |
| Image Buffer and ROI             | Pixel Color Filter | None       |   |
|                                  | Width              | 4096       |   |
|                                  | WidthMax           | 4096       |   |
|                                  | Height             | 1          |   |
|                                  | Multiple AOI Mode  | Off        |   |
|                                  | AOI Count          | 1          |   |
|                                  | AOI Selector       | 1          |   |
|                                  | AOI Offset X       | 1          |   |
|                                  | AOI Width          | 4096       |   |
|                                  | << Less            |            |   |
| [-] <b>Camera - CameraLink_1</b> |                    |            |   |
| Camera Information               |                    |            |   |
| Camera Control                   |                    |            |   |
| Digital IO Control               |                    |            |   |
| Flat Field                       |                    |            |   |
| Image Format                     |                    |            |   |
| Transport Layer                  |                    |            |   |
| Acquisition and Transfer Control |                    |            |   |
| Serial Port                      |                    |            |   |
| File Access Control              |                    |            |   |

## Image Format Control Feature Description

The following table describes these parameters along with their view attribute and minimum camera firmware version required. Additionally the firmware column will indicate which parameter is a member of the DALSA Features Naming Convention (DFNC), versus the GenICam Standard Features Naming Convention (SFNC not shown).

The Device Version number represents the camera software functional group, not a firmware revision number.

| Display Name       | Feature           | Description  | Device Version & View    |
|--------------------|-------------------|--|--------------------------|
| Test Pattern       | TestImageSelector | Selects the type of test image that is sent by the camera. Choices are either as defined by SNFC and/ or as provided by the device manufacturer. | 1.00<br>Beginner<br>DFNC |
| Off                | Off               | Selects sensor video to be output from sensor  |                          |
| Ramp               | Ramp              | Selects a grey scale   |                          |
| Color_Ramp         | Color_Ramp        | Selects a color ramp   |                          |
| Line Mirroring     | ReverseX          |  | 1.00<br>Beginner<br>DFNC |
| Off                | Off               | Video output in normal order   |                          |
| On                 | On                | Video output in a reverse order  |                          |
| Pixel Format       | Pixel Format      | Output image pixel coding format of the sensor.  | 1.00<br>Beginner<br>DFNC |
| RGB8               | RGB8              | RGB 8bit   |                          |
| RGB10              | RGB10             | RGB 10bit  |                          |
| RGB12              | RGB12             | RGB 12bit  |                          |
| BGR8               | BGR8              | BGR 8bit   |                          |
| BGR10              | BGR10             | BGR 10bit  |                          |
| BGR12              | BGR12             | BGR 12bit  |                          |
| RGB8+mono8*        | RGB8+mono8*       | RGB 8bit plus mono 8 bit*  |                          |
| BGR8+mono8*        | BGR8+mono8*       | BGR 8bit plus mono 8 bit*  |                          |
| RGB12+mono12*      | RGB12+mono12*     | RGB 12bit plus mono 12 bit*  |                          |
| BGR12+mono12*      | BGR12+mono12*     | BGR 12bit plus mono 12 bit*  |                          |
| RGB8+NIR8**        | RGB8+ NIR8**      | RGB 8bit plus NIR 8 bit**  |                          |
| BGR8+ NIR8**       | BGR8+ NIR8**      | BGR 8bit plus NIR 8 bit**  |                          |
| RGB12+mono12**     | RGB12+NIR12**     | RGB 12bit plus NIR 12 bit**  |                          |
| BGR12+mono12**     | BGR12+NIR12**     | BGR 12bit plus NIR 12 bit**  |                          |
| Pixel Color Filter | PixelColorFilter  | Indicates the type of color filter applied to the image. (RO)  | 1.00<br>Beginner<br>DFNC |
| Pixel Coding       | PixelCoding       | (RO)   | 1.00<br>Beginner<br>DFNC |
| Width              | Width             | Width of the Image provided by the device (in pixels).(RO)   | 1.00<br>Beginner<br>DFNC |

|                                    |                                  |  |                          |
|------------------------------------|----------------------------------|--|--------------------------|
| Max Width                          | WidthMax                         | The maximum image horizontal dimension of the image. (RO)                                | 1.00<br>Beginner         |
| Height                             | Height                           | Height of the Image provided by the device (in lines). (RO)                              | 1.00<br>Beginner         |
| Multiple AOI Mode<br>Off<br>Active | multipleAOIMode<br>Off<br>Active | Turns on an output Area of Interest<br>Area of interest is off<br>Area of interest is on | 1.00<br>Beginner         |
| Multiple AOI Count                 | multipleAOICount                 | Set the number of output area of interest<br>1-4   | 1.00<br>Beginner<br>DFNC |
| Multiple AOI Selector              | multipleAOISelector              | Selects the area of interest to be setup   | 1.00<br>Beginner<br>DFNC |
| AOI Offset X                       | multipleAOIOffsetX               | Set the start of area of interest (pixels)   | 1.00<br>Beginner<br>DFNC |
| AOI Width                          | multipleAOIWidth                 | Set the width of area of interest (pixels)   | 1.00<br>Beginner         |

\*P4-CC-02K07Q-00-R

\*\*P4-CC-02K07N-01-R

## Area of Interest (AOI) Setup

The Area of Interest (AOI) feature can be used to reduce the amount of image-data output from the camera. Use this feature when there are areas in the image that contain unneeded information.

An example where you would use this feature is in an application that is inspecting several separated lanes of objects with one camera and the image between the lanes can be ignored.

The AOI feature allows from one to four specific areas of the pixel line to be specified where image data will be output. Since the AOI feature reduces the amount of data output, this has the additional benefit of allowing the cameras to operate at higher EXSYNC rates when using base, medium, or full camera link modes.

For example, if the total number of pixels for the specified AOI's is less than 1 K when using dual base Camera Link mode at 85 MHz, the maximum EXSYNC rate can be 70 KHz; versus 40 KHz if all 2K pixels were output.

**Note:** The setup of AOI is always with respect to the sensor. Therefore, if you are using the mirroring mode with AOI, be aware that pixel one will be on the right side of the displayed image.

### Custom AOI Rules

- 1) The sensor has pixels numbered 0 to 2048.
- 2) Three values (red, blue, green) are output per pixel in RGB mode.
- 3) Whether mirroring is on or off, 0 is the leftmost pixel.
- 4) Whether mirroring is on or off, AOI 1 is readout first.
- 5) In normal mode, AOI 1 is closest to the sensor's left edge.

- 6) In mirror mode, AOI 1 is closest to the sensor's right edge.

### In order to set up an AOI for the camera:

1. The AOI mode must first be in the off position.
2. Use the AOI Count to select the total number of AOIs desired to a max of 4.
3. To set up each AOI individual use the AOI Selector to point to the AOI to be set up.
4. AOI Offset X is used indicate the starting pixel of the AOI.
5. AOI Width is used to indicate the width of the AOI.

The screenshot shows the 'Parameters' window with the 'Camera - Camera' category selected. The 'Image Format' sub-category is expanded, showing various parameters. Five callouts provide instructions for setting up an AOI:

- 1. Must be off to set up the AOI.** Points to the 'Multiple AOI Mode' parameter, which is set to 'Off'.
- 2. Set up the number of AOI desired to max of 4.** Points to the 'AOI Count' parameter, which is set to '1'.
- 3. Select area to set up.** Points to the 'AOI Selector' parameter, which is set to '1'.
- 4. Select beginning of selected area** Points to the 'AOI Offset X' parameter, which is set to '1'.
- 5. Set up width of selected area** Points to the 'AOI Width' parameter, which is set to '2048'.

| Category        | Parameter         | Value      |
|-----------------|-------------------|------------|
| Board           | Test Pattern      | Color_Ramp |
|                 | Line Mirroring    | Off        |
|                 | Pixel Format      | RGB8       |
|                 | Color             | None       |
|                 | Width             | 4096       |
|                 | WidthMax          | 4096       |
|                 | Height            | 1          |
|                 | Multiple AOI Mode | Off        |
|                 | AOI Count         | 1          |
|                 | AOI Selector      | 1          |
| Camera - Camera | AOI Offset X      | 1          |
|                 | AOI Width         | 2048       |
|                 | << Less           |            |

## In order to initiate operation of the AOI once setup:

1. The AOI mode must be changed to Active.
2. Be sure to set the frame grabber image width to the sum of all AOI widths set up in the camera.

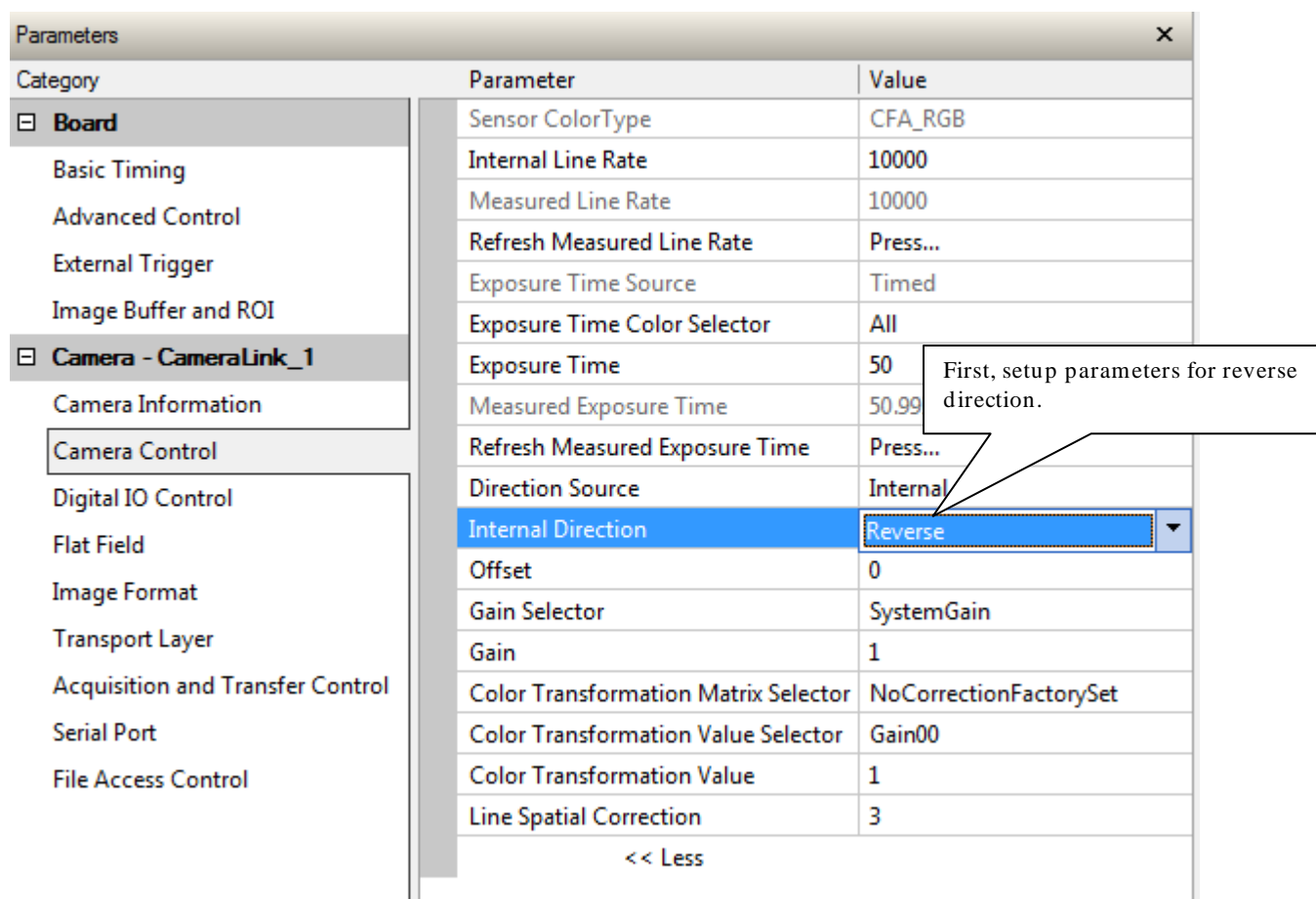
The screenshot shows the 'Parameters' dialog box with a tree view on the left and a list of parameters on the right. The 'Board' category is expanded, showing 'Basic Timing', 'Advanced Control', 'External Trigger', and 'Image Buffer and ROI'. The 'Camera - CameraLink\_1' category is also expanded, showing 'Camera Information', 'Camera Control', 'Digital IO Control', 'Flat Field', 'Image Format', 'Transport Layer', 'Acquisition and Transfer Control', 'Serial Port', and 'File Access Control'. The 'Image Format' category is selected, and the 'Width' parameter is highlighted. A callout box points to the 'Width' parameter with the text: 'Once all AOI are set up change to active.'

| Category              | Parameter          | Value     |
|-----------------------|--------------------|-----------|
| Board                 | Test Pattern       | Color_Ram |
|                       | Line Mirroring     | Off       |
|                       | Pixel Format       | RGB8      |
|                       | Pixel Coding       | Color     |
| Camera - CameraLink_1 | Pixel Color Filter | None      |
|                       | Width              | 4096      |
|                       | WidthMax           | 4096      |
|                       | Height             | 1         |
|                       | Multiple AOI Mode  | Off       |
|                       | AOI Count          | 1         |
|                       | AOI Selector       | 1         |
|                       | AOI Offset X       | 1         |
|                       | AOI Width          | 4096      |
|                       | << Less            |           |

# Instructions on using the camera scan direction to control camera parameters

The camera is capable of adjusting camera parameters on-the-fly based on the scan direction of the camera. These parameters include gain, flat field coefficients, white balance and exposure time.

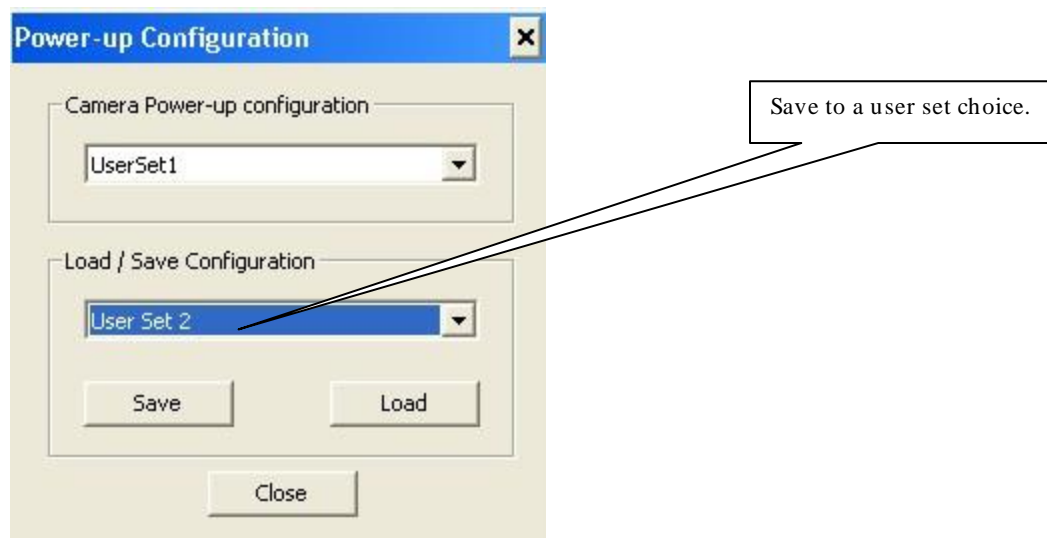
1. The first step is to put the camera in the reverse direction. This can be done using a reverse signal through CC3 and the Direction Source set to external or by having the Direction Source set to Internal and the Internal Direction set to reverse.
2. Set up all the desired parameters, including flat field corrections.



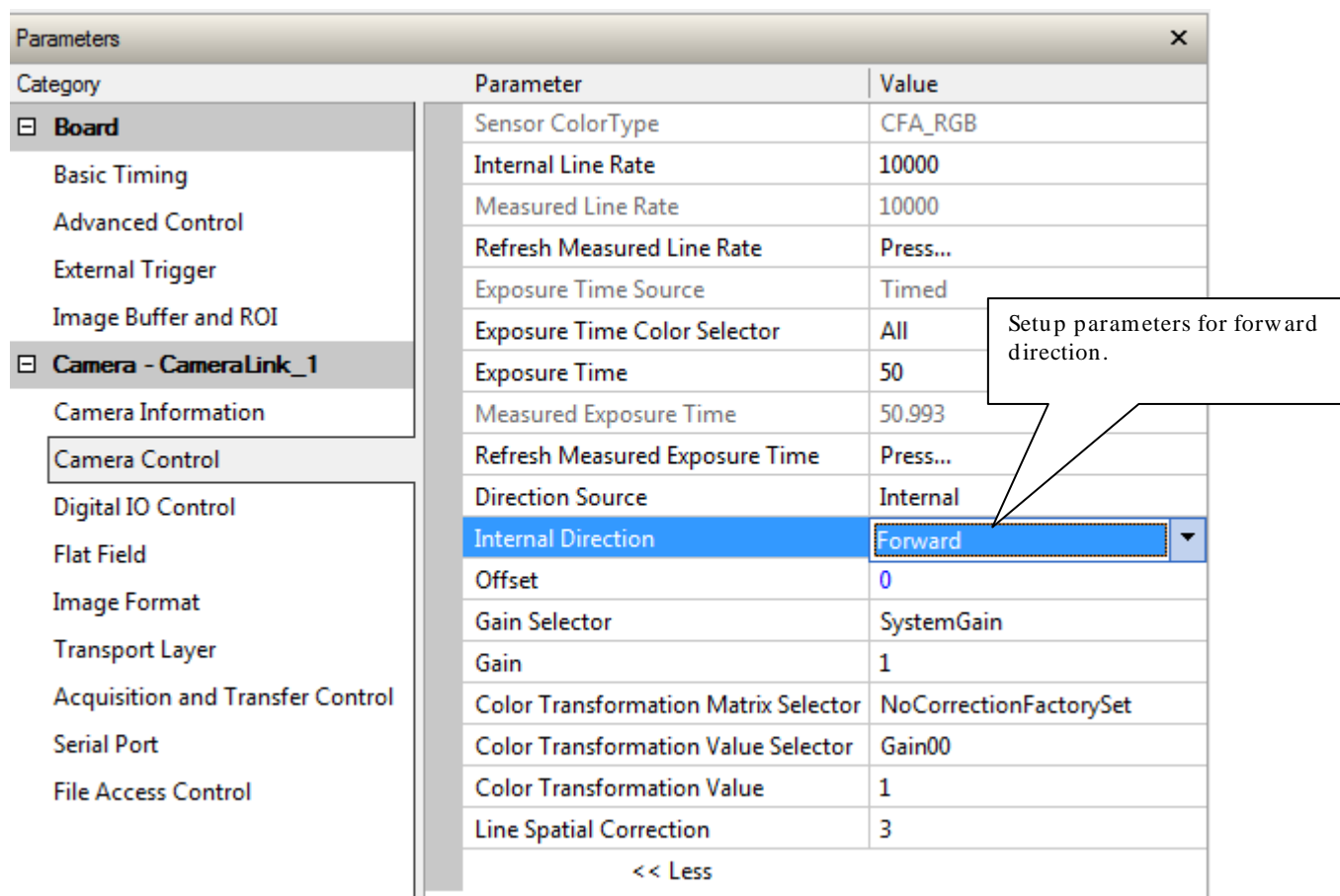
The screenshot shows the 'Parameters' window with a tree view on the left and a table of parameters on the right. The 'Camera - CameraLink\_1' category is selected. The 'Internal Direction' parameter is highlighted, and its value is 'Reverse'. A callout box points to the dropdown menu of 'Internal Direction' with the text: 'First, setup parameters for reverse direction.'

| Category              | Parameter                            | Value                  |
|-----------------------|--------------------------------------|------------------------|
| Board                 | Sensor ColorType                     | CFA_RGB                |
|                       | Internal Line Rate                   | 10000                  |
|                       | Measured Line Rate                   | 10000                  |
|                       | Refresh Measured Line Rate           | Press...               |
|                       | Exposure Time Source                 | Timed                  |
| Camera - CameraLink_1 | Exposure Time Color Selector         | All                    |
|                       | Exposure Time                        | 50                     |
|                       | Measured Exposure Time               | 50.99                  |
|                       | Refresh Measured Exposure Time       | Press...               |
|                       | Direction Source                     | Internal               |
|                       | Internal Direction                   | Reverse                |
|                       | Offset                               | 0                      |
|                       | Gain Selector                        | SystemGain             |
|                       | Gain                                 | 1                      |
|                       | Color Transformation Matrix Selector | NoCorrectionFactorySet |
|                       | Color Transformation Value Selector  | Gain00                 |
|                       | Color Transformation Value           | 1                      |
|                       | Line Spatial Correction              | 3                      |
|                       | << Less                              |                        |

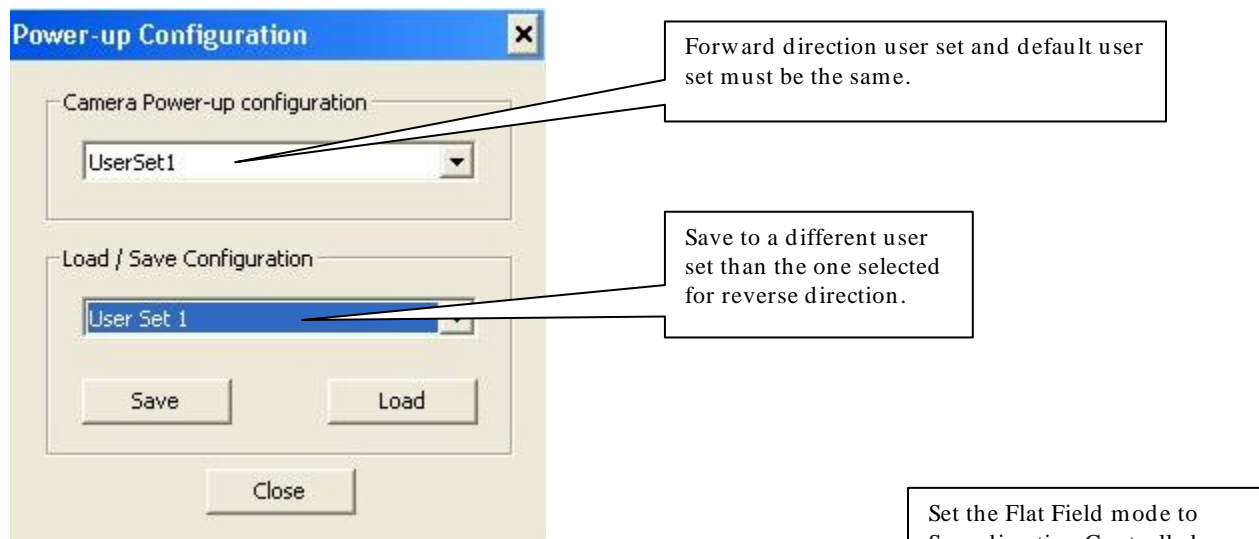
3. Save the camera parameters to a User set other than the default user set.



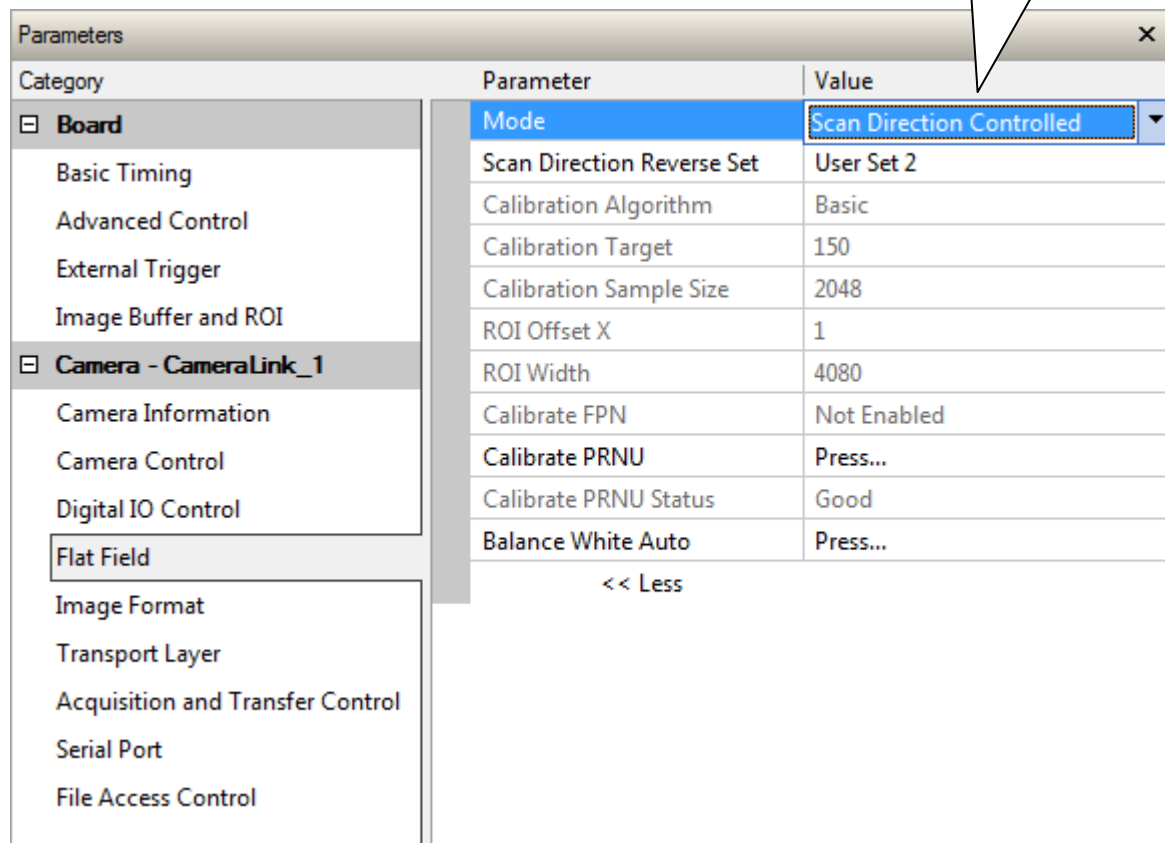
4. The next step is to put the camera in the forward direction. This can be done using a forward signal through CC3 and the Direction Source set to external or by having the Direction Source set to Internal and the Internal Direction set to forward.
5. Set up all the desired parameters including doing a flat field.



- Save the camera set to User Set other than the saved to for the reverse direction. The forward direction user set and the default user set must be the same.



- In the Flat Field area change the mode to Scan Direction Controlled.





## A Note on External Direction, Direction Source, and User Sets

If using external direction control through CC3 ensure that the Direction Source is both set to external and saved in the user set. Also ensure that the polarity on CC3 is set appropriately for the desired direction.

# Transport Layer Control Category

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.

Features listed in the description table but tagged as *Invisible* are usually for Teledyne DALSA or third party software usage—not typically needed by end user applications.

| Parameters                       |                            |              | × |
|----------------------------------|----------------------------|--------------|---|
| Category                         | Parameter                  | Value        |   |
| [-] Board                        | Restart Camera             | Press...     |   |
| Basic Timing                     | XML Major Version          | 0            |   |
| Advanced Control                 | XML Minor Version          | 0            |   |
| External Trigger                 | Refresh GenCP Status       | Press...     |   |
| Image Buffer and ROI             | Last GenCP Status          | 0            |   |
| [-] Camera - CameraLink_1        | CameraLink Clock Frequency | CL85MHz      |   |
| Camera Information               | Camera Link Configuration  | Medium       |   |
| Camera Control                   | Tap Geometry               | Geometry_1X6 |   |
| Digital IO Control               | << Less                    |              |   |
| Flat Field                       |                            |              |   |
| Image Format                     |                            |              |   |
| Transport Layer                  |                            |              |   |
| Acquisition and Transfer Control |                            |              |   |
| Serial Port                      |                            |              |   |
| File Access Control              |                            |              |   |

## Transport Layer Feature Descriptions

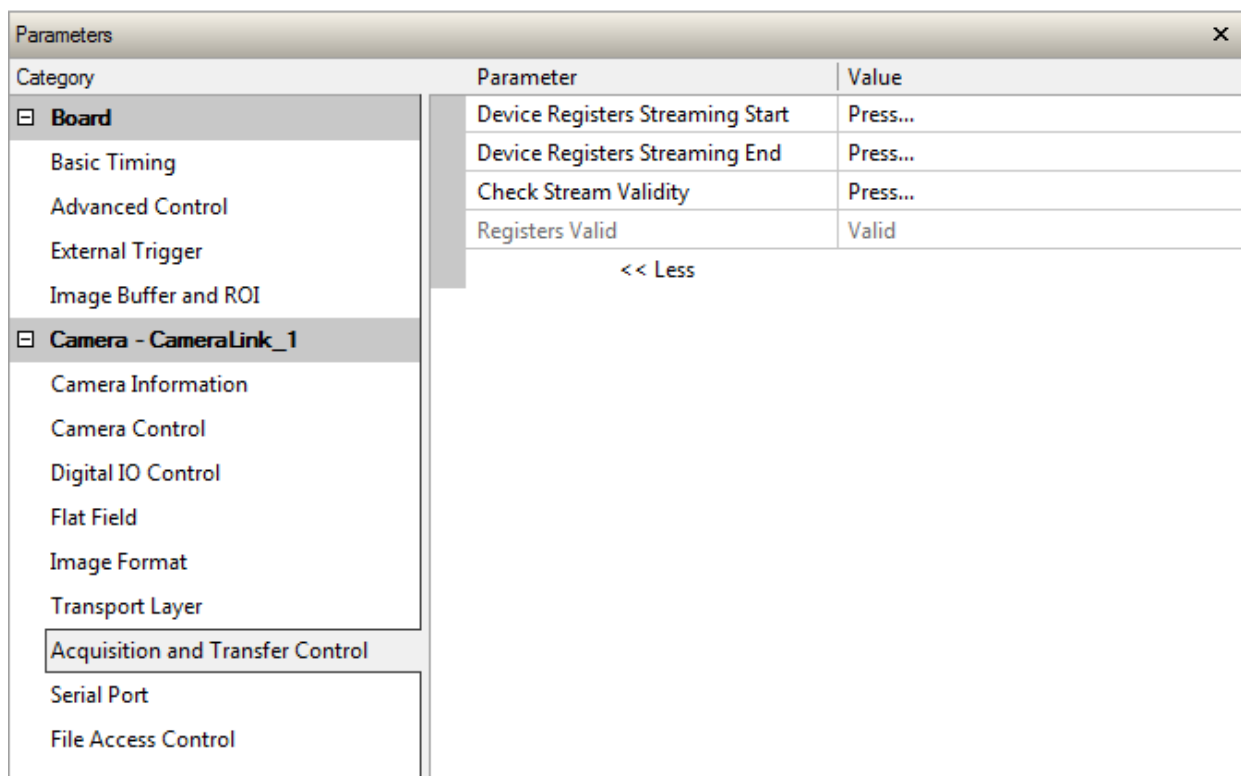
The following table describes these parameters along with their view attribute and minimum camera firmware version required. Additionally the firmware column will indicate which parameter is a member of the DALSA Features Naming Convention (DFNC), versus the GenICam Standard Features Naming Convention (SFNC not shown).

| Display Name              | Feature   | Description  | Device Version & View    |
|---------------------------|---|--|--------------------------|
| Restart Camera            | DeviceReset                                       | Used to restart the camera, warm reset   | 1.00<br>Beginner<br>DFNC |
| XML Major Version         | DeviceManifestXMLMajorVersion                     | Together with DeviceManifestXMLMinorVersion specifies the GenICam™ feature description XML file version (RO)   | 1.00<br>Beginner<br>DFNC |
| XML Minor Version         | DeviceManifestXMLMinorVersion                     | Together with DeviceManifestXMLMajorVersion specifies the GenICam™ feature description XML file version (RO)   | 1.00<br>Beginner<br>DFNC |
| Last GenCP Status         | genCPStatus                                       | If a feature read or write fails then Samera only returns that it fails – read this feature to get the actual reason for the failure<br>Returns the last error<br>Reading this feature clears it | 1.00<br>Beginner<br>DFNC |
| Refresh GenCP Status      | refreshGenCPStatus                                | Press to return the current status of the GenCP  | 1.00<br>Beginner         |
| Camera Link Configuration | ClConfiguration<br>Base<br>Medium<br>Full<br>Deca | Camera Link Output configuration   | 1.00<br>Beginner         |
| Camera Link Configuration | clDeviceClockFrequency<br>CL85MHz<br>CL66MHz      | Set the camera link clock rate   | 1.00<br>Beginner         |
| Tap Geometry              | DeviceTapGeometry                                 | (RO)   | 1.00<br>Beginner         |

# Acquisition and Transfer Control Category

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

Features listed in the description table but tagged as *Invisible* are usually for Teledyne DALSA or third party software usage—not typically needed by end user applications.



## Acquisition and Transfer Control Feature Descriptions

The following table describes these parameters along with their view attribute and minimum camera firmware version required. Additionally the firmware column will indicate which parameter is a member of the DALSA Features Naming Convention (DFNC), versus the GenICam Standard Features Naming Convention (SFNC not shown).

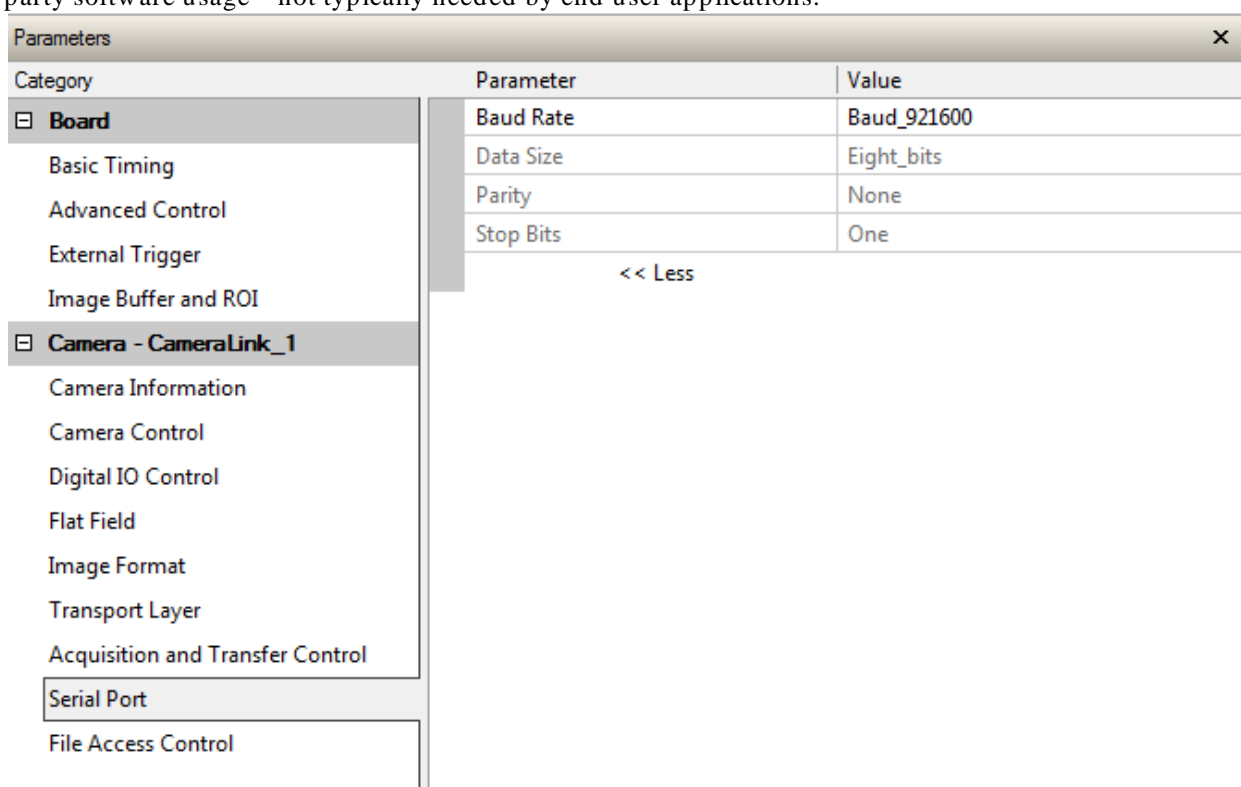
| Display Name                     | Feature                       | Description  | Device Version & View    |
|----------------------------------|-------------------------------|--|--------------------------|
| Device Registers Streaming Start | DeviceRegistersStreamingStart | Announces the start of registers streaming without immediate checking for consistency.                         | 1.00<br>Beginner<br>DFNC |
| Device Registers Streaming End   | DeviceRegistersStreamingEnd   | Announces end of registers streaming and performs validation for registers consistency before activating them. | 1.00<br>Beginner<br>DFNC |

|                       |                      |   |                          |
|-----------------------|----------------------|---|--------------------------|
| Check Stream Validity | DeviceRegistersCheck | Press to check the validity of the current register set.    | 1.00<br>Beginner<br>DFNC |
| Registers Valid       | DeviceRegistersValid | States if the current register set is valid and consistent. | 1.00<br>Beginner<br>DFNC |

## Serial Port Control Category

The Serial Port control in CamExpert allows the user to select an available camera serial port and review its settings.

Features listed in the description table but tagged as *Invisible* are usually for Teledyne DALSA or third party software usage—not typically needed by end user applications.



## Serial Port Control Feature Descriptions

The Device Version number represents the camera software functional group, not a firm ware revision number.

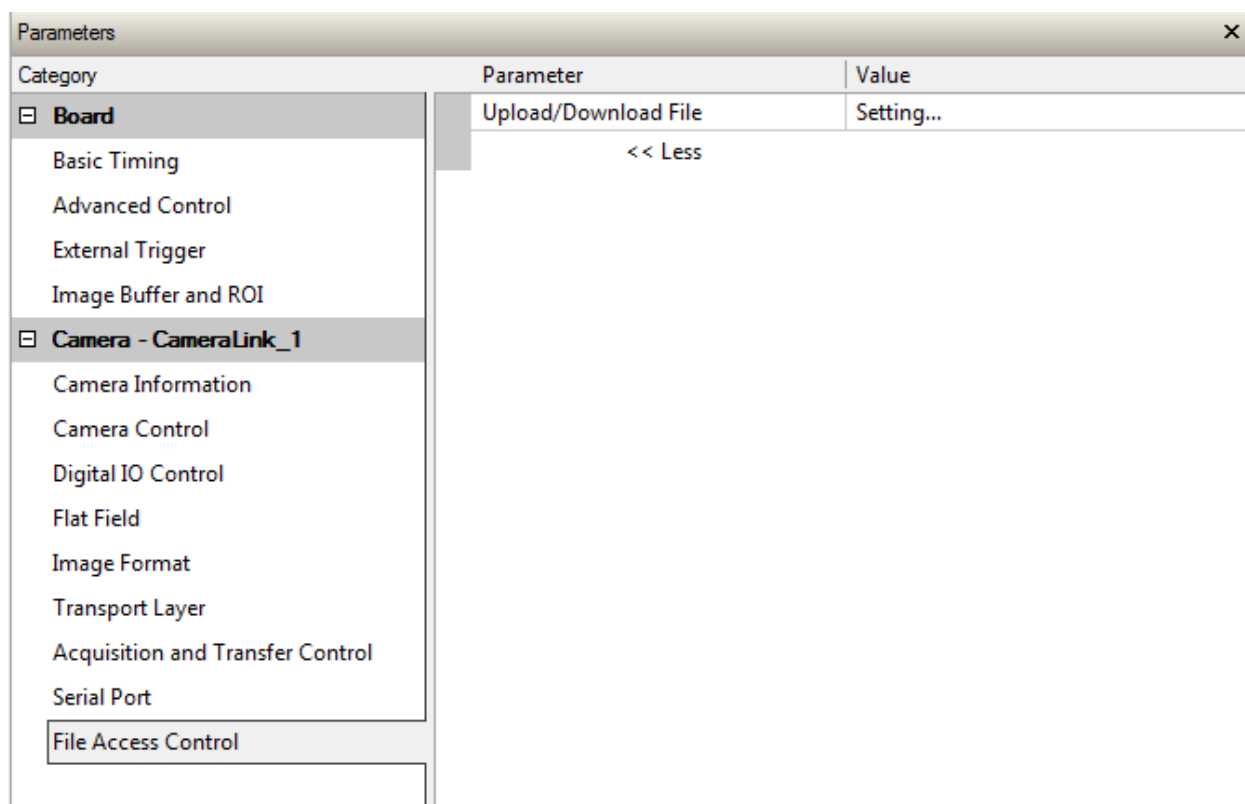
| Display Name | Feature                  | Description   | View                     |
|--------------|--------------------------|---|--------------------------|
| Baud Rate    | DeviceSerialPortBaudRate | Sets the baud rate used by the selected device's serial port. Available baud rates are device-specific. | 1.00<br>Beginner<br>DFNC |

|                    |                          |  |                          |
|--------------------|--------------------------|--|--------------------------|
| Baud 9600          | Baud 9600                | Baud rate is 9600  |                          |
| Baud 19200         | Baud 19200               | Baud rate is 19200   |                          |
| Baud 57600         | Baud 57600               | Baud rate is 57600   |                          |
| Baud 115200        | Baud 115200              | Baud rate is 115200  |                          |
| Baud 230400        | Baud 230400              | Baud rate is 230400  |                          |
| Baud 460800        | Baud 460800              | Baud rate is 460800  |                          |
| Serial Port Parity | deviceSerialPortParity   | Sets the parity checking type on the selected serial port.(RO) | 1.00<br>Beginner<br>DFNC |
| None               | None                     | Parity checking is disabled                                    |                          |
| Data Size          | deviceSerialPortDataSize | Sets the bits per character (bpc) to use (RO).                 | 1.00<br>Beginner<br>DFNC |
| Eight Bits         | bpc8                     | Use 8 bits per character                                       |                          |
| Stop Bits          | deviceSerialPortNumberOf | Sets the number of stop bits to use.                           | 1.00<br>Beginner<br>DFNC |
| Stopbits1          | Stopbits1                | Use 1 stop bit   |                          |

## File Access Control Category

The File Access control in CamExpert allows the user to quickly upload various data files to the connected camera. The supported data files are for camera firmware updates, Flat Field coefficients, LUT data tables, and a custom image for use as an internal test pattern.

Features listed in the description table but tagged as *Invisible* are usually for Teledyne DALSA or third party software usage—not typically needed by end user applications.



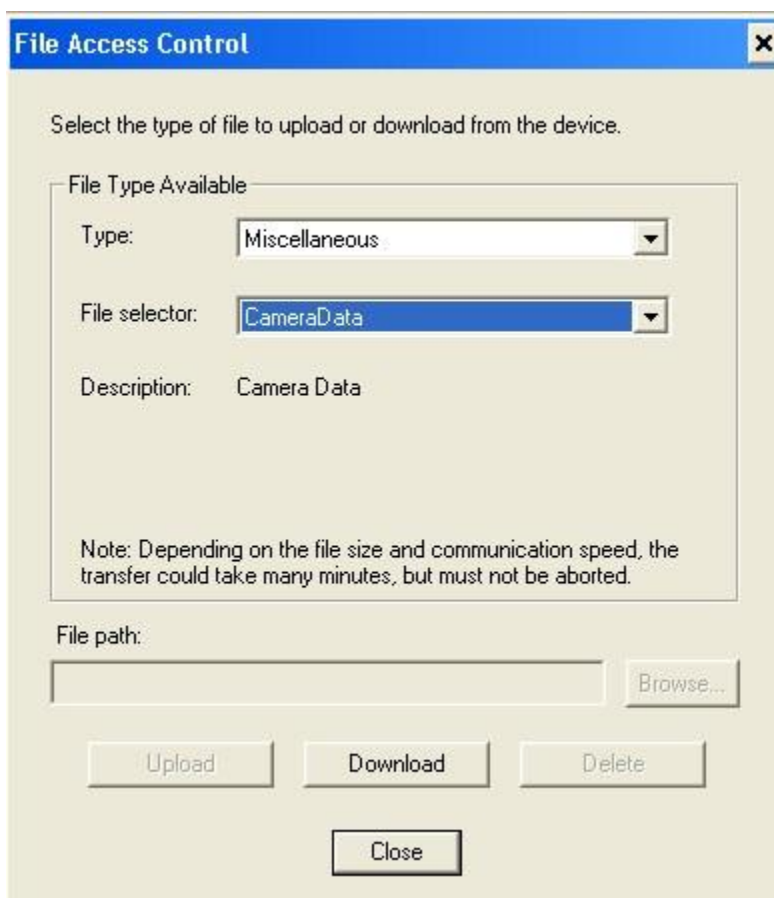
## File Access Control Feature Descriptions

| Display Name                   | Feature               | Description   | View             |
|--------------------------------|-----------------------|---|------------------|
| File Selector                  | FileSelector          | Selects the file to access. The file types which are accessible are device-dependent.   | 1.00<br>Beginner |
| FPGA Code                      | Firm ware1            | Upload new FPGA to the camera which will execute on the next camera reboot cycle.   | DFNC             |
| Micro Code                     |                       | Upload new micro codeto the camera which will execute on the next camera reboot cycle.  |                  |
| CCI                            |                       | Upload new CCI to the camera which will execute on the next camera reboot cycle.  |                  |
| XML                            |                       | Upload new XML to the camera which will execute on the next camera reboot cycle.  |                  |
| User Set                       |                       | Use UserSetSelector to specify which user set to access.  |                  |
| Factory FlatField coefficients |                       | Use UserSetSelector to specify which user flatfield to access.  |                  |
| User FPN                       |                       | Use UserSetSelector to specify which user FPN to access.  |                  |
| ColorCorrectionMatrix          |                       | Upload new color correction matrix to the camera.   |                  |
| CameraData                     |                       | Download camera information and send for customer support.  |                  |
| File Operation Selector        | FileOperationSelector | Selects the target operation for the selected file in the device. This operation is executed when the File Operation Execute feature is called. | 1.00<br>Guru     |
| Open                           | Open                  | Select the Open operation - executed by FileOperationExecute.   |                  |
| Close                          | Close                 | Select the Close operation - executed by FileOperationExecute.  |                  |
| Read                           | Read                  | Select the Read operation - executed by FileOperationExecute.   |                  |
| Write                          | Write                 | Select the Write operation - executed by FileOperationExecute.  |                  |
| Delete                         | Delete                | Select the Delete operation - executed by FileOperationExecute.   |                  |
| File Operation Execute         | FileOperationExecute  | Executes the operation selected by File Operation Selector on the selected file.  | 1.00<br>Guru     |
| File Open Mode                 | FileOpenMode          | Selects the access mode used to open a file on the device.  | 1.00<br>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.                    | 1.00<br>Guru     |
| File Access Offset             | FileAccessOffset      | Controls the mapping offset between the device file storage and the file access buffer.   | 1.00<br>Guru     |
| File Access Length             | FileAccessLength      | Controls the mapping length between the device file storage and the file access buffer.   | 1.00<br>Guru     |

|                       |                     |  |              |
|-----------------------|---------------------|--|--------------|
| File Operation Status | FileOperationStatus | Displays the file operation execution status. (RO).  | 1.00<br>Guru |
| Success               | Success             | The last file operation has completed successfully.  |              |
| Failure               | Failure             | The last file operation has completed unsuccessfully for an unknown reason.  |              |
| File Unavailable      | FileUnavailable     | The last file operation has completed unsuccessfully because the file is currently unavailable.                                    |              |
| File Invalid          | FileInvalid         | The last file operation has completed unsuccessfully because the selected file is not present in this camera model.                |              |
| File Operation Result | FileOperationResult | Displays the file operation result. For Read or Write operations, the number of successfully read/ written bytes is returned. (RO) | 1.00<br>Guru |
| File Size             | FileSize            | Represents the size of the selected file in bytes.   | 1.00<br>Guru |

## File Access via the CamExpert Tool

1. Click on the “Setting...” button to show the file selection menu.



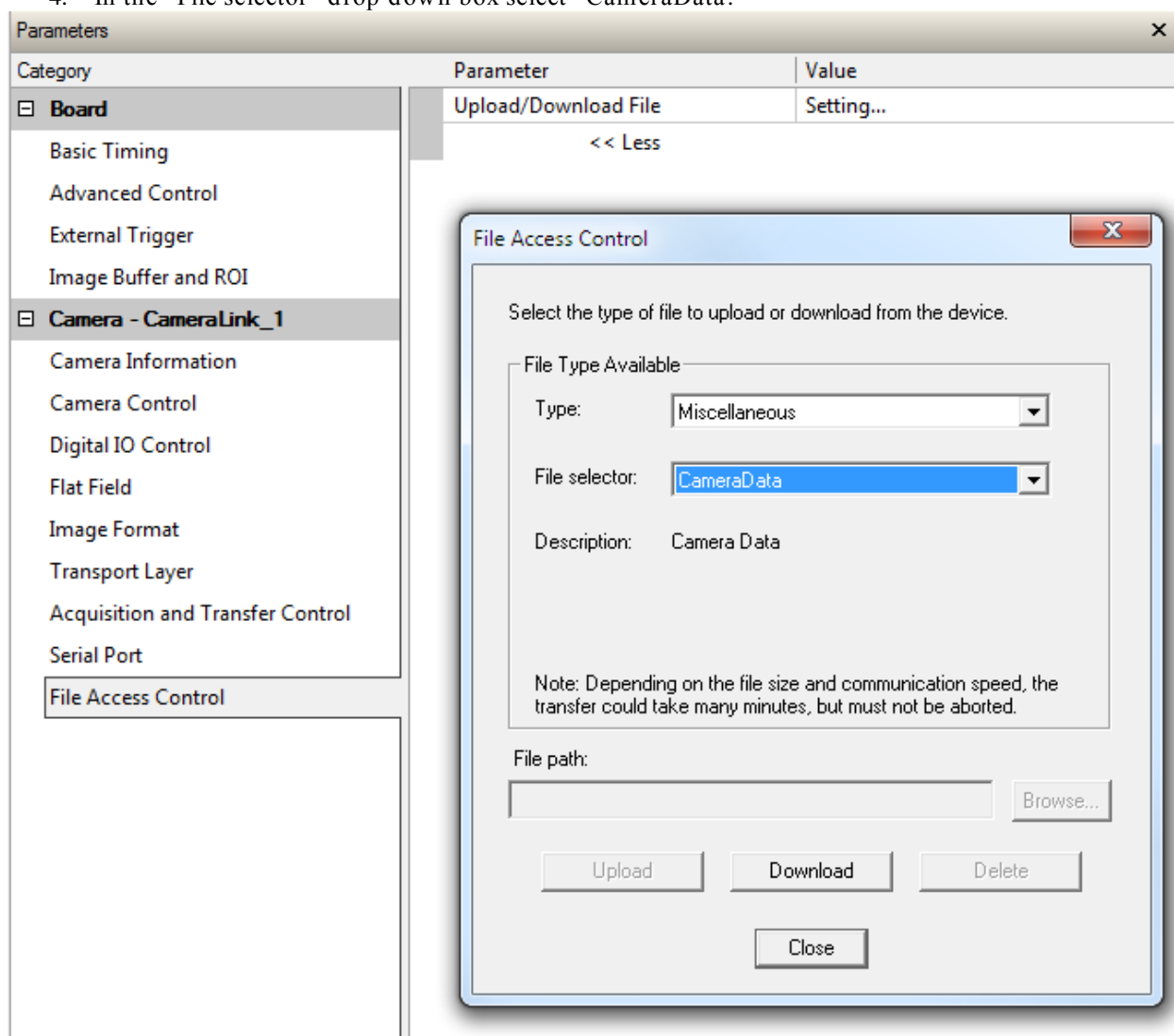
2. From the Type drop menu, select the file type that will be uploaded to the camera.

3. From the File Selector drop menu, select the camera memory location for the uploaded data. This menu presents only the applicable data locations for the selected file type.
4. Click the Browse button to open a typical Windows Explorer window.
5. Select the specific file from the system drive or from a network location.
6. Click the Upload button to execute the file transfer to the camera.
7. Note that firmware changes require a device reset command from the Camera Information Controls and, additionally, CamExpert should be shutdown and restarted following a reset.

## Download a List of Camera Parameters

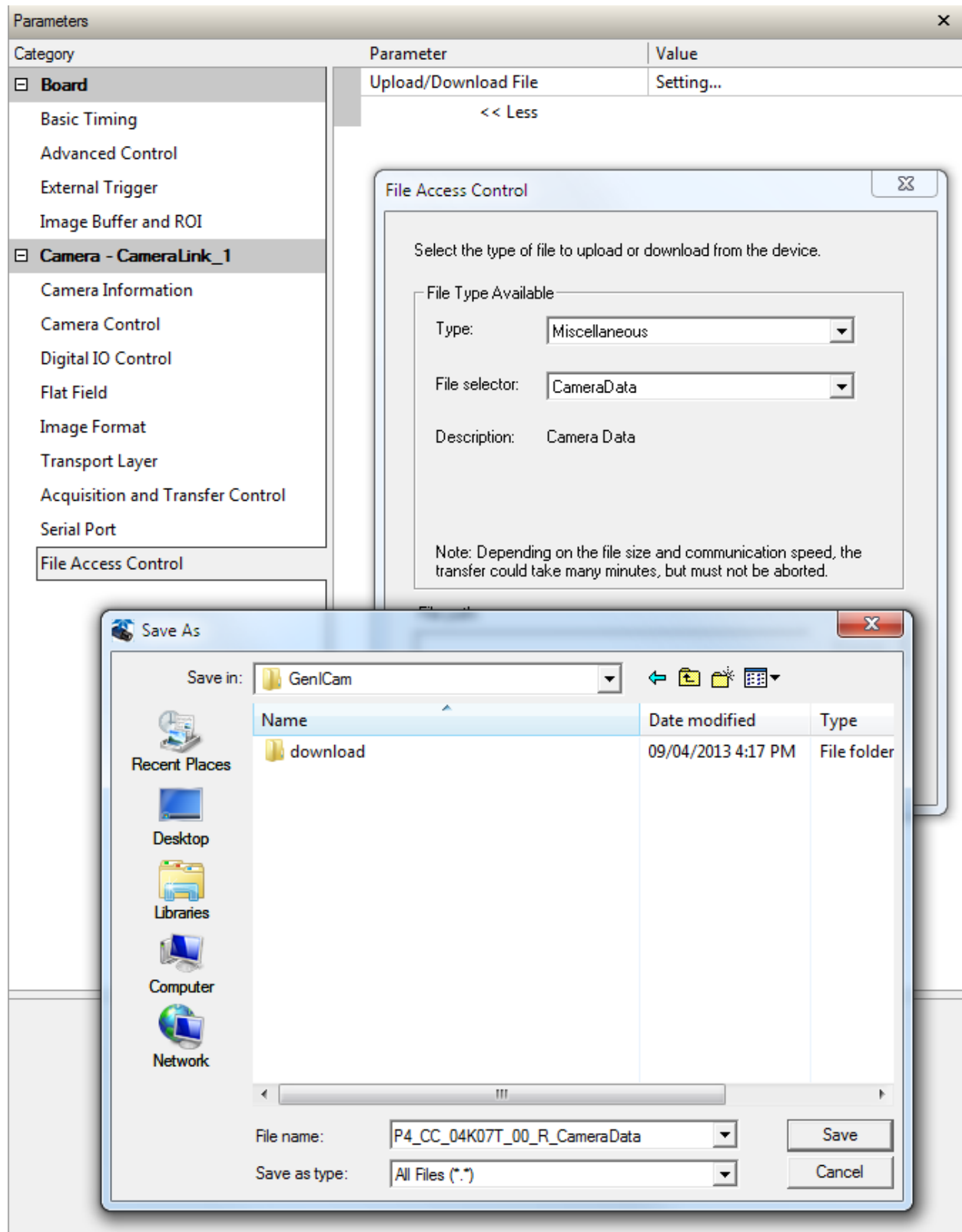
For diagnostic purposes you may want to download a list of all the parameters and values associated with the camera.

1. Go to File Access Control
2. Click on Settings
3. In the “Type” drop down box select “Miscellaneous.”
4. In the “File selector” drop down box select “CameraData.”



5. Hit “Download”
6. Save the text file and send the file to Teledyne DALSA customer support.





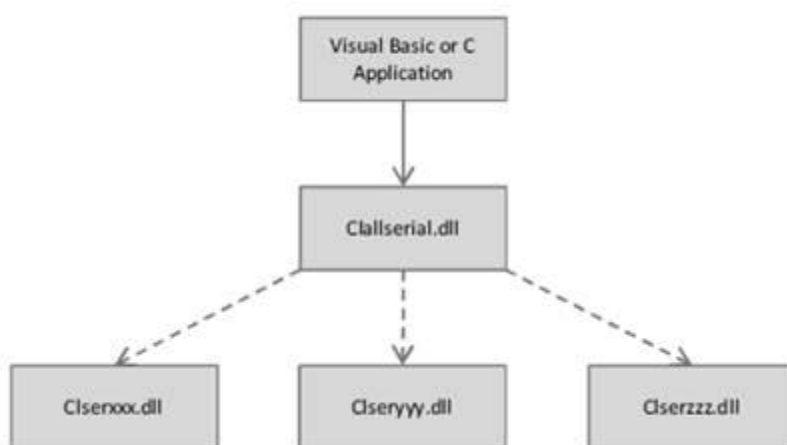
# Appendix B: ASCII Commands

The following commands can be used to control the Teledyne DALSA Piranha4 cameras.

## Accessing the Three Letter Commands (TLC)

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

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



**Figure 25: 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
  - local echo
  - (carriage return / linefeed)
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 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: “←”.

## ASCII to GenCP

To switch from the ASCII-command interface to the GenCP interface, the camera must be either reset (RC) or the power must be cycled. Note that GenCP and ASCII commands cannot be accessed simultaneously.

**Note that the HyperTerminal application is not available on the Windows 7 OS.**

### Alternatives to HyperTerminal

The following alternative ASCII-interfaces have been tested and shown to work with this camera: PuTTY and TeraTerm. Note that PuTTY does not have Xmodem capability while TeraTerm does. Xmodem is required to update code in the camera.

TeraTerm <http://logmett.com/index.php?download/tera-term-473-freeware.html>

PuTTY <http://putty.en.softonic.com/>

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 not case sensitive
- One command and argument(s) per line
- To enter a floating point number prefix it with a “F” – for example “ssg 0 f1.5”
- Error codes returned are the same as the GenICam™ interface – see Diagnostics | Error Codes
- Follow each command with the carriage return character – 0x0D

## Commands

|                    |   |  |
|--------------------|---|--|
| <b>Full Name</b>   | <b>Balance White Auto</b>   |  |
| <b>Mnemonic</b>    | <b>BWA</b>  |  |
| <b>Argument(s)</b> |   |  |
| <b>Description</b> | Perform automatic white balance   |  |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Gain each color such that the average of each is at the same level as the average of the most responsive.</li> </ul> |  |

|                    |  |  |
|--------------------|--|--|
| <b>Full Name</b>   | <b>Calibrate User FPN</b>                        |  |
| <b>Mnemonic</b>    | <b>CCF</b>                                       |  |
| <b>Argument(s)</b> | # of lines to average                            | <ul style="list-style-type: none"> <li>2048</li> </ul> |
| <b>Description</b> | Calibrate user FPN dark flat field coefficients. |  |

|                    |                             |                        |
|--------------------|-----------------------------|------------------------|
| <b>Full Name</b>   | <b>Camera Link Speed</b>    |                        |
| <b>Mnemonic</b>    | <b>CLS</b>                  |                        |
| <b>Argument(s)</b> | Frequency                   | 0. 85 MHz<br>1. 66 MHz |
| <b>Description</b> | Camera Link clock frequency |                        |

|                    |                         |  |
|--------------------|-------------------------|--|
| <b>Full Name</b>   | <b>Camera Link Mode</b> |  |
| <b>Mnemonic</b>    | <b>CLM</b>              |  |
| <b>Argument(s)</b> | Mode                    | 0. Base<br>1. Medium<br>2. Full<br>3. Deca<br>4. Dual Base |
| <b>Description</b> | Camera Link Mode        |  |

|                    |                              |   |
|--------------------|------------------------------|---|
| <b>Full Name</b>   | <b>Color Matrix Selector</b> |   |
| <b>Mnemonic</b>    | <b>CMS</b>                   |   |
| <b>Argument(s)</b> | Device                       | 0. Factory<br>1. User   |
|                    | # of lines to average        | 0 or 1, when factory selected above then<br>2. White LED<br>3. No correction (unity matrix) |
| <b>Description</b> | Color matrix selector        |   |

|                    |  |  |
|--------------------|--|--|
| <b>Full Name</b>   | <b>Calibrate Flatfield</b>   |  |
| <b>Mnemonic</b>    | <b>CPA</b>   |  |
| <b>Argument(s)</b> | Algorithm  | 0. Basic<br>1. Low-pass filter                         |
|                    | # of lines to average  | <ul style="list-style-type: none"> <li>2048</li> </ul> |
|                    | Target   | 0 to 255   |
| <b>Description</b> | Calibrate user PRNU flat field coefficients  |  |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Coefficients are saved and loaded with user set (e.g. USS / USL)</li> <li>Basic algorithm flattens each color and then uses color gains to achieve target</li> <li>Whereas low-pass filter algorithm does not adjust color gains</li> </ul> |  |

|                    |  |   |
|--------------------|--|---|
| <b>Full Name</b>   | <b>Color Transformation Value</b>  |   |
| <b>Mnemonic</b>    | <b>CTV</b>   |   |
| <b>Argument(s)</b> | Selector   | 0. $c_{rr}$ gain<br>1. $c_{rg}$ gain<br>2. $c_{rb}$ gain<br>3. $c_{gr}$ gain<br>4. $c_{gg}$ gain<br>5. $c_{gb}$ gain<br>6. $c_{br}$ gain<br>7. $c_{bg}$ gain<br>8. $c_{bb}$ gain<br>9. $k_r$ offset<br>10. $k_g$ offset<br>11. $k_b$ offset |
|                    | Floating Point Value   | <ul style="list-style-type: none"> <li>Gains: -16 to +16</li> <li>Offsets: 0 to 255</li> </ul>  |
| <b>Description</b> | Color Transformation Matrix  |   |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Value must be immediately preceded with a "F" (e.g. <code>ctv 0 f1.5</code>)</li> </ul> |   |

|                    |   |   |
|--------------------|---|---|
| <b>Full Name</b>   |   |   |
| <b>Mnemonic</b>    | <b>FCS</b>  |   |
| <b>Argument(s)</b> | File selector   | 0. User Set<br>1. User PRNU<br>3. FPGA<br>4. Microcode<br>5. CCI<br>6. XML<br>15. User FPN<br>16. Color correction matrix |
| <b>Description</b> | <ul style="list-style-type: none"> <li>• Upload file to camera using Xmodem protocol (HyperTerminal)</li> <li>• User set, PRNU, FPN, and color correction matrix are saved in the currently active set</li> <li>• Location to save color correction matrix is specified with CMS command</li> </ul> |   |
| <b>Notes</b>       | 1. Enter "FCS <#>" command from HyperTerminal<br>2. Click on "Transfer"<br>3. Browse and find file<br>4. Select "Xmodem" protocol<br>5. Click "Send"<br>6. When it indicates that it is done click "Close"<br>7. Upload all files and then reset camera   |   |

|                    |                       |  |
|--------------------|-----------------------|--|
| <b>Full Name</b>   | <b>Flatfield Mode</b> |  |
| <b>Mnemonic</b>    | <b>FFM</b>            |  |
| <b>Argument(s)</b> | Mode                  | 0. Disable use of user FPN and PRNU flat field correction coefficients<br>1. Enable use of user FPN and PRNU flat field correction coefficients<br>2. Reset user FPN coefficients to zero and user PRNU coefficients to one<br>3. Scan direction controlled user set loading |
| <b>Description</b> | Set flat field mode   |  |
| <b>Notes</b>       |                       |  |

|                    |   |        |
|--------------------|---|--------|
| <b>Full Name</b>   | <b>Set Flatfield Scan Direction Reverse Set</b> |        |
| <b>Mnemonic</b>    | <b>FRS</b>                                      |        |
| <b>Argument(s)</b> | User Set Number                                 | 1 to 8 |
| <b>Description</b> | Set scan direction controlled reverse set       |        |
| <b>Notes</b>       |   |        |

|                    |  |
|--------------------|--|
| <b>Full Name</b>   | <b>Display Camera Configuration</b>  |
| <b>Mnemonic</b>    | <b>GCP</b>   |
| <b>Argument(s)</b> |  |
| <b>Description</b> | Display current value of camera configuration parameters   |
| <b>Notes</b>       | <pre> USER&gt;gcp Model          P4_CC_02K07Q_00_R Microcode      03-081-20294-92 CCI            03-110-20300-93 FPGA           03-056-20457-99 Serial #       19620110 User ID BiST:          Good  DefaultSet     1 Ext Trig       Off Line Rate      10000 [Hz] Meas L.R.      10000 [Hz] Max L.R.       19047 [Hz] Exp. Mode      Timed Exp. Red Time  49000 [ns] Exp. Gr. Time  50000 [ns] Exp. Bl. Time  51000 [ns] Exp. Mono Time 5000 [ns] Meas E.T.      51000 [ns] Max E.T.       98500 [ns]  Test Pat.      0:Off Direction      Internal, Forward Line Delay     2.00 Flat Field     Off Color Plane Selector: All Offset         0 System Gain    1.00 Red Gain       1.00 Green Gain     1.00 Blue Gain      1.00 Mono Gain      1.00 Color Matrix Selector: Factory 2 Color Correction Matrix: 1.000000, 0.000000, 0.000000, 0                         0.000000, 1.000000, 0.000000, 0                         0.000000, 0.000000, 1.000000, 0  Mirror         Off AOI Mode:      Off CL Speed       85MHz CL Config      Dual Base Pixel Fmt      RGB8 CPA ROI        1-2048 USER&gt; </pre> |

|                    |  |
|--------------------|--|
| <b>Full Name</b>   | <b>Get Value</b>   |
| <b>Mnemonic</b>    | <b>GET</b>   |
| <b>Argument(s)</b> | <'parameter'>  |
| <b>Description</b> | The “get” command displays the current value(s) of the feature specified in the string parameter. Note that the parameter is preceded by a single quote “'”. Using this command will be easier for control software than parsing the output from the “gcp” |

|              | command.                |  |
|--------------|-------------------------|--|
| <b>Notes</b> | User>get `ssf`<br>10000 |  |
|              | Short                   | Full Name                      Displayed Value and Description                               |
|              | bwa                     | Balance white auto              No value returned  |
|              | ccf                     | Calibrate User FPN              No value returned  |
|              | cls                     | Camera Link Speed              0: 85MHz or 1: 66 MHz   |
|              | clm                     | Camera Link Mode              0: Base 1: Med 2: Full 3: Deca                                 |
|              | cms                     | Color matrix                    0: Factory1, 1: Factory2, 2: User1, 3: User2                 |
|              | cpa                     | Calibrate Flatfield              No value returned   |
|              | ctv                     | Color Transformation Value      12 lines, floating point values                              |
|              |                         | Gain 00  |
|              |                         | Gain 01  |
|              |                         | Gain 02  |
|              |                         | Gain 10  |
|              |                         | Gain 11  |
|              |                         | Gain 12  |
|              |                         | Gain 20  |
|              |                         | Gain 21  |
|              |                         | Gain 22  |
|              |                         | Offset 1   |
|              |                         | Offset 2   |
|              |                         | Offset 3   |
|              | ffm                     | Flat Field Mode                0: Off, 1: On, 3: Scan direction controlled                   |
|              | frs                     | Flat Field Reverse Set          Set number 0-8   |
|              | gcp                     | Camera Configuration          No value returned  |
|              | h                       | Help                              No value returned  |
|              | rc                      | Reset Camera                    No value returned  |
|              | roi                     | Region of Interest              Start pixel and end pixel numbers                            |
|              | rpc                     | Reset Pixel Coefficients        No value returned  |
|              | sac                     | Set AOI Count                   Number of AOI's 1-4  |
|              | sad                     | Last AOI Set                    AOI 1 Offset   |
|              |                         | AOI 1 Width  |
|              |                         | AOI 2 Offset   |
|              |                         | AOI 2 Width  |
|              |                         | ...  |
|              | sam                     | Set AOI Mode                    0: Disabled, 1: Enabled                                      |
|              | sbr                     | Set Baud Rate                   No value returned  |
|              | scd                     | Scan Direction                  0: Internal, 1: External (CC3) control                       |
|              |                         | 0: Forward, 1: Reverse   |
|              | sem                     | Exposure Mode                  0: Internal, 1: External                                      |
|              | set                     | Exposure Time                  ns  |
|              | smm                     | Mirroring Mode                  0: Enabled, 1: Disabled                                      |
|              | spf                     | Pixel Format                    0: RGB8, 1: RGB10, 2: RGB12                                  |
|              | ssa                     | Set Spatial Alignment          0 to 5  |
|              | ssb                     | Offset                           -512 to 511 12-bit DN                                       |
|              | ssf                     | Internal Line Rate              Hz   |
|              | ssg                     | Gain (four lines)               0: System, 1: Red, 2: Green, 3: Blue, floating point numbers |
|              | stm                     | Trigger Mode                    0: Internal, 1: External                                     |
|              | svm                     | Test Pattern                    0: sensor video, 1: mono ramp, 2: color ramp                 |
|              | usd                     | Default User Set                Set number 0-8   |
|              | usl                     | Load User Set                   Last set loaded 0-8  |
|              | uss                     | Save User Set                   Last set saved 0-8   |
|              | vt                      | Temperature                    No value returned   |
|              | vv                      | Input Voltage                   No value returned  |



| Full Name   | Help   |
|-------------|--|
| Mnemonic    | H  |
| Argument(s) |  |
| Description | Display list of three letter commands  |
| Notes       | <p>USER&gt;h</p> <p>P4 (03-081-20294-92): Command Line Interpreter Oct 18 2013, 10:49:07</p> <p>bwa - Balance white auto</p> <p>ccf - Calibrate User FPN &lt;2048&gt;</p> <p>cls - Camera Link Speed &lt;0 - 85MHz, 1 - 66MHz&gt;</p> <p>clm - Camera Link Mode &lt;0:Base 1:Med 2:Full 3:Deca 4:Dual Base&gt;</p> <p>cms - Color matrix selector &lt;device 0-Factory, 1-User&gt; &lt;Selector 1-2&gt;</p> <p>cpa - Calibrate Flatfield &lt;0:basic 1:filter&gt;&lt;2048&gt;&lt;DN target&gt;</p> <p>ctv - Color transformation value &lt;0-Gain00/1-Gain01/2-Gain02/3-Gain10/.../8-Gain22/9-Offset1/10-Offset2/11-Offset3&gt; f&lt;value&gt;</p> <p>dek - disable ESC key &lt;0/1&gt;</p> <p>ffm - Flat Field Mode &lt;0:Off 1:On 2:Initialiaze 3:Scan direction controlled&gt;</p> <p>frs - Set Flatfield Scan Direction Reverse Set &lt;set 1-8&gt;</p> <p>gcp - Display Camera Configuration</p> <p>get - Get value '&lt;string&gt;</p> <p>h - Help</p> <p>lpc - Load Pixel Coefficients &lt;set 0-8&gt;</p> <p>rc - Reset Camera</p> <p>roi - Set Flatfield ROI &lt;1st pixel&gt; &lt;last pixel&gt;</p> <p>rpc - Reset Flatfield Coefficients</p> <p>sac - Set AOI Count &lt;value 1-4&gt;</p> <p>sad - Set AOI Selector, Offset and Width &lt;selector 1-AOI Count&gt; &lt;1st pixel&gt; &lt;width &gt;= 40&gt;</p> <p>sam - Set AOI Mode &lt;1-enable, 0-disable&gt;</p> <p>sbr - Set Baud Rate</p> <p>&lt;9600 19200 38400 57600 115200 230400 460800 921600&gt;</p> <p>scd - Direction &lt;0:Fwd, 1:Rev 2:Ext&gt;</p> <p>scl - Select Exposure Time Color Selector &lt;0-All,1-Red,2-Green,3-Blue,4-Mono&gt;</p> <p>sem - Exposure Mode &lt;0:Int 1:Ext&gt;</p> <p>set - Set Exposure Time [ns]. See manual for restrictions on integration time</p> <p>smm - Mirroring &lt;0:Off 1:On&gt;</p> <p>spf - Pixel Format &lt;0:RGB8 2:RGB12 3:BGR8 5:BGR12 6:RGB8+mono8 7:BGR8+mono8 8:RGB12+mono12 9:BGR12+mono12&gt;</p> <p>ssa - Set Line Delay f&lt;0-6&gt;</p> <p>ssb - Offset &lt;DN&gt;</p> <p>ssf - Internal Line Rate &lt;Hz&gt;</p> <p>sha - Set horizontal alignment in float &lt;0-Red, 1-Green&gt; f&lt;value 0-3&gt;</p> <p>shm - Set horizontal alignment mode &lt; 0-Off, 1-Active&gt;</p> <p>ssg - Gain &lt;0-System/1-Red/2-Green/3-Blue/4-Mono&gt; f&lt;gain&gt;</p> <p>stm - External Trigger &lt;0:Off 1:On&gt;</p> <p>sui - Set User ID '&lt;string&gt;</p> <p>svm - Test Pattern &lt;0-2&gt;</p> <p>usd - Default User Set &lt;0-8&gt;</p> <p>usl - Load User Set &lt;0-8&gt;</p> <p>uss - Save User Set &lt;1-8&gt;</p> <p>vt - Temperature</p> <p>vv - Input Voltage</p> <p>USER&gt;</p> |

|                    |   |                                  |
|--------------------|---|----------------------------------|
| <b>Full Name</b>   | <b>Load Pixel Coefficients</b>  |                                  |
| <b>Mnemonic</b>    | <b>LPC</b>  |                                  |
| <b>Argument(s)</b> | Set selector  | 0. Factory set<br>1-8. User sets |
| <b>Description</b> | Load user set   |                                  |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Loads FPN coefficients and PRNU coefficients from a user set ( only coefficeints, no other camera parameters)</li> </ul> |                                  |

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

|                    |   |           |
|--------------------|---|-----------|
| <b>Full Name</b>   | <b>Set Flatfield ROI</b>  |           |
| <b>Mnemonic</b>    | <b>ROI</b>  |           |
| <b>Argument(s)</b> | First pixel   | 1 to 2048 |
|                    | Last pixel  | 1 to 2048 |
| <b>Description</b> | Flat field region of interest   |           |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Specifies the pixels that CCF and CPA will calibrate <ul style="list-style-type: none"> <li>Pixel coefficients outside this region are not changed</li> </ul> </li> <li>Last pixel must be greater than or equal to first pixel</li> </ul> |           |

|                    |   |  |
|--------------------|---|--|
| <b>Full Name</b>   | <b>Reset Flatfield Coefficients</b>                                     |  |
| <b>Mnemonic</b>    | <b>RPC</b>  |  |
| <b>Argument(s)</b> |   |  |
| <b>Description</b> | Reset all user FPN values to zero and all user PRNU coefficients to one |  |
| <b>Notes</b>       |   |  |

|                    |                      |        |
|--------------------|----------------------|--------|
| <b>Full Name</b>   | <b>Set AOI Count</b> |        |
| <b>Mnemonic</b>    | <b>SAC</b>           |        |
| <b>Argument(s)</b> | Number of AOI's      | 1 to 4 |
| <b>Description</b> | Set AOI Counter      |        |
| <b>Notes</b>       |                      |        |

|                    |   |                              |
|--------------------|---|------------------------------|
| <b>Full Name</b>   | <b>Set AOI Selector</b>   |                              |
| <b>Mnemonic</b>    | <b>SAD</b>  |                              |
| <b>Argument(s)</b> | Selector  | 1 to 4                       |
|                    | Offset  | 1 to 2048, multiple of eight |
|                    | Width   | 40 to 2048                   |
| <b>Description</b> | Define an AOI   |                              |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Must not overlap with an already existing AOI</li> </ul> |                              |

|                    |                     |                         |
|--------------------|---------------------|-------------------------|
| <b>Full Name</b>   | <b>Set AOI Mode</b> |                         |
| <b>Mnemonic</b>    | <b>SAM</b>          |                         |
| <b>Argument(s)</b> | Mode                | 0. "Off"<br>1. "Active" |
|                    |                     |                         |
| <b>Description</b> | Set AOI mode        |                         |
| <b>Notes</b>       |                     |                         |

|                    |   |        |
|--------------------|---|--------|
| <b>Full Name</b>   | <b>Set Baud Rate</b>  |        |
| <b>Mnemonic</b>    | <b>SBR</b>  |        |
| <b>Argument(s)</b> | Baud rate   | 9600   |
|                    |   | 57600  |
|                    |   | 115200 |
|                    |   | 230400 |
|                    |   | 460800 |
|                    |   | 921600 |
| <b>Description</b> | Set baud rate   |        |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Send command and then change speed of HyperTerminal</li> </ul> |        |

|                    |                           |  |
|--------------------|---------------------------|--|
| <b>Full Name</b>   | <b>Direction</b>          |  |
| <b>Mnemonic</b>    | <b>SCD</b>                |  |
| <b>Argument(s)</b> | Direction                 | 0. Forward<br>1. Reverse<br>2. External – controlled by CC3 signal |
|                    |                           |  |
|                    |                           |  |
| <b>Description</b> | Set sensor scan direction |  |
| <b>Notes</b>       |                           |  |

|                    |  |   |
|--------------------|--|---|
| <b>Full Name</b>   | <b>Select Exposure Time Color Selector</b>           |   |
| <b>Mnemonic</b>    | <b>SCL</b>   |   |
| <b>Argument(s)</b> | Color Selector                                       | 0. All<br>1. Red<br>2. Green<br>3. Blue<br>4. Mono (2k07Q model only)<br>NIR (2K07N model only) |
| <b>Description</b> | Select the color to apply an exposure time value to. |   |
| <b>Notes</b>       |  |   |

|                    |   |                            |
|--------------------|---|----------------------------|
| <b>Full Name</b>   | <b>Exposure Mode</b>  |                            |
| <b>Mnemonic</b>    | <b>SEM</b>  |                            |
| <b>Argument(s)</b> | Mode  | 0. Internal<br>1. External |
| <b>Description</b> | Set exposure time mode  |                            |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>• In internal mode the exposure time is controlled by the SET command</li> <li>• In external mode the sensor is exposed while CC1 signal is high</li> <li>• External mode is only available when the trigger mode is also external (STM 1)</li> <li>• SEM 1 overrides internally generated independent exposure times</li> </ul> |                            |

|                    |   |                       |
|--------------------|---|-----------------------|
| <b>Full Name</b>   | <b>Exposure Time</b>  |                       |
| <b>Mnemonic</b>    | <b>SET</b>  |                       |
| <b>Argument(s)</b> | Exposure time   | 8 000 to 3000000 [ns] |
| <b>Description</b> | Set internal exposure time  |                       |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>• Line time &gt; ( Exposure time + 1,500 ns )</li> </ul> |                       |

|                    |  |   |
|--------------------|--|---|
| <b>Full Name</b>   | <b>Select Flatfield Color Selector (2K07N model only)</b>  |   |
| <b>Mnemonic</b>    | <b>SFS</b>   |   |
| <b>Argument(s)</b> | Selector   | 0. All<br>1. RGB<br>2. Red<br>3. Green<br>4. Blue<br>5. NIR |
| <b>Description</b> | Select which color(s) to be flatfielded by the cpa command |   |

| Full Name   | Set Horizontal Alignment   |                    |
|-------------|--|--------------------|
| Mnemonic    | SHA  |                    |
| Argument(s) | Selector   | 0. Red<br>1. Green |
|             | Pixels   | 0 to 3             |
| Description | The value entered will stretch the chosen color to align the colors. |                    |
| Notes       |  |                    |

| Full Name   | Set Horizontal Alignment Mode    |                 |
|-------------|----------------------------------|-----------------|
| Mnemonic    | SHM                              |                 |
| Argument(s) | Selector                         | 0. Off<br>1. On |
|             |                                  |                 |
| Description | Enable the horizontal correction |                 |
| Notes       |                                  |                 |

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

| Full Name   | Pixel Format     |  |
|-------------|------------------|--|
| Mnemonic    | SPF              |  |
| Argument(s) | Selector         | 0. RGB8<br>1. RGB10<br>2. RGB12<br>3. BGR8<br>5. BGR12<br>6. RGB8+mono8 (2k07Q model)<br>RGB8+NIR8 (2k07N model)<br>7. BGR8+mono8 (2k07Q model)<br>BGR8+NIR8 (2k07N model)<br>8. RGB12+mono12 (2k07Q model)<br>RGB12+NIR12 (2k07N model)<br>9. BGR12+mono12 (2k07Q model)<br>BGR12+NIR12 (2k07N model) |
|             |                  |  |
| Description | Set pixel format |  |
| Notes       |                  |  |

|             |   |        |  |
|-------------|---|--------|--|
| Full Name   | Set Line Delay  |        |  |
| Mnemonic    | SSA   |        |  |
| Argument(s) | # of lines  | 0 to 5 |  |
| Description | Sets the number of lines of delay between colors that are read out from the sensor (default 3).   |        |  |
| Notes       | If your line rate matches the speed of the object, then the value of the line delay will be 3. 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. Values entered must be between 0 and 5. Decimal places are valid for sub-pixel correction. |        |  |

|                    |   |                           |   |
|--------------------|---|---------------------------|---|
| <b>Full Name</b>   | <b>Offset</b>   |                           |   |
| <b>Mnemonic</b>    | <b>SSB</b>  |                           |   |
| <b>Argument(s)</b> | Offset  | 8 bit<br>10-bit<br>12-bit | -32 to 31<br>-128 to 127<br>-512 to 511 |
| <b>Description</b> | Set offset  |                           |   |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Range changes depending on pixel format (SPF)</li> </ul> |                           |   |

|                    |   |                  |
|--------------------|---|------------------|
| <b>Full Name</b>   | <b>Internal Line Rate</b>   |                  |
| <b>Mnemonic</b>    | <b>SSF</b>  |                  |
| <b>Argument(s)</b> | Line rate   | 1 to 70,000 [Hz] |
| <b>Description</b> | Set internal line rate  |                  |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Line time &gt; ( Exposure time + 1,500 ns )</li> </ul> |                  |

|                    |  |  |
|--------------------|--|--|
| <b>Full Name</b>   | <b>Gain</b>  |  |
| <b>Mnemonic</b>    | <b>SSG</b>   |  |
| <b>Argument(s)</b> | Selector   | 0. System<br>1. Red<br>2. Green<br>3. Blue<br>4. Mono (2k07Q model)<br>NIR (2k07N model) |
|                    | Gain   | 1 to 10  |
| <b>Description</b> | Set gain   |  |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Multiplier must be immediately preceded with a “F” (e.g. ssg 0 f1.5)</li> </ul> |  |

|                    |  |                            |
|--------------------|--|----------------------------|
| <b>Full Name</b>   | <b>External Trigger</b>  |                            |
| <b>Mnemonic</b>    | <b>STM</b>   |                            |
| <b>Argument(s)</b> | Mode   | 0. Internal<br>1. External |
| <b>Description</b> | Set trigger mode   |                            |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>In internal mode line rate is controlled by SSF command</li> <li>In external mode readout starts on falling edge of CC1 signal</li> </ul> |                            |

|                    |   |   |
|--------------------|---|---|
| <b>Full Name</b>   | <b>Test Pattern</b>   |   |
| <b>Mnemonic</b>    | <b>SVM</b>  |   |
| <b>Argument(s)</b> | Mode  | 0. Off – sensor video<br>1. Ramp<br>2. Color Ramp |
| <b>Description</b> | Select test pattern   |   |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>When a test pattern is selected all digital processing (e.g. flat field, gain) is disabled – it is re-enabled when sensor video is selected</li> </ul> |   |

|                    |  |                                  |
|--------------------|--|----------------------------------|
| <b>Full Name</b>   | <b>Default User Set</b>  |                                  |
| <b>Mnemonic</b>    | <b>USD</b>   |                                  |
| <b>Argument(s)</b> | Set selector   | 0. Factory set<br>1-8. User sets |
| <b>Description</b> | Select user set to load when camera is reset   |                                  |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>The settings include all those listed by the GCP command plus the user FPN coefficients, user PRNU coefficients, and color correction matrix</li> </ul> |                                  |

|                    |  |                                  |
|--------------------|--|----------------------------------|
| <b>Full Name</b>   | <b>Load User Set</b>   |                                  |
| <b>Mnemonic</b>    | <b>USL</b>   |                                  |
| <b>Argument(s)</b> | Set selector   | 0. Factory set<br>1-8. User sets |
| <b>Description</b> | Load user set  |                                  |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Loads and makes current all the settings listed by the GCP command plus the user FPN coefficients, user PRNU coefficients, and color correction matrix</li> </ul> |                                  |

|                    |  |        |
|--------------------|--|--------|
| <b>Full Name</b>   | <b>Save User Set</b>   |        |
| <b>Mnemonic</b>    | <b>USS</b>   |        |
| <b>Argument(s)</b> | Set selector   | 1 to 8 |
| <b>Description</b> | Save user set  |        |
| <b>Notes</b>       | <ul style="list-style-type: none"> <li>Saves all the current settings listed by the GCP command plus the user FPN coefficients, user PRNU coefficients, and color correction matrix</li> </ul> |        |

|                    |   |
|--------------------|---|
| <b>Full Name</b>   | <b>Temperature</b>                              |
| <b>Mnemonic</b>    | <b>VT</b>                                       |
| <b>Argument(s)</b> |   |
| <b>Description</b> | Display internal temperature in degrees Celsius |
| <b>Notes</b>       |   |

|                    |                        |
|--------------------|------------------------|
| <b>Full Name</b>   | <b>Voltage</b>         |
| <b>Mnemonic</b>    | <b>VV</b>              |
| <b>Argument(s)</b> |                        |
| <b>Description</b> | Display supply voltage |
| <b>Notes</b>       |                        |



---

# Appendix C: Quick Setup and Image Acquisition

If you are familiar with the operation of Camera Link cameras and have an understanding of imaging fundamentals, the following steps will show you how to quickly set up this camera and begin acquiring images.

## 1. On Power Up

The color camera has been calibrated and configured at the factory to be ready for your evaluation when first powered up. The default conditions are set as follows:

- System gain is set to the lowest value of one.
- Flat field calibration is *not* active as this feature is dependent on your light source and lens.
- Line rate and exposure time are set to for internal generation by the camera.
- White balance is set for white LEDs.
- Camera Link mode is set to the standard RGB medium mode which allows operation of up to 40 KHz line rate. The camera will run at up to a 69 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.

## 2. Communicating with the Camera

- The color camera is designed to power up with a GenICam-compliant interface.
- CamExpert provides an easy-to-use GUI that can be used to set up and evaluate the camera.
- The camera also comes with Teledyne DALSA's three letter command (TLC) interface option, which can be accessed using a suitable terminal program such as HyperTerminal™.
- If you want to use the TLC interface, press the 'Esc' key while using a terminal program and after the LED indicator on the camera turns green. Note that the camera defaults to 9.6 KBaud when first powered up.
- On receiving the 'Esc' character, the camera will output a list of the available TLC commands. You can then proceed to enter TLC commands as required.
- Enter 'h' at any time to get the list of commands from the camera.
- Enter the 'gcp' command at any time to get the current setup conditions of the camera.

### 3. Setting Up Your Optical Configuration

Typically, the first thing you want to do is to evaluate the camera's image quality under operating conditions similar to those that you are likely to use in your application. In order to do this, take the following steps:

- The illumination, lens magnification, and focus should be set up as per your application.
- Getting the magnification right is best accomplished by setting the object-to-sensor distance. Use the formula  $\text{lens focal length} \times (2 + 1/\text{magnification} + \text{magnification})$  to calculate this distance. Magnification equals the sensor pixel size (10.56  $\mu\text{m}$ ) / (your object pixel size in  $\mu\text{m}$ ).
- The approximate location of the sensor position is at the first groove in the side of the case, back from the front face.

### 4. Camera Timing & Control

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

- Since we recommend starting with Camera Link medium mode, set a suitable line rate less than 40 KHz, using the 'ssf' command.
- 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.
- You can set the exposure time using the 'set' command. Ensure that the exposure time period is not greater than the period of the line rate minus 1.5  $\mu\text{sec}$ .
- The camera will indicate an error if you select an exposure time that is too long. The minimum exposure time is 7  $\mu\text{sec}$ .
- Set your camera direction using the 'scd' command. Refer to the Camera Direction diagram in this manual for a definition of 'forward' and 'reverse'.

### 5. 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 the system gain to adjust the camera output to achieve the desired response. The system gain range is from 1x to 10x.
- Once you have a suitable response, you can now focus the lens.
- If you are using white LEDs, your image will have reasonable color reproduction.
- The image may be darker at the edges due to lens vignetting, but this will be improved once the camera is calibrated.
- Calibration is performed using a white reference where your object is normally located.
  - Use a white material that has no texture, such as a non glossy plastic.

- If you must use white paper, make sure it is moving during the calibration process. If you do not do this, your image will have vertical stripes.
- Calibration is easily performed using the TLC 'cpa' command.
- The cpa command has two parameters.
  - The first is the number of lines you want to average over. Use a value of 2048\* to achieve the best average.
  - The second is the eight bit target value you want for all three colors after calibration.
- The cpa command takes several seconds to complete. The slower the line rate, the longer it will take.
- On completion of the 'cpa' command, you should see an image from the camera that is white balanced with all three colors at the target level you set.

You are now ready to evaluate the image quality of the P4 color camera under your operating conditions.

## 6. Improving Your Color Image

The color response of the P4 color camera is quite good even when using white LED's and even without color correction. The camera has a factory set white LED color correction matrix that can be selected to improve color response for those using white LED's. If you are using a different light source, a suitable color correction matrix can be downloaded to the camera. A software tool to generate this is available with the Spera Essentials processing applications, which can be downloaded from the Teledyne DALSA web site (60 day free trial). 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 here, [Support](#).

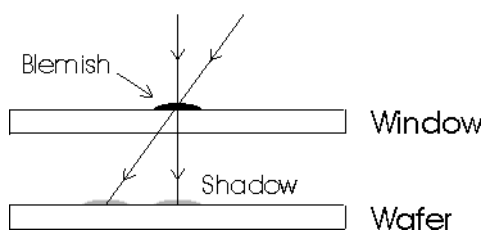
# Appendix D: The Sensor Window

## 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 fingercots 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.

### An 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 make 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.
- 3M ionized air gun 980  
([http://solutions.3mcanada.ca/wps/portal/3M/en\\_CA/WW2/Country/](http://solutions.3mcanada.ca/wps/portal/3M/en_CA/WW2/Country/))
- Ionized air flood system, foot operated.
- Swab (HUBY-340CA-003)  
(<http://www.cleancross.net/modules/xfsection/article.php?articleid=24>)
- Single drop bottle (FD-2-ESD)
- E2 (Eclipse optic cleaning system ([www.photosol.com](http://www.photosol.com)))

## Procedure

- Use localized ionized air flow 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 location of any remaining contamination.
- Clean the contamination on the sensor using one drop of E2 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.

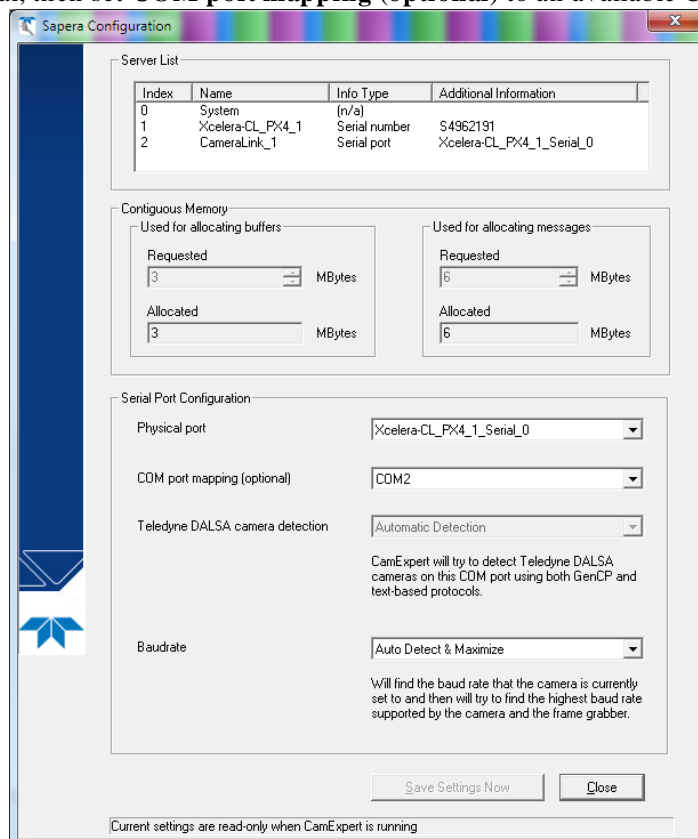
# Appendix E: Camera, Frame Grabber Communication

## Setting Up Communication between the Camera and the Frame Grabber

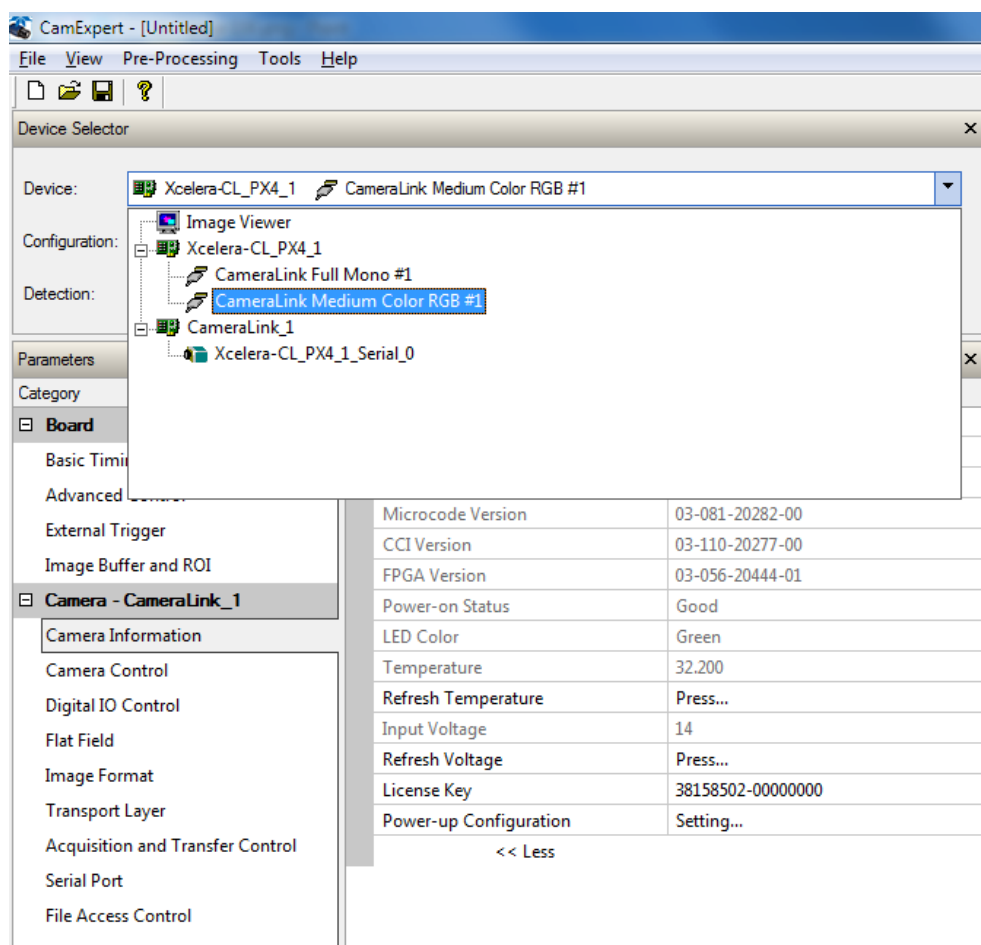
Teledyne DALSA Camera Link cameras support the GenCP Camera Link standards.

To configure Teledyne DALSA GenCP Camera Link Cameras:

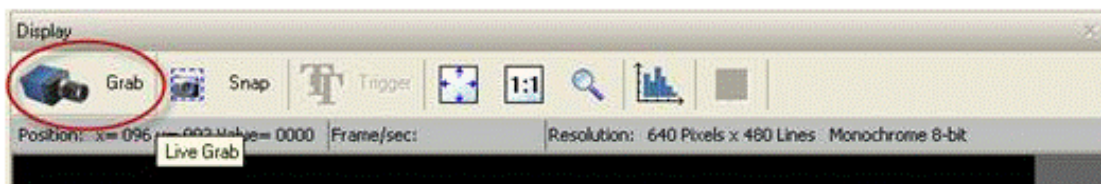
1. Install the Teledyne DALSA frame grabber in the host computer; refer to the hardware installation manual.
2. Install Spera LT and the Teledyne DALSA frame grabber driver.
3. Connect the camera to the frame grabber; refer to the camera installation manual.
4. Power up the camera and wait until the status LED is solid green.
5. Run the Spera Configuration utility and select the frame grabber serial port connected to the camera. Set **Teledyne DALSA camera detection** to **Automatic Detection** and **Baudrate** to **Auto Detect & Maximize**.
6. If the camera will be configured using three-letter text commands via a terminal program, such as HyperTerminal, then set **COM port mapping (optional)** to an available COM port (e.g. COM2).



7. Start the CamExpert application. In the **Device** tab, select **CameraLink Medium Color RGB #1**.



8. Modify the camera and frame grabber parameter settings as required. 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.



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

# Appendix F: Error and Warning Messages

BiST: Built in Self Test

The BiST error flags are binary flags with each bit being independent from each other. The message from the BiST 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. Any of these errors will result in the status light turning red.

| Definition                 | BiST Flag                        |
|----------------------------|----------------------------------|
| I2C error                  | 1                                |
| Unable to configure fpga   | 10                               |
| Unable to configure fpga   | 100                              |
| EXT_SRAM Failure           | 1000                             |
| ECHO_BACK Failure          | 1,0000                           |
| FLASH_TIMEOUT              | 10,0000                          |
| FLASH_ERROR                | 100,0000                         |
| NO_FPGA_Code               | 1000,0000                        |
| NO_COMMON_SETTINGS         | 1,0000,0000                      |
| NO_FACTORY_SETTINGS        | 10,0000,0000                     |
| NO_USER_SETTINGS           | 100,0000,0000                    |
| NO_FLAT_FIELD Corrections  | 1000,0000,0000                   |
| NO MISC corrections        | 1,0000,0000,0000                 |
| NO_FPN Correction          | 10,0000,0000,0000                |
| NO_FPN Correction          | 100,0000,0000,0000               |
| NO_PRNU Correction         | 1000,0000,0000,0000              |
| NO_FEED Through Correction | 1,0000,0000,0000,0000            |
| NO_LINEARITY Correction    | 10,0000,0000,0000,0000           |
| SYNC_ERROR                 | 100,0000,0000,0000,0000          |
| OVER_TEMPERATURE           | 1000,0000,0000,0000,0000         |
| SPI Failure                | 1,0000,0000,0000,0000,0000       |
| NO_USER_FPN                | 10,0000,0000,0000,0000,0000      |
| PLL_LOCK_FAILED            | 100,0000,0000,0000,0000,0000     |
| INVALID_CCI                | 1000,0000,0000,0000,0000,0000    |
| No LUT                     | 1,0000,0000,0000,0000,0000,0000  |
| Incompatible FPGA code     | 10,0000,0000,0000,0000,0000,0000 |



## Operational Error Codes

| Code   | Description           |
|--------|-----------------------|
| 0X8002 | Invalid Parameter     |
| 0xC01C | CPA_TOO_MANY_OUTLIERS |
| 0x401E | USER_FPN_CLIPPING     |
| 0x401F | FLAT_FIELD_CLIPPING   |

---

# EMC Declaration of Conformity

We, TELEDYNE DALSA  
605 McMurray Road  
Waterloo, Ontario  
CANADA N2V 2E9

Declare under sole responsibility that the cameras:

Brand Name: Piranha4

Models: P4-CC-02K07Q-00-R, P4-CC-02K07N-01-R

Which are components to be integrated into larger systems, were evaluated according to the CE Mark, FCC Part 15, VCCI, Israel, Korea, and Industry Canada ICES-003 Evaluation and satisfy the requirements of the following standards:

EN 55022 (2010)  
EN 55011 (2009)  
EN 61326-1 (2006)  
EN 55024 (2010)  
CISPR-22  
ICES-003  
CISPR-11  
FCC Part 15

Place of issue: Waterloo, Ontario, Canada

Date of Issue: February 4, 2013

Hank Helmond  
Director of Quality, TELEDYNE DALSA Corp.



---

# Revision History

| Revision | Change Description                      | Date               |
|----------|---|--------------------|
| 00       | Release of the initial manual revision. | September 16, 2015 |

# Index

## B

baud rate, 52  
BiST, 112  
black level  
  control, 51

## C

calibration, 54  
  flat field, 56  
  process chain, 54  
camera control signals, 26  
camera information, 42  
camera interfacing tool, 38  
Camera Link  
  cables, 35  
  input signals, 35  
  outputs, 35  
Camera Link connector, 25  
CamExpert, 39  
certifications, 10  
cleaning  
  sensor window, 109  
clock signals, 35  
compliance, 10  
connectors, 24  
  Camera Link, 25  
  power, 36

## D

data bus, 35  
direction  
  sensor shift, 18  
  web movement, 18  
direction control, 53

## E

error and warning messages,  
  112  
exposure  
  control, 46  
  external frame rate,  
    programmable exposure time,  
    48  
  externally controlled, 48  
  internally controlled, 48  
exposure modes  
  descriptions of, 46

## F

exposure time  
  set, 51  
EXSYNC, 35

## G

factory settings, 42

## H

Gain  
  control, 51  
grounding instructions, 24  
GUI  
  CamExpert, 39  
  overview, 37

## I

heat sinks, 20

## L

image acquisition, 46  
input/ output, 24  
interface  
  mechanical, 8

## M

LED  
  definitions, 36

## P

mechanical  
  camera, 19  
  specifications, 8  
models, 8

performance specifications, 8  
pixel format, 53  
power  
  connector, 36  
  connectors, 36  
  guidelines, 36  
  pinout, 36  
precautions, 6

**Q**

quantum efficiency  
graph, 10

**R**

rebooting, 53  
requirements  
PC, 22  
responsivity  
graph, 10  
revision history, 115

**S**

safety, 6  
Sapera, 38  
sensor controls, 63, 69, 72, 83  
settings  
current, 45  
default, 46  
factory, 42, 46  
loading, 44

**T**

saving, 44  
user, 45  
setup  
overview, 22  
shift direction, 18  
size  
image, 52  
software  
required, 8  
specifications  
mechanical, 8  
performance, 8

**V**

temperature  
verify, 43  
test patterns, 41  
trigger modes, 46

voltage  
verify, 43