

# PPM meter

Intempco Inc.



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## 1. Product description

The Intempco PPM Meter is a microprocessor based instrument designed to measure the Methane or Ethanol concentration in the liquid.

The PPM Meter consists of two main units: the Gas Sensing Probe, installed inside the fermentor and the Probe Control Box (see figure 1).

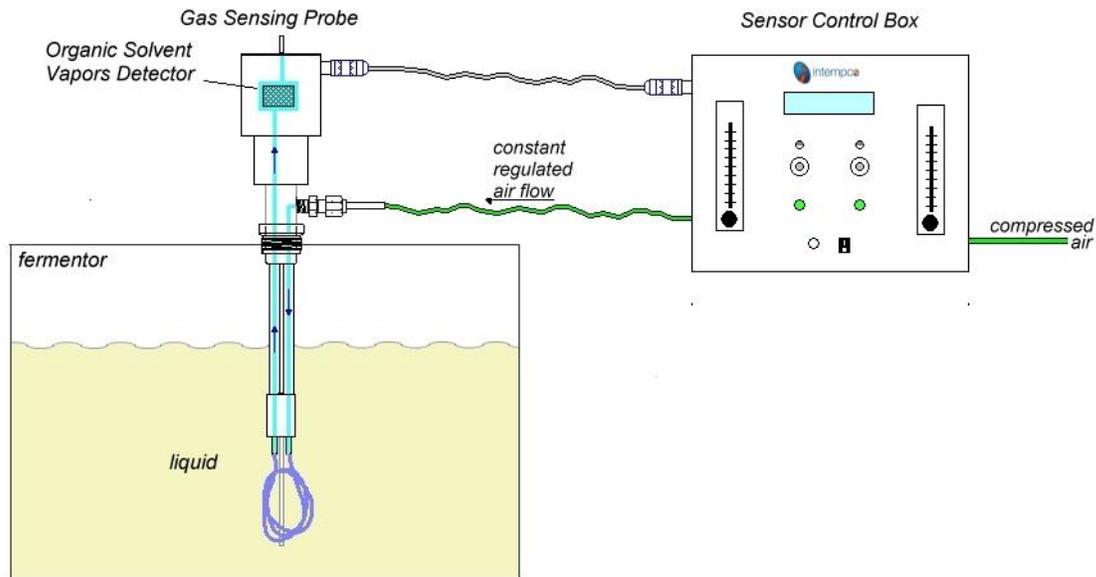


Fig. 1

The Gas Sensing Probe makes use of the permeability of silicone to gases but not to liquids. This property makes it possible to extract some volatile compounds from liquids, and to evaluate their concentration by the Organic Solvent Vapors Detector. To extract these volatile compounds, a carrier gas (air) circulates in a silicone tube. This gas, while circulating in the tube, extracts volatiles from the liquid. Those volatiles are transported outside the sterile environment of the fermentor towards a semiconductor Organic Solvent Vapors Detector installed in an industrial headset (figure 1). This sensor responds to certain volatile compounds, including Methane and Ethanol (figure 2). Their presence will make the resistance of the sensor vary.

Data are displayed on the LCD or are available over an USB port on the PC running supplied PPMETER.exe software.

The unit is factory pre-programmed and pre-calibrated but may need a few steps setup after installation.

You can connect **two** Gas Sensing Probes to one Control Box.

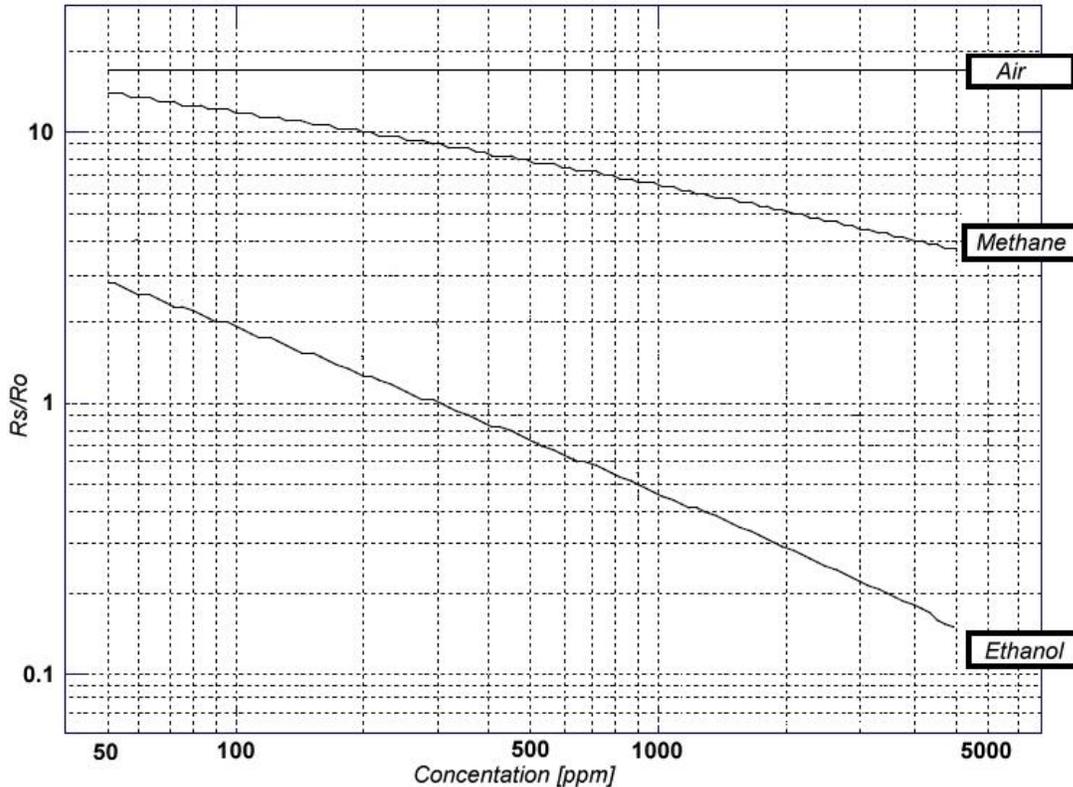


Fig. 2

## 1.1. Technical Data

Power Supply	9-12VDC / 500 mA
Gas Sensor	Figaro TGS 822
Sensing tubing	Silicone 0.058 ID x 0.076 OD x 0.09 wall (preferred)
Flow rate of carrier gas	0-250 cc/min
Air supply	Unregulated dry clean air at 15psi. Air pressure is regulated inside the control box to 10 psi.
Output	4 - 20 mA Two dry contacts relays
Response time	5 min to 90%
Sensitivity	0.02% to 10% (depending on the tubing length, type and flow rate of the carrier gas)
Communication	USB port MODBUS protocol Function: read data, configuration, calibration
Storage Temperature	-40 to 70°C (-40 to 167 °F)
Operating Conditions	Calibration must be made under working temperature and humidity values of the fermentation process. Recommended: 20 ±2 °C ( 68 ± 4 °F) and 65 ± 5% humidity

Gas Probe Sensor mounting	19 mm port on the fermentor vessel
Air supply connection	¼ inch press-to-fit connector
Dimensions:	
Gas Probe Sensor	26cm x 21 cm x 21 cm (10½" x 8½" x 8½")
Control Box	H=38 cm (15"), Diam=5cm (2")

## 1.2. Limitations

The PPM Meter is not an analyser. It gives a good estimate of the volatile content into the liquid. The probe is sensitive to pressure and temperature. Any variation in those parameters will affect the output from the probe. Thus users should use an off-line analyser to confirm the probe reading done on-line. There is no guaranty that the probe will work with every medium.

The calibration must be done under the same conditions of pressure and temperature as the fermentation process.

Other silicone tube other than the one proposed can be used. Response time may vary as well as sensitivity. Any tubing that have OD < 0.1in and ID < 0.075 in. should fit. It is the responsibility of the users to make tests with their process.

## 2. Preparation of the probe

### 2.1. Silicone tube installation

The silicone tube employed is thin-walled and is very flexible. When it is soaked in chloroform it becomes softer and its diameter increases. It is then possible to insert it on the metal tubes of the probe. The tube should be replaced after each fermentation process.

For the installation you will need the following elements:

- Chloroform and a small container,
  - A chemical hood,
  - Gloves compatible with chloroform,
  - A stand to hold the probe
1. Check the cleanliness of the probe.
  2. Cut a silicone tube of suitable length (40cm is a good length). A shorter length or thicker wall may be used for the detection of higher concentrations.
  3. Inside the hood, soak one end of the tube in chloroform for one minute

4. Pinch the tube to keep chloroform in the tube and direct the silicone tube above one of the metal tubes of the probe.
5. Slip the silicone tube onto the metal tube all the way to the base (some practice is necessary the first times). If the tube tears a little at the base, cut the damaged part off and start again. The tube quickly retrieves its original dimensions with the evaporation of chloroform and will stick firmly to the metal tube.
6. Thread the tube through the perforated plate, making smooth loops in order to avoid pinching the silicone tube (figure 3).
7. Soak the other end of the silicone tube in chloroform and complete the installation on the probe.
8. Connect the carrier air supply to the probe,
9. To check the correct operation of the probe and tubing, soap can be applied on carrier gas body outlet. Bubbles should form.

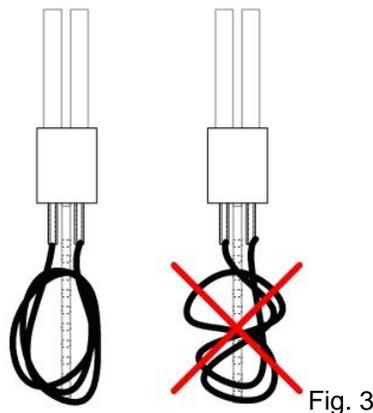


Fig. 3

## 2.2. Installation of the probe on the vessel

The probe is installed in a 19 mm port on the lid of the fermentor. According to the type of vessel, O-rings will have to be positioned in order to maintain the probe in place firmly. The probe can be used on two types of 19mm port:

- 1- New-Brunswick Scientific fermentor vessels type:

The O-ring must be placed under the shoulder of the probe. The Teflon ring normally installed above the O-ring when the port is closed with the New-Brunswick stopper, must be removed. No O-ring is needed in the bottom groove of the probe.

- 2- BioEngineering, Infors or Chemap fermentor vessel type:

An O-ring must be placed in the bottom groove. In the case of an Infors fermentor one O ring must placed over the shoulder in order to maintain the

pressure on the body (Figure 4). BioEngineering or Chemap vessel does not need this O ring.

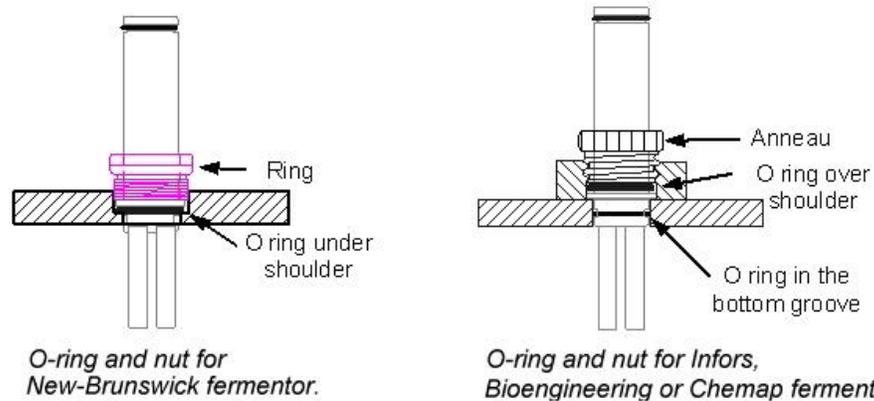


Fig. 4

Insert the Gas Sensing Probe into the fermentor and tighten the ring. The probe should be oriented so that the plate is parallel to the liquid flow in the tank (figure 5).

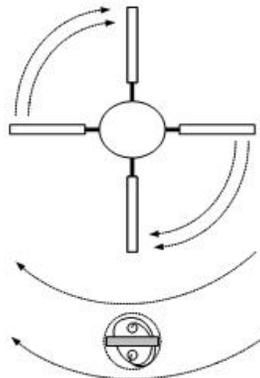


Fig. 5

### 2.3. Air supply

The air supply inlet is a ¼ inch press-to-fit connector located at the back of the box. An air regulator is located inside the box and is set to 10 psi. Air supply pressure must be at least 15 psi. If the pressure available is less than 15 psi, adjust the internal pressure regulator to get 7 psi over the working pressure of the fermentor.

If the probe is to be used in a pressurized fermentor it is recommended to increase the pressure to at least 7 psi over the working pressure of the fermentor.

To disconnect the air supply from the Press-to-fit connector, press the ring of the connector and firmly pull the tube. It will go out.

## **2.4. Connection of the tube for carrier gas**

A rotameter is installed inside the Control Box, allowing the possibility to adjust the flow rate of the carrier gas to the probe. A flow rate of 100 cc/min on the rotameter gives a satisfactory response. By reducing the flow rate to the probe, the sensitivity will increase but, however, the response time will also increase.

One end of the ¼ inch carrier gas tube is installed on a compression fitting on the front of the case (air out). The other end is installed on the probe's air inlet compression fitting. Each end is preswaged and only needs only to be slightly tightened on its fitting.

## **2.5. Conditioning of the probe**

The sensor located in the probe headset must be connected at least a week in advance if not used for a long period of time. It is thus preferable to always leave the probe headset connected on the box and powered in order to maintain the conditioning of the probe for the next uses.

The sensor is made of a semiconductor. It is sensitive to moisture and temperature. In order to guarantee stability of reading, the probe and its headset must be installed in advance on the fermentor under fermentation conditions. Good control of the fermentor parameters (temperature, aeration, pressure) is mandatory otherwise fluctuations will be noticed on the probe reading.

## **2.6. Sterilization**

The Gas Sensing Probe is sterilizable in the autoclave with the fermentor. Some care must however be taken:

- Remove the probe head from the probe body but keep it connected to the box,
- Disconnect the carrier gas tube from the probe,
- Put an aluminum foil on the probe end,
- After sterilization and cooling of the fermentor, plug the carrier gas tube onto the probe body.
- Wait before reinstalling the headset. Moisture can condense in the tube following sterilization,
- Reinstall the headset on the probe.

### 3. Control Box

#### 3.1. Front Panel



Fig. 6

- 1 LCD display
- 2 Probe #1 connector
- 3 Probe #2 connector
- 4 Probe #1 rotameter
- 5 Probe #2 rotameter
- 6 Probe #1 air connector
- 7 Probe #2 air connector
- 8 Probe #1 heater status (green light on when OK)
- 9 Probe #2 heater status (green light on when OK)
- 10 Power switch
- 11 Power light

### 3.2. Back Panel



Fig. 7

- 12 Compressed Air manometer
- 13 Compressed Air regulation
- 14 Relay #1 NO and NC outputs
- 15 Relay #2 NO and NC outputs
- 16 Relay #1 output selection
- 17 Relay #2 output selection
- 18 Relay #1 two 120 VAC outputs
- 19 Relay #2 two 120VAC outputs
- 20 USB connector
- 21 Power cable

## **4. Reading Data**

### **4.1. Power up**

The PPM unit starts to operate as soon as the power supply is connected, However the sensor located in the probe headset must be connected at least a week in advance if not used for a long period of time. It is thus preferable to always leave the probe headset connected on the Control Box and powered in order to maintain the conditioning of the probe for the next uses.

After a short period of time selected values will be shown on 2 lines LCD display

### **4.2. Reading data from display**

The BTUM unit has a 2 lines LCD display to show measured and/or calculated values. The content of these lines is configurable and the following values can be displayed:

- Gas Concentration PPM or %, for each probe or for both
- Current output mA
- Relay status ON or OFF

All measured and calculated data are available after connecting the PC computer to the USB port using supplied PPMETER software.

### **4.3. Reading data using PC software**

Connect the USB type B cable to USB port of the Control Box and run PPMETER.exe program on the PC. There are two choices to select of. The first one – PPM Meter Reading – allows to read all current measured and calculated values. The second one – PPM Meter Setting – allows PPM unit configuration and calibration. The second option is password protected and can be used only by trained technicians (see paragraph 5 for more details).

If the user wants to use more then 2 probes, he will need to run multiple PPMETER programs (max. 2 probes per program) and may have multiple graphs displayed on the screen. In order to link probes to programs there is a small rectangle on the top right cornet of the. It allows you select the color associated with the program. The selection will be saved for future use.

Click on “PPM Meter Reading” button (figure 8).



Fig. 8

The PPMETER program main screen is shown on figure 9.

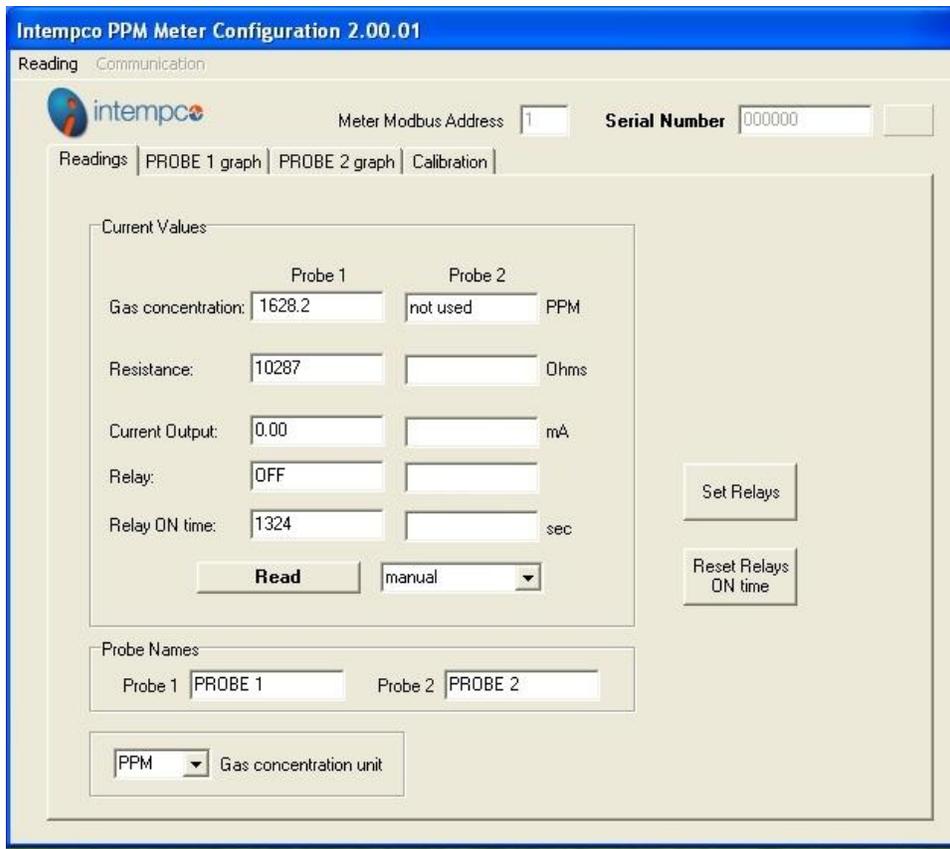


Fig.9

PC connects automatically with the PPMM unit and downloads current PPM values for one or two Gas Sensing Probes, as well as Probe(s) resistance, current output value(s) and relay status (figure 9). The Probes controller is also totalizing time then the Relay was energized (ON state).

When running the software for the first time you may get the ‘No Answer’ message. In this case you need to select the communication port used by your computer to communicate with the PPMM unit. In most case this will be the port other than COM1.

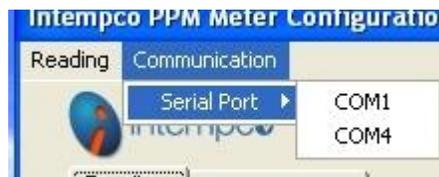


Fig.10

Select ‘Communication’ from the main menu, next ‘Serial Port’ and finally select the COM port (figure 10). This selection will be automatically saved for future use.

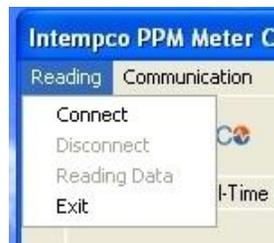


Fig. 11

If you had to select the new communication port, you have to connect manually to the PPMM unit. Select ‘Reading’ from the Main Menu and click on ‘Connect’ (figure 11).

After the unit is connected you will see the PPMM unit Serial Number and the Modbus unit address (figure 8).

The default MODBUS address is 1. It can be changed in PPMM unit setting.

You can select the continuous reading. Select the reading interval from the popup list located on the right of READ button, and click on the READ button. You can see a small blue point flashing on every reading. To stop reading click on the STOP READING button (figure 12).

The user can name each probe as it’s convenient for him. He can also select the unit to display the gas concentration (“PPM” or “%”). Use selection boxes located on the bottom of the screen. User’s selections will be saved for next runs.



Fig. 12

The PPMM unit can detect the probe heating failure and displays a message “Probe(s) heating failure!”.

#### 4.4. Set Relays function

The user can modify setting for activating relays by clicking the SET RELAYS button.

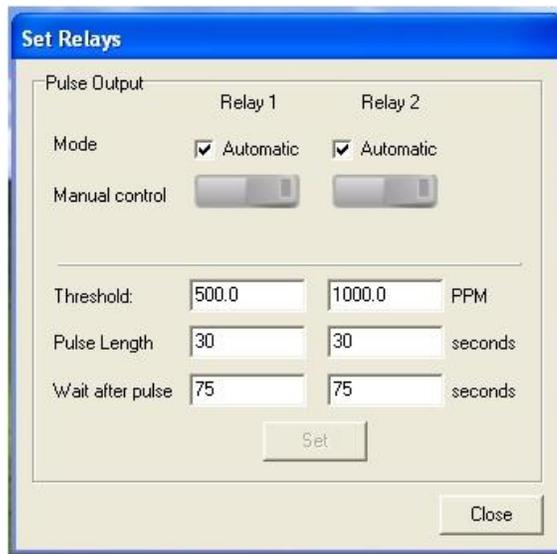


Fig. 13

You can modify the threshold values (measured Gas concentration values lower then the threshold will set the corresponding relay ON), the pulse length and the time to wait after the relay pulse to perform the next comparison. Press SET button to update the value.

You can also set manually relays ON or OFF. If the Relay is set to Automatic mode, put it in manual mode and next click on the switch. The relay in ON position is represented by the switch with yellow dot, as shown on figure 14.



Fig. 14

The time the relay is switched manually ON will be displayed just under the switch.

You cannot close the “Set Relays” window until you switch all relays off. You can move the window on the screen and perform other tasks. The presence of the window will remind you that the relay was switched manually. If you change the relay back to Automatic mode the relay will be switched OFF.

#### 4.5. Reset Relays ON time

The user can reset Relays ON times by clicking on the RESET RELAYS ON TIME, and then selecting the relay and clicking on RESET. (figure 15).



Fig. 15

#### 4.6. Real-time graph (PC software)

In order to acquire data over a long period of time select the “PROBE 1 graph” or “PROBE 2 graph” (displayed only if 2<sup>nd</sup> probe is configured) tab. You can start process for any probe independently,

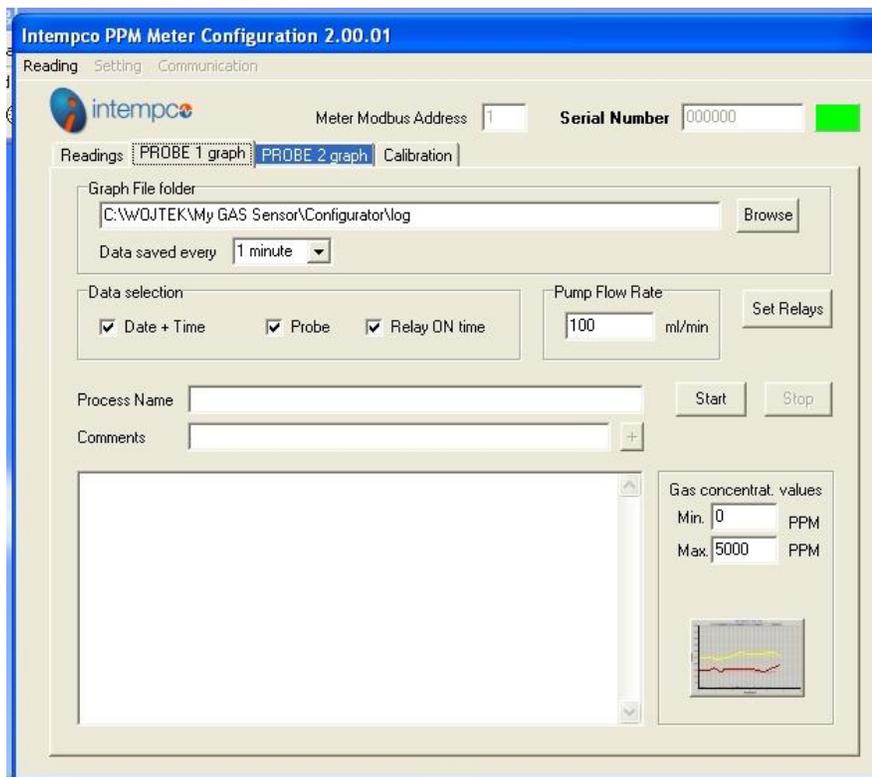


Fig. 16

If the graph tab name is shown blue (as seen on figure 16), means that the process for the corresponding probe is running.

All data will be saved in .CSV (Excel compatible) file and will be shown in graphic mode. The name of the file is generated automatically from starting date and time (format: "ProbeN\_YYYY\_MM\_DD-HH\_MM [process\_name].csv", where N=1 or 2). You have to select data: Date + time, Probe and Relays ON time (relay will be grayed if set to manual mode), select the Methane Flow rate (to calculate Methane consumption) and the minimum and maximum Gas Concentration value (for graph – these values can be changed later at any time) (figure 16).

Select the selecting the reading interval as shown on figure 17.

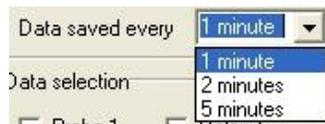


Fig. 17

The process name (if entered) will be saved in the first line of the log file. Click on START button. A blue dot will flash every time there is a new reading and a new line will be added inside the data box (figure 18).

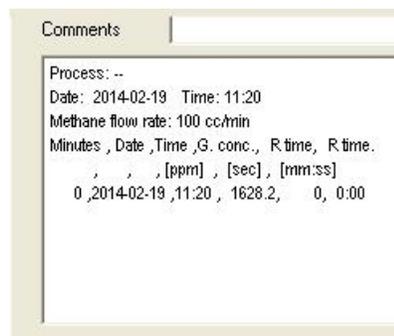


Fig. 18

Comments can be added to the log file at any time: type the comment line and click on the '+' button.

Click on the STOP button to stop the automatic data acquisition.

Click on GRAPH icon (figure 16) to see the graphic presentation of acquired data (figure 19).

Gas concentration (in PPM or %) is represented by the blue line (left axis) and Relay ON time by the red line (axis on the right).

Click on the PRINT button to print currently displayed graph on your default printer (see Windows printers setting).

If the process is running for longer time what shown on the screen you can click the REVIEW button to re-view the graph.

Click on HIDE button to close the graph window. You can re-open if by clicking on the GRAPH icon (figure 16).



Fig. 19

After the automatic acquisition was stopped you can still review the last graph by clicking on the LAST GRAPH icon. This time you will see additional buttons to navigate in the time as shown on figure 20.



Fig. 20

Buttons from left to right: go to the beginning, previous, next, go to the end.

From graph tab the user can set manually Relay states by clicking on SET RELAY button (see paragraph 4.4).

#### 4.7. Calibration

Select the "Calibration" tab. The current PPM calculation coefficients for both probes are displayed on the top of the screen (figure 21

For the new unit always perform the calibration for both channels. You have to enable both probes (figure 24).

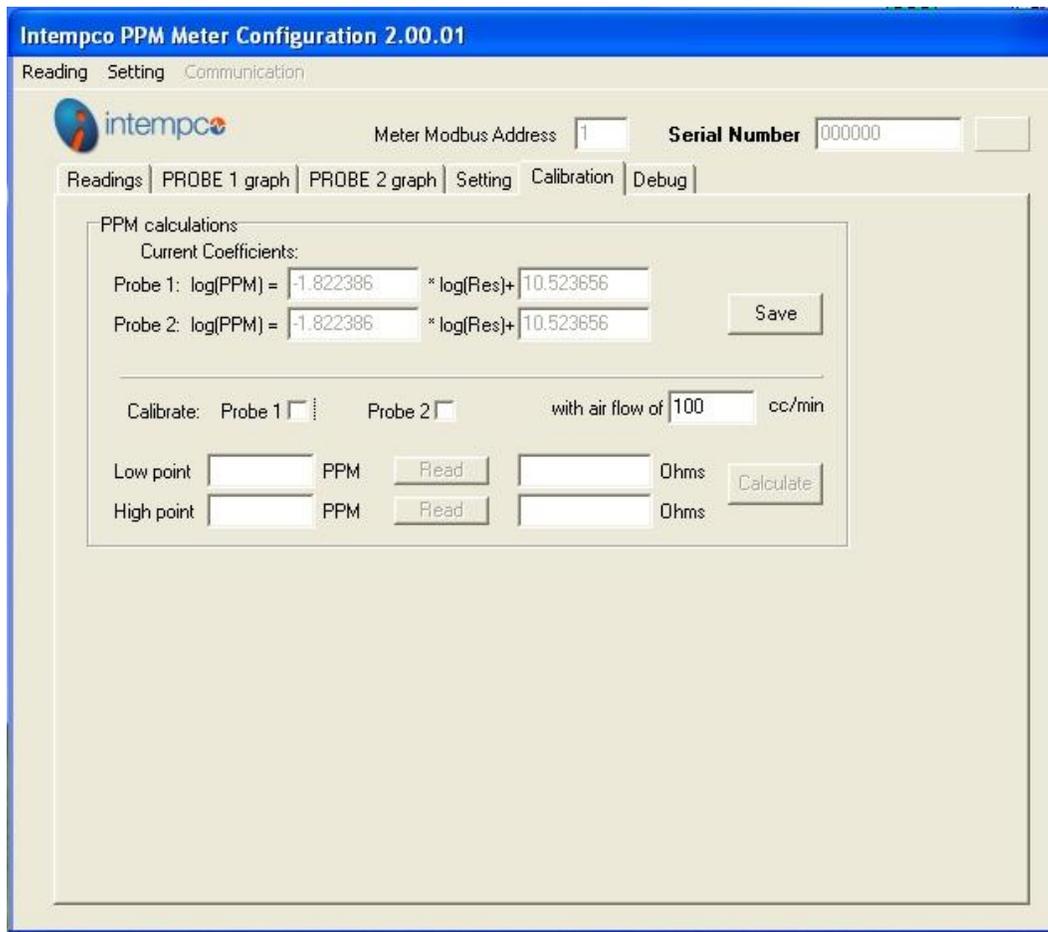


Fig. 21

You can perform the calibration for any probe independently, even if the 2<sup>nd</sup> probe is used in the process. “Low point”, “High point” and corresponding resistances used for calibration are saved and can be reused in calculations. For example you can do the calibration for the High PPM point and calculate new coefficients using previously saved values for low PPM point.

The calibration is made for two PPM values – for example 1000 PPM and 5000 PPM. For each point the probe must be immersed in the liquid with the above concentration of Methane or Ethanol.

Set the Air Flow to 100 cc/min (or any other value which will be used in your installation) and enter the value in the “with air flow of” field.

Procedure:

- Connect the Probe to the “Probe#1” connector. Put the probe into the 1000 PPM liquid
- Select ‘Probe 1’ (see figure 21),

- Enter the Low Point value: 1000 PPM and click on the upper READ button. You will see the small graph (figure 22) showing the probe resistance change in the time and filtered current resistance value.

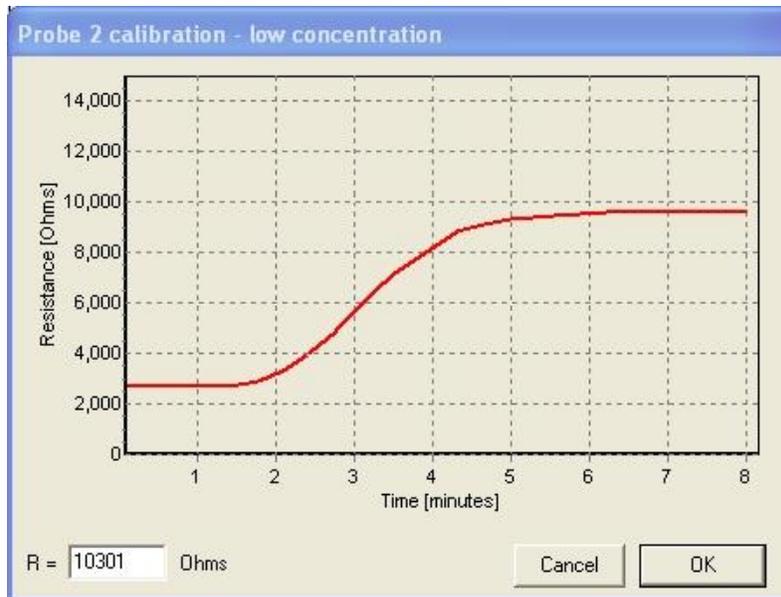


fig. 22

- Wait some time the reading will stabilize (horizontal red resistance line) and then click OK. The current probe resistance reading will be shown at the right of the “Read” (figure 23). You can repeat this action few times until the readings doesn’t change.

Fig. 23

- Put the probe into the 5000 PPM liquid.
- Enter the High Point value: 5000.
- After the probe resistance stabilize click on OK button (figure 22). The current probe resistance reading will be shown at the right of the “Read” (figure 23).
- Click on the “Calculate” button. New calculated calibration values for Probe 1 will be displayed as new Current Coefficients

• Press “Save” button (in PPM calculations section) to copy newly calculated values to the PPMM unit configuration data set.

Repeat the same procedure for Probe 2, if necessary.

## 5. PPM Meter Setting

*NOTE: if you entered the “PPM Meter Reading” of the PPMETER program and don't see “Setting” tab, please exit and re-run the PPMETER.exe.*

Click on “PPM Meter Setting” button (figure 8). Access to the configuration and calibration functions is password protected. The user will be asked to enter the factory password (figure 21).



Fig 24

After the entered password is accepted you will see the similar screen on figure 9, but with an additional tab “Setting” (figure 25).

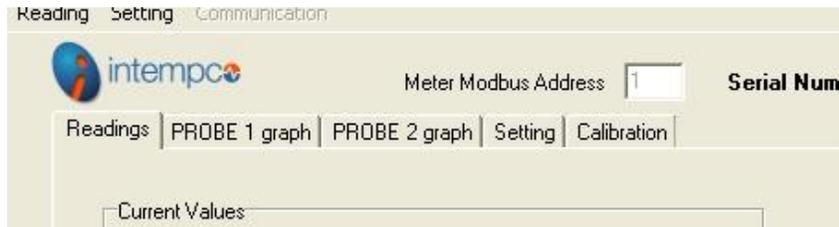


fig.25

### 5.1. Setting

First we need to retrieve current configuration data from the PPM unit. Select “Setting” from the Main Menu and “Retrieve from Meter” (figure 26).

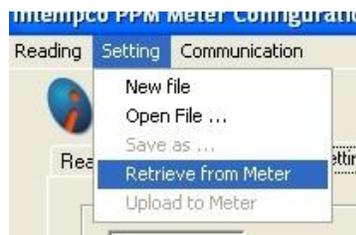


Fig. 26

The “Setting” tab will appear with all fields filled with data as shown on figure 27. All data in not grayed fields can be modified.

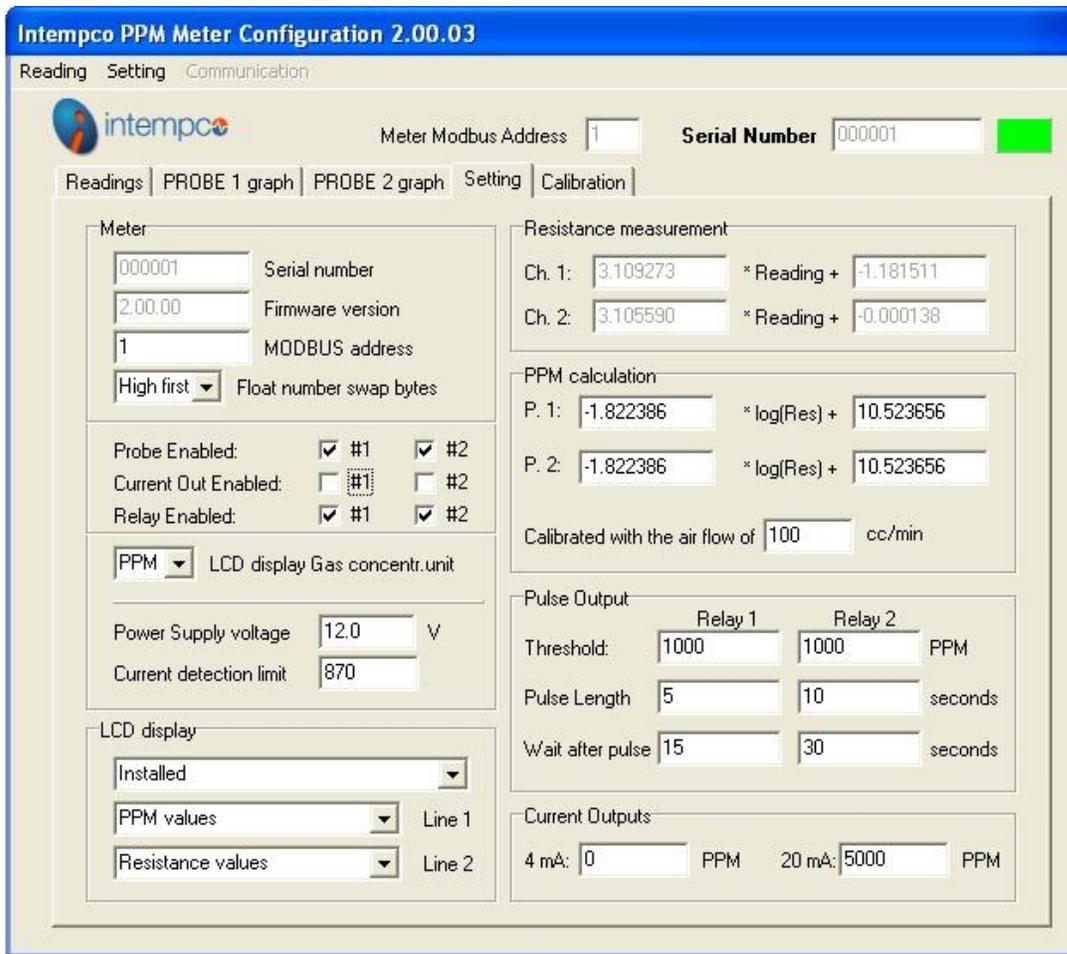


Fig. 27

Values within the “Resistance Measurement” and “PPM calculation” should NOT be modified manually, but set using calibration functions. See paragraph 5.3 for more details.

Here are some parameters:

Serial Number	can be set only <u>once</u> in the factory for the new unit
Firmware version	Cannot be modified, hardcoded in firmware
MODBUS address	Default value is 1. Can be modified if accessing more than one Controller or when installed in larger installation on Modbus network.
Float number swap bytes	Some MODBUS masters needs floating data swapping
Probe enabled	If one probe attached, connect the probe to channel 1 and enable “Probe 1”
Current out. enabled	Enable current output
Relay enabled	Enable relay outputs
Reheat time	Reheat time needed for the probe to achieve the full functionality. Disabled if set to 0.
Power supply voltage	To calculate the current detection limit (line below) used for

	heaters malfunction detection. <b>Measure the exact voltage on controller board POWER connector.</b>
Current detection limit	Cannot be changed manually
LCD display	Indicate if LCD is installed or not Parameters to show on each of two lines
Resistance measurement	Coefficients to calculate the probe resistance. Cannot be changed manually – use calibration.
PPM calculation	Coefficients to calculate the gas concentration (PPM value). Cannot be changed manually – use calibration.
Air flow used for calibration	Calibration coefficients used to calculate the gas concentration (PPM value) depends on the air flowing thru the silicon tube. The used has to set the air flow to the same value during real measurements.
Pulse output threshold	The gas concentration lower then the threshold value will energize the relay for the “Pulse length”
Pulse length	Relay pulse length
Wait after pulse	The time to wait after the relay activation for next comparison.
Current outputs	Gas concentration values corresponding to 4 mA and 20 mA

Modified data can be send back to the PPMM unit by selecting “Setting” from the Main Menu and “Upload to meter” (figure 28).



Fig. 28

Configuration data can be saved locally on the PC hard drive for future use. Select the “Setting” from the main menu, next “Save as” (figure 28) and select the name of the file.

Previously saved data can be retrieved form the PC hard drive and uploaded to the BTUM unit (unchanged or modified) by selecting “Setting” from the Main Menu and “Upload to meter” (figure 28).

To exit from the program, select “Setting” from the Main Menu and “Exit” (figure 11).

## 5.2. New unit configuration

Every new unit is preset with factory default values but some of them need to be individually set for each BTUM unit.

To set data for the new BTUM unit proceed as follows:

- Connect the external power supply.
- Connect the BTU unit to the PC (USB cable)
- Run PPMETER program, as described in paragraph 5.
- After successful connection select 'Setting' from the main menu, next 'Login' and enter the factory password (figure 24).
- Select "Setting" from the Main Menu and "Retrieve from Meter" (figure 25). Alternatively you can load data from template file by selecting "Setting" from the main menu, next "Open file" and select the file name.
- Modify Serial Number – can be set only once and cannot be change later.
- Enable probes, relays and current outputs according to customer specifications
- Enter the Power supply voltage
- Set parameters to be displayed on the LCD according to customer specifications.
- Selecting "Setting" from the Main Menu and "Upload to meter" (figure 28).

## 5.3. Resistance measurement calibration (for FACTORY USE ONLY)

Select the "Calibration" tab. The current resistance measurement coefficients for both channels are displayed on the bottom of the screen (figure 29).

For the new unit always perform the calibration for both channels. You have to enable both probes (figure 27).

The calibration is made for two resistance values – for example 1000 Ohms and 10000 Ohms, using Calibration Decade Resistance (CDR).

Procedure:

- Connect the CDR to the "Probe#1" connector (front panel) and set resistance to 1000 Ohms
- Select 'Channel 1' (see figure 29),
- Enter the Low Point value: 1000 Ohms
- Click on the upper "Read" button. The current A/D reading will be shown at the right of the "Read" (figure 30).
- Set CDR resistance to 10000 Ohms

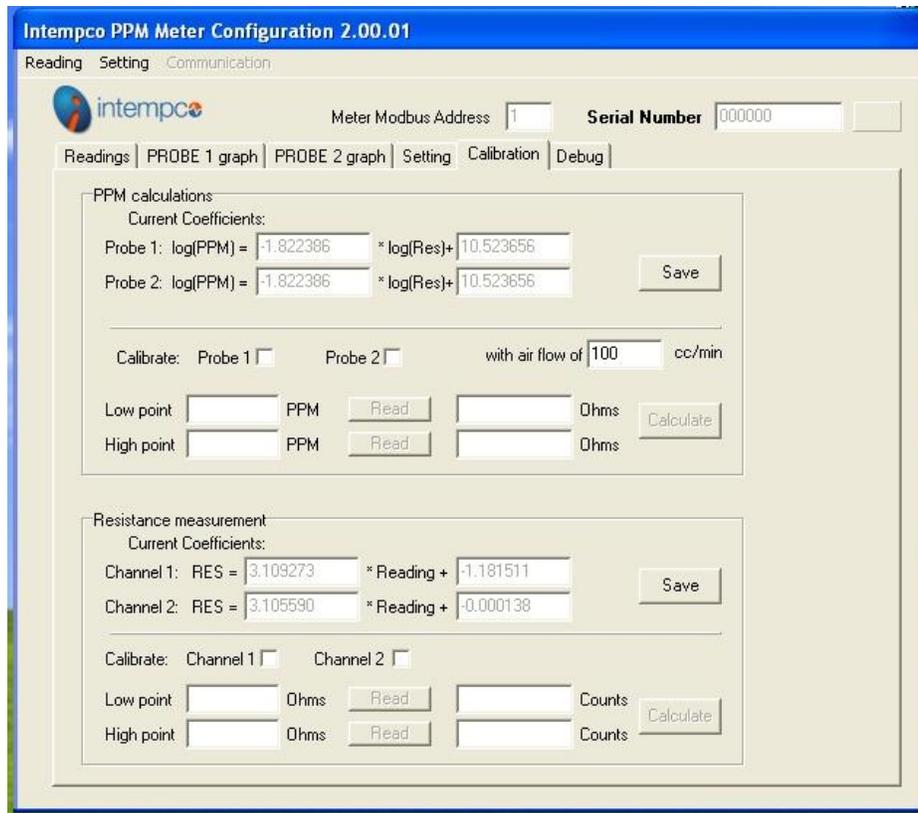


Fig. 29

- Enter the High Point value: 10000,
- Click on the lower “Read” button. The current A/D reading will be shown at the right of the “Read” (figure 30).
- Click on the “Calculate” button. New calculated calibration values for Channel 1 will be displayed on the top of the screen



Fig. 30

Press “Save” button (in Resistance measurement section) to copy newly calculated values to the PPMM unit configuration data set. You should now see these values on the “Setting” tab (figure 27).

Repeat the same procedure for Channel 2, even if it will be not enabled at this time. Disable the 2<sup>nd</sup> probe if necessary (figure 27).

#### 5.4. PPM calculation coefficients

See paragraph 4.7.

## 6. List of MODBUS registers

Holding registers		Type	Notes
1	Unit Address	W	
2	Serial Number	W	
3	Software Revision	W	
4	Float Swap Bytes	W	<i>0 – high bytes first, 1 – low bytes first</i>
5	CH1: Resistance calibration - A	F	
6	CH2: Resistance calibration - A	F	
7	CH1: Resistance calibration - B	F	
8	CH2: Resistance calibration - B	F	
9	P1: PPM calculation coefficient A	F	
10	P2: PPM calculation coefficient A	F	
11	P1: PPM calculation coefficient B	F	
12	P2: PPM calculation coefficient B	F	
13	Air flow used for probes calibration	W	[cc/min]
14	Probe 1 enabled	W	0- No, 1-Yes
15	Probe 2 enabled	W	0- No, 1-Yes
16	Current output 1 enabled	W	0- No, 1-Yes
17	Current output 2 enabled	W	0- No, 1-Yes
18	Relay output 1 enabled	W	0- No, 1-Yes
19	Relay output 2 enabled	W	0- No, 1-Yes
20	Curr. Output: PPM value for 4 mA	F	[PPM]
21	Curr. Output: PPM value for 20 mA	F	[PPM]
22	Relay 1 output threshold	F	[PPM]
23	Relay 2 output threshold	F	[PPM]
24	Relay 1 pulse length	W	[second]
25	Relay 2 pulse length	W	[second]
26	Time to wait after the pulse (relay 1)	W	[second]
27	Time to wait after the pulse (relay 2)	W	[second]
28	Gas concentration unit on LCD	W	0-PPM, 1-%
29	LCD display installed	W	0- No, 1-Yes
30	Displayed on line 1	W	0-none, 1-PPM values, 2-Curent outputs,
31	Displayed on line 2	W	3-Relays, 4-resistances, 5-Current+relays
32	<i>Max Voltage for heaters</i>	W	<i>For factory use only</i>
33	Power Supply voltage	W	V * 10
34	<i>PPM calibration points -PPM low 1</i>	W	<i>For factory use only</i>
35	<i>PPM calibration points - PPM low 2</i>	W	<i>For factory use only</i>
36	<i>PPM calibration points -PPM high 1</i>	W	<i>For factory use only</i>
37	<i>PPM calibration points - PPM high 2</i>	W	<i>For factory use only</i>
38	<i>PPM calibration points –RES low 1</i>	W	<i>For factory use only</i>
39	<i>PPM calibration points – RES low 2</i>	W	<i>For factory use only</i>
40	<i>PPM calibration points -RES high 1</i>	W	<i>For factory use only</i>
41	<i>PPM calibration points - RES high 2</i>	W	<i>For factory use only</i>
Input Registers			
1	Probe 1 – gas concentration	F	[PPM]
2	Probe 2 – gas concentration	F	[PPM]
3	Relay 1 ON time	DW	[seconds]
4	Relay 2 ON time	DW	[seconds]
5	Probe 1 resistance	DW	[Ohms]

6	Probe 2 resistance	DW	[Ohms]
7	Current output 1	F	[mA]
8	Current output 2	F	[mA]
9	Relay Outputs	W	<i>0-both OFF, 1-1st ON, 2-2nd ON, 3-both ON</i>
<b>Coils</b>			
1	Relay 1		
2	Relay 2		

**Types:**

- W** - 16-bits integer
- DW** - 32-bits integer
- F** - 32-bits float