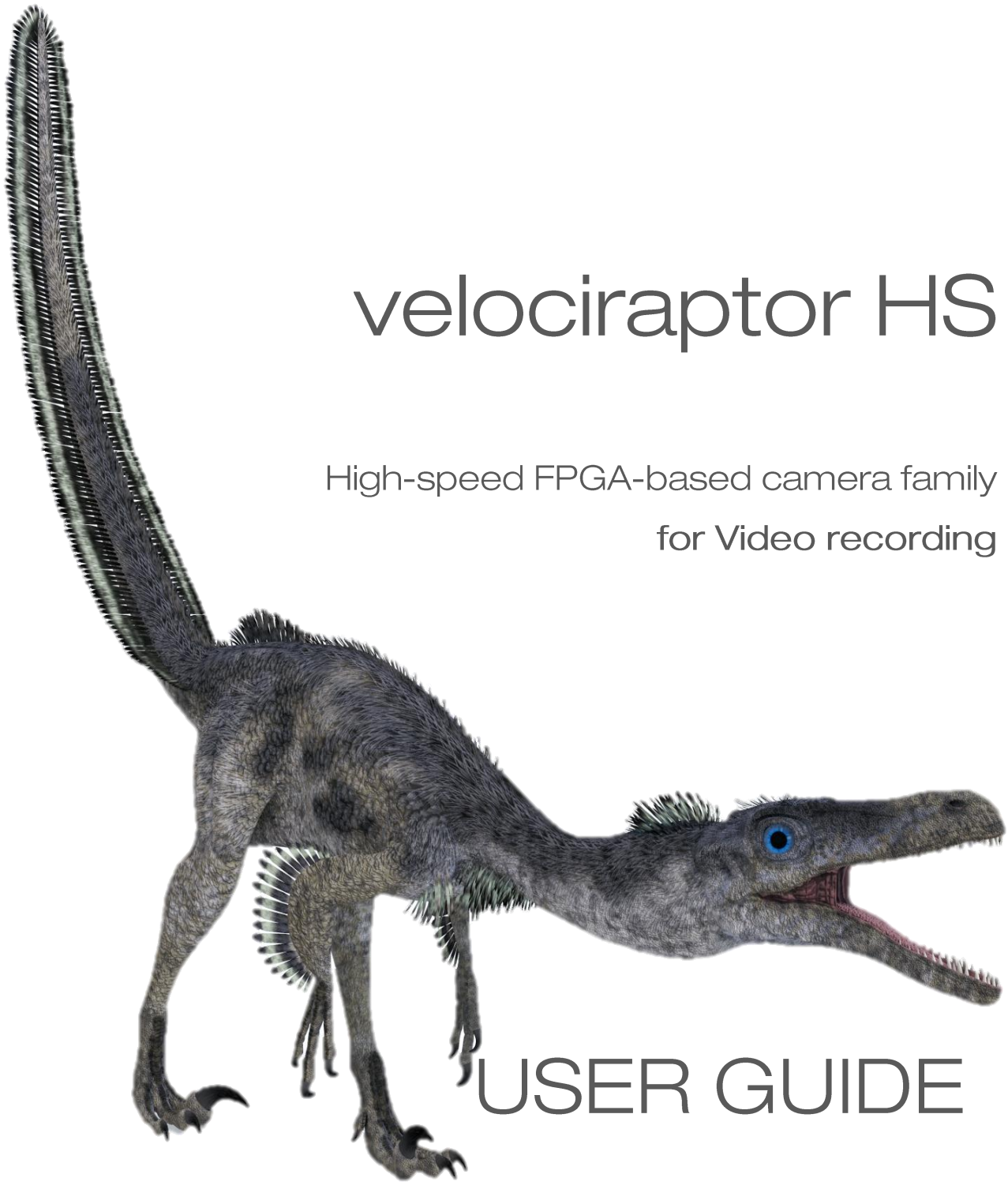

velociraptor HS

High-speed FPGA-based camera family

for Video recording

USER GUIDE

Velociraptor HS is fast running and fast grabbing!

Save a tree...please don't print this document *unless you really need to.*

OPTOMOTIVE, MECHATRONICS Ltd., V MURGLAH 229, SI-1000 LJUBLJANA
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Table of Contents

1. Introduction

Dear Customer,
We thank you for selecting our products and are pleased to count you amongst our very valued customers at *OPTOMOTIVE*.
We trust that the use of the *VELOCIRAPTOR hardware* developed and designed to the highest standards of quality, will give you complete satisfaction.
Please read carefully the **User Guide**, which contains all the necessary information and describes all you need to know about the use of the VELOCIRAPTOR camera.

Thank you for choosing *OPTOMOTIVE!*

2. Contact

For all your enquiries, support and feedback, we are available on:

E-mail: info@optomotive.si
Telephone: +386 1 429 29 14
Address: OptoMotive, mechatronics Ltd.
V Murglah 229, SI-1000 Ljubljana,
Slovenia

For additional info on our products and software download, visit us at www.optomotive.com.

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4. Scope of supply and system requirements

4.1. Package contents

1 CAMERA
1 Power over Ethernet (PoE) power supply unit (delivered with the Camera)
2 CAT5e Ethernet cables (delivered with the Camera)
1 Software installation package (delivered with the Camera)

4.2.System requirements

Platform supporting Microsoft *Windows XP SP2* or higher, 64bit recommended
Microsoft .NET Framework 4.0 (supplied with the software)
Min. *100MB* hard disk space
Min. *4GB RAM*
Processor: Core i5 or better recommended
1 free Gigabit Ethernet port

5. Compatibility

5.1. Compatibility

Regular upgrading for the following platforms: All platforms that support *Windows XP SP2* or higher.

6. Precautions

Observe these precautions when installing Velociraptor camera to reduce the risk of injury or equipment damage:

- Do not install Velociraptor cameras where they are directly exposed to environmental hazards such as excessive heat, dust, moisture, humidity, impact, vibration, corrosive substances, flammable substances, or static electricity.
- To reduce the risk of damage or malfunction due to over-voltage, line noise, electrostatic discharge (ESD), power surges, or other irregularities in the power supply, route all cables and wires away from high-voltage power sources.
- Do not expose the sensor to laser light; CMOS sensors can be damaged by direct, or reflected, laser light. If your application requires the use of laser light that may strike the CMOS sensor, a lens filter at the corresponding laser's wavelength is recommended. Contact our application engineer for suggestions.
- Do not open the Velociraptor camera. The device does not contain user-serviceable parts.
- Do not make electrical or mechanical modifications to Velociraptor components. Unauthorized modifications may violate your warranty.
- Changes or modifications not expressly approved by the party responsible for regulatory compliance could void the user's authority to operate the equipment.
- Cable shielding can be degraded or cables can be damaged or wear out more quickly if a bend radius or service loop is tighter than 10x the cable diameter.
- Service loops should be included with all cable connections.

Warning! (Grounding Instructions)

Static electricity can damage electronic components. Please discharge any static electrical charge by touching a grounded surface, such as the metal computer chassis, before performing any hardware installation.
If you do not feel comfortable performing the installation, please consult a qualified technician.

7. General information

Velociraptor is the ultimate FPGA camera with very large Xilinx Spartan-6 FPGA and highs peed imaging sensor. It is based on new GigaBee modules, which incorporate dualDDR3 memory and Gigabit Ethernet. It is ultimate-performance system-on-chip (SOC) technology, combined with latest turbocharged industrial CMOSIS imaging sensors. With high performance FPGA system-on-chip (SoC) technology Velociraptor opens new dimensions in computer vision. It is global shutter industrial camera with incredible frame rates and range of image processing cores (JPEG compression, colour processing, etc.).

Key camera features:

- Sensor:
  - CMOSIS CMV2000, 2/3" CMOS colour, monochrome or NIR sensor, 2048 x 1088pixels, 5.5 µm pixel size, 333 FPS at JPEG video acquisition
  - CMOSIS CMV4000, 1"CMOS colour, monochrome or NIR sensor, 2048 x 2048 pixels, 5.5 µm pixel size, 178 FPS at JPEG video acquisition

- Connectivity, I/O:
  - Gigabit Ethernet (isolated Power over Ethernet)
  - 4 pin trigger connector(3x bidirectional IOs)

- FPGA:
  - Spartan-6LX150 with 2x128 MB DDR3 SDRAM
  - Ultimate FPGA System-on-Chip
  - Capable of intensive real-time image processing

- Options:
  - C or CS housing (IP67 option)
  - Stable, Tripod or Swivelling mounts available
  - Real-time JPEG compression core

This user guide has been put together to make the Velociraptor camera easy to use and accessible to everyone. Before starting the camera, we advise you to read through the Digital camera basics chapter.

Each camera is supplied with:

- Software: SHARKi software for image capturing and recording
- Cable: 2x Ethernet Cable CAT5E
- Power Supply: 100-240V single port PoE injector

8. Installation procedure

8.1. Pre-requisites

Before starting with the installation you need:

- Velociraptor camera
- Power Over Ethernet power supply unit (delivered with the Camera)
- 2 pieces of CAT5e Ethernet cables (delivered with the Camera)
- Installation software (delivered with the Camera)
- PC (Core 2 Duo recommended) with Microsoft Windows XP or Vista with minimal 2GB RAM, 64bit also supported

8.2.Software installation

Open the CD-ROM delivered with the camera and double click on Optomotive_SHARKi_install_vX_X_X.exe to start the installation process. Follow the instructions of the Installation manager and complete the installation procedure.

Installed folders:

- Program Files\Optomotive\SHARKi; Camera GUI application
- Program Files\Optomotive\SHARKi\UserGuides; Documentation
- Program Files\Smartek\GigEVisionSDK; GigE Vision Application Program Interface

8.3.Hardware installation

Connect camera to output port of Power Over Ethernet power supply (PoE injector). If connecting camera to PoE capable network card or switch, plug the network cable directly to network card or switch.
If using PoE injector connect the other port or the injector to PC. Plug in the PoE injector to wall socket.

Figure 1: Connecting camera

The camera has on the lower side multiple connectors and LEDs:

- Ethernet connector for communication and power with TX and RX status LED. The Ethernet connector has two holes for waterproof connector mounting.
- IO connector for synchronization: trigger and illumination strobe.
- Status LED

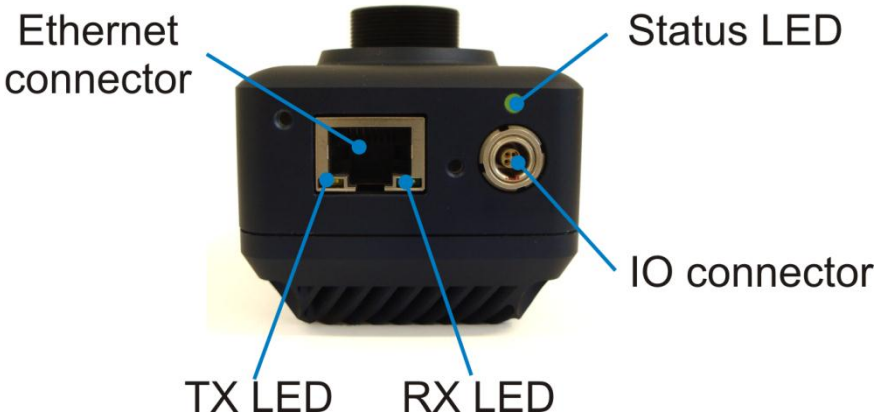


Figure 2: Camera connectors and LEDs

The status LED signalling:

- No light: camera is booting FPGA or no power is applied
- Orange: camera is booting OS or the PC connection is not valid
- Green: camera has a valid connection to PC
- Red: camera firmware upgrade is in progress (do not unplug the power cable!)

8.4. Supported network configurations

Upon connecting the Velociraptor to your PC, the camera attempts to obtain a valid IP address as specified in GigE Vision specification. The camera performs IP configuration using different strategies in the order specified:

1) Persistent IP (if enabled)
2) DHCP
3) LLA

Persistent IP is a user configurable static IP address which is stored in camera's non-volatile memory. If Persistent IP is enabled by the user, the camera will use the static IP provided by the user. By default, Persistent IP is disabled.

DHCP (Dynamic Host Configuration Protocol) is a well-known scheme to dynamically obtain a valid IP address upon connecting to a network. If Persistent IP is disabled, the camera will try to obtain an IP address via DHCP. If there are any DHCP servers present on the network, the camera will negotiate an IP address which will usually be on the same subnet as the DHCP server.

If there are no responses from DHCP servers, the camera will obtain an IP address via LLA (Link Local Address). LLA IP configuration scheme consists of randomly choosing an IP address within the 169.254.xxx.xxx subnet and then checking if the chosen IP address is already in use by sending ARP queries. If the IP address is already in use, the procedure of choosing a random IP address is repeated.

It is necessary for the camera to be on the same subnet as the PC which controls the camera. In case the camera's IP configuration procedure chooses an IP address on a different subnet as the controlling PC, the IP of the camera can be changed by using the "FORCE IP" command.

NOTE: For optimal performance we recommend to enable "Jumbo" frames on your PC network card. "Jumbo" frames are Ethernet packets larger than 1500 bytes. This way less CPU time is spent for data reception therefore increasing performance and minimizing data loss. If camera cannot be found in software please disable Windows or third party firewall.

9. Digital camera basics

This chapter covers basic facts about OptoMotive digital cameras.

9.1. Camera structure

The camera is composed of a 2 basic parts:

- FPGA System on a module
- Sensor board

All of the vital system components are assembled on a module. This includes power supply, FPGA, DDR SDRAM, Ethernet PHY controller and SPI Flash. The module is Power over Ethernet powered with triple DC-DC converters for maximal power efficiency (Switching Mode Power Supply). The core is a Xilinx Spartan-6 FPGA coupled to dual 128 MB DDR SDRAM. The DDR has 16-bit wide data bus running at 333 MHz offering 1,332 GB/s peak bandwidth. The gateway to the PC is a well proven Marvell Alaska PHY which offers up to 118 MB/s of bandwidth from FPGA to PC. The board also includes 8 MB non-volatile QUAD SPI FLASH memory. The sensor board is connected to system module with two board to board connectors. The sensor sends data directly to FPGA via 16 channels each of 10bit and 480Mb/s per channel interface.

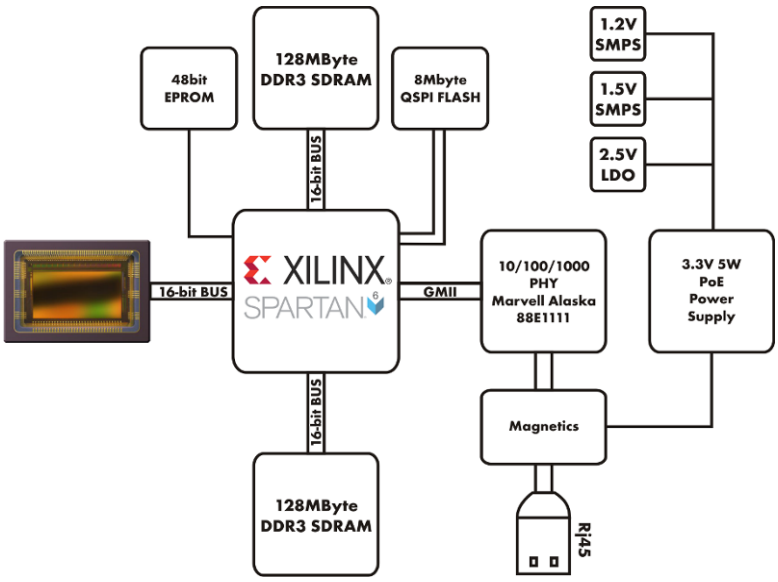


Figure 3: Camera structure

10. Imaging Sensor

10.1. Optical format

Optical format refers to the size of the imaging area of the sensor. Optical format of a sensor (CMOS chip) must match the one on the lens system. In other words, the optical format of the sensor determines what size lens is needed for use with the imager.

Sensor sizes of many digital cameras are generally expressed in inches. To understand the sizing you need to know some history. In the early video cameras, a standard 1'' camera tube had only 16 mm of useful imaging area, which means that the actual diameter of the imaging area is about 2/3 of the designated area. The same designation is still used, and today, most of the modern sensors are expressed in the same measure.

Digital imaging optical format is defined as the **length of the diagonal of the imaging area**.

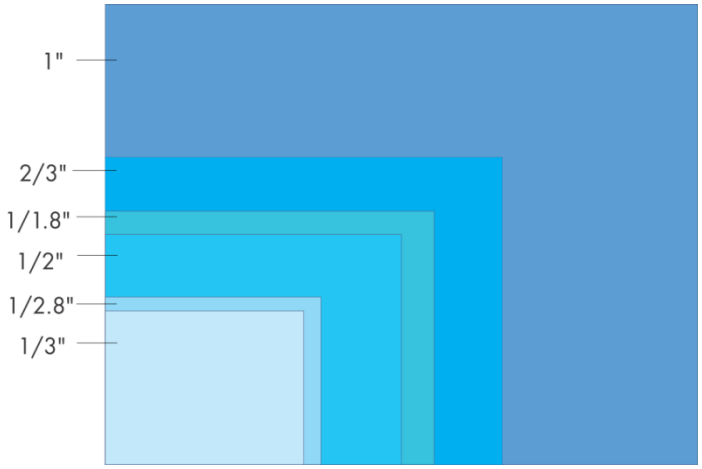


Figure 4: Sensor sizes

Velociraptor cameras use a 2/3'' type sensor for the 2.2M pixel model, and 1'' type sensor for the 4M pixel model.

10.2. Optics

To get a quality capture, lens has to focus light directly upon the light-sensitive sensor area. With that in mind, sensor has to be put to a distance, which corresponds to the focal plane array (FPA).
The area that is imaged by a camera is usually given by an **angle of view** or AOV. AOV is the angular extent of a subject seen by an optical system.

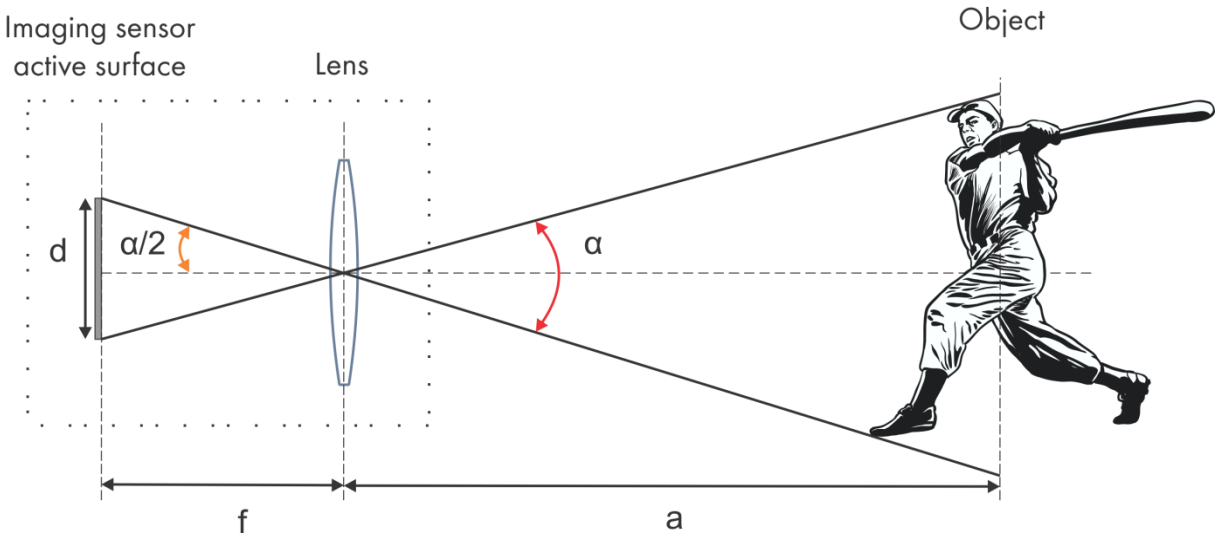


Figure 5: Angle of view

Using basic trigonometry, we can find:

$$\tan\left(\frac{\alpha}{2}\right) = \frac{d}{2f}$$

We can then solve this equation for **α**:

$$\alpha = 2\arctan\left(\frac{\mathbf{d}}{\mathbf{2f}}\right),$$

which describes how the angle of view **α**depends on height (width) of the sensor **d** and focal distance **f**.

10.3.Shutter

The image acquisition process is achieved in three phases:

- Reset pixels
- Pixels exposure
- Readout

As opposed to a mechanical (physical) shutter, sensors of Velociraptor cameras use a digital shutter to expose pixels to light. The sequence of exposure and readout process is determined by a so-called shutter method. There are two general methods used in digital imaging: global shutter and rolling shutter method. All Velociraptor cameras use the **global shutter** method.

10.3.1. Global shutter

A global shutter captures all of the information from every photosite on a sensor chip all at once. It can also be thought of as a 'snapshot' exposure mode, meaning that all pixels of the array are exposed simultaneously, to stop the movement of an object. This functionality requires specific design features, and not all sensors have them.

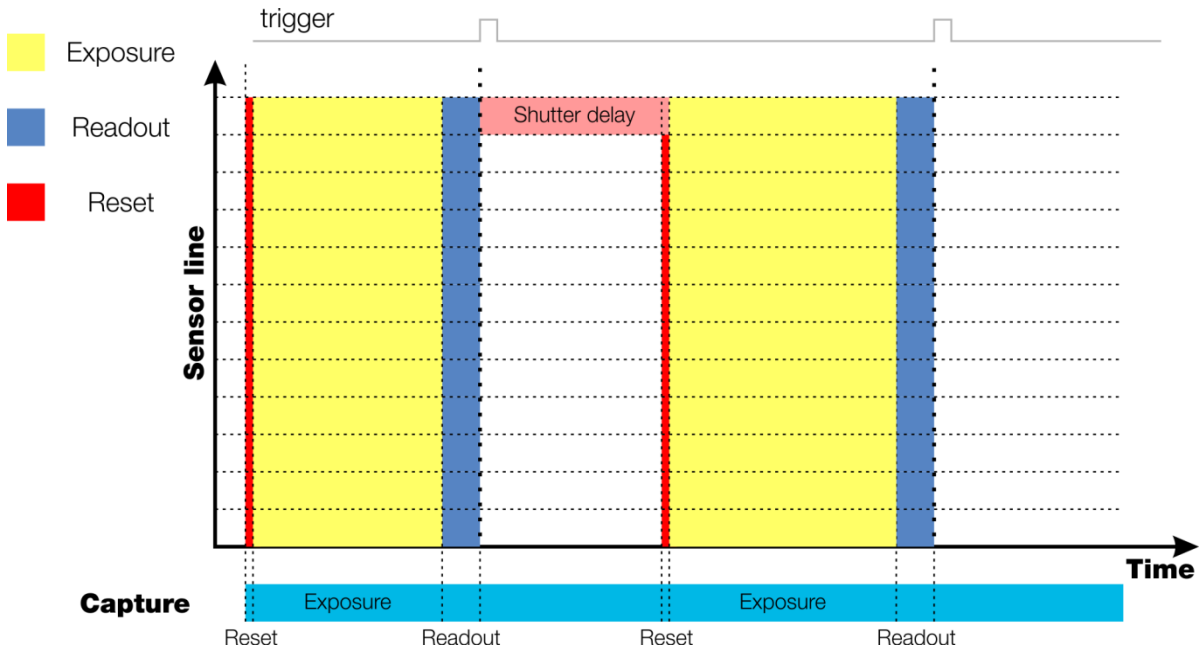


Figure 6: Global shutter diagram

10.4. Bayer filter

A Bayer filter[1] is a colour filter array, put across the imaging area of the sensor. The pattern corresponds to the sensitivity of a human eye; hence it is 25% red, 50% green and 25% blue. The Bayer pattern is displayed in the image below.

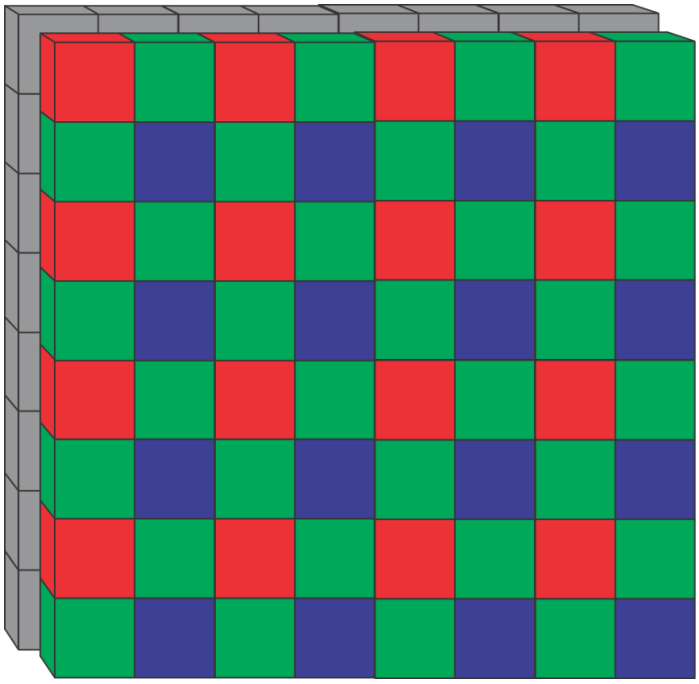


Figure 7: Bayer pattern

Photo sensors detect light intensity with no wavelength sensitivity; therefore need a colour filter to separate colour information. Brightness and colour information (of three primary colours) are calculated for each pixel. Various colour reconstructive algorithms are used to interpolate the complete set of red, green and blue values and interpolate them into a colour (RGB) image. After this interpolation the image is composed of three colour planes: Red, Green and Blue. The image size (in bytes) is usually three times larger than the raw image from the sensor.

[1] named after its inventor, **Bryce E. Bayer** of Eastman Kodak

10.5.Region of interest (ROI)

Used to increase the frame rate by reducing the amount of data transferred from the camera, ROI is a function that minimizes the area of a captured image, to a specified dimension. Once you have set the size and position of that area, only the data inside the area is transferred to the camera.

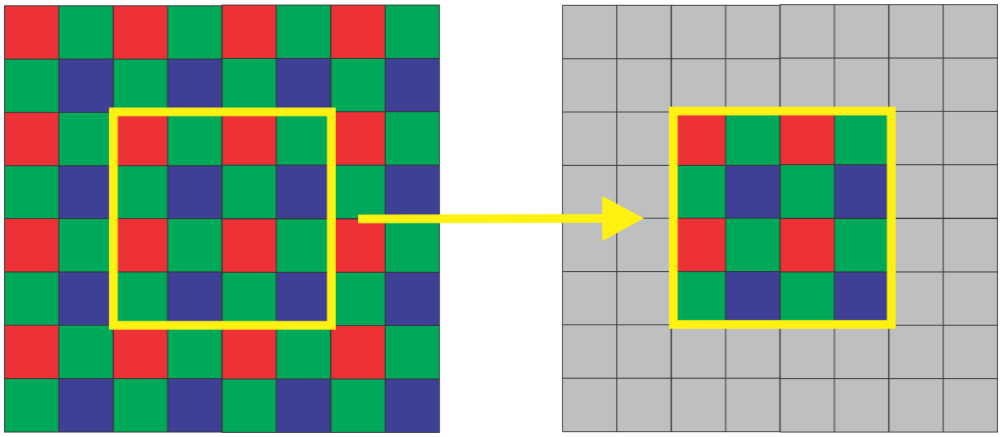


Figure 8: Region of interest

10.6.Image digitalization

All OptoMotive cameras use CMOS imaging sensors. They offer a large of on-chip functions, like: conversion of electrical charge into voltage, analogue to digital conversion, timing generator and eventually basic image processing and noise reduction.

Analogue to digital conversion is done by Analogue-to-Digital Converter (ADC), which is usually integrated into CMOS imaging sensor. In the sensor there are usually multiple ADC converters to increase data rate and not affecting digitalization quality. The output of the sensor is a digital signal.

10.6.1. Bit depth

ADC output is a digital representation of sampled analogue signal in a digital numerical value. More bits are offered by an ADC, better the signal is represented. If, for example, a 2 bit ADC resolution (bit depth) is offered, there are $2^2 = 4$ brightness levels to represent an analogue signal.

ADC resolution	Levels
8 bit	256
10 bit	1024
12 bit	4096
14 bit	16384

Table 1: ADC resolution

For better understanding of different bit depths see the figure bellow. A digital representation with a 1 bit ADC resolution can be done with two levels of brightness: 0 (black) and 1(white). With greater bit depth, many more combinations of those two numbers occur. All zeroes then represent black and all ones represent white.

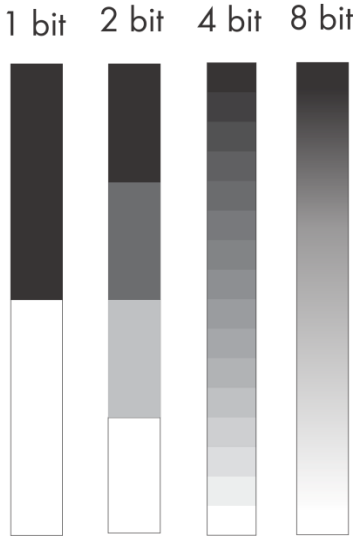


Figure 9: ADC resolution (Bit depth)

Velociraptor cameras offer a 10 bit ADC resolution, with an option of 12 bit resolution at lower frame rates.

10.6.2. Dynamic range

Dynamic range is defined as a ratio between the smallest and the greatest possible value of a changeable quantity. In image processing, dynamic range refers to the brightness levels in an image. A scene with a lot of different brightness levels (dark and bright parts), gives us a high dynamic range.

Figure 10: Image with a high dynamic range

Figure 11: Image with a low dynamic range

Dynamic range is generally expressed in decibels, a standard logarithmic unit. A ratio between two brightness values, where b1 is the lowest and b2 is the highest, can be expressed in dB through this equation:

$$DR = 20 \log\left(\frac{b2}{b1}\right) dB$$

ADC resolution	Levels	Dynamic Range
8 bit	256	48 dB
10 bit	1024	60 dB
12 bit	4096	72 dB
14 bit	16384	84 dB

Table 2: Dynamic range of different bit depths

Most imaging sensors do not have a dynamic range higher than 60 dB. Sensors with a so-called high dynamic range (HDR mode) possibility, could reach up to 120 dB. With HDR we get quasi-logarithmic response which compresses HDR into low bit depth.

10.7. Data formats

The image is captured in different data formats. Basically we have two data formats: monochrome and colour. Velociraptor cameras support Monochrome (8 bit) and Bayer (8 bit) data format.

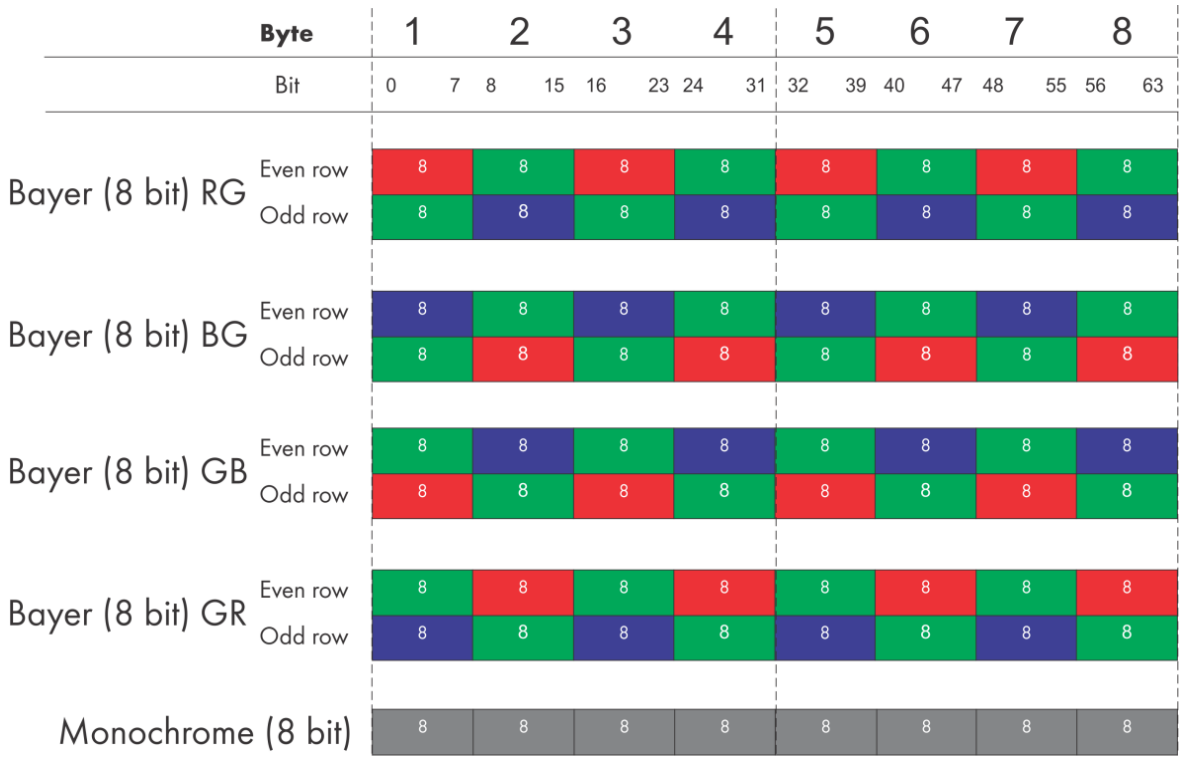


Figure 12: Data formats

10.8. Camera booting

Boot-up sequence:

- Connect the camera
  When the Ethernet cable is inserted into the device and the 48V PoE power is applied which feeds the internal camera power supply the camera starts connecting.

- Powering up the FPGA and memory
  The FPGA is configured to load bitstream from external SPI FLASH on power up.

- Booting FPGA from FLASH
  When the bitstream is loaded in to the FPGA it is verified and the FPGA is loaded with a new architecture. Soft microprocessor inside the FPGA then starts execution of instructions stored inside the FPGA memory.

- Booting of LINUX OS
  Soft microprocessor inside the FPGA then starts execution of instructions stored inside the FPGA memory that is booting LINUX OS from FLASH file system

- Execution of GigE Vision program

  - Powering up the sensor
    The soft microprocessor first gives power to the imaging sensor and loads default values into the imaging sensor internal registers.

  - Camera self-test
    The soft processor checks all the connected peripherals which include: external memory buffer, access to sensor registers and sensor data bus.

  - Execution of GigE Vision routines
    - Loading of XML file
    - Registers setup
    - Image transmission pipeline initialization

10.9. Camera modes of operation

OptoMotive cameras support two basic modes of operation: free-running and trigger.

10.9.1. Free-running

In free-running mode images are captured and transferred one after another at a set frame rate. The delay from start of acquisition to the first captured frame varies and can be up to one frame time ($t_f = \frac{1}{framerate}$).

10.9.2. Trigger

In trigger mode, sensor is not functioning, but rather waiting for a trigger signal to become active. Trigger signal can be either a software command (software trigger) or a digital signal through digital input of the camera (hardware trigger). The delay from trigger signal to start of exposure is determined by camera parameters (frame rate and exposure time). Readout and trigger signal can overleap.

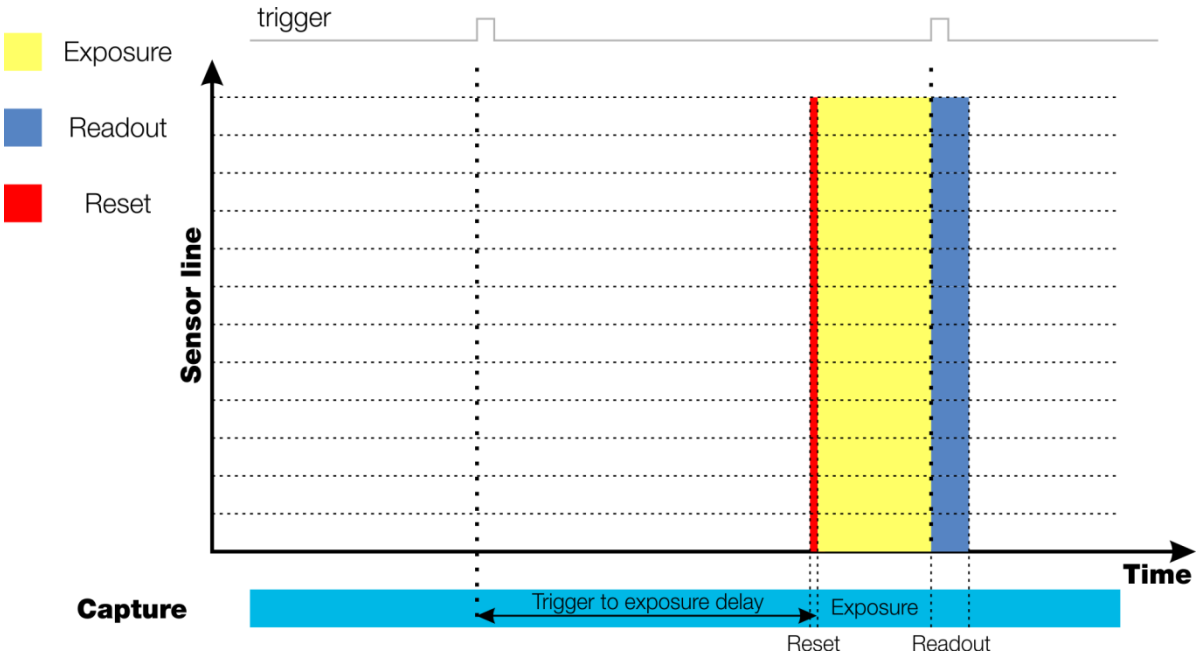


Figure 13: Trigger and shutter synchronization

The trigger signal detection has three possible options: rising edge, falling edge and both edges trigger.

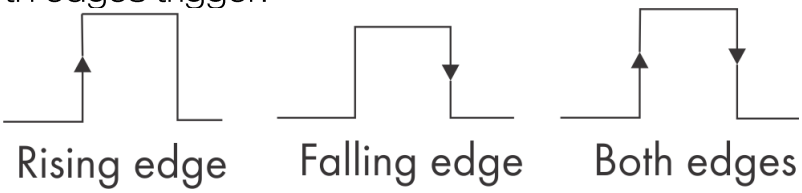


Figure 14: Trigger edge detection modes

When using a hardware trigger, an additional delay can be added to trigger to exposure delay. This way user can precisely adjust timing between trigger and exposure. The internal trigger signal is therefore delayed with respect to received hardware trigger.

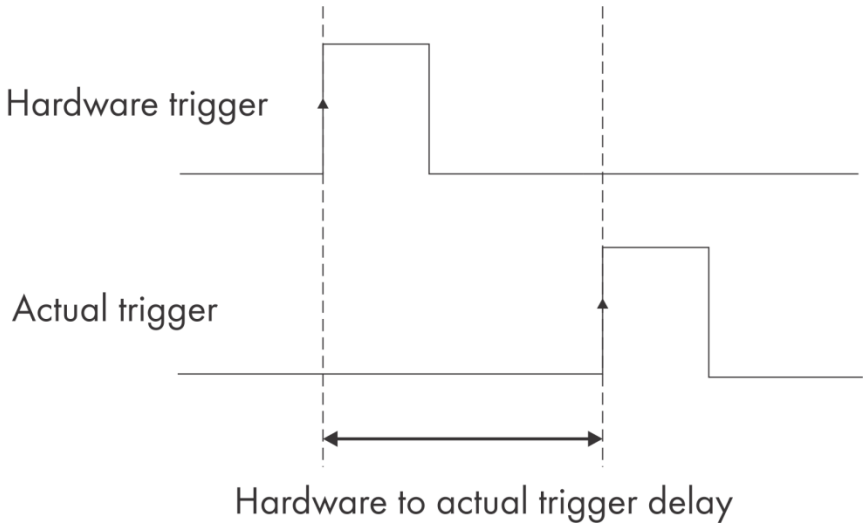


Figure 15: Hardware to actual trigger delay

Exposure of the second frame can begin before Readout of the first is complete, in other words Exposure and Readout can overlap.

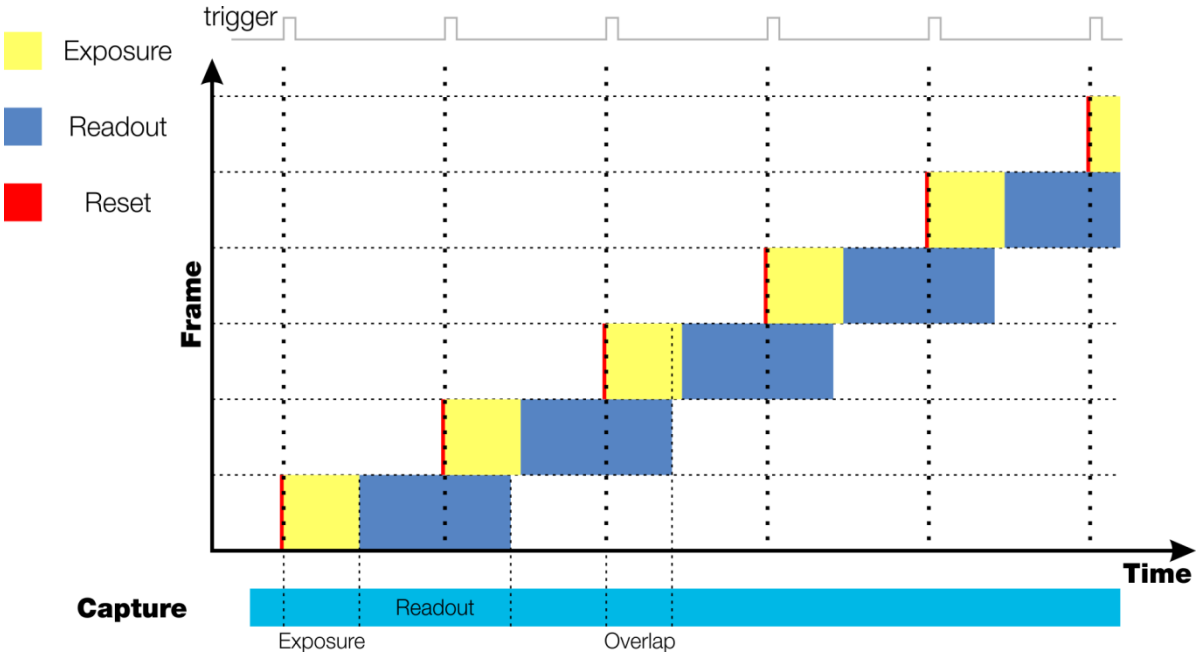


Figure 16: Exposure and Readout overlap

A trigger filter determines if a hardware trigger signal is suitable to start the actual trigger. All signals shorter than a filter period are discarded. The trigger filter **also adds additional delay** to hardware to actual trigger and has a value of filter period.

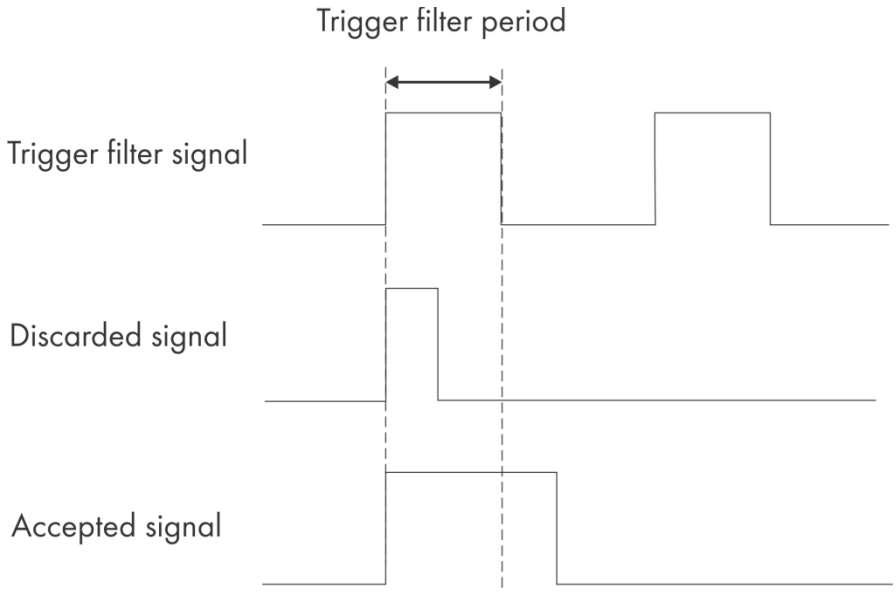


Figure 17: Trigger filter

10.10. Flash output

Flash output is controlled via SHARKi application. You can delay flash output signal with use of flash output option (digital output). This way user can precisely adjust timing between exposure and flash.

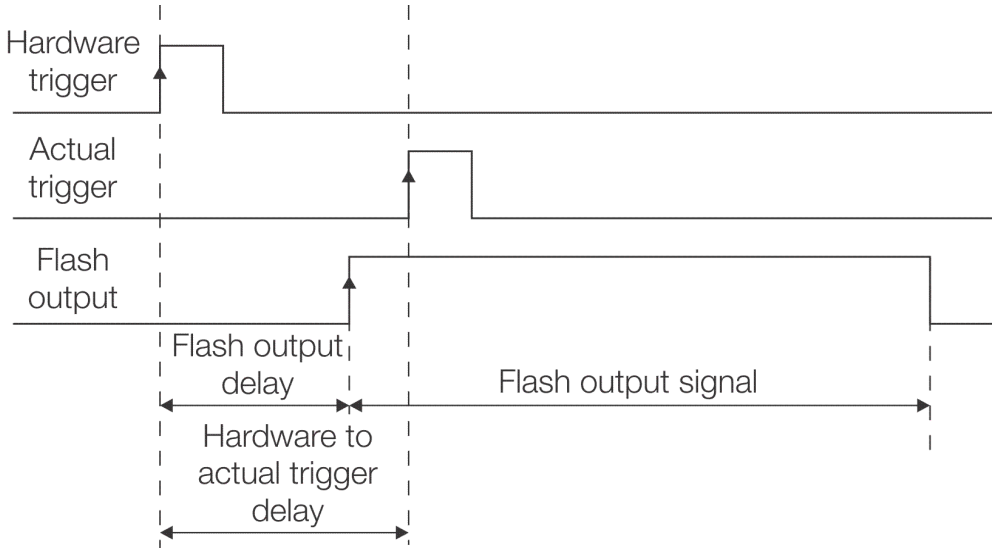


Figure 18: Flash output delay

10.11. Digital I/O's

10.11.1. Reconfigurable digital I/O's

Connector on the camera is LEMO EXG 00 304, 4pin micro connector with GND line and 3x bidirectional I/O's, 3.3Voutput, 24V tolerant.

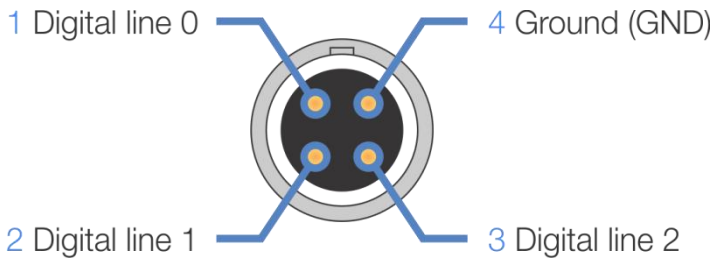


Figure 19: LEMO EXG 00 304 connector – camera side

Mating cable connector is LEMO FGG 00 304.

Figure 20: LEMO FGG 00 304 connector with wire colours and description

10.11.2. Digital I/O's wiring

Digital I/O's are ESD protected and equipped with a resettable fuse. The I/O configuration is set up according to GeniCam standard, and all the parameters can be accessed via registers listed in the XML file. User can browse the property tree for trigger features.

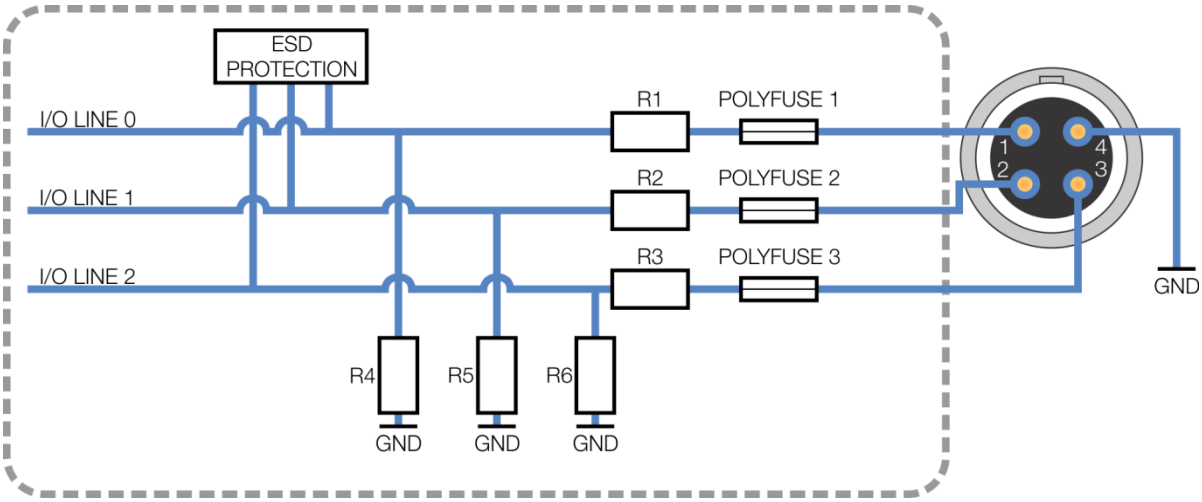


Figure 21: Digital I/O's wiring

	Min.	Max.	Unit
Level low	0	2	V
Level high	0,8	3,3	V
Voltage range	-24	24	V

Table 3: Digital I/O's specifications

11. Specifications VELOCIRAPTOR HS

11.1. Specification table

Camera Family		Velociraptor HS					
Camera model		2.2M	2.2IR	2.2C	4.2M	4.2IR	4.2C
imaging sensor	Model (CMOSIS)	CMV2000			CMV4000		
		2E5M1 PP	E12M1 PP	2E5C1 PP	2E5M1 PP	E12M1 PP	2E5C1 PP
	Colour filter	None	None	Bayer	None	None	Bayer
	Diagonal	12.7 mm (2/3")			15,92 mm (1")		
	Active pixels	2048 x 1088			2048 x 2048		
	Pixel size	5.5 µm x 5.5 µm					
	Pixel data formats	MONO8 (M and IR), BAYER8 (C only) JPEG					
	Region of interest	YES, with 8 pixel increments					
	Pixel clock speed	760 MHz (8 pixels @ 95 MHz)					
	Frame rate (Full frame)	333 FPS			178 FPS		
	Frame rate (full HD resolution, 1920x1080)*	336 FPS					
	RAW frame rate	55 FPS			28 FPS		
	Max. frame rate*	18400 FPS					
	ADC resolution	10 bit					
	Lenses	Only C/CS mount holder without lens included.					
	Analogue Gain	1 - 1.6x					
	Digital Gain	Programmable Look Up Table in FPGA					
	Shutter type	Electronic Global Shutter					
	Shutter resolution	21 ns					
	Shutter time	210 ns – 90 s					
	Exposure	Linear, 3Slope High Dynamic Range					
	Scanning system	Progressive					
Features	Trigger modes	Free running, trigger, overlap, pulse width					
	Trigger features	Delay 0 – 1000 ms LP Filter 1.5Hz - 100 kHz					
	Dynamic range	60 dB					
Processing	FPGA	15 Mgates Spartan-6LX					
	Volatile memory	2x 128 MB DDR3 SDRAM					
	Non-volatile memory	8MB flash					

Mechanical	Lens mount	C-mount (1" 32G thread)
	Temp range	0 - 50°C
	Mass	50 g OEM / 290 g with housing
	Protection	Up to IP67 with housing
	Housing material	CNC-machined aluminium, anodized in a special OptoMotive blue colour
	RoHS	RoHS compliant
	Fixing holes	4 x M3 OEM / 2 x M6 with housing
Electrical	Input voltage	Power over Ethernet, 42-57V
	Consumption	6W
	IO	3x bidirectional
	IO isolation	No, but camera has 1.5kV PoE isolation
	Connectors	RJ45, 4 pin LEMO EXG 00 304
Functionalities	Real-time image processing	Yes. JPEG compression core implemented as a standard configuration
	Software	Compatible with OptoMotive SHARKi software (full source included), and any other GigE vision software
	Operating system	Windows 7, 64bit and 32bit compatible
	Protocols	GigE Vision® 1.2 and GenICam™ 2.0 compliant
	Supported vision libraries	MathWorks MATLAB, MVTec HALCON, National Instruments LabVIEW, etc.
Standards	CE	EN55022, class A EN61000-4-2 EN61000-4-3 EN61000-4-4 EN61000-4-6
	FCC	Part 15, class A
	RoHS	Compliancy as per European directive 2002/95/EC
	GiGE VISION	Compliant with the GigE Vision 1.2 specification which defines the communication interface protocol used by any GigE Vision device. The device description and capabilities are contained in an XML file.

Table 4: Specifications table

11.2. Resolution / FPS

Specifications of resolutions and maximum frame rates with JPEG compression Core integrated are shown in Table 5.

The following equation is used for calculating a theoretical maximum acquisition speed (FPS) refers to a given resolution:

$$FPS = \frac{47500000}{129 \times Y + 1548}$$

Sensor type	CMV2000	CMV4000
Active pixels	2048 x 1088	2048 x 2048

STANDARD RESOLUTIONS

Resolution	Active pixels	MAX. FRAME RATE	MAX. FRAME RATE
Full frame 4.2M	2048 x 2048	N/A	178 FPS
Full frame 2.2M	2048 x 1088	333 FPS	333 FPS
2K	2048 x 1080	336 FPS	336 FPS
HD 1080	1920 x 1080	336 FPS	336 FPS
SXGA	1280 x 1024	355 FPS	355 FPS
XGA	1024 x 768	471 FPS	471 FPS
HD 720	1280 x 720	502 FPS	502 FPS
SVGA	800 x 600	600 FPS	600 FPS
PAL	768 x 576	625 FPS	625 FPS
WVGA	752 x 480	748 FPS	748 FPS
VGA	640 x 480	748 FPS	748 FPS
QVGA	320 x 240	1460 FPS	1460 FPS

Table 6: Resolution / FPS table

The resolutions are scaled to standard sizes for easier comparison; the frame rate depends on the number of lines only.

The following equation is used for calculating of resolution (number of lines - Y) refers to a given or wanted FPS:

$$Y = \frac{47500000}{129 \times FPS} - 12$$

where: Y - *Number of lines*
where: FPS - *Frames per second*

Active pixels	MAX. FRAME RATE	MAX. FRAME RATE
2048 x 2048	N/A	178 FPS
2048 x 1088	333 FPS	333 FPS
2048 x 1080	336 FPS	336 FPS
2048 x 1024	355 FPS	355 FPS
2048 x 768	471 FPS	471 FPS
2048 x 720	502 FPS	502 FPS
2048 x 600	600 FPS	600 FPS
2048 x 576	625 FPS	625 FPS
2048 x 480	748 FPS	748 FPS
2048 x 240	1460 FPS	1460 FPS

Table 7: Frame rates table

11.3. Recording time

Recording time vary on the amount of hard disk available on the PC side and the JPEG compression quality setting. The table below shows the recording time by using a 400GB of free hard disk drive capacity and a JPEG compression ratio of 1/10 (approx. 80 JPEG quality setting).

Active pixels X	× Y	Acquisition speed	Max. Recording Time
2048	2048	178 FPS	1 h 35 min
2048	1600	225 FPS	1 h 37 min
2048	1088	333 FPS	1 h 36 min
1920	1080	150 FPS	3 h 50 min
2048	1080	336 FPS	1 h 36 min
1920	1080	336 FPS	1 h 42 min
1024	768	150 FPS	10 h 6 min
1024	768	300 FPS	5 h 3 min
2048	768	471 FPS	1 h 36 min
1024	768	471 FPS	3 h 13 min
1280	720	150 FPS	8 h 37 min
1280	720	300 FPS	4 h 18 min
2048	720	502 FPS	1 h 36 min
1280	720	502 FPS	2 h 34 min
800	600	150 FPS	16 h 34 min
800	600	300 FPS	8 h 17 min
800	600	450 FPS	5 h 31 min
2048	600	600 FPS	1 h 36 min
800	600	600 FPS	4 h 8 min
768	576	150 FPS	17 h 58 min
768	576	300 FPS	8 h 59 min
768	576	600 FPS	4 h 29 min
2048	576	625 FPS	1 h 37 min
768	576	625 FPS	4 h 18 min
640	480	150 FPS	25 h 53 min
640	480	300 FPS	12 h 56 min
640	480	600 FPS	6 h 28 min
2048	480	748 FPS	1 h 37 min
640	480	748 FPS	5 h 11 min
320	240	150 FPS	103 h 33 min
320	240	300 FPS	51 h 46 min
320	240	600 FPS	25 h 53 min
320	240	900 FPS	17 h 15 min
320	240	1200 FPS	12 h 56 min
2048	240	1460 FPS	1 h 39 min
320	240	1460 FPS	10 h 38 min

Table 8: Recording time table

The following equation is used for calculating a maximum recording time:

$$Time[s] = \frac{Disk\ space\ [\mathrm{kB}]}{Image\ size\ [\mathrm{kB}] \times FPS}$$

where:	*Time* [s]	-	*Recording Time*
	Disk space [kB]	-	*Available disk space*
	Image size [kB]	-	$\frac{Active\ pixels\ X \times Active\ pixels\ Y}{1024 \times 10}$
	FPS	-	*Acquisition speed*

11.4. IP Cores

11.4.1. IP Cores with Eight Pixel per Clock Performance for Velociraptor HS camera with JPEG compression core embedded

11.4.1.1 JPEG compression core

- Real-Time compression reduces bandwidth to GigE transmission
- 760Mpixel/s peak input bandwidth (760MB/s for monochrome and 2,28GB/s for colour version) – runs at maximal sensor speed
- Baseline encoding, JFIF format
- Format: 4:0:0 (monochrome), 4:2:2 (colour)
- Software adjustable quality 0-100
- timestamp insertion into JPEG header

11.4.1.2 Other IP Cores

Velociraptor HS is designed to work with One-Pixel per Clock and Eight-Pixel per Clock IP Cores. To harness full capabilities of Velociraptor HS camera Eight-Pixel per Clock Performance IP cores are recommended.

Demosaicing and JPEG compression cores are embedded in the camera as standard equipment. Other IP Cores available on the request.

11.5. Mechanical drawings

11.5.1. Velociraptor HS in a housing with C-mount lens holder (IP67 optional)

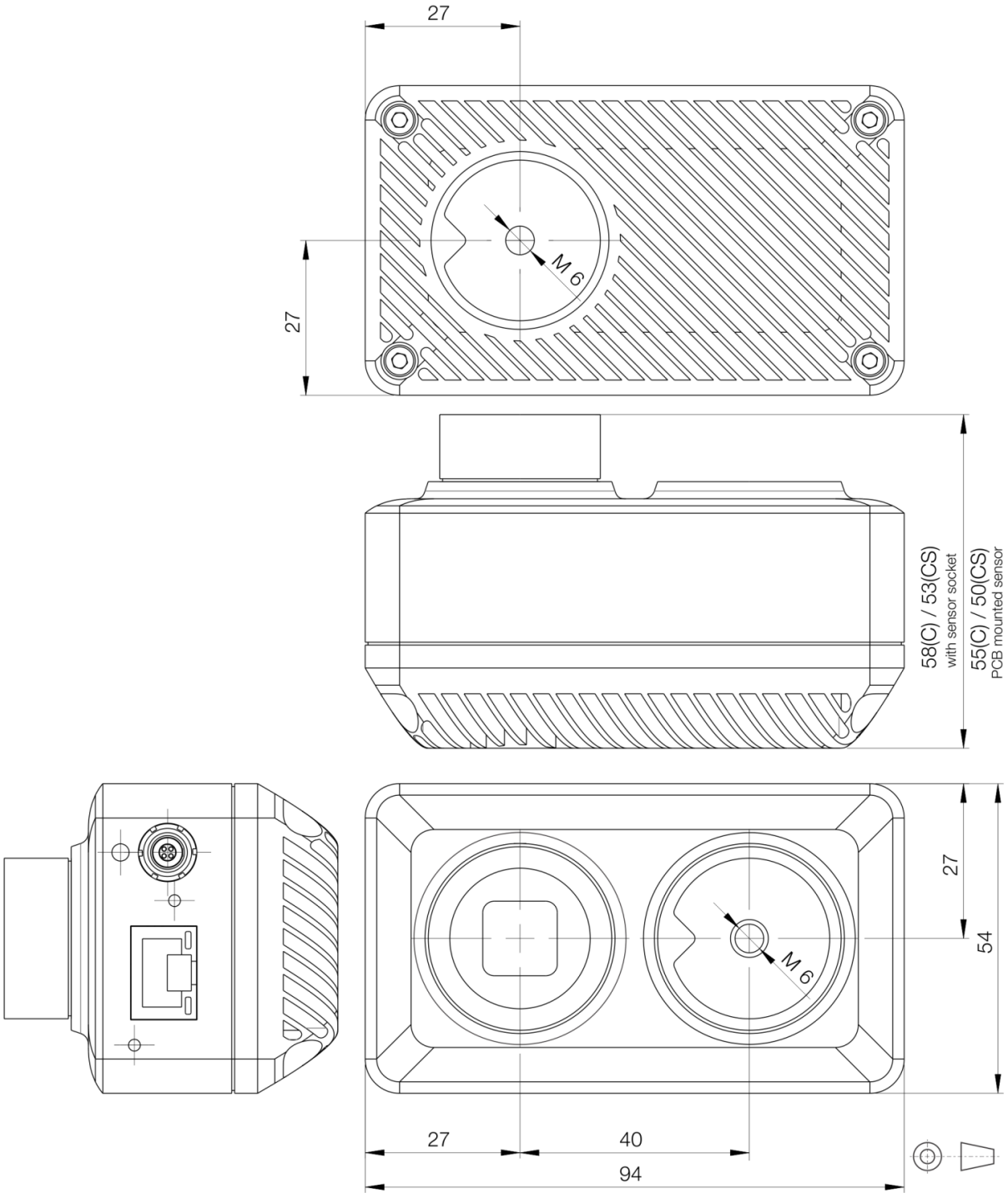


Figure 22: Velociraptor HS in a housing with C-mount lens holder

12. Cleaning and maintenance

12.1. Cleaning the camera

To clean the outside of the camera, use a small amount of mild detergent cleaner or isopropyl alcohol on a cleaning cloth. Do not pour the cleaner directly onto the camera.

12.2. Cleaning the sensor window

To remove dust from the outside of the sensor window, use a soft brush for cleaning optics or pressurized air duster. The air must be free of oil, moisture or other contaminants that could remain on the glass and possibly degrade the image. Do not touch the glass window. If oil/smudges still remain, clean the window with a cotton bud using alcohol (ethyl, methyl or isopropyl). Do not pour the alcohol directly on the window.

13. Recycling at the end of service life

NOTE: This product has been designed to respect the environment, using materials and components respecting eco-design rules. It does not contain CFCs (Carbon Fluor Chloride) or HCFCs (Halogen Carbon Fluor Chloride).

OPTOMOTIVE, in compliance with environment protection recommends to the *User* that the product or its equipment, at the end of its service life, must be recovered conforming to the local applicable regulations.

14. Troubleshooting

In rare cases an installation may fail or there are problems in controlling and using the Velociraptor camera. This section highlights issues or conditions which may cause installation problems and additionally provides information on computers and network adapters which have caused problems with Velociraptor. Emphasis is on the user to perform diagnostics with the tools provided and methods are described to correct the problem.

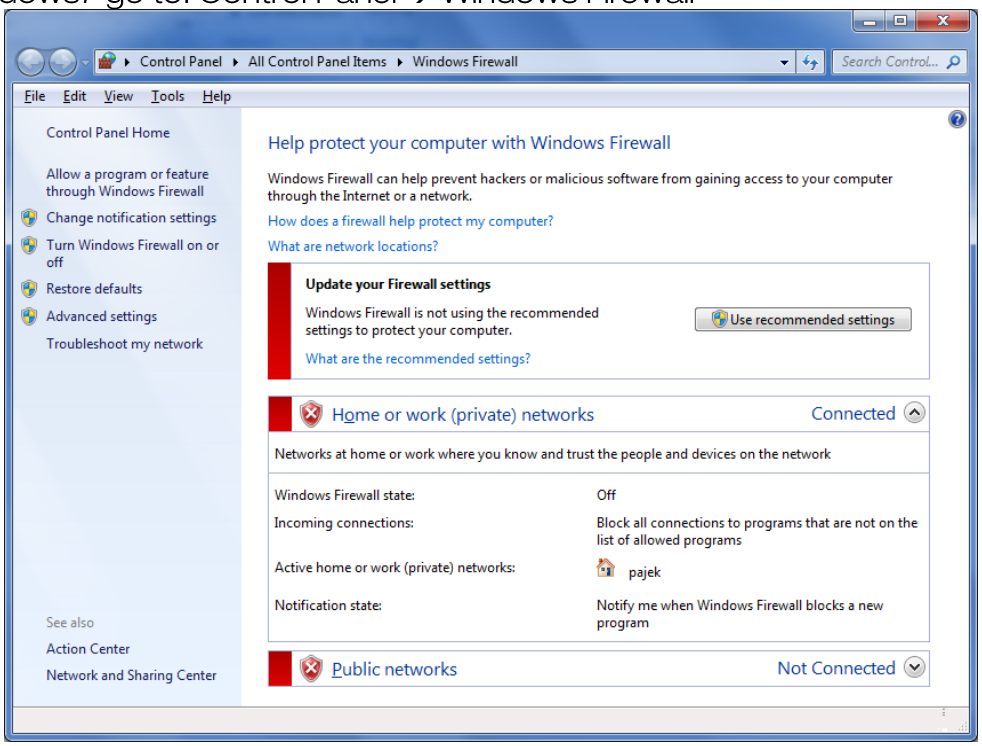
Before Contacting Technical Support

Carefully review the issues described in this Troubleshooting table

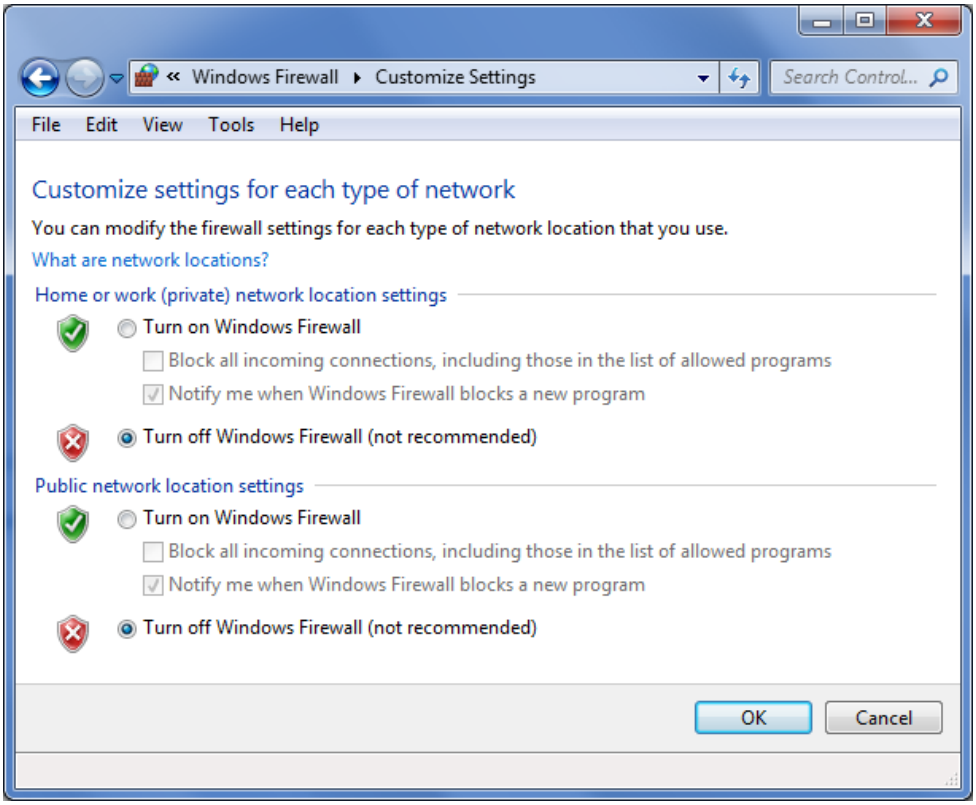
Problem	Action to take / Repair
SHARKi will not start	If SHARKi application won't start: • Install .NET redistributable package
Device Not Available in SHARKi	This indicates either a camera fault or condition such as disconnected power, or a connection issue where there is no communication. • Verify required installation steps (driver installation procedure) • Try disconnecting and reconnecting the camera
Device Available but with Operational Issues	Camera firmware does not match a newer version of installed Framework software is likely to have unpredictable behaviour. Problems might be: • Camera is not found by the device discovery process. Check info tab in SHARKi • Camera self-test should Pass
No camera exposure when expected	Verify by using the camera in free-running mode. Do not use external trigger mode when testing a camera setup. • If using free-running mode, verify that the exposure period is set to the maximum possible for the set frame rate. • Disconnect and reconnect the camera. This will reset the camera to its nominal acquisition rate.
There is a problem with the trigger	If external trigger is in use: • Verify that trigger input is working properly (check levels, pulse length, …)
Communication problems	• Verify cabling • Check that the Ethernet cable is connected to the camera, PoE power supply and the computer on the other end.
Camera is functional, frame rate is as expected, but image is black	• Verify that the lens cover is removed and iris is open. • Aim the camera at a bright light source. • Check that the programmed exposure duration is not too short or set it to maximum.

Table 9: Troubleshooting

In case you encounter problems with connection, first disable the firewall.
For Windows7 go to: Control Panel → Windows Firewall



Click Turn off Windows Firewall.



15. Technical support

Any support question or request can be submitted via:

- web page: www.optomotive.com
- email: info@optomotive.si
- phone: +386 1 291 41 429

Support requests for imaging product installations:	info@optomotive.si
Support requests for imaging applications:	info@optomotive.si
Product literature and driver updates:	info@optomotive.si

16. CE declaration of Conformity

CE DECLARATION OF CONFORMITY

We, OptoMotive, mechatronics Ltd.
V Murglah 229
SI – 1000 LJUBLJANA

Declare under sole legal responsibility that the following products conform to the protection requirements of council directive 89/336 EEC on the approximation of the laws of member states relating to electromagnetic compatibility, as amended by directive 93/68/EEC:

CAMERA: Velociraptor HS

The product to which this declaration relates are in conformity with the following relevant harmonized standards, the reference numbers of which have been published in the Official Journal of the European Communities:

EN55022:1998- Residential, Commercial and Light Industry
ENV50204: 1995
EN61000 4-2: 1995 A1 1998 A2 2001
EN61000 4-3: 1996 A1 1998
EN61000 4-4: 2004
EN61000 4-6: 1996 A1 2001

Place: Ljubljana, Slovenia

Date: August, 01. 2011

Barbara Rakovec Gorkič
CEO

17. Warranty

17.1. Warranty period

The original OptoMotive Product you have purchased is covered by a warranty of 12 months. The warranty period begins on the date of purchase of brand new, unused products by the first end user. Please retain your delivery note or your invoice as proof of purchase.

17.2. Standard warranty terms and conditions

17.2.1. General terms and conditions

As a Producer and Seller, OptoMotive mechatronics Ltd (Hereinafter referred to as "OptoMotive") will handle all warranty related affairs and shall satisfy OptoMotive warranty obligations by remedying any material or manufacturing faults free of charge at OptoMotive discretion either by repair or by exchanging individual parts or the entire appliance.

The Product is guaranteed to be free from defects in workmanship and parts in the warranty period. Defects that occur within this warranty period under normal use and care will be repaired or replaced at OptoMotive discretion.

OptoMotive reserves the right to replace the Product or relevant part with the same or equivalent product or part, rather than repair it. Where a replacement is provided the Product or part replaced becomes the property of OptoMotive. OptoMotive may replace parts with refurbished parts. Replacement of the Product or a part does not extend or restart the Warranty period.

In the event that no identical Product is available for service repair, OptoMotive has the right to replace the Product with a device of equal capacity, or offer the customer the choice of a Product upgrade which may incur an extra cost.

The benefits conferred by this warranty are in addition to all rights and remedies in respect of the Product that the consumer has under EU territory laws.

The Warranty is transferable to a new owner, in the event of sale of the Product, provided the new owner has the receipt of purchase and the Product is still within the warranty period.

17.2.2. Proof of purchase

Please keep your delivery note or your invoice as proof of purchase and as proof of the date on which the purchase was made. The proof of purchase must be presented when making a claim under this warranty. If in the event the proof of purchase is not presented, then this warranty is invalid.

17.3. Service or replacement during the warranty period

In the event that this Product is dead on arrival, you have 14 days in which to return the Product to OptoMotive or your local place of purchase for a new replacement. If you do not return the Product within 14 days then the Product will be treated under normal warranty conditions.

17.3.1. Replacement and Repair

Products sent in for repair or replacement will be repaired or replaced with a product deemed to be of equal or greater performance by OptoMotive if an exact replacement is not available. All products returned from OptoMotive are thoroughly tested recertified products.

17.3.2. Shipping

- OptoMotive provides repair at the company headquartered in Ljubljana, Slovenia only.
- OptoMotive provides replacement at the local sales point or at the authorized distributor from which the product was purchased only.
- Sales Tax, Custom duties and Freight in both ways are the responsibility of the Costumer.
- OptoMotive does not ship to PO Boxes, also any cross-shipped product cannot be sent to a mail forwarding address.
- Damaged boxes, or products received in shipping envelopes will be immediately rejected and returned to sender. Please ensure that for transport the Product is properly packed so as to ensure that no damage occurs to the Product during transit. Also make sure you have included an explanation of the problem.

- If your product is shipped to you and the address is invalid upon delivery, you are responsible for a redirect or re-ship fee which will vary depending on your region. You must contact OptoMotive prior to shipment for assistance to avoid this charge. OptoMotive is not responsible for packages delivered to an outdated address.
- If the product is returned to OptoMotive you will be responsible to pay for additional shipping charges. OptoMotive encourages you to check your shipping address prior to submitting any repair or replacement request.

All repairs and replacements will state "Warranty Replacement / Repair" on the package to assist in avoiding any taxes, duties and/or brokerage fees through customs or otherwise. OptoMotive is not responsible for any fees charged by the destination country's government body, brokers or other third party.

- Postal mail is not recommended for shipping any OptoMotive product. If your package is received with physical damage, a claim cannot be processed due to the limitations with postal services and the package will be returned to sender without alternative options.
- OptoMotive recommends shipping via UPS, and to always purchase insurance to protect your investment.

Please Note: As OptoMotive strives to honour the best warranty in the business, we have and will continue to make policy changes. Make sure you read this document carefully and check back for updates. OptoMotive reserves the right to change this policy without notice. Last update 19/4/2012.

17.4. General exclusions and limitations

This warranty will not apply if the factory-applied serial number has been altered or removed from the Product.

This warranty is limited to defects in workmanship or parts. This warranty does not extend to accessories. This warranty does not cover manuals and packaging, line cords or wiring batteries or any other consumable item.

This warranty will not apply if damage, malfunction or failure resulting from alterations, accident, misuse, abuse, improper installation or operation, lack of reasonable care, loss of parts, tampering or attempted repair by non-authorized person, fire, liquid spillage, mis-adjustment of customer controls, use of an incorrect voltage, power surges and dips, thunderstorm activity, voltage supply problems, use of defective or incompatible accessories, exposure to abnormally corrosive conditions or entry by any foreign object in the Product.

This warranty does not cover damage arising during transportation, installation or while moving the Product, or to any transportation costs of the Product or any parts thereof to and from the owner.

OptoMotive is not being liable for any loss, damage or alterations to third party hardware or software. OptoMotive is not be liable for any loss, damage or alterations data or information stored on any media or any part of the Product, no matter how occurring; or for any loss or damage arising from loss of use, loss of profits or revenue, or for any resulting indirect or consequential loss or damage.

OptoMotive will not provide refund directly to end-user in any circumstances.

OptoMotive excludes all other warranties, conditions, terms, representations and undertakings whether expressed or implied.

18. International warranty certificate

Section #1: Customer Information

Name: _____

Address: _____

City / State / Zip: _____

Telephone: _____

E-mail: _____

Section #2: Camera Information

Camera Type (check one): ☐ Cameleon ☐ Camelopard ☐ Velociraptor

Sensor Type (check one): ☐ Monochrome ☐ Colour

Model: _____

Serial number: _____

Section #3: Purchase Information

Purchase date: _____

Invoice number: _____

Seller: _____

Date:	Stamp:	Responsible person:
_____	_____	_____

19. Return form

Include this form with your return. Write clearly so we will be able to get in contact with you. If we replace the product we will ship it out to you as quickly as we can. If it is a repair situation, we will contact you before any charge is incurred.

Name _____

Contact person _____

Address _____

City _____ State _____ Zip: _____

EMAIL address _____

Phone _____ Mobile _____

CAMERA TYPE: ☐ Cameleon ☐ Camelopard ☐ Velociraptor

Model _____

Serial number _____

Date of purchase _____

Location of purchase _____

Has the camera been repaired or modified in any way? ☐ Yes ☐ No

If so, explain: _____
_____

DESCRIPTION OF DAMAGE: (What type of problem are you experiencing with your camera): _____
_____
_____

LOCATION OF DAMAGE: (Where on item did it happen?): _____
_____
_____

ADDITIONAL INFORMATION about the situation – please provide as much information as possible: _____
_____

Date of return: _____ Stamp: _____ Responsible person: _____

20. Standards

20.1. Certifications

CE	EN55022, class A EN61000-4-2 EN61000-4-3 EN61000-4-4 EN61000-4-6	Radio Disturbance Characteristics Electrostatic discharge immunity test Radiated, radio-frequency, electromagnetic field immunity test Electrical fast transient/burst immunity test Immunity to conducted disturbances, induced by radio-frequency fields
FCC	Part 15, class A	
RoHS	Compliancy as per European directive 2002/95/EC	

Table 10: Camera certifications

20.2. Supported industry standards

OptoMotive Velociraptor HS camera is 100% compliant with the GigE Vision 1.0 specification which defines the communication interface protocol used by any GigE Vision device. The device description and capabilities are contained in an XML file.

21. Revision history

Rev	Date	Author	Description
1.0	3.11.2011	JuS	Created
1.0.1	12.09.2012	JuS	Updated
1.2	25.09.2012	HM	Technical data sheet updated
1.3	11.10.2012	AG	Hardware Installation chapter added

Table 11: Revision history