GigE Vision Bilinear Color Line Scan Camera

Spyder3 Color GigE Vision

User Manual

SG-32-04k80-00-R
SG-32-02k80-00-R

DALSA

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About DALSA

DALSA is an international high performance semiconductor and electronics company that designs, develops, manufactures, and markets digital imaging products and solutions, in addition to providing semiconductor products and services. DALSA's core competencies are in specialized integrated circuit and electronics technology, software, and highly engineered semiconductor wafer processing. Products and services include image sensor components; electronic digital cameras; vision processors; image processing software; and semiconductor wafer foundry services for use in MEMS, high-voltage semiconductors, image sensors and mixed-signal CMOS chips. DALSA is listed on the Toronto Stock Exchange under the symbol "DSA". The Company has its corporate offices in Waterloo, ON and over 1000 employees world-wide.

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

DALSA Sales Offices

Waterloo	Europe	Asia Pacific
605 McMurray Rd Waterloo, ON N2V 2E9 Canada Tel: 519 886 6000 Fax: 519 886 8023 www.dalsa.com sales.americas@dalsa.com	Breslauer Str. 34 D-82194 Gröbenzell (Munich) Germany Tel: +49 - 8142 – 46770 Fax: +49 - 8142 – 467746 www.dalsa.com sales.europe@dalsa.com	Ikebukuro East 13F 3-4-3 Higashi-Ikebukuro Toshima-ku, Tokyo 170-0013 Japan Tel: 81 3 5960 6353 Fax: 81 3 5960 6354 (fax) www.dalsa.com sales.asia@dalsa.com

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1

Spyder3 GigE Vision Color Camera Overview

1.1 Camera Highlights

Features and Programmability

- Single color broadband responsivity up to 79 DN (nJ/cm²) @ 20dB gain
- 2048 or 4096 pixels, 14 µm x 14 µm (2k) and 10µm x 10µm (4k) pixel pitch
- Fill factor 90% (2k) and 86% (4k)
- Up to 18 KHz (2k) and 9 KHz (4k) line rates
- Dynamic range up to 677 : 1
- Data transmission up to 100 m
- ±50 µm x, y sensor alignment
- RoHS and CE compliant
- GeniCam compliant
- Easy-to-use GUI
- Optional serial interface (ASCII, 57600 baud, adjustable to 19200, 57600, 115200), through virtual serial port through Ethernet (not GeniCam compliant)
- Programmable gain, offset, exposure time and line rate, trigger mode, test pattern output, and camera diagnostics
- Flat-field correction—minimizes lens vignetting, non-uniform lighting, and sensor FPN and PRNU

Description and Applications

The Spyder3 GigE Vision (GEV) Color camera is DALSA's latest GigE Vision camera. The GigE Vision interface eliminates the need for a frame grabber, resulting in significant system cost savings.

The Spyder3 GEV Color is also DALSA's first dual line scan color camera. The Spyder3 GEV Color camera is ideal for:

- Cotton and textile inspection
- Food, drug, and tobacco inspection
- Wood, tile, and steel inspection
- Postal sorting
- Recycling sorting
- 100% print inspection (lottery tickets, stamps, bank notes, paychecks)
- General web inspection

Models

The Spyder3 GEV color camera is available in the following configurations:

Table 1: Spyder3 GigE Vision Color Camera Models Overview

Model Number	Description
SG-32-02K80-00-R	2k resolution, 80 MHz data rate, 18 KHz line rate.
SG-32-04K80-00-R	4k resolution, 80 MHz data rate, 9 KHz line rate.

1.2 Performance Specifications

Table 2: Spyder3 GigE Vision Color Camera Performance Specifications

Feature / Specification	2k	4k
Imager Format	Bilinear CCD	
Resolution[1]	2048 pixels	4096 pixels
Pixel Fill Factor	90%	86%
Pixel Size	14 x 14 µm	10 x 10 µm
Output Format (# of taps)	2	
Antiblooming	100x	
Gain Range	0 to 20 dB	
Color Output/Arrangement	R/G/B and Mono	
Exposure Times	3 to 3,000 µs	
Speed	**2k**	**4k**
Maximum Line Rate	18 KHz	9 KHz
Minimum Internal Line Rate	300 Hz	
Data Rate	80 MHZ	
Mechanical Interface	**2k**	**4k**
Camera Size	72 (h) x 60 (l) x 50 (w) mm	65 (h) x 60 (l) x 85 (w) mm
Mass	< 300 g	< 300 g
Connectors		
power connector	6 pin male Hirose	
GigE connector	RJ45 with screw locks	
GPI/O connector	High density 15-pin dsub	
Optical Interface		
Back Focal Distance	6.56 ± 0.25 mm	
Lens Mount Adaptors	Lens mount adapters are available. Contact Sales for more information.	
Sensor Alignment		
x	±50 µm	
y	±50 µm	
z	±0.25 mm	
Yz	±0.2°	
Electrical Interface		
Input Voltage	+12 to +15 Volts	
Power Dissipation	< 10.5 W	
Operating Temperature	0 to 50 °C	
Bit Width	8 bit	
Output Data Configuration	GigE Vision	

Notes

1. The interpolation procedure does not work on the first and last pixels; as a result, the number of effective full color (RGB) pixels for the 2k and 4k cameras is reduced by 2 to 2046 or 4094 respectively.

Table 3: Camera Operating Specifications (Single Color)

Specifications	Unit	0 dB			10 dB			20 dB		
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max
Broadband responsivity	DN/(nJ/cm²)									
2k			7.9			25			79	
4k			4			12.6			40	
Random noise rms	DN									
2k						0.788	1.56		2.5	5
4k				0.75		1.19	2.38		3.75	7.5
Dynamic range	DN:DN	335	677		106	214:1		33:1	67.7:1	
FPN global	DN p-p									
Uncorrected				4			12.5			40
Corrected				2			2			4
PRNU ECD										
Uncorrected local	%			8.5						
Uncorrected global	%			10						
Corrected local	DN p-p			5						
Corrected global	DN p-p			5						
PRNU ECE										
Uncorrected local	%			8.5						
Uncorrected global	%			10						
Corrected local	DN p-p			5						
Corrected global	DN p-p			5						
SEE (calculated)	nJ/cm²									
2k			32.2			10.1			3.21	
4k			64.3			20.2			6.43	
NEE (calculated)	pJ/cm²									
2k			31.7			31.7			31.7	
4k			95			95			95	
Saturation output amplitude	DN					255				
DC offset	DN		2	5				5		5

Test conditions unless otherwise noted:

- 8-bit values, Flat Field Correction (FFC) enabled.
- CCD Pixel Rate: 40 MHz per sensor tap
- Line Rate: 5000 Hz
- Nominal Gain setting unless otherwise specified
- Light Source: Broadband Quartz Halogen, 3250k, with 750 nm highpass filter installed
- Ambient test temperature 25 °C
- Exposure mode disabled.
- Unless specified, dual line mode.

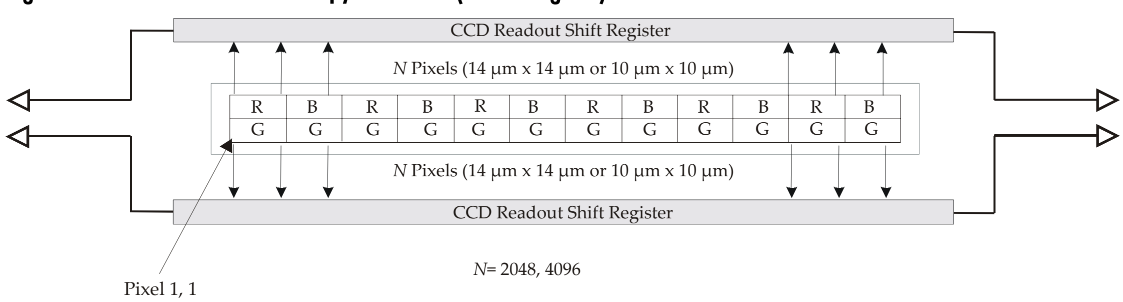
Notes

1. PRNU measured at 50% SAT.

1.3 Image Sensor

This color bilinear camera is based on DALSA's bilinear CCD sensor. The first line of this two line sensor has red (R) and blue (B) alternating pixels, while the second line has all green (G) pixels. There is no gap in between the two lines and this minimizes any artifact due to spatial correction. The G channel can be used as a monochrome output. The sensor has a 2 tap output.

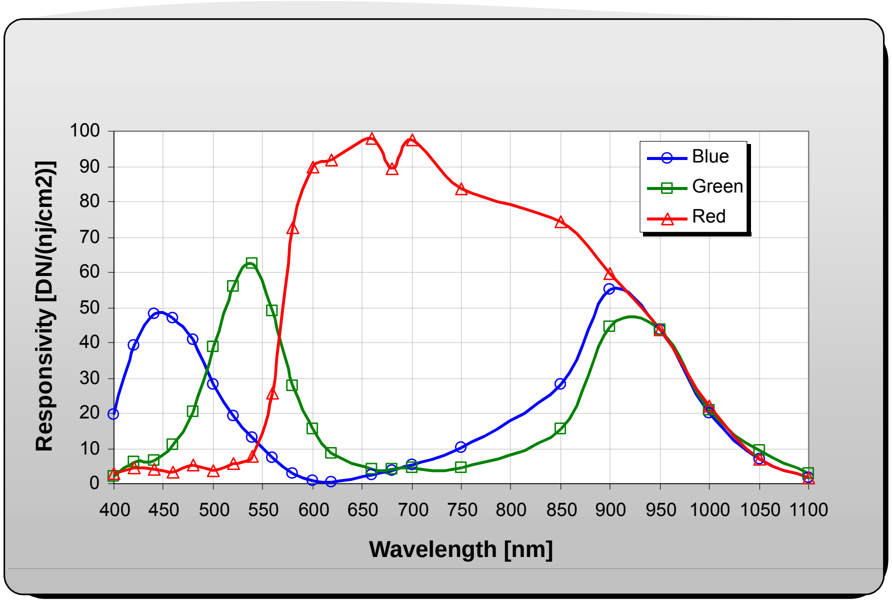
Figure 1: Bilinear sensor used in Spyder3 Color (block diagram)



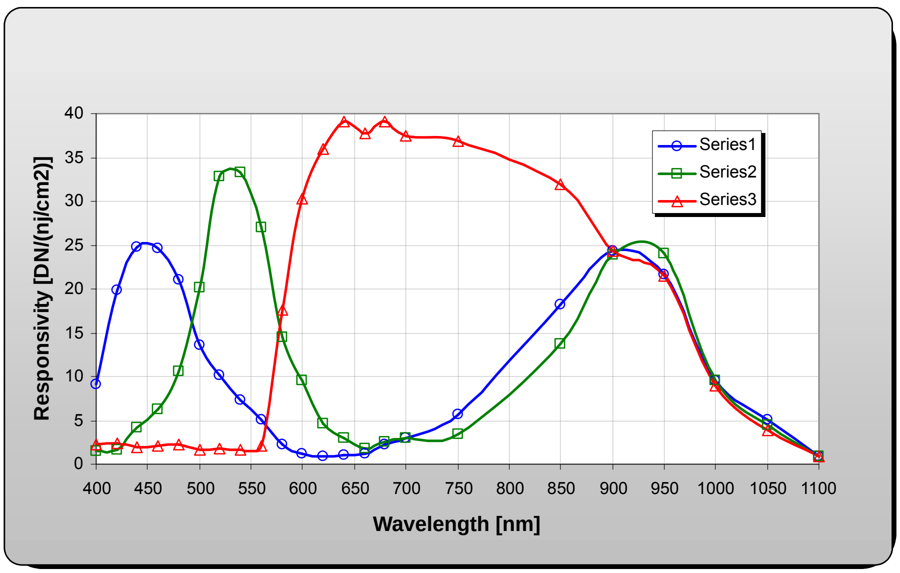
Please note that interpolation procedure does not work on the first and last pixels; as a result, the number of effective full color (RGB) pixels for the 2k and 4k cameras is reduced by 2 to 2046 or 4094 respectively.

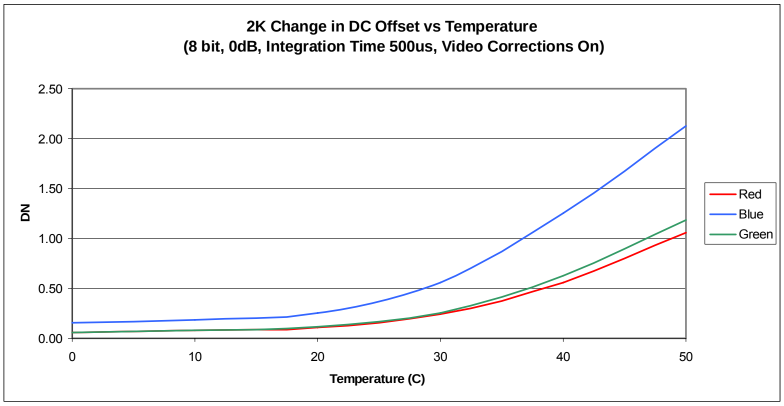
1.4 Responsivity and Derating Curves

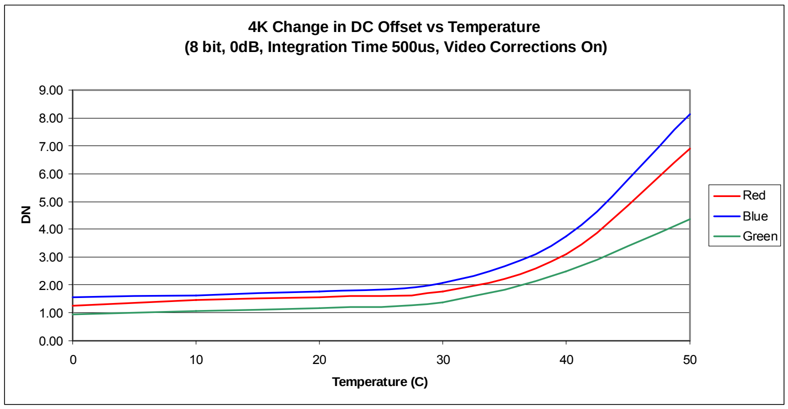
Spyder3 2k GEV Color

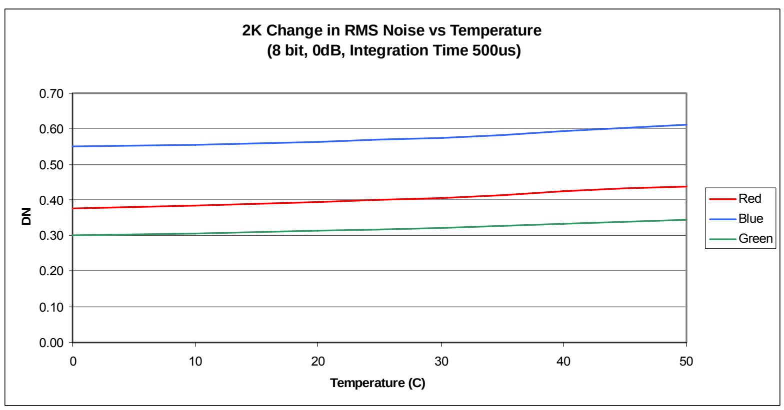


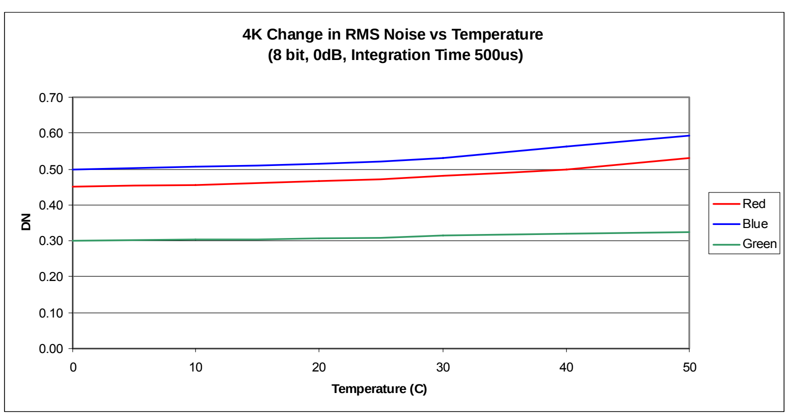
Spyder3 4k GEV Color

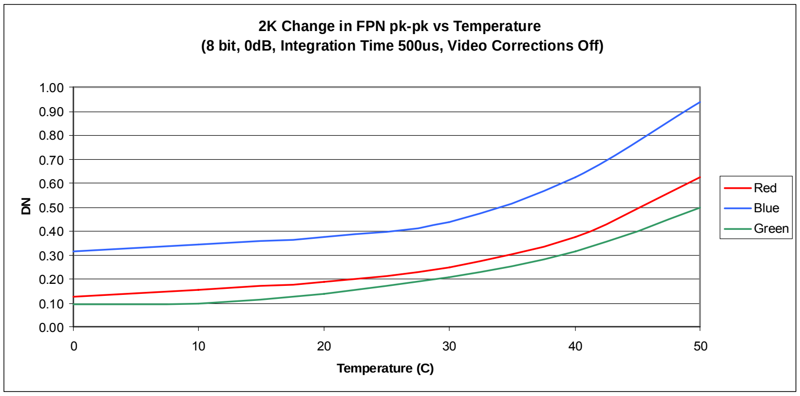


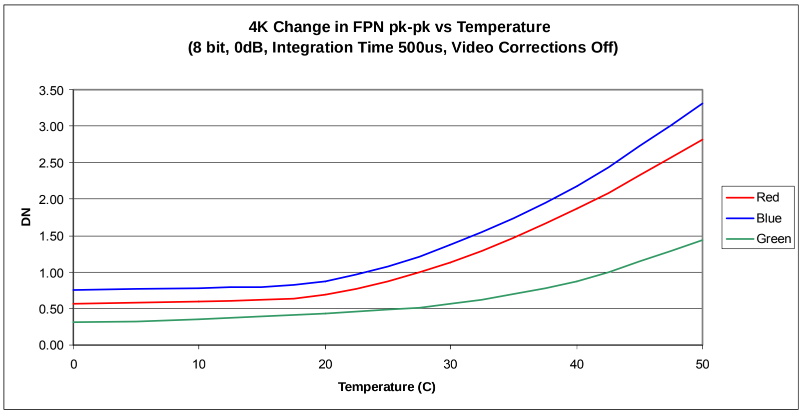

2K Change in DC Offset vs Temperature
(8 bit, 0dB, Integration Time 500us, Video Corrections On)
2.50
2.00
1.50
1.00
0.50
0.00
DN
0
10
20
30
40
50
Temperature (C)
Red
Blue
Green

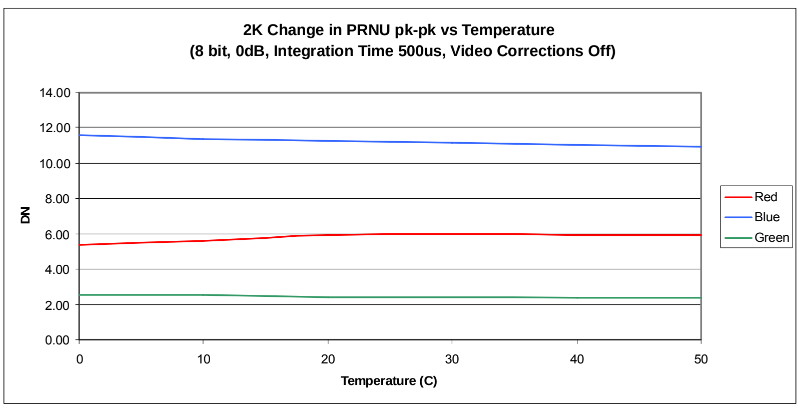

4K Change in DC Offset vs Temperature
(8 bit, 0dB, Integration Time 500us, Video Corrections On)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
DN
0
10
20
30
40
50
Temperature (C)
Red
Blue
Green

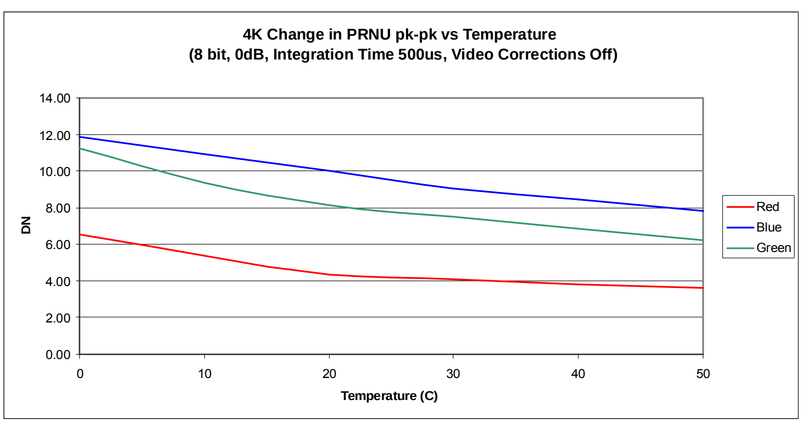

2K Change in RMS Noise vs Temperature
(8 bit, 0dB, Integration Time 500us)
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
DN
0
10
20
30
40
50
Temperature (C)
Red
Blue
Green


4K Change in RMS Noise vs Temperature
(8 bit, 0dB, Integration Time 500us)
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
DN
0
10
20
30
40
50
Temperature (C)
Red
Blue
Green


2K Change in FPN pk-pk vs Temperature
(8 bit, 0dB, Integration Time 500us, Video Corrections Off)
DN
Temperature (C)
Red
Blue
Green


4K Change in FPN pk-pk vs Temperature
(8 bit, 0dB, Integration Time 500us, Video Corrections Off)
DN
Temperature (C)
Red
Blue
Green


2K Change in PRNU pk-pk vs Temperature
(8 bit, 0dB, Integration Time 500us, Video Corrections Off)
DN
Temperature (C)
Red
Blue
Green


4K Change in PRNU pk-pk vs Temperature
(8 bit, 0dB, Integration Time 500us, Video Corrections Off)
DN
Temperature (C)
Red
Blue
Green

1.5 Supported Industry Standards

Spyder3 GEV cameras are 100% compliant with the GigE Vision 1.0 specification. This specification defines the communication interface protocol used by GigE Vision devices. For more information on these requirements refer to the following site: http://www.machinevisiononline.org/public/articles/details.cfm?id=2761

Spyder GEV cameras implement a superset of the GenICam™ specification which defines device capabilities. This description takes the form of an XML device description file respecting the syntax defined by the GenApi module of the GenICam™ specification. For more information on these requirements refer to the following site: www.genicam.org.

2

Mechanical, Optical, and Electrical Interfaces

2.1 Mechanical Interface

Figure 2: Spyder3 2k GigE Vision Color Camera Mechanical Dimensions

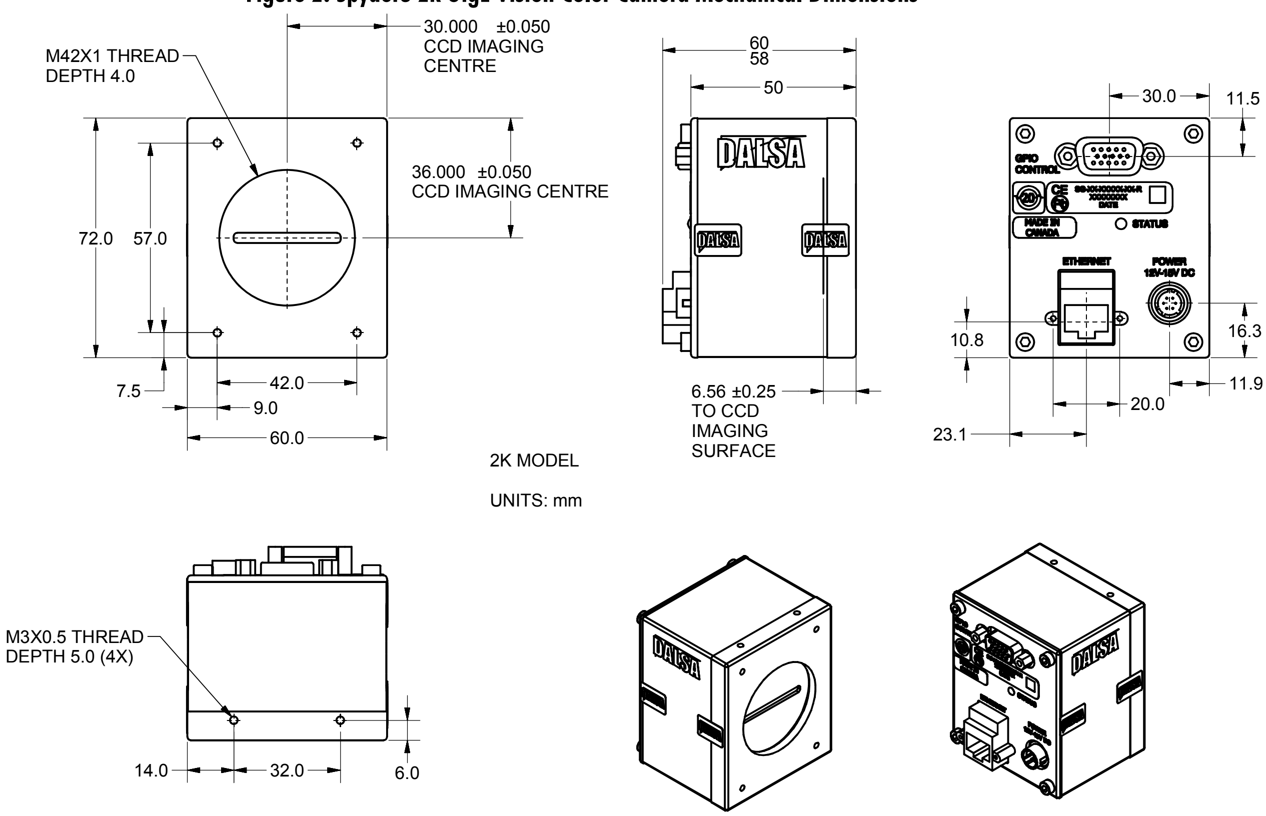
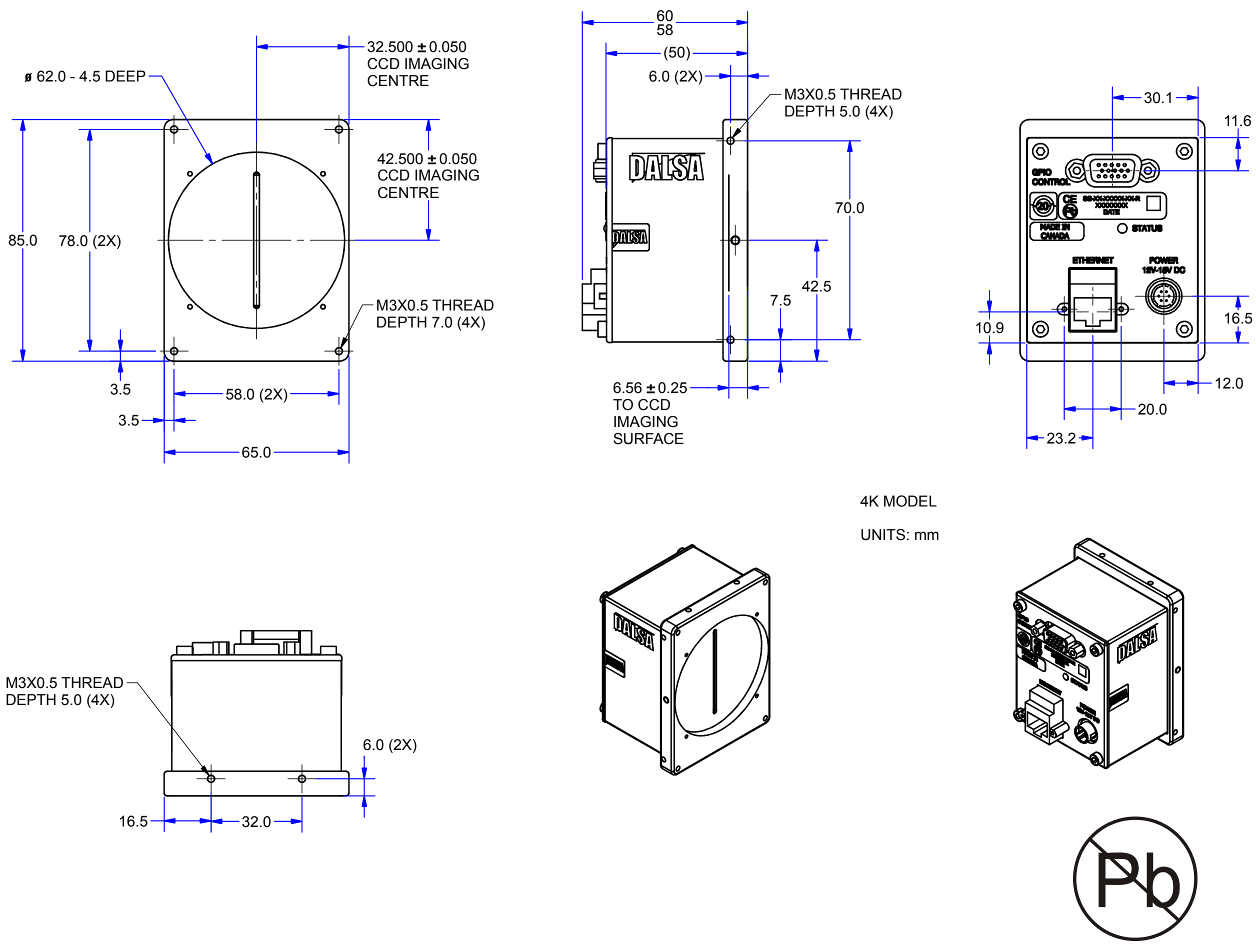


Figure 3: Spyder3 4k GigE Vision Color Camera Mechanical Dimensions



2.2 Optical Interface

Illumination

The amount and wavelengths of light required to capture useful images depend on the particular application. Factors include the nature, speed, and spectral characteristics of objects being imaged, exposure times, light source characteristics, environmental and acquisition system specifics, and more.

DALSA's Web site, http://mv.dalsa.com/, provides an introduction to this potentially complicated issue. See "Radiometry and Photo Responsivity" and "Sensitivities in Photometric Units" in the CCD Technology Primer found under the Application Notes and Technology Primers section of the Knowledge Center (www.dalsa.com/knowledge).

It is often more important to consider exposure than illumination. The total amount of energy (which is related to the total number of photons reaching the sensor) is more important than the rate at which it arrives. For example, 5μJ/cm^2 can be achieved by exposing 5 mW/cm^2 for 1 ms just the same as exposing an intensity of 5W/cm^2 for 1μs.

Light Sources

Keep these guidelines in mind when setting up your light source:

- LED light sources are relatively inexpensive, provide a uniform field, and longer life span compared to other light sources. However, they also require a camera with excellent sensitivity, such as the Spyder3 GEV camera.
- Halogen light sources generally provide very little blue relative to infrared light (IR).
- Fiber-optic light distribution systems generally transmit very little blue relative to IR.
- Some light sources age; over their life span they produce less light. This aging may not be uniform—a light source may produce progressively less light in some areas of the spectrum but not others.

Filters

CCD cameras are extremely responsive to infrared (IR) wavelengths of light. To prevent infrared from distorting the images you scan, use a "hot mirror" or IR cutoff filter that transmits visible wavelengths but does not transmit wavelengths over 750 nm. Examples are the Schneider Optics™ B+W 489, which includes a mounting ring, the CORION™ LS-750, which does not include a mounting ring, and the CORION™ HR-750 series hot mirror.

IR Cutoff Filter

Please note that in order to achieve good color reproduction, we strongly recommend that you use an IR cutoff filter with this camera.

2.3 Electrical Interface

The Spyder3 GEV Color cameras have been designed for EMC compliance. The test setup has been verified to the following EMC standards:

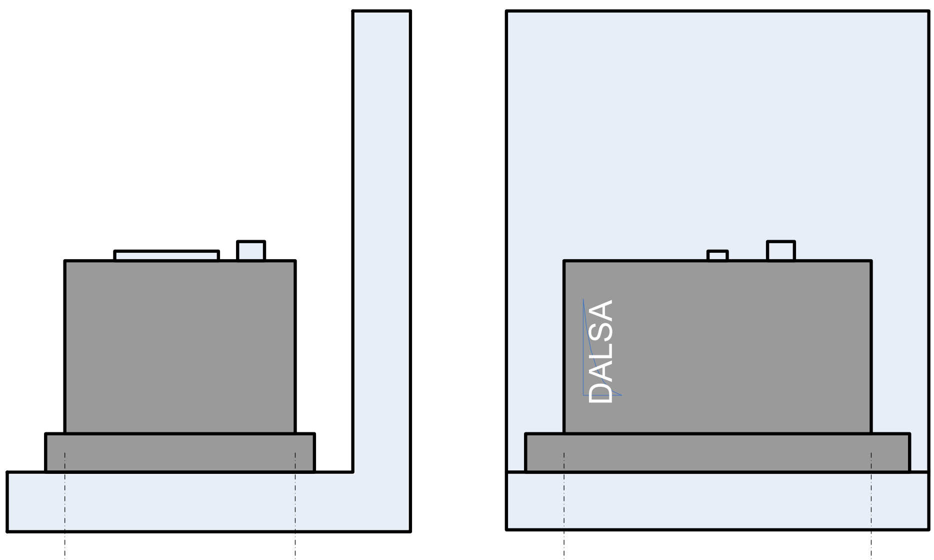
- CISPR-11:2004
- EN 55011:2003
- EN 61326:2002

To achieve EMC compliance, follow these specific guidelines:

- Ensure that all cable shields have 360° electrical connection to the connector.
- Fasten and secure all connectors.

2.4 Mounting

DALSA recommends that you allow the heat generated by the camera to move away from the camera. One way to do this is by mounting the camera correctly, as shown:



3

Setting Up the Camera

3.1 Installation Overview

1. Install Ethernet card

Following the manufacturer's instruction, install an Ethernet card. For gigabit performance, you must install an Intel PRO/1000 Ethernet card.

Note: Do not install the manufacturer's driver. You will install the appropriate QuickCam driver in a later step.

2. Install QuickCam GUI

Insert the Spyder3 GigE Vision Color CD into your CD-ROM drive and follow the onscreen instructions to install the QuickCam GUI.

3. Install QuickCam driver

There is an overview of the available drivers in the section below.

Open the Driver Installation Tool. On the Windows task bar, click Start > Programs > DALSA QuickCam GEV > Tools > Launch EbDriver Tool.exe

From the Driver Installation Tool window, select the network adapter that is connected to the camera and click the Configure... button.

From the Driver selection window, select your preferred driver.

For SG-32 cameras using the Intel PRO/1000 NIC adapter, choose the eBus Optimal Driver.

If you are not using an Intel PRO/1000 adapter, choose the eBus Universal Driver and use a network driver.

4. Connect GPIO cable

If using an external sync, external direction control, or any other external signals, connect the GPIO cable to the back of the camera.

5. Connect Ethernet cable

Connect a Cat 5e or Cat 6 cable from the camera to the computer Ethernet jack.

6. Connect power cable

Connect a power cable from the camera to a +12V to +15V power supply.

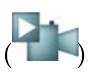
7. Open QuickCam

On the Windows task bar, click Start > Programs > DALSA QuickCam GEV > DALSA QuickCam GEV.

8. Confirm or enter IP address

In the Set Camera's IP Address dialog box, confirm or enter the camera's IP address. Click OK.

9. Start acquiring images

On the QuickCam toolbar, click the Continuous Grab icon (). The image should be visible in the Image Output window.

Note: Refer to the following sections for details on equipment recommendations and camera connector information.

3.2 Equipment Recommendations

PC Requirements

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

- Processor: AMD Athlon XP 2000+ or Intel P4 2.0 GHz.
- Memory: 512 MB DDR-RAM PC2700.
- Motherboard: Mid-end without embedded graphic card. Avoid using onboard video cards as they may compete with other components for shared memory.
- VGA card: Nvidia GForce 2 or better (ATI not recommended). Some ATI video cards will use a high amount of the PCI bandwidth and compete with other components, such as the GigE network card. This may lower the expected data rate of applications.
- GigE network adapter (either PCI card or LOM): For high performance, you must use a Intel PRO/1000 MT adapter.
- Operating system: Windows XP Professional.

Network Adapter Requirements

The Spyder3 GEV camera works best with network adapters based on the Intel 82546, 82541, and 82540 network chips. The driver will also function with adapters based on the Intel 82544 chip, but these are not recommended due to bugs in the chip that can cause control packets to be lost if sent while data is streaming.

Contact DALSA for information on how to use these network chips with the DALSA QuickCam High-Performance IP Device Driver.

Ethernet Switch Requirements

When you require more than one device on the same network or a camera-to-PC separation of more than 100 meters, you can use an Ethernet switch. Since the Spyder3 GEV camera complies with the Internet Protocol, the camera should work with all standard Ethernet switches. However, switches offer a range of functions and performance grades, so care must be taken to choose the right switch for a particular application. Please contact DALSA Technical Support if you need more information about Ethernet switches.

3.3 Drivers: Overview

eBus Optimal Driver

The eBus Optimal Driver is our recommended driver for applications demanding high bandwidth. The driver is a purpose-built replacement for the regular driver that comes with Intel PRO/1000 card or 825xx chip. Designed to maximize throughput and minimize

CPU usage, this driver is ideal for high-bandwidth applications that need virtually all the CPU for other application tasks. (It also supports corporate network connectivity.)

Efficiency ★★★★★

Usage High bandwidth with CPU-intensive applications

Limitations Requires NIC from Intel's family of PRO/1000 cards and 825xx chips

eBus Universal Driver

The eBus Universal Driver replaces the CPU intensive Windows network stack. It works with almost any NIC because it works in conjunction with your NIC's regular driver. It supports corporate network connectivity.

Efficiency ★★★★☆

Usage High bandwidth application that can tolerate some sharing of the CPU capacity

High Performance Driver Mode

If you are upgrading your existing systems, have an existing project, and you don't require a GigE Vision compliant connection, then we recommend that you continue to use your current driver.

In high-performance mode, the Spyder3 GEV works with the High-Performance IP Device Driver to transfer data between cameras and PCs with very low, predictable latency at rates of up to 1 Gb/s (100 MB/s). The video data is streamed directly into PC memory using almost no PC CPU resources. This leaves the CPU free to process applications.

Efficiency ★★★★★

Usage Existing projects requiring high-bandwidth

Limitations Requires NIC from Intel's family of PRO/1000 cards and 825xx chips

To achieve this performance level, PCs must be equipped with a GigE network interface (also referred to as a network adapter) based on Intel's 82540 chip. Many motherboard manufacturers have designed this chip directly into their board in "LAN on the motherboard (LOM)" implementations. Alternately, an Intel 82540-based network adapter, also known as a network interface card, can be slotted into a PC.

The High-Performance IP device driver is very efficient but disregards regular Internet traffic. Because of this, it doesn't support corporate network connectivity.

Standard Driver Mode

In standard mode, the Spyder3 GEV operates with any vendor's Ethernet network adapter. The driver shipped with the adapter transfers the data to the Windows network stack, which handles IP communications tasks.

Efficiency ★☆☆☆☆

Usage Low-bandwidth application or temporary

Standard mode is recommended for applications where flexibility is more important than performance. The Windows network stack uses significant levels of CPU processing power to transfer data to memory, which can result in lost packets, severely degrading performance.

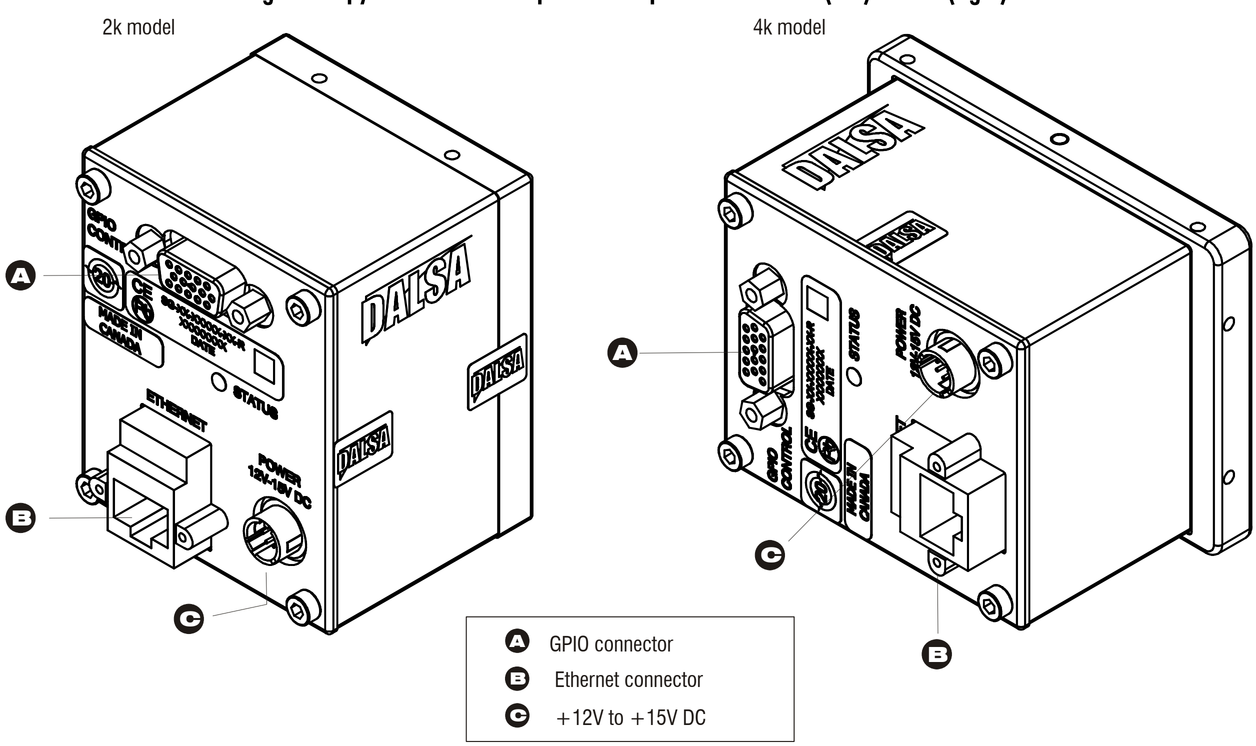
Standard mode is thus suitable for applications that require bandwidths of only 100 Mb/s or less. If this mode is used with bandwidths of 1 Gb/s, application performance will greatly degrade when CPU usage hits 100%. Additionally, at high rates like these, insufficient CPU resources may be available to process or even display images.

3.4 Camera Connectors

This camera uses the following connectors:

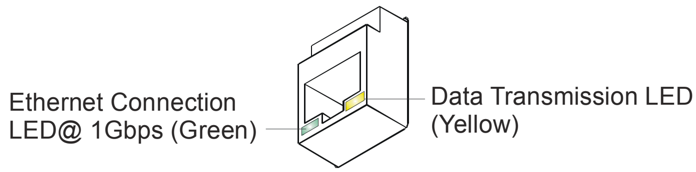
- An RJ-45 connector for Gigabit Ethernet signals, data signals, and serial communications. Refer to section Ethernet Connector for details.
- One 6-pin Hirose connector for power. Refer to section Power Connector for details.
- One 15-pin general purpose input/output (GPIO) connector. Refer to section GPIO Connector for details.

Figure 4: Spyder3 GEV Color Input and Output Connectors 2k (left) and 4k (right)



WARNING: It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages may damage the camera. See section 2.4 for more details.

Ethernet Connector



Ethernet Connection LED

Steady green indicated that an Ethernet connection is successfully established at 1 Gbps.

Data Transmission LED

Steady yellow indicates that the camera is ready for data transmission. Flashing yellow indicates that the camera is transmitting or receiving data.

Power Connector

Figure 5: Hirose 6-pin Circular Male—Power Connector

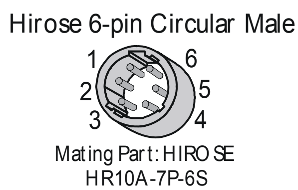


Table 4: Hirose Pin Description

Pin	Description	Pin	Description
1	Min +12 to Max +15V	4	GND
2	Min +12 to Max +15V	5	GND
3	Min +12 to Max +15V	6	GND

The camera requires a single voltage input (+12 to +15V). 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 **fast-blow fuse** between power supply and 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 **linear** supplies in order to minimize noise.

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

Run the **ReadVoltageAndTemperature** GenICam command to verify the voltage you are using.

GPIO Connector

The GPIO connector is used to receive or control external signals. For example, the GPIO connector can be used to receive EXSYNC, PRIN (pixel reset), and direction signals.

Figure 6: GPIO Connector and Pin Numbers

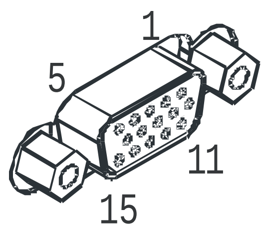


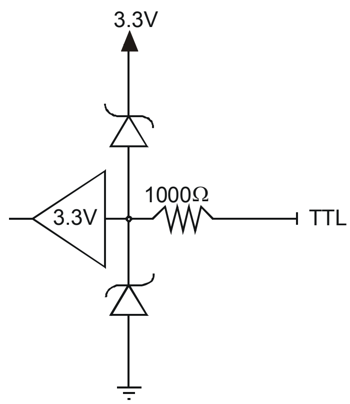
Table 5: GPIO Connector Pinout

Pin	Signal	Description	GenICam Default
1	INPUT_ 0+	LVDS/TTL format (positive)	EXSYNC +
2	INPUT_0-	LVDS (negative)	EXSYNC -
3	INPUT_1+	LVDS/TTL format (positive)	FrameTrig +
4	INPUT_1-	LVDS (negative)	FrameTrig -
5	GND		
6	INPUT_2+	LVDS/TTL format (positive)	Direction +
7	INPUT_2-	LVDS (negative)	Direction -
8	INPUT_3	TTL auxiliary input	
9	OUTPUT_3	TTL auxiliary output	
10	OUTPUT_2+	LVDS/TTL auxiliary output	
11	OUTPUT_0+	LVDS/TTL auxiliary output	
12	OUTPUT_0-	LVDS (negative)	
13	OUTPUT_1+	LVDS/TTL auxiliary output	
14	OUTPUT_1-	LVDS (negative)	
15	OUTPUT_2-	LVDS (negative)	

A schematic of the TTL input circuitry is shown in Figure 7: TTL Input Schematic. The input signals are fed into the engine from external sources via the GPIO connector.

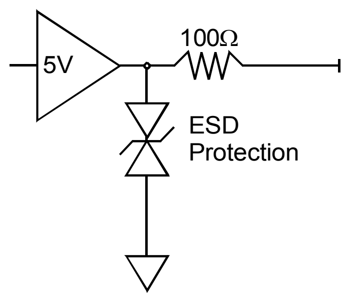
TTL Inputs and Outputs

Figure 7: TTL Input Schematic



- Termination: 1000 Ω series
- Input current: minimum 0 mA; maximum 2 mA
- Input voltage: maximum of low 0.66 V; minimum of high 2.6 V
- TTL inputs are 5V and 3.3V logic tolerant

Figure 8: TTL Output Schematic



- Termination: 100 Ω series
- Output current: sink 50 mA; source 50 mA
- Output voltage: maximum of low 0.55 V @ 32 mA; minimum of high 3.8 V @ 32 mA.

LVDS Inputs and Outputs (LVDS compliant)

Figure 9: LVDS Input

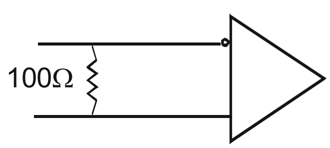
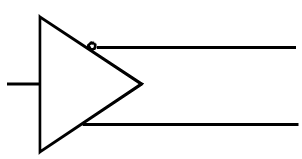


Figure 10: LVDS Output



GPIO Isolation

All of the GPIOs are isolated from the rest of the camera and the camera case. They are not isolated with respect to each other and share a common return (ground) through pin 5 of the GPIO connector.

Note: The shell connection of the GPIO connector is not isolated and it should not be used as a return (ground) for the GPIO signals. The shell connection is attached to the camera case.

Programming the GPIO Connector

The GPIO connector is programmed through the QuickCam application or through the QuickCam SDK.

After you have installed the QuickCam program, refer to the QuickCam User’s Manual or the QuickCam help topic, GPIO Control, for more information on programming this connector.

3.5 Camera LED

The camera is equipped with a red/green LED used to display the status of the camera's operation. 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. Error and warning states are accompanied by corresponding messages that further describe the current camera status.

Table 6: Diagnostic LED

Priority	Color of Status LED	Meaning
1	Flashing Red	Fatal Error. For example, camera temperature is too high and camera thermal shutdown has occurred.
2	Flashing Green	Camera initialization or executing a lengthy command (e.g., flat field correction commands).
3	Solid Green	Camera is operational and functioning correctly.

4

EMC Declaration

DALSA's SG-32 cameras meet the requirements outlined below which satisfy the EMC requirements for CE marking, the FCC Part 15 Class A requirements, and the Industry Canada requirements.

Model SG-32-04K80
The CE Mark Evaluation of the DALSA SG-32 Camera, which is manufactured by Dalsa Inc., meets the following requirements:
EN 55022 , EN 55011 , and FCC Part 15 Class A Emissions Requirements EN 61326-1 and EN 55024 Immunity to Disturbances
Models SG-32-02k 80
The CE Mark, FCC Part 15, and Industry Canada ICES-003 Evaluation of the DALSA Spyder3 GigE Camera meets the following requirements:
EN 55022 Class A, and EN 61326 Emissions Requirements EN 55024, and EN 61326 Immunity to Disturbances

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at the user's own expense.

Changes or modifications not expressly approved by DALSA could void the user's authority to operate the equipment.

Name and Signature of authorized person

Hank Helmond
Quality Manager, DALSA Corp.

5

Controlling the Camera

To control the camera, you have a choice of using the following:

- GenICam Interface. (See below).
- The DALSA QuickCam graphical user interface (GUI). QuickCam provides a quick and easy way to start imaging with the camera. All camera functionality can be controlled with the QuickCam application. QuickCam is available on the Spyder3 GigE Vision Color CD. Online Help is available through the QuickCam GUI. The QuickCam GUI can also be used to send ASCII commands to the camera.
- The DALSA QuickCam SDK. All the functionality of the QuickCam application is also available in custom built applications created using the Camera Interface Application SDK. You can also use the SDK to create a new, camera specific, interface. The SDK is available on the Spyder3 GigE Vision Color CD.
- ASCII commands. All of the camera's functionality is accessible through the camera's serial interface. A list of the available ASCII Commands can be found in the Appendix.

5.1 GenICam Interface

GenICam Environment

Spyder3 GEV cameras implement the GenICam™ specification, which defines the device capabilities.

The GenICam XML device description file is embedded within the Spyder firmware allowing GenICam applications to recognize the Spyder3 GEV cameras' capabilities immediately after connection. For more information about the GenApi module of the GenICam™ specification see www.genicam.org.

5.2 GenICam Commands: Reference

GenICam Register	Description	Values
AcquisitionLineRateAbs	This feature controls the rate (in Hertz) at which the Lines in a Frame are captured when TriggerMode is Off for the Line trigger.	300-18000 Hz for 2K and 300-9000Hz for 4K

BackgroundSubtractRaw	Subtract a background value from digitized image data (in DN)	
CalibrateWhiteBalance	Adjust the color gain so that each color's average is equal to the CalibrateWhiteBalanceTarget.	
CalibrateWhiteBalanceTarget	The goal of the CalibrateWhiteBlance command (in DN).	
ColorCorrectionInputChannel	Specifies the index for the color correction input value.	Red (0x0) Green (0x1) Blue (0x2) Offset (0x3)
ColorCorrectionOutputChannel	Specifies the color to correct using the color correction matrix.	Red (0x0) Green (0x1) Blue (0x2)
ColorCorrectionValueRaw	The colour correction value for the given indicies.	
ColorGainAbs	The gain in dB for a given color and tap.	
ColorGainReferenceAbs	The color gain reference value.	
ColorGainReferenceUpdate	Provides a new baseline for the colour gain. Sets the current colour gain value to 0.0 dB.	
ColorSelector	Selects which color to control.	All (0x0) Red (0x1) Green (0x2) Blue (0x3)
ColorTapSelector	Selects the tap to control.	All (0x0) Tap1(0x1) Tap2(0x2)
CorrectionSamples	The number of correction samples used in the PRNU and FPN calibration and white balance.	
DeviceID	This feature stores a camera identifier.	
DeviceManufacturerInfo	This feature provides extended manufacturer information about the device.	
DeviceMaxThroughput	This feature indicates the maximum bandwidth of data that can be streamed out of the device.	
DeviceModelName	This feature provides the model of the device.	
DeviceReset	This command is used to reset the device and to put it in its power up state.	
DeviceSerialNumber	The camera's serial number.	
DeviceTemperature	The camera's temperature in Celsius	
DeviceUserID	This feature stores a user-programmable identifier.	
DeviceVendorName	This feature provides the name of the manufacturer of the device.	
DeviceVersion	This feature provides the version of the device.	
DeviceVoltage	The camera's DC voltage(V).	
DigitalGainAbs	The digital gain amplification in dB.	
DigitalGainRaw	The digital gain in device units. The gain is limited by the highest ColorGain. The TotalColourGain (= DigitalGain * ColorGain) must be between -0.92 and 24 dB.	
ExposureMode	This feature is used to set the operation mode of the Exposure (or shutter).	Off (0x0) Timed (0x1) TriggerWidth (0x2)
ExposureTimeAbs	This feature is used to set the Exposure time (in	3-3300 µsec

	microseconds) when ExposureMode is Timed.	
ExternalDirection	Returns externally controlled direction.	
ExternalLineTriggerFrequency	Reads the external line trigger frequency.	
FPNCalibrate	Calculate the fixed pattern noise correction coeffients. This should be performed with a dark sensor.	
FPNEnabled	The state of the fixed pattern noise correction.	False (0x0) True (0x1)
FrameStartTriggerActivation	Specifies what type of signal (i.e. high, or low) causes a frame trigger.	
FrameStartTriggerMode	Specifies whether the external frame trigger is on or off.	
FrameTriggerActiveActivation	Specifies what type of signal(i.e. high, or low) causes a variable length frame trigger.	
FrameTriggerActiveMode	Specifies whether the external variable length frame trigger is on or off. This trigger takes precedence over the FrameStartTrigger.	
FrameTriggerSoftwareToggle	TriggerSoftware is a command that can be used by an application to generate an internal trigger when TriggerSource is set to Software.	
FrameTriggerSource	The line that triggers a frame trigger.	
LightSource	Specifies the adjustment to the color gain values for a given light source.	
LineConnectorPin	The physical pin used.	
LineFormat	This feature returns or sets (if possible) the current electrical format of the selected physical input or output Line.	NoConnect (0x0) TTL (0x2) LVDS (0x3)
LineFunction	Displays the line's function.	
LineSelector	This feature selects which physical line (or pin) of the external device connector to configure.	Line0(0x0) Line1(0x1) Line2(0x2) Line3(0x3)
LineTriggerActivation	Specifies what type of signal(i.e. high, or low) causes a line trigger.	
LineTriggerMode	The state of the line trigger. If the trigger is off, then the line trigger is internally generated otherwise it is caused by an external signal.	Off (0x0) On (0x1)
LineTriggerSource	The external line that causes a line trigger.	
PixelFormat		
PixelSetFPNSave	Saves the FPN Correction Coefficients (specified by the PixelSetSelector) to the camera's non-volatile memory.	
PixelSetLoad	Loads the Flat Field Correction Coefficients specified by the PixelSetSelector) from the cameras non-volatile.	
PixelSetPRNUSave	Saves the PRNU Correction Coefficients (specified by the PixelSetSelector) to the camera's non-volatile memory.	
PixelSetReset	Resets the Pixel Coefficients to effectively turn off flat field correction.	
PixelSetSelector	Selects the pixel set to load, save, and configure.	Default (0x0)

		Set N (0xN)
PRNUCalibrate	Performs a PRNU Calibration.	
PRNUCalibrationTarget	The target value of the PRNU calibration.	
PRNUEnabled	The state of the PRNU correction.	False (0x0) True (0x1)
ReadExternalLineFrequency	Read the external line trigger frequency and updates the ExternalLineTriggerFrequency register.	
ReadoutMode	Controls the way the dark current charge is cleared from the vertical transfer gates.	Auto (0x0) DarkCurrentClear (0x1) ImmediateReadout (0x2)
ReadSensorShiftExternalDirection	Read current direction of the external signal that controls the sensor shift direction.	
ReadVoltageAndTemperature	Voltage and temperature information	
RegionOfInterestWidth	The width of the region of interest.	
RegionOfInterestX	The starting horizontal position of the region of interest. The region of interest defines which pixels are used in calibration algorithms and end of line statistics.	
SensorShiftControl	CCD sensor shift direction.	
SensorShiftExternalActivation	Specifies the type of signal that will activate the external direction control signal.	
SensorShiftExternalSource	Displays the external source of the sensor shift signal.	
SensorShiftExternalDirection	The current sensor shift direction when the direction is externally controlled.	
TestImageSelector		
TotalColorGainAbs	Displays the combination of the ColorGain, ColorGainReference and DigitalGainAbs in dB.This value ranges from -0.92 to 24.0	

Camera Functions

Information and Description	5.4
Camera ID Camera Manufacturer External Line Trigger Frequency Model Name Maximum Throughput Serial Number User ID Vendor Name Version	5.4

Color Selection and Output	5.5
Color Selection Scanning Direction Region of Interest (ROI)	5.5

Exposure and Synchronization	5.6
Timing Exposure Modes Readout Mode Line Rate Frame Rate Exposure Time	5.6

GPIO Setting	5.7
Line Selection Line Format	5.7

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Test Patterns Temperature Measurement Voltage Measurement Signal Measurement Errors	5.11

5.3 First Power Up Camera Settings

When the camera is powered up for the first time, it operates using the following factory settings:

- Forward CCD shift direction.
- Internal line trigger mode. Timed exposure mode.
- 800 Hz (4k) and 1600 Hz (2k) line rates.
- Factory calibrated analog gain and offset.
- Factory calibrated FPN and PRNU coefficients using the following process: line rate of 800 Hz (4k) and 1600 Hz (2k), analog gain calibrated to an average pixel value of 248, 8 bit output.

5.4 Camera Information

The following commands retreive camera information:

DeviceID	Camera identifier.
DeviceManufacturerInfo	Provides extended manufacturer information about the device.
DeviceModelName	Provides the model of the device.
DeviceMaxThroughput	Provides the value of the maximum bandwidth of data that can be read from the camera
DeviceSerialNumber	The camera's serial number.
DeviceUserID	Stores a user-programmable identifier.
DeviceVendorName	Provides the name of the manufacturer of the device.
DeviceVersion	Provides the version of the device.
ExternalLineTriggerFrequency	Reads the external line trigger frequency.
ReadoutExternalLineFrequency	Reads the external line trigger frequency and updates the register.
ReadVoltageAndTemperature	Voltage and temperature information.

5.5 Output Format

Pixel Format

Selects the camera’s pixel format: Mono/Green only, or RGB.

GEN<i>CAM

PixelFormat
Mono 8. 1 tap, internal, Mono/GreenOnly.
RGB 8 Packed. 24 bit RGB pixel, 1 tap, 40 MHz data rate, 2048 total pixels.

CCD Shift Direction

Use this command to select the forward or reverse CCD shift direction or external direction control. This accommodates object direction change on a web and allows you to mount the camera "upside down".

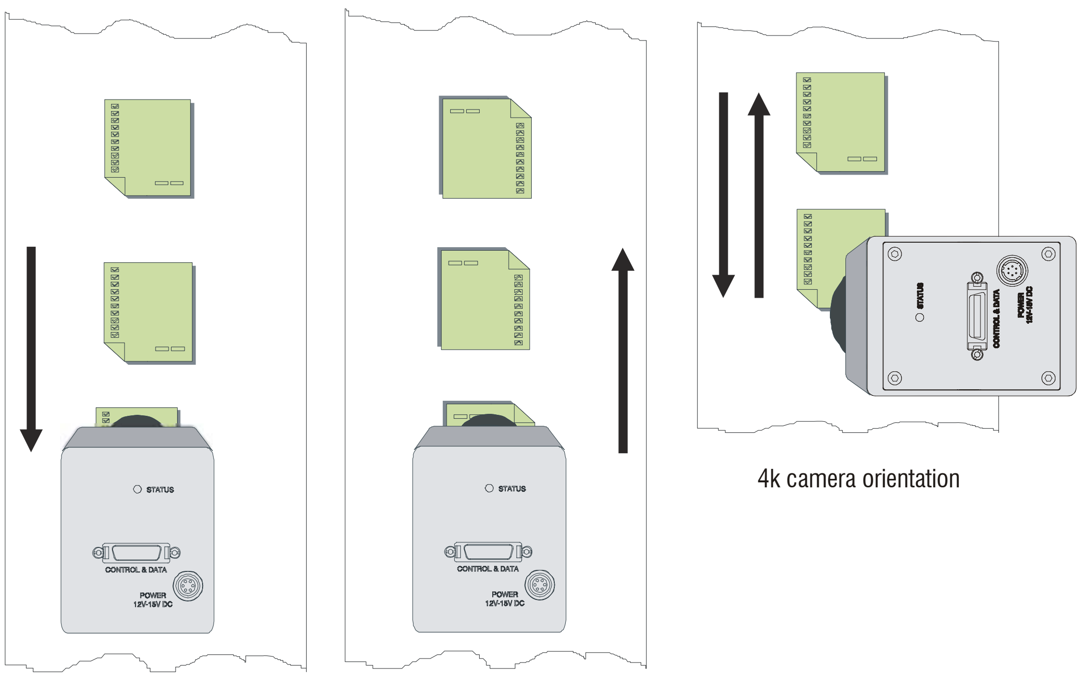
```
SensorShiftMode
Forward (0x0)
Reverse (0x1)
External (0x2)
```

- Refer to Figure 11: Object Movement and Camera Direction Example using an Inverting Lens for an illustration of when you should use forward or reverse shift direction.

Sensor Shift Direction

You can select either forward or reverse CCD shift direction. Selectable direction accommodates object direction change on a web and allows you to mount the camera "upside down."

Figure 11: Object Movement and Camera Direction Example using an Inverting Lens



Arrows denote direction of object movement

4k camera orientation

Camera should operate in **reverse** shift direction SensorShiftMode 1

Camera should operate in **forward** shift direction SensorShiftMode 0

Note: You can control the CCD shift direction through the serial interface. Use the software command **SensorShiftMode** to determine whether the direction control is set via software control or via the Camera Link control signal on CC3. Refer to the CCD Shift Direction section of this manual, page 36, for details.

Setting a Region of Interest (ROI)

The region of interest (ROI) crops the image to a specified height and width.

The ROI also sets the pixel range used to collect the end-of-line statistics and sets the region of pixels used in the **FPNCalibrate** commands.

In most applications, the field of view exceeds the required object size and these extraneous areas should be ignored. It is recommended that you set the region of interest a few pixels inside the actual useable image.

GEN<i>CAM

RegionOfInterestX. The starting x position of the ROI, in a value of 1 to sensor resolution.
RegionOfInterestWidth. The Width of the ROI, in a value of 1 to sensor resolution.

Related Commands: **FPNCalibrate**, **PRNUCalibrate**

5.6 Timing: Exposure and Synchronization

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

Free running (trigger disabled): The camera free-running mode has a programmable internal timer for frame rate and a programmable exposure period. Frame rate is 0.1 fps to the maximum supported by the sensor. Exposures range from the sensor minimum to a maximum also dependent on the current frame rate. This always uses Synchronous mode where exposure is aligned to the sensor horizontal line timing.

External trigger: Exposures are controlled by an external trigger signal. External signals are isolated by an opto-coupler input with a time programmable debounce circuit. The following section provides information on external trigger timing.

Software trigger: An exposure trigger is sent as a control command via the network connection. Software triggers can not be considered time accurate due to network latency and sequential command jitter. But a software trigger is more responsive than calling a single-frame acquisition (Snap command) since the latter must validate the acquisition parameters and modify on-board buffer allocation if the buffer size has changed since the last acquisition.

Timing

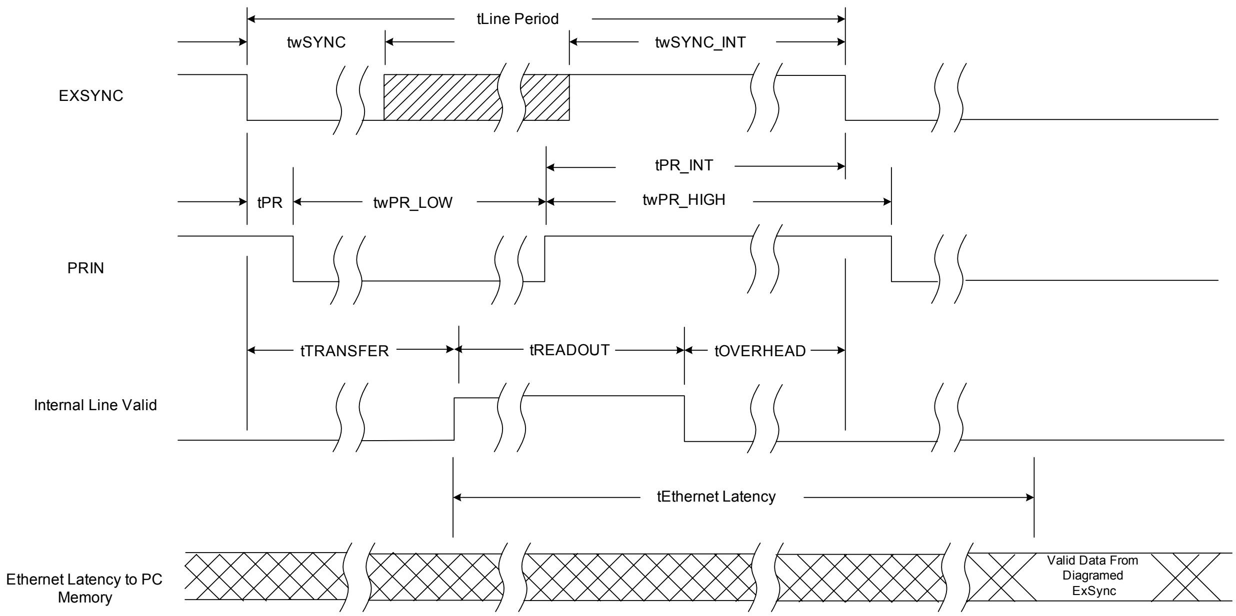


Table 7: Timing Parameter Table

	Units	Min.	Typ.	Max.	Notes
tLine_Period	μs	55.55 (2k) 110.9 (4k)		1000	2K
		27		1000	4k
twSync	ns	100			
twSYNC_INT	ns	100 (3000*)			For exposure mode 4 this value needs to be >3000ns other wise >100ns
tPR	ns	0			
twPR_LOW	ns	3000			
twPR_HIGH	ns	3000			
tPR_INT	ns	3000			

Table 8: tReadout Values

tREADOUT		
Sensor Size	**# Taps**	**Readout Time**
2048	2	51200 ns
4096	2	104275 ns

Table 9: tOverhead Values

tOVERHEAD		
Sensor Size	# Taps	Readout Time
2048	2	725ns

Overhead Delay

Overhead_Delay can range from 5 to 6μs and depends on the internal operations of your computer.

Exposure Mode, Readout Mode, Line Rate and Exposure Time

Overview

The camera's line rate (synchronization) can be generated internally through the GenICam command **AcquisitionLineRateAbs** or set externally with an EXSYNC signal, depending on your mode of operation.

To select how you want the camera's line rate to be generated:

1. First set the camera mode using **ExposureMode** and **LineTriggerMode** commands.
2. Next, if using mode 2, 6, or 7 (see below) use the commands **AcquisitionLineRateAbs** and/or **ExposureTimeAbs** to set the line rate and exposure time.

1. Set the Exposure Mode

Sets the camera's exposure mode allowing you to control your sync, exposure time, and line rate generation.

```
ExposureMode
Off (0x0)
Timed (0x1)
TrigerWidth (0x2)

LineTriggerMode
Off (0x0) - Internal
On (0x1) - External
```

- Refer to the following table for a list of available modes, or to the following sections for a more detailed explanation.

Related Commands: **AcquisitionLineRateAbs**, **ExposureTimeAbs**

Table 10: Spyder3 GigE Vision Color Exposure Modes

Mode	LineTriggerMode	ExposureMode	Programmable Line Rate	Programmable Exposure Time	Description
2	Off (Internal)	Timed (Internal)	Yes	Yes	Internal line rate and exposure time. Exposure mode enabled (ECE).
3	On (External)	Off (Internal)	No	No	Maximum exposure time. Exposure control disabled (ECD).
4	On (External)	TriggerWidth (Internal)	No	No	Smart EXSYNC. ECE.
6	On (External)	Timed (Internal)	No	Yes	Fixed integration time. ECE.
7	Off (Internal)	Off (Internal)	Yes	No	Internal line rate, maximum exposure time. ECD.

Note: When setting the camera to external signal modes, EXSYNC must be supplied.

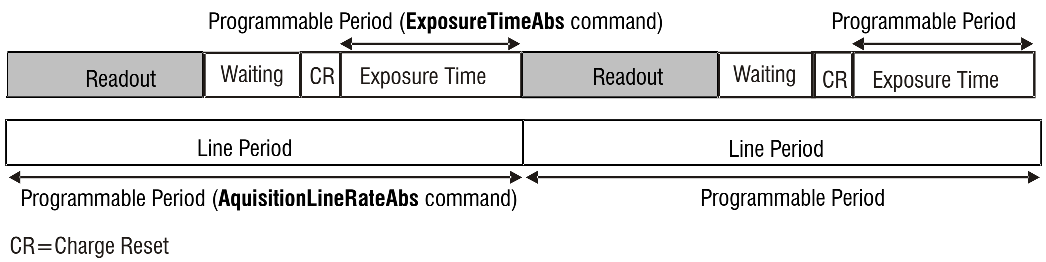
Exposure Modes in Detail

Mode 2. Internally Programmable Line Rate and Exposure Time (Factory Setting): ExposureMode Timed and LineTriggerMode Off (Internal)

Operates at a maximum line rate and exposure time.

- When setting the line rate (using the **AcquisitionLineRateAbs** command), exposure time will be reduced, if necessary, to accommodate the new line rate. The exposure time will always be set to the maximum time (line period – line transfer time – pixel reset time) for that line rate when a new line rate requiring reduced exposure time is entered.
- When setting the exposure time (using the **ExposureTimeAbs** command), line time will be increased, if necessary, to accommodate the exposure time. Under this condition, the line time will equal the exposure time + line transfer time.

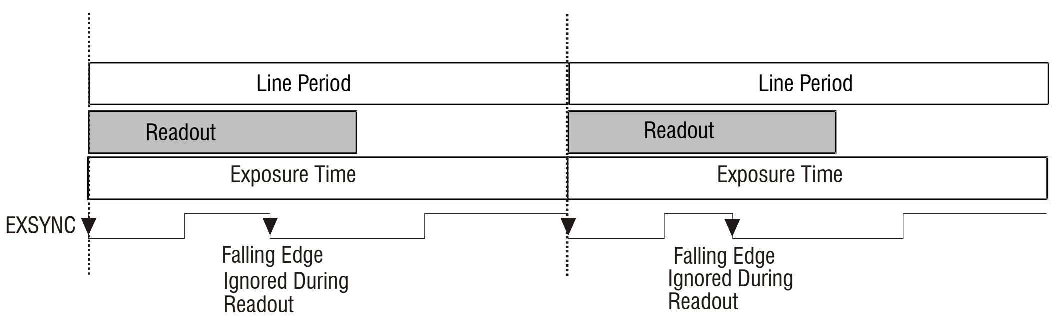
Example 1: Exposure Time less than Line Period



Mode 3. External Trigger with Maximum Exposure: ExposureMode Off and LineTriggerMode On (External)

Line rate is set by the period of the external trigger pulses. The falling edge of the external trigger marks the beginning of the exposure.

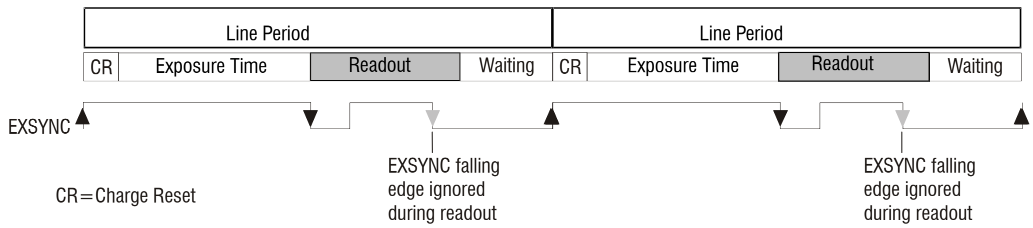
Example 2: Line Rate is set by External Trigger Pulses.



Mode 4. Smart EXSYNC, External Line Rate and Exposure Time: ExposureMode TriggerWidth and LineTriggerMode On (External)

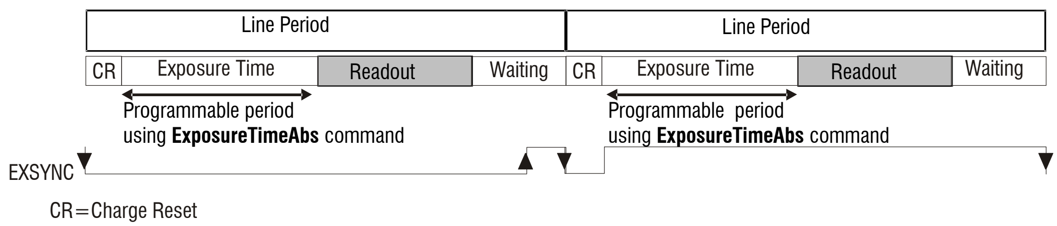
In this mode, EXSYNC sets both the line period and the exposure time. The rising edge of EXSYNC marks the beginning of the exposure and the falling edge initiates readout.

Example 3: Trigger Period is Repetitive and Greater than Read Out Time.



Mode 6. External Line Rate and Internally Programmable Exposure Time: ExposureMode Timed and LineTriggerMode On (External)

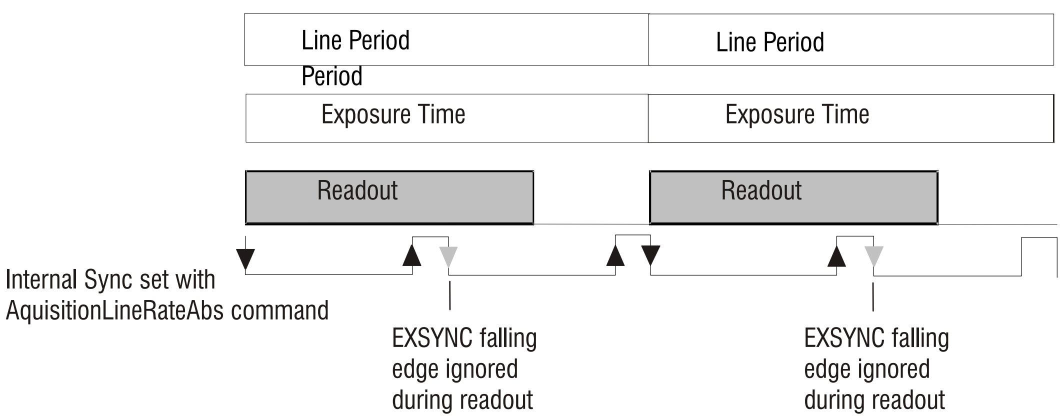
Figure 12: EXSYNC controls Line Period with Internally controlled Exposure Time



Mode 7. Internally Programmable Line Rate, Maximum Exposure Time: ExposureMode Off and LineTriggerMode Off (Internal)

In this mode, the line rate is set internally with a maximum exposure time.

Figure 13: Mode 7 Camera Timing



Setting the Readout Mode

Refer to the Clearing Dark Current section, page 59, for more information on this feature.

Use this command to clear out dark current charge collected in the vertical transfer gates immediately before the sensor is read out.

GEN<i>CAM

ReadoutMode
Auto. Clears dark current below ~ 45% of the maximum line rate.
DarkCurrent. Dark current clear. Always clears dark. Reduces the maximum line rate.
ImmediateReadout. Immediate readout. Does not clear dark current. (Default mode.)

- The vertical transfer gates collect dark current during the line period. This collected current is added to the pixel charge. This additional charge is especially noticeable at slower line rates.
- This value is saved with the camera settings.

Related Commands: **DALSAExposureMode, AcquisitionLineRateAbs**

Setting the Line Rate

Applies to Modes 2 and 7

Sets the camera's line rate in Hz. Camera must be operating in exposure mode 2 or 7.

GEN<i>CAM

AcquisitionLineRateAbs = line rate in Hz.

Syntax Elements: **i**

Desired line rate in Hz. Allowable values are:

2k: **300-17900** Hz

4k: **300-9000** Hz

Related Commands: **DALSAExposureMode, ExposureTimeAbs**

Setting the Exposure Time

Applies to Modes 2 and 6

Sets the camera's exposure time in µs. Camera must be operating in mode 2 or 6.

GEN<i>CAM

ExposureTimeAbs = exposure time in µs. Allowable range is 3 to 3300 µs.*

- If you enter an invalid line rate frequency, an error message is returned.
- *The exposure time range is based on the current line rate.

Related Commands: **DALSAExposureMode, AcquisitionLineRateAbs**

5.7 Configuring the GPIO Connector

The following commands provide a connection between the GPIO controller and the camera’s internal functions.

Setting the GPIO Output Number

Sets the signal type for the selected output.

GEN<i>CAM

`LineSelector`
Line0 (0x0). Output 0, pin 11 (TTL) or 11 and 12 (LVDS)
Line1 (0x1). Output 1, pin 13 (TTL) or 13 and 14 (LVDS)
Line2 (0x2). Output 2, pin 15 (TTL) or 15 and 10 (LVDS)

If you enter an invalid configuration, an error message is returned.

Setting the GPIO Signal

Sets the signal type for the selected input.

GEN<i>CAM

LineFormat[LineSelector]
NoConnect (0x0)
TTL (0x2)
LVDS (0x3)
If you enter an invalid configuration, an error message is returned.

5.8 Data Processing

Digital Signal Processing Chain

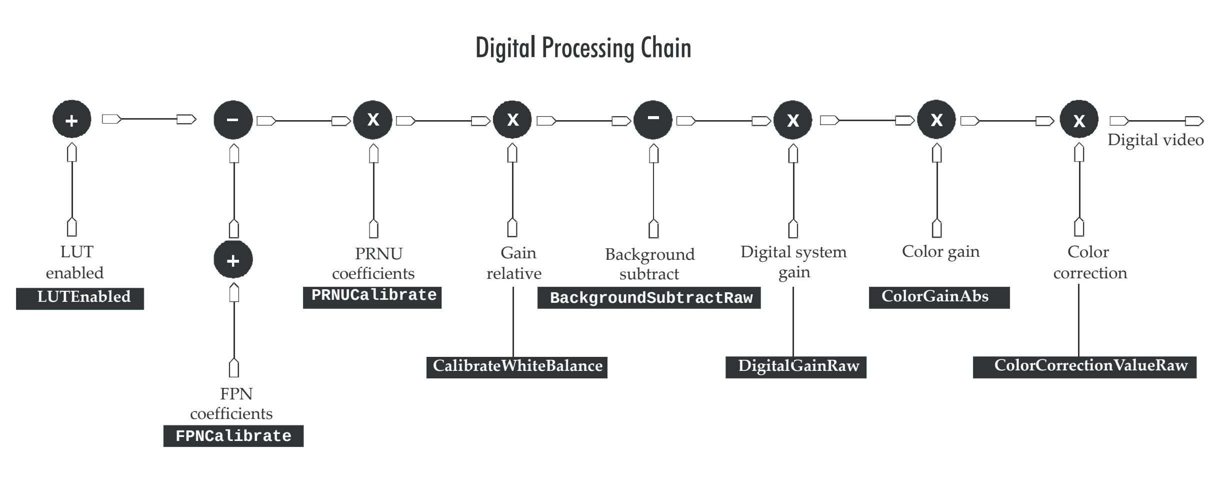
Processing Chain Overview and Description

The following diagram shows a simplified block diagram of the camera's digital processing chain.

The digital processing chain contains the FPN correction, the PRNU correction, the background subtract, and the digital gain and offset adjustments.

These elements are user programmable.

Figure 14: Signal Processing Chain



Digital Processing

1. Fixed pattern noise (FPN) calibration (calculated using the **`FPNCalibrate`** command) is used to subtract away individual pixel dark current.

2. Photo-Response Non-Uniformity (PRNU) coefficients (calculated using the **`PRNUCalibrate`** commands) are used to correct the difference in responsivity of individual pixels (i.e. given the same amount of light different pixels will charge up at different rates) and the change in light intensity across the image either because of the light source or due to optical aberrations (e.g. there may be more light in the center of the image). PRNU coefficients are multipliers and are defined to be of a value greater than or equal to 1. This ensures that all pixels will saturate together.

3. Background subtract (**`BackgroundSubtractRaw`** command) and system (digital) gain (**`DigitalGainRaw`** command) are used to increase image contrast after FPN and PRNU calibration. It is useful for systems that process 8-bit data but want to take advantage of the camera's 12 bit digital processing chain. For example, if you find that your image is consistently between 128 and 255 DN (8 bit), you can subtract off 128 (**`BackgroundSubtractRaw 2048`**) and then multiply by 2 (**`DigitalGainRaw 8192`**) to get an output range from 0 to 255.

Calibrating the Camera to Remove Non-Uniformity (Flat Field Correction)

Flat Field Correction Overview

This camera has the ability to calculate correction coefficients in order to remove non-uniformity in the image. This video correction operates on a pixel-by-pixel basis and implements a two point correction for each pixel. This correction can reduce or eliminate image distortion caused by the following factors:

- Fixed Pattern Noise (FPN)
- Photo Response Non Uniformity (PRNU)
- Lens and light source non-uniformity

Correction is implemented such that for each pixel:

$$V_{output} = [(V_{input} - FPN(pixel) - digital\ offset) * PRNU(pixel) - Background\ Subtract] \times System\ Gain$$

where	V_{output}	=	digital output pixel value
	V_{input}	=	digital input pixel value from the CCD
	PRNU(pixel)	=	PRNU correction coefficient for this pixel
	FPN(pixel)	=	FPN correction coefficient for this pixel
	Background Subtract	=	background subtract value
	System Gain	=	digital gain value

The algorithm is performed in two steps. The fixed offset (FPN) is determined first by performing a calibration without any light. This calibration determines exactly how much offset to subtract per pixel in order to obtain flat output when the CCD is not exposed.

The white light calibration is performed next to determine the multiplication factors required to bring each pixel to the required value (target) for flat, white output. Video output is set slightly above the brightest pixel (depending on offset subtracted).

Flat Field Correction Restrictions

It is important to do the FPN correction first. Results of the FPN correction are used in the PRNU procedure. We recommend that you repeat the correction when a temperature change greater than 10°C occurs or if you change the analog gain, integration time, or line rate.

Note: If your illumination or white reference does not extend the full field of view of the camera, the camera will send a warning.

PRNU correction requires a clean, white reference. The quality of this reference is important for proper calibration. White paper is often not sufficient because the grain in the white paper will distort the correction. White plastic or white ceramic will lead to better balancing.

For best results, ensure that:

- 50 or 60 Hz ambient light flicker is sufficiently low not to affect camera performance and calibration results.
- For best results, the analog gain should be adjusted for the expected operating conditions and the ratio of the brightest to darkest pixel in a tap should be less than 3 to 1 where:

$$3 > \frac{\text{Brightest Pixel (per tap)}}{\text{Darkest Pixel (per tap)}}$$

- The camera is capable of operating under a range of 8 to 1, but will clip values larger than this ratio.
- The brightest pixel should be slightly below the target output.
- When 6.25% of pixels from a single row within the region of interest are clipped, flat field correction results may be inaccurate.
- Correction results are valid only for the current analog gain and offset values. If you change these values, it is recommended that you recalculate your coefficients.

Calibration Overview

When a camera images a uniformly lit field, ideally, all of the pixels will have the same gray value. However, in practice, this is rarely the case (see example below) as a number of factors can contribute to gray scale non-uniformity in an image: Lighting non-uniformities and lens distortion, PRNU (pixel response non-uniformity) in the imager, FPN (fixed pattern noise) in the imager, etc.

Figure 15. Image with non-uniformities

By calibrating the camera you can eliminate the small gain difference between pixels and compensate for light distortion. This calibration employs a two-point correction that is applied to the raw value of each pixel so that non-uniformities are flattened out. The response of each pixel will appear to be virtually identical to that of all the other pixels of the sensor for an equal amount of exposure.

Camera Calibration Wizard

DALSA strongly recommends that you use the QuickCam Calibration Wizard to calibrate the camera. This is the fastest and easiest way.

Manual calibration instructions using the ASCII commands are available in Appendix C.

Digital Signal Processing

FPN Correction

Performing FPN Correction

Performs FPN correction and eliminates FPN noise by subtracting away individual pixel dark current.

GEN<i>CAM

`FPNCalibrate`

- Perform all analog and digital adjustments before performing FPN correction.
- Perform FPN correction before PRNU correction.
- Refer to Calibrating the Camera to Remove Non-Uniformity (Flat Field Correction) on page 46 for a procedural overview on performing flat field correction.
- To save FPN coefficients after calibration, use the **`PixelSetFPNSave`** command. Refer to section Saving and Restoring PRNU and FPN Coefficients for details.

Related Commands: **`PixelSetFPNSave`**

PRNU Correction White Balance

Performing PRNU to a user entered value

Purpose: Performs PRNU calibration to user entered value and eliminates the difference in responsivity between the most and least sensitive pixel creating a uniform response to light. Using this command, you must provide a calibration target.

Executing these algorithms causes the **BackgroundSubtractRaw** command to be set to 0 (no background subtraction) and the **DigitalGainRaw** command to 4096 (unity digital gain). The pixel coefficients are disabled (**PRNUEnabled 0**) during the algorithm execution but returned to the state they were prior to command execution.

GEN<i>CAM

PRNUCalibration = [PRNUCalibrationTarget]

PRNU calibration algorithm calculates the PRNU coefficients using the entered target value as shown:

$$\text{PRNU Coefficient}_i = \frac{\text{Target}}{(\text{AVG Pixel Value}_i)}$$

The calculation is performed for all sensor pixels but warnings are only applied to pixels in the region of interest. This algorithm is useful for achieving uniform output across multiple cameras. Is important that the target value (set with the next parameter) is set to be at least equal to the highest pixel across all cameras so that all pixels can reach the highest pixel value during calibration.

Peak target value in a range from 1024 to 4055 DN. The target value must be greater than the current peak output value.

- Calibrate FPN before calibrating PRNU. If you are not performing FPN calibration then issue the **PixelSetReset** (reset pixel coefficients) command.

Subtracting Background

Use the background subtract command after performing flat field correction if you want to improve your image in a low contrast scene. This command is useful for systems that process 8 bit data but want to take advantage of the camera's 12 bit digital processing chain. You should try to make your darkest pixel in the scene equal to zero.

GEN<i>CAM

BackgroundSubtractRaw = Subtracted value in a range in DN from 0 to 4095

- When subtracting a digital value from the digital video signal the output can no longer reach its maximum. Use the **DigitalGainRaw** command to correct for this where:

$$\text{DigitalGainRaw} = \frac{\text{max output value}}{\text{max output value - BackgroundSubtractRaw value}}$$

See the following section for details on the DigitalGainRaw command.

Related Commands: **DigitalGainRaw**

Digital System Gain

Improves signal output swing after a background subtract. When subtracting a digital value from the digital video signal, using the **`BackgroundSubtractRaw`** command, the output can no longer reach its maximum. Use this command to correct for this where:

$$\text{DigitalGainRaw} = \frac{\text{max output value}}{\text{max output value - BackgroundSubtractRaw value}}$$

GEN<i>CAM

`DigitalGainRaw` = Gain The gain ranges are 1 to 65535

Gain setting. The gain ranges are 1 to **`65535`**. The digital video values are multiplied by this value where:

$$\text{Digital Gain} = \frac{i}{4096}$$

Use this command in conjunction with the **`BackgroundSubtractRaw`** command.

- 4k model limited to 12953 (0 dB effective at factory set analog gain of -10 dB).

Related Commands: **`BackgroundSubtractRaw`**

Enabling and Disabling Pixel Coefficients

Enable FPN coefficients

Enables and disables FPN coefficients.

GEN<i>CAM

```
FPNEnabled
False (0x0). FPN coefficients disabled.
True (0x1). FPN coefficients enabled.
```

Enable PRNU coefficients

Enables and disables PRNU coefficients.

GEN<i>CAM

```
PRNUEnabled
False (0x0). PRNU coefficients disabled.
True (0x1). PRNU coefficients enabled.
```

5.9 Color Correction Matrix

The color matrix adds color space conversion functionality to the camera, allowing you to improve the color response.

A color space is a way to manage the display of image color using a three-dimensional coordinate system. Different color spaces are best for different devices, such as RGB (red-green-blue) for CRT monitors or YCbCr (luminance-chrominance) for digital television.

The color correction matrix provides a flexible and efficient means to convert image data from one color space to another, using user-entered multipliers. This process is suitable for use in a wide variety of image processing and display applications.

The primary purpose of the color correction is to make color display better on the output device (i.e CRT, LCD, Plasma, etc.).

In order to get the decimal equivalent multiplication, every number in the table has to be divided by 4096

The table should be read as follows:

```
RED = 4096(/4096)*RED + 0*GREEN + 0*BLUE + Offset

GREEN = 0*RED + 4096(/4096)*GREEN + 0*BLUE + Offset

BLUE = 0*RED + 0*GREEN + 4096(/4096)*BLUE + Offset
```

The default values in the color correction matrix are:

```
Color Correction:      O    r       g      b

                     r 0    4096    0      0

                     g 0    0    4096      0

                     b 0    0       0   4096
```

An example on how to use the color matrix

After calibrating the camera and reviewing the output, you determine that you need to increase and add more green to your red output.

The registers **ColorCorrectionInputChannel** and **ColorCorrectionOutputChannel** are used to choose locations in the table: ColorCorrectionInputChannel specifies the input channel and ColorCorrectionOutputChannel specifies the output channel.

The register **ColorCorrectionValueRaw** specifies the correction coefficient.

Starting with the default values:

```
Color Correction:

                    Input Channel   r       g       b
Output Channel   r               4096       0       0
                 g                  0    4096       0
                 b                  0       0    4096
```

Default values 4096

```
OK>ColorCorrectionInputChannel Red
OK>ColorCorrectionOutputChannel Red
OK>ColorCorrectionValueRaw 8191
```

```
Color Correction:
          r       g       b
r      8191       0       0
g         0    4096       0
b         0       0    4096
```

Increase Red input and output to 8191

```
OK>ColorCorrectionInputChannel Green
OK>ColorCorrectionValueRaw 2048
```

```
Color Correction:
          r       g       b
r      8191    2048       0
g         0    4096       0
b         0       0    4096
```

Increase Green Input to 2048 (maintaining Red output)

Ending with an increase of red and green in the red output.

Set Color Correction Input

Specifies the input channel.

GENICAM

ColorCorrectionInputChannel
Red (0x0)
Green (0x1)
Blue (0x2)

Related commands:

ColorCorrectionValueRaw, ColorCorrectionOutputChannel

Set Color Correction Output

Specifies the output channel.

GENICAM

ColorCorrectionOutputChannel
Red (0x0)
Green (0x1)
Blue (0x2)

Related commands:

ColorCorrectionValueRaw, ColorCorrectionInputChannel

Set Color Correction

Specifies the color correction coefficient. In a range -32000 to 32000.

GEN<i>CAM **ColorCorrectionValueRaw** [ColorCorrectionSelectorX] [ColorCorrectionSelectorY]

Related commands:

ColorCorrectionOutputChannel, ColorCorrectionInputChannel

5.10 Saving and Restoring Settings

For each camera operating mode the camera has distinct factory settings, current settings, and user settings. In addition, there is one set of factory pre-calibrated pixel coefficients and up to four sets of user created pixel coefficients for each operating mode.

Factory Settings

On first initialization, the camera operates using the factory settings.

User Settings

You can save or restore your user settings to non-volatile memory using the following commands. Pixel coefficients are stored separately from other data.

- To save your current user settings to EEPROM, use the command **UserSetSave**. The camera will automatically restore the saved user settings when reset/powered up. **Note:** While settings are being written to nonvolatile memory, do not power down camera or camera memory may be corrupted.
- To restore the last saved user settings, use the command **UserSetLoad**.
- To save the current pixel coefficients, use the command **PixelSetPRNUSave** and **PixelSetFPNSave**.
- To restore the last saved pixel coefficients, use the command **PixelSetLoad**.

Current Session Settings

These are the current operating settings of your camera. To save these settings to non-volatile memory, use the command **UserSetSave**.

Saving and Restoring PRNU and FPN Coefficients

Saving the Current PRNU Coefficients

Saves the current PRNU coefficients.

GEN<i>CAM

PixelSetSelector / PixelSetPRNUSave

4k model **PixelSetSelector =** set 1, set 2, set 3, set 4

PixelSetPRNUSave = Executes the command

Saving the Current FPN Coefficients

Saves the current FPN coefficients.

PixelSetSelector / PixelSetFPNSave

4k model **PixelSetSelector =** set 1, set 2, set 3, set 4

PixelSetFPNSave = Executes the command.

Loading a Saved Set of Coefficients

Loads a saved set of pixel coefficients.

PixelSetLoad[PixelSetSelector]

Related commands: **PixelSetPRNUSave, PixelSetFPNSave**

Resetting the Current Pixel Coefficients

Resets the current pixel coefficients to zero. This command does not reset saved coefficients.

FFCCalibrationReset

Rebooting the Camera

The command **DeviceReset** reboots the camera. The camera starts up with the last saved settings and the baud rate used before reboot. Previously saved pixel coefficients are also restored.

DeviceReset

5.11 Diagnostics

Generating a Test Pattern

Generates a test pattern to aid in system debugging. The test patterns are useful for verifying camera timing and connections. The following tables show each available test pattern.

Note: The test patterns below are with unity gain for all color gains. Altering the color gains will alter the hue of the test pattern.

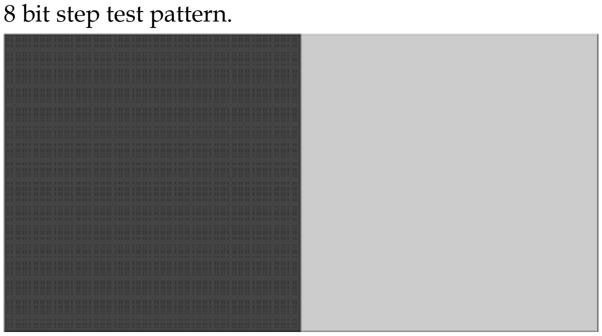
GEN<i>CAM

```
TestImageSelector
Off(0x0) - Video
IPEngineTestPattern(0x80000000) - Ethernet test pattern ( no serial
command)
GreyHorizontalStep(0xC)
GreyHorizontalPeak(0xD)
```

Video

8 bit test pattern

8 bit step test pattern.

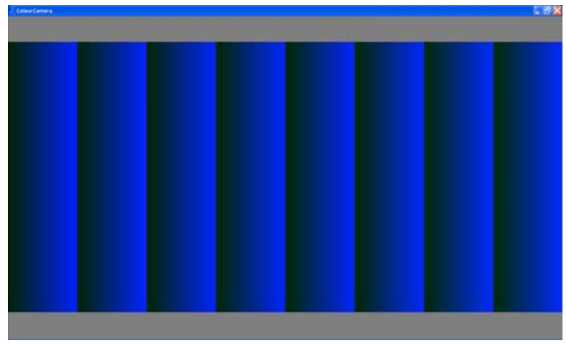


Ethernet Test Pattern

A third test pattern—Ethernet—is accessible using the GUI.

Purpose:	Generates a test pattern to aid in system debugging. The test patterns are useful for verifying camera timing and connections. The following table shows the Ethernet test pattern available through the GUI.
Availability:	Select the IP Engine tab in the configuration window. Expand the IP engine Node and check the Emit Test Pattern Check box

Ethernet.



Temperature Measurement

To determine the temperature of the camera, use the **`DeviceTemperature`** command. This command will return the internal chip case temperature in degrees Celsius. For proper operation, this value should not exceed 75°C.

Note: If the camera reaches 75°C, the camera will shutdown and the LED will flash red. If this occurs, the camera must be rebooted using the command, **`DeviceReset`** or can be powered down manually. You will not be able to restart the camera until the temperature is less than 65°C. You will have to correct the temperature problem or the camera will shutdown again. The camera allows you to send the verify temperature command while it is in this state.

`DeviceTemperature`

Voltage Measurement

The command **`DeviceVoltage`** displays the camera's input voltage. Note that the voltage measurement feature of the camera provides only approximate results (typically within 10%). The measurement should not be used to set the applied voltage to the camera, but only used as a test to isolate gross problems with the supply voltage.

`DeviceVoltage`

Camera Frequency Measurement

Purpose:	Returns the frequency for the requested Camera Link control signal
Syntax:	**`ExternalLineTriggerFrequency`**
	Signal to measure: EXSYNC
Note:	• Camera operation may be impacted when entering the gsf command (i.e., poor time response to direction change or video may have artifacts (gain changes) for several lines while the camera returns signal information) • This command is not available when operating the camera with external CCD direction control.

Error Handling

The following table lists warning and error messages and provides a description and possible cause.

Warning messages are returned when the camera cannot meet the full value of the request; error messages are returned when the camera is unable to complete the request.

Table 11: Warning and Error Messages

Message	Description
OK>	Command sent and executed successfully.
Warning 01: Outside of specification>	The parameter accepted was outside of specified operating range (e.g. gain greater than ± 20 dB of factory setting).
Warning 02: Clipped to min>	Parameter was clipped to the current operating range. Use the **`gcp`** command to see the value used.
Warning 03: Clipped to max>	Parameter was clipped to the current operating range. Use the **`gcp`** command to see the value used.
Warning 04: Related parameters adjusted>	Parameter was clipped to the current operating range. Use the **`gcp`** command to see the value used.
Warning 05: Can't set LVDS for this GPIO signal	Input 3 and Output 3 cannot be set to use an LVDS signal.
Warning 07: Coefficient may be inaccurate A/D clipping has occurred>	In the region of interest (ROI) greater than 6.251% single or 1% of averaged pixel values were zero or saturated.
Warning 08: Greater than 1% of coefficients have been clipped>	A FPN/PRNU has been calculated to be greater than the maximum allowable 511 (8).
Warning 09: Internal line rate inconsistent with readout time>	
Warning 10: TX timeout recovery>	Potential loss of data during the last command response.

Message	Description
Message	**Description**
Error 02: Unrecognized command>	Command is not available in the current access level or it is not a valid command.
Error 03: Incorrect number of parameters>	
Error 04: Incorrect parameter value>	This response returned when: · Alpha received for numeric or vice versa · Not an element of the set of possible values. E.g., Baud Rate · Outside the range limit
Error 05: Command unavailable in this mode>	Command is valid at this level of access, but not effective. E.g. line rate when in smart EXSYNC mode.
Error 06: Timeout>	Command not completed in time. E.g. FPN/PRNU calculation when no external EXSYNC is present.
Error 07: Camera settings not saved>	Tried saving camera settings but they cannot be saved.
Error 08: Unable to calibrate - tap outside ROI>	Cannot calibrate a tap that is not part of the region of interest.
Error 09: The camera's temperature exceeds the specified operating range>	Indicates that the camera has shut itself down to prevent damage from further overheating.

Appendix A

Clearing Dark Current

Gate Dark Current Clear

Image sensors accumulate dark current while they wait for a trigger signal. If the readout is not triggered in a reasonable amount of time, then this dark current accumulation may increase to an excessive amount. The result of this happening will be that the first row, and possibly additional rows (frames), of the image will be corrupt.

The sensor used in the Spyder3 GEV camera contains two sources of dark current that will accumulate with time: 1) in the photo sensitive area, and 2) in the gates used to clock-out the charge.

The gate dark current can account for approximately 20% of the total dark current present. While the exposure control has direct control over the amount of dark current in the photo sensitive area, it has no control over the charge accumulated in the gates. Even with exposure control on, at low line rates, this gate charge can cause the camera to saturate.

Using the **`ReadoutMode`** command, the camera user can control the camera's behavior in order to minimize the dark current artifact.

The modes of operation selected by the `ReadoutMode` command are: Auto, DarkCurrentClear, and ImmediateReadout.

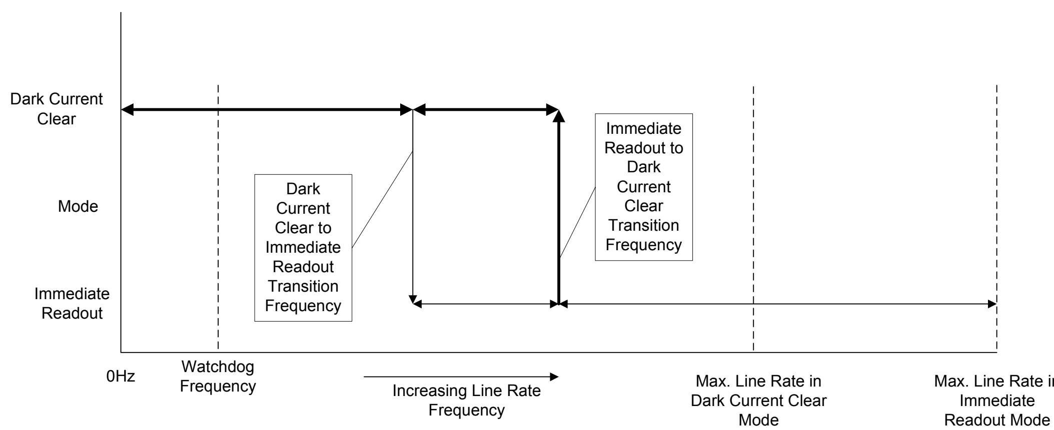


Figure 16: Gate Dark Current Clear

Table 12.

	Transition Frequencies	
Model	**Dark Current Clear to Immediate Readout Transition**	**Immediate Readout to Dark Current Clear Transition**
SG-32-02K80	6767 Hz	8176 Hz
SG-32-04K80	3518 Hz	4257 Hz

Immediate read out mode (default, ImmediateReadoutMode)

In this mode the image is read out, including accumulated dark current, immediately following the trigger or the EXSYNC falling edge.

There are no line rate limitations other than the amount of gate dark current that can be tolerated at low line rates.

There are no timing or exposure anomalies other than situations where EXSYNC is removed from camera. In this case, the camera will operate in a "watchdog" state.

For information on artifacts that may be experienced while using this mode, see the Artifacts section below.

Gate dark current clear mode (always on, DarkCurrentClear)

In this mode the gate dark current will be cleared continuously.

After the trigger (EXSYNC) is received, the dark current is cleared from the image sensor before the image is acquired. The line rate is limited to ½ the maximum line rate available for that model of camera.

For information on artifacts that may be experienced while using this mode, see the Artifacts section below.

Table 13.

	Max. Line Rate	
Model	**Immediate Readout Mode**	**Dark Current Clear Mode**
SG-32-02K80	18000 Hz	9000 Hz
SG-32-04K80	9000 Hz	4500 Hz

When operating in the dark current clear mode, there will be a slight delay, equivalent to one readout time, before the actual exposure is implemented. The actual exposure time will not be altered.

Table 14.

Model	Exposure Delay and Max Exposure Time in Auto Mode
SG-32-02K80	55.5 µs
SG-32-04K80	111 µs

Auto Mode (Auto)

In this mode the line rate from the camera will automatically cause a switch between the gate dark current clear mode and non-gate dark current clear mode.

The frequency of when this mode switchover occurs depends on the camera model.

In cases where the line rate is rapidly increased from below the Dark Current Clear to Immediate Readout Transition Frequency to above the Immediate Readout to Dark Current Clear Transition Frequency, the first line following this transition will likely be corrupted.

The table below outlines the artifacts that may be seen during this transition period. All subsequent lines after this occurrence will be as expected.

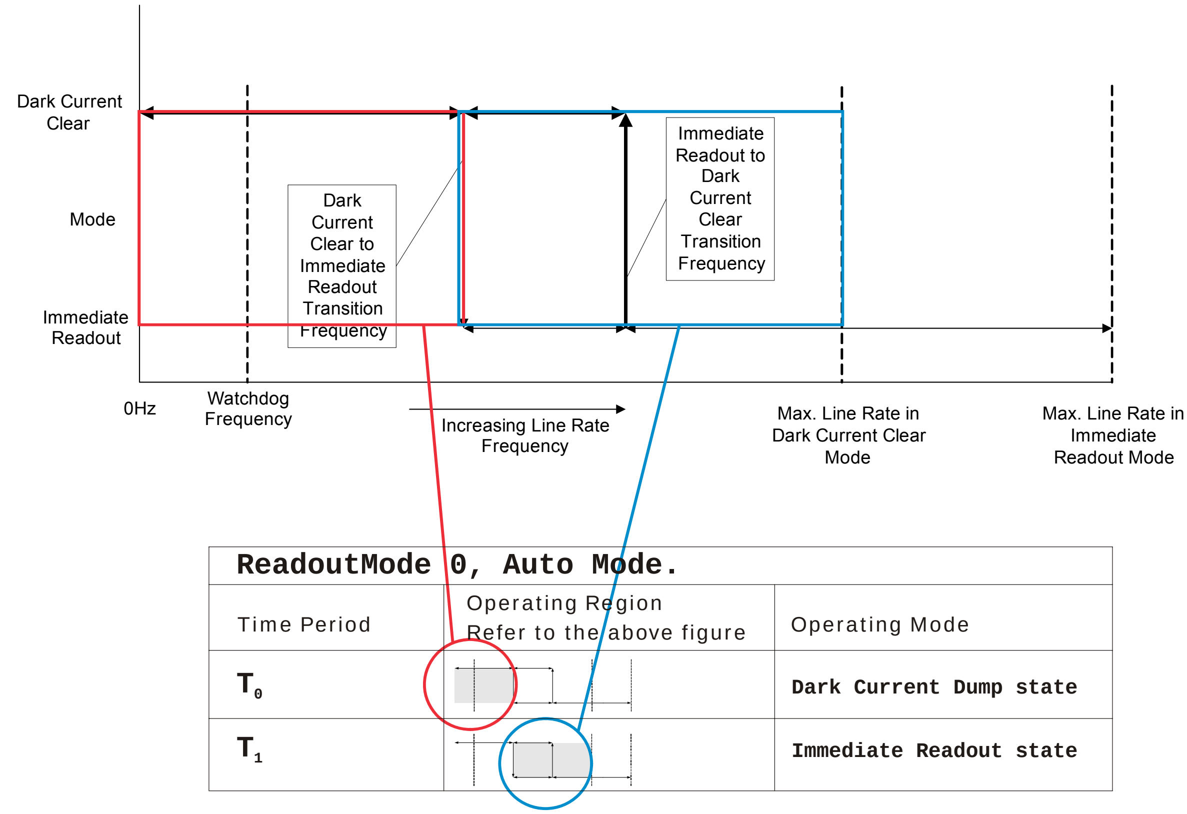
In the case of a slow transition (that is, when the EXSYNC line rate increases by less than 10% of the previous line rate) a line readout will not become corrupt.

There are also limitations on the exposure time when operating in auto mode: If the line rate exceeds half the maximum line rate, then the exposure time cannot exceed the time stated in Table 14.

Note: DALSA recommends Auto mode for most users.

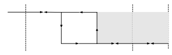
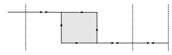
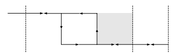
For information on artifacts that may be experienced while using this mode, see the Artifacts section below.

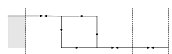
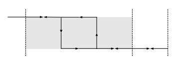
Please note: The graphic below explains the relationship between the following tables and the diagram shown at the start of this section, above. The operating regions described in the tables refer to a specific region the diagram.



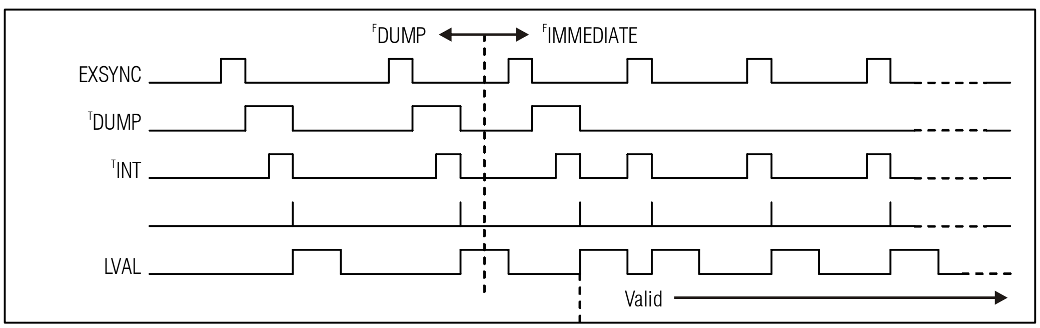
Dark Current Dump to Immediate Readout: Multi-Line Artifacts.

ReadoutMode 0, Auto Mode.		
Time Period	**Operating Region Refer to Figure 16.**	**Operating Mode**
T_0		Dark Current Dump state
T_1		Immediate Readout state

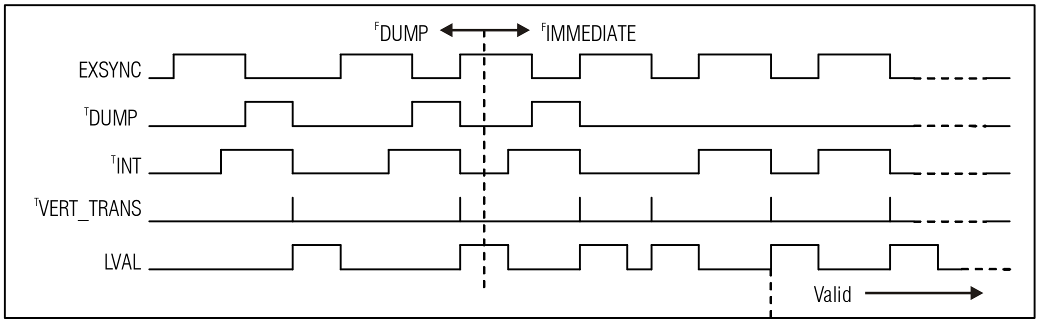
ReadoutMode 0, Auto Mode.		
Time Period	**Operating Region Refer to Figure 16.**	**Operating Mode**
T_0		Immediate Readout state
T_1		Dark Current Dump state
T_2		Immediate Readout state

ReadoutMode 2, Immediate Readout Mode.		
Time Period	**Operating Region Refer to Figure 16.**	**Operating Mode**
T_0		Dark Current Dump state
T_1		Immediate Readout state

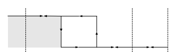
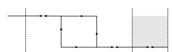
Dark Current Dump to Immediate Readout (T_{INT} < #)

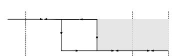
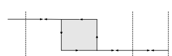
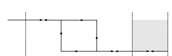


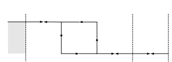
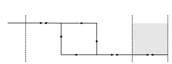
Dark Current Dump to Immediate Readout ($T_{INT} > \#$)



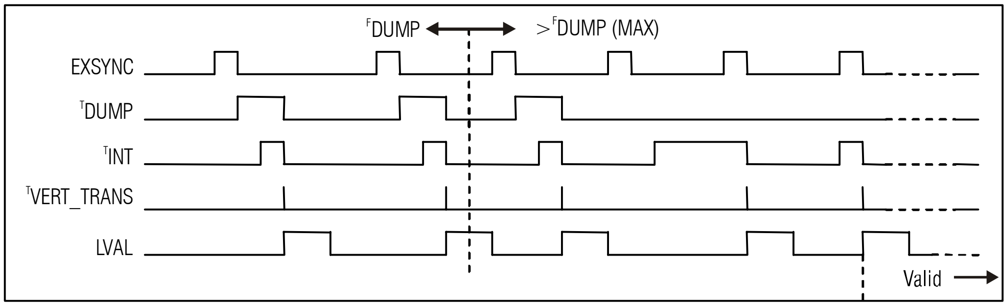
Dark Current Dump to Immediate Readout: Multi-Line Artifacts

ReadoutMode 0, Auto Mode.		
Time Period	**Operating Region Refer to Figure 16.**	**Operating Mode**
T_0		Dark Current Dump state
T_1		Immediate Readout state

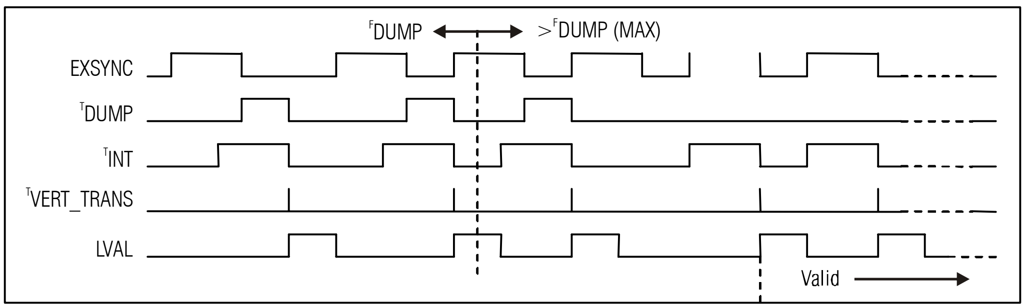
ReadoutMode 0, Auto Mode.		
Time Period	**Operating Region Refer to Figure 16.**	**Operating Mode**
T_0		Immediate Readout state
T_1		Dark Current Dump state
T_2		Immediate Readout state

ReadoutMode 2, Immediate Readout Mode.		
Time Period	**Operating Region Refer to Figure 16.**	**Operating Mode**
T_0		Dark Current Dump state
T_1		Immediate Readout state

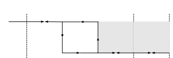
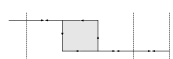
Dark Current Dump to Immediate Readout (T_{INT} < #)

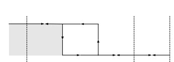
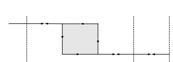
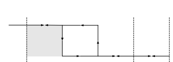


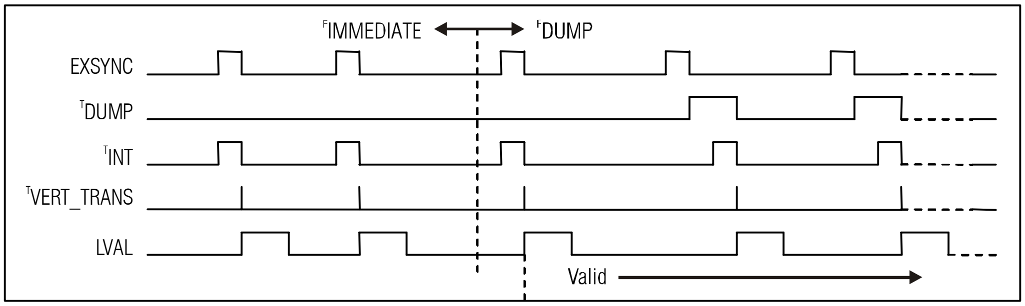
Dark Current Dump to Immediate Readout (T_{INT} > #)



Immediate Readout to Dark Current Dump: Hysteresis Artifacts

ReadoutMode 0, Auto Mode.		
Time Period	**Operating Region Refer to Figure 16.**	**Operating Mode**
T_0		Immediate Readout state
T_1		Dark Current Dump state

ReadoutMode 0, Auto Mode.		
Time Period	**Operating Region Refer to Figure 16.**	**Operating Mode**
T_0		Dark Current Dump state
T_1		Immediate Readout state
T_2		Dark Current Dump state



Setting the Readout Mode

Use this command to clear out dark current charge in the vertical transfer gates immediately before the sensor is read out.

```
ReadoutMode
Auto (0x0)
DarkCurrentClear (0x1)
ImmediateReadout (0x2)
```

Auto. Clears dark current below ~ 45% of the maximum line rate.

DarkCurrentClear. Always clears dark. Reduces the maximum line rate.

ImmediateReadout. Does not clear dark current. (Default mode.)

- The vertical transfer gates collect dark current during the line period. This collected current is added to the pixel charge. The middle two red taps have more vertical transfer gates and, therefore, more charge. This additional charge is especially noticeable at slower line rates.
- If the user is in **Exposure Modes `2: ExposureMode Timed and LineTriggerMode Off (Internal),`** or **`7: ExposureMode Off and LineTriggerMode Off (Internal),`** and **`ReadoutMode ImmediateReadout`**, with **`AcquisitionLineRateAbs`** at 45% of the maximum, and then ReadoutMode DarkCurrentClear is selected, the following warning will be displayed, but the AcquisitionLineRateAbs value will not be changed: Warning 09: Internal line rate inconsistent with readout time> The effect in both internal and external line rate modes is that an EXSYNC is skipped and, therefore, the output will be at least twice as bright.
- This value is saved with the camera settings.

Related Commands: **`DALSAExposureMode, AcquisitionLineRateAbs`**

Appendix B

ASCII Commands

Using ASCII Commands

All the functionality available through the QuickCam GUI is also available through the serial interface using the camera-specific three letter commands.

There are three ways to enter ASCII commands: (1) through the QuickCam Command tab, (2) through the Configuration window, or (3) through the virtual serial port. Entering commands through the QuickCam Command window is the simplest method.

Command Window Method:

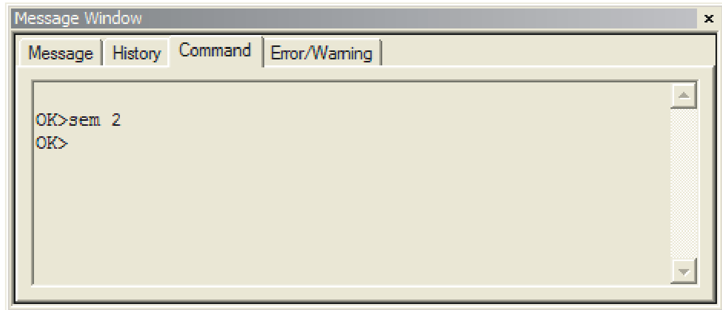
1. Open the QuickCam application.

   In the Message Window:

2. Open the **Command** tab.
3. At the `OK>` prompt, enter the ASCII command. Refer to Appendix A for details on all of ASCII commands available with this camera.
4. Press **Enter**.

The camera responds with `OK>` if the command was successful or an error or warning message as appropriate.

Figure 17: Command Tab after Sending the sem (Set Exposure Mode) Command



Configuration Window Method:

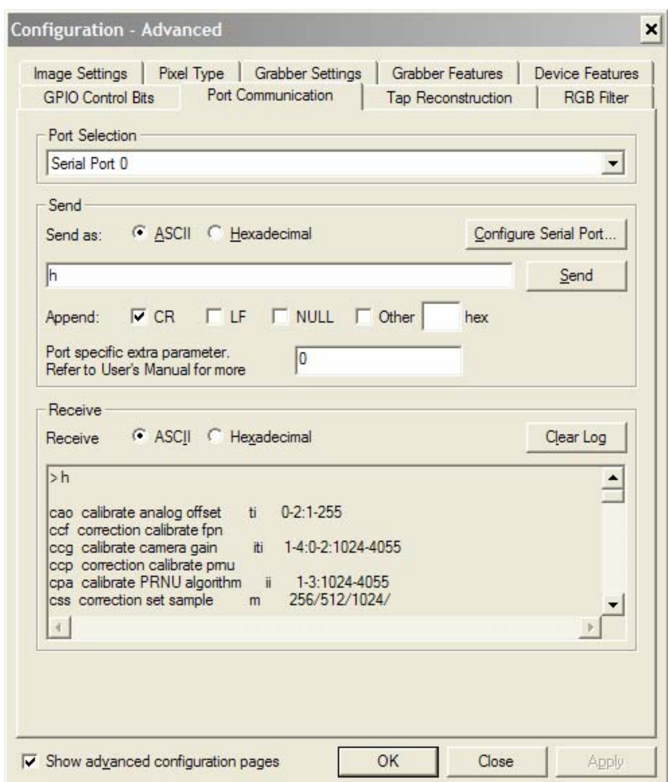
1. Open the QuickCam application.

   In the **Camera Configuration Window**:

2. Open the **Exposure/GPIO tab**.
3. Click **Advanced…**
4. Open the **Port Communication tab**.

The Port Communication tab provides an ASCII interface. In order to comply with DALSA camera command protocol, you must send and receive as ASCII and ensure that the CR checkbox is checked (default).

Figure 18: Port Communication Tab after Sending the h (Help) Command



Virtual Serial Port Method

1. Open the QuickCam application.
2. Select **Configure** → **Serial Port Link** to enable or disable the virtual serial port.

Some camera control tools can connect only to a Windows system serial port. To avoid asking for changes from camera manufacturers, two serial COM ports in the PC can be linked together to share the serial channel to the IP engine. Using this link, data written to one port can be read by the other port, and vice-versa.

These linked serial COM ports can be either "virtual" or physical. To set up virtual ports, use a virtual serial port driver. Some good virtual serial port drivers are available at: http://www.softinfinity.com/ or http://www.virtual-serial-port.com/.

Alternatively, if a PC has two free physical serial ports, they can be connected together and used as a pair, in the same manner as a virtual serial port driver.

The Serial Port Configuration dialog box allows you to attach the serial channel in QuickCam to one port in a serial port pair, whether a physical pair or virtual pair. Therefore, an external application needs simply to connect to the other serial port of the pair to communicate with the camera.

Serial Protocol Defaults

- 8 data bits
- 1 stop bit
- No parity
- No flow control
- 57.6 kbps
- Camera does not echo characters

Command Format

When entering commands, remember that:

- A carriage return <CR> ends each command.
- The camera will answer each command with either <CR><LF> OK > or <CR><LF> Error xx: Error Message > or Warning xx: Warning Message. The > is always the last character sent by the camera.

The following parameter conventions are used in the manual:

- ***i*** = integer value
- ***f*** = real number
- ***m*** = member of a set
- ***s*** = string
- ***t*** = tap id
- ***x*** = pixel column number
- ***y*** = pixel row number

Example: to return the current camera settings

gcp <CR>

Camera Command Help

For quick help, the camera can return all available commands and parameters through the serial interface.

There are two different help screens available. One lists all of the commands available to configure camera operation. The other help screen lists all of the commands available for retrieving camera parameters (these are called "get" commands).

To view the help screen listing all of the camera configuration commands, use the command:

Syntax: **h**

To view a help screen listing all of the "get" commands, use the command:

Syntax: **gh**

Notes: For more information on the camera's "get" commands, refer to section **Error! Reference source not found.**.

The camera configuration command help screen lists all the available commands. Parameter ranges displayed are the extreme ranges available. Depending on the current camera operating conditions, you may not be able to obtain these values. If this occurs, values are clipped and the camera returns a warning message.

Some commands may not be available in your current operating mode. The help screen displays NA in this case.

Commands

Parameters:
t = tap id
i = integer value
f = float
m = member of a set
s = string
x = pixel column number
y = pixel row number

The following table lists all of the camera's available ASCII commands. Refer to Appendix A for detailed information on using these ASCII commands.

Table 15: Command Quick Reference

Mnemonic	Syntax	Parameters	Description
correction calibrate fpn	`ccf`		Performs FPN calibration and eliminates FPN noise by subtracting away individual pixel dark current.
calculate PRNU algorithm	`cpa`	`i`	Performs PRNU calibration according to the selected algorithm. The parameter is the target value to use in a range from **1024** to **4055** DN. $\text{PRNU Coefficient}_i = \frac{\text{Target}}{(\text{AVG Pixel Value}_i)}$ The calculation is performed for all sensor pixels but warnings are only applied to pixels in the region of interest. This algorithm is useful for achieving uniform output across multiple cameras.

Mnemonic	Syntax	Parameters	Description
correction set sample	**css**	**m**	Sets the number of lines to sample when using the gla command or when performing FPN and PRNU calibration where **m** is **256**, **512**, or **1024**
calibrate white balancing	**cwb**	**i**	Adjust color digital gain to make the color output to the given value while imaging a white reference where **i** is in a range from **1024** to **4055.**
display gpio configuration	**dgc**		Current state of the gpio (i.e. if I/O set for TTL, LVDS, or no signal).
display pixel coeffs	**dpc**		Displays the PRNU and FPN pixel coefficients in the order FPN, PRNU, FPN, PRNU, …
enable FPN coeffs	**efc**	**i**	Sets whether FPN coefficients are enabled or disabled. Where **i** is: **0** = FPN coefficients disabled **1** = FPN coefficients enabled
enable input LUT	**eil**	**i**	Enable input LUT, where: **0**: Off **1**: On 4k model only.
enable line delay	**eld**	**i**	**0** : Off **1** : On
end of line sequence	**els**	**m**	0/3/7
enable PRNU coefficients	**epc**	**i**	Sets whether PRNU coefficients are enabled or disabled. Where **i** is: **0** = PRNU coefficients disabled **1** = PRNU coefficients enabled
get camera model	**gcm**		Reads the camera model number.
get camera parameters	**gcp**		Reads all of the camera parameters.
get camera serial	**gcs**		Read the camera serial number.
get camera version	**gcv**		Read the firmware, CCI table, and FPGA version.
get values	**get**	**s**	Returns the value of the parameter specified.
get help	**gh**		Returns all of the available "get" commands.
get line	**gl**		Gets a line of video (without pixel coefficients applied) displaying one pixel value after another and the minimum, maximum, and mean value of the sampled line.
get line average	**gla**		Read the average of line samples.
get signal frequency	**gsf**	**i**	Reads the requested control frequency. **1** = EXSYNC frequency **3** = Direction

Mnemonic	Syntax	Parameters	Description
get status led	`gsl`		Returns the current state of the camera's LED where: **1** = Red **2** = Green **5** = Blinking green **6** = Blinking red
help	`h`		Display the online help.
load pixel coefficients	`lpc`		Loads the previously saved pixel coefficients from non-volatile memory.
load user settings	`lus`		Loads the previously saved user settings.
reset camera	`rc`		Resets the entire camera (reboot). Baud rate is not reset and reboots with the value last used.
reset pixel coeffs	`rpc`		Resets the pixel coefficients to 0.
set baud rate	`sbr`	`m`	9600 / 19200 / 57600 / 115200
set color correction	`scc`	`i`	Set the values in the color matrix that is multiplied at the end of the digital processing. Range **-8192** to **8191**.
set ccd direction	`scd`	`i`	Sets the CCD shift direction where: **0 =** Forward CCD shift direction. **1 =** Reverse CCD shift direction. **2 =** Externally controlled direction control via CC3. (CC3=1 forward, CC3=0 reverse.)
set color gain	`scg`	`f`	Set color gain for current color in a range of **-20.0 to 20.0**. The current color is set from **scl** command.
set color index	`scl`	`m`	Selects color for gain application. rgb/r/g/b/. Used prior to the **scg** command.
set current tap	`sct`	`t`	Where: **0 =** All **1 =** Tap 1 (0 to 1023) **2 =** Tap 2 (1024 to 2048) Used prior to the **scl** and **scg** commands.
set color correction matrix X index	`scx`	`m`	Set current color correction x index in a range of **o/r/g/b**.
set color correction matrix Y index	`scy`	`m`	Set current color correction y index in a range of **r/g/b/y**.

Mnemonic	Syntax	Parameters	Description
set data mode	**sdm**	**i**	Sets the camera's bit width where: **0** = 1 tap, internal, Mono/GreenOnly. **2** = 8 bits mono, 2 taps, 40 MHz data rate, 4096 total pixels (dump of both sensor rows) **5** = 24 bit RGB pixel , 1 tap, 40 MHz data rate, 2048 total pixels
set exposure control mode	**sec**	**m**	t/w/m This command combined with the slm command is equivalent to the sem command. If input is **t**, this mode uses the value set by the **set** command for the exposure time. If input is **w**, this mode uses the width of the line trigger pulse. If the user tries to set this mode while **slm** is set to internal, then they will receive an error: not available in this mode. If the user sets the slm to internal while the sec value is set to width. The camera will return a warning message and change the exposure control to maximum. If input is **m**. The camera uses the maximum possible exposure time for the given line rate.
set exposure mode	**sem**	**m**	Sets the exposure mode: **2 =** Internal SYNC, internal PRIN, programmable line rate and exposure time using commands **ssf** and **set** **3 =** External SYNC, internal PRIN, maximum exposure time **4** = Smart EXSYNC **6** = External SYNC, internal PRIN, programmable exposure time **7 =** Internal programmable SYNC, maximum exposure time. Factory setting. **8** = Internal SYNC, internal PRIN, programmable exposure time. Maximum line rate for exposure time.
set exposure time	**set**	**f**	Sets the exposure time. Refer to the camera help screen (**h** command) for allowable range.
set FFC selector	**sfs**	**m**	Set to load/save using the **lpc**, **wpc**, **wfc** commands. 0/1/2/3/4/5/6/7/8/99.

Mnemonic	Syntax	Parameters	Description
set GPIO input	**sgi**	**i**	Sets the GPIO input signal, where: **0** = disabled **1** = TTL **2** = LVDS
set GPIO number	**sgn**	**i**	Sets the GPIO pinout number in a range from **0** to **3**.
set GPIO output	**sgo**	**i**	Sets the GPIO output signal, where: **0** = disabled **1** = TTL **2** = LVDS
set line mode	**slm**	**m**	Set the line trigger mode as either external or internal: **i** = internal **e** = external
set light source	**sls**	**i**	Set current light source in a range of **0 to 4**.
set lower threshold	**slt**	**i**	The pixels below the lower threshold are checked for and reported in the end-of-line sequence in a range from 0 to 4095.
set mirroring mode	**smm**	**i**	Set tap readout direction: left to right (0), or right to left (1).
set pixel window width	**spw**	**x**	Set horizontal width used in gl, gla, dpc commands. 1 to 2048.
set pixel X position	**spx**	**x**	Set horizontal starting position used in gl, gla, dpc commands. 1 to 2048.
set readout mode	**srm**	**i**	Set the readout mode in order to clear out dark current charge in the vertical transfer gates before the sensor is read out. **0** = Auto. **1** = Dark current clear. **2** = Immediate readout. Does not clear dark current.
set ROI width	**srw**	**x**	Specify the width of the ROI. 1 to 2048.
set ROI X	**srx**	**x**	Specify the starting X position of the ROI. 1 to 2048.
set subtract background	**ssb**	**i**	Subtract the input value from the output signal. **i** = Subtracted value in a range from **0** to **4095**.
set sync frequency	**ssf**	**f**	Set the frame rate to a value from **300** Hz to **18000** Hz (2k), and from **300** Hz to **9000** Hz (4k). Value rounded up/down as required.
set system gain	**ssg**	**i**	Set the digital gain. **i** = Digital gain in a range from **0** to **65535**. The digital video values are multiplied by this number.

Mnemonic	Syntax	Parameters	Description
set user set selector	**sus**	**m**	0/1/2/3/4/5/6/7/8/99
	sut	**i**	The pixels equal to or greater than the upper threshold are checked for and reported in the end-of-line sequence in a range from 0 to 4095.
set video mode	**svm**	**i**	Switch between normal video mode and camera test patterns: **0**: Normal video mode **1**: Camera test pattern **2**: Camera test pattern
update color reference	**ucr**		Set the color reference value to the current color gain value.
verify temperature	**vt**		Check the internal temperature of the camera
verify voltage	**vv**		Check the camera's input voltages and return OK or fail
write FPN coefficients	**wfc**		Write all current FPN coefficients to non-volatile memory.
write PRNU coeffs	**wpc**		Write all current PRNU coefficients to non-volatile memor.
write user settings	**wus**		Write all of the user settings to non-volatile memor.

Appendix C

Calibration Steps

Camera Calibration Wizard

DALSA strongly recommends that you use the QuickCam Calibration Wizard to calibrate the camera. This is the fastest and easiest way.

Manual calibration instructions using the ASCII commands are as follows:

Step 1: Preparing for Calibration

If you do not want to change the current camera settings, but want to calibrate the camera, skip this step and move to Step 2: FPN Calibration.

To check the current camera settings, use the get camera parameters (**gcp)** or the **get** commands.

You can change some or all of the following settings before calibrating:

1. Set user set selector using the command **sus m**, where m = 0/1/2/3/4/5/6/7/8.
2. Set coefficient set number using the command **sfs m,** where m = 0/1/2/3/4/5/6/7/8.
3. Set data mode using the command **sdm m**, where m = 2 or 5.
4. Set exposure mode using the command **sem m**, where m = 2/3/4//6/7.
5. Set line sync frequency (line rate) using the command **ssf f**, where f = 300 - 7,900 Hz for 2k, 300 - 9000 Hz for 4k.
6. Set exposure time using the command **set f**, where f = 3 - 3300 µs in an available mode.
7. Set colour gain for current color (**get scl** command shows colour selection) using command **scg i**, where i = -20 – 20.
8. Set scanning direction using command **scd i**, where i = 0 or 1.
9. Save user settings using command **wus.**

Step 2: FPN Calibration

Note that you do not need to turn off the FPN and PRNU coefficients before calibrating, the camera will do this automatically.

1. Stop all light from entering the camera. The best way to do this is to put on lens cap.
2. Calibrate FPN using the command **ccf**.
3. Save the calibrated FPN coefficients using the command **wfc**.

Step 3: PRNU Calibration: White Calibration

1. Remove the lens cap and prepare a white, uniform target.
2. Adjust the line rate so that the average output is about 80% of the full output by: adjusting the lighting, if you are using an internal exposure mode. Or, adjust the line rate, if you are using the Smart Exsync mode.
3. Calibrate the PRNU using the command **cpa i,** where i is the target value (and is always counted as 12-bit) and the value of i is 1024 to 4055 DN. For example, if you want to set the target to 255 x 80% = 204 DN in 8-bit mode, then the target value is (204/255) x 4096 = 3277 DN in 8-bit mode. Therefore, you can set the target to 3300 DN: PRNUCalibrationTarget 3300.
4. After the above command is completed, both the FPN and PRNU coefficients are automatically turned on.
5. Note: If you set the target higher than the highest output, then the PRNUCalibrate command does the PRNU correction first and then does the white balance. Otherwise, do the white balance using the command **cwb i**, where i is the white balance target in a range of 1024 to 4055 DN. This value should be larger than the target used in PRNUCalibrationTarget command. For example: cwb 3400.
6. Save the PRNU coefficients using the commands **wpc**.

Step 4: Calibration in the Other Direction

If you want to calibrate the camera in the other scanning direction use the **scd** command (e.g. SensorShiftMode 1) to change the direction, and then repeat the steps above.

Note that the Spyder3 GEV Color camera applies a different coefficient set to each direction and, as a result, you have to calibrate each direction separately if you want to use both directions optimally.

Appendix D

Troubleshooting

Troubleshooting

The information in this chapter can help you solve problems that may occur during the setup of your camera. Remember that the camera is part of the entire acquisition system. You may have to troubleshoot any or all of the following:

- power supplies
- Ethernet hardware & software
- light sources
- operating environment
- cabling
- host computer
- optics
- encoder

LED

When the camera is first powered up, the LED will glow on the back of the camera. Refer to section **Error! Reference source not found.** for information on the LED.

Connections

The first step in troubleshooting is to verify that your camera has all the correct connections. Refer to section 3.4 Camera Connectors for more information on the proper connectors.

Cable Length/Type

Ensure that cable lengths are no longer than 100m.

Equipment Requirements

Ensure that you are using compatible equipment, as outlined in section 3.2 Equipment Recommendations.

Power Supply Voltages

Check for the presence of all voltages at the camera power connector. Verify that all grounds are connected. Refer to the Diagnostics tab in QuickCam to verify your voltage level.

EXSYNC

When the camera is received from the factory, it defaults (no external input required) to exposure mode 7 (5000 Hz line rate, internal Sync to trigger readout). After a user has saved settings, the camera powers up with the saved settings.

If you change to an exposure mode that requires an external sync, then ensure that you properly providing an external sync

Camera Operation and Test Patterns

To validate camera and Ethernet connections, have the camera send out a test pattern and verify that it is being properly received.

To send a test pattern:

Under **Test Pattern** on the **Diagnostics** tab in QuickCam:

1. Select a test pattern from the **Camera** dropdown box to confirm camera functionality.

Communications and Verify Parameters

To quickly verify serial communications, check the **Diagnostics tab** in QuickCam. Communication is working properly if the camera settings are properly displayed in the **Camera Settings** section.

Verify Voltage

To check the camera's input voltage, refer to the **Temperature/Voltage** section on the **Diagnostics tab** in QuickCam.

Verify Temperature

To check the internal temperature of the camera, refer to the **Temperature/Voltage** section on the **Diagnostics tab** in QuickCam. The camera will shut itself down if the internal temperature exceeds 75°C.

Specific Solutions

No Output or Erratic Behavior

If your camera provides no output or behaves erratically, it may be picking up random noise from long cables acting as antennae. Do not attach wires to unused pins. Verify that the camera is not receiving spurious inputs (e.g. EXSYNC if camera is in exposure mode that requires external signals).

Line Dropout, Bright Lines, or Incorrect Line Rate

Verify that the frequency of the internal sync is set correctly, or when the camera is set to external sync that the EXSYNC signal supplied to the camera does not exceed the camera's useable Line rate under the current operating conditions.

Noisy Output

Check your power supply voltage outputs for noise. Noise present on these lines can result in poor video quality.

Dark Patches

If dark patches appear in your output the optics path may have become contaminated. Clean your lenses and sensor windows with extreme care.

7. Take standard ESD precautions.
8. Wear latex gloves or finger cots
9. Blow off dust using a filtered blow bottle or dry, filtered compressed air.
10. Fold a piece of optical lens cleaning tissue (approx. 3" x 5") to make a square pad that
11. is approximately one finger-width
12. Moisten the pad on one edge with 2-3 drops of clean solvent—either alcohol or acetone. Do not saturate the entire pad with solvent.
13. Wipe across the length of the window in one direction with the moistened end first, followed by the rest of the pad. The dry part of the pad should follow the moistened end. The goal is to prevent solvent from evaporating from the window surface, as this will end up leaving residue and streaking behind.
14. Repeat steps 2-4 using a clean tissue until the entire window has been cleaned.
15. Blow off any adhering fibers or particles using dry, filtered compressed air.

Horizontal Lines or Patterns in Image

A faulty or irregular encoder signal may result in horizontal lines due to exposure time fluctuations; ensure that your exposure time is regular. If you have verified that your exposure time is consistent and patterns of low frequency intensity variations still occur, ensure that you are using a DC or high frequency light source.

Product Support

If there is a problem with your camera, collect the following data about your application and situation and call your DALSA representative.

Note: You may also want to photocopy this page to fax to DALSA.

Customer name	
Organization name	
Customer phone number **fax number** **email**	
Complete Product Model Number **(e.g. SG-32-04k80-00-R)**	
Complete Serial Number	
Your DALSA Agent or Dealer	
Acquisition System hardware (frame grabber, host computer, light sources, etc.)	
Power supply setting and current draw	
Data rate used	
Control signals used in your application, and their frequency or state (if applicable)	EXSYNC BIN LVDS/TTL Other _______
Results when you run an error report	*please attach text received from the camera after initiating an error report*
Detailed description of problem encountered.	*please attach description with as much detail as appropriate*

In addition to your local DALSA representative, you may need to call DALSA Technical Sales Support:

	North America	Europe	Asia
Voice:	519-886-6000	+49-8142-46770	+1-519-886-6000
Fax:	519-886-8023	+49-8142-467746	+1-519-886-8023
Email:	support@dalsa.com	support@dalsa.com	support@dalsa.com

Appendix E

Revision History

Rev Number	Change Description	Date
00	Preliminary release.	March 1, 2010

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