USER MANUAL

Sonel ThermoAnalyze2® software

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All products of Sonel S.A. are manufactured in accordance with Quality Management System which is approved to ISO9001:2008 for the design, manufacturing, and servicing.

Due the continuous development of our products, we reserve the right to introduce changes and improvements in the thermal imaging camera and in the software described in this manual without prior notice.

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1 Introduction

This publication provides the necessary information required to use computer software Sonel ThermoAnalyze2® designed to analyse static thermal images and video material recorded using a thermal imaging camera manufactured by SONEL S.A.

It is recommended that this user manual and the thermal imaging camera manual are read thoroughly before using this software.

It is also recommended that this manual and other materials provided with the equipment are consulted when using the software.

Technical support

SONEL S.A. provides technical support on weekdays between 7 a.m. and 3 p.m. via phone at +74 858 38 60 and via e-mail at export@sonel.pl.

Feedback from users

From our side, we guarantee to make every effort to ensure proper operation of the equipment and the software. In case of any changes, related to continuous development of our product, information on such changes will be available on our website www.sonel.pl. Additionally, you are appreciated to let us know of any comments you have on this software and any possible errors you may find therein. Please, provide any suggestions on improvements and changes to the following address: export@sonel.pl.

2 Software installation

2.1 Hardware requirements

Processor	Pentium 4 2.4 GHz or higher
RAM	256 MB (512 MB recommended) or more
Free space on hard disk	2 GB (40 GB recommended)
Operating system	Windows XP 32-bit/64-bit or higher
Graphics Card	NVIDIA GeForce 5200 128 MB or higher
Additional software	Adobe Reader

Before installation, it is recommended to close all running applications.

2.2 Software installation

Before installation, it is recommended to close all running programs.

The installation program should run automatically when the CD with the software (supplied with the camera) is inserted in the CD-ROM drive. If it does not start automatically, run the **autorun.exe** in the root directory of the CD.

After selecting the language, select "**Thermal Cameras**" in the window that appears

and then "**Install Thermo Analyze2**":

When the installation program starts, follow the prompts on the screen.

NOTE

If the user selects a different folder than the default, the program will be installed in the folder **C:\Program Files\Sonel ThermoAnalyze2**. During the installation shortcuts will be created on the desktop and in the Start Menu.

2.3 Driver installation

The driver should install automatically with the installation of Sonel ThermoAnalyze2®. If it does not, the driver must be installed as follows. It is recommended to install the driver before connecting the camera to the computer.

The installation program should run automatically when the CD with the software (supplied with the camera) is inserted in the CD-ROM drive. If it does not start automatically, run the **autorun.exe** in the root directory of the CD.

After selecting the language, select "**Thermal Cameras**" in the window that appears:

and then "**Install Drivers**"

and the type of driver, depending on your operating system (32- or 64-bit).

If the camera is connected to the computer before installing the drivers or in the absence of the original installation CD, you can install manually, by using the drivers (e.g. downloaded from www.sonel.pl). When the camera is connected to the USB port of your computer, the Installation Wizard will start in order to install new hardware; when asked about searching appropriate driver in the Internet, select "**Not this time**" and click "**Next**." Then let the PC search the driver automatically – the program will check data storage devices in the search for the driver:
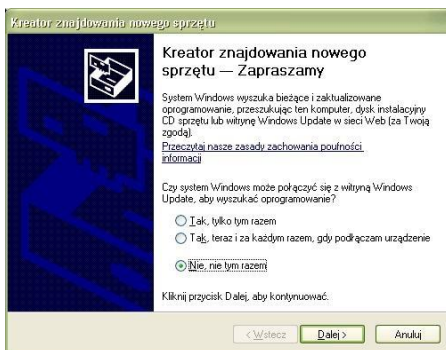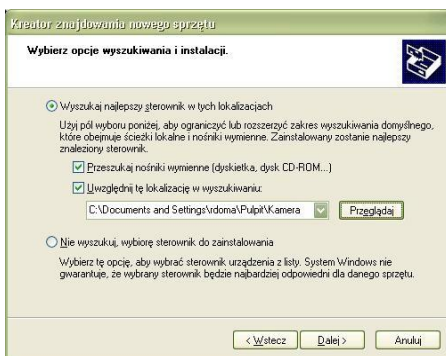
If the driver is not found automatically, then select "**Install from a list or specific location (Advanced)**":
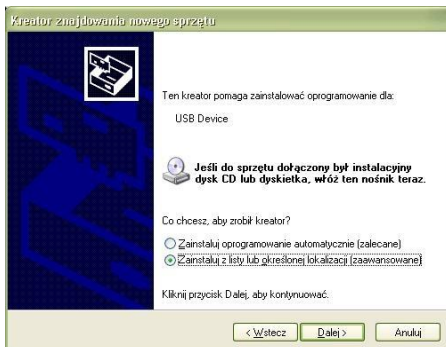
Select the folder (drive), which contains the driver files and click **"Next"** to continue:

The installation begins. After reaching the stage shown below, select "**Continue Anyway**":

After installation is completed an adequate message is displayed, press the "**Finish**" button.

2.4 Uninstalling the program

Go to the program manager of the operating system. On the application list point Sonel ThermoAna-lyze2®, right-click the application and choose "**Uninstall**".

# 3 Using the program – basic information

3.1 Settings

After installation the program will open in default language, i.e. English.

To change the language, click the **Settings** ⚙ icon in the top right hand corner of the home screen and then select the first tab **Language** and select the target language. The language will be automatically changed in the software and stored as preferred.
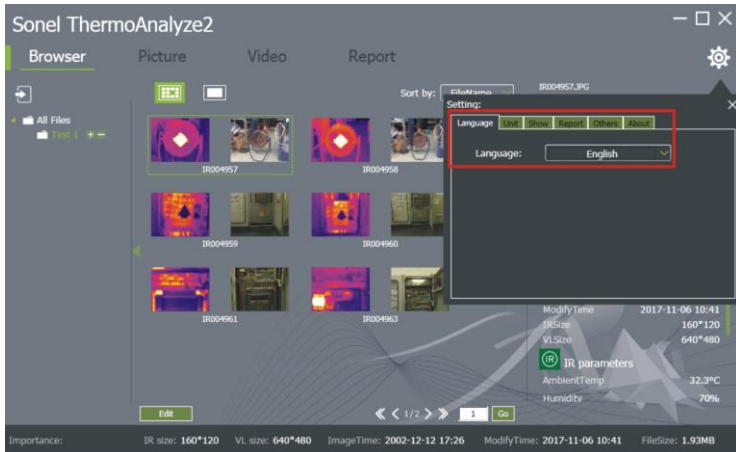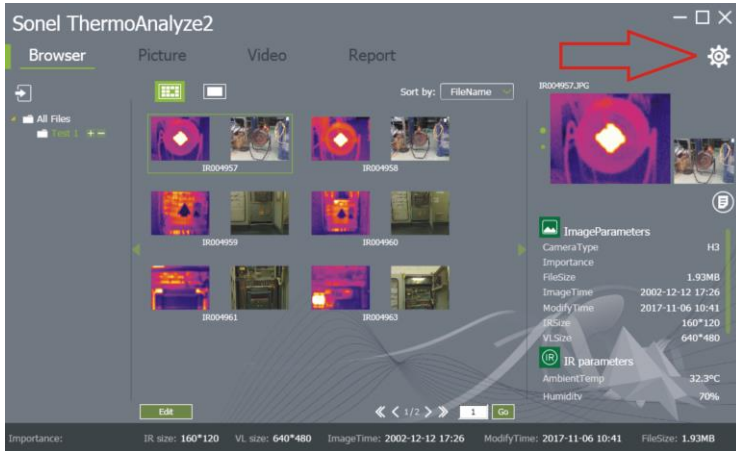
Another tab in settings is **Unit.** It allows to change the temperature units (**Celsius**, **Fahrenheit**, **Kelvin**) and the distance units (**meter**, **inch**).
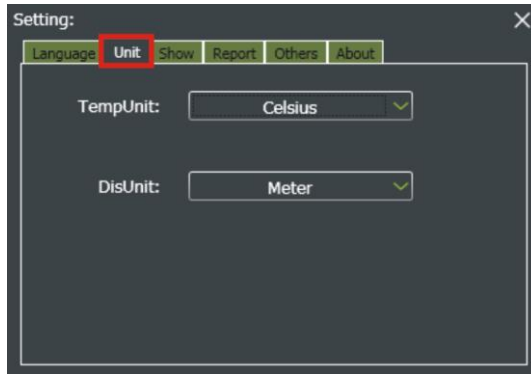
The **Show** tab allows to define the points which will be displayed:
– on the objects added during the analysis of the thermograms (**ObjShow**),
– on the thermogram (**PicShow**).
If option **MaxT + MinT** is selected in "**PicShow**", the points of the maximum and minimum temperatures will be automatically indicated on the thermogram. The same will apply to the inserted object of thermogram analysis.

Report tab allows user to select the type of desired report. It may be generated both as a **PDF** or a **Word document**. Each option has its own settings. By ticking individual boxes, you may select thermal image parameters for the report, as well as the parameters of presented objects. These include minimum, maximum and average temperature, distance, humidity, emissivity, reflection and photo creation date or date of generating the report. In addition, it is possible to change the default logo, adding a default header and footer of the report. Checking the "**AutoOpen**" window will automatically open the generated report in PDF format.

Settings – PDF:

Settings – Word:

The **Others** tab allows to specify any location, from which thermograms will be read into Sonel ThermoAnalyze2®.
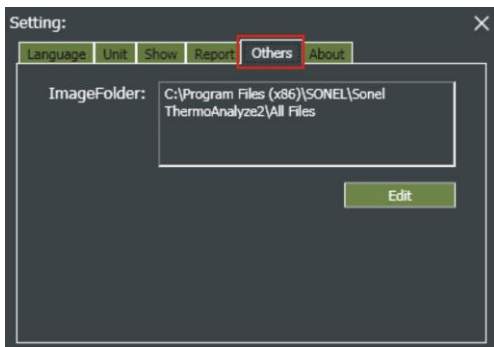
The last tab **About** will display the current software version.
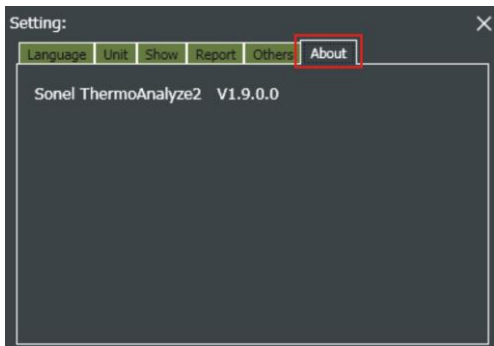
3.2 Software interface

After starting the program, a window shown below will be displayed. It contains four basic tabs:
Browser, **Picture**, **Video** and **Report.**

3.2.1 Browser tab

Browser tab allows to import IR images from the camera to the computer memory (for selected models), create folders with IR images and easily preview the IR images taken. Menu on the left side of the main window allows to create and delete folders.

Hiding and showing menu bars on both left and right side is provided by clicking the icons
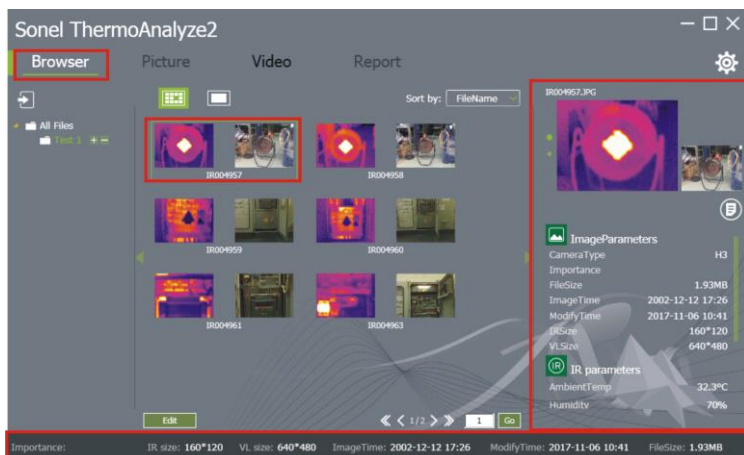
After selecting one of the images in the list (single left click), the program will display additional information on the selected IR image in the column on the right of the main screen, such as:

Image parameters – information on validity, file size, date of image capture, date of image modification and thermal image resolution.

IR parameters – information on the set ambient temperature, humidity, emissivity, distance to the measured object.

Measurement info – informing on maximum and minimum registered temperatures.

The **Edit** buton at the bottom of the file list opens the file management menu.

Additional properties of the selected image are displayed on the bottom screen bar.

3.2.2 Picture tab

The **Picture** tab allows thorough analysis and edition of the recorded IR thermogram before a report is issued.
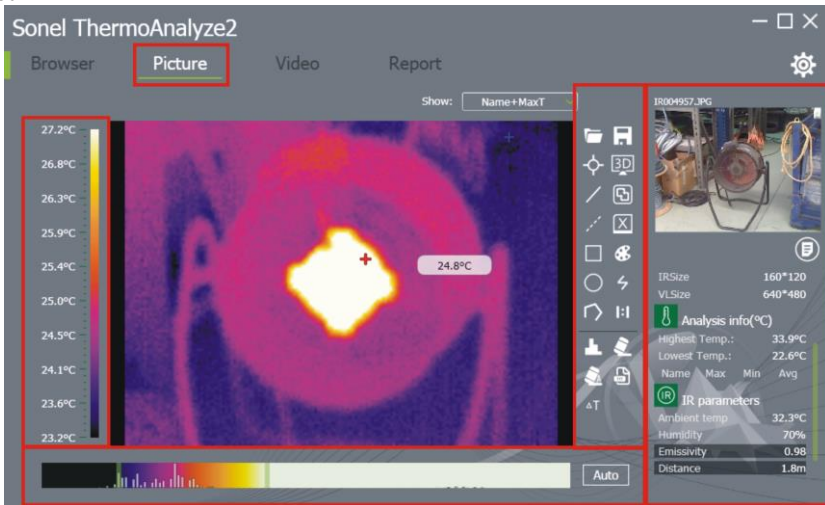
On the left side of the thermogram a temperature scale is shown with the colour corresponding to a given temperature.

Below the IR thermogram there is a bar for adjusting the graphical representation of temperature. The program automatically sets the scale depending on the maximum and minimum temperature registered using the thermal imaging camera. Manual adjustment of the graphical representation of temperature is also possible. To **change the graphical representation of the maximum or the minimum temperature**, move the cursor over the green bar (at the end or the beginning of the temperature graphical representation adjustment bar located below the thermogram), press and hold the left mouse button and then move to the left or to the right.

The **Auto** button **changes the graphical representation of temperatures back to default**.

On the right side of the image there is an iconic Menu with tools that enable more detailed IR image analysis and edition (see **section 5.2**).

The right section of the **Picture** tab allows i.a. to add a **comment to the IR thermogram**, **define validity** and **change emissivity** for an IR thermogram an to **display additional information** on the displayed IR thermogram. In this window it is also possible to **view the real image** (if the thermal imaging camera offers a feature of real time image recording).

3.2.3 Video tab
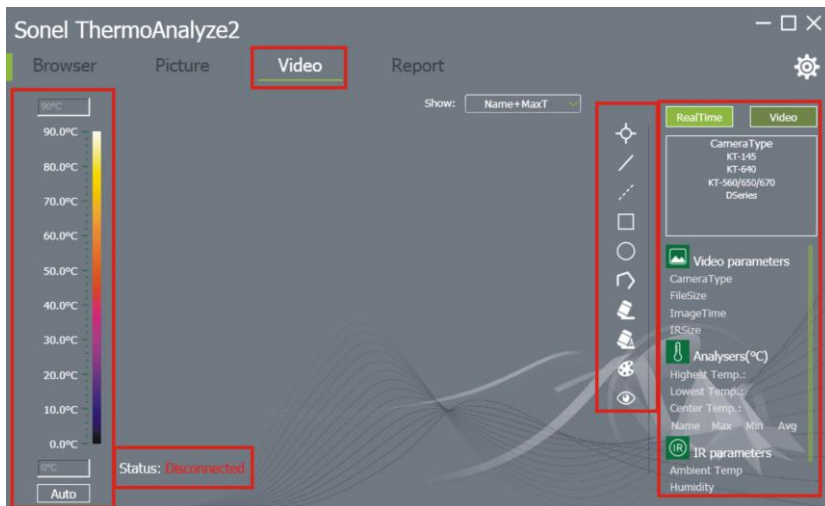
The **Video** tab allows to analyse the video images recorded in the on-line mode (for selected models) and videos previously recorded by the thermal imaging camera. On the left side of the IR image a temperature scale is shown with the colour corresponding to a given temperature. In the bottom left hand corner thee is information on the status of the IR camera connection if the **RealTime** mode was selected (section on the right side of the window). On the right side of the image there is an iconic Menu with tools that enable more detailed IR video analysis and edition. The right window of the "**Video**" tab allows to i.a. select the operation mode as **Real Time** or From a **Video** file.

At any time it is possible to capture a video image as a thermogram. The tab also contains an iconic menu with the same features as the **Picture** tab (see **section 5.2**).

NOTE
Analysis is available only for files in **IRGD** format.

3.2.4 Report tab

The **Report** tab allows to prepare a report based on the captured IR images.
The report may be generated both in PDF and Word format. The format is selected in the program settings (see **section 3.1**).

If you import photos taken in the MIF mode (real image outline overlaid on the thermogram), only the thermograms will appear in the report. Real-image camera photos must be imported separately.

Report in PDF:
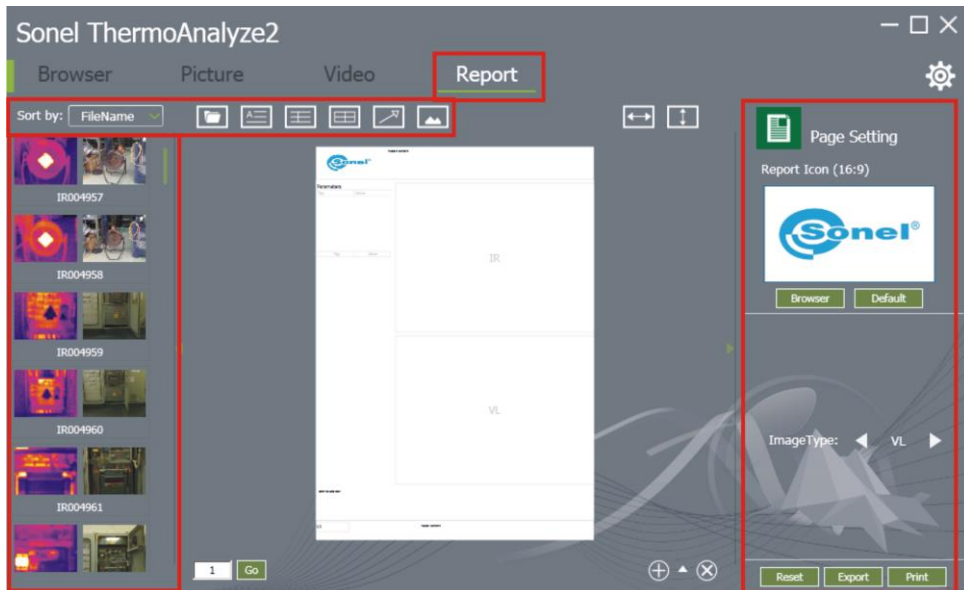
On the left side there are images that may be placed in the report. On the upper bar there are buttons that allow to open a file, add a text, comment, tag or image to the report.

On the right side there is information on the selected object in the report. It is also possible to modify the selected object in the report, e.g. to add a row or a column in the report table.

Report in Word:
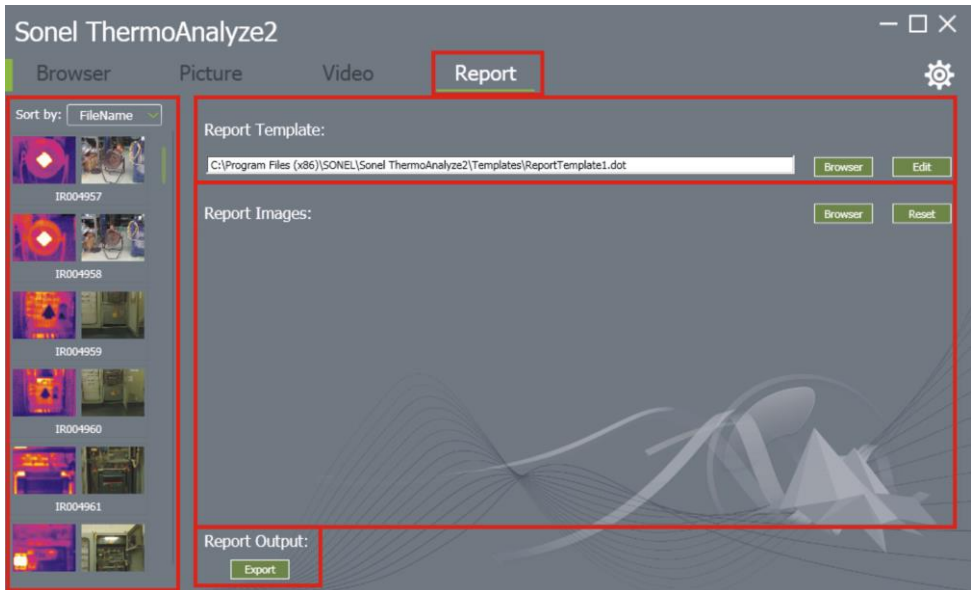
On the left side there are images that may be placed in the report. The upper bar "**Report Template**" contains fields for selecting the report template. Fields "**Report Images**" enables user ability to add or remove images to be included in the report. To generate a report, click the **Export** button at the bottom of the screen.

4 Import of IR files to the program

ThermoAnalyze2® software offers three possible methods of importing files. Using a wireless connection, via USB or by direct file copying from the SD card to the computer disk.

4.1 Import of IR files using the system browser

Using an SD card reader or, in case of cameras which work as card readers in the USB mode, copy (transfer) the IR files from the SD card into a folder on the computer disk. It should be a folder in the location specified in the **Settings/Others** tab.
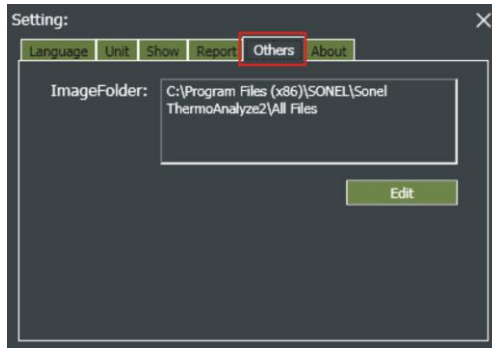
After copying the files, restart the program. The IR files will appear in the list in the **Browser** tab.

4.2 Import of IR files from the program level

To import files using the USB interface (for selected camera models), connect the camera to the computer using the USB cable included. The camera will be detected automatically (does not apply to cameras working as card readers in the USB mode).

Click the icon ▢ and **usb** in the **IR files** and then **download**.
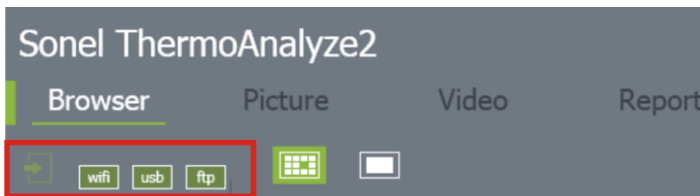
The program will display a list of files saved on the SD card. It is possible to download the selected images or all the images at once.

4.3 Import of IR files via Wi-Fi

To connect to the camera via wireless network, there must be a right Wi-Fi SD memory card.

Then, while first connecting to a given computer, connect to the **ez Share** network in the wireless network manager. It may be done automatically (recommended), by selecting from the list of available W-Fi networks and clicking **Connect**. Standard password: **88888888**.
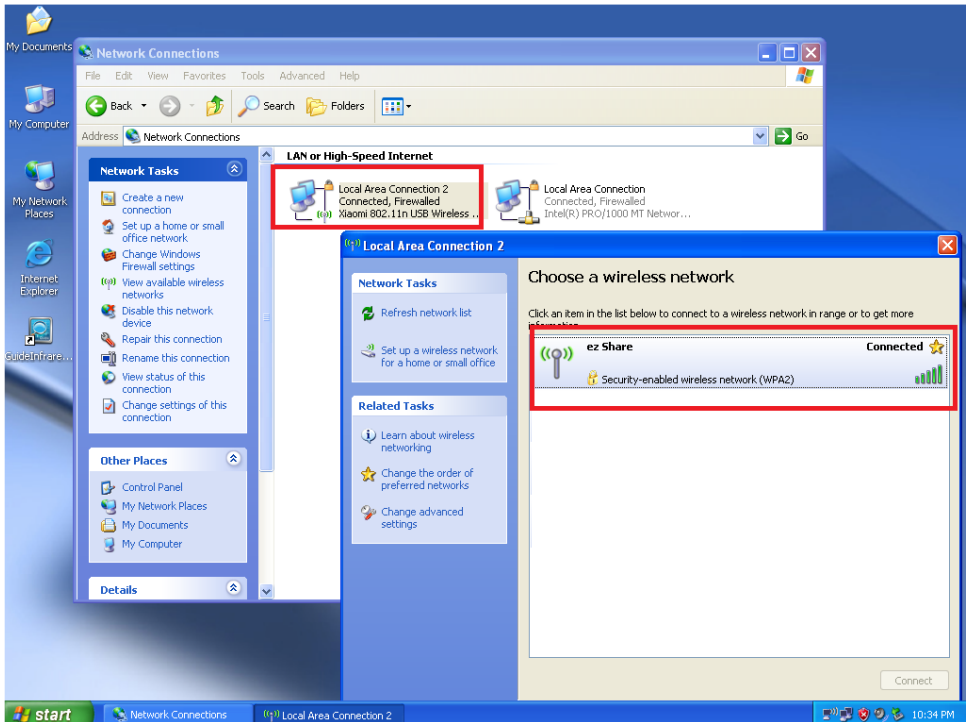
The network data and the card settings are set automatically.

In case of connection problems (method suitable for advanced computer users) the IP address should be changed manually, after connecting to the **ez Share** network. Enter the network card settings (Wi-Fi cards) and enter the following data in the settings:
– IP **192.168.4.x** (x from range 2-255)
– default gateway and DNS: **192.168.4.1**
as below:
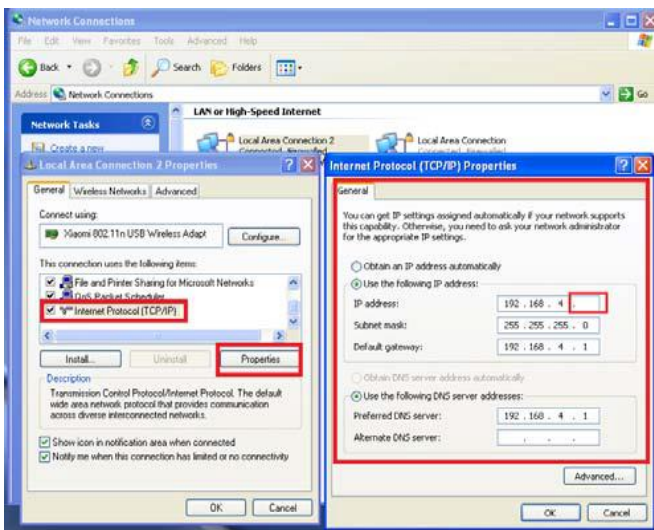
The settings must be saved (in most operating systems it is done automatically).

After connecting to a Wi-Fi network, run Sonel ThermoAnalyze2®. To connect to the camera using Wi-Fi, click the data import symbol the the **Browser** tab ➡ and next click **wifi**.


The program will dispaly a list of files saved on the SD card. It is possible to download the selected images or all the images at once.

NOTE

In case of any problems with detecting the SD Wi-Fi SD card in the camera, make sure that the card's name is "**111**".

To do this:
- insert the card in your computer
- right-click the card icon, then select "**Properties**":
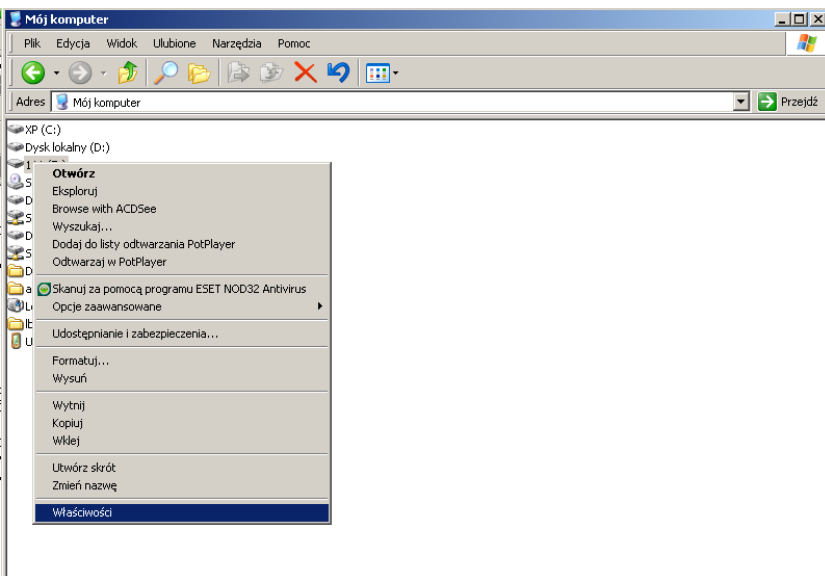
- The name field should state "**111**". If not, enter the correct name.

5 Analysis of IR images

5.1 Analysis of IR images

To start analysing an IR image, double-click the selected image in the **Browser** tab. It will be transferred to the **Picture** tab, where it is possible to analyse IR images. It is also possible to add the IR image directly from the **Picture** tab by clicking the folder icon in the upper right hand corner and indicating the IR image to be opened.

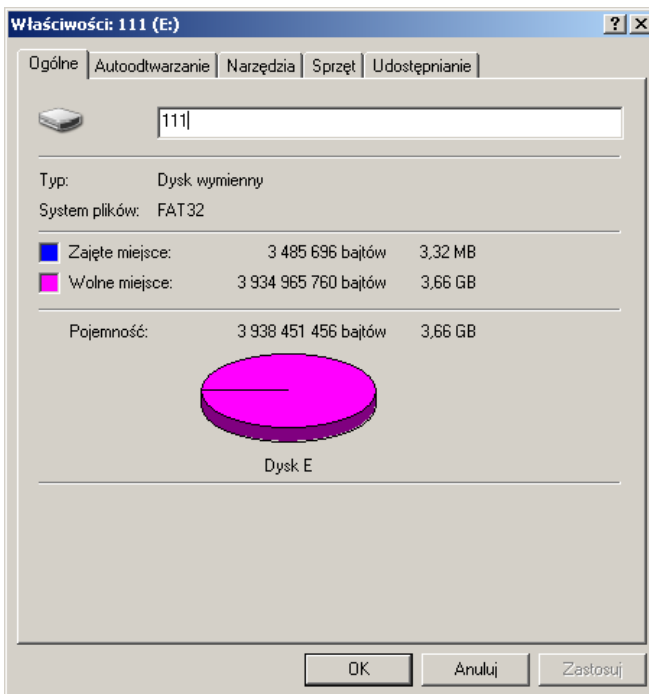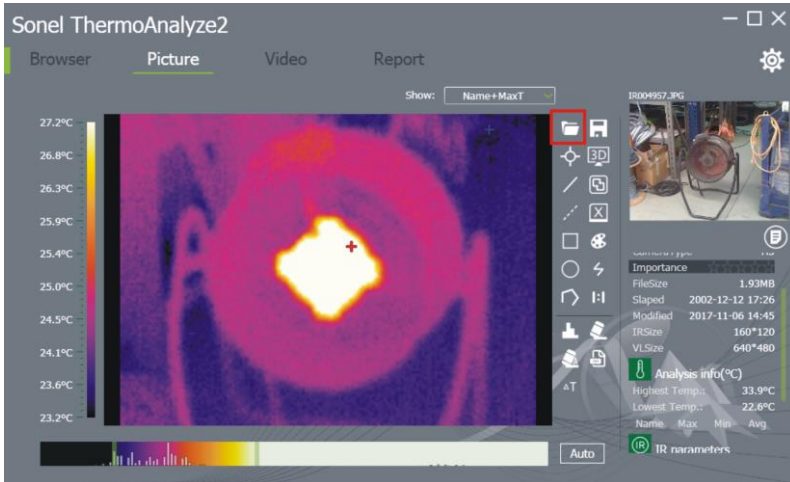## 5.2 Tools for analysis and edition of IR images

The **Picture** tab allows to edit and analyse IR images. On the right side of the window the temperature range registered for a given IR image is shown as well as the colour corresponding to a given temperature. The program automatically sets the scale depending on the maximum and minimum temperature registered using the thermal imaging camera. Manual adjustment of the graphical representation of temperature is also possible.
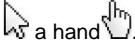
O the right side of the IR image ther is an iconic menu with the following tools:

Open – allows to open an IR image from any location

Spot – adds a point on the thermogram where the temperature value will be given. This function is also available in the **Video** tab.

- To **relocate a given point**, move the mouse cursor over the point. The cursor will change from an arrow to ⌐ a hand ✋. It is possible to relocate a given point on the thermogram by holding the left mouse button. To rename a given point, double-click the default name of the point with the left mouse button. The name appears in the list on the right side of the thermogram. Double-clicking with the left mouse button opens a window that to change the pa-

rameters of the point such: name, display mode, emissivity, distance, humidity, reflection, alarm setting for the maximum or minimum temperature.
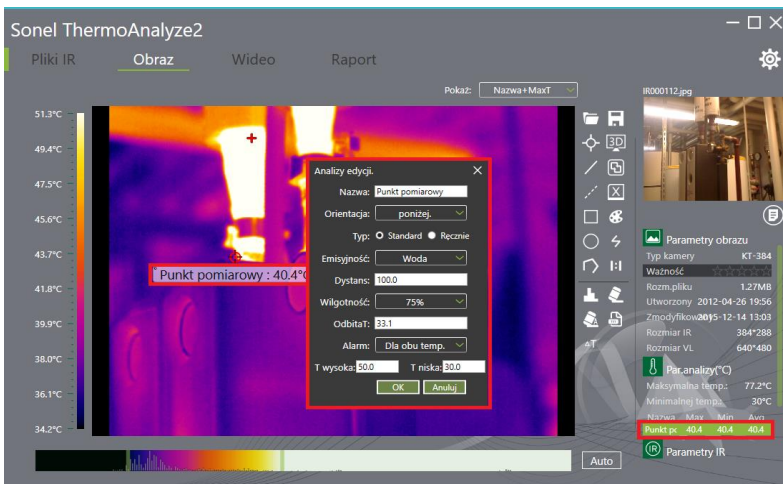
Line – places a line on the thermogram to show the lowest, the highest and the average temperature in the selected section. This function is also available in the **Video** tab.

- To **relocate a given line**, move the mouse cursor over the line. The cursor will change from an arrow to a hand. It is possible to relocate a given line on the thermogram by holding the left mouse button.

- To **move the end of the line** (which enables to shorten or extend the line), move the mouse cursor to the end of the line marked with a green dot. The cursor will change from an arrow to a cursor with several arrows. By holding the left mouse button it is possible to change the location of the line end.

- To **add the next point in the line** (creating an **open polygon**), double-click on this line – one of the green dots of the line will start flashing. Each single-click in the thermogram window generates a new nod of the open polygon.

- To **exit the mode of adding open polygon points**, right-click any area within of the thermogram..

- To **rename a given line**, double-click the default name of the line with the left mouse button. The name appears in the list on the right side of the thermogram.

Delta (differential measurement) – allows to calculate the difference between the temperatures of two points indicated by the user and marked on the thermogram. This function is also available in the **Video** tab.

- To **relocate a given differential measurement**, move the mouse cursor over the differential measurement. The cursor will change from an arrow to ⊾ a hand 🖑. It is possible to relocate a given differential measurement on the thermogram by holding the left mouse button.

- To **relocate the points** between which the temperature difference is calculated, move the mouse cursor over the end of the dotted line marked with a green dot. The cursor will change from an arrow ⊾ to a cursor with several arrows ✥. By holding the left mouse button it is possible to change the location of the differential measurement point (see – changing parameters of the point).

- To **change the parameters of a given differential measurement**, double-click the default name of the line with the left mouse button. The name appears in the list on the right side of the thermogram.

Rectangle – places a rectangle on the thermogram, within the selected area The rectangle will indicate the highest, lowest and average temperature. This function is also available in the **Video** tab.

- To **relocate a given rectangle**, move the mouse cursor over the square. The cursor will change from an arrow to ⊾ a hand 🖑. It is possible to relocate the selected rectangle on the thermogram by holding the left mouse button.

- To **change the dimensions of the rectangle**, move the cursor over any green point located on the rectangle. The cursor will change from an arrow ⊾ to one of possible cursors ⟺, ⇕, ⬉, ⬈ at the same time indicating the directions in which the shape change is possible. By holding the left mouse button it is possible to change the shape of the rectangle in any manner, in the directions indicated by the cursor arrows.

- To **change the parameters of the rectangle**, double-click the default name of the rectangle with the left mouse button. The name appears in the list on the right side of the thermogram (see – changing parameters of the point).

Circle – places a circle on the thermogram, within the selected area The circle will indicate the highest, lowest and average temperature. This function is also available in the **Video** tab.

- To **relocate a given circle**, move the mouse cursor over the circle line. The cursor will change from an arrow to ⊾ a hand 🖑. It is possible to relocate the selected circle on the thermogram by holding the left mouse button.

- To **change the dimensions of the circle**, move the cursor over any green point located on

the circle. The cursor will change from an arrow ↘ to one of possible cursors ⇔, ⇕, at the same time indicating the directions in which the shape change is possible. By holding the left mouse button it is possible to change the shape of the circle in any manner, in the directions indicated by the cursor arrows.

- To **change the parameters of a circle**, double-click the default name of the circle with the left mouse button. The name appears in the list on the right side of the thermogram (see – changing parameters of the point).

Polygon – places a polygon on the thermogram, within the selected area The polygon will indicate the highest, lowest and average temperature. This function is also available in the **Video** tab.

- To **relocate a given polygon**, move the mouse cursor over the polygon line. The cursor will change from an arrow to ↘ a hand 🖐. It is possible to relocate the selected polygon on the thermogram by holding the left mouse button.

- To **change the dimensions of the polygon**, move the cursor over any green point located on the polygon. The cursor will change from an arrow ↘ to a cursor with several arrows ✥ By holding the left mouse button it is possible to change the location of the polygon point.

- To add another point in the polygon, double click the polygon line with the left mouse button. Two points on the polygon will start flashing and a new point may be added between them.

- To **exit the mode of adding polygon points**, right click any area within of the thermogram.

- To **rename a polygon**, double-click the default name of the circle with the left mouse button. The name appears in the list on the right side of the thermogram.

Histogram – shows the percentage values of the temperature distribution within the selected object by a bar graph. To use this function, select the desired area on the image and right-click the histogram icon. By moving the mouse pointer into the bar area showing a given temperature, you will get more detailed information on the value and the percentage within this area.
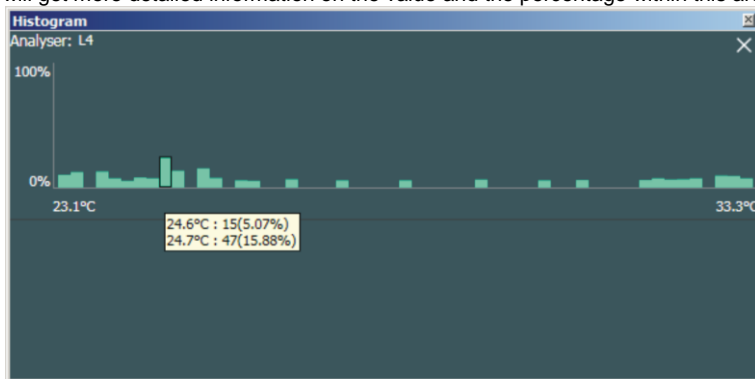
Remove – removes a selected/active thermogram analysis element from the thermogram. This function is also available in the **Video** tab.

Remove all – removes all elements introduced in the thermogram. This function is also available in the **Video** tab.

Save – saves the thermogram along with all introduced changes.

3D mode – allows to preview the thermogram in 3D perspective. In many cases the 3D image preview generated on the basis of the temperature distribution significantly facilitates precise location of faults.
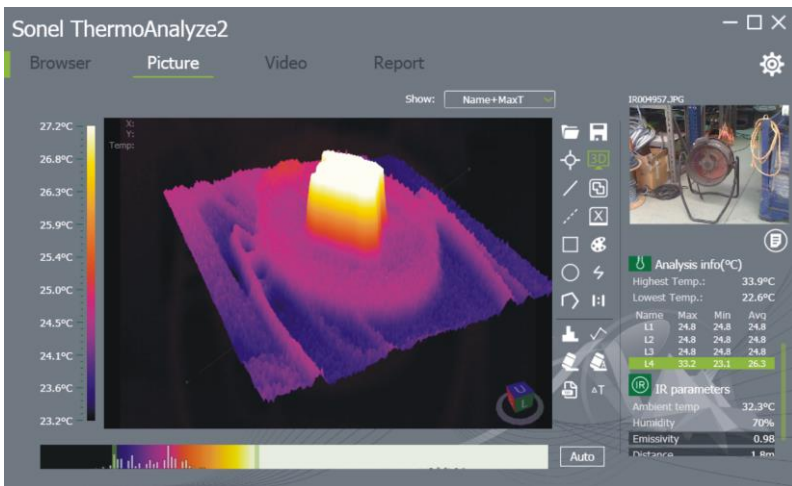
- To **zoom** the 3D image **in** or **out**, use the mouse wheel. Moving the wheel forward zooms the 3D image in, moving the wheel in the opposite direction zooms the 3D image out.

- To **move** the image, press the wheel and move the mouse in any direction.

- It is possible to **rotate** the 3D image in three planes after pressing the right mouse button. In the upper left corner, the program shows the coordinates of the mouse pointer, with the temperature value.

- To **save** the image use the keyboard shortcut CTRL+S. The window for choosing the directory will appear.

IR merging – allows to merge the IR image and the visible image photograph. In the case of combining the visible image with the thermogram, an additional bar is displayed that facilitates

⇒ adjustment of the thermogram to the visible image,
⇒ adjustment of the visible image to the thermogram.

Click the green buton under the workspace to choose the appropriate image (IR – thermogram, VL – visible image).
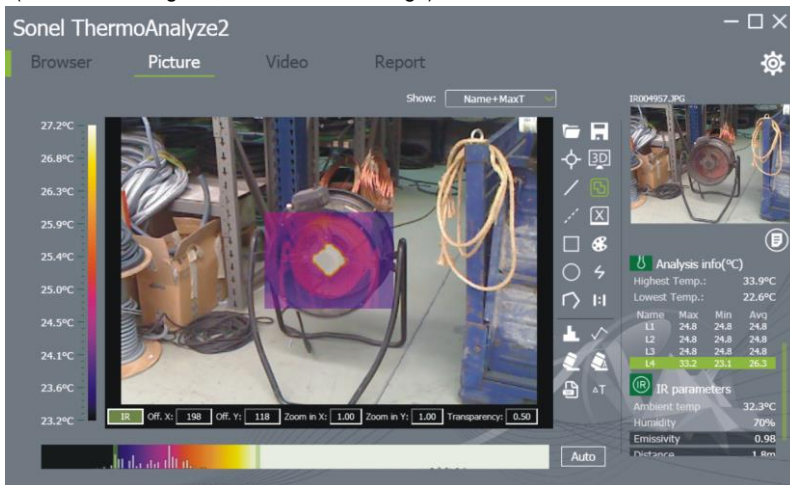
- To **move** the image, press and hold the left mouse button ad then move the mouse in the required direction.

- To **zoom** the image **in** or **out**, move the mouse wheel up or down. There are windows below the thermogram that allow to change the image position, size and the level of the image transparency.

Off. X: allows to **move the image to the left or right**. To move the image to the left or right, left-click the window to the right of the description Off. X and then, by moving the mouse wheel up or down, move the image up or down.

Off. Y: allows to **move the image up or down**. Left-click the window to the right of the Off description to move the image up or down. Y: and then, by moving the mouse wheel up or down, move the image to the left or right.

Zoom in X: allows to **enlarge (expand) the image horizontally**. To expand or contract an mage horizontally, left-click the window to the right of the Zoom in X description: then moving the mouse wheel up or down expand or contract the image to the required size.

Zoom in X: allows to **enlarge (expand) the image vertically**. To expand or contract an mage vertically, left-click the window to the right of the Zoom in Y description: then moving the mouse wheel up or down expand or contract the image to the required size.

Transparency: allows to **change the transparency of the image.** To modify the transparency, left-click the field to the right of the Transparency: description. Then moving the mouse wheel up or down set the appropriate transparency value.

Report – allows to move straight to the **Report** tab in order to develop a report of infrared measurements.

Palettes – displays 9 possible colour palettes. This function is also available in the **Video** tab.

Isotherm – allows to add isotherms to an active thermogram. After clicking the icon you will be able to define a temperature in the selected range and assign it with a selected colour.
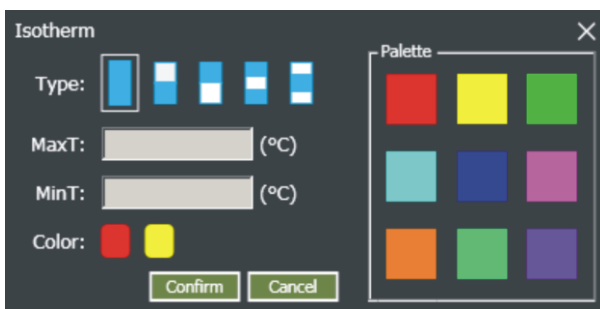
Scaling – enables user to scale the thermogram in 1:1 ratio.

Saving to txt – enables user to save the parameters of the analysed object to txt file.

△T   **Comparison** – enables user to compare temperature parameters of the selected objects. After clicking the icon, a window will open presenting data such as: the difference of minimum, maximum and average temperatures with the names of compared objects.

6 Creating IR test report

6.1 Report in PDF format

To open a new report, go to the tab **Report**. If PDF format is selected in the **Settings/Report** menu (**section 3.1**), a window as shown below opens.

In the upper right hand corner of the window there is a default logo that is placed in the report. To change the logo, press the **Browser** button under the preview window. This opens a window for a new logo selection.
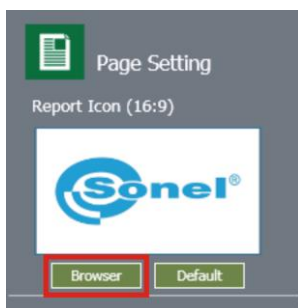
In the bottom right hand corner of the **Report** window there are icons that allow to **add** or **remove a page in the report** and an arrow pointing upwards that allows to expand the templates window. The templates window allows to **ad a prepared report page as a template** to be used in subsequent reports, which significantly speeds up and facilitates the work.

| | **Add page** – adds a new page to the report. |

| | **Delete page** – removes the selected page from the report. |

| | **Open template window** – opens the window with available templates. Clicking en empty template adds the created report to templates. We can remove any template by clicking the minus located in the bottom right hand corner. |

There are three buttons in the bottom right hand corner of the **Report** tab.

| Reset | Export | Print |

Reset – removes all previously generated report pages and returns to the default settings. The previously generated reports are not deleted.

Export – allows to save a prepared PDF-report in the user-selected folder.

Print – allows to print the prepared report.
The thermograms that may be displayed will be highlighted on the right side of the report window. To place a given thermogram in a report, double-click the thermogram with the left mouse button. The program will automatically place information on all objects of a given thermogram previously selected and analysed in a table on the left side of the report.

- To **zoom in** the report, move the mouse wheel up. To **zoom out** the report, move the mouse wheel down.
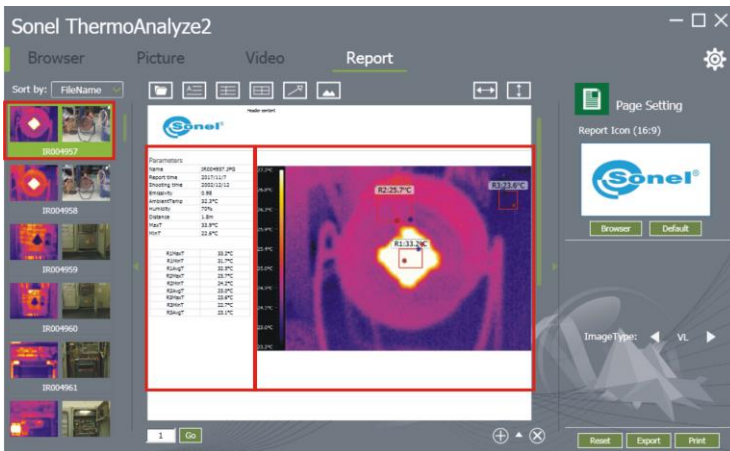
- To **add text to the report**, left-click the location where the text is to be added.

In the upper left hand corner there is an iconic menu that allows to add objects to the report.

Add text – allows to add a text box in the report, whose location and size are determined by pressing and holding the left mouse button. After a given text box is selected, the parameters that may be changed are displayed on the right side of the report.

TitleFontSize:	◄ 11 ►
TitleFontBold:	◄ Normal ►
TextType:	◄ Normal ►
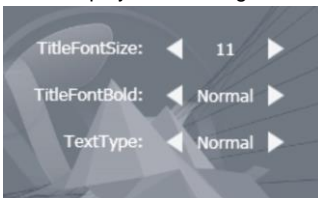
Add comment – allows to add a comment box in the report, whose location and size are determined by pressing and holding the left mouse button. After a given comment is selected, the comment parameters that may be changed are displayed on the right side of the report.

Rows:	◄ 1 ►
TitleFontSize:	◄ 14 ►
TitleFontBold:	◄ Normal ►
TitleFontSize:	◄ 11 ►
TitleFontBold:	◄ Normal ►
TableType:	◄ Normal ►

Add table – allows to add a table in the report, whose location and size are determined by pressing and holding the left mouse button. After a given table is selected, the table parameters that may be changed are displayed on the right side of the report.

Rows:	◄ 1 ►
Columns:	◄ 1 ►
TitleFontSize:	◄ 11 ►
TitleFontBold:	◄ Normal ►
TableType:	◄ Normal ►
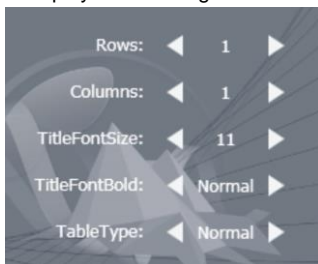
Add tag – allows to place a tag, which allows to precisely indicate the location on the thermogram that is described in a table, comment or text box. After a tag is placed in the report, it is possible to freely move its end and beginning. To do this, left-click the tag. Circles will appear at its end and at the beginning. By moving the cursor over one of the circles and holding the left button it is possible to freely relocate them in the report.

Add image – allows to place an image in the report. After left-clicking the icon, pick the **Browse** button in the right menu bar. Dialog window will appear – point the location of the appropriate image file.
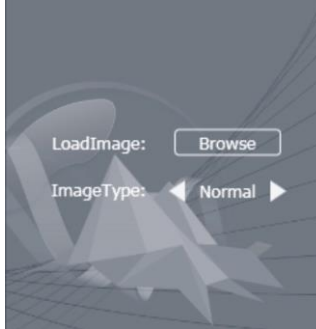
- To **move the image within the report**, point it with the cousor, click and hold the left mouse button. Move the coursor to the appropriate position and release the mouse button.

Left-right fit – adjusts the enlargement of the report to the window width.

Top-down fit – adjusts the enlargement of the report to the window height.

6.2 Report in Word format

To open a new report, go to the last tab **Report**. If Word format is selected in the **Settings/Report** menu (**section 3.1**), a window as shown below opens.
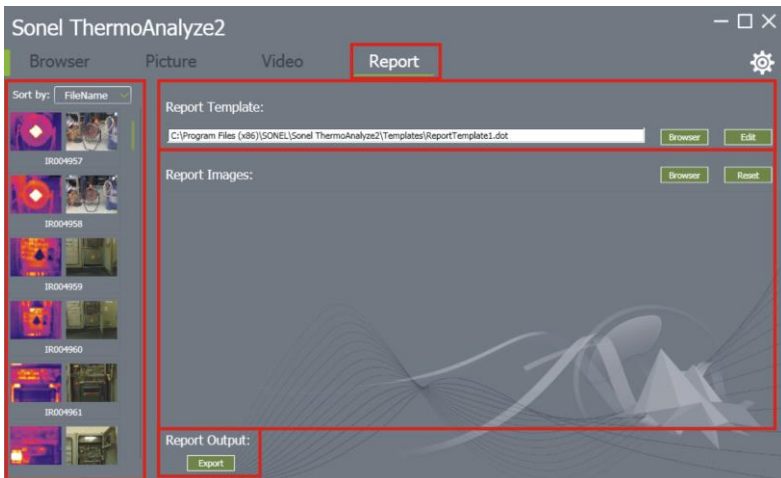
A report template can be set in the „**Report Template"** bar. The **Browser** button opens a dialog window, in which the path to an appropriate template must be set. The **Edit** button edits the chosen template.

The „**Report Images"** bar presents thermograms destined to be in the report.
Loading the thermogram to the report may be done in one of two ways:
   $\Rightarrow$ double-clicking one of the images in the left menu bar,
   $\Rightarrow$ via pressing **Browser** button. This button opens a dialog window, in which a path to the re-
      port-destined thermograms must be pointed.

To **delete** the thermogram click the thermogram with the left mouse buton, and then click the red wheel symbol.

The **Reset** button deletes all loaded thermograms.

The **Export** button creates a report. By default the files are saved in the folder defined in **section 3.1** (the **Settings/Others** menu). However the dialog window allows to save the report in other localization, too.

7 Emissivity

What is emissivity?

The concept of emissivity is inseparably connected with the physical model of the black body. It is a concept applied in physics that relates to an object that absorbs all incident electromagnetic radiation, regardless of the body temperature, angle of incidence and the spectrum of the incident radiation. The absorption factor for such body is equal to unity for any wavelength.

The black body model is generally an irregular interior, covered in soot, with only one small hole. Radiation entering through the hole is reflected from the walls many times, which means it becomes totally absorbed. Thus, the parameters of the radiation from the inside of the black body solely depend on the temperature of its interior.

On this basis, it is possible to build a radiation source for thermogram calibration – an object to the inside of which leads only one hole whose surface does not exceed 5% of the body surface (the passing radiation is less than 1/1000 of the radiation that enters through the hole).

The surface of a real object emits less radiation than the black body of the same temperature. The ratio of the emitted radiation to the radiation that would be emitted by the black body is called the emissivity factor.

$$\text{Emissivity} = \frac{\text{Radiation emitted by the surface of a given temperature}}{\text{Radiation emitted by the black body of the same temperature.}}$$

How to treat emissivity?

If temperature is read ignoring the phenomenon of emissivity, the read temperature is lower than the actual value. This temperature depends on the emissivity value: it is defined as the "visible temperature" or "brightness" of the surface. If the emissivity factor is constant, the changes in the read temperature are similar to the changes in the actual temperature.

The interest is in the actual temperature of the object, therefore:

actual measurement = ε * measurement for black body

To obtain actual temperature of the object surface, the emissivity factor must be taken into account for a given material while converting the measured radiation to temperature.

Therefore, when staring IR measurement it is necessary to know the relevant values of the emissivity factors for the measured objects.

Many sources give emissivity factor values for different materials. However, it must be remembered that the factor depends not only on the surface material itself but also:

– surface roughness

– temperature (including ambient temperature)

– angle at which an object is measured

– wavelength of infrared radiation.

For materials of smooth, unoxidised surface the emissivity factor is generally within the range of 0,05...0,5 and is strongly dependent on the wavelength, reaching higher values for shorter waves.

The relevant values of the emissivity factor for materials measured with KT-160 camera are given in the tables below. Please note that the values may significantly increase in the case of an oxidised or rough surface. If "oxidised" has been indicated, it means that the given values relate to strongly oxidised materials. In the case of a thin layer of oxide the emissivity factor adopts a value between that value and the value of an unoxidised surface.

When adjusting the emissivity factor of an object or of the entire thermogram, remember to take account of **the actual ambient temperature** while taking measurements.

Sample values of emissivity factor

aluminium	0,05	glossy lead	0,08
rough aluminium	0,07	grey lead	0,28
oxidised aluminium	0,25	oxidised lead	0,63
oxidated aluminium	0,30	white paper	0,90
asphalt	0,90	black glossy paper	0,90
asbestos (sheet, slate)	0,96	mat black paper	0,94
asbestos (fibre)	0,78	tarred paper	0,92
Bakelite	0,93	black plastic	0,95
bronze mat, matted	0,22	platinum	0,10
polished bronze	0,10	glazed porcelain	0,92
porous, rough bronze	0,55	mercury	0,10
standard glass bricks, rough	0,85	soot	0,95
refractory brick, rough	0,94	lampblack	0,96
cement	0,54	silver	0,03
cement (concrete)	0,90	galvanised steel	0,28
chromium	0,15	oxidised steel	0,88
polished chromium	0,10	freshly rolled steel	0,24
tin	0,09	rolled steel	0,56
zinc	0,05	rough steel	0,96
red brick	0,93	rusty red steel	0,69
oil paint	0,94	nickel-plated steel	0,11
fired clay	0,91	glaze	0,90
clay	0,40	glass	0,92
graphite	0,85	frosted glass	0,96
frozen ground	0,94	snow	0,80
rubber	0,93	insulating tape	0,95
cobalt	0,18	fabric	0,85
quartz	0,93	titanium	0,30
white lacquer	0,87	coal	0,90
glossy black lacquer	0,87	pulverised charcoal	0,96
mat black lacquer	0,97	tungsten	0,13
silver lacquer	0,31	oxidised tungsten	0,11
ice	0,97	gold	0.02
magnesium	0,12	shiny iron	0,16
copper oxide	0,65	hot-rolled iron	0,77
oxide copper black	0,88	oxidised iron	0,74
polished copper	0,07	polished iron	0,23
polished copper, annealed	0,01..0,02	oxidised iron and steel	0,85
brass	0,10	iron, raw casting	0,81
oxidised brass	0,61	polished cast iron	0,21
polished nickel	0,05		

NOTES