Operator’s Manual

HiSpec Cameras
Models 1 & 2
Models 4 & 5

Digital Motion Analysis Recorder

Version 1.0

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1 General

Congratulations! The HiSpec is an excellent choice, because the HiSpec is an extremely versatile, advanced and self contained digital camera system. Fastec Imaging has combined progressive camera technology with software which is very easy to operate. Thus the HiSpec is the ideal solution for high speed recording. This manual provides information about the features and operating modes of four models of HiSpec.

1.1 Essentials of HiSpec Cameras

With the HiSpec – the Digital Motion Analyzer Recorder – rapidly moving or explosive processes can be continuously recorded and stored at up to 298,000 images per second (HiSpec 5) and can be displayed and analyzed in detail immediately after the end of a sequence. The images are always initially stored in the internal frame memory of the camera. Because of the built-in rechargeable battery, (not available for HiSpec 1 & 4 cameras), the cameras can operate up to 60 minutes in record mode and can store the recorded data in the internal frame memory for up to 2 hours, (and more than 20 hours in case of the standby option). Switch on the camera and after a few seconds it is ready for high speed recording at full resolution without any additional components. The HiSpec must be connected to a host PC via fast Ethernet only when downloading recorded sequences or when camera parameters need to be modified or changed.

The HiSpec 2 camera comes with a higher photosensitivity than the HiSpec 5 cameras.

1.2 Customer indications

1.2.1 For customers in the U.S.A.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart J of Part 15 of FCC Rules.
1.2.2 For customers in Canada
This apparatus complies with the Class A limits for radio noise emissions set out in Radio Interference Regulations.

1.2.2 Pour utilisateurs au Canada
Cet appareil est conforme aux normes Classe A pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

1.2.3 Life Support Applications
These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Fastec Imaging customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Fastec Imaging for any damages resulting from such improper use or sale.

1.3 Declaration of conformity

O.E.M. Manufacturer: Mikrotron GmbH
Address: Landshuterstr. 20-22
85716 Unterschleissheim
Germany

Product: High Speed Camera HiSpec

The dedicated products conform to the requirements of the Council Directives 2004/108/EG for the approximation of the laws of the Member States relating to electromagnetic consistency. The following standards were consulted for conformity testing with regard to electromagnetic consistency.

<table>
<thead>
<tr>
<th>EC Regulation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 61000-6-3</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EN 61000-6-1</td>
<td>Immunity</td>
</tr>
</tbody>
</table>

Unterschleissheim, December 1th 2009

Mikrotron GmbH

Bernhard Mindermann
Managing Director, Fastec Imaging GmbH
Warranty Note
Do not open the body of the camera. The warranty becomes void if the camera body is opened.

1.4 Remarks, Warnings
This document contains important remarks and warnings. See the corresponding symbols:

- **Important remark**
- **Attention, Warning**
1.5 Side and backside views of HiSpec cameras

1.5.1 The rear of the camera

1.5.1.1 HiSpec 2 & 5

The identification type plate is to be found at the rear of the camera. It contains the serial number and the MAC-address for identifying the device in a network.

1.5.1.2 HiSpec 1 & 4

Besides the identification type plate is to be found here: the power- / signal-connector (chapter 11.2.1), below the LED (chapter 1.6.2.3.2) for the internal camera state plus the Gigabit-Ethernet connector.
1.5.2 The right side of the camera, HiSpec 2 & 5

1.5.2.1 Connectors

There are 3 connectors, 2 switches and 2 LEDs mounted on the right side of the Camera. The pin assignments of these connectors are described in chapter 11.2

"Power " for connecting the power supply

"Signal input/Sync " for connecting digital and analog input, trigger- and sync-signals

GigaBit Ethernet connection

1.5.2.2 Switches

Power on/off

Start/Stop recording (trigger)

For cameras with standby facility, press the power switch longer than 1 second for switching off the camera!
1.5.2.3 LEDs

With the color LEDs of HiSpec the actual operating condition is indicated. Three colors are possible (and off-state):

RED
GREEN
ORANGE

1.5.2.3.1 Upper LED: battery charging and power indication

<table>
<thead>
<tr>
<th>Color</th>
<th>LED-state</th>
<th>Camera state</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>-</td>
<td>Switched off</td>
</tr>
<tr>
<td>RED</td>
<td>constant</td>
<td>Switched off, battery charging in progress</td>
</tr>
<tr>
<td>GREEN</td>
<td>constant</td>
<td>Switched on, no charging (battery full or no power supply connected)</td>
</tr>
<tr>
<td>ORANGE</td>
<td>constant</td>
<td>Switched on, battery charging in progress</td>
</tr>
</tbody>
</table>

In addition for HiSpec 2 & 5 with according hardware version supporting the standby facility:

<table>
<thead>
<tr>
<th>Color</th>
<th>LED-state</th>
<th>Camera state</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED/ORANGE</td>
<td>flashing</td>
<td>Standby mode with external power supply</td>
</tr>
<tr>
<td>GREEN/ORANGE</td>
<td>flashing</td>
<td>Switched on, with internal power supply (battery)</td>
</tr>
</tbody>
</table>

With empty batteries it may take a few minutes of initial charging until the camera can be switched on.
### 1.5.2.3.2 Lower LED: internal camera state

<table>
<thead>
<tr>
<th>Color</th>
<th>LED-state</th>
<th>Camera state</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED</td>
<td>constant</td>
<td>Boot procedure failure. Switch off the camera and try again.</td>
</tr>
<tr>
<td>ORANGE</td>
<td>after power on HiSpec: 3 sec</td>
<td>Power up boot procedure in progress</td>
</tr>
<tr>
<td>GREEN</td>
<td>constant</td>
<td>Ready for the first recording after power up</td>
</tr>
<tr>
<td>ORANGE</td>
<td>blinking</td>
<td>Circular recording in progress, waiting for stop.</td>
</tr>
<tr>
<td>ORANGE</td>
<td>steady</td>
<td>Circular recording stopped. Wait for next start signal</td>
</tr>
</tbody>
</table>

### 1.5.3 The front of the camera

The “C”-mount (optional F-Mount) for the lens is located at the front of the camera.
1.6 Scope of delivery

The following components are included as part of the delivery:

- 1 HiSpec camera, version as ordered, see selection below
- 1 Interface cable Gigabit Ethernet
- 1 110-220V power supply
- 1 CD with HiSpec operating software
- 1 connector for signal Input
### 1.7 HiSpec Versions:

<table>
<thead>
<tr>
<th>Identifier (1)</th>
<th>Recording time [s] (3)</th>
<th>Max. Resolution (4)</th>
<th>Max. frame-rate [fps] (5)</th>
<th>Lens mount (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HiSpec 1</td>
<td>3</td>
<td>1280x1024</td>
<td>111,000</td>
<td>C / F</td>
</tr>
<tr>
<td>HiSpec 2</td>
<td>6.5</td>
<td>1280x1024</td>
<td>111,100</td>
<td>C / F</td>
</tr>
<tr>
<td>8GBMRM</td>
<td>13.0</td>
<td>1280x1024</td>
<td>111,000</td>
<td></td>
</tr>
<tr>
<td>HiSpec 4</td>
<td>1.5</td>
<td>1696x1710</td>
<td>298,000</td>
<td>C / F</td>
</tr>
<tr>
<td>HiSpec 5</td>
<td>3.0</td>
<td>1696x1710</td>
<td>298,000</td>
<td>C / F</td>
</tr>
<tr>
<td>8GBMEM</td>
<td>6.0</td>
<td>1696x1710</td>
<td>298,000</td>
<td></td>
</tr>
</tbody>
</table>

**Additional configuration options:**

- **C**: Color (otherwise monochrome)
- **HG**: Indicates the Hi-G version, (ruggedized for crash and vibration)
- **IBTRIG**: Camera has ImageBLITZ Auto Trigger option
- **IRIG**: IRIG-B input processing option
- **MS**: Camera has Multi-Sequence option
- **M13**: 13 seconds recording time
- **PB**: Phoenix connector

**HiSpec 1 & 2**: Seconds when using 500 fps and 1280x1024

**HiSpec 4 & 5**: Seconds when using 523 fps and 1696x1710

**Resolution in Width x Height**

**Frames per second**

Reduced resolution when using more than 500/523 fps

**Lens mount:**
- **CM**: “C”-Mount, optional **FM**: F-Mount
1.8 Power supply and charging

HiSpec 2 & 5 cameras contain an integrated, rechargeable battery, which provides the necessary voltage for operation. Use an external power supply for charging the battery and for external power operation.

Only voltages in the range from 10.5 to 30 Volts @ 15W max. are permitted. Higher input voltages may seriously damage the camera. Damage of this type is not covered by our warranty.

1.8.1 Battery charging

HiSpec 2 & 5 cameras contain an integrated, rechargeable battery. Thus the camera can operate as stand alone without any power connection for up to 60 minutes of circular recording with full resolution. HiSpec EoSens mini cameras don’t have a battery.

Stored images can be retained in the camera up to two hours with a fully charged battery. With the standby option, more than 20 hours are possible.

The battery will be automatically charged when the power supply (10.5 – 30 V DC) is connected to the camera and the camera is switched off. Charging of a completely empty battery will take 3 hours.

If the camera is switched on and a power supply connected, the battery is charged to a fraction of its total capacity, it will operate a few minutes when disconnected from power supply.

If the camera is switched on and a power supply is connected, the battery will be charged as well.

A fully charged battery will discharge within a few days when not used.

Always use an external power supply if the battery condition is unknown.
2 Operating Modes

After switching on the camera it is ready for operation within a few seconds. HiSpec 4 & 5 cameras with according hardware version have a standby mode available.

2.1 Standby (for HiSpec 4 & 5 cameras only)

The intended purpose of the standby mode is to store the camera’s recorded images for a longer time (up to ca. 20 hours and more) without any external power supply. To manage this, in standby mode several components of the camera’s electronic will be shutdown and mainly only the image memory will be provided with power.

In standby mode, there is no access to the camera’s image memory.

To get the camera into the standby mode you have to

- press the camera’s power switch for a short moment (less than 1 second), when the camera is ready-to-operate
- configure it with the HiSpec software as described in chapter Standby after record end.

To get the camera out of the standby mode you have to press the camera’s power switch for a short moment (less than 1 second).

Please pay attention: If you press the switch longer than 1 second, you will shut down the camera completely and the recording will be lost!

The standby mode will be indicated by the LEDs in the following manner:

- the lower LED (TRIGGER) is switched off
- the upper LED (POWER) is flashing:

<table>
<thead>
<tr>
<th>Power LED color</th>
<th>Power supply</th>
<th>advice</th>
</tr>
</thead>
<tbody>
<tr>
<td>red / orange constant flashing</td>
<td>external</td>
<td></td>
</tr>
<tr>
<td>green flashing 1 .. 5 times every 2 seconds</td>
<td>internal (battery)</td>
<td>If the battery is fully charged, there is a quintuple blinking.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the battery is discharged, there is a single blinking.</td>
</tr>
</tbody>
</table>
2.2 Ready-to-operate

By means of the HiSpec Director 2 software, (control program), the camera can be set up for recording in different operating modes.

If the camera is disconnected from the PC, reconnect it and then wait a few seconds until the camera is shown in the list of available cameras, select the camera from the list and click the Connect button in order to establish the Gigabit Ethernet link.

![Available cameras table]

It’s very important to press the “Connect button” after the camera is reconnected with your system. If this button is not pressed after reconnection the chronology of a meanwhile recorded sequence may be lost!
The same applies to a completed recording session that has been started with the camera’s trigger switch. In this case click on “Disconnect” followed by “Connect” for getting the sequence completely.

HiSpec 4 & 5 cameras hold up to 8 Gbyte internal frame memory. From this memory, a very small part (only as much as required by one frame) is used for storing the frames for the live mode. The remaining memory is used for sequence recording.

2.1.1 Live mode

The camera images are continuously recorded and displayed. This mode is optimal for defining image detail, adjusting the focus and setting up the various camera parameters. Switch the camera to live mode by pressing the "Live" button.

2.1.2 Prepare for recording

When the camera parameters are adjusted according to the user’s needs it can be disconnected from the PC to make an autonomous recording, (HiSpec 2 & 5 cameras only). The recording can be started via the trigger switch on the camera. If the camera is still connected to the PC always start the recording by the “Record Button”.

2.1.3 Start recording

After power up, the camera starts with the factory settings. If you need a different resolution/frame speed, the new parameters must be entered via the control software.

There are 3 methods to start recording (Method 1 for HiSpec 4 & 5 cameras only):

1. Press the Start/Stop recording switch on the right side of the camera.
2. In this case, a reconnect by clicking on the Disconnect / Connect-button has to be accomplished after the completion of the recording sequence in order to save the chronology of the pictures.
3. Press the red start recording button in the HiSpec control program
4. Press the F5 key

2.1.3.1 Recording modes

HiSpec has 2 recording modes. The main difference is the usage of the camera’s image memory and trigger.

2.1.3.1.1 Single mode (non circular)

The camera stops recording when the internal frame buffer is full.

2.1.3.1.2 Ring mode (circular recording)

The camera records frames in a circular mode, (i.e. the oldest frames are always overwritten by the newest), and waits for a signal to stop. There are 4 methods to stop recording, (first method for HiSpec 4 & 5 cameras only):

1. Press the Start/Stop recording switch on the camera.
2. Apply a trigger signal (rising or falling edge, depends on setting “Trigger edge” in form “Camera Setup”) to the appropriate camera input connector.
3. Change the scene if ImageBLITZ is activated.
4. Press the Stop button in the HiSpec control program
3  **Installation of HiSpec**

Insert the HiSpec Setup-CD in the CD-Rom drive on the PC. Start the setup.exe program and follow the instructions through the rest of the installation process.

3.1  **Minimal system requirements (PC)**

For error-free operation of HiSpec the following minimum PC specifications are required:

- Pentium IV 2GHz CPU with MMX-technology
- Windows XP / Windows7 operating system
- 1 Gbyte PC Ram
- 20 Gbyte Hard disk
- 32 Mbyte graphic memory
- Display with 1280 x 1024 pixels
- Gigabit Ethernet Adapter

For optimal operation of HiSpec, a PC with the following minimum specifications are recommended:

- Intel Core 2 Duo
- Windows XP / Windows7
- 2 Gbyte PC Ram
- 40 Gbyte Hard disk
- 256 Mbyte graphic memory
- Display with 1400 x 1050 pixels / 24 Bit
- Gigabit Ethernet Adapter (Intel Pro 1000)

3.2  **Prerequisites**

- The Gigabit Ethernet adapter and driver should be installed before the software is installed. For details see the Gigabit Ethernet adapter manual.
- Microsoft .NET Framework >= 3.5 SP1
- Latest Windows **Service Pack**

Please make sure that you have installed the prerequisites before starting the software
3.3 Assigning an IP-address to the network card (NIC)

In order to communicate with the camera through Ethernet an appropriate IP address must be assigned to the used network card.

- Open the “Network and Dial-up Connections” window from the Windows Control Panel.

- Right click on the desired connection in the panel and click the “Properties” item. The properties dialog for the connection, shown in the next figure on the next page, will be displayed.
• Highlight the Internet Protocol (TCP/IP) by clicking on the text-part, not on the check-box.
• Click the “Properties” button. The next dialog will allow you to assign an IP-Address and the subnet-mask of the Gigabit network-adapter.
• Assign any desired IP address, that is not used, e.g. 192.168.101.1, set the subnet-mask to 255.255.255.0.
• Click on “OK”
3.4 Connecting the camera to the PC and start the application

To properly connect the camera to the PC please follow these steps:

1. Connect the Gigabit Ethernet cable to the camera and then to the PC
2. Connect the power supply to the camera
   Switch on the camera by pressing the power-switch

   See Switches (for HiSpec 4 & 5 cameras only)

3. Start the program. All network adapters will be checked for available cameras. The found cameras will be listed in the “Available cameras” section. This could take a few seconds.

4. Select the camera to use by clicking on the appropriate entry.

5. Click on “Connect” in order to get the communication established with this camera. Repeat step 5 and 6 for other cameras that you like to operate in a parallel mode.

6. The camera’s status symbol will change to green when the communication is established.

7. Now the software is ready to operate.
3.4.1 Assigning a name to the camera

If you would like to use a name for your camera, you may enter this name in the “name” field of the menu „camera and application info“. By clicking on “Apply” the entered name will be used for the camera. The menu will be activated for the selected camera by clicking on the info button.
3.4.2 Multi camera operation

If you want to use two or more cameras simultaneously, (up to 4 are possible), first select the camera in the list of available cameras, then click on connect. Repeat these steps for all cameras that you want to use.

You may use up to four cameras simultaneously.

For connecting the cameras with your PC you should use one Gigabit-Ethernet network adapter for each camera. If your system holds not enough adapters, you could use a Gigabit-Ethernet switch. The following switches are recommended for use:

- SMC Tiger Switch 86xxT family
- 3COM 3C1740x (3800 family)
- Dlink DGS-10xxTx 10/100/1000 family
- SMC 8505 or SMC 8508
- NETGEAR ProSafe 16 Port Gigabit Smart Switch GS716T

3.4.2.1 Synchronizing cameras

For synchronizing multiple cameras you only have to connect the sync output of the master camera or of an external clock generator to sync input of the slave cameras, as described in detail chapter External signals.

3.5 Recommended network adapters

For best performance, you should use Intel Pro 1000 series network card. Please contact the Fastec Imaging support team to get more information on how to increase the performance of the application.
3.6 Network-configuration file "mfggb.ini"

If the "mfggb.ini" does not exist on program startup it will be created when the application is closed. The following parameters are included:

[00-17-31-78-81-7e]
FirstPacketTimeout=0
PacketTimeout=1000
RequestTimeout=1100
DefaultImageTimeout=1000
AnswerTimeout=1000
HeartbeatTimeout=5000
HeartbeatInterval=1500
GevSCPSPacketSize=1440
InterPacketDelay=2000
MaximumPendingResends=0
BlockTransferMode=False

The first entry of a section is the MAC-address of the network adapter followed by some stream parameters. Please do not change these parameters.

Please contact the Fastec Imaging support team if you have problems with your camera connection.
4 **HiSpec Director2 in practice**

The full range of functions and camera parameters may be set by means of the software. The user interface is organized in three parts.

On the left side, there is the control panel for the camera and program settings, in the middle the image window and below the panel for controlling the application. Each part may be enlarged or minimized, undocked and docked again.

4.1 **The user interface**

The camera is completely controlled through the user interface. All parameters of the camera for recording, playback and saving the frames after recording may be adjusted here. After recording, stored sequences of images may be subsequently edited. Start the software by double clicking on the appropriate symbol on the PC desktop or choose the application in the windows start menu. After selection of the camera (by clicking on the appropriate entry in the list of "Available cameras" and establishing the connection by clicking on “Connect”) the following screen mask will appear:

![Image of user interface](image)

Select modes of operation or change parameters by pressing a command-button or by selecting an item in an expander control (e.g. camera settings). If the mouse cursor is moved slowly over some of the command buttons and symbols, information about this object will be displayed ("tool tip text").
4.2 Program settings

4.2.1 Changing the playback speed

The playback speed of a recorded sequence may be adjusted by the slider „Playback speed“. The unit is frames per second. If the speed is too high, some frames will be omitted during playback.

4.2.2 Live mode after connect

With this check box you may control, if live mode is active after connecting a camera.

If the camera holds a recording sequence, live mode will not be active but a frame of the recorded sequence will be shown.

4.2.3 Display Info line

Shows an info line at the bottom of the camera’s image:

1. timestamp of the recorded sequence
2. rel. time after / before trigger [ms]
3. actual frame number
4. camera model
5. manufacturer of camera
6. adjusted resolution of camera
7. recording speed in frames per second
8. exposure time

Depending on the used camera model the digital and analog IO values are also shown in the info line, if enabled. The above info line will be created for recorded sequences. In live mode it will differ slightly.
4.3 Loading and saving camera profiles

A profile is a set of all camera parameters that may be changed by the user.

Profiles are stored in XML format. If you save a profile, the actual camera settings will be written to file. If you load a profile, the parameters in the file are read and sent to the camera.

Loading and saving of profiles is accomplished by clicking on the "Load profile" and "Save Profile" button.
4.4 Camera settings

The adjustments of the camera may be done in 3 groups, which are selected by the appropriate expander controls. If you use more than one camera simultaneously, the settings of the selected camera are shown on the left panel.

4.4.1 Frame rate, exposure time and frame size

These parameters are elements of the expander control „Camera settings“.

```
<table>
<thead>
<tr>
<th>Camera settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Framesize</td>
</tr>
<tr>
<td>Frame rate [fps]</td>
</tr>
<tr>
<td>Shutter [µs]</td>
</tr>
</tbody>
</table>
```

The frame rate und exposure time may be adjusted with the slider „Frame rate [fps]“ and „Shutter [µs]“ or you enter the values via keyboard in the corresponding input fields. The adjustments will take effect immediately.

4.4.1.1 "Low light" mode

In low light mode the camera's exposure-time is extended up to 99.9 milliseconds in order to increase its sensitivity. This mode is good for setting up the frame size and the focus in “Live” mode. Select your exposure time with the slider " Shutter [µs]" or input it directly in the appropriate number-field. Low light mode will be automatically finished if a recording is started.

4.4.1.2 Max Shutter

If this check box is activated, the maximal exposure time for the actual frame size and frame rate will be used.
4.4.1.3 Adjust ROI (changing the frame size)

Click on "Adjust ROI" button to adjust the "Region Of Interest" or image section.

The ROI can be changed by

- inputting the values for offsetX, offsetY, Width and Height into the textboxes
- moving and changing of the red rectangle onto the displayed image
- moving and changing of the green rectangle in the left control

By clicking on "Apply ROI", the adjustments will be applied.

Changes of resolution or frame rate may alter the quality of recorded images. Be sure that you have saved your recorded images to file before applying these changes because the recorded images may be destroyed or lost!
External signals

With “Camera IO” the input and output ports of the HiSpec cameras may be configured for external signals.

4.4.1.4 Trigger input

If recording sequences should be finished by an external trigger signal, the check box “Enable external Trigger” must be activated. In this case, the "rising edge" or the "falling edge" of the signal could be selected for stopping the sequence.

4.4.1.5 Enable Sync in

With “Enable sync In” enabled it is possible to synchronize a camera with other cameras or with an external clock generator.

- Connect the "Sync Out" of your master camera with the “Sync In” of the slave cameras.
- Connect the ground of the master camera with the ground of the slave cameras
- Select a frame rate for the slave camera (s) that is slightly above the master cameras frame rate.
- The slave cameras will be synchronized with the master camera now.

4.4.1.5.1 Frame rates of master and slave camera

If you synchronize a slave camera by a master camera, then the frame rate of the slave camera must be slightly above the master cameras frame rate, otherwise the slave camera will not provide the same frame rate as the master camera.

Example:

You want to record with 1000 frames per second. Adjust the master camera to the desired 1000 fps, select 1004 fps for the slave camera. Then the slave camera will deliver the master camera’s frame rate (1000 fps)!
4.4.1.6 ARM or “Sync out” signal

You may choose between “ARM” or “Sync out” signal for pin 3 of the output connector by using the combo box sync. See “Sync/Arm Output” for details.

4.4.1.6.1 Sync out activated

If you select “Sync out”, it is possible to synchronize other cameras. The rising edge of the signal provided on pin 3 shows the beginning of the exposure of the master camera’s image, the falling edge the end.

4.4.1.6.2 ARM activated

If you select “ARM”, you get a signal if the camera is ready for triggering in the ring mode (circular recording mode).

With the combo box on the right side of the Sync out/ARM you may define if ARM is active high or low. Please note: this does not apply to the “Sync out” signal.

4.4.1.7 Display input ports

If “Display input Ports” is enabled (checked), the digital input and the analog input values of the camera are displayed in the info line, if enabled. See Display Info line. Please note: HiSpec 1 & 4 cameras are not provided with an analog input.

4.4.1.8 Convert Analog Values (HiSpec 4 & 5 cameras cameras only)

The camera’s A/D converter delivers 0 for an input voltage of 0 Volts and 255 for 2.5 Volts. To convert the A/D value to physical units, edit the values “A” and “B” of the conversion formula:

Converted unit = A * X + B, where X is the A/D converters value.

If you want to display Volts, use for the factor A: 2.5 / 255 = 0.0098039 and 0 for B.
4.4.2 Advanced settings

With "Advanced settings" special settings like gain or black level may be performed.

4.4.2.1 Black level

With the black level parameter, (controlled with slider "Black level" or text field), you may adjust the camera’s image sensor base black level. The base black level must be set to a value between 0 and 255. Setting to the correct value, the sensor will deliver the pixel value 0, (which means totally black), for a complete black image.

If the value is too big, the sensor will deliver a pixel value above 0 (which means gray).

If the value is too small, the sensor will deliver a pixel value 0 (totally black) for images that are gray and not completely black.

In live mode, close the lens of the camera for getting a completely black image. Adjust the black level until the black line in the Luminance selection touches the 0-line of the diagram. See Show Histogram Window

4.4.2.2 Digital Gain

The gain may be adjusted with the slider “Digital Gain” or input in the text field. Factors 1 to 4, (HiSpec 1 & 2) or 1 to 2, (HiSpec 4 & 5), are allowed. But please note: The quality of the image decreases the more you increase the gain.
4.4.2.3 Linear or logarithmic

With the “Dynamic range adjustment” parameter you may adjust the sensor’s characteristic in order to avoid overexposure of very bright parts in the image.

If the slider is moved to 1, the sensor’s characteristic is linear, normal illuminated scenes will be displayed well.

If there are very bright areas in the scene, then the image will be overexposed, details of the motif will be lost. In this case you should move the slider to the right, (up to 99 max.), whereby details in bright parts of the image will become visible again. The correct setup value depends on the brightness spreading of your motif. In normal illuminated scenes you should use “1”.

4.4.2.4 "Quad Mode" (for black and white HiSpec 1 & 2 cameras only)

Monochrome HiSpec 2 cameras starting from firmware version F2.90 and HiSpec 1 cameras from version F2.19 provide the “Quad Mode.” In this mode the camera may achieve a nearly quadruple higher frame rate and recording time without changing the image section (width and height of the image). The only drawback is a decrease in image quality.

By clicking on the check box “Enable Quad Mode” in the expander control “Advanced Settings” this mode will be activated. Please note that this adjustment will take a few seconds.

Without “Quad Mode”, the full quality of the image without the increased frame rate and recording time will be delivered. See Select the interpolation algorithm

4.4.2.5 Check camera temperature

After activating “Check camera temperature” the internal camera temperature will be measured and checked every minute. If the temperature is in
the normal range, the temperature status will be shown as green circle beside the frame size indicator. If the temperature is too high, it’s the circles color becomes red. In this case the camera should be cooled.

After establishing the link with the camera, ("Connect" button), this feature will be always deactivated.
4.5 Record settings

There are 2 record modes available:

---

**Single mode, record until end of buffer**

<table>
<thead>
<tr>
<th>Record mode</th>
<th>Single mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record size</td>
<td>38682 [Frames] 73.96 [s]</td>
</tr>
<tr>
<td>Single mode</td>
<td>Record until end</td>
</tr>
</tbody>
</table>

- [ ] Activate auto save
- [ ] Set camera in standby mode after record end

---

**Ring mode, circular recording**

<table>
<thead>
<tr>
<th>Record mode</th>
<th>Ring mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record size</td>
<td>38682 [Frames] 73.96 [s]</td>
</tr>
<tr>
<td>Record sequences</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pre trigger frames</th>
<th>Post trigger frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>37243</td>
<td>71,21 [s]</td>
</tr>
<tr>
<td></td>
<td>1439</td>
</tr>
<tr>
<td></td>
<td>2,75 [s]</td>
</tr>
</tbody>
</table>

- [ ] Activate auto save
- [ ] Activate ImageBLITZ
- [ ] Set camera in standby mode after record end

---

HiSpec 4 & 5 cameras with an appropriate hardware version may change to standby mode automatically after the end of a recording sequence.

### 4.5.1 Standby after record end

If “Set camera in standby mode after record end” is selected, the camera will switch to the standby mode automatically after the end of the next recording session.

This activation is valid only for the next recording session and will be deactivated automatically afterwards. If the camera is set to standby the communication with the PC is stopped, which results in a: “Connection to device ... lost” warning message.

In order to get access to the camera’s image memory again, you must set the camera into the ready-to-operate state: Please press the camera’s power switch for a short moment, (less than 1 second), and start a reconnect cycle: wait until the camera is detected, select it and click on the “Connect” button. The recorded sequence is displayed automatically.
4.5.2 Record until end of buffer (single mode)

4.5.2.1 Without trigger “Record until end”

The camera stops recording when

- the end of the buffer is reached
- the “Stop” button or the F12 key is pressed.
- the ESC key is pressed. This will destroy your recorded sequence.

HiSpec cameras with corresponding hardware version are able to process a trigger signal in single mode.

During a recording session with triggering actual images are shown as long as the camera provides them on account of the active trigger. While waiting for the next trigger there are now images shown.
4.5.2.2 Recording while trigger is active

As long as the trigger is active, recording will proceed. When the trigger gets inactive before the image buffer is full, the camera is waiting for the next trigger. Not until the end of the buffer is reached the recording ends (or if the recording was stopped before by clicking on the “stop” button or pressing the key F12).

The trigger may be:

1. The camera’s trigger switch (HiSpec 2 & 5 cameras only)
2. An external trigger signal connected with the camera’s trigger input, provided that “Enable external trigger” in “Camera IO” is activated. The active edge or the active state of the signal may be selected in “Camera IO” as well.
3. Changing of the contents in a specific part of the actual recorded image if ImageBLITZ is used, i.e. “Activate ImageBLITZ” is activated.

With this trigger setting, the active state of the trigger is essential, not the edge.
### 4.5.2.3 Fixed number of frames per trigger (burst trigger)

For each trigger edge a preset number of frames will be recorded. The number may be chosen between 1 and 1022.

Enter the number in the input field or move the slider into the desired position. In the figure above 10 frames per trigger edge are selected.

After every recording, which was initiated by the trigger edge, the camera will wait for the next edge as long as the end of the memory is not reached.

After reaching the end of the memory, the recording is completed. Alternatively the recording may be stopped via the Stop button or F12.

As described in the chapter before, the trigger could be the camera’s trigger switch, an external trigger signal or the ImageBLITZ.

With this trigger setting, the active edge of the trigger is essential, not the state.
4.5.3 Record in ring mode (circular)

The camera records in a circular mode, i.e. the oldest frame is overwritten by the newest until an event occurs.

The recording stops when:

- The “Stop” button or the F12 key is pressed.
- A trigger event occurs.
- The ESC key is pressed. This will destroy your recorded sequence.

After the circular recording has been stopped (is not aborted by ESC) as many frames as defined with “Frames before trigger”, (37234 in our example), will be kept and the rest of the frame buffer will be filled up with frames. With the slider you may vary the trigger position from the first frame (“1”) to the last possible frame as well.

"Activate ImageBLITZ", (trigger with ImageBLITZ), and "Record Sequences", (Multi-sequence mode), are available, if the camera holds the corresponding option ("IB" and "MS").

4.5.3.1 Trigger modes

There are two trigger modes available, which may be selected independently. Choose an external signal and / or ImageBLITZ Auto Trigger by clicking the appropriate checkbox.

4.5.3.1.1 Trigger with external signal

If external trigger is selected, a rising or a falling edge, depending on the settings stops the recording. See Trigger input
4.5.3.1.2 Trigger with ImageBLITZ Auto Trigger – optional

If ImageBLITZ is selected ("Activate ImageBLITZ"), changes in the contents in a specific part of the actual recorded image will stop the recording. This specific part is called the “ImageBLITZ Window”. The ImageBLITZ parameters are "Record settings" during “Live” mode.

The ImageBLITZ window is shown as a green or red rectangle in the displayed frames.

**ImageBLITZ is an optional camera feature (option = „IB“)**

Movements of the ImageBLITZ window while recording are not possible.
4.5.3.1.2.1 ImageBLITZ parameters

If ImageBLITZ is activated, the camera compares the contents of the ImageBLITZ window of the actual frame with the reference frame. If the differences exceed a limit, the ImageBLITZ triggers.

The two parameters for adjusting the ImageBLITZ may be set manually by entering the values in the release parameters fields or automatically by clicking on “Auto adjust”.

4.5.3.1.2.1.1 Pixel value difference (“Gray difference“)
This parameter defines the absolute limit for the difference in the gray values within the ImageBLITZ-window of both images. The value range is 1 to 255.

With a small value, small changes in the image detail because the ImageBLITZ Auto trigger to stop the recording, with a big value change the ImageBLITZ trigger gets less sensitive. Under normal conditions, this value should be between 10 and 70.

4.5.3.1.2.1.2 Relative object size (“Rel. Object size“)
This parameter defines the relative size of the area within the ImageBLITZ window that must be different from the reference frame before ImageBLITZ triggers. The value range is 1 to 100 percent. If you use a small value, e.g. 5, then ImageBLITZ triggers when 5% of the image details within the ImageBLITZ window are different compared to the reference frame.

4.5.3.1.2.1.3 ImageBLITZ reference frame
The ImageBLITZ reference frame is taken when the trigger is activated. If you like to update the reference frame, just click on “Update ImageBLITZ“.

4.5.3.1.2.1.4 ImageBLITZ window colors
The color of the ImageBLITZ window borderline is used to indicate the current state of ImageBLITZ:

<table>
<thead>
<tr>
<th>color</th>
<th>meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>ImageBLITZ is active and waiting for a trigger situation</td>
</tr>
<tr>
<td>Red</td>
<td>ImageBLITZ is active and has triggered</td>
</tr>
</tbody>
</table>
4.5.3.2 Multi sequence mode - optional

The frame memory may be divided into up to 16 same-sized memory ranges for sequences, called multi sequence mode. Each memory range is then filled by a trigger event, i.e. by the occurrence of the external trigger signal or the ImageBLITZ Auto trigger. After a trigger event the post-trigger frames will be recorded and the camera switches to the next sequence, beginning the recording of the pre-trigger frames. Thus the recording proceeds until all sequences are complete.

If a trigger event occurs before the predefined number of pre-trigger frames are recorded, the number of pre-trigger frames will be less than predefined, whereas the number of post-trigger frames will be as expected. If a multi sequence recording is stopped the current active sequence will be completed.

Multi sequence mode is provided only by means of the software. It’s not possible to start a multi-sequence recording session if the camera is not online.

- **Multi sequence is an optional camera feature.**

You can choose between five different sequence settings: 1, 2, 4, 8, and 16.

<table>
<thead>
<tr>
<th>Record mode</th>
<th>Ring mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record size</td>
<td>38682 [Frames] 73.96 [s]</td>
</tr>
<tr>
<td>Record sequences</td>
<td>1</td>
</tr>
<tr>
<td>Pre trigger frames</td>
<td>2</td>
</tr>
<tr>
<td>37243 71.21</td>
<td>4, 8</td>
</tr>
<tr>
<td>16</td>
<td>2.75 [s]</td>
</tr>
</tbody>
</table>

The number of sequences used for the next recording can be selected in the record sequences combo box.

- **Multi sequence mode is only available in ring mode**
If you have selected more than one sequence, the current record sequence is shown at the top of the display window while recording is running.

After the recording session is finished, the sequence command buttons are enabled in the bottom control. By clicking on a button you navigate to the frame immediate after the trigger event in the appropriate sequence.
4.5.3.2 Auto Save

If the Auto Save mode is activated, frames will be stored to hard disk in the REC data format (REC format) automatically after the end of a triggered circular recording sequence. After completion of storing the frames, a new recording sequence will be automatically started.

The auto save can be initiated by an internal trigger (e.g. ImageBLITZ) or by the F12 key. To stop Auto save use the “Stop Button” in the bottom control. If the disk runs out of space the auto save is stopped by default. The parameters for the auto save mode can be adjusted when the "Activate auto save" checkbox is activated.

The following parameters need to be set.

- The pre- and post trigger frames. All images between the entered values are stored for each sequence when the auto save is initiated.
- The directory used for exporting the files.

The name of the files (Autosave_DATE_TIME.rec) is assigned automatically.

---

<table>
<thead>
<tr>
<th>Record sequences</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre trigger frames</td>
<td>29011</td>
</tr>
<tr>
<td>Post trigger frames</td>
<td>9671</td>
</tr>
<tr>
<td>Pre trigger frames [s]</td>
<td>55,47</td>
</tr>
<tr>
<td>Post trigger frames [s]</td>
<td>18,49</td>
</tr>
<tr>
<td>Percentage</td>
<td>25% 50% 7%</td>
</tr>
</tbody>
</table>

- Activate auto save

| Number of frames | 9672 |
| Pre trigger frames | 1 |
| Post trigger frames | 9671 |
| Export size [MByte] | 1.022,75 |
| Export directory | F:|
| Free space [MByte] | 12,683,00 |
4.5.3.2.1 Start an auto save session

If you click on the checkbox “Activate auto save”, the next recording sequence that will be started will be an Auto Save session.

4.5.3.2.2 Stop an auto save session

An active auto save session could be stopped by clicking the stop button. If you want to store the current frames in a REC file use the F12 key to initiate the auto save before you stop. If the hard disk runs out of space, the auto save session will be stopped automatically.

4.5.3.2.3 Show the saved frames

After completion of an Auto Save session, each recording sequence of the camera is stored in a different file. To display the files see Import images.
5 Arrange a scene
Click on the "Live"-Button to get a live-image from the camera. The camera may now be focused and aligned for the details of the scene. You may use the low light mode to increase the camera's sensitivity (available only in live-mode because on the other side the frame rate will be decreased!)

5.1 Recording in non circular mode
See Record settings section on how to set up the single record mode. The recording can be started by clicking the record button or by F5 key. The recording is automatically stopped when the internal buffer is full. During recording, the recorded frames are displayed. After recording, the first (oldest) recorded frame will be displayed.

> Recording in non circular mode may only be achieved by software and not with the trigger switch or the trigger signal!

5.2 Recording in circular mode
Circular mode should be used if a trigger is applied.

The trigger may be
- the closing of the EoSens Cube camera's trigger switch
- a trigger signal
- the ImageBLITZ Auto Trigger
- the stop button in the software

A trigger is necessary if images are needed before and/or after an event. The trigger defines the point of time of your event.

Circular mode is selected in the Expander control „Record settings“ => “Record mode“ => “Ring mode“:

The circular mode is defined by the following parameters:

- The number of Frames before the trigger (Pre Trigger Frames)
- The number of Frames after the trigger (Post Trigger Frames)

During the recording a preview of the recorded frames is displayed by the software.

After recording, the trigger frame will be displayed. The timestamps will be set in relation to the point of time of the trigger-moment, i.e. the first frame after the trigger is set to 0 ms. Negative values indicate that the displayed frame was recorded before the trigger; positive values indicate frames after the trigger.
5.2.1 Start recording

There are 3 various methods to start recording

1. Press the Start/Stop recording switch of the EoSens Cube camera. In this case, a reconnect (click on Disconnect-/Connect-button) has to be accomplished after the completion of the recording sequence in order to save the chronology of the pictures
2. Press the start recording button in the control program
3. Press the F5 key

The internal camera state LED (Camera state LED) will start flashing orange. This indicates that the recording is in progress and the camera is waiting for the trigger to complete the sequence.

5.2.2 Stop recording

There are 4 various methods to stop recording:

1. Press the Start/Stop recording switch of the EoSens Cube camera.
2. Apply a trigger signal to the appropriate camera input connector.
3. Change the image within the ImageBLITZ area
4. Press the stop button.

The internal camera state LED (Camera state LED) stops blinking orange. The sequence is complete after the post-trigger frames have been recorded.

<table>
<thead>
<tr>
<th>🔄</th>
<th>Depending on the selected post trigger frames stop recording could take a while.</th>
</tr>
</thead>
</table>

5.3 Playback of a sequence

The recorded frames in the camera may be accessed after recording. If the camera is disconnected from the PC’s Gigabit-Ethernet it must first be connected. Wait until the camera appears in the list of available cameras and the click “Connect”. If there is a recorded sequence available it is automatically loaded on connect. The internal recorded sequence can be reloaded by doing a reconnect (Disconnect/Connect).

<table>
<thead>
<tr>
<th>🔄</th>
<th>It’s important to do a reconnect (Disconnect/Connect) when a recording sequence was started by the camera switch, otherwise the chronology of a meanwhile recorded sequence may be lost.</th>
</tr>
</thead>
</table>

Use the play-forward 🔄 and play-backward 🔄 buttons to start the playback of the images. If you want to step through the single images you can use the step buttons beside the scrollbar or the mouse wheel. Alternatively use the arrow keys. To change the playback speed see Changing the playback speed.
The scrollbar can also be used to view the images. The number of the current image along with the timestamp relative to the trigger frame is displayed at the bottom right of the control. If you want to jump directly to the trigger frame (frame after the trigger occurred) use the "Jump to trigger" button.

5.3.1 Edit and save a sequence

Since not all recorded frames are always needed it’s possible to select arbitrary sequences from the recording for playback and storage.

5.3.2 Select a sequence for playback and storage

To select a sequence push the “C” Key at the start of the sequence and release the “C” Key at the end of the sequence. You are able to select arbitrary sequences as shown in the picture above.

To remove a sequence move the scrollbar to the sequence until it’s selected and then click “Remove selection”. To remove all the sequences click “Remove all selections”.

The selected sequences are used for playback and for image export. Simply click save to start the image export dialog. See Image export.

5.4 Open stored images
See Import images
6 The display window

All of the image processing functions are available through the display window. Every camera is displayed in a separate window and can be setup up individually. The name of the current used camera or file is shown in the windows title.

6.1 Dock/Undock the display window

Depending on the current state of the window it is docked or undocked. In undocked state the window can be moved and the size of the window can be changed. In docked state the window is fixed.
6.2 Fit to window/Display origin size

Depending on the current state the displayed image, it is fit to the window size or the image will be displayed in its original size. If the origin image is smaller than the window size the image is not fit.

6.3 Minimize/Maximize the window

Depending on the current state the window is maximized or minimized.

6.4 Show/Hide the toolbar

Depending on the current state the windows toolbar is shown or hidden. If the window is minimized the toolbar is automatically hidden.

6.5 Zoom

The image can be zoomed by the mouse wheel or by clicking the zoom button in the toolbar. If the button in the toolbar is clicked a control panel is shown at the bottom of the window. To reset the zoom simply click the mouse wheel over the image or see 6.2.

6.6 Change Brightness

Changes the brightness of the displayed image. The control panel is shown at the bottom of the window.

6.7 Gamma Correction

If you want to exponentially adapt the percentage brightness of the image you can use the gamma correction. The adjust panel is shown at the bottom of the window. A gamma value of 1 leaves the brightness unchanged. Values greater than 1 let dark parts of the image become brighter. Values smaller than 1 let bright parts become darker.
6.7.1 Gamma correction samples

6.7.1.1 Gamma = 0.6, Image gets darker

6.7.1.2 Gamma = 1.0, Unchanged

6.7.1.3 Gamma = 2.0, Image gets brighter
6.8 Image rotation

Allows to rotate the displayed image clock or anticlockwise. The image is rotated in 90 degrees steps.

6.9 Bayer adjustment (White balance)

This element is only available for color cameras. The changed values are automatically saved inside the camera.

Good illumination is extremely important for optimal true color display. Best results are achieved by using daylight or halogen light. For recalibrating the color correction, start the live view of the camera and the click "white balance". The control to adjust the white balance is displayed at the bottom of the display window.

6.9.1 Adjust the white balance manually

To adjust the white balance manually the “Control Line Window” is needed. Adjust the size of the green check line, which is automatically displayed in the camera image when the “Control Line Window” is opened. Move this line over a white area using the mouse. (Click and hold on the line and move it). See Show Histogram Window

The values of the pixels along this line will be shown as three curves – red, green and blue. Using the "R", "G" and "B"-sliders, move the three curves until they are nearly congruent as shown in the figure above.
6.9.2 Adjust the white balance automatically

Take a picture of a scene that contains in its middle area mostly white. Click on the “Auto WB” button in the bottom control to adjust the white balance automatically. The above mentioned line will not be used for auto white balancing.

6.9.3 Save the white balance values in the camera

The changed values are automatically saved inside the camera.

6.10 Display RAW image data

The RAW camera data is displayed without any changes. Thus the image is always shown as a gray color image because no Bayer correction is done.

This element is only available for color cameras. If enabled only the RAW Data is stored even a non RAW export format is selected.

6.11 Edit the infoline

This element is only available if the info line is activated.

Option to add an arbitrary text to the info line. Look at Display Info line
6.12 Show Histogram Window

Shows the histogram of the current displayed image.

The area which is used to compute the histogram can be changed by moving the yellow rectangle.

6.13 Add image marker

Up to 10 markers may be added to the image. Markers are magenta colored lines that overlay the camera image. The size may be adjusted and moved with the mouse. Markers are used for tagging the position of an interesting part in the displayed sequence.

Markers have no relevance for the saved frames!
6.14 **Show grid lines**

Displays a grid upon the image. The width and height of the grid can be freely adjusted.

The grid has no relevance for the saved frames!

6.15 **View the RGB Values**

Shows the RGB values at the current mouse position. The values are displayed at the bottom of the display window. The mouse must be over the displayed image.

6.16 **Select the interpolation algorithm**

This element is only available if the camera supports data reduction.

Changes the interpolation algorithm to scale up the current image data to its origin size. The following algorithms are supported (Nearest Neighbor, Bilinear).

6.17 **Revert all changes**

All settings are reset to its default state.

The settings of the white balance are not affected.
7 Image export

The "Image Export Dialog" can be open by clicking the save button of the bottom control.

7.1 Select the images to be exported
Image range to be exported. To change the export image range edit the textfield and click apply. Values are seperated by a semicolon e.g. 10-100;200-300; Alternatively close this window and select the images on the bottom scrollbar.

See Select a sequence for playback and storage

7.2 Select the export directory
The export directory can be selected arbitrary. Within the export directory a new folder is created each time images are exported. The name of the export folder is composed by the entered export name, date and time of the export.

File naming: EXPORTNAME_IMAGECOUNT

7.3 Select the export format
The used export format can be selected within the combo box. See Supported export formats

7.4 Image cropping
If you want to store only a part of the image it can be cropped before export. The “Crop image” button displays a rectangle on the image which can be freely moved. The rectangle defines the selected export area.

The selected area is applied for the whole image sequence.
7.5 Supported export formats

All changes that are done inside the display window are saved, except a RAW Format is selected.

7.5.1 BMP

All images are stored uncompressed as BMP.

7.5.2 JPG

The images are stored in JPG format. It’s possible to select the compression quality.

7.5.3 TIFF

The images are stored in TIFF format (Tagged Image File Format). You can choose between the following compression algorithms:

- Uncompressed

7.5.4 AVI

The images are stored in the AVI container format. The AVI format allows compressed or uncompressed storage. All available CODEC’s on the system can be used.

7.5.5 DNG (RAW format)

All images are stored in Adobe DNG, (Adobe Digital Negative), format. DNG is a RAW format which can be directly imported into Adobe Photoshop to post process the data. Many other image processing tools also support DNG since it’s a common file format for raw camera data.

7.5.6 REC (RAW format)

Stores the images as a REC file. The REC file is a "Fastec Imaging Proprietary" container format. All the raw image data is stored in one file. Additionally all image information needed to post process the data is stored in the header of the file.

The REC file is written faster to disc compared to the other formats. Therefore it should be used whenever the record needs to be read out fast. The post processing of the raw image data can be done within the software or by external software. The REC file can be easily integrated since the specification of the format is freely available.
### 7.5.6.1 Specification REC Format

All the numbers are in decimal notation

<table>
<thead>
<tr>
<th>Field</th>
<th>Example</th>
<th>Number of chars</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>[RAWHEADER]</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>FormatIdentifier=</td>
<td>MRAW</td>
<td>32</td>
<td>Every field is finished by CRLF</td>
</tr>
<tr>
<td>HeaderVersion=</td>
<td>1,0002</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>OffsetToFirstFrame=</td>
<td>1310720</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>VendorId=</td>
<td>Fastec Imaging GmbH</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Software Version=</td>
<td>1.10.6</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Firmware=</td>
<td></td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>CameraType=</td>
<td></td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>CameraSerialNumber=</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>ColorMode=</td>
<td>0</td>
<td>32</td>
<td>1=BAYER</td>
</tr>
<tr>
<td>CameraMode</td>
<td>0</td>
<td>32</td>
<td>0=DEFAULT</td>
</tr>
<tr>
<td>FrameTopInPixel=</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>FrameLeftInPixel=</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>FrameWidthInPixel=</td>
<td>1280</td>
<td>32</td>
<td>1280</td>
</tr>
<tr>
<td>FrameHeightInPixel=</td>
<td>1024</td>
<td>32</td>
<td>1024</td>
</tr>
<tr>
<td>BitsPerPixel =</td>
<td>8</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>BayerFilterStart=</td>
<td>0/1/2/3</td>
<td>32</td>
<td>0 = GreenRed, 1 = RedGreen, 2 = GreenBlue, 3 = BlueGreen</td>
</tr>
<tr>
<td>BayerFilterRed=</td>
<td>1,0000000000</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>BayerFilterGreen=</td>
<td>1,000000000</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>BayerFilterBlue=</td>
<td>1,0000000000</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>GammaRed=</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>GammaGreen=</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>GammaBlue=</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Param_1=</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Param_2=</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Param_3=</td>
<td></td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>FrameRate=</td>
<td>1000</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>ShutterTime_µs=</td>
<td>20</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>TimerBasis_µs=</td>
<td>49,913194444</td>
<td>32</td>
<td>[µs]</td>
</tr>
<tr>
<td>InfoText=</td>
<td>Experiment 26</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>CompleteFixedInfoPart=</td>
<td>1280x1024, 500 Hz, 564 µs, *1.5, HiSpec EoSens</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Value</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>BaseTime</td>
<td>2008-12-17 23:50:00</td>
<td>Time basis for trigger timestamp</td>
<td></td>
</tr>
<tr>
<td>NumberOfSequences</td>
<td>1</td>
<td>Number of sequences</td>
<td></td>
</tr>
<tr>
<td>[SEQUENCES]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NumberofFrames_00</td>
<td>1000</td>
<td>Number of frames within the first sequence</td>
<td></td>
</tr>
<tr>
<td>FirstFrameNumber_00</td>
<td>1</td>
<td>Number of the first frame</td>
<td></td>
</tr>
<tr>
<td>TriggerFrameNumber_00</td>
<td>50 (1...x)</td>
<td>Number of the trigger relative to first frame number</td>
<td></td>
</tr>
<tr>
<td>Reftim1_00</td>
<td>268582,89928164</td>
<td>Time of trigger frame in µsec based on BaseTime</td>
<td></td>
</tr>
<tr>
<td>NumberofFrames_01</td>
<td></td>
<td>Second sequence</td>
<td></td>
</tr>
<tr>
<td>FirstFrameNumber_01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TriggerFrameNumber_01</td>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reftim1_01</td>
<td>1050 (1...x)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NumberofFrames_02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Changes to previous version:

- CameraType field is now 64 byte.
- CameraMode field added.
- TriggerFrameNumber is now relative to the first frame in the sequence.

### 7.6 Export image data from multi cameras

If there is a recording with multi cameras the export of the image data is done per camera. In the display window you can set one of the cameras as master. This camera is used for image export.
7.7 Additional export info file

Each image export creates an additional file inside the export folder. This file (.exp) contains additional information about the recording and can be used to import the images all at once. The structure of the file is shown below.

[COMMENT]
Comment=No comment entered.

[EXPORTINFO]
Type=bmp

[CAMERA]
Manufacturer=Fastec Imaging GmbH
Model=HiSpec EoSens Cube6 color
Frame rate=500
Shuttertime=1994
Serial=00146
Firmware=B3.01-F2.96-V4.31

[RECORD]
StartTime=Unknown
ImageCount=11

[IMAGEDESCRIPTION]
ImageWidth=1280
ImageHeight=1024
ImageFormat=COLOR_RGB32

[SEQUENCEINFORMATION]
NumberOfFrames_00=6
TriggerFrameNumber_00=39
TriggerRefTime_00=1170,0192
NumberOfFrames_01=5
TriggerFrameNumber_01=20
TriggerRefTime_01=1170,0192

[EXPORTEDIMAGES]
8 Import images

Click the „Open Button“ in the bottom control to open a file dialog for selecting the images to be imported.

The following files can be imported:

- REC (Fastec Imaging Proprietary format)
- BMP
- TIFF
- JPG

By selecting the additional .exp file (if available) the images of a previous export can be imported all at once.

See Additional export info file

If a bunch of single images is imported, all of them must have the same width and height to be displayed correctly.
9 Maintenance

During normal use an occasional cleaning of the optical path is necessary. Information about cleaning the lens is provided by the respective manufacturers.

9.1 Cleaning of the HiSpec infrared filter

HiSpec, (color), contains a filter to suppress infrared light. Dust and dirt, which may deposit on this filter is best removed by means of an oil free air pressure spray or with a lens cleaning tissue. Sticky mud and fingerprints may be cleared away with medical alcohol.

Figure: Improper cleaning agents may damage the filter. Such damage may alter the quality of the images.

Infrared light is part of the visible light spectrum and warps the color in the camera images. Therefore it is necessary to illuminate infrared light with the filter.

9.2 Battery

HiSpec 2 & 5 cameras contain four AA size NiMh accumulator cells.

Figure: Batteries can be replaced by removing the cameras rear cover. This should be done by the Fastec Imaging support only!
10 Troubleshooting

The software won’t start
- Please check if you have installed all the software prerequisites. See Prerequisites.
- Make sure you have installed the Microsoft .NET Framework 3.5 SP1.

There are no cameras found by the software
- Check, if the camera and the PC are connected via the Ethernet.
- Check if you have assigned an IP address to the network card. See Assigning an IP-address to the network card (NIC)
- Check if the Camera LEDs are in a state as described in chapter 1.6.2.3 on page 11.
- Check if the windows firewall allows HiSpec to work! If the firewall is active, set it to inactive, close HiSpec and start it again. If it works now, you may configure HiSpec in the windows firewall as an exceptional program and activate the firewall again.
- Disable any antivirus programs, close HiSpec and start it again. If it works now, you may configure HiSpec in the antivirus application as an exceptional program and activate the antivirus program again.

The selected camera can’t be connected
- Check if the windows firewall allows HiSpec to work! If the firewall is active, set it to inactive, close HiSpec and start it again. If it works now, you may configure HiSpec in the windows firewall as an exceptional program and activate the firewall again.
- Disable any antivirus programs, close HiSpec and start it again. If it works now, you may configure HiSpec in the antivirus application as an exceptional program and activate the antivirus program again.

The performance of the camera connection is very slow
- check the speed of the Gigabit Ethernet network adapter. It should be 1 GBit/s (1000 Mbit/s). Usually there is a LED in the slot cover of the network card indicating, if the actual transmission speed is 1Gbit/s. If it’s below 1 Gbit, (e.g. 10 Mbit/s, which is much too low), you may try to configure the settings of the network card. (Duplex mode). Please contact the Fastec Imaging support team on how to increase the performance of the software.
11 Appendix
11.1 Technical data

11.1.1 HiSpec 1 & 2

<table>
<thead>
<tr>
<th>Sensor type</th>
<th>Monochrome/Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pixel</td>
<td>1280 x 1024</td>
</tr>
<tr>
<td>Pixel size</td>
<td>14 x 14 µm</td>
</tr>
<tr>
<td>Sensitivity at 550 nm @ Vref = 1V (a2 = 66h)</td>
<td>25 V/lux-sec</td>
</tr>
<tr>
<td>Active area</td>
<td>17.92 (H) x 14.34 (V) mm</td>
</tr>
<tr>
<td>Fill factor</td>
<td>40%</td>
</tr>
<tr>
<td>Spectral response</td>
<td>400 ... 1.000nm</td>
</tr>
<tr>
<td>Trigger</td>
<td>External Signal, ImageBLITZ Auto Trigger (optional)</td>
</tr>
<tr>
<td>Internal Dynamic</td>
<td>57 dB</td>
</tr>
<tr>
<td>Power supply</td>
<td>10.5 ... 30 V</td>
</tr>
<tr>
<td>Power consumption max., continuous recording @ 512 x 512 resolution and 2500 frames/sec.</td>
<td>12W</td>
</tr>
<tr>
<td>Thermal resistance typ.</td>
<td>6.25°/W</td>
</tr>
<tr>
<td>Serial data link</td>
<td>Gigabit Ethernet, Baud Rate 19200</td>
</tr>
<tr>
<td>Digital video</td>
<td>GigaBit Ethernet</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>+5...45°C</td>
</tr>
<tr>
<td>Shock &amp; vibration</td>
<td>100g, 10grms</td>
</tr>
<tr>
<td>Dimensions (WxHxD)</td>
<td>HiSpec 1: 63 x 63 x 65 mm (c-mount)</td>
</tr>
<tr>
<td></td>
<td>HiSpec 2: 69 x 69 x 93 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>HiSpec 1: ca. 900 g</td>
</tr>
<tr>
<td></td>
<td>HiSpec 2: ca. 280 g</td>
</tr>
<tr>
<td>Lens mount</td>
<td>C-mount or F-mount</td>
</tr>
<tr>
<td>Software</td>
<td>&quot;click, drag and drop&quot; for Windows XP</td>
</tr>
<tr>
<td>Computer requirement</td>
<td>Min. Pentium III 650 MHz, 1024 * 768 Pixel, 256 MB RAM, 10 Gbyte Hard disk, Gigabit Ethernet</td>
</tr>
<tr>
<td>File format</td>
<td>AVI, BMP, JPG, DNG, RAW</td>
</tr>
<tr>
<td>Recording frequency [frames per second = fps]</td>
<td>Up to 111,000</td>
</tr>
<tr>
<td>Shutter time</td>
<td>min. 2 µs</td>
</tr>
<tr>
<td>Recording modes</td>
<td>Non circular or circular with pre - and post trigger</td>
</tr>
<tr>
<td>Frame buffer [Gbyte]</td>
<td>2, 4 or 8</td>
</tr>
<tr>
<td>Replay frequency</td>
<td>20 – 50 fps @ 1280 x 1024, depending on the performance of the PC</td>
</tr>
</tbody>
</table>
### 11.1.2 HiSpec 4 & 5

<table>
<thead>
<tr>
<th><strong>Sensor type</strong></th>
<th><strong>Monochrome/Color</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pixel</td>
<td>1696 x 1710</td>
</tr>
<tr>
<td>Pixel size</td>
<td>8 x 8 µm</td>
</tr>
<tr>
<td>Sensitivity at 550 nm @ Vref = 1V</td>
<td>3.81 V/lux-sec</td>
</tr>
<tr>
<td>(a2 = 66h)</td>
<td></td>
</tr>
<tr>
<td>Active area</td>
<td>13.57 (H) x 13.68 (V) mm</td>
</tr>
<tr>
<td>Fill factor</td>
<td>36%</td>
</tr>
<tr>
<td>Spectral response</td>
<td>400..900 nm</td>
</tr>
<tr>
<td>Trigger</td>
<td>External Signal, ImageBLITZ Auto Trigger (optional)</td>
</tr>
<tr>
<td>Internal Dynamic</td>
<td>60 dB</td>
</tr>
<tr>
<td>Power supply</td>
<td>10.5 ... 30 V</td>
</tr>
<tr>
<td>Power consumption max.,</td>
<td>HiSpec 4: 7.5W</td>
</tr>
<tr>
<td>continuous recording @ 512 x 512</td>
<td>HiSpec 5: 15 Watt</td>
</tr>
<tr>
<td>frames/sec.</td>
<td></td>
</tr>
<tr>
<td>Thermal resistance typ.</td>
<td>6.25°C/W</td>
</tr>
<tr>
<td>Serial data link</td>
<td>Gigabit Ethernet, Baud Rate 19200</td>
</tr>
<tr>
<td>Digital video</td>
<td>GigaBit Ethernet</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>+5..45°C</td>
</tr>
<tr>
<td>Shock &amp; vibration</td>
<td>100g, 10grms</td>
</tr>
<tr>
<td>Dimensions (WxHxD)</td>
<td>HiSpec 4: 63 x 63 x 65 (C-Mount)</td>
</tr>
<tr>
<td></td>
<td>HiSpec 5: 69 x 69 x 93 (C-Mount)</td>
</tr>
<tr>
<td>Weight</td>
<td>HiSpec 4: 900 g</td>
</tr>
<tr>
<td></td>
<td>HiSpec 5: 280 g</td>
</tr>
<tr>
<td>Lens mount</td>
<td>C-mount or F-mount</td>
</tr>
<tr>
<td>Software</td>
<td>&quot;click, drag and drop&quot; for Windows XP</td>
</tr>
<tr>
<td>Computer requirement</td>
<td>Min. Pentium III 650 MHz, 1024 * 768 Pixel, 256 MB RAM, 10 Gbyte Hard disk, Gigabit Ethernet</td>
</tr>
<tr>
<td>File format</td>
<td>AVI, BMP, JPG, DNG, RAW</td>
</tr>
<tr>
<td>Recording frequency [frames per</td>
<td>Up to 298,000</td>
</tr>
<tr>
<td>second = fps]</td>
<td></td>
</tr>
<tr>
<td>Shutter time</td>
<td>min. 2 µs</td>
</tr>
<tr>
<td>Recording modes</td>
<td>Non circular or circular with pre- and post trigger</td>
</tr>
<tr>
<td>Frame buffer [Gbyte]</td>
<td>HiSpec 4: 2</td>
</tr>
<tr>
<td></td>
<td>HiSpec 5: 2, 4 or 8</td>
</tr>
<tr>
<td>Replay frequency</td>
<td>20 - 50, fps @ 1280 * 1024, depending on the performance of the PC</td>
</tr>
</tbody>
</table>
11.2 Connector assignments

11.2.1 Power / Signal connector of HiSpec 1 & 4

<table>
<thead>
<tr>
<th>Pin Nr.</th>
<th>Level Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pwr GND</td>
</tr>
<tr>
<td>2</td>
<td>=10..30V Pwr Voltage</td>
</tr>
<tr>
<td>3</td>
<td>Opto In Sync</td>
</tr>
<tr>
<td>4</td>
<td>Opto In Trigger</td>
</tr>
<tr>
<td>5</td>
<td>Opto GND</td>
</tr>
<tr>
<td>6</td>
<td>Opto out STRB/ARM</td>
</tr>
</tbody>
</table>

Table 11.2-1

11.2.2 “Power” connector, male, type Lemo HiSpec 2 & 5

select the plug according to your requirements
(Right-angle plug / water-resistant etc.)
e.g. straight plug: FGG.1B.305.CLAD42ZN

(Mounted socket in camera: EEG.1B.305.CLL)

<table>
<thead>
<tr>
<th>Pin Nr.</th>
<th>Signal Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power</td>
<td>+10.5 - 24V=</td>
</tr>
<tr>
<td>2</td>
<td>Power</td>
<td>+10.5.-.24V=</td>
</tr>
<tr>
<td>3</td>
<td>n.c.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Power</td>
<td>GND</td>
</tr>
<tr>
<td>5</td>
<td>Power</td>
<td>GND</td>
</tr>
</tbody>
</table>

Table 11.2-2
### Pinning of matching signal plug (male, solder side)

<table>
<thead>
<tr>
<th>Pin Nr.</th>
<th>Signal Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>2</td>
<td>0..2.5V@ 1MΩ</td>
<td>Analog input voltage, 8-Bit resolution</td>
</tr>
<tr>
<td>3</td>
<td>LVTTL</td>
<td>Sync Output / ARM</td>
</tr>
<tr>
<td>4</td>
<td>LVTTL</td>
<td>Digital Input 1</td>
</tr>
<tr>
<td>5</td>
<td>LVTTL</td>
<td>Digital Input 2</td>
</tr>
<tr>
<td>6</td>
<td>LVTTL</td>
<td>Digital Input 3/ IRIG-B Input (optional HiSpec 1 &amp;2, HiSpec 4 &amp; 5)</td>
</tr>
<tr>
<td>7</td>
<td>LVTTL</td>
<td>Digital Input 4/ Trigger Input</td>
</tr>
<tr>
<td>8</td>
<td>LVTTL</td>
<td>SYNC Input</td>
</tr>
</tbody>
</table>

Table 11.2-3

11.2.3 “Signal input/sync” connector, male, type Lemo HiSpec 2 & 5

select the plug according to your requirements (right-angle plug / water-resistant etc.) under [http://www.lemo.com/](http://www.lemo.com/)

e.g. straight plug FGG.1B.308.CLAD52ZJ

(Mounted socket in camera: EEG.1B.308.CLL)
11.2.3.1 IRIG-B input

The level of the IRIG-B signal connected at pin nr. 6 should be typically 3V for mark’, 1V for ‘space’. Important is the ratio of the signal level of mark and space of 3 to 1.

11.2.3.2 Trigger/Sync input signal definition

The Digital Input 4/ Trigger and the Sync Input is isolated from the rest of the circuitry by an optocoupler. The pull-up resistors R33/R32 are powered by an internal DC/DC converter (X3.3V). The optocoupler will switch if the input is connected to the common GND signal. (Pin 1 on Signal I/O connector).

A positive edge on the Sync input will output the next image if the positive “Sync in edge” is selected in the camera menu.

A positive edge on the Trigger input will stop a circular recording if the positive “Trigger edge” is selected in the camera menu.

![Circuit diagram]

The minimum diode current for an active signal is 5mA.
11.2.3.2.1 Sync input timing

The end of the exposure of the camera may be synchronized with an external signal. The rising or falling edge can be selected in the camera menu as the active edge. The frequency of the external signal must be less than the frame rate of the camera.

1/frame rate seconds after the active edge of the sync input signal the exposure time of the image is finished, the sync out signal will be deactivated. The exposure (and the active edge of the Sync Out signal) will be started shutter time microseconds before the deactivation of the Sync Out signal.

The active edge of the Sync Out signal may jitter 4 µsec referred to the sync input signal.

Example for the timing relationship, shown in the following oscillogram:

The upper trace (yellow) is the external sync input with 332 Hz (max. 495 would be possible when using 500 frames per second)

The lower trace (blue) is the Sync Out signal

Frame rate = 500 Hz
External sync in frequency = 332 Hz
Shutter time = 562 µsec (not affected by the sync input signal)

With the active sync input edge (A), the 1/frame rate cycle (2000 µsec) starts.

After 2000 µsec (B) the frame is complete, 562 µsec before exposure started.

If you want to synchronize external hardware with the start of the exposure, you may use the Sync Out signal for this purpose. Sync Out indicates the exposure of the image.
11.2.3.2.2 Trigger signal pulse width

The trigger signal is debounced to use an external mechanical switch. Minimum pulse width according to the camera model is given in the following table.

<table>
<thead>
<tr>
<th>Trigger polarity selection:</th>
<th>Shape</th>
<th>HiSpec Cube 1-3</th>
<th>HiSpec Cube 4,5, EoSens</th>
</tr>
</thead>
<tbody>
<tr>
<td>rising</td>
<td>![Shape Diagram]</td>
<td>50 ns</td>
<td>100 ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 ms</td>
<td>5 ms</td>
</tr>
<tr>
<td>falling</td>
<td>![Shape Diagram]</td>
<td>100 ms</td>
<td>5 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50 ns</td>
<td>5 us</td>
</tr>
</tbody>
</table>
11.2.3.3 Trigger connection example

The analog input is protected by a 330kΩ series resistor and adjusted to deliver the digital value of 255 for 2.55V input voltage.

11.2.3.4 Analog input signal definition

The analog input is protected by a 330kΩ series resistor and adjusted to deliver the digital value of 255 for 2.55V input voltage.
11.2.4 Digital Inputs 1-3 signal definition

The signals DIG IN1-3 are TTL input signals and are used as process signals, which are superimposed to the image.

11.2.4.1 Sync/Arm Output

This pin can output a Sync signal or an arm signal, selected by a check box in the camera menu. If Sync out is selected, this output will carry a Strobe that corresponds to the selected exposure time of the camera. If Arm is selected, it will be active if the camera runs in circular recording mode.

The optocouplers output will sink 13 mA with max. 0.6V output voltage. The output polarity is positive when the selected signal is active. The suppressor diode protects the output against reverse voltages. It starts conducting if the voltage on the output pin is greater 6V.
11.3 Spectral response

11.3.1 HiSpec 1 & 2

Monochrome and color version with Bayer filter

![Graph showing spectral response of HiSpec 1 & 2 with different colors representing red, green, blue, and monochrome versions. The graph plots wavelength against response (in V/s, W/m²).]
11.3.2 HiSpec 4 & 5
11.4 Pixel sensitive area

11.4.1 HiSpec 1 & 2

Pixel size: 14 x 14µm
Fill factor: 40%
Sensitive area: 17.92 (H) mm x 14.34 (V) mm

11.4.2 HiSpec 4 & 5

Pixel size: 8 x 8µm
Fill factor: 36%
Sensitive area: 13.568(V) mm x 13.68 (H) mm
11.5 Dimensions

11.5.1 Top/bottom view HiSpec 4 & 5

The camera body is with its dimensions of 93 x 69 x 92 mm (WxHxD, c-mount without lens) very compact. To fasten the camera there are two mounting holes M4x7mm and one tripod connection on each side available.

Maximum torque for M4 fastening screws: 2.5 Nm
11.5.2 Side HiSpec 2 & 5

C-mount

f-mount
11.5.3 Front / side / rear view of HiSpec 1 & 4

Specifications without dimension are in mm.

11.5.3.1 “C”-mount version

11.5.3.2 F-mount version