

Motion Studio

User Manual

(For Windows™)

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1. Terms and Conditions

For more detailed information, refer to **IDT's GENERAL TERMS & CONDITIONS OF SALE AND DELIVERY** included with your product.

2. System Overview

2.1. Software package

Upon the installation of the Motion Studio software package several options are available to the user. These options are easily accessed via the Program menu under the Windows Start button. The programs and associated files are organized under the **IDT/MotionProX** folder (**IDT/MStudio64** for the 64 bit version). The folder includes the programs and the associated documentation. Other software components included in the package are copied into “Public Documents/IDT. The path of “Public Documents” folder depends on the operating system.

Windows 7, 8, 8.1, 10 and 11: “C:/Users/Public/Documents/IDT”

2.2. Minimum computer requirements

Ethernet and USB 2.0 cameras	
Operating System	Windows 7, 8, 8.1, 10 and 11
Processor	Pentium III or equivalent with 500 MHz processor.
RAM	4 GB
USB 2.0 Port	USB 2.0 port that is NOT shared with other devices (X and Y)
Network adapter	10, 2.5 or 1 Giga-Ethernet (recommended).
Hard Drive	500 GB or greater hard drive (recommended).

3. Installing the System

This section specifies the minimum recommended computer requirements and gives the procedures needed to install the Camera Head, Camera Cable, Power Supply, I/O Cable, and software.

3.1. IDT Cameras Installation

3.1.1. Software Installation

Windows 7/8/10/11

Before installing the software make sure that the computer has 7, 8, 10 or 11 installed as operating system.

1. Log into Windows with a username and password that has **ADMINISTRATIVE PRIVILEGES**.
2. Insert the Motion Studio USB Key in a USB slot. Locate the SETUP.EXE file in the root and run it.
3. Select Motion Studio 32 or 64 and follow the on-screen instructions.
4. EXIT when the installation is complete.

3.1.2. Hardware installation (USB 2.0)

A 24 VDC, 1 Amp supplies the camera with the necessary power. This power supply unit is included with the camera system package. All communication and data transfer with the host computer is done via the USB 2.0 or the Giga-Ethernet interface. The USB 2.0 interface requires a single cable, which is also supplied with the camera package. External triggering and synchronization are done via the two connectors (BNC type). Triggering is expected to be done with a TTL pulse. The synchronization signal is also TTL level.

NOTE: Connect the camera to the computer before connecting the camera to the power source.

Windows 7/8/10/11

1. Connect the USB 2.0 cable to an available USB 2.0 port on your computer.
2. Connect the other end of the USB 2.0 cable to the back of the camera.
3. Connect the camera to the power source.
4. Turn the camera ON/OFF switch to the ON position and wait a few seconds for the camera to initialize it self.
5. Follow the on-screen instructions. Click on the **YES** or **Continue Anyway** button when prompted by the operating system to proceed with the installation.

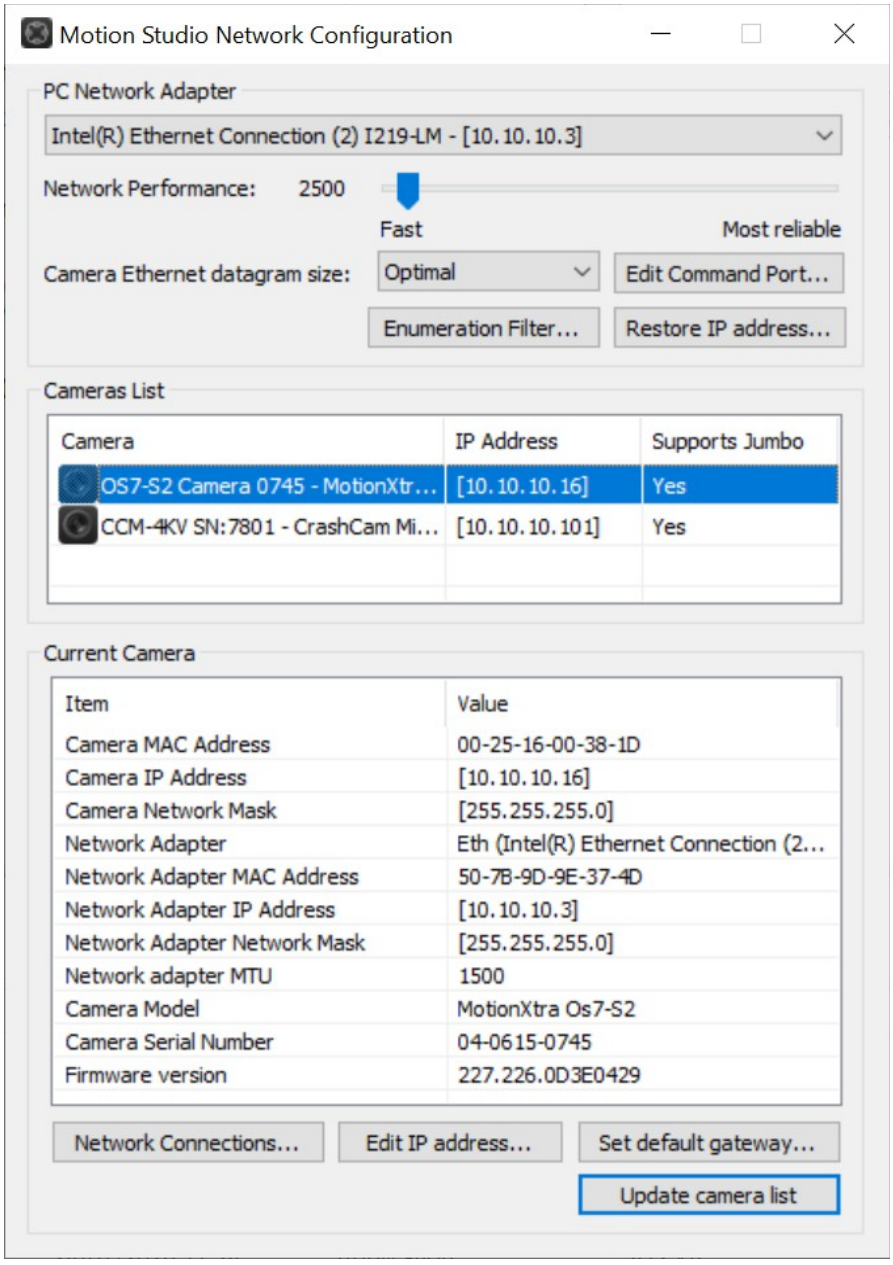
NOTE: Use an USB 2.0 port on your computer. USB 1.0 does NOT support camera operation.

4. Configuration of Giga-Ethernet cameras

4.1. Motion Studio Network Configuration Utility

The network configuration utility is an external application that allows the user to configure the IP addresses of the cameras.

From Windows “Start” menu, select All Programs, then IDT, then Motion Studio, then Tools and then “Network Configuration”



Some of the parameters that can be configured are the same for all the camera models.

Network adapter: the default value is broadcast (the driver searches for cameras through each enabled network adapter). If a specific adapter is selected, the driver searches for cameras only through it.

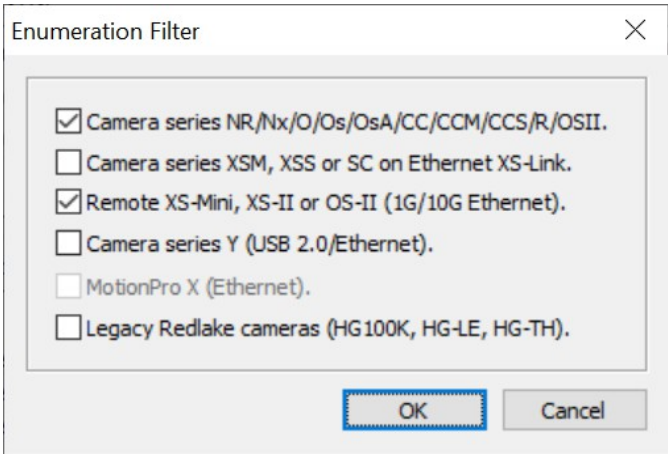
Network performance: it's a delay added to the data exchange between the cameras and the computer. If there is traffic on your local network, then move the slider to "More reliable" to avoid loss of data during the communication**.**

Network Connections: click this button to open the "Network Connections" control panel applet and configure the network adapter's IP address.

Ethernet Datagram size: see one of the topics below.

Restore IP address: if the IP address of a camera has been configured with a wrong value and communication is not possible, click this button. Enter the camera MAC address, type the correct IP address and click OK. Please make sure that no other cameras are connected to your computer via Ethernet.

Enumeration filter: click this button to select which cameras are going to be listed when the list of cameras is updated (see below).



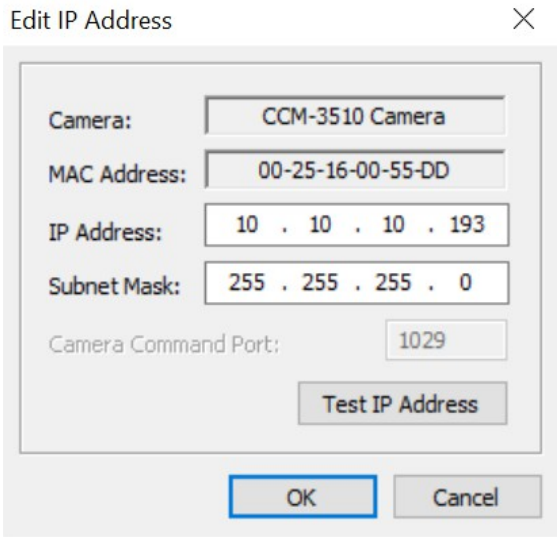
4.2. Configuring camera IP address

To edit the camera IP address, please follow the instructions below.

- Connect the camera to the computer via the Ethernet cable.
- Run the "**Network Configuration**".
- The camera will be detected. Select it, and click the "Edit IP Address…" button.
- Enter the IP address and the sub-net mask. Then click OK and exit the configuration utility.
- Turn off the camera and turn it on (not needed if the camera is Os, CC or CC-mini.

NOTE: if the camera IP address is not compatible with the adapter's IP address, the camera will be listed with a yellow exclamation mark. If you try to open a session in this condition the software will not be able to grab images from the camera and an error message will appear.

NOTE2: Y cameras IP address can be configured even if the camera is connected through USB.



4.3. Forbidden IP addresses

The following IP addresses are not allowed to be configured on the camera.

- **Loopback addresses**: from **127.0.0.0** to **127.255.255.255**.
- **Multicast addresses**: from **224.0.0.0** to **239.255.255.255**.

The following combinations of IP address and subnet mask are not allowed as well:

- **Broadcast addresses**: (IP_subnet_mask | IP_address) = 255.255.255.255.
- **Sub-network addresses**: (~IP_subnet_mask & IP_address) = 0.0.0.0

The IP address 0.0.0.0 is allowed. In that case the camera is supposed to connect to a DHCP server and receive a valid IP address.

4.4. Set Default gateway

Camera default gateway can be configured. The value is stored in camera flash memory. Default value is 0.0.0.0.

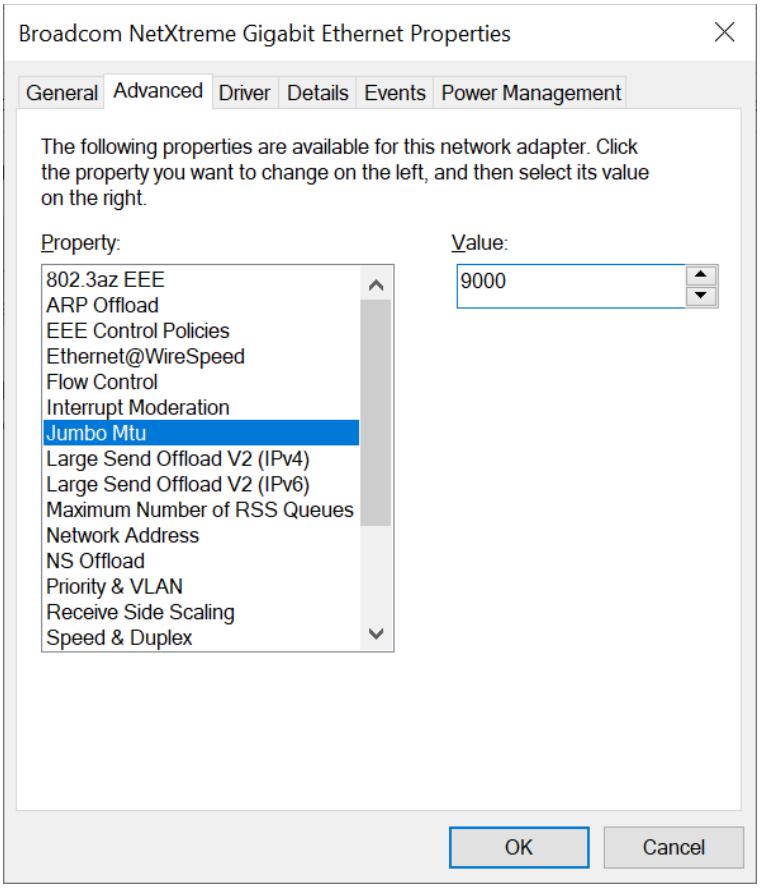
4.5. Large datagram size (Jumbo packets)

Some Giga-Ethernet network adapters are able to send and receive large data packets. Usual datagram size is 1500 bytes. Large datagram packets, called Jumbo packets, can go up to 16000 bytes.

If both camera and adapter can use jumbo packets, the transfer speed is increased. To activate jumbo packets, do the following.

Configuring Jumbo packets on the Network adapter

1. From Windows “Start” menu, open the “Network Connections” window and select the network adapter.
2. Right click and select the Properties menu item.
3. From the Properties dialog box, click the “Configure…” button.
4. From the network adapter configuration dialog, select the “Advanced” tab.
5. From the property list, locate the “Jumbo Packet” item (or “Jumbo MTU” or similar) and change the value from 1500 to the maximum.



Configuring Jumbo packets on the camera

1. From the Motion Studio program group, select Tools and run the "**Network Configuration**".
2. Make sure that the camera is listed and the "Jumbo" item in the camera list is set to "Yes".
3. From the "Ethernet Datagram Size" list. select any size that is "smaller" than the value selected in the network adapter configuration. If the size is set to "optimal" the software automatically sets on camera a value that matches the adapter's size.

NOTE: in some network environments the maximum datagram size might be not supported and the cameras may time out and/or behave in a strange way. To avoid that, reduce the datagram size on both adapter and camera.

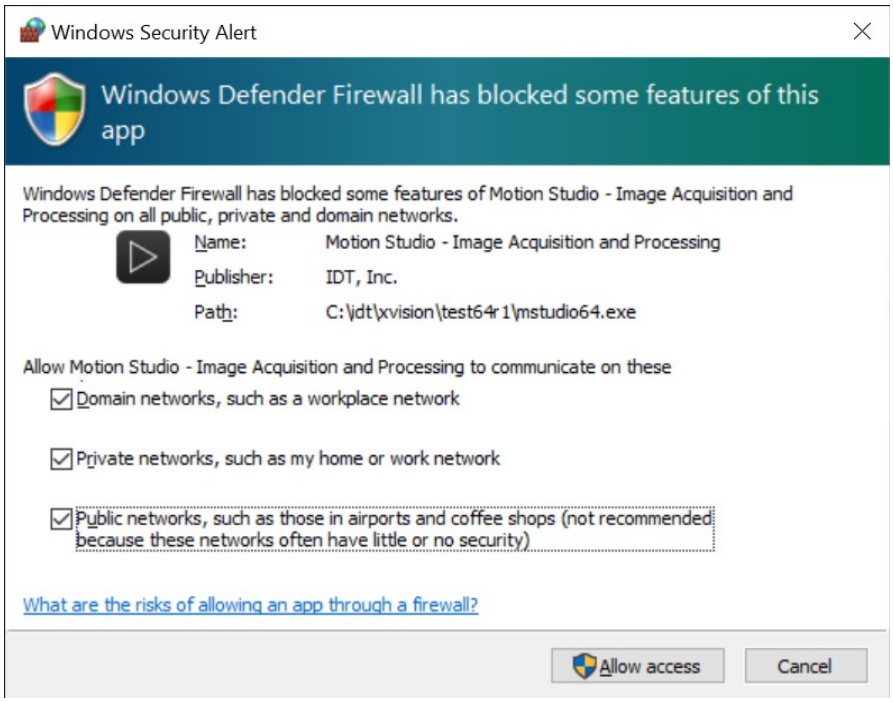
4.6. Configuring the Windows Firewall

All the cameras that support gigabit Ethernet communication may have issues if the Windows Firewall is installed. They communicate through the UDP network protocol and need to open listening ports to receive the images.

In most of the cases, the windows firewall shouldn't be disabled, Motion Studio should be added to the list of the allowed programs and some other parameters should be configured in the firewall (especially with HG cameras).

4.6.1. How to add Motion Studio to the list of allowed programs.

When an Ethernet camera is operated for the first time, the Windows firewall detects the attempt to communicate through the network and tries to block it. The message below appears



The software will be allowed to communicate through the network if both the private and public options are selected. Then click the "Allow access" button. If the User Account Control (UAC) is disabled or you don't check both the options, you may still allow the communication through the firewall.

- From the control panel, start the Windows Firewall and select "Allow a program or feature through Windows Firewall".
- Scroll the list and make sure that "Motion Studio" is in and all the check boxes are selected.

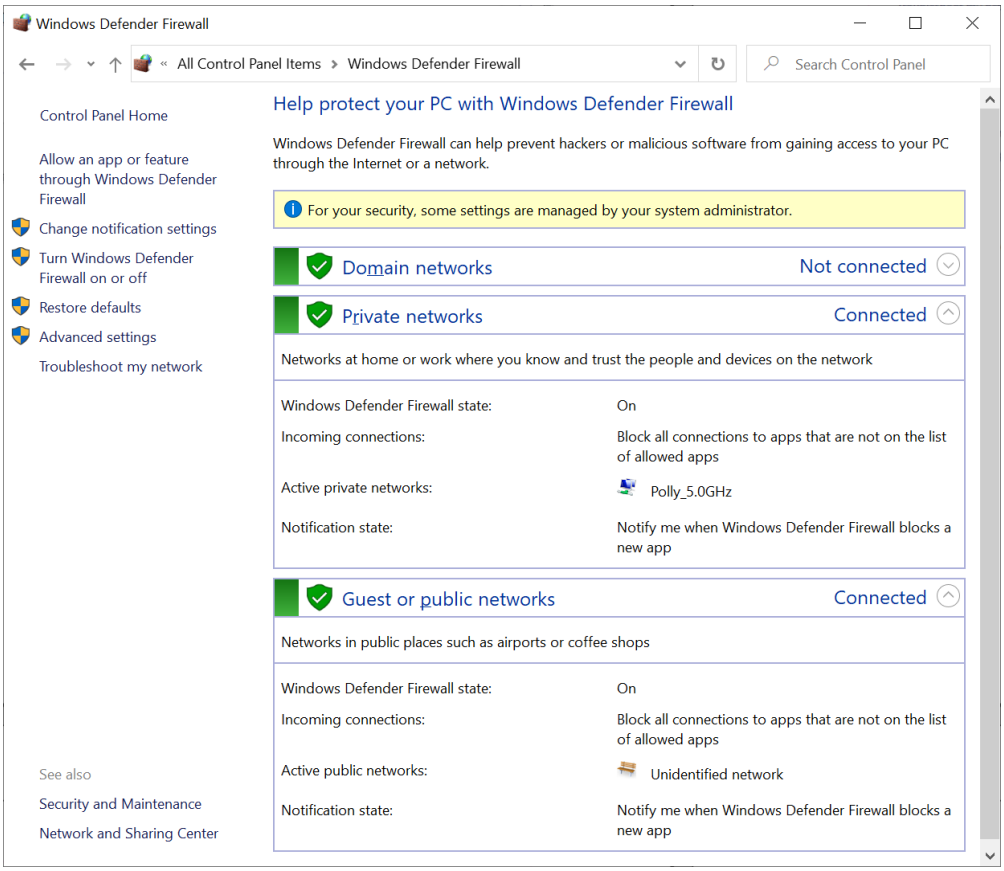
4.6.2. How to disable the Windows Defender Firewall

To disable Windows firewall the user needs Administrative privileges. The firewall separately manages three profiles and it should be disabled on all of them:

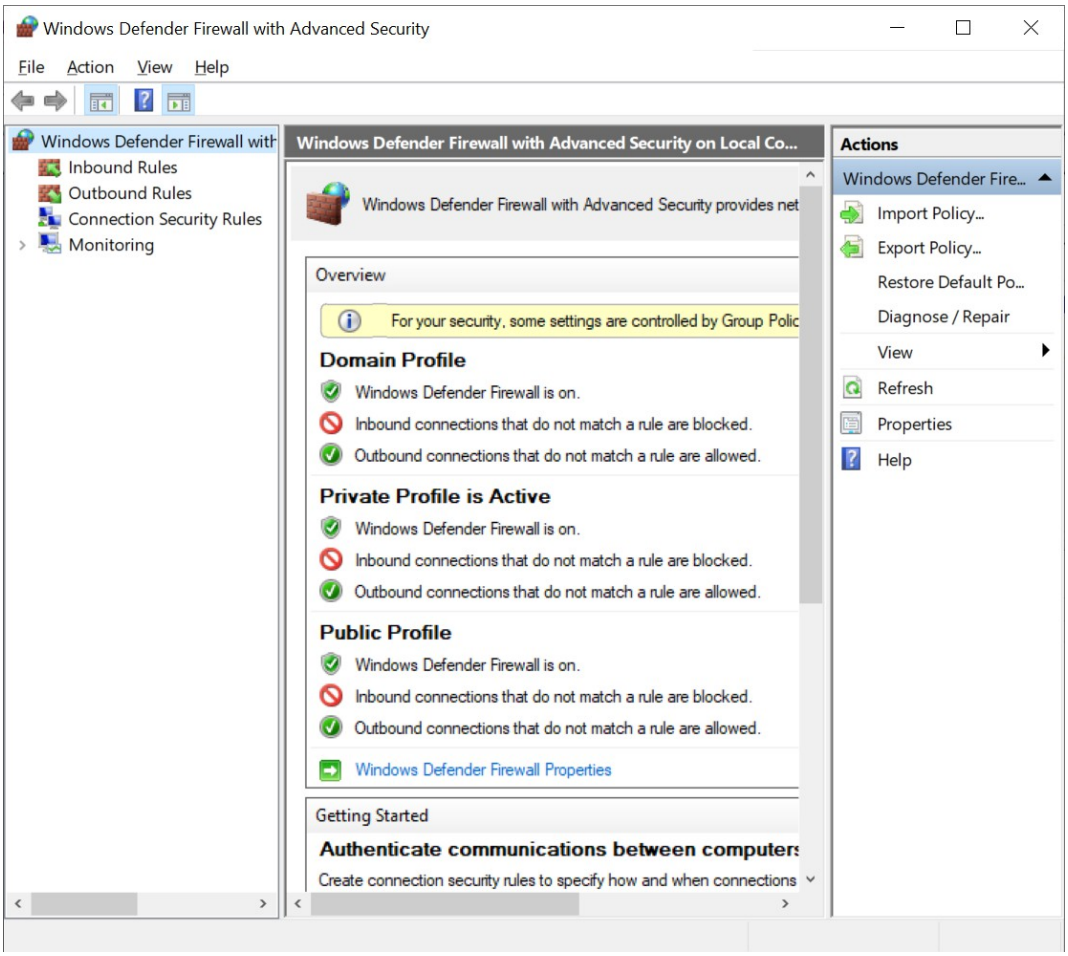
- Domain profile.
- Private Profile.
- Public Profile.

To disable the firewall, follow the instructions below:

From the Control Panel, open the Windows Firewall dialog box.

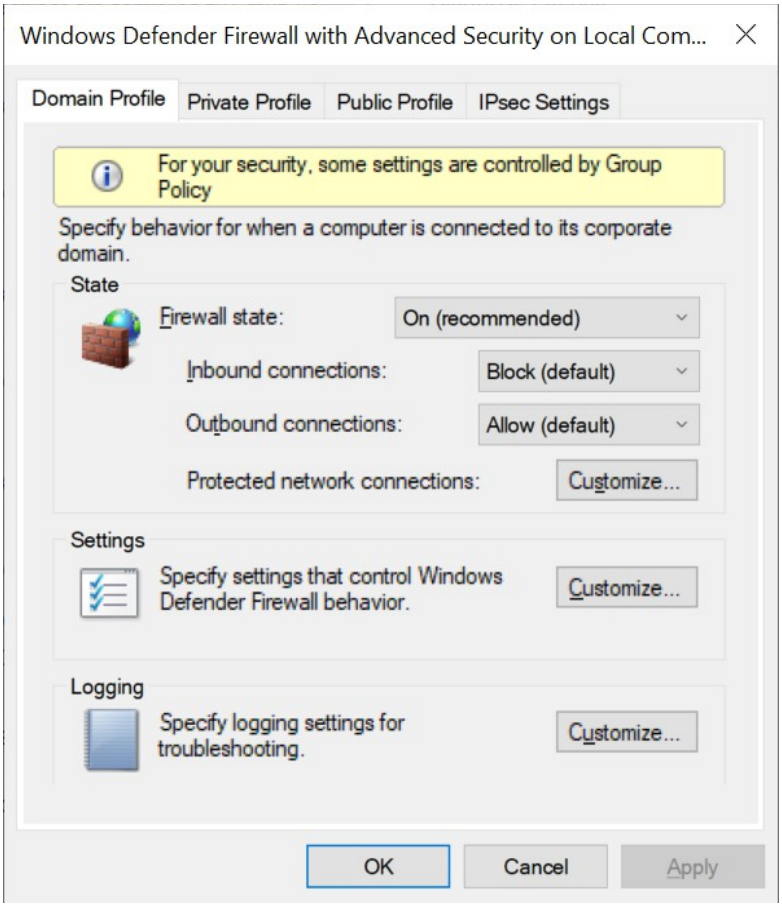


From the options list on the left, select “Advanced Settings” and open the “Windows Firewall and advanced security” window.



Click the “Windows Defender Firewall Properties” button and open the “Properties” dialog box.

Select the “Domain Profile” tab and set the “Firewall State” to off, then select the “Private Profile” and set the “Firewall State” to off, and then select the “Public Profile” and set the “Firewall State” to off.



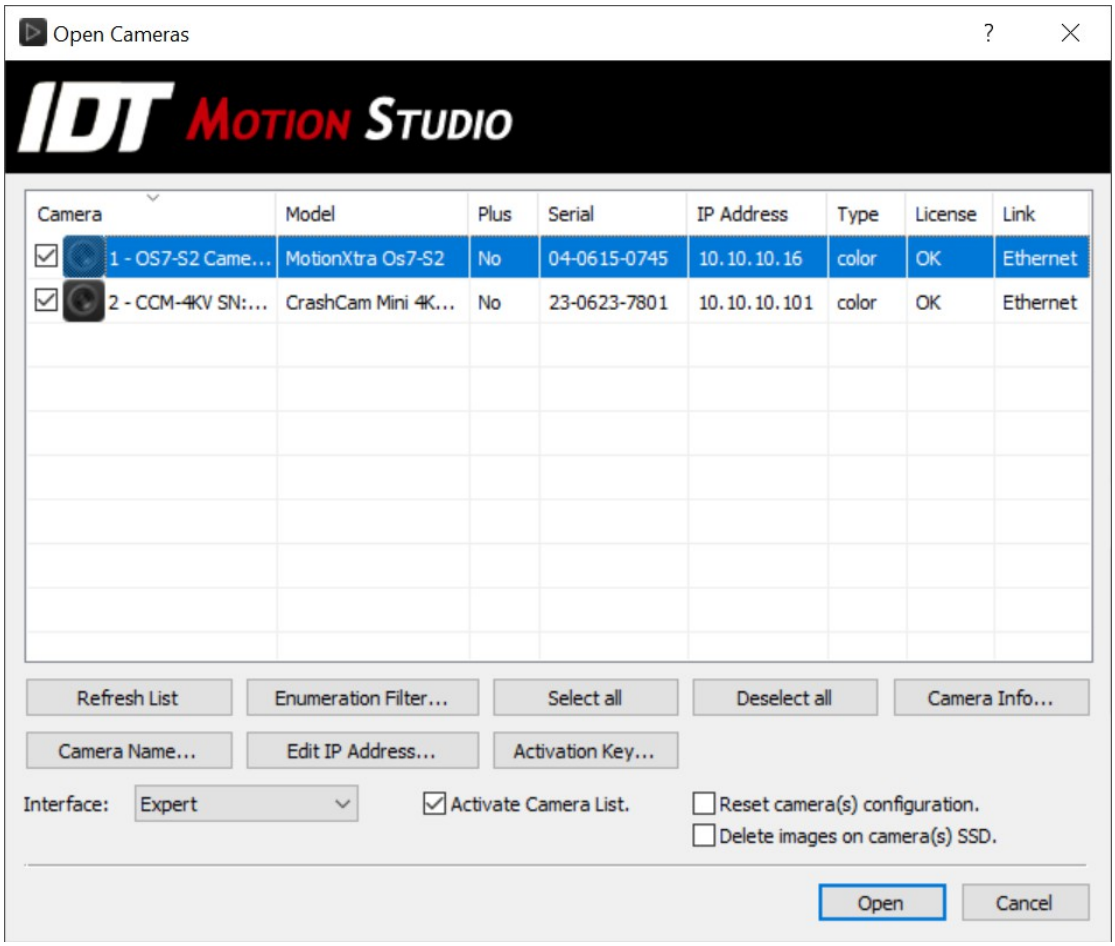
5. Motion Studio™

This application allows the user to acquire, save/play-back image records, and control the camera in Single or Double Exposure modes. It also allows the user to retrieve file images from previous acquisitions for display and further manipulation. Upon execution the user can select to use the application to open a file images or to open a camera window.

5.1. Open camera Wizard



A discussion of the program interface as it applies to the live camera window is provided first. Once the camera option is selected from the first menu the Camera Wizard is displayed. This wizard allows the user to select which camera to control and access if more than one camera is attached to the computer system.



Sort

The cameras can be sorted by clicking the header of the corresponding column.

Refresh List

Click this button to restart the cameras enumeration procedure.

Enumeration filter

The user can select which camera type is enumerated and listed in the camera wizard window.

1. Click the “Enumeration Filter…” button.
2. Select or deselect the camera models.
3. Click OK.

Select/Deselect All

Click “Select All” to select all the cameras of the list, click “Deselect All” to deselect them.

Camera Info

Click this button to display the camera information.

Camera name

Each camera has a name. If the camera has flash memory, the name is stored into it. Cameras without flash memory have the name stored in a configuration file in the hard disk. To change camera name, click the “Edit name…” button.

Edit IP Address

Click the “Edit IP address” button and manually assign an IP address to the camera. The user may edit and test the camera IP address and sub-net mask (disabled for X cameras). By pressing the “Test IP address” button the user sends a PING command to the specified address and checks if it is available

Activation Key

Some cameras have time limited license. If the license has expired and you have a 16 digit activation key, click the button and enter the key.

Camera interface

Before opening camera windows the user may select the interface.

- **Standard**: a limited set of controls are displayed in a vertical bar on the right side of the camera window.
- **Automotive**: the controls used in a typical automotive environment.
- **Expert**: all the camera controls are displayed.

Activate Camera List

If more than one camera is going to be used, the camera list interface may be activated. For a more detailed description of camera list mode, see the “Multiple Camera Support” topic.

Plus Mode

Plus option can be activated on each camera independently. To do so, click on the Plus cell in camera list and select Yes or No. The option is disabled if the camera does not support it. In Plus™ mode, the camera is capable of acquiring images at double speed and with double memory space.

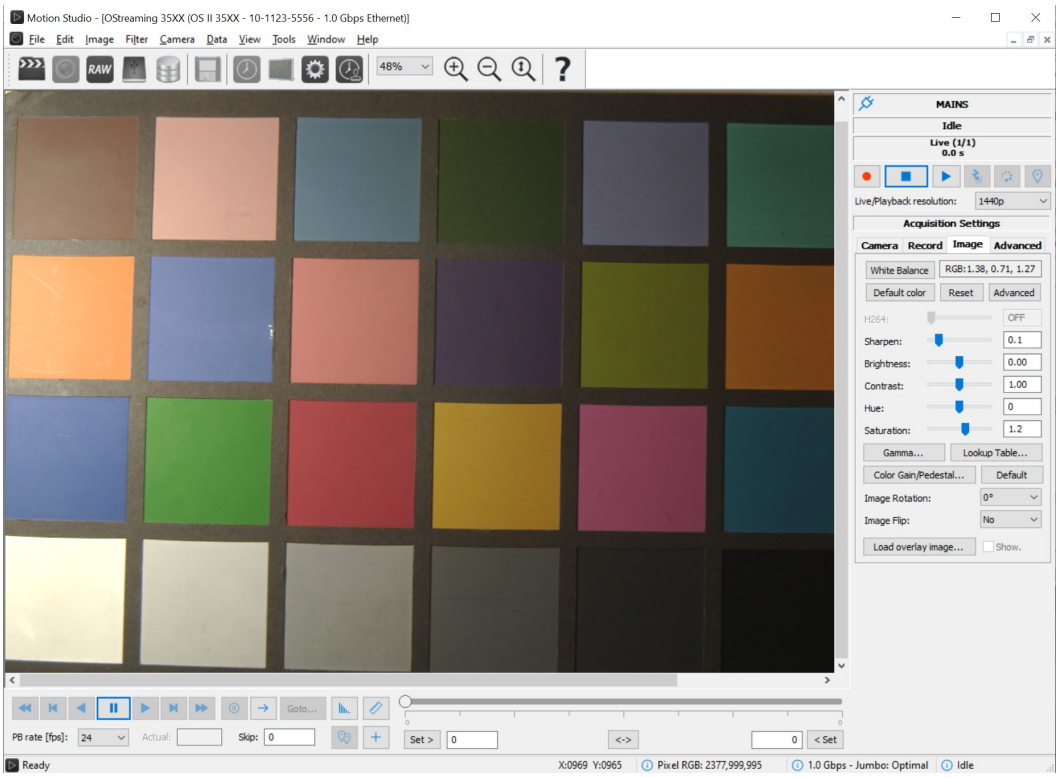
Reset camera configuration

If this option is selected, the configuration stored in the camera is reset and the camera is opened with default settings.

Delete images on camera SSD

If this option is selected, all images stored in the camera SSD are erased.

Once the Wizard competes the initialization procedure for the camera the application window for the active camera is open as shown below (expert interface).



Along with the usual top bar menu structure the application also includes a docked dialog bar on the right side, a bottom bar for playback and a pan tool. In this menu the main operational controls of the camera are grouped by function: Camera Control (Live and Playback), Acquisition Settings (Camera, record and Color). The function of these controls is in great part also accessible from the top menu bar.

5.2. Motion Studio Menu structure

The main menu bar contains the following options:

File

Edit

Image

Filter

Camera

Playback

Tracking

View

Tools

Window

Help

The application also includes a docked dialog bar on the right side. The Docked Dialog Bar has the main operational controls of the camera and they are grouped by function: Camera Configuration, Image Recording Configuration, Color Configuration (for color cameras only) and Playback controls for acquired images.

5.3. File Menu

The file menu contains the following options:

- Open previously acquired and filed images.
- Open the camera window.
- Open the RAW files.
- Open the database viewer window.
- Load an overlay image.
- Save images on the hard disk and close windows
- Select from a list of the five most recently displayed images.

5.3.1. Initialize a camera window

From the main menu select File > Open > Camera.

5.4. Open File Images

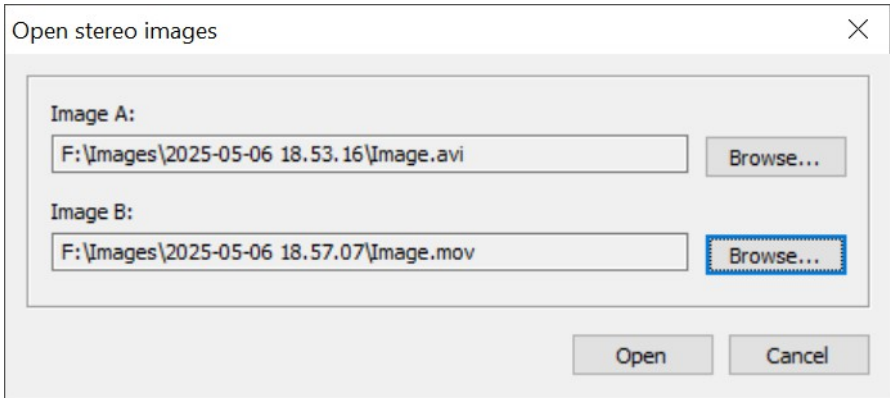
From the main menu select File > Open > Images.

Motion Studio can open all the most common image and video files (TIF, BMP, JPG, PNG, AVI, MOV, ...) as well as IDT raw files (RAW) and IDT proprietary video files (MRF, MCF).

5.4.1. Open stereo images

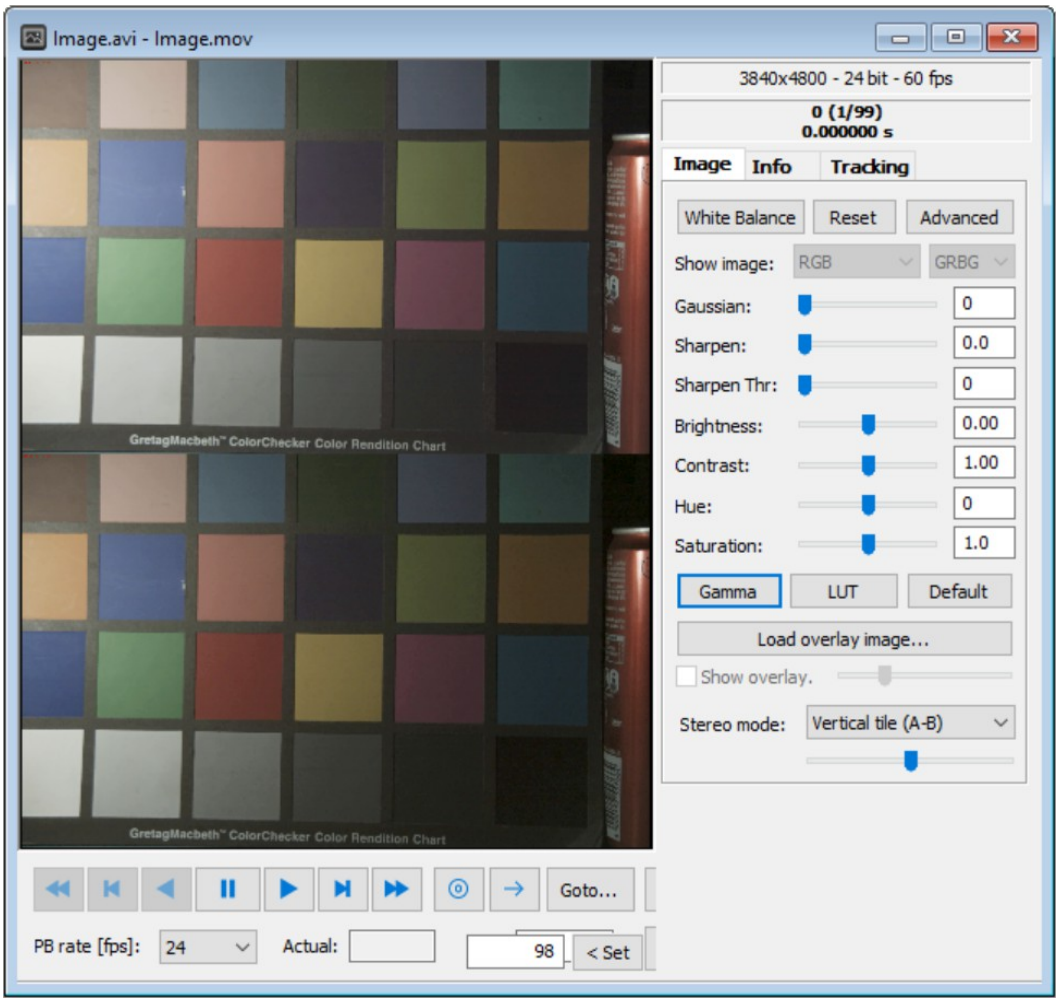
From the main menu, select File > Open > Stereo Images.

The dialog box below will appear.



Click the Browse button to select two sequences of images or videos. Each sequence must have the same pixel depth (monochrome or color).

Click “Open” to open the images.



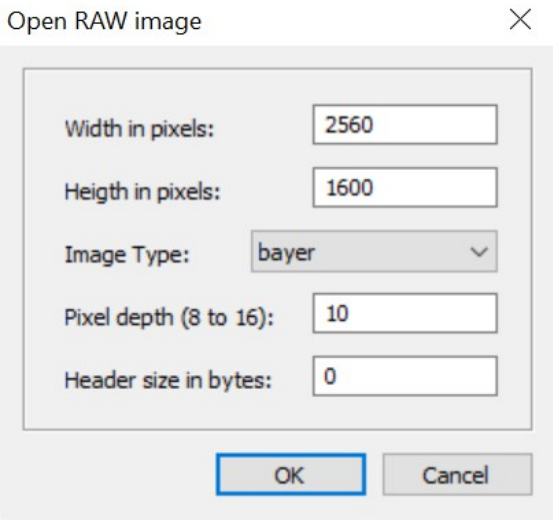
Stereo images can be displayed in the following ways:

- **Horizontal tile**: left and right.
- **Vertical tile**: top and bottom
- **Anaglyph**: this applies only to color images. The image is combined by taking the red channel from one image and Green and Blue channels from the other.
- **Sequence**: one frame from sequence A and one from sequence B.
- **Superposed**: in this case the relative opacity of image A and B can be adjusted with a slider.

5.4.2. Open non-IDT file images

From the main menu select File > Open > Images.

Select a RAW file and click Open.



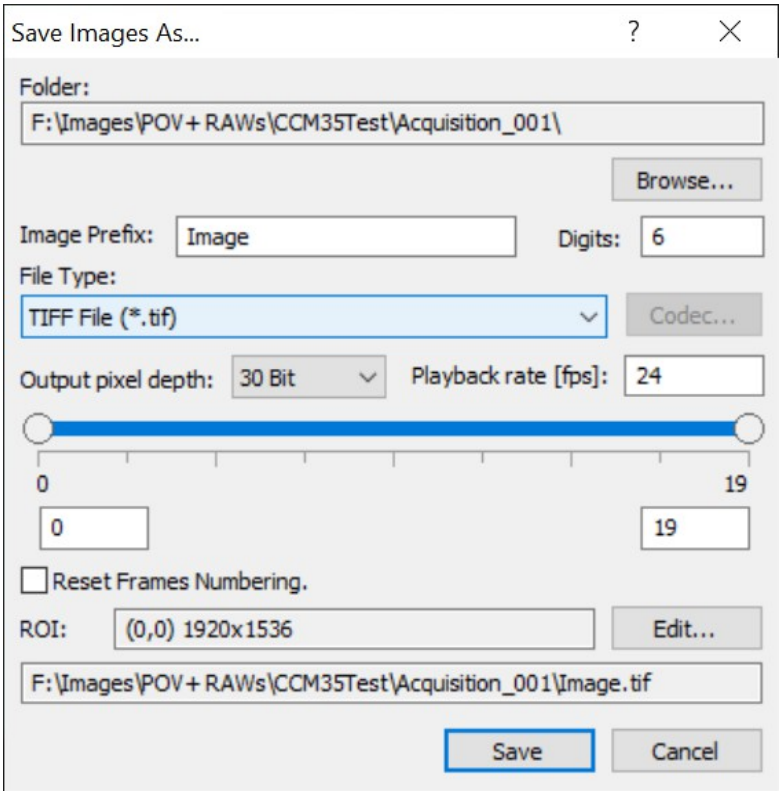
Enter the size of the image in pixels, the image type (mono, color Bayer or color RGB), the pixel depth and the header size (the image may have a header).

Click OK.

5.5. Save images

Each acquired sequence may be opened and saved in a different format.

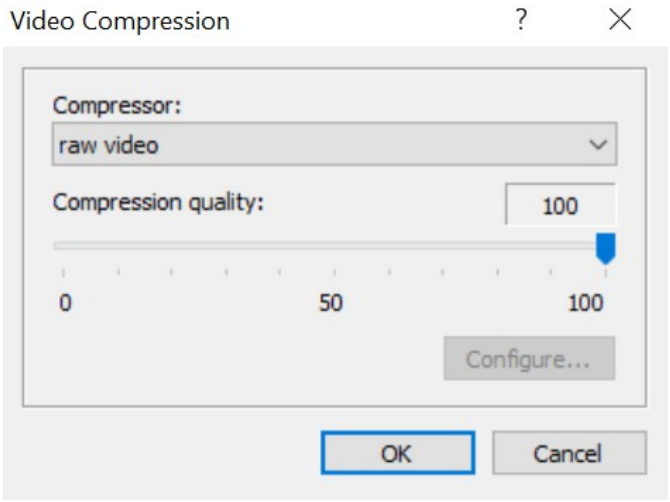
From the File menu select File >> Save



1. Click “Browse” to change the folder where the images are saved.
2. Enter the image prefix and the number of digits (only if the file format is not AVI, MPG, MOV, ...).
3. Select the file type and the rate. If the file supports compression, select a codec.
4. Select start index and stop index.
5. Select the "Reset frames numbering" option to change start image index to 0.
6. A region of interest of the image may also be selected.
7. If tracking is enabled, you may select to save the tracking points in the images.
8. Select the Data Acquisition File Type, if present.
9. Click “Save”.

5.5.1. AVI, MPEG, MOV Codec/JPEG quality selection

The default codec used in Motion Studio to save AVI files is “**Uncompressed AVI**”. If other codecs are installed, the default codec may be changed each time a new sequence of images is saved in AVI format.



- Select the codec from the list.
- Select the compression quality with the slider (0 to 100).

If the quality slider is disabled, the video compressor does not support it.

Some AVI codec allow the user to configure other parameters. In this case, the “Configure...” button is enabled.

JPEG and MOV compression quality may be selected in the same dialog box. The default is 100.

5.6. Add time stamp to images

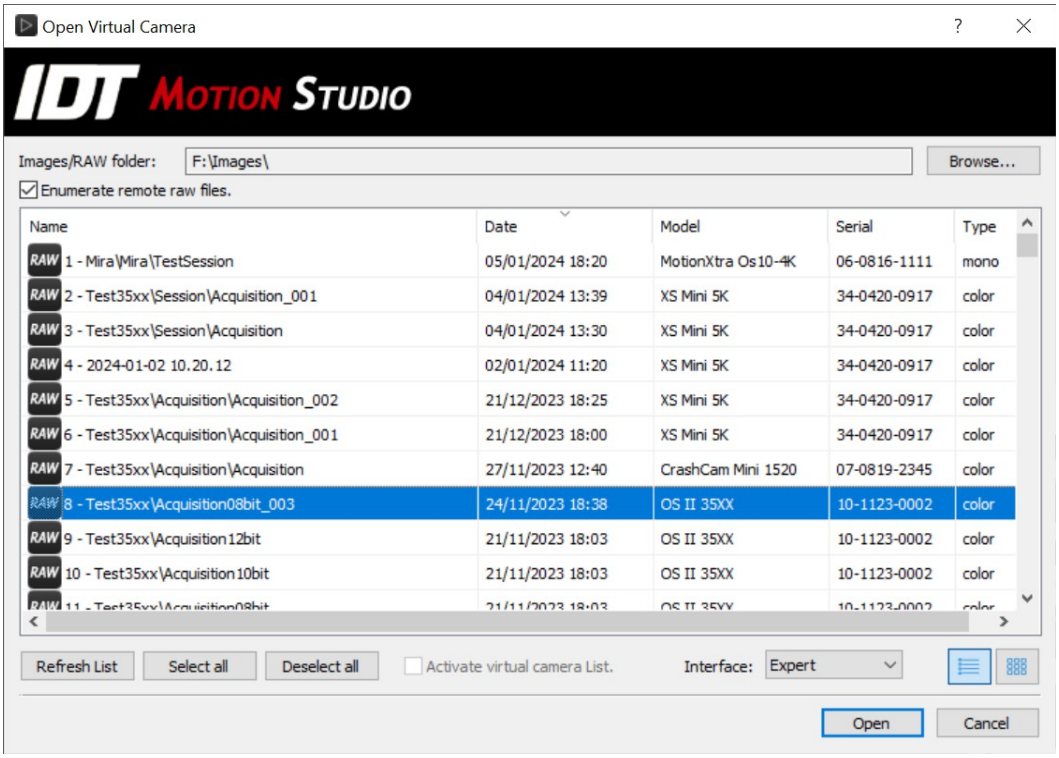
Sequences of images acquired from other cameras may be imported in Motion Studio and time stamped.

- Open a sequence of images.
- Right click on the image and select "Time stamp" from the drop-down menu.
- Open the time stamp dialog box and select the time stamp items.

5.7. Open RAW files

The images saved with fast download in the RAW format may be open and reviewed.

- From the File menu, select Open, then “RAW Files”.
- Click “Browse…” to select a different Images folder.
- Select a raw file from the list and click Open.



The raw file is open as a virtual camera with a single acquisition. The user may playback the images and save them in any format.

More than one RAW sequence may be open in Camera List mode. Then the virtual cameras images may be selected and converted like in a multiple camera environment.

Enumerate remote raw files: some raw files can be enumerated and open from a remote computer. The remote computer must run “XS-RT remote control” software.

“**Enumerate from Images/Raw folder**” or “**from Write to disk folder**”: when Write to disk is enabled on XS-Mini cameras, raw data may be saved on different local disks. The folder name may be different from the folder selected for regular images download.

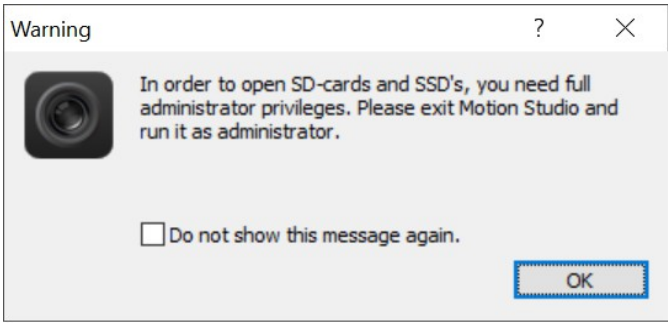
View list / thumbnails: two buttons on the right of interface control allow the user to show the list of raw files as a list with details or thumbnails.

5.8. Open removable SSD and SD-Card

Some IDT camera models may save images into removable solid state disks (O-series) or micro SD-Cards (Crash-Cam Mini).

The images stored in the removable device can be displayed from any USB SATA adapter or USB SD-Card reader that supports the camera disks. To do that, connect the adapter/reader to a USB 2.0 or 3.0 port and wait until a new disk drive is shown in Windows explorer, then from Motion Studio Main menu, select File, then Open, then “SD-Card/SSD...”

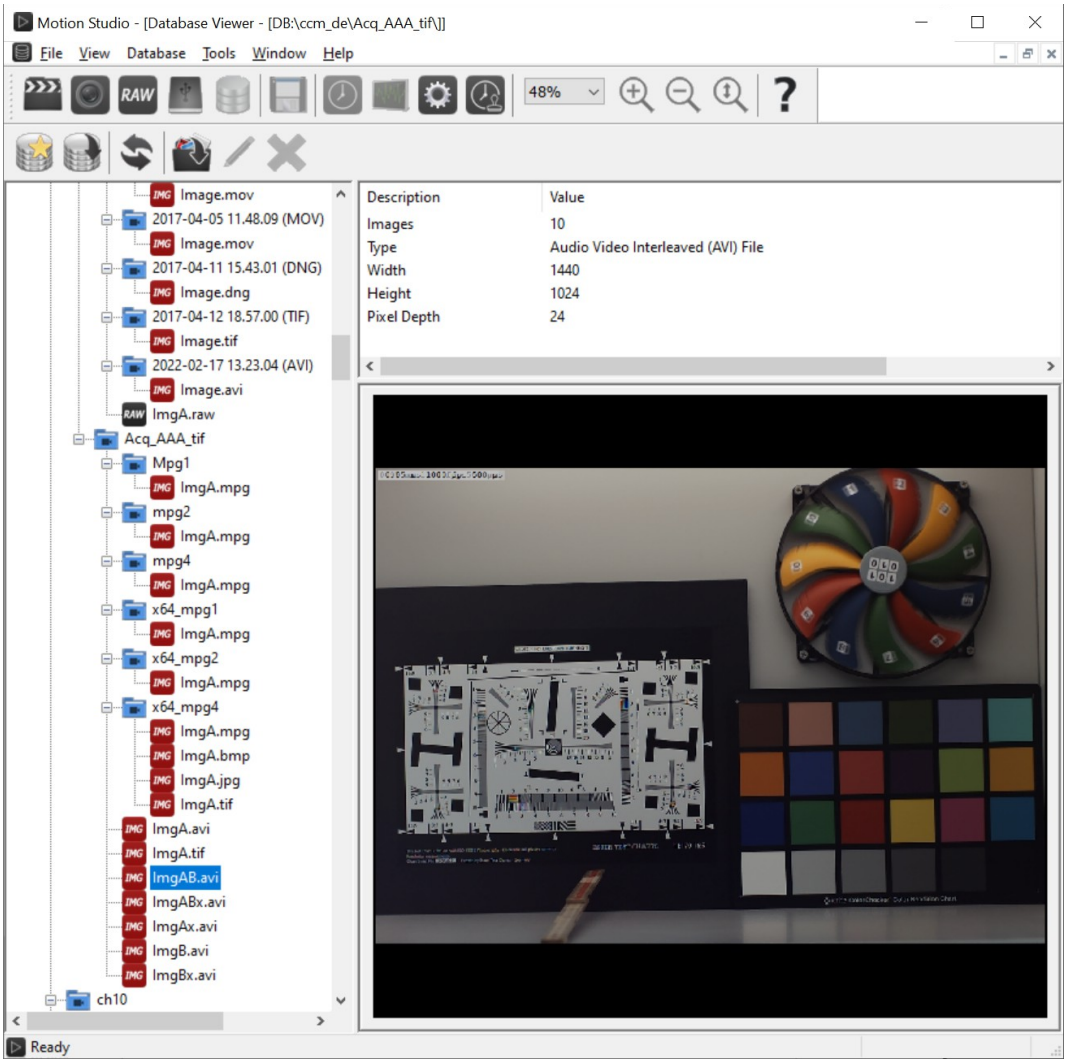
If you don't have Administrator privileges, a warning message will appear.



5.9. Database viewer

The database viewer window browses the current Images folder and enumerates the acquisition folders. It shows also the cameras and devices connected to the computer (Timing Hub/Data Acquisition).

The window has three panes.



Left Pane: the left pane is a tree view and displays the tree structure of the images database. It shows images, raw files and data acquisition files.

Right Upper Pane: it's a list view and it shows the main parameters of the selected item. If the item is a device it shows the device ID, serial number, etc. If the item is an acquisition it shows all the acquisition parameters.

Right Lower Pane: the pane is used to preview the first frame of a sequence.

5.9.1. Viewer Toolbar

New Database

The selection of this item opens the 'Create New database' dialog box. The user may browse the existing directories in the hard disk or create a new directory. If the OK button is pressed the root database files are copied in the new directory and the user can start saving new sequences in the new folder.

Open Database

Browse the directories in the hard disk and locate a database folder. The program recognizes as valid database locations the directories where the file **xvdb.mdb** is found. Changes to the currently selected database are reflected on the settings.

Refresh

Click this button to refresh the viewer contents.

Open Item

Click this button to open the currently selected item. The button is enabled if the selected item is a sequence or a camera.

Edit Item

Click this button to edit the currently selected item. The button is enabled if the selected item is an acquisition folder. The user may change the folder name, date, time and acquisition comment.

Delete Item

Click this button to delete the currently selected item. The button is enabled if the selected item is an acquisition folder.

5.10. Load overlay image

An overlay image can be displayed on top of the image sequence. To do that:

- Select the “Load overlay image” menu item.
- Locate the image. Allowed file types are: TIFF, Bitmap, JPEG and PNG.
- Click “Open”.

Once the image is loaded, the user can show it or hide it by selecting the “Show overlay image” option in the “Image” tab.

5.11. Edit menu

The Edit menu contains UNDO and REDO for image operations. It also has a “Go To...” function for jumping to a particular frame in a sequence.

5.12. Image menu

The Image menu contains the LUT operations. It also allows flipping and rotating of the image. If the Camera window is open and the Thumbnails bar is in use, the “Thumbnails Cfg...” option displays for Thumbnail view configuration options. For more information, refer to “View Thumbnails”.

If an image sequence is open, the Image menu has an Image Info option for displaying and editing the acquisition settings. The Adjust sub menu has controls for the following:

- Color Map for colorizing monochrome images
- Inverting.
- Background removing for monochrome images (old MotionPro X4 only).

5.13. Lookup Table

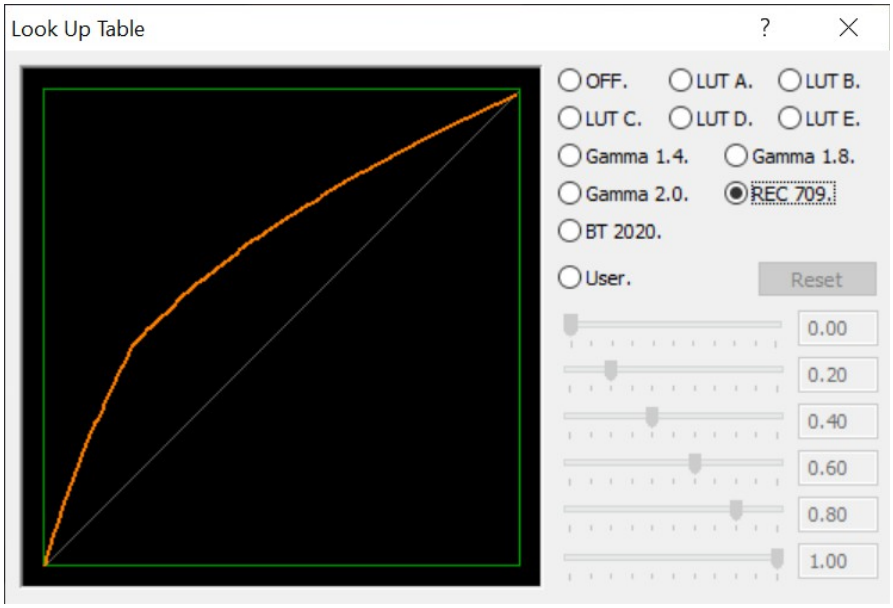
The *lookup table* (LUT) transformations are basic image-processing functions that you can use to improve the contrast and the brightness of an image by modifying the dynamic intensity of region with poor contrast. LUT transformations can highlight details in areas containing significant information, at the expense of other areas.

A LUT transformation converts input gray-level or color values (8, 10 or 12 bit) into other gray-level or color values. The transfer function has an intended effect on the brightness and contrast of the image. Each input value is transformed into a new value by a *transfer function*

Output value = F (input value)

Where F is a linear or nonlinear, continuous or discontinuous transfer function defined over the interval [0, max]. In case of an 8-bit image, a LUT is a table of 256 elements. Each element of the array represents an input value. Its content indicates the output value.

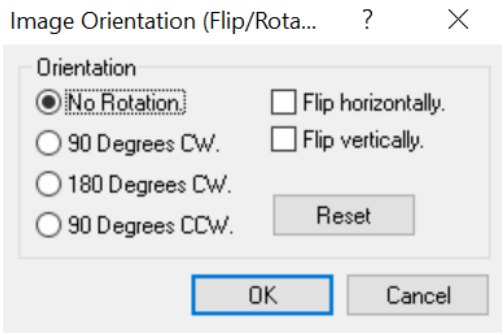
1. Select one of the Lookup Tables or.
2. Select “User” option.
3. Drag and drop the red handles in the curve window.
4. Move the sliders to change the Y position of the handles.
5. Click Reset to reset the lookup table to the original diagonal value.



5.14. Orientation

The image may be rotated and/or flipped.

1. Select Image from the main toolbar.
2. Select “Orientation” from the drop-down menu.
3. Edit the parameters.
4. Click OK.



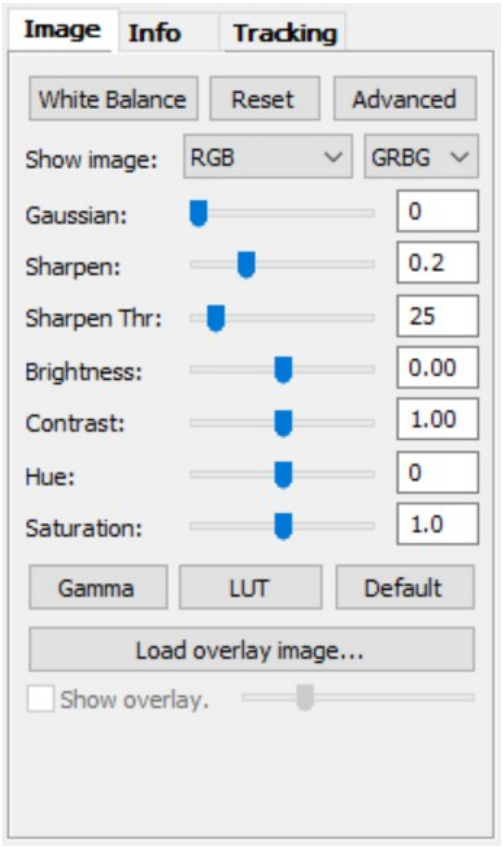
5.15. Color Map Adjustment for monochrome images

The Color Map has controls for displaying black and white images in color using a user-defined color scheme.

1. Select Image from the main toolbar.
2. Select Adjust from the Image drop-down list.
3. Select Color Map.
4. Select Base Color Map from the drop-down list.
5. Change the RGB values and Point Index.
6. Click OK to change the image.

5.16. Sharpen, gamma, brightness, contrast, hue, saturation

Some image adjustment controls have been added to the image vertical bar. The parameters improve the image quality.



Show image: Bayer images may be displayed in three different ways. RGB, Bayer (mono) or Bayer (Color).

CFA filter: if the file is TP2, FBA or MRF, the control configures the interpolation algorithm.

Anti-Alias: it reduces alias on edges with a Gaussian filter. The range is from 0 to 1.0. the default value is 0.0.

Sharpen/Sharpen Threshold: it sharpens the image edges. The range is from 0.0 to 1.0. The default value is 0.0.

Brightness: it increases or decreases the image brightness. The range is from -0.25 to 0.25. The default value is 0.0.

Contrast: it increases or decreases the image contrast. The range is from 0.5 to 1.5. The default value is 1.0.

Hue (color images only): it modifies the image hue. The range is from -180 to 180. The default value is 0.

Saturation (color images only): it modifies the color saturation. The range is from 0.0 to 2.0. The default value is 1.0.

Gamma: introduces a gamma correction to the image. The range is from 0.1 to 4.0. The default value is 1.0.

LUT: it toggles the Look-Up Table dialog box.

Default: sets the default image values.

Load / Show overlay image: load and show o hide an overlay image.

5.17. Filter menu

The filter menu has several preset filters as well as user defined filters. A preview window with an image thumbnail is available and includes the filter kernel display box.

From main toolbar select Filter > the desired filter sub-menu from the following:

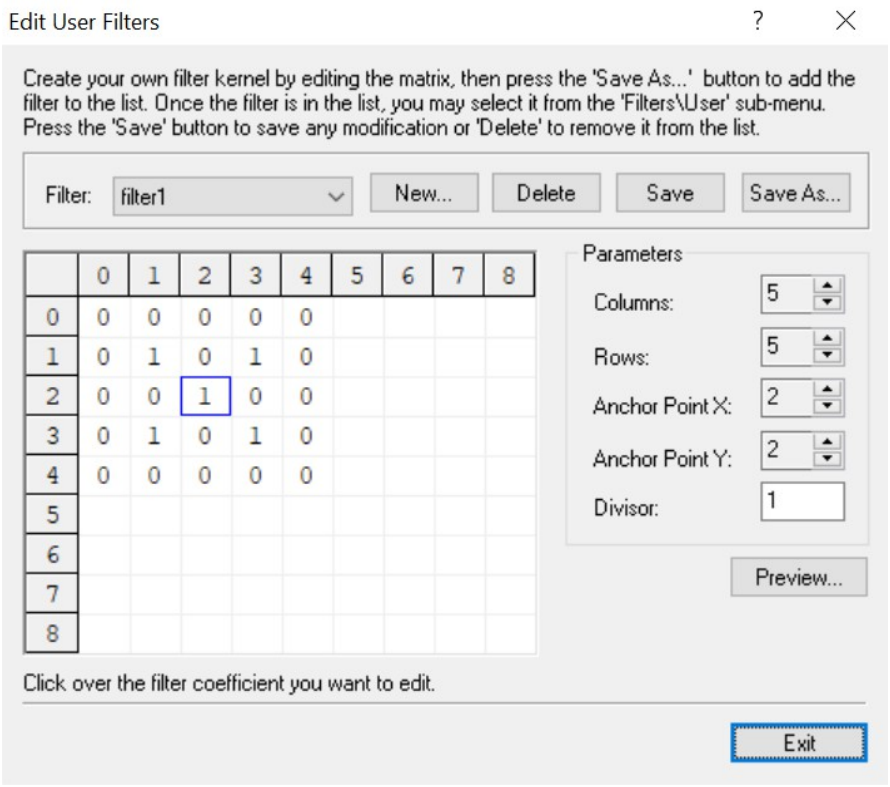
- Sharpening filters: Laplace, Prewitt and Sobel.
- Smoothing filters: Average, Gaussian, Smooth, and Median.
- Effect filters: Minimum and Maximum.

5.17.1. Create a User-defined filter

The **User filter** utility has the flexibility to apply a custom filter and save the kernel for future use. The filter kernel size, anchor point and image divisor are custom configurable.

Once a custom filter has been created and saved, the user-defined filter is added to the Filter drop-down list.

1. Select Filter from the main toolbar.
2. Select User from the drop-down list.



5.18. Camera Menu

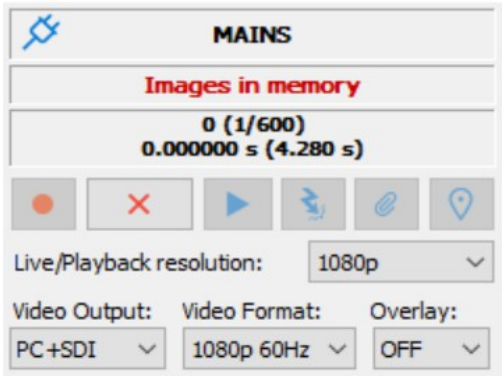
The Camera Menu on the main toolbar offers an alternative to using the buttons and dialog box provided by the Docked Dialog menu including the following functions:

- Record, Stop, Play, trigger, attach.
- Playback controls.
- Acquisition configuration, erase, restore.
- Edit Region of Interest (ROI).
- Advanced menu.

5.19. Camera Control - Live

Camera Controls are located at the top of the Docked Dialog menu:

- Record.
- Stop/Snap.
- Live play of images (continuous).
- Trigger.
- Attach.
- Enable/Disable streaming (only on cameras that support streaming).
- Bookmark a frame.



Live/Playback resolution

The user may select to display the image in full resolution or decimated (1080p, 720p, 480p). This selection does not affect the resolution of downloaded images.

Video Output / Format

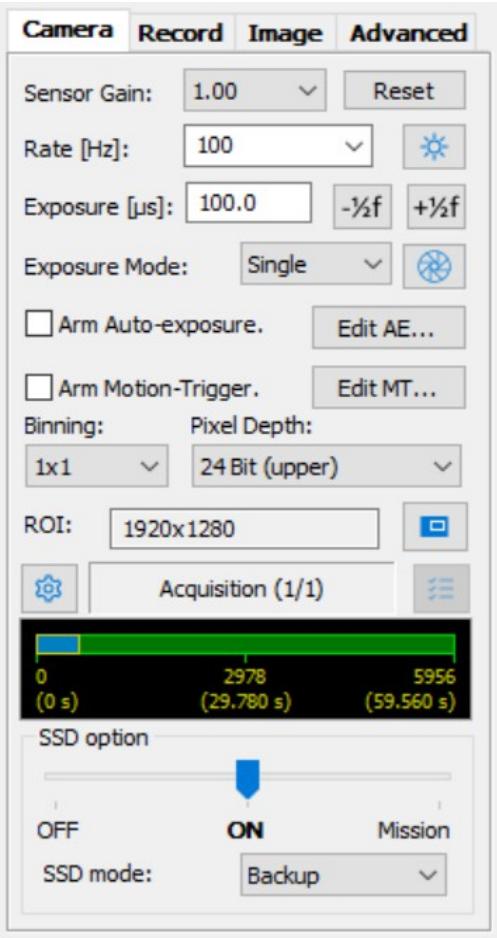
This option enables or disables video output in IDT cameras. Each model has its own list of HDMI (Y cameras) or SDI (Os, CC and CCM) formats.

- **PC**: images are sent to the computer via GE or USB, no HDMI/SDI output is produced.
- **PC+HDMI/SDI**: any time an image is sent to the computer (playback or live) the same image is sent also to the video output. Live/playback speed is reduced because the images are created twice.
- **HDMI/SDI**: the images are sent to the video output only. Computer image is not updated.

Overlay

Select if the camera parameters are displayed on the video output.

5.20. Camera Configuration



In expert mode, use the Camera Tab on the Docked Dialog menu at the right of the image to configure the camera. The configuration options are as follows:

Sensor Gain
Use the sensor gain drop-down list to select a Gain value from “1.00” to “2.82”.

Reset
Click the Reset button if a Device IO Control error message appears. The Reset button restores the camera from the error condition.

Rate
Use the Rate drop-down list to select a new Frame Rate value. If the current exposure is too large for the selected rate, the program automatically adjusts it to an acceptable value.

Low Light mode
Click the button to set the rate to 25 Hz and the exposure to four times the current value. If the button is clicked twice or an acquisition is started the original values of exposure and rate are restored. The option is useful for preview in low light conditions.

Exposure
Use the f-stop buttons to select a new exposure value. The value is in microseconds.

Exposure Mode
Use the drop-down list to select either Single or Double.

Lens Control
Some camera models are equipped with support for motorized lenses. Click this button to open the control of focus and aperture.

Auto-Exposure
Select this option to activate the automatic exposure adjustment.

Motion Trigger
Select this option to activate the motion trigger.

Binning
Use the Binning drop-down list to select a new value from 1x1 to 4x4. Pixels may be grouped to form a larger pixel, which results in added SNR and sensitivity. When this parameter is changed, the Region of Interest (ROI) is reset. The control is disabled when the camera is in live mode.

Pixel Depth
Use the drop-down list to select the pixel depth: 8, 9 or 10-bit for monochrome cameras, 24, 27 or 30-bit (RGB) for color cameras.

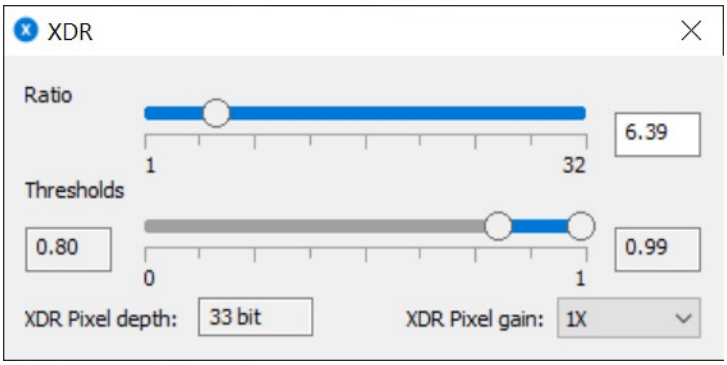
ROI
Click on the ROI button to open the ROI dialog, and change the current settings. For more information, see “Set a Region of Interest (ROI)”.

5.20.1. XDR (eXtended Dynamic Range)

XDR stands for eXtended Dynamic Range. It is a specialized shooting mode that allows the camera to record details in both very bright and very dark areas simultaneously, solving a common limitation in high-speed photography where high-contrast environments cause overexposure or underexposure.

In XDR mode, the camera's sensor acts in a "Dual Exposure" capacity, simultaneously capturing two distinct sets of recordings at different exposure settings for every frame. One exposure is optimized to capture details in the highlights (preventing bright areas from blowing out), while the other is optimized for shadows (boosting visibility in dim areas).

To enable XDR, select it in the “Exposure mode” control in cam,era Tab.



Ratio: this slider controls the ratio between the two exposures in dual exposure mode.

Upper threshold: This setting establishes the clipping boundary for the longer (brighter) exposure. When a pixel's brightness value surpasses this designated threshold, the software recognizes that the area is overexposed (blown out). It automatically swaps that pixel's data for the corresponding pixel from the shorter (darker) exposure.

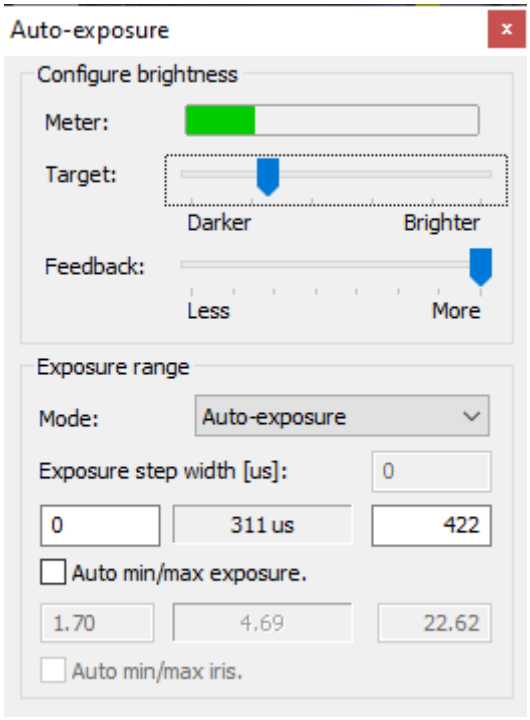
Lower Threshold: rather than hard-switching between exposures, which creates harsh, noticeable edges, this threshold sets a crossover range. Within this specified pixel intensity zone, the software applies a gradient algorithm to smoothly interpolate and merge the data from both exposures.

Pixel gain: within the increased pixel depth of XDR images, the user can select which part of the original pixel depth can be extracted and displayed.

5.20.2. Auto-exposure

When this option is selected, the camera automatically adjusts the exposure to match a the average value in a specified region of interest. The camera reacts to any change of external light intensity by changing the current exposure value.

1. Click the “Edit AE…” button. The AE ROI frame will appear as well as the parameters dialog box (see below).



2. Put the camera in Live mode, select the “Arm auto-exposure” option in the camera bar and configure the parameters.

3. Move the target slider to increase or decrease the reference intensity.

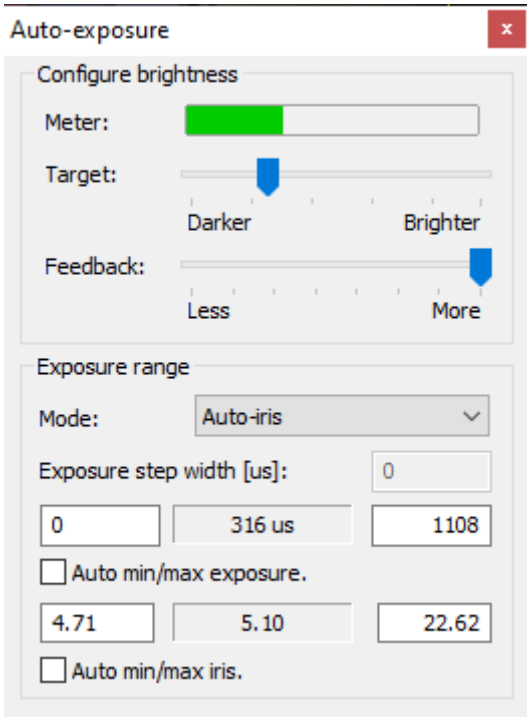
4. Move the Feedback slider to configure the reaction speed.

5. Select the mode among Standard, Two exposures (the camera will jump between two exposure values) or Exposure steps (you may select a limited set of exposures).

6. Edit the minimum and maximum exposure values to limit the exposure dynamic range or select “Auto min/max exposure” to automatically set exposure range to the maximum.

5.20.3. Auto-iris

XS-Mini cameras equipped with motorized lens support auto-iris. Auto-iris can be selected from “Mode” option. Instead of changing camera exposure, auto-iris open and closes lens aperture (see below).

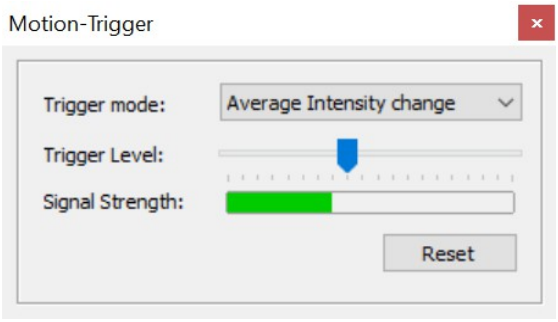


Like exposure limits, iris limits can be configured. If “Auto min/max iris” option is selected, those limits are taken from lens minimum and maximum aperture.

5.20.4. Motion Trigger

The motion trigger option activates the trigger when a change in the image is detected.

1. Click the “Edit MT…” button to open the configuration dialog. The MT region of interest frame and the configuration dialog will appear.



2. Change the trigger condition and move the level slider from left (more sensitive) to right (less sensitive).

3. Put the camera in Live mode and test the MT condition by changing the image intensity. The Signal strength bar will change color from green to red when the condition is true.

4. Click Reset to restore the reference conditions.

5.20.5. Region of Interest (ROI)

The IDT cameras have a **Partial Windowing** capability that can be selected and set via the software interface. A region of interest for the image that is less than the total available area of the sensor may be selected. This region can be interactively adjusted and can occupy any area of the sensor's active pixels.

1. Click on the ROI button on the Camera Configuration Tab.
2. From the Edit Region of Interest dialog box, select the ROI by setting the numerical values for its origin and dimensions or by dragging the handles of the red box that highlights the ROI within the sensor area.

Once the ROI is configured only the active portion of the image is acquired and displayed. It is important to note that the maximum framing rate of the camera is inversely proportional to the number of rows in the ROI. The options are below:

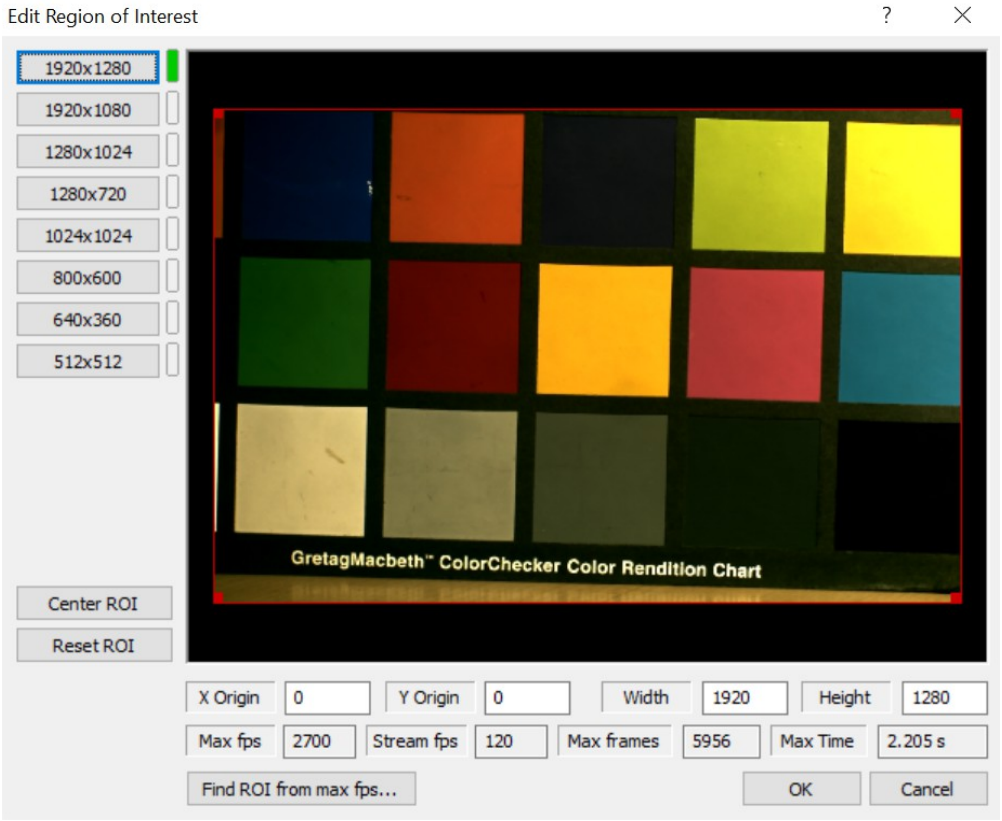
Resolution: select a resolution from the buttons on the left side or edit the values in the X Origin, Y Origin, Width and Height text boxes.

Center ROI: click the button to center the current ROI.

Reset ROI: click the button to reset to the maximum value.

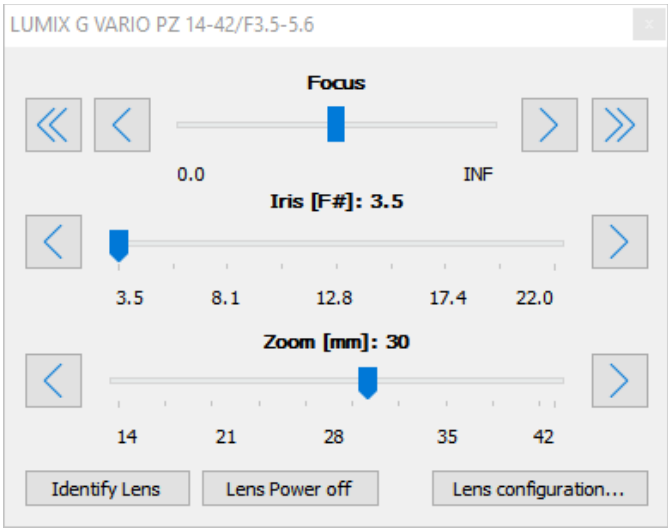
Max fps, frames, time: displays the maximum acquisition rate, the max number of frames and the corresponding recording time for each ROI. If the camera has on-board SSD, it shows also the streaming fps that is the frame rate that allows continuous streaming on the disk without overrun.

Find ROI from max fps: click this button to open a dialog box where you can edit a frame rate value. Then click OK and the software will calculate the resolution that allows the camera to record images at that frame rate.

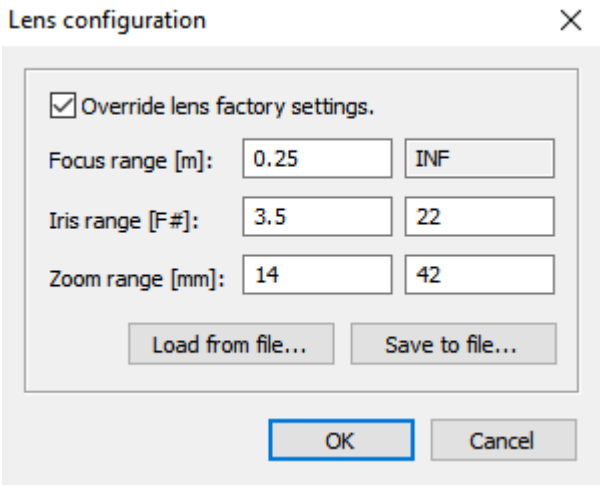


5.20.6. Motorized lens control

Some cameras (O, Os, XS-PCIe, XS-Mini) are equipped for motorized lenses. Focus, iris and zoom can be controlled within Motion Studio.



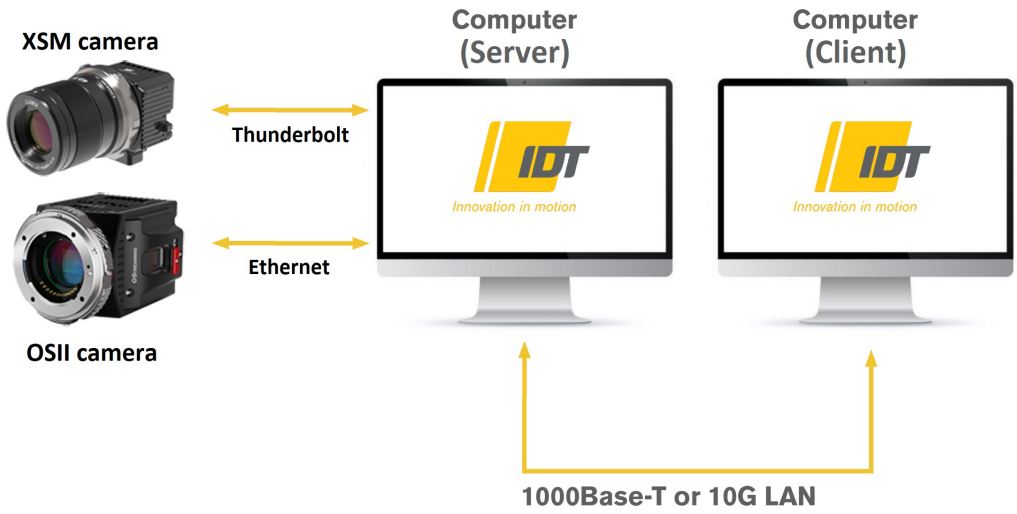
If a lens has not been detected, click “Identify lens”. Click “Lens power off” to turn off the lens. Click “Lens configuration” to override the lens settings and save them to a file.



5.21. Remote cameras

XSM, XSS and OSII cameras can be remotely controlled in a 1G or 10G Ethernet network.

To enable remote camera control, the “MS Remote Control” app must be installed and executed on each remote computer that is locally connected to an IDT camera (server). Motion Studio is executed on a separate computer (client).



Remote cameras are enumerated and open as any other Ethernet camera. They can record in local DDR and stream to disk; recorded data is stored in the server computer. Once recorded, images and raw files are stored as in the list below.

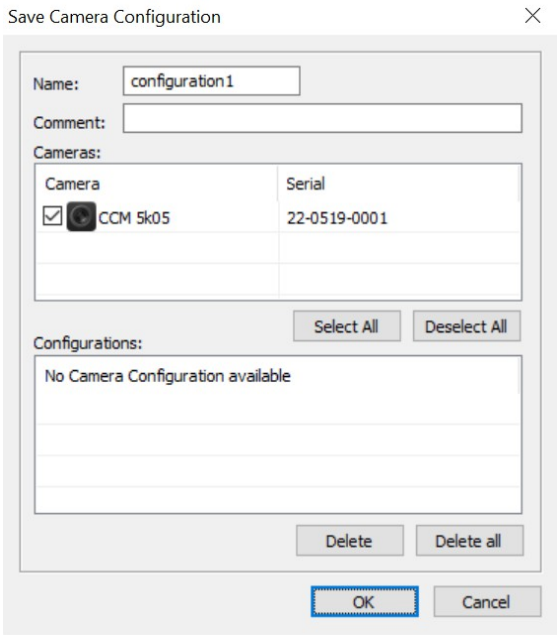
- **Streaming to disk data**: streaming to disk generates a raw sequence which is stored in the server computer. The MS remote control creates a sub-folder with current date and time. Motion Studio creates a folder with the same name in client computer and stores info about remote data. Thanks to this info, MS can open the remote raw folder and convert raw into images in client computer.

- **Raw download data**: raw files are stored in the local computer (server). The MS remote control creates a sub-folder with current date and time. Motion Studio creates a folder with the same name in client computer and stores info about remote data. Thanks to this info, MS can open the remote raw folder and convert raw into images in client computer. Motion Studio can also open remote raw files and playback.

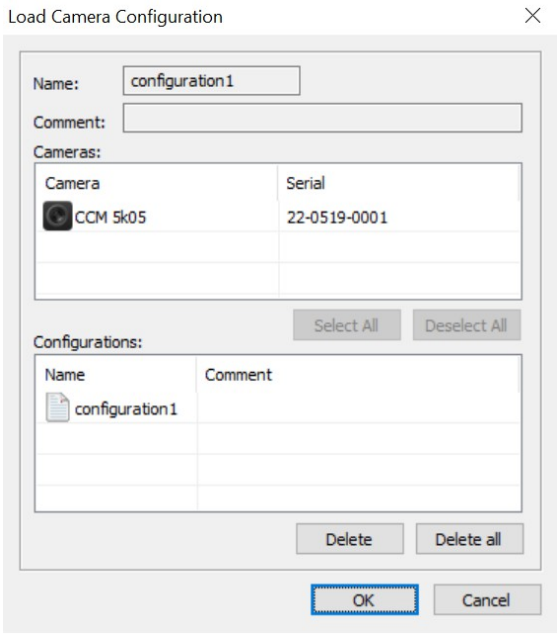
- **Images data**: images are stored in the local camera computer (server), but they can be immediately transferred to the client, by activating a tool (remote transfer monitor), that copies files from the server to the client. The automatic transfer is enabled in the general options.

5.22. Save and Load camera configuration

To Save the current camera configuration, select “**Save camera Cfg…**” from File menu, then select one of the available configurations or type a new name and comment. Then click OK. Configuration files may be also deleted.



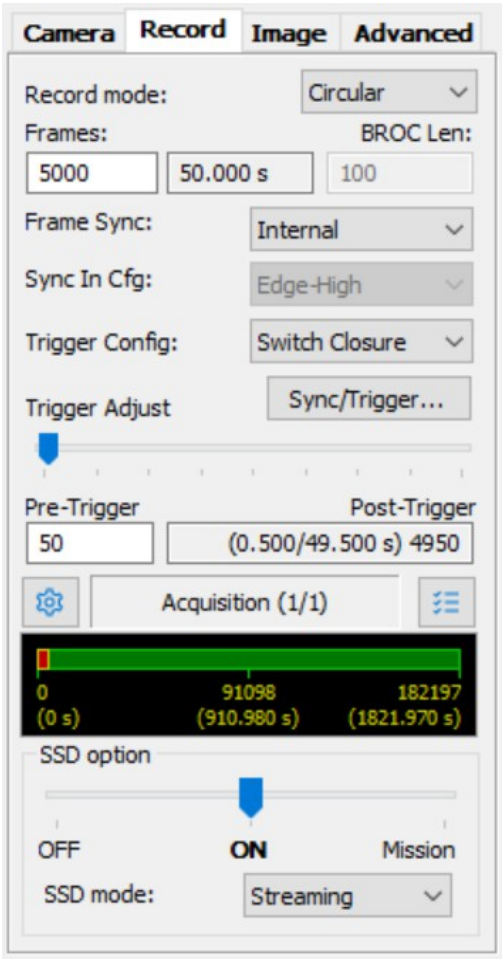
To load a camera configuration, select “Load Camera Cfg…” from File menu, then select one of the available configurations and click OK.



5.23. Record Configuration

5.23.1. Record Tab

Use the Record tab on the Docked Dialog box at the right of the image to set the record options.



Record mode

Use the drop-down list and select one of the following options:

Normal: the camera acquires and stops when the memory segment is filled.

Circular: the camera acquires and restarts when the memory segment is filled. The camera waits for an event trigger to complete the acquisition.

BROC (Burst Record on Command): the memory segment is divided into sub-segments; the camera acquires in circular mode in a sub segment. When the event trigger is issued, the camera completes the acquisition and start acquiring in the following sub-segment until the memory segment is filled.

Frames

In the text box edit the number of frames to be recorded to the camera memory in a single acquisition. The values can be set from 1 up to a maximum number depending on the amount of free memory and the number of rows on each frame. Select the number of rows on each frame with the ROI setting.

BROC Length

If BROC mode is selected, use the text box to type the number of frames of each sub-segment. If the number of frames is 1000 and the BROC length is 100, the camera will acquire 10 sub-segments.

Frame Sync / Sync Configuration

Sync Configuration and Event Trigger configuration are separated. Synchronize the camera with a pulse train and simultaneously issue an event trigger from the “Trigger In” BNC connector. Use the drop-down list to select Internal or External synchronization source. If the “Frame Sync” is external, use the “Sync Cfg” drop-down list to select one of the following options: edge-high, edge-low, pulse-high, and pulse-low. Cameras with more recent firmware support two new sync modes:

- **Phase Lock Loop (PLL)**: the sync is locked to an external signal whose frequency can be divided to generate a multiple; if the external sync is interrupted, the camera keeps recording at the configured frame rate.
- **Dynamic pulse**: the camera works in pulse mode and it “follows” the external pulse width if it changes.

Trigger Configuration

In Circular or BROC mode, select from the following event triggers options:

- Edge High

- Edge Low
- Switch Closure

Trigger Adjust

When the record mode is set to Circular or BROC, the Trigger Adjust controls are active. In this mode the camera acquires the set number of frames before the trigger event (pre-trigger) and the remaining after (post-trigger) the trigger event. Use the slider to adjust the number of pre- and post-trigger frames or edit the pre-trigger box.

“Sync/Trigger” advanced configuration

Click the “Sync/Trigger…” button to open the advanced Trigger, Sync In and Sync Out configuration dialog.

Acquisitions Configuration

Use the Wheel Icon button to open the Advanced Acquisitions Configuration dialog.

Select Acquisition

Use the arrow buttons to select the previous or next acquisition.

Memory Indicator Bar

The colored bar depicts the available memory.

5.23.2. SSD Options

Os cameras are equipped with 8 GB RAM (DDR) and onboard solid state disk (256 or 512 GB). The images may be recorded into RAM and/or SSD in the modes listed below.

OFF: the SSD is not used and the camera acquires images in the DDR like any other IDT camera without SSD.

ON: images are acquired in camera memory and stored in the SSD. Two modes are available.

- **Backup**: the DDR is used as a temporary buffer. The images are acquired in the DDR and, when recording is done, the images are transferred to the SSD asynchronously. The camera can record at any frame rate but the maximum number of frames that can be recorded in each acquisition is limited by the DDR size.

- **Streaming**: In SSD streaming mode, the DDR is used as a temporary buffer. The images are acquired in the DDR and synchronously transferred to the SSD. Since the write to disk speed (in frames per second) is fixed and the write to DDR speed is configurable, the maximum number of frames that can be recorded depends on the difference between those two numbers. The “Streaming fps” is the frame rate that corresponds to the write to disk speed. If frame rate is lower than streaming fps, the max number of frames that can be acquired is limited by the SSD size. If frame rate is larger than the streaming fps, the max number of frames is variable and it’s calculated assuming that the record mode is normal. If the record mode is circular and you wait too long before triggering, you may receive a disk overrun error message.

Mission: in mission mode, the DDR is used as a temporary buffer. For more information, see the topic below.

5.23.3. Automatic Backup mode

Auto-backup mode is supported by the following camera models.

- Os/CC/CC-mini cameras in SSD Backup mode. The images are saved to SSD/SD-card.
- Nx cameras with latest firmware. The images are stored to camera DDR.

Execute auto-backup when MS is closed: if this option is selected and Motion Studio is closed, the camera is automatically armed and it waits for trigger. When the trigger is received the images are recorded, saved to SSD and camera is armed again. The number of times that the camera will be armed is set in the segments field.

Execute auto-backup at next camera power cycle: at next camera power cycle the camera is armed. When the trigger is received the images are acquired and saved in the SSD (if the camera is Os). Then the camera is armed again. The number of times that the camera will be armed is set in the segments field.

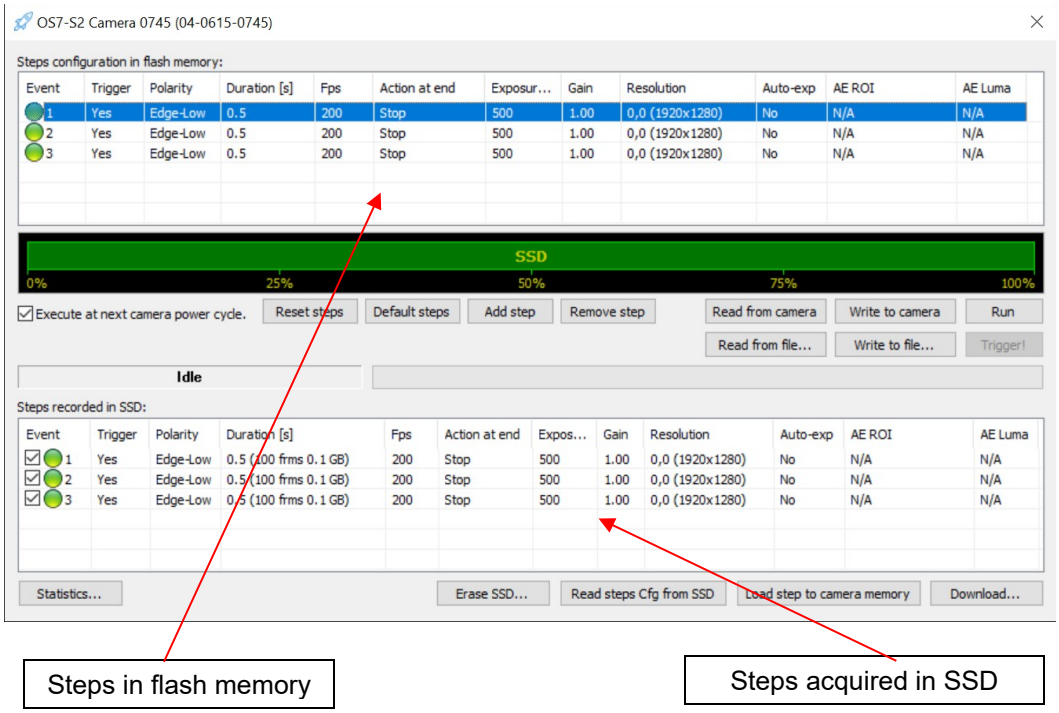
At each power cycle, restart from...: this option is supported only from firmware version 200. If it's selected, the user can record a few segments and reboot the camera, then the firmware starts recording from the first undone segment, and so on until all the segments are recorded. If this option is off, when the camera is rebooted and not all the segments have been recorded, the firmware starts from the beginning.

Start recording with trigger at next camera power cycle: the option is available only if SSD recording mode is set to “Streaming”. In this fashion, the camera do not start streaming until a trigger pulse is detected. Then it streams data to the SSD and stops when the second trigger occurs.

5.23.4. SSD mission mode

The mission mode has been designed to acquire images when the camera is disconnected from the computer. The SSD may be divided into segments, called steps; each step may have different parameters such as exposure, frame rate, region of interest. Each step is recorded in normal mode and the recording start may be automatic or generated by the trigger.

The picture below shows the interface.



To configure the camera in mission mode:

- Click “Reset Steps” to clear the upper list.
- Click “Add step” as many times as the required number of steps.
- Edit the parameters by clicking on the corresponding field in the list. If a step need to be automatically executed after the previous one, select “Auto advance” in the “Action at end” column of the previous step, otherwise, select “Stop”.
- Select the “Execute at next camera power cycle” to enable the execution of the mission when the camera is powered up.
- Click “Write to camera”
- Exit the program. The next time the camera will be power cycled the steps will be automatically executed and the image stored in the SSD. Once the mission is executed once, the camera may be power cycled more times, but the images will not be overwritten.

To display images acquired during the mission:

- Run Motion Studio and select the SSD mission mode.
- If the steps have been recorded and stored in the SSD, they will be listed in the lower list of the mission dialog.

- Highlight one of the steps of the list and click “Load step to camera memory”. If the step size is larger than the camera memory, a drop down menu will appear, showing a list of segments. Select one of them to load the images.

To save images acquired during the mission:

- Check or deselect the boxes on the left side of each step and click Download. The images will be downloaded in RAW format.

The steps may be saved on the hard disk (Write to file...) and loaded (Read from file...).

Each step has the following parameters:

Trigger polarity: the user may select among “edge-high” or “edge-low”

Duration: it controls the duration of the step in seconds.

Fps: the frequency of the steps in frames per second.

Action at end: it controls whether the camera stops when the step is acquired or automatically starts the next step. If the action is set to “auto-advance” the “Trigger” item in the next step will show “No”.

Exposure: the integration time in microseconds

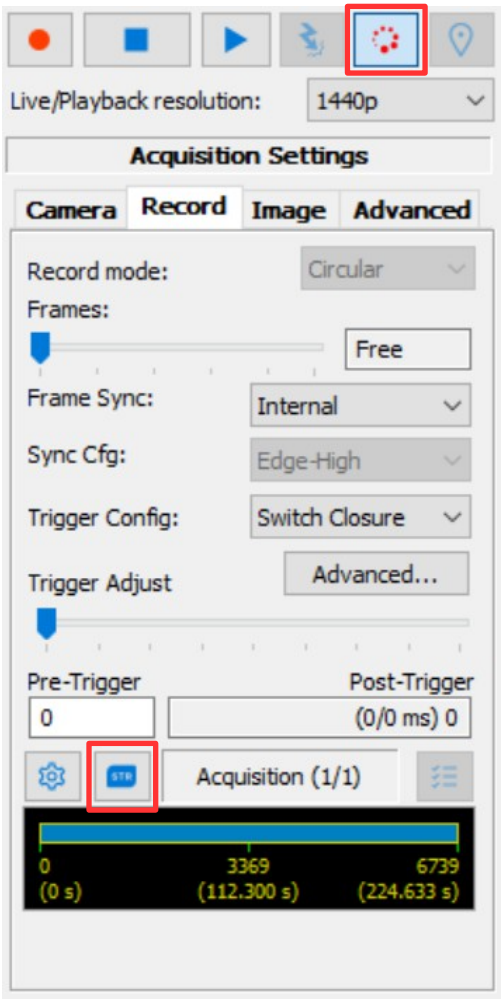
Gain: the camera sensor gain.

Resolution: the camera region of interest.

Auto-exposure: the user may activate the auto-exposure capability, select the corresponding ROI and set the average luminance used as reference.

5.23.5. Direct streaming to disk (W2D)

XSM and OSII cameras support direct streaming to disk. To enable and configure streaming to disk, two buttons are added to the camera bar.



The button on Live tab enables and disables streaming to disk. The button on Record tab opens the configuration dialog.

Once Streaming is enabled, the user can configure streaming duration (Frames) and pre-trigger and can select how many disks will be involved in the recording (Record tab).

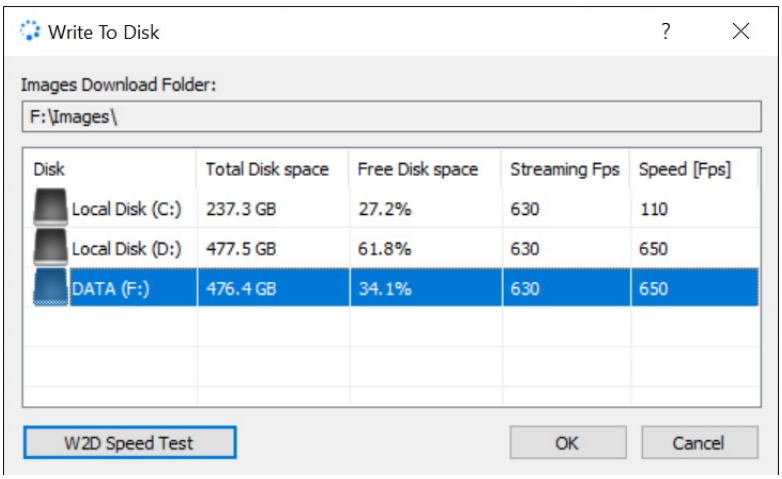
Streaming frames

If the “Frames” slider is set to “Free”, the duration of the recording is not defined. Once the camera is armed (Rec button), the first trigger starts the recording and the second stops it. Pre-trigger can be configured.

If the “Frames” slider is set to any other position, the duration of the recording is fixed. Once the camera is armed, the first trigger starts the recording and it automatically stops when the desired number of frames has been saved. Pre-trigger can be configured.

Configuration and test

Direct streaming to disk can be configured and tested (see the picture below).



5.23.6. Sync/Trigger Advanced Configuration

Trigger In

Y and N cameras can enforce a minimum time that the trigger input must remain continuously at its active level before it recognizes a valid trigger. This parameter is called “Debounce” and can be used to reject noise pulses on the trigger input, or to de-bounce mechanical contacts used as trigger sources.

After it recognizes a valid trigger pulse, the camera can wait for a few microseconds before issuing the trigger. This parameter is called “Delay”.

Sync In

The “Debounce” and “Delay” parameters can be applied to the sync in source as well (see above). If an external sync source is connected to the camera, the software is able to detect the rate and the pulse width of the signal. The PLL mode and IRIG jitter parameters can be configured.

Some cameras support configurable PTP. User can select “Ethernet” or “UDP”. In some environments PTP synchronization takes some time: the user can select how many seconds the camera firmware must wait before starting PTP synchronization.

Sync Out

The sync out mode can be configured:

- **Default**: the sync out signal follows the sync in (internal or external). The signal width is the exposure time.
- **Inverted Default**: the signal follows the sync in as in the default, but it’s inverted.
- **Configurable Width**: the user can define the width of the sync out signal.
- **Inverted Configurable Width**: like in the option above, but inverted.
- **Disabled**: the sync out signal is disabled.

A “Delay” can also be added to the Sync Out signal.

Alignment: when the auto-exposure option is selected the exposure is done at the end of the acquisition period. Then the period and exposure are not aligned. The alignment option is used to decide whether the sync out will be aligned to the period or to the exposure.

Marker

If this option is enabled, the user can send to the camera a pulse that gets recorded in one frame. The recorded pulse is a marker in the frame and lets the user know that something happened at that time. The marker is shown in the frame if the “Marker” Time stamp option is selected.

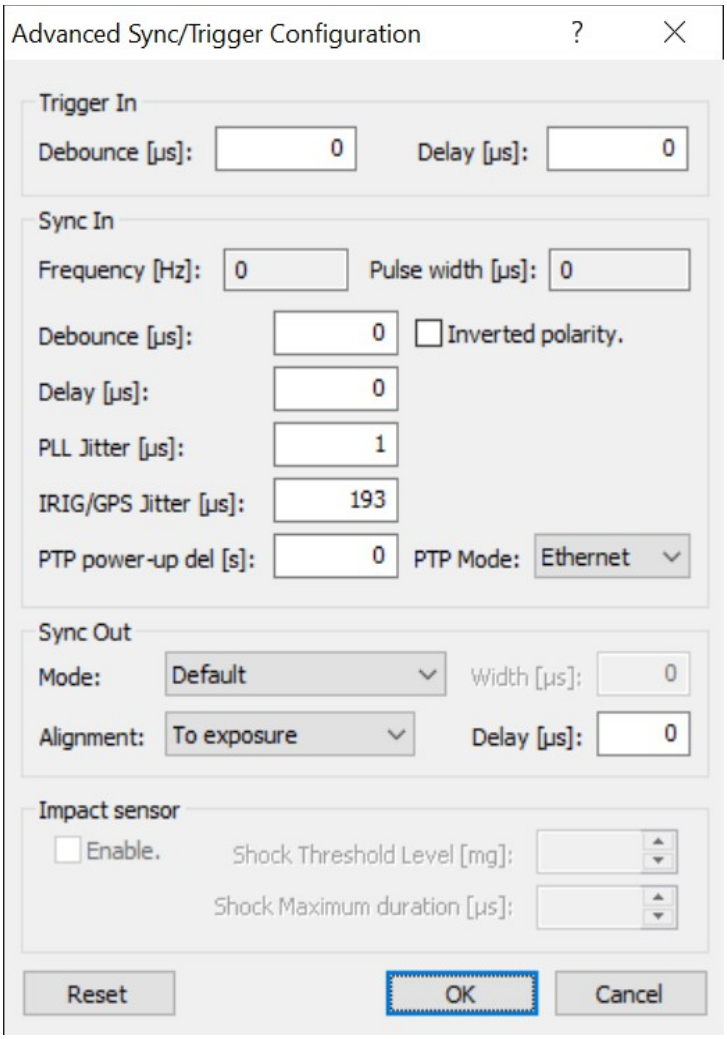
The pulse can be sent through “Sync In” or “Trigger In” connectors.

Shock Sensor

Crash-Cam Mini models are equipped with a shock sensor that can be used as a trigger backup in crash test environment. The parameters that can be configured are:

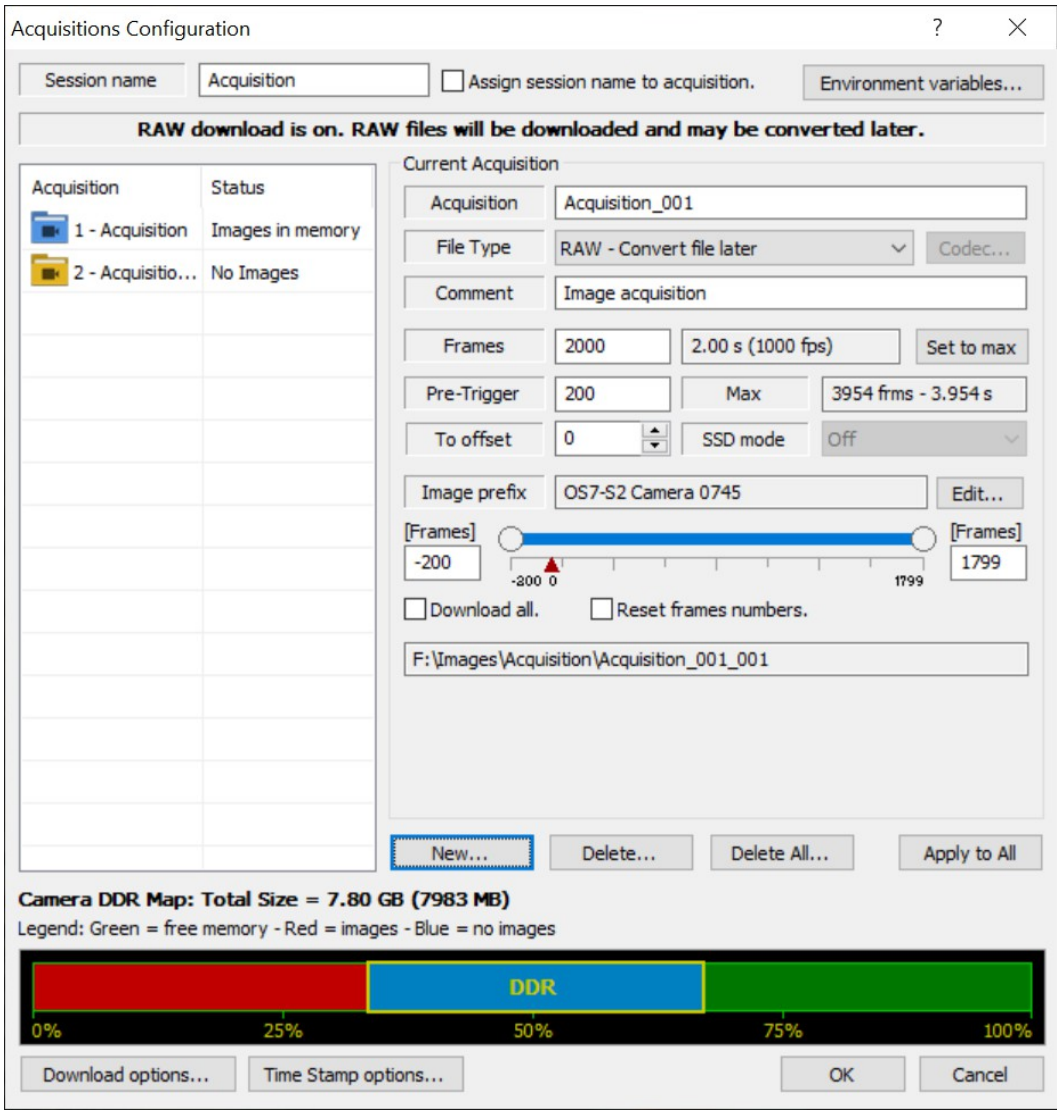
Threshold level: the minimum acceleration level in mg that activates the trigger.

Maximum duration: if the acceleration stays above the threshold for more than this parameter, the trigger is not issued.



5.24. Acquisition configuration

The acquisitions configuration dialog is activated by clicking the gear icon on “Camera” or “Record” tab.



Images are stored in a set of sub-folders organized as below:

“Images Folder”/”Session Folder”/”Acquisition Folder”

The Images folder is set in the “Download options” dialog and should not be changed frequently (see the topics below).

Session Name: this parameter is the name of the test session folder and it is created before saving the images. It will contain all the acquisition folders.

Assign session name to the acquisition: if this option is selected, the acquisition folder name is the same of the session folder. If more than one acquisition is saved, a number is added to the folder name in order to avoid overwriting the images.

Environmental variables: it shows a set of variables that can be used to generate file names (images, avi) or a path for automation transfer (see below).

Acquisition: this parameter is the name of the prefix of the acquisition folder. Each folder name is created by adding a number to this parameter (for example, if the name is “Acq” the folders will be “Acq_000”, “Acq_001”…).

File Type and Codec: use the drop-down list to set the image type format for archiving files to the hard drive of the computer. Some image formats support codec’s.

Comment: type a comment to the acquisition. The comment will be saved in a configuration file with the images and may be also shown in the time stamp.

Image Prefix: click edit to modify the image prefix (see below).

Frames: the number of frames to record.

Pre-trigger: pre-trigger frames, must be less or equal to frames.

To Offset: the position of trigger frame (T0) can be adjusted and it's useful in those scenarios where the trigger event has a known delay. The parameter is applied to the trigger position after each recording. The value can be either positive or negative.

SSD mode: if SSD option is set to ON, current segment mode can be configured as backup or streaming. Mode cannot be changed if segment is not at the bottom of segments list.

Set To Max: click this button to set the number of frame to the maximum allowed in the current segment.

Time: displays the acquisition record time.

Min and Max slider: selects the subset of images that will be saved after the recording.

Download all: this option overrides the selection of start and stop frame in the playback bar.

Reset frames numbers: if the file type is “single image” (TIFF, PNG, JPG) and the acquisition has a pre-trigger, the file names will contain negative numbers (Img-0000001.tif, Img-000002.tif, …). Click this option to reset the numbers and make them start from zero.

AVI file name and slider: if the create AVI option is selected in the general download options, these controls are enabled and the user may edit the avi file name and the subset of frames that will be converted.

Multiple acquisitions buttons

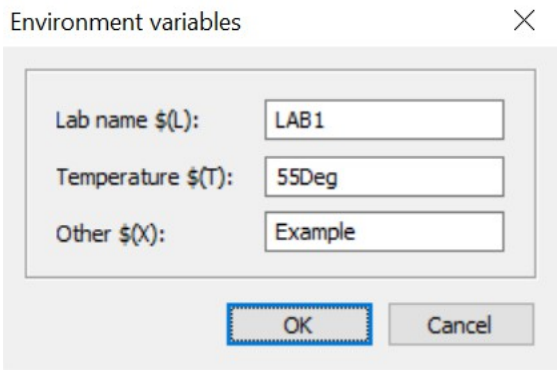
New: create new acquisitions in camera memory or SSD.

Delete and Delete All: delete the current acquisition or all the acquisitions.

Apply to all: copy the settings of current acquisition into the others.

5.24.1. Environment variables

Environment variables are placeholders that can be included in file name generation.

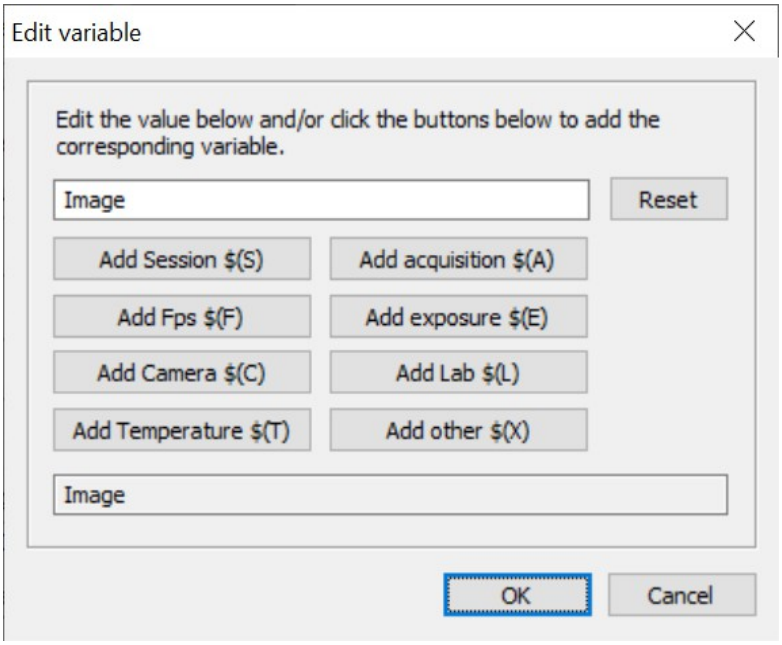


Those names can be modified once and included in file name or avi generation. Every time the user adds the variable to a name, the placeholder will be replaced with the corresponding value (see the example below).

Image-$(L)-$(T)-$(X) will be converted into **Image-LAB1-55Deg-Example**

5.24.2. Edit image prefix or AVI file name.

Click “Edit..” to modify the image prefix or the AVI file name (if enabled).



The image name can be generated by typing a name and/or including some variables (placeholders).

Session: the session name $(S).

Acquisition: the acquisition name $(A).

Fps: the recording frequency $(F).

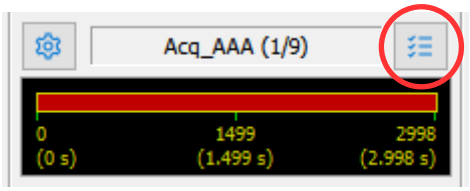
Exposure: the exposure in microseconds $(E).

Camera: the camera name $(C).

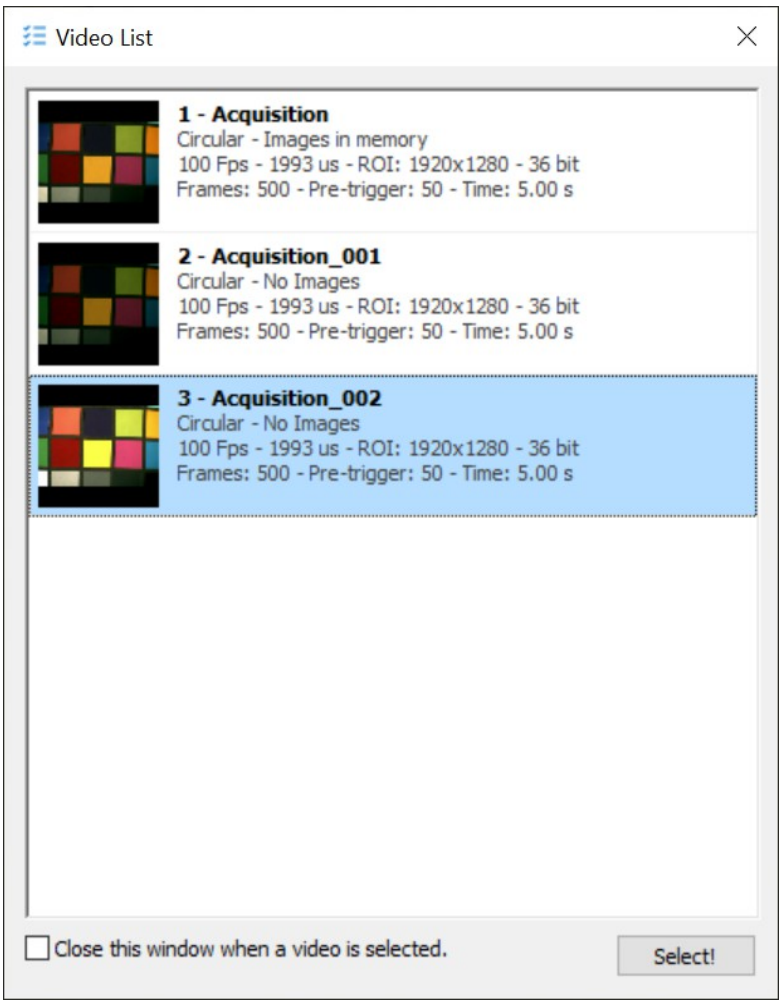
Lab, temperature and other: environment variables (see previous topic).

The advantage of including a variable is the following: if the variable changes, the name that includes the variable will be automatically updated. Then the user doesn't have to change it when a new recording is started.

5.24.3. Select a segment among multiple



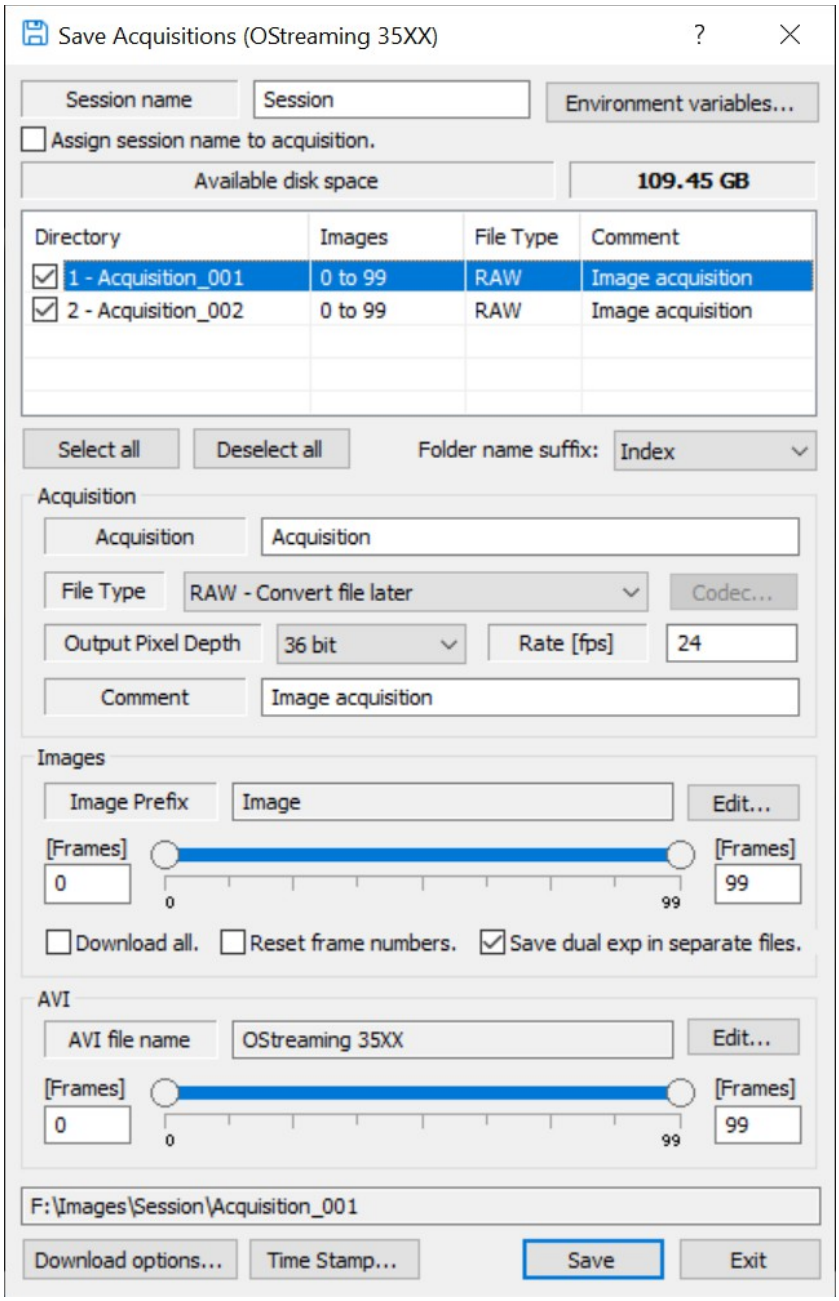
When multiple segments are configured in the camera DDR or SSD, the user can activate one of them by clicking the “Acquisition selection” button.



To activate a segment, select it from the list and click “Select!” or double-click the item.

5.25. Save acquired images and data (single camera)

The acquired images stored in different areas of the camera memory can be saved to the computer's hard drive. Click the Save button on the main toolbar or select File from the main toolbar > Save Acquisitions…



Some of the parameters are described in the "Acquisitions Configuration" topic above.

Select/Deselect all: selects and deselects all the acquisitions.

Folder name suffix: this option determines if and how a suffix is added to the acquisition name. "Index" means that a number is added (_001, _002); "None" means that no suffix is added and images can be overwritten; "Date/Time" means that a string made with current date and time is added.

Output Pixel Depth: the output file pixel depth may be different from the original image's pixel depth. Use the drop-down list to select the pixel depth.

Rate [fps]: if the sequence is saved in AVI or MOV format, the playback rate may be configured.

Images/AVI: type or select the desired start frame index and stop frame Index or move the double slider. If the "**Save and create AVI**" option is selected the user may select the images that will be saved in AVI format independently from regular images. The second double slider has been added for that purpose.

Reset frames numbers: if the images have been acquired in circular mode the indexes of the images may be negative. When a sequence is saved the file names are generated using the prefix and the image index, then the resulting file names may be "ImgA-000001.tif". If the "Reset" option is selected, the indexes are reset and the image names are generated starting from index 0 (example: Img000000.tif, Img000001.tif...).

Save dual exp in separate files: if the recording has been executed in dual or double exposure modes, first and second exposure frames can be separately saved. This option doesn't appear if exposure mode is single.

If data acquisition is connected and some data have been acquired with the images, the user may select the file format. Available formats are: ASCII, Tecplot, LabVIEW, Excel XML spreadsheet and Excel XLS workbook.

Tile Images: the data graph is printed and tiled to the bottom of the image.

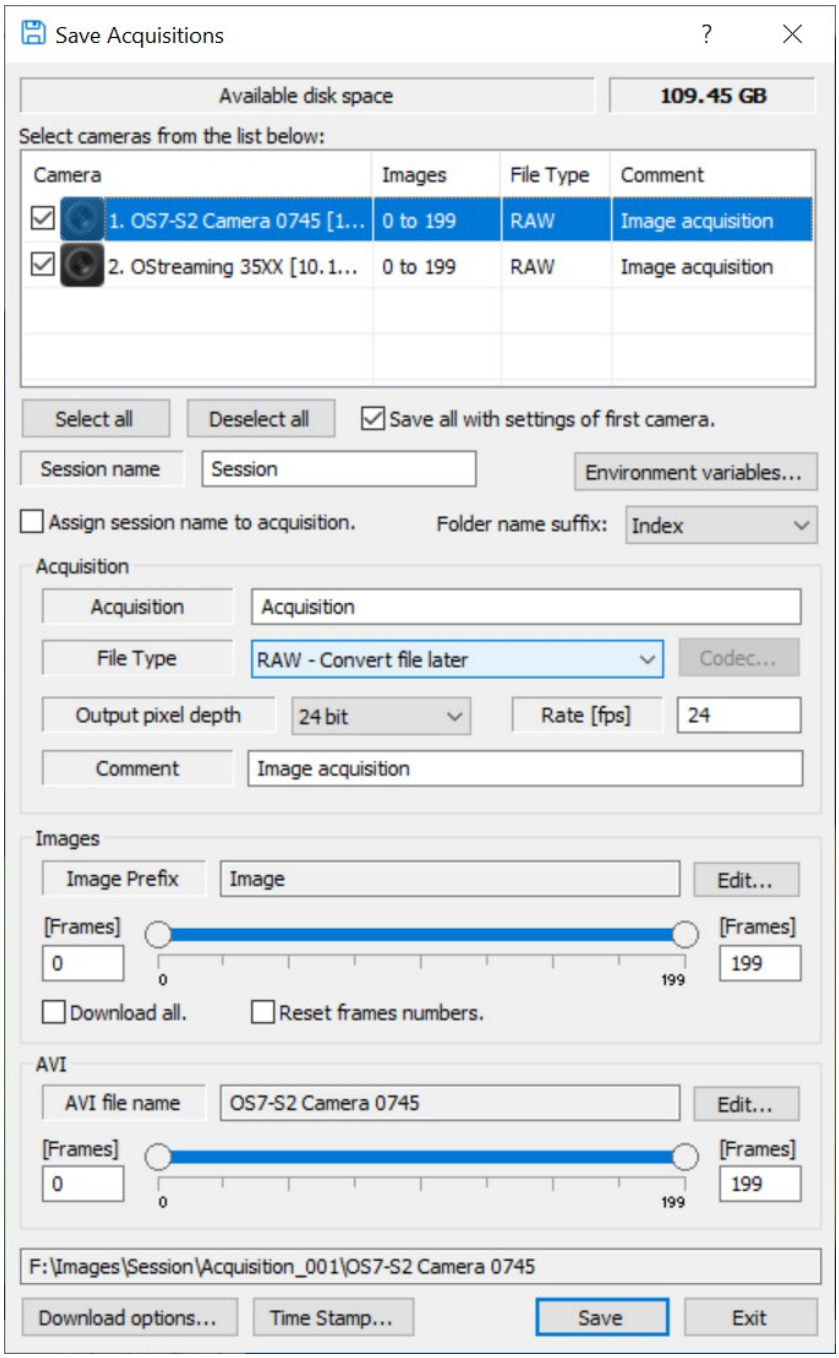
Minimum width: the minimum width of the image when the data is tiles with the image.

Show colored graph: if the camera is monochrome, the images are converted into color and a colored data graph is tiled.

Print graph label: a label with a description of each channel is added to the data graph.

5.26. Save acquired images and data (multiple cameras)

In multiple cameras environment, the interface is a little different but most of the parameters are the same.



Camera list: the user may check and deselect the cameras. the images will be downloaded only from checked cameras.

Save all with the settings of first camera: if this option is selected, the settings of image index, frame index, file type and comment are taken from the first camera of the list and applied to the other cameras. Otherwise, each camera saves the images with its own independent configuration of image index, AVI index, file type and comment.

Save all segments of each camera: this option appears only if cameras have multiple segments. If this option is selected all the segments of each camera will be downloaded, otherwise only current segment will be downloaded.

Folder name suffix: this option determines if and how a suffix is added to the acquisition name. “Index” means that a number is added (_001, _002); “None” means that no suffix is added and images can be overwritten; “Date/Time” means that a string made with current date and time is added.

Images/AVI: if the "Create and save AVI" option is selected, the user may select the images that will be saved in AVI format independently from regular images. Two double sliders have been added for that purpose.

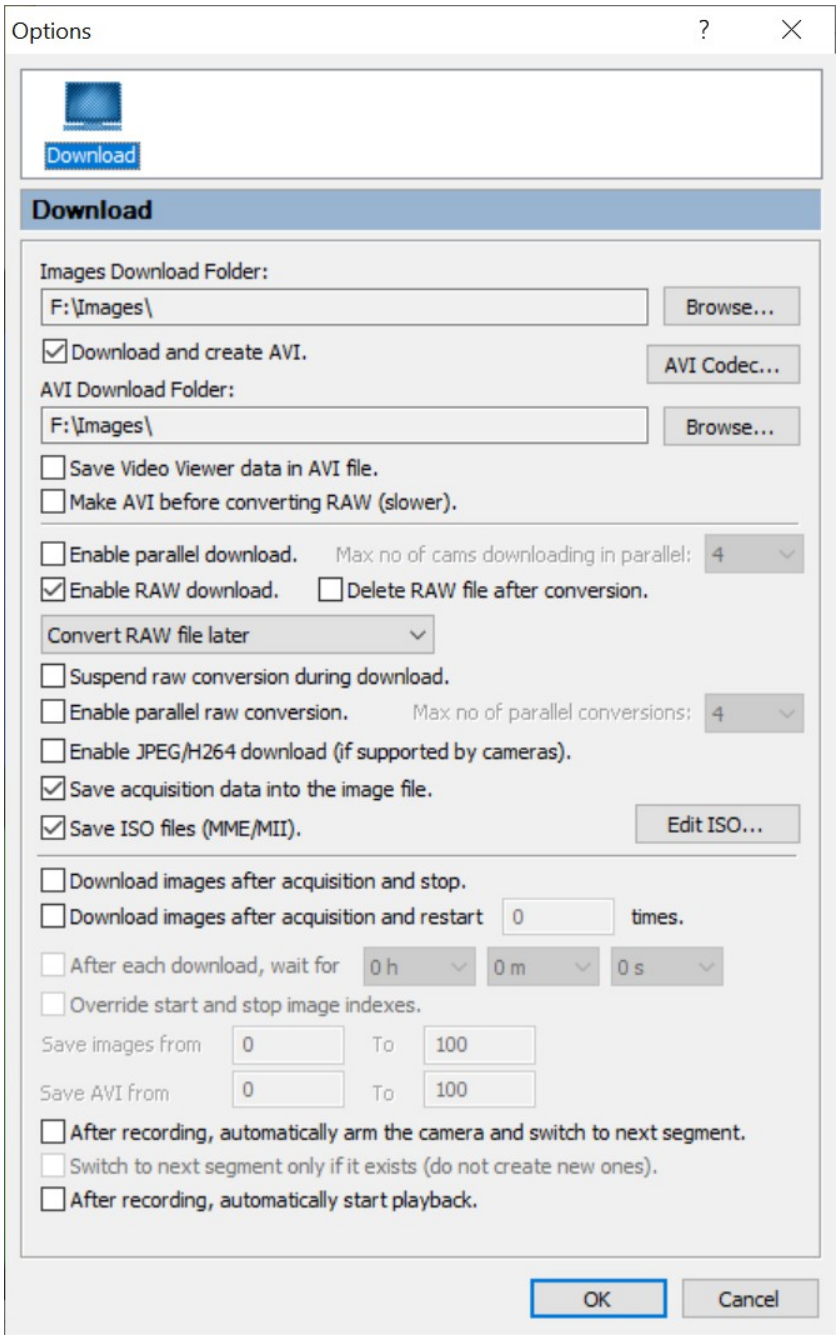
5.27. Operating Os cameras with a backup battery

The purpose of the battery is to provide a backup to the camera when the power goes off. It should provide enough power to let the camera finish recording and save the current images to the SSD.

For this reason the battery is turned on when the camera is “attached” by the software or when an auto-backup or mission session is started. When the camera is detached by software the battery is turned off, but only if it's not recording or saving images to the SSD.

5.28. Download Options

The download options may be enabled from the “Acquisition Configuration” dialog box, from the “Save Acquisitions” dialog box or from the “General Options” dialog box.



Images Download folder

The images folder is where the session folders, the acquisition folders and the images are stored (in raw or any other format). Click “Browse...” to change the folder name. This folder should not be frequently changed.

Download and create AVI

If this option is selected, the software downloads an AVI file after the download of regular images. The folder where the AVI is stored may be different from the regular images folder.

AVI codec

Click this button to edit the AVI codec

AVI download folder

The folder where the AVI files are stored may be different from the folder where regular images are stored (raw files included). Click “Browse…” to edit the name of the AVI folder.

Save Video Viewer data in image file

Some of the acquisition parameters are saved into the AVI file in a format that is compatible with the tool “Motion Analysis Video Viewer” by Concurrent Processing, Inc.

Make AVI before converting RAW (slower)

When raw download is enabled, the avi file is generated only when the raw conversion is performed. If this option is selected, Motion Studio downloads raw data and creates the AVI at the same time. The process is slower.

Enable parallel download

if this option is enabled, MS activates an independent thread for each camera and downloads images in parallel.

Max number of camera downloading...

Set the maximum number of cameras that can download in parallel (the parameter goes from two to eight cameras).

Enable RAW Download and Convert

If this option is enabled, the camera downloads the images in raw meta-data format. Once the raw download is activated and the raw data is saved, the data may be converted into a standard image format. The conversion process may be started automatically (“Convert after download” option) or postponed (“Convert later” option). If the “Delete after conversion” option is enabled, the raw file is deleted after the conversion. If the “Suspend raw conversion...” option is selected, the separate process that converts the images is suspended when the cameras are downloading the images and resumed immediately after the download. For more information about this topic, refer to the RAW converter topic below.

Parallel raw conversion

Parallel raw conversion can be enabled. The user can select the maximum number of raw files that can be converted in parallel.

Jpeg download

Some camera models (HG and Y-series) support direct jpeg download. The images are converted into jpeg by the camera firmware and sent to the computer. The software reads the images and stores them to the hard disk without any conversion.

Save acquisition data

The program saves acquisition data to the images file. The data may include IRIG time, temperature, image index, exposure, rate and other information.

Save ISO files.

If this option is selected, the MME/MII files are generated in the acquisition folder. Click Edit to modify some of the MME/MII strings.

Download images after acquisition and stop

If this option is selected, Motion Studio stores the data to the hard disk immediately after each acquisition.

Download images after acquisition and restart “N” times

If this option is selected, Motion Studio stores the data to the hard disk immediately after each acquisition. After saving the images, the camera is armed. The process is repeated N times.

After each download, wait...

If a recording is automatically restart after download, the user can configure a timer that inserts a delay between recordings. The delay can be a few seconds or hours.

Override start and stop indexes

If automatic download is enabled, the user may select the start/stop indexes that will be used to download the images and/or the AVI files. If this option is active, the sequence is trimmed and saved with the overridden indexes.

Arm the camera and switch to next segment

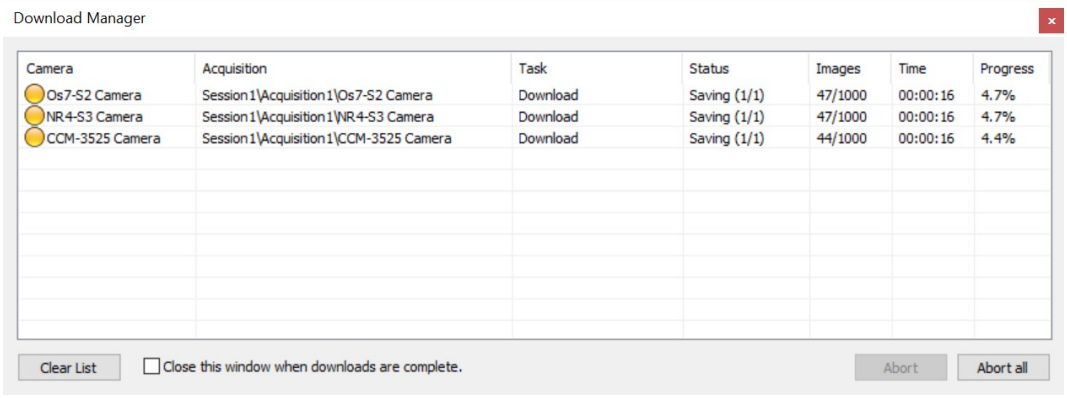
If the camera memory is segmented and this option is selected, the software automatically switches to the next segment when the previous acquisition is complete.

Switch to next segment only if it exists: if switch to next segment option is on, MS can have two different behaviors: create a new segment and record until DDR (or SSD/SD-card) is full or record only the segments that have been previously configured.

After recording, automatically start playback: this option is activated only if the options above are disabled (automatic download or camera rearm). After a sequence recording is done, playback is automatically started.

5.29. Download Manager

The download progress is reported in a window called Download manager. Downloads are queued and executed in the correct order. The status of each download is continuously updated (see below).



The download of the current acquisition process may be aborted at any time by clicking the “Abort” button.

All the acquisition in the list may be aborted by clicking the “Abort all...” button.

Click the “Close the window…” button to hide the manager window when downloads are complete.

5.30. Raw Download and Raw Converter

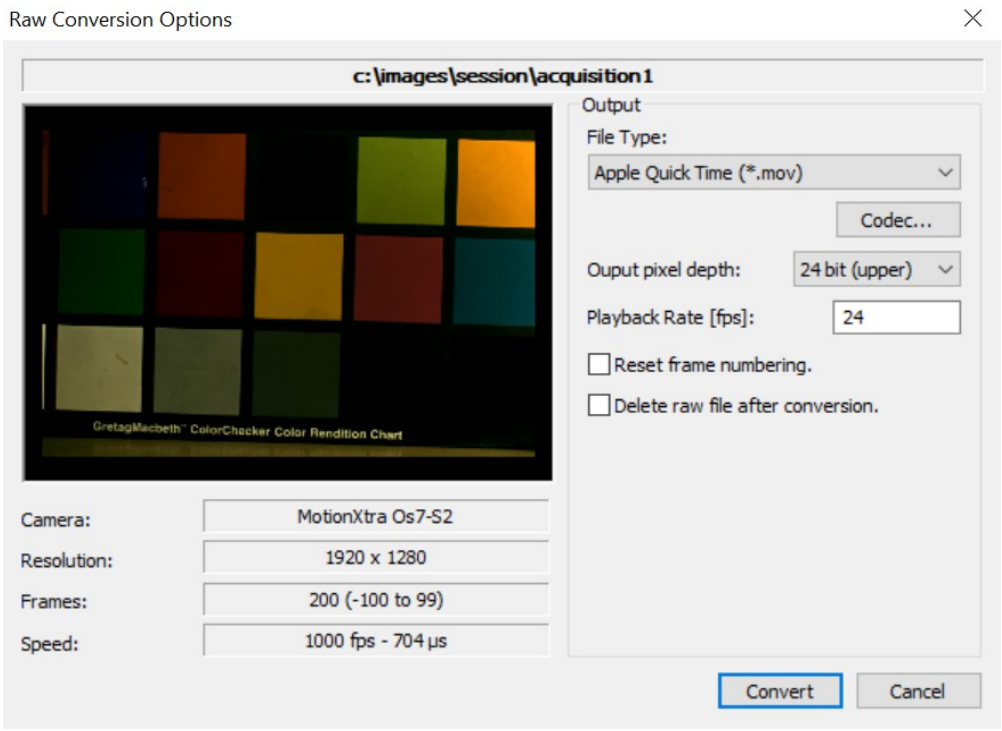
Once the raw download is activated and the raw data is saved, the data may be converted into a standard image format. The conversion process may be started automatically (“Convert after download” option) or postponed (“Convert later” option).

Convert after download: the file is automatically converted after the download. The raw converter runs in background and converts the file. An icon is displayed in the tray notification area of Windows. A red icon means that the conversion process is in progress, a green icon means that the conversion has been completed. The raw converter window may be displayed at any time by clicking on the tray area icon.

Convert later: the file is converted manually by the user. From the Start menu select “All Programs”, then “IDT”, then “Motion Studio”, then “Tools” and then run the “Raw Converter”.

Once the raw converter is started, an open file dialog appears. Locate the args.ini file in the acquisition directory and click OK.

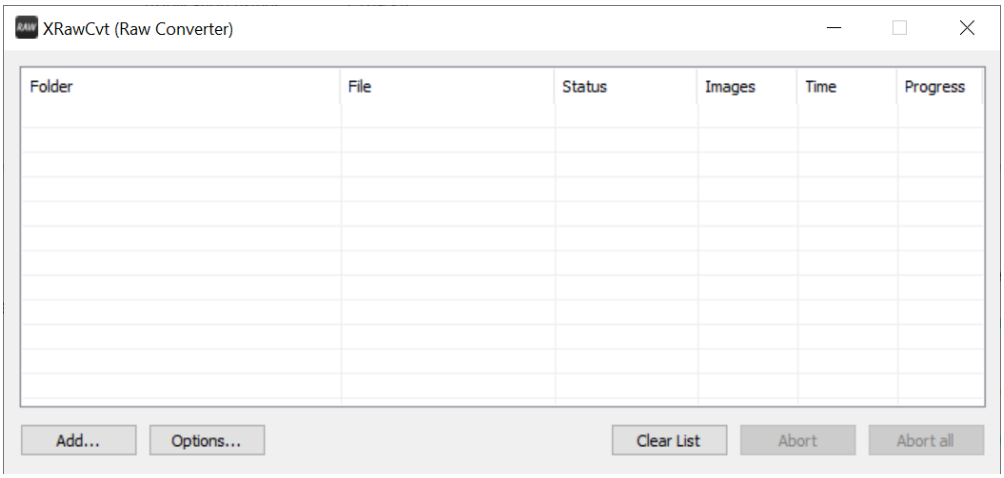
Then select the conversion options. The file format may be changed and the raw file can be kept and converted more than once.



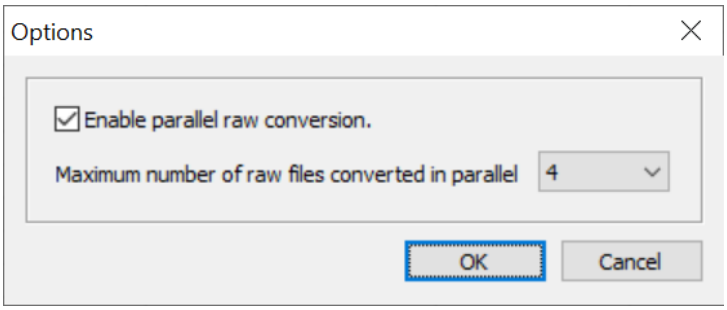
Some of the conversion options can be modified before the conversion (file type, codec, pixel depth and playback rate).

When the OK button is clicked, the raw converter is started and the sequence queued in the conversion manager. The conversion process may be aborted at any time, by clicking the “Abort” button.

More than one conversion can be added by clicking the Add button in the raw converter main window.



Click “Options” button to open the general options.

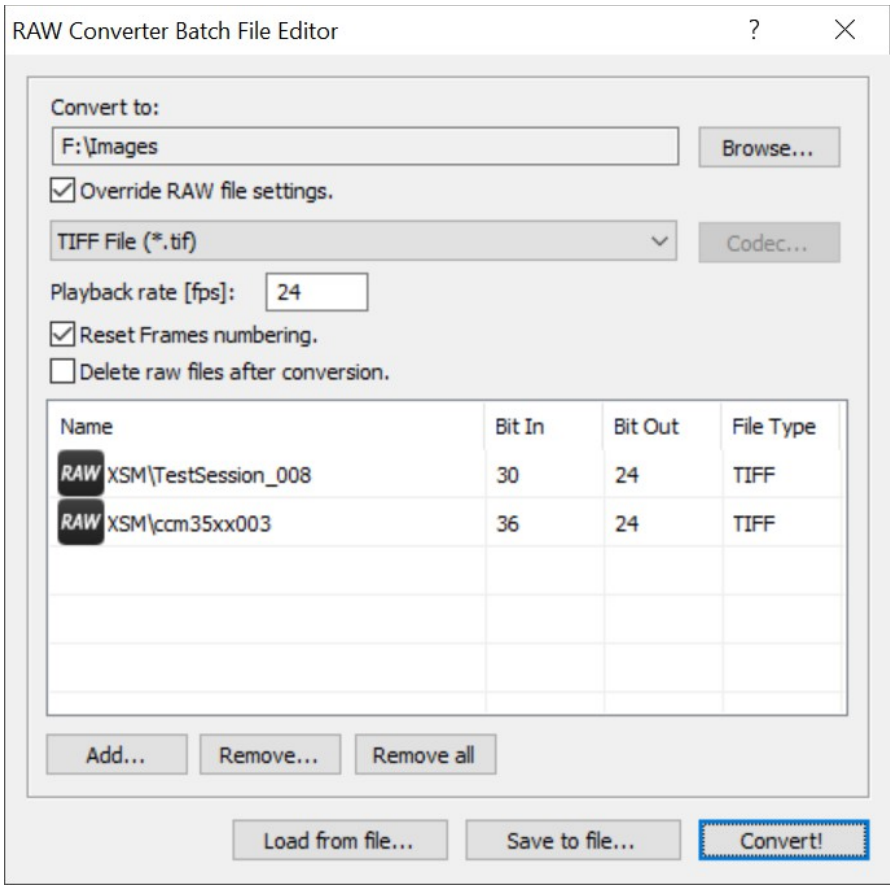


The user may:

- Enable or disable parallel conversion.
- Set the maximum number of raw files that can be converted in parallel (from 2 to 12).

5.30.1. Raw converter batch files

If the amount of raw sequences to convert is large, the user may generate a batch file and run the conversion once. From Tools menu, select “Raw batch editor…”



New batch file: click this button, to reset the current batch and generate a new file.

Open batch file: opens a previously generated batch file.

Save batch file: save the changes in the current batch file or in a new file.

Add: adds a sequence to the current batch file (ARGS.INI file)

Remove: removes a sequence from the current batch file.

Remove all: removes all the sequences from the list.

Convert to: the files may be converted in a folder that is different from the source images folder. Click Browse to select an existing folder or create a new one.

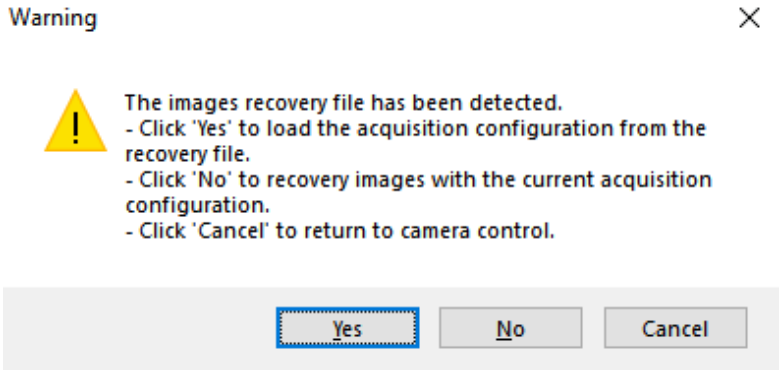
Override images settings: click this option if you want to convert all the raw files in a single file format, set a single playback rate, reset frames numbering in all the selected sequences. The settings of each sequence will be overridden by the selected options.

Once the batch file is generated and saved, you may launch the converter right away or save the batch file and convert it later. To do that, launch the raw converter and open the batch file. All the sequences included in the batch file will be converted.

5.31. Images Recovery

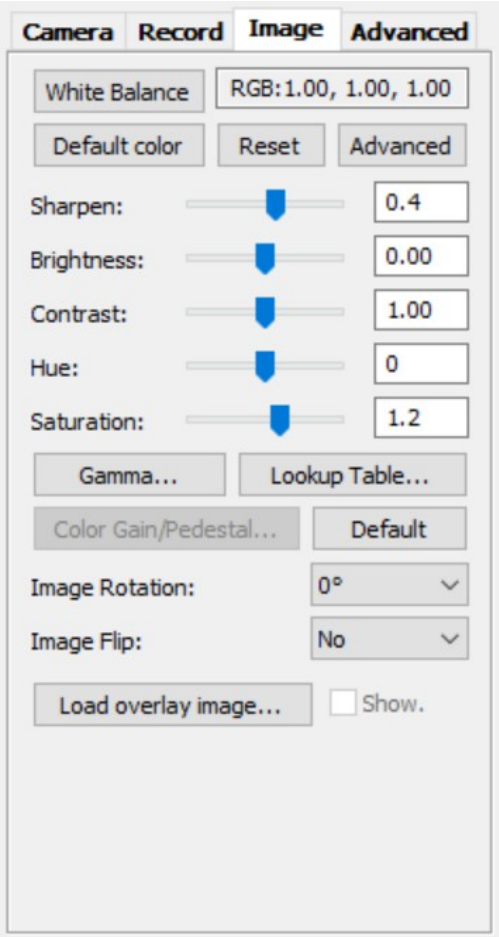
After each acquisition a local configuration file is saved in the database directory (_nnn_recover.xsv, where “nnn” is the serial number of the camera). The file contains the information about the latest acquisition. If any error has occurred after an acquisition and the program has been restarted before the images have been saved, the acquisition may be recovered.

- From the main toolbar select the File menu.
- From the drop-down menu select the “Images Recovery” item.
- Select one of the options.



5.32. Image Configuration

The image tab includes controls for color reconstruction and white balance and controls for image improvement. Sharpening, gamma, brightness and contrast are active for monochrome cameras also.



White Balance / Advanced color

See topics below

Default Color

Click this button to select the optimal color balance values for the camera.

Reset

Click this button to reset the color balance matrix to unity.

Advanced

See below.

Sharpen

Sharpen the image edges. The range is from 0.0 to 1.0. The default value is 0.0.

Brightness

Increase or decrease the image brightness. The range is from -0.25 to 0.25. The default value is 0.0.

Contrast

It increases or decreases the image contrast. The range is from 0.5 to 1.5. The default value is 1.0.

Hue (color only)

It modifies the image hue. The range is from -180 to 180. The default value is 0.

Saturation (color only)

It modifies the color saturation. The range is from 0.0 to 2.0. The default value is 1.0.

Gamma

Click to show/hide the gamma configuration dialog.

Lookup Table

Click to show/hide the LUT configuration dialog.

Color Gain/Pedestal

Click to show/hide the gain/pedestal configuration dialog.

Default

Click on the Default button to reset to the original values.

Rotation and flip

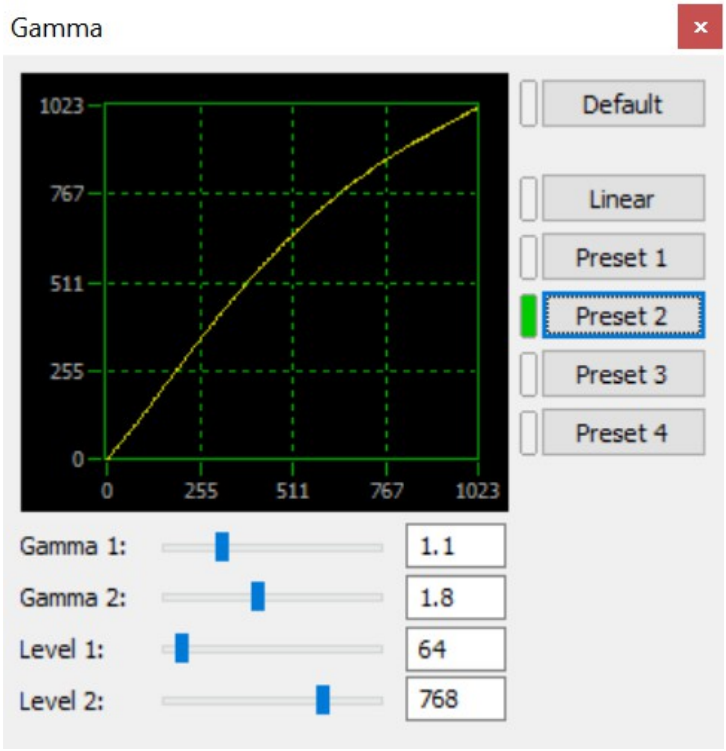
Select rotation angle and/or flip (vertical/horizontal).

Load/Show overlay image

Click “Load overlay image...” to load an overlay image and “Show” to show/hide it.

5.32.1. Gamma

The simple gamma slider has been replaced by a dialog box.



If we assume that the camera pixel range is from 0 (black) to 1023 (white), that range is divided into three zones:

1. **Zone 1** (from 0 to level 1): in this zone the gamma 1 value is applied.

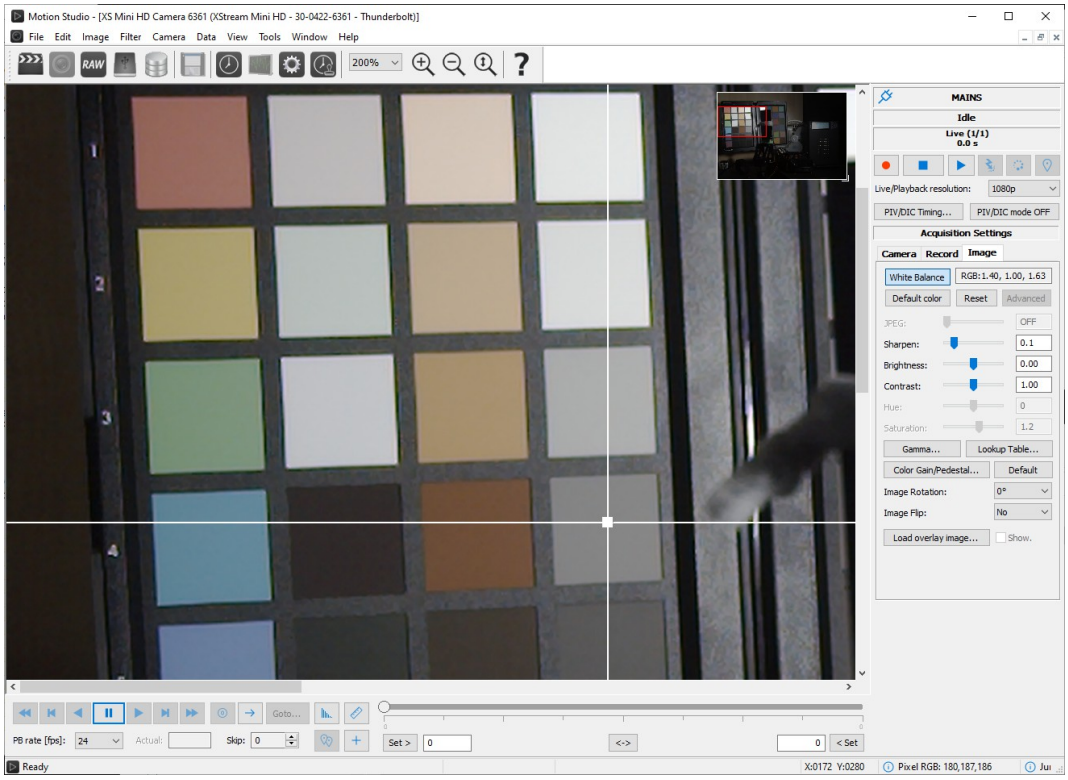
2. **Zone 2** from level 1 to level 2: in this zone the gamma is a linear combination of gamma 1 and gamma 2.

3. **Zone 3** (from level 2 to 1023): in this zone the gamma 2 value is applied.

5.32.2. Automatic White Balance

Edit color gains manually or use the automatic balance procedure:

- Select the Color tab from the Docked Dialog Bar.
- Press the White Balance button. A target will appear on the image.
- Click on the image to move the target on a gray, non-saturated area.
- White balance will be automatically calculated and applied.

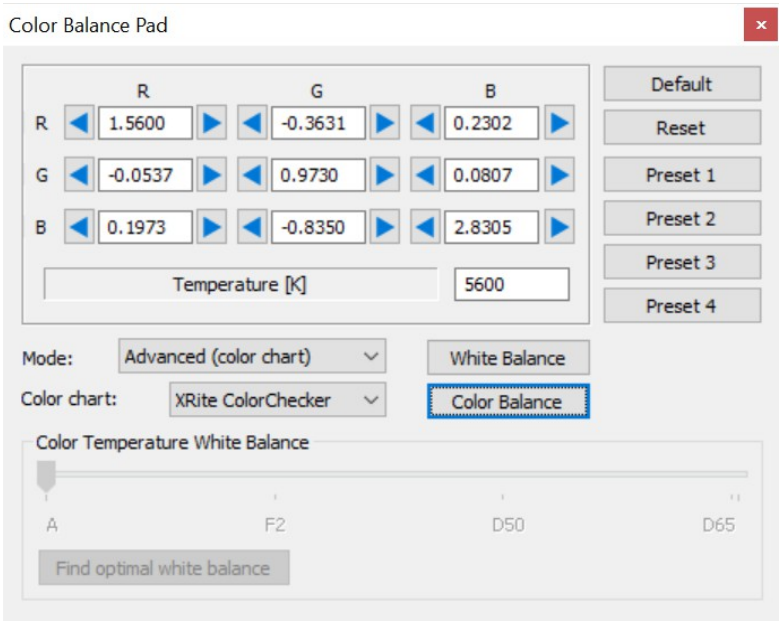


5.32.3. Advanced Color Balance Adjustment

1. Click the “Advanced Colors” button.
2. Use the Color Balance Pad, to create a new color scheme.
3. Click **Reset** to reset the table to diagonal values.
4. Click **Default** to load the default color table.

Color balance procedure

1. Select the Mode. If mode is advanced, select the color chart.
2. Overlap the rectangular grid to the color chart image (advanced) or drag the colored circles to the corresponding color area (standard).
3. Click the “Color Balance” button.

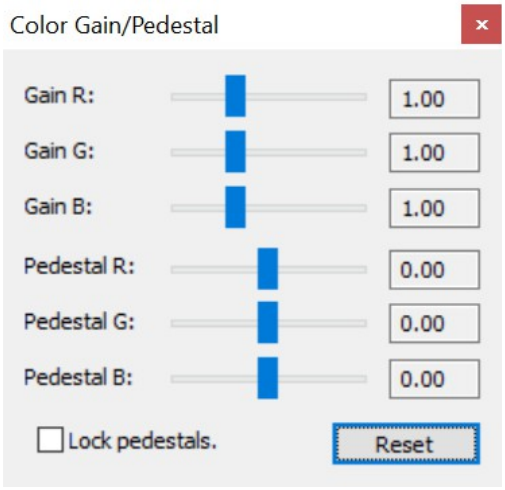


Motion Studio supports 4 preset values of the color balance tables. To record a preset table, keep the corresponding button pressed for more than 2 seconds, enter the preset table name and click OK. To load a preset table, click the corresponding button.

If Color temperature tables have been loaded into camera flash memory, the user may select color temperature by dragging the slider.

5.32.4. Color Gain/Pedestal

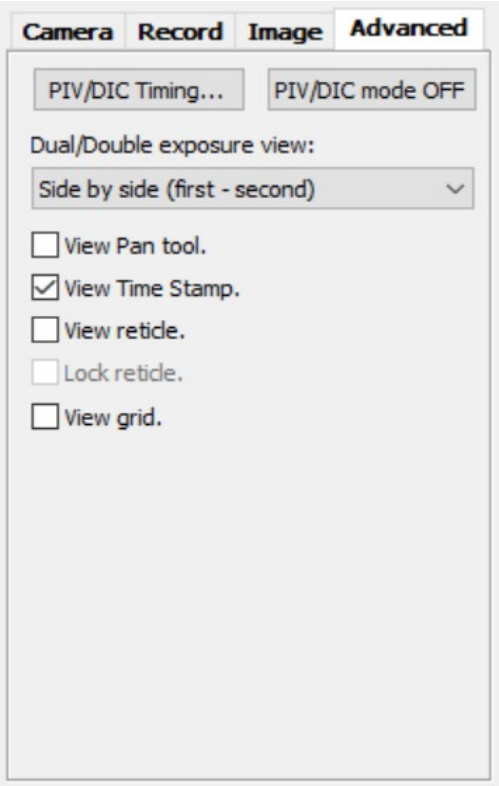
Some camera models support color gain/pedestal parameters.



Each color component can be independently configured by adding an offset (pedestal) and applying a gain.

5.33. Advanced camera tab

The advanced tab controls some advanced parameters.



PIV/DIC Timing: see next topic.

Dual/Double exposure view

If the camera exposure mode is set to dual or double, first and second exposure frames can be displayed in the following modes:

Default: a single frame is shown regardless if it's a first or second exposure frame.

Single (first exposure): only first exposure frames are displayed in live and playback.

Single (second exposure): only second exposure frames are displayed in live and playback

Side by side: first and second exposure frames are shown side by side.

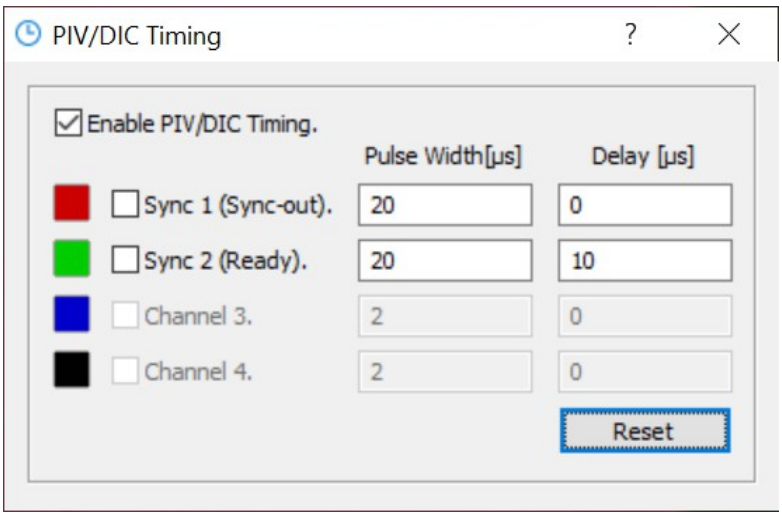
Top/Bottom: first and second exposure frames are vertically tiled.

View options: those check boxes control the display of Pan tool, Time stamp, reticle and grid.

5.34. PIV/DIC mode and timing

PIV-ready cameras may generate timing signals from sync out and ready signals (Os, CC-mini, XS-Mini) or from the 4-pins LEMO connector located at the back of the camera (Y cameras).

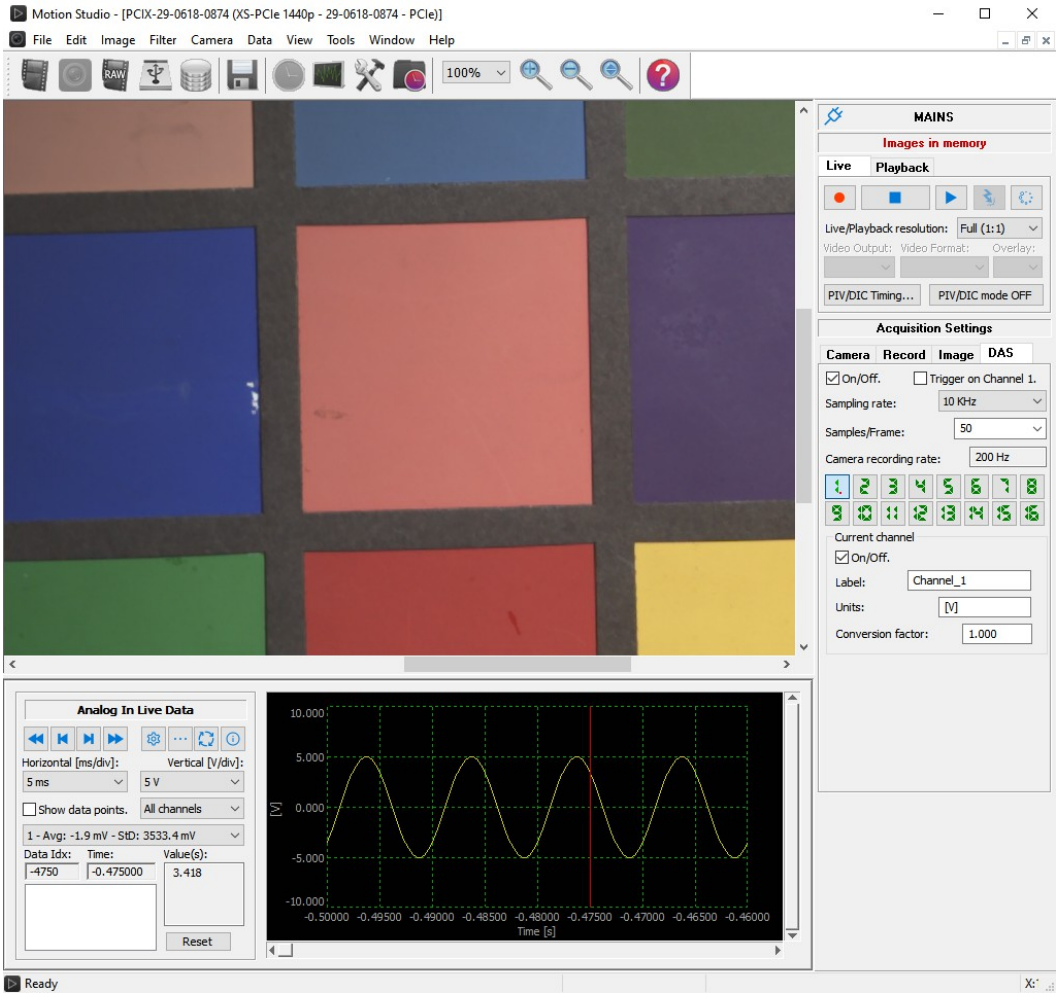
PIV/DIC mode ON/OFF: enables and disables PIV/DIC mode. In this mode, any improvement in image quality is disabled.



For each output signal (channel), pulse width and a delay may be configured. The frequency of signals is the frame rate of the camera. Signals are generated when camera is recording.

5.35. Data Acquisition module

The MotionPro Data Acquisition System is integrated in Motion Studio. When a Data Acquisition module is detected the camera window is split in two panes and an “Analog In” tab is added to the “Acquisition Settings” Tab. See the picture below.



5.35.1. Data acquisition cables and back panel

The picture below shows the data acquisition module back panel



The BNC connectors are grouped into two groups:

Analog Inputs

- **AIN1 to AIN15**: the analog input channels
- **Sync In**: the analog input external synchronization input
- **Trig In**: the analog input external event trigger input
- **Sync Out**: the analog input output signal.

Analog Outputs

- **AOUT1 to AOUT4**: the analog output signals
- **Sync In**: the analog output external synchronization input
- **Trig In**: the analog output external event trigger input

For the connection of the DAS to the camera there are 2 possible scenarios.

1) Simple connection

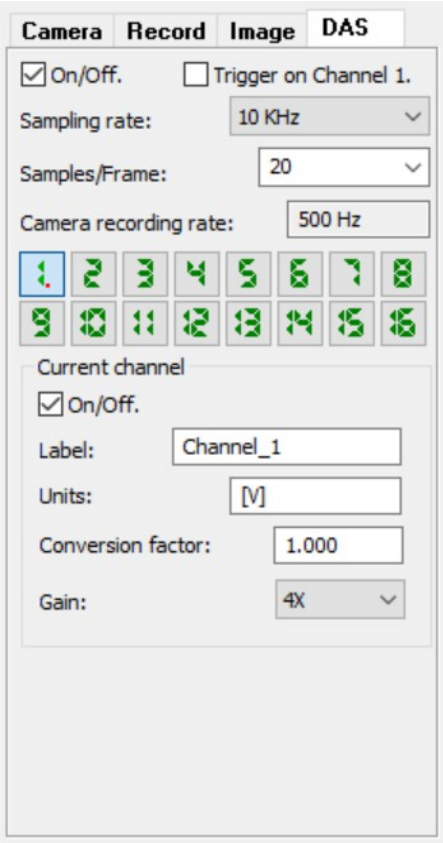
The “Sync Out” connector of the “Analog Input section” of the Data Acquisition back panel is connected to the “Sync In” connector of the camera. The Data Acquisition module generates the camera acquisition rate, the camera acquires in External Sync In configuration.

NOTE: The trigger signal must be connected to the camera “Trigger In” connector only, not to the Data Acquisition module

2) Connection with “Trigger In” signal

In some specific conditions it is convenient to connect the Trigger In signal to the Channel 1 of the data acquisition. The “Sync Out” connector of the “Analog Input” section of the DAS back panel is connected to the “Sync In” connector of the camera. The trigger signal is connected to the “Trigger In” connector of the camera and to the “AIN 1” connector of the DAS. In the software, the option “Trigger on Chn 1” must be selected.

5.35.2. Analog Input Configuration



On/Off

The acquisition module may be enabled and disabled. If enabled, the camera rate control is grayed out and the acquisition rate is automatically computed and configured. See below.

Trigger In on Chn 1

Select this option and connect the trigger signal to the channel 1 input. The sampling of the trigger signal will help synchronizing the images with the data.

Sampling Rate

Select the number of samples per second. The max sampling rate is 500 KHz.

Samples per frame

Select the number of data samples per camera frame. The value is used a divider of the acquisition rate to compute the camera acquisition rate. The number is a multiple of the active channels number.

Camera recording rate

The camera rate is automatically computed with the formula below:

Cam Rate = (DAS Sampling Rate) / (Samples per Frame)

Channels selection

Each channel may be independently enabled and configured.

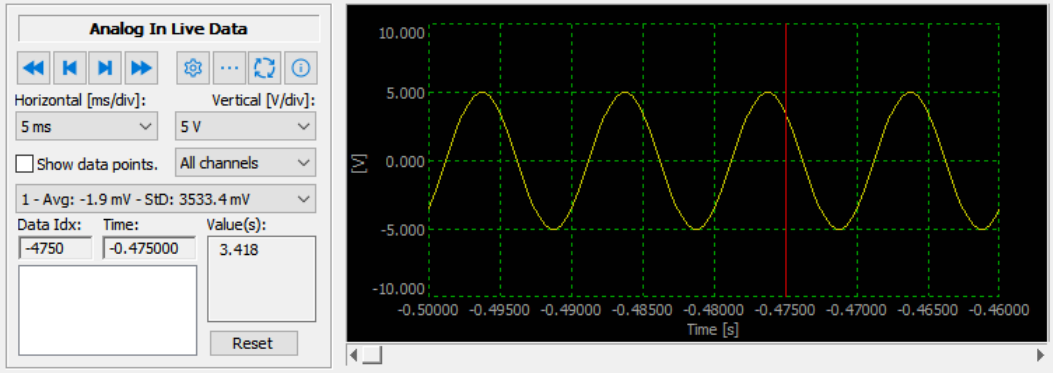
Channel On/Off

Enables and disables the channel

Label, Units, Conversion factor Gain

Enter the channel label, units, conversion factor and digital gain.

5.35.3. Analog Input Data Pane



The acquired data is shown in a pane below the image window.

Navigation buttons: first sample, previous sample, next sample, last sample.

Data graph configuration: see below.

FFT and Power Spectrum: see below.

Data Processing Menu: see below.

Data Information: see below.

Horizontal resolution: select the graph horizontal resolution in milliseconds per division.

Vertical resolution: select the graph vertical resolution in Volts per division.

Show Data Points: if this option is checked, the data points are highlighted (squares).

Channel: select if you want to be displayed all the channels or one single channel.

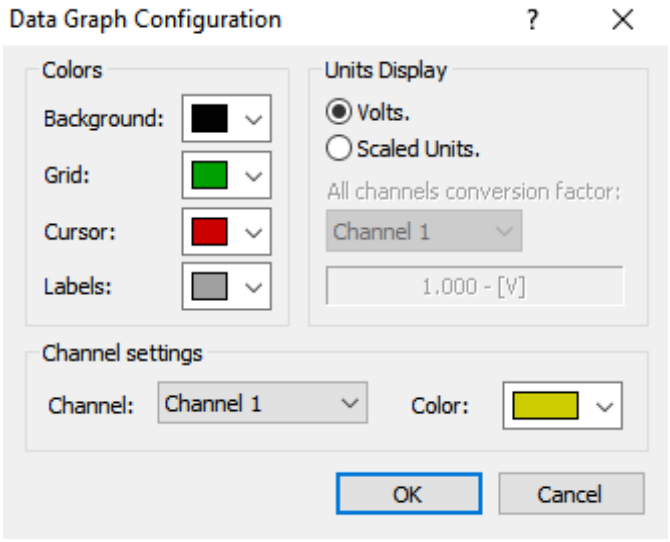
Average and Standard Deviation: for each channel the average and the standard deviation are shown.

Data Index, Time and value: the index, time and value of the currently selected data item.

Operations list: see the Data Processing topic below.

5.35.4. Data Graph Configuration

From the data pane, click the data graph configuration button.



Background color: the data graph background color.

Grid color: the data graph grid color.

Cursor Color: the data graph cursor color (vertical line).

Labels color: color of labels (seconds, units)

Units Display: the graph may be displayed in Volts or in converted units.

All channels conversion factor: If all the channels are shown in the graph window, select which conversion factor to use for the visualization.

Channel color: select the channel and set the graph color.

5.35.5. Data Processing Menu

The acquired data may be processed in the current window. To activate the filters or the mathematical operations, click the Data Processing button.

Select the Filter sub-menu or the Math sub-menu.

Filter operations: low pass filter, high pass filter, Band Pass filter, Band Stop filter or Remove average.

Mathematical operations: Negative, Invert, Square and Square Root.

If the filters or the mathematical operations are activated the operations list is filled with those operations. The user may:

- Select the items in the list and activate the single operation.
- Reset the list and delete the operations.

5.35.6. FFT and Power Spectrum

The FFT dialog box appears if the FFT button is clicked. The user may select the channel to display, the FFT and the power spectrum.

5.35.7. Data Information

From the data pane, click the data Info button. General information about the data acquisition is displayed.

5.35.8. Note about the “Overrun” error

“Overrun” error message appears when the buffers allocated for data acquisition are not enough and acquisition is too fast. The error appears more easily when large sampling rates are configured (100 KHz, 250 KHz or 500 KHz). To avoid that error, increase the number of frames to acquire.

5.36. Advanced Camera Configuration in Camera menu

From the main toolbar select Camera > Advanced to enable advanced operations on camera image.

5.36.1. Copy Calibration file from CD

Each camera is shipped with a calibration file. For versions of Motion Studio below 2.07.04, the file is stored in the **WINDOWS\System32** directory (WINNT\System32 for Windows 2000). For versions of Motion Studio above 2.07.04, the file is stored in "**C:\Common Files\IDT\CameraFiles**".

If the file is not stored in the local directory, it may be copied from the camera CD.

5.36.2. Download Calibration file from flash memory

Giga-Ethernet cameras have on-board flash memory. The calibration file is stored in the flash memory and may be downloaded and copied to the hard disk.

5.36.3. Camera Calibration

To reduce the noise associated with CMOS sensors and improve the performance of the default calibration file, Motion Studio offers a Calibration dialog box.

1. Select Camera from the main toolbar.
2. Select Advanced > Camera Calibration.

To reduce the noise associated to the CMOS sensor and improve the performance of the default calibration file, select the following options:

Enable background removal (factory calibration): it removes the background from any acquired images and reduces the noise.

Enable pixel sensitivity correction (factory calibration): it enables the compensation of differences in pixels sensitivity.

Enable noise reduction with dark columns: the option enables or disables the use of masked (dark) columns to reduce the time-dependent noise. In some camera models the option is enabled and cannot be disabled.

Acquire the background images in the optimal conditions: the camera lens cap must be on. The driver acquires the background images in the optimal conditions for all the parameters (exposure, rate, sensor gain and pixel gain). The background images are not saved into the calibration file. This option is disabled on “new design” cameras.

Reload factory calibration file: the driver loads the default camera calibration file. This option is useful if the user wants to reload the default background images

To reduce the background noise in current conditions, select the following options.

Enable current condition background removal: if this option is selected the driver uses the background images that have been acquired in current conditions and corrects the images. The background calibration data is saved in a file and reloaded when the program is launched. This option is disabled on “new design” cameras.

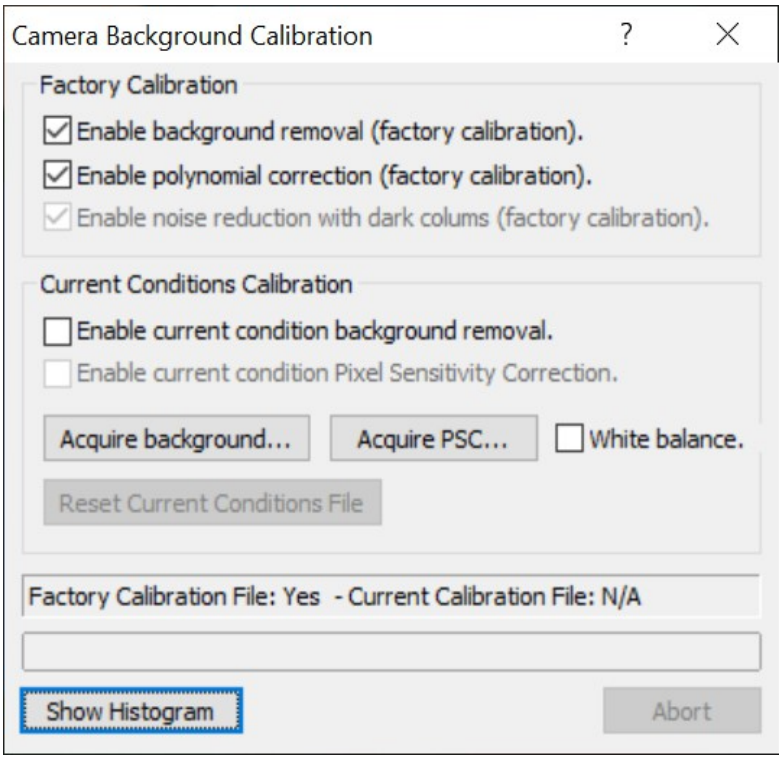
Enable current condition pixel sensitivity correction: if this option is selected the driver uses the coefficients that have been computed in current conditions and corrects the acquisitions. The coefficients are saved in a file and reloaded when the program is launched. This option is disabled on “new design” cameras.

Acquire the background images in current conditions: the camera lens cap must be on. The driver computes the background images for the current operating conditions. If the sensor gain or the region of interest change after the calibration, the correction may be wrong. This option is disabled on “new design” cameras.

Acquire the PSC images in current conditions: the lens must be removed and a constant light should illuminate the sensor. The driver computes the pixel sensitivity correction coefficients for the current operating conditions. If sensor gain and region of interest change after the calibration, the correction may be wrong. This option is disabled on “new design” cameras.

White balance: select this option to enable white balance alignment on current PSC.

Reset current conditions file: if this option is selected, the current conditions calibration file is deleted and the current images and coefficients are reset.


Camera Background Calibration
?
Factory Calibration
Enable background removal (factory calibration).
Enable polynomial correction (factory calibration).
Enable noise reduction with dark colums (factory calibration).
Current Conditions Calibration
Enable current condition background removal.
Enable current condition Pixel Sensitivity Correction.
Acquire background...
Acquire PSC...
White balance.
Reset Current Conditions File
Factory Calibration File: Yes - Current Calibration File: N/A
Show Histogram
Abort

5.36.4. Flash Memory Diagnostics

It’s a tool to test camera flash memory.

1. Select Camera from the main toolbar.
2. Select Advanced > Flash Memory Diagnostics.
3. Click Test Flash Memory to perform a test.

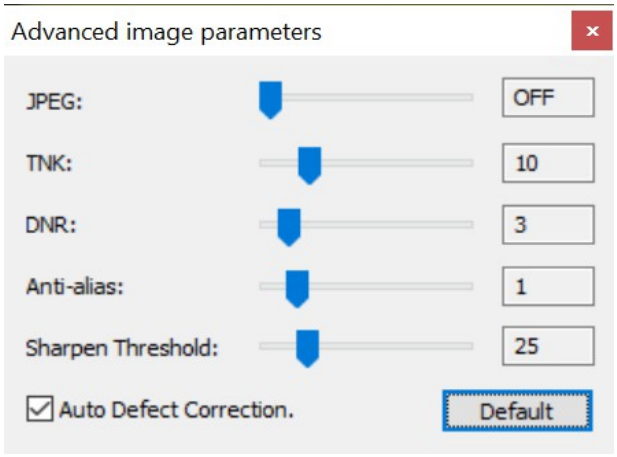
5.36.5. HG Logs

HG cameras store error and update log files in the on-board flash memory. The HG log menu items allow to:

- Download and show the error log files stored in the HG camera flash memory.
- Download and show the update log file stored in the HG camera flash memory.
- Delete the log error files from the HG camera flash memory.

5.36.6. Advanced Image parameters

Image parameters that are not supposed to be frequently changed, are stored here.



JPEG: some camera models support live JPEG compression. The slider controls the quality of JPEG compression.

TNK (Temporal Noise Killer): the slider controls the time-dependent noise reduction filter. Each pixel value is compared with the same pixel value in images acquired before and after and the result is used to eliminate the component of noise that is not a fixed pattern.

DNR (Dynamic Noise Reduction): reduce the effect of noise in the image (not all the camera models support it).

Anti-Alias (Gaussian): the slider controls the strength of the smoothing effect on the image. The effect is a reduction of image noise and a reduction of details due to the blurring.

Sharpen Threshold: the threshold value used in sharpening filter. If the value is large the sharpening has less effect on the image.

Auto defect correction: enables and disable the automatic defect correction filter on camera.

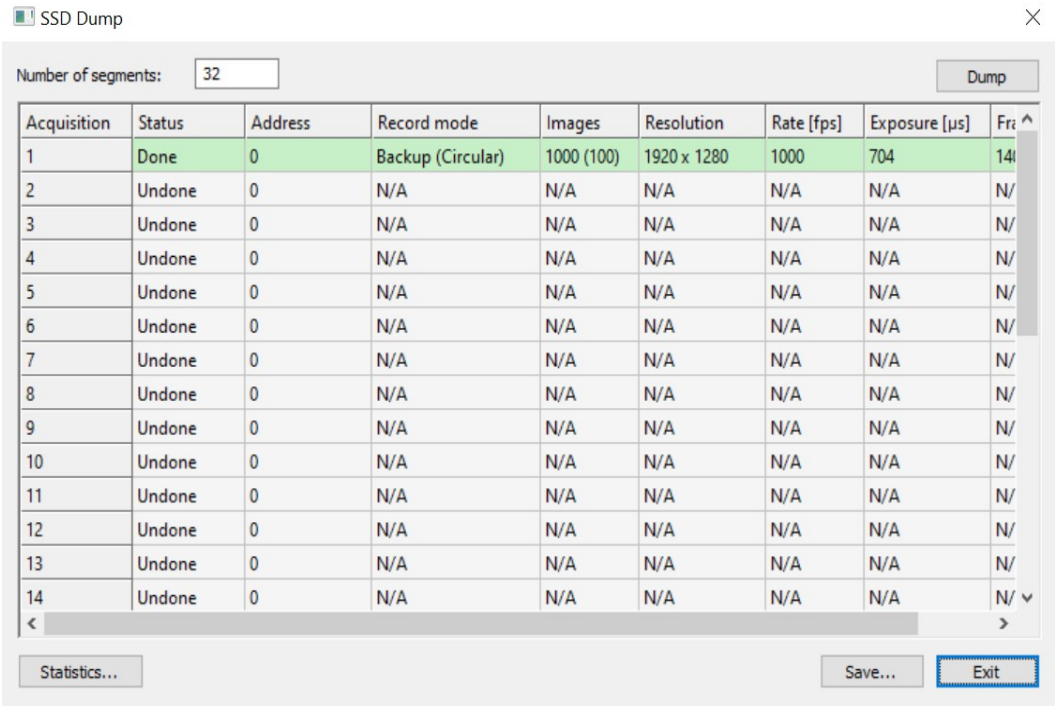
IDT recommends that those parameters are not changed. The values should be always set to default (optimized image quality).

5.36.7. SSD Erase

If this option is selected, the SSD is physically erased. All the images stored in the disk are overwritten by black images.

5.36.8. SSD Dump

The user may display the SSD portion that stores the acquisition information. The data is in binary format and may be saved to a file. The user may select the number of items and then click “Dump” to read the data (see below).

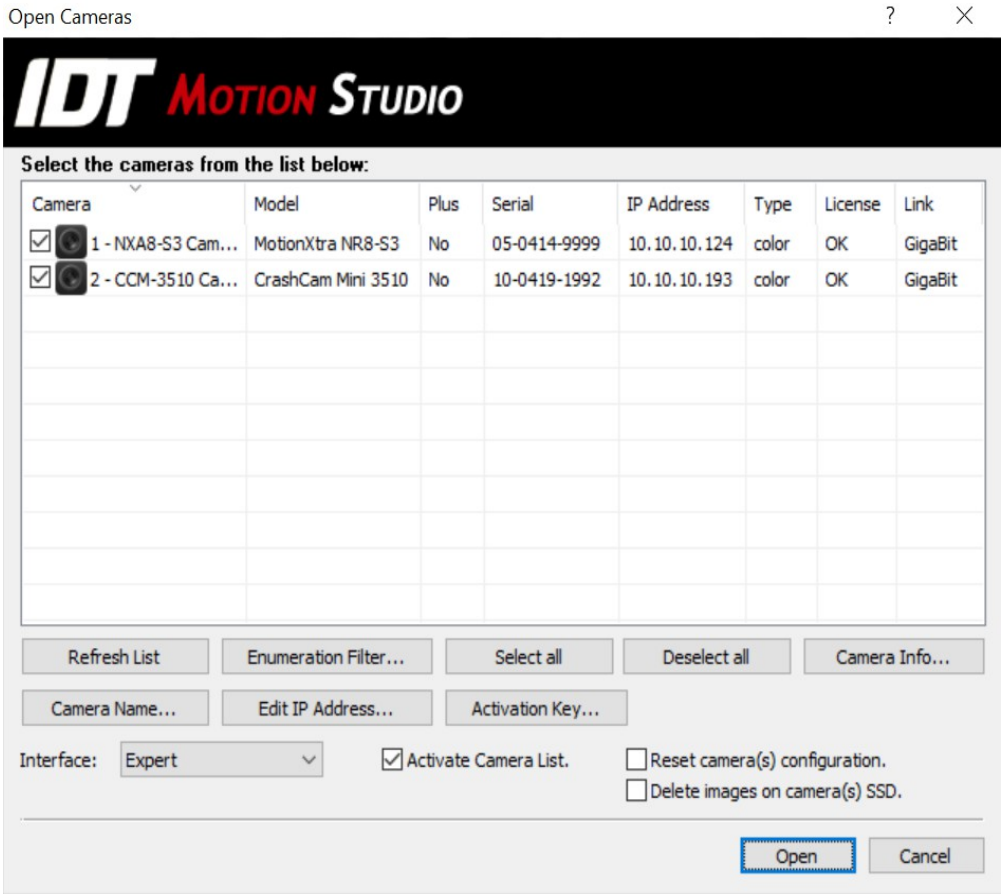


5.36.9. Camera Power cycle

This option is implemented on XS-Mini and XS-Stick cameras. If this item is selected, the camera is turned off for about two seconds, then restarted. Motion Studio should be restarted.

5.37. Multiple cameras support

Motion Studio supports multiple cameras systems.



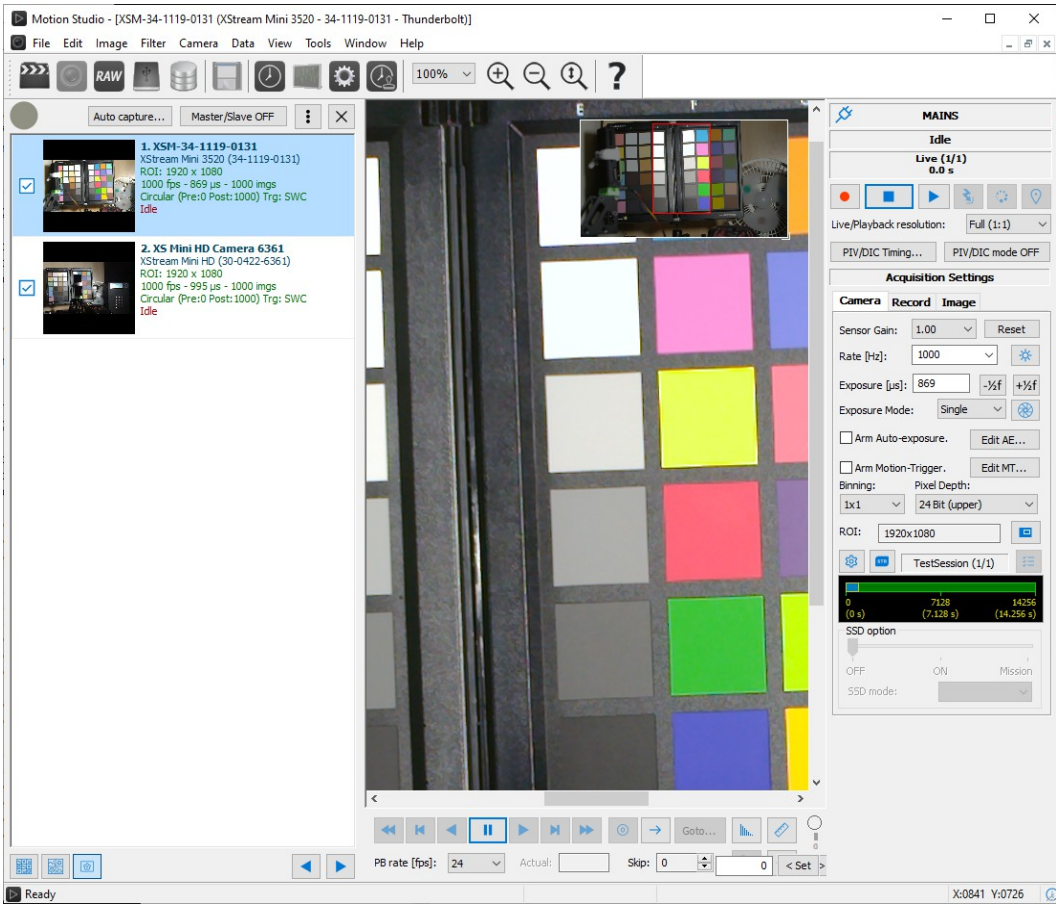
The way the camera views are shown depends on the selected options.

If the “Activate camera list” option is not selected, the program opens a separate window for each camera. The windows are tiled and each camera can operate independently from each other. Each camera may have different parameters from other cameras. The cameras may be also configured as master/slave.

5.37.1. Activate camera list

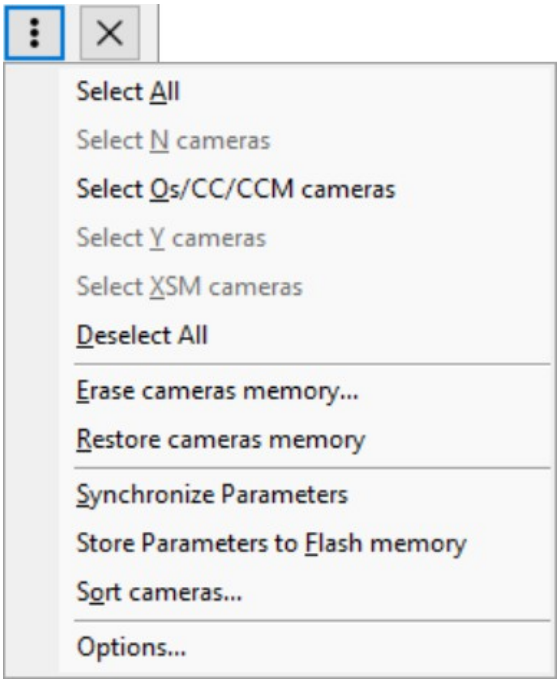
If this option is selected, the program opens a vertical “camera list” bar. From this bar the user may:

- **Select a camera**: do a single click on the camera thumbnail to activate it. Do a double click to activate the camera and start Live.
- **Select a subset of the cameras**: check the check boxes at the left side of the camera thumbnail and operate the camera control bar. Click “Select All” to select all the cameras, click “Deselect All” to deselect all the cameras.
- **Rename a camera**: right click on the camera icon and select the “Rename” option.
- **Activate the “Tools” menu**: see below
- **Configure the “Options”**: see below.
- **Display the status of cameras**: below the camera name, model and serial number, the camera status is displayed (Ready, Live, Recording…).
- **Exit session**: Click the Exit button to exit the session.



5.37.2. Tools menu

Click on the Tools button to activate a menu:



- **Select items/deselect**: the user may select or deselect all the cameras, or select cameras of the same family (N, Os/CC, Y, or XSM). When more than one camera is selected, Motion Studio detects any conflict in the parameters and shows a red warning icon.
- **Erase camera memory**: the camera memory is erased and the images deleted. Actually the images are not physically erased from memory and may be restored later.
- **Restore cameras memory**: Motion Studio tries to restore deleted images. This option is not available on HG cameras.
- **Synchronize parameters**: the parameters of the camera that is currently in foreground are copied to any other camera that is selected (check box on the camera list). The parameters that are not supported by other cameras are not configured and the corresponding item in the camera list is marked in red.
- **Store parameters to flash memory**: the current configuration is stored in the camera flash memory. If the camera looses power after this operation, the configuration is loaded and applied the next time the camera is powered up.
- **Sort cameras**: sort the cameras.
- **Options**: opens the options dialog box (see below).

5.37.3. Options

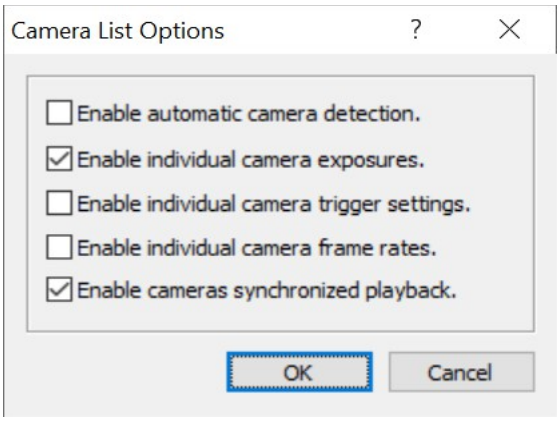
Enable automatic camera detection: if this option is selected, Motion Studio activates a timer that enumerates cameras. If a new camera is detected it will be automatically added to the list.

Enable individual camera exposure: if this option is selected, the user may set different values of exposure in selected cameras, otherwise exposure is the same in every selected camera.

Enable individual camera trigger settings: if this option is selected, the user may set different values of trigger configuration (edge-high, edge-low, switch closure) in selected cameras, otherwise trigger configuration is the same in every selected camera.

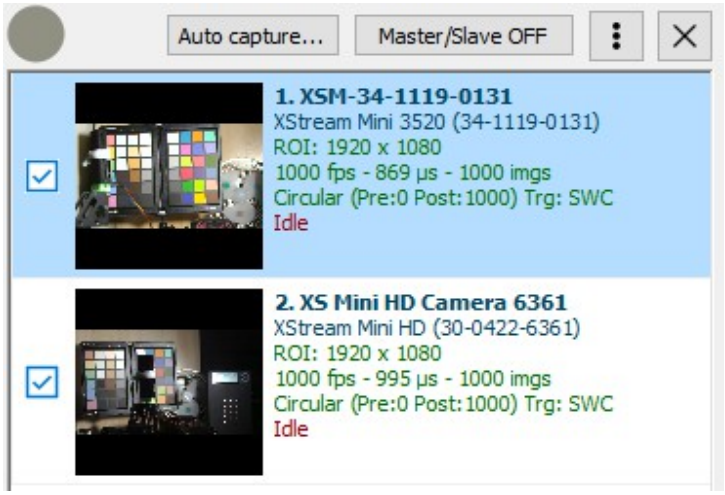
Enable individual camera frame rates: if this option is selected, the user may set different values of frame rate in selected cameras, otherwise frame rate is the same in every selected camera.

Enable cameras synchronized playback: if this option is selected, playback is started and stopped simultaneously on each camera. Also, single frame step and go to start/stop buttons produce synchronized actions.



5.37.4. Master/Slave operation modes

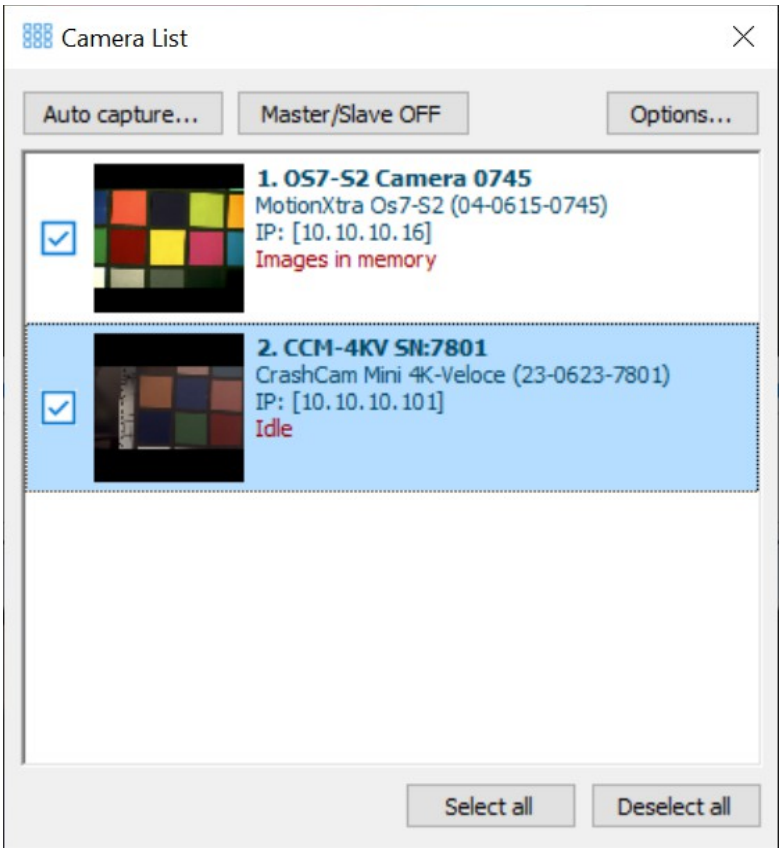
In this mode, one of the cameras acts as master and others as slaves. Master camera controls its own parameters and some of the slaves', such as record mode, acquisition rate, etc. To set one camera as master, toggle the “Master/Slave” button on the “Camera List”.



Master camera’s “Sync Out” signal must be connected to slave camera’s “Sync In” connector. To provide simultaneous trigger to cameras (circular and BROC mode), master camera and slave camera should receive the same trigger signal.

5.37.5. Show cameras in separate windows

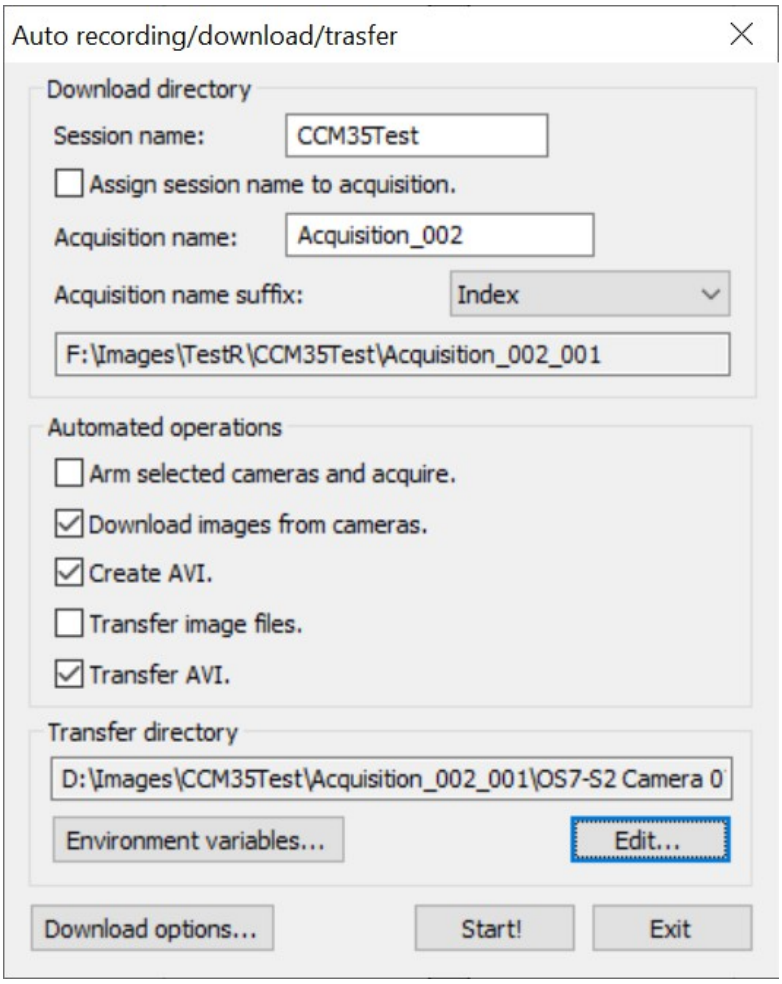
If “Activate camera list” option is not selected, cameras are open in separate windows and a floating list dialog is created.



The floating dialog replaces the camera list bar and includes most of its capabilities.

5.38. Auto capture

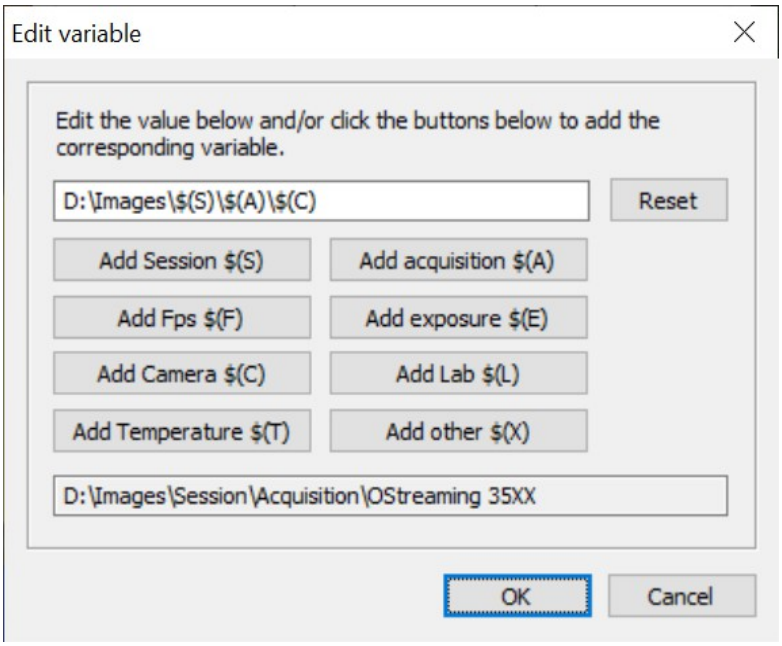
The auto capture dialog box allows the user to setup a list of camera operations that will be automatically executed when the 'Start' button is clicked (see below).



The operations are:

- Arm cameras: start a recording (camera DDR or SSD).
- Download images or raw files.
- Create AVI file.
- Transfer downloaded images or raw.
- Transfer created AVI.

If one of the transfer options is selected, the user may define the path of the folder where the files will be transferred. The procedure is similar to image file generation and includes typing the path and/or adding variables (see below).



Other options are:

Acquisition name suffix: this option determines if and how a suffix is added to the acquisition name. “Index” means that an auto-incrementing number is added (_001, _002); “None” means that no suffix is added and images can be overwritten; “Date/Time” means that a string made with current date and time is added.

5.39. Playback Bar

Playback controls work like other familiar media player controls. The controls include the following:

- Directional play
- Forward or reverse
- Step forward and reverse
- Skip to first or last frame
- Stop play



Zero button

Click this button to set the frame 0 position (trigger).

Loop playback button

Click on the button to continuously loop the acquisition.

Goto Button

It opens a dialog box. Enter the image index to be displayed.

Playback rate list

It adjusts playback speed. Actual playback rate depends on processor speed and it is shown in the box above the slider. If actual rate is slower than desired one, increase or decrease “skip frames” to change it.

Skip frames

Use to skip frames during playback.

Histogram

See below.

Distance/Angle Measurement

See below.

Edit bookmarks

See below

Toggle cross-hair

See below

Playback slider

Use the slider bar to browse through the frames. In Circular or BROC acquisition mode when the pre-trigger and post-trigger have been selected, a red marker shows the position of Frame 0 (the trigger frame). Indexes of frames before the trigger frame display Negative and indexes of frames after the trigger display Positive.



Move the slider to select a frame. The red triangle indicates the position of frame 0 (circular mode only).

Set (start/stop frame)
To set the start/stop frame, move the slider to the desired image and click the "Set" button.

Reset Start/Stop frames
Click the reset button (<->) to reset the start and stop frames to the default values (minimum and maximum).

5.40. Playback Menu

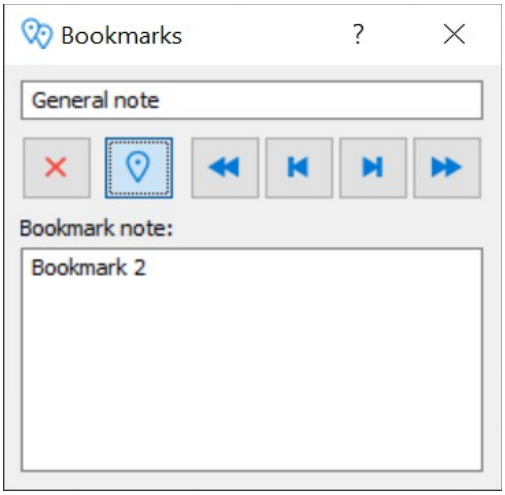
The Playback menu displays when file images are open. When the program is in Camera mode, access the Playback menu through the Camera Option on the main toolbar. Standard operations include the following:

- Play Forward or Backward
- Jump to First or Last frame
- Loop Through
- Playback's Start and End frames for loop through.

The items share their functionality with the docked button bar on the right side of the application window.

5.41. Bookmarks

The Edit bookmarks button on the playback bar enables the bookmarks dialog box. The user can add comments to the images of a sequence and jump form one bookmark to the next.



General note

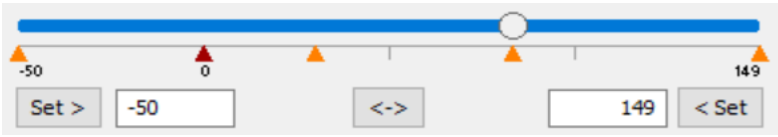
Add a general comment to the acquired sequence.

Bookmark annotation

A bookmark may be added to the current image. Use the playback slider/buttons in the playback bar to locate an image and click the bookmark button to add it. An orange triangle will appear on the playback bar. Click the bookmark button to erase an existing bookmark.

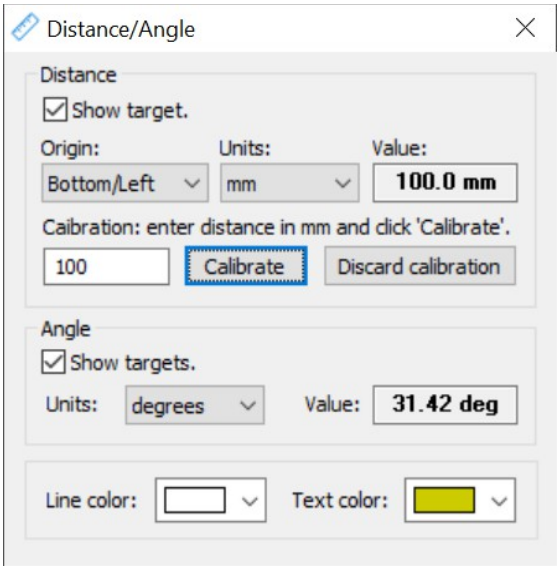
Use the arrow keys on the bookmark dialog to navigate the bookmarks.

Click the X button to erase all the bookmarks in a sequence.



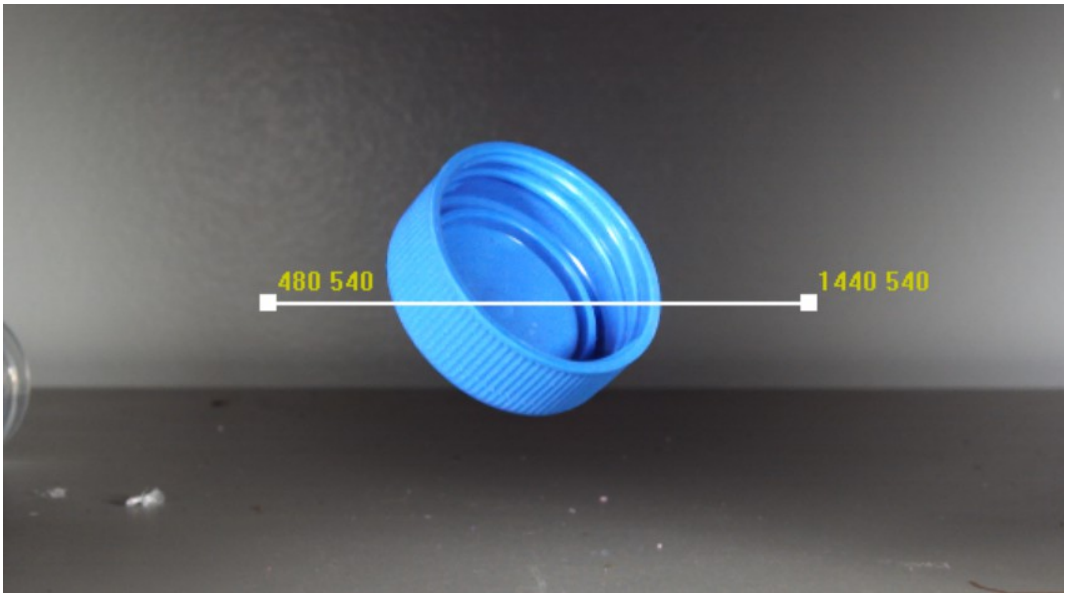
5.42. Distance/Angle measurement

Motion Studio can calculate distances and angles.



5.42.1. Distance

Enable “show target” in distance section and move the targets in the image. Distance is measured in pixels.

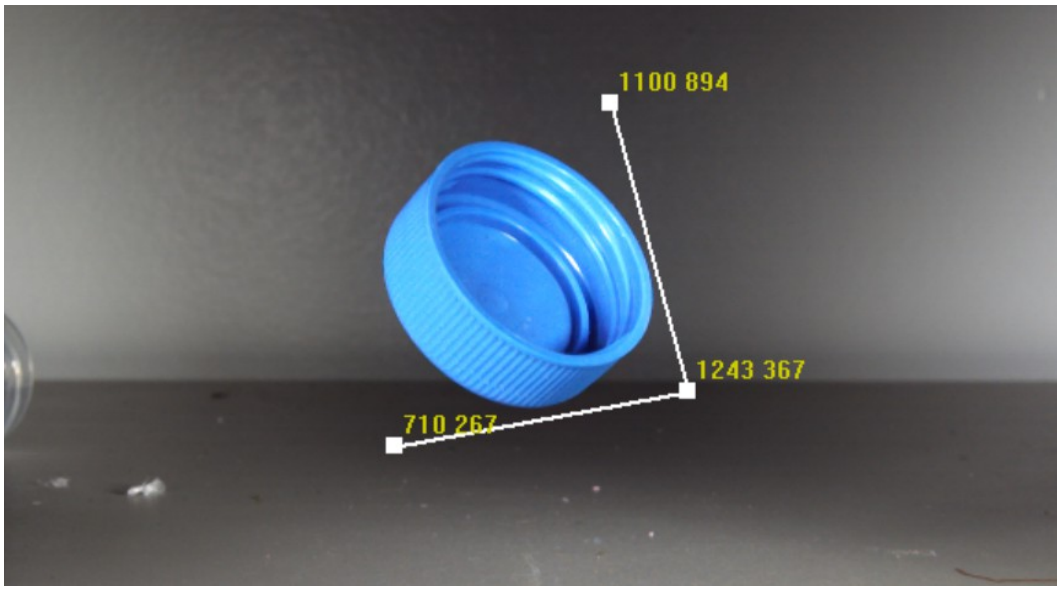


If you want to show the distance in units, enter a known distance in mm and click “Calibrate”. After this calibration, units can be calculated in mm, m, inches and feet. Calibration can also be discarded.

The coordinates of target handles are shown in pixels or in other units. The origin can be configured to be one of the four vertices of the images. X axis goes from left to right, Y axis from bottom to top.

5.42.2. Angle

Enable “Show target” in Angle section and move the handles in the image. Angle can be measured in degrees or radians.



5.43. Tracking menu

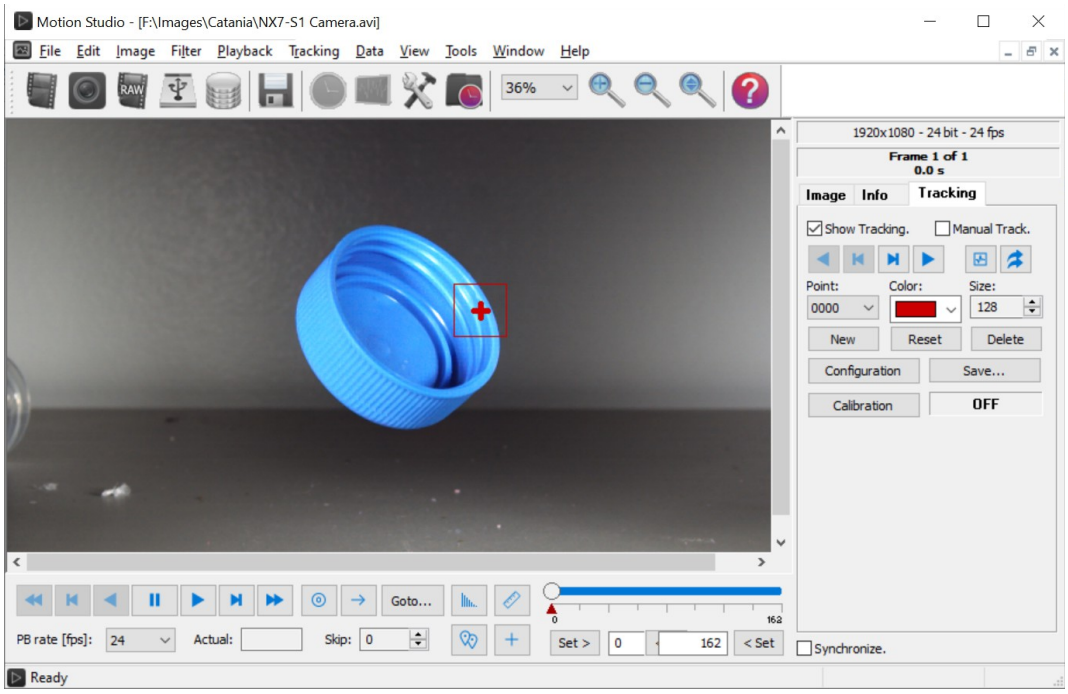
The Tracking Menu on the main toolbar offers an alternative to using the buttons and dialog box provided by the Docked Dialog menu including the following functions:

- Enable and disable tracking.
- Open the tracking configuration dialog.
- Add, remove or reset the track-points.
- Compute tracking.
- Show or hide the vectors, the table/graph dialog box and the correlation windows.

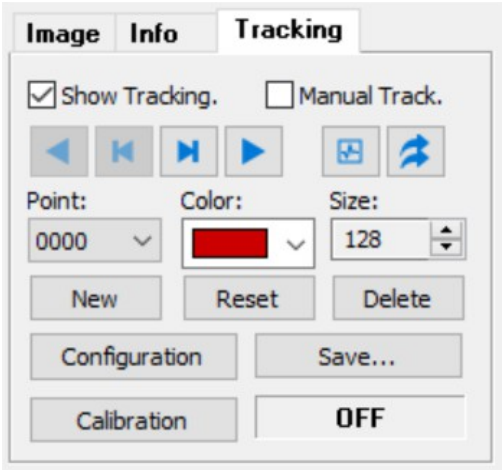
5.44. Tracking control

Important: tracking is enabled only when a sequence of images is open in Motion Studio. Tracking is not supported in live camera windows or when a RAW file is open.

The tracking control tab appears on the main dialog bar when a sequence of images is open.



Select the “Track” tab to enable and configure the tracking points. The options are as follows:



Show tracking: enables or disables the display of the tracking point and trajectory. If this option is unchecked no tracking can be computed.

Manual Track: select this option to disable any automatic calculation and manually track the points.

Track computation buttons: click the track buttons to compute tracking one step forward or backward, to the first frame or to the last frame.

Table/Graph: shows or hides the table graph window.

Vectors: shows or hides the trajectory vectors.

Point: select the track point to configure

Color: the track point color

Size: the correlation area size in pixels. The area is a square.

New: click the button to add a new track-point.

Reset: click the button to reset all the computed positions.

Delete: click this button to delete the current track point.

Configuration: click this button to open the tracking configuration dialog box.

Save: click this button to save the tracking results in ASCII, LabVIEW, Tecplot or Excel format.

Calibration: opens and closes the tracking calibration dialog box.

5.45. Tracking procedure

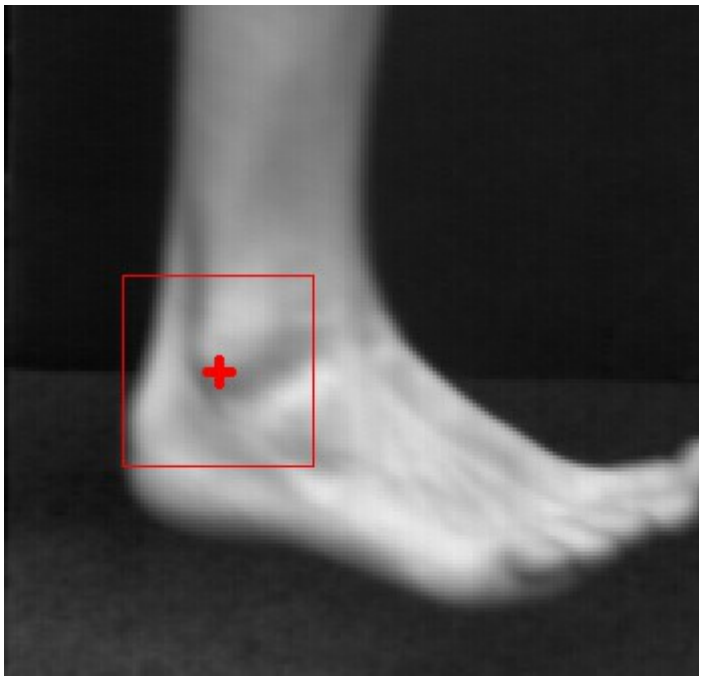
5.45.1. Add a new track-point and compute

To add a new track-point, follow the steps below:

1. Click the New button on the tracking tab. The cursor will change into an arrow with a plus symbol.

2. Move the cursor to the image and click on the position where the track-point needs to be added. The cursor will change to the standard arrow.

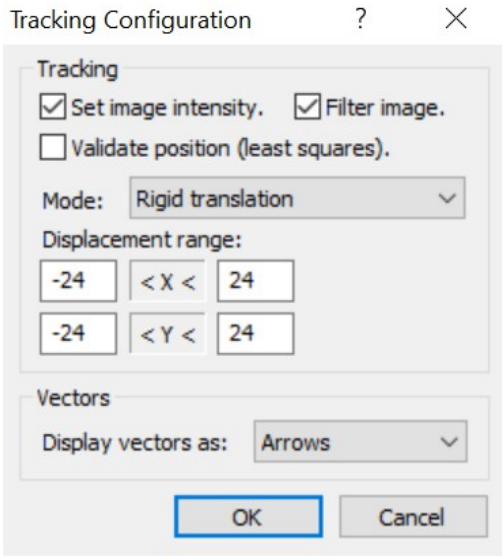
3. The track-point position may be changed by dragging the central cross (see below).



4. Then the point trajectory may be computed by clicking the green arrow buttons on the tracking bar.

5.45.2. Edit tracking configuration

Click the “Trk Config” button on the tracking bar or select the “Configuration” item from the tracking menu. The options are as follows.



Set Image intensity: when a new track-point is added the program computes the intensity range on the current image. The current image will be considered as a reference image for the computations. If the option is disabled, no intensity is computed.

Filter image: before each computation a set of sharpening filters is applied to the images. The filters reduce the effect of the background on the computation. If the option is disabled no filter is applied before the computations.

Validate position: after the regular calculation of a track point a least squares algorithm is applied. The algorithm is performed with the point and other four points (two before and two after). The result is used to correct (validate) the point position.

Mode: the tracking algorithm can be adapted to different tracking conditions (deformable translation, rigid translation and rigid translation with rotation).

Displacement range: the displacement from one point to the next may have a limited range. Enter the values to avoid errors.

Display vectors: the track-point trajectory may be displayed as a sequence of arrows, a continuous line or a dotted line. The trajectory is shown is the “Vectors” button in the tracking bar is selected.

5.45.3. Show tracking data and the vectors

From the tracking bar, click the Table/Graph button. The same dialog box shows a table with the values and graphs.

The first column lists the frame number, the second lists the time. Then for each point there are listed the position (in pixels or mm if the calibration is on), the speed and the acceleration.

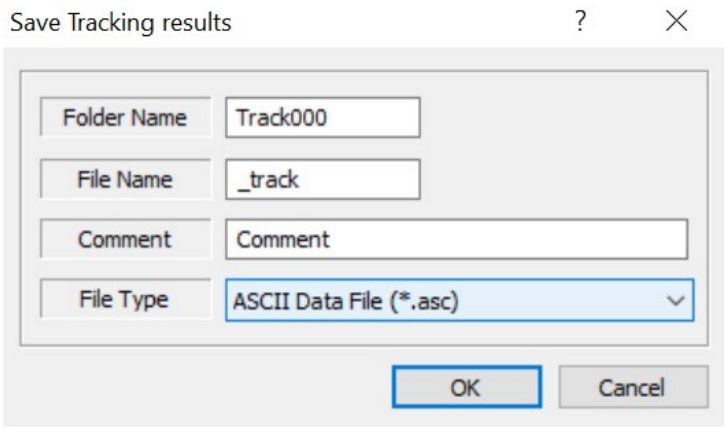
Calculate V and A: click this button to calculate speed and accelerations of the tacking points.

Each component of the data can be separately displayed in a graph. The “Point” combo-box lists the configured points, and the “Show” combo-box lists the components (X, Y, Vx, Vy, Ax, and Ay).

5.45.4. Save tracking data

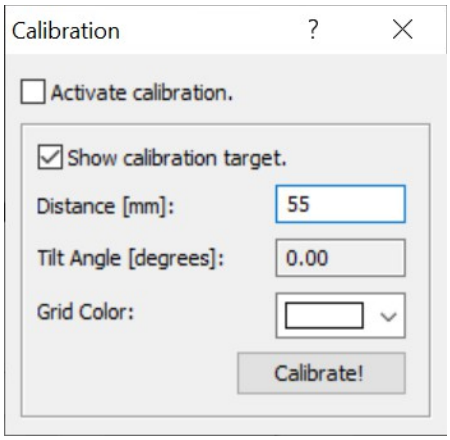
The tracking results are always saved in a default binary file and reloaded when the image sequence is open again. The user may save the data in a different format:

1. From the tracking bar, click the “Save…” button.
2. Enter the folder name, the file name and a comment (optional).
3. Select the file format:
    - Binary file (**BIN**).
    - ASCII text file (**ASC**).
    - Tecplot Text file (**PLT**).
    - LabVIEW Measurement file (**LVM**).
    - Excel XML Spreadsheet file (**XML**).
    - Excel XLS Workbook file (**XLS**).
    - Comma separated values file (**CSV**).
4. Click the OK button.



5.45.5. Calibration

Tracking displacements are computed in pixels and can be converted into mm through a calibration. Click the calibration button on the tracking tab to open the calibration window.



The calibration grid has two handles. Drag the handles over two reference points on the calibration image, enter a known distance between those two points and click “Calibrate”.

Once calculated, the calibration can be enabled or disabled through the “Activate calibration” check box.

5.46. Data menu

When acquired data pane is visible and some data is displayed the DATA menu is active.

Use the Data menu to apply filters and mathematical operators, to show or hide the FFT/Power Spectrum window and to open the data graph configuration dialog box.

5.47. View menu

Use the View menu to magnify the image, restore the original size (100% zoom) or compute a zoom factor that fits in the window.

Use the View menu to select the toolbar options.

5.47.1. Zoom Tools

The **Zoom In** and **Zoom Out** tools let you change the image magnification.

The **Dynamic Zoom** tool lets you zoom in or our by dragging the mouse or mouse wheel up or down.

To Increase or decrease magnification, do one of the following:

- Select a magnification percentage from the toolbar Zoom menu.
- From the View menu, select the Zoom In or the Zoom Out tool, and then click the image. To zoom in on a specific area, use the Zoom In tool and draw a rectangle.
- From the View menu, select the Dynamic Zoom tool and then drag up to zoom in to the area where you begin dragging, or drag down to zoom out from that location.

To deselect one of the Zoom tools, press the ESC key on the keyboard.

5.48. Tools menu

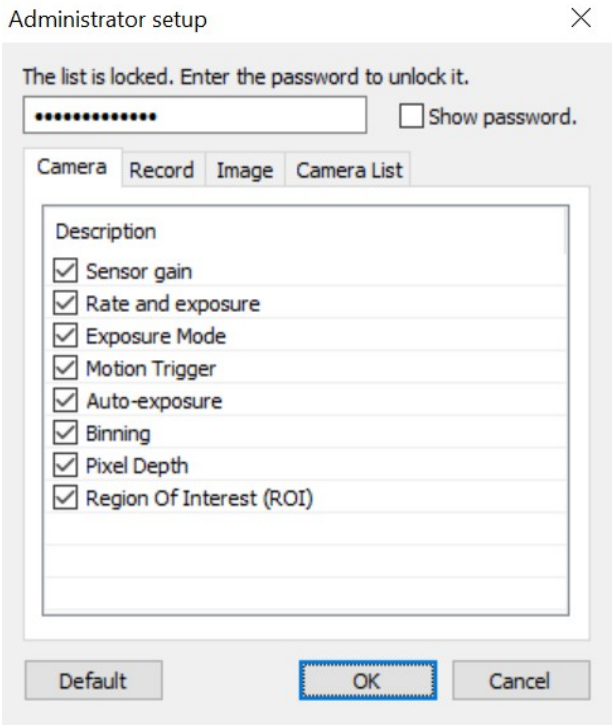
The Tools menu has the General Options for the program and the Timing Hub control dialog. If a Camera window is open, the Tools menu contains the following options:

- Administrator setup.
- Download Manager.
- Advanced Acquisition Configuration dialog box (see Acquisitions Configuration on the Record tab).
- Histogram window.
- Grid display.
- Distance and angle measurement.
- Reference image calculation.
- Focus Line tool for help focusing the image.
- Snapshot sequence: a tool to save a sequence of snapshots.
- Timing Control for the generation of timing signals with the MotionPro Timing Hub.
- Analog output for the generation of analog wave-forms with the MotionPro Data Acquisition System (DAS).
- Ethernet cameras network configuration.
- Raw Image converter and Batch editor.
- Image tile utility.
- Vidi Motion (Lens Calculator).
- Giga-Ethernet cameras monitor.
- Options dialog box.
- Language selection.

5.48.1. Administrator setup

Some of the camera controls may be disabled in Administrator Setup.

- Before opening any camera, from Tools menu, select "Administrator setup"

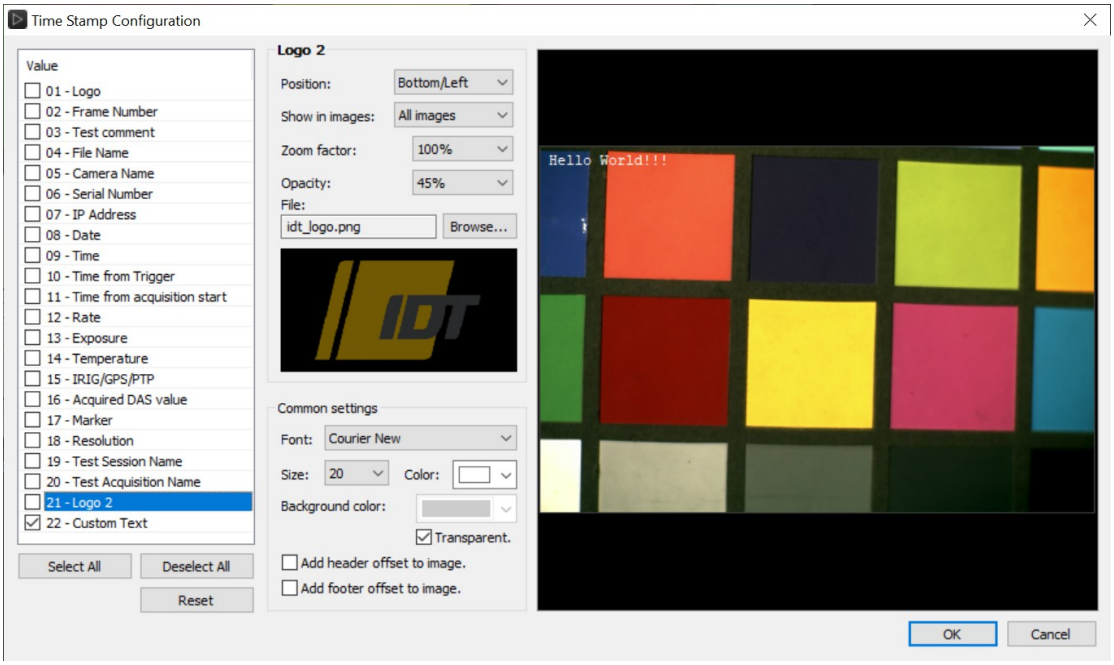


- Enter the password "**IdtMStudio123**" to enable the check-box list. The password is case sensitive.
- Check/uncheck the controls that you wish to enable/disable. The controls are listed in four tabs corresponding to the camera bar tabs (Camera, Record and Image) and to the active camera list controls.
- Click Default to enable all the controls.
- Click OK and open cameras.

5.48.2. Time Stamp

Time stamp interface has been improved and removed from the Options dialog box. To enable time stamp configuration, click the icon on main toolbar.

Each time stamp item can be independently configured (see below).



Select the item from the list on the left size, check it and configure the parameters. Some parameters are item specific, others are available for each item.

- **Position**: select the position of the time stamp item (left, center, right, top and bottom).
- **Show in images**: the item can be displayed in each image, in the first image, in the last image or in the trigger image.

Some of the items have specific parameters.

- **Logo**: the logo supports alpha channel in PNG files. Also, the opacity and the zoom factor may be configured.
- **Time from trigger**: the "precision" may be configured. The user may also select if the time is calculated from the trigger pulse or from the leading edge of the "zero" frame.
- **Rate**: the user may select the units that are displayed in time stamp ("fps" or "Hz").
- **Exposure**: the user may select the units (milliseconds, microseconds or nanoseconds).
- **Temperature**: the user may select the units (Celsius or Fahrenheit).
- **IRIG/GPS**: the IRIG/GPS time is always calculated in UTC units, then the user may add and an offset to adapt the time to his own time zone
- **Acquired DAS value**: the user may select the precision in digits.

Common settings include.

- **Font:** select the font for the time stamp.

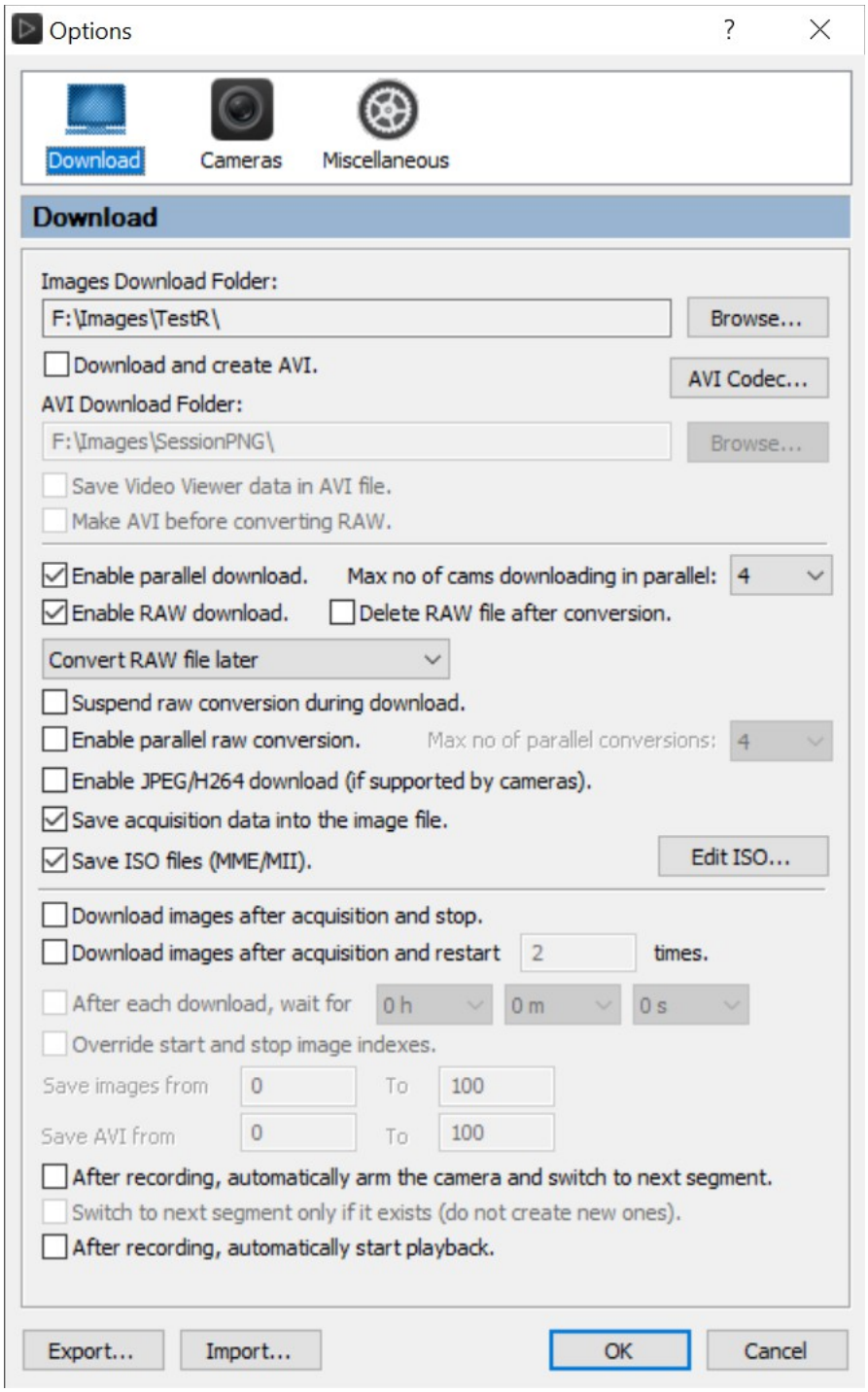
- **Size:** select the font size.
- **Color:** select the time stamp color. If the image is monochrome, the color is converted into gray-scale.
- **Background color**: the time stamp strings may have colored or transparent background.
- **Add header/footer offset to the images**: an offset may be added to the top or to the bottom of the image. If one of those options is selected the time stamp is not printed on the image, but on a horizontal black stripe set above or below the image. The stripes are saved on the images when the frames are saved

The items that can be added to the time stamp are listed below.

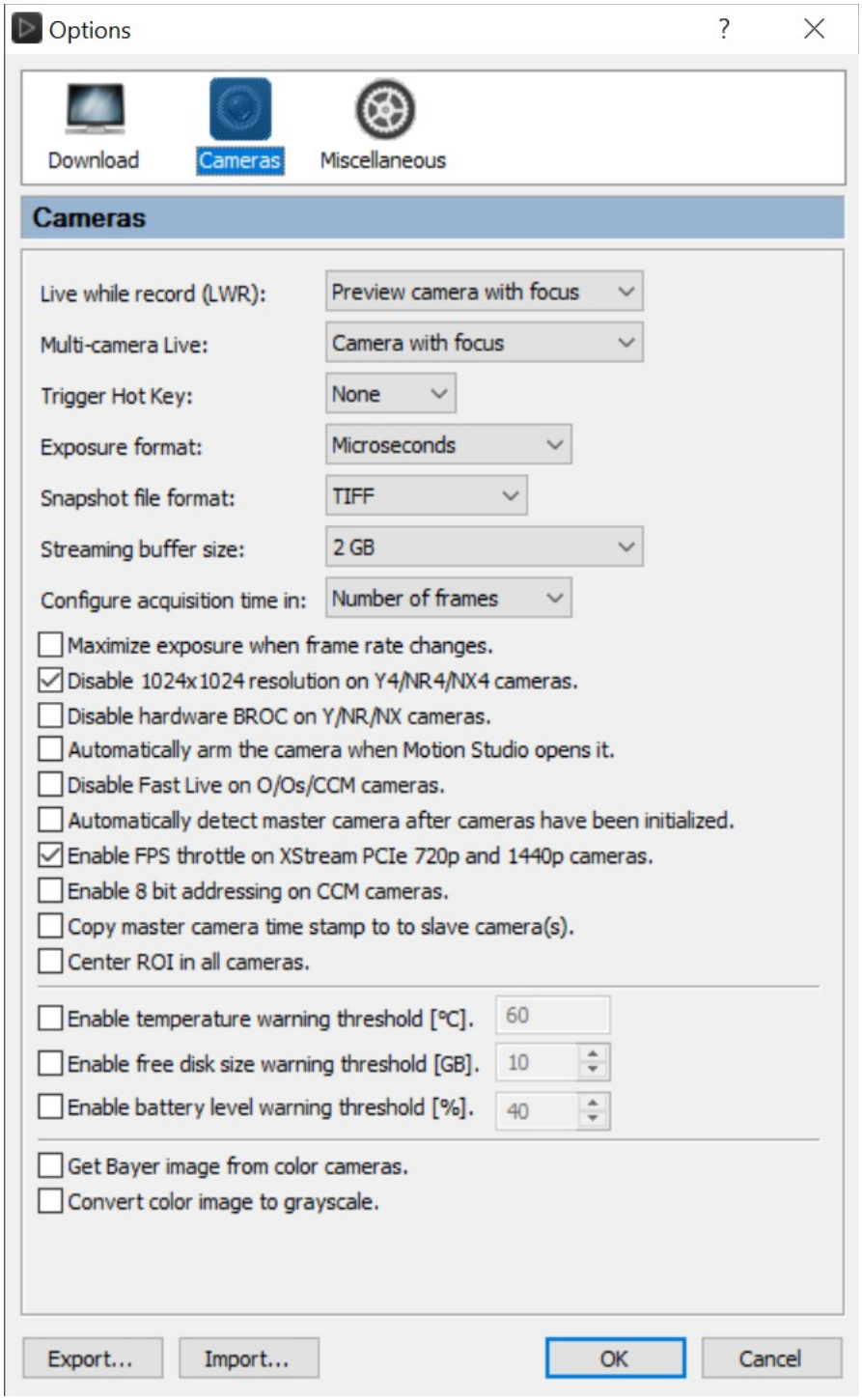
- **Logo:** a bitmap can be displayed on the acquired frames and saved to the image files. Click the browse button to locate a TIFF, BMP or PNG file.
- **Frame Number:** the frame index.
- **Comment:** the acquisition comment.
- **File Name:** the name of the file where the image is stored.
- **Camera name:** the name of the camera.
- **Serial number**: the camera serial number
- **IP address**: the camera IP address.
- **Date:** the acquisition date.
- **Time:** the acquisition time (or current time during live) with seconds or milliseconds precision.
- **Time from trigger**: the elapsed time from the trigger frame. The number of digits is configurable. You may either display in seconds with up to 6 decimal digits or in milliseconds with up to 3 decimal digits.
- **Time from acquisition start:** it shows on each frame the time elapsed from the start of the acquisition.
- **Rate and Exposure:** the values of rate and exposure during the acquisition.
- **Temperature and units:** the camera board temperature and the units (degrees Celsius or Fahrenheit).
- **IRIG/GPS**: the IRIG or GPS date and time.
- **Acquired DAS value**: the data acquired from the DAS.
- **Marker:** the frame marker.
- **Resolution**: the width and the height of the image.
- **Test session name:** the name of current session.
- **Test acquisition name**: the name of current acquisition segment.
- **Logo 2**: a second logo can be displayed.
- **Custom text**: users can include any text or information they want within the timestamp.

5.48.3. Download Options

Download options are described in the topic 5.29 (see above).



5.48.4. Camera Options



Live While Record: during a recording session the preview can be enabled on all cameras, fully disabled or activated only on the camera window that has the focus.

Multi-camera live: in multi-camera environment, live can be read from all the selected cameras or from the camera that has the focus.

Trigger Hot Key: the software trigger can be sent to the cameras by clicking the Trigger button on the camera toolbar or by pressing a keyboard key. The user can configure that key.

Exposure format: the exposure may be displayed in microseconds, in shutter angle units (degrees) or in fractions of seconds.

Snapshot file format: select the file format used to save snapshots.

PCIe memory buffer size: select the size in GB of the buffer used by XStream PCI cameras and XS-Mini.

Configure acquisition time in: the acquisition duration may be configured in number of frames, seconds or milliseconds.

Maximize exposure: if this option is selected, the exposure is automatically set to the maximum every time the frame rate changes.

Disable 1024x1024…: new Y4 and NR4 cameras have 1024x1024 maximum resolution, while older ones have only 1016x1016. In a mixed environment the user may want to operate all the cameras with 1016x1016 maximum resolution. This option disables the 10124x10124 resolution in new cameras.

Disable hardware BROC…: Y cameras with firmware 151.137 (and newer) and N/NR/NX cameras with firmware 159.134 (and newer) support hardware BROC. With this feature BROC is executed in camera firmware and the maximum number of BROC segments is limited to 256. Software BROC supports 1024 segments, so the may disable hardware BROC and allow the camera to acquire up to 1024 segments in software.

Automatically arm the camera when MS opens it: if this option is selected, Motion Studio puts the camera in record mode immediately after opening it.

Disable fast live in O/Os cameras: if this option is enabled the live is executed in O/Os cameras as in any other model.

Automatic master camera detection: if this option is selected, Motion Studio detects the master camera and sets the other to slave, when a camera session is started.

Enable fps throttle: if PCIe and TB camera cannot sustain current maximum frame rate, MS automatically reduces it until the camera supports it.

Enable 8 bit addressing on CCM: CCM cameras with latest firmware have configurable addressing (8 or 10 bit). To make those cameras compatible with previous 10 bit firmware, 8 bit addressing can be disabled.

Copy master camera time stamp to slave cameras: In master/slave mode, when master camera receives the timing from GPS, PTP or IRIG, slave cameras don't, because their sync source is generated by master camera. If the master camera source is not GPS, PTP or IRIG, the trigger event can be recorded in each slave camera in different positions within trigger frame period. If this option is enabled, master camera timing is transferred to slave cameras. If the master sync is not GPS/PTP/IRIG the time from trigger value is copied from master to slave cameras.

Center ROI in all cameras: if this option is selected, camera ROI is always centered even if differently configured.

Enable temperature warning threshold: if a camera supports temperature read, a warning threshold can be set. A warning message pops up the the camera temperature goes above the threshold.

Enable free disk size warning threshold: if this option is selected and the amount of free disk goes below a threshold, a warning message pops up.

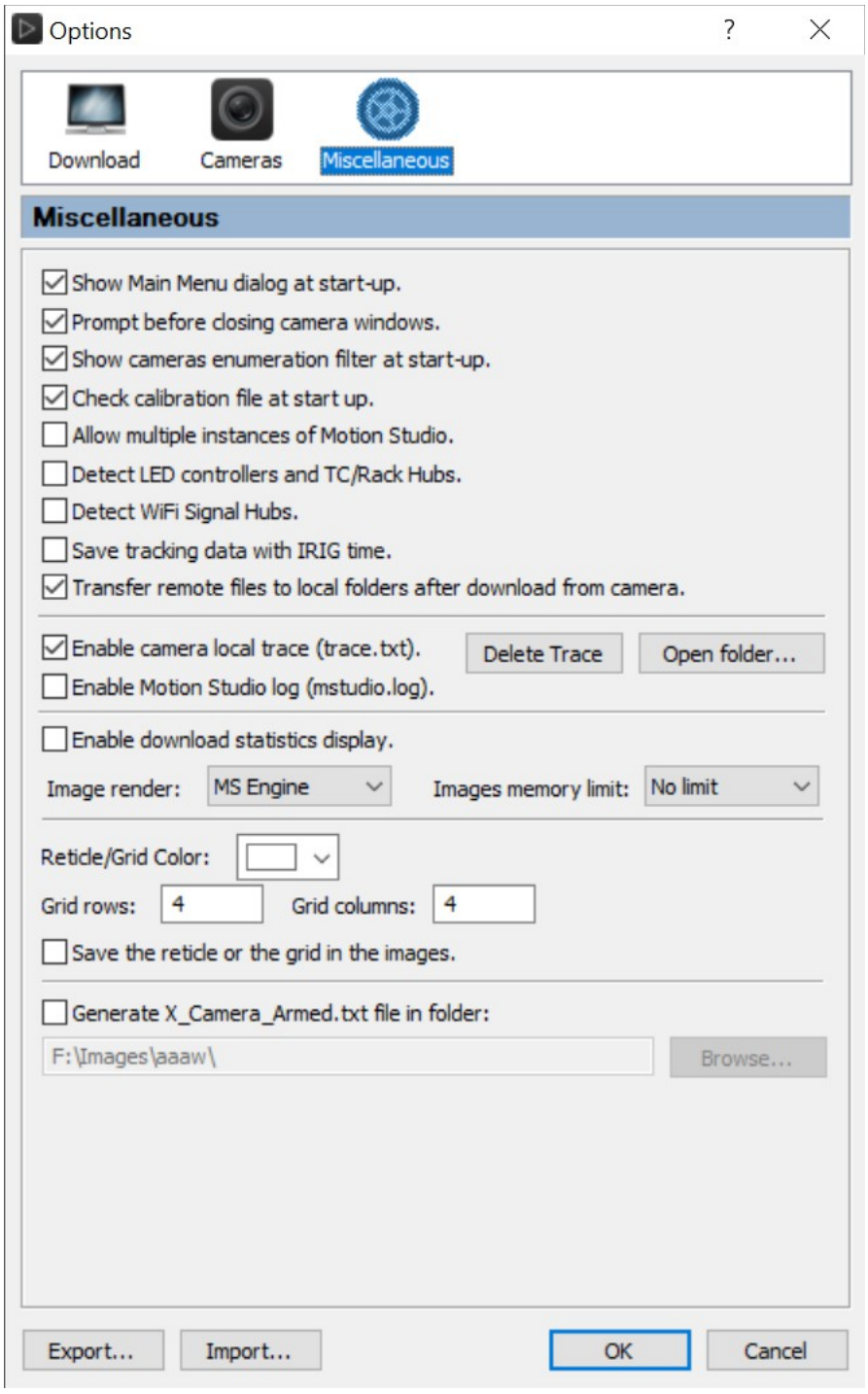
Enable battery level warning threshold: if this option is selected and the battery level goes below a threshold, a warning message pops up.

Get raw gray data from color cameras: gray scale images coming from the sensor are not converted into RGB format. The frames are acquired and displayed as black and white images.

Convert color data to gray scale: converts color RGB images into 8-bit gray-scale images.

Network performance: the network performance is a delay added to the data exchange between the cameras and the computer. If there is traffic on your local network, then move the slider to “More reliable” to avoid loss of data during the communication.

5.48.5. Miscellaneous Options



Show Main Menu dialog at start-up: it displays the main menu dialog box when Motion Studio is initialized.

Prompt before closing camera windows: the program will prompt the user before closing any camera window.

Show cameras enumeration filter at start-up: if the option is checked the camera enumeration filter dialog is displayed when the camera wizard is started.

Check Calibration file at start up: if this option is selected the program checks the calibration file when the camera is open. If the camera does not have a calibration file, the option may be unchecked. This option applies to old non-pipeline cameras and X-Stream PCI cameras.

Allow multiple instances of Motion Studio: if this option is selected, more than one instance of MS may run at the same time, otherwise only one instance may run.

Detect LED controllers and Rack-Hubs: if this option is selected, any LED controller or Rack-Hub is detected when cameras are open.

Detect WiFi Signal Hubs: if this option is selected, any WiFi Signal Hub is detected when cameras are open.

Save Tracking data with IRIG time: if this option is selected, the tracking data is saved with the IRIG time information.

Transfer remote files: MS can operate remote XS cameras. Recorded image are saved in the local computer and can be automatically transferred after download.

Enable Camera Local Trace: it logs each camera operation in a text file in the program directory for diagnostic purposes.

Enable Motion Studio Log: it records any operation executed in Motion Studio into mstudio.log file.

Delete Trace: all the trace files stored in the local hard disk are deleted.

Show trace: opens the folder where the trace files are stored.

Enable Remote Connection server: if this option is selected the remote connection server may be started and the camera may be remotely controlled by a Pocket PC via the wireless LAN. For more info, see the “Motion Studio Remote Control” paragraph.

Enable download statistics: if this option is selected, download statistics are displayed every time a download is done.

Image render: select which engine is used to zoom images, Windows or an advanced IDT resize algorithm.

Image memory limit: select the maximum amount of memory that can be allocated when a sequence is loaded from disk and displayed.

Reticle/Grid Color: select the color of the reticle and the grid.

Grid rows/columns: select the number of rows and columns of the grid.

Save the reticle or the grid in the images: if the reticle or the grid are is visible and this option is selected, they are burned in saved images and AVI files.

Generate X_Camera_Armed.txt file: Some third party software's require that a file is generated in a specific folder anytime the cameras are armed. If anything happens and one or more cameras stop recording or disconnect from the network, the file is deleted. The file name is X_Cameras_Armed.txt (where X is the total number of armed cameras) and it's created by MS in a configurable folder.

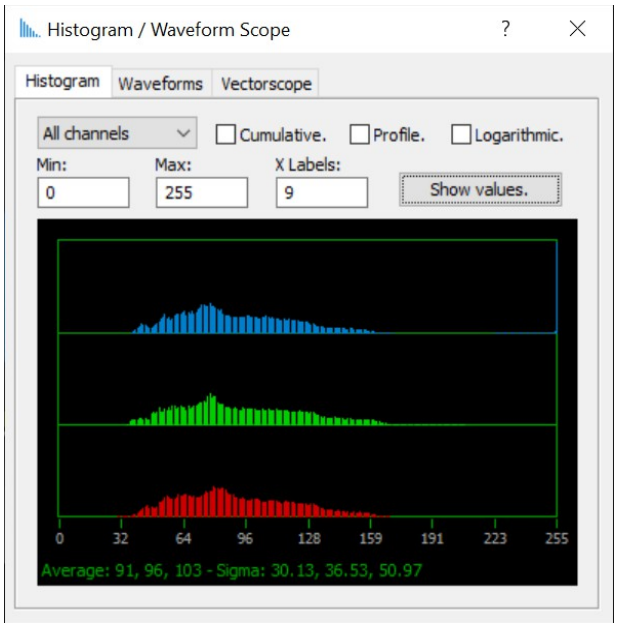
5.48.6. Reticle / Grid

The reticle is a pair of crossed lines drawn over the image. It may be used to vertically or horizontally align the camera. The color of the cross may be edited in the general options. The cross position can be changed by clicking on the image.

The grid is a grid of rectangles drawn on the image. The number of rows and columns may be configured but the position cannot be changed (see below).

5.48.7. Histogram

The image intensity histogram is used to set the camera exposure parameters and with the camera focusing to optimize the dynamic range. Color cameras have three color components (red, green and blue) and intensity. For monochrome cameras the histogram is computed on the gray-scale pixel values.



Two more graphs are included in histogram dialog: wave-forms and vector-scope.

5.48.8. Focus Line / Image Profile

The Focus Line Intensity dialog box displays the values of image intensity (levels of gray in monochrome images and levels of red, green, blue or luminance on color images) along the points of the focus line. If the image is well focused, you will see the intensity changing when the line crosses an edge of the image.

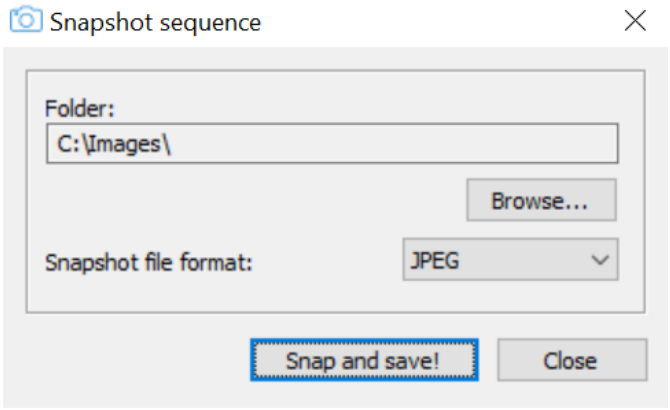
1. From the main toolbar select Tools > Focus Line/Image Profile.
2. Use the “Type” drop-down list to select Focus Line or Image Profile.
3. Use the “Color” drop-down list to select the Focus Line color.
4. To position the focus line, drag the line handles and position them across the image edges.

A measure tool has been added to the image profile.

1. Move the image profile line to the target.
2. Enter the conversion factor from pixels to the desired units. The distance is automatically calculated.

5.48.9. Snapshot sequence

A set of snapshot taken at different times can be generated.



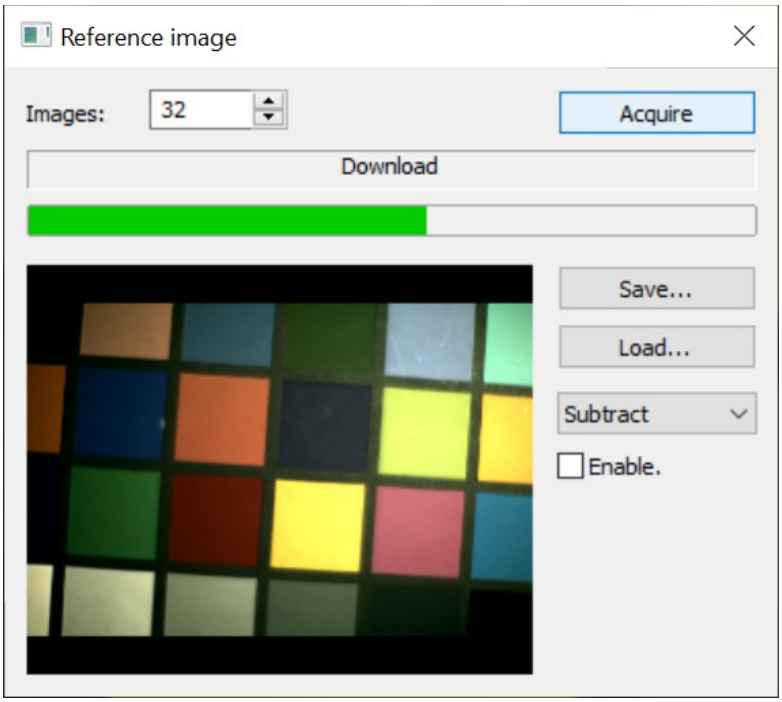
Browse: select the folder where the sequence will be saved.

File format: select the file format among TIFF, BMP, JPEG and PNG.

Snap and save: anytime the button is clicked a snapshot of the current image is taken and saved in the selected folder.

5.48.10. Reference image

Motion Studio is capable of recording a sequence of images, average them and create a reference image file. The reference image can be added or subtracted from live and playback images.



The image can be acquired, saved to a file or loaded from a file.

Images: select how many images to average for the creation of the reference image.

Acquire: click to start recording the sequence

Save: click to save the current image into a file (TIF, BMP, JPG or PNG).

Load: click to load an image from the local disk.

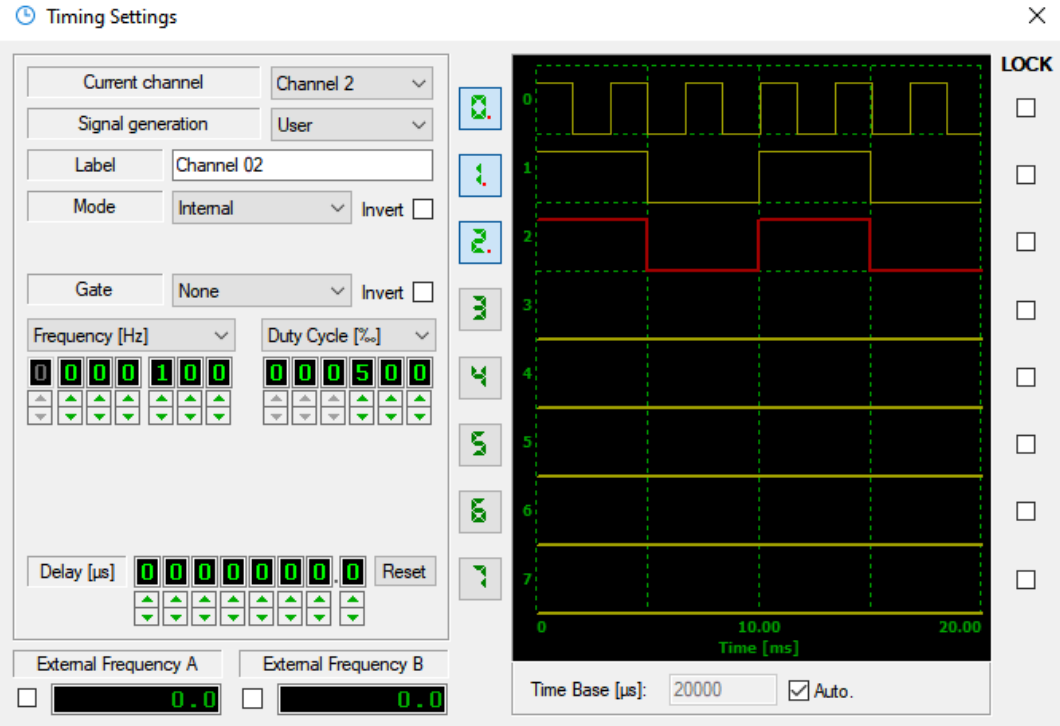
Operation list: select Add or subtract.

Enable: select to activate or deactivate the reference image operation.

5.48.11. MotionPro Timing Hub Control

Motion Studio provides the controls for the MotionPro Timing Hub. If a Timing Hub is detected, a Timing Control menu item is displayed in the Tools menu.

From the main toolbar select Tools > Timing Control.



Current channel: select the channel you want to configure.

Signal generation: see the “Signal generation” topic below.

Label: The user may change the label of the output channel.

Mode: The operating mode may be selected. For a more detailed description of the modes, refer to the topics below.

External In: when the selected mode is “external”, the user may select the external input channel (0 or 1).

Gate: each channel may be gated. The gate channel may be one of the two external inputs (0 or 1) or one of the other output channels. The gate selection is disabled if the mode is “Start/Stop” or “Rate Switch”.

Invert: the output signal, the input signal (external mode only) and the gate signal may be inverted.

Frequency/Period: the user may select the frequency in Hz or the period in us of the selected channel.

Duty cycle: the user may select the channel duty cycle in percentage (1 to 999) or duration of the high value of the channel in us.

Pulses: if the mode is burst the user may select the number of pulses generated by the trigger.

Delay: the output delay may be adjusted. The range is from 0 to 9 s (steps of 100 ns). If the mode is external the delay steps are in external signal clocks.

Reset: the delay may be reset to the default value (0).

External Frequencies: the external input channels frequency may be displayed by selecting the check box.

Signals buttons: each channel may be turned on and off by clicking the corresponding button.

Output channels signals are displayed. The user may select the Time base period. If auto is selected, MS shows four periods.

Lock: two or more output channels may be locked by checking the “lock” check boxes. If two or more channels are locked, they are simultaneously turned on and off when one of the channel buttons is clicked.

Internal Mode

Output signals are generated by internal clock. The user may adjust internal frequency or period and the duty cycle. The channel may be inverted and gated by another signal. The gate can be selected among the external inputs (0 or 1) or among one of the other output channels.

The diagram below shows an example with the following configuration:

- **Output channel 0**: F = 100 Hz, duty cycle 50%, no gate.
- **Output channel 1**: F = 50 Hz, duty cycle 50%, no gate.
- **Output channel 2**: F = 100 Hz, duty cycle 50%, gate = output channel 0.

The output channel 0 frequency is 100 Hz. The output channel 1 frequency is 50 Hz. The output channel 2 frequency is 100 Hz but the channel is gated by the output 0, so the result is a signal which has 100 Hz frequency and a duty cycle of 25%.

External Mode

Output wave-forms are generated by an external signal. The user may adjust the output channel divider and duty cycle. The output channel may be inverted and gated by another signal. The gate can be selected among the external inputs (0 or 1) or among one of the other output channels.

Let’s assume that the external frequency is 200 Hz. The diagram below shows an example with the following configuration:

- **Output channel 0**: F = 100 Hz, duty cycle 50%, external input 0, no gate.
- **Output channel 1**: F = 50 Hz, duty cycle 50%, external input 0, no gate.
- **Output channel 2**: F = 100 Hz, duty cycle 50%, external input 0, gate = output channel 0.

The output channel 0 frequency is half the external frequency. The output channel 1 frequency is one fourth the external frequency. The output channel 2 frequency is equal to the external frequency but the channel is gated by the output 0, so the result is a signal which has half the external frequency and a duty cycle of 25%.

Start/Stop Mode

The two external signals drive the output signals generation. The input 0 starts the output, while input 1 stops it. The frequency and delay of the output are configured as in “internal” mode. No gate is allowed. When the stop signal level is high, the output signal is truncated.

Rate Switch Mode

The two external signals drive the output signals generation at two different frequencies. Input 0 starts the outputs at the frequency 1, while input 1 switches the frequency to the Frequency 2 value.

The diagram below shows an example with the following configuration:

Output channel 0: mode = Rate Switch, F1 = 100 Hz, duty cycle1 = 50%, F2 = 50 Hz, duty cycle1 = 50%. When the input 0 level goes high, the output signal starts at 100 Hz. When the input 1 level goes high, the output 0 frequency switches to 50 Hz.

“Burst Single” Mode

In burst (single) mode, one of the external inputs or one of the output channels is used as trigger to generate one or more pulses. The frequency and the Duty cycle controls are used to determine the duration of the pulse. The generation of the pulses may be also delayed. Both the output signal and the trigger may be also inverted.

The diagram below shows an example with the following configuration:

Output channel 0: mode = Burst (single), Trigger = External Input 0, F = 100 Hz, duty cycle = 50%, pulses = 3. The external Input 0 serves as a trigger. When the trigger goes high, three pulses are generated by the output channel 0. The duration of the pulses is about 5 ms (50 % of 100 Hz). The pulses are generated once.

“Burst retriggered” mode

The Burst retriggered mode is equivalent to the burst single mode. The pulses are generated any time the trigger signal goes high and not only once.

The diagram below shows an example with the following configuration:

Output channel 0: mode = Burst (retriggered), Trigger = External Input 0, F = 100 Hz, duty cycle = 50%, pulses = 2. The external Input 0 serves as a trigger. When the trigger goes high, three pulses are generated by the output channel 0. The duration of the pulses is about 5 ms (50 % of 100 Hz). The pulses are generated each time the trigger goes high.

Signal generation (Camera synchronization)

MotionPro Timing Hub may be used to synchronize a camera or other devices. Signal generation options are:

- **User**: the output signal synchronizes an external device. No internal control is done by the program.

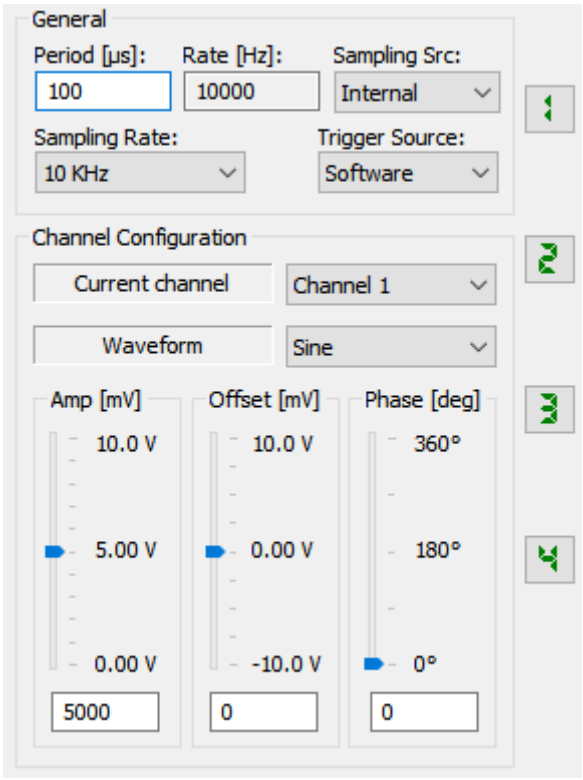
- **Camera (simple)**: the label edit box will be converted into a list of open cameras. In the camera dialog bar the “Rate” control will be disabled, the “Rate Sync” control will be set to “External” and the camera operation frequency will be configured directly from the timing panel. If the “Sync Cfg” value is set to “Pulse High” or to “Pulse Low”, the camera exposure is controlled by the duty cycle of the external square wave. In this condition the exposure edit box is grayed out and the value is automatically computed.

    1. If “Sync Cfg” value is set to Pulse High, the exposure is equal to the inverse of the output channel frequency multiplied by the duty cycle.
    2. If “Sync Cfg” value is set to Pulse Low, the exposure is equal to the inverse of the output channel frequency multiplied by (100 - duty cycle).

5.48.12. Analog Data Output

Motion Studio provides the controls for the generation of analog output with the MotionPro Data Acquisition System (DAS). The available analog output channels in the module are four.

From the main toolbar select Tools > Analog Out. The dialog box has two sections.



Period and Rate: select the period of the generated waveform. The corresponding rate in Hertz is displayed.

Sampling Source: the sampling source may be the internal module clock or an external digital signal.

Sampling Rate: select the sampling rate in Hz. If the sampling source is external, enter the external signal frequency.

Trigger Source: the event trigger starts the waveform output. It may be software, external edge high, or external edge low.

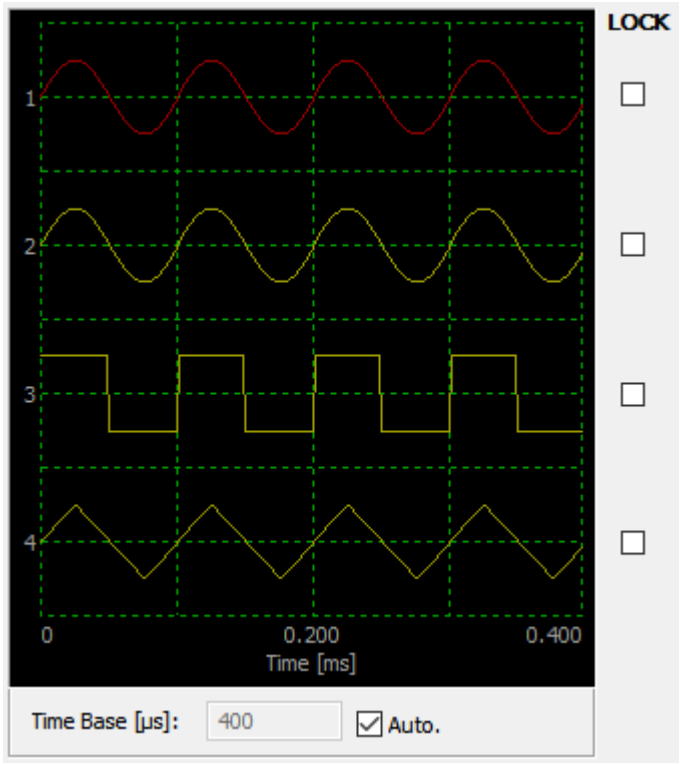
Current channel: select the channel you want to configure.

Waveform: select the channel waveform: square, sine, triangle, saw tooth, or waveform file.

Amplitude, Offset and Phase: if a waveform is selected, edit the amplitude, the offset and the phase.

Browse: if the “File” option is selected, click the “Browse” button to open a data file. The file will be played back.

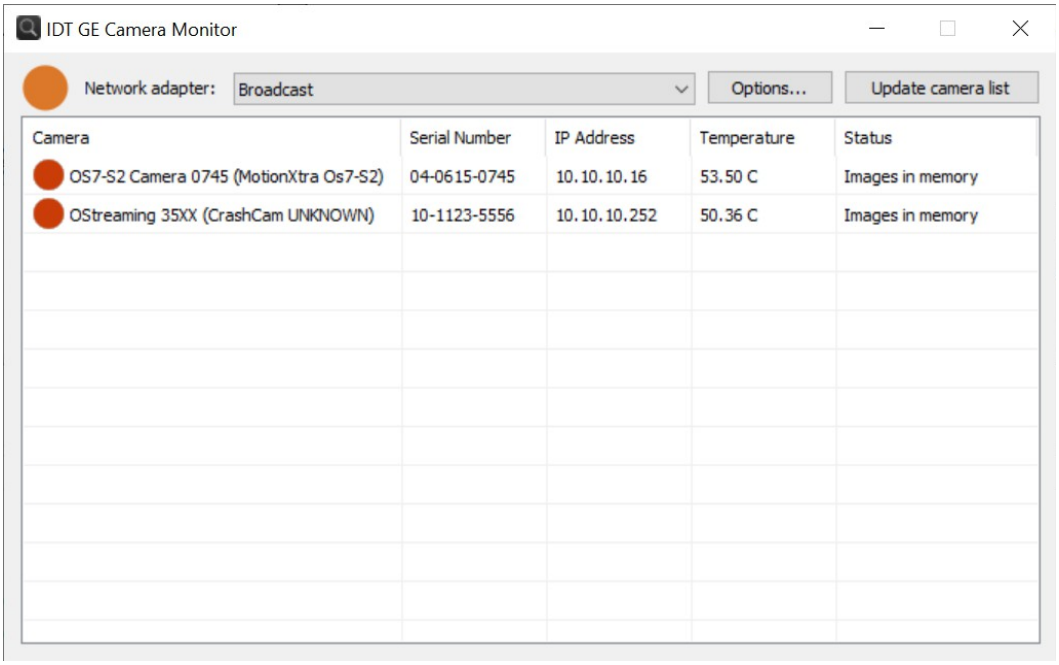
Signals buttons: each channel may be turned on and off by clicking the corresponding button.



Output signals are displayed. The user may select Time Base period in microsecond. If auto is selected, MS shows four periods.

Lock: two or more output channels may be locked by checking the “Lock” options. If two or more channels are locked, they are synchronously turned on and off when one of the channel buttons is clicked.

5.48.13. GE Camera Monitor

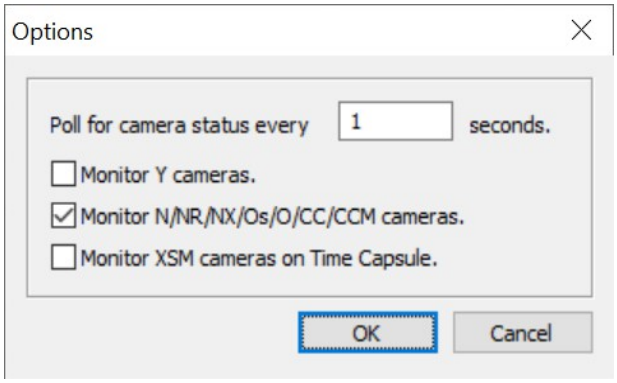


The tool detects the Ethernet cameras connected to the network and updates their status in real time. Some of the detection parameters may be changed.

Network adapter: select the computer network adapter that is connected to the camera network.

Update Camera list: click this button to reset the list and restart camera detection process.

Some options may be modified:

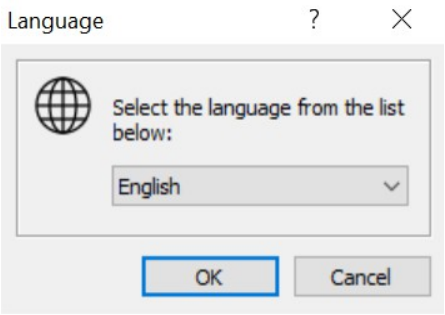


Poll for camera status: it configures how frequently camera status is updated.

Camera series: select which camera model should be detected and listed.

5.48.14. Language Selection

1. From the Tools menu, select “Language…”
2. Select the language from the list and click OK.



Currently the supported languages are English, German, Italian and Japanese.

5.48.15. Vidi Motion

For a detailed description of Vidi Motion tool, please refer to Vidi Motion topic.

5.49. Window menu

If more than a window is open in the Motion Studio program, use the window menu to cascade, tile horizontally, tile vertically or select one of the windows.

5.50. Help menu

This menu contains support options and information including: e-mail tech support and software and manual updates.

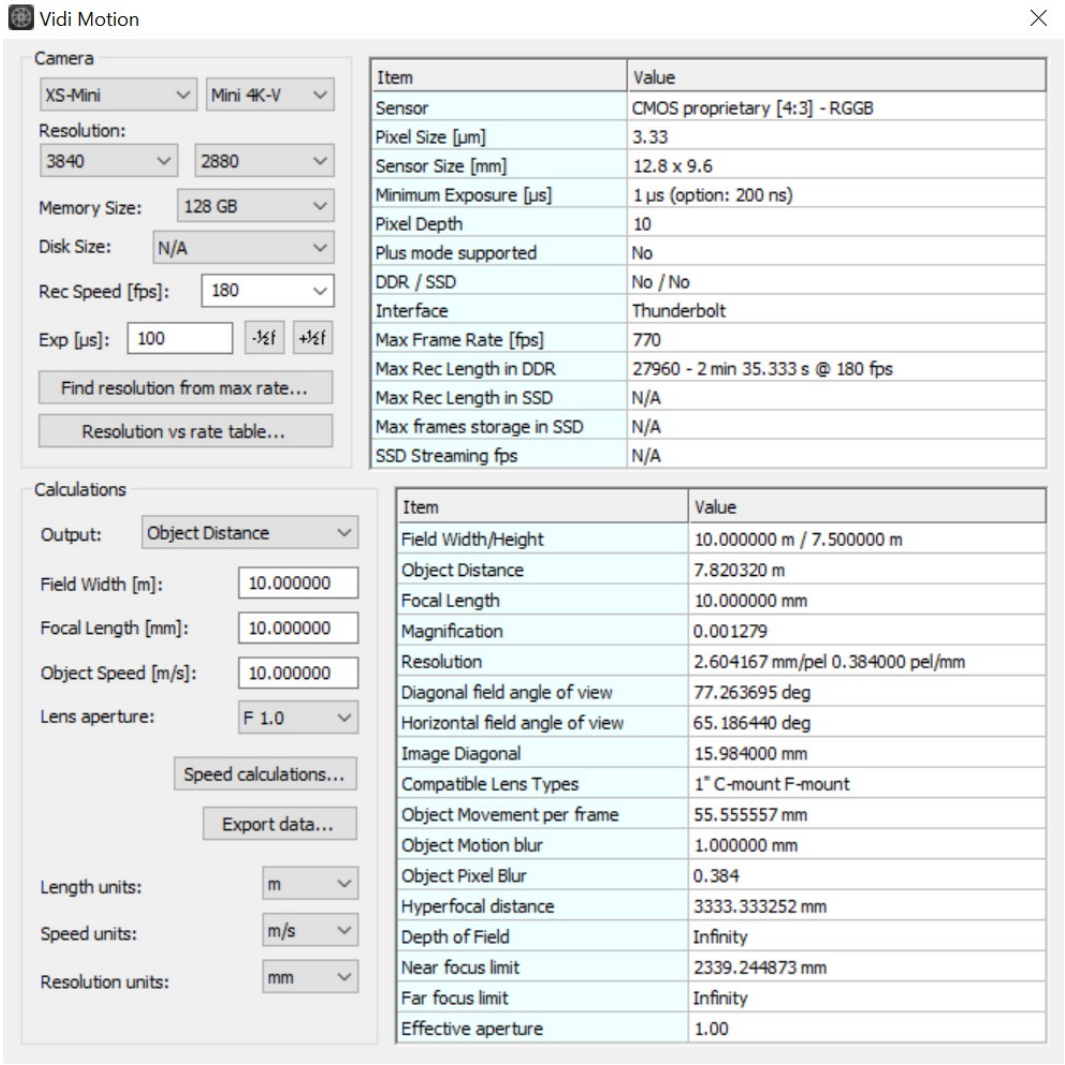
5.50.1. Camera Information

Cameras Info displays a dialog box with the information about the cameras, such as model, type (color or black and white), ID and serial number. The information may be saved in a text file by clicking the “Save…” button.

From the main toolbar, select Help > Cameras Info.

6. Vidi Motion (Lens calculator)

6.1. Overview



Vidi Motion contains the most important specifications of the IDT cameras and a lens calculator. With Vidi Motion you may:

- Show the main specifications of each camera model.
- Find the resolution that fits a specific frame rate.
- Print a table of “resolution versus frame rate” or “frame rate versus resolution”.
- Calculate amount of motion blur, correct exposure time, depth of field, hyper focal distance etc.
- Calculate the speed at impact, of a free falling object. It is assumed that the object falls in vacuum, thus no compensation for air resistance is included.
- Calculate the circumference speed of a spinning object.

6.2. Camera information

- Select the camera Family.
- Select the camera model.
- Set the resolution, memory size, frame rate and exposure.

The right pane will show some camera specifications and:

- The **maximum frame rate** for the selected resolution (in normal and in plus mode, if supported)
- The **maximum recording length** in frames. If the camera has onboard SSD, the value is calculated for the disk.
- The **maximum recording time** for the selected frame rate.
- The **streaming fps**: if the camera has onboard SSD, the streaming fps is the maximum frame rate that allows streaming to the disk without overrun.

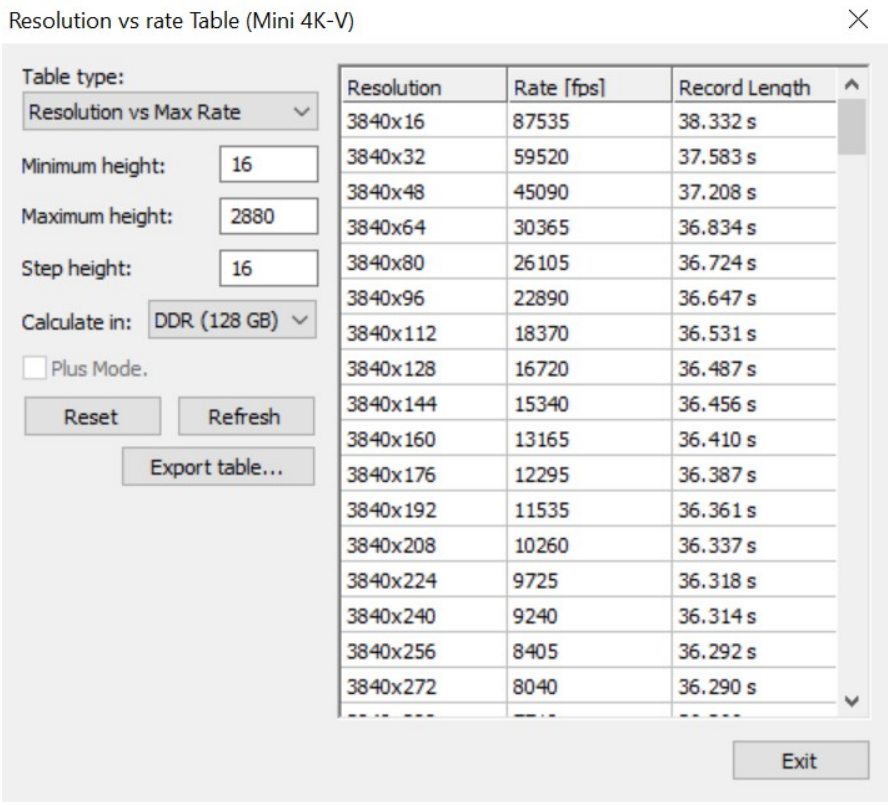
6.3. Find resolution from max rate

- Click the “Find resolution from max rate” button.
- Type a frame rate and select “Plus mode” if required.
- Click OK.

The utility will calculate the resolution that fits the required frame rate. If the camera cannot support the frame rate, an error message will appear.

6.4. Resolution versus rate table

- Click the “Resolution vs rate table…” button.
- Select the table type.
- Enter the minimum height (or rate), the maximum height (or rate) and the step.
- Select the source(DDR or SSD, if available).
- Click Refresh.
- Click “Export table” to save the table o a text file.



6.5. Lens Calculations

Select the calculation of **Focal length**, **Field of View** or **Object Distance**.

Select the lens aperture and the measurement units for length, speed and resolution.

The result will be displayed in the pane at the right side, including: **Field Height and Width**, **Resolution**, **Angle of View**, **Image Diagonal**, **Magnification** factor and the **compatible lenses types**. If the lens specifications shown are not compatible with your lens, you need to lower the **Horizontal and Vertical Resolution** to avoid “vignetting”.

For fast moving object calculations enter the **object speed** in the selected units. The **Object movement per frame**, the **object motion blur** and the **object pixel blur** will be calculated.

If the object movement is too big: increase the recording speed. If the motion blur is too high: decrease the exposure time.

6.6. Speed calculations

Speed calculations include circumference speed and falling objects speed.

The object **circumference speed** can be calculated by entering the speed of the spinning object in rpm and the diameter of the object in the configured units.

The theoretical impact speed of a **falling object** may be calculated. The starting speed of the object is assumed to be equal to 0. Input the distance from the object to the impact point in the correct units and the speed will be calculated.

7. Frame Synchronization and Event Triggering

7.1. Overview

The camera and software enable external sync and triggering capabilities. The camera is synchronized externally via a trigger source in the form of a TTL pulse. The synchronization INPUT signals as well as a synchronization OUTPUT signal are handled through BNC connectors. The synchronization signal is output for every frame that is acquired and can supply the time reference for other pieces of hardware, for example a strobe for illumination.

Two options are available:

1. **Cameras with 2 BNC connectors**: 1 input connector is used for synchronization and event triggering. The output connector is used for sync out.

2. **Cameras with 3 BNC connectors**: a “Trig In” connector is used for event triggering, a “Sync in” connector is used for external synchronization. The output connector is used for sync out.

7.2. Record Modes and Trigger Configuration

On the Record tab, the default Frame Sync source of the camera is set to Internal. If in External, the camera must have an external Sync signal.

TRIG IN: use the Trigger in connector at the back of the camera for event triggering.

SYNC IN: use the Sync In for external synchronization.

SYNC OUT: use the Sync Out for sync out.

Record Mode	Sync In Configuration	Trigger In Configuration
Normal	Internal or external (the BNC is used to provide a sync signal)	Ignored (the camera does not require event trigger)
Circular/BROC	Internal or external (the BNC is used to provide a sync signal)	All values (the camera requires an event trigger)

7.3. Change the Sync and the Trigger

- Select the Record tab.
- Use the Frame Sync drop-down list to select from the following options:
- Select Internal to acquire frames continuously at a rate that is dependent on the frame read-out time and the exposure
- Select External to wait for an external trigger input to acquire frames. An external signal must be provided.
- In external mode, the camera waits for an external sync input to acquire a frame. Use the Sync Cfg drop-down list to select from the following options.
- Select Edge-High to trigger on the positive going slope of the signal.
- Select Edge-Low to trigger on the negative slope of the signal.
- Select Pulse High mode to set the duration of the exposure to equal the trigger signal duration (High state).
- Select Pulse Low mode to set the duration of the exposure to equal the trigger signal duration (Low state).

The time delay between the trigger signal and the acquisition of the image is less than 20 ns.

If the record mode is set to “Circular” or “BROC” each acquisition requires an event trigger. To set a trigger, click on the Trigger button on the Camera Control tab for a software trigger, or use an external trigger source.

1. Select the Record tab.
2. Use the Record Mode drop-down list to select BROC or Circular.
3. Use the Trig Cfg drop-down to select from the following options: Edge High, Edge Low, and Switch Closure.

7.4. Triggering the camera and synchronizing with strobe light

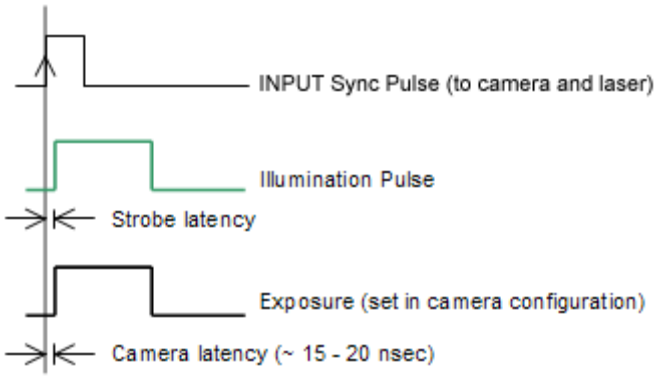
The camera cab is used together with a strobe for illumination. In this case it is necessary to synchronize the illumination pulse event with the camera exposure. Examples of methods that can be employed are presented in the following. The schematics of various timing diagrams are included. This diagram assumes the use of an externally pulse(s) (TTL) to synchronize both the camera and the strobe.

7.4.1. Synchronizing via the leading edge of a pulse event (Single exposure)

The figure shows the timing signals in a single exposure configuration. In the Record Tab the frame sync is set to “External Edge-High” and the exposure mode is set to “single”. The camera exposure is started by the leading edge of the pulse signal and the exposure duration is set in the “Exposure” control of the camera software panel.

Definitions:

- Input sync pulse is **TTL level**.
- Illumination pulse duration: typical 7-10 ns for flash lamp and 100-150 ns for diode pumped lasers respectively).
- **Camera exposure > Illumination latency + Illumination pulse duration**.

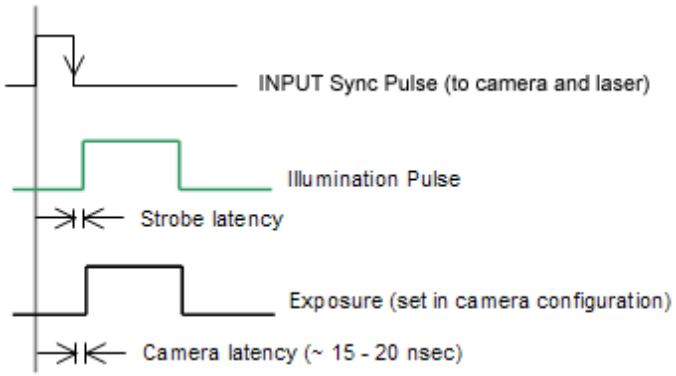


7.4.2. Synchronizing via the trailing edge of a pulse event (Single exposure)

The figure shows the timing signals in a single exposure configuration. In the Record Tab the frame sync is set to “External Edge-Low” and the exposure mode is set to “single”. The camera exposure is started by the trailing edge of the pulse signal and the exposure duration is set in the “Exposure” control of the camera software panel.

Definitions:

- Input sync pulse is **TTL level**.
- Illumination pulse duration: typical 7-10 ns for flash lamp and 100-150 ns for diode pumped lasers respectively).
- **Camera exposure > Illumination latency + Illumination pulse duration**.

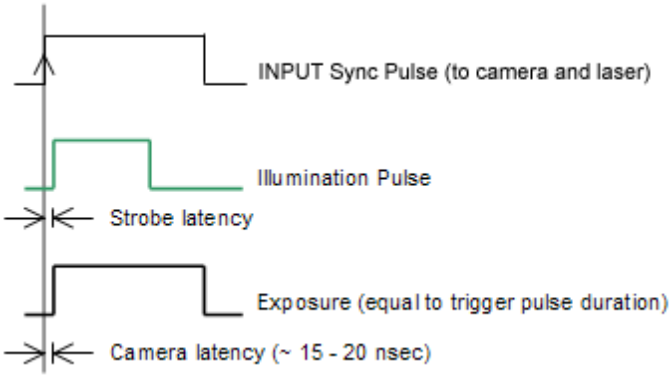


7.4.3. Synchronizing and controlling the exposure with an input pulse

The figure shows the timing signals in a single exposure configuration. In the camera panel the frame sync is set to “External Pulse-High” and the exposure mode is set to “single”. The camera exposure is integrated over the high part of the input pulse and the camera ignores the exposure value set in the “Exposure” control of the camera software panel.

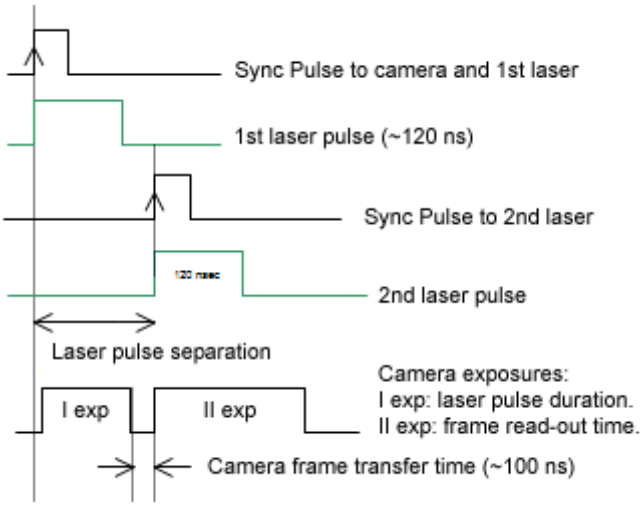
Definitions:

- Input sync pulse is **TTL level**.
- Illumination pulse duration: typical 7-10 ns for flash lamp and 100-150 ns for diode pumped lasers respectively).
- **Camera exposure > Illumination latency + Illumination pulse duration**.



7.4.4. Synchronizing in double exposure mode

The figure below shows the timing signal in a typical double exposure PIV configuration. In the camera panel the sync mode is set to “External Edge-High” and the exposure mode is set to “double”. The time between the two laser pulses must be larger than the sum of the first laser pulse duration and the camera frame transfer time. The second exposure duration cannot be set and depends from the camera frame readout, so the second laser pulse duration must be configured to the desired exposure time.



8. Appendix A - Image Formats

Motion Studio supports the image formats listed in the table below:

Format	Ext	Pixel Depth	Notes
Tagged Image File Format - TIFF™	**TIF**	8/16/24/48	Gray/Color
Windows™ Bitmap	**BMP**	8/24	Gray/Color
JPEG File	**JPG**	8/24	Gray/Color
Portable network Graphics – PNG	**PNG**	8/16/24/48	Gray/Color
Type 2 Bayer	**TP2**	8	Gray/Bayer
Falcon eXtra RAW	**FBA**	8/24	Gray/Color
Digital Picture Exchange	**DPX**	8/16/24/48	Gray/Color
Digital Negative	**DNG**	8/16/24/48	Gray/Color
Multi-Page TIFF	**MPT**	8/16/24/48	Gray/Color
Multi-page Raw (IDT proprietary)	**MPR**	8/16/24/48	Gray/Color
Multi-page Compressed (IDT proprietary)	**MCF**	8/16/24/48	Gray/Color
Audio Video Interleaved (AVI)	**AVI**	8/24	Gray/Color
Apple Quick Time (MOV)	**MOV**	8/24	Gray/Color
Weinberger Sequence (BLD)	**BLD**	8/24	Gray/Color
Moving Picture Experts Group (MPEG)	**MPG**	8/24	Gray/Color
MPEG H.264 (Advanced Video Coding, MPEG4)	**MP4**	8/24	Gray/Color
Windows Media Video	**WMV**	8/24	Gray/Color

8.1. Formats Overview

8.1.1. TIFF Format

TIFF pictures store a single raster image at any color depth. TIFF is arguably the most widely supported graphic file format in the printing industry. It supports optional compression, and is not suitable for viewing in Web browsers.

The TIFF format is an extensible format, which means that a programmer can modify the original specification to add functionality or meet specific needs. This can lead to incompatibilities between different types of TIFF pictures.

8.1.2. Bitmap Format

Windows bitmap files are stored in a device-independent bitmap (DIB) format that allows Windows to display the bitmap on any type of display device. The term "device independent" means that the bitmap specifies pixel color in a form independent of the method used by a display to represent color. The default filename extension of a Windows DIB file is .BMP.

For further information, refer to the Microsoft™ documentation.

8.1.3. JPEG Format

The name "JPEG" stands for Joint Photographic Experts Group, the name of the committee that created the standard. The JPEG standard specifies both the codec, which defines how an image is compressed into a stream of bytes and decompressed back into an image, and the file format used to contain that stream. The compression method is usually lossy, meaning that some visual quality is lost in the process and cannot be restored. However there are variations on the standard baseline JPEG that are lossless.

8.1.4. PNG Format

PNG is an extensible file format for the lossless, portable, well-compressed storage of raster images. PNG provides a patent-free replacement for GIF and can also replace many common uses of TIFF. Indexed-color, grayscale, and true-color images are supported, plus an optional alpha channel. Sample depths range from 1 to 16 bits.

PNG is designed to work well in online viewing applications, such as the World Wide Web, so it is fully stream-able with a progressive display option. PNG is robust, providing both full file integrity checking and simple detection of common transmission errors. Also, PNG can store gamma and chromaticity data for improved color matching on heterogeneous platforms.

PNG is a platform-independent format that supports a high level of lossless compression, alpha channel transparency, gamma correction, and interlacing. It is supported by more recent Web browsers.

8.1.5. TP2 format

Type-2 format is the Redlake raw data format. It's the format used to save raw image data.

8.1.6. FBA format

The FBA format is the Falcon eXtra raw data format. It's the format used by Falcon eXtra software to save raw image data. For further information, please refer to falcon documentation.

8.1.7. DPX format

Digital Picture Exchange is a common file format for digital intermediate and visual effects work. It provides storage of digital motion picture data in a bitmap file format. DPX is a modification of the Kodak Cineon format. The Society of Motion Picture and Television Engineers (SMPTE) added header information to DPX not present in the original Kodak Cineon format.

8.1.8. DNG Format

Digital Negative (DNG) is a patented, open, non-free lossless raw image format written by Adobe(TM). It is based on TIFF/EP standard format, and mandates significant use of meta-data. CinemaDNG is the the result of an Adobe-led initiative to define an industry-wide open file format for digital cinema files. CinemaDNG caters for sets of movie clips, each of which is a sequence of raw video images, accompanied by audio and meta-data.

8.1.9. AVI Format

The Microsoft AVI file format is a Resource Interchange File Format (RIFF) file specification used with applications that capture, edit, and play back audio-video sequences. In general, AVI files contain multiple streams of different types of data. Most AVI sequences use both audio and video streams. A simple variation for an AVI sequence uses video data and does not require an audio stream. The program supports uncompressed (raw) and compressed AVI. The INDEO 5.11 codec is installed on 32-bit Windows.

8.1.10. MOV Format

The Apple Quick Time MOV file format is used with applications that capture, edit, and play back audio-video sequences. In general, MOV files contain multiple streams of different types of data. The codec supported in Motion Studio are RAW, TIF and H264. **Apple QuickTime™ is required**.

8.1.11. BLD Format

The BLD format corresponds to the file format RAW, which is known from several applications. Each BLD file needs a corresponding descriptor file in the DSC format. In a BLD file all single frames of an image sequence are stored successively uncompressed in the block format. The data is in binary raw data format (e.g. for grayscale pictures 1 Byte per Pixel). The descriptor file (DSC) belonging to the BLD file is a line-orientated ASCII file, in which values like e.g. resolution, frames or date are stored. The DSC file can be created with any text editor.

8.1.12. MPEG Format

MPEG, which stands for “Moving Picture Experts Group”, is a name of family standards used for coding audio-visual in a digital compressed format. MPEG is a generic means of compactly representing digital video and audio signals for consumer distribution. The basic idea is to transform a stream of discrete samples into a bit-stream of tokens which takes less space, but is just as filling to the eye. The graphic library implements the MPEG-1 format, the standard on which such products as video CD and MP3 are based. The compression/decompression technique implemented in MPEG is “**lossy**”, e.g. some amount of data information is lost.

8.1.13. MPEG H.264 (Advanced Video Coding)

It is also known as MPEG-4 Part 10 or MPEG-4 AVC (Advanced Video Coding). The intent of the H.264 project was to create a standard capable of providing good video quality at substantially lower bit rates than previous standards without increasing the complexity of design so much that it would be impractical or excessively expensive to implement. An additional goal was to provide enough flexibility to allow the standard to be applied to a wide variety of applications on a wide variety of networks and systems, including low and high bit rates, low and high resolution video and broadcast. *The MPEG H.264 format is supported only on a 32 bit Windows OS with installed QuickTime™.*

8.1.14. Windows Media Video

Windows Media Video is a video coding format developed by Microsoft. Motion Studio supports WMV 9.

8.1.15. Multi-page Bayer Format (MRF)

Multi-page Bayer Format (MRF) is an uncompressed IDT proprietary file format. Multiple raster images are stored in a single file. The format is described below.

Each MRF file contains a file header, an image header and an array of bytes that defines the image data bits. The image raster data is not compressed and stored in the file “as it is”. Mono images pixel depth may be 8, 9 or 10; color images are stored in Bayer format (8, 9, 10 bit) or in BGR format (24, 27, 30 bit). The file structures are the following:

8.1.15.1. File header

A MRF file begins with a file header structure containing the IDT signature.

```
typedef struct _MRFFILE_HEADER
{
  char szSign[8];           // IDT signature
  unsigned int nReserved;   // reserved
} MRFFILE_HEADER, *PMRFFILE_HEADER;
```

Members

szSign[8]: a 8 char buffer which contains the signature “IDT-MRF”. It indicates that the file contains a valid Multiple Raw File.

nReserved: this field is reserved for future use.

8.1.15.2. Image header

The file header is followed by the image header which contains general information about the images.

```
typedef struct _MRFIMG_HEADER
{
  unsigned int nSize;          // size of this header
  unsigned int nPages;         // number of pages/frames
  unsigned int nWidth;         // image width
  unsigned int nHeight;        // image height
  unsigned int nBPP;           // bits per pixel
  unsigned int nReserved1;     // reserved
  unsigned int nReserved2;     // reserved
  unsigned int nReserved3;     // reserved
  unsigned short nBayer;       // the image is Bayer
  unsigned short nCFAPattern; // Bayer pattern
  unsigned int userData[59];  // user data array
  unsigned int nRecSpeed;      // recording speed
} MRFIMG_HEADER, *PMRFIMG_HEADER;
```

Members

nSize: size of the structure in bytes.

nPages: number of images contained in the file

nWidth: width of each image in pixels.

nHeight: height of each image in pixels.

nBPP: number of bits per pixels

reserved1,2,3: reserved values.

nBayer: the image is Bayer.

nCFAPattern: color filter array pattern used to de-bayer the image (0:GRBG, 1:BGGR, 2:RGGB, 3:GBRG).

nRecSpeed: the recording speed.

userData: an array of 59 unsigned integer values.

nRecSpeed: the recording speed multiplied by 1000.

8.1.15.3. Data arrays

The image header is followed by the images data. Images are stored contiguously in uncompressed format.

8.1.16. Multi-page Compressed Format (MCF)

Multi-page Compressed Format (MCF) is a compressed IDT proprietary file format. Multiple raster images are stored in a single file.

8.1.17. Note on 16 bit gray-scale formats

10-bit images acquired from the camera may be saved in different 16 bit formats. These formats include TIF, PNG, MPT, MRF and MCF. Since 16 bit grayscale format is not a standard, not all the applications for image processing may correctly display the saved images.

9. Appendix B – Error codes

A list of Motion Studio error codes with a brief description is below.

ERR001: Internal error. The program has generated a severe internal error and must be restarted.

ERR005: Invalid database path. The program is trying to open a database from a wrong directory.

ERR011: Error opening file. The program failed opening an image file because it is damaged or the format is not supported.

ERR012: Error opening image sequence. The program failed opening an image sequence because it is damaged or the format is not supported.

ERR023: Camera generic error. Unspecified camera error.

ERR027: Camera play time out. The camera cannot snap images and a time out occurred. Check if the camera sync configuration is set to external and the external sync signal is available.

ERR028: Camera acquisition time out. The camera cannot acquire images and a time out occurs.

ERR033: Unable to open camera. The program cannot start the communication with the camera. Check the hardware and the cables.

ERR034: Unable to create a folder. The program cannot create a new folder in the database for the storage of the acquired images. Check your administrator privileges.

ERR035: not enough camera memory to add a new acquisition. All the camera memory is filled with acquisitions. A new acquisition cannot be added.

ERR036: Unable to delete the current acquisition. The program cannot delete the current acquisition from the camera memory configuration.

ERR037: Camera hardware generic error. An error occurred in the communication through the USB or the Ethernet cable.

ERR038: The buffer is too small. The buffer allocated for the image snap is too small.

ERR039: Camera device I/O error. An error occurred in the communication through the USB cable. Check the cables and the USB board.

ERR040: Camera I/O read error. An error occurred while the program was reading an image from the camera. Check the cables and the USB board.

ERR041: Cannot complete the operation because the camera is busy. The camera is busy and cannot perform the requested operation. Wait and try again.

ERR042: An error occurred during the calibration procedure. The error can occur during the camera background calibration or during the tracking calibration. Restart the program and try again.

ERR045: Invalid range value. The error occurs when the user tries to configure a parameter which is out of the allowed range. Correct the value and try again.

ERR048: An error occurred during the color balance and/or white balance procedure because one of the circular targets is outside the image. Move the targets and try again.

ERR049: An error occurred during the color balance and/or white balance procedure. Move the targets and try again.

ERR055: Unable to create a new database. The error occurs when the program tries to create a new database. Check your administrator privileges and try again on a different folder.

ERR056: Unable to delete folder. The error occurs when the program tries to delete a folder (acquisition, calibration or tracking) from the current database. Check your administrator privileges.

ERR059: Unable to create calibration folder. The error occurs when the program tries to create a new calibration folder and save the calibration image.

ERR061: Unable to copy file. The error occurs when the program tries to copy the camera calibration file from the distribution CD. Check your administrator privileges and the CD integrity.

ERR065: Invalid camera calibration file. The error occurs when the program tries to copy a camera calibration file that is not valid. Check if the file is damaged.

ERR067: Camera I/O write error. An error occurred while the program was trying to write a parameter to the camera. Check the cables and the USB board.

ERR068: Unable to open camera driver. The program cannot start the communication with the camera. Check the hardware and the cables.

ERR070: Invalid iTunes version. The error occurs because the program is trying to communicate with the iPod through iTunes and the version is not valid. Install a newer version of iTunes.

ERR071: iTunes Type library is not compatible. The error occurs because the program is trying to communicate with the iPod through iTunes and the version is not valid. Install a newer version of iTunes.

ERR072: Unable to connect to iPod through iTunes. There is a communication error between the program and the iPod. Try again.

ERR073: More than one iPod found. The computer is connected to more than one iPod. Disconnect one of them and try again.

ERR074: Unable to connect to iTunes. There is a communication error between the program and iTunes.

ERR075: Not enough space on the destination database. The error occurs because the program tries to synchronize with the iPod, but the iPod disk has not enough space to store the database.

ERR076: Unable to delete the iPod acquisition list. The error occurs because the program is trying to synchronize with the iPod but it’s not able to delete the previous acquisition list.

ERR077: Unable to delete the acquisition folder. The error occurs because the program is trying to synchronize with the iPod but it’s not able to delete one of the acquisition folders.

ERR078: Unable to create the acquisition folder. The error occurs because the program is trying to synchronize with the iPod but it's not able to create a new acquisition folder.

ERR079: Unable to copy the database system files. The error occurs because the program is trying to synchronize with the iPod but it's not able to copy the database system files.

ERR080: Unable to find images. The error occurs because the program is trying to synchronize with the iPod but it cannot find images in the source database.

ERR081: Unable to add files to the iPod acquisition list. The error occurs because the program is trying to synchronize with the iPod but it cannot add a sequence to the iPod list.

ERR082: Unable to add files to the iPod acquisition list. The error occurs because the program is trying to synchronize with the iPod but it cannot add a sequence to the iPod folders.

ERR083: Unable to convert the acquisition to the iPod format. The error occurs because the program is trying to add a sequence to the iPod list but it cannot convert it to the proper iPod format.

ERR084: Multiple camera snap time out. The error occurs because the program is trying to snap an image from a multiple camera setup. One or more cameras failed, check the cables. If the system is in Master/Slave configuration check that the sync in connector of the slave camera is connected to the sync out connector of the master.

ERR086: Unable to save calibration image. The error occurs because the program tries to save a tracking calibration image. Check your administrator privileges and try again.

ERR087: Unable to download the camera calibration file from flash memory. Check the cables and try again.

ERR088: The command line passed to the raw converter to convert a file is not correct.

ERR089: Unable to find acquisition directory. This error occurs when the Raw Converter tries to open an INI files but is not able to find it. Check the command line path and try again.

ERR090: Invalid configuration file. This error occurs when the Raw Converter tries to convert a sequence but the configuration file is not valid.

ERR091: Unable to read the RAW file. This error occurs when the Raw Converter tries to convert a sequence but the raw file is not valid or damaged.

ERR092: the raw file and the converter have different versions. This error occurs when the Raw Converter tries to convert a sequence generated by an older version of the software.

ERR093: Unable to set the IP address. This error occurs when the program tries to change the camera IP address and it fails. Check that the selected IP address is compatible with the network adapter subnet mask and disconnect the USB cable if it's connected.

ERR094: Unable to assign a specific IP address to the camera. The automatic assignment of the IP addresses has failed. Try with the manual configuration.

ERR095: Data acquisition module over-run. A data acquisition module internal error has occurred.

ERR096: Data acquisition module under-run. A data acquisition module internal error has occurred.

ERR097: Unable to download the camera calibration file from flash memory because the camera calibration file is not stored in the flash. Contact the technical support.

ERR098: The calibration file download has been aborted. The user has clicked the Abort button during the download.

ERR099: Unable to set the IP address. An error occurred in the procedure of setting the IP address starting from the camera MAC address. Make sure that the MAC address is correct and the camera is connected to the network.

ERR100: Unable to save tracking data. The error occurs because the program tries to save the tracking results to a file and it fails.

ERR101: Invalid file format. The error occurs when a waveform file is not valid. The file may be damaged or have invalid data.

ERR102: Unable to save to a file. The error occurs when the program cannot save an image to the specified file format.

ERR103: Unable to save to a file. The error occurs because the file is too large and the file format does not support that size.

ERR104: Unable to allocate enough computer memory for the acquisition. This error occurs when cameras try to acquire a large number of images in computer memory.

ERR105: The camera cable has been disconnected.

ERR106: The program is unable to attach to the camera. The program instance has been detached from the camera because the control has been taken by someone else.

ERR107: Unable to configure the camera for first use. The procedure of setting up the camera for the first time failed.

ERR108: Aborted operation. The error message occurs when the user aborts the raw conversion procedure.

ERR109: The selected region of interest is not supported by this file format.

ERR110: the application is not able to open a device in the Galileo network.

ERR111: the HG100K camera memory cannot be erased.

ERR112: a Galileo wireless device cannot be configured.

ERR113: a frame cannot be read from the camera during a procedure of sequence save.

ERR114: the compressed AVI codec is not valid and the sequence cannot be saved.

ERR115: memory allocation error. The program cannot allocate enough memory to open and display a sequence of images.

ERR116: write to disk overrun. When the program acquires in direct write to disk mode, the memory allocated for buffering is not enough and it is overwritten.

ERR117: SD card download error. The camera cannot download the images to the SD card.

ERR118: the time limited license has expired. Contact IDT for a new activation code.

ERR119: The activation key cannot be sent to the camera. Reboot the camera, restart Motion Studio and try again.

ERR120: Read EEPROM error. The camera cannot be initialized because the EEPROM data cannot be read.

ERR121: The HDMI output cannot be initialized.

ERR122: SD card download error. Some cameras were not able to save the images to their SD card devices.

ERR123: Unable to save images (communication error). The HG camera is not able to switch to 1 Gbps speed and the images cannot be downloaded.

ERR124: the message appears when the cameras are configured a Master/Slave and a time out occurs.

ERR125: When the user selects the Master/Slave mode, the software tries to understand if the cameras are properly connected. If the detection procedure fails an error message is generated.

ERR126: the message appears when the user tries to open a raw file generated by old N cameras. That file cannot be displayed by the RAW viewer but it can be converted by the RAW converter.

ERR127: some IP addresses such as loopback addresses or multicast addresses, cannot be used to configure the camera.

ERR128: the log files cannot be downloaded from the HG camera flash memory.

ERR129: the log files cannot be deleted from the hard disk. Make sure they are not used by some other application.

ERR130: the message appears when the user tries to close Motion Studio when one or more cameras are still downloading images to the hard disk. The user should wait before the download is complete.

ERR131: the message appears when the information stored in the camera EEPROM cannot be retrieved. If the software cannot read the proper information from the camera, the camera should not be opened because the results are unpredictable. Such error may appear when there is a communication problem between the camera and the computer through the Ethernet network.

ERR132: this message appears when the software is not able to send to the camera the command that stores the configuration in the flash memory. It is a camera internal firmware error.

ERR133: in SSD mission mode, the configuration cannot be stored into the camera flash memory.

ERR134: in SSD mission mode, the SSD cannot be erased.

ERR135: in SSD mission mode, a segment of the mission cannot be loaded from the SSD to the camera memory

ERR136: in SSD mission mode, the configuration cannot be stored into the camera flash memory and executed right away.

ERR137: in SSD mission mode, the images cannot be read from the SSD to the camera memory.

ERR138: the specified file cannot be erased.

ERR139: a RAW file cannot be converted because the data cannot be read.

ERR140: unable to read mission data from an XML file.

ERR141: unable to save mission data to an XML file.

ERR142: one or more cameras cannot be armed. The recording is aborted. Check the cameras cable and power.

ERR143: the values of exposure and frame rate are not the ones that should be configured in the camera. The recording is aborted and the user should check the cameras configuration.

ERR144: the data cannot be read from the RAW file and it cannot be converted into an image.

ERR145: this warning is shown when the camera temperature goes above the threshold level configured in the general options.

ERR146: this warning is shown when the user configures the steps in mission mode and the number of steps that he is trying to add exceeds the actual SSD capacity.

ERR147: this error message appears when camera internal memory has issues. Power cycling the camera may help.

ERR148: this error message appears when MS is not capable to allocate the computer memory that is needed to operate the camera. It may happen when a few cameras are open at the same time.

ERR149: this error message appears when MS tries to open a removable SSD or an SD-card and it doesn't succeed because data is corrupted.

ERR150: this error happens when MS is not able to start direct streaming to disk. Streaming to disk is supported by Xstream PCIe and Xstream Mini cameras.

ERR151: this error happens when stream to disk is too slow and computer memory is written before images can be stored to the local disk. To avoid this, reduce camera recording frequency.

ERR152: this error happens when image backup to SSD/SD-Card stops. Images are still in camera DDR and can be retrieved.

ERR153: this error happens when there's an overflow in memory transfer in TB3 V5 XS-Mini cameras.

ERR154: this error happens when there's a problem opening a raw file.

ERR155: this error happens when the local disk is full and stream to disk cannot continue.

ERR156: this error happens when a raw file rendered with an XSRT device is already open in MS (deprecated).

ERR157: this error happens when a raw file is open in MS and and the user tries to open an XS-Mini camera that will try to use the XS-RT pipeline. To avoid this message, close the raw file and try again (deprecated).

ERR158: this error happens when MS configuration settings cannot be save to an XML file.

ERR159: this error happens when MS configuration settings cannot be loaded from an XML file to MS.

ERR160: this error happens when images cannot be recorded and averaged to create a reference image.

ERR161: this error happens when generals settings are imported in Motion Studio and the image folder stored in those settings cannot be created.

ERR162: this error happens when MS tries to open an XSL 2.5GE device (or 10GE) and it doesn't have any image either in the DDR or in the SSD.

ERR163: this error happens when two sequences of images cannot be open as stereo images. It's a generic error

ERR164: this error happens when two sequences of images cannot be open as stereo images because the necessary memory cannot be allocated. A computer reboot may help.

ERR165: this error happens when two sequences of images cannot be open as stereo images because they have different pixel depth. For example, one sequence is color RGB and the other is mono.

ERR166: this error happens when a video in a TCII device has been recorded by a camera that has a different model from the camera currently open.

ERR167: this error happens when the command of deleting the latest video from a TCII recorder cannot be executed because a time out occurred.

ERR168: this error happens when the command of deleting all the videos from a TCII recorder cannot be executed because a time out occurred.

ERR169: this error happens when the software detects that the network speed is less than 1Gbps. IDT cameras cannot operate in a 100Mbps network. It's too slow.

10. Appendix C - Spatial filtering

Spatial filters alter pixel values with respect to variations in light intensity in their neighborhood. The neighborhood of a pixel is defined by the size of a matrix, or mask, centered in the pixel itself. These filters can be sensitive to the presence or the absence of light intensity variations. Spatial filters can serve a variety of purposes, such as detecting edges along a specific direction, contouring patterns, reducing noise and detail outlining and smoothing.

Spatial filters fall in two categories:

High-pass filters emphasize significant variations of the light intensity usually found at the boundary of object. They are also called **sharpening** filters.

Low-pass filters attenuate variations of the light intensity. They have the tendency to smooth images by eliminating details and blurring edges. They are also called **smoothing** filters.

In the case of a 3x3 matrix, the value of the central pixel derives from the values of its eight surrounding neighbors. A 5x5 matrix specifies 24 neighbors; a 7x7 matrix specifies 48 neighbors and so forth.

If $\mathbf{P}_{(i,j)}$ specifies the intensity of the pixel P with the coordinates (i,j), the pixels surrounding $P_{(i,j)}$ can be indexed as follows (in the case of a 3x3 matrix):

$\mathbf{P}_{(i-1,j-1)}$	$\mathbf{P}_{(i,j-1)}$	$\mathbf{P}_{(i+1,j-1)}$
$\mathbf{P}_{(i-1,j)}$	$\mathbf{P}_{(i,j)}$	$\mathbf{P}_{(i+1,j)}$
$\mathbf{P}_{(i-1,j+1)}$	$\mathbf{P}_{(i,j+1)}$	$\mathbf{P}_{(i+1,j+1)}$

A **linear filter** assigns to $\mathbf{P}_{(i,j)}$ a value which is a linear combination of its surrounding values. For example:

$$\mathbf{P}_{(i,j)} = \mathbf{P}_{(i-1,j-1)} + \mathbf{P}_{(i,j-1)} + \mathbf{P}_{(i+1,j-1)} - \mathbf{P}_{(i-1,j+1)} - \mathbf{P}_{(i,j+1)} - \mathbf{P}_{(i+1,j+1)}$$

A **nonlinear filter** assigns to $\mathbf{P}_{(i,j)}$ a value that is not a linear combination of the surrounding values. For example:

$$\mathbf{P}_{(i,j)} = \max(\mathbf{P}_{(i-1,j-1)}, \mathbf{P}_{(i+1,j-1)}, \mathbf{P}_{(i-1,j+1)}, \mathbf{P}_{(i+1,j+1)})$$

10.1. Linear filters (Convolution filters)

A *convolution* is a mathematical function that replaces each pixel by a weighted sum of its neighbors. The matrix defining the neighborhood of the pixel also specifies the weight assigned to each neighbor. This matrix is called the *convolution kernel*.

For each pixel $\mathbf{P}_{(i,j)}$ in an image, the convolution kernel is centered on $\mathbf{P}_{(i,j)}$. Each pixel masked by the kernel is multiplied by the coefficient placed on top of it. $\mathbf{P}_{(i,j)}$ becomes the sum of these products.

In the case of 3x3 neighborhood, the coefficients of the kernel matrix can be indexed as follows.

$K_{(i-1,j-1)}$	$K_{(i,j-1)}$	$K_{(i+1,j-1)}$
$K_{(i-1,j)}$	$K_{(i,j)}$	$K_{(i+1,j)}$
$K_{(i-1,j+1)}$	$K_{(i,j+1)}$	$K_{(i+1,j+1)}$

The grater the absolute value of a coefficient $K_{(a,b)}$, the more the pixel $P_{(a,b)}$ contributes to the new value of $P_{(i,j)}$. If a coefficient $K_{(a,b)}$ is 0, the neighbor $P_{(a,b)}$ does not contribute to the new value of $P_{(i,j)}$.

0	1	0
1	**0**	1
0	1	0

then

$$P_{(i,j)} = P_{(i,j-1)} + P_{(i-1,j)} + P_{(i+1,\ j)} + P_{(i,j+1)}$$

If the kernel contains both negative and positive coefficients, the transfer function is equivalent to a weighted differentiation and produces a sharpening or high-pass filter (like **Laplacian**, **Prewitt** and **Sobel** filters).

If all coefficients in the kernel are positive, the transfer function is equivalent to a weighted summation and produces a smoothing o low-pass filer (like **Average** and **Gaussian** filters).

10.2. Linear sharpening filters

Typical smoothing filters are:

Gradient filters

A gradient filter highlights the variation of light intensity along a specific direction, which has the effect of outlining edges and revealing texture.

A gradient convolution filter is a first-order derivative. Its kernel uses the following matrix:

a	-b	c
b	**x**	-d
c	d	-a

Where a, b, c and d are integer coefficients and x=0 or x=1.

This kernel has an axis of symmetry that runs between the positive and negative coefficients of the kernel and through the central element. This axis of symmetry gives the orientation of the edges to outline.

There are two sets of pre-defined gradient filters used in Motion Studio. They are listed below.

The **Prewitt filters** have the following kernels. The notations N (north) NE(north-east) E (east) SE (south-east) S (south) SW (south-west) W (west) NW (north-west) indicate which edges of bright regions they outline.

The **Sobel filters** are very similar to the Prewitt filters except that they highlight light intensity variations along a particular axis that is assigned a stronger weight. They have the following kernels.

Laplacian filters

A Laplacian filter highlights the variation of the light intensity surrounding a pixel. The filter extracts the contour of objects and outline details. Unlike the gradient filter, it is omni directional.

The Laplacian filter is a second-order derivative. Its kernel uses the following matrix:

a	d	c
b	**x**	b
c	d	A

where a, b, c and d are integers.

The Laplacian filter has two different effects, depending on whether the central coefficient x is equal or greater than the sum of the absolute values of the outer coefficients.

If x is equal to that sum, the filter extracts the pixels where significant variations of light intensity are found. The presence of sharp edges, boundaries between objects, modification in the texture of a background, noise, and other effects can cause these variations. The transformed image contains white contours on a black background.

If x is greater than that sum, the filter detects the same variations as mentioned above, but superimposes them over the source image. The transformed image looks like the source image, with all significant variations of the light intensity highlighted.

10.3. Linear Smoothing filters

A **smoothing filter** attenuates the variations of light intensity in the neighborhood of a pixel. It smooths the overall shape of objects, blurs edges, and removes details.

It is an averaging filters and its kernel uses the following matrix:

a	d	c
b	**x**	b

c	d	a

where a, b, c and d are positive integers, and x=0 or x=1.

Because all the coefficients are positive, each central pixel becomes a weighted average of its neighbors. The stronger the weight of a neighbor is. The more influence it has on the new value of the central pixel.

A list of average smoothing kernels is shown below

A **Gaussian filter** attenuates the variations of light intensity in the neighborhood of a pixel. It smooths the overall shape of objects and attenuates details. It is similar to a smoothing filter, but its blurring effect is more subdued.

Its kernel uses the following matrix.

a	d	c
b	**x**	b
c	d	a

where a, b, c and d are positive integers, and x=0 or x=1.

Because all the coefficients are positive, each central pixel becomes a weighted average of its neighbors. The stronger the weight of a neighbor is. The more influence it has on the new value of the central pixel.

Unlike a smoothing kernel, the central coefficient of a Gaussian filter is greater than 1. Therefore the original value of a pixel is multiplied by a value greater than the weight of any of its neighbors. As a result, a greater central coefficient corresponds to a more subtle smoothing effect. A larger kernel size corresponds to a stronger smoothing effect.

10.4. Nonlinear filters

A nonlinear filter replaces each pixel with a nonlinear function of its surrounding pixels. Like the convolution filters the nonlinear filters operate on a neighborhood.

A **Median filter** is a nonlinear low pass filter that assigns to each pixel the median value of its neighborhood, effectively reducing isolated pixels and reducing details. However, the median filter does not blur the contour of objects.

A **Maximum Filter** is a nonlinear filter that assigns to each pixel the maximum value of pixels in its neighborhood. This has the effect to increase the contrast of the image.

A **Dilation** of an image is a particular case of max filter. The output pixel is set to the maximum of the corresponding input pixel and its 8 neighbors. The effect of dilation is to fill up holes and to thicken boundaries of objects on a dark background (that is, objects whose pixel values are greater than those of the background).

A **Minimum Filter** is a nonlinear filter that assigns to each pixel the minimum value of pixels in its neighborhood. This has the effect to decrease the contrast of the image.

An **Erosion** of an image is a particular case of min filter. The output pixel is set to the minimum of the corresponding input pixel and its 8 neighbors. The effect of erosion is to remove spurious pixels (such as noise) and to thin boundaries of objects on a dark background (that is, objects whose pixel values are greater than those of the background).

Opening an image is a sequence of erosion followed by dilation. The process of opening has the effect of eliminating small and thin objects, breaking objects at thin points, and generally smoothing the boundaries of larger objects without significantly changing their area.

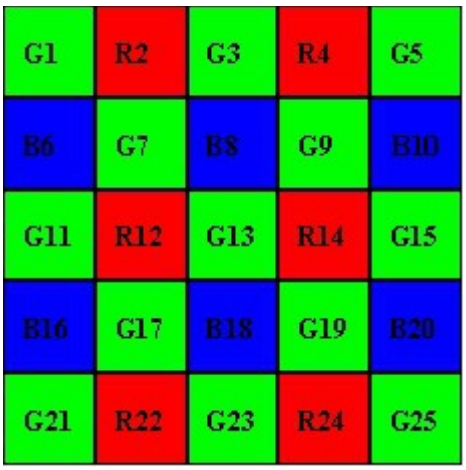
Closing an image is a sequence of dilation followed by erosion. The process of closing has the effect of filling small and thin holes in objects, connecting nearby objects, and generally smoothing the boundaries of objects without significantly changing their area.

11. Appendix D - Color Filter Arrays (CFA)

The Color camera uses a single image sensor. Color imaging with a single sensor requires the use of a **Color Filter Array** (CFA) which covers the sensor array. In this fashion each pixel in the detector samples the intensity of just one of the three color components (red, green or blue). The recovery of full-color images from a CFA-based sensor requires a method of calculating values of the other color separations at each pixel. These methods are commonly referred as color interpolation or color “de-mosaicing” algorithms.

In a single-sensor camera, varying intensities of light are measured at a rectangular grid of image sensors. To construct a color image, a CFA must be placed between the lens and the sensors. A CFA typically has one color filter element for each sensor. Obviously, the color interpolation algorithms depend on the CFA configuration. Many different CFA configurations have been proposed. The one used in IDT cameras is the **Bayer pattern**.

A Bayer pattern consists of pixels on your sensor tinted green, red or blue and set in a mosaic pattern. Consider the figure below: moving from left to right and then down, you see that you have a GR-BG pattern. This is your Bayer pattern, and is then placed all over the sensor to form the Bayer Mosaic Pattern. This means that you have half of your pixels tinted with a Green sensitive element, a quarter tinted with a Red sensitive element, and a quarter tinted with a Blue sensitive element.



12. Appendix G – Glossary

A

Ambient Light
It's the available natural light completely surrounding a subject. It's tight already existing in an indoor or outdoor setting that is not caused by any illumination supplied by artificial light source.

Aperture
It's the lens opening. The hole or opening formed by the metal leaf diaphragm inside the lens or the opening in a camera lens through which light passes to expose the sensor. The size of aperture is either fixed or adjustable. Aperture size is usually calibrated in f-numbers-the larger the number, the smaller the lens opening. Aperture affects depth of field, the smaller the aperture, the greater is the zone of sharpness, the bigger the aperture, the zone of sharpness is reduced. The size of the aperture is indicated by its f-number.

ASCII
American Standard Code for Information Interchange, an encoding system for converting keyboard characters and instructions into the binary number code that the computer understands.

Aspect ratio
It's the ratio between the width and height of an image or image sensor.

Auto focus
It's a system that automatically focuses the camera lens.

AVI (Audio Video Interleaved)
It's a file format used to store video and audio. For further information, refer to the Microsoft™ documentation.

B

Bandwidth
It's the capacity of a networked connection and determines how much data can be sent along the networked wires. The bandwidth is particularly important for Internet connections, since greater bandwidth also means faster downloads.

Bayer pattern
A Bayer pattern consists of pixels on the sensor tinted green, red or blue and set in a mosaic pattern. Moving from left to right and then down, the pattern may be GR-BG. This is the sensor's Bayer pattern, and is then placed all over the sensor to form the Bayer Mosaic Pattern. This means that half of the pixels are tinted with a Green sensitive element, a quarter tinted with a Red sensitive element, and a quarter tinted with a Blue sensitive element.

Binning
Binning is a method of increasing camera speed and sensitivity to boost low signals. Binning causes the acquired image to be brighter and smaller, but the resolution will be lower as a result. Because the image is smaller, the image transfer time is reduced significantly. When you select a binning setting in your imaging software, the camera combines data from several pixels in the camera's CCD into a single super pixel. For example, a 2x2 bin means that 2 pixels in the horizontal direction and 2 pixels in the vertical direction are combined to form one super pixel.

Bit Depth
It's the color or gray scale of an individual pixel. A pixel with 8 bits per color gives a 24 bit image. (8 Bits x 3 colors are 24 bits.) 24 bit color resolution is 16.7 million colors.

BMP (Bitmap)
It's a file format used to store images. For further information, refer to the Microsoft™ documentation.

BNC
BNC is the acronym for Bayonet Neill-Concelman (for the inventors Paul Neill and Carl Concelman). It's a twist-and-lock connector for coaxial cables, used for electronic equipment and for wiring LANs.

Brightness
It's the value of a pixel in an electronic image, representing its lightness value from black to white. It's usually defined as brightness levels ranging in value from 0 (black) to 255 (white).

BROC (Burst Record on Command)
It's one of the operating modes of a camera with on board memory. The memory is divided into segments; the camera acquires in circular mode in a segment. When the event trigger is issued, the camera completes the acquisition and start acquiring in the following segment until the memory is filled.

C

C-Mount
A standard threaded lens mount used to attach a camera to a microscope, or a separate lens to a camera.

CCD (Charge Coupled Device)
It’s the light sensitive silicon chip near the optical interface of the camera that converts light intensities into electrical signals. Every pixel's charge is transferred through a very limited number of output nodes (often just one) to be converted to voltage, buffered, and sent off-chip as an analog signal. All of the pixel can be devoted to light capture, and the output's uniformity (a key factor in image quality) is high.

Circular Mode
It’s one of the operating modes of a camera with on board memory. The camera acquires and restarts when the memory is filled. The camera waits for an event trigger to complete the acquisition.

CFA (Color Filter Array)
The filter dyes placed directly over each pixel on the chip surface.

CMOS (**Complementary Metal-Oxide Semiconductor)**
It’s the light sensitive silicon chip near the optical interface of the camera that converts light intensities into electrical signals. Each pixel has its own charge-to-voltage conversion, and the sensor often also includes amplifiers, noise-correction, and digitization circuits, so that the chip outputs digital bits. These other functions increase the design complexity and reduce the area available for light capture. With each pixel doing its own conversion, uniformity is lower. But the chip can be built to require less off-chip circuitry for basic operation.

Contrast
It’s a measure of rate of change of brightness in an image.

D

Dark Current
The charge accumulated by pixels while not exposed to light. Normally, this charge is reduced or eliminated prior to capturing a picture.

Depth of Field
The distance between the nearest and farthest points that appears in acceptably sharp focus in a photograph. Depth of field varies with lens aperture, focal length, and camera-to-subject distance.

Diaphragm
An adjustable device inside the lens which is similar to the iris in the human eye, it's comprised of six or seven overlapping metal blades; continuously adjustable from "wide open" to "stopped down"; controls the amount of light allowed to pass through the lens and expose the sensor when a picture is taken. It also controls the amount of depth of field the photograph will have. Openings are usually calibrated in f-numbers. The more blades used will have a more natural and rounded spots.

Digitization
It's the process of converting analog information into digital format.

Digital Camera
It's an electronic device used to capture and store photographs electronically instead of using photographic film like conventional cameras. Modern compact digital cameras are typically multifunctional, with some devices capable of recording sound and/or video as well as photographs.

Double Exposure
It's a capability of CCD and CMOS cameras to acquire two images within a 100 ns interval. The first camera exposure may be controlled while the second exposure doesn't.

DLL (Dynamic Linking Library)
A dynamic link library (DLL) is a collection of small programs, any of which can be called when needed by a larger program that is running in the computer. The small program that lets the larger program communicate with a specific device such as a printer or scanner is often packaged as a DLL program (usually referred to as a DLL file). The advantage of DLL files is that, because they don't get loaded into RAM together with the main program, space is saved in RAM.

Dynamic Range
It's the ratio of the saturation level of the CCD to the readout noise of the CCD camera system. Dynamic range is a measure of the ability of the camera to capture both bright and dark features in a single image. In general, the higher the camera's dynamic range, the more information per pixel it can capture. It's usually expressed in dB.

E

Ethernet (10Base-T)
It’s a local area network (LAN) architecture developed by Xerox Corporation in cooperation with DEC and Intel in 1976. Ethernet uses a bus or star topology and supports data transfer rates of 10 Mbps.

Exposure
The amount of time that light reaches the image sensor.

F

F-Number
The ratio of the diameter of the opening to the focal length of the lens; a large aperture is indicated by a small numerical f-number. The f-number series is a geometric progression based on changes in the size of the lens aperture, as it is opened and closed. As the scale rises, each number is multiplied by a factor of 1.4. The standard numbers for Calibration are 1.0, 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32, etc., and each change results in a doubling or halving of the amount of light transmitted by the lens to the film plane.

Fast Ethernet (100Base-T)
A newer version of Ethernet, called also 100Base-T, which supports data transfer rates of 100 Mbps.

Field of View
It's the area visible through the camera's optics.

Fill Factor
The fill factor indicates the size of the light sensitive photodiode relative to the surface of the pixel. Because of the extra electronics required around each pixel the "fill factor" tends to be quite small, especially for Active Pixel Sensors which have more per pixel circuitry. To overcome this limitation, often an array of micro-lenses is placed on top of the sensor.

FireWire (IEEE 1394)
High bandwidth (40 megabytes/second - 1394a; 80 megabytes/second - 1394b) interface for connecting digital imaging, storage, and other devices to host computers.

Focal Length
The distance from the optical center of the lens to the image sensor when the lens is focused on infinity, usually expressed in millimeters.

Focus
It's the process of bringing one plane of the scene into sharp focus on the image sensor.

Fps (Frames per second)
It's used to describe how many frames a camera can acquire per second.

Frame
One of the still pictures that make up a video.

Frame Grabber
It's a device that lets you capture individual frames out of a video camera or off a video tape.

Frame Rate
It's the number of frames that are shown or sent each second. Live action relates to a frame rate of 30 frames per second.

G

Gigabit Ethernet
A version of Ethernet, which supports data transfer rates of 1 Gigabit (1,000 megabits) per second. The first Gigabit Ethernet standard (802.3z) was ratified by the IEEE 802.3 Committee in 1998.

Gray Level
It's the brightness of a pixel.

Gray Scale
It's an image containing shades of gray as well as black and white.

GUI (Graphical User Interface)
A system that simplifies selecting computer commands by enabling the user to point to symbols or illustrations (called icons) on the computer screen with a mouse.

H

High-G
It refers to the Vehicle Impact Test or similar environment that includes up to 100-G shock and 5-G vibration stress. Generally indicates ability to withstand extreme shock and vibration forces.

I

Image Intensifier
It's an electro-optical vacuum tube which intensifies or amplifies on low light level images.

Integration
It's the active collection of photons as done by an image sensor.

Interpolation
Method used to increase the resolution of an image map by adding pixels to an image based on the value of surrounding pixels. This method can cause artifacts.

IP Address
The Internet Protocol Address is a unique set of numbers used to locate another computer on a network. The format of an IP address is a 32-bit string of four numbers separated by periods. Each number can be from 0 to 255 (i.e., 1.154.10.266). Within a closed network IP addresses may be assigned at random, however, IP addresses of web servers must be registered to avoid duplicates.

IRIG (Inter-Range Instrumentation Group)
Time code signals of various formats defined by the IRIG 200-98 standard/time derived from GPS satellites. Both require an optional receiver/decoder/generator module.

Iris
It's a diaphragm in the lens that opens or closes to set the aperture (the amount of light that passes through the lens to the CCD).

J

K

L

Laser
Laser is an acronym for Light Amplification by Stimulated Emission of Radiation. A laser is a cavity, with mirrors at the ends, filled with material such as crystal, glass, liquid, gas or dye. It's a device which produces an intense beam of light with the unique properties of coherence, collimation and mono-chromaticity.

LED (Light Emitting Diode)
Light producing transistor used to display dots, numeric and text, slowly replacing by LCD display.

Lens
One or more pieces of optical glass or similar material designed to collect and focus rays of light to form a sharp image on the sensor.

Lossless
It's an image format which stores the image in a non-compressed format, or in a compressed format that don't loose information.

Lossy
It's an image format that sacrifices a certain amount of image information in order to create a smaller compressed file.

Low-G
It refers to a general industrial environment with less than 10-G shock and 2.5-G vibration stresses.

M

MAC Address
The Media Access Control address is a hardware address that uniquely identifies each node of a network. A MAC address is 48 bits long and is commonly written as a sequence of 12 hexadecimal digits (for instance, 48-3F-0A-91-00-BC). MAC addresses are uniquely set by the network adapter manufacturer and are sometimes called "physical addresses" for this reason.

MCF (Multi-page Compressed Format)
Multi-page Compressed Format (MRF) is a compressed IDT proprietary file format. Multiple raster images are stored in a single file.

Micro-lens
To overcome the limitations of a low fill factor, on certain sensors an array of micro-lenses is placed on top of the pixel array in order to funnel the photons of a larger area into the smaller area of the light sensitive photodiode.

Megapixel
It means having a resolution of one million pixels.

MOV
It’s a file format used to store images. The Apple Quick Time MOV file format is used with applications that capture, edit, and play back audio-video sequences.

MPEG (Moving Picture Experts Group)
It’s a file format used to store videos. MPEG is a name of family standards used for coding audio-visual in a digital compressed format. MPEG is a generic means of compactly representing digital video and audio signals for consumer distribution.

MRF (Multi-page Raw Format)
Multi-page Raw Format (MRF) is an uncompressed IDT proprietary file format. Multiple raster images are stored in a single file.

N

NTSC (National Television Standards Committee)
It's a standard for video broadcasting and recording in the US and Japan.

O

Offset
It's the offset value adjusts the CCD black level relative to the analog-to-digital converter zero. It is factory-optimized for the camera's maximum dynamic range.

Optical Zoom
It indicates that the camera has a real multi-focal length lens, as opposed to a digital zoom, which magnifies the center portion of the picture.

P

PAL (Phase Alternation Line)
It's a standard for video broadcasting and recording in Europe.

Palette
It's a thumbnail of all available colors to a computer or devices. The palette allows the user to choose which colors are available for the computer to display. The greater the number of colors, the larger the data file becomes and more processing time is required to display your images. If the system uses 24-bit color, then over 16.7 million colors are included in the palette.

Peltier Cooler
Thermoelectric cooling uses the Peltier effect to create a heat flux between the junctions of two different types of materials. This effect is commonly used in electronic components and small instruments. There are no moving parts and such a device is maintenance free.

Pixel
It's an individual element of either a sensor or a digital image.

PIV (Particle Image Velocimetry)
Particle Image Velocimetry is an optical method used to measure velocities and related properties in fluids. The fluid is seeded with particles, which, for the purposes of PIV, are generally assumed to faithfully follow the flow dynamics. It is the motion of these seeding particles that is used to calculate velocity information.

Plug-in
A file containing data used to alter, enhance, or extend the operation of a parent application program. Plug-ins, both commercially and independently authored, can usually be downloaded for free and are stored locally. Plug-ins come in different versions specific to particular operating systems.

PNG (Portable Network Graphics)
It's a file format used to store images. PNG is an extensible file format for the lossless, portable, well-compressed storage of raster images. PNG provides a patent-free replacement for GIF and can also replace many common uses of TIFF. Indexed-color, grayscale, and true-color images are supported, plus an optional alpha channel. Sample depths range from 1 to 16 bits.

Pulse
It's a signal whose amplitude deviates from zero for a short period of time. A pulse may be periodic (pulse train) and not periodic (single pulse). The **Pulse Width** is the time between the rising edge and the falling edge of a pulse. If the pulse is periodic it has a period and a duty cycle.

Q

Quantum Efficiency
It's a quantity defined for a photosensitive device such as photographic film or a sensor (CCD or CMOS) as the percentage of photons hitting the photo reactive surface that will produce an electron-hole pair. It is an accurate measurement of the device's sensitivity. It is often measured over a range of different wavelengths to characterize a device's efficiency at different energies.

R

Resolution
Resolution is expressed as either the number of pixels counted horizontally by the number of pixels counted vertically or by the number of mega pixels. It can be expressed as one of the following formats: QVGA (320 x 240), VGA (640 x 480), SVGA (800 x 600), XGA (1024 x 768) UXGA (1600 x 1200).

RGB (Red, Green and Blue)
The color system used in most digital cameras in which the image is separated by capturing the red, green, and blue light separately and then are re-combined to create a full color image.

S

Sensor
It's an electronic device that converts the light allowed in by the shutter to an electrical signal.

Sensor Gain
It's the amount of analog signal amplification. The gain is factory-optimized for the camera's maximum dynamic range.

Sharpness
The clarity of detail in a photo

Shutter
It's the device in the camera that opens and closes to let light from the scene strike the image sensor and expose the image. The three primary types used in digital photography are digital shutters, iris shutters and focal plane shutter.

SDK (Software Development Kit)
It's a programming package that enables a programmer to develop applications for a specific platform. An SDK typically includes one or more APIs programming tools and documentation.

Spike
It's a short pulse of voltage or current, usually undesirable.

Square wave
It's a periodic signal which changes instantaneously between two fixed levels. The values are usually 0 and 5 V (TTL) or 0 to 3.3 V (CMOS).

Switch Closure
It's a type of external event trigger. The trigger is detected when the poles of the trigger connector are shorted by a switch.

Synchronous
Synchronous events occur at the same time or at the same rate or with a regular or predictable time relationship or sequence.

T

TIFF (Tagged Image File Format)
It’s a file format used to store images. TIFF pictures store a single raster image at any color depth. TIFF is arguably the most widely supported graphic file format in the printing industry. It supports optional compression, and is not suitable for viewing in Web browsers.

Thumbnail
It’s a small, low-resolution version of a larger image file that is used for quick identification.

Trigger
A trigger is something that causes a data acquisition system to start collecting data or a camera to start acquiring images. It may be as simple as pressing a software button or a set of conditions which when met trigger data capture (internal triggers), or an externally generated, hardware signal (an external trigger).

Tripod
A tripod is a three-legged supporting stand used to hold the camera steady, especially useful when using slow shutter speeds. Another is the monopod, single leg tripod.

TTL (Transistor-Transistor Logic)
A common semiconductor technology for building discrete digital logic integrated circuits. For digital circuits, logic 1 is obtained for inputs of 2.0 to 5.5 V and logic 0 for inputs of 0 to 0.8 V.

TWAIN
It’s a protocol for exchanging information between applications and devices such as scanners and digital cameras. TWAIN makes it possible for digital cameras and software to "talk" with one another on PCs.

U

Underexposure
A picture that appears too dark because not enough light got to the imaging system.

USB (Universal Serial Bus)
It's a serial bus standard for connecting devices. It was designed for computers such as PCs and the Apple Macintosh, but its popularity has prompted it to also become commonplace on video game consoles, PDA, cell phones. It has a slow version (USB 1.1 – 12 Mbps) and a high speed version (USB 2.0 – 480 Mbps).

USB 2.0
Finalized in 2001, Universal Serial Bus (USB) 2.0 is a complete overhaul of the Universal Serial Bus input/output bus protocol which allows much higher speeds than the older USB 1.1 standard did. The goal of the new serial bus is to broaden the range of external peripherals that can be used on a computer. A hard drive can easily hit the USB 1.1 bottleneck whereas it now becomes more 'usable' under USB 2.0 conditions. USB 2.0 maximum speed is 480 Mbps.

V

W

White balance
It's a function to compensate for different colors of light being emitted by different light sources.

X

Y

Z