

STATIONARY GAS ANALYSER



Manual

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madur
E L E C T R O N I C S

Contents

1. Introduction	4
2. Package content	5
3. Monitor construction	6
3.1. Casing	7
3.2. Gas channel	9
3.2.1. Gas dryer with filter	10
3.2.2. Peristaltic pump	11
3.2.3. Solenoid valve	12
3.2.4. Gas pump	12
3.2.5. Gas sensors	12
3.3. Electric connectors of the monitor	13
3.3.1. Digital inputs	13
3.3.2. Analogue outputs	14
3.3.3. Digital output (PWM)	15
3.3.4. Relay outputs (optional)	16
3.4. Monitor power supply	17
3.5. Configuration possibilities	18
3.5.1. Types of the measured gases	18
3.5.2. Additional and optional equipment	19
4. Monitor installation	20
4.1. Connecting the monitor	21
4.1.1. Connecting the electric wires	21
4.1.2. Connecting the gas hoses	24
4.2. First start-up	27
5. Operation	27
5.1. Basic operation	27
5.2. Monitor function	28
5.2.1. Cyclic work mode	28
5.2.2. Scheduled work mode	30
5.3. Communication with monitor	31
5.3.1. Monitor network (RS485)	32
5.3.2. Communication via USB port	33
5.3.3. Communication via Ethernet	37
5.4. MMC module	41
5.4.1. Possible flashing sequences of the MMC control diode lamp	44
5.4.2. Formatting SD / MMC card in FAT-16 file system	44
5.5. Updating the monitor's firmware	45
5.5.1. The procedure of updating firmware	45
5.6. Flow velocity measurement	49
5.7. Replacing the dryer filter	51
5.7.1. Replacing the filter in MD2 dryer	51
5.7.2. Replacing the filter in MD3 dryer	53
5.8. Replacing the head of the peristaltic pump	54
6. Presenting the results	54
6.1. Calculating the results	55

6.2. Displays' work modes	55
7. Software used for operating the monitor	57
7.1. Installation	57
7.2. Operating the MaMoSII.exe program	58
7.3. The functions of the MaMoSII.exe program	59
7.3.1. Reconnect (restart transmission)	59
7.3.2. Program settings	60
7.3.3. Main settings	62
7.3.3.1. Calculations of the results	63
7.3.3.1.1. Calculations of CO₂	63
7.3.3.1.2. Calculations of NO_X	63
7.3.3.1.3. Fuel parameters	64
7.3.3.1.4. Calculations of mg/m³	66
7.3.3.2. Stabilisation of internal temperature	67
7.3.3.3. Gas pump	68
7.3.3.4. Results storage (SD card)	69
7.3.3.5. Displays	70
7.3.3.6. Results	72
7.3.4. Results	72
7.3.5. Memory card	74
7.3.5.1. Report's data	75
7.3.5.2. Chart	76
7.3.5.3. Columns	77
7.3.6. Memory card → Report settings	77
7.3.7. Displays	78
7.3.8. Work cycles	79
7.3.8.1. Work mode	79
7.3.8.2. Duration of cycle's phases	80
7.3.8.3. Scheduler	82
7.3.8.4. Graphic section	82
7.3.8.5. Input IN1 / IN2	83
7.3.9. Analogue outputs	83
7.3.9.1. Setting the voltage outputs	84
7.3.9.2. Setting the current outputs	85
7.3.9.3. Analogue outputs behaviour	87
7.3.10. Relays	88
7.3.10.1. Outputs' settings	89
7.3.11. 1-point calibration for maMoS II monitor	92
7.3.11.1. IR sensor calibration	93
7.3.11.2. Electrochemical sensor calibration	94
7.3.12. Service mode	95
7.3.13. About the program...	95

1. INTRODUCTION

maMoS is a high quality gas monitor. The device is produced using the latest technology. Due to the modular design of **maMoS** it is possible to meet the individual client's expectations by adjusting it to performing particular measurements, such as concentration of various gases, pressure, temperature and a number of boiler parameter measurements.

The monitor is in particular designed for flue (boiler) gas analysis, but it can be used for different purposes (such as producing biogas from garbage and animal excrements) as well.

Each **maMoS** monitor, according to its configuration, enables the user to measure concentrations of one or more gases. Additionally the device can present the measurement results on the liquid crystal displays and up to eight analogue outputs. Independently of the built-in measurement equipment there is also the possibility of reading the measurement results and changing the settings with the help of the computer program provided.

It is worthwhile devoting some time to reading this manual. This will help the users familiarise themselves with the device and its operation. Proper operation will assure the failure-free working of the device.

2. PACKAGE CONTENT

Along with the monitor the following elements are enclosed in the package:



Picture 1. The CD containing the software used for operating the monitor



Picture 2. Communication cable between PC computer and the analyser

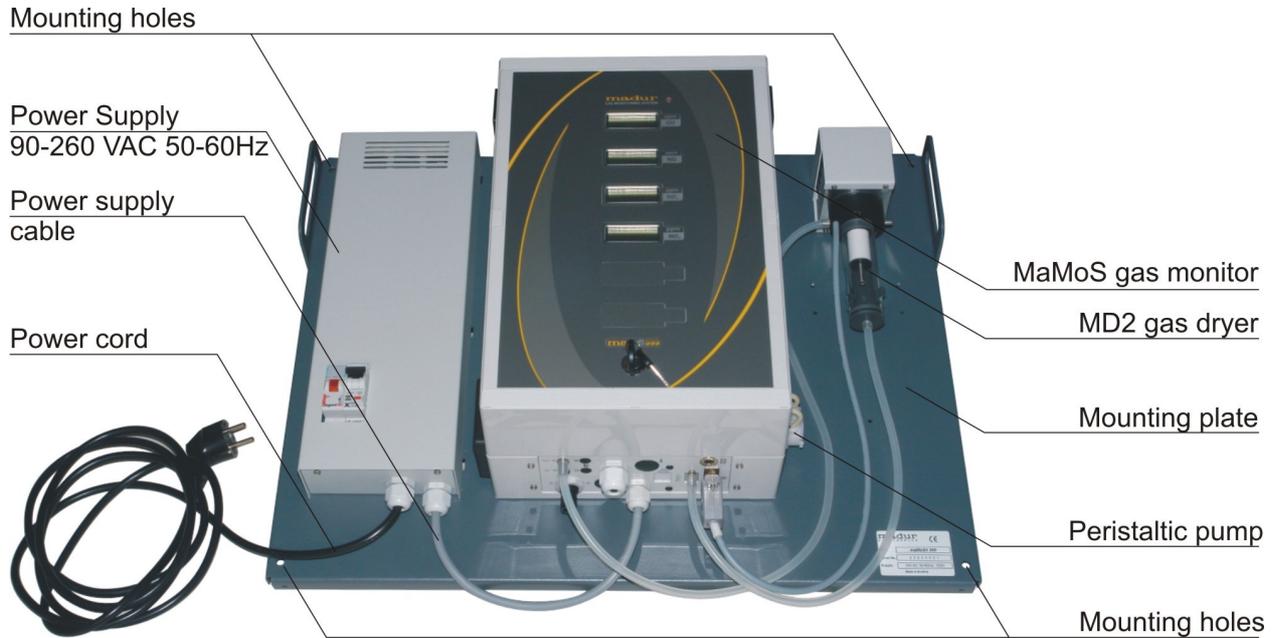


Picture 3. 4 screws used for mounting the analyser on the wall

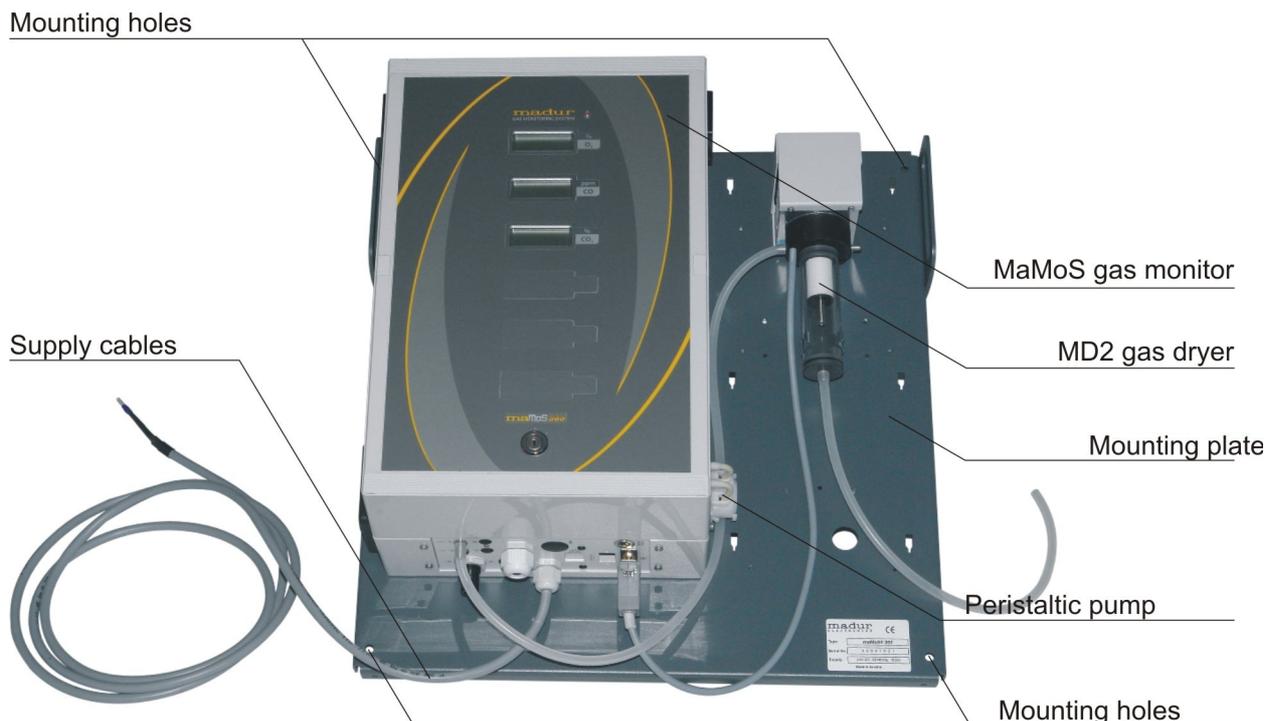
3. MONITOR CONSTRUCTION

The **maMoS** monitor has been constructed as a modular device which assures the user of the possibility of creating any desired configuration.

On request the **maMoS** monitor can be constructed of any of the available modules. The possibilities for the device are described in chapter 3.5.



Picture 4. Complete maMoS 400 gas monitor with the MD2 gas dryer and with optional power supply unit.



Picture 5. Complete maMoS 400 gas monitor with the MD2 gas dryer

There are four different types of **maMoS** monitors:

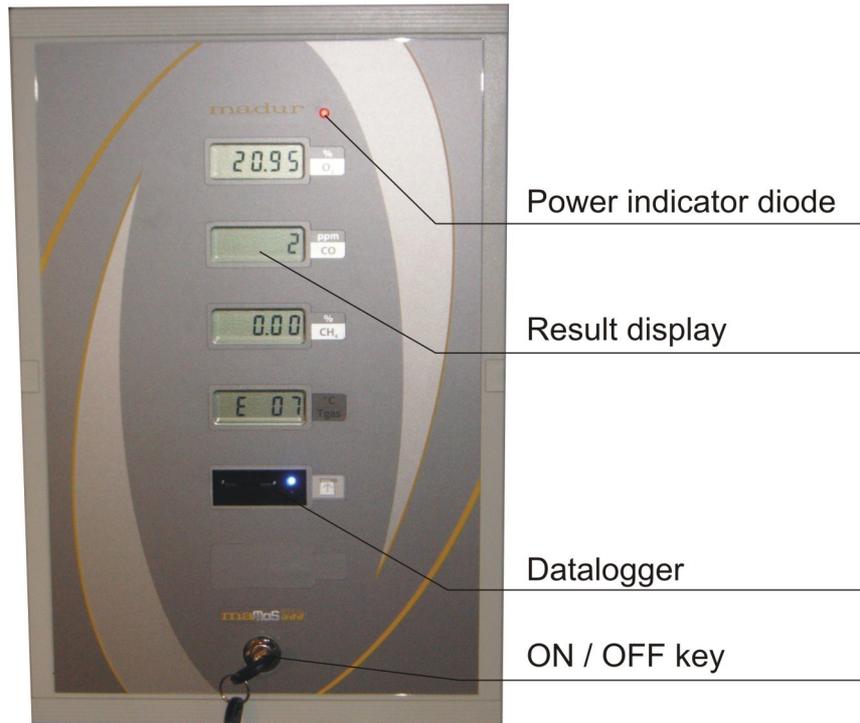
- **maMoS100** – the monitor is equipped with a single display (display #1).
- **maMoS200** – equipped with two displays (display #1, display #2).
- **maMoS300** – equipped with three displays (display #1, display #2, display #3)
- **maMoS400** – equipped with four displays (display #1, display #2, display #3, display #4).

The number of the device's displays does not refer to the number of the sensors which have been installed in the monitor as, besides displaying the measurement results, the monitor can also present the results of additional calculations (such as stack loss and boiler efficiency).

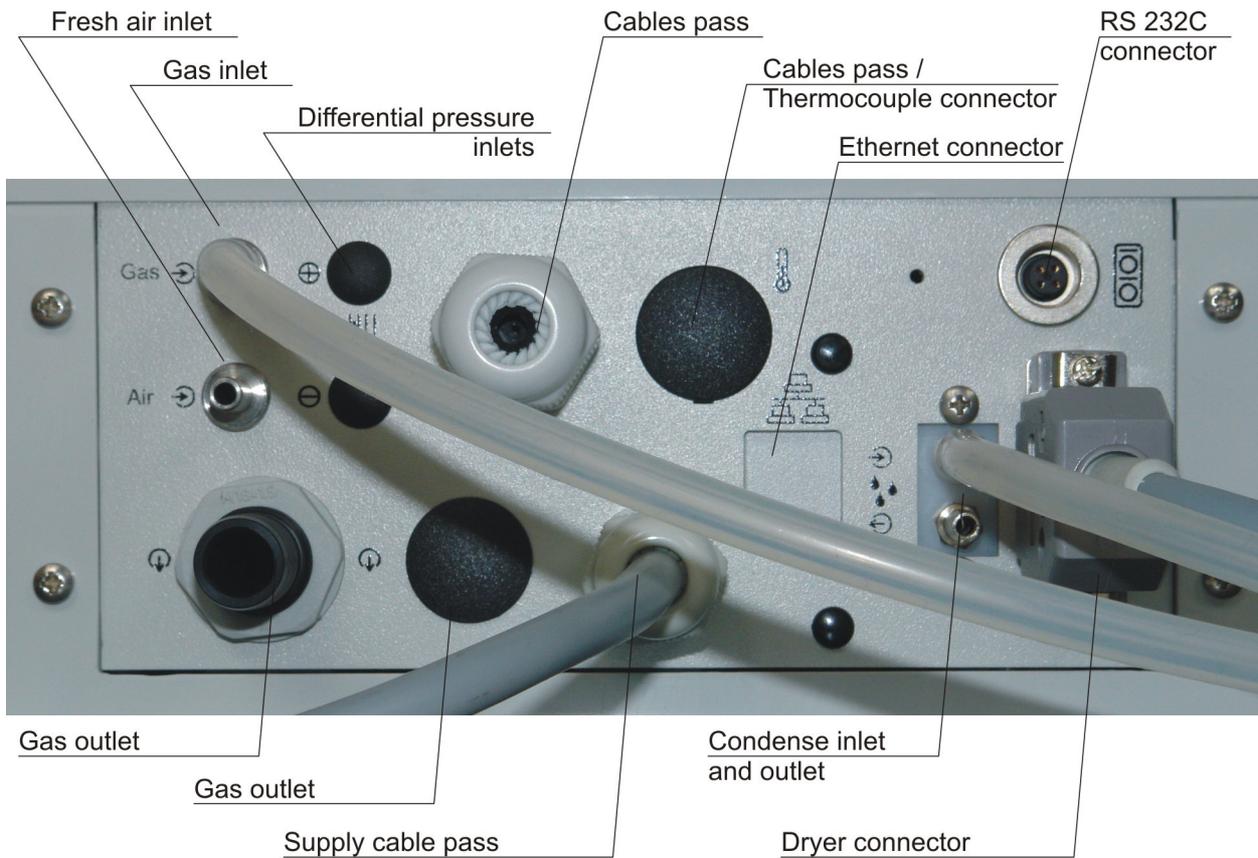
The following chapters describe the elements forming each of the monitors.

3.1. Casing

The analyser with the gas dryer and optionally with the power supply unit is mounted on one mounting plate. The analyser itself is installed in ROBUST 240 casing (dimensions: 240 x 360 x 120 mm). In the front of the analyser there are: displays (that show the results from the gas sensors, temperature, pressure sensors and others), red diode that indicates the work of the analyser (installed over the displays) and the key that protects against unauthorised turning on / off of the analyser. Additionally, as an option, the analyser can be equipped with a data-logger, that allows to store the results of the measurements on a MMC card. Afterwards the results can be viewed on a PC computer.

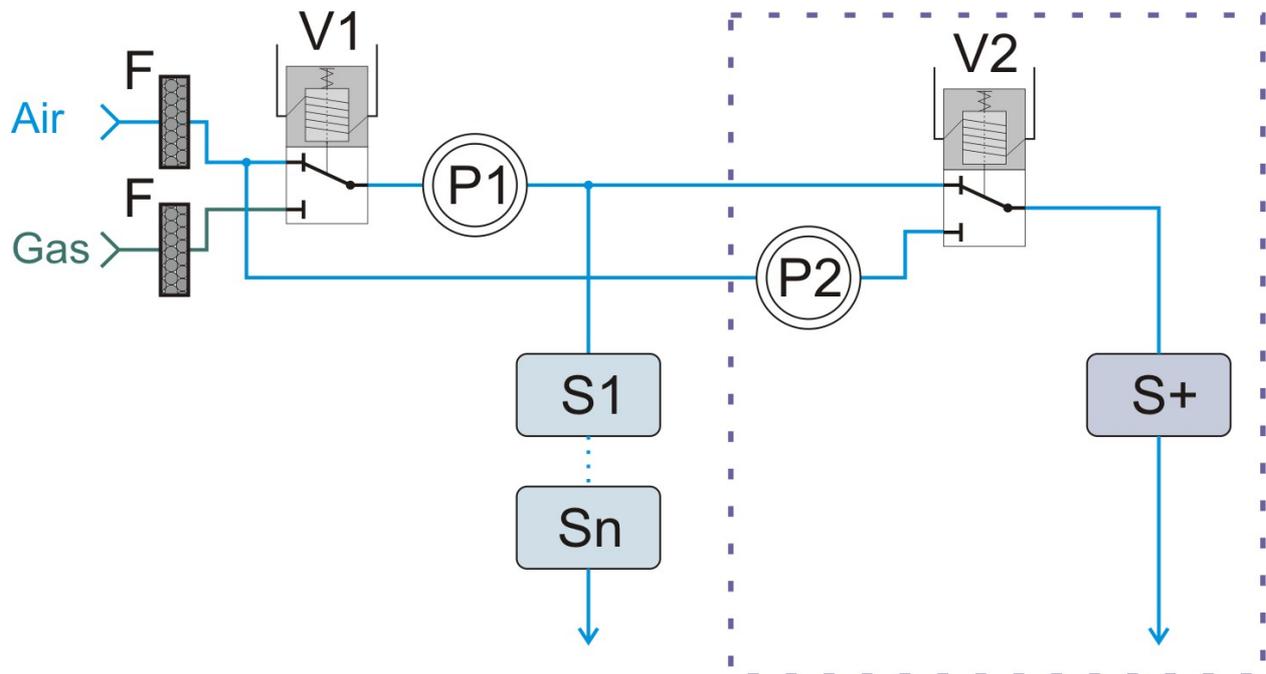


Picture 6. mamos front panel



Picture 7. Casing – bottom view

3.2. Gas channel



Picture 8. The schematic diagram of the gas channel.

Labels used in the diagram:

- The additional gas channel has been framed with violet.
- V1 – ventilation valve of the main channel.
- V2 – ventilation valve of the additional channel.
- P1 – gas pump.
- P2 – gas pump ventilating the additional channel.
- S1...Sn – gas sensors of the main channel.
- S+ – gas sensor of the additional channel.
- F – Hydrophobic filter.

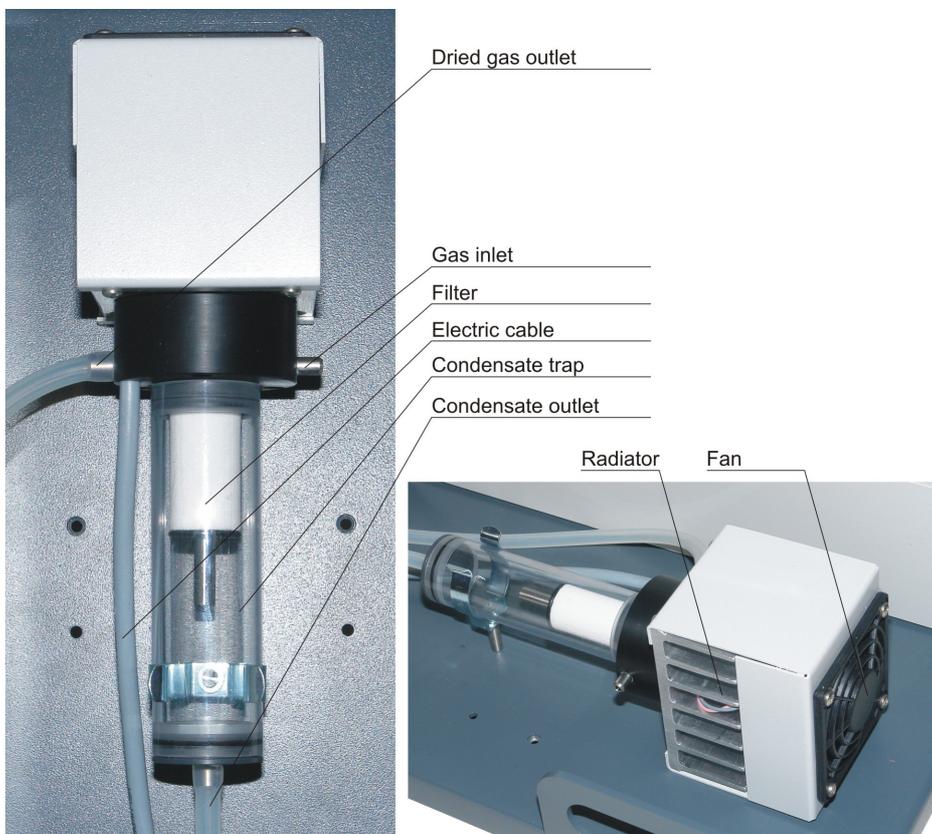
The elements in the direct contact with the examined gas create the gas system. At first the gas sample passes through the dryer, where it is cooled (in order that the water vapour condenses) and filtered. Afterwards, the sample is passed through the 3-way solenoid valve and the pump to each of the gas sensors for analysis.

The **maMoS** analysers can be optionally equipped with an additional gas channel. In such cases the gas sample is passed to the separate sensor (or sensors) through the additional ventilation valve. The separate outlet has been installed in the additional gas channel not to disturb the measurement process performed in the main channel. As a result the gas sample can be supplied to the separate sensor only when the concentration

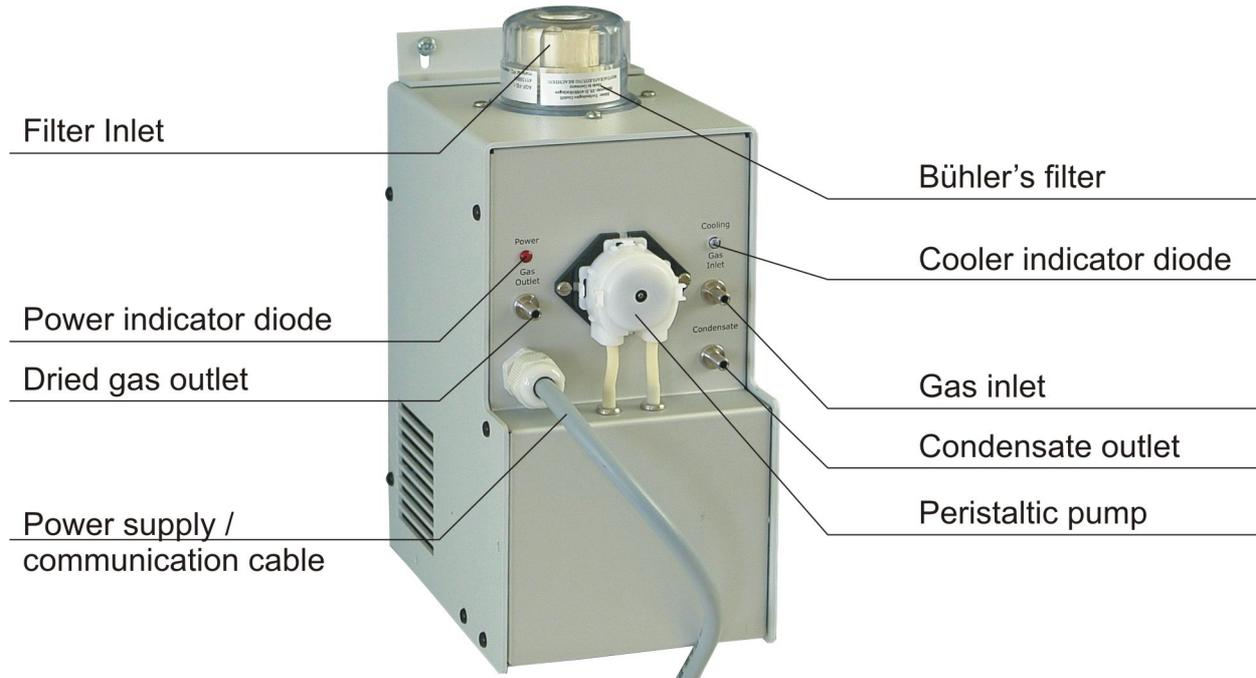
value is measured – apart from that throughout the measurement cycle the sensor is ventilated with the inert gas with use of an additional ventilation pump. Independently of the additional channel the sensors in the main gas channel are continually supplied with the gas sample (during the “MEASUREMENTS” stage). This option can be found particularly useful in case a H₂S (hydrogen sulphide) sensor is used – these are very sensitive and wear out fast. Thanks to such a solution they can be separated from the main channel, supplied with gas only when the measurement has to be performed and ventilated while the other sensors perform the measurement process. It extends their lifetime, and as a result decreases the analyser's maintenance cost.

3.2.1. Gas dryer with filter

The gas dryer is installed on the outside of the monitor casing on the backplate of the device. Its main task is to remove moisture from the examined gas sample. The dryer uses a Peltier element to cool the flue gases to approximately 12°C and to condense the water out of the gas sample. The condensed water gathers in the transparent container from where it is pumped by means of the peristaltic pump. Moreover, the dryer is equipped with a replaceable inlet filter which removes the dirt from the gas sample (Picture 9.).



Picture 9. mamos MD2 gas dryer

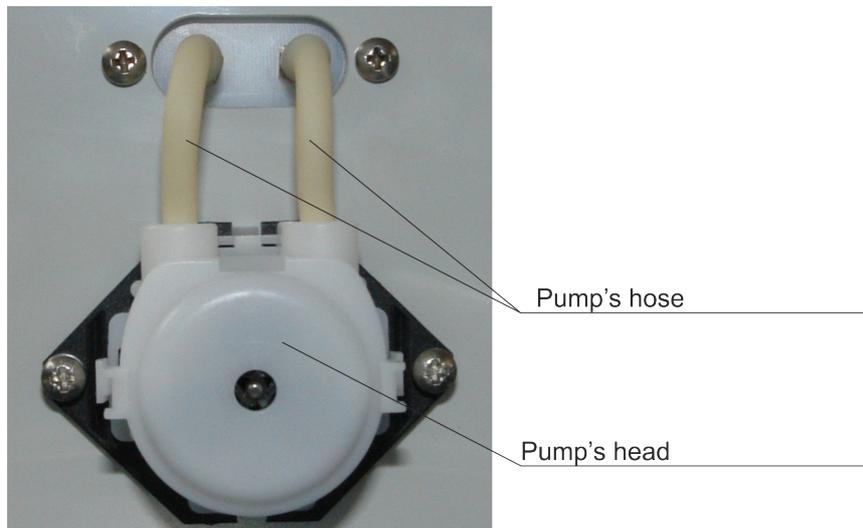


Picture 10. mamos MD3R/S gas dryer

3.2.2. Peristaltic pump

A peristaltic pump is used to remove the condensate gathered in the dryer container. The pump is installed on the right side of the casing (Picture 11.). The pump's head is placed outside the casing (or in the front of the MD3 gas dryer) to ensure easy replacement of pump's tubings and head.

The condensate is removed from the dryer container and transported through the elastic hose to the pump, which pumps it further to the appropriate container.



Picture 11. Peristaltic pump head (casing right side)

3.2.3. Solenoid valve

The monitor is equipped with a three-way solenoid valve to make periodical ventilation of the device possible. The ventilation process has to be performed in order to zero the sensors. During ventilation the valve cuts the gas inlet off and the free air is let in.

3.2.4. Gas pump

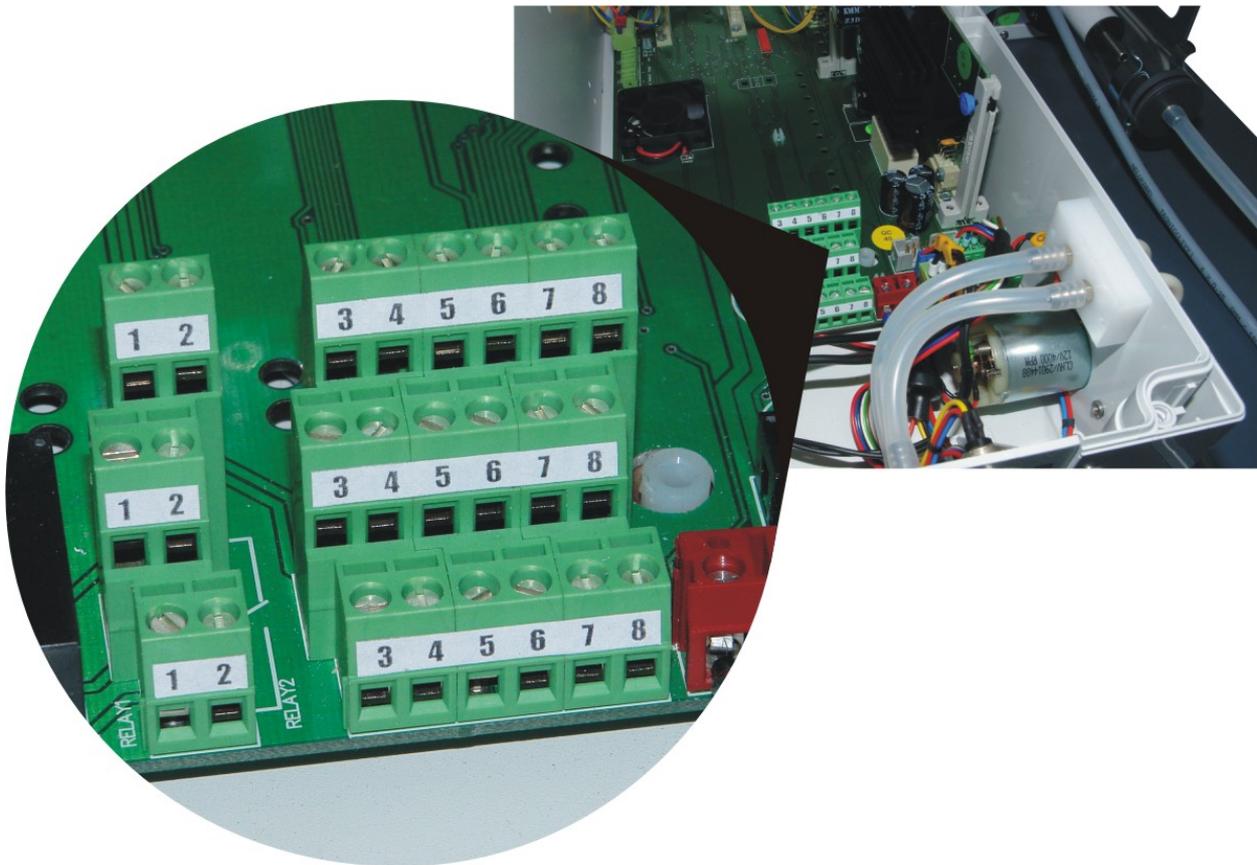
To guarantee the proper gas flow the monitor has been equipped with a diaphragm pump which pumps gas at a rate of more than 30l/h. As the pump works almost throughout the working-time of the monitor it wears out in time. It is essential to check the contamination level of the gas dryer's filter to extend the lifetime of the gas pump. High contamination level exerts a negative influence on the pump function. The pump efficiency can be set with the help of the mamos PC program (see chapter 7.3.3.3.).

3.2.5. Gas sensors

The gas sensors are the last element of the gas system. The **maMoS** monitor can be equipped with up to four sensors measuring concentrations of different gases. Both electrochemical and **NDIR** (Non-dispersive Infra-red) sensors can be used for performing measurements. The type of sensor used depends on the measured gas.

The types of the gases the **maMoS** monitor can measure are presented in chapter 3.5.1.

3.3. Electric connectors of the monitor



Picture 12. Location of the inputs, outputs and power supply connectors

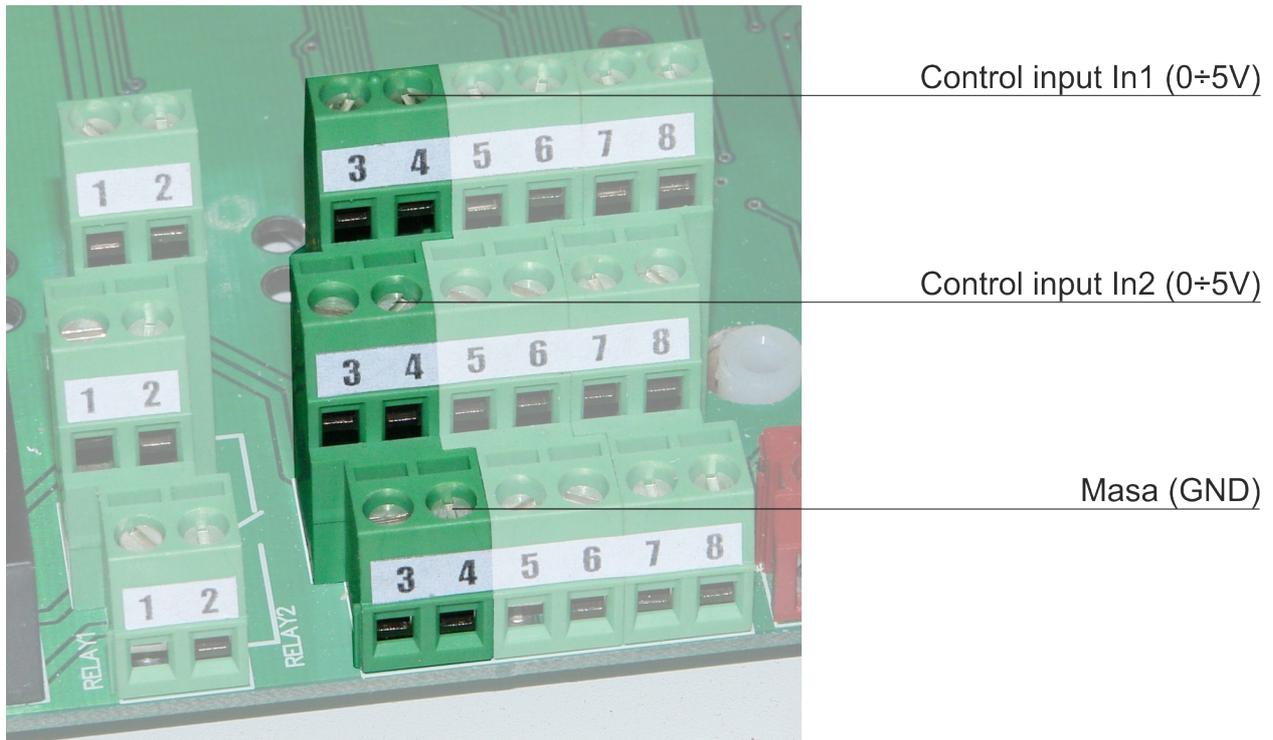
The **maMoS** monitor has a number of electric connectors which enable the user to connect the monitor to a power supply and additional devices. All the inputs, outputs and power supply connectors are to be found inside the monitor on the device main board (Picture 12.). The wires should be connected as described in section 4.1.1. Each of the inputs and outputs can perform several functions which can be defined with the help of the **MaMoSII.exe** software. The PC and the dryer connector are to be found at the bottom of the monitor casing (Picture 7.).

3.3.1. Digital inputs

The monitor has two digital inputs which can be configured by the user: **In1** and **In2**. According to the settings the inputs can be used for:

- restarting the measurement cycle (which means aborting the current cycle regardless of its stage and starting the new cycle with the ventilation process),
- controlling (switching on or off) any of two relays

- controlling (switching on or off) the PWM digital output.



Picture 13. Digital inputs on the monitor.

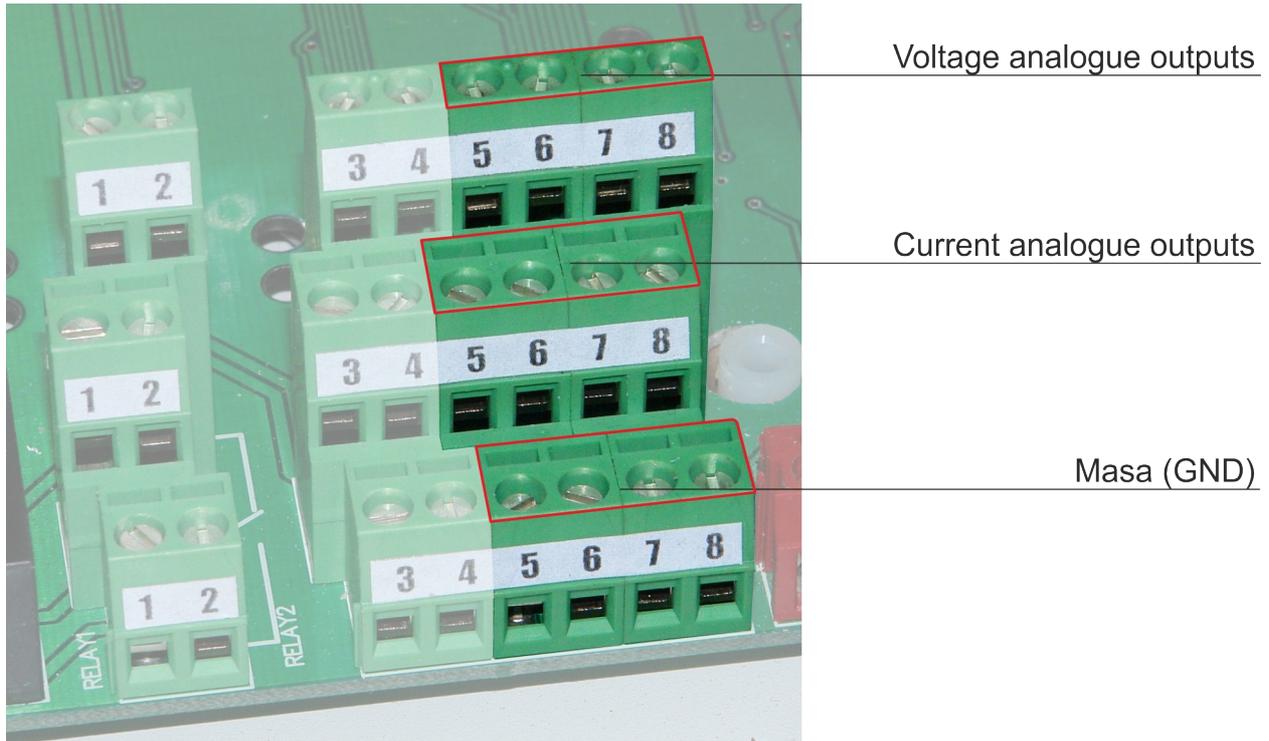
Changes to the settings can be made with the help of the **MaMoSII.exe** software. The voltage range of each of the inputs is $0V \div 5V$. The input is regarded as active when its voltage is $0V$ (in particular short-circuit with GND). A disconnected (or connected to voltage of $+5V$) input is regarded as inactive.

If the input has been set to restart the measurement cycle the active state ($0V$) has to last at least $2s$ to evoke the zeroing.

3.3.2. Analogue outputs

The monitor has 8 analogue outputs which can be configured by the user: **U1** ÷ **U4** and **I1** ÷ **I4**.

With the help of the software each of the outputs can be assigned to any of the measured (or calculated) value. In such case a signal proportional to the measured quantity will appear on the output. The **MaMoSII.exe** software also enables the user to define the range of the presented value.

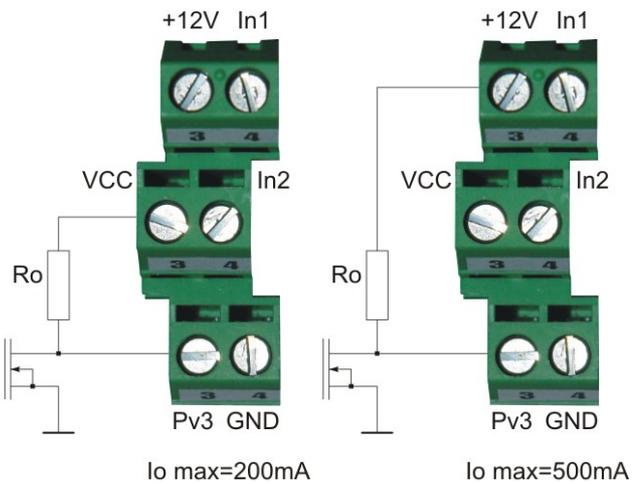
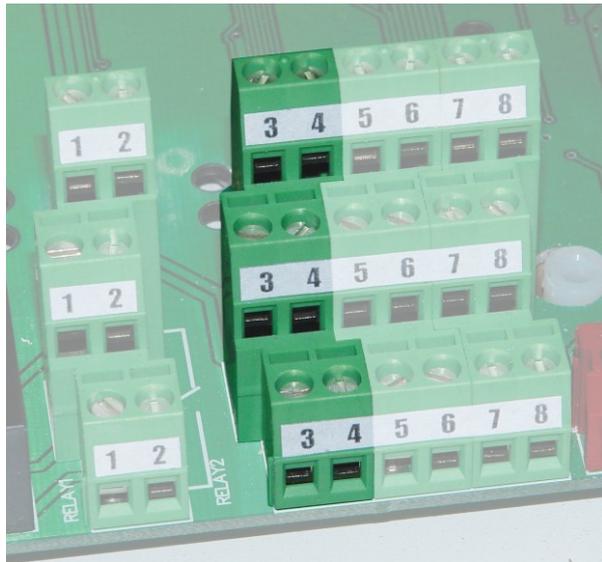


Picture 14. Analogue outputs on the monitor.

The analogue output (**U1 ÷ U4**) signal range is 0 ÷ 5V or 0 ÷ 10V (set with the help of the **MaMoSII.exe** software), whereas the current output (**I1+I4**) signal range is 0÷20mA or 4÷20mA (also set with the help of the **MaMoSII.exe** software).

3.3.3. Digital output (PWM)

The monitor has a single digital *PWM* output (**PV3**). This is an open drain output, the active state of the output means short-circuiting the **PV3** ending to the ground potential by internal high-power N-MOS transistor. This can be used for switching an external relay, etc. The *PWM* output can be controlled via analogue outputs or digital inputs. It can also proceed to the active state when the monitor has initiated the measurement phase. The *PWM* output function can be defined with the help of the **MaMoSII.exe** software.



Picture 15. The PWM output and the load connection.

One of the two connectors: **12V** or **VCC** (+5V) (Picture 15.) can be used for supplying the receiver controlled via the output. If the 12V supply is used the maximum load current amounts 500mA, whereas for the 5V supply it is 200mA.

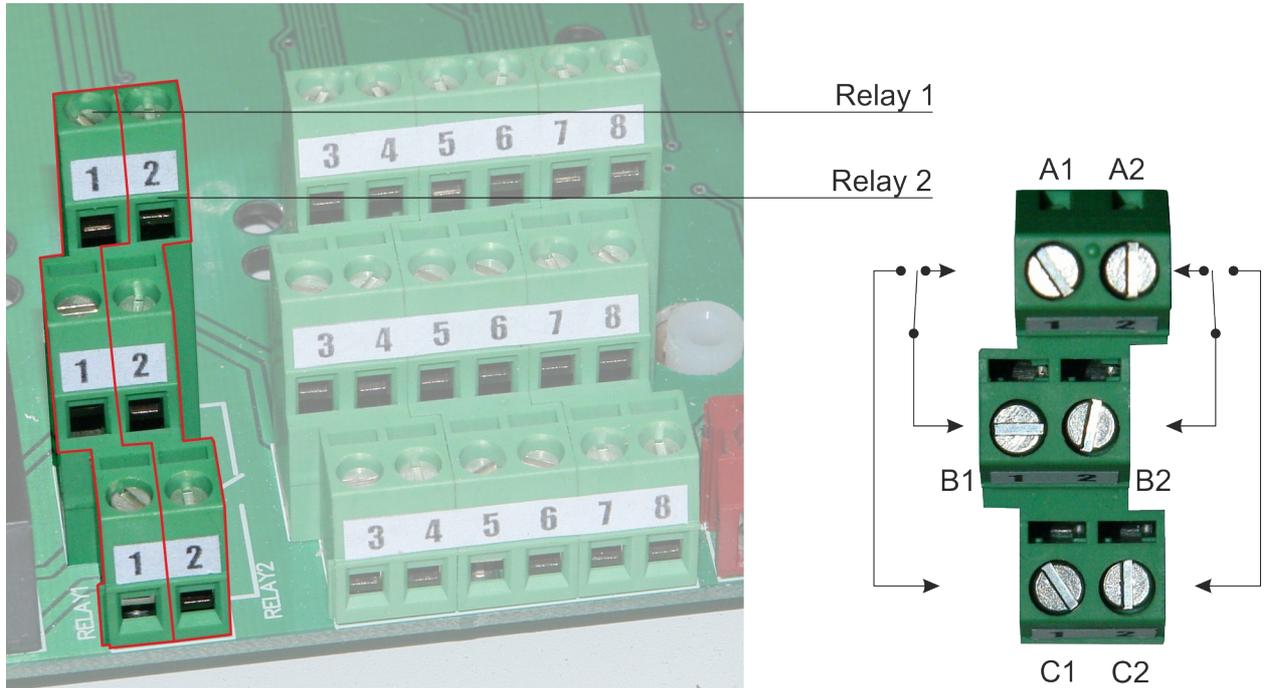
3.3.4. Relay outputs (optional)

Optionally the monitor can be equipped with two independent *SPDT* relays *Relay #1* and *Relay #2* connected with a connector as shown in Picture 16. The B ending is a common ending, the A ending is a normally closed ending (*NC*) and the C ending is a normally open ending (*NO*). The *Relay #1* is connected with the **A1**, **B1** and **C1** connectors, whereas the *Relay #2* is connected with **A2**, **B2** and **C2**. The relays enable the user to switch voltages up to 230V and currents below 2A.

The relays can:

- be controlled by one of the analogue outputs **U1 ÷ U4**, **I1 ÷ I4** (according to the level of signal on the analogue output the relay either switches on or off with a certain hysteresis).
- be controlled by the digital input (the relay follows the **In1** or **In2** digital input state, which means it switches on when the input is active and switches off when it is inactive).
- work according to the measurement cycle stage (the relay switches on in the "MEASUREMENT" stage and switches off during other stages)
- be permanently switched off.

The changes to the configuration can be made with the help of the **MaMoSII.exe** software.



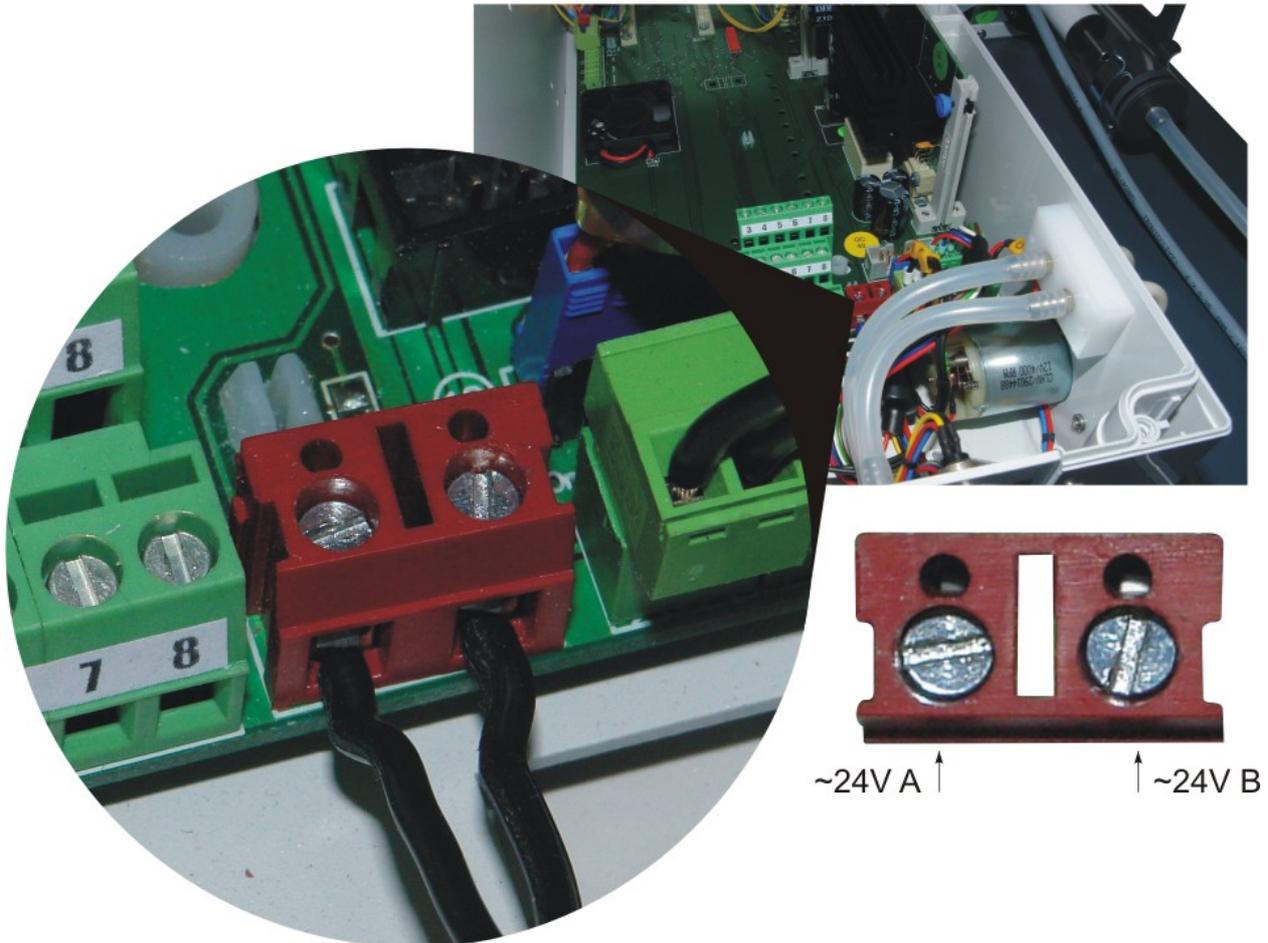
Picture 16. Relay outputs.

3.4. Monitor power supply

It is advised to supply the **maMoS** monitor with AC voltage of 24V +/-10%, 50/60Hz and power of more than 150W.

The power supply should be connected to the connectors placed on the main board which are shown in Picture 17.. The location is shown in Picture 12..

A monitor can be ordered complete with an appropriate power supply – shown in Picture 4.



Picture 17. Power supply connectors

ATTENTION!

Connecting the supply to the connectors other than shown in the Picture 17. will cause the permanent damage to the device.

3.5. Configuration possibilities

Due to its modular design, the **maMoS** monitor can be configured in many different ways. Below all the extra modules and the gases the monitor measures have been listed.

3.5.1. Types of the measured gases

The **maMoS** monitor can measure the concentration of up to four different gases using electrochemical or **NDIR** (Non-dispersive Infrared) sensors. In the Table 1. the sensors which can be used by the monitor have been listed.

Due to continual development of the monitor, the sensor types and their measurement ranges might change. If the needed sensor or measurement range does not appear

in the above table it is advisable to contact **madur** to inquire after current measurement capabilities.

Gas type	Sensor type	Measurement range
O₂ oxygen	electrochemical	max. 25 %
CO carbon monoxide	electrochemical	2000ppm ÷ 10 %
CO carbon monoxide	NDIR	5% ÷ 100 %
CO₂ carbon dioxide	NDIR	5000ppm ÷ 100 %
H₂S hydrogen sulphide	electrochemical	6000ppm
CH₄ methane	NDIR	5 % ÷ 100 %
NO nitric oxide	electrochemical	5000 ppm
NO₂ nitrogen dioxide	electrochemical	1000 ppm
SO₂ sulphur dioxide	electrochemical	5000 ppm
N₂O nitrous oxide	NDIR	5000 ppm

Table 1. Gas sensor types.

Apart from gas concentration, an appropriately equipped monitor can also measure temperature, differential pressure and atmospheric pressure and calculate a number of auxiliary parameters (such as: stack loss, excess air factor, flow velocity and many others).

3.5.2. Additional and optional equipment

The following modules can be chosen as the additional equipment of the **maMoS** monitor:

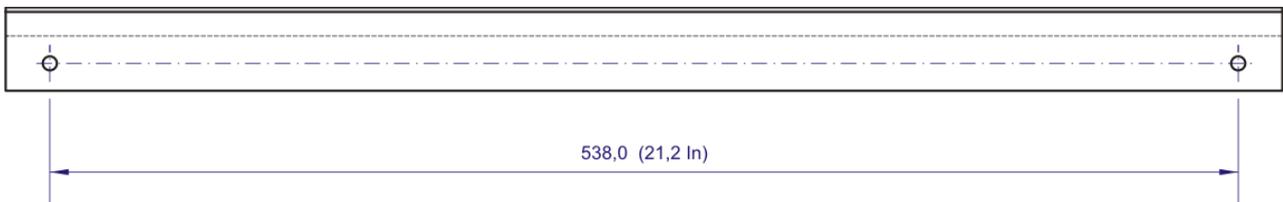
- the additional gas channel which separates one or more sensors from the main gas channel (see chapter 3.2.),
- a module for digital recording of the measurement results – data-logger. It enables the user to save measurement data on a flash memory card - *MMC (MultiMedia Card) / SD (Secure Digital)*,
- replacing the RS232C interface with a RS485 interface which enables the device to operate in a network (up to 15 devices) and extends the communication lines up to 100m,
- replacing the RS232C interface with a USB interface to make operating with computers not equipped with a RS232C connector possible,
- replacing the RS232C interface with the Ethernet connector,
- communication cable of a non-standard length,

- **RS485 Switch** to communicate with several **maMoS** devices,
- temperature sensors: thermocouple (temperature range up to 1000°C) or Pt sensor (temperature range up to 100°C),
- atmospheric pressure sensor,
- differential pressure sensor, range: -5 ÷ +20hPa or -20 ÷ 20hPa,
- differential pressure sensor with gas channel flow control and dryer's filter contamination level control,
- Pitot's tube - used for indirect measurements of gas flow velocity with the help of the differential pressure sensor.

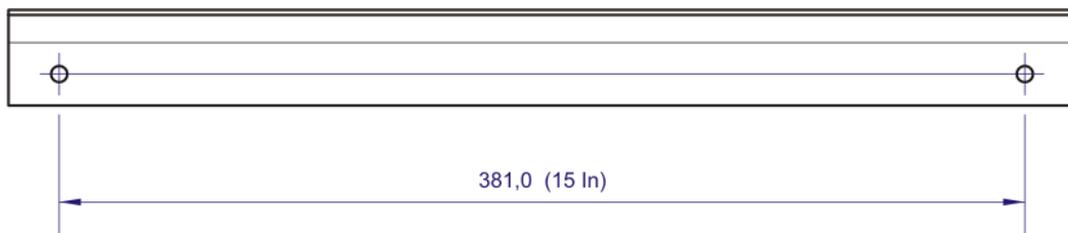
4. MONITOR INSTALLATION

Mounting the monitor upright on a wall will assure correct function. The device should be installed in a place not exposed to weather conditions (rain, snow, sun exposure, temperatures below 0°C and above 40°C). It is advisable to avoid high dust concentration in the air.

To attach the monitor to the wall the user should make four holes in the wall (diameter $\varnothing = 10\text{mm}$). The placement of the mounting holes is presented in the below drawing.



Picture 18. Mounting holes placement



Picture 19. Mounting holes placement

The monitor should be attached to the wall with screws (the set of needed screws has been enclosed with the monitor – see Picture 3.).

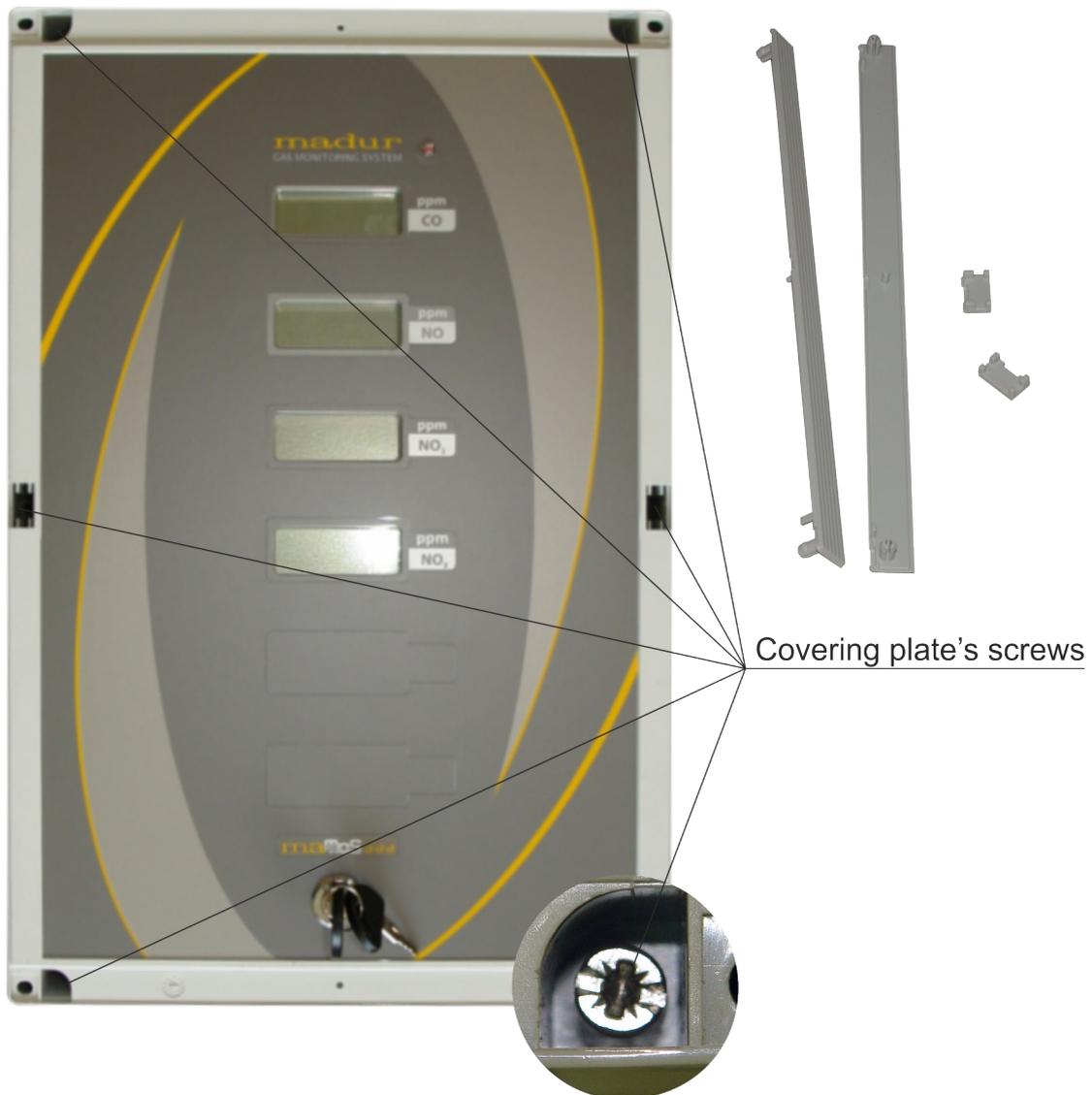
4.1. Connecting the monitor

After the monitor has been mounted on the wall the electric and gas lines should be connected to the monitor according to the instructions below.

4.1.1. Connecting the electric wires

All the electric connectors are placed inside the device. To connect the wires the user should unscrew the cover of the monitor's casing, run the wires through the grommets and connect them to the correct connectors.

To open the casing the user should remove the masking plates (using a slotted screwdriver) and unscrew six screws mounting the cover using a Pozidriv screwdriver (PZ1), and then open it to the left on hinges (Picture 20. and Picture 21.).



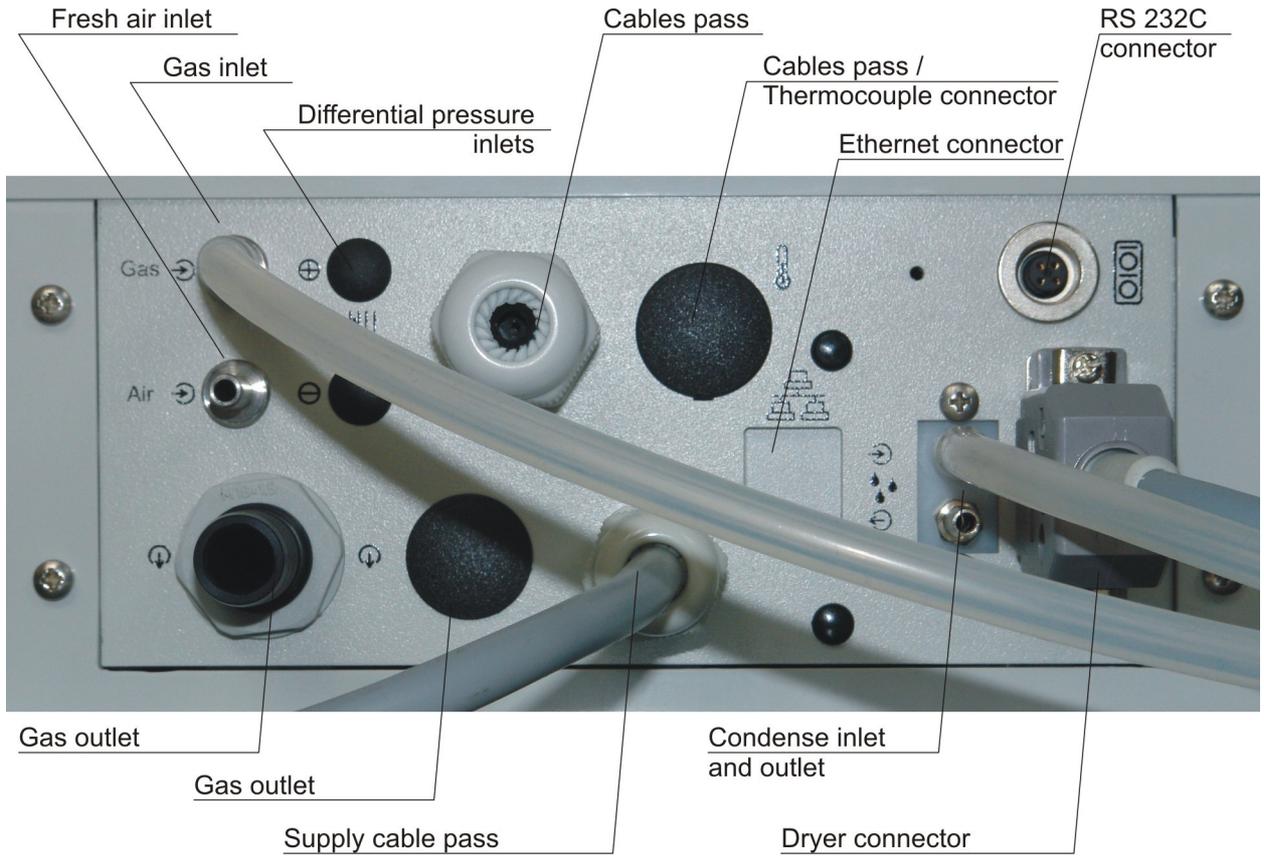
Picture 20. Location of the screws mounting the cover of the monitor's casing.



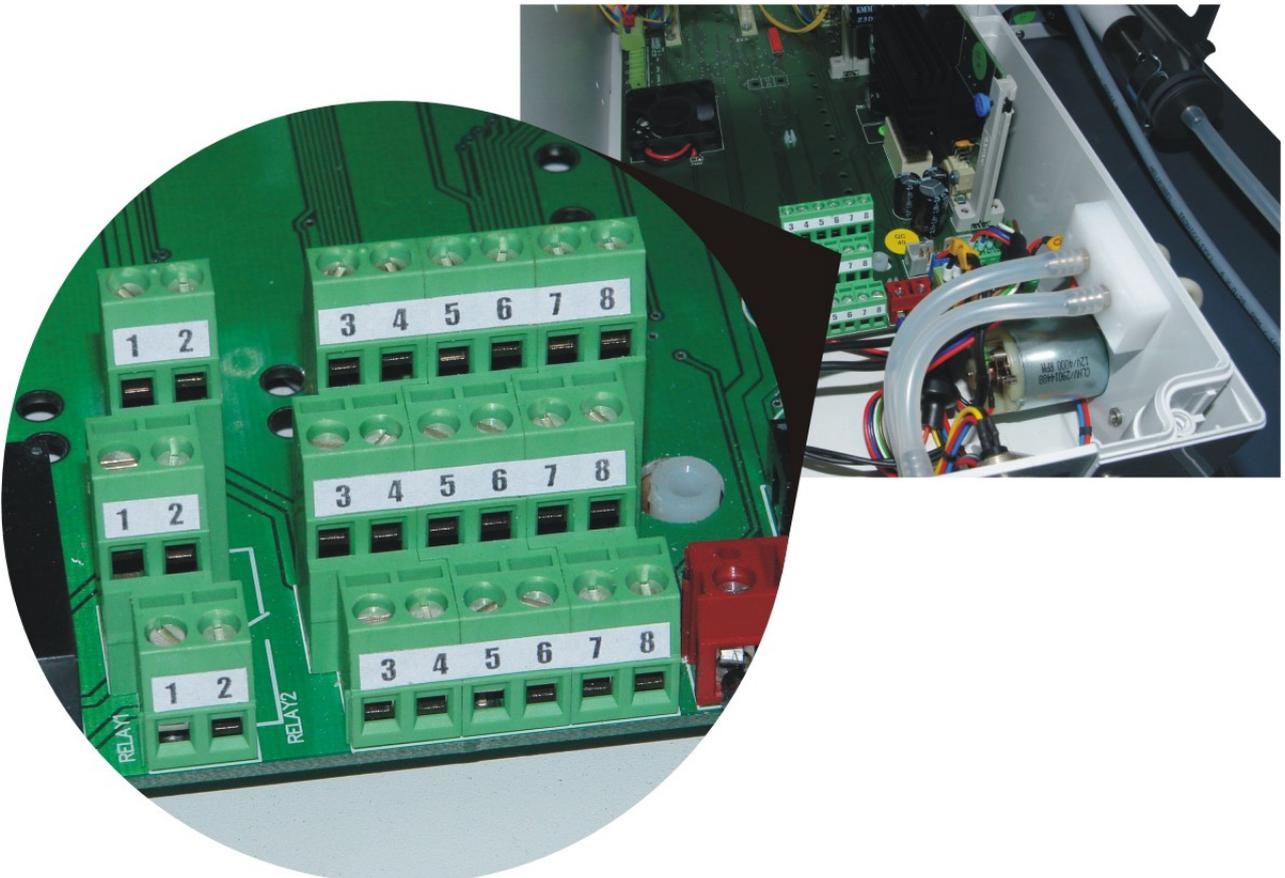
Picture 21. The way of opening the mamos cover.

After the casing has been opened connector's cover must be removed and the wires which are to be connected should be led to the inside of the device through the grommets placed on the bottom side of the casing (Picture 22.).

To connect the wire the user should remove about 5-6 mm of insulation of the wire's ending, slacken the connector screw enough to be able to put the wire's ending in the connector and screw the connector tight again, so that the wire does not slip out of it.



Picture 22. The bottom side of the casing with the connectors and cables' grommets.



Picture 23. View of the connectors inside the casing of the maMoS monitor.

4.1.2. Connecting the gas hoses

To assure proper measurement results it is necessary to supply the examined gas to the monitor and to remove it from the device in an appropriate way. The supply and waste gas hoses as well as the condensate outlet hose should be made of materials resistant to chemical agents whose influence they might be exposed to. Most often silicone hoses are used.

As the waste gas might be poisonous or flammable, it should be removed directly to a ventilating flue or back to the gas source. The condensate exiting from the device should be collected in a container resistant to corrosive substances. In order to ventilate the monitor properly the ventilation gas inlet should be connected to a source of inert gas which contains 20.95% of O₂ and no toxic gases - most often fresh air.

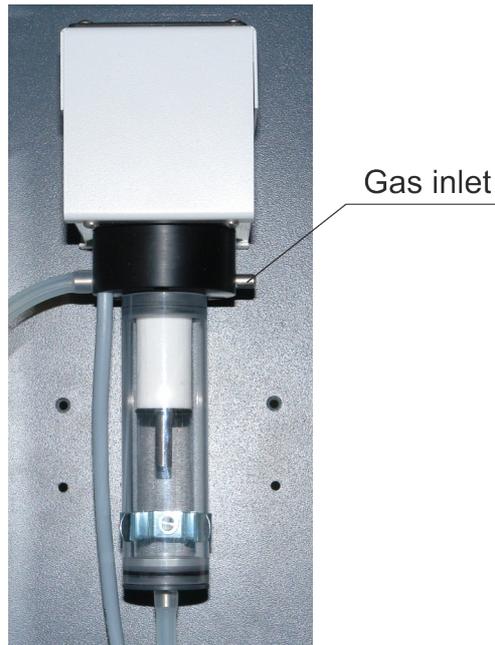
Attention!

Neither the measurement gases nor the ventilation gas should be supplied to the device under pressure. The monitor is equipped with a pump for drawing gas samples. The maximum overpressure is 20 hPa and the maximum underpressure is -50 hPa.

There should be no pressure applied to the gas outlet of the device either. This is particularly important if electrochemical sensors have been installed in the device. A pump drawing the gas directly from the outlet should not be used.

The hose bringing the gas sample should be connected to the inlet on the right side of the dryer – in case of the mamos equipped with MD2 gas dryer (Picture 24.). In case of MD3 dryer the gas inlet is located in the front panel (Picture 25.) The input is not barbed and its outside diameter is 5 mm. It is advisable to use a silicone hose 3 x 2 mm (inside diameter x wall thickness). In order to avoid water condensing in the hose the user should limit the hose length and avoid dips in the hose. The gas should generally flow downwards from the sampling point to the instrument.

The input of the hose transporting the ventilation gas (fresh air) is placed at the bottom of the monitor casing (Picture 26.) and it is the same size as the gas inlet. Most often there is no need to connect any hose to this inlet – then the device uses the air from the surroundings. If the composition of the surrounding air does not resemble the composition of "fresh" air, the ventilation gas should be supplied with the help of a hose. Silicone hose (3 x 2 mm) should be used here as well.

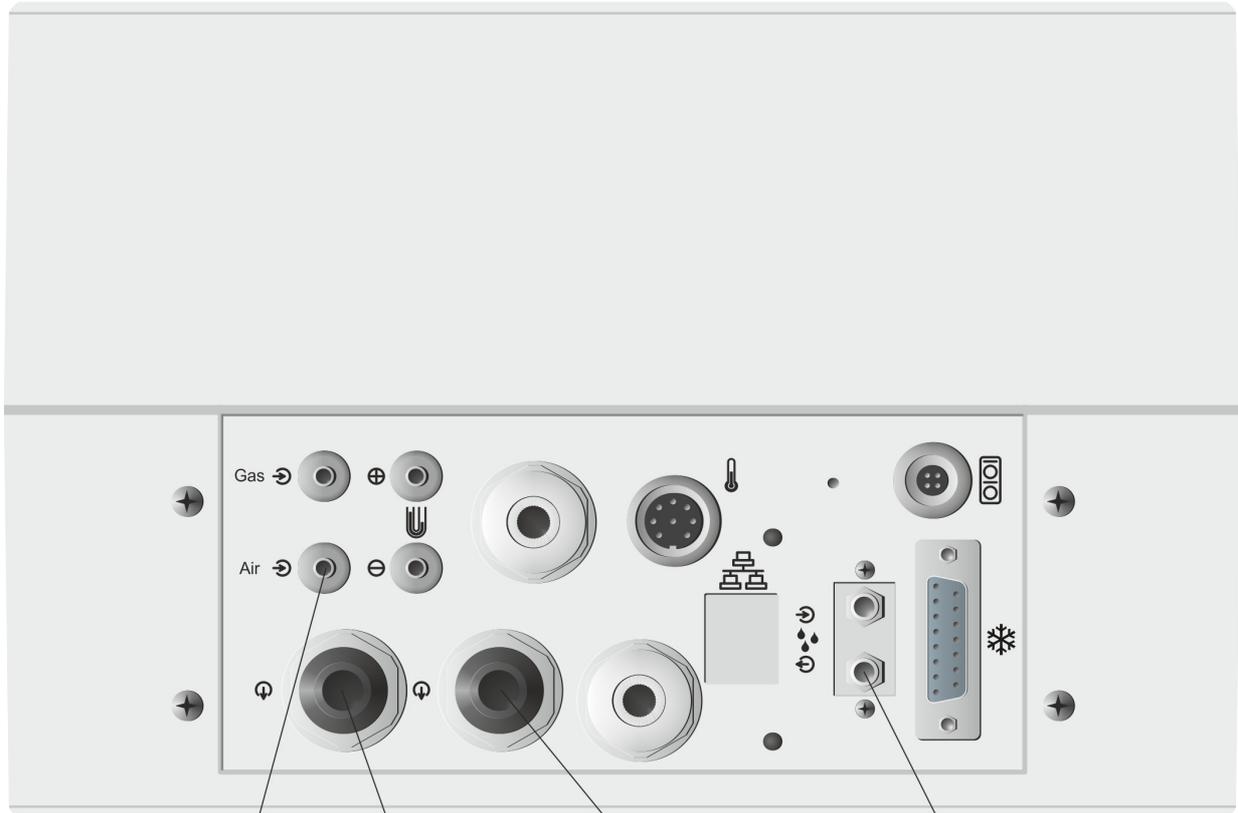


Picture 24. Location of the sample gas inlet in MD2 gas dryer



Picture 25. Location of the sample gas inlet in MD3 gas dryer

The outside diameter of the gas inlet and the waste gas outlet of the additional channel (if installed) is 16 mm. A hose of 15 mm inside diameter should be connected to the output. The outlet hose should be as short as possible and should not cause high flow resistance. Overpressure occurring in the hose can disturb proper measurement (particularly if electrochemical sensors are used).



Fresh air inlet
(Ventilation gas)

Gas outlet
(main channel)

Gas outlet
(additional channel)

Condensate
outlet

Picture 26. Gaseous connections: ventilation gas, gas outlets, condensate outlets.

The hose for removing the condensate should be connected to the outlet that is located at the bottom of the analyser (see Picture 26.). The outlet is not barbed and has 4mm outside diameter. It is advised to use 3x2 silicone tubing.

In the table below the outside diameters and the lengths of the gas inputs/outputs have been listed.

Inlet/outlet type	Outside diameter [mm]	Length [mm]
Sample gas inlet	5	7
Waste gas outlet	16	32
Inert gas inlet	5	11
Condensate outlet	4	12,5 22,5 (<i>maMoS</i> 100/200)

Table 2. Diameters and lengths of the gas inlets/outlets

4.2. First start-up

After the monitor has been mounted and all the necessary electric and gas lines have been connected the device can be started up. The monitor starts-up when connected to the power source which is signalled by the red indicator lamp on the device's front panel. After the testing and initial stages (the warming-up stage) the monitor proceeds to work in a cyclic mode according to factory settings.

The next thing to do is to set the monitor's settings to the user's need. Changes to the monitor settings can be done with the use of the **MaMoSII.exe** software. Chapter 7. contains a description of the program's functions.

Attention!

As the maMoS analysers are compensated thermally the proper measurement results are possible only if the analyser works in the upright position with the casing closed. Otherwise the proper temperature distribution in the device cannot be assured.

5. OPERATION

To simplify the operation of the monitor the basic operational rules and service activities have been described below.

5.1. Basic operation

To assure proper, failure-free working of the device the rules below should be followed:

1. The condition of the filter of the external dryer should be checked regularly, dirty filters should be replaced with new ones.
2. The condition of the hose of the peristaltic pump should be checked regularly, the hose or even the whole head of the pump should be replaced when damaged.
3. The device works properly only when mounted upright on the wall. This position assures the appropriate outlet of the condensate from the dryer. If the condensate is not allowed to exit correctly, the monitor might suck the condensate in and be damaged.

4. The measurement gas inlet should be disconnected if the monitor stays switched off for a longer period of time to prevent the sensors from wearing out and not to pollute the gas system.
5. To prevent damage to the sensors, the monitor should not be cleaned with chemical agents.

5.2. Monitor function

After the monitor has been switched on, the installed components are tested. When the display test has been completed the information on the current software version is shown for a few seconds in the first display. Then the monitor proceeds to the warming-up stage which includes preparing the gas dryer to work properly and stabilising the interior temperature of the device. The warming-up typically lasts 15 minutes and its duration can be set with the help of the computer program (operating in the service mode). Then, according to the settings either cyclic work or the scheduled work proceeds. The monitor performs the programmed cycles until it is switched off.

5.2.1. Cyclic work mode

In the cyclic work mode the monitor performs the cycle, consisting of the below stages, one after another:

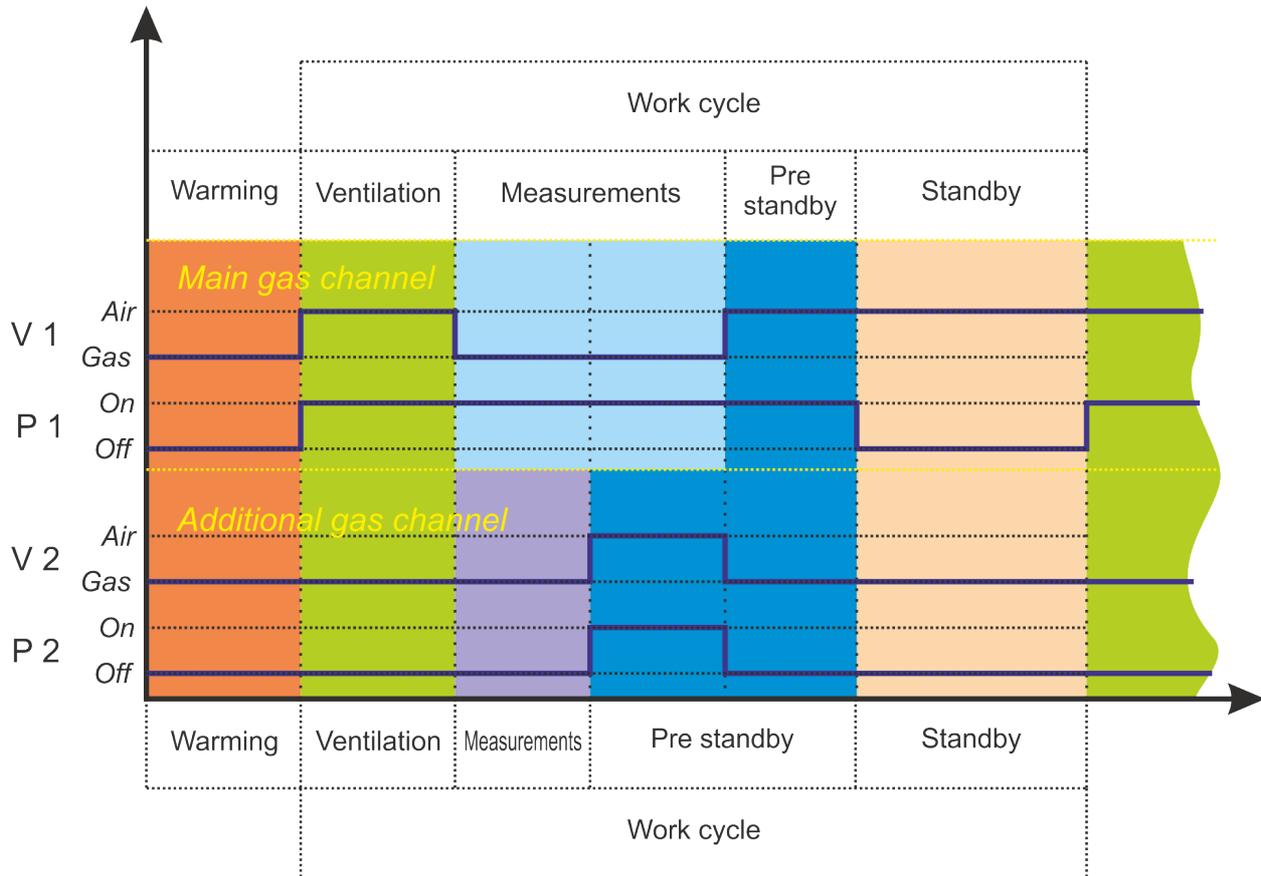
1. "**VENTILATION**" – the analyser switches the main channel valve to ventilation stage and the additional channel valve (if installed) to passing the gas sample and it ventilates the sensors with inert gas in order to zero their indications. The gas pump is switched on whereas the additional pump is switched off. The duration of this phase can be set to either 5, 10 or 15 minutes. It is advisable to set it to 15 minutes.
2. "**MEASUREMENTS**" – after the sensors have been ventilated the main channel valve switches to passing the gas sample and the analyser begins the measurement process presenting the results on the displays. The gas pump is switched on whereas the additional pump is switched off. The additional ventilation valve remains in the state it was put in during the ventilation stage. After the measurement process in the additional channel has been completed the additional valve switches to ventilation process and the additional pump is switched off. Both the measurements duration can be set independently within the range from 15 minutes to 4 hours (see point 7.3.8.2.).

3. "VENTILATION BEFORE STAND-BY" – if the cycle does not end with the completion of the "MEASUREMENTS" stage the monitor should proceed to the "STAND-BY" stage. However, it is necessary to remove the remains of gas from the monitor. The "VENTILATION BEFORE STAND-BY" stage is actually suppose to provide proper cleansing of the gas system. The user cannot change the duration of this stage. It is set automatically by the device. It can last up to 5 minutes, however according to the duration of the whole cycle it can be automatically shortened or skipped. The gas pump and the valves work as during the "VENTILATION" stage.
4. "STAND-BY" – in this stage the monitor waits until the next cycle starts. It switches the gas pumps off and blocks the measurement gas inlet by switching the valve to the inert gas inlet. The "STAND-BY" stage depends on the duration of the whole cycle and might not occur.

		Work cycle				Work c...		
		Warming	Ventilation	Measurements	Pre standby	Standby	Ventilation	Measurements
Main		1min+4h	5,10,15min	15min+4h	max. 5min	0+???	5,10,15min	15min+4h
Add.		1min+4h	5,10,15min	15min+4h	0+???	0+???	5,10,15min	15min+4h 0+???
		Warming	Ventilation	Measurements	Pre standby	Standby	Ventilation	Measurements

Picture 27. The sequence of the cycle stages and their duration.

The user can define the duration of the single cycle with the help of the computer program (see chapter 7.3.8.). The duration of the "VENTILATION BEFORE STAND-BY" and "STAND-BY" is set automatically by the monitor according to the chosen duration of the whole cycle and the two preceding stages. It might occur that the duration of the whole cycle equals or is only slightly longer than the total duration of the "VENTILATION BEFORE STAND-BY" and "STAND-BY" stages and so these stages are skipped or their duration is reduced (Picture 27.). In case the total duration of the two initial stages is longer than the whole cycle duration the "MEASUREMENTS" stage is shortened automatically so that the new cycle can proceed on time.



Picture 28. The working state of the pumps and valves according to the performed stage of the measurement cycle. The separate stages are marked with colours matching those used in Picture 27. (V1 – the main channel ventilation valve, V2 – the additional ventilation valve, P1 – the main gas pump, P2 – the additional channel pump).

If the measurement in the additional channel lasts shorter than the "MEASUREMENTS" stage, after it has completed the additional channel will be ventilated unless the measurement in the main channel completes. After the monitor proceeds to the "VENTILATION" stage both the channels are ventilated simultaneously.

5.2.2. Scheduled work mode

The user can arrange up to 24 measurements cycles within a twenty-four hour period if the device is working in the scheduled work mode. The beginning time for each of the cycles can be set independently with resolution of 1 second. Similarly to the cyclic work mode, all the cycles of the scheduled work consist of the same stages. However, only the duration of the two beginning stages can be set: the "VENTILATION" and "MEASUREMENTS". After the measurement has been completed the "STAND-BY" stage proceeds (following the "VENTILATION BEFORE STAND-BY" stage) until the next cycle starts according to schedule.

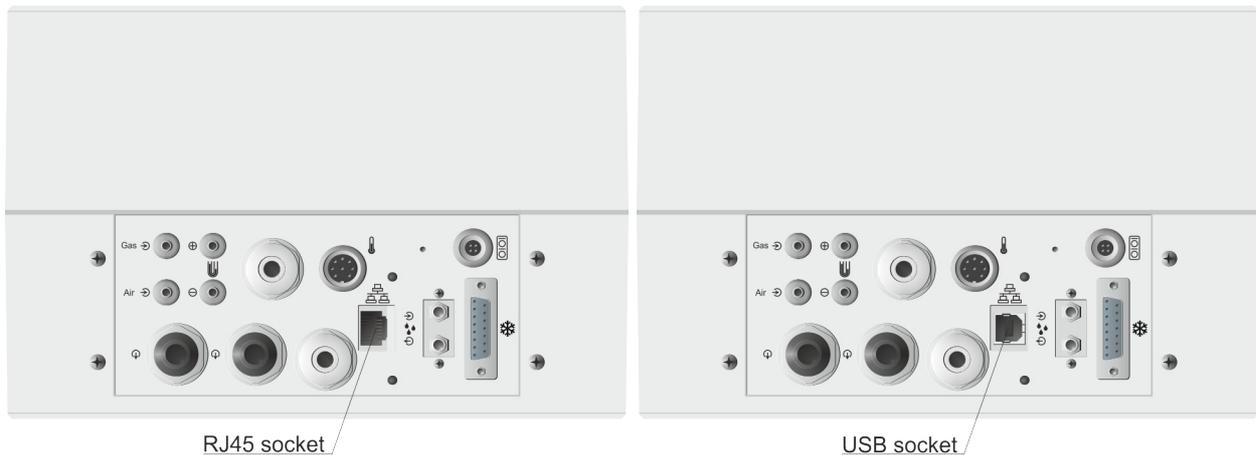
The working of the monitor can be precisely planned with the help of the scheduled work mode. In such cases the measurements can be performed exactly when required.

5.3. Communication with monitor

The **maMoS** is by default equipped with an RS232C interface (Picture 2.), which enables the user to connect the device to a computer in order to perform calibration, make changes to the device settings or see the measurement results. The maximum length of the wires used for the connection is 30m. Some new computers are not equipped with an RS232C interface. In such case **madur** can supply the monitor equipped with an USB interface instead of the standard RS232C interface. The maximum cable length for the USB interface is 3m.

On demand the monitor can also be equipped with an RS485 interface (instead of RS232C) assuring simultaneous communication with up to 15 monitors (network). The maximum recommended cable length for the RS485 interface is 100m. In a network, communication with a single device is performed using the device's unique identifier (address). The RS485 interface connector is identical to and replaces the RS232C connector.

There is also a possibility of equipping the monitor with an Ethernet RJ45 socket (replacing the RS232C). The maximum cable length for the Ethernet interface is 100m.



Picture 29. Location of RJ45 and USB sockets

The operation of the monitor has been greatly simplified by the fact that it is performed mainly with the help of a computer and the changes to the settings are made via **MaMoSII.exe** program. The monitor has no keyboard, it is only equipped with the displays on which the measurement results are presented and the LED which signals that the

monitor is on. Moving the control from monitor to computer is a great improvement especially if the monitor has been installed in a hard to reach place.

5.3.1. Monitor network (RS485)

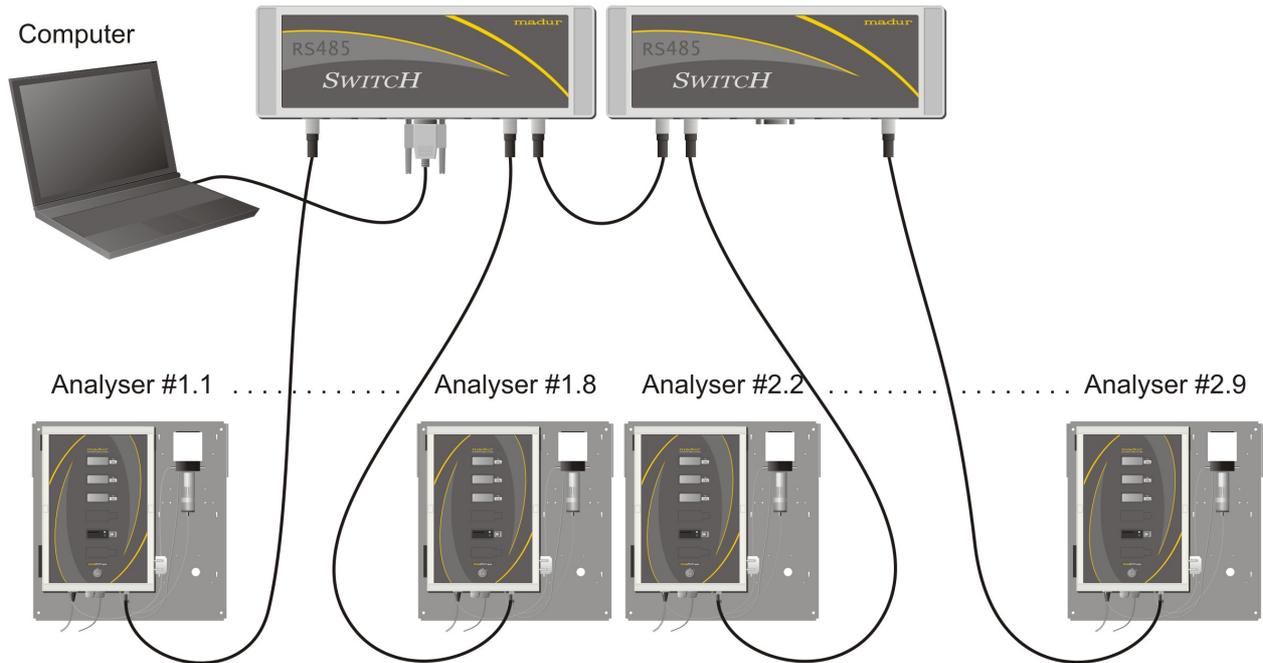
Up to 15 monitors equipped with the RS485 communication interface can form a network and be controlled by a single computer with the use of a single session of the **MaMoSII.exe** program. This useful possibility will simplify the simultaneous operating monitors located in different places.

To form such a network all the devices should be connected to the computer via an appropriate switch unit. Such a device - **RS485 Switch** is on offer in the **madur** catalogue. The switch (Picture 30.) has nine connectors designed for connecting the monitors and one used for connecting the computer.



Picture 30. Switch for connecting the monitors into the RS485 network.

Each of the monitors should be connected to the inputs labelled "Analyser #1" - "Analyser #9", whereas the computer should be connected to the "Computer" connector. The network can be formed by up to 15 **maMoS** monitors.



Picture 31. Example of a *maMoS* monitors network.

As the switch serves only nine monitors, if the number of the devices is bigger, two switches should be connected together with the help of a monitor connector and the computer should be connected to one of the switches. The picture below shows an example of a *maMoS* monitors network.

5.3.2. Communication via USB port

Proper cooperation of the monitor equipped with the USB port and the *MaMoSII.exe* program is possible after the appropriate drivers have been installed. The drivers can be found on the CD provided with the monitor but can be also downloaded from the www.madur.com website). The installation of the drivers is not complicated and takes just a few minutes. The installation procedure for the *Windows XP* system has been described below (the installation process for other Windows systems runs similarly).

The installation of the drivers for the monitor with the **USB** port runs as follows:

1. The *madur_USB_drivers* folder should be copied from the CD and saved anywhere on the disk, for instance [C:\Program Files\Common Files\](C:\Program Files\Common Files).
2. The monitor should be connected to a free USB port.
3. The monitor will be detected as a new device and the "*Found New Hardware Wizard*" window will open (Picture 32.).



Picture 32. Main window of "Found New Hardware Wizard".

4. The user should choose the option "**Install from a list or specific location (Advanced)**" (Picture 32.), and then click on the "Next>" button.
5. Choosing the "Browse" option in the wizard's new window (Picture 33.) displays a directory list.



Picture 33. Driver location choice.

6. The location of the **madur_USB_drivers directory** (copied earlier as described in the point 1.) should be chosen from the list. The directory with the drivers appropriate for the operating system used should be chosen from the **madur_USB_drivers directory**.



Picture 34. Folders list.

7. After the drivers directory has been selected the option "Next>" should be chosen (in the wizard's window) - Picture 33..
8. If the *Windows XP* operating system is used the creator might display a note (Picture 35.) informing on the incompatibility of the drivers with the *Windows* system. The option "Continue anyway" should be chosen.



Picture 35. Note informing of incompatibility of the drivers with the *Windows* system.

9. The installation of the drivers will begin. After the installation process has been completed the following window appears.



Picture 36. Window confirming completion of USB drivers installation.

10. After the USB drivers installation has completed the installation of the COM virtual serial port will proceed automatically (Picture 37.).



Picture 37. Installing COM virtual serial port.

11. In the window of the "Found New Hardware Wizard" (Picture 37.) the user should check the option "**Install from a list or specific location (Advanced)**" and press the "Next>" button.
12. In the window that appears the default directory will be the directory with the USB drivers, the user should once again press the "Next>" button.



Picture 38. Window pointing to the driver location.

13. Once again a note informing of the incompatibility of the drivers with the *Windows* system might appear. To continue the installation the option "*Continue anyway*" should be chosen.
14. After the installation of the virtual serial port has been completed the monitor is ready to operate.
15. The list of the available COM ports in the "*Program settings*" option of the **MaMoSII.exe** program (chapter 7.3.2.) will be extended by a new position which should be chosen if connecting with a monitor equipped with the USB port.

5.3.3. Communication via Ethernet

If the **maMoS** monitor is equipped with a RJ45 socket (Ethernet) then it is possible to connect the device to a LAN network. Connect the the device with a free Switch port. Then configure a PC computer you wish to connect to **maMoS** monitor. In order to do that please install Tibbo software (from **madur** software CD: **mamosII\Ethernet**) according to following instructions:

1. Connect the monitor to your LAN network and power up the device.
2. If the computer you are installing the software has "*Firewall*" software working on, disable it during the installation.
3. Run the installation software: **mamosII\Ethernet\Setup.exe**



Picture 39. Tibbo drivers and software installation window.

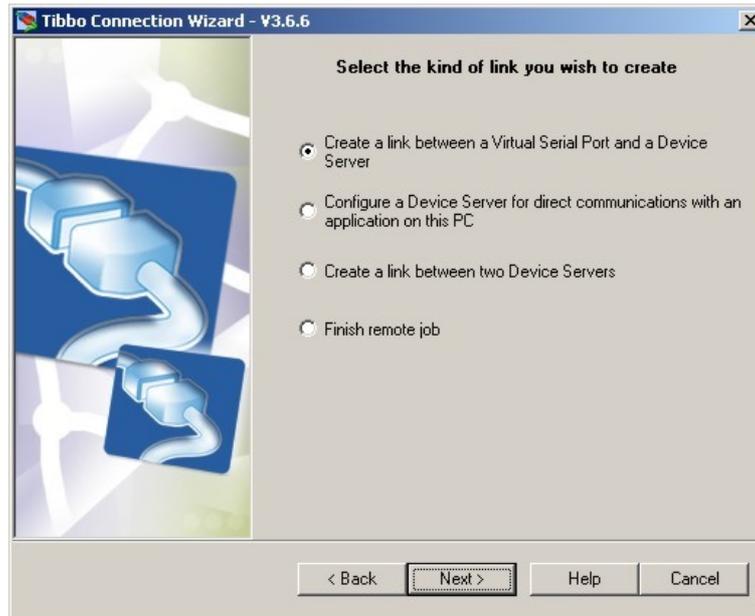
The program creates a virtual COM port on your computer that will refer to specific monitor in **MaMoSII.exe** program.

4. Follow the instructions of Tibbo installer.
5. When the installation is done run the **Connection Wizard** from "*Start/Programs/Tibbo/Connection Wizard*" (if the Tibbo software was installed in the default location).



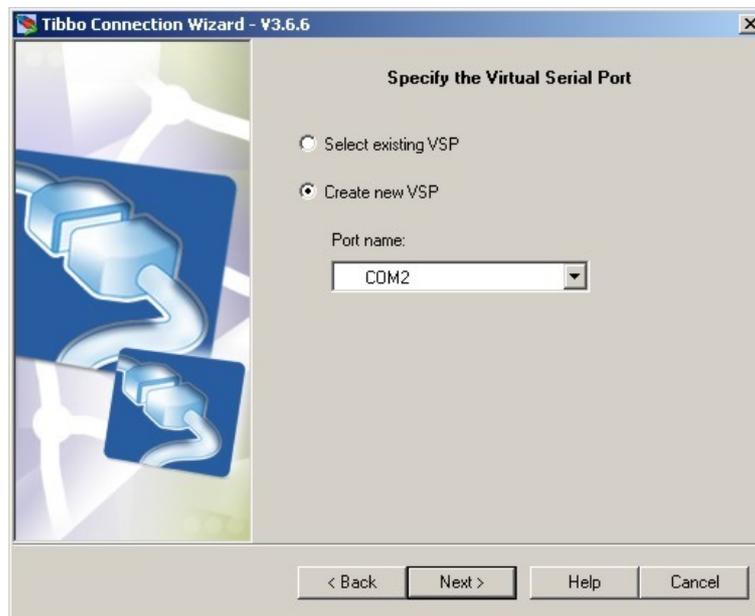
Picture 40. Tibbo „Connection Wizard” window.

6. Press "Next" in the first window.
7. Select "Create a link between a Virtual Serial Port and a Device Server" as shown in the picture below:



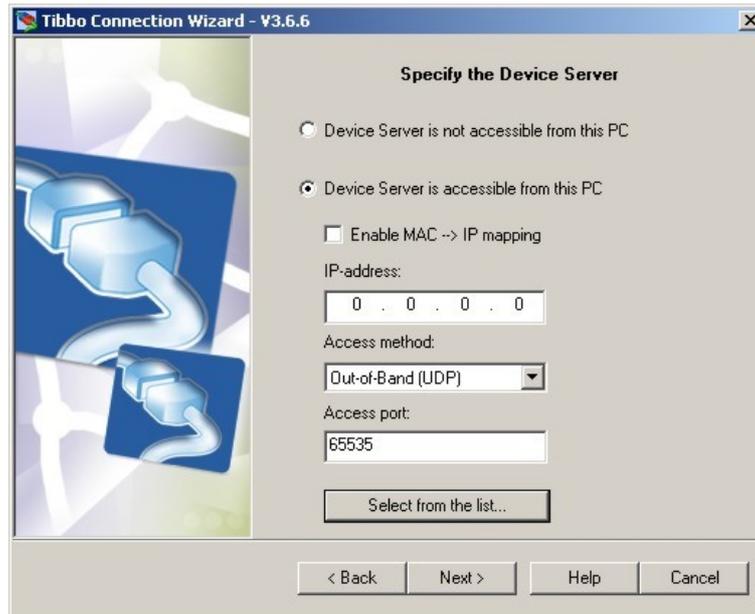
Picture 41. Selection of connection window

8. Create a new Virtual Port (VSP), select a PORT (remember your choice as this port number will be used in communication with MaMoS. If the configured port is designated for the following MaMoS in the net remind to provide each MaMoS with unique Virtual Port number. Press "Next" to skip to next window.



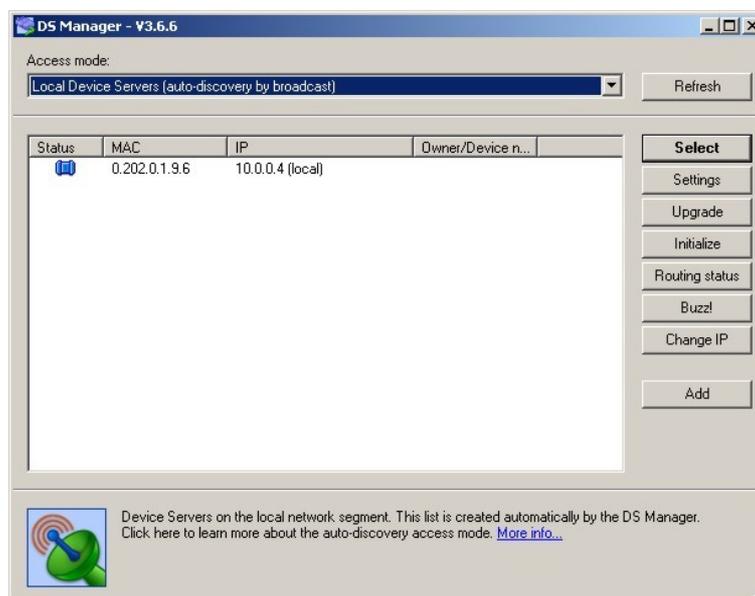
Picture 42. Selection of COM port that will be used in communication with the device.

9. In the next window press "Select from the list..." button



Picture 43. Selection of a device assigned to a COM port.

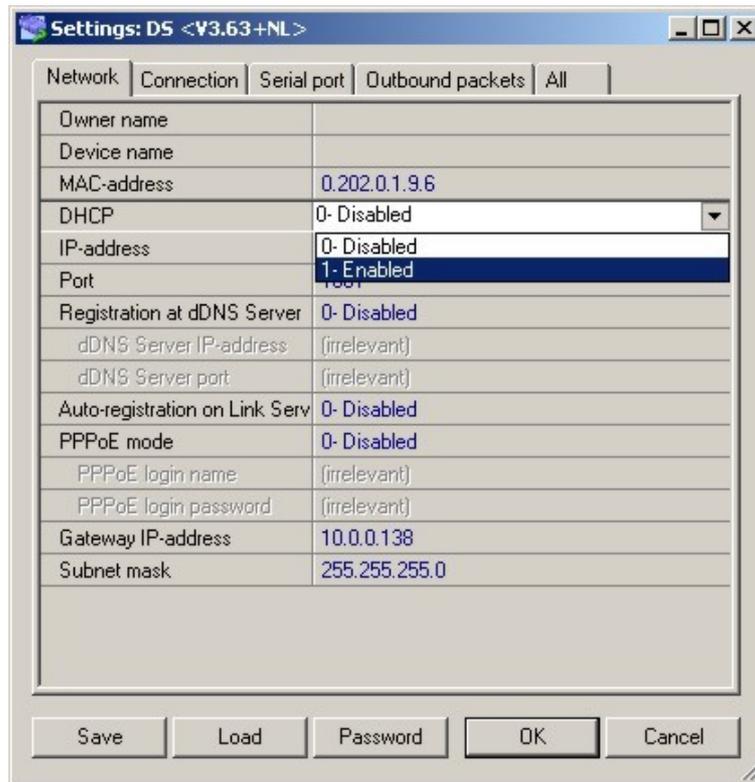
10. The next window shows the list of found **mamos** monitors in the LAN network. If the list is empty check the firewall settings and ensure that mamos devices are switched on.



Picture 44. The list of available mamos analysers in the LAN network

11. Select a device from the list that you wish to assign to a specific COM port and press "Settings" button. If many devices are to work in the network to ease the selection from the list you can turn off the devices you are not currently configuring.

12. In the next window change **DHCP** option from “0 – Disabled” to “1 – Enabled” and confirmed it by pressing “OK” button.

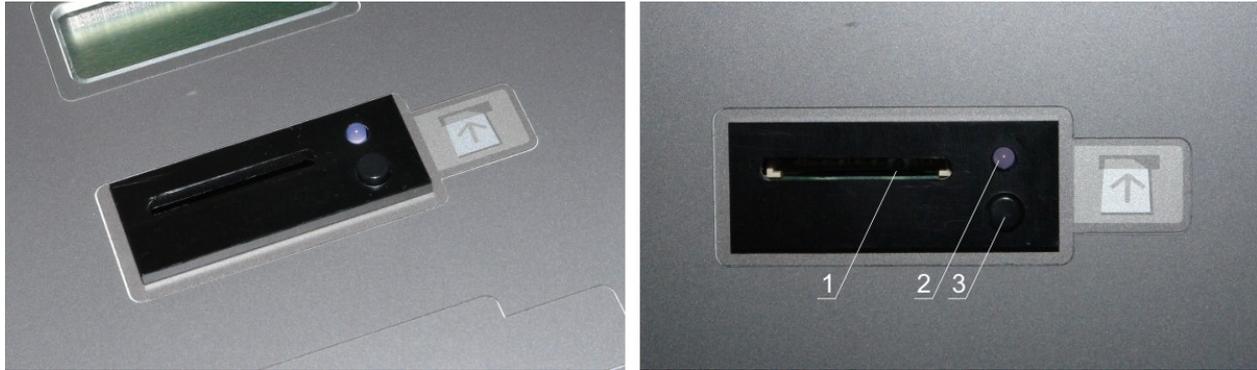


Picture 45. Setting the DHCP option.

13. After returning to the previous window press “Refresh” button and reselect the device from the list.
14. Leave the rest of the options as default by pressing the “Next” button in the following windows in the **Wizard Configuration**.
15. After completing the **Wizard Configuration** go to **MaMoSII.exe** program (see chapter 7.3.2.) and select the configured COM port.

5.4. MMC module.

The **maMoS** monitors can be optionally equipped with a module used for registering the measurements results on a flash memory card (*MultiMedia Card*) in a digital way. If the module is installed the card slot can be found underneath the lowest display. Such a module is shown in Picture 46. On the right-hand side of the card slot (1) there is a button (2) used for holding the recording process (if the card is to be removed) and a control LED (3) which signals the current work mode of the MMC.



Picture 46. The MMC module: 1–MMC slot; 2–Hold recording button ; 3–control diode lamp.

The *MMC* module of the *maMoS* monitor works properly with MMC / SD cards with a maximum capacity of 4 GB and a *FAT-16* file system format. The files containing the current measurement results shown on all the displays and analogue outputs are stored on the card. The files are saved in the root directory of the card. A single file can consist of up to 10 000 results. If the amount is exceeded a new file will be created and the succeeding results will be saved in it.

The file name is created according to the *FAT-16* system in a 8+3 pattern (which is: eight characters forming the name and three characters of the file's extension). The files containing the measurements are given the *mrp* extension. The file name is the next number from the device's internal counter (for example 00000012.mrp) which counts the number of files created by the monitor.

Attention!

If one card is used in several devices the monitor might create a file named the same as the one already existing on the card file. It will be impossible to read such a file afterwards.

Such a situation can be avoided in a number of ways:

- a separate *MMC* can be used for each of the devices;
- the card can be formatted before it is inserted into the analyser's *MMC* slot (the *FAT-16* file system) – more informations can be found in chapter 5.4.2.
- before the card is inserted into the slot a new subdirectory should be created on the card. That is where the files from the previous measurements can be moved. The new measurement results are saved only in the root directory of the card.

Due to the *FAT-16* file system restrictions the main catalogue can consist of up to 512 files. If the number is exceeded an error occurrence will be reported (the LED will be flashing – see point 5.4.1.).

The *MMC* module of the **maMoS** monitor works in several stages – each of them signalled with an appropriate flash code of the LED (see point 5.4.1.).

- **No card** – no card is in slot (the LED is constantly off).
- **Initialisation** – performed when the card is inserted into the slot or immediately after the recording starts. This stage lasts for about 5 s during which the card parameters are read and (eventually) a new file used for recording the data on the card is created (the LED flashes ten times per second).
- **Off** – module proceeds to this stage if the recording is stopped (the LED flashes once every three seconds).
- **Recording** – during this stage the measurement results are periodically recorded on the card (the LED is constantly on). The recording frequency can be set with the use of the **MaMoSII.exe** software.
- **Stopping** – during this stage the *MMC* module closes the current file (the LED flashes ten times per second) and, according to the situation:
 - proceeds to the **Initialisation** stage – if the maximum file size has been exceeded (10 000 records),
 - proceeds to the **Off** stage – if the recording process has been stopped with the help of the computer program,
 - proceeds to the **Stopped** stage – if the **Hold recording** button has been pressed.
- **Stopped** – stays on hold for 10 s in order to make it possible for the user to remove the card (the LED is off). If the card is not removed the recording will be automatically restarted.
- **Error** – the module proceeds to this stage if it detects any errors in the card's working (the LED flashes once per second). In this case storing and reading the data from the card is impossible.

Before the card is removed from the slot the user must press the *Hold recording* button for at least two seconds and release it. The file with the results will then be closed and the recording will stop (the LED will be flashing quickly and then it will turn off). The card can then be safely removed. If the card is not taken out of the slot the **Initialisation** and **Recording** will start after 10 seconds. During the **Recording** stage (when the LED

flashes) if the removal of the card is not preceded by pressing the button the data stored in the current file can be lost. However, if the *MMC* module is working in the **Off** stage (the diode flashes more seldom) the card can be removed straight away.

5.4.1. Possible flashing sequences of the MMC control diode lamp.

The current *MMC* state is continually signalised by the control diode lamp which can be found on the right-hand side of the card slot (Picture 46.). The diode lamp turns on and off in a particular pattern according to the currently performed process. All the possible flashing patterns have been listed below:

1. ○ – the LED is turned off – this state can appear if
 - the card has not been inserted into the slot,
 - the card has been inserted but the recording has been held in order to remove the card.
2. ● – the LED is turned on – this means that:
 - data is being stored on the card (the **Recording** stage).
3. ●○●○. . . – the LED flashes quickly (the LED flashes ten times per second) – this state appears when:
 - the **Initialisation** stage is proceeding,
 - the recording is held as a result of pressing the button (the **Stopping** stage).
4. ●○●○. . . – the LED flashes more seldom (the LED flashes once every three seconds) – this means that :
 - the card has been inserted into the slot but the recording is stopped (the **Off** stage).
5. ●○●○. . . – the diode flashes rhythmically (the LED flashes once per second) – this state appears if:
 - the card is inserted and an error has occurred – **Error** stage (reading and recording is impossible).

5.4.2. Formatting SD / MMC card in FAT-16 file system

If for any reason it is necessary to reformat the CD / MMC card one must mind that the card has to be formatted in the FAT-16 system in order for card to work in mamos analyser.

If the operating system will not allow to select the FAT-16 system, the card can be formatted differently. Please follow the instructions below to format the card:

1. Run the command line terminal – execute program: *C:\Windows\System 32\cmd.exe*
2. Enter command: *format X: /FS:FAT*
where *X* is a card's drive letter.
3. Confirm the selection of 64KB clusters
4. Optionally, enter the cards label.

5.5. Updating the monitor's firmware.

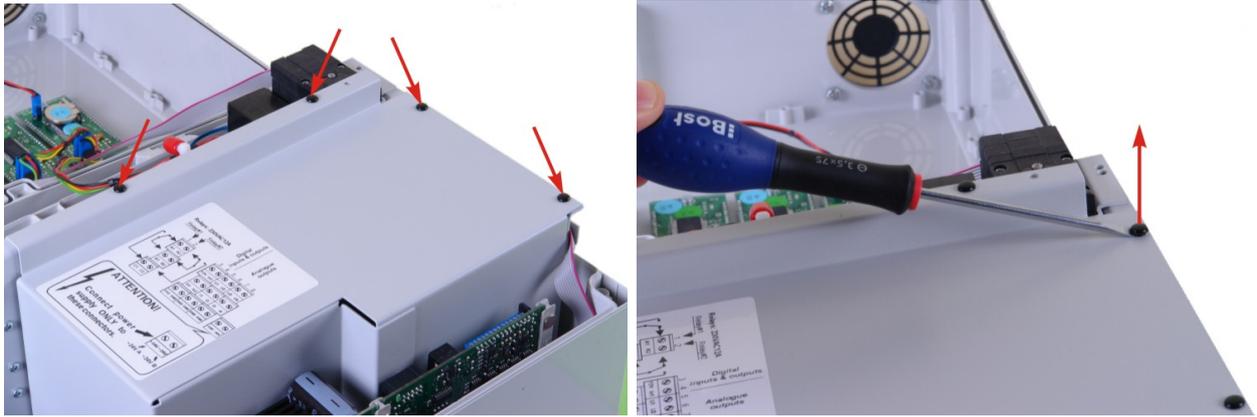
The modular design of the monitor and the fact that its construction is based on the latest technological achievements enable the user to improve the functionality of the device by changing its software. As the **madur** products are systematically upgraded, new programs for operating the devices (so-called firmware) are continually improved. The firmware is available from the company's website (www.madur.com).

5.5.1. The procedure of updating firmware

To update the firmware successfully the *WSD* software from the *Analog Devices*[®] company should be installed. The software is recorded on the CD provided with the monitor in the catalogue: *x:\service_wsd_v6.7* (where: *x*: - stands for the letter of the CD-ROM drive, and *v6.7* indicates the program's version – the software version can be different on the provided CD). During the installation process the user should follow the instructions given in the installation program.

Updating the firmware should be performed as follows:

1. The monitor should be switched off.
2. The top of the casing should be opened (see Picture 21. – section 4.1.1.) and the metal cover should be removed (Picture 47. and Picture 48.).
3. The CPU should be localised (the upper rightmost slot) and a short-circuit made on the two upper pins of the five pin connector with a 2.54 mm jumper (Picture 49.).
4. The monitor should be connected to the computer using the RS232C or USB socket.

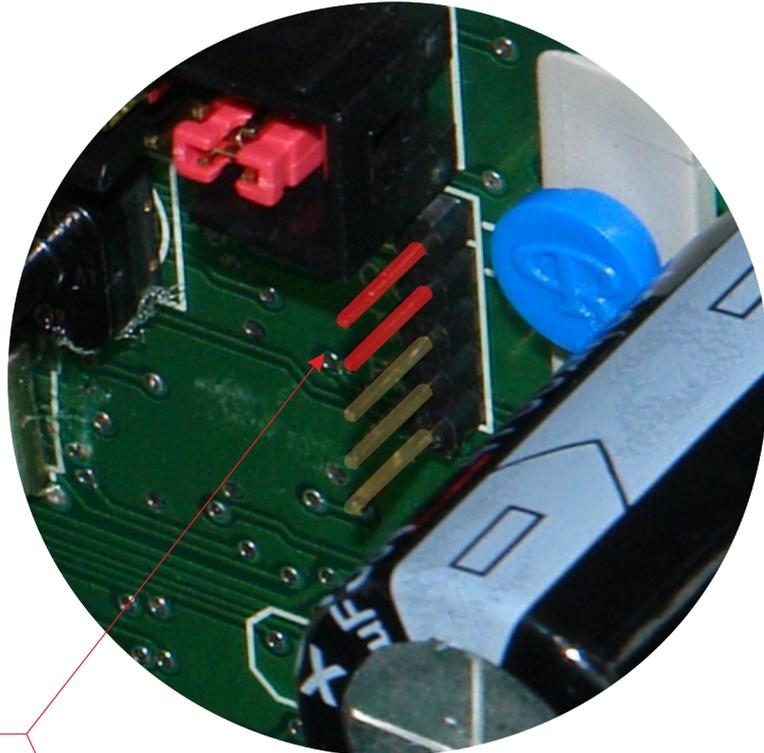


Picture 47. Metal cover – location of the removable rivets and the way they should be removed.

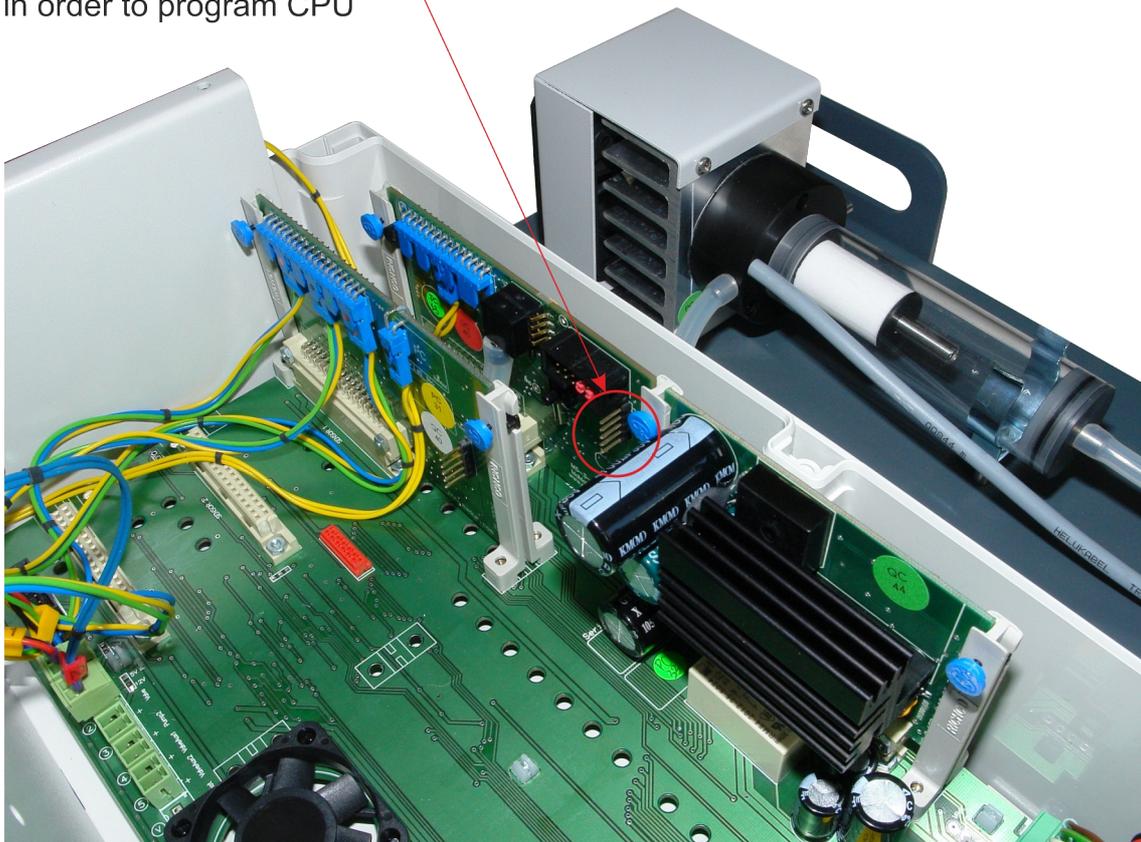


Picture 48. Metal cover – location of holding screw.

5. The monitor should be switched on. It starts-up in the programming mode (the displays are switched off).
6. The *WSD* program should be launched (menu *Start*→*Programmes*→*ADuC*). The port to which the monitor is connected should be defined with the help of the "*Configuration*" options in the main window of the *WSD* program (Picture 50.).



Location where the 2,54mm jumper should be installed in order to program CPU

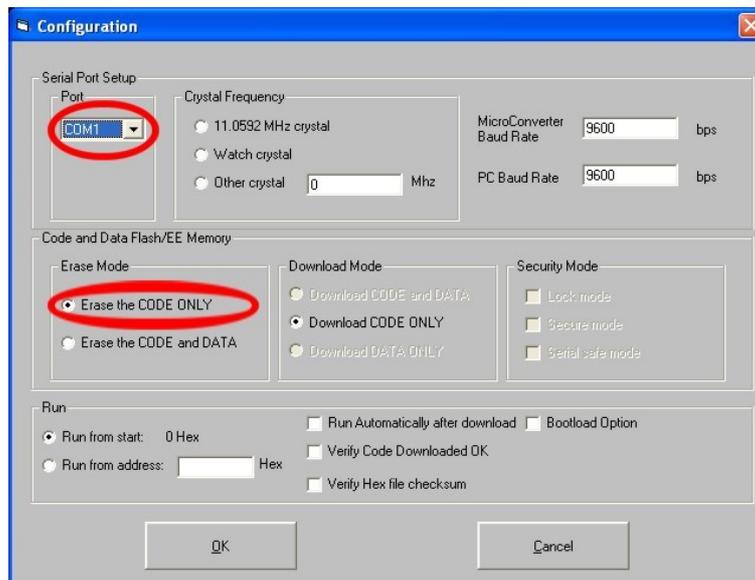


Picture 49. The view at the CPU board – programming pins are marked in red – place where the 2,54 jumper should be installed.



Picture 50. Main window of the WSD program.

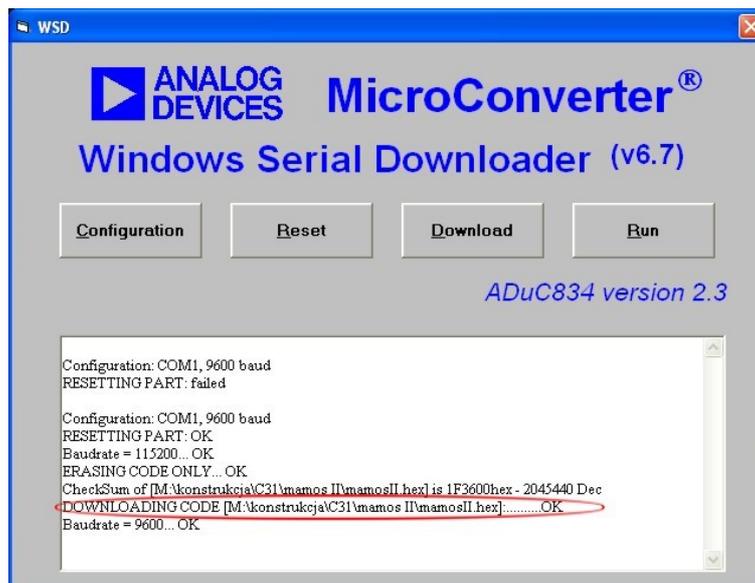
7. **ATTENTION!** The "Erase the CODE ONLY" option has to be chosen as shown in the Picture 51.. If the option is not chosen all the monitor settings will be erased and as a result the device will not work properly.



Picture 51. Configuration of the WSD program when updating the monitor's firmware.

8. Pressing "OK" returns to the main window of the WSD program.
9. The "Download" button should be pressed. The file with the new program (the file with the .hex extension) should be selected in the dialogue box.
10. The monitor will then be programmed which will be signalled by the message: "DOWNLOADING CODE [x:\mamosII.hex]...OK" (Picture 52.). This may take a few minutes.

11. To check whether the programming process has been successful the user should:
- switch the monitor off
 - remove the jumper
 - switch the monitor on and confirm whether the firmware version is correct (appears on the display #1 several seconds after the device has been switched on). If the firmware version is correct the monitor can be switched off and the casing of the device should be closed.



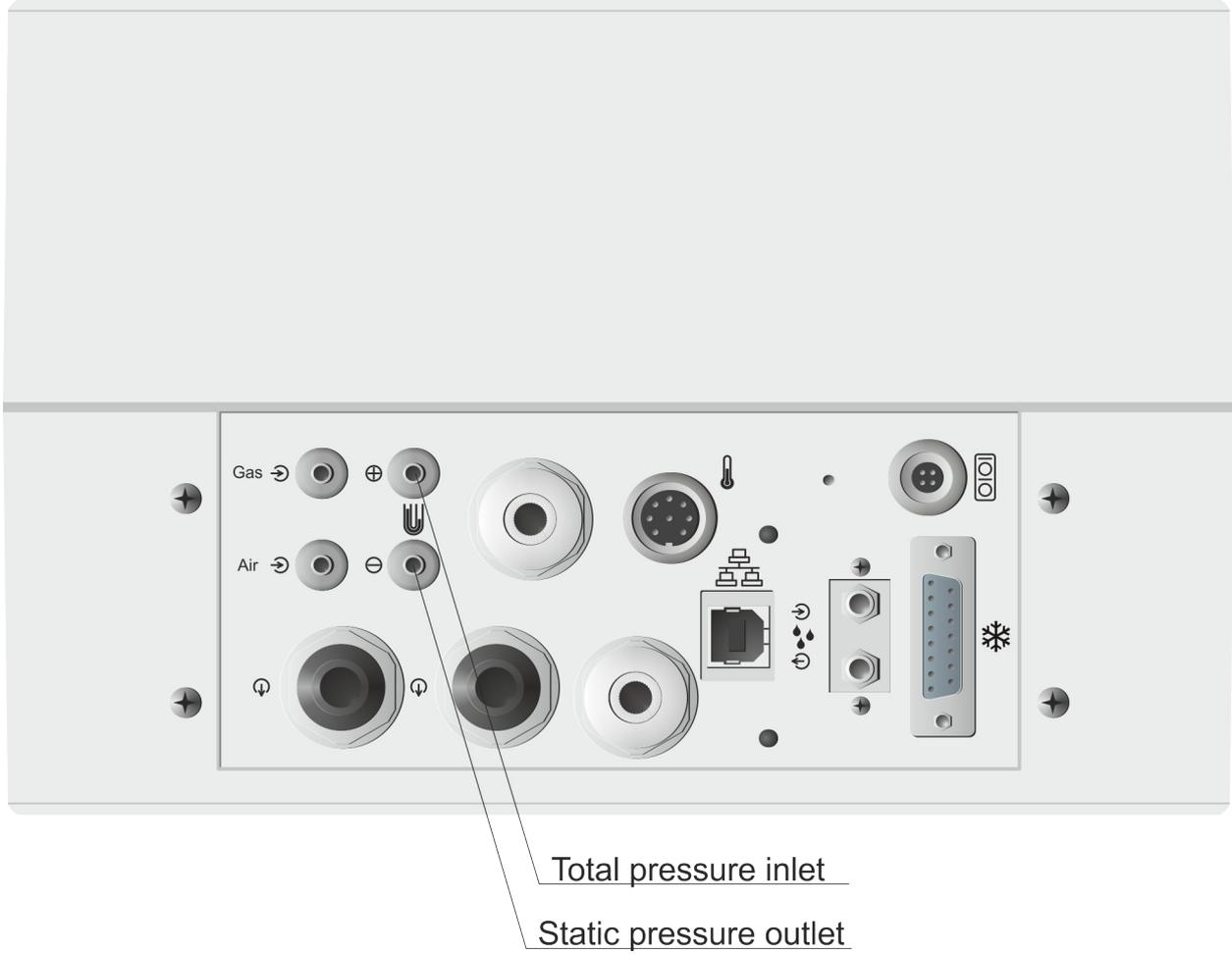
Picture 52. Information of the completion of the updating process.

5.6. Flow velocity measurement

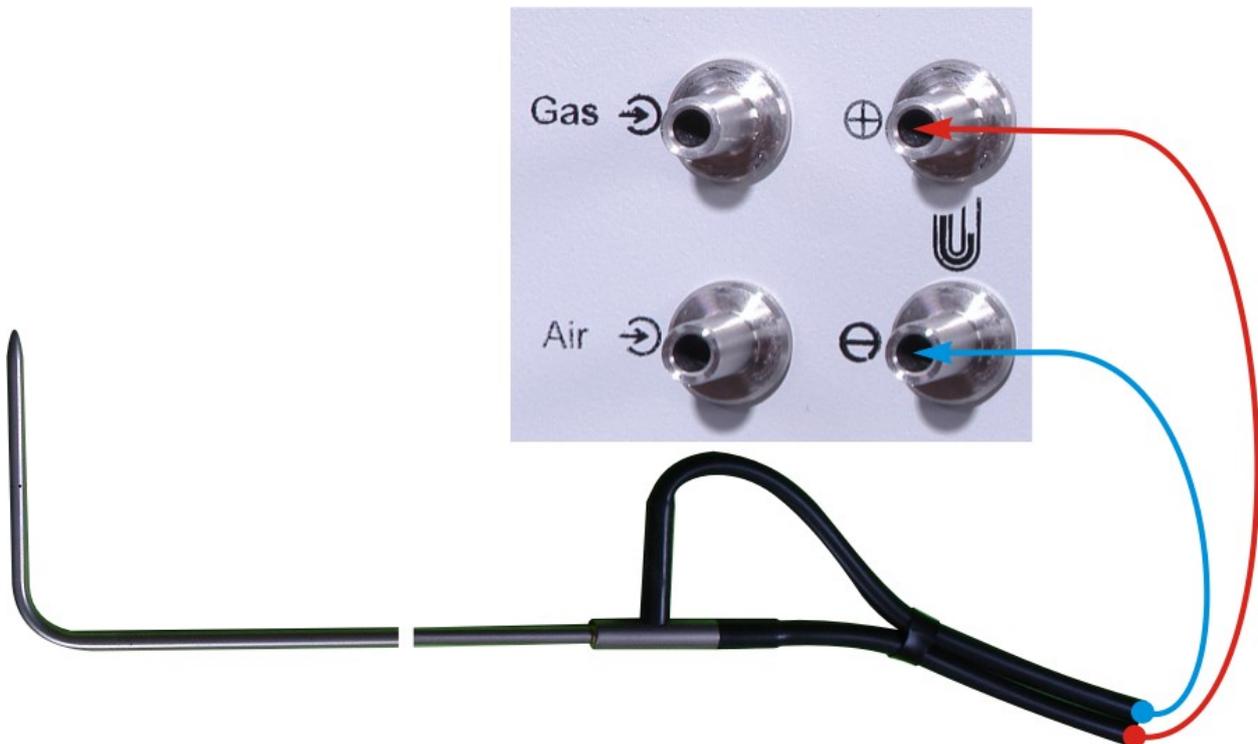
MaMoS analyser can optionally measure gas flow velocity (for example in chimneys). If this option is available then the analyser is equipped with the pressure measurement inlet and outlet. They are installed at the bottom part of the housing next to fresh air inlet and gas outlet.

The measurement of the flow velocity is made via measurement of total and static pressure using Pitot tube. To perform the measurement correctly connect the Pitot tube as follows:

- The outlet of the static pressure connect to the inlet signed with \ominus symbol
- The inlet of the total pressure connect to the inlet signed with \oplus symbol



Picture 53. Location of pressure measurement inlet and outlet.



Picture 54. Connection of the Pitot tube to pressure inlet and outlet.

The result can be viewed on one of the displays and on an analogue output. Necessary configurations must be done from the **MaMoSII.exe** program.

5.7. Replacing the dryer filter

During the ordinary working of the monitor the filter inside the gas dryer wears out. The condition of the filter should be checked regularly. It is advisable to check the filter at least once a week. If the device is used intensely or the measurement gas is polluted the filter should be checked more often. If the filter is very dirty it should be replaced with a new one.

5.7.1. Replacing the filter in MD2 dryer

To replace the filter properly the user should:

1. Switch the monitor off.
2. Disconnect the electric wire connecting the dryer to the monitor and disconnect all the hoses from the dryer.
3. Unhook the dryer – to do so the user should raise the dryer holding the radiator and slip it from the hooks and clips as shown in the pictures below.



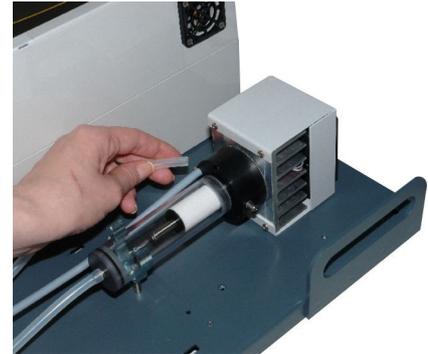
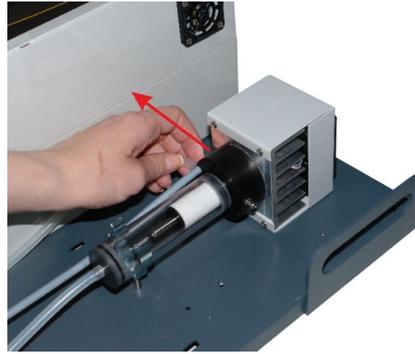
Turn off the analyser.



Disconnect the electric cable between the analyser and the gas dryer.



Disconnect the tubing that feeds the gas to the dryer.

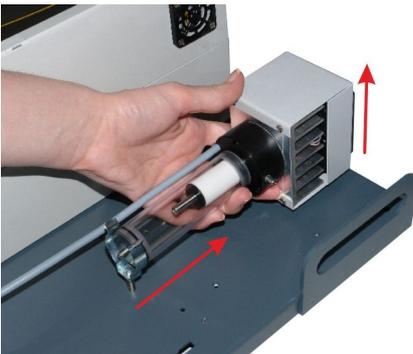


Disconnect the tubing that feeds the gas from the dryer to the analyser.



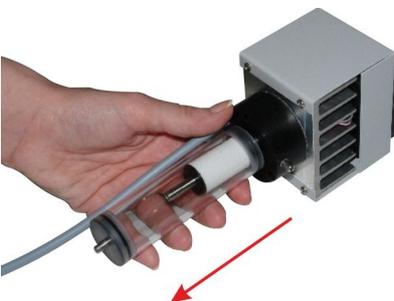
Disconnect the tubing that removes the condensate from the dryer.

Pull the dryer from the grip holder.

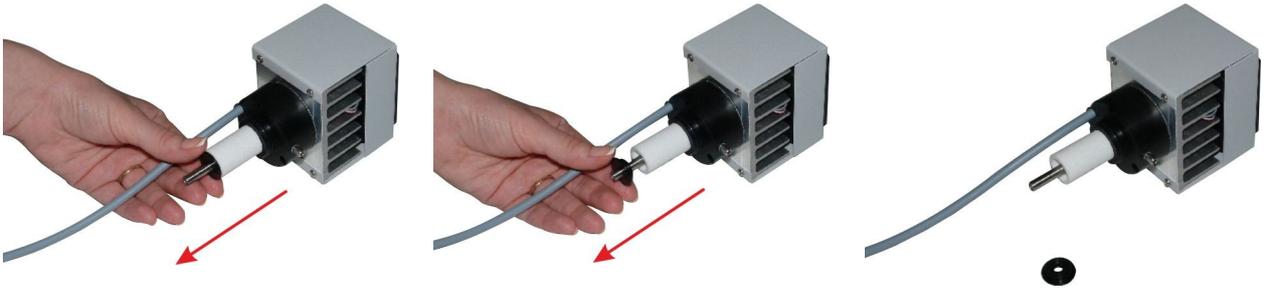


Slip the dryer from the the hooks.

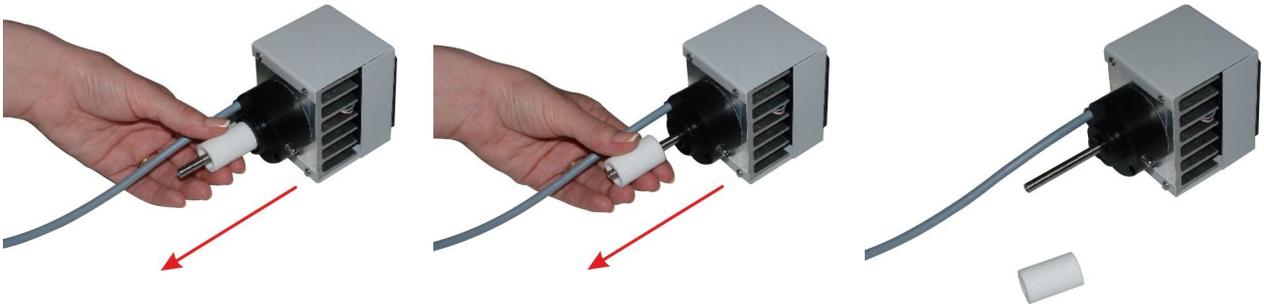
4. Remove the transparent condensate container – it should be gently slipped out of the gasket (twisting the container will simplify the action).



Remove the transparent condensate trap by slipping it out of gasket.



Remove the clamp that holds the filter inlet.



Slip off the filter inlet.

5. Replace the filter – by removing the outworn one as shown in the pictures above.
6. Install the condensate container.
7. Place the dryer on the hooks.
8. Connect the dryer cable and hoses.

5.7.2. Replacing the filter in MD3 dryer

To replace the filter properly the user should:

1. Switch the monitor off.
2. Twist off the filter's cover.
3. Replace the filter's inlet.



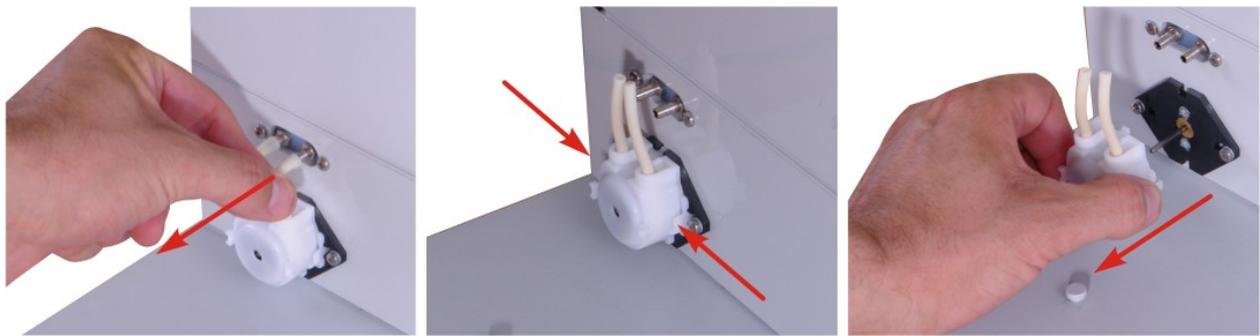
Picture 55. Replacement of filter inlet in MD3 gas dryer.

5.8. Replacing the head of the peristaltic pump

As the mechanism of the peristaltic pump and its hose wear out with time there is a possibility of replacing the whole head of the peristaltic pump.

To replace the head of the peristaltic pump it is necessary to:

1. Switch the monitor off.
2. Slip the pump tubing from the metal tubes
3. Remove the head – by squeezing the head latches gently with fingers (Picture 56.) and slip the head off the axis.
4. Install the new head in the reverse order.



Picture 56. The peristaltic pump of the *maMoS* monitor (the arrows indicate the direction of releasing the latches).

6. PRESENTING THE RESULTS

The values of all the results measured and calculated by the monitor can be presented on the built-in displays and/or on analogue outputs. The device has eight analogue outputs: four voltage (potential) and four current and up to four LCD displays (4.5 digit). What is more the monitor is equipped with a digital output (*PWM*) and can be optionally equipped with two relay outputs which can be assigned to any of the measured values.

Configuring the displays, the analogue outputs and the relays can be performed with the help of the *MaMoSII.exe* program.

The way the results are presented depends on the currently performed stage of the cycle. During the "*MEASUREMENTS*" stage the results displayed and shown on the analogue outputs are the actually measured values. During the "*VENTILATION*" and "*STAND-BY*" stages the results are presented in a way defined in the *MaMoSII.exe* program (see chapter 7.3.3.5.).

6.1. Calculating the results

The **maMoS** monitor, basing on the measurement results, calculates many additional parameters, for example: the stack loss, the boiler efficiency or the CO₂ concentration (using the oxygen concentration measurement result). The exact information on the formulas used for calculating the results are available in a separate brochure "**Calculation of results in the madur gas monitors**", which can be downloaded from the **madur** website: www.madur.com.

6.2. Displays' work modes

According to the stage of the work cycle, different information appears on the monitor displays. The list of all the stages with the description of the information appearing on the display has been given below.

1. **TESTING** – the first stage of the monitor's operation (lasting for a few seconds after the monitor has been switched on) during which all the segments of the displays are lit and the information on the current firmware version appears on the first (top) display.
2. **WARMING-UP** – the stage is to prepare the monitor and particularly the gas dryer to work properly. In the upper left corner of the first display the arrow appears and the beginning time of the next cycle is presented on the display.



Picture 57. Example of the first display reading (*display #1*) during the "**WARMING-UP**" or "**STAND-BY**" stages.

If the monitor has been equipped with more than one display the current time from the internal clock is presented on the second display and all the other displays are off (blank).



Picture 58. Example of the second display reading (*display #2*) during the "**WARMING-UP**" or "**STAND-BY**" stages.

3. *VENTILATION* – the displays flash presenting the current measurement results. The signals on the analogue outputs depend on the settings defined using the computer program (the analogue outputs in particular may freeze the result directly preceding the *VENTILATION* or continue displaying the current results – see chapter 7.3.3.5.).



Picture 59. Example of the display reading during the "*VENTILATION*" stage.

4. *MEASUREMENTS* – the current measurement results are displayed.



Picture 60. Example of the display reading during the "*MEASUREMENTS*" stage.

Moreover during the *MEASUREMENTS* stage the display showing the results of the measurements performed in the additional gas channel may present the **OFF** note and the last measured value appearing in turns. This informs the user that the ventilation process is performed in the channel and the device displays the last measured value.



Picture 61. While the additional channel is being ventilated the device displays the **OFF** note and the last measured value in turns.

5. *STAND-BY* – during this stage, as during the ventilation stage, the display #1 presents the beginning time of the next cycle.

It is also possible that an error code will appear on the display. If the monitor detects an error in the operation of any of its components, for example – the sensor, the appropriate error number will be given on one of the displays. As the information may prove useful when diagnosing the damage it is advisable to note it and pass it to the service staff when reporting the failure. This will allow service staff to prepare for the repair and shorten the repair process.



Picture 62. Example of an error code.

Error codes that can be displayed on the mamoS displays:

- E01 – an incorrect (non-existing) variable assigned to the display
- E03 – can occur only in the devices that were equipped with flow control sensor. This error means that the flow dropped below the acceptable level. It may be caused by excessive pollution of the gas filters (in that case those should be replaced immediately) or by other blockade, e.g. gas tubing is crushed. The correct flow rate is adjustable from the PC program – see chapter 7.3.3.3. for more details.
- E07 – means result's error / no result. It may be caused by:
 - the result is out of range
 - the result could not be calculated by the analyser (applicable only to the calculated results)
 - communication problems with particular sensor, e.g. when sensor was removed.

7. SOFTWARE USED FOR OPERATING THE MONITOR

Operating and setting the **maMoS** monitor can only be performed with the help of a personal computer. For that reason the CD containing the **MaMoSII.exe** software is provided with each monitor. The installation process and the **MaMoSII.exe** program functions have been described in this chapter.

7.1. Installation

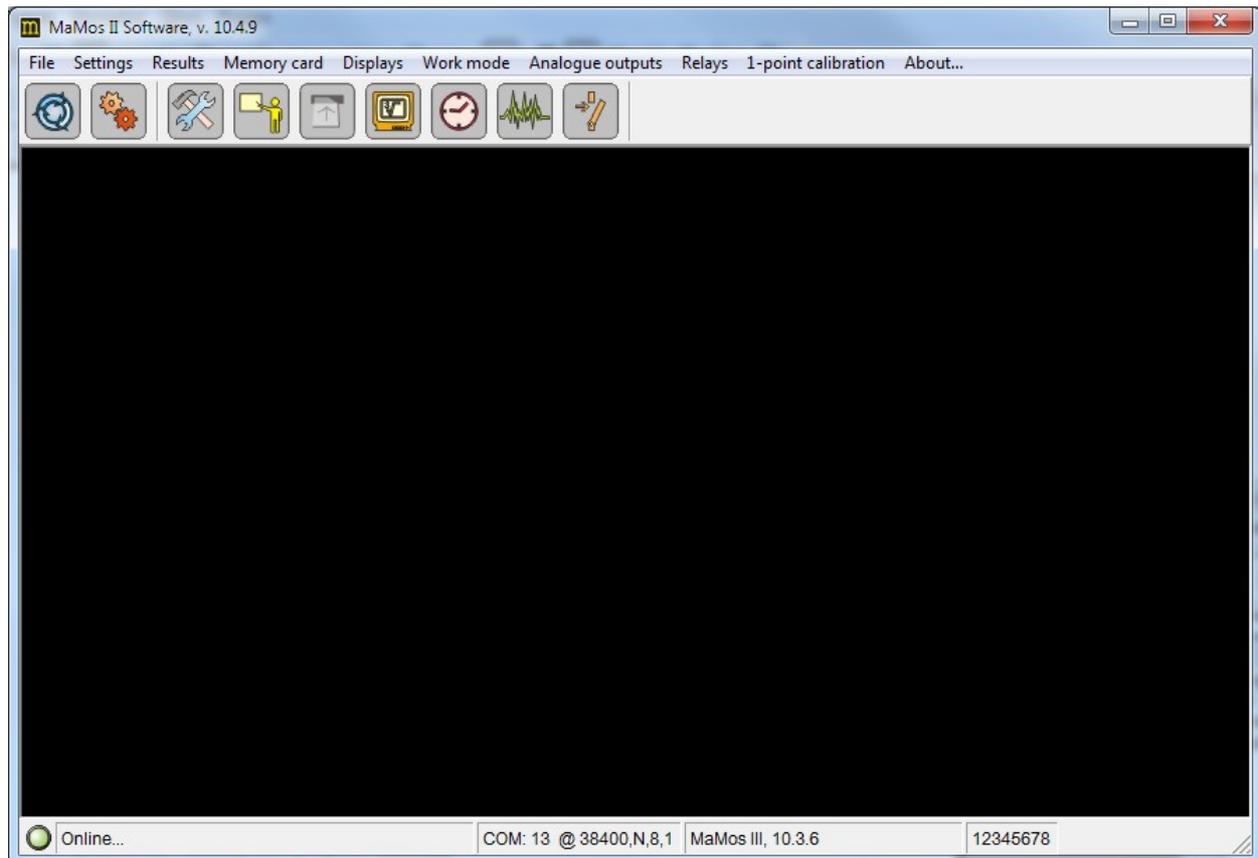
The **MaMoSII.exe** program can be installed on a computer with Windows 95/98/ME/2000/XP/Vista operating system. Free disk space of 3,5 MB and RS232C serial interface (optionally RS485, USB or Ethernet RJ45) are necessary.

After the CD has been inserted into a CD-ROM drive the **setup_MaMoSII_v3.1.EXE** installation program has to be started. The version of software (here 3.1) can be different on the provided CD. The installation program can be found in [x:\mamosII](#) directory (where x stands for the CD-ROM drive letter on the particular computer). Throughout the installation process the user should follow the installation program

instructions. The process will last for a few minutes. After the installation process has completed the program can be used.

7.2. Operating the MaMoSII.exe program

After the proper installation process the program can be started via menu *Start*→*Programmes* by choosing *madur*→*mamosII*. The main window of the program (as presented below) will appear.



Picture 63. The main window of the *MaMoSII* program.

In the bottom left corner of the program window on the status bar information about the state of the connection between the monitor and the computer is given. If the monitor is disconnected or switched off, the red dot and a note "*No monitor...*" appear. The green dot and a note "*Ready...*" mean that a successful connection has been established between the monitor and the computer. The information concerning the parameters of the port chosen for the communication purposes, the software version and the monitor's serial number are also given in the status bar.

After the connection between the monitor and the computer has been established changes to the settings, the configuration and reading the current measurement results

can be performed using the program. All of the program functions can be reached from the menu bar or with the help of the quick access buttons (icons) located at the top of the program window. All the functions which can be evoked with the help of the buttons can also be reached via the menu bar.

7.3. The functions of the MaMoSII.exe program

Below, the program functions accessible from the quick access bar (in the order of appearance in the bar) and the functions reachable only from the menu bar are described. A description of each of the functions in the quick access bar is preceded with an appropriate icon referring to the function in the bar.

If communication between the monitor and the computer has not been established the functions based on the monitor data will be inactive.

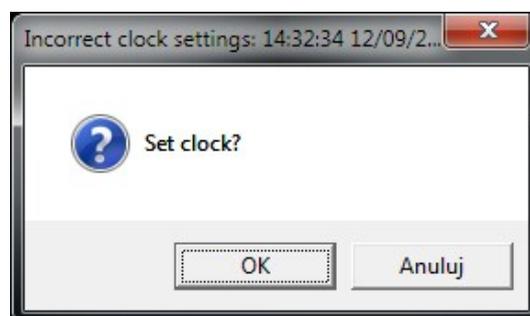
7.3.1. Reconnect (restart transmission)



If the connection between the monitor and the computer has been lost or the monitor was not connected to the computer when the program was started the connection can be established with the help of the above icon. Information about the current connection state is presented in the bottom left corner of the program window.

This function can be reached by pressing the *F8* button, the icon in the quick access bar or from the menu *File*→*Reconnect*.

After the connection has been established the readings of the monitor's internal clock are checked. If the readings differ from the computer clock the user will be asked whether the monitor's clock settings should be changed. The user can decide whether to change the monitor's settings.

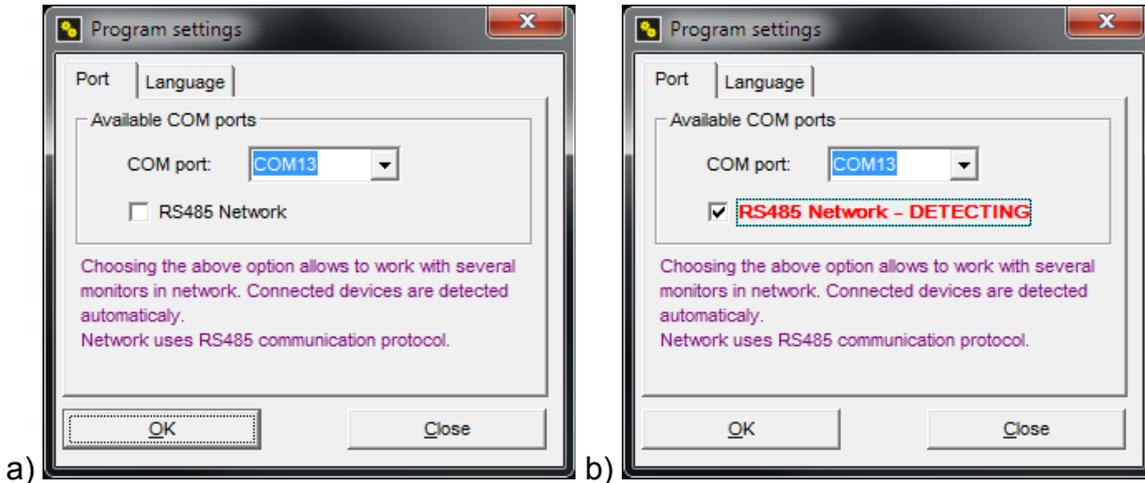


Picture 64. The window of the monitor's clock setting.

7.3.2. Program settings

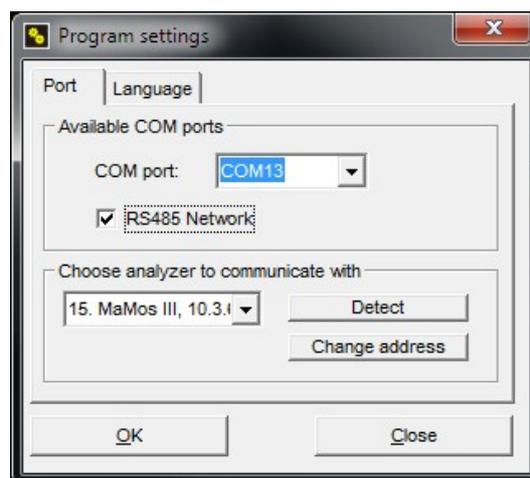


After the function has been started with the help of the quick access button or from the menu *File*→*Program settings*, the window with the program settings will be displayed. The window contains two tabs: *Port* and *Language*.



Picture 65. The window of the program's main settings: a) port settings; b) RS485 port settings.

With the help of the *Port* tab (Picture 65.) the user can choose the transmission type (the single unit mode or network mode) and select the serial port to which the monitor is connected. Choosing the *RS485 network* option enables operation with a maximum of 15 monitors. However, the option is available only if the connected monitors are equipped with a transmission module compatible with the RS485 standard.

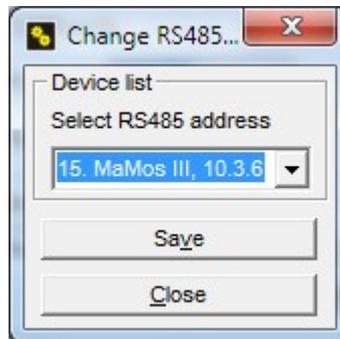


Picture 66. Additional settings to RS485 communication interface

If the "*RS485 Network*" option is chosen the additional functions will appear at the bottom of the program settings window (Picture 66.). The process of detecting the access-

ible monitors will last for a few seconds. The addresses of the detected devices will appear in the list below. The monitor whose settings are to be changed has to be chosen from the list. There are two buttons on the right side of the list. The "*Detect*" button can be used for detecting the available monitors. The "*Change address*" button enables the user to assign a new address (1 to 15) to the chosen analyser. This can be performed to avoid communication problems caused by the fact that two monitors have the same address. To change the address of one of the monitors the user should:

- disconnect the other one
- press the "*Change address*" button – the window shown below will appear:



Picture 67. Window enabling change of the monitor address (when operating in RS485 network).

- choose the available address from the list and press *Save* button.
- After the address has been changed all the connected monitors will be detected once again.

The *Language* tab (Picture 68.) enables the user to change the program interface language. The choice of the language can be made with the help of the drop-down list placed in the middle of the tab.



Picture 68. Setting the language of the program

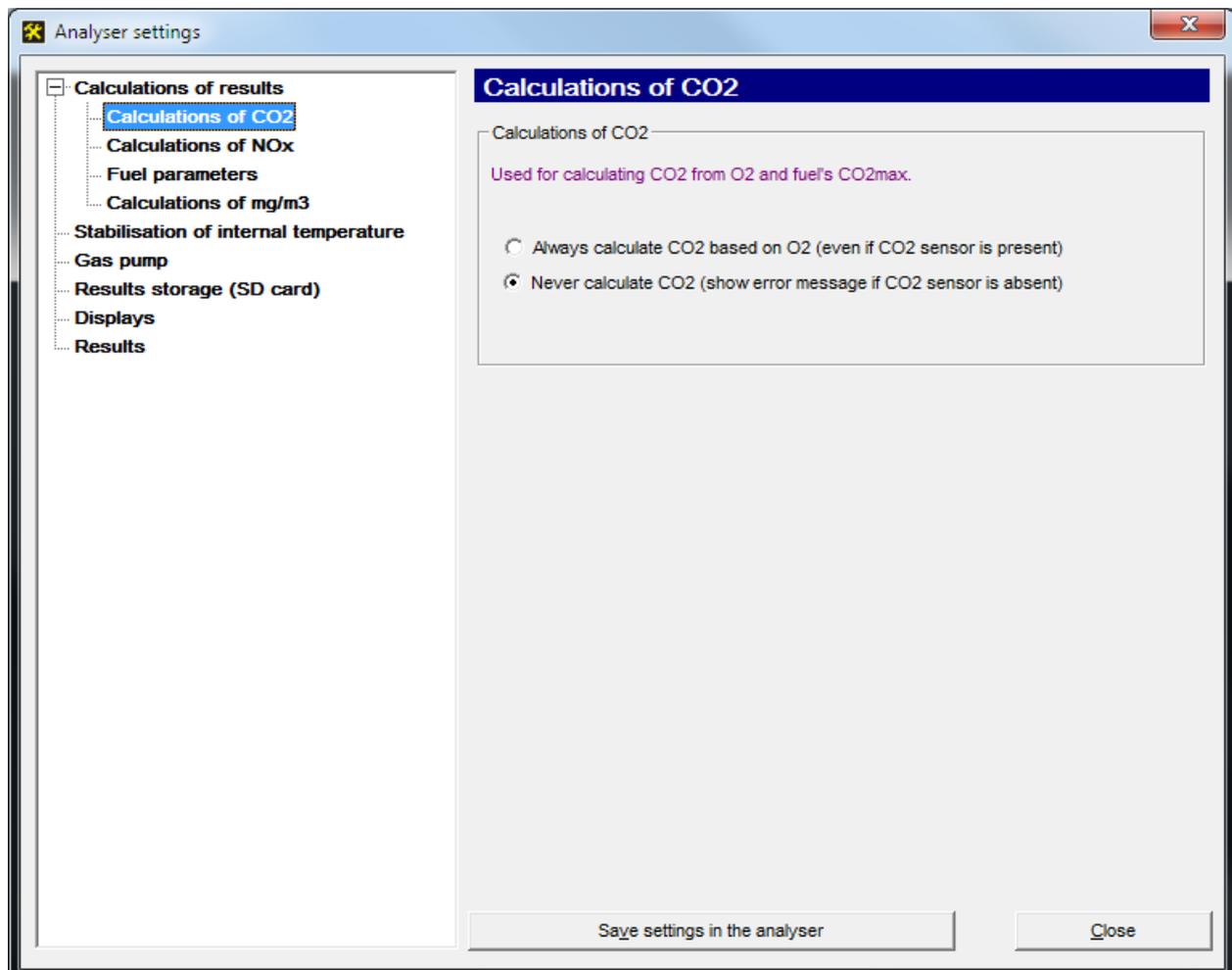
7.3.3. Main settings



This function enables the user to change the settings of the connected monitor. It can be reached via the "Main settings" menu or with the help of the quick access button. It evokes the window shown in the Picture 69. which allows to set the following parameters:

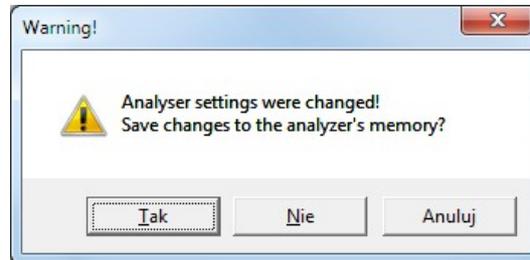
- Calculations of results (CO₂, NO_x, fuel parameters, calculations of $\frac{mg}{m^3}$);
- Stabilisation of internal temperature
- Gas pump
- Results storage (SD card)
- Displays
- Results

Changing any setting (value) in the "Main settings" window is signalled immediately as the option's or the section's name turns red.



Picture 69. The monitor's main settings – Calculations of CO2.

After the necessary changes to the settings are made, confirm them by pressing the "Save settings in the analyser" button. If the user makes an attempt to close the window before the changed settings are sent to the monitor the confirmation note will appear (Picture 70.).



Picture 70. Confirming the changes of the settings.

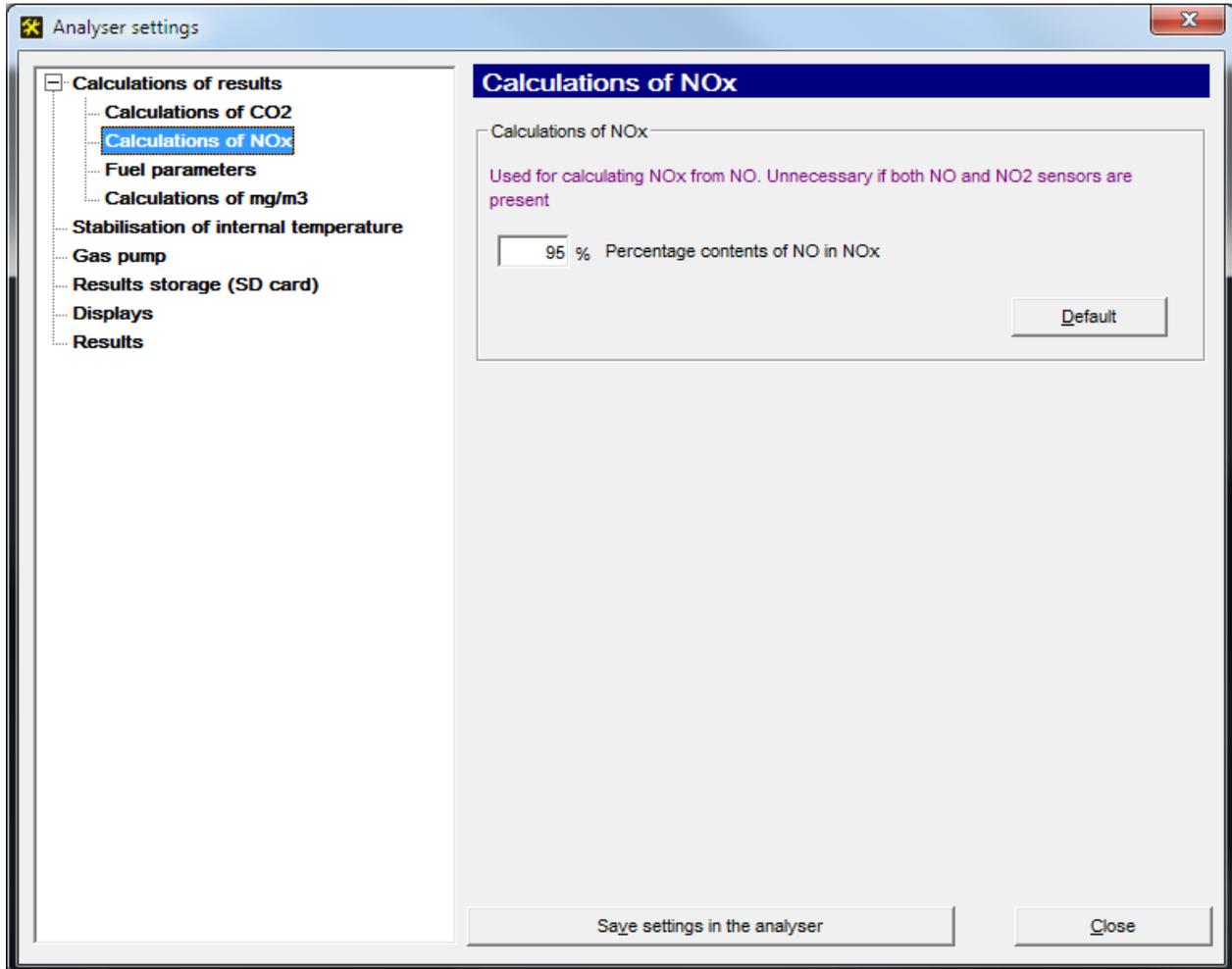
7.3.3.1. Calculations of the results

7.3.3.1.1. Calculations of CO₂

In the "Calculate CO₂" section (Picture 69.) the user can choose from two options which influence the monitor's function unless the CO₂ sensor has been installed. If the first option: "Always calculate CO₂ based on O₂..." is chosen the CO₂ concentration value is calculated by the monitor on the basis of the measured O₂ concentration and the **CO₂max** fuel parameter. If the user chooses the second option: "Never calculate CO₂..." the presented CO₂ concentration value will be the result of the measurement performed by the CO₂ sensor. If the monitor is not equipped with such a sensor and this option is chosen a message about an error will appear on the display (see the brochure "**Calculation of results in the madur gas monitors**" which can be downloaded from the website: www.madur.com).

7.3.3.1.2. Calculations of NO_x

The "NO in NO_x" section enables the user to define the percentage of the nitrogen monoxide (NO) content in the total nitrogen oxides NO_x content of the examined gas. The parameter is used for assessing the nitrogen oxides NO_x concentrations based on the measured NO concentration value (see the brochure "**Calculation of results in the madur gas monitors**" which can be downloaded from the website: www.madur.com).

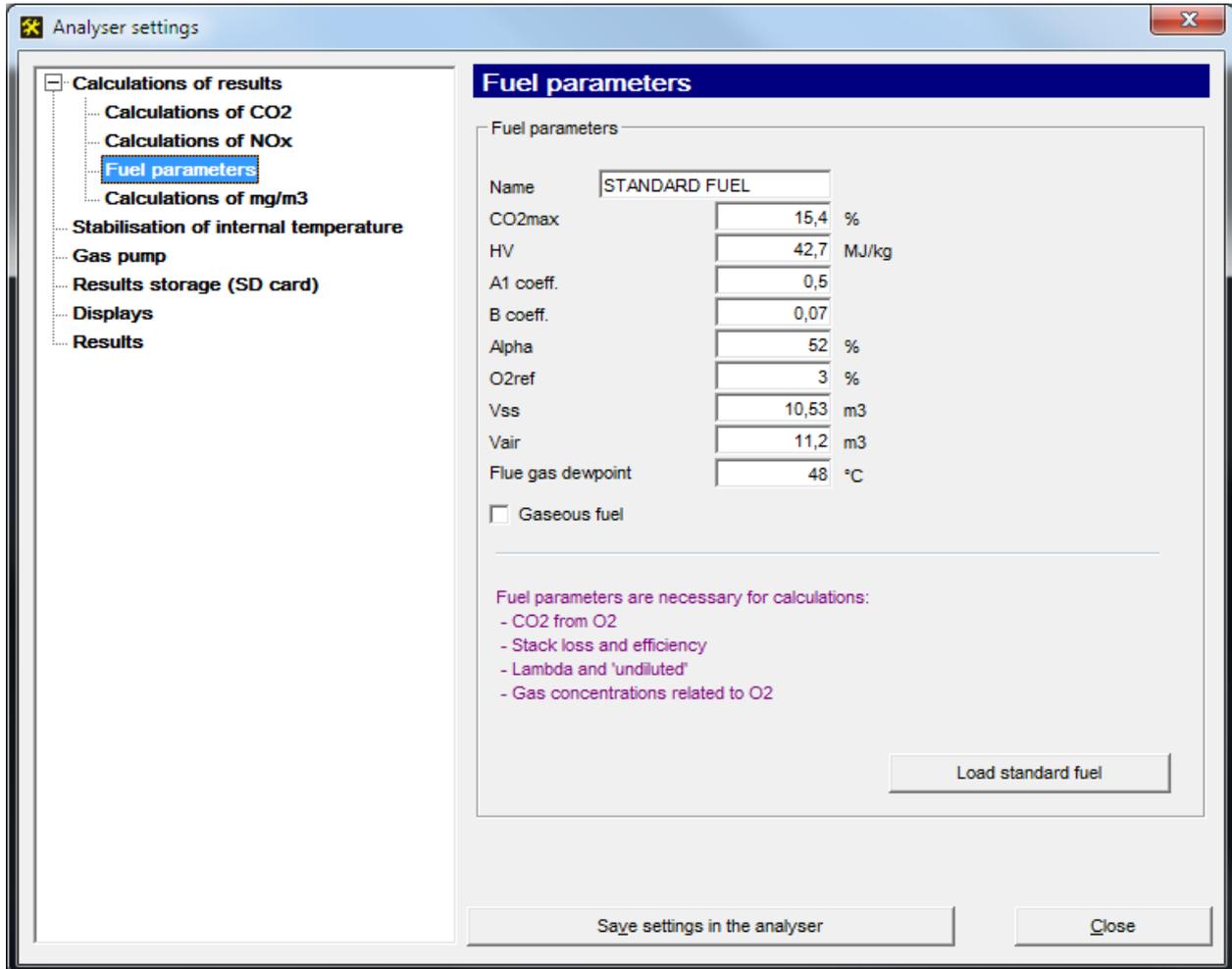


Picture 71. Analyser settings – Calculations of NO_x

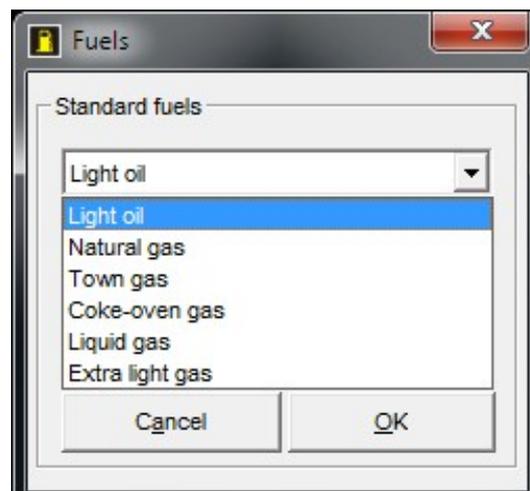
7.3.3.1.3. Fuel parameters

The "*Fuel parameters*" section enables the user to define the parameters of the fuel used for the burning process during which the examined flue gas is emitted. These parameters are necessary for calculating stack loss and boiler efficiency (see the brochure on "**Calculation of results in the madur gas monitors**" which can be downloaded from the *www.madur.com* website). The results of the calculations can be presented on one of the device's displays. The values of the fuel parameters do not influence the gas measurement results. However, they do have an effect on the results calculated by the monitor (such as CO₂ concentration calculated on the basis of the O₂ measurement).

With the help of the "*Standard fuels*" button the user can load the values of the parameters characteristic of the most common fuels. Pressing the button calls the window presented in Picture 73.

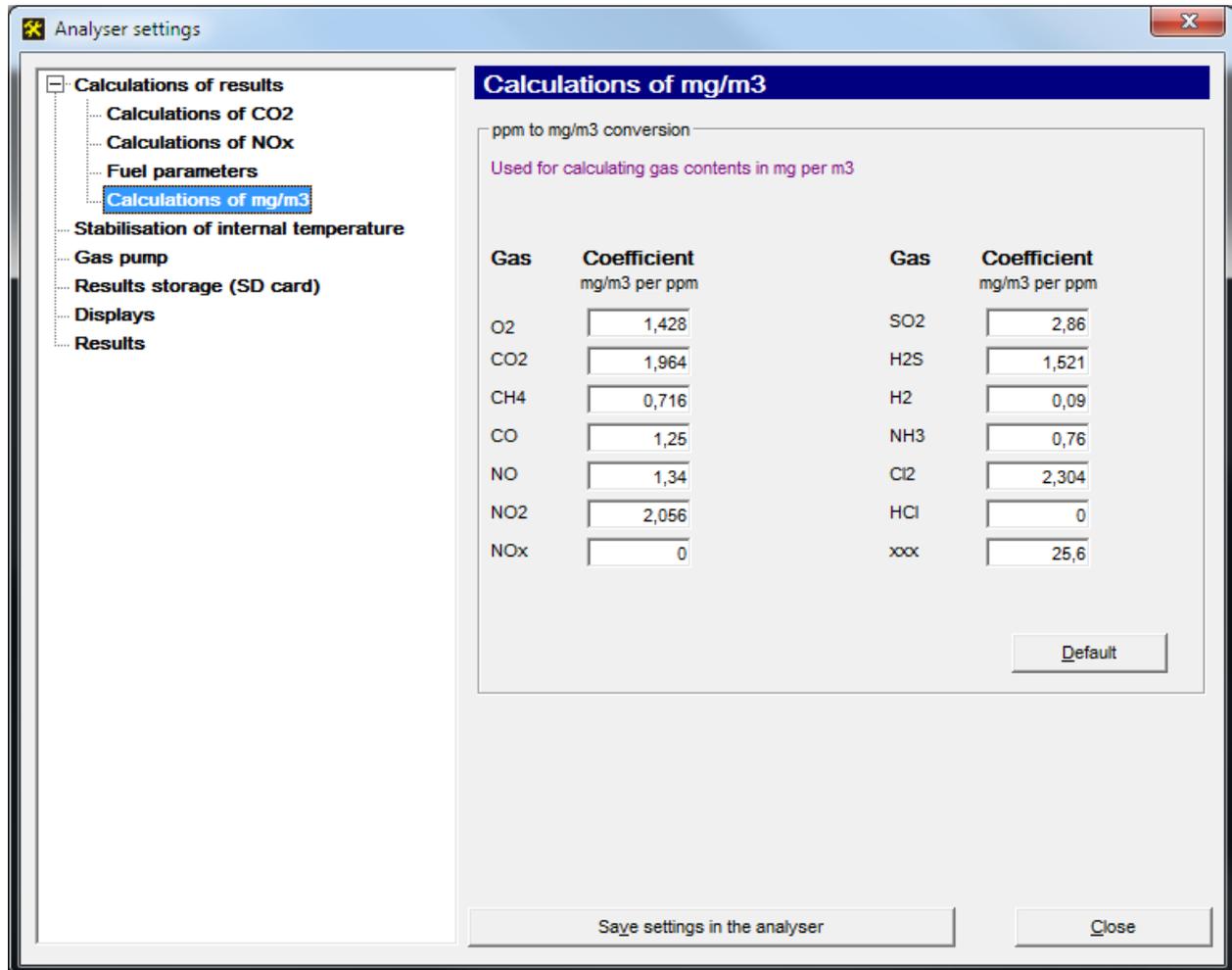


Picture 72. Analyser settings – Fuel parameters



Picture 73. The list of standard fuels defined in the analyser's memory

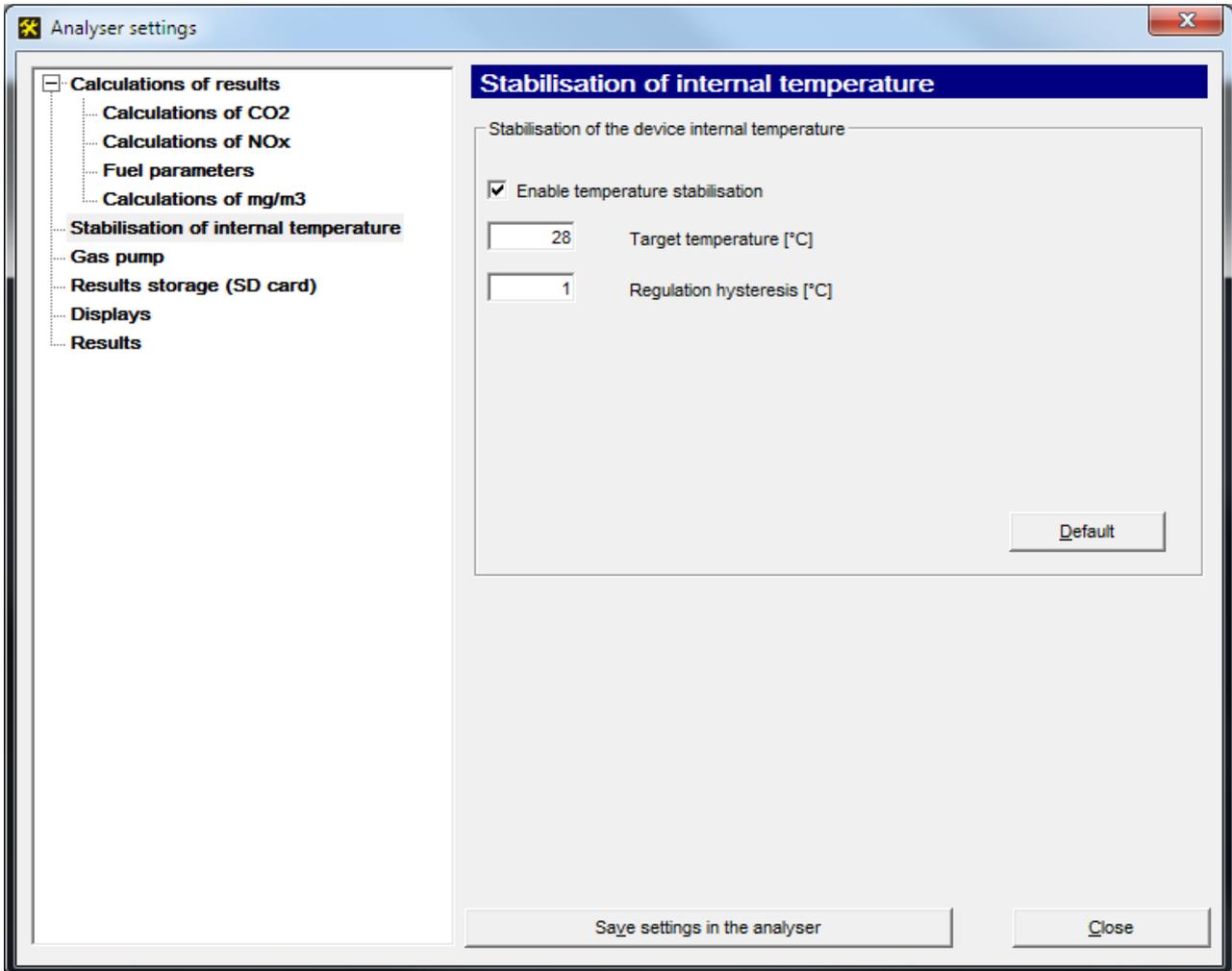
7.3.3.1.4. Calculations of mg/m³



Picture 74. Analyser settings – Calculations of mg/m3

The "*Calculations of mg/m3*" section lists the factors that are used when converting the values given in $[ppm]$ into the values given in $[\frac{mg}{m^3}]$. The factor specifies how many $[\frac{mg}{m^3}]$ are equal to 1 ppm of gas. Pressing the "*Default*" button restores the factory settings which refer to the parameters of gases at standard conditions (a pressure of 1013 hPa and temperature of 0°C).

7.3.3.2. Stabilisation of internal temperature



Picture 75. Analyser settings – Stabilisation of internal temperature

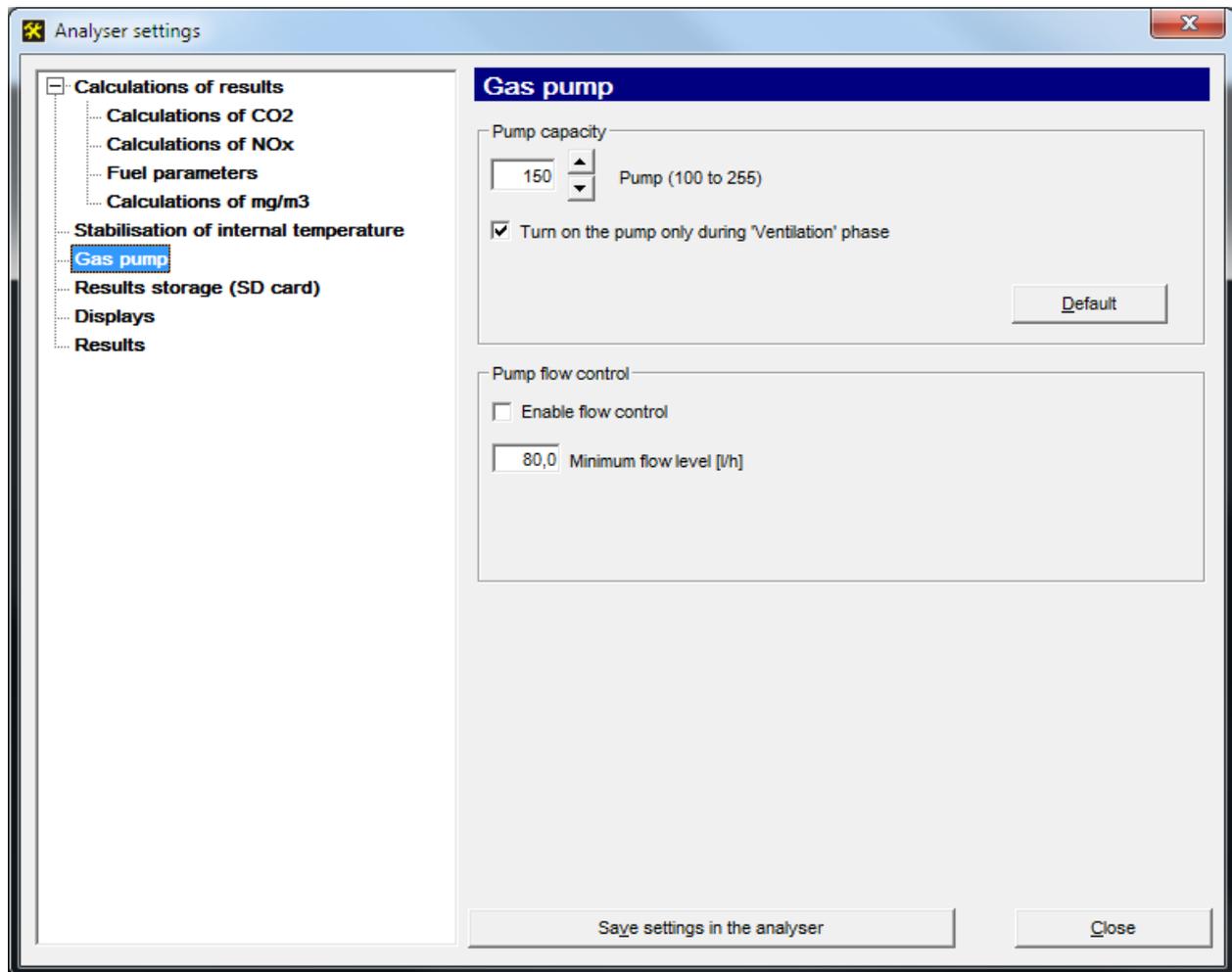
The analyser is capable to stabilise its internal temperature by cooling the temperature down using the fan. This way the electronic components are protected against overheating. In section “*Stabilisation of internal temperature*”, one can set:

- Enable the temperature stabilisation.
- Set the target temperature that the analyser would try to adjust to. The default Target temperature is 28°C
- Set the Regulation hysteresis.

The fan starts when the T_{INT} (temperature inside of the analyser) exceeds the value = Target temperature + Regulation hysteresis.

The fan is stopped when the T_{INT} drops below the Target temperature.

7.3.3.3. Gas pump



Picture 76. Analyser's settings – Gas pump

In the "Pump capacity" section the gas pump *capacity* can be set. The *capacity* can be set from 100 to 255 (100 is the minimum and 255 – the maximum pump speed (efficiency)).

Section "Flow control" is active only when the device is equipped with the differential pressure sensor that allows to control the flow in gas channel. This function allows to control the capacity of dryer's filter and permeability of the hose supplying the gas samples.

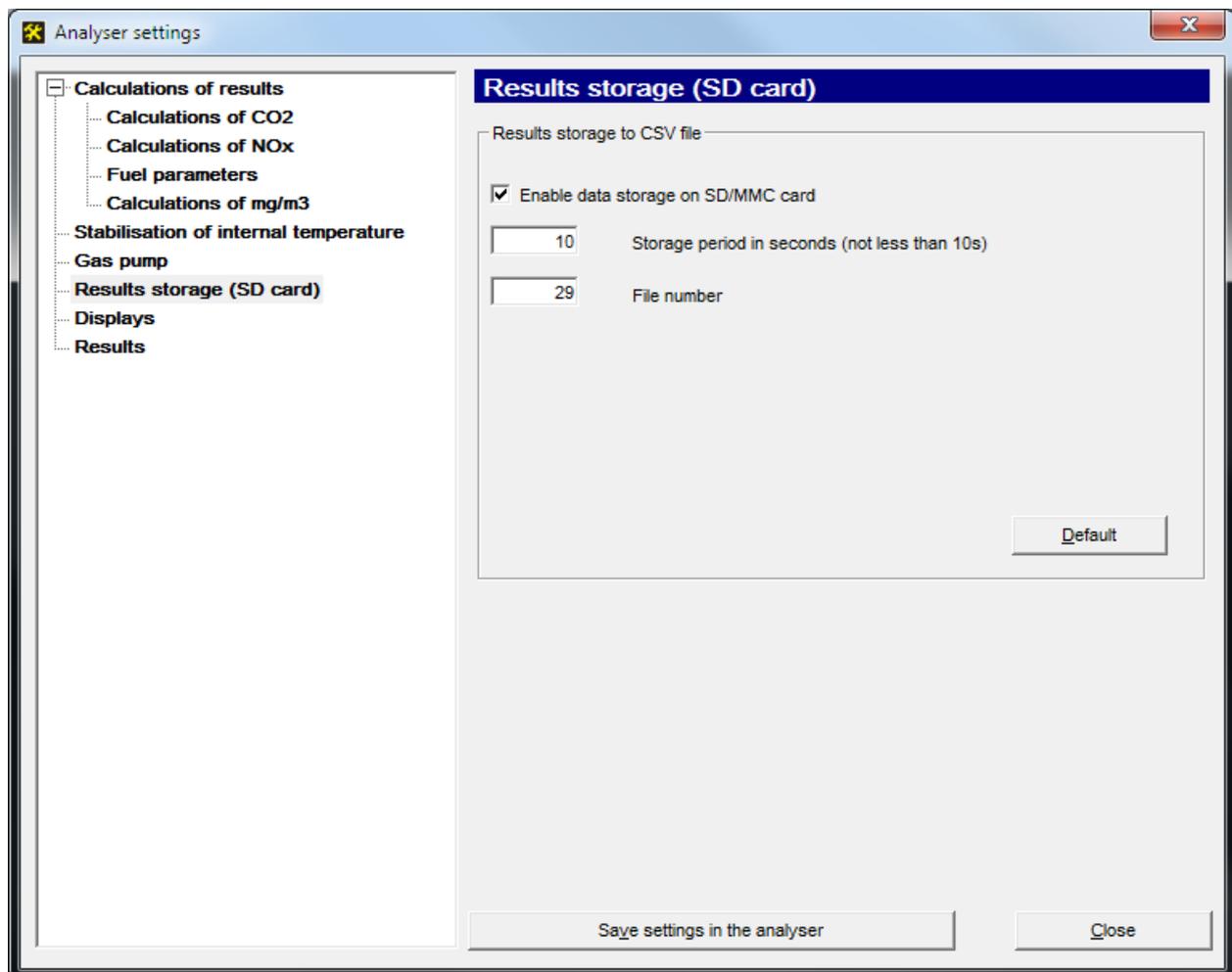
"Enable control" option turns on/off the flow control. In window "Minimum flow level [l/h]" user can enter the minimum flow value below which the analyser will signalise that the flow is to low.

If the flow control is turned on and the analyser is in one of the cycles which requires the use of pump ("VENTILATION", "MEASUREMENTS" or "VENTILATION BEFORE STAND-BY"), and this cycle lasts for more than 30s then the analyser measures the

flow level in the gas channel. If flow drops below the value entered in the “*Minimum flow level [l/h]*” the analyser generates error *E-03*. This error remains until the flow increases over 107% of the minimal flow value. If the “*STAND-BY*” cycle appears during the measurement cycle for at least 30s then the pressure sensor is zeroed at the end of the stand-by cycle.

To show the flow on one of the displays assign the value “*PumpFlow*” to a chosen display (see chapter 7.3.7.). The flow can also be assigned to one of the analogue outputs and one of the relays (see chapters 7.3.9. and 7.3.10.). If the relay is connected to “*PumpFlow*” value and the flow drops below the critical level then the relay opens.

7.3.3.4. Results storage (SD card)



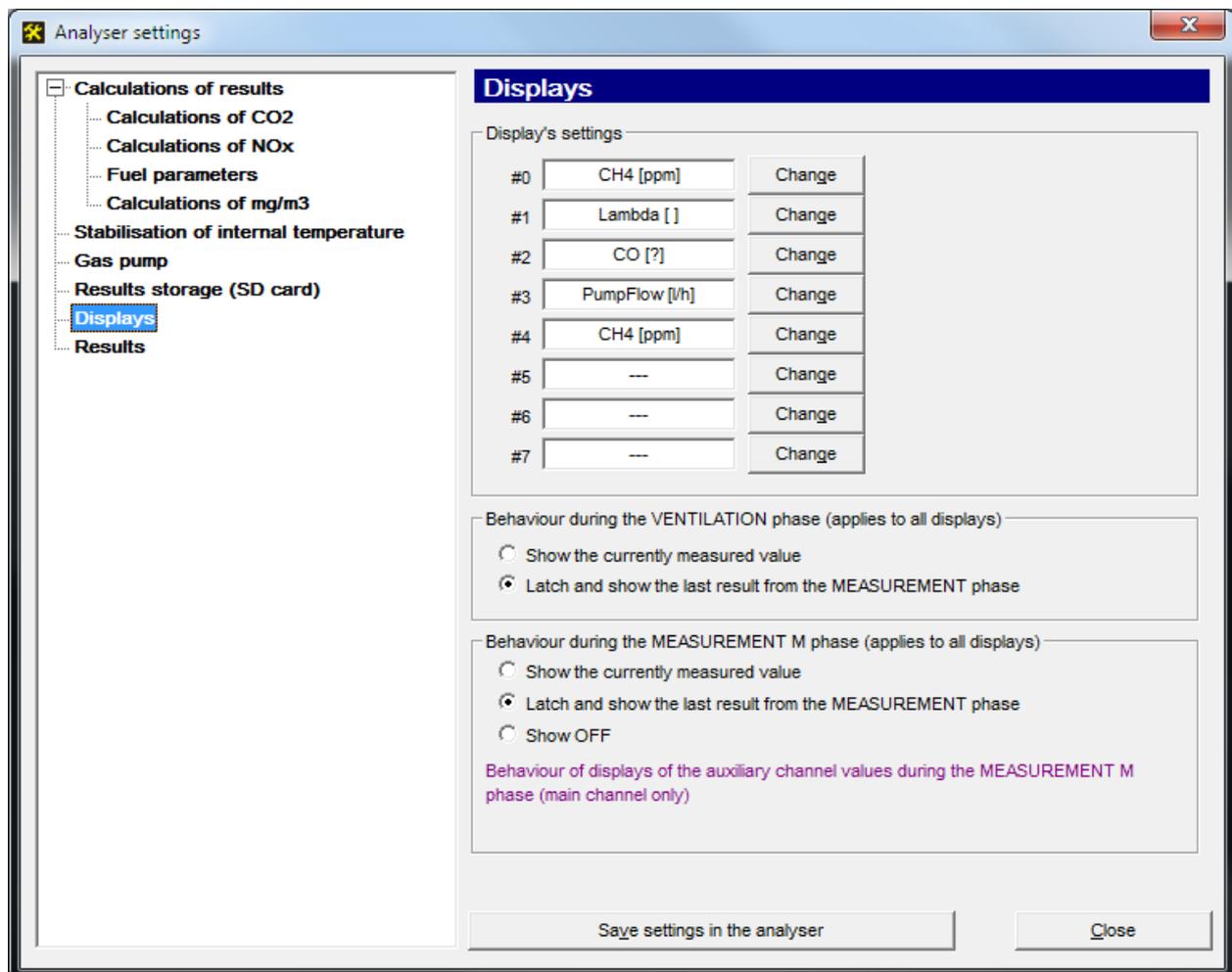
Picture 77. Analyser settings – Results storage (SD card)

This section adjusts the storages of the results to the MMC / SD card. If the control “*Enable data storage on the SD/MMC card*” is on then the recording will start automatically

after inserting the card into slot. The unit will proceed to the **MMC ON** state. After switching the storage off (checkbox not ticked) the unit will proceed to **MMC Off** state.

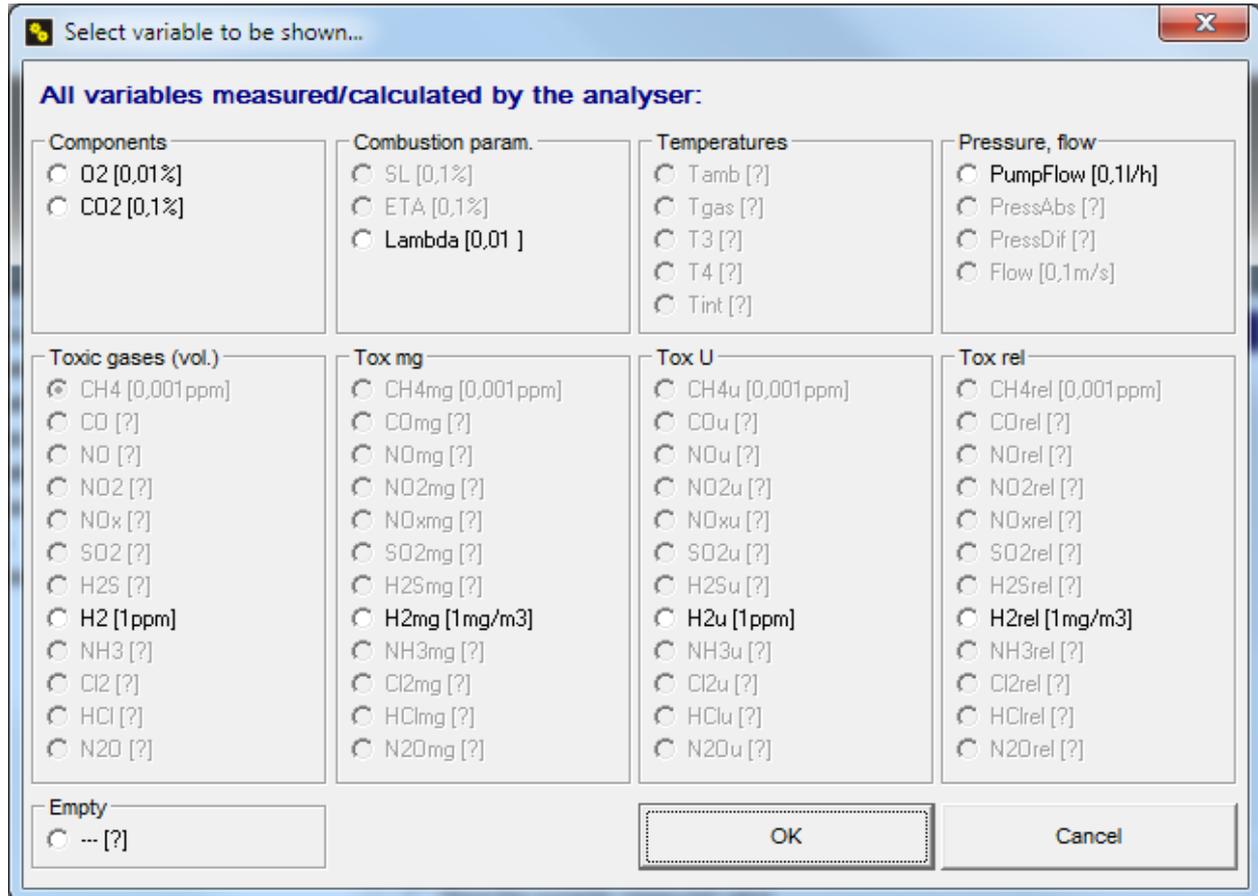
Underneath, the field of the storage interval choice can be found. As each card has a limited storage capacity if there is no need to register the results frequently it is advisable to choose a long storage interval which will lengthen the card life time. Below the list of the storage interval choice a field containing a number (from 0 to 65535 range) can be seen. This will be assigned to the next file used for storage. It can be changed by typing a new number in the box. The confirmation of the changes made can be done with the help of the "Save settings in the analyser" button.

7.3.3.5. Displays



Picture 78. Analyser settings – Displays

In this section user can assign any measured / calculated value to a display. Press *Change* button right next to a specific display number. It will open a screen presented below.



Picture 79. Measurement blocks – a list of all variables measured and calculated by the analyser

Variables to be selected to be shown are divided into blocks:

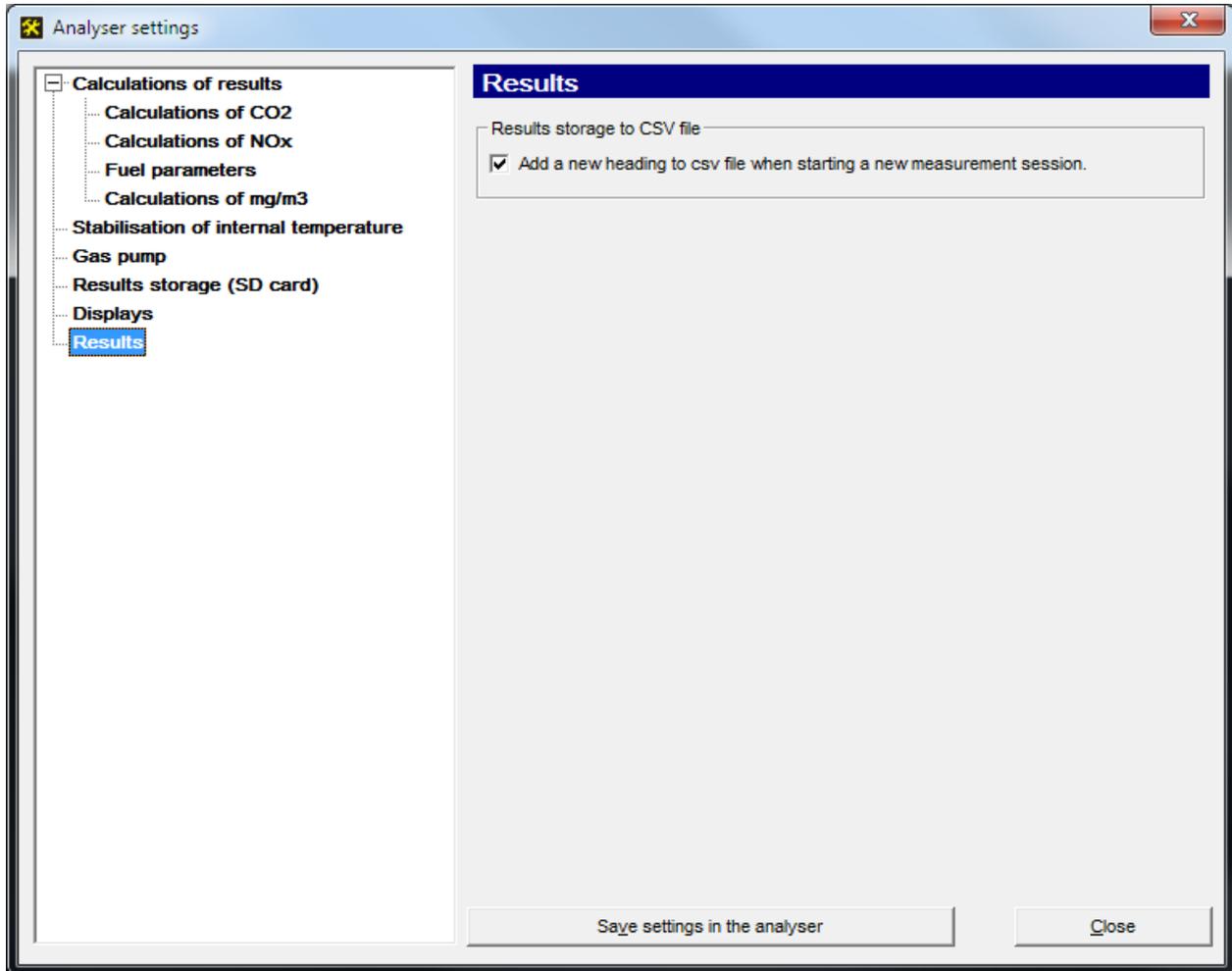
- Components – gases that are present in ambient air
- Combustion parameters – calculated by the analyser
- Temperatures
- Pressure, flow
- Toxic gases – gases that are present in the fumes
- Tox mg
- Tox U
- Tox rel
- Empty – if there is a need to deactivate a display.

The following frame in the Displays section: “*Behaviour during the VENTILATION phase (applies to all displays)*” allows to choose what will the displays show during the ventilation: currently measured value or the last measured value from the measurement phase.

Option “*Behaviour during the MEASUREMENT M phase (applies to all displays)*” determines what will show the displays that are assigned to sensors installed in the addi-

tional gas channel during the measurements only in the main channel (when the additional channel is ventilated).

7.3.3.6. Results



Picture 80. Analyser settings – Results

This option allows to enable / disable adding a new heading to the results stored into CSV file when a new measurement session is started – see Picture 81.

7.3.4. Results



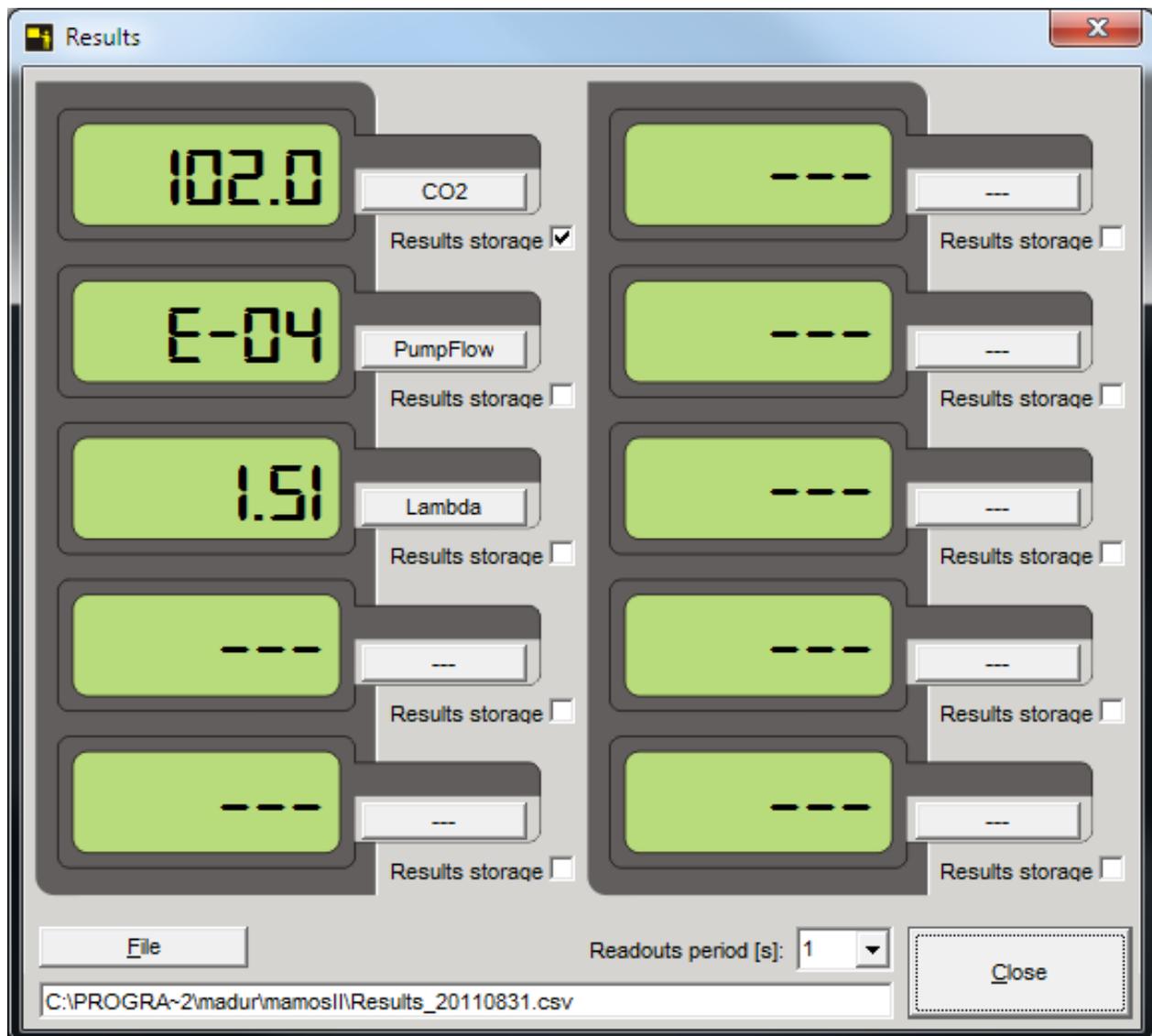
This window enables the user to see the current measurement results on ten "virtual" displays (Picture 81.). This function can be reached with the help of the quick-access button and via the menu bar → "Results".

Each of the measured values can be assigned to any of ten displays with the help of the drop-down lists placed next to the displays. What is more a "Results storage" check-

box can be found next to each of the displays. If the option is checked the results presented on the "virtual" displays will be continually saved in a file. If any of the "Results storage" checkboxes is checked a list enabling the user to define the recording interval will appear at the bottom of the screen. Below, the "File" button can be found. After the button has been pressed the name and the folder of the file where the results are saved can be changed. The files with the results are by default stored in the program's main directory and their names are by default formed by the following pattern: **result_yyyy-mm-dd.csv** (for example result_2007-05-01.csv).

When more than one "Results storage" checkboxes are selected, the results of those variables are stored into one csv file.

Storages to csv file is performed only when the Results screen remains opened. As soon as this window is closed, the results storage is interrupted.

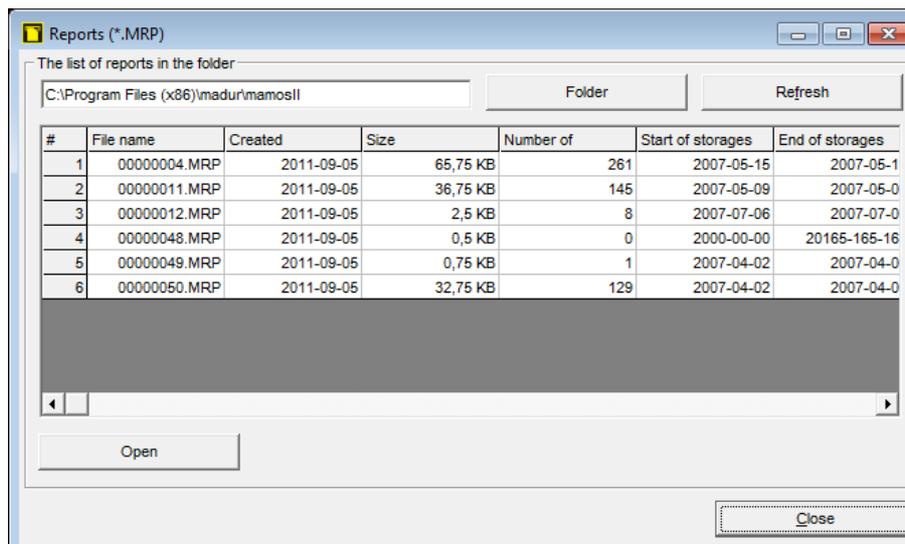


Picture 81. Results screen.

7.3.5. Memory card

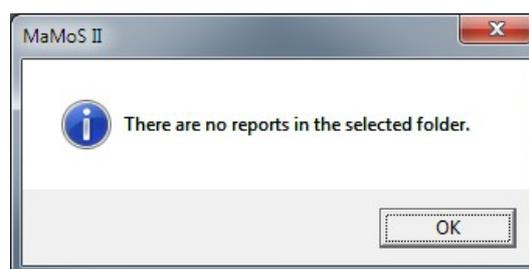


The "Memory card" option enables the user to read the measurement results stored on the MMC/SD card. It is also possible to access this option from the *Main bar* → *Memory card* → *Report preview*. To be able to view the reports stored on the card it is necessary either to insert the card in to the PC card reader or to copy the reports to the hard drive. To select the folder where the reports are, press *Folder* button.



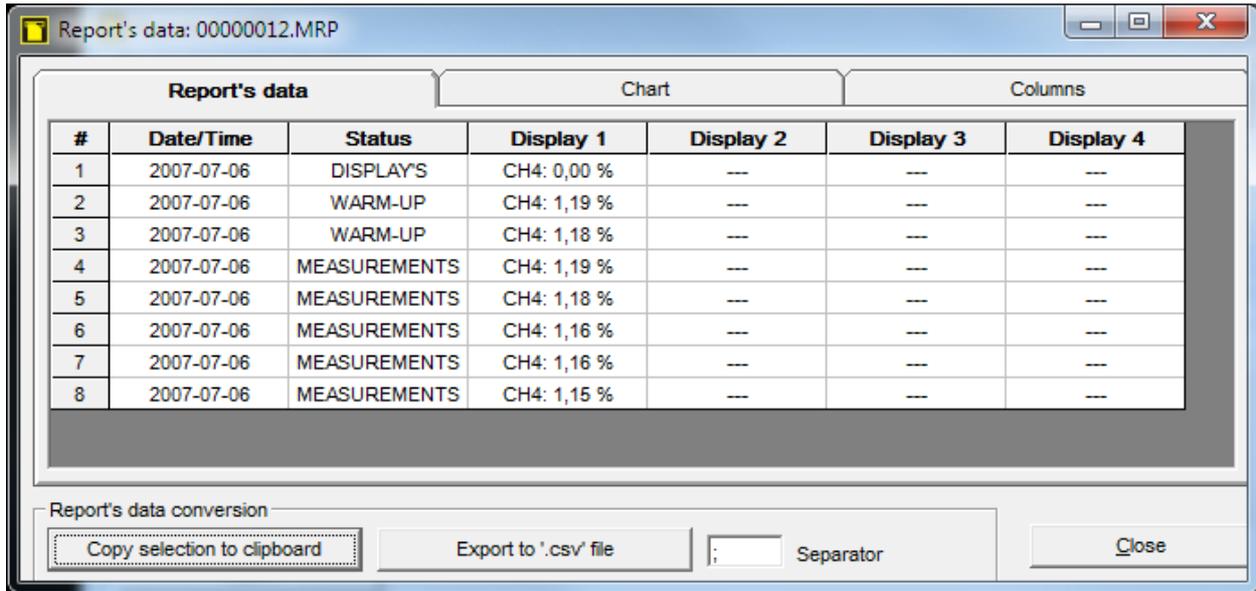
Picture 82. The selection of the report to preview.

If the selected folder does not contains any reports a following information is displayed (Picture 83.).



Picture 83. Information that the selected folder does not contains report files.

If the chosen folder contains report files, they will be presented as a list. To select a report to view, double click it or select it and then press the *Open* button. Report will open in a new window – as presented in Picture 84.



Picture 84. Report's data

Report's data window consists of three tabs.

7.3.5.1. Report's data

The first tab (presented in Picture 84.) contains a table with results from Displays 1÷8, analyser's inputs and outputs. Each result is presented in a separate column:

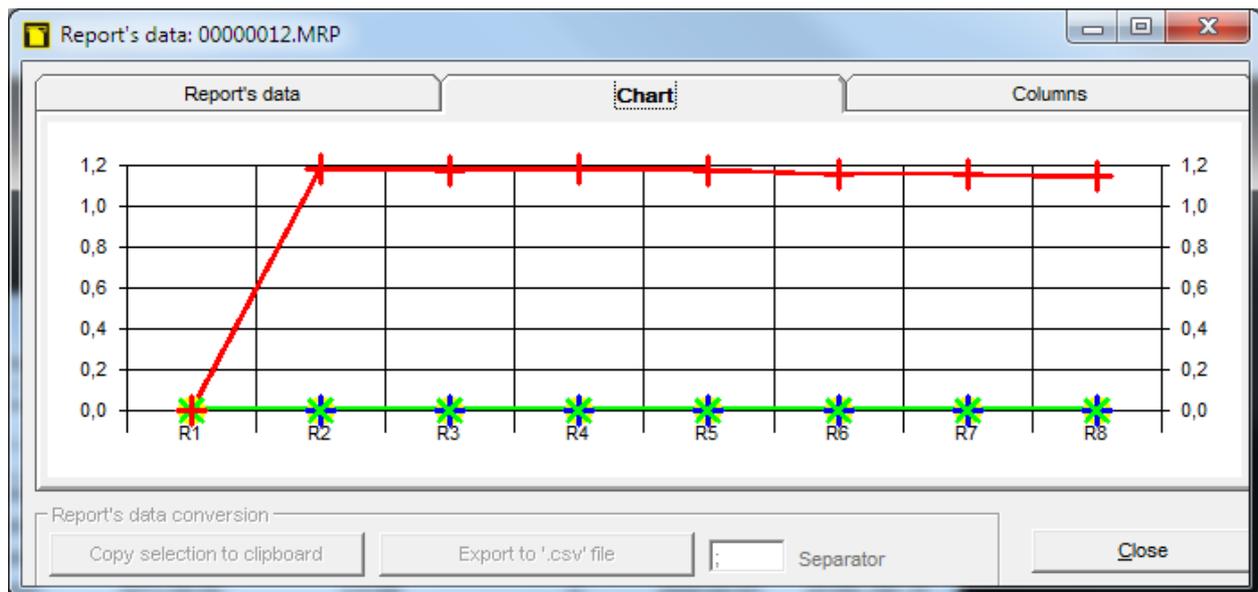
- Column **Date/Time** shows the date and time of storage for each record.
- Column **Status** shows the stage of the unit cycle which took place during storage .
- Columns **Display 1÷8** contain the results from monitor displays. Information about which variable was presented on the display and what was its value is shown (e.g.: O2: 20.95%).
- Columns **AnaOut U1÷U4** and **AnaOut I1÷I4** contain data from each analogue output. Information about which variable was presented on the output, what was its value and what was the electrical signal on the output is shown (e.g. O2: 20.95 %; 12760 uA)
- Columns **Relay #1** i **Relay #2** contain the data concerning the relay outputs. Information about which analogue output was the control signal for the relay and the relay status is shown (1 stands for energized relay, 0 for non-energized) e.g.: AnaOut U3; 1.
- Column **PWM3** contains data on the PV3 output status. The information is displayed in the same way as for **Relay #1** and **Relay #2**.

- Columns **InOuts1** and **InOuts2** present status of all the digital inputs and outputs of the monitor.

Below the table the additional functions can be found. With the help of the "*Copy selection to clipboard*" button the selected table's cells can be copied to the clipboard and then pasted in any document as a text. In particular the selection can be pasted into a *MS Excel* worksheet. The way data will be placed into *MS Excel* worksheet depends on *MS Excel* settings. If tabulator is selected as a delimiter data will have the same format as in *mamosll.exe* program. Using space character and/or semicolon and/or colon as a delimiter will enable data to be split into additional columns.

The user may use the "*Export to '.csv' file*" button to save the whole table in *CSV* format and open it via the *MS Office Excel* program. The sign separating the data in the *CSV* format can be set in the *Separator* field (default separator is semicolon).

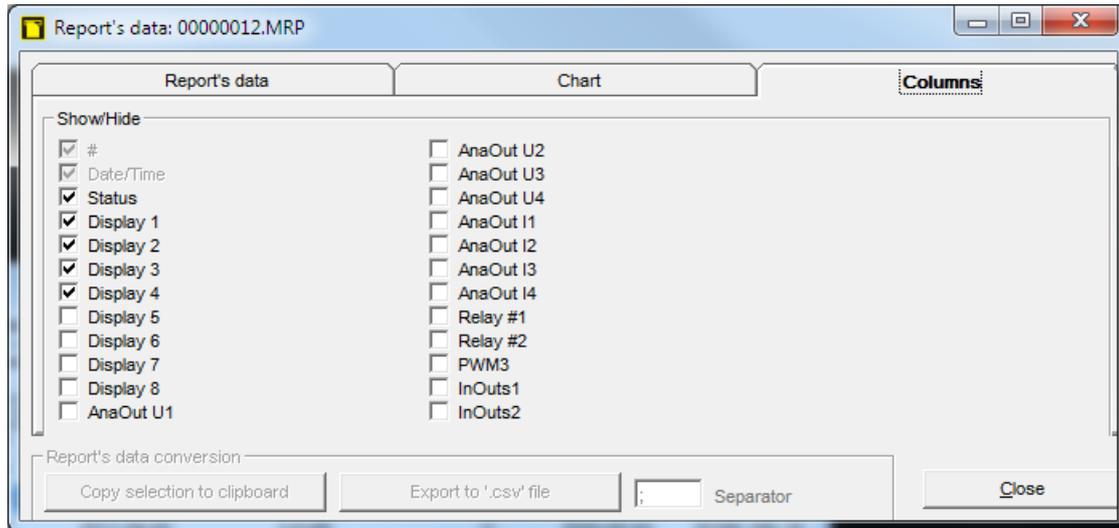
7.3.5.2. Chart



Picture 85. Chart's tab in the Report's data window

Chart allows to view the results in a graphical form.

7.3.5.3. Columns

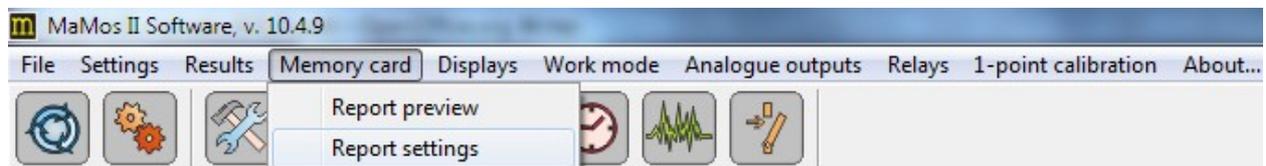


Picture 86. Columns' tab in the Report's data window

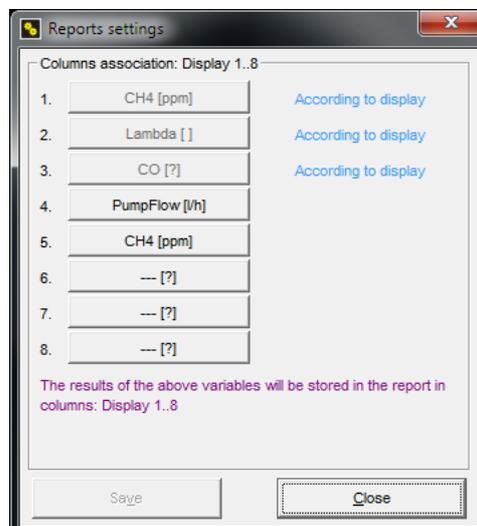
Allows to show / hide columns in the Report's data and Chart's tabs.

7.3.6. Memory card → Report settings

Additional settings to the reports are available from the Main menu → Memory card → Report settings.



Picture 87. Main menu → Memory card → Report settings.



Picture 88. Reports settings

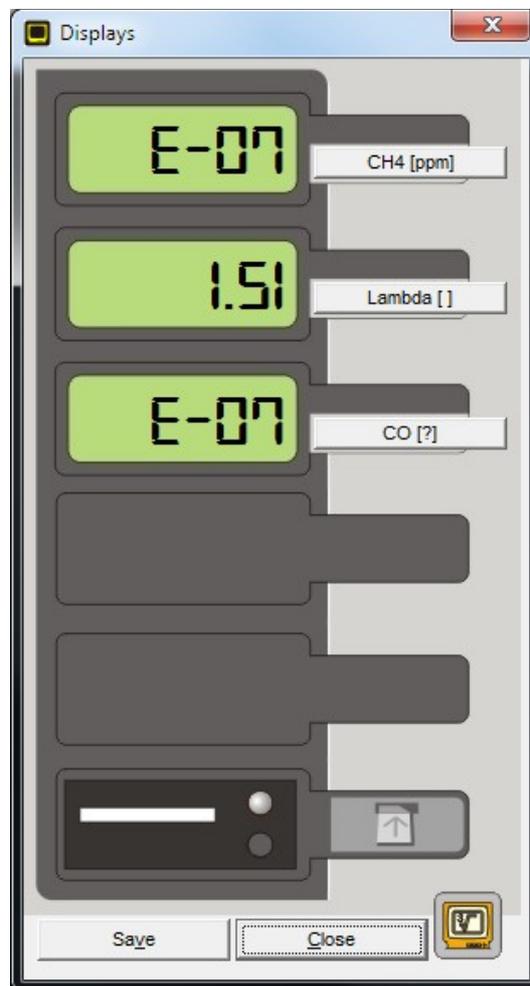
Reports settings window allows to change the values assigned to the columns Display 1 ÷ Display 8. Any change to the settings are indicated in red, and activates the Save button.

7.3.7. Displays



This function can be called using the quick access icon and via the menu bar by pressing the "Displays" button. After the function has been called the window presenting the monitor's displays (Picture 89.) appears.

The user is able to assign any of the measured values to each of the displays. The user should confirm the changes made to the settings using the "Save" button.

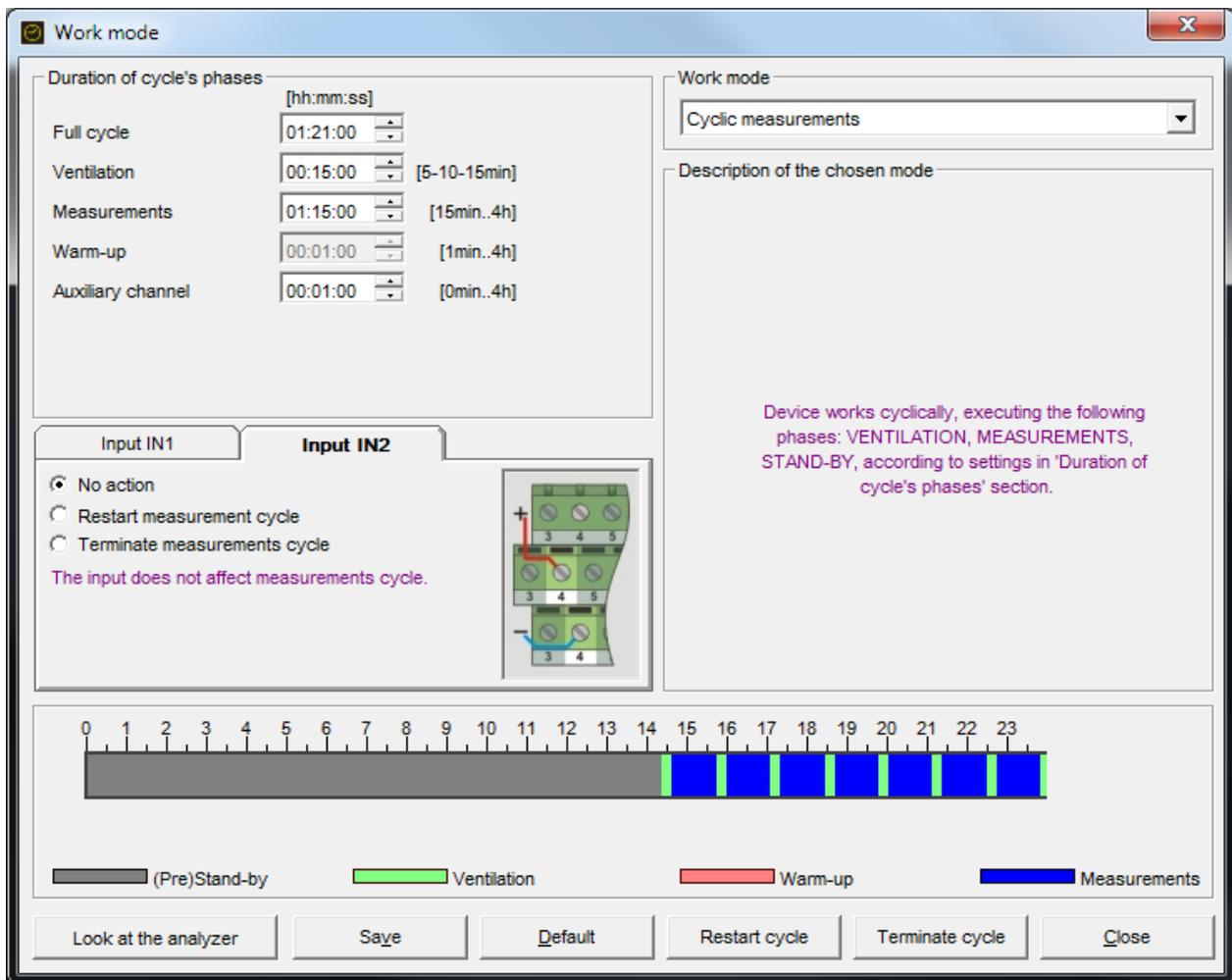


Picture 89. Display window.

7.3.8. Work cycles



The function is available using the quick access button or via the menu bar by pressing the "Work mode" button. If the function is called, the window shown in Picture 90. appears. The window enables the user to check the monitor's work stage, set the new work cycle, prepare the work schedule or set the restarting of the cycle with the help of the digital inputs. The "Work mode" window is divided into five sections (frames) – each referring to particular working settings. To view the current mode or to swith into settings adjustment use the button "Look at the analyser" / "Abandon preview".



Picture 90. The "Work mode" window – setting for the Cyclic measurements.

7.3.8.1. Work mode

This section allows to select the work mode the analyser is using. Depending on the chosen work mode, the contents of the work mode window changes and shows appropriate information. Work modes available to choose from:

- Cyclic measurements - Picture 90.
- Measurements according scheduler - Picture 93.
- Measurements triggered by IN1 and/or IN2 input

7.3.8.2. *Duration of cycle's phases*

The "*Duration of cycle's phases*" section enables the user to check and change the current length of the two first stages of the monitor's work cycle.

The length of the *Full cycle* can be chosen from the range of 24 hours with a resolution of 1 second.

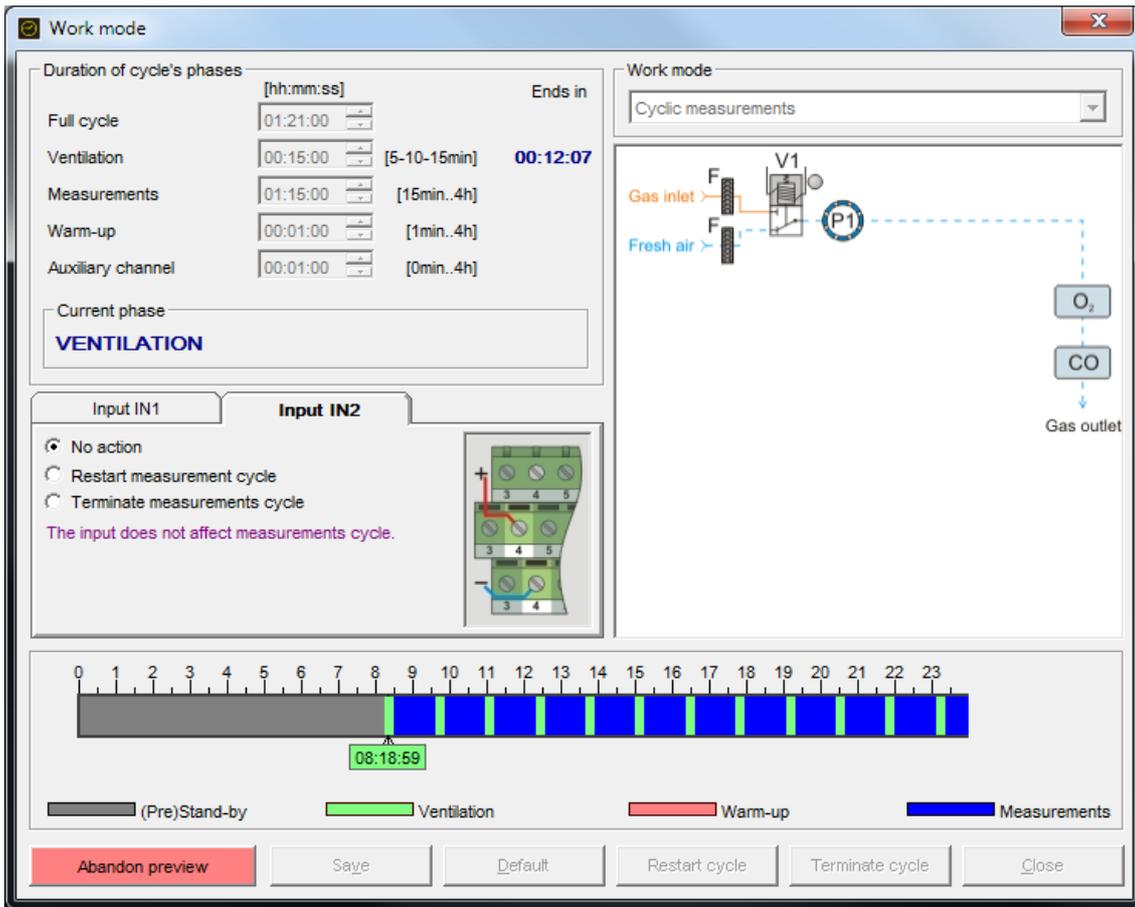
The ventilation time can be set to 5, 10 or 15 minutes. It is advisable to set the ventilation length to 15 minutes. Too short ventilation stage may cause inaccurate zeroing of the sensors resulting in incorrect measurement results.

The measurement duration can be set from 15 minutes to 4 hours with a resolution of 1 minute.

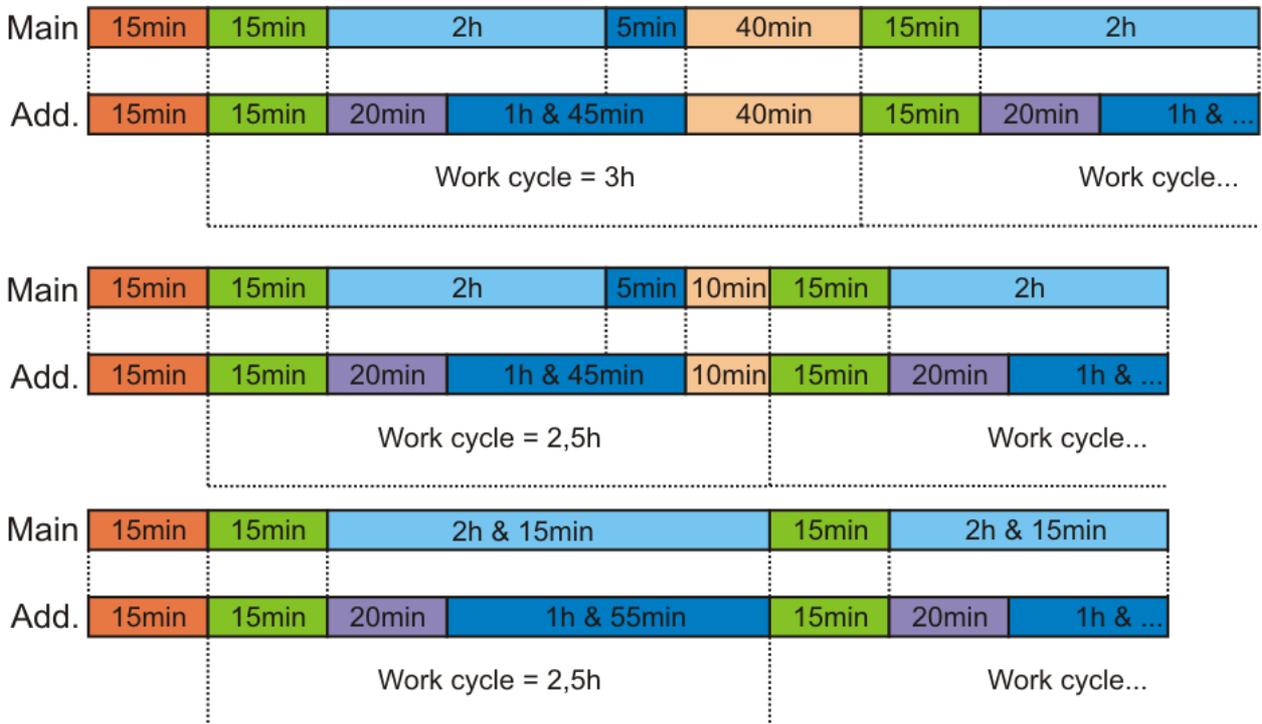
The „*Additional channel [hh:mm]*” option enables the user to set the length of the measurements performed in the additional gas channel from 0min. to 4h.

The user can check the current cycle stage with the help of the "*Look at the analyser*" button. After the button has been pressed the information on the current cycle's name appears on the left side of the section, the time remaining until the end of the current stage is presented on the right side under the "*Ends in*" message (Picture 91.). The possibility of changing the cycle length will be blocked. The "*Look at the analyser*" button label will be replaced with the "*Abandon preview*" label. If the "*Abandon preview*" button is pressed the information on the monitor's work stage is no longer displayed (which has no influence on the device's function).

There is one more parameter which can be set via this section: the "*Warm-up time*". The duration of the WARM-UP stage (the stage following switching the monitor on) can be defined with the help of this option. However, the option is inactive in the regular working mode. The length of this process can be set from 1 minute up to 4 hours but can be performed only if the **MaMoSII.exe** program is working in service mode (see chapter 7.3.12.).



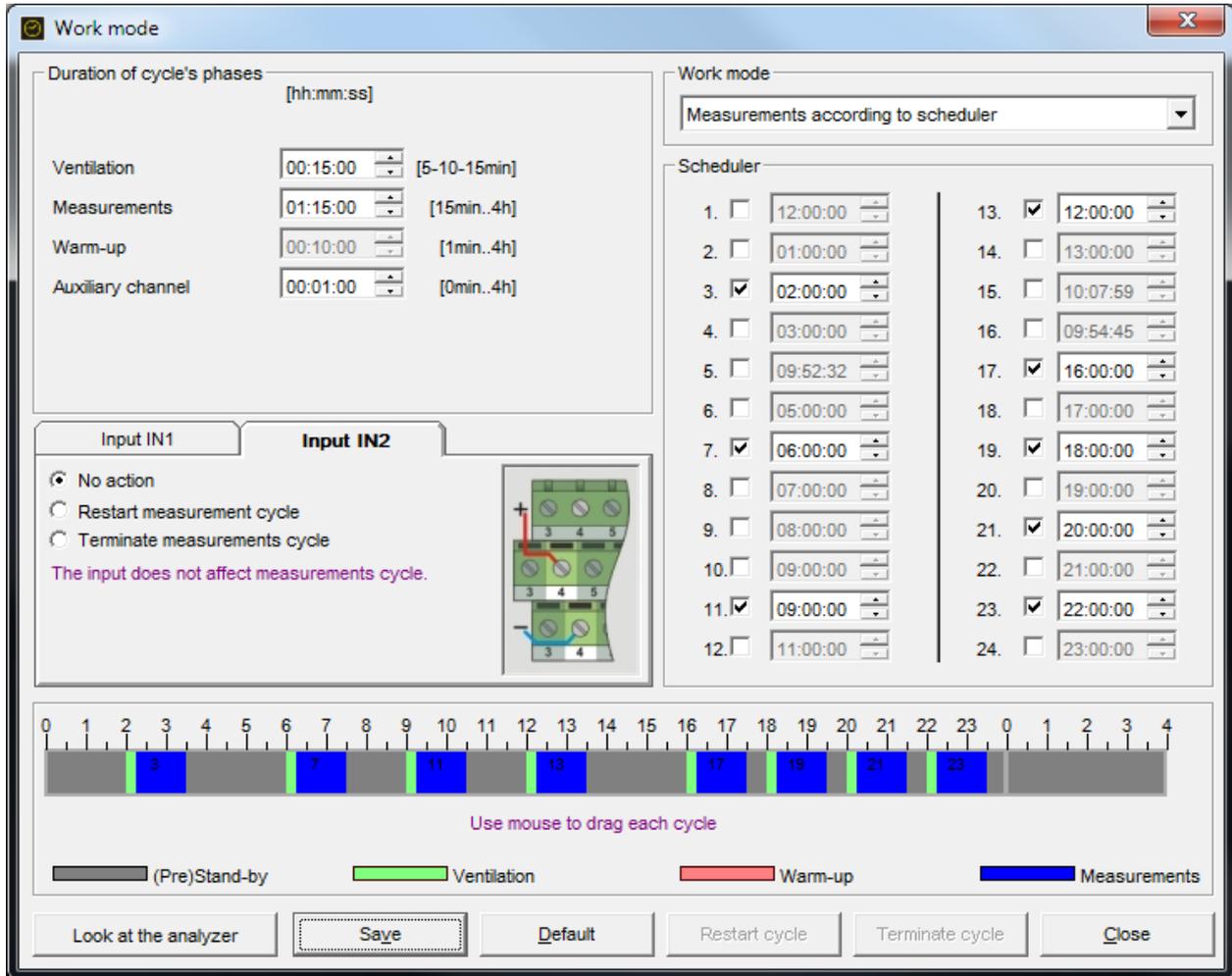
Picture 91. Information on the current working stage of the monitor.



Picture 92. Exemplary lengths of the measurement cycle stages. The „VENTILATION BEFORE STAND-BY” and the „STAND-BY” durations are set automatically and they may not occur (the bottom chart)

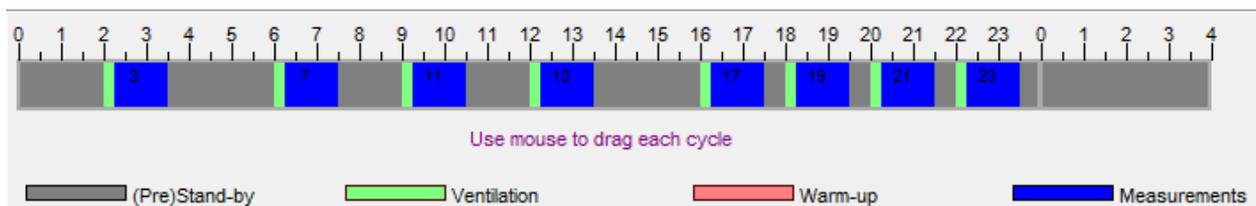
7.3.8.3. Scheduler

When the work mode: "Measurements according to scheduler" is selected, the "Scheduler" section appears (as shown in Picture 93.). Scheduler allows to set the start times for 24 cycles. The duration of VENTILATION, MEASUREMENT are set the same way they are set in case of *Cyclic work mode*.



Picture 93. Measurements according to scheduler.

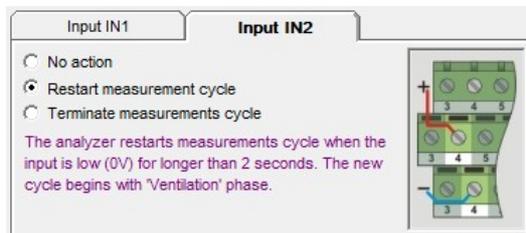
7.3.8.4. Graphic section



Picture 94. Graphic section of the Work mode window

At the bottom of the "Work mode" window the graphic section can be found. The separate cycle stages of the monitor are presented as coloured rectangles on the time axis (Picture 94.). The location/size of each of the rectangles refers to the beginning/duration of each of the stages. When changes are made to the stages' duration in the "Duration of cycle's phases" section the graph enables the user to see how the measurements will be performed during a 24-hour period. If working in the *scheduler* mode each of the cycles has its own number which is also given on the graph.

7.3.8.5. Input IN1 / IN2



Picture 95. Setting of the action triggered by the digital input

The "Input IN1 / IN2" section enables the user to restart the monitor's work cycle with the help of the *IN1* or *IN2* digital input.

If the user activates the "Restart measurement cycle" option the monitor breaks the measurement cycle and begins a new one with the ventilation stage. The active state must be present on the *IN1 / IN2* input for more than 2 seconds for this to happen.

If the user activates the "Terminate measurement cycle" option the monitor breaks the measurement cycle and goes into STAND-BY mode. The active state must be present on the *IN1 / IN2* input for more than 2 seconds for this to happen.

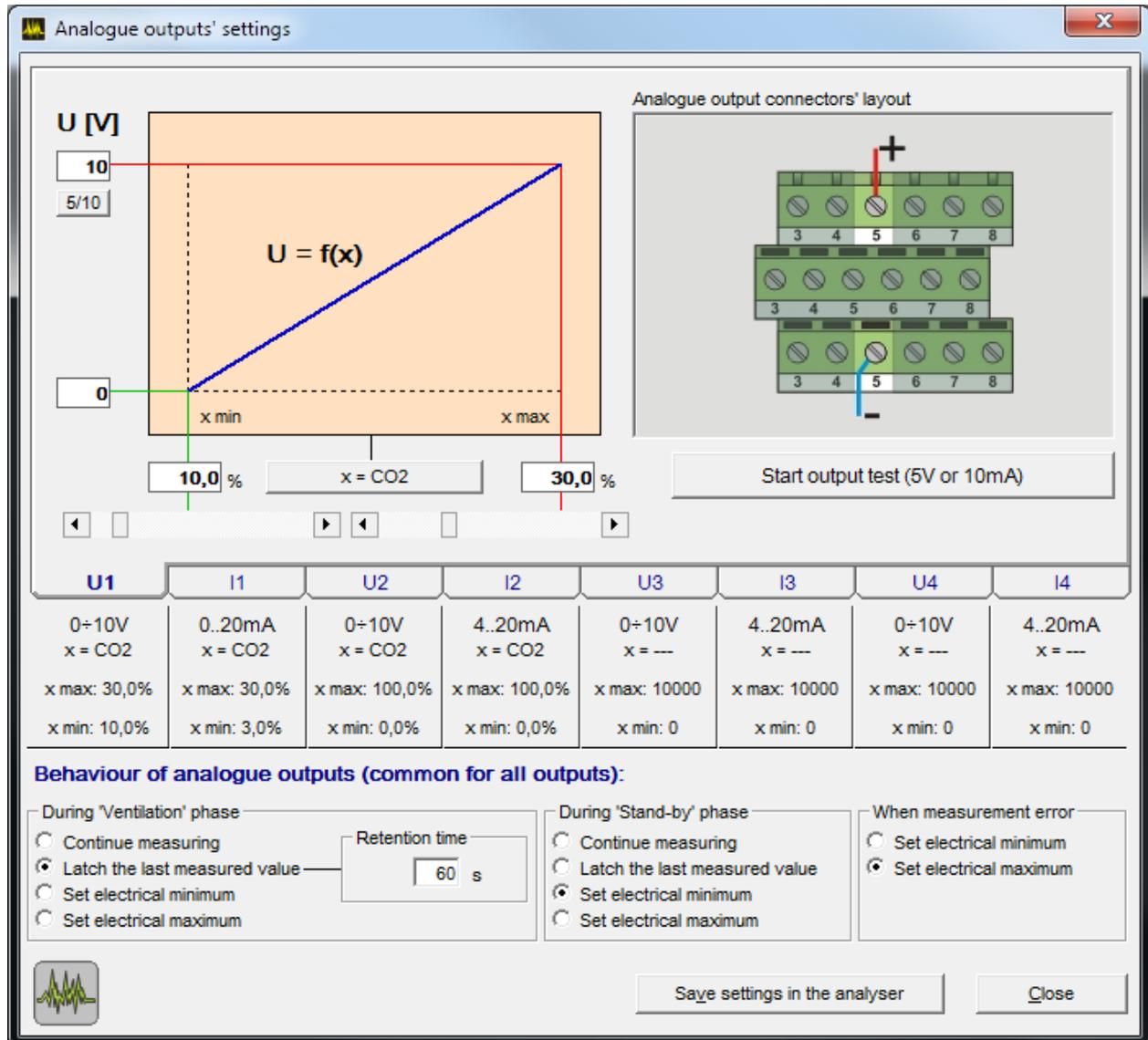
7.3.9. Analogue outputs



This function enables the user to configure the analogue outputs and to define their action during each of the cycle stages. The function is available after pressing the quick access button or via the menu bar after pressing the "Analogue outputs" button.

When the function has been opened the "Analogue outputs settings" window appears on the screen (Picture 96.). The window consists of eight tabs – each referring to a separate output. Changes to the settings are signalled in red. The present settings of all the outputs can be seen below the tabs no matter which tab is the currently chosen. The

changes made in the window will not effect the monitor's settings unless the "Save settings in the analyser" button has been pressed.



Picture 96. The "Analogue output settings" window (the tab of the voltage output U1 can be seen).

7.3.9.1. Setting the voltage outputs

To make changes to the settings of a particular voltage output the appropriate tab should be chosen (U1 ÷ U4). The drawing presenting the location of the chosen output on the connectors of the monitor's main board and the way of connecting the wires will be presented on the right side of the tab whilst the voltage characteristic of the output will be shown on the left-hand side (Picture 96.). With the help of the button the chosen output can be assigned to any value measured by the monitor (Picture 79.).

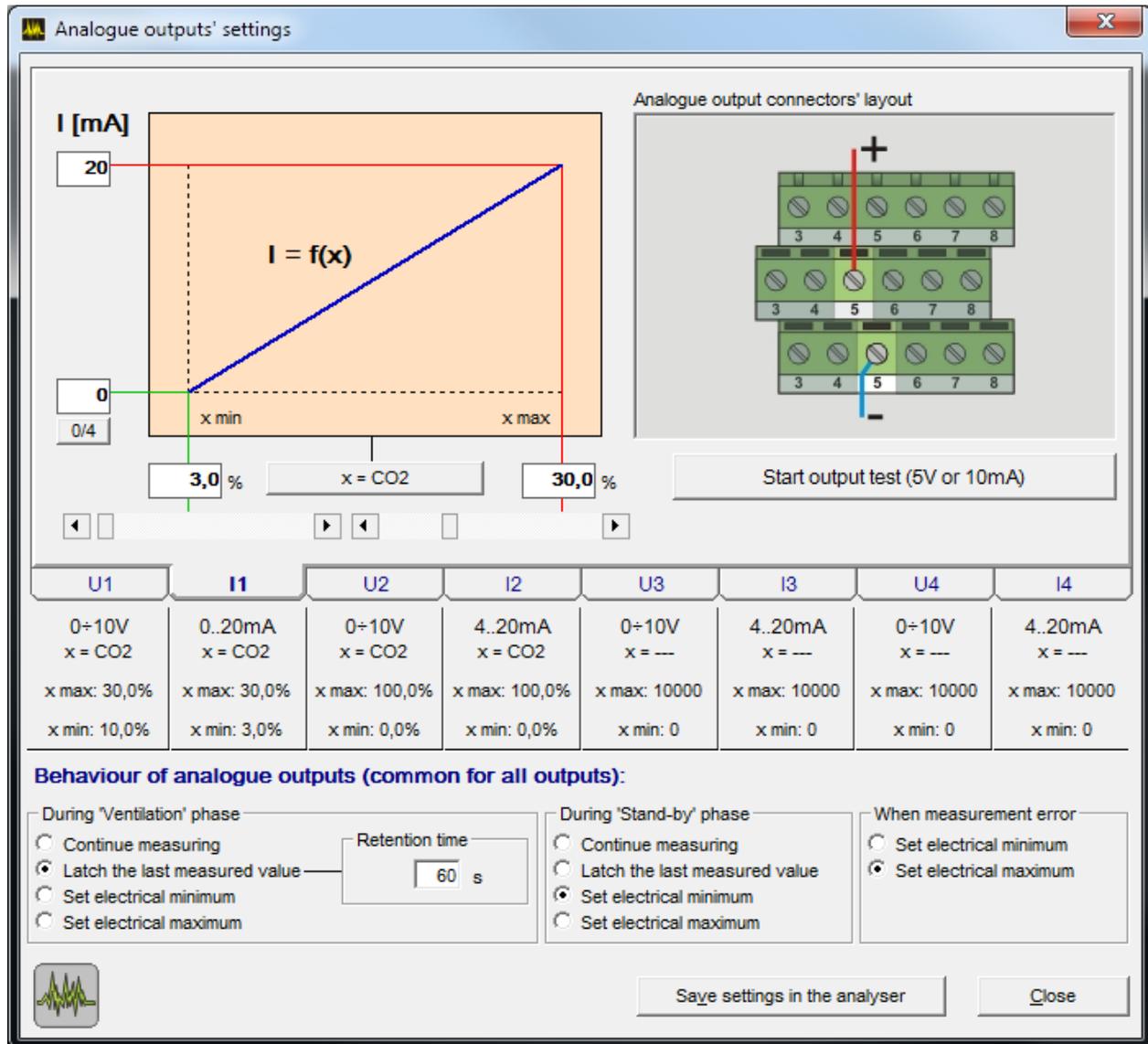
Changes to the value will result in changes to the output's voltage. With the help of the sliders, situated below the graph characterising the output, the user is able to assign any value of the chosen component (chosen from the measurement range) to the minimum and maximum output voltage. The left slider is responsible for setting the value referring to the 0V output voltage, the right one – to the maximum voltage (5 or 10 V). If the value has to be accurate it can be entered directly in the box above the slider. On the left side of the graph there is a button enabling the user to set the maximum value of the output voltage. The maximum voltage can be chosen from 5 and 10V and the choice can be seen in the box above the "5/10" button.

If the "Start output test 5V or 10mA" button is pressed the voltage of 5V appears on the output. This can be used when checking whether the device connected to the output reacts to the signal from the monitor. Pressing the button once again ends the test.

An example of the U1 voltage output settings can be seen in Picture 96. The output has been assigned to the CO₂ concentration measurement. The maximum output voltage has been set to 10V. With the help of the sliders a 10 % carbon dioxide concentration has been assigned to the minimum output voltage and a 30 % carbon dioxide concentration – to the maximum output voltage. This means that unless the carbon dioxide concentration exceeds 10 % the output voltage will equal 0 V. If the carbon dioxide concentration increases above 10 %, the output voltage also goes up until the carbon dioxide concentration reaches the 30 % value. If the concentration value increases more, the output voltage stays on the maximum level. The other voltage outputs are set similarly.

7.3.9.2. Setting the current outputs

Settings the current outputs is carried out similarly to setting the voltage outputs. After the appropriate tab has been chosen the settings of the output's parameters will be displayed. The drawing presenting the location of the chosen output on the connectors of the monitor's main board and the way of connecting the wires will be presented on the right side of the tab whereas the current characteristic of the output will be shown on the left-hand side (Picture 97.). With the help of the  button, the chosen output can be assigned to any value measured by the monitor (Picture 79.). Changes to the value will result in changes of the output's current. With the help of the sliders, situated below the graph characterising the output, the user is able to assign any value for the chosen component (chosen from the measurement range) to the minimum and maximum output current.



Picture 97. The "Analogue output settings" window (the tab of the current output I1 can be seen).

The left slider is responsible for setting the value referring to the minimum output current (0 or 4 mA), the right one – to the maximum current (20 mA). If the value has to be accurate it can be entered in the box above the slider. On the left side of the graph there is the "0/4" button enabling the user to set the minimum value of the output current range. The minimum current can be chosen from 0 mA and 4 mA and the choice can be seen in the box above.

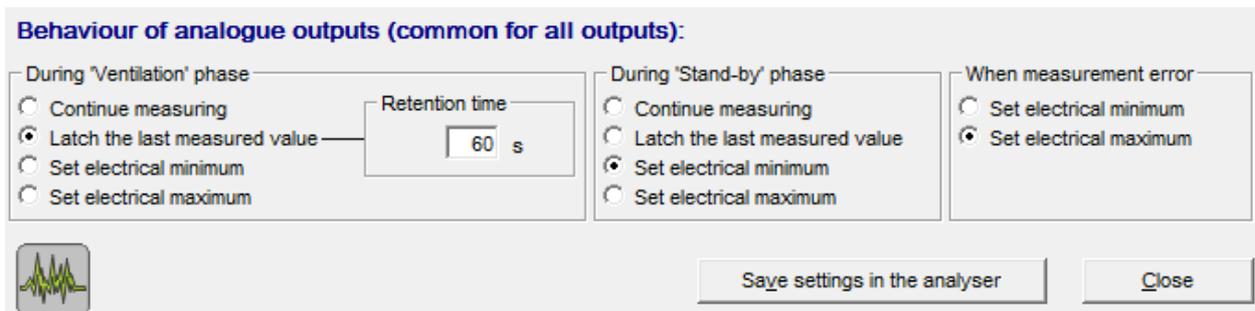
If the "Start output test 5V or 10mA" button is pressed a current of 10 mA appears on the output. This can be used when checking whether the device connected to the output reacts to the signal from the monitor. Pressing the button once again ends the test.

An example of the I1 current output settings can be seen in Picture 97. The output has been assigned to the CO₂ concentration measurement. The minimum output current has been set to 0 mA. With the help of the sliders the output current has been set to 0 - 20

mA for a 5 – 30 % carbon dioxide concentration. The other current outputs are set similarly.

7.3.9.3. Analogue outputs behaviour

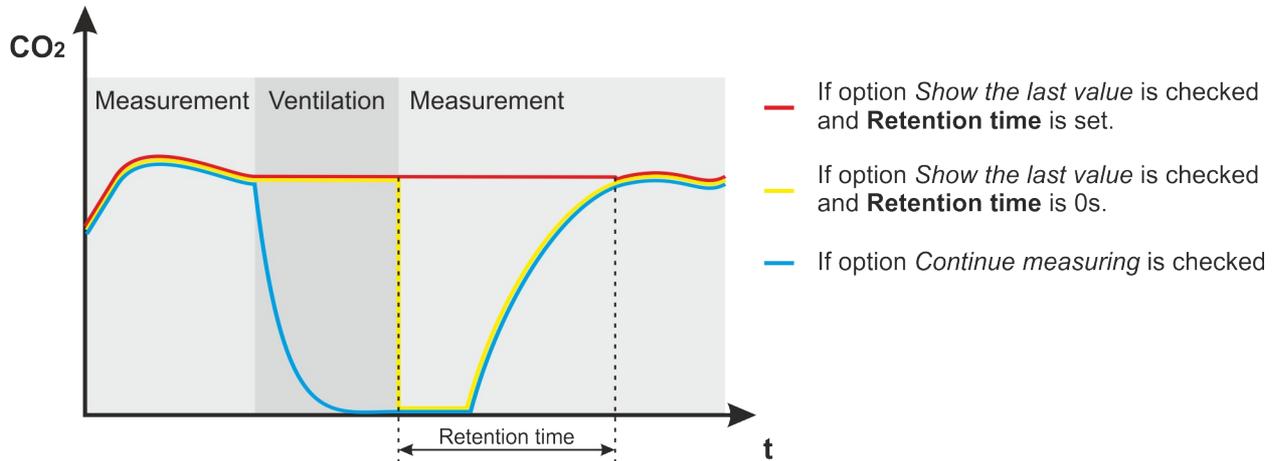
In the section at the bottom of the window the actions of the outputs during the VENTILATION (*During Ventilation time*) and STAND-BY (*During Standby time*) stages and in case of occurrence of an error in measurement (*If error frame*) can be set. The settings refer to all the analogue outputs.



Picture 98. Analogue outputs behaviour during the Ventilation, Stand-by, an in case of error occurrence.

The user can choose one of the following options:

- *"Continue measuring"* - the current measurement results will appear on the outputs. The user should remember that while the gas system is being ventilated the monitor is supplied with inert gas and during the stand-by stage the pump is switched off. For this reason the measured values are the concentrations in the inert gas.
- *"Latch the last measured value"* - the signal on the particular output is latched showing the last value presented on the output before the stage begins. If this option is chosen in the *"During Ventilation"* frame additionally the *"Retention time"* can be set. This setting defines for how long the last measured value appears on the analogue outputs after the ventilation process has completed. As directly after the end of the ventilation (before a new gas sample reaches the sensor) the gas system is filled with inert gas, both the sensor readings and the signals of the analogue outputs refer to the concentration of the inert gas. To eliminate the sudden drop of the signal on the outputs after the ventilation stage the proper Retention time should be set (Picture 99.).



Picture 99. The graph showing the signal level on analogue output during successive stages of measuring cycle for different options.

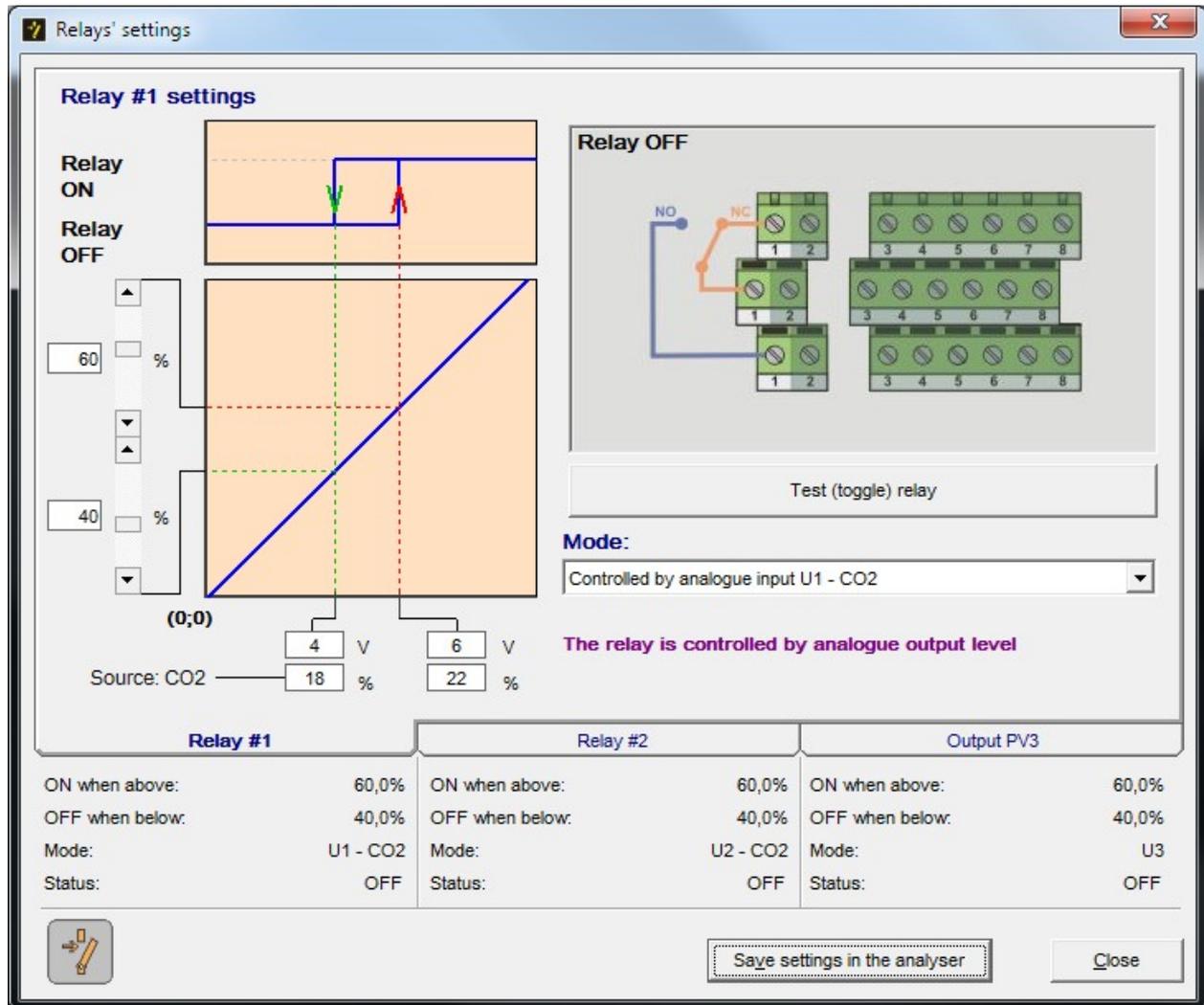
- *"Set the electrical minimum"* - the minimum signal level is set on the outputs (0 V, 0 mA or 4 mA).
- *"Set the electrical maximum"* - the maximum signal level is set on the outputs (5 V, 10 V or 20 mA).

If an error has occurred only the *"Set the electrical minimum"* or *"Set the electrical minimum"* options can be set.

7.3.10. Relays



The function enables the user to set the parameters of the relay outputs and the PWM (PV3) digital output. The function can be reached by pressing the quick access button and via the menu bar with the help of the *"Relays"* button. After the function has been opened the window shown in Picture 100. appears. The window consists of three tabs – each assigned to a separate output. Changes to the settings are signalled in red. The changes made in the window will not effect the monitor's settings until the *"Save settings in the analyser"* button has been pressed. If the changed settings are not sent to the monitor and the user makes an attempt to close the window a confirmation message will appear. The current settings of all the outputs can be seen below the tabs no matter which tab is currently open.



Picture 100. The "Relay settings" window.

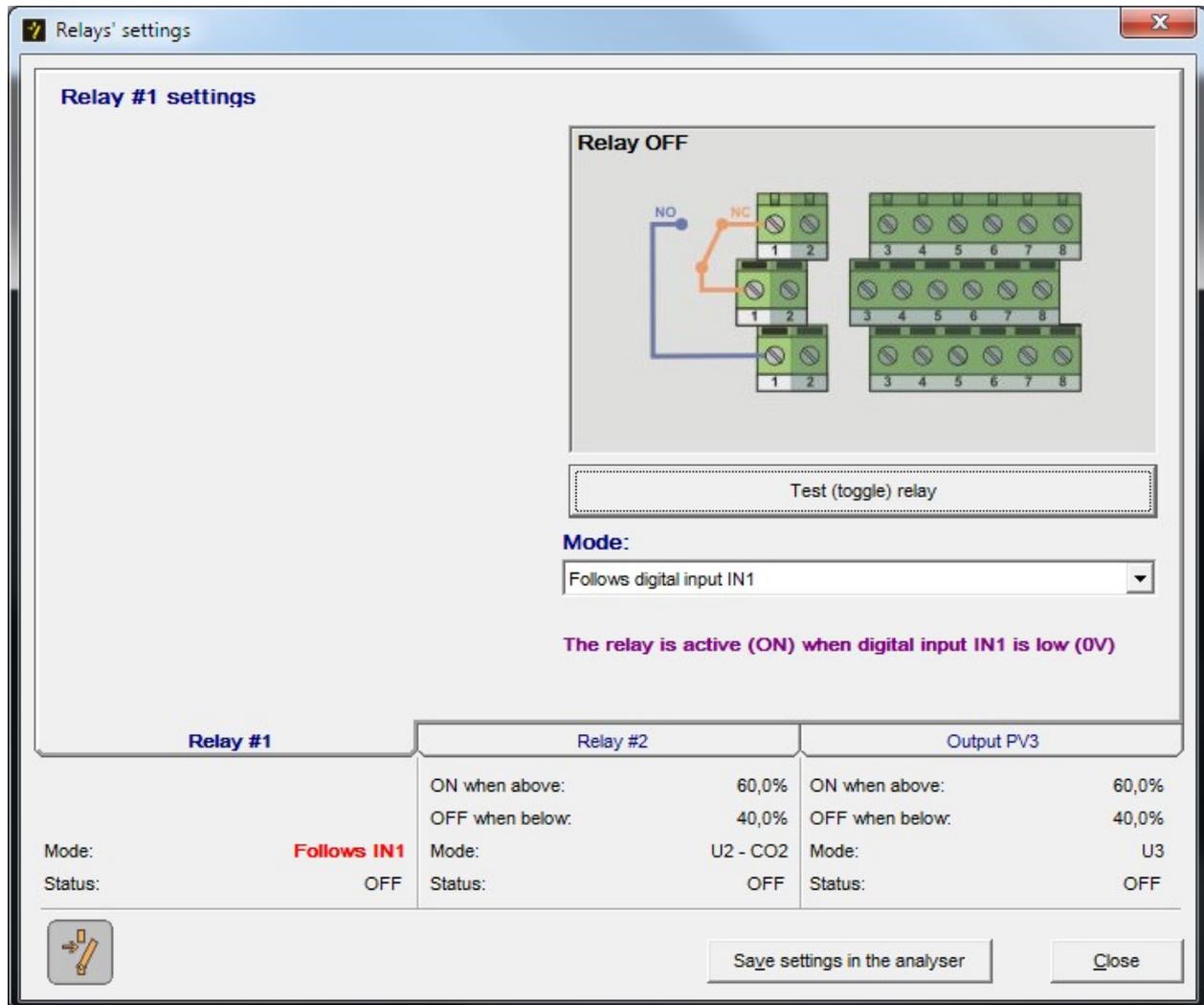
Attention!

The relays and the accompanying connector are optional equipment and are not provided with every monitor.

7.3.10.1. Outputs' settings.

Both relay outputs and the *PWM* output are configured in the same way. To set their parameters the appropriate tab has to be chosen. The "Relay #1" and "Relay #2" tabs are assigned to the outputs of the two relays whilst the "PV3" tab refers to the *PWM* output. After the tab referring to the output which is to be configured has been chosen, a picture showing the location of the chosen output on the connectors of the monitor's main board will appear on the right side of the screen (Picture 100.). The drawing symbolically shows which contacts refer to which signals of selected output. Using the "Test (toggle) relay" button (placed below the picture) the working of the particular output

can be checked. After the button has been pressed the state of the relay output will be replaced with the opposite one for 8 seconds. After that time the actions of the outputs will be performed according to the settings.



Picture 101. The settings of the relay in case the IN1 inlet is chosen for the source.

The choice of the source signal controlling the output can be made with the help of the list located below the picture. The choice can be made between the analogue outputs, the digital outputs (labelled as "Follows IN1" and "Follows IN2"), the "Follows Measurement", the "Flow control" position and the "No action" position. If the "No action" option is chosen, the output is switched off (it remains inactive). If the "Flow control" option is selected then the relay reacts to the flow value in the gas channel. If the flow drops below the critical level the relay opens. Choosing the "Follows Measurement" switches the output on when the monitor proceeds to the "MEASUREMENTS" stage. The output is switched off during all other stages. If the user chooses the "Follows IN1" or "Follows IN2" the appropriate relay is activated when the input (IN1 or IN2) is in active stage. As the state on the in-

put changes the relay switches off. If any of the analogue outputs has been chosen from the list the additional options appear in the tab (Picture 102.). They enable the user to specify the exact values that switch the outputs "ON" and "OFF".

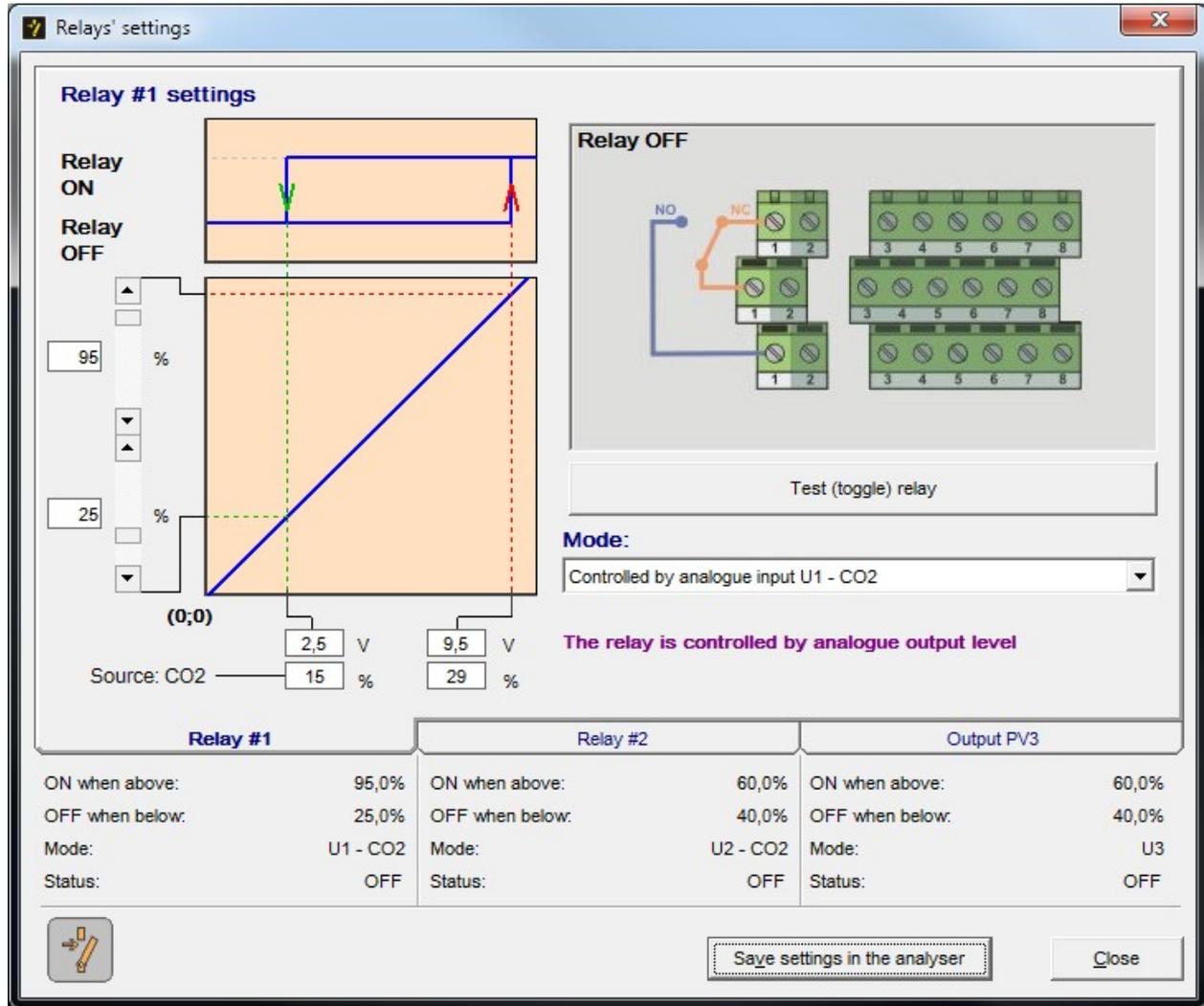
After one of the analogue outputs has been chosen for the source of the signal used for controlling the relay the additional options shown in the Picture 102. appear on the left side of the tab. On the top a graph showing the relay's hysteresis appears. The characteristic of the chosen output can be seen below it. With the help of the sliders situated on the left side of the graph the user can set the values (in percent) switching the relay on and off according to the level of the signal on the chosen output. In consequence switching the relay depends on the concentration of the gas assigned to the chosen output. The upper slider can be used for setting the value which turns the relay on (marked with the red line on the graph) and the lower slider regulates the value for which the relay turns off (the green line). These can be set by defining the level of the source signal in percent. The information on the source signal value and the concentration of the gas assigned to the output referring to the current sliders positions can be seen below the graph.

In the example shown in Picture 102., the U1 output (which is assigned to the CO₂ carbon dioxide measurement) has been chosen to control the relay. The U1 output is set as follows: the 0V value is assigned to 10% CO₂ concentration and the 10V value refers to a concentration of 30% CO₂. With the help of the sliders the value for which the relay is switched on - "Relay ON" has been set for 95 % of the range (i.e. 9.5V) and the value for which the relay is switched off - "Relay OFF" has been set for 25% of the range (i.e. 2.5V). The data below the graph informs the user that the relay will be switched on if the voltage of the U1 output exceeds a value of 9.5V – equivalent to a concentration of 29% oxygen:

$$\frac{30\% CO_2 - 10\% CO_2}{10V - 0V} \cdot 9,5 V + 10\% CO_2 = 29\% CO_2$$

The relay switches off if the voltage drops below 2.5V – equivalent to a concentration of 15% oxygen:

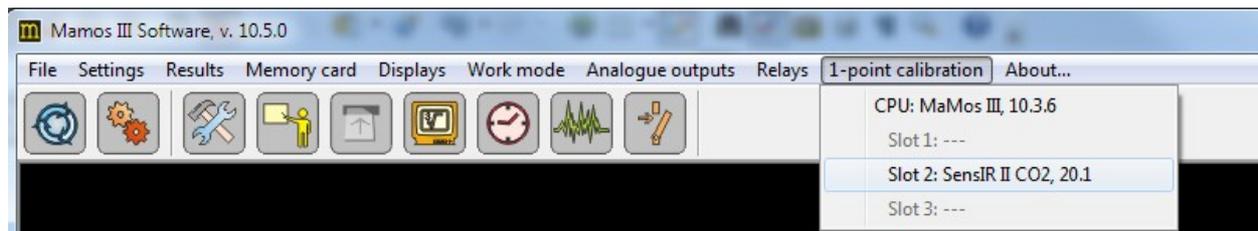
$$\frac{30\% CO_2 - 10\% CO_2}{10V - 0V} \cdot 2,5 V + 10\% CO_2 = 15\% CO_2$$



Picture 102. The settings of the relay in case one of the analogue outputs is chosen as the source.

7.3.11. 1-point calibration for maMoS II monitor

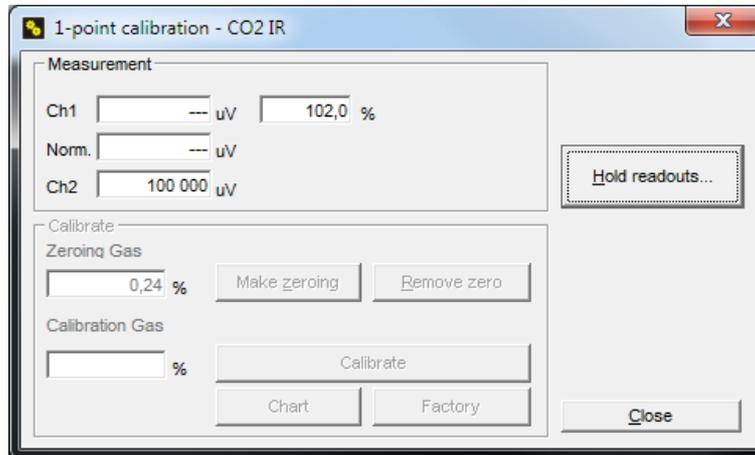
This function can be reached only via the menu bar. It enables the user to perform the calibration of any of the IR or electrochemical sensors installed in the device.



Picture 103. The list of the available IR sensors in the „1-point calibration” menu.

7.3.11.1. IR sensor calibration

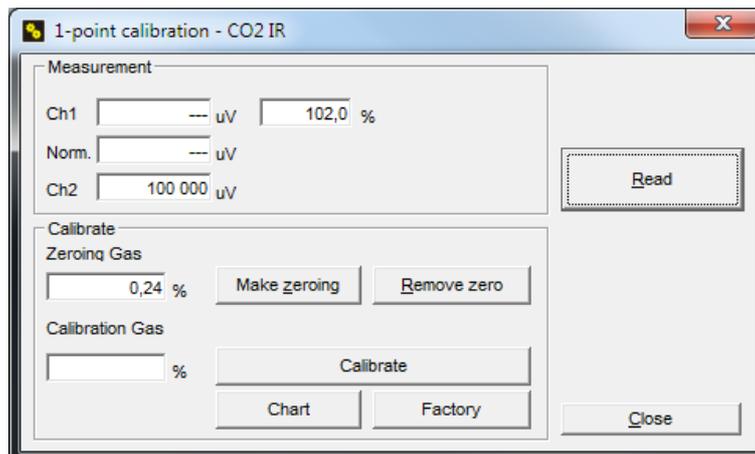
After the sensor which is to be calibrated has been chosen from the „1-point calibration” menu, the window shown below will appear.



Picture 104. The window containing the IR sensor readings.

To execute calibration:

1. Apply a neutral (for the specified sensor) gas to the device and wait for the values in fields "Ch1", "Norm." and "Ch2" to stabilize. Press "Hold readouts" button.



Picture 105. The readings if the zeroing gas is supplied.

2. Enter the concentration of the neutral gas into "Zeroing gas" field, and then press "Make zeroing" button.
3. After zeroing, apply the reference gas and enter its concentration into "Calibration Gas" field. Then, press "Read" and wait for the values in fields "Ch1", "Norm." and "Ch2" to stabilize.

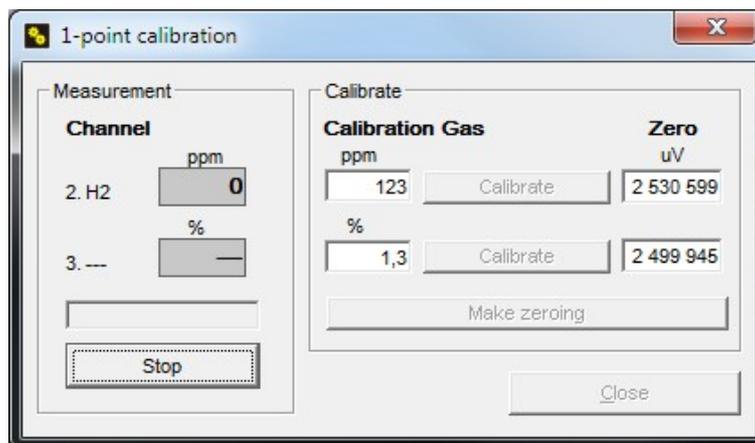
ATTENTION!

It is forbidden to use a mixture of gases to execute calibration process. If the analyser is equipped with the sensor which detects any gas being a component of the mixture the calibration will never be performed properly.

4. Press "Hold readouts" button, and then "Calibrate". In the left corner of the status bar you can observe the progress of calibration data being saved.
5. After several seconds a calibration curve will appear. If the chart is illegible close it and reopen it using "Chart" button.
6. If a new curve is incorrect or if the sensor starts working improperly you can restore the factory curve using "Factory" button.

7.3.11.2. Electrochemical sensor calibration

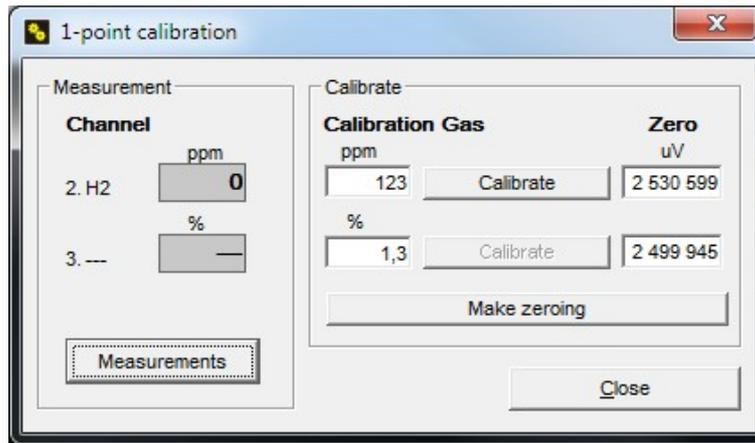
If the "CPU: Mamos III" or "SensElch" slot is chosen from the "1-point calibration" menu then the following window appears:



Picture 106. 1-point calibration window for the electrochemical sensors

Window shows all sensors available in the chosen channel. To calibrate a sensor follow the instructions:

1. Interrupt running measurements by pressing "Stop" button. Current results will no longer be visible and buttons referring to installed sensors will become active.
2. Apply the fresh air to the gas inlet or switch the sensor into a "VENTILATION" phase (using cycle's reset function (see chapter 7.3.8.). Ventilation should last for about 15 minutes.



Picture 107. Calibration window after the measurements are interrupted.

3. After ventilating the sensor press “*Make zeroing*” button – all electrochemical sensor are zeroed.
4. Apply the reference gas to gas inlet and wait until the results stabilize. Press “*Measurements*” button to check current results.

ATTENTION!

Sensor calibration with a gas mixture will always supply incorrect results. If the analyser is equipped with sensor of a gas that is present in the mixture the calibration is never correct.

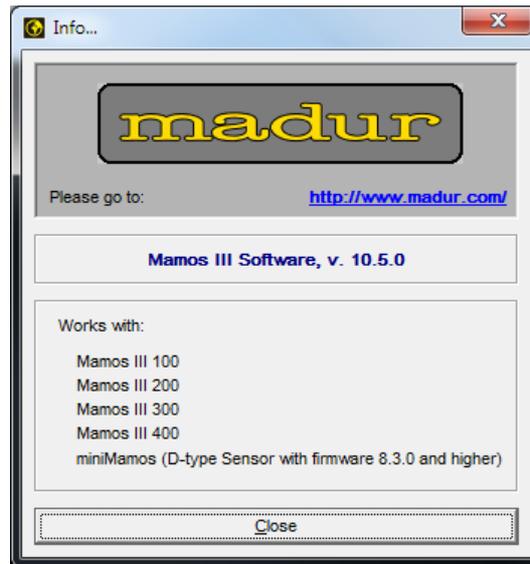
5. When the sensor's readings are stable press “*Stop*” button and enter the value of reference gas concentration into the proper field and press “*Calibrate*” button.
6. Repeat steps 1÷5 for the other sensors. Remember to ventilate the measurement channel with the fresh air before any calibration.

7.3.12. Service mode

The option is available only for the **madur** service staff. It is used for calibration and setting the gas sensors.

7.3.13. About the program...

The option is available only via the menu bar. Choosing the option displays information about the *MaMoSII* program.



Picture 108. The window containing information about the program.