

FLUE GAS ANALYSER

Photon

Manual

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madur[®]

E L E C T R O N I C S

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Introduction

Congratulations on your purchase of the microprocessor-controlled flue gas analyser - **PHOTON**.

The **PHOTON** is a high-quality instrument produced with use of the latest technical discoveries. In addition to its exceptional measurement abilities it is also handy and easy to use.

We strongly recommend careful reading of this manual as it contains many tips and problems solutions.

1. Tips on using the analyser

1.1. (Electrochemical) gas sensors

- Do not exceed the measurement range of the analyser.
- The sensors can react unpredictably to chemicals whose components are not typically found in combustion gases. For this reason the equipment should not be cleaned with chemical solvents. The vapour produced by such solvents can lead to destabilisation and even permanent damage to the sensors.
- Some of the sensors need constant power supply, even when the analyser is off -line. Be sure that the batteries are charged.
- It is advisable not to switch the analyser off before the gas system is free of flue gases.
- The analyser should be kept in a cool place if it is not to be used for some time. This will reduce the wear on the sensors.

1.2. Gas system

The instrument should be used with the external conditioner for drying the gases. If any gas is drawn in directly by the analyser the sensors might get damaged.

1.3. Service

Due to the fact that the parameters of electrochemical cells change with time it is necessary to carry out a periodical service connected with either the calibration of the electrochemical cells or their replacement.

The **PHOTON** analyser is equipped with a work-time counter, which will inform the user about the necessity of calibration.

1.4. Possible errors

The **PHOTON** gas analyser has an auto-control system, which alerts to any problems encountered during work.

2. General information

The **PHOTON** analyser can be equipped with up to 9 electrochemical cells and 5 IR sensors. Depending on the configuration, the instrument can measure the concentration of following gases: O₂, CO₂*, CH₄*, CO*, NO*, NO₂, NO_x, SO₂*, H₂S, H₂.

CO₂, CH₄, CO, NO and SO₂ are generally measured with use of the optical sensors (NDIR). All the other gases are measured with the help of the electrochemical cells. Gases marked with * can be measured both by electrochemical or IR sensors. Gas concentration can be presented as:

- the volume concentration (% or ppm)
- the mass concentration (mg/m³)
- the mass concentration referred to O₂ (mg/m³)

Additionally the analyser is adjusted to measure the flue gas temperature and the ambient temperature (using thermocouple and Pt-500 sensors), the absolute pressure and the differential pressure. On the basis of the measurement data and the fuel parameters, the analyser calculates the combustion parameters:

- the stack loss,
- the loss by incomplete combustion,
- the efficiency,
- the excess air coefficient (lambda)

All the measured or calculated values can be presented on the **PHOTON** analyser's display, and saved as reports on the MMC card or in the on-board memory and presented in analogue form, as current or voltage outputs.

3. Construction

3.1. Gas system

3.1.1. Preparing the gas sample

If the device is to work correctly it is necessary to remove all the molecules of solids from the sample and also to reduce and stabilize the level of the humidity in the measurement gases.

The analyser requires that an external device conditioning the sample is used. It is advised to make use of the external gas conditioner equipped with an input heated gas filter and a heated hose. The filter removes all the molecules of solids from the sample, the heated hose makes it impossible for water vapours to condensate in the tubing, and the conditioner stabilizes the humidity level in the measurement gas.

The proper preparation of the gas sample is one of the most important elements of correct measurement.

3.1.2. Gas probe

The gas sample is drawn in with the help of the gas probe, which is additionally equipped with the flue gas temperature sensor. Typical probe lengths are: 150mm, 300mm, 750mm, 1500mm.

3.1.3. Gas pump

The **PHOTON** analyser is equipped with a gas pump (with a capacity of 90 lph). It pumps gases to the IR sensors and to the chamber with electrochemical cells. There is a possibility of turning the pump off if the device works with the external gas conditioner equipped with an additional pump. In such case, the analyser pump tasks are performed by the additional pump.

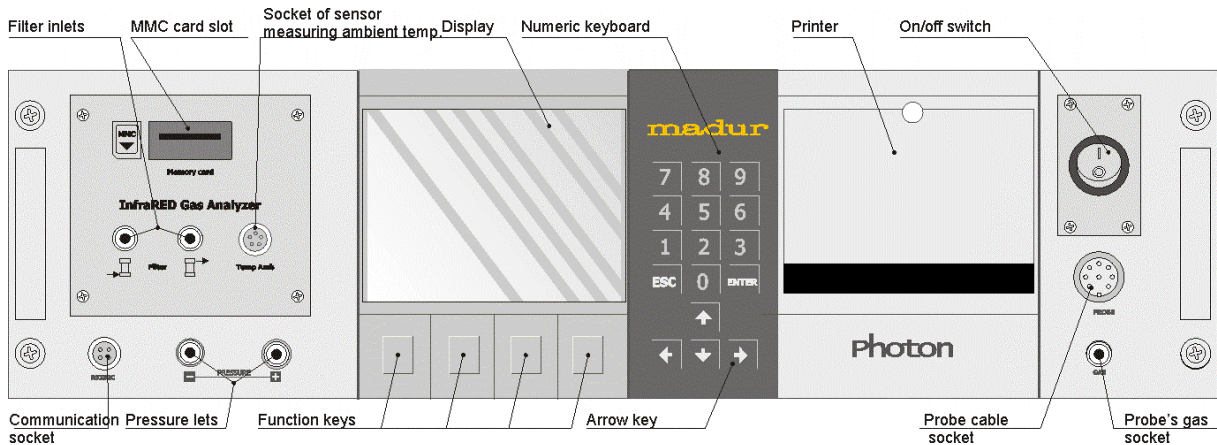
3.1.4. Electrochemical cells

The level of O₂ and some other gases is measured by the electrochemical cells. The O₂ sensor is being calibrated during the initial calibration process with use of the fresh air. All the other sensors are zeroed during the initial calibration.

3.1.5. IR sensors

The **PHOTON** analyser can be equipped with up to 5 IR sensors. These sensors are used to measure the concentration of the following gases: CO₂, CH₄, CO, NO and SO₂. All of them are two-channel NDIR sensors.

3.2. Front panel



3.2.1. Filter inlets

The filter inlets are used for connecting the gas filter units (placed in the casing cover) to the device.

3.2.2. MMC card slot

The slot of the MMC card which is used for storing the results of the measurements carried out by the analyser.

3.2.3. Socket of the sensor measuring the ambient temperature

This is a socket of a Pt500 sensor which is responsible for measuring the ambient temperature.

3.2.4. Display

The monochrome LCD display is ¼ VGA and is used for the presentation of the measurement results. It is equipped with backlighting and contrast regulation which greatly improves its legibility.

In the bottom line of the most of the displayed screens there is a bar with the labels of the function keys.

3.2.5. Numeric keyboard

Allows numeric values to be entered.

3.2.6. Arrow keys

Allows the user to look through the analyser menus.

3.2.7. Printer

The printer is used for printing the reports. The printing speed is 2.5 lines per second. The standard paper of 57 mm width is used.

3.2.8. Function keys

The function keys allow the user to access the functions of the analyser's programme quickly. The function key labels are shown at the bottom of the screen. The *Data* function key brings the user back to the first results screen. The *Esc* function key displays the previous screen.

3.2.9. On/off switch

With the help of this key the user can turn the analyser on and off.

3.2.10. Communication cable socket

The analyser can be connected to the PC with RS232 cable. The computer programme created especially for the needs of **PHOTON** analyser allows the user to make changes to the device settings and to create the clients and fuels database.

3.2.11. Probe cable socket

Enables the user to connect the gas probe to the analyser.

3.2.12. Gas outlet

The gas outlet is used for connecting the probe hose to the analyser.

3.2.13. Pressure outlets

The pressure outlets are used for the pressure and chimney draught measurements.

3.3. Power supply

The **PHOTON** analyser works only when supplied by mains voltage ranging from 90 to 240V. The built-in batteries are only used to supply the electrochemical cells and the clock when the analyser is turned off.

4. Operation

4.1. Switching the analyser on

The user can start the analyser with the help of the key placed on the front panel. However, it will not be possible unless the on/off switch situated next to the power cable (on the bottom left-hand side of the device casing) is turned on.

When the power supply to the analyser is turned on and the key on the front panel remains switched off the heating process of the casing will get started and the battery will be charged.

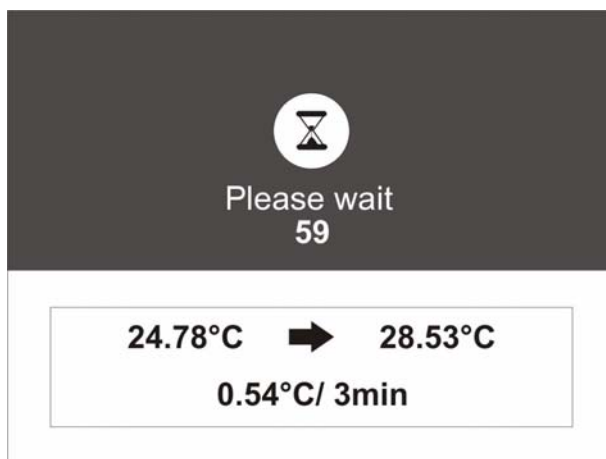
After the analyser has been switched on the following welcome screen will appear:

Photon

Serial #: 07499360
Software: 0.01

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Before the device begins to work it has to stabilize its interior temperature. This process proceeds right after the instrument has been switched on. While the interior temperature is being stabilized the user is not able to operate the device and the following screen is displayed:



In the upper part of the screen the length of the period of time since the beginning of the stabilization process is displayed (here: 59 seconds)

In the bottom part of the screen the following information is displayed:

- the current temperature (on the left-hand side)
- the calculated target temperature (on the right-hand side)
- the three-minute temperature increase (at the bottom)

The stabilization process lasts until the three-minute temperature increase drops below 0.09 °C.

Attention !

The stabilization process can last up to several hours (its length depends on the external conditions).

Should the ambient temperature change considerably and the analyser not be capable of keeping the interior temperature at a stable level the stabilization process will be automatically carried on.

After the stabilization process has finished the zeroing of the gas sensors will proceed.

10:17:48

Initial configuration



Please wait
10 sec

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The procedure of zeroing lasts 300 seconds and is essential for the precision of the measurement. The length of the period of the time remaining till the completion of the zeroing process is displayed on the screen. After the zeroing has finished the device is ready to work. The working parameters screen will appear.

Attention!

While the sensors are being zeroed the analyser should be drawing in fresh air.

4.2. Preparing to the measurement

Before switching the analyser on it is necessary to put together the complete measuring set, which means to:

- connect the probe to the heated hose
- connect the heated hose to the gas conditioner (the magnetic inlet and the electric joint)
- connect the gas conditioner to the analyser with use of the gas hose
- connect the gas conditioner to the analyser with use of the communication cable



- connect the supplying conductors to the gas conditioner and the analyser

- make sure that the outlet hose for water from the conditioner is situated in a way making it impossible for the water to damage the device
- start the conditioner and set the target temperature of the hose, the radiator and the pump capacity.

Attention!

It is necessary to make sure that the main pump is in the ON mode. The pump will turn on when the hose and the radiator reach the target temperature.

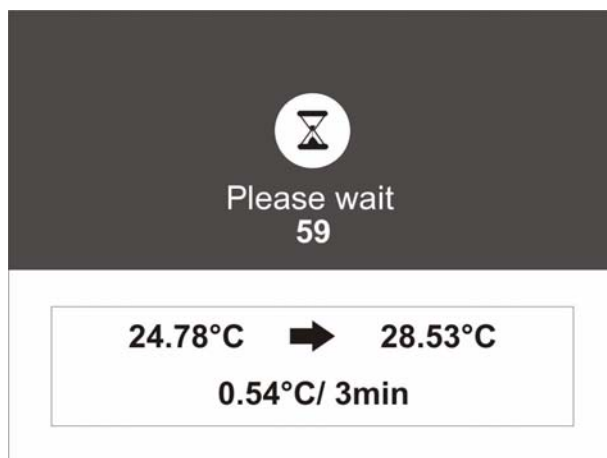
- start the analyser with use of the key situated on the side of the device's casing and the switch on the front panel

The process of warming-up and zeroing of the analyser will start and may take from about 30 minutes up to 1.5 h depending on the ambient temperature.

Attention!

During the process of warming-up and zeroing of the device the probe should be drawing in fresh air.

While warming-up the following screen will appear:



At the top of the screen the period of time since the beginning of the warming-up process is given. Below the following values are given:

- the current temperature of the interior of the device
- the target temperature
- the three-minute temperature increase

If, during the process of warming-up, the exterior conditions change or the device is not capable of reaching the target temperature within 1.5 h. for some other reason, the warming-up will be restarted with a different target temperature.

The warming-up finishes when the speed of the temperature change drops below 0.09°C / 3min. After warming-up the zeroing process lasting 5 min. proceeds.

We recommend strongly that the sensors be zeroed manually before any measurements are carried out.

After that the analyser is ready to work.

4.3. PHOTON analyser screens

4.3.1. *Measurement parameters screen*

Measurement parameters	10:15:22
► Averaging t:	2 s
Time of XL test:	10 min
Reference O2:	3 %
Fuel	0
Light oil	

Esc Change Data

With the help of this screen the user can change the working parameters of the analyser. To move around the screen, the arrow keys are used. The arrow up/down keys are used to switch between the parameters. The active parameter is labelled by an arrow. The value of the parameter can be changed by the arrow left/right keys, which decreases/increases the value, or by pressing the *Change* function key.

User can change the following parameters of the measurement:

- **Averaging time** – the averaging time for the measurement results presented on the display
- **Time of XL test** - the single XL measurement length (Range of setting: 10 s, 20 s, 30 s, 1 min, 2 min, 5 min, 10 min, 15 min, 20 min, 30 min)
- **Reference O2** – the value of reference oxygen used to calculate relative concentrations of components

- **Fuel** – the fuel in use (the name of the fuel is displayed in the line below)

The last two values are used for calculations and therefore if they are to assure the correctness of the measurement results, they should represent the real values.

The user can choose the averaging time from the following values: 2 s, 6 s, 10 s, 20 s, 30 s, 60 s, 120 s, 180 s.

The XL test can last 10s, 20 s, 30 s, 1 min, 2 min, 5 min, 10 min, 15 min, 20 min or 30 min.

Pressing the *Enter* key while looking through the screen enables the user to switch to the instant results (averaging time of 2 s)

Attention!

This operation changes the averaging time globally – if any measurements are in progress their results will also be stored with the 2 sec averaging time.

The *ESC* key allows the user to switch to results screen.

4.3.2. Results screen

An example of the results screen:

1 M003 F1 T=2s 0:04 XL1 10:13			
CO	22 ppm	NO	10 mg/m ³
NO ₂	13 ppm	H ₂ S	12 mg/m ³
SO ₂	220 ppm	NH ₃	160 mg/m ³
H ₂	45 ppm	HCl	286 mg/m ³
Cl ₂	15 ppm	NO*	0 mg/m ³
----	--- ppm	----	--- mg/m ³
M+ Operation Print Param.			

On the top of the screen there is the status bar:

- **1** – the screen number. 4 results screens are available. These can be called up with use of the arrow up/down keys. The contents of the screens can vary depending on the analyser's configuration.
- **M003** – the multiple storage in progress; the number indicates how many storages there are pending.

- **F1** – the number of the fuel in use; the choice of the fuel in use is made on the *Measurement parameters* screen.
- **T=2s** – the averaging time; the user can change the averaging time on the *Measurement parameters* screen. If the period of time measured since the starting of the instrument is shorter than the chosen averaging time, this value will refer to the current averaging time (the length of the period of time since the starting-up of the analyser).
- **0:04 XL1** – the XL test in progress; in this case a single test or the first test of the triple XL test is carried out. 4 seconds remaining till the end of the test.
- **10:13** – the current time.

The description of the function keys on the results screen:

- **M+** - enters the *Saving options* screen (see 4.3.4)
- **Operation** – enters the *Operation* screen (see 4.3.5)
- **Print** – enters the *Print options* menu (see 4.3.6)
- **Param.** – enters the *Measurement parameters* screen (see 4.3.1)

The symbols of the measured gases concentrations are labelled as follows:

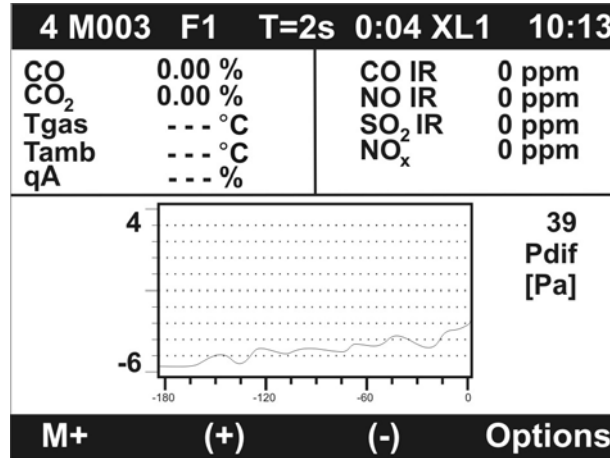
- **CO** – the volume gas concentration (% or ppm)
- **CO_m** – the mass concentration (mg/m³)
- **CO*** - the mass concentration referred to O₂ (mg/m³)

The same symbols are used in printouts.

The results displayed on the screen are updated every two seconds. The result which is currently displayed is a result averaged for the period of time (of the chosen length) which has just passed.

4.3.3. Results screen no 4

The fourth results screen is unusual as it presents the measurement results graphically.

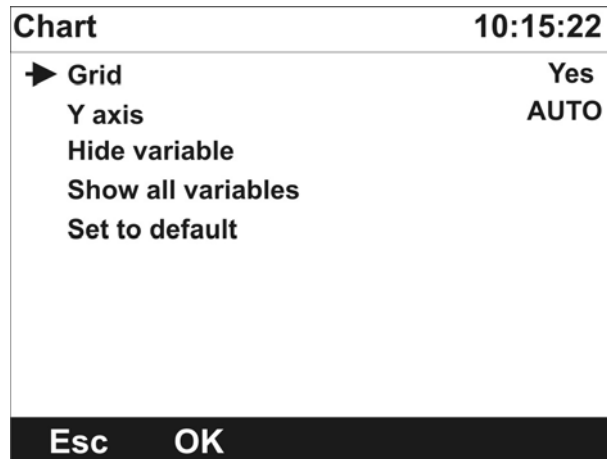


The vertical axis of the chart presents the value of the variable. The period of the last 180 seconds is shown on the horizontal X axis. The measurement results for the chosen variable are presented on the chart as a curve.

On the right-hand side of the display, next to the graph, the name, the number and the unit of the chosen variable are presented.

Pressing the following key:

- **M+** enters the *Saving options* screen
- **(+)** changes the currently displayed measurement channel for the next one
- **(-)** changes the currently displayed measurement channel to the previous one
- **Options** - calls the screen of the graph options



The user can change the following chart settings:

- **Grid** – showing/hiding the grid on the chart
- **Y axis** – presenting the measurement results on different scales:
 - AUTO** – adjusting the range of the scale to the range of the measurement results for the particular measurement channel
 - Full** – adjusting the range of the scale to the maximum measurement range for the particular measurement channel
 - Default**- adjusting the range of the scale to the range typical of the particular measurement channel
- **Hide variable** – hiding the chosen variable
- **Show all variables** – showing all the hidden variables
- **Set to default** - returning to the default settings

4.3.4. Saving options screen

The **PHOTON** analyser stores the measurement results as reports containing the information on the current measurement parameters and all the measured and calculated values. The results can be saved on the MMC card and in the on-board memory. The on-board memory for 4 reports is used when there is no MMC card or when the card is full.

Saving options	10:16:15
▶ Current results	
Single XL test	10 sec
Triple XL test	3 x 10 sec
Multiple storage:	Off
<hr/>	
Memory card:	64 MB
Available memory:	37.2 MB
Storage period	10 sec
Storage quantity	5
No. of reports to save:	3
<hr/>	
Esc	Start
Options	MMC

The MMC card is detected automatically. After it has been inserted into the slot the information screen appears for a few seconds.

When the MMC card is inserted the option of saving the reports in the on-board memory is blocked. However, it is possible to move the previously saved reports from the on-board memory to the MMC card. The data in the on-board memory will then be lost. Information about the card capacity and the free space available on the card is sent to the analyser when the card is inserted. That is why it is possible to fill the free space available on the card up even if the information presented on the display says otherwise.

Each of the reports is saved as a separate file (with the exception of the multiple storage and the triple XL test, the whole series of which are saved as a single separate files) named report_number.rp

At the bottom of the screen the information about the MMC card, the memory capacity and the number of the free reports in the on-board memory are shown. The information about the multiple storage settings are also presented.

At the top of the screen the available saving options are presented. The arrow up/down keys are used to choose between the available storage formats. The current choice is indicated with an arrow.

- **Current results** – all the currently measured and calculated values averaged for the period of time set on the *Measurement parameters* screen, will be saved.
- **Single XL test** – a long-period measurement (the length of the period of time set on the *Measurement parameters* screen) will be carried out. The storage period can be changed with use of the arrow left/right keys on the currently displayed screen or on the *Measurement parameters* screen. The

measurement result will be averaged for the period of time the length of the measurement process.

- **Triple XL test** – three long-period measurements will be performed (each of the measurements the length of the single XL test). The results of each of three measurements will be averaged for the period of time the length of the single XL test. The results of the triple XL test are stored in a single file.
- **Multiple storage** – a series of measurements will be performed. The number of tests and the length of the interval between them are shown at the bottom of the screen. The saving parameters can be changed with the help of the screen appearing after pressing the *Options* function key. The series of results is saved in one file.

The *Start* function key carries the chosen saving process out. The *Esc* function key returns to the previous menu.

Report saving	10:27:49
----------------------	-----------------

Enter customer number

0145
↑

Esc	OK	C
------------	-----------	----------

If the *OK* function key is pressed the following screen will be displayed. The user is asked to enter the customer number (using either the arrow left/right keys to change the position of the indicator and the arrow up/down keys to increase/decrease the indicated digit or the numeric keyboard to enter the customer number right away).

When there is no MMC card installed and no free space in the on-board memory available a following screen will be displayed:

Report saving	11:10:18
----------------------	-----------------



No free mem for report!

Overwrite oldest?

Esc	Yes
------------	------------

The *Esc* function key navigates the user back to *Saving options* screen. After the *Yes* key has been pressed the oldest report is overwritten.

Pressing the *Options* function key on the *Saving options* screen displays the following screen:

Storage - options	10:15:22
➔ Storage period:	10 s
Storage quantity:	60
Time of XL test:	10 min

Esc	Change
------------	---------------

Any parameter change can be made with use of the arrow left/right keys or with the *Change* function key.

Pressing the *MMC* function key on the *Saving options* screen allows the user to view the contents of the MMC card.

MMC card		10:15:22		MMC card		10:15:22	
Name	Size	Date	Time	Name	Size	Date	Time
00000017.RP	10	12.08.04	11:30	00000017.RP	10	12.08.04	11:30
→ 00000216.RP	65530	15.08.04	23:31	→ 00000216.RP	65530	15.08.04	23:31
00001447.RP	123	12.08.04	06:54	00001447.RP	123	12.08.04	06:54
				00001448.RP	123	12.08.04	07:54
				00001449.RP	123	12.08.04	08:54
				00001450.RP	123	12.08.04	09:54
				00001451.RP	123	12.08.04	10:54
				00001452.RP	123	12.08.04	11:54
				00001453.RP	123	12.08.04	12:54
				00001454.RP	123	12.08.04	13:54
				00001455.RP	123	12.08.04	14:54
Esc	Home	Print	Erase	Esc	Next ...	Print	Erase

If the card contains a number of files bigger than the number of lines that can be displayed on the screen, the *Next...* function key is shown. It is used for displaying the following screens. When the last screen is displayed the *Next...* function key is replaced by the *Home* function key, which enables the user to go to the first screen.

The user can make a choice of the report with use of the arrow up/down keys.

In case of constant storages, the information on the size of the file which is currently being saved is updated when the screen containing this particular information is next displayed.

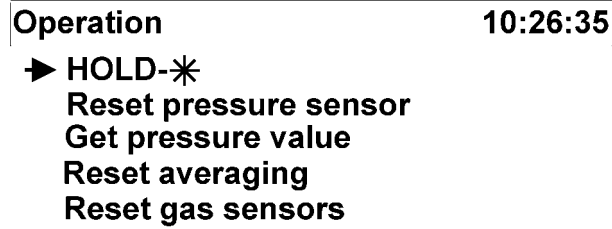
The description of the single line of the *MMC card* screen.

- **00000216.RP** – the file name,
- **15/08/04 23:31** – the exact date and time of saving of the report,
- **65530** – the size of the file (the number of records in a file)

The *Print* function key will carry out the process of printing of the report. If any file contains more than one report (the multiple storage or the triple XL test files) the first report will be printed.

Erase function key is used for erasing all the data saved on the MMC card.

4.3.5. Operation screen



Esc OK Data

The screen enables the user to perform the following operations:

- **Hold** - “freezes” the values presented on the screen. However, all the measurements and calculations are still performed. Pressing the * function key switches the *Hold* mode off.
- **Reset pressure sensor** - sets the current pressure value measured at the pressure inlets as the reference pressure (the current pressure level will be set as the 0 value). It is recommended to perform this operation before carrying any pressure measurements out.
- **Get pressure value** - the analyser performs a single pressure measurement. The result of this action is presented on the screen:



and saved in the next report.

- **Reset averaging** - clears the latest results buffer. The data used for averaging of the results is stored from the moment the option has been chosen.

- **Reset gas sensors**- calibrates the gas sensors as during the initial configuration process. The user is asked to confirm this operation:

Initial configuration	11:10:18
-----------------------	----------



Reset sensors?

Esc Yes

Attention!

During the calibration of the gas sensors, the sensors should be drawing in the fresh air. Due to the length of the tubing including the gas conditioner, the probe should be in fresh air for about 3 minutes before performing this operation.

4.3.6. Printing options screen

Print options	11:10:18
➔ Current results	Format: 2
Report/On-board mem	Format: 3
Report/ MMC card	Format: 3

Esc Yes

On the above screen three options are available:

- **Current results** – the currently measured values are printed.
- **Report/ On-board mem** – a printout of a report stored in the on-board memory proceeds.
- **Report/ MMC card** – a printout of a report stored on the MMC card is performed.

Data concerning the followings are contained in the printouts:

- the exact date and time of the measurement process,
- the fuel in use,
- the operator,
- the customer,
- the averaging time,
- the measurement results.

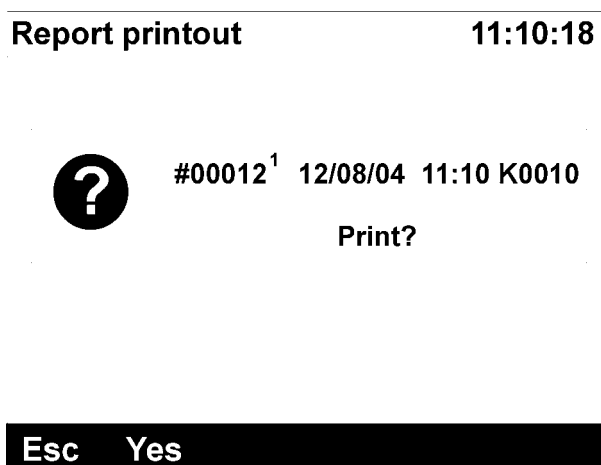
The user can choose from eight printout formats.

The first four printout formats are the default ones and may not include all the measured values. The remaining four are designed for the particular analyser and include data from all the installed sensors.

The description of the printout formats:

- **Format 5** – enables the user to print the current values; it mainly includes the volume concentration values of the measured gases
- **Format 6** – enables the user to print the reports; it mainly includes the volume concentration values of the measured gases
- **Format 7** – enables the user to print the current values; it includes the mass concentration values of the measured gases
- **Format 8** – enables the user to print the reports; it includes mass concentration values of the measured gases

If the stored report printout has been chosen, the following screen will be displayed:



If the chosen report is a part of the triple XL test report, pressing the *Average* function key will average the three partial reports and print them as one.

4.4. Menu

To access the *Menu* screen the user can press the arrow right key or any of the numeric keyboard keys while on the results screen. The following screen will be displayed:

```
Menu 10:15:22
  ▶ Measurement parameters
    Settings
    On-board memory
    Clock/ Date
    Service
```

```
Esc Enter Data
```

4.4.1. Measurement parameters

Pressing the *Enter* function key while the cursor points at the *Measurement parameters* line on the *Menu* screen displays the *Measurement parameters* screen (see 4.3.1).

4.4.2. Settings

Pressing the *Enter* function key while the cursor points at the *Settings* line on the *Menu* screen displays the following screen:

Settings	10:52:33
▶ Pressure unit:	hPa
Temperature unit:	°C
Language	English
Contrast	2
Main pump	50%
External pump	Yes

Esc OK Data

enabling the user to change the following settings:

- **Pressure unit** – the user can make a choice from: Pa, hPa, mmH₂O, inH₂O,
- **Temperature unit** – the choice can be made from: °C or °F,
- **Language** – allows the user to change the analyser programme language,
- **Contrast** – enables the user to set the display contrast; available contrast levels: 0 – 5,
- **Main pump** – the user can set the main pump capacity when the external pump is switched off (the pump capacity can be set choosing the appropriate value from 50%, 55%, ...,100%),
- **External pump** – allows the user to switch the main pump off which is necessary when the device works with the external gas conditioner

The values of each of the parameters can be set with use of the arrow left/right keys or the *Change* function key.

4.4.3. On-board memory

Pressing the *Enter* function key while the cursor points at the *On-board memory* line on the *Menu* screen displays the *On-board memory* screen.

On-board memory		10:58:23
▶ #00012 ¹	12/08/04 11:10 K0010	3min
#00012 ²	12/08/04 11:13 K0010	3min
#00012 ³	12/08/04 11:16 K0010	3min
#00013	12/08/04 12:36 K0013	2sec

Esc Print Erase ▶MMC

The above screen enables the user to access the reports stored in the on-board memory.


The reports stored in the memory are presented in four lines.

The description of a single line of the *On-board memory* screen:

- **#00012¹** – the serial number of the report. The number ¹ indicates that this is the first of the three reports of the triple XL test,
- **12/08/04 11:10** – the exact date and time of the measurement process,
- **K0010** – the customer number,
- **3min** – the averaging time of the results; (when the information concerns the triple XL test the displayed time is the length of the whole measurement process.)

Each of the reports can be printed, erased, or moved to the MMC card.

If the *Erase* function key is pressed when the particular report has been chosen a following screen is shown:

Erasing reports		11:10:18
<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: auto;">  <p>#00012 12/08/04 11:10 K0010</p> <p>Erase report?</p> </div>		
Esc All Yes		

Pressing the *All* function key erases all the reports stored in the on-board memory.

4.4.4. Gas conditioner

Pressing the *Enter* function key while the cursor points at the *Gas conditioner* line on the *Menu* screen displays the *Gas conditioner* screen.

Gas conditioner		10:15:22	
	Is	Set	
▶ Pump setting:	30	50	%
Hose temperature:	100	130	°C
Cooler temp.:	6	3	°C
*** STATUS ***			
Esc	(+)	(-)	On/Off

The screen makes it possible for the user to change the PGD-100 external gas conditioner settings. The (+)/(-) function keys enable the user to increase/decrease the conditioner's parameters values. The conditioner's parameters are: the pump setting, the hose temperature and the cooler temperature.

The *Is* column presents the current values of the parameters sent to the analyser from the conditioner whereas the *Set* column shows the values set by the analyser or the conditioner operator. Therefore the user is capable of changing the values of the parameters presented in the *Set* column with the help of the analyser or conditioner keyboard.

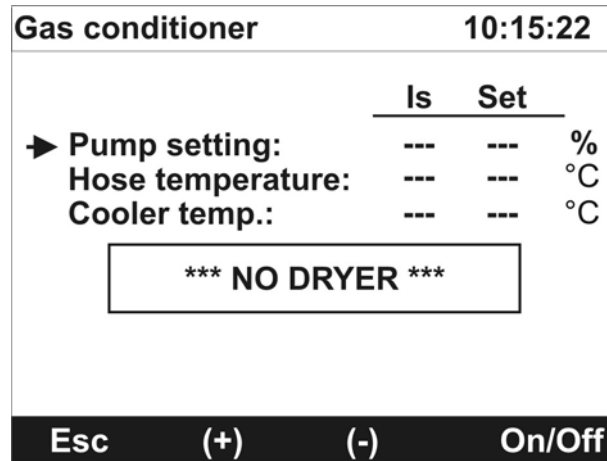
The field marked with the *STATUS* sign is to inform the user about the working mode of the gas conditioner.

The gas conditioner has the following working modes:

- **READY** – the connection with the **PHOTON** analyzer has been established and the parameters of the conditioner have reached the required values (the hose and the cooler temperature)
- **NOT READY** – the connection with the **PHOTON** analyzer has been established but the parameters of the conditioner have not reached the required values (the hose and the cooler temperature)

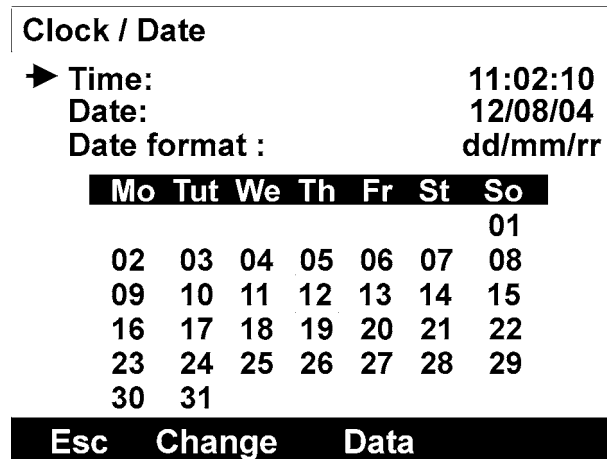
- **NO DRYER** – the connection with the **PHOTON** analyser has not been established

When there is no communication between the gas conditioner and the analyser the following screen will be displayed.



4.4.5. Clock/ Date

Pressing the *Enter* function key while the cursor points at the Clock / Date line on the *Menu* screen displays the *Clock/Date* screen.

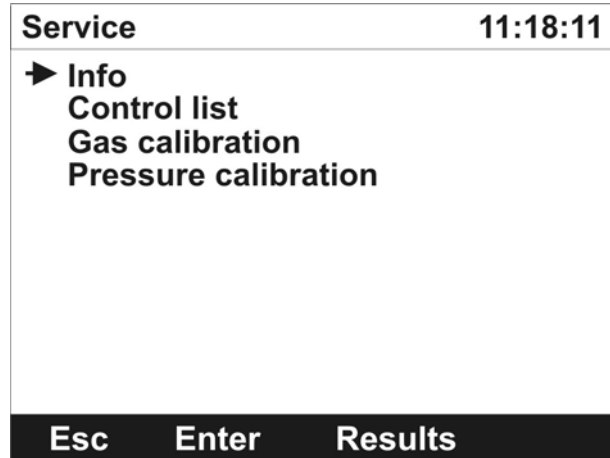


This menu enables the user to set the clock and the current date.

With use of the arrow up/down keys the user can choose the option which is to be changed: the time, the date and the date format. With the help of the *Change* function key the user is capable of changing the value of the currently indicated parameter. Two date representation formats are available. The user can choose between: Day – Month – Year and Month – Day – Year date format. At the bottom of the screen the calendar is shown.

4.4.6. Service

Pressing the *Enter* function key while the cursor points at the *Service* line on the *Menu* screen displays the *Service* screen.

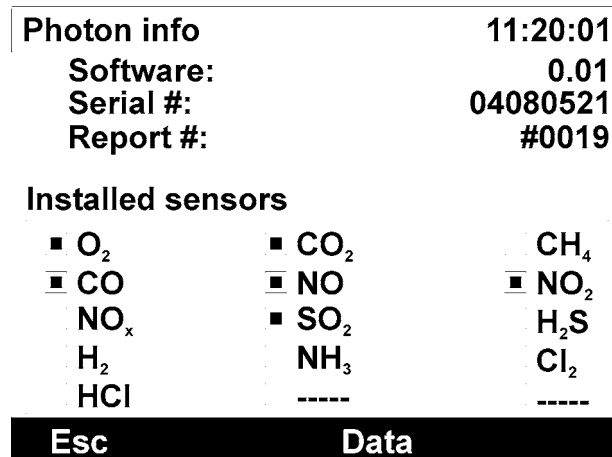


4.4.6.1. Info

Pressing the *Enter* function key while the cursor points at the *Info* line on the *Service* screen displays the *Photon info* screen.

The *Photon info* screen contains the basic information concerning the analyser, these are:

- the software version,
- the analyser serial number,
- the number of the latest report,
- a list of the installed sensors.



4.4.6.2. Control list

A service-only option.

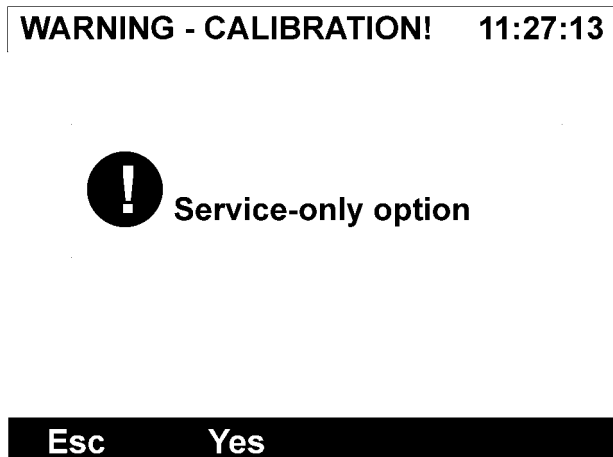
4.4.6.3. Gas calibration

A service-only option.

4.4.6.4. Pressure calibration

A service-only option.

After any of the calibration options has been chosen the analyser will show the alert screen:



After confirmation with the *Yes* function key, the pressure calibration screen will be displayed:

Pressure calibration		11:32:11	
		Signal	Pa
Measurement Storage		11325	1203
		12007	1350
▶ Pressure		1350 Pa	
Esc		Change	OK

The calibration procedure

Pressing the *Change* function key displays the screen where the model pressure (pressure at the analyser's front panel outlets) should be set. When the value of the pressure is stable, the *OK* function key is to be pressed – the measured pressure is set as the reference pressure in the pressure converter.

The completion of the operation is signalled with the appearance of the screen:

Photon Done!

4.5. Finalising work with the analyser

The instrument should not be switched off until

- the gas probe has been removed from the stack/ or the gas hose has been disconnected from the analyser
- all the flue gases have been purged from the system with clean air
- the instrument has been allowed to run in air for about a minute.

5. Service program

The **PHOTON** service programme is used to operate and service the gas analyser. It enables the user to reach the settings of the device, look through and store the current results and their printouts.

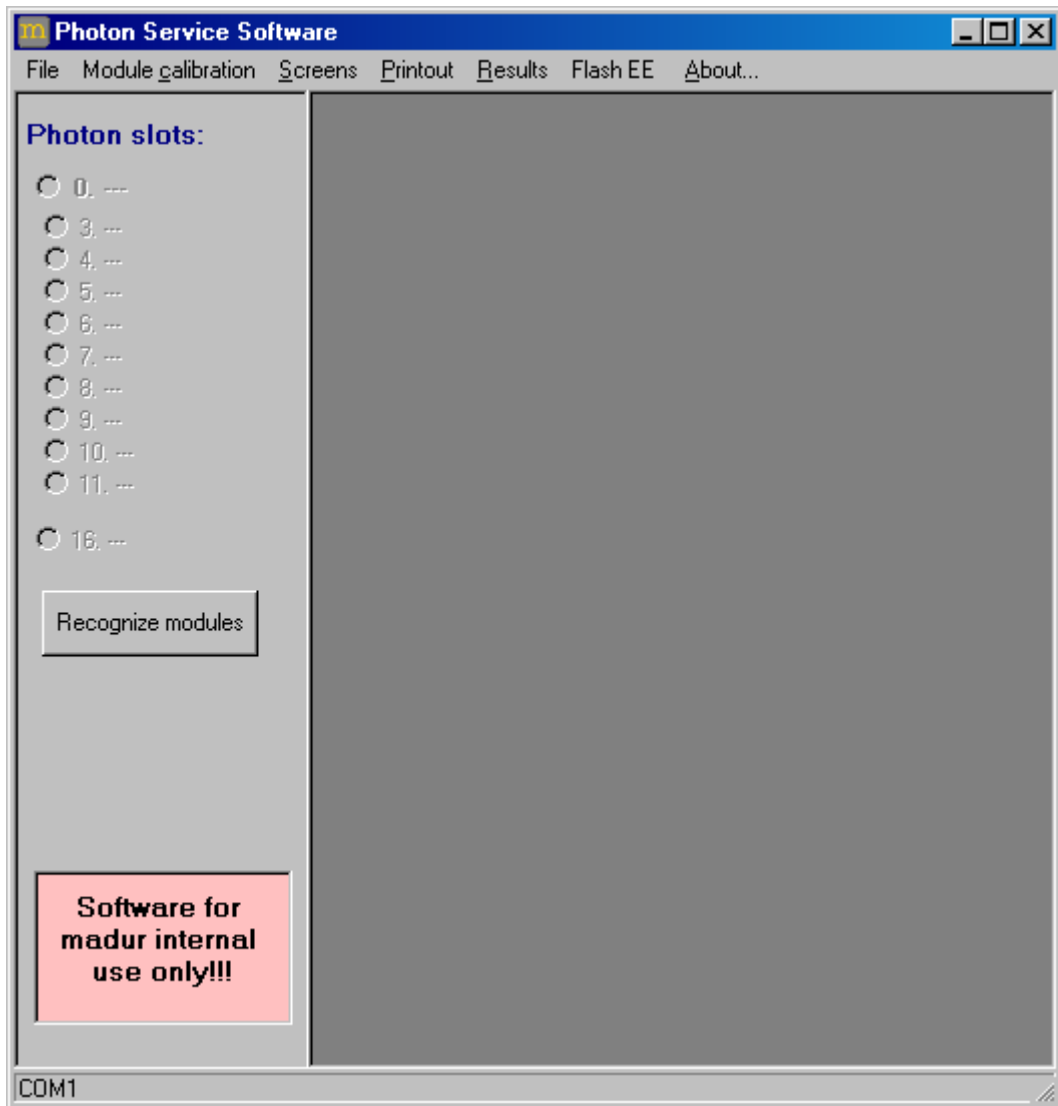
It makes it possible for the user to proceed the process of the calibration, see interior parameters of the device and to diagnose the correct action of the device.

5.1. The installation of the programme

To begin the installation process it is necessary to start the setup_photon.exe file and then to follow the instruction which will appear on the screen.

5.2. Starting up the programme

When starting the programme up the user should turn the analyser on and connect it to the computer with use of the communication cable. After the **PHOTON** programme has been started the following screen will appear:

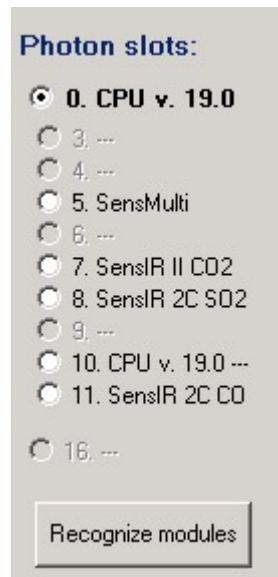


The access to all the programme's options is available from the *Main menu* bar. Below the *Main menu* bar, on the left-hand side, there is a panel, on which all the detected elements of the analyser are marked (*Photon slots*), and the *Recognize module* key responsible for establishing the connection is situated. In the remaining field the windows used for operating the analyser appear.

5.3. Connection with the analyser

Establishing the connection with the analyser is carried out after the appropriate port has been selected in the programme's options (*Menu > File > Options*) and the *Recognize module* key on the programme's left panel has been pressed.

After the successful connection process the programme will detect and show the modules available in a particular device and will display the list of sensors on the left panel.



Switching between the analysers (and the available sensors) is carried out by choosing different positions from the list. Marking any of the sensors (or the CPU board) relates all the programme's actions to the chosen element of the analyser.

While establishing the connection with the analyser the programme might display the following message:

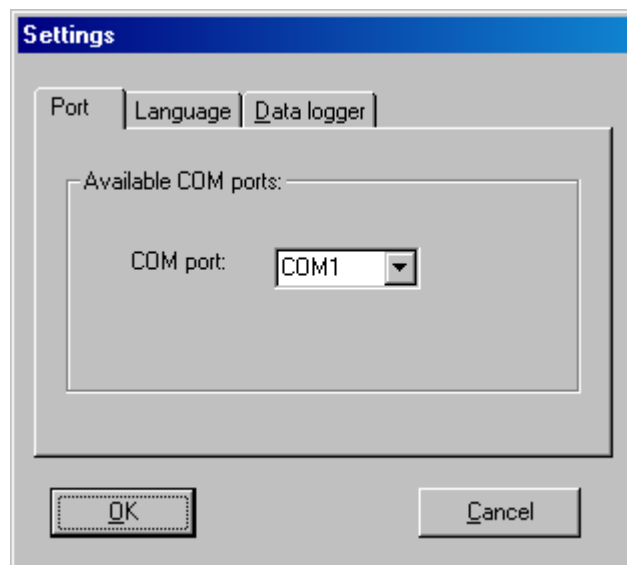


This means the connection process has not been completed successfully, which might have been caused by the inappropriate setting of the serial port in the programme (*Menu > File > Options*) or by a damaged or improper communication cable.

5.4. File menu- the programme settings

- Quit - exits the programme
- Options - enables the user to set the parameters of the **PHOTON** programme

5.4.1. Port – the port settings



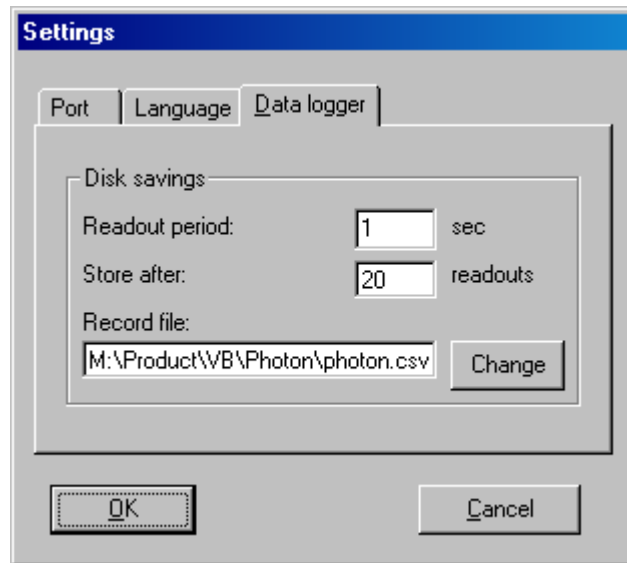
5.4.2. Language – language settings

This option is inactive.

The programme is available only in an English language version.



5.4.3. *Data logger – saving the results*



The options:

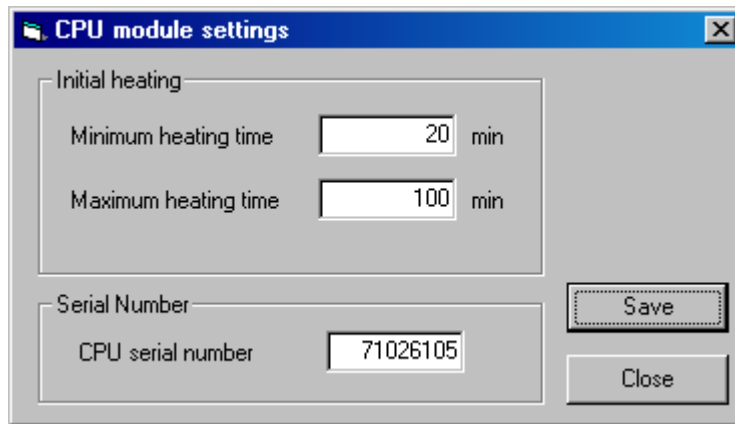
- Readout period - the length of the interval between the following readouts of the current measurement results
- Store after - the amount of readings after which the storing process proceeds
- Record file - the name and the path to the file used for storing the results

5.5. *Module Calibration menu*

The calibration options are the most widely extended module of the programme and they depend on the chosen sensor.

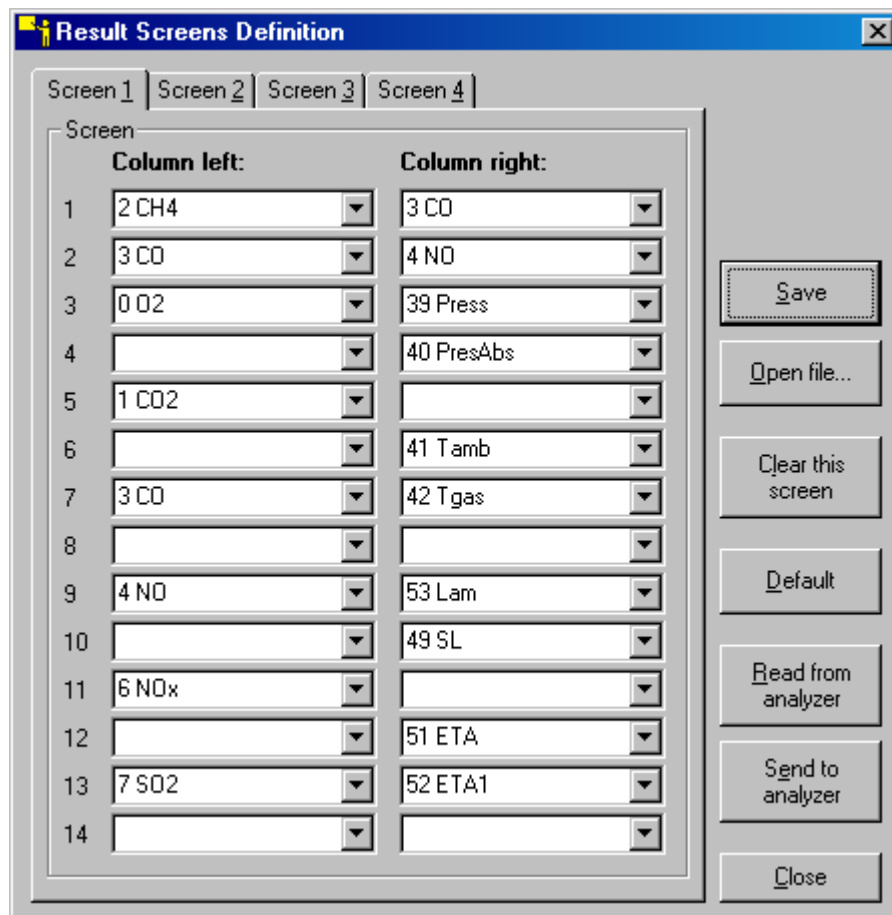
The particular calibrations are described precisely in the chapter Calibration.

In case the CPU board is chosen the calibration process concerns:



- the minimum and maximum heating time of the device
- the serial number of the device (the CPU board)

5.6. Screens menu – result screens definition



With the help of the results screen window one may define the results which are to be shown on particular screens on the device display. It is possible to display

the results on four screens - each of them made up by two columns consisting of up to 14 positions each, in the configuration defined by the user.

It allows the user to adjust the device to the needs of the measurement which is being carried out by observing the selected results on one screen avoiding useless switching between different results screen.

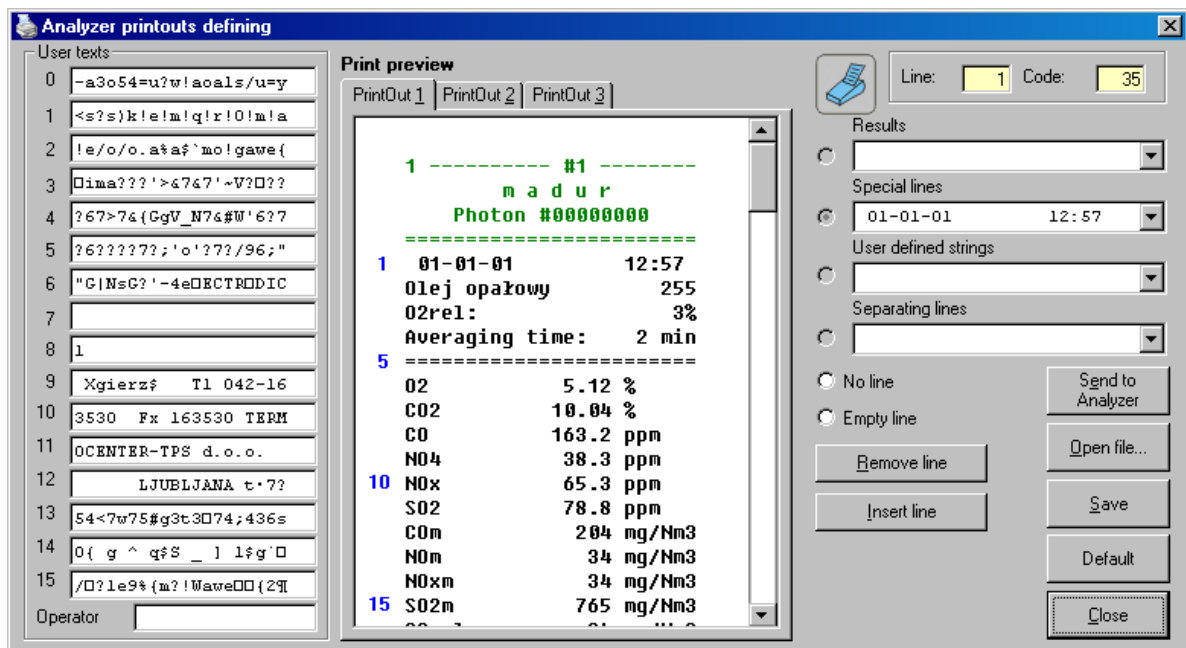
No change in the window will influence the device settings unless the current setting is sent to the device with use of the *Send to analyser* key.

Attention!

Setting the status line is available only in the first upper line.

The particular defined by the user configuration of the positions on the results screen can be stored on the hard disk of the computer until it is read and used again (with use of the *Save* and *Open file* keys).

5.7. Printout menu – analyser printouts definition



The window makes it possible for the user to define the appearance and the parameters of the printout of the built-in printer.

The printout may consist of up to 40 lines and a heading containing the number of the printout, the company name, the device name and serial number.

The user can define and store in the device up to 16 notes which can be later placed in the printouts (for instance as the comments on the measurements).

Defining the appearance of the printouts is about assigning certain definitions chosen from the panel on the right-hand side to each of the lines. On the panel there are four lists with the selection of the line's content:

- results
- special lines
- user defined strings
- separating lines

Each time the window is opened the printout settings are read from the analyser and actualized. Storing the definition of the printouts will be carried out after the *Send to analyser* key is pressed.

The particular defined by the user appearance of the printouts can be stored on the hard disk of the computer until it is read and used again (with use of the *Save* and *Open file* keys).

5.8. Results menu

The screenshot shows a window titled "Results readouts" with a table of gas measurements and a section for "Temperatures & initial heating data".

	Main channel	Normalised	Reference channel		Gas result	
CO ₂	150402	-8388074	100000	uV	0	ppm
CH ₄	---	---	---	uV	---	ppm
CO	194480	83879920	190621	uV	0	ppm
NO	193659	83877500	144681	uV	0	ppm
SO ₂	156922	127182	137691	uV	0	ppm

Temperatures & initial heating data

Tgas	---	°C	Tamb	---	°C	Tint	42.22	°C
Delta	0.02	°C	Tprim	-0.02	°C	Target	42.35	°C
<input checked="" type="checkbox"/> VarsFilled			<input type="checkbox"/> LockHeater			Heater	96	

At the bottom, there is a checkbox for "Results storage", a "Stop" button, and a "Close" button.

In the *Results readouts* window the current measurement results from the ducts (sensors) available in the particular device are displayed:

- **Main channel** - the level of the signal in the gas duct

- **Normalised** - the level of the signal after normalization
- **Reference channel**- the level of the signal in the reference duct
- **Gas result** - the content of the gas given in ppm

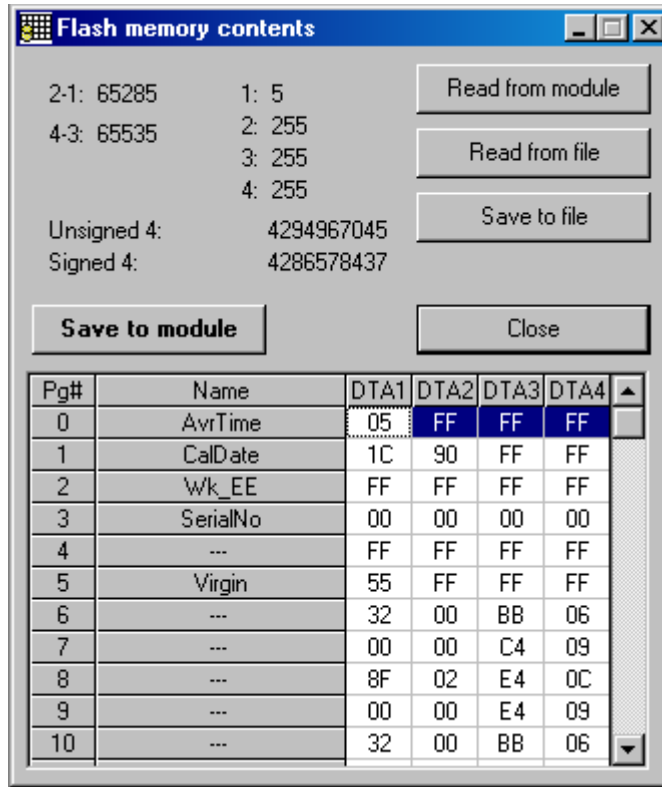
and the temperatures are shown:

- **Tgas** - the gas temperature (after the probe has been connected)
- **Tamb** - the ambient temperature (after the probe has been connected)
- **Tint** - the interior temperature
- **Delta** - the temperature increase
- **Tprim** - the three-minute temperature increase
- **Target** - the heating temperature (the target temperature)

Below there is the *VarsFilled* marker informing whether the process of heating and keeping the temperature in the measurement course of the device on the particular level has been carried out properly. The *LockHeater* marker informs whether the heater is running (*Heater* – the heating level is given).

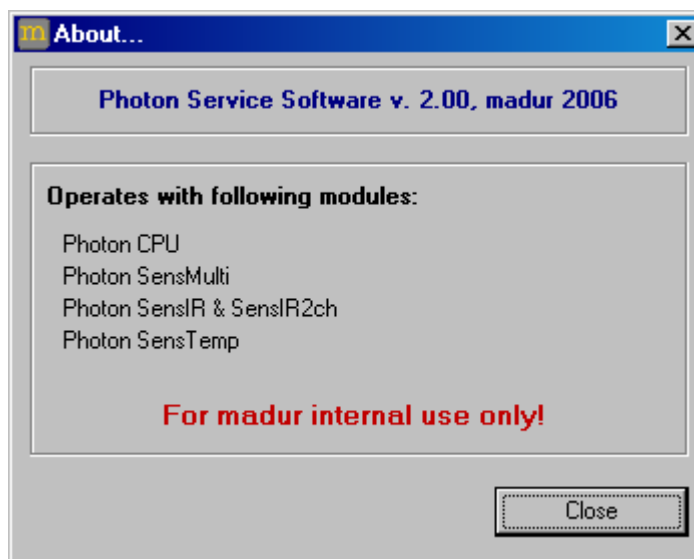
Results storage – this marker is used for storing the information from the current window on the hard disk in the *Recording.csv* file in the programme directory. The storing process is carried out every two seconds.

5.9. Flash EE menu- memory contents readouts



For controlling and servicing purposes there is a possibility of reading the content of the device's memory and storing it in the binary file on the computer's disk (the FlashEE.bin in the current programme's directory).

5.10. About... menu - information on the programme



The window informing about the number of the programme version.

6. Calibration

The calibration settings are designed only for the qualified service. Madur does not recommend making any changes to these settings.

The calibration of the device is limited only to the basic settings. All other changes should be carried out with the help of qualified staff.

6.1. IR sensors calibration

The screenshot shows the 'Module SensIR/Sensir 2ch - gas calibration & main settings' window. It features a 'Multipoint calibration' table with columns for Reference gas (%), Signal uV(Ch1), and Signal uV(Ch2). The 'Measurements' section displays Ch1 (150 567 uV), Norm. (-8 387 092 uV), Ch2 (100 000 uV), and Temp (70.00 °C). The 'Zeroing' section includes ZeroShift (2 ppm) and Zero gas (0 %). The 'Sensor type (measured gas)' is set to CO2. The 'Sensor range' section shows Range (25%) and DeltaPPM (1000). The 'Correction for CH4 (SO2 s. only)', 'Correction for CO2', and 'Correction for O2 (NO s. only)' sections each have a value of 0. The 'Divider/Rounder/DP' section includes Divider (100), Rounder (1), Rounder1 (10), DP (2), and Unit (%). A 'CALIBRATE' button is located at the bottom center of the window.

The procedure of the IR sensor calibration

Attention!

If the process of the calibration is to be carried out properly the calibration points should cover the whole measurement range.

The calibration of the **PHOTON** analyser is about generating the calibration curve used for evaluating the measurement results with the help of the signals received from the sensors.

If the calibration is to proceed, standard gases have to be supplied to the device and the particular signal from the measurement converter have to be matched with the appropriate gas concentration (*Capture*) in the *Multipoint calibration* box.

Before the signal level can be "captured" it is advisable to wait until the measurement has stabilized. This will be signalled by the delta value from the *Ch1* channel displayed on the right-hand side of the *Measurements* box.

The delta value should oscillate around zero and its oscillations should not exceed the values given in the table below:

Calibrated gas	Delta value
CO, NO	<10
SO ₂	<15-20
CO ₂	<50

The device should be supplied with clean carrier gas, for which the first point of the curve is defined (it can be seen that the field used for filling in the gas level the first line is inactive and shows 0 value).

The person carrying out the calibration process can define the level with the *Capture* key remembering to check the oscillation of the signal level delta.

The following points of the curve are defined in the similar way.

The device should be supplied with the model gas and the value should be filled in the left column.

The case shown above concerns the gas with the concentration of 20ppm ascribed to the signal level of 98905.

The signal in the reference channel does not depend on the gas concentration and should not change significantly during the calibration process.

The calibration curve will be generated on the basis of all the points defined in the same way.

Attention!

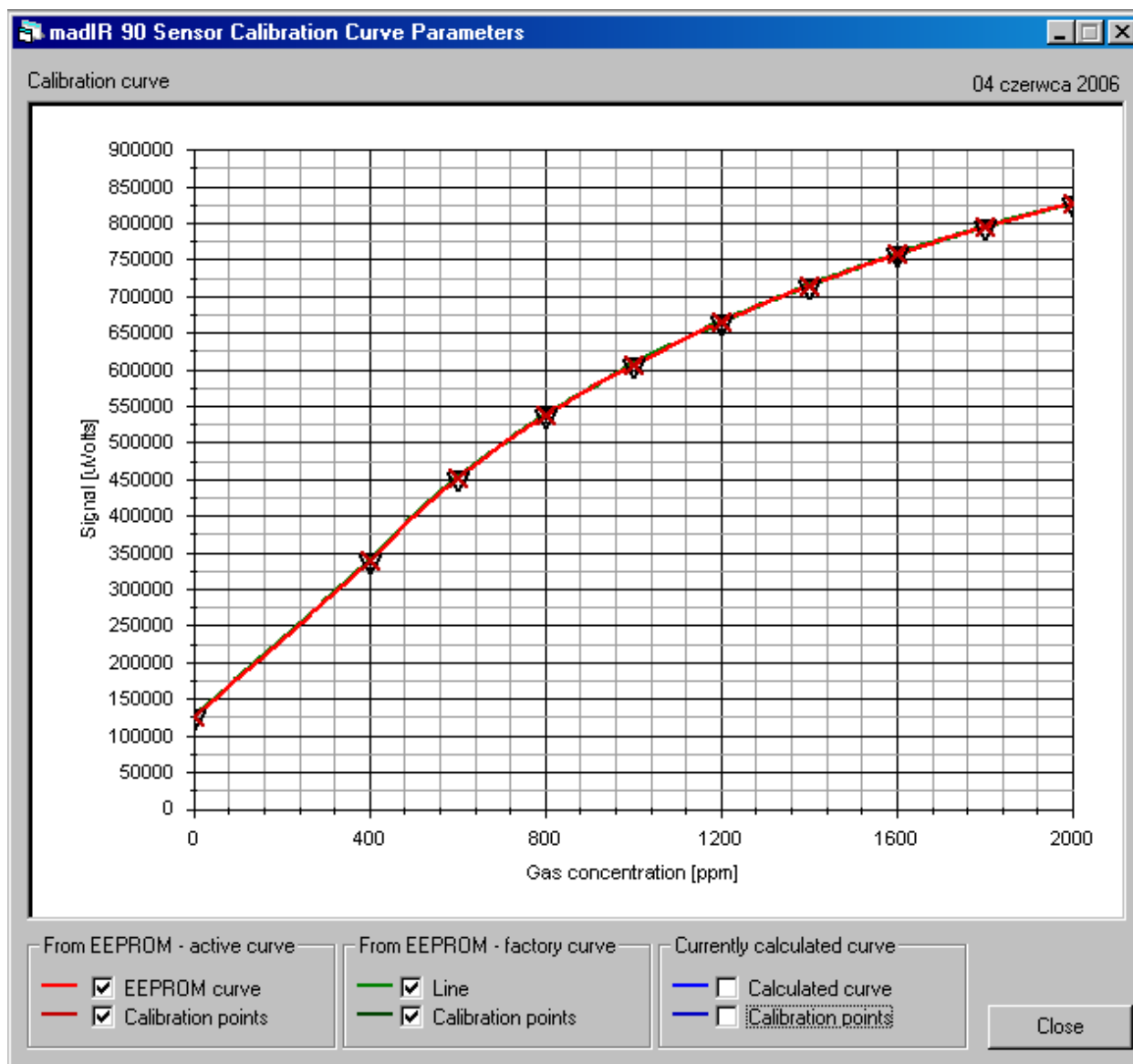
The bigger the number of the defined points gets the more precise the measurements carried out with the help of the analyser are.

After the calibration points have been defined it is necessary to hold the measurements with use of the *Stop* key. At that point the other keys in the window will be activated. Storing the calibration points and generation of the calibration curve follows pressing the *CALIBRATE* key.

After the measurement has been stopped it is possible for the user to access the following options:

- **CALIBRATE** -storing the calibration curve in the analyser
- **Chart** -the window displaying the calibration curve
- **Enter hypothetical data** - entering the hypothetical calibration points (deletes the calibration data)
- **Read cal. points** -the readout of the points from the device (deletes the calibration data)
- **Read factory** -the readout of the factory curve (deletes the calibration data)

The programme will start the process of generating the calibration curve and then it will display the curve's appearance in the chart window (which can be also accessed with the help of the *Chart* key).



After the chart has been displayed, a note asking for confirmation of the decision to save the data in the device memory will appear, after confirmation the calibration data will be changed.

6.2. Calibration of the electrochemical cells

Module SensMulti calibration & main settings

Results

	uV	Result	AVRTime
0. THCO	- 482 851	-11881 uV	5 s
1. PTC0	8 388 550	2075,7 ohm	5 s
2. PTC1	8 388 549	2080,4 ohm	5 s
3. Press	- 115	-0,3 Pa	5 s
4. APress	1 474 802	1000,0 hPa	5 s
5. O2	114 224	20,95 %	5 s
6. Tox0	4	0 ppm	5 s
7. Tox1	1	0 ppm	5 s
8. Ubat	- 2	0 mV	5 s
9. Tint	248 620	1225 ohm	4 s

References / calibration / zeroing

Ref	Signal uV	Zero uV
12 218 uV	496 564	1 197
500,3 ohm	63 187	58
600,8 ohm	75 706	59
1 500,0 Pa	- 589 091	- 30 073
997,0 hPa	1 461 967	0
1 012,0 hPa	1 525 911	
+15hPa		
21,00 %	115 183	916
20,95%		
32 767 ppm	8 388 607	- 3
32 767 ppm	8 388 607	- 2
32 767 mV	8 388 607	0
2 396 ohm	486 444	76

Tox0/1 channels settings

Gas	ZeroShift [ppm]	Correction for SO2 [ppm/1000ppm]	Correction for NO [ppm/1000ppm]
6. ---	0	0	0
7. ---	0	0	0

Serial No
Serial No
71001055

Reload
Measurements
Close

Module software version: 16.3

The procedure of calibration of the electrochemical cells

The calibration of electrochemical cells is about defining two points assigned to a particular signal level for the zeroed channel:

- **Zero uV** - the zero level (the lowest signal level)
- **Ref** - the model signal level

In the *Results* box there are the following channels:

0. **THCO** - the thermocouple, uV
1. **PTCO** - the thermocouple, the thermistor
2. **PTC1** - PT500
3. **Press** - the differential pressure
4. **APress** - the ambient pressure
5. **O2** - the oxygen sensor
6. **Tox0** - the additional sensor channel
7. **Tox1** - the additional sensor channel
8. **Ubat** - the supply voltage

9. **Tint** - the interior temperature

The type of the installed Tox0 and Tox1 sensors is defined in the *Tox0/1 channels settings* box in the column *Gas*.

For example, the calibration of the oxygen sensor requires an oxygen-free gas to be supplied (for instance CO) and the *Zero uV* signal level to be captured with use of the *Zero* key.

And then defining the other point – for the standard oxygen concentration 20,95% - with use of the *Calibrate* key.

Attention!

During the calibration of the electrochemical sensor it is necessary to remember to stabilize the sensors (oscillations of the sensors should be minimum).