

OPERATING MANUAL

Photon

Operating manual

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E L E C T R O N I C S

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1 INTRODUCTION

The Photon II gas analyser is a device designed according to the latest technologies which makes use of the most recent techniques in the gas analysing field.

The analyser is built based on an extremely efficient PC-104-class computer using by the Windows CE 5.0 operating system. The device is equipped with a high-quality VGA touchscreen (with a resolution of 640 x 480). The use of this computer allows the user to connect a USB flash drive or peripheral device (such as mouse or keyboard) to the analyser. The only restriction on the use of these devices are the appropriate drivers – they have to be included in the already pre-installed Windows CE system.

2 CONSTRUCTION

Photon stationary gas analyser consists of three modules:

- Control unit
- Measurement unit
- Gas conditioning unit

Each of these modules are 19" rack compatible and can be provided with /without suitable rack. Modules are connected with each other with electrical and gaseous connections.

2.1 Control unit

The heart of the Control *unit* is a PC-104 industrial computer with 10" large, colour VGA (640x480) touchable screen to present results, make adjustments view device parameters, etc.

Control unit also gathers all digital and analogue inputs and outputs.

In the Drawing 1 elements that are marked:

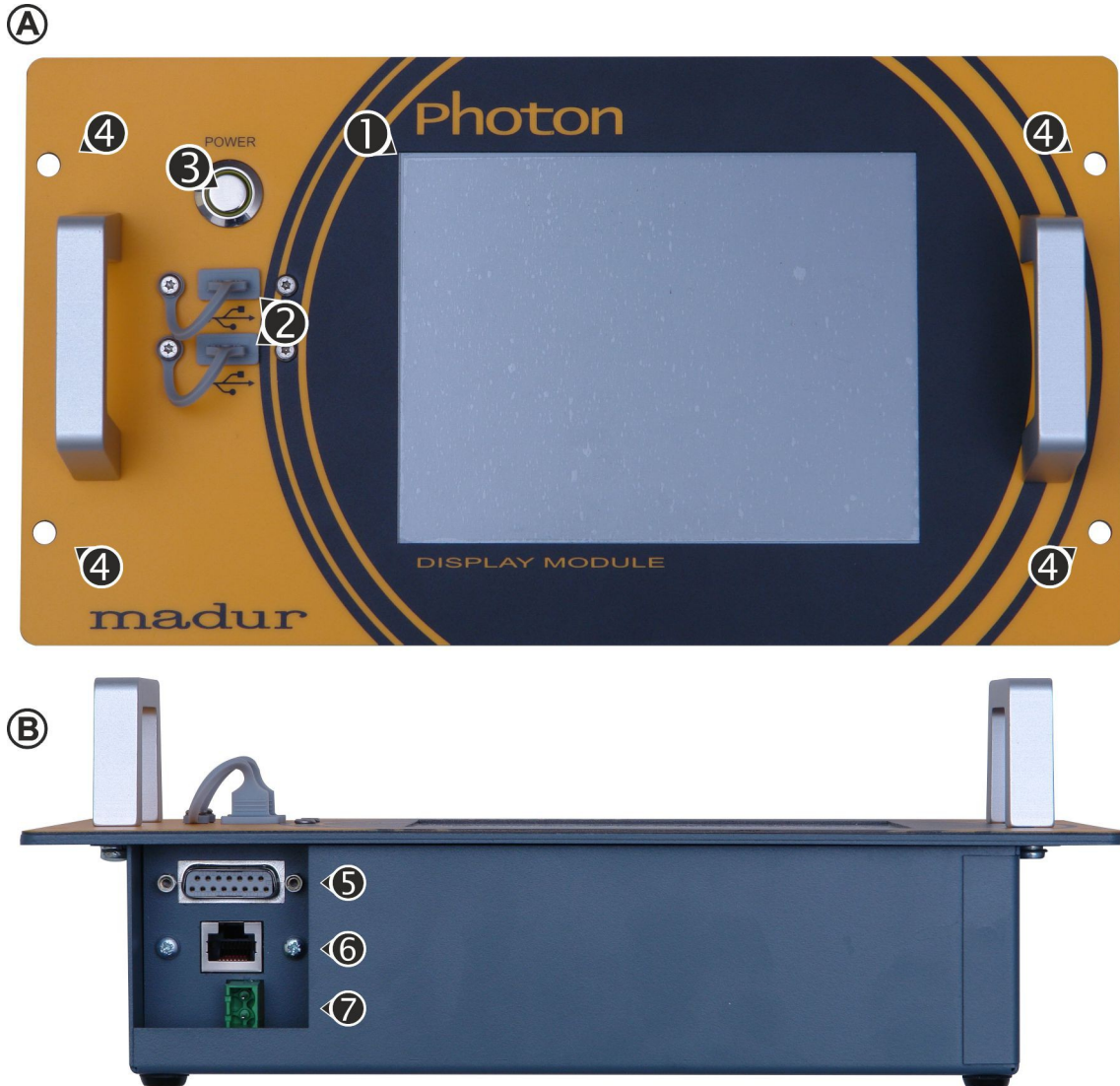
1. VGA (640x480) display with touch panel to present results, give commands.
2. Power button – to switch analyser on / off.
3. Analogue outputs (current and voltage).
4. Digital inputs / outputs.
5. Free expansion slot.
6. Control diodes.
7. Module communication port – connector is unified, there is no difference which port will be used for communication between modules.
8. Module communication port.
9. Supply connector if the display is separated from the control unit (optional solution).
10. Power cord.
11. Grounding.
12. Module's cooling fan.
13. Rear expansions slot.



Drawing 1 Control unit. A – front view, B – rear view

If the display is separated from the Control unit – it is deprived from display (1 in Drawing 1) and additional module is present Drawing 2:

1. VGA (640x480) display with touch panel to present results, give commands
2. USB ports for external devices like USB keys, keyboards, etc.
3. Power button – to switch analyser on / off
4. Holes to connect display module $\Phi = 12\text{mm}$
5. D-SUB 15pin connector to connect the control unit (with 7 or 8 in Drawing 1)
6. Ethernet RJ45 connector to connect to PC
7. 2-pin Mini-Combicon connector to connect power supply (connect with 1 in Drawing 1)



Drawing 2 Control unit – display module. A – front view, B – side view

2.2 Gas Conditioning unit

Gas Conditioning unit – gas dryer, prepares gas sample for measurement, i.e. removes dust particles and removes condensate. This way, the sample that reaches the Measurement unit is clean and dry.

Conditioning unit is also responsible for humidifying the NO sensor channel. NO measurement is influenced by presence of water. By stabilising the water level in NO channel, it is possible to achieve accurate NO results.



Drawing 3 Gas conditioning unit. A – front view, B – rear view.

1. Power button
2. Bühler gas filter (filter inlet made from fibreglass, pore size = 2 μ m)
3. Water reservoir – condensate container and a water source for humidifying NO channel.
4. Peristaltic pump for removing condensate / humidifying NO channel.
5. Module communication port
6. Module communication port
7. Nafion dryer water (in gaseous state) outlet
8. Dry gas outlet
9. Humid gas outlet
10. Power cord
11. Module's cooling fan
12. Fan of the Peltier cooler
13. Heated hose gas connection (gas inlet)
14. Heated hose electric connection

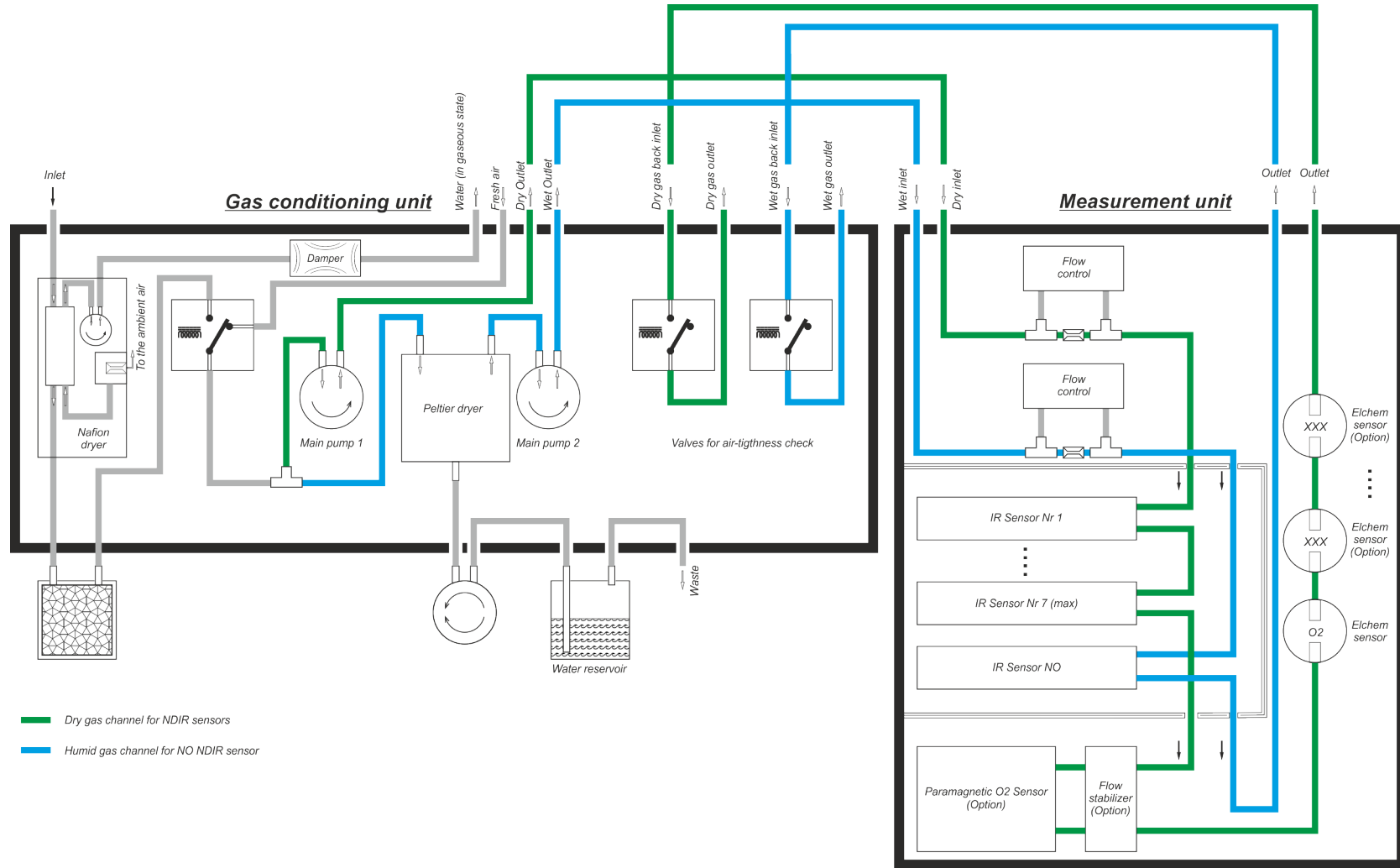
2.3 Measurement unit



Drawing 4 Measurement unit. A – front view, B – rear view.

1. Power button
2. Control diodes
3. Module communication port
4. Module communication port
5. Dry gas inlet
6. Humid gas inlet
7. Temperature sensors' connector
8. Power cord
9. Module's cooling fan
10. NDIR sensors' bay
11. Grounding

2.4 Gas channel



Drawing 5 The complete block diagram of Photon S analyser

The block diagram in the Drawing 5 shows all the possible full configuration of the analyser. Depend on the configuration of the analyser not all of the elements may be present in a specific device.

NAFION dryer is the most efficient type of device to remove humid from the gas, but it is not always possible to use it. One example of such situation is presence of NH_3 gas (ammonia) in the measured gas. Ammonia poisons NAFION material to the point of damaging it – then the condensation dryer must be used (based on the Peltier element).

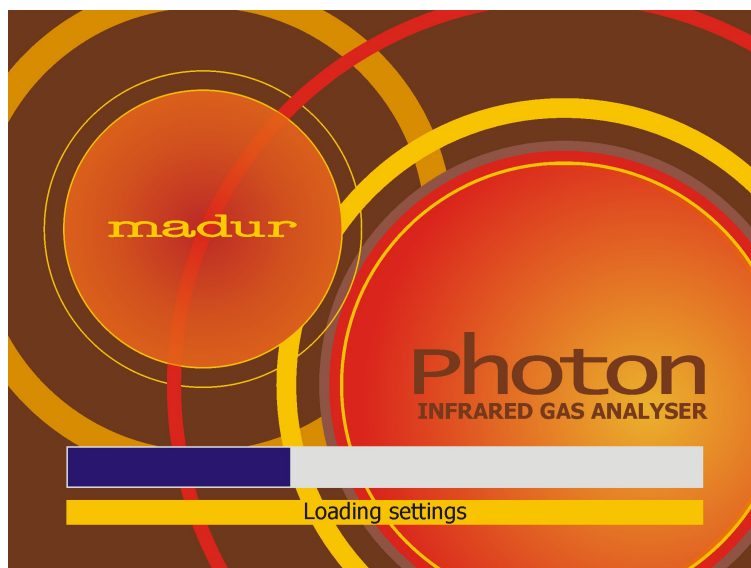
If the analyser is equipped with NO NDIR sensor, then it is necessary to humidify the gas (after it was dried with NAFION dryer), but at constant and known level. This way the measurement of the NO gas is possible and accurate. Humidification of gas is performed with Peltier cooler.

Photon S can be equipped with option of checking the air-tightness of the entire device and peripherals – then the additional solenoid valves are present (at the end of the gas channel).

3 OPERATING THE ANALYSER – SCREENS DESCRIPTION

3.1 Starting the analyser up

To turn the analyser on it is necessary to press the "POWER" button situated on the analyser front panel. Initially the PC-104 computer (the unit responsible for the proper operation of the analyser) starts up – meanwhile the device's screen remains switched off and the yellow LED of the "POWER" button flashes. After the PC-104 computer operation has been initialised, the Photon S operating program loads and the screen shown in the picture below (Drawing 6) appears on the device's display. At the bottom of the screen the information on loading of each of the program's modules successively appears. When the program has been loaded successfully, the user (the operator) selection screen appears (Drawing 7).



Drawing 6 Initialisation of the Photon program



Drawing 7 User selection screen


3.2 Program screens

After the user has been selected the first of the result screens (fundamental when using of the analyser) appears. Each of the analyser screens is divided into three sections: a top bar, a bottom bar and, between the two, the section that contains information on the measurement results, graphs, settings, etc. The top and the bottom bars look alike on each of the Photon's screens and they contain a similar set of functions and information.











3.2.1 The top bar of the screen



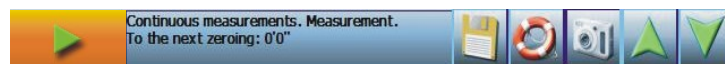
Drawing 8 The top bar

On the left side of the bar an icon  appears. It is to inform the user that the bar is actually a link, i.e. if pressed it evokes a *Quick menu* screen (described in detail in chapter 3.2.7). It is only possible to access the *Quick menu* by pressing the top bar on one of the three result screens. On any other screen the top bar is inactive.

On the right side of the bar the following information is contained:

-  - the icon signalling whether the results are being saved to the database. If the saving process is currently in progress the icon flashes red:
 - 
-  - the currently set averaging time (more information concerning the averaging times are contained in chapter 3.2.9.2)
-  - the currently chosen analyser work mode – in this case: the Continuous measurement (more information concerning the work modes can be found in chapter 3.2.13) The other possible options and their descriptions:
 -  - Cyclic measurement
 -  - Scheduled measurements
 -  - Single XL measurement
 -  - Triple XL measurement
 -  - n-Point measurement (Wizard measurement)
-  - the clock – shows the current time.





3.2.2 The bottom bar of the screen





Drawing 9 The bottom bar

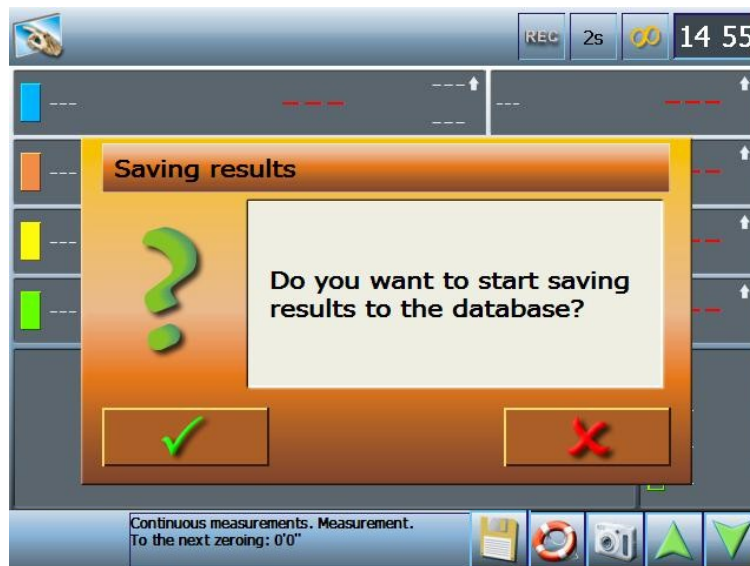
The bottom bar consists of:

- The action button appearing on the left side of the bottom bar on the result screen (provided that it is necessary) can look as shown below:







-  - pressing this button starts the measurement in the XL / 3XL measurement modes
-  - pressing this button stops the XL / 3XL measurement being currently in progress. If the key is pressed during the warming-up phase the warming-up process is discontinued enabling the user to perform some rough measurements
-  - pressing this button starts the succeeding measurement in the 3XL mode
-  - this icon indicates that the measurements performed in the XL / 3XL mode have been completed; pressing this button evokes an inquiry whether the measurement results should be saved to a database.

More information concerning XL / 3XL work modes can be found in chapter 3.2.13.4.

-  - The information box containing the basic information on the analyser performance (for instance: the amount of time remaining until the next zeroing, the dryer status, etc.). Short hints concerning the currently selected option are also displayed in the information box. The notes can be displayed in two different colours: black – information note, and red – error alerts. More information on the error alerts has been contained in chapter 3.4.
-  - This icon appears on the screens that enable the user to change settings or edit data (analyser work mode settings, fuel data, etc.). It makes it possible to save the introduced changes. On the result screen this button allows the user to initiate storing of the measurement results to the database. Pressing this key evokes the confirmation window.



Drawing 10 Saving results to the database – confirmation window



-  - The help button. Evokes the appropriate context-sensitive help window.
-  - The „*Snapshot*” button – enables the user to save the current screen shot as a JPG file on the hard disk. This option can be useful in case the user wants to store the current graph appearance or to provide documentary evidence of improper operation for service.
-  - The arrow navigation buttons. Some menus consist of a number of lines that cannot be displayed at a time within one screen. If the particular menu has more option lines the arrow buttons remain active enabling user to switch between the screens with the following options. Otherwise they appear as inactive i.e. faded: . In case of the result screens the arrows make it possible to switch between the three screens.
-  - The back navigation button appears on all the screens except from the result screens. It navigates the user back to the previously viewed screen.
-  - The back-to-the-results button appears on all the screens except for the result screens. It navigates to the result screen.

3.2.3 Keyboard

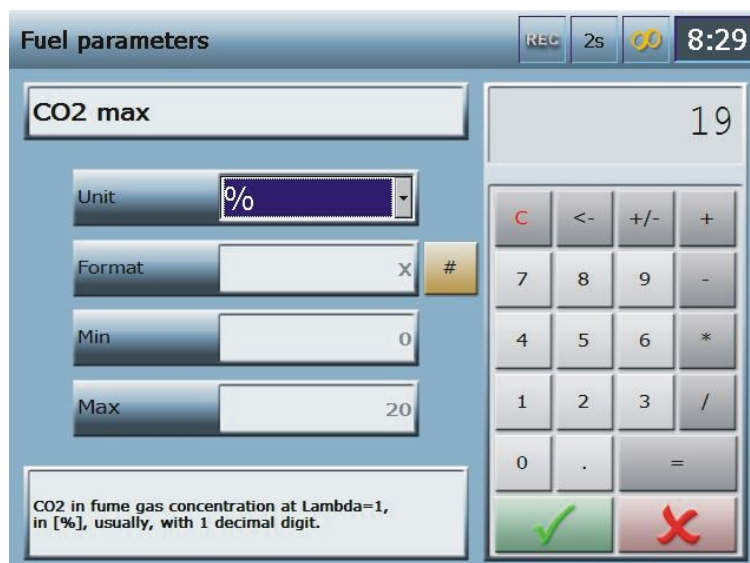


Drawing 11 Keyboard

In case it is necessary to type in a text, name, description, etc. a keyboard is displayed on the analyser's screen. The national characters are available after the "ALT" key has been pressed. Save the changes and return to the previous screen by pressing

the  button. Pressing the  button also navigates to the previous menu screen, however it does not save the introduced changes. The name of the box where the data is being typed in appears on the top bar.



3.2.4 Numeric keypad



Drawing 12 Fuel parameters screen – numeric keypad operation

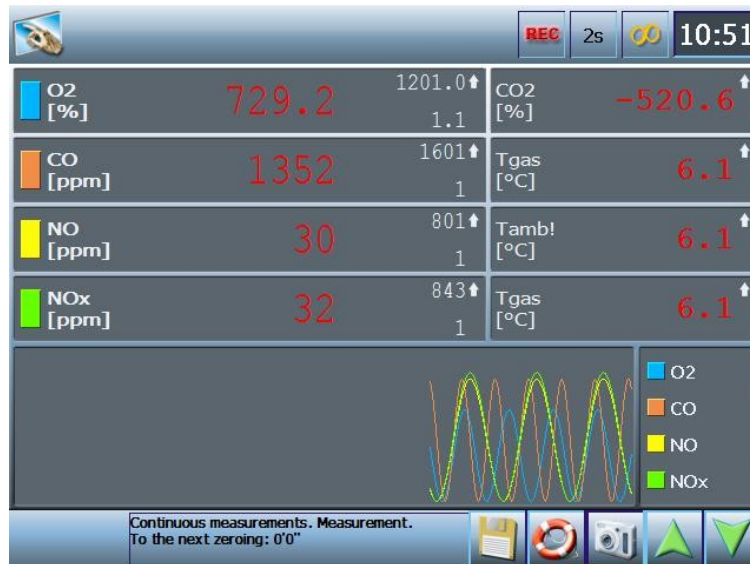
After clicking on a box where it is necessary to enter a value, an auxiliary screen containing a numeric keypad will appear. The name of the screen where the data is being entered appears in the top bar (in the example above, it is the fuel parameters screen). The name of the variable appears in the box right below the top bar. On the left-hand side of the screen the following information is displayed:

- the name of the modified value (in this case: CO2max);
- the unit; it is possible to select a unit from the drop-down list containing all the available units; if a change is made to the set unit the value shown on the calculator is automatically recalculated;
- the format of the value – it informs the user of the accuracy of the displayed values, i.e. the number of significant decimal digits to the right of the decimal mark;
- the minimal value – the minimum of the value's range;
- the maximal value – the maximum of the value's range.

On the right side of the screen there is a calculator enabling the user to perform simple calculations. Similarly to operating the keyboard, saving the changes and returning to the previous screen follows pressing the  button. Pressing the  button also navigates to the previous menu screen, however it cancels all the introduced changes.

3.2.5 Result screens

The analyser has three different result screens. Any user can define each of the result screens according to their personal preferences.



Drawing 13 Results screen 1

In the top part of the first result screen (up to) eight currently measured variables are presented. The four of them displayed on the left side of the screen have three values. The current value is typed in the biggest characters. The smaller characters present the maximal value (the upper number) and the minimal value (the bottom number). The little white arrow pointing up or down indicates the tendency of the value changes. These four variables are also presented graphically at the bottom of the screen.

At the top right there are another four variables (as a default these are auxiliary values, such as gas and ambient temperature, pressure, etc.).

On each of the results screens the currently measured values can be displayed in different colours of characters:

- **White** – an accurate result meaning that the analyser is ready for measurements and the currently displayed value is correct and can be saved to a database and processed further.
- **Violet** – an uncertain result meaning that the analyser has not yet reached the optimal working parameters (i.e. the warming-up phase has been interrupted, the gas dryer has reached the set parameters but they differ from the optimal ones).
- **Red** – an incorrect result meaning that the analyser is not ready for the measurements (the device has not been warmed-up yet, the gas dryer has not been connected, it reports an error or has not reached the set parameters yet, etc.).

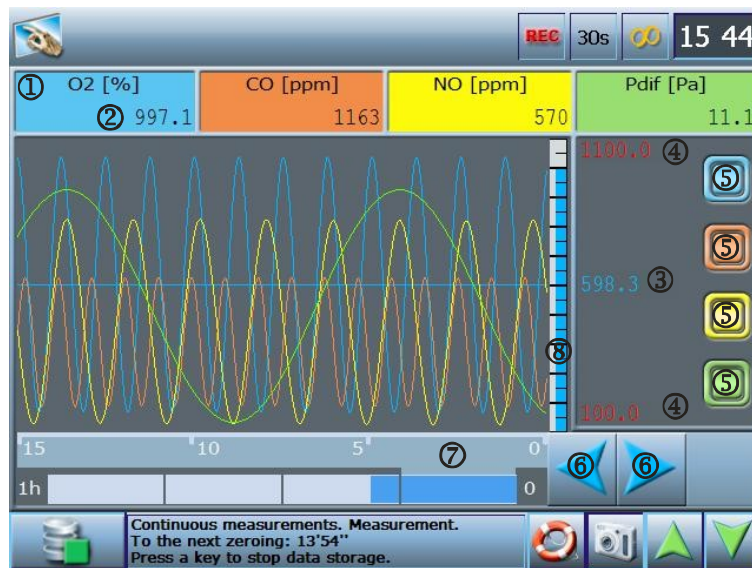
- **Grey** – a useless result meaning that the analyser is undergoing the warming-up or zeroing phase.

To choose another variable to be shown on the display it is necessary to click on and hold for a few seconds the box which is to be modified. A screen making it possible for the user to assign a variable to the appropriate box will appear (more information can be found in chapter 3.2.6).



Drawing 14 Result screen 2



The second result screen can display a set of variables completely different from the ones shown on the result screen 1. It contains four main variables presented in the upper part of the screen. On the left hand side the variable values are presented. The appropriate graphs illustrating the four variables are shown on the right. The eight auxiliary variables are displayed at the bottom of the screen.



Drawing 15 Result screen 3 - graph

The result screen 3 presents the measurement results in the form of a graph. The graphical representation of up to four values is constantly updated so it shows the variable curve up to a current value. Above the graph the variables' names ① and their current values ② are shown in a boxes highlighted in a colour matching the colour of the curve representing the appropriate variable on the graph.

Single clicking the coloured box highlights the appropriate variable (the font size is enlarged and the curve on the graph is thickened). On the right side of the screen there are switches enabling the user to hide or show the appropriate curve on the graph ⑤.

-  - a curve displayed on the graph
-  - a hidden curve

Clicking on and holding the coloured box for a few seconds opens a screen making it possible for the user to select the variable to be shown on the graph (more information in chapter 3.2.6).

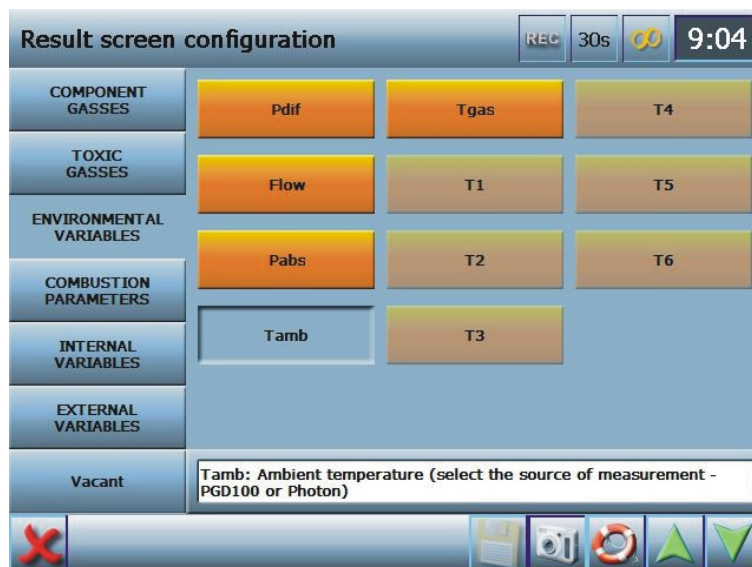
Additionally, on the graph, the average value of the selected variable (or the variable on the left-hand side if none of the variables is selected) is presented in a form of a horizontal line and a numerical value ③. On the vertical axis the maximal and minimal values ④ of the particular variable are marked (the values are displayed in a colour to show whether the result is accurate, uncertain, incorrect or useless – more detailed information has been given above). On the vertical axis a bar of a height and a colour

relating to the current selected variable's value is shown making it easier for the user to read the graph ⑤.

The analyser buffer stores the results of the last 60 minutes from all the available sources (IR and electrochemical sensors, temperature, pressure sensors, etc.). The graph is drawn basing on the data stored in the buffer. For the clarity of the graph only the results of a 15-minute period are displayed at once. It is possible to switch between the four quarters of the last hour (0÷15, 16÷30, 31÷45, 46÷60) with the use of the blue horizontal arrows ⑥. Underneath the horizontal axis the degree of buffer load is shown graphically ⑦ (as the continuously enlarging blue part of the horizontal bar below the chart). The degree to which the buffer storing the results is loaded is the amount of time for which the results can be shown on the graph.

3.2.6 Changing variables shown on result screens

To select a variable presented on the result screen it is necessary to click on and hold for a few seconds the box of a variable which is to be changed. The screen shown below will appear.



Drawing 16 Result screen configuration - screen enabling user to configure result screen

On the left there are the categories of variables. The chosen category is marked as a “pressed button” (in the example above – Environmental variables).

On the right side of the screen the variables that can be presented in the result screens are listed. The selected variable is marked as a “pressed button” (in the example above – Tamb). The variables the user can choose from are shown in a bright-orange colour. The variables marked with a pale-orange colour are the variables the user cannot

select (for example if the analyser did not detect the presence of an appropriate sensor or the selection is available only for the service staff). Above the bottom bar a short description of a selected variable is displayed.

The categories of the variables:








- Component gases – the gases being the components of air (O₂, CO, CO₂, etc.).
- Toxic gases – the gases whose concentrations are measured most frequently (NO₂, SO₂, H₂S, etc.).
- Environmental variables – pressure and temperature.
- Combustion parameters (calculated by the analyser).
- Internal variables – the temperature inside the analyser, the heated hose temperature, etc.
- External variables – the analogue outputs' currents and voltages.
- Vacant – the option selected if the particular box on the result screen is not to display any variable.







3.2.7 Quick menu



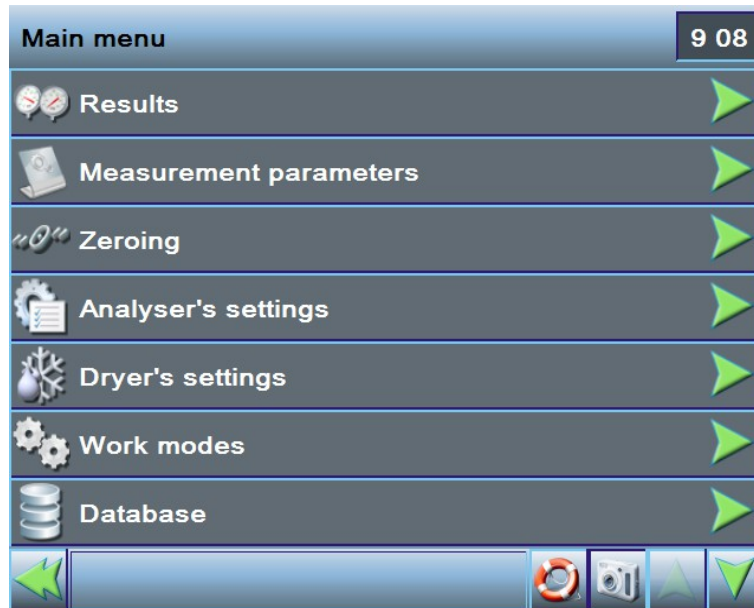
Drawing 17 Quick menu

If the user clicks on the top bar on any of the result screens the *Quick menu* shown in the Drawing 17 appears for a few seconds. The *Quick menu* contains a set of icons – links to the most frequently used screens when operating the device:

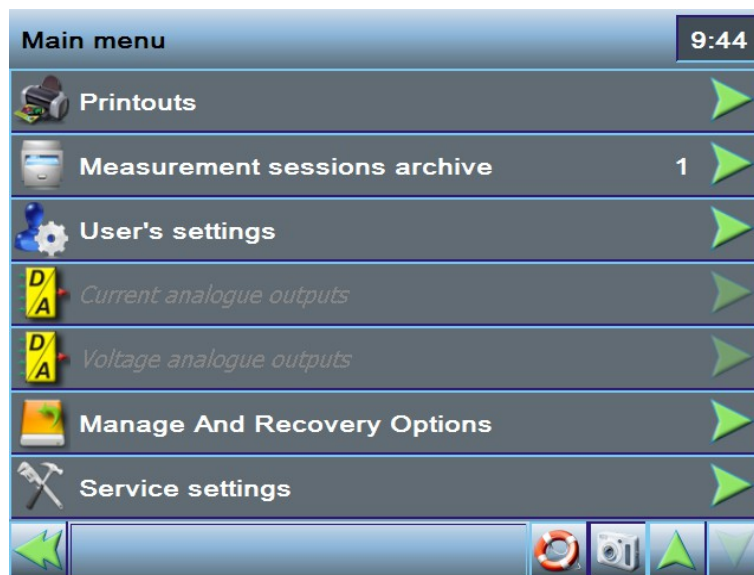
-  - Returns to the result screen (it is also possible to return to the result screen by clicking the *Quick menu's* top bar or by not touching the screen for a few seconds – the program will automatically return to the result screen).
-  - Navigates to the screen enabling the user to adjust the analyser working parameters (such as O₂ reference definition, fuel selection, etc.). This screen has been described in detail in chapter 3.2.9.
-  - Makes it possible for the user to reach the analyser work mode screen and select the analyser's work mode. This screen and the available work modes have been described in detail in chapter 3.2.13.
-  - Navigates to the screen enabling the user to perform the zeroing of the sensors (gas, temperature, pressure, etc.) More details can be found in chapter 3.2.10.
-  - Evokes the program's *Main menu*. It allows the user to access every available option, setting, the analyser database, etc. The detailed description of the *Main menu* screen has been contained in chapter 3.2.8.
-  - Navigates to the *Archive* where all the performed measurement results are stored. The *Archive* screen enables the user to view the stored session in a form of a graph or copy the stored session onto a USB flash drive to process it further with the help of a laptop or a PC. The screen has been thoroughly described in chapter 3.2.16.
-  - Evokes the screen making it possible to select the user that operates the analyser. The device stores the personal settings of each of the users registered in the database. More details can be found in chapter 3.2.11.6.

-  - Navigates to the *Analyser's settings* screen enabling the user to change, among others, the display backlight, time and date settings or the device's program language. The analyser settings screen has been described in detail in chapter 3.2.11.
-  - Opens the screen allowing the user to select the industrial site where the measurements are to take place. To each industrial site stored in the database the user can assign the contact details and the information concerning the measurements, such as the type of the fuel in use, shape of the chimney, etc. These data makes it easier to perform measurements and later to prepare a proper report (in accordance with the standards). More details can be found in chapter 3.2.14.1.
-  - Navigates to the screen enabling the user to make a printout of a report, a measurement session stored in a database or a previously saved screen shot. The screen has been thoroughly described in chapter 3.2.15.
-  - Displays the analyser status screen. The quantity and the type of the installed IR and electrochemical sensors, the analyser running time, the advised amount of the time remaining until the next calibration performed by the service staff, etc. More details can be found in chapter 3.2.11.1.
-  - Evokes the *Dryer settings* menu allowing the user to adjust the working parameters of the dryer working with the analyser and to view its current status. The screen has been described in detail in chapter 3.2.12.
-  - Enables the user to reach the analyser database where all the data concerning the clients, industrial sites, users, fuels, etc. are stored. With help of the *Database* menu it is possible to view, edit or add database elements. More details can be found in chapter 3.2.14.

3.2.8 Main menu




Drawing 18 Analyser main menu (screen 1)

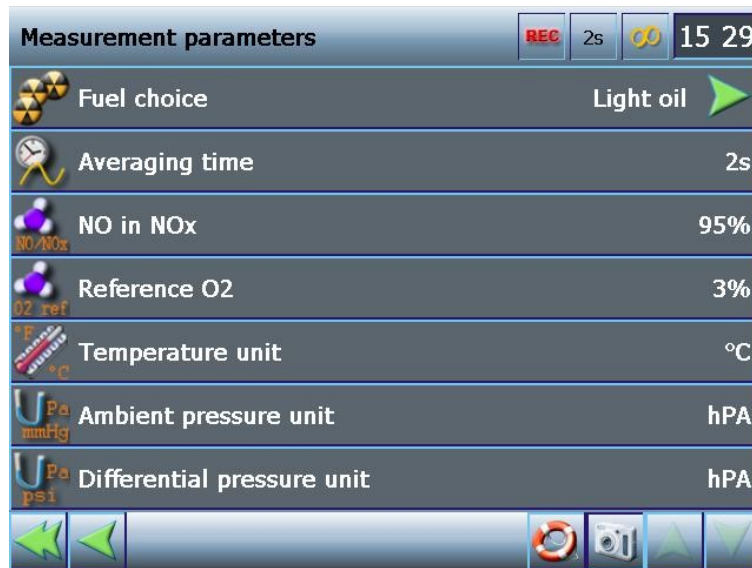


Drawing 19 Analyser main menu (screen 2)

Most of the analyser's menus have the bar form. Each bar consists of an icon symbolising the particular option (on the left) and the option's name displayed next to the icon. If clicking the particular bar evokes another screen the green arrow appears on the

right end of the bar .

3.2.9 Measurement parameters





Drawing 20 Measurement parameters screen


3.2.9.1 Fuel choice




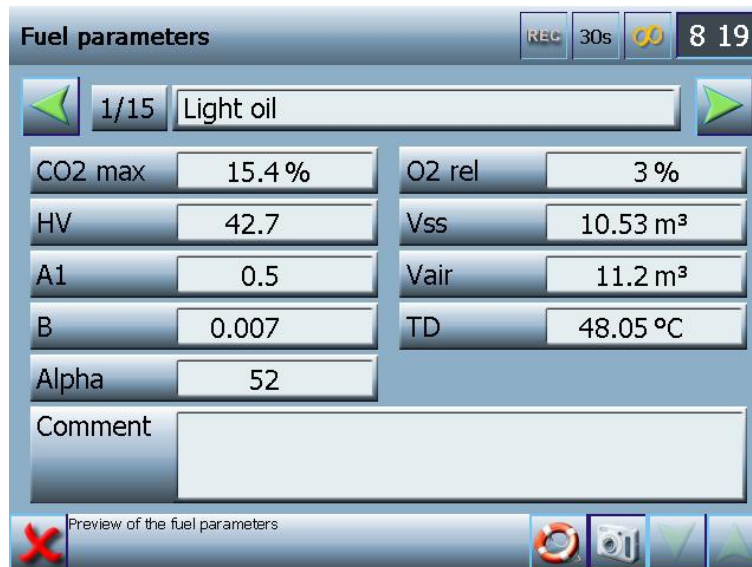
Drawing 21 Fuel choice screen

The device has a predefined set of fuels of a certain parameters according to which the analyser calculates the combustion parameters. The icon  symbolises a fuel which has been defined by the producer and whose parameters cannot be edited by

the user. However, it is possible for the user to define their own set of fuels. The fuel defined by user is marked with an icon .

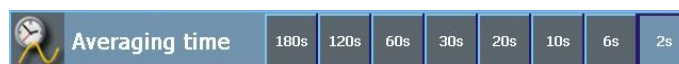
The currently selected fuel is marked with an icon  placed on the right side of the bar. The selection of the fuel in use can be made by clicking on the particular fuel's bar. With the help of the *Fuel choice* menu it is possible to view the particular fuel

parameters. Clicking the icon  evokes the preview screen shown in Drawing 22. The screen is much alike the fuel parameters edition screen accessible from the database menu. However, unlike the edition screen, the fuel parameters preview screen does not allow the user to introduce any changes to the fuel settings. More information on editing fuel parameters can be found in chapter 3.2.14.3.



Drawing 22 Preview of the fuel parameters

3.2.9.2 Averaging time



Drawing 23 Averaging time selection

The Photon II analyser stores (in the internal buffer or on a compact flash drive) the performed measurements results every 2 seconds. The averaging time serves only for the purpose of presenting the results on the graph. Storing the results does not depend on the selected averaging time in any way. Therefore the averaging time can be changed at any time during the measurements process – this change will only affect the


appearance of the graph. The available averaging times are: 2s, 6s, 10s, 20s, 30s, 60s, 120s, 180s, 1+n (the average of the whole measurement session).

3.2.9.3 **NO in NO_x**



Drawing 24 NO in NO_x selection

This parameter is used to estimate the concentration of nitrogen oxides in the environment basing on the nitric oxide content. It is most frequently assumed to equal 95% or 97%. It is possible to define this parameter manually with the help of the numeric



keypad, by clicking the  icon. Instructions on how to use the numeric keypad can be found in chapter 3.2.4.

3.2.9.4 **O2 reference**



Drawing 25 O2 reference selection

This parameter is used for calculating the relative content of components. The available values are: 3% or 11%. The O2 reference value can also be an assigned

characteristic of a particular fuel defined through a database  or can be typed in manually with the help of the numeric keypad .

3.2.9.5 **Temperature unit**



Drawing 26 Temperature unit selection

This bar enables the user to select the unit, in which the temperature values are displayed on the result screens and stored in the database. The choice can be made between: K, °F and °C.

3.2.9.6 **Ambient pressure unit**



Drawing 27 Ambient pressure unit selection

This bar allows the user to select the unit, in which the ambient pressure values are displayed on the result screens and stored in the database. The available ambient pressure units are: inch Hg, mm Hg, PSI, Pa, hPa.

3.2.9.7 Differential pressure unit



Drawing 28 Differential pressure unit selection

This bar makes it possible for the user to select the unit, in which the differential pressure values are displayed on the result screens and stored in the database. The available differential pressure units are: inch Hg, mm Hg, PSI, Pa, hPa.

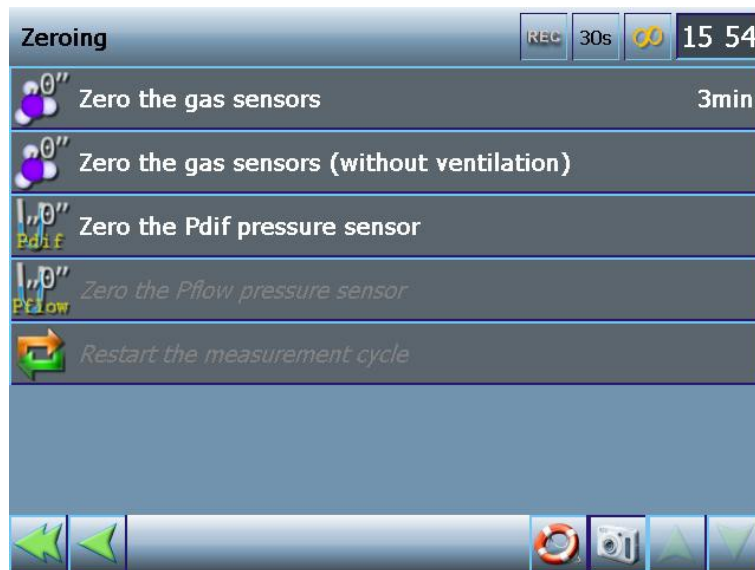
3.2.9.8 List of gases

This menu contains the list of all the gases measured by the device. It enables the user to select the basic unit, in which the gases concentrations are to be displayed on the result screens.



Drawing 29 List of gases

3.2.10 Zeroing



Drawing 30 Sensor zeroing screen

3.2.10.1 Zero the gas sensors

Clicking the *Zero the gas sensors* option starts the zeroing process. The gas channels are being ventilated with clean air for a few minutes. After the ventilation process has been completed, the sensors readings are assumed to be the zero values.

3.2.10.2 Zero the gas sensors (without ventilation)

The gas sensors zeroing (without ventilation) can be also described as fast zeroing. The analyser assumes that the current sensor readings are the zero values. As the fast zeroing does not include the ventilation process it is crucial to make sure the gases which are to be measured later on are absent in the environment during the zeroing procedure. Otherwise the sensors are zeroed improperly which will cause faulty measurement results.

3.2.10.3 Zero the Pdif pressure sensor

The analyser assumes that the current differential pressure value equals zero.

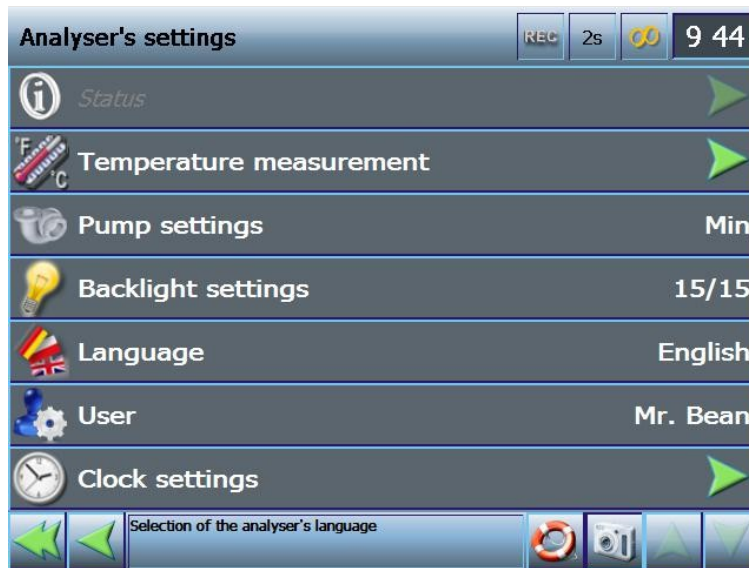
3.2.10.4 Zero the Pflow pressure sensor

The analyser assumes that the current flow pressure value equals zero.

3.2.10.5 Restart the measurement cycle

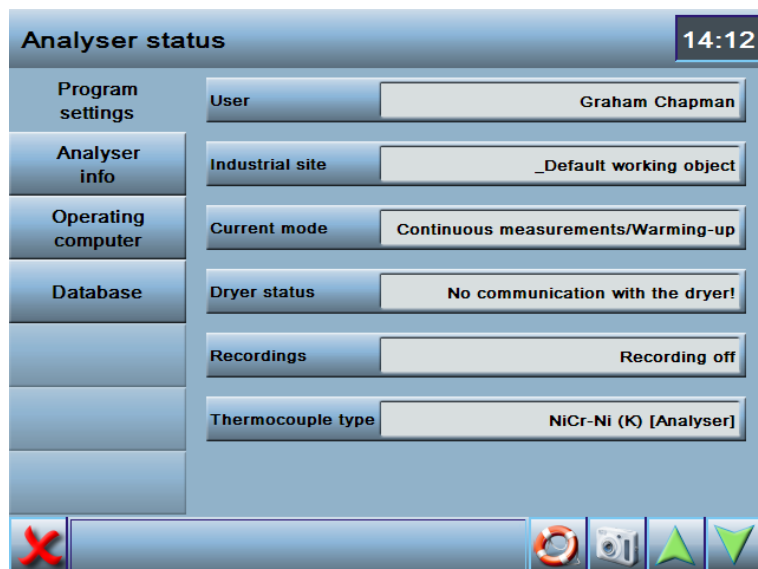
This option is active only if the analyser is working in the cyclic measurement mode. Clicking this option discontinues the currently proceeding measurements, starts the ventilation process, induces the zeroing procedure and finally lets the analyser restart the measurements.

3.2.11 Analyser's settings



Drawing 31 Analyser's settings screen

3.2.11.1 Status



Drawing 32 Analyser status screen – program settings

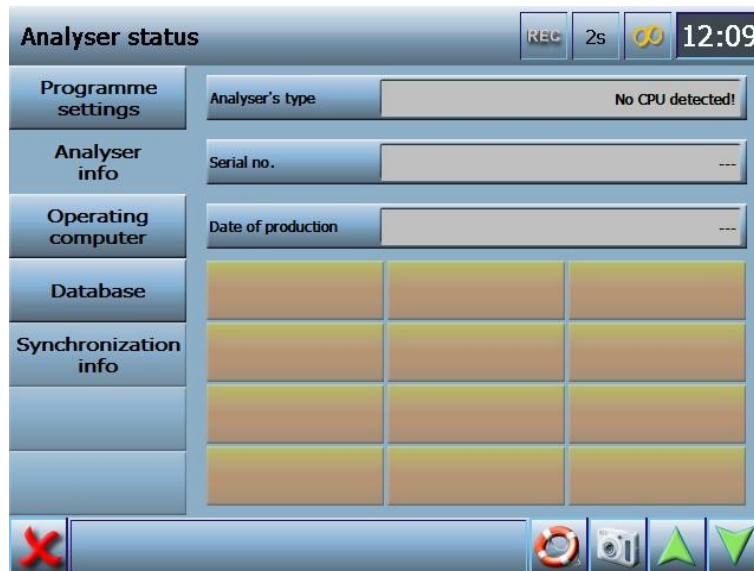
Status screens gather information concerning the analyser function and its current state. On the left there are the information categories. The currently selected category is marked as a “pressed button”. On the right side the information of a particular category is listed.

3.2.11.1.1 Program settings

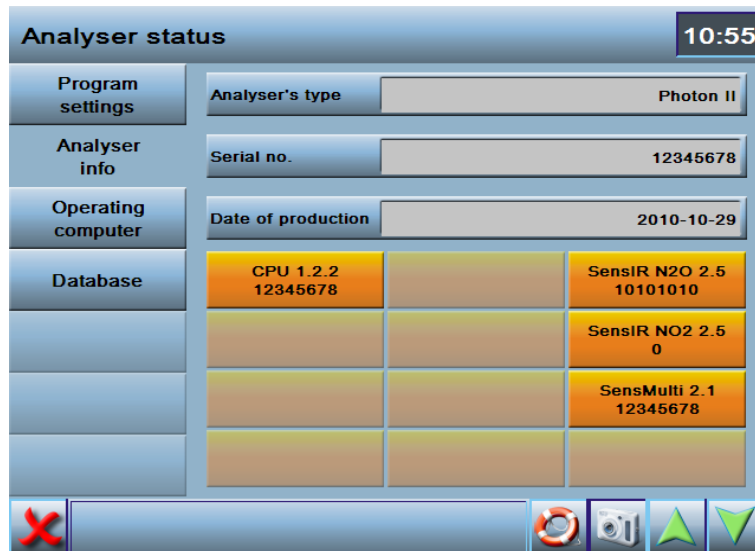
See Drawing 32

- User, the person currently operating the analyser
- Industrial Site – selected from the database
- Current mode – the current work mode / the current work cycle phase
- Dryer status
- Recordings – information on whether the results of the currently performed measurement are stored in the database
- Thermocouple type – the currently selected thermocouple type (more information can be found in chapter 3.2.11.2)

3.2.11.1.2 Analyser info



Drawing 33 Analyser status screen – analyser info (in case no modules have been installed)



Drawing 34 Analyser status screen – analyser info (in case any modules have been installed)

- Analyser's type
- Serial number
- Date of production
- A list of the installed sensors in a form of orange boxes. There are twelve of them. The faded orange box indicates that a particular spot in the analyser is available and an installation of a sensor is possible. The box displayed in a bright orange colour contains information concerning a particular sensor installed in the analyser. The following details are given in the box:
 - sensor's name
 - firmware version number
 - serial number

Clicking on the box opens the screen containing detailed information on the sensor. Two different screens are available:

- SensIR module details – detailed information about an IR sensor;
- SensMulti module details – detailed information about the Multi module.

3.2.11.1.2.1 SensIR module details

Drawing 35 SensIR module details screen

The following information concerning a particular sensor is given on the screen:

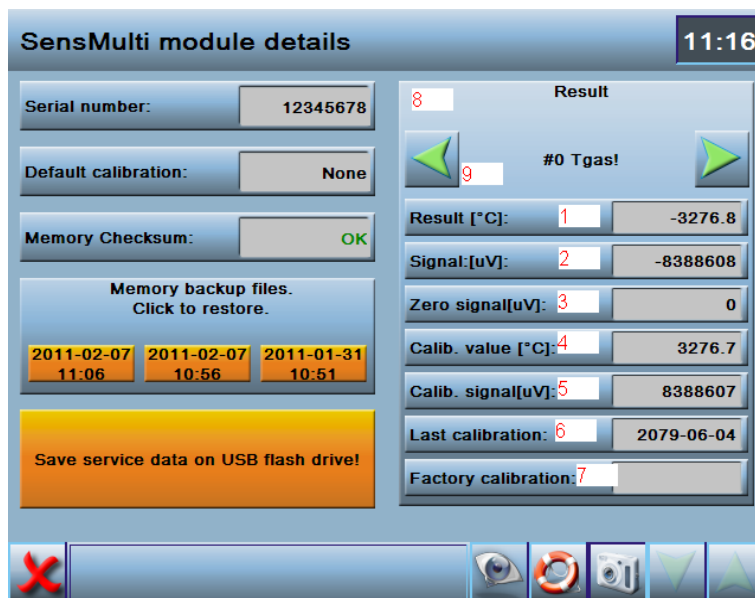
- sensor's range – the maximum gas concentration the sensor can measure (1),
- sensor's unit – the unit used for displaying the measurement results (2),
- zero gas – the signal value for the zero gas (3),
- serial number – the sensor's serial number (4),
- last calibration – date of the last calibration (5),
- factory calibration – the factory calibration date (6),
- default calibration – the information whether the present calibrations are default (8),
- signal – the current signal value in the measurement channels 1 and 2 and in the reference channel as well as the current gas concentration (7).

The *Save service data on USB flash drive!* button (9) enables the user to store a text file on a USB flash drive. The file containing all the crucial work parameters and the sensor's settings can be found useful when diagnosing the potential problems in the sensor's functioning.

In the *Memory backup files* box (11) there are the three buttons responsible for restoring the memory backup file of the sensor's settings and calibration parameters. The

date of the backup file creation is displayed on each of the buttons. Restoring such a file is initiated after the particular button has been clicked on. After a while the user will be asked to confirm that the current sensor settings are to be replaced with the ones stored in the particular memory backup file. At the same time the program informs whether the current memory checksum (10) of the sensor settings is correct. The process of restoring the sensor settings from the memory backup file SHOULD NOT be performed if the current memory checksum is correct. If any of the three backup file buttons is faded the backup file is not available. It is necessary to remember that the device systematically controls the sensor's settings and calibration parameters and independently stores the required backup files. The user is immediately informed if any irregularity is detected and a solution to the problem is recommended.

2.2.11.1.2.1 SensMulti module details



Drawing 36 SensMulti module details screen

The following information concerning the particular sensor is listed on the left-hand side of the screen:

- serial number – the module's serial number,
- default calibration – the calibration type/ the information whether the present calibrations are the default ones,
- memory checksum – the state of the sensor's settings memory checksum (restoring process can be run as described for the IR sensor),

On the right-hand side of the screen a box (8) presenting the parameters, readings and settings of the measurement channels is displayed. The detailed information contains:

- result – the measured value (1),
- signal – the signal value of the sensor (2),
- zero signal – the signal value for the zero gas (3),
- calib. value – the value of the measured parameter for which the channel has been calibrated (4),
- calib. signal – the value of the signal during the calibration process (5),
- last calibration – the last calibration date (6),
- factory calibration – the factory calibration date (7).

With the use of the arrow keys (9) the user is able to switch between the sensor's measurement channels for which the above information (1-7) is to be displayed.

3.2.11.1.3 Operating computer

- Firmware version – the current version of the operating program (the information on the firmware updating process can be found in chapter 3.3)
- Previous firmware version – the version of the firmware before the latest update process
- Factory firmware version – the version of the firmware loaded onto the device at the moment of its production
- RAM memory – the amount of free RAM memory
- Disk size – the information on the amount of used and free disk space
- USB flash drive size – the information on the total amount of disk space and the amount of free disk space on a flash drive inserted into the USB port.

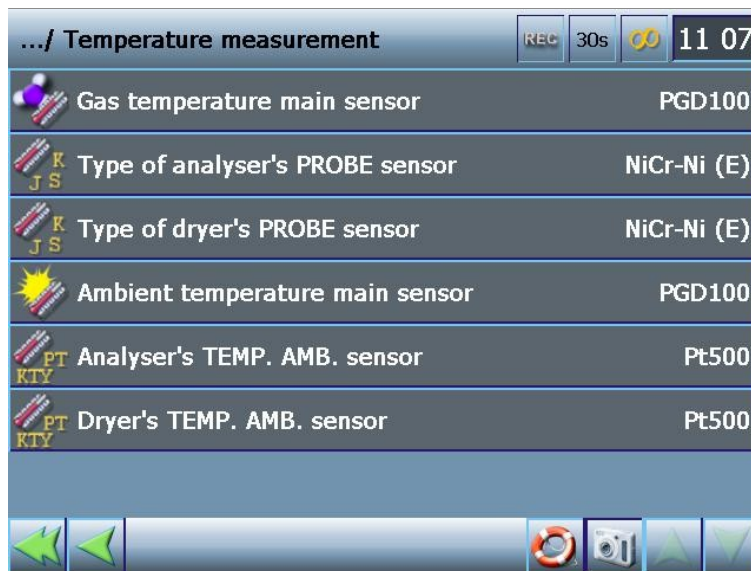
3.2.11.1.4 Database

- Database version
- Previous database version

- Factory database version
- Database size in bytes – the disk space occupied by the database
- Number of measurement sessions – the information on the amount of the measurement sessions stored in the database
- Database status – the information on whether the data stored in the database is correct and has not been damaged.

3.2.11.1.5 Synchronization info

3.2.11.2 Temperature measurement



Drawing 37 Temperature measurement screen – temperature measurement settings

3.2.11.2.1 Gas temperature main sensor

Selecting the main sensor measuring the gas temperature. The options available for the user to choose from:

- Photon – The only gas temperature sensor is the one installed in the analyser.
- PGD-100 – The only gas temperature sensor is the one installed in the dryer.
- Photon → PGD-100 – The device will work with the use of the gas temperature sensor which is detected first. If this option has been selected

the program initially tries to communicate with the analyser sensor. If the sensor is detected the program stops the search. In case the analyser sensor is not found the program tries to communicate with the dryer sensor.

- PGD-100 → Photon – The device will work with the use of the gas temperature sensor which is detected first. If this option has been selected the program initially tries to communicate with the dryer sensor. If the sensor is detected the program stops the search. In case the dryer sensor is not found the program tries to communicate with the analyser sensor.

3.2.11.2.2 **Type of analyser PROBE sensor**

The type of the gas temperature sensor used in the analyser. From the available options the user should select the one actually in use. The options available for the user to choose from are:

- NiCr-Ni (K) – the type of the sensor typically installed in all the madur analysers
- NiCr-Ni (E)
- PtRh-Pt (S)
- Fe-CuNi (J).

3.2.11.2.3 **Type of dryer PROBE sensor**

The type of the gas temperature sensor used in the dryer. From the available options the user should select the one actually in use. The options available for the user to choose from:

- NiCr-Ni (K) – the type of the sensor typically installed in all the madur analysers
- NiCr-Ni (E)
- PtRh-Pt (S)
- Fe-CuNi (J).

3.2.11.2.4 **Ambient temperature main sensor**

Selecting the main sensor measuring the ambient temperature. The options available for the user to choose from:

- Photon – The only ambient temperature sensor is the one installed in the analyser.
- PGD-100 – The only ambient temperature sensor is the one installed in the dryer.
- Photon → PGD-100 – The device will work with the use of the ambient temperature sensor which is detected first. If this option has been selected the program initially tries to communicate with the analyser sensor. If the sensor is detected the program stops the search. In case the analyser sensor is not found the program tries to communicate with the dryer sensor.
- PGD-100 → Photon – The device will work with the use of the ambient temperature sensor which is detected first. If this option has been selected the program initially tries to communicate with the dryer sensor. If the sensor is detected the program stops the search. In case the dryer sensor is not found the program tries to communicate with the analyser sensor.

3.2.11.2.5 **Analyser TEMP. AMB. sensor**

The type of ambient temperature sensor used in the analyser. From the available options the user should select the one actually in use. The options available for the user to choose from:

- PT-500
- KTY

3.2.11.2.6 **Dryer's TEMP. AMB. Sensor**

The type of the ambient temperature sensor used in the dryer. From the available options the user should select the one actually in use. The options available for the user to choose from:





- PT-500
- KTY

3.2.11.3 **Pump settings**



Drawing 38 Pump settings selection - setting the analyser main pump power

Enables the user to set the analyser main pump efficiency to a particular level:





-  the pump is turned off
-  the pump power level equals 30% of maximum
-  the pump power level equals 60% of maximum
-  the pump power level equals 100% of maximum

3.2.11.4 **Backlight settings**



Drawing 39 Backlight settings selection – setting the display backlighting level

Enables the user to set the display back-lighting to a particular level:

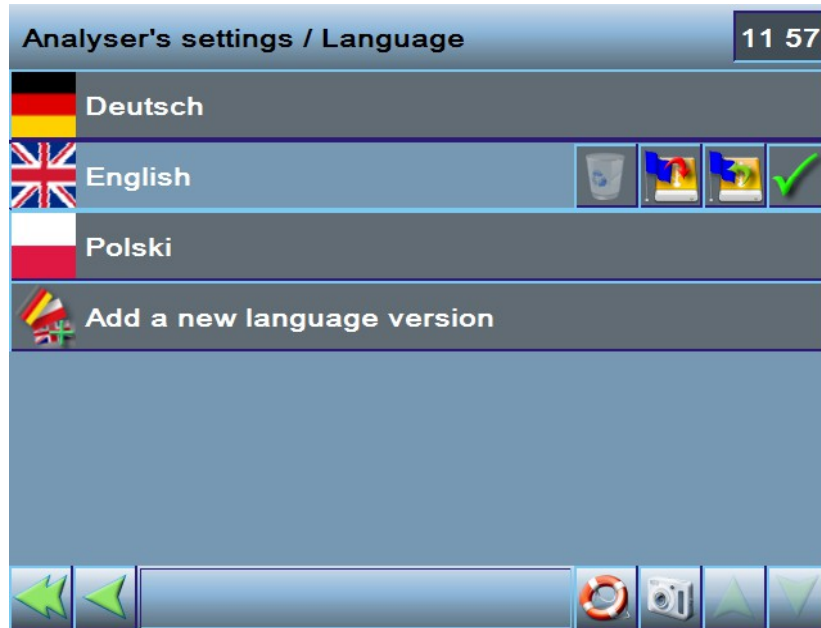
-  the display back light level set manually (it is possible to enter any value from the 1÷15 range with the help of the numeric keypad)
-  the minimal display back light (level 1)
-  the medium display back light (level 7)
-  the maximal display back light (level 15)

3.2.11.5 **Language**







Drawing 40 Language selection

The user can select the appropriate language version by clicking on the *Language* bar which evokes the list of the available language versions.



Drawing 41 List of the available language versions.

To choose a particular language version it is necessary to click on the appropriate bar and press the  button. The language version will be changed shortly. Additionally the language versions can be:

- deleted  (NOTICE! Deleting some of the language versions may be blocked.),
- exported onto a USB flash drive ,
- exported onto a USB flash drive  in a special operator version.

At the moment the following language versions are available: Polish, English, German and Italian. The operator can introduce other language versions on their own. In order to prepare another language version of the program and to learn the adding procedure the user is advised to contact their sales representative (to receive the files for translation).

3.2.11.6 User selection



Drawing 42 User selection screen – choosing the device's current operator

Clicking on the *User selection* bar opens the list of the operators stored in the database (Drawing 42). The *_GUEST* user is the operator for whom the typical settings have been defined. The *_GUEST*'s access to the service options is limited. Switching between the operators causes an automatic and irreversible zeroing of the measurement buffers.

3.2.11.7 Date and time settings



Drawing 43 Date and time settings screen

To change the time settings it is necessary to select the box of the element which is to be changed (an hour, minutes or seconds). This activates the arrow keys enabling the user to adjust the settings.

The changes to the year and month settings are introduced similarly. The appropriate day of the month can be chosen from the calendar on the right-hand side. The format in which the date is presented can also be set on the *Date and time settings* screen. With the help of the arrow keys the user can switch between the available options: DD-MM-YYYY, MM-DD-YYYY or YYYY-MM-DD.

3.2.11.8 Internet settings

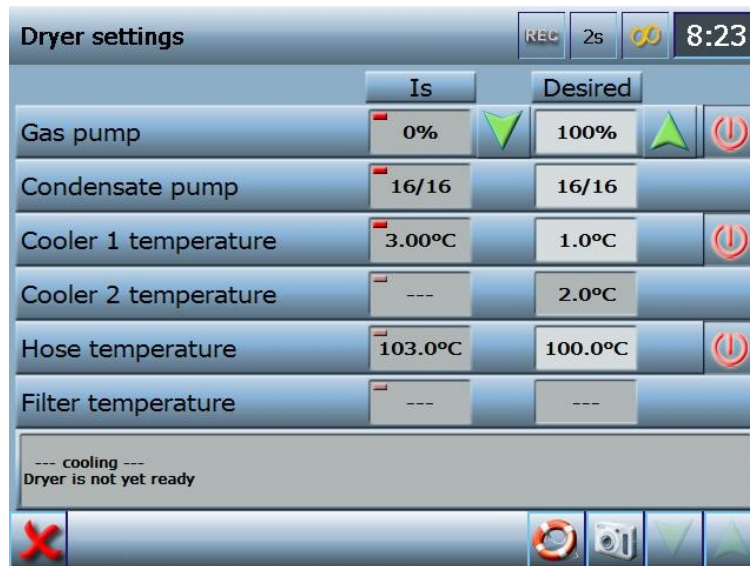
The Photon II analyser can be connected to the local Ethernet network with the help of the standard, straight through ethernet cable made of a twisted pair CAT5 cable with a RJ45 connector. Photon II can also be connected directly to a laptop. In such a case a cross-cable is required. This enables the user to view the measurement results and adjust the analysers settings on the PC with the use of the Photon II operating program. What is more it does not require the RS232 connection making it possible for the user to operate the Photon II analyser from a PC while the gas dryer is working. To use the Ethernet connection it is necessary to adjust some settings accessible from the *Analyser's settings* menu contained on the *Internet settings* screen.

The *Internet settings* screen enables the user to:

- check the current IP address of the device, the subnet mask and the default gateway received from the DHCP server in the local network,
- stop/start the automatic download of the network settings from the DHCP server in the local network,
- enter the default IP of the device, the subnet mask and the default gateway in case the DHCP server has not been detected in the local network to which the Photon II is connected or in case the device is connected directly to the PC


It is advised to connect the Photon II to a computer network equipped with a Router with the DHCP server. In such a case all the required internet settings are adjusted automatically.

3.2.12 Dryer settings



Drawing 44 Dryer settings screen

In the left *Is* column the values currently measured by the dryer sensors are listed. The red “LED diode” in the corner of each *Is* box turns off the moment the dryer reaches the desired value. The right *Desired* column contains the values of the parameters the dryer should reach before the measurement proceeds. These can be

defined by the user unless the particular box is displayed in a grey colour. The  button allows the user to turn the particular module on or off. The desired values can be changed with the help of the arrow keys accessible directly on the screen or the numeric keypad evoked if a particular *Desired* box is clicked on. The large grey box above the bottom bar contains the information on the dryer status. The madur company recommends the following dryer settings as the optimal for the Photon II analyser proper operation:

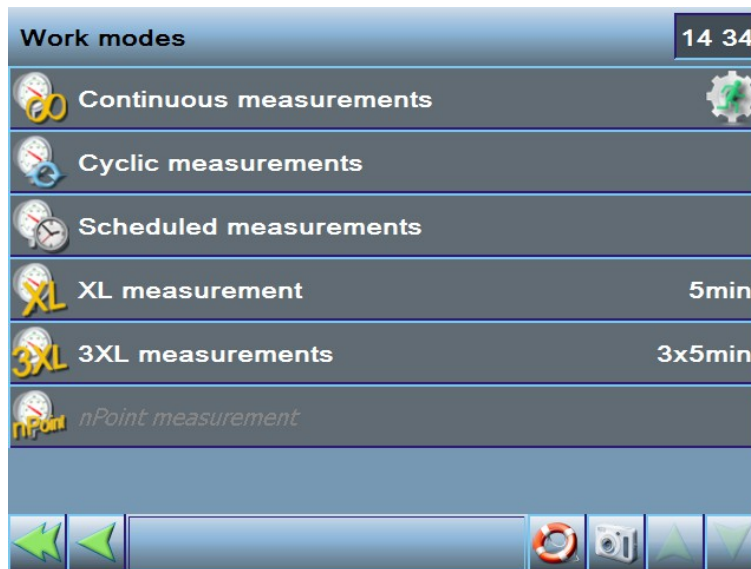
- Gas pump setting: >30%
- Cooler 1 temperature: ≤4°C
- Cooler 2 temperature: ≤4°C
- Condensate pump setting: > 0 / 16
- Hose temperature: > 100°C if the analyser IS NOT EQUIPPED with an SO₂ sensor
- Hose temperature: > 150°C if the analyser IS EQUIPPED with an SO₂ sensor

All the threshold values of the dryer parameters' recognised as optimal can be defined through the *Service* menu.


ATTENTION!



If the dryer reaches the desired parameters, but those differ from the ones listed above, the analyser presents the results as uncertain (in violet).


3.2.13 Work modes




Drawing 45 Work modes screen – work mode selection


The analyser current mode is indicated with the  icon (appearing on the right side of the bar). Additionally, the appropriate icon symbolising the current work mode is displayed in the top bar (next to the clock). Selecting the work mode navigates the user to the results screen and the analyser proceeds with the measurements starting automatically at a certain time or waits for the user to start the measurements by pressing

the  key. Selecting a certain work mode does not automatically start storing the results in the database. To save the measurement results to the database it is necessary to press the  key.

- In the *Continuous measurement* mode the results are stored from the moment the  key is clicked.

- In the *Cyclic measurement / Scheduled measurement* mode if the results of the measurements are to be stored the user should either press the  key the moment the particular work mode is chosen (the results will be stored as soon as the measurements proceed) or any time when the analyser is working if the user decides that the results are to be stored from that point.
- In the *XL / 3XL* modes the device inquires whether to store the results after the measurements have been completed.



The analyser stores only the useful results – the results coming from the measurement phase. The results obtained during the zeroing or awaiting the measurement phase are not saved in the database.

To adjust the particular work mode settings it is necessary to click on the appropriate bar and then press the  icon. There are five measurement modes available. Their parameters are adjusted to the different needs concerning the duration of the measurement and the zeroing and the automation of the whole measurement process. The following measurement modes are available:

- continuous measurement mode,
- cyclic measurement mode,
- scheduled measurement mode,
- XL measurement mode – single long lasting measurement,
- 3XL measurement mode – triple long lasting measurement.

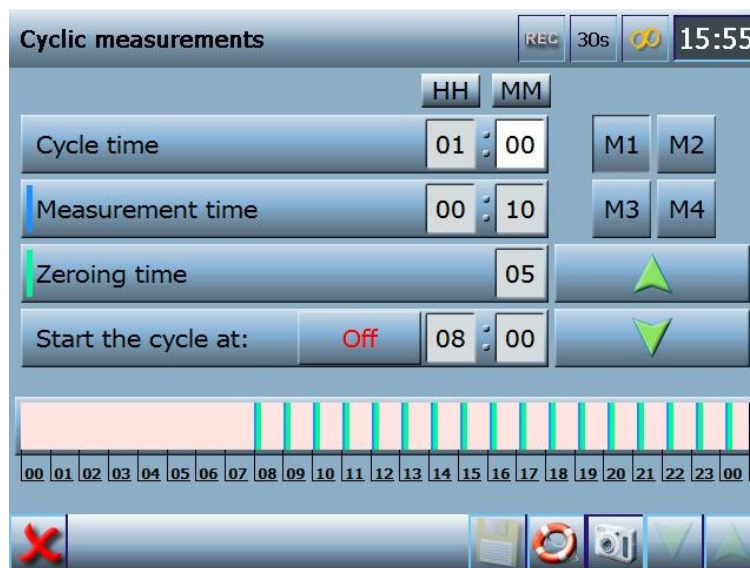
3.2.13.1 Continuous measurement

The device's basic work mode. The Photon II analyser starts working in the continuous measurement mode the moment it is switched on. Beginning and ending storage of the measurement session depends directly on the user's decision. Recording

the results in the database can be started by pressing the  icon on any of the result screens (the storage does not proceed unless the user confirms the alert note inquiring whether to save the results in the database). To discontinue storing the results in the database it is necessary to press the  icon once again on any of the result screens. Pressing the icon produces the alert note preventing the user from accidental termination

of the storage. It is crucial to realize that in this work mode the sensors ARE NOT zeroed automatically. After being zeroed the sensors can operate for a certain amount of time. After this amount of time has been exceeded the results obtained by the sensors can be incorrect. The Photon II device counts the amount of time elapsed since the last zeroing and warns the operator if the acceptable amount has been exceeded. If the time for the sensors to be zeroed has come the measurement results on the result screen will be displayed in pink. It indicates that the operator should perform the zeroing process as soon as possible. Additionally, information about an error occurrence will be displayed on the bottom bar. Storing the results in the database is continued. However, if the zeroing is not performed within the next half an hour, storing the results in the database discontinues and the device displays the note informing that the critical amount of time between the zeroings has elapsed. The measurement results will be presented in red meaning that they are no longer reliable.

3.2.13.2 Cyclic measurements



Drawing 46 Cyclic measurements screen

The *Cyclic measurements* mode enables the user to perform constant measurements (with regular sensors zeroing). The horizontal graph above the bottom bar shows when the particular phases of the work mode will occur. The work mode consists of the following phases:

- measurement,
- zeroing,

- awaiting the next measurement (stand-by).

Duration of each of the cycle's phases can be defined by:

- pointing the element which is to be adjusted,
- changing the value with the help of the green arrows.

Up to four different cyclic work mode settings can be stored. Each of them is saved in the device's memory and can be loaded by clicking on the appropriate M1-M4 button.


The phases of the cyclic work mode:

Cycle time – the cycle consists of: the zeroing time, the measurement duration and (optionally) the Standby time. The cycle time must at least equal the sum of the measurement duration and the zeroing time.

Measurement time – the time of the uninterrupted measurements. The gas sensors are zeroed before each measurement session. The maximal duration of the measurement after the sensors have been zeroed is 30 minutes.

Zeroing time – for the correctness of the measurements it is crucial to zero the gas sensors regularly (and to ventilate the gas channels beforehand). There are three options available for the zeroing time setting: 5, 10 and 15 minutes.


Start the cycle at – turning this option on enables the user to define the exact time the analyser is to begin working in the cyclic measurements mode (starting with the zeroing phase). The analyser continues working unless the user stops its performance by

pressing the  key. In the example shown in the Drawing 46 the analyser starts the measurements in the cyclic mode at 8.00 AM.

3.2.13.3 Scheduled measurements



Drawing 47 Work cycle according to the scheduler screen – scheduled measurements mode


The scheduled measurements mode's operating principles resemble the cyclic measurements mode. Also here there is a possibility of storing up to four different mode settings. As well as in the cyclic mode, the measurement duration can be set within the range of 1-30 minutes and the zeroing time can take 5, 10 or 15 minutes. However, in the scheduled measurement mode it is possible to define freely up to 25 different hours (during a day) at which the measurement phases are to start. To define a particular phase it is necessary to turn it on by clicking on the  icon and set the starting time with the help of the arrow keys.


3.2.13.4 Single XL measurement



Drawing 48 Single XL measurement

A simple work mode enabling the user to perform a single measurement. The available measurement durations for the user to choose from: 5, 10, 15, 20, 30 minutes.



The analyser operation begins the moment the  button is clicked on. Before the measurement proceeds, the gas channels are ventilated and then gas sensors are

zeroed. As the measurement has been completed the key  appears. Clicking on the key evokes a confirmation note inquiring whether the measurement results are to be stored in the database.

3.2.13.5 Triple XL measurement



Drawing 49 Triple XL measurement

The triple XL measurement mode is much alike the single XL measurement mode. Each of the three measurements is started on the user's demand (the first one, after clicking on the  icon, the other two by pressing the  key). Before the first measurement proceeds, the gas channels are ventilated and the gas sensors are zeroed. The next measurements are preceded by the zeroing only if necessary.

3.2.13.6 n-Point measurement (wizard measurements)

3.2.14 Databases






Drawing 50 Database screen

All the information (the measurement results; the fuels, customers and users data, etc.) are stored by the analyser in the database.




There are two types of database element: the data defined by the producer (the user is only capable of viewing such elements) and the elements defined by the user (which can be viewed, edited, added or deleted by the user).

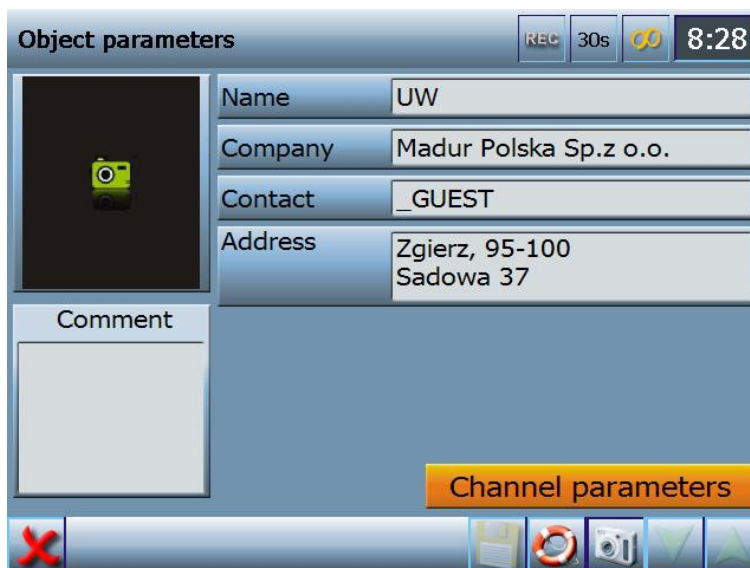
The database screen enables the user to:


-  - add new elements,
-  - delete the existing elements (before a particular element is deleted an alert note appears and a confirmation is required),
-  - edit the elements of the database.

Clicking on any of the menu's bars navigates the user to the list of the elements of the particular type stored in the database. The number given on the right side of each bar (next to the green arrow) stands for the amount of the elements of the particular type stored in the database.

3.2.14.1 **Industrial sites**

The Industrial sites list consists of the predefined objects  and the objects defined by the user . An industrial site is a place where the measurements are performed. To add a new site it is necessary to press the  key which evokes the form shown below (unlike in the picture the boxes will not be filled in).



Object parameters	
	Name: UW
	Company: Madur Polska Sp.z o.o.
	Contact: _GUEST
	Address: Zgierz, 95-100 Sadowa 37
Comment	
Channel parameters	

Drawing 51 Object parameters screen - defining new /editing existing industrial site

Each Industrial Site is described by the following data:

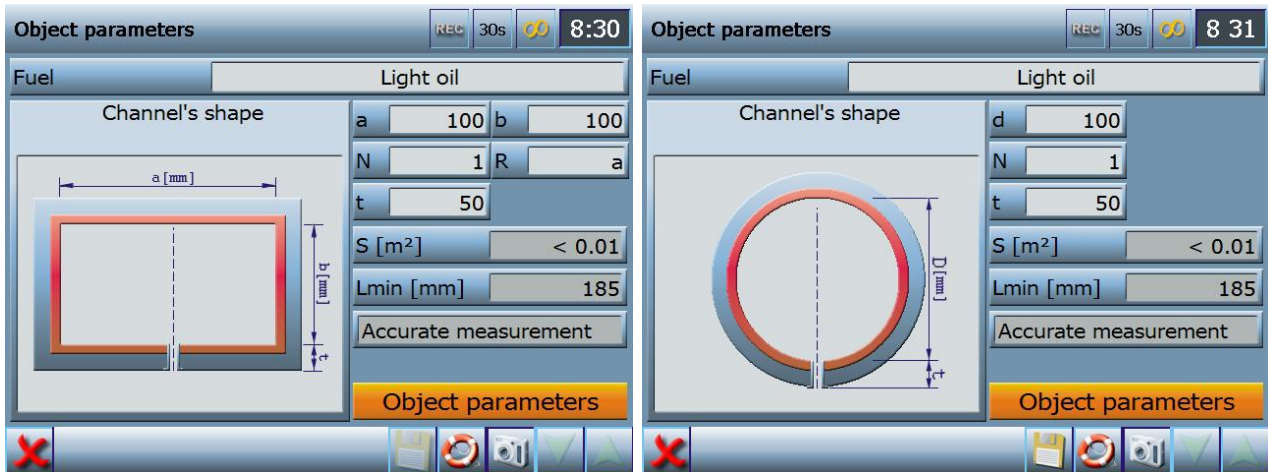
- Name – the site's name (entered with the help of the keyboard)
- Company – the name of the company that owns the site (selected from the list of the companies stored in the database – see Drawing 52)
- Contact – the name of the contact person (selected from the list of the customers stored in the database)
- Address – the site's address
- Comment – any useful comment that would simplify working at the particular site
- Photo – (to be displayed in the black box in the upper left corner of the screen) it is possible to select a photo from the analyser's compact flash drive and to assign it to the particular site.



Drawing 52 Company selection screen - assigning company that owns industrial site

Channel parameters

- clicking on this button navigates the user to the screen where the industrial site's physical parameters can be defined.



Drawing 53 Object parameters screen – defining physical parameters of industrial site

The screens shown above enable the user to define the following physical parameters of the particular industrial site:

- Fuel – the type of the fuel used at the particular site (the choice can be made between all the fuels stored in the database)
- Channel shape – the chimney's cross-sectional shape (round or rectangular)
- for the rectangular shapes: a – the length of the chimney section longer side (in mm)
- for the rectangular shapes: b – the length of the chimney section shorter side (in mm)
- for the round shapes: d – the chimney diameter (in mm)
- R – the chimney direction – specifying whether the measurement holes are situated on the a or b side
- N – the number of the measurement axis (the holes for a probe)
- t – the thickness of the lagging (the chimney's insulation) along the chimney's measurement axis (in mm)

According to the data entered by the user the analyser calculates the chimney's cross-sectional area S (in m^2), and suggests the length of the probe suitable for the performance of the measurements (L_{min}).

3.2.14.2 Customers



New customer data REC 30s 8 49

Surname*

Name*

City

Postcode

Street

Comment

Email

Phone*

GPS

Enter the data about a new user.
* - fields required!

Drawing 54 New customer data screen – defining new/editing existing customer

The customers database stores the information on the people the user is in contact with. These include the companies' and the sites' contact people and other people (unrelated to the above) the user contacts.

The customers database contains the people's contact details (the elements marked * have to be filled in):

- Surname*
- Name*
- City
- Postcode
- Street
- E-mail address
- Phone number*
- GPS coordinates

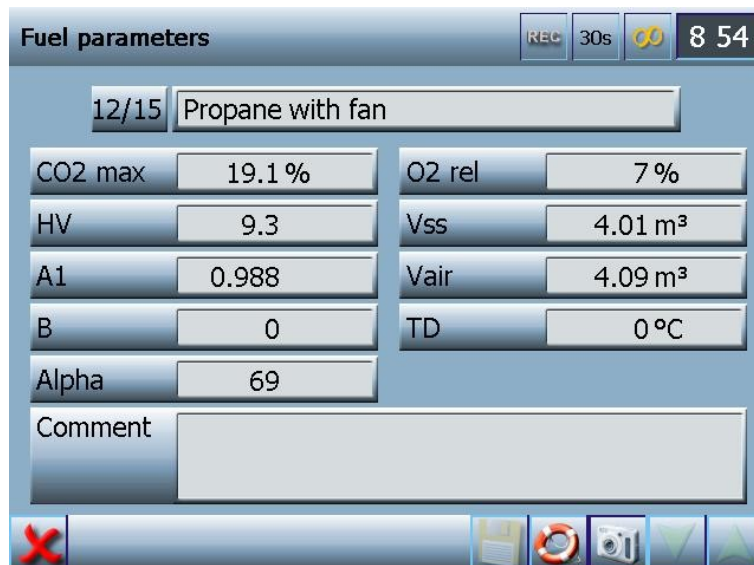
3.2.14.3 Fuels

The fuel database stores the information on the fuels. Each fuel type has a specific set of the combustion parameters according to which the analyser performs the calculations. Therefore it is crucial that the entered values relate to the real conditions.

The producer has defined a number of 22 fuels:

- Light oil

- Natural gas
- Town gas
- Coke-oven gas
- Liquid gas
- Bio-Diesel
- Extra light oil
- Heavy oil
- Coal -Tar
- Natural gas with fan
- Town gas with fan
- Propane with fan
- Propane
- Butane with fan
- Butane
- Biogas with fan
- Biogas
- Mineral coal HV 31.5
- Mineral coal HV 30.3
- Lignite HV 8.16
- Lignite HV 9.34
- Dry wood



Fuel parameters REC 30s 8 54

12/15 Propane with fan

CO2 max	19.1 %	O2 rel	7 %
HV	9.3	Vss	4.01 m ³
A1	0.988	Vair	4.09 m ³
B	0	TD	0 °C
Alpha	69		

Comment

Navigation icons: Close (X), Save, Refresh, Print, Back, Forward

Drawing 55 Fuel parameters screen - defining a new/editing existing fuel









The fuel's name is presented in the top part of the screen. Then the typical fuel parameters are listed:

- CO₂ max – percentage of the carbon dioxide in the fumes, based on the assumption that $\lambda=1$
- HV – heating value expressed in $\left[\frac{MJ}{kg} \right]$ or $\left[\frac{MJ}{m^3} \right]$
- A1 – Sievert's formula coefficient; dimensionless
- B – Sievert's formula coefficient; dimensionless
- Alpha – coefficient used for calculating the loss by incomplete combustion; dimensionless, alpha can equal: 32, 52, or 69
- O₂ ref – assumed oxygen level, usually an independent parameter used for calculating the relative concentrations values, expressed in [%]
- V_{df} – volume of dry fumes produced in the combustion process of a single unit of the particular fuel with $\lambda=1$, expressed in [m³]
- V_{air} – volume of the air necessary for a combustion of a single unit of the particular fuel with $\lambda=1$, expressed in [m³]
- TD – dew point temperature for $\lambda=1$, expressed in [°C]
- Comment – any text (description) the user can assign to a fuel

3.2.14.4 Users

The database also contains the information on the users that operate the analyser. The analyser stores the personal settings of each of the registered users. Defining / editing the particular operator's data can be performed as described for the customer database.

3.2.14.5 Registered files

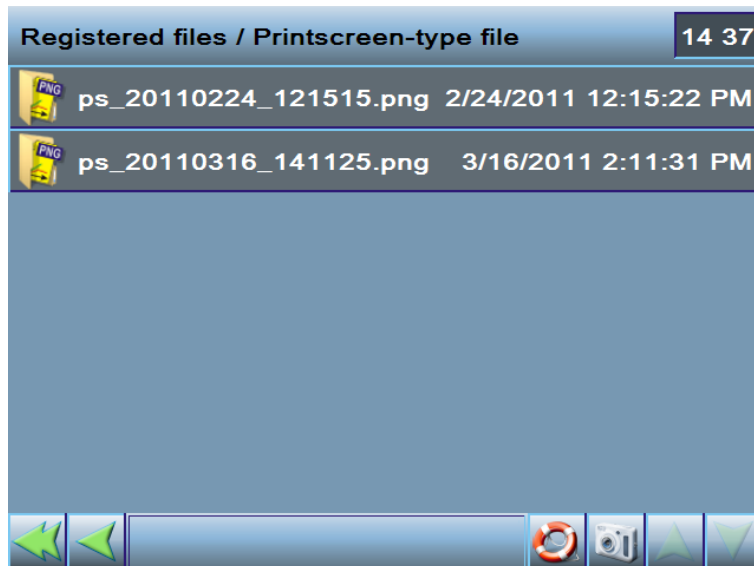
Database / Registered files		14 36
 Picture-type file	0	
 Printout-type file	0	
 Form-type file	10	
 Printscreen-type file	2	

The *Registered files* screen contains a list of all the files generated by the device and stored on its disk. The list consists of four different file categories: Database / Registered files screen

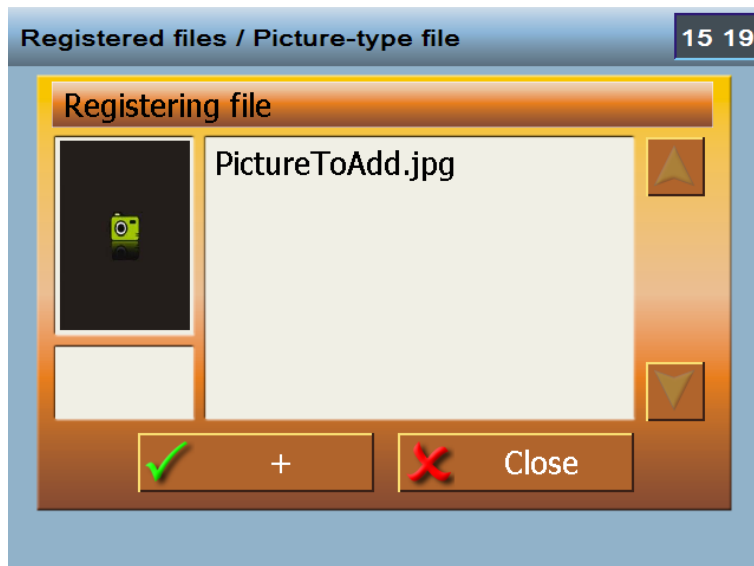
3.2.14.5.1 *Picture-type file*

The graphic files of .jpg or .png extension added by the user. These include the operators, industrial sites, clients photographs which can be used in the operators or industrial sites profiles. This may simplify operating the device and can be an interesting addition to the printouts.

To add a graphic file the user has to paste it into the "mPhoton\data\import" directory on a USB flash drive. As a file has been saved on a USB flash drive it is necessary to click on the "Add a new picture" bar which evokes the window containing the list of the graphic files which can be added to the device database.



Drawing 56 Registered files / Printscreen-type file screen



Drawing 57 Registering file window

3.2.14.5.2 Printout-type file

The printout files generated by the device in a form of .png files.

3.2.14.5.3 Form-type file

The templates according to which the device generates the printout files.

3.2.14.5.4 PrintScreen-type file

The PrintScreen files – the device screen shots.

Clicking on a particular file's bar enables the user to perform the following operations:

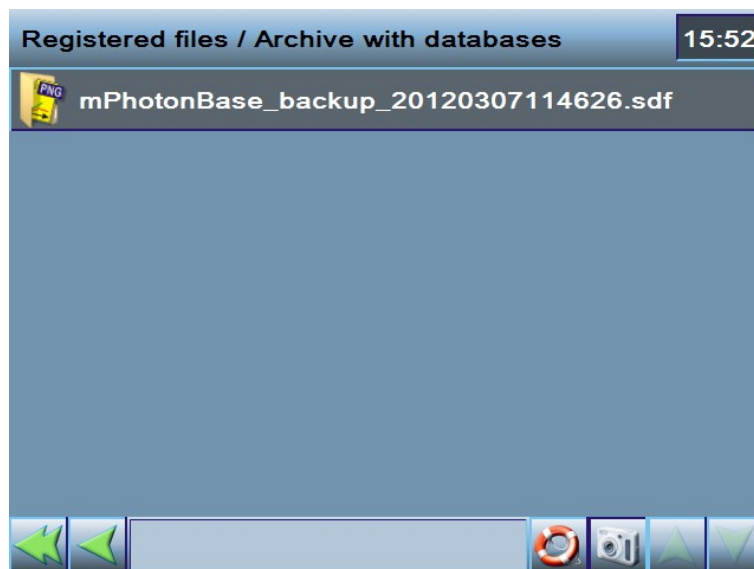
- copy the file onto a USB flash drive

- delete the file from the Photon II disk
- view the file's contents
- prepare the page with the file's contents printout.

3.2.14.5.5 *Archive with databases*

Contains a list of available copies with databases. When file is selected it has to possible options:

- Copy file to USB flash drive
- Remove file from the disk.



Drawing 58 List of databases archive.

After the database file is copied to USB flash drive it is recommended to delete it from the disk in order to reclaim disk space.

3.2.14.6 **Companies**

Makes it possible for the user to define the companies for which the measurements are performed (invoicing).

Company's parameters		15 59
*Name	madur electronics	
*Contact	_GUEST	
WWW	www.madur.com	
VAT no.	00000000	
*Address	Vienna, 1220 Voigtgasse 4	
Comment		

Drawing 59 Company parameters screen - defining new/editing existing company

Each company is defined by the following data:

- Name*
- Contact* - the contact person's name selected from the customers database
- www – the webpage address
- VAT no. – the VAT number (if applicable)
- Address*

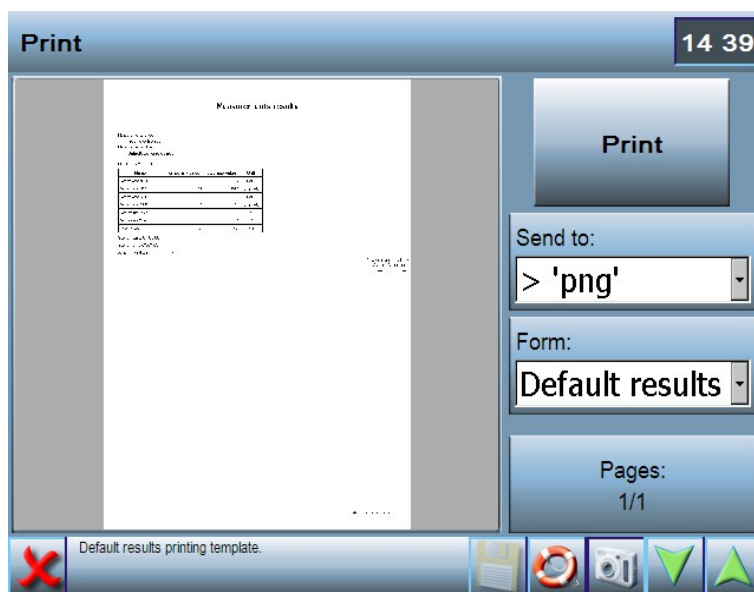
The boxes marked with * have to be filled.

3.2.15 **Printouts**

The Photon II analyser creates the possibility of printing the measurement results as well as the additional information. The printouts can be prepared in two different ways:

- as .png files, for the needs of an external printer connected to a PC,
- as a printout on thermal paper from the printer which can be provided as the optional equipment of the Photon II analyser.

The first printouts creation mode is the default one. The printout page is created according to the default template definition.

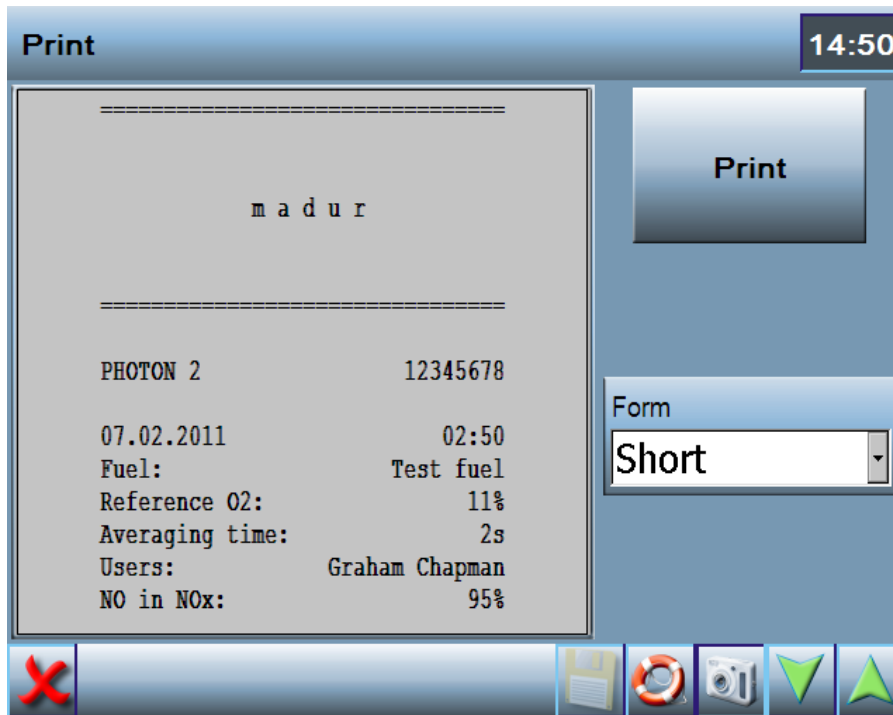


Drawing 60 Print screen – creating printouts

The default printout page contains:

- the averaged gas concentrations measurement results,
- the measurements' time and date,
- the name of the site where the measurements were performed,
- the name of the operator who performed the measurements.

The other printouts creation mode is available after the thermal printer (being the part of Photon II equipment) has been connected to the device. The moment the user evokes the *Print* screen the printer should be already connected to the analyser. In this mode the Send to .png option is not available. On the left-hand side of the *Print* screen the preview of the printout can be seen.



Drawing 61 Print screen – printing to thermal printer

With the help of the *Print* button located on the right-hand side of the screen the user can start the printing process. Below there is a printout *Form* choice list. Two different printout forms are available:





- short – containing information on all the working parameters during the measurement process and the measurement results – but only those displayed on the result screens,
- full – containing information on all the working parameters during the measurement process and all the measurement results.

3.2.16

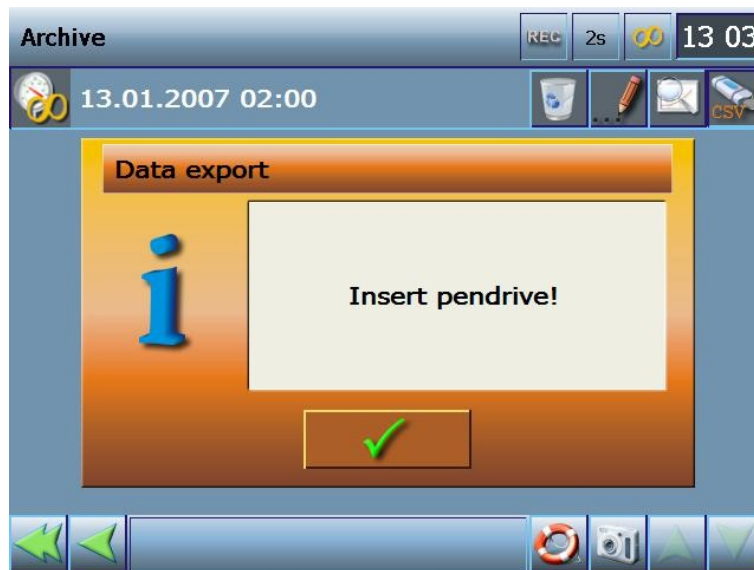
**Archive**

Drawing 62 Archive screen

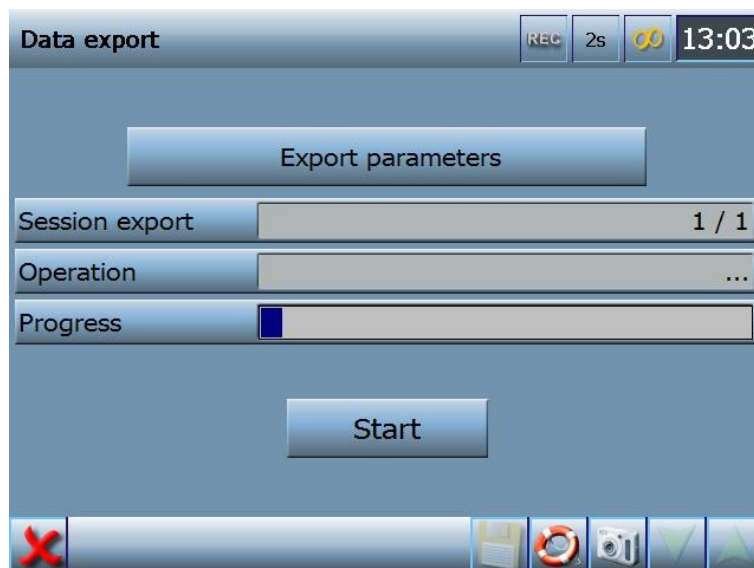
The *Archive* screen shows the list of the measurement sessions stored in the database. The icon on the left of each of the bars informs on the type of the work mode the measurement was performed in. Each of the bars contains also information on the precise time and date of the measurement. On the right-hand side of the bar the duration of the measurement is displayed. It is possible for the user to:

-  - delete each of the measurement sessions from the database;
-  - edit the session's headline (its name, a comment);
-  - view the session's results on the analyser screen; the results will be displayed on the result screens, however they will be highlighted in green; the result screen 1 and 2 will contain the arithmetic average of the whole measurement session, and the result screen 3 (the graph) will display the momentary values;
-  - copy the session's results to a file on a USB flash drive; if no disk is connected to the USB port the note shown in Drawing 63 appears. It is necessary to insert the USB flash drive and click on the OK key. Drawing 64 presents a screen enabling the user to export the data. The session's measurement results can be stored as a text file in a CSV format or in a binary file in a RP format. By pressing

the *.csv button the user exports the data to a text file. The data saved to a file will be averaged according to the averaging time set in the *Averaging time* (AVR) box. Any change introduced to this setting does not influence the analyser current averaging time set for the presentation of the results. To simplify analysing the data with the help of a spreadsheet programme (Excel, Calc) it is possible to specify the decimal separator used for the data presentation. It is advised to select the one used by the operating system of the computer which will process the data. The available decimal marks for the user to choose from are '.' and ','. The data stored in a CSV file are separated with a semicolon.



Drawing 63 Data export alert – no USB flash drive in USB port



Drawing 64 Data export screen – exporting data to csv file

3.2.17 The current and voltage analogue outputs

To open the screen enabling the user to change the analogue outputs settings (shown in Drawing 65) it is necessary to click on the "Current analogue outputs" or the "Voltage analogue outputs" bar. The red frames mark the sections of the screen responsible for the particular settings.

1. *Source* – This section makes it possible for the user to assign a source of signal to a particular analogue output. The user can switch between the source categories with the help of the green arrows. If a particular signal is unavailable (for example: if the specific sensor is not detected in the analyser) it will be impossible for the user to choose it. The button with its name will be inactive. All the available sources are highlighted in a bright orange colour.



Drawing 65 Analogue outputs' settings screen

2. *Min.* and *Max.* - These boxes make it possible for the user to assign the values of the particular source to the maximal and the minimal values of the analogue output's range. For example if the selected source is the oxygen – O_2 , the min. and max. values has been set as follows: min.=3% max.=21%, and the output range has been defined as 4÷20mA, for the oxygen level $O_2 \leq 3\%$ the current on the output will equal 4mA, and the current of 20mA will appear for the oxygen level $O_2 \geq 21\%$.
3. *Range* – The user is capable of defining the signal range for the particular output. The ranges available for the current outputs: 0÷20mA and 4÷20mA. The ranges available for the voltage outputs: 0÷10V and 0÷5V.

4. *When error* – This section enables the user to define the output's action if an error of the particular source has occurred. The option „Go to MIN” will switch the output to the minimal value of the output's range, the option „Go to MAX” will switch the output to the maximal value of the output's range.
5. *During ventilation* – This section enables the user to define the output's action during the ventilation process. The option „Go to MIN” will switch the output to the minimal value of the output's range, the option „Go to MAX” will switch the output to the maximal value of the output's range. The option “Show the last value” will keep the signal value of the output measured directly before the ventilation process. The option “Continue measuring” sets the output signal to the current value of the assigned source.
6. This section enables the user to choose the output whose settings are to be changed by clicking on the appropriate icon. The user can choose from either the current or the voltage outputs depending on which menu position has been chosen beforehand.

Introducing changes to any analogue output setting will be shown in red colour. In such a case the floppy disk icon on the bottom bar becomes active and enables the user to save the new settings. Clicking on the icon saves the introduced alterations momentarily. If the user is to leave the screen or switch between the outputs after some changes have been made a note asking the user to confirm or cancel the alterations appears.

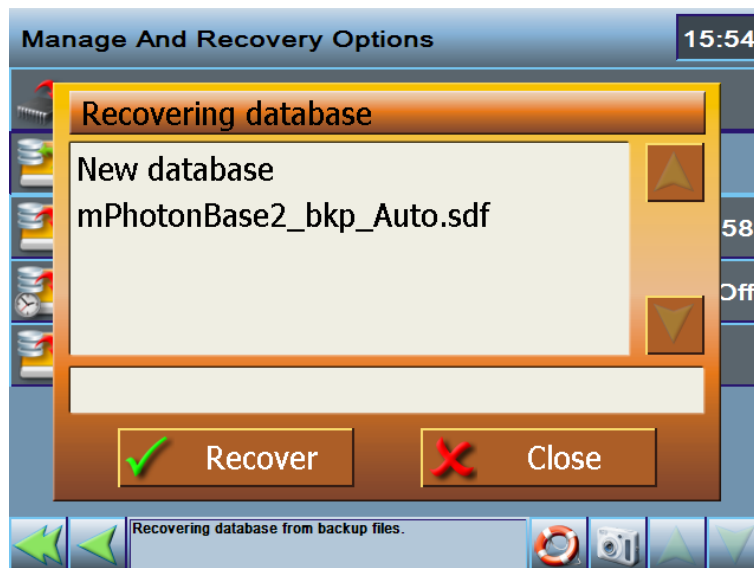
3.2.18 **Manage and Recovery Options**



Drawing 66 Recover data screen

3.2.18.1 **Database recovery**

This option allows to restore a database from the archive. After it is selected a window appears where user can select an archive file from which a recovery of database will be performed. The first position on the list “New database” allows to create an empty database with a default settings for the analyser.



Drawing 67 A list of files from which database can be recovered

After a file is selected, the current database will be deleted and replaced with data from the file or with a clean database.

3.2.18.2 Database backup

This options create a backup of the current database. It is possible to restore all the device information from the backup file (as described in chapter 3.2.18.1) or to copy a backup file to a USB flashdrive (as described in 3.2.14.5.5).

3.2.18.3 Automatic database backup

Option allows to enable automatic backup of database and to define how often will it be performed: once a week ÷ 4 weeks.



Drawing 68 Automatic database backup

Program creates maximum of four automatic databases. If this number is exceeded the oldest file is automatically removed to allow to create a new backup.

3.2.18.4 Copy the current database

This option allows to copy the currently used database directly to USB flashdrive.

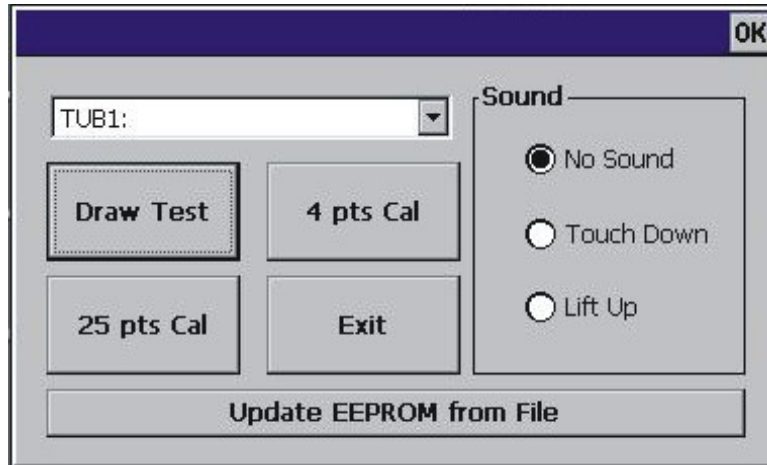
3.2.19 Service settings



Drawing 69 Service settings screen

3.2.19.1 Touchscreen calibration

If pressing a particular element on the touchscreen does not cause the appropriate action that is when aiming at the objects on the screen fails it is necessary to start the calibration procedure (and only then).



Drawing 70 Touchscreen calibration screen

To calibrate the touchscreen the user should select the type of calibration:

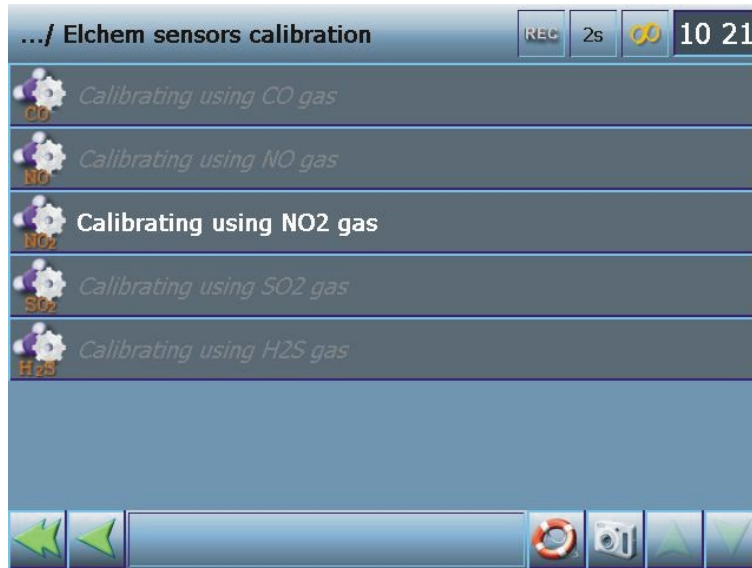
- 4 pts Cal – the 4-point calibration
- 25 pts Cal – the 25-point calibration (more accurate)

Choosing the calibration formula initiates the calibration process – the user should follow the instructions displayed on the screen. It is necessary to indicate the flashing crosses appearing on the display with the help of an object with a sharp end (such as the stylus supplied with the analyser). After the calibration process has been completed the user can navigate back to the analyser's screen with the help of the *Exit* button.

3.2.19.2 Pdif pressure sensor calibration

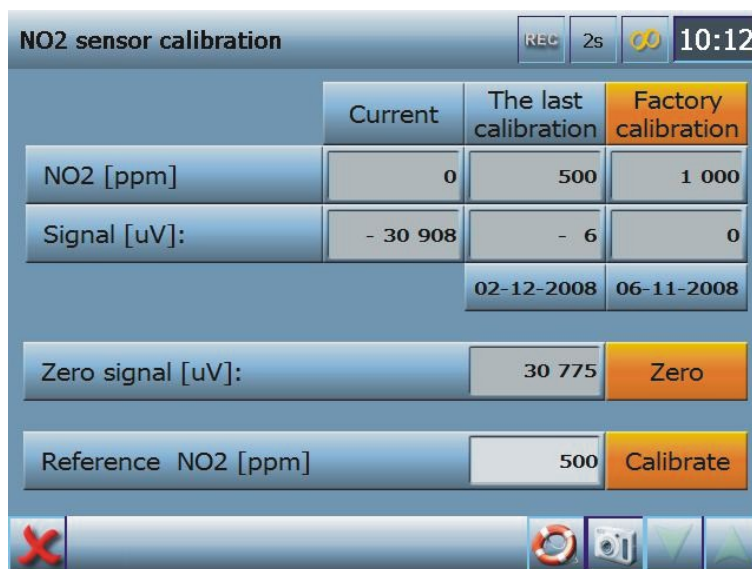
This option remains inactive.

3.2.19.3

**Electrochemical sensors calibration**

Drawing 71 Electrochemical sensors calibration screen

To calibrate an electrochemical sensor it is necessary to select it from the list of the installed sensors. The installed (detected) sensors' names are displayed in white. The unavailable sensors (the undetected / not installed ones) are presented in grey. Clicking on a particular sensor's bar navigates the user to the screen similar to the screen presented in Drawing 72.



Drawing 72 NO2 sensor calibration screen – calibrating electrochemical sensor

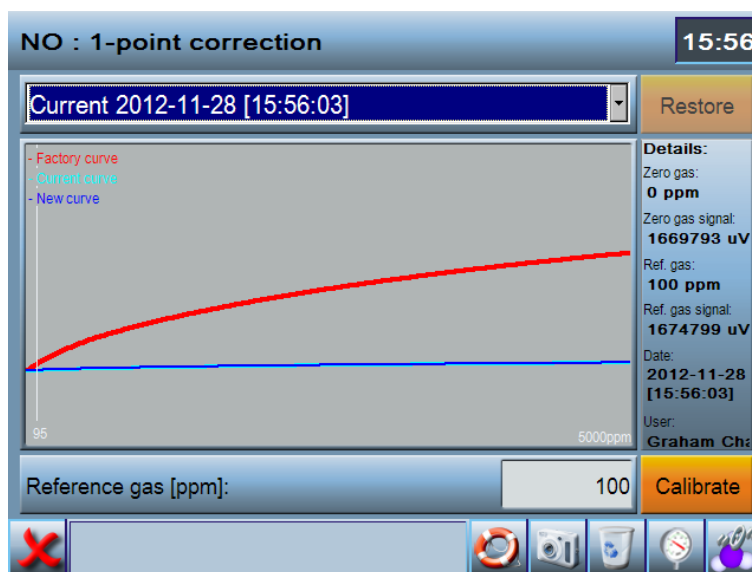
The example above shows the calibration of the NO2 sensor. The orange buttons are the active ones. In the top part of the screen there are:

- Current – the currently measured gas concentration (in ppm or %) and the related electrical signal value expressed in μV .
- The last calibration – the last saved sensor calibration. The date of the calibration process is presented below.
- Factory calibration – the factory calibration performed at a date displayed below. Pressing the *Factory calibration* button restores the factory calibration settings for the sensor.


To perform a calibration process it is necessary to:

1. Apply the inert gas to the analyser (the applied gas should be inert to the gas whose sensor is to be calibrated – in this case it can be the synthetic air).
2. Wait for the zero signal to stabilise.
3. Press the *Zero* button.
4. Apply the gas whose sensor is to be calibrated to the analyser (notice: the applied gas should be of a known concentration)
5. Enter the known gas concentration in the only active box (the one not displayed in grey)
6. Wait for the concentration value to stabilise.
7. Press the *Calibrate* button.

3.2.19.4 IR sensors calibration



Drawing 73 NO sensor calibration screen – calibrating IR sensor

This screen enables the user to perform a single-point correction of the IR sensor's calibration curve and to restore a curve from backup (restore a factory curve) – to restore curve, select one from the drop-down list and press .


The calibration process should be performed very thoroughly and only if the sensor's readings significantly differ from the standards.

After the user has evoked the calibration screen the current and the factory sensor's characteristics are loaded and their curves are presented on the graph at the bottom part of the screen. As the data has been loaded it is possible to initiate the calibration process acting as follows:

1. Supply the analyser (through the heated hose and the dryer) with a gas inert to the particular sensor, such as nitrogen (N₂).

ATTENTION!

If the sensor is to be zeroed with a gas containing a certain concentration of the measured gas it is necessary to enter the gas concentration in the *Zero gas* box. Such a need may occur when zeroing the CO₂ sensor with the help of air containing about 400 ppm of CO₂.

2. Observe the readings from the sensor on the graph and wait until they stabilise – and press  button. The sensor will be zeroed and the program will save the zero signal value.
3. Supply the analyser (through the heated hose and the dryer) with the gas of a known concentration to which the calibrated sensor reacts.
4. Wait for the sensor's readings to stabilise – observe them on the graph.
5. Enter the concentration of the reference gas in the field below the graph.
6. Click on the *Calibrate* button. The single-point calibration will be performed and the sensor will start working according to the new calibration curve.

If, for any reason, the calibration process has not been performed properly and the sensor's readings are incorrect the sensor's factory characteristics can be restored by selecting it from the drop-down list.

ATTENTION!

If the sensor which is to be calibrated reacts to the presence of carbon dioxide (such as the NO₂, NO, N₂O, CO sensors) and the analyser IS NOT equipped with the CO₂ sensor IT IS NECESSARY to choose the Test fuel from the database before the calibration proceeds.

3.2.19.5 O₂ sensor zeroing

This option enables the user to zero the oxygen sensor which, during the usual zeroing procedure, is calibrated with the air to a 20.95% value (the content of the oxygen in the ambient air). To zero the oxygen sensor it is necessary to supply the analyser with an inert gas (it is advisable to use nitrogen N₂) for at least 3 minutes. Later on the option *Zero O₂ sensor* should be chosen from the service menu and the *Inert gas* alert should be confirmed.

3.2.19.6 Determine λ with the help of

This setting determines the way the analyser calculates the excess air coefficient. Two options are available:

- O₂ – the excess air coefficient is determined according to the measured

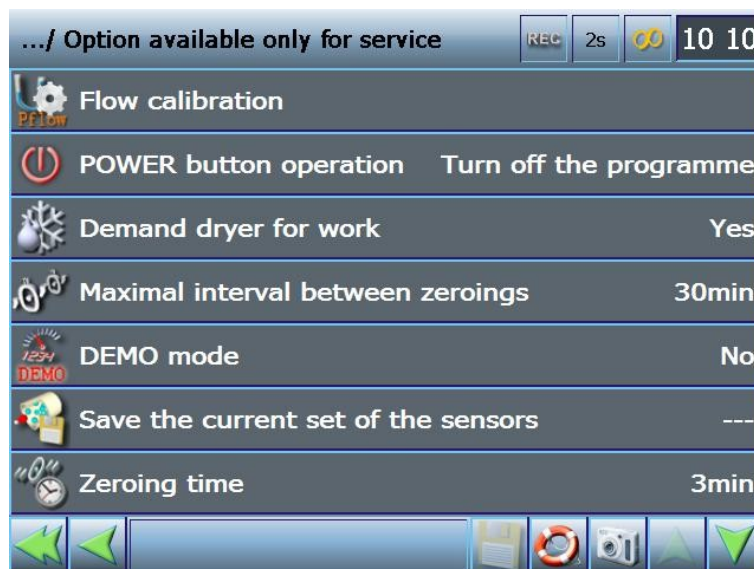
$$\text{oxygen concentration: } \lambda = \frac{20.95}{20.95 - O_2}$$

- CO₂ – the excess air coefficient is determined basing on the chosen fuel's CO_{2max} parameter and the measured carbon dioxide concentration:

$$\lambda = \frac{CO_{2\max}}{CO_2}$$

3.2.19.7  Service only options

Unauthorised changes to the service only options may cause an improper operation of the device. Therefore the access to these options is protected with a password.



Drawing 74 Option available only for service screen

3.2.19.7.1 **Flow calibration**

The option remains inactive.

3.2.19.7.2 **POWER button action**

By default the POWER button turns the analyser off. It is also possible for the button to end the Photon II program operation and return to the Windows CE operating system.

3.2.19.7.3 **Demand the dryer for work**

For the accuracy of the measurements (in the normal conditions) the analyser requires the presence of the gas dryer. The lack of the dryer is therefore signalled with an error occurrence alert. However, if the analyser is used for laboratory measurements which enable the operator to prepare the gas sample beforehand without the use of the dryer, it is possible to switch the dryer off. In such a case the analyser will not signalise an error occurrence.

3.2.19.7.4 **Maximal interval between zeroings**

The analyser gas channels need to be regularly ventilated and the gas sensors require zeroing with the inert gas (the air). This setting defines the maximal interval between zeroings, i.e. how long the sensors can perform measurements without being ventilated and zeroed.

3.2.19.7.5 **DEMO mode**

Starting the DEMO mode “breaks” the connection with the signals coming from the sensors. The results displayed on the screens are created by the sinusoid generator.

3.2.19.7.6 **Save the current set of sensors**

The analyser software stores the number and the status (the serial numbers, the ranges, etc.) of the sensors the analyser has been initially equipped with. The user will learn whether, for any reason, a single sensor or a number of sensors has been unmounted, replaced, etc. in the *Analyser's status* menu (more information has been given in chapter 3.2.11.1). An intentional change made to the sensors' configuration can be saved with the use of the *Save the current set of sensors* option.

3.2.19.7.7 **Zeroing time**

This option enables the user to define the duration of the sensors' zeroing process. The minimal value equals 3 minutes, whereas the maximal value is 120 minutes.

3.3 **Firmware upgrade**

The latest version of the analyser firmware can contain patches, new functions, extensions, etc. Therefore it is important to check whether the producer has released a new firmware version regularly. The user should check the analyser firmware version (the detailed information has been given in chapter 3.2.11.1 – Operating computer) and compare it to the version available on the producer's website: <http://www.madur.pl/downloadcenter/>. If the analyser firmware version is prior to the version published on the website the latest firmware version should be downloaded. The file contents should then be unpacked onto the USB flash drive. Finally it is necessary to upgrade the device's firmware:

1. Navigate to any of the result screens.
2. Remove all the USB peripherals, like analogue inputs / outputs.
3. Insert the USB flash drive with the downloaded and unpacked files into the USB port.
4. After a few seconds a confirmation screen appears. The screen contains the information on the current program version and the version of the program found on the USB flash drive and an inquiry whether to proceed with the update procedure.

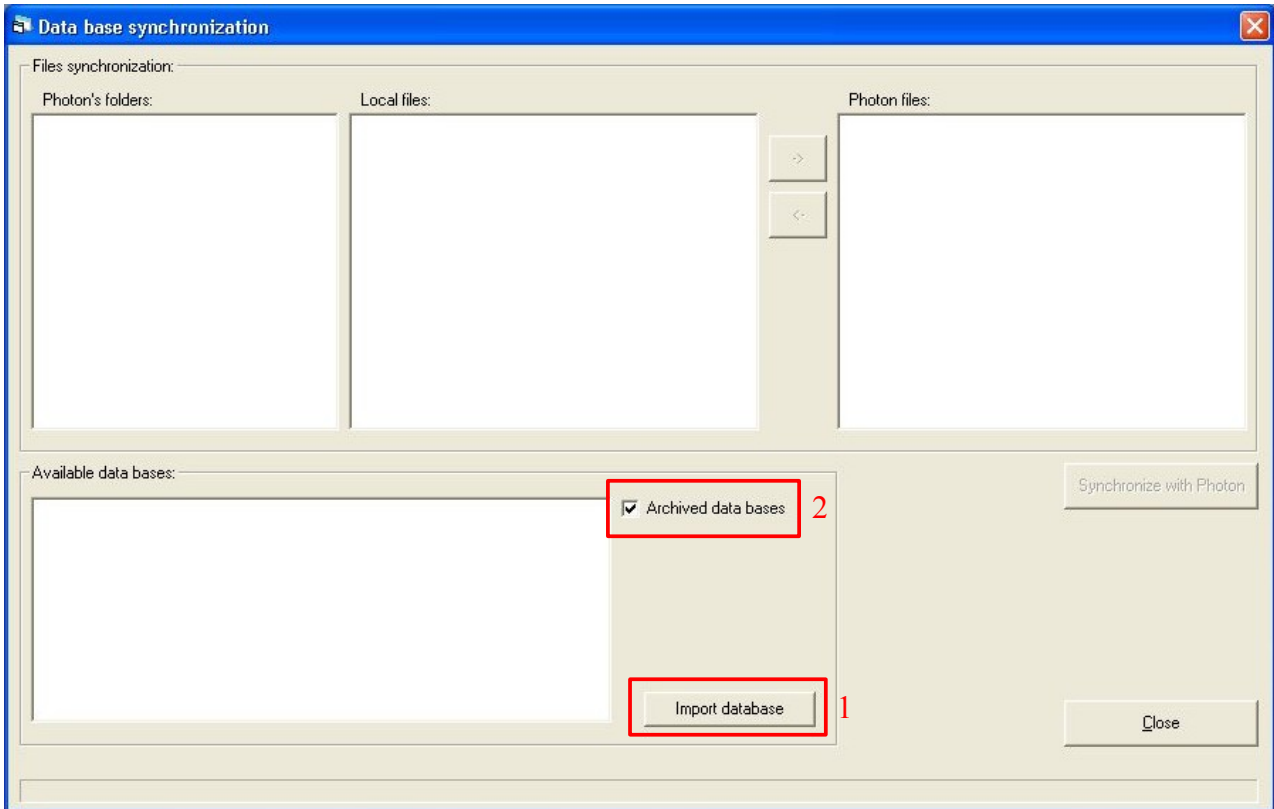
5. If the inquiry is confirmed, the files from the USB flash drive are copied to the analyser and the analyser will be restarted in order to apply changes.
6. ATTENTION: The firmware upgrade DOES NOT erase any data stored in the database (the saved measurement sessions, the analyser settings, the fuel parameters, etc.). All database contents will be identical to the data stored by the prior firmware version.
7. ATTENTION 2: If the current program version is lower than 3.1.0 then the current database will be archived and replaced with a new database. After the upgrade the new database will contain only the last stored measurement session. Access to the earlier measurement sessions will be possible only with help of PC program.

3.3.1 Importing archive database via the Photon_II PC software

To be able to view the results stored in analyser's database from the PC computer, one must use Photon_II software in version 2.0.0. and higher (able to download from madur webpage: <http://www.madur.pl/downloadcenter/>).

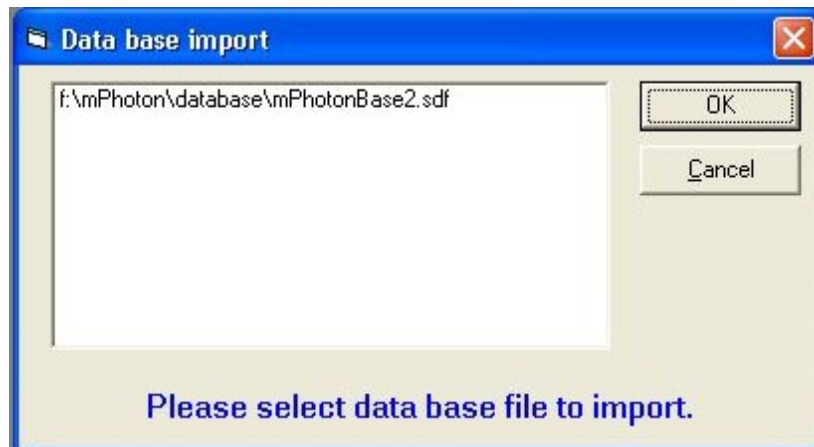
After it is installed on a PC:

1. Copy the archive database from the analyser to USB flash-drive (see chapter 3.2.14.5.5 for more details).
2. Insert USB drive with database file into PC's USB port.
3. Run Photon_II program (*START* → *Programs* → *madur* → *Photon II*).
4. From the menu select Database → Synchronisation
5. In the synchronisation window press "Import database" (Drawing 75, point 1)



Drawing 75 Synchronisation of database

6. Select file with database you wish to import and press OK.



Drawing 76 List of files with databases.

7. After the import is done, check option "Archived databases" (Drawing 75, point 2) and select just imported database. Close the synchronisation window.
8. From menu select *Databases* → *Measurement sessions*. A list of stored measurement sessions will be displayed. Select one session to export it to csv file.

Measurements export

Stored sessions: 20121129_083845

Session details:

Name: 20121129_083845 Operator: Graham Chapman

Industrial site: _Default working object Creation date: 2012-11-29 08:39:16

Work mode: Continuous Fuel: Light oil

Measure time: 0min. 30sec. Records no.: 15 Cycles no.: 1


NO in NOx [%]: 95 Ref. O2 [%]: 11 Average time [s]: 2

Export options:
 Export all data
 Export calculated results
 Average time [s]: 2
 Refresh
 Export to *.CSV file
 Close

Record no.	Time 1	Time 2	Records' arr	Session I ID	Session II ID	O2 [%]	CO2 [%]	CO [ppm]	NO [ppm]	SO2 [ppm]	Pdif [Pa]	Pabs [hPa]	Tamb [°C]	Tgas [°C]
1	29 08:38:48	29 08:38:48	1	2	0	20.95	0.0	0	74	0	5.2	973.2	23.8	22.7
2	29 08:38:51	29 08:38:51	1	2	0	20.95	0.0	0	75	0	5.3	973.2	23.9	22.7
3	29 08:38:53	29 08:38:53	1	2	0	20.95	0.0	0	1	0	5.3	973.2	23.9	23.1
4	29 08:38:55	29 08:38:55	1	2	0	20.95	0.0	0	1	0	5.3	973.2	23.9	23.2
5	29 08:38:57	29 08:38:57	1	2	0	20.95	0.0	1	3	0	5.2	973.2	23.9	23.3
6	29 08:38:59	29 08:38:59	1	2	0	20.95	0.0	1	2	0	5.2	973.2	23.9	23.4
7	29 08:39:01	29 08:39:01	1	2	0	20.95	0.0	1	2	0	5.2	973.2	23.9	23.4
8	29 08:39:03	29 08:39:03	1	2	0	20.95	0.0	1	3	0	5.3	973.2	23.9	23.4
9	29 08:39:05	29 08:39:05	1	2	0	20.95	0.0	1	2	0	5.2	973.2	23.9	23.4
10	29 08:39:07	29 08:39:07	1	2	0	20.95	0.0	1	2	0	5.2	973.2	23.9	23.4
11	29 08:39:09	29 08:39:09	1	2	0	20.95	0.0	0	2	0	5.2	973.2	24.0	23.4
12	29 08:39:11	29 08:39:11	1	2	0	20.95	0.0	0	3	0	5.2	973.2	23.9	23.4
13	29 08:39:13	29 08:39:13	1	2	0	20.95	0.0	0	3	0	5.1	973.2	24.0	23.4
14	29 08:39:15	29 08:39:15	1	2	0	20.95	0.0	0	2	0	5.1	973.2	24.0	23.4
15	29 08:39:17	29 08:39:17	1	2	0	20.95	0.0	0	2	0	5.2	973.2	24.0	23.3

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3.4 Error announcements

The information box on the result screens  can contain, apart from the status information, the error announcements.

If the analyser registers an error it alerts the user with a proper announcement. The error announcements (displayed in red) appear in turns with the status information (typed in black).

An error announcement is displayed in three lines. The first line informs on the dryer errors, the second one alerts to the thermostat errors whereas the third one contains all the other errors that may occur when working with the device. If a single error of a certain kind has occurred it is fully described. If the number of errors is bigger, the analyser displays only the error numbers, e.g. **Error: 9, 10**. The possible errors and their numeration can be found below:

- Error 01 – The warm-up phase was interrupted

The warm-up phase has been interrupted and the analyser has not reached the optimal working state (the temperature is floating). The error note will be erased

after the sensors are zeroed when the analyser has been fully warmed-up. If the error occurs the results shown in the result screens are displayed as **Uncertain**.

- Error 02 – The set of sensors was changed

An error is reported if the set of sensors is different from the factory one. The error note can be erased from the service menu with the help of the *Save the current set of sensors* option.

- Error 03 – Analyser Tgas sensor error

Signalises the lack or the excessive readings of the analyser Tgas sensor in the PROBE connector. The error is reported if the Tgas measurement is erroneous and the temperature sensor (the option *Temperature measurement* in the *Analyser settings* menu 3.2.11.2.2) has been set to *Photon* or *Photon → PGD-100*.

- Error 04 – Dryer Tgas sensor error

Signalises the lack or the excessive readings of the dryer Tgas sensor. The error is reported if the Tgas dryer measurement is erroneous and the temperature sensor (the option *Temperature measurement* in the *Analyser settings* menu 3.2.11.2.3) has been set to *PGD-100* or *PGD-100 → Photon*.

- Error 05 – Analyser Tamb sensor error

Signalises the lack or the excessive readings of the analyser Tamb sensor in the Temp. amb. connector. The error is reported if the Tamb measurement is erroneous and the temperature sensor (the option *Temperature measurement* in the *Analyser's settings* menu 3.2.11.2.5) has been set to *Photon* or *Photon → PGD-100*.

- Error 06 – Dryer Tamb sensor error

Signalises the lack or the excessive readings of the dryer Tamb sensor. The error is reported if the dryer Tamb measurement is erroneous and the temperature sensor (the option *Temperature measurement Measurement sensor* in the *Analyser settings* menu 3.2.11.2.6) has been set to *PGD-100* or *PGD100 → Photon*.

Error 02 ÷ Error 06 occurrence does not influence the colour the results are typed in.

- Error 07 – Improper gas flow / No pump is turned on

In the analysers equipped with a gas flow sensor the error is reported if the required gas flow cannot be reached.

In the analysers with no gas flow sensor the error is reported if no gas pump (neither the analyser nor the dryer pump) is turned on.

- Error 08 – Sensor zeroing needed

The error is reported if the time elapsed since the last zeroing is longer than the maximal interval between zeroings (set in the service only options – described in chapter 3.2.19.7.7). The error note is erased if the zeroing is initiated or if the Error 09 occurs.

- Error 09 – Zeroing is indispensable

The error is reported if the time elapsed since the last zeroing is greater than 1.5 * the maximal interval between zeroings. Erased if the zeroing process is started.

- Error 10 – Zeroing was unsuccessful

The error is reported after the three unsuccessful attempts to perform zeroing has been made. Erased after the successful completion of the zeroing process.

- Error 11 – No communication with CPU

Reported if the time elapsed since the last successful attempt to communicate with the CPU is >4 seconds. Erased after a correct answer has been received from the CPU.

Error 07 ÷ Error 11 occurrence changes the colour the results are displayed in to red **Wrong**.