

# Combicontrol PIC432B

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# 1 Introduction

Combicontrol PIC432B is a unit designed for measuring and control of pH, mV and temperature. The pH/mV input is designed for connection to combination electrodes for pH, redox or ion selective electrodes. The temperature sensor used for the unit is a standard PT100 sensor with a range of 0 to 150 °C.

The measured values are handled by two to four independent control machines, which supervises the signals and controls external units. The control is performed as On/Off control, APC or PI control based on frequency or time. The four control machines - referred to as Limit A, Limit B, Limit C and Limit D - have individual output relays (Though Limit C and Limit D share relays with Limit A and Limit B respectively). Limit A and Limit B may be on the basis of either pH/mV or temperature. A set of parameters determines the behavior of each control machine. The Parameters are examined later in this document. Setting up these parameters may be done via

the keypad of the unit or with a PC-software (PICSetup) supplied with PIC432B. The unit has three analogue outputs, which may be programmed as 0-20mA, 4-20mA or 0-5V. The unit may also be set up so the analogue outputs #2 and #3 follow a proportional band and hence be used for control of frequency inverters or similar.

Two Flash memory circuits are build into the PIC432B for data acquisition; one for temperature and one for pH/mV. The sampling rate may be set up to 1 second, 10 seconds or 600 seconds. Using 60 seconds data may be stored for 2 years. The stored data may be exported to a spread sheet programme for instance Microsoft Excel. PIC432B may also be delivered with the possibility of continous transmission of measurements for external data acquisition or control.

The unit is made for wall mounting and is IP65. Supply ranges from 80 to 250V AC/DC.

## 2 Installation

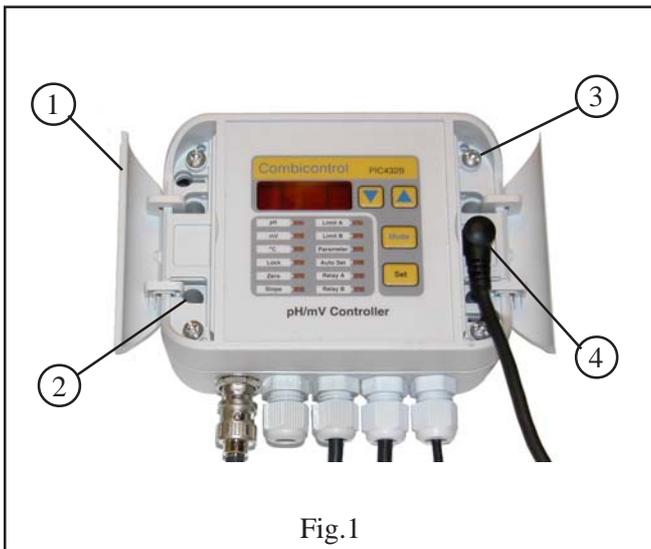


Fig.1

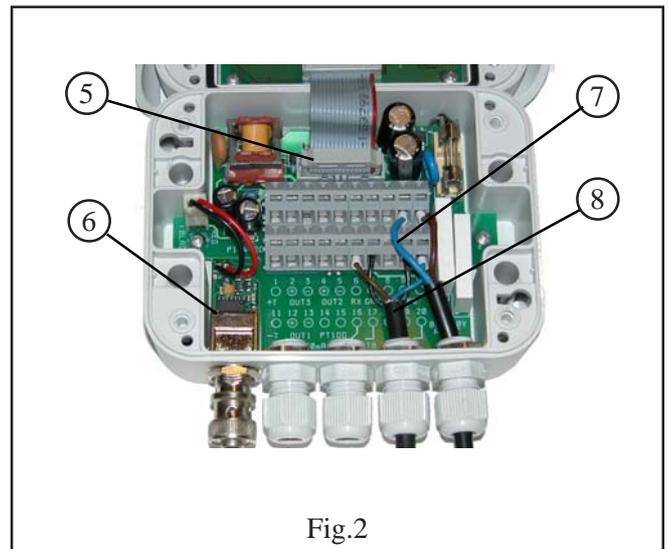


Fig.2

### 2.1 Typical installation

The unit is made for wall mounting and may hence be placed close to the place of measurement. After opening the covers marked 1 the unit is easily mounted on the wall via the holes marked 2. Access to the terminals is gained by loosening the four screws marked 3, after which the top is tipped and placed on the lower part as shown in figure 2. The top may also be removed completely by pulling out the cable marked 5. The terminals used in the PIC432B are all screw less, but use a patented spring system. Outline of the terminal connections is found on page 11. In fig. 2 a setup is shown, where the output relays are series coupled. The supply voltages is connected (marked 7). The relay output controls a dosing pump via the cable marked 8.

### 2.2 Supply

PIC432B is supplied with voltage ranging from 80 to 250V AC/DC connected to terminals 9 and 10.

### 2.3 pH/mV connection

The measuring electrode is connected to the BNC bush.

### 2.4 Pt100 connection

The Pt100 temperature sensor is connected to terminals 14 and 15. As the connection is a 2-wire connection, please use wires with at least 0,5 mm<sup>2</sup> at considerable distance between the measurement and the unit.

### 2.5 Relay connection

The two built-in relays should be connected to the external equipment to give the desired function. The relays are activated (closed) in normal condition but may be inverted via the parameters.

### 2.6 Serial port RS232

The unit may be connected to a PC via terminals 6-7-8 or via the enclosed cable, marked 4 on figure 1.

### 2.7 Analogue outputs

The analogue outputs #1-3 may be programmed via setup to one of the following: 0-20mA, 4-20mA or 0-5V. Max. load for 0(4)-20mA output is 300Ω and min. 25 kΩ for 0-5V output. The outputs correspond to the following:

**Output 1.** Proportional to pH or mV. If both Limits are temperature controlled the output is proportional to temperature.

**Output 2.** Proportional to temperature. If Limit A is used for APC, the output is APC. See. 4.16

**Output 3.** Is only used when Limit B is APC.

### 2.8 Clock/Date circuit

The built-in clock/date circuit is equipped with a Li-battery back-up. The battery is expected to have a life time of at least 10 years. Time and date may be setup from the front of the unit via **Parameters # 25-26-27**. The setup may also be done via the PC-programme PICSetup. See page 7.

### 2.9 Data acquisition

A circuit for data acquisition is build into the unit. Via PICSetup sampling rates of 1, 10, 60 or 600 seconds may be selected. The rate may also be set from the front of the unit via **Parameter # 24**. The collected data is stored in 2 pcs. 1Mb Flash circuits. If the Flash circuits are full, the oldest data will be erased automatically. Under **Parameter # 28** the Flash circuits may be erased manually.

### 2.10 pH transmitter

The input circuit for pH/mV is mounted on a separate pcb with connection to the terminal pcb via a two-wire connection. The input pcb is marked 6. If the pcb is not mounted or defective, 'Err1' is shown in the display. If the place of measurement is far from the unit a stand alone pH/mV transmitter should be used. The input circuit mentioned above may be supplied as such a stand alone unit.

## 3 Display and programming

### 3.1 Display

PIC432B contains a 4 digit numerical display and 12 LEDs, used to indicate various functions/parameters, as one of these is selected.

The numerical display has multiple functions. Besides displaying measurements it is also used for showing parameters as well as programming them. See below for a complete overview.

### 3.2 Display of measurements

pH is displayed as 0-14 pH with two decimals.

mV is displayed as 0-1000 with sign (positive without +).

Temperature is displayed from 0 to +150 with 1 decimal.

Changing between the measurements is done with the 'Mode'-key.

### 3.3 Peak detectors

For each measurement there is a Max.- and a Min. peak detector, which accumulate Max.- and Min.- values of the measured value. The values are displayed by activating the 'Arrow-up' for the max. values and the 'Arrow-down' for the min. values. The peak detectors may be reset by the corresponding arrow-key and the 'Set'-key simultaneously.

### 3.4 Programming

PIC432B is programmed via 4 keys; 'Mode', 'Arrow-up' and 'Arrow-down' as well as the 'SET'-key. 'Mode' is used for selecting one of the programmable parameters. When a parameter is selected, the value may be altered using the arrow-keys. 'Arrow-up' increases the value and 'Arrow-down' decreases it. **To programme the new value press the 'Set'-key.**



PIC432B

Before programming the PIC432B, the unit must be unlocked. This is done by selecting 'Lock' with the 'Mode'-key; The display now shows 'On' and may be changed to 'Off' using one of the arrow keys. The unit automatically locks after 5 minutes without key-activity. All programmed values are stored in EEPROM.

### 3.5 Programming via PC

After installation of the enclosed program -PICSetup-programming is easily done from the PC. All parameters may be stored on disc and transferred to other units. The programme is described on page 6.

### 3.6 User interface

Mode	Function	Description
pH	Display	Displays the actual pH-value. If Redox-mode the pH readout is not accessible.
mV	Display	Display of the actual mV-measurement
°C	Display	Display of the actual temperature
Lock	Active	Changes between On and Off by activation of the arrow keys. Must be Off in order to change parameters.
Zero	Active	Manual adjustment of buffer (zero)
Slope	Active	Manual adjustment of slope (gain). Depending on the measurement value one of two slope values are adjusted
Limit A	Active	Actual setpoint for Limit A. The unit follows the selected unit for limit A
Limit B	Active	Actual setpoint for Limit B. The unit follows the selected unit for limit B
Param.	Active	Gives access to a list of parameters
Auto Set	Active	Access to automatic calibration of pH
Relay A	Display	Shows the position of relay A; LED on = Relay closed
Relay B	Display	Shows the position of relay B; LED on = Relay closed

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## 4 System description

### 4.1 Generally

In the following the unit's features will be described in details including a description of the various control algorithms.

### 4.2 pH/mV measurement

The pH/mV input stage consists of a circuit with very high input resistance and extremely low input current. After the signal treatment the signal is transmitted through a galvanic isolation system to the micro processor, which handles the display- and control functions etc.

### 4.3 Temperature measurement

The temperature sensor is supplied with a current of app. 2.5mA and the generated mV signal is amplified and transmitted to the micro processor, where it is linearized.

### 4.4 Temperature compensation

If automatic temperature compensation is selected, this is done by the micro processor on the basis of the measured temperature. The unit also gives the possibility of using a fixed temperature as basis of the compensation; Select 'Set' under **parameter #13** and enter the desired temperature under **parameter #14**.

Note! The mV measurement is not compensated.

### 4.5 Manual zero adjustment

If a zero adjustment is required (Valid only for pH), please select 'Zero' with the 'Mode'-key and the display value may be adjusted with the arrow keys to correspond with a known resolution.

The adjustment does not affect the mV measurement.

### 4.6 Manual Slope adjustment

Adjusting the Slope is done by selecting 'Slope' with the 'Mode'-key and adjusting with the arrow keys (Valid for both pH and Redox). If the unit is set up to use dual slope (Valid only for pH), two slope values are stored. Using single slope only one slope (gain) is stored, which will be used for the whole range. By pH measurement the adjustment does not affect the mV measurement, which may then be used as electrode check.

### 4.7 Automatic calibration

Using Auto-Set the 'Mode'-key is used to select the function and the text 'SEt0' is shown in the display toggled with the actual measurement. Using the arrow keys also the 'SEt1' and 'SEt2' may be selected. To be able to use Auto-Set the known resolutions must be programmed into the unit under parameter **Parameter #22** and **Parameter #23**. The range of the resolutions is listed below:

'SEt0' = pH7 (always pH7,00)

'SEt1' = pH10 (8,00 pH 13,00)

'SEt2' = pH4 (1,00 pH 6,00)

When the buffer resolution with the value corresponding to the selected Auto-Set point is chosen, please activate the 'Set'-key. If the calibration is valid, the display will stop flashing the measurement value and will only show 'SEtx'. If the display continues to flash, the buffer reso-

lution lies outside the valid range which is the programmed value  $\pm 1$  pH.

### 4.8 Control features

Limit A and Limit B may be programmed independently to one of the following control modes: 1. On/Off, 2. Proportional frequency, 3. Proportional time. 4. APC-function, which is Analogue Proportional Control. The limits may be chosen as Max. or Min. limits. The different control modes may be related to any of the three possible measurements.

Limit C and Limit D both run On/Off control if enabled. Both limits may be selected independently as max.- or min.-limits.

Limit C may only be enabled if Limit A is selected as APC. Limit C activates Relay A. The limit is related to the measurement of Limit A.

Limit D may only be enabled if Limit B is selected as APC. Limit D activates Relay B. The limit is related to the measurement of Limit B.

### 4.9 Parameter setting

For selection and description of the various parameters please refer to the parameter list on page 10. If the setup is to be done via 'PICSetup', please refer to the paragraph describing the PC-software on page 6.

### 4.10 On/Off control

When the measurement crosses the chosen setpoint, the corresponding relay will open and will not close again until the measurement exceeds the hysteresis band.

### 4.11 Hysteresis band

A hysteresis band always lies above a Min limit and below a Max limit.

### 4.12 Proportional band

The proportional band is a range where a variable control is performed. A proportional band always lies above a Min limit and below a Max limit.

### 4.13 Basic frequency

The basic frequencies for Limit A and Limit B may be set from 1 imp/min to 180 imp/min.

### 4.14 Proportional frequency control (PI)

If the measurement lies outside the proportional band the relay will pulsate with the basic frequency. Inside the proportional band the frequency is changed linearly towards zero as the measurement approaches the setpoint.

### 4.15 Time proportional control

The frequency is constant = the basic frequency. Instead the duty cycle is changed according to the same principle as for PI control. If the measurement lies outside the proportional band the relay is closed permanently and open permanently if the limit is exceeded.

### 4.16 Analogue proportional control

Selecting APC for Limit A causes the analogue output #2 to be used as APC-output. Limit B always controls output #3 at APC. APC has the following algorithm:

If the measurement lies outside the proportional band the analogue output will equal 100%. When the measurement approaches the setpoint the analogue output is changed linearly towards 0%.

#### 4.17 Control examples

On/Off control may be used for alarms and control of pumps. Proportional frequency control is primarily designed for the control of dosing pumps. Proportional time control may be used for control of heating elements. APC may be used for control of frequency inverters.

## 5 The PC- programme PICSetup

### 5.1 Installation

The programme is installed from the enclosed CD-ROM or downloaded from the internet on [www.hydrria.dk](http://www.hydrria.dk)

### 5.2 System requirements

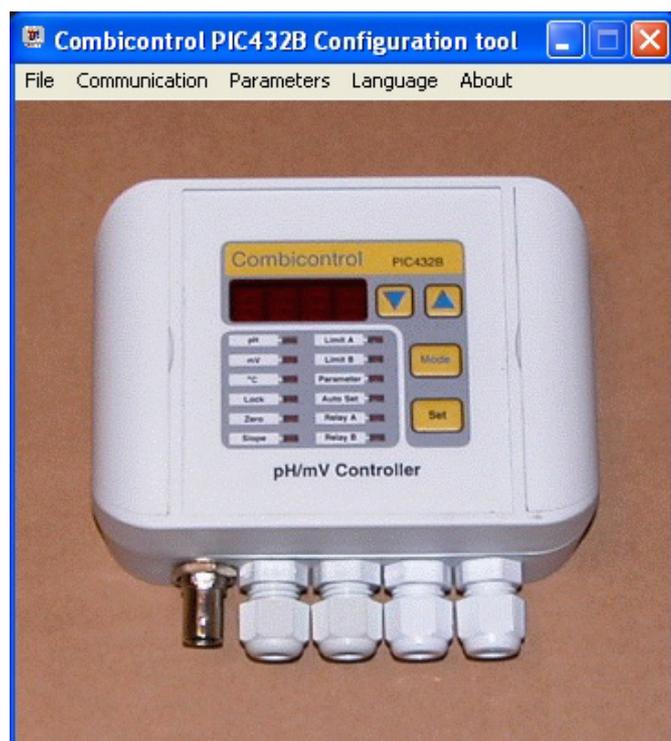
The programme runs under the following Windows versions:

- 98 and ME
- NT 3.5 or newer, and 2000
- Xp
- 7
- 8, 8.1
- 10

Minimum disc place is required - app. 1Mb.

### 5.3 Communication

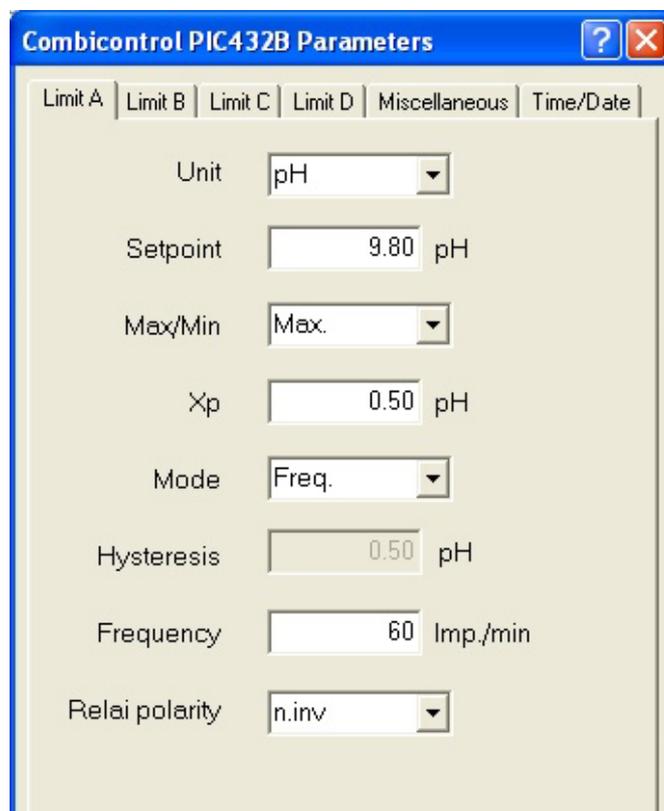
From the menu select the used COM-port under 'Communication'. If it is not obvious which port the PIC432B is connected to, the PICSetup software features an auto connect functionality, which searches all available COM-ports for the PIC432B. This functionality is found in the menu under „Communication->Auto connect“.



If the unit is found the connected COM-port may be seen under „Communication“. If not, a message is given telling

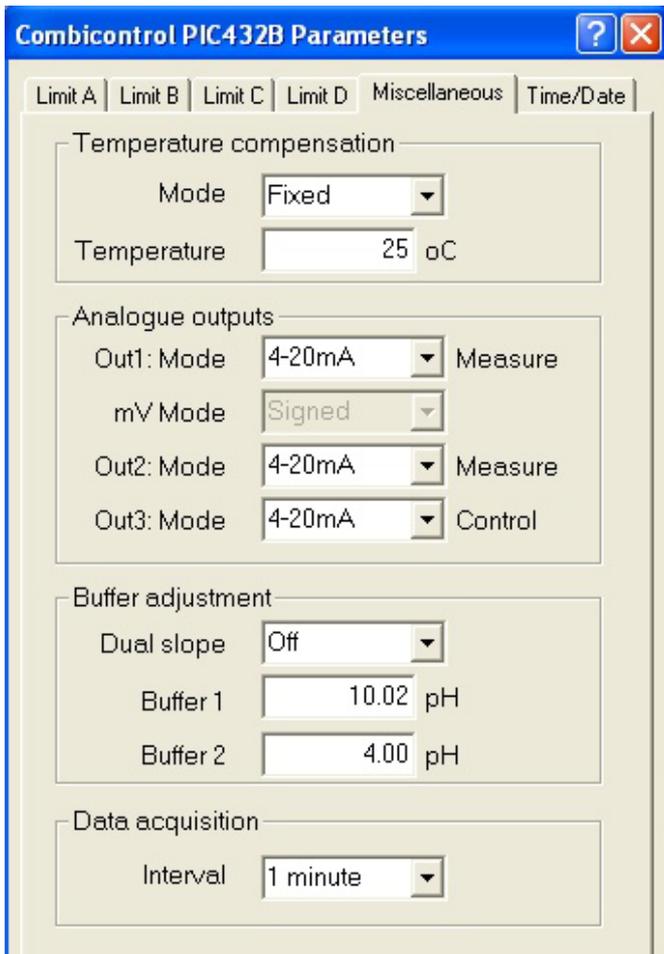
### 5.4 Parameter setup of PIC432B

Activating 'Parameters' from the menu produces the property sheet shown in the following figure. Each parameter category appears by selecting the corresponding property sheet; 'Limit A', 'Limit B', 'Limit C', Limit D', 'Miscellaneous' and 'Time/Date'. After setting the required parameters always exit by pressing the 'OK'-button to transfer the new settings to the unit. Pressing 'Cancel' discards the changes. If the parameters are not transferred correctly to the unit a message is given in the form of a dialog box. The user may therefore be sure of the transfer if no message has been given within a couple of seconds after pressing the 'OK'-button.



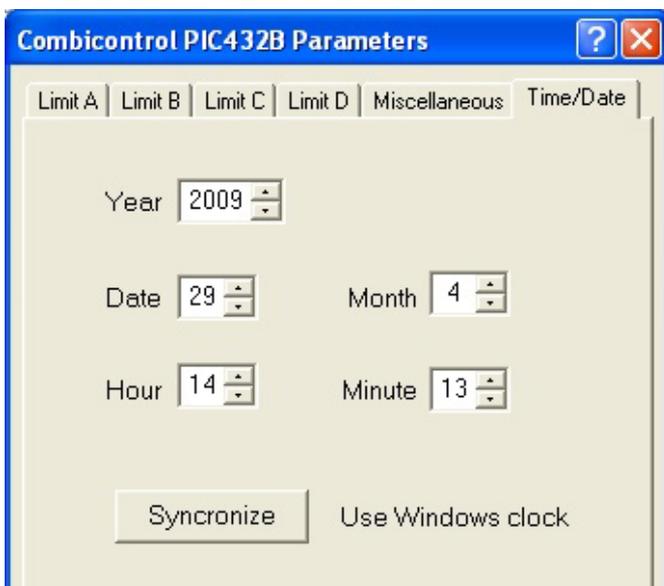
### 5.5 General Setup

On the property sheet 'Miscellaneous' various parameters which are general for the unit can be found. These may be altered as described in chapter 5.4.



### 5.6 Time/Date

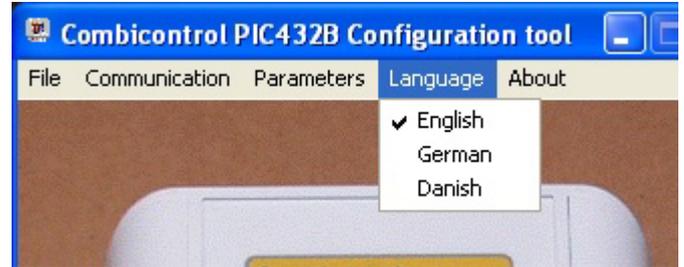
On the property sheet 'Time/Date' the settings for the time stamp of the collected data are found. Opening this sheet causes the actual time from the PIC432B to be transferred; Hence - the time/date shown is not the Windows time on the PC!. Using the Windows time in the unit is possible by pressing the button 'Synchronize' followed by pressing the 'OK'-button to transfer the settings to the unit.



### 5.7 Language

The software supports three languages - English, German and Danish. Selecting the language is done from the menu under 'Language' as shown in the following figure.

When a language is selected the menu, the dialog boxes and all texts are presented in the chosen language.



### 5.8 Save / Load parameters on disc

For a later programming or reprogramming of the Controller a feature for storing a parameter set on disc exists. It is selected from the menu under 'File'.

When a parameter set is saved, the most recent transferred parameters are stored. So, to be sure that the correct parameters are stored, please select 'Parameters' from the menu before saving to disc. This causes a transfer of the current parameters from the connected PIC432B.

Loading a parameter set transfers a parameter set from disc to the connected unit. If the transfer is not correct a message is given.

## 6 The PC- programme DataView

### 6.1 Installation

The programme is installed from the enclosed CD-ROM or downloaded from the internet on [www.hydrria.dk](http://www.hydrria.dk)

### 6.2 System requirements

The programme runs under the following Windows versions:

- 98 and ME
- NT 3.5 or newer, and 2000
- Xp
- 7
- 8, 8.1
- 10

Minimum disc place is required - app. 1Mb.

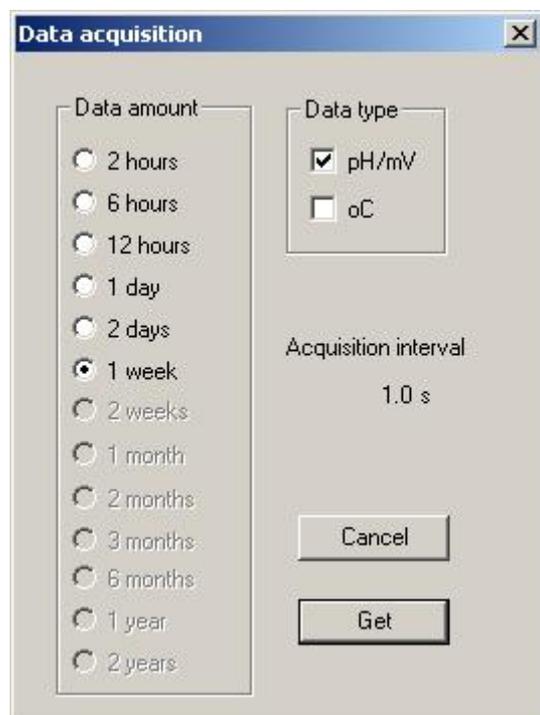
### 6.3 Communication

From the menu select the used COM-port under 'Communication' (See chapter 5.3).

### 6.4 Data

Data for processing may be „input“ in two ways: Transfer from PIC432B or opening of previously transferred data.

Transfer from PIC432B is done by activating „Data acquisition“ in the menu, after which the following dialog box appears.



The user must select the amount of data as well as the type of data. For information the unit's acquisition time is also shown, since it determines the possible amount selections. To start the transfer please press „Get“, and to cancel the selections press „Cancel“ . If a transfer is started a progress window will appear as shown in the following

figure. This progress window is present as long as the transfer is in progress.



The transfer may be aborted at any time by pressing the „Abort“-button. When the transfer is completed the programme shows the transferred data and the user is now able to process them.

For later display / proces of the transferred measurements, the software allows the user to store the data on disk. This is done via the menu under „File->Save“ as shown in the following figure.

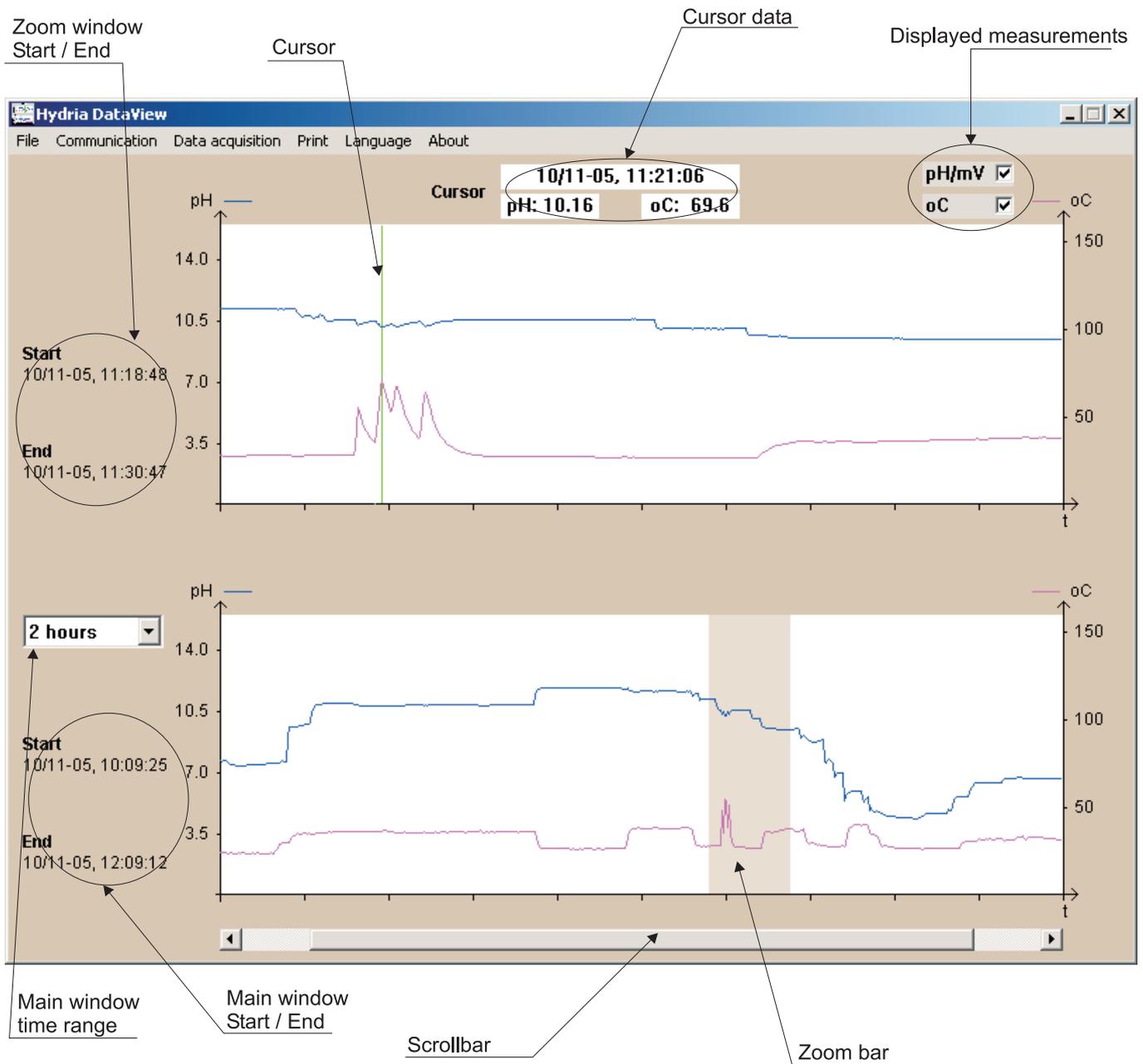


Opening of previously transferred data is done via the menu under „File->Open“ (See above). This allows the user to search the discs for the file containing the desired data. When the file is found, the data is opened and the software displays the loaded measurements.

### 6.5 Layout

The input data is presented as shown in the following figure. The presentation is built around a main window and a zoom window. The main window shows up to all measurements (determined by the **main window time range**), whereas the zoom window always shows 1/10 of the main window. If the number of measurements exceeds the main window time range, a **scrollbar** appears making the display of all measurements possible. For information to the user the **start- and end time** for the measurements in both the main window and the zoom window are displayed. These times represent the time of the first measurement in the window (start) and the last measurement in the window (end). Which part of the data amount to be displayed in the zoom window is determined by the user with the **zoom bar**, which may be moved by „dragging“ it with the mouse.

If both pH/mV- and temperature measurements are present, the user may select which measurements to display using the checkboxes for **displayed measurements**.



The zoom window contains a **cursor**, which may be moved inside the whole zoom window using the mouse or the arrow keys. **Cursor data**, i.e. the time for the measurement(s) as well as the value(s) (pH/mV and temperature), are shown above the zoom window. These values change with the movement of the cursor.

Using the main window time range as well as the zoom bar and the cursor it is possible to display every single measurement.

## 6.6 Output

The programme has built-in functions for external documentation - both electrical and on paper. Electrical in the form of export to spread sheet as well as screen dump in Windows BITMAP format.

Export to spread sheet is found under „File->Export->...“ and allows the user to export the measurements shown in

the zoom window or in the main window or export of all measurements. If export of zoom window data or main window data is selected, only the displayed measurements in the zoom- or main window respectively are exported. The decimal separator may be chosen as comma (,) or decimal point (.).

Screen dump may be used directly in a document, since the BMP-format may be imported into most word processing softwares.

Print out on paper is selected via the menu under „Print->Printer“ and gives a complete print out of both windows as well as all time- and cursor data.

## 6.7 Language

The programme supports at present three languages: English, German and Dansk. Selecting a language causes all menus, dialog boxes and texts to change.

# 7 Parameters

## 7.1 Setting up Parameters

In the table below a list of all parameters is shown along with their function and setting range. The term „Default“ means factory setting.

If a parameter requires changing PIC432B must be unlocked first. Then 'Parameters' are selected with the 'Mode'-key and the parameter number is found with the

arrow keys. When the desired number is shown on the display the 'Mode' key is pressed again to display the value of the parameter. Now the parameter may be changed using the arrow keys. **To programme the change press the 'Set' key. To discard the change press the 'Mode'-key.**

Par.#	Parameter	Description	Programming	Default
1	Unit (A)	Limit A on °C, pH or mV	0=pH, 1=mV, 2=Temp.	0
2	Unit (B)	Limit B on °C, pH or mV	-A- = (As A), °C = Temp	-A-
3	Mode (A)	Control mode for Lim A	0=On/Off, 1=PI, 2=Time prop., 3=APC	1
4	Mode (B)	Control mode for Lim B	0=On/Off, 1=PI, 2=Time prop., 3=APC	0
5	Max/Min (A)	Lim A as Max. or Min.	0=Min, 1=Max	1
6	Max/Min (B)	Lim B as Max. or Min.	0=Min, 1=Max	0
7	Xp (A)	Proportional band for Lim A	Max 2,5pH, Max 250mV, Max 25 °C	0,50
8	Xp (B)	Proportional band for Lim B	Max 2,5pH, Max 250mV, Max 25 °C	0,50
9	Hyst. (A)	Hysteresis band for Lim A	Max 2,5pH, Max 250mV, Max 25 °C	1,00
10	Hyst. (B)	Hysteresis band for Lim B	Max 2,5pH, Max 250mV, Max 25 °C	1,00
11	Freq. (A)	Basic frequency for Lim A	1-180 imp/min	60
12	Freq. (B)	Basic frequency for Lim B	1-180 imp/min	60
13	Comp.	Temperature compensation	"Auto" or "Set"	Set
14	TComp	Fixed temperature setting	0 - 150 °C	25,0
15	IV output 1	Analogue output 1 mode	"0-20", "4-20" or "0-5"	4-20
16	IV output 2	Analogue output 2 mode	"0-20", "4-20" or "0-5"	4-20
17	IV output 3	Analogue output 3 mode	"0-20", "4-20" or "0-5"	4-20
18	mV lout	Numerical or absolute	1000=numerical, 2000=absolute	1000
19	Pol. (A)	Relay polarity for relay A	"inv" or "ninv"	Ninv
20	Pol. (B)	Relay polarity for relay B	"inv" or "ninv"	Ninv
21	Dual Slope	Enable Dual Slope	OFF=Single slope, On=Dual slope	OFF
22	Buffer 1	Upper reference value	8.00 - 13,00 pH	10,00
23	Buffer 2	Lower reference value	1,00 - 6,00 pH	4,00
24	DAQ-t	Sampling time	1, 10, 60, 600 (seconds)	60
25	Limit (C)	Activation of Lim C, max/min	Off, 1 = Min, 2 = Max	Off
26	Limit (D)	Activation of Lim D, max/min	Off, 1 = Min, 2 = Max	Off
27	Setpoint (C)	Setpoint for Lim C	0..14pH, 0..±999mV, 0..150 °C	9.80
28	Setpoint (D)	Setpoint for Lim D	0..14pH, 0..±999mV, 0..150 °C	7.50
29	Hyst. (C)	Hysteresis band for Lim C	Max 2,5pH, Max 250mV, Max 25 °C	0.50
30	Hyst. (D)	Hysteresis band for Lim D	Max 2,5pH, Max 250mV, Max 25 °C	0.50
31	Clock (Time)	Hour in 24h format (tt,mm)	0..23, 0..59	
32	Clock (Date)	Date (mm.dd)	1..12, 1..31	
33	Clock (Year)	Year	2009..2099	
34	Default	Factory settings	"dEF" = keep, "rSt" = reset	"dEF"
35	Erase Flash	Erase data flash	"dAtA" or "dEL"	dAtA

## 8 Terminal connections

Ter. #	Description	Ter. #	Description
1	+T. Ext. Transmitter	11	-T. Ext. Transmitter
2	Output 3 +	12	Output 1 +
3	Output 3 -	13	Output 1 -
4	Output 2 +	14	Pt100
5	Output 2 -	15	Pt100
6	RS232 RX	16	Output B (C)
7	GND	17	Output B (NC)
8	RS232 TX	18	Output A (NO)
9	Power 80-250V	19	Output A (C)
10	Power 80-250V	20	Output A (NC)

The table above shows an overview of the connections to the two terminal rows found on the terminal pcb in the unit.

Please note the following:

Terminals 1 and 11 are used only when using an external pH/mV transmitter.

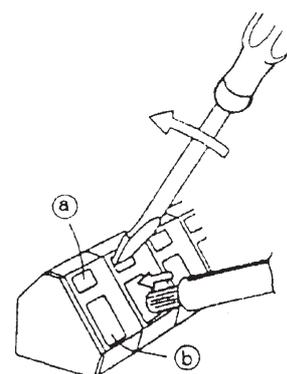
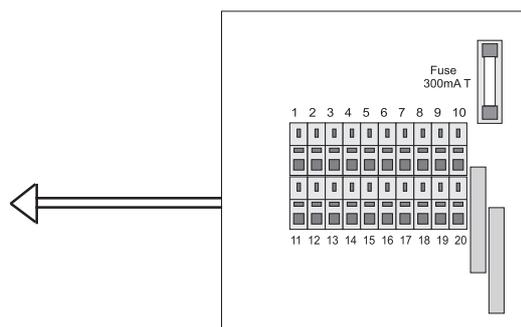
Outputs 1-3 are analogue outputs; Please note the polarity. Terminals 14 and 15 are for connection of a temperature sensor if such is required. The polarity is of no importance.

Terminals 6-7-8 are used only when using a permanent RS232 connection.

Terminals 18-19-20 are Relay A connections.

Terminals 16-17 are Relay B connections.

Terminals 9-10 are voltage supply connections.



The drawing above shows the principle of the screw less terminal construction. The mounting of connecting wires happens in the following way: Insert a flat-bed screwdriver into the upper hole marked A and insert the depeeled wire into the hole marked B. Press the screwdriver in the direction of the arrow and press the wire into place. Now remove the screwdriver.

Recomendable wire sheath peeling length is 5mm.

## 9 Technical data

Mechanical		Electrical	
Housing:	Wall cabinet	Supply:	80-250VAC/DC
Material:	ABS UL94V-0	Consumption:	3VA
IP Class:	IP65	Relay outputs.:	Max 5A,250VAC AC1
pH/mV input:	BNC connector	pH range:	0.00 to 14.00
Com. connection:	3,5 mm Jack bush	mV range:	± 1000mV
Cable inputs:	4 x PG7 holes	pH/mV input:	Max. 0,1 pA, 10TΩ
Terminals:	Max 10A, max 1,5 mm	Accuracy:	± 0.2% for pH and mV
Temp.:	-15 to 55 °C	Temp. range:	0 to 150 °C
Dimensions:	120x90x50 mm	Accuracy:	± 0.3 °C
Weight:	app. 350g	Analogue outputs:	(0)4-20mA, max 300Ω
CE mark.:	EN61326-1, EN61010-1		0-5V min 25kΩ
		Serial port:	RS232C, 57.6 kbaud