



RF200C

SOFTWARE

FOR OPTICAL RADIATION PROBES

OPERATING WITH THE RF-200C CONVERTER

INSTRUCTION MANUAL

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1. CHARACTERISTICS OF PROGRAM

1.1. Purpose of program

The RF200C program constitutes the basic accessory for the RF-200C converter and is intended for the control of SONOPAN optical radiation probes co-operating with the above-mentioned converter. The measurement probes are complete meters that communicate with a control unit through a digital interface with the use of the manufacturer's data transmission protocol. The description should be treated as an expanded reference material for the instruction manual for the attached probe because it constitutes the visualization system of the measured values.

The RF200C program enables the User to:

- configure the attached device,
- download the partial results of the measurement,
- average the read measured values,
- display the averaged measurement result,
- compile and archive the obtained measurements.

The procedures for processing of the partial results downloaded from the attached probe are placed in the separated measurement module of the RF200C program. The module has its own serial number independent of the number of the main program version. Besides, it constitutes the integral part of the meter of the photometric or radiometric quantities. Other RF200C modules do not influence the metrological parameters of the attached probe.

1.2. Hardware requirements and usage restrictions

- The RF200C program requires any PC with Windows or a tablet with Windows 10 installed.
- The SONOPAN RF-200C converter is required for communication with the measurement probe.
- The USB 2.0 port of a PC is necessary for communication with the RF-200C interface.
- The RF200C is free of charge. It can be installed in any number of PCs for an unlimited period of time.
- All rights for the RF200C program are reserved by SONOPAN Sp. z o.o.
- After the RF200C program is started for the first time, it is necessary for the User to get familiar with the details of the License Agreement (**Help→Licence**).

1.3. Main program window

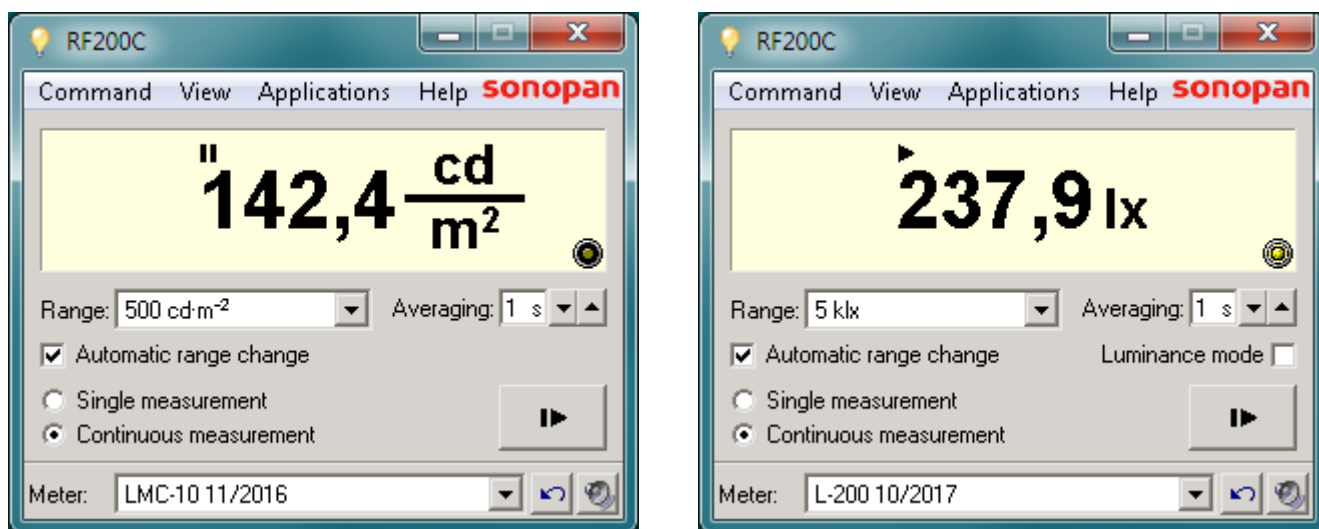


Fig. 1. View of RF200C main program window: with the attached LMC-10 probe (left) and with the attached L-200 probe (right).

The RF200C main program window is shown in Fig. 1.

The main program window consists of:

- Menu system.
- Result panel.
- Graphical controls (buttons, checkboxes etc.).

1.3.1. Menu system

1.3.1.1. Command menu

- **Start detector zeroing** - starts the procedure for determination of detector dark current. The procedure should be conducted only when the probe is covered.
- **Start system zeroing** - starts the procedure for determination of measurement circuit offset voltage.
- **Automatic range change** - turns on/off the automatic change of the measurement range.
- **Single measurement** - it turns on the single measurement mode.
- **Continuous measurement** - it turns on the continuous measurement mode.
- **Luminance mode** - it turns on the luminance measurement mode. It is required to attach the suitable adapter to the measurement probe. The menu command is visible only for the probes that are illuminance/irradiance meters.
- **Calibration** - it opens the window that enables the User to conduct the procedure of the calibration and adjustment of the attached probe (see Sec. 2.4).
- **Quit** – it ends the program operation.

1.3.1.2. View menu

- **Maximum resolution** - it displays the result with the maximum resolution of the chosen measurement range. In the normal mode, the result is rounded up to the number of significant digits dependent on the attached probe. These are usually four digits.
- **Always on top** – it sets the attribute of the main program window so that it is not covered with any other application window.
- **Window size** - it allows the User to choose one of the four sizes of the program window. The option is useful for small high-resolution screens.
- **Play sound** - it activates the acoustic indication of the events: the result refreshing and using the key of the attached probe.
- **About meter** - it opens the window with the basic data of the attached measurement probe (see Fig. 2).
- **Select language** - it changes the language of the program.

1.3.1.3. Applications menu

- **Tests of monitors** (see Sec. 3.1) - it opens the window of specialised application intended for tests of medical imaging monitors.
Only some measurement probes have access to this application.
- **Measurement memory** (see Sec. 3.2) - it opens the window that enables the User to save the chosen measurements to a PC disc.
All measurement probes have access to this application.
- **Advanced** (see Sec. 3.3) - it opens the window that enables the User to:
 - conduct the relative measurement with any reference,
 - integrate the measured quantities in time,
 - conduct simple statistical calculations on the measurement results.Only some measurement probes have access to this application.
All applications ensure the archiving of the results on a PC disc.

1.3.1.4. Help menu

- **Instruction manual** - it displays the instruction manual for the program in PDF format.
- **Licence** - it displays the window with the terms of the program licence.

- **About** - it opens the window containing information about the program (see Fig. 3).
- <http://www.sonopan.com.pl> - the link to the manufacturer's website.

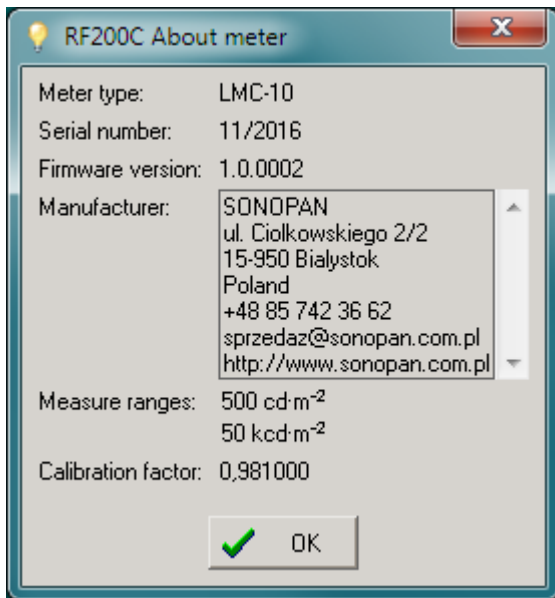


Fig. 2. View of the window containing information about the meter (with the attached LMC-10 probe).

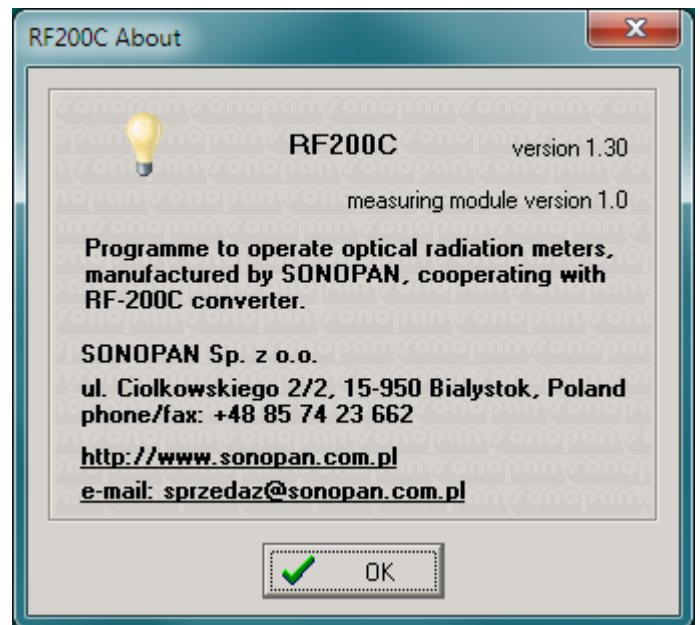


Fig. 3. View of the window containing information about the program.

1.3.2. Result panel



Fig. 4. Result panel view.

The result panel (see Fig. 4) consists of:

- The value of the measurement result.
- The unit of the measured quantity with SI prefix.
- The measurement status indicator: ► (measurement in progress) / ■ (measurement stopped).
- The result refreshing indicator: ⌚ / ⌚.
- The indicator of the measurement range exceedance ↑ placed in front of the result.
- The indicator of turning off the temperature compensation in the probe e.g. during calibration (see Sec. 2.4), exceedance of the operational temperature range or the failure of the temperature sensor: 🌡️.

The reason for the appearance of this indicator is marked red in the **About meter** window (see Fig. 2). The window can be open with the menu command (see Sec. 1.3.1.2) or with the direct click on the indicator 🌡️.

The result panel presents the averaged value of the measured quantity. The result is the moving average within the set averaging time and it is refreshed every second. The indicator 🌡️ pulses at the moment of calculation and presentation of the new averaged value. The measurement result is rounded up to the number of significant digits dependent on the attached probe (these are usually four digits) unless the **Maximum resolution** menu option is marked (see Sec. 1.3.1.2), the result is then presented with the highest precision. If the average comprises at least one partial measurement exceeding the value allowed within the current measurement range, the ↑ indicator is displayed in front of the result. The measurement result can significantly exceed the value of measurement range for some probes. Such a result is correct if the indicator of the exceeded range does not come up on the screen.

The metric prefix can be added to the original unit of the measured quantity in accordance with the International System of Units (SI).

The used symbols are given below:

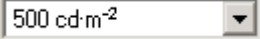


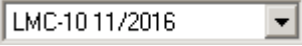


sub-multiplies			multiplies		
symbol	name	base 10	symbol	name	base 10
y	yocto	10^{-24}	k	kilo	10^3
z	zepto	10^{-21}	M	mega	10^6
a	atto	10^{-18}	G	giga	10^9
f	femto	10^{-15}	T	tera	10^{12}
p	piko	10^{-12}	P	peta	10^{15}
n	nano	10^{-9}	E	eksa	10^{18}
μ	mikro	10^{-6}	Z	zetta	10^{21}
m	mili	10^{-3}	Y	yotta	10^{24}

1.3.3. Graphical controls

Graphical controls of the RF200C main program window ensure:

- the choice of one of the probes connected to a PC,
- the choice of the probe measurement range,
- the settings of the measurement parameters,
- the measurement control.

The available controls are as follows:

-  - The drop-down list of the measurement range chosen manually. The control is taken over by the RF200C program when the automatic range change option is set.
-  - The choice of the averaging time of the measurement result. The value can be entered in an edit box or can be set with the use of the keys within the 1s time interval in 1-10s range.
- Automatic range change - The choice field of the automatic change of measurement range. It duplicates the **Command→Automatic range change** menu command.
- Luminance mode - The choice field of the luminance measurement mode. It is visible only for the probes that are illuminance/irradiance meters. It is required to connect the proper adapter to the probe for the luminance mode. It duplicates the **Command→Luminance mode** menu command.
- Single measurement / Continuous measurement - The choice fields of single/continuous measurement mode. It duplicates the following menu commands: **Command→Single measurement** / **Command→Continuous measurement**.
-  - Start/stop measurement button.
-  - The drop-down list of the available devices connected to a PC.
-  - Button to refresh the list of available devices.
-  - Button to turn on/off the acoustic indication of events: the result refreshing and using the key of the attached probe. It duplicates the **View→Play sound** menu command.
- [sonopan](#) - The link to the manufacturer's website.

1.4. Saved parameters

Some of the RF200C program settings are saved and restored after it is restarted. They are as follows:

- the set measurement mode: single/continuous,
- the setting of the automatic change of measurement range,
- the set result averaging time,
- the setting of the result display with the maximum resolution,
- the setting of the acoustic indication of events,
- the set language,
- the "always on top" setting,
- the size and position of the main program window,
- the chosen location of data files saved to the PC disc,
- the settings of the graphical controls controlling the saving to the file by the "Tests of monitors" application,
- the settings of the graphical controls steering the saving to the file by the "Advanced" application,
- the settings of the graphical controls steering the saving to the file by the "Measurement memory" application,
- the settings of the active tab of the "Advanced" application.

2. WORKING WITH MEASUREMENT PROBE

2.1. RF-200C converter

Before starting the program for the first time, the RF-200C converter (see Fig. 5) should be connected to the USB 2.0 port of a PC. The system installs by itself the proper driver of the device. The converter is ready to operate.



Fig. 5. View of RF-200C converter.

In the older systems, in case of lack of communication with the device, it is necessary to follow the below-placed procedure:

- Find the converter driver in the system window "Device Manager". It is displayed as the "USB Serial Converter" in the category: "Universal Serial Bus controllers".
- Select "Properties" of the driver, then go to the "Advanced" tab. Check the "Load VCP" control – it should be unmarked..

ATTENTION If the COM port related to the RF-200C device is open by any application, the above-mentioned tab is not visible.

- If the "Load VCP" control is marked, it is necessary to clear it and confirm the change with the OK key. Then, it is required to disconnect the RF-200C from the PC and connect it once again.
- In case of further lack of communication with the converter, it is necessary to update the driver by downloading it from the installation CD of the RF200C program (the "USB Driver" folder).

2.2. Connection of measurement probe to measurement system

2.2.1. Elements of measurement system

- measurement probe,

- RF-200C converter,
- measurement module of RF200C software,
- RF200C software,
- PC / tablet.

In metrological sense, the meter consists of the first three elements of the system. The measurement probe is powered from USB 2.0 port.

2.2.2. Assembling of measurement system

- Connect the RF-200C converter to a PC or tablet with the USB-A – Mini USB-B cable.
- Connect the measurement probe to the RF-200C converter.
ATTENTION **Connect to the RF-200C interface only these devices that are intended for this kind of connections.**
- Run the RF200C software. Choose the proper device from the drop-down list of available devices in the main window. If only one meter is connected to the PC, it is chosen automatically from the list
ATTENTION **Both measurement probes co-operating with the RF-200C software and the RF200C software itself are adapted for their connection and disconnection on the fly, without the necessity of disconnection of the converter from the PC. The software recognises the new probe and configures it properly.**

2.3. Measurement

2.3.1. Preparation for instrument operation

The measurement should be started (see Sec. 2.3.2) and the instrument readings with the covered probe should be checked. If the instrument does not read zero, the zeroing procedure should be conducted (see Sec. 2.3.1.1). After the zeroing procedure is finished, the probe should be uncovered. The instrument is ready for operation.

2.3.1.1. Zeroing of detector

The zeroing procedure of the detector consists in the measurement of the dark current of the measurement probe detector and its corresponding temperature (see Sec. 2.3.4). On the basis of this, the probe calculates the correction for the current operation temperature and deducts it from the result. The proper procedure is started with the use of the **Command→Start detector zeroing** menu command. It can be conducted only with the covered reception field of the probe. The value of the dark current and the temperature of the zeroing are saved to the memory of the measurement probe.

2.3.1.2. Zeroing of measurement system

The zeroing procedure of the detector consists in the measurement of the dark current of the measurement probe detector and its corresponding temperature (see Sec. 2.3.4). On the basis of this, the probe calculates the correction for the current operation temperature and deducts it from the result. The proper procedure is started with the use of the **Command→Start system zeroing** menu command. The value of the correction and the temperature of the zeroing are saved to the memory of the probe.

2.3.1.3. Automatic change of measurement range

In order to turn on/off the automatic change of the measurement range, the User should follow the **Command→Automatic range change** menu command or the suitable graphical control of the main program window (see Sec. 1.3.3). The manufacturer recommends turning on the automatic change of the measurement range. The manual control is used for checking the linearity during the calibration or in the specific conditions of the measurement when the

measured value changes in time in such a way that the instrument is incapable of determining the proper measurement range.

2.3.1.4. Additional actions

If the instruction manual of the attached probe requires the conduction of any additional actions which are not included in Sec. 2.3.1, these activities should be conducted.

2.3.2. Measurement triggering

To trigger the measurement, use described in Sec. 1.3.3 button of the main program window or the key which some measurement probes are equipped with. The device key can also have other functions, which depends on the currently running application of the RF200C software. If the measurement is triggered with the program main window button, the measurement time depends on the set operation mode:

- **Single measurement mode** - the measurement lasts for the set averaging time and it stops automatically when the set time elapses.
- **Continuous measurement mode** - the measurement lasts until the key for starting the measurement is pressed once again (in the main program window or on the instrument).

In the case of the measurement triggering with the use of the probe key, the measurement lasts until the key is released, but not shorter than the set averaging time. If during the averaging time at least one partial result is measured when measurement range is exceeded, the measured value is considered to be erroneous and the proper icon: ↑ is displayed in front of the result. The icon is turned off after the set averaging time has elapsed since the last exceedance. The measurement is stopped after the trigger key is pressed again. The result is not refreshed then.

2.3.3. Averaging of results

The measurement value displayed in the measurement window consists of many partial measurements taken from the attached probe. The displayed result is the arithmetic average of all the read values within the set averaging time. The frequency of reading partial results from the probe depends on its type and is chosen so as not to omit any of them. The averaging time is set in the main program window within the 1 – 10 seconds range. The result is refreshed every second and is the moving average from N last seconds where N stands for the set averaging time.

2.3.4. Temperature compensation

The change in the temperature of the probe influences the measurement result. Due to the temperature change, the other parameters also change and they are as follows:

- detector dark current - shift of zero indication,
- offset voltage of the measuring circuit - shift of zero indication,
- responsivity of a detector - change of measured quantity value,
- gain of the measuring circuit - change of measured quantity value.

Measuring probes are equipped with the temperature sensor and functions that minimise the influence of the above-mentioned factors on the measured value. The compensation of zero indication occurs after the zeroing of the detector (Sec. 2.3.1.1) or measuring circuit (Sec. 2.3.1.2). Moreover, all measurement probes are equipped with the function of automatic compensation of temperature influence on the measurement result. That solution significantly expands the operating temperature range minimising the measurement uncertainty.

2.3.5. Luminance mode

Illuminance/irradiance probes with the suitable adapter attached to them become luminance/radiance meters – depending on the probe type. Each type of the measuring probe has assigned permissions to adapters, which they can work with.

To set the luminance mode, it is necessary to follow the below-given instructions:

- connect the proper adapter to the measurement probe,
- follow the **Command**→**Luminance mode** menu command or check the proper control of the main program window (see Sec. 1.3.3), the window for selecting the type of attached adapter opens (see Fig. 6),
- select the proper type of the adapter,
- confirm the choice with the OK key.

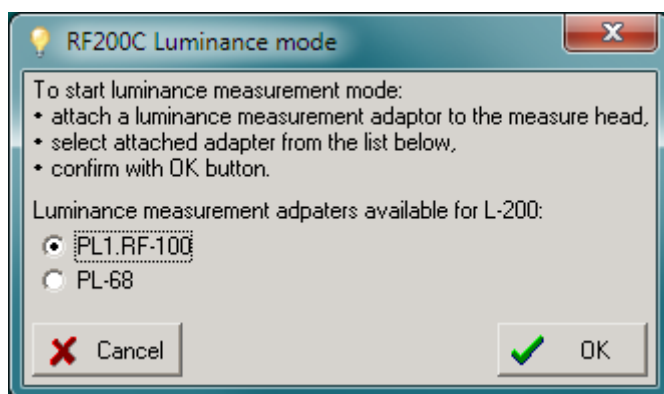



Fig. 6. Window for turning on the luminance mode.

ATTENTION

The measurement probes that co-operate with the luminance adapter have one calibration factor related to illuminance/irradiance measurement. The adjustment of the luminance meter, which consists of the L 2xx probe and adapter, should not be conducted because it influences the correctness of the illuminance measurement after the adapter is disconnected from the probe.

2.4. Calibration and adjustment of measuring probe

Calibration and adjustment procedure is the comparison of the measured values with those of a calibration standard of known accuracy. On the basis of this comparison, the calibration factor is calculated and saved to the measuring probe. Calibration should be conducted by a competent laboratory equipped with the suitable instruments and the proper photometric/radiometric standards. The calibration procedure is started with **Command**→**Calibration** menu command. Before the calibration window is opened (see Fig. 7), there comes up a message about the consequences of the improper adjustment of the meter. In the calibration mode, the temperature compensation is turned off, which is displayed with the use of the indicator  on the result panel (see Sec. 1.3.2). The temperature, in which the adjustment is made, is measured with the probe and is the reference for the temperature compensation algorithm.

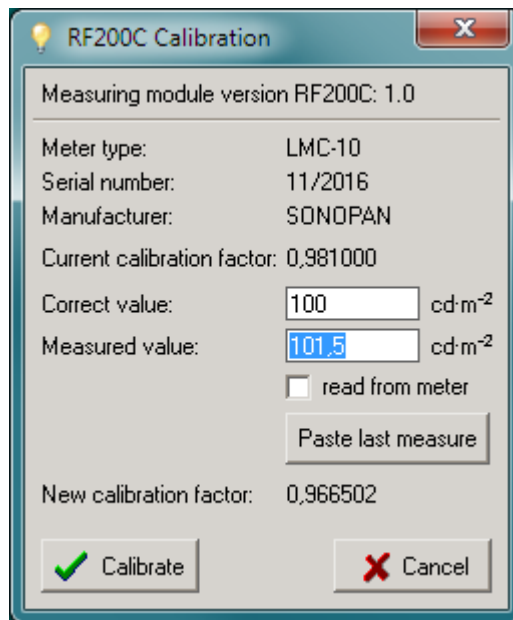


Fig. 7. Calibration window.

In the calibration window there is displayed the basic data that identifies the attached probe and the version of measurement module of the RF200C program. The measurement module forms the integral part of the meter which consists of the following elements:

- measurement probe,
- RF-200C converter,
- measurement module of RF200C software.

The correct and the measured value is entered in the edit boxes described respectively. The last measured value can be copied to the proper edit box with the use of the button. After marking the read from meter control the measurement is triggered and its results are pasted to the measured value edit box on an ongoing basis. In such a case it is impossible to stop the measurement in the main program window or with a key on the probe. The results are always pasted with the maximum resolution in order to decrease the adjustment uncertainty. After both required values are entered, a new calibration factor is calculated.

After the button is pressed, it is programmed into the measurement probe

3. RF200C PROGRAM APPLICATIONS

The RF200C software is equipped with the applications that extend the range of the probe usage or simplify its use. The access rights to the certain application depend on the type of the attached measurement probe. All the applications have the possibility of archiving of the measurements results to a PC disc. The data is saved in text files where the tabs are separation signs. Such a file format enables the User to open it directly with the spreadsheet. The collected results can also be copied to the clipboard and pasted directly to the spreadsheet or any other document.

The available applications are as follows:

- **Test of monitors** (it is started with the **Applications**→**Test of monitors** menu command),
- **Measurement memory** (it is started with the **Applications**→**Measurement memory** menu command),
- **Advanced** (it is started with the **Applications**→**Advanced** menu command).

The Advanced application ensures:

- relative measurement with any reference,
- integration in time,
- simple statistical calculations on measurement results.

3.1. Application: Tests of monitors

The application is intended for measuring heads that are luminance meters. It enables the User to conduct tests of medical imaging monitors in accordance with the guidelines of the American Association of Physicists in Medicine (AAPM).

It allows the User to conduct the following tests:

- grayscale mapping curve according to DICOM GSDF ¹,
- compliance of the maximum luminance between monitors of one station,
- luminance uniformity.

Only some measurement probes have access to this application. The detailed information on the permissions to the applications is included in the instruction manual of the attached instrument.

The tests can be conducted for a maximum of 8 monitors in one diagnostic station. The results of all the tests can be labelled with one comment and saved to the text file which can be open directly with a spreadsheet. The collected results can also be open and pasted to the copy of the MonitorCheck.xls spreadsheet template (see Sec. 3.1.6).

The application window comprises the following elements:

- Header panel,
- DICOM GSDF spreadsheet tab,
- Uniformity spreadsheet tab,
- Comment spreadsheet tab.

3.1.1. Header panel

The header panel used for the Tests of monitors application is shared by all tabs. It contains the menu system of operation on files and controls to the application operation.

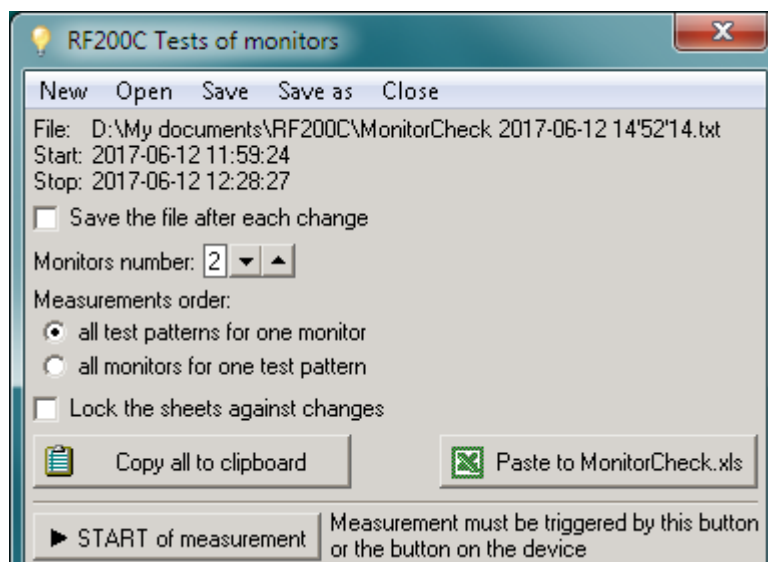


Fig. 8. View of Header panel of Tests of monitors application.




3.1.1.1. Menu system

- **New** - it clears all application spreadsheets.
- **Open** - it opens a file with the saved test results.
- **Save** - it saves the results of all tests and a comment to a file. If the file does not exist, it is displayed with a default name that consists of the prefix "MonitorCheck" and the starting date and time of the tests.

¹ DICOM GSDF: Grayscale Standard Function according to PS 3.14-2011 Digital Imaging and Communications in Medicine (DICOM) Part 14: Grayscale Standard Display Function.

- **Save as** - it saves data in the way mentioned above in the location and under the name indicated by the User. If the file does not exist, a default name is suggested.
- **Close** - it closes the application window.

3.1.1.2. Controls

- **File:** - location of the results file.
- **Start:** - starting date and time of measurements.
- **Stop:** - ending date and time of measurements.
- **Save file after each change** - marking this field protects from data loss in case of power failure or system reset. In this case data file is saved after every change. If the file is not created earlier, it is given a default name.
- - a number of tested monitors in one diagnostic station. 8 is the maximum number of the chosen monitors.
- Marking one of the options described as **Measurements order** defines the sequence of the automatic choice of consecutive sheet cells where the test results are entered:
 - **all test patterns for one monitor** - luminance of the screen is measured for the test images that are changed successively; the whole procedure is then repeated for consecutive monitors in a diagnostic station,
 - **all monitors for one test pattern** - luminance of all the monitors placed in one diagnostics station is measured for one test pattern; the whole procedure is then repeated for consecutive test patterns.
- **Lock sheets against changes** - marking the field prevents the modification of measurement results and comments, which secures data against any accidental changes. This option is set automatically after finishing all the measurements or after opening the data file.
-  **Copy all to the clipboard** - it is used to copy to the clipboard all the sheet data as well as the User's comments. They can be pasted to the spreadsheet or any other document using the combination of keys <Ctrl>+<V>.
-  **Paste to MonitorCheck.xls** - it is used to launch Microsoft Excel or OpenOffice Calc program that opens the MonitorCheck.xls template file (see Sec. 3.1.6), where the measurement results are processed.
-  **START of measurement** - this button or the key on the attached probe should be used to start the measurement. Single measurement is triggered with the averaging time specified in the main window, regardless of the measurement mode that is set in the main program window (single/continuous). Its result is pasted to the selected cell of the current sheet.

3.1.2. DICOM GSDF tab

This tab (see Fig. 9) is intended for the conduction of grayscale mapping curve according to DICOM GSDF with the aid of test images TG18-LN-12-01 ... TG18-LN-12-18 (see Sec. 3.1.5). The collected data is used simultaneously to assess the compliance of maximum values of luminance between the monitors of one diagnostic station. The number of sheet columns is the same as the number of monitors which is set in the header panel. After the application is started, the cell of the test image TG18 LN 01 for the first monitor is selected by default. It can be changed and the measurements will start from it. After conducting the measurement and entering its value into the active cell, the next cell is selected, according to the set measurements order. While changing consecutive test images on the screens of the tested monitors, a full set of tests should be conducted. The measurement result entered in the sheet cell can be deleted with the use of the <Delete> key on a PC keyboard.

As the above-described MonitorCheck.xls template is created for the data that comes from two monitors, in the case of the larger number of monitors it is necessary to specify which results are pasted to the spreadsheet. It is done by marking the **paste data to Excel** box in the

proper columns. This selection also applies to the **Uniformity** tab. Obviously, maximum two monitors can be marked simultaneously.

Test pattern	Monitor 1	Monitor 2
	<input checked="" type="checkbox"/> paste data to Excel	<input checked="" type="checkbox"/> paste data to Excel
TG18-LN12-01	1,00	1,03
TG18-LN12-02	2,11	2,12
TG18-LN12-03	3,80	3,82
TG18-LN12-04	6,22	1,94
TG18-LN12-05	9,57	
TG18-LN12-06	14,08	
TG18-LN12-07	20,06	
TG18-LN12-08	27,87	
TG18-LN12-09	37,99	
TG18-LN12-10	50,99	
TG18-LN12-11	67,62	
TG18-LN12-12	88,78	
TG18-LN12-13	115,63	
TG18-LN12-14	149,59	
TG18-LN12-15	192,47	
TG18-LN12-16	246,50	
TG18-LN12-17	314,42	
TG18-LN12-18	400,00	

DICOM GSDF Uniformity Comment

Fig. 9. View of DICOM GSDF test tab.

3.1.3. Uniformity tab

This tab (see Fig. 10) is intended for the conduction of luminance uniformity tests using the test images TG18-UNL-10 and TG18-UNL-80 (see Sec. 3.1.5). After the application is started, the cell of the upper-left part of the test image TG18-UNL10 for the first monitor is chosen by default. It can be changed and measurements will start from it. After conducting the measurement and entering its value into the active cell, the next cell is selected, according to the set measurements order. While changing consecutive test images on the screens of the tested monitors, a full set of tests should be conducted. The measurement result entered in the sheet cell can be deleted with the use of the <Delete> key on a PC keyboard.

As the above-described MonitorCheck.xls template is created for the data that comes from two monitors, in the case of the larger number of monitors it is necessary to specify which results are pasted to the spreadsheet. It is done by marking the paste data to Excel box in the proper columns. This selection also applies to the **DICOM GSDF** tab. Obviously, maximum two monitors can be marked simultaneously.

	Monitor 1	Monitor 2
	<input checked="" type="checkbox"/> paste data to Excel	<input checked="" type="checkbox"/> paste data to Excel
Test pattern: TG18-UNL10		
upper-left	118,56	123,16
upper-right	121,22	122,31
center	122,96	123,13
bottom-left	122,71	123,72
bottom-right	123,53	120,53
Test pattern: TG18-UNL80		
upper-left	124,46	120,45
upper-right	124,63	122,77
center	124,49	120,03
bottom-left	124,27	120,08
bottom-right	124,16	120,77

DICOM GSDF Uniformity Comment

Fig. 10. View of luminance uniformity test tab.

3.1.4. Comment tab

Medical imaging workstation consists of two monitors Barco E-3620.
SN: 1234, 5678

DICOM GSDF Uniformity Comment

Fig. 11. View of Comment tab.

This tab (see Fig. 11) is designed to enter the User's comments concerning the tested objects, tests conditions, etc. It is saved to the file alongside with the measurement data.

3.1.5. Conduction of tests

The files of control images and the possibility of their display on the tested monitors are indispensable for the conduction of tests. Each diagnostic station should be equipped with them. The files of control images published by the EUREF (European Reference Organization for Quality Assured Breast Screening and Diagnostic Services)² can be found on the installation disc of the RF200C program (the "Test patterns" folder).

The procedure goes as follows:

- Prepare the meter for operation in accordance with 2.2 and 2.3.

² Source: <http://www.euref.org/downloads/software-physico-technical-protocol/monitor-qc-test-patterns>.

- Put a stabilising cap on the probe if it is equipped with it.
- Set the proper averaging time in the main window of the RF200C program. The more unstable the luminance value of the tested monitor is, the longer time should be.
- Enter the number of tested monitors in the header panel as well as the sequence of the conducted measurements in relation to the adopted method
- Conduct a sequence of measurements according to Sec. 3.1.2 and Sec. 3.1.3.
- Describe the measurement environment on the comment tab (see Sec. 3.1.4).
- Process the measurement results using your own procedures or with the aid of the MonitorCheck.xls spreadsheet template (see Sec. 3.1.6).

3.1.6. MonitorCheck.xls template

The **Tests of monitors** application enables the User to process quickly the measurement results by pasting them in the MonitorCheck.xls spreadsheet template. The template is prepared by the LRCB Dutch Expert Centre for Screening³ and published on the website of the EUREF (European Reference Organisation for Quality Assured Breast Screening and Diagnostic Services). The file is installed along with the RF200C program and is located in [Documents]\RF200C\ folder. In order to open it, it is required to use Microsoft Excel or OpenOffice Calc program. The RF200C program launches Microsoft Excel or OpenOffice Calc program that opens the MonitorCheck.xls template file. Next, it pastes the results of the conducted measurements to the suitable cells of the spreadsheet where they are processed. The RF200C program creates additional tab named "Comment" in the spreadsheet and writes to it additional data about the measurement. The data contains the name of the meter type used for the conduction of the measurements, its serial number, RF-200C converter serial number, RF200C software measurement module version, starting and ending date and time of measurements and the User's comment.

3.2. Application: Measurement memory

The application (see Fig. 12) allows the User to collect single measurements or to create automatically the measurement history log. It is used to save the collected measurements to a PC. The file is saved in text format which can be open directly with the aid of the spreadsheet program. The file includes the name of the meter type, which is used for the conduction of measurements, its serial number, RF-200C converter serial number, RF200C software measurement module version, starting and ending date and time of measurements as well as the collected measurement results with individual comments attached to them and the User's global comment.

All measurement probes have access to this application.

The application window consists of:

- menu system of operation on files,
- header,
- graphical controls,
- measurements results sheet with individual comments,
- User's global comment window.

³ Source: <http://www.euref.org/downloads/software-physico-technical-protocol/monitor-check>.

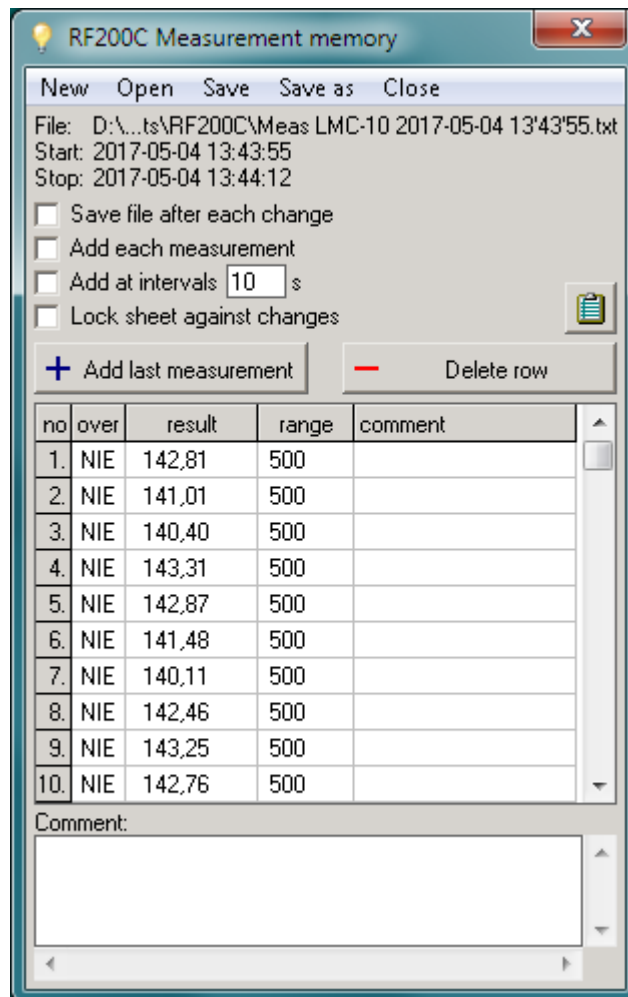


Fig. 12. View of the Measurement memory application window.

3.2.1. Menu system


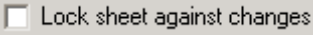
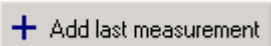
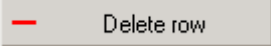

- **New** - it clears the results sheet and global comment window.
- **Open** - it opens a file with the saved results.
- **Save** - it saves the results and a comment to a file. If the file does not exist, it is displayed with a default name that consists of the prefix "Meas", the meter type and the starting date and time of the measurements.
- **Save as** - it saves the data in the way mentioned above in the location and under the name indicated by the User. If the file does not exist, a default name is suggested.
- **Close** - it closes application window.

3.2.2. Header

- **File:** - location of the results file.
- **Start:** - starting date and time of measurements.
- **Stop:** - ending date and time of measurements.

3.2.3. Controls

- **Save file after each change** - marking this field protects from data loss in case of power failure or system reset. In this case data file is saved after every change. If the file is not created earlier, it is given a default name.
- **Add each measurement** - marking this field results in appending to the result sheet each measurement from the results panel of the main RF200C program.

-  - marking this field results in appending to the result sheet measurements from the results panel of the main RF200C program with the time interval set in the edit field. The values are given in seconds from 1 - 9999s.
-  - marking the field prevents modification of measurement results and comments, which secures data against any accidental changes. This option is set automatically after opening the data file.
-  - it is used to add the last measured value from the results panel of the main RF200C program window to the results sheet.
-  - it is used to delete the selected row from the results sheet.
-  - it is used to copy to the clipboard the results sheet data as well as the User's comments. They can be pasted to the spreadsheet or any other document using the combination of keys <Ctrl>+<V>.

3.2.4. Results sheet

The results sheet is used to store the results chosen manually or entered automatically. Each measurement is presented in a separate row. It can be given an individual comment by double clicking the cell of the "comment" column or with the use of the <Enter> key when the cell is selected.

The columns in the results sheet are as follows:

- **no.** - successive measurement number,
- **over** - exceedance of measurement range,
- **result** - measured value, always displayed with the maximum resolution,
- **range** - measurement range of result,
- **comment** - individual commentary on result.

3.2.4.1. Automatic tracking

If any cell of the last row in the results sheet is selected and the new measurement is saved, a cell of the new row is automatically chosen. In other case, it is possible to browse the saved data and add an individual comment during recording of the measurements history log. In order to return to the automatic tracking mode, it is necessary to select any cell of the last row or click on the title of the **no.** column.

3.2.5. User's global comment

The measurements can be given a joint comment by entering it in the window placed below the results sheet.

3.3. Application: Advanced

The application window consists of three tabs:

- **Relative**
- **Integration**
- **Statistics**

Only some measurement probes have access to this application. The detailed information on the permissions to applications is included in the instruction manual of the attached instrument.

3.3.1. Relative measurement

The **Advanced/Relative** application (see Fig. 13) enables the User to conduct the measurements whose results are expressed as a percentage of any reference.

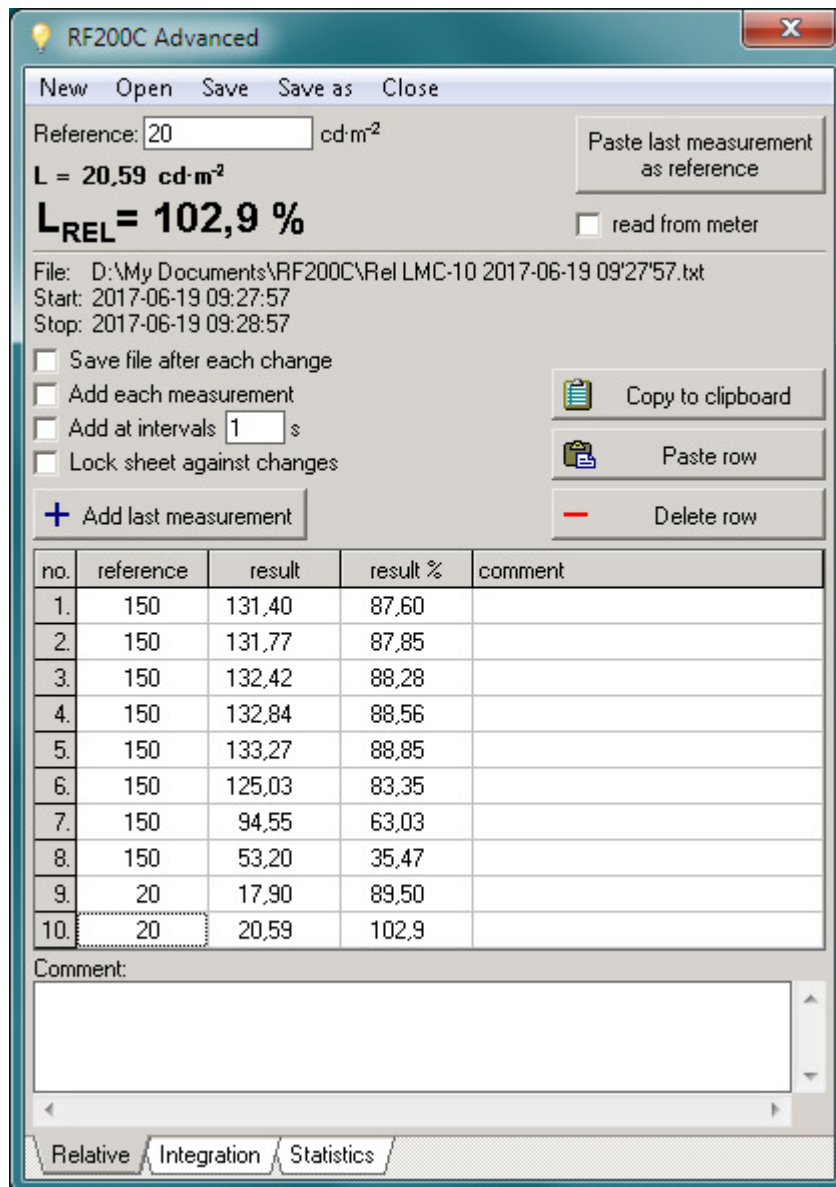


Fig. 13. View of the Advanced/Relative application window.

The application window consists of:

- menu system of operation on files,
- results panel,
- header,
- graphical controls,
- measurements results sheet with individual comments,
- User's global comment window.

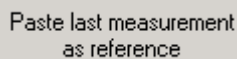
3.3.1.1. System menu

- **New** - it clears the results sheet and global comment window.
- **Open** - it opens a file with the saved results.
- **Save** - it saves the results and a comment to a file. If the file does not exist, it is displayed with a default name that consists of the prefix "Rel", the meter type and the starting date and time of the measurements.
- **Save as** - it saves data in the way mentioned above in the location and under the name indicated by the User. If the file does not exist, a default name is suggested.
- **Close** - it closes the **Advanced** application window.

3.3.1.2. Results panel

The results panel of the **Advanced/Relative** application should be treated as the extension of the main RF200C program window results panel.

The reference value, with respect to which the relative percentage value of measured value from the results panel of the main RF200C program window will be calculated, is entered into the Reference: $\text{cd}\cdot\text{m}^{-2}$ edit field.

 Paste last measurement as reference

Use the  button to set the last measured value as a reference.

After marking the read from meter field and triggering the measurement in the main RF200C program window, the current measurement results is displayed in the results panel as:

- **L = 20,59 $\text{cd}\cdot\text{m}^{-2}$** - the absolute measured value, always displayed with maximum resolution. If the measuring range is exceeded, the ↑ indicator will be placed in the front of the result.
- **L_{REL} = 102,9 %** - the relative value of the measurement result expressed as a percentage of the reference value displayed with an accuracy of four significant digits.

3.3.1.3. Header

- **File:** - location of the results file.
- **Start:** - starting date and time of measurements.
- **Stop:** - ending date and time of measurements.


3.3.1.4. Controls

Save file after each change - marking this field protects from data loss in case of power failure or system reset. In this case the data file is saved after every change. If the file is not created earlier, it is given a default name.

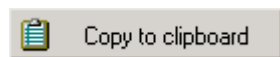
Add each measurement - marking this field results in appending to the result sheet a complete set of results from the results panel.

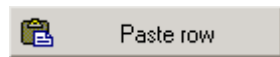
Add at intervals s - marking this field results in appending to the result sheet a complete set of results from the results panel with the time interval set in the edit field. The values are given in seconds from 1 - 9999s.

Lock sheet against changes - marking the field prevents modification of measurement results and comments, which secures data against any accidental changes. This option is set automatically after opening the data file.

 + Add last measurement - it is used to add the last complete set of results from the results panel to the results sheet.

 Delete row - it is used to delete the selected row from the results sheet.

 Copy to clipboard - it is used to copy to the clipboard the results sheet as well as the User's comments. They can be pasted to the spreadsheet or any other document using combination of keys <Ctrl>+<V>.

 Paste row - it is used to copy the results from the selected row of the results sheet to the results panel.

3.3.1.5. Results sheet

The results sheet is used to store the results chosen manually or entered automatically. Each measurement is presented in a separate row. It can be given an individual comment by double clicking the cell of the "comment" column or with the use of the <Enter> key when the cell is selected.

The columns in the results sheet are as follows:

- **no.** - successive measurement number,
- **reference** - reference value for relative value calculation,
- **over** - exceedance of measurement range,
- **result** - measured absolute value,
- **result %** - relative measured value,

- **comment** - individual commentary on result.

3.3.1.5.1. Automatic tracking

If any cell of the last row in the results sheet is selected and the new measurement is saved, a cell of the new row is automatically chosen. In other case, it is possible to browse the saved data and add an individual comment during recording of the measurements history log. In order to return to the automatic tracking mode, it is necessary to select any cell of the last row or click on the title of the **no.** column.

3.3.1.6. User's global comment

The measurements can be given a joint comment by entering it in the window placed below the results sheet.

3.3.2. Integration

The **Advanced/Integration** application (see Fig. 14) provides a function of integration of measurement results in time. It can be used to assess the hazards of optical radiation with the use of the suitable measurement probes. In photometry, the time integral of illuminance or luminance has no practical use. However, the integration function can become useful in the measurement of the highly variable values.

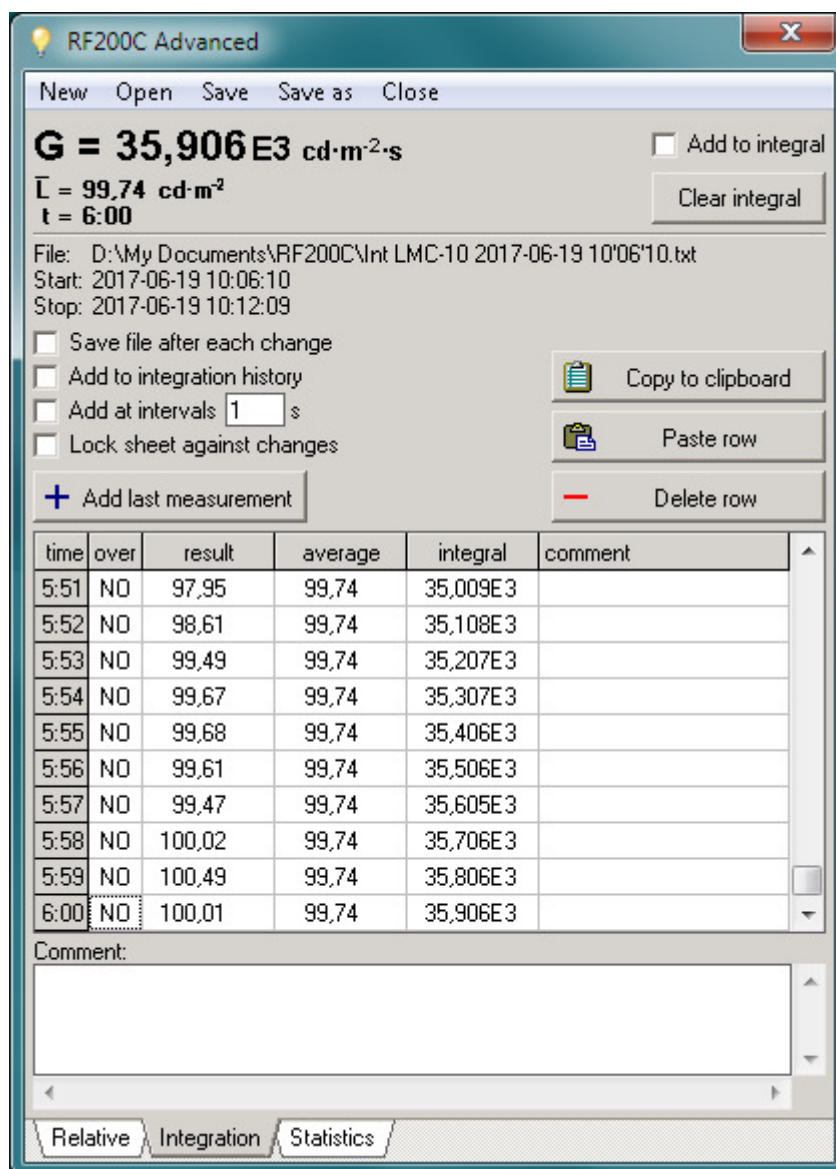


Fig. 14. View of the Advanced/Integration application window.

Using the integration mode, the measurement should be conducted until the average value of the measured quantity is steady. This value is the proper measurement result and it is the

arithmetic average measured in integrating time. When using the integration function, it is recommended to set in the main program window the averaging time that amounts to 1 second and turn on the automatic range change (see Sec. 1.3).

The application window consists of:

- menu system of operation on files,
- results panel,
- header,
- graphical controls,
- measurements results sheet with individual comments,
- User's global comment window.

3.3.2.1. System menu

- **New** - it clears the results sheet and global comment window.
- **Open** - it opens a file with the saved results.
- **Save** - it saves the results and a comment to a file. If the file does not exist, it is displayed with a default name that consists of the prefix "Int" the date and time of starting the measurements.
- **Save as** - it saves the data in the way mentioned above in the location and under the name indicated by the User. If the file does not exist, a default name is suggested.
- **Close** - it closes the **Advanced** application window.

3.3.2.2. Results panel

The results panel of the **Advanced/Relative** application should be treated as the extension of the main RF200C program window results panel.

It displays as follows:

- The value of the integral of the measured quantity labelled depending on the attached probe as:
 - H** - for illuminance/irradiance measurement probes,
 - G** - for luminance/radiance/photon radiance measurement probes.If the measuring range is exceeded during integration, the **↑** indicator will be placed in front of the result.
- The average value of the integral value for the integration time labelled depending on the attached probe as:
 - \bar{E}** - for illuminance/irradiance measurement probes,
 - \bar{L}** - for luminance/radiance/photon radiance measurement probes.
- Integration time labelled with the **t** letter. The time is displayed in: hhhh:mm:ss (hours, minutes, seconds) format. If the number of hours is zero, it is omitted.

After marking the **Add to integral** field and triggering the measurement in the main RF200C program window, the integration of measured quantity in time begins.

Use the button to clear all the values in the results panel. The integration time and integral value will be calculated from zero.

3.3.2.3. Header

- **File:** - location of the results file.
- **Start:** - starting date and time of measurements.
- **Stop:** - ending date and time of measurements.


3.3.2.4. Controls


Save file after each change - marking this field protects from data loss in case of power failure or system reset. In this case the data file is saved after every change. If the file is not created earlier, it is given a default name.

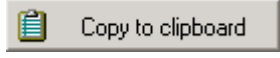
Add to integration history - marking this field results in appending to the result sheet a complete set of results from the results panel.

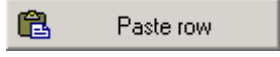
Add at intervals s - marking this field results in appending to the result sheet a complete set of results from the results panel with the time interval set in the edit field. The values are given in seconds from 1 - 9999s.

Lock sheet against changes - marking the field prevents modification of measurement results and comments, which secures data against any accidental changes. This option is set automatically after finishing all the measurements or after opening the data file.

 - it is used to add the last complete set of results from the results panel to the results sheet.

 - it is used to delete the selected row from the results sheet.

 - it is used to copy to the clipboard the results sheet as well as the User's comments. They can be pasted to spreadsheet or any other document using combination of keys <Ctrl>+<V>.

 - it is used to copy results from the selected row of the results sheet to the results panel allowing the continuation of measurements.

3.3.2.5. Results sheet

The results sheet is used to store the results chosen manually or entered automatically. Each measurement is presented in a separate row. It can be given an individual comment by double clicking the cell of the "comment" column or with the use of the <Enter> key when the cell is selected.

The results sheet may store several integration histories or a few final integration results that do not contain the entire history of partial results.

The columns in the results sheet are as follows:

- **time** – integration time,
- **over** - exceedance of measurement range,
- **result** - measured value of the integrated quantity,
- **average** - average value of the integral value for the time from the first column,
- **Integral** - integral value for the time from the first column,
- **comment** - individual commentary on result.

3.3.2.5.1. Automatic tracking


If any cell of the last row in the results sheet is selected and the new measurement is saved, a cell of the new row is automatically chosen. In other case, it is possible to browse the saved data and add an individual comment during recording of the measurements history log. In order to return to the automatic tracking mode, it is necessary to select any cell of the last row or click on the title of the **time** column.

3.3.2.6. User's global comment

The measurements can be given a joint comment by entering it in the window placed below the results sheet.

3.3.2.7. Continuation of previous measurements

The integration history log saved earlier can be continued later. In order to do it, it is necessary to comply with the following instructions:

- open the results data file, the last cell of the last row is selected automatically, so it should not be changed,
- use the  button to copy the last row of the results sheet to the results panel,
- mark the box: Add to integration history,
- mark the box: Add to integral on the results panel,

- trigger the measurement in the main RF200C program window.

3.3.3. Statistics

The **Advanced/Statistics** application (see Fig. 15) allows the User to conduct simple statistical operations on the measurement results. The results may be, among others, illuminance uniformity or contrast ratio.

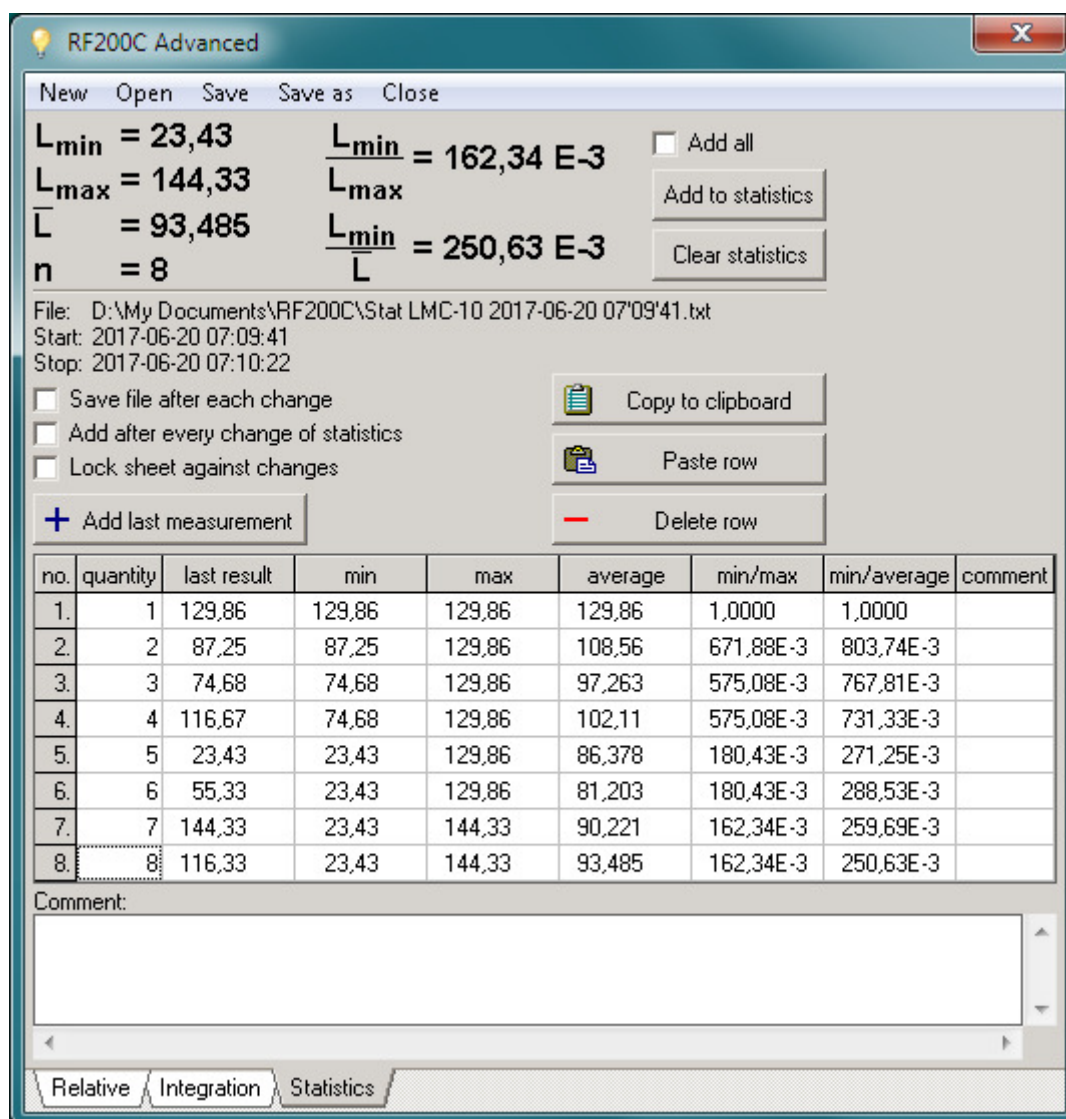


Fig. 15. View of the Advanced/Statistics application window.

The application window consists of:

- menu system of operation on files,
- results panel,
- header,
- graphical controls,
- measurements results sheet with individual comments,
- User's global comment window.

3.3.3.1. Menu system

- **New** - it clears the results sheet and global comment window.
- **Open** - it opens a file with the saved results.
- **Save** - it saves the results and a comment to a file. If the file does not exist, it is displayed with a default name that consists of the prefix "Stat" and the date and time of starting the measurements.
- **Save as** - it saves the data in the way mentioned above in the location and under the name indicated by the User. If the file does not exist, a default name is suggested.

- **Close** - it closes the **Advanced** application window.

3.3.3.2. Results panel

The results panel of the **Advanced/Statistics** application should be treated as the extension of the main RF200C program window results panel.

It displays as follows:

L_{min} / E_{min} the minimum value of the result saved in the statistics.

L_{max} / E_{max} the maximum value of the result saved in the statistics.

\bar{L} / \bar{E} the average value of the result saved in the statistics. If the measuring range is exceeded for any of the results in the statistics, the ↑ indicator will be placed in front of the result.

n the number of measurements saved in the statistics.

$\frac{L_{min}}{L_{max}} / \frac{E_{min}}{E_{max}}$

the quotient of the minimum and maximum value.

$\frac{L_{min}}{\bar{L}} / \frac{E_{min}}{\bar{E}}$

the quotient of the minimum and average value.

After marking the **Add all** box, all the measurements from the result panel of the main RF200C program window is added to the statistics.

Use the button: that adds the current measurement to the statistics.

Use the button: that clears all values in the results panel.

3.3.3.3. Header

- **File:** - location of the results file.
- **Start:** - starting date and time of measurements.
- **Stop:** - ending date and time of measurements.

3.3.3.4. Controls

Save file after each change - marking this field protects from data loss in case of power failure or system reset. In this case the data file is saved after every change. If the file is not created earlier, it is given a default name.

Add after every change of statistics - marking this field results in appending automatically a new row to the result sheet after every change of statistics in the results panel.

Lock sheet against changes - marking the field prevents modification of measurement results and comments, which secures data against any accidental changes. This option is set automatically after finishing all the measurements or after opening the data file.

- it is used to add the last complete set of results from the results panel to the results sheet.

- it is used to delete the selected row from the results sheet.

- it is used to copy to the clipboard the results sheet as well as the User's comments. They can be pasted to spreadsheet or any other document using combination of keys <Ctrl>+<V>.

- it is used to copy the results from the selected row of the results sheet to the results panel allowing continuation of measurements.

3.3.3.5. Results sheet

The results sheet is used to store the results chosen manually or entered automatically. Each measurement is presented in a separate row. It can be given an individual comment by double

clicking the cell of the "comment" column or with the use of the <Enter> key when the cell is selected.

The results sheet might store several statistics histories or a few final statistics results that do not contain the entire history of partial results

The columns in the results sheet are as follows:

- **no.** - successive measurement number,
- **quantity** - number of measurements in the statistics,
- **over** - exceedance of measurement range,
- **last result** - value of the last result in the statistics,
- **min** - minimum value of results in the statistics,
- **max** - maximum value of results in the statistics,
- **average** - average value of results in the statistics,
- **min/max** - quotient of minimum and maximum value,
- **min/average** - quotient of minimum and average value,
- **comment** - individual commentary on result.

3.3.3.5.1. Automatic tracking


If any cell of the last row in the results sheet is selected and the new measurement is saved, a cell of the new row is automatically chosen. In other case, it is possible to browse the saved data and add an individual comment during the recording of the measurements history log. In order to return to the automatic tracking mode, it is necessary to select any cell of the last row or click on the title of the **no.** column

3.3.3.6. User's global comment

The measurements can be given a joint comment by entering it in the window placed below the results sheet.

3.3.3.7. Continuation of previous measurements

The results of statistical calculations saved earlier can be continued later. In order to do it, it is necessary to comply with the following instructions:

- open results data file, the last cell of the last row is selected automatically, so it should not be changed,
- use the button:  to copy the last row of the results sheet to the results panel,
- mark the box: Add after every change of statistics,
- mark the box: Add all on the results panel,
- trigger the measurement in the main RF200C program window.