GRAYESS Inc.

IRT Analyzer

User manual

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www.grayess.com

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1 Installation and introduction

1.1 About IRT Analyzer

Welcome to IRT Analyzer, the premier solution for professional infrared image analysis and reporting in R&D and process automation environments.

Our system offers a comprehensive set of tools for thermographic engineers to create accurate, detailed analysis and quickly generate informative, visually appealing reports. Furthermore, IRT Analyzer provides a means for real-time image acquisition, analysis and process control, complete with alarms and external I/O capabilities. It also allows engineers to monitor and control processes remotely and analyze data in real-time, making it an essential tool for any R&D or process automation environment.

Key features of IRT Analyzer include:

- A user-friendly, customizable workspace
- High-speed data acquisition from multiple cameras
- A full range of analysis tools, including powerful trend analysis and statistics
- Flexible process automation capabilities
- Template-based report generation system based on Microsoft Word documents
- A variety of image filters
- Multiple export options for easy data sharing and reporting.

1.2 License agreement

IMPORTANT NOTICE

Read this License Agreement carefully before using this Software. BY USING THIS SOFTWARE IN ANY WAY YOU ACKNOWLEDGE THAT YOU HAVE READ, UNDERSTAND AND AGREE TO THE TERMS OF THIS AGREEMENT. IF YOU DO NOT AGREE TO THESE TERMS, DO NOT USE THIS SOFTWARE IN ANY WAY, AND PROMPTLY RETURN IT OR DELETE ANY COPIES OF THIS SOFTWARE IN YOUR POSSESSION.

By installing software in his or her PC, the end-user agrees to be bound to the terms of this agreement. The use of this software is licensed. GRAYESS Inc. grants a unique, nontransferable, personal license to use this software on single computer systems for an unlimited time. This documentation is under copyright, all rights reserved. This document may not, in whole or in part, be copied or changed without prior consent in writing from GRAYESS Inc.. Unauthorized use of this software can result in civil and criminal prosecution.

Warranty

The software and accompanying written materials are provided as is. GRAYESS Inc. makes no other warranty, either expressed or implied, concerning the contents of this documentation or the performance of the software.

1.3 System requirements

Software

IRT Analyzer has been designed to work with Microsoft Windows 7/8/10/11 32- and 64 bit operation systems (PC only, ARM architecture is not supported).

To use reporting features of IRT Analyzer you will also need Microsoft Word 2007/2010/2013/2016 or Microsoft Office 365 installed on your PC.

Hardware

PC hardware requirements depend on the combined camera resolution and on the computation complexity of the tasks that will be running by IRT Analyzer. For one 640x480 IR camera (or for four 320x240 cameras) we recommend having at least the following configuration:

- Processor: x64 architecture, two-core with 3 GHz per core or four-core with 2 GHz per core
- RAM: 6 GB
- Hard disk: 20 GB free space, 7200 RPM HDD or an SSD
- Display: 1920x1080 resolution (minimum - 1280x768)
- Gigabit Ethernet LAN adapter

1.4 Installation

Important

Administrator privileges are required to install IRT Analyzer and associated drivers. If you install IRT Analyzer on a computer managed by an IT department, please contact your System Administrator for assistance.

After installation, IRT Analyzer can be used as a normal user, a*dministrator privileges* are not required.

Installation procedure

You will receive IRT Analyzer installation file in the camera memory or as an Internet download in form of MSI or EXE installation file. To install software on your computer, run the installation file (double click on it in Windows Explorer) and follow the instructions on the screen.

After installation completed, IRT Analyzer will be started for the first time and you will need to enter the *Installation Key* that you have gotten together with the installation file. Please see Managing licenses for details.

Installing camera drivers

If your camera is equipped with USB, IEEE1394 or other interface which is not Ethernet you will also need to install camera drivers. They are not included with IRT Analyzer installation, so please consult documentation delivered by the camera manufacturer. Cameras with LAN, Ethernet, GigE or GigEVision interfaces usually do not require drivers.

Firewalls

During installation IRT Analyzer automatically adds itself to the Windows Firewall exceptions list. Steps below are required only if you have problems connecting to your camera.

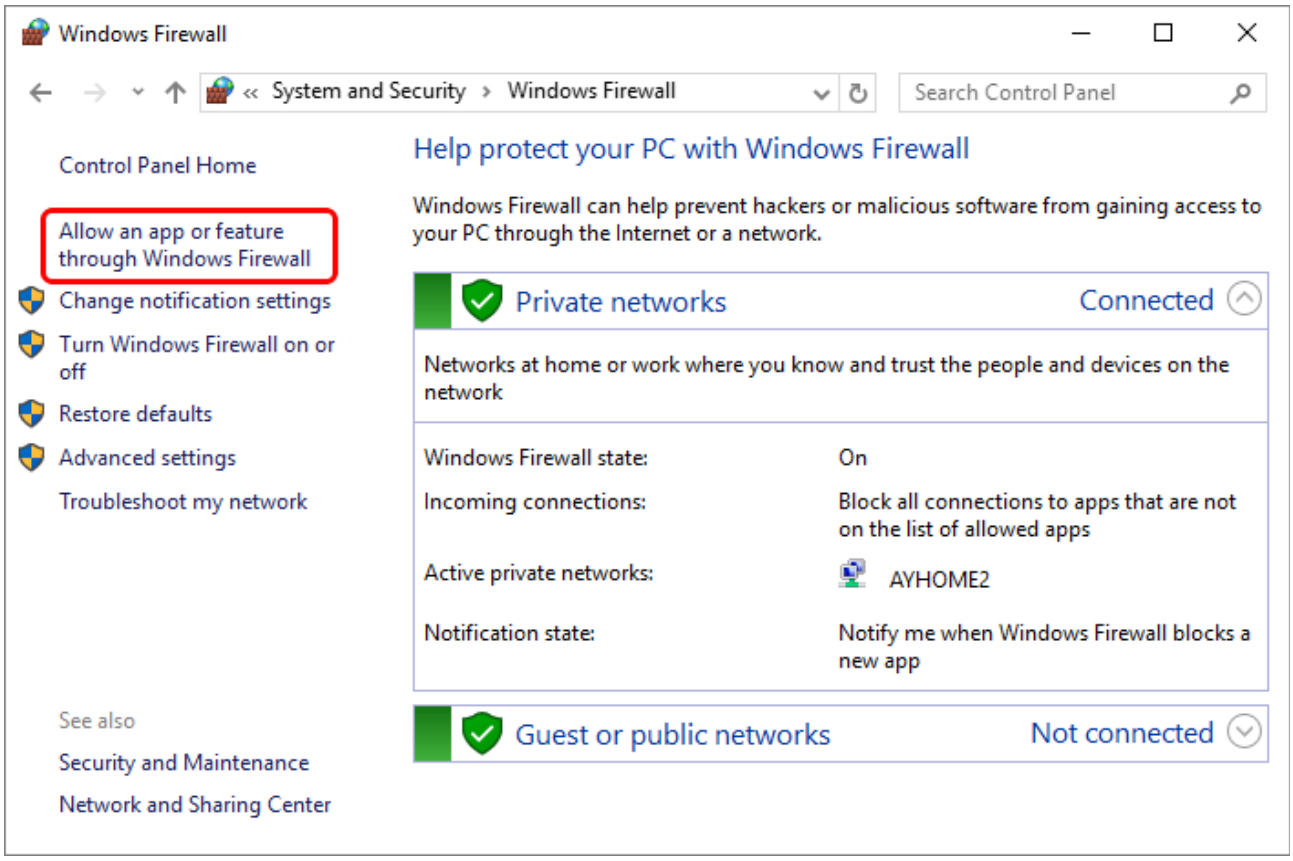
Applies to cameras with LAN, Ethernet, GigE or GigEVision interfaces.

Firewalls will generally block connectivity to a camera. To restore the connectivity, you need to change configuration of the firewall. We will discuss Window Firewall as it is delivered with every Windows installation. If you use another firewall, please consult its documentation.

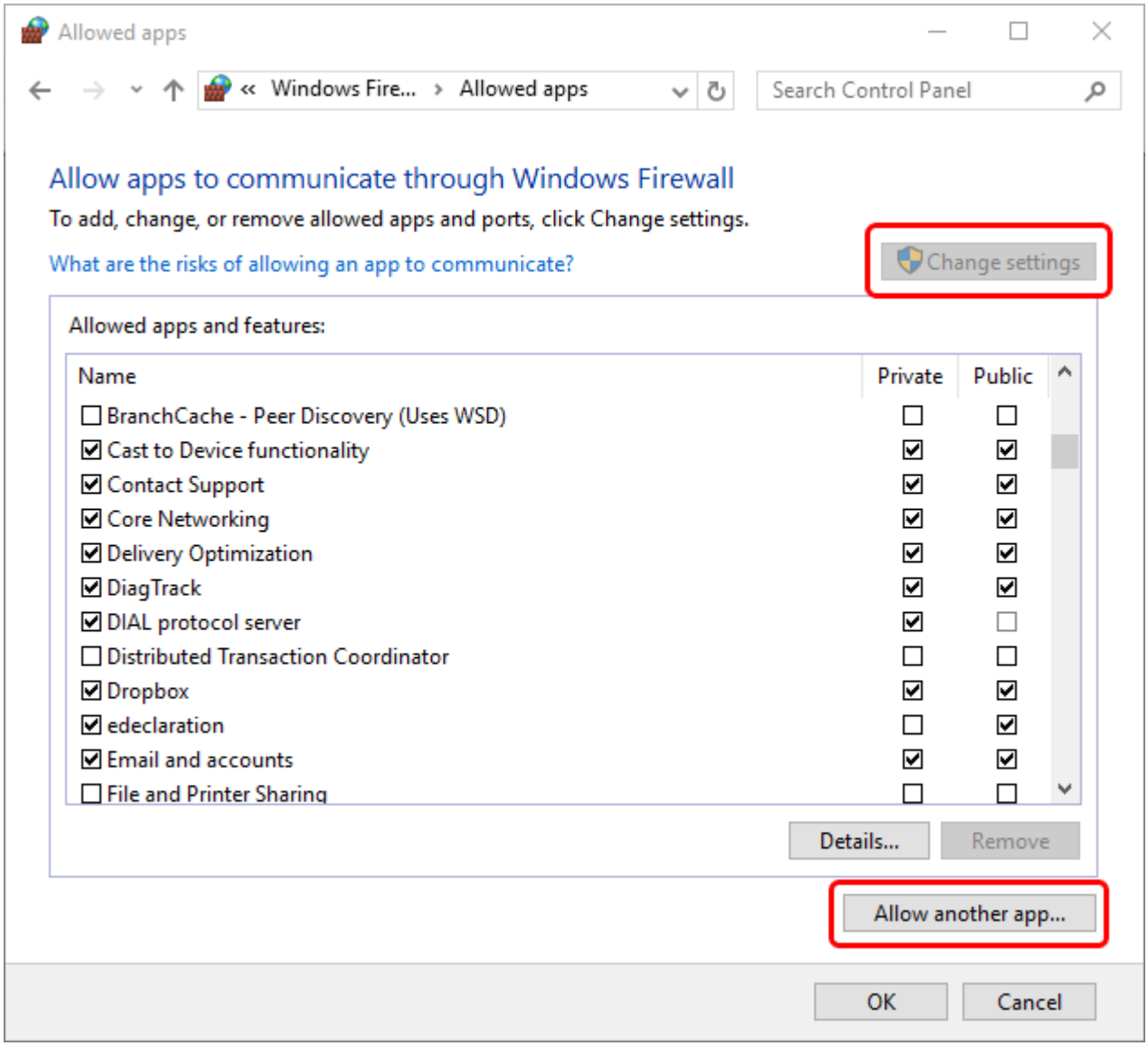
IRT Analyzer is automatically added to the exceptions list in Windows Firewall during the first start at the end of installation procedure. If automatic configuration did not work out, please configure Windows Firewall manually as described below.

To allow IRT Analyzer to receive image data on the network you need to add IRT Analyzer to the exceptions list (list of programs allowed to send data to the network) in Windows Firewall:

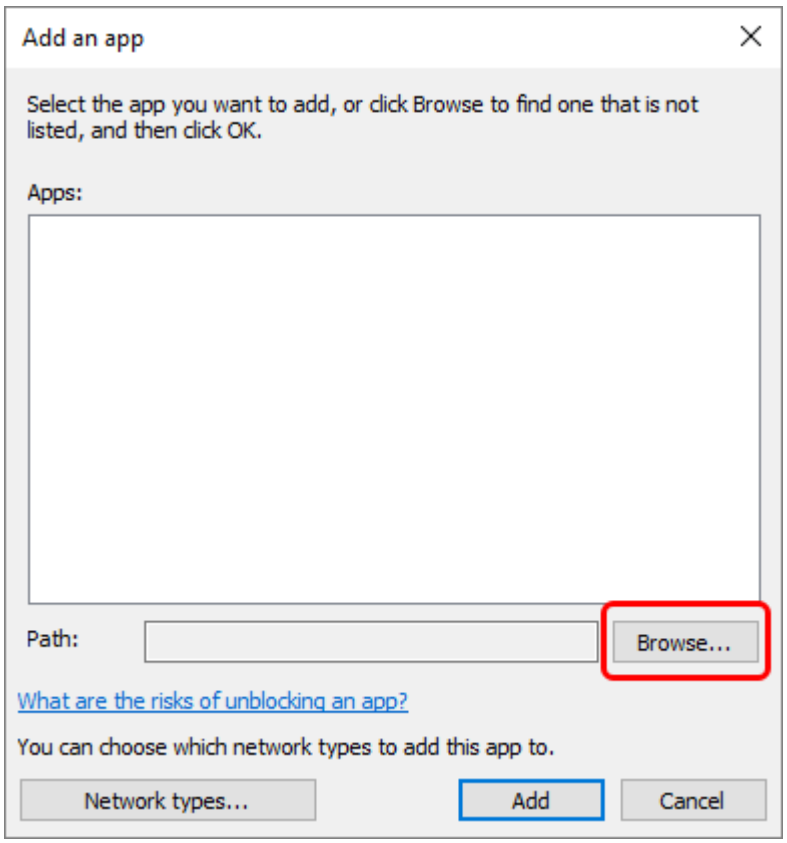
1. Open the Control Panel (icons view) and click/tap on the Windows Firewall icon.
2. Click/tap on the 'Allow a program through Windows Firewall link' in the left pane.



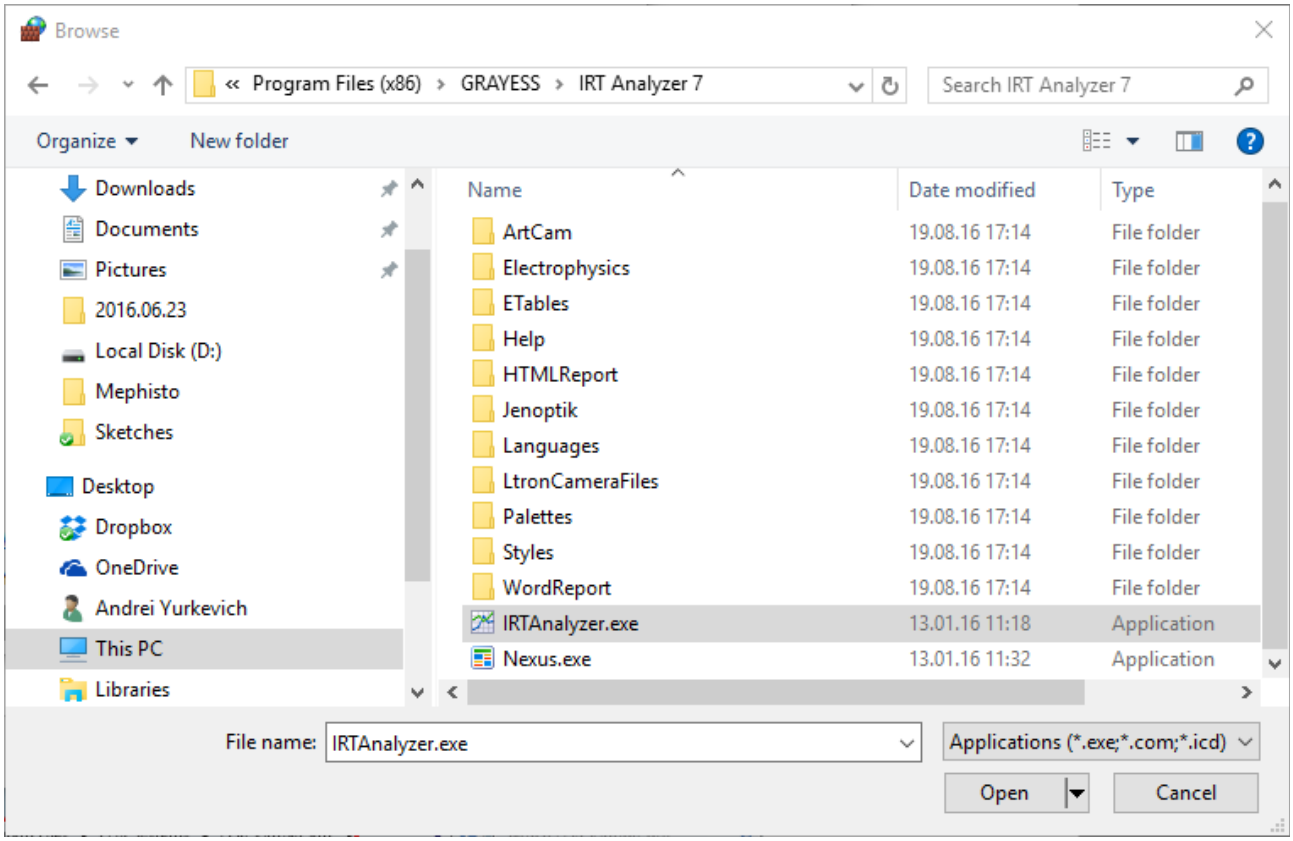
3. Choosing the option to allow a program through the firewall will present you with a list of current exceptions. If the 'Allow another app…' button is disabled, then you will need to click the 'Change settings' button. If your computer is controlled by an IT department you may not have permission to change these settings and you will have to get your IT administrator involved.



4. Then you will see the 'Add an app' dialog



5. Click the 'Browse...' button. Go to the place on your hard drive where IRT Analyzer is installed. Select IRTAnalyzer.exe.



Enable all the check boxes for Private/Public/Domain.

Removing IRT Analyzer

You can remove IRT Analyzer from your computer by using the Microsoft Windows uninstall program procedure (Start > Control Panel > Programs > Programs and Features).

1.5 Managing licenses

GRAYESS IRT Analyzer incorporates cloud-based licensing system to prevent unauthorized use of the software. With your copy of software, you will get so called *Installation Key*, a text string in form:

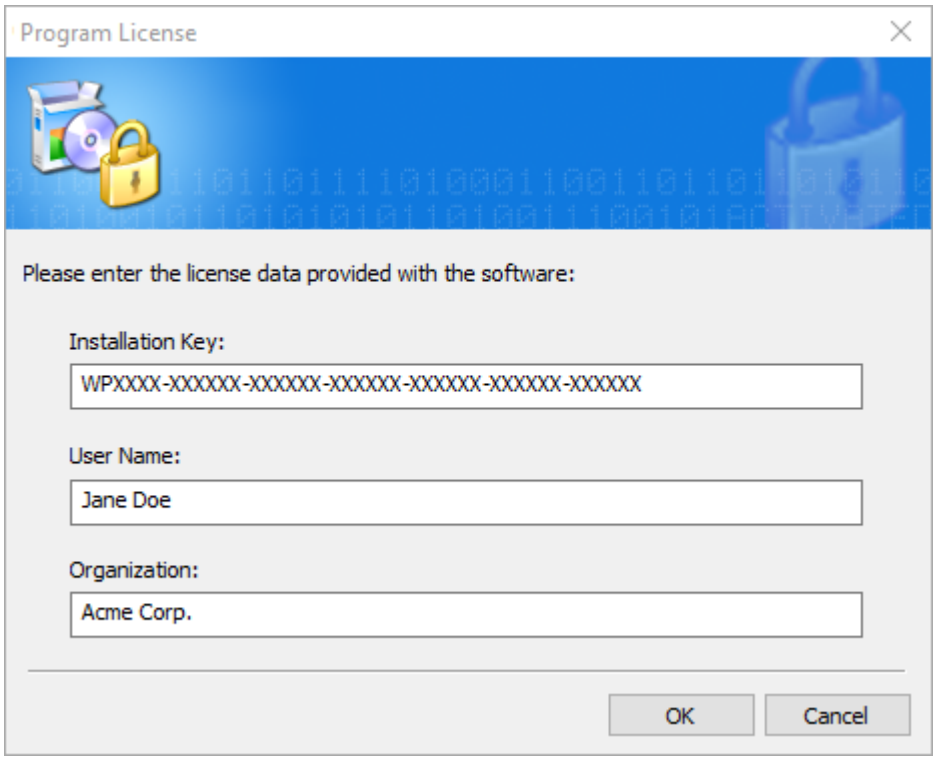
WPXXXX-XXXXXX-XXXXXX-XXXXXX-XXXXXX-XXXXXX-XXXXXX.

This key represents your license and links your copy of software with our licensing database. With one *Installation Key* you can install software on one or more PCs. This depends on the license that you have purchased.

There are also trial installation keys available that allow to use IRT Analyzer with all its functions for a limited period.

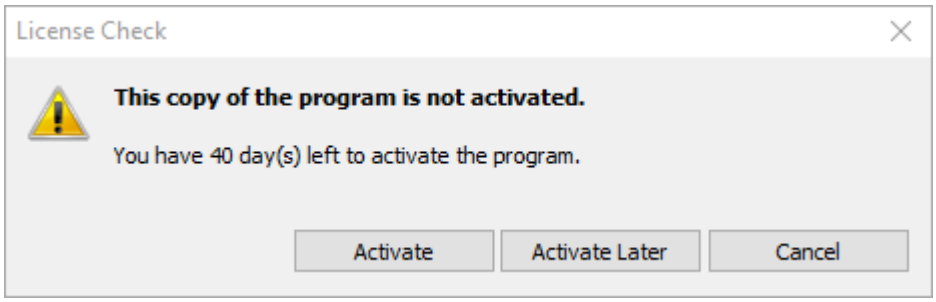
First run

After installation IRT Analyzer will be launched for the first time and you will need to enter *Installation Key*, your name and name of organization purchased license belongs to.

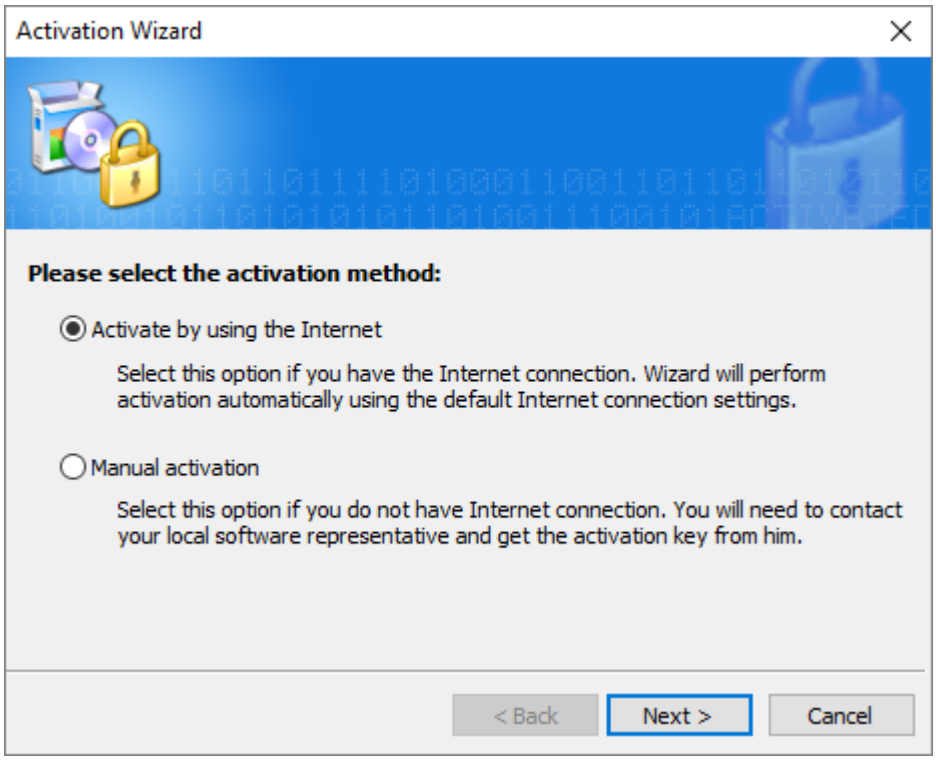


Activation

Before you can use the software, you need to connect to our licensing server and activate the program.



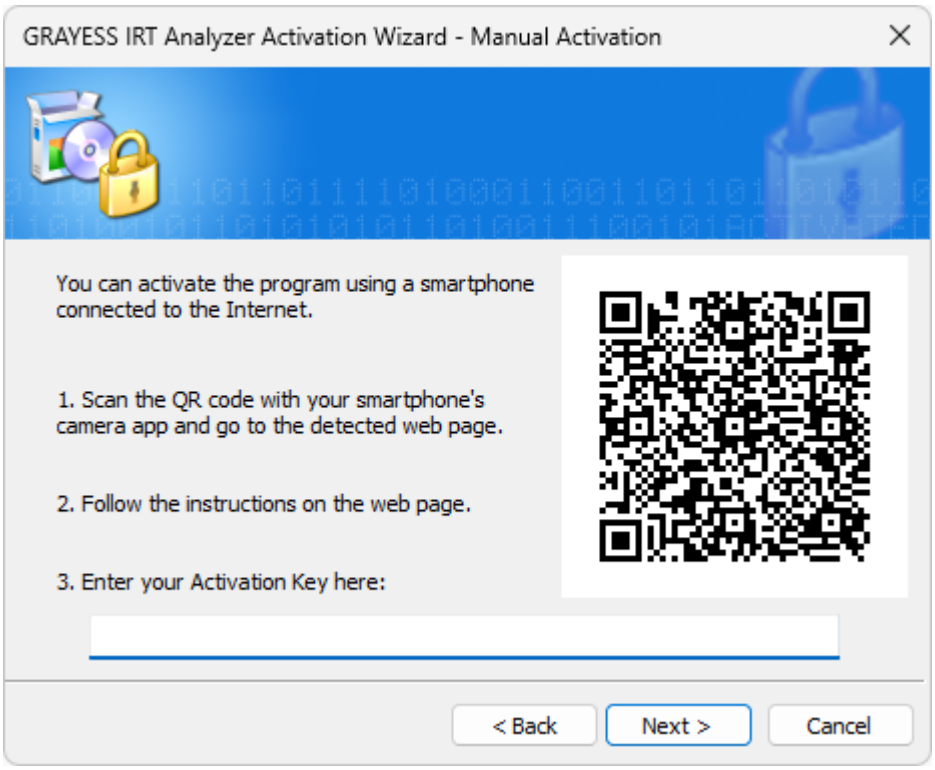
If you have Internet connection, select "Activate by using the Internet".



IRT Analyzer will connect to the activation server and activate your copy of the program.

Manual activation

If your PC is not connected to the Internet, select the "Manual activation" option. To activate the program, you will need a smartphone with an Internet connection and a camera application that can recognize QR codes. Most standard camera applications can do this, but if you have an older smartphone model, you may need to use a special application for scanning QR codes.

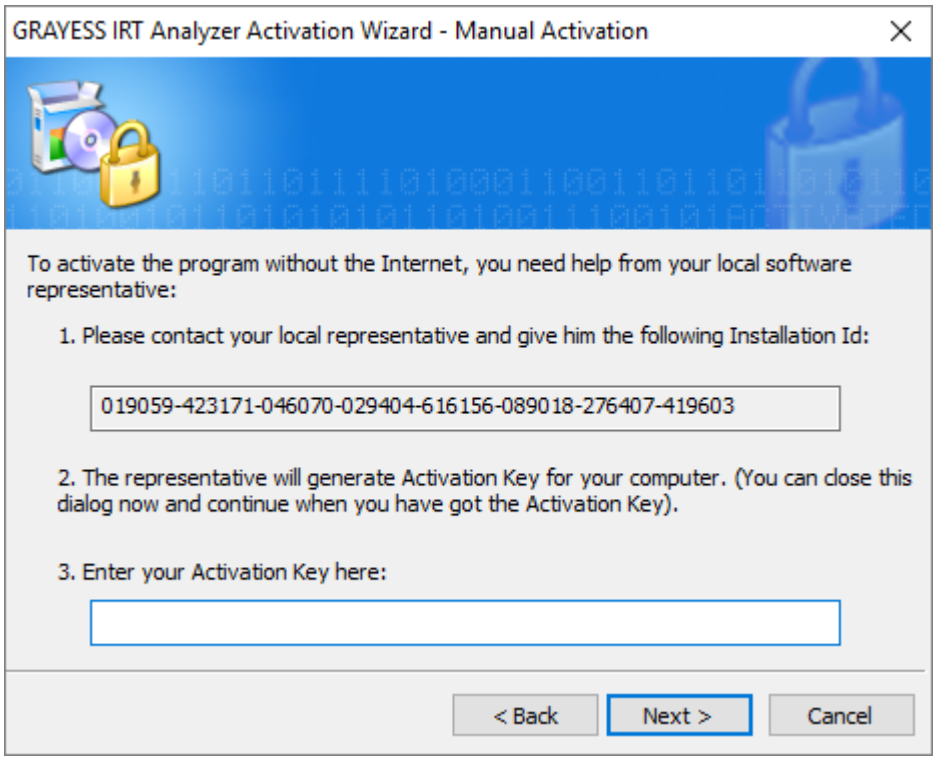


Use the camera on your smartphone to scan the QR code. The QR code contains a link, which will take you to the program's activation page. On this page, an **Activation Key** will be generated for you. Enter this key in the corresponding field in the Activation Wizard on the page with the QR code.

> **Note**
>
> It's important to remember that if you generate an Activation Key but don't use it, the program license will still be activated and your computer will be counted as activated.

Activation with help from your software provider

If, for some reason, both activation options did not work for you, you can contact your software provider to get assistance. Please leave the Activation Key field blank and press 'Next' button. This will bring you to a page with an **Installation Id** code. This code is needed for our support team to find your license on the server, solve the problem and generate an Activation Key for you.



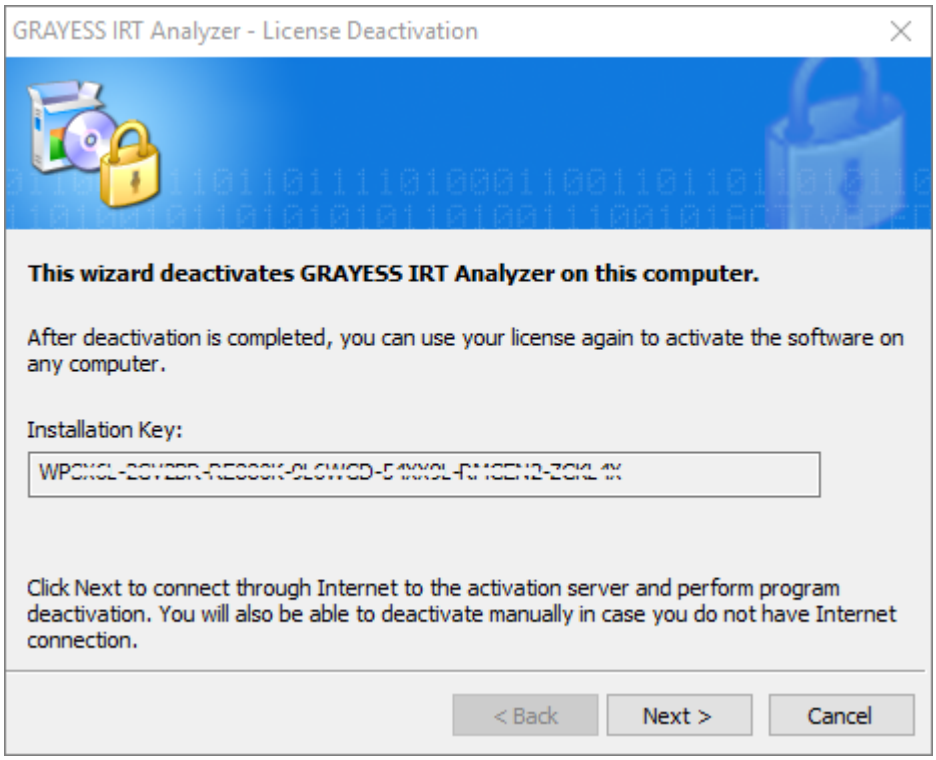
Please copy and pass the *Installation Id* to your software provider.

At this point you can close Activation Wizard. When you will get *Activation Key*, please run Activation Wizard again (you will need to close and open IRT Analyzer) and type or copy *Activation Key* to the corresponding edit box (the key can be entered also on the page with QR code). Click 'Next' to finalize the activation.

Transferring license to another PC

If you do not need IRT Analyzer on your computer, you can transfer your license to another PC. For this, you will need to deactivate the license on the old PC. After that, your license (*Installation Key*) can be used again to install IRT Analyzer on any other PC.

Select 'Help | Deactivate License' in the main menu.



Click 'Next' to deactivate the software automatically through the Internet. In case your computer is not connected to the Internet, you will be given the possibility to deactivate manually with help of a QR code and a smartphone. Procedure is very similar to the manual activation described above.

Important

When you reach the page with the QR code, the program will be deactivated but will still be counted as active on the license server. To complete the deactivation process, you must either use the QR code or seek assistance from your software provider.

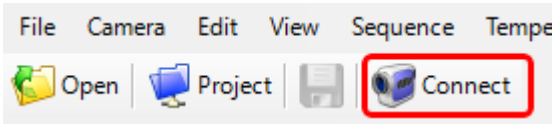
If for any reason the deactivation process was not completed, you will need to reactivate the software on this computer and then deactivate it again in order to remove the computer from the activation list and free up the license.

1.6 Getting started

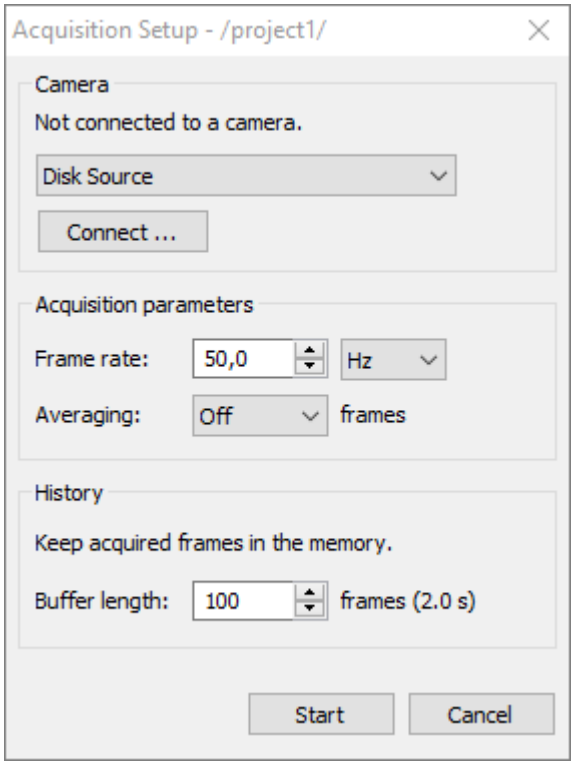
We will briefly discuss here how to connect to a camera, start IR video acquisition and record video to the hard drive. In details these functions will be discussed later in this manual.

Connecting to a camera

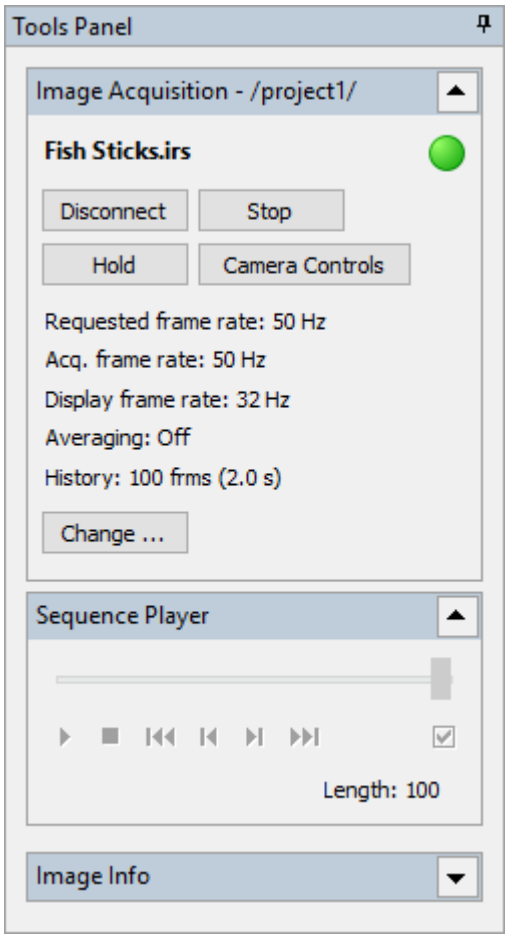
1. Make sure that camera drivers and other necessary software delivered with the camera is installed. Consult the camera documentation.
2. Connect the camera to the computer and power it on.
3. Run IRT Analyzer and click **'Connect'** button in the toolbar.

4. 

5. You will see 'Acquisition Setup' dialog. First you need to select camera driver in the **'Camera'** combo box. 'Disk Source' driver can be used to emulate data from a camera using a prerecorded video stored on disk.

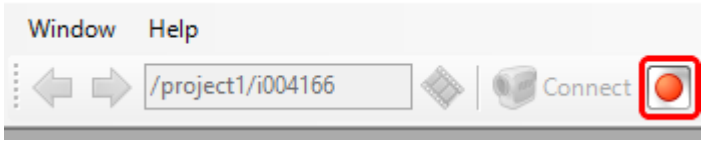


5. Click **'Connect'** button. You will see a configuration dialog to adjust camera communication parameters. For 'Disk Source' driver you may select a sample video located in 'Documents\Infrared Samples'.
6. Click **'Start'** to start acquiring IR video from the camera.
7. To stop image acquisition, click **'Disconnect'**.

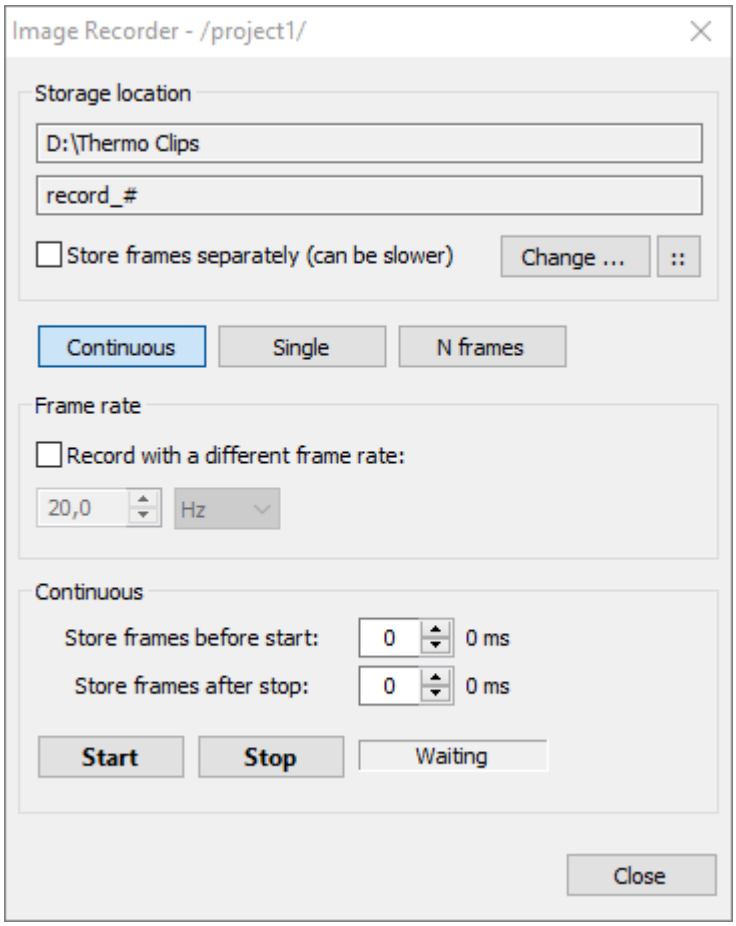


Recording IR video

1. Click on **'Record Images'** button in the toolbar:



This will display the 'Image Recorder' dialog.



2. Select where you want to store your record by clicking on the **'Change'** button.
3. Click **'Start'** button to start recording and **'Stop'** to stop.

Loading the recorded file

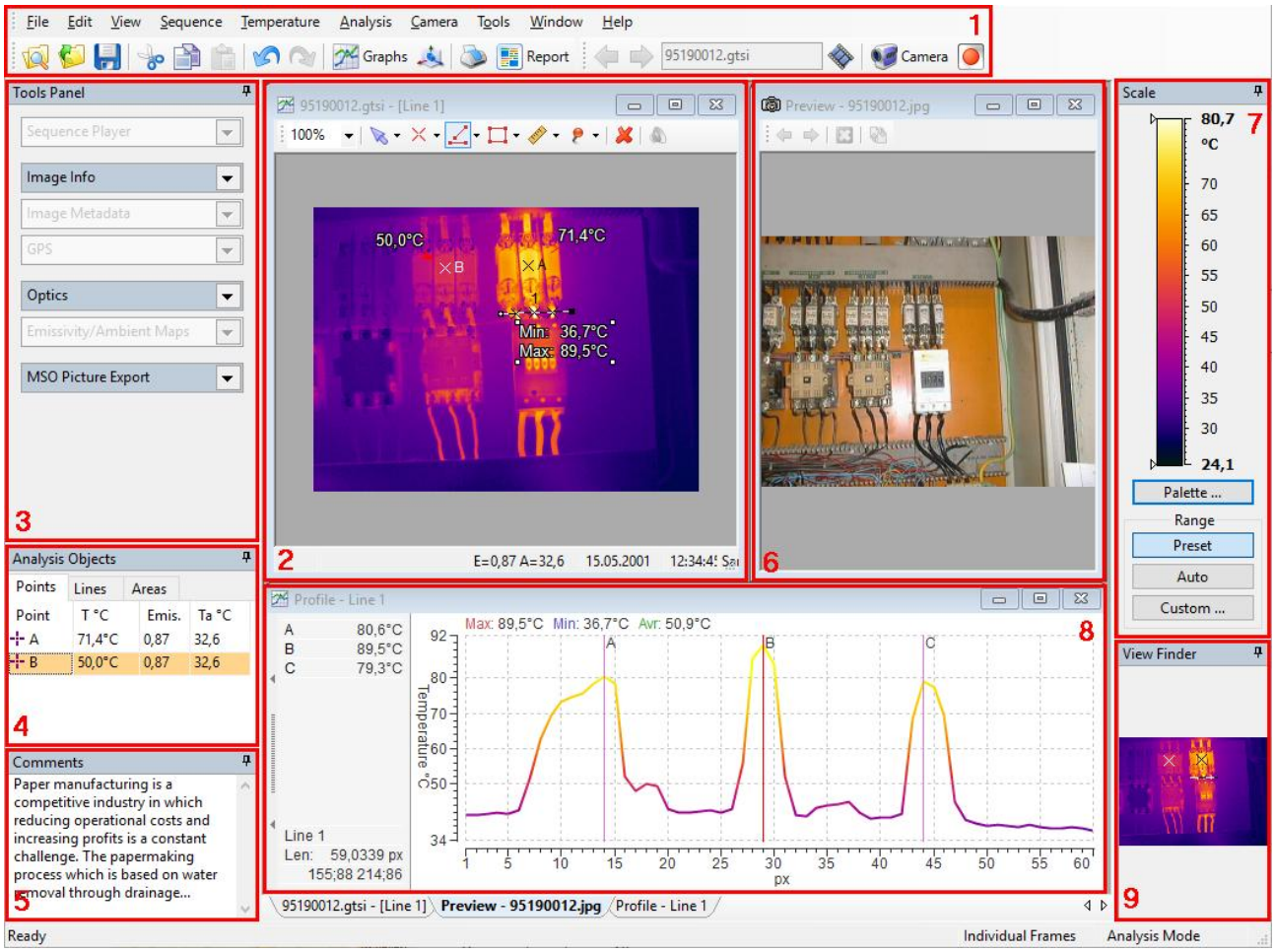
Recorded IR video file can be opened for detailed offline analysis. Use main menu **'File | Open'** and browse for the storage location which was selected when images were recorded.

1.7 Main window

IRT Analyzer application's main window consists of the following items:

- Main menu and toolbar (**1**).
- IR image window (**2**): displays the infrared image with analysis objects.
- Tools Panel (**3**): contains list of dialogs and information windows allowing to change active image properties or perform some action.
- Analysis Objects window (**4**): contains information about all analysis objects, such as spot values, average, minimum, maximum values, and others.
- Comments window (**5**): text comments.
- Preview window (**6**): this window can display corresponding visual image or also another infrared image.
- Temperature scale (**7**): shows relation between color and temperature values.
- Diagram window (**8**): displays a graph for the active object, like profile, histogram or trend.

- View Finder (**9**): always displays full IR image preview, this is helpful when main IR image is zoomed.

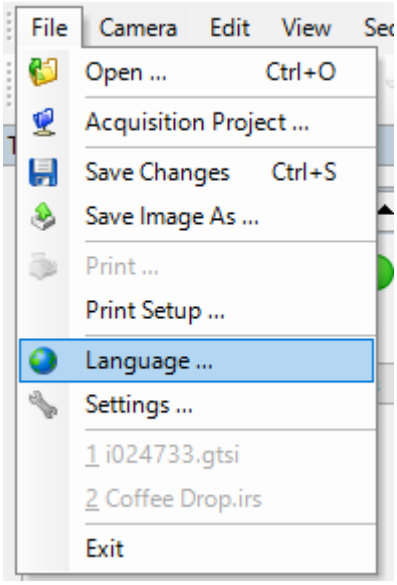


Positions of all windows are not fixed, windows can be moved and rearranged the way you like.

Interface language

IRT Analyzer is translated into several languages. By default, the language that corresponds to your OS system language is selected. You can also select another language.

- Choose main menu 'File | Language'.
- Select preferred language from the list and click OK.



You will be prompted to re-run the application, because newly selected language can be applied only during the start of the program.

2 Acquiring IR images

2.1 Acquisition setup

To see live IR image, you need to connect to the camera and start image acquisition.

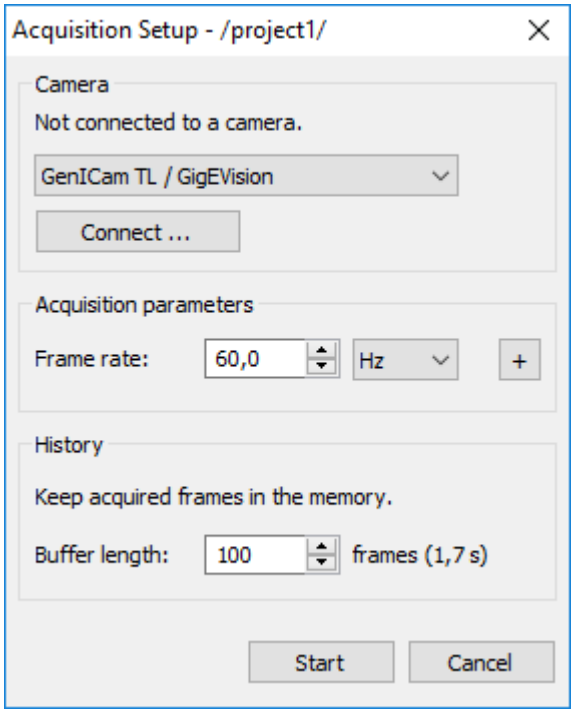
Camera drivers

If your camera uses USB or IEEE1394/Firewire interfaces to connect to PC you need to make sure that appropriate camera drivers are installed.

IRT Analyzer does not include camera drivers, please consult camera documentation for the driver installation procedure.

To connect to a camera, select **'Camera | Connect'** in the main menu or press the corresponding button 

in the toolbar.



After connecting to the camera and setting acquisition parameters press **'Start'** to start image acquisition.

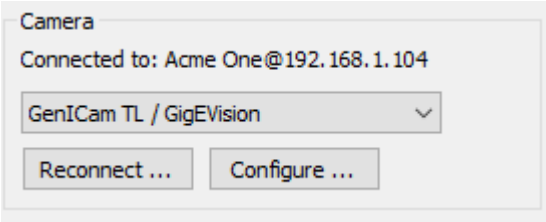
Connecting to the camera

In the **'Camera'** group select camera type that you are connecting to. Press **'Connect'** button.

You will see connection parameters for your type of camera:

- FLIR T-series and FLIR A3X0
- Jenoptik VarioCam HD
- ThermoView TV40
- ThermoView Pi20
- Fluke Tix560

When connection to the camera is established, you will see the corresponding message:



Acquisition parameters

Frame rate

IRT Analyzer does not know the real frame rate of the connected camera; it allows to set any frame rate. If you want to run acquisition at the maximum frame rate then select a value which is obviously bigger than the maximum camera frame rate, for example 100 Hz.

To reduce frame rate - select a value lower than the camera frame rate. IRT Analyzer will try to send a command to the camera to deliver frames at a lower frame rate. If such command is not available frame rate will be reduced by skipping excess frames.

Frame rate is normally specified in Hz which has the same meaning as frames per second (FPS). When you need low frame rates, lower than one frame in a second, it is more convenient to use time delay between frames as measure of the acquisition speed. For example, you can set frame rate to be '2 min': one frame will be acquired every 2 minutes.

History buffer

IRT Analyzer keeps acquired images in the memory buffer. Here you can set the size of this buffer. It is a cycle buffer - when it gets full the oldest frame is removed to free space for the new frame.

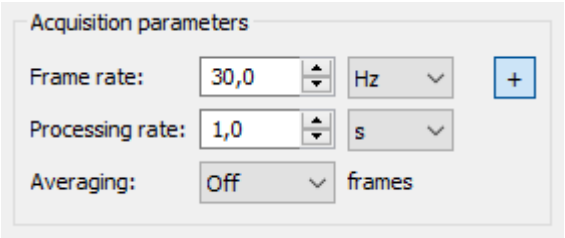
Maximum buffer size is limited only by available PC memory. You can set any buffer length, but when IRT Analyzer sees that there is no more memory available it starts to delete old frames even when buffer length has not reached the specified limit.

Uses of the history buffer:

- You can pause image acquisition and go back in time to see what was happening before.
- Images in the memory buffer are used to build temperature trends.
- After acquisition is stopped you can save images from the memory buffer to disk (for high-speed IR cameras this is the only way not to lose frames because of HDD is not fast enough).
- Frames from the memory buffer are used for pre-trigger recording to save events that were happening just before start trigger was fired.

Advanced acquisition parameters

To show advanced acquisition parameters click on the button with plus sign.



Processing rate

With the help of *processing rate* parameter, it is possible to set a lower update rate for analysis functions:

1. History buffer. Allows to not to put all acquired images to the buffer and therefore to cover longer period with the same limited buffer size.
2. Trends.
3. Automation mode measurements and alarms.

Averaging

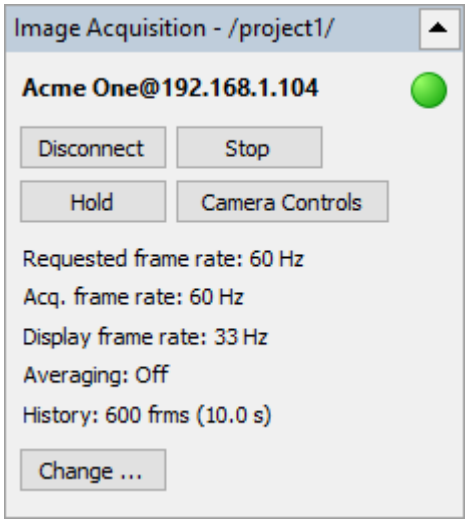
When averaging is enabled, several consequent frames are combined together. Every pixel of the resulting frame has a value which is an average of pixel values of the several source frames.

Averaging is used to improve temperature reading accuracy, but it can only be used on slowly changing scenes.

Applying averaging will not reduce resulting frame rate - IRT Analyzer updates averaged image with every new frame.

Acquisition status window

State of the running acquisition is shown in the Tools Panel:



This window contains several important real-time parameters:

- Green light signals that connection is present - data is being received from the camera.
- *Requested frame rate*: rate that program tries to achieve (excess frames are skipped).
- *Acquisition frame rate*: real measured rate at which frames are acquired and added to the memory buffer. Having this value lower than the frame rate at which camera works (and of the requested frame rate) means that there are either problems with data transfer or with PC performance.
- *Display frame rate*: real measured rate at which frames are displayed on screen. This parameter is sacrificed when program tries to meet goals for the acquisition frame rate.

And command buttons:

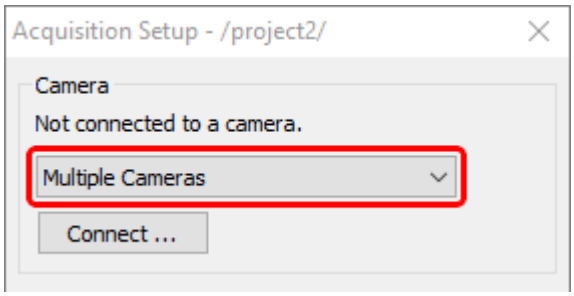
- *Disconnect*: stops acquisition and disconnects from the camera. Use it to change acquisition parameters, to reconnect the camera or to connect to another camera.
- *Stop/Start*: stops image acquisition if it is running or starts it when acquisition is stopped. Connection to the camera is kept, but the camera is instructed not to send image data.
- *Hold/Resume*: stops or resumes live display of the acquired images. When on hold, images continue to be added to the memory buffer (no data loss), but the current image is frozen. Also, in the hold mode you can use Sequence Player to display an earlier frame from the memory buffer.

- *Camera Controls*: shows dialog with camera controls, like focusing, temperature range selection and others.
- *Change*: allows to change acquisition parameters (frame rate, averaging, buffer size) without disconnecting from the camera.

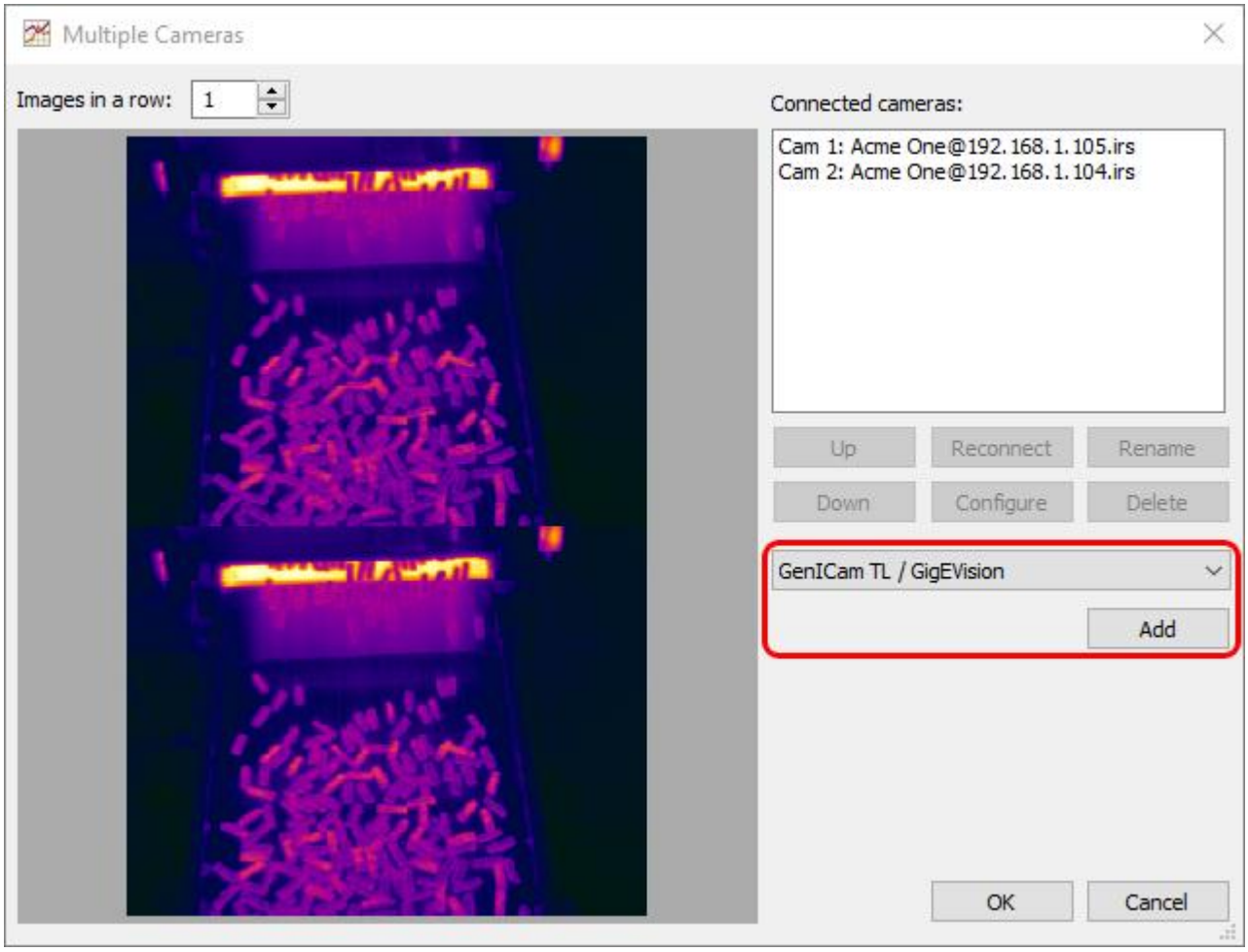
2.2 Multi-camera acquisition

IRT Analyzer supports simultaneous connection to several IR cameras. Images from all cameras are combined into one big image. Number of source cameras is only limited by performance of your PC and communication channels.

To connect to several cameras simultaneously open the usual Acquisition Setup dialog (menu **'Camera | Connect'**) and select **'Multiple Cameras'** in the combo box:



Press 'Connect'.



Choose the camera type and press **'Add'** button. Select camera you want to connect to (exact actions depend on the camera type). Repeat these steps for the next camera.

Images from the connected cameras are combined by placing them one next to the another in the order they are displayed in the connected cameras list. Number of images in one row is set in the edit box above the image.

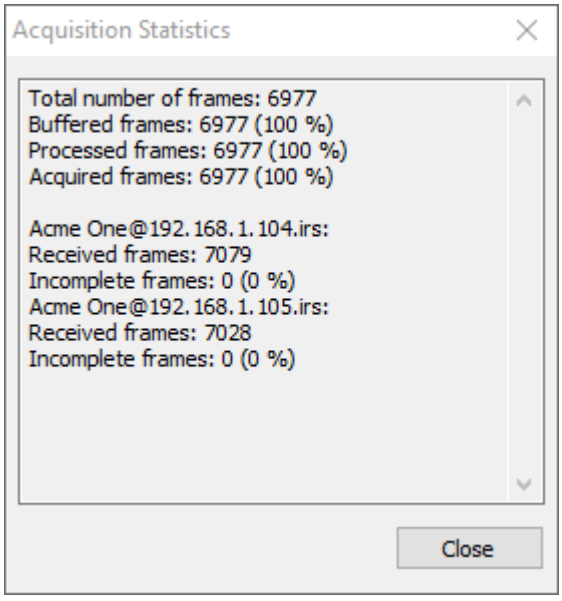
When you start acquisition, the composite image is displayed in the main IR image window with all analysis tools available.

> One instance of IRT Analyzer can display only one main (analyzed) IR image window. To display images from several cameras in different windows you will need to run multiple instances of IRT Analyzer. For details, please see Multiple program instances topic.

2.3 Resolving problems with acquisition frame rate

If you do not achieve the necessary frame rate, you can check acquisition statistics to see where frames are lost.

Select **'Camera | Statistics'** in the main menu.



- *Total number of frames*: number of frames counted by camera driver (in case of multiple cameras used - number of composite frames). Frames dropped by camera driver (e.g., incomplete frames) are not counted.
- *Buffered frames*: frames put to the processing buffer (value in brackets - relative to the total number of frames).
- *Processed frames*: number of frames checked for alarms in case automation mode is running, otherwise same as buffered frames (value in brackets - relative to the total number of frames).
- *Acquired frames*: number of frames put to the history buffer and available for analysis (also trends), display and recording. Value in brackets is the portion of acquired frames comparing to the total number of frames. Acquisition frame rate displayed in the camera status window is measured by this number.

Then you can see acquisition statistics for each camera individually:

- *Received frames*: number of frames counted by the camera driver (incomplete frames are not counted).

- *Incomplete frames*: number of frames dropped by the camera driver because data was partly lost (corrupted) during transportation.

Interpretation

IR image frames are received from the camera (*total number of frames*), then put to the processing buffer (*buffered frames*), then checked for alarms if automation mode is running (*processed frames*) and finally analyzed and put to the history buffer where they are available for further handling - display, recording, etc. (*acquired frames*). Frames analysis includes on-image objects, diagrams, trends and is running after processing, in a lower-priority thread.

Knowing this, we can make the following interpretation of acquisition statistics:

- Number of buffered frames is less than 100%: calculation needed to process each frame (check for alarms) is too time consuming; CPU is not fast enough. IRT Analyzer sees this and automatically drops some frames at the buffering stage as they won't be handled anyway.
- Number of processed frames is less than 100%: CPU is not fast enough to process (check for alarms) all frames. Solution: reduce frame rate; make alarms checks less computationally expensive (use smaller analysis objects, do not use averaging and other filters).
- Number of acquired frames is less than 100%: CPU is not fast enough to analyze and display analysis results. Solution: reduce frame rate; use smaller analysis objects; do not use averaging and other filters; close unneeded diagrams and trends.

2.4 Acquisition projects

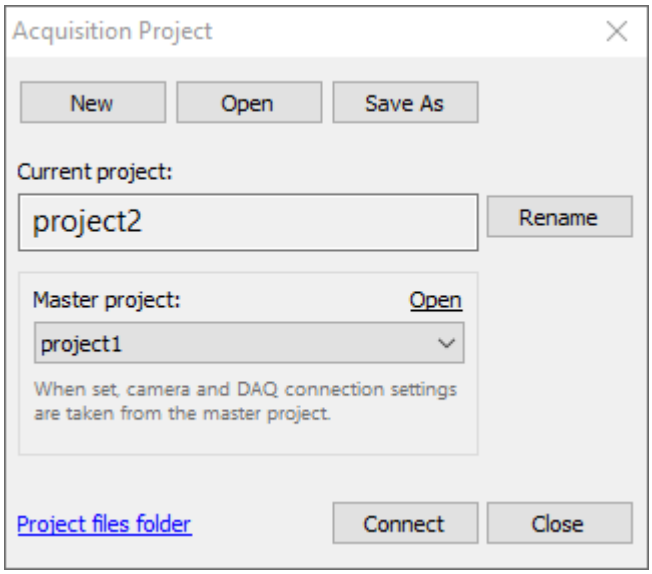
Acquisition projects are used to store parameters of connected cameras, measurement objects and other acquisition and automation related settings. Acquisition projects are only needed when you work with an IR camera. When you work with stored images or sequences projects are not used.

An acquisition project stores the following data:

1. Address and other connection parameters of the camera.
2. State parameters of the camera like working range, motorized focus position, non-uniformity correction (NUC) periods.
3. Measurements: analysis objects and graphs.
4. Image recorder storage names and locations.
5. Automation mode settings including DAQ configuration.
6. Auto-start options.

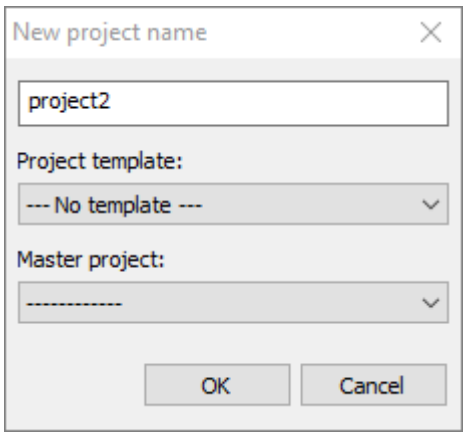
> **Note**
>
> IRT Analyzer always has an associated acquisition project, even when you do not define it specially. When IRT Analyzer is started for the first time a new empty project is created. When you quit IRT Analyzer the active acquisition project is remembered and will be used when you will start the program next time.

Projects are loaded, created and saved with the help of Acquisition Project dialog. Open it using main menu **'File | Acquisition Project'**.



Creating a new project

Press **'New'** button to create a new project.



New project can be based on a project template. In this case it will copy analysis, automation and other settings from the template.

Opening an existing project

Projects are stored in the special projects folder: %ProgramData%\GRAYESS Inc.\GRAYESS IRT Analyzer\Projects.

Press **'Open'** button to show projects folder and select needed project to load it. You can also browse to a different folder and load a project from there. In this case selected project will be first copied to the projects folder and then opened.

Saving changes made in a project

Changes made in a project are saved using main menu **'File | Save Changes'** or the save button  in the toolbar. When you quit IRT Analyzer and your current project is modified, program will remind you to save changes.

Saving a project with a new name

You can save a copy of the current project with a new name. Use **'Save As'** button for this. If there are not saved modifications in the current project they will be saved to the new project, the old project will remain unchanged.

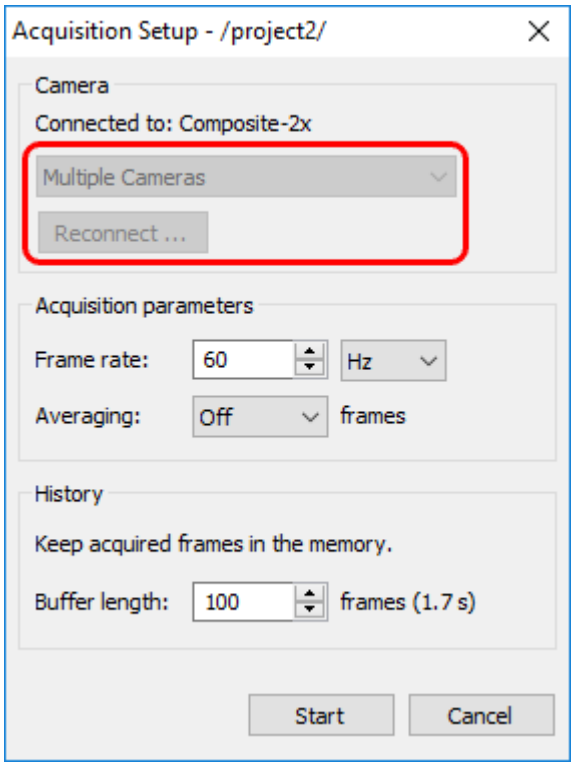
Use **'Rename'** button to rename the current project.

Master project

If master project is set the following setting are taken from it and cannot be edited in the current project:

- camera connection settings;
- DAQ configuration;
- PTZ configuration;
- Project loading automation list.

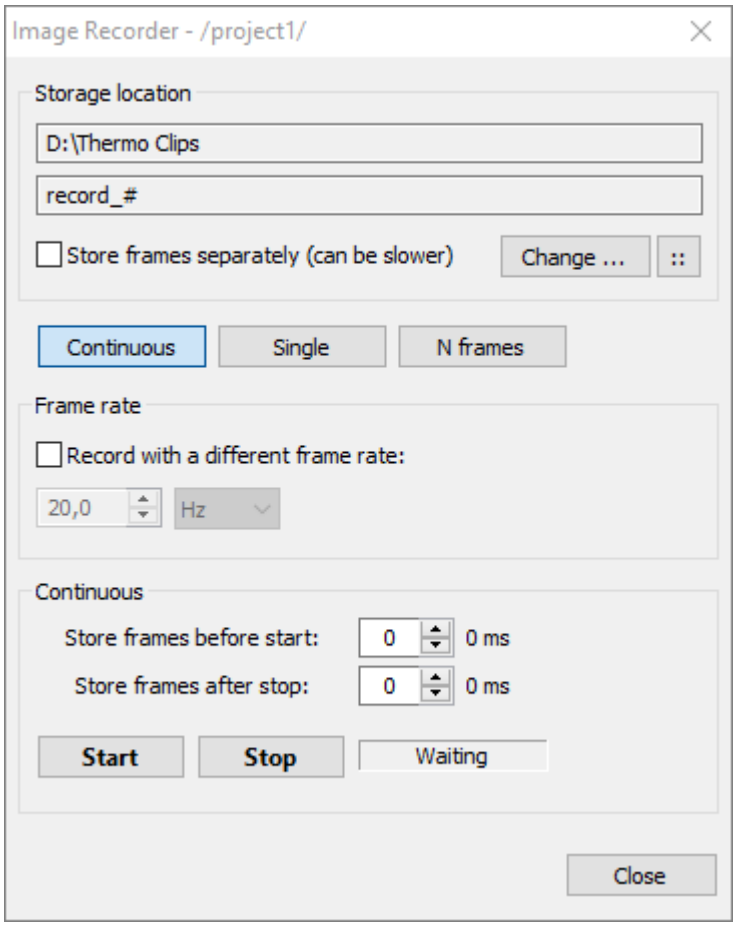
On the screen shot below camera connection settings cannot be changed because they are taken from the master project.



2.5 Image recorder

Image recorder is used to capture image data coming from the camera and save it to disk.

To open Image Recorder dialog select **'Camera | Record Images'** or press corresponding button  in the toolbar.



Storage location

IR video is stored in IRS (infrared sequence) files. When you start recording, program opens a new file to store data. IRT Analyzer never overwrites existing files. So that it is possible, file names are made unique with the help of a counter or using the current date and time. When a counter is used, program examines which numbers are already taken by checking files in the folder and selects the next available number.

For example, for the settings shown in the screen shot above the following files will be recorded:

```
D:\Thermo Clips\record.irs
D:\Thermo Clips\record2.irs
D:\Thermo Clips\record3.irs
...
```

Store frames separately

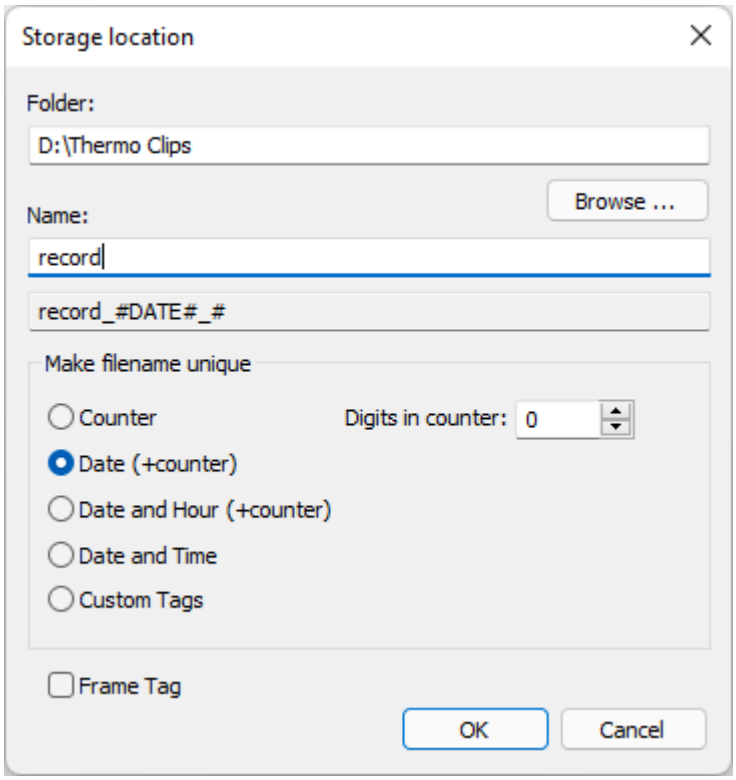
There is a possibility to save every video frame in a separate file. This option is enabled by marking **'Store frames separately'** check box. In this case instead of sequence files IRT Analyzer creates folders. Every file in such folders stores single video frame.

File naming schemes

There are two options to define file naming scheme: simple and advanced. To use the simple naming scheme, click on **'Change'** button and in the standard file dialog select a file path. IRT Analyzer will use this file path for the first recording, for next recordings it will automatically add sequential numbers to the file name.

In the advanced scheme you can use timestamps in the records names and define custom naming schemes.

Click on :: button to show the advanced storage location settings:



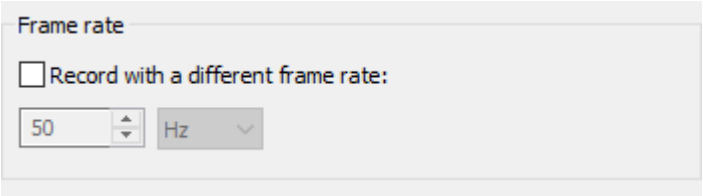
Here you separately specify folder path and file name:

1. To select a folder, click on **'Browse'** button.
2. Type in a file name and select a method to make every record name unique:
   - *Counter*: program will add sequential numbers at the end of every record name. You can also set the number of digits in the counter to have numbers looking like 0001, 0002 and so on.
   - *Date and Counter*: date in format 20171231 and counter will be added.
   - *Date and Time*: date and time in format 20171231_235959 will be added.
   - *Custom Tags*: you are supposed to use your own tags (see below) in the Name field. If your tags do not produce unique file names, program will add counter at the end to ensure that names are unique.
   - *Frame Tag:* when this option is marked, program will add frame tag (image comment) to the file name. It will be added to both sequence file names and to frame names in case separate frame storage is enabled.

With every naming option, and especially with Custom Tags option, you can use additional tags in the Name field. Tags are special words in angular brackets. They will be replaced by the actual values at the moment the file is created on the disk:

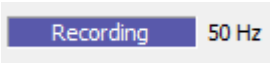
- <project>: name of the acquisition project
- <dtime>: date and time in format 20171231_235959
- <date>: date in format 20171231
- <dd>: day 1-31
- <MM>: month 1-12
- <yy>: last two digits of the year
- <yyyy>: year
- <hh>: hour 0-23
- <mm>: minute 0-59
- <ss>: second 0-59
- <mss>: millisecond 0-999
- <tag>: frame tag (comment)

Recording frame rate



If **'Record with a different frame rate'** is not marked, IRT Analyzer will try to record all video frames. Please be aware that there can be significant amount of data and the hard drive of your computer may not be fast enough to write the data at the necessary speed. When the hard drive does not have time to write all the data, IRT Analyzer will automatically drop some frames.

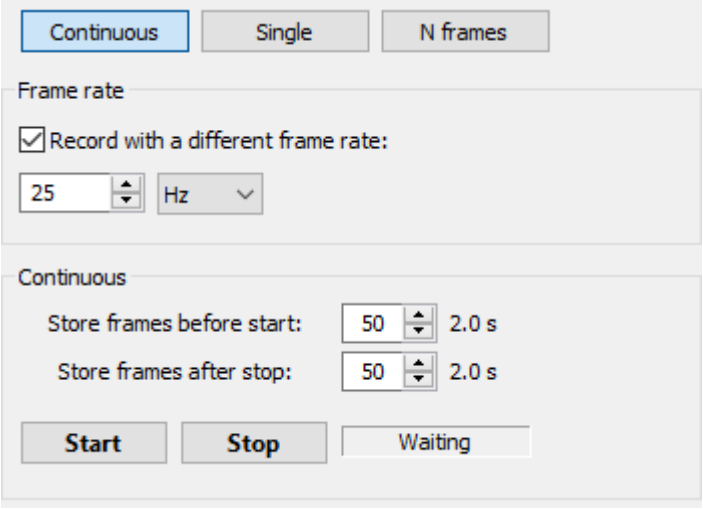
Real recording frame rate is displayed in the dialog during recording:



You can change recording speed to save less data. Frame rate is normally specified in Hz which has the same meaning as frames per second (FPS). When you need low frame rates, lower than one frame in a second, it is more convenient to use time delay between frames as measure of the recording speed. For example, you can set frame rate to be '2 min': one frame will be recorded every 2 minutes.

Continuous recording

This mode is used when you record video clip. Press **'Start'** to start recording and **'Stop'** to stop recording.



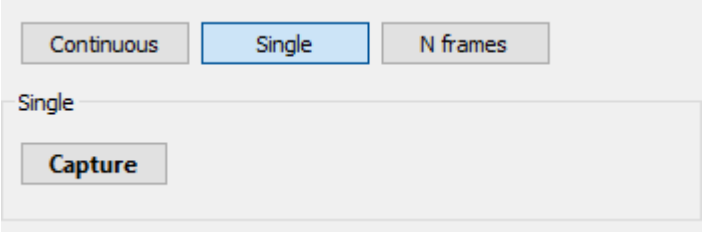
Pre- and post-trigger recording

You can setup image recorder that it will record data acquired before you pressed the **'Start'** button. This will compensate your reaction delays for quick processes. Length of the recorded pre-trigger video is limited by the size of the history buffer defined during acquisition setup. Number of frames taken from the history buffer is defined by **'Store frames before start'**.

In the same way you can tell image recorder to record some data after you press **'Stop'** button. This is defined in the **'Store frames after stop'** field. Length of the post-stop video is not limited as history buffer is not used in this case.

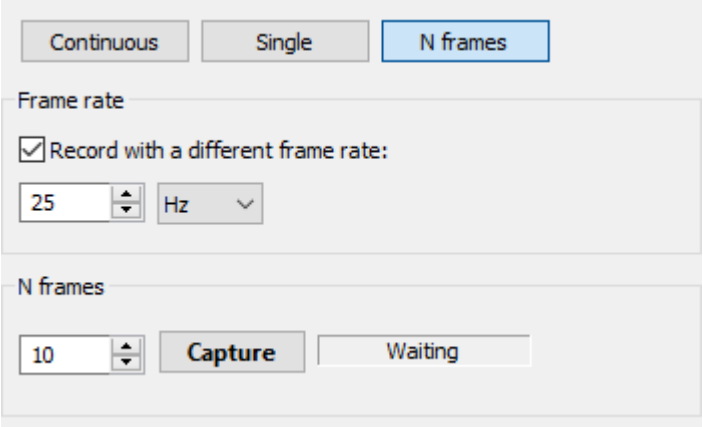
Single-frame recording

This mode is simple. You press **'Capture'** button, and the current IR image is stored to the disk. The image is stored in a GTSI file with analysis information in it.



N frames recording

This mode is like the continuous mode, but the length of the recorded sequence is limited. After program records the specified number of frames, recording is automatically stopped. Pre/post trigger recording is not available in this mode.



2.6 Connecting cameras

2.6.1 Fluke TV40

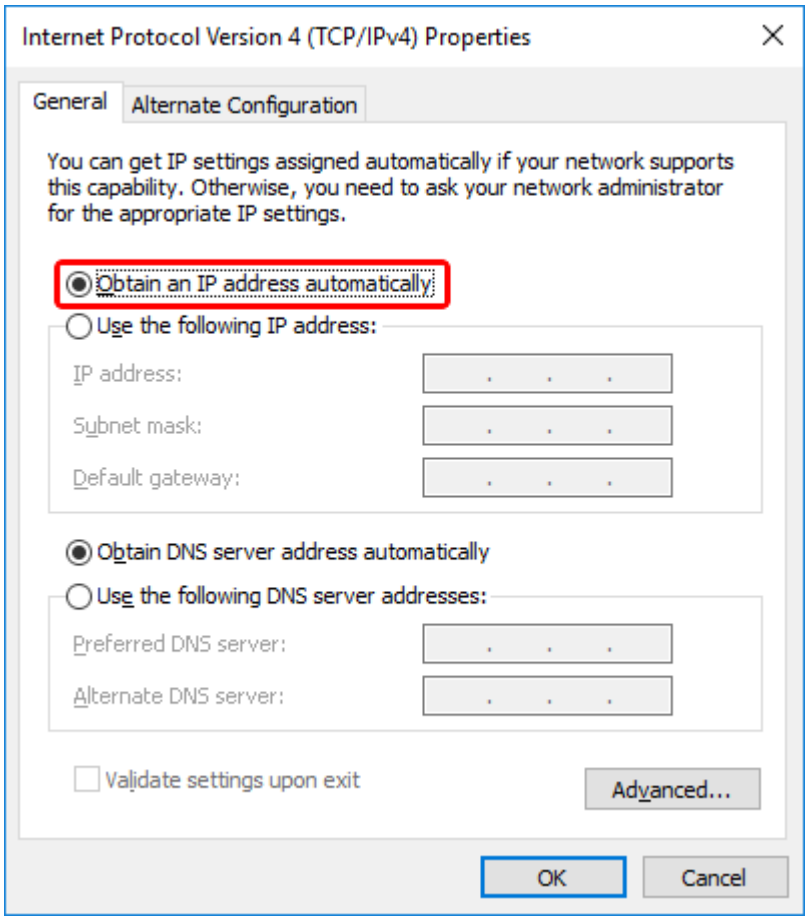
Fluke TV40 series cameras have GigEVision interface and can be connected to a PC using Ethernet cable. When connected to a local area network the camera acts as any other Ethernet (IPv4) device and needs an IP address:

- If a DHCP server is available, camera gets IP address from the DHCP server.
- If there are no DHCP server or camera is connected directly to the Ethernet port of a PC - IP address is selected automatically from the private IP range: 169.254.0.1 through 169.254.255.254.
- It is also possible to set a fixed IP address in an Internet browser using the camera web interface (you need to know current IP address of the camera and type it in the address line).

Configuring network adapter for direct camera to PC connection

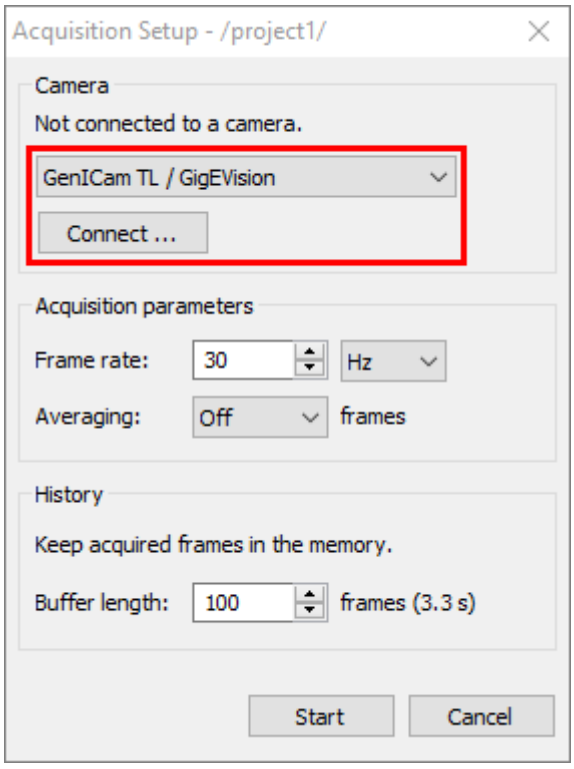
You can connect Ethernet cable from the camera directly to the PC, without any router in between. In this case camera IP address is selected from the automatic private IP range.

To communicate with the camera, your PC network adapter must be configured to use the same IP range (subnet). The easiest way to do it is to select "Obtain an IP address automatically" option in the TCP/IPv4 settings of the PC network adapter connected to the camera. In this case computer's IP address will be also automatically selected in the same 169.254.X.X range.

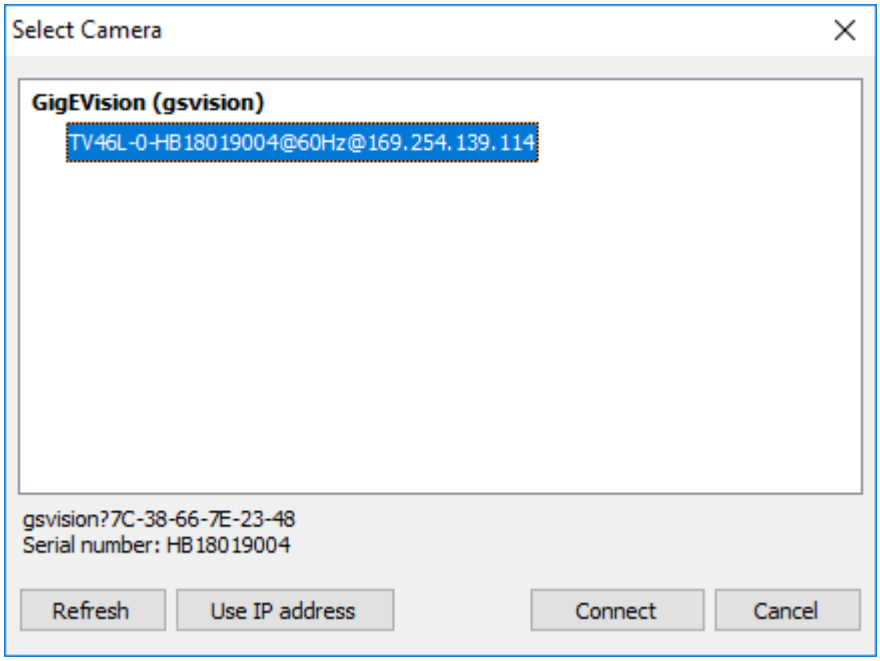


Connecting to the camera

1. In IRT Analyzer open Acquisition Setup dialog by selecting main menu item **'Camera | Connect'**. Chose **'GenICam TL / GigEVision'** camera type and press **'Connect'** button.



2. Select the camera you want to connect to, and press **'Connect'** button. If you do not see the camera in the list, you can try to update camera list by pressing **'Refresh'** button.



Text "***other subnet***" after the camera name means that IP address of the camera does not match IP address of the PC: the PC and the camera are in different subnets. If the subnets are not linked by a router connection to the camera will not be possible.

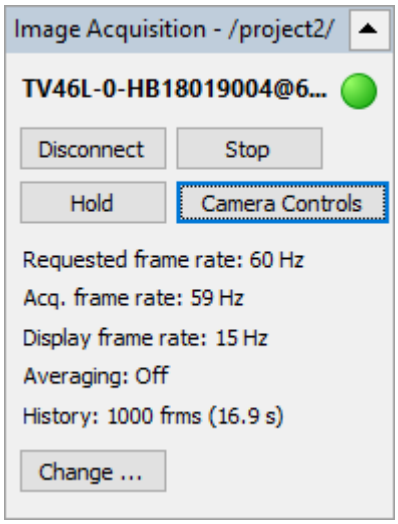
Text "***in use***" after the camera name means that another PC or another program on your PC already established connection with the camera. This will not allow you to connect.

Connecting to camera in another subnet

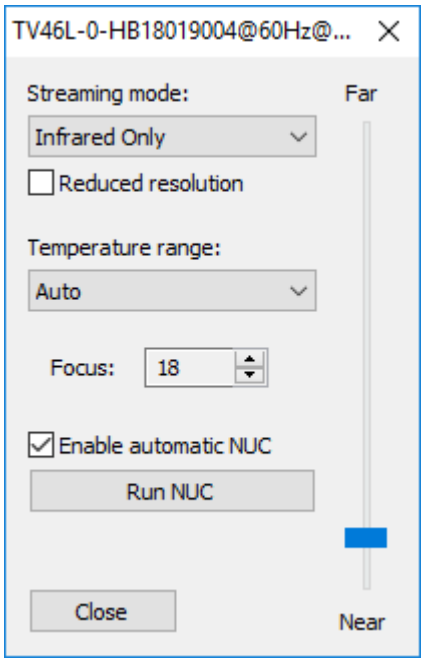
If the camera and the PC are in different subnets, IRT Analyzer cannot detect camera automatically. Reason for this - camera discovery messages are broadcasted and, in most cases, broadcasted messages are not forwarded by routers to other subnets. To overcome this limitation, you must know the IP address of the camera and set it by clicking **'Use IP address'** button.

Changing camera settings: focusing, temperature range, shutter

After you connected to the camera you can change camera settings, like focusing, temperature range and non-uniformity correction parameters. Chose **'Camera | Camera Controls'** in the main menu or click corresponding button in the **'Image Acquisition'** window.



When you press **'Camera Controls'** you will see this dialog:



Streaming mode

TV40: Can be 'Infrared Only' or 'Fusion'. TV40 cameras also have visible module, in case of 'Fusion' images from this visible module are sent to IRT Analyzer, displayed in Preview window, and can be used with the Fusion function.

Reduced resolution

TV40: This option allows to reduce infrared image resolution by half. Can be useful when you experience problems with losses during data transmission or low PC side performance.

Temperature range

Your camera is calibrated to measure temperatures in different ranges. If the viewed object has a high temperature and a low temperature range is selected in the camera, measured temperature values will be inaccurate or completely wrong.

'Auto' range: camera will automatically select the appropriate range. Using Auto range is not recommended in Automation mode as range switch may happen during an important measurement. Range switch procedure takes several seconds. During this period measured values may be wrong.

Focus

Allows to drive motorized focus position. Displayed focus position number has no physical meaning. Use **'Near-Far'** slider to change focus position. Focus edit box spin buttons are handy for fine focus changes.

Enable automatic NUC

TV40: When enabled, camera will run non-uniformity correction procedure at moments of time it selects automatically by measuring the sensor temperature.

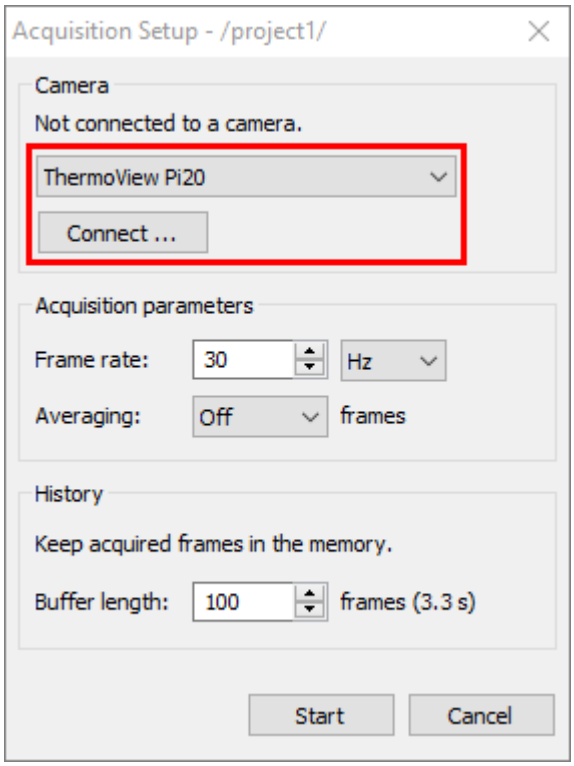
TV30: Automatic NUC is always enabled.

Run NUC

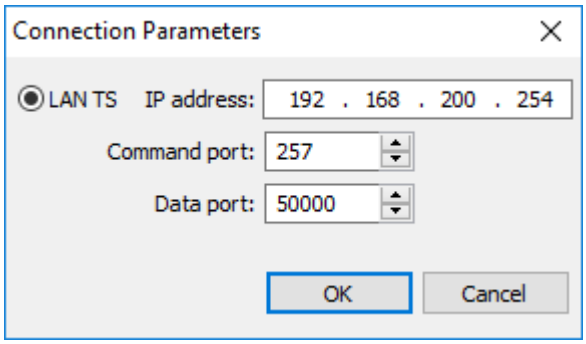
TV40: Press this button to tell camera to execute non-uniformity correction.

2.6.2 ThermoView Pi20

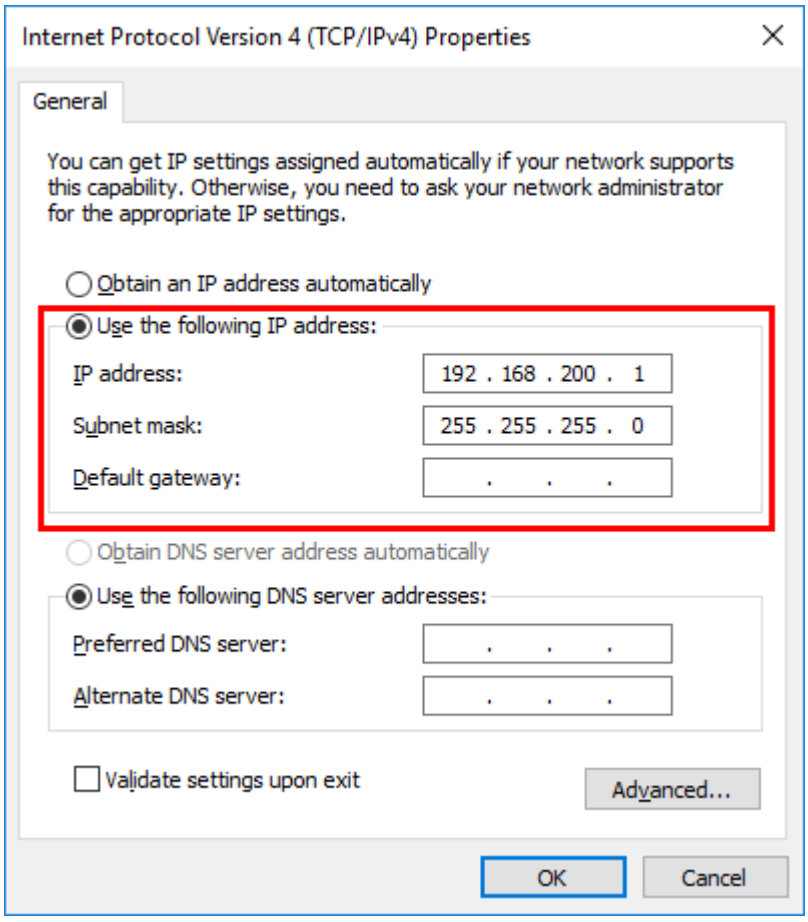
Choose **'ThermoView Pi20'** camera type, then press **'Connect'** button.



Default camera IP address is **192.168.200.254**. Command port is normally **257**; data port is **50000**.

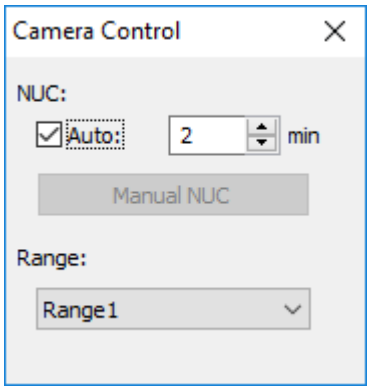


Your computer's PC adapter must be configured to be in the same subnet, so if camera has the default IP address, your computer IP address should be 192.168.200.X:



After camera is connected you can change its settings - working temperature range and NUC periods. These settings will be remembered in the project file and automatically restored when camera is reconnected.

'Manual NUC' button becomes available only when automatic NUC is turned off.



2.6.3 Fluke Tix560

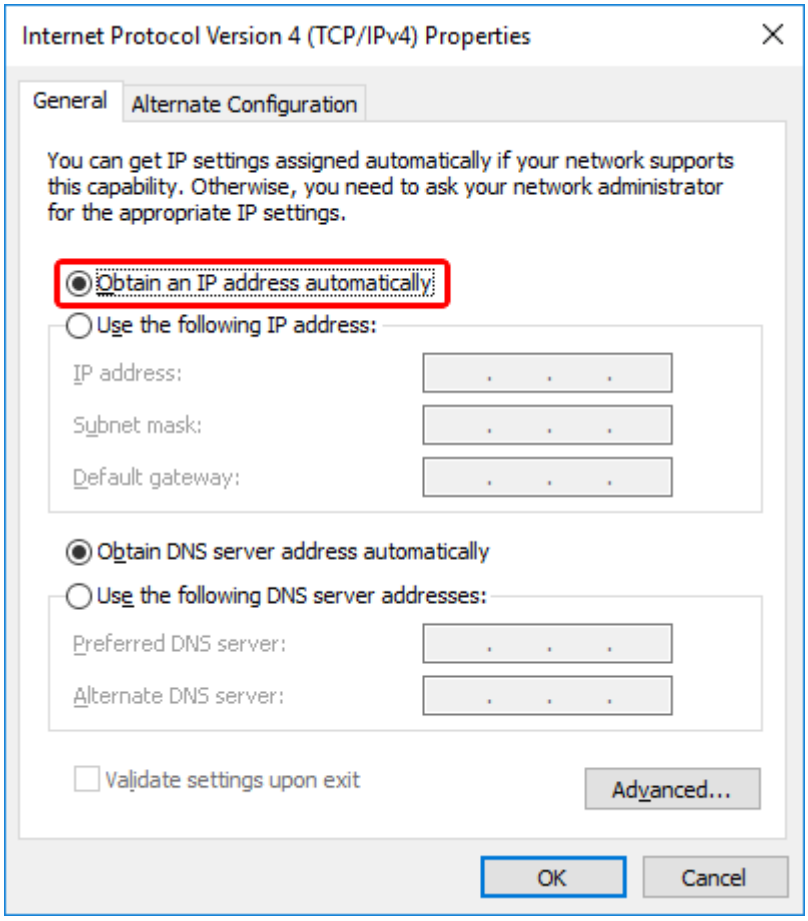
To connect Tix camera to the PC you need to use the USB port of the camera and a USB to LAN converter.

Configuring network adapter

You can connect LAN cable from the camera directly to the PC, without any router in between. In this case camera IP address is selected automatically from the automatic private IP range: 169.254.0.1 through 169.254.255.254.

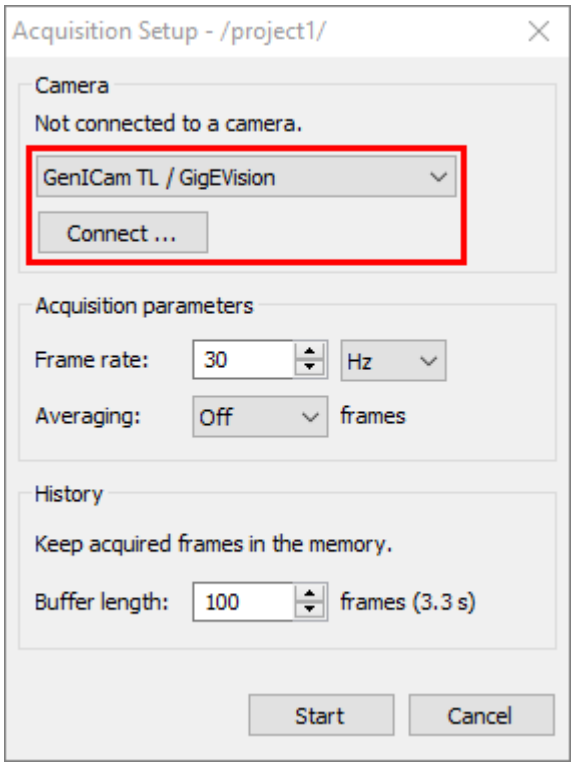
In order to communicate with the camera, your PC network adapter must be configured to use the same IP range (subnet). The easiest way to do it is to select "Obtain an IP address automatically" option in the

TCP/IPv4 settings of the PC network adapter connected to the camera. In this case computer's IP address will be also selected in the same 169.254.X.X range.

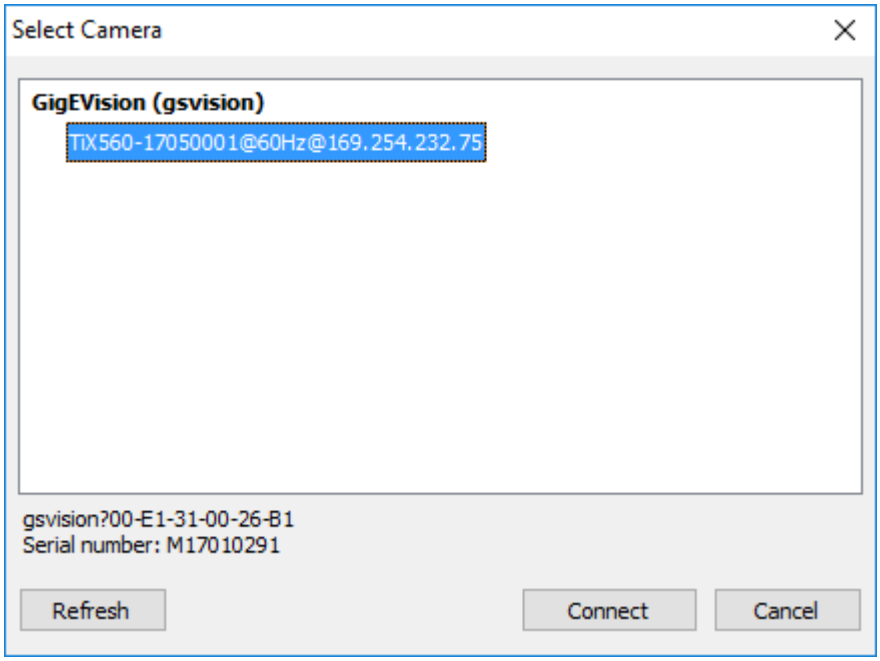


Connecting to the camera

1. In IRT Analyzer open Acquisition Setup dialog by selecting main menu item **'Camera | Connect'**. Chose **'GenICam TL / GigEVision'** camera type and press **'Connect'** button.



2. Select the camera you want to connect to and press **'Connect'** button. If you do not see the camera in the list, you can try to update camera list by pressing **'Refresh'** button.



If you see text "***unreachable***" after the camera name this means that IP address of the camera does not match IP address of PC - PC and the camera are in different subnets. Connection will not be possible.

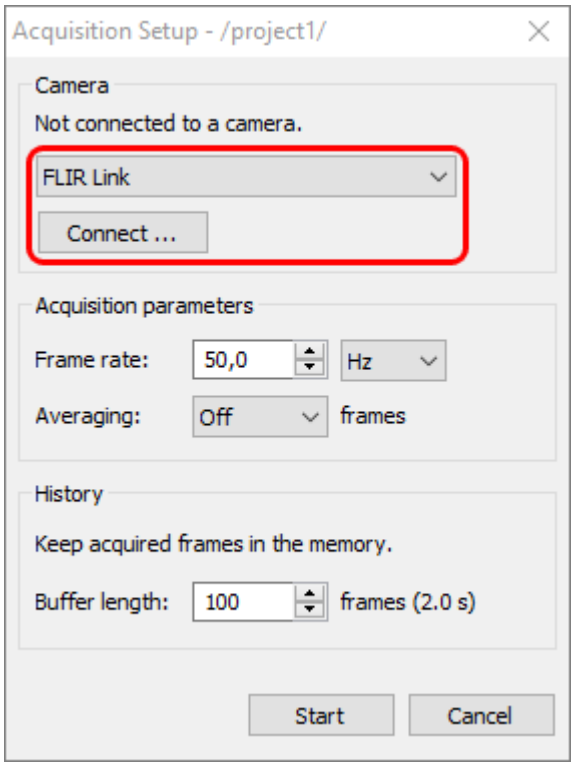
Text "***in use***" after the camera name means that other PC or other program on your PC already established connection with the camera. This will also not allow you to connect.

2.6.4 FLIR T-series, A3X0

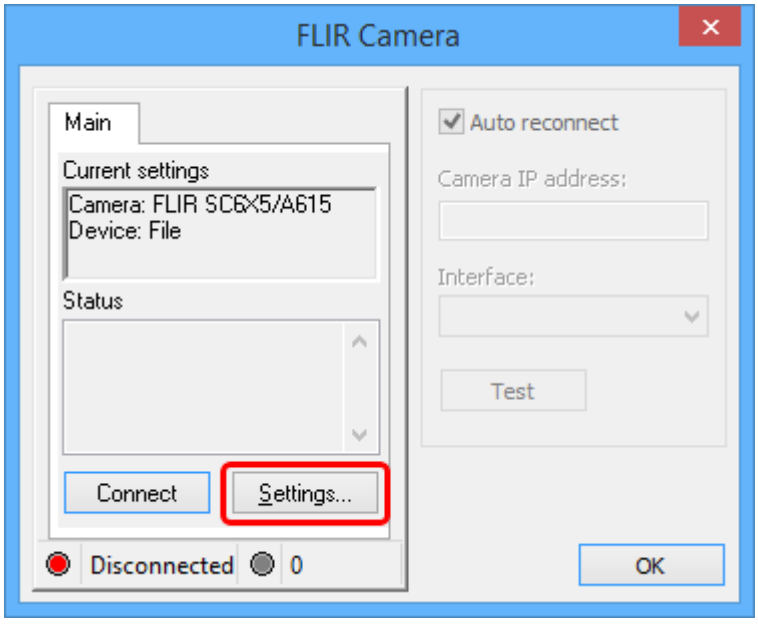
1. Before you can connect to a FLIR camera, FLIR ThermoVision SDK runtime must be installed on the computer, it is not included with IRT Analyzer and should be downloaded and installed separately. Latest version of the SDK runtime can be downloaded from FLIR web site or from here: http://www.grayess.com/data_exchange/ThermoVision_SDK_Runtime.msi

2. Camera should be connected to the PC and, in case of USB connection, camera drivers must be installed on the computer. It is also helpful to check if the standard FLIR software, delivered with the camera, can detect the camera and acquire IR images from it.

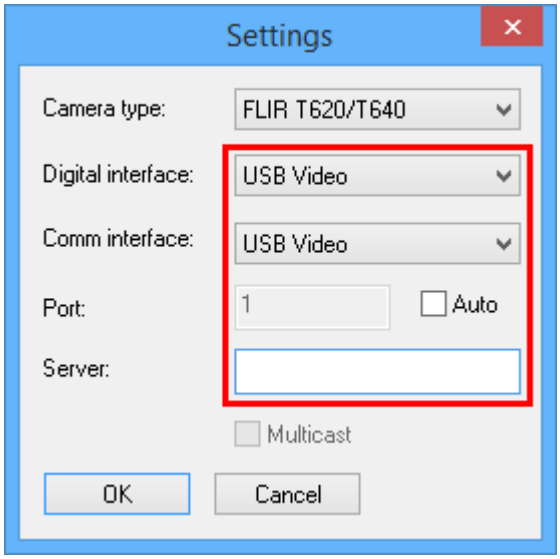
3. In IRT Analyzer select main menu 'Camera | Connect'. Choose 'FLIR Link' as the camera type. Press 'Connect'.



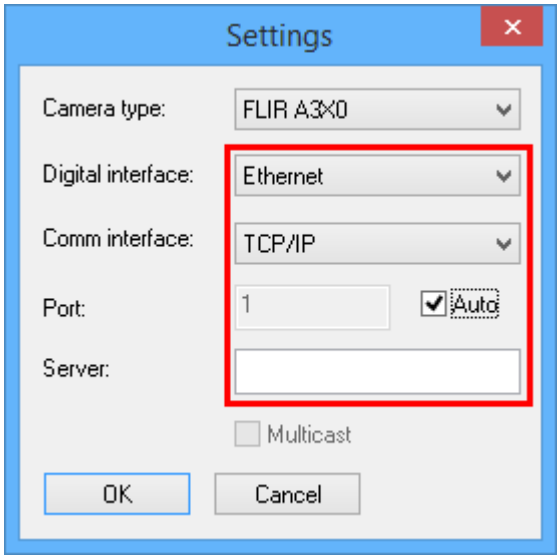
4. Press 'Settings' button to configure connections parameters.



5. Select camera type and other parameters according to your camera and its communication interface.



FLIR T640: make sure that 'Server' field is empty

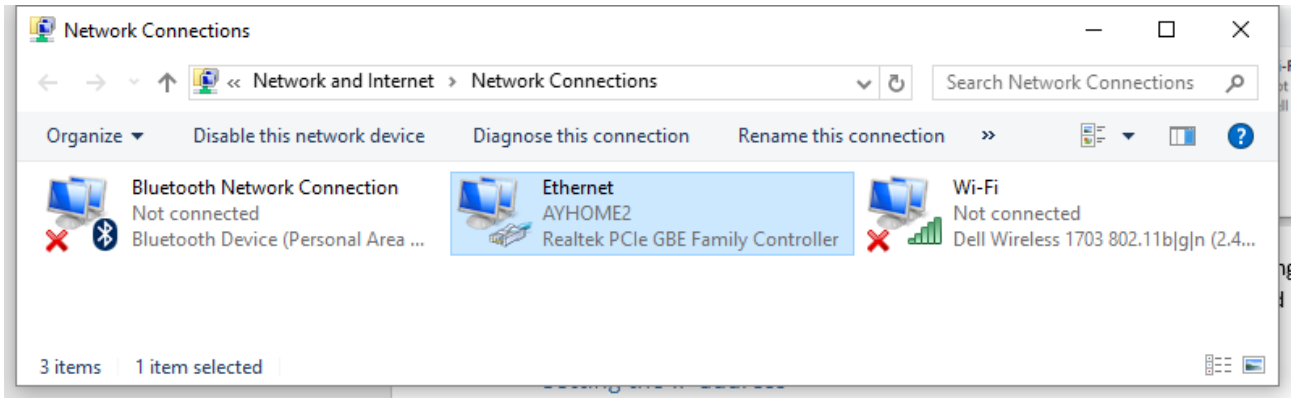


FLIR A3X0

6. For Ethernet interface it is necessary to check that network communication is not blocked by Windows Firewall. IRT Analyzer must be in the exception list in Windows Firewall configuration.

2.6.5 VarioCam HD

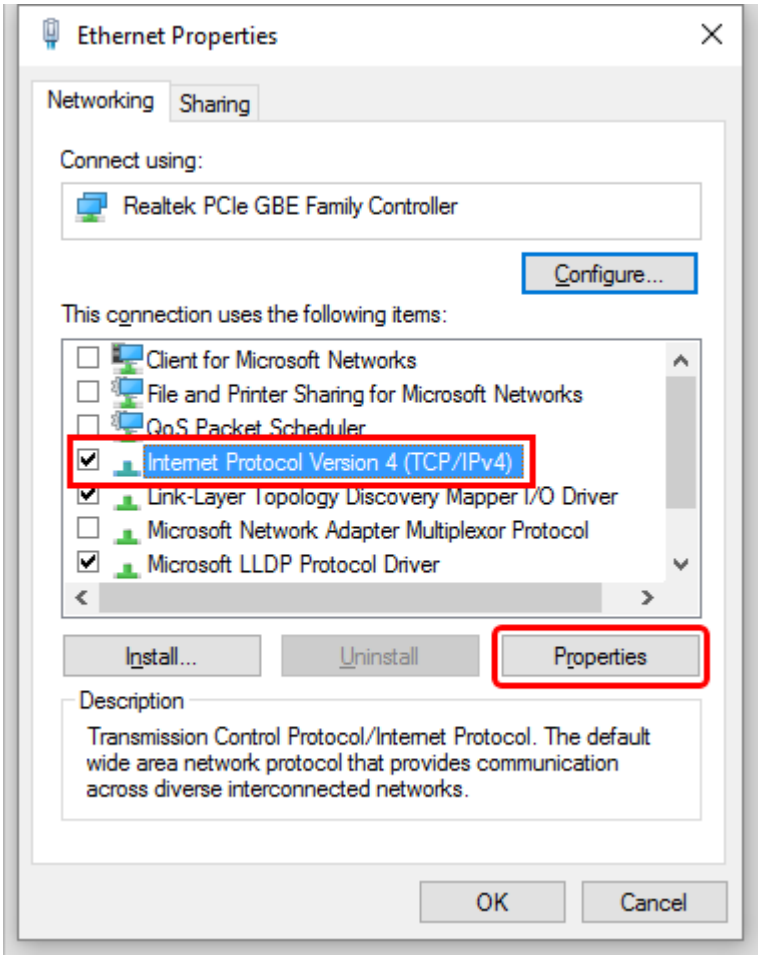
Setting up the network adapter



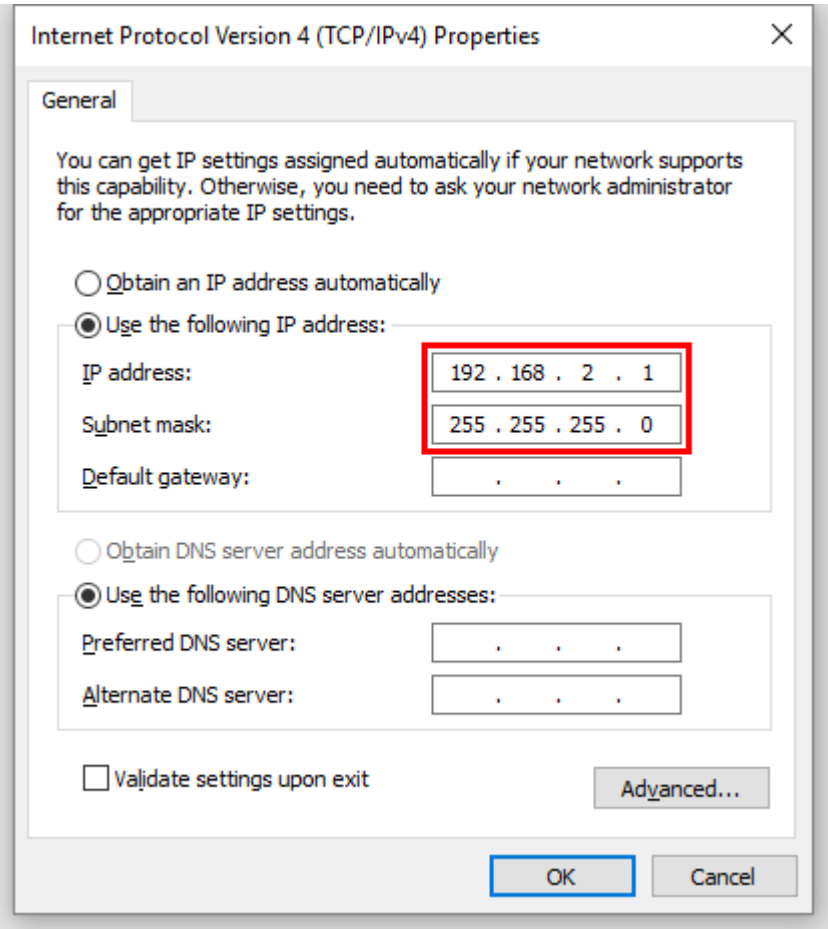
Upon opening the “Network and Sharing Center”, the “Change adapter settings” menu item should be selected. In this menu item, the network card to be used must be highlighted and its properties must be opened using the right mouse button.

Setting the IP address

Before configuring the network card for being used in connection with the camera, the properties of the interface card to be used must be inspected. It is important that fixed IP address is used. The screen-shots shown below provide an overview:



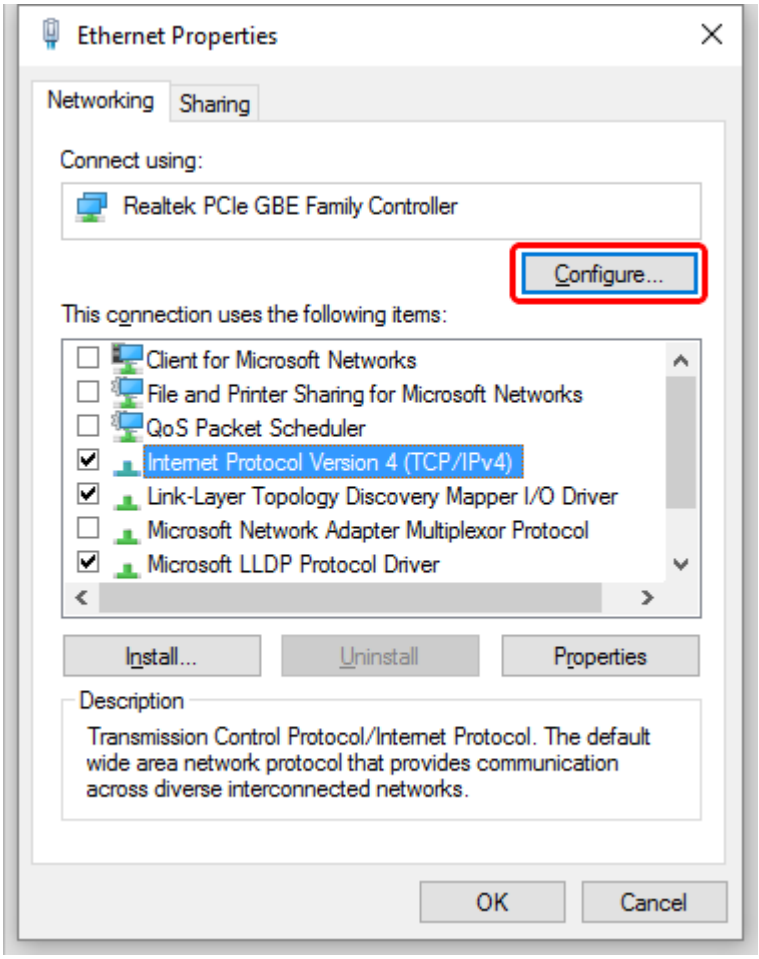
Please note that you only need the components marked above in order to establish an Ethernet connection to the VarioCAM® HD head. Therefore, we recommend deactivating any other components in the list. If the option “Internet protocol Version 4 (TCP/IPv4)” is selected, you can use the “Properties” button to set the IP address of the GigE network adapter.



Default camera IP address is **192.168.2.201**. Your PC should be in the same subnet, so the IP address of your PC card can be set to, for example, 192.168.2.1.

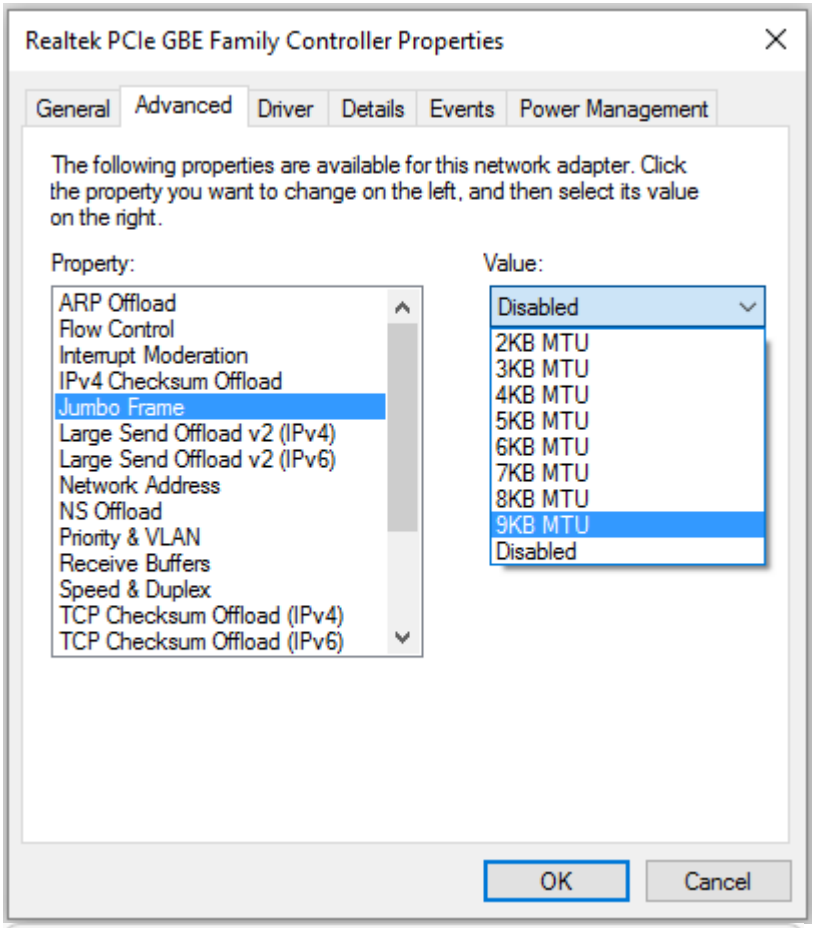
'Retrieve IP address automatically' option must not be used. If this option is activated, the computer will try to retrieve a dynamic network address from the camera system and no connection will be established.

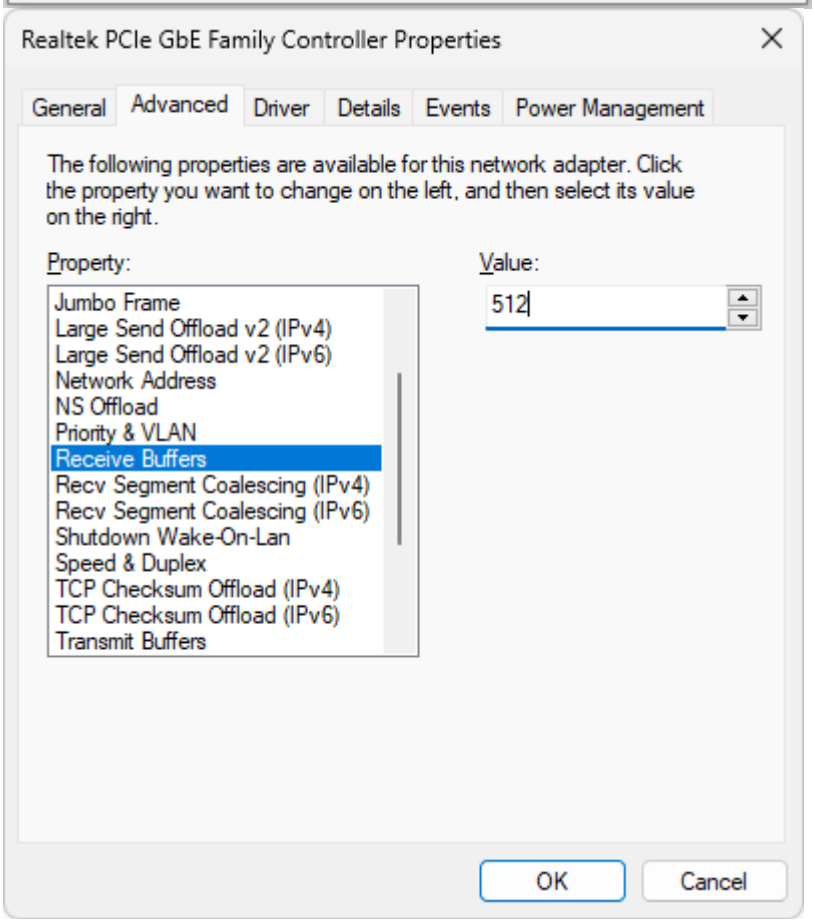
Configuration of the network card

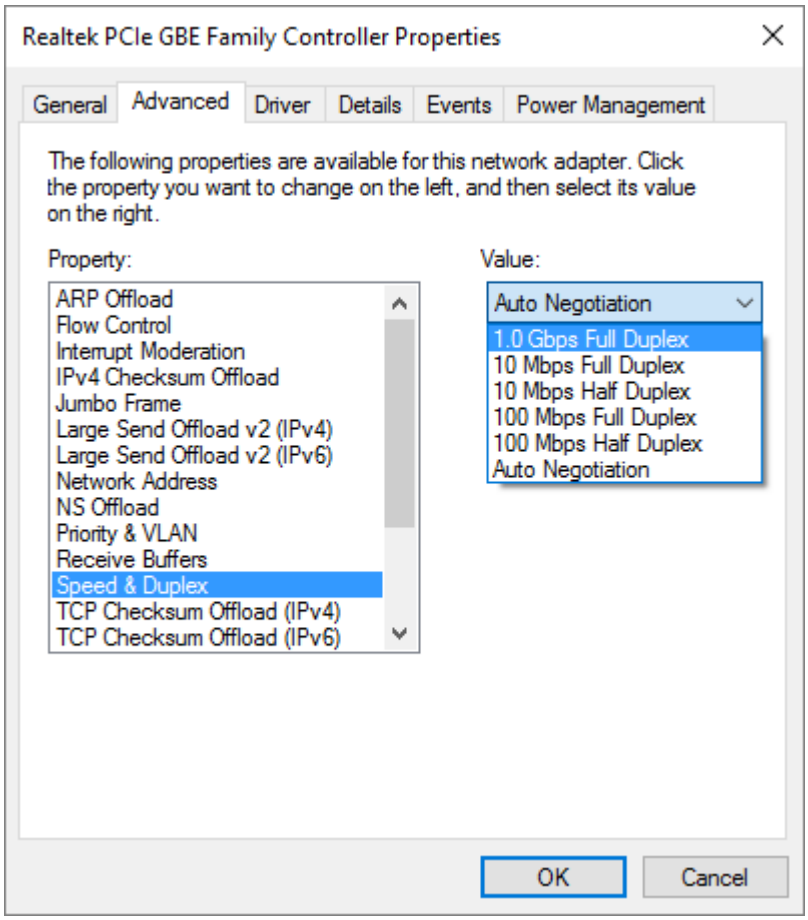


You can use **Configure** button in the 'Properties of LAN connections' window in order to define the properties of the network card. We strongly recommend activating the **Jumbo Packet** property in order to achieve a trouble-free Ethernet connection to the VarioCAM® HD head. This function significantly reduces the occupancy rate of the network and allows for loss-free data transmission even at high frame rates. Please note, that if you use a router, it must also support the selected packet size.

Sometimes it also helps to set **Receive Buffers** to a higher value and check that **Speed & Duplex** is at least 1 Gbps Full Duplex.


Realtek PCIe GBE Family Controller Properties
General
Advanced
Driver
Details
Events
Power Management
The following properties are available for this network adapter. Click the property you want to change on the left, and then select its value on the right.
Property:
ARP Offload
Flow Control
Interrupt Moderation
IPv4 Checksum Offload
Jumbo Frame
Large Send Offload v2 (IPv4)
Large Send Offload v2 (IPv6)
Network Address
NS Offload
Priority & VLAN
Receive Buffers
Speed & Duplex
TCP Checksum Offload (IPv4)
TCP Checksum Offload (IPv6)
Value:
Disabled
2KB MTU
3KB MTU
4KB MTU
5KB MTU
6KB MTU
7KB MTU
8KB MTU
9KB MTU
Disabled
OK
Cancel


Realtek PCIe GbE Family Controller Properties
General
Advanced
Driver
Details
Events
Power Management
The following properties are available for this network adapter. Click the property you want to change on the left, and then select its value on the right.
Property:
Jumbo Frame
Large Send Offload v2 (IPv4)
Large Send Offload v2 (IPv6)
Network Address
NS Offload
Priority & VLAN
Receive Buffers
Recv Segment Coalescing (IPv4)
Recv Segment Coalescing (IPv6)
Shutdown Wake-On-Lan
Speed & Duplex
TCP Checksum Offload (IPv4)
TCP Checksum Offload (IPv6)
Transmit Buffers
Value:
512
OK
Cancel



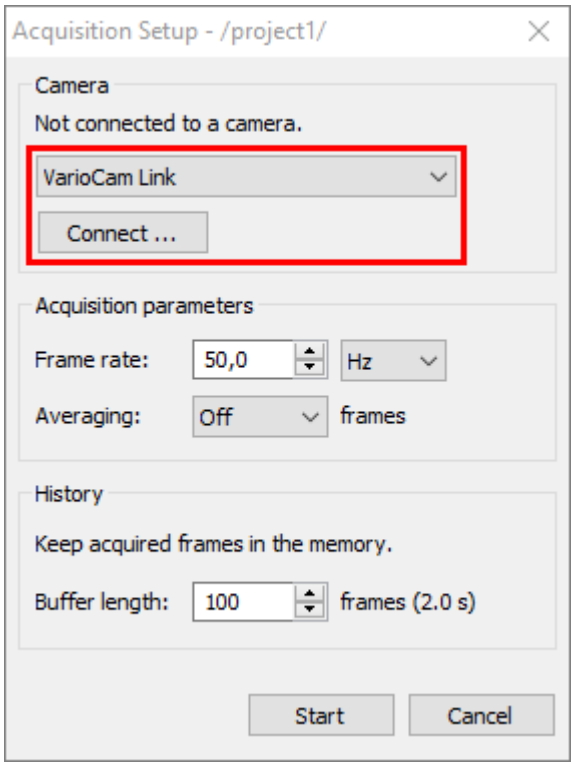
For **Jumbo Packet** select the highest possible value available in the drop-down list.

For **Speed & Duplex** preferentially select the value “1.0 Gbps Full Duplex” or “Auto Negotiation” item only if the 1.0 Gbps full duplex value is not available.

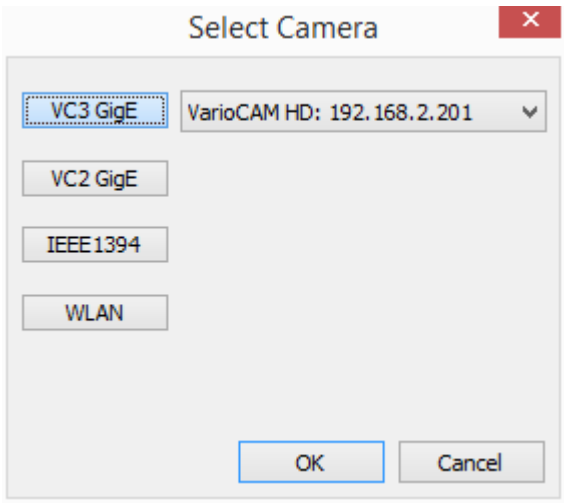
For **Receive Buffers**, selected the maximum accepted value (2048).

Making the connection in IRT Analyzer

Run IRT Analyzer and select 'Camera | Connect' in the main menu. Select 'VarioCam Link' as the driver. Press 'Connect' button.



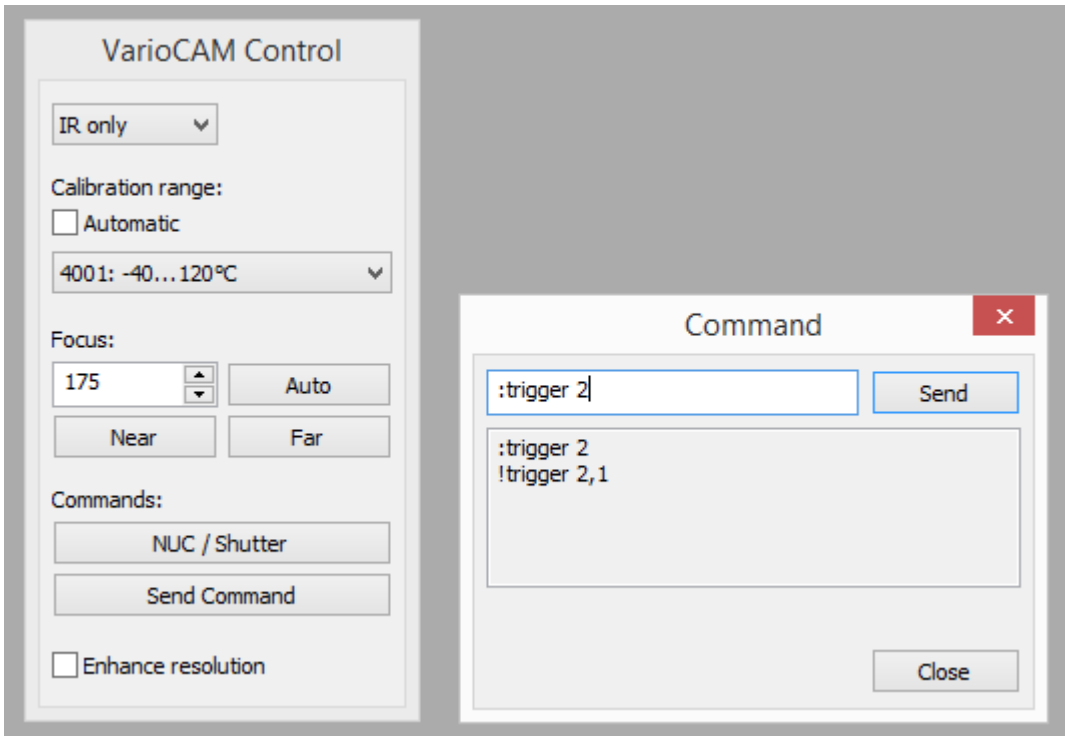
In 'Select Camera' dialog, click on 'VC3 GigE' button and select camera in the combo box (in case you have more than one camera connected):



Using camera triggers

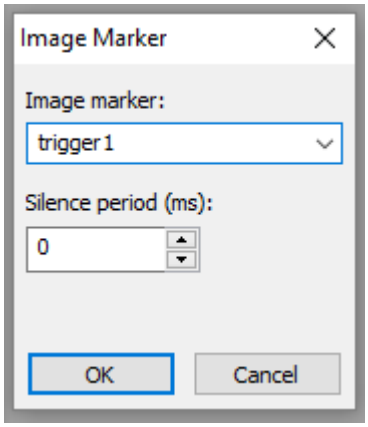
VarioCam HD has two TTL trigger inputs. When trigger is activated, camera sets a flag in the image header. This flag is checked by IRT Analyzer and can be used to start and stop image recording.

This triggering functionality is always off at camera start. To turn it on, a text command must be sent to the camera.



Command ":trigger 2" enables the first trigger input; ":trigger 2,2" enables the second.

After trigger is enabled in the camera, it can be used in IRT Analyzer, "Img Marker" trigger:



Here is the full description of the :trigger command.

```
2.217 Command :trigger

Description:
set the camera trigger mode
Invocation:
:trigger <switch>[,<trigger no>]
Parameters
<switch> - the new trigger state
0 = trigger off ( default at camera start )
2 = trigger input ( L/H ) on to generate a high resolution IRB
timestamp
3 = frame sync input on, directly sensor trigger - this trigger type is
exclusive
and do not work for any trigger mode at more than one inputs at the
same time.
5 = trigger input ( L/H ) on to generate a high resolution IRB
timestamp and save a IRB image
8 = frame sync output on
<trigger no> - optional parameter: <switch> effects the I/O line with the number
<trigger no> ( default: 1 )
```

```
1 = effects the I/O line 1
2 = effects the I/O line 2
Returns
!trigger <switch>[,<trigger no>]
if successfully, otherwise error message
```

3 Thermographic analysis

3.1 Image window

In IRT Analyzer there is only one infrared image or sequence that can opened for analysis at the same time. You cannot open two image windows and display them side-by-side, for this you need to run two IRT Analyzer instances, or as an alternative, use the preview window. Image currently displayed in the image window is called *active image*. Diagrams and property windows show values which they take from the active image.

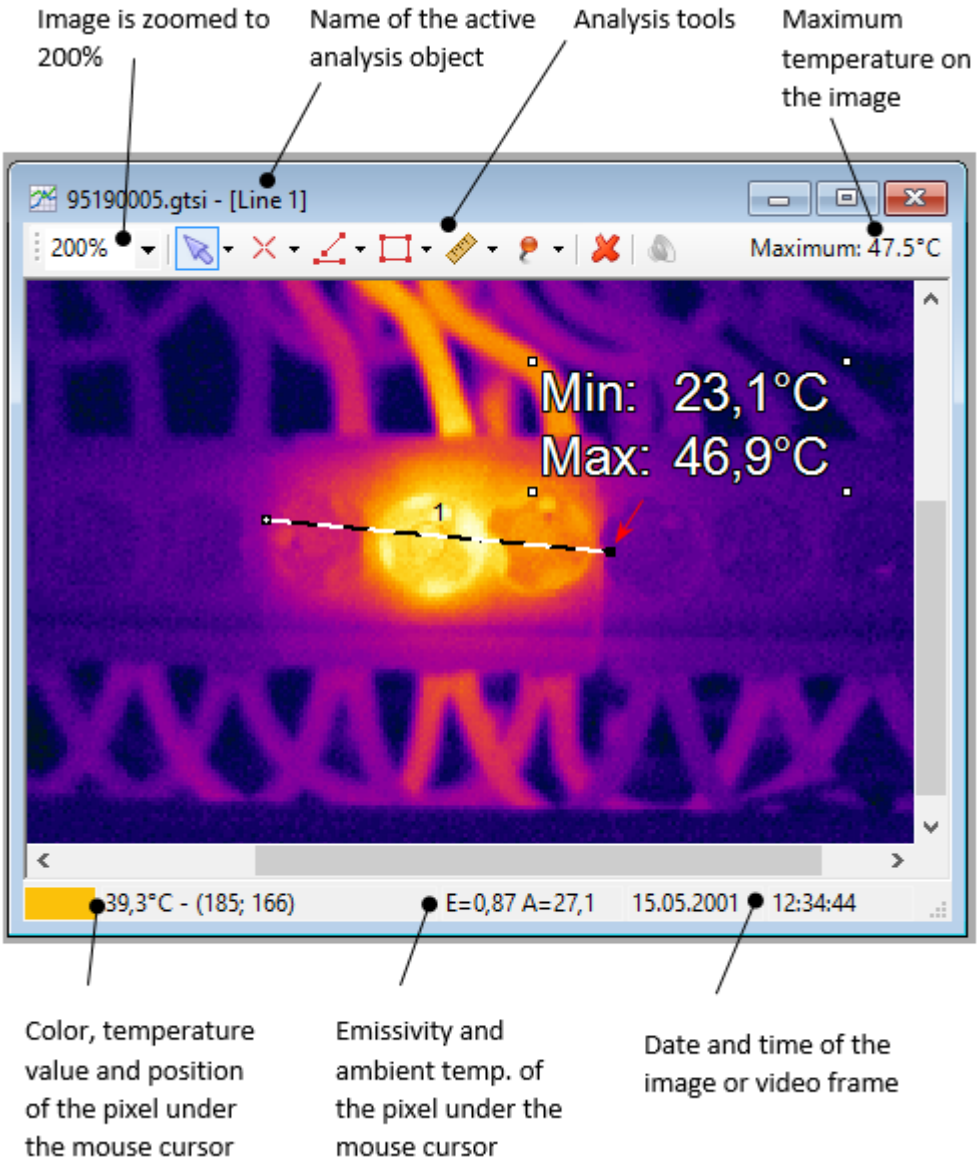
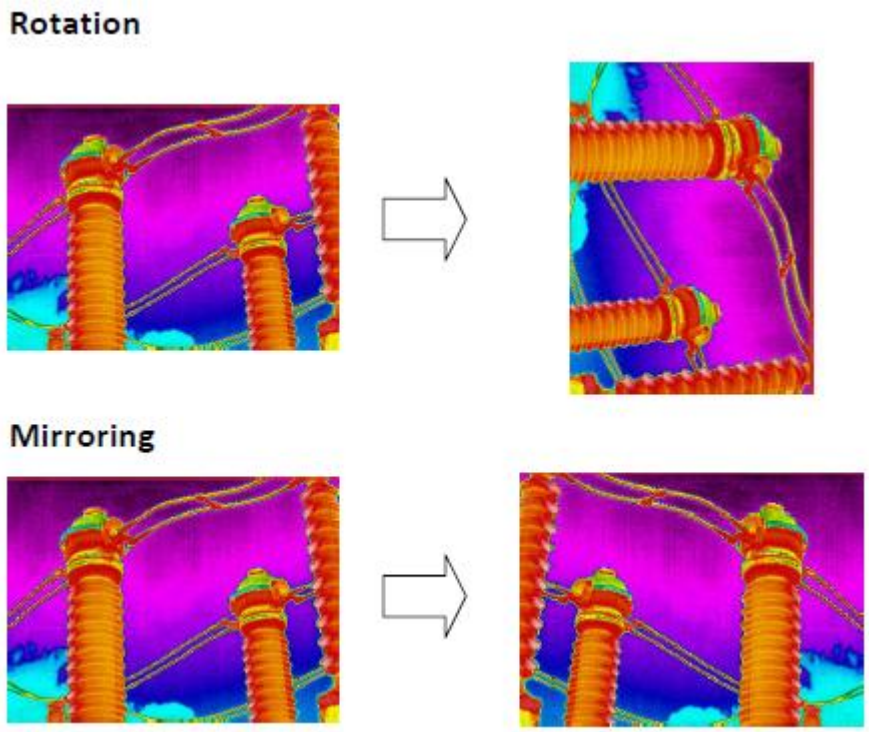


Image scaling and orientation

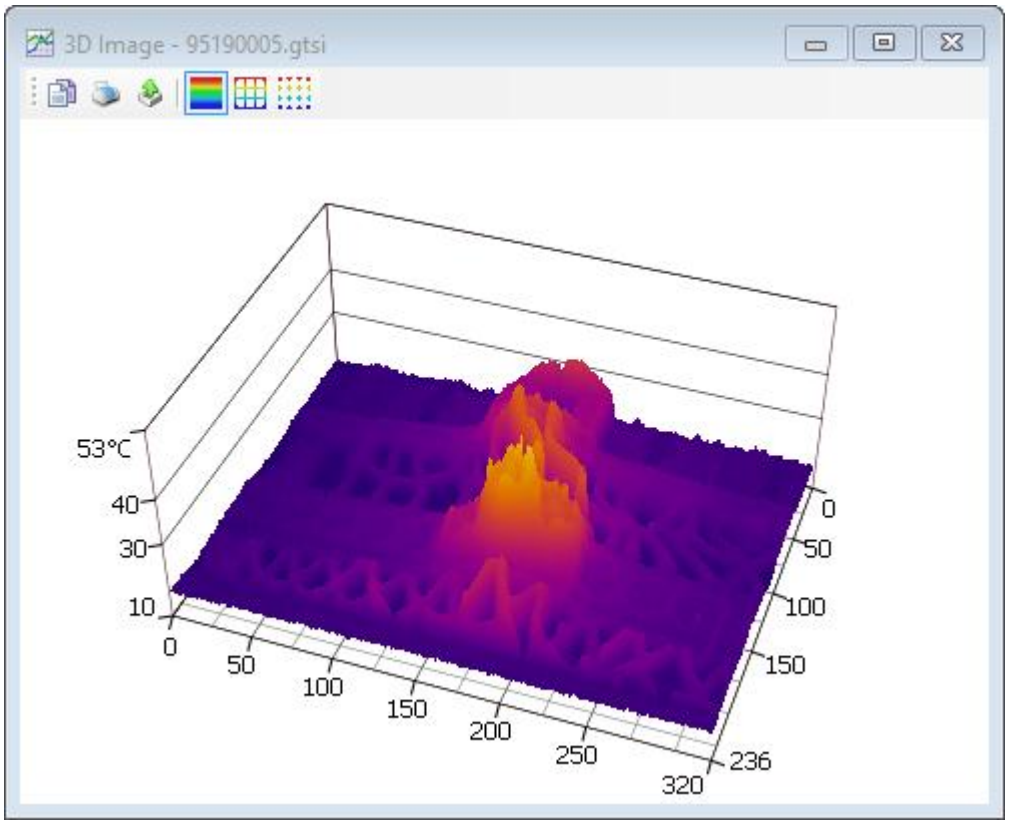
IRT Analyzer has tools to scale images and to change their orientation. Scaling is important when you want to position analysis objects more accurately. And you can rotate and mirror (flip) the picture.



Changing image size and orientation does not change image pixels; only the way image is displayed on the screen is affected. Because of this, when you save rotated image to a new raw image file, it keeps its original size and orientation.

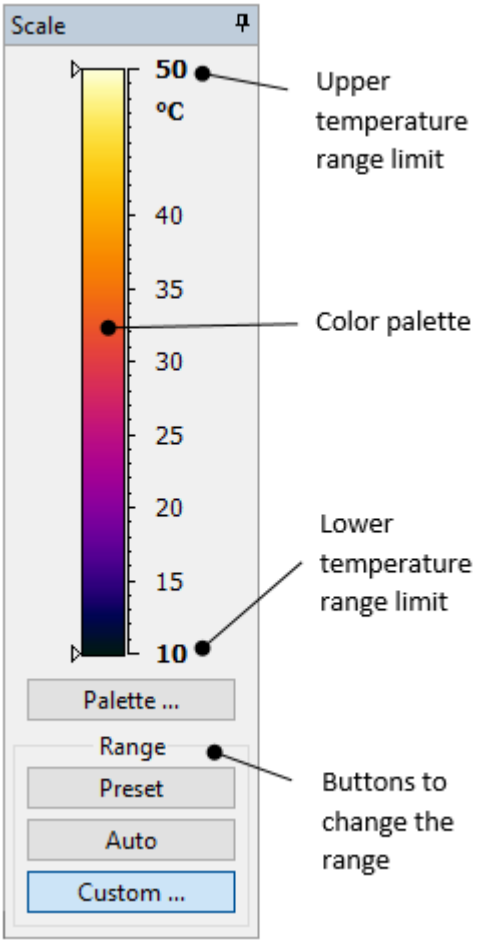
3D view

Click main menu **'View | 3D View'** to display active image as a three dimensional graph.



3.2 Temperature scale

In infrared images color of every pixel depends on its temperature. IRT Analyzer has means to adjust this dependency to make visual appearance of the image better and to intensify important details. To set relation between colors and temperature you need to define *temperature range* and select *color palette*.



Temperature range

Temperature range defines visible temperatures of the image. Pixels with temperatures below the lower range limit are shown with the darkest palette color (color at the bottom of palette); pixels with temperatures above the upper range limit are shown with the brightest palette color (color at the top); pixels with temperatures in between have corresponding intermediate palette colors.

At the picture on the left side, you see that temperature range is set to be 50 to 10 °C. Image pixels with temperature values 50°C and higher will be shown with bright yellow color, pixels below 10°C will be dark blue, pixels in between will change their colors according to the palette.

There are three possibilities that you can use to set temperature range:

1. **Preset:** this is the default temperature range. Normally this range is the range that was selected in the camera when the image was taken. If camera does not set any temperature range - auto range limits are used.

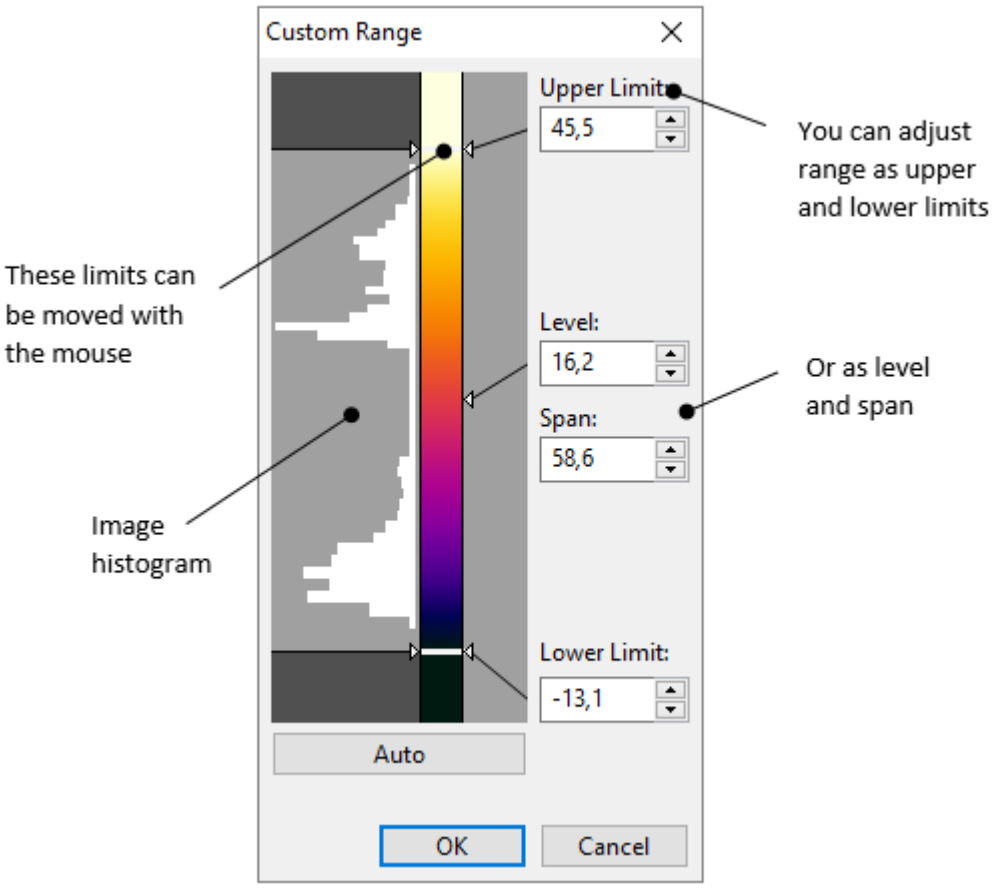
2. **Auto:** IRT Analyzer calculates the range automatically based on image histogram to make all temperatures present on the image visible.

3. **Custom:** you can set your own range limits. This is useful when you are not interested in all temperatures present on the image but need a sub-range.

Custom temperature range

Auto range works well in many situations, but not always. Often in the camera field of view you have objects with very different temperatures. Auto range will try to select temperature range so that all objects are visible. If you need to see one of the objects more clearly, you can adjust temperature range manually. Use the **'Custom'** range button.

Here is how manual selection of temperature range looks like:

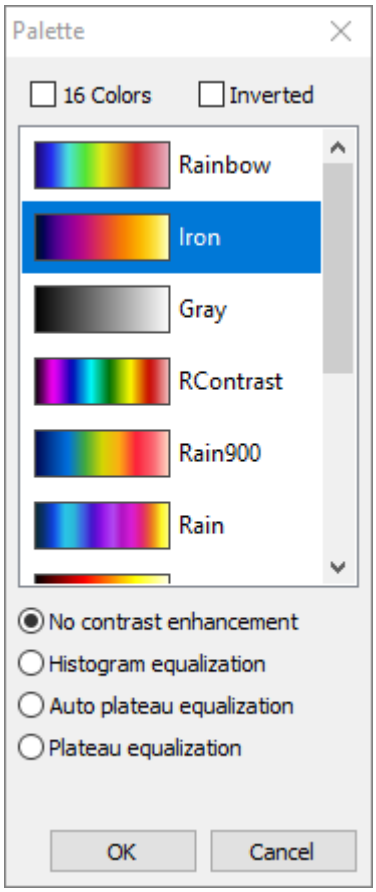


You can set the range by specifying its upper and lower limits. And it is also possible to define it as level and span, which is the middle point and width of the range.

Palette

Palette is the set of colors that allow to see temperature differences. IRT Analyzer has a wide selection of color palettes that can be used to display infrared images. Sometimes one palette suits better to reveal the problem than the other.

To change the palette, click the **'Palette'** button. Select the needed palette and click **'OK'** to apply it.



16 colors palette and inverted palette

Any palette can be presented in 16-color mode. For this mark '16 Colors' check box.

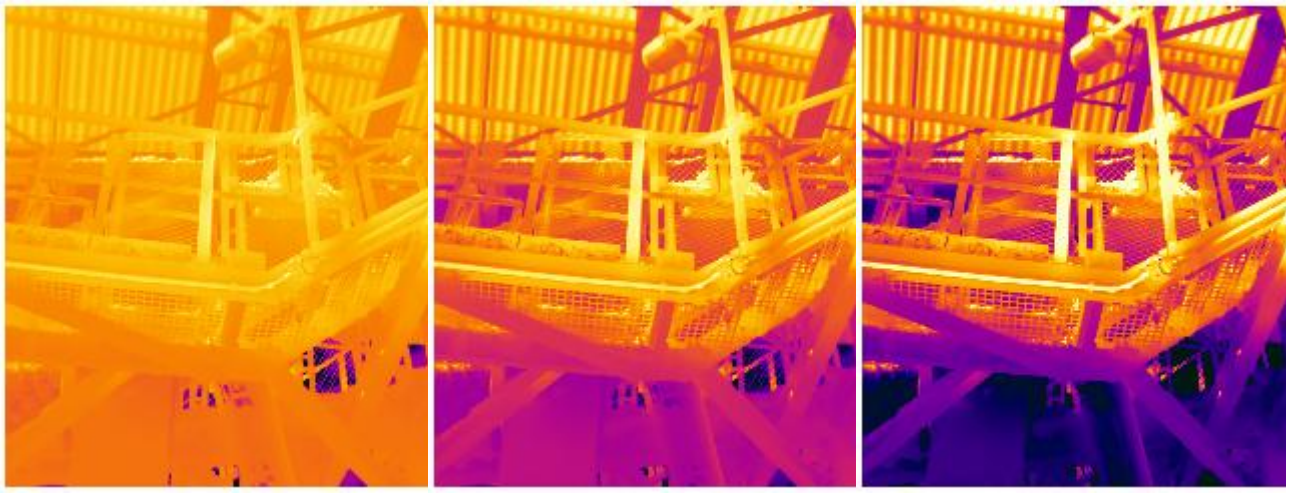
Also, you can invert palette colors - inverted palette takes colors opposite (in the color spectrum) to those of the original palette. To invert a palette, mark 'Inverted' check box.

Image contrast enhancement (AGC algorithm)

By default (no contrast enhancement) colors are distributed evenly through the selected temperature range. This is not always good because some areas of the image may not get enough colors and human eye will not see the differences in these areas - they will be not contrast. To improve this IRT Analyzer has contrast enhancement techniques, histogram equalization and plateau equalization:

- Histogram equalization: distributes colors taking data from image histogram.
- Plateau equalization: improved histogram equalization algorithm. Introduces additional "plateau level" parameter (adjusted with a slider) which allows to define position in the range that should get most contrast.
- Auto plateau equalization: same as plateau equalization, "plateau level" is selected automatically.

It should be noted that contrast enhancement techniques modify only the palette colors and do not change image temperature values.

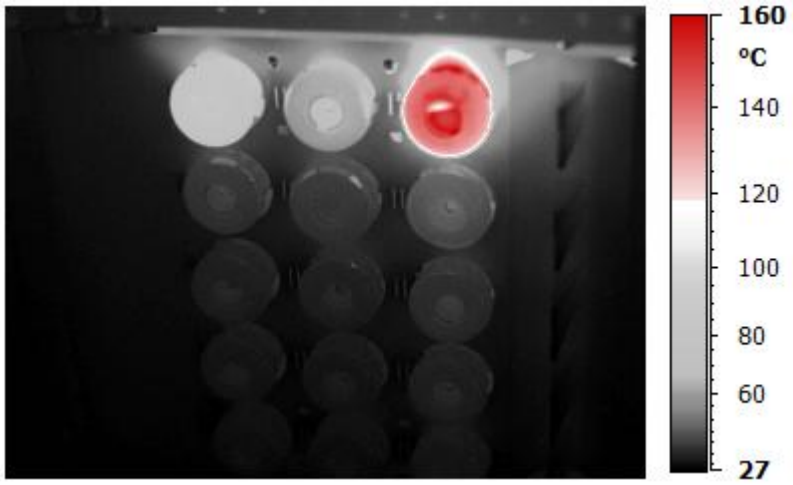


Pic.1 No contrast enhancement **Pic.2 Histogram equalization** **Pic.3 Auto plateau equalization**

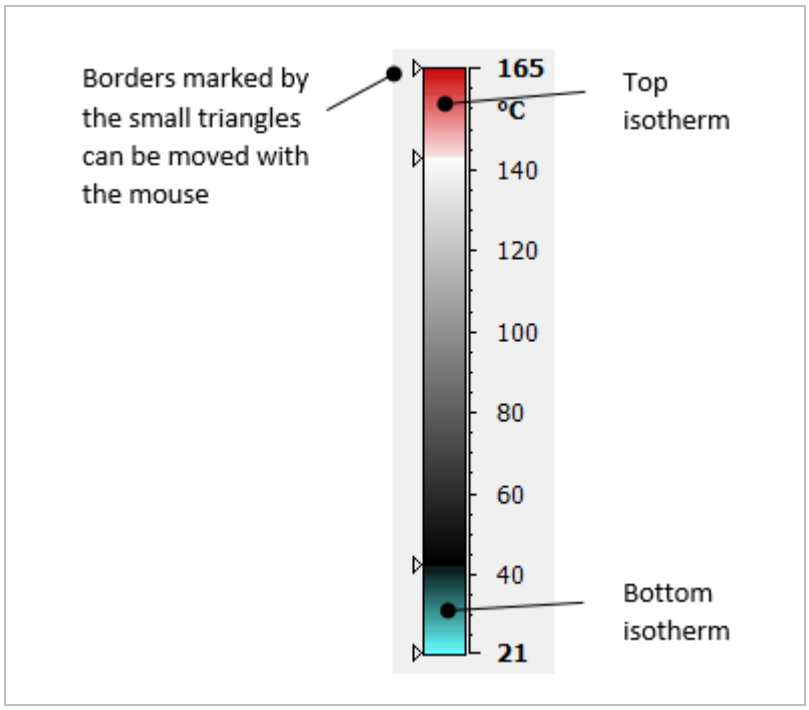
On the pictures above you see the same image with different contrast enhancement algorithms. Please note that they all have the same temperature range. With the help of different palette color distributions, we can enhance contrast of the image.

3.3 Isotherms

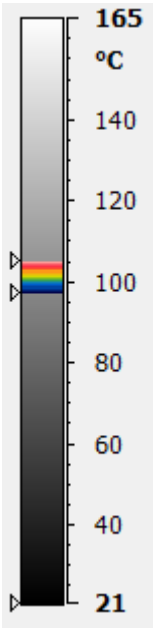
You can mark parts of the temperature range so that they have colors very different to the colors of the rest of the image. For example, often it is useful to paint pixels that have high temperatures in red color while keeping rest of the image black and white.



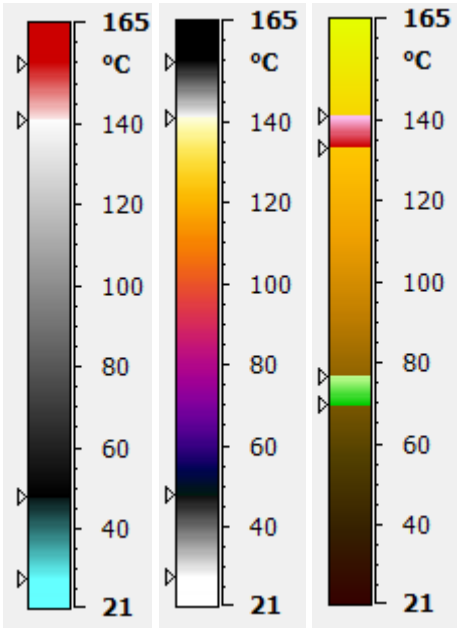
In IRT Analyzer this function is called *Isotherms* and adjusted in the 'Temperature Scale' dialog:



You can freely move isotherm borders and the isotherm itself with the mouse.



If you move upper isotherm limit below the lower isotherm limit, you will get the interval isotherm.

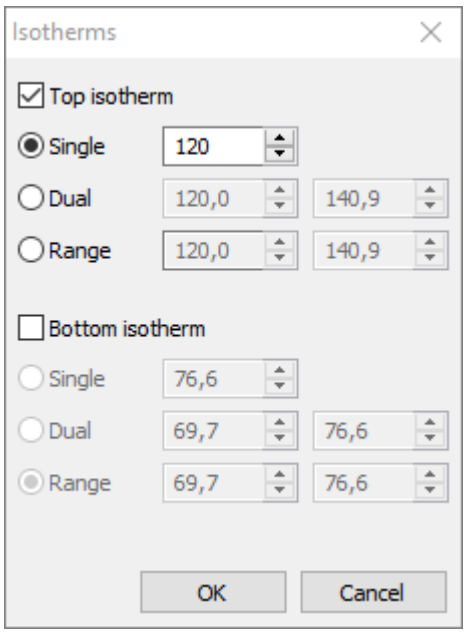


There are many isotherm combinations, here are several examples.

Note

Each palette has its own fixed isotherm colors. It is not possible to change them. If you do not like isotherm colors of the current palette, please, try other palettes.

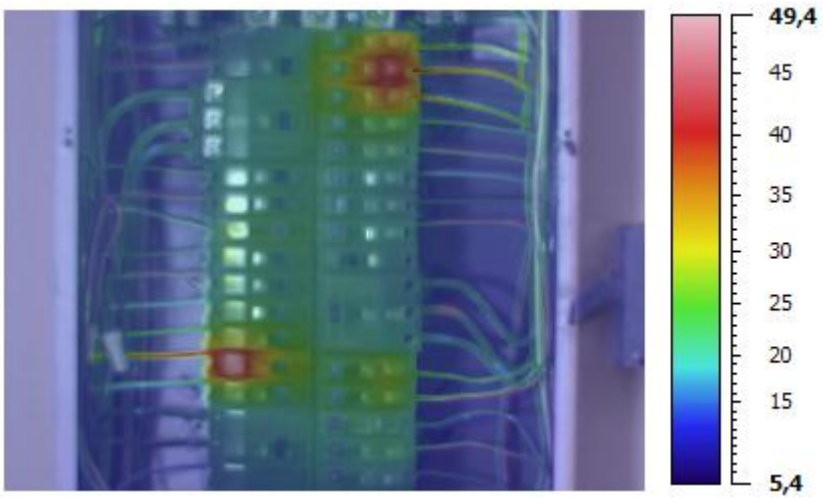
It is possible to set exact isotherm limits as temperature values. Please right click on the temperature scale and select **'Isotherms'** item in the context menu:



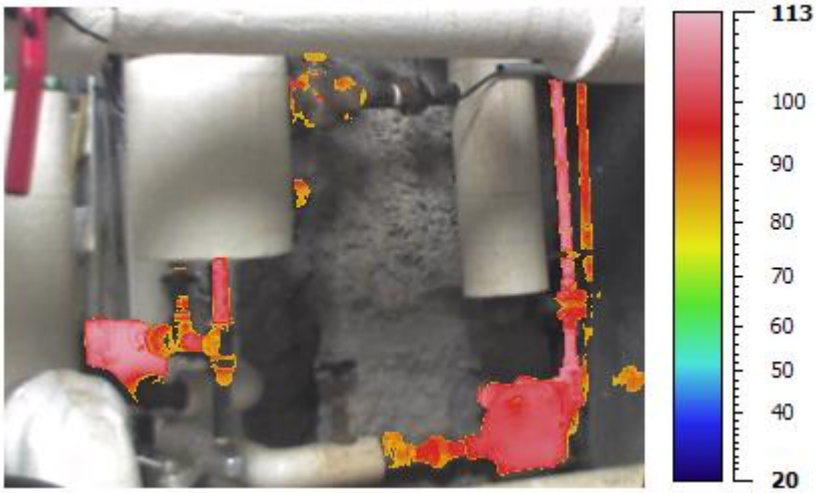
3.4 Fusion of infrared and visual images

When infrared camera has a built-in visible light camera, it is possible overlay the two images – infrared and visual. There are several parameters of how infrared image is fused with the visual image which include transparency blending, details enhancement and alarm range.

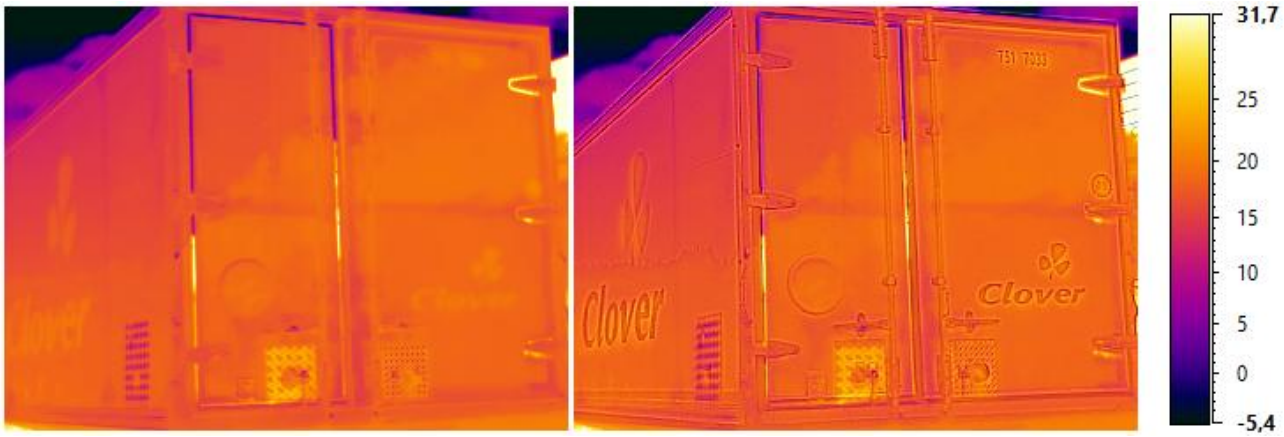
Transparency blending: infrared image pixels are mixed with visible image pixels using alpha blending method.



Alarm range: only pixels with temperatures that fall into the defined range are visible, other pixels are transparent.

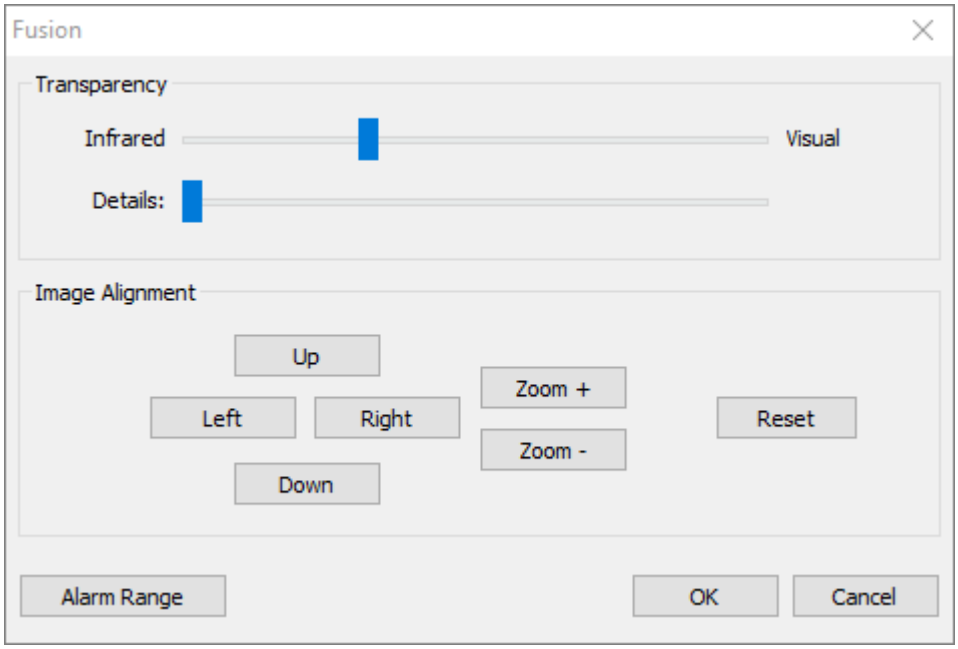


Details enhancement: fine details from visible image are added to the infrared image.



Use menu **'View | Fusion'** in the main menu or **'Fusion'** in the context menu of the infrared image. Fusion menu is only available when there is a visible image opened in the Preview window.

Fusion dialog will be displayed.



Transparency blending

Infrared image is placed on top of the visual image. With the help of the transparency slider, you can change transparency of the infrared image from 100% infrared (left side) to 100% visual (right side). If you stop the slider somewhere in between, infrared image will be semi-transparent so that you can see the visual image under it.

Details enhancement

Details enhancement works in a such way that fine objects and edges from the visible image are added to the infrared image. Drag the details slider from left to right to increase details intensity.

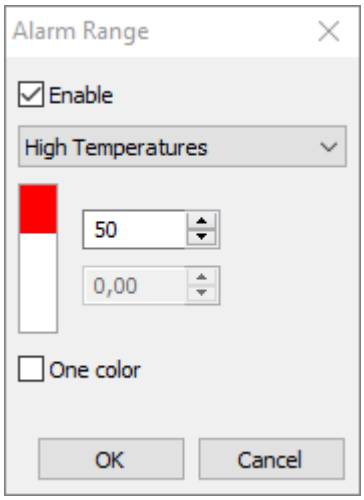
Image alignment

If infrared and visual images were not aligned properly by the camera, you can realign them or fine-tune the alignment. Make the infrared image semi-transparent to see both infrared and visual images (increasing details level also helps seeing objects from both images at the same time).

- Use **'Left'**, **'Right'** and **'Up'**, **'Down'** buttons to move the visual image.
- Use **'Zoom+'** and **'Zoom-'** buttons to scale the visual image.

Alarm range

The alarm range function allows you to highlight target object areas of thermal interest by making the out-of-range area fully transparent. You can enable an alarm range based on high, low, high and low, or in-range temperature values.



One color (isotherms on visual image). Sometimes marking areas of interest with only one same color produces more comprehensive results. Place a check mark in the **'One color'** check box to highlight high temperatures with red color, low temperatures with blue color and in-range temperatures with green color.

Disabling fusion

To disable fusion, drag the transparency slider and the details slider to the left.

3.5 Analysis objects

IRT Analyzer uses so-called *analysis objects* to present thermal information contained in an infrared image.

Objects belong to five groups:

- Points (spots)
- Lines
- Areas

- Measures
- Annotations

Measures and annotations do not use temperature information. Measures display geometrical dimensions of objects on the image. Annotations are used to put text and visually mark areas on the image.

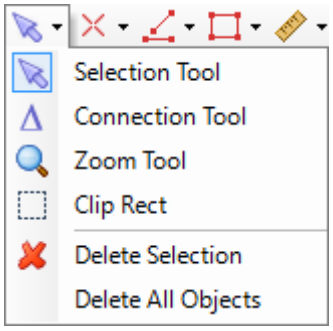
Points, lines, and areas are thermographic objects. They participate in image temperature calculation. Same as the whole image, every thermographic analysis object can have its own emissivity, ambient temperature, averaging factor, software filters and other parameters.

Creating objects

To create an object, you should use a corresponding object tool from the image toolbar.

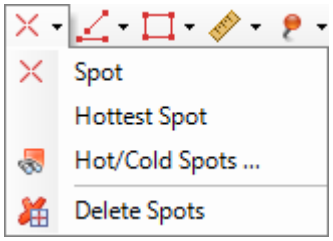


Selection tools



- *Selection tool*: selects, moves, resizes, and activates objects.
- *Connection tool:* connects two or more objects to compare them.
- *Clip rectangle tool*: marks some part of an image to copy it to the Clipboard.
- *Delete Selection*: deletes selected objects from the image.
- *Delete All Objects*: deletes all object from the image.

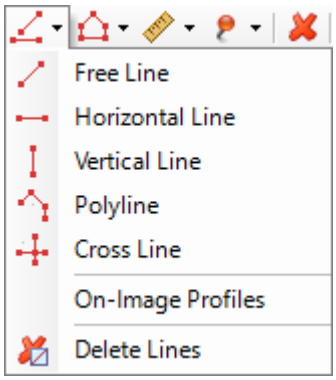
Spot (point) tools



- *Spot tool*: creates a new spot object.
- *Hottest Spot*: finds the hottest point on the image and creates spot object there - hot spot object.
- *Hot/Cold Spots*: opens a dialog to search for more hottest or coldest spots on the image.
- *Delete Spots*: deletes all spots from the image.

To create spot objects, select the spot tool and click on the image.

Line tools

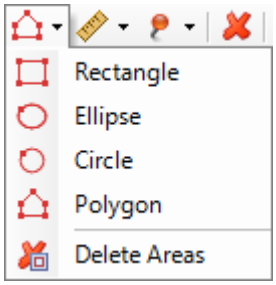


- *Free Line* | *Horizontal Line* | *Vertical Line* | *Polyline* | *Cross Line*: creates line of the corresponding type on the image.
- *On-Image Profiles*: turns on or off profile display on all lines on the image.
- *Delete Lines*: deletes all line objects.

To create a line object, select the corresponding line tool. Press the left mouse button on the image spot where line must begin and, holding the button, move the mouse to the spot where line must end, release the mouse button.

To create a polyline, create the first segment as described above, then click on image successively to create next segments. To stop polyline creation, press the right mouse button or select any other tool in the toolbar.

Area tools

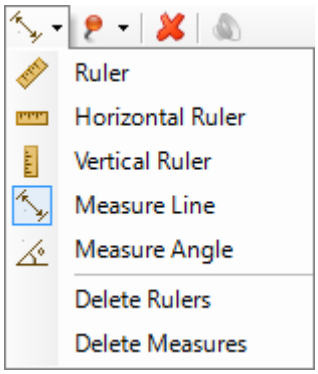


- *Rectangle* | *Ellipse* | *Circle* | *Polygon*: create the corresponding area object.
- *Delete Areas*: deletes all area objects.

To create an area object, select the corresponding area tool. Press the left mouse button on an image spot and, holding the button, move the mouse to another image spot, release the mouse button.

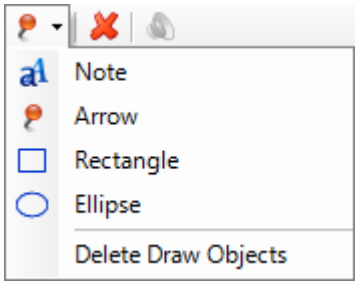
To create a polygon, create the first polygon segment as described above, then click on image successively to create next segments. To stop polygon creation, press the right mouse button or select any other tool in the toolbar.

Measure tools



- *Ruler* | *Horizontal Ruler* | *Vertical Ruler*: create a ruler object. Ruler object defines image real world dimensions.
- *Measure Line:* creates a measure object to measure distance between two image points.
- *Measure Angle:* creates an angle object to measure angles on the image.
- *Delete Rulers*: deletes all rulers.
- *Delete Measures*: deletes all measures.

Drawing tools

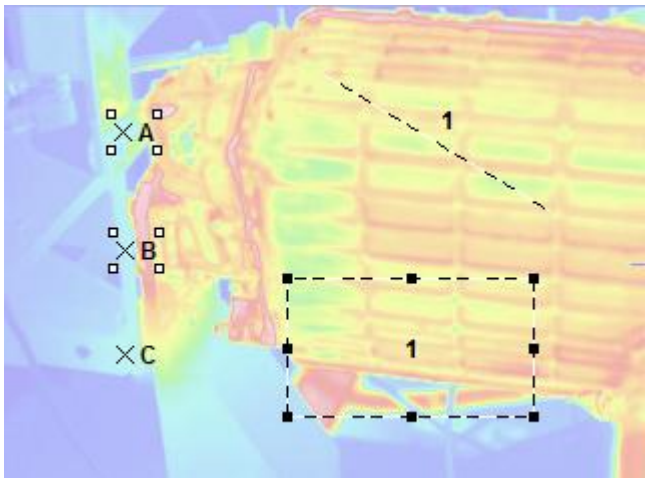


- *Note*: creates a text object on the image
- *Arrow*: draws arrow on the image.
- *Rectangle* | *Ellipse*: draws rectangle or ellipse.
- *Delete Draw Objects:* deletes all draw objects.

Active and selected objects

Object can be in the following states:

- *active* (only one)
- *selected* (several is possible)
- *not selected*



The picture above shows objects in all three states:

- Area 1 is active (black squares around)
- Points A and B are selected (white squares)
- Line 1 and Point C is neither active nor selected

Active object is important - many operations, that need an object, use the active object. This is why name of the active object is show in the caption of the image window. When there is no active object, whole image is active. To activate the image, click outside objects with the selection tool.

You will use multiple object selection, for example, to move several objects together, keeping relative positions unchanged. Selecting objects in IRT Analyzer is like selecting icons on the desktop. To select several objects, use the selection tool and, holding the *Shift* key, click on objects you want to select. Active object is always the last clicked one.

> To switch quickly to the selection tool after an object is created, click with the right mouse button at any place on the image.
>
> To select all objects, use Ctrl+A key combination.

Object groups

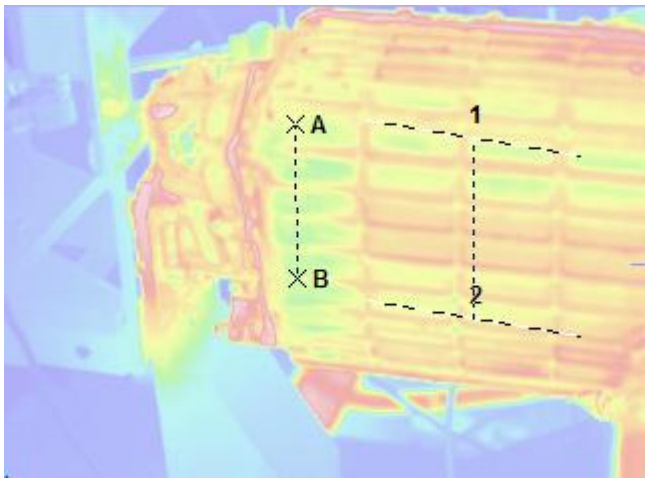
You can group several objects together. Grouped objects are similar to selected objects, but selection is permanent: when you select one object, other objects in the group are selected automatically.

To group several objects, select them, click with the right mouse button on one of them and choose **'Group'** in the menu. To ungroup objects, call the context menu and choose **'Ungroup'**.

> Grouping two area objects does not union their areas. They are still two separate objects.

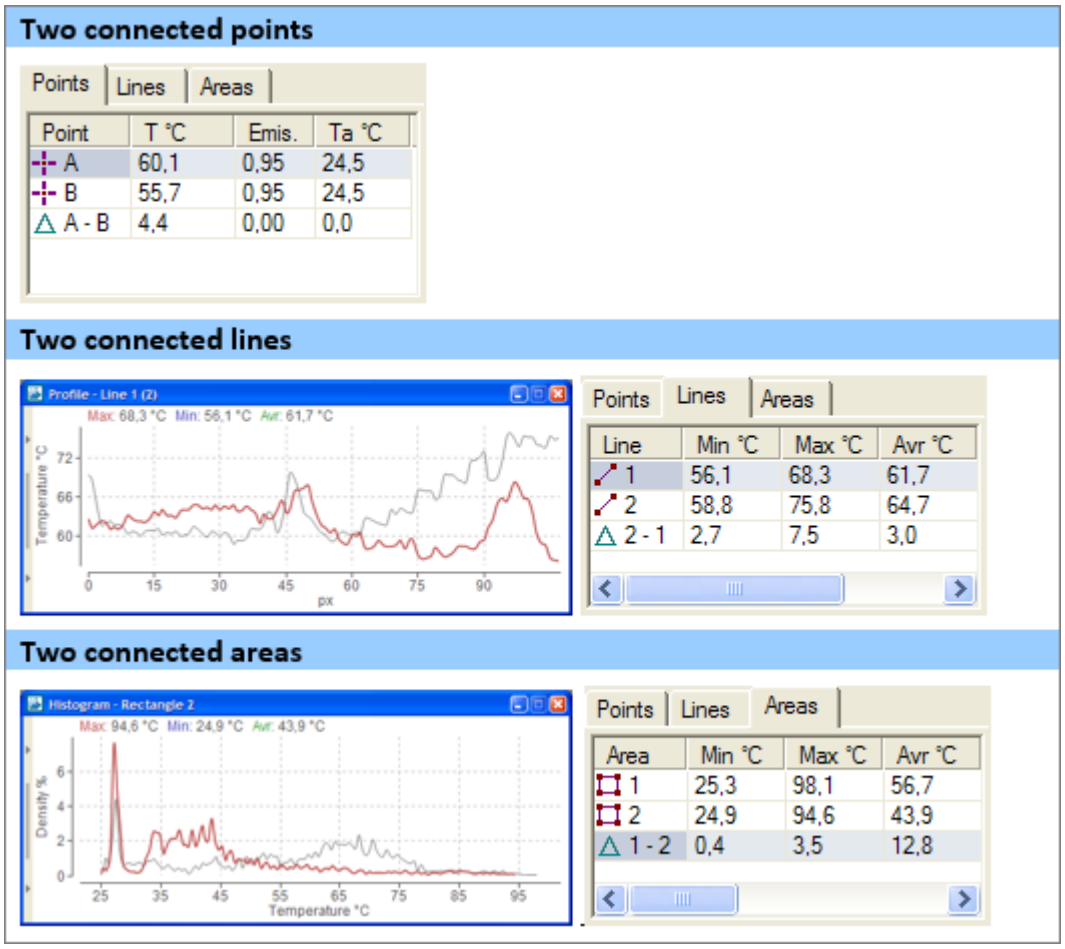
Connected objects

To connect two objects, use the connection tool: click on one object with the left mouse button and, holding it, move the mouse pointer to the second object, then release the button. If you made it correctly, you will see a dash line connecting the objects.



Only objects of same type connect to each other: points to points, lines to lines, areas to areas.

The effect of connecting two objects depends on the objects type. For points you will see temperature difference if the 'Analysis Objects' statistics window. For lines and areas, beside the difference calculation, you will see two and more profiles or histograms in one window.



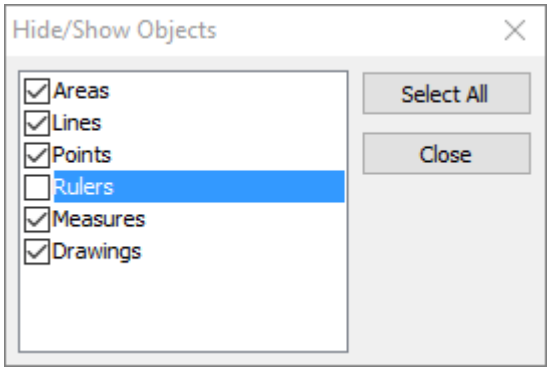
Another way of creating connected objects is to use the selection tool: holding the *Control* key, move the desired object to another place. In this case the two objects will be connected, and the second object will be an exact copy of the first one.

Hidden objects

Sometimes you do not need to have all the objects visible at the same time. Especially this is the case for the ruler objects.

To hide an object, click on it with the right button and in the context menu choose 'Hide'. The object will disappear, but it is not deleted.

To show an object back choose **'Hide/Show Objects'** in the main menu or the same item in the context menu of the image. A dialog will appear, where you can select which type of object to make visible or invisible.

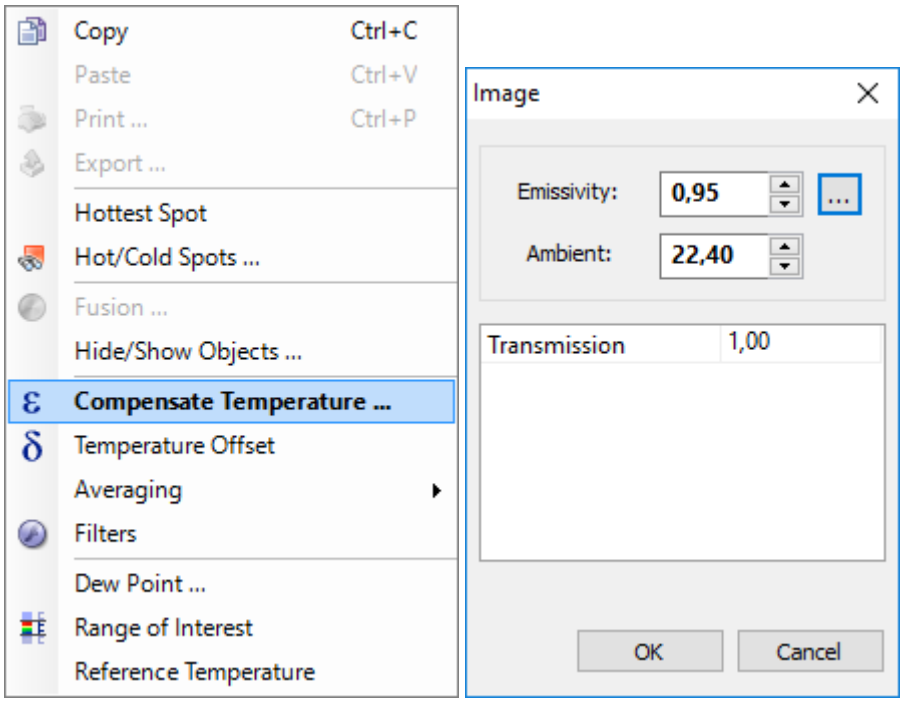


3.6 Temperature calculation

As known from the infrared thermography, there are several parameters that affect temperature calculation. The main of them are *emissivity* and *ambient (reflected) temperature*. Some infrared cameras, in addition to emissivity and ambient temperature, can also compensate transmission losses. This needs transmission coefficient, atmosphere temperature, humidity, and distance to the object to be known.

IRT Analyzer allows to adjust these parameters for the entire image and for every analysis object individually.

To change emissivity, ambient temperature and other temperature calculation parameters use main menu command **'Temperature | Compensate Temperature'** or the same command in the context menu of an object or the image.



By default, objects use temperature calculation parameters from the image.

Intersecting objects

Every analysis object calculates its temperatures independently. When one object sits on another object (intersects) it will not use temperature values calculated by the object behind it.

This is true also for points placed on top of areas.

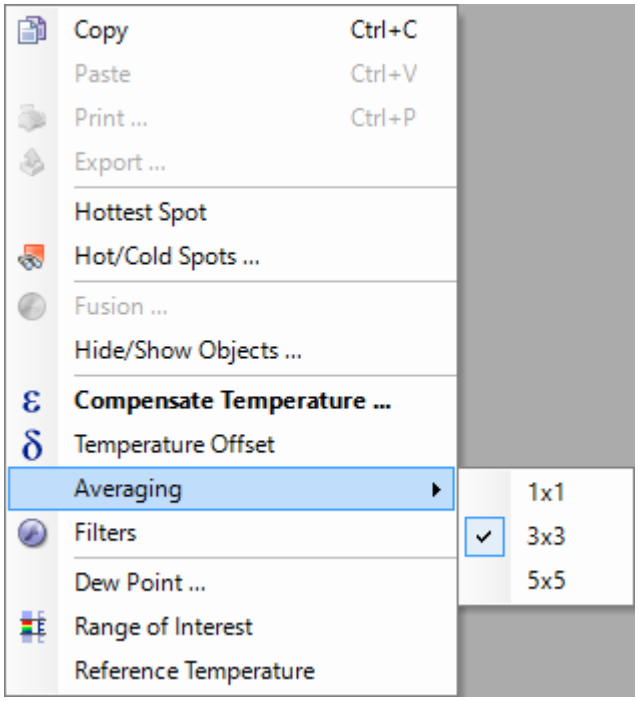
Temperature offset

You can add or subtract some value from image or object temperatures. Click with the right mouse button on an object (or anywhere on the image to change image setting) and in the context menu select **'Temperature Offset'**. Then enter a positive or a negative value.

In the case above temperature offset value is constant. To make it variable, for example depending on reference temperature, use temperature offset script.

Averaging

Averaging is used when image is noisy and you want to get more reliable values not affected by noise at individual pixels (especially this is useful for points and lines).



Averaging here is *spatial* averaging: to calculate a pixel value, program takes values also from pixel's neighbors and calculates their average.

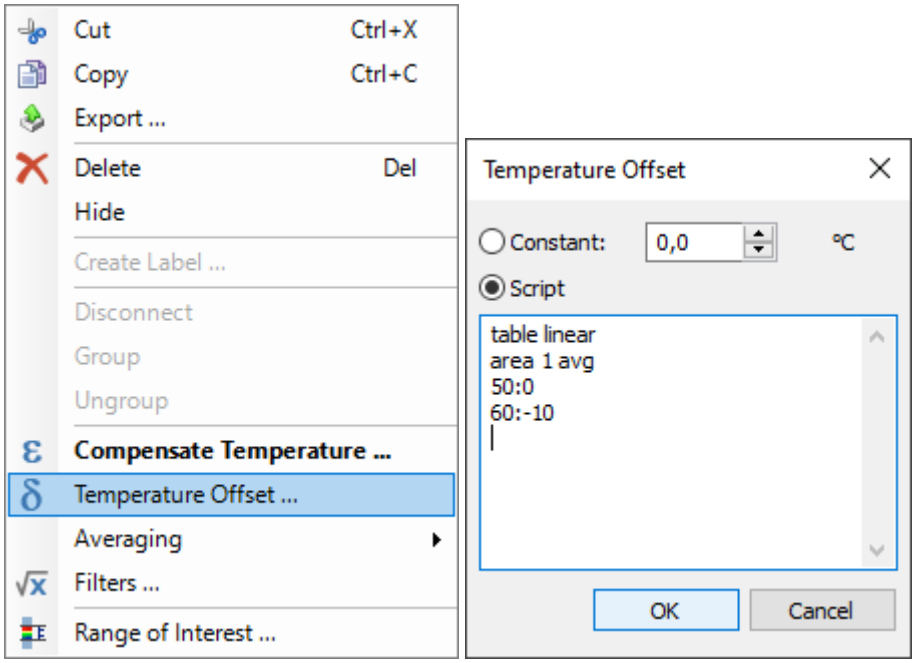
To change averaging for an object (or the image), click on the object (or anywhere in the image) with the right mouse button and in the context menu choose **'Averaging'** and then **'3x3'** or **'5x5'**. 3x3 or 5x5 is the size of a window around every pixel. Values for averaging are taken from this window.

To remove averaging, choose **'Averaging | 1x1'**.

3.7 Temperature offset script

Temperature offset is a correction value that can be added to each pixel of an analysis object (image, point, line, or area). Offset value can be a constant or a calculated value defined by a script.

To set temperature offset right click on an analysis object (or empty space in the image to apply temperature offset to image). In the context menu select **'Temperature Offset'**.



These script types are supported:

1. Table
2. Reference (correction by a black body)

Table script

Table script allows to read another analysis object value and adjust temperature offset depending on that value. Dependency between object value and offset value is defined by a table - several "object value to offset value" pairs.

Syntax:

```
table [linear] <measurement> <value_pair> <value_pair>...
       <measurement>: area|point|line <object_index> min|max|avg|val
       <value_pair>: <measurement_value> : <offset_value>

linear: When 'linear' is specified, calculated offset value will be linearly
        interpolated using two closest entries from the table. When 'linear' is
        not defined the offset value from the table is used unchanged as it is
        defined for the corresponding range.

<measurement>: defines the analysis object (area, point or line) and its measurement
               (min, max, avg or val) to be used as the control value. Please pay
               attention that points as well as lines and areas are indexed by
               numbers (1,2,..), not by letters.

<value_pair>...: at least two "measurement:offset" pairs; values in each pair are
                 separated by colon.

example: table point 2 val 40:5 50:0 60:-5

Point B value  Offset
Below 40       5
40 to 50       5
50 to 60       0
60 and above   -5
```

Reference script (correction by a black body)

Reference script can be used to correct camera reading drift if you have an object on the image with known temperature (usually a black body).

Syntax:

```
reference area|point|line <object_index> min|max|avg|val <reference_value>

Define analysis object (area, point or line) with index and its measurement (min,
max, avg or val) to be used as the control value. Please pay attention that point
objects are also indexed by numbers (1,2,..), not by letters.

<reference_value>: value that will be compared with the value measured by the camera
                   and used in the correction formula.

example: reference point 2 val 50

Meaning: point B measured value should be 50, if it is not, apply a correction to
the measured signal so that point B value becomes 50.
```

In case of reference script, offset is applied to the measured camera signal, not to the temperature value. In simplified form, formula can be written as:

$$Offset = U(Treference) - Umeasured$$
$$Tcorrected = T(Umeasured + Offset)$$

where U is energy detected by camera sensor.

This provides proper compensation for objects with different emissivity factors.

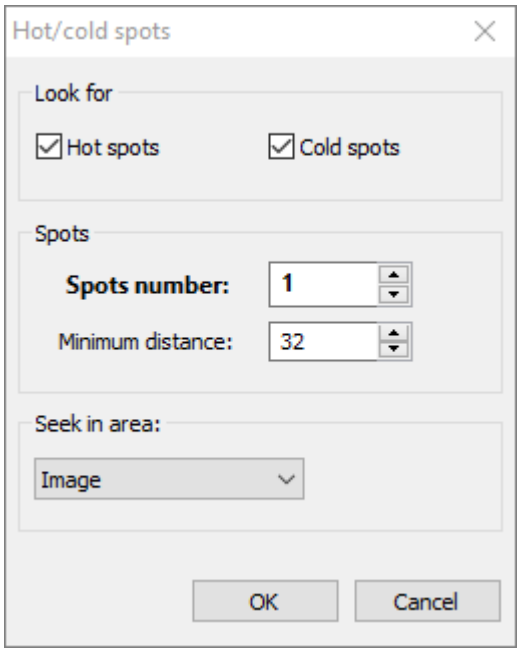
3.8 Hottest/coldest spot detection

IRT Analyzer can automatically detect hottest and coldest spots on an image. A hot/cold spot is a local extremum - a point on the image having the highest or the lowest temperature value among all its neighbors (in some adjacent area).

IRT Analyzer marks detected hot/cold spot using the usual spot objects. Extremum objects have an exclamation sign in their names and cannot be moved.

To find just the hottest spot, select main menu **'Analysis | Hottest Spot'** or the corresponding item in the context menu of the image.

To find cold spots or to find more than one extremum spot and to use additional search parameters, use menu **'Analysis | Hot/Cold Spots'**.



Hot spots/Cold spots: defines if you want to find hot spots, cold spots or both.

Spots number: the number of spots of each type to find.

Minimum distance

This parameter defines how close extremum spots are allowed to be to each other (measured in pixels). Normally you need to find several hot objects and not the many neighbor pixels on one hottest object. 'Minimum distance' parameter allows to separate the objects and find extremum spots on each of them.

Seek in area

If you need to find extremum spots within some area, not on whole image, you first need to create an area object. When such area object is present on the image, you can select this object in 'Seek in area' combo box. Extremum spots will be searched only within pixels belonging to the selected area.

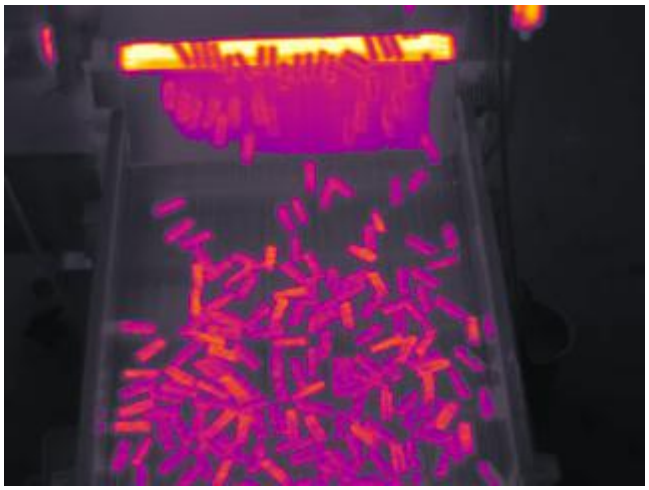
Limiting extremum spots search area by a temperature range

If the image has a range of interest defined, extremum spots will be searched only among pixels with temperature values belonging to this range.

3.9 Range of interest

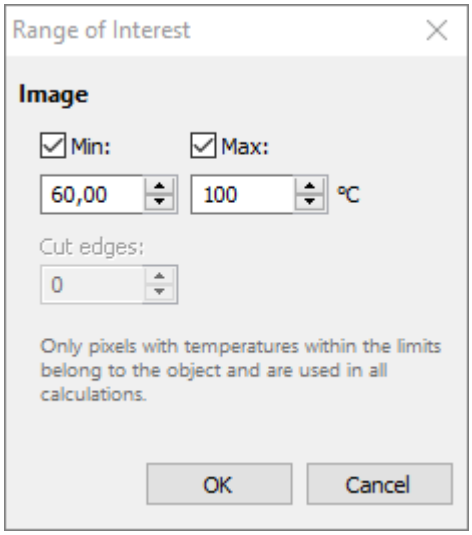
Image range of interest

Range of interest when applied to an image changes its visual appearance: pixels outside the range lose their colors to black and white. This gives you an additional possibility to visually emphasize some area on the image.



Some IRT Analyzer features use image range of interest for their needs. For example, hot/cold spot are detected only within pixels in this range.

To set range of interest, right click on the image and select **'Range of Interest'** in the context menu.

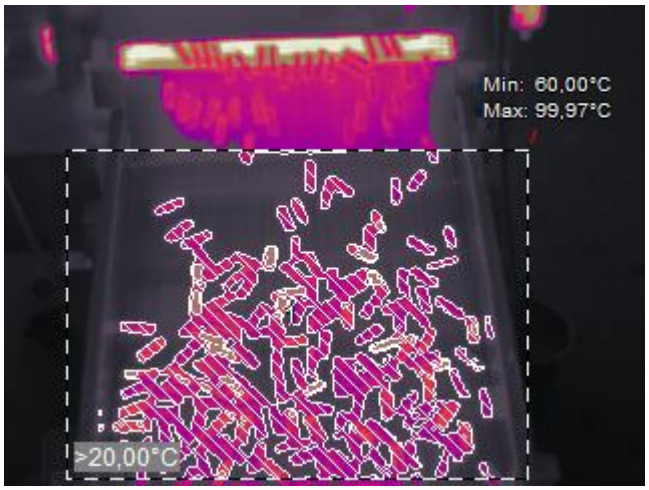


Range of interest can have only the bottom limit, only the top limit or both limits enabled:

1. When only the bottom limit (Min) is enabled, active pixels are the pixels with temperatures above the bottom limit.
2. When only the top limit (Max) is enabled, active pixels are the pixels with temperatures below the top limit.
3. When both limits are enabled, pixels with temperatures inside the min-to-max range are active.

Range of interest for area objects

Range of interest, if set for an area, defines pixels which belong to that area. For example, you have created a rectangle. If you assign some temperature range to it, IRT Analyzer will take into account only those pixels of the rectangle that fall into the defined range – the rest will not belong to the object.



Only the crosshatched pixels at the picture belong to the area object and only they are taken when the histogram of object area is calculated. It is also true for other operations with areas – min, max, average calculation, trend analysis, region where the filters are applied and so on.

Range of interest for areas is defined using image temperatures, which can be different to the object temperatures (in case of different emissivity, for example). This is done to prevent object shape changing when you change its emissivity.

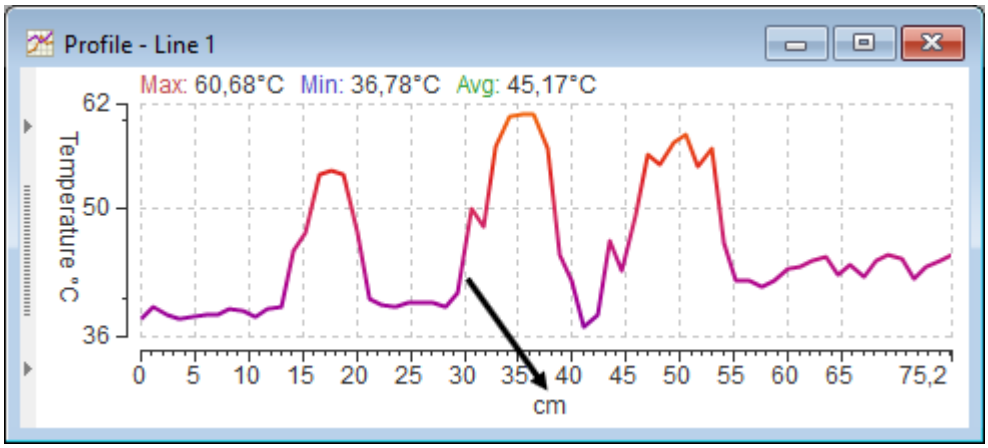
Range of interest for area objects have an additional parameter - **'Cut Edges'**. *Edges* are image points at which temperature changes sharply. When 'Cut Edges' is bigger than 0, IRT Analyzer finds edges inside the area and removes them from the resulting region. The bigger this parameter is the bigger the tolerance for the edge detection algorithm (more edges detected). Cut Edges function can be useful, as edges (because of spatial resolution of the camera detector) often do not show real temperature values and it is better not to use them in calculations.

Object area (pixel count) calculation

Range of interest defined for an area and for the image affects object area calculation. Pixels that do not belong to the range of interest (both image and area) are not counted.

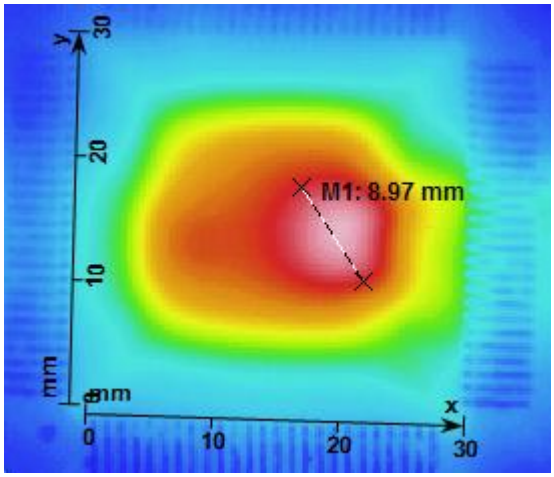
3.10 Real-world image size

The real-world size of objects displayed on infrared images depends on many parameters: camera optics, object to camera distance, tilt angle and others. IRT Analyzer has tools to define real-world coordinate system. When you have coordinate system for an image defined, IRT Analyzer will show real length units at diagrams, which might help to locate the problem zone on a real-world object.



Using rulers and measures

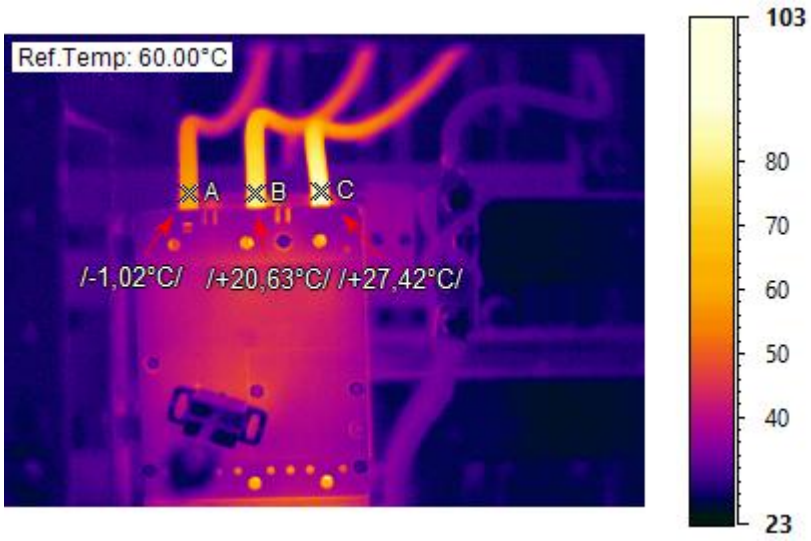
To define coordinate system for an image you should use rulers. When you create a ruler object you define the real-world size of an image pixel. Knowing pixel size IRT Analyzer can recalculate real-world sizes of other analysis objects - lines and areas. There are also special measure objects, their only use is to show size or angle values.



3.11 Reference temperature

It is possible to define a temperature value which will serve as a reference level. When reference temperature is set, all analysis objects will show how much their values are bigger or smaller if to compare with the reference value.

To set reference temperature use main menu **'Temperature | Reference Temperature'** or the same item in the image context menu.



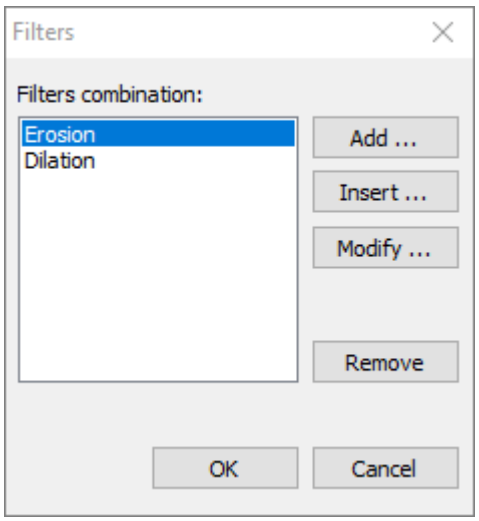
Only analysis objects on the image will display their temperatures relatively to the reference level. All other windows in IRT Analyzer (diagrams, trends) will be still displaying absolute values.

3.12 Image filters

If you have a noisy image, you can apply averaging to reduce the noise and get more accurate measurements. Averaging is an image filter and there are more image filters available in IRT Analyzer:

1. Median filters.
2. Convolution filters with different kernels: Gaussian, Laplacian, Prewitt, Sobel, Sharpen. Also you can use your custom kernels.
3. Dilation and erosion.
4. Memory operations to create filter combinations.

Filters can be applied to the entire image or to an analysis object. Click on an analysis object to make it active or click outside any analysis object to make the entire image active and select **'Temperature | Filters'** in the main menu (there is also corresponding item in context menus).



Filters will be applied one after the other as you see them in 'Filters combination' list.

Median filter

Median filter sets every pixel value to be the median of the pixel values in the neighborhood of that pixel. As the averaging filter median filter is used to reduce noise. The outcome of median filtering is that pixels with outlying values are forced to become more like their neighbors. The advantage of median filter is that it does not make the image blurry (edges are preserved).

Definition: the median *m* of a set of values is such that half the values in the set are less than *m* and half are greater.

For example, suppose pixel's neighbor values are (10, 18, 20, 15, 17, 20, 22, 25, and 100). If we sort the values we get (10, 15, 17, 18, |20|, 20, 22, 25, 100) and the median here is 20.

Pixel's neighborhood is always a square and its size is selectable to be 3x3, 5x5 or 7x7.

Convolution filters

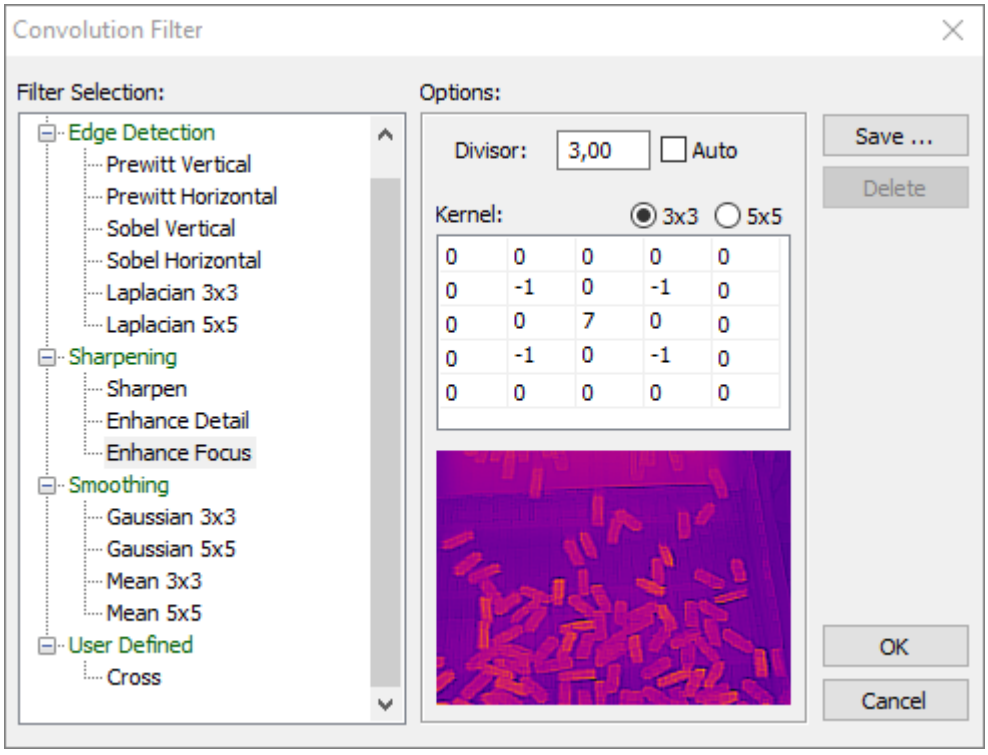
The 2D convolution is a versatile image processing primitive which can be used in a variety of image processing operations, for example, edge detection, blurring, noise removal, and feature detection. It is also known as mask convolution or spatial convolution.

For 2D convolution, a rectangular kernel is used. The kernel is a matrix of signed integers. The kernel could be a single row (a row filter) or a single column (a column filter) or composed of several rows and columns. The center cell in the kernel is called *anchor*. For each input pixel, the kernel is placed on the image such that the anchor coincides with the input pixel. The output pixel value is computed as:

$$y_{m,n} = \sum_i \sum_k h_{i,k} x_{m-i,n-k}$$

where $x_{m,n}$ is the input pixel value and $h_{i,k}$ denotes the kernel. The output pixel value is scaled by the *divisor*.

IRT Analyzer provides a set of predefined kernels, namely: Prewitt (vertical and horizontal), Sobel (vertical and horizontal), Laplassian, Gaussian, Mean, Sharpen kernel and kernels to enhance focus and details. These kernels are organized in groups by their effect on image pixels.

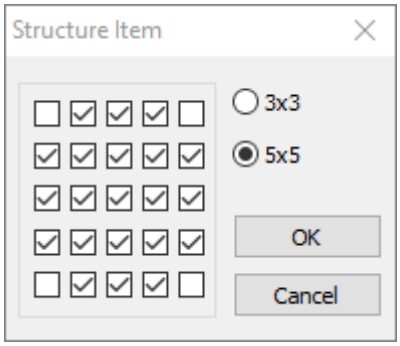


In addition, you can define your own kernel by editing the 'Kernel' table. Your custom kernels can be remembered for future use (press **'Save'** button to name your kernel and save it).

Mathematical morphology filters (erosion and dilation)

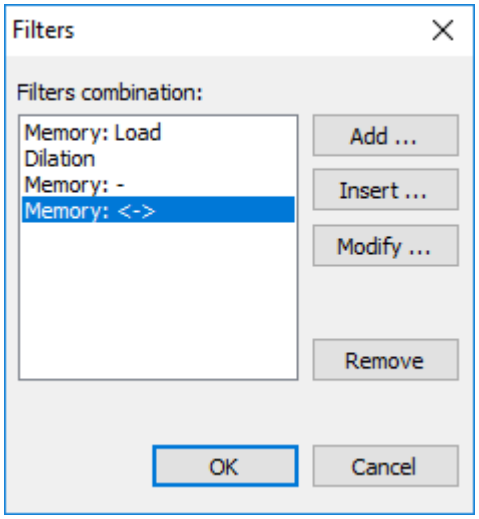
Morphological image processing pursues the goals of removing image imperfections (such as noise or texture) by accounting for the form and structure of the image. It is beyond the scope of this manual to describe how morphological filters work, please refer to the corresponding topic in image processing theory.

When you add dilation or erosion filters you need to specify their structure item, which can be a 3x3 or 5x5 matrix.

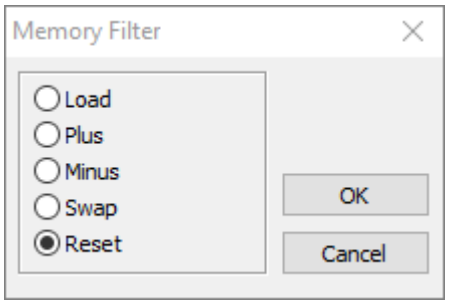


Memory

This is not a real filter. It behaves like the memory function of a usual calculator and allows to make a more complicated combinations of image filters. For example, filter below will outline edges on an image.



Memory filter operations:



Load: puts the image into the memory in its current state.

Plus: adds the current image values to the image value already in the memory.

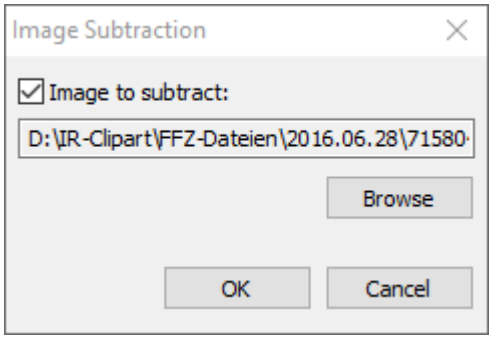
Minus: subtracts the current image values from the image values already in the memory.

Swap: swaps the current image and the image in the memory.

Reset: resets the memory image to zeros.

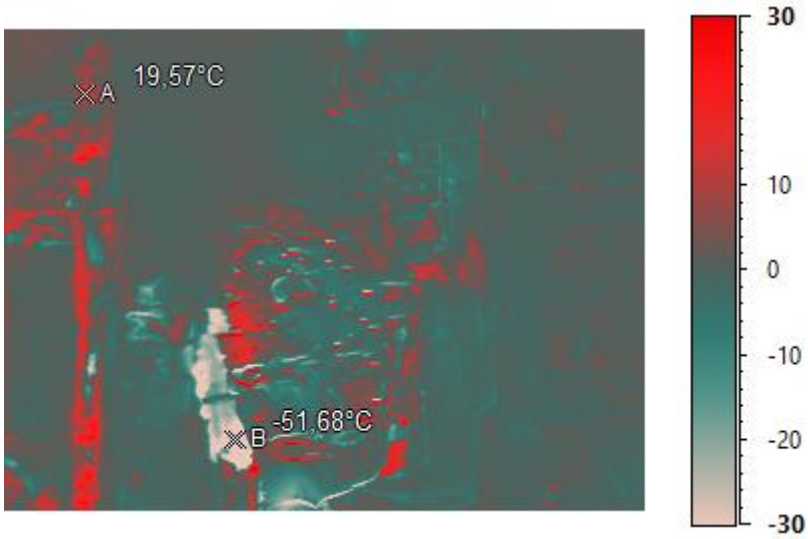
3.13 Image subtraction

To subtract a pre-saved image from the main image (this can also be a sequence or live image) select **'Temperature | Image Subtraction'** from the main menu.



Mark **'Image to subtract'** check box and press **'Browse'** button to select image that will be subtracted (subtrahend image).

Subtrahend image uses the same temperature correction parameters (emissivity, ...) as the main image.



When image subtraction is used, all measurements and diagrams will display differences between main image and subtracted image pixel values.

3.14 Emissivity map

The purpose of this function is to eliminate the effect of different emissivity values at different points on an object allowing temperatures measurements to be more accurate.

For example, this method may be applied for thermal analysis of circuit boards, that consist of parts with different emissivity values.

IRT Analyzer gives you the option to measure emissivity values at each image pixel, and then apply these measurements to other images to calculate their true temperatures. In order for this method to work, object position must stay precisely the same on the image emissivity map is calculated from and on the image emissivity map is applied to.

Theory

The intensity of infrared radiation coming from a point on an object is the sum of the radiation emitted by the object itself and the ambient radiation reflected by the object:

$$I = \varepsilon I_{object} + (1-\varepsilon) I_{ambient}$$

Where,

I_{object} is the intensity of radiation coming from the object.

$I_{ambient}$ is the intensity of radiation coming from the object's environment.

ε is the emissivity of the surface of the object.

I is the intensity of detected radiation.

Note: The emissivity is in general a function of both the object temperature and the frequency of the radiation, but in practice, it is regarded, to a good approximation, as independent of these factors for the materials and temperatures that are likely to be encountered. We also assume that the contributions from atmospheric absorption and emission are insignificant.

Equation above shows that in order to calculate the true temperature at a point on an object from the detected intensity, you need to know the emissivity and the ambient temperature values at that point.

Emissivity map (one image method)

If to assume that the effect of the background is uniform across the whole surface of an object, to calculate emissivity map it is enough to have a single image with object heated to a known uniform temperature (this temperature must be different from the ambient temperature). The intensity of emitted radiation should be larger than the reflected ambient radiation, you should heat your object to a temperature higher than the ambient temperature.

Emissivity and background map (two image method)

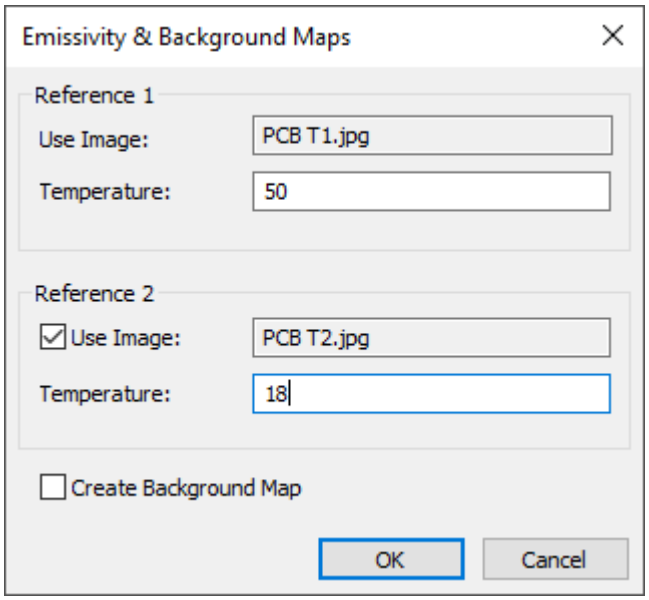
If effect of the background is not uniform and you want to compensate for it, you need to calculate both emissivity and background maps. For this you need to heat your object to two known uniform temperatures - first to T1 and then to T2 and calculate emissivity and background maps from the two infrared images. Temperatures T1 and T2 should be as distanced from each other as possible, this will allow more accurate results.

Emissivity map created using the two image method is more accurate than the map calculated from a single image. You can use the two image method also when you do not need background map.

Creating emissivity maps

To create an emissivity / background map:

1. Open one or two infrared images that contain your object heated to a know temperature.
2. In the main menu select **'Temperature/Save Emissivity Map'**.



Background map can be only created when you have two images. Emissivity map can be calculated from one image, but calculations will be more accurate if to use the two image method.

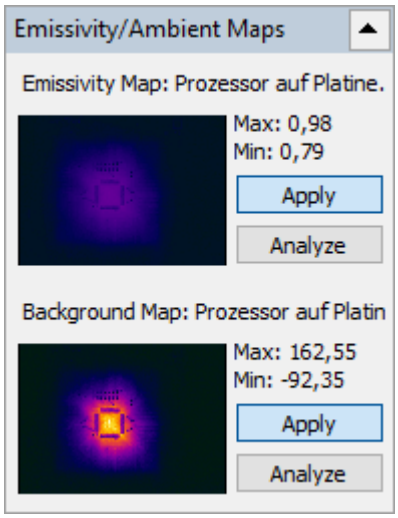
If it is not possible to measure emissivity or ambient temperature at some pixels, IRT Analyzer will show you how many such pixels are there in percents.

After emissivity / background map is created and saved, it is loaded and applied to the source images for you to check the accuracy of the calculations.

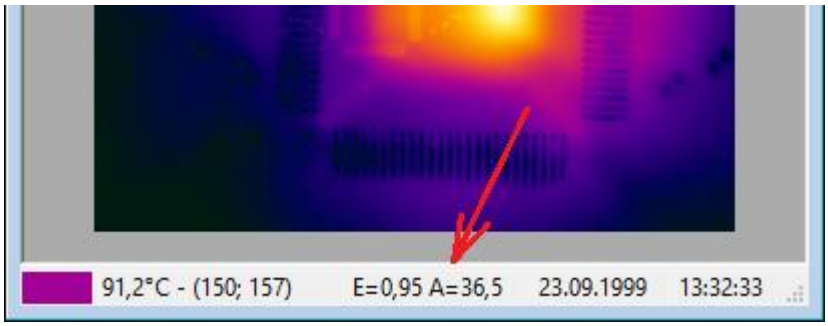
Applying emissivity maps

To load a previously saved emissivity / background map, select **'Temperature/Load Emissivity Map'** in the main menu. Loaded emissivity / background map will be applied to the active image.

Image(s) of the emissivity / background map will be displayed in the navigation panel in the **'Emissivity/Ambient Maps'** dialog.



When maps are applied, to learn values for emissivity and ambient temperature at any pixel of the image, simply move the mouse cursor to that pixel. The values will be displayed in the status bar at the bottom of the image.



Analyzing emissivity maps

An emissivity or background map can be treated as an image and IRT Analyzer can open them as images. Use the usual **'File/Open'** menu or press **'Analyze'** button on the **'Emissivity/Ambient Maps'** dialog.

With emissivity / background maps, you can do same operations as with normal infrared images, for example, you can apply analysis objects and create diagrams.

3.15 Graphs

IRT Analyzer can draw the following graphs:

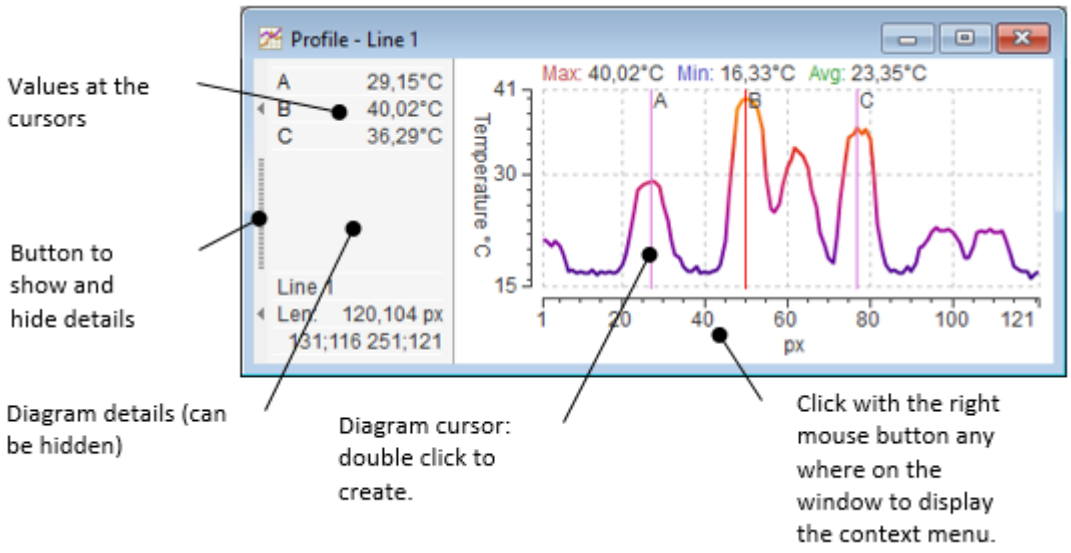
1. Line profiles
2. Area histograms

Graphs described here use data only from one infrared image. There are also analysis trend graphs, which use data from a sequence of images. They are discussed later in this manual.

Line profiles

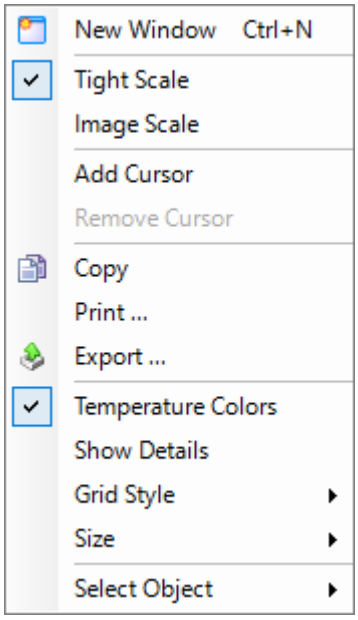
Line analysis objects in IRT Analyzer include segments (arbitrary, horizontal, vertical), polygonal lines and crossing lines. *Line profile* visualizes primary analysis information about a line. *Line profile* is a curve showing temperature values of every line point.

To show a line profile diagram, create an analysis line object and select main menu item **'Analysis | Analysis Graphs | Profile'**.



As you can see from the picture, a diagram window contains the diagram itself and a table with details. The details part can be hidden. It shows values at the diagram cursors and additional information about the line

object. To change diagram appearance, use its context menu (click with the right mouse button on the diagram).



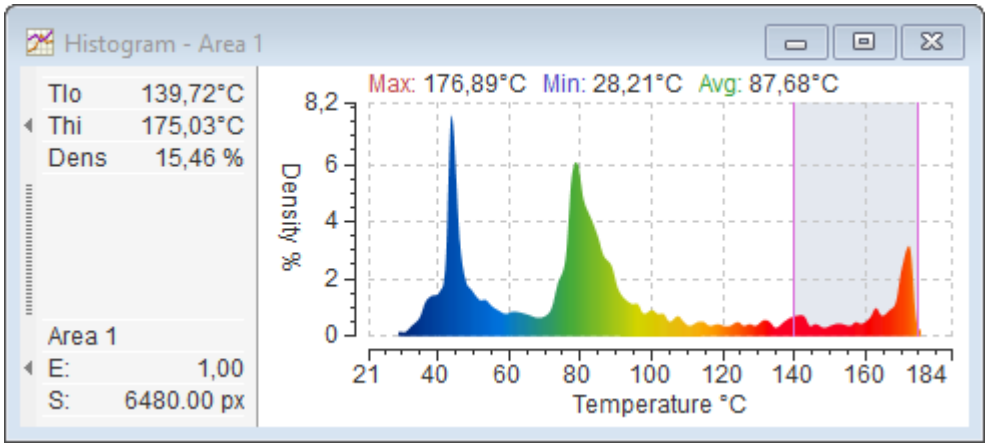
Here is what every menu item does:

- **New Window**: opens an additional diagram window of the same type (in this case an additional profile diagram). If you have two line objects, this new window will show a profile for the second line.
- **Tight Scale**: affects the temperature axis. When selected temperature axis limits will be the minimum and maximum values on the line.
- **Image Scale**: affects the temperature axis. When selected temperature axis limits are set to be the same as the image temperature range.
- **Add Cursor/Remove Cursor**: adds a new cursor to the diagram or removes the cursor you have clicked on.
- **Copy**: copies the diagram into the clipboard.
- **Print**: prints the diagram.
- **Export**: saves diagram data to a file in a variety of formats (picture formats, CSV, TXT, AVI video).
- **Temperature Colors**: when selected, diagram uses “temperature colors” to draw the curve. This means, color of every profile point depends on its value and is taken from the image palette. When 'Temperature Colors' mode is not active, all pixels have the same color.
- **Show Details**: shows and hides the details part of the window.
- **Grid Style**: diagram draws lines from axes ticks, which create a grid. In this menu, you can delete these lines or choose their visual style.
- **Size**: there is a selection of three sizes – small, normal and large. Choose the one which better fits your screen resolution and preferences.
- **Select Object**: allows you to select another line object to be shown in the diagram.

Area histograms

Area histogram is a diagram showing temperature distribution in an area. In other words, for any temperature range, you can see the percentage of pixels falling into this range.

To show an area histogram diagram, create an analysis area object and select main menu item **'Analysis | Analysis Graphs | Histogram'**.



As you can see on the picture, histogram window looks similar to the profile window. Same as for a profile window, using histogram's context menu you can create diagram cursor, hide, and show the details part, size the window, select the grid style, copy and export diagram data, change axes scale and select which area object to use.

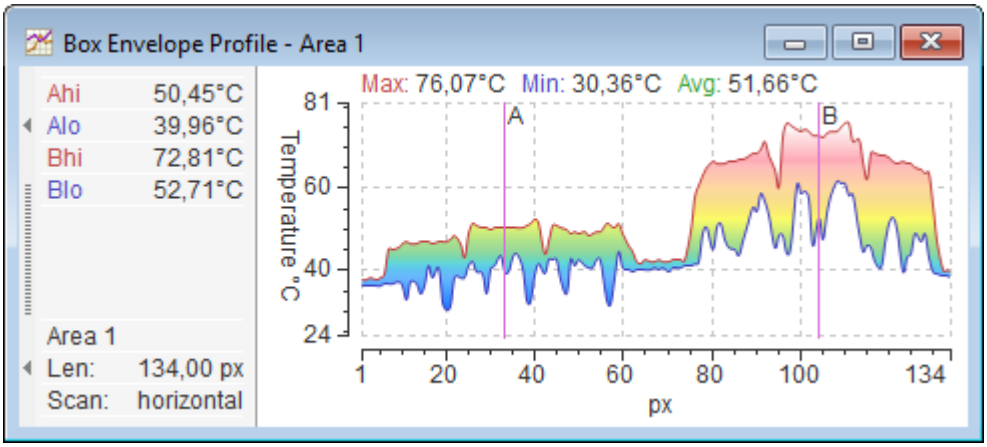
Only one cursor is allowed for a histogram. Histogram cursor defines a temperature range, its parameters are shown in the details part:

- Tlo – cursor's lower limit.
- Thi – cursor's upper limit.
- Dens (density) – the percentage of pixels falling into the cursor range.
- E – emissivity of the object.
- S – area of the object.

Box envelope profiles

To create an envelope profile is a rectangular area is needed. Envelope profile consists of two curves: the upper curve shows the maximum value for every vertical (horizontal) line of a rectangle, the lower shows the minimum.

To show a box envelope profile diagram, create a rectangular analysis area object and select main menu item **'Analysis | Analysis Graphs | Box Envelope Profile'**.



You can add several cursors to it and their values will be shown in the details part.

By default, the rectangle is scanned from left to right (horizontal scan). You can change this to the vertical scan and the object will be scanned from top to bottom. To do so, choose **'Vertical Scan'** in the context menu of the diagram window.

3.16 Analysis trends

Graphs described in the previous topic needed only a single infrared image. *Trends* are different - they take data from a sequence of images and display how temperature is changing with the time.

Analysis trends are primarily designed to analyze prerecorded sequences of images. But it is also possible to use analysis trends with live image. In this case frames from the acquisition history buffer are used to build the graph. Acquisition history buffer length is limited, so analysis trends length is also limited. With live image we recommend using real-time trends, they are specially designed for real-time and can be much longer in time.

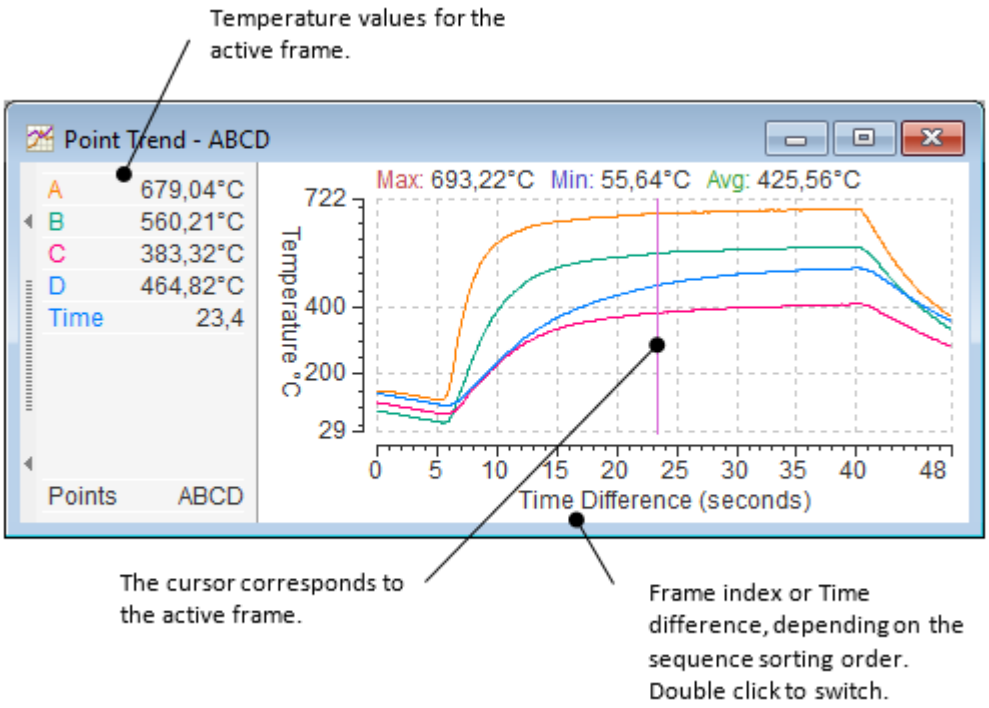
IRT Analyzer can build the following trends:

1. Point trend
2. Area trend
3. Mixed trend
4. Profile trend envelope
5. Box line trend

Point trend

Point trend shows a spot temperature value change over time. Curves of up to 6 spots can be displayed on one trend diagram.

To show point trend, create spot objects and select main menu item **'Analysis | Analysis Graphs | Point Trend'**.



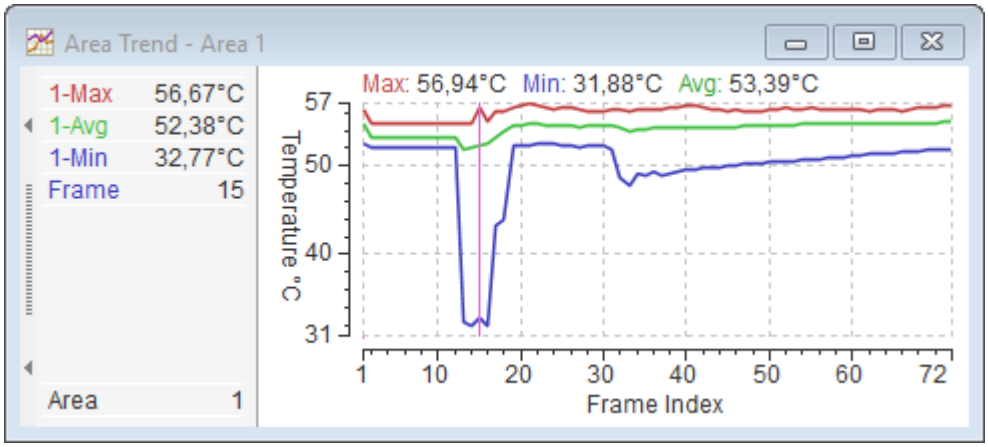
> In order to avoid dependency on the pixel noise, consider applying averaging to the points.

To add and to remove points from the trend select **'Select Points'** in the context menu of the point trend window.

Area trend

An *area trend* can be built by an area or a line object. It shows the minimum, maximum and average temperature in this area for every frame in the sequence. Only one area or line object can be used to build this trend.

To show area trend, create area or line objects and select main menu item **'Analysis | Analysis Graphs | Area Trend'**.

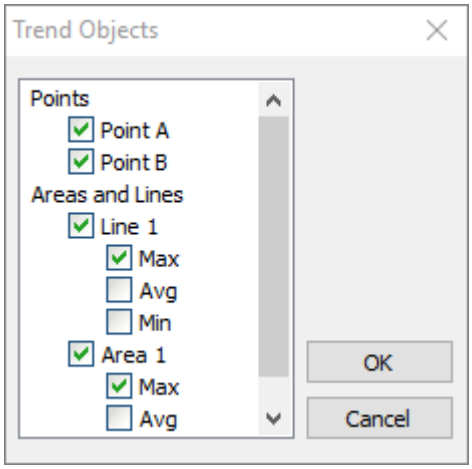


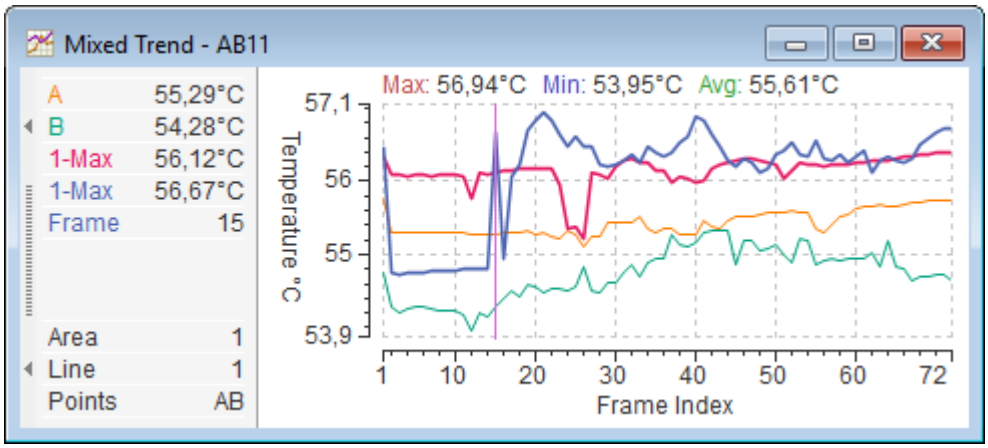
Mixed trend

Mixed trend can show point trend curves and area trend curves on the same diagram.

To show mixed trend, create needed analysis objects and select main menu item **'Analysis | Analysis Graphs | Mixed Trend'**.

Mark objects and properties you want to see in the trend in 'Trend Objects' dialog.

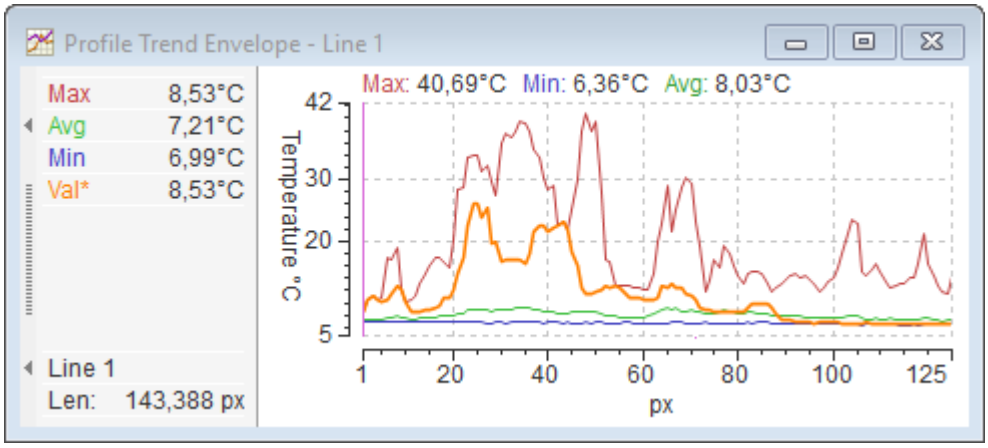




Profile trend envelope

A *profile trend* envelope shows aggregated minimum, maximum and average line profile of all frames in a sequence. In other words: for every point of a line IRT Analyzer calculates minimum, maximum, and average values among all frames in a sequence. So, it is not really a trend as it does not have time axis.

To show profile trend envelope, create needed analysis objects and select main menu item **'Analysis | Analysis Graphs | Profile Trend Envelope'**.

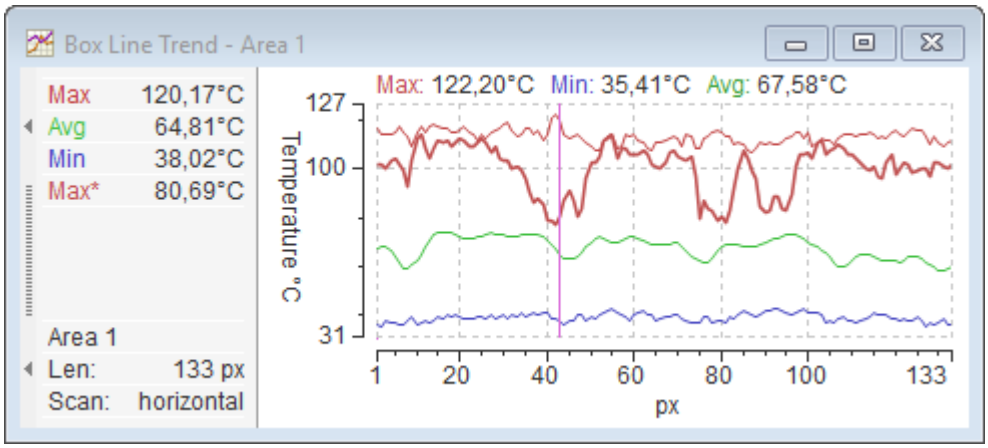


- The red curve shows the aggregated maximum profile.
- The blue curve shows the aggregated minimum profile.
- The green curve shows the aggregated average profile.
- The orange curve shows the profile of the active frame.

Box line trend

Box line trend is a box envelope profile generalization for the case of many images. A box line trend shows minimum, maximum, and average temperature value for each vertical (horizontal) line of a rectangle, taken from all frames in a sequence.

Box-line trend needs a rectangular area object. To show box line trend, create a rectangle area object and select main menu item **'Analysis | Analysis Graphs | Box Line Trend'**.



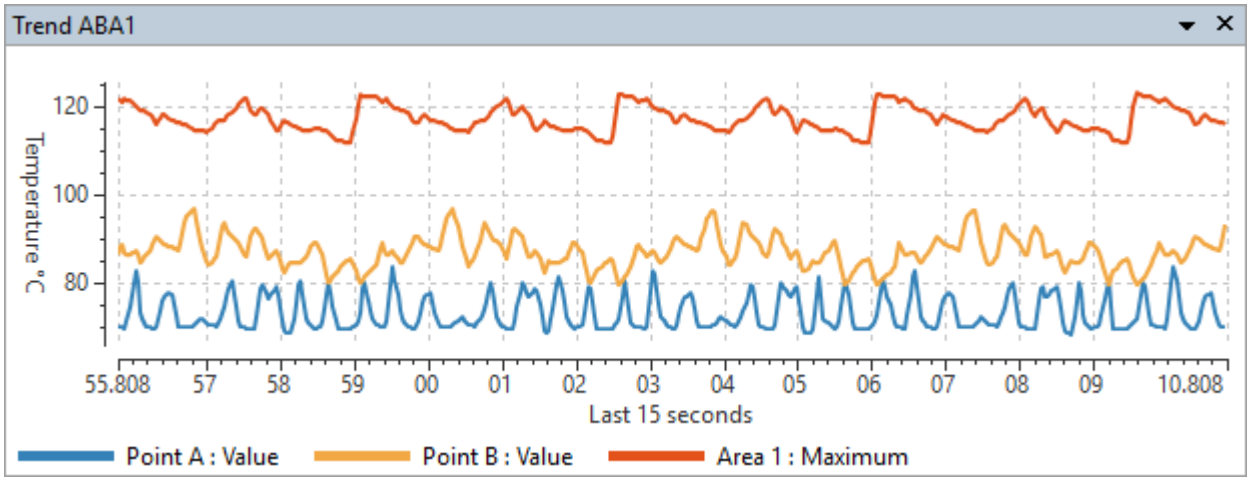
You can also show box envelope profile values of the active frame. In the context menu choose **'Frame Max'**, **'Frame Min'** or **'Frame Average'**.

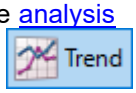
3.17 Real-time trends

Like analysis trends *real-time trends* display how temperature of some object is changing with the time. Real-time trends are created by live image from a camera: every frame in the live video stream adds data to the real-time trend.

Real-time trends can be built by the following objects and their values:

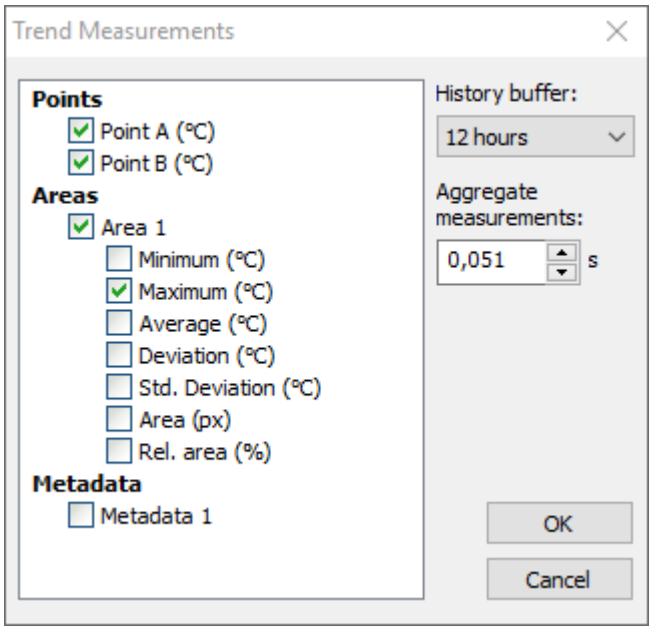
- Points: value.
- Lines: minimum, maximum, and average temperature values, deviation.
- Areas: minimum, maximum, and average temperature values, deviation, standard deviation, object area, object relative area.
- Image metadata.



You can create several real-time trend windows. To create a trend: start image acquisition, create analysis objects you want to see in the trend and click **'Analysis | Real-time Trend'** in the main menu (or 

button in the toolbar).

You will see a dialog with a list of measurements available for building a trend:



'History buffer': defines period trend data is kept for. Older records are deleted.

'Aggregate measurements': defines time interval for one trend record (trend data resolution). If there are more than one image frame coming during this time interval, measurements are aggregated into one record and then this record is added to the trend.

Trend data is kept in the memory, its length cannot be infinite. There are three parameters that define the size of memory buffer needed for a trend:

1. Number of measurements
2. Data frequency
3. History period

When you mark measurements in the list, you define the number of measurements; 'Aggregate measurements' time defines data frequency; history time is defined by 'History buffer'. Memory buffer reserved for each trend cannot exceed 64 MB. When you increase one parameter, IRT Analyzer may decrease other parameters to keep trend memory buffer in the allowed limit.

Let's assume that the camera is running at 60 Hz. This produces 60 trend records every second. Time interval for one record is 1 second / 60 = 0.0167 seconds. If you set aggregate interval to 0.016 seconds or to a smaller value, all records will be written to the trend. If to a bigger value, some records will be aggregated together into a single record and then this single record will be written to the trend.

If you need keep old records for, let's say, 1 week, you will not have enough memory if aggregate interval is 0.016 seconds. You need to sacrifice trend resolution and set aggregation interval to a bigger value (IRT Analyzer does it automatically for you).

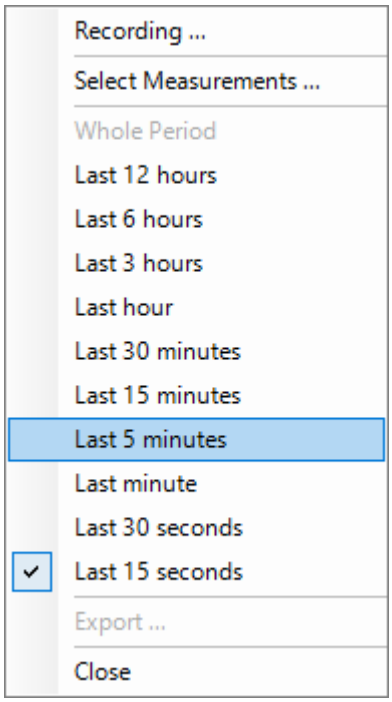
Methods used to aggregate measurements:

- Point values: maximum.
- Line/area maximum values: maximum.
- Line/area minimum values: minimum.
- Line/area average values: mean.
- For all other measurements maximum is used.

Set 'Aggregate measurements' to 0.001 s to write all records to the trend without aggregation.

Trend display mode

When acquisition is running, trend graph is scrolled automatically to always show the most recent measurements. You can change the displayed period length in the context menu of the trend window:

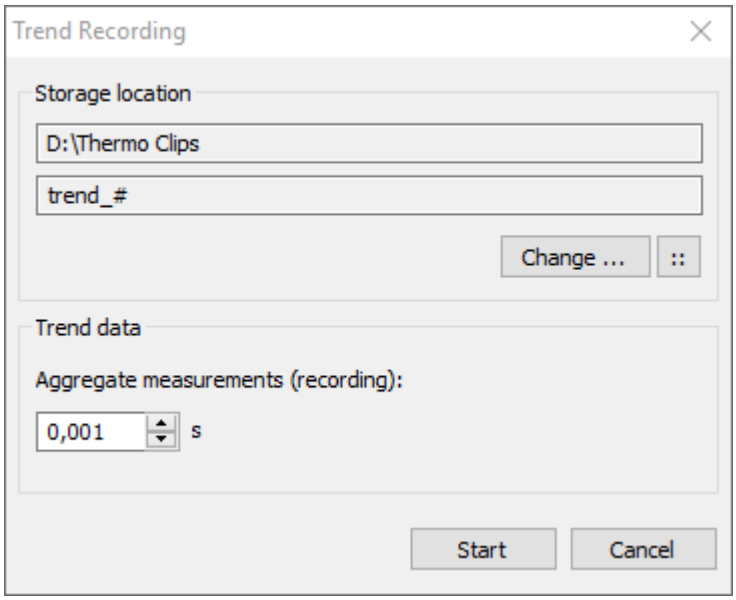


When acquisition is stopped or put on hold, trend automatically switches to **the free navigation mode**:

- Using the mouse, you can drag trend graph left or right to see older/newer records.
- You can change trend scale (zoom in/out) using the mouse wheel.
- By clicking on trend graph, you can set trend cursor to show corresponding infrared image (image will be shown only if it is present in the acquisition history buffer).

Recording trend to a file

To start trend recording to a file select **'Recording'** in the context menu of trend window.



You need to specify trend file location. It works the same as setting location for recording images.

Then you need to specify 'Aggregate measurements' interval, which can be different to the interval selected for the trend in the memory and will affect the size of recorded file.

Click **'Start'** to start recording to a file. Only new records will be recorded. Trend data recorded to the memory before Start is pressed will not be saved to the file.

To stop trend recording, select **'Stop Recording'** in the trend context menu.

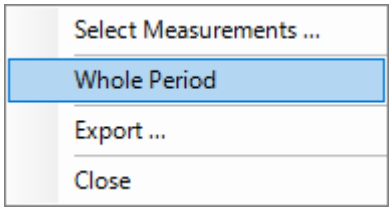
Trend is saved in a proprietary format. After trend is recorded, you can load it back to IRT Analyzer and convert it to CSV or Text format using **'Export'** command in the context menu.

Export command is available when acquisition is not running or put on hold. Unlike trend recording, export saves only the trend data currently in the memory.

Loading trend from disk

Recorded trend can be opened in IRT Analyzer with the usual **'File | Open'** command**.**

Trend is opened in the free navigation mode, so you can use the mouse to move and zoom the trend. To return to the whole trend period, select the corresponding item in the context menu:

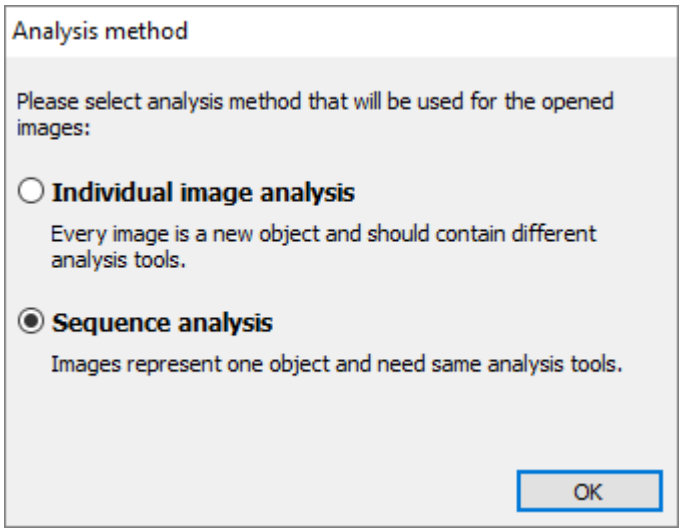


4 Working with stored images and sequences

4.1 Opening images and sequences

IRT Analyzer supports several image formats. Supported image formats are listed in the program license, therefore some of them may be not licensed and are disabled.

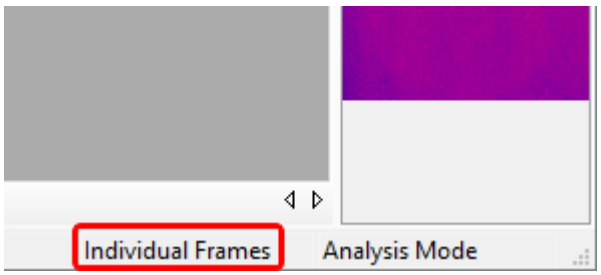
There are video and single image files. Video files are called *sequences* in IRT Analyzer. You will want to analyze these two types of data differently - for single images you will need individual set of analysis objects for every image, for sequences you will utilize trend analysis with one single set of analysis objects for the whole sequence. Depending on the file type IRT Analyzer will automatically select the appropriate analysis method (individual or sequence). When you open multiple single image files IRT Analyzer cannot decide how to treat them - as a sequence or as many independent images. In this case you will be asked to make the decision:



Individual images

These are the one-shot pictures, when you are not interested in the time process, but only in the current state of the object. You can open several such pictures simultaneously and analyze them one by one. Every picture will have its own individual settings - analysis objects and set of diagrams. When you switch from one image to another, set of analysis tools also changes. When you close such images, analysis tools are remembered individually for every image.

Active analysis method is shown in the bottom-right part of the main window. It is not possible to change it after images where opened. You need to open them again.

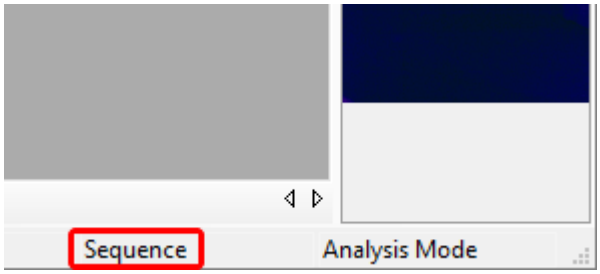


Use main menu **'File | Open'** (or button in the toolbar) to show the standard file open dialog and select the images. Examples of individual images can be found in 'Documents | Infrared Samples | PPM'. They have ".gtsi" extension and can store analysis objects inside image file.

Sequences

Sequence files normally contain many images - IR video. Sequence will have only one set of analysis tools associated with it. When you switch from one frame to another, analysis objects and windows are not replaced.

Active analysis method is shown in the bottom-right part of the main window:



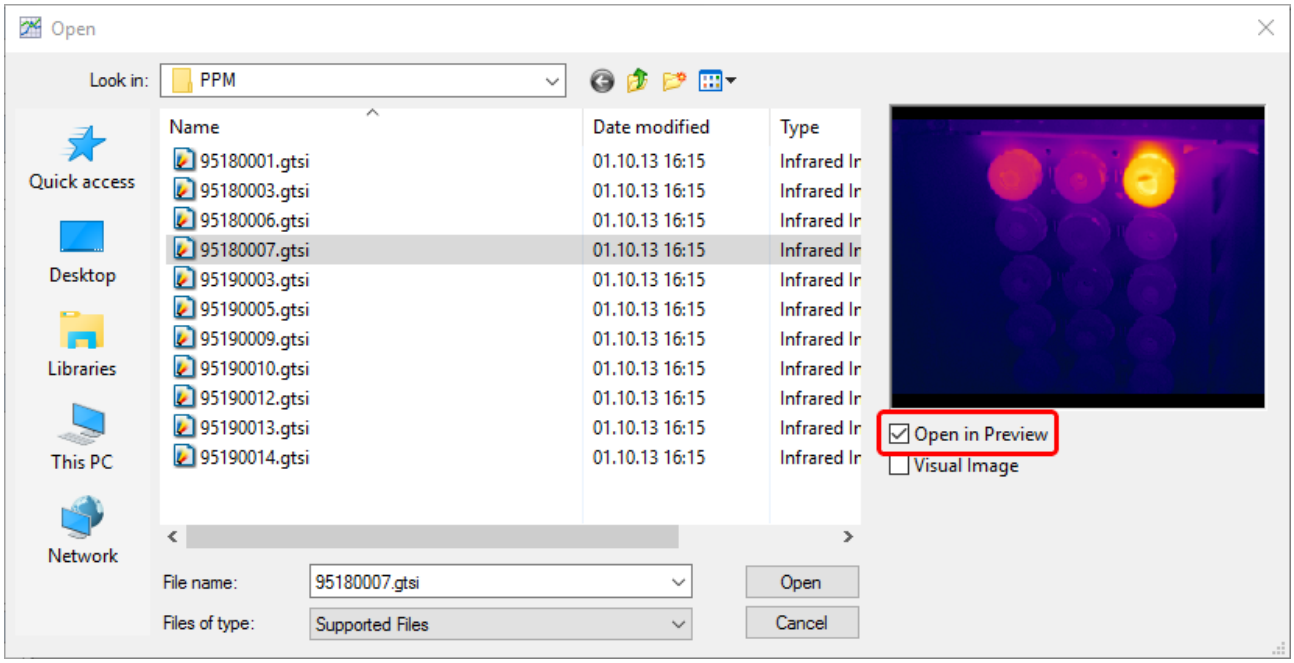
Use main menu **'File | Open'** to show the standard file open dialog and select a sequence file. You can open only one sequence file (you can add another sequence file afterward in Sequence Editor). Examples of sequences can be found in 'Documents | Infrared Samples'.

Often camera or 3rd-party image recorder saves sequence of images in many files - one frame per file. Such sequences can also be opened in IRT Analyzer with sequence analysis method. To do so in file open dialog select all the files that comprise one sequence and open them. IRT Analyzer will ask if you want to analyze these frames as individual frames or as a sequence, select **'Sequence analysis'**.

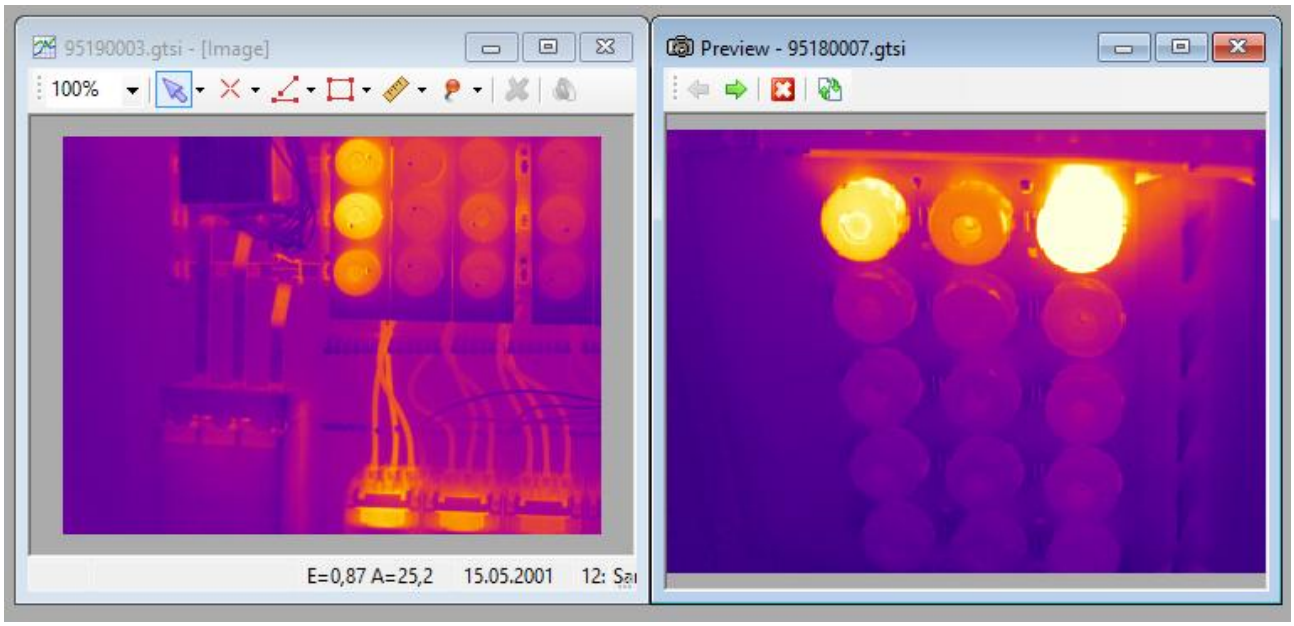
Infrared images in preview mode

In IRT Analyzer you cannot open two IR images in analysis mode and display them side-by-side. For this you will need to run two IRT Analyzer instances. Yet it is possible to show one image in analysis mode and others in the *preview* mode.

To open an additional IR image in the preview mode, use the same main menu **'File | Open'** (or button in the toolbar). Place mark in the **'Open in Preview'** check box.

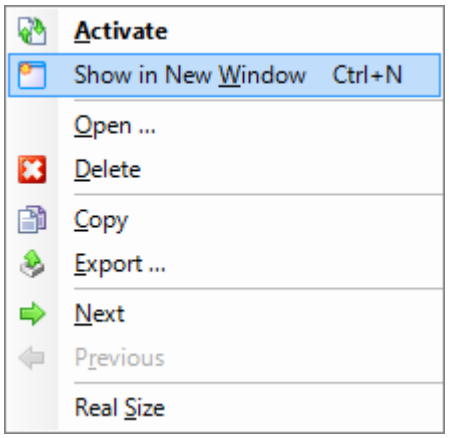


New image will be shown in a separate Preview window:



It will use the same temperature scale as the main image, so you can compare image temperatures by the color.

You can open more than one image in the preview mode. They can be all stacked in one window (and you switch between images with the arrow buttons), or you can show them in separate preview windows. To show active preview image in a separate window, right click on it to show context menu and select **'Show in New Window'**.



In individual image analysis mode you can replace main IR image with the image from the preview window. For this right click on the preview image and select 'Activate' from the context menu. Double clicking on the preview image does the same thing. When you have an image sequence open, or live image is running, this function is not available.

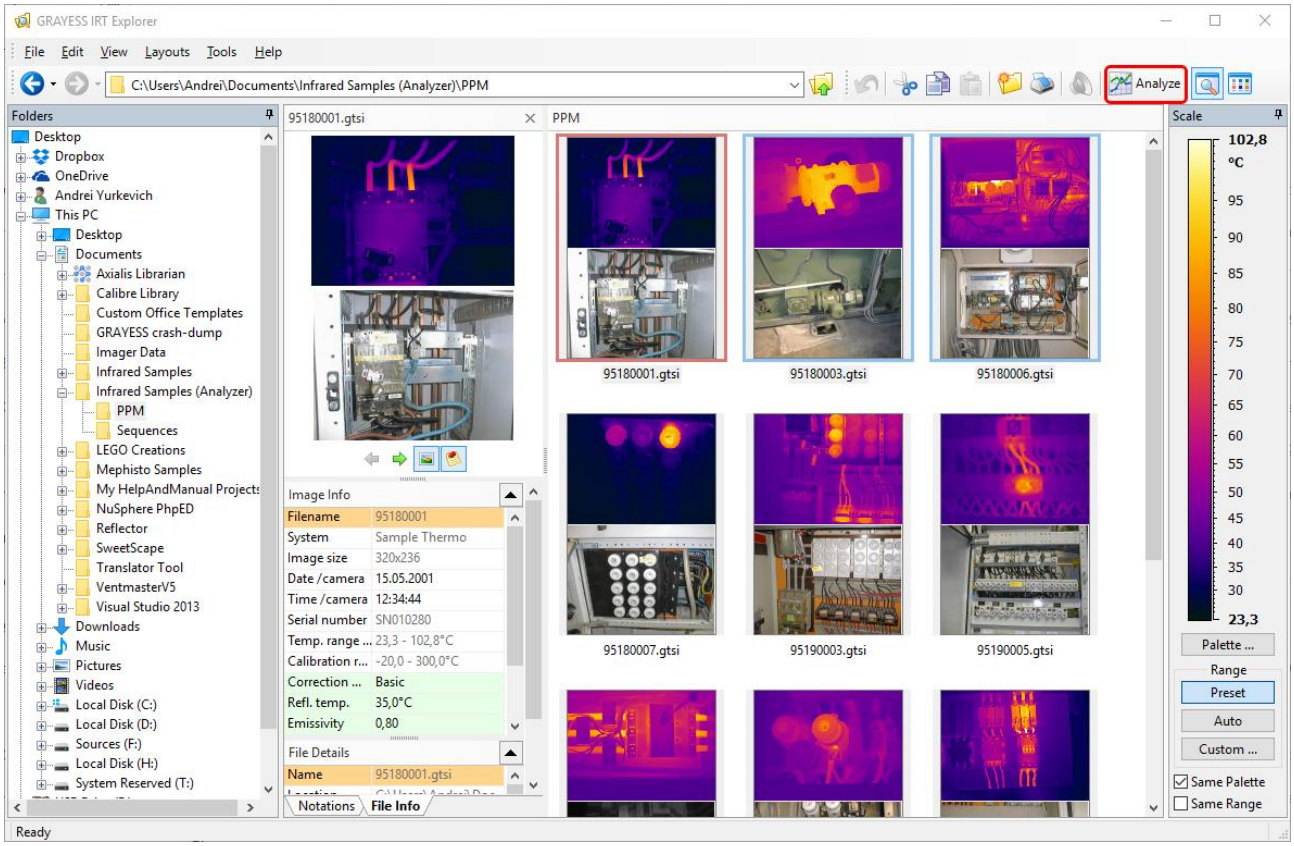
Visual images

Often visual light images are stored together with infrared images. In this case they will be automatically loaded to the preview window when you open the infrared image. If visual image is stored separately, you can link it to the infrared image by manually opening it. Use the same main menu 'File | Open' or the button in the toolbar.

Opening images with IRT Explorer

We developed a special explorer for infrared images. This explorer is similar to Windows Explorer but has many additional functions for convenient work with infrared images. You can use IRT Explorer to load images and sequences to IRT Analyzer. It is more convenient because you can always see thumbnails and

additional properties of IR images. Also you can use IRT Explorer to link visual image to their IR counterparts (if they are not already linked).



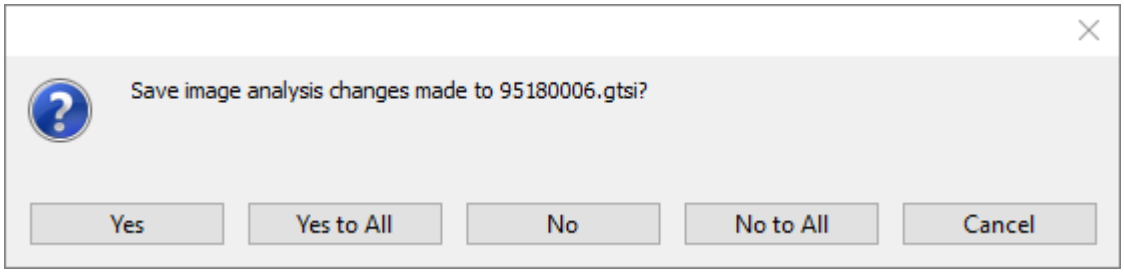
Select images or sequences you want to open and click **'Analyze'** button in the toolbar.

4.2 Saving your work

IRT Analyzer is designed in a way that it saves analysis data (analysis objects, diagrams) to images automatically - you do not need to select place to store changed files. Original image pixels and data are not modified - collection of objects and information about diagrams is stored nearby. Exact storage place depends on the source image format:

1. **Raw single images** (as they are created by the camera): analysis data is stored next to the image file in a file with ".clt" extension.
2. **Analyzed image format** (".gtsi" extension): analysis data is stored inside ".gtsi" file.
3. **Sequences** (one file many frames): sequence analysis data is stored next to the sequence file in a file with ".cltsq" extension.
4. **Sequences stored as many single images**: sequence analysis is stored in a ".cltsq" file next to the first frame file.

When you close main image window, you will be asked whether you want to save analysis changes.

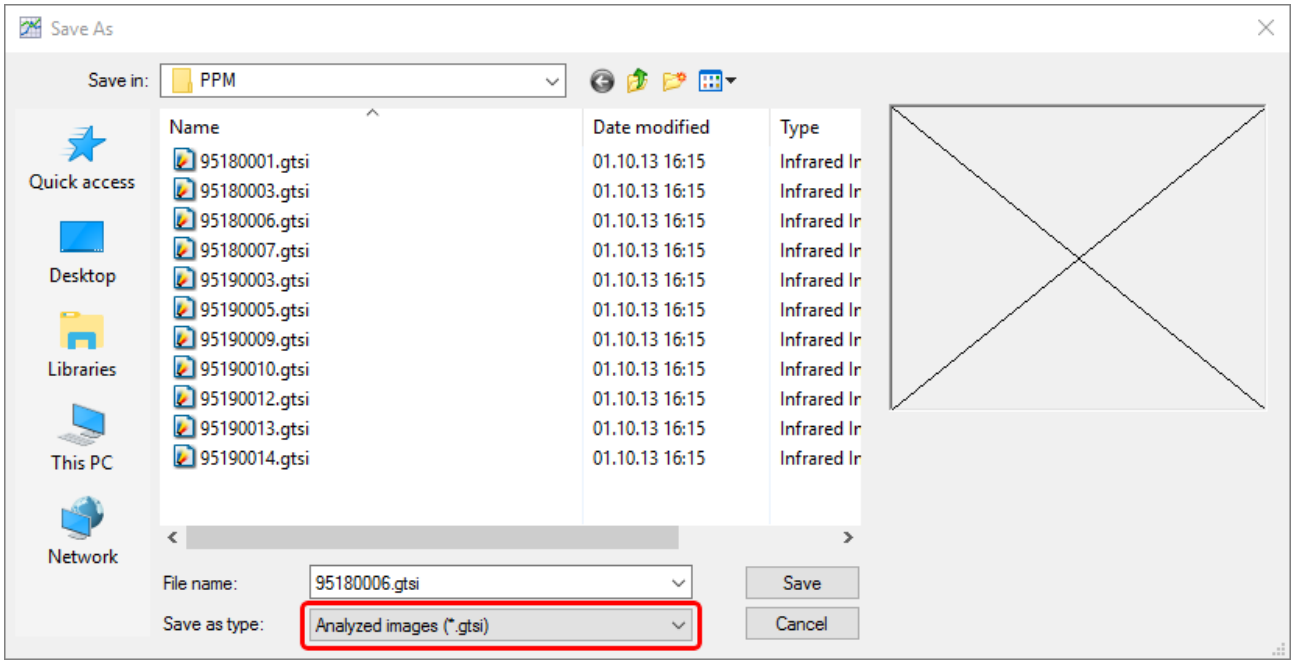


You can also save analysis changes any time using the main menu **'File | Save Changes'** or the corresponding button  in the toolbar.

Saving to a new image file

It is possible to save current image with or without analysis to a new image file.

Click **'File | Save Image As'** in the main menu:



In **'Save as type'** combo box you can select image format. There are two options - "Analyzed images (*.gtsi)" and raw images (format used by the camera):

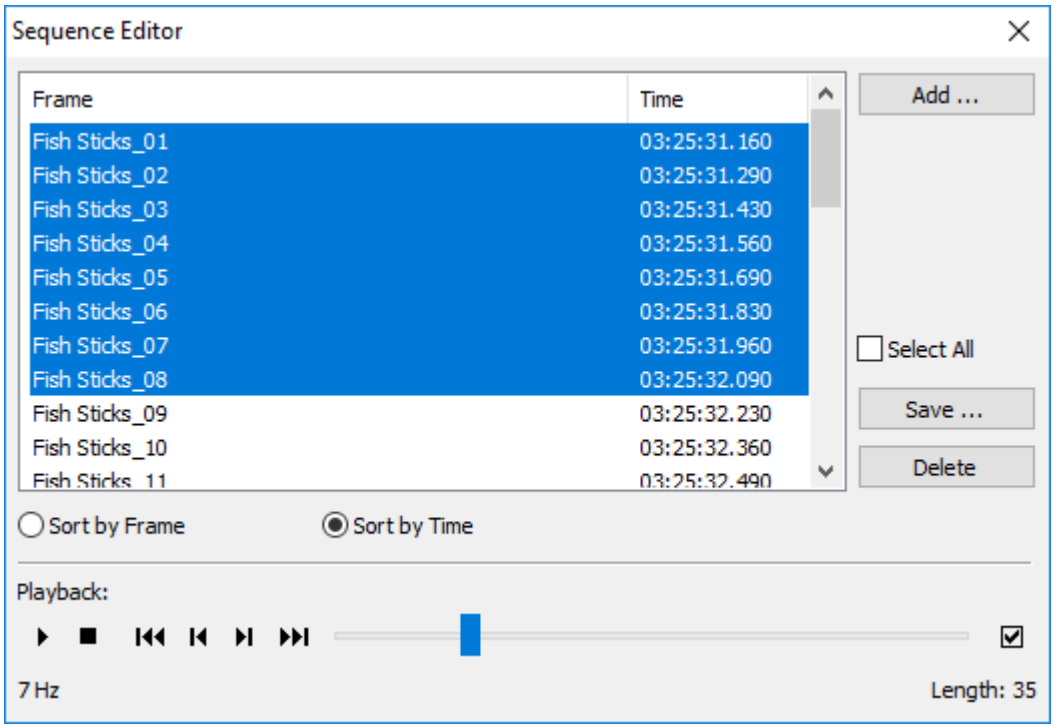
1. Analyzed images are stored with analysis objects, diagrams, and a visible image - altogether in one file.
2. Raw image is only the IR image, image pixels are recalculated using the current analysis set and correction parameters.

4.3 Editing sequences

It is possible to edit recorded video. Here are the available operations:

1. Sort images in a sequence.
2. Cut frames at any place in the sequence.
3. Join two or more sequences together.
4. Save modified sequence into a new file.

Sorting, cutting and joining operations are done in the 'Sequence Editor' dialog. Select **'Sequence | Edit Sequence'** in the main menu or press corresponding button in the toolbar .



Sorting frames

There are two sorting options:

1. **'Sort by Frame'**: frames will be sorted by file name (in case of many single-image files are open) or by frame index (in case a sequence file is open).
2. **'Sort by Time'**: frames will be sorted by timestamps recorded by the camera in every infrared image.

Cutting unneeded frames

In the list of frames, select frames you want to cut and press **'Delete'** button.

To select multiple frames, hold *Control* or *Shift* keys when you click on frames with the mouse.

Joining two sequences together, adding frames

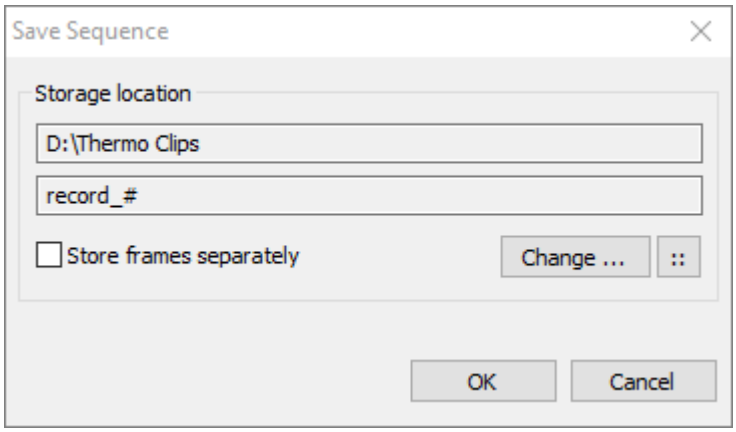
In 'Sequence Editor' dialog press **'Add'** button and select another sequence or separate images that should be added to the existing sequence.

Selected frames will be added to the sequence at places determined by the sorting order: by names or by timestamps. There is no way to insert new frames at a defined position, frame positions always determined by sorting order.

Saving part of a sequence to a new file (or files)

To save part of sequence to a new file, in the list of frames select frames you want to save and press **'Save'** button. If you want to save all frames, mark **'Select All'** check box.

You will be presented with 'Save Sequence' dialog where you need to specify how you want to save the selected frames.



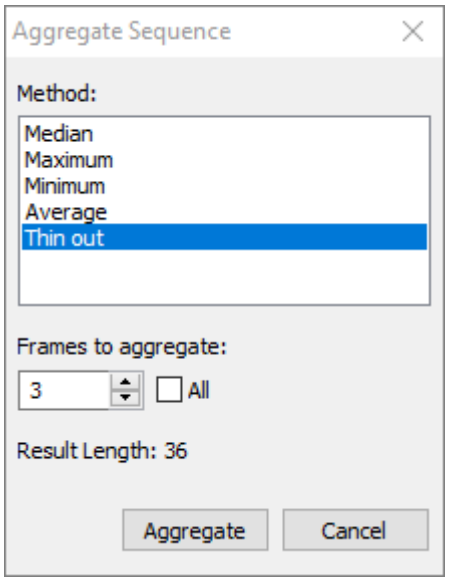
Press **'Change'** button to specify location where you want to save the new sequence. Mark **'Store frames separately'** if you want to save each frame in a separate file.

It is also possible to use tags in file names, for example, to include time in every frame name. Press :: button to select advanced options for file naming. See Image recorder storage location description for details.

4.4 Frames aggregation, frame rate reduction

You may want to reduce frame rate of an already recorded sequence or improve data quality by combining sequential blocks of frames into one frame. For such operations you need to use 'Aggregate Sequence' function of IRT Analyzer.

Select **'Sequence | Aggregate'** in the main menu.



There are several methods to compress the sequence. Each method takes specified number of frames (a block of frames) and, with the help of some algorithm, makes a single frame.

Let us assume that the **'Frames to Aggregate'** parameter is equal to N.

- **Thin out**: throws away N-1 frame, leaving only the first one in every block. This allows to reduce frame rate by throwing away unneeded frames. If N = 1, frame rate will be reduced by half, for N = 2 : 3 times, N = 3 : 4 times and so on.
- **Average**: each pixel of the resulting image is the average of corresponding pixels of all images in the block. This method enhances the sensitivity (temperature measurement accuracy) for static scenes.

- **Minimum, Maximum**: each pixel of the resulting image is the minimum (maximum) of corresponding pixels in the block.
- **Median**: median filter applied to pixels in the block. Suppresses pixel noise.

4.5 Exporting image data, clipboard operations

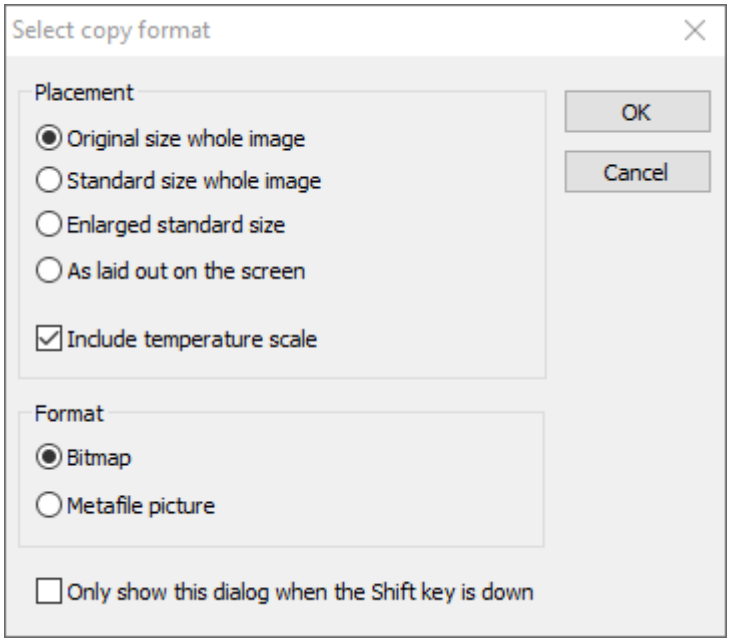
IRT Analyzer has several features to make the data exchange between applications simpler:

- Copying infrared images and diagrams into the Clipboard.
- Saving infrared images and diagrams to files in commonly used picture formats.
- Exporting infrared image data and graph data to text and binary files.
- Printing.
- There is a special feature for quick copying of multiple pictures into Microsoft Office documents.

How to copy an infrared image

To copy an infrared image into the Clipboard in a picture format, click on the image with the right mouse button and in the appeared context menu click **'Copy'**.

A dialog will show up where you should select a picture format, part and size of image to copy and whether to include the temperature scale or not.



Original size whole image: image will be copied using its original, not scaled size.

Standard size whole image: the standard image size is 320x240 pixels. If original image resolution is close to this size (e.g., 256x256), original size will be used. If not close, then image will be scaled to be close to the standard size.

Enlarged standard size: 640x480 or close to it.

As laid out on the screen: infrared image will be copied with the scale and position as you see it in the window. If image is smaller than the window - borders will be added, if bigger - exactly the visible part of the image will be copied.

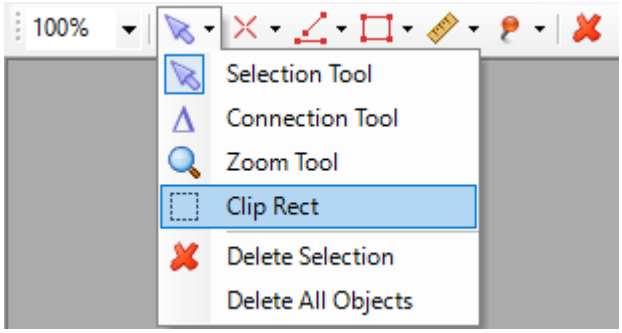
Bitmap / Metafile picture: metafile is a vector picture format; it is better for printing as then text will be of higher quality. Bitmap format is better for display on screen.

By selecting **'Only show this dialog when the Shift key is down'**, you tell IRT Analyzer not to show the dialog every time, but to remember the last used selection.

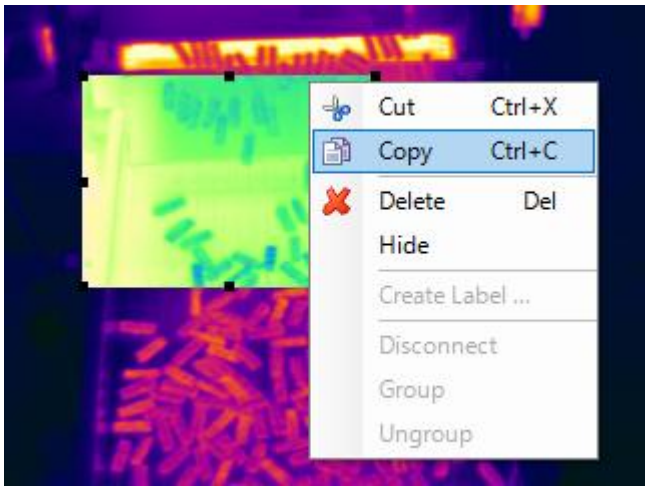
If you want to display 'Select copy format' dialog again, you need to hold the *Shift* key when copy function is selected in the menu.

Copying a rectangular part of an image

You can copy a part of an infrared image into the Clipboard using the **'Clip Rect'** tool – activated by **'Edit | Clip Rect'** in the menu.

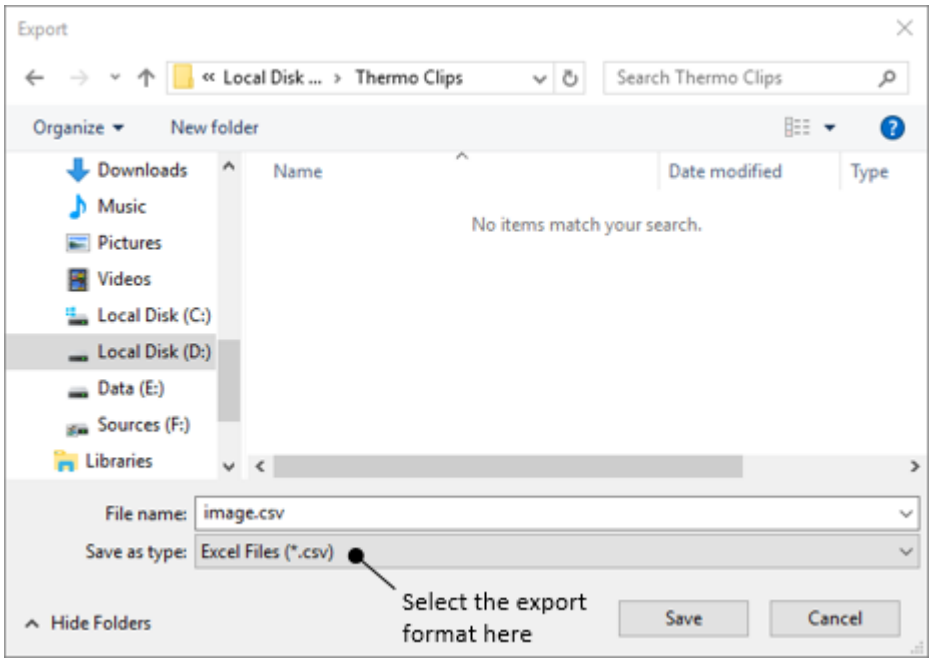


Outline the needed area, then in the context menu of the object click **'Copy'**.



How to export an infrared image

To export an infrared image to the disk in a variety of formats, click **'Export'** in the context menu of the image. The standard dialog for file saving will appear. To select the export format, use the **'Save as type'** combo box.



You have a selection of the following formats:

- PNG picture
- JPEG picture
- Windows Enhanced Metafile (vector graphics) picture
- ASCII text: table of image pixel temperature values
- CSV text: table of image pixel temperature values separated by commas
- MATLAB: matrix files in MATLAB format
- Binary: image pixel values in the simple binary format:

Simple binary image format

Little endian

4 bytes, integer: image width

4 bytes, integer: image height

Width x Height x 4 bytes, float: image pixel temperature values

How to copy and export diagrams and data windows

The operation is similar for all diagram windows and for 'Image Info' window and for 'Statistics' window.

- To copy a diagram into the Clipboard, click with the right mouse button on a diagram window and select **'Copy'** in the context menu.
- To export graph data or picture to a file, click **'Export'** in the context menu of the diagram. The standard dialog for file saving will be displayed. In the **'Save as type'** combo box select the format for the export.

How to export all images in a sequence

You can export all images in a sequence to PNG, JPEG, ASCII text, CSV, MATLAB or binary files in a single step. Click on the corresponding item in **'Sequence | Export'** main menu. A dialog for folder selection will be displayed. Select a folder (this folder should already exist) and press OK. All images will be saved under the original file names with extensions corresponding to the selected format, one file for each image frame.

How to make movie clips (AVI)

You can create a movie clip from a sequence of images or even a movie showing how a profile, or a histogram is changing.

To create a movie clip from an image sequence:

- Open a sequence of images.
- Click **'AVI Video'** in **'Sequence | Export'** main menu.
- The standard file dialog for saving will be displayed. In the additional field **'Speed (fps)'**, enter the playing speed for your movie in frames per second; type in a file name and click **'Save'**.
- Then you will see 'Select copy format' dialog where you can select a size of video image and set option to include the temperature scale.

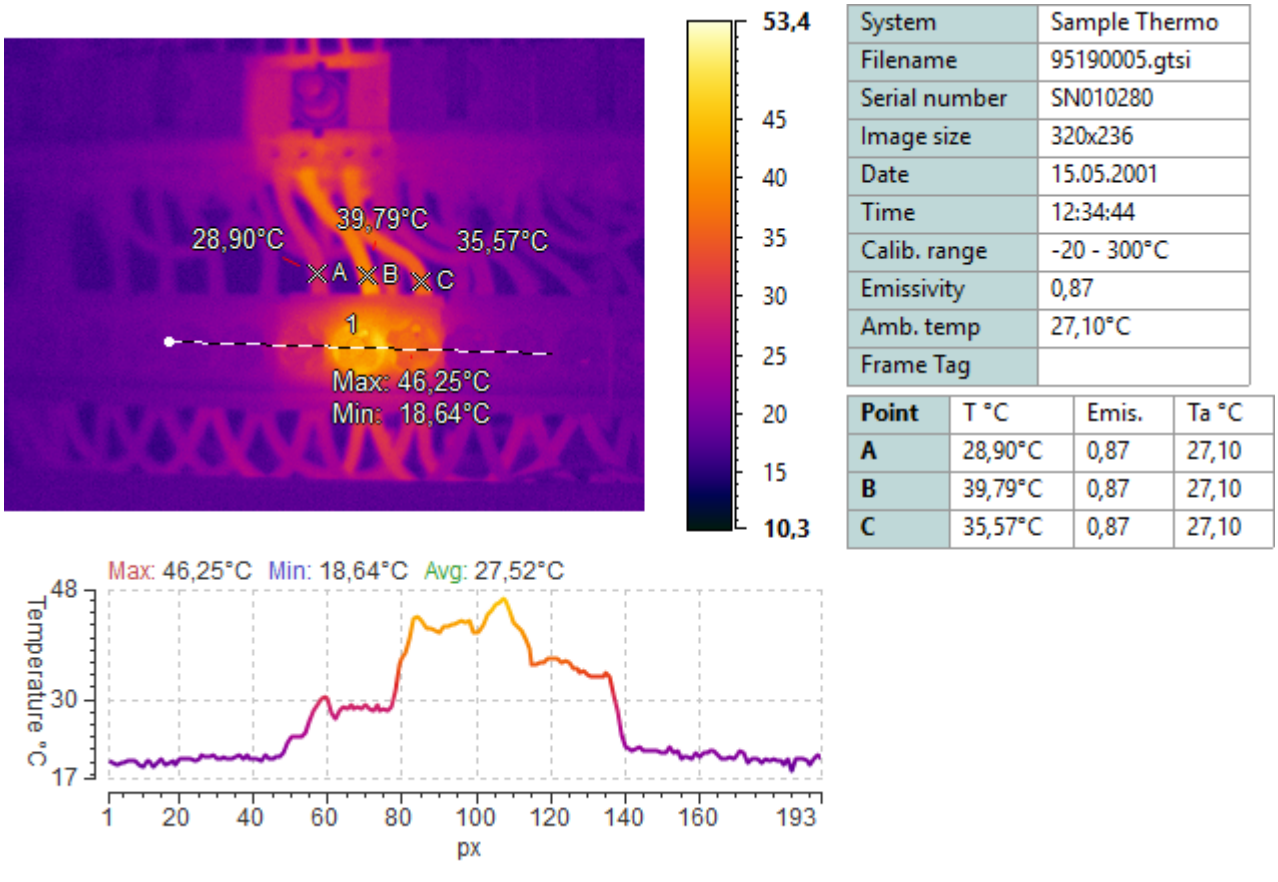
To create a movie clip from a profile or a histogram:

- Open a sequence of images, create a diagram you want to export.
- Click **'Export'** in the context menu of the diagram. The standard file save dialog will be shown. Select **'Avi Files (*.avi)'** in the 'Save as type' combo box, type in a file name, and click **'Save'**.
- Enter speed for your movie in frames per second (fps).

AVI video file will be saved using MPEG4 compression method.

Copy with details

You can copy the picture containing an infrared image, a points table, an image information table, a profile, and a histogram into the Clipboard. Choose main menu **'Edit | Copy with Details'**. Image information window is only copied when visible.



System	Sample Thermo
Filename	95190005.gtsi
Serial number	SN010280
Image size	320x236
Date	15.05.2001
Time	12:34:44
Calib. range	-20 - 300°C
Emissivity	0,87
Amb. temp	27,10°C
Frame Tag	

Point	T °C	Emis.	Ta °C
A	28,90°C	0,87	27,10
B	39,79°C	0,87	27,10
C	35,57°C	0,87	27,10

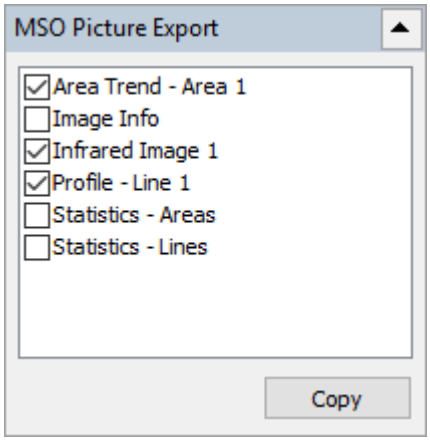
Printing

- You can print out an infrared image with analysis (points, image information, a profile and a histogram, same picture as produced by copy with details). Choose **'File | Print'** in the main menu to display print preview and print the pictures.
- It is also possible to print each diagram separately: select **'Print'** in the context menu of a diagram you want to print.

Copy into Microsoft Office

If you are using one of Microsoft Office applications, you have an option of copying multiple pictures into the Clipboard at once.

Open **'MSO Picture Export'** tab in the Tools Panel. Export dialog will pop up containing a list of all available exports.



Check the items you need to copy and click **'Copy'**. After that, you can paste all the selected pictures to a Microsoft Office document.

5 Automation and process control

5.1 Automation mode

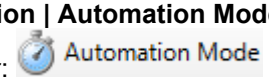
Automation mode is used when IRT Analyzer controls a process fully automatically, without human intervention. There are the following automation capabilities:

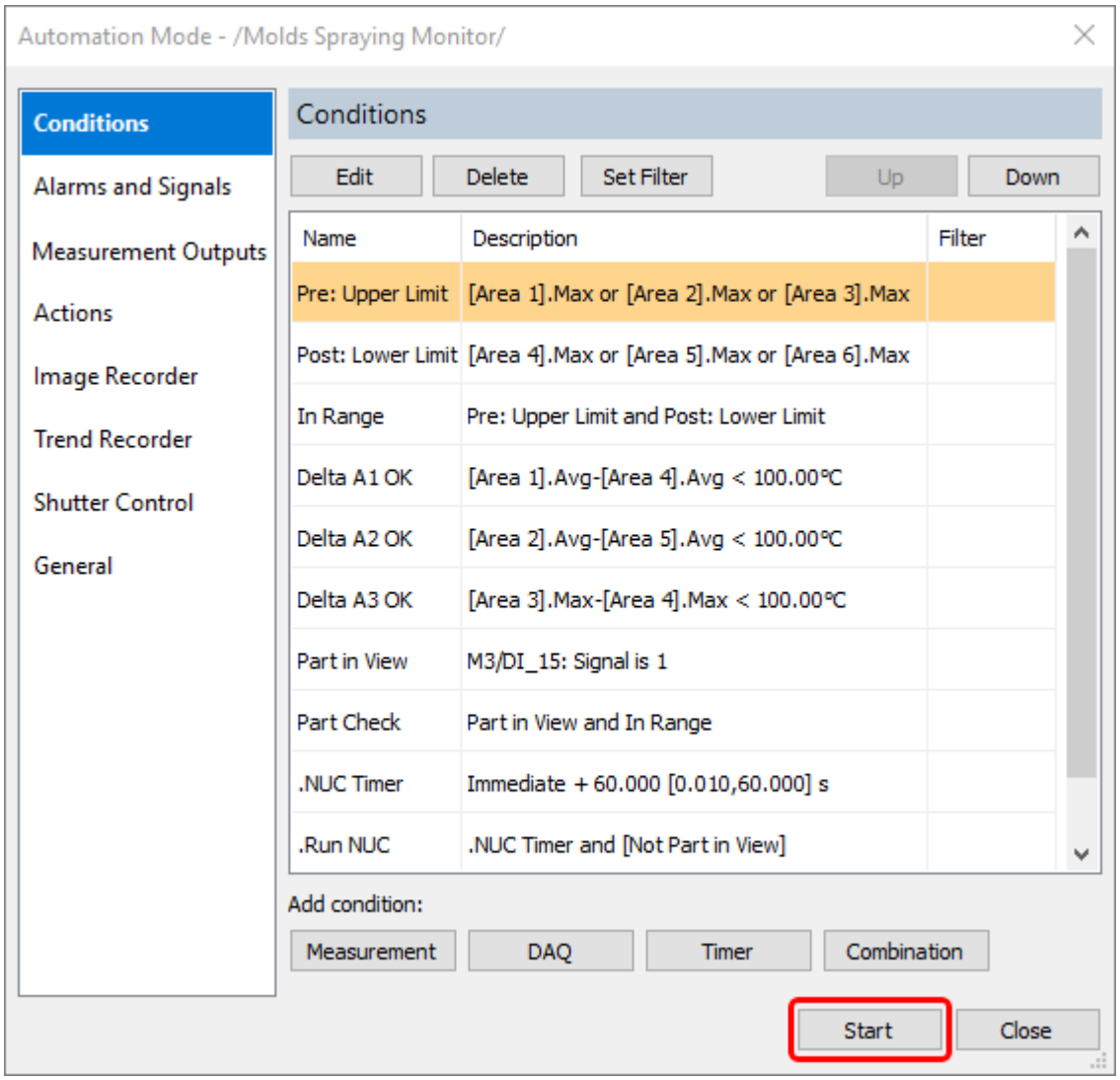
1. Temperature measurements based on IR images and objects of different configurations (spots, lines, areas).
2. Trigger based image recorder: various triggers are available, by measured temperature and received from outside through digital inputs.
3. Trigger based trend recorder.
4. Alarms and signals: on-screen and external.
5. Digital outputs: driving of external digital signal by a calculated condition.
6. Analog outputs: conversion of measured temperature (or other parameters) into analog signal.
7. Actions: actions executed when a temperature condition or an external condition is met.
8. Camera shutter control: to be sure that camera shutter is not closed when important measurement is running.
9. IR image conditional composition: several IR image panels with conditions that define when and which panel is updated with the data coming from the camera.

Automation mode configuration

Configuration of the automation mode is stored in the active acquisition project.

- Before starting the automation mode or creating a new automation mode configuration please select corresponding acquisition project (or create a new one).
- You need to have image acquisition configured and started.
- If you are using digital inputs or outputs, make sure that your digital acquisition device (DAQ device) is configured and connected.

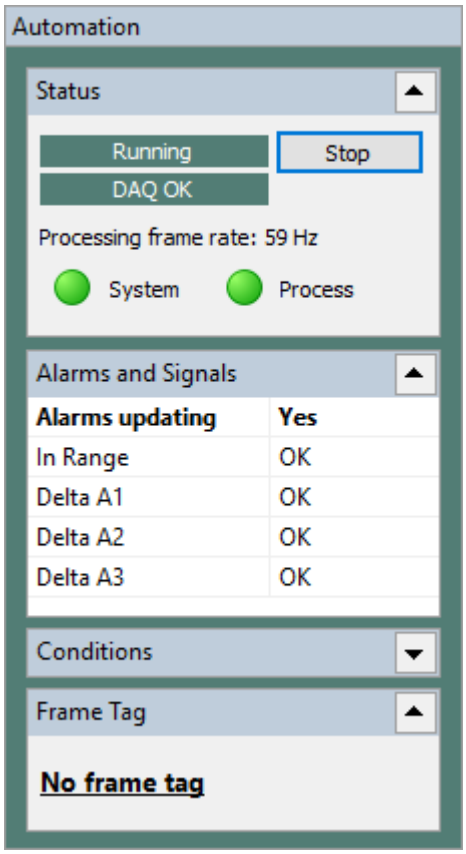
Use main menu **'Automation | Automation Mode'** to open Automation mode configuration dialog. There is also a button in the toolbar: 



Running automation mode

Press **'Start'** button in the automation mode configuration dialog to run automation mode and begin data processing.

When automation mode is running, 'Automation' panel is shown on the screen. Actual status of all automation parameters and actions are displayed in this panel.



Automation status

General status

Can be either *Running* or *Stopped.*

DAQ status

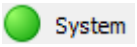
DAQ status is not shown if DAQ is not used or not configured in the automation mode settings. Otherwise, the status can be one of the following:

- *DAQ OK*: DAQ is running correctly. If client connections are needed (Ethernet/IP) they are present.
- *DAQ not ready*: used only with Ethernet/IP. No clients (PLCs) that consume data are connected and IRT Analyzer is waiting for them.
- *DAQ recovering*: a recoverable fault is reported by a DAQ device or interface, and IRT Analyzer is trying to restore the normal operation. Error description is added to the Messages window.
- *DAQ failed*: a DAQ device or interface encountered an unrecoverable error. Error description is added to the Messages window.

Processing frame rate

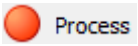
Real-time measured frame rate at which IR images are checked for conditions.

System alarms indicator



System alarm is an indicator of the current state of the monitoring system; IRT Analyzer creates it automatically. Green color means that all system parts (cameras, DAQ devices) are running correctly, no problems detected.

Process alarms indicator



Process alarm is an alarm configured for the currently monitored process. These alarms are configured in the automation mode setup dialog. Red color of this indicator means that at least one alarm is active.

Delay between data processing and display

IR images are evaluated for alarm conditions in the high priority processing thread. Because of that and because of buffering, in the worst cases, up to 1-2 seconds may pass between IR image alarm evaluation and IR image display.

- Data that you see on screen is a little delayed. But not the 'Status' window - System and Process indicators always display statuses of the processing thread with no delay.
- 'Alarms and Signals', 'Conditions' and 'Analog outputs' windows show information for the currently displayed image. When you put IR video acquisition on HOLD, these windows stop updating and display information corresponding to the image on hold.

5.2 DAQ configuration

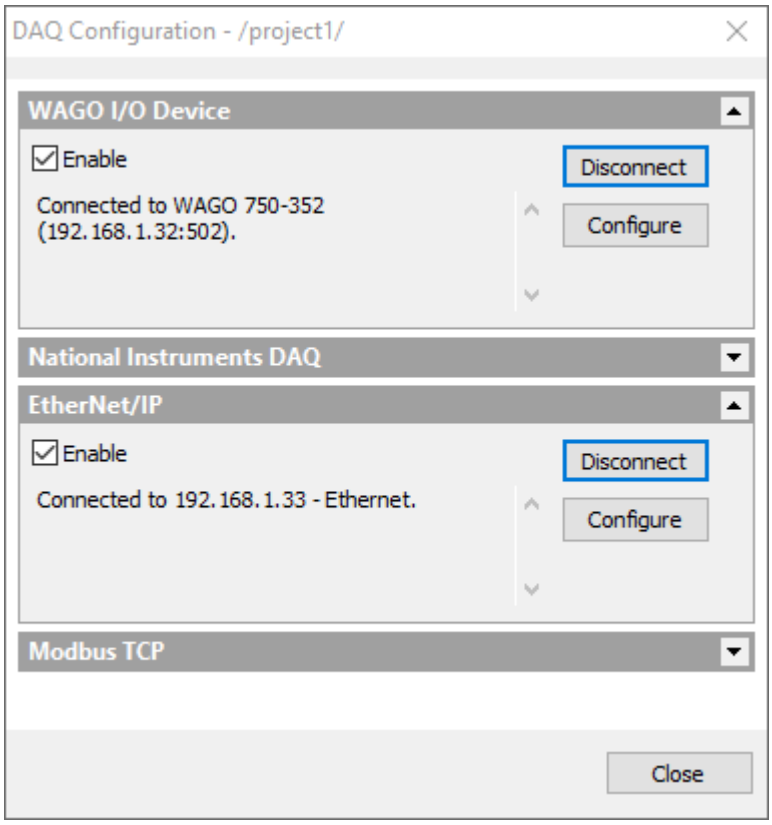
IRT Analyzer supports the following I/O hardware:

- WAGO 750-362 fileldbus coupler (Modbus TCP protocol).
- National Instruments DAQ (not all devices).

Also, IRT Analyzer can run a server with industrial protocols stacks:

- Modbus TCP

To open DAQ configuration, select **'Automation | DAQ Configuration'** in the main menu.



Mark **'Enable'** check box to enable an I/O device or protocol stack. Use **'Connect'** button to establish a connection to a device or to run protocol server. **'Configure'** button is needed to adjust device/interface specific parameters.

5.2.1 WAGO 750-362 fieldbus coupler

The older version of the fieldbus coupler WAGO 750-352 is also supported.

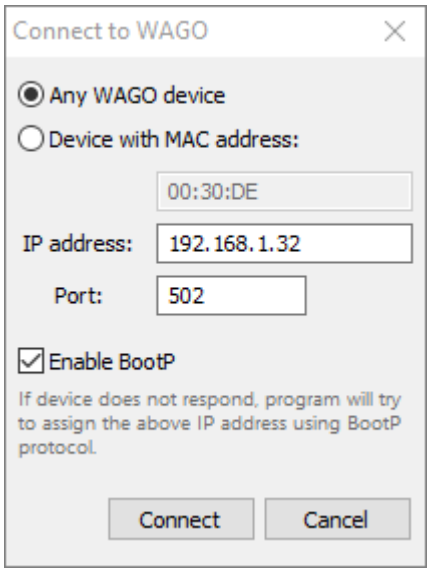
The following WAGO 750 extension modules are recommended as they were fully tested:

750-1504, 750-1406, 750-513, 750-563

Proper work of other modules is not guaranteed. With big probability, IRT Analyzer will reject to work with modules which have mixed input-output types (digital and analog, input and output on the same module).

If a not supported module is used, IRT Analyzer may not be able to address inputs and outputs correctly even in the supported modules. Because of that program will not allow to connect to the device. A corresponding error message will be displayed.

Before you can use WAGO 750-362 you need to configure connection parameters of the device. Enable "WAGO I/O Device" in the 'DAQ Configuration' dialog and press the **'Connect'** button.



MAC address

If you have several fieldbus couplers in your network, you need to select to which of the available couplers to connect. The identification is done using the MAC address. There is a sticker with unique MAC address on every WAGO fieldbus coupler.

If you have just one fieldbus coupler, select Any WAGO device option.

IP address

WAGO fieldbus coupler supports several methods of IP address assignment. You can read about them in the WAGO fieldbus coupler documentation. In this manual you will find description of methods that we recommend to use. Please see it below.

Port

If not changed in fieldbus coupler configuration, port used to exchange data with the fieldbus coupler is 502 (default for Modbus protocol).

Enable BootP

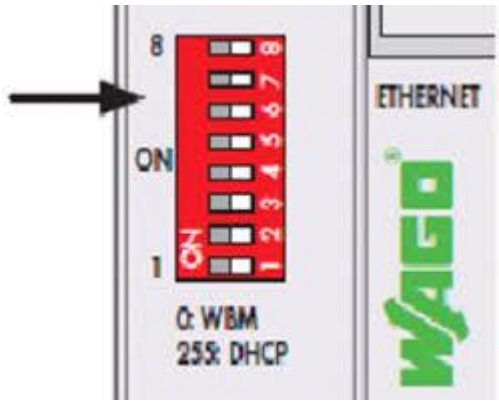
Mark the check box to enable BootP protocol on the PC side.

Using BootP protocol to connect to a WAGO device

May not work if device's factory default configuration is changed.

We recommend using BootP protocol for IP address assignment. This is also the default method - WAGO fieldbus coupler has BootP enabled in the factory default configuration.

Before you try to connect to your WAGO device, please make sure that all switches on the red DIP switch on the fieldbus coupler case are set to 0. On the picture below, all switches (white) are moved to the right, OFF side.



You need to select proper IP address that will be assigned to the WAGO fieldbus coupler:

IP address of the WAGO device must belong to the same subnet with PC's network adapter to which the coupler is connected to. For example, if PC's network adapter has IP address 192.168.1.X, for the fieldbus coupler you should select IP address which also starts with 192.168.1. Make sure that no other PC or network device uses the same IP address.

To know which IP address your PC adapter has you need to find the adapter in Windows settings and check its properties.

Please also consider the following:

- If WAGO device already has an IP address assigned, it cannot be changed with BootP.
- BootP server is running only during the connection process. It is stopped as soon as appropriate WAGO device is found and connected.
- IP address negotiation with BootP protocol may take some time, but not longer than two minutes.
- If IP address assignment takes too long, you may try to restart (power-on reset) the WAGO device, then it will send a BootP request immediately after booting.
- If BootP is used as the IP address assignment method, you should leave 'Enable BootP' option on as the BootP-assigned IP address is not remembered when WAGO device is rebooted.

Using DIP switch to set IP address

Again, we assume here that factory default configuration of WAGO fieldbus coupler is not changed.

Default WAGO IP address starts with 192.168.1 and you can use the red DIP switch located on WAGO device case to set the IP address last number. There are 8 switches which allows to select a number from 0 to 255 in the binary form:

- **0**: WAGO WBM (web based) configuration is used, which has BootP method enabled (factory default). This is the BootP option described above.
- **1-254**: WAGO device will have fixed IP address 192.168.1.1-192.168.1.254, BootP protocol will not be used.
- **255**: WAGO device will use IP address assigned by a DHCP server (DHCP server should be available on LAN where WAGO device is connected to). This option is not recommended as DHCP assigned IP addresses are often dynamic and there is no easy way to know which address was used.

You should set 'IP address' field in 'Connect to WAGO' dialog to the same value as was configured by the DIP switch.

Other IP address selection methods

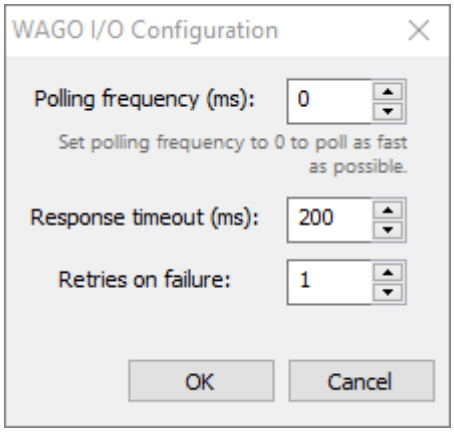
BootP and the DIP switch is not the only methods of IP address configuration. Fieldbus coupler settings can be also changed in Web-based Management System (WBM). If they are changed, methods described above may not work. Please read WAGO documentation for details.

Configuring data exchange delays for WAGO fieldbus coupler

Modbus TCP protocol is used to read input signals and to set output signal values. The protocol works in a way that PC program sends a request to the WAGO device and WAGO device reports current state of the inputs. You can configure how often to check the state of the inputs. The faster your controlled process is the higher should be the polling rate, but there are limitations.

> In perfect conditions (short Ethernet cable, no interferences) it takes about 2 ms for WAGO device to respond. This allows to read input states about 500 times per second. Windows is not a real-time OS, at some moments response time may fall to about 20-40 ms.

To open WAGO configuration dialog press **'Configure'** button in the 'DAQ Configuration' dialog.



Polling frequency

Specify the delay in the polling requests in milliseconds. 10 ms delay corresponds to 100 requests per second. If you set the delay to 0, polling will be done at the maximum frequency. This frequency is limited by WAGO filedbus coupler response time and the network capabilities. Practically the maximum frequency that can be achieved is 400-500 Hz (2-3 ms delay between requests).

Response timeout / Retries on failure

This is the time in milliseconds PC waits for a response from the WAGO fieldbus coupler. If response is not coming in this time, fieldbus coupler failure is suspected. Program will try to repeat the request. Number of such requests is defined by 'Retries on failure' field. If after the retries response is still not received, a connection loss state is reported.

> These timeouts are used only during device polling.
>
> To connect to a device, other values, from an INI file are used. Please check *ConnectResponseTimeoutSec*, *ConnectRetryCount*, *BootPTimeoutSec* parameters in **gsmodbus.ini** file located in the program installation folder.

5.2.2 National Instruments DAQ

Supported devices:

USB-6009/6008, NI-6518

Some others might be also working, but not tested.

National Instruments DAQ does not need connection (as it is ether installed in a PCI slot or connected to a USB port). There is also no configuration needed. But you need to install **NI-DAQmx** software from National Instruments (comes with the I/O device) in order to use NI DAQ devices.

5.2.3 EtherNet/IP server

EtherNet/IP (Ethernet/Industrial Protocol) is a communication system suitable for use in industrial environments. EtherNet/IP allows industrial devices to exchange time-critical application information. These devices include simple I/O devices such as sensors/actuators, as well as complex control devices such as robots, programmable logic controllers (PLCs), welders, and process controllers.

EtherNet/IP uses CIP (Control and Information Protocol), the common network, transport and application layers also shared by ControlNet and DeviceNet. EtherNet/IP then makes use of standard Ethernet and TCP/IP technology to transport CIP communications packets. The result is a common, open application layer on top of open and highly popular Ethernet and TCP/IP protocols.

EtherNet/IP provides a producer/consumer model for the exchange of time-critical control data. The producer/consumer model allows the exchange of application information between a sending device (e.g., the producer) and many receiving devices (e.g., the consumers) without the need to send the data multiple times to multiple destinations. For EtherNet/IP, this is accomplished by making use of the CIP network and transport layers along with IP Multicast technology. Many EtherNet/IP devices can receive the same produced piece of application information from a single producing device.

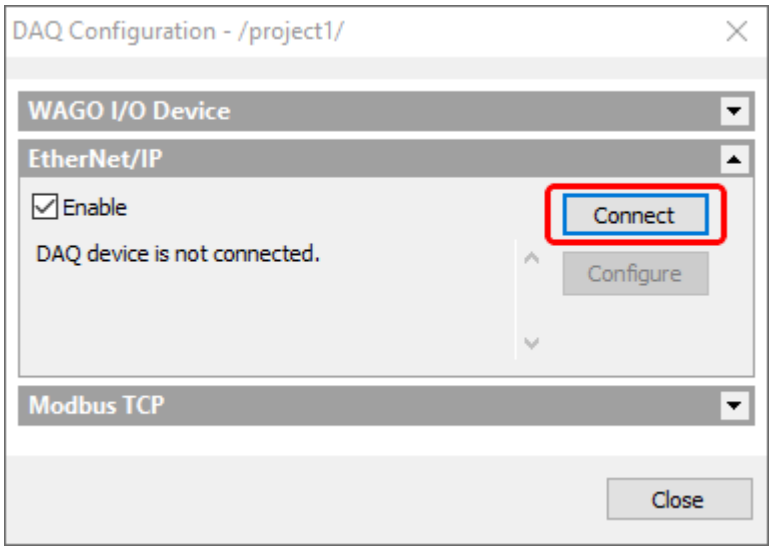
EtherNet/IP makes use of standard IEEE 802.3 technology; there are no non-standard additions that attempt to improve determinism. Rather, EtherNet/IP recommends the use of commercial switch technology, with 100 Mbps bandwidth and full-duplex operation, to provide for more deterministic performance.

Notes

1. When configured, IRT Analyzer behaves as an EtherNet/IP adapter or server. It does not establish communication with other devices by itself, but only reacts to transmissions originated by other modules (called clients). A client device is needed to receive and interpret data produced by IRT Analyzer.
2. IRT Analyzer EtherNet/IP server starts when DAQ Configuration dialog is opened or when the automation mode is started or being configured. Otherwise, the server is not running and is not visible for other devices in the network. Once the server is started it continues to run as long as IRT Analyzer is running.

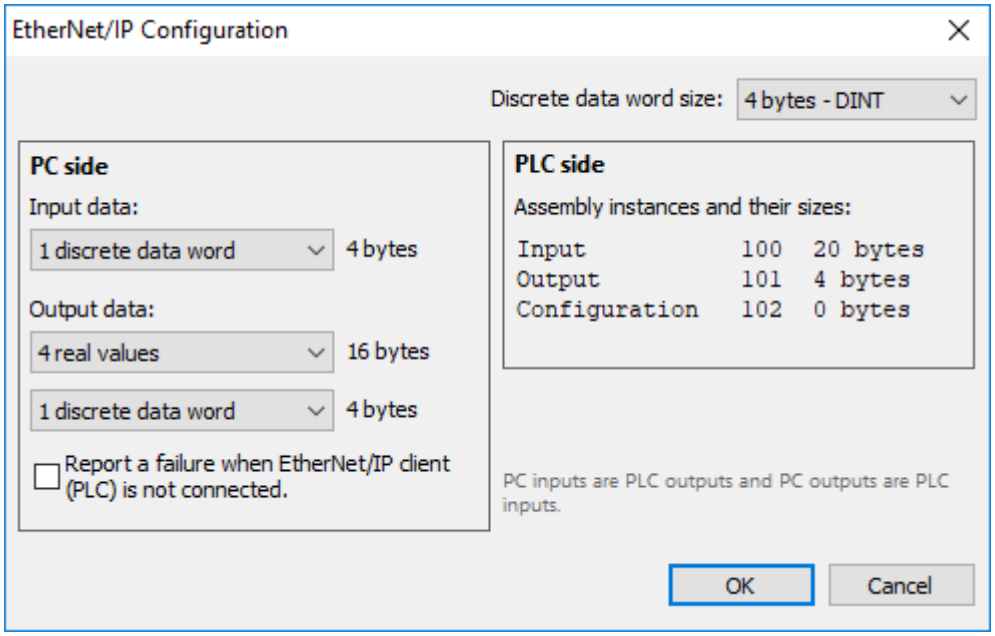
Configuring EtherNet/IP server

EtherNet/IP adapter in IRT Analyzer is implemented as a DAQ module and can be enabled in 'DAQ Configuration' dialog (main menu **'Automation | DAQ Configuration'**).



Firstly, it is necessary to specify which Ethernet adapter (PC may have several Ethernet adapters) is to be used by the EtherNet/IP server. Press **'Connect'** button to select an adapter. When Ethernet adapter is selected you will see a message confirming this: "Connected to 192.168.1.33 - Local Area Connection".

After that you need to define how much data is needed to fit all inputs and outputs used in the automation project. Press **'Configure'** button.



We can look at the data from the two sides - PC and PLC (EtherNet/IP network).

PC (IRT Analyzer) side

On the PC side we define how much data is needed as input data and how much as output data.

- Input data: we can use each bit of the input data as a discrete input for DAQ conditions.
- Output data: consists of real data (4-byte floating point numbers) used as outputs for measurements and discrete data used as outputs for alarms and signals.

For convenience purposes and for compatibility with Rockwell software discrete data is divided into words which can have different length - 8 bit per word (1 byte, SINT), 16 bit per word (2 bytes, INT) and 32 bit per word (4 bytes, DINT).

PLC (network) side

To be used by EtherNet/IP client's data is packed into Input and Output *assemblies* (objects defined by CIP protocol).

> **Note**
>
> Please note that from the network point of view (PLC side) data directions reverse. IRT Analyzer input data is output data for PLC/network and IRT Analyzer output data is input data for PLC/network.

Input assembly

- Instance number 100
- IRT Analyzer outputs go here
- First real values, then discrete values

RData: array of 4-byte real values (measurement outputs)	DData: array of discrete data words (outputs from alarms and signals)

Output assembly

- Instance number 101
- IRT Analyzer reads inputs from here
- Only discrete values are supported

DData: array of discrete data words (inputs for DAQ conditions)

Configuration assembly

- Instance number 102
- There are no configuration variables used, so the size of Configuration assembly is always 0.

'Report a failure when Ethernet/IP client (PLC) is not connected' option

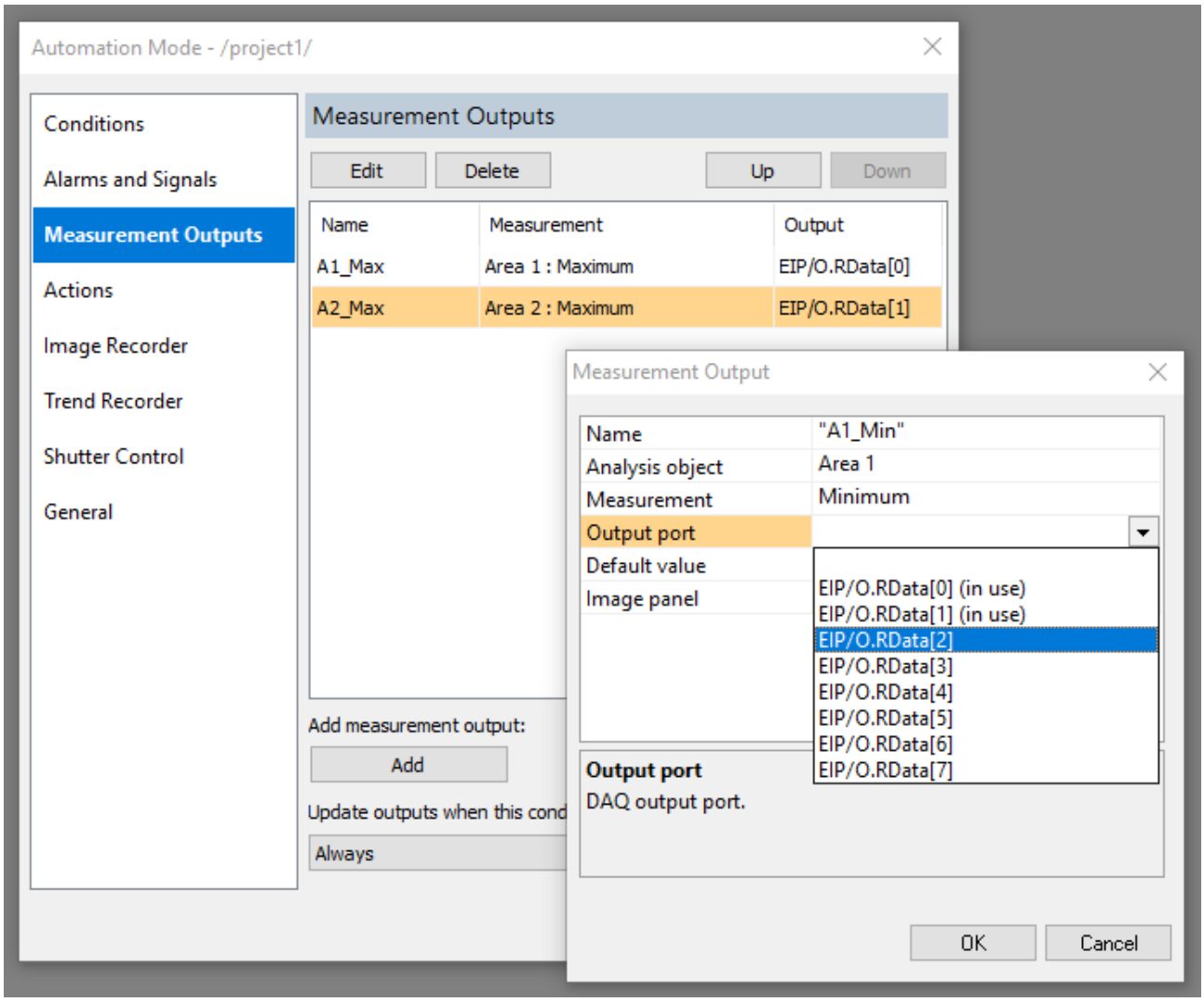
When IRT Analyzer depends on external signals, it is important to properly handle situations when there is nobody connected and data is not sent (PLC is not connected).

Event	Option is enabled	Option is disabled
PLC is not connected when automation mode starts.	All processing is suspended until PLC is connected, a wait dialog is shown.	Automation mode starts immediately, input values are undefined.
PLC disconnects when automation is running.	The system goes to the failure state, input values are undefined.	No system failure, input values keep their last set states.

Selecting measurements and alarms/signals to fill Output data

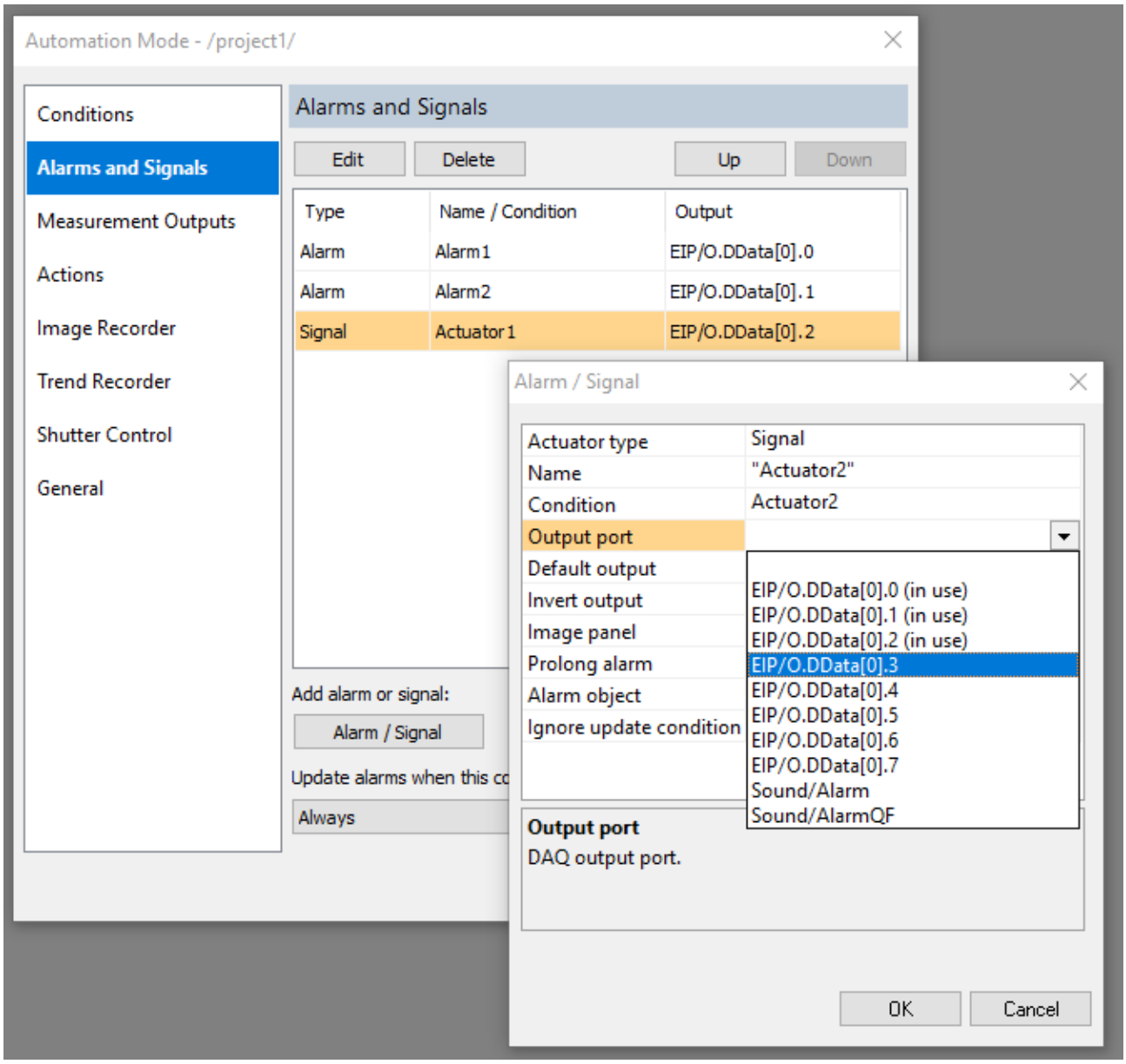
Data for EtherNet/IP is not filled automatically. You need to manually select measurements and alarms/signals that will be written to the data array before it is sent to EtherNet/IP clients.

Use **'Measurement Outputs'** tab in the 'Automation Mode' dialog to fill the **RData** (real data) array:



For details, please read "Measurement outputs" topic.

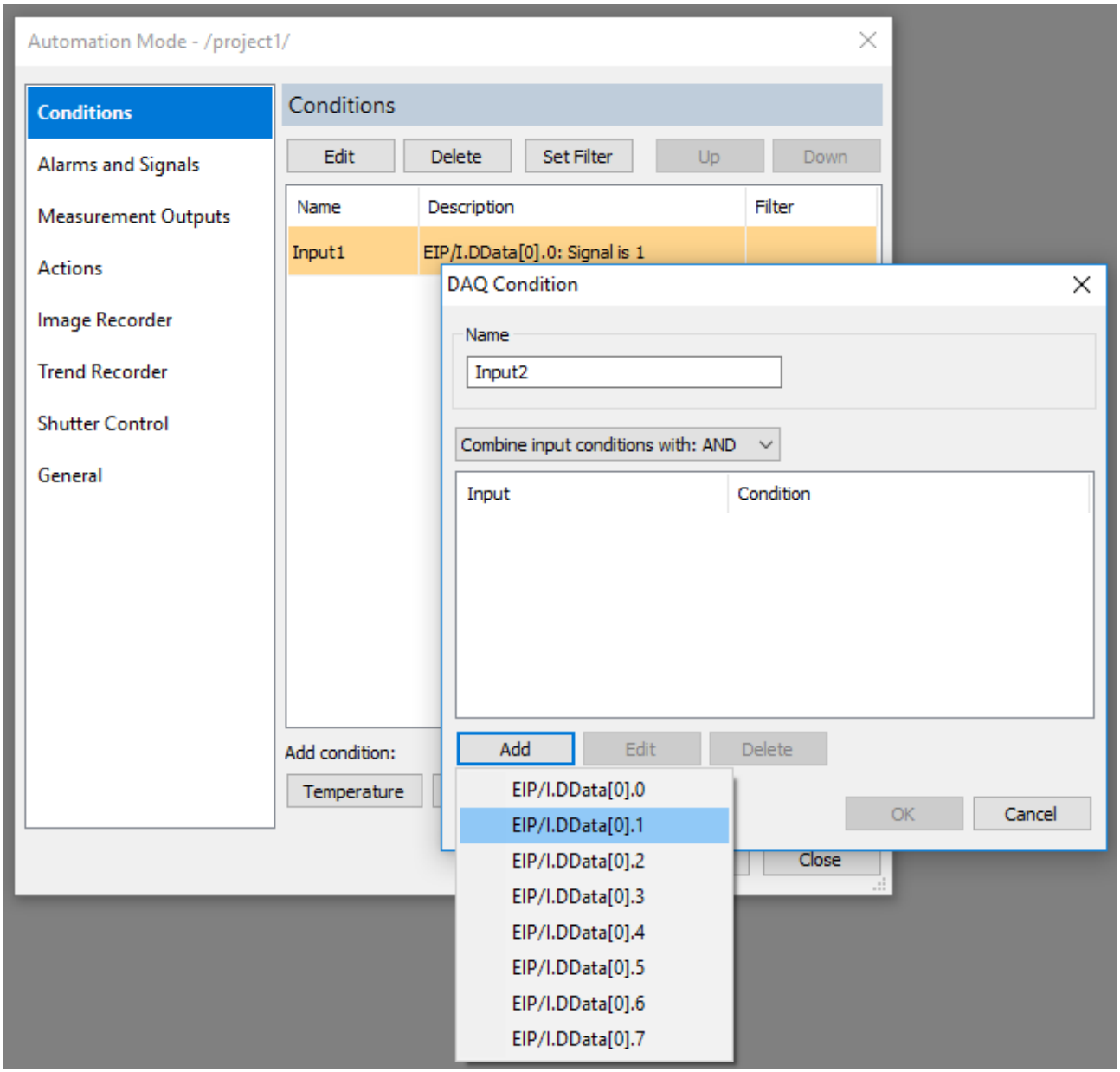
Use **'Alarms and Signals'** tab in the 'Automation Mode' dialog to fill the **DData** (discrete data) array:



For details, please read "Alarms and signals" topic.

Using Input data in discrete inputs

Use **'Conditions'** tab in the 'Automation Mode' dialog to test bits in the **DData** (discrete data) array:



For details, please read "DAQ Conditions" topic.

5.2.4 Setting up Rockwell Studio 5000 for EtherNet/IP communication to IRT Analyzer

When IRT Analyzer EtherNet/IP DAQ module is enabled and running, you can connect and exchange data using any EtherNet/IP client (scanner) device or software. We will discuss here how to program an EtherNet/IP enabled PLC in Rockwell Studio 5000.

Start Rockwell Studio 5000 Logix Designer, create a new project for your PLC and follow the steps below.

Import the EDS file

EDS files contain information needed for Studio 5000 software to communicate with EtherNet/IP enabled devices. IRT Analyzer EDS file is delivered with IRT Analyzer installation and must be imported in Studio 5000.

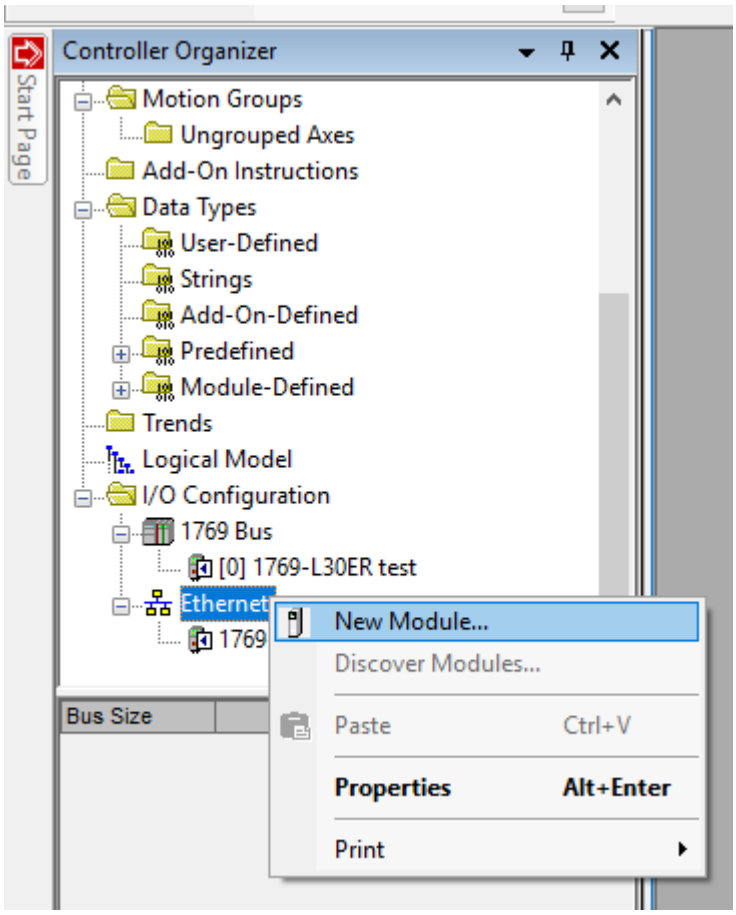
EDS file is in the program installation folder (usually "Program Files\GRAYESS\IRT Analyzer 7").

In the main menu of Logix Designer select **'Tools | EDS Hardware Installation Tool'** and follow the instructions on the screen. This step should be done only once, no need to do it for every new project.

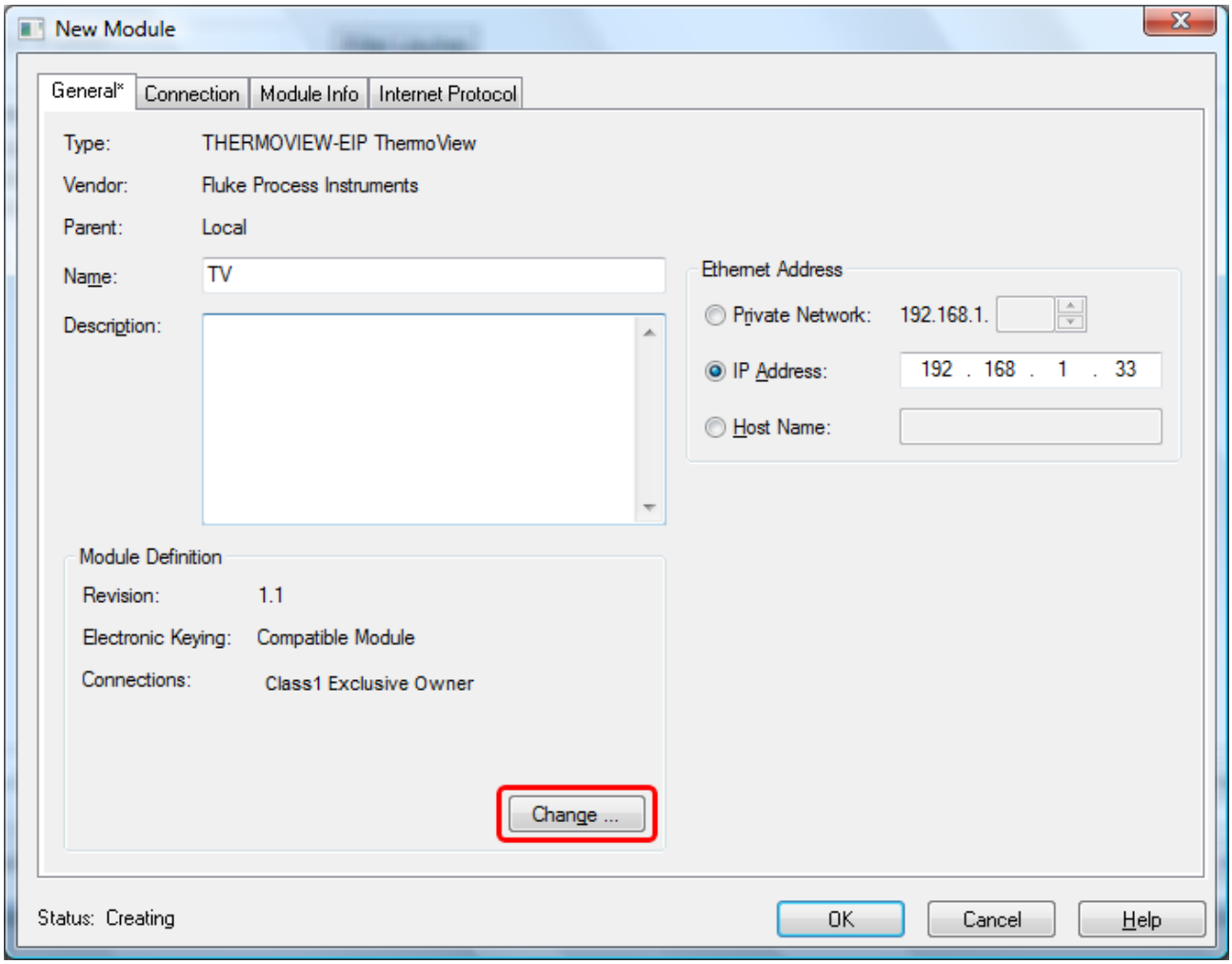


Create I/O module for IRT Analyzer

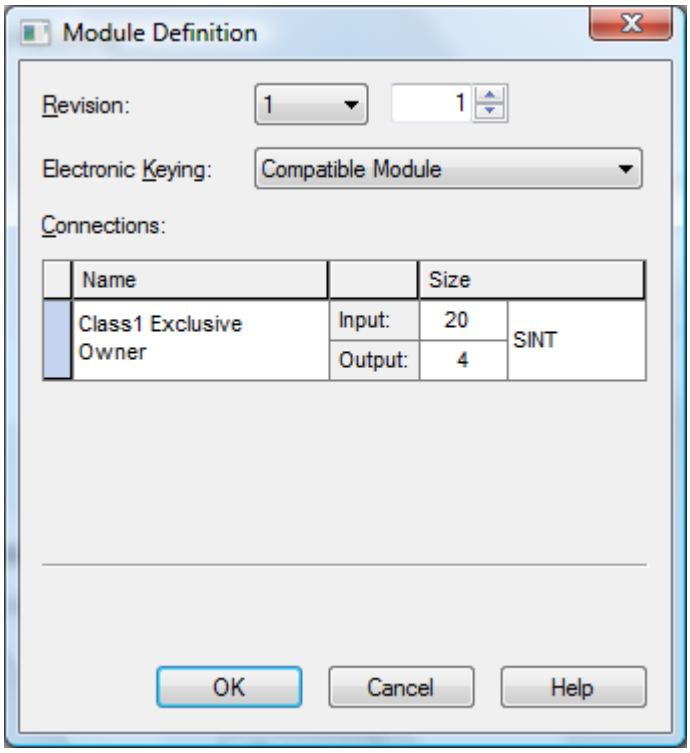
In **'Controller Organizer'** window, in the tree find **'Ethernet'** item, right click on it and select **'New Module'.**



You will see a dialog with a list of all supported modules. In this list find an entry with Catalog Number 'THERMOVIEW-EIP', click on it, then click on **'Create'** button. This will bring the **'New Module'** dialog**:**



Type a name for the module, set the IP address and then press **'Change'** button to open **'Module Definition'** dialog and to configure the connection type and data sizes.



It is important to correctly define Input and Output assembly sizes to match them with sizes set in IRT Analyzer EtherNet/IP DAQ module configuration.

Sizes are defined in words of the following types:

- SINT - 1 byte
- INT - 2 bytes
- DINT - 3 bytes
- REAL - 4 bytes

For example, if you set the size to be 10 INT, size in bytes will be 10 x 2 = 20 bytes.

1. Logix Designer can only treat data as an array with elements of one type. If your Input assembly contains both REAL and discrete data you should select any type here and then convert data to a user-defined type in the PLC program before you use it.
2. It is not possible to define different types for Input and Output data.

Connection types

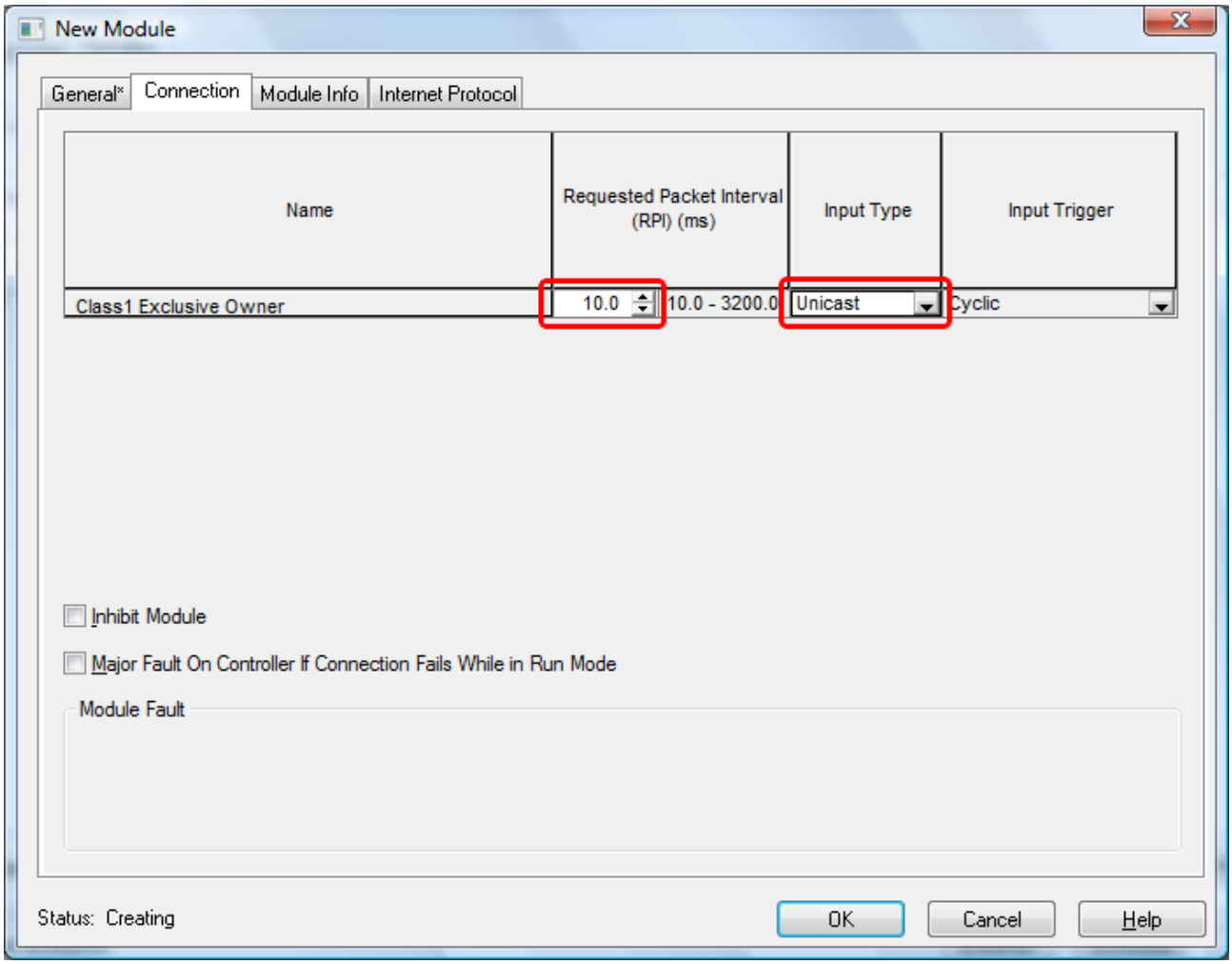
There are three types of connections available:

1. *Class1 Exclusive Owner*: this type is used in most cased. PLC will establish an exclusive connection, will read the Input data from IRT Analyzer, and will update the Output data. Only one device is allowed to control the outputs and therefore only one connection of this type can be active simultaneously.
2. *Class1 Input Only*: a non-exclusive connection will be established allowing PLC to read the Input data. No access to the Output data.
3. *Class1 Listen Only*: this connection type is like Input Only (allows reading the Input data) with the difference that it works only when another device is connected using the Exclusive Owner connection type and multicast data transmission. Listen Only connection is stopped automatically when the exclusive owner device breaks its connection.

"Class1" means that IRT Analyzer EtherNet/IP server behaves according to Transport Class 1 specification defined by Common Industrial Protocol.

Packets production frequency

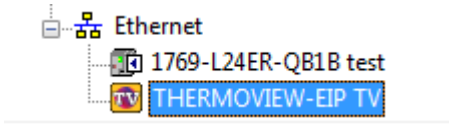
On the 'New Module' dialog select **'Connection'** tab.



To define packet production frequency, set Requested Packet Interval (RPI) in milliseconds. Also at this page it is possible to select unicast or multicast transmission types.

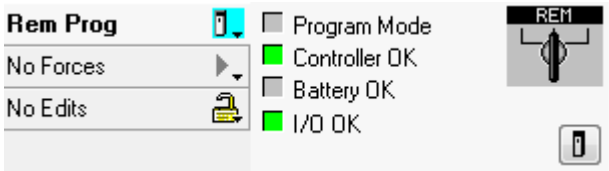
Supported production trigger type is only *Cyclic*. *Change-Of-State* and *Application* types are not supported.

There is nothing more that you can configure in 'New Module' dialog. Press **'OK'** to close the dialog and to create IRT Analyzer module in Logix Designer.

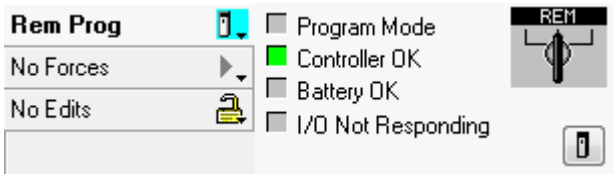


Check that PLC can connect to IRT Analyzer

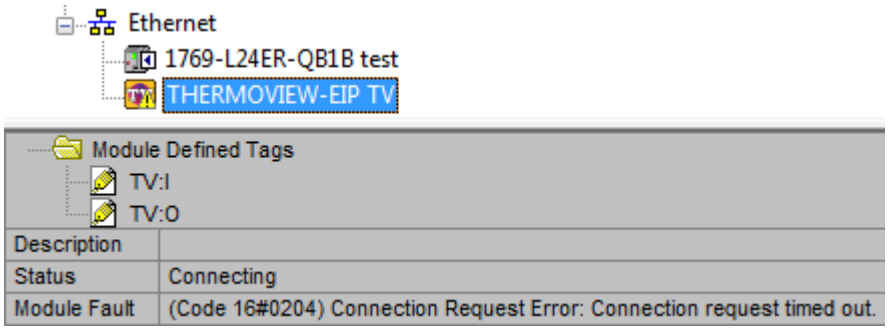
If you will go online with the project now, PLC will try to connect to IRT Analyzer and will show connection status. When everything is fine, you will see green I/O status indicator:



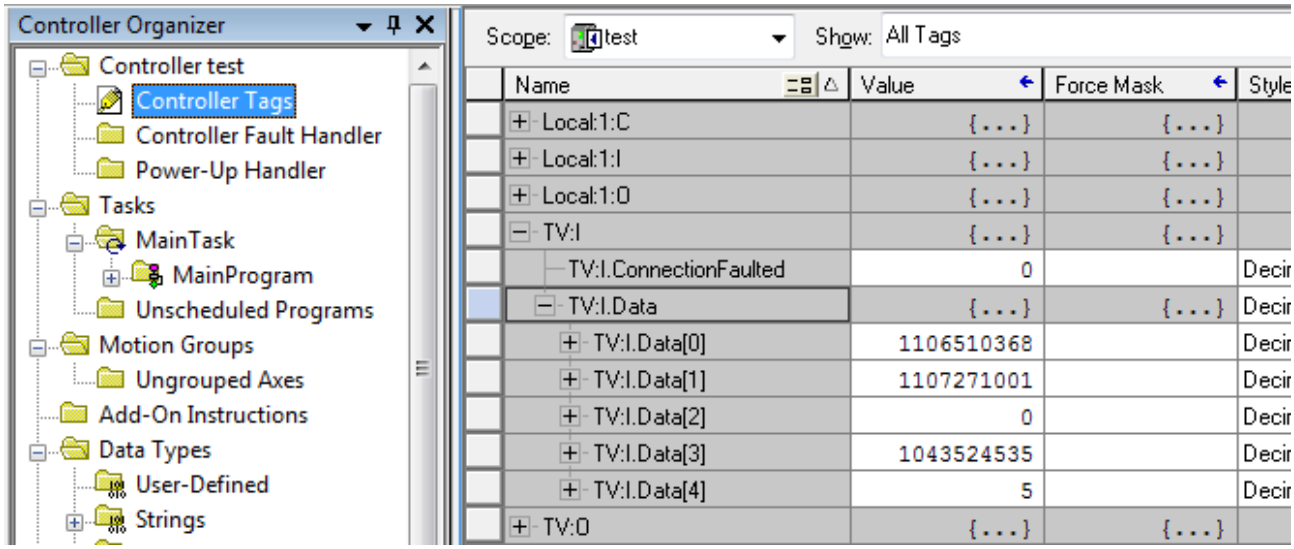
If something is wrong, you will see I/O indicator blinking:



You can find out what problem occurred in the module status window (IRT Analyzer module must be selected in the tree):



To see data values, use **'Controller Tags'** window (can be found in the 'Controller Organizer' tree):



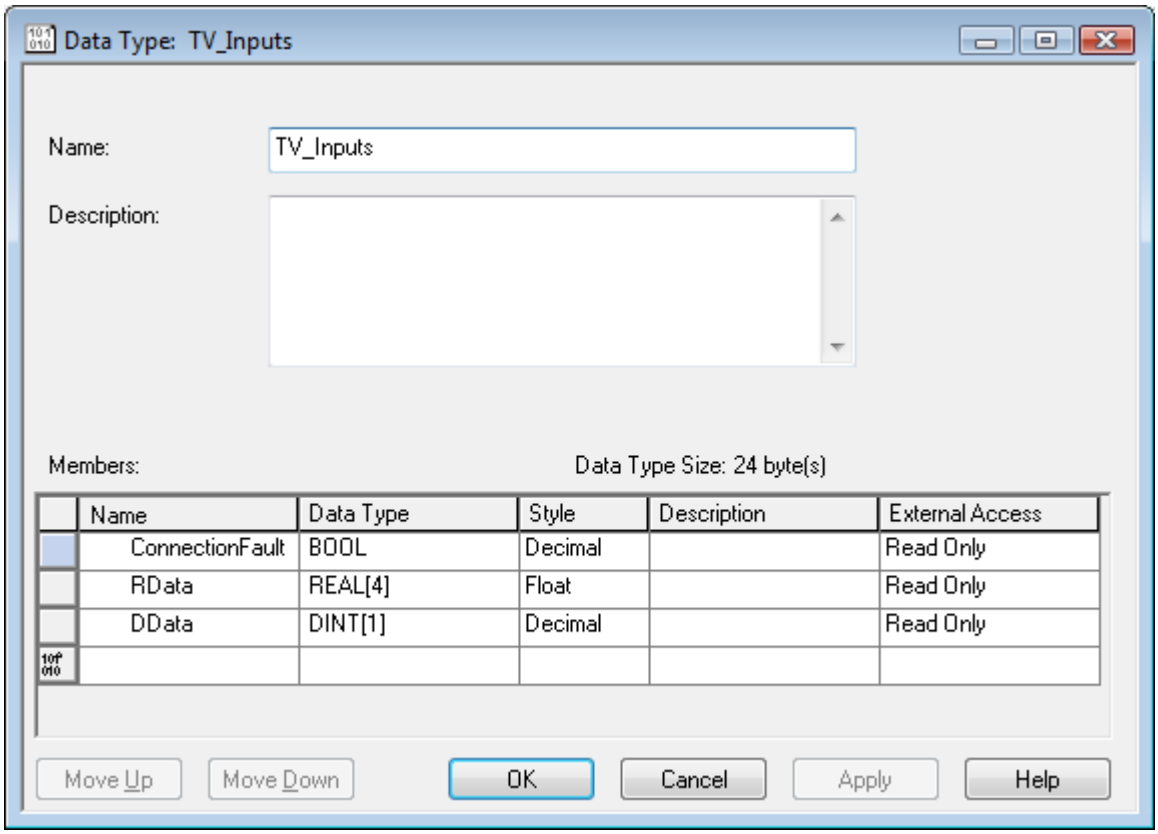
As you can see on the screen shot, using controller tags generated automatically by Logix Designer is not convenient because all data is displayed as an array of elements of one type, while data may contain real and discrete values. To overcome this limitation, you can convert data into a user-defined type that better suits your needs.

Create user-defined data types

Create two user defined data types called *TV_Inputs*, and *TV_Outputs*. To do this, in the 'Controller Organizer' tree right click on **'User Defined'** and select **'New Data Type'**.

TV_Inputs

Define *TV_Inputs* type as shown on the screenshot:

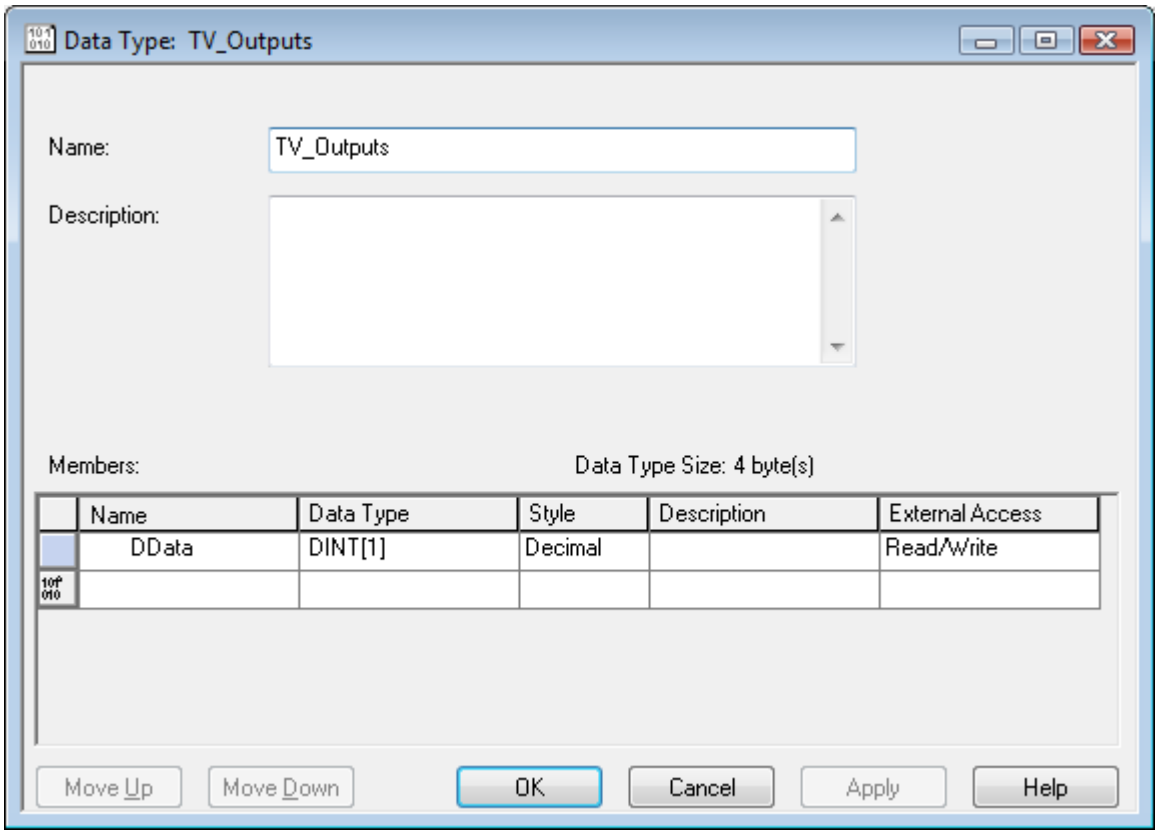


Please note:

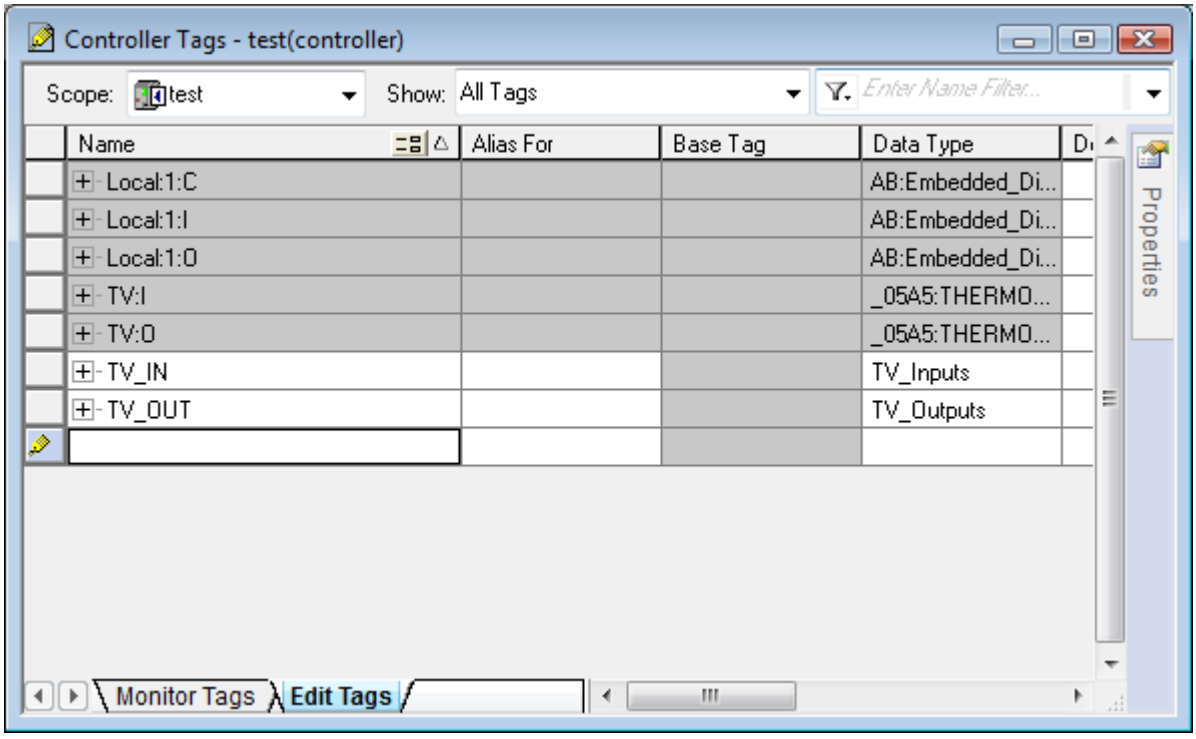
1. It is important to create *ConnectionFault* field. It is not part of data sent by IRT Analyzer, but it is present because of EtherNet/IP protocol.
2. Sizes of *RData* and *DData* arrays must correspond to the full size of the Input assembly.
3. Instead of *RData* array you can use a list of variables that corresponds to the specific measurements selected in IRT Analyzer.

TV_Outputs

Create *TV_Output* type in the similar way:

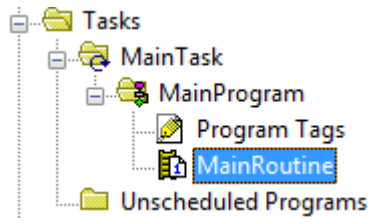


Next step is to create controller tags with the new types. Open the controller tags and click on the **'Edit'** tab. Add two tags *TV_IN* with data type *TV_Inputs* and *TV_OUT* with data type *TV_Outputs*:

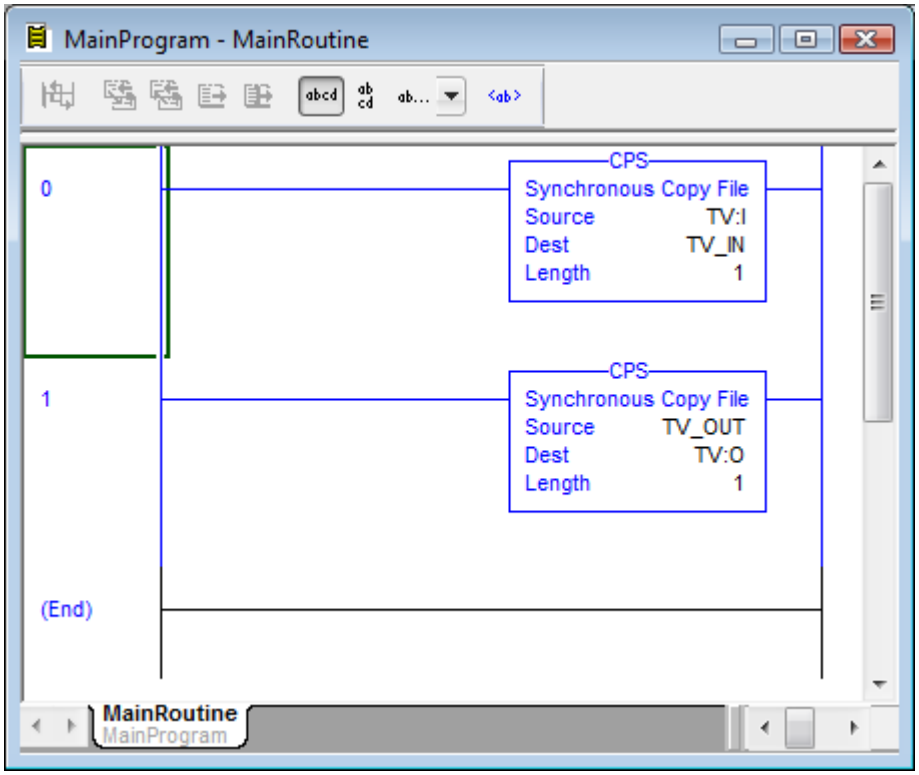


Now new tags are present, but they are not filled with values. We need to write a small PLC program to fill them with real data.

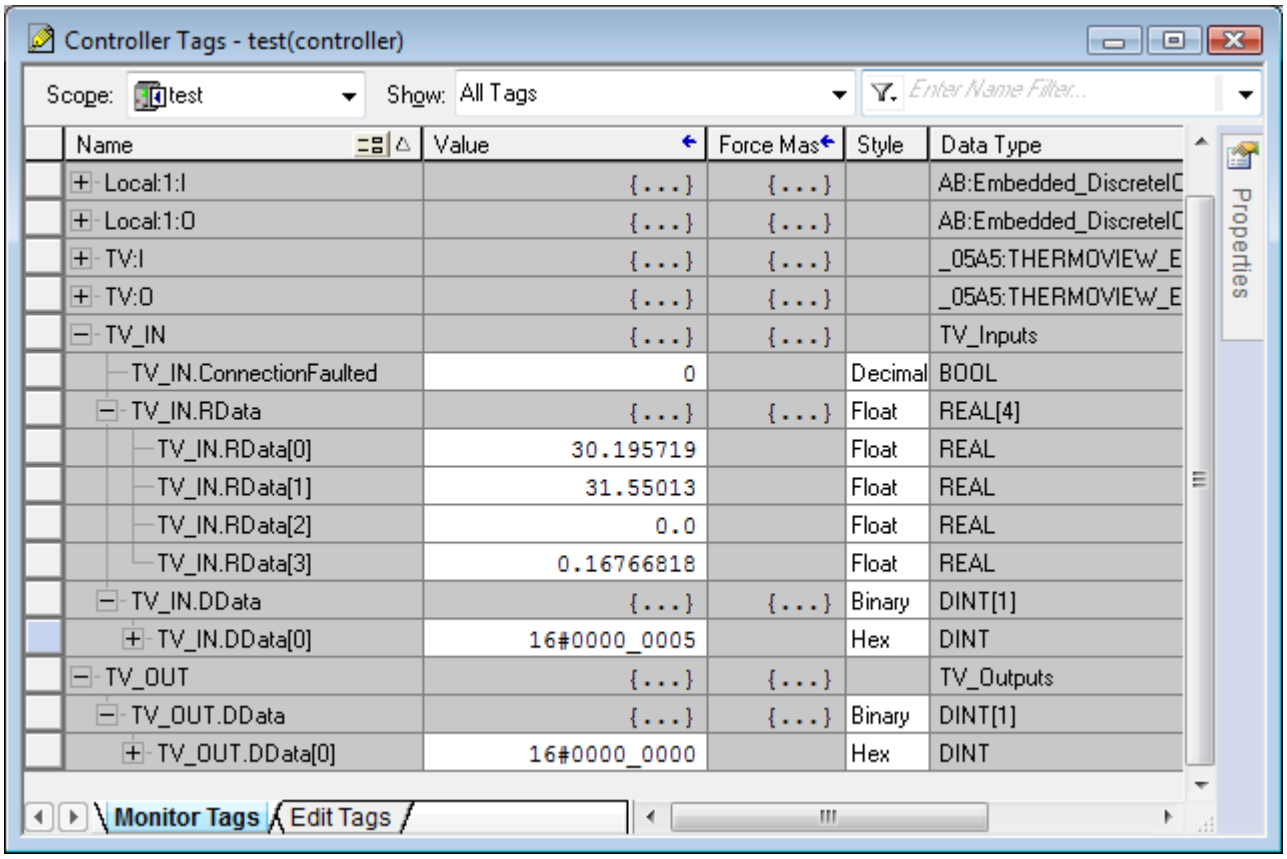
In 'Controller Organizer' window double-click on **'MainRoutine'** to enter the ladder logic program.



Insert ‘Synchronous Copy File’ (CPS) instructions to copy the auto-generated tags to the user-defined tags (TV:I to TV_IN and TV_OUT to TV:O). Please note the copy directions, they are different for input and output data.



Download the project to the controller and set the controller to the **RUN** mode. Now 'Controller Tags' window shows the data in a better way:



5.2.5 Modbus TCP server

Modbus is a serial communications protocol originally published by Modicon in 1979 for use with its programmable logic controllers (PLCs). Modbus has become a de facto standard communication protocol and is now a commonly available means of connecting industrial electronic devices. The main reasons for the use of Modbus in the industrial environment are:

- developed with industrial applications in mind,
- openly published and royalty-free,
- easy to deploy and maintain,
- moves raw bits or words without placing many restrictions on vendors.

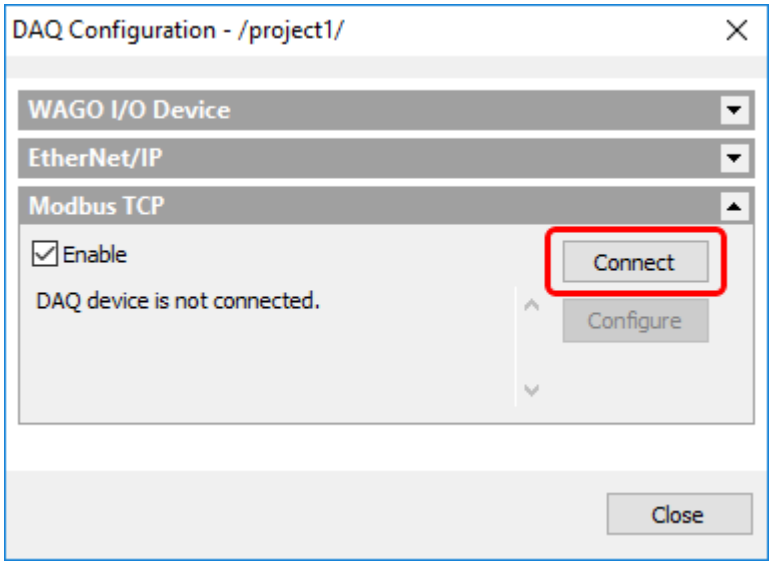
Modbus TCP/IP or Modbus TCP is a Modbus variant used for communications over TCP/IP networks, connecting over port 502.

Notes

1. When configured, IRT Analyzer behaves as a Modbus slave or server device. It does not establish communication with other devices by itself, but only reacts to transmissions originated by other modules (called Modbus masters or clients). A client device is needed to receive and interpret data produced by IRT Analyzer.
2. IRT Analyzer Modbus TCP server starts when DAQ Configuration dialog is opened or when the automation mode is started or being configured. Otherwise, the server is not running and is not visible for other devices in the network. Once the server is started it continues to run as long as IRT Analyzer is running.

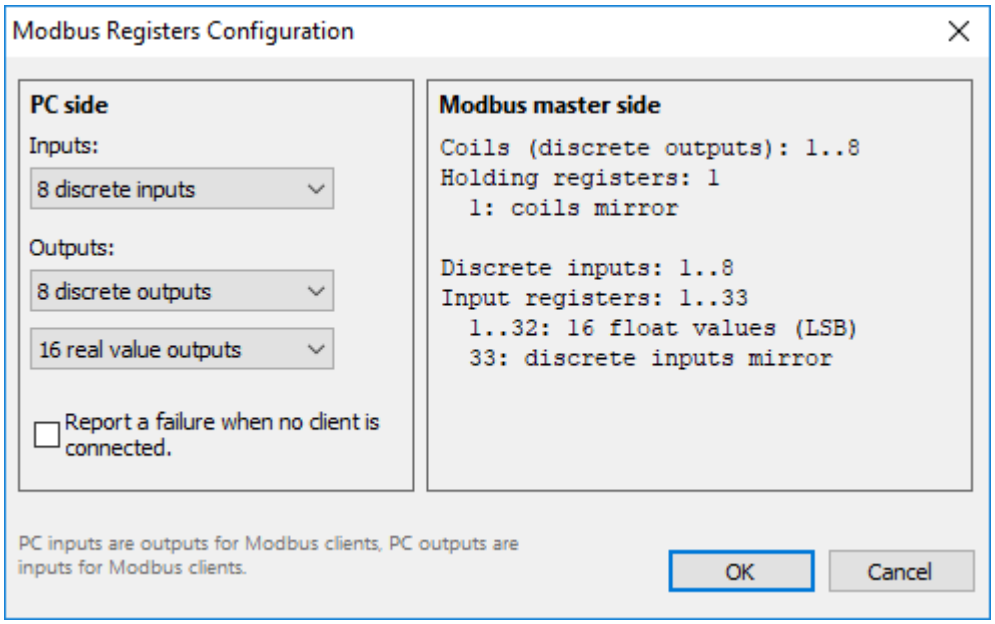
Configuring Modbus TCP server

Modbus TCP server in IRT Analyzer is implemented as a DAQ module and can be enabled in 'DAQ Configuration' dialog (main menu **'Automation | DAQ Configuration'**).



Firstly, it is necessary to specify which Ethernet adapter (PC may have several Ethernet adapters) is to be used by the Modbus server. Press **'Connect'** button to select an adapter. When Ethernet adapter is selected you will see a message confirming this: "Connected to 192.168.1.33 - Local Area Connection".

After that you need to define how many inputs and outputs are needed to cover all inputs and outputs used in your automation project. Press **'Configure'** button.



Note

Please note that from the network point of view (Modbus client side) data directions reverse. IRT Analyzer input data is output data for clients/network and IRT Analyzer output data is input data for clients/network.

PC (IRT Analyzer) side

On the PC side we define how many inputs and outputs are needed. These numbers depend on your automation project needs.

- Discrete inputs: we can use each input as an input for DAQ conditions.
- Discrete outputs: can be used as alarm and signal outputs.
- Real value outputs: 4-byte floating point numbers used as outputs for measurements.

Modbus master (network) side

Up to 16 clients can connect to IRT Analyzer Modbus TCP server simultaneously.

The following table describes object types provided by IRT Analyzer Modbus slave to a Modbus master device:

Object type	Access	Size	Usage
Discrete inputs	Read-only	1 bit per input	IRT Analyzer discrete outputs go here.
Coils	Read-write	1 bit per coil	IRT Analyzer uses coil states as discrete inputs.
Input Registers	Read-only	16 bits per register	IRT Analyzer measurement outputs are stored in these registers. Each value (4-byte floating point) occupies 2 registers in LSB order.
Holding Registers	Read-write	16 bits per register	IRT Analyzer uses these registers only for coils mirror (see below).

Object addresses start from 1.

Discrete inputs and coils mirror

One or more registers are used as mirror for discrete inputs and coils. This allows to read full state (both registers and discrete inputs) with one Modbus read command (can be useful because of performance reasons). Mirror registers go right after the "normal" registers.

'Report a failure when no client is connected' option

When IRT Analyzer depends on external signals, it is important to properly handle situations when there is nobody connected and data is not sent (Modbus master is not connected).

Event	Option is enabled	Option is disabled
Master device is not connected when automation mode starts.	All processing is suspended until Master device is connected; a wait dialog is shown.	Automation mode starts immediately, input values are undefined.
Master device disconnects when automation is running.	The system goes to the failure state, input values are undefined.	No system failure, input values keep their last set states.

5.3 Automation logic

Conditions

Condition is a state that must exists when some action is activated.

Most of the process control logic is defined by *conditions.* Conditions are universal, they can be used in different circumstances: alarm conditions, conditions that start or stop recording, conditions that enable image panel updating and so on.

- We can define conditions that use temperature measurements made on acquired infrared images (*temperature conditions*), for example “Area 1 maximum temperature is bigger than 50 °C”.
- Conditions getting external signals from digital acquisition (I/O) devices (*DAQ conditions*): “Signal on digital input 5 is 1”.
- Also, we can make any combination of temperature and DAQ conditions using logical operations OR, AND, NOT (*combo conditions*): “<object is hot> AND <part in view>”.

Condition can have one of the three states:

  - *true (1)*
  - *false (0)*
  - *undefined*.

Before condition is verified its state is undefined. After condition has been verified its state becomes true or false. Condition state remains undefined when condition verification is not possible (data used in condition is not available) or other condition, which this condition depends on, has undefined state.

After a condition is created it can be used:

  - As an alarm check
  - As output value for a digital signal

- As a trigger to start or stop recording.

Conditions are also used as special tests, for example we can use a condition to enable or disable outputs updating.

Alarms and Signals

Alarm is a warning that something goes not as needed. It is displayed on screen in red color and can drive a digital output.

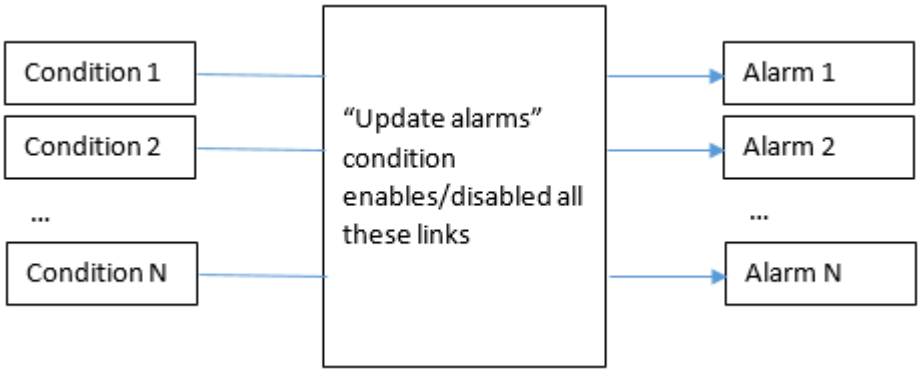
Signal is very similar to alarm but is not displayed as something abnormal. It also can drive a digital output, and this is its primary purpose. Term “alarm” will also include signals below in this text.

Alarm is always linked to a condition. Alarm gets its state from the linked condition. Same as condition state alarm state can be true, false, or undefined. Alarm state is undefined when its linked condition state is undefined, or condition state was not yet assigned to the alarm state.

'Update alarms' condition

Alarm state does not always need to be the same as the state of the linked condition. For example, if alarm uses an object temperature and object is not present now on the image, alarm state must not be updated. To achieve this the special 'Update alarms' condition must be defined. In the object temperature check case 'Update alarms' condition will be a condition that is true when object is in view.

One 'Update alarms' condition is used to enable/disable updating of all alarms. It is not possible to define 'update alarm' condition for every alarm individually.



At the beginning alarm state is undefined until linked condition data is available. Alarm state will also stay undefined as long as 'Update alarms' condition disables alarm state updating.

Digital outputs

Alarms (and signals) can have linked digital outputs. Alarm will set value of its digital output based on its current state.

By default, digital output value corresponds to the alarm state value – 1 when true, 0 when false or undefined:

Alarm value	Digital output value
True	1
False	0
Undefined	0

Default correspondence between alarm and output values

It is possible to invert the output value. When inversion is active output value will be 0 when alarm state is true and 1 when alarm state is false:

Alarm value	Digital output value
True	0
False	1
Undefined	0

Correspondence between alarm and output values when inversion is active

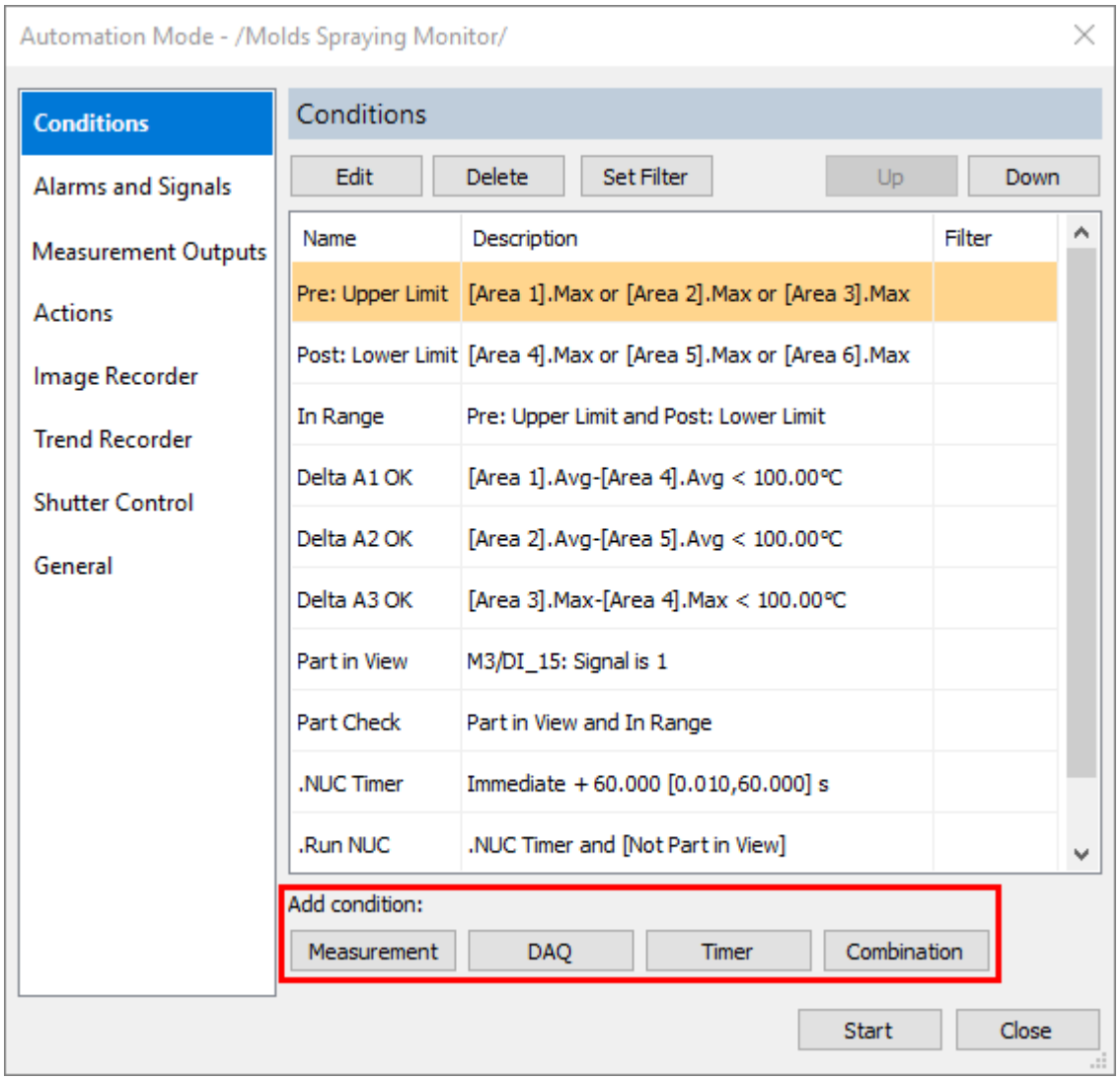
It is also possible to define what value output will have when alarm state is undefined:

Alarm value	Digital output value
Undefined	0 or 1

5.4 Conditions and triggers

See Automation logic topic for general information about conditions.

To configure conditions, open Automation Mode setup dialog (main menu **'Automation | Automation Mode'**) and select **'Conditions'** tab. You will see the list of all currently setup conditions:



Use buttons under the list to create new conditions.

Hidden conditions

If condition name starts with dot, it will be hidden. It can be used as any other condition but will not be shown in the 'Conditions' status window.

Measurement conditions

Measurement condition is a condition that uses a measurement made on image temperature data. Measurements are taken from the analysis objects. Before you can create a temperature condition, the source analysis object must already be present on the image.

IRT Analyzer calculates the following values that can be used as data source for temperature conditions:

Points:

- Temperature value at a spot

Lines:

- Minimum, maximum or average of pixel values belonging to a line
- Deviation: maximum of [maximum temperature minus average temperature] and [average temperature minus minimum temperature]

- Peaks and valleys: number of profile peaks or valleys.

Areas:

- Minimum, maximum or average of pixel values belonging to an area
- Deviation
- Standard deviation
- Area of the part of an area object with temperatures higher or lower than the defined threshold
- Relative area: ratio of the area with threshold to the whole area

Object groups:

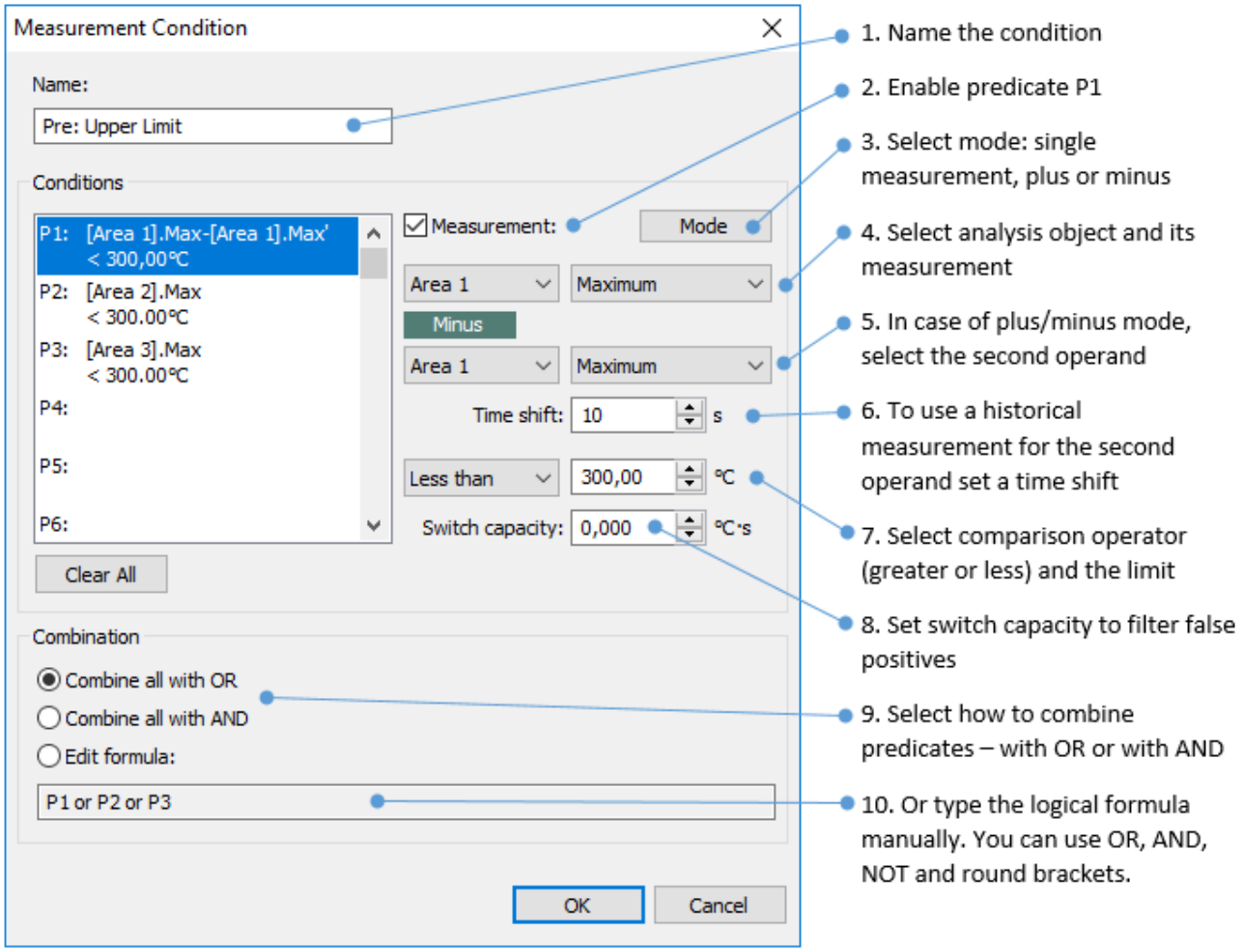
- Minimum, maximum or average of a group of objects (All Points, All Lines and All Areas groups are available)
- Minimum of maximums and maximum of minimums of each object in a group

Image metadata:

- Additional data stored with the image. Depending on the camera it can be shutter temperature, housing temperature, lens temperature and other parameters.

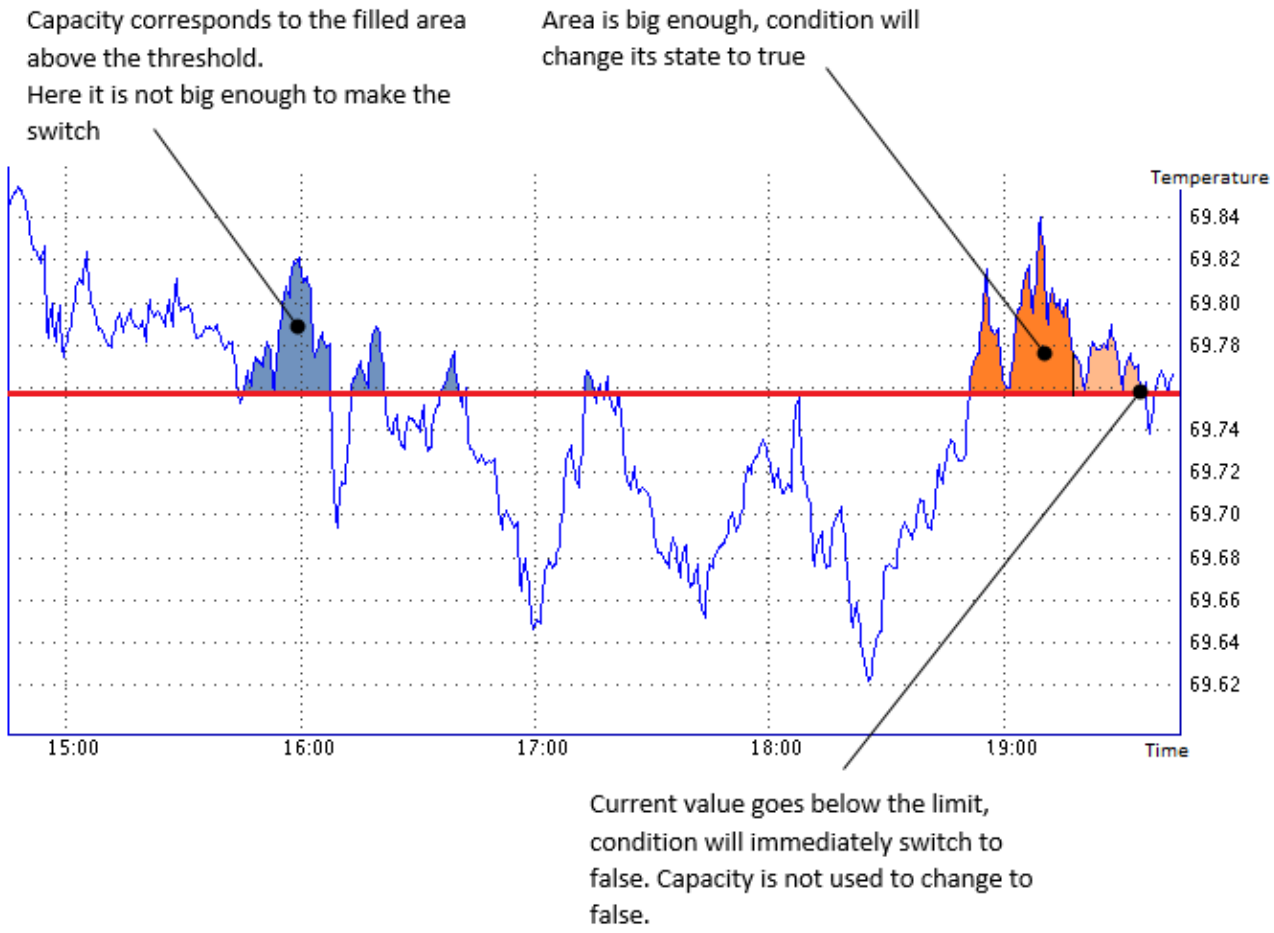
Combinations:

- Sum or difference of two other measurements (from the same or different objects). Measurements must have the same unit.



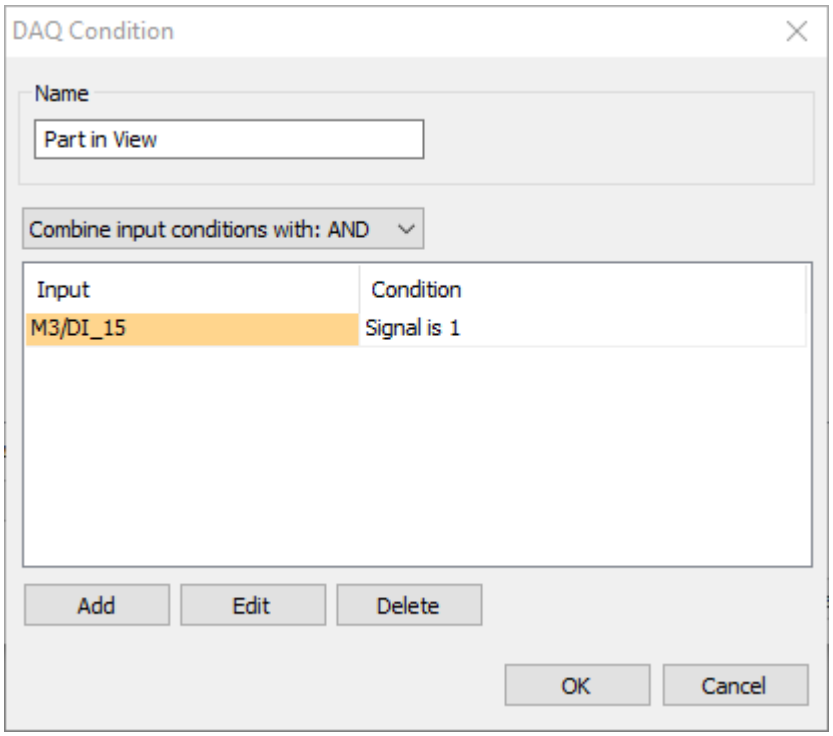
Switch capacity

This is kind of hysteresis for temperature conditions. It allows to turn alarm not right away when limit is crossed, but with a “saturation” period. The bigger the number, the more time or bigger exceeding of the limit is required to make the switch.

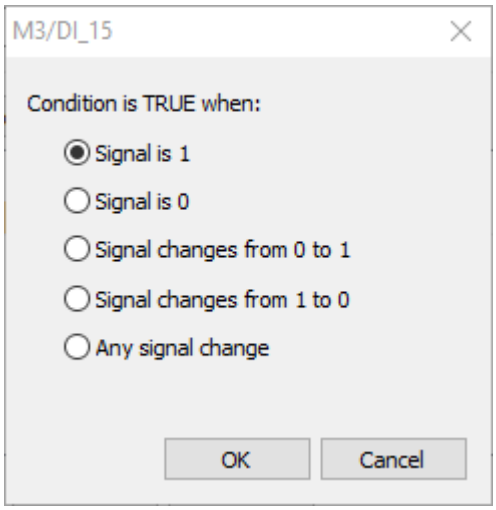


DAQ conditions

DAQ stands for digital acquisition. DAQ condition checks values from one or more digital inputs. Before you can create a DAQ condition, DAQ device must be connected and configured.



1. Name the condition
2. Select a digital input by pressing 'Add' button



3. Select signal value or signal value change that satisfies the condition.
4. Sometimes you need two or more inputs to be in some state to satisfy the condition. In this case add two or more inputs and select how to combine them - with AND or with OR.

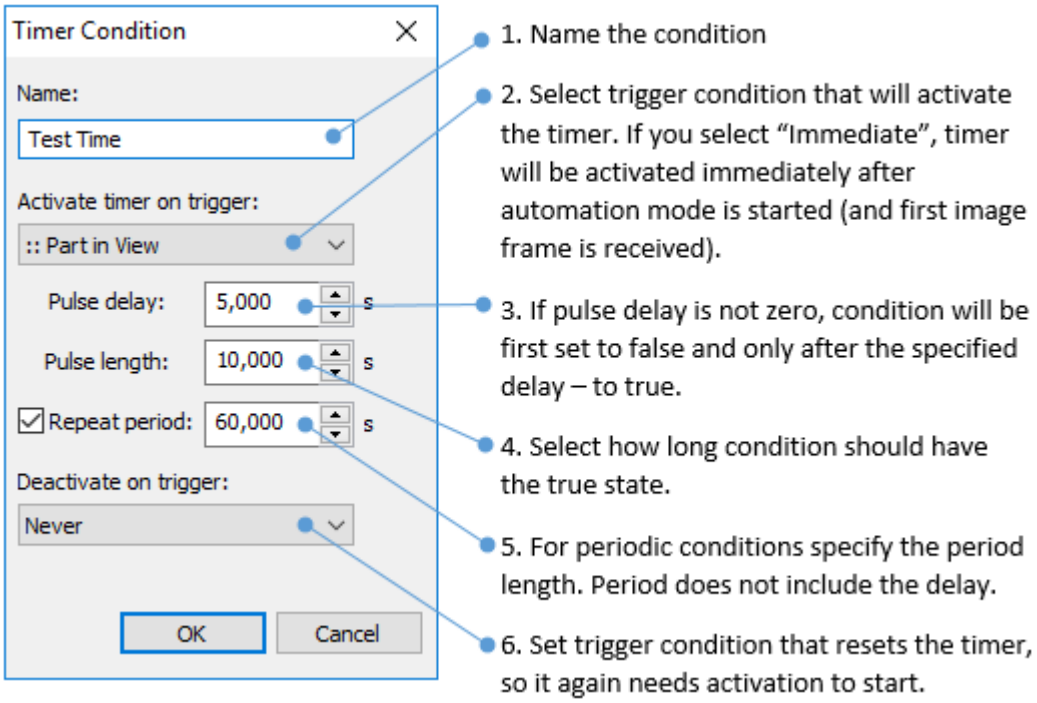
Notes

- The same digital input can be used in many different conditions.
- Signal change conditions (0 to 1, 1 to 0) cannot be used with alarms as they do not have time duration. Such conditions can only be used as triggers.

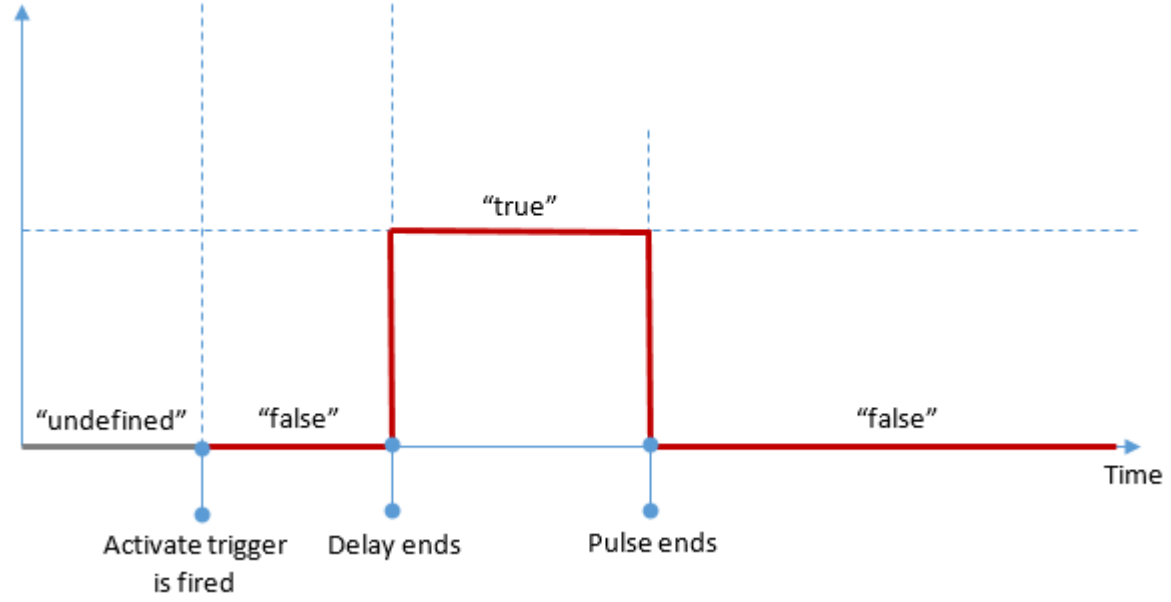
Timer conditions

Timer conditions allow to define time constraints and to generate timer events. With a timer condition you can:

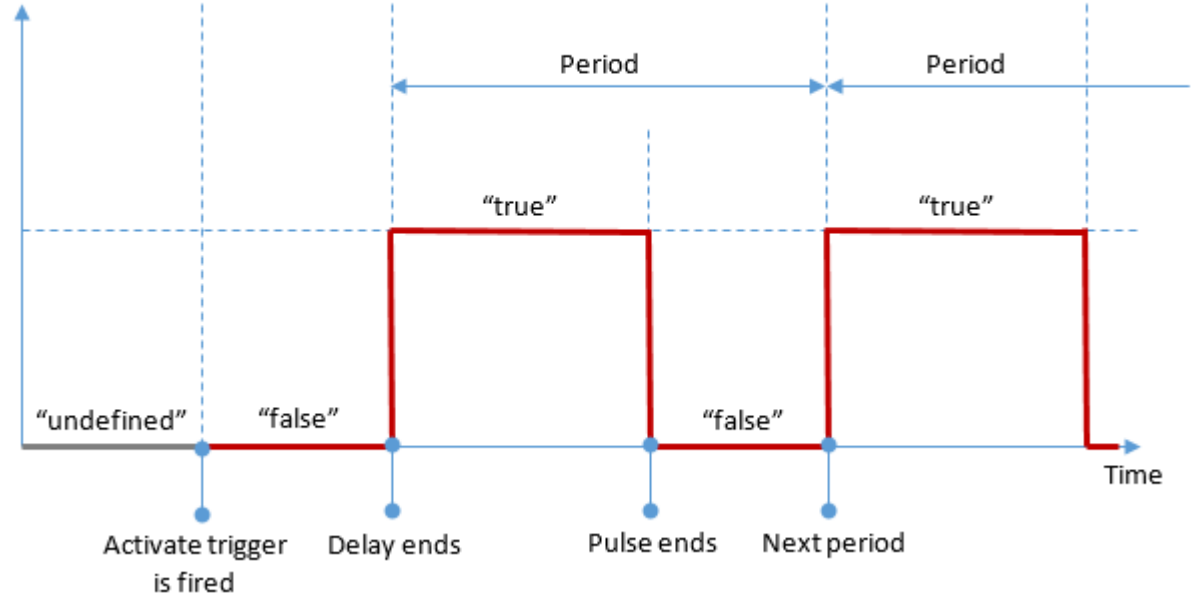
1. Run some process for a period of time.
2. Run a process with a delay after some event.
3. Run a process that starts with some event and stops with another event.
4. Run a process periodically.



Non-periodic timer condition



Periodic timer condition



Notes

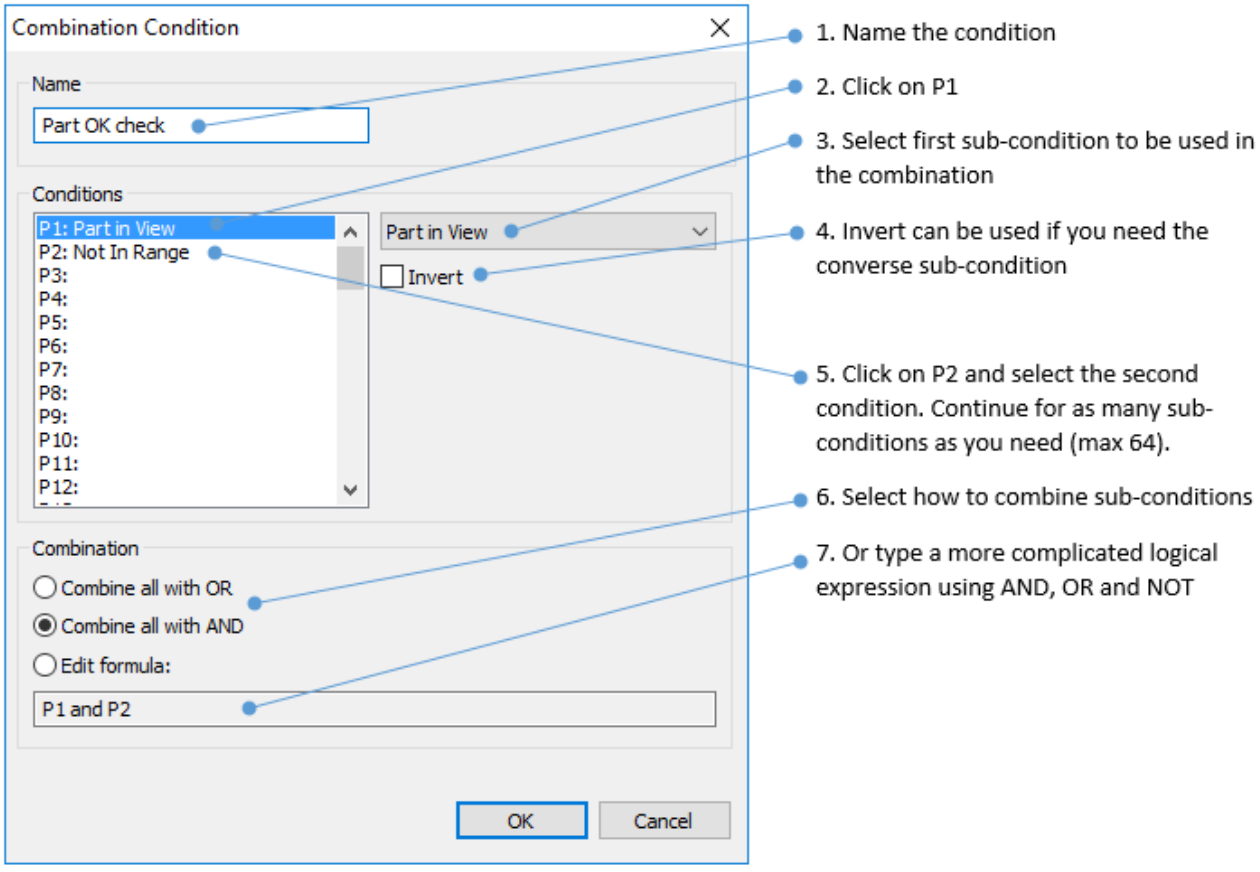
Before timer condition is activated and after it is deactivated, its state is undefined.

To create "always positive" timer condition that remains true all the time (after delay is over), set period length equal to the pulse length.

Timer accuracy is 1 ms. But due to system limitations, pulse length cannot be set shorter than 10 ms. And the period length cannot be too close to the pulse length. It should be at least 10 ms different, otherwise condition will be "always positive".

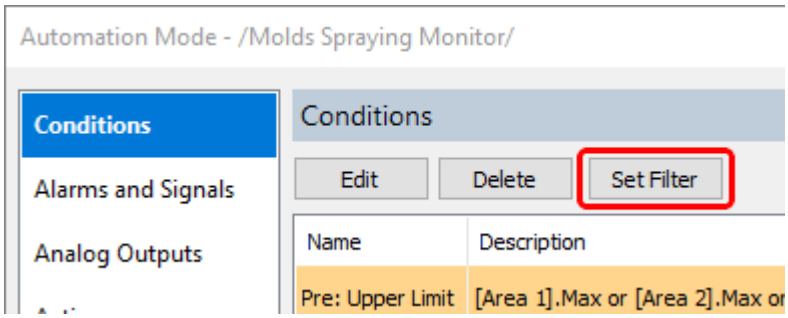
Combination conditions

Combination conditions allow to make a logical expression with other conditions. This way you can combine, for example, temperature conditions with DAQ conditions.



Time filter for conditions

It is possible to set a requirement, that if condition has the true state for a period of time which is too short, it is not recognized as satisfied condition.



- Select condition you want to set time filter for and press the 'Set Filter' button.
- Define time in seconds. Condition will be regarded as true condition only after the defined time has passed and true state remained stable.

Time filter can be applied to all condition types, DAQ, temperature and others.

Triggers

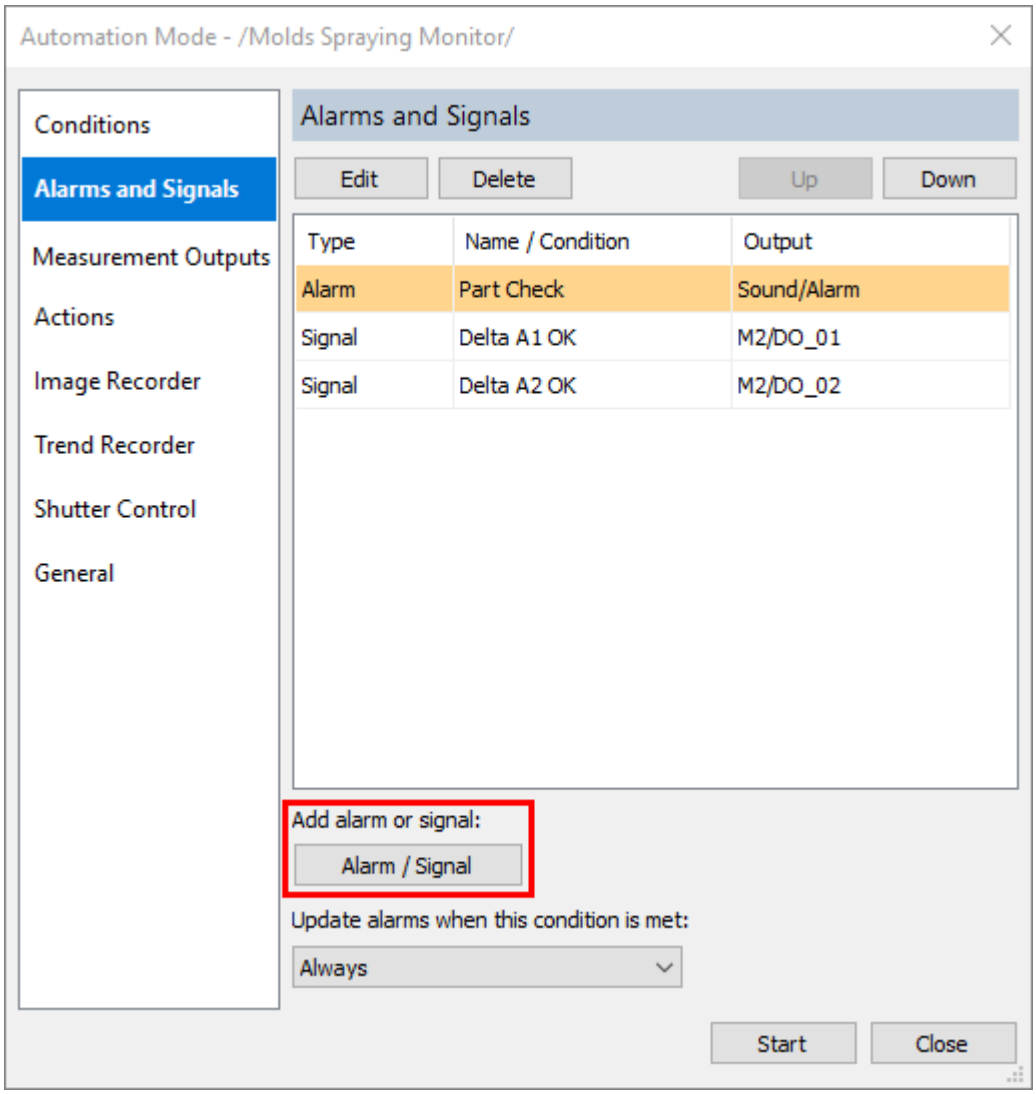
Any condition can be used as a trigger. Trigger is fired when condition changes its state from false to true or from undefined to true.

Conditions that do not have time duration (for example, signal 0 to 1 edge detection conditions, or condition combination that uses on edge detection condition) can only be used as triggers. Such conditions are marked **trigger only** and are not available to be used for alarms. If you need to use edge detection condition with alarms, you can do it using a timer condition.

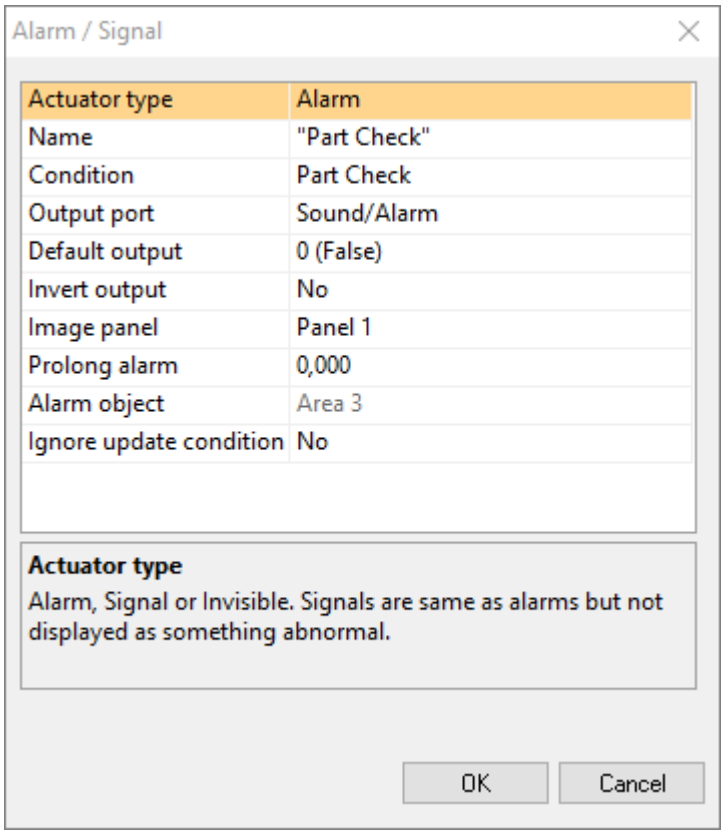
5.5 Alarms and signals

See Automation logic topic for general information about alarms and signals.

To configure alarms and signals open Automation Mode setup dialog (main menu **'Automation | Automation Mode'**) and select **'Alarms and Signals'** tab. You will see the list of all currently setup alarms and signals:



Use **'Alarm / Signal'** button under the list to create new alarm or signal.



Actuator type

Can be "Alarm", "Signal" or "Invisible". Signals drive digital outputs but are not displayed as something abnormal as alarms do. Invisible signals just drive digital outputs in background, they are not displayed on screen (this is useful, for example, when you want an alarm to change an output and to start sound alarm).

Name

With this name alarm will be displayed on screen. When no name is selected, the name of the linked condition is used.

Condition

Alarm is linked to a condition. This condition is the alarm condition - when alarm condition is true, alarm is in the signaled stated.

Alarm does not always have the same state as its linked condition. '[Update alarms]' logic may block alarm state updates.

Output port / Default output / Invert output

Defines a digital output linked to the alarm and correspondence between alarm condition state and output signal value.

For details see digital outputs description in [Automation logic] topic.

Image panel

This setting is used when [multi-image composition] is configured and links the alarm with an image panel.

By default, no image panel is selected, and the alarm is updated even when the image panel is not active. When an image panel is linked to the alarm, alarm state is updating (taken from the linked condition) only when the specified image panel is updating.

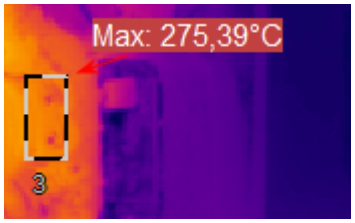
Prolong alarm

Prolong alarm (defined in seconds) will keep alarm state activated (true) for a longer period. Alarm and linked digital output will be in the signaled state for at least the specified time even when underlying alarm condition is not true anymore.

Alarm object

This setting links analysis object on the image with the alarm. It only affects visual appearance and has no influence on alarm condition calculation.

When alarm condition is true, specified analysis object label will change its appearance to signal the alarm state.



Alarm object displays the alarm condition state, not the alarm state (they are not always equal). But in case of alarm prolongation, object label will stay in signaled state, not necessarily corresponding to the state of alarm condition.

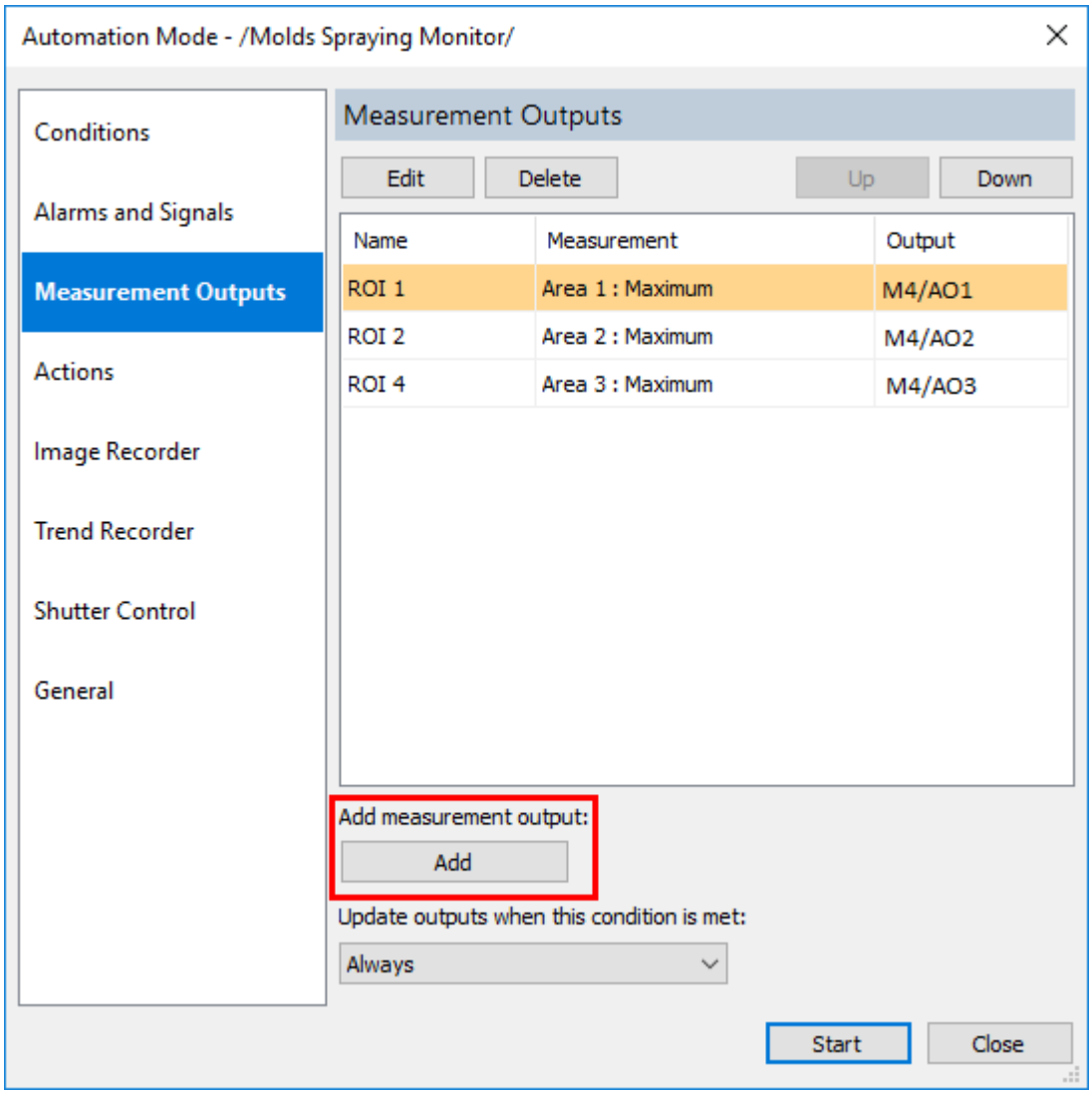
Ignore update condition

When this property is set to Yes, alarm will ignore 'Update alarms condition' and will be updated even when 'Update alarms condition' is not active.

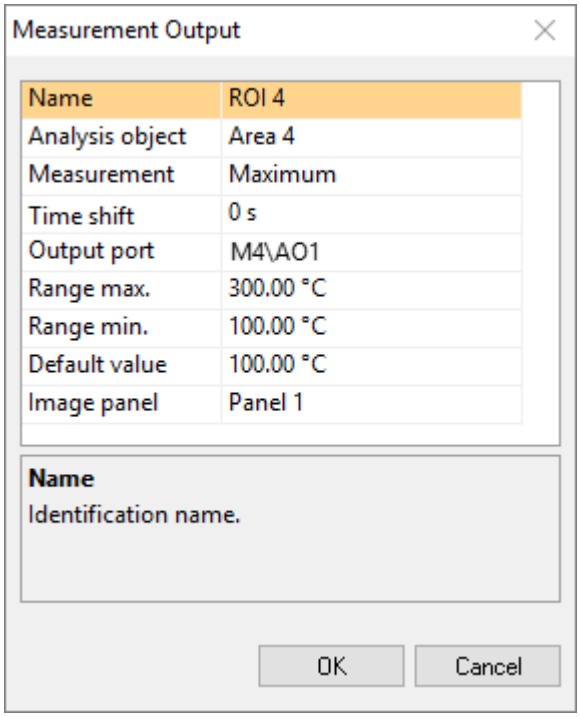
5.6 Measurement outputs

IRT Analyzer can convert a temperature measurement into analog output signal.

To configure analog outputs, open Automation Mode setup dialog (main menu **'Automation | Automation Mode'**) and select **'Measurement Outputs'** tab. You will see the list of all currently setup analog outputs:



Use **'Add'** button under the list to create new measurement output entry.



Name

Name for the output as it will be displayed on screen.

Analysis object

Object which measurement will be used as source for the output value.

Measurement

Object's measurement (for example, temperature maximum or deviation or area) used for the output.

Time shift

To use a historical measurement, set a time shift value in seconds.

Output port

Output port name on the connected DAQ adapter.

Range min / max

Temperature range which is mapped to the available output range (e.g. current 4..20 mA) of the output port.

Default value

Measurement value used when the output did not have chance to update (for example, conditions for update were not yet met).

Image panel

If selected, the output value will be updating only when specified image panel is updating. See Multi-image composition for details about image panels.

5.7 Actions

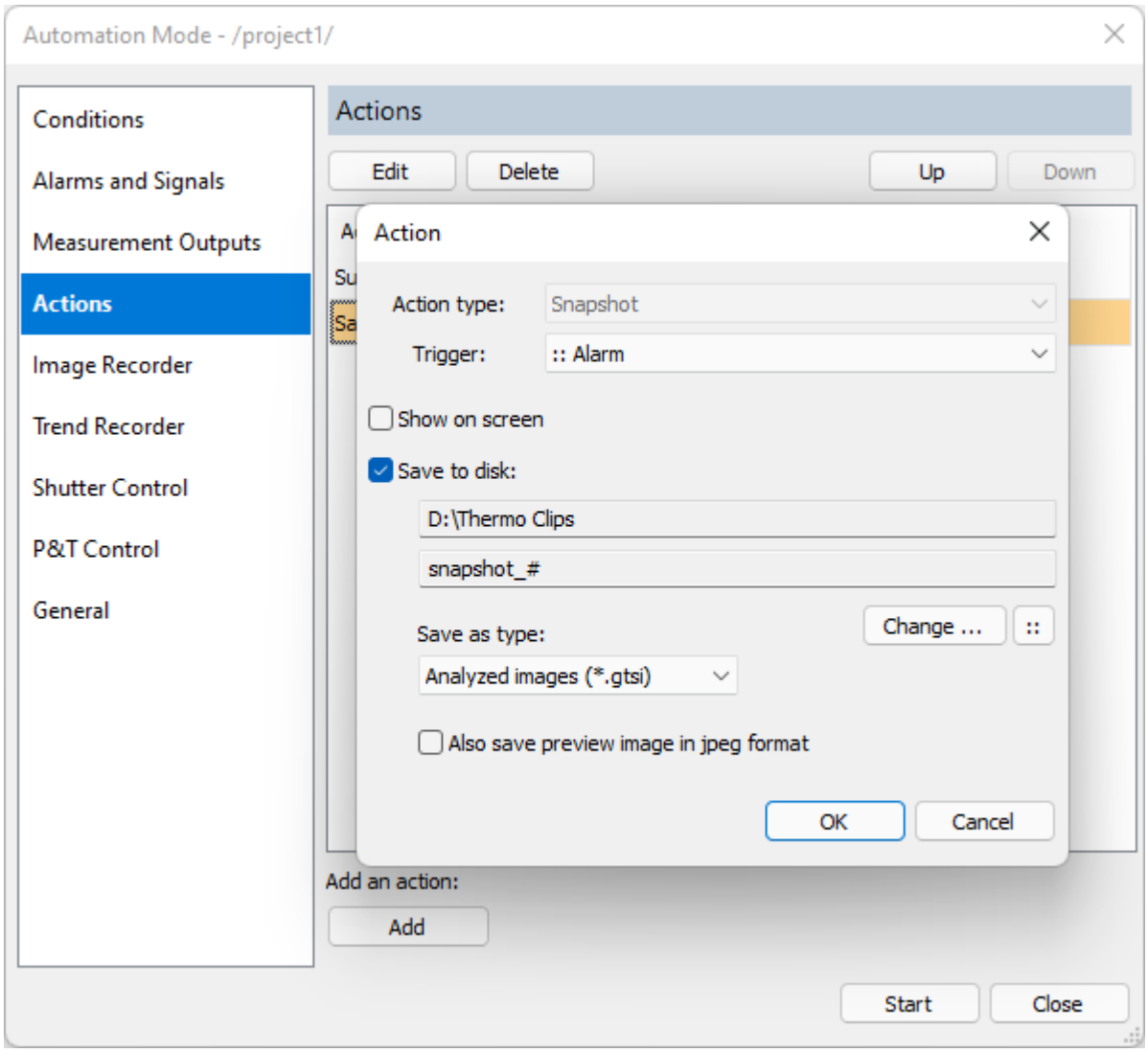
Automation mode *action* is executed when its trigger condition is satisfied. IRT Analyzer supports these actions:

1. Snapshots
2. E-mail notifications
3. Image subtraction
4. Python script

5.8 Snapshots

Snapshots are single infrared images saved to files. There is an automation mode *action* which saves a snapshot.

To configure snapshots saving, open Automation Mode setup dialog (main menu **'Automation | Automation Mode'**) and select '**Actions'** tab. Press **'Add'** button to add a new action, select 'Snapshot' as the 'Action type'.



Trigger condition is used to specify the moment when snapshot should be made. Snapshots can be shown on screen and/or saved to disk.

Show on screen

Snapshot is shown on screen in an additional preview window. Image state (temperature range, palette, emissivity and other parameters) and analysis objects at the moment when snapshot was taken are remembered and cannot be changed.

Save to disk

Snapshots can be saved in several formats:

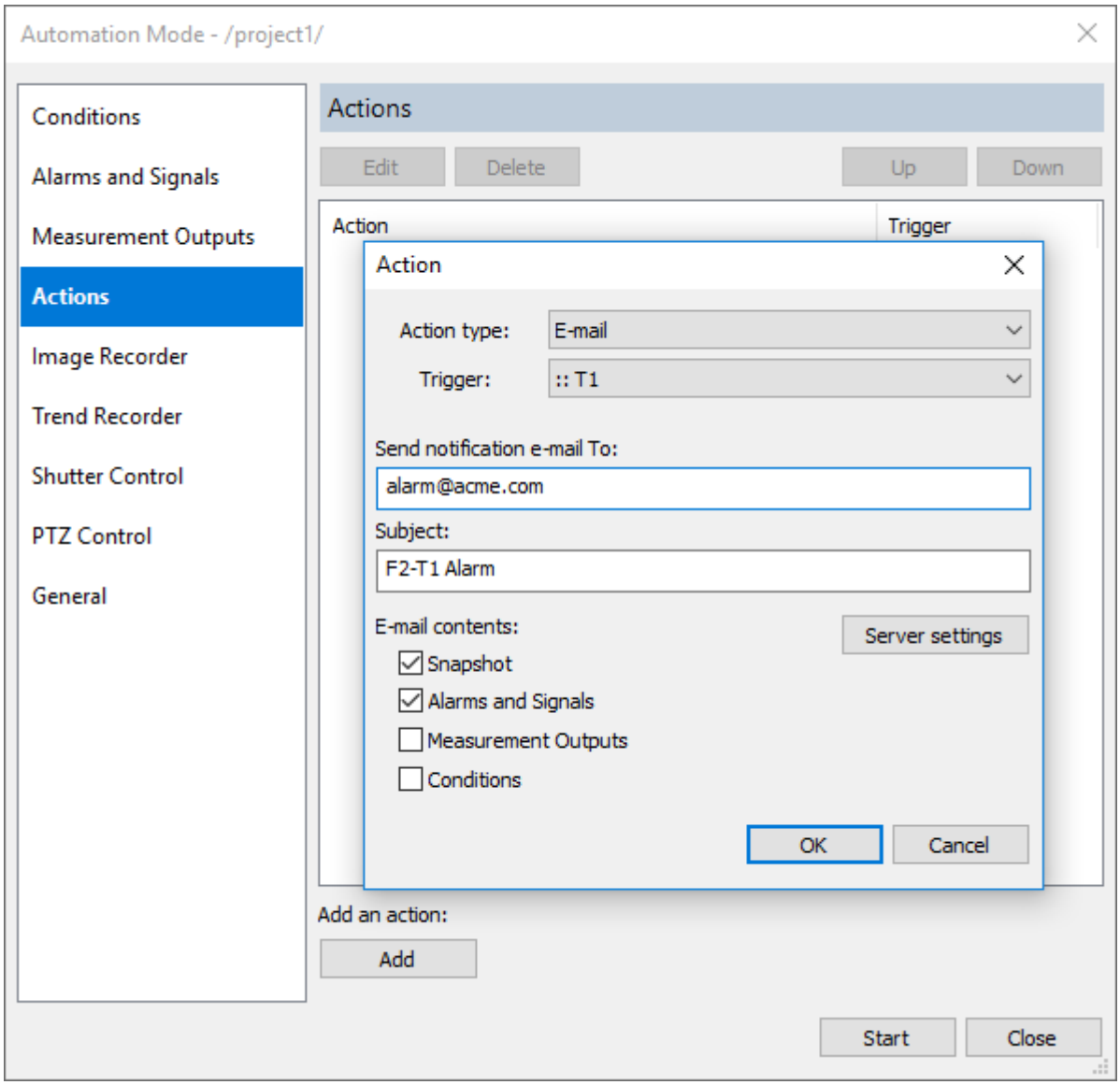
- Analyzed images (*.gtsi): format that stores infrared image, analysis objects and visible image, when available;
- Jpeg Files (*.jpg): a picture with analysis objects and the temperature scale;
- Excel Files (*.csv): comma separated text file format (the separator character can be different depending on Windows regional settings);
- ASCII Files (*.txt): similar as CSV, but tab is used as separator character;
- Binary Files (*.bin): simple binary image format.

In addition to the snapshot file there is an option to also save a preview picture in jpeg format. This picture will contain an infrared image with a temperature scale and analysis objects as you see them on the screen.

5.9 Alarm notification e-mails

It is possible to configure IRT Analyzer to send notification e-mails when an alarm condition is met.

Open Automation Mode setup dialog (main menu **'Automation | Automation Mode'**) and select '**Actions**' tab. Press **'Add'** button to add a new action, select **'E-mail'** as the 'Action type'.



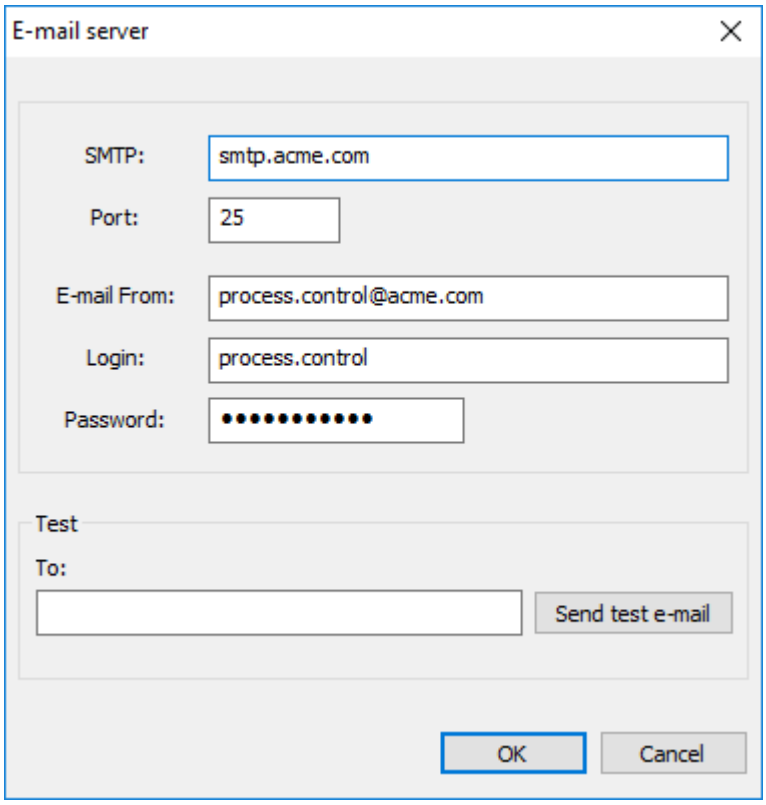
Trigger condition is used to define the moment when alarm notification should be generated.

You can select to add IR image snapshot to the notification e-mail. Also, you can specify what to include in the e-mail text: Alarms and Signals, Measurement Outputs and Conditions.

E-mail server

To send e-mails, IRT Analyzer needs access to an e-mail server that will handle e-mail delivery. To configure server settings press **'Server settings'** button.

All e-mail actions in the current instance of IRT Analyzer will use the same e-mail server. It is not possible to use different e-mail servers.



SMTP: the address of the e-mail server.

Port: the port to use to send e-mail messages to the server.

E-mail From: the source e-mail address (alarm notifications will be coming from this address).

Login: the login required to sign into the e-mail server.

Password: the password required to sign into the e-mail server.

Testing if e-mail server is configured properly

To test that e-mail server configuration is correct, try to send a test e-mail to any address of yours. Type the address in the **'Test/To'** field and press **'Send test e-mail'** button.

Limitation for e-mail sending frequency

IRT Analyzer does not allow to send e-mail notifications too frequently. The default limit is 20 messages per day and 3 messages per hour. When the limit is reached, new e-mail notifications are not sent, and you get a warning in the log file (Messages Window).

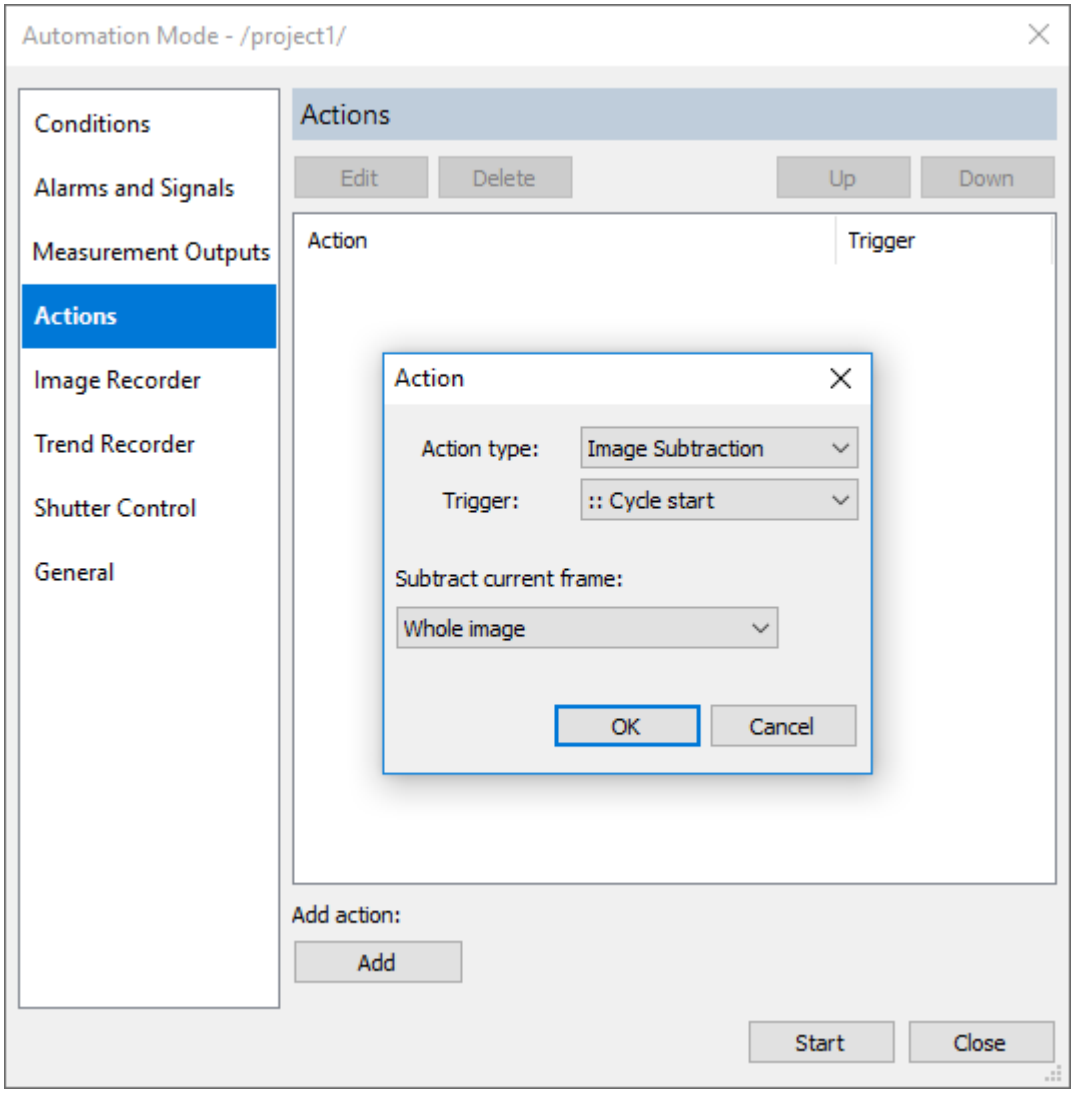
You can change the limits. This is done in **appconfig.ini** file, section **[EmailServer]**, **FrequencyRule** entry.

Frequency rule syntax: [number of e-mails],[period in seconds]; [another number of e-mails],[another period in seconds];...

5.10 Image subtraction by a trigger

It is possible to change subtracted image by a trigger condition. Automation mode action is used to do this.

To configure image subtraction, open Automation Mode setup dialog (main menu **'Automation | Automation Mode'**) and select **'Actions'** tab. Press **'Add'** button to add new action, select 'Image Subtraction' as the 'Action type'.



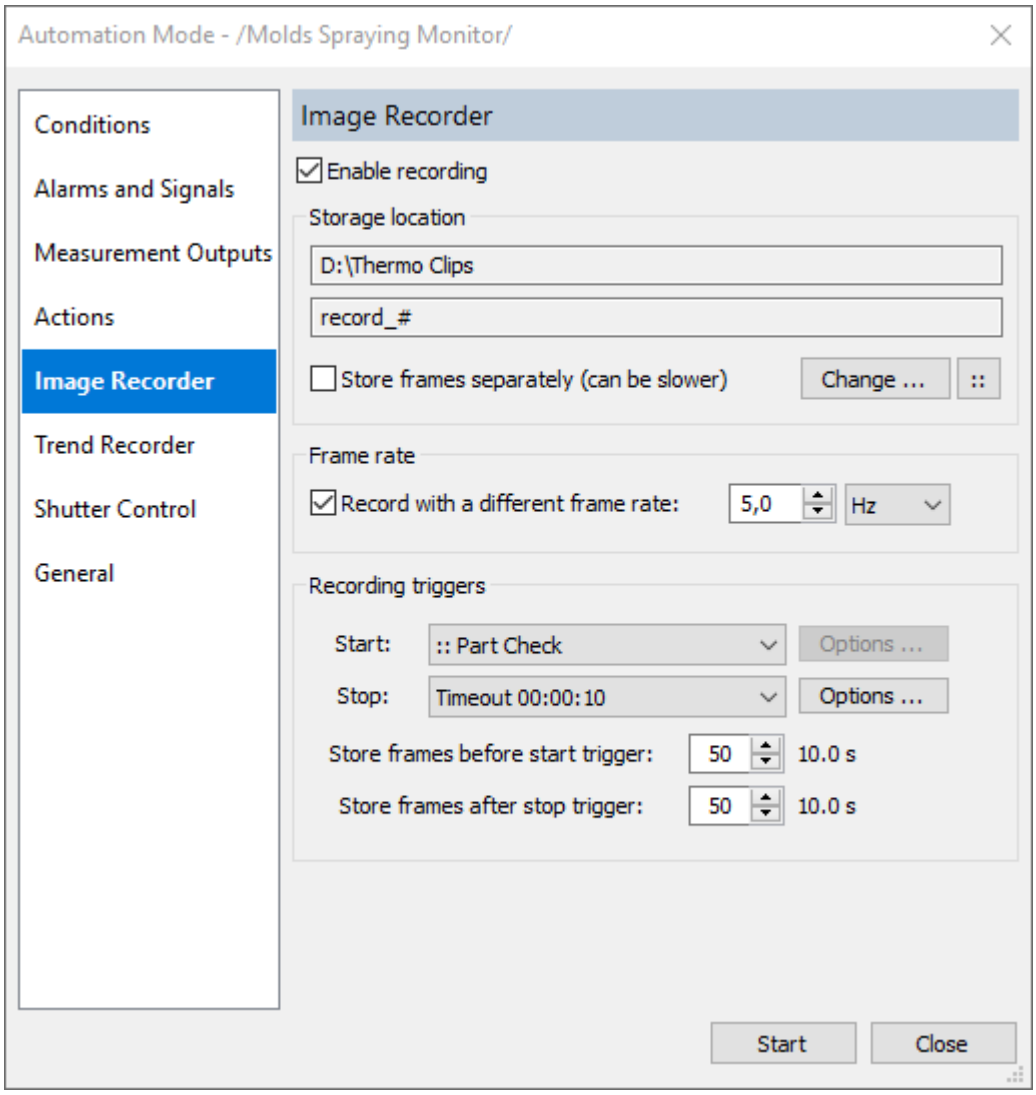
When trigger is fired current frame is set to be the subtrahend frame.

In case of multiple image panels, it is possible to treat each panel individually.

5.11 Image recorder with triggers

Image recorder with triggers can record images automatically, starting and stopping recording by trigger events.

To configure image recorder, open Automation Mode setup dialog (main menu **'Automation | Automation Mode'**) and select **'Image Recorder'** tab.



- Marking **'Enable recording'** check box will enable recorder.
- Storage location: see description in the Image recorder topic.
- Frame rate: recording frame rate can be lower than acquisition frame rate.

Recording triggers

Conditions can be used as triggers. When condition changes its state from false to true or from undefined to true, trigger is fired.

Conditions are listed in the **'Start'** and **'Stop'** trigger combo boxes with :: in the name.

And there are special triggers available:

1. *Frame counter*: fires after the specified number of frames is recorded. Can be used only as a stop trigger.
2. *Timeout: s*tops after the defined time period. If used as stop trigger, timer is started when recording starts. If used as start trigger, timer is started after image acquisition starts or after recording stop.
3. *Screen Button*: allows to simulate trigger event using an on-screen button. Sometimes it is convenient to start recording manually, and stop by some condition or time event.
4. *COM Port*: uses loop-back on RS232 port of computer to get external events (line closed, line open).

Store frames before and after (pre/post event recording)

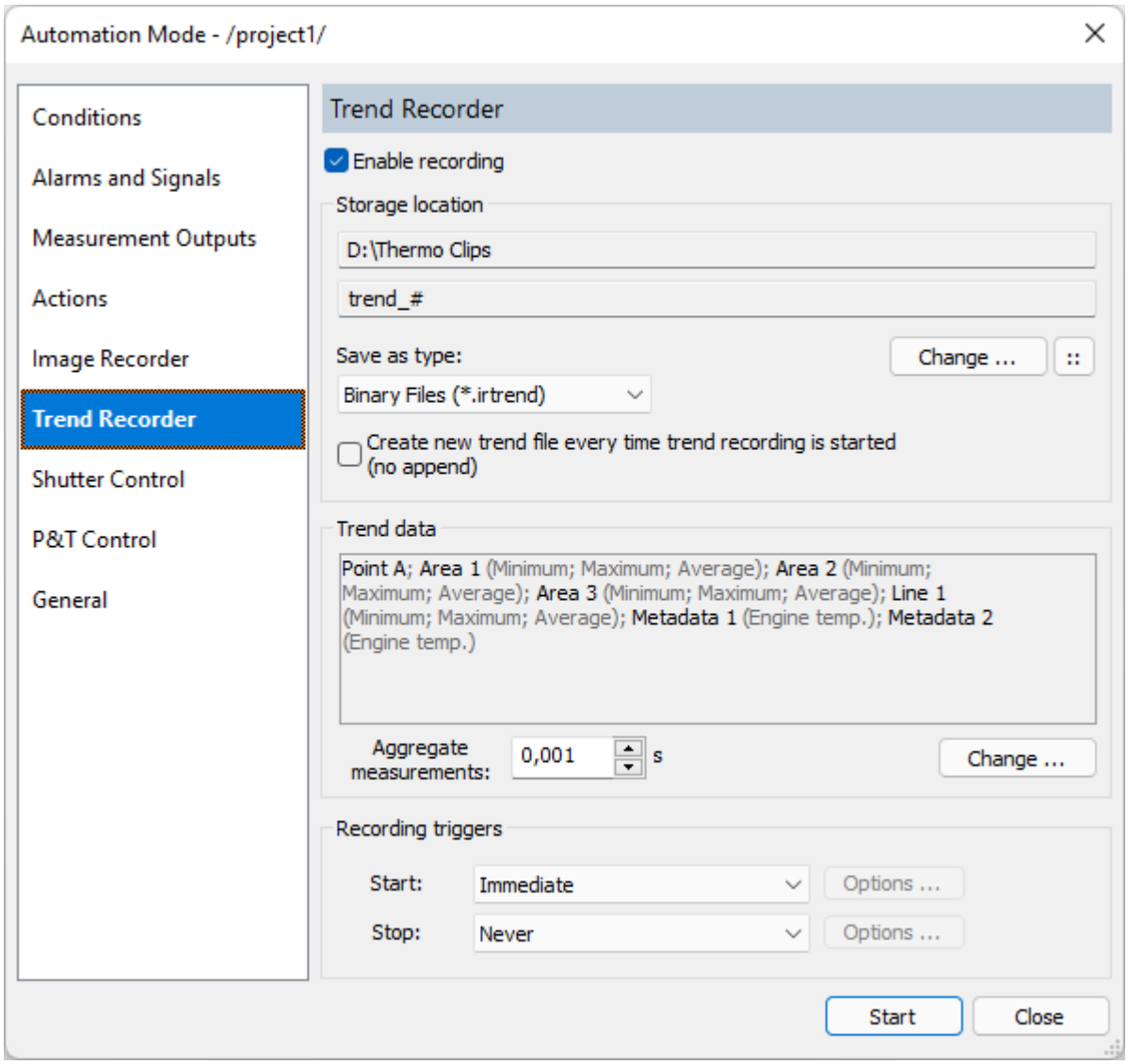
You can setup image recorder that it will record data acquired before start event. This will compensate reaction delays for quick processes. Length of the recorded pre-trigger video is limited by the size of the history buffer defined during acquisition setup. Number of frames taken from the history buffer is defined by **'Store frames before start trigger'**.

In the same way you can tell image recorder to record some data after the stop event. This is defined in the **'Store frames after stop trigger'** field. Length of the post-stop video is not limited as history buffer is not used in this case.

5.12 Trend recorder with triggers

Trend recorder with triggers can start and stop trend data recording automatically by trigger events.

To configure trend recorder, open Automation Mode setup dialog (main menu **'Automation | Automation Mode'**) and select **'Trend Recorder'** tab.



- Marking **'Enable recording'** check box will enable recorder.
- Storage location: see description in the Image recorder topic.
- **Save as type**: binary (Binary Files) or comma separated (Excel Files).
- Trend data: press **'Change'** button to select which measurements to save to the trend file.

- **'Aggregate'**: allows to reduce the amount of stored data by aggregating excessive measurements together. See real-time trend topic for details.
- Recording triggers: same triggers can be used as in image recorder.

Recorded trend can be loaded into IRT Analyzer using **'File | Open'** main menu command.

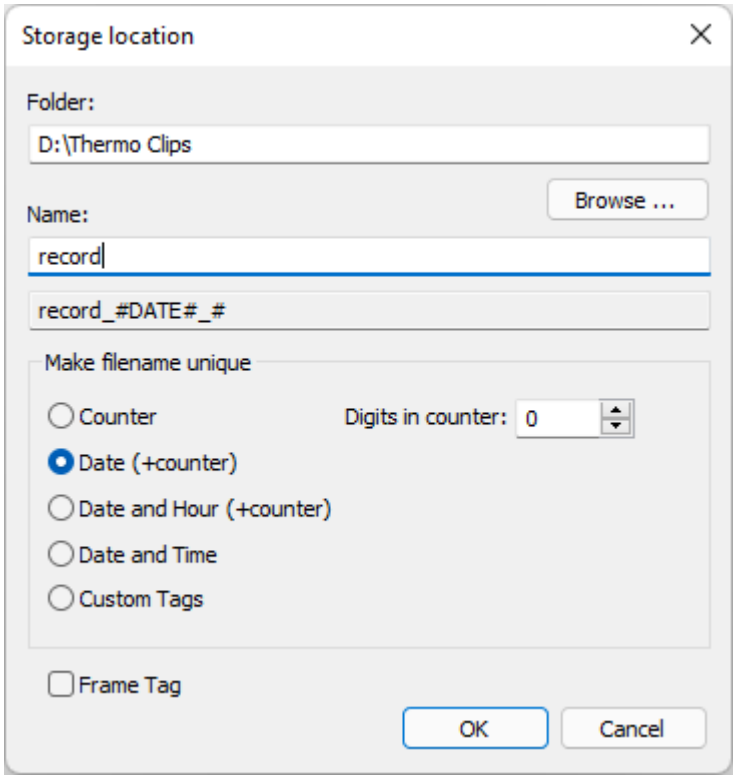
Appending new data to existing files

When trend recording is started (which can be right after a project is loaded and the automation mode is started or by a trigger condition) IRT Analyzer is looking for a file where trend data should be stored. If it finds an existing file with the configured trend name, it appends data to the existing file. IRT Analyzer will not allow a trend file to grow too big (the limit is 1024 MB; it can be changed in appconfig.INI configuration file: [RealtimeSupply]/TrendMaxFileSizeMB parameter). When the file size limit is reached a new trend file is started automatically.

If **'Create new trend file every time trend recording is started (no append)'** option is selected, IRT Analyzer will not append data to existing files, it will create new files every time start recording condition is triggered.

Separate trend data by time

IRT Analyzer can automatically separate recorded trend data by time. It can start new trend file every day or every hour. To configure IRT Analyzer doing so you should use the advanced file name dialog (the **'::'** button) and select **'Date'** or **'Date and Hour'** option:



'Create new trend file every time trend recording is started (no append)' option must not be enabled.

5.13 Camera shutter control

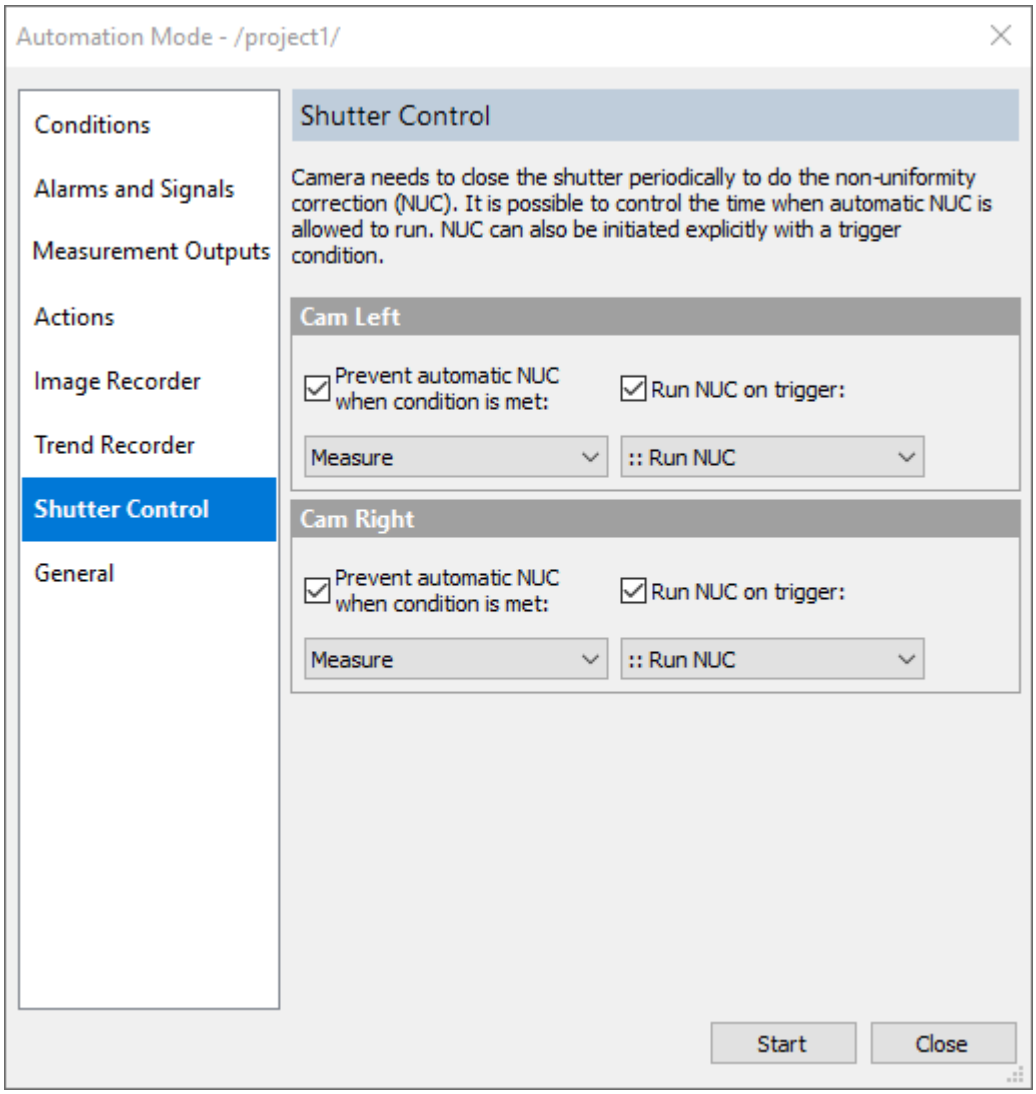
Infrared cameras need to run non-uniformity correction (NUC) procedure from time to time to maintain accurate temperature measurement. Most of IR cameras use internal shutters. When it is the time to run NUC, shutter closes detector field of view and NUC coefficients are recalculated. This takes one, two, sometimes more seconds, depending on the camera model. When shutter is closed, camera does not measure temperatures of the scene and image data is not sent to PC (image freezes). It is necessary to ensure that NUC is not blocking camera use when temperature measurement is running, especially when object is in view for a short period of time.

To control the NUC timing IRT Analyzer uses conditions:

1. It is possible to define a condition (for example, external signal condition) that will tell camera not to run NUC at some time periods (when analyzed object is in view).
2. It is possible to define a trigger condition that will force camera to do NUC (for example, just before measurements).

Automatic NUC settings (time periods, temperature delta) are individual for each camera model; they are adjusted in the Camera Controls dialog.

Shutter conditions are set in the Automation Mode dialog, on the **'Shutter Control'** page:



"Measure" and "Run NUC" in the screen shot above are conditions prepared beforehand in the Conditions page.

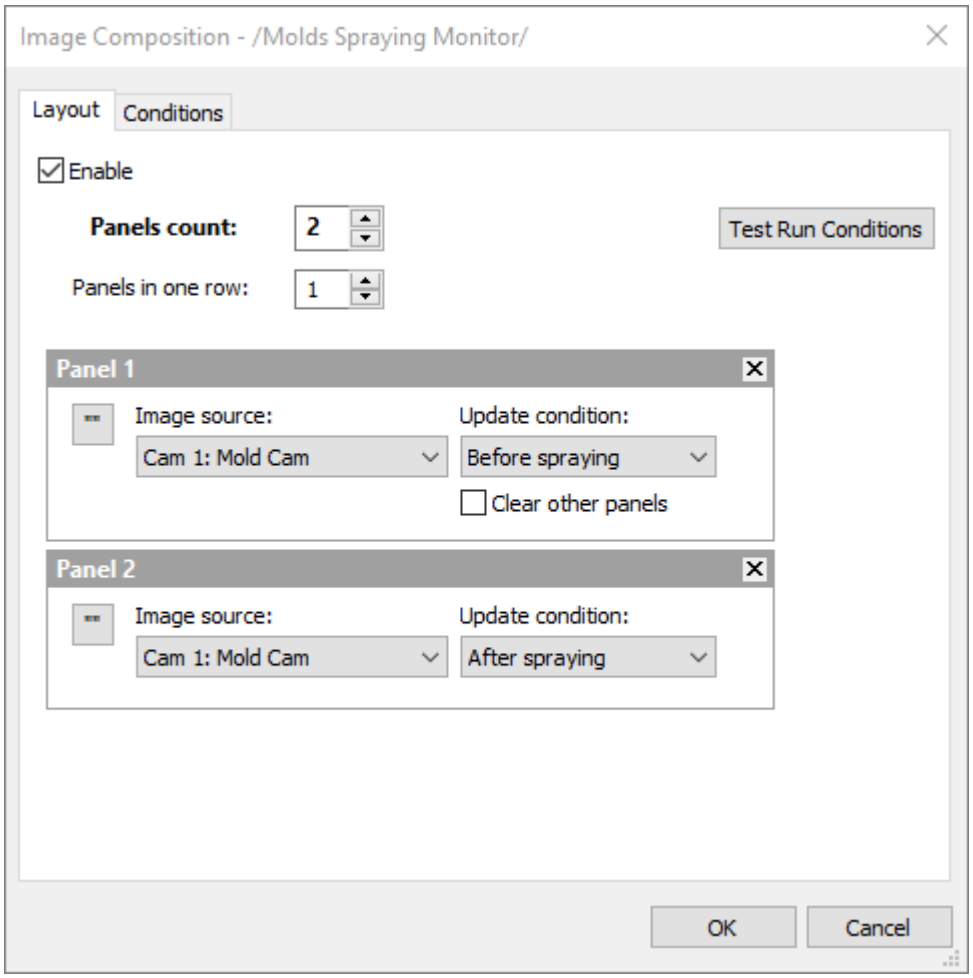
> **Note**
>
> Please be aware that 'Prevent automatic NUC' prevents only NUCs executed automatically by the camera. It does not block NUCs initiated by 'Run NUC on trigger'.

5.14 Multi-image composition (image panels)

You can create several image panels and define condition when to update which panel. For example, one camera can be used to update several image panels. First panel is updated when the first part is being checked, second when the second part is in view and so on.

> Before you can setup multi-image composition, you need to start image acquisition for all cameras that will be used.

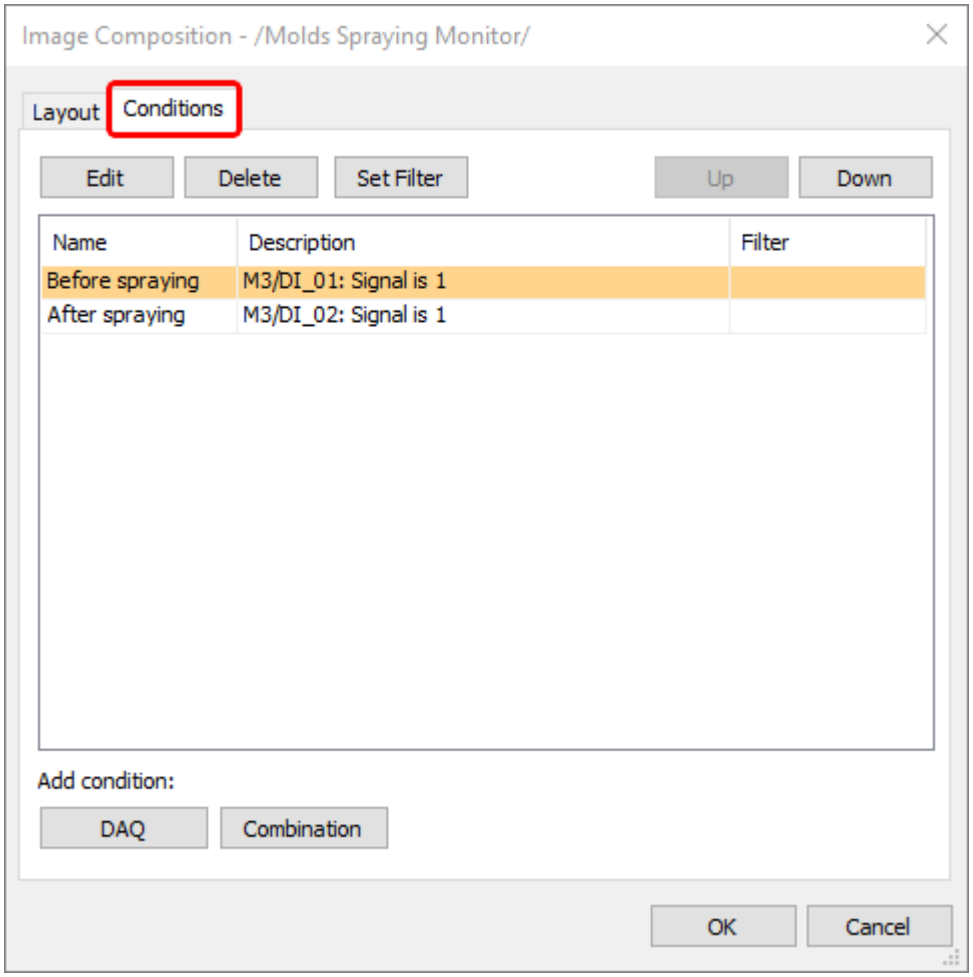
To define image panels and their update conditions use main menu item **'Automation | Image Composition'**.



- Firstly, you need to set how many image panels you want to use.
- Then you need to define which camera is used as image source for the panel. One camera can serve as image source for several panel.
- Finally, you need to select conditions to define when each panel is updated.

Image composition uses its own set of conditions, not the conditions from the automation mode. Temperature conditions cannot be used to update image panels.

Select **'Conditions'** tab to define conditions for image panels.

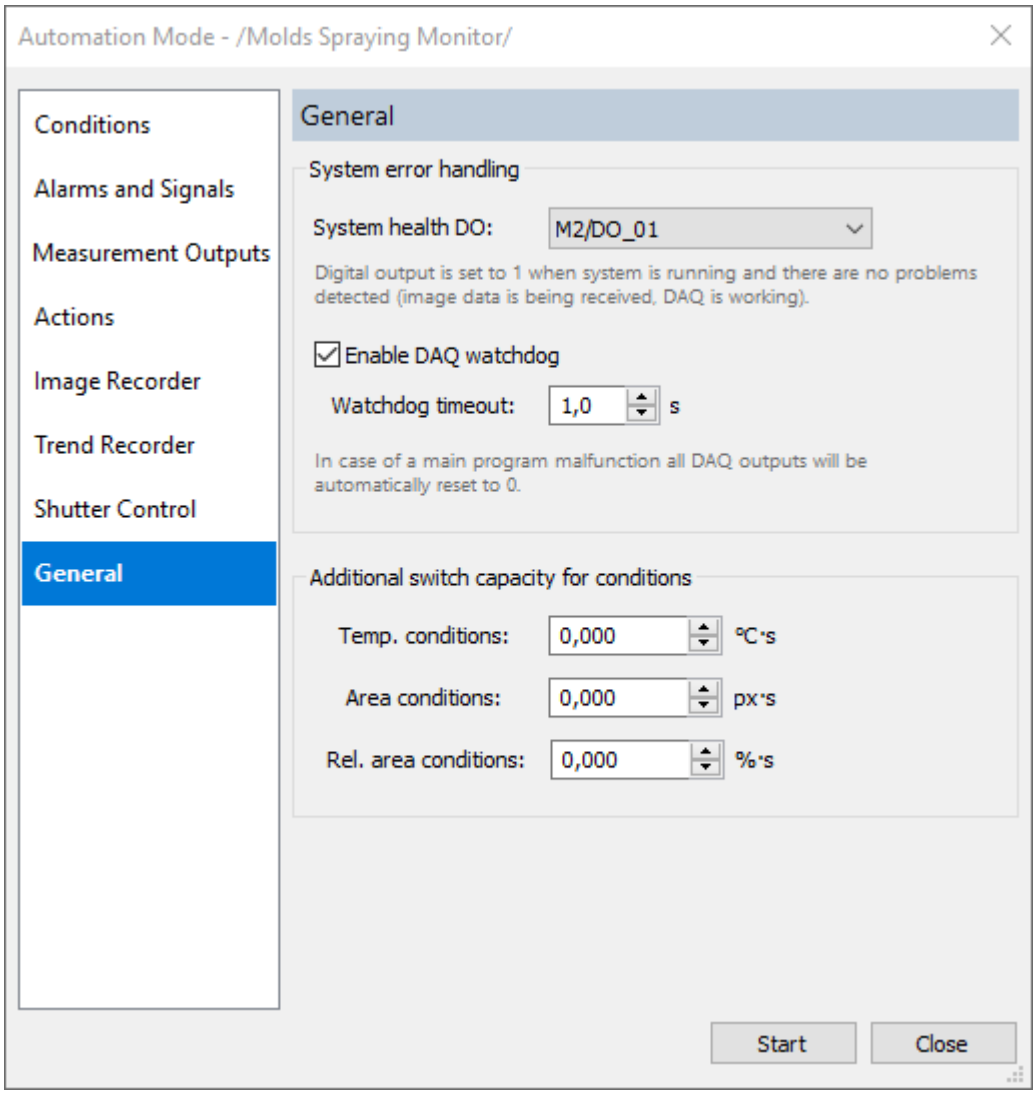


Conditions are defined exactly in the same way as conditions in the automation mode.

5.15 System health watchdog

When running the automation mode, IRT Analyzer is permanently checking that each used camera is connected and images are being received. When connection to a camera is lost, IRT Analyzer automatically tries to reconnect the camera. Same procedure is used for DAQ devices that need connection (WAGO).

System health parameters are setup at the **'General'** page of the Automation Mode dialog:



System health DO

IRT Analyzer can report running status to the outside world using a digital output. When automation mode is running and there are no errors, select output port is set to 1. When system is not running or there is an error (e.g., communication with a camera lost), output value will be 0.

DAQ watchdog

In case IRT Analyzer stops working (crashes, hangs), DAQ device can detect that there are no commands coming from the main program and do some actions. WAGO fieldbus coupler supports watchdog functionality - when watchdog timeout is reached, it automatically resets all output to 0 state.

Watchdog timeout: if there are not commands received from the main program during the specified time (in seconds), watchdog recovery plan is activated (all outputs are set to 0).

5.16 Python scripts

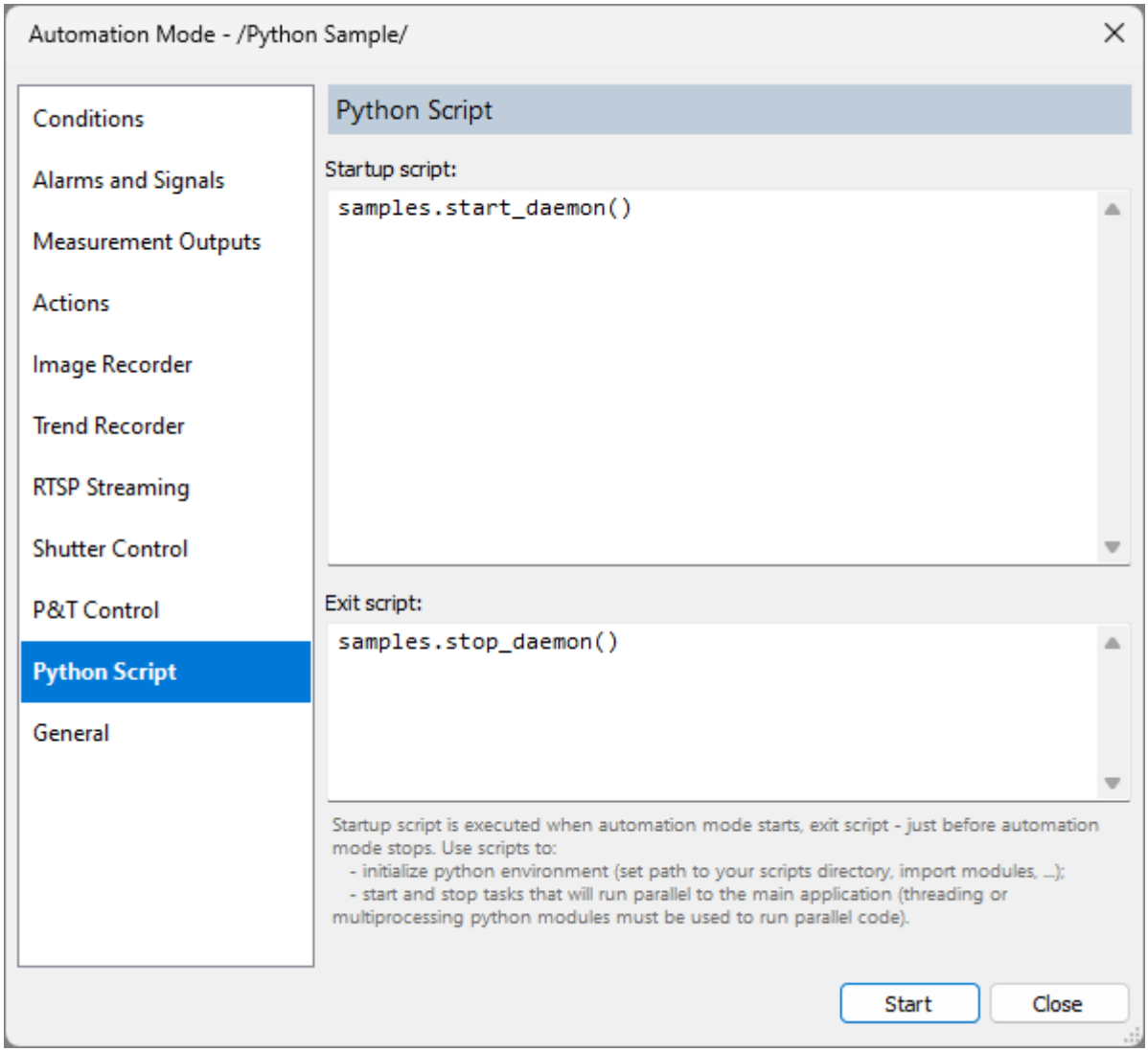
You can enhance the functionality of IRT Analyzer by integrating Python scripts in various ways:

1. **Script Triggered as an Action**: Run a Python script in response to specific events.
2. **Conditions Logic**: Implement automation conditions controlled by Python scripts for more complex automation.

Configuring Python Scripts

Python scripts can be configured in the Automation Mode setup dialog, specifically on the Python Script page. Here, you define scripts that run when automation mode starts and stops. Due to limited space for script text on this page, it is recommended to use this area solely for loading the necessary Python modules and calling initialization or deinitialization routines.

- **Startup Script**: Executed when automation mode starts.
- **Exit Script**: Executed just before automation mode stops.



Your Python modules should be stored in the **'PyProcessControl'** subfolder of the directory where IRT Analyzer is installed (typically within Program Files). To import your module in the Startup script, use the statement **'import <your_module_name>'**. It is advisable to keep most of your Python code within these modules, limiting the Automation Mode setup to just module calls.

Console Output

Console output from Python scripts, such as from **'print'** statements, is directed to the Messages Window. To view this, select **'View | Messages Window'** from the main menu or press **F4**.

Python Script Samples

IRT Analyzer includes a **'samples.py'** module with simple code examples illustrating how Python actions and events work within IRT Analyzer. This module can be found at **'PyProcessControl\embedscripts\samples.py'**. The samples module is imported automatically, so manual importing is unnecessary.

Examples provided in the **'samples'** module include:

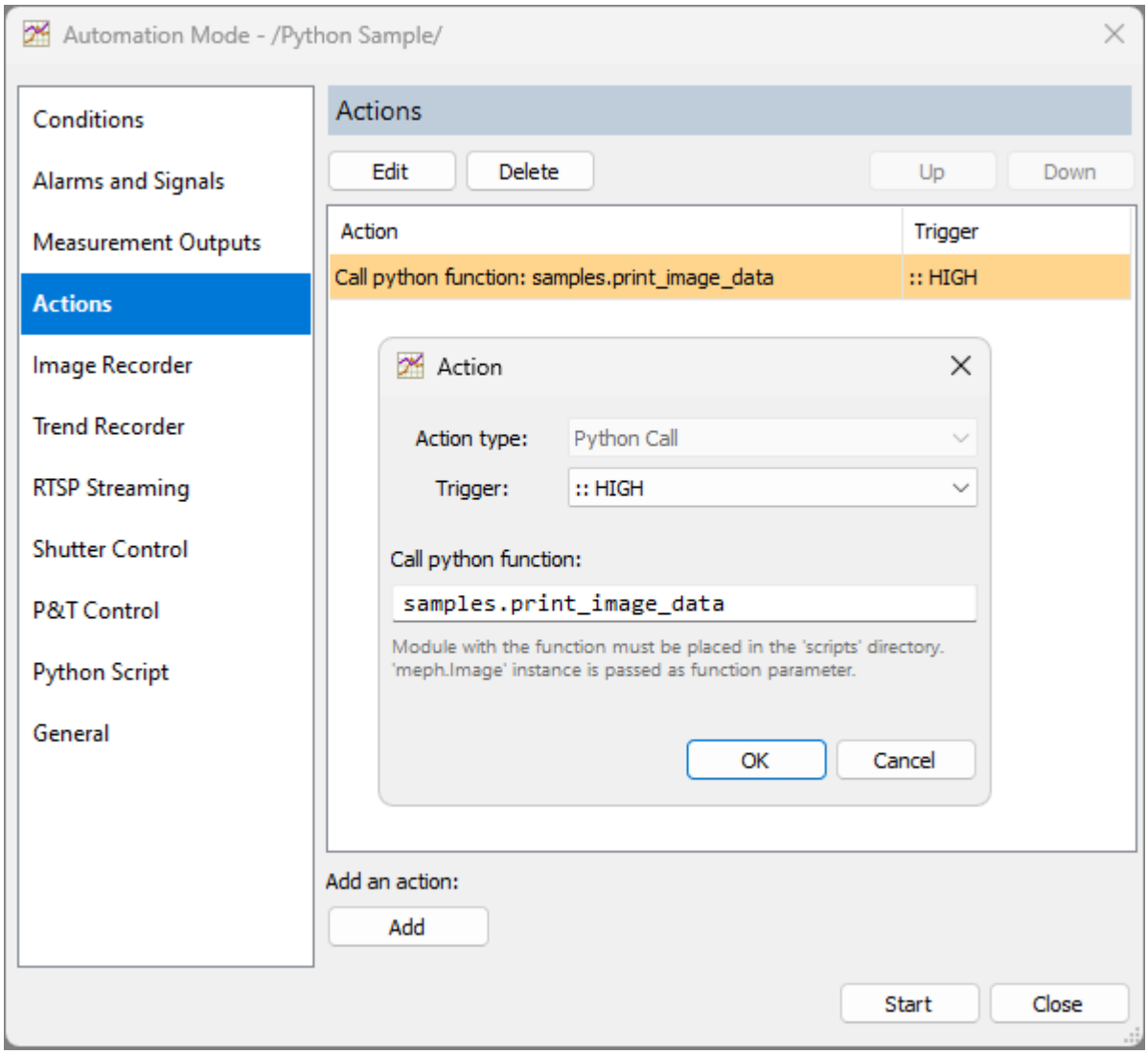
- **print_image_data**: A function callable as an action, which prints current image measurements to the Messages Window.
- **send_to_influxdb**: Demonstrates storing measurements in an InfluxDB database.
- **start_daemon, stop_daemon, daemon_thread**: Showcases running Python code in parallel and setting up Python automation conditions.

Python Actions

Actions in IRT Analyzer are triggered when a specific condition is met. To create a Python Script action, open the Automation Mode setup dialog, select the Python Script tab, and press the 'Add' button. Choose either 'Python Call' or 'Python Script' as the Action type.

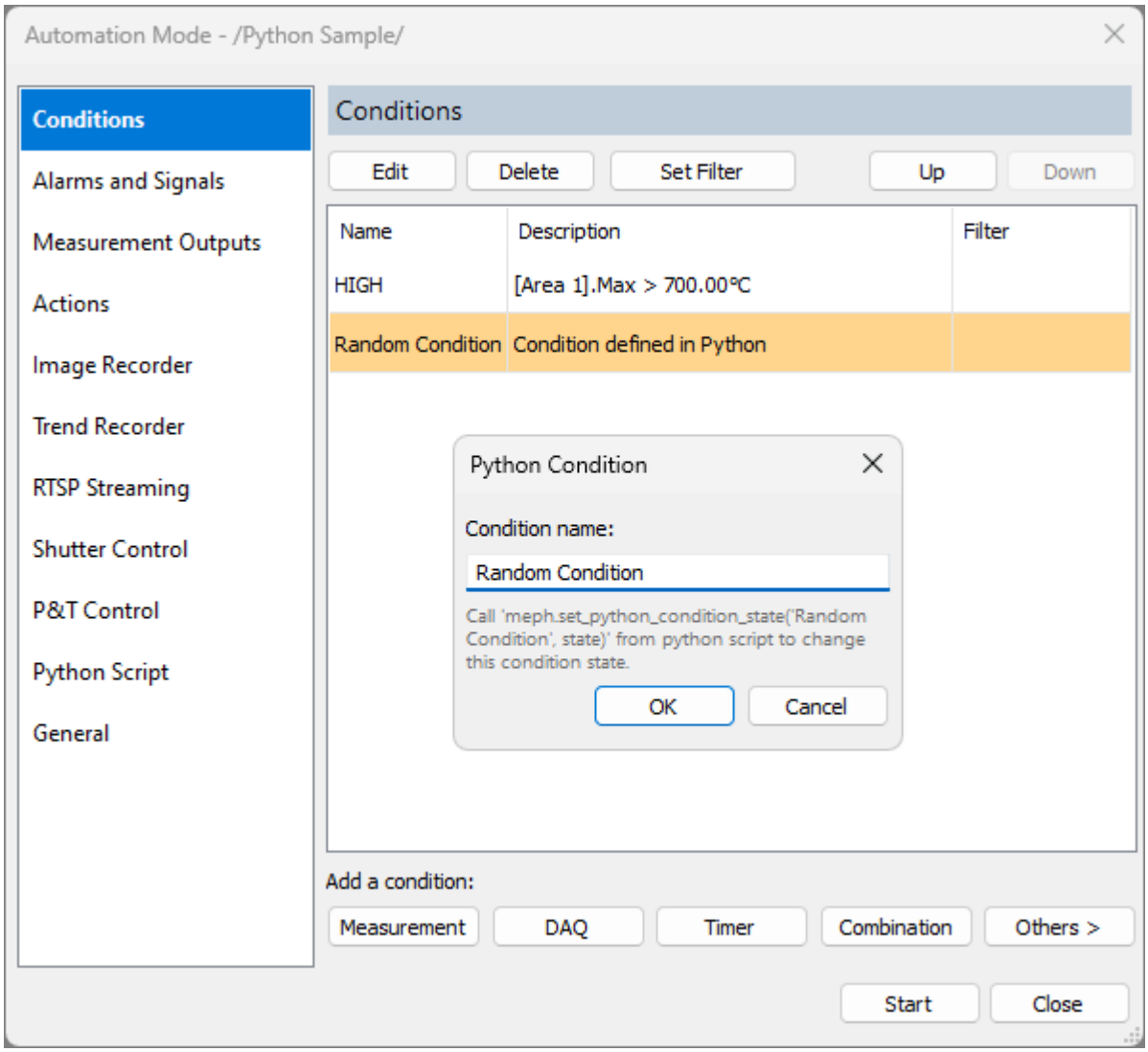
- **Python Call**: Calls an existing Python function by name. The function must be defined in the Startup script or in a module imported therein.
- **Python Script**: Allows entering a script that executes when a trigger is activated.

When a Python Call function is triggered, it receives one parameter of type **'meph.Image'**. When a Python Script is triggered, a **'meph.Image'** object is passed as a local variable named **'img'**.



Python Conditions

To add a new condition controlled by a Python script, go to the Conditions page and click the **Python** button under 'Add a condition'. After naming the condition, you can control its state within your Python code using the **'set_python_condition_state(condition_name, state)'** function.



Running Python Code in Parallel

For automation conditions dependent on external processes or devices accessible from your Python script, you may need to run Python code in a separate thread or process. This is typically started in the Startup script. In this separate thread, you can subscribe to events from your process/device and update the IRT Analyzer Python automation condition using **'set_python_condition_state()'**.

Refer to the **'daemon_start'**, **'daemon_stop'**, and **'daemon_thread'** functions in the **'samples.py'** module for an example of this approach.

Classes and Functions

Classes and functions for accessing IRT Analyzer objects, such as images and measurements, are defined in the **'meph'** module. This module is imported automatically, providing access to its classes and functions in all scripts.

The **'meph'** module includes the following classes:

- Image
- Spot
- Line
- Area
- Metadata
- AutomationState

Additionally, the **'meph'** module provides functions such as **'set_python_condition_state'** for automation control, and logging functions like: **'system_log_info'**, **'system_log_warning'**, **'system_log_error'**, and **'system_log_set_error_state'**.

For details please check the source code in **'PyProcessControl\embedscripts\meph.py'**.

5.17 Multiple IRT Analyzer instances

When you have multiple image streams, it is not always convenient to process them in the same window as was suggested in Multi-camera acquisition topic.

Another possibility is to run additional IRT Analyzer instances which will work independently:

- IRT Analyzer will properly remember your settings in each instance, they will not overwrite each other.
- Each instance of IRT Analyzer will remember its own camera connection.
- Each instance will use its own acquisition project, with own automation configuration.
- It is possible to configure IRT Analyzer to automatically open additional instances when first instance is started. See Autostart dialog.

Limitations

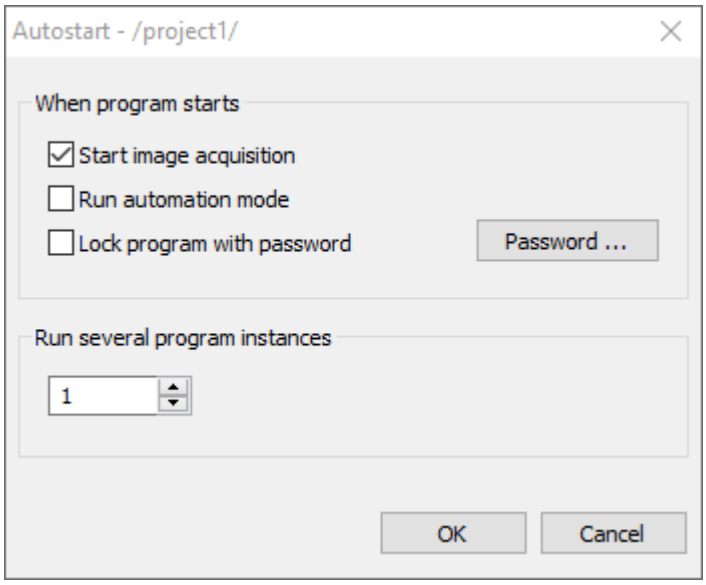
- Two instances cannot connect to the same camera at the same time.
- Each instance should use its own DAQ device, otherwise one instance can change settings and port values set by the other instance.

It is recommended to use several monitors, one IRT Analyzer instance per monitor.

5.18 Autostart

It is possible to start acquisition and automation mode automatically when program is started.

To enable such behavior, select **'Automation | Autostart'** in the main menu.



- **Start image acquisition**: when program starts it will automatically connect to the last used camera, start image acquisition, and load analysis collection saved to the project.
- **Run automation mode**: after starting image acquisition, program will run the automation mode.
- **Lock program with password**: already after start, program will be locked with a password, so not authorized people are not able to change configuration (they are only allowed to start the program in case of a breakdown).

Run several program instances

When more than 1 instance is selected, additional instances of IRT Analyzer will start automatically together with the first instance. Each instance will use its own configuration. See Multiple IRT Analyzer instances topic for details.

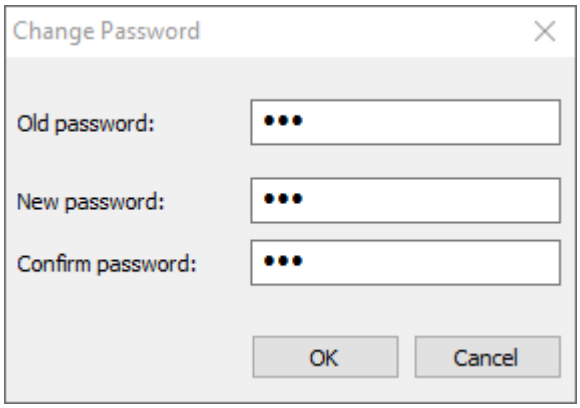
Autostart settings are saved in the project, so when you change some setting and want it remembered, do not forget to also save the project using **'File | Save Changes'** command or the corresponding button in the toolbar.

Number of program instances is not remembered in the project (as every program instance has its own project). It is remembered in the registry.

5.19 Password lock

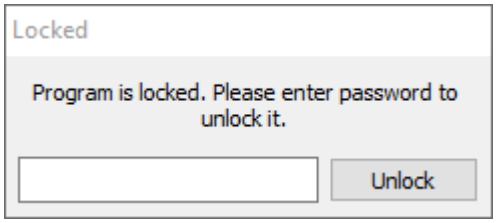
It is possible to set a simple password lock which will block access to the program.

To set/change password use main menu **'Window | Change Password'**.



When password is set, you will see an additional button in the toolbar: . Press this button (or use main menu **'Window | Lock'**) to lock the program. There is also *Ctrl+Alt+L* key combination.

When the program is locked this small window is shown:



This window blocks access to the main window and it is not possible to do anything with the program without entering the correct password.

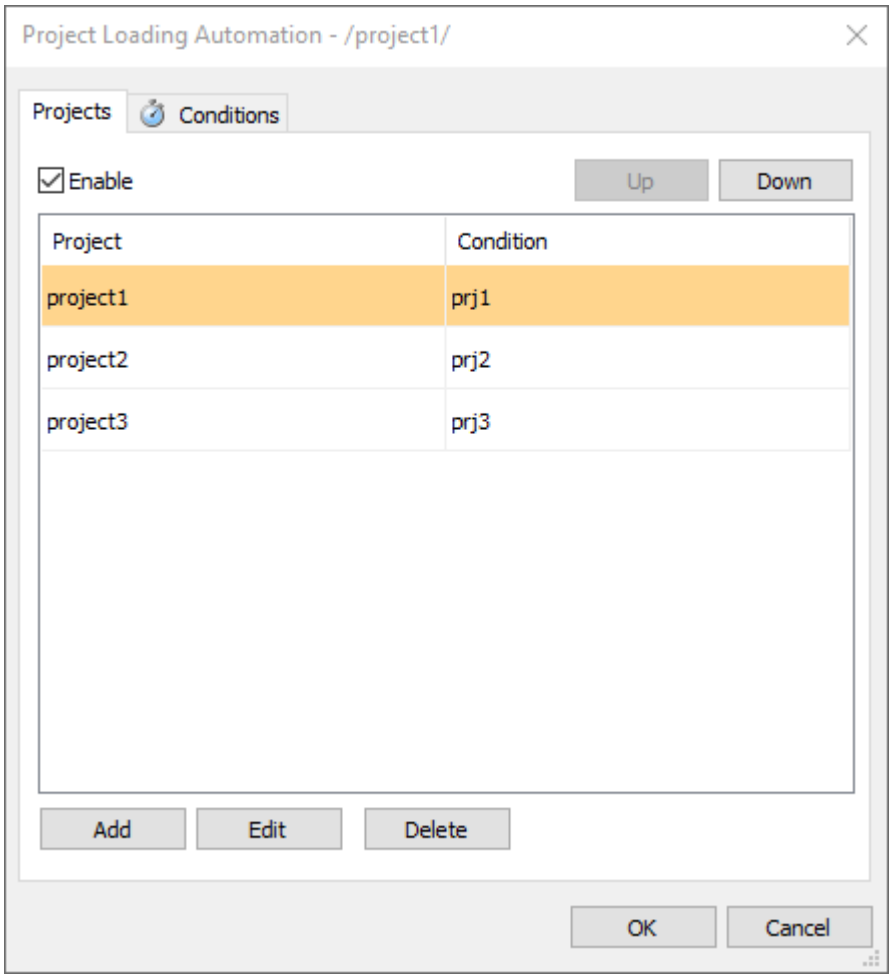
Forgot password?

To clear the password in case it is forgotten:

1. If IRT Analyzer is locked, close it with the help of Windows Task Manager.
2. Delete this key in the registry: HKEY_CURRENT_USER\Software\Fluke\Mephisto 7.0\CONFIG\Password.

5.20 Project loading automation

Acquisition projects can be automatically loaded by external events or by timer. To setup which projects should be loaded use main menu **'Automation | Project Loading'**.



External events that trigger projects loading are defined by conditions. Conditions are specified in the same way as conditions in the Automation mode, but a separate set of conditions is used. Click **'Conditions'** tab to create conditions for project loading.

Notes

1. Project loading uses its own set of conditions, not the conditions from the automation mode. Temperature conditions cannot be used to load projects.
2. The project loading list and conditions can be shared between projects with the help of master project.
3. Project loading is active only when automation mode is active.
4. If several project conditions are true simultaneously, project which is upper in the list will be loaded.
5. If a project condition is true for a period shorter than two seconds, it may not be recognized by the program.

Project loading by a TCP/IP command

It is also possible to change currently loaded project using a TCP/IP (Telnet) connection.

IRT Analyzer can run Telnet server and listen to commands. By default, port 23 is used. Telnet server is disabled by default and can be enabled in appconfig.ini file located in the program installation directory.

```
[TelnetServer]
Enabled = 1
Port = 23
```

When multiple program instances are used, Telnet server of each instance should use its own port number. To specify a different port number for the second instance create ini file named appconfig2.ini and add [TelnetServer] section with a different port number there.

A command is a text string trailed by <CR><LF>. IRT Analyzer answers each command with a response code and a text description. If command is not recognized the response is "400 Unknown command".

Supported commands:

list projects : outputs list of available projects.

Response: list of available project names separated by <CR><LF> followed by "200 OK"

load <project name> : stops currently running project and loads project with <project name>, starts image acquisition and runs the automation mode (if configured).

Response:

"200 The File has been successfully loaded." in case of success.

"404 File Not Found" if project with the specified name does not exist.

"500 Project loading failed." when an error is encountered during project loading. This response is followed by a more descriptive error message that explains the failure.

stop automation : stops automation mode and disconnects from the camera.

Response: "200 Automation mode stopped."

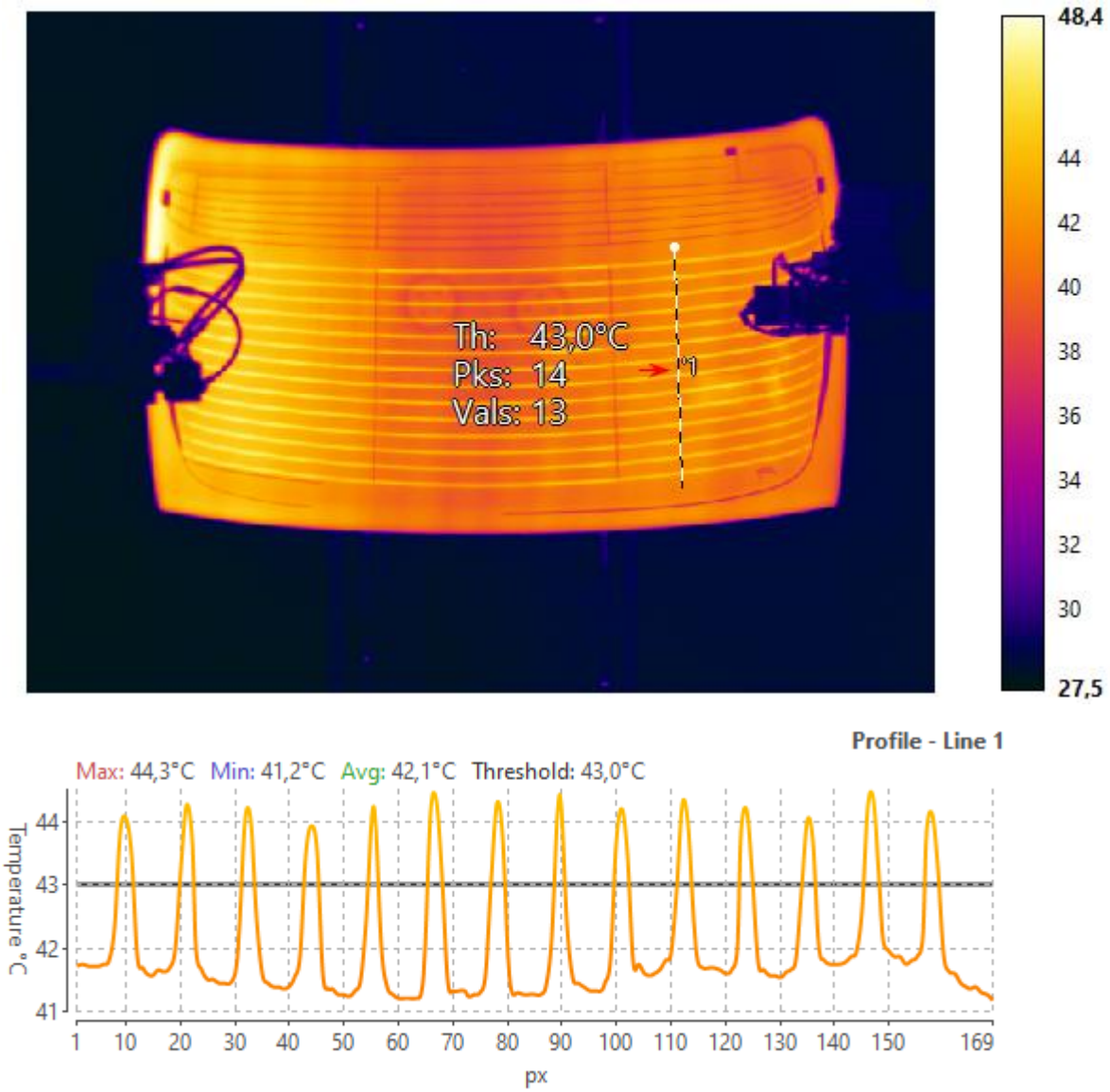
A client program to test project loading

Any program that can connect to TCP/IP port in text mode can be used to test, for example, **Telnet Client** program (delivered with Windows, should be enabled in Windows features).

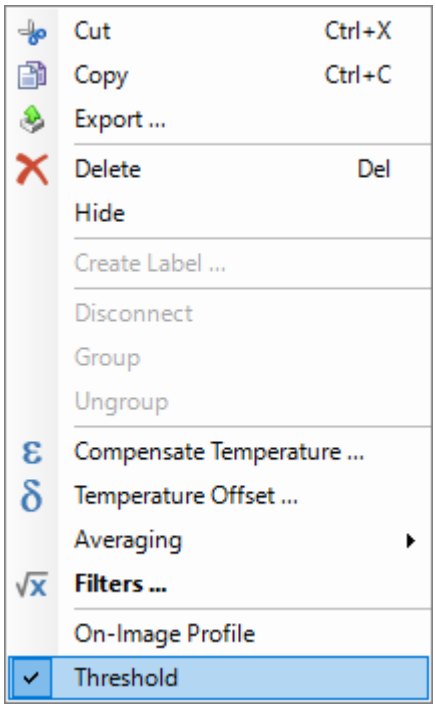
5.21 Profile peaks and valleys counter

It is possible to set a threshold for a line object and count the number of peaks (continuous profile sections above the threshold) and the number valleys (sections below the threshold).

For example, using peaks and valleys counter in the image below we can count the number of hot strings. Only full peaks and valleys are counted (each peak or valley must cross the threshold line twice). In our example there are 14 peaks and 13 valleys.

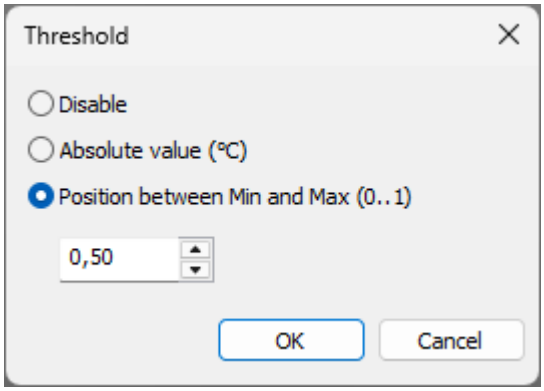


To set a threshold for a line object, click with the right mouse button on the object and select **Threshold** in the context menu. After that peaks and valleys are counted automatically and you can display them by selecting corresponding properties in the object label settings. Peaks and valleys counters can be also used in automation conditions.



Threshold can be set as an absolute temperature value.

Or alternatively as a relative value that will be calculated from the current line minimum and maximum: Threshold = (1-P) * LineMin + P * LineMax.



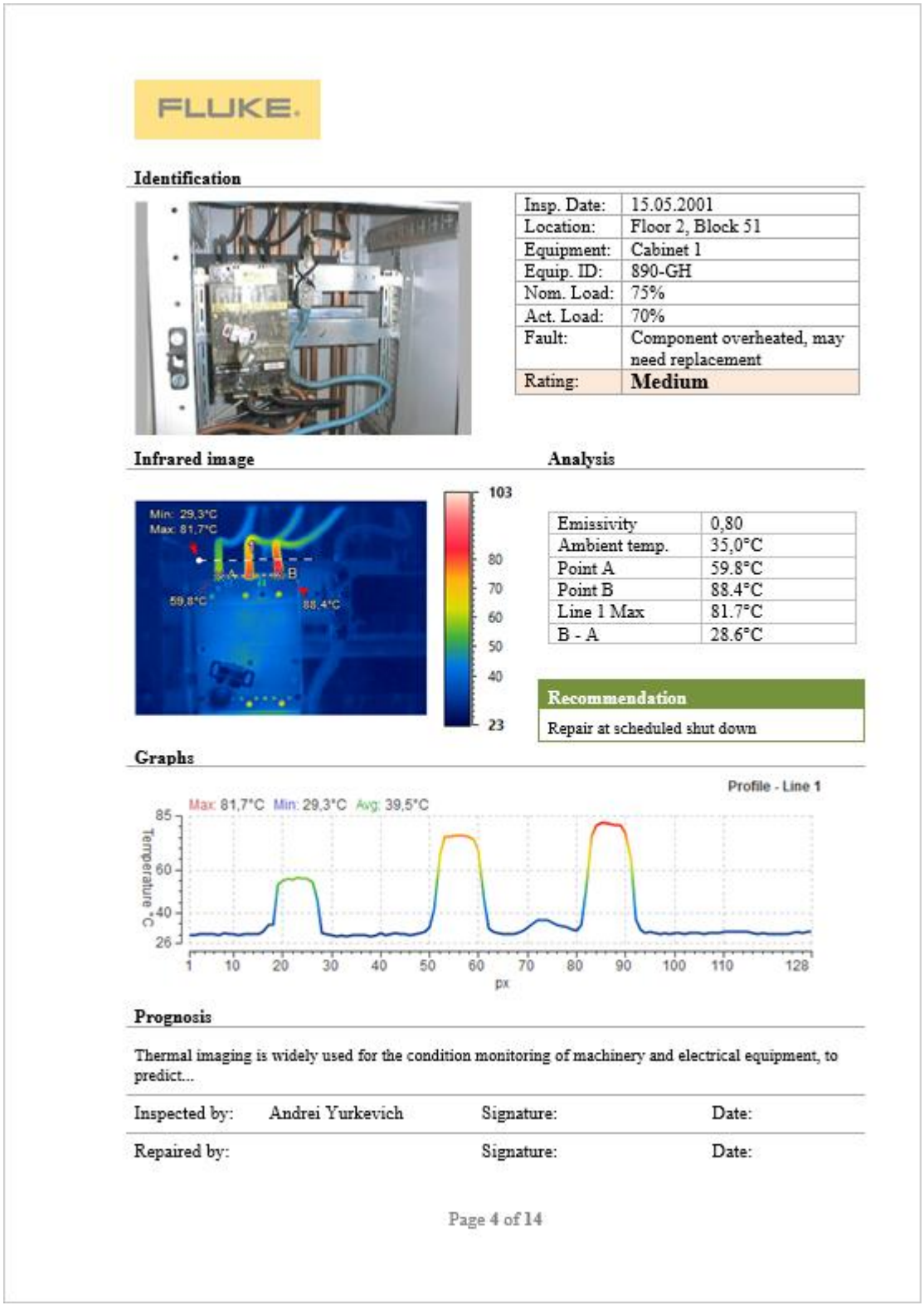
6 Reports

6.1 Reports in Microsoft Word

IRT Analyzer can generate reports in the format of Microsoft Word documents.

Important: To generate a report you need Microsoft Word installed on your computer. All versions since Office 2003 are supported, both 32 and 64 bit. If you use Office 365 it must be installed locally on your PC, not in the cloud.

Infrared images with thermal analysis, linked to them visual images and comments are stored and handled in IRT Analyzer. When a report document is created, it gets linked with IRT Analyzer and can import pictures and data from it. Using tools from *Thermo Reports* tab you create special *placeholders* that are automatically filled with data from IRT Analyzer.



FLUKE.

Identification

Insp. Date:	15.05.2001
Location:	Floor 2, Block 51
Equipment:	Cabinet 1
Equip. ID:	890-GH
Nom. Load:	75%
Act. Load:	70%
Fault:	Component overheated, may need replacement
Rating:	**Medium**

Infrared image

Analysis

Emissivity	0,80
Ambient temp.	35,0°C
Point A	59.8°C
Point B	88.4°C
Line 1 Max	81.7°C
B - A	28.6°C

Recommendation

Repair at scheduled shut down

Graphs

Prognosis

Thermal imaging is widely used for the condition monitoring of machinery and electrical equipment, to predict...

Inspected by:	Andrei Yurkevich	Signature:	Date:
Repaired by:		Signature:	Date:

Page 4 of 14

Resulting report is a single file in the widely spread Microsoft Word format, which can be easily sent to a customer or converted into another form, for example PDF. Pictures, diagrams and data in a report are active. This means that at any time if you find a mistake, you can return the picture with the analysis back to IRT Analyzer for correction.

To speed up report creating you can use *templates*. Templates are predefined report documents with placeholders not filled with any data. During automatic report generation templates are filled with real data, image by image, page by page, and you get a ready report. You can use templates provided with IRT Analyzer or prepare your own templates.

There are two methods to create a report:

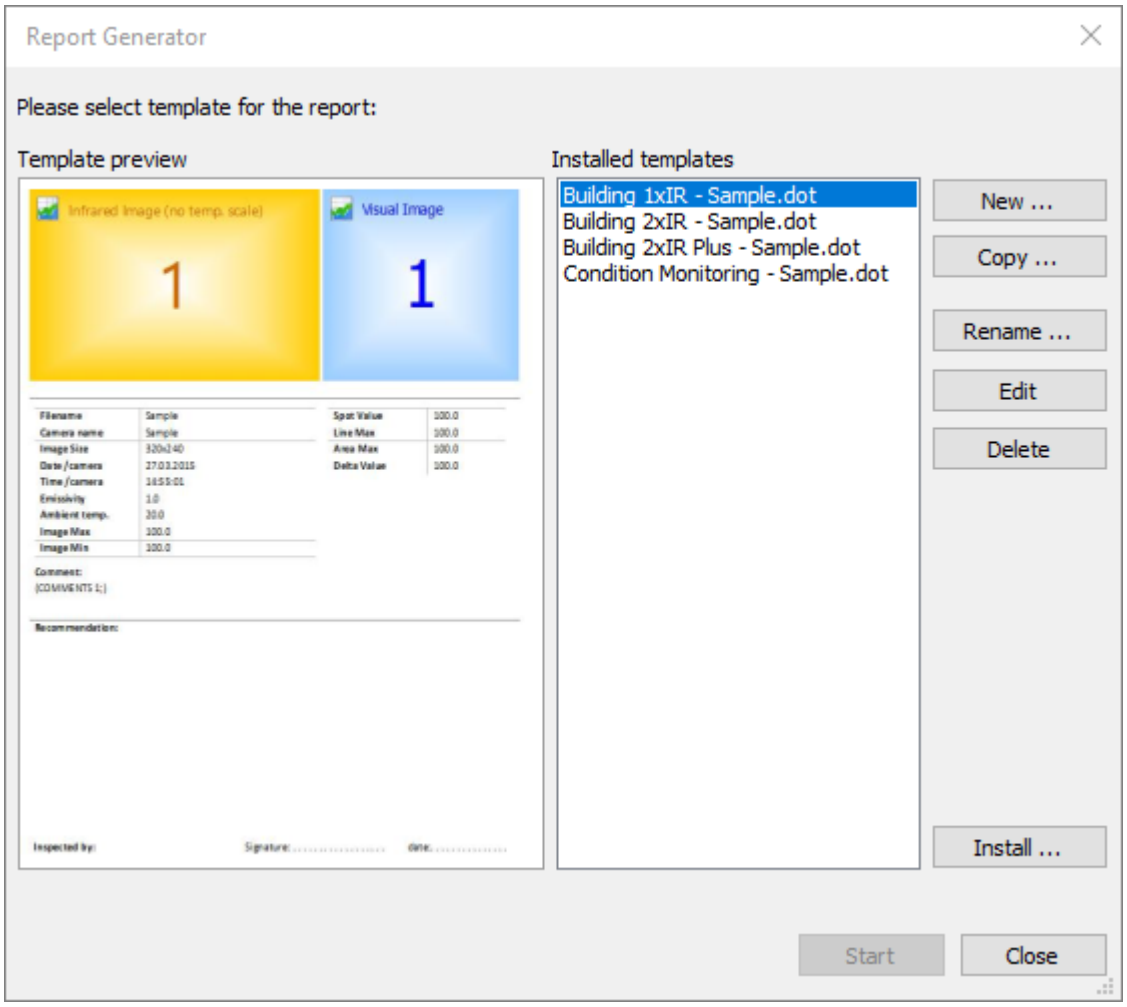
1. **Automatic generation of reports using templates**. This is the fastest method of report creation, it suits well when you need to create a report having many similar pages. Please take into account that template based report generation is designed for "individual images" analysis. This is when each image contains a different object and is independent from the others. If you have an infrared video, generating a report with a template will produce many pages, each page showing a video frame. This is not what you normally would need.
2. **Manual report creation method:** creating a new or editing an existing document, periodically inserting pictures and analysis data. You will import and place every picture/diagram/data separately in this case. The advantage is that it does not require a prior created report template. This method can be used when you need to edit an already existing report.

6.2 Generating reports using templates

To generate a report using a template, you should have a report template available. Use one of the templates included with IRT Analyzer or create your own (see Custom report templates for details).

> Please note that template based report generation is designed for "individual images" analysis. This is when each image contains a different object and is independent from the others. If you have an infrared video, generating a report with a template will produce many pages, each page showing a video frame. This is not what you would normally need.

Before creating a report, you need to prepare your infrared images - open all images as a sequence in Individual image analysis mode, create necessary analysis objects and edit comments for each image. Your analysis and comments will be saved with each infrared image. When everything is prepared, select main menu **'Tools | Multi-Page Report'** to show template selection dialog:



Select needed template and press **Start** button. IRT Analyzer will go through all infrared images in the sequence and export them into the report. Now your report is ready! It is opened in Microsoft Word, you can change whatever you need and save the document, specifying the location where to save it.

Before starting report generation, you can select quality for exported images.

6.3 Image quality settings

When IRT Analyzer exports images to Microsoft Word it has several possibilities to prepare images. They can be of higher or lower resolution and their format can be different.There are two options available in the IRT Analyzer for image export and you can choose what suits you better.

To show settings for export to reports in IRT Analyzer click on '**File | Settings**' item in the main menu, then select '**Reports**' tab.



On-screen quality

Images and graphs are copied in the same resolution as you see them on screen in bitmap format. As implies from the name, this option is better for documents that will be viewed on screen, not printed. File size of the resulting document is smaller than when the printing quality is selected.

Printing quality

Image analysis objects and graphs are copied in a vector format (EMF). This option is better for documents that will be printed or viewed on high DPI screens. Resulting file size is larger.

Background color

You can change background color of exported graphs and of infrared images (temperature scale background). By default the color is white, you can make it, for example, gray. If you make background color too dark, you will not be able to read text as it still stays black.

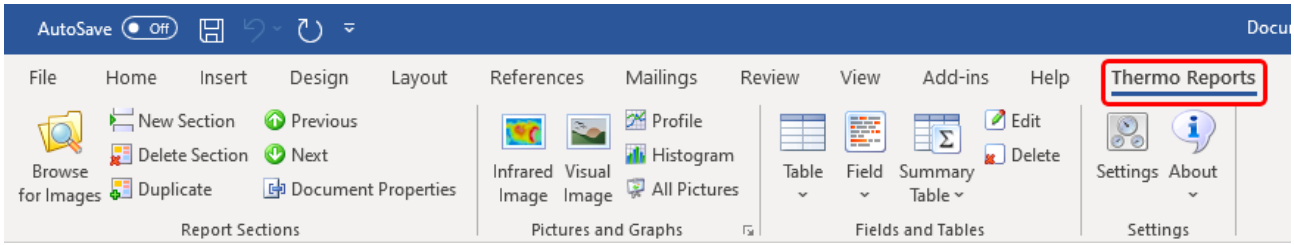
Same settings can be accessed from Word document when you use '**Settings**' in Thermo Reports toolbar.

New settings are not applied automatically to images already exported to a report - you need to regenerate the report or update each image manually.

6.4 Editing generated reports

After IRT Analyzer has generated the report, you, most likely, will want to check it or make additional comments. You should feel free here, as the generated report is a usual Word document and you can use all the Word features. For example, you can type some more text, change formatting, draw an arrow connecting the problem zones at the infrared and visual images and so on.

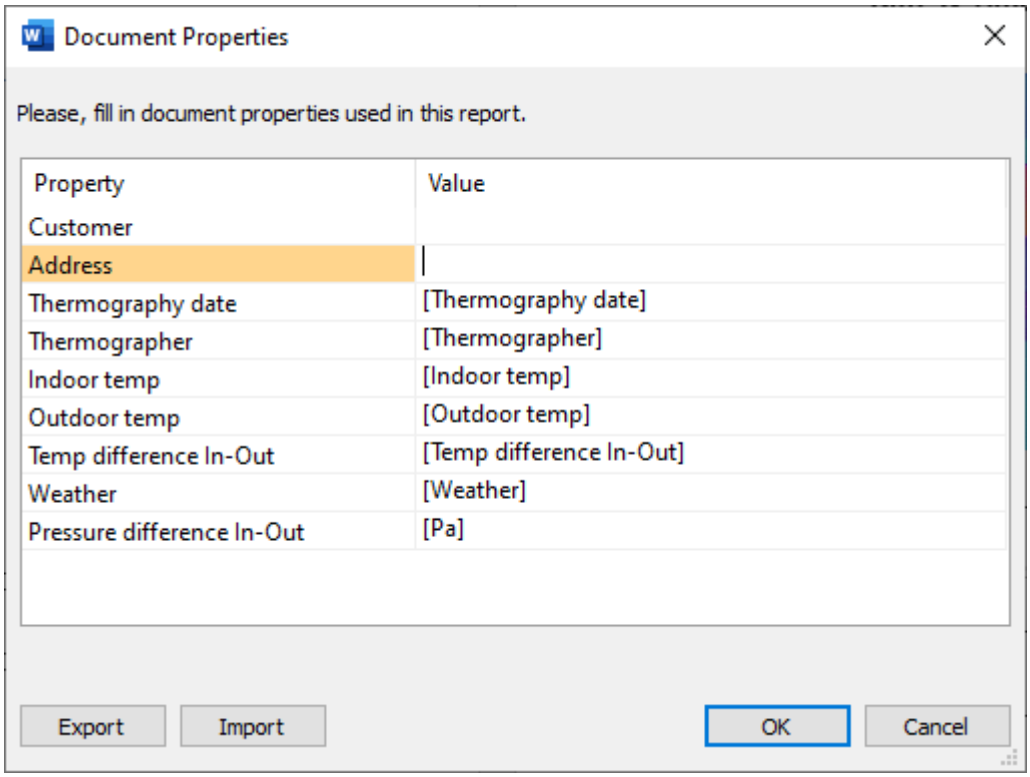
IRT Analyzer adds its own *Thermo Reports* toolbar into Microsoft Word. This toolbar is designed to help you performing report creation tasks.



For more information, see Thermo Reports toolbar.

Document properties

If template contains Document Properties, after report is generated you will need to fill them.



You can also change document properties at any time later. Click on **'Document Properties'** button in the Thermo Reports toolbar,

Correcting mistakes

If you have noticed, that some of the information is not correct (or not full) and changes are required, do not worry, you do not need to recreate the complete report again. Links to the original images and corresponding analysis collections are stored together with the document. You just need to send the IR image you want to change to IRT Analyzer, make necessary corrections and then apply the changes back into the report.

To edit an image or a diagram or any data imported from IRT Analyzer:



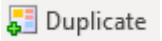
1. Place the cursor (click) on an image, a diagram or a text field you want to change.
2. Press the **'Browse for Images'** button in the Thermo Reports toolbar. IRT Analyzer will open with the corresponding IR image loaded for additional analysis.
3. Make needed corrections in IRT Analyzer, press **'Apply'** button in the **'Switch to Report'** toolbar to apply the changes. (Press **'Close'** button to return to Word ignoring the changes.)



Inserting a new infrared image

Sometimes you need to extend the report with data of an additional infrared image.

To add one more infrared images into the report:



1. Choose a place where you want to insert a new image by placing the cursor there.

2. Press **'Duplicate'** button in the **'Report Sections'** group of the Thermo Reports toolbar to insert a new section (an empty copy of the template). A new section will be added after the current one.
3. Click on the infrared image placeholder (the rectangle marked with caption 'Infrared Image') and press the **'Browse for Images'** button in the Thermo Reports toolbar. This will open IRT Analyzer.
4. In IRT Analyzer: open needed IR image, make the analysis and click **'Apply'** button in the **'Switch to Report'** toolbar.

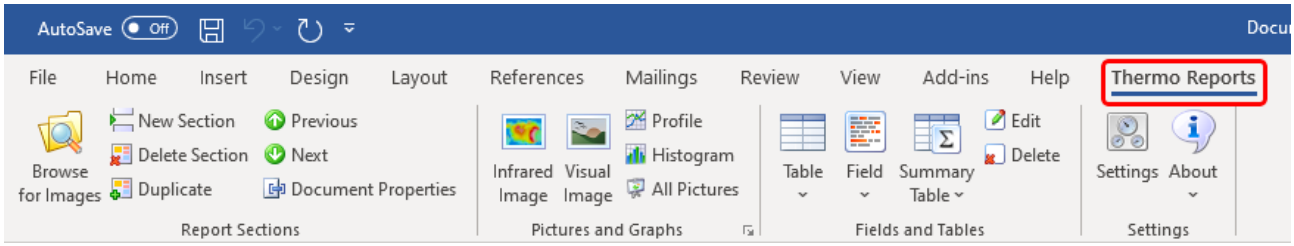
Deleting an image



Click the image you want to delete and press **'Delete Section'** button in the **'Report Sections'** group of the Thermo Reports toolbar. Current section with infrared image will be deleted from the report together with the information attached to this image.

6.5 Thermo Reports toolbar

For you to be able to edit generated reports and to create new templates IRT Analyzer adds Thermo Reports toolbar to Microsoft Word.



If you cannot find Thermo Reports toolbar in your Word, please see Troubleshooting reporting problems.

Report Sections

Sections are used to separate report header/footer pages from the pages with images and inspection data imported from IRT Analyzer.

- **'Browse for Images':** opens IRT Analyzer so you can select IR image to fill current section if it is empty. If current section is not empty, this command opens IR image stored in the section for editing. See Editing generated reports for details.
- **'New Section':** adds a new section to the document. Sections are used to separate IR images and to link them with graphs and tables. In templates, section with an IR image placeholder defines document part that is duplicated for every reported image.
- **'Delete Section':** deletes the current section.
- **'Duplicate':** creates a new section (page) at the current position and copies section layout from the previous section. Use this command to insert new image and inspection data.
- **'Previous/Next':** jumps to the previous or to the next section in the document.
- **'Document Properties':** displays a dialog to change values of the document properties.

Pictures and Graphs

With the help of Pictures and Graphs group you can create picture *placeholders*. Placeholders are special objects that mark places in the document where infrared or visual images, profiles or histograms will be placed.

- **'Infrared Image':** inserts infrared image placeholder at the current position. Double click on the inserted picture to load data to it. If used in a template, report generator will replace this placeholder by an infrared image.
- **'Visual Image':** inserts a visual image placeholder at the current position.
- **'Profile':** inserts a profile graph placeholder. Graph will be drawn only when the source infrared image contains line objects. Second profile placeholder in the same section will use the second line object from the image.
- **'Histogram':** inserts a histogram graph placeholder. Graph will be drawn only when the source infrared image contains area objects. Second histogram placeholder in the same section will use the second area from the image.
- **'All Pictures':** allows to insert other placeholders supported by IRT Analyzer (not all available placeholders have buttons in the toolbar).

Fields and Tables

Fields and Tables are similar to placeholders, only they are replaced not with pictures but with text information.

- **'Image Info':** inserts a table which is automatically filled with infrared image properties information. You can select what data will be show in the table.
- **'Analysis Info':** inserts a table which is automatically filled with data taken from analysis objects (e.g. spot temperature values). You can select what data will be show in the table.
- **'Notations':** inserts a table which is automatically filled with notations (not supported by IRT Analyzer). You can select what data will be show in the table.
- **'Insert Field':** inserts a text field which will be replaced by a text value (image date, temperature at a spot, formula result, etc.).
- **'Insert Document Property Field':** inserts a document property field - a text field that takes its value from the Document Properties.
- **'Formulas':** displays formulas stored in the document. Formulas are mathematical calculations based on infrared image measurements.
- **'Link Notations':** by linking a notations set, you will be able to insert image notations from this set as Fields and Tables.
- **'Insert Summary Table':** inserts a summary table. Summary table shows information about all measurements in the report (one row per each IR image).
- **'Update Summary Table':** updates contents of a summary table. When you add new data to the report or modify some data the summary table is not updated automatically, you need to update it by pressing this button.

- **'Edit':** changes properties of the active report element (placeholder, field or table).
- **'Delete':** deletes active report element (placeholder, field or table).

Settings

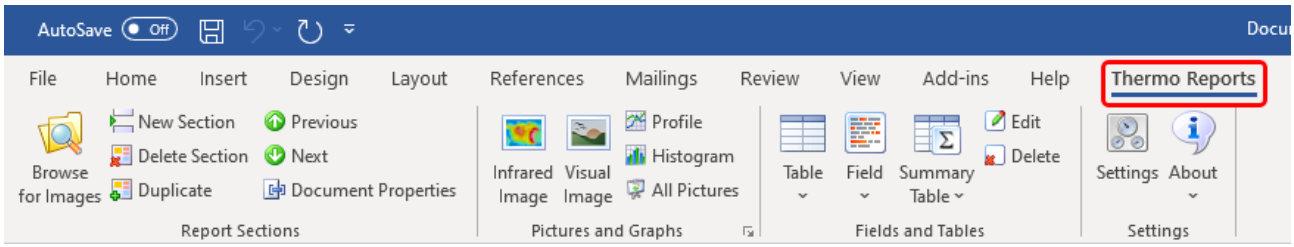
'Settings': allows to select general properties of the report document: type of section breaks (page or continuous), imported pictures format parameters (like image quality optimization - screen or printing) and some parameters for drawing diagrams.

'About': gives information about the company and the product.

6.6 Manual report creation method

This method does not require use of report templates. You open a new document in Microsoft Word and edit it just as you edit any other document. IRT Analyzer provides images, graphs and data for your document.

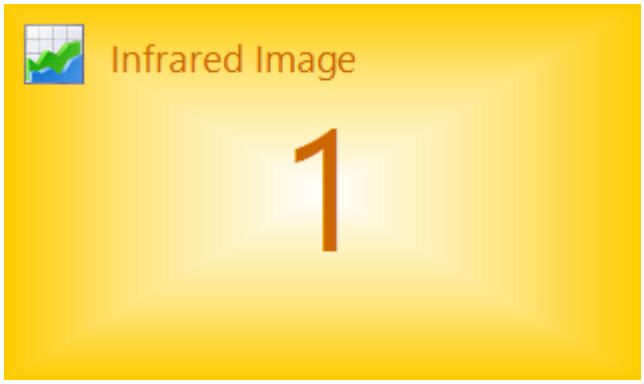
Images and data are imported from IRT Analyzer with the help of **'Thermo Reports'** toolbar. See Thermo Reports toolbar topic for reference.



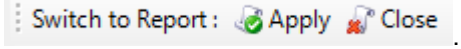
Infrared image

You should start with putting an infrared image into your document. If infrared image is not present in the document (more precisely - in the current section), you will not be able to import other images and data.

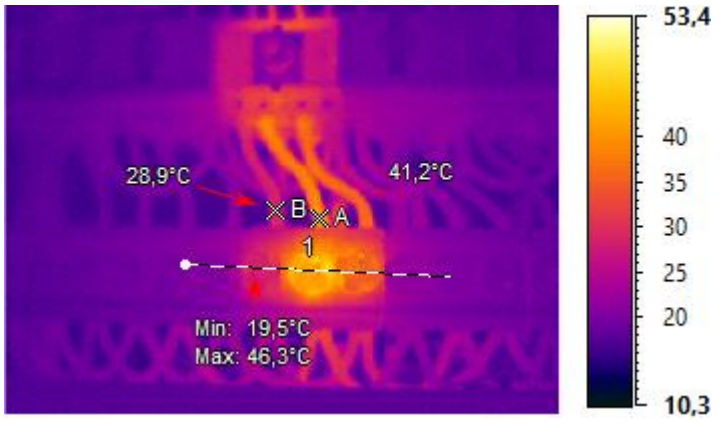
To insert an infrared image to the document, move the caret to the position where you need the image and click on **'Infrared Image'** button in the Thermo Reports toolbar. This will add an empty infrared image placeholder to your document.



Now you can fill this placeholder with an actual image. Double click on the placeholder to open IRT Analyzer. In IRT Analyzer open an infrared image, click **'Apply'** button in the **'Switch to Report'** toolbar



. This will transfer infrared image with analysis data to your Word document.



If you double click on a placeholder filled with an infrared image, its contents is opened in IRT Analyzer. You can modify the image (like change temperature scale, change analysis objects). Press '**Apply**' in 'Switch to Report' toolbar to update the data in the document.

Temperature scale

You can select not to show temperature scale on an infrared image drawing. To select this option, click on the infrared image once to make it selected and press '**Edit**' in Thermo Reports toolbar. Remove mark from '**Include temperature scale**' check box.

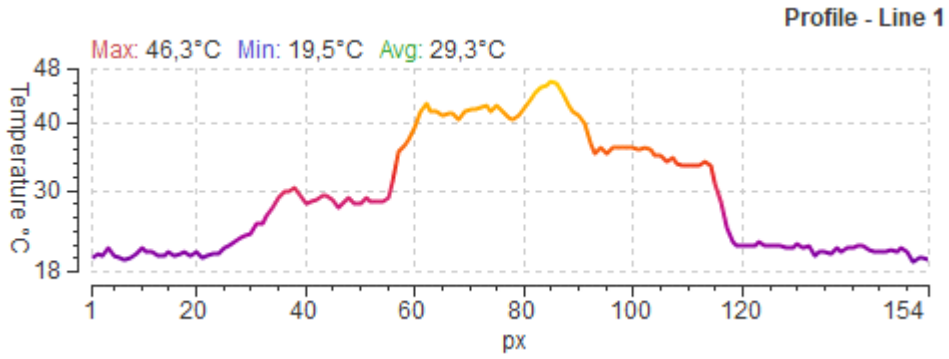
> **Note**
>
> The source infrared image is not stored inside Word document, only a link to the image on disk is stored. When you double click on an infrared image placeholder IRT Analyzer uses the link saved with the placeholder to load the data.
>
> This means that if you (or another person) open the document on a computer that does not have access to the original images, it will be not possible to change how the image looks or change its analysis objects.

Graphs

Profile or Histogram

After you inserted an infrared image into your document, you can insert graphs related to this image. Move the caret to the position where you need the graph and click on **'Profile'** or **'Histogram'** button in Thermo Reports toolbar. Please note that your infrared image should already contain the needed analysis object (a line for profile graph, an area for histogram).

The first graph will display data for the first object. If you insert a second graph, it will take data from the second object, and so on. It is not possible to specify which object should provide data for a graph - graphs select their objects automatically.



To modify graph data you need to change corresponding object in the infrared image. Double click on the infrared image to open it in IRT Analyzer and change the object there.

Visible image

Visible image saved with the infrared image can be inserted in the same manner: use '**Visual Image**' button in Thermo Reports toolbar.

Other graphs

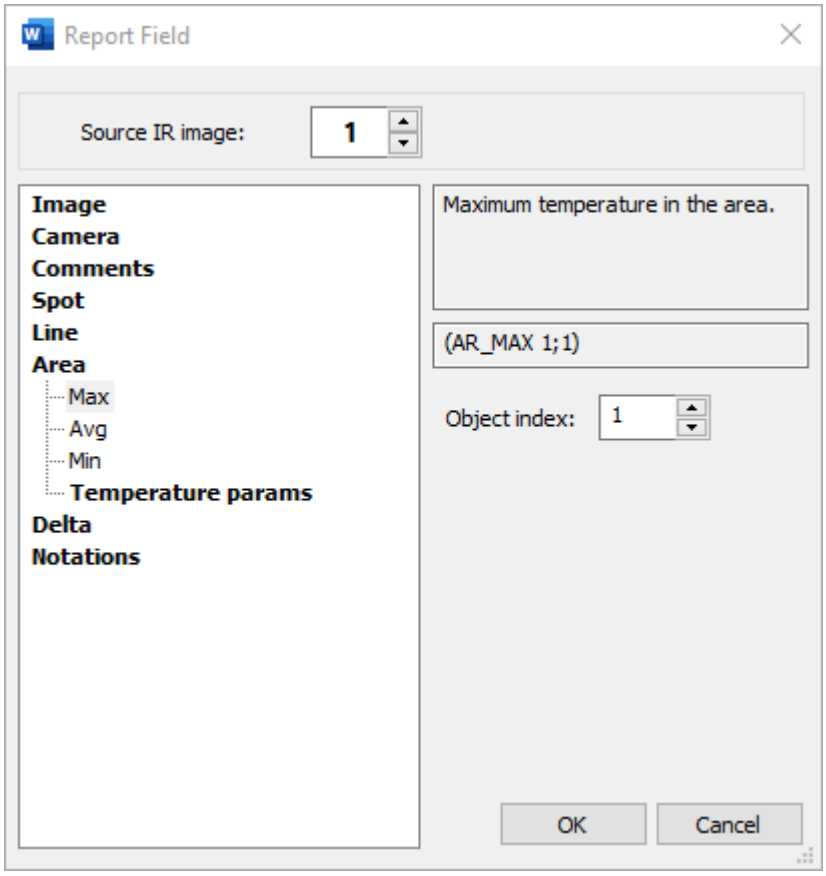
IRT Analyzer supports several other graph types, for example, trends. There are no individual buttons in Thermo Reports toolbar for each graph, but you can use '**All Pictures**' button to show dialog with a list of all supported image placeholder and use any of them.

Fields

Measurement data, like spot temperature values, and other text data, like image date and time, can also be easily added to your document. *Fields* are used to show such information. There are standard fields supported by Word, for example page number field, and there are special "thermo" fields handled by IRT Analyzer.

To insert a "thermo" field to your document, use '**Field**' button in Thermo Reports toolbar (new field will be inserted at the caret position).

Field selection dialog:



For analysis objects like spots or areas you need to select object index.

When you place the caret in a field placeholder in the document its background becomes gray: 81.7°C. In other regards it is a normal text, you can change its style (font, color) as you wish.

Changing a field

If you want to modify a field, place the caret in a field and click on '**Edit**' button in Thermo Reports toolbar. It, naturally, works only for fields created with Thermo Reports toolbar.

There is 'Edit Field' item in the context menu of a field, you do not need this one. It opens Word's field dialog, it is not useful for "thermo" fields.

Deleting a field

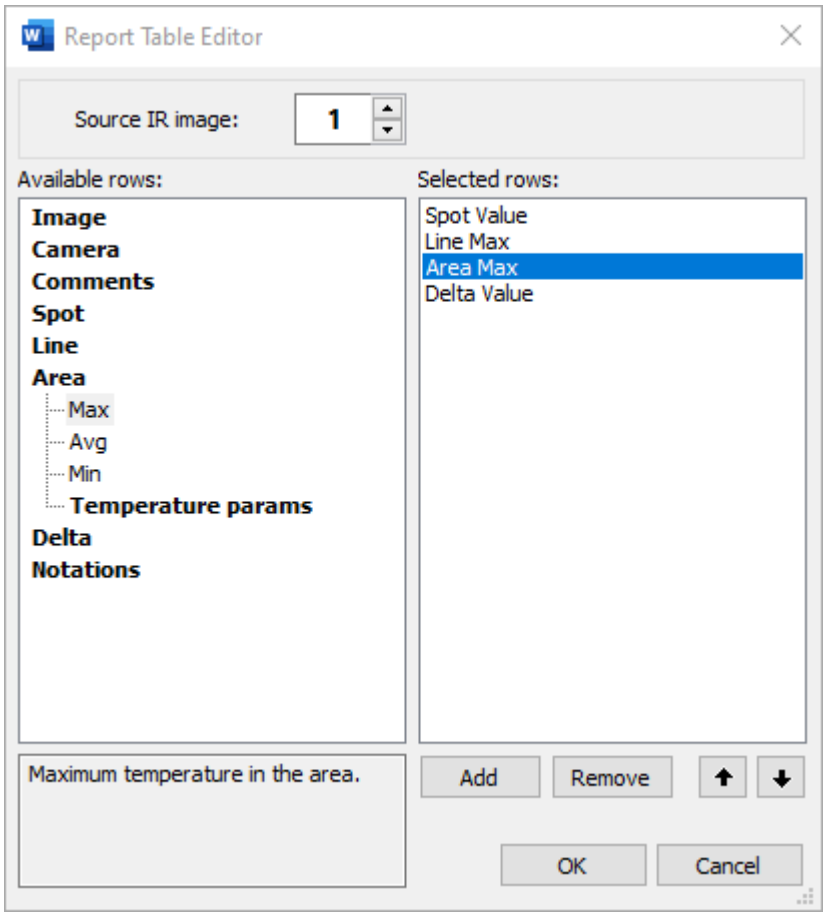
To delete a field created with Thermo Reports toolbar, place the caret in a field you want to delete and click '**Delete**' in Thermo Reports toolbar. You can also delete fields just as you delete any other text with Delete or Backspace keys.

Tables



With fields you can display any text information provided by IRT Analyzer. But often there is lot of such information needed in your document. *Tables* in IRT Analyzer reports organize fields into tables. Also tables help when you do not want to care about how many analysis objects there are on the image - when you add or delete an object, corresponding rows will be automatically added or removed from the table.

Use '**Table**' button in Thermo Reports toolbar to create a table. There are three types of tables: '**Image Info**', '**Analysis Info**' and '**Notations**'. 'Image Info' and 'Analysis Info' tables are similar, the only difference is the preselected rows that are present in the table by default (and you can change them). Notations table is different, it is automatically filled with all notations saved with an infrared image. See Notations in reports for more details.



You need to select rows that will be present in the table. Please note that for analysis objects, you do not need to specify object index - if there are more than one object, they all will be added to the table automatically.

Here is how a new table looks like by default:

Point A	59.8°C
Point B	88.4°C
Line 1 Max	81.7°C
Line 1 Min	29.3°C

And here is how it can look with formatting applied:

Point A	**59.8°C**
Point B	88.4°C
Line 1 Max	81.7°C
Line 1 Min	29.3°C

Formatting will not be lost when table is refilled after source image analysis changes. This becomes particularly important when tables are used in templates.

Changing an existing table

If you want to modify an existing table, place the caret in any place of a table and click on '**Edit**' button in Thermo Reports toolbar. It works only for tables created with Thermo Reports toolbar.

Deleting an existing table

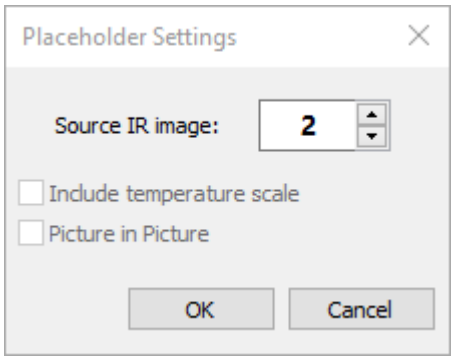
To delete a table created with Thermo Reports toolbar, place the caret in any place of a table and click '**Delete**' in Thermo Reports toolbar.

More than one infrared image in a document

You can put many infrared images into your document. Here are some hints how to handle them properly.

Graphs

When there are several infrared images in a document and you want to add a graph, you will obviously need to point to which infrared image your graph belongs. When you add a graph and IRT Analyzer report system sees that there are several infrared images, it shows a dialog where you need to specify an index of an infrared image the graph should be linked to.



You can relink a graph to another infrared image afterward: double click on a graph placeholder to show the dialog again.

Fields and tables

With fields and tables it is similar. When you create a field or a table, you can specify index of an infrared image this field or table should be linked to.

Using sections to separate infrared images

When you need many infrared images in your document, not just 2, 3 or 4, the method for linking graphs, fields and tables described above becomes rather cumbersome. This is where *sections* come to help.

Sections are subdivisions of a document. Once a document is divided into sections, you can make formatting changes that apply only to one section. For instance, you can change the page orientation or the number of

columns for just one section. Sections also separate infrared data - you cannot link a graph or a field with infrared images from other sections. Infrared image numbering is reset.

This makes it convenient to put every infrared image into a separate section. Then you do not need to bother with image indexing - all graphs, fields and tables are automatically linked to the infrared image found in the same section.

Section breaks

Sections are separated with section breaks. You can use Word's means to add a section break or the '**New Section**' button in Thermo Reports toolbar. There are section breaks that start a new page - *Section Break (Next Page)* and sections breaks that does not - *Section Break (Continuous)*. You can use section break type that suits better for you. 'New Section' button in Thermo Reports toolbar always start a new page.

Duplicate section

Often reporting you need to make for each infrared image is very similar. It is then convenient to do one image, then copy it and then fill it with new data.

There is '**Duplicate**' button in Thermo Reports toolbar that does exactly this. It adds a new section and copies all the data (text, placeholders, fields, tables - everything) from the previous section. Placeholders, fields and tables are emptied so you can select a new infrared image from IRT Analyzer to fill them.

By default, 'Duplicate' adds section breaks that start new pages. You can change this in the settings - click on '**Settings**' button in Thermo Reports toolbar and select "Several sections per page" option.

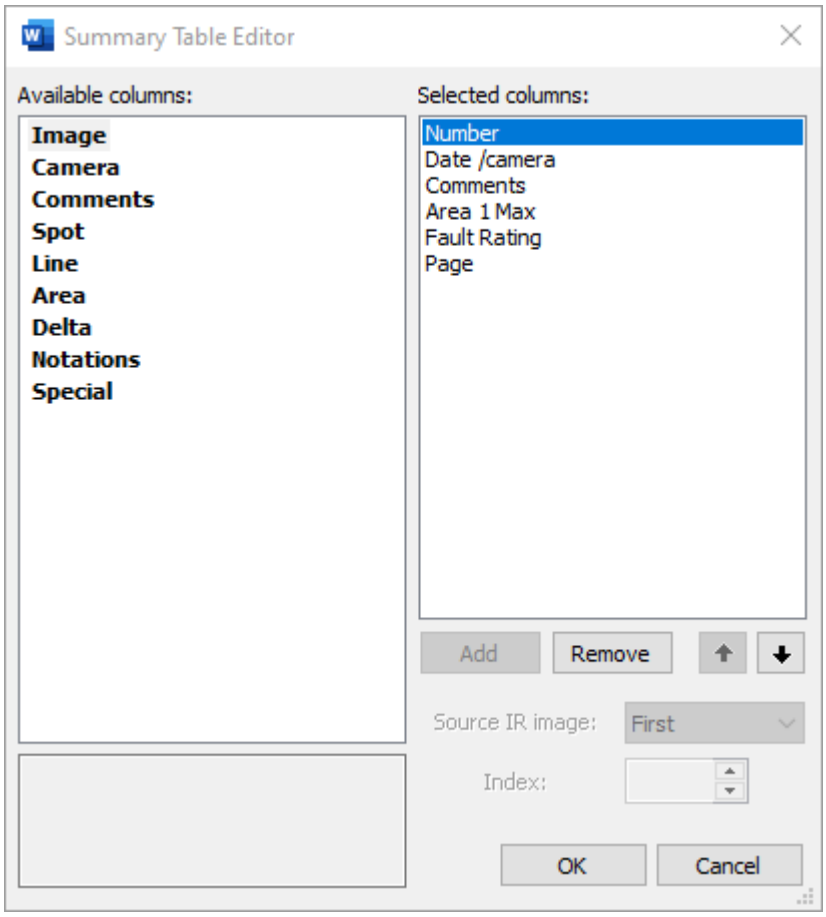
Summary table

Summary table is a table of fields taken not just from one infrared image but from all images in the document. It is kind of *table of contents* for reports. Each row of a summary table represents one infrared image. Columns can be any data available for the fields.

To create a summary table:

1. Add several infrared images to your document, so new summary table is not empty.
2. Move the caret to a place where you want to insert a new summary table and click on '**Summary Table**' button in Thermo Reports toolbar.
3. Select necessary categories in the 'Summary Table Editor', press 'OK'.
4. Use Microsoft Word features to format your table, for instance, use tools in 'Table Design' and 'Layout' tabs.

Summary Table Editor is very similar to the normal fields table editor. In the left part of the dialog there is a list of all available fields grouped under several categories.



The list of fields is the same as in the fields editor with the exception of '**Special**' category that contains two fields:

- 'Number': index of infrared image in the report (same as the row number in the summary table);
- 'Page Number': page number of the page that contains corresponding infrared image .

You can have as many columns in the summary table as you can fit on your document page. To add a column, click on it and push '**Add**' button. It will appear in the right part of the dialog which contains the list of selected columns (fields). To remove a field from the list, click on it in the right part of the dialog and push '**Remove**' button. You can also add and remove fields by double clicking on them.

To define columns ordering use buttons with '**Up**' and '**Down**' arrows.

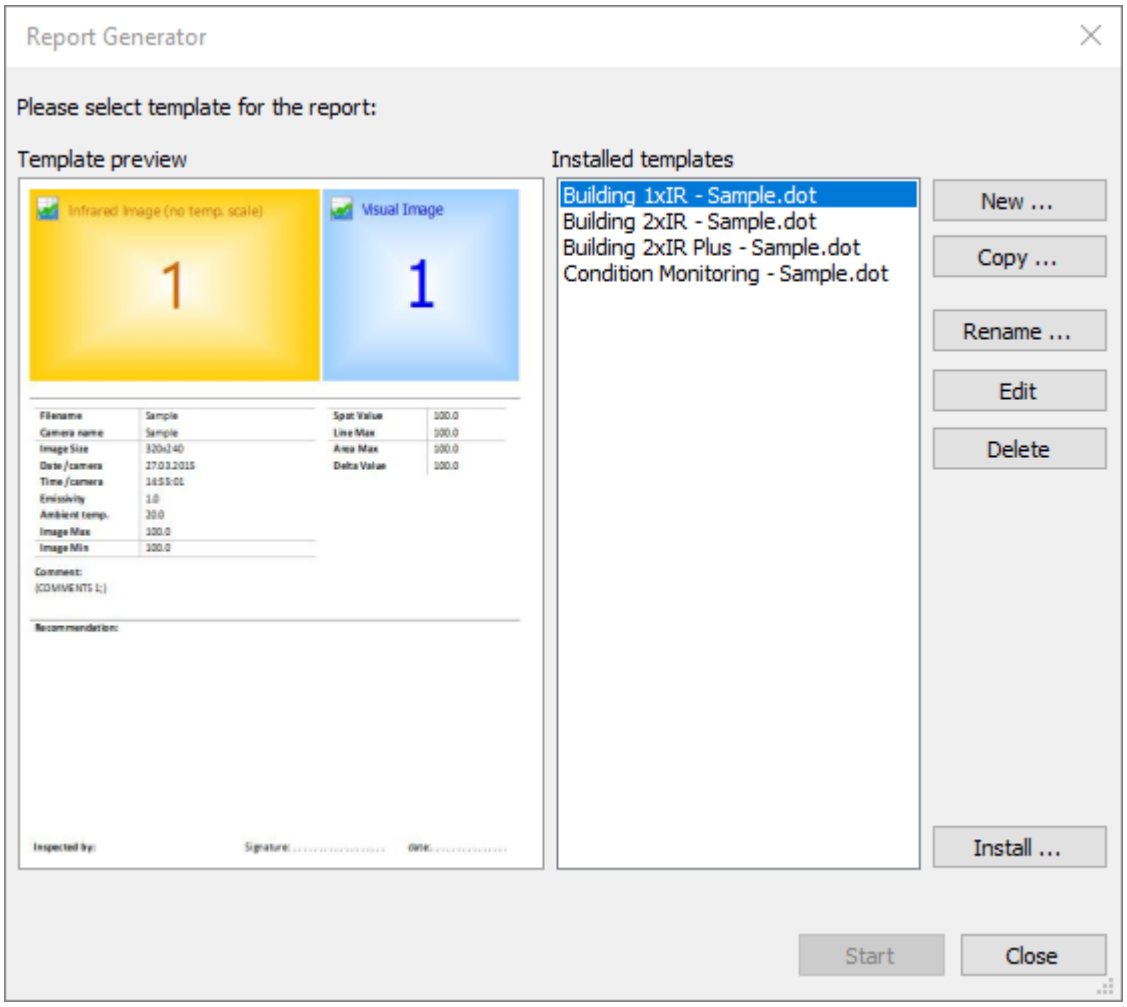
The table will be added to the document at the caret position. For templates, summary table is not allowed to be in the same section together with infrared image placeholder, if you select such insertion place, a new section will be added and summary table will be created there.

Below is an example of how a summary table may look.

№	Image Filename	Image Date	Problem	Page
1	95180001	16.06.2002	Component overheated, may need replacement	1
2	95180003	15.05.2001	Circuit hot, maybe overloaded	2
3	95180006	17.05.2001	Unknown fault	3
4	95180007	19.05.2001	Unknown fault	4
5	95190001	15.05.2001	Circuit hot, maybe overloaded; Temperature annomality	5
6	95190005	25.05.2001	Fuse clip overheated	6
7	95190013	15.05.2001	Circuit hot, maybe overloaded	7
8	95190014	31.05.2001	Circuit hot, maybe overloaded	8
9	95200003	15.05.2001	Fuse clip overheated	9
10	95200007	15.05.2001	Fuse clip overheated	10
11	95200008	22.05.2001	Temperature annomality	16
12	96200001	05.05.2001	Unknown fault	17

6.7 Custom report templates

To manage templates, use Report Generator dialog. To open it, in the main menu select '**Tools | Multi-Page Report**'.



Install a template received by e-mail

To install a template received by e-mail:

1. Save received template file to your PC hard drive.
2. If the file is a compressed archive (for example zip) you need to unpack it first. Correct template file must have **dot**, **dotx** or **dotm** extension.
3. In IRT Analyzer in Report Generator dialog, click on '**Install**' button. Select report template file.

Now your new template is copied to the proper place where report system can find it. It should appear in the '**Installed templates**' list and you can use it to generate reports.

Create new template

Click on '**New**' button to create a new template. You will be asked for a name. New template will be opened in Word for editing. It will not be empty - a helper template will be used where you can delete parts that you do not need. If you want to start from scratch - just delete everything.

Also you can copy an existing template and then modify it to your needs. Select a template you want to copy, click on '**Copy**' button and enter a name for the new template. New template will be opened in Word for editing.

Template structure

A template is just another Word document. We can think of a template as of a report with just one infrared image section. This image section will be repeated for every infrared image sent to a report. Sections without infrared images will be left unchanged.

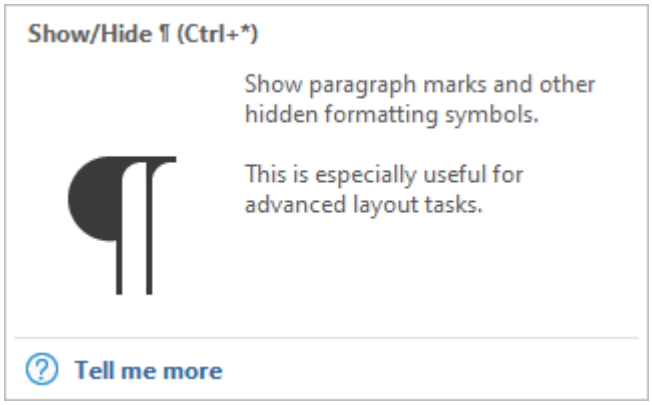
As a template is simply a report document, Manual report creation method works also for template creation.

Rules and hints for report templates organization

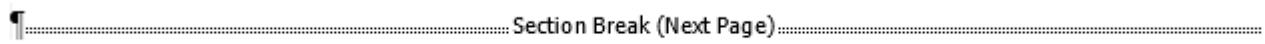
1. Placeholders, fields and tables must be not filled with real images (Thermo Reports toolbar will not allow to fill them).
2. Every template must have at least one infrared image placeholder.
3. Usually a template has three parts - report header (title page), main part and report footer. There can be more parts, but only the main part is duplicated when data is sent to a report, other parts are left unchanged. The main part is the one with infrared image placeholders.
4. Template parts are separated with the help of *sections* (read about sections here). For templates sections are especially important as they define what part of document is duplicated when data is sent to a report.

Section containing infrared image placeholder called a *main section*. It is duplicated, other sections are not.

5. To see if your template is properly separated into sections you can show hidden formatting symbols:



Section breaks look like this:



Such marks should appear between the part of your template that is duplicated and the other parts.

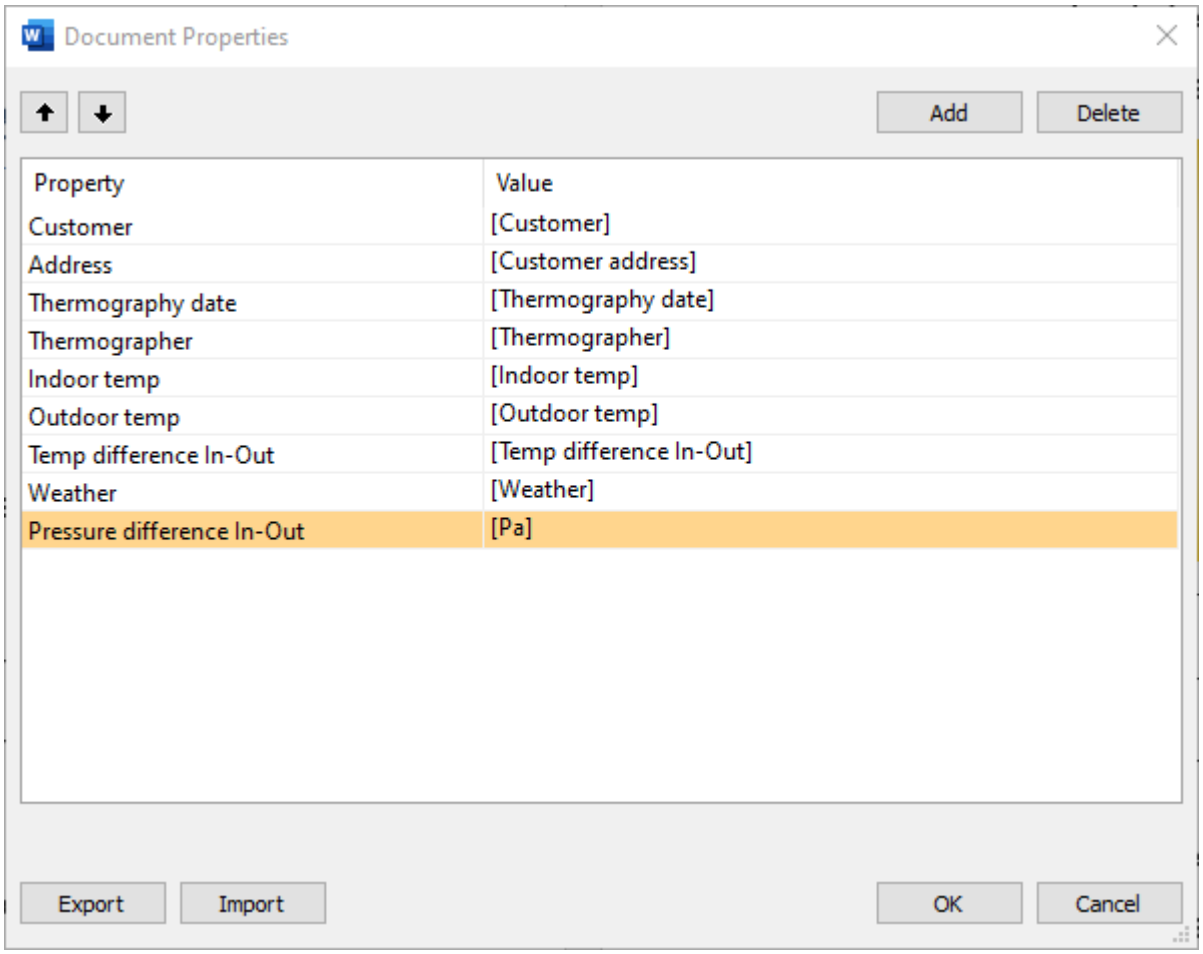
6. If you use a summary table it should be either in the report header or in the report footer, not in the main section.
7. Often images and tables change their positions during report generation. To make this does not happen it is recommended to organize objects and text on your page in one big table with invisible borders. *Text Wrap* for image placeholders must always be '*In Line with Text*'.

Document properties

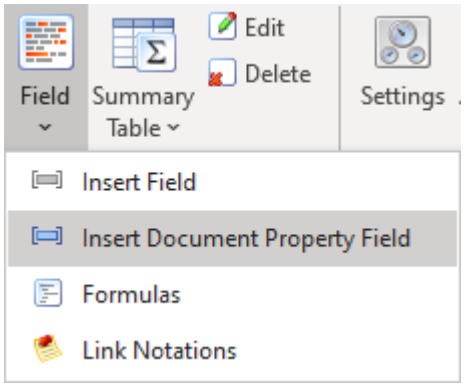
Document properties are text properties related to whole report, not to a particular infrared image. Examples of such properties are customer name and address, report title, report data and so on. Document properties are filled by template user after report is generated.

For a template you first define all the properties. Then you insert them at different parts of your template as fields.

To define list of propertied click on '**Document Properties**' in Thermo Reports toolbar. Then add all properties you need to the list:



After you have a list of document properties ready you can insert them as fields. Put caret to a place in your template where you need a property to appear. Find '**Field**' button in the Thermo Reports toolbar and click on a small arrow under the 'Field' button, select **'Insert Document Property Field**'.



A small dialog will appear. Select a property there.

6.8 Notations

A set of frequently used notes, divided into categories is called *notations* in IRT Analyzer.

Consider, how many different sentences you use when writing an inspection report? Most likely not that many and they repeat frequently. Notations allow you to define all possible comments once and divide them

into groups. Every time, when you need to add a note to an image, instead of keying in the text again (or copying it from another image), you can simply choose it from a list of notations. Moreover, software of some infrared cameras allows you to do it in the field.

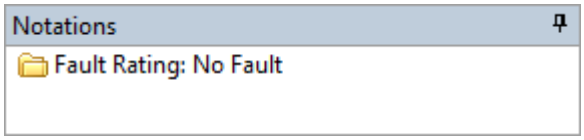
Notations are indispensable when creating reports. Just define places in a report template where to insert notations by category – and the textual part of your report is done automatically.

There is also *Notations Briefcase*, the place where you can store many sets of notations and select an appropriate one for your current case.

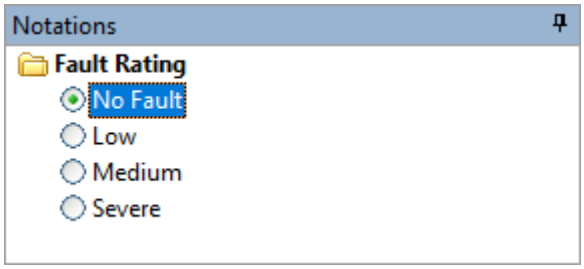
Selecting notations for images

Notations are available only in Individual image analysis mode.

When you have opened an image for analysis, you can find Notations window under the Analysis Objects window:

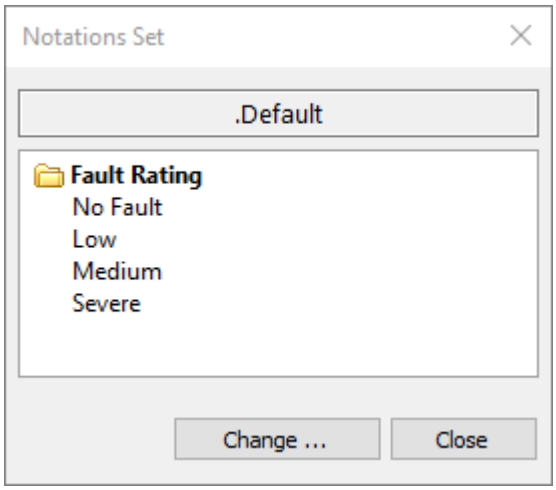


Default notations are very simple, you can only select a fault rating. Click on Notations window to activate edit mode and then mark appropriate options.

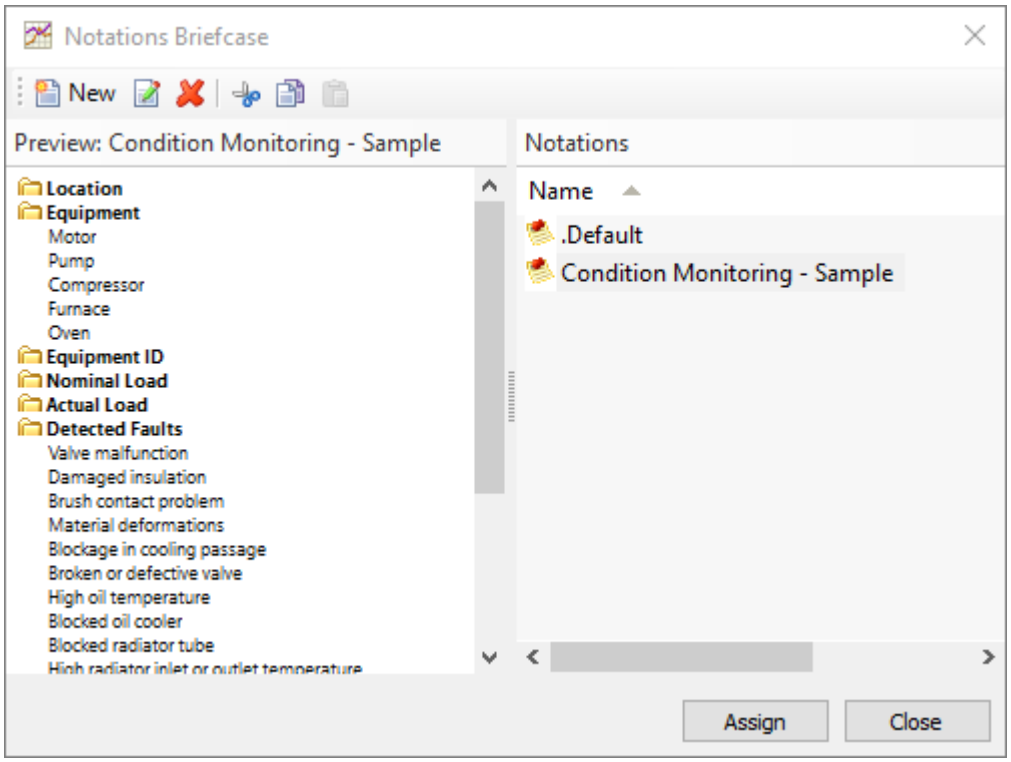


Selecting notation set from Notations Briefcase

You can assign a different notations set to your image. To do so in the main menu select '**Tools | Notation Set**'.



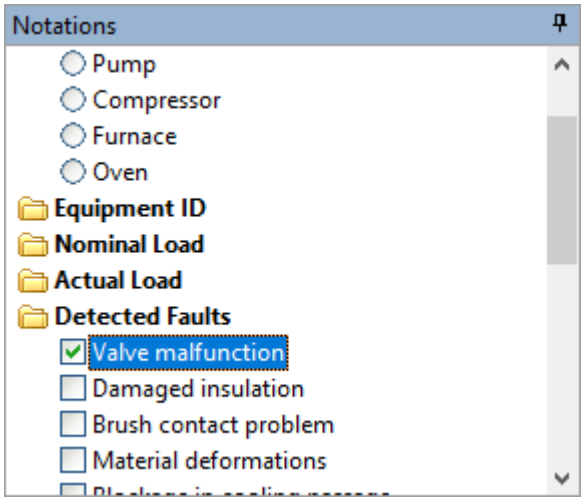
Press '**Change**' button to open Notations Briefcase:



Select needed notations set and press '**Assign**'.

Notations set will be active for the current image and for all other images stored in the same folder.

After you selected a new notations set, you can use it to annotate images:

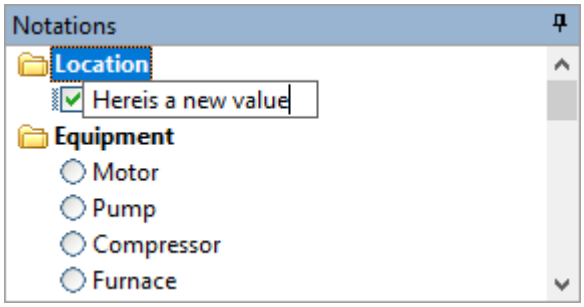


Note: when notations are chosen for an image, they remain with the image even if you select another notations set. In this case you will see combination of chosen notations from the old notations set and notations from the new notations set.

Adding new notations

Some notations categories do not have predefined values. Examples are "location" or "customer name". Sometimes you will not find the needed entry in the available notations list. In such cases you need to enter a new value.

Select the category you need to enter a new value for and press **Enter**.

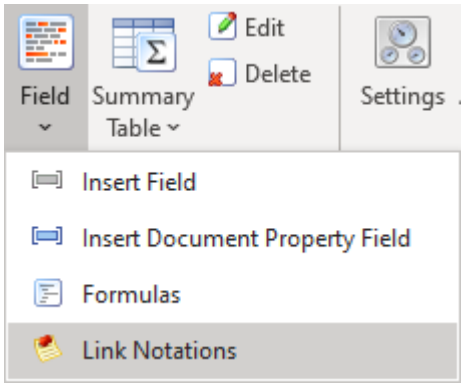


In the same manner you can add new categories to your notations, but this is not recommended as such categories will not be available for automatic import in the reports.

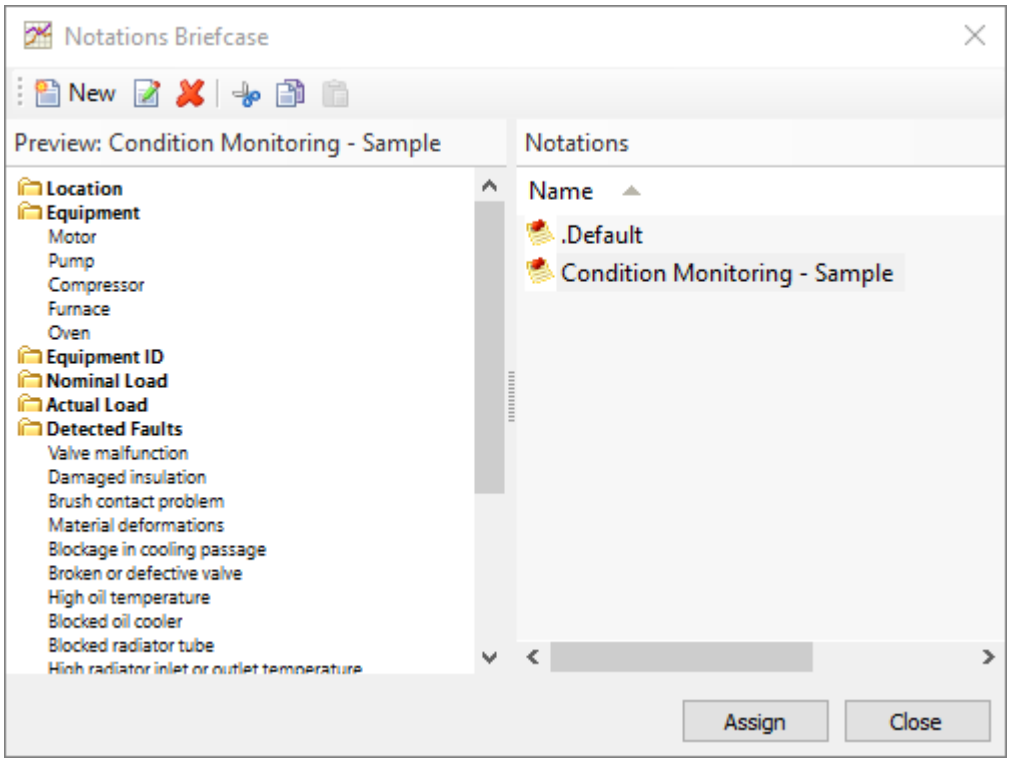
6.9 Notations in reports

Before you can work with notations in your document or template you need to import a notations set. (There is possibility to work with notations without importing notation set - it is to use Notations table.)

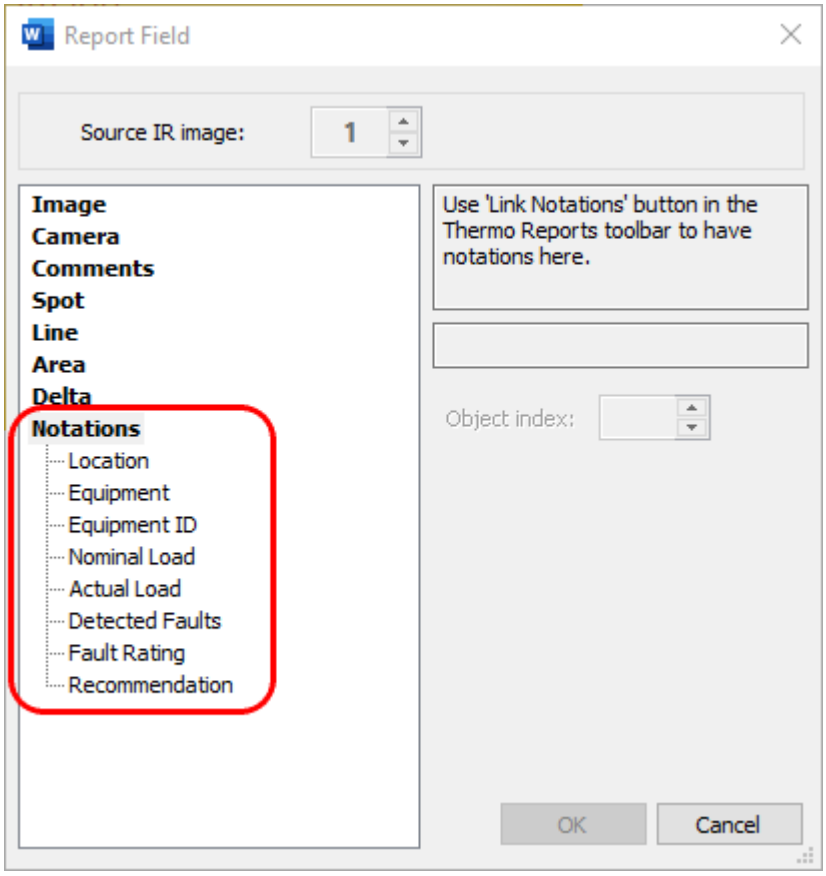
To import a notations set find '**Field**' button in Thermo Reports toolbar, click on the small arrow under it and select '**Link Notations**'.



This will open Notations Briefcase dialog where you need to select a notations set.



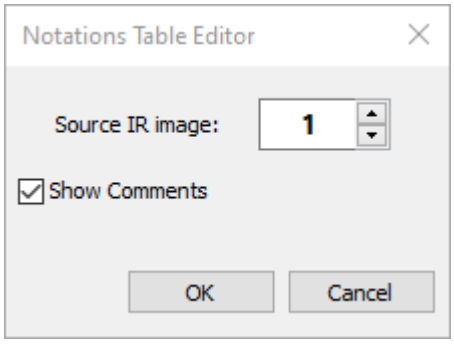
After notations are imported to your document or template, they become available as fields, in tables and in formulas:



Notations table

Notations table is a table with all notations chosen for an image. It can also contain comments.

To insert notations table move the caret to a place where you want to insert the table and click on '**Table | Notations**' in Thermo Reports toolbar.



You do not need to select which notations should be present in the table - all notations will be added automatically when the infrared image is exported to the report. If you do not want all notations, use 'Analysis Info' table and select only notation categories you need.

As notations table imports all notations, it does not need to know which notations categories are there in advance, so there is no need to import the notations set.

Location	**Floor 2, Block 51**
Equipment	Cabinet 1
Equipment ID	890-GH
Nominal Load	75%
Actual Load	70%
Detected Faults	Component overheated, may need replacement
Fault Rating	Medium
Recommendation	Repair at scheduled shut down

6.10 Formulas

For reports it is possible to define formulas that will take analysis object values (or other fields) as arguments. They are especially handy in templates.

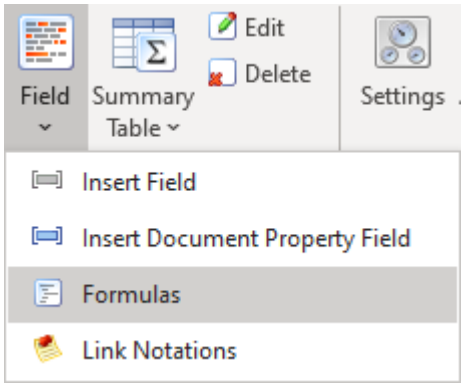
Formulas can be used to:

- Calculate special values based on thermal measurements;
- Automatically assign fault ratings and display them as text;
- Change text and color of a field by on a condition.

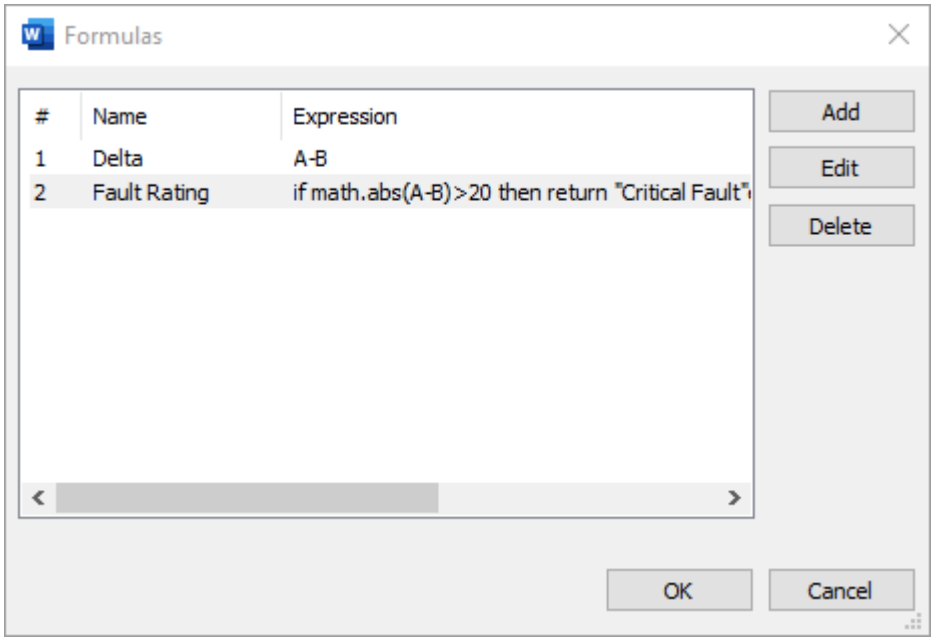
First you create formulas, after that you can use them as fields and in tables (including summary tables).

Creating list of formulas

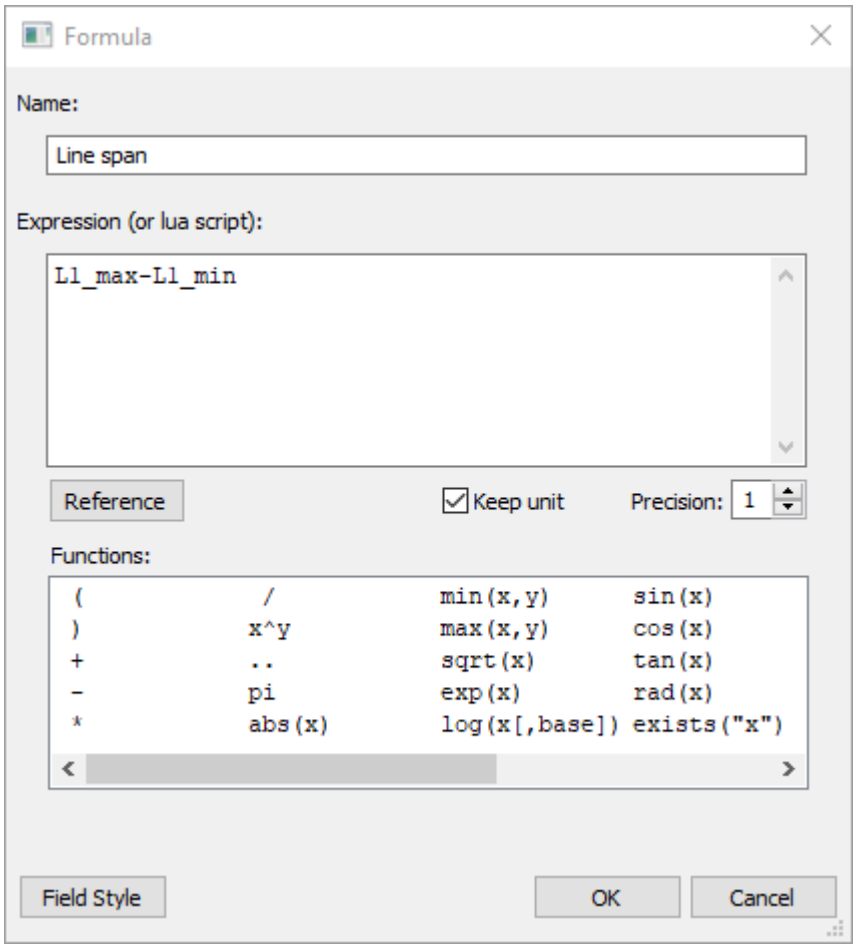
Open a report template (or a document) in Word. To define formulas find '**Field**' button in Thermo Reports toolbar, click on a small arrow under the button and select '**Formulas**' item.



A dialog with list of formulas will appear:



Click on '**Add**' to add a new formula:



First you should give your formula a name.

Then you need to enter your formula in the '**Expression**' box. You can use other fields as arguments of your formula. To insert an argument press '**Reference**' button and select a field you need in your formula.

Note: In formula expressions you cannot use other formulas.

Numeric formulas

Normally a formula is a numeric expression. In this case all arguments must be numbers. As arguments you can use such values as image temperature maximum or a spot value, and not text fields such as image name, comment or notation. For numerical expressions you can use functions you find in '**Functions**' list. Double click on a function to insert it to the expression.

Please pay attention that mathematical functions must have "math." prefix. For example *abs()* must be used as *math.abs()*.

Unit

For a numeric expressions you can use '**Keep unit**' to automatically add unit to the formula result. Unit is automatically deduced from the expression arguments. Usually this is the temperature unit. If unit of the formula result is different from the unit of arguments, you can add the correct unit explicitly using concatenation operator "**..**". For example:

```
A+273.15 .." K"
```

Precision

'Precision' defines how many digits after the decimal point resulting number must have. Precision does not work if you a add custom unit with ".." operator as described above.

Text formulas

Formula result can be some text. The simplest case - you just use a text field and add some symbols to it. Use concatenation operator:

```
"<<"..FAULT_RATING.."">>"
```

For a more realistic example you would need to use *if-then-else-elseif-end* keywords:

```
if math.abs(A-B)>20 then return "Critical Fault"
elseif math.abs(A-B)>10 then return "Possibly Fault"
else return "No fault"
end
```

Note: Formula expression can be any LUA script.

Inserting formula as a field

After list of formulas is ready you can use them in fields and in tables, just like any other field. For example, use '**Field**' button in Thermo Reports toolbar to create a field which takes its text from a formula (you will find formulas in the field tree).

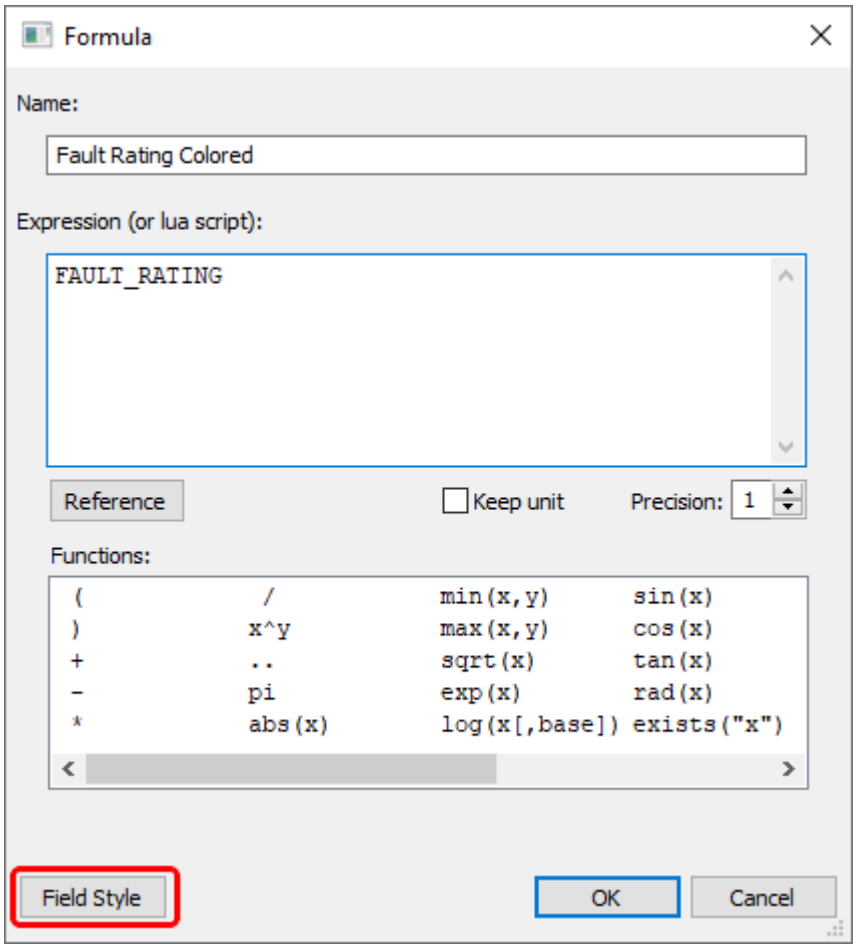
Conditional field coloring

Using formulas you can instruct report system to change color of a field when some condition is fulfilled. You can also make font of a field to become bold. This works for fields and also for fields in tables.

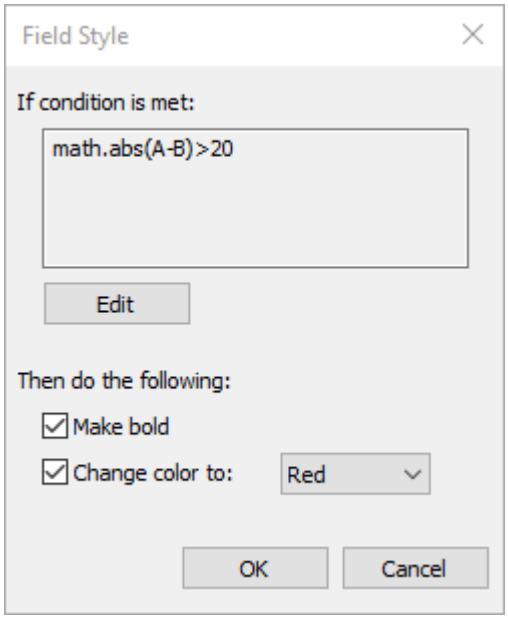
But it is a bit not straightforward. You cannot select any field and define a condition when it must be changed. It is only working for formula fields. So if you need a field to be conditionally colored you first convert this field into a formula and then define the coloring condition.

Let's assume we have Fault Rating notation and we want it to be displayed in our report bold and in red color when temperature difference between spots A and B is bigger than 20 degrees.

First we create a new formula that just copies value of Fault Rating field:



Now we can define a condition for coloring the text. Click on '**Field Style**' button and enter the condition text (using '**Edit**' button):



Now you can use formula 'Fault Rating Colored' as a field or in a table and text will automatically change its color when the specified condition is true.

6.11 Macros

It is possible to extend report template functionality with help of VBA scripts. You can use the standard Word events. Additionally, during report generation, IRT Analyzer calls these macros (if they are present in the template):

- *ThermoReportStarted:* called after report document is created;
- *ThermoReportFrameAdded:* called after a new section (possibly with several images) is added to the report document;
- *ThermoReportFinished:* called after all data is sent to the report.

To add macros to your template, open a report template for editing. Press Alt+11 to open Visual Basic editor, add these subroutines to TemplateProject:

```
Sub ThermoReportStarted(Doc As Document)
    'Your code here
End Sub

Sub ThermoReportFrameAdded(Doc As Document, FrameSectionIndex As Integer, NewSection As Boolean)
    'Your code here
End Sub

Sub ThermoReportFinished(Doc As Document)
    'Your code here
End Sub
```

6.12 Troubleshooting reporting problems

Thermo Reports toolbar is not present in Microsoft Word.

You cannot find Thermo Reports tab among other tabs in Microsoft Word. When the tab is not present, report generation will not work either.

Possible cause: ThermoReport Add-In was disabled by Word. This sometimes happens when Word decides that this add-in is causing problems. The solution is to go to Word Options (menu '**File > Options > Add-ins**') and check that ThermoReport AddIn is not disabled.

Then you can always try to reinstall IRT Analyzer and ThermoReport WordAddin:

1. Uninstall IRT Analyzer
2. Uninstall ThermoReport WordAddin (64 or 32 bit).
3. Install IRT Analyzer.

An error occurs during report generation

Actual errors can be different. In most cases this means that something is wrong with your Microsoft Office installation. First thing you need to try is to repair Office installation (please look in the Internet for detailed steps for how to do it).

If repairing of Office installation did not help, here is what you can try next (requires advanced Windows user skills for editing registry):

Removing Outdated References to Office from the System Registry

Uninstalling old versions of Microsoft Office can sometimes leave behind "orphan" keys in the System Registry. These references to products that are no longer installed can prevent Thermo Report add-in from working correctly with Microsoft Word — you may see error messages such as "Library not registered", "Interface not registered", or "Object variable or with block variable not set".

To remove the outdated references, you will need to edit the System Registry, as detailed below. Please proceed as follows:

1. Close all Office applications (Word, Excel, Outlook, Project, …).
2. Click Start » Run, type **regedit** and click **OK**.

Keys for Office

1. Click on '**Computer**' at the top of the left-hand panel, then press **Ctrl+F** to bring up the search window. Paste the following string, including the {}, into the search window:

{2DF8D04C-5BFA-101B-BDE5-00AA0044DE52}

Mark the '**Keys**' and '**Match whole string only**' check boxes; clear '**Values**' and '**Data**'.

2. Click the + sign to expand the key. You will see one or more sub-keys:

2.3 for Office 2003
2.4 for Office 2007
2.5 for Office 2010
2.6 and **2.7** for Office 2013
2.8 for Office 2016 (2.6 and 2.7 are okay for Office 2016 as well, if there is a reference to Office16)

3. Identify the key(s) that do not match version(s) of Office you actually have installed on your PC. If all of them do match installed Office versions, omit steps 4 and 5.
4. You are about to delete the key(s) that correspond to versions of Microsoft Office that you do not have. For safety's sake, you may want to back them up first. Right-click on **{2DF8D04C-5BFA-101B-BDE5-00AA0044DE52}**, select Export, and save the file where you'll be able to find it.
5. Right-click the '**2.*something'*** key that does not match, select '**Delete**', and confirm the deletion. Repeat for each '**2.*something'*** key that does not belong.
6. The **{2DF8D04C-5BFA-101B-BDE5-00AA0044DE52}** key can occur in more places. Usually they all have the same sub-keys, but not always, so you need to examine every instance. Tap the **F3** key to get to each of the others in turn. For each one, repeat steps 2 through 5 (click the + sign, export the key to a new file, and delete the orphaned 2.*something* entries).
7. Close the Registry Editor.

Keys for Word

Repeat the above steps also for key **{00020905-0000-0000-C000-000000000046}**.

8.3 for Office 2003 (not sure)
8.4 for Office 2007 (not sure)
8.5 for Office 2010 (not sure)
8.6 Office 2013
8.7 for Office 2016

After that report generation should run correctly.

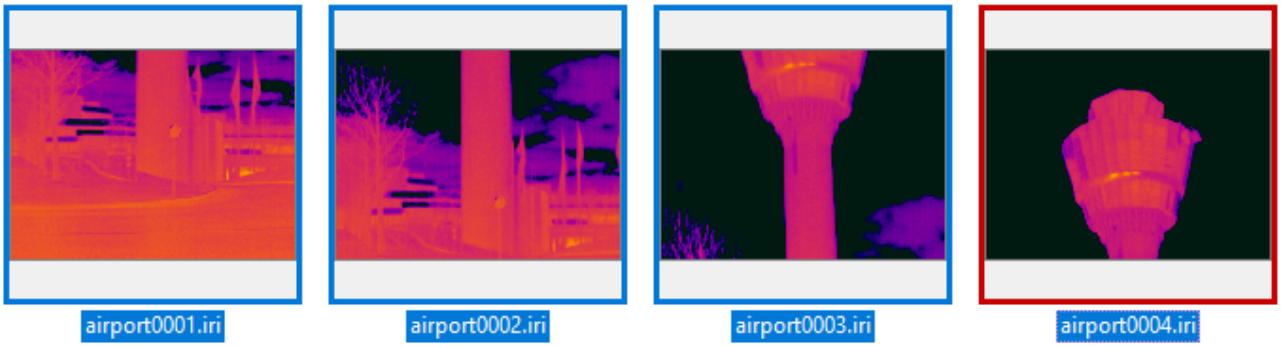
7 Extra tools

7.1 Image stitching

Automatic image stitching

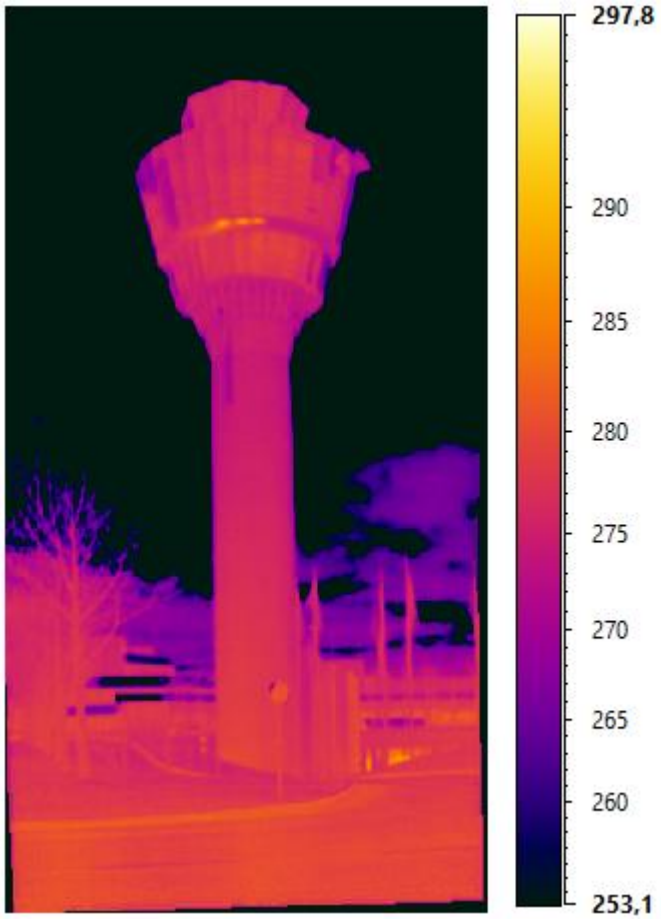
You can stitch several images together using IRT Explorer:

1. Run IRT Explorer: main menu '**File | Explore**'.
2. Navigate to the folder where your images are stored.
3. Select images you want to stitch together.



4. Right click on them and in the context menu choose '**Stitch**'.

IRT Explorer will try to stitch images automatically. Not all images are good for automatic stitching. Stitching algorithm tries to locate same geometry like corners or lines on adjacent images and then aligns them. Often it cannot find such geometry and fails.

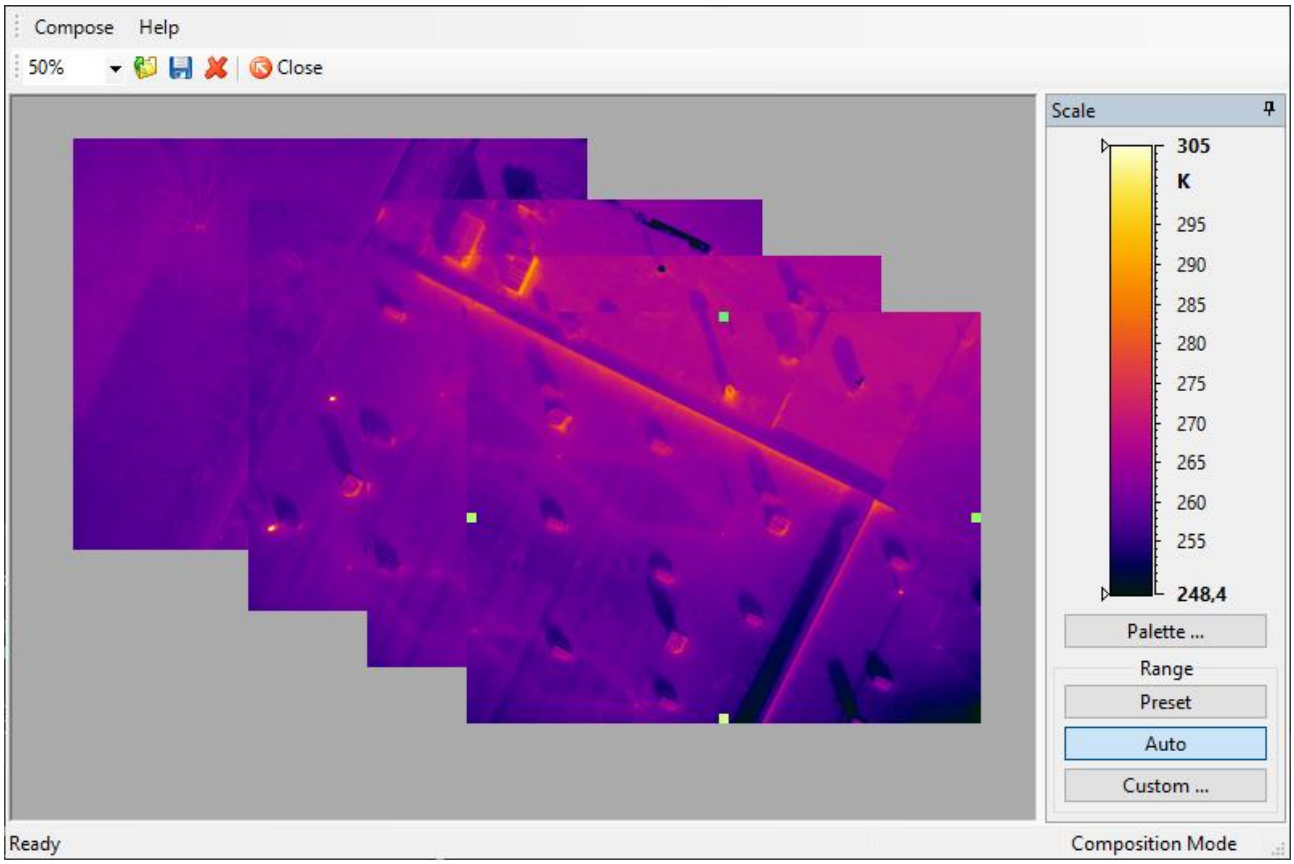


Simple composition tool

IRT Analyzer also includes a simple tool to manually compose several infrared images into one bigger image. It does not allow to change scale and perspective of images, you only can do kind of collage of several images.

To open this tool in the main menu select '**Tools | Compose Picture**'.

First you open images you want to combine into one image, then position images on screen in the order you need. After that you can save the resulting image.

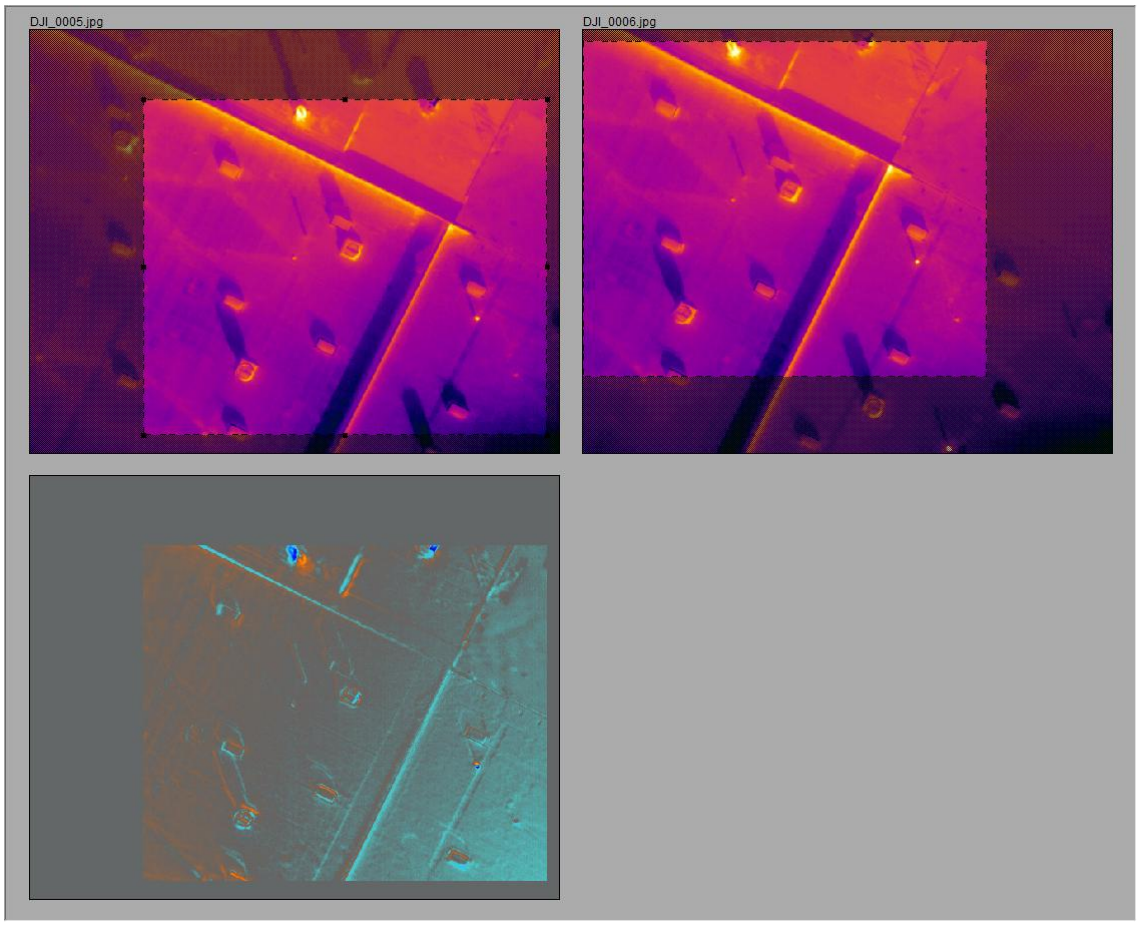


7.2 Subtraction tool

In addition to Image subtraction function IRT Analyzer has a separate subtraction tool that allows you to align two images before subtraction.

To run the tool select '**Tools | Picture Subtraction**'.

1. Open two images.
2. If they need alignment, select '**View | Subtract Area**'. You will see two rectangles on the images.
3. Move the rectangle on one image so that objects on both images align. You can also use keyboard to move the rectangles.
4. Save the resulting image.


DJI_0005.jpg
DJI_0006.jpg

8 3rd party libraries

To implement some features IRT Analyzer uses these open source libraries and programs:

Python



https://www.python.org/

zlib



https://zlib.net/

Copyright (C) 1995-2017 Jean-loup Gailly and Mark Adler

libzip

https://libzip.org/

Copyright (C) 1999-2017 Dieter Baron and Thomas Klausner <libzip@nih.at>

libcurl



https://curl.haxx.se/libcurl/

Copyright (c) 1996 - 2019, Daniel Stenberg, <daniel@haxx.se>

Lua



https://www.lua.org/

Copyright © 1994–2019 Lua.org, PUC-Rio.

libmodbus

https://libmodbus.org/

Copyright © 2001-2013 Stéphane Raimbault <stephane.raimbault@gmail.com>

libtelnet

http://github.com/seanmiddleditch/libtelnet

OpENer

https://github.com/EIPStackGroup/OpENer

Copyright (c) 2009, Rockwell Automation, Inc. ALL RIGHTS RESERVED. EtherNet/IP is a trademark of ODVA, Inc.

libpng

http://www.libpng.org/

Copyright (c) 1995-2019 The PNG Reference Library Authors.

libtiff

http://www.libtiff.org/

Copyright (c) 1988-1997 Sam Leffler

Copyright (c) 1991-1997 Silicon Graphics, Inc.

QR Code generator library

Copyright © 2022 Project Nayuki. (MIT License)

https://www.nayuki.io/page/qr-code-generator-library

Axialis

http://www.axialis.com

Some of the used icons are courtesy of Axialis Software.

If source code of a library was modified it can be downloaded from here:
http://www.grayess.com/open_source/

9 Document revisions

1.4-7.5.240

1. WAGO 750-352 fieldbus coupler -> WAGO 750-362 fieldbus coupler. Two first sentences are changed to tell that old 750-352 is also supported.
2. System requirements: Windows 11 is added to the list of supported OSes.

1.5-7.5.242

1. Managing licenses: QR code activation method added.
2. 3rd party libraries: Nayuki QR code library added.

1.6-7.8.36

Profile peaks and valleys counter: added a possibility to set threshold as a relative value.