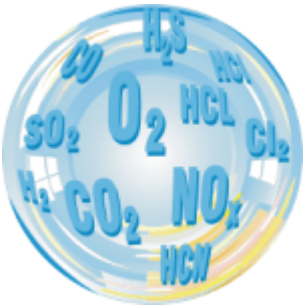


MAMOS – PC SOFTWARE

User manual

Version: 1.2
12/2019
Software version: 13.1.8

madur

INDEX

1. INTRODUCTION

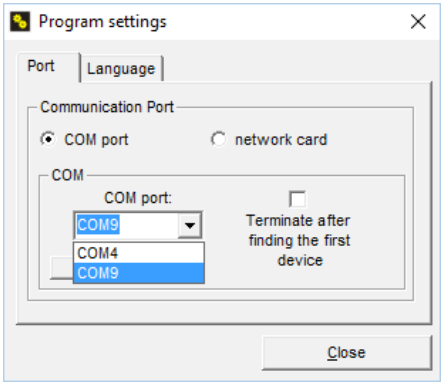
Madur PC software provides PC communication with several madur devices: mamos, SENma sensors, IRma sensors, INERma sensors and others. Program identifies the type of device it is connected to, and shows appropriate set of settings. This manual covers all possible settings, though, not every may appear with your device.

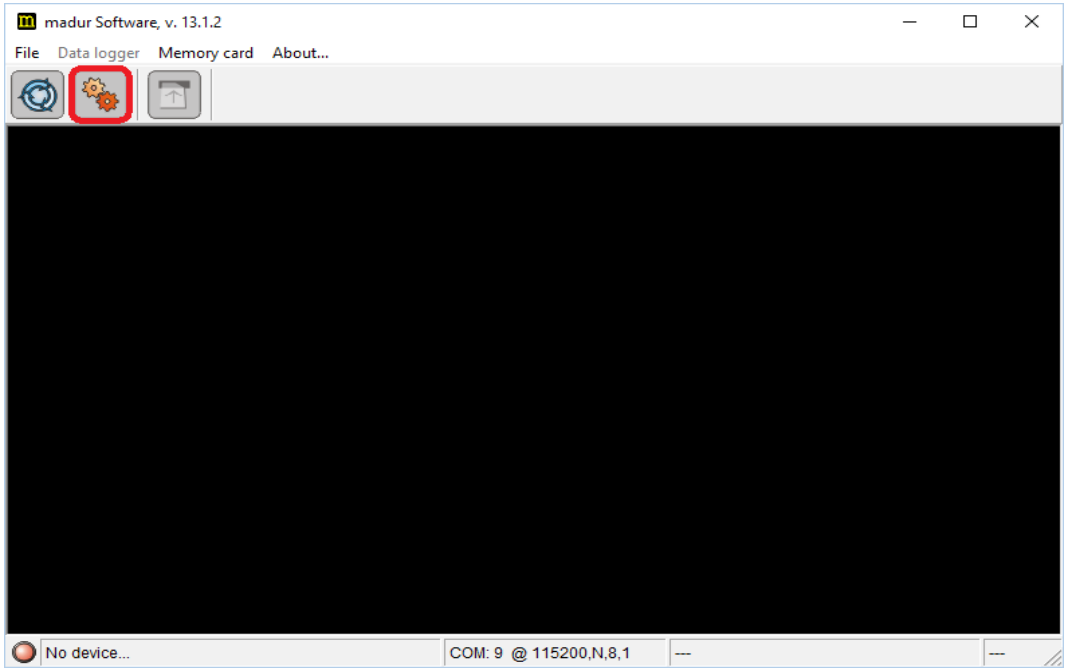
Installation file can be found on software CD (attached with every analyser) and on madur webpage.

2. CONNECTING TO MAMOS

Program will try to connect to mamos using the last selected COM port. If the COM port has changed (e.g. due to different cable or connecting to a different mamos), it is necessary to select a proper one.

Select File → Program settings. Or use icon :





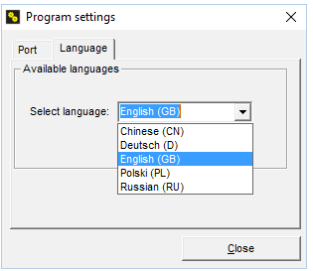
Select proper COM port (that "stands behind" the cable you use to communicate with mamos.

In case only one analyser is connected to PC, in order to speed-up the discovery process, select the option Terminate after finding the first device.

Press Connect to initialise discovery process.

It is possible to reconnect to a device (using the last selected options) by pressing icon.

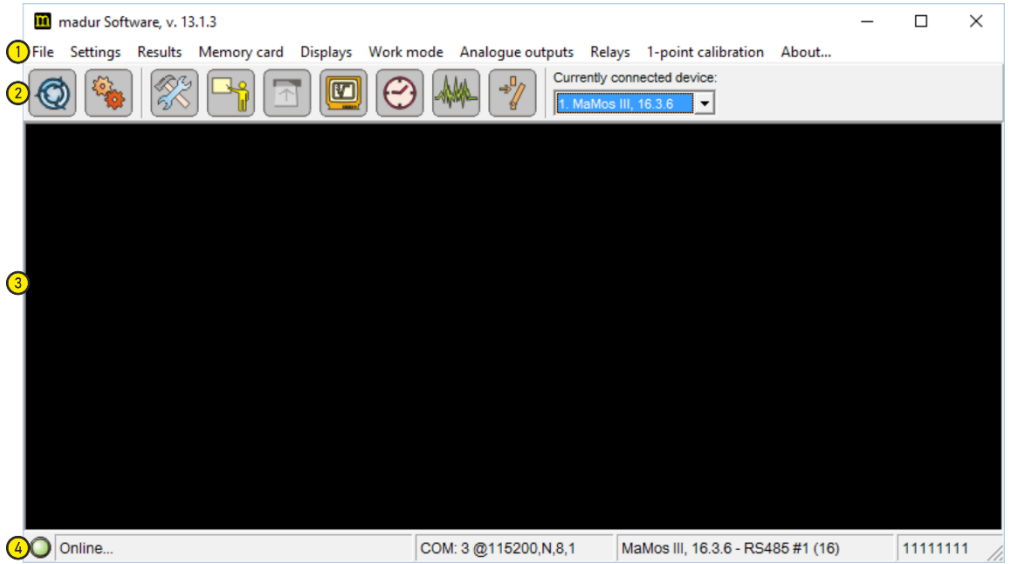
3. PROGRAM LANGUAGE



1. From main menu, select: File → Program settings, or click icon.
2. Select the second tab: Language
3. From drop-down menu select your language
4. Close Settings window

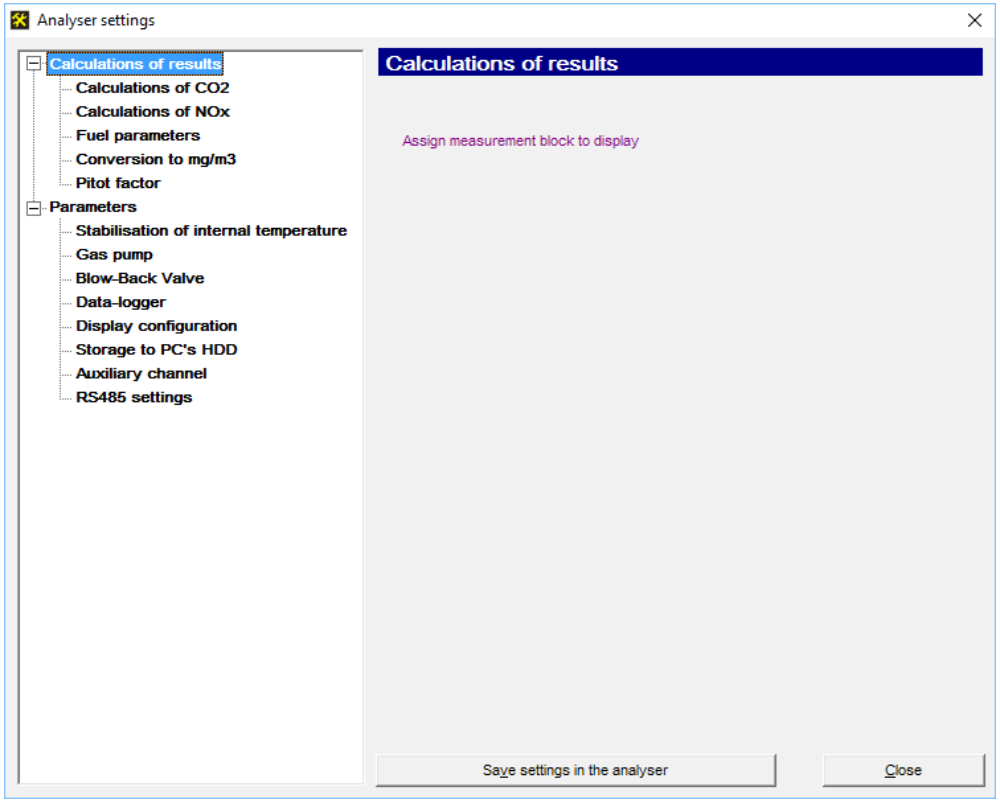
madur can share language files for translation in order to prepare your language version – please contact our sales team: sales@madur.com

4. MAIN WINDOW



1. Main menu
2. Bar with icon short-cuts to the most common options (that are also available from main menu):
   - Restart communication
   - Program settings
   - Analyser settings
   - Results
   - Memory card
   - Analyser status
   - Work modes
   - Analogue outputs
   - Relays and digital outputs
   - Currently connected device: 1. MaMos III, 16.3.6 – Device selection, when more than one device is connected via RS485
3. Contents window, where sub-menus are opened
4. Status bar with information about:
   - connection status (Online / Offline)
   - connection port (COM number, and COM settings)
   - type of device and firmware version
   - device serial number

5. ANALYSER SETTINGS



This window gathers settings concerning calculations performed by analyser, but also its working parameters.

Each change, to take effect must be send to analyser with this button: Save settings in the analyser.

- Calculation of results
  - Calculations of CO_2
  - Calculations of NO_x
  - Fuel parameters
  - Conversion to mg/m^3
  - Pitot factor
- Parameters
  - Stabilisation of internal temperature
  - Gas pump
  - Blow-Back Valve
  - Data-logger
  - Displays
  - Storage to PC's HDD
  - Auxiliary channel
  - RS485 settings

5.1. Calculations of CO2

In case of analysis of a combustion process. CO2 value can be either measured directly (with CO_2 NDIR) or calculated using result from O2 sensor, and fuel parameters, according to formula:

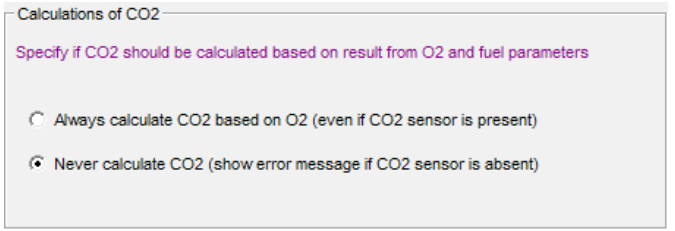
$$CO_2 = CO_{2max} \cdot \left(1 - \frac{O_{2max}[\%]}{20{,}95\ [\%]}\right)$$

Where:

CO_2 – calculated CO_2 content in the combustion gas (as a percentage)
$CO_{2\,max}$ – parameter characteristic for a selected fuel
$O_{2\,max}$ – oxygen content in the combustion gas (as a percentage)

User can specify from where the results will be "taken":

- Always calculated
- Always a direct reading from CO 2 – if CO 2 sensor is not present display will show "– – –"



5.2. Calculations of NO_X

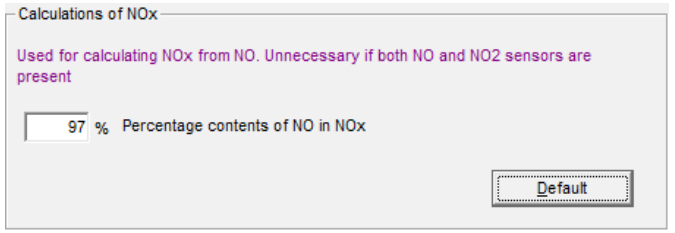
$$NO_x[ppm] = \frac{NO[ppm]}{0{,}97}$$

Where:
NO – results from NO sensor
0,97 – percentage contents of NO in total contents of all NO_x (parameter modified in mamos software)

If both NO and NO2 sensors are installed:

$$NO_x[ppm] = NO[ppm] + NO_2[ppm]$$

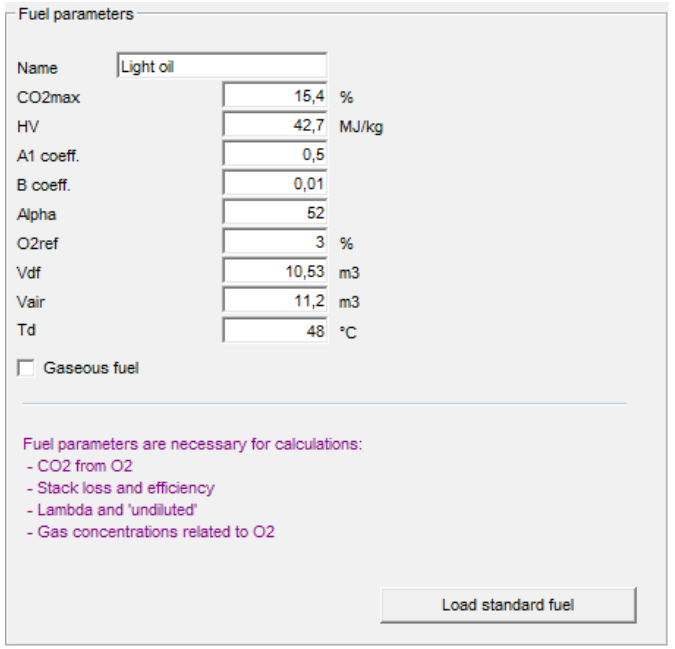
Mamos can estimate the total contents of NO_X concentration based on the results from NO sensor. It is assumed that circa 97% of all nitric oxides (NO_X) present in fumes is nitric oxide (NO). This percentage value can be modified in mamos PC program. In case both NO and NO2 sensors are installed in analyser, this coefficient is obsolete, as in this case, the concentration of total NO_X is assumed as a sum of nitric oxide and nitrogen dioxide concentrations.



5.3. Fuel parameters

Mamos analyser can perform calculations of different values, including combustion parameters, like stack loss, efficiency, etc. For these calculations analyser must "know" what kind of fuel is used for combustion, as different fuels have their unique parameters. Madur has over 20 different fuels listed in database, user can select one, from the list: Load standard fuel, or manually modify the parameters:

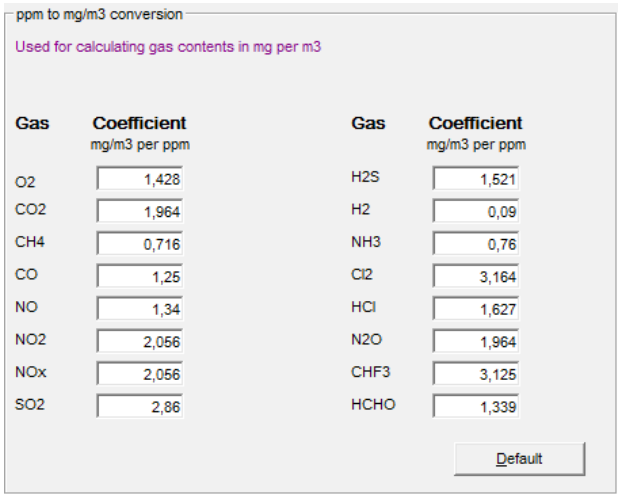
- CO_{2max} — Concentration of carbon dioxide in fumes in case of stoichiometric combustion
- HV — Heating Value – the amount of heat produced by stoichiometric combustion a unit quantity of a fuel
- A_1,B — Coefficients of Siegert's empirical formula
- Alpha (α) — coefficient used for calculating the loss by incomplete combustion, its value differs for fuels:
  α = 69 – for solid fuels
  α = 52 – for liquid fuels
  α = 32 – for gas fuels
- O_{2ref} — reference oxygen – the parameter used for calculating the relative content of components
- V_{DF} — Volume of Dry Fumes – amount of fumes from stoichiometric combustion, after water vapour has been condensed
- V_{AIR} — Volume of air required for stoichiometric combustion
- T_d — Flue gas dew point – the temperature at which the water vapour in a sample of air at constant barometric pressure condenses into liquid water.
  Parameter that specifies contents of water vapour in flue gas.
- Gaseous fuel — Switch for HV unit: MJ/kg or MJ/m



5.3.1. Standard fuels available in madur analysers

No.	Fuel name	CO_{2max} [%]	HV [MJ/unit]	A_1	B	Alpha (α)	O_{2REF} [%]	V_{DF} [m3]	V_{AIR} [m3]	T_D [°C]	unit
1	Natural gas	11,7	35,90	0,3700	0,009	32	3	8,56	9,54	56,05	m^3
2	Natural gas with fan	12,1	35,90	0,4600	0,000	32	3	8,56	9,54		m^3
3	Town gas	13,1	16,10	0,3500	0,011	32	3	36,10	3,90	60,05	m^3
4	Town gas with fan	10,0	16,10	0,3800	0,000	32	3	3,61	3,90		m^3
5	LPG (Liquid gas)	14,0	93,20	0,4200	0,008	32	3	22,30	24,36	55,05	m^3
6	Coke-oven gas	10,2	17,40	0,2900	0,011	32	3	22,30	24,36	64,35	m^3
7	Propane	13,7	93,20	0,4750	0,000	32	3	22,30	24,36	51,5	m^3
8	Propane with fan	13,7	93,20	0,5000	0,000	32	3	22,30	24,36		m^3
9	Butane	14,1	123,80	0,4750	0,000	32	3	29,69	32,31	50,7	m^3
10	Butane with fan	14,1	123,80	0,5000	0,000	32	3	29,69	32,31		m^3
11	Biogas	11,7	35,90	0,7100	0,000	32	3	8,54	9,56		m^3
12	Biogas with fan	11,7	35,90	0,7800	0,000	32	3	8,54	9,56		m^3
13	Bio-Diesel	15,7	41,80	0,4567	0,005	52	3	10,44	11,15		m^3
14	Light oil	15,4	42,70	0,5000	0,007	52	3	10,53	11,20	48,05	kg
15	Extra light oil	15,3	41,80	0,5900	0,000	52	3	10,53	11,20	47,05	kg
16	Heavy oil	15,9	41,00	0,6100	0,000	52	3	10,08	10,73	50,50	kg
17	Gasoline (C8H18 average)	14,5	44,40	0,5000	0,007	52	3	11,26	12,19	49,3	kg
18	Coal-tar	18,0	37,70	0,6500	0,000	52	3	9,32	9,66		kg
19	Anthracite	19,1	31,50	0,6830	0,000	69	11	9,40	9,50	27,22	kg
20	Bituminous coal	18,4	26,75	0,6720	0,000	69	11	6,90	7,00	44,00	kg
21	Lignite	18,6	19,50	1,0000	0,000	69	11	5,70	8,40	44,35	kg
22	Coke	19,1	27,05	0,2900	0,000	69	11	8,40	8,00		kg
23	Peat	18,6	18,05	0,7000	0,000	69	11	5,70	5,90		kg
24	Dry wood / wood pellet	19,7	18,60	0,6500	0,000	69	11	4,40	5,00	57,55	kg

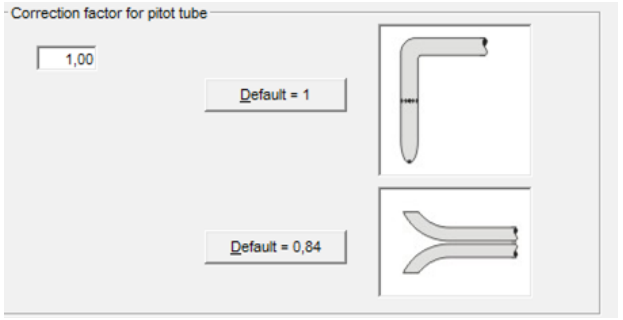
5.4. Conversion to mg/m³



mamos measures gas as volume concentrations, i.e. ppm or %vol. It is possible to convert volume concentration to mass concentration, i.e. mg/m3. Mass concentration depends on the temperature and pressure, and these parameters should be taken into account for conversion purposes. In mamos PC program it is possible to define conversion factors for several gases (those that can be measured with mamos).

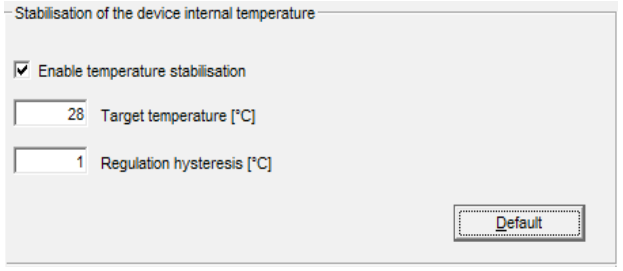
Using  button resets all the conversion factors to the STP conditions.

5.5. Pitot factor



If mamos analyser is equipped with differential pressure sensor, it is possible to use it for measurement of flow velocity. Flow velocity is measured indirectly, with the help of pitot tube. There are two types of tube available: L and S. Each of them has its own correction factor used for calculation.

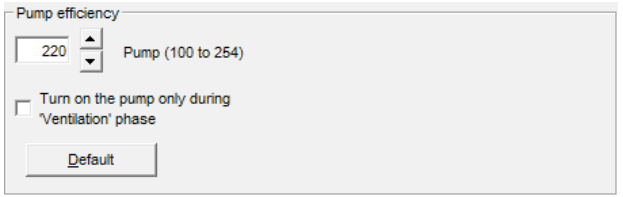
5.6. Stabilisation of internal temperature



Stable temperature is important for accurate measurements. Even though the gas sensors have correction factors for thermal drift implemented into analyser's firmware, it is optimal to keep their temperature stable. Mamos has simplified temperature stabilisation mechanism, i.e. it has temperature sensor and fan with regulation. Mamos will try to keep internal temperature at constant (adjustable from PC program) level.

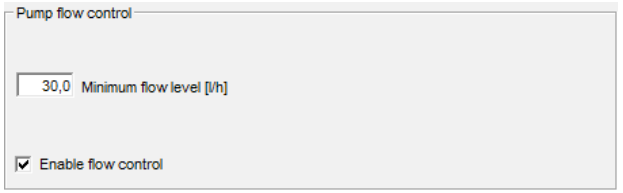
Stabilisation is performed with *hysteresis*, that is also adjustable.

5.7. Gas pump



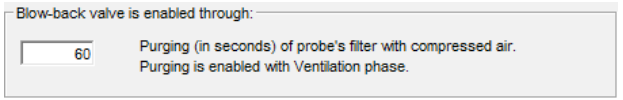
By default analyser's pump is adjusted to give flow 90l/h. It is possible to modify the flow by changing pump's efficiency.

If the process is at slight overpressure (within acceptable range for mamos analyser), it is possible to disable the pump during measurement phase – then the gas is fed by process itself. It is still necessary to use the pump to drive the ambient air for ventilation purposes.



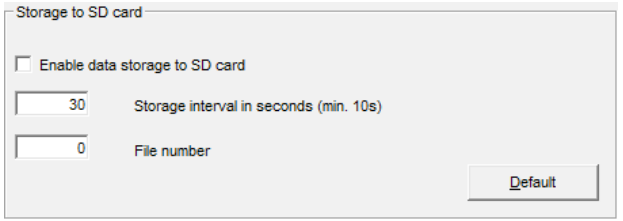
Every mamos analyser is equipped with differential pressure sensor that controls the flow through the analyser. Gas flow may drop to a number of reasons (e.g. due to clogging of filters, pump malfunction, blockage of gas tubes, etc.). When flow drops below sea level (by default set to 30 l/h), then mamos reports "Flow too low error"

5.8. Blow-Back valve



mamos that is equipped with stationary gas probe with filter and cleaning option, sends electric signal to the pilot electromagnetic valve that enables compressed air source for filter's cleaning. Cleaning of probe's filter is synchronised with ventilation of gas sensors. User can set the duration of filter's purging (max 60 seconds)

5.9. Data-logger



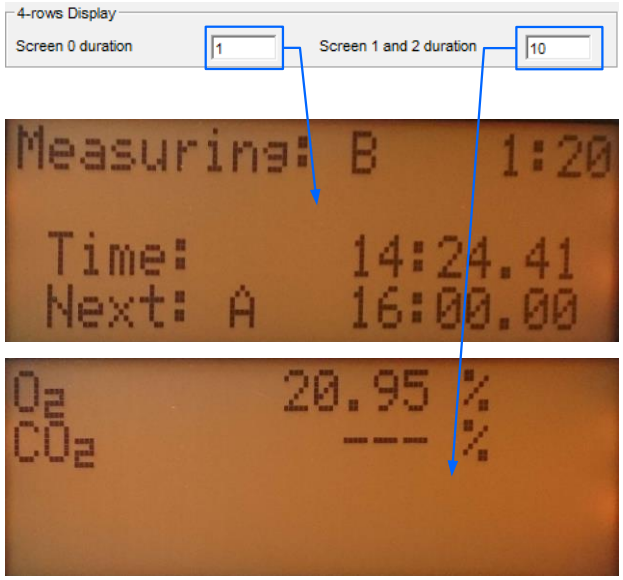
Measurement results can be stored on SD card. Storage must be enabled in PC program – then, whenever SD card is detected in data-logger, analyser will start recording.

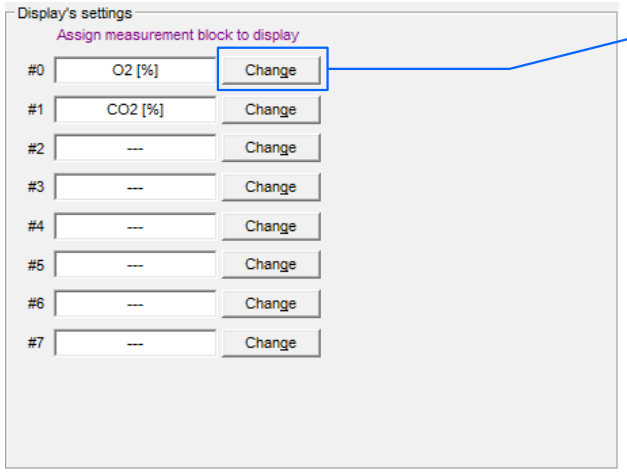
It is possible to set how often the results will be stored. And also to define the starting number for the files' counter – new file is created, e.g. when limit of 10.000 results in a file has been reached.

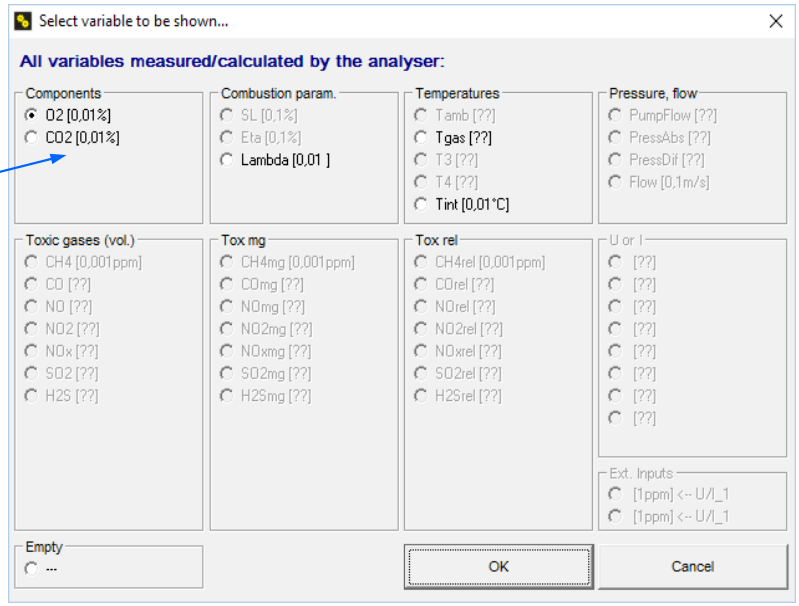
5.10. Display configuration

Mamos allows for a flexible adjustment of parameters that will be shown on display – only available parameters can be selected (non-available are greyed out).

It has 4 lines, so in case one wants to show more than 4 variables, display will switch PC software also allows to set visibility duration of different screens: Screen 0 – status, Screen 1,2: results.

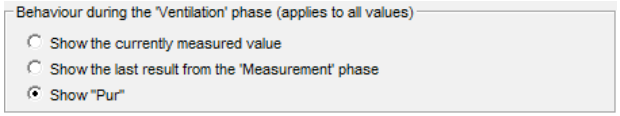




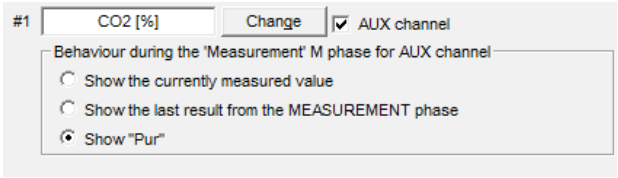


User can define how display will behave during Ventilation phase:

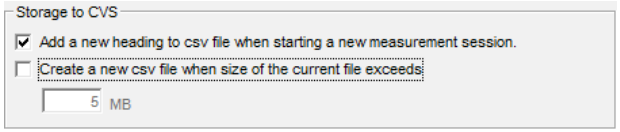
- Presented values can continue measurements – they will start to drop at the beginning of ventilation and go to the (near) zero values
- Values can be “latched” - display will show the last measured value before Ventilation phase begins
- Display will clearly inform user that results are meaningless due to Ventilation – display will show *Pur* instead a value.



If selected sensor is installed in auxiliary channel, user can specify what will happen when AUX sensor is disabled (ventilated with air). Selection is identical to behaviour during Ventilation.



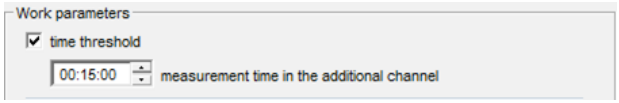
5.11. Storage to PC's HDD

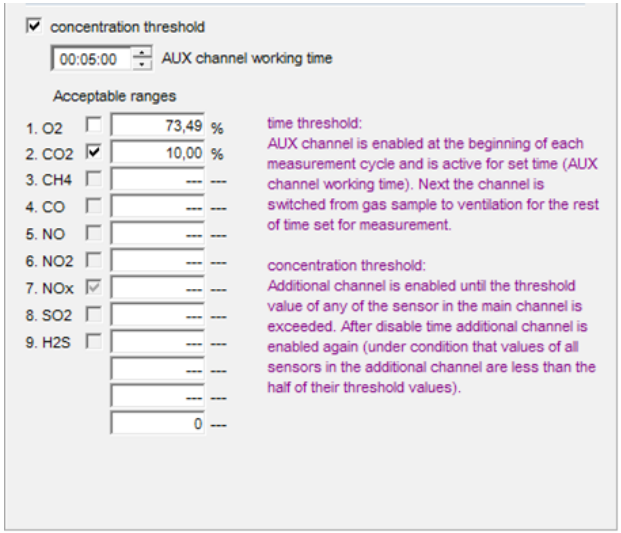


Even if the analyser is not equipped with data-logger, it still allows to perform storage of results directly to PC hard disk to a CSV file.

User can specify if program should create a new file if size exceeds certain capacity, and if a new header should be added (as a row) every time a new data recording begins.

5.12. Auxiliary channel



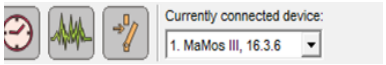


If mamos is equipped with auxiliary channel for sensitive sensors user can select how channel is disabled (= sensors in AUX channel are ventilated with air). It is either:

- time threshold – sensors in AUX channel measures only for the first XX minutes of the Measurement phase (in this case 15 minutes)
- concentration threshold – sensors in AUX channel will be disabled if range on a selected sensor is exceeded
  - in the example: AUX channel is disabled when concentration of CO_2 is higher than 10%
  - it is possible that AUX channel is disabled by sensor installed in AUX channel (self-protection of sensor) – in this case AUX channel is disabled when CO_2 concentration exceeds 10%. Channel is disabled for 5 minutes, after which channel is enabled to check the current CO_2 concentration. If it is within safe range, AUX channel stays enabled. If CO_2 concentration is still dangerously high, AUX channel is disabled for another 5 minutes for another check **????**

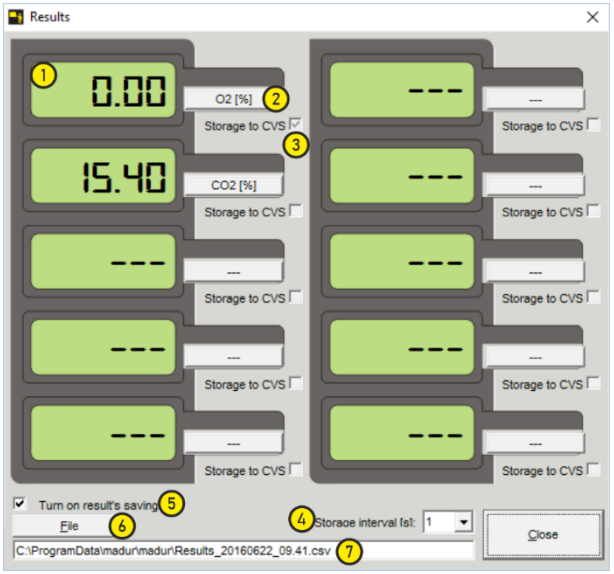
5.13. RS485 settings

If more than one mamos works in one network, it is possible to communicate with all of them (one at a time) using one instance of PC program – in this case each mamos analyser must be assigned with a unique address.



After address is assigned it is possible to select (on the fly) a device for communication – using drop-down list located in a short-cuts bar

6. RESULTS



This window allows to view results (independently from device display) and to store them directly to CSV file on hard disk (under condition that this window is active)

5. Value of the selected variable

Variable's label, also allows to change variable's assignment to the selected display

Only the selected variables (check box Storage to CSV ticked) are saved to hard disk, others are ignored

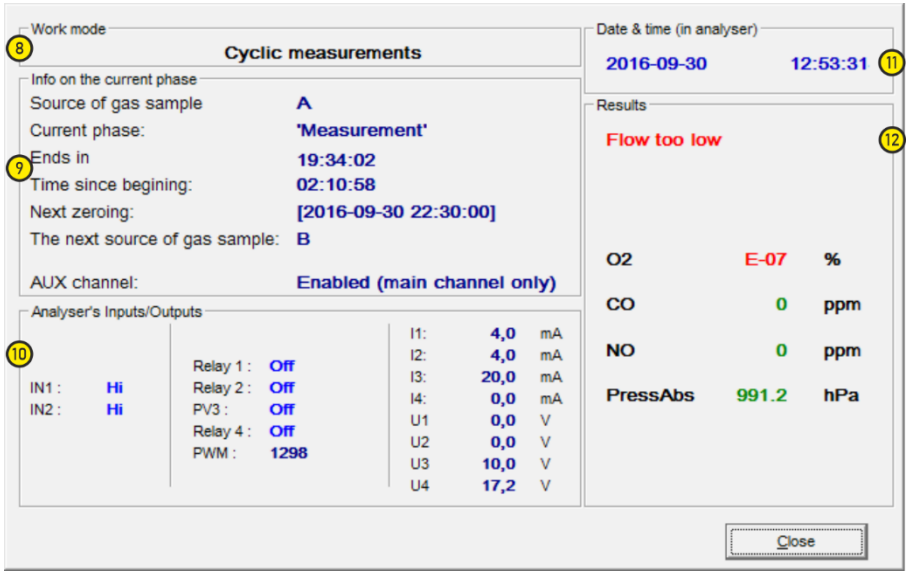
Storage interval (how often results will be stored to CSV file. 1, 2, 5, 10, 30 and 60 seconds.

Switch that turns on storage to hard drive

File - allows to define location of the CSV file on a hard drive

Path to the CSV file. By default, CSV file is stored in an installation folder (or other system related folder) – depends on the version of Windows operating system

7. ANALYSER STATUS



This a general view on the analyser most important parameters:

Type of selected work mode

Information on the current measurement phase:

- from where the gas sample is collected (for twin-split configuration)
- which phase currently occurs
- how long until the end of the current phase
- how long is analyser in the current phase (time since the previous phase)
- when is the next zeroing of gas sensors (=the final moment of ventilation)
- from where the sample will be collected in the next Measurement phase
- Status of the AUX channel

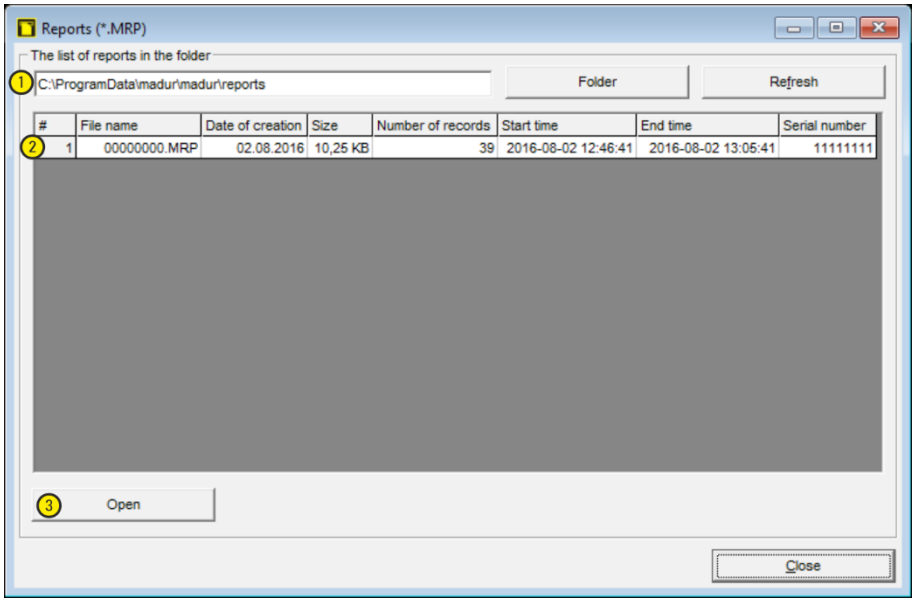
Status of analyser's inputs and outputs

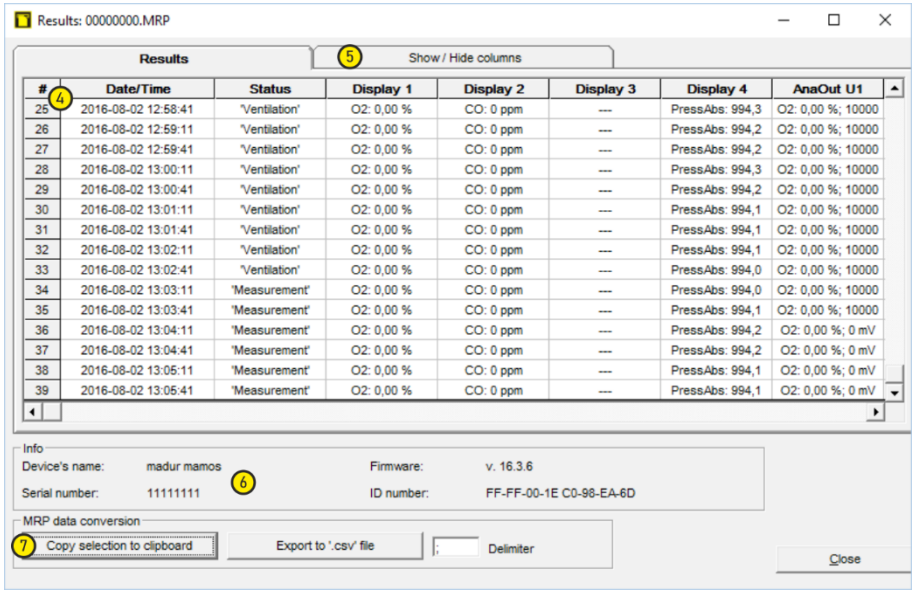
Current date and time (according to analyser's clock

Results from sensors (only those assigned to display)

8. MEMORY CARD

1. Mamos PC program allows to read and convert reports stored by analyser's data-logger to binary files. Binary files, with MRP extension stored on data-logger's SD card must be copied to a user-selected folder – that must be specified in mamos PC program: Folder
2. List of MRP report files stored in the selected folder. Contains following information:
   - index number
   - file's name
   - date of creation
   - file's size
   - number of records
   - date and time when files was created (beginning and end)
   - serial number of the device that created records
3. Select a specific file and press open





4. Preview of recorded results
5. Options to preview and export – allows to select what data will be presented
6. General information about device that recorded data
7. Binary file conversion options:
   - Copy previously selected data to clipboard. Later on data can be pasted to txt file, word, excel, email, etc.
   - Export to CSV file to hard drive – user will be prompt to specify file's name and storage location
   - Delimiter – what character should be used for separation of each column

9. WORK MODES

9.1. Cyclic measurements

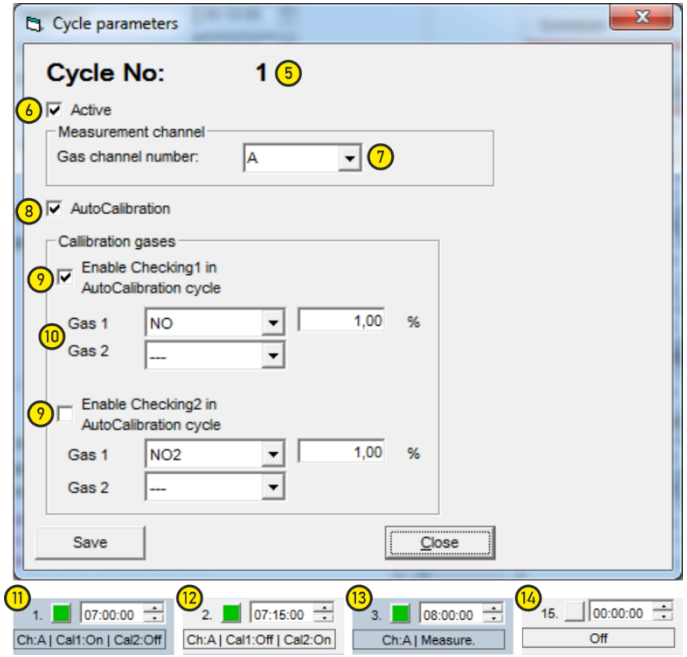
1. Adjustment of duration of cycle phases:
   - Full cycle time – adjustable in range 0÷100 h with 1 sec. step. Full cycle time = Ventilation + Measurements + Stand-by (Stand-by occurs only if TC>TV+TM)
   - Ventilation – adjustable in range 5÷15 min., with 5 min. step
   - Infusion – fixed to 1 minute – informally it is the last moment of ventilation – this is when process gas begins to be fed to sensors, therefore readings on sensors are still uncertain.
   - First zeroing – work phase that occurs right after Warming Up. Time is fixed to 2 minutes
   - Measurement – the essential phase. User-adjustable in range 0÷100 h, with 1 min. resolution.
   - Warm Up – after device is turned on, it requires to prepare components to work, e.g. to stabilise internal temperature.
   - AUX channel – AUX channel is enabled at the beginning of the Measurement phase, after T_A time it is disabled.
2. Selection of work mode
3. Start time for the first zeroing – parameter characteristic for Cyclic measurement work mode. Allows to adjust the Cycles along a day.
4. Assigning actions to digital inputs
5. Graphical representation for the current work cycle
6. Function buttons:
   - *Preview* of the current settings (see chapter: 9.8.)
   - *Save* current settings to analyser
   - Restore *Default* settings
   - Send signal to the analyser to *Restart* the measurement *cycle*
   - Send signal to the analyser to *Terminate* the measurement *cycle*

9.2. Measurements according to scheduler

1. Adjustment of duration of cycle phases
2. Scheduler – allows to select 1÷24 cycles during a day. User can freely specify the start time of each cycle. Cycle will start with ventilation, go to measurements and finally to standby.
   Active cycles are marked with green rectangle Times of each phase is also adjustable.
3. Graphical representation for the current work cycle – in Scheduled work mode, each cycle is labelled with own number.
4. Duration of calibration phase
5. Number of cycle being adjusted

9.3. Auto-calibration with reference gases

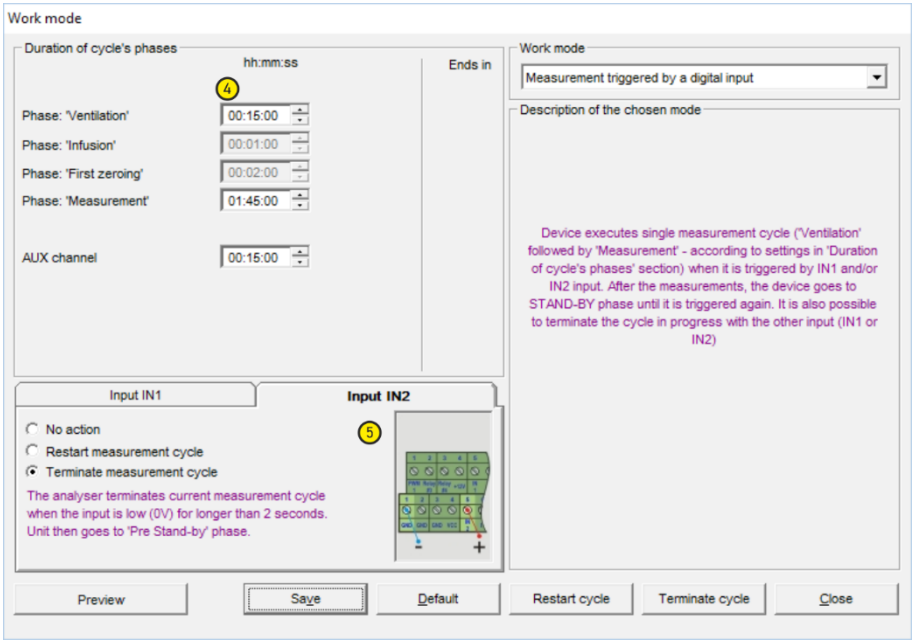
If mamos analyser is equipped with calibration module, scheduler work mode allows to specify when the calibration with reference gases occurs, and to specify parameters of reference gases:



6. Checkbox that enables/disables cycle in scheduler
7. Selection of gas sources (in case of twin-split configuration)
8. Checkbox that enables/disables autocalibration at the beginning of adjusted cycle
9. Specify which calibration channel will be used (only one can be selected at a time
10. Specify parameters of connected reference gas (type of gas and concentration)
11. ÷ 14. Information on parameters the cycle (below cycle's start time):
    - Ch: - gas source (twin-split configuration)
    - Cal1 / Cal2 – autocalibration enabled from reference gas 1/2

In the example above: At 7.00 A.M.: Cycle #1 and Cycle #2 are auto-calibration ones (respectively with reference gas #1 and #2). Because their only purpose are to calibrate sensors, they are interrupted by another cycle with starting point in the middle of measurement phase of the previous cycle. Cycle #3 and #4 are "normal" measurements with full-length cycles. This process repeats at 2.00 P.M.

9.4. Measurements triggered by digital input

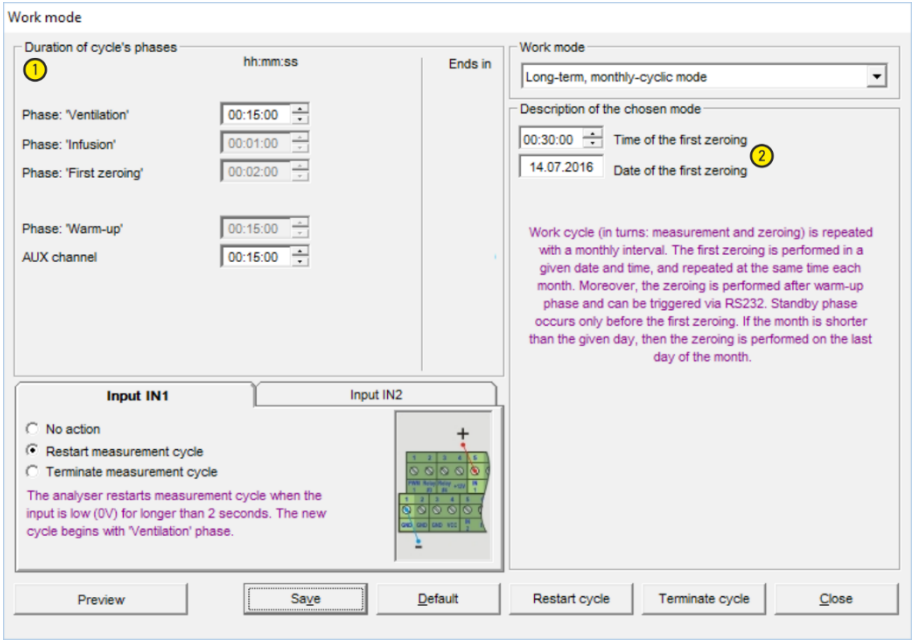


1. Adjustment of duration of cycle phases
2. Assigning actions to digital inputs:
   - Restart measurement cycle – start a new cycle (if measurements are in process, interrupts them) with Ventilation then goes to Measurement – according to defined times.
     If Measurements are set to 00:00:00, then mamos will measure until it receives Terminate signal on digital input.
     Use with caution! Sensors require periodical ventilation for proper work!
   - Terminate measurement cycle – Interrupts Measurements and goes to Stand-by

9.5. Long-term, monthly-cyclic mode

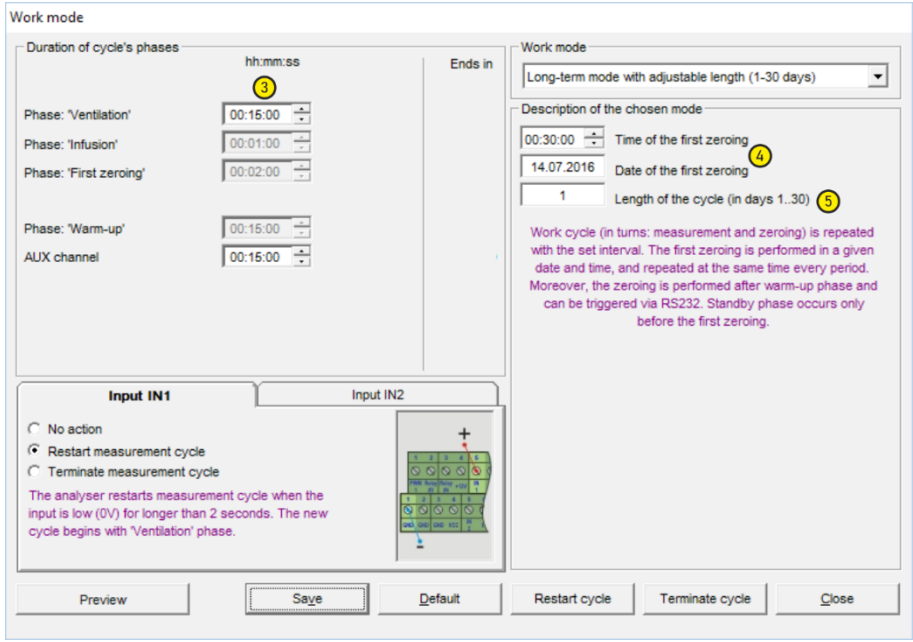
1. Adjustment of duration of cycle phases
2. Definition of the cycle's start:
   - Time of the first zeroing
   - Date of the first zeroing

   Measurement phase lasts for 1 month – the following zeroing will be performed in the next month (in the example, on 2016-08-14) at the same time, i.e. half past midnight.
   User should also specify the ventilation time and time when AUX channel (if present) is enabled.
   Use with caution! Sensors require periodical ventilation for proper work!

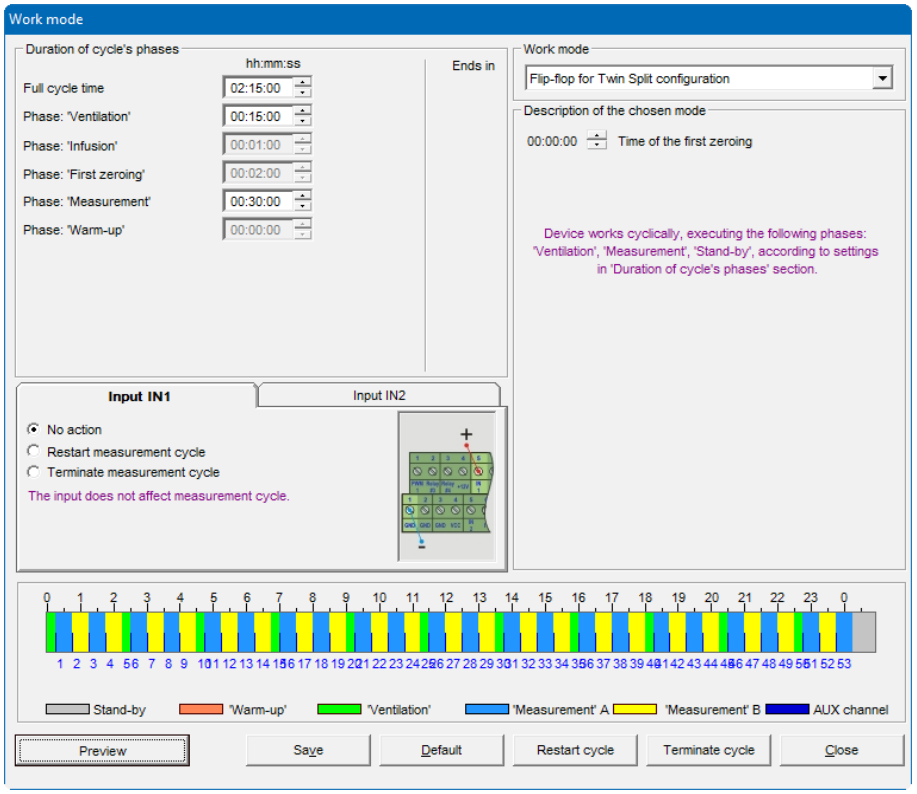


9.6. Long-term mode with adjustable length

3. Adjustment of duration of cycle phases
4. Definition of the cycle's start
5. Definition of the cycle's duration in days (adjustable in range 1÷30)
   This mode work similar to monthly mode, but Measurement phase is shorter.
   Use with caution! Sensors require periodical ventilation for proper work!

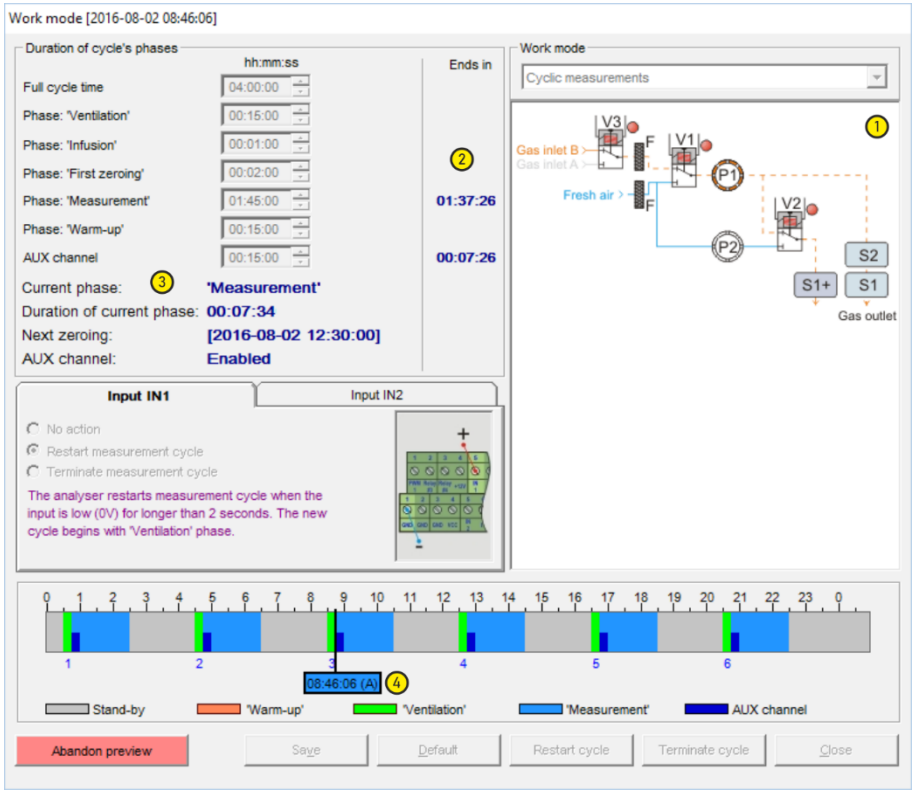


9.7. Flip-flop mode for Twin-Split configuration



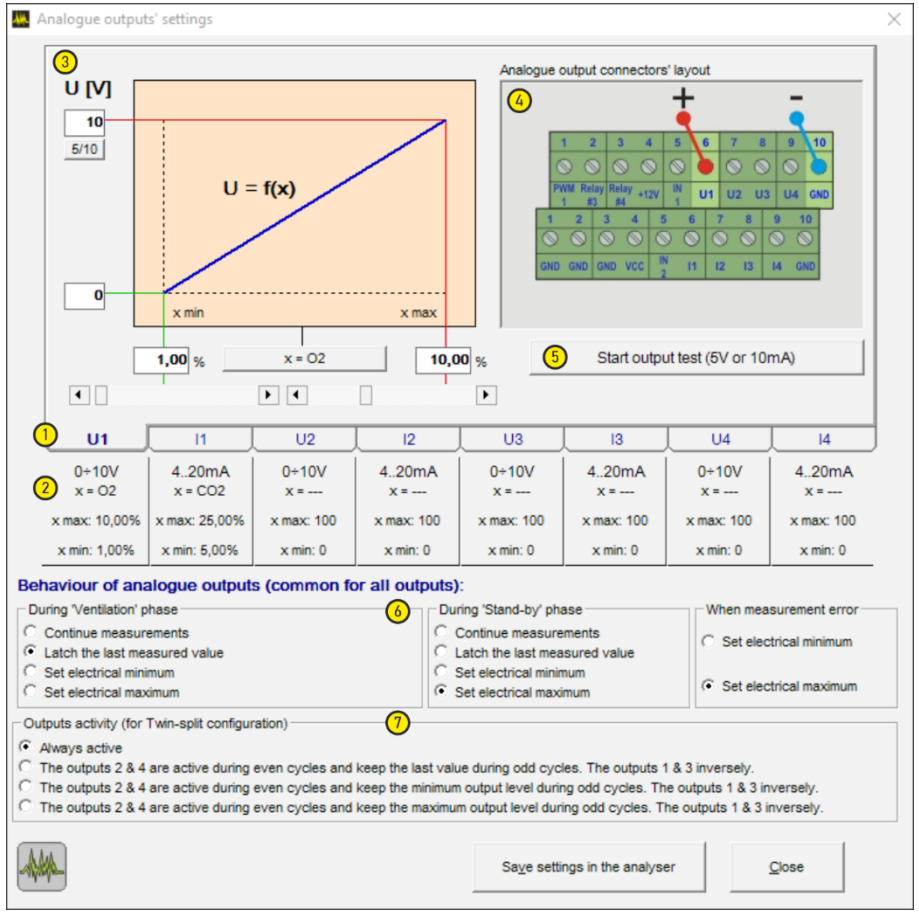
Flip-flop mode is designed for Twin-split configuration. In this work mode Ventilation phase occurs only every N-measurement phases (depends on the set times). When time of Measurement-A finishes, instead of going into Ventilation, analyser continues with Measurement-B. It is advised to set the Measurement time to short period (5÷10min).
Every Measurement phase is preceded with infusion time (non-adjustable, 60 sec).

9.8. Preview of analyser's work status



1. Animated presentation of gas flow through the analyser
2. Information how much time is left until the end of the current work phase
3. Information on the current work phase
4. Time marker; changes the colour according to the current work phase

10. ANALOGUE OUTPUTS



1. All available analogue outputs in analyser divided into 8 tabs: 4x voltage (U1÷U4) and 4x current (I1÷I4)
2. Summary on all analogue outputs: assigned value and min, max values for output
3. Adjustment of selected output:
   a) Y axis:
   - Specify the minimum 0/4 (for current output)
   - or maximum range for voltage output: 5/10

   b) X axis:
   - Assign the value to represent on a selected analogue output: x = O2
   - Assign minimum from sensor / calculated value to the output's minimum e.g. 1%
   - Assign maximum from sensor / calculated value to the output's maximum e.g. 10%
4. Visualisation which terminals refer to the selected output
5. Button that enables test signal (output's mid-range value) – allows to verify if the cables are properly connected.
6. Definition of the outputs' behaviour – these settings apply to all outputs:
   a) During Ventilation
   - Continue measurements – values will be slowly drop to zero when ventilating (in case of O2 sensor will rise to 20,95%). After Ventilation, when process gas will reach start to reach sensors, the results will also start o to rise.
   - Latch the last measured value – to avoid above said, it is possible to "remember" the last measured values and keep them on analogue outputs until Ventilation is over.

   b) During standby
   - Set to minimum – user's system may be informed that mamos is ventilating, by setting all outputs to minimum
   - Set to maximum – user's system may be informed that mamos is ventilating, by setting all outputs to maximum

   c) When error occurs
   - Only two possibilities are available. User can inform own system be setting all outputs to minimum or to maximum
7. For the Twin-Split configuration odd outputs (U1,I1, U3, I3) are assigned to measurement place A, while even ones (U2, I2, U4, I4) are assigned to measurement place B. User can specify how "place A" outputs will behave when measurements are taken from the "place B" and vice versa:
   - always active (= Continue measurements for Ventilation phase)
   - keep the last value (latch)
   - go to max
   - go to min

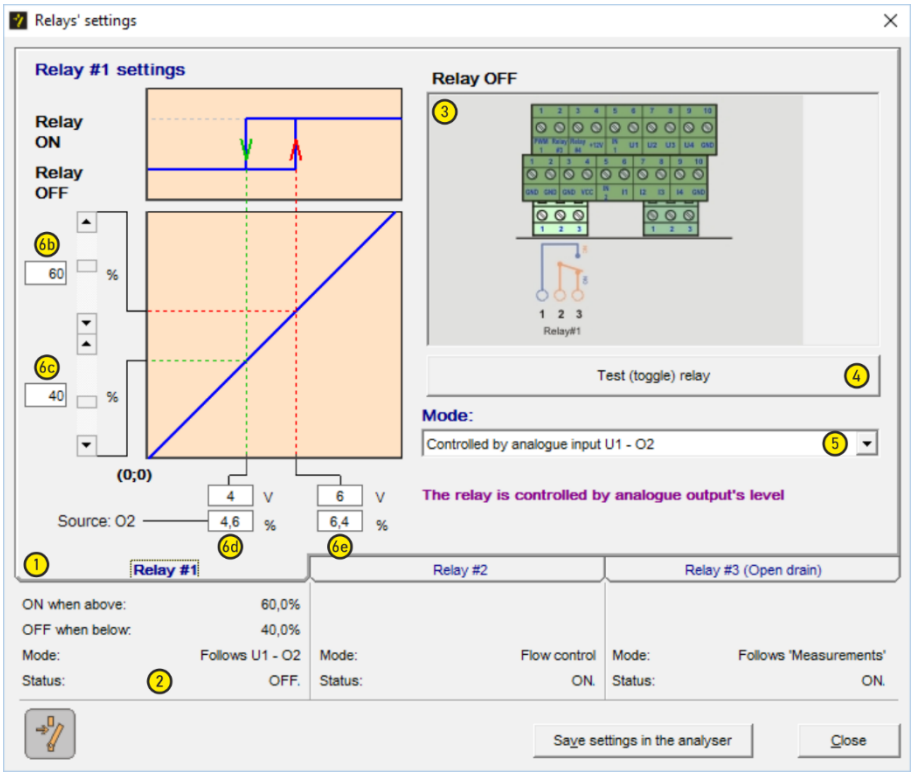
11. RELAYS AND DIGITAL OUTPUTS

Mamos analyser is by default equipped with 2x open drain digital outputs (Relay #3 and Relays #4). Relay #4 is fully controlled via MODBUS communication.

Optionally, mamos can be equipped with 2x SPDT relays (Relay #1 and Relay #2).

Relays #1, #2, #3 are configurable via PC program:

1. Available relays, divided into 3 tabs
2. Summary on all relays: selected mode (20), assigned value and current status (ON / OFF)
3. Visualisation which terminals refer to the selected relay
4. Button that enables test relay – allows to verify if the cables are properly connected.
5. Mode for relay output:
   a) Controlled by analogue output – used for alarm setting – see point 20 below
   b) Follow digital input IN1 / IN2 – mimics action on digital inputs – transfers this signal further
   c) Follow Measurements phase – informs user's application when mamos performs measurements. In other phases, like Ventilation or Stand-by, relay is OFF
   d) Flow control – ON when flow is within acceptable range. OFF when flow drops below threshold value (see chapter 9)
   e) ON during odd / even cycles – informs user's system about the sampling point (for Twin-Split configuration)
   f) No action
6. Relay may work as an alarm, if its mode is set to "controlled by analogue output". Then user can specify:
   a) source of alarm – by selecting appropriate output from drop-down list (Relay's mode (20))
      Because relay may work with hysteresis, both ON and OFF thresholds are assigned:



   b) Alarm's ON level; expressed as % of the corresponding analogue output's range – in this example 60% of U1 output → 6,4% of O_2 (shown on X axis **6d**)
   60% of outputs range = 60% (max-min) + level assigned to output's min.= 60% × (10% of O_2 – 1% of O_2) + 1% of O_2 = 60% × 9% of O_2 + 1% of O_2 = (5,4% + 1%) Of O_2 = 6,4% of O_2
   c) Alarm's OFF level; 40% of U1 output (**6e**)
   40% of outputs range = 40% (max-min) + level assigned to output's min.= 40% × (10% of O_2 – 1% of O_2) + 1% of O_2 = 40% × 9% of O_2 + 1% of O_2 = (3,6% + 1%) Of O_2 = 4,6% of O_2