# CMS - 7

## Service Programme

## Manual

01/2007 – v 2.03

**madur**®

E L E C T R O N I C S

# 1.Introduction

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

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

## 1.1. The installation of the programme

To begin the installation process it is necessary to start the setup_CMS7.exe file and then to follow the instruction which will appear on the screen.

## 1.2. Starting up the programme

When starting the programme up the user should turn the analyser on and connect it to the computer with use of the communication cable. After the **CMS** programme has been started the following screen will appear:
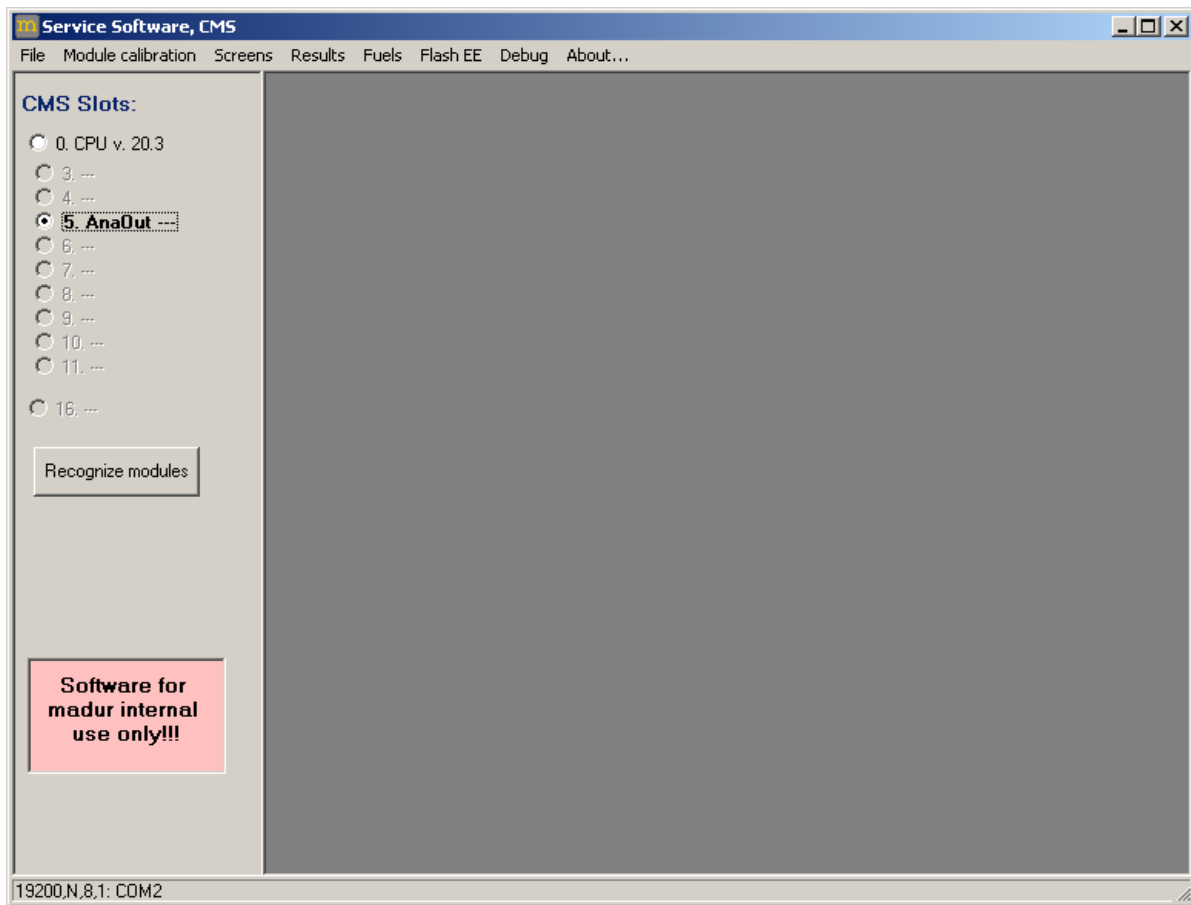
The access to all the programme's options is available from the *Main  menu* bar. Below the *Main menu* bar, on the left-hand side, there is a panel, on which all the detected elements of the analyser are marked (*CMS slots*), and the *Recognize module* key responsible for establishing the connection is situated. In the remaining field the windows used for operating the analyser appear.

## 1.3. Connection with the analyser

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

After the successful connection process the programme will detect and show the modules available in a particular device and will display the list of sensors on the left panel.
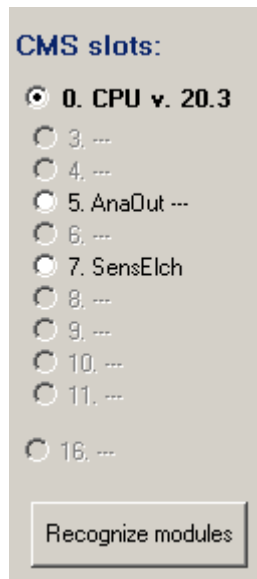
Switching between the analysers (and the available sensors) is carried out by choosing different positions from the list. Marking any of the sensors (or the CPU board) relates all the programme's actions to the chosen element of the analyser.

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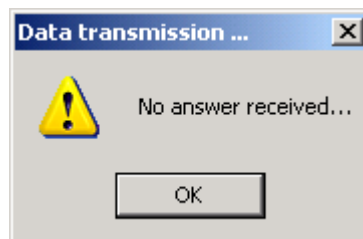


This means the connection process has not been completed successfully, which might have been caused by the inappropriate setting of the serial port in the programme (*Menu > File > Options*) or by a damaged or improper communication cable.

## 1.4. *File* menu– the programme settings
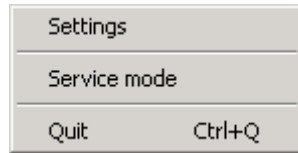


➔ **Settings**      - enables the user to set the parameters of the **CMS**
                 programme
➔ **Service mode**     - after the password has been entered the programme
                 switches to the service mode
➔ **Quit**       - exits the programme

### 1.4.1. *Port* – the port settings

The setting enables the user to choose the serial port to which the analyser is connected.
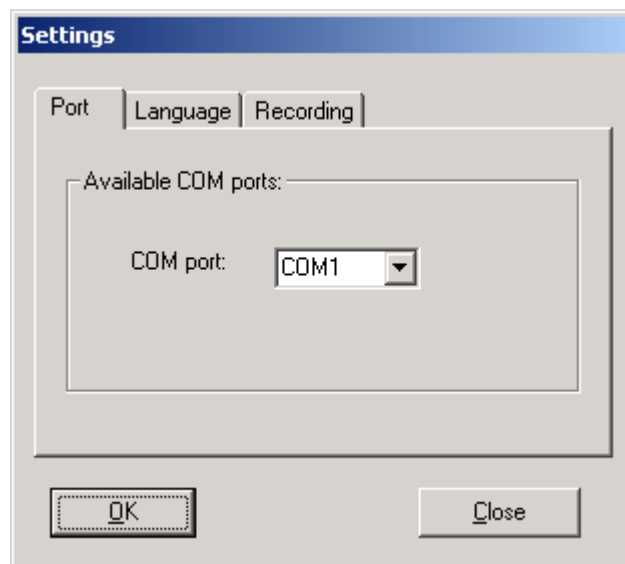


### 1.4.2. *Language* – language settings

The programme is available in several language versions.

### 1.4.3. *Data logger* – saving the results
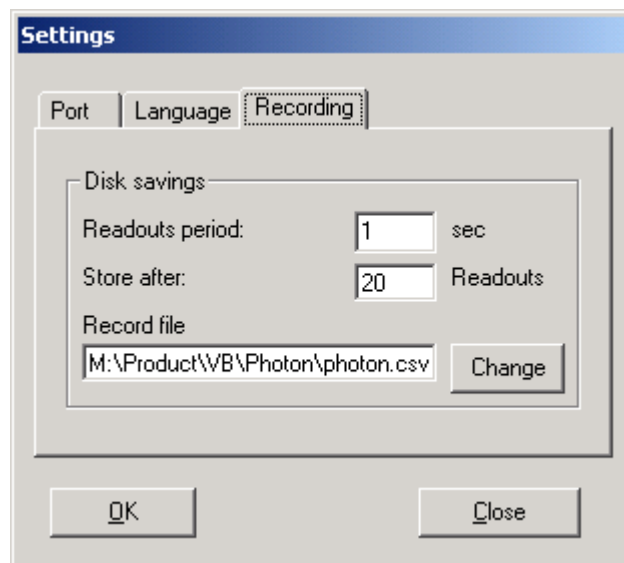
The options:

➔ Readouts period     - the length of the interval between the following readouts of the current measurement results

➔ Store after          - the amount of readings after which the storing process proceeds

➔ Record file          - the name and the path to the file used for storing the results

## 1.5. *Module Calibration* **menu**

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

The particular calibrations are described precisely in the chapter Calibration.

After selecting the CPU board on the left panel & pressing the **Module calibration** option from the main menu the following window will be displayed.
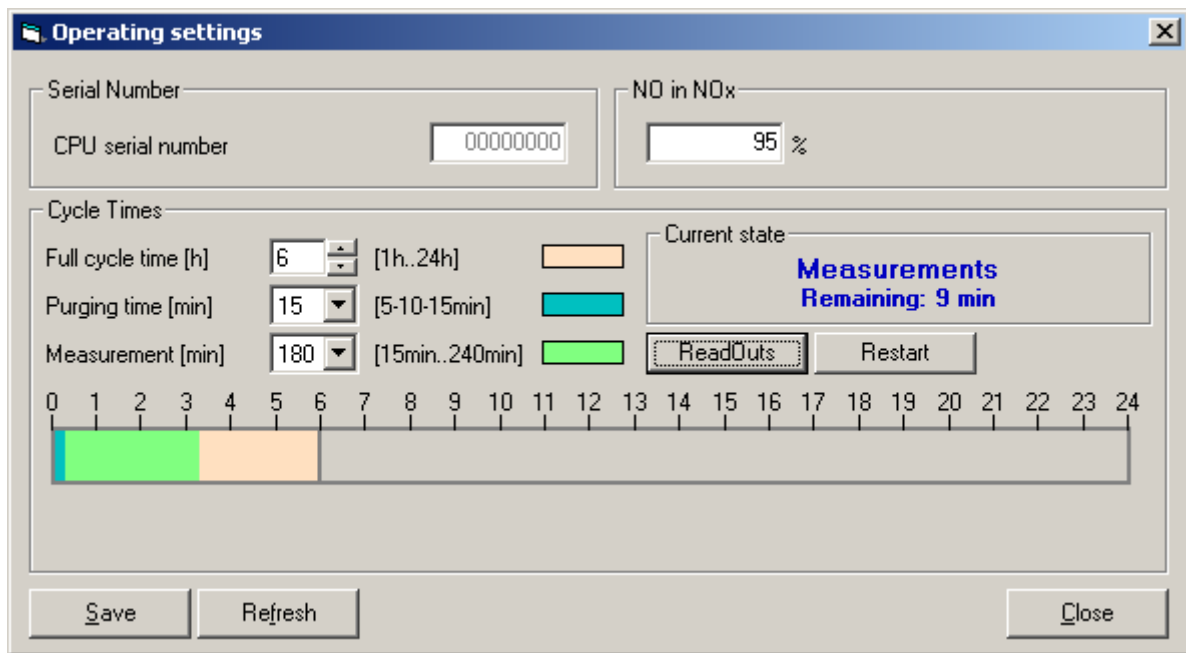


Using the *Operatings settings,* some CPU settings can be done. The setting s are divided into few frames.

a)  Frame **Serial Number** contains serial number of the CPU board. The user has no possibility to change this setting.

b)  Frame **NO in Nox** enables setting of NO in NOx contents in percent. The parameter serves for calculating NOx contents from measured NO contents.

c)  Frame **Cycle Times** contains information concerning the operating cycle of the CMS unit. The following settings can be done:

➔  Time of full operating cycle (***Full cycle time***), which can be set in range from 1h to 24h, with step of 1h,

➔ Time of ventilation (***Purging time***) i.e. time for zeroing sensors, which can be set in range from 5min to 15min with step of 5min,

➔ Time of the measure phase (**Measurement**), which can be set in range from 15min to 4h. The Measurement time can have following values (15/30/45min 1/1.5/2/3/4h).

A separate color is used for each phase of working cycle. The strip at the bottom of frame presents single operating cycle of the unit.
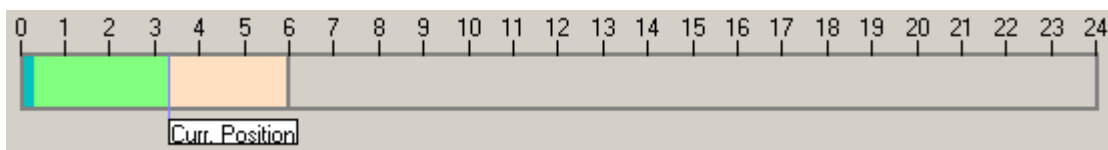


The whole strip length is equal to maksimum cycle length i.e. 24 hours. Separate phases of operating cycle are shown with their own colours. The  marker  **Curr. Position** points the current moment within the operating cycle.

Each cycle starts with **Ventilation** phase which is followed by **Measurement** phase. After **Measurement** phase the unit goes to **Standby** phase in which it stays until the next cycle begins. Time of **Standby** phase cannot be set by user – its length is a difference between the **Full cycle time** and **ventilation**+**measurement** phases.
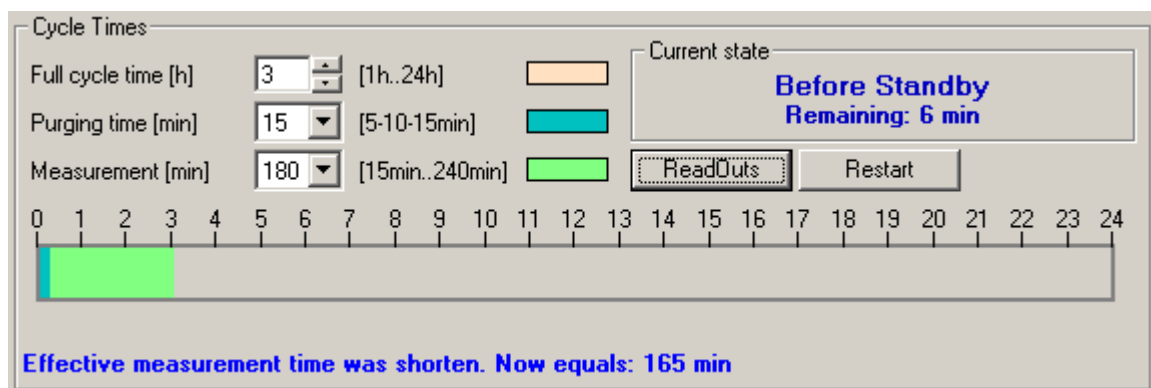


If the length of **ventilation** + **measurement** phases is longer than **Full cycle time** then the **Measurement** phase will be shorten. If the length of **ventilation** + **measurement** phases is shorter than **Full cycle time** then after **Measurement** phase

the standby phase will take place.

Additionally following buttons are placed within the frame:

➔ **Stop/ReadOuts** enables / disables continuous readings of unit status,

➔ **Restart** – restarts the unit operating cycle (beginning with ventilation phase),

d) Frame **Current state** shows the current phase of the CMS unit and time remining to the end of this phase. Following communicates are possible:

➔ *Purging* phase,

➔ *Measurement* phase.

➔ *Before Standby* phase, with fixed 5min length (user cannot change this phase length). This phase is a part of **standby** phase, the only difference is that pump continues working,
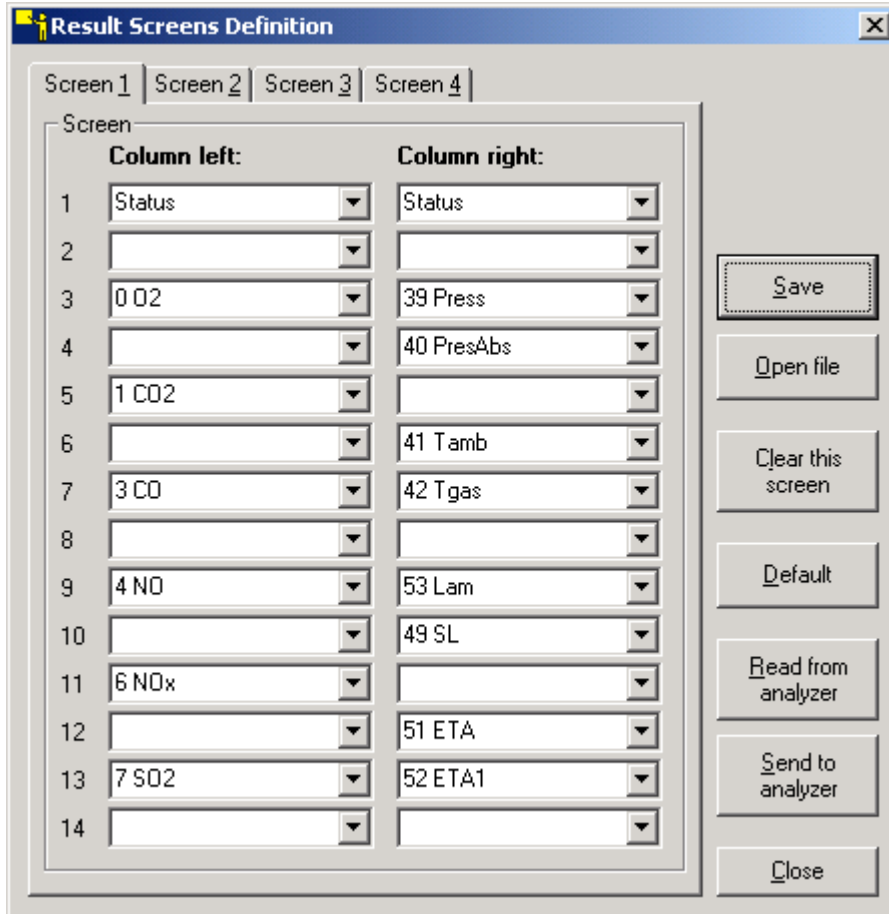
➔ *Standby* phase,

There are also some buttons on the form:

➔ **Save** – saves current settings to CPU board,

➔ **Refresh** reads all settings from the device and refills the form ,

➔ **Close** – closes the form

## 1.6. *Screens* menu – result screens definition



With the help of the results screen window one may define the results which are to be shown on particular screens on the device display. It is possible to display the results on four screens - each of them made up by two columns consisting of up to 14 positions each, in the configuration defined by the user.

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

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

**Attention!**

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

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

## 1.7. *Fuels* menu

The opening of the Fuels DataBase might be preceded by the appearance of the following note:
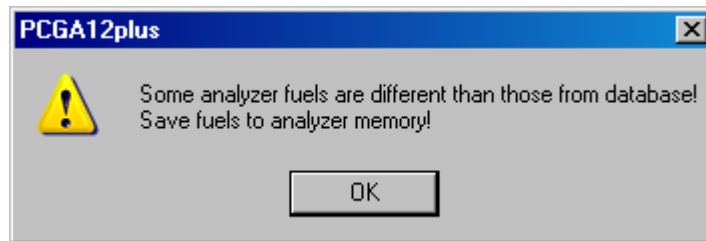


After confirmation the Fuels Database will be displayed.



The Fuels DataBase can hold up to 256 positions. Each fuel has its individual number Fuel #. The fuel number cannot be edited. The standard fuels are numbered 0-9.

These are:

0  Light oil

1  Natural gas

2  Town gas

3  Coke-oven gas

4  Liquid gas

5  Extra light oil

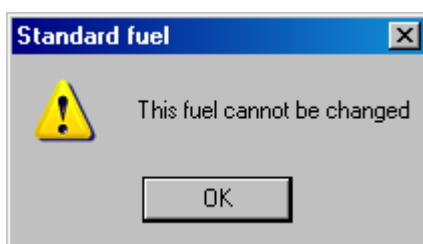6  Pit-coal 31.5

7  Pit-coal 30.3

8  Charcoal

9  * Test fuel *

The fuel number 255 is the so-called "empty fuel" - it will not be seen in the analyser . The parameters of the standard fuels cannot be edited:



All the other fuels (numbered 10-254) can be defined by the client. The analyser has six programmed standard fuels and the memory holding up to 4 additional fuels defined by the user. The Fuels DataBase window makes it possible for the user to define the new fuels and send their parameters to the analyser when needed.

The Fuels DataBase window elements:

| Fuel No | Name | CO2max | HV | A | B | Alpha | O2ref | Vss | Vair | Eta bonus |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Light oil | 15,4 | 42,7 | 0,5 | 0,07 | 52 | 3 | 10,53 | 11,2 | 0 |
| 1 | Natural gas | 11,7 | 35,9 | 0,37 | 0,09 | 32 | 3 | 8,56 | 9,54 | 0 |
| 2 | Town gas | 13,1 | 16,1 | 0,35 | 0,11 | 32 | 3 | 3,61 | 3,9 | 0 |
| 3 | Coke-oven gas | 10,2 | 17,4 | 0,29 | 0,11 | 32 | 3 | 3,86 | 4,28 | 0 |
| 4 | Liquid gas | 14 | 93,2 | 0,42 | 0,08 | 32 | 3 | 22,3 | 24,36 | 0 |
| 5 | Bio-diesel | 15,7 | 41,8 | 0,4567 | 0,05 | 52 | 3 | 10,44 | 11,15 | 0 |
| 6 | Fuel1 | 12 | 0 | 0,5 | 0 | 0 | 3 | 8 | 8 | 0 |
| 7 | Fuel2 | 15 | 0 | 0,5 | 0 | 0 | 3 | 8 | 8 | 0 |
| 8 | Fuel3 | 11,7 | 35,9 | 0,37 | 0,09 | 3200 | 3 | 10 | 9 | 1 |
| 9 | Fuel4 | 15 | 0 | 0,5 | 0 | 0 | 3 | 8 | 8 | 0 |
| 11 | Fuel5 | 15 | 0 | 0,5 | 0 | 0 | 3 | 8 | 8 | 0 |
| 191 | Fuel6 | 6540,3 | 6540,7 | 6,5535 | 490,19 | 65407 | 2 | 487,67 | 651,47 | 25,5 |
| 255 | Empty | 12 | 0 | 0 | 0 | 52 | 3 | 10 | 10 | 0 |

The above table contains the fuels parameters.



The table with the chosen fuel parameters.

The Edit button enables the user to edit the parameter values.



The numbers and the names of the fuels saved in the analyser's memory. Each of the fuels is highlighted with different colour. Accordingly, the lines containing the data of the particular fuel in the fuels parameters table is of the same colour. Pressing the Change key will replace

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the appropriate fuel with the one
currently indicated in the fuels
parameters table.
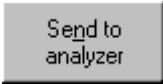
Pressing the [Send to analyzer] key sends the chosen fuel parameters to the analyser's memory.
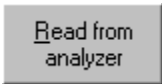
The [Read from analyzer] key imports the user's fuel parameters from the analyser.

## 1.8. *Results* menu



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

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

➜ **Normalised**             - the level of the signal after normalization

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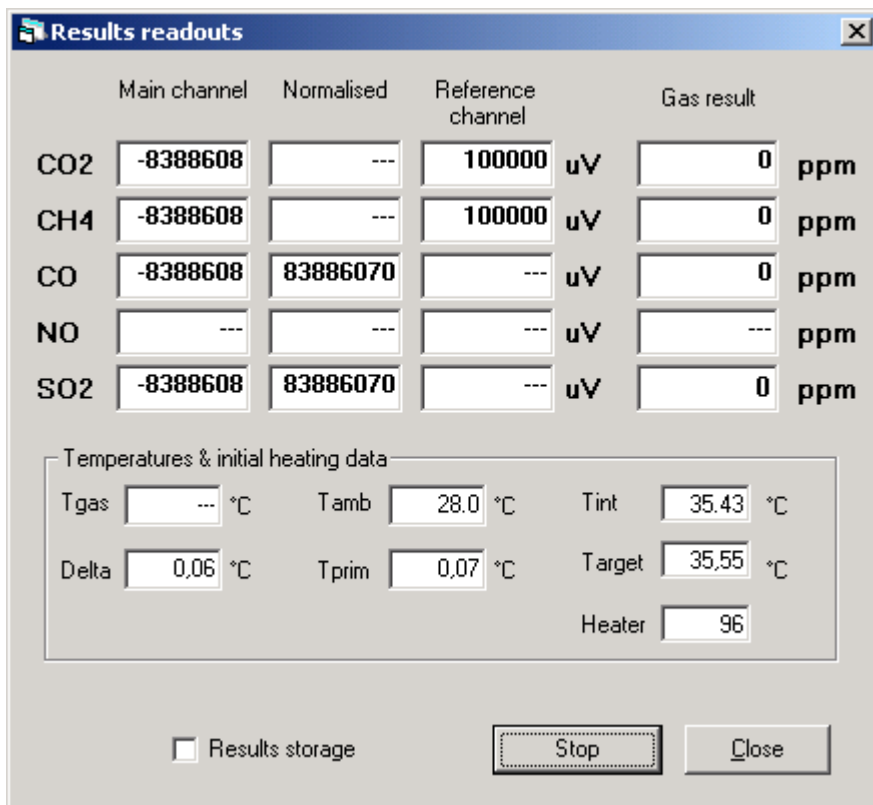
➜ **Gas result**             - the content of the gas given in ppm

and the temperatures are shown:

➜ **Tgas**                    - the gas temperature (after the probe has been connected)

➜ **Tamb**                   - the ambient temperature (after the probe has been connected)

➜ **Tint**              -        the interior temperature

➜ **Delta**                  - the temperature increase

➜ **Tprim**                  - the three-minute temperature increase

➜ **Target**                 - the heating temperature (the target temperature)

➜ **Heater**                 - the heating level is given

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

## 1.9. *Menu: Flash EE* – memory contents readouts
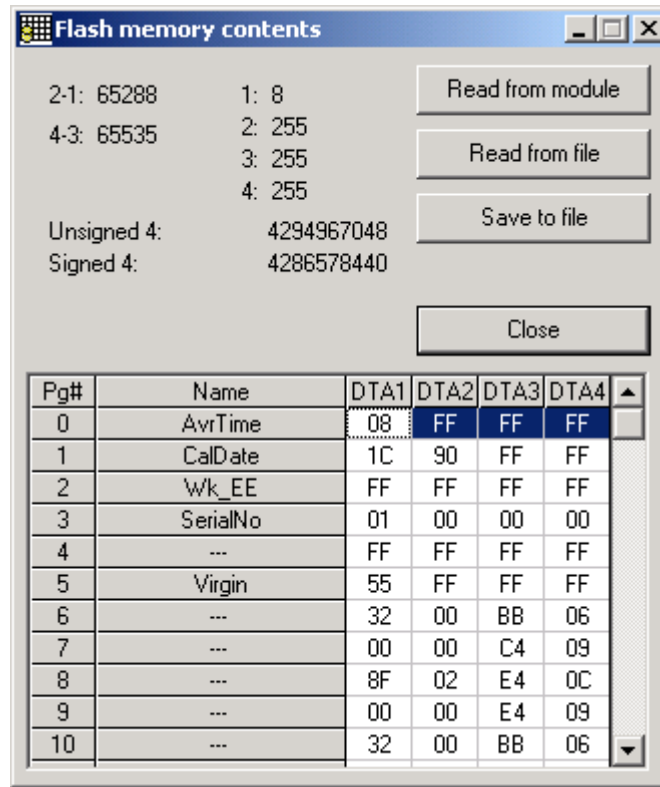


For controlling and servicing purposes there is a possibility of reading the content of the device's memory and storing it in the binary file on the computer's disk (the FlashEE.bin in the current programme's directory).

### 1.10. *About...* menu - information on the programme
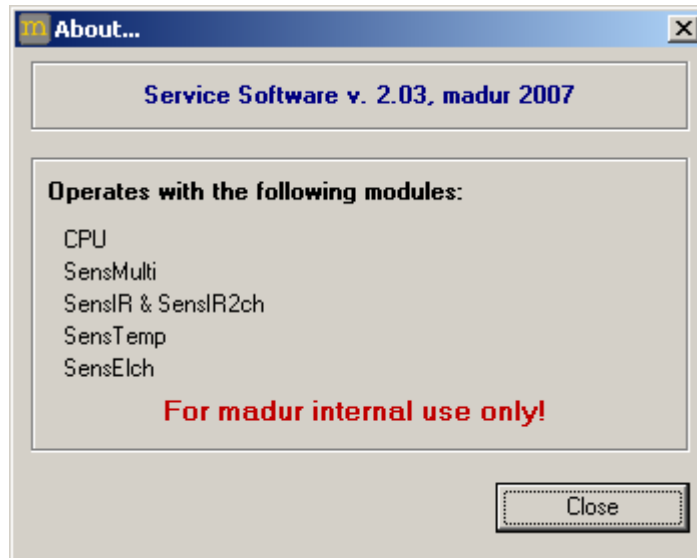


The window informing about the number of the programme version.

# 2.Calibration

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

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

## 2.1. IR sensors calibration
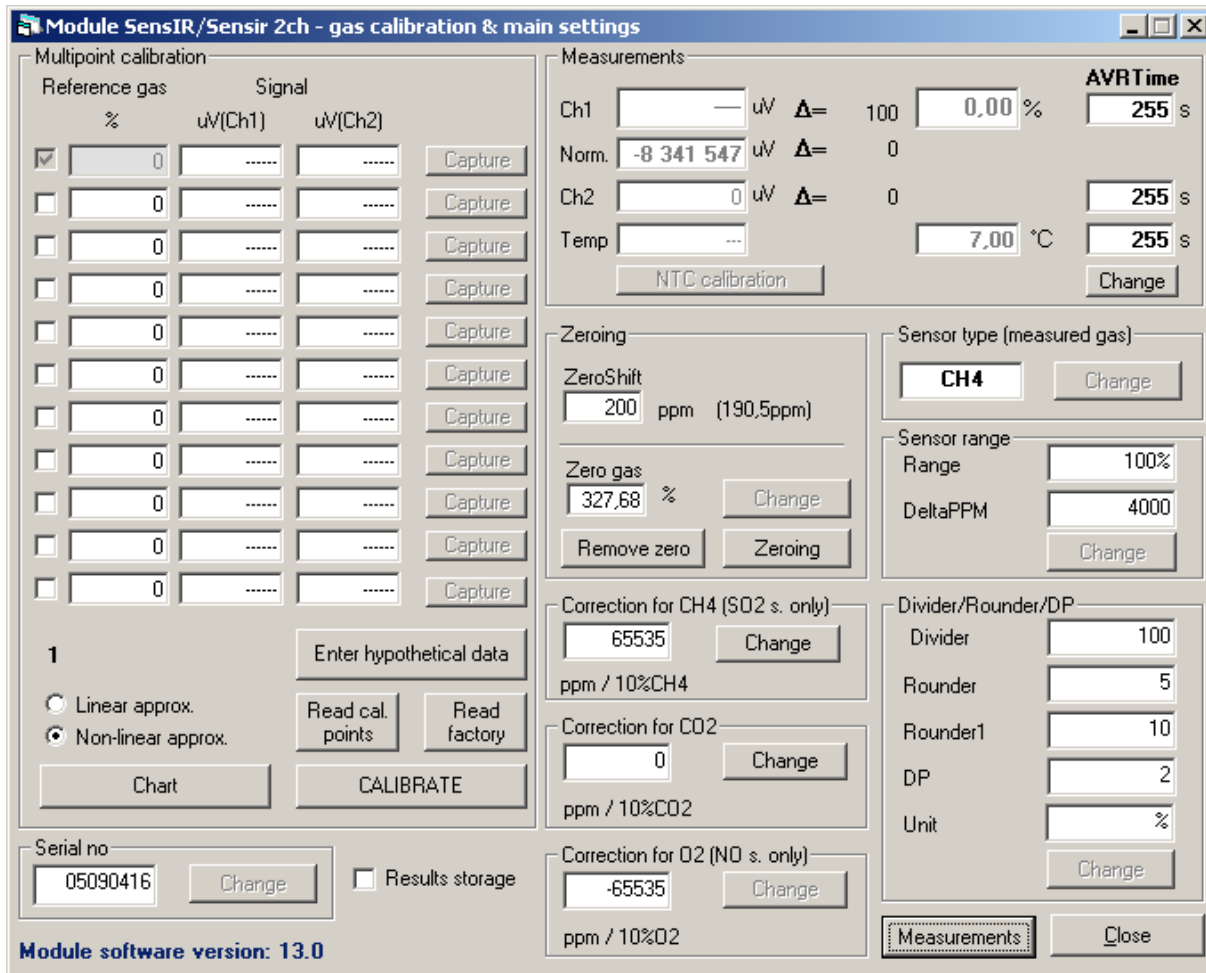


The procedure of the IR sensor calibration

**Attention!**

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

   The calibration of the **CMS-7** analyser is about generating the calibration curve used for evaluating the measurement results with the help of the signals received from the sensors.

   If the calibration is to proceed, standard gases have to be supplied to the device and the particular signal from the measurement converter have to be matched with the

appropriate gas concentration (*Capture*) in the *Multipoint calibration* box.

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

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

| Calibrated gas | Delta value |
|---|---|
| CO, NO | <10 |
| $SO_2$ | <15-20 |
| $CO_2$ | <50 |

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

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

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

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

| ✓ | 20 | 989 051 | 100 000 |

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

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

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

| ✓ | 20 | 989 051 | 100 000 |

Attention!

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

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

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

      **CALIBRATE**                  -storing the calibration curve in the analyser

      **Chart**                         -the window displaying the calibration curve

      **Enter hypothetical data** - entering the hypothetical calibration points (deletes the calibration                   data)

      **Read cal. points**          -the readout of the points from the device (deletes the calibration                   data)

      **Read factory**             -the readout of the factory curve (deletes the calibration data)

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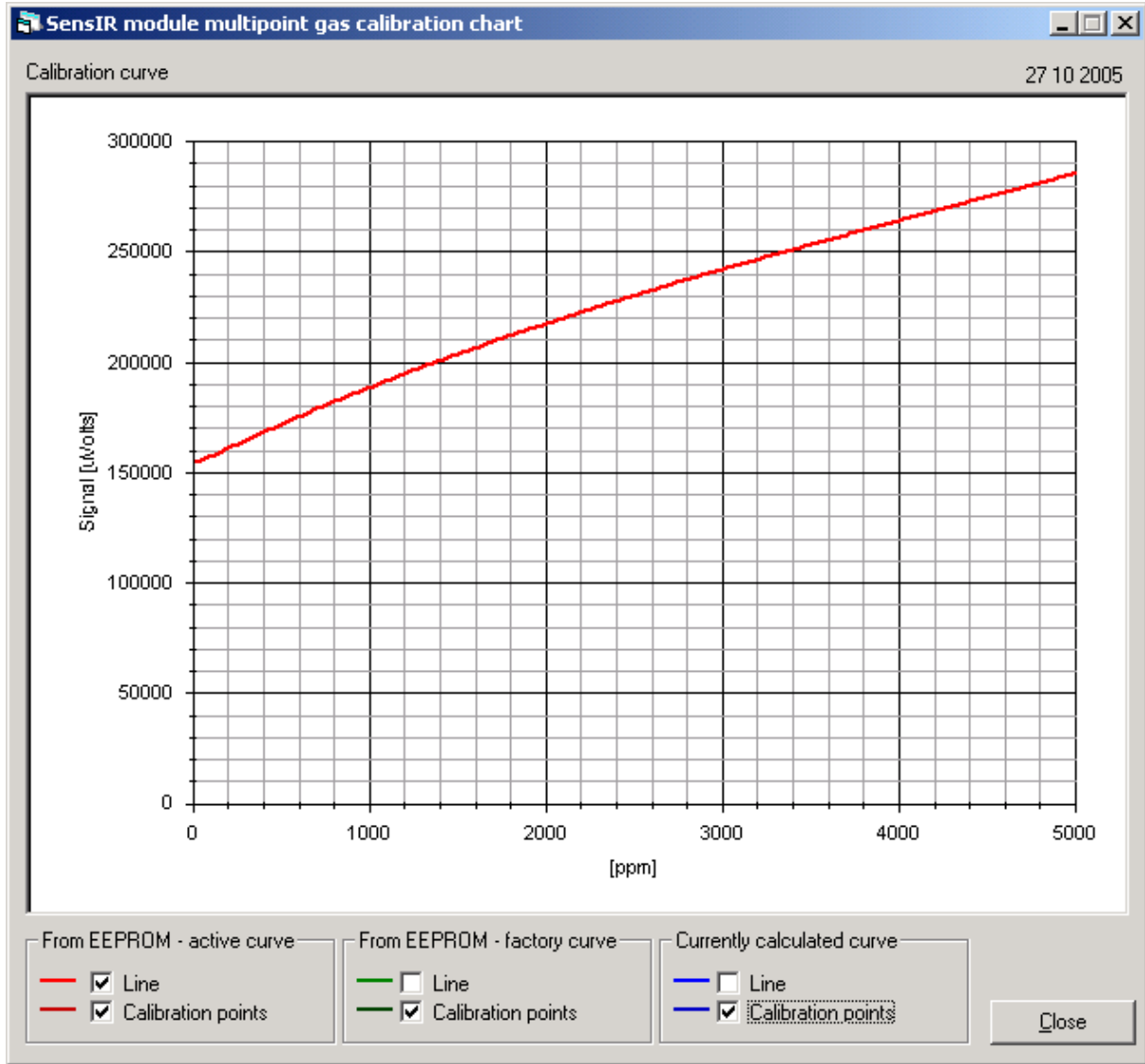


After the chart has been displayed, a note asking for confirmation of the decision to save the data in the device memory will appear, after confirmation the calibration data will be changed.

## 2.2. Calibration of the electrochemical cells
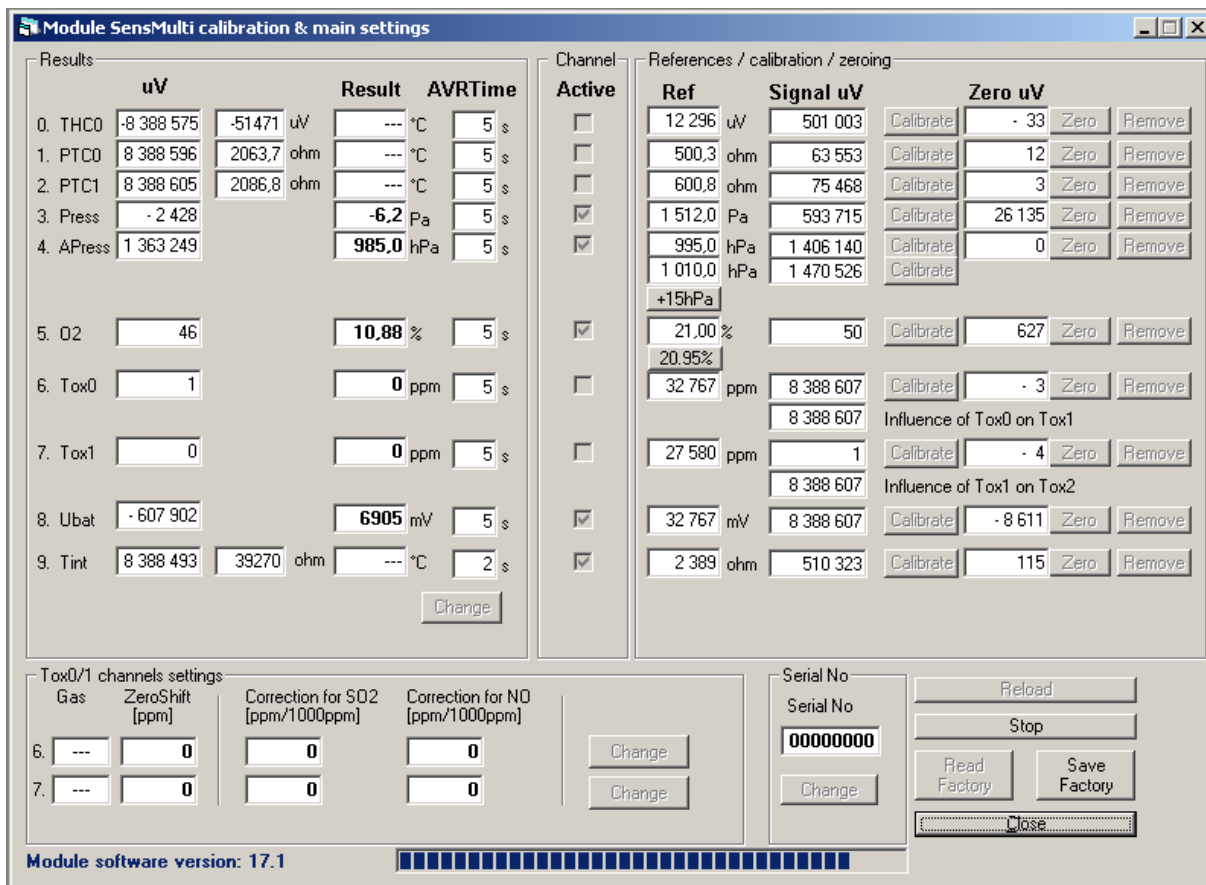


The procedure of calibration of the electrochemical cells

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

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

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

- ➔ **THC0**    - the thermocouple, uV
- ➔ **PTC0**    - the thermocouple, the thermistor
- ➔ **PTC1**    - PT500
- ➔ **Press**    - the differential pressure
- ➔ **APress**    - the ambient pressure
- ➔ **O2**    - the oxygen sensor
- ➔ **Tox0**    - the additional sensor channel

→ **Tox1**          - the additional sensor channel

→ **Ubat**          - the supply voltage

→ **Tint**          - the interior temperature

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

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

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

**Attention!**

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

## 2.3.Analogue outputs

To configure the analogue outputs select the *AnaOut* option from the left bar and choose *Module Calibration* from the *Main menu.* The following screen will appear.
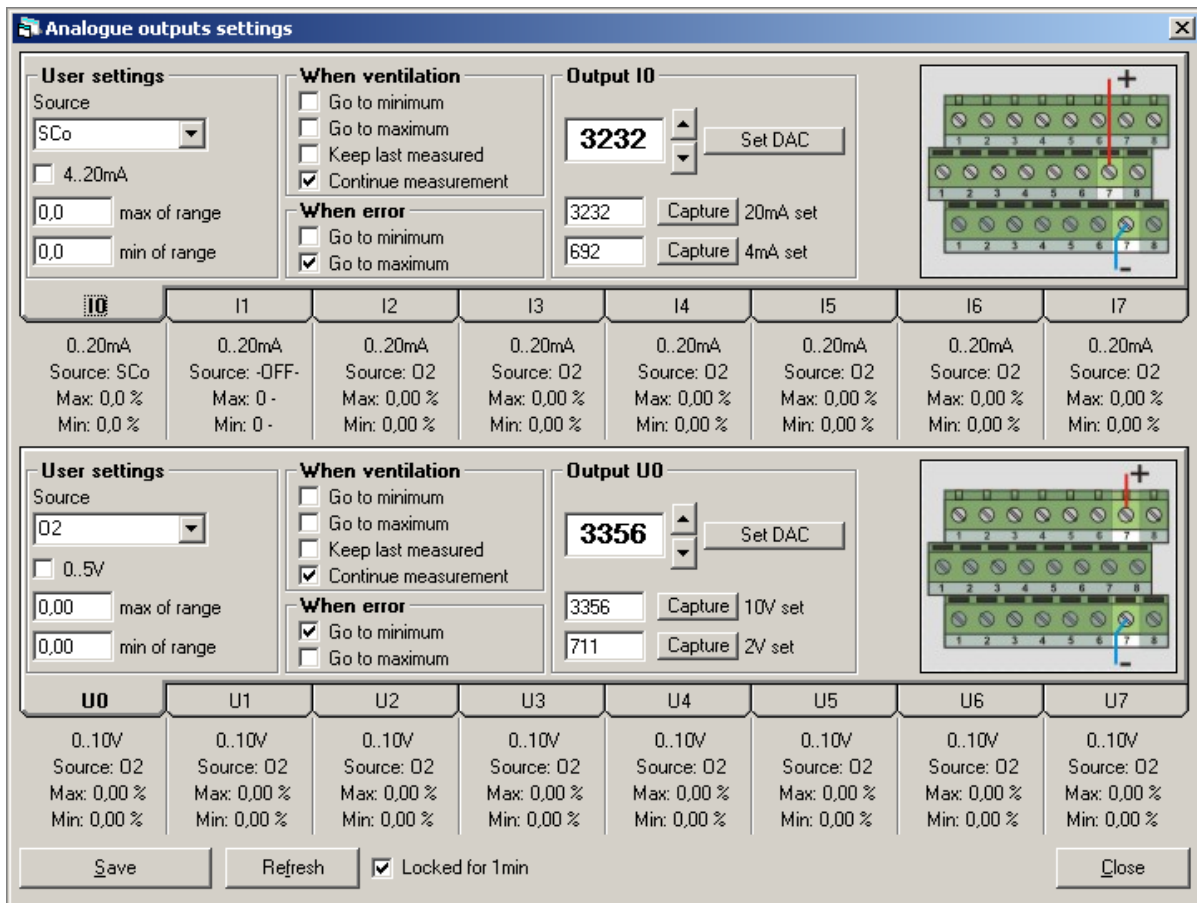
It allows to configure each analogue output's behavior. There are 16 analogue outputs – 8 current (**I0..I7**), grouped in tabs at the top, and 8 voltage ones (**U0..U7**), grouped in tabs at the bottom.  Below the each output's name current settings are displayed. To configure a specific output select it's tab. Settings for each tab look the same, and are displayed above. Information about current settings of each output are listed below it's name and contains:

→ range

→ assigned signal

→ signal's level assigned to maximum of output's range

→ signal's level assigned to minimum of output's range

**User Settings section**
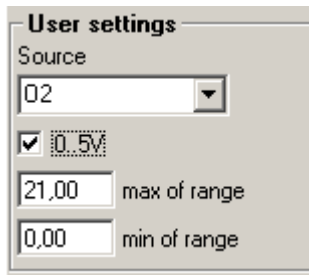
➔ **Source** – assigns specific signal to configured output. The drop-down menu contains all available signals.

➔ Output's range

- ☑ 0..5V - voltage outputs can work in two different ranges: 0-5V (check box on) or 0-10V (check box off).

- ☑ 4..20mA current outputs can work in two different ranges: 4-20mA (check box on) or 0-20V (check box off).

➔ **max of range** – sets the signal's level to the maximum of outputs range (5/10V or 20mA) (in the example: 5V refers to 21% of $O_2$ concentration)

➔ **min of range** – sets the signal's level to the minimum of outputs range (0V or 0/4mA) (in the example: 0V refers to 0% of $O_2$ concentration)

A drawing showing the localisation of specific output connector on the analogue outputs connector module is shown on the right side of form.
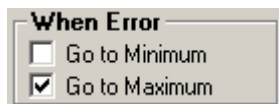
**When Ventilation section**
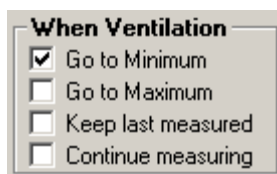


Determines how the output behaves during the ventilation time. (only one option is available to choose from)

➔ **Go to Minimum** – sets output to it's minimum value.

➔ **Go to Maximum** – sets output to it's maximum value.

➔ **Keep last measured** – remembers the last value that was measured before the ventilation process started.

➔ **Continue measuring** – ignores the fact of ventilation.

**When Error section**



Determines  how the output behaves if error occurs. (only one option is available to choose from)

➔ **Go to Minimum** – sets output to it's minimum value

➔ **Go to Maximum** – sets output to it's maximum value

**Refresh** button refreshes all window's fields from the device memory.

**Save** button saves changes to the device.

**Close** button closes the window without saving changes.

The form contains also few settings for each analogue output. These are as follows:

➔ analog output range, i.e. maximum voltage (5 or 10V for voltage output) or minimum current (0 or 4mA for current output),

➔ source variable – the measurement result presented on selectedeach analogue output,

➔ the source variable maximum – the value of source variable corresponding to maximum of the analogue output,

➔ the source variable minimum – the value of source variable corresponding to minimum of the analogue output,.

## 2.3.1. Analogue outputs calibration

### A. Current outputs configuration procedure:
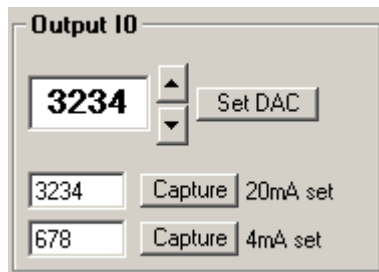


1) Connect an ammeter to selected current analogue output.

2) Make sure the field ☑ Locked for 1min is checked – this check box disables output's normal     work for a minute. Outputs will then (or when the check box is deactivated) resume their's     normal work.

3) Use the arrows or numeric keypad to change the value until the ammeter shows 20mA.

4) Press **Capture (20mA set)** button to save the result.

5) Use the arrows or numeric keypad to change the value until the ammeter shows 4mA.

6) Press **Capture (4mA set)** button to save the result.

7) Press **Save** button to send settings to the sensor.

8) Repeat the procedure for all the current outputs.

**B. Voltage outputs configuration procedure:**
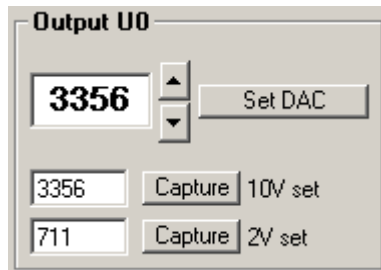


1) Connect a voltmeter to selected voltage analogue output.

2) Make sure the field  ☑ Locked for 1min  is checked – this check box disables output's normal        work for a minute. Outputs will then (or when the check box is deactivated) resume their's        normal work.

3) Use the arrows or numeric keypad to change the value until the voltmeter shows 10V.

4) Press **Capture (10V set)** button to save the result.

5) Use the arrows or numeric keypad to change the value until the voltmeter shows 2V.

6) Press **Capture (2V set)** button to save the result.

7) Press **Save** button to send settings to the sensor.

8) Repeat the procedure for all the voltage outputs.

## 2.4. Sensor SensElch

To calibrate Electrochemical sensors open the *Module SensElch calibration & main settings* window. To do that select *SensElch* option from the left bar and press *Module*

*calibration* from Main Menu. *Module SensElch calibration & main settings*  window is shown below. It is divided into several sections responsible for different actions: results' presentation, calibration, sensors' settings, etc.
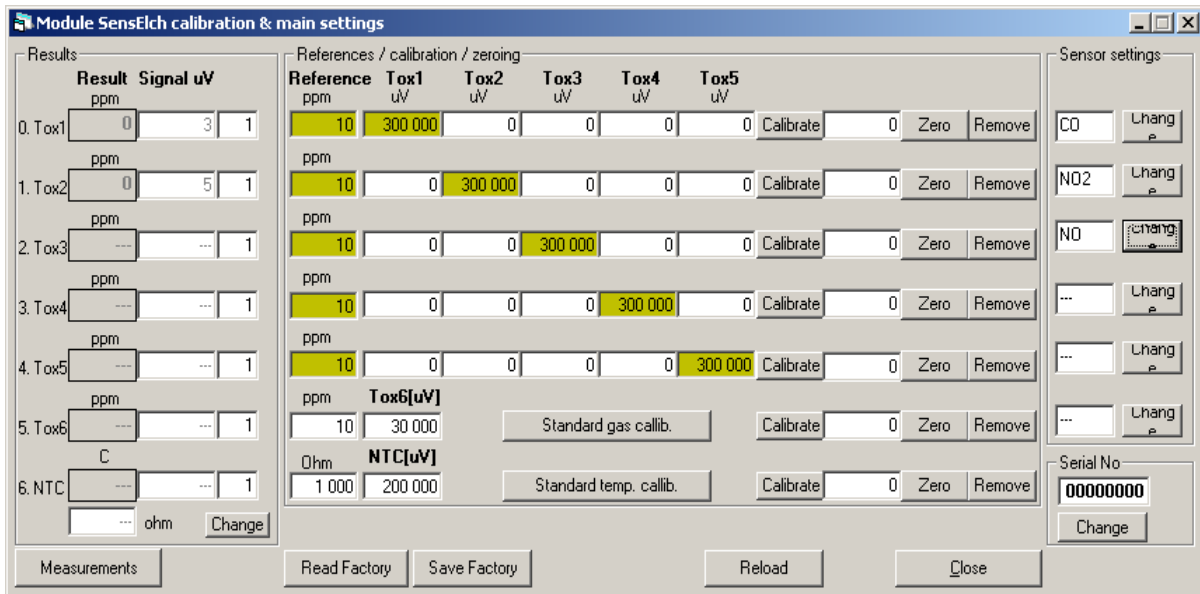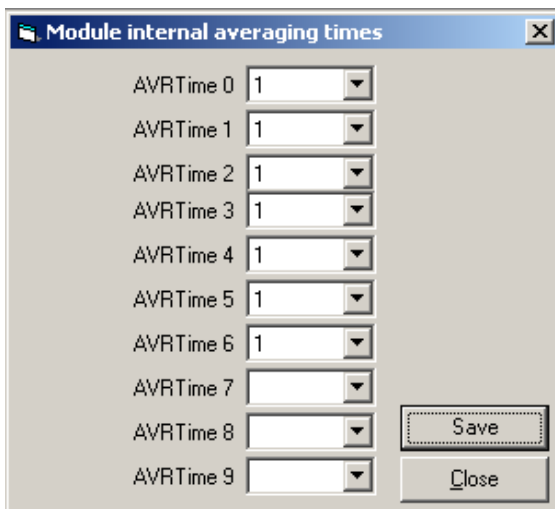


### Results section
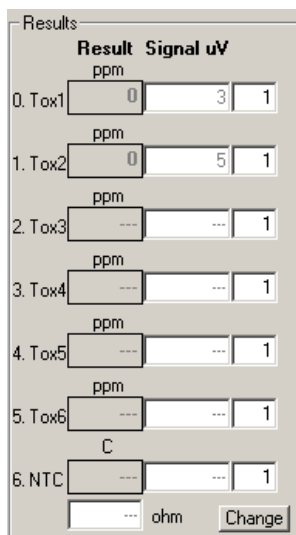


Presents 7 available channels' results (gas channels **Tox1..Tox6** and temperature channel **NTC**).

Each line contains:

➜ channel number,

➜ result in ppm,

➜ it's equivalent in µV,

➜ averaging time in ms. Can be changed by entering new value and pressing

➜ **Change** button. It will open the following window (where averaging times can also be changed)



**References / calibration / zeroing section**
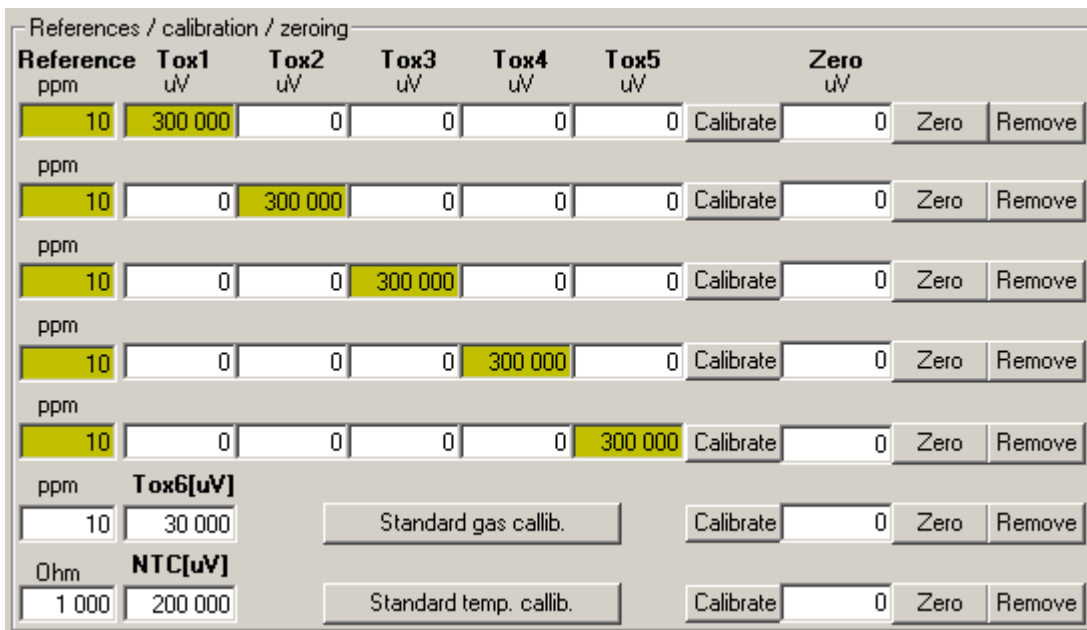
This section is responsible for the cross sensitivity calibration of channels **Tox1..Tox5** – each line refers to a different Tox channel.

Columns description:

➔ **Reference** shows reference gas concentration in ppm.

➔ **Tox1..Tox5** shows selected sensor's responses to other gas concentrations. Highlighted value indicates target gas.

➔ **Calibrate** – saves calibration values to sensor.

➔ **Zero** – shows sensor's response to zero gas.

➔ **Zero button** – zeros measurement channel.

➔ **Remove button** – removes previously set zero.

The 6th line contains **Tox6** channel settings which does not participate in cross sensitivity measurements.

The 7th line contains temperature channel settings. **Ohm** field indicates thermistor's resistance settings.  **NTC [µV]** – NTC voltage settings.

**Standard gas calib**. and **Standard temp. calib.** buttons are used for restoring default settings.

### Sensor settings section



Shows assigned gas type to the specific **Tox** channel. This assignment can only be changed from the service mode.  If **Change** button is pressed the following screen appears:
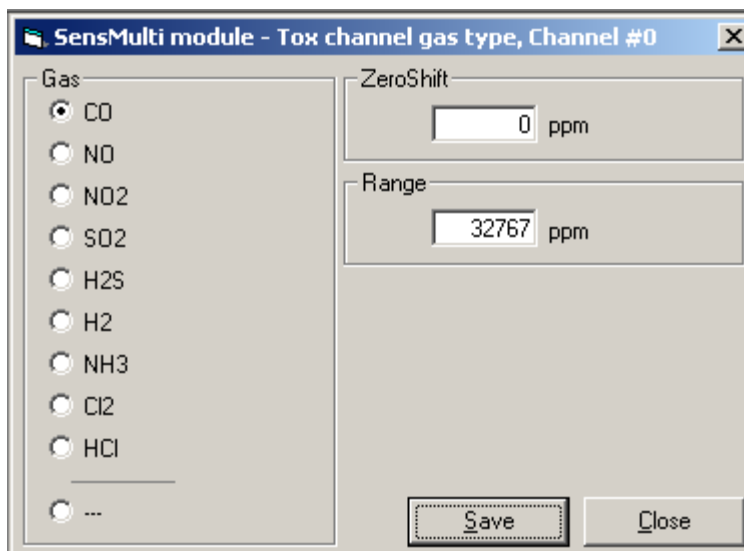


Choose gas from the list. Enter Zeroshift and Range values.

Control buttons:

➜ **Measurement/Stop** – turns on/off the measurements (setting can be done only when measurements are off).

➜ **Read factory** – restores factory settings (stored in the save memory area)

➜ **Save factory** – creates backup settings in a save memory area

➜ **Reload** – reloads settings from sensor's memory

➜ **Close** – closes the window without saving.

**Serial number section** – shows device's serial number.

## 2.4.1. Electrochemical sensor calibration

Sensors calibration made by unqualified personnel can cause the loss of the analyser's proper settings and because of that may prevent from correct measurements. madur strongly advise against any self-made calibration's modifications!!!

To calibrate SensElch sensor:

1) Go to service mode and open *Module SensElch calibration & main settings window.*

2) Assign sensors to each measurement channel. If no sensor is installed/assigned set "---".

3) Press **Standard gas calib.** button to fill fields in **References/calibration/zeroing** section with with "save" values

| Reference ppm | Tox1 uV | Tox2 uV | Tox3 uV | Tox4 uV | Tox5 uV |
|---|---|---|---|---|---|
| 100 | 30 000 | 0 | 0 | 0 | 0 |
| ppm | | | | | |
| 100 | 0 | 30 000 | 0 | 0 | 0 |
| ppm | | | | | |
| 10 | 0 | 0 | 300 000 | 0 | 0 |
| ppm | | | | | |
| 10 | 0 | 0 | 0 | 300 000 | 0 |
| ppm | | | | | |
| 10 | 0 | 0 | 0 | 0 | 300 000 |

4) Administer the gas of a known concentration to the analyzer's Tox1 channel.

5) Enter the concentration value into **Reference** field.

6) Wait for at least a minute for results to stabilize.

7) Press **Calibrate** button to save cross sensitivity values for the calibrated sensor.

8) Repeat points 4-7 for the remaining channels.

9) Press **Save** to store calibration setting to the sensor.

## 2.4.2. Temperature channel calibration

Temperature calibration can be executed in two ways.

➜ Standard calibration – press **Standard temp. Calib.** It will set the default values for NTC resistance and voltage.

➜ Enter the **Ohm** and voltage values and press **Calibrate**

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